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Chart 15, c. For Ci. read Cu.

Chart 18. On the outer circle of A. S., change the azimuth of the upper vector from (—0.7, —2.3) to (—0.7, +2.3). On the outer circle of A. Cu., change the azimuth of the upper and the left-hand vectors from (—2.4, +6.3) to (+2.4, +6.3).

Chart 27. In the wind vectors over Texas, interpolate three southerly to southwesterly vectors, which could not be computed.

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REPORT ON THE INTERNATIONAL CLOUD OBSERVATIONS.

MAY 1, 1896, TO JULY 1, 1897.

PREPARED UNDER DIRECTION OF WILLIS L. MOORE, CHIEF OF WEATHER BUREAU,

BY

FRANK H. BIGELOW, M. A., L. H. D.,
PROFESSOR OF METEOROLOGY.

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PREFACE.

The results of the cloud observations, which were made in cooperation with the scheme prepared by the International Cloud Commission, in the interval of time between May 1, 1896, and July 1, 1897, are herewith presented in this report. In order to submit these results to a careful discussion, it has been necessary to prosecute a critical comparative study of several important theories heretofore proposed by meteorologists, so that the comparison between observations and theoretical computations can be suitably carried out. Accordingly, a standard mathematical system has been constructed, including in a definite notation the constants, the thermodynamic and the hydrodynamic formulæ pertaining to the atmospheric physical processes and motions, by means of which the work of the several authorities can be reduced to one set of typical equations. The theories of the American and the German schools of meteorology have been contrasted, and the results derived from them have been compared with the facts obtained from these cloud observations. The grouping of the data secured by the theodolites and the nephoscopes has been so carried out as to make such a comparison simple and direct, the outcome being interpreted to mean that a modified theory of atmospheric motions is required to explain the local anticyclonic and cyclonic circulations, while the theory of the general cyclone, though partially sustained, also needs improvement in several important details. Furthermore, the thermodynamic processes have been submitted to a rigorous computation, especially in connection with cumulus clouds, by means of which the limits of the four standard stages, and the mean gradients of pressure, temperature, and vapor tension within each stage, have been carefully determined. The construction of this system of computation has put us in possession of a method of discussing several important fundamental characteristic features of the atmosphere, and it is evident that a continuation of research along these lines will not only tend to make of meteorology an exact science, but will also enable us to practically construct quite accurate daily weather maps at moderate elevations, that is, up to 1 and 2 miles above the surface. Such an outcome would amply repay the expenditure of much time and labor in the preliminary steps required to reach this goal; yet it is thought that the results contained in this report are such as to warrant the entering upon their actual application at once, with the expectation that further experience will merely improve upon the close approximations already secured.

The grounds for the recommendations which follow will be found in the body of the report, where they are explained more naturally in connection with the subject-matter itself, but it is at present believed that in view of the necessary expenses attending meteorological observations and research, those here mentioned offer the best prospect for a speedy and useful return to the Weather Bureau Service, in the practical work of forecasting the storm conditions over the United States.

I. The first recommendation is, the maintenance of one permanent primary station for theodolite observations at Washington, D. C., where such measures of cloud heights and velocities of motion can be made as experience calls for, to determine the special features of certain meteorological problems which are as yet only partially resolved. The indications are that a similar station on the northern Rocky Mountain Plateau, near where the northwestern storms first manifest themselves, and another in the west Gulf States, near where the southwestern storms are formed, would be of the greatest value to facilitate the progress of meteorological science. These three permanent observatories should be established and maintained as a part of the regular equipment of the Weather Bureau. As it would always require the services of two

men to operate each station having a base line, and since the computations can be performed suitably only by men of considerable skill in physics and mathematics, we should need at least two men of good capacity at each station to observe and compute the data through the preliminary stages, which could then finally be discussed at the Central Office.

II. It is very clear that a nephoscope should be added to the equipment of each of the first-order stations of the Weather Bureau, by means of which the relative velocity of the movement of the upper currents of the air may be recorded daily for the use of the forecast division. At present only the direction of motion for the levels of air above the surface is utilized, but it is certain that the velocity of motion should be known, since upon the velocity quite as much as upon the direction alone the forecaster ought to depend to make accurate deductions of the probable storm action. The forecast maps have heretofore dealt with the problem by means of isobars and isotherms, which record only the static conditions of the atmosphere, and yet it is the dynamic elements of force and velocity in the levels above the ground which really make up the true basis of knowledge for practical forecasts. Evidently maps having similar static conditions must receive very different interpretations, according to the dynamic elements which happen to accompany them. The forecaster has too long sought to interpret the maps with one type of data only before him, but it needs no further explanation to show that both types are equally valuable and that they should be used in conjunction. Since the time of a complete set of nephoscope observations is about half an hour for one observer, and the expense of a telegraphic report would not exceed that of one more syllable on the telegram now required, in order to add the relative velocity, it is thought that a minimum of expense is involved in this recommendation, which will afford the dynamic facts in a practical form, so far as it is possible to secure them. At present the office receives the kind of cloud and direction of motion; it is proposed to include also the relative velocity. This would be recorded on the cloud map by the length of the arrows, drawn to a simple scale. The computations required are exceedingly brief, and can be readily made by the observers now engaged at the Weather Bureau stations.

III. At the central office we can with the data above recommended construct at least two or three valuable auxiliary maps, which will no doubt be worth a practical trial. The first of these is a map of vapor tensions, expressed in terms of the ratio $\frac{e}{B}$, vapor tension divided by barometric pressure, so extensively used in this report as one of the fundamental meteorological quantities. Many attempts have been made by the office to utilize the element of humidity in various forms for practical forecasts, but without much success, so that the very condition upon which precipitation depends is in fact neglected in everyday work. Of course, it will not be possible to know, till a trial has been made, just how much value this ratio has in forecasting, but it is certainly more closely at the heart of the meteorological pulse, not only for the surface, but also for lower atmosphere generally, than any other aspect of the element of the aqueous vapor. It is just in this feature of precipitation that our forecasts need strengthening, and it is quite confidently expected that this new term in practical meteorology will overcome some of the difficulties which have been heretofore insuperable, or at least that its trial will lead to other and better methods than we now possess.

IV. Preliminary computations on the reduction of the barometric pressures to sea level for the stations of the Rocky Mountain Plateau have shown that the methods employed by the Weather Bureau for many years are very faulty. An improvement can be readily introduced, by means of which maps may be constructed at higher elevations than the sea level, whereby the actual configurations existing in the atmosphere at various heights will be exhibited with very little distortion. The heights at which such auxiliary maps should be made are as follows: (1) At the level of 3,500 feet = 1,067 meters, which is that of a mean plane cutting through the Rocky Mountain Plateau elevations, to which all those stations would be reduced with the least possible reduction for the entire system, and thus with the introduction of the minimum error through the reduction itself. Furthermore, this plane is nearly that of the base of the cumulus cloud type over the districts east of the Rocky Mountain Slope, upon which stratum our observations by means of theodolites and kite ascensions afford the most reliable determinations of the elements of reduction. These two circumstances, mean height for the mountain stations and average height for the cumulus bases, point to the 3,500-foot plane as the most important for practical

operations in this line of study. (2) The next plane for consideration is that of the strato-cumulus cloud level, which is about 10,000 feet = 3,048 meters above the surface in Washington, D. C., because it is demonstrated in this report that at this mean height the maximum gyratory cyclonic components exist, which are those most concerned in storm generation and activity. It is the level at which the great horizontal currents move with the least disturbance from the surface obstructions or from the permanent eastward drift of the higher levels. Storms undoubtedly should be interpreted at that level as far as possible. Furthermore, this height is always accessible by kite or by cloud observations on the plateau region, and it can be occasionally reached by kite ascensions, and always by theodolite observations at the Eastern stations. A more complete knowledge of the effect of dynamic motions in modifying the gradient systems which have been deduced in this report will make it practicable to construct such a daily map for forecast work. The possession of these maps, (1) at the sea level, (2) at the 3,500-foot elevation, and (3) at the 10,000-foot altitude, will so far increase our grasp upon the behavior of the lower atmosphere as to promise improvement in the success of the weather forecasts.

V. This report contains much evidence to the effect that the occasional kite ascensions to the base of the cumulus clouds possess great importance in procuring the values of the elements prevailing in the actual atmosphere, as distinguished from the theoretical adiabatic atmosphere. It depends upon the successful study of the relations between the actual and the adiabatic atmosphere to afford the means of perfecting the indispensable vertical gradients, upon which all map construction at higher levels must ultimately rely, making them so accurately known as to render it possible to thus improve our practical meteorology. Furthermore, as a result of the experience obtained in executing these observations and computations, many improved methods have suggested themselves by which the theodolite observations could be made more efficient. It is therefore very evident that the three proposed primary stations should be equipped for simultaneous observations with theodolites and with kites, and possibly with balloons, the operations being so planned and organized that these two classes of observations would supplement each other to the best advantage. It is accordingly recommended that the three cloud stations be made also first-class kite stations, and that men of experience and skill in science be placed in charge of them. It would be useless for unskilled men to attempt to execute the work herein described.

VI. There are many instructive scientific problems which are suggested and opened up by the discussions in this report. It is not possible to prescribe in advance the proper modes of dealing with them, yet the subject of meteorology will take on more definite aspects in proportion as they are successively treated and brought to a conclusion. These should, therefore, be pursued as rapidly as the resources of the office permit. It is not supposed that it will be possible to put in operation at once all of these recommendations, but they so far mutually help one another, that ultimately they all will probably be found to be necessary in a general plan of operations. The details of administration and appropriation which precede such plans as are here proposed must necessarily be first officially concluded, so that much must be left to a fortunate cooperation of the various branches of the Government to put them into practice.

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CHAPTER 1.

THE INTERNATIONAL CLOUD OBSERVATIONS.

HISTORY OF THE INTERNATIONAL CLOUD PROGRAMME.

At the International Conference, Munich, 1891, a committee was appointed (Report, p. 20) to consider the question of concerted observations on the Direction and Velocity of Motion and the Height of Clouds. The report of this committee will be found in the Appendices to the Munich Report (p. 66), and the Conference finally resolved (p. 49) that such observations of clouds should be commenced at certain stations distributed over the globe, and continuing for the space of one year. Prof. H. H. HILDEBRANDSSON, of Upsala, was requested to prepare short instructions for these observations, and the carrying out of the proposals was intrusted to the International Meteorological Committee. Furthermore, the Conference, by a majority, adopted the scheme of cloud classification put forward by Messrs. HILDEBRANDSSON and ABERCROMBY, and appointed a committee to prepare and publish a Cloud Atlas illustrative thereof. In accordance with these resolutions,* papers were prepared for the methods of observation and † a cloud atlas for type forms.

In the month of August, 1894, a meeting of the International Meteorological Committee was held at Upsala, and at the same time the committee on clouds, appointed at Munich, held a sitting at the same place. The most important resolutions adopted were as follows:

A. All countries are invited to take part in a common investigation of the upper currents of the atmosphere by means of observations of the direction, and by measurements of the altitudes and motions of the different forms of clouds.

B. These observations should commence May 1, 1896, and be continued one year.

C. In each country there should be a certain number of stations for the observation of the direction and apparent velocity of clouds without instruments, or with simple nephoscopes.

D. For the use of observers who adopt the international classification recommended at Munich, a Standard Cloud Atlas is in preparation and will soon be ready.

E. More detailed instructions for the observations.

F. It is hoped that in addition to the stations mentioned under "C," observations on the heights and motions of clouds will be made at some observatories of the first order. No fixed rules are laid down for these observations and each director is free to select the method which he prefers.

G. It would be desirable that the cloud observations from each country should be published *in extenso*, as a separate publication.

The following definitions of type cloud forms were adopted by the Weather Bureau, in conformity with the International System, and beginning with July 1, 1896, all observers were ordered to use them in their regular observations. As there was an unexpected delay in finishing

*Des principales méthodes employées pour observer et mesurer les nuages. Upsala 1893. Hildebrandsson and Hagström.

De l'emploi des photogrammètres pour mesurer la hauteur des nuages. Upsala 1894. Åkerblom.

†Atlas international des nuages, Paris 1896. Hildebrandsson, Riggenbach, Teisserenc de Bort.

the Standard Cloud Atlas, and since it was necessary to instruct our observers at once, a preliminary sheet of type cloud forms was prepared and issued to the service, the types being generally taken from Dr. SINGER'S Wolkentafeln, which anticipated the final system with sufficient exactness for the purpose.

DESCRIPTION OF CLOUDS.

1. *Cirrus* (Ci.). *Isolated feathery clouds of fine fibrous texture, generally of a white color,* frequently arranged in bands which spread like the meridians on a celestial globe over a part of the sky and converge in perspective toward one or two opposite points of the horizon. (In the formation of such bands Ci. S. and Ci. Cu. often take part.)

2. *Cirro-stratus* (Ci. S.). *Fine whitish veil,* sometimes quite diffuse, giving a whitish appearance to the sky, and called by many "cirrus haze," and sometimes of more or less distinct structure, exhibiting tangled fibers. The veil often produces halos around the sun and moon.

3. *Cirro-cumulus* (Ci. Cu.). Fleecy cloud. *Small white balls and wisps, without shadows, or with very faint shadows, which are arranged in groups and often in rows.*

4. *Alto-cumulus* (A. Cu.). Dense fleecy cloud. *Larger whitish or grayish balls with shaded portions, grouped in flocks or rows, frequently so close together that their edges meet.* The different balls are generally larger and more compact (passing into S. Cu.) toward the center of the group, and more delicate and wispy (passing into Ci. Cu.) on its edges. They are very frequently arranged in lines in one or two directions.

5. *Alto-stratus* (A. S.). *Thick veil of a gray or bluish color,* exhibiting in the vicinity of the sun and moon a brighter portion, and which, without causing halos, may produce coronæ. This form shows gradual transitions to cirro-stratus, but, according to the measurements made at Upsala, was only half the altitude.

6. *Strato-cumulus* (S. Cu.). *Large balls or rolls of dark cloud which frequently cover the whole sky, especially in winter,* and give it at times an undulated appearance. The stratum of strato-cumulus is usually not very thick, and blue sky often appears in the breaks through it. Between this form and the alto-cumulus all possible gradations are found. It is distinguished from nimbus by the ball-like or rolled form and because it does not tend to bring rain.

7. *Nimbus* (N.) Rain clouds. *Dense masses of dark formless clouds with ragged edges,* from which generally continuous rain or snow is falling. Through the breaks in these clouds there is almost always seen a high sheet of cirro-stratus or alto-stratus. If the mass of nimbus is torn up into small patches, or if low fragments of cloud are floating much below a great nimbus, they may be called fracto-nimbus ("scud" of the sailors).

8. *Cumulus* (Cu.). Woolpack clouds. *Thick clouds whose summits are domes with protuberances, but whose bases are flat.* These clouds appear to form in a diurnal ascensional movement, which is almost always apparent. When the cloud is opposite the sun the surfaces which are usually seen by the observer are more brilliant than the edges of the protuberances. When the illumination comes from the side this cloud shows a strong actual shadow; on the sunny side of the sky, however, it appears dark, with bright edges. The true cumulus shows a sharp border above and below. It is often torn by strong winds, and the detached parts (fracto-cumulus) present continual changes.

9. *Cumulo-nimbus* (Cu. N.). Thunder cloud; shower cloud. *Heavy masses of clouds, rising like mountains, towers, or anvils, generally surrounded at the top by a veil or screen of fibrous texture ("false cirrus") and below by nimbus-like masses of cloud.* From their base *generally* fall local showers of rain or snow, and sometimes hail or sleet. The upper edges are either of compact cumulus-like outline, and form massive summits, surrounded by delicate false cirrus, or the edges themselves are drawn out into cirrus-like filaments. This last form is most common in "spring showers." The front of thunderstorm clouds of wide extent sometimes shows a great arch stretching across a portion of the sky which is uniformly lighter in color.

10. *Stratus* (S.). *Lifted fog in a horizontal stratum.* When this stratum is torn by the wind or by mountain summits into irregular fragments, they may be called fracto-stratus.

Circular No. 1, sent out in October, 1896, stated that as there had been some delay in

commencing work at certain stations, it was desirable to continue the observations until January 1, 1898.

Circular No. 2, issued in December, 1897, urged the importance of publishing the cloud results *in extenso*, and in a uniform set of tabulations, of which specimens were given.

THE CLOUD SURVEY ORGANIZED BY THE UNITED STATES WEATHER BUREAU.

In order to take a share in these observations on the part of the United States, the following organization was made by direction of Prof. WILLIS L. MOORE, Chief of the Weather Bureau, under the authority of the honorable Secretary of Agriculture. The conduct of the observations and the computations was intrusted to Prof. FRANK H. BIGELOW and Mr. A. J. HENRY, and the following persons have rendered faithful and efficient service at Washington, D. C., as observers and computers during the period of the observations and the preparation of the report: Mr. R. H. DEAN, Mr. H. L. HEISKELL, Mr. H. H. KIMBALL, and Mr. C. S. GORGAS, the latter, however, having done no work with the instruments. At the Weather Bureau stations outside of Washington, D. C., the nephoscope observations were made as a voluntary addition to the regular duties of the service, and the persons thus cooperating merit the thanks of the Central Office for their contributions to the data that has thus been collected. Furthermore, the Blue Hill Observatory courteously sent their nephoscope observations to be incorporated with our own, and volunteer observers, Rev. F. L. ODENBACH, S. J., at Cleveland, Ohio, and Mr. FRANK W. PROCTOR, at Waynesville, N. C., who transferred his station during the year to Ocean City, Md., furnished good sets of daily observations, homogeneous with the other series.

The following observers conducted the nephoscope observations at the several stations:

1. Baker City, Oreg.....Mr. W. C. MCGINNESS.
2. St. Paul, Minn.....Mr. P. F. LYONS.
3. Kansas City, Mo.....Mr. P. CONNOR.
4. Abilene, Tex.....Mr. ALLEN BUELL.
5. Vicksburg, Miss.....Mr. R. J. HYATT.
6. Louisville, Ky.....Mr. FRANK BURKE.
7. Detroit, Mich.....Mr. NORMAN B. CONGER.
8. Buffalo, N. Y.....Mr. D. CUTHBERTSON.
9. Savannah, Ga.....Mr. WM. M. DUDLEY.
10. Key West, Fla.....Mr. HENRY B. BOYER.
11. Waynesville, N. C.....
12. Ocean City, Md.....} Mr. FRANK W. PROCTOR.
13. Cleveland, Ohio.....Rev. F. L. ODENBACH, S. J.
14. Blue Hill Observatory.....Mr. ARTHUR SWEATLAND.
15. Washington, D. C.....Mr. A. J. HENRY and Mr. R. H. DEAN.

The nephoscope station at Savannah, Ga., operated for the first half year, and at Baker City, Oreg., for the second half year. This makes fifteen stations engaged in the observations, giving thirteen series, covering the period of time from June 1, 1896, when the records were considered valuable after some preliminary practice, to July 1, 1897. The Washington station continued the measurements for heights, in addition to the nephoscope observations, for fourteen months, from May 1, 1896, to July 1, 1897. Having thus complied with the original programme of the international committee as at first promulgated, and being warned by the large mass of material awaiting discussion not to undertake so much work as to imperil its completion, the Weather Bureau decided not to extend the time of ending the observations to January 1, 1898, as requested in the second circular. It may also be remarked that the difficulty of publication *in extenso* increases rapidly with the number of observing stations. On the other hand, the requirements of the meteorological problems are so complex that a very large mass of individual observations must be used in the discussion. But practically, an extensive publication of the preliminary observations is not likely to precede the final satisfactory solution of the problem of the

Atmospheric Circulation. Rather the mean values for certain areas, specifying the number of observations upon which they depend, should be sufficient, and this policy would remove one of the serious difficulties encountered in prosecuting such a research.

ESTABLISHMENT OF THE BASE LINE.

The Weather Bureau is indebted to the engineer office of the District of Columbia for the survey of two points near the base line. Mr. GEORGE H. BAILEY, computing engineer of the District of Columbia, furnished the following data, with accompanying plans:

A. Center of bench mark on steps of main building of the Weather Bureau.

B. Center of east tower of State, War, and Navy Building.

The instrument was placed near the center of the corresponding west tower.

	Feet.
A is west of B	3,899.37
Instrument (2) is west of B	186.67
Instrument (1) is east of A	49.50
East-west distances between instruments	3,663.20
A is north of B	2,628.64
Instrument (2) is north of B	2.08
Instrument (1) is south of A	67.82
North-south distances between instruments	2,558.72

These distances between A B are given by the District survey, but the necessary offsets to the instruments were added, the latter having been measured by our observers. The east-west line makes the angle 89° 52′ with the true north-south line; hence the computed horizontal distance between the instruments is 4,463.5 feet. The length of the base line is $b = 1{,}360.47$ meters. It makes the angle 55° 9′ with the meridian, counted from south through the east, when looking from the first (1) station to the second (2) station, the former being on the Weather Bureau building and the latter on the State, War, and Navy building.

The elevation of the Weather Bureau bench mark is 78.98 feet above mean tide water; the axis of the instrument is 33.25 feet above the bench mark. Weather Bureau instrument is 117.23 feet, equal to 35.73 meters, above the sea level.

The elevation of the State, War, and Navy building bench mark is 50.08 feet above mean tide water; the axis of the instrument is 125 feet above the bench mark. State, War, and Navy instrument is 175.08 feet above sea level. Difference of elevation of the instruments is 57.85 feet. The elevation of the southeast end of the base line $= c = 17.5$ meters. The angular elevation is 0° 44′ 13″. In procuring measurements within the State, War, and Navy building the Weather Bureau is greatly indebted to the courteous assistance of the superintendent, Chief Engineer GEORGE W. BAIRD, U. S. N., who also furnished the observers every facility in locating the instrument and in the conduct of the observations throughout the year.

Since the computations were referred to the horizontal plane passing through the axis of the Weather Bureau instrument, the heights resulting therefrom must be increased by 35.73 meters to reduce them to sea level.

THE INSTRUMENTS EMPLOYED AND THEIR INSTALLATION.

Two methods of observation for the measurements of cloud heights, and the direction and velocity of motion, have been recommended by the International Commission, (1) the direct measures by theodolites, and (2) the indirect determination of the coordinates by the discussion of cloud photographs. No doubt each system has its advantages, but after consideration it was decided by the Weather Bureau to adopt the direct system, for the following reasons: The additional labor of executing the photography, and the measurement of the plates, as preliminary to the trigonometric computations, could be avoided to a considerable extent by making direct readings of the

CHART I.—WEATHER BUREAU STATION APPARATUS AT WASHINGTON, D. C.
OBSERVER AT WORK.

angles. The difficulty of obtaining photographs of all kinds of clouds and in all weather tends to make photography more advantageously applicable to certain cloud forms, and the outcome of the whole work would be to unduly emphasize some types, the others being necessarily comparatively neglected. If it is sought to minimize this imperfection by supplementing the photographs with direct measures, then we are dealing with the two systems of observations, and the results are not homogenous for discussion. The experience of the Blue Hill Observatory in 1890 and 1891 showed that direct theodolite work is capable of producing very satisfactory mean results when a large series of observations is made. The rough nature of cloud work at the best, in consequence of the rapid dissolution of cloud-points through their motion and evaporation, renders it really quite unimportant what method is used, provided many observations of the same type of cloud are made on a uniform plan. As explained also in the following section, it was decided not to attempt to give specific weights to the individual pointings on the same cloud, but to consider the settings of equal weight in case they are not specifically rejected for reasons. Many observations, each having the weight unity, describe the general method adopted for our own work.

The instruments were set up in the following manner: A cement foundation was constructed to rest on the flat roof of the building, having these specifications: A wooden frame about 40 inches square was laid down to outline the cement; a box having its bottom partly covered with bars, but furnished with a full top, 36 inches square, was sunk into 3 or 4 inches of cement which closed firmly above the open-bottom boards and gave sufficient weight to the base; the tripod of the theodolite was placed upon the top of the box, and a platform was built around it, so supported as to be entirely isolated from the foundation, since it rested itself at the edges of the walls, and was completely free from the tripod. Then a truncated pyramid of wood was constructed around the tripod, having the same general shape, and carrying a round table for the use of the observer, who could even lean upon it without disturbing the instrument in any way. This was convenient also for disposing of the timepiece, the recording books, and the telephone tube. Within the wooden case was placed the telephone and battery, which was thus suitably protected from the weather; a moveable galvanized iron hood was fitted over the instrument, and it could be fastened securely to the table, and thus effectively shield it from the weather when not in use. From the telephone a flexible tube passed through the table to the mouth of the observer, and a long thin tape carrying the wires of the receiver, which fitted over the head by means of a spring, completed the signaling arrangements. The standard clock of the Weather Bureau has a break-circuit apparatus for two-second intervals, and it also omits the fifty-eighth second. A common telegraph sounder was screwed upon the outside of the telephone case, and the clock beats were then distinctly heard throughout the circuit. The chronometers on the table facilitated the identification of the clock beats, and the fact that the observers heard the same seconds told off, made it possible to make the setting upon the cloud at an appointed second, usually the first of the minute, with remarkable precision.

Chart 1 shows the general arrangement of the apparatus at the Weather Bureau Station, with the observer at work. The tall post in the picture was one of a set carrying awnings for protection against the sun. These contrivances all worked well throughout the year and proved convenient and durable.

THE ALT-AZIMUTH THEODOLITES AND THE INSTRUMENTAL CORRECTIONS.

The Weather Bureau purchased two KEUFFEL & ESSER COMPANY surveyors' theodolites, having an azimuth circle of 16 cm. in diameter and an altitude circle of 12 cm. in diameter. The telescope with its axis was removed, and in their place was substituted a horizontal axis carrying the same altitude circle at one end and a pointing tube suitable for cloud observations at the other. This work of preparing the apparatus was done by the instrument division, in charge of Prof. C. F. MARVIN, who furnished the theodolites, the auxiliary attachments, and the nephoscopes required in our observations, and superintended the preparation of all the apparatus. The telegraph and telephone service were furnished by the District Telephone Company, under instructions from Mr. J. H. ROBINSON, chief of the telegraph division. Both of these officers contributed materially to the success of the cloud observations.

Besides the substitution of the cloud pointer for the ordinary telescope, the instruments were not otherwise modified in any way, and their form is so well known that they need little description in this place. The pointer was 460 mm. in length and had a clear aperture of 90 mm., giving an angular field of about 11° in the sky. A special feature of the object end was a reticle of lines etched on thin, clear glass, an arrangement which was of considerable advantage to the observers in making their settings. It had one central horizontal line and three long vertical lines 16 mm. apart, one of them being central; also four circles were drawn with centers on the intersection of the two middle lines. The diameter of the smallest circle subtended 1°—that is, 8 mm. for a radius of 460 mm.—the next 2°, the next 6°, and the outer 10°; two short vertical lines were drawn at the 8° points. Thus the horizontal line was divided into 1° intervals, and the central vertical line was similarly divided. The straight lines were useful in adjusting to the vertical plane by means of a plumb or other zenith-nadir line; the circles facilitated more precise setting upon the middle point of a small cloud by placing it symmetrically within the circles. The thin glass plate tended to obscure the stratus-cloud forms to some extent, but it was found that any cloud of sufficiently firm outline to be well observed at all could be seen through this glass reticle. It is to be noted that having once clamped the object glass in its normal position, no difficulty could be encountered in the midst of the series of observations by an accidental tearing of the reference lines, or by a variable collimation during the work. The eye end had a small hole, about 1 mm. in diameter, pierced in a slide piece, which was movable parallel to the horizontal line on the reticle. It was held in place by a set screw which fixed firmly the line of sight for collimation, after it had been carefully adjusted.

Collimation.—This correction was kept to a very small angular value by frequent tests. The horizontal circles of the theodolites, after examination, appeared to be of so good a quality that reversal through 180° of the circle was to be relied upon to fix a straight line far within the limit of error in cloud observations, provided there was no collimation. Two tests for collimation were frequently made. (1) Set on a distant point, turn the horizontal circle through 180°, reverse the pointer, and adjust for half the angular interval to the same point. Repeat this process till the correct collimation line is found. (2) Establish by observation a permanent straight line passing through the center of the instrument, having marks about 1 mile distant at either end. Set on one mark, reverse pointer, and adjust to half the interval to the other mark. Repeat till no correction is required. These processes fix a line perpendicular to the axis of rotation for the sight line.

Adjustment of the index of the vertical circle—It has been shown that the station on the State, War, and Navy building was 17.5 meters higher than the Weather Bureau Station, on a base line of 1,360.5 meters, and that instrument is therefore at an angular elevation of 44′.2 of arc. Hence, by pointing the horizontal thread on the instrument at the opposite station, and setting the index of the vertical circle to read 44′, above or below, as the case may be, we obtain the zero point for the altitude angles.

Adjustment of the index of the horizontal circle.—Since the observations in azimuth are primarily referred to the base line for zero, it was necessary merely to bring the upper and lower plates of the movable circles together, then point upon the opposite station, and clamp the lower plate for its zero point. Afterwards, by the addition of the azimuth angle, 55° 9′, the angles can be referred to the north and south line, which has been done in the computations.

VERIFICATION OF THE ADJUSTMENT BY OBSERVATIONS ON THE MOON.

It is of course assumed that the plates were carefully leveled by bubbles in the usual manner before adjustment for collimation or index readings. The practice has been to verify the position of the sight line daily; but also for a general test of the angles, settings were occasionally made upon the vertex of the moon. Since the instruments should read the same angles in this case, Table 1 shows the average divergence of our sight lines from being parallel to each other. The azimuth circles give a mean parallax angle of 1′.9 on a very distant object, and the vertical circle one of 3′.8. It was assumed that the movement of the eye at the eyepiece gave a parallax of an accidental character of about 6′.0, and as these values from moon observations fall on the average

within this limit they are neglected in the computations. One of the theodolites seems to have been reading a little too high in altitude for the other, but as the mean heights depend chiefly on the angle $(a_2 - a_1)$ in a large mass of observations no important systematic error can have occurred from this cause.

TABLE 1.—*Pointings on the vertex of the moon for difference of readings in azimuth and altitude.*

Date	$a_2 - a_1$	$h_2 - h_1$	Date	$a_2 - a_1$	$h_2 - h_1$
1896 May 15	+12 + 3 —	+10 + 2 − 1	1897 Feb. 24	+ 7 0 + 1	+5 + 5 +4
June 2	+26 +36 +26	+ 3 + 1 + 5	Mar. 13	+11 + 9 —	+5 +13 —
July 17	− 1 −16 − 2	−10 − 2 −11	Apr. 3	−11 +18 + 1	+6 + 7 +9
Aug. 15	0 − 6 —	−12 − 3 —	Apr. 9	− 3 + 5 −10	+2 + 4 +2
Aug. 31	+ 1 — —	− 4 — —	Apr. 12	+ 3 − 4 + 6	+3 + 2 +1
Sept. 16	+11 +13 +13	+ 5 + 6 +18	June 9	+11 + 1 +10	0 + 1 +1
Sept. 30	+ 3 + 1 − 1	+14 +17 +14			
* Sept. 30	+ 1 − 3 − 7	− 1 − 5 − 2			
Nov. 16	− 2 − 2 − 3	+ 5 +11 +11			
Dec. 9	− 8 + 2 − 4	+13 + 9 + 6			
Dec. 12	− 5 + 4 − 3	+11 + 6 +12			
Dec. 16	+ 2 + 7 + 9	+12 +12 + 7			
Dec. 29	+ 4 + 1 − 6	+ 1 + 1 + 8			

* Readjustment of the vertical-circle index:

$a_2 - a_1$ averages $+1'.9$ omitting June 2, 1896.

$h_2 - h_1$ averages $+3'.8$ omitting Sept. 30, 1896.

There were usually 3 settings on each date.

The figures are minutes of arc.

NUMBER OF THE THEODOLITE OBSERVATIONS.

On Table 2 is collected the number of cloud observations which have been actually computed, assuming at first that the angles are correct. It was found that of 6,609 observations there were 276 to be rejected as worthless for some reason, being a loss of about 4 per cent. This creditable showing is partly due to the fact that the observers regularly compared their settings, as soon as made, while at the instruments, since by their experience they could generally determine whether the same cloud point had been selected or not. Thus much labor was saved in executing the computations. An inspection of the column marked "rejected" indicates that the greatest difficulty in identifying the setting points by previous description over the telephone was encountered in the cumulus clouds, although the height of the stratum is not great. The stratus also show a large percentage, due to the thin, uncertain outline of that type of clouds. In making successive observations on the same cloud point for direction and velocity of motion, the rule was adopted of taking the settings exactly two minutes apart, thus giving equal intervals uniformly, and also ample time for making the record of the preceding observation. It is found that 2,023 single settings were made wherein no computations could be carried out for velocity and direction of motion. In these instances the cloud did not retain its shape long enough for the second observation, but it was available to compute only the height. There were, therefore, 4,310 observations to be combined in pairs for motion, of which there were 1,231 cases of 2 observations 120 seconds apart; 606 cases of 3 observations on the same cloud, the endurance of the cloud form being 4 minutes, the last column showing one instance of a cirrus which was followed through 20 minutes.

TABLE 2.—*Number of the theodolite cloud observations.*

Cloud	Total	Re-jected	Re-tained	Single setting	Number of settings; interval, 120s							Total
					2	3	4	5	6	7	10	
Cumulus	1621	101	1520	693	300	56	11	3				827
Cirrus	1393	37	1356	96	254	142	46	20	3	2	1	1260
Alto-cum.	1039	30	1009	320	224	54	16	3				689
Strato-cum.	804	42	762	371	141	35	1					391
Cirro-cum.	483	15	468	96	105	35	9	3	1			372
Cirro-strat.	357	6	351	37	50	47	12	5				314
Stratus	320	27	293	223	21	5	2	1				70
Alto-strat.	286	9	277	88	67	14	2	1				189
Cu-nimb.	218	7	211	50	55	13	3					161
Nimbus	72	2	70	36	14	2						34
Thin scud	11	0	11	11								0
Mam. cu.	5	0	5	2		1						3
Total	6609	276	6333	2023	2462	1212	408	180	24	14	10	4310

The outcome of these observations is such as to reflect much credit upon the care and patience of the observers to whom they were intrusted.

THE NEPHOSCOPE.

The MARVIN nephoscope was adopted for the Weather Bureau observations, because its construction is such as to require the minimum labor in the computation of the results. The instrument was mounted on an iron stand resting on a foundation made of concrete, similar to that used for the theodolites. The stands were generally placed on the roofs of the Weather Bureau offices, near the other meteorological instruments. The following description of the nephoscope is by Professor MARVIN:

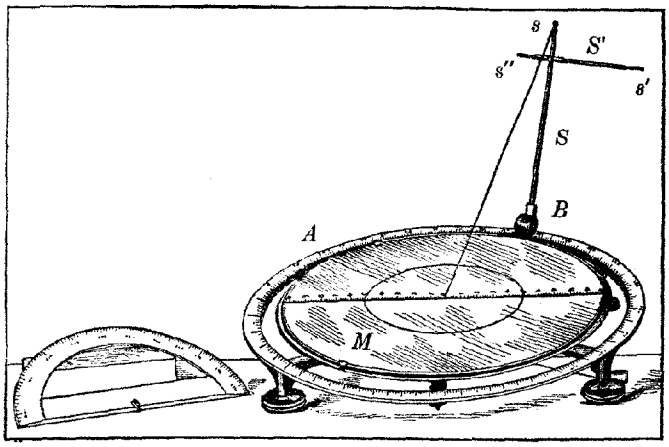


Chart 2.—Marvin's improved nephoscope.

The improved nephoscope.—In the instrument described below, which was devised for the use of the Weather Bureau observers, Professor MARVIN has sought to extend the utility of the nephoscope to the observation of every possible element; to insure a uniform degree of accuracy; to provide that the manipulation shall be as convenient as possible, and to choose such dimensions that the numerical computations incident to the reduction of observations shall be reduced to the minimum.

The instrument is shown in Chart 2, as arranged for general cloud work. The circular frame, *A*, is mounted upon three leveling screws and its upper surface is graduated to degrees, numbered from 0 to 360, the numbers increasing in a direction contrary to that of the motion of clock hands. This rotation is adopted at the suggestion of Professor BIGELOW, as this sequence of

angles conforms to that which obtains in the ordinary conception of trigonometrical functions, as also for the positive cyclonic rotation, and in magnetic elements. The plate and mirror, *M*, revolve smoothly within the circular rim, *A*, being carried upon a hollow vertical axis at the center. The arm, *B*, carrying the sighting staff, *S*, also revolves upon the central axis, the outer end traversing the narrow annular space between the mirror and graduated rim. The staff, *S*, is telescopic in construction and is attached to the arm at *B* by a hinge which permits the staff to be inclined from the vertical to any extent, but always in a plane perpendicular to the mirror. The top portion of the staff is provided with a crosshead, which is surmounted by a small sighting knob, *s*. The crosshead is adapted to receive the secondary staff, *S'*, which slides with gentle friction through the crosshead, and is tipped at either end with small secondary sighting knobs, *s'* and *s''*. By reason of the telescopic construction of the staff, *S*, the crosshead can not only be turned about in any direction, but it and the sighting knob, *s*, can be raised by various amounts, being held in place by friction. The hinge at *B* is made in such a manner that it can be firmly locked when the staff *S* is in a vertical position. The advantage of this will appear when the manner of using the nephoscope for observing apparent cloud velocities is described.

A fine line crossing the center of the mirror is etched upon the surface of the glass and is graduated into millimeters, the zero of the scale being placed at the center. The radius of the mirror is slightly more than 10 centimeters (4¼ inches). Two circles of 5 centimeters and 10 centimeters radius, respectively, are also engraved on the glass.

The center of the glass is pierced with a fine pin hole. A short length of silk twist is passed through this and the hollow axis of the instrument, and has attached to it below a small weight, whereas the end above the mirror is fastened to the sighting knob, *s*. The thread is kept taut at all times by the small weight below, and, if detached from the staff, *S*, is prevented from passing entirely through the mirror by the knob at the end. When in use, the nephoscope is mounted upon a hollow support, most conveniently made with iron piping, thus providing a sufficient space for the movements of the small weight, which is a convenient although not a necessary adjunct, as the result may be obtained in other ways.

The knob, *s*, is shown in the figure, the construction there being adopted in order that the line of the silk thread shall range accurately with the center of the mirror and the center of the sighting knob in whatever position the staff may be placed and however the crosshead may be turned. It will be seen from the figure that the prolongation of the staff, *S*, above the crosshead is pointed and serves as a pivot, which may turn within the sleeve of the knob when the crosshead is turned, and thus avoid winding the thread around the staff, while the knob itself is split and the thread is attached to a small pin through its center.

The object of the thread is to facilitate the measurement of the angular altitude of a cloud. In the use of the instrument the angle between the thread and the mirror is the angular elevation of the cloud observed, which, for most purposes, can be measured with sufficient accuracy by the use of an ordinary semicircular protractor of about 10 centimeters radius (3½ to 4 inches). The one shown at the side of the figure is provided with a small pointed projection at the center of the arc. This is applied to the mirror so that the point enters the small hole at the center; the angle of the thread is then read off with a very considerable accuracy.

A small level of the usual construction, seen at one side in the figure, accompanies each instrument, and, if desired, can be permanently attached, although the detached level is believed to be better and possibly less expensive.

Thus constructed the nephoscope becomes a very accurate cloud altazimuth, and is useful in many other kinds of observation where horizontal and vertical angles are to be measured, such as auroras, halos, etc.

For the best results each instrument should be provided with two mirrors; one for general use should be made of black glass ground true and flat. A splendid substitute for the black glass, which is rather difficult to procure, consists of an ordinary piece of clear glass, such as is used in mirrors, but from which the silvering has been moved, and the surface coated evenly with perfectly black paint. The top surface of such a glass becomes a partially reflecting surface. The loss in brilliancy from the partial reflection is of great advantage in observing strongly illuminated clouds. Nothing more than such a mirror is required, except in rare cases when the

clouds are dark and are devoid of any distinct and well-defined markings. A silvered mirror reflecting strongly from the top surface is then required. The ordinary mirror, silvered on the back, gives rise to double reflections that at times become troublesome.

Methods of observation.—The manner of using the nephoscope will be understood from a description of the method of observing each of the elements given in the list above.

Exposure.—For repeated and frequent observations some convenient and stable support should be provided and exposed at a point commanding an uninterrupted view of the sky. The nephoscope is to be placed upon its support so that the zero of the graduated circumference is set to the south point of the horizon. This adjustment being once established it is convenient to provide that the points of the leveling screws of the nephoscope fall, respectively, the one within a conical hole, another within a V-groove, and the third resting upon a flat surface. When returned to this support after removal the adjustment of the instrument to the south point is preserved.

The theory of the nephoscope requires that the mirror be accurately horizontal. This condition is secured in a satisfactory manner by means of the leveling screws, aided by the small level accompanying the instrument.

The manner of observing the *azimuth* of a cloud will be described. Looking at the mirror of the nephoscope the image of the selected cloud is found and the observer moves his head until the middle of the cloud image, or the point chosen, is seen at the center of the mirror, which is marked by the small hole through the glass. Keeping the cloud image always at the center of the mirror, the sighting staff *S* of the nephoscope is revolved about the central axis, and inclined until the small sighting knob *s* is likewise seen reflected with the cloud from the center of the mirror. At this moment of time the azimuth of the cloud is the reading on the graduated circle opposite the index attached to the base of the sighting staff.

The *angular altitude* of the cloud is likewise shown from the setting we have just described; that is, the angle made by the thread as it stretches from the center of the mirror to the center of the sighting knob *s* is the altitude of the cloud when it is in range with the knob. This angle is measured by placing the straight edge of the protractor on the mirror with the pointed projection entering the hole in the middle of the mirror.

It will be noticed that thus far the sighting staff is *beyond* the center of the mirror from the observer, so that the reflected image of the staff appears in the mirror. It is also possible to have the staff on the side *next* to the observer, but in this case the adjustment must be made so that the knob *s* is in the direct line from the center of the mirror to the observer's eye. The angular altitude of the cloud is given just the same as before, by this method of observing, but the azimuth of the cloud will be 180° different. The first described method is preferable.

Azimuth of motion of cloud.—The direction in which the cloud is moving is obtained with the nephoscope as follows:

The cloud in question is brought in range and the sighting knob *s* adjusted exactly as described. Unless the cloud is moving very slowly, the image in a very few seconds will be seen to move away from the center of the mirror. Two methods of following the image are now open to the observer:

First method.—Follow the motion of the cloud by keeping the images of the knob and the cloud together, not by moving the sighting staff, which under no circumstances must be changed from its first position, but by moving the head. As the cloud image thus appears to traverse the mirror from the center to the circumference the mirror is turned upon its axis so that the line of graduations across its surface appears to intersect the cloud and the knob *s*. When it is found that this line has been set to coincide with the path of the cloud image—that is, when the cloud follows along the line—then the latter is parallel to the direction of the cloud motion. Before describing the manner of reading off the azimuth of the motion the second method will be given.

Second method.—Instead of moving the head so that the cloud and the knob may be kept together on the mirror, the head may be kept stationary—that is, the head is held so that the knob is seen always at the center of the mirror. The cloud image will now, even more rapidly than before, appear to move toward the edge of the mirror, which, as before, must be turned until the graduated line is placed where the cloud will appear to follow it closely. Here, again, the line is in the same direction as the cloud motion.

The actual position of the line should be the same whether the cloud image was followed by the first or second method. After following the cloud toward the edge of the plate the reading on the graduated rim, where the cloud appears to pass off the plate, will be by the first method the direction whence the cloud came, and by the second method the direction toward which the cloud is moving.

It is important that the different results obtained by the two methods be not confused in case observations are made in both ways.

The two methods contrasted.—In the first method the speed with which the cloud image traverses the plate depends upon the height of the knob above the mirror. As this is always less than the height of the head above the mirror the apparent speed will be much less by the first than by the second method. The first method is therefore not so well adapted to determine the direction of motion of very high or very slow-moving clouds, nor those whose forms change greatly in a few seconds. In general the second method will be the best to employ where directions of motion only are desired.

It will be noticed here that, having adjusted the nephoscope on the cloud and having set the line on the mirror to coincide with the direction of cloud motion, these operations have determined each of the three elements—that is, the reading on the graduated rim opposite the base of the sighting staff is the azimuth of the cloud; the angle between the thread and the mirror is the angular altitude of the cloud, and, finally, the direction of motion is determined from the position of the line on the mirror.

The observation of the *apparent velocity* of the cloud is attended with a little more complication than any of the preceding elements. It consists in following the cloud image according to the above-described first method, and in noting the number of divisions on the graduated line traversed in a stated number of seconds—for example, thirty seconds. Instead of this we may note the number of seconds required for the cloud image to traverse a fixed distance on the plate, say, for example, from the center to the edge or halfway to the edge. The two circles engraved on the mirror are for this purpose. In order that the apparent velocity of one cloud may be compared with that of another, it is necessary that the vertical distance of the sighting knob above the mirror be constantly the same, or, if different, that the height be known. Furthermore, the actual velocity can be determined from the apparent velocity when the height of the cloud is known.

From many observations that have already been made it has been discovered that there is quite a definite relation between the height of clouds and their appearance. These relations are indicated in the cloud classification already given. It therefore results that observations of apparent cloud velocities by the nephoscope can be made to give very fair ideas of the actual velocities of the clouds themselves, and the nephoscope described above has been arranged with particular reference to this use.

For this purpose the hinged joint is locked so that the sighting staff assumes its vertical position. The knob s is now disregarded, and the clouds are sighted in reference to the knobs s' or s'' according to convenience. The arm S' slides easily through the crosshead and can be revolved about the vertical staff S, which motions, together with the rotation of the staff around the central axis, is always sufficient to bring the knobs in range with any cloud except it be of low elevation (under 20°). The observation of such low clouds is not altogether desirable. The knobs, in whatever position set, are always at a constant distance above the mirror—namely, 4.73 inches (12 cm.). The line engraved across the mirror is graduated to millimeters. Under these dimensions it will be found on computation that the number of millimeters traversed by a cloud image in thirty seconds will be the velocity of the cloud in miles per hour, provided the cloud is just 1 mile high. If the cloud is 2 miles high the velocity will be double, and so on, in like proportion for other heights.

This same relation holds equally well for any other system of units; for example, the space traversed by the cloud image in thirty seconds, measured in millimeters, is the velocity in kilometers per hour of a cloud 1 kilometer high.

In order to obtain the velocity in meters per second on the basis of a cloud 1,000 meters high, it is necessary to time the cloud for twenty-five seconds. One-third the space traversed in millimeters is then the velocity in meters per second.

These explanations show the advantage of exercising a proper choice in selecting the dimensions of the parts of the nephoscope, and how simple the computation of actual cloud velocities then becomes.

Owing to the slow motion of the cloud images in some cases, the rapid motion in others, or the rapid change of the cloud in still others, it may not always be possible to observe the motion for just the specified time. In such cases the time may be halved or doubled, for example. The method of observation outlined above forms a good basis for general work in observing apparent cloud velocities.

We now come to the consideration of the measurement of cloud *heights*. This is really a matter of great difficulty, and the present discussion will be confined to explaining how measurements of this sort can be somewhat imperfectly made with the nephoscope. For this purpose two stations must be established within sight of each other and at a known distance apart. A mile or more is necessary for high clouds, but for nephoscopic observations upon clouds of moderate elevations a less distance between stations may be fairly satisfactory. The zero points of the graduated rims of the nephoscopes had best be set exactly on the line between the two stations, although this is not necessary if the azimuth of this line is taken into account.

The observations require that the observers at the two stations shall first decide upon some particular cloud, or spot on the cloud, to be measured. Telephonic communication is quite indispensable for this purpose. When a mutual identification of a spot has been reached each observer measures with his nephoscope the altitude and azimuth of the spot and records the time. The height of the cloud is determined from these measurements in a mechanical way, as follows: Lay off a line on the floor having a length corresponding to the distance between the stations. A scale of 1 inch to 100 feet will be convenient. Tack strings to the floor, one exactly at each end of the line. Stretch these strings up through the air so that the angular altitude above the floor corresponds to the altitudes obtained from the observations of the two nephoscopes, respectively. The threads must also make the same horizontal angles with the base line found from the observation of the azimuth of the cloud. If the two observers sighted on the same point of the cloud, and the strings were nicely adjusted, they should intersect at a point above the floor. This point represents the cloud, and its vertical height above the floor, measured on the same scale as the base line (for example, 1 inch equals 100 feet), is the desired height of the cloud. Generally the strings will fail to intersect, which means that the two observers were not looking at the same point. If the discrepancy is not too great the height of the cloud may be measured from a point midway between the strings where they are nearest together.

The averages of several observations are necessary to get fairly good results. Generally, however, it is necessary to employ theodolites in order that the angles may be measured with greater accuracy, and photography is called in to obviate the difficulty of fixing upon a definite point of observation.

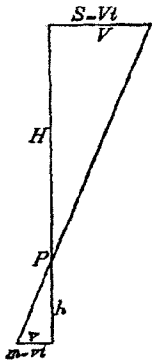


CHART 3.—Relative heights and velocities with a nephoscope.

THEORY OF THE NEPHOSCOPE VELOCITIES.

h = height of sighting point P above the mirror.

H = height of the cloud above the sighting point.

m = distance in mm. traversed by the image on the mirror.

s = distance traversed by the cloud in the sky.

v = velocity of the image.

V = velocity of the cloud.

h = 120 mm.

Miles per hour.

$$V = v\,\frac{H}{h} = \frac{m}{t}\,.\,3600\,.\,\frac{H}{120}\,. \qquad \text{For}\begin{cases} V = m \\ H = 1 \text{ mile.} \end{cases} \qquad t = 30^{s}.$$

Kilometers per hour.

$$V = v\,\frac{H}{h} = \frac{m}{t}\,.\,3600\,.\,\frac{H}{120}\,. \qquad \text{For}\begin{cases} V = m. \\ H = 1 \text{ kilo.} \end{cases} \qquad t = 30^{s}.$$

Meters per second.

$$V = v\,\frac{H}{h} = \frac{m}{t}\,.\;\;1\;\;.\,\frac{H}{120}\,. \qquad \text{For}\begin{cases} V = \frac{m}{3}. \\ H = 1000 \text{ meters.} \end{cases} \qquad t = 25^{s}.$$

These give the three rules for velocity found in the text.

CHAPTER 2.

FORMULÆ FOR COMPUTING THE HEIGHT, DIRECTION, AND VELOCITY OF MOTION BY THEODOLITE OBSERVATIONS.

A brief summary of the important formulæ for computing the heights of clouds, together with the direction and the velocity of their motions, is here presented in a condensed form. It includes several practical methods, which have been found useful in actual observations and are well adapted to a variety of conditions. There are yet other processes available, which are suitably described in Prof. C. ABBE's Treatise on Meteorological Apparatus and Methods, Report C. S. O., 1887, p. 310.

I.—CLOUD CROSSING THE BASE LINE.

Having a base line such as that established at Washington, D. C., in 1896, with one station higher than the other, equipped with two alt-azimuth theodolites, one at either end, it is evident that three cases may occur when the cloud crosses the base line—

(1) between the stations.

(2) beyond the higher station.

(3) beyond the lower station.

Let b = the length of the base line.

c = the height of one station above the other.

A = the projection of the radii r_1 or r_2, when required, upon the base line.

$h_1\ h_2$ = the altitude angles at the stations.

$r_1\ r_2$ = the radii from the stations to the cloud.

Then, since $y = o$, x and z are derived as follows in each case:

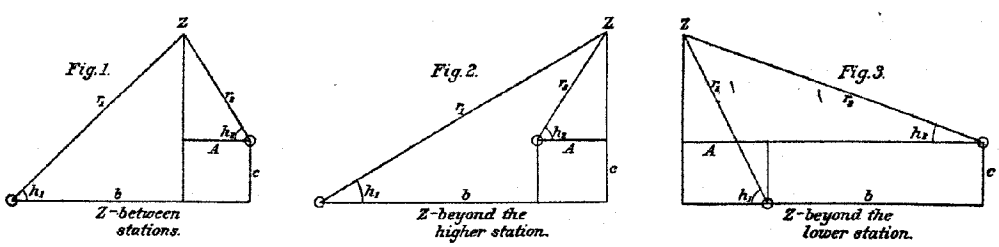


CHART 4.—Three cases where the vertical z is on the base line.

Case 1. $\tan h_1 = \dfrac{z}{b - A}$. $\quad \tan h_2 = \dfrac{z - c}{A}$.

$$A = b - z \cot h_1 = -c \cot h_2 + z \cot h_2.$$

$$z = (b + c \cot h_2) \frac{1}{\cot h_1 + \cot h_2} = (b + c \cot h_2) \frac{\sin h_1 \sin h_2}{\sin (h_1 + h_2)}.$$

$$x = b - A = z \cot h_1 = b - (z - c) \cot h_2.$$

Case 2. $\tan h_1 = \frac{z}{b + A}$. $\tan h_2 = \frac{z - c}{A}$.

$$A = -b + z \cot h_1 = -c \cot h_2 + z \cot h_2.$$

$$z = (b - c \cot h_2) \frac{1}{\cot h_1 - \cot h_2} = (b - c \cot h_2) \frac{\sin h_1 \sin h_2}{\sin (h_2 - h_1)}.$$

$$x = b + A = z \cot h_1 = b + (z - c) \cot h_2.$$

Case 3. $\tan h_1 = \frac{z}{A}$. $\tan h_2 = \frac{z - c}{A + b}$.

$$A = z \cot h_1 = -b - c \cot h_2 + z \cot h_2.$$

$$z = (b + c \cot h_2) \frac{1}{\cot h_2 - \cot h_1} = (b + c \cot h_2) \frac{\sin h_1 \sin h_2}{\sin (h_1 - h_2)}.$$

$$x = b + A = z \cot h_1 = (z - c) \cot h_2 - b.$$

II.—CLOUD NOT OVER THE BASE LINE.

Trigonometric method.

The general case is where the vertical to the cloud does not lie on the base line. To make the case complete in its conditions, the axis x will be taken on the base line, which makes the angle φ from the south point of the horizon, counted in the right-hand direction of rotation, SENW. Let the following additional notation be used:

$d_1\ d_2$ = distances from the stations to the foot of z in a horizontal plane.

$a_1\ a_2$ = the azimuth angles at the stations.

θ = the angle at the cloud between $r_1\ r_2$.

The following trigonometric development determines $(x_1 y_1 z_1)$ and $(x_2 y_2 z_2)$, the rectangular coordinates of the points with origin at the two respective stations, the distance between these two cloud points being Δ, which ought to vanish in perfect work, for simultaneous observations. When two determinations are made at different moments, T' and T'', the distance moved in a horizontal plane is D for the interval of time $T = T'' - T'$, and the velocity of motion is $V = D/T$ counted in the direction *toward* which the motion takes place—that is, as the "arrow flies;" the azimuth of the motion is A referred to the base line and $\varphi + A$ referred to the south point of the horizon.

The right-hand azimuth rotation.

It will be observed that in establishing this vector system an important change has been made from the common meteorological notation, wherein the azimuth rotates in the opposite direction, from the south through the west (SWNE.), and the direction is that *from* which the wind blows. It is done for the following reasons:

1. The vector having left-hand rotation does not conform to the accepted convention of modern physics, which is right-handed.

2. It does not readily harmonize with FERREL'S fundamental notation, wherein the axis
   x is laid on the meridian southward,
   y is laid on the parallel eastward,
   z is laid on the vertical zenithward,
but introduces anomalies in the analytic equations.

3. Since the rotation of the earth, with the geographical north pole on the axis, and $r\ .\ \theta\ .\ \lambda\ .$ the polar coordinates, develops the angle λ eastward relative to a fixed point in the heavens, it is proper in passing to the cylindrical coordinates $\varpi\ .\ \varphi\ .\ z\ .$ to retain the same rotation. This convention enables us with ease to transfer from the general circulation to the local cyclones of the northern hemisphere, and with the least possible confusion, which is of great value in this complex branch of meteorology.

4. The vector direction *from* which the index arrow is drawn is anomalous and in contravention to all the canons of analysis, and therefore meteorology should conform to this fundamental definition and make the arrow tangent to the motion in the stream line and in the same sense—that is, *toward* which the wind blows.

5. This vector direction is in agreement with the common notation on the daily weather map, namely, that the "arrow flies with the direction of the wind."

Since some of the international cloud work will be done on the old system of vectors, for the sake of ease in comparison, a portion of our results, especially in the theodolite observations, give these two azimuth directions underneath one another.

6. The relations of meteorology to terrestrial magnetism also require a uniformity of coordinate systems, and as this point has been more fully stated elsewhere a reference is made to my paper, "The standard system of coordinate axes for magnetic and meteorological observations and computations," Monthly Weather Review, May, 1897. With this explanation the following equations will be readily understood. They are the ones adopted in the Weather Bureau computations, and are recommended for use by those employing trigonometric methods of observation—that is, nonphotographic processes.

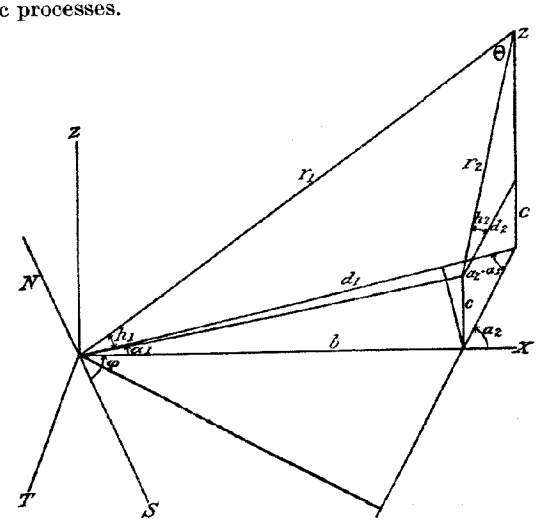


CHART 5.—The vertical z not on the base line x.

$$d_1 \sin (a_2 - a_1) = b \sin a_2.$$

$$d_1 = \frac{b \sin a_2}{\sin (a_2 - a_1)} = \frac{z_1}{\tan h_1}.$$

$$x_1 = d_1 \cos a_1 = \frac{b \sin a_2 \cos a_1}{\sin (a_2 - a_1)}.$$

$$y_1 = d_1 \sin a_1 = \frac{b \sin a_2 \sin a_1}{\sin (a_2 - a_1)}.$$

$$z_1 = d_1 \tan h_1 = \frac{b \sin a_2 \tan h_1}{\sin (a_2 - a_1)}.$$

$$\Delta = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}.$$

$$V = \frac{D}{T} = \frac{\sqrt{(x'' - x')^2 + (y'' - y')^2}}{T'' - T'}.$$

$$\tan A = \frac{y'' - y'}{x'' - x'}.$$

$$d_2 \sin (a_2 - a_1) = b \sin a_1.$$

$$d_2 = \frac{b \sin a_1}{\sin (a_2 - a_1)} = \frac{z_2 - c}{\tan h_2}.$$

$$x_2 = b + d_2 \cos a_2 = b + \frac{b \sin a_1 \cos a_2}{\sin (a_2 - a_1)}.$$

$$y_2 = d_2 \sin a_2 = \frac{b \sin a_1 \sin a_2}{\sin (a_2 - a_1)}.$$

$$z_2 = c + d_2 \tan h_2 = c + \frac{b \sin a_1 \tan h_2}{\sin (a_2 - a_1)}.$$

$$D = \sqrt{(x'' - x')^2 + (y'' - y')^2}.$$

Motion *towards*, as arrow flies.

$\varphi + A$ = azimuth of motion, from south through the *east*.

III.—THE ANALYTIC METHOD.

In the preceding method the distance Δ practically lies upon the vertical line z, the common height line of the cloud points selected in the actual observations, as derived from this form of the computation. But it may be desired, as was first done by EKHOLM and HAGSTRÖM,* to compute the shortest distance between the two sight lines $r_1 r_2$. Let $(\lambda_1 \mu_1 \nu_1)$, $(\lambda_2 \mu_2 \nu_2)$ be the angles that the lines r_1 and r_2, respectively, make with the coordinate axes $x_1\ y_1\ z_1$ at the two stations, $(l_1\ m_1\ n_1)$, $(l_2\ m_2\ n_2)$, the corresponding direction cosines, then the following analytic development is readily obtained.

$$l_1 = \cos \lambda_1 = \cos h_1 \cos a_1. \qquad l_2 = \cos \lambda_2 = \cos h_2 \cos a_2.$$

$$m_1 = \cos \mu_1 = \cos h_1 \sin a_1. \qquad m_2 = \cos \mu_2 = \cos h_2 \sin a_2.$$

$$n_1 = \cos \nu_1 = \sin h_1. \qquad n_2 = \cos \nu_2 = \sin h_2.$$

$$\cos \theta = \sin h_1 \sin h_2 + \cos h_1 \cos h_2 \cos (a_2 - a_1).$$

$$r_1 = + bl_1 + cn_1 + r_2 \cos \theta. \quad \text{Three projections on } r_1.$$

$$r_2 = - bl_2 - cn_2 + r_1 \cos \theta. \quad \text{Three projections on } r_2.$$

$$r_1 + r_2 = b(l_1 - l_2) + c(n_1 - n_2) + (r_1 + r_2) \cos \theta.$$

$$r_1 + r_2 = [b(l_1 - l_2) + c(n_1 - n_2)] \frac{1}{1 - \cos \theta} = A.$$

$$r_1 - r_2 = [b(l_1 + l_2) + c(n_1 + n_2)] \frac{1}{1 + \cos \theta} = B.$$

$$r_1 = \frac{A + B}{2}. \qquad r_2 = \frac{A - B}{2}.$$

$$x_1 = r_1 l_1. \qquad y_1 = r_1 m_1. \qquad z_1 = r_1 n_1.$$

$$x_2 = r_2 l_2 + b. \qquad y_2 = r_2 m_2. \qquad z_2 = r_2 n_2 + c.$$

$$\Delta_1 = [(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2]^{\frac{1}{2}}$$

Discussion of the weights to be assigned to the observations will be introduced a little later. The analytic formulæ involve so laborious a scheme of computation as to render them less desirable than the trigonometric method, and their relative accuracy is only a little greater, the mean errors of Δ_1 by the analytic method averaging about three-fourths of Δ by the trigonometric method. The Blue Hill observations† of 1890–1891 were reduced by the EKHOLM and HAGSTRÖM formulæ, but those of 1896–1897 by the trigonometric formulæ.

IV.—VELOCITY AND DIRECTION OF MOTION BY MEANS OF A POSITION CIRCLE AND ONE OBSERVATION FOR HEIGHT.

Since it is not possible at all times to secure a second observation, after the lapse of a considerable interval, by the above methods, a single simultaneous observation for height at the two stations may conveniently be supplemented by a subordinate observation for direction of motion and velocity. For this purpose the instrument must be fitted with a position circle. A suitable one can readily be provided by placing at the object end of the sighting tube a clear glass reticle on which a network of lines has been etched. Practically, to make these rulings, one covers a

* Measures des hauteurs et des movements des nuages, par N. Ekholm et K. L. Hagström, Upsal, 1884.

† Measurements of Cloud Heights and Velocities, by H. H. Clayton and S. P. Fergusson, Annals Harv. Coll., 1892.

glass with wax, draws the required lines with a stylus or a machine, and etches the exposed glass with acid. Such a glass is easily adjusted and is sufficient for the work required in cloud observations.

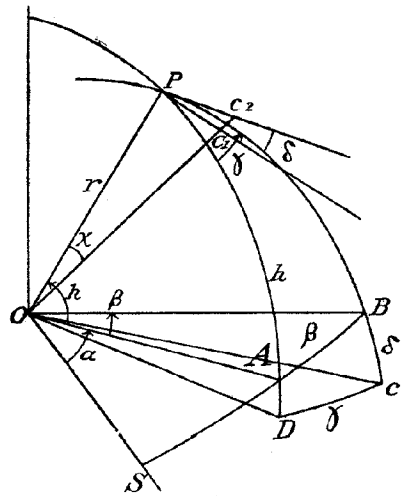


CHART 6.—Velocity and direction of motion by means of a position circle and one observation for height.

Let O = the position of the eyepiece of the telescope.
OP = the sight line of the telescope.
PD = the vertical great circle through P.
PC = the circle through the cloud motion.
γ = the position angle CPD = projection of β.
Pc_2 = the tangent to PC.
Pc_1 = the projection of Pc_2 on the plane of the reticle, through the angle $\delta = c_2Pc_1 = BC$.
χ = angle of a point on the reticle from the sight line.
$a\ h$ = azimuth and altitude of the sight line.
β = AB in the plane of the horizon, fixes the plane of cloud motion PBC.
v = velocity per second.
s = number of seconds.
φ = azimuth of the cloud motion.
$SABO$ = plane of the horizon, and S the south point.
DCO = plane parallel to the reticle through the eyepiece O.

In the triangle APB, $A = 90°$. $PB = 90 - \delta$. $AP = h$.

Chauvenet Trig., p. 169. $\begin{cases} \tan \beta = \tan \gamma \sin h. \\ \tan \delta = \cos \gamma \cot h. \end{cases}$ $\delta = BOC = c_2Pc_1$. $z = r \sin h$.

$$\frac{\text{Movement on reticle}}{\text{Movement in path}} = \frac{Pc_1}{Pc_2} = \frac{\sin Pc_2c_1}{\sin Pc_1c_2} = \frac{\sin (90 - \chi)}{\sin [90 - (\delta - \chi)]}.$$

$$\frac{vs}{r \tan \chi} = \frac{vs}{\tan \chi} \cdot \frac{\sin h}{z} = \frac{\cos \chi}{\cos (\delta - \chi)}.$$

$$v = \frac{z \sin \chi}{s \sin h \cos (\delta - \chi)}.$$

$$\varphi = a + \beta.$$

V.—DETERMINATION OF CLOUD HEIGHT BY OBSERVATION ON THE SHADOW FROM ONE ELEVATED STATION.

It is possible to determine quite accurately the height of a cloud by an observation on its shadow from one station. A good map of the topography of the surrounding country is first to be prepared, so that distances and elevations relative to the station may be procured. This

method was first proposed by FEUSSNER.* It may be noted that in Abbe's Treatise, 1887, p. 321, a statement regarding the method of determining the altitude angle of the cloud as seen from the shadow, h_2, was inadvertently omitted, though clearly given by FEUSSNER, p. 462. In the Monthly Weather Review, April, 1897, p. 135, Mr. H. H. CLAYTON supplies this deficiency, and thus reinvents the FEUSSNER method, though he claims that it is a new one.

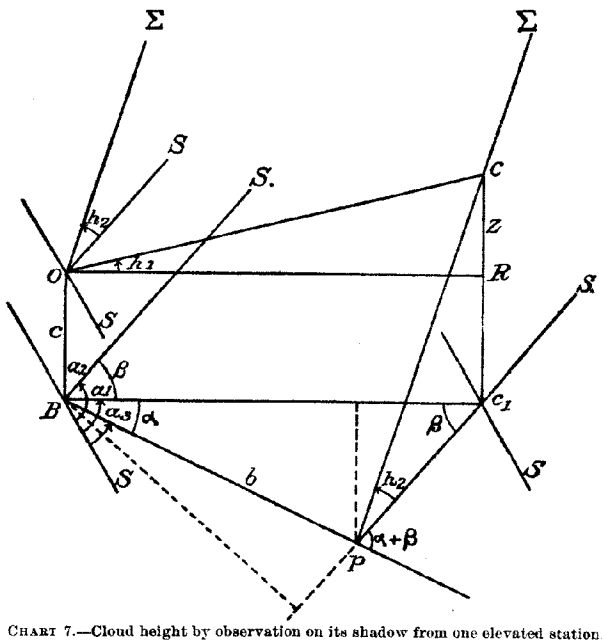


CHART 7.—Cloud height by observation on its shadow from one elevated station.

Let O = the elevated station, Σ the direction of the sun, C the cloud, P the cloud shadow.
$O\Sigma$ and $P\Sigma$ are sensibly parallel.
OS_o, BS_o, PS_o, projections of the sun's rays.
c = elevation of the station, CC_1 of the cloud.
b = base line or distance to the shadow.
$a_1\ a_2\ a_3$ = azimuths to the cloud, sun, and shadow.
$h_1\ h_2$ = altitudes of the cloud and sun.
$\alpha = a_1 - a_3 = C_1BP$.
$\beta = a_2 - a_1 = BC_1P$.
$z = RC = CC_1 - c$.

From the station O, with the theodolite, measure the angles $(a_1\ h_1)$, $(a_2\ h_2)$, a_3, and the distance b on the map. The height c must be determined from the known topography of the shadow point. A second observation of the point P, after the interval of time T, will afford data for a computation of the direction and the velocity of the cloud motion, as in the preceding cases.

$$\alpha = a_1 - a_3. \qquad \sin\alpha = \frac{x}{b}. \qquad z = PC_1 \tan h_2.$$

$$\beta = a_2 - a_1. \qquad \sin\beta = \frac{x}{PC_1}. \qquad z = b \sin\alpha \operatorname{cosec}\beta \tan h_2.$$

$$\alpha + \beta = a_2 - a_3. \qquad \tan h_2 = \frac{z}{PC_1}. \qquad z = b \sin(a_1 - a_3) \operatorname{cosec}(a_2 - a_1) \tan h_2.$$

$$z_1 = b \sin(a_2 - a_3) \operatorname{cosec}(a_2 - a_1) \tan h_1.$$

$$z_2 = z - c.$$

This is precisely the same case for computation as in the trigonometric method given above.

* Ueber zwei neue Methoden zur Hohenmessung der Wolken, von Dr. Feussner, Annalen der Physik und Chemie, Bd. 144, 1871.

REDUCTION OF THE OBSERVATIONS.

The trigonometric method was used throughout the computations, and the following example is added *in extenso* to show the manner of the arrangement of the formulæ:

TABLE 3.—*Example of computation of the cloud observations.*

Constants

$b = 1360.5$
$c = 17.5$
$A = S\ 55°\ 9'\ E.$

$z_1 = b \sin a_2 \operatorname{cosec} (a_2 - a_1) \tan h_1.$

$z_2 - c = b \sin a_1 \operatorname{cosec} (a_2 - a_1) \tan h_2.$

$y = z_m \cot h_1 \sin a_1. \quad x = z_m \cot h_1 \cos a_1.$

$v = \frac{D}{T} = \frac{\sqrt{(y'' - y')^2 + (x'' - x')^2}}{t'' - t'}$

$\tan \varphi = \frac{y'' - y'}{x'' - x'}$ (towards).

Date	1897 May 8					
Hour	1. 27	1. 29	1. 31	1. 33	1. 27	1. 27
Cloud	Ci	Ci	Ci	Ci	Ci	Ci
a_2	126 56	121 00	114 42	106 48	128 56	126 56
a_1	122 46	116 28	108 47	100 9	122 46	122 46
$a_2 - a_1$	4 10	4 32	5 55	6 39	6 10	4 10
h_1	35 28	38 3	40 33	42 28	35 28	37 28
h_2	34 00	36 42	39 17	41 30	34 00	34 00
$\tan h_1$	9. 85273	9. 89359	9. 93227	9. 96155	9. 85273	9. 88446
$\sin a_2$	9. 90273	9. 93307	9. 95833	9. 98106	9. 89091	9. 90273
$\log b$	3. 13370	3. 13370	3. 13370	3. 13370	3. 13370	3. 13370
$\operatorname{cosec} (a_2 - a_1)$	1. 13872	1. 10216	0. 98682	0. 93628	0. 96891	1. 13872
$\sin a_1$	9. 92473	9. 95192	9. 97623	9. 99315	9. 92473	9. 92473
$\tan h_2$	9. 82899	9. 87238	9. 91276	9. 94681	9. 82899	9. 82899
$\log z_1$	4. 02788	4. 06252	4. 01112	4. 01259	3. 84625	4. 05961
$\log z_2 - c$	4. 02614	4. 06016	4. 00951	4. 00994	3. 85633	4. 02614
$z_2 - c$	10620	11486	10221	10232	7183	10620
z_2	10638	11504	10239	10250	7201	10638
z_1	10663	11548	10259	10294	7019	11472
$z_2 - z_1 = \Delta z$	− 25	− 44	− 20	− 44	+ 182	− 834
z	10650	11526	10249	10272	7110	11055
z_m	10674					
$\sin a_1$	9. 92473	9. 95192	9. 97623	9. 99315	9. 92473	9. 92473
$\log z_m$	4. 02832	4. 02832	4. 02832	4. 02832	3. 85187	4. 04356
$\cot h_1$	0. 14727	0. 10641	0. 06773	0. 03845	0. 14727	0. 11554
$\cos a_1$	−9. 73337	−9. 64902	−9. 50784	−9. 24607	−9. 73337	−9. 73337
$\log y$	4. 10032	4. 08665	4. 07228	4. 05992	3. 92387	4. 08383
$\log x$	−3. 90896	−3. 78375	−3. 60389	−3. 31284	−3. 73251	−3. 89247
y	+ 12599	+ 12208	+ 11811	+ 11480	+ 8392	+ 12129
x	− 8109	− 6078	− 4017	− 2055	− 5402	− 7807
$y'' - y'$	− 391	− 397	− 331			
$x'' - x'$	+ 2031	+ 2061	+ 1962			
$(y'' - y')^2$	152881	157609	109561			
$(x'' - x')^2$	4124961	4247721	3849444			
Sum	4277842	4405330	3959005			
D	2068	2099	1990			
T	120	120	120			
V	17. 2	17. 5	16. 6			
V_m	17. 1					
$\tan \varphi$	− . 193	− . 193	− . 169			
φ	349. 1	349. 1	350. 4			
$\varphi + A$	44. 3	44. 3	45. 6			
$(\varphi + A)_m$	44. 7					

On May 8, 1897, a cirrus cloud was observed four times in succession at two-minute intervals, giving an opportunity to compute three pairs for the velocity and the azimuth of the motion. All the values $a_1\ h_1\ z_1$ refer to the Weather Bureau Station, and $a_2\ h_2\ z_2$ to the State, War, and Navy building station. It is seen that the values of Δz are -25, -44, -20, -44 meters in this case, and that the mean height is 10,674 meters. This brings up the question of the weighting of the individual observations, and it had to be settled at the outset before any combinations for mean height, velocity, and azimuth could be made.

COMPARISON OF HEIGHTS BY THE TRIGONOMETRIC AND ANALYTIC METHODS.

The first step toward deciding this question was a direct comparison of the resulting heights and the differences $\Delta z = z_2 - z_1$, as obtained at the first and second stations, by the trigonometric and the analytic formulæ, respectively. For this purpose a recomputation of 85 miscellaneous examples of observations, taken from the data of the Blue Hill Station for 1890, pages 242–251, was executed and compared directly with the results there published, which were computed by the EKHOLM and HAGSTRÖM—that is the analytic method. The comparison is exhibited in Table 4.

TABLE 4.—*Comparison of heights computed by the trigonometric and the analytic methods.*

Observations	Height $T-A$	Bigelow z_2-z_1 Δz	Clayton z_2-z_1 Δz	Observations	Height $T-A$	Bigelow z_2-z_1 Δz	Clayton z_2-z_1 Δz	Observations	Height $T-A$	Bigelow z_2-z_1 Δz	Clayton z_2-z_1 Δz
1	+ 3	67	60	31	− 13	16	17	61	− 3	1	5
2	+ 30	88	110	32	− 9	0	11	62	+ 232	121	75
3	+ 97	35	7	33	+ 2	11	235	63	− 322	147	122
4	− 50	5	165	34	+ 25	1	13	64	+ 135	187	30
5	+571	66	215	35	− 42	22	10	65	− 9	28	15
6	−613	133	63	36	− 71	6	10	66	− 35	10	17
7	+542	183	38	37	+ 4	40	8	67	− 32	20	17
8	+258	114	90	38	+ 9	32	13	68	0	1	4
9	− 8	0	10	39	+ 20	40	105	69	− 79	39	31
10	− 1	43	40	40	+ 58	34	95	70	+ 35	22	17
11	− 21	225	190	41	+ 36	62	33	71	+ 360	159	128
12	+ 34	252	160	42	+ 4	49	35	72	+ 166	237	193
13	−257	87	50	43	+ 19	33	45	73	− 12	9	10
14	−727	201	100	44	−395	64	35	74	− 141	26	16
15	+503	357	302	45	+747	105	77	75	− 88	77	45
16	− 5	9	15	46	−469	42	27	76	− 42	12	10
17	− 58	27	30	47	− 10	45	140	77	− 176	419	231
18	+177	83	10	48	− 2	28	42	78	+ 11	46	14
19	− 34	33	12	49	− 29	48	27	79	− 7	15	9
20	− 25	52	15	50	+774	82	33	80	− 104	105	67
21	+ 5	46	42	51	−125	16	10	81	+ 37	121	105
22	+ 72	30	20	52	−464	133	89	82	− 2	8	7
23	− 69	29	21	53	+ 69	147	15	83	− 328	197	49
24	+439	138	101	54	−131	208	181	84	− 13	8	9
25	+359	137	102	55	− 8	1	4	85	+ 95	38	140
26	− 22	31	6	56	− 19	11	20		+5973	6318	4922
27	− 22	31	7	57	− 17	35	4		−5709		
28	− 16	18	12	58	− 38	21	50		+ 264		
29	+ 29	14	1	59	−540	301	60		+ 3		
30	− 10	9	23	60	+ 12	89	95				

The first column gives the number of the observations; the second column, the difference of height determined by the two methods, respectively, and marked $T—A$, Trigonometric-Analytic; the third column, the values of Δz by the former method; the fourth column, the same Δz by the latter method. The sum of the plus differences of heights is +5,973, and of the minus differences of heights is −5,709, showing that the two formulæ give very nearly the same average result for any large number of observations. The sum of the Δz by the trigonometric method is 6,318, and by the analytic method is 4,922, a ratio of four to three for the average difference of height, from the individual observations of each station.

DISTRIBUTION OF THE DIFFERENCES Δz WITH THE HEIGHTS.

The second step was to discuss the distribution of the differences Δz at the several levels to see what average error pertains to each cloud stratum. Dividing the atmosphere into layers of 1,000 meters, the number of Δs occurring within each 1,000-meter stratum was counted out from the Blue Hill data, pages 240–251; the number of observations being given in column 2 of Table 5,

TABLE 5.—*Distribution of the differences $\Delta z = z_2 - z_1$ for altitude, and the probability curves.*

Altitudes.	Number observations.	Mean Δ	Adjusted Δ_0	Extreme Δ_1	Abscissæ and ordinates of the probability curves																		
					0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	
12000–13000	31	145	132	476	9	9	9	9	8	8	7	7	7	6	5	4	3	3	2	2	2	1	
11000–12000	19	86	124	454	10	10	10	9	8	8	7	7	7	6	5	4	3	3	2	2		1	
10000–11000	46	114	116	432	12	12	10	10	9	8	7	7	7	5	4	3	3	2	2	1	1		
9000–10000	43	108	108	410	14	14	11	10	9	8	7	7	6	4	3	3	3	2	1	1	1		
8000– 9000	59	102	100	388	18	16	13	11	9	8	7	6	5	4	3	3	2	2	1	1			
7000– 8000	35	106	92	366	21	18	16	12	9	8	7	6	5	3	2	2	2	1	1				
6000– 7000	25	94	84	344	24	21	18	13	9	8	7	6	4	3	2	2	2	1					
5000– 6000	9	97	76	322	27	24	19	13	10	8	7	5	4	3	2	2	1	1					
4000– 5000	18	79	68	300	29	26	20	14	10	8	6	4	3	2	2	1	1						
3000– 4000	16	60	60	278	32	28	20	14	10	8	5	3	3	2	1	1	1						
2000– 3000	48	50	52	256	34	29	20	13	9	6	4	3	2	2	1	1							
1000– 2000	135	43	44	234	38	31	20	12	8	4	3	2	2	1	1								
0– 1000	50	40	36	212	43	32	21	11	7	3	2	2	1	1	1								
					0	27	53	80	107	133	160	187	213	240	267	293	320	347	373	400	327	427	

and their mean value in column 3. The adjusted value $\Delta = 36 + 8h$, where 36 holds for the 500-meter level and $h = 1{,}000$ meter, which was found by plotting the values of Δ and passing a straight line through them. The extreme value $\Delta_1 = 212 + 22h$, where 212 is the largest Δz for the first level, was obtained by plotting the individual Δs for altitude and magnitude on a diagram, and then by eye passing a straight line to exclude those cases, where the system clearly begins to straggle badly. Furthermore, the number of Δs occurring within each 1,000-meter stratum, and between each successive differences of 20, that is, between 0–20, 20–40, 40–60, etc., was counted, and the result, after reducing each series to 100 as the total number of observations, that is, supposing 100 observations made in each stratum, was plotted in a set of probability curves. The abscissæ and ordinates of the same, after a slight smoothing of the curves, are given on the same table.

Thus it means that between 0 and 1,000 meters 43 observations are likely to occur with the error $\Delta = 0$, 32 with the error 20, etc., in the same stratum; but if one goes upward to higher levels in the atmosphere the error 0 occurs 43, 38, 34, etc., times in the successive strata. The table is cut off to the right as soon as only 1 observation occurs, yet it should properly be extended to the limits assigned under Δ_1. Since these values are derived by the analytic method of computation, and it has been shown that the Δs by the trigonometric method are one-third greater, we may use this table also for the latter method by increasing, as in the lowest row, the abscissæ

in this ratio. From this system the probable error can be readily computed approximately by the formula*

$$r = 0.2691 \frac{N}{N_o} dx.$$

Where

N = the number in the series.
N_o = the number having the probability of an error 0.
dx = the interval 20.

Examples:

$$r = 0.2691 \times \frac{124}{43} = 0.776 \quad \text{at the 0-meter level.}$$

$$r = 0.2691 \times \frac{122}{38} = 0.863 \quad \text{at the 1,000-meter level.}$$

$$r = 0.2691 \times \frac{103}{10} = 2.772 \quad \text{at the 11,000-meter level.}$$

Hence the probability of close agreement of the two values of z_1 and z_2 is less as the altitude increases, and observations having the error Δ large at high elevations, have the same weight as the small Δs at low levels.

WEIGHTING OBSERVATIONS BY THE EKHOLM AND HAGSTRÖM METHOD.

E_o = instrumental error.

$\frac{\Delta}{2r}$ = angular error of a double point setting.

$$E_m \text{ (mean error)} = \frac{1}{0.6745}; \quad E_p \text{ (probable error)} = \pm \sqrt{E_o^2 + \left(\frac{\Delta}{2r}\right)^2}.$$

d_m = true error of the difference of pairs of angles in azimuth or altitude.

m_1 and m_2 = mean errors of the height z.

$$d_m = \sqrt{m^2_1 + m^2_2} = \sqrt{2}\, m = \pm \sqrt{2}\, z \left[\cot^2 \theta + \tfrac{1}{2} (\cot^2 h + \cot^2 \lambda)\right]^{\frac{1}{2}} \sqrt{E_o^2 + \left(\frac{\Delta}{2r}\right)^2}.$$

$$g = \frac{1}{m^2} = \frac{1}{z^2 \cot^2 \theta \left[E_o^2 + \left(\frac{\Delta}{2r}\right)^2\right]} \text{ approximately.}$$

$$M = \frac{1}{(g' + g'' + g''' + \ldots)^{\frac{1}{2}}}.$$

$$Z_m = (g' z_1 + g'' z_2 + g''' z_3 + \ldots) M^2.$$

Mean error of a number of observations.

An approximate value of m for $E_o = O$, is

$$m = z \cot \theta \frac{\Delta}{2r} = z \cdot \frac{r}{b \sinh} \cdot \frac{\Delta}{2r} = z \cdot \frac{\Delta}{2\, b \sinh}.$$

The EKHOLM and HAGSTRÖM method of weighting observations labors under several difficulties: (1) It is very laborious in computation; (2) it is obtained by a series of approximations involving intricate conditions and lack of simplicity; (3) it practically attempts to assign the error pertaining to one stratum simultaneously as a criterion of weight in all strata, and does not adhere sufficiently to the probability curves, since in practical work we seek at once to combine observations taken in quick succession; (4) the error $\Delta = z_2 - z_1$ proves to be, in using the

* Method of Least Squares. M. Merriam.

formulæ, a fair criterion of the fact that the altitude angles h_1 and h_2 pertain to the same cloud point, but it does not at the same time check the angle $a_2 - a_1$, upon which the height chiefly depends. An example will make this evident.

Referring to the data already given for May 8, 1897, Table 3, (1) the angle a_2 is arbitrarily altered from 126° 56′ to 128° 56′, and the height drops from 10,650 to 7,109, while Δ changes from -25 to $+183$; (2) when the angle h_1 is varied from 35° 28′ to 37° 28′ the height changes from 10,650 to 11,055 and Δ from -25 to -834. Now $\Delta = -834$ would be taken as ground for rejecting, and $\Delta = +183$ for retaining an observation, but clearly this would be a mistake, since the height 11,055 is nearly correct, as shown by the series.

As a result of experience with the formulæ, I believe that it is useless and misleading to attempt to weight individual cloud observations, because the computation is too involved and the setting the sight line on cloud points too rough for refined criteria. It has therefore been the policy of the Weather Bureau to assign *unit-weight* to successive observations on the same cloud point, after excluding those which are decidedly discrepant in the series.

From this criterion of equal weights we obtain the mean height for the cloud observed. Thence the values x . y . V. φ . are found as indicated in the formulæ. Barlow's Tables were employed in making the squares and the square roots. 6,609 computations were made similar to that of Table 3, and of these 4,310 fell into pairs for the determination of V. φ . Considering the loose character of cloud observations in themselves, it is concluded that this process is sufficiently exact for practical work, and that the means of a large number of observations upon the same types of clouds will give results which are to be relied upon in the averages.

CHAPTER 3.

THE THEODOLITE OBSERVATIONS.

The methods that have been adopted in measuring the heights and the velocities of the cloud movements by means of the theodolites placed at the ends of the Washington base line having been already fully described, the results of the observations themselves will be collected in this chapter. Table 6 gives the results *in extenso*, as desired by the International Cloud Committee, and it is as condensed in form as possible. The observations on the several types of clouds have been collected together, each type by itself, so that all the heights and velocities assigned to any given form are readily inspected and discussed. The cloud forms are placed in the order of their mean heights, as computed from these observations, namely, stratus, scud, nimbus, cumulus, cumulo-nimbus, strato-cumulus, alto-cumulus, alto-stratus, cirro-cumulus, cirro-stratus, cirrus. In the discussion of the velocities the scud and nimbus have been treated as stratus, and the cumulo-nimbus as cumulus, thus leaving eight levels to be described.

Under each level in Table 6, page 44, are given the date, hour, and minute of the observation; the computed height of the cloud point, and the part of the cloud upon which a setting was made, by attached letters, b = base, m = middle, t = top, s = side, the original notebooks containing a full description of each cloud and the point of the setting; the difference in height Δz between the two heights as derived from the observations at the two stations, this subject having been already discussed in the introductory chapter, φ_1 the direction from which the cloud moves in compass points, according to the method commonly used among meteorologists; the azimuth φ by the right-hand rotation adopted in this report, being the direction toward which the cloud moves, counted from the south point through the east; the velocity of the cloud motion in meters per second, according to the result of the computation.

No further use has been made of the Δz differences of height than to reject some of the observations by this criterion, where it was probable that the same point on the cloud had not been taken by the sight lines of the two theodolites. The weight *unity* was given to each observation in combining for the mean height of several determinations on the same cloud.

Under the date of the day's observations is placed the barometric pressure in millimeters, the air temperature in centigrade degrees, and the direction and relative intensity of the gradient, designated according to the gradient number which is determined by the scale described in Chapter 12, page 664. A complete record of the meteorological data for the day may be found in Table 129, page 636, corresponding to that inserted in Table 6.

TABLE 6.—*Summary of theodolite observations.*

STRATUS.

Note.—Under the date is given the meteorological data, barometer in millimeters, temperature in degrees centigrade, the wind direction and velocity in miles per hour. φ indicates the azimuth of the direction *toward* which the cloud moves, counted from the south through the east. φ_1 indicates the direction *from* which the cloud moves, expressed in compass points.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 4	1.46	954 b	+ 56		
765, 19	1.50	590 b	+120		
W 2					
June 15	6.47	866 t	+ 99	212.7 SSE	6.9
768, 19	.49	946 t	+ 68		
W 1					
June 16	6.39	856 t	− 41		
765, 21					
NW 1					
June 24	4.04	566 t	+ 12	220.5 SE	5.4
766, 21	.06	626 t	+ 21		
NW 3					
July 10	6.42	1412 t	+ 32		
769, 26					
NW 3					
July 22	9.39	1550 t	− 1		
764, 24					
N 3					
July 25	8.51	766 t	+ 12		
762, 21					
NE 5					
Aug. 15	8.22	945 t	+164		
766, 24	8.27	979 t	+240		
766, 29	1.17	1792 t	−125		
NW 2	1.21	1330 t	− 29		
	1.24	1521 t	+132		
	1.29	1741 t	+ 96		
	1.31	1834 t	− 34		
	1.33	1241 t	+ 10		
	1.36	1749 t	− 55		
	1.42	1313 t	+ 9	305.2 NE	4.8
	.44	1341 t	+ 21		
765, 28	3.56	1558 t	+ 7		
Sept. 5	8.15	950 t	− 15		
764, 17	8.20	919 m	+ 57		
NW 7	8.25	1042 t	+ 24		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Sept. 5	8.46	968 b	+ 22		
764, 17	8.49	588 t	− 2		
NW 7	8.53	626 t	+ 5		
Sept. 16	1.22	1045 b	− 51		
760, 23					
E 3					
Sept. 22	8.32	1748 t	+ 37		
759, 16	8.36	1976 t	+ 12		
NE 1	8.40	1699 b	−120		
	8.49	1712 t	+ 12		
	8.53	1727 t	− 4		
	8.57	2215 t	+ 26		
Oct. 10	8.44	1055 t	− 22	266.4 E	13.9
774, 8	.46	1070 t	−137		
S 8	9.02	1324 t	+267	275.6 E	13.0
	.04	840 t	− 277		
	9.10	986 t	+133		
772, 13	1.12	1170 t	+129		
	1.15	1128 t	+ 24		
	1.20	1151 t	+ 27		
	2.05	1034 t	+ 41		
771, 12	4.32	1558 t	+ 42		
	4.35	1158 t	+ 42		
	4.38	1103 t	+ 10		
	4.40	815 t	+141		
	4.46	1103 t	+ 10		
Oct. 13	1.27	1050 t	+ 12		
758, 12	1.32	560 t	+ 2		
E 7	1.44	803 t	+ 49		
	1.50	1439 t	−129		
	1.52	1361 t	−165		
	1.58	746 t	+ 22		
	2.15	650 m	− 48		
	2.20	698 t	− 47		
757, 12	4.05	795 t	−130		
	4.08	913 t	− 36		
	4.14	624 t	+ 33		

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Oct. 13	4. 19	1170 t	+148			Dec. 30	1. 23	1263 t	+ 54		
757, 12	4. 21	896 t	+ 9			772, 11	4. 00	1063 t	—105		
	4. 28	651 t	+ 20	26. 4 NNW	4. 2	NW 2	4. 02	1787 t	+ 74		
	. 30	626 t	— 1				4. 04	1798 t	+ 4		
							4. 06	1814 t	+ 6		
Oct. 14	1. 45	859 t	— 1				4. 11	2034 t	+ 91		
756, 13	1. 53	965 t	— 90	26. 0 NNW	7. 4		4. 13	1897 t	+ 32		
NE 5	. 55	1164 t	0				4. 16	1849 t	+ 41		
	1. 59	1156 t	— 55			1897					
	2. 07	704 t	— 99			Jan. 16	3. 09	846 t	+ 38		
	2. 27	934 t	+ 20			770, 1					
	2. 29	916 t	+ 38			W 1					
	2. 37	988 t	+ 27			Jan. 20	9. 14	1804 t	+ 8		
Oct. 30	1. 14	1458 t	+ 8			774, -39	9. 18	2040 t	+ 16		
761, 23	1. 31	1136 t	+ 41			771, 2	1. 34	2324 t	+ 57		
NW 6	1. 43	1156 t	+ 17			W 5	1. 40	2430 t	+ 114		
	1. 46	1204 t	+ 50				1. 42	2256 t	+ 49		
	1. 52	1170 t	+ 27				1. 46	2374 t	+ 17		
	1. 56	1486 t	— 45			Feb. 1	1. 34	586 b	+ 31		
	1. 58	1194 t	— 13			771, 2	1. 36	496 b	+ 55		
	4. 24	1370 t	+ 23			SW 5					
Nov. 4	8. 39	1662 t	+ 5			Feb. 5	1. 44	842 t	+ 43	228. 0 SE	4. 8
768, 13	8. 42	1575 t	+ 32			772, 2	. 46	910 t	+ 8		
NW 1						SW 3	1. 54	895 t	+ 56	212. 2 SSE	6. 2
Nov. 5	1. 12	1568 t	— 6				. 56	930 t	+ 2		
751, 21	1. 17	1230 t	— 14				2. 02	758 t	+ 13	62. 8 WNW	6. 5
NW 8							. 04	932 t	— 27		
Nov. 11	3. 53	777 t	—193			771, 1	4. 25	684 t	— 11		
762, 16							. 27	734 t	+ 2		
NW 6							. 29	781 t	+ 22		
							4. 33	896 t	+ 6		
Nov. 19	1. 46	1128 t	+ 15				. 37	687 t	— 40		
766, 17	1. 56	1161 t	— 35			Mar. 3	9. 00	954 t	+ 28		
Nov. 27	10. 27	810 t	+ 11			761, 2	9. 05	510 t	+ 10		
767, 16	10. 30	828 t	—241			N 8	9. 10	490 t	+ 2		
NE 4	10. 36	815 t	+ 68			Mar. 8	5. 24	651 t	— 4		
	10. 41	729 t	— 26			773, 3	5. 28	858 t	— 7		
	10. 48	947 t	+190			W 4	5. 32	820 t	+ 67		
Dec. 18	9. 03	1870 t	+103	133. 7 SW	20. 3		5. 34	716 t	+ 13		
764, 1	. 04	1950 t	0	128. 5 SW	18. 6		5. 37	846 t	+ 29		
NW 8	. 05	1953 t	— 81				5. 55	598 t			

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Mar. 10	9.02	402 t	+ 24			May 5	8.36	627 t	− 4	358.0 N	7.4
776, 12	9.05	378 t	− 4			760, 11	.37	712 t	+ 92		
N 3	9.09	317 t	+ 42			NW 1	8.41	720 t	− 6	355.5 N	6.8
Mar. 23	2.14	883 t	−106				.42	704 t	+ 6		
753, 18	2.16	917 t	0				8.48	821 t	+106		
W 1	2.24	816 t	− 6				8.52	647 t	− 22		
Apr. 5	9.55	826 t	+111				8.57	645 t	− 18		
750, 10	10.13	763 t	+ 8				8.59	886 t	− 10	335.9 NNE	5.8
NW 3											
							9.00	930 t	+ 5	342.0 NNE	4.6
Apr. 12	8.56	637 t	0				.01	970 t	+ 7		
773, 8	9.04	552 t	− 20			May 12	8.45	678 t	+ 59		
W 2						760, 19	9.02	726 t	+ 15		
Apr. 13	8.49	1296 t	+284			NW 7	9.06	1282 t	− 59		
776, 7	8.54	426 t	+ 3				9.14	766 t	− 68		
NW 5	9.04	892 t	− 20				9.20	915 t	+ 70		
	9.13	448 t	+ 11				9.31	752 t	− 5		
	9.15	648 t	+ 1				9.36	772 t	+ 81		
	9.19	545 b	− 36				9.48	710 t	+ 14		
	9.24	570 t	− 18			758, 24	1.12	1398 t	− 5		
	9.31	580 t	− 55				1.17	1128 t	− 9		
	9.36	460 t	0	175.5 S	4.5		1.21	1162 t	− 10		
	.37	488 t	+ 17				1.34	1918 t	−117		
	9.40	590 t	+ 6				1.36	1132 t	− 21		
Apr. 15	11.11	376 t	+ 20			May 13	6.09	1046 t	− 19	344.6 NNE	5.1
758, 14	11.15	574 t	− 89			756, 19	.11	958 t	− 11		
E 4	11.17	585 t	+124			NW 9	6.13	978 t	− 10		
	11.34	595 t	− 36				6.16	976 t	− 57	62.2 WNW	6.9
	11.38	768 t	+ 12				.18	1008 t	+ 7		
Apr. 30	8.59	754 t	+ 9				6.20	890 t	− 47	76.9 WNW	4.2
762, 15	9.09	791 t	− 48				.21	808 t	− 7		
SW 4	9.16	898 t	− 1				6.54	410 t	+ 2		
	9.42	893 t	+220				6.59	338 t	0		
	9.46	811 t	− 77			May 14	8.45	376 t	+ 61		
	9.59	716 t	+ 3			760, 16	8.52	385 t	0		
May 1	8.39	262 t	+ 13			N 6	8.59	363 t	− 4		
758, 18							9.03	394 t	+ 90		
SW 5							9.08	474 t	0		
May 3	3.07	622 t	+ 14				9.13	362 t	0		
756, 8	3.15	784 t	− 7	119.4 WSW	10.8		9.29	399 t	0		
	.16	1370 t	+ 72				9.31	340 t	0		

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATUS.

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m.p.s.*
May 14	9.33	397 t	+ 54		
760, 16	9.34	374 t	+ 25		
N 6	9.38	436 t	0		
May 21	6.18	1542 t	+ 28		
758, 21	.20	1741 t	— 4		
	6.22	1704 t	— 47		
	.23	2142 t	+ 13		
May 24	9.53	601 t	+ 91		
760, 19	10.02	668 t	+117		
N 3	10.07	1086 t	+193		
	10.09	1372 t	—174		
	10.15	888 t	+467		
	10.18	604 t	0		
June 3	8.42	669 t	0		
763, 20	8.45	620 t	0		
NW 8	8.46	566 t	0		
	8.50	636 t	+ 57		
	8.59	713 t	+ 34		
	9.02	677 t	+162		
	9.06	520 t	+ 6		
	9.08	733 t	+ 15		
	9.14	577 t	— 23		
	9.18	774 t	+105		
	9.21	584 t	— 9		
June 4	8.56	685 t	—184		
760, 23	9.00	635 t	+ 10		
N 2	9.04	556 t	0		
	9.06	1057 t	— 6		
June 7	1.14	558 t	— 10		
766, 14	1.20	583 t	+ 16		
W 6	1.41	428 b	+ 15		
	1.45	544 b	+ 9		
	1.48	570 s	—127		
	2.02	615 s	+ 6		
June 9	8.53	549 t			
764, 16	9.02	896 t	+100		
S 1	9.08	449 t	+ 10		
	9.11	606 t	+131		
	9.23	596 t	+ 44		
	9.26	413 b	— 32		
	9.35	496 t	— 4		

Date		Height z	Δz	φ φ_1	V
1897	*h.m.*	*m.*	*m.*	°	*m.p.s.*
June 9					
763, 19	1.05	796 t	— 3		
	1.08	660 t	— 20		
	1.16	861 t	+ 24	30.5 NNW	7.1
	.17	835 t	0	35.6 NW	4.9
	.18	859 t	+ 44	34.9 NW	4.5
	.19	905 t	+ 56	29.8 NNW	7.8
	.20	842 t	+ 4		
763, 19	6.42	864 t	— 12	9.4 N	5.1
	.43	849 t	+ 4	5.2 N	6.3
	.44	982 t	+ 40		
June 18	8.46	443 t			
759, 18	8.49	467 t			
W 2	8.53	475 t	+ 21		
	9.16	434 t			
	9.18	422 t			
	9.20	408 t			
	9.21	411 t			
	9.38	543 t	— 55		
June 23	6.51	843 t	— 23		
761, 22	6.53	903 t	+149		
NW 4	6.56	829 t			
	6.59	818 t	— 31		
	7.02	870 t	+ 15		
June 24	8.45	486 t	— 3		
762, 22	8.47	534 t	— 3		
NW 3	8.58	529 t	— 13	197.4 SSE	2.7
	.59	577 t	— 21		
	7.10	413 t	+ 16	247.5 ESE	2.1
	.11	448 t	+ 19		
	7.14	370 t	— 9	105.0 WSW	0.8
	.16	455 t	— 6	120.0 WSW	0.3
	.18	485 t	— 70		
June 28	1.18	765 t	— 14		
768, 18	1.22	631 t	+131		
NW	1.23	753 t	+ 11	111.3 WSW	10.1
	.24	841 t	— 21	143.2 SW	8.0

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 28	.25	799 t	− 3	134.0 SW	5.8	June 29	8.57	483 b	− 37		
768, 18	.26	812 t	+ 17			765, 24	9.00	428 b	− 19		
NW	1.27	786 t	− 27	110.6 WSW	5.6	NW 4	9.02	513 s	− 32		
	.28	768 t	+ 6	129.3 SW	5.5		9.08	465 b	+ 4	214.4 SE	5.7
	.29	770 t	− 3				.09	487 b	+ 18		
	1.32	797 t	− 2	205.3 SSE	5.7		9.11	490 s	+ 58	142.4 SW	0.7
	.33	824 t	+ 3	202.5 SSE	5.5		.13	470 s	+ 14		
							9.17	214 t	+ 46		
	.34	808 t	+ 29	200.0 SSE	6.8		9.22	481 t	− 35		
	.35	824 t	+ 29				9.27	1030 t	− 76		

THIN SCUD.

1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 30	6.34	2126 t	+ 17			Aug. 14	9.29	779 b	+ 6		
759, 25	6.43	1664 t	− 37			763, 25	9.34	1082 t	− 84		
NE 2	6.53	2281 t	+ 28			E 1	9.38	872 t	+ 12		
	6.55	2549 t	+ 36				9.55	1096 t	+ 6		
	6.57	1879 t	− 83				10.08	1100 t	+ 16		
							10.11	882 t	+109		

NIMBUS.

1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 24	1.06	814	+ 4			Aug. 21	6.21	1713 t	−194		
766, 21	1.13	844	+ 13			761, 25	6.25	2759 t	+ 18	110.0 WSW	8.1
NW 3	1.18	665	+ 36			W 3	.27	2715 t	+ 30		
	1.21	797	+ 55	228.9 SE	9.3		6.30	2605 t	+ 12		
	.22	851	+ 80			Sept. 15	1.15	3395 t			
	1.30	693	00	49.2 NW	6.6	760, 23					
	.32	1203	00			NE 1					
July 9	8.38	855	+ 16								
764, 24	8.49	864	− 17			Oct. 23	4.06	1076 t	− 19		
NW 5	1.28	634	− 44			755, 17	4.10	1023 t	+ 51		
						NW 5					
July 21	3.56	4239 t	+ 15	126.5 SW	11.5						
764, 27	.58	4142 t	− 52			Nov. 4	8.51	1574 t	−236		
NE 3	4.00	3685 t	+ 32			767, 14	9.00	1746 t	+101		
Aug. 21	6.06	2333 t	− 58	126.5 SW	8.6	NW 1	9.04	1533 t	− 33		
761, 25	.08	2149 t	− 20				9.07	1752 t	+121	193.5 SSE	10.4
W 3	6.10	2330 t	+ 63				.09	1700 t	+ 64		

TABLE 6.—*Summary of theodolite observations*—Continued.

NIMBUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Nov. 4	9. 15	1501 t	+ 73			Apr. 15	1. 15	1350 t	+ 7		
765, 20	1. 20	1966 t	+ 47			758, 16	1. 18	1274 b	+ 36	133. 6 SW	5. 9
	1. 31	1938 t	+ 33			E 4	. 20	1086 b	+ 8		
	1. 37	2190 t	− 70			May 21	8. 42	3276 t	+ 59	113. 2 WSW	13. 7
	1. 41	2015 t	− 4			756, 19	. 44	3100 t	− 57		
	1. 44	2240 t	− 11			NE 4	8. 46	2838 t	+ 99	120. 4 WSW	10. 8
	1. 47	2196 t	+ 88				. 48	2890 t	+ 69		
	1. 51	2496 t	− 10				8. 51	3070 t	− 51	121. 8 WSW	12. 6
	1. 53	2046 t	+ 27				. 53	2908 t	− 41		
	1. 57	2494 t	− 72				8. 55	3040 t	+126	123. 9 WSW	14. 0
Nov. 19	4. 01	2039 t	+ 80	99. 5 W	11. 2		. 57	3684 t	+ 92		
768, 14	. 03	1933 t	+ 48				9. 00	1036 b	− 30		
NE 4	4. 06	2038 t	+ 5	90. 4 W	12. 7	June 17	1. 26	935 b	+ 46		
	. 08	1812 t	− 31			756, 24	1. 28	926 b	+ 2		
	4. 14	1805 t	+ 13			W 2	1. 32	726 b	− 10	184. 2 S	5. 0
	4. 17	1911 t	+ 13	80. 0 W	11. 3		. 33	718 b	− 45	175. 5 S	4. 5
	. 18	1884 t	+ 21	71. 7 WNW	11. 9		. 34	668 b	−102		
	. 19	2020 t	+ 96				1. 35	883 b	− 10	166. 0 SSW	5. 4
	4. 25	2325 t	+136				. 36	910 b	+ 19		
	4. 28	1701 t	+ 26								
Dec. 15	4. 07	789 t	− 72								
759, 2	4. 10	646 t	− 42								
S 10	4. 12	662 t	+120								

CUMULUS.

1896	*h. m.*	*m.*	*m.*	°	*m, p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 6	1. 23	1432 t	− 46	40. 2 NW	1. 9	May 13	8. 20	2859 t	+ 28		
766, 13	. 25	1737 t	+111			763, 20	8. 53	3135 t	+ 8	83. 9 W	9. 2
NW 2						W 2	. 55	3004 t	+ 25		
May 7	7. 04	1154 t	0	180. 2 S	3. 3	763, 25	1. 13	1595 t	−116		
771, 14	. 06	1175 t	+ 88				1. 20	1168 b	−114	232. 4 SE	3. 0
W 3							. 22	1127 b	+ 14		
May 11	12. 31	1623 m	+ 11				1. 45	1358 t	+ 1		
759, 33	12. 33	2089 t	+ 15				1. 51	1274 t	+ 1		
NE 7	12. 40	2190 t	+ 27	66. 2 WNW	14. 7		1. 52	1294 t	− 5		
	. 42	2689 t	+ 1			May 15	8. 29	2605 t	− 24	127. 2 SW	12. 2
	12. 48	2416 t	+ 8	42. 2 NW	13. 9	762, 23	. 31	2864 t	+155		
	. 50	2426 t	− 21			NE 1	8. 37	2850 t	− 14	117. 1 WSW	13. 4
	12. 54	2968 t	0				. 39	2768 t	− 37		
	12. 56	2388 t	− 57				8. 48	2999 t	+ 18	128. 1 SW	13. 0
							. 50	2684 t	+ 34		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 15	8.52	1487 m	+ 9		
762, 23	9.00	1346 m	+ 3	46.4 NW	18.3
NE 1	.02	1448 m	− 28		
May 19	8.30	1990 t	+ 44	57.2 WNW	15.7
758, 23	.31	2052 t	− 34		
NE 3					
May 26	1.13	1868 t	+ 22		
759, 27	.14	2065 t	+ 36	98.4 W	12.0
N 9	.15	2117 t	+ 79		
	1.21	2144 t	−160		
May 27	8.27	2022 t	− 5	105.2 WSW	11.4
762, 21	.29	2128 t	+181		
NE 3	8.51	1985 t	− 7	100.4 W	11.0
	.53	1995 t	+ 21	95.7 W	11.5
	.55	1889 t	− 21		
May 28	2.33	1467 t	− 41	71.7 WNW	11.5
754, 30	.35	1329 t	− 29		
NW 9	2.44	2559 t	− 60	87.7 W	40.3
	.46	2149 t	− 60		
May 29	6.07	2374 t	− 96		
761, 21					
N 7					
June 1	6.25	2156 t	+161	93.7 W	2.0
763, 19	.27	3051 t	−140		
NE 5	6.48	2285 t	+ 41	45.1 NW	7.6
	.50	2401 t	−122		
June 3	1.56	1875 t	−250	201.6 SSE	2.4
768, 23	.58	1634 t	− 44	201.7 SSE	3.2
SW 3	.60	1879 t	−186		
	3.45	1697 m	− 4	150.7 SSW	14.7
	.47	1645 m	− 29		
767, 22	3.53	1744 m	+286		
	4.01	1624 t	+ 90		
	4.05	1931 t	+108	150.1 SSW	9.0
	.06	1993 t	+ 94		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 5	8.20	1042 t	− 39		
766, 20	8.26	1058 t	+ 11	307.1 NE	4.2
NW 2	.28	1245 t	+142		
	8.49	1290 t	− 83		
	9.33	1427 t	− 3		
	9.44	1443 t	− 85		
	9.52	1682 t	+254	218.1 SE	2.6
	.54	1681 t	+152		
	10.09	1095 t	− 53	71.7 WNW	3.8
	.11	1166 t	+ 30		
June 10	8.22	1948 t	+ 60	30.1 NNW	4.6
752, 21	.24	2180 t	+ 10		
NE 8	8.36	1939 t	−149		
	8.49	1825 t	+165		
	8.55	2484 t	− 88		
	9.13	1224 t	+ 81		
	9.16	1467 t	−106		
	9.21	1348 t	+ 57		
	9.35	1395 t	+ 6		
	9.40	1222 t	+ 3		
	9.44	1851 t	+ 45	49.5 NW	6.8
	.45	1751 t	− 23	22.4 NNW	9.2
	.46	1819 t	+ 45		
753, 25	1.08	1432 t	−235		
	1.17	1948 t	+ 22		
754, 22	3.32	1637 t	+ 41		
	3.35	1553 t	− 3	2.4 N	5.5
	.37	1461 t	+114		
	3.47	1428 t	+ 38		
	3.49	1343 m	− 55		
	3.55	1350 t	+ 11		
755, 21	6.06	1483 t	+ 15		
	6.16	1275 t	+ 5	31.4 NNW	9.6
	.18	1179 t	− 5		
	6.21	1530 t	+ 67	33.5 NNW	13.7
	.23	1311 t	− 83		
June 15	3.45	1839 t	+ 27		
768, 20	3.47	2790 t	− 15		
W 1	6.34	2630 t	−249		
	6.37	1312 t	− 40		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 16	1. 54	1020 t	+ 12	142. 5 SW	7. 3
766, 22	. 55	1043 t	— 15		
NW 1	6. 21	1970 t	— 32		
	6. 25	1629 t	— 50		
	6. 27	1262 t	— 31		
	6. 33	1465 t	—178		
June 17	3. 36	982 t	+ 18	158. 1 SSW	1. 3
762, 23	. 38	914 t	0		
NW 1	3. 44	915 t	— 4		
	3. 47	1412 t	— 4	64. 1 WNW	1. 2
	. 49	1315 t	—102		
	3. 53	1601 t	+ 11	34. 7 NW	1. 3
	. 55	1867 t	— 72		
June 18	1. 10	1187 t	+ 22	295. 5 ENE	3. 8
763, 26	. 12	1277 t	+ 16		
NW 1	1. 14	1121 t	+ 4		
	1. 18	1166 t	+ 11	39. 7 NW	2. 2
	. 20	1193 t	+ 86		
	1. 24	1275 t	+ 10		
	3. 25	1532 t	— 25		
	. 28	2130 t	+270		
	. 30	1567 t			
	3. 43	1892 t			
	. 45	1874 t			
June 19	9. 12	3318 t	— 62	251. 1 ESE	6. 1
764, 23	. 14	2808 t	— 33	197. 7 SSE	6. 2
NW 2	. 16	2994 t	+144		
763, 29	1. 09	1343 t	— 6	129. 7 SW	5. 5
	. 11	1475 t	— 70		
	1. 13	1534 t	+ 11		
	1. 17	1679 t **562** b	— 20	132. 9 SW	3. 3
	. 18	1677 t	+ 2	155. 9 SSW	3. 2
	. 19	1754 t	+ 27	124. 7 SW	3. 8
	. 20	1760 t	+ 7		
	1. 27	1344 m	— 39		
	3. 37	1740 t **1587** b	+ 23		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 19	3. 40	1854 t **1423** b	+ 4	136. 2 SW	5. 6
763, 29	. 42	1740 t	+ 39		
June 20	1. 15	2883 t **1887** b	— 93	98. 2 W	8. 0
762, 32	. 17	3275 t **2097** b	— 5	85. 2 W	4. 5
NE 3	. 19	3040 t **2281** b	+ 23		
	1. 23	3370 t **1644** b	+179		
	1. 40	2436 t	— 49	104. 7 WSW	5. 5
		1979 m **1687** b			
	. 42	2054 m	+ 17		
	2. 02	2547 t **2140** b	+109	82. 5 W	5. 1
	. 05	2726 t	— 80		
762, 31	3. 26	2142 m **1394** b	— 6	109. 4 WSW	5. 1
	. 28	2206 m	— 7	107. 5 WSW	5. 7
	. 30	2212 m	+ 23		
	3. 41	2480 t	— 29		
	3. 45	2550 t	— 66		
	3. 47	2976 t	+ 19		
	3. 53	2518 t	— 23		
762, 30	6. 01	2230 m	— 64		
	6. 04	1937 m	+ 93		
	6. 12	1969 t	+ 19	107. 2 WSW	5. 7
	. 14	2017 t	+ 60	99. 5 W	6. 4
	. 16	1974 t	+ 15	92. 1 W	4. 7
	. 18	2034 t	+123		
	6. 23	1968 t	—123	96. 1 W	5. 2
	. 25	1997 t	— 64		
June 22	*3. 36	2911 t	+137		
759, 26	6. 47	2474 t	+ 27	350. 7 N	6. 3
NE 3	. 49	2755 t	— 1		
June 24	1. 46	1311 t	—171		
766, 21	3. 32	1543 t	— 99	239. 5 SSE	15. 5
NW 3	. 33	1789 t	—118		

*760, 27.

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 26	1.09	1524 t	+ 14	94.7 W	1.8
764, 30	.11	1423 t	+ 9		
NE 4	1.19	1180 t	+ 30	123.2 WSW	5.5
	.21	1411 t	+ 78		
June 29	1.11	2278 t **904** b	+ 84	81.7 W	11.1
761, 29	.13	2066 t	+140		
NE 4	1.15	2346 t **1059** b	− 54	99.1 W	11.3
	.17	2246 t	+ 5		
	1.25	3262 t **1002** b	+ 28		
	1.30	2260 t **1555** b	− 4	111.2 WSW	9.4
	.32	1954 m	+ 17		
	1.37	2010 m	+ 28	115.2 WSW	8.3
	.39	2271 t	− 22		
761, 28	3.27	2240 t	+ 60	64.2 WNW	7.4
	.29	1999 m	− 22		
	3.31	1954 m	+ 11	98.5 W	8.0
	.33	2154 t	− 4		
	3.36	2155 t	+ 54	82.8 W	8.9
	.38	2000 t	− 36		
	3.42	3421 t **2628** b	+ 29	82.0 W	7.6
	.44	2453 t	+ 61		
	3.48	2167 t	+ 19		
July 1	1.37	1837 t	+ 54		
768, 28	1.40	1488 t	+ 23		
NE 2	1.43	1573 t	+ 15		
	1.46	1614 t	+ 46		
	1.50	1584 t	+ 18		
	1.53	1543 t	+ 17		
	1.59	1832 t	+ 16		
	2.06	2058 t	− 15	169.7 S	4.1
	.08	2144 t	− 51	186.4 S	5.1
	.10	2557 t	− 35		
768, 28	3.34	1351 m	− 46	202.2 SSE	2.5
	.36	1359 m	+ 17	222.2 SE	2.5
	.38	1397 m	+ 64		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 1	3.40	1855 t	+ 13	172.9 S	5.5
768, 28	.42	1796 t	+ 28	177.0 S	2.5
	.44	1732 t	+ 27		
	3.46	1560 m	+ 35	196.4 SSE	7.8
	.48	1964 m	− 38		
	3.52	1835 t **944** b	+ 1	172.0 S	1.7
	.54	1813 t	− 36		
July 3	1.16	2640 t	+137	107.2 WSW	0.5
764, 30	.18	2729 t	+125		
W 2					
July 6	1.29	1704 t **793** b	−156	48.8 NW	0.9
760, 28	.31	1639 t **821** b	+ 32		
N 2	1.35	1550 t	+ 32	76.8 WNW	5.9
	.37	1686 t	+ 31		
	1.39	1582 t **646** b	+ 19	67.5 WNW	2.6
	.41	1263 t	− 3	97.8 W	4.7
	.43	1844 t	+ 20		
July 9	9.00	1260 t	− 59		
764, 23	9.04	1554 t	− 69		
765, 27	12.06	2118 t	− 12	162.0 SSW	21.6
NW 5	.08	1879 t	+ 48		
	1.03	2206 t **952** b	− 23	177.0 S	13.8
	.05	2653 t	− 28		
	1.09	2488 t **621** b	− 24		
	1.11	2770 t **670** b	+ 48		
	1.14	2827 t **679** b	− 28		
	1.24	1713 t	+256		
765, 27	3.23	2001 t	+321	157.8 SSW	18.5
	.25	1736 t **1025** b	+240		
	3.30	1639 t **731** b	+ 11	161.5 SSW	12.1
	.32	2227 t **1045** b	+ 13		
	3.35	1984 t **1068** b	+ 6		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 10	1. 25	1173 t **588** b	− 35	177. 5 S	2. 8
769, 27	. 27	1371 t **621** b	− 11	152. 0 SSW	4. 0
NW 3	. 29	1415 t	+ 32		
	3. 15	1077 t	+ 2	136. 2 SW	4. 0
	. 16	1033 t	+ 46	160. 0 SSW	4. 4
	. 17	1043 t	− 5		
	3. 23	1239 t	− 89		
	3. 25	1144 t	+126		
	3. 29	1209 t **425** b	+ 10	156. 4 SSW	7. 2
	. 30	1244 t	+ 3	152. 4 SSW	6. 9
	. 31	1350 t	− 71	150. 0 SSW	5. 7
	. 32	1312 t	− 40		
July 11	2. 11	2091 t	− 7	52. 2 NW	9. 8
768, 29	. 13	1766 t	− 59		
N 3	2. 16	2020 t **1151** b	− 18		
	. 17	2460 t	−225	42. 7 NW	4. 0
	3. 19	2036 t	− 43		
July 13	1. 28	2066 t	+ 28	57. 2 WNW	9. 4
762, 31	. 31	1990 t	+ 49		
NE 2	1. 36	2168 t	− 18		
	1. 39	2573 t	+ 44	49. 5 NW	7. 7
	. 41	2859 t	− 10		
	1. 48	2389 t	− 7		
	1. 57	2378 t	+118		
762, 31	3. 32	3219 t	− 1	111. 4 WSW	9. 3
	. 34	3613 t	− 32		
	3. 39	3282 t	+ 95	77. 7 WNW	13. 3
	. 41	2546 t	− 84		
	3. 44	2142 t	+ 34	89. 7 W	7. 2
	. 46	2270 t	+ 45	74. 0 WNW	8. 6
	. 48	2206 t	+ 25		
	3. 55	2124 t	+ 39	60. 4 WSW	4. 6
	. 57	1759 t	+ 34		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 14	1. 42	2177 t	−196	76. 0 WNW	6. 5
761, 31	. 44	2051 t	+245		
NE 2	1. 52	1552 t	+ 10		
	2. 03	1414 t	0		
	2. 07	1320 t	− 11		
	2. 11	1620 t	+ 8	36. 5 NW	6. 0
	. 13	1904 t	+175		
July 17	8. 19	1634 t	− 9	27. 0 NNW	5. 7
765, 19	. 21	1652 t	− 44	29. 7 NNW	5. 8
E 3	. 23	1637 t	− 13		
	8. 27	1924 t	+ 18	39. 8 NW	7. 3
	. 29	1702 t	− 7		
	8. 39	2101 t	− 6	56. 0 NW	8. 1
	. 41	2218 t	+ 53		
	8. 46	1556 t	+ 28	33. 4 NNW	4. 9
	. 48	1611 t	− 22		
	8. 53	1963 t	−212		
766, 24	1. 17	1945 t	− 33	19. 5 NNW	6. 4
	. 19	1898 t	− 44	21. 0 NNW	6. 0
	. 21	1904 t	− 49		
	1. 24	2505 t	+197		
	1. 27	1923 t	+ 13		
	1. 40	1966 t	+ 1	17. 0 NNW	3. 8
	. 42	1820 t	+ 38		
	1. 51	1839 t	0		
	1. 55	1969 t	− 17		
766, 24	1. 58	1829 t	− 15		
	3. 27	2013 t	− 7	5. 5 N	6. 2
	. 30	1981 t	− 5		
	3. 32	1945 t	+ 38		
	3. 34	2135 t	− 21	33. 8 NNW	3. 5
	. 36	2227 t	+ 2		
	3. 41	2060 t	− 54	11. 5 N	4. 7
	. 43	2033 t	−110		
	3. 45	2070 t	− 36	11. 0 N	5. 8
	. 47	2057 t	− 79		
767, 23	6. 22	2069 t	− 91		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 18	1. 20	1933 t	− 22	330. 5 NNE	1. 5
770, 26	. 22	1855 t	+ 8	293. 2 ENE	2. 0
NW 1	. 24	1848 t	− 16		
	1. 29	1833 t	+123		
	3. 29	2670 t	+162	270. 0 E	3. 8
	. 31	2210 t	+ 95		
	3. 47	2627 t	+ 96	317. 7 NE	12. 7
	. 49	2127 t	− 52		
July 20	8. 27	985 t	+121		
766, 25	9. 04	1016 t	+ 41		
764, 30	1. 23	2447 t **776** b	+ 16		
NW 5	1. 26	1369 t	− 3		
	1. 33	1452 t	+ 36		
	2. 06	1003 t	+ 58		
	2. 10	1352 t	− 5	101. 8 WSW	11. 0
	. 12	1504 t	− 12		
764, 30	3. 31	1588 t	+ 6	120. 0 WSW	8. 7
	. 33	1613 t	− 53		
	3. 36	2054 t	− 92		
	3. 39	1711 t	+ 15		
	3. 41	2847 t	+ 11		
	3. 43	1447 t	+ 9		
July 21	1. 13	1161 t	− 32	107. 8 WSW	4. 3
764, 28	. 15	1502 t	0		
NE 3	1. 23	1462 t	+ 23		
July 22	9. 02	3019 t	− 44		
764, 24	9. 58	982 t	− 25		
764, 28	1. 20	2162 t	− 53		
N 3	1. 30	2095 t	0		
	1. 32	1195 t	− 8		
	1. 34	1569 t	− 14	105. 7 WSW	5. 2
	. 36	2050 t	− 68		
	1. 38	2343 t	− 35		
	1. 40	2692 t	− 29		
July 24	8. 45	1086 t	+ 60		
762, 21					
NW 5					

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 25	*8. 33	1135 t	+ 8		
764, 25	1. 14	1663 t	− 15		
NE 5	1. 18	1815 t	− 78	84. 8 W	7. 7
	. 20	1470 t	− 17		
	1. 22	1732 t	− 24		
	1. 25	1675 t	− 4		
	1. 26	1749 t	− 1		
	1. 30	1792 t	− 67		
	1. 32	1737 t	− 8		
	1. 36	1652 t	+ 4		
	1. 39	1819 t	+203		
	3. 26	2011 t	+163	9. 0 N	6. 3
	. 28	1535 t	− 52		
	3. 35	1775 t	− 3	21. 2 NNW	5. 8
	. 37	1951 t	+ 60		
	3. 44	1938 t **1352** b	−101		
	3. 46	1360 t	−104		
	3. 48	1935 t **1376** b	+ 1	19. 0 NNW	7. 8
	. 50	1886 t	− 6		
	3. 54	1734 t	+ 3	18. 0 NNW	5. 0
	. 56	1699 t	+ 43		
764, 24	6. 19	2015 t **1032** b	− 31	354. 5 N	2. 9
	. 21	1920 t **914** b	− 5	353. 4 N	2. 6
	. 23	1793 t	− 34		
	6. 26	1776 t **1209** b	+ 7	350. 8 N	2. 6
	. 28	1947 t **1224** b	+324	341. 0 NNE	2. 0
	. 30	1779 t **1265** b	− 21	1. 0 N	4. 4
	. 32	1584 t **1260** b	− 20		
	6. 42	1938 t **1445** b	+ 34	333. 2 NNE	4. 1
	. 44	2182 t	+ 81		
July 27	1. 28	1440 t	− 44		
761, 34	1. 33	1388 t	+ 68		
N 3	1. 37	1376 t	− 3		
	1. 40	1506 t	− 76		
	1. 43	1034 t	− 19		
	1. 45	1343 t	+ 30		

*762, 21.

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 27					
760, 33	3. 29	1469 t	+ 2		
	3. 31	1494 t	— 28		
	3. 33	1577 t	— 3		
	3. 56	1515 t	+127		
	3. 58	1553 t	— 5		
	4. 00	1482 t	— 15		
July 28	1. 47	1516 t	— 42		
763, 32	1. 49	1679 t	— 3		
NE 2					
July 29	1. 31	1103 b	— 56	82. 5 W	5. 3
763, 32	. 33	1005 b	+ 34		
NE 1	1. 37	1418 t	+ 13		
	1. 41	1590 t **1170** b	—105		
763. 32	3. 35	1408 t	— 7		
	3. 38	1505 t	— 8		
	3. 40	1696 t **1139** b	— 9		
	3. 42	1914 t **1206** b	+ 88		
	3. 44	2047 t **1194** b	+150		
July 30	7. 04	1879 t	+ 62		
759, 27					
N 4					
July 31	9. 02	1129 t	— 41		
762, 24	9. 04	1178 t	+ 34		
NE 4	9. 16	1341 t	+ 3		
	9. 19	1332 t	+ 7		
	9. 24	1696 t	+ 77		
	9. 28	1158 t	+ 11		
	9. 31	1182 t	— 4		
	9. 34	1529 t	—147		
	1. 18	1780 t	— 31		
764, 27	1. 22	2376 t	+ 89		
	1. 26	1570 t	+ 52		
	1. 29	1860 t **1097** b	+ 9		
	1. 31	2928 t **1735** b	+ 17		
	1. 34	1894 t **1247** b	— 3		
	1. 36	3100 t	+131		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 31	1. 41	1936 t	— 74		
764, 27	1. 45	2047 t **1248** b	— 22		
764, 26	3. 23	1792 t	+ 66	28. 5 NNW	5. 6
	. 25	1424 t	+162		
	3. 28	1743 t	+124		
	3. 32	1972 t	+ 70		
	3. 35	2128 t **1045** b	— 15		
Aug. 3					
762, 24	8. 19	1704 m	— 36	69. 0 WNW	4. 4
E 1	. 21	1697 m	—151		
763, 29	1. 11	2548 t	+ 12	70. 0 WNW	5. 7
	. 13	2350 t	— 3		
	1. 31	2255 t	— 35	72. 4 WNW	3. 4
	. 33	2210 t	+ 3		
	1. 35	2140 t	0		
	1. 38	1682 t	— 10		
	1. 48	2602 t	— 34		
	1. 56	2032 t	— 21	55. 5 NW	4. 0
	. 58	1888 t	— 32		
	2. 00	1832 t **1149** b	+ 20		
763, 29	3. 12	2709 t	+ 15		
	3. 14	2923 t	— 10		
	3. 20	2134 t **1041** b	+ 21		
	3. 24	2675 t **1192** b	+ 56		
	3. 26	3050 t **1336** b	— 70		
	3. 34	2654 t **1198** b	— 22		
Aug. 4	1. 03	1910 t **1016** b	+ 3	85. 5 N	5. 1
763, 32	. 05	1900 t	— 19		
NE 2	1. 09	3060 t **1676** b	+ 10		
	1. 15	2303 t	+ 75		
	1. 17	1766 t **996** b	+ 22		
	1. 20	1700 t	— 9		
	1. 24	1235 t **984** b	+ 69	89. 2 N	1. 9

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Aug. 4	.26	1747 t	+ 1			Aug. 11	3.54	1989 t	+ 81		
763, 32	1.29	1566 t	+189	136.4 SW	2.2	762, 33	3.56	1764 t	− 21		
NE 2						NW 2	3.59	2089 t	+209		
	.31	1655 t	− 24	119.2 SW	2.7	Aug. 12	1.14	2186 t	−171		
	.33	1656 t	− 80			763, 34	1.17	1854 t	+144		
763, 32	3.24	1784 t	− 31			NE 1	1.19	1765 t	+172		
	3.26	1647 t	+184				1.23	2292 t	+179		
	3.28	1596 t	+172				1.26	2087 t **1039** b	+132		
	3.30	1915 t	−101								
	3.33	1176 t	+ 26				1.33	1784 t	+ 29		
	3.40	1719 t	− 21				1.43	1819 t	− 30		
	3.42	1909 t	+157	83.5 W	5.2		1.46	2182 t **1583** b	+ 40		
	.44	1798 t	− 24			763, 34	3.28	3116 t	+ 47		
Aug. 6	1.10	5108 t **1708** m	−148				3.30	3275 t	+ 43		
							3.32	2046 t	+ 37		
764, 36	1.12	4831 t	− 27				3.34	1998 t	+ 15		
N 2	.14	5234 t	− 26				3.36	2732 t **1552** b	−246		
	1.17	3401 t **1566** m	− 38	174.4 S	5.9		3.38	2192 t **1253** b	− 5		
	.19	3621 t	− 40								
	1.27	1274 m	+ 67				3.40	2007 t	+ 64		
	1.40	1632 t	− 19				3.42	1649 t	+254		
	1.42	1954 t	− 42				3.44	2794 t	+ 37		
	1.46	6749 t **2827** m	+ 40	122.4 WSW	1.1		3.46	2157 t	+ 6	20.4 NNW	3.3
							.48	2882 t	+ 31		
	.48	6763 t **2890** m	+289			Aug. 13	1.03	2475 t **1525** b	+ 46		
Aug. 7	1.38	1905 t	+ 71	124.4 SW	1.5	762, 34	1.06	1966 t	+103		
762, 35	.40	2204 t	+ 50			E 1	1.10	1624 m	−113		
N 2							1.13	1811 t	+ 22		
Aug. 8	2.05	1541 t	+ 33	84.5 W	5.5		1.15	1889 t **1247** b	+154	20.7 NNW	0.5
762, 33	.07	1579 t	+ 34								
NW 2	2.11	2014 t	− 72	59.0 WNW	2.7		.17	2100 t	+ 47	48.0 NW	1.2
	.13	1892 t	+ 2				.19	1778 t **1238** b	− 71		
	2.17	1551 t	+ 75								
	2.22	2492 t	+ 27	58.4 NW	2.6		1.24	2856 t **1805** b	+ 91		
	.25	2429 t	+ 29								
	2.29	2412 t	+272	87.2 W	2.4		1.27	2128 t **1406** b	+ 19	48.2 NW	1.4
	.31	2399 t	+224				.29	2279 t **1448** b	+ 30	43.0 NW	1.2
	2.33	2358 t	+ 35								
Aug. 10	1.32	1399 t	− 24				.31	2312 t **1408** b	+ 36		
763, 33	1.35	1934 t	−174				1.43	2353 t	+ 48		
NE 3							1.46	2352 t	+ 67		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m.p.s.*
Aug. 13	1. 49	2468 t	−208		
762, 34	3. 32	1880 t	+224		
E 1	3. 38	1770 t	+ 82		
	3. 39	4768 t	+ 29		
	3. 41	4866 t **2560** b	+243		
	3. 59	2404 t	+ 24		
	4. 01	2564 t	+ 31		
Aug. 14	3. 21	1290 t	+ 24		
763, 28	. 23	1325 t	+ 12		
E 1	3. 31	1180 t	− 32		
	3. 37	1271 t	+ 46		
	3. 40	1318 t	+ 16		
	3. 46	1336 t	+141		
	3. 49	1338 t	+ 17	29. 2 NNW	4. 1
	. 51	1249 t	+ 23		
	3. 55	1376 t	+133		
	3. 58	1379 t	+ 38	10. 2 N	4. 5
	4. 00	1329 t	− 2		
Aug. 15	8. 34	1050 t	− 25		
766, 24	8. 37	1277 t	− 14		
NW 2	8. 41	1262 t	+ 3		
	9. 45	1608 t	+ 8		
	9. 47	1762 t	+ 31		
	9. 49	1617 t	− 67		
766, 29	1. 47	2747 t **1930** b	+ 6	293. 6 ENE	4. 8
	. 49	2538 t	− 17		
	3. 46	1917 t	+ 25	58. 7 WNW	3. 9
	. 48	1864 t	− 42		
Aug. 17	1. 14	2304 t	+ 13		
763, 26	1. 21	2272 t	+ 10		
NE 3	1. 23	2159 t **1171** b	+ 18		
	1. 26	2261 t **1140** b	+ 7		
763, 24	3. 17	2089 t	− 53		
	3. 21	2108 t	+ 7		
	3. 24	2071 t	+ 21		
	3. 27	2090 t	+ 54		
	3. 32	2057 t	+ 8		
	3. 37	2085 t	+ 8		
	3. 41	2019 t	− 5		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m.p.s.*
Aug. 18	1. 16	2834 t	− 49		
763, 25	1. 24	2488 t	+ 13		
NE 2	1. 25	2379 t	+ 38		
	1. 27	2323 t	+ 23		
Aug. 19	1. 06	1749 t	− 15		
768, 23	1. 11	2113 m	− 26		
SE 3	1. 13	2114 t	+ 2		
	1. 16	2176 t	− 35		
	1. 19	2083 t	+ 4		
768, 21	3. 24	2125 t	+ 8	13. 4 NNW	5. 0
	. 26	2018 t	− 1		
	3. 29	2179 t	+ 14		
	3. 32	2100 t	+ 18		
	3. 39	2214 t	−205	28. 9 NNW	8. 8
	. 41	2051 t	+ 57		
	3. 43	2247 t	− 72		
	3. 52	2107 t	+ 16	19. 0 NNW	8. 7
	. 54	2615 t	−247		
Aug. 20	12. 59	1830 t	+ 13	74. 6 WNW	2. 2
768, 24	1. 01	1677 t	− 39		
NE 4	1. 14	1882 t	+ 15		
	1. 17	1862 t **825** b	+ 55		
	1. 21	1188 b	− 59	233. 7 SE	0. 4
	. 23	832 b	+ 11		
	1. 28	1738 t	+ 16		
	1. 32	1998 t	− 2		
	1. 34	1834 t	− 28		
	3. 24	1987 t	+ 13	139. 4 SW	3. 2
768, 23	. 26	2073 t	+119	88. 2 W	1. 9
	. 28	2074 t	+ 13		
	3. 40	1971 t	− 13		
	3. 42	2451 t	+ 77		
Aug. 21	12. 41	1456 t Fr	− 27		
761, 27	12. 46	1824 t Fr	+ 61		
W 3	12. 51	1451 t Fr	+ 17		
	12. 53	2271 t Fr	+110		
	1. 19	1682 t	− 3	154. 4 SSW	6. 1
	. 21	1622 t	− 6		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Aug. 25	1.03	1460 t	+130			Sept. 1	2.57	2287 t	+ 21		
764, 27	1.07	1502 t	− 9			768, 23	2.59	2456 t	+116		
NW 3	1.10	1559 t	− 15			NE 3	3.01	2271 t	+ 28		
	1.15	1556 t	+ 93				3.07	2327 t	+ 2		
	1.18	1544 t	+ 71				3.12	2453 t	− 4		
	1.21	1251 t	+114	277.1 E	6.5		3.15	2322 t	+ 11		
							3.17	2571 t	+ 13		
	.23	1921 t	+ 16	250.8 ESE	2.1		3.19	2368 t	+ 19		
	.25	1885 t	+ 17				3.22	2416 t	− 4		
764, 25	3.28	1764 t	+105			Sept. 3	1.13	1798 t	+ 10		
	3.31	1738 t	+ 10			768, 24	1.20	2270 t	+ 24		
	3.34	1791 t	+106			N 6	1.22	2033 t	+ 9		
	3.36	1747 t	− 26				1.30	2127 t	+ 24		
	3.39	1803 t	+ 22				1.33	2329 t	+ 25		
	3.41	1765 t	− 2			Sept. 8	11.03	1546 t	+ 26		
Aug. 26	1.09	1755 t 996 b	+ 1	170.0 S	3.7	766, 20	11.06	1592 t	+ 11	334.9 NNE	7.2
764, 27	.11	1658 t	+ 8			W 2	.08	1550 t	+ 15		
N 5	1.13	2230 t	+ 65	256.6 ESE	3.4		11.10	1499 m	− 24		
							11.12	1465 t	− 8		
	.15	2683 t	+142				11.20	1549 t	+ 11		
	1.17	2391 t	+118				11.23	1636 t	+ 10		
	1.19	1839 t	+ 20			766, 23	1.04	1623 t	− 46		
	1.21	2057 t	+114				1.07	1746 t	− 1		
	1.25	1729 t	+ 9				1.12	1704 t	+ 14		
	1.29	1732 t	+ 25	142.5 SW	4.3		1.19	1708 t	+ 5	329.9 ENE	5.3
	.31	1724 t	+ 5				.21	1733 t	− 4		
763, 23	3.34	1979 t	+ 7	163.8 SSW	2.9		1.25	1722 t	+ 1	330.6 ENE	5.7
	.36	2011 t	+ 11	158.0 SSW	2.4		.27	1658 t	+ 15		
						Sept. 17	1.06	1597 t	+ 27		
	.38	1810 t	− 31			756, 26	1.11	1237 t	+ 7		
	3.45	1675 m	+ 5	168.2 SSW	3.8	N 2	1.22	1426 t	+ 4		
	.47	1650 m	− 5				1.28	1600 t	+ 15		
Aug. 29	10.11	1971 t	− 3				1.35	1556 t	− 12		
770, 17	10.18	1877 t	+ 9				1.37	1507 t	+ 20		
SE 3	10.20	1654 m	−103				1.39	1736 t	− 73		
	10.22	1811 m	− 22				1.45	1692 t	− 2		
	10.29	1861 t	− 1				1.50	1588 t	− 41		
	10.32	1861 t	+ 42			Sept. 18	1.06	1304 t	− 50		
	10.34	1812 t	+ 9			761, 27	1.14	1440 t	−140		
	10.37	1402 m	− 69			NE 5	1.18	2241 t	+ 93		
	10.41	1781 m	− 13				1.23	1193 t	+ 23		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date.		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Sept. 18	1. 28	1986 t	+141			Oct. 2	9. 22	1436 t	+ 11		
761, 27	1. 30	1303 t	+ 9			762, 17	1. 21	1313 t	+ 18		
NE 5	1. 35	1240 t	− 5				1. 23	1341 t	+ 19		
Sept. 23	8. 20	1311 t	+ 39				1. 32	1562 t	− 37		
768, 9	8. 24	1344 t	+ 7				1. 38	1404 t	+ 16		
NE 5	8. 33	1290 m	+ 9				1. 43	1377 t	+ 31		
	8. 37	1372 t	+ 25				1. 46	1439 t	+ 12		
	8. 39	1332 t	+ 11				5. 00	1592 t	+ 27		
	8. 43	1265 t	+ 24			Oct. 3	1. 11	1601 t	+ 85		
	8. 44	1249 t	+ 2			765, 18	1. 13	1942 t	− 17		
	8. 47	1273 t	− 18			SE 3	1. 15	1791 t	+ 27		
Sept. 28	*1. 15	2223 t	− 11				1. 21	1537 t	+ 14		
765, 22	5. 15	1939 t	+ 19			Oct. 5	1. 08	1941 t	+ 23		
S 3	5. 30	1999 t	+ 44	216. 2 SE	6. 0	765, 17	1. 11	1552 t	+ 17		
	. 32	1749 t	− 39			E 3	1. 14	1717 t	+ 49	27. 7 NNW	3. 8
Sept. 30	9. 53	1390 t	− 13				. 16	1696 t	+ 18	29. 5 NNW	6. 6
755, 19	9. 55	1371 t	− 4	159. 4 SSW	9. 7		. 18	1842 t	+ 60		
NW 4	. 57	1387 t	+ 2				1. 24	1952 t	+ 8	53. 4 NW	8. 8
	10. 02	1295 t	− 8				. 26	1862 t	+ 20		
	10. 06	1297 t	− 10	163. 9 SSW	7. 2		1. 34	1805 t	− 18	38. 2 NW	8. 3
	. 08	1282 t	− 8				. 36	1760 t	+ 15		
	10. 12	1446 t	− 34			Oct. 6	1. 11	1561 t	− 81		
	10. 14	1402 t	+ 23			764. 19	1. 13	1280 t	+ 23		
	10. 16	1336 t	+ 19	105. 2 WSW	3. 0	NE 3	1. 15	1282 t	− 32		
	. 18	1214 t	− 13				1. 18	1345 t	− 4		
Oct. 1	8. 44	1322 t	+ 21	40. 0 NW	10. 7		1. 20	1327 t	− 29		
760, 16	.46	1152 t	− 4				1. 23	1437 t	− 38	79. 5 WNW	3. 4
NE 4	9. 10	1213 t	+ 8				. 25	1426 t	+ 18		
	1. 09	1523 t	+ 14				1. 27	1551 t	+ 6		
	1. 11	1440 t	+ 49				1. 31	1353 t	+ 15		
	1. 15	1705 t	+ 46				1. 34	1387 t	− 1		
	1. 22	2001 t 980 b	+ 13			Oct. 7	9. 06	1458 t	− 53		
	1. 29	1947 t 894 b	+136	35. 9 NW	13. 6	763, 13	9. 08	1580 t	+ 14		
	. 31	1633 t	+ 17			NE 7	9. 10	1458 t	− 7		
	1. 35	1666 t	− 30	36. 2 NW	12. 7	Oct. 8	1. 12	1628 t	+ 22		
	. 37	1683 t	+ 14			769, 12	1. 15	1607 t	+ 8	37. 5 NW	5. 4
Oct. 2	9. 07	1264 t	+ 16	28. 0 WNW	8. 4	NE 4	. 17	1481 t	+ 71		
764, 14	. 09	1321 t	− 1				1. 22	1724 t	−121	53. 2 NW	4. 4
NE 3	9. 14	1182 t	+ 0				. 24	1549 t	+ 1		

*764, 24.

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Oct. 8	1.34	1594 t	+ 15		
769, 12	1.36	1657 t	− 6		
NE 4	1.38	1617 t	+ 16		
	1.43	1636 t	+ 10	23.4 NW	3.0
	.45	1684 t	+ 75		
Oct. 9	12.56	1432 t	+ 37		
773, 12	1.00	1457 t	+ 44		
S 3					
Oct. 16	1.02	2512 t	− 14		
754, 22	1.06	2382 t	+ 6		
NE 3	1.08	2160 t	− 19	77.7 WNW	10.3
	.10	2505 t	− 19	80.2 W	15.3
	.12	2414 t	− 6		
	1.15	2552 t	+ 48	90.0 W	19.2
	.17	3528 t	− 57		
	1.26	2684 t	+ 22		
Oct. 19	8.26	1424 t	+ 30	67.6 WNW	7.5
768, 5	.28	1392 t	− 3		
NE 4	8.31	1329 t	+183	67.8 WNW	9.2
	.33	1390 t	+183	61.2 WNW	8.1
	.35	1443 t	+ 3	67.4 WNW	7.8
	.37	1501 t	+ 12	68.7 WNW	7.2
	.39	1214 t	− 2		
	8.43	1472 t	+ 18	72.7 WNW	7.7
	.45	1491 t	+ 16	75.4 WNW	8.8
	.47	1492 t	+ 31		
766, 12	1.13	2802 t	+163	98.4 WSW	10.9
	.15	2882 t	+129	96.0 WSW	11.2
	.17	3029 t	+190		
	1.22	1758 t	+ 31	104.5 WSW	7.3
	.24	1810 t	+ 14	111.9 WSW	7.9
	.26	1690 t	− 18		
	1.28	1890 t	− 6		
	1.32	1669 t	− 79		
	1.34	2015 t	+ 11	108.5 WSW	5.7

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Oct. 19	.36	1889 t	+ 37		
766, 12	1.38	1562 t	− 77	54.3 NW	7.2
	.40	1981 t	+ 31		
766, 11	4.06	1931 t	+ 21	51.2 NW	8.5
	.08	1956 t	+ 8	66.0 WNW	5.6
	.10	1886 t	0	51.3 NW	5.4
	.12	1889 t	+ 11		
	4.14	1732 t	+ 4		
	4.17	1784 t	+ 18	57.5 WNW	5.5
	.19	1783 t	+ 8		
Oct. 21	1.06	1867 t	+ 22	73.5 WNW	10.2
760, 21	.08	1388 t	− 33		
N 4	1.12	1906 t	0		
	1.16	2023 t	+ 74	118.7 WSW	13.0
	.18	2093 t	+ 58		
	1.20	2106 t	+ 29		
	1.26	1932 t	+ 19	123.5 WSW	11.4
	.28	2081 t	+ 38		
	1.37	2268 t	+ 40		
Oct. 24	2.27	1910 t	− 9		
757, 12	2.31	1867 t	+ 18		
NE 5	2.34	1878 t	+ 9		
	2.36	1758 t	− 16		
	2.38	1648 t	− 5		
	2.39	1919 t	+ 36		
	2.41	1864 t	+ 13		
	2.43	1846 t	+ 5		
	2.45	1926 t	+ 10		
	2.50	1840 t	+ 67		
Oct. 29	4.18	1594 t	+ 14	115.0 WSW	11.0
768, 21	.20	1799 t	− 75		
W 2	4.22	1540 t	− 2		
	4.39	1620 t	+ 23	126.5 SW	8.0
	.41	1606 t	+ 20		
	4.43	1701 t	+ 26	125.0 SW	8.9
	.45	1688 t	+ 26		
	4.52	1908 t	+110		
	4.55	1778 t	+216	129.7 SW	10.0
	.57	1677 t	+ 20		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Oct. 31	9. 15	1428 t	+ 23	138. 0 SW	6. 8	Nov. 23	1. 17	1008 t	− 8	200. 5 SSE	6. 3
	. 17	1432 t	+ 33			779, 10	. 19	1003 t	−100		
761, 19	9. 20	1200 m	−259			NW 12	1. 21	1113 t	+ 8		
NW 3	9. 22	1112 m	+147				1. 23	1068 t	+ 9	198. 5 SSE	6. 3
	9. 25	1516 t	+ 3				. 25	1193 t	+ 36		
	9. 28	1454 t	− 13	120. 5 WSW	4. 9		1. 29	1069 t	+ 74	215. 5 SE	6. 3
	. 30	1127 t	−104				. 31	1076 t	+ 23		
Nov. 5	1. 24	1861 t	+ 12			Nov. 24	4. 20	1834 t	+205	72. 5 WNW	4. 5
751, 21	1. 28	1857 t	+ 22								
NW 8	1. 33	1600 t	+ 11			773, 17	. 21	1754 t	+111		
	1. 57	1400 t	+124			N 5					
	2. 00	1470 t	+ 25	131. 0 SW	16. 4	Nov. 27	1. 14	1292 t	+ 31		
	. 02	1641 t	+ 2			764, 22	1. 24	1216 t	+ 39		
	2. 07	1356 t	+ 13			NW 8	1. 27	1467 t	+ 77		
							1. 32	1473 t	+ 53		
Nov. 13	1 05	2548 t	0	79. 1 WNW	16. 4	Dec. 9	8. 20	1588 m	+ 8		
763, 7	. 07	2476 t	+ 23			757, 11	8. 22	1612 t	+ 46		
NE 8	1. 11	2336 t	− 23			NE 10	8. 24	1538 t	− 15		
	1. 15	2748 t	+ 40				8. 26	1785 t	+ 40		
	. 22	2094 t	+ 15			758, 12	1. 08	1817 t	+ 32	77. 1 WNW	12. 5
	1. 26	2224 t	+ 61	79. 4 WNW	14. 8		. 10	1950 t	+121		
	. 28	2408 t	+ 43				1. 14	1924 t	+ 36		
	1. 31	2290 t	+ 53				1. 17	1722 t	+ 23		
	1. 37	2852 t	+117				1. 19	1932 t	+104		
764, 5	4. 00	2069 t	+ 34	56. 2 WNW	15. 5		1. 21	1682 t	+ 39		
	. 02	2192 t	+ 19				1. 23	1718 t	− 5		
	4. 04	1926 t	− 7				1. 25	1860 t	+ 18	85. 8 WNW	16. 3
	4. 08	1592 t	+108				. 27	1754 t	+ 6		
	4. 10	1788 t	+ 76	48. 9 NW	14. 9		1. 29	1735 t	− 5		
	. 12	1919 t	− 69			Dec. 11	1. 16	1240 t	+ 3		
	4. 14	1906 t	− 48	53. 0 NW	13. 7	765, 9	1. 20	1492 t	+105		
	. 16	1970 t	+ 40			NE 11	1. 24	1264 t	+ 1		
	4. 19	1984 t	+ 15				1. 30	1282 t	+ 13		
	4. 22	1638 t	+ 13				1. 35	1367 t	+ 50		
Nov. 14	1. 14	1512 t	− 14				1. 37	1290 t	− 17		
771, 6	1. 16	1588 t	+ 2			Dec. 23	8. 24	1812 t **1541** m	− 19	55. 4 NW	19. 2
NE 6	1. 20	1564 t	+ 14								
	1. 24	1517 t	− 1			763, 1	. 26	1481 t **1251** m	+ 8	56. 7 NW	16. 7
Nov. 23	1. 09	1018 t	+ 23	197. 5 SSE	5. 4						
779, 10	. 11	1060 t	+ 12			E 8	. 28	1627 t **1320** m	+ 59		
NW 12	1. 13	1104 t	− 17				8. 41	2420 t	+ 54		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Dec. 23	8. 44	1586 t **1448** m	+202		
763, 0	1. 08	1444 t **1216** b	+ 5		
	1. 10	1350 t **722** b	+ 83		
	1. 13	1088 t	+ 54	38. 7 NW	14. 2
	. 15	1696 t	— 8	34. 3 NW	15. 5
	. 17	1556 t	+ 12	38. 3 NW	12. 0
	. 19	1453 t	+ 14		
	1. 21	1456 t **1005** b	+ 25		
	1. 24	1532 t **1302** b	+ 27	36. 2 NW	18. 1
	. 26	1411 t	+ 9		
	1. 29	1284 t **1139** b	— 4		
Dec. 30	1. 27	2095 t	+ 1	7. 32 WNW	10. 2
772, 11 NW 2	. 29	2063 t	+ 73		
1897					
Jan. 11	1. 04	2343 t	+ 10		
759, 7	1. 10	2670 t	+ 21	36. 8 NW	15. 9
NE 2	. 12	2476 t	+ 15		
	1. 19	2375 t	— 22		
	1. 31	2716 t	+ 36		
	1. 44	2284 t	+119		
	1. 55	1922 t	— 15		
	2. 03	1792 m	+ 58		
	2. 07	2251 t	+ 32		
Jan. 12	10. 44	1340 t	— 42		
765, 2	10. 49	1610 t	— 66		
NE 6	10. 51	1674 t	— 9		
	10. 59	1878 t	+ 1		
	11. 01	2391 t	0		
	11. 05	1992 t	— 11		
	11. 07	1644 t	+ 37		
	3. 21	2071 t	0		
	3. 23	1460 t	+ 8		
	3. 27	1905 t	+ 6		
	3. 33	1846 t	+ 77		
	3. 38	2486 t	—167		

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Jan. 19	1. 25	1618 t	+ 21		
773, 1	1. 29	1679 t	— 32		
NE 4	1. 31	1508 t	— 6		
	1. 35	1516 t	+ 35		
	1. 38	1338 t	+135		
	1. 43	1636 t	— 10		
	1. 48	2113 t	+ 4		
Jan. 21	1. 11	1486 t	+ 29		
756, 8	1. 15	1544 t	+ 13		
N 7	1. 17	1530 t	+ 10		
	1. 19	1534 t	+ 22		
	1. 20	1603 t	— 26		
	1. 22	1070 t	+ 17		
	1. 24	1068 t	+ 3		
	1. 26	1486 t	+ 18	83. 2 W	15. 7
	. 27	1478 t	— 2	98. 3 W	18. 7
	. 28	1396 t	— 41		
Jan. 23	8. 50	1346 t	+105		
763, 0	8. 52	1326 t	— 31		
NE 12	8. 54	1262 t	— 29		
	8. 58	1328 t	+ 12		
	9. 00	1426 t	— 26		
	9. 01	1310 t	+ 14		
	9. 09	1408 t	+ 65		
Jan. 25	10. 14	1354 t	+ 97		
766, 12	10. 16	1432 t	— 95		
NE 5	10. 20	1196 t	— 7		
	10. 22	1252 t	+ 16		
	10. 24	1233 t	+ 52		
Jan. 29	1. 04	1028 b	—173		
770, 4	1. 06	1560 t	+ 22		
NE 10	1. 10	1249 t	+ 6		
	1. 12	1361 t	—156		
	1. 14	1488 t	—105		
	1. 15	1247 t	+ 14		
	1. 17	1171 t	0		
	1. 20	1246 t	+ 11		
	1. 22	1378 t	— 9		
	1. 26	1296 t	— 49		
Feb. 9	4. 25	1034 t	+ 8		
768, 2	4. 27	1307 t	+154		
NE 5	4. 29	1054 t	+ 2		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Feb. 9	4. 31	1108 t	+ 80		
768, 2	4. 35	1341 t	+ 79		
NE 5	4. 37	1026 t	+ 11		
	4. 39	1006 t	+ 34		
	4. 41	989 t	− 16		
	4. 43	1040 t	+ 14		
	4. 45	1057 t	+ 28		
Feb. 16	1. 16	1250 t	+ 30		
759, 6	1. 20	1583 t	+ 6		
E 6	1. 23	1392 t	+ 10	42.7 NW	6. 4
	. 25	1730 t	−127		
	1. 27	1348 t	+ 11		
	1. 37	1486 t	−111		
	1. 39	1514 t	+ 3		
	1. 45	1402 t	+ 6		
	1. 48	1523 t	+ 24		
	4. 29	1664 t	+ 75		
	4. 31	1483 t	+ 2		
	4. 40	1498 t	+ 22	126. 0 SW	12. 1
	. 42	1460 t	− 5		
Feb. 23	11. 22	1348 t	− 3		
758, 8	11. 25	1454 t **1220** b	+ 3	101. 1 WSW	14. 6
NE 5	. 27	1344 t **1029** b	+104		
	11. 30	1390 t	+ 6		
	11. 36	1697 t **1402** b	− 63		
	11. 38	1391 t	− 10		
	11. 41	1601 t **925** b	+ 8		
756, 5	11. 45	1608 t	− 9		
	11. 48	1006 t **849** b	+ 99		
	11. 51	1422 t	− 1		
Feb. 24	8. 36	1428 t	+ 22		
769, 0	8. 38	1562 t	+ 2		
NE 6	8. 40	1525 t	− 2		
	8. 42	1552 t	+ 15		
	9. 06	1594 t	− 3		
	9. 08	1477 t	+ 82		
	9. 12	1468 m	− 4		
	9. 14	1781 t	− 40		
	9. 16	1718 t	+ 19		

Date		Height. z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Mar. 10	1. 28	3357 t	+154		
756, 15					
N 3					
Mar. 16	1. 36	1954 t	+ 18		
777, 7	1. 37	1896 t	+ 93		
N 4	1. 39	1846 t	+ 4		
Mar. 17	1. 18	1028 t	+ 25		
774, 7	1. 20	1544 t	− 92		
N 4	1. 27	1156 t	−109		
	1. 29	1104 t	+111		
	1. 35	1142 t	+ 39		
	1. 39	1096 t	+ 1		
	1. 40	1038 t	+ 8		
Mar. 20	1. 05	3434 t **2699** b	− 17		
750, 22	. 07	3334 t **2742** b	− 17		
NW 5	1. 09	3666 t **2222** b	− 3		
	. 11	3556 t **2523** b	+ 94		
	1. 13	3102 t **1882** b	+ 11		
	. 15	2925 t **1777** b	+ 10		
	1. 21	3614 t **1779** b	+ 23		
	. 23	3910 t **2576** b	− 41		
	. 31	3521 t **2815** b	− 24		
	. 33	3338 t **2646** b	+ 21		
Mar. 22	5. 27	3940 t **2513** b	−163	126. 2 SW	13. 9
758, 22	. 29	3982 t **2790** b	− 45		
NW 4	5. 31	3648 t	+ 9	100. 2 W	10. 4
	. 33	3604 t **2801** b	+ 43		
Mar. 24	1. 18	2997 t	+134		
746, 10	1. 20	2612 t	+ 13		
E 7	1. 36	1895 t	+ 4		
Mar. 25	8. 42	1695 t	+ 62		
753, 3	8. 45	1778 t	− 41		
NE 9	8. 47	2135 t	+ 37		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Mar. 25	8.48	1750 t	− 29			Mar. 26	.39	2057 t	+ 48		
753, 3	8.50	1792 t	+ 12			758, 5	5.24	2785 t	+ 34		
NE 9	8.54	1856 t	+ 15				5.27	2067 t	+ 10	52.2 NW	7.2
	8.57	1876 t	+ 30				.28	2286 t	+ 15	50.4 NW	11.9
	9.05	1818 t	+ 35				.31	2048 t	− 12		
	9.08	1875 t	+ 7				5.34	2067 t	− 2	59.0 WNW	8.4
752, 7	1.29	2289 t	− 65				.36	2054 t	+ 5	55.7 NW	11.6
	1.31	2232 t	+ 5				.37	2001 t	− 4		
	1.34	2026 t	+102	49.7 SSW	21.0		5.40	2108 t	+ 3	51.4 NW	9.2
	.35	1914 t	+ 38				.41	2036 t	− 3		
	1.38	2236 t	− 8	85.5 W	13.8		5.44	2128 t	+ 5		
	.40	2303 t	+ 22			Mar. 27	10.28	2058 t	+ 17	53.5 NW	9.4
754, 5	5.29	2667 t **1690** b	+ 6	78.3 WNW	15.9	761, 3	.30	1949 t **1440** b	+ 18		
	.32	2469 t **1560** b	− 2			E 3	10.34	1820 t **1498** b	− 9	82.6 NW	4.7
	5.36	2346 t	− 4	89.2 W	13.4		.36	1672 t **1350** b	+ 35		
	.38	2186 t	− 7				10.38	2112 t **1670** b	− 87	63.6 WNW	7.8
	5.40	2296 t	+ 12				.40	1686 t **1316** b	− 13		
	5.42	2382 t	+ 4	79.9 W	13.6		10.44	1725 t **1399** b	+ 8		
	.44	2253 t	+ 26	88.7 W	13.4		10.47	1763 t **1530** b	+ 8	44.5 NW	8.2
	.47	2274 t	− 9				.49	1798 t	+ 20		
	5.49	2292 t	+ 13				10.51	1875 t	+ 12		
	5.52	2170 t	+ 5			761, 8	1.16	2102 t **1423** b	+ 13		
Mar. 26	8.42	1664 t	+ 5				1.21	2476 t **1874** b	+ 39	31.9 NNW	12.3
757, 2	8.46	1798 t **1278** b	+ 6	60.4 WNW	13.8		.23	2718 t **2035** b	+ 24	35.0 NW	12.0
NE 7	.48	1710 t **1211** b	+ 12				.25	2232 t **1810** b	− 5		
	8.51	1851 t **1032** b	+ 8	59.7 WNW	16.5		1.27	3278 t **2468** b	+ 66	57.9 WNW	18.0
	.53	1762 t	− 7				.29	2701 t **2160** b	−120		
	8.55	1840 t **1271** b	+ 13	53.9 WNW	13.8		1.31	2297 t **1790** b	+ 6	43.6 NW	11.8
	.57	1852 t **1410** b	+ 5				.33	2197 t **1769** b	+ 6		
	8.59	1729 t **1545** b	− 8	62.7 WNW	16.3		1.35	2218 t	+ 9	32.0 NNW	13.7
	9.01	1750 t	+ 7	78.5 WNW	12.6						
	.02	1816 t	+ 9								
757, 6	1.34	1814 t	+ 1								
	1.36	1809 t	+ 32								
	1.38	1944 t	+ 27	53.7 NW	10.6						

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Mar. 27	.37	2161 t	− 8		
762, 6	5.33	2539 t	+ 20	51.7 NW	13.1
	.34	2498 t	+ 84		
	5.37	2400 t	−269	23.9 NNW	11.1
	.39	2361 t	+ 58		
	5.42	2568 t	− 2	22.4 NNW	11.2
	.44	2630 t	+ 36		
	5.58	2558 t	+ 10		
Apr. 5	2.00	**1564** b	+ 3	149.5 SSW	2.7
756, 19	.02	**1417** b	+ 62	163.1 SSW	3.4
NW 3	.04	**1306** b	− 5		
	2.07	**1142** b	+ 32	109.4 WSW	9.3
	.08	**1171** b	+ 21		
	2.12	**1125** b	+ 6		
755, 18	6.10	2337 t	+ 26	131.4 SW	12.2
	.12	1977 t	− 56	127.2 SW	13.4
	.14	1498 t	+ 1		
Apr. 6	1.44	1811 t	− 4		
758, 15	1.47	1824 t	+ 62		
N 2	1.54	2812 t	+ 42	132.8 SW	14.1
	.56	3280 t	− 34		
Apr. 7	1.50	1452 t	+ 72		
763, 13	1.59	1569 t	+ 18	135.1 SW	4.8
NE 2	2.01	1702 t	+ 1		
	2.04	1980 t	+ 18	86.4 W	16.9
	.05	1938 t	+ 71		
Apr. 10	8.59	1349 t	− 7		
760, 6	9.04	1423 t **1176** b	+ 6		
NE 5	9.07	1502 t	+ 26		
	9.09	1501 t	0		
	9.10	1350 t	+ 65	334.0 NNE	6.6
	.11	1368 t	+ 9	347.5 NNE	7.9
	.12	1364 t	+ 21		
	9.25	1364 t	0		
762, 9	1.32	1502 t	− 30		

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Apr. 13	5.53	1654 t	+115		
770, 10	5.55	1798 t	+ 5		
NW 5					
Apr. 16	9.42	2159 t	+ 4	139.5 SW	15.1
763, 8	.43	2152 t	+ 13		
760, 16	1.29	1746 t	+ 6		
NE 3	1.32	1652 t	+ 12		
	1.34	1796 t	− 23		
	1.36	1821 t	+ 2		
	1.38	1721 t	+ 12	22.1 NNW	5.4
	.40	1656 t	+ 11	335.7 NNE	5.3
	.42	1582 t	− 10		
Apr. 17	8.42	2003 t	− 94	87.2 W	12.3
761, 9	.44	1903 t	− 5		
SE 2	8.46	1064 s	+ 1		
	8.51	1032 s	+ 5		
	8.52	1272 s	+ 65		
	8.55	1126 s	+ 22		
	9.00	1387 t	− 26		
	9.04	1974 t	− 9		
	9.06	1280 t	+ 37	70.2 WNW	9.5
	.08	1304 t	− 7		
761, 12	1.23	1810 t	+ 4	106.2 WSW	13.2
	.25	2066 t	+113		
	1.29	1850 t	+ 49	93.1 W	6.7
	.32	1790 t	− 19		
	1.34	1797 t	+ 26		
	1.45	1734 t	+ 12	82.5 W	8.7
	.48	1613 t	+ 32		
	1.51	1602 t	− 41		
762, 10	6.17	1498 t	+ 17	325.5 NE	12.3
	.18	1538 t	− 5		
Apr. 19	1.01	2739 t	+ 34		
762, 22	1.06	2317 t	+ 14		
NE 3	1.28	2554 t	+ 10		
Apr. 24	2.23	3777 t	+ 14		
764, 29	2.26	2624 t **1207** b	+ 13		
NW 4	2.29	2743 t	− 30	65.3 WNW	4.9

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Apr. 24	.30	2722 t	− 19	58.1 WNW	4.6
764, 29	.31	2886 t	− 43	70.0 WNW	5.8
NW 4	.32	2774 t	+ 98	88.2 W	6.4
	.33	2924 t **1247** b	− 19		
	2.36	3799 t	+ 34	80.4 W	11.9
	.38	3802 t	+ 3	71.2 WNW	11.0
	.40	3898 t	− 27		
764, 25	6.09	2991 t	− 44	54.1 NW	12.2
	.10	2970 t	+ 37		
	6.12	2856 t	+ 22	54.5 NW	8.3
	.13	2897 t	+ 6	52.3 NW	10.7
	.14	2768 t	+ 35	54.4 NW	11.6
	.15	2868 t	+ 21	52.8 NW	11.7
	.16	2828 t	+ 3		
	6.30	2758 t	+ 60		
	6.37	2944 t	+ 52		
	6.39	3003 t	+ 38		
Apr. 27	8.39	1724 t	− 13	21.6 NNW	17.1
762, 7	.41	1774 t	+ 13		
N 5	8.44	1734 t	+ 17		
	8.47	1696 t	+ 1		
	8.50	1774 t	+ 4	27.9 NNW	17.5
	.51	1840 t	+ 23		
	8.53	2382 t	− 15		
	8.55	1734 t	+ 4		
	8.57	1662 t	− 20		
	8.59	1570 t	− 23		
Apr. 30	1.34	3238 t	+ 31	194.5 SSE	8.5
761, 22	.36	3291 t	+ 10		
SW 4					
May 3	2.53	896 t **407** b	− 10		
756, 8	2.57	1506 t **714** b	+ 15		
NW 1	2.59	1720 t **687** b	−167		

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 3	3.01	2064 t	− 11		
756, 8	3.09	1075 t	+ 6	81.5 W	11.5
NW 1	.10	1037 t	− 6		
May 5	1.17	1578 t	+ 6		
761, 15	1.21	1482 t	− 37	322.4 NE	8.0
E 4	.23	1660 t	− 20	319.3 NE	8.1
	.25	2240 t	− 11		
	1.27	1756 t **1036** b	− 8	306.4 NE	6.8
	.29	1990 t **1099** b	− 1		
	1.35	1519 t	+ 5	312.3 NE	6.6
	.36	1704 t	− 3		
May 6	1.19	2221 t	− 8		
	1.21	2036 t	− 36		
May 10	1.11	3006 t	+ 5		
757, 27	1.13	2605 t	+ 8	117.0 WSW	16.2
N 4	.15	2171 t	− 20		
	1.20	2617 t	− 40		
	1.24	2446 t	− 69		
	1.26	2290 t	+141		
	1.33	2434 t	+ 23		
	1.35	3530 t	− 11	109.5 WSW	20.1
	.36	3464 t	− 17		
	1.40	3409 t	− 8		
May 12	6.36	2514 t **1058** b	+163	139.1 SW	20.4
758, 22	.38	2568 t **1142** b	+ 55		
NW 7					
May 15	1.43	1630 t	− 24		
765, 19	1.47	2568 t	−164		
NE 2	1.52	1902 t	+ 34	58.2 WNW	3.2
	.53	1910 t	+ 63		
766, 17	6.13	2069 t	− 27	80.7 W	1.6
	.15	1872 t	+ 30		
	6.16	2002 t	− 3	102.7 WSW	3.5
	.17	1926 t	+ 90		
	6.19	1910 t	− 34	27.2 NNW	4.0
	.20	1914 t	− 47		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 15	6. 22	1820 t	− 1	32. 9 NNW	3. 2	May 18	. 17	2242 t	− 21	46. 0 NW	6. 2
766, 17	. 24	1795 t	− 8			768, 18	. 18	2470 t	− 13		
	6. 26	1906 t	− 87	16. 9 NNW	3. 8	NE 3	1. 19	2262 t	− 4	47. 7 NW	10. 2
	. 27	1872 t	− 26				. 20	2228 t	− 4		
May 17	1. 09	2534 t **2001** b	− 48	336. 0 NNE	4. 8	May 19	12. 55	1888 t	− 18		
768, 20	. 11	2898 t	− 76	344. 5 NNE	4. 4	768, 26	12. 57	1778 t	+ 81	359. 7 N	6. 4
SE 2	. 13	2657 t	− 41			NE 3	. 59	1986 t	− 21		
	1. 17	2984 t	−131	4. 1 NNW	7. 4		1. 00	1724 t	− 26		
	. 19	2817 t	−100				1. 06	1880 t	− 2		
	1. 22	3150 t **2678** b	− 11	344. 4 NNE	8. 6		1. 12	1869 t	− 48		
	. 24	3337 t	− 62				1. 15	1946 t **1463** b	− 2	35. 0 NW	5. 8
	1. 30	1456 b	+ 65	343. 4 NNE	5. 4		. 17	1946 t	+ 3	38. 0 NW	6. 8
	. 32	1356 b	−189				. 19	1914 t	− 14		
	1. 37	3223 t	−106			May 21	1. 24	2675 t	−150	90. 5 W	6. 9
768, 18	6. 15	3308 t	− 32			755, 24	. 26	2214 t	−159		
	6. 17	3910 t	+111	38. 2 NW	14. 2	NE 4					
	. 18	3035 t	− 89			May 24	1. 22	1222 t **967** b	+ 15		
	6. 20	3410 t	− 17	38. 8 NW	5. 3	760, 24	1. 32	1108 t	− 34	179. 4 S	7. 7
	. 21	3263 t	− 34			N 3	. 33	1094 t	− 13		
May 18	11. 09	2446 t	+ 75	356. 2 N	14. 3		1. 38	1198 t	+ 1		
768, 18	. 11	2106 t	+ 25				1. 43	2045 t **1317** b	+ 45		
NE 3	11. 13	2230 t **1645** b	+ 67	346. 6 NNE	20. 1		1. 45	1612 t **1032** b	− 14	175. 4 S	7. 4
	. 14	2054 t **1347** b	− 2				. 47	1960 t **1205** b	+ 19		
	11. 16	2110 t **1437** b	+ 27	352. 3 N	7. 0	May 25	9. 35	1134 t	+ 33	37. 2 NW	9. 7
	. 17	2237 t	− 14	27. 8 NW	5. 4	763, 15	. 36	1152 t	+ 36		
	. 18	2170 t	− 5	42. 0 NW	7. 2	NE 20	9. 38	1341 t	+126		
	. 19	2158 t	0				9. 42	1116 t	+ 9	34. 2 NW	9. 3
	1. 10	2232 t	+ 9				. 43	1126 t	− 11		
	1. 12	2164 t	+ 46	24. 3 NNW	8. 8		9. 48	1063 t	− 83		
	. 13	2368 t	+ 19	33. 4 NNW	6. 8		9. 49	1306 t	− 13	41. 3 NW	10. 0
	. 14	2332 t	− 19				. 50	1215 t	+ 20	53. 7 NW	9. 9
	1. 15	2404 t	+ 9	40. 9 NW	10. 4		. 51	1252 t	+137		
	. 16	2288 t	− 10	36. 4 NW	8. 9	764, 18	1. 33	2701 t **1779** b	−121	53. 1 NW	8. 4
							. 35	2356 t **2026** b	+127	45. 2 NW	7. 2
							. 36	2345 t **1925** b	+ 26		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 25	1. 38	2432 t **1600** b	+ 67	36. 1 NW	5. 6
764, 18	. 39	2404 t **1503** b	− 92	35. 7 NW	3. 4
	. 40	2364 t **1541** b	+ 35		
	1. 43	1516 t	− 12	42. 1 NW	5. 8
	. 44	1496 t	+ 25	46. 5 NW	5. 9
	. 45	1564 t	−111		
	1. 48	2054 t	+ 16	31. 4 NNW	5. 8
	. 49	2032 t	+ 24		
May 26	10. 38	1605 t **1048** b	+ 20	358. 4 N	9. 8
767, 16	. 40	1514 t **958** b	− 11		
E 4	10. 43	1730 t **953** b	+ 12	1. 5 N	9. 3
	. 45	1608 t **913** b	− 9		
	10. 47	1797 t **884** b	− 62	11. 9 NNW	6. 6
	. 49	1782 t **1131** b	−108		
	10. 53	1766 t **978** b	+ 1	355. 9 N	9. 9
	. 55	1482 t **1137** b	− 56		
	11. 02	1681 t	− 6	359. 1 N	9. 2
	. 03	1056 t	+ 46		
767, 18	1. 13	1882 t	+ 83		
	1. 15	1705 t	− 22	9. 4 N	7. 2
	. 16	1556 t	− 83		
	1. 18	1768 t	− 45	356. 7 N	8. 0
	. 19	1768 t	− 46		
	1. 26	1776 t	− 15	16. 9 NNW	8. 3
	. 27	1522 t	− 96		
	1. 30	1956 t	+ 1		
	1. 32	2002 t	− 8	10. 5 N	10. 3
	. 33	1790 t	+ 17		
May 29	1. 48	1612 t	+ 23		
758, 18	1. 53	1608 t	+ 50	83. 6 W	9. 5
N 4	. 55	1640 t	0		

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 1	1. 09	2307 t	+ 22	73. 4 WNW	15. 9
764, 20	. 10	2475 t	− 18		
NE 5	1. 12	2482 t	+ 13		
	1. 18	2322 t	−113	62. 1 WNW	18. 7
	. 19	2130 t	− 2		
	1. 22	2579 t	− 20	65. 1 WNW	25. 2
	. 23	2222 t	+ 53		
	1. 27	2167 t	+ 8	62. 6 WNW	17. 8
	. 28	2146 t	+ 23	72. 4 WNW	19. 5
	. 29	2013 t	− 20		
June 3	12. 52	1115 t	− 48		
761, 28	12. 55	996 t **959** b	− 16		
NW 8	12. 57	1134 t	− 30	145. 7 SW	14. 7
	. 58	1367 t	+114		
	1. 08	1084 t	− 56		
	1. 10	1422 t	+ 07	114. 6 WSW	4. 0
	. 11	1172 t	− 3		
	1. 15	1220 t	+ 31		
June 4	1. 19	1693 t **1370** b	+ 34	131. 8 SW	7. 8
758, 29	. 21	2157 t	+ 62		
N 2					
June 5	9. 18	**806** b	+ 11		
760, 18	9. 23	**706** b	− 1	15. 4 NNW	7. 3
NE 2	. 24	1084 t	− 46		
761, 21	12. 51	1487 t	− 14		
	12. 58	1501 t	− 10	319. 8 NE	3. 0
	. 59	1520 t	− 40		
	1. 01	1480 t	− 25		
	1. 03	1547 t	− 2	31. 8 NNW	4. 6
	. 04	1478 t	− 1		
	1. 06	1569 t	− 10		
June 10	8. 45	**890** b		44. 5 NW	9. 2
763, 17	. 46	**858** b	− 21	43. 1 NW	8. 5
NE 7	. 48	**850** b	− 70		
	8. 50	**814** b	− 3	49. 1 NW	8. 3
	. 52	**959** b	+ 92		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m*	*m.*	°	*m. p. s.*
June 10	8. 54	**826** b	+ 4	40. 2 NW	9. 3	June 14	10. 05	2144 t **800** b	+ 7	19. 5 NNW	14. 4
763, 17	. 56	**942** b	− 6			759, 23	. 06	1950 t **798** b	+ 19	357. 4 N	9. 1
NE 7	8. 59	**886** b	+ 6			NE 4	. 08	2512 t **870** b	+ 84		
	9. 02	**916** b	− 16				10. 11	2233 t **778** b	+ 22	16. 2 NNW	14. 2
	9. 04	**856** b	− 3				. 13	2444 t	− 10		
763, 21	1. 17	1404 t	− 3				10. 19	2037 t **797** b	+ 7	5. 7 N	7. 2
	1. 24	1340 t	− 13				. 20	1816 t **731** b	+ 55		
	1. 27	1490 t	− 1				10. 24	2184 t	− 78	27. 3 NNW	9. 3
	1. 41	1387 t	− 22	359. 2 N	12. 2		. 25	1826 t	− 48		
	. 42	1340 t	+ 22				10. 30	1875 t	− 14		
	1. 45	1412 t	+ 2			760, 27	1. 35	2654 t	+ 55	34. 2 NW	8. 9
	1. 53	1540 t	+ 4				. 37	2653 t	− 22		
	1. 56	1560 t **1328** b	+ 16	19. 0 NNW	12. 1	June 16	1. 09	1562 t **89** b	+ 57	41. 6 NW	9. 0
	. 57	1506 t	+ 11			759, 30	. 10	1824 t **1032** b	− 24	53. 5 WNW	3. 6
June 11	9. 55	1849 t **851** b	− 6	48. 5 NW	3. 8	NE 3	. 11	2659 t **1558** b	+ 6		
764, 20	. 57	2284 t **817** b	+ 11			June 18	1. 34	1279 t **911** b	+ 59	321. 4 NE	10. 0
NE 4	10. 00	2155 t **799** b	−180			760, 24	. 35	1663 t b	+ 49		
	10. 04	2042 t	− 45			W 2					
	10. 06	1738 t	− 7	26. 2 NNW	6. 5	June 19	1. 35	1384 t	− 28		
	. 08	1826 t	+ 5			763, 26	1. 44	1359 t	− 13	192. 8 SSE	7. 4
	10. 14	1614 t	− 63	46. 0 NW	9. 7	W 3	. 45	1359 t	− 8		
	. 15	1505 t	− 1			June 21	8. 45	1435 t	− 11	308. 5 NE	10. 3
	10. 17	1629 t	+ 2	11. 0 N	7. 2	762, 15	. 46	1299 t	+ 17		
	. 18	1666 t	− 73			NE 3	8. 47	1309 t	− 7	301. 8 ENE	5. 4
762, 24	1. 06	1722 t	+ 13				. 48	1578 t	+ 60		
	1. 08	1790 t	+ 9				8. 50	1080 t	+ 7	310. 9 NE	5. 7
	1. 10	1830 t	+ 1	49. 7 NW	6. 3		. 52	1513 t	+ 2		
	. 12	1610 t	+ 31	2. 5 N	4. 3		8. 54	1515 t	− 8		
	. 13	1695 t	+ 33				8. 57	1510 t	− 6		
	1. 14	1820 t **1512** b	+ 21	38. 6 NW	11. 2		8. 59	1174 t	+ 38	335. 1 NNE	6. 6
	. 15	1685 t **1421** b	− 56				9. 00	1554 t	+ 1		
	1. 20	1774 t	− 17	35. 9 NW	9. 4	762, 21	1. 13	1810 t	0	13. 0 NNW	5. 7
	. 21	1756 t	− 2								
	1. 26	1644 t	− 5								
June 12	11. 02	1793 t	+ 86	58. 9 WNW	10. 1						
757, 29 NE 2	. 04	1535 t	+ 14								

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 21	.14	2027 t	− 16	49.9 NW	3.8	June 25	1.14	1722 t	+ 55	35.8 NW	6.4
762, 21	.15	2002 t	− 25	109.9 WSW	2.7	758, 32	.15	1740 t	− 9		
	.16	1903 t	+ 10			NE 3	1.25	1736 t	+ 27	47.0 NW	5.3
	1.18	1793 t	+ 10				.26	1904 t	+ 51	54.0 NW	6.7
	1.20	1834 t	− 47				.27	2020 t	+ 25		
	1.21	1845 t	+ 17	42.9 NW	3.5	June 26	1.04	1840 t	− 31	51.2 NW	9.2
	.22	1884 t	+ 7			762, 25	.05	1759 t	− 30		
	1.25	1729 t	+ 12	27.3 NNW	4.6	E 4					
	..26	1764 t	+ 15				1.10	1858 t	+ 7	25.8 NNW	7.8
							.13	1687 t	− 15		
June 22	1.11	2209 t		157.9 SSW	9.8		1.20	1480 t	+ 34	358.4 N	5.4
763, 22	.12	1993 t		148.2 SSW	11.4		.21	1518 t	−294		
NW 2	.13	2031 t					1.23	1844 t	+ 10	29.1 NNW	8.3
	1.35	2081 t		58.0 WNW	9.8		.24	1737 t	−113		
	.36	2357 t				June 30	9.00	1456 t	+ 9	77.0 WNW	12.7
June 23	1.14	1213 t	+ 13	205.0 SSE	5.4	758, 28	.01	1457 t	− 15		
761, 24	.15	1152 t	− 4			N 4	9.04	1190 t	− 16	51.4 NW	10.6
NW 4	1.18	1180 t	+ 15	191.6 SSE	4.6		.05	1041 t	− 27		
	.20	1193 t	− 5			757, 32	1.16	2776 t **2196** b	+ 8		
	1.45	1308 t **771** b	+ 7	179.4 S	7.0		1.18	3022 t **2559** b	+ 7	52.0 NW	6.9
	.46	1481 t	− 31				.19	3118 t	− 68		
	1.50	1114 t	+ 11	145.8 SW	8.0		1.21	2977 t **2659** b	− 17	36.8 NW	16.9
	.51	1036 t	+ 22	149.4 SSW	7.4		.22	2936 t	+ 11		
	.52	1026 t	+ 3				1.39	2639 t	− 2	35.4 NW	16.1
							.40	3085 t	+ 26		

CUMULO-NIMBUS.

1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 12	6.14	8399 t	+153			May 12					
761, 25	6.16	7999 t	+124			761, 25	.40	9375 t **1100** b	−177		
NE 2	6.21	7513 t	+ 6	67.7 WNW	22.0	NE 2	6.44	6367 t	−257		
	.22	7529 t	− 1			May 13	8.53	3135 t	+ 8		
	.24	8182 t **1200** b	− 73			763, 20	.55	3004 t	+ 25		
						W 2					
	6.32	6057 t	−157	43.4 NW	25.7	May 18	2.01	2820 t	+ 38		
	.34	5653 t **1000** b	− 14			760, 33	2.04	3385 t	+208	93.5 W	13.0
						NE 4	.05	3057 t	− 75		
	6.38	6651 t	+ 41	59.1 WNW	25.7	759, 27	6.54	4073 t	− 39	84.1 W	20.7

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULO-NIMBUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 18	.55	4221 t	+ 43			June 16	3.23	3921 t	+ 12	214.2 SE	2.9
759, 27	6.59	4071 t	+ 75	81.9 W	27.0	766, 21	.25	3879 t	− 4		
	7.00	4405 t	+ 48			NW 1	3.31	3142 t	− 1	156.2 SSW	12.5
May 22	11.39	3679 t	+ 80	22.5 NNW	16.3		.33	3762 t	−316		
764, 23	.41	3489 t	−255			June 17	4.02	4513 t	+342		
N 3	11.45	4396 t	+ 2	88.7 W	10.6	762, 23 NW 1					
	.47	4878 t	−285								
	11.51	3922 t	− 1	82.9 W	11.3	June 26	3.38	1568 t	+154	167.4 SSW	11.0
	.53	3455 t	+197			764, 27	.39	1898 t	−245		
	11.57	2651 t	+313			NE 4	3.46	3419 t	+ 61	105.7 WSW	11.2
764, 24	1.17	2976 t	− 78	91.5 W	6.6						
N 9	.19	3076 t	+ 64				.48	3826 t **1069** b	+ 22	76.1 WNW	9.2
	1.22	2840 t	− 31								
	1.28	3769 t	+208	32.5 NNW	9.3		.50	3257 t	− 3		
							3.52	3483 t **831** b	+ 24	37.5 NW	12.9
	.30	4148 t	−251	91.1 W	20.6						
	.32	4371 t **900** b	−165				.54	3434 t	+ 77		
	1.41	5543 t	+158	331.1 NNE	9.3	July 3	1.25	3237 t	−335	82.5 W	6.6
	.43	5879 t **1100** b	+282			764, 30	.27	3815 t	− 16		
						W 2	1.43	4886 t	+202	103.0 WSW	6.3
	1.55	4195 t	−129				.45	4801 t	− 30		
	1.57	4632 t	−104				2.02	4599 t	+ 89	82.2 W	8.8
May 28	8.45	3512 t	+ 70				.04	4424 t	+ 66		
760, 21	8.50	2424 t	+ 3			764, 28	3.28	5209 t **1377** b	+ 47	120.7 WSW	8.6
NW 9	8.53	3240 t	− 67	161.4 SSW	24.5						
	.54	2889 t	+105				.30	5878 t	+301		
754, 30	2.13	3736 t	+114	110.1 WSW	5.4		3.32	3354 t **982** b	+308	61.4 WNW	1.8
	.15	2804 t	− 91								
	2.24	2158 t	+ 39				.34	3355 t	+338		
	2.26	3613 t	−273				3.37	4758 t	+ 27	19.0 NNW	1.9
June 10	1.20	3841 t	− 16	41.7 NW	5.8		.39	5599 t	+179	14.8 NNW	1.8
754, 25	.21	3213 t	+329				.41	5998 t	+230	16.7 NNW	1.9
NE 8	1.34	3065 t	+ 34				.43	6073 t	+148		
	1.36	2794 t **950** b	−133				3.47	5960 t	+111	35.0 NW	7.8
	1.39	4341 t	− 52	40.9 NW	12.1		.49	6270 t	+158		
							3.53	8298 t	+174		
	.41	4008 t **1050** b	+ 14				3.55	8400 t	+399		
	1.44	3677 t	+ 13	352.7 N	25.3	July 6	3.42	4305 t	+225	88.5 W	3.4
	.46	3602 t **1000** b	− 2			761, 27 N 2	.44	4211 t	+113		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULO-NIMBUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 7	1.10	5152 t	− 4			July 28	6.05	3154 t	+ 8	90.2 W	13.1
760, 29	1.14	4427 t	+ 11			763, 30	.07	2154 t	+ 24		
N 1	1.15	3994 t	+ 78	79.4 W	8.0	NE 2	6.12	2145 t	− 56		
	.16	3900 t	+ 56	85.4 W	7.0		6.22	7742 t	−128	99.0 W	23.6
	.17	4027 t	+ 54				.24	8526 t **800** b	− 9		
	3.37	4140 t	+ 14								
	3.44	5116 t	− 66	94.0 W	10.2	July 29	8.32	5860 t	− 85		
						765, 26	3.48	13458 t	−278	75.2 WNW	37.5
	.46	6817 t	−340	104.5 WSW	15.2	NE 1	.50	16091 t	−619		
	.48	4306 t **1100** b	+ 20			764, 31	4.00	11917 t	−323		
							4.04	11520 t	−151	69.8 WNW	22.1
	3.50	6533 t	−345	111.4 WSW	18.5						
	.52	4521 t	− 15				.06	10136 t	− 55		
	3.54	3900 t	+143	101.2 WSW	16.7		4.16	6169 t	− 25	59.0 WNW	12.5
							.18	6833 t	+ 55		
	.56	3158 t	+138			762, 28	6.11	3584 t **784** b	+179		
	3.59	7136 t	+ 64								
July 15	6.14	9562 t **791** b	+150	89.0 W	27.3		6.14	3502 t **746** b	− 57		
758, 29	.16	11018 t	−177	88.0 W	25.5		6.19	2118 t	− 69		
N 1	.18	12893 t	+251				6.21	3379 t	− 9		
	6.21	4630 t	− 37				6.52	14474 t	− 56		
	7.05	7434 t	− 72	121.2 WSW	13.9		6.54	13132 t	− 47		
							6.56	15715 t	+ 69		
							6.58	13291 t	− 19		
	.07	8069 t **912** b	− 96	123.8 WSW	13.6		7.01	9993 t	− 35	58.2 WNW	15.3
	.09	8949 t	+255								
	7.13	13848 t	−100	22.8 NNW	2.5		.03	10489 t	+ 2	61.2 WNW	14.6
							.05	8847 t	+ 28		
	.15	14362 t	− 67	12.2 NNW	2.8	July 30	6.32	7711 t	− 5		
	.17	10745 t	+354			759, 29	6.37	3491 t	− 62	51.5 NW	13.1
July 21	1.27	4803 t	−187	117.0 WSW	7.7	N 4	.39	3828 t **1200** b	− 8		
765, 29	.29	4944 t	− 81								
NE 3	1.31	4486 t	− 29			Aug. 31	6.06	4917 t	+ 27	359.8 N	11.5
	1.34	5043 t	− 52	112.4 WSW	16.7	759, 26	.08	5910 t **1100** b	+223		
	.36	5907 t	+ 6	84.7 W	13.7	NE 3	6.16	3616 t	− 2		
	.38	5123 t	+ 9				6.25	3862 t	+ 34		
July 22	6.58	11167 t	−136	109.7 WSW	20.9	Sept. 3	1.40	12426 t	+161	77.7 WNW	24.4
759, 28	7.00	11050 t	−124								
N 3	7.02	12030 t	−254	126.7 SW	22.9	759, 33	.42	10935 t	+ 83	79.0 WNW	24.0
	.04	10128 t **900** b	− 98			N 6	.44	10482 t	+139	77.0 WNW	24.0

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULO-NIMBUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Sept. 3	.46	12848 t	+138		
759, 33	1.48	11600 t	+206		
N 6	1.54	12300 t	+ 81	80.1 W	26.0
	.56	12101 t	+ 87	82.9 W	27.1
	.58	11827 t **1200** b	+ 8		
Sept. 18	5.57	5854 t	+ 90	100.7 WSW	26.8
761, 26	.59	6067 t	+ 40	97.7 W	21.8
NE 5	6.01	5854 t	+ 34	107.4 WSW	24.9
	.03	5684 t	− 70		
	6.05	6439 t	+ 85	92.7 W	26.5
	.07	6975 t **700** b	+132		
Sept. 22	1.59	2244 t	+ 34		
758, 19	2.01	2145 t	+ 26		
NE 1					
Sept. 28	1.20	3926 t	+304		
764, 24	1.22	2956 t	+ 46	153.0 SSW	8.0
S 3	.24	3007 t	+ 36		
	1.27	3509 t	+ 62	158.0 SSW	14.3
	.29	3897 t **800** b	+ 23		
Nov. 18	8.27	3411 t	+ 33		
768, 12	8.30	3868 t	+ 37		
NW 2	8.46	3637 t	+ 20	82.2 W	3.5
	.47	3342 t **1100** b	+ 12		
	9.10	3834 t	− 8		
	9.16	3003 t	− 44		
	9.20	3388 t	+ 34		
	9.25	3027 t	+ 39	87.7 W	9.4
	.27	2986 t	+ 10		
1897					
Mar. 3	5.20	2664 t	+ 71		
760, 14	5.23	4254 t **958** b	+ 41	62.2 WNW	35.5
N 8	.24	4599 t **1114** b	+ 39	134.5 SW	25.7
	.25	4546 t **1209** b	+158	101.9 WSW	20.9
	.29	3250 t **808** b	− 18		

Date.		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Mar. 3	5.34	4424 t **1018** b	− 5	107.9 WSW	47.4
760, 14	.35	4532 t **1075** b	−370		
N 8	5.38	2395	+186	103.6 WSW	22.0
	.39	2520	+ 23		
	5.43	5895 t	− 87		
Mar. 20	5.25	3492 t	− 18		
752, 13	5.27	3318 t	+ 84	112.0 WSW	9.8
NW 5	.28	3803 t	+ 82		
	5.31	4293 t	+ 10	83.0 W	21.5
	.32	3846 t	+ 71		
	5.35	3819 t	+130	95.8 W	16.9
	.36	4214 t	+ 25		
	5.40	4254 t **1000** b	+ 33		
	5.42	4212 t	+145	83.5 W	19.0
	.43	4291 t	− 14		
Apr. 14	1.24	3806 t **1645** b	+ 18	108.5 WSW	14.6
762, 24	.26	4073 t	+ 28	99.2 W	15.1
NW 5	.28	3484 t	0	105.2 WSW	12.8
	.30	3770 t	−172		
	1.36	3051 t **1685** b	+ 20	113.5 WSW	15.7
	.38	3446 t **1166** b	+ 3	114.7 WSW	13.8
	.40	3902 t	+ 61		
	1.46	3470 t	− 12	112.7 WSW	12.8
	.47	3684 t	− 17	108.7 WSW	13.8
	.48	3057 t	+ 60		
May 4	1.30	5324 t **1100** b	+ 7	63.2 WNW	16.9
760, 16	.31	5318 t	+ 8		
NE 8	1.43	5670 t	− 52		
May 21	1.37	2596 t	+ 37	81.9 W	16.8
755, 24	.39	2532 t	− 5		
NE 4	1.43	2728 t	− 13		
	1.50	2098 t	−608		
	1.56	**1062** b	−287		

TABLE 6.—*Summary of theodolite observations*—Continued.

CUMULO-NIMBUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 4	1.04	3304 t **1393** b	+ 30	117.5 WSW	18.5	June 19	.58	4305 t	− 31		
758, 29	.06	3014 t **1260** b	− 20			June 24	1.19	1328 t	+ 11	184.5 S	5.5
N 2	1.08	4234 t **1177** b	− 73	117.5 WSW	22.1	759, 29	.20	1394 t	+ 9	179.4 S	5.5
	.10	4405 t **1232** b	−183			NW 3	.21	1414 t	+ 4		
							1.27	5653 t	+143	94.6 W	15.0
							.28	5266 t	− 21		
June 15	6.55	2983 t	− 35				1.33	1604 t	− 11	192.4 SSE	4.6
759, 21											
NE 4							.35	1586 t	− 14		
June 16	6.29	4739 t	+ 14	72.0 WNW	7.0		1.39	994 b	− 26	218.6 SE	4.7
759, 24	.32	4483 t	− 57				1.40	1049 b	+ 23		
NE 3							1.45	1013 b	+ 24	206.5 SSE	3.4
June 19	6.43	5457 t	− 46	84.0 W	14.0		.46	1014 b	+ 7		
762, 24	.44	5447 t **1000** b	− 57			June 25	1.17	2792 t	+ 23	34.9 NW	15.1
W 3	6.47	5351 t	− 27	86.6 W	13.4	760, 32	.18	2681 t	+ 12		
	.48	5787 t	− 62	95.5 W	18.6	NE 3	1.20	4033 t	+ 14	54.5 NW	23.3
	.49	5424 t	−108				.22	4283 t	− 2		
	6.56	4453 t	− 87	77.5 W	10.6		1.33	3875 t	−140		
							7.03	8821 t	+ 56	18.7 NNW	23.0
	.57	4303 t	− 50	80.8 W	9.4		.05	8832 t	− 55		

STRATO-CUMULUS.

1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 8	6.10	2491 m	−213	15.7 NW	8.3	May 26	1.43	4079 t	−120	115.5 WSW	18.7
769, 17	.12	2169 m	− 11			759, 27	.45	3719 t	+ 7		
W 2	6.54	2000 m	+241			N 9					
	7.07	3542 m	+ 11			May 27	1.17	3863 t	+ 63	101.1 WSW	13.0
May 18	6.27	3728 m	+ 48	72.7 WNW	31.6	762, 26	.19	4395 t	+ 55		
758, 22	.29	3692 m	− 9			NE 3	1.25	3684 t	− 44	104.2 WSW	1.8
NE 4	6.33	3693 m	− 25	90.5 W	22.2		.27	4293 t	−154		
							1.33	4345 t	0	55.1 WNW	12.2
	.35	3793 m	−103				.35	4173 t	− 18		
	6.41	3780 m	−422				1.39	3640 t	−241		
	6.54	4073 t	− 39	81.9 W	27.0		1.46	2735 t	+381	119.7 WSW	11.9
	.55	4221 t	+ 43				.48	4300 t	+ 61		
May 19	6.07	3513 t	− 30	94.2 W	11.0	May 28	8.14	3700 m	−242	61.5 WNW	8.5
760, 24	.09	3263 t	+ 70			759, 22	.16	4000 m	−104		
NE 3	6.23	3548 t	+ 42			NW 9	8.23	4446 t	+291	95.9 W	13.3

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m*	*m.*	°	*m. p. s.*
May 28					
759, 22	.25	4790 t	+288	80.4 W	7.8
NW 9	.27	4493 t	−318		
June 1	6.08	2302 m	− 40	316.4 NE	3.3
763, 21	.10	2455 m	− 64		
NE 5	.16	1720 m	−130		
June 3	6.12	2322 t	+ 29		
767, 22	6.15	2648 t	+241	103.2 W	7.8
SW 3	.16	2727 t	+ 59		
	6.23	2211 t	+256	152.1 SSW	6.8
	.25	1781 t	− 36		
	6.32	2857 t	+ 99		
	6.36	3369 t	+153	97.7 W	7.9
	.38	3528 t	−197	89.8 W	3.7
	.40	3548 t	−214		
June 13	8.22	4690 t	+125		
754, 20	8.36	3385 t	+ 2	277.7 E	5.5
E 2	.38	3752 t	+137		
	8.41	2807 t	+ 22	283.1 ENE	14.7
	.43	3632 t	−131		
	8.47	3435 t	− 60		
	8.51	3623 t	− 10		
	9.04	4439 t	+127	193.4 SSE	6.4
	.06	4867 t	+368		
June 15	1.12	2764 t	+133		
768, 20	1.33	2743 t	+192		
W 1	.35	2215 t	+ 80	264.1 E	3.3
	2.16	2072 t	+267		
June 19	8.12	3716 b	+161	113.1 WSW	6.3
764, 23	.14	3842 b	+163	119.4 WSW	6.2
NW 2	.16	3731 b	+211		
June 22	1.25	3912 t	+ 40	78.2 WNW	13.5
760, 27	.27	3964 t	+ 80	94.7 W	9.9
NE 3	.29	3669 t	+ 26		
	1.37	4412 t	− 11		
June 23	6.09	3267 t	− 74		
764, 24	6.13	2972 m	+109	96.5 W	7.5
NE 2	.15	2581 m	−276		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 23	6.18	3252 t	+ 62	77.7 WNW	10.4
764, 24	.20	3682 t	−176	65.2 WNW	13.0
NE 2	.22	2726 t	−226		
	6.27	3508 t	+105	84.4 W	7.5
	.29	2991 t	−179	84.4 W	8.2
	.31	2136 t	0		
	6.33	2754 t	−154		
	6.35	2788 t	− 97		
June 26	6.20	6810 t	+134	58.0 WNW	10.6
764, 22	.22	5543 t	+164		
NE 4					
June 27	1.46	5548 t	+310	70.1 WNW	15.9
763, 26	.48	5550 t	+ 24	92.1 W	17.6
NE 3	.50	6954 t	+ 89	87.5 W	17.4
	.52	7285 t	+ 19		
July 3	8.33	3471 t	+237	101.2 WSW	6.4
766, 24	.35	3381 t	+208	113.2 WSW	6.6
W 2	.37	3441 t	+365		
July 7	6.45	2129 t	− 52	116.5 WSW	3.6
761, 24	.47	2016 t	−148		
N 1	6.51	2373 t	+ 14		
	6.55	2896 t	+ 33	116.7 WSW	7.4
	.57	3028 t	+ 55	116.2 WSW	8.0
	.59	3020 t	+ 37		
July 15	8.19	3731 t	+105		
758, 27	8.22	3696 t	− 38		
N 4	8.25	3690 t	− 15		
	8.28	3651 t	− 55	75.2 WNW	14.0
	.30	3654 t	+ 2	95.7 W	18.0
	.32	3843 t	+192		
756, 30	1.22	4036 t	+ 20	80.5 W	16.4
	.24	4117 t	0		
July 16	8.20	1751 t	+ 8		
757, 24	8.28	1829 t	− 40		
NE 3	8.32	1847 t	− 8		

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 16	8. 36	1840 t	− 42	58. 2 WNW	6. 5
757, 24	. 38	1859 t	+ 61		
NE 3	1. 07	1784 t	+ 33	106. 2 WSW	12. 1
	1. 17	2056 t	− 30		
	1. 22	2122 t	−106		
July 21	6. 36	4455 t	−126	72. 4 WNW	7. 2
764, 26	. 38	4170 t	− 91		
NE 3	6. 42	3655 t	− 89	95. 5 W	8. 9
	. 44	3505 t	−110	91. 7 W	10. 3
	. 46	3633 t	−219		
	7. 05	4998 t	+ 64		
July 22	3. 42	3642 t	+ 6		
760, 31	3. 45	3457 t	− 14		
N 3	3. 49	3323 t	+147	111. 5 WSW	17. 9
	. 51	3357 t	− 21		
	3. 54	3749 t	− 33		
	3. 56	4352 t	+114	98. 8 W	19. 3
	. 58	3486 t			
July 24	*8. 52	2234 t	+ 41		
758, 22	3. 54	3799 t	−310		
NW 5	4. 00	3353 t	− 36		
	4. 02	3803 t	− 33		
	4. 04	3815 t	− 11		
757, 23	6. 20	2858 t	− 17		
	7. 06	3207 t	− 72		
July 28	8. 24	3340 t	−217		
763, 26	8. 27	3610 t	−113		
NE 2	8. 36	3964 t	− 13		
	8. 39	4300 t	− 11	28. 4 NNW	13. 4
	. 41	3950 t	+ 4		
July 30	7. 09	3766 t	0		
759, 27					
N 4					
Aug. 1	1. 06	2416 t	− 39		
765, 25	1. 12	2061 t	+197		
763, 24	6. 15	1931 t	− 49		
W 4	6. 18	2097 t	− 11		
	6. 22	2035 t	+ 7		
	6. 27	2078 t	−102		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Aug. 1	6. 36	2927 t	− 81		
763, 24	6. 42	2038 t	+ 65		
W 4	6. 57	1999 t	+ 86		
Aug. 3	8. 27	2216 m	−126		
762, 24	8. 31	2102 m	+ 19		
763, 25	6. 12	1602 t	+ 19		
E 1	6. 17	1611 t	− 9		
	6. 20	1803 t	− 11	77. 8 WNW	4. 7
	. 22	1669 t	+ 45		
	6. 27	1494 t	+ 13		
	6. 32	1549 t	+ 83		
	6. 38	1485 t	+ 39		
Aug. 14	1. 11	1442 t	+ 60	24. 9 NNW	2. 4
763, 28	. 13	1380 t	+ 8		
E 1	1. 19	2168 t	− 31		
	1. 23	1629 t	− 51		
	1. 25	2188 t	+ 13		
	1. 29	2084 t	−122		
	1. 33	2138 t	−297		
	1. 41	2520 t	− 76	24. 9 NNW	2. 4
	. 43	2306 t	+ 26		
	1. 48	2779 t	−182		
Aug. 18	6. 10	3493 t	+ 15		
763, 22	6. 14	2903 t	+ 40		
NE 2	6. 16	3129 t	− 3		
	6. 19	2341 t	+ 60		
	6. 22	2694 t	+340		
	6. 25	3255 t	+ 5	48. 9 NW	16. 4
	. 26	3475 t	− 38	47. 2 NW	15. 1
	. 28	3563 t	− 25		
	6. 33	3291 t	− 2		
	6. 37	3506 t	− 14	55. 4 NW	11. 8
	. 39	3371 t	+ 3		
Aug. 20	6. 11	2442 t	+ 13	106. 5 WSW	4. 8
767, 22	. 13	2428 t	+ 17		
NE 4	6. 16	2565 t	− 12		
	6. 26	2340 t	− 22		
	6. 30	2452 t	+ 13	104. 2 WSW	7. 4
	. 32	2413 t	+ 9		

*761, 20.

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Aug. 20	6. 36	2318 t	− 34	114. 6 WSW	7. 0	Sept. 2	2. 25	1635 t	+ 32		
767, 22	. 38	2187 t	+ 19			768, 24	2. 33	2013 t	− 21		
NE 4	6. 48	2467 t	+ 47				2. 35	2394 t	− 4		
Aug. 21	8. 54	2239 t	+ 6				2. 38	2635 t	− 65		
764, 23	8. 58	2746 t	+ 2				2. 42	2489 t	− 11		
NE 2	9. 02	2393 t	+ 15			Sept. 3	6. 13	4070 t	− 8		
762, 25	3. 24	1805 t	+ 38			761, 22	6. 21	3949 t	+ 61		
NE 2	3. 27	1858 t	− 22	177. 4 S	6. 9	N 6	. 23	3888 t	+ 20		
	. 29	1909 t	+ 37				6. 26	3152 t	−116		
	3. 37	1771 t	+ 18				. 28	3527 t	−196		
	3. 41	1684 t	+ 6				6. 31	5148 t	−150		
	3. 44	2631 t	−150			Sept. 22	5. 21	1712 t	+ 30		
Aug. 24	8. 10	2696 t	−184			759, 16	5. 24	1917 t	− 24		
763, 24	8. 12	1855 t	+ 68			NE 1	5. 26	1774 t	+ 20		
NE 4	8. 21	2795 t	− 5				5. 32	1801 t	+ 6	42. 4 NW	10. 9
	8. 25	3188 t	+181				. 34	1853 t	+ 5		
Aug. 27	1. 05	4001 t	+112				5. 37	2705 t	−120		
765, 24	1. 13	4131 t	+ 59				5. 44	3283 t	+109		
E 2	1. 16	3914 t	+ 7			Sept. 28	8. 28	3455 t	+ 50		
	1. 21	4265 t	+ 65			765, 19	8. 33	3562 t	−200	143. 9 SW	6. 2
	1. 24	3608 t	+ 1			S 3	. 35	3753 t	+ 26	144. 9 SW	7. 5
	1. 32	2203 m	− 8				. 37	3514 t	+ 55		
	1. 36	2733 t	+ 47			765, 22	4. 56	1534 t	+ 27		
	1. 45	3306 t	− 52	109. 4 WSW	14. 7		4. 58	2879 t	+ 29		
	. 47	3606 t	− 31			Sept. 30	5. 13	2625 t	+ 32		
Aug. 31	2. 40	3468 t	− 12			755, 19	5. 15	2594 t	+ 3		
757, 30	2. 42	4494 t	+ 11			NW 4	5. 25	2158 t	+ 16		
N 3	2. 45	4005 t	− 36			Oct. 3	1. 25	1918 t	+ 5		
	2. 49	3672 t	+ 19	79. 8 W	18. 0	765, 18	1. 27	2596 t	−161		
	. 51	3716 t	+ 5			SE 3	1. 34	1929 t	−129		
	6. 11	2584 t	+ 1			Oct. 20	1. 26	2709 t	−130		
	6. 14	2576 t	+ 12			762, 18					
	6. 20	3420 t	− 95			N 7					
Sept. 2	8. 16	2344 t	0	79. 8 W	11. 2	Oct. 29	8. 40	1878 t	+161	108. 7 WSW	13. 0
770, 17	. 18	2568 t	− 4	81. 7 W	11. 3	770, 15	. 42	2238 t	−195		
W 4	. 20	2387 t	− 8			W 2	8. 57	2056 t	− 12	108. 7 WSW	7. 3
768, 24	1. 54	1956 m	− 2				. 59	1806 t	+ 23	110. 2 WSW	6 8
	2. 01	1733 m	− 11				9. 01	1632 t	+ 32		
	2. 08	1681 m	+ 27								
	2. 20	2124 t	− 23								

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Oct. 29					
770, 15	9. 11	2644 t	+ 37	122. 7 WSW	5. 5
	. 13	2402 t	− 46		
Oct. 30	1. 18	4110 t	− 43	84. 9 W	11. 8
761, 24	. 20	3434 t	+ 1		
NW 6					
Nov. 11	4. 04	2715 t	− 72	105. 7 WSW	16. 9
763, 15	. 06	2787 t	− 56		
NW 6	4. 08	2825 t	+ 32		
	4. 14	2896 t	−155		
	4. 22	2972 t	+ 16	81. 5 W	18. 1
	. 24	2844 t	− 37		
	4. 30	2889 t	+151	84. 5 W	20. 0
	. 32	2938 t	− 19		
	4. 36	3115 t	+ 74		
Nov. 13	8. 37	2071 t	+122		
764, 4	8. 49	2011 t	+ 6		
NE 8	8. 58	1565 t	+ 8		
	9. 01	1772 t	+ 43		
Nov. 19	1. 28	2764 m	+ 46		
766, 17	1. 31	2945 t	+ 20		
NE 4	1. 38	2926 t	+ 35	96. 1 W	14. 1
	. 40	2645 t	+ 60		
Nov. 23	8. 40	1402 t	+ 38		
781, 2	8. 50	1218 t	− 23		
NW 12	8. 53	1140 t	+199		
	9. 03	1128 t	+ 71		
	9. 10	1256 t	− 19		
	9. 13	1212 t	+ 13		
	9. 15	1514 t	+ 51	214. 5 SE	9. 2
	. 16	1180 t	+ 9		
	9. 22	1086 t	+ 51		
Nov. 24	*8. 45	4432 t	+ 78		
773, 19	1. 07	4099 t	+207	82. 6 W	14. 1
N 5	. 09	3211 t	+ 47		
	1. 11	3370 t	+ 43	83. 4 W	10. 5
	. 13	3472 t	+ 31	83. 3 W	11. 8
	. 15	3454 t	+ 22		
	1. 24	3606 t	−106	82. 7 W	12. 5
	. 26	3531 t	+ 36		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Nov. 28	8. 20	3616 t	−288	115. 5 WSW	18. 1
765, 18	. 22	3453 t	− 1		
NW 8	8. 27	3778 t	− 14	123. 5 WSW	19. 5
	. 29	3951 t	+ 25		
	8. 33	3338 t	+ 8		
	8. 35	3309 t	+ 24	114. 5 WSW	20. 3
	. 37	3914 t	+ 54		
	8. 39	3341 t	− 2	117. 0 WSW	18. 1
	. 41	3558 t	+ 78		
	8. 46	3488 t	− 3		
Dec. 7	1. 10	2011 t	+ 31		
766, 17	1. 12	2356 t	+ 93	70. 5 WNW	15. 0
NE 1	. 14	2203 t	+ 26		
	1. 20	2022 t	+ 9		
767, 16	4. 01	2312 t	+ 7		
	4. 04	1203 t	− 45		
	4. 07	2201 t	+ 3		
	4. 09	1113 t	− 6		
	4. 15	1342 t	− 22		
	4. 17	2467 m	+ 20	83. 2 W	16. 9
	. 19	2433 m	+ 84		
	4. 23	1468 t	− 46		
	4. 27	2740 t	+ 40		
	4. 35	2664 m	+ 24		
Dec. 8	8. 24	2387 t	+ 40		
769, 6	8. 43	3152 t	+ 11		
NW 2	8. 46	2570 t	− 3		
	8. 50	2766 t	+ 25		
	9. 06	2632 t	+ 39	106. 2 WSW	11. 0
	. 08	3052 t	− 58		
	9. 12	2851 m	+ 14	105. 2 WSW	10. 7
	. 14	2784 m	+ 17		
	9. 17	2790 t	+ 55	105. 1 WSW	9. 8
	. 19	2829 t	− 28		
763, 11	4. 04	4642 t	+ 27	112. 5 WSW	22. 4
	. 06	4326 t	−175		
	4. 08	4622 t	+119	97. 7 W	21. 6
	. 10	4321 t	+ 94		
	4. 18	4446 t	+ 37		

* 774.9.

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Dec. 8	4. 22	3510 t	− 93	119. 4 WSW	20. 8
763, 11	. 24	4056 t	− 40		
	4. 28	3911 t	+ 53		
Dec. 11	8. 21	1757 t	− 20		
762, 9	8. 24	1334 t	− 7	59. 0 WNW	8. 8
NE 11	. 26	1695 t	+ 52		
	8. 29	1691 t	− 38		
	8. 32	2032 t	+ 20		
	8. 36	1767 t	− 68		
	8. 45	1624 t	+ 22		
	8. 58	1488 t	+ 16		
	9. 07	1584 t	+ 12		
765, 9	1. 05	1008 t	+ 59		
	1. 08	1332 t	+ 35		
	1. 10	1236 t	+ 22		
	1. 12	1576 t	+ 20		
Dec. 14	4. 00	2427 t	− 92	86. 2 W	4. 8
763, 9	. 02	2412 t	− 74	80. 5 W	5. 5
SW 2	. 04	2253 t	+ 2		
	4. 07	2128 t	+ 33		
	4. 19	2115 t	+ 23	112. 7 WSW	5. 8
	. 21	2206 t	− 23		
	4. 29	2527 b	+ 34		
	4. 32	2692 t	+ 31		
	4. 34	2311 t	+ 16		
Dec. 18	8. 34	2173 t	+251		
763, 1	8. 47	3229 t	− 5		
S 10	8. 55	3161 t	+ 41		
761, 5	1. 15	3218 t	+ 42	121. 7 WSW	11. 0
	. 17	3383 t	+257		
	1. 19	3353 t	+ 4		
	1. 21	3523 t	+ 12		
	1. 26	3434 t	− 3		
761, 5	4. 03	3647 m	+ 18		
	4. 06	3365 t	+100		
	4. 09	3209 t	+ 25		
	4. 12	2523 t	+ 58		
	4. 15	2913 b	+116		
	4. 18	3092 t	− 64		
	. 20	3219 t	− 5		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Dec. 18	4. 23	2932 t	+213		
761, 5	4. 37	2939 b	+ 19		
	4. 40	3370 t	− 74		
Dec. 21	4. 21	1652 t	− 74		
762, 2	4. 25	2494 t	−108		
NE 2	4. 28	2150 t	+ 16		
	4. 35	1367 t	− 17		
	4. 38	1378 t	− 9		
	4. 52	2061 t	+ 52		
Dec. 22	1. 33	2343 t	+ 19	98. 4 W	23. 8
761, 2	. 35	2336 t	+ 86		
NW 4	1. 38	2478 t	+228		
	1. 41	3140 t	+ 27		
	1. 46	2168 t	−104		
Dec. 26	1. 18	1881 t	−104		
771, 0	1. 22	1898 t	+ 30		
NE 4	1. 24	1899 t	+ 7	78. 0 WNW	9. 1
	. 25	1939 t	+ 9		
	1. 30	1853 t	+ 10	61. 4 WNW	19. 1
	. 31	1893 t	+ 9	71. 0 WNW	20. 1
	. 32	1918 t	+ 38		
	1. 38	1922 t	− 43		
	1. 42	1886 t	+ 11	62. 5 WNW	20. 0
	. 44	1803 t	+ 3		
	4. 26	1785 b	+ 93		
772, 0	4. 38	1647 t	+ 16		
	4. 40	1632 t	+ 16	78. 0 WNW	16. 8
	. 41	1347 t	+ 15		
	4. 43	1729 t	− 7		
	5. 00	1645 m	− 14		
Dec. 30	8. 21	1663 t	+ 18		
774, 3	8. 32	1471 t	− 18	62. 7 WNW	8. 5
NW 2	. 34	1421 t	−167		
	8. 36	1580 t	−141		
	8. 38	1424 t	− 89		
	8. 40	1307 t	− 54		
1897					
Jan. 5	1. 00	1529 t	− 8		
755, 7	1. 10	1447 t	+ 92		
NE 3	1. 18	1541 t	+ 14		

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1897	*m. m.*	*m.*	*m.*	°	*m. p. s.*
Jan. 5	1. 23	1615 t	+ 21		
755, 7	1. 30	1299 t	+ 79		
NE 3	3. 54	1415 t	0		
	3. 57	2236 t	— 37		
756, 6	4. 06	1799 t	— 2		
	4. 09	1700 t	+ 15		
	4. 12	1688 t	— 4		
Jan. 11	8. 09	2248 t	+ 73	152. 7 WSW	3. 1
758, 2	. 11	2328 t	+ 16		
NE 2	8. 17	2206 t	— 11	109. 5 WSW	15. 2
	. 19	2436 t	+ 27	110. 0 WSW	15. 8
	. 21	2442 t	+ 41		
	8. 23	2424 t	+ 23		
	8. 35	2155 t	+ 18		
Jan. 18	10. 43	1740 t	— 41		
760, 5	10. 46	1748 t	+ 50		
NE 9	10. 50	1787 t	— 2		
	10. 55	1834 t	— 9		
	10. 57	1910 t	+ 35		
	11. 01	1907 t	+ 22		
	11. 06	2212 t	+ 37		
	11. 08	2133 t	— 46		
764, 3	3. 12	1658 t	— 41		
	3. 15	1613 t	0		
	3. 18	1578 t	+ 74		
	3. 20	1722 t	+ 47		
	3. 23	1576 t	— 16		
	3. 26	1610 t	— 31		
	3. 28	1523 t	+ 72		
	3. 31	1820 t	+ 67		
	3. 33	1538 t	+ 26		
	3. 35	2213 t	— 2		
Jan. 19	8. 56	2213 t	+ 2		
772, 2	9. 00	1768 t	+ 34		
NE 4	9. 04	1810 t	+ 61		
	9. 15	1656 t	+ 28		
Jan. 21	10. 37	1677 t	+ 60		
756, 5	10. 40	1553 t	+ 2		
N 7	10. 43	1669 t	+ 36		
	10. 45	1654 t	+ 7		
	10. 48	1469 t	+ 7		
758, 6	4. 04	1844 t	— 1		
	4. 08	1892 t	+ 51		

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Jan. 21	4. 09	1684 t	— 3		
758, 6	4. 11	1674 t	+ 3		
	4. 12	1910 t	+ 63		
	4. 15	1876 t	+ 81		
	4. 20	1776 t	+ 9		
	4. 26	1839 t	+ 49		
	4. 29	1735 t	+ 34		
	4. 32	1815 t	+ 14		
Feb. 9	1. 10	1932 t	—236		
768, 3	1. 15	1167 t	— 78		
NE 5	1. 21	810 t	+ 20		
	1. 25	1220 t	+ 19		
	1. 32	2010 t	— 4		
	1. 40	1088 t	+ 19		
	1. 42	1142 t	+ 25		
Feb. 10	4. 34	1008 t	+ 23		
769, 2	4. 38	968 t	+ 11		
NE 1					
Feb. 15	4. 14	4237 t	+ 28	103. 7 WSW	32. 8
755, 9	. 16	2727 t	+ 94	103. 2 WSW	27. 9
W 4	. 18	2976 t	+ 17		
	4. 20	2680 t	+ 53		
	4. 24	2606 t	+ 11	102. 7 WSW	20. 1
	. 27	2476 t	—153		
	4. 33	2438 t	+ 43	102. 4 WSW	20. 9
	. 35	2762 t	— 33		
	4. 40	2304 t	+ 7		
	4. 43	2502 t	+ 19		
Feb. 16	8. 54	4786 t	+196		
757, 5	8. 59	4738 t	— 11	123. 5 WSW	27. 2
E 6	9. 01	4346 t	—111		
	9. 05	4226 t	+ 42		
	9. 12	4286 t	+ 2[illegible]	120. 9 WSW	27. 8
	. 14	4208 t	— 31		
	9. 22	2874 t	+151		
	9. 24	2845 t	+ 38		
	9. 26	4601 t	— 6		
	9. 37	4464 t	+ 33		
Feb. 18	1. 35	2070 t	+ 23		
761, 11	1. 40	2502 t	+ 22		
NE 2	1. 47	1968 t	+ 35		

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m.p.s.*
Feb. 18	1.50	2042 t	+ 67		
761, 11	1.58	2014 t	− 1		
NE 2	2.02	2036 t	+ 18		
	2.05	2076 t	− 20	86.8 W	15.7
	.07	2064 t	− 65		
	2.10	1736 t	+141		
	2.13	1964 t	+ 30		
Feb. 26	1.16	2374 t	− 68		
766, 6	1.18	1960 t	− 15		
NE 2	1.20	1220 t	+ 13		
	1.22	1422 t	+ 7		
	1.27	1217 t	0		
	1.31	1330 t	+ 3		
	1.34	1365 t	+ 48		
	1.39	1136 t	+ 41		
	1.50	2198 t	+ 19		
	2.01	2505 t	+ 12		
Mar. 1	1.56	1798 t	−110		
777, 4					
W 9					
Mar. 8	1.41	822 t	+ 21		
774, 3	1.47	800 t	− 3		
W 4	2.01	966 t	+ 2		
Mar. 10	5.25	3046 t	− 79		
759, 14	5.27	2973 t	+136		
N 3	5.30	2714 t	+111		
	5.32	2964 t	− 2	118.2 WSW	23.3
	.34	3051 t	+ 33		
	5.41	2783 t	− 26	125.8 WSW	25.3
	.42	2771 t	− 94		
Mar. 22	5.38	3071 t	+ 10		
758, 2	5.42	3549 t	+ 58		
NW 4	5.46	3061 t	+ 8	91.7 W	10.5
	.47	3146 t	+ 8		
	5.51	3266 t	0		
Mar. 23	8.57	2716 t	+ 30	130.9 SW	7.4
756, 14	.58	2736 t	+ 19		
W 1	9.00	2703 t	+ 16	128.1 SW	6.8
	.01	2686 t	− 25		
	9.03	2564 t	− 1		

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m.p.s.*
Mar. 23	1.45	2918 t	− 9	131.3 SW	13.2
756, 14	.46	2428 t	+ 85		
W 1	1.56	3686 t	− 58	136.1 SW	14.9
	.57	3262 t	+ 17		
Mar. 24	8.57	1630 t	+ 3	99.0 W	6.2
746, 7	.59	1554 t	+ 14		
E 7	9.03	1655 t	+ 2		
	9.07	2287 t	−230		
	9.12	1718 t	−183	71.9 WNW	8.5
	.14	1738 t	− 33		
746, 10	1.28	3478 t	+ 16		
	1.38	3166 t	+ 9		
747, 9	5.31	2679 t	+ 16	80.5 W	21.1
	.33	2740 t	− 5		
	5.35	2714 t	+ 29		
	5.37	2836 t	+ 6	85.9 W	21.6
	.38	2868 t	+ 31		
	5.44	2578 t	+ 13	80.7 W	21.1
	.46	2626 t	− 54		
	5.58	2587 t	− 20	81.2 W	20.1
	6.00	2772 t	+ 29		
	6.02	2560 t	− 30		
Apr. 5	5.53	2824 t	− 1		
756, 19	5.56	2998 t	+ 6		
NW 3	5.58	3060 t	+ 57		
	6.06	2333 t	+ 7		
Apr. 6	1.23	3302 t	−133		
758, 15	1.25	1564 t	− 32		
N 2	1.28	1756 t	+ 18		
	1.31	2831 t	+ 12		
	1.36	2930 t	+ 12		
759, 13	5.41	2994 t	− 63		
	5.45	3304 t	+ 8		
	5.47	3120 t	− 48		
	5.51	3188 t	− 25		
	5.54	3246 t	− 8		
	5.56	3446 t	− 18		
	5.58	3234 t	− 14		
	5.59	3269 t	− 6		
	6.00	3200 t	− 18		

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Apr. 7	1.38	1960 t	+ 17		
763, 13	5.46	1866 t	− 3		
NE 2	5.49	1832 t	+ 1		
	5.55	2015 t	− 12	87.3 W	10.0
	.56	2029 t	− 10		
	6.06	1811 t	− 22	90.4 W	9.9
	.07	1955 t	+ 14		
Apr. 9	5.46	3798 t	− 45	98.6 W	26.4
750, 13	.48	4276 t	0		
N 5	6.10	3570 t	− 12		
	6.14	4466 t	+ 19		
	6.16	2120 t	− 2	115.7 SW	17.4
	.17	2150 t	+ 25	116.8 SW	21.2
	.18	2148 t	+ 3		
Apr. 10	5.58	1823 t	− 6	311.5 NE	3.5
763, 8	6.00	1844 t	+ 2	318.1 NE	4.0
NE 5	.02	1784 t	+ 27		
	6.11	1823 t	+ 12	315.9 NE	3.0
	.13	1695 t	− 6		
	6.16	1774 t	+ 57	305.2 NE	2.6
	.17	1834 t	+ 5	296.5 ENE	3.4
	.18	1922 t	− 41		
	6.21	1824 t	+ 30	297.5 ENE	3.4
	6.23	1845 t	+ 6		
Apr. 12	1.35	1192 t	+257		
776, 10	1.44	1338 t	− 19		
W 2	1.48	1142 t	−290		
	1.51	1465 t	+108		
	1.54	1254 t	− 3		
	1.58	1360 t	− 14	331.6 NNE	5.2
	.59	1394 t	+ 6	338.8 NNE	5.1
	2.00	1408 t	+ 14		
	6.02	1276 t	− 8		
Apr. 14	5.58	2890 t	−115		
761, 21	6.03	2348 t	+ 8	178.8 S	12.3
NW 5	.05	2915 t	− 1	170.6 S	10.4
	.07	3089 t	− 53		

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m, p. s.*
Apr. 14	6.12	3420 t	− 42		
761, 21	6.14	3320 t	+ 5		
NW 5	6.16	3540 t	+ 9	74.3 WNW	16.9
	.18	3460 t	+ 12		
Apr. 16	8.42	1432 t	− 51		
763, 9	9.00	1452 t	− 8		
NE 3	9.19	1299 t	+338		
	9.21	1430 t	+ 45	120.3 WSW	11.9
	.22	1387 t	− 26		
	9.30	1461 t	+ 22		
	.36	1258 t	+283		
Apr. 17	6.06	1840 t	0		
762, 9	6.09	1768 t	− 17		
N 3	6.11	1760 t	− 13		
	6.13	1851 t	+ 10		
	6.20	1741 t	+ 17		
Apr. 19	1.13	2384 t	+ 10		
762, 22	1.15	2510 t	− 15		
N 10	1.20	2642 t	− 13		
	1.24	2708 t	+ 29		
	1.31	2461 t	+ 10		
	1.35	2705 t	+ 34		
764, 19	5.59	3322 t	− 5		
	6.02	2812 t	− 11		
	6.05	3159 t	− 50	110.1 WSW	16.6
	.08	3492 t	− 30		
	6.11	3692 t	− 25	111.7 WSW	23.5
	.13	4490 t	+ 91		
	6.17	2697 t	+ 18	115.2 WSW	15.8
	.19	2574 t	− 13		
	6.23	3614 t	+148		
Apr. 26	6.10	2459 t	−238		
756, 18	6.15	4574 t	+ 20		
NW 3	6.31	2063 b	+ 18	75.5 WNW	20.0
	.32	2752 b	+ 1	73.4 WNW	21.2
	.33	2840 b	− 97		
	6.35	2891 t	+ 5	76.2 WNW	20.7
	.36	2667 t	− 98		
	6.40	2162 t	+ 71		

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V.
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Apr. 30	1. 10	1076 t	− 10			May 10	. 24	2107 t	− 58		
761, 22	1. 12	1081 t	+ 2	201. 7 SSE	6. 9	758, 24	6. 25	1895 t	− 2	71. 4 WNW	10. 9
SW 4	. 14	920 t	+ 37			N 4	. 26	1830 t	+ 4		
	1. 19	1097 t	0				6. 29	1995 t	− 20	79. 5 WNW	12. 7
	. 21	1036 t	+ 25				. 30	1922 t	− 5		
	1. 24	1050 t	− 11								
	1. 44	1075 t	− 2	217. 6 SE	6. 7	May 11	6. 17	1660 t	+ 28		
	. 46	1170 t	− 59			761, 21	6. 20	2381 t	− 70		
760. 21	6. 43	2767 t	−110	182. 9 S	11. 4	NW 3	6. 24	2478 t	+ 6	110. 5 WSW	16. 5
	. 45	2659 t	+218				. 25	2533 t	− 1		
May 1	8. 42	1994 t	+ 89				6. 29	2071 t	+ 48		
758, 18	8. 46	2096 t	+ 18				6. 33	2264 t	+ 21	108. 4 WSW	15. 1
SW 5	8. 52	2262 t	+131	207. 8 SSE	18. 2		. 34	2246 t	+ 7		
	. 53	2244 t	+ 86				6. 37	2379 t	+ 12	106. 4 WSW	12. 7
	8. 55	2144 t	− 33				. 38	2028 t	+ 18		
	8. 59	2082 t	+360				6. 42	2394 t	− 23		
	9. 03	1496 t	− 36			May 25	6. 13	2590 t	+ 21	338. 1 NNE	3. 8
	9. 05	1674 t	− 35								
	9. 12	1734 t	+ 35			765, 16	. 15	2605 t	+ 37	340. 1 NNE	3. 6
	9. 14	1928 t	− 15	211. 3 SSE	15. 2	NE 20	. 17	2574 t	+ 56		
	. 15	1954 t	+ 1				6. 20	2460 t	+176	352. 1 N	2. 2
May 4	1. 19	2493 t	−122				. 22	2516 t	− 23	346. 7 NNE	2. 4
760, 16	1. 21	2351 t	− 9	78. 8 WNW	8. 3		. 24	2537 t	− 2		
NE 8	. 23	2322 t	+ 18				6. 26	2710 t	+ 72	18. 3 NNW	3. 0
	1. 27	2358 t	− 14				. 28	2810 t	− 50		
	1. 37	2454 t	+ 4	73. 2 WNW	11. 9		6. 34	2717 t	+ 20	253. 6 ESE	2. 5
	. 38	2293 t	+ 6	71. 1 WNW	12. 8		. 36	2520 t	+ 3		
	. 39	2373 t	− 10			May 28	6. 25	3600 t	− 35	77. 5 WNW	15. 2
May 5	1. 48	2925 t	− 8			757, 23	. 27	3510 t	− 23		
761, 15	1. 49	3098 t	+ 4			NE 6	6. 31	3250 t	−203		
E 4							6. 33	3800 t	+ 6		
May 7	6. 14	2869 t	− 4				6. 45	3174 t	− 9	80. 6 W	15. 1
764, 21	6. 16	2667 t	+ 24				. 47	3070 t	− 25		
NE 1											
May 10	6. 13	1914 t	0	87. 8 W	10. 5	May 29	8. 50	1956 t	+ 4	68. 0 WNW	18. 3
758, 24	. 15	1978 t	+ 1			757, 15	. 51	1982 t	− 5	67. 8 WNW	17. 8
N 4	6. 17	1767 t	− 56	79. 1 W	9. 8	N 5	. 52	2026 t	+ 37		
	. 19	2167 t	+ 10				8. 56	2164 t	+ 14	110. 4 WSW	15. 0
	6. 22	2424 t	−223	58. 1 WNW	11. 5		. 58	2227 t	−101		

TABLE 6.—*Summary of theodolite observations*—Continued.

STRATO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 1	8.57	3217 b	+ 10	97.0 W	26.0	June 12					
763, 17	.59	3209 b	− 2			758, 23	.26	4863 t	+ 58	85.1 W	15.7
NE 5	9.03	3164 b	− 30			NE 2	.27	4649 t	−220		
	9.05	3411 b	−110	91.4 W	24.6	June 16	6.19	3242 t	− 8	68.8 WNW	10.1
	.06	3560 b	+ 41			759, 27	.20	3285 t	− 50		
June 3	6.32	3496 t	− 1	92.8 W	11.9	NE 3	6.21	3212 b	− 22	58.5 NW	13.3
760, 23	.34	3600 t	− 27				.23	3365 b	− 47		
NW 8	6.41	3800 t	− 67	95.8 W	11.7		6.25	3031 t	− 52	72.1 WNW	9.2
							.27	3342 t	+ 41		
	.43	3742 b	+ 1				6.34	3434 t	+ 21	69.5 WNW	11.7
	6.51	4180 b	+ 67	109.5 WSW	12.5		.35	3002 t	+ 9		
	.52	3564 b	− 27			June 17	1.49	2074 t	− 2	108.9 WSW	9.5
	6.57	4067 t	+ 26	108.3 WSW	14.2	756, 24	.50	2166 t	+ 45		
	.59	4136 t	− 56			W 2					
	7.07	3979 t	+ 69	99.8 W	11.9	June 26	8.46	2359 t	− 72	71.0 WNW	17.3
	.09	4368 t	+ 36			762, 21	.47	2388 t	− 6		
June 10	6.49	1938 t	− 63	18.1 NNW	10.1	E 4	8.54	2257 t	+ 18		
							9.14	2586 t	+ 15	70.8 WNW	24.6
763, 21	.50	1944 t	− 33	21.9 NNW	8.8		.15	2569 t	+ 14		
NE 7	.51	2008 t	− 27				9.17	2559 t	−182	61.1 WNW	18.6
	6.57	1678 t	+ 57	16.1 NNW	6.6		.18	2167 t	+ 58		
	.59	1712 t	+ 53				6.41	2580 t	+ 2	0.5 N	9.2
June 11	6.50	2857 t	− 74	41.4 NW	22.5		.43	2542 t	− 4		
762, 23	.51	2803 t	− 14				6.50	2438 t	+ 4	69.1 WNW	10.6
NE 4	6.53	2801 t	− 2	45.2 NW	23.2		.51	2507 t	+ 16		
	.54	2505 t	+100			June 29	6.40	4648 t	− 74	351.4 N	6.2
	7.00	2911 t	+ 14	37.1 NW	20.1	762, 27	.41	4745 t	+ 34		
	.01	3164 t	+ 14			NW 4	6.43	4232 t	+ 3	49.5 NW	17.5
June 12	8.17	4742 t	− 44	74.5 WNW	13.9		.44	4062 t	− 9	43.9 NW	15.2
							.45	4421 t	− 9		
758, 23	.18	4824 t	−129	79.4 W	15.0	June 30	7.06	4903 t	−273		
NE 2	.19	4474 t	− 33			757, 30	7.08	3976 t	−177		
	8.25	4658 t	+ 10	84.4 W	15.8	N 4					

ALTO-CUMULUS.

1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 8	10.39	3593 t	+416			May 8					
770, 14	11.00	3853 t	− 11			770, 14	11.37	2254 m	−204		
W 2	11.18	5283 b	+349	320.2 NE	28.0	W 2	.39	2038 m	−155		
						769, 18	6.16	4405 t	+169		
							6.33	2594 t	+116		
	.20	5501 b	−386				6.36	3988 t	+ 57		

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 12	8.31	4617 m	−242			May 26					
760, 22	8.32	5055 m	+ 59	59.6 WNW	24.8	761, 21	.52	7072 t	+300	87.8 W	17.7
NE 2	.34	4236 m	+106			N 9	.54	8113 t	+139		
	8.40	4970 m	+ 13			759, 25	6.27	4528 m	− 92	66.7 WNW	16.2
	8.46	4498 t	+130	161.1 SSW	6.0		.29	4625 m	−150		
	.48	4596 t	+332			June 1	8.46	8106 t	+178	87.7 W	40.3
	8.51	5140 m	+131			763, 16	.48	8628 t	+ 97		
	8.52	4984 m	+ 57			NE 5	8.50	8339 t	+ 87		
	9.00	5001 m	−202	83.7 W	17.1	June 3	6.45	5781 t	−330	91.8 W	33.1
	9.01	4887 m	+ 66			767, 22	.47	6667 t	+103		
	9.06	5222 m	+ 96			SW 3					
	.07	4927 m	+ 60			June 9	6.40	2978 t	+ 20		
	.08	5238 m	−108			752, 23	6.44	3295 t	+ 37	126.8 SW	15.5
May 13	*8.34	2729 m	− 66			N 2	.46	3535 t	0		
763, 25	1.25	3403 m	+174				6.56	3005 t	+ 28	80.8 W	14.1
W 2	1.34	3336 m	+ 5				.58	3289 t	− 46		
	1.37	3026 m	− 63			June 15	6.02	2966 t	+ 1		
763, 23	6.50	2666 t	−262			768, 20	6.06	3261 t	− 43		
	.52	3220 t	+ 54	52.5 WNW	2.5	W 1	.08	3359 t	+ 56		
	7.00	4749 t	+258				6.12	2518 t	− 10		
	7.04	4033 t	+329	234.2 SE	1.7		.14	2587 t	−271		
	.06	4170 t	+429			June 16	2.00	4135 t	− 20		
May 18	1.08	8428 t	−427	83.1 W	31.1	766, 22	2.03	4871 t	+133		
760, 33	.10	9590 t	+283			766, 20	6.44	3918 t	−165		
NE 4	1.14	6392 t	+734			NW 1	.46	3570 t	−139		
	1.23	9145 t	− 35	58.4 WNW	19.6		.48	3864 t	−166		
	.24	7939 t	−152			June 17	1.27	6807 m	− 39		
	1.35	7147 t	+ 18	66.8 WNW	19.7	762, 24	1.30	4592 m	− 1		
	.36	5497 t	−432			NW 1	1.36	7336 t	+222		
May 22	6.13	4628 t	+ 65	89.5 W	9.7		1.38	7262 t	−130		
764, 24	.15	5365 t	+ 45	56.2 WNW	9.5		1.44	6583 m	+ 82		
N 3	.17	4631 t	− 20				1.50	4517 t	− 9		
	6.51	7767 t					1.54	4787 t	+ 40	94.2 W	12.3
	.53	7271 t	−242	80.1 W	16.6		.56	4548 t	− 49	92.5 W	11.6
			−283				.58	4131 t	−260		
May 26	9.40	6086 m	+ 81	95.8 W	15.0	762, 22	6.12	3606 m	0		
761, 21	.42	7916 m	+ 27	95.7 W	17.0		6.17	3507 m	− 4		
N 9	.44	7087 m	+ 50				6.47	4709 m			
	9.50	6618 t	+411	87.1 W	18.2		6.50	4201 m			

*763, 21.

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 18	8. 16	4828 t	+137	126. 4 SW	11. 4	June 22	6. 51	8220 m	—119		
						759, 26	6. 55	8511 m	—103		
762, 22	. 18	4214 t	—357	94. 1 W	13. 5		6. 58	8243 m	— 66		
NW 1	. 20	4803 t	+102				7. 00	6248 t	+ 96	69. 7 WNW	19. 8
	3. 49	6049 m	—178	62. 7 WNW	5. 3		. 02	6007 t	+132	64. 4 WNW	17. 0
	. 51	5514 m	—375				. 04	6182 t	+ 63		
	3. 57	5419 m	—287								
June 19	8. 24	5147 b	—174	110. 1 WSW	7. 1	June 23	1. 12	4410 t	+207		
						764, 24	1. 17	2388 t	— 27		
758, 28	. 26	4580 b	— 5			764, 24	6. 33	2764 t	—154		
NW 2	8. 28	4246 m	+ 74			NE 2	6. 35	2788 t	— 97		
	8. 48	4595 t	+ 48	114. 9 WSW	10. 2	June 26	1. 26	2487 t	—151	43. 9 NW	8. 9
	. 50	4443 t	+ 37								
760, 24	6. 21	4322 t	+ 33	75. 7 WNW	10. 1	764, 29	. 28	2444 m	— 55	9. 1 N	6. 3
	. 23	4348 t	+226			NE 4	. 30	2300 m	—177		
	6. 27	4285 t	+ 26	73. 5 WNW	8. 2		1. 36	2362 m	+ 24		
	. 29	3660 t	+ 41				1. 42	2455 m	+ 22	78. 7 WNW	17. 5
	6. 31	3774 t	+128	56. 9 WNW	2. 8		. 44	2988 t	—141		
	. 33	4162 t	+109			764, 28	3. 29	2506 m	+ 4		
	6. 37	3959 t	—375				3. 32	2585 m	+ 38		
	6. 42	5261 m	—337				3. 35	2314 m	— 11		
	6. 46	3907 t	+ 67			June 27	1. 17	5276 m	+ 45	80. 1 W	14. 3
	6. 49	3889 t	+175								
June 22	8. 19	4100 t	+155			763, 26	. 19	6017 m	+202	80. 0 W	14. 4
760, 25	8. 32	4461 m	+ 41			NE 3	. 21	6327 m	+ 59	80. 3 W	16. 2
NE 3	8. 37	5951 m	+329								
	8. 46	5978 t	—289				. 23	5201 m	+119		
	8. 49	4157 t	+ 44	57. 4 WNW	8. 3		1. 29	6556 m	+138		
	. 51	4388 t	—162			762, 25	3. 28	4403 t	+ 80		
760, 27	1. 33	4221 m	+167				3. 38	3005 m	+237	95. 5 W	13. 2
	1. 45	9768 t	+ 18	94. 7 W	28. 3		. 40	3363 m	+ 59		
	. 47	9203 t	+ 93				3. 44	4533 t	+ 5		
760, 27	3. 49	5031 m	+135				6. 08	5341 m	+ 47	94. 4 W	16. 1
	3. 52	9695 t	+ 20	90. 1 W	23. 0		. 10	5324 m	+ 55		
	. 54	9889 t	—230	103. 2 WSW	20. 2		6. 15	5170 m	+ 27	86. 7 W	16. 3
	. 56	8611 t	— 48				. 17	5499 m	+ 63		
759, 26	6. 37	7849 t	+196				6. 25	4860 m	+ 22	97. 4 W	13. 6
	6. 39	7764 m	+ 91	65. 1 WNW	23. 9						
	. 41	9591 m	+ 62	67. 5 WNW	27. 3		. 27	5653 m	+137	95. 5 W	15. 2
	. 43	8624 m	+126				. 29	4760 m	+ 93		

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 29	8. 44	3812 m	+220	96. 5 W	21. 9	July 9	. 16	9530 m	− 85	155. 8 SSW	27. 5
760, 23	. 46	3734 m	− 31	115. 5 WSW	21. 5	765, 24	. 18	8735 m	−334		
NE 4	. 48	4652 m	+ 20	112. 8 WSW	21. 6	NW 5	6. 21	10779 m	−247	158. 0 SSW	29. 7
	. 50	5078 m	+251				. 23	10901 m	+217	158. 5 SSW	31. 0
July 2	6. 13	7832 t	+ 57	62. 0 WNW	15. 1		. 25	10415 m	−120		
766, 27	. 15	8634 t	− 61	69. 7 WNW	16. 4	July 10	1. 19	7487 m	−157		
W 3	. 17	7479 t	+224	66. 7 WNW	15. 4	769, 27	3. 35	3861 m	+ 40		
	. 19	7993 t	+213	68. 2 WNW	16. 2	NW 3	3. 37	5131 m	− 22		
	. 21	7600 t	+156				3. 47	3755 m	− 19		
	6. 39	7701 m	−242	80. 0 W	16. 5	768, 25	6. 24	7854 m	+ 9		
	. 41	6659 m	−265				6. 28	3766 t	+155		
July 3	8. 18	4043 m	+ 39	118. 4 WSW	10. 4		7. 16	5936 t	− 74		
766, 23	. 20	4996 m	+ 31	98. 8 W	7. 7		7. 19	4274 t	−257		
W 2	. 22	4278 m	+151	102. 5 WSW	11. 5		7. 24	3351 m	+ 24	130. 8 SW	10. 8
	. 24	4644 m	+ 59				. 26	3675 m	+ 16		
	8. 54	4228 m	+ 42			July 11	1. 26	9701 m	+ 48	97. 5 W	29. 6
	8. 56	3745 m	− 16			768, 29	. 28	9803 m	− 25	98. 0 W	28. 3
	9. 04	3598 t	− 78	126. 7 SW	5. 5	N 3	. 30	10487 m	− 35		
	. 06	3062 t	+ 89				1. 32	9715 t	+399	93. 0 W	24. 6
July 6	3. 29	6764 m	+ 18	137. 4 SW	24. 5		. 34	9665 t	− 16	96. 7 W	31. 1
761, 27	. 31	7613 m	+ 42				. 36	10288 t	− 50		
N 2	3. 36	6388 m	− 56	134. 7 SW	15. 6	767, 28	3. 38	8707 t	+123		
	. 38	5955 m	−184				3. 44	8555 m	+ 32	91. 0 W	23. 9
July 7	3. 24	7847 m	+ 79				. 46	8202 m	+ 36	93. 8 W	22. 6
760, 28	3. 28	8324 m	+128	116. 4 WSW	18. 9		. 48	8685 m	− 18		
N 1	. 30	5170 m	+116			July 14	8. 19	4335 m	− 49	12. 2 NNW	5. 9
July 9	11. 49	7490 m	+192			762, 26	. 22	5016 m	−225		
765, 24	12. 01	4778 t	+ 83			NE 2	8. 37	3009 m	+ 7	79. 7 WNW	8. 8
765, 27	1. 30	7559 m	+ 47	169. 5 S	21. 1		. 39	3033 m	0	78. 2 WNW	8. 8
	. 32	6318 m	+ 84				. 41	2979 m	+ 5	77. 7 WNW	9. 8
765, 26	3. 35	8296 m	+ 34				. 43	2991 m	+ 9		
	4. 09	8782 t	− 35	160. 5 SSW	27. 6		8. 53	3976 b	+ 16		
	. 11	9386 t	−182			761, 31	1. 14	3884 m	+ 2		
765, 24	6. 12	9646 m	−121	160. 8 SSW	26. 5		1. 17	3476 m	+ 67	84. 4 W	6. 6
NW 5	. 14	9453 m	− 4	161. 4 SSW	25. 0		. 19	4414 m	+ 16		

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 14	1. 39	3859 t	+162		
761, 31	3. 25	4322 t	+ 22		
	3. 28	4456 t	− 16		
	3. 30	5857 t	+204	84. 4 W	23. 5
	. 32	4518 t	− 13		
	3. 37	4126 t	−108		
July 15	3. 35	10032 t	−398	110. 5 WSW	21. 7
757, 28					
N 4	. 37	9329 t	− 97		
July 16	8. 49	3307 t	− 75	106. 2 WSW	12. 1
757, 24	. 51	2981 t	+ 3		
NE 3	9. 00	3255 t	+208		
	9. 08	3153 t	+ 6	105. 2 WSW	12. 5
	. 10	3339 t	+ 60		
	9. 13	3095 m	+ 11		
July 18	8. 48	8061 m	+ 45	97. 5 W	12. 9
771, 20	. 50	8000 m	+ 27	99. 0 W	10. 8
NW 1	. 52	8513 m	− 59		
July 20	6. 21	8377 m	− 59	78. 2 WNW	15. 4
764, 28	. 23	9071 m	−105		
NW 5	6. 26	8141 m	− 56	74. 8 WNW	13. 2
	. 28	7020 m	− 86	72. 2 WNW	12. 5
	. 30	7414 m	− 74		
July 21	4. 04	3617 t	− 51	105. 2 WSW	13. 2
764, 27	. 06	3921 t	− 84		
NE 3	4. 09	3657 m	− 86		
	4. 11	3557 m	− 7		
July 22	9. 06	5264 m	− 25	87. 8 W	17. 1
764, 24	. 08	5823 m	+ 69		
N 3	9. 18	5363 t	+ 34		
	9. 20	4592 m	+ 95		
	9. 23	5107 m	+ 4		
	9. 33	4935 t	− 14		
	9. 45	4296 t	− 51		
760, 30	3. 29	4903 t	− 32	102. 7 WSW	17. 1
	. 31	4610 t	− 25		
759, 28	6. 41	6841 t	− 39	109. 7 WSW	21. 7
	. 43	6812 t	− 35		
	6. 46	6528 m	−109		
	6. 49	6698 m	− 93		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 25	8. 41	5782 m	− 65		
762, 21	8. 43	5585 m	− 47	93. 5 W	26. 5
NE 5	. 45	5543 m	− 63		
	8. 48	5420 t	− 68		
July 27	8. 25	5386 m	+ 17		
763, 24	8. 28	5379 t	− 51	82. 0 W	20. 9
N 3	. 30	5185 t	− 41	83. 4 W	20. 6
	. 32	5343 t	−151		
	8. 40	4993 t	− 1	86. 8 W	19. 8
	. 42	4620 t	− 14		
760, 33	3. 43	3555 t	+179		
	3. 46	4579 t	− 48	87. 7 W	21. 9
	. 48	5331 t	− 4		
	3. 50	4012 t	−217		
	3. 52	4505 t	− 33		
July 28	8. 46	4526 t	−105		
763, 26	8. 49	4246 t	− 18	73. 0 WNW	15. 8
NE 2	. 51	4175 t	−106		
	8. 56	4218 m	− 92	71. 0 WNW	13. 8
	. 58	4412 m	+ 8		
	1. 53	5234 m	+ 24		
July 29	8. 20	6746 m	− 26	63. 7 WNW	18. 2
765, 26	. 22	7726 m	+ 2	58. 5 WNW	17. 6
NE 1	. 24	7632 m	− 91	62. 0 WNW	18. 1
	. 26	7306 m	+ 29	61. 4 WNW	18. 4
	. 28	7355 m	+ 5		
	8. 39	6211 m	− 39	60. 0 WNW	16. 3
	. 41	6567 m	− 13	58. 5 WNW	16. 0
	. 43	6312 m	− 60	59. 4 WNW	15. 5
	. 45	6445 m	− 28		
July 30	8. 16	5681 m	− 51	46. 5 NW	18. 2
761, 26	. 18	5663 m	− 49		
N 4	8. 29	7758 m	−227		
	8. 34	5875 b	−151	44. 7 NW	16. 4
	. 36	5753 b	−144		

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 30	8. 38	5698 m	− 84	42. 4 NW	15. 1	Aug. 10	. 12	4463 t	+361		
761, 26	. 40	5701 m	− 19	40. 2 NW	15. 7	763, 33	1. 14	5460 t	+255	70. 9 WNW	8. 5
N 4	. 42	5331 m	− 24				. 16	4389 t	+ 69		
	8. 57	5859 t	− 17				1. 26	3005 m	+ 1		
	9. 00	5789 m	− 22				1. 29	3303 m	+ 60		
760, 31	1. 12	5493 t	− 58	49. 8 NW	20. 7	763, 32	3. 32	4134 t	+ 55		
	. 14	5555 t	+ 2			Aug. 11	8. 12	4453 m	+ 86	92. 7 W	8. 2
	1. 23	3721 m	− 34	48. 2 NW	20. 2	762, 27	. 14	4640 m	−102	94. 2 W	7. 9
	. 25	3720 m	0			NW 2	. 17	4287 m	−116		
	1. 29	3495 t	+ 1	33. 4 NNW	9. 8		8. 23	4356 m	+131		
	. 31	3060 t	− 47				8. 29	4318 t	+ 21	92. 9 W	7. 1
	. 33	2853 t	+ 2				. 31	4088 t	− 21		
759, 30	3. 30	4939 m	− 18	53. 0 NW	15. 0		8. 41	4148 t	+ 56	94. 4 W	6. 7
	. 32	4896 m	− 20	54. 0 NW	16. 0		. 43	4294 t	+ 95	92. 9 W	6. 5
	. 34	4934 m	+ 28				. 45	4254 t	+128	97. 0 W	7. 0
	3. 37	4050 t	− 36	53. 2 NW	11. 0		. 47	4284 t	+ 49		
	. 39	4178 t	− 16	53. 0 NW	12. 0	762, 27	1. 15	2580 t	− 14	45. 2 NW	4. 1
	. 41	4069 t	− 33				. 17	2515 t	−283	17. 2 NNW	2. 8
Aug. 1	8. 24	2607 t	− 4	65. 5 WNW	7. 5		. 19	2499 t	− 80		
768, 19	. 26	2656 t	+ 10				1. 27	4762 t	−261		
W 4	8. 30	3277 t	+174				1. 31	2192 m	−240	13. 5 NNW	2. 4
	8. 33	3101 t	+ 75	57. 5 WNW	14. 0		. 33	2092 m	+ 49		
	. 35	2638 t	+115				1. 38	4493 m	+ 62	53. 7 NW	5. 7
	8. 40	2676 t	+ 25	58. 0 WNW	11. 8		. 40	3728 m	−136		
	. 42	2862 t	+ 30				1. 47	4455 m	+ 94	58. 7 WNW	5. 9
							. 49	3702 m	− 73		
Aug. 3	8. 40	4000 m	− 19			762, 32	3. 34	2414 t	+ 95	62. 2 WNW	3. 2
762, 24							. 36	2112 t	+218	57. 5 WNW	2. 9
E 1							. 38	2077 t	+125		
Aug. 10	8. 21	5360 b	+ 44	51. 7 NW	1. 2	Aug. 13	8. 16	6127 t	+ 42		
764, 29	. 24	5517 b	+ 78			763, 26	8. 18	5460 t	+196	59. 0 WNW	5. 3
NE 3	8. 31	4453 m	− 20			E 1	. 20	6278 t	+115		
	8. 39	4070 m	+102	60. 0 WNW	5. 8		8. 24	6155 t	− 80	73. 0 WNW	9. 3
	. 41	4139 m	− 94								
	8. 48	6088 t	+ 12				. 27	5899 t	−156	86. 4 W	9. 6
	8. 53	4455 m	+125								
763, 33	1. 10	4801 t	+ 75	72. 2 WNW	8. 6		. 29	6470 t	−319	70. 4 WNW	10. 2

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Aug. 13	.31	6458 t	−133		
763, 26	8.36	6950 m	+129	79.7 W	12.6
E 1	.38	6796 m	+184		
763, 34	4.04	6905 m	+ 86		
	4.06	6224 m	+104		
Aug. 14	9.01	4114 t	+195	100.5 W	12.9
763, 24	.03	4084 t	− 31		
E 1	9.06	2472 m	+ 23		
	9.09	2468 m	+ 28		
	9.12	2518 t	+ 51	108.2 WSW	7.7
	.14	2518 t	+ 97		
	9.16	2440 t	+ 33		
	9.21	2380 t	+ 75		
	9.23	2276 m	+111		
	9.26	2563 t	− 21		
Aug. 15	3.51	2840 t	+ 39	74.7 WNW	7.8
765, 28	.53	2227 t	− 86		
NW 2					
Aug. 17	6.16	2564 t	+ 13		
763, 24	6.21	2434 t	+ 12		
NE 1					
Aug. 21	1.08	4488 m	+ 5	72.6 WNW	13.0
761, 25	.10	4326 m	+ 63	70.8 WNW	13.3
NE 3	.12	4584 m	+ 40		
	3.21	4892 t	+ 27		
Aug. 22	3.21	4194 m	−246	89.5 W	7.4
761, 25	.23	4450 m	+ 42	89.3 W	7.4
NW 3	.25	4559 m	− 36		
	3.30	5264 t	− 71	81.4 W	11.7
	.34	4568 t	− 24		
	3.37	4573 t	+ 58		
761, 25	6.16	5107 t	− 24		
	6.23	4243 t	+ 13		
	6.28	4182 b	+ 6	38.3 NW	25.0
	.30	4279 b	− 7		
Aug. 27	8.29	2506 t	+ 38		
764, 21	8.38	2582 t	− 17	77.2 WNW	7.2
E 2	.40	2720 t	− 34		
	8.46	2972 t	+ 35	81.7 W	8.7

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Aug. 27	.48	3448 t	− 45		
765, 24	3.20	2660 m	+ 51		
	3.24	3063 t	+ 23		
	3.27	2921 m	+ 22		
	3.33	3024 m	− 7		
	3.37	3013 t	+ 11	117.4 WSW	15.4
	.39	2934 t	− 1		
766, 22	5.47	3200 t	+ 89		
	5.56	3300 t	+ 35		
Aug. 31	10.42	2988 t	+ 25		
758, 18	10.45	3322 t	+ 9	88.6 W	17.8
N 3	.47	3179 t	+ 23		
	10.50	3053 t	+ 2		
	10.52	2410 t	−108		
	10.54	2954 t	+ 14		
	10.56	2532 t	− 53	83.3 W	13.8
	.58	3115 t	+ 12		
	11.02	3147 t	− 51		
757, 30	1.19	2400 t	− 25		
	1.24	2009 t	+ 13	98.6 W	7.3
	.26	2149 t	− 18		
Sept. 1	8.24	2487 m	− 14		
767, 16	8.28	2496 m	− 22		
E 1	8.35	2492 m	− 6		
	8.40	2399 m	− 8		
	8.43	2459 m	−177		
	8.49	2553 m	+298		
	8.51	2391 m	+ 13		
	8.55	2381 m	+ 26	85.2 W	15.5
	.57	2744 m	−137		
	9.01	2402 m	− 2	83.9 W	15.3
	.03	2361 m	− 11		
	5.27	5144 t	+121	85.1 W	22.7
	.29	5741 t	+181	79.1 W	24.2
	.31	5892 t	− 23		
Sept. 16	10.03	3058 t	+ 74		
760, 19	10.08	2984 t	+ 33		
E 3	10.16	3050 t	− 9		
	10.25	2942 t	+ 73		
	10.29	3010 t	+ 14		

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Sept. 17	10. 34	3008 t	+ 18	99. 0 W	2. 9	Sept. 26	1. 53	6018 t	− 10	96. 9 W	16. 3
760, 19	. 36	3132 t	− 49			769, 23	. 55	5327 t	+ 39		
E 3	10. 40	2891 t	+ 8			Sept. 28	*8. 54	4382 t	+140		
	10. 42	2876 t	+ 20	126. 0 SW	5. 4	765, 20	5. 02	5483 t	+120	153. 0 SSW	8. 0
	. 44	2705 t	+ 29			S 3	. 04	5763 t	+ 17		
Sept. 17	5. 47	2509 t	+ 50				5. 09	5914 t	+ 26		
756, 26	5. 49	2594 m	− 7			Oct. 1	8. 50	2374 t	+ 9		
N 2	5. 51	2347 m	− 71			764, 16	9. 00	2369 t	+ 22		
	5. 53	2543 m	+ 5			763, 17	5. 07	2114 m	+ 53		
Sept. 18	5. 41	5784 t	+244	95. 2 W	26. 9	NE 4	5. 10	2173 t	− 48		
761, 26	. 43	5855 t	+ 44				5. 13	2189 m	− 1	30. 4 NNW	10. 7
NE 5	5. 45	5955 t	+189	89. 7 W	40. 4		. 15	2147 m	+ 6	32. 0 NNW	9. 9
	. 47	6328 t	−197				. 17	2195 m	+ 34		
Sept. 22	1. 22	6677 t	+ 79	125. 0 SW	37. 4		5. 19	2228 m	+ 27		
758, 19	. 24	6527 t	0				5. 23	2185 t	+ 3	39. 7 NW	11. 3
NE 1	1. 26	6173 t	+ 80	130. 2 SW	29. 3		. 25	2396 t	+ 46		
	. 28	5285 t	+104				5. 28	2262 t	+ 39		
	1. 33	5420 t	+ 22	111. 4 WSW	35. 2	Oct. 2	8. 54	2536 t	−242		
	. 35	5440 t	+ 75			760, 14	9. 01	3196 t	+173		
	1. 39	5147 t	+125	115. 5 WSW	31. 5	NE 3					
	. 41	5595 t	+ 58			Oct. 3	8. 23	2380 t	+187		
	1. 45	5258 t	+ 35	115. 7 WSW	32. 9	764, 12	8. 27	2175 b	−176	222. 3 SSE	1. 6
	. 47	5180 t	+ 70			SE 3	. 29	1981 b	+ 53		
758, 17	5. 14	2806 t	+ 18				8. 32	2152 m	+ 26	238. 3 ESE	3. 7
	5. 16	2810 t	+ 15				. 34	2079 m	+ 70	244. 4 ESE	4. 1
	5. 19	2945 t	− 7				. 36	2136 m	+ 11	238. 0 ESE	3. 7
Sept. 26	8. 39	5128 t	+ 76				. 38	2114 m	+ 14		
771, 15	8. 42	5204 t	+123	60. 0 WNW	12. 2		8. 47	2237 t	+ 13	244. 5 ESE	4. 0
N 5	. 44	5210 t	+ 54				. 49	2190 t	+ 79		
769, 23	1. 06	6059 t	+ 63				8. 54	2118 t	+ 9	255. 4 ESE	3. 5
	1. 09	6070 t	+ 26	107. 3 WSW	11. 7		. 56	2127 t	+ 17		
	. 11	5778 t	+ 77	106. 9 WSW	11. 3	765, 18	1. 46	2239 t	− 20		
	. 13	5877 t	+ 73	107. 9 WSW	11. 2		1. 48	2327 t	+ 64		
	. 15	6235 t	+ 94	110. 9 WSW	11. 1		1. 51	2216 t	+ 92		
	. 17	5454 t	− 23			Oct. 5	8. 19	2191 t	+119		
	1. 32	6273 t	− 42			767, 13	8. 28	2031 m	0	44. 9 NW	7. 9
	1. 40	4974 t	+ 58			E 3	. 30	2020 m	− 5		
							8. 32	2056 m	+ 23	41. 7 NW	7. 6

*764, 24.

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Oct. 5	.34	2136 m	+ 35			Oct. 22	4.07	2384 t	−224		
767, 13	8.41	2075 m	− 73	36.0 NW	8.1	764, 12	4.14	3023 t	+ 8		
E 3	.43	2098 m	+ 46			NE 4	4.19	2971 t	+ 13		
	8.50	2039 t	+ 23	47.0 NW	6.8		4.21	2774 t	−454	66.2 WNW	24.6
	.52	2133 t	+ 25				.23	2598 t	− 91		
	8.55	2138 t	+ 8				4.25	2882 t	+ 8	66.1 WNW	26.6
766, 17	1.40	2853 t	− 22				.27	2994 t	+107		
Oct. 14	4.09	3045 t	−242	334.0 NE	7.0		4.29	2721 t	−366		
							4.32	3048 t	+ 12		
757, 12	.11	2967 t	− 4				4.35	3021 t	+ 8		
NE 5	4.33	2340 t	+ 83			Oct. 23	* 10.56	4213 t	+104		
	4.42	2473 t	+ 84			757, 19	1.06	3744 t	+ 51	107.7 WSW	17.2
	4.45	2842 t	− 3			NW 5	.08	3767 t	+ 54		
Oct. 17	1.06	3335 t	−125	137.9 SW	4.8		1.11	3410 t	+ 33		
758, 16	.08	2795 t	+ 61	136.8 SW	5.0		1.13	3740 t	+ 13	119.1 WSW	15.7
SE 4	.10	2278 t	− 53				.15	3914 t	−144		
	1.16	2857 t	+126	139.9 SW	16.6		1.16	3822 t	+ 39	110.0 WSW	16.3
	.18	2732 t	− 15				.18	3566 t	+201		
	1.38	4001 t	+ 63			Oct. 24	8.36	2998 t	−326	108.2 W	15.3
	1.44	2037 t	+ 2								
	1.47	2107 t	+ 21	145.5 SW	10.0	754, 9	.38	3150 t	− 83		
	.49	2192 t	+ 19			NE 5					
759, 12	4.02	2382 t	+ 19	129.2 SW	12.6	Oct. 29	8.45	2534 t	+ 34	101.5 WSW	9.2
	.04	2302 t	+ 33								
	4.06	2212 t	− 8			770, 14	.47	2544 t	+ 25	101.5 WSW	8.6
	4.10	2267 m	+ 19	116.7 WSW	10.8						
	.12	2023 m	− 22			W 2	.49	2558 t	+ 19	106.7 WSW	8.6
	4.16	2450 t	+ 13	123.0 WSW	11.6		.51	2671 t	+ 27		
	.18	2340 t	− 4	126.0 SW	11.5	Oct. 30	1.23	3632 t	+111	102.7 WSW	12.0
	.20	2387 t	+ 96			761, 23	.25	3427 t	+ 41	100.2 W	12.2
	4.22	2371 t	+ 1	124.0 WSW	12.1	NW 6	.27	3316 t	+ 35		
	.24	2416 t	+ 14								
						Nov. 3	4.04	7145 t	+ 2	77.9 WNW	15.2
Oct. 20	8.21	2687 t	− 98			769, 18	.06	7189 t	+118		
764, 9	8.29	2692 t	+ 3			W 3	4.08	6920 t	+ 90	90.4 W	14.4
N 7	8.33	2487 t	+ 18								
	8.36	2649 t	− 2				.10	7452 t	− 41	90.2 W	16.6
	8.42	2706 t	+ 40				.12	7672 t	+162		
	8.45	2542 t	+ 81				4.14	7000 m	+ 34	89.9 W	14.3
	8.48	2622 t	0	125.0 SW	17.3		.16	6991 m	− 4	89.4 W	14.6
	.50	2611 t	+ 8								

* 761, 11.

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Nov. 3	.18	6826 m	− 39		
769, 18	4.20	7658 m	+ 23	95.0 W	20.1
W 3	.22	7612 m	+ 41		
Nov. 13	8.21	2407 t	−200	54.0 NW	16.2
764, 4	.23	2437 t	+ 36		
NE 8	8.27	2401 t	+ 55	49.0 NW	14.8
	.29	2224 t	+ 17		
	8.31	2248 t	+131	45.5 NW	10.5
	.33	2407 t	+ 80		
Nov. 17	1.06	2931 t	+ 50	117.9 WSW	14.9
767, 24	.08	2356 t	− 65		
768, 20	4.16	7274 t	+ 79	96.6 W	15.1
NE 3	.18	7124 t	+201	102.7 WSW	18.1
	.20	7573 t	− 33		
Nov. 18	1.02	3210 t	+ 31	103.7 WSW	4.6
767, 24	.04	3275 t	+ 40		
	1.06	3327 t	+ 60	114.3 WSW	15.7
	.08	2976 t	− 46		
	1.13	3261 t	+ 38	101.4 W	11.6
	.15	3607 t	− 28		
	1.17	3194 t	+ 41	104.0 WSW	11.2
	.19	3306 t	+ 85	95.2 W	10.4
	.21	3046 t	− 29		
	4.07	2538 t	+ 23		
	4.10	2512 t	+ 60		
	4.12	2432 t	− 30		
Nov. 19	8.31	3033 t	− 37	91.4 W	9.5
764, 10	.33	3234 t	+ 27	98.2 W	9.9
NE 4	.35	3236 t	− 69		
	8.48	3870 t	+ 26	86.4 W	13.9
	.50	4104 t	− 15		
	8.55	4652 t	+175	81.7 W	15.7
	.57	4448 t	+ 5		
766, 17	1.15	5065 t	+279		
	1.18	4421 t	+ 42	81.0 W	19.6
	.19	5020 t	+113		
	1.23	4639 t	+ 73		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Nov. 20	8.34	3355 t	+ 88	89.5 W	22.9
776, 3	.36	3654 t	+ 33		
S 4	8.38	3532 t	+ 9	88.5 W	21.8
	.40	3645 t	−216		
	8.43	3432 t	+ 41	93.2 W	28.3
	.45	3026 t	+163		
	8.52	3117 t	+ 38	102.7 WSW	28.5
	.54	2992 t	+ 24		
Nov. 24	8.25	4718 t	+ 14	92.1 W	13.0
774, 9	.27	4653 t	+ 19		
N 5	8.33	4492 t	− 9	91.0 W	14.2
	.35	4479 t	+ 1		
	8.40	4834 m	+ 40	94.2 W	15.3
	.42	4615 m	− 31		
774, 17	4.23	3508 m	+ 35		
	.25	3552 m	− 83	71.5 WNW	9.1
Dec. 3	8.32	7184 t	+ 1		
771, 6	8.42	5931 t	+ 7	108.1 WSW	21.8
E 4	.44	6214 t	− 65		
	8.46	5985 t	+ 32	105.7 WSW	22.6
	.48	6415 t	+ 44		
Dec. 4	4.05	4372 m	− 13	118.7 WSW	26.9
767, 0	.07	3614 m	− 34		
E 4	4.18	4375 m	+229	117.0 WSW	29.7
	.20	5051 m	+ 3		
	4.30	4731 m	+231	116.5 WSW	31.9
	.32	4499 m	+ 71		
Dec. 7	8.23	6594 t	+ 85	95.0 W	40.0
766, 2	.25	7055 t	+ 82		
NE 1	8.28	6383 t	+ 56	96.2 W	36.4
	.30	5758 t	+173		
	8.32	6742 m	+ 39		
	8.36	6702 m	−181	98.2 W	42.2
	.38	6112 m	+107		
Dec. 8	1.13	7764 t	+153	106.1 WSW	42.9
766, 13	.15	7534 t	−172		
NW 2	1.17	7097 t	+282	107.0 WSW	40.8

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Dec. 8	.19	7258 t	+ 9	107.2 WSW	43.2	Dec. 21	11.26	2750 t	+ 91	95.5 W	2.4
766, 13	.21	7450 t	+ 51			762, 0	.28	2705 t	— 4		
NW 2	1.23	7469 m	— 24	106.0 WSW	43.5	NE 2	11.35	2509 t	+ 14		
	.25	7655 m	— 32				11.40	2108 t	+ 10		
	1.28	7646 t	+ 15	110.9 WSW	43.4		11.44	2056 t	— 23		
	.29	7431 t	+ 32				11.46	2090 t	+ 6	73.2 WNW	3.9
	1.36	7592 t	+ 47				.48	2520 t	— 99		
Dec. 14	8.40	1766 t	+ 20				11.51	2497 t	+ 83		
763, 7	8.45	1755 t	+ 35				11.55	2167 t	+108	64.7 WNW	7.1
	9.00	1780 t	+ 47				.57	2067 t	+ 12		
763, 11	1.21	2381 t	— 95				4.06	2123 t	— 26		
SW 2	1.24	2304 m	— 27				4.11	2150 t	+ 25	57.7 WNW	13.1
	1.30	2111 t	+ 13				.13	2086 t	+ 17		
	1.32	2545 t	— 79				4.16	2260 t	— 12		
	1.39	2188 m	+ 17	72.1 WNW	6.1	Dec. 22	8.24	4373 t	+ 37		
	.41	2145 m	— 3			765, 2	8.29	4235 t	— 9		
764, 9	4.14	2519 t	+ 15			NW 4	8.32	4696 t	+ 16		
Dec. 16	12.41	2708 t	0				8.35	4289 t	+ 42	92.9 W	22.7
760, 4	12.45	2807 t	— 45				.37	4934 t	+ 41		
E 10	12.49	2899 t	— 27				8.40	4676 t	+179	101.4 WSW	24.0
	12.52	2646 t	— 71	348.5 NNE	17.3		.42	4859 t	+ 55		
	.54	2777 t	— 13				8.45	5854 t	+ 29		
	1.02	2768 t	+ 46				8.48	5368 t	+226		
	1.07	2818 t	— 4			761, 2	1.18	3848 t	+ 91		
761, 3	4.28	3813 t	+ 14	17.4 NNW	10.5		1.22	4253 t	+ 3		
	.30	3899 t	— 18				1.25	3968 t	+ 15		
	4.32	3927 t	+ 8				1.27	4148 t	+ 35		
	4.34	3545 t	+ 87				1.30	4929 t	+ 72		
	4.37	3435 t	+ 91			Dec. 26	8.35	6262 t	+ 21		
	4.39	3938 t	— 6			771, 4	8.38	5432 t	— 17	75.9 WNW	24.6
Dec. 18	8.20	5022 t	+ 5	119.4 WSW	29.5		.40	6749 t	+113	75.8 WNW	24.2
765, 1	.22	4882 t	+ 19			NE 4	.42	5890 t	+ 48		
NW 8	8.24	5003 t	— 12	101.2 WSW	6.4		8.44	5466 t	—191	72.0 WNW	23.0
	.26	5953 t	+ 14				.46	4982 t	— 1	80.0 W	22.0
760, 5	1.32	4308 t	+ 89				.48	5841 t	+ 37	81.9 W	22.3
	1.34	4074 t	+110				.50	5412 t	— 29		
	1.42	3966 t	— 17	110.4 WSW	22.4		8.53	6031 t	+ 42	69.4 WNW	13.6
	.43	3910 t	— 34	110.5 WSW	23.9		.56	5223 t	+ 60		
	.44	3767 t	—199								

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m.p.s.*
Dec. 30	1. 18	2016 t	− 9	69. 4 WNW	9. 0
772, 11	. 20	2223 t	− 77		
	1. 32	1784 m	− 6		
NW 2	1. 34	2594 m	+ 9		
	1. 39	2232 m	− 67	79. 8 W	10. 6
	. 41	2224 m	+ 41	75. 3 WNW	10. 0
	. 43	2192 m	+ 87		
1897					
Jan. 6	8. 27	2231 t	+ 18		
763, 5	8. 30	2335 m	+ 30		
NE 9	8. 35	2134 m	− 8		
	8. 39	2169 t	− 2		
Jan. 11	1. 58	5146 t	−133		
759, 7					
NE 2					
Feb. 1	1. 07	1749 m	+ 2		
771, 2					
SW 5					
Feb. 17	4. 07	7856 t	+ 80	90. 3 W	40. 0
759, 13	. 09	6913 t	+ 60		
NW 8					
	4. 15	6709 t	+ 10		
	4. 20	6592 t	+ 45		
	4. 22	4382 m	+ 50		
Feb. 25	3. 26	7652 t	+167	132. 0 SW	50. 3
763, 5	. 28	7109 t	− 56		
N 2	3. 30	6952 t	+ 51	131. 4 SW	47. 6
	. 32	6891 t	+ 44	130. 5 SW	47. 6
	. 34	6916 t	+ 89		
	3. 37	6970 t	−107	131. 4 SW	51. 7
	. 39	6862 t	+171		
	3. 41	6398 t	+147	132. 2 SW	53. 9
	. 43	6806 t	+ 33		
Feb. 26	8. 54	1866 t	+ 25		
767, 0	8. 58	1584 t	− 18		
NE 2	9. 01	1522 t	− 43		
	9. 09	1536 t	− 2		
	9. 15	1439 t	− 24		
	9. 22	1408 t	− 18		
	9. 46	1370 t	− 3		

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m.p.s.*
Mar. 1	1. 46	3526 t	− 37		
777, 4	1. 58	3132 t	−110		
W 9	2. 00	2820 t	+152		
	2. 02	3144 t	+ 15		
	2. 10	3011 t	+ 1		
	. 12	2980 t	− 88		
	2. 17	2892 t	+ 1		
775, 4	5. 14	3663 t	− 98		
	5. 18	4203 t	+ 11		
	5. 21	4250 t	+ 21		
	5. 23	4416 t	− 2	98. 8 W	23. 2
	. 25	4498 t	+160		
	5. 27	4290 t	+ 24	99. 8 W	24. 0
	. 29	4471 t	+ 22		
	5. 33	4696 t	− 31		
	5. 40	4400 t	− 50	96. 2 W	21. 4
	. 42	4472 t	+ 13		
Mar. 2	8. 40	3155 t	− 22	114. 5 WSW	20. 9
769, 8	. 42	3318 t	+ 36		
W 2	8. 47	3090 t	+ 71		
	8. 50	2695 t	− 16		
	8. 57	3070 t	− 17		
	9. 00	3048 t	+ 19		
	9. 06	2418 t	− 49		
	9. 12	2973 t	− 16		
	9. 18	2722 t	+ 37		
	9. 20	2851 t	− 4		
Mar. 22	1. 04	5434 t	+ 10	135. 2 SW	17. 4
757, 25	. 06	5280 t	− 2	137. 8 SW	17. 0
NW 4	. 08	5054 t	+ 23	137. 5 SW	17. 9
	. 10	4236 t	+ 71		
	1. 20	4922 t	+ 85	92. 0 W	17. 9
	. 22	5057 t	+ 36		
Mar. 23	9. 11	3932 t	− 2		
756, 15	9. 13	3286 t	− 38		
W 1	9. 15	3933 t	+ 46		
	9. 18	3848 t	+ 34	113. 0 S	13. 0
	. 20	3838 t	+ 15		
753, 18	1. 40	5296 t	− 89		
	1. 42	6746 t	− 53		

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Mar. 24	8. 48	3342 t	+ 31	153. 0 SSW	27. 7
746, 7	. 50	3340 t	+ 11		
E 7	8. 52	3234 t	— 28	145. 2 SW	31. 4
	. 53	3096 t	+ 3		
Mar. 31	8. 42	5444 t	+ 44	57. 0 WNW	20. 1
769, 8	. 44	5544 t	+ 21	61. 6 WNW	20. 7
S 4	. 46	5286 t	+ 2	61. 6 WNW	20. 0
	. 48	5791 t	+ 20		
	8. 51	5756 t	+ 3	56. 2 WNW	20. 7
	. 53	5596 t	— 7		
	9. 19	5422 t	+127		
	9. 23	5564 t	+ 27		
Apr. 3	8. 39	4735 t	+102		
770, 9	8. 41	4124 t	— 13		
SW 2					
Apr. 7	8. 34	3574 t	0		
764, 9	8. 36	3686 t	— 6		
NE 2	9. 03	3802 t	+ 67		
	9. 06	3194 t	+ 53		
	9. 12	3440 t	— 3		
	9. 16	3404 t	— 12	101. 9 WSW	28. 1
	. 17	3296 t	— 8		
	9. 20	3343 t	— 12	111. 5 WSW	25. 3
	. 22	3210 t	+ 34		
	1. 45	4833 t	+ 36		
Apr. 8	8. 47	3408 t	+ 16		
766, 9	8. 51	3422 t	— 8		
SW 1	8. 58	4180 t	— 69	92 8 W	29. 2
	. 59	3698 t	— 11		
	9. 01	4022 t	— 39	93. 8 W	27. 5
	. 03	3916 t	+ 5		
Apr. 14	8. 42	3406 t	+ 8		
765, 16	8. 47	3246 t	+ 8		
NW 5	8. 49	3257 t	— 34		
	8. 54	3204 t	— 9	189. 2 S	15. 0
	. 56	3177 t	+ 2		
	8. 59	3192 t	0		

Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Apr. 14	9. 04	3518 t	+ 41	171. 8 S	16. 1
765, 16	. 05	3264 t	+ 1		
NW 5	9. 07	2748 t	+ 5	180. 8 S	11. 3
	. 08	2920 t	— 3		
Apr. 16	5. 57	3806 t	+183	136. 1 SW	19. 2
759, 15	. 59	3768 t	— 91		
NE 3	6. 01	3845 t	— 10	128. 3 SW	10. 7
	. 03	3878 t	—195		
Apr. 17	5. 55	1784 t	— 11		
762, 11	5. 57	1782 t	— 23		
N 3	6. 01	1826 t	+ 3		
Apr. 28	8. 37	3761 t	+ 30		
764, 11	8. 47	4458 t	+ 36	8. 0 N	29. 9
NE 6	. 48	4923 t	— 22		
	8. 54	4781 t	— 38		
	8. 56	3590 t	— 43		
	8. 59	3700 t	+ 13	18. 0 NNW	29. 3
	9. 01	3399 t	+ 11		
Apr. 29	8. 48	4318 t	+ 86	45. 0 NW	15. 9
763, 11	. 50	4187 t	— 46		
W 7	8. 53	4766 t	+ 26		
	9. 02	4796 t	+105		
	9. 06	4748 t	+ 43		
	9. 09	4758 t	+ 74		
	. 10	4604 t	+129		
762, 18	12. 37	5793 t	— 4	43. 4 NW	16. 0
	. 39	5500 t	+192		
	12. 44	5706 t	— 40	41. 5 NW	13. 1
	. 46	5476 t	+ 45	47. 2 NW	13. 5
	. 48	5567 t	+ 14		
	12. 51	5648 t	+ 9	46. 8 NW	15. 2
	. 53	5820 t	— 6	43. 2 NW	15. 4
	. 55	5769 t	+ 2		
	12. 59	5875 t	— 14		
	1. 02	5780 m	— 97		
Apr. 30	6. 05	5362 t	— 29	169. 9 S	13. 2
760, 21	. 07	5327 t	+138		
SW 4	6. 09	6444 t	—150	159. 2 SSW	7. 6

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	*m.*	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	*m.*	*m. p. s.*
Apr. 30	.11	6640 t	− 75			May 12	6.21	3634 t	−150	115.7 WSW	17.2
760, 21	6.13	5264 t	− 19	205.2 SSE	8.1	758, 22	.23	3774 t	− 16		
SW 4	.15	5349 t	− 86				6.29	2956 t	− 27		
	6.17	4660 t	− 29	192.5 SSE	11.3	May 13	6.24	6303 t	− 44	128.4 SW	35.9
	.19	4929 t	+150			759, 18	.25	5306 t	−221		
	6.22	6709 t	− 24	205.7 SSE	6.4	NW 9					
	.24	6166 t	− 91			May 24	1.26	5758 t	+ 39	129.2 SW	29.5
May 7	11.08	4098 t	− 37			760, 24	.28	5776 t	− 1	135.2 SW	27.8
763, 20	11.10	4274 t	− 29			N 3	.30	6233 t	− 36		
NE 1	11.12	5346 t	− 35	52.5 NW	21.6	June 1	8.38	3844 t	−193	93.9 W	28.5
	.14	4747 t	+ 50			763, 17	.40	3899 t	+224		
	11.16	4206 t	− 12	50.8 NW	21.2	NE 5	8.46	3638 t	− 29	95.0 W	29.6
	.17	4416 t	− 13				.48	4038 t	− 20		
	11.23	4094 t	− 14	45.3 NW	22.8	June 4	8.44	4564 t	− 5	115.2 WSW	17.8
	.24	4069 t	− 20			760, 23	.46	4434 t	− 5	116.4 WSW	16.5
763, 23	1.42	4136 t	−149			N 2	.48	4834 t	− 14	116.5 WSW	17.1
	1.59	4290 t	− 3	41.6 NW	26.1		.50	4740 t	− 45		
	2.00	4708 t	− 10				8.52	4540 t	+ 18	115.4 WSW	18.9
	2.02	4352 t	− 32	44.1 NW	26.9		.54	5046 t	+ 51		
	.04	4430 t	− 25			June 5	9.04	3136 t	+ 25	76.4 WNW	4.4
	2.07	4216 t	− 13	44.2 NW	25.8	761, 18	.06	3454 t	+ 81		
	.09	4156 t	+ 37			NW 5	9.08	3274 t	− 14	122.0 WSW	12.4
	2.12	4146 m	− 11				.09	3217 t	− 28		
	2.22	4576 t	+ 3			June 12	8.10	5578 t	+ 21	87.1 W	18.4
	2.27	4272 t	− 33			758, 23	.11	5146 t	− 25		
May 10	10.50	6000 t	− 37	98.5 W	14.1	NW 2	8.13	4655 t	− 79	99.7 W	10.4
759, 21	.52	6758 t	− 28				.14	5747 t	−156		
N 4	10.54	6440 t	+ 3	99.2 W	13.7	758, 25	10.50	4984 t	− 8	75.6 WNW	20.7
	.56	6568 t	− 23				.52	5782 t	+ 95		
	11.13	6608 t	− 71	88.5 W	11.6		10.54	4641 t	+ 18	69.9 WNW	15.5
	.15	6659 t	+ 2				.56	3648 t	− 24		
May 12	*9.54	6315 t	− 41				11.06	4609 t	−113	66.0 WNW	15.1
758, 24	1.39	9422 t	−175				.08	3934 t	+ 40		
NW 7	1.46	6836 t	− 30				11.14	5086 m	+ 60	79.1 WNW	17.2
	1.55	5680 t	− 48				.16	5090 m	+ 91		
758, 22	6.10	6292 t	− 38	123.7 WSW	18.1						
	.12	5952 t	− 88								
	6.14	5298 b	+ 25	124.6 SW	18.2						
	.16	6163 b	− 65								
	6.19	5997 t	+ 40								

* 760, 20.

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 15	8. 42	4775 t	+ 18			June 19	. 38	2307 t	+ 36		
761, 20	8. 44	4442 t	+156	42. 7 NW	18. 8	762, 25	6. 38	5813 t	+ 25	87. 2 W	15. 1
NE 2	. 45	4532 t	− 48	45. 0 NW	17. 8		. 39	5584 t	− 41		
	. 46	4632 t	− 15			June 24	9. 19	5314 t	+ 4	104. 5 WSW	13. 2
	1. 12	4305 t	− 18								
	1. 14	4576 t	− 4	51. 8 NW	15. 8	761, 23	. 21	5391 t	− 11	96. 6 W	12. 7
	. 15	5236 t	+ 94			NW 3	. 23	4971 t	−185		
	1. 19	4446 t	+ 36	39. 9 NW	20. 7		1. 14	2307 t	+ 29	136. 0 SW	6. 2
	. 20	4766 t	− 9	39. 2 NW	18. 2		. 15	2322 t	+ 17	143. 2 SW	5. 5
	. 21	4521 t	+ 7				. 16	2290 t	+ 20	134. 6 SW	6. 7
	1. 30	5449 t	+ 6				. 17	2234 t	+ 85		
	1. 34	4735 t	+ 11								
	1. 37	4205 t	− 53	38. 2 NW	10. 9	June 25	6. 47	4586 t	− 23	65. 7 WNW	17. 6
	. 38	4208 t	− 93			757, 31	. 48	3944 t	− 79		
June 16	8. 45	4427 t	+ 6	58. 9 WNW	20. 8	NE 3	6. 50	4722 t	+ 19	63. 5 WNW	22. 1
							. 51	4590 t	− 16		
760, 24	. 46	4550 t	+ 49	60. 8 WNW	18. 0	June 26	8. 20	2307 t	+ 12	78. 7 WNW	15. 6
NW 1	. 47	4153 t	− 74			762, 21	. 21	2377 t	+ 18		
	8. 53	4346 t	− 27	63. 0 WNW	19. 4	762, 25	1. 07	4735 t	−101	32. 8 NNW	24. 8
	. 54	4178 t	− 25				. 08	4644 t	− 31		
June 17	8. 54	6088 t	− 19								
758, 22	9. 09	6173 t	− 15	101. 2 WSW	14. 3	June 29	1. 16	8758 t	+ 58	41. 5 NW	23. 3
W 1	. 10	6159 t	+ 45			763, 27	. 18	8906 t	+ 23	43. 5 NW	22. 0
	9. 15	7121 t	+ 52			NW 4	. 20	9233 t	− 68		
June 18	1. 22	7131 t	+ 67	54. 7 NW	10. 2		1. 24	9269 b	+ 25	42. 5 NW	23. 4
760, 24	. 23	6769 t	− 93	54. 7 NW	10. 1		. 26	9328 b	+ 69	45. 4 NW	22. 5
W 1	. 24	6175 t	−218				1. 29	8728 b	+ 62	41. 6 NW	24. 8
June 19	8. 42	2630 t	+ 8	55. 3 NW	10. 2		. 31	8956 b	+ 41		
764, 21	. 43	2610 t	+ 5	55. 4 NW	13. 1		1. 34	8637 t	− 34	41. 1 NW	24. 8
N 2	. 44	2439 t	+ 5				. 36	9153 t	+ 18	42. 3 NW	25. 4
	8. 46	2837 t	− 4	243. 4 ESE	7. 5		. 38	9159 t	+ 5		
	. 47	2701 t	0			762, 27	6. 47	5496 t	+ 11	65. 4 WNW	18. 6
	1. 25	2316 t	− 27	60. 3 WNW	10. 1		. 48	5441 t	+ 23	67. 4 WNW	18. 8
763, 26	. 26	2343 t	− 18								
W 3	1. 37	2166 t	+ 96	52. 6 NW	10. 9		. 49	5500 t	+ 45		

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-STRATUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 19	8. 20	6283 t	+ 79			June 26	5. 59	12191 b	+115	109. 4 WSW	20. 4
758, 23	8. 22	8096 m	+336	93. 1 W	21. 2						
NE 3	. 24	6931 m	+ 25			764, 26	. 61	13158 b	+ 61	107. 9 WSW	23. 5
May 27	9. 12	4802 t	−151	87. 4 W	22. 8	NE 4					
							6. 05	12451 b	+196		
762, 21	. 14	5950 t	−108	96. 4 W	21. 2		6. 08	7259 t	− 7	65. 9 WNW	26. 0
NE 3	. 16	6620 t	−170								
							. 10	5958 t	+183		
	9. 18	5053 t	+ 36								
	9. 23	5508 t	+ 84	110. 4 WSW	23. 5	July 2	1. 24	10541 s	− 86	126. 0 SW	10. 0
	. 25	5206 t	+ 11			767, 29	. 26	7067 s	+261		
June 2	6. 11	9478 t	−119	88. 7 W	47. 5	W 3	1. 29	10414 m	+ 79	121. 4 WSW	12. 9
767, 21	. 13	7115 t	−491				. 31	9548 m	− 18		
NE 5	6. 19	7558 m	+104	90. 4 W	27. 0	July 9	6. 51	8707 m	−113	156. 0 SSW	23. 8
	. 21	8654 m	+204			765, 26	. 53	8042 m	+198	154. 0 SSW	22. 0
	6. 26	7960 t	+266	81. 1 W	31. 0	NW 5	. 55	8354 m	+343		
	. 28	9092 t	+ 55			July 10	3. 51	12253 b	−218	128. 0 SW	35. 9
	6. 33	9777 t	+490			769, 23	. 53	10341 b	−136		
	6. 42	8461 t	+ 69	71. 1 WNW	15. 4	NW 3					
	. 44	8569 t	+ 47			July 11	8. 12	10462 b	+710	111. 5 WSW	36. 4
	6. 54	10524 t	−173	74. 5 WNW	32. 3						
	. 56	8360 t	−200			768, 23	. 14	13434 b	−157	101. 2 WSW	38. 2
June 9	7. 02	6427 t	+ 16			N 3	. 16	10722 b	+492	98. 4 W	40. 4
752, 19	7. 04	5863 t	+ 72				. 18	11326 b	+444		
N 2	7. 11	5610 t	+117	123. 5 WSW	16. 4	July 14	8. 59	6958 t	+ 72	93. 2 W	18. 3
	. 13	5821 t	+202			762, 26	. 61	7301 t	−200		
June 10	4. 12	3607 t	+ 33			NE 2					
754, 22	4. 15	4128 t	−162	17. 7 NNW	12. 5	July 15	3. 26	12828 t	− 30	106. 2 WSW	7. 5
NE 8	. 17	3164 t	+179								
June 22	3. 42	10658 t	+ 98	82. 1 WNW	30. 8	756, 30	. 28	11834 t	+ 43	113. 0 WSW	9. 8
760, 27	. 44	10290 t	+163			NE 2	. 30	11549 t	+ 33	116. 4 WSW	8. 0
NE 3							. 32	12786 t	− 13		
June 23	3. 18	4230 m	− 43	93. 1 WNW	14. 1	July 20	6. 35	8009 t	− 67	85. 7 W	12. 7
764, 24	. 21	4550 m	+188			764, 29	. 37	7890 t	+380		
NE 2	3. 23	3947 m	+116			NW 5	6. 43	5559 t	+166	80. 5 W	10. 9
	3. 29	6082 t	+ 52	102. 7 WSW	17. 5		. 45	5838 t	+ 79		
	. 31	5756 t	+ 28				6. 53	7172 t	+ 63		
	3. 38	6972 m	+162			July 21	8. 18	7425 t	+ 30	63. 7 WNW	26. 6
	3. 42	5511 t	+ 33			764, 26	. 20	7407 t	+162		
	3. 53	6570 t	+136			NE 3	8. 37	7103 t	− 11	83. 7 W	10. 9
	3. 58	6223 t	+368								

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-STRATUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 21	.39	6313 t	− 84	87.4 W	13.4	Aug. 17	8.30	2546 t	− 24		
764, 26	.41	6767 t	+ 25			763, 22	8.34	3599 t	− 54		
NE 3	8.49	8239 t	− 32			NE 3	8.39	2007 b	+ 11		
	8.55	6074 t	+ 7	88.0 W	12.9		8.46	2883 b	+ 32		
	.57	5149 t	− 96				8.53	3114 t	− 22		
	8.59	6387 t	− 52				8.55	2973 t	+ 9		
July 22	7.09	7031 t	− 69				9.02	3067 t	+ 31		
759, 26	7.12	6683 t	− 42			Aug. 18	8.13	7822 t	−138		
N 3	7.14	6835 t	− 29			764, 20	8.17	7996 t	+ 24	85.2 W	30.0
July 24	6.25	4819 m	−134			NE 2	.19	6897 t	+ 67	82.6 W	33.1
758, 23	6.38	5124 m	− 10								
NW 5	6.42	4940 m	−219				.21	6023 t	+ 49		
	6.49	5119 m	−154	73.0 WNW	18.6		8.31	6312 t	+133	89.5 W	32.5
	.51	5575 m	+ 36				.33	6118 t	+ 72		
July 25	8.18	5587 t	− 67			Aug. 31	1.32	3717 t	+ 6		
762, 21	8.24	4914 t	+102	96.2 W	19.4	757, 30	1.35	3413 t	− 69		
NE 5	.26	4550 t	−118			N 3	1.38	4291 t	− 22		
	8.28	5508 t	− 79			Sept. 12	8.23	4050 t	−122	145.3 SW	8.5
July 27	4.45	7753 t	+ 35			765, 20	.25	4278 t	+ 6		
763, 24						SW 1	8.45	8735 t	− 45	278.7 E	8.1
NE 3											
							.48	8299 t	−104		
July 28	6.17	10871 b	−112				8.54	7484 t	+ 52		
763, 27							8.57	6696 t	+ 50	293.5 ENE	8.7
NE 2											
							.59	5864 t	− 1		
July 30	1.40	4712 m	− 28	40.5 NW	12.2		9.04	6426 t	+ 91		
							9.07	5938 t	− 31	254.0 ESE	6.0
760, 31	.42	4257 m	− 91	46.8 NW	13.8						
N 4	.44	4189 m	−150				.09	6001 t	+ 1		
Aug. 10	3.35	12190 m	+278	68.0 WNW	13.3	766, 32	1.38	3784 t	+ 5		
							1.41	4466 t	− 2	328.9 NNE	12.2
763, 31	.37	15552 m	+686	73.4 WNW	12.7		.43	4900 t	− 73		
NE 3	.39	14300 m	+653				1.45	4304 t	+119		
	3.41	14090 m	+ 65	82.5 W	12.4		1.49	3534 t	+ 83	336.2 NNE	15.0
	.43	14399 m	+474								
							.51	3892 t	+ 51		
Aug. 11	6.48	6412 t	+213			766, 27	5.54	3081 t	+ 15	287.9 ENE	6.3
763, 31	6.53	8176 t	+134	88.5 W	4.4						
NE 2	.55	7506 t	+ 94				.56	3144 t	+ 12		
							6.00	2841 t	− 37		
Aug. 13	3.44	6228 t	+ 65			Sept. 18	5.52	6738 t	+117	112.7 WSW	14.0
763, 33	3.46	6252 t	+ 96								
E 1	4.10	6233 t	+ 80	68.7 WNW	12.6	761, 26	.54	8847 t	+168		
	.12	6096 t	− 15			NE 5					

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-STRATUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Sept. 21	1. 14	5460 t	+ 11			Nov. 9	4. 06	9195 t	+257		
762, 20	1. 18	5492 t	− 28			766, 4	4. 10	8176 t	+223	105. 2 WSW	38. 0
NE 2	1. 23	5279 t	+ 56			NE 3	. 12	7550 t	+102		
	1. 27	4645 t	−263			Nov. 10	8. 26	5180 t	− 73	85. 9 W	24. 5
	1. 33	5699 t	− 70								
	1. 50	5802 t	+289			771, 1	. 28	5374 t	− 27	93. 2 W	27. 4
	1. 54	5598 t	+107			W 4	. 30	6475 t	+ 81		
761, 19	5. 40	5783 t	+176				8. 36	5874 t	+ 27	93. 2 W	26. 2
	5. 46	6502 t	+266								
	5. 53	7186 t	+152				. 38	5469 t	+ 9		
	5. 58	7394 t	+ 78				8. 42	5586 t	+ 39	107. 9 WSW	26. 5
Sept. 26	8. 26	5519 t	+ 8	113. 5 WSW	13. 6		. 44	5734 t	− 1		
771, 15	. 28	5476 t	+ 27	113. 4 WSW	13. 2		8. 48	4234 t	−112	101. 9 WSW	18. 3
							. 50	5005 t	− 26		
N 5	. 30	5523 t	+ 34	111. 2 WSW	14. 3		8. 52	4943 t	+ 24		
							9. 00	5034 t	+ 41	93. 9 W	17. 7
	. 32	5734 t	+ 57	112. 7 WSW	14. 8		. 02	4888 t	− 61		
	. 34	5649 t	+ 49			770, 9	3. 58	3906 t	+ 19	104. 9 WSW	17. 8
Oct. 23	10. 36	2902 t	+186				4. 00	4201 t	+156		
760, 12	10. 40	3734 t	− 53	111. 7 WSW	23. 3		4. 04	3624 m	− 20		
NW 5	. 42	4676 t	+157				4. 08	3704 m	−250		
	10. 44	3882 t	+ 32				4. 11	3638 m	+205	100. 9 W	18. 1
	10. 46	2914 t	+ 38				. 13	3737 m	− 64		
	10. 48	2668 t	−136	89. 0 W	12. 1		4. 30	3858 t	− 35	103. 4 WSW	16. 9
	. 50	2514 t	+ 49				. 32	3697 t	− 88		
	10. 52	2656 t	+ 5	89. 0 W	11. 7		4. 34	4624 t	+297	119. 9 WSW	40. 9
	. 54	2092 t	− 91				. 36	5615 t	+ 6		
757, 19	1. 21	4686 b	− 25	88. 2 W	19. 4	Nov. 17	4. 28	8087 t	+188		
	. 23	4597 b	− 32	83. 6 W	18. 2	767, 22	4. 31	6154 b	+ 65	95. 7 W	16. 5
	. 25	4121 b	− 83			NE 3	. 33	5959 b	+101		
						Dec. 3	8. 51	6472 m	+ 28	111. 9 WSW	28. 1
Oct. 30	8. 38	7220 t	+ 97			771, 5	. 53	6819 m	− 90		
765, 16	8. 45	6095 t	+106			NW 3	8. 57	6235 m	− 66	106. 5 WSW	24. 1
NW 6	8. 50	5848 t	+ 97	93. 6 W	14. 2		. 59	6403 m	+ 67		
	. 52	4318 t	+ 30								
	8. 57	5006 t	+251	107. 9 WSW	11. 9	Dec. 4	1. 20	4417 t	+ 14		
	. 59	4956 t	+130			769, 1	1. 49	4616 b	+302		
	9. 02	7617 m	+170			768, 0	4. 01	4566 t	+ 77	118. 7 WSW	22. 3
	9. 08	6840 t	+ 71	111. 0 WSW	16. 2	NE 1	. 03	4342 t	− 36		
	. 10	5497 t	−167				4. 14	3264 t	+ 22	118. 5 WSW	21. 9
	9. 13	5670 t	+ 52				. 16	2962 t	+ 10		

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-STRATUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m.p.s.*	1897	*h. m.*	*m.*	*m.*	°	*m.p.s.*
Dec. 12	4.08	8086 t	− 60			May 19	12.53	2086 t	− 1		
763, 9						769, 26					
NE 3						NE 3					
Dec. 19	1.44	2880 t	+155			May 21	1.19	3292 t	+115	101.1 WSW	18.2
769, 2						755, 24	.21	3405 t	+ 81		
SW 2						NE 4					
1897						May 24	10.23	4545 t	− 33	130.6 SW	24.8
Feb. 26	8.50	2958 t	+ 52			760, 24	.24	4756 t	+ 8	131.6 SW	25.4
766, 13						N 3	.25	4526 t	− 33		
NE 2											
Mar. 1	2.20	1935 t	+ 24			June 5	9.10	2932 t	− 1	125.3 SW	11.3
777, 4						761, 18	.11	2908 t	− 10	117.5 WSW	10.5
W 9						NE 2	.12	2898 t	− 8		
Mar. 3	9.15	2262 t	+ 19			June 16	1.21	4133 t	−110		
761, 13	9.18	3010 t	−100			759, 30					
N 8	9.23	2901 t	− 50			NE 3					
Mar. 12	1.13	2172 t	− 19			June 17	8.42	5326 t	+ 10		
753, 12						759, 22	8.44	4252 t	− 4		
N 3						W 2	8.47	6773 b	+ 68	98.6 W	16.9
Mar. 31	9.04	3106 t	+ 10	67.8 WNW	21.6		.48	6533 b	+ 74	98.8 W	16.4
769, 7	.06	3137 t	+ 16				.50	7048 b	− 10		
S 4											
Apr. 19	1.08	4168 t	+ 23			June 19	8.54	1731 t	− 12		
762, 22						764, 20	8.57	1631 t	− 21		
N 10						W 3	9.00	1774 t	0	65.4 NW	7.3
Apr. 28	8.40	3760 t	− 15	17.0 WNW	30.5		.01	1742 t	− 21		
764, 11	.41	3557 t	0				9.04	1799 t	+ 10	73.5 WNW	7.2
NE 6							.05	1900 t	+ 29		
May 10	10.45	5991 t	− 30	98.9 W	13.7	763, 26	1.11	1461 t	− 13	99.6 W	5.8
757, 27	.47	6028 t	− 17				.13	1505 t	− 15		
N 4							1.19	1432 t	+ 1		
May 12	1.51	7043 t	+ 50	125.2 WSW	22.3		1.23	1399 m	− 3		
758, 24	.52	6536 t	−175				1.28	1475 t	− 20		
NW 7						June 23	1.58	2568 t	−119		
May 18	11.33	4047 t	+ 28	21.9 NNW	6.4	761, 24					
769, 17	.35	3957 t	+ 6			NW 3					
NE 3						June 24	6.49	4043 t	+ 27	49.5 NW	9.7
						760, 26	.50	3620 t	+ 56	45.7 NW	11.0
						NE 3	.51	3907 t	− 7		

TABLE 6.—*Summary of theodolite observations*—Continued.

ALTO-STRATUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 24	6. 56	3978 t	+ 33	43. 3 NW	11. 6	June 26	1. 07	4734 t	−101	32. 8 NW	24. 0
760, 26	. 57	3972 t	− 22			762, 25	. 08	4644 t	− 31		
NE 3	7. 03	2847 t	+ 50	58. 4 WNW	2. 7	E 4					
						June 30	8. 45	3454 t	− 9	76. 1 WNW	11. 3
	. 04	3691 t	+ 1								
NE	7. 08	5818 t	− 52			758, 28	. 48	3354 t	− 60	82. 4 W	14. 1
						N 4	. 50	3442 t	− 15		

CIRRO-CUMULUS.

1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 11	6. 12	7384 m	− 92	79. 8 WNW	8. 1	May 22	6. 39	9667 t	−122	74. 4 WNW	14. 2
759, 30	. 14	7000 m	+ 59			764, 24	. 41	9863 t	−138	74. 7 WNW	17. 7
NE 7	6. 18	7862 m	− 81	90. 3 W	10. 9	N 3	. 43	9406 t	−185		
	. 20	6607 m	−114			June 1	9. 16	9898 t	−160	87. 5 W	45. 0
	6. 25	8505 t	+134	79. 1 WNW	9. 9	763, 17	. 18	10032 t	−200		
	. 27	7655 t	− 43			NE 5	9. 35	10767 t	− 12	84. 7 W	41. 4
May 13	8. 10	7568 m	+ 23				. 37	8750 t	−129		
763, 20	8. 12	9183 m	−372			June 12	3. 13	9836 t	+151		
763, 23	6. 18	6204 m	− 89			754, 28	. 15	8748 t	−281		
W 2	6. 39	7358 t	+ 49			763, 26	6. 28	8990 t	+150	105. 7 WSW	26. 0
	6. 42	5135 t	+169								
May 14	6. 13	6708 m	+352	69. 6 WNW	11. 8	NE 5	. 30	9006 t	+ 21	105. 7 WSW	26. 0
760, 23	. 15	7172 m	− 84	72. 5 WNW	13. 6		. 32	8907 t	+120	118. 1 WSW	28. 9
NW 4	. 17	6912 m	+ 52				. 34	8998 t	+125		
	6. 20	6830 m	+152	62. 7 WNW	9. 6	June 17	6. 23	9682 t	− 79	124. 1 SW	28. 9
	. 23	6613 m	−172			762, 24	. 25	8242 t	+200		
	6. 34	6602 m	−238	96. 1 W	11. 9	NW 1	6. 38	8634 t	+120	99. 4 W	24. 3
	. 35	6878 m	− 31								
	6. 39	5829 m	+ 26				. 40	7863 t	+111	103. 0 WSW	25. 1
	6. 46	6531 t	+ 38	95. 2 W	14. 5		. 42	7581 t	+146		
	. 48	7563 t	+ 52			June 18	1. 43	9426 t	−282		
May 22	6. 24	12196 t	+172	129. 2 SW	29. 9	763, 26	4. 01	9416 m	−260		
						NW 1	4. 15	9593 t	+ 11	112. 5 WSW	11. 7
764, 24	. 26	11249 t	+328								
N 3	6. 32	10850 t	−409	138. 8 SW	26. 3		. 17	9090 t	− 68		
						762, 24	6. 31	9551 t	+ 62	114. 9 WSW	13. 8
	. 34	10621 t	−281	134. 7 SW	17. 5						
							. 33	9023 t	+ 60	120. 4 WSW	14. 1
	. 36	10372 t	−117								

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 18	.35	10109 t	− 86	118.1 WSW	13.1
762, 24	.37	11262 t	+207		
	6.50	8972 t	+ 35	101.7 WSW	11.0
	.52	8673 t	+ 12		
June 22	1.45	9768 t	+ 18	94.7 W	28.3
760, 27	.47	9208 t	+ 93		
NE 3	3.25	7001 m	+ 3	99.7 W	19.5
	.27	7243 m	+ 88		
June 23	8.23	6627 t	−309		
764, 22	8.30	8625 m	+ 41	70.1 WNW	22.7
NE 2	.32	7554 m	+128	73.2 WNW	21.1
	.36	7528 m	− 61		
	8.39	7703 t	+164	66.7 WNW	19.7
	.41	7972 t	+102		
	8.46	8752 t	− 44	70.4 WNW	18.2
	.48	8272 t	+ 26	72.5 WNW	19.6
	.50	6854 t	− 35		
June 26	8.21	12399 t	+649		
767, 20	.23	9571 t	+163		
NE 4	.25	9990 t	+376		
	8.29	10078 m	+ 10		
	8.34	8725 m	+142		
	.36	8703 m	+435		
June 27	1.86	11117 t	+123	92.9 W	24.6
763, 26	.38	13867 t	+665	83.2 W	32.6
NE 3	.40	11730 t	+217	79.2 W	31.4
	.42	8667 t	+371		
June 30	6.14	11222 m	+ 57	108.7 WSW	34.1
768, 24	.16	10946 m	+206	109.0 WSW	33.6
NE 2	.18	11929 m	+ 56		
July 2	8.48	10110 t	+ 52	155.7 SSW	16.8
768, 22	.50	10665 t	−562		
767, 29	1.34	7929 m	− 35		
W 3	1.36	8897 m	+ 97		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 2	1.40	7704 m	+340	129.2 SW	10.0
767, 29	.42	8403 m	+ 91	119.7 WSW	9.7
W 3	.44	8061 m	+ 77		
767, 28	3.30	8418 m	+ 77	98.0 WSW	17.0
	3.56	8330 m	+120	115.2 WSW	9.5
	.58	9126 m	+298		
	.60	8245 m	+ 73		
July 6	1.48	6447 m	+499	106.4 WSW	10.9
760, 28	.50	6753 m	+248	123.5 WSW	14.9
N 2	.52	8358 m	+212		
July 9	1.17	10048 t	−428		
765, 27 NW 5					
July 10	3.06	10439 m	+174	127.7 SW	27.2
769, 27	.08	7594 m	− 22		
NW 3	7.29	7910 m	+145		
July 11	8.28	8041 m	− 25	111.5 WSW	29.3
768, 23	.30	9311 m	−156		
N 3	8.34	13731 m	+ 64	111.7 WSW	44.2
	.36	14558 m	− 26	103.2 WSW	31.6
	.38	15603 m	− 87		
	8.53	12187 m	− 44	115.7 WSW	30.4
	.55	10247 m	+445		
768, 29	1.49	12526 m	−605	101.7 WSW	38.6
	.51	11795 m	−119		
	3.31	8002 m	+151		
	3.33	8630 m	−412		
July 13	6.20	12472 t	+378	15.7 NNW	17.4
761, 29	.22	12793 t	+278	5.8 NNW	20.8
NE 4	.24	12517 t	+347	6.8 NNW	21.3
	.26	15219 t	+285		
July 14	6.55	6150 m	−138	80.0 W	10.4
760, 28	.57	7973 m	+ 83	78.7 WNW	12.0
NE 2	.59	7003 m	+ 29	72.2 WNW	8.1

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRO-CUMULUS.

Date		Height. z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 14	.61	7461 m	− 7		
760, 28	7.07	7571 m	− 2	35.8 NW	6.1
NE 2	.09	6824 m	−121		
July 18	6.25	10376 t	+ 77	31.5 NNW	12.1
770, 25	.27	10459 t	+124	23.8 NNW	11.9
NW 1	.29	10032 t	+ 61		
	6.45	13686 t	−194	1.0 N	17.8
	.47	11870 t	−495	357.7 N	20.1
	.49	11653 t	−122		
July 20	8.34	7284 t	− 29	95.2 W	11.4
766, 25	.36	7786 t	− 52	90.8 W	11.9
NW 5	.38	7391 t	− 27	93.0 W	11.9
	.40	7338 t	− 28		
	8.48	8061 t	+ 45	97.5 W	12.9
	.50	8000 t	+ 27	99.0 W	10.8
	.52	8513 t	− 59		
764, 30	2.16	5944 m	−105	88.7 W	6.2
	.18	5772 m	− 10		
July 21	8.30	6038 m	+100	95.2 W	13.4
764, 16	.32	6354 m	−101		
NE 3					
July 22	1.48	8528 t	+275		
760, 31	3.35	6517 t	− 25	105.2 WSW	19.6
N 3	.37	6186 t	+131		
July 23	3.31	7990 m	+258		
763, 27	3.54	9778 m	−167	34.2 NW	36.3
NE 5	.56	10567 m	+ 7		
763, 26	6.14	11869 m	−228	43.7 NW	36.5
	.16	8759 m	−390		
	6.22	14432 m	+126	44.0 NW	41.9
	.24	11231 m	−107		
	6.30	11685 t	−133	43.0 NW	39.8
	.32	11004 t	−120	42.0 NW	40.6
	.34	11476 t	−220	43.4 NW	39.8

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 23	.36	13753 t	+287	41.7 NW	40.5
763, 26	.38	12388 t	+134	39.6 NW	40.6
	.40	13517 t	+166		
	6.44	7943 m	− 1	76.1 WNW	22.9
	.46	7586 m	− 72	78.5 WNW	23.7
	.48	7850 m	+ 5		
July 25	9.01	6278 t	+ 9	91.7 W	27.7
762, 22	.03	5984 t	− 8		
NE 5					
July 27	1.15	11638 t	−410		
761, 34	1.21	14257 t	−508	98.0 W	31.2
N 3	.23	14086 t	−161	96.0 W	31.8
	.25	11388 t	−421		
July 28	1.17	6845 t	− 27		
764, 32	1.24	6859 t	−105		
NE 2	1.27	6882 t	+ 74		
	1.56	10001 t	−500	90.2 W	23.8
	.58	12773 t	− 90		
	2.01	11958 t	−114	89.5 W	23.8
	.03	11610 t	− 5		
763, 31	3.31	6591 m	+393	71.0 WNW	24.4
	.33	7769 m	− 64		
	3.45	8266 m	+371	62.7 WNW	24.5
	.47	8080 m	− 75		
July 30	3.44	5795 m	− 63		
760, 31	3.47	5383 t	− 40		
N 4	3.49	5579 t	− 57		
	3.51	5842 t	− 24		
Aug. 7	1.04	8225 m	+249		
762, 35					
N 2					
Aug. 11	6.42	8406 t	− 43	92.9 W	6.5
762, 33	.44	8536 t	− 99		
NW 2					
Aug. 17	6.26	11269 t	+100	69.3 WNW	57.8
764, 24	.28	9607 t	− 75	71.8 WNW	57.7
NE 3	.30	9448 t	− 2	71.7 WNW	56.3
	.32	10101 t	+ 40		

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Aug. 18	8. 25	7782 m	+ 39	92. 0 W	33. 5
764, 20	. 27	7601 m	+ 57		
NE 2	8. 41	7398 t	−300		
	8. 43	6271 t	+ 14		
763, 25	1. 09	8461 t	+240		
	1. 21	9359 t	−492		
Aug. 21	1. 01	8376 t	+ 78		
762, 27					
W 3					
Aug. 22	6. 34	7553 t	− 92		
761, 25	6. 38	6789 t	+ 27		
NW 3	6. 41	6985 t	+ 29	69. 9 WNW	21. 8
	. 43	6504 t	+ 60		
	6. 46	7177 t	+ 93		
Aug. 27	8. 15	7815 t	− 1	120. 2 WSW	29. 4
764, 21	. 17	7174 t	+ 8		
E 2	8. 20	6615 t	− 14		
	8. 22	9453 t	+328		
Sept. 16	6. 14	12714 t	+223	55. 2 NW	33. 7
759, 22	. 16	9419 t	+200		
E 3					
Sept. 21	8. 22	8612 m	+ 24		
765, 13	8. 26	8545 m	0		
NE 2	8. 43	8134 t	+ 14	87. 0 W	28. 0
	. 45	7951 t	+ 28		
Oct. 1	8. 31	9548 t		130. 5 SW	9. 4
760, 16	. 33	9442 t		129. 0	10. 1
NE 4	. 35	9356 t		135. 9	15. 0
	. 37	9821 t			
Oct. 7	8. 39	8140 t	−230		
763, 13	8. 47	9096 t	+151	96. 7 W	40. 2
NE 7	. 50	8558 t	−201		
	9. 00	11350 b	− 41	93. 8 W	48. 9
	. 02	9971 b	− 47	95. 2 W	48. 9
	. 04	9526 b	− 24		
Oct. 10	9. 19	10831 t	−136		
774, 9	9. 26	12425 t	+139		
S 8					

Date		Height z	Δz	φ φ_1	V
1896	*m. h.*	*m.*	*m.*	°	*m. p. s.*
Oct. 16	1. 20	6186 m	+349	98. 4 W	27. 4
754, 22	. 22	6188 m	+315		
NE 3					
Oct. 17	8. 13	7136 m	+ 15	116. 2 WSW	37. 2
759, 11	. 15	6154 m	+223		
SE 4	8. 22	6557 t	− 34	103. 4 WSW	32. 8
	. 24	6438 t	+117		
	8. 29	6413 t	+ 64	117. 5 WSW	35. 5
	. 31	6343 t	+ 28		
	8. 37	4985 t	+113		
	8. 44	6547 t	−112	117. 4 WSW	38. 3
	. 46	6576 t	− 28		
Oct. 21	8. 57	3316 t	+ 6	102. 9 WSW	22. 2
760, 12	. 59	4439 t	− 86		
N 4					
Oct. 24	8. 40	5792 t	+ 94	108. 0 WSW	30. 3
755, 9	. 42	5302 t	+ 17		
NE 5	8. 44	4884 t	− 11		
	8. 45	5320 t	+ 52		
	8. 50	5385 t	+144		
	8. 53	5297 t	+155	102. 2 WSW	20. 9
	. 55	5217 t	+170		
	8. 57	5868 t	− 16		
Oct. 28	1. 12	10040 s	+184	101. 1 WSW	18. 2
760, 21	. 14	9306 s	+ 35	103. 7 WSW	20. 5
NW 2	. 16	9367 s	+262	100. 7 W	18. 7
	. 18	9120 s	− 3	101. 1 WSW	20. 5
	. 20	8753 s	+ 74		
	1. 24	9585 t	− 54	101. 4 WSW	21. 1
	. 26	8852 t	+ 83		
760, 20	4. 12	6958 t	+ 39	62. 9 WNW	21. 2
	. 14	6970 t	− 68		
	4. 16	7625 t	− 39	58. 4 WNW	22. 5
	. 18	7110 t	+270	59. 1 WNW	21. 3
	. 20	6828 t	− 43		

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRO-CUMULUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Oct. 28	4. 22	7733 m	+ 2	73. 4 WNW	16. 2
760, 20	. 24	7553 m	+ 80	72. 4 WNW	16. 1
	. 26	7536 m	+ 64		
Nov. 3	8. 43	10733 m	− 57	89. 5 W	33. 6
770, 9	. 45	10660 m	−327		
W 3	8. 50	11362 m	+ 20		
	8. 53	12048 t	+ 27	106. 2 WSW	50. 9
	. 55	12356 t	−472		
769, 21	1. 06	9048 t	+ 17	102. 4 WSW	33. 6
	. 08	9607 t	− 24	101. 1 WSW	34. 3
	. 10	9445 t	+162	97. 9 WSW	33. 9
	. 12	9920 t	+ 21	98. 2 WSW	32. 9
	. 14	9373 t	− 40		
Nov. 7	4. 27	10070 t	− 4	105. 7 WSW	40. 2
760, 14	. 29	11093 t	−118	105. 7 WSW	38. 1
N 3	. 31	10696 t	+129	103. 0 WSW	39. 7
	. 33	10601 t	+ 2		
	4. 37	9668 t	+ 89	105. 7 WSW	35. 1
	. 39	9390 t	+ 29	107. 2 WSW	33. 8
	. 41	9926 t	− 28		
Nov. 9	3. 52	9760 t	+117		
766, 3	4. 00	7092 t	+112		
NE 3					
Nov. 14	8. 21	7273 t	+ 82	60. 9 WNW	32. 2
771, 1	. 23	7585 t	−152		
NE 6	8. 25	7984 m	+ 88	62. 0 WNW	53. 0
	. 27	7822 m	+ 31		
	8. 29	8094 m	+ 67		
	8. 34	9253 t	− 63	67. 2 WNW	29. 0
	. 36	7708 t	− 40	71. 2 WNW	27. 4
	. 38	8902 t	−151		
Nov. 17	1. 22	8860 t	+ 49	90. 7 W	16. 7
770, 5	. 24	9666 t	+ 14	85. 4 W	17. 1
NE	. 26	8413 t	+290		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Nov. 20	8. 28	5798 t	+ 68	89. 5 W	23. 4
776 3	. 30	6040 t	− 27		
S 4					
Dec. 1	8. 47	11116 t	+117	103. 2 WSW	90. 0
776, 7	. 49	12902 t	+424		
NE 6	1. 04	10878 t	+197	109. 5 WSW	78. 7
	. 06	11102 t	+235		
	1. 08	10116 t	+226	107. 9 WSW	69. 1
	. 10	9865 t	+ 93		
	1. 30	9311 t	+ 58	111. 9 WSW	72. 5
	. 32	8349 t	+ 94		
Dec. 5	1. 22	7027 t	− 16	107. 5 WSW	28. 0
767, 12	. 24	7265 t	+ 79		
NW 3	1. 28	7287 t	− 1	105. 7 WSW	29. 9
	. 30	7114 t	+ 9		
766, 8	4. 08	6578 t	− 15	118. 1 WSW	29. 5
	. 10	6502 t	+ 36	118. 0 WSW	29. 0
	. 12	6504 t	+ 27		
	4. 16	6783 b	+136	110. 7 WSW	28. 3
	. 18	6604 b	− 15		
Dec. 7	8. 19	8021 t	+480	103. 5 WSW	41. 1
766, 2	. 21	7097 t	+ 90		
NE 1	8. 41	6415 t	+100		
Dec. 9	4. 14	8493 t	+199	51. 7 NW	43. 0
757, 10	. 16	8503 t	+ 42		
NE 10	4. 29	8437 t	+ 36	49. 1 NW	39. 5
	. 31	7417 t	− 50		
Dec. 10	8. 28	10174 t	−280	59. 3 WNW	40. 8
759, 8	. 30	10892 t	+245		
NE 5	8. 32	11326 t	+ 57	59. 3 WNW	38. 4
	. 34	10825 t	+126	56. 5 WNW	40. 1
	. 36	10979 t	+ 30		
	8. 38	10992 t	+ 38	62. 5 WNW	37. 5
	. 40	10483 t	+162	55. 5 WNW	38. 1
	. 42	10110 t	+190		
	8. 53	10220 t	− 73	65. 0 WNW	35. 5
	. 55	10300 t	+ 83		

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m.p.s.*	1897	*h. m.*	*m.*	*m.*	°	*m.p.s.*
Dec. 14	1.18	5577 m	+ 32			Jan. 11	8.30	2978 m	+ 7		
763, 11						758, 3	8.42	3166 b	+ 85		
SW 2						NE 2					
Dec. 16	4.02	5856 m	−104			Jan. 22	1.04	9074 t	+159	100.4 W	49.0
763, 4	4.05	5845 m	+ 44			755, 8	.06	7335 t	− 34		
E 10	4.08	6139 t	− 22			NW 4	1.15	7115 t	− 88		
	4.09	6043 m	+ 87				1.34	7496 t	+ 81		
Dec. 19	1.09	6542 t	−148	133.2 SW	43.7		1.36	8570 t	+ 7		
769, 2	.11	7623 t	− 27			Feb. 1	1.45	6668 t	+ 24		
NE 5	1.13	8430 t	+152			771, 2	1.49	6366 t	− 54		
	1.22	7200 m	+339			SW 5	4.27	5780 t	+ 26	142.5 SW	12.0
	1.25	6581 t	−232				.29	5294 t	+ 88		
	1.29	9669 t	−153			Feb. 3	9.12	8985 t	+ 98	342.6 NNE	5.2
Dec. 23	8.30	6570 t	+ 50	79.2 WNW	42.1	758, 1	.14	8894 t	+144	346.8 NNE	4.7
759, 1	.32	6944 t	+ 27	82.0 W	43.3	NE 6	.16	9031 t	+152	346.5 NNE	5.2
E 8	.34	7156 t	+ 42				.18	9092 t	+153	341.5 NNE	3.6
	8.36	6398 b	+ 8	81.9 W	40.3		.20	9178 t	+130		
	.38	6218 b	+ 63								
Dec. 26	4.45	7786 t	+ 41	93.2 W	19.2	Feb. 18	8.41	8561 t	+114	96.6 W	42.9
772, 0	.47	7716 t	+ 10			760, 7	.43	7242 t	+207		
NE 4	4.51	6752 t	+ 45			NE 2	8.44	7586 m	+ 68	96.9 W	39.5
	4.57	6014 b	+ 24								
Dec. 29	1.37	6345 t	+ 58	111.7 WSW	20.7		.46	8070 m	+ 45	96.0 W	39.1
775, 4	.39	7474 t	+ 97				.48	7907 m	− 46		
775, 3	4.20	7964 t	+ 67	93.7 W	20.6		8.53	7734 b	+ 34	98.8 W	38.1
NW 4	.22	8330 t	+ 28	98.2 W	22.7		.55	6995 b	+ 80		
	.24	8134 t	+ 50				8.58	7423 t	+102	96.9 W	37.7
	4.26	7526 t	+ 98	95.4 W	20.5		9.00	8404 t	− 25	97.1 W	39.6
	.28	8105 t	+ 4	96.9 W	21.4		.02	7920 t	+ 98		
	.30	7973 t	− 60			Feb. 19	8.39	9154 t	− 6	86.5 W	63.1
1897						770, 2	.41	8305 t	− 3		
Jan. 8	8.25	4390 t	− 19	124.8 SW	2.1	NE 4	8.51	10060 m	− 28	69.3 WNW	74.4
772, 6	.27	4512 t	− 48				.53	9932 m	+ 83		
S 6	8.30	4481 m	+ 44				8.55	9920 t	+ 84	69.1 WNW	73.2
	8.33	4517 t	+ 48	97.0 W	3.5		.57	9843 t	+ 60		
	.35	4561 t	+ 29			771, 5	1.35	8110 t	+133		
	8.39	4412 t	+ 8				1.38	7634 t	+ 79		
	8.42	4622 t	+ 64	91.5 W	3.3		1.40	7302 t	+135		
	.44	4495 t	+ 15								

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Feb. 19	1. 45	7310 t	+452			Mar. 31	5. 33	8238 t	+ 41	55. 1 NW	41. 8
771, 5	1. 51	6706 t	+ 32			769, 12	. 35	8040 t	+ 26	54. 6 NW	41. 7
	1. 58	7230 t	+ 13			S 4	. 37	8276 t	+ 27		
	2. 07	7005 t	+111								
772, 4	4. 39	6450 t	+ 10			Apr. 2	5. 57	6196 m	− 41	63. 3 WNW	20. 2
	4. 43	5710 t	+ 35			767, 14	. 59	6296 m	− 82		
	4. 47	4954 b	− 69			NE 3	6. 01	5418 t	+ 75	62. 1 WNW	17. 7
	4. 52	6841 t	+ 16	65. 8 WNW	71. 4		. 03	5643 t	+ 32		
	. 54	8606 t	+ 53				6. 06	6226 m	+ 12		
	4. 57	6868 t	− 10								
	4. 59	6834 t	+125			Apr. 6	9. 11	8624 t	− 56		
	5. 02	7896 m	− 99			757, 12	9. 20	8846 t	− 4	115. 7 WSW	54. 4
Feb. 23	2. 53	7199 m	+ 23			N 2	. 22	9138 t	− 11		
759, 8	2. 56	7841 m	+ 40				9. 25	10640 t	−105	118. 5 WSW	64. 9
NE 5	2. 59	7678 m	−257				. 27	8490 t	+ 57		
Mar. 2	1. 36	3682 t	+ 1	110. 6 WSW	22. 9	Apr. 10	1. 45	6766 t	− 44		
767, 17	. 38	3850 t	− 2			763, 9	1. 48	5874 t	− 35		
W 2						NE 5	1. 50	5733 t	+ 53		
							1. 57	5605 t	− 80		
Mar. 11	1. 31	6749 t	+169	91. 4 W	34. 2	Apr. 13	6. 03	6496 t	−117	125. 7 SW	43. 5
766, 14	. 33	4413 t	− 60			770, 13	. 05	4250 t	+ 99		
NE 4	1. 37	5780 t	+182	94. 8 W	37. 6	NW 5					
	. 39	6700 t	+ 91								
	1. 42	4417 t	+ 27			Apr. 26	8. 52	8712 m	+ 71	115. 5 WSW	18. 3
	1. 55	6106 t	+ 9	96. 4 W	34. 8	759, 14	. 54	7046 m	− 57		
	. 57	6429 t	+ 73			NW 3	8. 56	7134 t	+ 17	116. 9 WSW	17. 7
							. 58	6302 t	− 87		
Mar. 12	10. 33	7939 t	+207	125. 3 SW	37. 7	Apr. 29	6. 12	10176 t	+ 29	92. 1 W	17. 8
756, 6	. 35	6958 t	+ 92	127. 5 SW	37. 4	760, 19	. 14	9411 t	− 94		
NE 4	. 37	7670 t	+ 56			W 7	6. 15	9674 t	− 64	93. 4 W	15. 7
							. 17	9530 t	− 64		
Mar. 16	1. 23	6871 t	+ 38	121. 2 WSW	50. 0		6. 20	10732 t	− 29	89. 4 W	19. 3
777, 7	. 25	7459 t	+ 46				. 23	8886 t	− 72		
NE 4							6. 25	8631 t	0	92. 4 W	12. 7
							. 27	7516 t	− 38		
Mar. 22	1. 26	4929 t	+ 14	131. 0 SW	14. 8	May 12	6. 34	7091 t	+ 2		
758, 25	. 28	5156 t	+ 25			758, 22					
NW 4						NW 7					
Mar. 31	5. 27	9312 t	− 41	54. 2 NW	44. 8	May 14	1. 19	8530 t	− 47	144. 3 SW	25. 2
769, 12	. 29	8244 t	+ 28	54. 7 NW	44. 6	758, 23	. 21	7452 t	+ 24		
S 4	. 31	8584 t	+ 49			N 6					

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRO-CUMULUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 5	1. 31	8514 t	+ 52			June 18	1. 10	7783 t	+138	21. 1 NNW	13. 0
761, 22	1. 33	7890 t	− 63			760, 24	. 12	7271 t	+ 95	50. 7 NW	11. 6
NE 2						W 2	. 14	7561 t	+ 51		
June 16	8. 59	6973 t	− 5			June 24	9. 08	5398 t	+ 39	104. 2 WSW	15. 4
759, 25						762, 22	. 10	5279 t	+ 6		
NE 3						NW 3					

CIRRO-STRATUS.

1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 19	6. 29	7842 t	+ 8	89. 8 W	28. 8	June 3	8. 48	6994 b	− 25	97. 4 W	20. 2
760, 22	. 31	9761 t	+357			769, 17	. 50	6356 b	− 88	103. 2 WSW	20. 8
NE 3						SW 3	. 52	6798 b	+ 45		
May 26	10. 01	8018 t	+171	88. 8 W	22. 4	768, 23	1. 38	8020 b	+ 87	102. 5 WSW	22. 1
760, 22	. 03	8423 t	+ 79	82. 4 W	21. 3		. 40	8205 b	+129	97. 5 W	24. 2
N 9	. 05	8263 t	+ 4				. 42	6727 b	0		
	10. 17	7352 t	−134	92. 7 W	17. 6		1. 48	8124 b	+ 60	105. 2 WSW	23. 6
	. 19	8165 t	− 31	91. 2 W	18. 3		. 50	6528 b	− 24	101. 8 WSW	21. 2
	. 21	7741 t	− 37				. 52	7740 b	− 5		
	10. 25	9731 t	+353	91. 1 W	19. 0		2. 13	10722 t	−399	96. 5 W	25. 9
	. 27	9293 t	+321				. 16	9908 t	+ 71		
759, 23	6. 20	6961 b	− 4	70. 7 WNW	12. 6	767, 22	3. 34	8419 t	+325		
	. 22	6201 b	+117	53. 2 NW	7. 5		3. 36	9266 t	−502		
	. 24	6850 b	−106			June 18	6. 23	8460 t	+101	122. 4 WSW	12. 4
	6. 37	9555 t	+ 39	138. 7 SW	18. 7	762, 27	. 25	9282 t	+ 81	122. 5 WSW	13. 5
	. 39	8364 t	+476			NW 1	. 27	9839 t	+124	117. 5 WSW	13. 5
June 3	8. 15	7404 t	+179	103. 4 WSW	21. 9		. 29	8681 t	+ 34		
769, 17	. 17	7726 t	+ 22			June 22	1. 55	8729 b	+156	110. 7 WSW	18. 8
SW 3	8. 21	7538 b	− 27	101. 7 WSW	22. 4	760, 27	. 57	9746 b	− 67	92. 7 W	19. 9
	. 23	7453 b	− 48	101. 1 WSW	22. 9	NE 3	. 59	7993 b	− 93		
	. 25	7014 b	− 53			June 26	6. 13	12842 t	+ 48	97. 9 W	24. 0
	8. 36	7983 m	+ 7	93. 1 W	20. 8	764, 26	. 15	11783 t	+168	84. 5 W	20. 6
	. 38	7708 m	+ 27	97. 8 W	24. 7	NE 4	. 17	13842 t	+154		
	. 40	7306 m	+ 30								

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRO-STRATUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 27	8. 50	10650 b	− 91	104. 7 WSW	30. 2	July 27	6. 34	15437 t	− 55	30. 2 NNW	17. 1
766, 22	. 52	11376 b	+335	112. 7 WSW	34. 2	760, 32	. 36	16165 t	−454	43. 0 NW	19. 8
NE 3	. 54	8623 b	+192			N 3	. 38	15720 t	−205		
	8. 58	9804 t	+123	87. 1 WSW	26. 8		6. 42	13719 t	− 92	30. 7 NNW	15. 4
	. 60	9192 t	+176				. 44	12450 t	− 64		
June 30	1. 22	13888 t	− 57	132. 5 SW	35. 5		6. 47	14688 t	+ 61	32. 0 NNW	17. 1
769, 26	. 24	14520 t	+289	111. 0 WSW	45. 7		. 49	15970 t	+ 32	35. 2 NNW	18. 9
NE 2	. 26	16144 t	+194				. 51	12496 t	+179	32. 7 NNW	17. 3
	1. 29	11947 m	+477	114. 5 SW	32. 3		. 53	13697 t	+ 3		
	. 31	13692 m	+ 72	111. 8 WSW	33. 1	Aug. 26	6. 24	12254 b	+ 21	116. 0 WSW	37. 0
	. 33	13876 m	−176								
	3. 59	13930 m	+208	76. 5 WNW	33. 2	764, 25	. 26	11844 b	− 8	117. 4 WSW	35. 1
	. 61	14596 m	+157			N 5	. 28	13526 b	− 38		
768, 19	6. 28	13456 m	− 44			Aug. 27	8. 35	6796 t	−32		
July 2	8. 14	9746 m	+606	5. 7 N	1. 5	764, 21 E	. 2				
768, 22	. 16	10875 m	+420								
W 3	8. 20	12930 m	+171	147. 7 SW	5. 6	Sept. 18	8. 28	10766 b	−551	90. 4 W	35. 4
	. 22	12351 m	−352				. 30	12350 b	−132		
July 13	6. 28	13194 m	+ 91	15. 2 NNW	20. 0	760, 23	8. 37	8793 t	+ 49		
761, 29	. 30	13397 m	+ 83	13. 7 NNW	24. 8	NE 5	8. 43	9563 b	+369		
							8. 48	9519 b	− 39		
NE 4	. 32	13289 m	−506	8. 8 NNW	22. 7		. 50	11533 b	+ 54	85. 0 W	28. 0
	. 34	12314 m	+234			Sept. 19	8. 44	9820 b	−247	95. 7 W	17. 5
July 20	1. 57	10311 t	− 66	76. 8 WNW	10. 2						
							. 46	10524 b	− 9	93. 7 W	18. 5
764, 30	. 59	10275 t	− 8	85. 0 W	9. 2	757, 24	. 48	10287 b	+ 30		
NW 5	. 61	9703 t	− 59	65. 4 WNW	11. 1	NW 5	1. 15	9169 t	+107	70. 2 WNW	21. 6
	. 63	9520 t	+383				. 17	12066 t	+169	72. 2 WNW	20. 9
764, 29	3. 47	11823 t	+178	53. 2 NW	15. 5						
	. 49	11344 t	−133	48. 0 NW	17. 6		. 19	13282 t	+251		
							1. 21	10617 t	+211	59. 7 WNW	20. 5
	. 51	10563 t	−103								
July 27	6. 27	11919 t	+102	38. 5 NW	18. 1		. 23	12250 t	+186	58. 5 WNW	23. 1
760, 32	. 29	15091 t	− 77	39. 0 NW	17. 7		. 25	11203 t	+191	59. 8 WNW	22. 8
N 3	. 31	15363 t	−129				. 27	10669 t	+ 88		

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRO-STRATUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Sept. 21	8. 16	11041 t	+101	99. 7 W	31. 0
765, 13	. 18	10983 t	−137	104. 5 WSW	27. 1
NE 2	. 20	8997 t	− 47		
Sept. 22	1. 02	10880 b	−309		
758, 19	1. 09	10802 b	+209	141. 4 SW	55. 5
NE 1	. 11	8163 b	+ 73		
Sept. 26	8. 49	7449 b	− 28	76. 4 WNW	12. 2
771, 15	. 51	7481 b	−139		
N 5					
Oct. 16	8. 51	10108 t	+ 54	79. 4 WNW	24. 1
756, 2	. 53	10003 t	−276	80. 2 W	22. 0
NE 3	. 55	10194 t	+ 17		
Oct. 20	1. 15	10770 t	− 39	122. 7 WSW	28. 5
762, 18	. 17	10314 t	−208	122. 2 WSW	29. 1
N 7	. 19	11115 t	+283	122. 1 WSW	30. 3
	. 21	10726 t	+100		
	1. 38	10260 t	+363		
762, 15	4. 06	9768 t	+189	116. 0 WSW	35. 8
	. 08	11936 t	−273		
	4. 11	10833 m	0	114. 6 WSW	33. 3
	. 13	9654 m	+ 11	114. 5 WSW	33. 9
	. 15	8997 m	+204		
	4. 17	10566 t	+131	116. 7 WSW	34. 7
	. 19	11178 t	+ 90	112. 2 WSW	34. 2
	. 21	10122 t	−147		
	4. 25	9002 t	+145	112. 4 WSW	31. 0
	. 27	10612 t	+ 97		
Oct. 21	8. 30	7335 t	− 26		
761, 12	8. 40	7006 t	+ 65	110. 4 WSW	37. 8
N 4	. 42	7171 t	− 66		
	9. 07	6632 m	−289	117. 5 WSW	36. 4
	. 09	6528 m	− 20		
	9. 17	6079 m	−151		
Oct. 28	8. 36	11108 t	+113	69. 2 WNW	23. 9
761, 7	. 38	10372 t	+110	70. 7 WNW	22. 3
NW 2	. 40	10400 t	+ 88	69. 7 WNW	24. 1

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Oct. 28	. 42	10178 t	+152	64. 7 WNW	22. 6
761, 7	. 44	11974 t	+ 31		
NW 2	8. 46	10105 t	+112	62. 0 WNW	22. 1
	. 48	10968 t	+146	66. 4 WNW	23. 4
	. 50	10813 t	+142	65. 0 WNW	24. 4
	. 52	11094 t	+ 7	62. 5 WNW	21. 3
	. 54	10511 t	+ 65		
770, 21	1. 29	9930 t	− 5	107. 2 WSW	20. 4
	. 31	9925 t	+ 86	107. 9 WSW	20. 4
	. 33	10420 t	+310		
770, 19	4. 08	8002 t	+108	75. 1 WNW	18. 0
	. 10	7888 t	+137		
Nov. 3	9. 00	11242 s	− 95	103. 5 WSW	35. 3
770, 14	. 02	9962 s	− 76	103. 5 WSW	35. 1
W 3	. 04	10236 s	0	103. 2 WSW	36. 6
	. 06	10455 s	− 32	100. 1 W	36. 7
	. 08	9916 s	−243		
Nov. 16	1. 07	10928 b	− 20	74. 0 W	18. 3
769, 21	. 09	11019 b	− 30	57. 8 W	19. 3
NW 5	. 11	9040 b	−355	59. 5 W	19. 4
	. 13	9971 b	+ 44		
	1. 16	9340 m	+115	70. 6 W	19. 3
	. 18	11334 m	−208	81. 5 W	21. 2
	. 20	9996 m	− 19	73. 6 W	19. 6
	. 22	9988 m	+ 64		
	1. 28	9629 t	− 60	66. 2 W	15. 2
	. 30	10775 t	−306		
Nov. 17	4. 39	8962 t	+114		
768, 19					
NE 3					
Nov. 19	8. 37	9862 m	+ 5	88. 7 W	26. 7
764, 10	. 39	9624 m	− 2	86. 7 W	29. 8
NE 4	. 41	9166 m	+ 43		

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRO-STRATUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Nov. 19						Dec. 12	8. 25	8811 t	+ 39	76. 5 WNW	30. 4
764, 10	9. 08	11640 t	+ 52	82. 5 W	31. 4	766, 1	. 27	8914 t	+ 7	77. 7 WNW	32. 3
NE 4	. 10	9978 t	+123			NE 3	. 29	8435 t	+ 45	78. 0 WNW	31. 1
Nov. 24	8. 59	8767 m	+126	83. 6 W	23. 4		. 31	9254 t	+ 22		
774, 9	9. 01	9247 m	+ 61	86. 2 W	22. 9		8. 35	9440 t	+ 71	78. 0 WNW	34. 0
N 5	. 03	9132 m	+ 59				. 37	9206 t	− 7	75. 7 WNW	34. 3
773, 14	4. 09	11572 m	+ 94	55. 5 NW	18. 3		. 39	8440 t	+151		
	. 11	10163 m	+ 65				8. 45	9997 t	− 46	77. 9 WNW	38. 2
	4. 14	13983 b	− 24	55. 9 NW	25. 0		. 47	10146 t	−145	71. 1 WNW	36. 6
	. 16	12314 b	+ 15				. 49	10226 t	+ 86		
	4. 28	11549 m	+138	58. 7 WNW	17. 9	764, 10	1. 13	9250 t	− 57	84. 0 W	31. 2
	. 30	11383 m	+130				. 15	7662 t	− 19	84. 4 W	29. 1
Dec. 1	8. 15	13674 t	+ 272				. 17	7048 t	− 95		
776, 6	8. 22	11680 m	+ 65				1. 19	7722 t	+200	82. 0 W	31. 3
NE 6	8. 25	11304 t	+258				. 21	8046 t	+ 37	81. 5 W	30. 8
	8. 37	11677 m	+219				. 23	8205 t	− 42	81. 4 W	32. 2
	8. 40	12368 t	+ 270	107. 2 WSW	91. 9		. 25	7458 t	+ 3	79. 2 WNW	28. 7
	. 42	10768 t	+122				. 27	7682 t	−131		
Dec. 4	8. 25	9106 m	−138				1. 29	6890 m	+ 18	82. 5 W	25. 7
773, 6	8. 30	7717 t	+ 36	124. 7 SW	39. 1		. 31	6145 m	− 48		
E 4	. 32	8599 t	− 28			763, 8	4. 10	9715 t	− 92	88. 0 W	34. 4
	8. 34	7649 t	− 50	126. 3 SW	35. 7		. 12	10920 t	+117		
	. 36	9390 t	−102				4. 15	9470 m	+ 89	92. 4 W	33. 3
	8. 39	9150 t	− 25				. 17	8192 m	+135		
	8. 46	7441 t	+ 30	123. 2 WSW	36. 9		4. 20	9048 m	+273		
	. 48	7087 t	− 94	121. 2 WSW	33. 8		4. 23	10433 t	+112	89. 9 W	31. 8
	. 50	8048 t	+108	121. 6 WSW	36. 4		. 25	7953 t	+ 84		
	. 52	8473 t	+147				4. 28	11524 m	+134	86. 6 W	37. 9
Dec. 5	1. 04	7305 b	+103	105. 3 WSW	29. 4		. 30	9799 m	−128		
777, 12	. 06	7641 b	+ 84			Dec. 14	8. 32	8490 m	+ 25	94. 4 W	16. 4
NW 3	1. 08	7563 b	+ 57	104. 5 WSW	30. 4	763, 6	. 34	8339 m	+ 95	102. 0 WSW	13. 8
	. 10	7515 b	+ 8			SW 2	. 36	8771 m	+168		
	1. 12	7489 m	+ 78	116. 0 WSW	30. 1		8. 48	8634 t	+133	98. 7 W	14. 5
	. 15	7465 m	+ 26								
777, 9	4. 21	5300 m	+ 93	115. 7 WSW	20. 7						
	. 25	5137 m	+267	113. 9 WSW	21. 2						
	. 27	4992 m	+201								

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRO-STRATUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Dec. 14	.50	8125 t	+165			Mar. 10	8.35	9651 t	− 12		
763, 6	8.54	8872 t	−132	101.2 WSW	16.8	756, 11	8.38	8691 t	+ 58	116.0 WSW	55.3
SW 2	.56	8715 t	+ 88			N 3	.39	9466 t	+ 13	111.0 WSW	50.7
764, 11	1.07	9382 m	+215	104.7 WSW	31.8		.40	9508 t	+ 60	110.7 WSW	49.0
	.09	9031 m	−184	108.5 WSW	35.3		.41	10804 t	+ 91	106.2 WSW	47.8
	.11	9588 m	+ 79				.42	11916 t	+197		
Dec. 19	1.57	8464 t	+284				8.44	9025 t	0	106.4 WSW	47.1
769, 2							.45	9059 t	+ 46	101.4 WSW	47.8
NE 5							.46	11390 t	+187	108.7 WSW	51.8
Dec. 29	8.24	11259 m	+ 29	94.2 W	28.0		.47	10265 t	+198		
778, 5	.26	11069 m	+ 55	94.3 W	29.0	Apr. 3	5.58	12850 t	− 17		
NW 4	.28	10856 m	+ 81			771, 13					
	8.31	11358 m	+ 48	91.9 W	26.5	SW 2					
	.33	9656 m	+300	102.7 WSW	23.7	Apr. 12	6.14	7720 t	+ 5	55.9 NW	33.3
	.35	9736 m	+ 85			776, 9	.16	8172 t	− 13	55.7 NW	33.8
1897											
Jan. 22	1.20	7823 t	+ 10	92.8 W	51.1	W 2	.18	6846 t	−127		
755, 8	.22	6808 t	+ 36	96.0 W	51.8	Apr. 26	9.07	8604 t	+ 7	116.9 WSW	11.7
NW 4	.24	8150 t	+ 43			759, 14	.09	8568 t	− 15		
	1.26	8517 t	+ 50	72.5 WNW	45.3	757, 21	1.12	7642 t	+132	119.1 WSW	21.4
	.28	7761 t	+ 75			NW 3	.14	7901 t	+ 48	121.4 WSW	21.9
Feb. 1	1.10	10792 t	− 5	115.7 WSW	30.1		.16	8486 t	+225		
771, 2	.12	10163 t	+188				1.18	8822 t	+216	123.7 WSW	23.4
SW 5	1.15	10368 t	+216	109.5 WSW	36.6		.20	8144 t	+265	123.1 WSW	23.4
							.22	7572 t	+ 23		
	.17	12450 t	+ 53	108.9 WSW	38.9		1.27	8638 t	+417	109.9 WSW	23.6
	.19	11392 t	− 12				.29	8124 t	−107	106.0 WSW	23.2
Feb. 3	9.25	8976 b	−145	353.0 N	4.9		.31	7474 t	− 46		
758, 1	.27	9332 b	−180			Apr. 28	9.09	10116 t	+ 79		
NE 6						764, 12					
						NE 6					
Mar. 2	5.07	9435 t	+ 12	100.9 W	22.7	May 11	8.41	8765 t	− 26		
765, 14	.09	9623 t	− 8	100.9 W	22.3	762, 19	8.45	11241 t	− 28	74.1 WNW	32.4
W 2	.11	9954 t	+ 7			NW 3	.47	11042 t	−351	83.5 W	34.7
	5.23	8872 t	−343								

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRO-STRATUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 11	.49	10444 t	−131			May 21	6.28	9144 b	− 75		
762, 19	8.51	10331 t	+ 54	77.6 WNW	32.1	756, 21	6.30	8995 b	− 11	48.0 NW	35.4
NW 3	.53	11792 t	− 9			NE	.32	9038 b	− 3		
	8.55	10550 t	−112	79.5 WNW	30.5		6.37	10300 b	+ 8	332.5 NNE	40.3
	.58	10885 t	− 30				.39	11399 b	−223	332.8 NNE	38.0
	9.09	8889 t	− 48	78.6 WNW	27.2		.42	9550 b	+ 82		
	.11	9911 t	+ 30			May 29	9.02	10840 t	−101		
May 13	6.44	11731 t	− 82	141.5 SW	45.3	757, 15	9.05	11172 t	− 40	101.7 SW	49.9
759, 18	.46	11268 t	+ 37	144.4 SW	43.1		.07	10316 t	+ 35		
NW 9	.48	11674 t	−197			June 14	1.17	9106 t	+ 52	37.5 NW	47.8
May 14	1.34	12174 t	− 8	149.9 SSW	41.9	760, 27	.19	9958 t	− 54		
758, 23	.36	9672 t	− 26	151.6 SSW	40.8	NE 4	1.22	9874 m	+ 55	41.2 NW	47.4
N 6	.38	13060 t	+135				.24	9757 m	− 8		
May 15	8.45	9106 b	+ 61	326.2 NNE	43.7		1.58	6089 b	−206		
764, 13	.47	9143 b	+ 18	326.0 NE	43.9	June 15	8.49	11257 t	− 39	55.7 NW	28.2
NE 2	.49	8628 b	+ 1	325.6 NE	43.3	761, 20	.51	10489 t	− 58	57.7 NW	26.4
	.51	8394 b	+ 40			NE 4	.53	9519 t	− 53		
	8.54	8435 b	+ 70	326.4 NNE	45.3	June 16	8.49	7834 t	− 34	54.5 NW	22.8
	.56	8775 b	+138			760, 24	.50	7584 t	+ 56		
765, 19	1.27	9880 m	− 20	330.9 NNE	50.2	NE 3	9.08	7241 t	+ 88		
	.29	8465 m	+ 21			June 30	8.52	11616 t	− 22	48.4 NW	32.8
	1.36	8718 t	−164			758, 28	.54	12637 t	+ 9	48.7 NW	33.7
May 20	6.53	9848 t	+ 40			N 4	.56	11528 t	+ 79		
760, 25							1.58	10112 t	+ 30	55.4 NW	30.7
N 6							2.00	11123 t	−156	58.3 WNW	31.8
							.02	9940 t	+ 31		
							6.52	9732 t	+ 34		
							6.56	9098 t	− 5	52.6 WNW	34.0
							.58	8758 t	− 79		

CIRRUS.

1896	*h. m.*	*m.*	*m.*	°	*m. s. p.*	1896	*h. m.*	*m.*	*m.*	°	*m. s. p.*
May 6	6.36	7210 m	− 15	358.2 N	12.7	May 9	1.19	6279 m	+122	253.6 ESE	1.0
766, 14	38	8978 m	+ 21			763, 31	.21	7423 m	+339		
NW 2	6.46	6087 m	− 9	347.6 NNE	3.4	NW 3	1.30	11773 m	+300		
	.48	5872 m	− 56				1.33	6986 m	+313		
							1.39	8584 m	−298		

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 9						May 15	.31	16465 m	−806		
762, 29	6.23	13585 m	+227	303.4 ENE	22.0	764, 26	6.38	12865 m	−714	71.5 W	24.1
	.25	15822 m	+ 55			NE 1	.39	11143 m	+289	95.2 W	26.9
	6.29	15741 m	−318				.40	12401 m	+191		
	6.32	8872 b	− 87	310.2 NE	12.3		6.45	13174 m	+102	95.5 W	30.2
	.34	8190 b	−294	312.2 NE	13.5		.46	10865 m	−766		
	.36	10647 b	−394			May 16	1.09	7002 m	+615		
	6.39	9897 t	+ 80	307.7 NE	13.3	766, 22	1.17	6860 m	+319		
	.41	13811 t	− 19	316.8 NE	11.5	W 2	1.30	9959 m	−318	40.4 NW	30.3
	.43	14990 t	−317				.32	7260 m	− 65	28.1 NNW	29.8
	6.50	14438 b	−456	356.2 N	16.6		.34	9620 m	−723		
	.52	11994 b	−655			765, 22	6.12	7967 t	+261	74.4 WNW	17.0
May 11	6.36	11830 t	+100	79.3 W	20.9		.14	10416 t	+214		
759, 31	.38	12688 t	+ 43	76.3 WNW	21.2		6.18	11370 t	+ 91	124.7 SW	13.5
NE 7	.40	9191 t	+360				.20	10172 t	+ 95		
	6.49	8250 m	−253	77.2 WNW	8.5		6.26	8198 m	+ 57		
	.51	10002 m	−497				6.29	8867 m	+255	69.5 WNW	20.0
	6.58	10350 m	−364	250.1 ESE	17.3		.31	12102 m	− 96		
	7.00	12942 m	− 40				6.35	9815 m	+139	85.1 W	18.1
	7.08	11511 m	−162				.37	9606 m	− 40		
May 12	1.08	8514 m	+ 67	35.2 NW	23.1	May 18	8.32	12024 m	+110	88.5 W	29.1
760, 30	.10	8314 m	− 36	101.7 WSW	30.6	762, 22	.34	11235 m	−524		
NE 2	.12	8703 m	− 83			NE 4	8.39	11582 t	−541	31.8 NNW	30.7
	1.17	8726 m	+ 40	75.3 WNW	19.8		.41	9262 t	−162		
	.19	8472 m	+ 12	62.8 WNW	29.4		8.43	10850 t	+336		
	.21	6860 m	−169			May 19	8.35	9130 m	−176	75.7 WNW	20.2
	1.30	10580 t	+352	103.4 WSW	30.0	758, 23	.37	10997 m	+ 44		
	.32	10386 t	−190			NE 3					
	1.36	9990 t	−132	79.2 W	30.7	May 26	9.18	8346 b	+417	51.7 NW	13.6
	.38	9456 t	+ 40			761, 21	.20	7530 b	−245		
	1.45	7118 m	+ 12	72.9 WNW	19.1	N 9	9.24	6926 b	− 26	83.4 W	16.5
	.47	7439 m	+391				.26	7090 b	− 12		
May 15	6.13	13344 b	− 94	99.2 W	30.8		9.30	7723 t	+418	88.5 W	24.3
764, 26	.15	12004 b	−152	79.2 W	37.6		.32	8257 t	+ 17	86.1 W	20.4
NE 1	.17	13491 b	− 51				.34	7973 t	−207	90.1 W	22.2
	6.22	11324 m	+111				.36	7310 t	−167		
	6.29	13252 m	+511	104.4 WSW	25.1						

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 26					
759, 24	6. 14	7756 m	+ 78	121. 5 WSW	38. 1
	. 16	6114 m	+105		
May 28	12. 12	13189 s	−109		
754, 30	12. 20	8944 m	+387		
NW 9	12. 26	11010 m	−229	224. 4 SE	16. 9
	. 28	8672 m	−317		
June 1	8. 57	9783 t	− 22	86. 7 W	44. 5
763, 16	. 59	10037 t	+ 33		
NE 5	9. 10	11912 t	−344		
	6. 21	9571 m	−250	88. 2 W	49. 1
	. 23	11550 m	+ 9		
	6. 33	10802 t	+482		
June 2	8. 15	13405 m	+265	76. 8 WNW	60. 9
767, 17	. 17	13622 m	+337		
NE 5	8. 23	10034 m	−725	78. 8 WNW	42. 2
	. 26	10720 m	−727		
	8. 34	14478 t	+469		
	8. 39	11362 m	− 97	78. 1 WNW	47. 1
	. 41	12346 m	+156		
	8. 48	11128 t	+123	82. 4 W	46. 8
	. 50	11743 t	+114	76. 1 WNW	44. 2
	. 52	10717 t	+374		
	12. 50	10972 t	−211		
767, 22	12. 52	8858 t	−533		
	12. 55	9214 t	− 6	82. 8 W	32. 6
	. 57	8157 t	− 93	80. 5 W	32. 1
	. 59	6390 t	−186		
	1. 03	9109 m	− 30	76. 2 WNW	40. 0
	. 05	7724 m	−123		
	1. 11	11089 m	−680	93. 5 W	46. 6
	. 13	10378 m	+276		
	1. 27	12748 t	+124	87. 7 W	53. 3
	. 29	12769 t	− 18		
June 10	6. 34	10027 t	+589	316. 2 NE	12. 9
754, 22	. 36	9686 t	+174	335. 2 NNE	5. 6
NE 8	. 38	8748 t	+179	331. 6 NNE	5. 6
	. 40	8808 t	+162		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 12	2. 41	7875 t	+ 76	81. 5 W	21. 0
754, 28	. 43	11494 t	+306		
NE 5	2. 50	9648 t	+197	88. 2 W	19. 7
	. 52	8010 t	+126	82. 2 W	16. 1
	. 54	7321 t	+253		
	2. 58	8223 t	+ 86	84. 1 W	19. 9
	. 60	7970 t	+126	86. 1 W	19. 8
	. 62	8054 t	− 94		
	3. 06	12840 t	+663	65. 2 WNW	24. 3
	. 08	10888 t	+549		
754, 26	6. 11	8510 t	+ 93	105. 2 WSW	26. 1
	. 13	8888 t	+145	107. 4 WSW	26. 8
	. 15	7890 t	+ 12	103. 5 WSW	24. 7
	. 17	9625 t	+ 70	109. 1 WSW	27. 3
	. 19	8162 t	+310		
June 15	4. 08	7635 t	+104		
768, 20	4. 15	6913 t	−310		
W 1					
June 18	1. 34	8994 t	−179	92. 2 WSW	5. 9
	. 36	8038 t	−277		
763, 26	6. 41	11348 b	+227	116. 7 WSW	11. 9
NW 1	. 43	9090 b	+172	113. 5 WSW	12. 1
	. 45	9080 b	+ 91	113. 1 WSW	11. 6
	. 47	10487 b	+210		
June 19	3. 27	12127 t	+157	296. 2 ENE	8. 2
763, 29	. 29	12034 t	−167	268. 5 E	6. 7
NW 2	. 31	11113 t	+ 74	254. 5 ESE	8. 6
	. 33	11146 t	− 11		
June 20	6. 29	7472 t	+153	85. 5 W	20. 5
762, 30	. 31	10920 t	+360		
NE 3					
June 22	3. 30	10046 t	+ 88	72. 9 WNW	19. 9
760, 27	. 32	11462 t	+237		
N 3					

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 23	8.54	15360 t	−107	74.5 WNW	42.8
764, 22	.56	13291 t	+243		
NE 2	9.00	12902 t	+139	68.1 WNW	36.2
	.02	10453 t	− 50	68.2 WNW	32.0
	.04	12789 t	− 63		
June 27	8.10	9205 t	+315	76.4 WNW	27.7
766, 22	.12	11392 t	− 51		
NE 3	8.16	11772 t	+140	76.1 WNW	34.1
	.18	10772 t	+230		
June 29	8.35	6898 t	+214	124.2 WSW	31.6
760, 23	.37	9523 t	+110		
NE 4	8.39	5354 t	+ 20	113.4 WSW	30.2
	.41	10706 t	+418		
June 30	1.11	11854 m	+ 86	105.8 WSW	37.2
769, 26	.13	12521 m	−185	117.7 WSW	36.5
NE 2	.15	13154 m	+157		
	1.36	11598 m	+399	111.5 WSW	31.1
	.39	10897 m	7		
	3.31	10896 m	+ 92	114.2 WSW	30.9
	.33	10627 m	− 19		
	3.38	11137 t	− 46	115.4 WSW	34.0
	.40	10602 t	− 4		
	3.47	11170 t	+ 61	112.4 WSW	30.3
	.49	12115 t	−130		
	3.51	11594 m	− 65	110.7 WSW	32.6
	.53	10578 m	+ 29	112.5 WSW	34.5
	.55	9413 m	+146		
768, 24	6.21	10429 b	+ 33	97.2 WSW	30.9
	.23	10019 b	+ 76	97.5 WSW	30.3
	.25	10197 b	+ 76		
	6.32	14700 m	+139		
	6.35	9267 m	+144	127.5 SW	14.5
	.38	9559 m	+264		
July 1	6.09	11123 m	+179	131.7 SW	10.6
768, 26	.11	12555 m	+ 99	125.8 SW	11.9
NE 2	.13	11118 m	− 22	127.4 SW	10.6

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	m.	*m.*	°	*m. p. s.*
July 1	.15	11206 m	+ 14	126.5 SW	11.3
768, 27	.17	11429 m	+ 85		
NE 5	6.21	12424 m	+229	135.0 SW	13.9
	.23	12331 m	+ 55	148.2 SW	15.8
	.25	13441 m	+382	130.0 SW	14.3
	.27	13565 m	+329	125.4 SW	15.8
	.29	13499 m	+560		
	6.31	13660 m	+337	219.4 SE	9.9
	.33	13829 m	− 6		
July 2	8.26	14531 t	+ 21	154.2 SSW	15.7
768, 22	.28	13036 t	+494	159.2 SSW	18.2
W 3	.30	14199 t	+497	160.0 SSW	21.4
	.32	12807 t	−640		
	1.16	10134 m	+263	114.0 WSW	11.8
	.18	9025 m	+128	125.4 SW	14.1
	.20	9750 m	+232		
767, 29	3.35	9113 b	+183	133.3 SW	7.8
	.37	9206 b	+160	138.4 SW	5.9
	.39	9225 b	+215	131.7 SW	6.9
	.41	8602 b	+288		
	3.47	10563 t	+ 65	114.4 WSW	10.2
	.49	9048 t	+ 46	111.7 WSW	9.1
	.51	8741 t	+174	102.0 WSW	8.2
	.53	9136 t	+347		
766, 28	6.25	9800 t	+134	72.0 WNW	26.9
	.27	11643 t	+ 51	72.4 WNW	27.3
July 6	1.22	10381 t	+106	72.8 WNW	9.2
760, 28	.24	10387 t	+646	69.7 WNW	7.6
N 2	.26	9205 t	− 20		
July 9	6.43	11664 m	−338	154.8 SSW	34.0
765, 27	.45	10004 m	−136	157.4 SSW	33.0
NW 5	.47	12698 m	−304		

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 11	8. 58	5754 m	−122		
768, 23	9. 02	5600 m	−391	72. 7 WNW	41. 2
N 3	. 04	9837 m	− 7	102. 5 WSW	28. 7
	. 06	9832 m	− 82		
768, 29	1. 21	9437 m	+ 40	77. 7 WNW	49. 6
	. 23	8906 m	− 63		
	1. 40	6098 m	− 88	92. 5 W	18. 1
	. 42	7729 m	−170	100. 5 W	25. 9
	. 44	8087 m	+ 31		
768. 29	3. 24	10299 m	−260	95. 8 W	38. 4
	. 26	12881 m	−416		
767, 28	6. 16	9564 t	−330	88. 2 W	36. 8
	. 18	8428 t	− 72	88. 5 W	29. 2
	. 20	10407 t	− 79		
	6. 23	11236 m	+182	83. 5 W	34. 6
	. 25	10064 m	+ 54		
	6. 28	11891 m	+ 17	87. 5 W	38. 9
	. 30	10406 m	+ 15	86. 4 W	33. 6
	. 32	10839 m	+ 9		
	6. 35	14541 m	−107	89. 7 W	42. 2
	. 37	12244 m	+ 17	84. 5 W	40. 9
	. 39	11227 m	−161		
July 13	8. 47	8982 t	+132	4. 5 N	7. 2
763, 26	. 49	9238 t	+178	2. 2 N	9. 5
NE 4	. 51	9757 t	+337		
	8. 56	8669 t	− 60	2. 0 N	9. 4
	. 58	9244 t	+ 92	352. 8 N	9. 6
	. 60	9245 t	−162	7. 8 N	9. 5
	. 62	9399 t	− 5	11. 2 N	7. 9
	. 64	10849 t	+205		
	2. 02	15873 t	+108	35. 5 NNW	25. 3
	. 04	14911 t	+ 56	25. 7 NNW	17. 3
	. 06	14744 t	+ 87		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 14	7. 12	11273 b	−109	80. 7 W	20. 9
760, 26	. 14	11873 b	+288	81. 0 W	21. 9
NE 2	. 16	11433 b	+ 77		
July 15	8. 46	11711 b	−357	74. 7 WNW	9. 1
759, 26	. 48	10604 b	−102		
N 4					
July 18	1. 38	11566 m	− 42	11. 8 NNW	17. 0
770, 26	. 40	11586 m	+214		
NW 1	1. 44	10632 m	−142	22. 0 NNW	14. 8
	. 46	10067 m	− 84	11. 0 NNW	14. 4
	. 48	10658 m	−102	24. 0 NNW	15. 1
	. 50	11027 m	− 88		
	1. 58	12527 m	−193	21. 5 NNW	12. 5
	. 60	11598 m	− 81	21. 8 NNW	12. 5
	. 62	12309 m	−123	30. 0 NNW	9. 5
	. 64	11973 m	+370		
770, 26	3. 35	9947 t	− 38	29. 7 NNW	15. 1
	. 37	9262 t	−116	27. 5 NNW	15. 7
	. 39	9511 t	− 81	28. 8 NNW	15. 6
	. 41	10853	+ 30		
770, 25	6. 16	10574 m	− 59	17. 2 NNW	13. 0
	. 18	10692 m	− 36	17. 0 NNW	13 7
	. 20	10533 m	+ 23	20. 8 NNW	10. 8
	. 22	10205 m	+185		
	6. 34	10805 t	− 80	23. 0 NNW	12. 2
	. 36	11005 t	− 70		
July 20	8. 57	14658 t	+ 6	38. 2 NW	23. 1
766, 25	. 60	14220 t	+397		
NW 5					
July 22	6. 26	10669 t	+ 7	103. 5 WSW	24. 5
760, 28	. 28	10864 t	+ 63	94. 0 W	23. 1
N 3	. 30	9709 t	+333	115. 0 WSW	18. 0

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
July 22	.32	9971 t	−418			July 29	.17	11105 t	− 89	49.7 NW	18.0
760, 28	6.35	9980 t	+ 2	105.8 WSW	20.2	764, 32	.19	9451 t	−117	48.7 NW	18.3
N 3	.37	9731 t	− 42	107.5 WSW	21.7	NE 2	.21	9931 t	−221		
	.39	9833 t	+ 65				1.23	11572 t	− 85	46.0 NW	19.0
July 23	3.45	9675 t	+ 88	33.5 NNW	30.1		.25	11405 t	− 46	50.7 NW	18.7
763, 26	.47	7946 t	−304				.27	11026 t	−161	49.4 NW	19.0
NE 5	3.50	11770 t	+254	35.8 NW	36.4		.29	11216 t	− 69		
	.52	11342 t	+ 80			July 30	6.25	11066 t	− 54	52.7 NW	21.4
763, 26	4.02	12269 t	−186	39.0 NW	42.5	759, 29	.27	10948 t	− 60	51.8 NW	20.3
	.04	10139 t	− 91	38.5 NW	40.6	N 4	.29	10576 t	− 90		
	.06	12737 t	− 49			July 31	8.49	12846 t	− 82	62.7 WNW	27.4
763, 25	6.52	9937 t	− 49	52.2 NW	33.1	762, 24	.51	11877 t	− 68	62.2 WNW	28.9
	.54	9826 t	− 92	53.8 NW	33.0	NE 4	.53	11055 t	− 28		
	.56	8811 t	−151			Aug. 7	1.20	8670 t	+379	41.4 NW	3.6
	6.58	11937 t	−128	54.2 NW	37.7	762, 35	.22	9128 t	+169		
	.60	10700 t	−155			N 2	1.27	7689 t	+455	35.4 NW	4.7
July 24	6.55	11100 t	− 38	85.5 W	22.1		.29	8930 t	+393		
757, 22	.57	10839 t	− 39	87.0 W	21.8	Aug. 8	8.33	14098 m	+ 66	54.4 WNW	11.3
NW 5	.59	11203 t	− 81			760, 27	.35	15199 m	+ 40	48.2 WNW	10.6
July 27	8.19	12800 t	−136	73.4 WNW	20.0	NW 2	.37	13486 m	+263	50.7 WNW	12.9
763, 24	.21	12329 t	−142	87.0 W	21.4		.39	13473 m	+274	39.7 WNW	9.7
N 3	.23	12532 t	+181				.41	12108 m	+421		
July 28	3.37	9335 t	− 76	89.4 W	16.0		8.48	10712 t	+216	42.7 WNW	10.1
763, 30	.39	9397 t	−101	79.0 W	16.7		.50	10473 t	+197		
NE 2	.41	9973 t	+ 70				8.54	11033 m	+250		
	3.50	12158 t	+121	79.2 W	29.5	Aug. 10	9.02	9911 b	+296	46.5 WNW	1.2
	.52	13003 t	−119	80.0 W	28.4	764, 29	.04	9343 b	+440		
	.54	10741 t	+218			NE 3	9.08	9334 b	+344	93.9 W	2.8
July 29	8.55	9643 t	+164	44.7 NW	21.6		.10	8373 b	+472		
765, 26	.57	8814 t	−247	45.0 NW	23.6	Aug. 11	6.31	13750 t	+ 73	68.9 WNW	7.0
NE 1	.59	9970 t	−159	38.8 NW	23.3	762, 29	.33	14766 t	− 72	71.2 WNW	7.7
	.61	8594 t	−283			NW 2	.35	13454 t	+169	65.9 WNW	7.4
764, 32	1.15	11548 t	− 81	50.7 NW	18.5						

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Aug. 11	.37	14246 t	−265	71.2 WNW	6.4	Aug. 26	3.25	14161 t	− 26	108.4 WSW	36.3
762, 29	.39	15328 t	− 84			764, 27	.27	13812 t	+ 96	105.6 WSW	37.8
Aug. 15	9.58	12460 t	+ 40			N 5	.29	14694 t	+191		
766, 24	10.02	11486 t	− 59			766, 21	6.05	11038 t	+ 70	116.8 WSW	31.5
NW 2	3.31	11566 t	+ 9	116.4 WSW	14.9		.07	12231 t	+199		
							6.11	11809 t	+ 17	110.3 WSW	25.2
766, 29	.33	11303 t	+156	106.2 WSW	13.5						
	.35	11142 t	+201				.13	9551 t	+ 14	115.0 WSW	29.7
							.15	9497 t	− 10		
	3.38	9568 t	+170	102.6 WSW	11.0		6.17	12150 t	+ 14	111.7 WSW	30.9
	.40	10384 t	+ 85								
765, 27	6.23	12687 b	+ 47				.19	12239 t	− 78	112.3 WSW	31.3
	6.27	10949 m	+116	89.4 W	16.0		.21	12040 t	− 43		
	.29	11494 m	+616			Sept. 1	5.52	11072 t	+ 36	72.7 WNW	27.9
Aug. 17	1.35	10894 m	+ 96	75.7 WNW	52.3	768, 22	.54	11196 t	− 27	74.7 WNW	28.4
763, 26	.37	9532 m	− 30			NE 3	.56	11042 t	− 53	75.5 WNW	28.9
NE 3	1.41	11507 t	+ 85	53.2 NW	57.4						
	.43	9520 t	−121				.58	10806 t	+ 95	73.7 WNW	27.6
763, 25	3.44	10776 t	− 57	65.9 WNW	49.2	768, 21	6.00	10520 t	− 3		
	3.46	8756 t	− 16				6.04	10101 t	+109	71.8 WNW	27.7
	3.48	9528 t	− 42	67.5 WNW	49.4						
							.06	11313 t	+ 86	79.6 WNW	26.1
	.50	9225 t	+ 72								
763, 24	6.11	11134 t	− 34	71.8 WNW	55.4		.08	11097 t	+ 7		
	.13	13613 t	−199			Sept. 2	8.41	12179 t	+ 36	104.4 WSW	7.1
	6.37	9036 b	+ 3	70.7 WNW	54.4	770, 17 W 4	.43	12007 t	+ 7		
	.39	9571 b	+165	68.8 WNW	53.3						
	.41	9232 b	−164			Sept. 4	5.43	11351 b	− 35	93.3 W	28.9
Aug. 20	1.05	8012 t	+ 88	73.4 WNW	18.3	766, 20	.45	9350 b	− 8	95.6 W	27.9
768, 24	.07	10104 t	+238	67.5 WNW	21.2	NE 4	.47	10026 b	− 19		
NE 4	.09	8282 t	+166				5.49	9206 b	− 43	97.9 W	25.3
Aug. 21	8.08	11815 m	− 25	45.4 NW	48.9						
764, 19	.10	9688 m	+ 69				.51	8617 b	+ 72	99.8 W	24.8
W 3	8.15	12116 t	− 58	44.6 NW	49.4		.53	8784 t	+136		
	.18	11896 t	+ 98				5.56	8404 t	+ 79	97.4 W	25.5
	8.22	14087 t	+ 84								
	8.29	14211 t	−250	25.1 NNW	53.2		.58	8789 t	+112	97.2 W	25.6
	.31	14683 t	−247				6.00	8816 t	+107		
762, 27	1.26	9098 t	+ 71				6.03	9282 t	+ 39	109.4 WSW	42.2
W 3							.05	8019 t	+ 75		

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Sept. 16	6.03	9226 t	+246		
760, 22	6.06	10877 m	+118	54.4 NW	37.6
E 3	.08	10369 m	+ 88	54.2 NW	35.3
	.10	11119 m	+ 75		
Sept. 18	1.44	12219 m	+319	65.0 WNW	29.2
761, 27	.47	10651 m	+117		
NE 5	1.54	11005 b	+130	75.9 WNW	31.5
	.56	10969 b	+217		
Sept. 19	8.20	15072 t	−359	90.4 W	26.9
757, 24	.22	15099 t	+186	91.0 W	24.3
NW 5	.24	15375 t	−536		
753, 34	1.11	12340 t	+183		
	1.30	10394 m	−132	62.2 WNW	26.2
	.32	8331 m	−147		
Sept. 21	8.35	10159 m	+169		
764, 13	8.48	11060 t	+ 39	80.4 W	40.7
NE 2	.50	9976 t	−353		
Sept. 24	5.14	11987 t	− 71	25.4 NNW	34.9
770, 16	.16	11165 t	− 21	26.7 NNW	33.5
NE 3	.18	12427 t	− 46	25.4 NNW	34.8
	.20	10680 t	−123		
	5.25	9164 t	−383	25.4 NNW	29.7
	.27	9603 t	− 38	26.4 NNW	30.7
	.29	9789 t	+171	24.7 NNW	29.9
	.31	10783 t	+ 87	25.2 NNW	32.4
	.33	11509 t	+ 47	24.7 NNW	28.1
	.35	13048 t	+ 92	23.4 NNW	36.4
	.37	10118 t	+119		
Sept. 25	8.39	10291 t	+ 62	72.2 W	15.7
771, 12	.41	12767 t	+267		
NW 5	8.47	10916 t	+ 50	52.4 NW	17.0
	.49	11055 t	+ 80	52.5 NW	21.1
	.51	11424 t	− 72		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Sept. 25					
769, 23	1.08	11164 t	+140		
	1.11	12076 t	+ 25	77.0 WNW	18.4
	.13	11715 t	+145	81.7 W	18.8
	.15	12416 t	+291	82.5 W	18.9
	.17	12669 t	+ 60	76.0 WNW	18.5
	.19	12867 t	−123		
	1.29	9679 t	+209	80.0 W	16.4
	.31	10018 t	+136		
	1.40	11112 t	+ 44	88.5 W	20.4
	.42	10803 t	+ 8	90.0 W	19.4
	.44	10825 t	+113		
Sept. 26	1.44	11519 t	+ 30	111.9 WSW	30.3
769, 23	.46	10744 t	+287	112.9 WSW	32.5
N 5	.48	10378 t	+ 72		
769, 21	5.07	10838 t	+160	108.0 WSW	30.5
	.09	9912 t	+145	109.5 WSW	32.0
	.10	11285 t	+ 65	106.2 WSW	29.0
	.12	11121 t	− 37	102.0 WSW	29.0
	.14	9761 t	+117		
	5.18	9975 t	+137	111.5 WSW	25.8
	.20	9461 t	+164	111.2 WSW	26.3
	.22	9894 t	+ 67		
	5.26	12969 b	− 98	125.9 SW	38.3
	.28	9882 b	+ 91		
Oct. 1	8.41	10864 t	+178		
760, 16	9.16	9311 b	+ 52	113.2 WSW	12.8
NE 4	.18	8947 b	+ 69	114.0 WSW	13.3
	.20	8650 b	+ 10		
Oct. 2	9.27	8125 b	+ 66	117.0 WSW	15.3
760, 14	.29	8448 b	− 10	114.5 WSW	15.9
NE 3	.31	7967 b	+ 28	122.4 WSW	14.9
	.33	8067 b	− 65		

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Oct. 2						Oct. 16	8. 26	9814 t	−123	79. 2 W	22. 2
762, 16	5. 07	7371 t	+157	107. 7 WSW	1. 5	756, 11	. 28	8614 t	− 42	89. 8 W	24. 5
NE 3	. 09	7624 t	+ 32	127. 0 SW	2. 0	NE 3	. 30	8377 t	− 58	86. 2 W	21. 8
	. 11	8393 t	+ 21	135. 9 SW	1. 9		. 32	10629 t	+207		
	. 13	8707 t	+ 29				8. 35	9906 t	+ 39	87. 3 W	27. 4
	5. 15	7508 t	+ 80	131. 8 SW	2. 9		. 37	9177 t	+ 22	78. 0 WNW	25. 7
	. 17	7522 t	+169				. 39	10676 t	− 60		
	5. 19	7776 t	+ 77	132. 3 SW	2. 9	Oct. 20	8. 53	9840 t	+ 89	91. 2 W	36. 8
	. 21	7583 t	+159			764, 9	. 55	11303 t	+ 1		
	5. 23	7053 t	+155	113. 9 WSW	2. 2	N 7					
	. 25	7235 t	+177			Oct. 21	8. 50	9350 t	+ 67		
Oct. 7	1. 22	10360 t	+ 78	135. 3 SW	43. 3	760, 12 N 4					
764, 14	. 24	9468 t	+237	139. 1 SW	44. 4	Oct. 29	1. 09	10504 t	+ 51	42. 7 NW	28. 3
NE 7	. 26	8909 t	+162			769, 22	. 11	10448 t	+ 63	45. 5 NW	28. 3
	1. 28	9695 b	+ 89	139. 2 SW	47. 1	W 2	. 13	9687 t	−120		
	. 30	9303 b	+106	139. 0 SW	42. 9		1. 16	11730 b	+ 30	46. 9 NW	27. 9
	. 32	9345 b	+ 8				. 18	10372 b	+124	44. 4 NW	28. 2
	1. 35	9386 b	+ 32	139. 2 SW	40. 6		. 20	10958 b	+114	47. 5 NW	27. 9
	. 37	8166 b	+124	139. 4 SW	41. 6		. 22	11492 b	+132		
	. 39	8053 b	− 77				1. 24	11536 t	+100	38. 7 NW	30. 0
	1. 50	10222 m	− 18				. 26	10456 t	+ 69	41. 9 NW	30. 7
Oct. 15	8. 10	10565 m	+215	359. 4 N	19. 8		. 28	12146 t	+132		
758, 12	. 12	11656 m	+ 93	5. 4 N	24. 2	Oct. 31	3. 03	11444 t	+ 45	98. 8 W	58. 6
NE 6	. 14	9980 m	+ 45	358. 5 N	23. 1	760, 20	. 05	12603 t	+ 54	97. 9 W	59. 7
	. 16	12370 m	+127								
	8. 20	10282 t	+ 33	5. 2 N	28. 2	NW 3	. 07	10597 t	+186	97. 4 W	58. 9
	. 22	9997 t	+ 58	3. 0 N	28. 0		. 09	10398 t	− 14		
							3. 12	11437 t	−207	96. 5 W	58. 7
	. 24	9420 t	− 41	5. 0 N	27. 7		. 14	13442 t	−305		
	. 26	11052 t	−102				3. 18	12270 t	−541	97. 6 W	58. 0
	8. 42	12105 t	−142	9. 4 N	25. 1		. 20	10226 t	+211	96. 7 W	57. 2
	. 44	8378 t	− 2				. 22	12204 t	−385	91. 5 W	49. 0
Oct. 16	8. 18	11485 b	+105	83. 6 W	17. 7		. 24	10494 t	−326	99. 7 W	49. 9
756, 11	. 20	8607 b	−160	85. 2 W	23. 5		. 26	9038 t	−418		
NE 3	. 22	8579 b	−120								

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Nov. 2	1.16	12532 t	−311	89.7 W	54.0	Nov. 9	3.39	8430 t	−208	102.7 WSW	46.4
768, 22	.18	14169 t	+ 22	80.9 W	46.9	766, 4	.41	9756 t	+112		
NW 6	.21	13106 t	+258	78.2 W	50.5	NE 3	3.44	11728 m	+117	105.7 WSW	57.0
	.23	15810 t	+369				.46	11218 m	+ 45		
	1.28	10474 m	−470	82.0 W	35.5		3.55	7402 t	+180	108.5 WSW	37.2
	.30	10586 m	−121				.57	7970 t	+ 26		
	1.34	12103 m	−230	76.4 WNW	35.8		4.22	7258 t	+ 46		
	.36	12178 m	+ 62	73.8 WNW	38.5	Nov. 14	8.40	8216 t	+ 43	64.0 WNW	55.7
	.38	11080 m	−249			771, 1	.42	8806 t	+ 78		
	4.00	7777 t	+105	25.8 NNW	31.4	NE 6	1.27	13419 t	+216	60.5 WNW	55.9
768, 16	.02	8312 t	+582	31.5 NNW	27.4		.29	11032 t	+161	57.2 WNW	43.4
	.04	8322 t	+273	17.2 NNW	30.7		.31	12810 t	+587		
	.07	9260 t	−196	27.0 NNW	29.3		1.33	8260 t	+180	59.1 WNW	31.4
	.09	8908 t	+107	26.0 NNW	29.8		.35	8380 t	+171	56.9 WNW	35.2
	.11	9100 t	+121	27.7 NNW	30.1		.37	8364 t	+ 37		
	.13	7662 t	+109	23.7 NNW	30.5	Nov. 16	8.26	7342 m	+ 75	47.9 NW	15.1
	.15	8274 t	+422	27.1 NNW	29.6	770, 6	.28	9870 m	− 74		
	.17	8606 t	+111	26.9 NNW	26.7	NW 5	8.31	9076 m	+ 29	40.1 NW	17.6
	.19	9658 t	+484				.33	9423 m	− 90		
Nov. 3	1.17	8778 b	+ 11	102.2 WSW	34.6		8.35	9570 m	+ 75		
769, 21	.19	9062 b	− 33				8.38	9789 b	+ 22	48.1 NW	17.6
W 3	1.23	8812 b	+126	104.2 WSW	33.9		.40	9006 b	− 1	52.0 NW	16.4
	.25	9433 b	−129	104.0 WSW	34.7		.42	9591 b	+141		
	.27	8881 b	+ 6				8.45	9718 t	+156	51.7 NW	15.2
Nov. 7	4.03	10103 b	+389	109.5 WSW	32.8		.47	9974 t	− 27		
760, 16	.05	9366 b	− 34	114.0 WSW	32.7	769, 18	4.14	9964 t	+ 12		
N 3	.07	9588 b	+ 51	111.7 WSW	31.5		4.17	9925 t	+ 40	81.3 W	16.1
	.09	9298 b	− 25				.19	9564 t	+ 73	78.0 WNW	13.9
	4.24	9554 t	− 71				.21	9359 t	− 32	67.2 WNW	15.3
							.23	9482 t	− 32	79.4 WNW	13.2
							.25	9380 t	+105	58.9 WNW	13.8
							.27	9795 t	+ 8		

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Nov. 17	8. 17	10172 t	+ 90	91. 5 W	13. 6
770, 5	. 19	10320 t	− 67	89. 9 W	13. 9
NE 3	. 21	9792 t	− 97	92. 1 W	13. 8
	. 23	10127 t	− 8	91. 4 W	13. 0
	. 25	10982 t	−275	91. 9 W	13. 9
	. 27	11099 t	+ 66		
	8. 30	8076 m	+155	101. 0 W	11. 6
	. 32	9128 m	+ 31	95. 4 W	11. 6
	. 34	9896 m	−235	92. 9 W	11. 2
	. 36	9791 m	+ 14		
	1. 14	9540 m	+175	105. 2 WSW	15. 1
	. 16	9772 m	+ 77	105. 2 WSW	15. 6
	. 18	10031 m	+ 94		
Nov. 18	4. 05	11806 m	− 38		
768, 20	4. 10	8897 t	−317	40. 0 NW	19. 2
NW 2	. 12	10199 t	−394		
	4. 15	11615 m	−488	34. 2 NW	19. 0
	. 17	10479 m	−112		
	4. 34	11181 t	+ 98	32. 9 NW	26. 3
	. 36	11062 t	+ 96		
	4. 38	12170 t	+173	37. 2 NW	27. 5
	. 40	11413 t	+ 63	45. 4 NW	25. 7
	. 42	11220 t	+ 36		
Nov. 25	1. 07	11722 m	+293	43. 7 NW	18. 4
773, 19	. 09	12118 m	− 8	45. 9 NW	17. 6
SW 3	. 11	11416 m	+ 29	45. 0 NW	19. 3
	. 13	10892 m	+ 40		
	1. 21	9567 b	+ 54	44. 5 NW	14. 6
	. 23	10643 b	+ 53	44. 7 NW	14. 6
	. 25	10110 b	−138	44. 5 NW	15. 6
	. 27	8042 b	−129	45. 1 NW	15. 6
	. 29	8974 b	− 76		
	1. 32	9168 b	+442		

Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Nov. 25					
773, 17	4. 00	11941 t	+215	41. 5 NW	17. 7
	. 02	12032 t	+192		
	4. 07	11741 t	+ 48	22. 8 NNW	22. 0
	. 11	12048 t	−203	23. 2 NNW	21. 7
	. 13	12896 t	+134		
	4. 16	12924 t	+ 67	26. 4 NNW	23. 8
	. 18	12033 t	+ 21	24. 2 NNW	22. 6
	. 20	12357 t	+ 81		
	4. 29	13258 t	+ 35	26. 9 NNW	21. 4
	. 31	11882 t	+ 22		
Nov. 27	1. 43	12499 t	+211	96. 8 W	30. 1
764, 23	. 46	12271 t	+149	109. 5 WSW	27. 5
NW 8	. 48	11971 t	+288		
	1. 54	10872 t	+ 13	105. 2 WSW	23. 4
	. 56	9814 t	+165		
764, 21	3. 37	11809 t	+112	111. 0 WSW	21. 4
	. 39	11144 b	+181		
	3. 43	9052 b	+ 56	106. 4 WSW	24. 0
	. 45	9167 b	+ 60	138. 5 WSW	20. 2
	. 48	9822 b	− 26		
	3. 57	13721 m	−117	111. 7 WSW	22. 8
	. 59	12305 m	−182	115. 9 WSW	22. 3
	4. 01	11852 m	+ 88	112. 9 WSW	27. 2
	. 03	10935 m	+ 23		
	4. 10	10171 m	+125	96. 8 W	20. 5
	. 12	11675 m	+210		
Dec. 1	1. 13	10426 t	+204		
774, 2	1. 25	8648 t	+ 90	113. 4 WSW	68. 1
NE 6	. 27	7993 t	− 78		
Dec. 4	4. 25	7976 b	+198	73. 0 WNW	41. 0
768, 1	. 27	7508 b	−143		
E 4					
Dec. 5	8. 25	9691 m	+ 66	98. 9 W	21. 6
767, 4	. 27	10779 m	+108	95. 5 W	22. 8
NW 3	. 29	9241 m	+ 66		

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Dec. 5	8.33	10310 t	+ 90	85.0 W	23.5	Dec. 19	4.01	8832 t	+113	86.9 W	51.8
767, 4	.35	8626 t	+ 9			768, 1	.03	8210 t	+ 79		
NW 3	8.38	10421 m	− 39	95.5 W	27.2	NE 5	4.12	8949 t	+ 38	88.9 W	54.8
	.40	9843 m	− 55	98.0 W	25.7		.14	9029 t	+ 40	88.1 W	55.4
	.42	9540 m	+ 45				.16	9024 t	+ 27		
	8.46	8639 m	+195	92.7 W	25.3		4.19	10695 t	+111	85.5 W	61.6
	.48	8913 m	+ 99				.21	7868 t	− 4		
766, 8	4.32	9182 m	+ 61	112.2 WSW	33.8		4.23	8569 b	− 44		
	.34	9321 m	− 30				4.27	8493 t	+122	80.5 W	80.2
Dec. 7	1.26	9737 t	+243	89.2 W	47.7		.29	8230 t	−124		
766, 2	.28	8379 t	+ 78	90.3 W	47.8	Dec. 29	1.21	9406 t	+257	97.7 W	23.9
NE 1	.30	9115 t	− 27	89.0 W	47.7	775, 4	.23	9077 t	+122	99.4 W	24.3
	.32	8084 t	− 29			NW 4	.25	8945 t	+ 67	102.7 WSW	22.9
Dec. 9	4.00	7883 t	+ 42	53.9 NW	39.0		.27	10018 t	+ 55		
757, 10	.02	8361 t	+ 66	52.9 NW	43.0		1.32	9092 b	+157	100.4 W	23.6
NE 10	.04	7442 t	−125				.34	8805 b	−195		
	4.07	8781 t	+110	51.7 NW	45.0		1.42	11023 t	− 1	104.7 WSW	28.5
	.09	9278 t	+ 26	52.7 NW	46.8		.44	12145 t	+ 50		
	.11	8390 t	+ 26			775, 2	4.44	6646 t	+136		
Dec. 16	1.16	9093 t	− 13				4.46	7908 t	− 28	102.2 WSW	20.5
760, 4	1.19	7154 t	+ 68	143.6 SW	5.8		.48	7530 t	− 79		
E 10	.21	6616 t	+112				4.50	7614 b	+ 18		
Dec. 17	1.23	12006 t	− 36	75.5 WNW	43.0	1897 Jan. 2	11.01	9229 t	− 24	79.3 WNW	10.4
769, 6	.25	11079 t	+ 88			779, 5	.03	8580 t	− 25		
NE 5	1.27	9050 m	− 34	78.0 WNW	38.2	SW 3	11.06	9615 t	+120	73.2 WNW	11.2
	.29	8456 m	+144	76.1 WNW	37.5		.09	10909 t	+ 51	67.0 WNW	13.2
	.31	8137 m	+ 61				.11	9113 t	+ 23	68.5 WNW	13.6
	1.33	8370 t	+137	76.1 WNW	34.7		.13	10968 t	+ 85		
	.35	8438 t	+ 50	75.5 WNW	36.2		11.16	8715 t	+ 26	69.1 WNW	10.1
	.37	7971 t	− 17	76.7 WNW	36.9		.18	7828 t	+ 31		
	.39	8157 t	+ 28	76.5 WNW	39.3		11.24	9828 t	+236		
	.41	7658 t	+ 93			Jan. 7	9.45	8659 m	+131	117.4 WSW	23.8
						772, 4	.47	8187 m	+110		
						NE 6	9.52	8546 m	+ 56	117.7 WSW	22.3

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Jan. 7	.54	8269 m	+ 93	118.4 WSW	21.6	Feb. 3	8.50	7739 t	+ 2	286.2 ENE	1.6
772, 4	.56	7835 m	− 5								
NE 6	10.01	8349 m	+157	118.1 WSW	22.0	758, 1	.52	7898 t	+ 31	288.7 ENE	1.6
	.03	8868 m	+222			NE 6	.54	7863 t	+ 82	293.0 ENE	1.7
	10.06	7926 t	+ 3	119.7 WSW	20.0						
							.56	7937 t	+ 20	296.9 ENE	2.0
	.08	8212 t	+ 50	109.2 WSW	21.5		.58	7956 t	+ 41		
	.10	7579 t	+297				1.07	8500 t	− 37	276.7 E	1.7
771, 1	1.32	8044 t	+ 56	126.0 SW	21.3						
	.34	7643 t	+ 74			759, 3	.09	7957 t	0	266.7 E	2.1
	1.41	7340 t	+ 18	123.5 SW	19.6						
	.43	6769 t	− 6				.11	8110 t	+ 43	263.5 E	2.1
	1.46	8680 t	− 28	125.2 SW	22.6		.13	8380 t	+105		
							1.24	7298 m	+ 39	105.2 WSW	5.0
	.49	8626 t	0	125.1 SW	23.5		.26	7520 m	+158		
	.51	8279 t	+ 54				1.34	6152 b	+170	113.4 WSW	6.0
Jan. 8	3.23	6559 t	− 32	32.4 NNW	2.5		.36	6465 b	+125		
							1.42	8100 t	+ 43	221.7 SE	3.1
771, 1	.25	7160 t	0	28.5 NNW	2.8		.44	8350 t	+139		
S 6	.27	7530 t	+ 83								
	3.32	7585 b	+134	31.9 NNW	2.9	Feb. 19	8.43	6256 t	+ 82	70.1 WNW	60.4
	.34	7413 b	+164	27.4 NNW	2.6	770, 1	.45	10239 t	+ 92	69.6 WNW	66.2
	.36	7278 b	+ 66			NE 4	.47	10006 t	−125	68.5 WNW	65.6
Jan. 25	4.02	8286 b	− 36	92.7 W	78.0		.49	8666 t	− 45		
						Feb. 23	2.43	11850 t	+320		
765, 10	.04	8841 b	+296	91.7 W	78.9	759, 2	2.48	7638 t	+ 16	61.2 WNW	67.6
NE 5	.06	8997 b	+186			NE 5	.50	7148 t	+ 11		
Jan. 26	2.47	9578 t	+ 44	88.2 W	64.8	Mar. 2	1.15	7498 t	+ 60	91.0 W	23.4
765, 6	.49	8616 t	+ 40								
NE 8	2.56	8362 t	+ 10	90.3 W	46.4		.17	8089 t	+ 64	91.8 W	24.4
							.19	8074 t	− 18		
	.58	9310 t	+232	89.9 W	48.3		.21	8136 t	− 17	92.8 W	25.0
	3.00	8184 t	+188								
Feb. 1	4.06	11310 t	+164	120.7 WSW	34.2	767, 17	.23	7270 t	+ 78	94.2 W	23.8
771, 2	.08	10334 t	+ 93	120.2 WSW	34.6	W 2	.25	7356 t	+ 97	95.2 W	23.3
							.27	7284 t	+ 51	94.5 W	23.8
SW 5	.10	9714 t	+ 23	122.7 WSW	34.1		.29	7578 t	+128		
	.12	10977 t	+122								
	4.21	9955 t	+ 32	123.6 WSW	35.4	766, 15	5.13	7707 b	− 12	103.0 WSW	25.1
	.23	9628 t	+125				.15	7418 b	+ 63		

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Mar. 2	5.19	7810 b	+ 51	100.7 W	27.2	Mar. 13	.32	10374 t	− 3		
776, 15	.21	6745 b	+ 12			768, 6	5.34	10779 t	+ 63	86.6 W	81.2
W 2	5.28	9199 t	+ 20	94.6 W	25.7	NE 4	.36	12103 t	− 65		
	.30	8709 t	+ 88				5.38	8160 t	− 75		
							5.47	7610 t	+119	81.1 W	57.7
Mar. 8	2.10	7973 t	+ 32				.49	8617 t	−168		
774, 3	2.15	7560 t	+245			Mar. 15	8.47	8672 t	− 18		
W 4	2.17	6476 t	+ 26			773, 3	8.53	8800 t	+ 32		
	2.31	8026 b	− 46			NE 3	8.55	11598 t	+ 1	93.3 W	83.7
	2.33	8050 b	+197								
	6.01	12742 t	+ 41	48.6 NW	30.4		.56	11850 t	+ 3		
	.04	11570 t	+ 50				9.02	9743 t	+ 50	96.2 W	77.4
Mar. 11	9.53	10182 t	+ 14	85.6 W	77.1		.04	9064 t	− 3	94.1 W	71.6
767, 3	.55	11826 t	−105				.06	11274 t	+151		
NE 4	9.58	11043 t	+170	83.9 W	82.2		9.15	9850 t	− 2		
	10.00	12452 t	+ 17			773, 8	1.20	11048 t	− 97	96.1 W	76.0
	10.05	9965 t	+286				1.22	8770 t	− 25		
	10.10	10804 t	+ 32	86.4 W	71.0		1.25	11930 b	− 71	95.4 W	79.6
	.12	9398 t	−120				.27	8318 b	+119		
	10.17	10009 t	+179	88.3 W	60.5		1.31	9710 t	−283	96.8 W	86.7
	.19	8716 t	− 11				.33	13077 t	214		
766, 14	2.01	10599 t	+ 58	104.7 WSW	57.9		1.37	10874 t	+222	97.8 W	86.3
	.03	10879 t	−158				.39	11290 t	+235		
Mar. 12	10.43	10134 t	+ 19				1.47	9230 t	+210	97.1 W	67.9
753, 12											
N 3							.49	9036 t	+263		
Mar. 13	12.51	10470 t	+131	88.7 W	73.9	Mar. 16	8.44	9588 t	− 29	77.2 WNW	61.6
	.53	11991 t	+294			777, 2	.46	9914 t	− 48		
768, 8	12.56	9791 t	+ 24	90.8 W	70.7	NE 4	8.47	10396 t	− 25	77.8 WNW	66.2
NE 4	.58	9860 t	−159				.49	9499 t	− 6		
	1.03	14327 t	+135				8.51	9352 t	+ 62	81.1 W	69.3
	1.06	12296 t	−195								
	1.08	7366 t	+109	78.7 WNW	37.5		.53	9088 t	− 34	76.4 WNW	68.1
	.10	9188 t	+269				.55	11954 t	+125		
	1.15	7842 t	+ 99	93.0 W	54.1		8.59	13358 t	−103	79.8 WNW	78.7
	.17	8764 t	+ 39								
768, 6	5.25	9920 t	+ 66	87.6 W	70.4		9.01	9760 t	− 37	77.9 WNW	79.2
	.27	9903 t	− 11				.03	12408 t	−294		
	5.30	11340 t	− 17	89.2 W	80.0	777, 7	1.29	9325 t	0	67.4 WNW	53.4

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Mar. 16	.31	7010 t	+104	68.9 WNW	51.5	Mar. 27	5.50	6540 t	−15	30.4 NNW	17.5
777, 7	.33	7371 t	+ 22								
NE 4	1.41	7653 t	+ 32	70.2 WNW	52.5	762, 6	.52	6773 t	− 28	26.4 NNW	19.2
	.43	9003 t	−110			E 3	.54	6767 t	+ 42		
777, 5	5.32	10056 t	+ 24	62.9 WNW	76.1	Mar. 29	1.44	11681 m	−146		
	.34	12144 t	+124			770, 13	1.51	10448 b	+209	61.5 WNW	59.8
	5.36	11474 t	+ 5	65.9 WNW	73.5	NE 5	.53	9860 b	−175		
	.38	9224 t	+ 15				1.56	10404 b	+117	63.5 WNW	57.6
	5.39	9680 t	− 59	63.4 WNW	77.0						
	.41	11192 t	+ 4				.58	9484 b	− 22	63.4 WNW	56.3
	5.44	10627 t	− 15	69.5 WNW	68.3		2.00	10644 b	+ 33		
	.46	9768 t	− 30				2.03	10359 t	+ 10	65.9 WNW	50.6
	5.48	9064 t	− 23	66.4 WNW	56.7		.05	7825 t	+ 48		
	.50	7159 t	−142				5.28	10383 t	+ 58	80.0 WNW	50.1
Mar. 17	8.55	9776 t	+ 91	62.3 WNW	50.7						
778, 0	.57	9943 t	− 22	59.2 WNW	52.9		.30	11367 t	−148	76.1 WNW	48.9
							.32	11308 t	+ 16		
W 4	.59	8505 t	− 8	66.0 WNW	50.9		5.34	10098 t	+112	77.7 WNW	48.5
	9.01	8856 t	− 76								
	9.05	9858 t	− 33	63.1 WNW	55.5		.36	11275 t	− 4	78.7 WNW	48.8
	.07	10120 t	+ 14				.38	10924 t	− 3		
	9.09	9065 t	− 24				5.41	11245 m	+ 16	76.2 WNW	50.5
	9.16	9752 t	− 69								
	9.20	8408 t	− 37	66.3 WNW	47.2		.43	11927 m	+ 54		
	.22	9890 t	−309				5.45	10107 t	− 12	76.1 WNW	46.4
Mar. 22	8.39	8748 t	−132	86.1 W	34.1		.47	9690 t	− 49		
760, 10	.41	8503 t	−236	82.9 W	33.3	Mar. 30	8.35	8085 t	+ 86	58.5 WNW	26.8
NW 4	.43	8406 t	−154								
758, 25	1.13	7879 t	+ 62	89.1 W	16.9	770, 6	.37	9816 t	+ 23	57.7 WNW	24.2
	.15	6377 t	− 38			W 4	.39	9490 t	+ 1		
							8.41	9598 t	+ 35	64.6 WNW	25.1
Mar. 25	1.43	5430 t	− 31	86.5 W	14.6		.43	8877 t	−104		
752, 7	.45	6008 t	+131				8.45	9772 t	+ 36	59.7 WNW	25.9
NE 9											
							.47	9296 t	+ 10		
Mar. 26	1.18	7594 t	+ 38	61.9 WNW	8.6		8.50	9782 t	− 4	60.3 WNW	26.4
757, 6	.20	8225 t	+ 52	59.5 WNW	8.0						
							.52	10283 t	+ 34	59.4 WNW	28.0
NE 7	.22	8347 t	− 66				.54	10844 t	+127		
	1.24	7572 t	− 35	56.0 WNW	8.6	767, 18	1.30	9525 m	+ 14	52.9 NW	21.4
	.26	7402 t	+ 26	56.1 WNW	7.7						
	.28	7079 t	+136				.32	9787 m	0	52.6 NW	19.3

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Mar. 30	.34	9220 m	+ 79	53.6 NW	21.1	Apr. 1	.03	10596 b	+194		
						772, 10	2.05	9900 t	+104	43.7 NW	44.2
767, 18	.36	9548 m	−132	53.9 NW	20.3						
						SW 8	.07	9707 t	0	40.7 NW	48.1
	.38	7114 m	+284								
							.09	9476 t	+ 34		
	1.44	9261 b	−100	46.1 NW	23.0						
						773, 9	6.00	11976 t	+ 57	58.4 WNW	48.8
	.46	9616 b	− 41	27.7 NNW	23.3						
							.03	10682 t	− 10	56.3 WNW	43.9
	.48	10694 b	− 60	48.9 NW	23.2						
							.05	9839 t	+ 56		
	.50	9425 b	+ 37	40.8 NW	23.4		6.07	10940 m	+ 88	57.0 WNW	45.6
	.52	10491 b	− 62				.09	10482 m	−102	60.0 WNW	47.5
767, 15	5.38	8229 t	− 50								
	5.45	9386 t	+ 13	47.7 NW	24.3		.11	10264 m	−127	60.5 WNW	46.9
	.47	8502 t	5				.13	10212 m	−301		
	5.51	7544 t	−150	58.8 WNW	18.5	Apr. 2	8.36	9046 t	− 13	61.0 WNW	22.2
	.53	8616 t	− 81			771, 6	.38	8967 t	+ 24	60.2 WNW	22.9
	5.55	6827 t	+ 54	62.8 WNW	19.0						
						NE 3	.40	8501 t	+ 2	59.3 WNW	22.9
	.57	7102 t	+ 36								
	6.03	7032 t	+ 42				.42	8358 t	+ 65	61.4 WNW	22.9
	6.05	6830 t	+ 29	62.4 WNW	18.6						
							.44	7914 t	+ 37		
	.07	6868 t	+ 13				8.51	9130 b	+ 68	58.0 WNW	24.4
Mar. 31	1.12	8470 b	+ 49	64.0 WNW	30.7						
							.53	8838 b	+ 67		
769, 13	.14	8758 b	−169	62.1 WNW	31.3		9.07	9006 t	+ 21	59.9 WNW	22.9
S 4	.16	9451 b	+ 82								
							.09	8585 t	+ 28	58.6 WNW	20.4
	1.25	8750 t	− 47	58.7 WNW	34.2						
							.11	9223 t	+ 2		
	.27	10364 t	− 28	56.3 WNW	30.2	768, 16	1.41	9140 b	+ 29		
	.30	9688 t	+ 35				1.43	7988 t	+ 21		
	1.34	10958 t	+ 33	57.3 WNW	40.2		1.49	8890 t	+197	72.0 WNW	20.3
	.37	13838 t	+ 15	51.7 NW	41.9		.51	7486 t	− 15		
	.39	11020 t	+179				1.53	8556 t	+ 3	72.7 WNW	22.6
	1.43	6766 t	− 54								
769, 12	5.39	7863 t	+ 30	54.7 NW	48.0		.55	9872 t	+ 5	74.0 WNW	23.9
	.41	8090 t	+ 31								
							.57	11094 t	+ 57		
	5.43	8116 t	+ 50	52.1 NW	43.8						
	.45	8646 t	+108				1.59	8622 b	+ 82	75.5 WNW	20.8
Apr. 1	1.56	10249 t	+ 80	38.4 NW	49.4		2.01	9162 b	+117		
772, 10	.58	11499 t	+164			767, 15	5.42	8339 t	+ 32		
SW 8	2.01	9148 b	+ 85	40.5 NW	45.0		5.46	7714 m	+ 92	72.5 WNW	16.4

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Apr. 2	.48	8156 m	+205	62.8 WNW	17.1	Apr. 16	1.47	11451 t	− 86	121.9 WSW	38.7
767, 15	.50	8400 m	+ 29			760, 16	.49	10980 t	− 89	115.5 WSW	43.7
Apr. 5	5.47	7250 t	− 52	122.8 WSW	40.1	NE 3	.51	10232 t	+123		
754, 19	.49	7130 t	− 24			759, 14	6.05	10273 t	+144	123.7 WSW	63.5
NW 3							.07	11093 t	+ 81		
Apr. 6	8.40	9697 t	− 90	114.5 WSW	60.2		6.15	10008 t	−239	127.3 SW	60.5
757, 12	.42	10296 t	−239				.17	10582 t	− 90		
N 2	8.56	10266 b	+ 62				6.20	11172 t	+ 39	127.7 SW	65.9
	9.00	8492 t	− 56	112.9 WSW	49.2		.22	10552 t	−101		
	.02	7964 t	− 47			Apr 21	1.07	9660 b	−234		
Apr. 9	5.57	8554 t	+ 45	68.1 WNW	11.7	776, 14	1.10	11439 t	−342	34.3 NW	32.1
750, 13	.59	9119 t	+ 40			W 3	.12	8815 t	−164		
N 5	6.05	9302 t	+ 19				1.14	7086 b	−165	37.1 NW	21.9
Apr. 10	8.43	9790 t	+155				.16	8076 b	−125		
761, 6	8.52	9960 b	+ 49				1.19	9596 t	+120	31.7 NNW	29.1
763, 9	1.35	5950 t	−232								
NE 5	1.41	5280 b	− 48				.21	9118 t	+ 43	33.7 NNW	28.5
	2.03	4982 t	− 80				.23	8248 t	+148		
	2.11	5983 m	− 24	65.5 WNW	47.8		1.24	9708 m	−240		
	.12	5875 m	+ 32			776, 12	5.56	10016 m	+ 22	28.2 NNW	24.5
Apr. 13	1.18	11528 m	+ 23	103.2 WSW	34.1		.58	9500 m	− 37	27.5 NNW	24.0
772, 13	.20	11155 m	− 62	104.7 WSW	33.8		6.00	10088 m	+ 32		
NW 5	.22	12459 m	− 4				6.04	10436 t	+ 2	27.6 NNW	26.1
	1.24	10540 t	−262	96.8 W	27.2		.06	9984 t	+ 76	27.0 NNW	26.9
	.26	11386 t	+ 42	109.1 WSW	29.3		.08	10096 t	+ 87		
	.28	9668 t	+ 56				6.14	11532 t	−135	24.5 NNW	29.0
	1.30	11381 t	− 63	96.3 W	29.5		.16	12355 t	− 48		
							6.21	11428 t	− 1	27.4 NNW	27.4
	.32	11092 t	+ 59	96.6 W	26.3		.23	11143 t	− 12		
	.34	11330 t	+103			Apr. 23	1.02	8537 t	+108		
	1.35	10513 t	+125				1.06	8492 t	+ 45		
769, 13	5.50	10354 t	−144	117.5 WSW	30.7	769, 24	1.11	9126 t	+ 15	73.0 WNW	9.8
	.52	10062 t	− 86				.13	9320 t	−106		
	5.58	9620 t	+ 78	114.1 WSW	25.7	NW 4	1.30	9268 t	+ 18		
	6.00	8684 t	− 7				.32	9758 t	+103	76.7 WNW	11.0
	6.09	9366 t	− 12	110.9 WSW	24.8		.34	9990 t	+127	93.5 W	10.3
	.12	10146 t	−198								

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
Apr. 23	1.40	9370 t	+ 18	97.0 W	10.1	Apr. 28	6.20	9229 t	+178		
769, 24	.42	9510 t	+ 17			760, 17	6.23	8001 t	− 73	336.7 NNE	43.8
768, 21	6.05	12903 t	+ 98	45.1 NW	17.0		.25	10248 t	− 5		
	.07	12748 t	+ 7	39.1 NW	16.0	Apr. 29	8.39	8112 t	+ 15	37.0 NW	22.6
	.09	12789 t	+ 68			762, 12	.41	9692 t	+ 12	38.3 NW	23.5
	6.11	11852 t	+ 79	46.7 NW	15.7	W 7	.43	8672 t	− 21		
	.13	12581 t	+ 22	47.3 NW	16.6		6.32	9192 b	−128	96.4 W	16.2
	.15	12768 t	+ 22				.34	9887 b	− 93		
	6.17	10654 t	+ 47	45.1 NW	14.5	May 4	8.40	7790 t	+120	22.9 NNW	18.8
	.19	11940 t	+ 60	42.1 NW	16.1	760, 11	.42	8386 t	−112	32.7 NNW	20.6
	.21	11858 t	−15	47.8 NW	16.9	NE 8	.44	7252 t	+ 92		
	.23	10748 t	+123				8.54	7754 t	+ 36	50.5 NW	23.7
Apr. 26	8.42	9332 t	+126	108.9 WSW	24.0		.56	8549 t	+ 91		
759, 14	.44	10088 t	+ 7	112.5 WSW	24.1		8.59	8286 t	+ 60	46.5 NW	19.6
NW 3	.46	10562 t	+ 30	112.2 WSW	24.2		9.01	8187 t	+ 4		
	.48	10148 t	+219				9.03	7066 t	− 22		
Apr. 28	1.26	8323 b	− 20	30.6 NNW	41.6		9.08	7566 t	+ 61	51.7 NW	19.0
761, 20	.28	8792 b	− 61	31.2 NNW	42.[illegible]		.09	7860 t	+ 25		
NE 6	.30	7947 b	−214			May 5	6.08	8453 t	+ 50	255.4 ESE	27.2
	1.33	11327 t	− 17	25.7 NNW	51.8	761, 16	.10	7702 t	+154		
	.35	12771 t	+ 54			[illegible] 4	6.12	8483 t	+ 76	258.5 ESE	25.6
	1.39	11180 t	− 62				.14	8120 t	+ 9	256.3 ESE	25.8
	1.43	9979 t	− 95	33.8 NNW	44.5		.16	8422 t	+245		
	.45	12143 t	− 9	29.7 NNW	49.9		6.25	10022 t	+ 77	256.5 ESE	29.8
	.47	10860 t	− 9	28.7 NNW	48.2		[illegible]	9652 t	+259	256.9 ESE	29.2
	.49	10928 t	+ 19				.29	8516 t	− 21		
760, 17	6.05	10032 t	402	341.9 NNE	38.2		.31	[illegible]428 t	+ 73	202.4 SSE	28.1
	.07	9649 t	+ 10	328.2 NNE	34.4		.33	755[illegible] t	− 2	200.9 SSE	25.8
	.09	10458 t	−231				.35	7361 t	+ 34	203.9 SSE	26.5
	6.12	9744 t	+ 29	335.7 NNE	39.3		.37	7576 t	+ 47		
	.14	9178 t	− 62			May 7	6.22	9751 m	−[illegible]84	39.6 NW	31.9
	6.16	9713 t	+ 75	335.0 NNE	40.2	764, 20	.23	11032 m	−169	44.1 NW	28.1
	.18	9247 t	− 28			NE 1	.25	9593 m	+ 28	41.8 NW	30.0

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 7	.27	10232 m	− 20			May 14	1.25	9869 m	− 58	137.9 SW	36.4
764, 20	6.35	11308 t	+ 5	42.0 NW	33.1	758, 23	.27	9278 m	− 61		
NE 1	.37	11978 t	+342			May 15	9.07	8528 t	+ 53	347.5 NNE	46.2
	6.39	8168 t	+ 50	45.2 NW	29.5	764, 14	.09	8977 t	−178		
	.41	9168 t	+ 1			NE 2					
May 8	8.33	9430 t	+ 25	33.2 NNW	20.6	May 20	6.16	9870 b	−232	94.7 W	12.6
772, 11	.35	9276 t	+153	31.5 NNW	14.9	760, 26	.18	9776 b	+109	83.8 W	11.8
SW 4	.37	9248 t	+195			N 6	.20	9961 b	− 9		
	8.39	11966 t	−279	37.5 NW	20.4		6.24	10722 t	− 82	87.3 W	16.0
	.41	12482 t	−407				.26	10280 t	− 87		
	8.43	11932 t	−161	42.7 NW	17.6		6.28	10213 t	−262	86.7 W	13.1
	.45	12554 t	−539				.30	10407 t	266	88.2 W	12.8
	8.48	10608 t	− 84	34.3 NW	18.2		.32	10206 t	− 36		
	.50	10684 t	− 59	36.5 NW	13.7	May 21	1.30	8370 t	− 85	115.6 SW	28.3
	.52	10795 t	−112			755, 24	.32	7884 t	+ 39	93.9 W	26.5
771, 17	1.12	9888 t	− 21	42.6 NW	15.4	NE 4	.34	7896 t	+ 31		
	.15	9670 t	−117	43.3 NW	16.8	May 28	8.45	8587 t	−106	67.5 WNW	33.2
	.17	8961 t	− 76	42.9 NW	14.5	762, 16	.47	9339 t	− 18	68.9 WNW	34.6
	.19	8998 t	+173	43.1 NW	15.5	NE 6	.49	10714 t	+ 47		
	.21	9486 t	+ 99	39.4 NW	16.8		8.53	9122 t	− 67	69.2 WNW	37.0
	.23	9442 t	+ 9				.55	9932 t	+ 96		
	1.27	10650 t	− 25	44.3 NW	17.2		8.58	8991 t	−226	66.7 WNW	31.6
	.29	11526 t	− 44	44.3 NW	17.5		9.00	8864 t	− 64		
	.31	10249 t	− 20	45.8 NW	16.6		9.04	9130 t	0	71.1 WNW	33.1
	.33	10272 t	− 44				.06	9817 t	− 4		
May 10	10.41	8825 m	− 16	100.4 W	12.6	758, 23	1.17	9524 t	− 70	79.1 WNW	39.6
759, 20	.43	7712 m	+ 42				.19	10588 t	+ 75	75.3 WNW	38.3
N 4							.21	10056 t	+ 5		
May 12	1.43	11138 t	−271	115.5 WSW	32.3		1.24	9641 t	+ 43	71.8 WNW	42.3
758, 24	.45	10838 t	+ 80				.26	10224 t	−347	71.0 WNW	40.7
NW 4							.28	11320 t	+ 50		
May 14	1.08	10842 t	− 38	145.0 SW	41.9		1.31	9487 t	− 55	81.5 W	41.1
758, 23	.10	11397 t	−158	144.4 SW	41.7		.33	11040 t	+425	65.7 WNW	41.7
N 6	.12	11000 t	− 17								

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
May 28	.35	10662 t	0	68.2 WNW	39.0	June 2	8.51	9420 t	− 19	57.0 WNW	13.6
758, 23	.37	11371 t	−242			769, 14	.53	9650 t	− 37	60.8 WNW	13.2
757, 22	6.21	13524 t	+215	80.5 W	63.5	NE 1	.55	9930 t	+ 9	56.5 WNW	12.4
	.23	14082 t	−145				.57	11160 t	+ 21	58.9 WNW	12.9
May 29	9.10	10250 t	+ 21	94.7 W	49.0		.59	10744 t	+ 2	60.3 WNW	14.2
757, 15	.12	11617 t	+ 14				9.01	7833 t	+ 9	55.9 WNW	11.5
N 4							.04	8892 t	− 19		
	1.30	8944 t	−151	110.4 WSW	44.3	June 4	1.12	6390 t	+ 30	132.5 SW	19.1
758, 18	.32	9436 t	+ 59			758, 29	.14	7288 t	+ 50	134.8 SW	20.6
	1.35	9332 t	+ 121	109.5 WSW	41.6	N 2	.16	7226 t	+ 19		
	.37	9572 t	−135	107.7 WSW	44.8		1.24	7480 t	− 61		
	.39	8813 t	+ 94			June 5	*1.09	12091 t	− 78		
	1.41	8964 t	− 15	124.2 WSW	45.0	761, 20	6.50	10696 t	−131	137.9 SW	52.2
	.43	10465 t	+ 76			NE 2	.52	11962 t	+ 143		
759, 16	6.09	11650 t	+ 18	103.2 WSW	58.0		6.55	10584 t	+ 25	141.3 SW	47.8
	.10	9806 t	+ 109				.57	11268 t	− 13		
	6.12	11566 t	+ 6	102.0 WSW	62.1		6.59	10470 t	+ 33	139.1 SW	47.6
	.13	12577 t	− 44	108.5 WSW	52.7		7.00	11048 t	− 20	136.0 SW	42.4
	.14	11104 t	+263	92.1 W	69.3		.01	10172 t	−109	139.8 SW	55.8
	.15	11032 t	+295	101.9 W	60.2		.02	11040 t	− 49		
	.17	11772 t	− 43				7.11	11743 t	+ 24	130.8 SW	41.7
	6.20	11498 t	+126	95.1 W	67.0		.13	9492 t	+ 61		
	.22	11723 t	+ 99	109.7 WSW	59.7	June 10	†1.21	7418 t	−191		
	.24	11362 t	− 67				6.43	8943 t	+ 18	53.2 NW	18.6
June 1	6.35	11804 t	− 13	63.8 WNW	59.9	763, 21	.45	9034 t	−221	53.5 NW	17.6
764, 16	.37	10121 t	− 6			NE 7	.47	9438 t	+ 48		
NE 5	6.39	10658 t	− 35	59.4 WNW	44.8		6.53	10080 t	+ 97	51.2 NW	16.8
	.41	11170 t	−129				.55	9800 t	+ 81		
	6.47	11478 t	+279	54.7 NW	51.2	June 12	7.00	9078 t	+ 51	63.4 WNW	30.1
	.49	10978 t	− 55			757, 24	.02	8841 t	+ 12	64.7 WNW	31.4
	6.56	10648 t	− 8	76.5 WNW	46.3	NE 2	.04	9262 t	+ 2	67.2 WNW	30.7
	.58	11573 t	− 20								
	6.59	10566 t	+ 2	68.0 WNW	50.5						
	7.01	11329 t	+368								

*761, 22. †763, 21.

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1897	*h. m.*	*m.*	*m.*	°	*m. p. s.*
June 12	.06	10202 t	− 25			June 22	8.52	10598 t	− 70		
757, 24	7.07	9235 t	+ 94	70.8 WNW	31.9	763, 17	9.00	8139 b	− 58	93.6 W	22.9
NE 2	.09	10112 t	+ 13			NW 2	.02	8362 b	− 53		
	.11	9762 t	− 17	62.8 WNW	30.3		9.05	8192 m	−136	88.1 W	18.6
	.13	9670 t	− 4				.07	8462 m	− 29		
	7.15	11833 t	−146	61.8 WNW	37.1	763, 22	1.19	10693 t	− 69	89.7 W	19.1
	.17	10397 t	+166				.21	10727 t	− 97	101.9 W	17.5
June 14	6.24	9118 t	− 7	43.2 NW	43.6		.23	10751 t	+ 60		
760, 26	.26	9586 t	+ 24				1.26	9064 t	−253	89.0 W	15.2
NE 4							.28	7219 t	−166		
June 15	8.59	12545 t	+ 43	57.0 WNW	26.9	June 23	8.40	9280 t	− 24		
761, 20	9.01	10820 t	+ 66	58.3 WNW	26.7	762, 21	8.42	8095 t	− 72		
NE 4	.04	10548 t	− 23			NW 4	8.47	8049 t	− 17	74.5 WNW	9.8
June 16	1.15	10177 t	+ 75	55.4 WNW	28.8		.49	9754 t	− 98		
759, 30	.17	10461 t	− 6	68.0 WNW	29.2		8.55	6891 t	+144	85.8 W	6.2
NE 3	.18	9970 t	− 29	57.6 WNW	29.0		.56	7471 t	− 46		
	.19	10124 t	− 50			761, 23	6.45	12626 t	+ 24	49.5 NW	18.2
	1.24	10548 t	− 4	54.5 WNW	27.2		.47	13448 t	−102	52.2 NW	18.6
	.25	10335 t	+ 45				.49	13009 t	+ 80		
June 18	6.36	12644 t	−237	357.4 N	17.5		7.12	12463 t	−327	37.5 NW	21.7
761, 23	.38	12240 t	+ 25	53.9 NW	17.3		.16	11552 t	+ 13		
W 2	.40	12563 t	+ 27			June 24	8.50	5220 b	+120		
	6.42	12847 t	+ 33	53.2 NW	18.3	762, 22	8.54	5489 t	− 26	103.5 WSW	14.1
	.44	13243 t	+135			NW 3	.55	5370 t	− 1	105.9 WSW	15.2
	6.46	10520 t	+ 27	66.7 WNW	14.2		.56	5524 t	− 9		
	.48	12990 t	− 4	60.5 WNW	16.7		9.04	5618 b	− 14	104.2 WSW	15.4
	.50	12469 t	+ 21				.06	5781 t	+ 83		
	6.52	12154 b	− 91	62.1 WNW	16.4		6.41	10306 t	− 4	117.9 WSW	13.5
	.54	12623 b	− 42				.43	10169 t	− 20	133.9 SW	12.1
June 22	8.42	8064 t	+ 86	87.2 W	19.0		.46	9386 t	− 63		
763, 17	.44	8097 t	− 48			June 25	6.42	12030 t	+ 54		
NW 2	8.46	8365 t	− 12	86.6 W	19.9	758, 30	6.54	11922 t	−118	73.5 WNW	14.0
	.48	8149 t	− 26	85.7 W	19.0	NE 3	.56	13496 t	− 89		
	.50	8121 t	− 41			June 26	6.47	10870 t	− 60	48.5 NW	47.6
						763, 22	.49	11819 t	−100		
						E 4	6.54	12743 t	− 38	46.5 NW	49.3

TABLE 6.—*Summary of theodolite observations*—Continued.

CIRRUS.

Date		Height z	Δz	φ φ_1	V	Date		Height z	Δz	φ φ_1	V
1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*	1896	*h. m.*	*m.*	*m.*	°	*m. p. s.*
	.56	10107 t	— 50			June 30	6.39	9471 t	+ 23		
	6.59	13794 t	+ 55	51.5 NW	55.2	757, 30	6.40	9851 t	+ 17		
	7.01	13031 t	— 59			N 4	6.43	9345 t	— 38	52.4 NW	30.0
June 29	6.52	10879 t	— 47	52.5 NW	29.1		.45	8950 t	— 6		
762, 27	.55	10100 t	— 46				6.47	8957 t	+ 10	61.4 WNW	28.3
NW 4							.49	7728 t	— 51		

CHAPTER 4.

THE NEPHOSCOPE OBSERVATIONS.

THE IDEAL SCHEME OF OBSERVATIONS.

The observations with the Marvin nephoscopes have all been taken according to the instructions given for this purpose in chapter 1. The objects sought in particular are the relative velocity and the direction of motion in the several levels, distinguished by the cloud types prevailing and designated through the International nomenclature. We have endeavored to so arrange the compilation and discussion of the observations as to bring out the features belonging to the circulation of the atmosphere over the United States in the high and the low areas, respectively. Since the movements of the currents of air are functions of the latitude, it has been our purpose also to compute the data pertaining to the northern and to the southern districts separately. For these objects it is evidently necessary to subdivide a high or low area into smaller areas and to collect together all the observations in each of the eight cloud levels which fall into the individual area of the adopted twenty minor divisions. Summarizing the situation, there are eight levels; these are grouped in the northern and the southern circuits; each of these is collected in high and low areas; and, finally, each major area has twenty subareas. Hence if forty observations could be secured in every one of the final areas, even provided the observations were to be distributed to the best advantage, 25,600 vectors would be required. Now, furthermore, we have sought to distinguish between the four seasons of the year, and since three settings and readings of azimuth and velocity are needed for every mean vector, and also since the same work is required three times a day to bring out the diurnal variations, it is easily calculated that about one million settings would be required to give us good working data for the full discussion of this problem. Taking 300 observing days in the year, each day should produce 3,300 settings, and since 30 settings a day is the maximum laid down by the instructions for any station, we should need 110 stations to reach this number. On the other hand, we have had 15 stations only; the number of settings per day at each station will average about 12, taking the clear days and the rainy days into the account, which gives 180 daily settings instead of 3,300; and since the distribution of the stations is not entirely favorable, it turns out that some of the minor areas are quite full and others entirely vacant in several of the cloud levels. It is estimated that we have made not far from 25,000 observations of the clouds, besides the accompanying meteorological observations. The recital of these facts indicates two things: (1) That in spite of the hearty cooperation of our fifteen stations for twelve months, the data falls far short of what we should like to have to bring out the results to the best advantage; from which it is estimated that at least three years of work ought to be expended along these lines instead of only one; and (2) that the printing and discussion of this mass of material from the nephoscopes *in extenso*, as desired by the International Committee, becomes well-nigh impractical for any country contributing more than two or three stations to the enterprise. For it must be remembered that the other mass of observations, obtained by the Washington theodolite observers, has to be treated as well, and all this is to be supplemented with an analytic discussion of the results, and their relations to the circulation in cyclones, anticyclones, and the general movements of the atmosphere.

THE RIGHT-HAND AZIMUTH ROTATION AND DIRECTION "TOWARD."

In order to facilitate the understanding of the discussion that follows, three charts are introduced to show the scheme of the operations. Chart 8 gives a comparison of the azimuth system commonly employed by meteorologists with the one adopted in this report. The former is the left-hand rotation, such as astronomers use, and is counted from the south through the west point of the horizon. In this system, also, the observer faces the wind and gives the azimuth of the direction *from which* it blows. This has been abandoned for the reasons already mentioned, and in place of it is substituted the right-hand rotation, wherein the azimuth is counted from the south through the east point. Here the observer receives the wind on his back and looks toward the

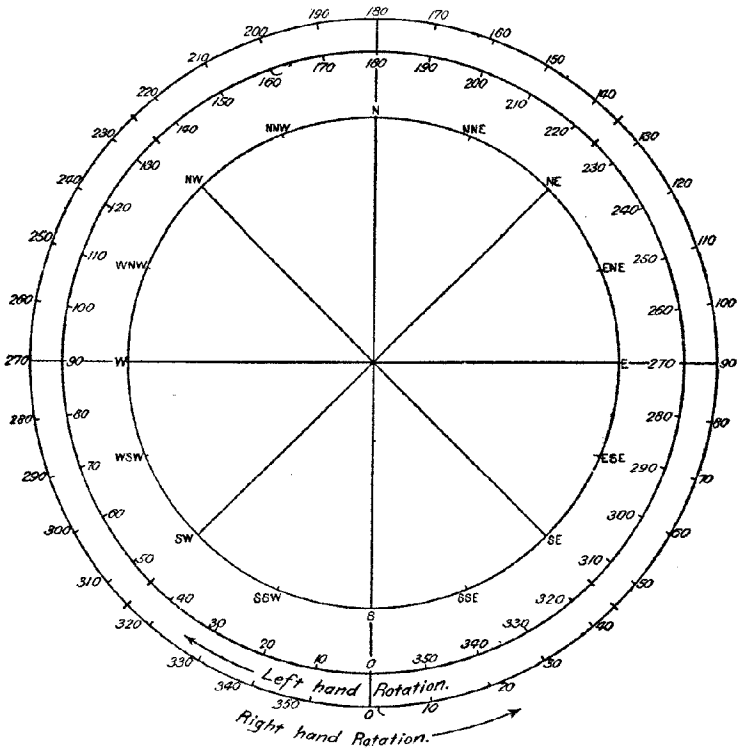


CHART 8.—Comparison of the two azimuth systems.

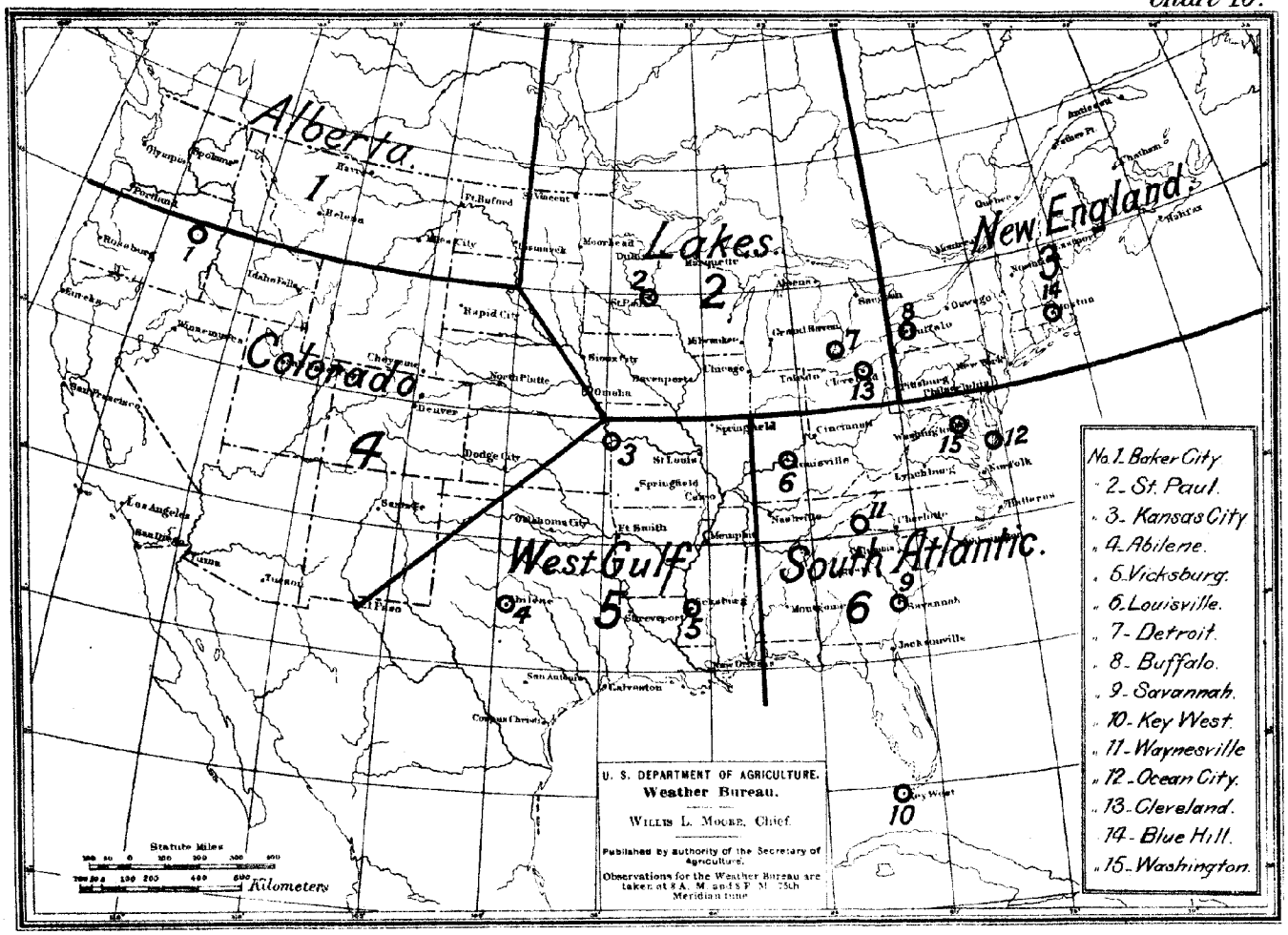
Left-hand rotation gives azimuth of "motion from."
Right-hand rotation gives azimuth of "motion toward."
Positive translation is vertically upward.

direction that the arrow flies and *toward which* the air is moving. Thus a wind *from the NW.* by the former system, with azimuth angle 135°, becomes a wind *toward the SE.*, with the azimuth angle 45°, by the latter system. The working out of the results by this system, ready for analytic discussion, as will be seen, involves a minimum of computation, and besides this it reduces all the velocity components to the fundamental rectangular system of coordinates adopted by FERREL in his treatise, and continued in the "Standard System" which forms a part of this paper.

THE SUBAREAS, AZIMUTH, AND COMPASS POINTS ADOPTED.

Chart 9 shows the plan of subdividing the circular areas surrounding the center of the high or low pressures into such minor areas as will most readily facilitate the analytic computation which follows. For this purpose, after some deliberation, twenty areas were taken, distributed as

Chart 10.


Alberta.
1
Lakes.
2
New England.
3
Colorado.
4
West Gulf.
5
South Atlantic.
6
U. S. DEPARTMENT OF AGRICULTURE.
Weather Bureau.
WILLIS L. MOORE, Chief.
Published by authority of the Secretary of Agriculture.
Observations for the Weather Bureau are taken at 8 A. M. and 8 P. M. 75th Meridian time.
Statute Miles
Kilometers
No. 1. Baker City.
" 2. St. Paul.
" 3. Kansas City.
" 4. Abilene.
" 5. Vicksburg.
" 6. Louisville.
" 7. Detroit.
" 8. Buffalo.
" 9. Savannah.
" 10. Key West.
" 11. Waynesville.
" 12. Ocean City.
" 13. Cleveland.
" 14. Blue Hill.
" 15. Washington.

shown in Chart 9. They are numbered with the right-hand rotation, and they are central each on some cardinal point of the compass. Thus on the north-south line 17, 9, 3, 1, 5, 13 are located; on the west-east line 19, 11, 4, 2, 7, 15 are found; while 18, 10, 6, 14 run from NW. to SE., and 20, 12, 8, 16 from SW. to NE. Hence it is seen that all the N.-S. and W.-E. areas are immediately available for composition in rectangular and in cylindrical coordinates, while the rectangular coordinates of the NW.-SE. and SW.-NE. areas which come from the first collection need only a simple transformation to become the radial and tangential components of cyclonic circulation. These latter are to be ultimately worked out, and we shall then have three sets of coordinates

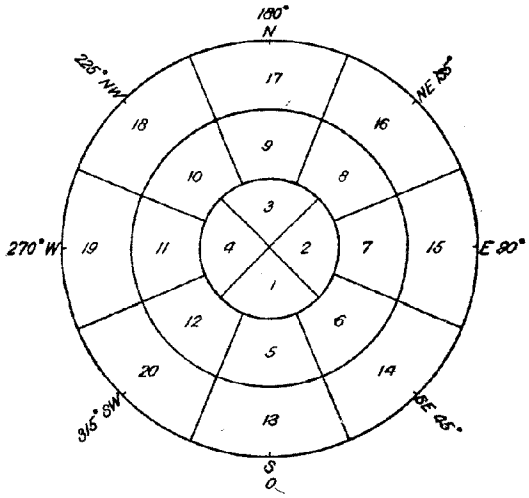


CHART 9.—Plan of the subareas, azimuths, and compass points, adopted in high and low areas, for the discussion of cloud observations.

The mean of areas 1 to 4 = I, at the average distance 250 km.
The mean of areas 5 to 12 = II, at the average distance 750 km.
The mean of areas 13 to 20 = III, at the average distance 1,250 km.

arranged symmetrically about the center of the three circles I, II, III at certain evenly distributed distances. The scale of this diagram is on a radius of 3 centimeters; on the weather maps this is equivalent to 15 centimeters, where 1 centimeter is equal to 100 kilometers. The reduced scale is therefore *one-fifth* the scale of the daily weather map, and on it 1 centimeter represents 500 kilometers or 310.7 miles, and one millimeter is equivalent to 50 kilometers, or 31.1 miles. All the diagrams of this report, as far as possible, are reproduced on this scale, but they are readily interpreted on the weather map, so far as linear dimensions are concerned.

LOCATION OF THE NEPHOSCOPE STATIONS.

Chart 10 shows the location of the fifteen nephoscope stations. No. 9 was transferred to No. 1 and No. 11 to No. 12 during the year, so that on an average thirteen stations were at work simultaneously. It is to be observed that the stations all lie east of the Rocky Mountain Plateau except Baker City, and that therefore this work contributes results pertaining only to the central and eastern portions of the United States. As most of the labor was performed by volunteer observers, and the possibility of taking up such additional labor was conditioned by the personnel of the local offices, a more perfect distribution of the stations could not be secured. These are quite satisfactory over the southern storm tracks, but in the northern tracks, passing over the Lakes and New England, our stations lie in the central or southern areas of the diagram, so that subareas 3, 8, 9, 10, 16, 17, 18 are almost without observations for the northern highs and lows. It is not easy to see how this can be remedied except by cooperation with the Canadian stations during another campaign. The defect is quite serious in our computations, because the even balance of the observations is disturbed over the high or low area, and it is not easy to supply the deficiency rigorously by any plan of adjustment.

THE SIX SUBDIVISIONS OF THE UNITED STATES.

The United States as a whole has been divided into six districts, as indicated on Chart 10, for the purpose of grouping the observations according to the geographical and the latitude features, named: (1) Alberta; (2) Lakes; (3) New England; (4) Colorado; (5) West Gulf; (6) South Atlantic. Since the eastward drift over the northern groups is more rapid than over the southern, because the latter lie near the permanent high-pressure belt, it has been the custom to group 1, 2, 3 together and 4, 5, 6 together, though evidently No. 1 and No. 4 contribute very little to the result.

THE FORM FOR RECORDING AND COMPUTING THE NEPHOSCOPE OBSERVATIONS.

TABLE 7.—*Specimen of the record of the nephoscope observations made at Key West, Fla., H. B. Boyer, observer.*

JUNE 1, 1896.

Month and date. June 1, 1896.		Time (seventy-fifth meridian).	Kind of cloud.	Seen in azimuth.	Angular elevation.	Azimuth of motion toward—	Velocity. mm.	Velocity. Sec.	Velocity. Relative.	Motion from (in points, N, NE, etc.)—	Actual velocity.
A. M.	1	8.48	Ci.	221	62	67	8	50	1.3	WNW	
	2	8.54	Ci.	158	39	72	7	50	1.2	WNW	
	3	8.58	Ci.	153	42	69	7	50	1.2	WNW	
	4	9.03	Ci. S.	141	26	49	(*)	(*)		NW	
	5	9.07	Ci. S.	138	28	43	(*)	(*)		NW	
	6	9.11	Ci. S.	125	26	43	(*)	(*)		NW	
	7	9.15	Fr. Cu.	54	47	224	28	25	9.3	SE	
	8	9.28	Fr. Cu.	64	49	228	32	25	10.7	SE	
	9	9.35	Fr. Cu.	74	38	233	32	25	10.7	SE	
	10	9.39	Fr. Cu.	77	36	232	33	25	11.0	SE	
Means.		8.0	Ci.			69			1.2		11.8
		9.5	Fr. Cu.			229			10.4		15.6
		Reduced pressure.	Temperature.	Humidity.	Direction of wind.	Velocity of wind.					
Before observation.		29.99	81.9	76	E	10					
Midday	1	1.33	Ci. S.	266	49	96	8	50	1.3	W	
	2	1.37	Ci. S.	303	53	103	10	50	1.7	W	
	3	1.41	Ci. S.	3	75	99	9	50	1.5	W	
	4	1.45	Ci. S.	349	52	99	8	50	1.3	W	
	5	1.49	Ci. S.	235	49	101	7	50	1.2	W	
	6	1.54	Cu.	175	35	224	25	25	8.3	SE	
	7	2.00	Cu.	193	41	227	22	25	7.3	SE	
	8	2.04	Cu.	196	48	230	25	25	8.3	SE	
	9	2.09	Cu.	167	51	226	24	25	8.0	SE	
	10	2.14	Cu.	216	54	239	24	25	8.0	SE	
Means.		1.7	Ci. S.			100			1.4		13.7
		2.1	Cu.			229			8.0		12.0
		Reduced pressure.	Temperature.	Humidity.	Direction of wind.	Velocity of wind.					
Before observation.		29.98	83.0	75	SE	10					

* Too low to obtain the velocity.

TABLE 7.—*Specimen of the record of the nephoscope observations made at Key West, Fla., etc.*—Cont'd.

JUNE 1, 1896—Continued.

Month and date. June 1, 1896.	Time (seventy-fifth meridian).	Kind of cloud.	Seen in azimuth.	Angular elevation.	Azimuth of motion toward—	Velocity. mm.	Velocity. Sec.	Velocity. Relative.	Motion from (in points, N, NE, etc.)—	Actual velocity.
P. M. 1	5.29	Ci. S.	227	27	267	8	50	1.3	E	
2	5.33	Ci. S.	310	31	276	10	50	1.7	E	
3	5.39	Ci. S.	201	36	278	8	50	1.3	E	
4	5.43	Ci. S.	342	42	274	9	50	1.5	E	
5	5.48	Ci. S.	185	61	276	8	50	1.3	E	
6	5.56	Fr. Cu.	201	25	80	45	25	15.0	W	
7	6.00	Fr. Cu.	229	57	73	46	25	15.3	W	
8	6.09	Fr. Cu.	247	47	75	46	25	15.3	W	
9	6.15	Fr. Cu.	230	35	78	49	25	16.3	W	
10	6.26	Fr. Cu.	257	41	71	48	25	16.0	W	
Means.	5.7	Ci. S.			274			1.4		13.7
	6.1	Fr. Cu.			75			15.6		23.4
	Reduced pressure.	Temperature.	Humidity.	Direction of wind.	Velocity of wind.					
Before observation.	29.98	82.7	74	E	12					
Remarks.	Point of radiation.	Undulated clouds.	Density of cirrus.	Direction of banks.	Cumuliforms.	Mamato cumulus.	Stationary or rapid.	When cirrus first seen.	When cum. first seen.	When rain begins.
A. M.			Thin and irregular	SW						
Midday.	W									
P. M.										
Notes.	Seventy-fifth meridian time is 27 minutes faster than local time.									

Having thus explained the divisions for grouping the observations, we proceed to introduce the nephoscope data in some detail. The accompanying Table 7 is a specimen of the actual nephoscope observations, as recorded at the several stations. There is a place on the form for three distinct sets to be taken each day—one in the forenoon, one near midday, and one toward night. Each set has provision for ten observations, and since three settings on the same cloud stratum is usually sufficient to determine the azimuth and relative velocity, this gives room enough to record three kinds of clouds, which is suitable for ordinary circumstances. The observation includes the time of the setting; the kind of cloud; the azimuth in which the observer looks to see the cloud; the angular elevation of the cloud above the horizon; the *azimuth toward* which the cloud moves according to the new system; the azimuth in points of the compass *from which* the cloud moves, taken as a check upon the other azimuth observations; the number of millimeters passed over on the nephoscope scale, where the sighting point and the cloud are at first seen in superposition at the center of the nephoscope and are allowed to trail together along the millimeter scale a certain distance; the time allowed for the motion, which is usually some multiple of 25 seconds. The relative velocity means the meters per second of the actual motion as *projected upon the 1,000-meter plane*, to which all the relative motions given by the nephoscopes are referred. The relative velocity on the 1,000 meter plane is found as follows: "Divide the number of millimeters by 3, if the time interval is 25 seconds; or else by such a factor as will be equivalent to that result, as by 6 if the interval is 50 seconds." The actual velocity of the cloud is to be

found afterwards by multiplying this relative velocity by the height of the cloud stratum in kilometers. For example, we find for Key West, June 1, 1896, 8 to 9 a. m., that the relative velocity for cirrus clouds was 1.2 meters per second on the 1,000 meter plane. The height of the cirrus clouds will be shown by the theodolite observations to be 9.8 kilometers on the average, so that the actual velocity was 11.8 meters per second at the cloud level. As the outcome of the theodolite work the multiplying factors to reduce from the 1,000-meter plane to the respective mean cloud levels are as follows:

TABLE 8.—*Multiplying factors for the cloud levels.*

Cloud	Factor	Height
Cirrus	9.8	9829
Cirro-stratus	9.8	9775
Cirro-cumulus	8.1	8119
Alto-stratus	5.9	5866
Alto-cumulus	4.5	4540
Strato-cumulus	2.5	2520
Cumulus	1.5	1821
Stratus	0.9	901

In the last column is given the mean heights of the cloud strata from which the factors are obtained. It is evident that unless we know perfectly the height of any given cloud for a single observation, an error will result from using these mean factors for the velocity; but that when applied to any large number of observations of the same kind of cloud the resulting velocity will be accurate. In the case of the cumulus clouds there is more difficulty in assigning the proper reduction factor. The mean height of all our cumulus observations, including those of the bases, the tops of the ordinary cumulus layers on which occur the majority of settings in our work, and the high domes, is 1,821 meters. But an examination of Chart 72 of the cumulus formation shows that this height runs through the middle of the diurnal expansion, leaving out of consideration the towering domes. I have finally adopted 1,500 meters as the working height of this layer, which is a fair compromise among all the existing conditions. The multiplying factor is accordingly 1.5 for the cumulus layers. The cumulo-nimbus type has not been included in the discussion of velocities, because it does not occur throughout the year, and also on account of its immense diurnal range in height. The nimbus type has also been omitted entirely, because it was impossible for us to secure many satisfactory observations with the apparatus at our disposal, the few settings we have on the nimbus being confined to the instances when the sheet was breaking up and showing rifts. It would seem to be necessary to deal with the nimbus stratum by means of the kites or balloon ascensions.

Referring back to the Key West example, against the means are entered the *times of observation*, the *kind of cloud*, the *azimuth of motion*, and the *relative velocities*. These are the quantities which are to be transferred to the forms headed "*Summary of Nephoscope Observations*," where this example from Key West is found to be transcribed. Furthermore, the meteorological data were read just before the nephoscope observations began, and the *pressure, temperature, humidity, direction and velocity of the wind* are likewise transferred to the space allotted to Key West. A few general remarks may be added upon the nephoscope record, according to the suggestions placed at the bottom of the form for the observations.

SUMMARY OF THE NEPHOSCOPE OBSERVATIONS.

The results of the nephoscope observations are all recorded in Table 9. The stations are so arranged that the results on a given date fall on the same horizontal row. In order to identify briefly the locus of the station relatively to the center of the high or low pressure area, with which it is locally identified, the following notation is adopted. Taking the six districts of the United

States shown on Chart 10, which are numbered Alberta, 1, Lakes, 2, New England, 3, Colorado, 4, West Gulf, 5, South Atlantic, 6, the first three cover the northern circuit and the last three the southern circuit, the circuits being divisions in the general circulation as described in Bulletin No. 20, Storms and Storm Tracks, 1897. Hence, any center lying within the area Alberta 1 is numbered H . 1 or L . 1 for a high or low, respectively. On the left side of the page, just under the date, is given the pressure, whether high or low, its district. the longitude and latitude of the center. For example, on June 1, 1896:

H . 2 . 95° . 44° = high; area, Lakes, 2; longitude, 95; latitude, 44°.
L . 5 . 91 . 35 = low; area, West Gulf, 5; longitude, 91; latitude, 35.
L . 3 . 66 . 48 = low; area, New England, 3; longitude, 66; latitude, 48.

While there may sometimes be a doubt about the location of the true center of action, these figures indicate the point that has been adopted in each case. The diagram of the twenty subareas on Chart 9 was copied on semitransparent celluloid, with a scale of 15 centimeters radius, giving 1 centimeter to 100 kilometers on the weather map. A line was drawn through the center of the areas 17 to 13 for a reference line, which was always placed parallel to the meridian on the map passing through the central point of the high or low area. The several stations then fell within some one of the twenty areas, and that number was assigned to the station. Frequently the same station would occupy more than one area relatively to the different centers of highs and lows on the map, and then the data of the station could be properly repeated in these several connections. Thus Cleveland for June 1, 1896, gives H . 2 . 15, L . 5 . 16, L . 3 . 20; that is, area 15 for a high over the lakes, area 16 for a low in the West Gulf district, and area 20 for a low over New England. These distributing numbers are printed in heavy-faced type at the top of the rectangles devoted to the several stations. Underneath these figures come the four columns of data transcribed from the original observation sheets, and they contain, in order, the time of the observations, hour and tenth of an hour, the kind of cloud observed, the azimuth of motion "towards" in the right-hand system, and the relative velocity of motion on the 1,000-meter plane. Then under the line are found the meteorological elements corresponding to the morning, midday, and the evening observations, namely, the barometer in inches and tenths, the temperature in Fahrenheit degrees, the relative humidity, the velocity of the wind in miles per hour, and the direction in the points of the compass from which the wind blows.

It should be noted that cumulo-nimbus have always been entered as cumulus, and that nimbus and scud have been entered as stratus for obtaining the motions, and that we have thus retained eight distinct levels for working out our problem. Then the cirrus, cirro-stratus, cirro-cumulus, and alto-stratus are regarded as the upper clouds; alto-cumulus, strato-cumulus, cumulus, and stratus as the lower clouds, for the more general purposes of our study.

TABLE 9.—*Summary of nephoscope observations.*

JUNE 1 TO JUNE 4, 1896.

NOTE.—Under the date, H = high area, L = low area; the attached numbers give the district in which the center is located, with area could not be classified as H or L. Under these are found, in order, the hour and tenth of observation, the kind of cloud, the azimuth tridaily observations, forenoon, midday, and afternoon, in their order, barometer in inches, temperature in degrees Fahrenheit, relative The data for Baker City, Key West, and Waynesville will be found at the end of this table.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
June 1 ° ° H . 2 . 95 . 45 L . 5 . 91 . 35 L . 3 . 66 . 48			**H—2—13.** **L—5— 1.** 8.8 A. Cu. 122 1.7 ... . 1.6 A. Cu. 110 1.1 ... . 5.2 Ci. S. 124 2.4 ... . 30.0 81 70 4 W. 29.9 88 52 6 W. 29.9 92 41 4 W.	**L—5—15.** 8.4 Ci. 43 2.2 ... . 1.6 S. 126 3.2 ... . 5.6 S. 9 5.9 ... . 30.0 81 68 9 W. 30.0 92 48 8 NW. 30.0 88 85 11 NW.	**H—2—14.** **L—5— 8.** 8.2 A. S. 46 5.4 8.4 S. 45 5.2 1.2 A. S. 85 4.9 ... . 5.7 S. 143 1.2 ... . 30.0 60 75 12 NE. 30.0 60 76 14 NE. 30.1 66 59 4 NE.
June 2 ° ° H . 2 . 84 . 44 L . 3 . 62 . 49			**H—2—20.** 8.8 Cu. S. 142 3.3 ... . 1.7 Ci. S. 145 4.1 5.1 Ci. S. 134 3.1 30.0 69 86 9 SE. 29.9 84 53 3 N. 29.9 83 66 10 E.	**H—2—13.** 9.1 S. 121 2.7 9.3 A. S. 295 10.9 1.9 Cu. S. 284 7.8 5.6 S. 109 2.3 30.1 71 72 6 NE. 30.1 85 60 6 NE. 30.1 80 75 9 E.	**H—2—12.** 7.9 Ci. 119 7.5 ... . 12.8 A. S. 115 5.0 ... . 30.2 63 61 10 NE. 30.1 74 41 12 NE. ....
June 3 ° ° H . 3 . 74 . 40 L . 5 . 91 . 29			**L—5—3.** ... . 1.8 Cu. 296 6.5 ... . 5.2 Ci. Cu 302 2.7 ... . 29.9 85 53 12 E. 29.8 85 60 10 E.	**H—3—20.** **L—5— 7.** 9.1 A. S. 232 5.8 ... . 1.6 N. 137 4.8 ... . 5.3 N. 145 5.0 ... . 30.1 78 79 9 S. 30.1 77 80 7 SE. 30.0 75 70 6 E.	**H—3—11.** **L—5—16.** 8.1 S. Cu. 152 3.5 8.2 A. Cu. 150 2.7 12.7 N. 115 3.5 12.9 Cu. 123 4.2 5.5 Cu. N. 120 1.5 ... . 30.0 66 85 3 E. 30.0 75 78 6 S. 30.0 75 66 4 SE.
June 4 ° ° H . 6 . 74 . 38 L . 4 . 101 . 39			**L—41—14.** 8.7 Cu. S. 220 11.0 ... . 1.9 Cu. 203 4.4 ... . 5.2 Ci. 301 2.4 ... . 29.9 79 79 8 E. 29.8 89 52 8 SE. 29.8 85 63 8 SE.	**H—6—12.** 8.6 S. 316 5.1 ... . 1.1 S. 340 7.2 ... . 5.6 S. 305 6.1 ... . 30.0 81 72 6 NE. 30.0 78 73 10 NE. 30.0 81 72 5 N.	**H—6—11.** **L—4—15.** 8.0 Cu. 133 30.0 ... . 12.8 Cu. 127 4.1 ... . 5.4 Cu. 51 2.7 5.5 A. Cu. 30 3.4 30.0 73 74 7 S. 30.0 85 53 8 SE. 29.9 86 52 5 SE.

TABLE 9.—*Summary of nephoscope observations.*

JUNE 1 TO JUNE 4, 1896.

its longitude and latitude. The heavy-type headings give the area of pressure, the general district, and the subarea; when omitted, the toward which it moves, and the relative velocity in meters per second. Beneath the line is given the meteorological data, usually for the humidity, velocity of the wind in miles per hour, and the compass direction from which it blows.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
L—5—16.				**H—2—15.**				**H—2—15.**				**H—2—15.**				**L—3—12.**			
L—3—20.				**L—5—16.**				**L—5—16.**				**L—5—16.**							
				L—3—20.				**L—3—19.**				**L—3—20.**							
8.8	Ci. S.	68	3.6	10.1	Ci.	85	3.1	...	.....	...	...	8.6	Cu.	23	3.9	7.9	A. Cu.	48	2.6
...	....	...	...	...	.....	...	...	...	.....	..	..	...	.....	...	...	7.8	S. Cu.	80	2.6
1.4	A. Cu.	78	3.9	2.6	Ci.	85	3.8	1.4	Cu.	20	7.2	1.6	Cu.	39	4.2	2.1	S. Cu.	63	3.8
2.1	Ci. S.	87	4.4	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
6.0	A. Cu.	24	4.2	5.8	Ci.	80	5.0	...	.....	...	...	...	.....	...	...	5.7	A. Cu.	304	3.1
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	5.8	Cu.	290	7.0
30.0	61	61	10 N.	30.1	57	68	9 NW.	...	..	..	....	30.0	52	69	10 N.	29.9	58	79	14 NW.
30.0	72	40	14 W.	30.2	62	50	12 NW.	30.3	60	63	9 NE.	3.1	57	63	12 W.	29.8	68	58	24 NW.
30.1	67	51	3 N.	30.2	60	58	8 NW.	..	..	..	....	....	..	..	....	29.9	54	63	21 NW.
H—2—6.																**H—2—7.**			
																L—3—20.			
4.7	A. S.	65	4.4													8.1	Cu.	38	14.2
...	.....	...	..													...	.....	...	...
1.0	Ci. S.	87	3.6													2.1	Cu.	43	6.3
...	.....	...	...													...	.....	...	...
30.2	63	55	9 N.													30.0	58	73	26 NW.
30.2	72	39	6 NW.													30.0	62	64	27 NW.
30.2	67	60	3 W.													....	..	..	....
H—3—4.				**H—3—11.**				**H—3—10.**				**H—3—10.**				**H—3—8.**			
9.4	A. S.	87	3.2	...	.....	...	...	8.0	Cu.	0	0	8.7	Ci.	112	1.6	...	.....	...	...
...	.....	...	...	..	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.8	Ci.	90	0.9	1.5	Ci. Cu.	102	3.0	1.9	S. Cu.	114	4.1	...	....	...	...	2.1	Ci.	72	4.2
1.9	Ci. S.	70	2.2	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
7.1	A. Cu.	97	4.7	6.4	A. Cu.	150	1.6	...	.....	...	...	5.3	Ci. Cu.	68	1.0	6.5	Ci.	69	2.0
...	.....	...	...	6.1	Ci. Cu.	87	2.6	...	.....	...	...	5.4	Ci.	92	4.0	...	.....	...	...
...	.....	...	...	6.3	Cu.	190	3.6	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.3	64	70	7 E.	....	..	..	...	30.1	59	72	6 NE.	30.2	58	44	6 E.	....	..	..	....
30.2	74	43	7 SE.	30.1	71	56	9 N.	30.1	69	63	7 NE.	30.0	80	61	6 NW.	30.1	75	59	12 W.
30.2	70	66	6 S.	30.0	71	58	6 N.	....	..	..	....	....	..	..	....	30.1	72	58	13 SW.
H—6—4.				**H—6—10.**				**H—6—10.**				**H—6—10.**				**H—6—8.**			
				L—4—15.				**L—4—15.**											
11.1	N.	178	10.9	8.5	Cu. N.	80	1.9	8.1	Ci. Cu.	62	5.4	8.9	Cu. S.	272	0.4	7.9	Ci.	57	2.3
...	.....	..	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	8.1	Ci. Cu.	57	2.5
12.8	Scud.	150	31.0	2.0	Fr. Cu.	140	1.8	1.2	Cu.	0	0	...	.....	...	...	2.1	Ci. Cu.	53	2.4
2.1	N.	142	21.2	2.1	Cu.	140	1.5	...	.....	...	...	...	.....	...	...	2.2	Cu.	51	2.8
6.7	N.	191	10.9	7.3	A. Cu.	73	2.0	5.2	Ci.	99	3.7	...	.....	...	...	5.7	Ci.	72	2.8
...	.....	...	...	...	.....	...	...	...	.....	...	...	..	.....	...	...	...	.....	...	...
30.2	61	89	9 SW.	30.0	70	74	5 SW.	30.0	66	92	4 E.	30.1	64	74	5 W.	30.1	67	74	10 SW.
30.1	66	90	4 S.	30.0	71	72	10 N.	30.0	72	73	8 E.	....	..	..	....	30.0	80	44	13 S.
30.1	66	90	6 S.	30.0	74	70	4 E.	30.0	74	72	7 NE.	....	..	..	....	30.0	71	68	16 S.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 5 TO JUNE 8, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.				Savannah.				Louisville.			
June 5							H—3—20.				H—3—20. L—2—14.			
° ° H. 3. 78. 38			8.6	Cu. S.	187	8.9	9.1	S.	324	4.7	7.9	Ci.	118	1.4
L. 2. 90. 47			8.8	Ci. S.	220	1.9	...	.....	...	...	8.1	A. S.	127	4.6
			...	.....	...	...	...	....	...	...	8.3	Cu.	136	7.5
			1.8	Cu. S.	170	2.0	1.1	S.	316	5.4	12.8	Cu.	161	3.2
			...	.....	...	...	...	....	...	...	1.1	A. Cu.	267	2.4
			5.8	Ci. S.	179	3.1	5.6	S.	322	8.3	..	.....	...	...
			...	.....	...	...	...	.....	...	...	..	.....	...	...
			30.0	81	76	7 SE.	30.1	75	78	8 N.	30.1	78	73	7 S.
			29.9	90	56	3 SE.	30.1	80	68	12 NE.	30.0	86	48	8 S.
			29.9	90	56	4 SE.	30.0	79	75	9 SE.	30.0	88	49	4 SE.
June 6														
° ° H. 3. 65. 47			8.7	Cu.	212	8.7	8.9	S.	320	7.1	...	.....	...	...
			8.9	Ci.	228	1.1	...	.....	...	...	...	.....	...	...
			2.3	Cu. N.	313	9.6	1.1	S.	252	3.6	12.7	A. Cu.	145	3.4
			...	.....	...	...	...	.....	...	...	12.8	Cu.	135	4.1
			...	.....	...	...	...	.....	...	...	...	.....	...	...
			...	.....	...	...	5.6	Ci.	47	3.0	5.9	Ci. Cu.	76	3.5
			...	.....	...	...	...	....	...	...	6.2	Ci.	79	2.2
			30.0	80	72	8 SE.	30.1	79	83	5 NE.	....	..	..	....
			29.9	86	63	3 E.	30.0	84	56	13 E.	30.0	88	52	6 S.
			....	..	..	....	30.0	80	68	12 E.	30.0	88	53	8 S.
June 7														
June 8			H—6—19. L—2—13.				H—6—4. L—2—13.				H—6—10. L—2—5.			
° ° H. 6. 80. 31														
H. 3. 63. 47			8.8	Cu.	189	10.1	9.0	S.	124	2.3	...	.....	...	...
L. 2. 86. 43			...	.....	...	...	...	.....	...	...	..	.....	...	...
			1.9	Cu.	133	6.1	1.2	S.	148	6.7	12.7	Cu.	100	19.9
			...	.....	..	...	1.4	Ci.	126	3.9	12.9	A. S.	93	11.2
			...	.....	...	...	...	.....	...	...	1.0	Ci. Cu.	140	3.2
			...	.....	...	...	5.6	A. S.	177	2.0	...	.....	...	...
			...	.....	...	...	...	.....	...	...	...	.....	...	...
			...	.....	...	...	...	.....	...	...	...	.....	...	...
			29.9	78	83	13 SE.	30.1	83	73	4 SW.	....	..	..	....
			29.8	88	67	8 SW.	30.0	85	80	11 SE.	29.8	76	81	15 SW.
			29.8	90	62	6 NW.	29.9	85	73	12 S.	....	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 5 TO JUNE 8, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—3— 1.				**H—3—11.**				**H—3—11.**				**H—3— 4.**				**H—3—2.**			
L—2—14.				**L—2— 6.**				**L—2— 6.**				**L—2—15.**							
8.6	Cu. S.	200	2.1	9.0	Cu.	118	3.0	8.2	Cu.	105	7.7	8.7	Ci.	75	4.1	8.1	Ci.	18	2.3
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	..	...	.....	...	...
...	.....	...	..	...	.....	...	..	...	.....	...	...	...	.....	...	...	...	.....	...	...
2.1	A. Cu.	90	1.7	2.3	Ci. Cu.	80	2.2	1.2	Cu.	83	11.8	1.2	Ci.	43	0.3	2.2	Ci.	30	5.8
2.6	Cu.	90	2.2	...	.....	...	...	...	.....	...	...	1.3	Cu. S.	35	2.7	...	.....	..	...
6.3	A. Cu.	185	1.4	5.8	Fr. Cu.	17	3.4	5.2	Cu.	66	8.2	5.4	Ci. S.	50	5.6	5.2	Ci.	20	4.2
...	.....	...	...	5.8	Ci.	85	1.6	5.5	A. Cu.	66	8.7	...	.....	...	...	...	.....	...	...
30.1	67	88	2 S.	30.1	76	74	5 SW.	30.0	72	82	9 SW.	30.1	70	72	9 SW.	30.1	69	73	8 N.
30.1	74	66	4 S.	30.0	78	63	9 S.	30.0	84	54	9 SW.	30.0	80	74	6 W.	30.1	71	56	14 NE.
30.1	73	71	3 S.	30.0	80	68	11 S.	30.0	81	63	9 S.	30.0	79	57	10 W.	30.1	73	59	6 E.
				H—3—19.								**H—3—19.**				**H—3—12.**			
				8.7	C.	47	2.8					8.7	Ci. Cu.	50	4.3	...	.....	...	...
				8.9	Cu.	35	5.3					...	.....	...	...	...	.....	...	...
				2.5	Cu.	50	3.0					...	.....	...	...	2.2	Ci.	25	3.3
				...	.....	...	...					...	.....	...	...	2.2	Ci. Cu.	29	2.6
				...	.....	...	...					...	.....	...	...	2.3	S.	287	41.2
				5.8	Ci. S.	50	1.9					5.6	Ci. S.	118	1.8	5.5	Ci. S.	37	4.1
				...	.....	...	...					...	.....	...	...	...	.....	...	...
				30.0	72	36	10 S.					30.0	66	71	14 SW.	....	..	..	....
				30.0	82	65	10 NW.					....	..	..	....	30.2	59	84	24 E.
				30.0	74	54	13 SW.					29.9	78	62	4 SW.	30.2	57	100	17 NE.
				8.3	C.	32	0.8												
				2.2	Fr. Cu.	90	5.0												
				2.4	Cu. N.	90	1.9												
				2.5	Ci.	90	1.0												
				3.1	N.	?	?												
				30.0	79	71	8 SW.												
				29.9	86	54	7 SW.												
				29.9	67	95	8 E.												
H—6— 9.				**H—6—17.**				**H—6—17.**				**H—6—17.**							
H—3—20.				**L—2— 2.**				**L 2— 2.**				**H—3—19.**							
L—2— 6.												**L—2— 7.**							
8.7	Ci.	140	0.3	9.2	A. S.	121	3.9	8.3	Cu. S.	78	18.9	8.8	Cu. S.	102	10.0				
...	.....	...	..	11.3	N.	98	13.2	...	.....	...	...	8.9	Ci. S.	71	5.0				
1.4	Cu.	145	5.6	1.6	Fr. Cu.	130	5.5	1.8	Cu. S.	136	13.5	1.5	Ci. S.	96	2.8				
3.0	Scud.	170	3.1	...	.....	...	...	...	.....	...	...	1.9	Cu. S.	126	6.7				
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...				
6.0	A. Cu.	100	2.4	6.6	Fr. Cu.	105	2.3	5.4	Cu. S.	87	9.7	5.6	S.	150	3.0				
...	.....	...	...	...	.....	...	...	5.4	A. Cu.	160	9.3	...	.....	...	...				
...	.....	...	...	...	.....	...	...	5.5	Cu. S.	46	8.3	...	.....	...	..				
29.9	72	88	5 S.	29.7	77	71	11 S.	29.7	68	90	9 SW.	29.7	72	75	8 S.				
29.7	86	57	8 S.	29.7	70	86	9 NW.	29.6	77	61	8 W.	29.6	80	61	5 SW.				
29.7	74	86	3 E.	29.6	68	93	2 SE.	29.6	76	..	6 NW.	29.6	72	77	10 S.				

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 9 TO JUNE 13, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
June 9 ° ° H . 6 . 79 . 30 L . 3 . 76 . 44			**H—6—19.** 8.8 Cu. 98 7.8 ... . 1.9 Cu. 116 10.0 ... . 29.8 80 81 12 SW. 29.8 87 67 14 SW.	**H—6— 3.** **L—3—13.** 8.6 S. 122 14.4 ... . 1.2 S. 119 11.0 5.6 S. 118 12.8 ... . 29.9 82 80 11 S. 29.8 89 55 11 SW. 29.7 85 73 12 S.	**H—6—18.** **L—3—20.** ... . 12.8 A. S. 56 8.9 12.9 Cu. 54 8.0 1.0 N. 52 9.4 ... . 5.6 S. Cu. 32 11.7 5.7 A. S. 40 3.8 5.8 A. Cu. 34 2.9 29.7 73 57 12 W. 29.7 79 54 14 NW. ....
June 10 ° ° H . 2 . 92 . 46 L . 3 . 70 . 42			**H—2—13.** 8.8 Cu. 85 5.2 ... . 1.8 Cu. 15 4.1 ... . 5.3 Cu. 9 3.7 ... . 29.9 74 66 4 NE. 29.8 80 54 8 N. 29.8 80 55 6 NE.	**L—3—20.** 8.8 S. 105 20.3 9.1 Ci. 97 0.8 1.8 A. S. 94 7.4 .. .. 5.6 A. S. 104 6.5 ... . 29.8 84 69 12 W. 29.8 79 85 9 W. 29.8 76 74 9 SW.	**L—3—19.** **H—2— 6.** 8.0 S. 5 16.9 ... . 1.6 S. Cu. 352 8.0 1.7 A. Cu. 5 4.3 4.9 A. S. 320 8.1 ... . 29.9 60 79 8 N. 29.9 69 58 8 N. 29.9 71 60 9 W.
June 11 ° ° H . 4 . 98 . 41 L . 3 . 61 . 48			**H—4—14.** 8.8 A. S. 78 2.7 2.4 Cu. 360 3.2 5.1 A. Cu. 34 2.2 30.0 70 74 4 N. 29.9 78 49 11 N. 29.9 76 55 8 NW.	8.8 S. 212 7.6 1.4 S. 108 15.0 5.7 Ci. Cu. 107 6.8 29.9 78 83 3 W. 29.9 80 79 5 W. 29.9 82 69 3 E.	
June 12 ° ° H . 5 . 100 . 37 L . 3 . 63 . 45			**H—5—6.** 8.8 Cu. S. 6 3.7 ... . 1.8 Cu. 26 5.2 ... . 29.9 72 69 8 N. 29.9 80 50 6 N. W.	8.8 Ci. S. 216 0.9 9.2 S. 40 1.9 2.5 S. 97 9.0 ... . 5.6 Cu. S. 83 4.0 29.8 77 69 8 NW. 29.8 90 47 5 N. 29.7 81 76 10 S.	**H—5—15.** ... . 12.6 S. 67 21.8 12.8 A. S. 118 7.2 4.9 Cu. 84 8.4 .... 29.9 69 60 24 W. 29.8 71 54 15 W.
June 13 ° ° L . 6 . 77 . 36 H . 5 . 99 . 32				**L—6—12.** 9.1 Ci. Cu. 118 18.4 ... . 1.6 Cu. 99 8.9 ... . 5.8 Cu. 88 7.7 29.8 78 64 10 W. 29.8 85 70 15 W. 29.8 83 30 12 W.	**H—5—16.** **L—6—10.** 8.0 Scud 8 42.9 7.9 A. Cu. 9 4.3 8.0 S. 8 8.5 12.8 Cu. 345 7.6 12.7 A. Cu. 325 4.6 5.6 Ci. Cu. 22 5.2 29.8 59 78 12 NW. 29.9 68 54 11 N. 29.9 73 52 9 NW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 9 TO JUNE 13, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6—17.				**H—6—17.**				**H—6—17.**				**H—6—17.**				**L—3—2.**			
L—3— 5.				**L—3—12.**				**L—3—12.**				**L—3— 4.**							
8.7	S.	110	12.8	9.1	Cu.N.	150	5.2	...	.....	...	...	...	.....	...	...	...	.....	...	...
8.8	A. Cu.	100	5.1	9.3	Ci. Cu.	(?)	1.6	...	.....	...	...	...	.....	...	...	...	.....	...	...
9.6	Cu.	100	5.2	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
12.8	Cu.	114	4.7	...	.....	...	...	1.2	Cu. S.	6	33.1	1.6	Cu. S.	81	11.1	2.2	Ci.	123	3.0
12.9	Ci.	130	3.9	...	.....	...	...	...	.....	...	...	...	.....	82	8.9	2.3	Cu.	132	27.3
1.3	Cu. S.	83	4.0	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.7	A. Cu.	125	3.6	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
7.3	S. Cu.	130	4.8	6.2	Fr. N.	350	10.6	5.4	Cu. S.	1	26.4	5.2	Cu. S.	...	...	6.2	Ci. Cu.	120	5.9
....	... .	...	..	6.3	A. Cu.	(?)	(?)	...	.....	...	...	...	.....	...	...	6.3	Cu.	125	18.5
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
29.7	69	93	5 S.	29.6	68	81	8 SW.	....	..	..	....	....	..	..	....	....	..	..	....
29.6	68	88	4 NE.	....	..	..	....	29.7	65	85	7 N.	29.6	69	76	8 NW.	29.6	73	86	9 SW.
....	..	..	....	29.7	63	84	11 N.	29.7	63	89	7 N.	29.7	64	74	15 NE.	29.6	75	89	17 SW.
L—3—12.				**L—3—11.**								**L—3—11.**				**L—3—4.**			
H—2—14.				**H—2— 6.**								**H—2—15.**							
8.7	S. Cu.	22	15.6	9.2	A. Cu.	320	2.4					8.7	Ci. S.	10	3.3	...	... .	...	...
...	.....	..	...	...	.....	...	...					...	.....	...	...	...	.....	...	...
2.6	Cu.	16	5.7	...	.....	...	...					...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...					...	.....	...	...	...	.....	...	...
4.6	Ci. S.	10	2.9	...	.....	...	...					...	.....	...	...	5.3	Ci. Cu.	96	3.2
5.9	S. Cu.	15	6.0	...	.....	...	...					...	.....	...	...	...	.....	...	...
29.6	68	83	12 NW.	29.8	62	79	18 NE.					29.8	59	83	18 NE.	....	..	..	....
29.8	76	57	14 N.	....	..	..	....					....	..	..	....	....	..	..	....
29.7	69	72	3 N.	....	..	..	....					....	..	..	....	29.5	62	78	8 W.
																L—3—20.			
																9.4	Cu.	63	9.5
																2.7	Cu.	42	6.2
																...	.....	...	...
																29.6	59	57	20 W.
																29.5	66	49	29 NW.
																....	..	..	....
L—3—20.												**L—3—19.**				**L—3—12.**			
...	... .	...	...	9.0	Ci.	(?)	(?)					...	.....	...	...	7.9	S. Cu.	46	12.5
...	.....	...	...	10.9	Ci.	95	1.8					. .	.....	...	...	...	.....	...	...
3.7	Ci.	94	2.5	...	.....	. .	...					...	.....	...	...	2.2	A. Cu.	26	7.4
...	.....	...	...	...	.....	...	...					...	.....	..	...	2.3	Cu.	33	9.2
5.7	Ci.	102	2.8	...	.....	...	...					5.3	Ci.	112	4.5	7.7	S. Cu.	68	4.1
29.8	68	52	8 W.	29.8	68	64	9 NW.					....	..	..	....	29.6	56	76	20 NW.
29.7	81	30	4 SW.	....	..	..	....					....	..	..	....	29.6	64	51	26 NW.
29.7	75	51	2 S.	....	..	..	....					29.7	70	42	8 W.	29.7	59	58	7 NE.
L—6—3.				**L—6—10.**				**L—6—10.**				**L—6—9.**				**L—6—8.**			
8.9	A. S.	204	0.8	8.8	Fr. Cu.	65	8.8	...	.....	...	...	8.8	Ci. Cu.	101	0.3	8.1	A. Cu.	78	4.9
...	.....	...	...	9.5	Ci. Cu.	320	1.0	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
3.2	N.	245	6.4	6.5	Ci. S.	70	(?)	1.2	Cu.	198	4.3	1.4	Cu.	289	3.3	2.1	Ci. S.	97	3.5
...	..	..	....	...	.....	...	...	...	.....	...	...	1.6	Ci. S.	110	5.0	2.2	S. Cu.	110	3.3
6.9	N.	265	6.0	...	.....	...	...	5.0	Cu.	357	10.7	5.6	Ci. S.	157	6.0	...	.....	...	...
29.7	68	81	2 S.	29.7	65	75	8 NW.	....	..	..	....	29.8	66	53	6 SE.	29.9	61	51	9 NE.
29.7	62	82	2 S.	....	..	..	....	29.8	75	46	7 SE.	29.8	74	26	18 E.	29.9	63	57	16 E.
29.8	62	89	12 NW.	29.8	66	66	13 SE.	29.8	75	55	6 NE.	29.8	72	31	22 N.	....	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 14 TO JUNE 18, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
June 14					
June 15 ° ° H. 6. 76. 38 L. 5. 96. 38			**H—6—20.** **L—5— 6.** ... . 5.9 Ci.Cu. 33 1.8 ... . 30.1 85 44 6 W.	**H—6—12.** ... . 1.2 Cu.S. 86 3.9 ... . 30.2 83 46 8 E.	**H—6—11.** **L—5— 7.** 8.0 Ci. 56 4.4 ... . 12.6 Ci.S. 74 4.9 12.7 Cu. 110 6.3 5.2 Ci.Cu. 82 4.7 5.4 Ci. 78 3.6 30.2 73 57 3 S. 30.1 82 33 14 SW. 30.1 82 41 8 SW.
June 16 ° ° H. 6. 73. 37			8.9 A.Cu. 90 3.2 ... . 2.9 Cu.S. 155 3.8 ... . 5.1 Cu. 80 5.0	**H—6—12.** 8.7 Ci.S. 115 5.1 ... . 2.4 Ci.S. 164 6.1 2.0 S. 211 3.1 2.7 Cu. 342 5.7 5.3 Ci.S. 142 5.9 30.2 72 66 3 N. 30.2 82 61 6 E. 30.1 80 67 12 E.	**H—6—19.** 7.8 Ci.S. 73 4.3 8.0 A.S. 77 5.3 12.6 Cu. 81 6.1 12.8 Ci.S. 85 4.1 ... . 5.3 Cu. 49 1.8 29.6 70 57 1 S. 30.1 80 52 7 W. 30.0 81 52 6 SW.
June 17 No circulation. ° ° H. 3. 70. 40			... . 2.9 Cu. 122 1.8 ... . 5.7 S. 182 2.3 ... . 29.9 90 47 4 NW. 29.9 87 54 9 NE.	**H—3—20.** 9.1 Cu. 143 3.6 9.2 Cu.S. 292 4.3 2.6 Cu. 52 3.4 ... ... 5.8 Ci.S. 132 7.8 .. .. 30.1 80 64 3 N. 30.0 86 70 8 SE. 30.0 82 55 8 SE.	**H—3—19.** ... . 12.7 Cu.N. 65 2.3 12.8 A.S. 125 2.1 ... . 4.7 A.S. 130 1.8 4.9 Scnd. 295 3.5 .... 30.0 75 74 8 SW. 30.0 73 75 6 SW.
June 18 No circulation. ° ° H. 6. 80. 38			**H—6—20.** 8.8 Ci. 164 0.8 ... . 2.9 Cu. 276 1.3 ... . 5.2 A.S. 215 1.1 ... . 30.0 74 78 3 NW. 30.0 84 48 4 N. 29.9 86 45 5 NE.	**H—6—5.** 9.1 S. 93 16.9 ... . 1.6 S. 122 7.1 ... . 5.6 A.S. 112 4.0 ... . 30.1 81 72 7 SW. 30.0 86 63 9 E. 30.0 82 65 10 SE.	**H—6—11.** 7.8 Ci.S. 352 0.4 7.9 A.Cu. 280 8.6 8.2 Cu. 282 9.2 12.6 Cu. 249 3.2 12.8 Ci.S. 270 0.7 ... . 5.2 A.S. 310 1.8 5.4 Cu. 331 2.6 ... . 30.0 72 71 4 N. 30.0 79 53 9 NW. 30.0 83 56 4 N.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 14 TO JUNE 18, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
				...	.....	...	...												
				...	.....	...	...												
				6.9	Ci. S.	50	1.1												
				....	..	..	....												
				....	..	..	....												
				30.1	70	52	7 NW.												
H—6—1.				**H—6—4.**				**H—6—10.**				**H—6—3.**				**H—6—8.**			
				L—5—15.				**L—5—16.**											
11.0	S. Cu.	152	4.1	9.0	S. Cu.	100	2.6	...	.....	..	...	8.7	Ci. S.	116	1.2	8.1	N.	348	55.5
11.2	A. Cu.	110	2.8	...	....	...	..	...	.....	...	...	...	.....	..	...	...	.....	...	...
2.8	A. Cu.	94	3.3	2.6	S.	215	3.2	1.2	Cu. S.	260	8.4	1.4	Cu. S.	297	1.9	2.1	N.	6	21.0
2.7	Cu.	200	5.0	...	.....	...	...	1.3	Cu.	98	4.3	1.5	Ci. S.	125	4.3	...	... .	...	...
5.7	S. Cu.	200	5.4	6.2	Fr. Cu.	180	4.1	5.1	A. Cu.	60	3.3	5.6	Cu. S.	90	2.5	6.4	S. Cu.	7	9.8
5.7	A. Cu.	85	3.0	6.6	A. Cu.	130	2.0	5.2	Cu. S.	0	0	5.3	Ci. S.	94	5.7	...	.....	..	...
30.3	60	75	6 E.	30.2	65	68	4 SE.	....	..	..	....	30.2	66	72	3 SE.	30.2	48	100	20 N.
30.2	68	72	4 E.	30.1	67	59	7 NW.	30.1	61	87	9 E.	30.1	73	39	6 NE.	30.2	53	88	5 N.
30.2	67	80	6 SE.	30.1	63	84	10 E.	30.1	65	93	11 NE.	30.1	71	45	12 E.	30.2	53	97	4 S.
H—6—4.				**H—6—10.**				**H—6—10.**				**H—6—10.**				**H—6—8.**			
8.8	Scud	164	66.7	9.2	Cu.	89	3.4	...	.....	...	..	8.5	Cu. S.	170	3.1	8.1	Ci.	105	2.4
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	..	...
12.2	S. Cu.	142	9.0	...	.....	...	...	1.3	Cu. S.	315	7.5	1.6	S.	150	5.8	2.0	Ci.	112	4.4
3.0	Cu. N.	119	4.6	...	.....	...	..	1.4	Cu.	39	8.0	...	.....	...	...	2.1	Cu.	75	1.5
3.1	A. S.	100	3.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
7.3	A. Cu.	88	3.4	...	.....	...	...	...	.....	...	...	5.4	Ci. S.	125	5.3	6.7	Ci.	117	3.4
30.2	63	95	8 S.	30.1	61	85	7 W.	....	..	..	....	30.2	64	79	11 E.	30.2	62	73	10 NW.
30.2	72	78	6 S.	....	..	..	....	30.1	67	62	9 E.	30.1	67	71	13 N.	30.2	75	45	6 W.
30.1	67	90	4 S. E.	....	..	..	....	....	..	..	....	30.1	67	71	18 E.	30.2	70	60	17 S.
H—3—11.												**H—3—11.**				**H—3—8.**			
8.8	S.	140	5.1									8.6	Ci. Cu.	80	1.0	8.5	N.	131	4.9
11.8	S. Cu.	105	3.0									...	.....	...	...	...	.....	...	...
12.2	Ci. S.	105	3.4									...	.....	...	...	2.2	Ci. S.	132	3.3
12.4	Ci. Cu.	105	3.4									...	.....	...	...	2.2	Ci. Cu.	125	2.7
2.3	Cu.	125	3.9									...	.....	...	...	...	.....	...	...
7.2	A. Cu.	91	2.8									5.6	Ci. S.	340	2.3	6.0	Ci.	111	7.9
...	.....	...	..									...	.....	...	...	6.0	Ci. Cu.	139	2.2
30.1	68	93	2 NE.									30.1	62	79	3 SW.	30.2	60	90	17 SW.
30.0	74	74	4 S.									....	..	..	....	30.1	70	58	27 S.
30.0	71	86	5 SE.									30.0	71	68	5 SW.	30.0	64	77	26 S.
H—6—2.																**H—6—8.**			
8.5	Cu. S.	19	6.0													8.1	S.	117	24.2
8.7	Ci. Cu.	107	2.2													...	.....	...	...
...	.....	...	...													...	.....	...	...
2.1	Cu.	350	2.7													2.2	Cu.	84	8.3
2.3	A. S.	120	1.8													...	.....	...	...
2.6	Cu.	50	2.8													...	.....	...	...
7.0	A. Cu.	115	1.6													...	.....	...	...
7.2	Ci.	120	1.6													...	.....	...	...
7.3	Ci. S.	120	1.7													...	.....	...	...
30.0	65	95	2 N.													30.0	64	90	14 W.
30.0	79	59	8 S.													29.9	75	65	18 S.
30.0	75	82	2 SW.													....	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 19 TO JUNE 22, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
June 19 H. 6. 78°. 31° L. 2. 88°. 48°		8.5 A.S. 36 0.6 ... ... 29.9 81 54 12 SE.	**H—6—19.** ... ... 1.9 Cu. 303 1.3 ... ... 5.2 Cu. 297 1.6 ... . 30.0 86 50 6 W. 29.9 86 54 10 E.	**H—6—4.** 8.8 Cu. S. 148 2.4 ... ... 1.6 S. 203 8.0 ... ... 5.6 S. 183 3.4 30.1 79 79 8 S. 30.1 84 63 8 SE. 30.1 79 83 11 S.	**H—6—18.** **L—2—13.** ... ... 12.7 Cu. 75 2.0 ... ... 30.0 85 47 3 E. ... .
June 20 H. 6. 80°. 32° L. 3. 68°. 48°			**H—6—19.** ... ... 1.9 Cu. 80 1.3 2.8 S. 270 0.7 5.2 Ci. S. 67 1.1 ... ... 30.0 90 70 15 N. 30.0 74 78 12 SW.	**H—6—4.** 8.6 S. 138 27.8 8.7 Ci. S. 128 4.7 ... ... 1.8 S. 206 18.4 1.9 Ci. 131 1.0 5.6 S. 203 16.8 ... ... 30.2 80 79 8 SW. 30.1 86 77 9 SE. 30.1 80 83 12 S.	**H—6—10.** ... ... 12.6 Cu. 124 3.2 ... ... 5.4 A. S. 138 0.2 ... ... 30.0 88 44 4 SW. 29.9 87 48 3 SE.
June 21 L. 2. 82°. 48° H. 6. 78°. 32°					
June 22 H. 6. 81°. 30° L. 3. 66°. 49° H. 2. 98°. 49°			**H—6—19.** ... ... 1.8 Cu. 319 1.7 ... ... 5.1 Cu. 217 1.3 ... ... 30.0 88 58 10 W. 29.9 81 80 7 SW.	**H—6—3.** 9.1 Cu. S. 133 2.9 ... ... 1.7 S. 233 15.1 ... ... 30.2 80 79 5 SW. 30.1 84 63 12 SE. 30.1 75 91 13 S.	**H—6—18.** **H—2—14.** 7.6 Ci. S. 65 1.5 8.0 A. S. 70 2.4 8.1 Ci. 67 1.7 12.5 A. S. 73 3.0 12.6 Cu. 30 3.9 12.7 A. Cu. 65 6.5 ... ... 30.0 75 74 6 SW. 30.0 85 60 5 S. ... .

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 19 TO JUNE 22, 1896.

Washington.					Cleveland.					Detroit.					Buffalo.					Blue Hill.				
	H—6— 9.					**H—6—17.**					**H—6—17.**					**H—6—17.**					**H—6—16.**			
	L—2—14.					**L—2— 6.**					**L—2— 6.**					**L—2— 6.**								
8.4	Ci. Cu.		95	1.6	9.4	Ci.		330	...	...	.....		...	...	8.5	Ci. S.		78	2.7	...	.....		...	...
...	.....		...	...	9.4	Ci. Cu.		330	...	...	.....		...	...	8.8	A. S.		18	4.2	...	.....		...	...
...	.....		...	...	10.9	Cu.		124	2.5	...	.....		...	...	...	.....		...	...	...	.....		...	...
12.8	Cu.		131	3.7	...	.....		.	...	..	.....		...	...	1.7	Ci.		42	4.0	2.1	Ci.		52	2.4
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	2.2	Cu.		94	3.2
7.0	A. Cu.		90	1.8	6.0	Ci. S.		42	1.4	5.4	Cu.		286	6.2	5.4	Ci. S.		111	3.2	5.9	Ci.		40	1.8
30.1	73	88	1 NW.		30.0	78	50	10 SW.		....	..	..	....		30.0	70	60	6 SW.		....	..	..	....	
30.0	84	49	8 S.		....	..	..	....		....	..	..	....		30.0	74	50	12 SW.		29.9	85	38	18 W.	
30.0	80	66	5 S.		29.9	82	45	5 E.		29.9	81	51	8 S.		29.9	74	62	14 SW.		29.9	80	45	19 W.	
	H—6— 9.					**H—6—17.**					**H—6—17.**										**L—3—5.**			
	L—3—20.					**L—3—20.**					**L—3—20.**													
...	.....		...	...	9.2	Ci. S.		70	1.7	...	.....		...	...						8.1	Ci. S.		42	2.6
...	.....		...	...	9.4	Ci. Cu.		85	2.2	...	.....		...	...						8.2	Ci. Cu.		77	3.3
...	.....		...	...	..	.....		...	...	...	.....		...	...						8.3	A. Cu.		82	3.1
2.0	Cu.		115	3.5	2.5	Cu.		125	6.2	1.2	Cu.		93	6.5						2.1	A. Cu.		88	4.7
...	.....		...	...	...	.....		...	...	...	.....		..	...						...	.....		...	...
6.6	Ci.		83	1.7	...	.....		...	...	5.1	Ci.		280	1.7						5.3	Ci.		43	2.2
...	.....		...	...	...	.....		...	...	...	.....		...	...						5.4	Cu. N.		61	1.7
30.1	76	76	4 W.		30.0	78	63	6 S.		....	..	..	....							29.9	72	82	20 SW.	
30.1	90	41	6 S.		30.2	83	52	9 S.		29.9	82	60	12 SW.							29.9	85	41	22 W.	
30.0	83	68	4 S.		29.9	81	65	11 S.		29.9	83	64	8 S.							29.9	84	51	18 W.	
						H—6—17.															**H—6—17.**			
						L—2— 5.															**L—2—14.**			
					9.2	A. Cu.		105	4.1											8.0	A. Cu.		77	3.3
					2.4	Cu. N.		80	4.1											2.1	Ci. S.		92	2.4
					...	.....		...	..											2.1	Cu.		117	9.0
					...	.....		...	...											6.1	S. Cu.		121	4.9
					29.9	78	71	5 E.												29.9	77	74	8 SW.	
					29.8	78	71	10 S.												29.8	86	54	24 SW.	
					....	..	..	....												29.8	77	77	22 SW.	
	H—6—17.					**H—6—17.**					**H—6—17.**					**H—6—17.**					**L—3—12.**			
	L—3—20.					**H—2—14.**					**H—2—14.**					**H—2—14.**								
						L—3—20.										**L—3—20.**								
8.8	A. Cu.		66	3.1	8.6	Ci. S.		95	5.0	8.2	Ci.		66	1.4	8.6	Ci.		88	4.0	8.4	Ci.		101	3.0
...	.....		...	...	8.8	A. Cu.		50	3.4	...	.....		...	...	...	.....		...	...	8.5	Ci. Cu.		93	8.2
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
2.6	Cu.		70	6.7	2.5	A. Cu.		50	3.9	1.4	Ci. Cu.		61	3.3	1.6	Ci. S.		82	4.3	2.1	Ci.		120	2.4
2.8	Ci. S.		102	1.8	2.7	Ci. Cu.		115	2.6	1.5	Cu.		12	7.0	...	.....		...	...	2.2	Ci. S.		112	3.0
...	.....		..	...	...	.....		...	...	...	.....		...	..	...	.....		...	...	...	.....		...	...
5.7	Ci.		45	2.0	6.3	Ci.		80	3.4	5.1	Ci. Cu.		74	13.0	...	.....		...	...	...	.....		...	...
5.8	A. Cu.		45	2.0	...	.....		...	...	5.2	Ci. S.		74	10.8	...	.....		...	...	...	.....		...	...
7.2	A. Cu.		70	2.2	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
29.9	77	72	3 W.		30.0	70	68	8 N.		30.0	71	62	10 N.		29.9	68	51	12 NW.		29.7	73	81	19 W.	
29.9	80	70	6 W.		30.0	72	65	9 N.		30.0	72	57	12 E.		29.9	69	78	24 W.		29.7	83	39	34 W.	
29.9	78	81	4 S.		30.0	73	61	7 N.		30.0	73	53	13 E.		....	..	..	....		....	..	..	...	

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 23 TO JUNE 26, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
June 23			**H—6—19.**	**H—6— 4.** **H—2—13.**	**H—6—18.** **H—2—12.**
H . 6 . 79 . 31		... .	8.9 S. 160 2.1	9.1 S. 107 13.1	7.9 S. 95 9.1
H . 2 . 80 . 44		... .	... .	... .	8.0 A. Cu. 92 7.8
L . 3 . 57 . 57		2.2 Cu. 231 2.6	1.9 Cu. N. 166 3.9	1.6 S. 139 24.5	12.5 Cu. 135 18.8
		... .	... .	... .	12.8 A. Cu. 114 3.9
		5.5 Ci. 141 0.6	5.1 S. 176 4.1	5.6 S. 139 21.2	5.3 S. 166 16.3
		... .	... .	... .	5.4 S. Cu. 154 8.8
		... .	... .	... .	... .
		....	30.0 78 83 5 S.	30.1 82 74 6 SW.	30.0 73 86 6 E.
		29.8 93 29 9 SE.	30.0 80 60 5 SE.	30.1 88 64 3 W.	29.9 84 69 8 S.
		29.7 93 26 10 SE.	29.9 75 89 4 SW.	30.0 82 74 13 NE.	29.9 76 79 16 SE.
June 24					**H—3—19.**
H . 3 . 70 . 44		... .	9.1 Cu. 140 13.5	8.8 Ci. Cu. 126 1.2	7.9 Scud. 131 46.7
L . 2 . 98 . 49		... .	... .	... .	8.0 Ci. Cu. 133 2.7
		1.4 Cu. 196 3.3	2.7 Cu. N. 100 0.7	2.1 Cu. 160 11.3	12.6 A. Cu. 114 8.3
		... .	... .	... .	12.7 Cu. 106 8.9
		5.4 Cu. 187 3.6	5.1 A. S. 104 1.2	5.7 N. 167 3.9	5.6 Ci. 92 2.8
		... .	... .	... .	5.7 Ci. S. 87 2.4
		....	30.1 80 79 12 SW.	30.2 81 80 5 SW.	30.0 77 62 15 SW.
		29.9 93 31 10 SE.	30.1 72 94 7 SE.	30.2 89 71 6 S.	30.0 86 63 12 S.
		29.8 94 29 14 SE.	30.1 85 60 2 SE.	30.2 82 84 6 S.	30.0 84 61 9 S.
June 25		**H—6—19.** **H—4—14.**	**H—6—10.**	**H—6—2.**	**H—6— 9.** **L—2—13.**
H . 6 . 85 . 30					
H . 3 . 65 . 44		8.3 S. 163 6.4	8.7 A. Cu. 117 1.1	9.2 Ci. 126 3.9	7.8 S. 98 17.9
L . 2 . 90 . 48		... .	... .	... .	7.9 Cu. 98 12.0
H . 4 . 107 . 43		... .	1.8 Cu. 152 1.3	2.3 Cu. 119 8.7	12.6 Ci. 128 2.7
		... .	... .	... .	12.7 Cu. 100 15.7
		... .	5.1 Cu. 57 3.3	6.2 Cu. S. 131 1.9	4.9 A. Cu. 55 2.6
		... .	... .	... .	5.0 A. S. 57 2.8
		... .	... .	. ...	... .
		30.1 71 91 4 W.	30.2 80 79 5 W.	30.3 85 73 5 W.	30.2 77 78 8 SW.
		....	30.3 88 40 6 NE.	30.2 96 50 4 SW.	30.2 84 63 9 S.
		....	30.2 90 59 3 SW.	30.3 82 76 9 SW.	30.1 85 70 9 S.
June 26		**H—6—18.** **H—2—20.**	**H—6—10.** **H—2—18.**	**H—6—8.**	**H—6—17.** **H—2— 7.**
H . 6 . 87 . 28					
H . 2 . 94 . 42		... .	8.7 Ci. 227 1.1	8.9 Ci. 24 1.7	7.8 A. Cu. 45 5.6
L . 3 . 69 . 49		. ...	... .	... .	8.0 S. Cu. 46 5.5
		2.3 A. Cu. 154 3.3	1.8 Cu. 58 2.0	2.2 Cu. 47 9.8	12.6 Cu. 72 5.6
		2.8 A. S. 145 3.0	... .	... .	... .
		3.0 C. S. 155 2.5	... .	.. ..	5.5 Cu. 72 4.6
		5.5 Ci. Cu. 132 3.3	... .	... .	... .
		6.0 Ci. 146 1.7	... .	... .	... .
		....	30.3 80 75 4 SW.	30.2 86 70 8 NW.	30.3 77 67 4 NW.
		30.2 81 63 11 S.	30.2 87 60 6 W.	30.2 97 56 5 N.	30.2 .. 56 7 SW.
		30.0 90 58 10 SW.	....	....	30.1 84 59 8 W.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 23 TO JUNE 26, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6—9.				**H—6—17.**				**H—6—17.**				**H—6—17.**				**H—2— 7.**			
H—2—6.				**H—2— 1.**				**H—2— 4.**				**H—2— 1.**				**L—3—19.**			
8.6	Ci. Cu.	64	3.0	9.3	A. Cu.	75	2.9	8.3	Ci. Cu.	82	10.0	...	.....	...	...	...	.....	...	..
...	.....	...	...	...	.....	...	...	8.4	Ci. S.	81	8.7	...	.....	...	...	...	.....	...	...
...	.....	...	..	...	.....	...	...	1.5	Ci. Cu.	87	6.6	1.6	Ci. S.	80	3.8	2.1	Ci.	72	6.7
...	.....	...	...	..	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
4.0	A. S.	75	2.9	...	....	...	...	5.3	A. Cu.	86	4.4	5.4	Ci.	75	4.6	5.9	Ci. S.	81	4.6
4.3	Ci. Cu.	90	3.3	...	.....	...	...	..	.....	...	...	...	.....	...	...	...	.....	...	...
6.7	A. S.	80	3.3	..	.....	...	...	...	.....	...	...	...	.....	...	...	..	.....	...	...
30.1	72	49	8 N.	30.1	69	59	4 S.	30.1	68	74	9 NE.	....	..	..	....	....	..	..	....
30.1	76	48	4 SE.	....	..	..	....	30.1	72	50	9 E.	30.1	74	26	4 W.	30.0	71	37	15 NW.
30.1	74	54	4 E.	....	..	..	....	30.0	71	64	11 E.	30.0	71	37	22 NE.	30.1	70	40	10 NW.
H—3—12.				**H—3—11.**				**H—3—19.**				**H—3—11.**				**H—3—1.**			
								L—2—14.											
...	.....	...	...	...	.....	...	...	...	.....	...	...	8.8	S.	205	10.0	8.1	Ci. S.	68	5.2
...	.....	...	...	...	.....	...	...	...	.....	..	...	8.9	Ci. Cu.	96	3.3	...	.....	...	...
2.1	S. Cu.	220	8.3	2.6	S. Cu.	110	9.9	1.1	A. S.	122	13.6	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
5.6	N.	240	9.2	...	.....	...	...	5.2	Cu.	280	0.8	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.2	66	79	7 NE.	....	..	..	....	....	..	..	....	30.1	65	53	15 SE.	30.2	67	58	5 SE.
30.2	70	65	9 E.	30.1	73	78	8 NW.	30.0	68	81	12 E.	....	..	..	....	....	..	..	....
30.2	68	95	12 E.	....	..	..	....	30.0	71	77	8 E.	....	..	..	....	....	..	..	....
				H—3—19.				**H—3—19.**				**H—3—19.**				**H—3—11.**			
				H—6—17.				**H—6—17.**				**L—2—14.**							
				L—2—14.				**L—2— 6.**											
...	.....	...	...	8.7	Ci. Cu.	90	1.7	...	.....	...	...	...	.....	...	...	8.1	Ci. S.	40	3.9
...	.....	...	..	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.0	S.	310	...	...	.....	...	...	1.6	A. Cu.	72	7.6	1.7	S.	115	12.6	2.1	A. Cu.	150	3.1
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.1	S. Cu.	153	4.9
...	.....	...	...	6.1	Ci.	140	5.1	5.0	A. Cu.	100	8.0	...	.....	...	...	5.8	S. Cu.	63	2.3
...	.....	...	...	...	.....	...	...	5.2	St.	130	9.2	...	.....	...	..	...	....	...	...
...	.....	...	...	...	.....	...	...	5.4	Cu. S.	130	8.3	...	.....	...	...	...	.....	...	...
....	..	..	....	30.1	72	84	Lt. S.	....	..	..	....	....	..	..	....	30.4	64	65	7 SE.
30.2	67	85	5 N.	.....	..	..	....	30.0	81	72	12 SW.	30.1	75	62	4 SW.	30.3	69	57	11 S.
....	..	.	....	30.0	88	55	9 SW.	30.0	84	69	12 S.	....	..	..	....	30.3	64	66	13 SE.
L—3—20.				**H—2—15.**				**H—2— 7.**				**H—2—15.**				**L—3—5.**			
H—6—16.				**L—3—20.**				**L—3—20.**				**L—3—20.**							
H—2—15.																			
...	.....	...	...	9.6	Ci.	105	3.1	...	.....	...	...	8.8	Ci. Cu.	77	8.6	...	.....	...	...
...	.....	...	...	9.7	Fr. Cu.	55	5.9	...	....	...	...	...	.....	...	...	...	.....	...	...
12.4	A. Cu.	50	3.7	...	.....	...	...	1.2	Ci.	98	3.4	1.8	Cu.	40	9.8	2.1	S. Cu.	142	31.1
12.5	Ci.	45	0.9	...	.....	...	...	1.4	Cu.	31	7.6	1.9	Ci.	104	5.3	...	.....	...	...
3.3	Ci. S.	56	2.2	...	.....	...	...	5.4	A. S.	101	4.9	5.3	Ci.	75	6.0	5.9	Ci. Cu.	117	2.6
3.6	A. Cu.	53	4.4	...	.....	...	...	...	.....	...	...	...	.....	...	...	6.0	S.	137	24.2
3.8	Cu. N.	54	4.8	...	.....	...	...	...	.....	...	..	...	.....	...	...	..	.....	...	...
30.2	69	97	4 S.	30.2	73	57	12 NW.	....	..	..	....	30.1	70	66	10 NW.	....	..	..	....
30.0	76	85	5 N.	....	..	..	.....	30.2	78	48	7 NW.	30.0	72	57	24 W.	30.0	69	90	23 SW.
30.1	70	93	4 SW.	....	..	..	.....	30.2	75	55	8 W.	30.1	72	65	15 SW.	30.0	70	89	18 SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 27 TO JULY 1, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
June 27 ° ° H. 2. 80. 40 L. 2. 96. 47			**H—2—20.**	**H—2—5.**	**H—2—11.** **L—2—14.**
		8.3 Ci. Cu. 155 1.2	... .	1.7 Cu. 265 2.8	7.9 A. Cu. 60 5.5
		... .	... .	... .	... .
		2.4 Cu. 135 2.0	1.8 Cu. 78 2.7	... .	12.7 Cu. 85 7.2
		... .	... .	... .	12.8 A. Cu. 86 4.6
		... .	... .	... .	... .
		... .	... .	5.6 Ci. 313 0.6	5.6 S. 124 5.6
		... .	... .	... .	... .
		30.1 79 64 12 SW.	....	....	30.1 72 71 10 N.
		30.0 94 29 5 SW.	30.1 90 48 5 SW.	30.0 91 56 4 NE.	30.0 83 62 6 SW.
		....	....	29.9 86 70 8 E.	29.9 70 89 8 SE.
June 28 ° ° L. 3. 73. 49					
June 29 ° ° H. 5. 97. 37 L. 3. 68. 48		**H—5—12.**	**H—5—6.**		**H—5—7.**
		... .	8.8 Ci. S. 47 1.0	8.9 Ci. 164 0.8	... .
		... .	... .	... .	... .
		1.5 Ci. 141 0.2	12.8 Cu. 16 2.0	1.9 Cu. 125 8.1	12.7 Cu. 32 7.5
		... .	... .	... .	12.8 Ci. 90 6.2
		... .	4.3 Cu. N. 145 1.3	5.6 A. S. 203 2.0	5.0 Cu. 33 4.4
		....	30.0 84 77 6 SW.	30.0 84 69 7 NW.	....
		30.1 76 74 5 N.	30.1 92 48 5 N.	30.0 96 55 5 N.	30.1 82 40 6 W.
		....	30.0 90 52 10 NE.	30.0 84 69 10 S.	30.1 81 44 8 NW.
June 30 ° ° H. 6. 82. 40 L. 3. 66. 50			**H—6—20.**	**H—6—5.**	**H—6—4.**
		... .	9.2 Cu. 48 2.2	9.1 A. Cu. 297 4.4	8.0 Ci. S. 63 4.7
		... .	... .	... .	8.0 Ci. 65 3.5
		1.3 Cu. 229 3.5	12.7 Cu. 38 2.3	2.1 Cu. 257 6.3	12.9 Cu. 326 2.3
		... .	... .	... .	... .
		5.5 Cu. 169 2.0	4.8 A. S. 163 2.1	6.1 S. 272 4.3	... .
		6.0 Ci. 133 1.1	... .	... .	... .
		... .	... .	... .	... .
		....	30.1 85 60 5 E.	30.1 86 77 9 E.	30.3 71 56 4 NE.
		30.1 91 65 5 S.	30.1 90 46 6 NE.	30.1 87 64 9 E.	30.2 83 32 8 N.
		30.0 94 59 6 SE.	30.1 90 44 10 NE.	30.1 82 80 12 E.	....
July 1 ° ° H. 6. 76. 36 L. 3. 64. 49			**H—6—19.**	**H—6—12.**	**H—6—11.**
		8.4 Ci. 214 0.6	8.9 Ci. 2 0.7	8.9 S. 298 21.1	7.8 A. S. 82 1.9
		2.4 Cu. 236 3.2	... .	1.2 A. S. 293 19.9	12.7 Cu. 185 6.8
		... .	4.8 Ci. S.	5.8 Fr. S. 259 16.2	4.9 Cu. 186 3.0
		... .	... .	6.2 Ci. 128 2.8	5.1 Fr. Cu. 159 8.2
		... .	... .	6.5 Ci. S. 77 5.2	... .
		30.1 81 58 9 SW.	30.2 80 42 4 E.	30.2 81 80 3 E.	30.2 76 57 4 NE.
		30.0 94 31 8 S.	....	30.2 84 69 12 E.	30.2 88 39 9 E.
		....	30.0 91 39 2 NW.	30.2 80 79 11 SE.	30.1 89 47 5 E.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 27 TO JULY 1, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—2—2.				**H—2—3.**				**H—2—4.**				**H—2—3.**				**H—2—8.**			
				L—2—14.				**L—2—14.**				**L—2—15.**							
8.7	Ci. Cu.	85	2.7	9.4	Ci. Cu.	90	2.3	8.0	A. Cu.	73	7.3	...	.....	...	...	8.1	Ci. S.	76	3.2
8.9	Ci. S.	85	2.6	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.5	A. Cu.	90	2.8	2.7	A. Cu.	85	2.3	1.3	S. Cu.	90	4.9	1.6	Ci. Cu.	95	7.4	2.1	Ci. S.	98	4.5
1.7	Ci. Cu.	92	2.4	...	.....	...	...	1.4	A. S.	135	4.0	1.7	Ci. S.	95	5.7	2.1	Ci. Cu.	87	4.3
...	.....	...	...	...	.....	...	...	...	.....	....	...	...	.....	...	...	2.2	A. S.	106	3.9
5.8	A. Cu.	98	3.3	...	.....	...	...	5.1	S. Cu.	91	4.1	5.5	Ci. Cu.	106	3.8	6.1	Ci. S.	92	3.5
...	.....	...	...	...	.....	...	...	...	.....	...	...	5.6	Ci.	75	4.0	...	.....	...	...
30.1	71	68	5 N.	30.1	74	58	4 S.	30.1	70	68	2 N.	....	..	..	....	30.0	65	76	11 NW.
30.0	79	57	3 S.	30.0	75	58	8 SE.	30.0	74	62	15 S.	30.1	74	44	12 W.	30.0	78	51	6 N.
29.9	76	68	1 SW.	....	..	..	....	29.9	77	57	12 S.	29.9	75	46	12 W.	29.9	77	55	8 SW.
				L—3—20.												**L—3—5.**			
				9.2	S. Cu.	80	4.8									8.2	A. S.	111	5.3
				10.1	Cu. N.?	80	8.6?									...	.....	...	...
				2.3	Fr. Cu.	80	16.7									2.1	N.	105	7.3
				...	.....	...	...									...	.....	...	...
				29.7	71	81	10 SW.									29.9	62	81	13 SW.
				....	..	..	....									29.8	68	67	13 S.
				....	..	..	....									....	..	..	....
L—3—20.				**H—5—15.**				**H—5—16.**				**L—3—20.**				**L—3—5.**			
				L—3—20.				**L—3—20.**											
9.0	Ci.	115	4.2	9.4	S. Cu.	55	6.6	8.4	Cu.	43	23.3	8.6	Cu. S.	93	9.6	...	.....	...	...
10.3	Cu.	80	5.2	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.3	Cu.	90	4.9	...	.....	...	...	1.6	Cu.	65	4.6	...	.....	...	...	2.1	Cu.	83	9.4
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	..	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
29.9	74	67	4 NW.	29.9	76	63	11 NW.	29.9	67	76	10 NW.	29.8	67	78	30 SW.	....	..	..	....
30.0	84	42	15 SW.	....	..	..	....	30.0	73	42	9 NW.	....	..	..	....	29.8	76	50	22 W.
30.0	77	47	3 NW.	....	..	..	....	....	..	..	....	....	..	..	....	....	..	..	....
H—6—2.												**H—6—3.**				**H—6—7.**			
												L—3—20.				**L—3—12.**			
...	.....	...	..									...	.....	...	...	...	.....	...	...
11.0	Ci.	112	2.4									...	.....	...	...	...	.....	...	...
1.1	Ci.	110	2.4									...	.....	...	...	2.1	Cu.	52	11.0
1.4	Ci. S.	110	2.8									...	.....	...	...	...	.....	...	...
...	.....	...	...									5.4	Ci. S.	55	4.7	...	.....	...	...
6.1	Ci.	90	2.7									...	.....	...	...	...	.....	...	...
6.2	Ci. Cu.	108	3.0									...	.....	...	...	...	.....	...	...
30.3	70	44	7 NE.									....	..	..	....	....	..	..	....
30.3	79	34	12 W.									....	..	..	....	30.2	71	43	18 SW.
30.3	74	43	4 SE.									30.2	71	48	20 W.	....	..	..	....
H—6—3.																**H—6—8.**			
																L—3—12.			
...	.....	...	...													...	.....	...	...
2.4	Cu.	178	2.2													2.0	Ci.	...	...
6.6	Ci.	125	6.8													6.0	Ci.	...	...
...	.....	...	...													...	.....	...	...
...	.....	...	...													...	.....	..	...
....	..	..	....													....	..	..	....
30.3	83	50	8 SE.													30.2	84	44	20 SW.
30.2	79	60	5 SE.													30.2	79	52	16 SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 2 TO JULY 5, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
July 2 ° ° H . 6 . 75 . 35 L . 2 . 99 . 44				**H—6—12.**	**H—6—18.** **L—2—14.**
			... .	9.2 St. 228 2.6	7.7 Ci. S. 85 4.3
			... .	... .	7.8 Ci. Cu. 84 4.7
			... .	.. ..	8.0 A. Cu. 95 5.2
			2.2 Cu. 283 2.9	1.8 Fr. S. 229 14.8	12.8 Cu. 125 8.4
			... .	... .	12.9 Ci. Cu. 59 5.5
			... .	... .	... .
			4.7 A. S. 167 1.0	5.7 St. 231 6.6	5.3 A. S. 73 5.1
			... .	... ...	5.5 A. Cu. 71 5.0
			... .	... .	5.5 Ci. 76 3.5
			....	30.3 77 78 8 SE.	30.2 76 70 8 SE.
			.... 93 .. 4 NW.	30.2 83 73 7 SE.	30.1 90 43 6 S.
			30.0 90 53 8 E.	30.2 83 80 9 S.	30.1 83 51 10 S.
July 3 ° ° H . 6 . 79 . 32 H . 3 . 69 . 50 L . 5 . 98 . 40			**H—6—19.** **L—5—14.**	**H—6—4.**	**H—6—10.** **L—5—15.**
		... .	8.8 Cu. 241 2.7	9.0 Fr. S. 218 16.6	7.8 Cu. 100 8.6
		... .	... .	... .	8.0 Ci. 42 3.2
		... .	... .	... .	8.2 Ci. S. 42 3.3
		1.5 Cu. 325 0.4	12.7 Cu. 298 2.4	2.0 Fr. St. 224 10.8	12.7 N. 78 7.2
		... .	... .	... .	... .
		... .	4.8 Cu. N. 231 1.8	5.2 Cu. 241 15.7	5.4 A. Cu. 46 7.3
		... .	... .	... .	5.5 Ci. S. 46 2.1
		... .	... .	... .	5.6 Ci. Cu. 50 2.3
		... .	... .	... .	... .
		.. ..	... .	... .	... .
		....	30.1 82 52 4 NE.	30. 84 63 10 SE.	30.1 78 69 4 S.
		30.0 96 28 10 SE.	30.1 92 51 5 NE.	30.2 84 66 10 SE.	30.1 86 62 4 SW.
		....	30.0 83 69 15 SE.	30.2 82 66 11 SE.	30.0 83 67 9 S.
July 4 ° ° H . 6 . 84 . 33 L . 2 . 83 . 43					
July 5 ° ° H . 6 . 99 . 32 L . 3 . 71 . 44					

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 2 TO JULY 5, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6—3.				**H—6—10.**				**H—6—18.**				**H—6—9.**				**H—6—9.**			
				L—2—15.				**L—2—15.**											
8.8	Ci. S.	87	0.4	...	.....	...	...	8.3	Ci.	0	0.0	...	.....	...	...	8.4	Ci. Ci. S.	138	1.3
...	.....	...	...	..	....	...	...	8.5	A. Cu.	160	1.5	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.9	Ci. Cu.	130	..	2.3	Fr. Cu.	145	5.2	...	.....	...	...	...	.....	...	...	2.5	Ci.	117	3.2
2.0	Ci.	112	1.3	2.4	Ci.	105	2.0	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	2.5	Cu.	145	2.5	...	.....	...	...	...	.....	...	...	..	.....	...	...
5.4	Ci.	72	1.7	6.0	Cu. N.	115	4.2	5.0	Cu. S.	0	0.0	5.3	Ci. S.	90	2.0	6.3	Ci. Ci. S.	110	2.8
...	.....	...	...	6.2	Ci. Cu.	...	Calm.	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	..	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.2	71	75	2 S.	....	..	..	....	30.1	78	75	9 SW.	....	..	..	....	30.2	72	74	12 SW.
30.2	85	33	6 SE.	30.0	83	55	12 S.	....	..	..	....	....	..	..	....	30.1	81	46	21 S.
30.1	80	56	4 SE.	30.0	85	53	15 SW.	30.0	80	62	4 W.	30.0	83	46	8 SW.	30.1	74	85	21 S.
H—6—9.				**H—6—17.**				**H—6—17.**								**H—6—16.**			
H—3—20.				**H—3—20.**				**H—3—20.**								**H—3—5.**			
				L—5—15.				**L—5—15.**											
8.7	Ci. Cu.	95	1.7	8.9	Cu.	165	7.9	...	.....	...	...					8.1	Cu. Fr. Cu.	39	2.0
8.8	Cu.	102	1.3	...	.....	...	...	...	.....	...	...					...	.....	...	...
..	.....	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
1.5	Cu.	152	1.7	...	.....	...	...	1.4	A. S.	110	0.8					2.0	S.	315	...
1.5	Cu. N.	121	1.5	...	.....	...	...	...	.....	...	...					...	.....	...	...
6.3	Cu. N.	98	2.6	...	.....	...	...	5.2	A. Cu.	92	1.7					6.0	S.	−315	...
6.6	A. S.	40	..	...	.....	...	...	...	.....	...	...					...	.....	...	...
6.4	A. Cu.	90	0.7	...	.....	...	...	...	.....	...	..					...	.....	..	...
6.7	S.	90	15.0	...	.....	...	...	...	.....	...	...					...	.....	...	...
6.5	Fr. S.	180	8.3	...	.....	...	...	...	.....	...	...					...	.....	...	...
30.2	74	81	1 SW.	30.1	77	68	8 S.	....	..	..	....					30.1	73	80	9 SW.
30.1	86	48	10 SE.	....	..	..	....	30.0	85	58	6 SW.					30.2	59	85	28 E.
30.1	73	88	6 SW.	....	..	..	....	30.0	82	72	4 S.					30.2	58	94	14 NE.
				H—6—9.															
				L—2—1.															
				...	.....	...	...												
				1.5	Ci.	90	2.7												
				6.1	Cu. N.	90	3.2												
				6.3	Ci.	60	1.9												
				....	..	..	....												
				29.8	79	79	12 W.												
				29.8	81	72	Lt. W.												
H—6—9.				**H—6—17.**												**H—6—16.**			
L—3—12.				**L—3—11.**												**L—3—1.**			
8.4	S.	135	12.3	9.8	S. Cu.	40	3.4									...	.....	...	...
2.2	A. Cu.	130	3.3	...	.....	...	...									2.0	A. S.	88	10.4
2.2	A. S.	130	2.7	...	.....	...	...									...	.....	...	...
2.3	S. Cu.	97	5.9	...	.....	...	...									...	.....	...	...
6.1	Fr. N.	180	27.5	...	.....	...	...									...	.....	...	..
29.9	76	85	3 SW.	29.9	68	81	6 NW.									....	..	..	....
29.9	..	..	8 W.	....	..	.	....									29.8	63	95	7 E.
29.9	79	79	2 S.	....	..	..	....									....	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 6 TO JULY 9, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
July 6 ° ° H. 6. 79.32 L. 2. 80.45			**H—6—19.** 8.8 A.S. 8 0.2 ... ... 5.0 Cu.N. 341 4.6 ... ... 30.0 78 50 5 E. .... 30.1 76 87 4 SE.	**H—6— 4.** **L—2—13.** 8.7 A.S. 165 24.9 ... ... 1.8 Fr.S. 180 23.9 ... ... 5.5 Fr.S. 208 19.8 5.7 Ci.S. 139 1.4 30.1 83 76 8 S. 30.1 86 77 12 SE. 30.0 81 80 16 SE.	**H—6—10.** **L—2—12.** 7.8 A.Cu. 82 7.7 8.0 Ci.Cu. 85 5.8 8.2 Ci. 123 5.2 ... ... 12.8 Cu. 90 6.3 12.9 Ci. 139 5.2 ... ... 5.1 A.S. 98 4.0 ... ... 30.0 73 69 5 N. 30.0 82 51 9 NW. 29.9 84 51 6 SW.
July 7 ° ° L. 6. 88.30 L. 3. 79.48 H. 2. 99.44		**L—6 19.** **H—2—20.** ... ... 1.5 Cu. 296 2.3 ... ... 5.5 Cu. 270 1.7 5.7 Ci. 42 1.3 ... ... 30.0 92 33 7 NE. 29.9 94 29 11 NE.	**L—6— 4.** **H—2—13.** 8.8 Cu. 281 2.6 ... ... 12.7 Cu. 354 3.2 ... ... 4.9 Cu. 341 4.6 ... ... 30.0 78 60 6 N. 30.0 88 53 10 N. 29.8 90 44 12 N.	**L—6—7.** 8.9 S. 189 5.9 ... ... 1.7 Fr.S. 207 18.9 ... ... 5.7 S. 226 25.9 ... ... 30.1 78 75 3 SE. 30.0 84 73 17 S. 30.0 80 83 12 S.	**L—6— 9.** **L—3—20.** **H—2— 6.** 8.1 Ci. 93 3.6 8.1 Ci.S. 94 3.5 8.4 A.S. 131 5.3 1.5 Fr.Cu. 318 5.9 1.5 Cu. 317 8.3 ... ... 5.5 A.Cu. 126 5.5 5.4 Cu. 305 4.2 5.5 A.S. 126 5.7 30.1 68 58 12 N. 30.1 77 47 10 N. 30.0 77 48 11 N.
July 8 ° ° L. 6. 83.34 L. 3. 65.48 H. 2. 93.44	**L—6—18.** **H—2— 5.** 8.5 A.S. 15 ... ... 1.3 A.S. 46 ... 1.5 Ci.S. 41 ... 5.5 A.S. 14 ... 30.2 70 57 4 E. 30.1 79 59 6 E. 30.1 74 52 7 NE.	**H—2—20.** ... ... 1.5 Cu. 358 1.0 ... ... 5.6 A.Cu. 63 1.4 .... 29.9 95 23 5 SW. 29.9 95 20 12 E.	**L—6—11.** **H—2—13.** ... ... 12.5 Cu. 11 6.2 ... ... 4.8 A.S. 35 2.4 .... 30.0 84 57 8 NE. 29.9 85 79 7 NW.	**L—6—1.** 9.0 S. 182 32.7 ... ... 1.3 S. 180 26.0 ... ... 5.5 S. 138 9.8 29.9 78 75 22 SE. 29.9 80 76 22 S. 29.9 76 74 8 S.	**L—6—10.** **H—2— 6.** 8.8 Ci.S. 151 5.2 ... ... 1.1 Fr.Cu. 331 20.0 1.2 Cu. 330 16.2 .. .. 30.0 67 58 18 NE. 30.0 75 46 22 NE. 30.0 74 50 9 N.
July 9 ° ° L. 2. 83.41 H. 3. 70.40 H. 2. 93.42	**L—2—11.** **H—2— 1.** 8.5 Ci. 72 ... ... 1.7 Ci. 88 ... 1.9 Cu. 116 ... ... 5.5 Cu. 119 ... ... 30.1 72 57 7 E. 30.1 80 48 6 SE. 30.0 82 46 3 E.	**H—2—20.** 8.3 A.Cu. 46 2.5 ... ... 1.1 A.Cu. 90 ... ... 5.1 A.S. 68 ... ... 30.0 81 44 8 S. 30.0 76 66 30 NE. 29.9 74 70 13 S.	**L—2—20.** **H—2—13.** 8.8 Ci.Cu. 24 0.3 ... ... 12.2 Cu. 218 1.3 ... ... 4.6 Cu. 265 2.4 4.8 A.S. 109 1.7 ... ... 30.0 72 50 10 E. 30.0 83 40 6 NW. 30.0 88 39 4 E.	**L—2— 5.** **H—3—20.** 9.2 S. 183 7.4 ... ... 2.0 A.S. 216 26.9 .. .. 5.7 A.S. 180 17.4 ... ... 30.1 79 75 3 W. 30.1 82 80 12 SE. 30.2 78 79 12 S.	**L—2— 1.** **H—3—19.** **H—2— 6.** ... ... 1.3 Fr.Cu. 103 12.7 1.3 A.S. 90 12.5 1.4 A.Cu. 88 9.0 5.1 Cu. 86 3.6 ... ... 30.0 80 73 14 SW. 30.0 83 62 7 SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 6 TO JULY 9, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6—9.				**H—6—17.**				**H—6—17.**											
L—2—5.				**L—2— 1.**				**L—2— 1.**											
8.3	A. Cu.	90	1.8	8.8	Fr. Cu.	90	8.2	8.0	S. Cu.	100	13.2								
8.4	Ci. S.	45	3.0	...	.....	...	...	..	.....	...	...								
8.6	Cu.	140	11.6	..	.....	...	...	...	.....	...	...								
8.7	S.	58	8.1	..	.....	...	...	...	.....	...	...								
8.7	Ci.	30	1.5	...	.....	...	...	...	.....	...	...								
9.3	A. S.	80	2.2	...	.....	...	...	...	.....	...	...								
1.3	Ci. Cu.	40	1.8	2.4	Fr. Cu.	110	5.4	1.1	Cu.	64	6.7								
1.3	Ci. S.	60	2.0	...	.....	...	...	...	.....	...	...								
1.9	Cu.	146	1.8	...	.....	...	...	...	.....	...	...								
6.3	A. Cu.	355	3.0	6.5	Ci. S.	125	4.1	5.2	Cu.	80	3.5								
...	.....	...	...	...	.....	...	...	5.2	A. Cu.	90	6.4								
30.0	74	87	7 SW.	29.9	73	78	6 SW.	29.9	68	81	11 SW.								
29.9	82	74	10 W.	29.9	78	63	12 NW.	29.9	75	60	11 W.								
29.9	74	91	6 S.	29.9	75	91	10 NW.	29.9	77	78	12 NW.								
L—6—16.				**L—6—16.**				**L—6—17.**				**L—3—12.**							
L—3—13.				**L—3—12.**				**L—3—20.**				**H—2—15.**							
H—2—15.				**H—2—15.**				**H—2— 7.**											
11.8	S. Cu.	133	8.1	9.3	Ci. Cu.	45	4.4	...	.....	...	...	8.6	S.	130	10.0				
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...				
...	.....	. .	...	...	.....	...	...	...	.....	...	...	...	.....	..	...				
12.0	A. Cu.	130	2.6	...	.....	...	...	1.2	Cu. S.	222	7.3	1.9	S.	66	9.3				
12.7	Ci. Cu.	128	3.3	...	.....	...	...	...	.....	...	...	...	.....	...	...				
1.0	Cu.	120	8.0	...	.....	...	...	...	.....	...	...	...	.....	...	..				
1.7	Fr. S.	120	7.3	...	.....	...	...	...	.....	...	...	...	.....	...	...				
1.9	Fr. Cu.	65	...	...	.....	...	...	...	.....	...	...	...	.....	...	...				
5.7	Fr. S.	135	3.1	...	.....	...	...	5.2	Cu.	338	9.2	5.2	S.	150	5.7				
5.8	S. Cu.	88	2.7	...	.....	...	...	...	.....	...	...	5.3	Cu. S.	130	5.3				
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...				
30.0	14	93	2 SW.	30.1	68	58	12 N.	....	..	..	....	30.0	57	81	11 NW.				
29.9	82	69	11 SW.	....	..	..	....	30.1	70	60	10 N.	30.0	67	49	12 W.				
30.2	72	75	6 N.	....	..	..	....	30.0	75	74	6 N.	30.0	66	80	12 NW.				
L—6— 8.				**L—6—9.**				**L—6—9.**				**L—6—17.**				**L—6—16.**			
H—2—15.				**H—2—7.**				**H—2—7.**				**L—3—20.**				**L—3—12.**			
												H—2—15.							
...	.....	...	...	...	.....	...	...	8.5	A. S.	129	3.8	8.7	Ci. S.	116	5.0	8.1	Ci. Cu.	123	5.3
..	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	8.1	A. S.	120	5.6
12.7	A. S.	195	5.3	...	.....	...	...	1.4	Cu.	144	7.4	...	.....	...	...	2.1	A. S.	112	5.2
11.0	N.	294	14.0	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.1	Cu. Fr. Cu.		
...	.....	...	...	6.5	A. S.	155	1.6	5.3	A. Cu.	165	7.7	...	.....	...	...	5.6	A. S.	113	5.2
....	..	..	....	....	..	..	....	30.1	70	62	8 N.	30.0	66	60	10 NE.	30.1	60	81	11 W.
....	..	..	....	....	..	..	....	30.1	76	43	9 E.	....	..	..	....	30.1	71	66	11 W.
....	..	..	....	30.0	73	53	14 NE.	30.1	77	71	7 NE.	....	..	..	....	30.1	69	70	13 SW.
L—2— 7.				**L—2— 2.**				**L—2— 3.**				**L—2— 2.**				**L—2—15.**			
H—3—11.				**H—3—19.**				**H—3—19.**				**H—3—10.**				**H—3— 8.**			
H—2—15.				**H—2— 7.**				**H—2— 7.**				**H—2—15.**							
9.0	S. Cu.	180	15.1	9.2	Fr. Cu.	200	9.4	...	.....	...	...	8.7	Cu. S.	116	5.2	8.1	Ci.	102	2.4
10.5	A. Cu.	175	3.6	...	.....	...	...	...	.....	...	...	...	.....	...	...	8.2	Ci. Cu.	100	3.2
...	.....	. .	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	8.3	{A. Cu. or S. Cu.}	107	10.6
1.9	A. Cu.	170	3.3	2.5	A. Cu.	180	10.2	1.3	Cu. N.	244	14.0	1.7	Cu. S.	114	5.2	2.1	Ci.	72	0.8
2.0	S. Cu.	170	12.3	2.8	S. Cu.	180	17.3	...	.....	...	...	...	.....	...	...	2.1	Cu.	104	4.0
...	.....	...	...	...	.....	..	...	...	.....	...	...	...	.....	...	...	...	.....	...	..
6.1	A. Cu.	160	3.9	6.6	S. Cu.	170	23.9	...	.....	...	...	5.7	Cu. S.	115	5.6	...	.....	...	...
7.1	Ci.	160	2.8	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
7.2	A. S.	160	3.0	...	.....	...	...	...	.....	...	...	...	.....	...	..	...	.....	...	...
30.1	74	93	6 SE.	29.8	68	67	20 SE.	....	..	..	....	30.0	68	78	12 SE.	30.3	73	65	8 SW.
30.1	80	68	15 S.	29.9	68	67	22 SE.	29.9	68	78	16 SE.	30.0	81	48	12 S.	30.2	80	80	16 SW.
30.1	78	73	6 SW.	29.9	65	75	30 SE.	....	..	..	....	30.0	83	49	12 W.	....	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 10 TO JULY 13, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
July 10 ° ° H. 6. 77. 34	... . 1.8 Cu. 173 ... . 5.8 Cu. 228 ... ... 30.1 82 38 8 SE. 30.1 84 37 6 SE.	8.5 A. Cu. 80 3.4 9.0 Fr. S. 180 8.3 ... . 1.3 Cu. 84 2.3 ... . 5.5 N. 33 1.3 ... . 30.1 72 86 6 SE. 30.0 88 44 8 W. 30.0 70 90 12 SE.	**H—6—19.** 8.8 A. S. 66 0.3 ... . 12.7 Cu. S. 274 1.9 ... . 4.7 Cu. 245 2.8 5.0 A. S. 90 1.9 30.1 82 53 4 SE. 30.1 87 51 2 W. 30.0 88 49 4 NW.	**H—6—4.** 9.0 A. S. 145 6.6 ... . 2.2 Fr. S. 106 21.1 ... . 5.5 Fr. S. 223 24.7 ... . 30.3 80 75 7 SE. 30.3 82 76 13 SE.	**H—6—10.** 8.0 Ci. 108 4.8 8.2 A. Cu. 109 ... ... 1.3 Fr. Cu. 180 1.3 1.6 Cu. 186 2.0 ... . 30.2 75 59 4 S. 30.2 85 44 9 SE. ....
July 11 ° ° H. 6. 79. 33 L. 3. 60. 49	... . 1.8 Cu. 153 ... ... 5.3 Cu. 156 ... ... 30.1 86 44 10 S. 30.1 86 47 8 S.	8.2 Fr. S. 216 11.7 8.5 A. S. 173 2.8 8.8 Ci. 156 2.5 9.3 Cu. 200 6.7 1.5 Cu. 220 2.6 1.5 Ci. 127 ... ... 5.5 A. S. 280 1.3 5.5 A. Cu. 314 1.7 6.0 Ci. Cu. 156 1.3 ... . 30.1 72 86 6 S. 30.1 82 52 4 S. 30.1 74 74 12 SE.	**H—6—19.** 8.8 Cu. 4 2.7 ... . 12.4 A. S. 218 2.4 ... . 4.6 Cu. 172 ... 4.7 S. 175 1.7 ... . 30.2 82 60 9 NE. 30.2 81 54 6 SE. 30.1 81 72 7 SE.	**H—6—4.** 9.0 Cu. 233 8.0 ... . 3.0 S. 232 8.1 ... . 30.3 85 63 3 S. 30.3 86 60 12 SE.	**H—6—10.** 8.0 A. Cu. 110 6.2 8.2 Ci. Cu. 110 3.7 ... . 1.1 Fr. Cu. 120 4.6 1.2 Cu. 118 10.1 ... . 5.2 A. S. 154 5.2 5.3 Ci. 156 3.7 5.5 A. Cu. 118 4.9 5.8 Ci. Cu. 124 5.2 30.2 77 60 4 SE. 30.2 86 57 3 N. 30.2 83 63 3 S.
July 12 ° ° H. 6. 80. 32 L. 3. 65. 50		... . 5.5 A. S. 161 3.3 6.0 A. Cu. 168 3.0 .... 30.1 74 86 12 S.			
July 13 ° ° H. 6. 85. 31 L. 3. 60. 47 H. 2. 94. 52 L. 4. 105. 45	**H—6—18.** **H—2—13.** **L—4—14.** 10.4 Cu. 143 ... ... 1.8 Cu. 146 ... ... 5.7 Cu. 225 ... ... 30.1 .. .. 13 SW. 30.0 88 49 15 SW. 30.0 89 47 12 SW.	**H—6—19.** 8.5 A. Cu. 168 3.3 8.3 Fr. Cu. 200 13.3 1.5 Cu. 202 4.7 1.9 Ci. 172 2.4 5.5 A. S. 169 1.7 6.0 Cu. N. 188 ... 30.2 73 86 12 SE. 30.0 84 56 16 S. 30.0 85 66 8 SE.	**H—6—11.** 8.8 Cu. 348 3.0 ... . 12.8 Cu. 216 3.0 ... . 4.8 A. S. 79 2.3 ... . 30.3 80 48 5 W. 30.2 86 55 6 W. 30.1 90 52 7 SW.	**H—6—2.** 9.3 A. S. 45 3.4 ... . 1.7 Cu. 41 5.4 ... . 5.3 S. Cu. 95 10.7 ... . 30.3 85 66 6 W. 30.1 92 68 4 NE. 30.1 84 73 10 SW.	**H—6—9.** ... . 1.2 Fr. Cu. 78 4.0 1.3 Cu. 67 6.3 5.2 A. S. 70 4.8 5.5 Cu. 68 ... . 30.1 90 53 8 W. 30.0 88 54 10 SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 10 TO JULY 13, 1896.

Washington.					Cleveland.					Detroit.					Buffalo.					Blue Hill.				
H—6—9.					**H—6—10.**					**H—6—18.**					**H—6—17.**					**H—6—16.**				
8.5	N.		176	5.8	...	.....	...	...		8.3	A. S.		116	25.2	8.8	Ci. Cu.		121	8.0	8.2	Ci.		87	2.3
8.3	Fr. N.		180	16.7	...	.....	...	...		...	.....		...	...	...	.....		...	..	8.3	{Ci. Cu. or A. Cu.}		142	3.3
11.7	A. S.		130	3.0	...	.....	...	...		...	.....		...	...	...	.....		...	...	8.3	S. Cu.		60	34.7
2.2	A. S		128	4.2	2.2	Fr. Cu.		130	5.2	1.0	Cu.		90	13.4	...	.....		...	...	2.1	Ci. Cu.		...	...
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	2.2	Cu. Fr. Cu.		105	10.0
6.2	A. Cu.		117	2.4	...	.....		...	...	5.2	A. Cu.		82	14.0	...	.....		...	...	5.2	Ci. S.		116	3.1
6.8	S.		180	16.7	...	.....		...	...	...	.....		...	..	...	.....		...	...	5.2	Cu. Fr. Cu.		108	9.7
30.3	73	72	6 S.		....	..	..	....		30.1	68	90	18 SW.		30.1	68	58	24 SW.		30.2	75	83	16 SW.	
30.2	80	70	7 S.		30.1	72	77	14 NW.		30.1	75	66	16 W.		....	..	..	....		30.2	85	47	24 W.	
30.2	74	88	8 S.		....	..	..	....		30.1	79	68	16 SW.		....	..	..	....		30.2	80	60	22 SW.	
H—6—9.										**H—6—17.**										**H—6—16.**				
																				L—3—20.				
9.2	Ci.		103	3.3						...	.....		...	...						8.1	Ci. Cu.		102	7.5
9.4	Ci. Cu.		103	3.4						...	.....		...	...						8.2	Cu. Fr. Cu.		110	32.0
9.5	Ci. S.		103	3.3						...	.....		...	...						...	.....		...	...
...	.....		...	...						...	.....		...	...						...	.....		...	...
1.0	Ci. S.		103	2.5						2.2	Cu.		82	6.4						2.1	Cu. Fr. Cu.		75	8.9
1.3	Ci.		103	3.3						...	.....		...	...						...	.....		...	...
1.2	A. S.		103	3.3						...	.....		...	...						...	.....		...	...
4.0	Ci. Cu.		95	2.5						...	.....		...	...						...	.....		...	...
5.6	Ci.		90	3.2						...	.....		...	...						5.9	A. Cu.		59	5.3
5.6	Ci. Cu.		90	2.8						...	.....		...	...						...	.....		...	...
...	.....		...	...						...	.....		...	...						...	.....		...	...
...	.....		...	...						...	.....		...	...						...	.....		...	...
30.2	74	85	2 SW.							....	..	..	....							30.1	74	86	18 SW.	
30.2	84	46	6 SW.							30.2	86	36	8 SW.							30.0	81	48	38 W.	
30.2	80	68	3 SW.							....	..	..	....							30.0	78	57	19 NW.	
																				H—6—16.				
																				L—3—20.				
																				8.1	Ci. S.		62	1.7
																				2.1	Ci. S.		64	1.2
																				2.2	Cu. Fr. Cu.		74	3.9
																				...	.....		...	...
																				...	.....		...	...
																				30.0	75	68	13 W.	
																				29.9	87	45	18 W.	
																				29.9	83	52	19 SW.	
H—6—16.					**H—6—17.**					**H—6—17.**					**H—6—17.**					**L—3—20.**				
8.9	Ci.		28	0.8	...	.....		...	...	5.4	S. Cu.		102	6.1	...	.....		...	...	8.2	Ci.		78	1.4
...	.....		...	...	...	.....		...	...	...	.....		...	..	...	.....		...	...	...	.....		...	...
1.5	Cu.		52	4.9	2.1	Cu.		95	5.0	1.2	Cu. N.		49	8.4	1.7	Cu. S.		112	5.5	2.6	Ci.		78	1.3
...	.....		...	...	2.5	Ci. S.		40	2.8	..	.....		...	...	...	.....		...	...	2.2	Cu.		67	5.8
6.2	Ci. Cu.		20	1.8	...	.....		...	...	4.9	S. Cu.		61	14.7	...	.....		...	...	6.2	N.		96	4.8
6.4	Ci. S.		20	1.7	...	.....		...	...	5.0	A. Cu.		61	13.3	...	.....		...	...	...	.....		...	...
30.0	78	70	12 NW.		29.9	86	57	18 NW.		29.9	78	69	9 SW.		....	..	..	....		29.9	77	67	13 W.	
30.0	88	43	6 NW.		....	..	..	....		29.9	89	67	22 W.		29.9	74	70	18 W.		29.9	89	47	25 W.	
30.0	84	62	2 W.		....	..	..	....		29.9	73	91	12 SW.		....	..	..	....		29.8	77	70	13 W.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 14 TO JULY 17, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
July 14	**H—6—18.** **L—2—13.**	**H—6—19.**	**H—6—3.**	**H—6—8.**	**H—6—17.** **H—2—20.**
H . 2 . 78 . 48					
H . 6 . 88 . 29	... .	8.1 Fr. Cu. 179 18.0	... .	9.3 A.Cu. 101 4.0	7.9 Ci. 78 1.8
L . 2 . 95 52	... .	8.5 Ci. Cu. 155 1.7	... .	... .	8.2 A. Cu. 67 5.7
L . 3 . 61 . 45	... .	... .	... .	... .	8.3 S. Cu. 67 7.2
	1.3 Cu. 139 ...	1.6 A.Cu. 129 1.7	12.6 Cu. 146 4.2	1.7 Cu. 14 7.2	1.3 S. Cu. 90 2.2
	... .	1.7 Cu. 192 6.6	... .	... .	1.4 Cu. 93 5.8
	... .	... .	... .	... .	1.6 Fr. Cu. 82 10.4
	5.7 Cu. 135 ...	5.6 Ci. Cu. 125 1.0	... .	5.8 Cu. 93 4.3	5.2 S. 33 2.0
	... .	... .	... .	... .	... .
	....	30.1 78 63 16 SW.	....	30.2 88 58 8 W.	30.1 78 67 ... SW.
	30.0 90 67 14 S. W.	30.0 86 51 12 S.	30.1 89 49 8 SW.	30.1 93 46 9 NW.	30.0 90 64 10 SW.
	29.9 93 48 12 S. W.	30.0 87 45 14 S.	....	30.0 88 61 12 SW.	30.0 84 66 8 SW.
July 15	**H—6—18.**	**H—6—19.**	**H—6—4.**	**H—6—8.**	**H—6— 9.** **L—3—20.**
L . 3 . 76 . 48					
H . 6 . 87 . 30	... .	... .	... .	... .	7.9 A. S. 98 7.3
	1.2 Cu. 116 ...	1.7 Ci. 94 1.2	... .	1.7 Cu. 88 10.0	1.3 Cu. 84 12.2
	... .	2.2 Cu. 167 3.5	... .	... .	1.3 A. S. 232 7.5
	... .	.. ..	... .	... .	1.3 Fr. Cu. 101 13.3
	5.5 S. Cu. 78 ...	... .	4.8 A. S. 352 2.1	5.5 Fr. S. 102 10.7	5.3 S. Cu. 72 5.8
	... .	... .	... .	... .	... .
	... .	... .	... .	... .	... .
	....	....	....	....	29.9 82 71 9 SW.
	29.9 94 44 5 W.	30.0 88 43 20 SW.	....	30.0 95 44 9 NW.	29.8 92 72 22 SW.
	29.8 93 68 8 SW.	....	30.0 90 41 12 SW.	30.0 87 70 14 S.	29.8 78 85 7 S.
July 16	**H—2—5.**		**H—6—18.**	**H—6—9.**	**H—6—17.** **H—2—14.**
H . 6 . 81 . 26					
L . 3 . 65 . 49	10.4 S. Cu. 297 ...	8.8 A. S. 136 2.3	8.8 Ci. 62 0.7	9.3 A. S. 100 7.7	... .
H . 2 . 97 . 46	... .	... .	... .	... .	... .
	1.3 S. Cu. 284 ...	1.3 S. 163 2.8	12.4 Cu. 149 1.8	1.8 A. S. 131 6.9	1.2 Cu. 349 10.8
	1.6 Ci. 105 ...	... .	... .	... .	1.3 A. Cu. 95 7.5
	5.4 Cu. 279 ...	5.5 A. Cu. 174 3.2	4.8 Ci. 254 1.3	5.9 A. S. 11 3.4	5.1 Cu. 54 8.3
	30.1 70 69 10 NE.	30.0 75 80 4 S.	30.0 81 46 10 W.	30.0 81 76 8 W.	29.9 63 95 12 NW.
	30.0 76 59 8 E.	29.9 82 58 18 SW.	30.0 88 55 5 SW.	30.0 93 51 8 SW.	30.0 75 74 14 N.
	30.0 77 58 7 E.	....	29.9 92 46 10 SW.	29.9 85 70 12 N.	30.0 76 59 12 N.
July 17	**H—6—18.** **H—2—20.**	**H—6—18.**	**H—6—10.** **H—2—20.**	**H—6— 8.** **H—2—13.**	
H . 6 . 87 . 28					
H . 2 . 85 . 45	8.6 S. Cu. 160 ...	8.3 Fr. Cu. 170 15.2	8.7 A. Cu. 354 2.0	9.3 S. 125 5.1	
	... .	... .	... .	... .	
	... .	... .	... .	... .	
	... .	1.3 Cu. 187 5.0	12.6 Cu. 152 2.0	1.8 S. 104 3.7	
	... .	1.7 Ci. 345 1.2	... .	... .	
	... .	5.4 A. Cu. 142 2.4	... .	5.8 S. 95 3.6	
	... .	5.5 A. S. 329 1.7	... .	... .	
	... .	5.9 Ci. S. 53 1.8	... .	... .	
	30.0 67 76 12 SE.	30.0 77 71 14 SW.	30.0 90 48 12 W.	30.1 77 83 9 W.	
	....	29.9 88 46 12 S.	30.0 90 53 5 W.	30.0 85 63 4 SW.	
	....	29.8 91 33 12 SW.	30.0 94 46 6 W.	30.1 81 73 14 S.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 14 TO JULY 17, 1896.

Washington.					Cleveland.					Detroit.					Buffalo.					Blue Hill.				
	H—6—16. H—2— 5. L—3—19.					H—2—12.					H—2—12. L—2—14.					H—2— 5. L—3—19.					H—2— 6. L—3—11.				
8.5	Ci. Cu.	73	2.4		...	.....	...	...		8.2	Cu. S.	65	11.1		8.7	Ci. Cu.	115	4.0		8.4	A. Cu. A. S.	266	6.2	
...	.....	...	..		...	.....	...	...		...	.....	...	...		8.9	Ci. S.	115	2.7		...	.....	...	...	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...	
1.6	Ci. Cu.	68	2.8		2.2	A. Cu.	80	3.8		1.7	Cu.	73	18.2		1.7	Cu.	110	1.8		2.1	Ci. S.	100	3.9	
1.7	Fr. Cu.	52	4.1		2.3	Cu.	115	6.5		...	.....	...	...		...	.....	...	...		2.2	Ci. Cu.	102	3.5	
...	.....	...	...		2.6	Ci. S.	65	2.6		...	.....	...	...		...	.....	...	...		2.2	Cu. N.	72	3.9	
6.5	A. S.	63	1.3		6.4	Ci. S.	85	2.5		5.0	Cu.	82	8.3		5.2	Ci. Cu.	113	2.7		5.8	Ci. Cu. A. Cu.	79	4.2	
6.7	Ci. Cu.	60	1.3		...	.....	...	...		...	.....	...	...		5.3	Ci. S.	114	2.0		...	.....	...	...	
30.0	78	75	2	SW.	....	..	..	....		30.0	72	77	4	E.	30.0	70	64	7	NE.	29.8	73	86	15	NW.
30.0	87	54	5	NW.	28.9	82	72	7	N.	29.9	80	68	8	SW.	29.9	81	53	6	SW.	29.9	75	70	11	E.
29.9	78	87	2	W.	29.8	79	79	7	S.	....	..	..	....		29.8	78	53	5	SW.	29.9	72	80	11	SE.
	H—6—16. L—3—13.					H—6—17. L—3—12.					H—6—17. L—3—12.					L—3—5.					L—3—6.			
8.6	Fr. Cu.	94	3.3		10.1	S. Cu.	80	11.5		8.2	Cu. S.	67	45.4		8.4	Cu. S.	110	6.7		8.1	N.	144	13.4	
1.3	A. Cu.	80	3.7		...	.....	...	...		1.1	Cu. S.	62	19.5		1.2	Cu. S.	108	6.6		2.1	A. Cu.	109	5.6	
1.5	S. Cu.	91	5.2		...	.....	...	...		...	.....	...	...		...	.....	...	...		2.3	S. Cu.	110	6.7	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		2.2	Fr. Cu.	123	18.2	
6.0	Ci. S.	110	1.3		...	.....	...	...		5.1	A. S.	137	8.4		5.2	Ci. S.	111	2.9		5.5	Ci. S.	89	4.3	
6.0	Cu. N.	110	7.0		...	.....	...	...		5.2	Cu.	70	9.1		5.5	Cu. S.	109	5.0		5.5	Ci. Cu.	96	1.9	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		5.6	A. S.	88	2.1	
29.9	79	79	3	S.	29.8	72	86	14	W.	29.8	71	88	7	SW.	29.7	74	93	34	SW.	29.8	70	89	20	SW.
29.8	86	61	8	SW.	....	..	..	....		29.8	80	60	10	NW.	29.7	72	84	34	W.	29.6	80	79	26	SW.
29.8	82	92	Calm.		....	..	..	....		29.8	72	77	11	NE.	29.7	76	84	28	SW.	29.6	78	83	22	SW.
	H—2—14.					H—2—6.					H—2—6.										L—3—12.			
8.8	Fr. Cu.	48	5.8		9.0	Cu.	3	5.2		8.2	Cu.	358	12.8							8.2	N.	50	8.2	
9.0	A. Cu.	103	3.6		...	.....	...	...		...	.....	...	...							...	.....	...	...	
1.2	Cu. S.	60	3.3		...	.....	..	...		1.1	S. Cu.	10	5.1							2.2	Ci. Cu.	110	6.9	
...	.....	...	...		...	.....	...	...		...	.....	...	...							2.1	Cu. Fr. Cu.	102	5.2	
6.7	A. S.	105	4.4		6.3	Cu.	00	4.9		4.9	Cu.	2	16.5							5.4	A. S.	106	6.7	
29.8	76	78	3	NW.	29.9	66	61	14	N.	30.0	60	73	11	N.						29.7	63	97	7	W.
29.9	70	90	10	E.	....	..	..	....		30.0	66	42	6	N.						29.7	76	44	10	W.
29.9	68	83	4	NE.	30.0	67	53	13	N.	30.0	66	52	9	NE.						29.8	73	50	10	W.
	H—6—16. H—2— 6.					H—2—1.					H—2—1.					H—2—7.					H—2—15.			
8.8	A. Cu.	35	2.9		8.3	Cu.	00	1.9		...	.....	...	...		...	.....	...	...		8.2	Ci. S.	136	3.8	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		8.3	A. S.	160	4.3	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		8.3	Fr. Cu.	106	3.3	
1.0	Cu.	29	3.3		...	.....	...	...		1.2	Cu.	272	...		1.1	Cu. S.	26	1.9		2.1	Cu. Fr. Cu.	56	4.1	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...	
...	.....	...	...		..	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...	
30.1	58	61	6	N.	30.2	65	61	5	SE.	....	..	..	....		....	..	..	....		30.0	62	69	12	N.
30.1	75	44	9	NW.	....	..	..	....		30.2	69	38	10	E.	....	..	..	....		30.1	71	58	10	E.
....	..	..	....		....	..	..	....		...	..	..	....		....	..	..	....		30.2	66	68	12	SE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 18 TO JULY 21, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
July 18 ° ° H . 3 . 69 . 46 L . 2 . 96 . 52 L . 5 . 98 . 38	**L—5—2.** **L—2—13.** 11.3 Fr. S.* 192 ... 11.4 S. Cu. 172 ... 11.5 Ci. Cu. 112 ... 1.4 S. 162 ... 2.4 Fr. S. 215 ... 2.5 S. N. 73 ... ... 30.0 80 74 7 E. 29.9 82 78 8 SE.	**L—5—5.** 8.3 Fr. Cu. 171 13.2 ... ... 1.4 Cu. 197 3.8 ... ... 5.5 Cu. 197 4.1 ... ... 30.0 78 71 12 SW. 30.0 90 44 12 SW. 29.9 92 40 12 SE.	**L—5—6.** 8.8 A. Cu. 341 0.3 ... ... 12.5 Cu. 37 1.7 ... ... 30.1 84 64 4 W. 30.1 90 56 4 NW.	9.3 Cu. 187 11.7 ... ... 1.7 S. 132 19.6 ... ... 5.7 Ci. S. 69 Calm ... ... 30.2 83 73 6 S. 30.2 84 73 15 SE. 30.2 82 65 12 S.	**L—5—15.** ... ... 1.2 Ci. S. 54 2.2 ... ... 5.1 A. S. 86 2.1 ... ... 30.2 70 60 4 N. 30.2 86 50 6 S. 30.1 85 53 5 SE.
July 19 ° ° H . 3 . 66 . 42 L . 5 . 95 . 39		**L—5—12.** 8.5 Ci. 328 1.4 1.8 Cu. 157 2.6 ... ... 30.1 80 63 16 SW. 30.0 92 37 12 SW.			
July 20 ° ° H . 6 . 76 . 39 L . 2 . 87 . 49	**L—2—20.** ... ... 11.3 Cu. 255 ... ... 5.5 Ci. 84 ... ... 30.0 82 65 5 NE. 30.0 84 66 5 NE.	8.5 Ci. 316 1.2 ... ... 1.1 Ci. 298 1.4 1.4 Cu. 230 1.2 ... ... 5.4 Ci. 313 1.1 ... ... 30.1 81 58 10 W. 30.0 90 40 8 SE. 29.9 91 37 9 SE.	**H—6—19.** 8.8 Cu. 354 3.0 ... ... 12.5 Cu. 138 2.9 ... ... 4.7 A. S. 186 1.3 ... ... 30.2 83 58 9 S. 30.1 86 57 8 SW. 30.1 85 62 12 SE.		**H—6—18.** **L—2—13.** 7.9 S. 118 13.5 8.3 Fr. S. 124 50.8 8.1 S. Cu. 119 13.3 8.2 Cu. 118 12.8 ... ... 5.0 Fr. Cu. 114 5.8 5.2 Cu. 192 20.8 5.2 A. Cu. 102 8.5 30.1 76 80 8 S. ... . 30.1 74 95 10 SE.
July 21 ° ° H . 6 . 78 . 32 L . 3 . 69 . 49	8.5 Cu. 117 ... 8.5 S. Cu. 124 ... ... 2.1 Cu. 135 ... ... 5.7 S. Cu. 98 .. 5.8 Cu. 82 ... ... 30.0 75 83 10 S. 30.0 86 72 9 SW 29.9 .. .. 11 SW	8.2 Ci. 315 1.2 8.5 Fr. Cu. 155 10.0 ... ... 1.2 Cu. 173 4.8 ... ... 5.5 Cu. 195 3.8 ... ... 30.1 80 64 14 SW. 30.0 90 41 12 S. 29.9 92 35 14 S.	**H—6—19.** 8.7 S. Cu. 278 1.7 9.2 Cu. 354 2.7 ... ... 12.5 Cu. 142 2.3 ... ... 4.6 Ci. 82 1.1 ... ... 30.2 84 60 9 SW. 30.2 88 52 11 SW. 30.1 91 50 8 SW.		**H—6—18.** 8.1 A. Cu. 81 5.7 8.2 S. 133 25.3 8.2 Ci. Cu. 80 ... 8.2 Fr. S. 133 26.7 12.7 Cu. 102 29.3 12.9 Ci. Cu. 105 3.5 5.3 A. Cu. 116 4.0 5.4 A. S. 116 4.2 ... ... 30.1 73 92 8 SW. 30.1 80 79 12 SW. 30.1 74 87 7 S.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 18 TO JULY 21, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—3—20.				**H—3—19. L—5—16.**				**H—3—19. L—5—16. L—2—14.**				**H—3—11.**				**H—3—1.**			
9.7	Cu.	254	2.0	9.7	Ci.	40	1.4	8.1	Cu.	72	5.3	8.5	Ci. Cu.	119	1.7	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	..	...	...	.....	...	...
1.4	Ci.	41	1.3	2.1	Cu.	170	5.9	1.2	S. Cu.	68	6.8	...	.....	...	...	...	.....	...	...
1.2	Cu.	240	1.6	2.2	A. Cu.	100	3.2	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	..	...	...	.....	...	...
6.3	Ci.	28	1.2	5.9	Cu.	155	5.1	5.2	A. S.	132	6.3	5.2	A. S.	119	1.8	5.4	Ci.	24	2.9
6.4	Ci. Cu.	29	1.4	6.0	Ci. Cu.	105	1.4	...	.....	...	...	5.5	A. Cu.	119	2.0	...	.....	...	...
30.3	68	74	Calm.	30.2	74	54	7 SE.	30.2	69	65	4 SE.	30.3	66	52	5 S.	30.4	68	76	9 NE.
30.3	78	43	3 E.	30.2	79	50	11 S.	30.2	75	49	8 SE.	....	..	..	....	30.4	72	55	11 NE.
30.3	75	53	5 SE.	30.2	79	57	10 S.	30.2	75	47	4 S.	30.2	76	54	5 W.	30.4	68	60	12 E.
				H—3—19. L—5—15.												**H—3—4.**			
				9.2	St.	95	2.6									8.9	Cu.	309	5.3
				...	.....	...	...									2.0	Ci.	92	...
				...	.....	...	...									2.1	Cu.	125	5.3
				...	.....	...	...									8.3	A. Cu.	113	2.3
				30.2	75	74	10 SW.									30.4	68	75	6 NE.
				....	..	..	....									30.3	72	61	10 SE.
				....	..	..	....									30.3	63	83	15 S.
H—6—9. L—2—14.				**H—6—18. L—2—6.**				**H—6—18. L—2—6.**								**H—6—16. L—2—14.**			
8.8	Fr. Cu.	137	18.2	9.1	Cu. N.	135	25.4	...	.....	..	...					8.2	Ci.	116	2.3
9.0	A. Cu.	80	1.5	...	.....	...	...	...	.....	...	...					8.3	Ci. Cu.	107	3.6
9.3	Ci.	51	1.3	...	.....	...	...	...	.....	...	...					...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
1.1	Ci. Cu.	84	1.0	4.8	Cu. N.	100	9.4	1.0	Cu. S.	107	19.5					2.1	Ci. Cu.	104	2.9
1.1	Fr. Cu.	125	5.6	...	.....	...	...	...	.....	...	...					2.2	S. Cu.	139	12.4
1.3	Cu.	86	5.6	...	.....	...	...	...	.....	...	...					...	.....	...	...
1.6	Ci. S.	86	1.2	...	.....	...	...	...	.....	...	...					...	.....	...	...
5.4	Ci. S.	60	1.2	6.5	{Cu. N. / Fr. St.}	80	12.3	5.0	Cu. S	95	8.3					...	.....	...	...
...	.....	...	...	6.6	A. S.	95	4.5	...	.....	...	...					...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
30.2	78	80	8 S.	30.0	73	88	17 SW.	....	..	..	....					30.2	67	85	15 SW.
30.1	86	60	12 S.	29.9	74	95	13 W.	29.9	76	77	9 SW.					30.1	73	68	29 SW.
30.0	82	72	12 S.	29.9	74	91	8 SW.	29.9	77	71	9 SW.					30.0	68	100	32 S.
H—6—9. L—3—20.								**H—6—17. L—3—20.**								**H—6—16. L—3—5.**			
9.3	A. S.	100	2.6					...	.....	...	...					8.2	N.	101	68.9
...	.....	..	...					...	.....	...	...					...	.....	...	...
...	.....	...	...					...	.....	...	...					...	.....	...	...
...	.....	..	...					...	.....	...	..					...	.....	...	...
1.3	S. Cu.	164	2.4					1.3	Cu.	165	17.5					2.1	Ci. S.	104	4.0
4.4	N.	102	1.7					1.4	A. Cu.	113	6.3					2.1	Cu. Fr. Cu.	106	10.7
6.7	A. S.	118	2.0					5.1	Cu. S.	110	9.4					6.0	{Ci. Ci. S. / & Ci. Cu}	111	5.4
...	.....	...	...					...	.....	...	...					6.1	Cu.	189	6.7
...	.....	...	..					...	.....	...	...					6.1	S. Cu.	125	33.3
30.1	78	81	4 NW.					....	..	..	....					30.0	71	99	21 W.
30.1	83	73	4 N.					30.0	78	75	9 SW.					30.0	82	72	17 SW.
30.1	76	89	2 S.					30.0	82	68	7 SW.					30.0	80	75	11 SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 22 TO JULY 26, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
July 22 ° ° H . 6 . 86 . 29 L . 2 . 90 . 50	**H—6—18.** **L—2—20.** 8.5 Ci. Cu. 80 ... ... 3.0 Cu. 122 ... ... 30.1 77 80 3 S. 30.1 90 71 7 NW.	**H—6—19.** ... . 1.6 Cu. 195 3.2 ... . 5.5 Cu. 180 3.4 ... . 30.2 80 61 20 S. 30.1 91 30 12 SE. 30.0 93 31 12 SE.	**H—6—10.** 8.8 A. S. 341 0.2 ... . 12.6 Cu. 146 2.0 ... . 4.6 Cu. N. 353 1.3 ... . 30.3 84 48 9 W. 30.2 90 53 4 SW. 30.1 92 52 8 SW.		**H—6—17.** **L—2—18.** 7.9 S. Cu. 95 24.5 ... . 12.8 Cu. 58 17.3 ... . 30.1 78 73 13 SW. 30.0 86 55 16 W. ....
July 23 ° ° H . 6 . 89 . 29 L . 3 . 68 . 48 L . 4 . 104 . 38	**H—6—18.** **L—4— 7.** 8.5 Ci. Cu. 82 ... ... 1.1 Ci. Cu. 83 ... ... 5.2 Ci. 101 ... ... 30.0 .. .. 10 S. 29.9 91 55 12 S. 29.8 93 54 14 S.		**H—6—18.** **L—4—14.** 8.8 S. Cu. 201 0.7 ... . 12.8 A. S. 155 1.0 ... . 3.8 Cu. 101 1.3 4.8 A. Cu. 75 1.4 ... . 30.2 79 62 2 SW. 30.1 88 67 4 W. 30.1 91 62 4 N.		**H—6—17.** ... . 12.7 A. Cu. 89 9.8 12.9 Cu. 124 16.7 ... . 5.2 S. Cu. 110 9.0 5.2 A. Cu. 111 2.6 5.3 A. S. 92 6.1 30.0 92 54 12 SW. 30.0 78 75 15 N. ....
July 24 ° ° H . 6 . 85 . 28 L . 2 . 84 . 41 H . 4 . 105 . 45	**L—2—11.** **H—4—14.** 8.6 S. 332 ... 1.1 S. 350 ... ... 5.3 S. 315 ... ... 30.0 61 75 11 NE. 30.1 64 72 11 N. 30.1 67 68 4 NE.	**H—6—19.** **H—4—13.** ... . 5.5 Ci. 178 ... ... 29.8 97 25 10 S.	**H—6—10.** **L—2—20.** 8.9 Cu. 352 0.7 12.5 Cu. 132 4.5 ... . 4.8 Ci. 224 1.9 ... . 30.1 82 63 9 W. 30.1 89 52 10 SW. 30.0 91 45 7 SW.		**H—6—17.** **L—2— 1.** ... . 12.8 Cu. 94 25.8 12.9 A. Cu. 85 8.6 5.1 S. Cu. 96 14.0 ... . 29.9 78 93 6 S. 29.9 88 58 20 SW. 29.9 84 61 21 W.
July 25 ° ° L . 3 . 64 . 42 H . 6 . 86 . 29 H . 2 . 89 . 39	**H—6—8.** **H—2—4.** 8.5 S. Cu. 93 ... 8.6 Fr. S. 237 ... ... 12.8 Ci. Cu. 100 ... 12.9 S. Cu. 220 ... 5.4 S. Cu. 178 ... 30.1 65 81 8 SE. 30.0 77 74 8 SE. 29.9 84 73 7 SE.	**H—6—19.** **H—2—20.** ... . 1.6 Cu. 191 3.8 ... . 30.0 94 31 12 S.	**H—6—10.** **H—2— 5.** ... . 12.8 Cu. 161 2.1 ... . 4.8 Ci. 296 1.2 .... 30.0 90 48 5 SW. 30.0 92 44 8 SW.		**H—6—17.** **H—2— 2.** 8.1 Cu. 257 13.2 ... . 12.7 Cu. 310 5.1 12.8 A. Cu. 324 4.4 ... . 30.1 70 64 8 N. 30.1 77 59 4 E. ....
July 26 ° ° H . 6 . 80 . 32 L . 2 . 89 . 50					

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 22 TO JULY 26, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6—16.				**H—6—17.**				**H—6—17.**											
L—2—14.				**L—2— 5.**				**L—2— 5.**								**L—2—14.**			
9.0	Fr. Cu.	87	4.6	11.9	Cu. N.	210	2.0	8.2	S. Cu.	97	7.3					...	.....	...	...
9.2	A. Cu.	92	2.9	...	.....	...	...	...	.....	...	...					...	.....	...	...
12.3	Ci.	65	1.3	...	.....	...	...	1.1	S. Cu.	132	5.5					2.1	Ci. Cu.	201	2.2
1.7	Cu.	103	6.9	...	.....	...	...	...	.....	...	...					2.2	S. Cu.	172	8.2
6.2	Ci.	96	2.3	...	.....	...	...	...	.....	...	...					6.2	Ci.	100	3.0
6.6	A. Cu.	97	3.1	...	.....	...	...	...	.....	...	..					...	.....	...	...
30.0	76	93	2 SW.	29.9	75	87	4 E.	....	..	..	....					....	..	..	....
29.9	87	64	8 SW.	....	..	..	....	29.9	70	88	5 NE.					29.9	78	75	15 S.
29.9	78	85	9 S.	....	..	..	....	29.9	76	66	8 SW.					29.9	72	90	15 S.
L—3—20.				**L—3—20.**				**L—3—19.**				**L—3—20.**				**L—3—12.**			
9.2	Fr. Cu.	47	10.9	8.7	Cu.	60	9.5	...	.....	...	...	8.6	Cu. S.	51	4.7	8.1	Ci. Cu.	111	4.4
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	8.6	Fr. Cu.	85	25.5
...	.....	...	...	...	.....	...	...	1.2	Cu. S.	67	8.9	1.2	Cu. S.	43	4.7	2.1	Cu. Fr. Cu.	90	5.0
...	.....	...	...	...	.....	...	...	...	.....	...	...	1.5	Ci. Cu.	77	2.0	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	1.8	Ci.	76	1.7	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	5.2	A. S.	64	3.4	...	.....	...	...
.	.....	...	...	...	.....	...	...	...	.....	...	...	5.5	Cu. S.	105	4.4	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	. .	...	...	.....	...	...	...	.....	...	...
30.0	77	72	10 NW.	30.1	67	76	10 N.	....	..	..	....	30.0	60	74	16 NW.	29.7	72	90	18 W.
30.0	80	36	15 NW.	....	..	..	....	30.1	70	53	8 NW.	30.0	68	68	12 NW.	29.7	77	55	32 NW.
....	..	..	....	....	..	..	....	....	..	.	....	30.0	70	68	12 SW.	....	..	..	....
H—6—16.				**L—2—2.**				**L—2—3.**				**L—2—2.**				**L—2—15.**			
L—2— 7.																			
...	.....	...	...	...	.....	...	...	...	.....	...	..	8.2	S.	100	1.3	9.2	A. Cu.	96	12.8
3.9	A. S.	50	3.6	...	.....	...	...	1.2	S. Cu.	307	32.0	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
6.3	A. Cu.	72	5.4	5.5	Cu.	40	5.9	5.1	S. Cu.	11	20.6	5.5	S.	104	1.8	5.8	A. S.	149	7.6
6.7	Ci.	72	2.2	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
....	..	..	....	....	..	..	....	....	..	..	....	29.9	62	79	5 SE.	30.0	67	62	6 SW.
29.9	68	100	10 NW.	....	..	..	....	29.8	62	89	9 NE.	....	..	..	....	....	..	..	....
29.8	73	93	3 S.	29.8	65	85	13 N.	....	..	..	....	29.9	70	78	7 S.	29.9	61	93	13 S.
H—6—16.				**H—6—17.**				**H—6—17.**				**L—3—11.**				**L—3—4.**			
L—3—11.				**L—3—19.**				**L—3—19.**				**H—2— 8.**							
H—2—15.				**H—2— 8.**				**H—2— 8.**											
8.6	Fr. Cu.	4	9.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
8.7	A. Cu.	96	4.7	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
8.8	Ci. Cu.	96	4.4	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
4.0	Fr. Cu.	19	3.8	...	.....	...	...	1.2	Cu.	118	4.8	...	.....	. .	...	2.1	Cu.	36	15.5
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	..	...	...	.....	...	...
6.2	Fr. Cu.	1	2.4	6.5	Ci.	70	3.8	5.1	Cu.	84	13.1	5.2	Cu. S.	277	5.3	...	.....	...	...
30.0	70	70	10 NW.	....	..	..	....	....	..	..	.....	....	..	..	....	....	..	..	....
30.1	77	49	12 N.	....	..	..	....	30.0	73	59	13 SW.	....	..	..	....	29.9	64	80	12 N.
30.1	74	64	Calm.	30.0	74	67	6 N.	30.0	75	62	9 SW.	29.8	65	87	12 NE.	....	..	..	....
				H—6—17.												**H—6—16.**			
				L—2—14.															
				...	.....	...	...									...	.....	...	...
				...	.....	...	...									2.1	Ci.	47	5.3
				...	.....	...	...									2.1	Cu.	104	3.9
				6.2	Fr. Cu.	79	7.4									5.7	Cu.	44	5.0
				....	..	..	....									....	..	..	....
				....	..	..	....									30.0	80	44	15 W.
				29.9	79	71	12 S.									30.0	76	60	16 SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 27 TO JULY 31, 1896.

Date.	Kansas City.	Abilene.	Vicksburg.	Savannah.	Louisville.
July 27 ° ° H . 6 . 88 . 29 L . 2 . 84 . 51	**H—6—18.** ... . 1.7 A. Cu. 121 ... 2.6 Cu. 124 ... 5.2 Cu. 133 ... ... 29.9 91 69 6 SW. 29.9 91 71 6 SW.		**H—6—8.** 8.7 Cu. 341 3.0 ... . 12.8 Cu. 159 ... ... 4.8 Ci. 165 1.2 ... . 30.1 86 71 9 W. 30.1 91 47 10 SW. 30.3 92 45 7 SW.		
July 28 ° ° H . 6 . 85 . 30 L . 3 . 61 . 47 L . 1 . 106 . 48	**H—6—18.** **L—1—14.** ... . 1.4 Cu. 220 ... ... 5.2 Cu. 156 ... ... 30.0 87 62 4 SE. 30.0 89 58 7 SE.		**H—6—10.** 9.0 Cu. 358 1.7 ... . 30.0 92 43 7 W.		**H—6—9.** 7.9 A. Cu. 87 4.2 8.2 Cu. 86 4.5 12.8 Cu. 88 7.1 ... . 30.1 85 63 5 S. 30.0 96 44 12 S. ....
July 29 ° ° H . 6 . 85 . 29 L . 2 . 92 . 47					
July 30 ° ° H . 6 . 90 . 29 L . 3 . 75 . 48 H . 2 . 100 . 48 L . 4 . 106 . 41	**H—6—17.** **H—2—14.** **L—4—15.** 8.5 A. S. 91 ... ... 30.0 84 73 4 NW.	**H—6—18.** **L—4—14.** ... . 1.5 Fr. Cu. 221 4.5 5.7 Fr. Cu. 210 3.5 ... . 30.1 93 26 10 SE. 30.0 94 25 9 SE.			**H—6—17.** **L—3—20.** ... . 12.7 Cu. 65 7.0 ... . 30.0 96 41 12 SW. ....
July 31 ° ° H . 5 . 92 . 28 L . 3 . 65 . 47 H . 2 . 82 . 48 L . 4 . 102 . 43	**H—5—17.** **H—2—20.** **L—4— 6.** 8.5 Cu. 119 ... ... 30.0 85 71 11 S.	**H—5—10.** **L—4—13.** ... . 1.5 Cu. 170 3.1 ... . 5.6 Cu. 185 2.5 ... . 30.0 95 28 9 SW. 29.9 97 23 9 SW.	**H—5—8.** ... . 12.8 S. Cu. 128 1.8 ... . 5.3 A. S. 193 1.3 ... . 30.0 96 40 4 NW. 30.0 98 37 6 SW.		**H—5—16.** **H—2—18.** **L—4—15.** ... . 12.7 Cu. 56 8.7 12.8 A. Cu. 32 5.3 ... . 30.1 88 46 12 N. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 27 TO JULY 31, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
L—2—14.				**L—2—13.**				**L—2—5.**				**L—2—6.**				**L—2—14.**			
8.7	A. Cu.	87	4.1	5.2	Cu. N.	105	8.7	8.2	A. S.	92	32.2	8.6	Cu. S.	103	0.7	8.1	A. S.	82	4.4
...	.....	...	...	10.3	Fr. N.	95	8.5	8.4	Cu.	101	41.7	...	.....	...	...	.	.....	...	...
1.4	Fr. Cu.	98	8.1	2.5	Fr. S.	65	10.8	1.1	A. S.	111	3.7	1.6	A. S.	131	4.5	2.1	A. Cu.	78	5.0
...	.....	...	...	2.7	N.	95	4.2	1.2	Cu. N.	83	11.4	1.8	Ci. S.	104	3.0	2.2	S. Cu.	140	23.8
6.5	Ci. S.	7	1.2	5.5	A. Cu.	90	7.4	5.1	S. Cu.	100	14.4	5.5	Cu. S.	164	5.1	6.3	A. Cu.	79	2.9
...	.....	...	...	6.3	Cu. N.	90	4.6	...	.....	...	...	...	.....	...	...	6.3	S. Cu.	94	5.0
...	.....	...	...	6.3	Ci.	90	3.2	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.0	75	82	4 SW.	29.9	76	82	12 W.	30.0	71	86	10 SW.	29.8	71	85	22 W.	29.9	67	81	21 S.
30.1	77	49	12 S.	29.9	81	76	9 W.	29.8	81	63	9 W.	29.8	76	88	6 SW.	29.8	74	72	35 SW.
29.9	86	75	6 SW.	29.9	78	81	7 W.	29.9	79	75	12 W.	29.8	68	90	12 W.	29.8	71	97	23 SW.
H—6—16.				**H—6—17.**				**H—6—17.**								**L—3—12.**			
8.4	Cu. S.	74	3.2	10.7	A. Cu.	85	5.1	...	.....	...	..					8.1	Ci. Cu.	80	11.7
...	.....	...	...	11.0	N.	100	7.7	...	.....	...	...					8.2	S. Cu.	5	17.5
1.9	Ci. Cu.	79	3.9	2.3	S. Cu.	100	4.3	1.5	Cu.	93	10.3					2.2	Cu.	98	...
2.0	Ci.	82	1.8	...	.....	...	...	...	.....	...	...					...	.....	...	...
4.3	Ci. Cu.	70	2.7	6.6	A. Cu.	85	3.5	...	.....	...	...					6.1	Cu. N.	84	3.3
4.3	Ci.	70	1.7	...	.....	...	...	...	.....	...	...					...	.....	...	...
30.0	78	68	3 W.	30.0	78	75	11 SW.	....	..	..	....					29.9	73	78	12 N.
30.1	90	57	5 W.	30.0	79	75	12 NW.	30.0	84	63	8 SW.					30.0	80	62	9 SE.
30.0	80	83	4 SW.	30.0	82	72	5 NW.	....	..	..	....					30.0	74	70	16 SE.
H—6—16.				**H—6—17.** **L—2—14.**				**H—6—17.** **L—2—6.**				**L—2—15.**							
8.4	A. Cu.	59	2.7	9.6	Ci. Cu.	85	2.3	8.0	Cu.	82	4.2	8.7	Ci. S.	66	6.7	8.1	A. Cu.	55	3.4
8.6	Ci. Cu.	67	1.9	...	.....	...	...	...	.....	...	...	8.7	Ci. Cu.	92	9.2	8.2	Cu. N.	85	1.9
8.7	Ci.	47	2.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.5	Ci.	52	1.7	2.5	Fr. Cu.	120	8.1	1.2	Cu.	135	13.1	1.7	Ci. S.	97	8.6	2.1	Cu. Fr. Cu.	99	1.6
1.6	Cu.	85	4.9	2.6	Ci. Cu.	75	4.5	...	.....	...	...	2.0	Ci. Cu.	122	10.7	...	.....	...	...
6.1	Ci.	56	2.1	...	.....	...	...	5.1	Cu.	86	18.3	...	.....	...	...	5.9	Ci.	38	3.8
6.3	Fr. S.	77	6.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
6.6	Cu. N.	58	2.4	...	.....	...	...	...	....	...	...	...	.....	...	...	...	.....	...	...
30.1	78	85	4 W.	30.0	80	75	8 S.	30.0	75	87	9 W.	30.0	76	84	8 W.	30.0	75	83	12 SW.
30.1	90	58	7 W.	29.9	90	58	10 W.	29.9	84	72	10 SW.	30.0	85	60	8 W.	30.0	75	77	15 S.
30.0	78	87	8 N.	29.9	87	60	15 W.	30.0	87	57	10 SW.	....	..	..	....	30.0	72	86	18 S.
L—3—13.				**L—3—12.**				**L—3—12.** **H—2—15.**				**L—3—12.**				**L—3—6.**			
8.5	A. Cu.	63	3.2	...	.....	...	...	...	....	...	...	8.6	Cu. S.	104	16.1	...	.....	...	...
8.7	Ci. Cu.	44	2.7	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.4	A. Cu.	51	3.4	2.3	Fr. Cu.	70	2.6	1.3	Cu.	40	5.3	...	.....	...	...	2.1	S. Cu.	50	10.6
6.1	A. Cu.	51	2.4	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
6.2	Ci.	51	1.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.0	80	66	6 W.	....	..	..	....	....	..	..	....	....	..	..	....	....	..	..	....
29.9	87	57	5 W.	29.9	85	73	15 NW.	29.9	88	50	8 NW.	....	..	..	....	29.7	78	79	19 NW.
29.9	81	58	6 NW.	....	..	..	....	....	..	..	....	....	..	..	....	29.7	80	73	8 NW.
L—3—20. **H—2—13.**								**L—3—19.** **H—2—5.**				**L—3—19.** **H—2—6.**				**L—3—12.** **H—2—14.**			
8.6	Fr. Cu.	3	10.3					...	.....	...	...	...	.....	...	...	...	.....	...	...
1.4	Fr. Cu.	8	4.3					1.3	Cu.	63	4.2	1.9	Cu.	35	9.8	...	.....	...	...
...	.....	...	...					1.2	Ci. Cu.	41	6.4	...	.....	...	...	...	.....	...	...
...	.....	...	...					5.0	A. Cu.	90	8.4	5.2	Ci. S.	34	2.0	...	.....	...	...
...	.....	...	...					5.2	St.	0	0	...	.....	...	...	...	.....	...	...
30.0	76	70	6 NW.					....	..	..	....	....	..	..	....	29.8	68	68	33 NW.
30.1	81	47	10 N.					30.2	72	57	9 E.	30.1	75	76	6 NE.	29.9	72	38	34 NW.
....	..	..	....					30.1	76	39	7 E.	30.1	67	59	6 N.	30.0	69	38	21 NW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 1 TO AUGUST 5, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Aug. 1 ° ° H. 6. 75. 40 L. 2. 90. 43 L. 1. 109. 52	**L—2—12.** 8.5 S. 40 ... ... 1.9 Cu. 71 ... ... 5.3 Fr. Cu. 33 ... ... 29.9 73 82 6 NW. 29.9 85 70 11 NW. 29.9 85 66 12 N.	**L—2—4.** **L—1—14.** ... . 4.9 Cu. 342 7.6 5.0 A. Cu. 53 16.7 ... . 29.9 84 40 12 NW	**L—2—20.** 8.8 Ci. Cu. 210 1.6 ... . 1.2 Cu. 297 2.5 ... . 30.1 83 49 9 SW. 30.0 96 26 8 SE.	**L—2—13.** 9.2 A. Cu. 142 2.0 ... . 12.8 A. Cu. 142 2.3 ... . 4.8 A. S. 358 3.4 ... . 30.0 86 63 6 SW. 30.0 90 61 5 W, 29.9 89 58 5 SW.	**H—6—11.** **L—2— 6.** 8.9 A. Cu. 85 7.4 ... . 12.7 A. Cu. 95 6.7 12.8 Ci. Cu. 102 8.9 5.1 A. Cu. 110 10.7 ... . 30.0 80 72 6 SE. 29.9 93 54 12 S. 29.8 93 57 13 S.
Aug. 2 ° ° H. 6. 86. 22 L. 3. 74. 42			**H—6—18.** ... . 1.4 Cu. 225 1.5 1.7 Ci. 206 2.0 5.4 Ci. 190 1.5 .... 29.9 98 23 9 S. 29.8 98 19 7 SE.		
Aug. 3 ° ° H. 6. 85. 23 L. 2. 94. 48		**L—2—1.** 8.3 S. 120 20.8 12.1 Ci. Cu. 121 20.8 12.2 A. Cu. 120 16.7 12.3 A. S. 180 20.8 ... . 29.7 70 86 5 SE. 29.8 86 54 11 SW.	8.3 Ci. 201 1.5 ... . 5.7 Cu. 193 3.0 30.0 81 41 16 SW. 29.9 95 25 9 S. 29.8 96 24 14 SE.	**H—6—10.** 9.2 Cu. 148 8.0 ... . 30.1 82 72 10 SW.	**H—6—17.** **L—2—14.** ... . 12.8 A. Cu. 168 5.9 ... . 5.8 Fr. Cu. 139 3.2 .... 30.0 85 53 6 N. 30.0 85 56 6 W.
Aug. 4 ° ° H. 6. 87. 28 L. 3. 68. 49 L. 4. 101. 43		**L—4—7.** ... . 12.2 Ci. 106 2.1 12.4 Ci. Cu. 190 8.8 ... . 29.7 92 45 8 S		**H—6—10.** **L—4—18.** ... . 12.7 Cu. 341 2.3 ... . 30.1 91 62 5 W.	
Aug. 5 ° ° H. 6. 78. 33 L. 1. 100. 52		**L—1—6.** 8.1 A. Cu. 144 8.5 8.4 Ci. Cu. 148 12.1 8.4 Ci. 156 8.9 12.2 A. S. 148 9.4 12.2 S. 124 4.2 ... . 29.7 77 80 5 W. 29.8 80 67 5 NW.	8.5 Ci. 20 0.6 ... . 29.8 79 62 20 SE.	**H—6—19.** ... . 4.8 A. S. 199 1.4 ... . 30.0 98 38 3 NW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 1 TO AUGUST 5, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6—4.				**H—6—10.**				**H—6—10.**				**H—6—10.**				**H—6—2.**			
L—2—15.				**L—2—7.**				**L—2—7.**				**L—2—7.**							
8.5	A. Cu.	58	4.6	9.2	S. Cu.	90	2.8	8.3	Cu. S.	115	14.2	8.6	Cu. S.	76	8.5	8.1	Ci.	73	5.0
8.7	Ci.	70	2.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.2	S. Cu.	79	4.4	2.3	S.	130	5.5	1.2	Cu. S.	140	21.0	1.3	Cu. S.	73	8.3	2.1	Ci. Cu.	62	3.6
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
5.8	S. Cu.	100	5.4	6.6	Cu.	120	12.2	5.0	Cu. S.	115	17.5	...	.....	...	...	5.4	Ci. Cu.	68	2.7
6.7	A. Cu.	93	4.7	...	.....	...	...	...	.....	...	...	...	.....	...	..	...	.....	...	...
6.1	A. S.	90	2.6	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.2	67	71	5 NE.	30.0	68	71	12 SE.	30.0	70	76	9 SE.	30.1	64	..	7 S.	30.2	61	63	8 W.
30.1	78	53	9 S.	29.9	74	74	8 E.	30.0	73	73	5 SE.	30.1	76	68	6 W.	30.1	74	37	17 SW.
30.0	75	64	9 SE.	29.8	79	71	12 W.	....	..	..	....	....	..	..	....	30.0	69	47	20 SW.
				L—3—11.												**L—3—2.**			
				9.3	A. S.	20	...									...	.....	...	...
				1.6	Fr. S.	15	3.3									2.2	S. Cu.	42	28.0
				...	.....	...	...									...	.....	...	...
				5.6	Fr. S.	10	5.0									...	.....	...	...
				29.9	69	88	10 N.									....	..	..	....
				29.9	72	77	10 N.									29.7	67	83	27 NW.
				29.9	74	74	7 NW.									....	..	..	....
H—6—16.				**L—2—14.**				**L—2—14.**				**L—2—15.**							
8.7	A. Cu.	73	2.2	10.4	Cu.	...	2.5	...	.....	...	...	8.5	Cu.	110	2.0	...	.....	...	...
2.2	Fr. Cu.	85	2.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.3	Ci.	80	2.7
2.9	Cu.	79	2.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.1	Cu.	93	3.8
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
6.0	A. Cu.	100	...	...	.....	..	...	5.1	A. S.	61	5.5	...	.....	...	...	6.1	Cu.	83	4.9
30.0	76	71	4 N.	30.0	75	51	4 Lt.	....	..	..	....	30.0	68	63	6 SW.	....	..	..	....
30.9	84	53	8 S.	....	..	..	....	....	..	..	....	....	..	..	....	30.0	79	57	5 W.
30.0	80	63	6 SE.	....	..	..	....	....	..	..	....	....	..	.	....	30.0	73	75	13 S.
H—6—16.				**L—3—20.**				**L—3—20.**								**L—3—5.**			
L—3—20.								**L—4—15.**											
8.0	A. Cu.	110	...	...	.....	...	...	8.3	A. S.	23	8.1					...	.....	...	...
11.0	Cu.	55	4.6	...	.....	...	...	...	.....	...	...					...	.....	...	...
2.2	Cu.	80	3.7	2.2	Ci. Cu.	35	1.3	1.2	A. Cu.	73	4.1					2.1	Ci.	50	4.4
1.8	A. Cu.	80	2.7	...	.....	...	...	...	.....	...	...					...	.....	...	...
...	.....	...	...	6.8	Ci.	120	1.0	...	.....	...	...					5.5	Ci.	51	4.8
30.1	74	84	3 S.	....	..	..	....	30.0	77	69	19 SW.					....	..	..	....
30.1	89	44	7 W.	29.9	86	67	18 S.	30.0	80	66	10 S.					29.9	85	49	19 W.
....	..	..	....	29.9	86	60	10 S.	....	..	..	....					29.8	84	54	20 W.
H—6—9.																**H—6—16.**			
11.0	A. Cu.	327	2.9													8.0	Ci.	47	4.2
...	.....	...	...													...	.....	...	...
...	.....	...	...													...	.....	...	...
...	.....	...	...													2.4	Ci.	51	3.9
...	.....	...	...													2.5	Cu.	101	5.9
6.9	Ci. Cu.	98	1.5													5.3	Ci.	44	2.2
6.8	Ci.	98	1.2													5.3	A. Cu.	49	7.7
30.1	77	87	3 NW.													30.0	77	74	2 SW.
30.1	92	45	7 S.													29.9	81	76	3 S.
....	..	..	....													29.8	64	96	15 NE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 6 TO AUGUST 10, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Aug. 6 ° ° H . 6 . 79 . 33 H . 3 . 63 . 47 L . 1 . 109 . 49	8.7 S. 131 ... 1.8 Ci. Cu. 116 ... 1.9 Ci. S. 128 ... 5.1 Ci. 116 ... ... 30.0 73 73 4 SE. 29.9 86 60 5 S. 29.9 89 70 6 NE.	**L—1—15.** 8.2 Ci. 170 6.6 ... . 30.0 77 51 5 NW.		**H—6—19.** ... . 12.7 Cu. 141 1.0 ... . 4.8 S. 323 2.1 ... . 30.0 94 42 6 NW. 30.0 88 61 8 SE.	**H—6—10.** 7.9 Ci. 140 1.9 12.8 Cu. 154 6.8 ... . 4.8 Cu. 110 6.0 4.9 A. S. 112 4.0 30.1 85 64 4 SE. 30.0 96 44 9 S. 29.9 94 53 10 S.
Aug. 7 ° ° H . 6 . 78 . 32 L . 3 . 70 . 50 L . 1 . 105 . 46		**L—1—7.** ... . 12.2 S. Cu. 188 18.8 12.4 Cu. 183 14.0 12.7 A. Cu. 198 14.7 ... . 29.9 86 68 5 SE.		**H—6—19.** ... . 8.7 Cu. 213 3.0 ... . 30.1 91 50 8 W.	**H—6—10.** 8.0 Ci. Cu. 45 2.2 ... . 12.7 Ci. S. 23 5.2 12.9 Cu. 121 5.8 ... . 5.0 Ci. S. 157 4.7 5.0 A. S. 100 2.8 5.1 Cu. 94 6.0 30.1 82 65 7 SE. 30.1 96 45 5 SW. 30.0 95 56 7 S.
Aug. 8 ° ° H . 6 . 80 . 30 L . 2 . 94 . 53	... . 4.7 Ci. S. 83 ... 4.9 Ci. Cu. 74 ... . 29.9 100 40 12 SW.	**L—2—5.** ... . 5.2 Cu. 83 13.9 ... . 29.8 85 40 8 NW.		**H—6—19.** .. .. 12.7 Cu. 142 0.3 2.8 Cu. N. 261 1.3 4.8 S. 271 1.3 ... . 30.1 90 41 6 W. 30.0 90 71 6 SW.	**H—6—18.** ... . 4.8 A. S. 161 ... . 30.0 95 55 85
Aug. 9 ° ° H . 6 . 85 . 30 L . 3 . 72 . 48			**H—6—19.** ... . 1.6 Cu. 180 3.4 ... . 30.0 92 35 13 S.		
Aug. 10 ° ° H . 6 . 87 . 28 L . 3 . 64 . 48			**H—6—18.** ... . 5.6 Cu. 206 1.9 ... . 29.8 96 22 12 SE.	**H—6—10.** ... . 12.7 Cu. 184 1.7 3.6 Cu. N. 165 1.9 5.1 A. S. 172 1.8 .. .. 30.1 89 41 6 W. 30.1 81 72 6 SW.	**H—6—17.** 7.9 Ci. Cu. 121 6.0 ... . 12.8 Cu. 112 10.2 ... . 30.1 84 61 .. S. 30.1 94 44 8 S. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 6 TO AUGUST 10, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
H—6—9.	**H—6—17.**	**H—6—17.**	**H—6—17.** **H—3—19.**	
... . 1.2 Cu 169 1.4	9.2 Ci. Cu. 100 0.6 2.2 N. 70 3.3 ... . 6.1 Fr. Cu. 90 1.8 ... . 30.0 82 72 8 S. 30.0 72 95 18 NW. 30.0 73 93 8 SE.	8.4 A. S. 61 2.6 1.3 A. S. 120 1.4 ... . 5.1 S. Cu. 101 3.6 5.2 A. S. 101 4.5 30.0 77 83 7 S. 30.0 77 74 7 S. 30.0 79 79 9	8.5 Cu. S. 109 1.7 ... . 30.0 77 78 18	
H—6—9. **L—3—20.**	**H—6—17.** **L—3—20.**	**H—6—17.** **L—3—20.**	**H—6—17.** **L—3—20.**	**H—6—16.** **L—3—5.**
... . 11.1 Ci. Cu. 90 1.2 ... . 2.9 Cu. 130 3.2 ... . 6.1 Ci. S. 50 0.7 ... . 30.0 95 39 7 W. 30.0 84 63 9 NW.	9.5 S. Cu. 60 2.2 ... . 2.1 Ci. 80 1.7 ... . 5.3 Ci. 80 2.3 ... . 30.0 75 87 7 W. 30.0 79 77 16 NW. 30.0 82 69 8 NW.	8.3 S. Cu. 80 7.6 ... . 1.1 S. Cu. 38 4.2 ... . 5.1 Cu. 123 5.2 ... . 30.0 76 82 4 NW. 30.0 80 77 4 N. 30.0 82 57 5 E.	8.5 Ci. Cu. 110 3.0 8.8 S. Cu. 87 5.0 1.3 S. Cu. 111 4.7 ... . 5.1 A. S. 110 4.7 ... . 30.0 75 84 18 SW. 30.0 78 83 18 SW. 30.0 75 78 12 SW.	... . 2.1 Ci. 87 2.8 2.3 Ci. Cu. 87 7.1 2.4 A. Cu. 54 3.3 5.9 Ci. Cu. 56 2.7 5.9 A. Cu. 75 4.0 ... . 30.0 69 100 16 W. 29.9 83 74 12 W. 29.9 78 69 12 W.
H—6—17.	**H—6—17.**	**H—6—17.**		
7.9 Ci. 68 2.9 12.9 Cu. 30 2.0 ... . 30.0 80 73 12 NW. 30.0 91 50 10 W.	8.4 Ci. 90 1.7 2.3 Ci. 93 1.8 ... . 5.6 Ci. 100 1.0 ... . 30.0 78 81 5 SW. 29.9 87 67 11 SW. 29.9 88 71 15 SW.	... . 1.1 Cu. 180 22.0 ... . 5.0 S. Cu. 128 7.1 ... . 29.9 84 56 12 S. 29.9 88 71 14 S.		8.1 Ci. Cu. 73 4.2 2.1 Cu. Fr. Cu. 78 3.1 ... . 6.0 Ci. 41 2.7 ... . 30.0 76 85 9 N. 29.9 85 60 5 N. 29.9 79 63 4 SE.
	H—6—17. **L—3—20.**			**L—3—5.**
	8.5 A. Cu. 65 2.7 ... . 1.5 Cu. 93 ... 6.3 Ci. 190 0.6 .. .. 29.9 82 80 11 S. 30.0 91 65 12 NW. 29.9 90 68 3 W.			8.1 Ci. S. 97 2.0 8.2 Ci. Cu. 66 3.9 2.1 Ci. S. 93 2.8 6.0 Cu. N. 16 1.8 6.1 Ci. 76 2.2 30.0 80 79 14 SW. 29.9 85 71 24 S. 29.8 80 86 15 SW.
H—6—16.				**L—3—12.**
8.2 A. Cu. 51 1.6 ... . 1.2 A. Cu. 52 1.6 ... . 30.0 84 56 8 NW. 30.0 92 55 9 N.	7.0 Cu. N. 0 9.3 9.1 S. 90 ... ... 5.3 Cu. N. 70 10.0 5.5 Fr. S. 50 32.3 30.0 74 88 18 SE. .... 30.0 73 86 66 NW.	... . 3.1 Cu. N. 88 36.9 3.2 N. 80 17.3 ... . 30.0 74 71 15..	8.4 A. S. 84 6.7 ... . 30.0 75 89 36 W.	8.1 Ci. S. 72 1.8 ... . 2.1 Ci. Cu. 67 2.0 ... . 5.7 Ci. 82 1.8 5.8 Cu. Fr. Cu. 84 8.0 29.9 79 63 6 NW. 29.9 92 54 10 S. W. 29.9 86 70 10 S.

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 11 TO AUGUST 14, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Aug. 11	**H—6—18.**	**L—2—12.**	**H—6—18.**	**H—6—10.**	**H—6—17.**
° °	**L—2—20.**	**H—1—15.**			**L—2—13.**
H. 6. 88. 28	8.7 Ci. S. 100 ...	8.2 A. Cu. 114 16.2	... ...	... ...	... ...
L. 2. 89. 49	... ...	... ...	... ...	... ...	... ...
H. 1. 109. 50	... ...	... ...	1.8 Cu. 239 2.2	12.6 Cu. 152 1.0	12.8 Cu. 100 7.5
	... ...	... ...	... ...	... ...	... ...
	... ...	... ...	... ...	... ...	... ...
	5.2 Ci. Cu. 86 ...	... ...	5.5 Cu. 236 2.0	... ...	5.0 Cu. 94 2.6
	... ...	... ...	... ...	... ...	5.0 Fr. Cu. 97 3.3
	30.0 82 64 13 SW.	....	....	....	....
	....	....	30.0 94 29 11 S.	30.1 89 46 5 W.	30.1 94 39 7 SW.
	30.0 95 54 8 N.	....	29.8 95 25 10 SE.	....	30.0 94 46 7 SW.
Aug. 12	**H—6—10.**		**H—6—19.**	**H—6—4.**	**H—6—9.**
° °	**H—2—5.**				**H—2—14.**
H. 6. 88. 34					
L. 3. 66. 48	8.6 S. Cu. 221 ...		8.7 A. Cu. 285 1.7	... ...	7.9 Cu. 71 4.6
H. 2. 92. 47	... ...		8.2 Fr. Cu. 230 2.0	... ...	8.1 A. Cu. 76 3.6
	... ...		8.5 Ci. 5 0.9	... ...	8.3 S. Cu. 70 4.3
	... ...		8.7 Cu. 213 1.8	... ...	... ...
	1.5 A. Cu. 105 ...		1.2 A. Cu. 337 1.8	... ...	12.9 A. Cu. 92 2.4
	1.7 Ci. 128 ...		1.2 Cu. 193 1.7	... ...	12.8 Cu. 220 3.3
	... ...		5.5 St. 329 0.7	4.8 St. 191 2.1	4.8 A. Cu. 82 4.2
	... ...		... ...	... ...	4.9 Ci. 98 ...
	30.1 70 74 10 N.		30.1 80 57 10 SW.	....	30.1 76 78 8 N.
	30.1 82 67 6 SE.		30.0 93 31 12 SE.	....	30.1 85 68 5 N.
	....		30.0 84 49 6 NW.	30.0 95 39 3 NW.	30.1 83 71 5 NW.
Aug. 13	**H—5—9.**	**H—2—11.**	**H—5—4.**	**H—5—7.**	**H—5—16.**
° °	**H—2—20.**	**L—1—14.**			**H—2—13.**
H. 5. 97. 31	11.2 A. Cu. 94 ...	... ...	8.4 Cu. 240 1.6	8.9 A. Cu. 202 2.7	8.0 A. Cu. 90 7.3
H. 2. 82. 48	11.8 S. Cu. 121 ...	... ...	... ...	... ...	... ...
L. 1. 104. 54	... ...	... ...	... ...	... ...	... ...
	1.2 Ci. S. 51 ...	12.1 Cu. 205 4.9	1.0 Cu. 257 1.3	12.7 A. Cu. 182 0.2	12.8 Cu. 12 3.4
	... ...	... ...	... ...	3.2 Cu. N. 194 ...	... ...
	... ...	... ...	5.7 Cu. 227 1.4	... ...	... ...
	... ...	... ...	... ...	... ...	... ...
	30.1 76 83 4 SE.	....	30.1 79 64 12 SW.	30.1 84 63 4 NW.	30.1 78 71 3 N.
	30.2 70 82 12 NE.	30.0 79 37 5 SE.	30.0 89 38 4 NE.	30.0 95 48 4 NW.	30.1 87 52 6 NW.
	....	....	29.9 92 30 10 SE.	29.9 100 34 6 NW.	....
Aug. 14	**L—2—18.**	**L—2—1.**		**H—6—18.**	**H—6—18.**
° °					**H—3—20.**
H. 3. 74. 47					**L—2—14.**
L. 2. 92. 49	8.5 S. Cu. 82 ...	8.2 Ci. S. 129 7.5	... ...	9.0 A. Cu. 241 1.0	... ...
H. 6. 80. 29	8.6 Fr. S. 224 ...	... ...	... ...	... ...	... ...
	... ...	... ...	... ...	... ...	... ...
	... ...	... ...	... ...	... ...	... ...
	1.2 Ci. 115 ...	... ...	1.7 Cu. 231 2.2	12.8 S. Cu. 292 0.3	12.8 Cu. 47 2.7
	... ...	... ...	... ...	... ...	12.9 Ci. 85 1.1
	5.5 Ci. S. 100 ...	5.2 St. 93 7.8	... ...	4.3 S. Cu. 301 1.9	5.2 Ci. S. 82 2.8
	... ...	... ...	... ...	... ...	5.3 A. S. 78 3.1
	30.0 77 72 6 SW.	30.0 73 64 6. SW.	....	30.1 85 60 4 N.	....
	30.0 87 55 12 SE.	....	30.0 94 27 9 S	30.1 87 52 4 NW.	30.1 90 50 10 NW.
	30.0 90 57 3 E.	29.9 82 45 6 W.	....	30.0 86 54 19 E.	30.0 88 55 5 N.

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 11 TO AUGUST 14, 1896.

Washington.					Cleveland.					Detroit.					Buffalo.					Blue Hill.				
						L—2—14.										L—2—14.								
8.5	Ci. Cu.		101	1.7	8.4	Fr. Cu.		80	6.9						8.5	S. Cu.		110	7.6	8.1	Ci.		86	1.2
...	.....		..	...	8.5	Ci.		80	0.8						...	.....		...	...	...	.....		...	...
1.1	Ci. Cu.		44	1.6	...	.....		...	...						...	.....		...	...	2.0	A. Cu.		73	2.3
...	.....		...	...	...	.....		...	...						...	.....		...	...	2.1	Ci.Cu.A.Cu.		73	2.0
...	.....		...	...	...	.....		...	...						...	.....		...	...	2.2	S. Cu.		140	2.8
6.0	Ci.		92	0.7	...	.....		...	...						...	.....		..	...	6.3	A. Cu.		76	2.0
7.1	Ci. Cu.		92	0.6	..	.....		...	...						...	.....		...	...	...	....		...	..
30.0	80	75	3 W.		30.0	75	78	8 W.							30.0	74	84	20 S.		30.0	79	79	9 N.	
30.0	92	46	9 SW.		....	.	..	....							....	..	..	....		29.9	91	53	6 W.	
30.0	84	66	2 W.		....	..	..	....							....	..	..	....		30.0	81	78	7 S.	
	H—6—16.					H—6—16.					H—6—16.					H—6—16.					L—3—12.			
	L—3—20.					L—3—20.					L—3—20.					L—3—20.								
	H—2—14.					H—2— 6.					H—2— 6.					H—2—15.								
10.9	Cu.		339	3.5	8.5	S. Cu.		70	1.5	8.3	A. S.		120	7.7	8.5	A. S.		54	2.0	8.1	Ci. Cu.		71	2.3
...	.....		...	...	...	.....		...	...	..	.....		...	...	...	.....		...	...	...	.....		...	..
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
12.7	Cu.		20	2.5	2.0	A. Cu.		110	2.0	1.4	A. Cu.		356	1.5	...	.....		...	...	2.1	Cu. N.		87	1.4
...	.....		...	...	2.1	Fr. S.		30	22.9	...	.....		...	...	...	.....		...	...	2.2	Cu.		71	2.2
...	.....		...	...	6.0	Ci. Cu.		110	1.4	5.1	Ci.		0	0	...	.....		...	...	5.6	Ci.		70	1.7
...	.....		...	...	6.1	Fr. Cu.		340	8.3	...	.....		...	...	...	.....		...	...	...	.....		...	...
30.1	82	65	4 W.		30.1	75	82	3 SW.		30.1	71	84	6 NE.		30.0	71	86	9 NW.		30.0	79	79	10 N.	
30.0	93	46	8 N.		30.1	80	79	16 NW.		30.1	80	57	4 N.		....	..	..	....		30.0	90	57	11 NW.	
....	.	..	....		30.0	80	79	12 NE.		30.1	77	47	9 N.		....	..	..	....		30.0	84	68	10 S.	
	H—2—13.					H—2—5.					H—2—5.					H—2—5.					H—2—14.			
8.8	Cu.		80	1.6	8.7	S. Cu.		102	1.2	...	.....		...	...	8.5	Ci. Cu.		110	1.7	8.1	A. Cu.		110	1.0
...	.....		...	...	...	.....		...	...	...	.....		...	...	8.8	A. S.		110	1.7	8.2	Cu.Fr.Cu.		46	2.9
...	.....		...	...	...	.....		...	...	...	.....		...	...	..	.....		...	..	8.2	Ci. Cu.		116	1.1
1.6	Cu.		115	1.6	1.5	S. Cu.		90	1.7	1.1	S. Cu.		337	4.0	...	.....		...	...	2.1	Ci.		109	2.1
1.4	Ci.		129	2.4	...	.....		...	..	...	.....		...	...	...	.....		...	...	2.2	Ci. Cu.		78	2.4
6.2	N.		14	...	...	.....		...	...	5.1	A. Cu.		90	0.6	...	.....		...	...	5.7	Ci. S.		84	2.8
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	5.8	Ci.Cu.A.Cu.		96	3.4
30.1	79	76	4 N.		30.1	73	86	4 SE.		....	..	..	....		....	..	..	....		30.0	72	96	21 NE.	
30.0	93	46	5 NW.		30.1	74	70	13 E.		30.1	69	67	8 E.		....	..	..			30.0	76	74	14 NE.	
30.1	70	100	5 N.		....	..	..	....		30.1	72	57	7 E.		....	..	..	....		30.0	71	87	10 E.	
	H—6—17.					H—6—17.					H—3—12.										H—3—5.			
	H—3—12.					H—3—12.					L—2—14.													
						L—2—14.																		
8.7	Fr. Cu.		48	2.0	...	.....		...	...	...	.....		...	...						...	.....		...	.
8.8	Fr.S.		27	7.7	...	.....		...	...	...	.....		...	..						...	.....		...	...
8.8	Ci. Cu.		93	3.3	...	.....		...	...	...	.....		...	...						...	.....		...	...
9.0	A. Cu.		94	3.3	...	.....		...	...	...	.....		...	...						...	.....		...	...
1.8	S. Cu.		58	2.2	...	.....		...	...	...	.....		...	...						2.1	A. S.		86	1.5
...	.....		...	...	...	.....		...	...	...	.....		...	...						...	.....		...	...
...	.....		...	...	5.5	Ci. S.		70	2.1	5.1	St.		180	1.4						5.3	A. Cu.		70	1.0
...	.....		...	...	...	.....		...	...	...	.....		...	...						...	.....		...	...
30.1	74	86	5 NW.		....	..	..	....		....	..	..	....							30.1	67	99	15 NE.	
30.0	83	62	12 N.		....	..	..	....		....	..	..	....							30.0	69	93	13 N.	
....	..	..	....		30.0	78	65	6 N.		30.1	76	61	5 S.							30.0	68	90	17 NE.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 15 TO AUGUST 18, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Aug. 15	L—2—13.	L—2—12.		H—6—19.	H—6—18. L—2—13.
° °					
H . 6 . 77 . 30	8.6 A. S. 54 ...	8.2 A. S. 124 9.3		9.0 Ci. S. 202 1.0	... ...
H . 3 . 60 . 47	... ...	... ...		... ...	... ...
L . 2 . 89 . 50	... ...	... ...		12.6 Cu. 278 0.7	12.8 Cu. N. 63 10.4
	... ...	... ...		... ...	12.8 S. Cu. 64 8.7
	... ...	... ...		... ...	12.8 Fr. Cu. 58 7.3
	... ...	... ...		... ...	12.9 Cu. 57 9.3
	... ...	5.1 St. 78 10.3		4.8 S. Cu. 282 3.2	... ...
	30.0 84 63 11 SW.	30.0 64 69 6 SE.		30.1 84 66 3 N.	30.1 83 64 2 E.
	....	....		30.1 91 42 4 NW.	30.1 92 45 4 N.
	....	30.0 73 60 5 W.		30.0 90 50 12 SW.	....
Aug. 16					
° °					
L . 3 . 75 . 48			... ...		
H . 3 59 . 45			... ...		
			1.1 Cu. 324 2.1		
			... ...		
			5.7 Cu. 320 1.7		
			... ...		
			....		
			30.0 97 25 12 NE.		
			29.9 98 21 12 NE.		
Aug. 17		H—1—14.			
° °					
L . 3 . 66 . 48	... ...	... ...	... ...	... ...	7.9 Ci. S. 54 4.7
H . 1 . 103 . 52	... ...	... ...	. . ..	... ...	8.1 Ci. 51 4.9
	1.5 N. 78 ...	12.1 Cu. 57 10.2	1.4 Cu. 254 2.5	... ...	12.7 A. S. 70 6.6
	2.0 A. S. 236 ...	12.3 S. Cu. 93 7.3	. . ..	... ...	12.9 Ci. 68 5.2
	... ...	12.6 Ci. S. 83 10.5	... ...	... ...	... ...
	... ...	5.1 Ci. S. 94 13.8	5.4 Cu. 232 2.0	4.1 S. Cu. 255 1.2	5.3 St. 95 3.3
	... ...	5.4 A. Cu. 88 14.5	... ...	... ...	... ...
	....	....	....	....	30.2 68 54 8 N.
	30.2 60 92 6 E.	30.3 69 38 7 W.	30.0 94 29 6 SE.	....	30.2 77 29 9 NW.
	....	30.2 70 38 10 NW.	29.9 95 28 10 SE.	30.0 98 41 5 SW.	30.2 75 45 10 W.
Aug. 18	H—5—17. H—2—18.	H—2—6.	H—5—10.	H—5—2.	H—5—16.
° °					
H . 5 . 94 . 30	... ...	... ...	8.5 Ci. 264 1.1	... ...	7.9 A. Cu. 39 8.8
L . 3 . 60 . 48	... ...	... ...	... ...	... ...	8.0 Ci. S. 47 5.6
H . 2 . 97 . 52	... ...	... ...	... ...	... ...	8.2 A. S. 49 8.6
	1.1 A. Cu. 70 ...	12.3 Cu. 46 9.2	1.2 Cu. 210 2.4	12.7 Cu. 60 1.7	12.7 Ci. 79 6.9
	... ...	... ...	... ...	.. ..	12.8 Ci. Cu. 75 5.8
	... ...	... ...	... ...	... ...	12.9 Cu. 65 6.6
	... ...	... ...	... ...	... ...	1.0 A. Cu. 73 5.8
	5.3 Ci. 86 ...	... ...	... ...	4.8 A. S. 71 1.1	... ...
	... ...	... ...	... ...	... ...	... ...
	....	....	30.1 82 55 12 SW.	....	30.1 69 67 6 N.
	30.2 66 72 8 E.	30.3 69 38 4 NW.	30.0 94 29 7 SW.	30.1 94 41 3 NW.	30.1 78 41 9 NW.
	30.2 72 68 6 NE.	....	....	30.0 92 56 4 N.	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 15 TO AUGUST 18, 1896.

Washington.					Cleveland.					Detroit.					Buffalo.					Blue Hill.				
	H—6—17.					H—6 17. L—2—14.					H—6—17. L—2— 6.										H—3—20.			
9.2	S.		315	...	...	.....		...	...	8.0	A.S.		0	0						...	.....		...	...
9.5	Cu.		324	...	...	.....		...	...	...	.....		..	...						...	.....		...	...
2.2	S.		293	2.5	1.4	A. Cu.		45	2.3	1.3	Ci.		90	7.8						...	.....		...	.
2.4	Cu.		183	1.2	1.5	Fr. Cu.		170	3.6	...	.....		...	...						...	.....		...	...
...	.....		...	...	...	.....		...	...	...	.....		...	...						...	.....		...	...
...	.....		...	...	...	.....		...	...	...	.....		...	...						...	.....		...	...
...	.....		...	...	6.2	A. Cu.		85	1.8	5.3	Cu. S.		155	13.7						6.0	S. Cu.		227	10.0
30.1	76	87	7	NE.	....	..	..	....		30.1	74	72	5	SW.						....	..	..	....	
30.2	84	58	10	E.	30.0	81	68	4	NW.	30.0	82	65	8	S.						....	..	..	....	
....	..	..	....		30.0	78	73	4	SE.	29.9	81	72	7	SW.						30.1	65	93	6	SE.
						L—3—12.					L—3—12.										L—3— 6. H—3—19.			
					8.4	Fr. S.		65	15.9	8.4	S.		110	...						...	.....		...	...
					8.6	Fr. Cu.		75	4.3	...	.....		...	...						...	.....		...	...
					2.5	Fr. Cu.		65	5.0	...	.....		...	...						2.1	Ci.		42	2.4
					...	.....		...	...	...	.....		...	...						2.2	Ci. Cu.		73	3.3
					...	.....		...	...	...	.....		...	...						5.3	Ci. S.		90	2.9
					...	.....		...	...	...	.....		...	...						5.3	A. Cu.		116	2.7
					30.1	73	86	9	NW.	30.0	73	93	9	SW.						....	..	..	....	
					30.0	76	74	8	NW.	....	..	..	....							29.9	77	61	23	SW.
					....	..	..	....		....	..	..	....							39.8	69	82	24	SW.
	L—3—20.					L—3—20.					L—3—19.					L—3—20.					L—3—12.			
9.0	A. S.		72	4.3	8.0	Fr. Cu.		35	4.2	...	.....		...	...	...	.....		...	...	8.0	Ci. S.		125	6.2
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
12.7	Fr. Cu.		69	5.7	...	.....		...	...	1.4	S. Cu.		32	5.7	1.3	S. Cu.		110	5.0	3.1	Cu.		78	4.4
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
6.0	Ci.		68	4.6	6.0	Fr. Cu.		65	3.9	5.0	S. Cu.		55	4.2	5.3	S. Cu.		111	5.0	...	.....		...	...
6.9	A. Cu.		77	6.0	...	....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
30.0	72	69	6	N.	30.2	68	50	11	N.	....	..	..	....		....	..	..	....		29.9	66	72	15	NE.
30.1	78	43	9	SW.	....	..	..	....		30.2	70	52	13	W.	30.1	69	58	12	NW.	29.9	73	63	10	NW.
30.1	72	58	6	N.	30.1	69	49	6	W.	30.1	72	45	8	W.	30.1	68	54	18	NW.	....	..	..	....	
																					L—3—20.			
8.9	A. Cu.		92	4.7	8.8	Fr. Cu.		55	5.7	...	.....		...	...	8.5	Cu. N.		100	4.0	8.5	Ci. S.		106	4.4
9.0	A. S.		92	4.2	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
12.4	Cu.		90	5.0	2.2	Cu.		48	4.1	1.1	S. Cu.		53	9.3	...	.....		...	...	2.1	Ci. S.		87	4.4
12.5	Ci.		90	5.7	...	.....		...	...	...	.....		...	...	...	.....		...	...	2.2	A. Cu.		90	1.1
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	2.2	Cu.		94	3.9
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
5.8	S. Cu.		60	5.1	...	....		...	...	5.0	Cu.		49	5.7	...	.....		..	...	5.9	N.		86	5.0
5.8	Ci. Cu.		53	4.0	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
30.1	67	59	4	NW.	30.1	68	55	12	NW.	....	..	..	....		30.0	61	66	8	W.	30.0	63	68	10	NW.
30.1	77	35	9	W.	30.1	68	54	14	NW.	30.1	70	48	12	W.	....	..		....		30.0	75	40	12	SW.
30.1	70	55	7	N.	....	..	..	....		30.1	69	52	10	NW.	...	..	..	....		30.0	56	95	7	SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 19 TO AUGUST 23, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Aug. 19 ° ° H. 2. 83. 50 L. 1. 108. 52 L. 3. 58. 47		**H—2—12.** **L—1—14.**			**H—2—13.**
	8.4 A. Cu. 42 ...	8.2 Ci. 85 6.8	... .	9.0 A. Cu. 126 2.3	... .
	... .	8.3 Ci. S. 87 9.7	... .	... .	... .
	1.8 S. Cu. 255 ...	... .	1.3 Cu. 226 2.9	12.7 A. S. 97 0.2	12.8 Cu. 139 2.7
	... .	... .	1.8 Ci. 272 1.9	... .	... .
	... .	5.2 A. Cu. 90 7.9	5.2 Ci. Cu. 262 1.7	4.8 A. Cu 41 2.3	5.2 Ci. Cu. 80 4.5
	... .	5.4 Ci. Cu. 82 8.0	5.7 Ci. 263 2.0	... .	5.3 A. Cu. 76 5.7
	30.2 64 77 6 SE.	30.3 59 58 5 SE.	....	30.1 81 61 5 NE.	....
	30.2 72 72 12 SE.	....	30.0 96 26 12 SE.	30.1 88 41 8 N.	30.2 75 42 9 N.
	....	30.2 74 37 5 S.	29.9 95 25 10 SE.	30.1 86 57 7 NE.	30.2 74 47 8 N.
Aug. 20 ° ° H. 2. 78. 40 L. 1. 107. 47 L. 3. 60. 48	**H—2—19.** **L—1—14.**	**H—2—18.** **L—1—15.**		**H—2—20.**	**H—2—11.**
	8.5 S. Cu 70 ...	... .	8.8 Ci. 278 2.1	9.1 A. Cu. 168 1.3	... .
	... .	... .	... .	... .	... .
	1.8 Ci. Cu. 52 ...	12.7 Ci. S. 113 7.3	1.8 Cu. 197 3.2	12.7 Cu. 36 2.0	12.8 Ci. 30 7.5
	2.0 S. Cu. 172 ...	12.9 Ci. 115 8.0	.. ..	... .	... .
	5.1 A. Cu. 78 ...	5.5 Ci. 83 6.2	... .	4.8 A. S. 39 1.1	5.3 Ci. S. 76 4.1
	... .	5.5 A. Cu. 112 8.4	... .	... .	5.3 Ci. 81 4.6
	30.2 71 86 7 S.	....	30.1 84 49 14 SW.	30.1 76 78 3 N.	30.2 70 53 4 NE.
	30.0 82 72 11 S.	29.9 77 56 6 SE.	30.0 96 26 10 S.	30.1 89 56 10 NW.	30.2 83 30 7 E.
	29.9 82 79 5 S.	29.9 81 50 8 S.	....	30.1 90 50 6 NE.	30.1 80 34 6 SE.
Aug. 21 ° ° H. 6. 74. 36 L. 4. 99. 41 L. 1. 102. 52	**L—4—2.**	**L—4— 8.** **L—1—14.**	**L—4—5.**	**L—4—14.**	**H—6—19.** **L—4—15.**
	8.5 Ci. 112 ...	... .	... .	... .	... .
	... .	... .	... .	... .	... .
	... .	12.4 A. Cu. 84 6.0	1.8 Cu. 182 2.9	... .	12.8 S. 150 34.0
	... .	12.5 Cu. 312 13.0	... .	.. ..	1.0 A. Cu. 50 11.1
	... .	3.5 N. 214 6.5	... .	3.8 S. Cu. 55 1.1	5.2 Fr. Cu. 56 9.4
	... .	... .	... .	4.0 Cu. 236 2.6	5.3 A. Cu. 55 7.0
	... .	... .	... .	4.8 S. 171 1.1	5.4 A. S. 53 7.3
	29.8 84 67 13 SW.	....	....	....	30.0 67 83 5 SE.
	....	29.8 76 61 6 E.	29.8 96 28 17 S.	....	29.9 77 78 9 SE.
	....	29.7 72 70 5 SE.	....	29.9 92 53 12 W.	29.8 82 77 10 S.
Aug. 22 ° ° H. 3. 63. 45 H. 6. 78. 29 L. 2. 90. 47	**L—2—12.**	**L—2—4.**		**H—6—19.**	**H—6—18.** **L—2—13.**
	8.3 S. Cu. 128 ...	8.1 Ci. S. 114 12.2	.. ..	9.2 Ci. 83 1.3	7.9 Ci. S. 73 6.0
	... .	8.2 Ci. 138 12.4	. . ..	... .	8.0 A. S. 70 6.9
	... .	... .	... .	... .	8.1 A. Cu. 70 9.2
	1.9 S. 94 ..	12.1 Cu. 69 16.2	1.2 Ci. 86 2.2	... .	... .
	... .	12.4 A. Cu. 97 15.6	1.9 Cu. 169 2.8	... .	... .
	... .	12.6 Ci. Cu. 117 10.6	... .	... .	... .
	5.4 A. Cu. 80 ...	5.1 Cu. 101 13.3	... .	4.6 S. Cu. 210 3.3	5.1 Ci. 94 4.1
	... .	5.3 A. Cu. 63 14.9	... .	.. ..	... .
	29.8 72 80 11 W.	29.7 67 52 12 NW.	....	30.0 86 63 4 W.	29.9 79 71 12 SW.
	29.9 70 78 12 NW.	29.8 70 42 12 W.	29.8 98 29 12 S.	....	....
	29.9 71 65 9 NW.	29.8 66 45 18 NW.	....	29.9 94 50 7 SE.	29.9 93 50 12 S.
Aug. 23 ° ° H. 6. 80. 30 L. 2. 74. 48 H. 4. 106. 41			**H—4—14.**		
			... .		
			... .		
			... .		
			5.5 Fr. Cu. 345 5.8		
			....		
			....		
			30.2 74 62 7 NE.		

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 19 TO AUGUST 23, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—2—14.				**H—2—5.**				**H—2—5.**				**H—2—5.**				**L—3—20.**			
																H—2—14.			
...	.....	...	...	9.1	S. Cu.	30	4.1	8.1	A. Cu.	37	4.1	8.5	.....	25	4.7	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.7	Fr. Cu.	15	3.9	...	.....	...	...	1.2	Cu.	3	4.7	...	.....	...	...	2.1	Cu. N.	101	1.1
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.1	Cu. Fr. Cu.	36	2.1
...	.....	...	...	6.8	Ci.	40	4.2	5.0	A. Cu.	55	3.9	...	.....	...	...	...	.....	...	...
...	.....	..	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
....	..	..	....	30.3	65	10	13 N.	30.3	57	77	5 N.	30.2	56	77	10 N. E.	....	..	..	....
30.2	73	35	12 N.	..	..	..	....	30.3	62	57	9 E.	....	..	..	....	30.0	55	86	14 NE.
....	..	..	....	30.3	63	55	6 N.	30.3	64	51	8 E.	....	..	..	....	....	..	..	....
H—2—1.				**H—2—4.**				**H—2—10.**				**H—2—3.**				**L—3—20.**			
																H—2—8.			
9.0	Ci. S.	88	2.8	9.0	Ci. Cu.	55	1.6	8.3	Cu.	170	4.8	8.5	Ci.	111	1.7	...	.....	...	...
10.0	Ci. Cu.	92	2.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
11.5	Ci. Cu.	70	2.5	2.6	Ci.	57	3.7	1.1	Cu.	145	10.0	...	.....	...	...	2.1	Cu.	36	2.6
11.7	Ci.	75	2.3	...	.....	...	...	1.2	Ci.	70	1.5	...	.....	...	...	...	.....	...	...
5.9	Cu. S.	101	2.6	6.3	Ci.	50	3.8	5.0	A. Cu.	83	4.6	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	5.2	Ci.	55	4.6	...	.....	...	...	...	.....	...	...
30.3	60	72	3 N.	30.3	61	68	8 SE.	30.3	62	59	4 W.	30.3	66	63	9 S. W.	....	..	..	....
30.2	75	63	6 SW.	30.1	69	43	9 N.	30.2	68	46	7 SW.	....	..	..	....	30.2	70	46	8 NW.
30.2	70	52	3 SE.	30.1	66	57	8 E.	30.1	69	39	4 SW.	....	..	..	....	....	..	..	....
H—6—3.				**H—6—10.**				**H—6—18.**				**H—6—10.**				**H—6—9.**			
8.0	Fr. S.	133	8.2	8.7	Fr. N.	75	3.4	...	.....	...	...	8.5	A. S.	110	3.3	8.0	Ci.	326	1.7
8.9	Ci.	51	4.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.1	Fr. Cu.	157	4.7	...	.....	...	...	1.7	S. Cu.	64	6.2	...	.....	...	...	2.1	Ci. Cu.	105	1.7
1.1	Ci. Cu.	79	2.8	...	.....	...	...	1.8	A. Cu.	76	3.7	...	.....	...	...	2.2	Cu.	52	2.9
6.9	N.	95	3.5	6.3	Fr. Cu.	80	4.7	5.0	S. Cu.	38	7.0	5.5	A. S.	110	3.3	6.0	Ci. Cu.	107	1.3
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	..	.....	...	...
30.1	66	78	6 S.	30.1	63	74	8 SE.	....	..	..	....	30.0	66	63	9 SW.	30.1	63	74	8 SW.
30.0	80	47	10 S.	....	..	..	....	29.9	69	81	4 E.	....	..	..	....	30.0	73	42	17 S.
30.0	75	58	9 SE.	29.9	71	64	8 SE.	29.9	68	89	8 SE.	30.0	69	78	9 SW.	30.0	63	69	20 S.
H—3—20.				**H—6—17.**				**L—2—6.**				**H—3—19.**				**H—3—12.**			
H—6—17.				**L—2—6.**								**L—2—14.**							
L—2—14.																			
...	.....	...	...	...	.....	...	...	...	.....	...	...	8.5	A. Cu.	110	3.3	8.1	A. S.	122	5.3
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.2	S. Cu.	80	2.8	2.3	Ci.	75	1.8	1.0	S. Cu.	8	13.3	...	.....	...	...	2.1	S. Cu.	150	6.3
...	.....	...	...	2.5	Fr. S.	120	9.9	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
6.9	Ci. Cu.	35	7.1	6.1	Fr. Cu.	90	5.0	5.1	S. Cu.	82	13.2	...	....	...	...	...	.....	...	...
...	.....	...	...	8.4	N.	110	9.8	5.2	A. S.	70	3.8	...	.....	...	...	...	.....	...	...
....	..	..	....	....	..	..	....	....	..	..	....	29.9	65	65	6 S.	30.0	62	100	12 SW.
30.0	77	78	4 W.	29.8	79	68	12 S.	29.8	74	81	15 S.	....	..	..	....	30.1	69	72	20 S.
29.9	76	84	3 NE.	29.8	77	78	9 S.	29.7	74	88	8 SW.	...	..	..	....	....	..	..	....
				H—6—17.															
				L—2—5.															
				10.0	Fr. Cu.	110	10.2												
				10.3	Ci. Cu.	110	4.1												
				2.8	A. Cu.	115	5.0												
				..	.....	...	...												
				29.9	74	74	12 W.												
				29.9	74	70	19 W.												
				....	..	..	....												

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 24 TO AUGUST 27, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Aug. 24 ° ° L . 3 . 70 . 47 H . 5 . 98 . 34			**H—5—1.** 8.5 Ci. 147 ... 1.3 Ci. Cu. 141 1.7 2.0 Ci. 147 1.6 ... . 5.4 Ci. 146 1.6 30.3 70 72 2 N. 30.2 80 42 9 SE. 30.1 84 38 6 SE.	**H—5—7.** 9.1 S. 86 3.8 12.7 Cu. 32 3.3 ... . 4.7 S. Cu. 71 4.3 30.1 79 83 7 W. 30.0 89 53 3 NW. 30.0 78 89 3 SW.	**H—5—16.** 8.0 Ci. 99 5.6 ... . 5.2 Fr. Cu. 8 9.6 30.2 65 72 6 NW. .... 30.1 80 51 6 NW.
Aug. 25 ° ° H . 3 . 75 . 44 L . 2 . 95 . 51	**L—2—13.** ... . 1.8 Ci. 98 ... ... 5.4 A. Cu. 116 ... ... 29.9 85 59 15 SW. 29.8 84 55 12 S.	**H—3—19.** **L—2— 5.** 8.2 Cu. 137 10.6 8.3 A. Cu. 131 10.2 12.1 A. S. 116 13.5 ... . 5.1 Cu. 72 11.1 5.3 A. Cu. 82 15.3 29.6 69 57 10 S. 29.6 78 43 14 W. 29.7 72 38 13 NW.	8.2 Ci. Cu. 132 1.8 8.7 A. Cu. 129 2.2 1.9 Ci. 150 1.7 ... . 30.0 74 86 12 SW. 30.0 82 65 10 SW.	9.0 Cu. 100 3.4 ... . 12.5 Cu. 98 2.0 ... . 4.8 A. S. 172 1.6 ... . 30.0 75 82 2 N. 30.0 86 40 4 W. 29.9 88 58 5 W.	**H—3—20.** ... . 4.7 Ci. 97 7.8 ... . 30.0 82 33 8 N. ....
Aug. 26 ° ° H . 3 . 62 . 45 L . 2 . 80 . 47 H . 1 . 107 . 50		**L—2—19.** **H—1—14.** 8.4 Cu. 101 13.1 8.6 A. Cu. 98 18.7 12.6 Cu. 69 16.2 12.8 A. Cu. 63 16.2 ... . 30.0 56 56 10 W. 30.1 64 33 16 NW.	8.5 Ci. 179 0.7 ... . 12.8 Ci. 179 1.3 1.0 Ci. Cu. 179 1.9 1.4 Cu. 189 1.9 1.9 A. Cu. 209 1.1 2.1 Cu. N. 154 3.3 5.2 Ci. S. 74 1.0 5.4 Ci. 149 0.3 5.9 Fr. Cu. 236 2.6 30.0 75 74 5 S. 30.0 90 41 10 SW. 30.0 80 57 9 NE.	9.1 S. Cu. 77 2.7 ... . 30.1 78 87 6 W. .... 30.0 80 75 2 SW.	**L—2—20.** 7.9 Ci. 121 6.8 ... . 12.8 A. Cu. 117 8.2 12.9 Cu. 75 8.3 1.0 Ci. Cu. 110 7.2 ... . 5.2 Fr. Cu. 92 6.0 5.3 Cu. N. 90 5.5 ... . 30.0 69 63 5 S. 30.0 85 41 12 SW. 30.0 83 54 15 W.
Aug. 27 ° ° H . 3 . 61 . 45 H . 6 . 75 . 33 H . 2 . 93 . 41 L . 3 . 72 . 48			**H—2—20.** ... . 1.5 Cu. 231 2.7 ... . 5.2 Ci. 287 0.6 5.6 Ci. S. 52 1.2 .... 30.2 87 51 6 N. 30.1 86 48 12 W.	**H—6—19.** **H—2—13.** 9.1 Ci. S. 169 1.3 ... . 4.8 Ci. 124 1.6 ... . 30.2 75 66 7 N. ... . 30.2 83 40 10 N.	**H—6—18.** **H—2— 6.** ... . 12.8 Cu. 23 6.5 ... . 30.3 76 30 8 W. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 24 TO AUGUST 27, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
L—3—20.				**L—3—20.**				**L—3—20.**				**L—3—12.**				**L—3—5.**			
3.6	S. Cu.	102	4.6	10.2	Cu.	75	2.6	...	.....	...	...	8.5	Ci. Cu.	110	4.0	8.3	A. S.	104	7.0
...	.....	...	...	...	.....	...	...	1.3	Cu.	70	0.7	1.2	S. Cu.	100	3.7	2.1	Ci. S.	101	5.0
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.2	Ci. Cu.	104	4.8
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.2	Cu. Fr. Cu.	50	3.3
...	.....	...	...	...	.....	...	...	...	.....	...	...	5.5	Cu.	93	5.0	6.0	A. S. A. Cu.	122	4.9
30.0	74	85	1 NW.	30.1	68	76	7 W.	....	..	..	....	30.0	67	60	12 W.	30.0	67	90	13 NW.
30.1	67	66	5 N.	....	..	..	....	30.1	73	42	4 W.	30.0	74	68	12 W.	29.9	78	50	15 NW.
....	..	..	....	....	..	..	....	....	..	..	....	30.1	69	68	12 W.	29.9	72	59	11 W.
H—3—5.				**H—3—12.**												**H—3—2.**			
10.8	Cu.	277	3.8	...	....	...	...									8.1	A. Cu.	143	1.1
...	.....	...	...	...	.....	..	...									...	.....	...	...
1.9	Cu.	288	2.0	2.0	Cu.	125	...									2.1	A. Cu.	159	2.7
...	.....	...	...	...	.....	...	...									2.0	Cu.	148	2.3
...	.....	...	..	6.2	Ci. Cu.	120	4.3									...	.....	..	...
...	.....	...	...	6.2	Ci.	90	3.0									...	.....	..	...
30.1	67	88	7 N.	....	..	..	....									30.1	66	66	14 N.
30.1	80	44	8 NE.	30.0	77	42	6 SW.									30.1	70	56	14 E.
....	..	..	....	29.9	73	57	7 NE.									....	..	..	....
H—3—19. L—2—5.				**L—2—5.**				**L—2—6.**				**H—3—19. L—2—1.**				**H—3—11. L—2—6.**			
11.6	Cu.	136	2.1	8.1	A. Cu.	115	4.2	8.4	Cu. S.	124	15.2	8.6	S. Cu.	110	8.3	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	8.8	A. S.	108	6.3	..	.....	..	...
2.3	Cu.	152	1.7	2.4	Fr. Cu.	105	6.6	1.3	Cu. S.	29	33.1	1.2	Ci.	123	6.0	2.2	Cu.	182	4.4
3.9	Ci.	105	2.4	3.5	Fr. N.	40	11.7	...	....	...	...	1.4	Ci. S.	115	3.3	...	.....	...	...
...	.....	...	..	...	.....	...	...	...	.....	...	...	1.7	S. Cu.	133	6.7	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	..	...	...	.....	...	...	..	.....	...	...	...	.....	...	...
6.6	Ci.	115	2.4	5.7	Fr. N.	40	9.9	5.1	Cu.	81	15.4	5.2	A. S.	122	6.3	5.6	Ci.	93	2.3
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	5.8	Ci. Cu.	98	2.5
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.1	69	76	1 NE.	30.0	68	76	6 S.	29.9	70	62	18 SW.	30.0	70	66	23 SW.	....	..	..	....
30.1	80	47	12 S.	29.9	81	48	16 SW.	30.0	64	87	7 NW.	30.0	77	54	20 W.	30.1	72	73	14 E.
30.0	75	62	4 S.	30.0	66	90	14 NW.	30.0	69	55	8 NW.	30.0	68	72	23 W.	30.1	67	67	16 SE.
H—6—9. H—2—15. L—3—20.								**H—6—18. H—2—7. L—3—20.**				**H—6—17. H—3—19. L—3—12. H—2—15.**				**H—6—17. H—3—11. L—3—5.**			
8.9	A. Cu.	83	3.2					8.1	A. S.	101	10.6	8.5	A. Cu.	133	6.0	8.1	Ci. S.	130	4.7
...	.....	...	...					...	.....	...	...	...	.....	...	...	8.2	Ci. Cu.	132	4.3
12.9	S. Cu.	96	4.1					1.5	Cu.	40	10.2	1.3	S. Cu.	54	7.7	2.1	A. S.	145	7.3
3.1	Ci. Cu.	112	4.7					...	.....	...	...	...	.....	...	...	2.2	S. Cu.	68	...
3.2	A. Cu.	112	4.7					...	.....	...	...	...	.....	...	...	...	.....	...	...
5.8	A. Cu.	110	...					5.1	Cu.	66	7.2	...	S. Cu.	53	7.7	...	.....	...	...
...	.....	...	...					...	.....	...	...	...	.....	...	...	...	.....	...	...
30.1	70	90	3 S.					30.2	59	57	5 W.	30.2	61	68	7 W.	30.0	65	90	4 SW.
30.2	76	41	10 NW.					30.2	70	48	12 N.	30.2	65	68	12 W.	30.0	71	76	4 NW.
30.2	69	45	6 N.					30.2	69	39	9 W.	....	..	..	...	....	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 28 TO SEPTEMBER 1, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Aug. 28 ° ° L . 6 . 80 . 29 L . 3 . 61 . 44 H . 2 . 80 . 48 L . 1 . 99 . 45		**H—2—19.** **L—1— 7.** 8.1 Ci. S. 74 9.6 8.3 Ci. 56 7.3 12.2 Ci. S. 132 7.6 5.1 A. Cu. 123 6.7 5.3 Ci. Cu. 106 5.1 30.2 64 50 8 S. 30.1 83 33 12 S. 30.0 82 40 13 S.	**L—1—13.** 8.4 Cu. 146 1.2 ... . 1.5 Cu. 285 1.3 5.5 Ci. 2 1.4 ... . 30.3 75 72 5 SE. 30.2 88 44 6 SE. 30.1 89 44 8 E.		
Aug. 29 ° ° H . 3 . 76 . 41 L . 2 . 95 . 52	... . 1.7 A. S. 68 ... ... 5.4 S. Cu. 42 ... ... 30.1 65 82 6 SE. 30.1 69 78 6 SE.	**H—3—18.** **L—2— 5.** 8.4 A. Cu. 249 6.9 ... . 12.1 S. Cu. 83 7.2 ... . 5.1 A. Cu. 126 7.4 5.3 Cu. 77 6.5 30.0 70 60 10 S. 30.0 82 42 10 SW. 29.8 87 40 7 SW.	8.6 A. S. 14 1.2 9.0 A. Cu. 353 ... ... 30.2 74 60 9 S.	... . 4.8 A. S. 90 1.1 ... . 30.0 88 49 6 N.	**H—3—11.** 7.9 Ci. 44 3.9 8.0 Ci. S. 44 3.7 8.2 A. S. 44 ... ... 5.2 Ci. 94 2.2 5.2 Ci. S. 94 3.8 30.3 63 69 3 NE. .... 30.1 79 45 5 NE.
Aug. 30 ° ° H . 6 . 75 . 35 L . 2 . 85 . 49			8.4 A. Cu. 31 1.9 1.2 Ci. 31 1.1 1.6 Ci. Cu. 32 1.6 ... . 30.0 79 31 13 S. 29.9 92 30 12 SE.		
Aug. 31 ° ° L . 3 . 70 . 48 H . 2 . 98 . 49	**H—2—13.** ... . 2.6 Ci. 66 ... ... 5.2 A. Cu. 68 ... ... 30.0 77 46 6 NE. 30.1 77 42 2 NE.	**H—2—6.** ... . 5.2 Ci. 86 6.2 ... . 30.1 70 28 10 NW.	... . 1.5 Ci. 2 1.3 2.0 Cu. 279 2.2 ... . 5.6 Ci. 3 1.1 ... . 29.9 91 25 6 E. 29.9 90 25 10 SE.	... . 12.7 Cu. 342 1.3 ... . 4.8 Cu. 231 1.0 ... . 30.0 87 41 6 NW. 29.9 91 42 6 NW.	8.0 Cu. 88 17.9 ... . 12.8 Fr. Cu. 58 7.6 ... . 29.9 72 59 7 SW. 29.9 84 35 9 NW. ....
Sept. 1 ° ° H . 2 . 83 . 42 L . 3 . 53 . 49 L . 1 . 105 . 46	**H—2—19.** **L—1—14.** 8.5 A. S. 122 ... ... 30.2 66 78 6 SE.	**H—2—10.** **L—1— 7.** ... . 12.2 A. Cu. 102 6.6 12.4 Ci. Cu. 107 7.1 5.2 Ci. Cu. 134 8.6 5.3 A. Cu. 91 9.5 .... 30.0 72 34 13 S. 29.9 74 36 14 S.	... . 1.5 Cu. 206 1.2 ... . 5.4 A. Cu. 220 1.8 ... . 30.1 79 54 8 SW. 30.0 89 31 10 SE. 29.9 89 33 9 SE.		**H—2—1.** 7.7 Ci. 85 2.0 12.7 Ci. S. 90 3.1 ... . 5.2 Ci. 68 2.9 5.3 A. S. 72 3.5 30.2 65 61 8 N. 30.2 77 29 12 N. 30.2 76 34 10 NE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 28 TO SEPTEMBER 1, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
L—6—17. **L—3—19.** **H—2—13.** 10.3 Cu. 20 5.6 30.3 63 70 1 NW. 30.3 76 31 10 N.	**L—6—17.** **H—2— 5.** 9.5 S. Cu. 50 5.7 2.2 Fr. Cu. 60 5.1 30.4 68 46 5 SE. 30.4 67 53 10 N.	**L—6—17.** **H—2—12.** 1.1 Fr. Cu. 65 5.9 30.4 65 54 13 E.	**L—3—19.** **H—2— 5.** 1.3 S. Cu. 50 5.3 30.4 64 86 9 SW.	**L—3—11.** **H—2— 6.** 2.1 Cu. 58 3.2 5.8 Cu. Fr. Cu. 46 4.9 30.2 69 53 6 NE. 30.2 63 62 10 SE.
H—3—1. 9.9 Cu. 298 4.2 30.3 62 71 4 N. 30.2 74 36 10 SE.	**H—3—4.** 8.8 Ci. 65 1.2 30.3 63 64 3 SE.	**H—3—11.** **L—2—14.** 8.1 Ci. 95 1.6 5.0 Ci. S. 89 0.4 30.3 59 72 9 SW.		**H—3—2.** 2.1 A. Cu. 119 2.5 2.2 Cu. Fr. Cu. 119 3.6 6.1 Ci. S. 104 4.6 6.1 Ci. Cu. 113 2.6 30.2 68 55 10 SE. 30.2 62 77 15 SE.
	H—6—10. **L—2— 5.** 9.0 Ci. S. 47 1.2 6.4 S. 80 7.9 30.0 68 52 10 SW. 29.8 76 52			**H—6— 9.** **L—2—14.** 2.0 A. Cu. 157 2.0 29.9 73 46 14 S.
L—3—20. 10.4 Cu. 93 4.7 1.1 Cu. 88 4.3 1.7 A. S. 88 4.4 2.9 S. Cu. 82 4.9 5.8 S. Cu. 97 4.4 5.9 Cu. N. 97 3.6 29.9 64 83 4 S. 29.8 86 36 10 SW. 29.9 69 63 4 N.	**L—3—20.** 9.4 S. Cu. 95 4.6 9.5 Cu. S. 25 6.2 6.4 S. Cu. 32 5.0 29.9 65 65 12 NW. 30.0 66 50 8 NW.	**L—3—20.** 1.4 Cu. 60 9.9 1.5 A. Cu. 52 6.7 5.1 Cu. S. 80 7.1 30.0 68 46 9 NW. 30.0 67 41 4 NW.		**L—3—5.** 2.2 Cu. N. 122 7.4 6.0 A. S. 122 6.3 29.8 66 73 25 NW. 29.8 59 100 9 SW.
H—2—6. 8.0 A. Cu. 90 6.1 2.7 Cu. 48 4.6 3.5 A. Cu. 48 2.0 5.4 Ci. 72 2.5 30.2 61 53 8 N. 30.2 33 32 10 NW. 30.3 64 62 3 NW.	**H—2—2.** 8.7 S. Cu. 20 ... 30.2 60 58 9 E.	**H—2—3.** 8.2 Ci. 33 3.0 1.8 Cu. 70 5.0 30.3 55 70 5 NE. 30.3 62 50 6 E.		**H—2—15.** **L—3—20.** 2.0 Cu. 93 3.3 30.1 63 90 20 NW. 30.2 58 50 16 NW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 2 TO SEPTEMBER 6, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Sept. 2 ° ° H. 3. 73. 40 L. 2. 89. 42 H. 1. 106. 54	L—2—12. ... ... 5.4 A. Cu. 104 ... ... 29.9 89 46 8 S.	H—1—14. L—2— 4. ... ... 5.2 Ci. 86 6.2 ... ... 30.1 70 28 10 NW.		... ... 12.3 Cu. N. 177 5.0 ... ... 5.2 A. S. 229 3.9 ... ... 30.0 85 60 12 SE. 30.0 86 53 10 SE.	
Sept. 3 ° ° L. 3. 74. 48 H. 2. 100. 49 H. 6. 83. 34	H—6—18. H—2—13. 8.7 S. Cu. 316 ... ... 30.2 63 82 12 NE.	H—6—18. H—2— 6. ... ... 12.2 A. Cu. 73 3.5 12.3 Cu. 62 4.6 ... ... 30.3 62 41 7 NW.	... ... 1.4 Cu. 247 1.7 ... ... 30.0 90 29 4 SE.	H—6—11. 9.2 Cu. 272 2.0 ... ... 12.4 S. Cu. 168 2.7 ... ... 30.1 78 53 7 SE. 30.2 83 66 8 N.	H—6—10. 8.0 A. Cu. 105 15.0 8.0 Cu. 103 13.2 ... ... 5.0 St. 39 6.2 30.1 77 63 12 SW. .... 30.1 68 76 14 N.
Sept. 4 ° ° L. 3. 62. 48 H. 2. 81. 45 L. 1. 94. 52	H—2—20. L—1—13. 8.6 A. Cu. 86 ... ... 1.2 A. Cu. 89 ... ... 5.3 A. S. 63 ... ... 30.1 65 80 6 SE. 30.0 72 72 8 S. 29.9 66 92 3 NE.	H—2—11. L—1— 6. 8.3 S. Cu. 86 3.8 ... ... 12.1 S. Cu. 130 6.2 ... ... 30.0 55 73 5 SE. 30.0 64 56 7 S.	... ... 2.0 Cu. 124 1.0 ... ... 29.9 94 28 4 SW.		H—2—12. 7.8 S. Cu. 315 5.2 ... ... 12.8 Fr. Cu. 178 4.2 ... ... 4.9 A. S. 93 7.4 5.0 Ci. S. 91 8.3 30.2 62 76 11 NE. 30.1 72 53 7 NE. 30.0 76 56 4 SE.
Sept. 5 ° ° H. 3. 69. 45 L. 2. 90. 47 H. 1. 106. 51		L—2— 4. H—1—14. ... ... 12.2 S. Cu. 58 24.4 ... ... 29.8 56 74 12 W.		9.2 Cu. 158 2.0 12.4 Cu. 222 3.2 ... ... 30.0 78 35 5 N. 29.9 87 51 12 E.	L—2—5. 7.9 S. 109 7.2 12.8 Cu. 100 22.6 12.9 A. Cu. 100 19.3 ... ... 4.8 Fr. Cu. 98 20.0 4.9 S. Cu. 98 15.4 5.0 Cu. N. 95 11.7 29.8 68 85 8 S. 29.8 77 63 15 SW. 29.8 75 70 14 SW.
Sept. 6 ° ° H. 3. 58. 48 L. 2. 81. 45 H. 5. 95. 39			H—5—12. ... . 5.6 Ci. 58 1.9 .... 29.8 96 18 12 SE.		

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 2 TO SEPTEMBER 6, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
H—3— 4. **L—2—14.** 8.0 A. Cu. 76 5.0 8.8 Ci. Cu. 78 4.3 1.3 S. Cu. 88 6.0 ... . 5.8 S. Cu. 118 7.8 ... . 30.3 62 74 3 SW. 30.2 75 47 15 S. 30.2 71 64 8 NW.	**H—3—11.** **L—2— 6.** 9.2 Ci. 43 2.7 ... . 2.2 Ci. S. 47 1.2 ... . 6.7 Ci. Cu. 83 2.4 ... . 30.2 70 55 6 S. 30.1 75 78 6 S. 30.0 75 47 9 S.	**H—3—11.** **L—2— 6.** ... . 1.1 S. 82 7.4 ... . 5.2 Ci. 90 8.6 ... . 30.1 70 52 15 S. 29.9 74 47 17 S.	**H—3—10.** **L—2— 6.** ... . 5.2 A. S. 110 16.7 ... . 29.9 70 60 6 S.	**H—3— 3.** **L—2—15.** 8.1 Ci. 65 2.3 ... . 2.1 Ci. 87 3.7 2.2 Cu. 117 4.3 6.0 Ci. S. 87 3.7 6.2 Ci. Cu. 74 3.1 30.4 54 60 8 NW. 30.3 67 39 13 W. 30.2 60 67 20 S.
H—6— 8. **L—3—13.** ... . 1.9 Cu. 81 5.2 2.1 Cu. N. 84 1.0 5.7 S. Cu. 101 5.3 .... 29.9 91 44 7 SW. 30.0 72 88 8 W.	**H—6— 9.** **L—3—12.** 9.8 S. Cu. 87 8.7 ... . 3.1 S. Cu. 28 12.7 ... . 6.1 S. Cu. 15 11.0 29.9 70 68 8 W. 30.0 64 74 16 NW. 30.1 63 60 16 N.	**H—6— 9.** **L—3—20.** ... . 1.2 Cu. S. 5 10.8 ... . 5.2 S. Cu. 5 9.5 .... 30.0 68 54 11 N. 30.1 66 49 9 N.		**H—6—16.** **L—3— 5.** 8.3 S. Cu. 112 32.5 8.3 Fr. S. 148 36.6 2.2 S. Cu. 136 33.8 ... . 30.0 65 83 36 SW. 29.8 74 71 33 S. ....
H—2—6. ... . 5.5 Ci. 92 2.6 ... . 30.2 72 47 3 SW. 30.1 67 59 3 E.	**H—2—1.** 9.0 S. Cu. 349 3.9 9.2 Ci. 85 2.2 2.2 Fr. Cu. 222 3.5 ... . 6.0 Ci. 60 2.3 ... . 30.2 60 68 6 E. 30.1 61 63 11 N. 30.0 61 71 9 NE.	**H—2—1.** 8.4 Cu. 30 7.8 ... . 5.1 Cu. 160 4.0 ... . 30.2 54 73 2 N. .... 30.1 61 49 4 E.	**L—3—19.** **H—2— 1.** 8.7 A. S. 65 5.0 ... . 1.8 S. Cu. 248 4.0 ... . 30.2 54 60 6 E. 30.2 62 42 6 E.	**L—3—12.** **H—2— 7.** ... . 2.3 C. S. 101 2.7 2.2 Fr. Cu. 15 7.7 6.4 Ci. 103 2.3 ... . 30.1 64 45 10 NW. 30.1 60 51 6 N.
H—3—20. **L—2—14.** 9.2 S. 224 12.5 12.4 N. 256 12.9 ... . 30.1 63 79 8 SE. 30.0 64 100 3 E.		**H—3—19.** **L—2— 6.** ... . 1.2 Cu. N. 130 9.4 ... . 29.8 65 75 6 SW.	**H—3—11.** **L—2— 7.** 8.4 St. 138 13.3 ... . 29.9 58 62 15 E.	**H—3—1.** 8.2 Ci. S. 99 2.7 2.1 A. Cu. 180 3.3 2.2 S. Cu. 214 2.4 2.3 Ci. S. 88 3.3 6.0 Ci. S. 111 3.7 ... . 30.2 57 77 8 E. 30.2 63 56 9 SE. 30.1 56 73 22 SE.
	L—2— 1. **H—5—15.** 9.3 Fr. Cu. 105 20.0 9.3 S. Cu. 105 16.5 2.3 Fr. S. 100 10.2 2.3 S. Cu. 82 4.6 5.8 Fr. S. 92 8.2 29.8 57 77 16 SW. 29.8 63 62 18 SW. 29.9 62 69 10 W.			**H—3—19.** **L—2— 7.** ... . 2.3 N. 151 66.6 ... . 29.8 68 100 24 S. W. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 7 TO SEPTEMBER 10, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Sept. 7 L. 3. 70. 50 H. 6. 84. 39			8.4 A. Cu. 140 1.2 8.6 Cu. 154 1.0 1.4 A. Cu. 119 1.7 1.8 A. S. 161 2.0 2.0 Cu. 162 2.2 ... . 29.8 96 22 20 SW.		
Sept. 8 H. 3. 74. 46 L. 4. 99. 44	**L—4—6.** 8.6 S. 126 ... 1.8 N. 97 ... 2.9 A. Cu. 114 ... 3.0 S. Cu. 114 ... 5.5 S. Cu. 119 ... ... 29.8 69 66 13 SE. 29.7 81 61 13 S. 29.7 82 64 12 SE.	**L—4—2.** ... . 12.2 Ci. Cu. 145 3.9 12.4 A. Cu. 142 5.6 ... . 5.2 Ci. Cu. 144 6.5 5.3 A. Cu. 112 6.7 .... 29.7 78 54 12 S. 29.7 78 60 14 SE	**L—4—13.** 8.2 Cu. 114 0.3 1.8 Ci. 45 2.2 2.0 A. Cu. 150 1.8 ... . 5.6 Ci. 46 1.6 ... . 29.9 79 47 24 SW. 29.8 94 27 23 SW. 29.7 93 26 20 SW.		**H—3—20.** **L—4—14.** 7.0 A. S. 130 3.4 ... . 5.2 Ci. Cu. 85 4.0 ... . 30.1 64 65 3 E. 30.1 82 35 6 SW. 30.0 84 43 8 SE.
Sept. 9 L. 3. 70. 40 L. 5. 99. 37 H. 3. 65. 46	**L—5—2.** ... . 12.3 A. Cu. 108 ... 5.3 S. Cu. 114 ... ... 29.8 77 65 18 SE. 29.9 75 78 6 E.	**L—5—16.** ... . 5.2 S. 80 12.8 ... . 29.9 66 82 11 NW.		**L—5—6.** ... . 4.8 Cu. 174 3.9 ... . 29.9 91 42 5 NW.	**L—5—15.** 7.8 Ci. Cu. 97 2.2 8.0 A. Cu. 98 3.8 12.8 A. Cu. 69 3.3 5.2 Ci. Cu. 31 5.0 5.3 A. Cu. 41 3.3 5.4 A. S. 42 2.8 30.1 69 63 4 SE. 30.0 91 29 4 S. 30.0 90 35 4 SE.
Sept. 10 H. 6. 82. 31 L. 3. 70. 41 L. 5. 96. 37	**H—6—18.** **L—5—3.** 8.6 S. Cu. 146 ... ... 12.6 A. S. 149 ... 12.8 S. Cu. 149 ... ... 29.8 76 72 12 S. 29.8 66 85 6 S.	**L—5—9.** ... . 12.4 S. Cu. 34 15.5 ... . 5.4 A. Cu. 139 9.7 ... . 30.0 54 76 10 NW. 30.0 57 66 7 NW.	**L—5—12.** 8.3 Ci. 326 0.8 9.0 Ci. S. 293 1.1 1.4 A. Cu. 101 2.1 ... . 5.0 A. Cu. 141 1.7 5.7 Cu. 110 2.4 5.5 Ci. S. 67 0.7 6.2 Fr. S. 182 2.3 29.9 76 67 20 SE. 29.8 93 35 16 S. 29.8 83 61 13 W.	**H—6—11.** **L—5—6.** .. .. 12.2 Cu. 158 2.3 ... . 30.0 87 57 6 W.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 7 TO SEPTEMBER 10, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
				L—3—5. **H—6—16.** ... . 2.1 Ci. S. 150 4.6 ... . 6.2 Ci. S. 181 5.0 .... 30.0 73 50 13 W. 30.0 66 63 14 NW.
H—3—5. 11.3 Cu. 349 5.1 1.6 Cu. 350 4.2 ... . 30.2 64 69 8 NE. 30.1 75 47 7 N.	**H—3—12.** **L—4—15.** 10.9 Ci. 105 1.2 2.3 Ci. 101 1.2 ... . 6.1 Ci. 95 1.2 ... . 30.2 71 45 7 SE. 30.1 70 61 10 N. 30.1 73 53 5 SE.	**H—3—12.** **L—4—15.** 8.0 Ci. 132 3.7 1.6 Ci. 90 10.0 ... . 30.2 62 69 5 SE. 30.1 71 48 8 SE.		**H—3—1.** 8.2 Ci. S. 138 4.9 3.1 Ci. S. 146 2.8 ... . 30.2 56 82 16 NE. 30.2 60 63 20 NE. ....
	H—3—19. 9.7 Ci. Cu. 90 1.2 ... . 30.0 72 61 4 S.	**H—3—19.** **L—5—16.** 8.0 Cu. S. 61 8.4 ... . 1.2 Cu. S. 81 9.7 ... . 30.1 66 80 6 SE. 30.0 76 50 7 S.		**H—3—12.** 8.1 N. 308 34.4 ... . 30.0 57 91 33 NE. ....
	L—3—11. **H—6—17.** **L—5—16.** 8.9 A. Cu. 80 3.3 ... . 30.0 76 63 7 SW. .... 29.9 84 66 3 W.	**L—3—19.** **H—6—17.** **L—5—16.** 8.1 A. Cu. 65 11.3 ... . 1.1 A. Cu. 80 3.3 ... . 29.9 69 81 9 SW. 29.9 84 49 10 SW.	**L—3—11.** **H—6—17.** ... . 5.1 Ci. Cu. 52 6.7 5.3 A. S. 55 3.3 ... . 29.9 74 78 10 SW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 11 TO SEPTEMBER 14, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Sept. 11 ° ° H. 6. 78. 37 L. 5. 92. 37 H. 2. 95. 45 L. 1. 108. 48	**H—6—19.** **L—5— 8.** **H—2— 5.** **L—1—14.** ... . 1.9 A. Cu. 146 ... ... 5.3 A. Cu. 120 .. 5.5 S. Cu. 285 ... . 88 6 NE. 30.0 62 72 5 NE. 30.0 65 80 5 NE.	**L—5— 9.** **H—2— 2.** **L—1—15.** ... . 12.2 Cu. 318 6.2 ... . 30.0 62 44 7 NE.	**H—2—13.** ... . 1.4 A. Cu. 168 2.4 ... . 5.1 A. Cu. 141 1.1 5.5 St. 170 2.1 .... 30.0 77 52 8 N. 29.8 80 54 8 N.	**H—6—19.** **L—5— 1.** **H—2—13.** 9.3 Cu. 272 1.7 ... . 12.2 S. Cu. 205 2.2 ... . 4.2 Cu. S. 195 0.9 ... . 30.0 87 68 6 W. 30.0 89 56 5 NW. 29.9 84 71 5 SW.	**H—6—11.** **L—5— 7.** **H—2—14.** ... . 12.8 Cu. 137 5.9 ... . 29.9 94 30 10 SW. ....
Sept. 12 ° ° H. 2. 86. 49	**H—2—20.** 11.3 A. Cu. 140 ... 11.5 Fr. S. 278 ... 2.2 Fr S. 265 ... 2.3 Ci. 130 ... ... 5.3 Ci. 154 ... ... 30.1 67 61 6 NE. 30.1 75 72 5 NE. 30.1 73 79 7 E.	**H—2—12.** ... . 12.1 Ci. S. 142 7.6 12.3 S. Cu. 274 16.7 12.5 Cu. 243 13.1 5.2 S. Cu. 250 21.7 ... . 30.2 63 64 14 SE. 30.2 63 69 10 SE.	8.3 A. Cu. 220 2.3 8.9 Fr. Cu. 186 10.8 1.6 Cu. 226 5.1 1.7 A. Cu. 206 4.7 2.0 Ci. 131 1.2 5.4 Ci. 159 1.1 5.4 St. 189 1.8 30.0 75 72 10 S. 30.0 78 71 16 SW. 29.9 84 44 13 SE.	9.3 Cu. 102 2.0 ... . 12.2 Cu. 207 1.7 3.2 A. S. 232 0.8 ... . 30.1 82 48 2 NW. 30.0 88 55 5 NW. 30.0 87 64 3 SW.	**H—2—13.** 8.0 A. Cu. 255 2.5 ... . 12.2 Cu. 253 4.4 12.8 A. Cu. 271 2.5 ... . 30.1 76 64 5 SE. 30.1 87 48 4 S. ....
Sept. 13 ° ° H. 2. 82. 50			8.4 A. Cu. 209 2.0 8.8 Fr. Cu. 184 11.8 1.0 Cu. N. 229 2.3 1.8 Cu. 223 2.2 2.0 A. S. 240 2.0 5.2 A. Cu. 208 1.0 5.4 Ci. 181 1.0 5.7 Ci. S. 135 0.7 30.1 76 70 12 S. 30.1 85 50 9 S. 30.0 79 74 6 SW.		
Sept. 14 ° ° H. 3. 63. 47 H. 6. 75. 40 L. 5. 91. 38 H. 1. 108. 54	**L—5—4.** ... . 1.8 A. S. 123 ... ... 5.1 S. 86 ... . 30.1 78 78 10 N. 30.1 75 82 6 N.	**L—5— 9.** **H—1—14.** ... . 12.1 Ci. Cu. 258 6.9 12.3 A. Cu. 243 7.3 ... . 30.1 66 71 8 NW.	**L—5—20.** 8.3 Ci. 130 0.7 8.7 Ci. Cu. 348 ... 1.4 Cu. 282 3.2 1.6 A. Cu. 303 1.7 1.9 Ci. S. 131 1.0 5.5 A. S. 154 1.0 30.1 78 71 2 N. 30.0 83 55 12 SW. 30.0 78 75 4 NW.	**L—5—5.** ... . 12.2 Cu. 310 2.9 ... . 4.2 Cu. S. 269 2.3 .... 30.0 93 31 8 E. 30.0 86 44 8 SE.	**H—6—11.** **L—5— 2.** .... 12.8 Ci. 30 2.7 ... . 5.0 A. S. 122 1.6 .... 30.1 92 39 6 SE. 30.0 90 48 5 SE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 11 TO SEPTEMBER 14, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
		H—6—10. **L—5— 8.** **H—2—15.** ... . 1.6 S. Cu. 113 9.8 ... . 5.1 S. Cu. 128 4.8 ... . 29.9 83 55 12 SW. 29.9 80 72 6 N.		**H—6—8.** 8.0 Ci. 358 0.4 8.1 Ci. Cu. 3 0.3 2.2 Ci. 156 0.3 2.4 Fr. Cu. 67 3.3 ... . 30.0 68 85 18 W. 30.0 87 55 9 NW. ....
H—2—14. 8.1 A. S. 282 1.8 9.3 A. Cu. 282 1.5 1.4 A. S. 314 2.7 ... . 5.5 A. S. 282 2.3 ... . 30.1 68 90 1 NE. 30.2 79 68 7 S. 30.2 74 70 1 SW.		**H—2—5.** 8.1 S. Cu. 133 6.0 ... . 1.6 S. Cu. 111 2.7 ... . 5.1 S. Cu. 335 16.1 ... . 30.1 68 88 9 NE. 30.1 78 74 10 NE. 30.2 67 90 9 N.		**H—2—14.** 8.1 A. S. 223 2.0 ... . 2.1 Ci. Cu. 247 2.0 2.3 S. Cu. 241 11.3 2.5 Ci. 239 0.9 5.8 Ci. 180 0.7 5.9 S. Cu. 277 6.6 30.1 73 71 4 W. 30.1 78 76 12 NE. 30.1 71 100 14 SE.
	H—2—5. ... . 2.2 Fr. S. 75 0.8 ... . 6.3 Ci. 70 1.2 ... . 30.2 73 78 12 N. 30.2 67 90 9 N.			
H—3—20. **H—6— 4.** **L—5—15.** 8.8 S. 221 5.2 ... . 30.2 68 90 4 E. 30.1 71 88 5 SE.	**H—6—11.** **L—5— 8.** ... . 2.1 Fr. S. 30 3.2 ... . 30.1 70 86 12 NW.	**H—6—10.** **L—5— 8.** 8.1 Cu. S. 164 26.7 ... . 1.5 Cu. S. 54 16.0 ... . 5.1 Cu. S. 43 13.6 30.2 66 97 5 SW. 30.2 70 74 8 SW. 30.1 71 77 5 SW.	**H—3—19.** **H—6— 3.** **L—5—16.** 8.5 A. Cu. 90 10.0 8.7 A. S. 93 5.0 1.6 Ci. S. 60 3.3 1.7 A. S. 118 7.4 ... . 30.2 64 85 3 S. 30.0 77 58 8 W.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 15 TO SEPTEMBER 18, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Sept. 15 ° ° L. 3. 60. 48 L. 5. 88. 37 H. 2. 94. 52 L. 1. 119. 48	**L—5—10.** **H—2—13.** ... ... 1.9 S. Cu. 208 ... ... 30.0 75 72 6 NE.	**L—5—17.** **H—2— 5.** ... ... 5.1 S. Cu. 273 15.6 ... ... 30.1 57 94 7 SE.	**L—5—19.** 8.3 A. Cu. 290 0.9 ... ... 1.6 Cu. 338 0.6 1.8 Ci. 262 0.8 ... ... 5.3 Cu. 317 1.0 5.6 A. Cu. 218 1.2 ... ... 30.1 72 91 2 NW. 30.0 90 39 6 NW. 29.9 87 42 8 S.	**L—5—12.** 9.8 A. S. 272 0.3 ... ... 12.4 Cu. 264 2.8 ... ... 4.6 Cu. S. 253 2.4 ... ... 30.0 80 50 2 NW. 30.0 91 39 6 NW. 29.9 94 41 6 N.	**L—5—2.** 7.9 S. Cu. 80 9.3 8.2 Cu. 80 8.5 12.7 S. Cu. 88 11.2 12.8 Cu. 95 8.3 12.9 N. 0 18.0 5.0 A. Cu. 92 4.7 5.2 A. S. 86 4.1 5.2 Ci. S. 87 3.6 30.0 73 75 9 NE. 30.0 75 82 12 N. 30.0 75 82 5 N.
Sept. 16 ° ° L. 6. 74. 37 H. 3. 72. 47 L. 4. 98. 40 H. 1 121. 50	**L—4—2.** ... ... 1.7 Cu. 118 ... ... 29.7 92 63 12 SW.	**L—4—8.** 8.3 S. Cu. 172 7.1 ... ... 12.2 A. Cu. 44 18.2 12.5 Cu. 36 18.2 12.6 Ci. Cu. 74 20.5 5.1 S. Cu. 74 8.0 ... ... 29.8 56 94 5 S. 29.8 61 84 6 NW. 29.8 63 84 10 NW.	**L—4—5.** ... ... 1.8 Cu. 143 1.6 ... ... 29.9 93 31 8 SW.		**H—8—20.** **L—4—15.** **L—6—19.** 8.0 St. 260 7.1 ... ... 12.7 Cu. 73 6.5 12.8 A. Cu. 105 6.8 ... ... 5.1 Fr. Cu. 95 13.7 5.2 S. Cu. 96 8.6 30.0 69 88 4 E. 29.9 76 66 6 NW. 29.8 76 68 4 N.
Sept. 17 ° ° L. 2. 80. 48 H. 1. 121. 51 H. 6. 85. 87 L. 4. 112. 28	**H—6—18.** 8.6 S. Cu. 333 ... ... 1.0 S. Cu. 346 ... ... 5.5 A. S. 104 ... ... 29.9 67 88 10 NE. 29.9 71 74 10 NE. 29.9 72 81 10 NE.	**L—2—10.** .. .. 12.1 Cu. 87 9.5 12.3 A. Cu. 71 7.6 ... ... 29.8 63 57 10 W.	**H—6—19.** ... ... 1.4 Cu. 215 2.6 ... ... 29.8 93 26 14 S.	**H—6—11.** ... ... 12.4 Cu. 234 4.6 ... ... 4.2 Cu. 208 3.9 ... ... 29.8 91 50 8 W. 29.8 94 36 5 SW.	**H—6— 9.** **L—2—20.** 8.0 Cu. 66 18.3 8.0 Cu. N. 65 4.5 8.3 A. S. 0 0 12.7 Fr. Cu. 93 12.2 12.8 Cu. 112 12.7 5.2 Fr. Cu. 104 12.8 5.2 A. Cu. 100 8.5 29.8 71 77 1 SW. 29.8 84 59 5 N. 29.8 82 65 6 W.
Sept. 18 ° ° H. 6. 84. 30 L. 3. 56. 47 L. 2. 90. 50 H. 1. 107. 59		**L—2— 5.** **H—1—14.** 8.2 Ci. 109 6.9 ... ... 5.1 Cu. 83 11.5 5.2 S. Cu. 112 12.0 ... ... 29.9 52 78 8 S. .... 29.8 62 64 10 SW.	8.3 Fr. S. 190 16.9 8.6 Fr. Cu. 192 17.8 10.0 Ci. 176 1.3 10.8 Cu. 180 8.3 1.6 Cu. 205 2.7 5.4 Cu. 170 2.9 ... ... 29.8 76 70 16 S. 29.7 90 36 12 S. 29.7 89 39 14 SE.	**H—6—10.** ... ... 12.5 Cu. 187 2.7 4.6 Ci. 36 ... ... 29.9 89 52 9 W. 29.8 92 47 8 SW.	**H—6— 9.** **L—2—13.** ... ... 5.1 Fr. Cu. 140 11.4 5.1 Cu. 140 9.3 ... ...

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 15 TO SEPTEMBER 18, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
L—5—15.				**L—5— 8.**				**L—5— 8.**				**L—5—16.**				**L—3—20.**			
				H—2—14.				**H—2—14.**				**H—2—14.**							
10.9	S. Cu.	40	4.0	...	.....	...	...	8.0	Cu. S.	340	27.5	8.8	St.	10	25.0	8.0	A. S.	94	3.7
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
12.5	N.	78	3.5	3.6	Ci. S.	93	4.0	1.5	Cu.	330	7.2	1.8	Cu.	130	9.8	2.3	A. Cu.	98	5.1
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.3	S. Cu.	41	5.8
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
5.5	S. Cu.	79	4.0	...	.....	..	...	...	.....	...	...	...	.....	...	...	5.5	Ci.	100	5.0
5.7	A. Cu.	79	4.0	...	.....	...	..	...	.....	...	...	...	.....	...	...	5.5	S. Cu.	56	4.4
6.0	Cu. N.	79	4.9	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.0	70	98	4 SW.	....	..	..	....	30.1	60	86	10 N.	30.0	62	89	11 N.	29.9	61	100	12 W.
29.9	74	94	2 NW.	30.0	64	74	11 N.	30.1	67	60	7 NE.	30.0	68	46	12 N.	29.9	71	71	11 N.
29.9	70	95	6 NW.	....	..	..	....	....	..	..	....	....	..	..	....	29.9	64	95	10 SE.
H—3—20.				**H—3—20.**				**H—3—20.**				**H—3—12.**				**H—3—5.**			
L—6— 4.				**L—4—15.**				**L—4—15.**				**L—6—10.**				**L—6—9.**			
				L—6—10.				**L—6—18.**											
8.0	Fr. N.	321	...	9.6	S. Cu.	138	3.8	...	.....	...	...	8.7	Ci. Cu.	85	7.2	8.0	Ci.	93	4.0
10.1	A. Cu.	91	1.5	...	.....	...	...	...	.....	...	...	...	.....	...	...	8.1	Ci. Cu.	95	1.0
11.2	Ci.	90	2.7	...	.....	...	...	...	.....	...	...	...	.....	...	..	...	.....	...	..
11.2	Fr. S.	358	3.5	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.5	S. Cu.	11	2.1	...	.....	...	...	1.3	Ci.	90	4.0	...	.....	...	...	2.2	Ci.	96	3.8
2.0	A. Cu.	92	1.8	...	.....	...	...	1.2	Ci. S.	90	3.3	...	.....	...	...	2.3	Ci. Cu.	94	4.4
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.3	Cu.	136	26.7
5.5	A. Cu.	82	..	5.7	Ci.	83	3.3	4.9	Cu. S.	124	16.6	...	.....	...	...	...	.....	...	...
6.4	Ci. Cu.	57	3.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.0	65	92	8 N.	30.0	61	84	4 S.	....	..	..	....	30.0	54	84	6 SE.	30.0	58	78	23 NE.
29.9	74	68	4 N.	....	..	..	....	30.0	68	53	9 SW.	....	..	..	...	29.9	60	81	16 E.
29.9	70	83	3 S.	29.8	66	71	Lt. N.	....	..	..	....	....	..	..	....	....	..	..	....
H—6—16.				**H—6—17.**				**H—6—17.**				**H—6—17.**				**L—2—6.**			
L—2—13.				**L—2— 5.**				**L—2— 5.**				**L—2— 5.**							
10.8	S. Cu.	108	8.2	...	.....	...	...	8.0	Cu. S.	64	41.3	8.5	S. Cu.	110	7.5	8.8	Ci. S.	119	4.1
10.8	Ci. S.	88	3.4	...	.....	...	...	...	.....	...	...	8.6	S.	122	18.8	8.8	Ci. Cu.	114	3.4
11.0	Ci.	88	3.6	...	.....	...	...	...	.....	...	...	..	.....	...	...	...	.....	...	...
2.0	Cu.	86	6.3	2.3	S. Cu.	75	11.7	1.2	Cu. S.	50	18.1	1.7	S. Cu.	104	26.4	2.1	A. Cu.	106	5.3
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	..	2.2	S. Cu.	165	18.6
5.5	A. Cu.	77	5.7	6.1	St.	85	6.2	5.1	A. Cu.	76	...	5.6	S. Cu.	104	9.8	5.8	A. S.	101	4.4
...	.....	...	...	6.3	A. Cu.	77	5.6	...	.....	...	...	...	.....	...	...	5.9	S. Cu.	128	22.3
29.8	68	95	4 S.	....	..	..	....	29.7	64	89	12 W.	29.9	64	87	12 SW.	29.9	54	100	13 SE.
29.8	80	75	8 SE.	29.8	65	75	20 W.	29.8	66	61	9 W.	29.7	67	88	24 W.	29.7	65	80	22 S.
29.8	76	82	2 S.	29.8	64	74	9 W.	29.8	67	53	8 W.	29.7	65	65	23 NW.	29.7	61	98	15 S.
H—6—16.				**H—6—17.**				**H—6—17.**								**L—3—20.**			
				L—2—14.				**L—2—14.**											
8.6	A. S.	63	3.3	9.5	Ci.	80	4.0	8.0	Ci. S.	89	12.4					7.9	Ci.	85	6.2
...	.....	...	..	9.5	Cu.	130	6.7	8.1	A. Cu.	89	7.2					...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	..					...	.....	...	...
12.8	Cu.	75	4.2	...	.....	...	...	1.4	Cu. S.	85	13.5					2.0	Ci.	68	7.0
5.4	Cu. N.	105	3.0	6.3	S. Cu.	110	8.2	...	.....	...	...					5.9	Ci. S.	69	4.8
5.5	Fr. N.	82	4.4	...	.....	...	...	...	.....	...	...					...	.....	...	...
5.6	A. S.	105	2.9	...	.....	...	...	...	.....	...	...					...	.....	...	...
29.9	73	82	8 NE.	29.9	67	71	9 SW.	29.9	57	80	2 W.					29.9	59	69	22 NW.
30.0	81	61	8 E.	....	..	..	....	30.0	66	61	7 SW.					29.9	68	42	18 NW.
30.0	74	78	9 E.	29.9	65	85	41 NW.	....	..	..	....					30.0	63	51	10 SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 19 TO SEPTEMBER 22, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Sept. 19 ° ° L. 2. 77. 47 H. 4. 99. 43	**H—4—6.** 8.6 A.S. 77 ... ... 2.0 Ci. 96 ... ... 5.3 Ci. 96 ... ... 30.4 46 78 22 NE. 30.3 55 39 16 NE. 30.3 54 41 12 NE.		**H—4—13.** ... . 5.9 Ci. 151 1.7 6.0 Ci. Cu. 140 1.7 6.2 A. Cu. 165 ... 6.4 Cu. N. 140 1.9 6.9 St. 53 6.7 .... 29.8 73 91 4 S.	**H—4—14.** 9.7 Ci. Cu. 194 0.3 ... . 12.2 Cu. 162 1.3 ... . 5.1 A. S. 39 2.9 ... . 30.0 83 42 3 W. 30.0 88 52 5 NW. 29.9 90 46 5 NE.	**L—2—20.** **H—4—15.** 8.0 N. 109 20.2 ... . 12.7 S. 40 21.6 12.8 S. Cu. 110 11.0 1.0 A. Cu. 90 6.9 5.0 A. S. 94 11.7 ... . 29.9 71 82 8 SW. 30.0 64 60 14 NW. 30.2 57 51 20 NW.
Sept. 20 ° ° H. 2. 86. 40					
Sept. 21 ° ° H. 6. 74. 37 L. 3. 67. 50 H. 1. 106. 51	8.7 S. Cu. 95 ... ... 30.7 56 80 5 W.	**H—1—14.** 8.2 S. Cu. 8 31.6 .. .. 5.2 Cu. 22 12.6 ... . 30.1 50 80 6 N. .... 30.2 51 68 13 NW.		9.6 Ci. S. 201 0.2 ... . 12.2 A. Cu. 138 2.0 4.8 S. Cu. 175 3.0 5.1 A. Cu. 72 1.2 30.0 85 52 3 SE. 30.0 90 53 8 W. 29.8 85 66 10 N.	**H—6—19.** 7.9 A. Cu. 85 4.7 8.0 S. Cu. 86 7.5 ... . 12.7 N. 83 10.6 5.1 A. Cu. 88 8.1 ... . 30.1 58 72 1 SW. .... 30.0 62 69 5 S.
Sept. 22 ° ° L. 3. 70. 43 H. 2. 96. 43	**H—2—5.** ... . 1.5 Cu. 356 ... ... 30.4 62 68 12 N.		**H—2—13.** 8.3 Fr. S. 320 22.7 8.7 A. S. 330 15.0 8.9 A. Cu. 327 18.4 9.1 Fr. Cu. 327 5.8 1.6 Fr. Cu. 328 9.6 ... . 30.3 62 89 18 N. 30.2 70 60 19 N.	**H—2—13.** 9.5 Cu. 172 2.0 ... . 30.1 69 41 9 N.	**L—3—19.** **H—2—14.** 7.9 A. Cu. 42 15.5 8.1 Fr. S. 24 28.7 8.2 Cu. 41 14.3 ... . 12.8 Cu. 19 18.0 ... . 30.0 59 70 9 NW. 30.1 63 51 16 NW. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 19 TO SEPTEMBER 22, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
L—2— 5.				**L—2—12.**				**L—2—12.**								**L—2— 6.**			
H—4—24.				**H—4—15.**				**H—4—15.**								**H—4—41.**			
..?	Ci.	105	1.6	9.3	S. Cu.	55	16.5	...	.....	...	...					8.1	A. S.	100	6.2
...	.....	...	...	9.7	Fr. S.	55	52.2	...	.....	...	...					8.2	A. Cu.	110	13.9
12.7	Ci.	112	2.2	1.7	A. S.	91	3.8	1.4	Cu. S.	70	29.4					2.0	Ci.	113	4.4
12.8	Ci. S.	112	2.1	1.7	S. Cu.	91	9.1	...	.....	...	...					2.2	Ci. Cu.	117	5.0
...	.....	...	...	2.0	Fr. S.	68	13.7	..	.....	...	...					...	.....	...	...
5.7	Cu. N.	77	7.3	6.3	S. Cu.	40	9.7	4.8	Cu.	62	..					5.9	A. S.	113	6.7
6.3	Fr. S.	45	22.5	...	.....	...	...	...	.....	...	...					5.9	A. Cu.	110	4.7
...	.....	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
29.8	75	84	8 S.	29.7	59	97	5 W.	....	..	..	....					29.8	56	100	22 SE.
29.7	94	44	15 SW.	30.2	58	72	45 W.	29.9	56	55	20 NW.					29.6	72	84	28 SW.
29.8	64	62	26 NW.	30.0	55	59	35 NW.	30.0	54	45	18 NW.					29.5	68	94	33 S.
				H—2—2.															
				9.4	S. Cu.	348	2.2												
				...	....	...	...												
				6.3	Ci.	6.8	3.3												
				30.2	50	70	4 W.												
				....	..	..	....												
				30.1	58	51	Lt. NW.												
H—6—4.				**H—6—10.**				**H—6—18.**				**H—6—10.**				**H—6— 9.**			
				L—3—20.				**L—3—20.**				**L—3—20.**				**L—3—12.**			
9.1	A. Cu.	87	3.2	8.8	Ci. Cu.	85	2.7	8.1	A. Cu.	80	13.4	8.4	S. Cu.	110	5.0	8.0	Ci.	82	3.4
9.1	Ci. Cu.	87	4.0	9.0	Ci. S.	85	2.7	8.2	Ci. Cu.	78	5.2	...	.....	...	...	...	....	...	...
9.3	Ci.	87	3.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
12.8	S. Cu.	93	3.7	2.4	S.	95	5.2	1.3	S.	65	8.9	1.7	S. Cu.	114	15.0	2.0	A. S.	100	3.7
5.3	A. Cu.	90	3.6	5.5	S.	100	5.0	5.2	Cu. S	90	6.2	5.3	A. Cu.	104	12.7	8.2	A. Cu.	297	3.9
5.4	S. Cu.	98	3.7	...	.....	...	...	...	.....	..	...	...	.....	...	...	...	.....	...	...
30.1	56	88	4 S.	30.0	57	55	4 SW.	30.0	51	68	9 W.	30.0	56	68	8 SW.	30.1	52	71	13 W.
30.0	68	50	9 SW.	29.9	63	55	8 SW.	29.9	64	41	12 SW.	29.9	61	58	15 SW.	29.9	64	50	24 SW.
29.9	64	74	3 S.	29.9	61	58	5 W.	29.9	64	42	8 W.	29.9	60	56	16 W.	29.9	57	75	20 SW.
L—3—12.				**L—3—19.**				**L—3—19.**				**L—3—11.**				**L—3— 4.**			
H—2—24.				**H—2—15.**				**H—2—15.**				**H—2—15.**				**H—2—41.**			
8.3	S.	120	4.0	8.7	N.	28	6.2	8.1	Cu. S.	44	12.9	..	.....	...	...	8.3	Fr. S.	168	42.5
9.2	N.	120	7.3	9.0	Fr. S.	28	19.9	..	.....	...	...	..	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	..	...	...	.....	...	...	...	.....	...	...
12.5	S.	105	6.7	2.0	S. Cu.	40	4.6	1.5	Cu. S.	0	15.0	...	.....	...	...	3.2	N.	112	5.3
12.7	A. Cu.	117	5.8	2.3	Fr. S.	20	8.6	...	.....	...	...	...	.....	...	...	...	.....	..	...
12.7	Ci. Cu.	127	5.7	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
12.8	Ci. S.	140	5.7	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
2.0	Cu. N.	45	7.4	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	5.4	Ci. Cu.	53	1.8	5.1	Cu. S.	5	13.6	5.2	S. Cu.	17	15.0	6.1	N.	109	5.3
...	.....	...	...	5.4	S. Cu.	356	5.0	...	.....	...	...	...	.....	...	...	6.1	Fr. S.	48	18.4
...	....	...	...	5.5	Fr. S.	356	10.0	...	.....	...	...	...	.....	...	...	...	.....	...	...
29.9	60	84	4 W.	29.9	57	77	18 NW.	30.0	50	74	16 N.	....	..	..	....	29.8	58	97	17 S.
29.9	66	60	8 NW.	30.0	54	59	25 NW.	30.3	51	50	15 N.	....	..	..	....	29.7	57	93	3 S.
29.9	59	67	12 NW.	30.1	50	67	28 NW.	30.2	47	59	9 N.	30.1	46	68	9 NE.	29.8	54	100	11 N.

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 23 TO SEPTEMBER 26, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Sept. 23 ° ° L . 3 . 58 . 46 H . 2 . 86 . 40	**H—2—11.** ... . 5.5 Ci. 96 ... . 30.2 60 54 8 SE.	**H—2—10.** ... . 5.1 Ci. 29 3.1 .... 30.0 68 38 12 S.			
Sept. 24 ° ° H . 6 . 80 . 37 L . 2 . 100 . 51	**H—6—19.** **L—2—13.** ... . 1.2 S. Cu. 137 ... . 5.8 A. S. 139 ... ... 30.0 73 39 24 S. 29.9 72 72 12 S.	**H—6—18.** **L—2—6.** ... . 12.2 S. Cu. 173 8.4 ... . 5.0 A. Cu. 170 9.8 5.2 Ci. Cu. 168 9.7 .... 29.7 66 47 18 S. 29.6 68 50 24 S.	8.4 Ci. 128 1.9 8.7 A. Cu. 136 3.0 9.0 Ci. Cu. 142 3.2 1.6 St. 140 4.9 ... . 5.5 A. Cu. 135 3.3 ... . 30.1 65 56 10 SW. 30.0 72 65 10 S. 29.9 77 56 10 S.		**H—6—11.** ... . 12.8 Ci. 40 2.6 ... . 5.0 Ci. S. 78 3.8 ... . 30.2 76 22 10 S. 30.2 71 37 7 S.
Sept. 25 ° ° H . 3 . 67 . 43 L . 2 . 90 . 51		**L—2—5.** ... . 5.1 Ci. Cu. 79 7.3 5.3 A. Cu. 104 7.4 .... 29.9 58 51 10 W.	8.2 Fr. S. 140 13.1 ... . 1.3 Cu. 86 1.4 ... . 5.5 A. Cu. 89 1.5 6.0 Cu. 214 2.7 30.1 70 90 7 SW. 30.0 81 61 4 SW. 29.9 83 53 6 SE.	9.5 Cu. 351 0.7 ... . 30.2 69 58 4 NE.	**L—2—13.** 8.0 Cu. 115 13.0 8.1 S. Cu. 116 9.0 12.7 S. 140 11.8 .. .. 5.1 S. Cu. 141 16.2 ... . 30.2 62 50 6 S. .... 30.1 72 60 8 S.
Sept. 26 ° ° H . 3 . 62 . 43 L . 2 . 76 . 48 H . 4 . 105 . 42	... . 1.2 S. Cu. 3 ... ... 5.1 S. Cu. 347 .. .. 30.1 59 87 12 NW. 30.2 60 69 14 N.	**L—2—19.** **H—4—15.** ... . 12.1 A. Cu. 71 6.7 12.3 Cu. 37 7.4 ... . 30.3 54 45 6 NW.	**H—4—14.** 8.1 Fr. S. 189 21.4 8.3 A. Cu. 170 0.9 8.7 Cu. 110 2.2 9.2 St. 68 2.5 3.7 A. Cu. 102 1.4 ... . 4.1 Fr. S. 211 3.4 4.1 Fr. Cu. 158 2.3 4.3 St. 341 5.0 4.5 Cu. 320 3.0 4.6 Cu. N. 156 1.7 5.4 Ci. S. 158 2.7 5.6 A. Cu. 159 3.0 30.0 70 86 16 SE. 30.0 71 86 9 SE. 30.1 71 86 9 SE.	**H—4—23.** 9.5 A. Cu. 21 0.3 ... . 12.2 S. 200 2.4 ... . 5.0 S. Cu. 175 4.1 ... . 30.2 76 53 8 SE. 30.1 80 54 5 SE. 30.0 82 36 5 NE.	**L—2—20.** **H—4—15.** **H—4—24.** 7.9 A. Cu. 121 4.8 8.1 S. Cu. 121 7.0 ... . 12.8 A. Cu. 151 8.1 ... . 5.1 A. Cu. 132 6.6 ... . 30.2 69 57 6 S. 30.2 80 38 12 S. 30.1 79 45 8 SE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 23 TO SEPTEMBER 26, 1896.

Washington.					Cleveland.					Detroit.					Buffalo.					Blue Hill.				
H—2—7.					**H—2—2.**										**H—2—8.**					**L—3—19.** **H—2—15.**				
8.1	Cu.		19	10.8	9.3	S.Cu.	346		3.2						...	.....	...		...	...	.....	...		..
...	.....		...	...	...	.....	...		...						1.8	S. Cu.	93		10.0	2.1	Fr. Cu.	4		6.4
...	.....		...	..	...	.....	...		...						1.8	A. Cu.	60		7.7	...	.....	..		...
...	.....		...	...	...	.....	..		...						5.3	S. Cu.	115		15.0	...	.....	...		..
30.2	48	66	12	NW.	30.0	46	51	7	NW.						....	..	..	....		....	..	..	....	
30.2	57	36	18	NW.	....	..	..	....							30.3	48	56	14	W.	30.1	50	41	20	N.
....	..	..	....		....	..	..	....							30.2	51	59	22	W.	...	..	..	....	
H—6—3.					**H—6—9.**					**H—6—9.**					**H—6—9.**					**H—6—16.**				
...	.....		...	...	9.5	Ci.		26	3.0	8.3	Ci.		60	9.3	...	.....	...		...	8.1	S. Cu.	31		7.4
...	.....		...	...	...	.....		...	...	...	.....		...	...	..	.....	...		...	...	.....	...		...
...	.....		...	...	..	.....		...	...	...	.....		...	...	...	.....	...		...	...	.....	...		...
...	.....		...	...	...	.....		...	..	...	.....		...	...	...	.....	...		...	2.1	A. Cu.	42		7.1
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....	...		...	2.1	S. Cu.	43		6.0
5.2	Ci.		20	2.8	6.3	Ci.		54	2.3	5.1	Ci.		90	4.5	5.6	A. Cu.	42		3.5	5.7	S. Cu.	29		7.9
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....	...		..	...	.....	...		...
....	..	..	....		30.3	56	50	11	SW.	30.3	50	61	12	SW.	....	..	..	....		30.2	43	74	13	W.
....	..	..	....		....	..	..	....		....	..	..	....		....	..	..	....		30.1	59	58	22	NW.
30.3	57	71	1	SW.	30.2	64	44	7	S.	30.2	63	40	9	S.	30.0	58	68	28	W.	30.2	56	70	16	N.
H—3—11.					**H—3—19.** **L—2—14.**					**H—3—19.** **L—2—14.**					**H—3—11.** **L—2—14.**					**H—3—4.**				
10.0	Ci. S.		88	1.0	9.4	Ci.		126	2.7	8.0	Cu. S.		120	18.7	8.6	A. S.		90	3.5	...	.....	...		...
..	.....		...	...	...	.....		..	...	...	.....		..	...	...	.....	...		...	...	.....	...		..
12.7	Ci.		75	1.8	2.5	Ci.		137	3.7	1.4	S. Cu.		135	23.1	1.5	A. S.		137	4.2	2.1	Ci.	10		2.2
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....	...		...	2.2	Cu.	130		7.0
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....	...		...	2.3	Fr. Cu.	150		7.0
...	.....		..	...	6.2	Ci. Cu.		121	3.4	...	.....		...	..	5.3	St.		128	10.0	...	.....	...		...
...	.....		...	...	...	.....		...	...	..	.....		...	...	..	.....	...		...	...	.....	...		...
30.3	54	82	Calm.		30.1	53	61	11	S.	30.0	58	61	18	SW.	30.2	58	46	6	S.	....	.	..	....	
30.3	73	46	15	S.	30.0	72	42	7	SW.	30.0	62	60	17	SW.	30.0	71	38	24	SW.	30.3	64	59	21	S.
....	..	..	....		30.1	69	51	12	S.	....	..	..	....		30.0	71	38	24	SW.	....	..	..	....	
H—3—19. **L—2—18.** **H—4—40.**					**L—2—12.** **H—4—25.**					**L—2—12.** **H—4—25.**					**H—3—19.** **L—2— 5.** **H—4—41.**					**H—3—11.** **L—2— 6.** **H—4—57.**				
8.2	S. Cu.		112	2.6	8.7	S. Cu.		123	17.4	8.2	Cu. S.		138	24.0	8.7	St.		129	23.0	8.1	S.	133		65.5
9.4	Ci. Cu.		112	2.5	...	.....		...	...	...	.....		...	...	...	.....	...		...	...	.....	...		...
9.2	Ci.		110	2.5	...	.....		...	...	...	.....		...	...	...	.....	...		...	...	.....	...		...
9.3	A. Cu.		110	2.8	...	.....		...	...	...	.....		...	...	...	.....	...		...	...	.....	...		...
12.8	Ci. Cu.		114	2.1	2.2	Fr. Cu.		123	9.4	1.4	Cu. S.		120	11.5	2.2	St.		131	20.0	2.1	Fr. Cu.	130		11.1
2.1	A. Cu.		109	2.1	...	.....		...	...	...	.....		...	...	...	.....	...		...	...	.....	...		...
5.5	Ci.		110	2.6	...	.....		...	...	5.1	Ci.		90	3.9	...	.....	...		...	...	.....	...		..
...	.....		...	...	...	.....		...	..	...	.....		...	...	...	.....	...		..	...	.....	...		...
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....	...		...	...	.....	...		...
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....	...		...	...	.....	...		..
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....	...		...	...	.....	...		...
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....	...		...	...	.....	...		...
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....	...		..	...	.....	...		...
30.3	59	88	4	S.	30.2	60	89	13	SW.	30.2	60	95	7	SW.	30.2	65	63	18	SW.	30.4	58	100	20	SW.
30.3	73	61	10	S.	30.1	70	70	10	SW.	30.1	74	54	12	SW.	30.1	70	64	12	SW.	30.3	70	57	30	SW.
30.3	66	75	1	S.	....	..	..	....		30.1	72	49	7	W.	....	.	.	...		....	..	..	....	

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 27 TO OCTOBER 1, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Sept. 27 ° ° H . 3 . 68 . 41 H . 4 . 101 . 41			**H—4—5.** ... . 1.1 Fr. S. 7 15.1 1.4 A. Cu. 60 4.2 5.3 A. Cu. 90 3.4 .... 30.4 57 71 20 N. 30.3 59 67 14 N.		
Sept. 28 ° ° L . 6 . 84 . 29 H . 5 . 99 . 34	**L—6—18.** **H—5— 8.** ... . 1.3 Cu. 21 ... ... 30.2 56 72 7 NE.			**L—6—10.** **H—5— 7.** 9.7 Cu. 182 0.7 ... . 12.3 S. 12 9.2 ... . 4.8 S. Cu. 0 8.9 ... . 30.1 58 93 6 N. 30.0 59 83 8 NW. 30.0 59 72 12 N.	
Sept. 29 ° ° L . 6 . 82 . 31 H . 3 . 67 . 43 L . 2 . 96 . 51	**L—6—18.** **L—2—13.** 8.5 A. Cu. 352 ... 1.4 A. Cu. 13 ... ... 5.3 A. Cu. 32 .. 5.5 Ci. 24 ... 30.0 49 83 6 W. 29.9 62 43 11 NW. 29.9 66 48 6 NW.	**L—2—6.** 8.3 Ci. 38 6.1 12.1 A. S. 15 5.0 12.3 A. Cu. 338 4.0 5.1 A. S. 350 6.2 ... . 30.0 42 84 2 SE. 29.9 61 32 5 S. 29.8 59 60 2 SE.	... . 1.6 Ci. 88 2.8 ... . 29.9 78 33 16 SW.		**L—6—9.** ... . 5.0 S. Cu. 120 30.5 ... . 29.8 51 85 16 SW.
Sept. 30 ° ° L . 2 . 83 . 44 H . 2 . 100 . 50			... . 1.4 Ci. 124 2.9 ... . 5.4 Ci. S. 134 3.2 ... . 30.0 82 36 13 S. 30.0 83 34 . 12 SE.		**L—2—5.** ... . 12.8 S. 70 1.9 ... . 5.1 S. 56 20.0 5.1 S. Cu. 56 24.2 .... 29.8 63 48 16 SW. 29.9 67 54 12 SW.
Oct. 1 ° ° L . 3 . 69 . 49 H . 2 . 89 . 46 L . 1 . 101 . 52	**H—2—12.** ... . 5.4 A. Cu. 36 ... ... 30.1 83 46 6 S.	**H—2— 4.** **L—1—14.** ... . 5.0 Ci. S. 76 3.2 5.2 Ci. 73 1.8 ... . 30.1 63 38 5 SE.	8.0 Ci. S. 114 2.7 8.3 Ci. Cu. 141 1.7 9.2 A. S. 117 2.7 9.3 A. Cu. 113 1.7 1.3 A. S. 114 1.2 1.4 A. Cu. 129 1.2 5.3 Ci. 115 2.2 5.5 A. Cu. 127 1.0 5.8 Ci. S. 128 2.6 30.2 68 74 12 S. 30.2 82 42 6 S. 30.1 81 44 9 SE.	9.9 Ci. 195 0.7 ... . 12.7 Ci. S 212 0.7 ... . 5.1 A. S. 55 2.4 ... . 30.2 73 51 3 NW. 30.1 78 23 8 NW. 30.1 84 41 4 NW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 27 TO OCTOBER 1, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
	H—3—19. **H—4—25.** ... . 6.2 N. 343 13.9 .... 30.1 57 80 13 N.			**H—3— 4.** **H—4—57.** 11.0 Ci. 108 7.7 11.1 Ci. Cu. 199 9.3 11.2 Cu. 140 14.0 2.1 Cu. 136 15.4 ... . 30.2 57 100 16 SW. 30.1 73 62 27 SW. ....
L—6—16. **H—5—41.** 8.1 A. Cu. 115 2.3 ... . 12.8 A. Cu. 104 2.5 12.9 S. Cu. 242 6.7 2.0 N. 233 6.7 4.8 A. Cu. 107 2.4 5.4 S. Cu. 217 4.7 30.1 66 92 1 N. 30.1 76 70 7 NE. 30.1 70 90 6 NE.	**L—6—17.** **H—5—26.** 9.4 Fr. S. 218 11.1 ... . 2.0 S. 224 4.0 2.3 Fr. S. 270 7.0 ... . 30.2 53 87 10 E. 30.1 60 75 12 NE.	**L—6—17.** **H—5—26.** 8.3 A. S. 132 5.7 ... . 1.9 A. S. 185 4.1 ... . 5.1 St. 1 7.4 ... . 30.2 51 56 12 NE. 30.2 58 56 9 NE. 30.1 57 88 9 NE.	**H—5—42.** 8.7 S. 290 37.5 8.9 A. Cu. 110 6.7 1.3 A. Cu. 125 7.7 ... . 30.3 52 84 6 E. 30.2 59 44 22 E.	**H—5—58.** 8.3 A. S. 10 17.0 ... . 2.1 S. Cu. 304 27.4 ... . 30.2 59 98 23 NW. 30.2 57 86 16 NE. ....
L—6—16. **H—3—12.** 8.2 Fr. N. 250 33.3 ... . 30.0 70 91 12 E. 29.8 69 100 20 E.	**L—6—17.** **H—3—19.** ... . 2.0 Fr. S. 244 26.6 ... . 6.1 Fr. S. 230 27.2 ... . 29.6 66 95 18 E. 29.4 68 85 25 SE.		**L—6—17.** **H—3—11.** 8.8 S. Cu. 132 5.0 ... . 30.0 62 81 12 E.	**H—3—4.** 8.2 Ci. 88 5.0 2.2 Fr. S. 185 14.2 ... . 30.2 55 100 13 SE. 30.2 62 75 13 SE. ....
L—2—6. 9.6 Cu. 121 6.7 ... . 5.3 S. Cu. 97 9.7 ... . 29.8 64 70 8 W. 29.7 68 42 13 S. 29.7 67 59 10 SW.	**L—2—1.** ... . 1.9 N. 117 12.7 ... . 6.1 Fr. Cu. 64 4.6 ... . 29.5 51 81 12 29.6 52 87 9	**L—2—1.** ... . 1.5 S. Cu. 70 12.1 1.6 A. S. 17 9.2 5.1 S. Cu. 120 6.3 ... . 29.5 55 76 10 SW. 29.6 53 84 10 W.		**L—2—15.** 11.0 Ci. 140 3.3 11.1 S. Cu. 162 33.3 ... . 29.8 68 100 48 S. ....
L—3—20. **H—2—14.** 8.0 Ci. 112 1.2 8.2 A. Cu. 45 6.7 9.3 Ci. Cu. 152 1.1 ... . 1.2 Cu. 50 8.3 3.7 S. Cu. 30 7.8 4.7 A. Cu. 38 5.1 ... . 29.9 60 71 8 NW. 30.0 66 60 12 NW. 30.0 60 78 6 NW.	**L—3—20.** **H—2— 6.** 9.6 Fr. N. 15 15.1 ... . 2.2 Fr. N. 15 14.9 ... . 5.8 Fr. N. 6 15.2 ... . 30.0 53 81 20 NW. 30.1 52 87 13 NW. 30.2 52 87 12 NW.	**L—3—20.** **H—2— 6.** 8.1 Cu. S. 30 36.3 ... . 1.7 S. Cu. 12 13.9 ... . 5.5 S. Cu. 359 14.9 ... . 30.1 50 80 7 N. 30.2 52 81 8 N. 30.2 51 81 6 N.	**L—3—20.** **H—2— 7.** 8.9 S. 7 20.0 ... . 1.3 S. Cu. 120 6.7 ... . 5.5 S. Cu. 90 6.7 ... . 30.0 53 89 5 N.	**L—3— 5.** **H—2—15.** 8.1 N. 131 8.0 ... . 2.2 Ci. 153 1.8 2.2 Cu. Fr. Cu. 35 4.3 5.2 S. Cu. 30 2.7 ... . 29.8 56 87 15 SW. 29.8 66 50 20 NW. 29.8 59 66 15 NW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 2 TO OCTOBER 5, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Oct. 2 ° ° H . 2 . 81 . 47 H . 4 . 102 . 42 L . 1 . 111 . 52			**H—4—13.** 8.4 Ci. S. 106 1.5 ... . 1.5 Ci. S. 124 1.2 ... . 5.7 Ci. S. 135 1.4 5.8 A. S. 119 1.0 30.2 69 70 1 S. 30.1 84 32 5 NE. 30.0 82 36 3 E.		**H—2—12.** **H—4—15.** ... . 12.7 S. 303 3.5 ... . 4.8 S. 344 4.8 ... . 30.2 63 55 8 N. 30.1 59 61 12 N.
Oct. 3 ° ° H . 2 . 76 . 48 L . 1 . 104 . 47		**H—2—19.** **L—1— 7.** ... . 12.1 Ci. 25 4.2 ... . 5.1 Ci. 64 2.6 ... . 30.0 68 48 13 SE. 30.0 68 50 9 SE.	8.6 A. Cu. 88 1.2 ... . 5.5 A. S. 138 0.8 5.8 Ci. 132 1.2 30.1 66 75 3 S. .... 29.9 80 35 6 SE		**H—2—20.** 8.8 Cu. 315 5.0 ... . 30.1 63 46 10 N. ....
Oct. 4 ° ° H . 3 . 74 . 44 L . 2 . 98 . 43			**L—2—13.** ... . 1.2 Cu. 118 3.1 1.7 A. Cu. 163 2.1 5.7 A. Cu. 154 1.3 .... 30.0 80 44 10 S. 29.9 78 49 9 S.		
Oct. 5 ° ° H . 3 . 70 . 50 L . 2 . 88 . 47 H . 2 . 100 . 47	**L—2—12.** **H—2— 6.** 9.6 A. Cu. 93 ... 11.6 S. Cu. 309 ... ... 2.3 A. S. 112 ... ... 30.2 56 93 10 NE. 30.2 61 87 6 NE.	**L—2—4.** **H—2—7.** 8.2 Cu. 66 20.1 ... . 5.1 Ci. 101 7.7 30.2 46 75 10 NW. .... 30.2 52 57 7 NW.	8.1 Ci. Cu. 160 0.9 8.5 A. Cu. 193 2.6 8.5 Fr. S. 165 2.8 9.1 Fr. Cu. 180 11.4 1.2 Cu. N. 178 1.8 1.5 Cu. 182 2.0 ... . 30.2 73 65 3 S. 30.1 80 45 4 S.	9.9 Ci. Cu. 86 1.3 ... . 12.4 Ci. Cu. 76 1.3 ... . 30.0 74 76 3 SE. 30.1 83 38 6 NW.	**L—2— 5.** **H—2—14.** 7.9 A. Cu. 92 4.5 ... . 30.2 51 77 1 SW. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 2 TO OCTOBER 5, 1896.

Washington.					Cleveland.					Detroit.					Buffalo.					Blue Hill.				
H—2—5.					H—2—5.					H—2—1.														
8.3	A. Cu.		52	4.5	9.4	Fr. Cu.		341	4.9	...	.....		...	...										
9.7	Ci.		126	1.7	...	.....		...	...	...	.....		...	...										
9.8	Cu.		35	8.7	...	.....		...	...	...	.....		...	...										
12.8	S. Cu.		60	7.0	1.0	Ci. Cu.		240	1.9	1.3	S. Cu.		303	5.1										
12.9	A. Cu.		26	4.8	...	.....		...	...	...	.....		...	...										
4.8	A. Cu.		355	3.3	...	.....		...	...	...	.....		...	...										
...	.....		...	...	...	.....		..	...	...	.....		...	...										
30.1	56	80	6	NW.	30.1	52	90	5	NW.	....	..	..	....											
30.0	63	55	8	W.	30.1	56	65	13	N.	30.1	58	64	7	N.										
30.1	58	69	8	W.	30.1	54	59	9	N.	....	..	..	....											
H—2—13.					H—2—12.										H—2—5.					H—2—6.				
...	A. Cu.		241	2.2	8.5	Fr. Cu.		322	10.2						8.8	S.		308	26.7	9.2	S.		354	8.2
...	....		...	...	...	.....		...	...						...	.....		...	...	9.1	Ci.		161	2.1
...	...		...	...	...	.....		...	...						...	.....		...	...	9.2	Pr. S.		344	17.4
1.0	A. Cu.		156	3.3	2.3	Fr. Cu.		282	3.8						1.3	S.		308	24.0	2.3	S. Cu.		53	2.0
1.2	Cu.		...	3.3	...	.....		...	...						...	.....		...	...	...	.....		...	...
1.9	S. Cu.		153	1.4	...	.....		...	...						...	.....		...	...	...	.....		...	...
5.3	A. Cu.		155	0.8	...	.....		...	...						5.5	S.		308	22.7	5.1	S. Cu.		92	5.1
5.4	S. Cu.		224	1.1	...	.....		...	...						...	.....		...	...	...	.....		...	...
30.1	53	81	4	N.	30.1	47	76	2	E.						30.2	49	81	6	NE.	30.1	46	100	16	N.
30.1	64	51	9	NE.	30.1	57	60	14	E.						30.1	53	75	12	E.	30.1	53	81	4	NE.
30.1	58	86	4	NE.	30.1	54	67	10	E.						30.2	51	72	12	E.	30.2	53	79	4	NE.
																				H—3—5.				
																				...	.....		...	...
																				2.1	N.		289	16.2
																				...	.....		...	...
																				...	.....		...	...
																				....	..	..	....	
																				30.2	52	97	13	NE.
																				....	..	..	....	
H—3—20. L—2—14.					H—3—20. L—2— 6.					H—3—20. L—2— 6. H—2—15.					H—3—20. L—2— 6.					H—3— 5. L—2—15.				
8.1	S. Cu.		38	3.4	...	.....		...	...	8.2	Cu.		217	19.7	8.9	S. Cu.		294	11.7	9.3	N.		328	6.7
...	.....		...	...	...	.....		...	...	...	.....		...	...	..	.....		...	...	...	.....		...	...
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
12.9	Cu.		38	4.2	...	.....		...	...	1.8	S. Cu.		180	8.7	1.9	S. Cu.		310	6.0	...	.....		...	...
1.0	S. Cu.		40	3.5	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
...	.....		...	...	5.4	Ci. S.		80	2.3	5.0	A. S.		95	4.7	5.5	S. Cu.		340	7.3	..	.....		...	..
30.2	52	87	4	N.	....	..	..	....		30.2	54	79	5	SE.	30.2	47	81	6	SE.	30.2	47	96	34	NE.
30.1	62	64	6	NW.	....	..	..	....		30.1	60	70	3	SE.	30.2	54	53	5	E.	....	..		....	
....	..	..	....		30.1	59	72	4	N.	30.1	58	72	7	E.	30.2	53	69	8	NE.	....	..	..	....	

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 6 TO OCTOBER 10, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Oct. 6 ° ° L. 3. 66. 43 H. 4. 102. 41			**H—4—18.** 8.5 Cu. 222 2.5 8.4 A. Cu. 177 0.9 8.8 A. S. 111 4.0 9.0 Fr. Cu. 276 1.7 1.6 Fr. Cu. 340 12.9 1.8 A. Cu. 183 2.1 1.5 Ci. S. 129 4.0 2.0 A. S. 227 1.0 ... . 30.3 65 92 3 N. 30.3 69 59 18 N.		**H—4—15.** 7.9 S. Cu. 115 14.1 8.1 S. 102 7.5 ... . 12.8 S. 93 17.3 ... . 30.1 55 65 6 N. 30.1 68 65 15 SW. ....
Oct. 7 ° ° L. 3. 64. 44 H. 2. 95. 47			**H—2—36.** ... . 5.6 A. Cu. 81 1.3 ... . 30.2 57 77 5 NE.	**H—2—21.** 9.5 Cu. 172 1.3 ... . 12.8 Cu. 182 1.7 ... . 4.5 Cu. 334 2.0 ... . 30.2 63 51 8 NE. 30.2 64 41 6 N. 30.2 67 49 4 N.	**H—2—14.** .. .. 12.7 A. S. 90 5.0 ... . 30.3 58 37 6 NW. ....
Oct. 8 ° ° L. 3. 67. 48 H. 2. 85. 50 L. 1. 102. 53	**H—2—20.** 8.8 A. Cu. 79 ... . 1.5 A. Cu. 119 ... ... 30.0 47 68 6 SE. 30.2 61 66 11 SE.	**H—2—12.** **L—1—14.** 8.1 Cu. 71 9.4 ... . 10.3 Cu. 109 8.2 11.4 A. Cu. 130 9.8 5.1 Cu. 102 11.1 5.3 Ci. S. 105 11.5 5.5 S. Cu. 106 9.3 30.2 40 68 10 SE. 30.2 49 49 20 S. 30.1 53 47 14 S.	**H—2—51.** • 8.5 S. 358 1.7 8.7 Cu. 308 1.3 9.0 Fr. Cu. 53 2.9 1.5 Cu. 213 1.6 ... . 5.2 Fr. Cu. 192 2.1 ... . 30.2 53 79 2 S. 30.1 67 52 4 SE. 30.0 67 59 5 SE.	**H—2—52.** 9.7 A. Cu. 185 0.6 ... . 12.8 A. Cu. 141 1.2 ... . 4.8 S. Cu. 71 1.4 ... . 30.1 57 52 4 N. 30.1 62 56 4 N. 30.0 64 56 6 N.	**H—2—13.** ... . 12.7 Ci. 100 6.4 ... .
Oct. 9 ° ° H. 2. 78. 44 L. 3. 60. 48 L. 4. 101. 41	**H—2—19.** **L—4— 7.** 8.8 Ci. 110 ... ... 1.9 Ci. 114 ... 5.3 Ci. 116 ... ... 30.1 53 71 11 SE. 30.0 67 43 12 SE. 30.0 66 41 8 SE.	**H—2—19.** **L—4— 8.** 8.2 Cu. 180 17.8 8.5 A. Cu. 178 16.5 ... . 30.1 48 66 7 S.	**L—4—5.** ... . 5.5 Ci. 88 2.8 5.8 Ci. S. 93 2.5 .... 29.9 74 58 10 S.	**L—4—14.** ... . 2.3 A. Cu. 260 2.2 3.3 A. Cu. 288 1.4 .. .. 30.0 75 58 6 E. 30.0 78 56 6 E.	
Oct. 10 ° ° H. 3. 72. 47 L. 2. 94. 42 H. 4. 107. 43 L. 6. 79. 23	**L—2— 1.** **H—4—15.** 11.1 N. 36 ... ... 30.1 46 93 12 NW.	**L—2—3.** **H—4—15.** 8.2 S. 280 11.7 ... . 30.1 49 76 2 NE.	**L—2—20.** **H—4—14.** ... . 1.4 Cu. 108 4.3 1.5 A. S. 49 4.9 1.6 Fr. S. 4 10.8 2.0 Fr. Cu. 18 11.8 ... ... 30.2 58 64 14 N.	**L—2—18.** **L—6—18.** 9.7 A. S. 160 0.6 12.3 A. Cu. 160 0.2 ... . 4.9 Cu. 159 2.6 30.1 68 51 9 E. 30.1 77 44 6 SE. 29.9 78 46 4 SE.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 6 TO OCTOBER 10, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
L—3—19. ... ... 1.0 Cu. 66 3.8 ... ... 30.1 66 47 4 NW.	9.4 St. 121 1.7 ... ... 5.3 S. 90 5.4 30.1 46 93 Lt. SE. .... 29.9 53 94 6 SW.		**L—3—19.** 8.9 A. Cu. 104 7.3 ... ... 30.2 43 79 12 SE.	**L—3—1.** ... ... 2.1 S. Cu. 343 19.2 ... ... 5.5 S. Cu. 3 17.2 .... 30.1 46 84 18 N. 30.1 45 82 15 N.
H—2—23. **L—3—20.** 8.2 Cu. 55 12.1 9.3 Ci. Cu. 95 4.5 1.0 Ci. 99 4.3 1.9 Ci. Cu. 99 4.4 ... ... 30.0 55 58 16 NW. 30.1 57 37 25 NW.	**H—2—14.** **L—3—19.** 8.7 S. Cu. 40 8.3 ... ... 2.0 S. Cu. 48 9.9 ... ... 5.5 S. Cu. 60 5.6 ... ... 30.2 44 59 25 W. 30.2 44 63 18 W. 30.2 44 57 14 W.	**H—2—15.** 8.4 Cu. 41 32.9 ... ... 1.4 S. Cu. 30 20.9 ... ... 4.5 S. Cu. 48 16.7 ... ... 30.2 41 61 10 NW. 30.3 43 31 11 NW. 30.3 43 56 9 NW.	**H—2—15.** **L—3—19.** ... ... 1.5 S. Cu. 40 8.3 ... ... 5.0 S. Cu. 40 8.3 ... ... 30.1 45 64 22 NW. 30.1 43 63 26 NW.	**H—2—24.** **L—3—11.** 9.3 N. 126 4.4 .. .. 2.1 A. Cu. 112 8.0 2.2 S. Cu. 94 9.9 ... ... 29.9 44 85 6 S. 29.8 50 97 5 NW. 29.9 48 95 9 NW.
L—3—20. **H—2—14.** 10.1 Cu. 12 5.2 ... ... 12.6 Cu. 33 4.1 ... ... 30.3 45 64 3 W. 30.2 54 43 8 NW.	**L—3—20.** **H—2— 5.** 8.9 S. Cu. 60 2.3 ... ... 6.0 Ci. 100 2.3 6.3 S. Cu. 28 5.1 ... ... 30.3 44 74 14 W. .... 30.3 45 64 8 W.	**L—3—19.** **H—2— 5.** ... ... 4.8 Ci. 0 0 ... ... 50.4 47 59 4 NW.	**L—3—20.** **H—2— 6.** 8.6 S. Cu. 40 11.7 ... ... 1.9 S. Cu. 90 11.7 ... ... 5.1 S. Cu. 85 15.0 ... ... 30.3 40 80 12 NW. 30.3 44 50 15 W. 30.3 42 55 7 NW.	**L—3—12.** **H—2—14.** 9.7 Cu. Fr. Cu. 74 9.1 ... ... 2.0 A. Cu. 72 5.8 2.1 S. Cu. 66 6.9 ... ... 30.0 41 76 17 W. 30.1 49 54 26 NW. ....
		H—2—4. ... ... 1.6 S. Cu. 260 6.1 ... ... 30.4 51 68 13 NE.		**L—3—20.** **H—2— 7.** 7.8 Ci. 111 4.2 ... ... 2.0 Fr. Cu. 98 1.7 ... ... 30.4 37 74 20 NW. 30.4 47 46 15 NW. ....
H—3—20. **L—2—15.** **L—6—17.** 8.1 S. Cu. 272 11.3 1.6 S. Cu. 272 10.6 ... ... 4.4 S. Cu. 272 ... 30.5 46 79 10 NE. 30.4 54 46 12 NE. 30.4 53 69 9 NE.		**H—3—20.** **L—2—7.** 8.2 Ci. 97 2.6 1.3 Ci. 145 1.6 ... ... 4.8 Ci. 0 0 30.4 47 79 5 E. 30.3 58 59 8 E.		**H—3—5.** 4.7 Fr. Cu. 144 10.2 2.1 Ci. 110 3.3 ... ... 5.3 Ci. 108 3.7 30.6 38 75 13 NE. 30.6 46 54 20 E. 30.5 42 74 13 NE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 11 TO OCTOBER 15, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Oct. 11 ° ° H. 3. 64. 49 L. 5. 91. 39			**L—5—20.** ... . 5.5 Ci. 103 3.3 .... 30.0 71 30 9 S.		
Oct. 12 ° ° L. 6. 73. 37 H. 3. 69. 50 H. 1. 118. 46	**H—1—40.** 8.5 S. Cu. 346 ... ... 30.2 48 83 6 NE.	**H—1—1.** ... . 5.0 Cu. 11 1.3 ... . 30.2 62 43 2 NE.	**H—1—39.** 8.2 A. Cu. 123 2.5 8.7 A. S. 119 2.7 9.0 S. 167 2.0 9.4 Fr. S. 181 11.2 1.4 S. 225 6.5 ... . 30.1 60 58 14 S. 30.1 62 64 9 S.	... . 12.5 Ci. 166 1.5 ... . 30.1 72 64 8 NW.	**L—6—19.** **H—1—56.** 7.9 S. 95 14.9 7.9 A. S. 227 4.3 ... . 12.7 A. S. 237 8.3 12.9 Cu. 71 3.3 5.0 Fr. Cu. 324 6.3 5.0 S. Cu. 350 6.3 5.1 A. S. 338 5.1 30.0 52 75 7 SW. 30.0 60 48 6 SW. 30.1 60 51 12 NW.
Oct. 13 ° ° L. 6. 74. 39 H. 4. 106. 42			**H—4—14.** 8.7 S. 251 4.9 ... . 30.3 58 80 10 NE.	... . 12.6 Cu. 317 1.4 ... . 4.8 A. S. 152 4.3 ... . 30.2 69 58 6 NE. 30.1 71 45 6 N.	**L—6—19.** 7.9 Fr. Cu. 14 31.6 8.0 A. Cu. 15 7.3 12.8 A. Cu. 23 9.9 12.8 S. Cu. 18 23.9 ... . 30.1 52 60 10 NW. 30.1 59 57 14 NW. ....
Oct. 14 ° ° L. 3. 63. 44 H. 5. 98. 39 L. 2. 97. 51				**H—5—6.** 10.0 Ci. S. 352 0.4 1.6 Ci. S. 293 0.3 5.3 A. S. 108 4.8 ... . 30.2 62 51 4 N. 30.1 70 55 8 NW. 30.0 66 55 4 N.	
Oct. 15 ° ° L. 3. 67. 41 H. 4. 108. 43	**H—4—15.** 11.5 Ci. 91 ... ... 30.2 70 41 8 W.	**H—4—15.** ... . 12.3 Ci. S. 86 5.2 5.1 Ci. S. 51 6.1 5.3 Ci. 42 5.8 .... 30.1 56 46 13 NW. 30.1 55 38 10 NW.	**H—4—14.** ... . 1.7 Fr. S. 21 4.8 ... . 30.2 59 83 6 NW.	**H—4—23.** 9.5 A. Cu. 182 0.6 1.5 Ci. S. 281 0.3 5.1 A. Cu. 54 1.8 ... . 30.1 59 38 5 N. 30.1 69 34 5 NW. 30.1 70 48 4 NW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 11 TO OCTOBER 15, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
	L—5—8. ... . 2.4 Ci. Cu. 240 1.3 5.8 Ci. Cu. 240 1.3 .... 30.1 60 44 10 E. 30.1 54 67 5 E.			**H—3—12.** 8.1 S. Cu. 287 21.4 2.1 N. 318 33.3 4.9 S. Cu. 309 33.3 30.5 47 75 21 E. 30.4 48 86 32 NE. 30.3 48 92 39 NE.
H—3—20. **L—6— 4.** 9.5 N. 355 2.4 ... . 12.8 N. 330 14.6 ... . 3.8 S. Cu. 330 13.6 ... . 30.1 49 93 16 N. 30.0 52 81 12 N. 30.0 48 86 6 N.	**H—3—20.** **L—6—10.** ... . 8.3 Fr. S. 294 19.8 ... . 30.1 49 86 22 NE.	**H—3—20.** **L—6—10.** **H—1—57.** 8.3 A. S. 287 6.6 ... . 1.4 S. 270 10.6 ... . 30.2 50 77 10 N. 30.1 53 69 10 NE.	**H—3—20.** **L—6—10.** 8.4 A. S. 304 5.0 ... . 30.2 45 64 12 NE.	**H—3—5.** **L—6—6.** 8.1 S. Cu. 312 6.9 ... . 2.2 S. Cu. 307 ... ...
L—6—4. 9.0 N. ... 4.8 ... . 12.8 S. Cu. 35 8.6 ... . 4.6 N. 19 6.5 ... . 30.0 48 98 6 N. 29.9 53 69 12 NW. 29.8 52 81 3 W.	**L—6—11.** 8.5 Fr. S. 325 16.6 ... . 2.0 Fr. S. 350 16.7 ... . 5.7 S. 340 3.5 6.8 Fr. S. 10 10.1 30.0 47 89 5 E. 30.0 53 69 13 N. 30.0 53 75 11 N.	**L—6—10.** ... . 1.1 S. 10 7.2 ... . 4.7 Ci. 300 5.7 ... . 30.1 54 73 12 N. 30.1 55 51 7 N.	**L—6—10.** ... . 1.3 S. Cu. 300 6.0 ... . 5.3 S. 10 8.0 ... . 30.0 46 79 18 NE. 30.0 48 76 14 NE.	
L—3—20. 9.1 Cu. ... 21.5 1.0 Fr. N. 30 16.7 4.7 A. Cu. ... 4.2 4.8 St. 12 10.8 29.8 48 94 8 NW. 29.8 58 73 12 NW. 29.8 54 61 10 NW.	**H—5—15.** 9.0 Ci. S. 330 2.0 2.2 Ci. S. 320 2.2 5.9 Ci. S. 330 2.8 ... . 29.9 53 69 12 N. 29.9 56 55 15 N. 30.0 55 70 5 N.	**H—5—15.** **L—2—14.** 8.3 Cu. S. 386 1.5 1.3 Ci. 10 3.8 ... . 30.0 45 78 6 NW. 30.0 63 42 8 N.	**L—3—19.** 8.3 A. S. 20 4.7 1.3 A. S. 21 4.0 ... . 29.9 46 64 8 N. 29.9 54 65 8 N.	**L—3—11.** ... . 2.0 N. 352 21.4 ... . 29.7 48 94 12 NE. ....
L—3—11. **H—4—56.** 8.0 Ci. 6 2.2 ... . 29.8 54 58 12 NW. 29.8 67 30 12 NW.		**L—3—19.** **H—4—41.** ... . 4.7 Ci. 85 5.5 ... . 29.8 69 51 9 W.		

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 16 TO OCTOBER 20, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Oct. 16 ° ° L. 3. 56. 42 H. 1. 112. 52		**H—1—23.** ... . 5.1 S. Cu. 19 22.2 .... 30.0 41 69 14 N.		**H—1—54.** 9.7 A. Cu. 184 0.3 ... . 1.5 A. Cu. 139 1.0 ... . 4.6 St. 42 ... 30.0 57 46 3 NW. 30.0 66 40 6 W. 29.9 66 61 6 SW.	**H—1—55.** 7.8 Ci. S. 85 8.3 ... . 6.0 Fr. Cu. 102 3.5 30.0 50 64 12 N. .... 29.9 61 49 5 N.
Oct. 17 ° ° L. 3. 65. 50 L. 6. 79. 36 H. 1. 105. 51		**H—1—14.** 8.2 Cu. 46 13.3 ... . 4.8 Ci. 29 4.8 5.0 Ci. Cu. 56 7.7 5.2 A. Cu. 79 10.0 30.2 34 81 9 NW. .... 30.0 38 46 9 W.			**L—6—10.** ... . 12.7 Cu. 96 10.5 ... . 5.0 S. 48 13.6 ... . 29.9 60 44 9 W. 30.0 53 54 23 NW.
Oct. 18 ° ° L. 6. 73. 39 H. 5. 91. 34 H. 1. 106. 48		**H—5—17.** **H—1—15.** ... . 12.2 N. 26 20.7 ... . 29.8 42 76 12 NW.	**H—5—11.** 8.2 Ci. 105 2.4 ... . 5.4 A. Cu. 112 3.3 30.2 57 50 13 SE. .... 30.0 73 46 9 SE.		
Oct. 19 ° ° L. 3. 66. 49 H. 6. 83. 35 L. 2. 96. 44	**H—6—18.** **L—2— 5.** 8.8 A. Cu. 76 ... 11.7 Ci. 84 ... 2.2 A. S. 79 ... 5.4 A. S. 61 ... ... 29.9 53 54 14 SW. 29.8 71 46 12 W. 29.8 68 47 9 SW.				**H—6— 3.** **L—2—14.** 7.8 A. Cu. 80 11.8 8.0 S. Cu. 77 11.1 ... . 5.1 Ci. 91 8.9 5.2 Ci. Cu. 90 13.3 30.2 39 72 2 SE. .... 29.9 64 32 15 S.
Oct. 20 ° ° L. 2. 80. 48 H. 4. 98. 43	**L—2—20.** **H—4— 1.** 8.5 A. S. 44 ... 1.4 Ci. 72 ... ... 30.1 37 73 11 N. 30.1 50 53 7 NW.	**L—2—19.** **H—4— 8.** 8.2 S. 89 6.2 12.1 S. Cu. 56 13.1 5.0 S. Cu. 63 18.3 30.0 27 76 6 NW. 29.9 32 64 13 W. 29.9 30 72 13 W.	**H—4—13.** 7.5 Ci. 114 4.0 1.5 Cu. 148 2.8 5.5 A. Cu. 124 2.8 30.0 61 87 4 NW. 29.9 76 55 4 N. 29.8 75 58 6 N.	**H—4—14.** 9.7 A. Cu. 187 0.8 12.7 A. Cu. 213 1.2 4.8 S. Cu. 66 3.7 30.0 65 58 5 SE. 29.8 77 71 6 NW. 29.9 67 90 4 NE	**L—2—20.** **H—4—15.** 7.8 S. 132 16.2 ... . 29.9 58 44 9 S. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 16 TO OCTOBER 20, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
				H—1—56.				**H—1—40.**				**H—1—56.**				**L—3—19.**			
8.6	Ci.	86	2.4	8.8	S. Cu.	65	14.7	9.2	Cu.	32	29.6	8.3	S. Cu	29	13.3	7.9	Ci.	75	4.2
9.0	Ci. S.	95	2.3	...	.....	...	...	9.2	A. S.	82	10.4	...	.....	...	...	...	.....	...	...
12.7	Cu.	68	4.7	1.7	S. Cu.	72	8.9	1.9	Ci. Cu.	70	14.6	1.3	S. Cu.	28	13.3	2.1	Ci. S.	113	4.7
1.5	Ci.	105	3.7	...	.....	...	...	2.0	S. Cu.	30	14.6	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	4.9	S.	85	6.7	5.3	S. Cu.	28	13.3	8.1	Ci. Cu.	103	6.9
29.8	51	74	4 S.	29.8	48	79	15 W.	29.9	42	65	10 NW.	29.7	46	82	12 NW.	29.6	46	67	14 W.
29.7	71	41	16 NW.	29.8	46	72	14 W.	29.9	48	54	7 NW.	29.8	46	52	14 NW.	29.6	63	53	17 SW.
....	..	..	....	....	..	..	....	29.9	46	61	7 NW.	29.9	44	63	12 NW.	29.7	50	67	24 NW.
L—6—3.				**L—6—9.**								**L—3—20.** **L—6— 9.**				**L—3—20.** **L—6—16.**			
8.8	A. Cu.	117	5.3	11.0	A. S.	120	3.0					8.3	S. Cu.	28	11.0	8.0	A. S.	129	6.0
9.0	Ci. Cu.	125	6.9	11.1	Fr. S.	95	11.8					..	.....	...	...	...	.....	...	...
12.9	A. Cu.	142	5.5	2.3	A. S.	115	2.3					1.3	S. Cu.	28	11.0	2.0	S. Cu.	147	8.2
...	.....	...	...	2.3	Fr. S.	90	5.0					...	.....	...	..	...	.....	...	...
4.0	A. Cu.	125	5.0	5.8	N.	115	6.9					5.3	S. Cu.	70	10.0	5.0	A. S.	157	5.7
...	.....	...	...	...	.....	...	...					...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...					...	.....	...	...	...	.....	...	...
29.9	52	75	8 NE.	29.8	41	72	4 S.					29.9	40	60	5 E.	29.9	42	65	11 NW.
29.8	60	58	9 NE.	29.8	46	58	13 W.					29.9	43	54	14 NW.	29.9	47	55	6 NW.
29.9	52	68	4 NE.	29.9	43	85	8 N.					29.9	38	62	14 E.	30.0	45	68	12 E.
				L—6—10. **H—5—16.**															
				8.2	Fr. N.	50	4.8												
				2.1	A. S.	75	3.3												
				5.6	A. S.	75	3.3												
				30.1	38	75	9 N.												
				30.0	40	45	10 NW.												
				30.0	37	70	5 W.												
L—3—20. **H—6— 8.**								**L—3—19.** **H—6— 9.** **L—2—15.**				**L—3—20.** **H—6— 9.** **L—2—15.**							
8.5	Cu.	60	5.3					8.2	S. Cu.	80	10.0	8.3	S. Cu.	30	10.0				
...	.....	..	...					...	.....	...	...	...	.....	...	...				
12.6	Cu.	90	3.8					1.3	Ci.	110	16.0	1.3	S. Cu.	50	10.0				
4.0	Cu.	90	4.1					...	.....	...	...	5.2	S. Cu.	50	10.0				
...	.....	...	...					...	.....	...	...	...	.....	...	...				
30.2	41	76	3 NW.					30.2	34	81	12 SW.	30.1	35	82	12 NW.				
30.2	53	63	6 NW.					30.0	44	47	16 S.	30.1	38	84	24 E.				
30.2	47	66	8 S.					....	..	..	....	30.1	42	68	12 S.				
L—2—13.				**L—2— 5.** **H—4—15.**				**L—2— 5.** **H—4—15.**				**L—2—5.**				**L—2—6.**			
8.2	A. Cu.	...	6.4	11.0	A. Cu.	94	9.3	8.2	A. Cu.	90	11.8	...	.....	...	...	8.2	A. Cu.	112	14.5
1.5	Ci. S.	122	2.7	2.6	A. Cu.	110	7.1	1.5	S. Cu.	100	9.0	5.2	S. Cu.	120	23.3	2.6	Ci.	113	7.1
4.6	Ci. S.	...	3.0	5.1	A. Cu.	119	...	5.0	A. Cu.	122	17.1	...	.....	...	...	2.2	S. Cu.	131	18.5
30.1	48	63	12 S.	29.9	46	72	8 W.	29.9	40	80	13 SW.	....	..	..	....	30.2	40	58	26 S.
30.0	64	32	10 S.	29.8	50	67	10 NW.	29.9	47	53	6 SW.	....	..	..	....	30.1	53	58	34 S.
30.0	57	53	4 S.	29.8	48	73	4 N.	29.8	46	36	8 S.	29.9	48	68	12 W.	...	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 21 TO OCTOBER 25, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Oct. 21 ° ° H . 3 . 59 . 47 L . 2 . 80 . 48 H . 6 . 88 . 36		**L—2—19.** **H—6—18.** 12.1 S. 104 11.8 ... . 5.0 Ci. Cu. 83 11.9 5.2 A. Cu. 76 12.7 ... . 30.[illegible] 33 65 4 W. 30.0 35 45 3 W.	**H—6—19.** 8.4 A. Cu. 123 2.9 ... . 1.2 N. 160 2.9 ... . 5.3 St. 121 2.4 ... . 30.0 57 69 3 N. 30.0 65 95 3 S. 29.9 72 77 4 SE.	**H—6—1.** 9.6 A. Cu. 92 2.8 ... . 1.2 A. Cu. 149 1.0 ... . 4.3 Cu. 58 2.2 ... . 30.0 66 51 5 NE. 30.0 76 48 4 NW. 30.0 78 56 3 NW.	
Oct. 22 ° ° L . 3 . 65 . 49 H . 6 . 76 . 38 H . 1 . 107 . 50	**H—1—22.** 9.2 Ci. S. 97 ... 10.3 A. Cu. 106 ... 12.0 Cu. 193 ... ... 30.1 53 84 6 NE. 30.1 59 62 7 NE.	**H—1—14.** ... . 12.1 Ci. 72 8.8 ... . 30.2 43 42 5 SE.	**H—1—37.** ... . 1.6 S. 143 2.8 2.0 Fr. S. 271 24.4 ... . 29.9 64 85 20 E.	**H—6—19.** **H—1—38.** 9.7 Cu. 16 2.0 ... . 2.3 S. 95 1.4 ... . 4.6 Cu. N. 177 3.0 30.1 67 58 6 SE. 30.0 74 70 4 E. 30.0 72 84 4 E.	**H—6—11.** **H—1—39.** ... . 5.9 A. S. 113 2.7 .... 30.0 69 38 4 SW.
Oct. 23 ° ° L . 2 . 82 . 47 L . 5 . 93 . 32 H . 4 . 106 . 42	**L—2—20.** **L—5— 9.** **H—4—15.** ... . 1.8 A. Cu. 103 ... 5.3 A. Cu. 108 ... ... 30.0 52 42 12 N. 30.0 51 40 9 NW.		**L—5—11.** **H—4—14.** ... . 5.4 S. Cu. 12 15.6 . . .. 30.0 47 83 14 N.	**L—5—2.** 9.3 S. Cu. 41 2.3 1.4 S. 91 2.8 4.3 S. Cu. 9 23.6 ... . 29.7 65 62 10 SE. 29.7 73 59 12 W. 29.8 67 80 14 NW.	
Oct. 24 ° ° L . 3 . 70 . 46 H . 5 . 100 . 34 L . 1 . 105 . 51		**H—5—16.** **L—1—14.** 10.2 Ci. S. 93 5.3 ... . 4.9 Ci. Cu. 91 7.8 5.1 A. Cu. 91 10.5 30.0 28 77 2 SW. .... 29.9 42 40 5 S.	**H—5—1.** 9.0 A. Cu. 124 2.5 9.5 Fr. S. 11 6.7 10.0 Fr. Cu. 341 4.0 1.7 Cu. 28 2.0 ... . 5.3 S. Cu. 118 2.8 5.0 A. Cu. 134 ... 30.1 46 93 4 NW. 30.0 54 70 4 N. 30.0 56 65 2 NW.	**H—5—7.** 9.7 S. Cu. 182 3.4 ... . 1.6 A. S. 60 2.1 ... . 29.9 58 54 5 N. 29.9 61 87 7 N.	
Oct. 25 ° ° H . 6 . 79 . 38			... . 1.3 Cu. 140 4.9 ... . 30.0 66 61 8 S.		

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 21 TO OCTOBER 25, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
L—2—13. **H—6—16.** 8.0 Ci. Cu. 128 3.8 9.7 Ci. S. 115 4.3 1.3 Cu. ... 4.8 ... ... 29.9 54 64 3 S. 29.9 69 43 6 W.	**L—2—5.** **H—6—8.** 8.0 Ci. Cu. 107 5.1 8.2 Fr. Cu. 70 6.4 2.2 Fr. Cu. 103 9.7 ... ... 5.7 A. Cu. 65 4.1 5.9 Fr. Cu. 87 7.8 ... ... 30.0 36 73 12 SW. 30.0 43 49 20 W. 30.0 40 60 17 W.	**L—2—5.** **H—6—8.** ... ... 1.5 S. Cu. 100 15.9 ... ... 4.6 S. Cu. 100 8.9 ... ... 30.0 38 54 10 W. 30.1 38 63 12 SW.		**H—3—20.** **L—2— 6.** 8.1 S. Cu. 147 10.1 ... ... 2.0 A. Cu. 147 8.2 2.1 S. Cu. 178 34.4 5.0 Ci. 147 4.3 5.1 N. 138 6.7 6.0 A. Cu. 124 8.3 30.0 52 90 35 S. 29.8 58 83 35 S. 29.8 56 84 27 S.
L—3—20. **H—6— 3.** **H—1—56.** ... ... 4.2 A. Cu. 66 8.3 .... 30.1 60 34 4 SW. 30.1 52 54 6 S.		**H—6—10.** **H—1—40.** ... ... 1.7 Ci. 90 14.6 ... ... 4.9 Ci. 95 12.7 .... 30.1 48 45 8 SW. 30.0 46 58 10 S.	**L—3—20.** **H—6— 9.** **H—1—40.** ... ... 5.3 S. Cu. 80 13.3 .... 30.0 44 64 10 W.	**L—3—12.** **H—6— 8.** **H—1—56.** 8.3 Ci. S. 134 7.0 8.5 A. Cu. 128 6.1 2.1 Cu. 136 6.1 ... ... 5.1 Cu. Fr. Cu. 70 3.5 30.0 37 73 17 W. 30.0 48 41 20 NW. 30.0 42 68 22 W.
L—2—13. 8.4 N. 110 6.9 1.6 A. Cu. 115 7.3 3.7 N. 105 6.6 ... ... 30.0 51 75 8 S. 29.8 66 58 15 S. 29.7 59 86 4 SE.	**L—2— 5.** **L—5—16.** 7.9 S. Cu. 91 8.3 2.1 Ci. S. 95 5.0 5.6 Ci. S. 95 4.7 ... ... 29.9 40 72 5 W. 29.7 50 44 5 W. 29.7 46 55 5 W.	**L—2— 5.** **L—5—16.** 8.2 Ci. 92 17.3 1.4 Ci. 90 15.7 4.5 Ci. 95 16.0 4.6 A. S. 95 15.5 29.9 36 76 10 SW. 29.8 50 44 12 SW. 29.7 48 45 10 W.	**L—2—6.** 8.3 S. Cu. 90 16.0 ... ... 5.3 S. 90 10.1 ... ... 29.7 43 66 12 SW. ... . 29.7 44 63 14 SW.	**L—2—14.** 8.0 S. Cu. 97 7.8 2.1 S. Cu. 164 27.4 4.5 A. S. 108 7.8 ... ... 29.9 40 68 22 S. 29.8 52 70 40 S. 29.8 53 80 35 S.
L—3—12. 8.2 A. Cu. 107 5.0 8.6 A. S. 107 5.0 8.2 Ci. Cu. 107 5.0 2.3 Cu. 57 4.8 ... ... 29.7 48 70 16 NW. 29.8 53 42 25 NW.	**L—3—20.** 9.4 S. Cu. 77 7.7 ... ... 1.8 S. Cu. 55 5.6 ... ... 5.4 S. Cu. 40 3.4 ... ... 29.8 41 51 18 NW. 30.1 41 54 16 W. 30.0 41 46 10 W.	**L—3—19.** ... ... 1.4 Cu. 42 10.2 ... ... 4.6 S. Cu. 78 7.2 ... ... 29.9 43 49 15 W. 30.0 43 49 10 W.	**L—3—11.** 8.3 S. Cu. 90 6.7 ... ... 29.7 43 66 24 W.	**L—3—1.** ... ... 1.2 Ci. 133 5.0 1.3 S. Cu. 66 9.1 ... ... 29.4 56 49 27 NW. ... .
	H—6—3. 9.1 Ci. 80 4.0 2.2 Ci. 80 4.1 ... ... 30.1 42 48 5 S. 30.1 51 39 8 SW.			

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 26 TO OCTOBER 30, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Oct. 26 ° ° H . 6 . 75 . 39 H . 1 . 114 . 51	... . 1.9 Cu. 146 ... . 30.0 71 45 12 S.	... . 5.0 Ci. 77 6.2 ... . 29.9 68 48 5 S.	8.4 Ci. S. 123 2.1 1.4 Ci. 145 2.0 5.0 Ci. 137 2.8 5.5 Ci. S. 162 2.8 30.0 58 83 9 SW. 30.0 69 72 16 S. 30.0 71 68 8 S.	9.7 Ci. S. 342 0.3 1.6 A. Cu. 139 0.6 5.1 S. Cu. 121 2.9 ... . 30.0 70 53 6 SE. 30.0 73 56 5 SE. 30.0 76 63 4 E.	**H—6—11.** .. .. 12.7 A. Cu. 228 9.5 ... . 30.2 63 44 5 S. ....
Oct. 27 ° ° H . 6 . 80 . 38 L . 1 . 103 . 46	**H—6—18.** **L—1—14.** 9.1 S. Cu. 152 ... 1.4 S. Cu. 144 ... ... 5.1 Ci. 136 ... 5.2 S. Cu. 163 ... 29.9 60 82 16 SE. 29.8 74 58 16 S. 29.8 74 54 18 S.	**L—1—7.** 8.4 Ci. S. 163 6.2 12.1 S. Cu. 203 21.2 ... . 4.9 N. 160 18.2 ... . 29.9 52 81 4 SE. 29.8 66 50 14 SE. 29.[illegible] 62 74 12 SE.	8.3 N. 137 3.5 1.2 Ci. S. 146 3.5 1.5 Fr. Cu. 134 3.3 5.6 Fr. Cu. 169 9.7 ... . 29.9 64 95 12 S. 29.8 75 62 18 SW. 29.8 73 73 13 S.	**H—6—20.** ... . 1.5 S. 219 0.3 ... . 30.0 71 85 4 SE. 30.0 73 82 4 E.	**H—6—11.** 7.8 Cu. 130 3.1 12.7 Cu. 188 6.8 ... . 4.8 A. S. 163 5.2 ... . 30.2 52 72 2 NE. 30.1 77 39 6 E. 30.1 73 47 6 E.
Oct. 28 ° ° H . 3 . 69 . 46 L . 2 . 91 . 47 L . 5 . 104 . 37	**L—2—5.** **L—5—7.** 8.6 S. Cu. 155 ... ... 1.1 S. Cu. 149 ... ... 5.1 Cu. 187 ... ... 29.9 67 85 6 S. 29.9 73 76 9 S. 29.8 74 78 13 E.		**L—5—6.** 8.3 Fr. Cu. 193 27.6 8.6 Ci. 143 3.1 1.4 A. Cu. 160 4.5 1.8 Fr. Cu. 198 15.9 2.1 Ci. 143 4.2 2.3 Cu. 195 13.6 2.5 Cu. 176 5.4 4.3 Fr. Cu. 279 9.2 4.4 Ci. S. 134 4.3 5.2 St. 159 11.7 29.8 70 83 18 S. 29.7 78 63 24 S. 29.6 80 61 24 S.	**L—5—14.** 9.6 Ci. 141 1.4 ... . 1.5 A. Cu. 34 0.5 ... . 4.3 S. Cu. 48 3.4 ... . 30.0 76 53 8 SE. 29.9 80 64 6 SE. 30.0 79 68 8 SE.	**L—2—14.** 7.8 Ci. Cu. 103 5.8 ... . 12.7 Cu. 142 13.9 ... . 4.7 Ci. 95 4.1 5.0 A. S. 96 4.0 ... . 30.1 67 58 ... SE. 30.1 78 53 9 S. 30.1 75 55 11 SE.
Oct. 29 ° ° H . 3 . 62 . 43 L . 5 . 95 . 38 H . 2 . 99 . 52	**L—5— 3.** **H—2—13.** 10.0 S. Cu. 174 ... ... 12.4 S. Cu. 145 ... 12.4 A. Cu. 198 ... ... 4.4 S. Cu. 170 ... ... 29.6 65 94 16 SE. 29.5 62 68 12 SW. 29.4 63 61 12 S.			**L—5—6.** 9.6 S. Cu. 30 6.0 ... . 4.6 S. Cu. 166 18.3 ... . 29.9 75 73 16 SE. .... 29.8 67 100 12 SE.	**L—5—7.** 7.7 Ci. Cu. 124 5.7 7.9 A. Cu. 125 6.1 12.4 A. Cu. 173 5.6 12.5 S. Cu. 176 5.5 12.7 Fr. S. 176 17.8 ... . 30.1 66 68 5 SE. 30.0 77 50 20 SE. ....
Oct. 30 ° ° H . 6 . 76 . 33 L . 2 . 93 . 45	**L—2—5.** 8.8 S. Cu. 90 ... ... 1.6 Cu. 87 ... ... 29.8 41 72 12 SW. 29.8 52 58 12 SW.			**L—2—13.** ... . 4.8 Ci. 120 4.9 ... . 30.0 72 42 4 NW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 26 TO OCTOBER 30, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
			H—6—10.	**H—6—8.**
			... .	8.7 Ci. 72 7.3
			... .	2.1 Ci. 77 4.2
			... .	4.7 Ci. 77 4.8
			5.3 S. Cu. 80 5.0	... .
			....	30.2 36 60 10 SW.
			....	30.1 51 44 21 SW.
			30.0 46 64 24 W.	30.1 48 53 21 SW.
				H—6—8.
				... .
				2.1 Ci. Cu. 60 8.7
				... .
				... .
				... .
				....
				30.2 62 37 10 NW.
				....
H—3—20.	**H—3—19.**	**H—3—19.**	**H—3—11.**	**H—3—1.**
L—2—14.	**L—2— 6.**	**L—2— 6.**	**L—2—15.**	
9.0 Ci. S. 67 2.0	8.4 Fr. S. 125 4.1	... .	... .	8.2 Ci. 56 4.7
9.3 Ci. Cu. 90 1.7	... .	... .	... .	8.3 Fr. Cu. 297 5.2
12.9 Ci. S. 93 2.0	1.7 N. 125 5.0	1.3 S. Cu. 90 5.0	1.3 S. Cu. 110 7.3	2.1 Ci. 60 4.3
... .	2.2 A. Cu. 105 4.2	... .	... .	... .
... .	... .	... .	... .	... .
... .	... .	... .	... .	... .
... .	... .	... .	... .	... .
3.9 Ci. 72 2.0	5.4 Ci. S. 60 3.8	4.6 Ci. S. 49 5.8	5.3 S. Cu. 110 8.0	... .
4.4 Ci. Cu. 70 2.2	... .	... .	... .	... .
... .	... .	... .	... .	... .
30.3 44 100 3 NE.	30.2 53 63 11 SE.	....	....	30.4 46 71 14 E.
30.3 70 60 10 SE.	30.1 67 66 12 S.	30.1 60 81 10 SW.	30.2 63 46 6 SW.	30.4 47 62 12 E.
30.3 63 67 3 S.	30.1 67 66 12 S.	30.1 64 79 14 S.	30.2 65 54 10 SW.	....
H—3—19.	**L—5—15.**	**L—5—16.**	**H—3—19.**	**H—3—11.**
			L—5—16.	
8.7 S. Cu. 97 3.1	8.2 A. S. 77 1.5	8.2 Ci. S. 62 4.6	8.3 A. S. 110 7.3	10.0 A. S. 100 11.3
8.5 A. Cu. 108 3.8	... .	... .	8.5 S. Cu. 109 9.0	... .
1.1 Ci. 48 2.3	2.5 Fr. N. 150 6.5	1.8 S. Cu. 359 11.4	... .	2.0 Ci. Cu. 48 4.6
... .	... .	2.0 Ci. 101 3.8	... .	2.2 A. Cu. 52 3.6
... .	... .	... .	... .	... .
3.8 Cu. 133 5.6	5.2 A. Cu. 92 2.7	4.3 A. Cu. 128 4.1	... .	4.7 Ci. Cu. 48 5.0
3.9 Ci. 55 2.2	... .	... .	... .	4.8 A. Cu. 62 5.7
30.3 57 88 2 S.	30.2 70 23 9 SE.	30.1 55 94 9 S.	30.2 61 63 12 SW.	30.3 45 90 24 S.
30.3 72 71 6 S.	30.0 73 61 13 S.	30.0 67 56 11 S.	....	30.2 55 87 27 S.
30.3 67 66 3 S.	30.0 68 69 10 SE.	30.0 69 74 9 SE.	....	30.1 56 85 20 S.
H—6—9.	**H—6—18.**	**H—6—18.**	**H—6—17.**	**H—6—17.**
	L—2—15.	**L—2— 7.**	**L—2—15.**	
9.3 A. S. 98 2.4	9.0 Fr. N. 130 20.0	8.4 Cu. 164 41.7	8.3 A. S. 190 4.7	8.1 Ci. 52 4.6
8.9 A. Cu. 95 2.3	9.3 N. 143 5.0	... .	... .	8.2 A. Cu. 38 3.3
2.0 S. 129 4.6	... .	2.3 S. Cu. 154 16.9	1.3 A. S. 107 5.1	2.0 A. S. 87 3.2
2.2 A. Cu. 130 4.3	... .	... .	... .	2.1 S. Cu. 79 2.7
3.9 N. 133 1.3	... .	4.3 S. Cu. 159 16.5	5.2 S. Cu. 110 16.0	4.5 S. Cu. 97 4.4
4.5 Ci. 110 ...	... .	... .	... .	... .
4.2 St. 133 1.6	... .	... .	... .	... .
30.1 60 89 6 S.	29.9 70 44 14 S.	29.7 61 84 14 S.	29.9 67 58 12 S.	30.1 57 94 8 SW.
30.0 74 58 15 S.	....	29.6 64 56 20 SW.	29.7 70 62 22 SW.	30.0 70 61 17 SW.
29.9 71 68 12 S.	....	29.6 60 62 21 SW.	29.7 73 69 18 W.	29.9 65 66 22 SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 31 TO NOVEMBER 4, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Oct. 31 ° ° H. 6. 85. 32 L. 2. 84. 48 H. 4. 105. 36	**H—6—18.** **L—2—20.** **H—4— 7.** ... . 2.1 Cu. 95 ... 4.8 Ci. 61 ... . 30.0 62 43 11 W. 29.9 62 42 7 SW.	**L—2— 1.** **H—4—16.** ... . 12.1 S. Cu. 74 19.8 4.9 N. 88 20.4 .... 29.7 33 90 14 W. 29.7 32 95 12 W.		**H—6— 4.** **H—4—15.** 9.7 A. Cu. 24 0.7 ... . 1.3 A. S. 89 0.3 ... . 30.1 66 58 6 E. 30.0 70 60 3 E.	**H—6— 9.** **L—2—13.** ... . 4.6 Ci. 132 14.4 .... 30.0 63 44 4 SW.
Nov. 1 ° ° H. 6. 86. 33 L. 2. 89. 48			**H—6—19.** 8.6 Fr. S 180 46.1 8.7 Ci. 121 3.1 1.4 Ci. 131 3.6 .. .. 4.9 Ci. 130 3.0 30.0 59 89 12 SW. 29.8 76 41 24 SW. 29.8 73 56 12 S.		
Nov. 2 ° ° H. 6. 78. 37 L. 2. 95. 42	**H—6—19.** **L—2— 1.** 8.7 S. Cu. 105 .. .. 29.8 54 72 11 SW.	**L—2—3.** ... . 4.4 N. 168 27.1 .... 29.6 40 88 12 W.	**L—2—20.** 8.8 S. 98 10.9 ... . 1.3 Ci. S. 141 3.8 .. .. 30.0 67 33 8 N.	**H—6—19.** **L—2—13.** 9.5 A. Cu. 145 2.7 ... . 12.8 Cu. 20 2.0 1.1 Ci. 352 0.7 5.1 S. 172 4.0 30.1 62 85 8 SE. 30.0 72 68 6 S. 30.0 73 61 1 SW.	**H—6—11.** **L—2— 6.** 7.8 Ci. 121 5.1 8.0 A. S. 105 4.0 1.0 Ci. S. 115 6.6 12.8 A. Cu. 162 13.3 4.7 Ci. 138 6.4 30.2 54 53 5 SE. 30.1 72 36 12 S. 30.1 63 53 7 SE.
Nov. 3 ° ° H. 3. 72. 47 L. 2. 94. 51	**L—2—18.** 8.8 A. Cu. 149 ... ... 1.1 Ci. 138 ... 1.2 Cu. 142 ... 5.1 Ci. 136 ... ... 30.0 54 64 9 SE. 29.8 67 52 10 SW. 29.9 61 60 10 NW.	**L—2—5.** 8.5 Cu. 146 31.4 ... . 12.1 A. Cu. 156 11.8 12.3 Cu. 156 17.3 4.3 Cu. 137 16.1 4.7 A. Cu. 134 13.5 29.9 32 90 5 SW. 29.9 38 71 10 SW. 30.0 39 65 6 SW.	8.6 Fr. S. 174 2.6 ... . 5.0 Ci. 121 2.3 ... . 29.9 60 84 12 SW .... 29.8 75 44 10 SW.	9.6 S. 239 2.7 ... . 2.8 Cu. 10 2.6 3.2 Ci. 2 1.0 5.3 S. Cu. 175 ... ... 29.9 67 64 6 SE. 30.0 75 60 9 SE. 29.9 73 82 6 SE.	**H—2—20.** **L—2—14.** 7.8 Cu. 165 8.8 7.9 Ci. Cu. 109 7.3 8.0 Ci. S. 109 7.7 12.6 Ci. 133 8.2 12.8 Cu. 202 12.6 4.6 A. S. 200 3.5 ... . 30.2 58 59 9 SE. 30.1 71 48 8 SE. 30.0 67 56 5 SE.
Nov. 4 ° ° H. 3. 67. 47 L. 2. 86. 48 H. 4. 113. 40	**L—2—20.** **H—4—24.** 8.4 Ci. 158 ... 8.6 S. Cu. 21 ... 1.8 S. Cu. 28 ... ... 5.1 S. Cu. 43 ... ... 30.1 35 78 11 NW. 30.2 40 66 13 NW. 30.0 40 68 12 NW.	**L—2—12.** **H—4—25.** 8.1 S. 123 13.8 ... . 12.1 St. 131 13.0 ... . 4.4 St. 95 13.3 ... . 30.0 31 91 8 W. 29.9 32 79 11 W. 29.9 34 81 3 W.		**H—4—40.** 8.5 S. Cu. 125 1.3 ... . 12.8 A. Cu. 354 1.7 ... . 3.4 Cu. N. 102 5.2 4.6 S. Cu. 89 7.2 29.9 68 80 6 SE. 29.8 77 61 12 SW. 29.7 75 72 12 SW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 31 TO NOVEMBER 4, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
H—6—16. **L—2—14.** 9.2 Ci. 129 4.0 ... . 2.9 Ci. 102 4.9 ... . 30.0 65 73 4 NW. 30.0 74 33 8 S.	**H—6—16.** **L—2— 6.** ... . 5.7 Ci. S. 100 3.3 .... 29.8 46 39 14 SW.	**H—6—17.** **L—2— 6.** ... . 1.6 S. Cu. 122 15.9 ... . 29.8 53 47 32 SW.		**L—2—15.** 8.0 A. Cu. 116 6.8 8.1 S. 103 27.1 2.0 Cu. Fr. Cu. 129 7.9 ... . 29.8 62 87 20 SW. 29.8 72 44 23 W. 29.8 64 52 14 NW.
	H—6—9. **L—2—6.** ... . 2.6 A. Cu. 72 3.0 ... . 5.5 S. Cu. 76 7.7 .... 29.9 65 28 20 W. 29.9 61 40 10 W.			
H—6— 8. **L—2—15.** ... . 1.8 Ci. 90 4.4 ... . 4.6 Ci. 90 3.9 .... 30.2 70 34 10 S. 30.2 60 53 1 S.	**H—6—10.** **L—2—15.** 9.8 Ci. S. 75 3.3 ... . 3.2 Ci. S. 82 3.2 ... . 5.3 Ci. S. 82 3.3 30.1 56 55 4 NE. 30.0 68 42 9 S. 30.1 65 48 8 SE.	**H—6—10.** **L—2— 7.** 8.2 Ci. 87 13.2 ... . 1.1 Ci. S. 103 4.7 ... . 4.3 S. Cu. 180 5.3 30.3 46 79 12 NE. 30.1 62 50 14 SE. 30.1 58 69 14 SE.	**H—6— 9.** **L—2—15.** ... . 1.3 Ci. 60 3.3 ... . 30.2 57 63 14 E.	**H—6—8.** ... . 4.5 Ci. 75 5.0 .... 30.1 56 39 30 NW.
H—3—20. 8.6 Ci. Cu. 101 3.3 8.3 Ci. 101 3.3 ... . 1.7 Ci. Cu. 98 2.9 1.8 Ci. 97 3.1 4.5 A. Cu. 100 2.3 ... . 30.3 49 83 Calm. 30.3 68 67 14 S. 30.3 61 51 3 S.	**H—3—20.** **L—2—14.** 9.3 Ci. 100 4.2 ... . 1.7 Ci. 120 4.0 2.0 Cu. 162 4.0 4.8 Ci. S. 105 4.4 ... . 29.9 58 78 7 S. 29.8 62 84 14 SE. 29.8 61 84 12 SE.	**H—3—20.** **L—2—14.** 8.3 A. Cu. 164 9.7 ... . 1.7 A. Cu. 122 9.7 1.7 S. Cu. 126 8.0 4.7 S. Cu. 180 8.8 ... . 30.1 54 64 10 SW. 30.1 63 45 2 SW. 30.1 56 74 7 E.		**H—3—5.** ... . 2.3 Ci. 83 7.8 ... . 4.6 Ci. 88 7.3 ... . 30.4 51 58 10 E. 30.4 45 80 17 SE.
H—3—20. **L—2—18.** 9.4 N. 179 5.1 ... . 2.2 N. 178 7.2 ... . 5.3 N. 185 12.8 ... . 30.2 56 84 5 E. 30.1 77 77 12 SE. 30.0 64 87 10 SE.	**H—3—19.** **L—2— 6.** **H—4—57.** 9.0 N. 143 14.0 ... . 2.5 N. 152 11.5 .. .. 4.9 N. 180 25.6 ... . 29.9 58 78 7 S. 29.8 62 84 14 SE. 29.8 61 84 12 SE.	**H—3—19.** **L—2— 5.** **H—4—57.** 8.3 S. Cu. 147 6.9 8.4 A. S. 135 5.3 1.7 A. Cu. 105 5.7 1.7 S. Cu. 140 13.7 4.0 Cu. S. 128 25.0 4.0 N. 128 24.8 29.9 56 80 12 S. 29.8 62 74 16 SW. 29.8 60 84 10 S.	**H—3—19.** **L—2— 6.** **H—4—57.** ... . 5.3 A. S. 110 16.0 ... . 29.9 56 80 24 S.	**H—3—12.** **L—2—14.** 8.3 S. Cu. 240 28.2 ... . 2.0 Ci. S. 85 4.5 2.2 S. Cu. 194 7.6 4.5 A. Cu. 89 5.1 ... . 30.4 43 81 16 SE. 30.4 50 63 20 S. 30.4 47 70 20 SE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 5 TO NOVEMBER 9, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Nov. 5 ° ° H . 3 . 59 . 45 L . 2 . 83 . 42 L . 1 . 104 . 47		**L—2—11.** **L—1— 7.** ... . 12.2 St. 80 8.8 ... . 4.4 S. 97 12.3 ... . 29.8 31 89 6 NW. 29.8 30 78 10 NW.			**L—2—12.** 7.8 Fr. S. 105 27.1 7.9 S. Cu. 105 13.8 ... . 4.5 S. Cu. 92 23.7 ... . 29.8 40 68 13 W. .... 30.0 40 64 18 SW.
Nov. 6 ° ° L . 2 . 76 . 46 H . 6 . 84 . 36 L . 5 . 95 . 37 H . 1 . 114 . 54	**H—6—11.** **L—5— 8.** **H—1—39.** 8.7 Ci. S. 110 ... 9.9 S. Cu. 21 ... 1.8 S. Cu. 34 ... . 29.9 42 70 12 W. 30.0 42 68 14 NW.	**L—2—19.** **H—6—18.** **L—5— 9.** **H—1—28.** ... . 12.1 N. 243 3.8 4.4 N. 90 4.7 ... . 30.0 32 90 2 NW. 29.9 32 95 3 W.			
Nov. 7 ° ° L . 3 . 66 . 49 L . 2 . 86 . 46 H . 4 . 10 . 42	**L—2—20.** **H—4—15.** 8.4 S. Cu. 52 ... 1.1 S. Cu. 58 ... ... 5.2 S. Cu. 57 ... 30.3 30 83 12 NW. 30.3 34 68 11 NW. 30.3 34 69 11 NW.	**L—2—11.** **H—4—15.** 8.1 Cu. 33 31.1 12.1 N. 75 28.8 ... . 4.4 N. 73 14.4 29.9 31 80 14 NW. 30.0 32 84 18 W. 30.0 32 95 11 NW.		**L—2—13.** 11.3 S. 37 2.1 12.6 S. Cu. 320 1.8 ... . 4.8 Ci. 111 5.0 30.1 51 97 12 NW. 30.1 58 57 10 N. 30.1 57 40 13 NW.	**L—2—5.** ... . 1.1 Ci. Cu. 121 11.7 1.3 Cu. 78 12.4 4.5 S. Cu. 52 16.1 .... 30.1 46 49 11 W. 30.1 41 54 14 W.
Nov. 8 ° ° L . 2 . 82 . 41					
Nov. 9 ° ° H . 6 . 84 . 37 L . 3 . 65 . 47 L . 1 . 124 . 50	**H—6—11.** 8.7 A. Cu. 85 ... ... 1.2 Ci. 84 ... ... 29.8 40 75 18 S. 29.7 51 43 24 SW.		**H—6—19.** 8.1 Ci. S. 67 3.0 ... . 1.2 Ci. 94 3.1 5.8 Ci. S. 63 4.5 ... . 29.8 46 46 25 SW. 29.7 65 31 18 SW. 29.6 67 35 10 S.	**H—6—12.** 9.7 Ci. 24 0.3 ... . 12.8 Ci. 298 0.3 4.8 S. 97 3.4 ... . 29.1 45 92 10 SE. 30.0 53 41 11 SE. 30.0 54 48 5 SE.	**H—6—3.** ... . 1.0 Ci. 99 12.7 ... . 30.1 42 34 6 S. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 5 TO NOVEMBER 9, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
L—2—6. 8.8 N. 160 31.4 ... . 2.4 Fr. N 142 4.7 2.5 A. S. 142 4.8 4.2 Fr. S. 133 6.8 4.3 A. S. 138 6.0 4.6 A. Cu. 148 6.1 29.6 66 100 18 S. 29.6 58 40 16 SW. 29.7 64 65 15 NW.	**L—2—2.** 9.2 Fr. S. 195 32.3 9.5 S. Cu. 160 3.9 2.3 S. Cu. 128 22.9 ... . 5.3 S. Cu. 110 20.4 ... . 29.6 61 89 13 SE. 29.5 47 59 30 SW. 29.6 40 64 35 SW.	**L—2—1.** ... . 1.2 Cu. S. 138 55.6 ... . 4.4 Cu. S. 106 58.3 ... . 29.4 41 76 38 SW. 29.6 37 82 52 SW.		**H—3—19.** **L—2—15.** 8.0 N. 182 44.2 ... . 30.0 51 99 36 SE. ....
	L—2—12. **H—6—9.** **L—5—16.** 9.0 S. Cu. 80 17.7 ... . 30.0 36 77 15 W.	**L—2—12.** **H—6—9.** **L—5—16.** 8.3 Cu. S. 68 35.4 ... . 30.0 58 75 16 SW.	**L—2—5.** **H—6—8.** ... . 5.1 S. Cu. 110 22.7 .. .. 30.0 46 70 24 W.	**L—2—6.** **H—6—16.** 8.1 S. Cu. 88 14.6 ... . 2.1 S. Cu. 116 11.2 4.5 S. Cu. 93 14.5 4.7 Ci. Cu. 100 6.0 29.7 48 76 24 NW. 29.8 50 49 28 W. 29.8 47 49 32 W.
L—3—20. **L—2—14.** ... . 3.5 Ci. 104 3.0 ... . 4.7 Ci. S. 108 4.0 .... 29.9 40 88 14 SW. 29.9 58 51 3 S.	**L—3—20.** **L—2—6.** 8.5 Ci. Cu. 134 7.0 1.6 Fr. S. 103 23.2 ... . 5.2 S. Cu. 103 6.7 29.8 41 76 12 SE. 29.9 48 25 18 W. 29.9 38 67 13 W.	**L—3—20.** **L—2—1.** ... . 1.3 Cu. S. 108 37.0 ... . 4.1 S. Cu. 110 27.8 .... 29.9 38 75 15 W. 29.9 36 65 18 W.	**L—3—20.** **L—2—6.** ... . 1.3 S. Cu. 94 16.3 ... . 29.8 54 78 18 SW.	
	L—2—5. 9.0 S. Cu. 122 3.7 2.0 S. Cu. 55 4.7 ... . 5.4 Fr. S. 110 7.0 29.9 36 80 13 W. 29.9 34 81 15 SW. 29.9 33 80 14 SW.			**L—2—6.** 9.0 N. 141 12.8 3.0 A. S. 145 11.8 3.2 N. 153 15.8 ... . 29.8 51 100 20 S. 29.8 56 100 20 S. ....
L—3—20. **H—6—8.** ... . 3.4 Ci. 101 4.7 3.5 Ci. S. 101 4.3 4.0 Ci. Cu. ... 4.7 .... 30.0 42 47 6 SW. 30.2 36 70 1 N.	**L—3—19.** **H—6—9.** 9.7 N. 128 6.7 ... . 30.1 30 57 14 SW.	**L—3—19.** **H—6—9.** 8.4 Cu. N. 130 22.0 ... . 1.4 S. Cu. 116 23.1 4.5 S. Cu. 100 18.4 ... . 30.1 27 76 12 SW. 30.1 29 56 16 SW. 30.1 28 65 12 SW.	**L—3—19.** **H—6—8.** 8.3 S. Cu. 114 14.0 ... . 30.0 31 80 18 W.	**L—3—12.** **H—6—16.** 7.9 A. S. 155 7.4 8.0 A. Cu. 134 9.0 2.0 Cu. 75 ... 4.3 Fr. Cu. 76 ... ... 29.9 35 81 19 NW. 29.9 44 48 19 NW. 30.0 42 45 17 NW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 10 TO NOVEMBER 13, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Nov. 10 ° ° H . 3 . 73 . 40 L . 5 . 97 . 38 L . 1 . 123 . 49	**L—5—2.** 8.5 S. Cu. 143 ... 9.3 A. Cu. 138 ... ... 12.9 S. Cu. 74 ... 5.1 A. S. 121 ... ... 29.5 48 72 12 SE. 29.6 54 64 12 W. 29.8 39 68 11 NW.		**L—5—12** 8.8 Ci. S. 114 2.3 ... . 1.6 Ci. S. 103 2.2 5.0 Ci. 119 2.0 ... . 29.7 57 74 14 SW. 29.7 78 28 14 SW. 29.6 79 22 4 W.	**L—5—6.** 8.5 Ci. S. 155 4.0 ... . 12.7 S. Cu. 340 9.0 4.6 S. Cu. 259 11.1 ... . 30.0 51 82 11 SE. 29.9 74 61 18 S. 29.8 75 66 15 S.	**H—3—19.** **L—5— 7.** ... . 1.1 S. Cu. 140 26.5 4.3 S. Cu. 138 32.6 ... . 29.9 53 47 9 SE. 29.8 62 50 14 SE.
Nov. 11 ° ° H . 3 . 65 . 45 L . 2 . 84 . 48 H . 1 . 110 . 53 L . 5 . 96 . 30	**L—2—20.** **L—5—17.** **H—1—22.** 8.7 A. S. 167 ... ... 2.2 A. S. 132 ... ... 30.2 24 73 7 N. 30.2 30 64 4 NE.	**L—2—11.** **H—1—14.** 8.2 A. Cu. 98 16.1 ... . 30.0 60 87 4 SW.		**L—5— 8.** **H—1—54.** 8.8 S. Cu. 159 5.3 ... . 12.8 S. Cu. 313 7.2 ... . 4.9 Cu. 161 1.2 ... . 30.0 76 91 12 SW. 29.9 83 58 16 SW. 29.8 84 63 10 SW.	**L—2—18.** **H—1—39.** 7.8 S. 92 15.8 8.0 S. Cu. 123 17.8 8.1 A. S. 0 0 12.9 S. Cu. 117 19.6 ... . 4.7 A. S. 105 4.7 4.7 A. Cu 104 8.8 30.0 53 81 6 W. 30.0 54 61 6 NW. 30.1 52 64 8 N.
Nov. 12 ° ° L . 3 . 66 . 49 H . 6 . 79 . 30 H . 1 . 110 . 52		**H—1—14.** ... . 12.1 A. Cu. 75 20.7 12.3 Cu. 81 19.8 ... . 30.4 19 69 6 W.	**H—1—88.** 8.2 S. Cu. 132 2.5 ... . 1.3 Ci. 116 1.8 ... . 30.4 45 58 11 N. 30.4 55 43 14 N.	**H—6—19.** **H—1—54.** ... . 5.1 A. S. 117 4.6 .... 30.2 55 88 6 N.	**H—6—18.** **H—1—39.** 7.9 S. Cu. 98 15.7 ... . 30.2 43 77 2 N. ....
Nov. 13 ° ° L . 3 . 67 . 47 H . 5 . 96 . 34 L . 1 . 123 . 50	**H—5—9.** 8.6 Ci. 60 ... ... 1.9 Ci. 52 ... ... 5.1 Ci. 52 ... 30.4 32 68 6 SW. 30.3 53 36 16 SW. 30.2 55 38 13 S.	**H—5—17.** 8.2 Ci. S. 41 9.8 ... . 12.2 A. Cu. 71 10.9 ... . 4.1 Ci. S. 94 6.9 30.5 8 91 Calm 30.4 16 79 4 S. 30.3 16 83 5 SE.		**H—5—6.** 8.7 Ci. S. 0 0 ... . 12.4 Ci. 232 0.2 ... . 30.4 46 85 8 NE. 30.4 61 40 6 NE.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 10 TO NOVEMBER 13, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—3—11.				**H—3—11.**				**H—3—11.**				**H—3—10.**				**H—3—3.**			
				L—5—15.				**L—5—16.**											
8.1	A. S.	112	3.7	9.1	St.	130	6.5	8.2	Cu. S.	120	6.7	8.3	Ci.	92	3.3	8.3	Ci.	108	4.6
8.1	Ci. S.	112	3.7	...	.....	...	.	...	.....	...	...	8.4	A. S.	91	6.0	...	.....	...	...
8.2	A. Cu.	100	4.9	...	.....	...	..	...	.....	...	...	...	.....	...	...	...	.....	...	...
9.0	Ci. Cu.	102	4.0	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
9.2	Ci.	105	3.8	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.8	A. Cu.	102	5.0	2.3	S.	110	6.6	1.2	S. Cu.	180	12.9	1.3	Ci. Cu.	109	6.0	2.1	Ci. S.	107	4.4
3.9	S.	118	4.4	...	.....	...	...	...	.....	...	...	4.3	Ci. Cu.	111	6.0	...	.....	...	...
4.8	A. S.	118	4.9	...	.....	...	...	...	.....	...	...	..	.....	...	...	...	.....	...	...
30.4	33	80	2 N.	30.2	28	77	14 SE.	30.2	34	81	8 E.	30.3	31	68	12 S.	30.4	34	56	11 W.
30.3	50	55	4 S.	30.0	43	49	20 SE.	30.0	42	63	12 SE.	30.2	40	76	12 SE.	30.6	47	40	22 SW.
30.3	48	56	4 SE.	....	..	..	....	....	..	..	....	30.1	42	70	18 SE.	....	..	..	....
H—3—20.				**L—2—5.**				**L—2—5.**								**H—3—11.**			
L—2—14.				**H—1—40.**				**H—1—40.**								**L—2—14.**			
H—1—56.																			
8.3	St.	161	48.4	10.2	S. Cu.	117	9.4	8.1	Cu. S.	91	38.8					7.9	N.	176	15.0
...	.....	...	...	10.4	Fr. S.	95	25.2	...	.....	...	...					...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	..					...	.....	...	...
1.3	N.	145	41.7	2.5	Fr. S.	117	13.4	1.4	S. Cu.	72	33.1					2.0	A. S.	113	11.6
3.4	St.	115	21.3	...	.....	...	...	...	.....	...	...					2.1	N.	156	22.1
3.5	A. S.	90	8.3	...	.....	...	...	...	.....	...	...					...	.....	..	...
4.7	N.	115	6.7	4.7	A. Cu.	92	8.3	4.2	S. Cu.	110	30.5					...	.....	...	...
...	... .	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
30.1	50	93	10 S.	29.8	52	81	14 SW.	29.8	40	84	24 SW.					30.2	44	79	32 SE.
30.0	59	89	19 SW.	29.9	44	74	14 SW.	29.9	42	69	22 SW.					29.9	57	85	46 S.
30.1	60	92	4 NW.	30.0	42	88	11 W.	30.0	40	76	12 W.					29.9	55	100	36 SW.
L—3—20.				**L—3—20.**				**L—3—20.**				**L—3—20.**				**L—3—12.**			
H—6—17.				**H—6—17.**				**H—6—17.**				**H—6—17.**							
H—1—56.				**H—1—40.**				**H—1—40.**				**H—1—56.**							
9.1	S. Cu.	...	4.7	8.4	S. Cu.	44	8.3	...	.....	...	...	8.3	S. Cu.	90	18.6	8.0	A. Cu.	111	7.6
...	.....	...	...	...	.....	...	...	...	.....	...	...	8.5	Ci. Cu.	109	5.3	10.3	S. Cu.	116	10.7
1.0	N.	355	4.9	...	.....	...	...	...	.....	...	...	1.3	S. Cu.	90	8.7	2.1	A. S.	106	11.1
..	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	. .	.....	...	...
4.0	N.	355	4.7	...	.....	...	...	4.4	A. Cu.	90	3.3	4.2	S. Cu.	90	8.7	4.2	N.	106	10.0
30.1	56	88	2 N.	30.2	37	87	8 W.	....	..	..	....	30.2	40	56	16 W.	30.1	44	83	14 W.
30.1	54	70	12 N.	....	..	..	....	....	..	.	....	30.1	44	78	18 W.	30.0	49	54	16 NW.
30.1	47	96	4 NW.	....	..	..	....	30.2	39	59	7 W.	30.1	40	78	12 W.	30.0	47	65	11 W.
L—3—11.				**L—3—19.**				**L—3—19.**								**L—3—4.**			
				H—5—16.				**H—5—16.**											
8.1	S. Cu.	98	8.4	11.0	N.	55	6.1	8.3	Cu. S.	58	50.2					8.1	A. Cu.	128	8.6
8.1	A. Cu.	98	6.7	11.4	Fr. S.	55	13.6	...	.....	...	...					10.1	Fr. Cu.	252	3.4
...	.....	...	...	...	.....	...	...	...	.....	...	...					10.2	S. Cu.	283	6.5
1.8	Cu.	74	7.7	2.5	Fr. S.	67	13.0	1.7	N.	85	33.9					2.0	A. Cu.	195	1.8
...	.....	...	...	...	.....	...	..	...	....	...	...					2.2	Cu. N.	331	19.1
4.5	Cu.	59	9.3	...	.....	...	...	...	.....	...	...					. .	.....	...	...
30.1	40	88	1 N.	30.1	32	79	24 W.	30.2	28	65	12 SW.					30.0	33	78	18 N.
30.0	44	50	20 NW.	30.1	32	84	24 W.	30.2	31	68	....					29.8	38	92	19 N.
30.2	36	50	16 NW.	....	..	..	....	....	..	..	....					....	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 14 TO NOVEMBER 17, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Nov. 14 ° ° H . 6 . 58 . 42 L . 3 . 82 . 37 L . 2 . 97 . 50 H . 4 . 112 . 40		**H—6—18.** **L—2— 6.** 8.1 Ci. 106 4.3 8.3 Ci. S. 105 5.7 12.1 Ci. 90 5.9 4.1 Ci. 80 4.0 ... . 29.9 24 74 5 SE. 29.9 34 81 6 SE. 29.8 39 63 5 SW.	8.3 Ci. 114 1.6 ... . 30.2 56 65 15 SW.	**H—6—20.** ... . 12.7 Ci. 248 0.1 4.8 Ci. 67 2.4 ... . 30.3 65 31 6 SE. 30.2 66 29 14 SE.	**H—6—4.** 7.8 A. Cu. 40 11.8 ... . 4.5 Ci. S. 86 14.0 4.5 A. Cu. 80 15.0 4.6 Ci. 71 8.3 30.4 36 56 4 SE. .... 30.2 55 27 8 S.
Nov. 15 ° ° H . 6 . 80 . 35 L . 3 . 66 . 50			8.4 Fr. S. 174 25.2 1.2 Fr. Cu. 173 8.2 ... . 30.1 59 84 17 SW. 30.0 73 64 18 SW.		
Nov. 16 ° ° H . 6 . 80 . 34 L . 2 . 97 . 47 H . 3 . 66 . 46	**H—6—18.** **L—2— 5.** ... . 1.8 Cu. 147 ... ... 4.8 Cu. 142 ... . 30.0 73 58 18 SW. 30.0 72 51 12 SW.	**L—2—2.** 8.2 Ci. S. 141 3.5 12.8 A. Cu. 116 4.2 12.4 Ci. S. 112 4.8 12.6 A. S. 109 6.2 4.1 Ci. S. 94 6.1 29.7 35 82 8 SE. 29.7 49 60 7 SW. 29.8 45 67 6 W.		**H—6—19.** 8.5 A. Cu. 215 5.7 12.9 A. Cu. 41 3.2 ... . 4.8 A. Cu. 180 5.3 30.2 62 84 9 SE. 30.3 76 59 9 SE. 30.2 74 54 5 SE.	**H—6—10.** **L—2—14.** 7.8 Fr. Cu. 91 26.5 12.9 Cu. 127 21.8 ... . 4.7 S. Cu. 174 8.3 30.3 56 50 8 S. 30.2 72 54 12 SW. 30.2 69 56 7 S.
Nov. 17 ° ° H . 6 . 83 . 34 L . 3 . 68 . 49 H . 1 . 114 . 54	**H—6—18.** **H—1—39.** ... . 1.3 S. Cu. 156 ... 1.5 Ci. 103 ... ... 4.9 S. Cu. 152 ... . 30.1 65 87 12 SW. 29.9 72 72 14 S.			**H—6— 1.** **H—1—54.** 8.5 A. Cu. 166 0.3 ... . 1.9 S. Cu. 209 5.8 ... . 4.9 Ci. 108 2.8 ... . 30.3 62 83 7 SE. 30.3 74 66 6 SE. 30.2 72 63 4 SE.	**H—6— 3.** **H—1—55.** 7.8 S. Cu. 124 8.9 ... . 1.1 Cu. 123 12.2 ... . 30.3 61 51 6 S. 30.2 72 53 7 S. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 14 TO NOVEMBER 17, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
H—6—2.	**H—6— 3.** **L—2—14.**	**H—6— 9.** **L—2—14.**	**H—6—8.**	**L—3—19.** **H—6—16.**
8.2 Ci. Cu. 62 6.6	9.0 Ci. S. 50 ...	8.5 Ci. 40 4.7	8.3 S. Cu. 50 6.0	... .
8.2 Ci. 60 6.7	... .	... .	... .	... .
... .	2.3 Ci. S. 63 5.6	... .	... .	4.8 S. Cu. 12 6.1
... .	5.4 Ci. Cu. 63 6.5	... .	... .	2.0 Cu. Fr. Cu. 44 12.2
... .	... .	... .	... .	... .
... .	... .	... .	... .	... .
30.4 33 60 8 NW.	30.3 24 94 8 SE.	30.3 26 82 6 SW.	30.3 27 64 18 NW.	30.0 24 83 23 NW.
30.4 42 48 12 NW.	30.2 37 48 15 S.	....	....	30.1 31 60 29 NW.
....	30.1 37 58 14 S.	....	....	....
	H—6—9.			**L—3—12.** **H—6—16.**
	8.7 Ci. 87 3.3			8.1 Ci. S. 75 4.9
	2.5 Ci. 50 2.7			2.0 Ci. S. 82 4.4
	... .			4.0 Ci. 76 3.6
	... .			4.1 A. S. 84 8.2
	30.3 44 50 15 S.			30.1 36 62 25 SW.
	30.0 58 86 17 S.			30.0 49 42 34 SW.
	30.0 54 44 18 S.			30.0 49 48 30 SW.
H—6— 8. **H—3—20.**	**H—6— 9.** **H—3—20.** **L—2—15.**	**H—6— 9.** **H—3—19.** **L—2—15.**	**H—6—17.** **H—3—20.** **L—2—15.**	**H—6—16.** **H—3—12.**
8.5 Ci. 69 1.7	... .	... .	8.6 S. Cu. 110 26.7	8.0 A. S. 87 4.3
1.4 Ci. S. 58 2.2	2.4 Fr. Cu. 118 16.1	1.6 Cu. 120 33.9	1.8 S. Cu. 100 26.7	1.9 Ci. S. 87 3.1
... .	... .	... .	... .	... .
... .	... .	... .	... .	... .
... .	... .	... .	.. ..	... .
30.3 43 73 1 S.	... .	....	30.1 54 70 24 SW.	30.2 43 70 11 SW.
30.3 70 33 12 S.	30.0 66 57 20 S.	30.0 63 67 21 SW.	30.1 60 59 24 SW.	30.2 57 53 24 S.
....	....	....	....	....
H—6— 8. **H—3—20.**	**H—6— 9.** **H—3— 2.** **H—1—56.**	**H—6— 9.** **H—3—20.** **H—1—56.**	**H—6—17.** **H—3—20.** **H—1—56.**	**H—6—16.** **H—3— 5.**
8.4 Ci. 98 1.1	8.9 Fr. Cu. 95 8.1	8.4 S. 60 5.8	8.4 S. 115 9.3	8.6 Ci. 117 2.1
9.1 Ci. Cu. 98 2.0	... .	... .	8.6 Ci. 115 10.0	... .
... .	... .	... .	8.2 S. 115 19.0	... .
... .	... .	... .	8.4 Ci. Cu. 115 18.7	... .
1.5 Ci. 79 2.0	2.0 S. Cu. 88 5.0	... .	... .	2.1 Fr. Cu. 77 11.2
2.0 A. S. 79 2.0	... .	... .	... .	.. ..
3.8 Cu. 50 3.2	5.3 A. Cu. 70 5.0	... .	4.3 St. 112 14.3	... .
3.8 A. S. 50 4.1	5.5 Fr. S. 115 7.2	... .	... .	... .
30.3 43 85 Calm.	30.1 59 75 11 SW.	30.1 58 86 10 SW.	30.1 55 85 30 W.	30.1 51 68 21 SW.
30.2 76 38 8 W.	30.1 67 64 8 SW.	....	30.1 53 82 12 W.	30.0 68 54 24 SW.
30.2 63 62 2 S.	30.1 66 61 4 S.	....	30.1 54 83 10 NE.	... .

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 18 TO NOVEMBER 21, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Nov. 18 ° ° H . 3 . 63 . 43 H . 6 . 83 . 35 H . 1 . 113 . 52 L . 2 . 87 . 45	**H—6—18.** **L—2—12.** **H—1—39.** 8.4 S. Cu. 102 ... ... 4.7 S. Cu. 343 ... ... 30.0 52 88 12 NW. .... 30.3 33 67 11 N.	**H—6—18.** **L—2—11.** **H—1—24.** 8.3 S. 64 4.6 ... ... 12.1 A. Cu. 50 17.8 12.3 Ci. 127 9.3 4.2 A. Cu. 109 14.2 4.3 Ci. Cu. 106 8.7 ... ... 30.0 29 81 24 NW. 30.2 22 72 18 NW. 30.4 18 68 24 NW.		**H—6—11.** **L—2—13.** **H—1—55.** ... ... 12.9 A. Cu. 316 2.2 ... ... 4.9 A. S. 198 3.3 ... ... 30.2 76 59 6 SW. 30.1 77 59 1 NW.	**H—6— 3.** **L—2— 5.** **H—1—55.** 7.8 Ci. 37 5.2 7.9 Ci. S. 37 5.0 8.0 Ci. Cu. 133 10.4 1.2 Ci. S. 71 3.8 ... ... 4.6 Ci. Cu. 90 5.4 4.6 Ci. S. 87 5.0 4.8 A. Cu. 121 24.2 30.2 60 60 6 S. 30.1 72 50 9 S. 30.1 70 52 8 S.
Nov. 19 ° ° L . 3 . 62 . 49 H . 1 . 112 . 53	**H—1—39.** 8.8 S. Cu. 138 ... . 1.1 S. Cu. 134 ... ... 4.9 S. 188 ... ... 30.5 20 70 14 NE. 30.6 23 66 9 NE. 30.5 30 64 8 NE.	**H—1—23.** ... ... 12.1 Ci. Cu. 106 10.9 12.3 A. Cu. 99 11.5 ... ... 4.2 A. Cu. 127 4.7 ... ... 30.8 1 81 6 NW. 30.7 10 74 8 NW.	**H—1—38.** ... ... 1.3 S. Cu. 148 5.1 ... ... 30.4 41 48 12 N.	**H—1—54.** 8.7 Cu. 0 0 ... ... 12.6 Cu. 174 0.1 ... ... 4.5 Cu. 50 0.3 ... ... 29.9 67 80 1 SE. 30.2 75 61 3 SW. 30.2 78 60 1 N.	**H—1—55.** 7.8 S. 322 16.7 ... ... 1.3 S. Cu. 307 21.1 ... ... 30.3 44 70 13 N. ....
Nov. 20 ° ° L . 6 . 80 . 24 H . 1 . 111 . 51 L . 4 . 112 . 38	**H—1—23.** 8.6 S. 280 ... ... 30.4 29 85 7 E. .... 32 82 3 E.	**H—1—15.** ... ... 12.1 Cu. 116 9.7 12.3 A. Cu. 111 8.7 4.1 A. S. 188 12.0 ... ... 30.5 15 82 8 NE. 30.4 19 84 6 E.	**L—4—14.** **H—1—38.** ... ... 1.7 S. 186 19.3 ... ... 4.5 Fr. S. 180 15.1 4.9 A. Cu. 178 15.4 5.3 Fr. Cu. 174 20.8 5.5 Ci. 126 2.1 .... 30.2 52 75 8 SE. 30.1 61 68 8 SE.	**L—6—18.** **H—1—55.** ... ... 4.6 A. S. 167 4.7 ... ... 30.2 76 59 2 SE.	**H—1—39.** ... ... 12.8 S. 359 26.5 ... ... 30.3 43 87 6 NE. ....
Nov. 21 ° ° H . 3 . 64 . 46 L . 2 . 84 . 43 H . 1 . 107 . 51	**L—2—12.** **H—1—22.** 9.3 S. Cu. 8 .. .. 1.1 S. Cu. 357 ... ... 4.8 S. Cu. 55 ... 30.8 32 90 12 NW. 30.5 33 74 13 N. 30.5 32 75 10 N.		8.3 A. Cu. 132 2.4 9.0 S. Cu. 94 7.1 ... ... 30.1 60 92 6 SW.	**L—2—20.** **H—1—38.** 8.8 A. Cu. 248 0.3 ... ... 12.7 S. Cu. 124 1.0 ... ... 4.8 S. Cu. 127 3.3 30.2 64 80 4 SE. 30.2 75 61 4 SE. 30.1 74 58 4 SE.	**L—2— 5.** **H—1—39.** 7.9 Ci. 131 10.2 ... ... 12.9 A. Cu. 118 12.9 12.9 S. Cu. 118 14.2 1.1 A. S. 105 10.7 ... ... 30.2 48 74 4 SE. 30.1 62 59 14 W. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 18 TO NOVEMBER 21, 1896.

Washington.					Cleveland.					Detroit.					Buffalo.					Blue Hill.				
	H—6—8.					**H—6—9.**					**H—6—9.**					**H—3—19.**					**H—3—12.**			
	L—2—14.					**L—2—6.**					**L—2—2.**					**H—6—9.**					**H—6—16.**			
						H—1—56.					**H—1—56.**					**L—2—7.**					**L—2—15.**			
																H—1—56.								
8.1	A. Cu.	108	1.6		8.7	Fr. S.	120	8.3		8.4	S.	130	22.8		8.3	St.	115	13.3		8.0	Ci.	63	2.8	
8.2	A. S.	108	1.2		9.2	Fr. Cu.	130	5.0		...	.....	...	...		...	.....	...	...		8.0	S. Cu.	86	5.1	
9.7	Cu.	98	3.0		...	.....	...	...		...	.....	...	...		...	.....	...	...		8.1	A. Cu	77	4.1	
...	.....	...	...		2.2	A. Cu.	90	3.3		1.4	S. Cu.	130	60.9		1.3	S. Cu.	115	20.0		2.0	S.	202	18.3	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...	
4.8	Ci.	45	2.3		5.3	Ci. Cu.	80	3.3		4.0	N.	111	53.6		...	.....	...	...		3.9	Ci.	65	1.7	
...	.....	...	...		5.7	Fr. S.	108	18.8		...	.....	...	...		...	.....	...	...		...	.....	...	...	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...	
30.2	53	81	1 S.		30.0	61	76	17 S.		30.1	57	88	17 SW.		30.0	58	83	18 S.		30.3	43	79	20 E.	
30.1	73	38	12 S.		29.9	69	61	13 S.		29.8	64	74	25 SW.		29.9	63	74	25 S.		30.2	45	87	10 NE.	
30.1	63	51	4 S.		29.9	67	60	20 S.		29.9	64	76	26 SW.		....	..	..	....		30.2	45	98	8 NE.	
						H—1—56.					**H—1—40.**					**L—3—20.**					**L—3—20.**			
																H—1—56.								
8.1	Ci. Cu.	81	2.8		9.1	Fr. N.	90	8.3		8.5	A. Cu.	115	15.0		8.6	S. Cu.	40	8.3		8.0	A. Cu.	96	5.5	
8.3	A. Cu.	81	2.8		...	.....	...	...		...	.....	...	...		...	.....	...	...		8.1	S. Cu.	102	6.7	
1.0	A. Cu.	54	4.0		2.3	S. Cu.	355	2.3		1.3	S. Cu.	30	3.4		1.3	S. Cu.	41	5.3		1.8	Ci.	102	5.2	
2.4	St.	92	6.1		...	.....	...	...		...	.....	...	...		...	.....	...	...		2.1	Ci. Cu.	97	6.6	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		2.2	Ci. S.	101	6.4	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		2.3	Fr. Cu.	58	...	
3.8	S.	90	6.6		5.0	S. Cu.	344	5.0		4.5	Ci.	109	4.8		4.3	S. Cu.	40	6.0		4.0	Ci. S.	99	6.1	
...	.....	...	...		...	.....	...	..		4.5	S. Cu.	319	5.1		...	.....	...	...		8.4	Ci. Cu.	111	6.6	
30.1	50	80	1 S.		30.3	40	76	20 N.		30.5	32	59	13 N.		30.3	34	82	18 NW.		29.9	54	77	20 SW.	
30.2	68	64	11 N. W.		30.4	36	66	15 N.		30.5	34	62	10 N.		30.4	32	69	12 NW.		30.0	55	50	22 NW.	
30.3	51	56	10 N.		30.4	34	63	12 N.		30.5	32	53	6 N.		30.6	30	84	12 N.		30.1	46	51	20 N.	
	H—1—56.					**H—1—40.**					**H—1—40.**					**H—1—56.**								
8.0	A. Cu.	85	7.3		8.3	S.	101	5.7		8.5	Ci. Cu.	10	5.0		8.3	Ci. Cu.	115	11.0		8.3	A. S.	93	9.0	
...	.....	...	...		8.7	Fr. S.	90	6.2		...	.....	...	...		8.3	S. Cu.	115	8.7		10.3	Ci. S.	87	6.6	
...	.....	...	...		...	.....	...	...		...	.....	...	...		8.5	S. Cu.	115	13.3		..	.....	...	...	
1.0	S. Cu.	...	3.7		...	.....	...	...		1.3	A. S.	53	4.4		...	.....	...	...		2.1	Ci. S.	81	5.8	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		4.5	Ci. S.	83	6.2	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		8.0	Ci. Cu.	86	2.2	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...	
...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...		...	.....	...	...	
30.5	37	72	8 N.		30.5	31	89	9 E.		30.6	27	76	8 N.		30.6	26	63	6 S.		30.6	23	53	18 N.	
30.5	40	60	4 E.		30.4	36	61	12 E.		30.5	30	84	6 N.		....	..	..	....		30.6	27	44	24 NW.	
....	..	..	....		....	..	..	....		....	..	..	...		30.5	33	69	5 E.		30.6	26	46	20 NW.	
	H—3—20.					**H—3—19.**					**L—2—1.**													
	L—2—6.					**L—2—1.**					**H—1—40.**													
	H—1—56.					**H—1—40.**																		
...	.....	...	...		...	.....	...	...		...	.....	...	...											
...	.....	...	...		...	.....	...	...		...	.....	...	...											
1.3	S.	160	28.0		...	.....	...	...		1.5	Cu. S.	60	8.3											
...	.....	...	..		...	.....	...	...		...	.....	...	...											
...	.....	...	...		...	.....	...	...		...	.....	...	...											
3.8	S.	160	21.0		4.3	Fr. N.	72	47.8		4.3	S. Cu.	97	13.2											
....	..	..	....		....	..	..	....		....	..	..	....											
30.2	44	88	10 SW.		....	..	..	....		30.0	38	88	9 SW.											
30.2	46	89	8 S.		30.0	42	92	16 W.		30.1	40	84	12 W.											

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 22 TO NOVEMBER 26, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Nov. 22 ° ° L . 3 . 57 . 46 H . 2 . 85 . 50					
Nov. 23 ° ° H . 3 . 69 . 46 L . 2 . 90 . 50 H . 1 . 113 . 51	**L—2—13.** 8.8 N. 143 ... ... 1.2 N. 146 ... ... 4.6 S. 95 ... ... 30.1 53 94 17 SW. 30.1 53 94 6 SW. 30.1 52 90 6 S.	**L—2—12.** ... . 12.1 S. 113 10.6 12.3 A. S. 111 10.7 ... . 30.0 32 88 12 NW.	... . 1.3 S. Cu. 173 21.0 ... . 4.5 Fr. S. 179 12.2 ... . 30.1 63 84 12 SW. 30.1 70 68 13 SW.	9.5 S. 211 2.1 ... . 12.5 Cu. 221 2.9 ... . 4.8 A. S. 96 2.9 ... . 30.6 66 84 8 NE. 30.3 71 72 9 NE. 29.2 71 77 6 SE.	**L—2—13.** ... . 12.9 Cu. 130 18.3 1.0 Fr. S. ... 21.3 1.0 Ci. 115 3.7 1.1 Cu. N. 130 18.0 ... . 30.3 66 71 8 S. ....
Nov. 24 ° ° H . 6 . 80 . 35 L . 3 . 70 . 49 H . 1 . 113 . 48		**H—1—23.** ... . 12.2 A. S. 92 7.9 ... . 30.4 23 60 6 SE.	**H—1—38.** 8.8 Fr. S. 178 19.2 ... . 1.2 S. Cu. 183 8.8 ... . 4.3 Fr. S. 194 10.8 4.5 A. Cu. 123 3.8 30.2 63 61 10 SE. 30.1 71 68 13 SE. 30.1 70 72 14 SE.	**H—6—19.** **H—1—54.** 9.3 S. 236 2.7 ... . 12.8 S. Cu. 211 2.6 ... . 4.6 Cu. 179 5.1 ... . 30.4 64 85 8 SE. 30.3 71 68 7 SE. 30.3 70 77 8 E.	**H—6—10.** **H—1—55.** 7.9 S. Cu. 88 6.0 ... . 1.2 Cu. 135 13.4 ... . 4.3 Ci. 108 4.0 ... . 30.4 58 72 6 S. 30.4 68 67 4 S. 30.4 66 60 3 S.
Nov. 25 ° ° H . 3 . 73 . 49 L . 4 . 114 . 39 H . 1 . 110 . 54	8.7 S. Cu. 182 ... ... 12.9 S. Cu. 178 ... 4.8 N. 191 ... 30.1 63 88 13 SE. 30.0 65 92 15 SE. 29.9 64 94 14 SE.		**L—4—14.** **H—1—54.** 8.8 Fr. S. 192 20.6 ... . 4.6 Ci. S. 163 4.6 30.0 65 85 20 S. .... 29.8 66 71 25 S.	**H—1—54.** 9.5 S. 263 5.5 ... . 12.8 Cu. 184 5.2 4.8 A. S. 85 3.1 30.3 67 89 11 NE. 30.2 72 65 10 SE. 30.1 70 68 9 SE.	**H—1—55.** 7.8 S. Cu. 135 11.6 ... . 4.4 A. Cu. 110 4.1 30.4 59 81 5 S. ... . 30.3 70 53 5 SE.
Nov. 26 ° ° L . 2 . 94 . 40	**L—2—1.** ... . 11.3 S. Cu. 147 ... ... 29.4 61 89 24 SW.				

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 22 TO NOVEMBER 26, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
	H—2—5. 9.2 S. Cu. 30 8.3 ... . 2.4 S. Cu. 265 0.8 5.0 S. Cu. 212 4.7 30.4 35 69 17 N. 30.5 36 66 6 W. 30.5 35 73 3 N.			**L—3—19.** **H—2—14.** 8.1 S. Cu. 49 9.6 8.2 Ci. 117 6.4 ... . 30.2 34 81 24 N. ....
H—3—20. 8.1 S. Cu. 180 8.8 ... . 1.7 Cu. 181 7.9 ... . 4.0 S. Cu. ... 10.0 4.3 A. Cu. ... 5.0 30.8 30 74 2 NE. 30.7 50 58 7 S. 30.6 48 69 4 S.	**H—3—20.** **L—2—14.** 9.7 Ci. S. 99 6.7 4.5 Cu. N. 120 6.7 11.6 Fr. S. 120 13.3 2.3 N. 124 13.3 ... . 5.0 N. 124 8.3 ... . 30.3 34 81 16 SE. 30.2 53 75 20 S. 30.2 54 85 25 S.	**H—3—19.** **L—2—14.** 8.4 S. Cu. 75 25.0 ... . 30.3 35 76 9 W.	**H—3—11.** **L—2—14.** 8.5 Ci. 115 12.3 ... . 1.3 Ci. S. 114 15.7 ... . 30.5 32 72 6 E. 30.3 48 73 30 SW.	**H—3—1.** 8.2 A. Cu. 58 3.8 8.1 Ci. 78 5.2 ... . 2.1 Ci. Cu. 67 3.0 2.2 S. Cu. 187 14.3 ... . 6.5 S. Cu. 151 11.2 ... . 30.8 20 71 12 N. 30.8 37 59 16 S. 30.7 36 69 20 S.
L—6—8. **L—3—20.** **H—1—56.** 7.9 A. Cu. 101 3.0 9.2 Ci. S. 91 3.0 1.0 S. Cu. 85 4.0 1.9 A. Cu. 85 3.0 2.0 A. S. 85 3.4 4.7 Ci. S. 70 2.6 ... . 30.5 47 84 6 S. 30.4 66 53 10 S. 30.5 28 65 5 N.	**H—6—9.** **L—3—20.** **H—1—56.** 8.0 N. 93 10.8 8.4 Fr. S. 35 20.2 ... . 30.4 52 87 12 W.	**H—6—9.** **L—3—20.** **H—1—40.** 8.5 S. Cu. 70 10.0 ... . 1.4 Cu. 29 7.3 1.4 Ci. 102 6.5 ... . 4.4 Ci. 60 6.1 ... . 30.4 44 88 8 W. 30.5 45 71 5 N. 30.6 42 72 7 NE.	**H—6—9.** **L—3—12.** **H—1—56.** ... . 1.3 S. Cu. 80 15.3 ... . 30.4 44 74 12 NW.	**H—6—16.** **L—3—5.** 7.9 Fr. S. 126 57.4 8.5 A. S. 102 8.5 2.2 A. Cu. 105 18.9 2.5 Fr. Cu. 84 33.3 2.5 Ci. 70 5.3 5.3 S. Cu. 63 20.5 ... . 30.3 50 90 30 SW. 30.2 54 79 26 W. 30.3 53 79 19 W.
H—3—13. **H—1—56.** 8.3 S. 230 10.8 ... . 1.8 Ci. 40 2.0 4.6 Ci. S. 34 2.4 30.5 53 87 6 E. 30.4 66 64 6 S. 30.4 60 81 2 S.	**H—3—20.** **H—1—56.** 9.7 Ci. 60 2.5 ... . 2.1 N. 114 8.5 4.4 A. Cu. 105 5.0 30.3 58 72 20 S. 30.2 61 78 15 S. 30.2 62 79 7 S.	**H—3—20.** **H—1—40.** ... . 4.1 Cu. S. 90 13.0 .... 30.2 59 89 10 SW.	**H—3—12.** **H—1—56.** .. .. 4.3 S. Cu. 115 15.3 .... 30.2 50 88 6 S.	**H—3—5.** 7.9 A. Cu. 75 4.2 8.0 Ci. 84 5.0 2.1 A. S. 94 9.1 ... . 30.6 37 65 13 N. 30.5 42 61 7 NE. ....
	L—2—15. 9.7 Ci. S. 119 2.4 2.0 Fr. S. 140 13.3 ... . 30.1 55 82 12 SE. 29.9 70 55 20 S. 29.8 68 63 20 S.			

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 27 TO DECEMBER 1, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Nov. 27 ° ° H . 6 . 76 . 34 L . 2 . 87 . 49 H . 4 . 109 . 44	**L—2—20.** **H—4—15.** 8.4 S. Cu. 43 ... 8.5 Ci. Cu. 122 ... 1.7 Ci. 131 ... ... 30.3 13 72 14 NW. 30.4 15 65 16 NW.	**L—2—12.** **H—4—15.** ... . 12.1 A. S. 130 13.5 12.3 Cu. 135 18.4 4.1 Cu. 96 22.4 .... 30.1 5 74 24 W. 30.2 2 70 22 W.		**H—6—19.** 9.3 Cu. 179 6.7 11.6 Cu. 182 9.7 ... . 29.8 76 93 20 S. 29.9 79 66 20 S.	
Nov. 28 ° ° H . 6 . 75 . 34 L . 3 . 69 . 49 H . 4 . 108 . 43 L . 6 . 87 . 33		**L—6—17.** **H—4—15.** ... . 12.1 Cu. 82 10.0 ... . 4.2 Ci. S. 126 5.3 ... . 30.6 2 82 12 W. 30.6 3 71 8 W.	**L—6—19.** **H—4—14.** ... . 1.6 Ci. S. 110 ... ... 4.4 Ci. S. 130 5.5 ... . 30.5 30 62 16 N. 30.5 30 41 18 N.		**H—6—18.** **L—6— 9.** ... . 4.5 Cu. 21 10.6 4.5 A. S. 159 6.7 .... 30.5 27 73 10 NW.
Nov. 29 ° ° L . 6 . 62 . 29 L . 3 . 59 . 46 H . 1 . 111 . 52			**H—1—38.** 8.4 A. S. 113 3.5 ... . 1.4 A. S. 129 4.8 ... . 30.7 22 58 19 N. 30.7 29 35 18 N.		
Nov. 30 ° ° L . 6 . 82 . 27 H . 1 . 106 . 54		**H—1—14.** ... . 12.1 Ci. S. 92 3.8 4.1 Cu. 90 10.8 4.3 Ci. S. 95 13.4 .... 30.8 2 78 12 W. 30.8 0 67 14 W.	**H—1—37.** 8.5 A. S. 9 1.3 ... . 1.8 A. S. 175 1.9 4.4 A. S. 78 0.7 ... . 30.8 23 60 18 N. 30.8 29 66 12 N. 30.7 31 68 6 N.	**L—6—18.** **H—1—54.** 9.1 Ci. S. 91 3.1 ... . 12.7 A. S. 136 0.7 4.8 Cu. S. 144 1.9 ... . 30.5 29 84 8 E. 30.5 35 60 6 NE. 30.4 38 39 13 NE.	
Dec. 1 ° ° L . 6 . 83 . 26 L . 3 . 65 . 48 L . 4 . 105 . 50 H . 1 . 109 . 52	**L—4— 7.** **H—1—22.** ... . 1.7 Ci. Cu. 86 ... ... 4.8 Ci. 88 ... ... 30.4 39 71 12 S. 30.4 39 68 12 SE.	**L—4—16.** **H—1—14.** 8.2 Ci. Cu. 107 6.3 12.1 Ci. Cu. 100 9.5 12.3 A. Cu. 100 11.0 ... . 30.7 7 86 3 N. 30.7 0 67 3 SE.		**L—6—18.** **H—1—54.** 8.7 S. Cu. 98 1.1 1.2 S. 120 2.3 ... . 4.3 S. 303 5.3 ... . 30.4 33 80 10 NE. 30.3 38 66 7 NE. 30.3 37 57 8 NE.	**L—6—17.** **H—1—39.** ... . 1.0 A. S. 129 14.3 ... . 30.6 17 67 7 N ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 27 TO DECEMBER 1, 1896.

Washington.					Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6— 9.									**H—6—18.**				**H—6—17.**				**H—6—16.**			
L—2—14.									**L—2— 6.**				**L—2— 6.**				**L—2—14.**			
8.2	S.	144	...						8.5	A. S.	123	10.0	...	.....	...	...	8.1	C. S.	88	5.7
...	.....	...	...						...	.....	...	...	...	.....	...	...	...	.....	...	...
1.0	Fr. S.	135	12.5						1.5	S. Cu.	130	19.8	1.4	S. Cu.	115	16.2	2.1	Ci.	95	3.0
...	.....	...	...						..	.....	...	...	...	.....	...	...	2.2	Fr. Cu.	119	11.3
3.5	Ci.	94	1.8						...	.....	...	...	...	.....	...	...	4.4	Ci. Cu.	106	3.6
30.2	60	89	10 S.						29.8	55	76	....	....	..	..	...	30.1	58	87	30 SW.
30.1	74	55	18 SW.						29.8	55	59	....	29.9	57	88	25 SW.	30.0	68	65	36 SW.
30.1	68	71	12 S.						....	..	..	....	...	..	..	....	30.0	63	77	29 SW.
L—6—16.					**H—6—18.**				**H—6—18.**				**H—6—17.**				**H—6—17.**			
H—6— 9.					**L—3—20.**				**L—3—20.**				**L—3—20.**				**L—3— 5.**			
L—3—20.					**L—6—16.**				**L—6—17.**				**L—6—16.**							
9.2	N.	124	4.3		8.8	Cu. N.	40	7.9	...	.....	...	...	8.3	S. Cu.	40	5.3	8.2	S.	175	21.9
9.4	Fr. S.	141	22.0		..	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
9.5	A. Cu.	112	4.6		...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
9.9	S.	127	22.9		...	.....	...	...	...	.....	...	...	...	.....	..	...	...	.....	...	...
1.0	Fr. N.	128	16.5		2.5	S. Cu.	58	8.0	1.3	S. Cu.	90	18.6	1.5	S. Cu.	40	5.0	2.1	N.	118	38.2
1.5	N.	127	12.5		...	.....	...	...	...	.....	...	...	...	.....	..	...	...	.....	...	...
...	.....	...	...		5.1	S. Cu.	65	8.3	4.1	S. Cu.	100	23.7	4.3	S. Cu.	42	6.0	...	.....	...	...
...	.....	...	...		...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.1	65	89	12 S.		30.3	31	89	17 W.	....	..	..	....	30.2	34	81	12 NW.	30.0	61	93	32 SW.
30.1	67	89	12 S.		30.3	29	66	14 NW.	30.4	25	56	12 W.	30.3	32	69	7 NW.	30.0	62	95	20 SW.
....	..	..	.....		30.3	28	77	15 W.	30.4	24	74	16 W.	30.3	24	74	18 NW.	....	..	..	...
					L—6—17.												**L—3—19.**			
					H—1—56.															
					8.5	N.	70	6.8									8.1	N.	103	11.3
					...	.....	...	...									8.2	Fr. N.	11	13.3
					2.5	N.	70	7.2									2.1	Ci. S.	112	5.1
					...	.....	..	...									2.1	A. Cu.	113	8.8
					...	.....	...	...									2.2	S. Cu.	38	8.2
					5.1	N.	65	...									...	.....	...	...
					30.5	24	74	15 NW.									30.3	37	91	17 N.
					30.4	22	72	10 W.									30.3	36	70	12 N.
					30.4	22	72	11 W.									....	..	..	....
L—6—17.					**L—6—17.**				**H—1—39.**				**H—1—40.**							
H—1—55.					**H—1—39.**															
11.5	S.	115	6.7		9.3	Fr. N.	58	9.8	8.5	S. Cu.	80	18.6	8.4	S. Cu.	96	13.3				
...	.....	...	...		9.7	Cu. N.	45	6.4	...	.....	...	...	...	.....	...	...				
...	.....	...	...		2.2	Cu. N.	90	7.7	...	.....	...	...	1.6	S. Cu.	96	14.3				
3.4	S. Cu.	114	6.4		4.6	Cu. N.	75	7.9	8.2	Cu. S.	95	23.4	...	.....	..	...				
...	.. ..	...	...		...	.....	...	...	...	.....	...	...	...	.....	...	...				
30.5	29	84	8 N.		30.5	19	69	11 SW.	30.5	20	56	8 W.	30.5	22	78	12 W.				
30.4	29	77	12 N.		30.4	24	43	14 W.	....	..	..	...	30.4	22	86	18 W.				
30.5	28	65	5 N.		30.4	22	52	14 W.	30.5	20	77	13 W.	....	..	..	....				
L—3—20.					**L—3—20.**				**H—1—40.**				**L—3—20.**				**L—3—12.**			
H—1—56.					**H—1—40.**								**H—1—56.**				**H—1—56.**			
8.7	Ci. Cu.	102	7.5		8.2	N.	60	8.3	8.6	S. Cu.	92	16.9	8.4	S. Cu.	30	15.0	...	.....	...	...
1.2	Ci., Ci. Cu.	110	7.1		2.3	N.	60	8.6	1.4	S. Cu.	90	8.3	...	.....	...	...	2.3	Ci.	101	...
...	.....	...	...		...	.....	...	...	1.4	Ci.	90	7.7	...	.....	...	...	2.1	Cu.	63	6.8
4.0	Ci. Cu.	125	7.3		4.4	N.	60	5.4	...	.....	...	...	...	.....	...	...	4.2	Ci. S.	103	...
...	.....	..	...		...	.....	...	...	...	.....	...	...	...	.....	...	..	4.2	Fr. Cu.	63	6.3
30.5	19	69	1 NW.		30.5	14	81	16 SW.	30.6	13	61	12 W.	30.5	16	92	18 NW	30.4	18	68	17 W.
30.5	28	51	9 NW.		30.5	18	83	11 SW.	30.5	17	51	9 W.	....	..	..	....	30.3	25	45	23 W.
30.5	27	53	6 N.		30.5	18	75	11 SW.	....	..	..	....	....	..	..	....	30.3	25	46	17 W.

TABLE 9.—*Summary of nephoscope observations*—Continued.

DECEMBER 2 TO DECEMBER 6, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Dec. 2 ° ° L . 6 . 80 . 30 H . 3 . 75 . 48	8.7 A. Cu. 82 ... 12.9 A. S. 62 ... ... 30.4 34 73 9 S. 30.4 36 65 4 NW.			**L—6—19.** 8.7 Ci. 91 0.3 .. .. 30.2 35 54 8 N.	
Dec. 3 ° ° H . 2 . 85 . 40 H . 4 . 112 . 41	**H—2—11.** 8.6 Ci. S. 151 ... ... 1.9 A. S. 86 ... 4.7 A. S. 87 ... 30.4 30 75 8 SE. 30.2 46 73 16 SW. 30.2 46 60 14 SW.	**H—2—10.** 8.2 S. 124 9.6 ... . 4.2 N. 230 16.6 30.3 14 81 6 SE. .... 30.0 22 86 11 S	**H—4—14.** 8.3 Ci. 57 1.8	**H—2—12.** ... . 2.8 Ci. 94 0.2 4.5 A. S. 128 3.0 .... 30.3 52 51 6 N. 30.3 54 28 3 NE.	
Dec. 4 ° ° H . 6 . 74 . 39 L . 2 . 88 . 47 L . 1 . 111 . 49	**L—2—20.** ... . 2.2 A. S. 79 ... ... 5.3 A. S. 78 ... . 29.9 56 58 12 SW. 29.9 55 54 16 SW.	**L—2— 4.** **L—1—15.** ... . 12.1 S. 172 32.2 ... . 29.8 18 84 5 S.	... . 4.9 Ci. 53 5.2 .... 30.0 64 30 10 SW.		
Dec. 5 ° ° H . 6 . 80 . 35 L . 3 . 64 . 49 L . 2 . 92 . 43	**H—6—18.** **L—2—12.** 8.6 A. S. 132 ... 1.8 Ci. 164 ... ... 4.7 A. Cu. 140 ... ... 29.9 44 69 10 SW. 29.9 60 54 6 W. 29.9 60 53 5 NW.				
Dec. 6 ° ° H . 6 . 76 . 34 L . 2 . 79 . 46 L . 5 . 97 . 37			**L—5—8.** 8.8 Ci. S. 110 5.0 1.2 Ci. S. 107 4.4 ... . 29.9 52 59 6 S. 30.0 62 32 7 NW.		

TABLE 9.—*Summary of nephoscope observations*—Continued.

DECEMBER 2 TO DECEMBER 6, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
L—6—17. **H—3—13.** 8.0 A. S. 100 7.3 ... . 30.5 23 66 10 NE. 30.4 24 61 12 N.	**L—6—17.** **H—3—12.** 8.1 Fr. N. 15 8.3 2.2 Fr. N. 5 8.2 4.5 N. 335 8.8 30.4 18 83 3 S. 30.4 22 86 2 N. 30.4 21 85 25 SE.		**L—6—17.** **H—3—12.** 8.4 S. Cu. 290 8.3 ... . 30.5 19 84 6 SE.	**H—3—6.** 7.8 Ci. 108 8.1 2.1 A. S. 108 6.7 ... . 30.5 14 67 21 N. 30.4 17 40 16 N. ....
H—2—7. 8.1 A. Cu. 115 4.0 9.1 Ci. S. 110 4.0 ... . 30.4 21 57 7 N. 30.4 29 42 12 N.	**H—2—2.** 9.0 S.Cu. 40 6.0 ... . 2.5 S.Cu. 100 4.9 ... . 30.4 24 61 11 NW. 30.3 28 65		**H—2—8.** 8.3 S. Cu. 90 10.0 ... . 30.4 22 86 8 W.	**H—2—15.** 7.9 N. 315 14.2 ... . 2.0 Ci. S. 128 ... ... 30.3 10 77 25 N. 30.3 17 63 11 N. ....
H—6— 4. **L—2—14.** 8.0 Ci. S. 122 3.7 ... . 1.6 A. S. 135 7.9 ... . 3.8 A. S. 116 6.3 30.4 19 69 2 N. 30.3 34 76 3 S. 30.2 33 68 5 S.		**H—6—10.** **L—2— 6.** ... . 4.1 S. Cu. 130 27.8 .... 29.9 34 81 20 SW.	**H—6—10.** **L—2— 6.** 8.5 Ci. 90 6.7 8.7 Ci. S. 90 6.7 ... . 30.2 24 74 12 S.	**H—6— 3.** **L—2—15.** 8.1 Ci. 104 7.0 ... . 2.1 Ci. S. 131 5.6 2.2 Fr. Cu. 157 14.1 4.2 A. S. 148 17.0 30.4 18 53 16 W. 30.4 31 52 21 SW. 30.3 30 65 14 S.
H—6— 8. **L—3—20.** **L—2—15.** 8.0 Ci. 95 2.5 12.7 Ci. S. 103 3.7 12.9 Ci. 103 3.7 1.7 Ci. Cu. 101 4.0 3.7 A. S. 112 4.0 3.9 Ci. 119 4.3 4.0 A. Cu. 112 6.0 30.2 25 87 1 S. 30.2 53 36 15 S. 30.2 44 50 6 S.	**H—6— 9.** **L—3—20.** **L—2— 7.** 8.2 Ci. S. 95 4.6 ... . 2.8 Ci. S. 95 4.7 5.5 S. 110 7.4 ... . 30.3 34 81 10 SE. 29.9 46 46 15 E. 29.8 46 39 16 S.	**H—6— 9.** **L—3—20.** **L—2— 7.** ... . 4.1 S. Cu. 180 19.8 ... . 29.8 44 70 10 S.	**H—6— 9.** **L—3—20.** **L—2—15.** 8.4 S. Cu. 115 21.7 ... . 30.0 32 90 6 NW.	**H—6—16.** **L—3— 5.** ... . 2.1 Ci. 108 4.4 4.5 Ci. 111 4.7 ... . 30.1 41 53 20 NW. 30.1 38 59 9 W.
H—6—9. **L—2—5.** 10.0 Ci. 102 4.7 ... . 30.2 36 73 2 S.	**H—6—18.** **L—2—12.** **L—5—16.** ... . 2.4 Ci. S. 108 5.0 ... . 5.2 Ci. Cu. 100 4.9 30.0 42 62 8 S. 30.0 42 52 11 W. 30.0 42 84 Lt. E.			**H—6—16.** **L—2— 6.** 8.1 Ci. S. 104 5.4 2.1 Ci. 105 6.6 2.1 Ci. Cu. 99 5.4 ... . 30.2 35 81 24 S. 30.0 50 67 31 SW. ....

TABLE 9.—*Summary of nephoscope observations*—**Continued.**

DECEMBER 7 TO DECEMBER 11, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Dec. 7 ° ° H . 6 . 77 . 32 L . 3 . 62 . 48 H . 4 . 116 . 40			**H—4—15.** 8.6 Ci. S. 134 4.9 ... . 1.3 A. S. 135 4.9 ... . 4.6 Ci. S. 142 5.3 ... . 30.1 40 38 6 NW. 30.1 49 44 8 N. 30.1 50 69 6 N.	**H—6—19.** **H—4—40.** 9.7 A. Cu. 152 1.9 ... . 1.4 A. Cu. 183 2.1 ... . 30.1 65 75 6 SE. 30.0 74 58 7 SE.	**H—6—18.** **H—4—57.** 7.8 Cu. 106 16.0 8.0 S. Cu. 106 15.3 ... . 30.2 55 65 7 S. ....
Dec. 8 ° ° H . 6 . 70 . 40 H . 4 . 115 . 41		**H—4—25.** 8.1 S. 55 16.9 ... . 4.1 S. 43 13.8 29.9 33 90 5 SW. .... 30.0 28 82 8 W.		**H—4—40.** 9.7 S. Cu. 191 1.4 ... . 1.1 S. 170 2.0 ... . 30.2 64 85 6 S. 30.0 66 85 4 SW.	
Dec. 9 ° ° L . 3 . 71 . 44 L . 2 . 86 . 50 H . 4 . 113 . 41		**L—2—12.** **H—4—26.** 8.1 Ci. 76 9.7 8.3 Ci. Cu. 71 10.4 8.5 A. Cu. 57 11.1 ... . 4.0 Ci. Cu. 87 4.6 29.8 31 79 10 SW. .... 29.9 37 82 5 SW.			**L—3—19.** **L—2—13.** **H—4—41.** 7.7 Cu. 110 22.7 7.9 Fr. Cu. 110 24.3 ... . 30.2 39 55 12 SW. ....
Dec. 10 ° ° L . 3 . 58 . 48 L . 2 . 88 . 51 H . 4 . 109 . 39	**L—2—13.** **H—4—15.** 8.6 Ci. 38 ... ... 30.2 46 60 9 W.	**L—2—12.** **H—4—16.** ... . 4.1 Ci. S. 103 6.0 .... 30.1 41 69 6 SW.	**H—4—14.** 8.2 Ci. 94 2.8 .. .. 1.6 Ci. 111 3.4 ... . 5.3 Ci. 113 3.7 30.4 40 68 5 S. 30.4 68 23 5 NW. 30.2 74 18 2 E.		
Dec. 11 ° ° L . 3 . 59 . 48 L . 2 . 96 . 52 H . 4 . 111 . 40	**L—2—13.** **H—4—15.** 8.8 Ci. 120 ... 1.5 Ci. 108 ... ... 4.8 Ci. Cu. 107 ... 4.9 Ci. S. 107 ... 30.1 48 58 10 SW. 30.0 63 48 12 SW. 29.9 64 45 11 S.	**L—2—5.** **H—4—26.** ... ... 12.1 Ci. S. 136 3.3 12.3 Ci. 136 3.0 12.5 A. Cu. 145 4.9 4.1 Ci. 117 3.7 4.3 Ci. S. 120 5.1 .... 29.8 43 70 6 SW. 29.8 42 77 3 SW.	**H—4—14.** 8.7 Ci. S. 125 3.8 1.4 Ci. 131 3.5 ... . 4.8 A. S. 159 4.1 4.9 Ci. S. 135 3.3 30.3 48 60 6 S. 30.1 71 30 13 SW. 30.0 69 25 12 S.	**H—4—40.** 9.7 Ci. 21 0.7 2.6 Ci. 71 0.9 ... . 4.8 Ci. 99 3.4 ... . 30.4 57 66 2 W. 30.2 75 31 3 SW. 30.1 72 28 3 SW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

DECEMBER 7 TO DECEMBER 11, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6—9.				**H—6—17.**								**H—6—17.**				**H—6—16.**			
				H—4—57.								**L—3—19.**				**L—3—12.**			
8.1	Ci. Cu.	97	5.3	8.3	Ci. Cu.	95	6.7					...	.....	...	...	7.9	Ci.	104	5.3
8.1	A. Cu.	97	6.0	...	.....	...	...					...	.....	...	...	...	.....	...	...
1.2	A. Cu.	65	6.7	2.1	S. Cu.	60	3.2					...	.....	...	...	...	.....	...	...
2.8	S. Cu.	63	7.3	...	.....	...	...					...	.....	...	...	...	.....	...	...
3.7	S. Cu.	69	7.0	...	.....	...	...					4.3	S.	190	6.7	3.1	Ci. S.	94	9.4
3.8	Ci.	87	5.5	...	.....	...	...					...	.....	...	...	3.1	S. Cu.	53	10.9
30.2	35	82	0	30.1	39	83	5 N.					....	..	..	....	30.0	39	68	20 W.
30.2	62	45	3 SE.	30.2	44	78	6 N.					....	..	..	....	30.0	49	53	15 NW.
30.2	53	63	5 N.	....	..	..	....					30.3	38	90	6 E.	....	..	..	....
H—6—11.												**H—6—10.**				**H—6—8.**			
												H—4—57.							
8.0	S. Cu.	133	6.2									...	.....	...	...	8.2	Ci. S.	90	12.0
8.1	A. S.	103	3.7									...	.....	...	...	...	.....	...	...
9.4	Ci.	98	5.7									...	.....	...	...	...	.....	...	...
1.1	Ci.	105	5.5									1.6	S.	250	6.7	2.1	A. Cu.	88	7.1
1.7	Ci. Cu.	110	6.0									...	.....	...	...	2.2	Ci.	93	6.2
1.9	A. Cu.	110	5.9									...	.....	...	...	2.4	S. Cu.	132	17.9
3.7	S. Cu.	110	5.6									...	.....	...	...	4.0	S. Cu.	108	6.1
30.3	42	84	5 N.									....	..	..	....	30.3	28	81	14 N.
30.2	55	42	3 SE.									30.1	38	93	8 E.	30.3	39	52	12 S.
30.0	52	75	3 E.									....	..	..	....	30.3	37	80	13 S.
L—3—12.				**L—3—11.**				**L—3—19.**								**L—3—11.**			
L—2—14.				**L—2— 5.**				**L—2— 5.**								**L—2—14.**			
H—4—57.				**H—4—57.**				**H—4—40.**											
8.2	Cu.	65	13.7	9.2	Fr. N.	90	23.3	8.4	S. Cu.	94	31.7					...	.....	...	..
...	.....	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
1.0	Cu.	76	8.1	1.6	S.	55	6.7	1.7	A. S.	59	9.1					2.2	Ci. Cu.	48	12.9
...	.....	...	...	...	.....	...	...	...	.....	...	...					2.0	A. Cu.	69	10.0
...	.....	...	...	...	.....	...	...	...	.....	...	...					2.2	Fr. Cu.	52	33.3
3.6	Ci.	55	4.9	4.6	Fr. S.	60	6.8	...	.....	...	...					...	.....	..	...
29.8	52	51	20 NW.	29.9	36	76	17 W.	29.9	35	82	17 SW.					....	..	..	....
29.8	53	42	15 NW.	29.7	41	61	24 SW.	29.7	42	58	20 W.					29.8	40	72	55 NW.
29.8	48	36	10 SW.	29.7	44	57	25 SW.	....	.	..	....					....	..	..	....
H—4—57.								**L—2—14.**				**L—2—14.**				**L—3—20.**			
								H—4—41.				**H—4—57.**							
8.7	Ci. Cu.	61	3.4					...	.....	...	...	8.3	S. Cu.	90	23.3	...	.....	...	..
9.2	Ci.	65	3.4					...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...					...	.....	...	...	1.4	S. Cu.	115	14.3	2.1	S. Cu.	67	6.8
...	.....	...	...					...	.....	...	...	...	.....	...	...	2.2	Ci. Cu.	85	5.4
...	.....	...	..					4.0	S. Cu.	85	31.5	4.1	S. Cu.	115	14.3	4.1	S. Cu.	50	6.2
29.9	44	57	8 SW.					....	..	..	....	29.8	39	84	16 W.	....	..	..	....
....	..	..	....					....	..	..	....	29.8	42	77	20 SW.	29.7	42	45	25 NW.
....	..	..	....					29.8	48	66	21 W.	29.6	43	78	9 SW.	29.7	41	51	15 W.
H—4—57.				**H—4—41.**				**L—2—14.**				**H—4—57.**				**L—3—19.**			
								H—4—41.											
8.0	S. Cu.	26	1.7	...	.....	...	...	8.5	S. Cu.	112	19.7	8.3	S. Cu.	30	4.7	8.0	A. S.	47	4.4
1.8	Cu.	6	7.1	2.0	Fr. Cu.	120	8.3	1.3	Ci.	125	1.2	1.1	Ci.	115	16.0	2.0	S. Cu.	9	7.4
...	.....	...	...	2.3	Ci.	15	2.7	...	.....	...	...	1.5	A. S.	115	20.0	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	1.9	Ci. S.	115	15.8	...	.....	...	...
...	.....	...	...	...	.....	..	...	...	.....	...	...	4.1	S. Cu.	115	16.0	4.3	S. Cu.	31	6.5
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	4.5	Ci.	5	...
30.0	48	51	12 NW.	....	..	..	....	....	..	..	....	30.1	36	87	6 NW.	30.0	31	77	16 N.
30.1	48	49	14 NW.	30.0	47	59	11 SW.	30.1	45	67	15 SW.	30.1	42	73	15 W.	30.0	35	70	14 NE.
....	..	..	....	....	..	..	....	....	.	..	....	....	..	..	....	30.1	35	73	8 NE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

DECEMBER 12 TO DECEMBER 16, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Dec. 12 ° ° H. 6. 76. 34 L. 3. 67. 50 L. 2. 95. 52	**L—2—15.** ... . 3.1 Ci. 100 ... 4.8 Ci. 100 ... . 29.8 57 43 7 SW. 29.8 57 42 9 SW.		8.8 Ci. S. 123 6.0 ... . 1.5 Ci. S. 124 5.8 4.7 A. S. 134 5.6 ... . 30.0 52 30 13 SW. 29.9 73 16 18 W. 29.8 76 8 12 W.	**H—6—19.** 9.7 A. Cu. 179 1.0 ... . 2.9 S. Cu. 80 2.2 4.3 S. Cu. 103 4.9 ... . 30.2 58 49 10 SW. 30.0 65 54 3 SW. 30.0 65 44 3 SW.	**H—6—10.** ... . 4.4 A. S. 105 3.8 ... . 29.8 64 36 14 S.
Dec. 13 ° ° H. 6. 79. 32 L. 2. 78. 48					
Dec. 14 ° ° L. 3. 63. 48 H. 2. 84. 51 L. 5 93. 33 H. 4. 109. 42			**L—5—11.** **H—4—14.** 8.5 Fr. S. 46 3.3 ... . 30.1 42 69 12 NW.	**L—5—2.** 9.7 Cu. 92 2.9 ... . 5.2 Cu. 26 4.9 29.8 66 80 10 SW. .... 29.8 68 54 12 NW.	
Dec. 15 ° ° L. 6. 78. 32 H. 2. 77. 50 H. 5. 101. 31	**H—5—16.** ... . 4.9 Ci. 58 ... . 30.2 52 54 5 SW.		**H—5—2.** ... . 4.3 Ci. 104 3.4 .... 30.2 64 30 9 SE.		
Dec. 16 L. 3. 70. 40 H. 2. 77. 50 L. 4. 104. 43	**L—4—6.** ... . 2.5 Ci. S. 130 ... ... 4.6 S. Cu. 126 ... ... 30.0 48 52 12 SE. 29.9 51 54 12 SE.		**L—4—18.** 8.2 A. S. 133 4.1 ... . 1.3 A. S. 145 5.6 ... . 30.0 51 50 18 SE. 30.0 58 42 16 S.	9.7 Ci. 132 0.2 ... . 3.6 A. Cu. 110 0.7 ... . 4.8 A. S. 77 4.3 ... . 30.4 46 .. 6 E. 30.1 59 51 3 SE. 30.1 63 29 6 E.	**L—8—19.** **H—2—20.** 7.8 S. Cu. 352 29.6 ... . 1.4 S. Cu. 287 9.9 ... . 30.3 32 64 13 N. 30.3 34 68 7 N. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

DECEMBER 12 TO DECEMBER 16, 1896.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6— 9.				**H—6—18.**				**H—6—18.**				**H—6—17.**				**H—6—16.**			
L—3—20.				**L—3—20.**				**L—3—20.**				**L—3—20.**				**L—3— 5.**			
				L—2—14.				**L—2—14.**											
7.9	S. Cu.	75	4.0	8.2	Ci. S.	86	3.3	8.5	A. Cu.	108	11.2	...	.....	...	...	8.0	Ci.	70	2.0
8.2	Ci. S.	77	3.3	8.3	Ci.	89	2.7	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	8.5	Ci. Cu.	89	4.0	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.6	Ci. S.	87	2.0	2.0	Ci. S.	103	3.6	...	.....	...	...	1.3	Ci.	98	4.0	2.1	Ci.	84	2.0
3.9	A. S.	...	3.5	...	.....	...	...	...	.....	...	...	...	.....	...	...	4.2	Ci.	84	2.5
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.2	34	89	2 SW.	29.9	40	72	10 SW.	29.9	39	73	12 W.	....	..	..	....	30.1	31	82	22 SW.
30.1	49	56	12 SW.	29.8	57	40	12 S.	....	..	..	....	29.7	56	72	18 SW.	30.0	44	63	20 SW.
30.0	46	72	4 S.	....	..	..	....	....	..	..	....	....	..	..	....	30.0	44	68	17 SW.
				H—6—17.												**H—6—16.**			
				L—2— 5.												**L—2— 6.**			
				8.2	Ci. S.	102	4.0									11.0	S. Cu.	56	34.9
				2.5	Fr. S.	45	28.1									2.0	Ci.	109	3.4
				4.6	Fr. S.	45	18.0									...	.....	...	...
				29.7	40	88	11 S.									29.8	44	100	30 SW.
				29.7	44	78	15 W.									29.6	54	65	24 S.
				29.8	40	84	13 N.									....	..	..	....
H—2—14.				**H—2— 5.**				**H—2— 5.**				**L—3—20.**				**L—3—12.**			
				L—5—16.				**L—5—16.**				**H—2— 6.**				**H—2—14.**			
8.0	Ci. Cu.	92	1.7	8.8	A. S.	100	1.7	8.6	S. Cu.	330	26.0	8.3	S. Cu.	305	23.3	7.9	Ci.	104	3.4
8.1	Ci.	92	1.7	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
8.4	A. Cu.	74	4.7	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.0	Ci.	95	3.0	2.0	A. S.	90	2.2	1.2	S. Cu.	310	30.2	1.2	S. Cu.	305	22.7	2.1	Ci.	100	3.5
1.8	A. Cu.	75	2.7	...	.....	...	...	8.1	S. Cu.	310	30.2	4.4	Ci.	95	6.0	4.0	Ci.	98	3.3
3.8	S. Cu.	106	2.5	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.0	43	77	6 NE.	30.1	35	82	10 E.	30.1	34	81	10 NE.	30.2	30	87	10 N.	29.9	35	72	22 NW.
30.1	52	40	5 E.	30.0	38	76	15 NE.	30.1	32	90	11 NE.	30.2	30	78	10 NE.	30.0	41	31	23 NW.
30.1	45	58	7 NE.	....	..	..	....	30.1	33	80	10 NE.	30.2	32	78	6 E.	30.1	37	28	21 NW.
L—6— 9.				**L—6—17.**								**L—6—17.**				**L—6—16.**			
H—2—13.				**H—2— 5.**								**H—2— 5.**				**H—2— 6.**			
8.1	S.	270	2.4	...	.....	...	...					8.6	S. Cu.	305	23.3	8.1	S. Cu.	293	31.2
...	.....	...	...	...	.....	...	...					8.4	Ci. Cu.	95	4.7	...	.....	...	...
1.0	S.	289	17.0	...	.....	...	...					1.3	S. Cu.	305	22.7	2.1	S. Cu.	293	24.5
3.7	S.	297	26.4	4.8	Fr. N.	310	32.8					4.3	S. Cu.	305	21.3	...	.....	...	...
30.0	36	66	14 NE.	....	..	..	....					30.1	22	86	32 E.	30.2	19	79	18 N.
29.9	36	70	16 NE.	....	..	..	....					30.1	27	76	18 E.	30.1	27	73	26 NE.
29.9	32	100	16 N.	29.9	32	96	12 NE.					....	..	..	....	....	..	..	....
L—3—11.				**L—3—19.**								**L—3—10.**							
H—2—13.				**H—2—20.**								**H—2— 5.**							
0.8	S.	360	11.0	8.1	S. Cu.	355	15.3					8.3	S. Cu.	305	16.0				
...	.....	...	...	8.2	Fr. N.	340	17.9					...	.....	...	...				
1.7	A. Cu.	337	5.0	...	.....	...	...					...	.....	...	...				
2.0	Ci.	92	1.1	...	.....	...	...					...	.....	...	...				
2.2	Ci. Cu.	71	1.3	...	.....	...	...					...	.....	...	...				
3.7	A. Cu.	342	...	...	.....	...	...					...	.....	...	...				
3.9	Ci. Cu.	45	...	...	.....	...	...					...	.....	...	...				
29.9	34	53	12 N.	30.2	29	89	15 N.					30.2	22	78	11 NE.				
29.9	40	41	18 NW.	....	..	..	....					....	..	..	....				
30.0	36	38	8 NW.	....	..	..	....					....	..	..	....				

TABLE 9.—*Summary of nephoscope observations*—Continued.

DECEMBER 17 TO DECEMBER 21, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Dec. 17 ° ° L. 3. 60. 44 H. 2. 76. 48 L. 5. 95. 37				**L—5—6.** 9.7 Ci. 120 2.0 ... . 12.9 S. 270 4.0 ... . 4.3 S. Cu. 140 20.0 ... . 30.2 52 57 20 SE. 30.0 61 78 10 SW. 29.9 64 72 9 SW.	**H—2—20.** **L—5— 7.** 7.8 Ci. S. 96 6.7 ... . 1.2 Ci. Cu. 127 9.8 1.2 Ci. S. 127 7.8 ... . 30.2 32 74 11 E. 30.0 48 48 10 SE. ....
Dec. 18 ° ° H. 3. 68. 43 L. 2. 82. 45 H. 1. 101. 48	**L—2—20.** **H—1—14.** 8.7 S. Cu. 30 ... ... 2.0 S. Cu. 16 ... ... 4.8 S. Cu. 52 ... 30.4 25 84 15 NW. 30.5 29 71 9 NW. 30.5 30 75 6 NW.	Observations suspended temporarily.		9.7 A. Cu. 12 6.6 ... . 2.5 Ci. 37 2.7 ... . 4.6 Ci. 54 4.3 30.4 40 76 7 N. 30.4 49 72 10 NW. 29.3 48 53 8 N.	**L—2—12.** 7.9 S. 86 17.6 ... . 30.1 41 76 12 W. ....
Dec. 19 ° ° L. 3. 67. 45 H. 2. 85. 50 H. 5. 95. 36 H. 4. 113. 41	**H—2—20.** **H—5— 3.** **H—4—21.** 8.8 Ci. 43 ... ... 1.4 Ci. Cu. 83 ... ... 30.4 28 80 6 SE. 30.3 36 72 10 SW.		**H—5—12.** **H—4—23.** 8.4 Ci. S. 131 5.0 ... . 2.1 A. S. 141 5.1 ... . 4.3 A. S. 139 5.2 30.4 29 66 3 NE. 30.4 44 43 3 NW. 30.3 45 38 3 N.	**H—5— 6.** **H—4—40.** 9.7 Cu. 12 0.9 ... . 4.6 S. 263 5.1 30.4 42 77 6 NE. .... 30.2 41 76 4 NE.	**H—2—13.** **H—5— 7.** **H—4—41.** 7.8 S. 274 3.7 ... . 30.4 33 56 8 E. ....
Dec. 20 ° ° H. 6. 78. 31 L. 3. 57. 48					
Dec. 21 ° ° L. 3. 58. 47 H. 2. 84. 50 H. 4. 113. 42 L. 1. 112. 52	**H—2—20.** 8.7 Ci. 10 ... 9.7 A. Cu. 32 .. 12.6 A. Cu. 2 ... 4.9 Ci. 14 ... ... 30.2 32 78 10 SE. 30.1 43 63 8 S. 30.0 50 55 9 S.		... . 4.2 Ci. 21 1.7 ... . 30.2 66 29 6 NW.		

TABLE 9.—*Summary of nephoscope observations*—Continued.

DECEMBER 17 TO DECEMBER 21, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
	H—2—12. **L—5—16.** 8.0 Ci. S. 85 4.0 8.3 A. S. 85 4.0 8.2 S. 104 4.0 ... ... 30.2 23 93 5 SE. 30.1 37 57 10 SE.	**H—2—12.** **L—5—16.** ... ... 4.1 Ci. Cu. 120 1.7 4.1 Ci. 120 1.0 .... 30.1 32 79 7 SE.	**H—2—12.** **L—5—16.** ... ... 1.3 Ci. 95 4.7 ... ... 30.2 38 68 8 E.	**L—3—11.** **H—2—6.** 8.2 Ci. Cu. 330 ... ... 30.0 19 43 30 N. ....
H—3—12. **L—2—6.** 7.9 S. Cu. 122 5.5 8.7 S. 150 7.7 12.5 A. Cu. 108 6.1 ... ... 3.7 N. 109 ... 30.1 34 72 8 SE. 30.0 41 61 10 S. 30.0 39 79 3 S.	**H—3—19.** **L—2—1.** 8.1 N. 120 8.3 ... ... 2.4 Fr. N. 60 26.9 ... ... 5.2 Fr. N. 55 19.8 29.8 38 92 10 S. 29.9 35 95 20 W. 30.0 35 76 32 W.	**H—3—19.** **L—2—1.** ... ... 1.3 S. Cu. 60 45.6 ... ... 29.9 34 86 13 W.		**H—3—4.** **L—2—7.** ... ... 2.1 A. S. 128 3.4 2.1 S. Cu. 139 14.5 4.0 A. S. 30 13.9 .... 30.1 36 72 14 SE. 30.0 36 82 23 SE.
L—3—20. **H—2—14.** 11.6 Ci. 78 6.5 ... ... 12.8 Ci. Cu. 80 6.2 1.0 Ci. S. 80 6.0 4.2 Ci. 89 5.8 30.2 31 48 9 N. 30.2 35 37 16 NW. 30.2 32 68 4 W.	**L—3—19.** **H—2—5.** **H—5—16.** **H—4—57.** 8.2 S. Cu. 20 2.7 8.5 Fr. S. 45 5.9 1.2 S. Cu. 90 4.0 1.2 S. 120 5.3 ... ... 30.2 26 70 10 NW. 30.2 27 64 8 W.		**L—3—11.** **H—2—6.** **H—5—16.** **H—4—57.** 8.3 Ci. 45 6.3 8.5 S. Cu. 45 24.3 ... ... 30.2 23 86 14 NW.	
	H—6—17. 8.5 Fr. Cu. 118 12.7 8.9 A. S. 85 5.0 2.5 N. 118 11.9 4.4 A. Cu. 78 4.7 4.8 Fr. S. 120 13.5 30.0 25 87 8 S. 30.0 26 82 7 W. 30.0 28 77 9 W.			**H—6—17.** **L—3—12.** 8.0 Ci. S. 108 4.5 ... ... 30.0 12 55 22 NW. ....
H—2—14. 8.2 Fr. S. 69 6.0 8.3 S. 69 3.7 10.9 A. Cu. 87 3.0 3.9 S. Cu. 82 6.3 ... ... 30.0 27 88 1 NW. 30.0 38 50 2 SW. 30.0 35 54 4 NW.	**H—2—5.** 8.3 Cu. (ma.) 83 6.6 ... ... 2.0 S. Cu. 65 10.2 4.6 S. Cu. 45 10.0 ... ... 30.0 27 88 10 W. 29.9 24 68 14 W. 30.0 25 74 14 W.	**H—2—5.** ... ... 1.3 A. Cu. 71 6.6 4.2 A. Cu. 65 6.4 ... ... 30.0 26 62 12 W. 30.0 24 70 8 W.		**L—3—19.** **H—2—14.** ... ... 2.1 A. S. 86 4.1 4.0 A. Cu. 115 4.4 4.1 S. Cu. 90 5.0 .... 29.9 29 56 4 N. 29.9 28 60 6 NE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

DECEMBER 22 TO DECEMBER 27, 1896.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Dec. 22 ° ° H . 6 . 88 . 28 L . 3 . 55 . 49 L . 2 . 90 . 43 H . 4 . 112 . 41	**H—6—18.** **L—2—12.** **H—4—15.** 10.1 Ci. 38 ... ... 1.2 Ci. 28 ... ... 29.9 40 68 7 W. 30.0 52 46 12 NW.		**H—6—19.** **L—2—20.** **H—4—14.** 8.4 Ci. 357 2.4 ... . 30.3 41 61 3 SW.	**H—6—10.** **L—2—13.** ... . 12.9 Ci. 350 2.7 ... . 4.9 Ci. 18 3.4 ... . 30.1 56 64 12 SW. 30.0 64 30 10 SW.	**H—6—17.** **L—2— 6.** 7.9 S. Cu. 92 8.7 ... . 4.5 Ci. Cu. 100 3.5 4.6 A. S. 102 ... 29.9 35 65 13 SE. ....
Dec. 23 ° ° L . 3 . 71 . 40 H . 2 . 86 . 51 H . 4 . 109 . 43					**L—3—19.** **H—2—13.** 7.8 S. Cu. 40 16.9 12.9 Fr. Cu. 10 17.6 ... . 30.2 33 60 12 NW. 30.4 37 44 12 NW. ....
Dec. 24 ° ° L . 3 . 59 . 45 H . 2 . 95 . 42	**H—2—1.** ... . 1.5 S. Cu. 150 ... ... 30.8 29 74 3 N.		**H—2—20.** ... . 1.8 Ci. 103 2.0 4.2 Ci. 100 2.8 .... 30.7 36 73 14 N. 30.7 37 66 15 N.	**H—2—18.** ... . 4.3 Ci. 54 4.0 .... 30.6 47 59 12 NE.	
Dec. 25 ° ° L . 3 . 59 . 46 H . 6 . 85 . 37 L . 2 . 94 . 51			**H—6—19.** ... . 1.8 Ci. 118 1.9 4.3 Ci. 125 1.7 .... 30.5 46 54 6 S. 30.4 49 60 7 S.		
Dec. 26 ° ° L . 3 . 67 . 49 H . 6 . 86 . 34			**H—6—19.** ... . 1.5 S.Cu. 167 7.2 ... . 4.4 S.Cu. 167 9.8 .... 30.5 55 65 6 SW. 30.4 55 59 8 S.	**H—6—12.** 9.7 Ci. 132 0.3 ... . 4.1 Ci. 105 3.2 30.5 42 48 3 SE. .... 30.4 56 35 2 W.	
Dec. 27 ° ° H . 3 . 75 . 45					

TABLE 9.—*Summary of nephoscope observations*—Continued.

DECEMBER 22 TO DECEMBER 27, 1896.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
H—6—16. **L—2—15.** 8.0 S. Cu. 67 5.3 8.1 A. Cu. 67 5.3 12.9 S. Cu. 80 5.1 1.0 A. S. 83 5.7 ... . 30.1 29 66 1 W. 30.0 36 48 12 S.				**L—3—20.** ... . 2.2 Ci. S. 104 7.0 ... . 4.1 Ci. S. 114 8.0 ... . 30.0 20 48 12 NW. 30.0 21 49 2 N.
L—3—10. **H—2—14.** 8.2 Ci. Cu. 82 6.1 ... . 12.8 Cu. 48 13.7 4.1 S. Cu. 61 11.2 29.9 38 67 12 NW. 30.0 32 55 28 NW.	**L—3—11.** **H—2—13.** 8.3 Fr. N. 335 15.0 1.6 Fr. Cu. 30 5.6 2.0 Fr. S. 3 12.2 4.5 N. 15 11.9 30.1 25 74 14 NE. 30.2 23 73 14 N. 30.3 22 72 20 N.	**L—3—19.** **H—2—5.** ... . 4.1 S. Cu. 355 8.7 .... 30.4 22 80 6 N.		
	H—2—15. ... . 2.3 Fr. Cu. 35 4.0 4.9 Fr. Cu. 58 8.5 .... 30.5 20 70 14 W. 30.6 17 76 9 SW.	**H—2—7.** ... . 4.2 S. Cu. 40 9.3 .... 30.6 15 72 9 W.		**L—3—19.** 8.7 Ci. 14 2.3 ... . 30.2 1 64 24 NW. ....
	H—6—8. **L—2—14.** ... . 2.0 Ci. S 85 5.0 4.4 A. S. 85 5.2 .... 30.4 26 58 15 S. 30.4 24 67 14 W.			**L—3—19.** **H—6—16.** 8.1 S. Cu. 48 7.7 2.2 S. Cu 47 15.6 ... . 30.4 6 65 17 NW. 30.4 17 51 30 NW. ....
L—3—20. **H—6—8.** 8.1 S. Cu. 78 3.9 ... . 1.0 S. Cu. 72 9.9 3.8 S. Cu. 43 10.4 ... . 30.4 24 74 2 S. 30.4 32 64 3 SW. 30.5 32 69 2 W.	**L—3—20.** **H—6—8.** ... . 2.0 S. 45 8.2 ... . 4.5 N. 40 5.8 .... 30.3 31 79 10 W. 30.4 31 79 7 W.	**L—3—20.** **H—6—9.** ... . 1.2 S. Cu. 42 8.3 ... . 30.4 32 95 6 NW.	**L—3—20.** **H—6—16.** 8.3 S. Cu. 115 21.0 ... . 1.4 S. Cu. 115 19.3 ... . 4.1 S. Cu. 115 19.3 30.2 29 81 24 W. 30.3 32 84 20 W. 30.3 28 85 20 W.	**L—3—5.** 9.4 A. S. 90 8.3 8.0 Ci. 93 3.9 2.1 Fr. Cu. 64 8.3 2.7 S. Cu. 51 9.7 4.2 S. Cu. 47 9.1 30.1 21 55 32 SW. 30.1 31 53 20 W. 30.1 29 60 28 NW.
	H—3—12. ... . 2.2 S. 202 2.3 5.3 Fr. S. 225 4.1 .... 30.7 30 67 6 SE. 30.7 28 77 6 SE.			

TABLE 9.—*Summary of nephoscope observations*—Continued.

DECEMBER 28 TO DECEMBER 31, 1896. JANUARY 1 TO JANUARY 2, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Dec. 28 ° ° H. 3. 74. 41 L. 1. 110. 54				8.6 A. Cu. 190 2.3 2.9 A. Cu. 90 1.3 4.4 S. 124 4.7 ... . 30.6 45 68 12 SE. 30.5 60 67 5 E. 30.4 61 54 4 E.	
Dec. 29 ° ° H. 6. 78. 37 L. 1. 106. 51				**H—6—19.** 8.7 A. Cu. 172 1.0 12.9 A. Cu. 120 1.0 ... . 4.6 A. S. 94 4.2 ... . 30.3 55 64 6 SE. 30.4 63 58 4 E. 30.3 64 56 6 E.	
Dec. 30 ° ° H. 6. 85. 35 L. 2. 83. 51 H. 2. 98. 52	**H—6—10.** **H—2—13.** **L—2—20.** ... . 12.8 A. Cu. 176 ... 4.8 A. Cu. 179 ... 4.9 S. Cu. 182 ... . 30.3 56 72 2 S. 30.3 58 88 2 E.			**H—6—12.** ... . 4.6 S. Cu. 224 7.0 ... . 30.2 68 58 6 SE.	
Dec. 31 ° ° L. 3. 61. 46 H. 2. 79. 49 L. 1. 107. 47	**L—1—14.** ... . 4.5 S. Cu. 54 ... 4.6 Fr. S 42 ... . 29.8 53 94 10 SE.			9.2 S. Cu. 268 5.1 2.9 S. 260 4.7 ... . 4.6 Cu. S. 185 3.9 4.8 A. S. 160 3.3 30.2 58 89 10 SE. 30.2 57 94 12 SE. 30.0 62 87 9 SE.	**H—2—20.** 7.9 Ci. S. 58 4.4 12.9 Ci. S. 92 5.9 1.0 A. S. 92 5.0 4.3 Ci. 141 5.2 4.3 Ci. Cu. 138 6.0 30.4 40 75 5 NE. 30.3 61 49 7 E. 30.2 60 52 13 E.
Jan. 1 ° ° H. 3. 64. 48 L. 2. 96. 47	**L—2—5.** ... . 1.2 Cu. 154 16.8 3.2 Ci. 143 5.2 4.7 Ci. 142 4.9 .... 29.9 61 78 16 S. 29.9 62 77 9 SW.				
Jan. 2 ° ° H. 3. 63. 42 L. 2. 98. 49 L. 5. 100. 34				**L—5—2.** 8.9 S. 220 8.0 ... . 30.1 66 90 12 SE.	**L—2—13.** **L—5— 8.** ... . 1.4 S. Cu. 172 4.9 ... . 4.4 S. Cu. 177 ... . 30.1 65 54 24 S. 30.1 63 56 10 SE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

DECEMBER 28 TO DECEMBER 31, 1896. JANUARY 1 TO JANUARY 2, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
	H—3—11. 8.3 Ci. 60 2.3 2.0 Ci. S. 90 2.3 5.2 Ci. S. 90 2.3 ... . 30.6 16 95 10 E. 30.5 41 46 12 S. 30.5 36 63 8 S.	**H—3—11.** 4.6 A. S. 60 3.5 1.4 A. S. 46 6.5 4.2 A. S. 80 1.2 4.1 A. Cu. 80 1.8 30.6 23 80 9 S. 30.5 32 75 12 S. 30.4 33 75 14 S.	**H—3—4.** ... . 1.4 Ci. 115 3.3 ... . 30.6 34 62 18 SW.	**H—3—2.** ... . 4.4 Ci. 28 2.4 ... . 30.7 27 22 23 SW.
H—6—3. 9.0 Ci. S. 90 2.2 12.6 Ci. S. 105 2.5 1.1 Ci. Cu. 107 3.3 4.2 Ci. 98 2.5 4.2 Ci. Cu. 97 2.8 30.6 22 86 1 S. 30.5 39 59 4 S. 30.5 32 70 2 S.				**H—6—8.** 8.2 Ci. S. 90 2.3 2.3 Ci. Cu. 84 6.7 2.3 Ci. 93 6.0 4.3 Ci. S. 93 5.0 4.3 Ci. Cu. 91 6.0 30.5 25 67 28 SW. 30.3 34 54 22 SW. 30.4 34 55 22 SW.
H—6—8. **L—2—14.** 8.0 S. Cu. 92 3.0 12.8 A. Cu. 70 5.0 4.3 Fr. S. 67 9.1 ... . 30.5 37 82 1 W. 30.4 61 52 2 S. 30.4 42 80 1 SW.	**H—6—9.** **L—2—13.** ... . 5.6 Fr. S. 92 10.8 ... . 30.3 47 96 12 SW.		**H—6—16.** **L—2—6.** 8.2 S. 116 16.0 ... . 30.4 38 92 18 SW.	**H—6—16.** **L—2—14.** 7.9 S. Cu. 121 13.6 2.7 S. Cu. 92 13.6 4.0 S. 273 ... ... 30.4 33 86 10 NW. 30.3 39 75 15 SW. 30.2 39 78 20 SW.
				L—3—11. **H—2—6.** 8.1 Ci. 15 5.2 ... . 4.0 Ci. 85 ... ... 30.2 36 69 23 NW. .... 30.4 34 36 15 NW.
	L—2—15. 8.1 S. 135 9.8 ... . 5.2 S. 140 8.3 30.4 39 83 20 SE. .... 30.4 56 50 15 SE.			**H—3—12.** 7.9 S. Cu. 291 17.4 2.1 S. Cu. 239 6.3 ... . 4.1 Ci. 50 2.4 30.0 15 71 14 N. 30.0 28 70 4 NW. 30.0 29 73 6 NE.
H—8—19. **L—2—14.** 8.9 S. 210 21.2 11.4 Ci. 75 1.5 11.6 S. 212 2.5 .... 4.2 A. S. 77 2.5 30.7 32 90 3 NE. 30.6 53 77 3 N. 30.6 44 96 5 S.		**L—2—6.** **L—5—16.** 8.6 Cu. S. 125 25.6 ... . 2.0 S. 75 13.3 ... . 30.2 49 83 12 S. 30.2 55 76 15 S.	**H—8—19.** **L—2—6.** 8.2 S. Cu. 116 9.3 ... . 30.4 50 64 10 S.	**H—3—11.** **L—2—15.** ... . 2.3 S. Cu. 133 20.0 3.0 Ci. 68 3.7 ... . 30.6 39 78 20 SW. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 3 TO JANUARY 8, 1897

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Jan. 3 ° ° H . 6 . 74 . 39 L . 2 . 91 . 41					
Jan. 4 ° ° H . 3 . 64 . 43 L . 2 . 92 . 46			8.3 Ci. S. 92 4.7 ... . 30.5 31 68 7 NW.	**L—2—13.** 9.9 Ci. 265 0.8 ... . 30.3 33 84 4 NW.	**L—2—6.** ... . 4.4 Cu. 145 22.8 ... . 29.9 38 50 14 S.
Jan. 5 ° ° L . 3 . 75 . 48 H . 4 . 112 . 43	**H—4—24.** 9.2 S. Cu. 37 15.5 1.7 S. Cu. 42 10.1 ... . 30.2 11 76 13 NW. 30.2 16 64 10 NW.				
Jan. 6 ° ° L . 3 . 66 . 48 H . 4 . 110 . 42	**H—4—15.** ... . 12.9 A. Cu. 66 3.1 ... . 30.2 29 72 11 SW.		**H—4—14.** 8.7 Ci. 125 2.7 ... . 30.5 30 73 6 SW.	**H—4—39.** ... . 12.9 Ci. 134 0.7 ... . 4.8 Ci. 101 3.8 .... 30.2 40 68 3 NE. 30.2 42 55 7 W.	
Jan. 7 ° ° H . 6 . 81 . 36 H . 4 . 112 . 42			**H—4—23.** ... . 1.5 Ci. 99 4.8 ... . 4.3 Ci. S. 98 4.9 .... 30.4 56 34 5 W. 30.3 61 35 4 W.		
Jan. 8 ° ° H . 3 . 67 . 49 H . 4 . 112 . 42 H . 5 . 100 . 31			**H—5— 2.** **H—4—23.** 8.1 A. Cu. 124 1.8 8.9 Ci. S. 120 2.3 1.2 A. Cu. 116 2.3 4.2 A. Cu. 117 1.8 ... . 30.5 37 82 4 SW. 30.4 60 48 2 S. 30.3 60 30 9 S.	**H—5— 7.** **H—4—39.** ... . 3.3 Ci. 21 0.3 4.6 Ci. 85 4.0 .... 30.3 60 30 6 W. 30.4 61 49 3 W.	**H—5—16.** **H—4—40.** ... . 1.5 Fr. Cu. 34 15.6 4.5 Fr. Cu. 79 13.0 ... . 30.4 39 82 4 SW. 30.4 40 69 5 SE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 3 TO JANUARY 8, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
	H—6—10. **L—2— 7.** 8.2 A. S. 125 2.3 1.2 A. Cu. 145 3.5 1.5 Ci. 145 2.3 ... . 30.2 52 68 13 S. 30.0 60 58 14 S.			**H—6—3.** ... . 2.1 Ci. 104 1.2 ... . 30.4 46 78 18 SW. ....
H—8—19. **L—2—14.** 8.2 S. 167 13.0 1.4 S. Cu. 145 12.7 ... . 4.0 S. Cu. 156 11.3 ... . 30.1 52 94 2 E. 29.9 62 62 19 S. 29.8 57 83 6 S.	**H—8—19.** **L—2— 6.** ... . 1.0 S. 175 13.5 1.3 Fr. Cu. 130 10.0 4.5 Fr. Cu. 120 10.0 4.8 S. 190 15.2 29.8 40 96 15 W. 29.8 42 61 17 SW. 29.9 36 66 14 W.	**L—2—6.** 8.4 S. Cu. 154 31.8 1.0 S. Cu. 135 25.5 ... . 4.2 S. Cu. 126 18.7 ... . 29.8 39 92 7 SW. 29.8 33 75 23 SW. 29.9 29 89 15 SW.		**H—3—11.** ... . 1.2 Ci. 144 4.1 2.2 S. Cu. 163 19.2 ... . 30.1 49 84 14 S. ....
L—3—13. **H—4—56.** 8.1 S. Cu. 146 7.9 12.7 S. Cu. 133 5.9 3.5 S. Cu. 130 13.5 ... . 29.8 41 76 5 N. 29.8 44 60 3 W. 29.8 40 68 17 NW.	**L—3—12.** **H—4—56.** 8.2 N. 115 10.4 ... . 5.2 Fr. Cu. 115 12.7 5.6 Ci. S. 90 2.5 29.8 28 77 12 S. .... 29.9 17 19 14 W.			
L—3—20. **H—4—57.** 8.2 A. Cu. 105 7.4 ... . 30.0 22 72 22 NW.	**L—3—20.** **H—4—41.** ... . 2.2 Fr. N. 85 24.5 2.4 S. 70 11.7 ... . 30.0 22 72 22 W.	**L—3—20.** **H—4—41.** ... . 1.1 S. Cu. 64 22.6 ... . 4.2 S. Cu. 86 41.7 .... 30.0 24 74 21 W. 30.1 22 72 20 W.	**L—3—20.** **H—4—57.** ... . 1.3 S. Cu. 116 17.7 ... . 30.0 27 83 24 W.	**L—3—12.** 8.0 S. Cu. 120 8.8 2.0 A. Cu. 158 11.1 2.2 S. Cu. 144 13.9 4.5 Fr. Cu. 82 10.7 29.7 30 73 14 W. 29.7 28 68 24 W. 29.7 27 51 26 W.
H—6— 2. **H—4—57.** 9.0 Ci. 130 3.0 ... . 30.4 23 60 10 NW.	**H—6— 8.** **H—4—41.** ... . 2.3 Fr. S. 121 4.0 ... . 30.3 26 63 9 S.	**H—6— 9.** **H—4—41.** 8.4 S. Cu. 140 25.8 1.5 S. Cu. 135 17.0 1.6 A. Cu. 125 6.7 3.6 S. Cu. 135 13.0 30.3 16 83 14 SW. 30.3 25 68 13 SW. 30.2 24 76 12 S.		
H—8—20. **H—4—57.** 8.8 Ci. Cu. 102 0.8 ... . 30.4 22 72 1 NE.	**H—8—20.** **H—4—40.** 8.2 A. S. 132 3.0 ... . 2.1 A. S. 128 2.9 4.2 A. S. 128 3.0 ... . 30.4 28 94 4 E. 30.3 34 81 2 NW. 30.4 32 90 14 NW.			**H—3—12.** 8.2 Ci. 158 8.3 8.2 Ci. Cu. 153 8.3 2.1 N. 334 19.2 ... . 30.4 16 93 18 N. 30.4 22 76 25 N. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 9 TO JANUARY 14, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Jan. 9 ° ° L . 2 . 87 . 50 H . 4 . 112 . 43 H . 6 . 87 . 29	**L—2—20.** **H—6—18.** **H—4—24.** 9.3 Ci. 80 2.4 ... . 30.4 35 69 10 NW.			**H—6— 3.** **H—4—39.** 9.4 Ci. 91 0.7 ... . 30.5 46 58 10 SE.	
Jan. 10 ° ° L . 3 . 7 . 48 H . 6 . 88 . 28 H . 4 . 110 . 43			**H—6—18.** **H—4—14.** ... . 4.2 Ci. 104 4.8 .... 30.1 70 33 10 W.		
Jan. 11 ° ° L . 3 . 64 . 50 H . 4 . 109 . 42			**H—4—14.** 8.3 Ci. 100 3.1 ... . 1.3 Ci. Cu. 131 3.4 4.0 A. Cu. 124 3.3 4.3 A. S. 124 3.1 340. 34 81 3 SW. 30.3 53 63 4 NE. 30.2 54 59 7 E.	8.9 A. Cu. 80 2.2 ... . 12.9 Ci. 284 0.3 5.5 Ci. 131 0.7 ... . 30.2 52 69 6 NE. 30.2 61 49 5 N. 30.1 58 50 4 NE.	
Jan. 12 ° ° L . 3 . 61 . 44 H . 2 . 85 . 50 L . 4 . 105 . 43			**L—4—14.** ... . 1.5 A. S. 132 3.4 ... . 4.3 A. S. 132 5.1 .... 29.9 60 84 13 SW. 29.8 64 79 12 SW.	9.4 A. S. 81 4.2 ... . 1.4 A. S. 81 4.9 ... . 4.0 S. Cu. 95 5.6 30.1 49 43 12 SE. 30.1 55 88 8 SE. 30.0 56 44 10 SE.	**H—2—3.** ... . 1.1 Ci. 63 6.5 ... . 30.3 34 50 5 NW. ....
Jan. 13 ° ° L . 3 . 54 . 48 H . 2 . 75 . 44 L . 5 . 97 . 38			**L—5—5.** 8.3 S. 116 6.0 1.7 A. S. 116 5.1 ... . 4.3 A. S. 120 6.4 29.9 54 100 9 SW. 29.9 65 56 5 NW. 29.9 66 57 5 W.	**L—5—6.** 9.2 S. 112 ... 12.9 Cu. 113 9.4 ... . 4.6 S. Cu. 84 9.7 30.0 61 87 15 S. 30.0 65 85 10 SW. 29.9 68 74 10 SW.	
Jan. 14 ° ° L . 6 . 75 . 36 H . 2 . 98 . 51				**H—2—37.** 9.5 S. 50 1.1 ... . 30.0 65 87 1 SW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 9 TO JANUARY 14, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
	H—6—17. **H—4—57.** **L—2—14.** ... . 1.5 Fr. S. 125 16.6 ... . 30.0 42 62 20 W.	**H—6—17.** **H—4—41.** **L—2— 5.** ... . 1.5 S. Cu. 118 50.0 4.5 S. Cu. 78 55.6 .... 29.9 37 74 20 SW. 29.9 37 74 17 W.	**L—2—14.** **H—4—57.** 8.3 Ci. S. 115 6.7 8.5 Ci. 115 6.7 1.6 Ci. S. 70 3.3 ... . 30.2 27 82 15 SW. 29.9 40 83 20 SW.	**L—2—14.** ... . 2.0 Ci. 108 1.5 ... . 30.3 13 57 21 N. ....
	L—3—20. **H—4—41.** 8.6 S. Cu. 82 11.5 2.3 S. Cu. 105 9.0 ... . 4.4 S. Cu. 120 9.0 30.0 32 74 12 W. 30.0 35 73 13 W. 30.2 32 90 11 SW.			**L—3—5.** 8.0 S. Cu. 109 6.4 2.1 Ci. Cu. 94 6.8 2.2 S. Cu. 92 12.2 ... . 29.8 31 76 16 SW. 29.8 38 49 32 NW. ....
8.0 S. Cu. 114 6.3 9.3 Cu. 114 5.0 1.0 Cu. 98 9.4 4.0 Cu. 84 8.9 ... . 29.8 27 81 1 N. 29.8 44 43 15 NW. 30.0 36 56 14 NW.	... . 2.4 Fr. N. 48 20.0 5.2 Fr. N. 64 13.0 ... . 29.9 29 77 15 W. 30.0 28 65 25 W.	... . 1.7 S. Cu. 38 21.2 4.0 S. Cu. 72 18.3 ... . 29.9 26 81 14 NW. 30.0 24 87 10 NW.	**L—3—20.** 8.3 A. S. 101 13.3 ... . 4.3 S. 101 12.7 ... . 29.8 27 88 18 W. .... 30.0 30 83 15 NW.	**L—3—20.** 8.0 Ci. 107 9.7 8.1 A. Cu. 108 12.4 2.1 A. Cu. 105 10.8 ... . 29.8 29 72 12 SW. 29.7 33 67 10 W. ....
L—3—19. **H—2—14.** 10.0 Cu. 42 3.4 ... . 3.1 Cu. 51 9.1 30.1 27 63 6 W. 30.1 30 62 18 NW. 30.3 27 42 9 N.	**H—2—13.** 8.1 Fr. Cu. 27 6.7 8.5 A. Cu. 34 3.3 2.3 Fr. Cu. 33 4.2 ... . 5.1 Fr. Cu. 35 4.8 30.1 23 60 18 NW. 30.3 24 54 7 N. 30.3 23 53 6 NW.	**H—2—5.** ... . 1.5 S. Cu. 83 2.6 ... . 4.2 S. Cu. 85 2.1 .... 30.3 25 44 4 N. 30.3 24 53 5 W.	**L—3—19.** **H—2— 6.** 8.3 S. Cu. 35 22.7 ... . 30.1 12 84 18 N.	**L—3—11.** **H—2—14.** 9.0 N. 64 8.3 ... . 2.1 A. Cu. 96 3.3 2.2 S. Cu. 67 7.2 4.4 S. Cu. 70 3.6 29.8 22 79 15 NW. 29.8 21 58 26 NW. 29.9 19 53 32 NW.
H—2—5. 9.7 S. 92 6.0 1.6 N. 130 7.7 ... . 3.7 N. 120 11.0 30.4 19 67 2 N. 30.3 26 72 10 S. 30.3 26 94 5 S.		**H—2—11.** **L—5—16.** ... . 1.5 S. Cu. 248 16.7 ... . 30.1 24 80 11 SE.	**H—2—4.** 8.3 Ci. Cu. 33 4.7 1.3 Ci. S. 33 2.0 1.6 Ci. 33 3.7 1.8 Ci. Cu. 33 3.9 4.3 Ci. 33 2.7 30.4 60 80 12 E. 30.2 16 83 6 E. 30.2 20 76 7 E.	**L—3—19.** **H—2— 2.** ... . 2.1 Ci. 85 4.3 ... . 4.2 Ci. 84 4.9 .... 30.3 21 28 12 W. 30.3 22 29 13 W.
L—6— 3. **H—2—39.** 9.2 S. Cu. 88 4.6 ... . 4.1 N. 310 4.9 30.2 25 74 5 NE. 30.2 30 94 4 NE. 30.2 31 95 4 E.	**L—6—10.** **H—2—23.** 8.3 A. S. 75 2.6 ... . 30.1 27 70 8 E.	**L—6—18.** **H—2—23.** ... . 1.5 S. Cu. 285 10.1 ... . 30.2 25 81 10 NE.	**L—6—10.** **H—2—23.** 8.3 S. Cu. 275 12.7 ... . 30.2 16 83 12 E.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 15 TO JANUARY 20, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Jan. 15 ° ° H . 3 . 62 . 49				... . 12.9 S. Cu. 351 2.3 4.9 S. 295 6.7 .... 30.1 56 82 6 NE. 30.1 56 88 4 NE.	
Jan. 16 ° ° H . 6 . 75 . 39 L . 5 . 101 . 40			**L—5—5.** 8.3 Ci. S. 140 6.8 8.9 Fr. S. 118 12.0 1.7 A. S. 144 6.8 ... . 4.7 A. S. 148 6.4 29.8 58 94 12 SW. 29.8 60 73 9 W. 29.7 59 72 12 SW.	**L—5—14.** ... . 1.1 S. Cu. 223 3.4 ... . 4.6 S. 205 24.4 .... 29.9 58 83 12 SE. 29.9 62 89 10 S.	**H—6—11.** **L—5—15.** 7.9 S. Cu. 101 6.3 ... . 30.2 38 79 6 SE. ....
Jan. 17 ° ° H . 3 . 59 . 46 L . 2 . 86 . 47					
Jan. 18 ° ° H . 3 . 55 . 48 L . 3 . 70 . 49 H . 5 . 99 . 33 H . 4 . 112 . 43			**H—5—1.** **H—4—23.** ... . 4.2 A. S. 121 3.1 .... 30.4 47 47 9 NE.	**H—5—7.** **H—4—39.** 9.4 Ci. 101 2.3 ... . 12.8 Ci. 102 2.0 ... . 30.5 43 37 4 N. 30.4 49 47 5 N.	
Jan. 19 ° ° H . 2 . 84 . 50 L . 5 . 98 . 22	**H—2—20.** **L—5—17.** ... . 2.6 Ci. 134 3.5 5.1 A. S. 144 4.1 .... 30.2 44 56 10 SW. 30.2 46 60 10 SW.			**L—5—8.** 9.6 S. Cu. 70 0.3 1.3 Ci. 172 1.7 4.8 S. Cu. 169 8.2 30.3 42 60 6 E. 30.2 52 51 8 E. 30.0 55 54 12 E.	
Jan. 20 ° ° H . 3 . 68 . 43 L . 2 . 87 . 50 L . 5 . 90 . 35				**L—5—1.** 9.3 S. 90 6.0 12.9 S. Cu. 91 5.3 ... . 30.0 42 96 23 W. 30.0 45 67 12 W.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 15 TO JANUARY 20, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
... . 3.2 N. 2 12.5 .... 30.2 32 95 7 N. 30.2 33 90 5 N.		8.5 A. Cu. 118 3.6 1.5 S. Cu. 121 18.3 ... . 30.2 22 79 2 NE. 30.2 27 88 10 SW.	**H—3—19.** 8.3 Ci. 34 2.0 ... . 4.1 S. 90 6.0 30.2 16 86 8 E. .... 30.2 30 76 6 SE.	**H—3—20.** 8.1 N. 11 5.0 2.1 S. Cu. 320 11.0 4.1 S. Cu. 293 10.9 30.3 22 77 18 N. 30.2 28 82 16 NE. 30.3 26 86 13 N.
H—6—4. ... . 2.2 S. 220 8.0 ... . 30.3 34 90 4 S. 30.3 33 90 6 SW.				**H—6—8.** 10.5 N. 93 3.3 ... . 2.2 Ci. 73 2.2 2.4 Fr. Cu. 94 7.0 4.1 S. Cu. 69 9.8 30.2 22 91 6 N. 30.2 36 64 10 W. 30.2 36 57 9 SW.
	L—2—6. 8.2 Fr. S. 190 34.7 2.3 Fr. S. 130 31.2 2.6 Fr. Cu. 125 14.6 ... . 29.6 43 85 30 SE. 29.5 49 52 24 SW.			**H—3—19.** **L—2—15.** ... . 2.0 Fr. S. 300 28.1 ... . 30.2 33 94 27 S. ....
L—3—20. **H—4—57.** 10.0 Cu. 58 12.8 ... . 3.9 S. Cu. 55 9.5 29.9 40 58 18 NW. 30.0 40 38 22 NW. 30.2 34 40 24 NW.	**L—3—20.** **H—4—57.** 8.2 Fr. N. 65 13.3 8.6 S. Cu. 90 11.3 2.3 S. Cu. 85 13.9 ... . 5.0 N. 85 13.2 30.1 29 66 28 W. 30.2 25 62 30 W. 30.2 23 60 25 W.	**L—3—20.** **H—4—41.** ... . 1.3 S. Cu. 78 13.9 ... . 4.2 S. Cu. 100 24.9 .... 30.2 20 69 18 W. 30.2 21 71 12 W.	**L—3—12.** **H—4—57.** 8.3 S. Cu. 35 23.3	**H—3—19.** **L—3—5.** ... . 1.1 A. Cu. 144 8.5 1.6 Fr. Cu. 70 21.5 ... . 29.5 37 48 31 W. ....
H—2—14. 8.2 S. Cu. 61 9.5 2.0 S. Cu. 270 4.9 ... . 30.4 28 52 12 N. 30.4 30 41 10 NW.	**H—2—5.** ... . 2.2 N. 200 3.3 5.2 S. Cu. 155 6.5 .... 30.4 17 83 4 NW. 30.4 17 76 5 NW.	**H—2—5.** 8.5 A. Cu. 101 10.7 1.5 S. Cu. 106 5.0 4.4 Cu. 128 7.6 29.5 10 78 6 NE. 29.4 18 68 5 W. 29.4 16 74 9 SW.	**H—2—6.** ... . 4.3 S. Cu. 95 15.3 .... 30.5 13 83 6 NW.	
H—3—11. **L—2—14.** **L—5—16.** 8.2 S. 175 4.6 1.2 S. 206 2.8 ... . 30.5 25 73 6 E. 30.5 35 73 6 SE.				**H—3—4.** **L—2—14.** 10.3 Ci. 73 7.4 ... . 4.0 A. S. 107 13.0 4.2 S. Cu. 298 19.2 30.6 2 56 4 SW. .... 30.5 21 55 17 S.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 21 TO JANUARY 25, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Jan. 21 ° ° H . 3 . 59 . 46 L . 2 . 78 . 44	**L—2—19.** ... . 4.1 Ci. 52 3.7 .... 30.0 37 78 18 SW.			9.7 Ci. 127 1.0 ... ... 1.9 Ci. 112 2.4 ... . 4.3 Ci. 96 7.2 30.2 39 75 8 N. 30.2 47 33 6 N. 30.2 53 58 2 N.	
Jan. 22 ° ° L . 3 . 64 . 48 L . 2 . 84 . 45	**L—2—20.** ... . 1.1 Ci. 63 4.6 ... . 30.4 32 74 16 N.		... . 1.7 Ci. S. 155 1.1 ... . 4.2 Ci. 160 1.2 ... . 30.3 57 53 5 NW. 30.3 57 65 9 N.	**L—2—20.** 9.3 Ci. 93 0.7 12.9 Ci. S. 88 1.2 ... . 4.9 Ci. 115 5.7 ... . 30.2 40 80 3 S. 30.2 54 44 9 W. 30.2 58 46 4 S.	**L—2—5.** ... . 1.2 Fr. Cu. 77 33.0 ... . 4.5 Fr. Cu. 78 28.4 ... . 29.9 46 49 24 SW. 30.0 47 46 20 W.
Jan. 23 ° ° L . 3 . 69 . 49 H . 1 . 108 . 54	**H—1—22.** ... . 3.9 Ci. 89 3.4 4.1 S. Cu. 107 9.7 .... 30.0 49 70 9 SW.		**H—1—58.** 8.2 Ci. S. 173 4.2 1.6 Ci. S. 150 3.1 ... . 4.7 Ci. 10 0.8 ... . 30.3 38 83 4 NW. 30.2 52 75 9 SW. 30.1 54 65 8 S.	**H—1—54.** 9.7 Ci. 110 1.3 12.8 Ci. 102 2.7 ... . 4.6 A. Cu. 105 5.0 ... . 30.4 46 68 12 E. 30.2 52 40 6 SE. 30.2 53 42 4 W.	
Jan. 24 ° ° L . 3 . 59 . 48 H . 1 . 111 . 51					
Jan. 25 ° ° L . 3 . 58 . 49 L . 6 . 78 . 33 H . 1 . 111 . 52	**H—1—23.** 10.3 A. Cu. 16 5.1 ... . 2.1 A. Cu. 75 5.4 2.2 Ci. 108 2.3 ... . 30.6 −2 64 13 NW. 30.5 4 54 11 NW.		**H—1—38.** ... . 1.4 Fr. S. 356 9.6 1.9 A. S. 144 4.8 4.3 Fr. S. 9 8.7 ... . 30.6 8 70 14 N. 30.5 14 81 14 N. 30.4 15 68 13 NE.	**L—6—19.** **H—1—54.** 9.6 S. 160 2.0 ... . 12.8 S. Cu. 10 2.9 ... . 4.1 S. Cu. 0 6.6 ... . 30.3 28 78 10 N. 30.2 26 73 7 N. 30.3 26 63 9 NE.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 21 TO JANUARY 25, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
L—2—5.	**L—2—4.**		**L—2—1.**	**H—3—19.** **L—2— 7.**
9.1 S. 146 27.6	... .		8.3 S. Cu. 96 23.3	... .
10.7 S. Cu. 75 8.6	... .		... .	... .
1.0 Cu. 71 10.2	2.4 Fr. S. 100 26.4		... .	... .
1.3 S. Cu. 86 6.6	... .		... .	... .
... .	... .		... .	4.0 S. Cu. 117 10.0
29.8 34 91 6 W.	....		29.6 34 95 36 W.	....
29.8 47 59 18 NW.	29.8 32 79 18 W.		....	....
29.9 42 62 10 NW.	....		....	29.5 40 80 32 W.
L—3—20. **L—2— 6.**	**L—2—1.**			**L—3—12.** **L—2—15.**
10.0 Ci. S. 90 6.7	... .			8.1 Ci. Cu. 94 4.8
1.0 Ci. Cu. 95 6.2	2.5 Fr. S. 100 25.1			2.1 Ci. S. 93 5.0
1.0 Ci. S. 95 7.0	2.9 N. 85 15.1			2.2 Cu. 91 7.1
4.0 S. Cu. 95 10.8	... .			4.1 Ci. S. 95 4.8
4.3 Fr. S. 100 12.4	... .			... .
29.9 34 72 4 S.	....			29.7 30 63 19 W.
29.8 46 56 26 S.	29.6 35 76 18 W.			29.7 35 47 28 W.
29.7 44 60 10 NW.	....			29.7 36 48 15 W.
			L—3—11. **H—1—40.**	**L—3—4.**
			8.2 A. S. 18 13.3	11.1 S. Cu. 73 0.9
			... .	2.0 A. Cu. 49 4.3
			... .	2.1 S. Cu. 47 20.1
			... .	4.1 Fr. Cu. 38 8.1
			... .	... .
			29.8 22 86 36 W.	29.5 25 55 27 W.
			....	29.5 29 55 41 NW.
			....	29.6 29 47 41 NW.
	H—1—40.			**L—3—20.**
	8.4 S. Cu. 65 13.3			... .
	2.6 S. Cu. 80 15.3			2.0 Fr. Cu. 90 10.0
	... .			... .
	30.1 9 77 18 W.			....
	30.1 5 87 28 W.			29.8 20 53 16 W.
	....			....
L—6—9.				**L—3—20.** **L—6—16.**
8.1 Ci. S. 97 6.4				... ...
10.2 Cu. 70 10.0				... .
1.3 Ci. 94 7.7				2.0 Fr. Cu. 79 15.8
... .				... .
4.2 Ci. 95 6.8				4.1 Fr. Cu. 81 20.9
4.3 Ci. Cu. 95 7.1				... .
30.2 9 64 5 N.				....
30.1 14 51 28 NW.				29.6 9 46 50 W.
30.1 11 48 20 NW.				29.6 11 43 46 W.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 26 TO JANUARY 31, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Jan. 26 ° ° L . 3 . 68 . 50 H . 1 . 110 . 50 L . 6 . 82 . 21	**H—1—23.** 9.9 Ci. 100 3.6 ... . 30.6 −2 72 9 N.		**H—1—38.** 8.3 Cu. N. 239 6.3 1.7 S. Cu. 93 9.7 2.2 Cu. N. 4 6.7 ... . 30.5 11 90 14 N. 30.4 14 81 12 N.	**H—1—55.** **L—6—18.** ... . 4.5 S. Cu. 0 10.0 ... . 30.2 21 85 9 N.	
Jan. 27 ° ° L . 6 . 80 . 32 H . 1 . 112 . 52	**H—1—23.** ... . 2.7 S. Cu. 72 9.6 ... . 30.4 13 62 12 NW.		**H—1—38.** ... . 1.4 Cu. 122 2.6 1.7 Fr. Cu. 47 3.3 4.5 Cu. 45 2.0 .... 30.6 23 60 3 N. 30.5 23 66 3 NE.	**L—6—10.** **H—1—55.** 9.4 Cu. 40 1.0 ... . 12.8 Ci. Cu. 41 2.4 ... . 4.6 Ci. Cu. 42 2.3 30.3 20 85 12 N. 30.3 22 73 10 N. 30.3 26 72 12 N.	
Jan. 28 ° ° L . 3 . 71 . 41 H . 4 . 105 . 41 H . 1 . 111 . 52	**H—4— 7.** **H—1—23.** 10.3 S. Cu. 74 9.7 ... . 1.7 S. Cu. 58 8.2 4.6 S. Cu. 46 7.5 .. .. 30.5 5 65 10 NW. 30.5 9 62 12 NW. 30.4 14 60 10 NW.		**H—4—14.** **H—1—38.** 8.5 A. Cu. 92 3.6 ... . 1.4 Ci. S. 92 1.8 ... . 30.6 19 84 3 NE. 30.6 27 47 9 N.	**H—4—23.** **H—1—54.** 9.3 Ci. 110 2.0 ... . 4.8 Ci. 118 4.9 ... . 30.4 22 58 8 N. .... 30.4 32 40 9 N.	
Jan. 29 ° ° L . 3 . 64 . 45 H . 2 . 86 . 50 H . 5 . 93 . 34			**H—5—11.** 8.5 A. Cu. 111 1.3 1.2 A. Cu. 160 3.5 1.7 A. S. 154 7.3 4.8 A. S. 159 11.5 30.6 24 87 3 SE. 30.4 35 69 10 SE. 30.3 38 50 10 S.	**H—5—2.** 9.4 A. S. 150 1.0 12.9 A. S. 151 1.3 ... . 4.3 S. 95 2.0 30.5 23 72 6 NE. 30.5 29 82 4 N. 30.4 31 48 4 NE.	
Jan. 30 ° ° H . 2 . 85 . 40 L . 4 . 105 . 45	**L—4—14.** **H—2—11.** 8.8 S. Cu. 183 7.8 12.7 A. Cu. 171 8.5 4.9 A. Cu. 165 7.7 30.4 22 68 8 SE. 30.4 29 56 6 SE. 30.4 33 69 8 SE.		**L—4—18.** 8.6 S. 189 13.1 ... . 30.2 30 94 13 SE.	**H—2—12.** ... . 12.8 Ci. 172 0.3 ... . 30.3 37 73 6 NE.	
Jan. 31 ° ° H . 3 . 74 . 43			... . 1.6 S. Cu. 48 6.5 4.2 S. Cu. 45 5.8 .... 30.4 32 79 7 NW. 30.3 37 74 7 N.		

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 26 TO JANUARY 31, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
L—3—20. **L—6—15.** **H—1—56.** ... . 2.4 Ci. 86 5.7 ... . 4.0 Ci. 90 4.9 ... . 30.1 21 47 25 NW. 30.1 20 48 3 W.	**L—3—20.** ... . 2.5 Ci. 85 3.0 ... . 30.2 55 84 15 SW.			**L—3—5.** 8.0 A. Cu. 71 10.3 2.0 Ci. S. 69 4.5 2.1 Fr. Cu. 57 16.1 4.0 Ci. Cu. 61 4.5 4.1 Fr. Cu. 64 10.0 29.5 13 61 30 W. 29.5 28 45 54 W. 29.5 27 47 50 W.
L—6—9. **H—1—56.** 9.7 N. 135 5.2 9.7 Fr. N. 135 6.5 12.7 N. 147 6.7 ... . 30.0 18 42 6 N. 29.9 21 64 3 N.				**L—6—17.** 8.1 Ci. S. 105 8.0 ... . 2.1 A. S. 105 5.1 ... . 4.1 A. S. 120 5.7 29.9 16 70 14 W. 29.9 27 62 9 E. 29.9 27 64 6 E.
L—3—11. **H—4—41.** 8.3 S. Cu. 95 4.4 8.3 Ci. 95 1.1 12.5 Ci. Cu. 37 2.0 4.0 Ci. S. 44 3.8 ... . 29.8 11 68 16 NW. 29.9 13 58 36 NW. 30.0 12 60 24 NW.				
L—3—20. **H—2—14.** .. .. 1.0 Cu. 41 9.8 ... . 30.3 25 50 24 NW.				**L—3—12.** **H—2—14.** 10.5 Ci. 138 4.1 2.1 Ci. 82 2.3 ... . 4.7 Ci. 114 2.5 29.7 17 74 30 NW. 29.8 26 38 39 NW. 30.1 23 35 25 W.
H—2—7. 8.6 A. Cu. 22 13.9 ... . 3.0 Ci. 92 ... 30.6 15 68 8 NW. .... 30.6 23 60 1 N.	**H—2—2.** 8.2 S. Cu. 75 4.9 1.7 S. Cu. 35 4.0 4.2 S. Cu. 20 4.0 30.6 14 82 4 S. 30.6 22 72 3 SW. 30.6 20 85 4 N.		**H—2—8.** ... . 4.1 A. Cu. 93 10.0 .... 30.6 28 75 6 W.	
	H—3—11. 10.2 Ci. 90 2.0 2.2 Ci. 85 2.3 4.7 Ci. 60 2.3 30.7 8 76 6 SE. 30.6 26 58 15 SE. 30.6 24 74 6 E.			

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 1 TO FEBRUARY 5, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Feb. 1 ° ° H . 3 . 74 . 42 L . 6 . 87 . 33				**L—6—4.** 8.7 S. 41 3.6 ... . 30.1 36 84 12 W.	
Feb. 2 ° ° L . 6 . 75 . 36 H . 2 . 94 . 43 H . 5 . 97 . 30	**H—2— 1.** **H—5—17.** 11.5 S. Cu. 196 11.7 3.2 A. Cu. 65 3.2 ... . 30.2 38 75 8 S. 30.1 42 63 6 SE.		**H—2—20.** **H—5— 3.** ... . 4.7 Ci. S. 94 5.1 .... 29.9 69 43 12 SW.	**L—6—19.** **H—2—13.** **H—5— 8.** 9.1 Ci. 93 2.0 12.4 A. Cu. 110 0.7 ... . 30.3 36 74 3 W. 30.2 46 74 2 W.	
Feb. 3 ° ° L . 3 . 69 . 40 H . 2 . 84 . 50 L . 5 . 100 . 35			**L—5—1.** 9.0 A. Cu. 135 5.6 1.6 Ci. S. 122 5.4 4.6 Ci. S. 126 5.1 ... . 29.8 50 93 18 SW. 29.7 64 53 18 SW. 29.6 70 26 24 SW.	**L—5—7.** 8.4 Ci. 132 1.3 12.6 Ci. 136 0.7 4.5 Ci. 64 3.0 ... . 30.1 45 38 12 SE. 30.0 55 42 3 SE. 29.9 58 46 5 E.	
Feb. 4 ° ° H . 2 . 80 . 50 L . 5 . 95 . 34			**L—5—4.** 8.0 Ci. 145 2.7 8.5 S. 46 8.8 ... . 29.9 36 82 9 NW.	**L—5—2.** 8.6 A. Cu. 92 2.9 ... . 1.1 S. 120 1.3 4.6 S. 85 2.0 29.9 52 81 12 SE. 29.8 62 78 12 SE. 29.8 62 59 9 SE.	
Feb. 5 ° ° H . 3 . 73 . 44 L . 5 . 89 . 32			**L—5—19.** ... . 4.5 Ci. 58 5.2 .... 29.8 57 45 3 NE.	**L—5—4.** ... . 1.1 S. 10 2.0 4.7 S. Cu. 45 10.0 .... 29.7 45 92 6 W. 29.7 43 77 10 W.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 1 TO FEBRUARY 5, 1897.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—3—1.				**H—3—11.**				**H—3—11.**								**H—3—2.**			
L—6—13.				**L—6—16.**				**L—6—17.**											
8.1	S. Cu.	211	10.0	...	.....	...	...	8.5	A. S.	132	6.7					8.0	Ci.	84	2.1
12.3	A. Cu.	151	8.3	1.6	Ci. S.	105	2.0	...	.....	...	...					...	.....	...	...
1.2	A. S.	122	3.3	...	.....	...	...	...	.....	...	...					...	.....	...	...
1.7	Ci. Cu.	137	2.2	...	.....	...	...	...	.....	...	...					2.1	Ci.	85	5.9
2.1	Ci.	122	2.5	...	.....	...	...	...	.....	...	...					...	.....	...	...
2.2	Fr. S.	260	9.3	...	.....	...	...	...	.....	...	...					...	.....	...	...
4.6	Ci	130	2.7	...	.....	...	...	...	.....	...	...					4.2	Ci.	83	5.0
30.6	24	76	1 NE.	....	..	..	....	30.4	12	100	6 NE.					29.5	17	61	18 W.
30.3	36	62	12 NE.	30.2	35	73	6 S.	....	..	..	...					29.4	34	37	18 SW.
30.2	35	82	12 NE.	....	..	..	....	....	..	..	....					29.4	33	36	12 SW.
L—6—4.												**L—6—9.**				**L—6—8.**			
H—2—15.												**H—2—15.**							
10.5	N.	315	53.6									...	.....	...	...	8.0	A. Cu.	126	2.6
2.2	N.	325	46.0									1.1	S.	312	10.0	2.1	A. S.	111	1.6
4.6	N.	336	44.7									4.1	S.	315	10.0	4.3	A. S.	106	1.0
29.7	36	100	24 NE.									....	..	..	....	30.1	24	66	8 N.
29.6	37	100	18 NE.									30.0	30	57	14 NE.	30.0	27	75	12 NE.
29.6	35	100	18 N.									29.9	30	58	12 NE.	29.9	29	94	22 NE.
L—3—11.				**L—3—19.**								**L—3—10.**				**L—3—3.**			
H—2—14.				**H—2—5.**								**H—2—6.**				**H—2—14.**			
8.5	Ci. S.	313	0.5	...	.....	...	...					8.3	S.	311	5.3	...	.....	...	...
1.3	Ci.	151	0.7	2.3	Fr. S.	345	5.0					1.3	S.	311	7.7	...	.....	...	...
...	.....	...	...	...	.....	...	...					4.1	S.	311	7.7	5.0	A. S.	293	7.8
...	.....	...	...	...	.....	...	...					...	.....	...	...	5.1	Fr. S.	325	22.7
29.8	34	62	12 N.	....	..	..	....					30.1	29	56	14 NE.	....	..	..	....
29.9	38	50	18 NW.	30.1	30	78	10 N.					30.1	30	56	16 NE.	....	..	..	....
....	..	..	....	....	..	..	....					30.1	32	68	16 NE.	29.9	24	70	41 NE.
				H—2—5.								**H—2—5.**				**H—2—14.**			
				L—5—16.															
				8.3	Fr. S.	270	1.6					8.3	Ci.	43	3.3	8.0	S.	320	...
				...	.....	...	...					...	.....	...	...	...	.....	...	...
				2.2	Fr. S.	270	2.7					...	.....	...	...	2.1	Ci. S.	202	1.0
				...	.....	...	...					...	.....	...	...	...	.....	...	...
				30.2	27	82	Lt. S.					30.2	23	66	4 E.	30.2	15	67	26 N.
				30.2	32	69	7 E.					....	..	..	....	30.3	22	59	20 N.
				....	..	..	....					....	..	..	....	....	..	..	....
H—3—12.				**H—3—11.**								**H—3—11.**				**H—3—1.**			
L—5—16.				**L—5—16.**								**L—5—16.**							
10.3	A. S.	101	5.7	8.6	A. Cu.	140	3.4					8.3	A. S.	110	4.7	...	.....	...	...
11.7	S. Cu.	225	6.0	...	.....	...	...					...	.....	...	...	...	.....	...	...
2.0	S. Cu	212	8.2	...	.....	...	...					...	.....	...	...	2.0	Ci.	74	6.2
3.9	S.	...	8.2	...	.....	...	...					...	.....	...	...	5.0	Ci. S.	77	6.9
30.4	24	93	2 NE.	30.1	32	69	13 SE.					30.2	29	66	10 SE.	....	..	..	....
30.4	35	73	9 SE.	....	..	..	....					....	..	..	....	30.5	32	46	5 NE.
30.3	33	90	12 E.	....	..	..	....					....	..	..	....	30.5	31	43	6 E.

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 6 TO FEBRUARY 11, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Feb. 6 ° ° H . 3 . 63 . 47 L . 6 . 80 . 37 L . 4 . 103 . 40			**L—4—6.** 8.8 Ci. S. 116 5.2 ... . 29.8 43 78 7 S.	**L—6—19.** **L—4—14.** 8.6 A. Cu. 92 2.6 12.6 Ci. 94 2.3 4.6 Ci. Cu. 57 5.7 ... . 30.0 42 77 6 W. 30.0 55 62 5 S. 29.9 48 36 6 S.	
Feb. 7 ° ° L . 5 . 95 . 33			**L—5—4.** ... . 1.3 S. Cu. 28 13.3 ... . 30.1 43 36 24 NW.		
Feb. 8 L . 3 . 68 . 48 H . 5 . 99 . 36	**H—5—8.** ... . 1.1 S. Cu. 349 4.7 ... . 30.3 33 68 6 N.		**H—5—1.** 8.7 Ci. 118 3.8 8.7 Fr. S. 316 9.6 1.5 Ci. S. 118 4.0 5.5 Ci. S. 152 3.8 30.3 30 82 1 N. 30.3 47 66 6 E. 30.2 49 54 10 SE.	**H—5—6.** 8.7 S. Cu. 8 4.2 ... . 1.6 S. 10 3.0 4.3 S. 355 10.0 30.2 43 84 9 N. 30.1 48 84 10 N. 30.2 44 70 6 N.	
Feb. 9 ° ° L . 3 . 60 . 47 H . 6 . 85 . 38 H . 2 . 99 . 52	**H—6—11.** **H—2—21.** 8.9 A. Cu. 128 5.3 9.0 S. Cu. 179 3.6 1.8 Ci. 120 5.1 1.9 A. Cu. 112 6.9 ... . 30.2 27 73 10 SE. 30.1 37 64 11 SE.		**H—6—20.** **H—2—52.** 8.6 A. S. 156 4.2 ... . 1.6 Ci. S. 137 4.5 2.0 Fr. Cu. 171 7.5 5.2 S. 162 8.6 5.7 Ci. 145 5.3 30.1 41 77 7 SE. 30.0 55 65 19 S. 29.9 54 70 12 SE.	**H—6—12.** **H—2—37.** 8.8 S. Cu. 349 2.6 ... . 4.6 Ci. 108 6.2 ... . 30.2 41 84 12 E. .... 30.1 49 60 6 SE.	
Feb. 10 ° ° H . 2 . 85 . 50 L . 5 . 99 . 28			**L—5—9.** ... . 5.3 S. 113 3.0 ... . 29.9 56 82 3 S.	**L—5—8.** 8.8 S. Cu. 272 2.9 1.6 S. 210 2.3 4.6 A. S. 180 1.3 ... . 30.1 48 86 12 SE. 30.1 54 83 3 SE. 30.0 61 76 6 E.	**H—2—13.** ... . 1.2 Cu. 110 5.9 4.0 Ci. 87 5.0 4.1 A. Cu. 89 5.1 .... 30.2 47 53 7 SE. 30.1 45 51 5 N.
Feb. 11 ° ° L . 3 . 55 . 48 H . 2 . 79 . 48 L . 5 . 92 . 32			**L—5—11.** ... . 1.4 S. Cu. 78 8.2 ... . 30.0 44 72 5 NW.		

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 6 TO FEBRUARY 11, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
H—3—20. **L—6— 3.** 10.0 N. 250 61.7 12.7 N. 129 61.2 4.8 S. 178 8.2 4.9 Ci. 210 6.9 5.0 Cu. 198 ... 5.2 S. Cu. 160 14.0 29.8 41 100 22 E. 29.5 21 93 30 SE. 29.6 47 96 6 SE.				**H—3—12.** **L—6—16.** 8.3 S. Cu. 191 11.2 ... . 30.4 30 86 16 E. ....
L—3—20. 8.0 S. 128 8.3 ... . 2.8 A. S. 82 10.8 4.3 S. 192 8.9 30.0 36 86 1 NW. 29.9 34 98 3 SW. 30.0 36 91 2 N.		**L—3—19.** ... . 1.5 N. 70 23.0 ... . 30.0 31 89 12 NW.		**L—3—12.** 9.8 Ci. S. 106 3.8 ... . 29.9 32 85 16 W. ....
H—6— 7. **H—2—39.** 8.1 S. 22 12.8 ... . 2.0 S. Cu. 36 8.4 ... . 4.1 Cu. 62 6.9 ... . 30.2 35 82 12 NW. 30.3 37 66 16 NW. 30.3 33 70 4 N.		**H—6— 3.** **H—2—23.** ... . 1.6 Cu. N. 102 22.4 ... . 30.2 30 89 12 SW.	**H—6— 8.** **H—2—23.** ... . 4.1 S. 90 8.3 ... . 30.3 31 90 12 W.	**L—3—20.** **H—6—16.** **H—2—40.** 8.0 S. Cu. 49 14.4 ... . 2.1 Fr. Cu. 43 12.5 ... . 29.9 30 85 13 NW. 30.0 34 51 34 NW. ....
H—2—14. 8.0 S. 132 7.7 1.1 S. 88 4.3 4.0 S. Cu. ... 2.7 ... . 30.3 27 88 0 30.3 37 70 2 N. 30.3 34 80 2 N.			**H—2—6.** ... . 1.1 Ci. Cu. 318 8.3 ... . 30.3 23 69 13 NE.	**H—2—14.** 8.1 S. Cu. 60 9.8 ... . 30.2 26 75 14 NW. ....
H—2—18. 8.1 A. S. 3 3.9 ... . 30.2 32 76 8 NE.	**H—2— 5.** **L—5—16.** 8.1 Ci. 102 3.0 ... . 30.2 28 82 5 E.	**H—2—12.** **L—5—16.** 1.0 Ci. S. 101 8.0 ... . 30.1 26 81 12 NE.		**L—3—19.** **H—2— 6.** 8.0 Ci. Cu. 74 5.6 ... . 30.3 11 52 14 NW. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 12 TO FEBRUARY 16, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Feb. 12 ° ° H. 3. 70. 47 L. 2. 81. 41 L. 4. 105. 45	**L—2—19.** **L—4—14.** 9.1 Ci. 80 4.2 9.2 A. Cu. 80 4.0 ... ... 5.0 Ci. 90 3.9 ... ... 29.8 32 68 10 S. .... 29.7 44 52 9 SE.			**L—2—20.** 8.7 S. Cu. 81 5.3 ... ... 29.7 50 67 6 N.	**L—2—12.** 7.8 Fr. S. 79 26.4 7.9 S. Cu. 75 6.3 ... ... 29.8 40 76 11 SW. ....
Feb. 13 ° ° L. 3. 56. 48 H. 2. 82. 48 L. 2. 95. 43	**H—2—20.** **L—2—1.** ... ... 1.0 S. Cu. 74 17.7 ... ... 29.9 37 74 13 NW.				
Feb. 14 ° ° L. 3. 58. 48 H. 6. 78. 37 L. 2. 88. 50			8.6 Ci. 143 5.1 8.9 Fr. Cu. 165 20.2 1.7 Ci. 144 5.2 5.6 Ci. 150 5.7 29.9 54 88 8 SE. 29.9 65 26 24 W. 29.9 64 32 20 NW.		
Feb. 15 ° ° L. 3. 60. 48 L. 6. 86. 38	**L—6—11.** ... ... 1.8 S. Cu. 138 22.1 ... ... 30.0 33 74 11 SW.		**L—6—20.** 8.7 Ci. S. 132 5.8 ... ... 30.2 33 76 2 N.	**L—6—20.** 8.7 A. Cu. 131 2.1 ... ... 12.8 A. Cu. 134 2.0 ... ... 29.9 60 86 3 W. 29.9 66 48 2 NW.	**L—6—1.** 7.7 A. Cu. 120 23.3 7.9 Ci. S. 104 16.6 1.3 Cu. 99 9.5 4.4 S. Cu. 82 .. 29.7 44 63 1 E. 29.8 52 56 19 SW. 29.8 44 60 14 W.
Feb. 16 ° ° L. 3. 70. 41 H. 5. 96. 28 L. 1. 105. 50	**L—1—14.** **H—5—17.** 8.9 Ci. 82 5.0 ... ... 1.5 Ci. 87 5.1 5.5 Ci. 87 4.9 29.8 35 75 12 SW. 29.7 46 68 16 SW. 29.7 51 66 8 SW.		**H—5—10.** 8.5 Ci. 89 2.9 ... ... 1.5 Ci. 87 3.0 ... ... 30.0 50 55 9 S. 29.8 74 18 28 SW.		**L—3—19.** .. .. 1.1 A. Cu. 73 6.6 4.6 Ci. S. 60 5.0 .... 29.9 53 49 12 S. 29.9 54 47 12 W.

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 12 TO FEBRUARY 16, 1897.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—3—20.				**H—3—20.**				**H—3—20.**											
L—2— 2.				**L—2— 0.**				**L—2— 4.**											
9.3	Fr. N.	304	31.0	...	.....	...	...	...	.....	...	...								
...	.....	...	...	...	...	...	...	...	.....	...	...								
2.0	Fr. S.	49	29.0	...	.....	...	...	1.4	A. Cu.	30	S. 3								
2.0	S.	49	13.3	...	.....	...	...	...	.....	...	...								
3.0	S. Cu.	49	10.6	..	.....	...	...	...	.....	...	...								
4.1	S. Cu.	72	13.5	5.6	Fr. S.	65	26.4	4.2	S. Cu.	40	4.8								
4.2	S.	72	12.6	...	.....	...	...	...	.....	...	...								
29.8	31	100	8 NE.	....	..	..	....	....	..	..	....								
29.7	33	95	4 NW.	....	..	..	....	29.7	27	76	7 NW.								
29.8	34	95	4 W.	29.8	28	82	17 W.	29.8	27	76	11 NW.								
H—2—15.								**H—2—5.**								**L—3—20.**			
								L—2—7.								**H—2—14.**			
...	.....	...	...					...	.....	...	...					8.0	A. Cu.	60	4.6
1.3	Cu.	52	3.5					...	.....	...	...					...	.....	...	...
...	.....	...	...					3.9	S. Cu.	238	26.3					...	.....	...	...
...	.....	...	...					4.0	Ci. S.	99	4.0					...	.....	...	...
30.2	32	82	5 N.					....	..	..	....					30.0	13	90	17 NW.
30.2	41	69	5 N.					....	..	..	....					....	..	..	....
30.3	35	73	8 E.					30.1	25	76	12 SE.					....	..	..	....
				H—6—10.												**L—3—20.**			
				L—2—14.												**H—6— 8.**			
				8.2	Ci.	95	5.8									...	.....	...	...
				...	.....	...	...									...	.....	...	...
				...	.....	...	...									2.0	Ci. S.	85	5.9
				5.4	Ci.	100	5.0									5.2	Ci. S.	86	6.7
				30.0	35	82	11 W.									....	..	..	....
				....	..	..	....									29.9	35	50	22 SW.
				30.1	37	57	7 W.									29.9	35	59	28 SW.
L—6—7.				**L—6—8.**								**L—6—8.**				**L—3—20.**			
																L—6—16.			
8.3	A. S.	98	7.9	8.5	S. Cu.	138	5.2					8.3	S.	110	5.3	8.1	A. S.	98	11.2
10.1	A. Cu.	122	6.1	...	.....	...	...					...	.....	...	...	...	.....	...	...
12.5	Ci. S.	96	8.3	1.5	S. Cu.	120	8.8					...	.....	...	...	2.1	A. S.	114	8.1
4.5	S. Cu.	106	7.8	5.2	S. Cu.	315	16.3					...	.....	...	...	4.4	A. S.	123	5.0
30.0	38	81	3 E.	29.9	32	64	8 E.					29.9	29	77	4 SW.	30.0	29	56	13 W.
29.8	50	64	5 SE.	29.7	32	64	11 N.					....	..	..	....	29.9	35	56	6 SW.
29.9	55	46	7 SW.	29.7	31	84	8 N.					....	..	..	....	29.9	35	50	3 S.
L—3—11.				**L—3—11.**				**L—3—19.**				**L—3—11.**				**L—3—3.**			
8.5	S. Cu.	116	7.7	8.5	Fr. N.	125	9.8	...	.....	...	...	...	.....	...	...	...	.....	...	...
10.4	A. Cu.	120	7.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.9	Cu.	44	5.9	1.8	S. Cu.	105	6.7	1.1	Cu.	127	31.1	...	.....	...	...	2.5	S. Cu.	43	35.1
...	.....	...	...	5.2	Ci.	70	5.0	4.3	Cu. S.	140	29.4	4.0	S.	96	9.3	5.0	S. Cu.	16	7.6
29.8	42	64	14 NW.	29.9	32	84	6 SW.	....	..	.	....	....	..	..	....	....	..	..	....
30.0	57	40	14 NE.	29.9	38	75	12 W.	30.0	35	82	12 SW.	....	..	..	....	29.6	33	90	21 NW.
30.0	40	64	4 N.	29.8	40	63	13 S.	29.8	35	81	12 SW.	29.9	32	69	15 W.	29.7	33	79	22 NW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 17 TO FEBRUARY 21, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Feb. 17 ° ° L . 3 . 55 . 48 H . 6 . 78 . 32 L . 2 . 88 . 47	**L—2—20.** 11.7 Ci. 96 7.1 11.8 Ci. S. 93 8.7 1.4 Ci. 94 6.7 ... . 5.2 A. Cu. 101 5.8 30.0 44 70 12 NW. 30.0 45 65 10 N. 30.0 41 69 9 NE.				**H—6—18.** **L—2— 5.** 7.8 Ci. S. 96 1.7 ... . 29.9 51 45 10 S. ....
Feb. 18 ° ° H . 6 . 78 . 26 L . 3 . 69 . 46 H . 4 . 99 . 42	**H—4—6.** 10.8 [illegible] 92 6.8 10.9 A. S. 92 5.8 1.7 A. Cu. 87 4.3 5.2 Ci. S. 84 5.3 ... . 30.2 32 73 8 NE. 30.2 33 71 10 NE. 30.2 39 68 6 E.		**H—4—13.** .. .. 1.3 Ci. 105 5.4 5.2 Ci. S. 116 5.1 5.9 Ci. 104 3.5 6.1 A. S. 124 4.9 .... 30.1 58 56 4 NE. 30.0 62 47 9 E.	**H—6—18.** **H—4—14.** 8.7 S. Cu. 133 2.9 ... . 2.4 Cu. 148 4.3 ... . 30.0 66 84 9 S. 30.0 76 83 10 S.	**H—6—18.** **H—4—15.** 7.7 S. Cu. 94 5.3 ... . 30.1 38 63 12 N. ....
Feb. 19 ° ° L . 3 . 60 . 44 H . 2 . 85 . 40 L . 4 . 105 . 40			**L—4—13.** ... . 1.8 Ci. S. 137 6.4 2.2 A. Cu. 138 6.0 5.8 Ci. S. 133 6.2 ... . 30.0 65 80 8 SE. 29.9 70 72 12 S.	**H—2—20.** 8.7 S. Cu. 273 3.0 ... . 12.5 A. Cu. 90 2.1 ... . 5.6 Cu. N. 165 6.7 ... . 30.1 62 86 8 E. 30.0 71 64 3 NW. 30.0 75 66 6 E.	
Feb. 20 ° ° H . 6 . 73 . 38 L . 3 . 58 . 47 L . 2 . 99 . 47	**L—2—5.** 8.7 S. Cu. 94 17.4 ... . 12.0 S. Cu. 52 15.8 ... . 29.7 51 83 6 W. 29.8 48 78 12 W.		... . 1.3 Ci. S. 132 5.8 5.8 S. Cu. 137 5.1 5.8 Ci. S. 125 5.9 .... 29.8 79 37 8 SW. 29.7 83 23 7 SW.	8.5 S. Cu. 173 5.6 8.6 A. Cu. 150 4.7 ... . 4.4 A. S. 100 5.0 ... . 30.0 70 92 5 SW. 29.9 73 76 4 S. 29.9 77 52 15 S.	
Feb. 21 ° ° H . 3 . 59 . 47 L . 2 . 75 . 47					

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 17 TO FEBRUARY 21, 1897.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6—9.				**H—6—17.**				**H—6—17.**				**H—6—17.**				**L—3—20.**			
L—2—14.				**L—2—6.**				**L—2—6.**				**L—2—6.**				**H—6—16.**			
																L—2—15.			
8.3	S.	160	30.2	...	.....	...	...	8.4	A.S.	105	19.3	8.2	A.S.	110	19.0	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	8.5	Ci.	110	12.7	...	.....	...	...
3.4	Ci.Cu.	91	5.3	2.2	Ci.S.	94	5.0	1.7	Ci.S.	134	7.6	1.4	A.S.	110	16.7	2.1	Ci.Cu.	83	5.8
3.7	A.Cu.	81	5.7	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.1	A.Cu.	95	15.4
...	.....	...	...	5.2	S.Cu.	94	3.9	4.2	S.Cu.	100	6.7	4.1	A.S.	110	12.7	...	.....	...	...
30.1	34	96	8 SW.	....	..	..	....	29.8	39	75	12 SW.	29.7	40	84	31 S.W.	....	..	..	....
29.9	52	40	11 SW.	29.7	51	50	11 S.	29.7	42	62	17 SW.	29.8	39	75	24 S.W.	29.9	39	67	31 SW.
....	..	..	....	29.7	51	53	9 W.	29.7	42	55	13 SW.	29.8	38	75	24 S.W.	....	..	..	....
H—6—17.				**L—3—19.**				**L—3—19.**				**L—3—11.**				**L—3—1.**			
L—3—20.				**H—4—15.**				**H—4—15.**				**H—4—25.**				**H—4—41.**			
8.0	Ci.Cu.	87	5.3	8.2	Ci.	100	5.0	...	.....	...	...	8.3	S.Cu.	110	14.0.	8.1	Fr.Cu.	72	8.3
8.2	Ci.	87	5.0	...	.....	...	...	...	....	...	...	...	.....	...	...	8.8	Ci.	75	9.0
1.3	A.S.	87	6.9	2.2	Ci.S.	98	5.0	1.2	S.Cu.	90	13.6	1.1	S.Cu.	100	14.0	2.1	Ci.S.	91	...
4.1	N.	106	7.9	...	.....	...	...	4.2	Ci.S.	105	8.0	4.1	S.Cu.	100	14.0	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
29.9	44	74	2 SW.	30.1	30	57	7 W.	....	..	..	....	30.0	29	77	18 W.	29.8	39	75	30 W.
30.1	51	54	6 N.	30.1	34	81	14 W.	30.1	32	69	12 W.	30.0	28	73	25 W.	29.8	41	46	28 W.
30.1	40	88	5 NW.	....	..	..	....	30.2	35	54	12 W.	30.0	28	73	25 W.	....	..	..	....
L—3—19.				**H—2—2.**				**H—2—2.**				**L—3—19.**				**L—3—11.**			
H—2—7.												**H—2—8.**				**H—2—15.**			
8.2	Ci.Cu.	61	7.5	8.6	Ci.S.	72	9.0	...	.....	...	...	8.3	S.Cu.	35	9.3	...	.....	...	...
8.3	Ci.S.	71	8.0	...	.....	...	...	...	.....	...	...	...	.....	...	..	...	.....	...	...
8.4	Ci.	71	8.0	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
9.1	Ci.	71	7.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
9.2	Ci.S.	71	7.7	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
12.4	Ci.Cu.	80	8.3	1.6	S.Cu.	67	8.3	1.5	Ci.	80	8.7	1.1	S.Cu.	95	8.3	2.1	Fr.Cu.	35	7.1
...	.....	...	...	...	.....	....	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
4.2	Ci.Cu.	70	8.0	4.8	Ci.Cu.	60	5.7	4.4	Ci.	85	6.7	4.1	S.Cu.	35	8.3	...	.....	...	...
4.3	Ci.	70	7.0	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.3	33	77	4 N.	30.4	26	81	9 W.	....	..	..	....	30.3	26	56	12 NW.	....	..	..	....
30.3	41	54	13 NW.	30.4	35	73	10 NW.	30.4	34	62	12 SW.	30.4	30	73	18 NW.	30.0	30	42	40 NW.
30.4	38	50	10 N.	30.4	32	58	2 N.	30.4	35	65	5 W.	30.4	31	76	18 NW.	....	..	..	....
H—6—4.				**H—6—10.**								**H—6—18.**				**H—6—9.**			
				L—2—14.								**L—2—15.**				**L—3—19.**			
9.3	A.Cu.	69	7.5	...	.....	...	...					8.3	Ci.	98	6.0	...	.....	...	...
9.4	Ci.Cu.	69	5.0	...	.....	...	...					...	.....	...	...	...	.....	...	...
9.6	A.S.	74	7.8	...	.....	...	...					...	.....	...	...	...	.....	...	...
...	.....	...	...	2.3	Fr.S.	200	61.1					...	.....	...	...	2.5	Ci.S.	57	4.8
...	.....	...	...	...	.....	...	...					...	.....	...	...	5.0	Ci.	66	7.7
...	.....	...	...	...	.....	...	...					...	.....	...	...	5.1	Ci.Cu.	73	6.3
30.5	30	84	1 N.	....	..	..	....					30.3	24	74	12 SE.	....	..	..	....
....	..	..	....	29.7	36	91	28 SE.					...	..	..	....	30.3	30	43	13 W.
....	..	..	....	....	..	..	....					....	..	..	....	30.3	31	46	13 SW.
																H—3—20.			
																L—2—6.			
																...	.....	...	...
																2.1	Ci.S.	88	12.7
																2.2	Ci.	76	10.0
																4.8	Ci.S.	88	7.4
																....	..	..	....
																29.7	47	51	21 W.
																29.8	44	48	22 NW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 22 TO FEBRUARY 26, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Feb. 22 ° ° H . 2 . 80 . 49 L . 2 . 89 . 43 L . 5 . 92 . 34	**L—2—12.** **L—5—10.** ... ... 12.6 S. Cu. 3 3.7 ... . 30.0 29 83 11 NW.		**L—2—20.** **L—5—11.** 9.9 Ci. 135 8.5 ... . 30.1 59 19 19 NW.		
Feb. 23 ° ° L . 3 . 68 . 41 H . 4 . 114 . 42	**H—4—4.** 9.3 A. Cu. 102 7.4 ... . 30.4 19 73 10 W.			**H—4—40.** 8.7 A. Cu. 88 3.4 12.5 A. Cu. 130 4.2 ... . 4.5 A. Cu. 98 7.5 ... . 30.2 46 73 8 N. 30.2 50 73 4 N. 30.2 47 66 8 N.	
Feb. 24 ° ° L . 3 . 67 . 50 H . 2 . 85 . 38 H . 4 . 87 . 42 L . 2 . 93 . 46 H . 1 . 105 . 53	**H—2—11.** **H—4—24.** **L—2— 5.** 11.2 A. Cu. 103 7.1 1.1 Ci. 105 4.1 5.2 A. Cu. 106 7.3 30.3 38 68 13 SW. 30.2 43 58 13 W. 30.1 45 58 10 NW.	**H—2—18.** **H—4—25.** **L—2— 1.** **H—1—14.** 8.1 N. 155 10.5 12.1 A. S. 108 13.5 ... . 29.9 19 90 5 SE. 30.0 17 67 13 W.	**H—2—20.** **H—4—23.** 8.6 Ci. S. 124 4.9 1.5 Ci. S. 115 6.1 ... . 30.3 40 60 8 SE. 30.1 53 33 9 S.	**H—2—12.** **H—4—40.** 8.7 A. S. 121 1.0 1.5 A. S. 122 1.3 4.7 S. 90 4.7 30.3 46 79 10 N. 30.2 49 73 6 NE. 30.1 49 80 8 NE.	
Feb. 25 ° ° H . 3 . 60 . 43 L . 6 . 80 . 31 H . 1 . 106 . 53	**H—1—22.** 8.6 S. Cu. 304 8.9 1.9 S. N. 18 5.9 ... . 5.7 S. N. 44 7.7 ... . 30.3 27 79 7 NE. 30.3 26 91 7 NE. 30.3 26 89 8 N.	**H—1—14.** .... 12.1 A. S. 82 4.3 .... 5.1 S. 77 7.0 .... 30.5 3 70 6 NW. 30.4 7 74 11 NW.			
Feb. 26 ° ° L . 3 . 60 . 45 H . 2 . 98 . 45				**H—2—13.** ... . 4.6 A. S. 66 6.7 ... . 30.5 51 39 12 N.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 22 TO FEBRUARY 26, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
	H—2— 5. **L—2— 7.** **L—5—16.** ... . 1.5 Fr. S. 135 19.7 ... . 29.6 52 75 17 SW.			**H—2— 6.** **L—2—15.** 11.3 A. S. 117 ... 2.1 S. Cu. 11 17.8 ... . 30.1 29 55 17 NE. 30.1 32 67 20 E. ....
L—3—11. 8.1 A. Cu. 109 7.0 12.3 Cu. 92 9.4 2.3 Ci. Cu. 111 10.0 2.5 A. S. 113 8.9 4.2 Ci. 114 10.2 5.0 Ci. Cu. 117 11.2 29.8 39 94 10 NW. 29.9 47 59 24 NW. 30.0 41 61 15 NW.	**L—3—19.** **H—4—56.** ... . 2.0 Fr. Cu. 102 13.3 ... . 5.2 Fr. Cu. 120 13.3 ... . 29.9 33 51 20 W. 29.9 32 84 19 W.			**L—3—4.** 10.8 A. Cu. 113 9.5 2.4 S. Cu. 68 19.8 ... . 29.5 31 100 14 N. 29.6 32 85 8 NW. ....
L—3—20. **H—2— 7.** **L—2—14.** 7.8 S. Cu. 62 4.5 ... . 30.3 32 57 10 NW. 30.3 39 44 9 NW.	**L—3—20.** **H—2 —3.** **H—4—57.** **L—2—15.** 8.3 S. Cu. 105 10.0 ... . 30.3 17 67 8 W.			
L—6— 9. **H—1—55.** ... . 1.3 A. S. 142 4.5 3.1 A. Cu. 136 6.8 5.1 A. Cu. 125 7.4 5.3 S. Cu. 120 7.4 .... 30.0 .. .. 9 NW. 30.0 42 69 2 N.	**L—6—17.** **H—1—39.** 8.6 Cu. 105 8.6 2.0 Cu. 52 4.3 ... . 5.6 Cu. 33 4.3 ... . 30.1 28 60 15 W. 30.2 24 87 15 NW. 30.2 22 72 12 N.	**L—6—17.** **H—1—39.** ... . 1.2 S. Cu. 10 10.7 ... . 4.3 S. Cu. 40 6.1 ... . 30.2 24 58 8 N. 30.2 21 71 6 NW.	**L—6—17.** **H—1—40.** **H—3—19.** ... . 4.1 S. Cu. 36 14.2 ... . 30.2 30 76 22 NW.	**H—3—11.** **H—1—56.** 9.6 Ci. S. 115 10.0 ... . 5.5 A. S. 133 7.9 ... . 30.2 26 69 16 SW. .... 30.0 32 76 16 SW.
H—2—24. 8.3 Ci. Cu. 115 5.8 9.1 A. Cu. 130 8.3 9.5 S. Cu. 137 9.8 10.3 Cu. 230 3.1 2.2 S. Cu. 142 7.1 ... . 30.2 32 74 5 NE. 30.2 42 62 3 NE.		**H—2—7.** ... . 1.7 S. Cu. 88 7.0 ... . 4.4 Ci. 30 6.0 4.6 S. Cu. 80 12.0 .... 30.3 21 57 8 W. 30.3 20 67 12 W.	**H—2—25.** 8.3 Ci. 38 6.0 ... . 30.3 10 79 5 N.	**L—3—11.** **H—2—25.** 11.1 Ci. 123 7.1 ... . 2.1 Ci. 121 7.1 ... . 30.1 20 59 25 NW. 30.2 26 42 10 W. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 27 TO 28, MARCH 1 TO MARCH 3, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Feb. 27 ° ° H. 5. 90. 35	**H—5—10.** ... . 2.0 Ci. 66 5.2 5.8 Ci. 60 5.0 ... . 30.4 36 69 16 S. 30.3 38 73 12 S.	**H—5—17.** .... 12.1 Cu. 74 11.4 5.1 Ci. 85 9.4 .... 30.4 7 76 3 S. 30.4 13 73 3 SE.	**H—5—11.** .... 5.7 Ci. 84 4.9 .... 30.3 64 43 24 S.		
Feb. 28 ° ° H. 6. 80. 36 L. 3. 60. 48 H. 2. 87. 50			8.3 A. S. 122 4.7 8.4 A. Cu. 120 5.0 1.3 A. S. 119 4.8 5.1 A. S. 117 4.8 5.3 Ci. S. 117 4.8 5.7 A. Cu. 120 5.1 30.2 52 69 26 SW. 30.1 66 53 28 SW. 30.0 68 45 20 S.		
Mar. 1 ° ° H. 3. 70. 45 L. 2. 90. 42		**L—2—4.** ... . 12.1 A. S. 36 16.2 12.3 Cu. 36 16.1 ... . 30.3 19 69 13 NW.	8.4 A. Cu. 127 3.1 ... . 30.0 61 78 23 S.	8.7 S. Cu. 91 2.1 ... . 1.3 S. Cu. 102 1.8 ... . 5.1 S. Cu. 120 3.7 ... . 30.4 50 74 8 SE. 30.2 61 58 8 SE. 30.2 62 54 7 SE.	
Mar. 2 ° ° L. 3. 65. 43 H. 6. 78. 34 L. 5. 93. 37 H. 2. 85. 50		**H—2—12.** **L—5— 9.** ... . 5.2 N. 62 7.9 .... 30.2 14 81 3 NW.		**H—6—19.** **L—5— 6.** 8.4 S. Cu. 171 5.1 ... . 1.2 S. Cu. 268 8.4 ... . 5.0 S. Cu. 143 7.6 30.1 59 83 7 SE. 30.1 71 60 12 SW. 30.0 71 60 4 SW.	
Mar. 3 ° ° L. 3. 78. 44 H. 4. 99. 41 H. 6. 78. 31	**L—3—19.** **H—4— 2.** ... . 1.9 Ci. 86 3.7 ... . 5.3 Ci. S. 85 4.7 ... . 30.4 34 68 6 NW. 30.3 35 70 4 NE.			**H—6—19.** **H—4—14.** ... . 5.1 S. Cu. 103 5.1 ... . 30.1 69 76 3 W.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 27 TO 28, MARCH 1 TO MARCH 3, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
	H—5—16.	**H—5—16.**	**H—5—16.**	
	11.6 Fr. S. 113 8.5	... .	... .	... .
	1.7 Fr. S. 101 7.9	1.1 Cu. 99 36.1	... .	2.1 Fr. Cu. 79 4.5
	5.1 Ci. S. 82 6.2	... .	4.1 S. Cu. 100 19.0	... .
	... .	... .	... .	... .
	30.6 65 85 19 SW.	....	....	....
	30.6 17 51 7 W.	30.5 12 58 20 SW.	....	30.4 21 39 15 W.
	30.5 17 51 15 W.	....	30.4 14 80 48 W.	....
	H—6— 9.			**H—6—16.**
	H—2—14.			**L—3—20.**
				H—2—14.
	... .			... .
	... .			... .
	... .			3.0 Fr. Cu. 71 12.3
	5.5 Ci. S. 98 8.0			5.0 Fr. Cu. 82 11.6
	5.8 Fr. S. 300 13.1			... .
	... .			... .
	....			....
	....			30.4 25 39 26 W.
	30.6 21 78 11 E.			30.5 25 40 29 W.
H—3—12.				**H—3—1.**
L—2—14.				
8.4 A. Cu. 100 7.5				... .
9.7 Fr. S. 221 17.3				... .
1.0 S. Cu. 110 8.3				2.2 S. Cu. 170 14.6
1.7 A. Cu. 120 5.4				... .
5.8 A. Cu. 99 5.3				... .
... .				... .
30.7 33 88 2 E.				....
30.6 40 60 15 S.				30.7 25 59 16 SE.
30.5 40 72 6 S.				....
H—6— 9.			**H—6—17.**	**H—6—16.**
L—3—20.			**L—3—19.**	**L—3—12.**
H—2—14.			**H—2— 6.**	**H—2—14.**
L—5—15.			**L—5—16.**	
8.0 S. Cu. 116 4.8			8.3 S. Cu. 35 17.7	8.4 A. S. 102 9.9
8.7 A. Cu. 121 4.4			... .	... .
1.3 Ci. 92 3.9			1.3 S. 235 15.3	... .
1.7 Ci. Cu. 104 4.0			... .	... .
5.7 Ci. 93 3.1			... .	... .
30.3 46 74 1 S.			30.3 26 68 12 NW.	30.2 39 75 26 W.
30.2 62 49 13 NE.			30.3 25 74 11 NW.	....
30.1 58 61 6 S.			....	....
H—6—9.	**H—6—17.**	**H—6—17.**	**H—6—17.**	
L—3—5.	**L—3— 4.**	**L—3— 4.**	**L—3— 1.**	
	H—4—15.	**H—4—15.**		
8.2 Fr. S. 149 33.3	... .	... .	... .	
8.4 A. S. 120 6.1	... .	... .	... .	
... .	1.3 Fr. S. 97 29.8	1.2 S. Cu. 80 37.8	1.3 S. Cu. 114 20.7	
... .	1.5 S. Cu. 85 19.8	... .	... .	
4.5 A. Cu. 107 5.0	5.0 Fr. S. 78 19.9	... .	... .	
4.6 Cu. 98 8.8	5.4 S. Cu. 70 13.3	... .	... .	
4.7 Cu. N. 78 7.8	... .	... .	... .	
30.0 55 88 12 S.	....	....	....	
30.3 47 86 9 SW.	30.0 28 82 10 W.	30.0 26 88 9 W.	29.9 32 84 36 W.	
30.0 58 67 26 NW.	30.1 29 77 21 W.	....	....	

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 4 TO MARCH 8, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Mar. 4 ° ° L . 3 . 61 . 48 H . 3 . 80 . 40 L . 2 . 102 . 48		**H—3—18.** **L—2— 7.** 8.1 A. S. 120 8.9 12.1 S. 201 7.0 ... . 7.1 S. 254 7.0 ... . 30.2 7 78 5 SE. 30.0 26 78 8 SE. 29.8 25 87 8 SE.	... . 5.6 Cu. N. 134 6.4 5.5 Fr. Cu. 134 7.1 6.0 Fr. S. 222 6.0 .... 29.7 62 29 6 NE.	**H—3—20.** 8.7 A. S. 209 21.4 1.3 A. S. 209 19.7 ... . 4.7 S. Cu. 162 9.3 ... . 30.1 68 85 10 SE. 30.0 76 69 12 S. 29.9 75 62 15 S.	
Mar. 5 ° ° H . 3 . 68 . 42 L . 2 . 89 . 42	**L—2—12.** 8.7 S. Cu. 46 30.6 1.9 S. Cu. 5 12.1 5.3 S. Cu. 2 8.8 ... . 29.9 40 88 12 W. 30.0 40 80 10 NW. 30.1 40 81 10 N.	**L—2—3.** ... . 12.2 Cu. 34 20.1 5.1 A. Cu. 32 14.7 ... . 29.8 31 89 14 NW. 30.0 29 77 11 NW.	**L—2—20.** 8.4 Ci. S. 136 5.9 ... . 30.0 46 65 5 W.	**L—2—18.** 8.4 S. Cu. 150 16.7 12.7 S. Cu. 150 16.3 ... . 30.0 75 66 10 SW. 29.9 75 78 10 SW.	**L—2—6.** ... . 12.9 S. Cu. 129 20.5 4.9 S. Cu. 121 13.9 ... . 29.8 64 74 12 SW. 29.9 63 71 11 SW.
Mar. 6 ° ° L . 3 . 61 . 48 H . 1 . 112 . 51		**H—1—24.** ... . 5.2 A. S. 216 8.0 .... 30.6 17 68 7 E.	**H—1—38.** 8.3 A. Cu. 147 3.4 8.8 S. Cu. 144 4.2 ... . 30.2 51 71 16 E.	**H—1—55.** ... . 12.7 A. Cu. 172 3.0 5.1 A. Cu. 104 4.4 .... 30.1 66 81 5 N. 30.1 66 61 9 NE.	**H—1—55.** 7.8 A. Cu. 307 19.6 8.0 S. Cu. 307 20.0 ... . 30.3 40 50 12 N. ....
Mar. 7 ° ° H . 2 . 80 . 48			8.5 Fr. S. 196 34.6 1.7 Cu. 189 8.0 5.6 Ci. 112 5.3 30.1 62 89 10 SE. 30.0 75 49 20 S. 29.9 77 45 16 SE.		
Mar. 8 ° ° H . 3 . 64 . 44 L . 5 . 97 . 40	**L—5—2.** 9.5 S. Cu. 145 25.5 11.3 S. Cu. 128 22.5 1.5 Ci. 110 6.4 1.6 Cu. 136 8.9 ... . 5.8 Ci. 115 4.3 ... . 29.9 61 91 14 SW. 29.8 71 78 20 SW. 29.8 66 76 6 NW.	**L—5—8.** ... . 12.1 S. 302 8.1 ... . 30.0 31 90 10 E.	**L—5—5.** 8.3 S. 169 25.8 8.9 Ci. S. 121 5.1 1.6 Cu. 160 11.7 1.7 Ci. S. 127 4.7 ... . 5.6 S. Cu. 167 10.2 5.4 Ci. S. 117 5.1 30.0 68 90 14 S. 29.9 75 66 19 SW. 29.9 77 59 13 SW.	**L—5—14.** ... . 12.8 S. Cu. 143 2.7 ... . 5.3 S. Cu. 110 6.0 ... . 30.2 72 81 6 SW. 30.1 77 59 8 SW.	7.7 A. Cu. 110 5.3 ... . 1.2 S. Cu. 111 7.1 ... . 30.2 47 66 6 SE. 30.1 65 54 12 S. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 4 TO MARCH 8, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
		H—3— 3. **L—2—15.** 8.4 Cu. S. 138 10.1 1.8 S. Cu. 212 4.8 1.8 Ci. S. 35 4.0 4.4 Ci. S. 45 5.4 ... . 30.5 23 76 8 SW. 30.4 28 72 8 SE. 30.3 30 78 9 SE.		**L—3—20.** **H—3— 8.** 8.1 Fr. Cu. 57 24.7 2.0 Fr. Cu. 48 8.1 ... . 30.1 26 44 35 NW. 30.2 32 31 28 NW. ....
H—3—11. **L—2—15.** 8.5 S. 174 33.2 ... . 3.6 Fr. N. 175 60.0 ... . 30.3 39 83 6 S. 30.1 38 75 8 SW. 29.9 48 93 12 SW.	**H—3—19.** **L—2— 7.** 8.4 Fr. S. 190 34.7 2.3 S. 118 8.7 5.1 Ci. S. 122 6.0 5.2 Fr. Cu. 115 13.3 5.9 Fr. S. 120 26.7 29.8 47 83 18 S. 29.5 55 76 20 S. 29.6 58 74 20 S.	**H—3—19.** **L—2— 7.** ... . 4.2 S. Cu. 110 30.8 ... . 29.6 50 80 32 SW.		**H—3— 4.** **L—2—15.** 8.1 A. S. 89 5.4 ... . 30.4 26 56 14 S. ....
L—3—20. 8.3 N. 122 6.6 10.8 Fr. N. 345 15.1 1.0 Fr. N. 352 8.3 5.5 Fr. N. 158 9.8 30.1 54 94 2 NW. 30.3 47 86 9 N. 30.4 42 92 12 N.	**H—1—56.** ... . 4.7 Fr. N. 318 18.0 .... 30.5 24 93 16 NE.	**H—1—40.** ... . 1.4 S. Cu. 325 13.1 ... . 30.5 24 60 13 N.	**L—3—19.** **H—1—56.** ... . 1.2 S. Cu. 238 6.7 ... . 30.6 24 76 10 NE.	**L—3—12.** 8.1 A. S. 114 6.5 ... . 2.1 A. S. 118 7.9 ... . 30.0 44 83 23 NW. 30.2 42 55 25 NW. ....
				H—2—6. 8.0 S. Cu. 311 22.1 2.1 S. Cu. 293 6.1 ... . 30.7 16 58 16 N. 30.7 23 63 20 NE. ....
H—3—20. 8.2 Fr. Cu. 259 8.7 10.0 S. Cu. 236 3.0 2.2 S. Cu. 164 6.2 2.6 Ci. S. 82 5.1 2.6 Ci. 82 2.5 5.0 S. Cu. 198 6.6 5.1 Ci. 62 2.1 30.6 31 95 5 NE. 30.5 38 75 5 SE. 30.4 38 83 6 S.	**H—3—19.** **L—5—15.** 8.4 Ci. 105 3.0 ... . 1.3 Ci. S. 112 6.0 ... . 30.3 38 80 14 SE. 30.1 54 70 16 S.	**L—5—15.** 8.6 A. S. 74 10.5 ... . 30.2 36 82 3 E.	**H—3—19.** 8.3 A. S. 116 11.7 ... . 30.4 37 74 6 S.	**H—3—11.** ... . 2.0 Ci. 65 4.1 ... . 5.0 Ci. Cu. 85 5.1 5.0 A. Cu. 85 5.0 .... 30.5 34 69 15 NE. 30.5 37 61 15 SE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 9 TO MARCH 13, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Mar. 9 ° ° H . 3 . 61 . 45 L . 2 . 90 . 40 H . 1 . 109 . 52 H . 6 . 77 . 33	**L—2—4.** ... . 1.8 Ci. 114 6.9 1.9 S. Cu. 11 17.3 ... . 30.0 40 72 14 NW.	**L—2—10.** **H—1—14.** ... . 12.5 Ci. Cu. 127 7.5 ... . 30.0 21 78 14 W.	**L—2—20.** 8.4 Ci. S. 129 6.2 8.4 A. Cu. 162 5.6 1.6 Ci. 125 5.4 ... . 5.7 Ci. 122 5.8 30.0 65 85 10 SW. 30.0 74 22 7 N. 29.9 75 16 12 NW.	**H—6—19.** **L—2— 5.** 8.7 S. Cu. 163 6.7 ... . 1.5 Ci. 133 0.7 ... . 5.1 A. Cu. 97 5.0 30.1 71 77 10 S. 30.0 78 72 12 SW. 29.9 77 59 10 SW.	
Mar. 10 ° ° L . 3 . 76 . 48 H . 1 . 108 . 51 H . 5 . 95 . 38		**L—3—19.** **H—1—14.** **H—5— 9.** 8.1 A. Cu. 109 11.2 8.3 Cu. 111 13.4 ... . 30.1 10 88 5 SW.	**H—5—12.** 8.4 S. 206 10.2 ... . 1.4 S. 185 10.2 ... . 5.7 Ci. Cu. 118 5.4 6.0 Cu. 119 5.3 30.2 43 92 5 NE. 30.0 60 68 2 E. 29.9 62 81 9 SE.	**H—5—6.** ... . 12.9 Ci. 98 0.7 ... . 30.1 67 75 6 N.	**L—3—20.** **H—5— 7.** 7.7 Fr. Cu. 62 19.5 7.8 Cu. 62 19.4 ... . 30.2 41 61 8 W. ....
Mar. 11 ° ° L . 3 . 62 . 48 H . 6 . 75 . 35 L . 5 . 97 . 37	**L—5—2.** 8.5 S. Cu. 128 13.0 1.9 S. Cu. 83 9.4 ... . 29.7 48 74 10 SE. 29.6 52 76 7 SW.		**L—5—5.** 8.4 Ci. S. 110 6.5 ... . 5.5 A. Cu. 114 8.1 ... . 29.8 66 78 12 SW. .... 29.7 70 19 13 NW.	**H—6—19.** **L—5— 6.** 8.5 S. Cu. 100 3.7 12.7 Cu. 105 5.0 ... . 5.5 S. Cu. 130 9.8 ... . 29.9 70 81 10 SW. 29.8 78 62 20 SW. 29.7 78 60 12 W.	**H—6—11.** **L—5—15.** 7.8 S. Cu. 104 3.2 1.1 S. 132 6.9 ... . 4.5 S. 125 8.1 ... . 30.1 44 63 9 E. 29.9 57 45 18 SE. 29.8 54 68 13 SE.
Mar. 12 ° ° H . 3 . 64 . 44 L . 2 . 82 . 45	**L—2—20.** 8.8 Ci. 95 5.8 ... . 30.2 20 69 18 N.		8.7 Ci. S. 121 7.1 ... . 1.6 Ci. 126 6.6 5.5 A. S. 119 6.5 6.1 A. Cu. 125 7.6 30.0 40 60 18 NE. 30.0 47 50 10 N. 29.9 50 33 8 NE.	8.7 S. 138 3.1 ... . 1.1 S. 351 2.7 ... . 29.8 70 84 6 S. 29.8 66 78 6 N.	**L—2—12.** 7.8 Fr. Cu. 75 14.8 7.8 Cu. 74 13.7 1.2 A. Cu. 103 8.1 ... . 29.8 46 58 12 W. 29.9 48 40 18 W. ... .
Mar. 13 ° ° L . 3 . 66 . 49 L . 5 . 102 . 30 H . 2 . 95 . 50 H . 1 . 108 . 51		**H—2— 5.** **H—1—14.** ... . 12.1 S. 75 11.5 ... . 30.3 13 .. 5 SE.	**L—5— 3.** **H—1—37.** 8.4 A. S. 138 5.2 ... . 5.5 A. S. 142 6.8 29.9 40 64 3 N. .... 29.8 55 12 14 N.	**L—5—15.** **H—1—54.** ... . 5.0 A. S. 94 4.6 .... 29.7 69 76 7 SE.	**H—2—13.** **H—1—39.** ... . 1.0 Ci. S. 92 6.8 ... . 30.0 43 42 18 NE. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 9 TO MARCH 13, 1897.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—3—19.				**H—6—17.**												**H—3—11.**			
H—6— 9.				**L—2— 7.**												**H—6—16.**			
L—2—15.																			
9.4	N.	177	25.2	8.4	N.	125	16.7									...	.....	..	...
...	.....	..	...	...	.....	...	...									...	.....	...	...
1.1	N.	169	20.0	1.7	N.	105	18.1									2.1	S. Cu.	164	3.9
...	.....	...	...	...	.....	...	...									...	.....	...	...
3.4	N.	159	27.9	4.6	N.	160	18.2									5.0	N.	129	9.7
30.2	39	98	5 S.	29.9	55	88	18 S.									....	..	..	....
30.1	44	96	13 S.	29.7	56	92	11 S.									30.1	40	80	9 S.
30.0	48	93	4 S.	29.7	58	88	8 S.									30.1	40	74	7 S.
L—3—5.				**L—3—12.**				**L—3—12.**				**L—3— 5.**				**L—3—6.**			
				H—5—15.				**H—5—16.**				**H—5—16.**							
8.0	S. Cu.	112	6.4	9.6	S. Cu.	59	13.5	8.5	Cu.	72	50.6	8.3	S. Cu.	98	23.3	...	.....	...	...
8.1	As.	112	5.4	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
8.3	A. Cu.	117	7.8	...	.....	...	...	...	.....	...	..	...	.....	...	...	...	.....	...	...
8.3	Ci.	117	5.8	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
9.3	S.	122	24.6	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	..
1.1	S. Cu.	93	4.6	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.2	Cu.	128	5.0	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
5.1	Cu.	121	8.0	...	.....	...	...	...	.....	...	...	...	.....	...	...	6.2	A. Cu.	123	9.5
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
29.7	51	93	5 S.	29.9	34	91	17 S.	29.9	35	76	11 W.	29.7	37	82	16 W.	....	..	..	....
29.8	62	54	36 NW.	....	..	..	....	....	..	..	....	....	..	..	....	....	..	..	....
30.1	52	46	8 S.	....	..	..	....	....	..	..	....	....	..	..	....	29.7	46	85	19 W.
H—6—8.				**H—6—10.**				**H—6—10.**				**L—3—19.**				**L—3—20.**			
				L—5—16.				**L—5—16.**				**H—6— 9.**				**H—6— 8.**			
9.6	Ci.	88	6.7	9.0	Ci.	85	5.0	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.1	Ci. S.	85	6.9	1.8	A. Cu.	105	6.0	1.1	Ci. S.	90	3.7	...	.....	...	...	3.0	Cu.	98	10.8
1.2	Ci.	91	6.8	...	.....	...	...	...	.....	...	...	1.5	Ci.	114	3.3	...	.....	...	..
1.5	Ci. Cu.	98	5.8	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	..	...
5.2	A. S.	93	4.6	4.4	Ci. Cu.	110	3.0	4.2	A. S.	138	9.2	4.1	Ci.	114	3.3	...	.....	...	...
...	.....	...	...	4.6	Fr. S.	130	5.3	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.2	37	84	1 NW.	30.1	40	64	5 S.	....	..	..	....	....	..	..	...	....	..	..	....
30.1	58	33	12 SW.	30.0	46	56	8 N.	30.0	46	58	5 S.	30.1	36	76	24 W.	29.9	50	29	29 W.
29.9	58	78	4 W.	29.9	50	44	8 E.	29.9	43	67	9 NE.	30.0	37	76	24 W.	....	..	..	....
H—3—19.				**H—3—19.**				**L—2—1.**				**H—3—19.**				**H—3—11.**			
L—2— 6.				**L—2— 1.**								**L—2— 2.**				**L—2— 7.**			
10.5	A. S.	108	6.4	8.2	S. Cu.	128	23.9	8.5	S. Cu.	118	47.2	8.2	S. Cu.	114	18.7	8.0	S.	19.2	12.9
...	.....	...	...	..	.....	...	...	...	.....	...	...	..	.....	...	...	11.4	A. S.	11.2	3.6
1.0	A. Cu.	110	8.9	1.3	S. Cu.	110	13.6	1.0	S. Cu.	102	64.2	...	.....	...	...	...	.....	...	...
...	.....	...	...	4.8	N.	77	20.8	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	..	...	.....	...	...	...	.....	...	...
29.8	40	92	2 SW.	29.5	50	77	20 SW.	29.5	37	66	30 SW.	29.5	44	85	32 SW.	30.0	36	82	16 S.
29.6	54	74	10 S.	29.8	35	65	32 W.	29.7	29	67	40 SW.	....	..	..	....	....	..	..	....
....	..	..	....	29.9	28	84	24 W.	....	..	..	....	....	..	..	....	....	..	..	....
L—3—20.				**L—3—20.**				**L—3—20.**											
H—1—56.				**H—2—14.**				**H—2—14.**											
				H—1—40.				**H—1—40.**											
...	.....	...	...	10.0	S. Cu.	138	5.9	8.4	Cu.	3	12.2								
12.8	Ci.	89	7.2	...	.....	...	...	...	.....	...	...								
5.3	Ci.	89	7.0	4.6	Ci. S.	97	6.7	4.4	Ci. Cu.	114	4.2								
....	..	..	....	30.3	22	72	10 N.	30.3	20	77	5 NE.								
....	..	..	....	....	..	..	....	....	..	..	....								
....	..	..	....	30.2	28	77	18 N.	30.2	27	88	9 NE.								

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 14 TO MARCH 18, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Mar. 14 ° ° H . 3 . 68 . 44 L . 2 . 81 . 43			8.2 Ci.S. 142 5.2 . . .. 1.3 A. Cu. 171 8.4 5.4 A. Cu. 168 9.5 5.6 S. Cu. 167 9.9 30.0 29 66 8 NE. 30.2 54 59 8 SE. 30.1 55 . 19 13 E.		
Mar. 15 ° ° L . 3 . 56 . 48 H . 2 . 83 . 40 H . 2 . 100 . 50	**H—2—11.** **H—2—13.** ... . 5.8 Ci. 123 5.0 ... . 7 E.				
Mar. 16 ° ° H . 2 . 81 . 49 L . 1 . 108 . 52	**H—2—20.** 8.4 Ci. 125 4.2 ... . 1.4 Ci. 127 4.1 ... . 30.4 36 70 9 SE. 30.3 56 50 10 SE.	**H—2—19.** **L—1—14.** ... . 12.1 Ci. 137 6.5 12.3 A. Cu. 142 7.3 5.1 Cu. 130 9.8 ... . 30.4 27 78 7 SE. 30.3 36 66 8 SE.		... . 5.1 A. S. 103 4.7 ... . 30.2 68 74 6 E.	**H—2—13.** 7.8 Ci. 130 3.5 . . .. 1.1 Ci. 84 5.0 ... . 4.8 Ci. S. 93 6.0 4.9 A. S. 89 4.0 30.6 38 54 9 NE. 30.5 54 32 11 E. 30.5 54 40 12 NE.
Mar. 17 ° ° H . 3 . 75 . 42 L . 2 . 101 . 45	**L—2—6.** ... . 1.8 S. Cu. 137 13.8 ... . 29.9 52 78 12 SW.		**L—2—13.** ... . 1.3 Cu. 155 6.8 ... . 5.6 Ci. S. 154 6.9 6.0 Cu. N. 125 ... . 30.0 67 76 2 W. 29.9 66 77 7 S.	... . 12.6 Cu. 172 5.3 ... . 4.9 A. Cu. 104 4.0 ... . 30.0 78 56 10 E.	
Mar. 18 ° ° H . 3 . 70 . 43 H . 6 . 80 . 30 L . 1 . 106 . 46	**L—1—14.** ... . 2.6 Cu. 183 14.0 ... . 5.2 S. Cu. 140 9.1 5.3 Ci. 129 6.0 .... 29.7 60 74 12 S. 29.6 66 75 8 SE.		8.7 Ci. S. 167 5.8 1.3 Ci. S. 155 6.7 1.4 Cu. 144 6.3 2.0 Fr. Cu. 135 7.9 ... . 29.7 75 42 19 SW.	**H—6—19.** ... . 12.9 S. Cu. 138 3.7 ... . 29.9 74 72 5 SW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 14 TO MARCH 18, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
	H—3—19. **L—2— 1.** 8.0 Fr. S. 105 26.6 8.4 S. Cu. 120 14.6 2.0 Fr. Cu. 105 15.4 ... . 29.7 39 75 30 W. 30.0 36 82 30 W.			**H—3—4.** **L—2—7.** 8.0 A. S. 172 7.2 8.1 S. Cu. 262 ... . 30.3 27 65 14 E. ....
H—2— 7. **H—2—39.** 9.1 Ci. Cu. 92 7.6 1.1 Ci. 92 21.0 ... . 30.4 37 66 6 N. 30.5 46 48 14 NW.	**H—2— 3.** **H—2—28.** ... . 1.3 Ci. S. 103 7.6 ... . 30.5 30 57 9 NW.	**H—2— 3.** **H—2—23.** ... . 4.3 S. Cu. 110 5.2 ... . 30.5 34 75 10 SW.		**L—3—20.** **H—2—15.** **H—2—40.** 8.1 Fr. Cu. 58 13.3 3.8 Ci. 84 13.3 3.9 Fr. Cu. 59 14.9 .. .. 30.2 26 51 24 NW. ... ... 30.3 28 34 26 W.
H—2—13. 10.7 Cu. 46 6.9 ... . 1.1 Cu. 12 3.2 1.3 Ci. 70 6.4 ... . 5.6 Ci. 69 7.4 30.6 36 66 8 N. 30.6 44 50 9 N. 30.6 38 50 8 SE.	**H—2—5.** 8.2 S. Cu. 295 2.9 8.6 N. 330 6.7 ... . 5.3 Ci. 80 6.7 30.7 26 68 11 E. .... 30.6 28 77 16 NE.		**H—2—5.** ... . 1.5 S. Cu. 100 8.3 ... . 30.6 25 76 10 NW.	**H—2—14.** 8.0 Fr. Cu. 38 20.6 ... . 30.5 15 56 26 N. W. ....
H—3—1. 8.2 S. Cu. 149 11.2 9.2 Ci. 67 5.7 12.5 Cu. 167 7.2 1.1 A. Cu. 67 4.8 3.5 A. S. 56 4.5 ... . 30.6 31 74 5 E. 30.5 45 64 8 SW. 30.3 44 74 6 S.			**H—3—4.** 8.3 Ci. 111 3.3 ... . 1.2 Ci. 110 3.3 ... ... 4.1 Ci. S. 110 5.3 ... . 30.5 26 57 3 SE. 30.5 44 53 6 SE. 30.4 43 56 9 E.	**H—3—2.** ... . 6.0 Ci. S. 53 7.5 ... . 30.3 31 37 14 NW.
H—3—12. **H—6—17.** ... . 1.5 S. Cu. 185 14.0 ... . 4.2 S. Cu. 168 10.3 ... . 30.0 44 94 6 S. 30.1 41 96 8 S.	**H—3—11.** **H—6—17.** ... . 5.4 Ci. S. 95 5.8 ... . 29.8 60 78 Lt. W.	**H—3—19.** **H—6—17.** ... . 1.5 S. Cu. 123 16.5 ... . 4.3 Ci. 60 12.1 ... . 29.8 54 84 14 W. 29.8 56 80 10 W.	**H—3—11.** **H—6—17.** 8.3 S. Cu. 170 8.7 ... . 30.0 43 70 7 S.	**H—3—1.** 8.0 Ci. 59 3.2 2.1 A. Cu. 70 7.0 ... . 30.2 30 45 6 E. 30.1 37 61 7 NE. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 19 TO MARCH 23, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Mar. 19 ° ° H. 6. 81. 28 L. 2. 94. 41	**L—2—1.** 11.9 Ci. 124 3.3 1.7 Cu. 59 12.9 ... ... 5.2 Cu. 61 7.0 5.6 Ci. Cu. 98 3.3 5.7 A. Cu. 97 4.0 29.3 62 64 12 SW. 29.3 64 61 12 SW. 29.4 63 58 7 NW.	**L—2—3.** ... ... 5.1 N. 91 9.5 ... ... 30.3 37 93 3 NW.		**H—6—18.** **L—2—13.** 9.1 A. Cu. 138 4.8 ... ... 29.7 61 88 12 SW.	**H—6—17.** **L—2— 7.** ... ... 4.9 Fr. Cu. 98 31.6 4.9 Cu. 105 30.0 4.9 S. Cu. 105 25.0 ... ... 30.4 66 84 12 SW.
Mar. 20 ° ° L. 3. 63. 48 L. 2. 84. 45 H. 1. 111. 52	**L—2—20.** 8.5 S. Cu. 42 12.3 ... ... 1.2 Cu. 53 7.7 ... ... 29.8 40 72 11 NW. 29.8 46 62 8 NW.	**H—1—15.** **L—2—11.** 8.2 S. 124 30.0 ... ... 12.1 S. 70 11.2 5.1 Cu. 86 44.3 ... ... 29.4 35 91 10 W. 29.5 33 80 8 W. 29.6 32 79 20 W.	8.2 Ci. 119 4.0 ... ... 1.7 Ci. S. 134 4.1 5.6 Ci. S. 137 4.1 ... ... 29.8 53 40 2 N. 29.8 68 24 5 S. 29.6 72 31 8 S.	... ... 4.3 Ci. 87 5.6 ... ... 29.7 84 24 12 SW.	
Mar. 21 ° ° H. 6. 82. 39 L. 2. 78. 48					
Mar. 22 ° ° L. 5. 95. 30 L. 2. 84. 40 H. 1. 107. 50	**L—2—11.** **L—5—17.** 11.2 Ci. S. 139 6.3 11.4 S. Cu. 336 12.9 1.7 Cu. 298 6.1 1.8 Ci. 148 7.1 5.3 S. Cu. 291 5.9 30.1 41 67 12 NE. 30.0 48 63 11 NE. 30.0 48 72 7 NE.	**L—2—10.** **H—1—14.** 8.1 Ci. S. 10 1.7 ... ... 5.1 Ci. S. 202 28.3 30.2 25 68 9 N. ... ... 30.2 37 48 12 NW.	**L—5—10.** 8.0 Fr. S. 3 16.7 8.7 Ci. S. 154 5.5 ... ... 5.9 Fr. S. 122 6.0 30.0 43 77 18 NW. ... ... 29.9 58 42 8 N.	**L—2—20.** **L—5— 2.** 9.1 A. S. 105 4.9 ... ... 1.7 A. S. 110 4.4 ... ... 29.8 67 88 10 SE. 29.8 74 68 5 SW.	**L—2— 1.** **L—5—16.** ... ... 12.9 Cu. 83 5.8 ... ... 29.8 75 39 15 SW. ... ...
Mar. 23 ° ° L. 2. 87. 38 H. 2. 89. 52	**L—2—11.** **H—2—13.** ... ... 1.8 S. Cu. 40 1.9 ... ... 29.9 34 92 21 NW.	**L—2—10.** **H—2— 6.** 8.0 A. S. 41 4.1 ... ... 12.1 S. 337 20.7 ... ... 5.1 A. S. 82 6.2 30.1 26 88 5 N. 30.0 33 70 7 N. 30.0 34 62 10 NW.			**L—2—2.** 7.7 S. Cu. 313 8.6 ... ... 1.2 Fr. Cu. 118 11.6 ... ... 5.2 S. Cu. 113 19.4 29.7 50 80 8 NE. ... ... 29.6 56 76 20 SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 19 TO MARCH 23, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
H—6—17. **L—2—15.** ... . 12.4 N. 285 17.6 ... . 29.8 44 100 4 E. 29.7 49 93 4 E. 29.6 47 100 4 NE.				11.1 S. Cu. 110 9.5 2.2 Ci. 67 4.7 2.3 S. Cu. 75 2.9 5.1 S. Cu. 66 2.7 ... . 29.9 37 100 8 SW. 29.7 53 69 2 E. 29.7 44 84 10 E.
L—2—6. 11.2 S. 209 4.3 ... . 1.2 Cu. 81 6.9 5.8 Cu. 96 4.2 ... . 29.6 46 100 2 N. 29.5 72 73 6 SE. 29.7 56 91 5 NE.	**L—2—1.** 8.0 S. Cu. 102 13.6 8.3 Fr. S. 100 17.0 2.2 Fr. Cu. 100 9.7 5.2 Ci. Cu. 110 3.3 5.2 A. S. 125 4.0 5.8 Fr. S. 115 12.0 29.4 57 77 14 W. 29.5 51 68 16 W. 29.6 50 74 5 NW.	**L—2—1.** 8.4 S. Cu. 110 32.2 ... . 1.7 S. Cu. 113 18.8 4.3 S. Cu. 122 37.0 ... . 29.4 51 84 17 SW. 29.4 46 79 15 W. 29.6 46 75 15 W..	**L—3—19.** **L—2— 2.** 8.2 S. Cu. 111 14.3 ... . 30.3 48 100 9 SW.	
	H—6— 8. **L—2—12.** ... . 2.2 Ci. S. 104 4.2 5.3 Ci. 100 4.0 .... 29.9 50 55 11 NW. 29.9 52 78 6 N.			**H—6—8.** **L—2—6.** ... . 2.0 S. Cu. 76 25.6 ... . 29.8 47 66 26 W. ....
L—2—7. 8.2 Ci. 90 4.2 ... . 12.2 Ci. 92 4.2 1.0 A. Cu. 146 3.3 5.5 S. Cu. 91 3.9 29.9 50 87 2 E. 29.9 77 52 6 S. 29.9 66 68 10 NE.		**L—2—2.** 8.4 Cu. S. 81 10.7 ... . 1.7 Cu. 15 16.3 1.7 A. Cu. 115 11.2 4.2 S. Cu. 24 10.8 29.8 39 83 5 NE. 29.8 50 74 9 N. 29.9 48 76 13 N.	**L—2—2.** 8.1 A. S. 98 5.0 8.3 S. Cu. 110 10.0 .. .. 29.8 38 75 6 NE.	**L—2—15.** 8.1 S. Cu. 70 7.9 ... . 2.1 A. Cu. 91 8.3 ... . 5.5 S. 142 28.4 30.1 38 67 12 SW. 29.9 53 53 15 S. 29.9 45 56 26 S.
L—2—7. 8.2 S. Cu. 149 2.8 9.6 A. Cu. 125 1.6 10.4 Ci. Cu. 130 3.8 12.1 S. Cu. 142 4.9 12.2 A. Cu. 126 4.0 5.3 S. 192 9.5 29.8 58 83 2 NE. 29.6 65 70 14 SE. 29.5 62 84 7 SE.	**L—2—8.** 8.1 Ci. S. 142 5.0 8.2 Fr. S. 100 20.5 ... . 29.9 37 82 12 E.		**L—2—8.** 8.3 Ci. Cu. 98 4.7 ... . 1.1 S. Cu. 98 9.3 ... . 29.9 35 73 6 N. 29.8 50 76 7 N.	**L—2—16.** 8.0 Ci. S. 92 7.5 ... . 29.8 41 73 11 N. ... .

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 24 TO MARCH 28, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Mar. 24 ° ° L . 3 . 73 . 40 H . 2 . 100 . 50 H . 5 . 98 . 29	**H—5—17.** **H—2—13.** ... . 1.6 A. Cu. 51 7.0 ... . 30.0 45 62 6 W.	**H—2—6.** 8.1 S. Cu. 39 12.7 ... . 12.0 S. Cu. 38 13.1 ... . 30.0 26 88 10 NW. 29.9 32 59 10 NW.	**H—5—3.** ... . 1.8 Ci. 109 2.7 ... . 30.1 65 20 14 SW.		
Mar. 25 ° ° L . 3 . 70 . 45	8.4 Ci. S. 34 5.9 ... . 1.8 A. Cu. 39 6.8 ... . 5.1 S. Cu. 46 8.9 ... . 30.1 31 69 7 NW. 30.0 44 60 11 W. 30.0 45 64 7 W.			... . 4.6 Cu. 51 6.3 ... . 29.9 67 50 18 NW.	**L—3—20.** ... . 1.0 Cu. 97 6.1 ... . 4.8 S. Cu. 92 11.7 4.9 Fr. Cu. 91 12.6 .... 29.9 39 48 18 W. 29.9 40 50 15 W.
Mar. 26 ° ° L . 3 . 65 . 46 H . 6 . 88 . 29 H . 2 . 96 . 50	**H—6—18.** **H—2—13.** 8.6 A. Cu. 49 6.8 ... . 1.1 A. Cu. 57 5.8 ... . 30.0 39 78 6 E. 30.0 51 58 6 E.				**H—6—17.** ... . 4.9 Fr. Cu. 80 19.8 ... . 29.9 49 49 17 W.
Mar. 27 ° ° L . 3 . 58 . 42 H . 2 . 91 . 45 L . 4 . 106 . 41	**L—4—15.** **H—2—12.** 8.7 Ci. Cu. 100 3.7 ... . 30.2 35 60 14 E.		**H—2—20.** **L—4—14.** ... . 1.8 Ci. S. 130 6.9 5.5 Ci. S. 130 7.1 .... 29.9 80 29 16 SE. 29.8 78 27 18 SE.		**H—2—6.** ... . 1.0 Cu. 21 4.4 ... . 30.3 42 44 5 NW. ....
Mar. 28 ° ° L . 3 . 58 . 46 H . 6 . 84 . 38					

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 24 TO MARCH 28, 1897.

Washington.					Cleveland.					Detroit.					Buffalo.					Blue Hill.				
L—3—4.					**L—3—11.**										**L—3—10.**									
8.6	A. Cu.		156	8.3	8.5	N.		125	41.3						...	.....		...	...					
9.3	Cu.		108	9.5	..	.....		...	...						...	.....		...	...					
1.2	Cu.		106	6.2	..	.....		...	...						1.1	S. Cu.		110	20.7					
1.8	S. Cu.		125	6.4	...	.....		...	...						...	.....		...	..					
5.2	S. Cu.		92	7.2	5.3	Fr. N.		60	31.4						4.1	S. Cu.		110	20.7					
29.4	45	85	10	NW.	29.4	38	78	11	S.						....	..	..	....						
29.4	50	44	30	NW.	....	..	..	....							29.2	33	86	24	W.					
29.5	46	42	20	NW.	29.5	31	79	35	W.						29.2	31	86	18	W.					
L—3—12.					**L—3—19.**					**L—3—19.**					**L—3—11.**					**L—3—1.**				
9.3	Cu.		78	9.3	8.2	S.		65	8.0	8.6	Cu.		49	28.9	8.1	S. Cu.		30	20.7	8.0	A. Cu.		121	6.4
9.3	A. Cu.		70	9.9	8.3	Fr. Cu.		68	13.4	...	.....		...	...	...	.....		...	...	8.1	S. Cu.		83	21.9
...	.....		...	...	8.6	Fr. S.		70	16.4	..	.....		...	...	...	.....		...	...	...	.....		...	...
1.1	Cu.		78	6.2	1.4	Fr. S.		70	10.0	...	.....		...	...	...	.....		...	...	2.1	S. Cu.		95	18.0
1.1	A. Cu.		93	2.2	...	.....		...	..	..	.....		...	...	...	.....		...	...	...	.....		...	...
2.0	Ci.		90	2.6	...	.....		...	...	...	.....		...	...	...	.....		...	..	...	.....		...	...
...	.....		...	...	5.0	S. Cu.		68	4.4	4.4	S. Cu.		50	12.0	...	.....		...	...	...	.....		...	...
...	.....		...	...	5.3	Fr. S.		68	13.2	...	.....		...	...	...	.....		...	...	...	.....		...	...
29.6	37	48	24	NW.	29.7	29	66	21	W.	29.7	27	76	24	NW.	29.9	28	84	28	W.	29.2	35	67	28	W.
29.6	44	37	20	NW.	29.7	30	89	22	W.	....	..	..	....		....	..	..	....		29.2	38	52	33	W.
29.7	40	33	12	W.	29.8	30*	78	18	W.	29.7	33	85	22	W.	....	..	..	....		....	..	..	....	
L—3—20.					**L—3—19.**					**L—3—19.**					**L—3—19.**					**L—3—12.**				
H—6—16.					**H—2—14.**					**H—2—14.**														
...	.....		...	...	8.6	Ci. S.		63	7.2	...	.....		...	...	8.3	Ci.		92	7.7	8.1	A. Cu.		65	3.0
...	.....		...	...	...	.....		...	...	...	.....		...	...	8.5	S. Cu.		40	15.8	...	.....		...	...
12.5	Ci.		59	1.5	1.3	S. Cu.		105	5.0	2.0	S. Cu.		100	13.3	1.1	S. Cu.		92	10.0	2.1	S. Cu.		62	6.5
1.1	Cu.		44	7.9	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
4.4	Cu.		45	9.7	...	.....		...	...	5.2	A. Cu.		102	9.0	4.1	S. Cu.		92	10.0	5.5	S. Cu.		54	6.1
...	.....		...	...	...	.....		...	...	5.2	S. Cu.		44	10.8	...	.....		...	..	...	.....		...	...
29.8	35	65	12	W.	29.8	29	56	13	W.	....	..	..	....		29.8	26	57	24	NW.	29.5	33	62	22	NW.
29.8	43	49	22	NW.	29.6	36	73	9	N.	29.9	32	75	9	E.	29.8	32	64	24	W.	29.5	38	41	16	NW.
....	..	..	....		....	..	..	....		29.9	32	84	12	E.	29.8	31	68	22	W.	29.6	37	40	26	NW.
H—2—15.					**H—2—7.**					**H—2—7.**					**H—2—15.**					**L—3—19.**				
10.3	Cu.		52	5.2	8.7	S.		5	5.7	...	.....		...	...	...	.....		...	...	8.0	Ci		165	1.0
1.0	Cu.		49	5.9	1.9	Fr. Cu.		51	10.2	1.2	Cu.		34	6.2	1.5	S. Cu.		110	12.7	3.1	S. Cu.		93	3.9
5.3	Cu.		27	5.6	5.3	S. Cu.		52	5.8	4.2	Cu.		80	7.8	4.1	S. Cu.		111	11.0	5.4	S. Cu.		58	7.7
30.0	34	62	1	N.	30.1	30	67	13	NW.	....	..	..	....		....	..	..	....		29.8	33	68	10	NW.
30.0	46	46	20	NW.	30.1	33	80	17	W.	30.2	37	57	10	NW.	30.0	35	69	22	NW.	29.8	37	47	17	NW.
30.1	40	45	9	NW.	30.2	34	81	16	W.	30.2	38	58	12	W.	....	..	..	....		29.8	36	50	15	NW.
					H—6—3.															**L—3—19.**				
																				H—6—16.				
					8.3	S. Cu.		18	6.7											7.9	S.		4	7.9
					...	.....		...	...											2.1	S. Cu.		8	6.0
					...	.....		...	...											4.5	S. Cu.		13	6.5
					30.3	35	54	9	NW.											30.0	31	71	17	N.
					....	..	..	....												30.0	39	44	16	NW.
					....	..	..	....												30.0	40	42	22	NW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 29 TO MARCH 31, APRIL 1 TO 2, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Mar. 29 ° ° L . 3 . 57 . 48 H . 6 . 77 . 38 L . 1 . 110 . 50		**H—6—18.** **L—1—15.** 8.1 Ci. Cu. 113 4.6 12.1 Ci. Cu. 211 10.3 12.3 A. Cu. 211 10.8 ... . 30.0 40 76 7 SE. 30.0 53 55 6 E. 30.0 56 40 7 E.		**H—6—19.** ... . 1.3 A. Cu. 102 8.9 ... . 5.1 Cu. 110 10.0 .... 29.8 77 63 12 SW. 29.7 76 45 15 SW.	
Mar. 30 ° ° L . 3 . 54 . 48 H . 2 . 82 . 49 L . 4 . 104 . 38	**H—2—20.** **L—4— 7.** 11.6 S. Cu. 221 24.0 ... . 29.8 60 83 18 SE.	**H—2—11.** **L—4—16.** 8.1 S. Cu. 207 12.0 8.3 A. Cu. 223 9.7 12.1 A. Cu. 243 23.4 12.3 Cu. 231 25.0 5.1 S. Cu. 233 22.6 30.1 45 67 7 NE. 30.1 57 55 10 E. 30.0 59 57 6 E.	**L—4—6.** ... . 5.8 Ci. S. 129 6.2 .... 29.7 64 27 30 W.	**L—4—14.** ... . 1.4 Cu. 156 2.4 ... . 29.9 84 49 12 SE.	
Mar. 31 ° ° L . 3 . 54 . 48 H . 2 . 83 . 50 H . 1 . 111 . 52 L . 4 . 100 . 38	**H—2—20.** **L—4— 7.** ... . 1.6 Cu. N. 183 9.2 ... . 29.8 52 81 13 S.	**H—2—12.** **H—1—14.** **L—4— 8.** 8.3 A. S. 211 5.1 ... . 12.2 A. S. 270 3.8 5.1 A. S. 230 5.1 30.2 47 62 10 E. 30.2 54 48 16 NE. 30.2 55 39 20 NE.		**L—4—14.** ... . 4.8 S. Cu. 145 9.0 .... 29.8 72 69 15 SE.	**H—2—13.** **L—4—15.** 7.8 S. 138 2.0 ... . 30.1 56 . 6 NE. ....
Apr. 1 ° ° H . 2 . 82 . 50 L . 5 . 98 . 39		**H—2—20.** **L—5— 8.** 8.1 Ci. S. 237 5.5 8.3 Ci. 249 3.5 12.0 S. 242 10.6 ... . 5.1 S. Cu. 238 9.8 30.3 42 48 17 NE. 30.3 47 40 13 E. 30.2 49 41 13 NE.	**L—5—5.** ... . 5.6 Ci. S. 120 4.1 .... 30.0 69 30 4 SE.		
Apr. 2 ° ° H . 6 . 78 . 37 H . 2 . 85 . 50 H . 1 . 105 . 52		**H—2—12.** **H—1—14.** 8.1 S. 261 34.3 12.1 S. 273 36.1 5.1 S. 293 22.8 ... . 30.2 37 91 13 SE. 30.2 38 83 8 E. 30.2 43 85 4 SE.			

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 29 TO MARCH 31, APRIL 1 TO 2, 1897.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6—3.				**H—6—10.**				**H—6—10.**				**H—6—9.**				**L—3—20.** **H—6— 8.**			
...	.....	...	...	...	.....	...	...	8.3	A. Cu.	40	7.9	8.4	Ci. Cu.	44	8.0	...	....	...	...
1.7	Ci.	62	4.2	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.1	Ci.	31	4.8
...	.....	...	...	...	.....	...	..	...	.....	...	...	...	.....	...	...	...	.....	...	...
5.3	Ci.	87	4.3	5.6	Ci. S.	104	2.9	4.4	A. Cu.	66	1.7	8.1	Ci. Cu.	42	6.7	5.5	Ci.	43	3.3
....	..	..	....	....	..	..	....	30.3	36	73	6 E.	30.4	32	68	5 SW.	....	..	..	....
30.3	56	50	6 NW.	....	..	..	....	....	..	..	....	....	..	..	....	30.2	46	23	20 NW.
30.3	50	41	5 SE.	30.2	48	52	7 NE.	30.2	52	48	7 SE.	30.3	36	68	12 W.	30.2	46	21	21 NW.
H—2—13.				**H—2—5.**				**H—2—5.**				**H—2—5.**				**L—3—19.** **H—2—14.**			
8.7	Ci.	62	2.7	8.6	Ci.	60	1.5	8.5	Ci.	60	5.7	8.3	Ci.	44	6.0	8.2	Ci.	50	4.1
...	.....	...	...	...	....	..	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.7	Ci.	58	2.6	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	..	.....	...	..	...	.....	...	...	...	.....	...	...
5.4	Ci.	59	2.3	6.2	Ci.	90	1.7	4.7	Ci.	62	4.0	...	....	...	...	5.9	S. Cu.	45	10.7
30.3	44	73	1 E.	30.2	45	58	2 E.	30.0	43	70	8 NE.	30.3	42	88	8 NE.	30.3	37	43	7 NW.
30.2	64	30	4 N.	....	..	..	....	....	..	..	....	....	..	..	....	....	..	..	....
30.2	60	44	2 NE.	30.2	55	34	10 NE.	30.2	56	55	7 NE.	....	..	..	....	30.1	47	32	24 N.
H—2—14.				**H—2—5.**				**H—2—5.**								**L—3—19.** **H—2—14.**			
8.4	S. Cu.	55	3.3	...	.....	...	...	...	.....	...	...					...	.....	...	...
9.5	Ci. Cu.	45	3.7	...	.....	...	..	...	.....	...	...					...	.....	...	...
9.5	A. Cu.	45	3.7	...	.....	..	...	...	.....	...	...					...	.....	...	...
2.1	Ci.	56	3.3	...	.....	...	...	1.8	Ci.	49	3.6					2.6	Ci.	2	1.9
6.0	Ci.	55	5.2	6.2	Ci. S.	55	2.0	4.3	Ci.	40	5.2					6.0	Ci.	31	1.3
30.3	45	43	8 NE.	....	..	..	....	....	..	..	....					....	..	..	....
30.3	55	34	8 NE.	....	..	..	....	30.4	52	51	17 NE.					30.2	45	25	12 E.
30.3	53	25	7 N.	30.4	42	40	20 NE.	30.4	51	56	18 NE.					30.2	39	31	11 E.
H—2—13.				**H—2— 5.** **L—5—15.**				**H—2— 5.** **L—5—15.**								**H—2—14.**			
10.6	Ci. S.	51	5.3	8.2	Ci.	55	2.9	8.3	A. Cu.	81	8.7					...	.....	...	..
...	.....	...	...	...	.....	...	...	...	.....	...	...					..	.....	..	...
1.0	Ci. S.	42	4.2	...	.....	...	...	1.7	Ci.	65	2.4					2.0	Ci.	327	3.6
1.4	Ci.	42	4.5	...	.....	..	...	...	.....	...	...					...	.....	...	...
6.3	Ci.	53	4.3	5.6	Ci. S.	80	2.3	...	.....	...	...					5.8	Ci.	348	4.0
30.5	40	45	14 NE.	30.4	42	34	16 E.	30.5	38	58	22 NE.					....	..	..	....
30.4	50	27	11 NE.	....	..	..	....	30.5	46	39	22 NE.					30.4	43	31	9 N.
30.4	48	42	5 S.	30.4	47	40	12 NE.	....	..	..	....					30.3	45	26	14 NW.
H—6— 8. **H—2—14.**				**H—6—10.** **H—2—13.**				**H—6—10.** **H—2— 5.**				**H—6—9.** **H—2—6.**				**H—6— 8.** **H—2—14.**			
8.4	Ci.	62	2.3	9.2	Ci. S.	100	2.0	8.5	A. Cu.	97	6.5	8.7	S. Cu.	30	4.0	8.0	Ci.	53	3.3
1.6	Ci.	72	2.7	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
5.3	A. Cu.	70	3.5	..	.....	..	...	4.3	A. Cu.	75	4.0	...	.....	...	...	6.2	Ci.	57	4.1
5.4	Ci. S.	70	3.6	...	.....	...	...	4.2	A. Cu.	88	4.0	...	.....	...	...	...	.....	...	...
5.5	Ci.	77	2.7	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
6.3	Ci. Cu.	70	2.8	..	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.4	42	54	2 SW.	30.3	40	53	7 E.	30.3	41	72	7 NE.	30.6	36	57	13 NE.	....	..	..	....
30.2	61	35	8 SW.	....	..	..	....	30.3	52	56	9 NE.	....	..	..	....	30.0	58	15	29 NW.
30.2	54	35	0	....	..	..	....	30.2	52	57	15 S.	....	..	..	....	30.0	54	19	28 N.

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 3 TO APRIL 7, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Apr. 3 ° ° H . 2 . 78 . 48 L . 5 . 98 . 39 H . 1 . 110 . 52		**H—2—19.** **L—5— 8.** **H—1—14.** 8.1 A. Cu. 220 23.1 8.3 Cu. 222 4.9 12.1 Fr. S. 206 7.5 5.1 S. 253 13.0 30.2 45 75 5 E. 30.0 53 63 18 SE. 29.9 53 58 15 E.	**L—5—5.** 8.4 Ci. S. 125 4.8 .... 30.0 56 36 20 NW.		
Apr. 4 ° ° H . 3 . 72 . 41 L . 2 . 95 . 44					
Apr. 5 ° ° H . 3 . 69 . 49 L . 2 . 87 . 41			... . 1.1 Ci. 105 4.1 5.6 Ci. S. 112 4.2 ... . 30.0 70 40 13 NE. 29.9 72 35 14 NE.		**L—2—6.** ... . 5.2 Fr. Cu. 118 15.0 ... . 29.8 58 42 18 W.
Apr. 6 ° ° L . 3 . 74 . 42 H . 1 . 101 . 41		**L—3—19.** **H—1— 7.** 8.1 Ci. S. 348 4.1 ... . 5.1 Cu. 46 7.0 5.3 A. Cu. 49 6.6 30.1 35 65 4 NW. .... 30.0 45 44 5 NW.		10.3 S. Cu. 100 3.1 .. .. 12.9 Ci. 133 0.4 4.9 S. Cu. 115 5.3 ... . 30.0 68 33 6 NE. 30.0 74 68 5 E. 29.9 74 36 4 N.	**L—3—20.** **H—1—14.** 7.7 Cu. 58 20.5 ... . 12.8 Cu. 80 5.9 5.2 S. Cu. 118 5.1 ... . 30.0 48 63 15 SW. 30.0 54 48 12 W. 30.0 53 53 7 NW.
Apr. 7 ° ° L . 3 . 56 . 47 H . 2 . 85 . 50 L . 4 . 105 . 38		**H—2—12.** **L—4—16.** ... . 12.1 Cu. 60 6.7 12.3 A. Cu. 81 5.8 ... . 5.1 S. Cu. 107 7.8 .... 30.1 45 51 5 NW. 30.1 44 67 10 NW.	**L—4—6.** ... . 5.5 Ci. S. 110 3.9 .... 29.6 90 9 14 SW.	**L—4—15.** 8.5 S. 80 2.8 ... . 12.9 Ci. 86 2.1 ... . 4.6 Ci. 74 5.1 29.9 66 80 3 NE. 29.9 76 68 5 N. 29.9 77 56 5 NE.	**H—2—13.** ... . 1.1 Cu. 82 3.8 ... . 30.1 54 53 6 N. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 3 TO APRIL 7, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
H—2—13. 8.1 A. Cu. 38 2.2 ... . 5.8 Ci. S. 52 5.0 30.3 48 48 12 NE. .... 30.4 50 44 10 SE.				**H—2—6.** 7.9 Ci. 44 3.3 8.4 Fr. Cu. 4 5.2 ... . 30.4 30 62 16 NE. ....
	H—3—11. **L—2—15.** 8.2 N. 345 5.1 8.4 Fr. S. 0 16.2 ... . 30.0 52 51 20 SE.			**H—3—3.** 10.2 Ci. S. 39 3.2 ... . 2.0 Ci. S. 55 3.9 2.1 Ci. Cu. 62 4.3 ... . 30.4 34 80 8 W. 30.3 53 40 18 SW. ....
H—3—19. **L—2—14.** 9.4 S. 57 12.9 8.8 A. S. 116 6.7 2.0 Cu. 107 8.3 5.7 Cu. 118 5.1 5.7 A. S. 120 5.3 6.3 A. Cu. 121 5.3 6.4 S. Cu. 113 6.0 29.9 47 100 2 N. 29.8 66 61 8 S. 29.7 65 52 4 W.	**L—2—6.** 8.3 N. 120 8.9 ... . 1.6 Cu. N. 120 6.7 5.9 A. Cu. 115 5.2 ... . 29.7 54 64 13 S. 29.6 52 56 18 W. 29.7 50 61 17 W.	... . 1.2 S. Cu. 113 11.7 ... . 29.6 50 70 20 W.	**H—3—19.** **L—2—6.** 8.6 A. Cu. 95 5.0 ... . 1.3 S. Cu. 80 7.3 5.3 S. Cu. 110 11.7 ... . 29.7 50 81 12 S. 29.6 50 55 24 SW. 29.6 52 60 28 SW.	
L—3—13. 8.2 Cu. 97 5.3 8.2 A. S. 112 5.3 9.5 Ci. Cu. 113 5.7 1.2 Cu. 123 4.6 5.6 A. Cu. 112 3.8 ... . 29.8 54 77 3 W. 29.8 59 52 18 NW. 29.9 52 51 8 NW.	**L—3—12.** 8.2 N. 95 26.3 ... . 29.8 41 92 13 W.	**L—3—12.** **H—1—15.** ... . 1.7 S. Cu. 60 9.5 4.4 Cu. S. 50 21.9 ... . 29.9 40 80 12 NW. 30.0 42 77 8 NW.		**L—3—5.** 9.2 A. Cu. 93 6.7 9.2 S. Cu. 87 28.9 ... . 2.0 Cu. N. 117 11.1 ... . 29.7 48 100 12 W. 30.0 53 77 22 W. ....
H—2—14. 8.2 A. Cu. 113 7.7 8.9 S. Cu. 112 7.6 1.3 S. Cu. 127 5.1 1.8 A. Cu. 99 6.7 1.8 Cu. 99 6.0 6.6 S. Cu. 92 6.6 30.1 48 75 1 NW. 30.1 55 52 12 SW. 30.1 56 57 3 SW.	**H—2—5.** 8.3 N. 155 10.5 ... . 30.0 39 92 4 N.			**H—2—14.** **L—3—19.** ... . 2.0 S. Cu. 92 4.0 ... . 30.0 43 83 16 E. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 8 TO APRIL 12, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Apr. 8 L. 5. 94. 33		**L—5—17.** 8.0 A. Cu. 50 10.6 8.3 Cu. 56 12.7 12.1 Cu. 77 6.9 ... . 30.2 40 53 3 NW. 30.2 47 50 6 NW.	**L—5—12.** 8.6 Fr. Cu. 11 16.4 ... . 1.4 Cu. 15 8.5 ... . 30.2 46 57 30 NW. 30.2 55 43 24 NE.	**L—5—2.** 8.4 S. 150 11.5 ... . 29.8 74 74 24 S.	
Apr. 9 H. 3. 61. 44 L. 6. 81. 38 H. 2. 85. 50		**L—6—18.** **H—2—12.** 8.1 Cu. 137 3.4 12.2 S. 199 8.9 ... . 5.1 A. Cu. 27 3.6 5.3 Cu. 30 4.3 ... . 30.2 38 58 6 SE. 30.1 38 75 4 SE. 30.1 40 66 10 N.	... . 1.8 Ci. S. 124 4.4 ... . 5.7 Cu. 40 4.2 ... . 30.2 58 35 4 N. 30.1 61 49 5 NW.	**L—6—20.** 9.3 S. 350 5.9 1.3 A. Cu. 10 5.9 ... . 4.7 S. Cu. 165 4.1 ... . 30.0 50 50 20 NW. 30.0 54 69 12 N. 30.0 52 51 12 N.	**L—6—4.** **H—2—13.** ... . 1.1 S. Cu. 2 7.0 1.2 Cu. 2 7.0 5.0 Cu. 79 6.3 5.1 Fr. Cu. 78 6.9 ... . 30.0 47 53 14 NW. 30.0 46 50 12 N.
Apr. 10 L. 3. 69. 44 H. 2. 85. 50 L. 6. 81. 24 H. 4. 102. 41		**H—2—12.** ... . 5.1 Cu. 325 4.6 ... . 30.0 46 27 4 NE.	**H—4—14.** ... . 1.6 Fr. Cu. 44 6.3 ... . 30.1 69 26 24 NW.	**L—6—18.** 8.5 Ci. 145 1.6 ... . 12.6 A. Cu. 101 2.9 ... . 4.0 Cu. 86 1.3 ... . 30.2 58 61 5 SW. 30.1 58 72 8 SW. 30.1 64 34 7 SW.	**L—3—19.** **H—2—13.** ... . 4.8 Fr. Cu. 114 6.3 4.9 S. Cu. 113 7.0 5.0 A. S. 115 8.3 .... 30.0 56 52 6 SE.
Apr. 11 L. 2. 85. 50					
Apr. 12 L. 3. 54. 47 H. 2. 81. 41 L. 4. 93. 40		**H—2—18.** **L—4—8.** 8.1 S. 285 11.3 ... . 30.2 40 68 11 NE.	**L—4—5.** ... . 5.5 Ci. S. 120 4.8 .... 30.0 73 29 5 N.	**H—2—20.** **L—4—14.** 9.6 Cu. 160 5.6 ... . 12.6 A. Cu. 142 5.4 5.7 Ci. Cu. 152 7.0 30.2 68 56 15 SW. 30.2 71 42 14 S. 30.1 72 42 12 S.	**H—2—4.** **L—4—15.** 7.7 Cu. 82 13.3 7.8 A. Cu. 82 8.7 1.1 Ci. S. 81 3.8 5.2 Ci. S. 88 3.3 30.4 45 64 12 E. 30.3 64 38 16 E. 30.2 63 40 12 E.

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 8 TO APRIL 12, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
	L—5—16.	**L—5—16.**		
9.3 Ci. Cu. 92 6.7	... .	... .		... .
... .	... .	... .		... .
1.2 N. 134 5.4	1.7 N. 0 23.3	1.8 A. S. 97 4.0		1.9 Ci. Cu. 65 9.2
... .	... .	... .		2.0 S. Cu. 352 3.0
4.0 N. 162 4.0	... .	... .		... .
30.2 48 76 2 SW.	....	....		....
30.1 50 83 4 NE.	30.1 40 84 9 N.	30.1 43 70 9 E.		30.1 42 87 7 E.
30.0 46 93 8 N.	....	....		....
H—3—19.				
L—6— 2.				
H—2—14.				
... .				
... .				
... .				
4.7 S. Cu. 61 13.5				
5.3 A. Cu. 135 6.0				
6.3 S. Cu. 124 8.1				
....				
29.6 57 8 1 W.				
29.6 54 56 22 NW.				
L—3—12.	**L—3—19.**	**L—3—19.**		**L—3— 4.**
H—2—14.	**H—2— 5.**	**H—2— 5.**		**H—2—14.**
8.3 Ci. 122 8.3	8.3 Fr. N. 68 5.7	... .		... .
8.5 Cu. 37 7.9	.. ..	... .		... .
1.0 Cu. 32 3.4	1.4 S. Cu. 122 4.0	1.2 Cu. 101 6.0		2.0 S. Cu. 87 15.0
1.1 Ci. Cu. 135 7.7	.. ..	... .		... .
1.2 Ci. 144 7.0	... .	... .		... .
6.2 A. S. 130 5.0	... .	4.7 Cu. 64 6.7		... .
6.6 S. Cu. 267 2.3	... .	... .		... .
... .	... .	... .		... .
30.0 42 66 20 N.	30.0 32 79 9 W.	....		....
30.0 48 47 15 NW.	30.1 39 59 11 W.	30.1 41 60 10 SW.		29.9 43 86 7 W.
30.1 47 47 6 NW.	....	30.1 41 55 8 SW.		....
				L—2—14.
				... .
				2.1 S. Cu. 52 15.5
				... .
				....
				30.0 39 81 11 N.
				....
H—2—2.	**H—2— 3.**	**H—2— 3.**		**L—3—19.**
	L—4—15.	**L—4—15.**		**H—2— 7.**
9.4 S. Cu. 336 10.0	8.3 A. S. 58 4.0	... .		8.0 Ci. 104 4.5
8.2 Cu. 19 10.1	8.6 Cu. 220 3.7	... .		... .
1.2 S. Cu. 340 4.1	... .	12.4 Ci. S. 76 4.3		2.1 Cu. 50 2.0
5.7 S. Cu. 333 2.3	... .	4.5 S. 170 1.5		... .
30.4 45 80 14 N.	30.5 32 79 Lt. S.	....		....
30.5 50 61 8 NE.	....	30.4 44 57 11 SE.		29.4 39 52 6 NW.
30.6 47 66 4 SE.	....	30.4 45 64 12 SE.		29.4 51 23 17 NW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 13 TO APRIL 17, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Apr. 13 ° ° H . 3 . 61 . 44 L . 2 . 89 . 43 H . 4 . 106 . 41		**L—2— 4.** **H—4—16.** 8.1 S. 8 42.9 12.1 Cu. 334 35.2 12.3 A. Cu. 327 37.6 5.1 S. Cu. 41 11.1 ... . 30.0 37 87 14 NW. 30.1 45 64 10 NW. 30.1 53 42 7 NW.	**L—2—20.** **H—4—14.** 8.4 S. Cu. 175 5.5 1.5 S. 294 4.0 ... . 30.3 54 54 24 NE. 30.3 56 77 13 N.	**L—2—18.** 9.4 S. Cu. 16 2.3 1.0 Cu. 192 1.6 ... . 30.2 70 62 7 SW. 30.2 77 62 8 SW.	**L—2—6.** ... . 1.2 Fr. Cu. 116 13.2 ... . 30.1 65 61 26 S. ....
Apr. 14 ° ° H . 3 . 58 . 45 H . 6 . 77 . 33 H . 5 . 100 . 34 L . 2 86 . 52		**L—2— 5.** **H—5—16.** ... . 12.1 Cu. 133 6.3 ... . 5.1 Cu. 102 7.9 .... 30.0 53 47 9 S. 30.0 58 46 3 SW.		**H—6—19.** **H—5— 7.** 10.3 Cu. 100 4.7 12.7 S. Cu. 33 2.1 ... . 4.9 S. Cu. 81 4.8 29.0 66 82 10 W. 30.0 62 79 12 NW. 30.0 61 68 15 N.	
Apr. 15 ° ° L . 3 . 74 . 39 L . 2 . 88 . 48 H . 4 . 108 . 44		**L—2—12.** **H—4—15.** ... . 12.1 Cu. 354 13.6 ... . 30.0 49 49 18 NW.		10.9 Cu. 342 2.4 ... . 12.8 Ci. 132 0.3 ... . 30.2 58 56 6 NW. 30.1 63 61 6 NW.	**L—3—11.** **L—2—15.** 7.6 A. Cu. 302 9.0 ... . 30.1 46 75 5 NW. ....
Apr. 16 ° ° L . 3 . 67 . 47 L . 2 . 85 . 43 H . 4 . 99 . 42			**H—4—13.** 8.4 A. Cu. 45 2.5 ... . 30.3 53 78 4 NE.	**L—2—20.** **H—4— 8.** 10.0 A. S. 85 3.3 12.8 S. Cu. 83 1.9 ... . 30.1 62 44 5 NE. 30.1 58 83 12 N.	**L—2— 5.** **H—4—15.** 7.7 Cu. 77 32.3 1.3 Cu. 85 6.2 4.6 Cu. 80 4.3 ... . 30.1 47 66 14 W. 30.0 55 46 16 W. 30.0 55 48 15 W.
Apr. 17 ° ° L . 3 . 73 . 45 H . 5 . 94 . 39 L . 1 . 110 . 54		**H—5— 9.** **L—1—14.** 8.1 S. Cu. 21 7.2 ... . 5.1 A. S. 21 3.8 ... . 30.1 44 63 6 SW. .... 29.9 62 45 13 SW.	**H—5—12.** 8.3 A. Cu. 54 2.8 ... . 5.4 Ci. S. 78 4.4 5.5 A. Cu. 82 3.6 30.2 59 39 16 S. .... 30.0 77 35 14 S.		

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 13 TO APRIL 17, 1897.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—3—19.				**L—2—7.**				**L—2—7.**								**H—3—11.**			
L—2—16.																**L—2—15.**			
8.7	S.	203	11.9	8.3	Fr. S.	150	8.3	...	.....	...	...					8.0	Ci.	86	3.1
1.1	Ci.	100	2.5	1.0	Fr. S.	160	23.2	...	.....	...	...					2.1	A. S.	100	5.5
...	.....	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
5.5	Ci.	114	3.8	5.4	N.	140	24.0	...	.....	...	...					5.6	Ci. S.	90	2.4
5.6	A. S.	114	4.3	...	.....	...	...	4.3	S. Cu.	132	23.2					.	.....	...	...
30.6	42	84	6 SE.	30.0	53	52	15 SE.	....	..	..	....					29.6	44	46	9 SW.
30.4	56	55	12 S.	29.9	60	60	35 S.	....	.	..	....					29.5	49	27	32 S.
30.3	54	64	8 S.	29.9	60	70	30 S.	29.9	55	73	29 SW.					29.4	45	49	28 S.
H—6—9.				**H—6—17.**				**H—6—18.**								**H—3—19.**			
																H—6—16.			
8.2	A. Cu.	108	4.8	8.3	S. Cu.	90	7.2	9.3	Cu. S.	45	31.8					8.0	S. Cu.	127	9.8
1.1	Cu.	116	4.7	...	.....	...	...	1.7	S. Cu.	33	4.8					2.0	Ci. S.	97	10.2
...	.....	...	...	...	.....	...	...	1.8	Ci. Cu.	121	6.7					2.1	S. Cu.	114	18.6
6.6	S. Cu.	124	4.1	...	.....	...	...	4.3	S. Cu.	50	9.8					...	.....	...	...
30.1	60	78	15 SW.	30.0	40	84	12 W.	30.1	42	84	10 W.					30.1	48	89	24 SW.
30.0	75	35	10 SW.	....	..	..	...	30.1	48	73	4 W.					29.9	65	55	19 SW.
30.0	65	63	3 NE.	....	..	..	....	30.1	48	83	6 E.					....	..	..	....
L—3—4.				**L—3—10.**				**L—3—10.**				**L—3—10.**				**L—3—3.**			
L—2—14.				**L—2—6.**				**L—2—6.**				**L—2—6.**				**L—2—15.**			
10.4	N.	104	5.5	...	.....	...	...	8.2	Cu. S.	42	3.0	...	.....	...	...	8.0	N.	134	19.7
11.0	A. Cu.	91	4.0	...	.....	...	...	...	.....	...	...	...	.....	..	...	...	.....	...	..
11.8	S. Cu.	72	14.4	...	.....	...	...	...	.....	...	...	...	-----	...	...	...	.....	...	...
...	.....	...	...	...	.....	..	...	1.3	S. Cu.	91	5.0	1.5	S. Cu.	28	13.3	2.1	N.	149	41.3
...	.....	...	...	...	.....	...	...	...	.....	...	...	1.6	A. S.	75	2.0	...	.....	...	...
...	.....	...	...	5.6	A. Cu.	120	3.8	4.3	S. Cu.	94	5.0	...	....	...	...	...	.....	...	..
29.8	50	97	4 NW.	....	..	..	....	30.0	43	74	3 NW.	....	..	..	....	29.9	45	100	18 NE.
29.9	60	73	20 NW.	....	..	..	....	30.0	52	51	10 SW.	30.0	41	69	12 SW.	29.7	58	88	17 S.
30.0	50	62	8 N.	30.0	51	45	5 W.	29.9	53	52	10 S.	....	..	..	....	....	..	..	....
L—3—20.				**L—3—19.**				**L—3—19.**											
L—2—6.				**L—2—2.**				**L—2—2.**											
				H—4—15.				**H—4—15.**											
8.4	S. Cu.	121	7.6	8.6	N.	150	7.2	...	.....	...	...								
1.9	Ci.	128	4.9	1.5	N.	157	8.9	1.2	S. Cu.	140	11.7								
5.6	A. Cu	134	4.0	5.3	N.	127	12.2	4.4	S. Cu.	128	17.1								
5.6	Ci. Cu.	130	4.0	...	.....	...	...	...	.....	...	...								
5.7	A. S.	130	4.3	...	.....	...	...	...	.....	...	...								
6.5	Ci.	125	4.8	...	.....	...	...	...	.....	...	...								
30.0	46	79	2 N.	29.8	45	85	12 S.	....	..	..	....								
30.0	60	46	14 S.	29.8	50	83	18 W.	29.8	42	78	16 SW.								
29.9	58	61	5 SE.	29.9	45	58	13 SW.	29.8	41	76	23 SW.								
L—3—12.				**L—3—12.**				**L—3—11.**								**L—3—1.**			
H—5—15.				**H—5—15.**				**H—5—8.**											
8.3	Cu.	87	6.1	8.6	N.	55	16.6	8.2	Cu. S.	48	31.7					8.1	S. Cu.	162	9.8
1.0	Cu.	105	6.3	...	.....	...	...	1.4	S. Cu.	51	14.1					...	.....	...	...
6.3	S. Cu.	71	6.9	5.6	Fr. S.	75	11.8	4.4	Cu.	66	11.7					3.2	Ci.	197	9.5
...	.....	...	...	...	.....	...	...	...	.....	...	...					3.5	S. Cu.	99	20.8
29.9	48	79	1 NE.	30.0	36	77	21 W.	30.0	34	..	16 NW.					29.8	47	70	10 S.
30.0	53	52	24 NW.	....	..	..	....	30.1	36	82	11 W.					29.7	45	100	11 SW.
30.1	46	56	8 NW.	30.1	37	74	12 W.	30.1	44	62	12 W.					....	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 18 TO APRIL 22, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Apr. 18 ° ° H . 6 . 79 . 37 L . 2 . 92 . 48			... . 1.5 Ci. 54 2.4 5.6 Ci. 76 2.7 .... 30.0 76 31 30 S. 29.9 79 25 22 S.		
Apr. 19 ° ° L . 3 . 75 . 48 H . 6 . 84 . 32 H . 2 . 93 . 48		**L—3—19.** **H—2— 6.** 8.1 Cu. 230 9.2 ... . 30.5 24 48 13 NW.	**H—6—19.** ... . 1.6 Ci. 87 3.1 1.6 Fr. Cu. 222 16.1 5.4 Ci. S. 94 3.0 .... 30.2 70 62 18 SE. 30.2 71 68 18 SE.		**L—3—20.** **H—6— 9.** **H—2—14.** ... . 1.0 Ci. 76 3.7 ... . 30.3 53 44 18 N. ....
Apr. 20 ° ° H . 2 . 84 . 41		**H—2—10.** ... . 5.1 S. 198 13.2 ... . 30.3 44 43 16 SE.	8.6 Fr. S. 181 24.3 1.6 A. Cu. 114 3.9 5.7 Ci. S. 103 2.8 ... . 30.3 59 89 16 SE. 30.2 70 68 28 SE. 30.0 75 34 20 SE.	**H—2—20.** ... . 5.1 Ci. 115 4.5 ... . 30.3 73 39 4 N.	**H—2—1.** 7.7 Ci. 43 12.6 1.1 Ci. 50 4.2 5.1 Ci. S. 55 3.3 ... . 30.7 34 75 12 NE. 30.6 50 33 12 NE. 30.5 53 34 10 NE.
Apr. 21 ° ° H . 6 . 75 . 37 L . 1 . 108 . 54		**L—1—14.** 8.1 Fr. S. 213 43.1 12.1 S. 169 27.8 ... . 5.1 Cu. 164 25.8 5.3 A. Cu. 190 16.7 29.9 43 85 12 S. 29.8 58 67 18 S. 29.7 65 65 20 S.	8.7 A. Cu. 113 3.4 1.5 Fr. Cu. 172 15.6 1.7 A. Cu. 109 2.6 5.5 A. S. 147 4.2 5.9 Cu. N. 144 2.5 30.0 64 79 18 S. 30.0 71 65 34 S. 29.9 72 65 24 SE.	**H—6—19.** ... . 5.1 Cu. 176 6.8 ... . 30.2 81 35 20 SW.	
Apr. 22 ° ° H . 6 . 72 . 39 L . 2 . 85 . 51		**L—2—5.** ... . 5.1 A. Cu. 103 11.3 5.3 Cu. 107 13.8 .... 29.7 71 41 12 SW.	... . 1.5 Cu. 188 10.6 ... . 5.8 Ci. S. 120 3.8 5.7 S. 189 9.1 .... 30.0 73 58 24 SW. 29.9 77 56 20 SE.	9.2 Cu. 105 1.7 9.3 S. 175 8.3 12.9 Cu. 186 5.4 ... . 5.1 S·Cu. 104 3.3 ... . 30.2 72 66 12 SE. 30.2 79 62 14 S. 30.1 73 65 5 SW.	**H—6—19.** 7.6 Ci. S. 130 4.3 ... . 1.2 Cu. 124 8.5 1.3 A. Cu. 120 3.5 4.6 Cu. 134 6.2 ... ... 30.3 63 33 16 S. 30.2 74 32 14 S. 30.2 74 36 12 S.

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 18 TO APRIL 22, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
	H—6—10. **L—2—14.** ... . 1.6 Ci. 82 2.3 ... ... 30.0 60 34 22 S.			
L—3—13. **H—6—16.** 8.3 Ci. 113 1.8 11.8 A. Cu. 103 5.1 12.8 A. S. 100 8.3 1.7 S. Cu. 92 8.3 5.7 S. Cu. 116 6.4 30.1 54 64 12 S. 30.1 71 34 12 NW. 30.2 54 33 12 N.	**L—3—12.** **H—6—17.** **H—2—14.** 8.3 S. Cu. 50 23.0 ... . 1.6 S. Cu. 55 8.9 ... . 5.8 S. Cu. 72 5.8 30.1 35 65 31 W. 30.3 33 90 22 W. 30.4 32 90 15 NW.	**L—3—12.** **H—6—17.** **H—2—14.** 8.3 Cu. 54 10.3 ... . 1.8 S. Cu. 60 8.3 ... . 4.4 Cu. 60 8.6 30.2 26 69 24 NW. 30.4 32 50 13 W. 30.4 31 48 15 NW.		**L—3—6.** ... . 4.0 Cu. N. 136 14.3 .... 30.1 57 53 32 SW.
	H—2—2. 8.3 S. Cu. 320 4.3 ... . 30.7 28 88 6 NW.		**H—2—2.** 8.6 S. Cu. 75 11.7 1.7 S. Cu. 84 13.3 4.9 A. Cu. 73 15.0 5.0 S. Cu. 73 15.0 30.7 23 73 6 NE. 30.7 29 60 15 SW. 30.6 31 52 15 W.	
H—6—3. ... . 1.6 Ci. 24 3.0 ... . 5.7 Ci. 26 2.3 ... . 30.6 44 32 13 SE. 30.5 54 48 8 S.			**H—6—10.** ... . 1.8 Ci. S. 30 9.7 ... . 30.5 50 16 6 W.	
	H—6—10. **L—2—14.** 8.2 Ci. S. 124 3.3 8.5 S. 155 5.2 1.5 A. Cu. 140 5.4 ... . 5.6 Ci. Cu. 303 2.0 ... . 30.3 58 42 13 SE. 30.1 74 40 22 S. 30.2 70 52 13 S.	**H—6—10.** **L—2—14.** ... . 1.7 S. Cu. 121 13.3 ... . 4.3 S. 118 10.5 ... . 30.1 72 49 25 SW. 30.1 69 59 13 SW.	**H—6—10.** ... . 5.1 A. Cu. 125 5.0 5.2 S. Cu. 125 5.0 .... 30.1 63 38 20 W.	**H—6—3.** 8.2 Ci. 92 1.1 ... . 2.2 Ci. Cu. 85 0.8 ... . 30.5 48 66 13 SW. 30.4 64 29 20 S. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 23 TO APRIL 26, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Apr. 23 ° ° H. 6. 75. 36 L. 2. 90. 46		**L—2—4.** ... . 5.1 A. Cu. 122 7.1 5.3 Ci. 119 6.6 ... . 29.9 73 35 7 NW.	8.6 S. 190 23.1 ... . 1.2 S. 191 13.5 ... . 5.7 S. 191 6.1 6.0 Ci. 136 3.3 ... . 30.0 69 81 19 S. 29.9 74 62 20 SE. 29.9 74 58 19 SE.	10.1 S. Cu. 120 1.7 ... . 12.9 A. Cu. 102 1.6 ... . 5.1 Cu. 168 4.7 ... . 30.2 73 61 7 SE. 30.2 74 69 4 W. 30.1 79 43 3 N.	**H—6—11.** **L—2—6.** 7.6 S. Cu. 125 5.7 ... . 12.8 Cu. 116 6.5 ... . 5.3 S. Cu. 137 7.2 ... . 30.3 65 61 12 S. 30.2 72 48 10 S. 30.2 75 50 11 S.
Apr. 24 ° ° H. 6. 82. 34 L. 1. 102. 53		**H—6—18.** **L—1—14.** 8.1 S. Cu. 121 9.8 ... . 5.1 Cu. 66 10.4 ... . 30.0 49 73 7 NW. .... 29.9 64 43 13 NW.	8.2 S. 181 10.4 ... . 1.7 Cu. 175 4.8 ... . 5.8 Ci. S. 118 4.2 ... . 29.9 70 86 9 S. 29.9 78 60 13 SE. 29.8 77 65 22 SE.	**H—6—11.** 9.7 A. Cu. 190 2.2 ... . 1.0 Cu. 133 3.6 ... . 5.6 S. Cu. 145 3.7 ... . 30.2 72 55 6 SE. 30.2 76 72 9 W. 30.1 78 53 7 W.	**H—6—10.** ... . 1.1 Cu. 144 4.6 ... . 5.2 Ci. S. 140 1.7 ... . 30.2 81 40 14 S. 20.1 80 44 7 S.
Apr. 25 ° ° L. 3. 77. 48 H. 6. 80. 30 H. 4. 110. 43			**H—4—15.** 8.4 S. 205 1.8 ... . 1.4 S. 359 9.4 5.0 S. Cu. 333 3.3 5.6 Ci. S. 130 4.1 5.2 A. Cu. 123 3.0 30.2 61 87 5 NE. 30.2 66 75 13 N. 30.1 69 70 9 NE.		
Apr. 26 ° ° L. 2. 81. 45 H. 5. 101. 34			**H—5—1.** 8.1 Cu. 258 3.0 9.0 Ci. 106 4.8 .. .. 1.3 Cu. 216 1.9 ... . 5.7 S. 235 2.8 30.3 63 89 3 N. 30.1 74 54 7 SE. 30.0 76 50 9 SE.	**H—5—7.** ... . 5.1 Ci. 103 3.0 .... 30.0 74 40 5 NE.	**L—2—12.** **H—5—16.** ... . 5.2 Cu. 78 13.6 .... 30.0 74 50 17 NW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 23 TO APRIL 26, 1897.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6—3.				**H—6—10.**				**H—6—10.**				**H—6—10.**				**H—6—8.**			
L—2—14.				**L—2—6.**				**L—2—6.**				**L—2—15.**				**L—2—15.**			
11.7	Ci. Cu.	84	1.4	8.4	Fr. Cu.	75	3.3	...	.....	...	...	...	.....	...	...	8.1	Ci. S.	252	2.0
...	.....	...	...	8.6	Fr. S.	75	5.5	...	.....	...	...	...	.....	...	...	8.1	Ci. Cu.	260	2.0
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	8.1	Ci.	255	2.0
1.4	Ci.	68	1.2	2.6	Fr. N.	135	7.1	1.2	Ci. Cu.	120	6.5	1.8	Ci. S.	142	3.8	2.2	Ci. S.	239	0.8
...	.....	...	...	...	.....	...	...	1.3	S. Cu.	167	13.6	...	.....	..	...	...	.....	...	...
5.6	Ci.	33	1.3	5.7	Ci. S.	95	1.3	4.3	S. Cu.	128	26.7	5.0	Ci.	85	4.0	...	.....	...	...
...	.....	...	...	7.0	Ci. S.	90	1.7	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	7.2	Ci. Cu.	110	3.0	...	.....	..	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	7.4	Fr. S.	115	5.5	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.4	52	75	2 E.	30.2	64	70	10 S.	....	..	..	....	....	..	..	....	30.3	56	37	21 SW.
30.2	75	27	12 SE.	30.1	76	45	17 SW.	30.0	72	57	20 SW.	....	..	..	....	30.2	72	32	24 S.
30.2	68	48	4 S.	30.0	73	50	22 SW.	30.0	69	69	16 SW.	30.1	70	64	16 SW.	....	..	..	....
H—6—8.				**H—6—9.**				**H—6—9.**				**H—6—17.**				**H—6—16.**			
...	.....	...	...	8.5	Fr. N.	97	8.5	...	.....	...	...	...	.....	...	...	8.4	Ci. S.	89	1.1
...	.....	...	...	8.5	Ci. Cu.	85	4.0	...	.....	...	...	...	.....	...	...	8.4	Ci. Cu.	112	4.3
...	.....	...	...	8.8	Ci. S.	85	1.7	...	.....	...	...	...	.....	...	...	...	.....	...	...
2.6	Cu.	78	2.9	2.3	N.	140	7.7	1.8	Cu.	137	14.0	...	.....	...	...	2.2	A. Cu.	73	3.6
...	.....	...	...	2.5	Cu.	117	3.0	...	.....	...	...	...	.....	...	...	...	.....	...	...
5.9	A. Cu.	49	3.7	5.4	Ci.	89	2.0	4.3	S. Cu.	130	15.9	5.0	Ci. Cu.	80	4.7	6.1	A. Cu.	251	2.1
...	.....	...	...	5.6	Cu. N.	130	6.4	...	.....	...	...	...	.....	...	...	.	.....	...	...
....	..	..	....	30.1	62	79	8 W.	....	..	..	....	....	..	..	....	30.2	55	70	17 SW.
30.1	84	34	5 N.	30.0	77	52	7 NW.	30.0	72	69	8 S.	....	.	..	....	30.0	72	39	22 S.
30.1	74	47	4 S.	29.9	78	53	7 S.	30.0	72	77	17 SW.	30.0	60	76	12 SW.	30.1	61	56	22 S.
				L—3—12.												**L—3—6.**			
				H—6—17.															
				8.3	Fr. S.	120	21.1									8.6	Ci. S.	275	1.9
				8.7	S.	120	5.0									...	.....	...	...
				...	.....	...	...									2.1	Ci. S.	54	1.2
				...	.....	...	...									5.9	Ci.	118	2.2
				...	.....	...	...									...	.....	...	...
				...	.....	...	...									...	.....	...	...
				29.9	66	66	6 S.									30.0	57	70	14 S.
				....	..	..	....									29.8	76	38	26 S.
				....	..	..	....									29.8	61	55	23 S.
L—2—6.				**L—2—1.**				**L—2—1.**				**L—2—1.**				**L—2—7.**			
8.6	A. S.	115	2.5	8.3	S. Cu.	88	8.2	...	.....	...	...	...	.....	...	...	8.4	Ci. S.	121	3.9
9.4	Ci. Cu.	111	2.3	...	....	...	...	...	.....	...	...	...	.....	...	...	8.3	Ci. Cu.	128	4.7
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	8.4	Cu.	354	12.9
12.9	Ci. S.	121	2.8	1.7	S. Cu.	70	7.7	1.8	Cu.	35	8.3	1.8	S. Cu.	72	25.0	2.2	Ci. S.	137	4.7
...	.....	...	..	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.2	Cu.	155	18.1
6.5	S. Cu.	87	6.0	...	.....	...	...	4.3	S. Cu.	20	9.0	...	...	...	...	...	.....	...	...
29.9	58	64	8 N.	29.8	56	60	12 SW.	....	..	..	....	....	..	..	....	29.8	54	73	16 N.
29.8	69	35	10 SW.	29.8	58	42	23 W.	29.8	53	58	19 NW.	29.7	44	85	38 W.	29.6	64	45	12 S.
29.8	58	46	20 N.	....	..	..	....	29.9	52	57	18 NW.	....	..	..	....	....	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 27 TO APRIL 30, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
Apr. 27 ° ° L . 3 . 68 . 44 H . 2 . 85 . 42 L . 2 . 95 . 50		**H—2—10.** **L—2—6.** ... . 5.1 Ci. S. 56 4.2 ... . 29.6 76 45 24 SW.	8.7 S. 193 23.3 ... . 1.3 Fr. N. 189 17.3 1.6 Cu. N. 148 6.3 5.2 S. 186 16.0 5.6 Fr. N. 188 16.7 29.9 68 81 16 SE. 29.8 68 82 20 SE. 29.7 75 70 16 SE.	**H—2—20.** 8.7 Ci. 80 2.0 ... . 12.9 Ci. 43 0.8 ... . 5.1 Ci. 80 3.7 ... . 30.1 73 46 6 SE. 30.0 81 63 9 SE. 29.9 78 43 4 S.	
Apr. 28 ° ° H . 2 . 80 . 39 L . 3 . 68 . 42 L . 5 . 95 . 38 H . 1 . 103 . 52		**H—2—18.** **L—5—9.** **H—1—14.** 8.1 N. 13 16.7 ... . 12.1 S. 23 4.9 ... . 5.1 A. S. 156 4.2 ... . 29.8 53 63 15 N. 29.9 52 69 13 N. 30.0 56 30 16N.	**L—5—12.** ... . 1.5 Cu. 47 4.8 ... . 5.5 Cu. 41 11.2 ... . 29.8 76 35 20 NW. 29.9 64 65 50 NW.	**H—2—20.** **L—5—6.** 9.5 S. Cu. 100 5.0 .. .. 5.1 S. Cu. 141 6.7 ... . 29.9 73 65 8 SE. .... 29.8 68 81 4 SE.	**H—2—4.** **L—5—7.** ... . 4.9 Ci. Cu. 134 8.1 5.0 Ci. 132 5.3 .... 29.8 82 29 11 S.
Apr. 29 ° ° L . 3 . 69 . 42 L . 5 . 89 . 37 H . 2 . 90 . 52				**L—5—5.** 10.6 S. 95 3.8 ... . 5.6 S. Cu. 35 13.9 ... . 29.8 64 79 13 W. .... 29.8 62 74 15 NW.	**L—3—19.** **L—5—2.** **H—2—13.** 7.6 A. Cu. 144 6.9 7.7 S. Cu. 144 6.3 ... . 12.9 S. Cu. 164 4.9 ... . 29.8 67 66 9 SE. 29.7 77 47 9 SW. ....
Apr. 30 ° ° L . 3 . 62 . 44 L . 6 . 85 . 37 H . 2 . 85 . 50		**L—6—18.** **H—2—12.** 8.1 Ci. 99 6.4 .. .. 30.2 41 61 7 N.	**L—6—19.** 8.5 A. Cu. 57 2.8 ... . 30.2 56 60 7 N.	**L—6—12.** ... . 12.6 Cu. N 43 4.9 ... . 4.3 S. Cu. 12 18.3 ... . 29.9 60 73 22 NW. 29.9 61 68 20 NW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 27 TO APRIL 30, 1897.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
L—3—12.																**L—3—4.**			
H—2—6.																**H—2—15.**			
8.2	Cu.	25	11.3													8.2	A. S.	85	3.5
...	.....	...	...													8.2	S. Cu.	69	7.5
...	....	...	..													2.2	S. Cu.	45	11.8
...	.....	...	...													...	.....	...	...
...	.....	...	...													...	.....	...	...
...	.....	...	...													...	.....	...	...
30.0	45	51	26 NW.													29.6	41	52	30 W.
....	..	..	....													29.6	39	54	28 NW.
....	..	..	....													....	..	..	....
L—3—11.				**L—3—19.**				**L—3—19.**				**L—3—11.**				**L—3—4.**			
H—2—2.				**H—2—3.**				**H—2—3.**				**H—2—3.**				**H—2—8.**			
				L—5—16.				**L—5—16.**				**L—5—16.**							
8.4	A. S.	10	7.3	8.6	Ci.	35	2.7	8.4	Ci.	72	4.7	8.7	Ci. S.	43	3.3	8.3	A. Cu.	342	7.8
9.4	Ci. S.	25	4.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	8.3	Cu.	335	8.6
9.5	A. Cu.	12	8.0	...	.....	...	...	...	.....	...	...	...	.....	...	...	8.3	Fr. Cu.	320	16.0
10.2	Ci.	28	4.7	...	.....	...	...	...	.....	...	...	1.8	Ci.	59	4.0	2.1	Fr. Cu.	347	3.9
...	.....	...	...	...	.....	...	...	...	.....	...	...	2.0	Ci. S.	59	4.0	...	.....	...	...
5.8	Ci. S.	34	4.0	5.0	Ci. S.	90	2.3	4.2	A. Cu.	70	5.0	5.0	Ci. S.	48	5.0	...	.....	...	...
6.5	Ci.	35	4.0	5.1	Fr. S.	70	4.0	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	5.3	A. Cu.	58	2.3	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.1	51	35	16 NW.	30.1	49	54	10 E.	30.0	54	70	12 SW.	30.1	44	74	8 SW.	29.9	40	80	20 NE.
30.0	55	25	15 NW.	....	..	..	....	....	..	..	....	30.0	54	38	6 SW.	29.9	44	67	22 NE.
29.9	62	37	5 SE.	29.9	67	47	Lt. S.	29.9	69	51	11 SE.	29.9	61	9	5 SW.	....		..	....
L—3—12.								**L—3—19.**				**L—3—11.**				**L—3—4.**			
L—5—15.								**L—5—8.**				**L—5—16.**							
								H—2—14.				**H—2—14.**							
8.3	A. Cu.	35	3.7					8.4	Cu. S.	142	9.1	...	.....	...	...	8.3	A. Cu.	325	5.4
9.4	Ci.	37	2.3					...	.....	..	...	...	.....	...	...	8.6	Ci.	330	...
9.5	Ci. Cu.	35	3.3					...	.....	...	...	...	.....	...	...	...	.....	...	...
1.2	A. Cu.	48	2.5					...	.....	...	...	1.9	Ci. S.	68	4.0	2.1	A. S.	344	3.9
1.8	Ci.	48	1.6					...	.....	...	...	...	.....	...	...	2.2	S.	347	8.0
...	.....	...	...					...	.....	...	...	...	.....	...	...	2.4	Ci.	331	3.8
6.8	Ci. Cu.	96	1.7					...	.....	...	...	5.1	A. S.	0	6.0	2.5	Ci. Cu.	342	8.3
6.9	Ci.	101	1.9					...	.....	...	...	...	.....	...	...	...	.....	...	...
30.0	53	68	4 E.					29.9	55	65	7 NE.	....	..	..	....	29.9	44	78	14 N.
30.0	68	36	....					....	..	..	....	29.9	71	27	15 E.	29.8	53	72	13 E.
29.9	64	44	4 SE.					....	..	..	....	29.9	70	27	14 NE.	....	..	..	....
L—6—8.				**L—3—19.**				**L—6—9.**				**L—3—19.**				**L—3—11.**			
H—2—14.				**L—6—8.**				**H—2—5.**				**L—6—8.**				**L—6—16.**			
				H—2—13.								**H—2—6.**				**H—2—14.**			
8.7	S.	210	11.2	....	.....	..	...	8.3	A. S.	145	5.5	...	.....	...	...	9.2	Ci.	59	2.4
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	9.4	A. Cu.	62	6.5
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	9.7	Fr. Cu.	55	6.8
1.0	S. Cu.	213	8.3	...	.....	...	...	...	.....	...	...	1.8	S. Cu.	147	3.6	2.2	Ci.	70	1.9
...	.....	...	...	...	.....	...	...	...	.....	...	...	1.9	A. Cu.	147	3.3	...	.....	..	...
6.0	A. S.	162	2.3	5.5	Fr. S.	190	6.4	..	.....	...	...	5.0	S.	110	5.0	6.3	Ci.	77	...
6.7	S. Cu.	198	3.9	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
30.0	57	70	3 E.	....	..	..	....	29.9	52	74	9 N.	....	..	..	....	29.8	61	61	6 N.
30.0	72	61	12 SE.	....	..	..	....	....	..	..	....	29.9	64	53	23 E.	30.0	74	42	5 NW.
29.9	68	67	8 E.	29.8	51	87	8 NW.	....	..	..	....	29.8	61	57	24 E.	30.0	61	57	19 S.

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 1 TO MAY 5, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
May 1 ° ° H . 3 . 67 . 48 H . 5 . 99 . 33			**H—5—1.** ... . 1.4 Ci. 94 1.9 2.1 Ci. S. 95 1.7 5.4 Ci. 100 1.9 .... 30.1 73 42 6 SW. 30.0 74 33 5 SE.	**H—5—7.** 8.4 Cu. 350 3.5 ... . 30.0 60 58 12 N.	
May 2 ° ° L . 4 . 102 . 38			**L—4—5.** 8.4 A. Cu. 100 3.9 ... . 30.0 66 49 16 S.		
May 3 ° ° H . 3 . 61 . 47 L . 2 . 77 . 40 H . 4 . 97 . 42			**H—4—13.** 8.1 A. Cu. 102 1.9 8.7 A. S. 102 1.8 1.3 Ci. S. 133 2.3 1.4 A. Cu. 136 2.0 1.6 Fr. Cu. 227 4.8 1.9 A. S. 133 2.3 5.3 Ci. S. 84 2.0 5.8 A. S. 116 2.1 30.0 72 53 3 E. 30.0 82 47 10 NE. 29.9 79 34 22 NE.	**L—2—20.** **H—4—14.** 9.0 A. Cu. 40 3.4 ... . 5.1 Ci. 82 6.7 ... . 29.9 65 73 9 W. .... 29.9 78 43 3 NW.	
May 4 ° ° L . 3 . 75 . 43 H . 5 . 95 . 40 H . 3 59 . 47			**H—5—12.** 8.5 A. Cu. 128 2.1 ... . 1.6 A. Cu. 145 3.0 1.7 Cu. 190 4.2 5.3 A. Cu. 138 4.3 6.0 Fr. S. 241 5.0 30.1 64 44 19 E. 30.1 76 34 8 SE. 30.0 73 54 12 NE.	**H—5—6.** 9.6 Ci. 62 2.4 ... . 30.1 71 48 4 NW.	**L—8—20.** **H—5— 7.** ... . 12.8 S. Cu. 33 5.8 ... . 30.1 58 60 6 NW. ....
May 5 ° ° L . 6 . 73 . 37 H . 5 . 90 . 38 L . 2 . 100 . 46	**H—5—4.** **L—2—6.** ... . 1.2 Ci. 139 0.7 ... . 5.6 Ci. 69 2.0 .... 30.2 79 28 4 E. 30.1 77 30 4 NE.		**H—5—20.** **L—2—13.** 8.4 A. S. 133 2.4 9.9 A. Cu. 129 2.8 10.1 Fr. S. 122 13.3 1.6 S. 158 4.2 1.7 A. Cu. 105 2.9 5.7 Fr. S. 185 6.1 30.2 59 94 12 NW. 30.2 69 72 7 SW.	**H—5—5.** ... . 5.1 Ci. 73 6.0 .... 30.0 76 45 9 NW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 1 TO MAY 5, 1897.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—3—20.																			
8.3	Fr. S.	202	20.2																
8.5	S.	202	19.3																
3.0	Fr. N.	203	35.0																
...	.....	...	...																
5.7	N.	202	31.7																
29.8	64	82	10 SE.																
29.7	62	99	12 SE.																
29.6	61	93	12 SE.																
L—2—1.				**L—2— 4.**				**L—2—10.**				**H—3—19.**				**H—3—12.**			
				H—4—15.				**H—4—15.**				**L—2— 3.**				**L—2— 8.**			
												H—4—15.							
9.1	N.	212	11.2	...	.....	...	...	8.5	Cu.	328	11.3	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.6	N.	87	10.8	1.5	S. Cu.	340	3.1	1.7	S. Cu.	120	4.6	1.8	S. Cu.	336	8.3	2.2	Fr. Cu.	354	13.5
2.2	A. S.	233	1.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
2.3	Fr. S.	88	16.0	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
...	.....	...	...	5.2	S. Cu.	5	1.8	4.3	S. Cu.	82	10.0	...	.....	...	...	6.0	Ci.	165	4.1
...	.....	...	...	...	.....	...	...	...	.....	...	..	...	.....	...	...	6.1	Ci. Cu.	340	5.2
29.7	47	86	5 SE.	....	..	..	....	29.8	45	82	7 SW.	....	..	..	....	....	..	..	....
29.7	47	86	7 NW.	29.8	50	58	9 NW.	29.8	53	69	12 W.	29.8	50	64	12 W.	29.8	57	86	7 N.
....	..	..	....	29.8	50	61	9 N.	29.8	52	84	7 W.	....	..	..	....	29.8	52	83	8 E.
L—3—12.								**L—3—11.**				**L—3— 4.**				**H—3—19.**			
H—5—15.								**H—5—15.**				**H—5—15.**				**L—3— 2.**			
9.3	Ci. S.	66	2.5					8.4	S. Cu.	37	32.7	8.4	S. Cu.	322	31.7	8.1	Ci. Cu.	181	6.4
9.5	Ci. Cu.	119	6.0					...	.....	...	...	...	.....	...	...	8.2	Cu.	166	9.8
11.5	Cu.	102	5.0					...	.....	...	...	...	.....	...	...	...	.....	...	...
1.1	S. Cu.	98	3.4					1.8	S. Cu.	354	13.0	...	.....	...	...	2.1	Fr. Cu.	172	4.0
...	.....	...	...					...	.....	...	..	...	.....	...	...	...	.....	...	...
...	.....	...	...					4.5	S. Cu.	42	9.0	...	.....	...	...	...	.....	...	...
...	.....	...	...					...	.....	...	...	...	.....	...	...	...	.....	...	...
29.9	52	66	12 NW.					30.0	49	85	9 NW.	29.8	48	94	6 SW.	29.9	51	65	19 SW.
29.9	60	53	12 NW.					30.0	59	72	8 N.	....	..	..	....	29.9	62	46	17 S.
....	..	..	....					30.0	63	77	9 NW.	....	..	..	....	....	..	..	....
L—6— 4.				**L—6—10.**								**L—6—10.**				**L—6—9.**			
H—5—15.				**H—5— 8.**								**H—5—16.**							
8.3	S.	333	15.2	...	.....	...	...					...	.....	...	...	8.2	Ci. S.	188	2.8
9.1	N.	345	11.1	...	.....	...	...					..	.....	...	...	8.2	Cu.	193	3.3
...	.....	...	...	...	.....	...	...					...	.....	...	...	...	.....	...	...
1.0	S. Cu.	334	2.4	...	....	...	...					1.9	S. Cu.	309	8.3	1.7	Ci. S.	55	2.0
2.4	N.	314	5.7	...	.....	...	...					...	....	...	...	1.8	Ci. Cu.	285	1.3
6.8	Ci.	260	5.5	5.3	Ci.	355	4.0					...	.....	...	...	5.8	Ci. S.	174	1.7
29.9	52	87	8 N.	....	..	..	....					....	..	..	....	30.0	44	98	9 N.
30.0	59	67	10 N.	....	..	..	....					30.1	62	65	8 N.	29.9	63	37	12 NE.
29.9	60	60	9 NW.	30.0	58	61	6 N.					....	..	..	....	29.9	62	34	9 E.

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 6 TO MAY 10, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
May 6 ° ° L. 6. 73. 37 H. 5. 86. 38 H. 2. 82. 50	**H—2—20.** **H—5—11.** .. .. 1.8 Ci. 213 1.7 2.0 Cu. 161 2.7 5.4 Ci. 227 1.3 ... . 30.1 81 30 5 E. 30.0 81 28 4 E.		**H—5—20.** 8.3 N. 148 2.2 1.4 A. Cu. 102 5.4 1.8 Ci. S. 134 1.9 5.6 Cu. 164 1.9 5.8 Ci. S. 97 2.1 30.1 62 95 5 S. 30.1 65 85 13 SE. 30.0 72 69 5 SE.	**H—5—12.** ... . 12.1 Ci. S. 91 1.0 2.1 Ci. 103 1.1 5.1 Ci. 80 3.3 ... . 30.0 76 50 6 N. 30.0 80 51 9 NW. 30.0 79 40 7 N.	
May 7 ° ° L. 3. 55. 48 H. 2. 82. 48 H. 6. 94. 37	**H—2—20.** **H—6—19.** 8.4 Ci. 209 1.0 1.1 A. S. 198 1.0 5.7 Cu. 221 2.7 5.8 S. Cu. 221 4.0 30.1 61 71 2 W. 30.0 76 35 8 SE. 30.0 77 46 10 W.	**H—2—11.** **H—6—18.** ... . 12.1 Cu. 152 6.2 5.1 Cu. 180 6.2 ... . 30.0 81 33 7 S. 29.9 83 26 13 S.	**H—6—19.** ... . 1.8 Cu. 146 0.7 ... . 30.0 78 49 6 S.	**H—6—12.** 9.3 A. Cu. 88 1.5 1.9 A. Cu. 121 2.0 5.1 Ci. 60 2.7 ... . 30.1 76 65 4 SE. 30.0 84 72 8 SE. 30.0 82 33 8 SE.	
May 8 ° ° H. 3. 75. 44 L. 2. 100. 54 L. 3. 55. 48	8.7 S. Cu. 158 5.1 1.4 Cu. 151 4.0 ... . 5.2 Cu. 143 4.1 5.8 Ci. 63 2.7 30.1 64 79 9 SE. 30.0 78 47 12 S. 29.9 80 44 12 SW.	**H—3—19.** **L—2—14.** ... . 12.0 S. Cu. 157 13.4 12.3 Cu. N. 160 13.1 5.1 Cu. N. 129 13.7 5.3 Fr. Cu. 127 11.8 .... 29.9 78 39 16 S. 29.8 72 61 8 SW.	8.4 S. 176 24.4 1.4 Cu. 182 7.0 1.9 Fr. Cu. 212 11.9 ... . 30.0 67 81 9 S. 30.0 74 74 14 SE.	10.3 Ci. S. 92 1.4 1.9 Ci. 132 1.7 . . .. 30.1 74 70 5 E. 30.1 82 70 4 N.	
May 9 ° ° L. 3. 60. 47 H. 6. 78. 35 L. 2. 92. 51			... . 1.5 S. 190 6.1 5.5 Ci. S. 67 1.9 .... 30.0 71 82 12 SE. 30.0 73 81 19 SE.		
May 10 ° ° L. 3. 74. 46 H. 6. 80. 31	... . 1.7 Ci. 108 3.3 ... . 5.1 A. Cu. 101 3.7 ... . 29.9 73 38 7 S. 29.9 75 44 7 S.	**L—3—19.** 8.1 S. 135 7.2 ... . 12.1 N. 114 13.8 ... . 5.1 Cu. 105 13.2 5.3 Cu. N. 103 13.1 29.8 62 41 5 SW. 29.8 64 56 3 S. 29.6 70 44 13 SW.	8.5 S. Cu. 169 13.1 ... . 1.6 Cu. 159 4.9 1.2 Fr. Cu. 152 10.0 1.7 Ci. S. 91 2.9 2.0 Cu. N. 152 2.2 ... . 30.0 71 81 9 SE. 29.9 80 58 18 S.	**H—6—19.** 10.7 S. Cu. 122 2.1 10.6 Ci. 84 2.0 ... . 30.0 74 82 9 SW.	**L—3—20.** **H—6—10.** 7.8 Fr. Cu. 25 20.0 ... . 5.0 Ci. 84 1.7 ... . 30.0 66 71 12 NW. .... 29.9 72 54 6 S.

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 6 TO MAY 10, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
L 6— 4. **H—2—13.** **H—5— 7.** ... . 1.4 Cu. 346 4.8 ... . 30.0 63 64 13 N. 30.0 75 37 20 N. 30.0 70 53 0	**L—6—10.** **H—2— 5.** **H—5— 8.** 8.4 A. Cu. 25 3.3 ... . 5.6 S. 42 4.2 ... . 30.1 55 26 4 NW. .... 30.0 69 55 6 S.	**L—6—18.** **H—2— 5.** **H—5— 8.** 8.5 A. Cu. 60 4.4 ... . 30.1 60 70 11 SW.	**L—6—10.** **H—2— 5.** **H—5— 8.** 8.5 A. Cu. 41 8.0 ... . 30.1 52 42 20 E.	**L—6— 9.** **H—2—14.** **H—5—16.** ... . 6.2 Ci. 72 2.5 ... . 30.0 49 57 12 E.
H—2—13. **H—6— 8.** 11.0 A. Cu. 48 5.0 1.6 A. Cu. 43 6.2 6.8 Ci. 41 2.6 ... . 30.0 62 79 2 SW. 30.0 74 50 15 NE. 30.1 66 42 4 E.		**H—2—5.** **H—6—9.** ... . 4.4 Ci. 12 3.1 ... . 30.2 62 64 11 E.	**H—2—5.** **H—6—8.** ... . 1.4 A. S. 45 11.7 ... . 30.2 55 45 12 NE. .... 29.7 56 90 21 SW.	**L—3—19.** **H—2—14.** **H—6—16.** 8.2 A. Cu. 78 5.6 ... . 6.3 Cu. 57 5.6 ... . 30.0 48 71 7 NE. .... 30.1 42 90 15 NE.
H—3—5. 8.3 Ci. 29 1.5 12.9 Ci. 38 1.5 ... . 30.4 51 48 10 NE. 30.4 63 46 5 SW.			**H—3—4.** ... . 5.1 A. S. 110 19.0 ... . 29.7 56 90 21 SW.	**L—3—19.** **H—3— 2.** 8.3 Cu. 358 7.7 2.1 Ci. Cu. 354 4.8 ... . 30.4 42 71 11 NE. 30.2 56 23 15 NW. ....
	H—6— 9. **L—2—14.** 8.2 N. 112 3.6 1.6 N. 132 6.0 .. .. 30.0 60 53 11 SE. 29.9 77 63 30 SW.			**L—3—20.** **H—6—16.** 8.1 A. S. 45 7.1 ... .
L—3—5. **H—6—9.** 10.2 Ci. 98 1.2 10.4 A. Cu. 92 1.8 1.0 Ci. 104 1.2 1.8 S. Cu. 114 6.9 ... . 6.1 S. Cu. 86 5.2 ... . 29.9 67 73 8 SW. 29.8 80 41 25 SW. 29.9 72 59 8 NW.		**L—3—12.** **H—6—17.** ... . 1.5 Cu. 78 2.8 ... . 29.9 72 43 10 W.	**L—3—12.** **H—6—17.** ... . 1.4 Ci. S. 105 6.7 1.7 A. Cu. 105 7.3 ... . 5.1 S. Cu. 35 10.7 ... . 29.8 59 60 6 SW. 29.9 57 72 12 W.	**L—3— 1.** **H—6—16.** 8.1 Ci. S. 74 2.1 8.2 Ci. Cu. 79 4.2 2.1 Ci. S. 104 1.9 2.2 Fr. Cu. 92 5.4 ... . 5.5 Ci. Cu. 103 7.1 ... . 29.8 56 76 3 W. 29.6 78 44 12 W. 29.6 61 75 9 S.

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 11 TO MAY 14, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
May 11 ° ° H . 6 . 77 . 32 L . 2 . 88 . 50	**L—2—20.** 8.5 A.S. 118 4.3 1.8 Ci.S. 121 4.3 ... . 5.6 Ci.S. 112 4.0 ... . 30.0 58 65 10 NE. 29.9 67 36 12 N. 29.9 69 35 7 N.	**L—2—12.** 8.1 Ci. 104 7.0 12.1 S.Cu. 91 9.7 12.3 Cu. 91 7.7 ... . 29.8 54 53 5 NW. 29.7 59 47 13 W.	... . 1.3 Cu. 242 0.8 1.8 Cu.N. 274 6.1 5.6 S. 242 8.5 5.9 N. 241 6.5 .... 29.9 74 83 11 SE. 29.8 71 88 13 SE.		
May 12 ° ° H . 3 . 62 . 45 H . 6 . 77 . 32 L . 2 . 81 . 45	**L—2—20.** 8.5 Cu. 83 5.0 ... . 1.2 S.Cu. 95 7.6 ... . 5.6 S.Cu. 38 11.6 ... . 29.9 57 82 4 N. 29.9 64 76 12 N. 29.9 64 70 8 NW.	**L—2—11.** 8.1 A.Cu. 90 3.8 8.3 Cu. 72 4.6 12.1 Ci. 40 3.9 12.3 Cu. 107 5.9 ... . 5.1 A.Cu. 58 4.0 5.3 Cu. 74 6.7 29.8 51 74 6 NW. 29.7 59 38 3 W. 29.7 57 45 16 NW.	8.6 Cu. 12 6.9 ... . 1.6 Cu. 32 3.4 ... . 6.0 Ci.S. 119 3.7 ... . 30.0 63 82 5 NW. 29.9 74 66 6 N. 29.9 74 58 5 NE.	**H—6—19.** 10.4 S.Cu. 166 3.7 10.6 A.Cu. 90 2.2 12.9 S.Cu. 133 2.7 ... . 29.9 73 88 5 W. 29.8 75 86 6 W.	**H—6—18.** **L—2—12.** 7.7 Fr.Cu. 96 32.2 .. .. 12.8 A.Cu. 118 4.9 ... . 29.8 65 75 6 SW. 29.8 75 47 10 W. ....
May 13 ° ° H . 3 . 54 . 48 L . 2 . 90 . 47 H . 1 . 107 . 52	**L—2—20.** 8.5 S.Cu. 65 11.3 ... . 1.2 S.Cu. 79 8.8 ... . 29.9 58 77 12 SW. 29.9 63 53 12 NW.	**L—2— 4.** **H—1—14.** ... . 12.1 S. 38 9.3 ... . 5.1 S.Cu. 357 11.2 5.3 Cu. 6 8.4 ... . 29.8 52 40 12 NW. 29.8 52 40 13 NW.	8.4 Ci. 102 2.0 ... . 30.0 67 81 5 SW.	9.6 A.S. 89 1.9 9.7 Cu. 41 2.1 12.9 Cu. 42 2.5 ... . 30.0 68 85 2 N. 30.0 72 68 8 W.	**L—2—13.** ... . 1.0 Cu. 121 4.9 ... . 29.8 73 50 12 W. ....
May 14 ° ° H . 3 . 54 . 43 L . 2 . 80 . 45 H . 4 . 94 . 42	**L—2—20.** **H—4— 2.** ... . 5.6 Cu. 104 4.3 ... . 30.1 63 42 9 NW.	**L—2—19.** **H—4— 8.** 8.2 Cu. 56 19.5 ... . 12.1 S.Cu. 69 4.6 ... . 5.1 Fr.Cu. 57 10.3 ... . 30.0 49 73 8 NW. 30.0 50 67 16 NW. 30.0 51 39 17 NW.	**H—4—13.** 8.0 Fr.S. 319 12.7 8.5 A.Cu. 76 2.9 8.8 Cu. 211 11.6 1.5 Cu. 259 5.1 ... . 30.2 63 79 12 NE. 30.1 70 68 11 E.	**H—4—14.** 9.1 Cu. 352 6.0 ... . 1.9 Cu. 22 3.0 ... . 5.1 Ci.Cu. 101 2.7 ... . 30.0 72 82 10 N. 30.0 74 68 12 N. 30.0 71 46 7 NW.	**L—2—12.** **H—4—15.** ... . 12.7 Cu. 46 7.9 ... . 5.3 S.Cu. 89 8.4 ... . 30.1 58 36 12 SW. 30.1 59 46 9 SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 11 TO MAY 14, 1897.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—6—9.				**H—6—17.**				**H—6—17.**								**H—6—17.**			
L—2—14.				**L—2—14.**				**L—2—6.**								**L—2—14.**			
8.8	Ci. S.	85	2.7	8.5	Ci. S.	112	4.0	9.4	A. Cu.	118	10.0					...	.....	...	...
1.8	Fr. N.	131	4.3	1.0	A. Cu.	127	5.0	1.8	A. S.	122	4.7					2.1	Ci. S.	93	4.0
...	.....	...	...	1.3	Fr. Cu.	137	6.9	1.9	Cu.	155	3.8					2.1	Cu.	114	3.6
6.8	S. Cu.	114	4.5	5.4	N.	130	4.8	4.2	Cu.	147	4.3					5.6	Ci. S.	106	4.3
...	.....	..	...	..	....	...	...	...	.....	...	...					...	.....	...	...
30.0	66	71	2 SE.	29.9	65	61	4 S.	29.9	64	65	12 SW.					....	..	..	....
30.0	71	68	4 SW.	29.8	75	37	10 S.	29.8	71	45	12 S.					29.9	70	46	12 S.
29.9	69	72	4 S.	29.7	70	44	7 N.	29.8	69	48	8 SW.					30.0	62	50	22 S.
H—3—20.				**H—6—17.**				**H—6—18.**								**H—3—11.**			
H—6—9.				**L—2—1.**				**L—2—1.**								**H—6—16.**			
L—2—6.																**L—2—7.**			
8.1	S.	136	29.8	8.1	Fr. N.	140	12.8	7.2	Cu.	122	13.5					...	.....	...	...
10.1	A. Cu.	105	3.3	...	....	...	...	..	.....	...	...					...	.....	...	...
1.0	A. Cu.	116	3.7	1.1	Fr. N.	140	7.2	1.8	Ci. Cu.	105	3.8					...	....	...	...
1.1	S.	141	10.0	...	.....	...	...	1.8	Cu.	117	8.6					...	.....	...	...
2.0	Fr. S.	141	12.6	...	.....	...	...	...	.....	...	...					...	.....	...	...
6.9	A. Cu.	122	3.4	5.5	S.	130	5.6	4.3	A. S.	130	15.5					5.0	A. S.	111	4.1
6.9	S.	122	10.5	...	.....	...	...	...	.....	...	...					...	.....	...	...
29.9	66	95	13 SW.	29.7	61	94	6 SE.	29.7	64	77	9 SW.					....	..	..	....
29.8	76	70	18 SW.	29.7	68	58	14 W.	29.7	69	39	25 W.					....	..	.	....
29.8	71	81	5 S.	29.7	66	53	9 W.	....	..	..	....					29.8	60	95	30 S.
L—2—14.				**L—2—6.**				**L—2—6.**								**H—3—19.**			
9.1	Fr. N.	181	45.5	...	.....	...	...	...	.....	...	...					...	.....	...	...
12.3	N.	126	6.4	...	.....	...	...	...	.....	...	...					...	.....	...	...
3.1	N.	130	13.1	1.5	Ci.	130	4.3	1.8	Cu.	119	6.8					2.0	S.	73	66.5
...	.....	...	..	1.7	Cu.	120	8.2	...	.....	...	...					...	.....	...	...
6.6	S. Cu.	94	4.7	5.2	Fr. Cu.	122	5.3	4.7	S. Cu.	80	9.1					...	.....	...	...
7.2	S.	182	12.7	...	.....	...	...	4.7	A. Cu.	140	5.0					...	.....	...	...
7.3	Ci. S.	145	4.7	...	.....	..	...	...	.....	...	...					...	.....	...	...
29.8	66	95	12 S.	....	..	..	....	....	..	..	....					....	..	..	....
29.9	62	97	12 NW.	29.8	63	69	6 E.	29.7	65	42	18 W.					29.8	65	83	42 S.
29.9	63	92	6 S.	29.8	65	48	10 W.	29.8	64	56	17 SW.					....	..	..	....
L—2—5.				**L—2—1.**				**L—2—4.**				**L—2—1.**				**H—3—19.**			
				H—4—15.				**H—4—15.**								**L—2—7.**			
8.5	S.	168	12.9	8.3	Fr. Cu.	130	10.2	9.7	Cu. S.	122	30.5	...	.....	...	...	7.9	Ci. S.	44	4.9
8.3	Fr. S.	163	16.7	8.5	Fr. S.	130	20.2	...	.....	...	...	...	.....	...	...	7.9	Ci. Cu.	138	5.5
...	.....	...	..	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
1.3	Ci. S.	143	3.6	1.1	S. Cu.	109	9.3	...	.....	...	...	1.8	A. Cu.	148	16.7	...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...	1.9	S. Cu.	148	16.7	...	.....	...	...
...	.....	...	...	5.2	Fr. Cu.	85	6.9	...	.....	...	...	...	.....	...	...	...	.....	...	...
..	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
29.9	61	94	6 S.	29.7	51	87	8 E.	29.8	53	85	9 SW.	....	..	..	....	30.0	60	89	8 S.
29.9	..	..	14 S.	29.8	55	43	24 SW.	....	..	..	....	29.7	54	73	30 SW.	....	..	..	....
....	..	..	...	29.9	52	69	15 SW.	....	..	..	...	....	..	..	....	....	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 15 TO MAY 19, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
May 15 ° ° L . 3 . 68 . 49 H . 5 . 91 . 38 L . 1 . 102 . 54	**H—5—4.** 8.6 A. Cu. 48 7.0 ... . 1.8 A. Cu. 82 4.3 ... . 5.1 S. Cu. 82 4.7 ... . 30.2 55 58 6 E. 30.2 65 39 7 SE. 30.1 69 40 5 SE.	**H—5—9.** **L—1—14.** ... . 12.1 Cu. 92 4.8 ... . 30.2 56 40 6 NW.	**H—5—12.** .. .. 1.6 Cu. 165 2.5 ... . 5.2 Ci. S. 100 3.3 6.1 A. Cu. 81 2.9 .... 30.1 82 45 4 SE. 30.0 81 62 12 SE.		
May 16 ° ° H . 2 . 86 . 39			**H—2—20.** ... . 12.2 Cu. 191 1.9 ... . 30.1 85 46 3 SW.		
May 17 ° ° H . 2 . 85 . 40 L . 1 . 107 . 48	**H—2—11.** **L—1—14.** 8.3 Cu. 278 1.7 1.8 Cu. 212 1.0 ... . 5.2 Cu. 152 2.0 30.3 64 65 4 SE. 30.2 76 48 6 SE. 30.2 80 42 5 SE.		**H—2—20.** ... . 1.0 Cu. 188 5.3 1.4 A. Cu. 31 0.4 ... . 30.1 79 57 4 SW.		
May 18 ° ° L . 3 . 68 . 49 H . 6 . 85 . 38 H . 2 . 90 . 52	**H—6—11.** **H—2—18.** 8.4 Ci. 58 1.0 ... . 1.7 Cu. 171 3.3 ... . 5.1 Cu. 177 3.1 30.3 69 64 8 S. 30.3 80 33 12 SW. 30.2 80 32 10 S.	**H—6—18.** **H—2—5.** ... . 12.1 Cu. S. 180 3.7 12.3 A. S. 68 4.2 5.1 Cu. S. 105 3.6 .... 30.1 83 40 8 S. 30.1 83 40 8 SW.	**H—6—19.** 8.4 Fr. Cu. 191 11.2 8.5 Ci. Cu. 255 0.3 8.6 Ci. S. 213 15.0 1.3 Fr. Cu. 221 10.6 1.5 Cu. 242 3.1 ... . 30.2 69 77 9 SE. 30.2 77 52 12 SE.		
May 19 ° ° L . 3 . 49 . 47 H . 6 . 85 . 37 L . 2 . 101 . 45	**H—6—11.** **L—2—6.** ... . 1.4 Ci. S. 351 0.2 ... . 5.4 Ci. 58 0.1 ... . 30.2 78 38 12 SW. 30.1 82 35 14 SW.	**H—6—18.** **L—2—7.** 8.1 N. 191 5.7 12.1 N. 110 16.2 ... . 5.1 A. Cu. 77 7.4 5.3 Cu. 54 9.1 30.0 63 89 5 SW. 30.0 63 95 5 S. 29.8 76 62 3 W.		**H—6—12.** ... . 1.1 Cu. 222 0.8 ... . 30.2 81 72 5 NW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 15 TO MAY 19, 1897.

Washington.	Cleveland.	Detroit.	Buffalo.	Blue Hill.
L—3—20. **H—5—15.** 8.4 Ci. S. 144 4.7 9.2 Ci. 149 4.7 1.4 Cu. 209 2.4 1.5 Ci. S. 144 5.0 6.0 Cu. 56 2.4 ... . 30.1 56 82 6 NW. 30.0 64 65 6 NE. 30.1 60 68 3 N.		**L—3—20.** **H—5—8.** 9.4 Cu. 37 10.1 9.4 Ci. 0 0 1.8 Ci. 86 3.8 1.9 Cu. 36 4.1 ... . 30.1 50 76 5 W. 30.2 56 56 12 E.	... . 1.7 Ci. Cu. 88 3.4 ... . 30.2 52 55 10 W.	**L—3—5.** 7.8 A. S. 136 6.1 ... . 2.1 Ci. S. 149 5.1 ... . 5.9 Ci. S. 154 5.3 ... . 30.0 55 70 15 NW. 30.0 71 33 19 W. 30.0 66 31 12 W.
	H—2—2. ... . 5.4 Ci. Cu. 15 2.0 5.6 S. Cu. 5 2.5 .... 30.2 58 46 7 N.			**H—2—15.** 8.1 A. S. 145 4.3 ... . 2.1 A. S. 143 3.6 ... . 30.2 48 89 20 NE. 30.2 50 65 20 NE. ....
H—2—7. 11.5 Cu. 354 2.3 1.7 Cu. 239 1.7 ... . 30.3 59 62 4 N. 30.2 68 34 12 N.	**H—2—2.** 8.5 Ci. S. 350 5.0 2.4 A. Cu. 345 4.6 ... . 5.4 Ci. S. 355 1.7 30.3 58 44 6 S. 30.3 64 56 12 W. 30.2 63 46 6 W.	**H—2—3.** 8.0 Ci. Cu. 356 8.1 1.8 A. Cu. 359 4.1 ... . 4.8 S. Cu. 128 6.0 30.3 58 65 9 W. 30.2 67 45 8 W. 30.2 69 55 8 SW.	**H—2—8.** ... . 5.1 Ci. Cu. 0 6.0 .... 30.2 56 71 20 W.	**H—2—15.** 7.9 A. Cu. 191 1.9 2.1 Ci. S. 158 4.0 ... . 5.7 Ci. S. 173 5.3 30.2 56 62 14 N. 30.2 61 41 15 E. 30.1 61 52 5 SE.
L—3—20. **H—6—7.** 11.0 Cu. 20 3.8 ... . 1.5 Cu. 30 3.7 ... . 30.3 59 65 12 NW. 30.2 73 42 12 NW.	**L—3—20.** **H—6—8.** **H—2—14.** 8.6 S. Cu. 25 4.7 ... . 1.7 S. 26 4.2 ... . 30.2 61 58 13 SW. 30.2 69 51 20 W.	**L—3—20.** **H—6—9.** **H—2—14.** 8.0 A. Cu. 51 11.6 ... . 30.2 60 57 15 SW.	**L—3—20.** **H—6—8.** **H—2—14.** 8.5 A. Cu. 71 10.0 ... . 30.2 56 71 24 SW.	**L—3—5.** **H—6—16.** 8.1 Ci. 163 5.3 ... . 2.1 Ci. S. 159 6.1 2.1 Cu. 81 2.2 ... . 30.1 62 44 19 NW. 30.0 72 33 15 W. ....
H—6—7. ... . 12.7 A. S. 10 4.9 1.4 Cu. 20 3.8 ... . 30.3 67 58 7 N. 30.2 78 49 8 N. 30.2 72 56 5 SE.	**H—6—8.** ... . 1.3 Fr. Cu. 112 6.5 ... . 5.9 Ci. 63 1.6 ... . 30.2 77 42 5 W. 30.1 79 47 7 W.	**H—6—9.** **L—2—15.** ... . 1.7 Ci. Cu. 87 4.1 1.7 Fr. Cu. 129 4.3 4.0 A. Cu. 120 12.4 4.0 A. S. 108 8.8 .... 30.2 76 48 13 SW. 30.1 76 48 12 SW.	**H—6—8.** 8.7 A. Cu. 54 14.7 ... . 5.1 Ci. Cu. 114 6.0 ... . 30.3 53 51 14 E. .... 30.2 64 44 4 W.	**L—3—20.** **H—6—16.** ... . 2.1 Ci. 72 3.1 ... . 6.0 Ci. S. 72 ... ... 30.2 66 25 13 NW. 30.2 60 48 15 S.

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 20 TO MAY 23, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
May 20 ° ° H . 3 . 61 . 44 L . 2 . 82 . 45 H . 6 . 86 . 30 H . 1 . 103 . 51	**L—2—20.** **H—6—18.** **H—1—14.** 8.3 Cu. 84 3.7 ... . 1.1 Cu. 85 6.3 ... . 5.4 Cu. 75 4.0 5.5 Ci. 51 3.0 30.0 72 64 13 W. 30.0 84 40 13 W. 29.9 85 45 9 N.	**L—2—11.** **H—1—14.** 8.1 S. 42 6.6 ... . 12.1 S. Cu. 4 19.2 ... . 5.1 S. 9 17.9 ... . 29.9 59 83 18 NW. 30.0 60 63 18 NW. 30.0 55 70 7 N.			**L—2—12.** **H—6— 9.** 7.7 Ci. S. 82 1.3 ... . 1.0 A. Cu. 80 2.5 1.0 Ci. S. 80 2.7 4.9 A. S. 106 3.5 ... . 30.1 67 58 6 S. 30.0 81 45 24 SW. 29.9 79 47 20 SW.
May 21 ° ° L . 3 . 70 . 47 H . 2 . 91 . 45 H . 5 . 96 . 30	**H—2—12.** **H—5—17.** ... . 5.8 A. Cu. 168 3.0 ... . 29.9 79 52 12 E.		**H—2—20.** **H—5— 4.** 8.4 Ci. 97 0.9 ... . 1.4 Ci. S. 130 1.3 1.7 Cu. 162 2.1 ... . 30.1 71 52 16 SW. 30.0 80 35 12 SE.		**H—2— 6.** **H—5—16.** ... . 1.2 Cu. 330 10.9 ... . 30.0 59 50 12 N. ....
May 22 ° ° L . 3 . 64 . 47 H . 2 . 81 . 40 L . 2 . 95 . 51	**H—2—19.** **L—2—13.** 8.3 S. Cu. 132 6.0 ... . 1.2 Cu. 119 4.3 5.4 Ci. S. 26 1.0 5.5 S. Cu. 116 5.9 29.8 70 74 9 SW. 29.7 80 64 12 S. 29.7 77 52 13 W.		8.0 A. S. 89 1.3 8.3 Ci. S. 123 2.9 8.8 A. Cu. 72 1.7 1.0 Cu. 142 2.9 5.6 Ci. S. 115 1.8 ... . 29.8 70 72 20 SW. 29.8 87 42 13 S. 29.7 88 40 12 SE.	**H—2—20.** ... . 1.1 Ci. 142 0.9 5.1 Ci. 81 2.3 ... . 30.0 81 62 8 W. 29.9 83 54 6 SW.	
May 23 ° ° H . 3 . 70 . 39 L . 2 . 90 . 50			8.5 Ci. S. 358 1.2 ... . 1.3 Ci. 293 0.6 1.5 Cu. 325 4.0 8.7 Ci. 305 0.3 29.9 74 70 8 W. 29.9 83 49 12 NE. 29.9 82 48 13 N.		

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 20 TO MAY 23, 1897.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
H—3—19.				**L—2— 1.**				**L—2— 1.**				**H—3—19.**				**H—3—11.**			
L—2— 6.				**H—6—17.**				**H—6—17.**				**L—2— 1.**				**L—2— 7.**			
												H—6—16.							
...	.....	...	...	8.3	A. Cu.	110	2.6	...	.....	...	...	8.6	A. S.	85	4.0	7.9	Ci.	92	2.0
...	.....	...	...	...	.....	...	...	...	.....	...	...	8.7	Ci. Cu.	58	6.7	7.9	S. Cu.	95	5.4
...	.....	...	...	1.1	N.	97	9.3	...	.....	...	...	...	.....	...	...	2.1	Ci. S.	98	2.3
...	.....	...	...	...	.....	..	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
5.2	Ci. S.	70	1.1	...	.....	...	...	4.7	S. Cu.	100	16.5	...	.....	...	...	5.8	Ci. S.	90	2.0
6.9	Ci.	85	1.1	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
....	..	..	....	29.9	68	53	17 SW.	....	..	..	....	29.9	67	59	24 SW.	30.2	57	66	26 S.
30.0	80	50	20 S.	29.8	68	71	12 S.	....	..	..	....	....	..	..	....	30.0	65	28	39 S.
29.9	75	58	10 S.	....	..	.	....	29.7	66	80	20 W.	....	..	..	....	29.9	57	58	35 S.
L—3—20.				**L—3—20.**				**L—3—20.**				**L—3—12.**				**L—3—5.**			
H—2—14.				**H—2— 7.**				**H—2— 7.**				**H—2—15.**							
8.5	S. Cu.	132	3.7	8.5	Fr. N.	20	19.8	8.1	S. Cu.	4	12.3	8.6	S. Cu.	48	33.3	7.9	Ci.	138	3.1
...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...	7.9	A. Cu.	138	7.8
1.7	A. S.	116	4.0	1.7	Fr. N.	335	7.5	1.7	S. Cu.	17	6.7	1.8	S. Cu.	31	11.7	2.2	A. S.	126	4.7
2.0	Cu. N.	60	8.2	...	.....	...	...	...	.....	...	...	...	.....	...	...	2.3	Fr. Cu.	109	11.2
2.0	Fr. N.	15	9.3	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
3.2	Ci. Cu.	138	2.5	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
6.2	Fr. S.	26	6.1	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
6.0	A. S.	155	3.1	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	.....	...	...
29.8	67	73	6 S.	30.0	45	85	15 NW.	30.0	46	75	10 N.	29.9	44	76	20 N.	29.7	65	72	26 SW.
29.7	75	66	30 N.	30.0	50	67	15 NW.	30.0	58	51	6 NW.	29.9	48	66	10 N.	29.6	72	61	15 SW.
29.8	64	62	11 N.	....	..	..	....	....	..	..	....	....	..	..	....	....	..	..	....
L—3—20.				**H—2— 3.**				**H—2— 3.**											
H—2— 2.				**L—2—14.**				**L—2—14.**											
...	.....	...	...	...	.....	...	. .	...	.....	...	...								
...	.....	...	...	...	.....	...	...	...	.....	...	...								
...	.....	...	...	...	.....	...	...	...	.....	...	...								
...	.....	...	...	...	.....	...	...	1.8	Ci. S.	78	7.1								
7.4	Ci.	54	1.7	6.7	Ci.	97	1.7	...	.....	...	...								
...	.....	..	...	...	.....	...	...	...	.....	...	...								
....	..	..	....	....	..	..	....	....	..	..	....								
30.0	67	57	9 NW.	....	..	..	....	29.9	60	55	22 SW.								
30.0	65	52	4 S.	29.8	64	47	10 S.	....	..	..	....								
				H—3—19.												**H—3—9.**			
				L—2—14.															
				8.5	Ci. S.	124	5.0									8.1	Ci.	104	2.3
				8.7	Fr. Cu.	130	10.1									...	.....	...	...
				...	.....	...	...									...	.....	...	...
				...	.....	...	...									...	.....	...	...
				5.5	Cu. N.	125	5.7									...	.....	...	...
				29.6	68	63	14 S.									30.1	61	58	21 SW.
				....	..	..	....									....	..	..	....
				29.7	60	78	15 SW.									....	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 24 TO MAY 27, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
May 24 ° ° H . 3 . 57 . 46 L . 2 . 77 . 45 H . 2 . 96 . 44		**L 2—19.** **H—2— 2.** ... . 12.1 S. Cu. 187 8.5 ... . 30.3 49 54 7 NW.	**H—2—13.** 8.4 Cu. 276 10.3 ... . 1.3 Cu. 242 2.2 ... . 30.1 74 74 10 E. 30.1 82 46 9 SE.	**H—2—13.** ... . 1.3 Ci. Cu. 267 0.8 ... . 30.1 84 63 10 NW.	**L—2—20.** **H—2—14.** 7.6 Cu. 94 18.3 ... . 12.8 Cu. 25 6.3 ... . 5.4 A. Cu. 23 7.1 ... . 30.0 59 47 14 NW. 30.1 63 42 14 NW. 30.1 60 46 11 N.
May 25 ° ° L . 3 . 72 . 42 H . 2 . 88 . 43 L . 1 . 107 . 48	**H—2—12.** **L—1—14.** 8.5 S. Cu. 66 2.3 1.9 A. Cu. 74 1.7 5.7 A. Cu. 79 1.8 30.2 52 72 10 SE. 30.2 64 58 12 SE. 30.1 66 54 11 SE.	**H—2— 4.** **L—1—15.** ... . 12.1 Ci. 49 5.4 5.1 Ci. 63 4.9 .... 30.2 61 44 12 SE. 30.1 67 37 16 S.	8.4 Ci. 134 1.5 1.3 Ci. S. 130 1.4 5.7 Cu. 188 5.1 30.2 74 70 12 S. 30.0 85 33 13 S. 29.9 87 32 14 S.		**L—3—19.** **H—2— 5.** ... . 12.8 Cu. 356 3.8 ... . 30.3 61 50 9 N. ....
May 26 ° ° L . 3 . 67 . 42 H . 2 . 83 . 50 L . 1 . 103 . 51	**H—2—20.** **L—1—14.** 8.3 A. Cu. 84 0.7 8.4 S. Cu. 128 19.1 1.8 Ci. 120 0.5 1.9 Cu. 122 12.7 5.0 Ci. Cu. 88 0.7 ... . 30.0 62 72 12 SE. 30.0 79 50 13 SE. 29.9 85 48 12 S.	**H—2—12.** **L—1—14.** 8.1 N. 195 12.4 ... . 12.1 S. 199 13.2 ... . 5.1 S. 166 13.8 ... . 30.1 57 66 11 S. 30.1 61 68 12 SE. 30.0 69 55 13 S.	8.4 A. S. 324 2.9 ... . 1.8 Cu. 154 4.4 ... . 5.6 Ci. 180 0.9 5.6 Ci. S 156 1.3 30.1 74 70 18 SE. 30.0 82 52 16 SW. 29.9 83 49 17 SE.		**H—2—13.** ... . 12.9 Ci. 51 3.1 ... . 5.4 Ci. Cu. 62 2.9 ... . 30.2 70 40 6 E. 30.2 68 46 5 E.
May 27 ° ° L . 3 . 67 . 42 H . 2 . 80 . 40 H . 1 . 110 . 51	**H—2—19.** 8.4 S. Cu. 148 4.2 1.4 S. Cu. 142 3.9 ... . 5.5 A. Cu. 119 3.7 5.6 S. Cu. 85 15.7 30.1 70 80 5 SW. 30.0 72 76 10 SW. 30.0 74 78 5 NW.	**H—2—18.** **H—1—14.** 8.1 S. 112 17.1 12.1 S. 32 16.7 ... . 30.0 59 89 5 SW. 30.1 67 71 8 NW.	8.8 A. Cu. 38 1.3 1.2 Cu. 183 2.1 1.4 Ci. S. 161 1.3 1.9 A. Cu. 49 0.9 6.0 A. S. 140 1.0 ... . 30.0 74 70 13 SE. 30.0 86 46 10 S. 29.9 85 44 10 SE.	**H—2—20.** ... . 4.6 Ci. 106 1.6 ... ... 30.2 84 35 6 NW.	**H—2—11** 7.7 Ci. S. 44 3.8 12.8 A. Cu. 45 4.0 ... . 4.8 Ci. 68 2.3 4.9 Ci. S. 68 2.3 30.2 61 58 4 E. 30.2 72 .. 4 S. 30.1 72 45 5 SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 24 TO MAY 27, 1897.

Washington.					Cleveland.					Detroit.					Buffalo.					Blue Hill.				
L—2—5.					L—2—12. H—2—15.					L—2—12. H—2—15.					L—2— 1. H—2—15.					H—3—19. L—2— 6.				
9.5	S.		189	8.8	8.1	Fr. S.		110	5.1	9.4	Cu.		63	13.0	8.5	S. Cu.		124	11.7	9.0	S.		166	40.8
9.5	A. S.		172	3.4	...	.....		...	...	...	.....		...	...	8.7	A. Cu.		124	11.7	...	.....		...	...
10.5	A. Cu.		132	5.0	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
12.9	Ci. Cu.		134	4.3	...	.....		...	...	1.8	S. Cu.		58	6.2	...	.....		...	...	...	.....		...	...
1.0	A. Cu.		134	4.8	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
1.1	A. S.		134	5.8	...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...
1.3	Cu.		217	5.6	...	.....		...	...	...	.....		...	..	...	.....		...	...	...	.....		...	...
...	.....		...	...	5.9	Fr. N.		355	22.1	4.4	S.		38	12.1	5.3	S. Cu.		114	9.0	6.0	S. Cu.		138	5.2
...	.....		...	...	...	.....		...	...	...	.....		...	...	...	.....		...	...	6.1	S.		166	28.6
29.9	64	62	1 SE.		29.9	55	70	7 W.		29.9	55	70	10 NW.		29.8	54	86	15 W.		29.9	61	77	37 S.	
29.9	74	72	8 S.		....	..	..	....		30.0	54	72	10 NW.		....	..	..	....		....	..	...	....	
....	..	..	....		30.0	51	81	15 NW.		30.0	50	80	8 NW.		30.0	54	73	12 W.		30.0	59	93	18 S.	
L—3—11. H—2—14.					L—3—11. H—2— 7.					L—3—11. H—2— 2.					L—3—11. H—2— 7.					L—3— 2. H—2—15.				
9.9	Cu.		36	7.1	8.5	S.		7	5.8	...	.....		...	...	...	.....		...	..	...	.....		...	...
1.9	Cu.		35	4.7	...	.....		.	...	1.8	S. Cu.		3	4.3	1.9	Cu.		5	20.0	2.0	Ci. S.		160	4.9
6.5	S. Cu.		335	1.1	...	.....		...	...	4.3	S. Cu.		0	4.0	5.2	S. Cu.		1	7.3	5.8	Ci.		167	4.6
30.0	58	72	20 NW.		30.2	46	75	16 NW.		....	..	..	....		....	..	..	....		....	..	..	....	
30.1	64	65	15 NW.		....	..	..	....		30.3	56	55	6 NE.		30.2	53	50	10 NW.		29.9	64	83	26 S.	
30.1	58	64	12 NW.		....	..	..	....		30.2	57	66	5 N.		30.2	54	70	12 W.		29.9	63	82	17 SW.	
L—3—11. H—2—14.					L—3—19. H—2— 5.															L—3— 4. H—2—14.				
10.8	Cu.		356	6.4	...	....		...	...											8.2	Ci.		160	5.1
...	.....		...	...	...	.....		...	...											8.2	Fr. Cu.		11	13.3
1.0	Cu.		354	5.2	...	.....		...	...											2.2	S. Cu.		7	14.2
...	.....		...	...	...	.....		...	...											...	.....		...	...
...	.....		...	..	5.6	Ci.		17	1.7											5.5	Ci. S.		146	4.1
...	.....		...	...	...	.....		...	...											5.6	S. Cu.		343	5.5
30.2	55	67	14 N.		....	..	..	....												30.1	51	77	14 NW.	
30.2	63	44	15 NW.		....	..	.	....												30.1	55	85	11 NE.	
....	..	..	....		30.3	56	55	11 W.												30.1	52	87	11 E.	
					L—3—19. H—2— 3.					L—3—19. H—2— 3.										L—3—4. H—2—2.				
					8.2	Ci.		40	2.7	8.2	Ci.		27	6.2						8.0	S. Cu.		8	22.8
					...	.....		...	..	2.0	Ci.		18	3.8						2.1	S. Cu.		49	25.1
					...	.....		...	...	2.0	Fr. Cu.		103	4.4						...	.....		...	...
					...	.....		...	...	...	.....		...	...						...	.....		...	...
					...	.....		...	...	...	.....		...	...						5.5	N.		59	29.5
					...	....		...	...	...	.....		...	...						...	.....		...	...
					30.2	50	74	3 E.		30.2	57	64	3 E.							29.9	50	80	16 N.	
					....	..	..	....		30.2	64	51	9 SW.							29.8	51	84	21 NW.	
					....	..	..	....		....	..	..	....							29.8	47	85	21 NW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 28 TO MAY 31, 1897.

Date.	Kansas City.	St. Paul.	Abilene.	Vicksburg.	Louisville.
May 28 ° ° L . 3 . 70 . 43 H . 6 . 84 . 29 H . 4 . 104 . 40 L . 1 . 106 . 59	**H—6—18.** **H—4— 7.** 8.4 S. Cu. 322 12.7 ... ... 1.0 S. Cu. 340 2.7 ... ... 5.3 Cu. 354 4.3 ... ... 30.1 63 82 10 NE. 30.2 63 65 12 NE. 30.1 68 54 10 NE.	**H—4—16.** **L—1—14.** ... ... 12.1 Ci. 50 7.8 ... ... 30.3 63 26 10 NE.	**H—6—19.** **H—4— 6.** 8.6 S. 22 12.1 ... ... 1.0 Fr. N. 22 16.7 1.9 Cu. N. 19 5.1 2.2 A. Cu. 50 2.7 5.6 Fr. S. 8 8.5 ... ... 30.2 66 85 12 NW. 30.1 68 100 13 NW. 30.1 70 70 13 N.		
May 29 ° ° L . 3 . 71 . 49 L . 5 . 92 . 33 H . 4 . 102 . 38 H . 1 . 110 . 52	**L—5—9.** **H—4—7.** ... ... 5.1 Ci. 43 1.8 ... ... 29.9 68 53 7 NW.	**L—5—17.** **H—4—16.** **H—1—15.** ... ... 12.1 S. 60 10.2 ... ... 29.8 58 72 11 W.	**L—5—11.** **H—4— 5.** 8.2 Cu. 15 15.3 ... ... 30.1 62 89 13 N.	**L—5— 2.** **H—4—14.** ... ... 1.4 Cu. 272 1.6 ... ... 5.1 Ci. 135 1.6 ... ... 29.9 84 71 6 NW. 29.8 85 41 5 NW.	**L—5—8.** 7.5 Ci. S. 91 9.9 ... ... 30.0 51 62 12 N. ....
May 30 ° ° L . 6 . 81 . 34					
May 31 ° ° L . 3 . 73 . 48 H . 2 . 100 . 50 L . 4 . 111 . 42		**H—2— 6.** **L—4—15.** 8.1 S. 53 6.4 12.1 Cu. 54 10.8 12.3 A. Cu. 46 9.0 5.1 Cu. 21 8.0 5.3 A. Cu. 38 6.6 30.0 42 62 4 N. 30.0 48 48 5 N. 30.0 55 34 8 NW.	**L—4—14.** ... ... 5.7 Cu. 188 3.8 5.8 Ci. S. 158 1.3 .... 29.8 82 42 16 S.		

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 28 TO MAY 31, 1897.

Washington.				Cleveland.				Detroit.				Buffalo.				Blue Hill.			
L—3—12.				**L—3—11.**				**L—3—19.**								**L—3—1.**			
H—6—16.				**H—6—17.**				**H—6—17.**											
8.1	Ci. Cu.	62	3.3	8.5	S.	95	6.7	...	.....	...	...					8.0	N.	57	28.4
8.3	Ci.	64	3.5	...	.....	...	...	...	.....	...	...					...	.....	...	...
12.9	Ci. S.	67	3.6	...	.....	...	...	1.9	S. Cu.	40	13.2					2.2	A. S.	57	8.8
...	.....	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
...	.....	...	...	...	.....	...	...	...	.....	...	...					...	.....	...	...
6.1	Ci.	78	4.4	5.7	Fr. S.	51	16.6	4.6	S. Cu.	58	20.0					5.8	Ci. S.	77	3.0
6.8	S. Cu.	68	4.4	6.0	Cu. N.	70	9.0	...	.....	...	...					5.7	Ci. Cu.	72	5.9
...	.....	...	...	...	.....	...	...	...	.....	..	...					5.6	A. S.	87	7.9
30.0	59	62	4 NW.	29.9	58	67	9 S.	....	..	..	....					29.7	50	96	19 NW.
29.9	74	33	8 NW.	....	..	..	....	29.9	53	72	17 NW.					29.7	60	66	23 W.
29.8	71	48	3 SW.	29.9	53	75	16 W.	29.9	52	69	17 NW.					29.7	58	66	10 E.
L—3—20.				**L—3—20.**				**L—3—20.**				**L—3—12.**				**L—3—5.**			
H—4—15.				**L—5—16.**				**L—5—16.**											
8.2	S. Cu.	121	9.2	8.1	S. Cu.	72	13.2	8.3	Cu. S.	68	24.0	8.5	S. Cu.	42	31.7	7.9	A. Cu.	132	7.8
8.2	Ci.	94	4.8	...	.....	...	...	..	.....	...	...	...	.. .	...	...	...	.....	...	...
8.5	Ci. S.	97	4.7	...	.....	...	...	...	.....	...	...	...	.. ..	...	..	...	.....	...	...
1.2	Ci.	108	4.5	1.6	S. Cu.	101	7.4	1.9	S. Cu.	86	3.5	...	.....	...	...	2.1	Cu. N.	121	7.3
2.2	Cu.	59	6.0	...	.....	...	...	...	.....	...	...	...	.....	...	...	...	....	...	..
6.0	Ci.	100	5.5	5.4	Ci. Cu.	74	3.9	4.7	S. Cu.	110	4.0	...	.....	...	...	...	.....	...	...
...	.....	...	...	5.7	Fr. Cu.	88	6.7	...	.....	...	...	...	.....	...	...	...	.....	...	...
29.8	59	57	24 NW.	29.9	48	79	13 W.	29.9	50	77	10 W.	29.8	46	80	25 W.	29.6	60	74	18 S.
29.9	64	48	16 NW.	29.9	53	75	10 W.	29.9	60	63	7 W.	....	..	..	....	29.6	65	61	27 W.
29.9	60	60	4 N.	29.9	58	61	9 S.	29.9	60	68	9 S.	....	..	..	....	....	..	..	....
				L—6—9.												**L—6—16.**			
				8.6	S.	123	5.8									10.1	Ci.	105	4.5
				...	.....	...	...									10.2	Fr. Cu.	147	4.6
				2.3	S. Cu.	140	6.6									2.1	Ci.	105	4.6
				...	.....	...	...									2.2	Cu.	141	4.7
				5.5	Fr. S.	138	10.5									...	.....	...	...
				30.0	55	70	10 SE.									29.9	60	70	12 W.
				29.7	66	47	16 S.									29.9	69	49	29 S.
				29.8	57	61	9 W.									....	..	..	....
				L—3—20.												**L—3—5.**			
				8.2	S. Cu.	92	6.7									...	.....	..	...
				...	.....	...	...									1.8	A. S.	144	7.6
				...	.....	...	...									...	.....	..	...
				...	.....	...	...									...	.....	...	..
				...	.....	...	...									...	.....	...	...
				30.0	47	59	11 S.									....	..	..	....
				....	..	..	....									29.8	63	99	14 S.
				....	..	..	....									....	..	..	....

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 1 TO JUNE 11, 1896.

Date.	Key West.				Waynesville.			
June 1		**L—5—14.**						
° °	8.9	Ci.	69	1.2				
H. 2. 95. 45	9.4	Cu.	229	10.4				
L. 5. 91. 35	1.7	Ci. S.	100	1.4				
L. 3. 66. 48	2.1	Cu.	229	8.0				
	5.7	Ci. S.	274	1.4				
	6.1	Cu.	75	15.6				
	30.0	82	76	10 E.				
	30.0	83	75	10 SE.				
	30.0	83	74	12 E.				
June 2		**H—2—12.**				**H—2—13.**		
° °	...	.....	...	...	9.5	S. Cu.	123	3.0
H. 2. 84. 44	1.7	A. Cu.	181	2.0	1.8	Cu.	130	2.8
L. 3. 62. 49	1.9	Cu.	232	16.3	...	.....	...	...
	5.5	A. S.	186	1.7	...	.....	...	...
	5.9	N.	194	4.2	...	.....	...	...
	....	..	.	....	....	66	87	0
	30.0	84	74	12 SE.	....	74	64	9 S.
	29.9	82	77	12 SE.	....	..	..	....
June 3		**L—5—14.**						
° °	8.9	Cu.	201	21.4				
H. 3. 74. 40	1.6	Ci.	48	0.4				
L. 5. 91. 29	2.0	A. S.	76	5.3				
	1.9	Cu.	205	17.5				
	5.6	Ci. S.	34	0.5				
	5.8	S. Cu.	170	4.1				
	6.0	A. S.	167	1.8				
	30.0	83	75	13 SE.				
	30.0	83	78	12 SE.				
	30.0	82	77	9 SE.				
June 4						**H—6—11.**		
° °	9.1	Cu.	175	16.8	...	.....	...	...
H. 6. 74. 38	...	.....	...	...	2.0	Cu.	272	3.3
L. 4. 101. 39	...	.....	...	..	2.1	A. Cu.	41	1.4
	5.9	Ci.	332	0.7	...	.....	...	...
	30.0	82	80	10 S.	....	..	..	....
	....	..	..	....	....	74	64	Lt.
	29.9	85	69	4 SE.	....	..	..	....
June 5						**H—8—20.**		
° °						**L—2—14.**		
H. 3. 78. 38	8.9	Cu.	210	5.9	8.6	S. Cu.	357	8.3
L. 2. 90. 47	1.5	Ci.	315	0.3	1.9	Cu.	293	3.4
	...	.....	...	...	2.3	A. Cu.	48	2.0
	...	.....	...	...	5.8	Cu.	310	1.1
	...	.....	...	...	6.2	Ci.	72	2.6
	30.0	83	80	5 SE.	....	67	78	Lt. E.
	30.0	86	68	3 NW.	....	76	53	Lt. E.
	....	..	..	....	....	78	56	Lt. E.
June 6	8.9	Cu.	330	6.5	8.9	S. Cu.	343	4.2
° °	...	.....	...	...	2.0	Cu.	64	0.9
H. 3. 65. 47	...	.....	...	...	2.1	F. Cu.	260	1.9
	30.0	84	68	8 NE.	....	66	82	0
	....	..	..	....	....	78	61	0
	....	..	..	....	....	..	..	....
June 7								
June 8		**H—6—5.**				**H—6—9.**		
° °						**L—2—5.**		
H. 6. 80. 31	8.9	Ci.	8	1.2	8.6	F. Cu.	126	8.9
H. 3. 63 47	9.4	Cu.	342	6.8	8.7	Ci.	99	2.0
L. 2. 86. 43	...	.....	...	...	8.8	Cu.	118	2.4
	...	.....	...	...	1.9	Cu.	143	6.7
	...	.....	...	...	2.0	A. Cu.	103	2.3
	5.7	Ci. S.	344	0.8	5.7	S. Cu.	120	3.2
	...	.....	...	..	6.0	A. Cu.	109	2.2
	30.0	82	75	8 NE.	....	72	71	6 S.
	....	.	..	....	....	77	63	10 S.
	29.9	83	73	11 NW.	....	..	..	....
June 9		**H—6—5.**				**H—6— 9.**		
° °						**L—3—20.**		
H. 6. 79. 30	9.0	Ci. S.	346	0.5	9.4	Cu.	111	8.1
L. 3. 76. 44	9.3	Cu.	136	7.9	9.5	A. Cu.	98	5.6
	1.9	Ci. S.	282	0.2	...	.....	...	...
	...	.....	...	...	5.9	Cu.	75	11.1
	...	.....	...	...	6.2	S. Cu.	93	8.0
	30.0	82	76	8 SW.	....	..	..	....
	30.0	86	68	6 SW.	....	..	..	....
	....	..	..	....	....	69	66	....
June 10						**L—3—20.**		
° °						**H—2—14.**		
H. 2. 92. 46	8.9	A. Cu.	140	0.6	9.0	Cu.	30	5.2
L. 3. 70. 42	9.3	Ci.	50	0.5	9.2	A. Cu.	42	4.5
	9.4	Cu.	162	23.5	...	.....	...	...
	1.9	Ci. S.	134	2.3	1.7	A. Cu.	70	3.2
	2.0	Ci.	59	0.8	2.2	S. Cu.	23	6.5
	5.9	Ci. S.	114	1.1	5.8	A. Cu.	5	3.1
	6.4	Cu.	160	12.4	...	.....	...	...
	30.0	82	82	15 S.	....	60	75	Lt. N.
	30.0	86	71	10 SW.	....	69	55	Lt. N.
	30.0	85	75	9 S.	....	67	62	Lt. N.
June 11	1.7	Cu.	170	15.1				
° °	1.8	A. Cu.	142	5.4				
H. 4. 98. 41	2.0	Ci. S.	47	1.0				
L. 3. 61. 48	5.9	Ci.	52	0.7				
	6.2	A. Cu.	126	4.8				
	6.4	S.	148	9.0				
	....	..	..	....				
	30.0	85	77	11 S.				
	29.9	84	77	8 S.				

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 12 TO JUNE 23, 1896.

Date.	Key West.				Waynesville.			
June 12	8.9	Cu.	141	16.1	8.6	Ci.	74	1.9
° °	...	.....	...	...	9.1	Cu.	97	3.3
H. 5. 100. 37	1.8	Cu.	147	13.0	1.7	Cu.	102	3.0
L. 3. 63. 45	2.1	Ci. S.	74	1.6	...	.....	...	...
	...	.....	...	...	5.8	Cu.	105	4.2
	...	.....	...	...	5.9	A. Cu.	170	2.7
	....	..	..	....	....	59	81	Lt. N.
	30.0	83	77	12 SW.	....	74	53	6 S.
	30.0	85	739	SW.	....	73	59	Lt. N.
June 13		L—6—20.				L—6—4.		
° °	9.0	Ci. Cu.	117	1.4	8.9	Cu.	21	6.2
L. 6. 77. 36	9.4	Cu.	168	7.7	9.4	A. Cu.	51	5.5
H. 5. 99. 32	9.7	A. Cu.	161	4.7	...	.....	...	...
	...	.....	...	...	1.7	A. Cu.	70	4.4
	...	.....	...	...	2.0	S. Cu.	55	4.4
	...	.....	...	...	6.1	S. Cu.	59	3.5
	...	.....	...	...	7.0	Ci.	50	1.9
	29.9	83	76	14 S.	....	62	54	0 0
	....	..	..	....	29.9	65	54	0 0
	....	..	...	....	....	57	74	Lt. N.
June 14								
June 15						H—6—12.		
° °						L—5—15.		
H. 6. 76. 38	8.7	Ci. Cu.	122	1.4	...	.....	...	...
L. 5. 96. 38	9.1	Ci. S.	130	1.3	...	.....	...	...
	1.7	Cu.	268	5.5	1.9	A. Cu.	46	1.6
	2.0	Ci. S.	105	1.2	2.1	Cu.	38	3.0
	0.0	A. Cu.	158	1.7	5.7	Ci.	86	2.0
	5.9	Ci. S.	119	1.2	6.0	A. Cu.	49	1.4
	30.1	82	80	10 SE.	....	..	..	....
	30.1	85	72	6 SE.	....	74	42	Lt. SW.
	30.1	83	74	11 NE.	....	74	44	0
June 16						H—6—11.		
° °	8.8	Ci. S.	142	0.7	9.0	A. Cu.	82	2.8
H. 6. 73. 37	9.0	Ci.	97	0.8	...	.....	...	...
	9.1	Cu.	225	8.8	...	.....	...	...
	9.3	A. Cu.	253	1.6	...	.....	...	...
	1.6	Ci. S.	69	1.0	1.8	A. Cu.	88	1.3
	...	.....	...	...	2.0	Cu.	100	3.3
	5.7	Ci. Cu.	170	0.8	5.9	A. Cu.	108	2.9
	6.1	Ci. S.	97	1.3	6.1	Cu.	152	3.4
	30.1	84	77	9 E.	....	66	71	0
	30.1	85	67	8 SE.	....	74	50	Lt. S.
	30.0	84	68	5 SE.	....	71	60	Lt.
June 17						H—8—19.		
No circulation.	9.0	Cu.	209	10.2	8.8	Ci.	110	1.5
° °	9.2	A. Cu.	129	0.7	8.9	Ci. Cu.	125	3.4
H. 3. 70. 40	9.6	Ci. S.	65	1.1	...	.....	...	...
	1.6	A. S.	104	0.5	1.9	Ci. Cu.	155	1.6
	1.9	Ci. S.	75	1.0	2.0	Cu.	150	5.4
	5.7	Ci. S.	104	1.2	...	.....	...	...
	30.0	83	75	11 SE.	....	64	87	0
	30.0	85	66	8 SE.	....	67	78	0
	30.0	84	67	6 SE.	....	..	..	....
June 18						H—6—4.		
No circulation.	8.9	Ci. S.	96	1.0	8.7	F. Cu.	117	7.0
° °	9.3	Cu.	196	6.3	8.9	A. Cu.	110	4.1
H. 6. 80. 38	1.6	Ci. S.	97	0.8	2.0	A. Cu.	108	2.1
	1.9	Cu.	231	6.1	2.9	Ci.	110	3.2
	5.8	Ci. S.	293	0.9	6.0	A. Cu.	110	2.3
	...	.....	...	...	6.0	Cu.	96	2.6
	30.0	84	69	6 SE.	....	67	76	6 S.
	30.0	86	65	8 SE.	....	74	60	4 S.
	30.0	84	68	11 SE.	....	74	62	0
June 19		H—6—5.				H—6—10.		
° °						L—2—14.		
H. 6. 78. 31	9.2	Cu.	41	12.2	9.0	A. Cu.	130	3.2
L. 2. 88. 48	...	.....	...	...	10.4	Ci. Cu.	115	2.8
	1.8	Ci. S.	77	1.6	2.0	Cu.	116	2.4
	2.1	Cu.	227	3.6	2.4	Ci. Cu.	121	2.3
	6.0	Ci. S.	80	0.9	5.9	Ci. Cu.	116	1.2
	30.1	84	77	10 SE.	....	64	87	0
	30.1	85	71	8 SE.	....	75	50	0
	30.1	86	63	....	....	73	69	Lt. S.
June 20		H—6—5.				H—6—10.		
° °	8.9	A. Cu.	165	1.2	8.9	A. Cu.	160	0.9
H. 6. 80. 32	9.4	Ci. S.	81	0.9	9.2	Ci.	152	2.4
L. 3. 68. 48	...	.....	...	...	...	.....	...	...
	5.6	Cu.	45	4.6	...	.....	...	...
	5.9	Ci. S.	108	1.2	...	.....	...	...
	30.1	83	71	9 SE.	....	68	76	Lt. N.
	....	..	..	....	....	..	..	....
	30.1	84	76	7 SE.	....	..	..	....
June 21								
° °								
L. 2. 82. 48								
H. 6. 78. 32								
June 22						H—6—9.		
° °	8.8	Ci. S.	64	0.6	8.8	Cu.	102	3.5
H. 6. 81. 30	9.4	Cu.	221	11.0	9.2	Ci.	17	1.5
L. 3. 66. 49	1.7	A. Cu.	46	0.6	2.3	Ci.	25	1.3
H. 2. 98. 49	5.7	Ci. S.	66	0.5	5.9	A. Cu.	25	1.5
	...	.....	...	...	6.1	Ci.	77	0.8
	30.1	84	70	12 SE.	....	71	71	0
	30.1	86	64	14 SE.	....	77	63	Lt. N
	30.0	84	65	12 SE.	....	78	62	Lt. N.
June 23		H—6—5.				H—6—10.		
° °						H—2— 5.		
H. 6. 79. 31	8.7	Cu.	229	9.2	...	.....	...	...
H. 2. 80. 44	1.6	Cu.	238	9.3	1.6	A. Cu.	110	3.0
L. 3. 57. 57	5.6	Ci. Cu.	12	0.7	6.0	Cu.	103	2.5
	6.0	Cu.	245	13.0	...	.....	...	...
	30.1	84	71	9 SE.	....	..	..	....
	30.1	86	63	8 SE.	....	78	62	Lt. S.
	30.1	85	66	1 SE.	....	80	61	Lt. NE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JUNE 24 TO JULY 5, 1896.

Date.	Key West.				Waynesville.			
June 24					H—3—20.			
° °	9.0	A. Cu.	319	1.1	8.9	Cu.	97	6.6
H. 3. 70. 44	9.3	Cu.	250	10.5	...	.....	...	...
L. 2. 98. 49	1.6	A. Cu.	304	1.2	1.9	Cu.	100	5.6
	1.8	Cu.	253	12.0	...	.....	...	...
	5.6	A. Cu.	281	1.5	6.0	A. Cu.	95	5.2
	6.1	Cu.	255	16.0	...	.....	...	...
	6.2	A. S.	265	4.6	...	.....	...	..
	30.2	83	72	12 SE.	....	72	77	Lt. SW.
	30.2	87	61	13 E.	....	80	54	10 S.
	30.1	84	73	16 E.	....	79	63	Lt. S.
June 25	H—6—6.				H—6—9.			
° °	9.1	Cu.	258	13.5	8.6	Cu.	89	3.6
H. 6. 85. 30	1.6	Cu.	259	12.2	1.8	Cu.	28	6.6
H. 3. 65. 44	...	....	...	...	2.0	A. Cu.	116	2.1
L. 2. 90. 48	5.6	Cu.	279	12.2	5.9	Cu.	43	3.6
H. 4. 107. 43	30.2	85	70	17 E.	....	75	74	0
	30.2	87	65	16 E.	....	79	64	6 S.
	30.2	84	69	16 E.	....	79	62	Lt. N.
June 26	H—6—6.				H—6—8.			
° °					H—2—14.			
H. 6. 87. 28	9.1	Cu.	268	8.1	8.6	Cu.	32	7.9
H. 2. 94. 42	1.7	Cu.	295	5.9	2.6	Cu.	44	4.5
L. 3. 69. 49	5.7	Cu.	296	7.8	...	.....	...	...
	5.9	Ci. S.	268	2.1	...	.....	...	...
	30.3	85	66	12 E.	....	72	81	0
	30.2	86	64	9 E.	...	79	62	Lt. N.
	30.2	85	71	10 E.	....	..	..	....
June 27					H—2—12.			
° °	...	....	...	...	9.4	Ci. Cu.	70	1.3
H. 2. 80. 40	1.7	Cu. N.	277	3.2	1.8	Cu.	75	4.1
L. 2. 96. 47	6.0	Cu.	30	8.4	5.8	Cu.	79	3.0
	5.9	Fr. Cu.	273	0.7	...	.....	...	...
	....	..	..	....	....	76	68	0
	30.1	85	71	8 NW.	....	83	49	6 SW.
	30.0	85	76	14 NW.	....	79	59	Lt. N.
June 28								
° °								
L. 3. 73. 49								
June 29					H—5—15.			
° °	...	....	...	...	8.6	Ci.	87	1.7
H. 5. 97. 37	...	....	...	...	9.4	Cu.	45	6.0
L. 3. 68. 48	1.9	Ci. S.	322	0.5	1.6	Cu.	50	3.7
	1.8	Cu.	106	3.4	...	.....	...	...
	5.8	Ci.	326	0.5	...	.....	...	...
	6.4	Ci. Cu.	113	1.0	...	.....	...	...
	6.0	A. Cu.	86	0.8	...	.....	...	...
	....	..	..	....	....	67	80	Lt. N.
	30.1	84	71	9 NW.	....	77	48	5 NE.
	30.1	84	65	5 NW.	....	..	..	....
June 30					H—6—1.			
° °	8.9	Ci.	324	1.3	8.6	Ci.	90	2.0
H. 6. 82. 40	9.3	Cu.	222	3.0	...	.....	...	...
L. 3. 66. 50	1.7	Ci. S.	313	1.4	1.7	Cu.	129	3.4
	...	....	...	...	1.8	Ci. Cu.	111	1.9
	5.7	Ci. S.	301	0.6	5.8	Cu.	98	2.9
	...	....	...	...	6.0	Ci. Cu.	82	1.7
	30.2	86	63	3 SE.	....	65	68	Lt. N.
	30.1	86	66	6 SW.	....	79	47	6 NE.
	30.1	82	72	8 NW.	....	80	49	Lt. NE.
July 1					H—6—11.			
° °	...	....	...	...	...	.....	...	...
H. 6. 76. 38	1.8	A. S.	341	1.3	2.2	Cu.	83	1.0
L. 3. 64. 49	2.2	A. Cu.	251	0.9	...	.....	...	...
	5.8	A. S.	324	0.8	...	.....	...	...
	....	..	..	....	....	..	..	....
	30.1	84	71	9 S.	....	74	68	....
	30.1	83	73	9 E.	....	..	..	....
July 2	H—6—20.				H—6—11.			
° °	8.7	Cu.	237	4.9	...	.....	...	...
H. 6. 75. 35	9.0	A. Cu.	272	1.3	...	.....	...	...
L. 2. 99. 44	9.2	A. S.	2	1.1	...	.....	...	...
	1.7	A. Cu.	268	1.7	1.8	Ci. Cu.	114	0.9
	2.4	Ci.	336	1.7	1.9	Fr. Cu.	180	...
	...	.....	...	...	2.0	Ci.	43	1.4
	...	.....	...	...	2.3	A. Cu.	124	0.9
	5.8	Ci. S.	11	1.5	5.6	Fr. Cu.	140	3.0
	6.2	Cu.	265	8.8	5.8	A. Cu.	129	1.5
	...	.....	...	...	5.9	Cu.	115	1.2
	...	.....	...	...	6.2	Ci.	3	2.0
	30.1	80	79	8 SE.	....	..	..	....
	30.1	86	64	14 E.	....	75	72	Lt. SW.
	30.1	84	69	14 E.	....	76	59	Calm.
July 3	H—6—5.				H—6—10.			
° °	8.8	Cu.	266	8.8	8.8	Ci. Cu.	119	1.2
H. 6. 79. 32	...	.....	...	...	9.3	Ci.	56	2.0
H. 3. 69. 50	...	.....	...	...	9.4	A. Cu.	77	1.3
L. 5. 98. 40	1.7	Cu.	270	9.3	...	.....	...	...
	1.9	Cu. S.	232	1.1	...	.....	...	...
	5.7	Cu. N.	294	8.1	5.9	A. Cu.	43	1.4
	...	.....	...	...	6.3	Ci. Cu.	22	1.5
	...	.....	...	...	6.8	Ci.	305	1.9
	30.1	84	67	13 E.	....	70	81	Lt. S.
	30.1	86	60	12 E.	....	..	..	....
	30.0	84	64	15 E.	....	74	74	Lt. SW.
July 4								
° °								
H. 6. 84. 33								
L. 2. 83. 43								
July 5								
° °								
H. 6. 99. 32								
L. 3. 71. 44								

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 6 TO JULY 15, 1896.

Date.	Key West.	Waynesville.
July 6 ° ° H . 6 . 79 . 32 L . 2 . 80 . 45	**H—6—5.** 8.7 Ci. S. 143 1.3 9.0 A. Cu. 212 1.8 9.2 Cu. 232 10.9 1.7 A. S. 130 1.3 1.8 Ci. Cu. 190 0.8 ... . 30.0 84 79 7 SE. 30.0 85 63 10 SE.	**H—6—10.** **L—2—13.** 8.8 A. Cu. 113 2.7 9.1 Fr. Cu. 120 6.9 ... . 1.9 Cu. 89 3.5 2.0 A. Cu. 113 3.3 2.0 Fr. Cu. 88 4.9 .. .. 74 76 Lt. S. .... 76 70 ....
July 7 ° ° L . 6 . 88 . 30 L . 3 . 79 . 48 H . 2 . 99 . 44	**L—6—6.** 9.0 A. Cu. 188 1.4 9.3 Ci. S. 341 0.8 ... . 5.7 A. Cu. 181 0.4 30.1 82 73 9 SE. .... 30.0 84 70 10 SE.	
July 8 ° ° L . 6 . 83 . 34 L . 3 . 65 . 48 H . 2 . 93 . 44	**L—6—13.** 9.1 Cu. 182 10.9 1.6 A. Cu. 115 0.9 1.9 Ci. S. 42 1.1 2.1 Fr. Cu. 167 11.4 ... . 30.0 82 78 10 S 30.0 84 67 11 S.	**L—6—3.** **H—2—14.** ... . 5.8 Fr. N. 27 15.3 6.0 A. Cu. 85 1.8 .... 60 78 Lt. N.
July 9 ° ° L . 2 . 83 . 41 H . 3 . 70 . 40 H . 2 . 93 . 42	... . 5.6 A. Cu. 176 1.9 5.8 Cu. 244 10.0 ... . 30.1 83 73 12 E.	**L—2—5.** **H—3—19.** **H—2—14.** ... . 2.0 Ci. 130 3.2 2.2 Ci. 134 5.8 5.8 A. Cu. 158 2.0 6.0 Ci. 140 3.5 6.2 Fr. Cu. 135 4.2 6.2 Cu. 180 2.4 .... 72 52 3 SW. .... 74 47 4 S.
July 10 ° ° H . 6 . 77 . 34	**H—6—20.** 8.7 Ci. 328 1.5 9.0 Cu. 253 13.0 1.7 Cu. 260 10.5 ... . 5.8 Cu. 257 12.6 6.2 Ci. S. 214 1.1 ... . 30.2 84 73 13 E. 30.2 86 65 20 E. 30.1 84 73 17 E.	**H—6—10.** ... . 2.6 Ci. 140 1.8 2.8 Fr. Cu. 142 3.3 2.6 Cu. 125 ... 6.0 Fr. Cu. 140 4.9 6.0 Cu. 132 3.3 6.1 Ci. 121 2.3 .... 74 66 Lt. NE. .... 76 72 ....

Date.	Key West.	Waynesville.
July 11 ° ° H . 6 . 79 . 33 L . 3 . 60 . 49	**H—6—18.** 8.7 Cu. N. 265 ... 1.7 A. Cu. 249 1.0 2.0 Fr. Cu. 255 22.5 5.9 Ci. S. 253 1.4 ... . 30.2 83 76 19 E. 30.2 85 70 20 E.	**H—6—4.** ... . 1.6 A. Cu. 118 4.2 1.9 Fr. Cu. 92 3.8 5.5 Ci. 116 2.1 4.0 A. Cu. 116 2.9 .... 75 70 .... 74 70 Lt. SW.
July 12 ° ° H . 6 . 80 . 32 L . 3 . 65 . 50		
July 13 ° ° H . 6 . 85 . 31 L . 3 . 60 . 47 H . 2 . 94 . 52 L . 4 . 105 . 45	**H—6—6.** 9.4 Cu. 268 10.8 1.6 Cu. 170 9.3 ... . 30.2 84 68 12 E. 30.2 86 64 14 E.	**H—6—9.** ... . 1.6 Cu. N. 42 5.5 1.8 Fr. Cu. 32 3.6 1.9 Cu. 27 ... 2.1 A. Cu. 18 2.6 6.1 A. Cu. 29 2.4 6.2 Ci. 31 2.4 6.4 Fr. Cu. 60 3.8 6.4 Cu. 62 2.4 .... 78 62 .... 76 61 Lt. NE.
July 14 ° ° H . 2 . 78 . 48 H . 6 . 88 . 29 L . 2 . 95 . 52 L . 3 . 61 . 45	**H—6—6.** 9.1 Cu. 275 8.6 2.0 Cu. N. 290 5.0 ... . 30.2 84 68 7 E. 30.2 85 65 12 E.	**H—6—8.** **H—2—13.** 8.9 Fr. St. 280 3.3 1.7 A. Cu. 56 1.8 1.8 Fr. Cu. 24 5.2 1.9 Cu. 27 4.5 5.7 Fr. Cu. 12 4.5 5.6 Cu. 38 2.4 5.7 Ci. 44 1.2 .... 79 60 .... 74 80 Lt. SW.
July 15 ° ° L . 3 . 76 . 48 H . 6 . 87 . 30	**H—6—6.** 9.1 Cu. 240 6.4 ... . 1.5 Cu. 293 3.2 5.7 Cu. 282 3.2 30.2 85 67 9 SE. 30.1 88 61 7 E. 30.1 85 70 6 NE.	**H—6—8.** **L—3—20.** 8.7 Fr. S. 51 6.7 8.8 S. Cu. 51 5.4 ... . 5.7 Cu. 73 1.1 .... 70 73 .... 76 82 Lt. NE.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 16 TO JULY 25, 1896.

Date.	Key West.				Waynesville.			
July 16	**H—6—1.**				**H—6—17.**			
° °					**H—2—14.**			
H. 6. 81. 26	9.1	Cu.	265	5.0	10.7	S. Cu.	53	3.2
L. 3. 65. 49	1.6	Cu. N.	303	2.2	...	....	...	...
H. 2. 97. 46	1.7	Cu.	274	4.8	...	.....	...	...
	1.7	Ci. Cu.	90	1.0	...	.....	...	...
	5.8	Ci.	61	0.6	5.7	Fr. Cu.	41	7.1
	6.1	Cu. N.	280	5.5	5.7	Ci.	92	1.0
	...	.....	...	...	6.1	A. Cu.	52	4.2
	30.1	83	68	8 SE.	....	71	79	4 S.
	30.1	82	74	10 N.	....	..	..	....
	30.0	84	71	9 E.	....	74	82	....
July 17	**H—6—6.**				**H—6—8.**			
° °					**H—2—13.**			
H. 6. 87. 28	8.8	Cu.	220	5.7	9.0	Fr. S.	345	...
H. 2. 85. 45	1.6	A. Cu.	306	0.8	...	.....	...	...
	2.0	Ci. S.	287	1.5	...	.....	...	...
	5.6	Ci. Cu.	5	0.5	...	.....	...	...
	5.7	Ci. S.	314	2.1	...	.....	...	...
	6.0	Cu.	258	6.9	...	.....	...	...
	30.1	85	70	7 SE.	....	69	85	....
	30.1	82	74	11 SE.	....	..	..	....
	30.1	83	68	9 E.	....	68	88	....
July 18					**L—5—15.**			
° °	8.7	Cu.	248	6.0	8.5	S. Cu.	144	2.4
H. 3. 69. 46	...	.....	...	...	8.7	Fr. S.	232	4.2
L. 2. 96. 52	1.6	A. Cu.	278	1.5	...	.....	...	...
L. 5. 98. 38	2.3	A. S.	254	1.0	...	.....	...	...
	2.5	Cu.	260	2.8	...	.....	...	...
	...	.....	.	...	...	.....	...	...
	6.2	Cu. 24	5	13.1	...	.....	...	...
	30.1	84	75	12 SE.	....	64	87	Lt. N.
	30.1	85	74	9 SE.	....	..	..	....
	30.1	83	80	18 E.	....	..	.	....
July 19								
° °								
H. 3. 66. 42								
L. 5. 95. 39								
July 20	**H—6—20.**				**H—6—10.**			
° °	8.8	Cu.	261	14.3	8.8	Fr. Cu.	135	13.9
H. 6. 76. 39	1.6	Cu.	277	9.6	1.7	Fr. Cu.	109	5.0
L. 2. 87. 49	...	.....	...	...	1.9	A. Cu.	108	3.9
	...	.....	...	...	2.1	Ci.	8	...
	...	.....	...	...	2.2	S. Cu.	128	7.3
	5.9	Cu.	265	10.0	5.7	Ci. Cu.	359	0.4
	...	.....	...	...	5.9	Ci.	359	0.8
	...	.....	...	...	6.0	Fr. Cu.	113	7.5
	...	.....	...	...	6.2	A. Cu.	69	3.8
	30.2	84	68	16 E.	....	70	72	10 SW.
	30.2	85	70	16 E	....	75	66	10 SW.
	30.1	84	69	17 E.	....	74	74	7 SW.

Date.	Key West.				Waynesville.			
July 21	**H—6—12.**				**H—6—10.**			
° °	8.9	Cu.	266	9.2	...	.....	...	...
H. 6. 78. 32	1.6	Cu.	269	7.5	1.8	Fr. S.	93	8.3
L. 3. 69. 49	1.9	Ci. S.	282	1.2	1.9	Fr. Cu.	90	6.2
	5.7	Ci. S.	121	...	5.7	S. Cu.	70	3.8
	6.1	Cu.	254	12.3	...	.....	...	...
	30.2	83	69	14 E.	....	71	81	Lt. SW.
	30.2	85	68	13 E.	....	76	76	7 SW.
	30.2	84	66	13 E.	....	75	78	Lt. S.
July 22	**H—6—6.**				**H—6—8.**			
° °	8.7	Cu.	241	5.4	8.8	Fr. Cu.	94	8.3
H. 6. 86. 29	9.0	A. Cu.	205	0.3	...	.....	...	...
L. 2. 90. 50	9.3	Ci. S.	131	0.4	...	.....	...	...
	1.7	A. Cu	168	1.1	1.6	A. Cu.	83	2.9
	2.0	Cu.	268	3.5	1.8	Ci.	48	1.6
	...	.....	...	...	1.9	Fr. Cu.	65	..
	...	.....	...	...	5.8	Ci.	55	1.7
	..	....	...	...	5.9	Fr. Cu.	43	9.0
	30.2	83	73	10 SE.	....	72	82	4 SW.
	30.	285	66	11 E.	....	76	70	6 SW.
	....	.	..	...	....	76	70	4 SW.
July 23	**H—6—6.**				**H—6—16.**			
° °	8.8	Cu.	253	8.0	...	.....	. .	..
H. 6. 89. 29	1.7	Cu.	253	5.1	...	.....	...	...
L. 3. 68. 48	5.7	A. S.	20	0.8	5.9	Fr. Cu.	81	2.1
L. 4. 104. 38	5.8	Ci. S.	128	0.7	...	.....	...	...
	6.1	A. Cu.	47	0.7	...	.....	...	...
	30.2	83	77	9 E.	....	..	..	....
	30.2	85	66	8 SE.	....	..	..	....
	30.2	84	74	8 SE.	....	78	93	Lt. SW.
July 24	**H—6—6.**				**H—6—9.**			
° °					**L—2—5.**			
H. 6. 85. 28	8.9	Cu.	247	8.3	8.7	Fr. Cu.	99	8.3
L. 2. 84. 41	...	.....	...	...	...	.....	...	...
H. 4. 105. 45	1.9	Cu.	268	5.5	2.0	Fr. Cu.	91	8.5
	...	.....	...	...	2.2	Ci.	35	0.4
	...	.....	...	...	2.2	Cu.	91	3.8
	6.0	Cu.	266	7.8	5.8	Ci.	92	0.5
	...	.....	...	...	5.8	Fr. Cu.	78	7.2
	30.2	84	73	7 E.	....	74	80	Lt. SW.
	30.1	86	67	10 E.	....	82	58	7 S. W.
	30.1	84	71	8 SE.	....	81	65	10 SW.
July 25	**H—6—6.**				**H—6—8.**			
° °					**L—3—20.**			
L. 3. 64. 42					**H—2—6.**			
H. 6. 86. 29	8.8	Cu.	253	10.6	...	.....	...	...
H. 2. 89. 39	1.8	Ci. S.	292	2.2	1.6	Fr. Cu.	45	8.3
	2.1	Cu.	282	6.1	1.8	S. Cu.	55	7.4
	...	.....	...	...	1.8	A. Cu.	65	2.8
	5.9	Ci. S.	287	2.1	5.6	Ci.	67	...
	5.9	Ci.	277	2.7	5.8	Fr. Cu.	57	8.1
	30.2	84	68	10 E.	....	..	..	....
	30.2	85	63	10 E.	....	79	66	Lt. SW.
	30.1	84	69	8 E.	....	82	67	Lt. SW.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JULY 26 TO AUGUST 4, 1896.

Date.	Key West.				Waynesville.			
July 26 ° ° H . 6 . 80 . 32 L . 2 . 89 . 50								
July 27 ° ° H . 6 . 88 . 29 L . 2 . 84 . 51	**H—6—6.**				**H—6—16.**			
	8.8	Cu.	264	8.0	8.7	Fr. Cu.	61	6.1
	1.7	Cu.	269	5.1	2.1	Cu.	108	2.4
	1.8	Ci. S.	262	1.6	2.2	Ci.	110	0.4
	...	.....	...	...	2.5	A. Cu.	126	2.0
	5.9	Cu.	282	8.3	5.5	Ci.	45	0.6
	5.7	Ci. S.	270	2.8	5.7	Cu.	92	1.8
	...	....	...	...	5.7	Fr. Cu.	125	2.4
	...	.....	...	...	5.8	A. Cu.	95	1.4
	...	.....	...	...	6.0	Ci. Cu.	85	0.5
	30.2	84	70	10 E.	....	74	84	....
	30.2	86	69	10 E.	....	77	74	Lt. N.
	30.1	84	72	13 E.	....	77	74	....
July 28 ° ° H . 6 . 85 . 30 L . 3 . 61 . 47 L . 1 . 106 . 48	**H—6—6.**				**H—6—9.**			
	8.7	Cu.	249	10.0	9.1	A. Cu.	107	7.4
	1.6	Cu.	270	8.3	2.3	Ci.	173	0.7
	...	.....	...	...	1.9	Fr. Cu.	102	2.4
	...	.....	...	...	2.0	Cu.	105	2.3
	...	.....	...	...	2.6	A. Cu.	93	1.2
	...	.....	...	...	...	.....	...	..
	30.2	85	69	10 E.	....	70	90	Lt. N.
	30.2	86	62	12 E.	....	77	76	Calm.
	....	..	..	....	...	..	..	....
July 29 ° ° H . 6 . 85 . 29 L . 2 . 92 . 47	**H—6—6.**				**H—6—9.**			
	9.0	Cu.	262	7.3	...	.....	...	...
	2.1	Cu. N.	289	5.4	1.8	Fr. Cu.	64	2.8
	...	.....	...	...	1.9	Cu.	79	3.0
	5.8	Ci. S.	255	1.3	...	.....	...	...
	6.4	Fr. Cu.	276	4.8	5.7	A. Cu.	75	1.9
	30.2	85	68	8 E.	....	..	..	....
	30.2	85	69	....	....	83	58	Lt. NE.
	30.1	85	73	12 E.	....	82	68	Calm.
July 30 ° ° H . 6 . 90 . 29 L . 3 . 75 . 48 H . 2 . 100 . 48 L . 4 . 106 . 41	**H—6—6.**				**H—6—16.**			
	8.8	Cu.	211	10.2	...	.....	...	...
	8.8	A. S.	187	5.6	...	.....	...	...
	1.6	Cu.	219	9.5	1.8	Cu.	65	3.6
	...	.....	...	...	2.0	Fr. Cu.	56	2.8
	5.6	Ci. S.	287	1.4	5.8	Ci.	357	0.9
	...	.....	...	...	6.0	Ci. Cu.	357	0.9
	...	.....	...	...	6.1	Cu.	65	2.4
	30.2	64	71	10 SE.	....	..	..	....
	30.1	64	73	9 SE.	....	83	57	Lt. NE.
	30.1	65	68	9 SE.	....	86	62	Calm.

Date.	Key West.				Waynesville.			
July 31 ° ° H . 5 . 92 . 28 L . 3 . 65 . 47 H . 2 . 82 . 48 L . 4 . 102 . 43	**H—5—15.**				**H—5—16.** **H—2—13.**			
	8.8	Cu.	252	3.0	9.1	A. Cu.	45	1.7
	...	.....	...	...	9.1	Ci.	29	1.6
	...	.....	...	...	9.4	Fr. Cu.	32	...
	1.6	Ci.	299	2.5	1.7	Ci.	74	0.3
	1.8	Cu. N.	245	3.4	1.9	Fr. Cu.	63	2.7
	...	.....	...	...	2.1	Cu.	58	2.0
	...	.....	...	...	5.9	A. Cu.	123	...
	...	.....	...	..	6.1	Ci.	110	0.8
	30.1	85	70	5 SE.	....	74	80	Lt. S.
	30.1	87	65	5 SE.	....	84	53	7 NE.
	....	..	..	....	....	82	54	7 NE.
Aug. 1 ° ° H . 6 . 75 . 40 L . 2 . 90 . 43 L . 1 . 109 . 52					**H—6—12.** **L—2—14.**			
	8.8	Cu.	209	5.1	8.9	Fr. Cu.	161	3.9
	...	.....	...	...	9.2	Ci.	102	1.1
	...	.....	...	...	9.1	S. Cu.	162	4.2
	...	.....	...	...	9.7	Cu.	127	3.2
	1.8	Cu.	248	3.2	2.7	Ci.	110	1.7
	...	.....	...	...	1.9	Fr. Cu.	123	3.3
	...	.....	...	...	2.1	A. Cu.	119	1.5
	...	.....	...	...	...	.....	...	...
	30.1	84	68	7 SE.	....	72	82	Lt. N.
	30.1	86	62	7 SE.	....	84	53	4 SW.
	....	..	..	....	....	..	..	....
Aug. 2 ° ° H . 6 . 86 . 22 L . 3 . 74 . 42								
Aug. 3 ° ° H . 6 . 85 . 23 L . 2 . 94 . 48	**H—6—1.**				**H—6—9.**			
	8.8	Cu.	246	5.1	...	.....	...	...
	1.7	Cu.	330	4.7	2.0	Fr. Cu.	98	3.5
	...	.....	...	...	2.0	Cu.	91	...
	5.7	Cu.	334	4.8	5.9	Fr. Cu.	67	2.9
	...	.....	...	...	5.9	Cu.	55	2.9
	30.2	86	70	7 E.	....	..	..	....
	30.2	86	67	4 SW.	....	81	56	10 N.
	30.1	85	70	4 SW.	....	78	66	Lt. NE.
Aug. 4 ° ° H . 6 . 87 . 28 L . 3 . 68 . 49 L . 4 . 101 . 43	**H—6—6.**				**H—6—8.**			
	8.9	Cu.	295	2.8	...	.....	...	...
	1.7	A. Cu.	225	0.4	2.3	Fr. Cu.	268	1.6
	2.0	Ci. Cu.	9	3.5	2.2	Cu.	245	1.5
	2.2	Cu.	325	4.0	...	.....	...	...
	5.7	Cu.	320	3.4	5.6	Cu.	232	...
	30.1	84	77	3 W.	....	..	..	....
	30.1	81	84	3 NW.	....	83	49	6 NE.
	30.1	85	77	2 SW.	....	82	52	Lt. N.

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 5 TO AUGUST 16, 1896.

Date.	Key West.				Waynesville.			
Aug. 5	H—6—18.				H—6—10.			
° °	8.7	Ci. S.	304	1.9	8.7	A. Cu.	281	4.4
H. 6. 78. 33	1.8	Ci. S.	300	1.1	1.7	Fr. Cu.	194	...
L. 1. 100. 52	1.8	Cu.	299	2.4	1.8	Cu.	229	...
	...	.....	...	...	5.9	Fr. Cu.	287	...
	30.1	86	63	5 SE.	....	69	86	Lt. NE.
	30.1	86	67	4 SW.	....	86	48	4 W.
	....	..	..	....	....	84	53	....
Aug. 6	H 6—5.				H—6—10.			
° °	8.7	Ci. S.	296	1.3	8.7	S. Cu.	315	2.8
H. 6. 79. 33	9.0	Cu.	220	6.7	...	.....	...	...
H. 3. 63. 47	1.7	Cu.	254	3.2	1.8	Fr. Cu.	250	1.6
L. 1. 109. 49	...	.....	...	...	1.9	Cu.	143	1.7
	5.6	Ci. S.	312	1.4	6.0	A. Cu.	227	1.9
	...	.....	...	...	6.0	Ci.	348	0.6
	30.1	84	71	8 SE.	....	71	81	Lt. NE.
	30.1	86	66	9 SE.	....	..	..	...
	30.1	87	58	8 E.	....	82	62	Lt. W.
Aug. 7	H—6—12.				H—6—10.			
° °	8.7	Cu.	242	3.0	..	.....	...	...
H. 6. 78. 32	1.9	Ci. S.	138	0.3	1.8	A. Cu.	178	1.0
L. 3. 70. 50	2.1	Fr. Cu.	246	9.9	1.9	Ci. Cu.	342	0.8
L. 1. 105. 46	2.2	Cu.	262	9.0	...	.....	...	...
	5.8	Cu.	254	12.7	5.7	Ci.	306	0.9
	...	.....	...	...	5.9	Cu.	316	...
	...	.....	..	...	6.1	Fr. Cu.	294	...
	30.1	85	70	10 E.	....	..	..	....
	30.	86	70	14 E.	....	78	60	4 N.
	30.1	87	66	14 E.	....	80	63	6 SW.
Aug. 8	H—6—5.				H—6—9.			
° °	8.8	Cu.	264	9.0	9.0	S. Cu.	122	1.8
H. 6. 80. 30	1.7	Ci.	31	0.7	1.6	Fr. Cu.	67	2.4
L. 2. 94. 53	2.0	Cu.	258	9.7	1.8	A. Cu.	330	0.7
	...	.....	...	...	1.8	Cu.	342	...
	5.7	Ci. S.	6	0.3	5.9	A. Cu.	30	0.8
	6.2	Cu.	270	11.6	...	.....	...	...
	30.2	85	72	12 E.	....	71	86	Lt. E.
	30.1	86	64	16 E.	....	80	61	Lt. E.
	30.1	86	65	16 E.	....	..	..	Lt. N.
Aug. 9								
° °								
H. 6. 85. 30								
L. 3. 72. 48								
Aug. 10	H—6—6.				H—6—8.			
° °	9.0	Cu. N.	266	6.7	...	.....	...	...
H. 6. 87. 28	9.2	A. S.	322	1.3	...	.....	...	...
L. 3. 64. 48	1.7	A. S.	288	1.3	2.0	A. Cu.	104	0.7
	...	.....	...	...	2.0	Fr. Cu.	290	...
	2.0	Cu.	262	6.5	2.2	Ci.	225	0.8
	5.6	A. Cu.	230	1.0	5.7	Ci. S.	259	1.0
	30.1	84	78	9 NE.	....	..	..	....
	30.1	84	70	10 NE.	....	80	66	0
	30.1	83	68	15 NE.	....	77	69	Lt. N.
Aug. 11	H—6—6.				H—6—16.			
° °	9.0	A. Cu.	233	2.2	8.7	Ci.	249	0.8
H. 6. 88. 28	9.2	A. S.	222	1.5	...	.....	...	...
L. 2. 89. 49	1.6	A. S.	212	1.8	1.7	Ci.	241	0.7
H. 1. 109. 50	1.9	Cu. N.	265	3.3	2.3	Ci. S.	245	0.9
	2.1	A. Cu.	238	1.3	1.9	Fr. Cu.	18	3.2
	5.6	Cu.	301	7.9	5.7	S. Cu.	213	...
	5.9	Ci. S.	232	2.0	6.0	Fr. Cu.	29	...
	30.1	79	83	7 E.	....	68	93	Lt. E.
	30.1	84	76	9 NE.	....	83	56	5 NE.
	30.1	86	71	9 NE.	....	80	61	Lt. NW.
Aug. 12	H—6—14.				H—6— 8.			
° °					H—2—14.			
H. 6. 88. 34	9.3	Cu.	331	8.4	...	.....	...	...
L. 3. 66. 48	..	.....	...	...	1.8	Fr. Cu.	315	1.5
H. 2. 92. 47	6.1	S. Cu.	250	19.8	5.7	Ci.	90	1.0
	6.4	A. Cu.	232	6.8	...	.....	...	...
	6.5	Ci. S.	244	...	...	....	...	..
	30.0	83	77	12 N.	....	..	..	....
	....	..	..	....	....	84	45	Lt. NE.
	29.9	83	88	21 E.	....	82	58	Lt. SW.
Aug. 13	8.6	A. Cu.	227	2.3				
° °	8.8	Cu.	229	9.7				
H. 5. 97. 31	1.6	Cu.	240	6.4				
H. 2. 82. 48	5.6	Cu.	266	7.7				
L. 1. 104. 54	30.1	85	74	12 SE.				
	30.0	86	67	13 SE.				
	30.0	85	70	12 E.				
Aug. 14	H—6—5.							
° °	9.2	Cu. N.	236	8.6				
H. 3. 74. 47	1.8	Cu.	265	4.2				
L. 2. 92. 49	6.0	Cu.	258	9.4				
H. 6. 80. 29	6.3	Ci. S.	218	1.2				
	30.1	81	75	5 NE.				
	30.1	87	65	9 E.				
	30.0	85	71	11 E.				
Aug. 15	H—6—12.							
° °	8.9	Ci.	278	0.9				
H. 6. 77. 30	8.9	Cu.	260	5.2				
H. 3. 60. 47	9.4	Ci. Cu.	268	1.2				
L. 2. 89. 50	1.6	Cu. N.	244	6.1				
	5.9	Ci.	240	.10				
	6.1	Cu. N.	264	4.5				
	6.3	A. S.	282	0.5				
	30.1	84	69	12 E.				
	30.1	88	64	12 E.				
	30.1	84	68	3 E.				
Aug. 16								
° °								
L. 3. 75. 48								
H. 3. 59. 45								

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 17 TO AUGUST 29, 1896.

Date.	Key West.	Waynesville.
Aug. 17 ° ° L . 3 . 66 . 48 H . 1 . 103 . 52	9.3 Ci. 73 0.5 9.0 A. Cu. 299 4.0 1.6 Cu. 299 7.7 5.7 Cu. 296 8.6 30.1 83 76 12 NE. 30.0 85 71 14 NE. 30.0 85 70 15 E.	
Aug. 18 ° ° H . 5 . 94 . 30 L . 3 . 60 . 48 H . 2 . 97 . 52	**H—5—15.** 9.1 Cu. 246 4.4 9.0 A. Cu. 258 3.1 1.7 Ci. S. 312 1.2 1.8 A. Cu. 132 1.8 5.7 A. S. 276 1.3 30.0 85 70 6 E. 30.0 84 70 4 SW. 30.0 82 80 9 S.	
Aug. 19 ° ° H . 2 . 83 . 50 L . 1 . 108 . 52 L . 3 . 58 . 47	9.0 Cu. 176 10.9 ... . 30.1 83 75 4 S.	
Aug. 20 ° ° H . 2 . 78 . 40 L . 1 . 107 . 47 L . 3 . 60 . 48	8.9 Ci. S. 309 1.6 9.2 Ci. Cu. 312 1.2 9.5 Cu. 161 10.2 1.7 Ci. S. 310 1.7 5.7 Ci. S. 316 1.6 30.1 84 74 10 SW. 30.1 85 70 6 SW. 30.1 86 69 3 SW.	
Aug. 21 ° ° H . 6 . 74 . 36 L . 4 . 99 . 41 L . 1 . 102 . 52	8.8 Cu. 176 3.1 1.7 A. S. 328 ... ... 30.1 85 74 4 S. 30.1 87 66 6 SW.	
Aug. 22 ° ° H . 3 . 63 . 45 H . 6 . 78 . 29 L . 2 . 90 . 47	**H—6—12.** 8.7 Cu. 237 3.8 1.6 Cu. 288 3.7 5.7 Cu. N. 300 4.0 30.1 85 71 5 S. 30.1 88 62 6 SE. 30.1 85 65 6 SE.	
Aug. 23 ° ° H . 6 . 80 . 30 L . 2 . 74 . 48 H . 4 . 106 . 41		
Aug. 24 ° ° L . 3 . 70 . 47 H . 5 . 98 . 34	8.8 Cu. 294 6.5 1.6 Cu. 298 3.2 ... . 30.2 84 69 6 NE. 30.1 87 60 6 NE.	
Aug. 25 ° ° H . 3 . 75 . 44 L . 2 . 95 . 51	8.8 Ci. S. 315 ... 9.2 Cu. 302 ... 9.2 A. Cu. 278 ... ... 5.9 A. S. 280 1.0 6.1 A. Cu. 305 1.9 30.1 85 74 7 NE. .... 30.1 87 69 4 NW.	
Aug. 26 ° ° H . 3 . 62 . 45 L . 2 . 80 . 47 H . 1 . 107 . 50	... . 5.6 A. S. 290 1.1 5.8 Ci. 289 1.4 6.0 A. Cu. 272 ... . 30.1 83 76 3 W.	
Aug. 27 ° ° H . 3 . 61 . 45 H . 6 . 75 . 33 H . 2 . 93 . 41 L . 3 . 72 . 48	**H—6—20.** 9.2 Ci. S. 310 0.4 1.8 Ci. S. 327 0.4 5.8 Ci. S. 296 0.8 30.1 85 69 3 S. 30.1 88 64 6 SW. 30.1 87 64 3 SW.	
Aug. 28 ° ° L . 6 . 80 . 29 L . 3 . 61 . 44 H . 2 . 80 . 48 L . 1 . 99 . 45	**L—6—5.** 8.9 Ci. S. 270 0.7 9.3 Cu. 225 6.3 1.7 Ci. S. 286 1.0 2.0 Cu. 228 4.0 6.1 Ci. S. 296 1.0 30.1 85 71 9 SE. 30.1 87 68 6 SE. 30.1 82 72 7 NE.	
Aug. 29 ° ° H . 3 . 76 . 41 L . 2 . 95 . 52	8.8 Cu. 216 5.7 1.9 Ci. S. 200 0.3 5.8 Ci. S. 208 0.5 30.0 85 66 8 SE. 30.0 87 73 5 SW 30.0 82 .. 13 NE.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

AUGUST 30 TO SEPTEMBER 11, 1896.

Date.	Key West.				Waynesville.
Aug. 30	H—6—20.				
° °	...	.....	...	...	
H . 6 . 75 . 35	12.9	A. Cu.	174	...	
L . 2 . 85 . 49	1.1	A. S.	146	...	
	1.3	Fr. Cu.	220	...	
	...	.....	...	...	
	....	..	..	....	
	....	..	..	....	
	....	..	..	....	
Aug. 31	8.8	Cu.	233	3.9	
° °	...	.....	...	...	
L . 3 . 70 . 48	5.8	Ci. S.	193	0.2	
H . 2 . 98 . 49	30.0	84	69	9 NE.	
	....	..	..	....	
	30.0	84	69	6 SE.	
Sept. 1	...	.....	...	...	
° °	1.7	Cu	265	4.4	
H . 2 . 83 . 42	5.7	Ci. S.	45	0.4	
L . 3 . 53 . 49	....	..	..	....	
L . 1 . 105 . 46	30.1	87	66	8 SE.	
	30.0	85	66	5 SE.	
Sept. 2	9.3	Ci.	210	0.3	
° °	9.0	Cu.	252	8.1	
H . 3 . 73 . 40	1.6	Ci. S	2	0.6	
L . 2 . 89 . 42	1.9	Cu.	256	6.3	
H . 1 . 106 . 54	5.6	Cu.	264	7.4	
	30.1	86	70	8 SE.	
	30.1	88	61	14 E.	
	30.0	86	65	14 E.	
Sept. 3	H—6—13.				
° °	8.8	Ci.	288	0.7	
L . 3 . 74 . 48	9.2	Cu.	282	7.0	
H . 2 . 100 . 49	1.6	Cu.	278	8.2	
H . 6 . 83 . 34	5.7	Ci. S.	242	0.6	
	6.0	Cu. N.	263	5.6	
	30.0	85	76	12 NE.	
	30.0	87	64	12 E.	
	30.0	86	65	12 E.	
Sept. 4	9.2	Ci. S.	213	0.7	
° °	9.3	Ci.	179	0.3	
L . 3 . 62 . 48	9.6	Cu.	319	11.2	
H . 2 . 81 . 45	1.7	Ci. S.	209	0.7	
L . 1 . 94 . 52	1.9	Cu.	332	6.3	
	...	.....	...	...	
	....	..	..	....	
	30.0	85	73	12 NE.	
	29.9	..	..	11 N.	
Sept. 5	8.7	A. Cu.	6	...	
° °	9.2	Cu.	42	11.1	
H . 3 . 69 . 45	9.0	Ci. S.	223	0.8	
L . 2 . 90 . 47	1.7	Cu.	41	5.9	
H . 1 . 106 . 51	6.0	Ci. S.	214	1.2	
	6.4	Cu.	51	8.5	
	29.9	84	73	15 NW.	
	29.9	85	73	16 N.	
	....	84	..	10 NW.	
Sept. 6	11.5	A. Cu.	272	0.5	
° °	11.7	Cu.	59	5.0	
H . 3 . 58 . 48	11.9	Ci. S.	305	..	
L . 2 . 81 . 45	...	.....	...	...	
H . 5 . 95 . 39	...	.....	...	...	
	....	..	..	....	
	....	..	..	....	
	....	..	..	....	
Sept. 7					
° °					
L . 3 . 70 . 50					
H . 6 . 84 . 39					
Sept. 8	...	.....	...	...	
	...	.....	...	..	
H . 3 . 74 . 46	5.8	Ci. S.	142	...	
L . 4 . 99 . 44	....	..	..	....	
	....	..	..	....	
	....	85	..	3 W.	
Sept. 9	...	.....	...	...	
° °	...	.....	...	..	
L . 3 . 70 . 40	5.9	Cu.	334	10.3	
L . 5 . 99 . 37	....	..	..	....	
H . 3 . 65 . 46	....	..	..	....	
	30.0	84	69	16 NE.	
Sept. 10	H—6—5.				
° °	...	.....	...	...	
H . 6 . 82 . 31	1.6	Ci.	58	2.0	
L . 3 . 70 . 41	2.0	Cu.	303	...	
L . 5 . 96 . 37	5.9	Cu.	295	5.6	
	....	..	..	....	
	29.9	86	66	10 NE.	
	29.9	86	60	10 NE.	
Sept. 11	H—6—13.				
° °	8.8	A. Cu.	77	0.9	
H . 6 . 78 . 37	9.1	Ci. S.	68	1.3	
L . 5 . 92 . 37	1.6	Cu.	285	3.9	
H . 2 . 95 . 45	5.9	Cu.	266	7.8	
L . 1 . 108 . 48	29.9	83	74	12 E.	
	29.9	85	64	10 E.	
	29.9	84	61	13 E.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 12 TO SEPTEMBER 26, 1896.

Date.	Key West.	Waynesville.
Sept. 12 ° ° H . 2 . 86 . 49	8.7 Ci. S. 115 1.3 8.9 A. S. 146 ... 9.2 Fr. Cu. 253 8.8 1.6 A. S. 127 1.3 1.9 Cu. 148 6.8 ... . 30.0 83 73 10 E. 30.0 82 78 15 E.	
Sept. 13 ° ° H . 2 . 82 . 50		
Sept. 14 ° ° H . 3 . 63 . 47 H . 6 . 75 . 40 L . 5 . 91 . 38 H . 1 . 108 . 54	8.9 A. Cu. 226 1.2 9.4 Ci. S. 236 1.0 1.8 Ci. S. 212 1.2 .. .. 30.0 83 82 10 NE. 30.0 82 79 10 NE.	
Sept. 15 ° ° L . 3 . 60 . 48 L . 5 . 88 . 37 H . 2 . 94 . 52 L . 1 . 119 . 48	**L—5—14.** 8.8 Ci. S. 171 0.8 1.7 Ci. S. 136 1.4 5.7 Ci. S. 148 1.2 30.0 84 76 6 NE. 30.0 87 67 4 N. 29.9 85 71 7 N.	
Sept. 16 ° ° L . 6 . 74 . 37 H . 3 . 72 . 47 L . 4 . 98 . 40 H . 1 . 121 . 50	... . 1.8 A. Cu. 182 1.0 2.2 Ci. S. 93 1.0 5.7 A. Cu. 288 0.7 ... . 29.9 87 64 5 N. 29.9 85 67 7 SE.	
Sept. 17 ° ° L . 2 . 80 . 48 H . 1 . 121 . 51 H . 6 . 85 . 87 L . 4 . 112 . 28	**H—6—5.** 8.8 A. Cu. 240 1.5 9.2 Cu. 187 8.1 9.4 Ci. S. 118 .... 1.7 A. Cu. 194 3.3 1.9 Ci. S. 128 1.3 2.1 Cu. 219 7.3 5.7 Ci. S. 133 1.0 5.9 Cu. 206 6.6 6.1 A. Cu. 274 1.3 30.0 82 74 10 S. 30.0 83 73 8 S. 29.9 84 70 9 SE.	
Sept. 18 ° ° H . 6 . 84 . 30 L . 3 . 56 . 47 L . 2 . 90 . 50 H . 1 . 107 . 59		
Sept. 19 ° ° L . 2 . 77 . 47 H . 4 . 99 . 43		
Sept. 20 ° ° H . 2 . 86 . 40		
Sept. 21 ° ° H . 6 . 74 . 37 L . 3 . 67 . 50 H . 1 . 106 . 51	8.7 Ci. S. 68 1.1 ... . 30.0 80 85 6 E.	
Sept. 22 ° ° L . 3 . 70 . 43 H . 2 . 96 . 43	**H—2—88.** 8.9 Ci. S. 218 1.9 9.0 Cu. 217 2.9 2.1 Ci. S. 275 1.1 5.6 Ci. S. 256 1.0 30.0 86 69 8 SW. 29.9 85 77 6 W.	
Sept. 23 ° ° L . 3 . 58 . 46 H . 2 . 86 . 40	**H—2—21.** 8.6 Ci. S. 258 0.6 1.6 Ci. S. 256 0.5 5.6 Ci. S. 260 0.7 5.6 Cu. 291 1.7 30.0 86 70 6 N. 30.0 85 76 12 N.	
Sept. 24 ° ° H . 6 . 80 . 37 L . 2 . 100 . 51	**H—6—18.** ... . 1.6 Cu. 304 8.5 ... . 30.0 81 61 21 E.	
Sept. 25 ° ° H . 3 . 67 . 43 L . 2 . 90 . 51	... . 1.6 Cu. 290 8.8 5.6 Ci. Cu. 282 3.5 .... 30.0 80 75 22 NE.	
Sept. 26 ° ° H . 3 . 62 . 43 L . 2 . 76 . 48 H . 4 . 105 . 42	**H—4—55.** 8.6 Ci. S. 295 0.6 1.6 S. 282 2.2 ... . 29.9 82 74 22 NE. 29.9 78 86 17 E.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

SEPTEMBER 27 TO OCTOBER 12, 1896

Date	Key West	Waynesville
Sept. 27 ° ° H . 3 . 68 . 41 H . 4 . 101 . 41		
Sept. 28 ° ° L . 6 . 84 . 29 H . 5 . 99 . 34	**L—6— 6.** **H—5—23.** 8.6 Ci. S. . 1.1 1.6 Ci S 35 0.8 5.6 Ci. S. 43 1.0 29.9 83 66 11 SE. 29.8 86 75 13 S. 29.8 80 78 16 SE.	
Sept. 29 ° ° L . 6 . 82 . 31 H . 3 . 67 . 43 L . 2 . 96 . 51	**L—6—5.** 8.6 Cu. 220 17.4 1.6 Cu. 184 9.4 5.6 Ci. S 333 1.0 29.9 77 83 14 S. 29.9 85 80 12 S. 29.9 84 82 6 SE.	
Sept. 30 ° ° L . 2 . 83 . 44 H . 2 . 100 . 50	8.6 Ci. S. 15 0.3 8.5 Cu. 174 1.0 1.6 Cu. 19 0.5 5.7 (?) 208 0.7 30.1 84 80 5 S. 30.0 86 81 5 SW. 30.0 85 75 4 W.	
Oct. 1 ° ° L . 3 . 69 . 49 H . 2 . 89 . 46 L . 1 . 101 . 52	8.6 Cu. 337 9.0 1.7 Cu. 330 5.9 5.6 Ci. S. 0 0 30.1 82 84 11 NE. 30.0 83 73 12 NE. 30.0 81 61 11 NE.	
Oct. 2 ° ° H . 2 . 81 . 47 H . 4 . 102 . 42 L . 1 . 111 . 52	8.6 Cu. 327 6.3 ... . 30.0 79 57 10 NE.	
Oct. 3 ° ° H . 2 . 76 . 48 L . 1 . 104 . 47	8.6 Ci. S. 103 0.8 ... . 29.9 80 64 4 NE.	
Oct. 4 ° ° H . 3 . 74 . 44 L . 2 . 98 . 43		
Oct. 5 ° ° H . 3 . 70 . 50 L . 2 . 88 . 47 H . 2 . 100 . 47	8.6 Ci. S. 126 1.4 ... . 5.6 Cu. 323 2.1 30.0 81 76 13 NE. .... 30.0 82 69 16 E.	
Oct. 6 ° ° L . 3 . 66 . 43 H . 4 . 102 . 41		
Oct. 7 ° ° L . 3 . 64 . 44 H . 2 . 95 . 47	8.6 Ci. Cu. 323 2.9 .. .. 30.0 78 78 16 NE.	
Oct. 8 ° ° L . 3 . 67 . 48 H . 2 . 85 . 50 L . 1 . 102 . 53	... . 1.6 Ci. S. 132 1.6 5.6 Ci. S. 24 1.6 .... 29.9 80 64 12 NE. 29.9 79 68 6 E.	
Oct. 9 ° ° H . 2 . 78 . 44 L . 3 . 60 . 48 L . 4 . 101 . 41	... . 5.6 Cu. 315 10.2 ... . 29.8 77 91 9 SW.	
Oct. 10 ° ° H . 3 . 72 . 47 L . 2 . 94 . 42 H . 4 . 107 . 43 L . 6 . 79 . 23	**L—6—4.** ... . 5.6 Ci. S. 111 1.0 .... 29.8 78 87 5 NE.	
Oct. 11 ° ° H . 3 . 64 . 49 L . 5 . 91 . 39		
Oct. 12 ° ° L . 6 . 73 . 37 H . 3 . 69 . 50 H . 1 . 118 . 46	... . 1.6 Cu. 145 6.0 1.6 Cu. 180 0.5 ... . 30.0 84 80 6 SW. 30.0 82 84 3 SW.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 13 TO OCTOBER 28, 1896.

Date.	Key West.	Waynesville.
Oct. 13 ° ° L . 6 . 74 . 39 H . 4 . 106 . 42	8.6 Cu. 122 6.7 1.6 Ci. Cu. 142 5.5 ... . 30.0 81 80 6 NW. 30.0 81 72 15 NW.	
Oct. 14 ° ° L . 3 . 63 . 44 H . 5 . 98 . 39 L . 2 . 97 . 51	... . 1.6 Ci. S. 93 2.6 ... . 30 0 76 59 9 N.	
Oct. 15 ° ° L . 3 . 67 . 41 H . 4 . 108 . 43	8.6 Ci. Cu. 104 2.2 ... . 30.0 73 62 8 E.	
Oct. 16 ° ° L . 3 . 56 . 42 H . 1 . 112 . 52		
October 17 ° ° L . 3 . 65 . 50 L . 6 . 79 . 36 H . 1 . 105 . 51	**L—6—13.** 8.6 S. 139 24.6 1.6 Cu. 104 6.3 5.6 Ci. S. 110 0.6 29.9 82 76 26 SW. 29.9 81 80 13 W. 30.0 78 79 13 NW.	
October 18 ° ° L . 6 . 73 . 39 H . 5 . 91 . 34 H . 1 . 106 . 48		
October 19 ° ° L . 3 . 66 . 49 H . 6 . 83 . 35 L . 2 . 96 . 44	**H—6—13.** 8.6 A. Cu. 180 2.5 1.6 A. Cu. 152 2.5 5.4 A. Cu. 151 2.9 30.1 76 70 13 NE. 30.0 79 68 9 NE. 30.0 77 74 9 NE.	
October 20 ° ° L . 2 . 80 . 48 H . 4 . 98 . 43	... . 1.6 S. 161 0.7 5.6 A. S. 2 0.3 .... 30.0 82 80 4 NE. 30.0 80 83 4 NE.	
October 21 ° ° H . 3 . 59 . 47 L . 2 . 80 . 48 H . 6 . 88 . 36	**H—6—14.** 8.6 Ci. S. 133 0.3 9.1 A. S. 310 8.7 1 6 A Cu. 7 0.3 ... . 30.1 79 85 9 NE. 30.0 83 75 4 SW.	
October 22 ° ° L . 3 . 65 . 49 H . 6 . 76 . 38 H . 1 . 107 . 50	.. .. 5.6 Cu. 149 1.4 .... 30.0 83 88 4 N.	
October 23 ° ° L . 2 . 82 . 47 L . 5 . 93 . 32 H . 4 . 106 . 42	**L—5—14.** 8.5 Cu. 245 ... 1.6 Cu. 239 7.1 ... . 30.0 82 80 12 E. 29.9 85 73 9 SE.	
October 24 ° ° L . 3 . 70 . 46 H . 5 . 100 . 34 L . 1 . 105 . 51		
Oct. 25 ° ° H . 6 . 79 . 38		
Oct. 26 ° ° H . 6 . 75 . 39 H . 1 . 114 . 51	8.6 Ci. S. 122 1.4 12.8 Ci. S. 181 0.0 12.9 Cu. 121 1.0 5.7 Cu. 129 2.5 30.1 83 76 4 E. 30.0 87 67 5 NE. 30.0 83 73 5 E.	
Oct. 27 ° ° H . 6 . 80 . 38 L . 1 . 103 . 46	**H—6—13.** ... . 1.6 Cu. 241 2.6 ... . 30.0 85 66 9 SE.	
Oct. 28 ° ° H . 3 . 69 . 46 L . 2 . 91 . 47 L . 5 . 104 . 37	8.6 Cu. 259 6.0 1.6 Cu. 256 2.4 5.1 Cu. 273 1.4 30.1 82 72 10 E. 30.0 84 71 9 E. 30.0 82 72 11 SE.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

OCTOBER 29 TO NOVEMBER 13, 1896.

Date.	Key West.	Waynesville.
Oct. 29 ° ° H . 3 . 62 . 43 L . 5 . 95 . 38 H . 2 . 99 . 52	8.5 Cu. 264 4.1 1.6 Cu. 280 4.0 ... . 30.1 82 76 15 SE. 30.1 83 76 13 SE. 30.1 81 68 12 SE.	
Oct. 30 ° ° H . 6 . 76 . 33 L . 2 . 93 . 45	**H—6—20.** 8.5 Cu. 264 .. 1.7 Cu. 229 1.8 ... . 30.1 81 72 12 E. 30.0 83 69 11 SE.	
Oct. 31 ° ° H . 6 . 85 32 L . 2 . 84 . 48 H . 4 . 105 . 36	**H—6—6.** ... . 1.7 Cu. 277 6.6 ... . 30.0 83 59 12 E.	
Nov. 1 ° ° H . 6 . 86 . 33 L . 2 . 89 . 48		
Nov. 2 ° ° H . 6 . 78 . 37 L . 2 . 95 . 42	**H—6—13.** ... . 1.7 Ci. S. 104 1.7 2.0 Cu. 253 6.5 5.4 Ci. S. 148 1.1 30.1 79 75 4 E. 30.0 82 71 10 E. 30.0 80 72 13 E.	
Nov. 3 ° ° H . 3 . 72 . 47 L . 2 . 94 . 51		
Nov. 4 ° ° H . 3 . 67 . 47 L . 2 . 86 . 48 H . 4 . 113 . 40	8.5 Cu. 207 7.8 ... . 5.1 Ci. Cu. 179 0.4 30.0 81 68 10 SE. .... 29.9 81 76 9 SE.	
Nov 5 ° ° H . 3 . 59 . 45 L . 2 . 83 . 42 L . 1 . 104 . 47	8.6 Ci. S. 136 2.0 ... . 5.1 Ci. Cu. 144 1.9 30.0 80 79 8 SW. .... 30.0 81 80 8 SW.	
Nov. 6 ° ° L . 2 . 76 . 46 H . 6 . 84 . 36 L . 5 . 95 . 37 H . 1 . 114 . 54		
Nov. 7 ° ° L . 3 . 66 . 49 L . 2 . 86 . 46 H . 4 . 10 . 42	8.6 Ci. Cu. 181 0.6 ... . 5.1 Ci. S. 169 1.6 30.0 79 72 14 NE. .... 30.0 77 87 7 NE.	
Nov. 8 ° ° L . 2 . 82 . 41		
Nov. 9 ° ° H . 6 . 84 . 37 L . 3 . 65 . 47 L . 1 . 124 . 50	**H—6—13.** ... . 1.6 Cu. 222 3.4 5.1 S. 186 3.1 .... 30.0 80 83 9 E. 30.0 79 87 7 E.	
Nov. 10 ° ° H . 3 . 73 40 L . 5 . 97 . 38 L . 1 . 123 . 49	8.5 A. S. 142 2.7 1.6 Cu. 188 2.7 5.1 A. Cu. 178 1.4 30.1 81 80 8 SE. 30.1 83 73 7 N. 30.1 80 79 5 E.	
Nov. 11 ° ° H . 3 . 65 . 45 L . 2 . 84 . 48 H . 1 . 110 . 53 L . 5 . 96 . 30	**L—5—15.** 8.5 Cu. 214 3.6 1.6 Cu. 196 4.3 5.1 Ci. S. 71 2.9 30.2 83 80 5 E. 30.1 84 75 9 E. 30.1 81 84 8 E.	
Nov. 12 ° ° L . 3 . 66 . 49 H . 6 79 . 30 H . 1 . 110 . 52	**H—6—12.** ... . 1.7 Ci. S. 0 0 2.1 Cu. 213 4.1 ... . 30.1 82 76 14 E.	
Nov. 13 ° ° L . 3 . 67 . 47 H . 5 . 96 . 34 L . 1 . 123 . 50	... . 5.1 A. Cu. 184 1.2 .... 30.0 77 83 6 NE.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 14 TO NOVEMBER 28, 1896.

Date.	Key West.	Waynesville.
Nov. 14 ° ° H . 6 . 58 . 42 L . 3 . 82 . 37 L . 2 . 97 . 50 H . 4 . 112 . 40	**H—6—13.** ... . 5.1 A. S. 131 1.7 .... 30.1 74 66 30 E.	
Nov. 15 ° ° H . 6 . 80 . 35 L . 3 . 66 . 50		
Nov. 16 ° ° H . 6 . 80 . 34 L . 2 . 97 . 47 H . 3 . 66 . 46	**H—6—13.** 8.1 Ci. S. 126 1.6 1.1 Ci. S. 132 2.4 5.1 Ci. S. 121 2.6 30.2 72 77 16 NE. 30.2 75 66 18 NE. 30.2 75 74 14 NE.	
Nov. 17 ° ° H . 6 . 83 . 34 L . 3 . 68 . 49 H . 1 . 114 . 54	**H—6—13.** 8.6 Ci. S. 112 2.1 ... . 5.1 Ci. S. 109 2.7 30.2 73 86 18 NE. .... 30.1 75 87 18 NE.	
Nov. 18 ° ° H . 3 . 63 . 43 H . 6 . 83 . 35 H . 1 . 113 . 52 L . 2 . 87 . 45	**H—6—13.** 8.7 Ci. Cu. 134 1.0 8.9 Cu. 246 1.0 1.7 Ci. Cu. 109 1.2 2.1 S. 239 5.2 5.1 S. 226 1.8 30.1 74 70 14 NE. 30.0 74 82 17 NE. 30.0 87 75 22 NE.	
Nov. 19 ° ° L . 3 . 62 . 49 H . 1 . 112 . 53	... . 1.6 Cu. 262 4.8 5.1 A. Cu. 293 3.0 .... 30.0 79 71 16 NE. 30.0 77 70 16 NE.	
Nov. 20 ° ° L . 6 . 80 . 24 H . 1 . 111 . 51 L . 4 . 112 . 38	**L—6—4.** 8.6 Ci. S. 231 1.8 1.6 Cu. 291 5.6 5.0 Cu. 278 ... 30.1 75 82 15 NE. 30.1 80 68 16 E. 30.1 78 71 17 E.	
Nov. 21 ° ° H . 3 . 64 . 46 L . 2 . 84 . 43 H . 1 . 107 . 51	... . 1.3 Cu. 261 5.4 5.1 Cu. 288 4.9 .... 30.1 79 75 15 E. 30.1 74 82 18 E.	
Nov. 22 ° ° L . 3 . 57 . 46 H . 2 . 85 . 50		
Nov. 23 ° ° H . 3 . 69 . 46 L . 2 . 90 . 50 H . 1 . 113 . 51	8.6 Cu. 229 4.2 1.6 Cu. 254 9.7 5.1 Cu. 276 6.3 30.2 74 86 13 E. 30.2 79 71 19 E. 30.3 78 71 15 E.	
Nov. 24 ° ° H . 6 . 80 . 35 L . 3 . 70 . 49 H . 1 . 113 . 48	**H—6—13.** 8.6 A. Cu. 289 4.2 1.6 Cu. N. 306 5.7 5.1 Ci. S. 125 0.8 30.2 76 74 18 NE. 30.2 78 71 20 NE. 30.2 77 71 20 E.	
Nov. 25 ° ° H . 3 . 73 . 49 L . 4 . 114 . 39 H . 1 . 110 . 54		
Nov. 26 ° ° L . 2 . 94 . 40		
Nov. 27 ° ° H . 6 . 76 . 34 L . 2 . 87 . 49 H . 4 . 109 . 44	**H—6—20.** 8.6 Ci. Cu. 121 0.6 1.8 Cu. 234 6.9 1.9 Ci. S. 52 1.5 ... . 30.1 79 68 13 E. 30.1 80 68 13 E.	
Nov. 28 ° ° H . 6 . 75 . 34 L . 3 . 69 . 49 H . 4 . 108 . 43 L . 6 . 87 . 33	**H—6—20.** **L—6—14.** 8.6 Cu. 228 1.8 ... . 30.1 78 75 11 E.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

NOVEMBER 29 TO DECEMBER 15, 1896.

Date.	Key West.	Ocean City.
Nov. 29 ° ° L . 6 . 62 . 29 L . 3 . 59 . 46 H . 1 . 111 . 52		
Nov. 30 ° ° L . 6 . 82 . 27 H . 1 . 106 . 54		
Dec. 1 ° ° L . 6 . 83 . 26 L . 3 . 65 . 48 L . 4 . 105 . 50 H . 1 . 109 . 52		
Dec. 2 ° ° L . 6 . 80 . 30 H . 3 . 75 . 48	**L—6—5.** ... . 1.6 Cu. 98 10.2 5.0 Cu. N. 67 6.7 .... 29.9 76 74 30 NW. 29.9 72 82 26 NW.	
Dec. 3 ° ° H . 2 . 85 . 40 H . 4 . 112 . 41		
Dec. 4 ° ° H . 6 . 74 . 39 L . 2 . 88 . 47 L . 1 . 111 . 49	8.6 A. Cu. 114 3.2 ... . 30.1 66 80 10 NE.	
Dec. 5 ° ° H . 6 . 80 . 35 L . 3 . 64 . 49 L . 2 . 92 . 43		
Dec. 6 ° ° H . 6 . 76 . 34 L . 2 . 79 . 46 L . 5 . 97 . 37		
Dec. 7 ° ° H . 6 . 77 . 32 L . 3 . 62 . 48 H . 4 . 116 . 40	**H—6—12.** 8.6 A. Cu. 147 1.9 1.8 A. Cu. 79 0.9 1.9 Ci. S. 59 1.0 5.1 Ci. S. 127 3.2 30.1 71 91 10 NE. 30.1 75 82 10 NE. 30.1 75 87 10 NE.	
Dec. 8 ° ° H . 6 . 70 . 40 H . 4 . 115 . 41	8.6 Ci. S. 123 1.2 ... . 30.1 72 91 7 E.	
Dec. 9 ° ° L . 3 . 71 . 44 L . 2 . 86 . 50 H . 4 . 113 . 41	8.6 Ci. S. 76 2.9 1.8 Cu. 207 2.5 1.9 Ci. S. 111 2.3 5.1 Ci. S. 98 0.7 30.1 79 79 4 E. 30.0 80 72 5 SE. 30.0 78 79 3 SE.	
Dec. 10 ° ° L . 3 . 58 . 48 L . 2 . 88 . 51 H . 4 . 109 . 39	8.6 Cu. 179 1.5 8.9 Ci. S. 132 2.0 1.6 Cu. 125 1.7 ... . 30.1 78 83 5 SE. 30.0 80 79 9 S.	
Dec. 11 ° ° L . 3 . 59 . 48 L . 2 . 96 . 52 H . 4 . 111 . 40		
Dec. 12 ° ° H . 6 . 76 . 34 L . 3 . 67 . 50 L . 2 . 95 . 52	**H—6—20.** ... . 1.6 A. Cu. 278 7.5 5.1 A. Cu. 294 7.4 .... 30.2 73 69 12 NE. 30.1 74 70 8 E.	
Dec. 13 ° ° H . 6 . 79 . 32 L . 2 . 78 . 48		
Dec. 14 ° ° L . 3 . 63 . 48 H . 2 . 84 . 51 L . 5 . 93 . 33 H . 4 . 109 . 42	**L—5—14.** 8.6 A. Cu. 182 3.2 ... . 5.1 Ci. S. 136 3.1 30.0 78 66 7 S. .... 29.8 76 91 10 SW.	
Dec. 15 ° ° L . 6 . 78 . 32 H . 2 . 77 . 50 H . 5 . 101 . 31		

TABLE 9.—*Summary of nephoscope observations*—Continued.

DECEMBER 16 TO DECEMBER 31, 1896.

Date.	Key West.	Ocean City.
Dec. 16 ° ° L . 3 . 70 . 40 H . 2 . 77 . 50 L . 4 . 104 . 43		
Dec. 17 ° ° L . 3 . 60 . 44 H . 2 . 76 . 48 L . 5 . 95 . 37		
Dec. 18 ° ° H . 3 . 68 . 43 L . 2 . 82 . 45 H . 1 . 101 . 48	... . 1.6 Ci. 148 1.1 ... . 30.2 73 69 10 NE.	
Dec. 19 ° ° L . 3 . 67 . 45 H . 2 . 85 . 50 H . 5 . 95 . 36 H . 4 . 113 . 41	8.6 Ci. S. 117 2.6 1.6 Ci. S. 124 2.6 5.1 Ci. S. 142 1.3 30.2 70 77 6 NE. 30.1 73 61 7 NE. 30.1 71 64 9 NE.	
Dec. 20 ° ° H . 6 . 78 . 31 L . 3 . 57 . 48		
Dec. 21 ° ° L . 3 . 58 . 47 H . 2 . 84 . 50 H . 4 . 113 . 42 L . 1 . 112 . 52	... . 1.6 Ci. Cu. 125 3.6 5.1 Ci. S. 131 5.3 .... 30.0 65 57 14 NE. 30.0 65 75 13 N.	**H—2—14.** ... . 1.4 A. Cu. 60 5.6 ... . 36 47 Lt. NW. ....
Dec. 22 ° ° H . 6 . 88 . 28 L . 3 . 55 . 49 L . 2 . 90 . 43 H . 4 . 112 . 41	**H—6—6.** 8.6 Ci. Cu. 125 5.3 1.6 Ci. Cu. 120 4.8 ... . 30.2 63 60 16 NE. 30.2 65 52 12 NE.	**L—2—15.** ... . 1.4 Ci. S. 102 5.2 1.9 Ci. 96 4.7 1.9 Ci. Cu. 95 5.7 4.6 A. Cu. 85 5.7 4.9 S. Cu. 101 ... . 37 48 6 S. .... 37 57 9 S.
Dec. 23 ° ° L . 3 . 71 . 40 H . 2 . 86 . 51 H . 4 . 109 . 43	... . 1.6 Ci. S. 114 1.5 ... . 5.1 Ci. S. 112 4.7 .... 30.3 67 62 6 NE. 30.3 65 75 4 NE.	**L—3—4.** 8.3 S. Cu. 95 6.8 1.2 A. S. 108 ... 1.7 A. Cu. 90 7.9 1.8 Fr. Cu. 70 14.0 ... . 40 68 5 NW. .... 40 45 27 NW. ....
Dec. 24 ° ° L . 3 . 59 . 45 H . 2 . 95 . 42	8.6 Ci. Cu. 138 2.5 1.6 A. Cu. 129 3.9 5.1 A. Cu. 121 3.1 30.3 66 71 10 NE. 30.2 68 63 8 NE. 30.2 66 75 5 NE.	
Dec. 25 ° ° L . 3 . 59 . 46 H . 6 . 85 . 37 L . 2 . 94 . 51		
Dec. 26 ° ° L . 3 . 67 . 49 H . 6 . 86 . 34	**H—6—13.** ... . 1.6 Ci. 114 2.1 ... . 5.1 Ci. S. 111 2.2 .... 30.3 63 76 13 NE. 30.3 68 71 15 NE.	**L—3—20.** **H—6—16.** 8.3 Ci. Cu. 92 4.5 1.3 Ci. 107 ... 1.5 Ci. Cu. 92 7.0 ... . 28 77 5 SW. .... 40 38 5 NW. ....
Dec. 27 ° ° H . 3 . 75 . 45		
Dec. 28 ° ° H . 3 . 74 . 41 L . 1 . 110 . 54	8.6 Cu. 235 5.0 1.6 A. Cu. 223 2.9 5.1 Ci. S. 325 0.6 30.4 66 80 15 NE. 30.4 70 64 25 NE. 30.2 69 67 23 NE.	
Dec. 29 ° ° H . 6 . 78 . 37 L . 1 . 106 . 51	**H—6—13.** 8.6 Ci. S. 357 2.7 ... . 5.1 Ci. S. 3 0.6 30.3 67 85 10 NE. .... 30.2 71 72 18 E.	**H—6—3.** 8.4 Ci. S. 77 2.1 1.6 Ci. S. 103 3.3 4.2 Ci. Cu. 104 2.4 .... 26 88 0 .... 45 61 Lt. S. .... 39 75 Lt. S.
Dec. 30 ° ° H . 6 . 85 . 35 L . 2 . 83 . 51 H . 2 . 98 . 52	**H—6—13.** 8.6 Ci. S 109 1.1 ... . 1.6 A. Cu. 107 1.2 5.1 S. 16 0.9 30.2 67 85 15 NE. 30.1 71 81 7 NE. 30.2 69 90 9 NE.	**H—6—16.** **L—2—14.** 8.0 Ci. S. 122 ... 10.5 S. Cu. 94 5.7 ... . 32 91 0 ....
Dec. 31 ° ° L . 3 . 61 . 46 H . 2 . 79 . 49 L . 1 . 107 . 47		

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 1 TO JANUARY 14, 1897.

Date.	Key West.	Ocean City.
Jan. 1 ° ° H . 3 . 64 . 48 L . 2 . 96 . 47		**H—3—20.** 8.1 Fr. S. 262 8.3 1.3 S. Cu. 256 5.1 4.4 S. Cu. 286 5.8 .... 34 95 0 .... 43 77 Lt. E. .... 42 36 Lt. NE.
Jan. 2 ° ° H . 3 . 63 . 42 L . 2 . 98 . 49 L . 5 . 100 . 34	8.6 Cu. 246 2.9 1.6 Cu. 244 10.5 5.5 Cu. 215 5.3 5.4 Ci. S. 131 1.1 30.2 73 78 15 E. 30.2 76 59 22 E. 30.2 74 82 16 E.	**H—3—20.** 8.3 S. Cu. 156 5.7 ... . 4.2 Ci. 52 2.8 ... . 42 92 0 .... 44 92 Lt. NE.
Jan. 3 ° ° H . 6 . 74 . 39 L . 2 . 91 . 41		
Jan. 4 ° ° H . 3 . 64 . 43 L . 2 . 92 . 46	8.7 Ci. 82 2.6 ... . 1.8 Ci. S. 85 3.0 5.3 Ci. S. 80 3.0 30.1 70 68 13 NE. 30.0 72 61 10 NE. 30.0 71 64 5 NE.	**H—3—20.** **L—2—14.** 8.1 S. Cu. 186 8.3 8.4 Ci. S. 157 1.7 ... . 46 89 5 S. ....
Jan. 5 ° ° L . 3 . 75 . 48 H . 4 . 112 . 43	8.9 Cu. 349 14.7 1.8 A. Cu. 102 4.2 ... . 5.3 A. Cu. 78 4.2 30.1 67 76 13 N. 30.0 65 76 27 N. 30.0 63 65 30 N.	**L—8—13.** ... . 1.2 Ci. 158 5.0 1.4 A. Cu. 151 11.6 5.0 A. Cu. 106 5.2 .... 46 72 Lt. E. 42 84 0
Jan. 6 ° ° L . 3 . 66 . 48 H . 4 . 110 . 42	... . 1.6 A. Cu. 85 5.5 5.1 A. Cu. 104 7.2 .... 30.1 64 56 10 NE. 30.1 61 63 12 NE.	**L—3—20.** **H—4—57.** 9.0 S. Cu. 131 8.3 ... . 30 52 13 NW. ....
Jan. 7 ° ° H . 6 . 81 . 36 H . 4 . 112 . 42	**H—6—13.** 8.6 A. Cu. 114 5.6 ... . 5.3 A. Cu. 72 4.3 5.4 Ci. S. 94 4.5 30.2 59 57 11 NE. .... 30.2 61 63 9 NE.	**H—6—8.** ... . 4.2 Ci. 134 3.4 ... . 34 52 Lt. E.
Jan. 8 ° ° H . 3 . 67 . 49 H . 4 . 112 . 42 H . 5 . 100 . 31	8.6 Cu. 41 5.6 1.7 Cu. 11 12.4 ... . 30.4 60 68 10 NE. 30.3 60 68 7 N.	**H—3—20.** 8.3 S. Cu. 318 12.4 1.3 Ci. 180 0.9 3.9 S. Cu. 329 20.2 .... 31 74 5 N. .... 37 66 17 N. .... 36 73 17 N.
Jan. 9 ° ° L . 2 . 87 . 50 H . 4 . 112 . 43 H . 6 . 87 . 29		**H—6—16.** ... . 4.0 Ci. 29 3.2 .... 38 68 Lt. S.
Jan. 10 ° ° L . 3 . 7 . 48 H . 6 . 88 . 28 H . 4 . 110 . 43		
Jan. 11 ° ° L . 3 . 64 . 50 H . 4 . 109 . 42		8.2 Ci. Cu. 100 4.5 1.2 S. Cu. 100 12.6 1.7 A. Cu. 128 10.7 ... . 32 90 Lt. W. .... 41 69 7 N. ....
Jan. 12 ° ° L . 3 . 61 . 44 H . 2 . 85 . 50 L . 4 . 105 . 43		**L—3—20.** 8.4 S. Cu. 68 6.6 1.5 Cu. 60 7.0 1.6 Fr. Cu. 71 7.0 4.4 Cu. 60 ... . 31 43 4 NW. .... 32 50 10 NW. .... 30 48 5 NW.
Jan. 13 ° ° L . 3 . 54 . 48 H . 2 . 75 . 44 L . 5 . 97 . 38	8.8 Cu. 222 10.7 ... . 1.6 A. Cu. 251 2.1 5.5 Cu. 254 4.5 5.7 Ci. S. 45 3.9 30.2 66 84 8 NE. 30.1 68 78 11 NE. 30.2 72 62 7 SE.	**H—2—5.** 8.4 Ci. Cu. 93 5.1 8.6 Ci. S. 76 5.2 ... . 22 58 ....
Jan. 14 ° ° L . 6 . 75 . 36 H . 2 . 98 . 51	8.9 Ci. S. 61 3.8 9.1 Cu. 194 4.4 1.6 Cu. 175 3.8 5.6 Ci. Cu. 65 3.3 5.8 Ci. S. 42 3.4 6.0 Cu. 204 4.3 30.2 69 85 8 E. 30.2 76 59 7 SE. 30.1 72 69 5 SE.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 15 TO JANUARY 28, 1897.

Date.	Key West.	Ocean City.
Jan. 15 ° ° H . 3 . 62 . 49	.. .. 1.7 Ci. S. 49 2.1 5.2 Ci. S. 58 3.3 .... 30.1 72 77 5 NE. 30.1 71 82 5 N.	
Jan. 16 ° ° H . 6 . 75 . 39 L . 5 . 101 . 40	8.8 Ci. 71 2.9 1.9 Ci. S. 73 3.2 5.4 Ci. S. 77 3.0 ... . 30.1 68 87 10 NE. 30.1 67 85 8 N. 30.1 67 89 12 N.	**H—6—1.** ... . 4.9 Ci. 42 ... 4.9 S. Cu. 145 ... . 38 88 Lt. NE.
Jan. 17 ° ° H . 3 . 59 . 46 L . 2 . 86 . 47		
Jan. 18 ° ° H . 3 . 55 . 48 L . 3 . 70 . 49 H . 5 . 99 . 33 H . 4 . 112 . 43		**L—8—13.** **H—4—56.** 9.8 S. Cu. 113 9.4 1.4 Fr. Cu. 48 11.7 4.1 Fr. Cu. 48 10.8 .... 48 76 28 NW. .... 44 37 32 NW. .... 40 38 28 NW.
Jan. 19 ° ° H . 2 . 84 . 50 L . 5 . 98 . 22		**H—2—14.** 8.4 S. Cu. 63 7.5 1.3 Fr. Cu. 33 10.6 1.9 Cu. 77 8.3 4.6 Fr. Cu. 345 6.3 .... 29 66 Lt. NW. .... 30 62 Lt. N. .... 26 64 3 NE.
Jan. 20 ° ° H . 3 . 68 . 43 L . 2 . 87 . 50 L . 5 . 90 . 35	**L—5—14.** 8.8 S. Cu. 215 4.3 ... . 1.6 Cu. 217 8.2 5.4 A. S. 92 3.9 30.1 75 62 15 SE. 30.1 75 65 14 S. 30.1 74 70 6 SE.	**H—8—12.** **L—5—15.** 8.2 S. Cu 213 9.4 8.5 Ci. Cu. 89 4.2 ... . 4.2 Fr. S. 160 9.7 .... 34 66 5 S. .... 40 72 7 S.
Jan. 21 ° ° H . 3 . 59 . 46 L . 2 . 78 . 44	8.9 Ci. S. 97 3.9 ... . 1.6 Ci. S. 97 3.7 ... . 5.4 Ci. S. 104 3.9 ... . 30.1 75 76 7 SE. 30.0 76 70 6 SW. 30.0 72 86 4 NW.	**L—2—5.** 8.2 S. Cu. 135 12.2 8.4 Ci. Cu. 115 5.3 1.4 Fr. Cu. 57 12.2 1.5 Cu. 66 15.1 1.8 Ci. S. 109 ... 2.0 Ci. 109 7.5 2.2 A. Cu. 109 7.1 4.1 Ci. 116 7.7 4.1 Fr. Cu. 52 12.5 .... 45 89 5 W. .... 50 56 5 W. .... 49 57 4 W.
Jan. 22 ° ° L . 3 . 64 . 48 L . 2 . 84 . 45	... . 1.6 Ci. S. 103 3.7 5.2 Ci. S. 101 3.9 ... . 30.1 70 90 10 N. 30.1 69 87 9 NE.	**L—3—20.** **L—2—14.** ... . 1.6 Ci. 93 6.3 4.3 Ci. 96 8.0 4.4 Ci. S. 105 6.9 .... 48 46 7 S. .... 42 73 19 S.
Jan. 23 ° ° L . 3 . 59 . 49 H . 1 . 108 . 54	8.8 Cu. 305 7.4 1.7 A. Cu. 206 3.3 5.3 Ci. Cu. 111 3.3 30.2 67 77 16 NE. 30.1 67 62 15 NE. 30.1 70 68 15 NE.	**L—8—12.** ... . 1.1 Cu. 58 10.0 ... . 32 41 20 W. ....
Jan. 24 ° ° L . 3 . 59 . 48 H . 1 . 111 . 51		
Jan. 25 ° ° L . 3 . 58 . 49 L . 6 . 78 . 33 H . 1 . 111 . 52	**L—6—12.** 8.8 A. Cu. 90 4.1 1.6 A. Cu. 101 3.5 ... . 30.0 69 83 12 E. 30.0 70 81 12 NE.	**L—6—9.** 8.3 Ci. 88 6.9 1.0 A. S. 77 ... 4.1 A. Cu. 91 7.0 .... 12 50 5 NW. .... 16 50 18 W. .... 18 52 5 W.
Jan. 26 ° ° L . 3 . 68 . 50 H . 1 . 110 . 50 L . 6 . 82 . 21	**L—6—1.** 8.7 A. Cu. 102 5.0 1.6 Cu. 145 13.1 1.9 Ci. S. 115 4.0 5.2 A. Cu. 102 4.2 30.0 72 83 4 E. 29.9 76 80 12 S. 29.9 75 87 12 SW.	**L—3—20.** **L—6—16.** ... . 4.4 Ci. 88 4.8 .... 24 36 10 W.
Jan. 27 ° ° L . 6 . 80 . 32 H . 1 . 112 . 52		
Jan. 28 ° ° L . 3 . 71 . 41 H . 4 . 105 . 41 H . 1 . 111 . 52	**H—4—55.** ... . 5.2 Cu. 355 11.8 5.5 A. Cu. 99 6.1 .... 30.3 56 63 22 N.	**L—3—4.** **H—4—57.** 8.0 S. Cu. 88 2.3 ... . 4.1 S. Cu. 51 7.6 ... . 16 82 10 W. .... 16 56 18 W.

TABLE 9.—*Summary of nephoscope observations*—Continued.

JANUARY 29 TO FEBRUARY 12, 1897.

Date.	Key West.	Ocean City.
Jan. 29 ° ° L . 3 . 64 . 45 H . 2 . 86 . 50 H . 5 . 93 . 34	**H—5—14.** 8.9 A. Cu. 120 4.8 ... . 30.3 52 67 20 NE.	**L—3—20.** ... . 4.2 Ci. 93 8.3 .... 25 56 5 W.
Jan. 30 ° ° H . 2 . 85 . 40 L . 4 . 105 . 45		
Jan. 31 ° ° H . 3 . 74 . 43		
Feb. 1 ° ° H . 3 . 74 . 42 L . 6 . 87 . 33	**L—6—14.** ... ... 5.7 A. Cu. 112 5.0 .... 30.1 68 90 12 NW.	**H—3— 1.** **L—6—16.** 9.0 Ci. 91 3.3 1.3 A. Cu. 110 2.8 4.1 Ci. S. 111 3.0 .... 24 93 Lt. NW .... 40 80 Lt. E. .... 37 91 Lt. E.
Feb. 2 ° ° L . 6 . 75 . 36 H . 2 . 94 . 43 H . 5 . 97 . 30	**L—6—20.** 8.8 A. Cu. 79 7.5 1.7 Fr. Cu. 64 10.4 5.7 Cu. 54 12.2 30.1 67 59 28 NW. 30.1 66 66 24 NW. 30.0 66 71 24 NW.	
Feb. 3 ° ° L . 3 . 69 . 40 H . 2 . 84 . 50 L . 5 . 100 . 35	8.8 A. Cu. 67 5.0 ... . 30.1 64 55 12 N.	
Feb. 4 ° ° H . 2 . 80 . 50 L . 5 . 95 . 34		**H—2—13.** 8.3 S. Cu. 111 2.4 8.3 Fr. S. 326 ... ... 30 74 4 N. .... 31 58 5 N. ....
Feb. 5 ° ° H . 3 . 73 . 44 L . 5 . 89 . 32	**L—5—14.** 8.9 Fr. Cu. 166 11.6 1.8 Fr. Cu. 181 21.0 5.7 Fr. Cu. 173 15.5 5.7 A. Cu. 118 5.5 6.0 Ci. S. 116 4.3 30.0 74 74 13 SE. 29.9 76 74 18 SE. 29.8 75 83 15 SE.	**H—3— 5.** **L—5—16.** 8.2 S. Cu. 262 10.0 ... . 34 75 Lt. E. ....
Feb. 6 ° ° H . 3 . 63 . 47 L . 6 . 80 . 37 L . 4 . 103 . 40	**L—6—13.** ... . 1.8 A. Cu. 115 6.3 ... . 30.0 70 69 12 NW.	
Feb. 7 ° ° L . 5 . 95 . 33		
Feb. 8 ° ° L . 3 . 68 . 48 H . 5 . 99 . 36	... . 1.7 Cu. 149 ... ... 30.1 71 80 4 W.	**L—3—20.** 8.5 S. Cu. 109 5.5 ... . 34 91 0 ....
Feb. 9 ° ° L . 3 . 60 . 47 H . 6 . 85 . 38 H . 2 . 99 . 52	8.8 Ci. S. 100 4.0 1.7 Ci. S. 106 4.2 5.6 Ci. S. 104 4.2 30.1 69 93 4 E. 30.1 74 71 6 NE. 30.1 73 73 4 E.	**H—6— 7.** **H—2—39.** 8.0 S. Cu. 10 ... 1.1 S. Cu. 35 8.3 4.2 Fr. Cu. 27 5.5 .... 36 70 6 NW. .... 40 64 6 NW. .... 40 60 4 NW.
Feb. 10 ° ° H . 2 . 85 . 50 L . 5 . 99 . 28	8.7 Cu. 248 9.8 1.7 Cu. 257 12.5 ... . 30.2 74 75 4 E. 30.1 76 69 12 E.	
Feb. 11 ° ° L . 3 . 55 . 48 H . 2 . 79 . 48 L . 5 . 92 . 32	**L—5—14.** 8.8 Ci. S. 81 3.3 1.8 Ci. 80 3.3 2.0 Fr. Cu. 209 19.0 5.7 Ci. 68 3.7 30.1 74 73 9 S. 30.1 76 74 10 S. 30.0 73 82 8 SE.	
Feb. 12 ° ° H . 3 . 70 . 47 L . 2 . 81 . 41 L . 4 . 105 . 45	... ... 1.6 Ci. 95 3.0 ... . 30.0 76 84 6 S.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 13 TO FEBRUARY 25, 1897.

Date.	Key West.	Ocean City.
Feb. 13 ° ° L . 3 . 56 . 48 H . 2 . 82 . 48 L . 2 . 95 . 43	9.0 A. Cu. 139 3.2 9.2 Ci. 96 3.3 1.7 Ci. 94 3.1 ... . 30.1 76 84 6 S. 30.1 75 80 9 SW.	
Feb. 14 ° ° L . 3 . 58 . 48 H . 6 . 78 . 37 L . 2 . 88 . 50		
Feb. 15 ° ° L . 3 . 60 . 48 L . 6 . 86 . 38	... . 1.7 Cu. 200 9.4 ... . 30.1 78 67 10 S.	**L—6—7.** 8.6 Ci. Cu. 93 ... ... 4.4 Ci. Cu. 139 8.3 .... 38 96 0 .... 42 84 5 S.
Feb. 16 ° ° L . 3 . 70 . 41 H . 5 . 96 . 28 L . 1 . 105 . 50	**H—5—15.** ... . 1.7 A. Cu. 105 4.4 5.8 A. Cu. 105 4.2 .... 30.1 78 85 6 SW. 30.1 77 85 3 W.	**L—3—12.** ... . 4.1 Fr. Cu. 38 10.8 .... 44 56 7 NW.
Feb. 17 ° ° L . 3 . 55 . 48 H . 6 . 78 . 32 L . 2 . 88 . 47	**H—6—12.** ... . 1.7 A. Cu. 348 1.0 5.7 Ci. Cu. 86 3.8 ... . 30.2 80 73 6 E. 30.2 77 78 7 E.	**H—6—9.** **L—2—14.** 8.2 Ci. 82 5.6 8.2 Ci. S. 82 6.8 1.1 Ci. Cu. 90 5.5 1.1 Ci. 90 5.2 4.3 Ci. 90 5.9 4.7 A. Cu. 101 4.8 .... 38 82 4 S. .... 42 81 9 S. .... 42 81 Lt. SW.
Feb. 18 ° ° H . 6 . 78 . 26 L . 3 . 69 . 46 H . 4 . 99 . 42	**H—6—4.** **H—4—54.** 8.7 Ci. S. 103 3.0 1.7 Cu. 297 3.8 5.1 Ci. 151 2.1 ... . 30.2 76 82 3 SE. 30.2 79 68 9 SE. 30.1 77 74 5 E.	**H—6—17.** **L—3—20.** **H—4—40.** ... . 4.3 Fr. Cu. 90 6.8 4.5 A. Cu. 91 8.1 .... 48 60 Lt. NE.
Feb. 19 ° ° L . 3 . 60 . 44 H . 2 . 85 . 40 L . 4 . 105 . 40	8.6 Cu. 82 7.9 ... . 1.6 Cu. 124 2.6 ... . 30.2 76 78 8 SE. 30.2 77 78 9 NE.	**L—3—19.** **H—2—7.** 8.0 Ci. S. 65 ... 8.6 Ci. 63 6.7 1.0 Ci. S. 86 ... 1.3 Ci. Cu. 78 8.3 4.1 Ci. S. 65 8.3 .... 35 73 5 N. .... 40 50 6 NW. .... 42 48 9 NW.
Feb. 20 ° ° H . 6 . 73 . 38 L . 3 . 58 . 47 L . 2 . 99 . 47	... . 5.1 Ci. S. 277 0.8 .... 30.1 77 71 14 SE.	**H—6—4.** 8.0 Ci. 69 5.5 8.4 A. S. 59 5.5 ... . 34 81 Lt. NE. ....
Feb. 21 ° ° H . 3 . 59 . 47 L . 2 . 75 . 47		
Feb. 22 ° ° H . 2 . 80 . 49 L . 2 . 89 . 43 L . 5 . 92 . 34		
Feb. 23 ° ° L . 3 . 68 . 41 H . 4 . 114 . 42		**L—3—12.** 8.0 Fr. S. 52 5.0 8.2 A. S. 109 12.1 1.2 Ci. 108 13.4 1.3 Ci. Cu. 105 9.7 4.3 Ci. Cu. 110 8.3 .... 42 92 11 NW. .... 52 59 9 NW. .... 49 49 6 NW.
Feb. 24 ° ° L . 3 . 67 . 50 H . 2 . 85 . 38 H . 4 . 87 . 42 L . 2 . 93 . 46 H . 1 . 105 . 53	8.6 Cu. 285 4.8 1.6 Cu. 268 6.0 5.2 Cu. 286 4.6 30.2 78 79 6 SE. 30.1 80 72 12 SE. 30.1 78 75 9 SE.	**L—3—20.** **H—2—7.** ... . 4.0 Ci. 102 8.4 .... 35 54 Lt. E.
Feb. 25 ° ° H . 3 . 60 . 43 L . 6 . 80 . 31 H . 1 . 106 . 53		

TABLE 9.—*Summary of nephoscope observations*—Continued.

FEBRUARY 26 TO MARCH 11, 1897.

Date.	Key West.	Ocean City.
Feb. 26 ° ° L . 3 . 60 . 45 H . 2 . 98 . 45	**H—2—54.** 8.6 Ci. 80 2.7 ... . 5.2 Ci. Cu. 64 1.2 30.1 78 75 2 SW. ... . 30.1 72 82 15 N.	
Feb. 27 ° ° H . 5 . 90 . 35		**H—5—15.** ... . 1.3 Cu. 76 6.5 4.2 Fr. Cu. 88 4.7 4.2 Cu. 92 11.4 .... 29 56 4 NE. .... 30 52 Lt. NW.
Feb. 28 H . 6 . 80 . 36 L . 3 . 60 . 48 H . 2 . 87 . 50		
Mar. 1 ° ° H . 3 . 70 . 45 L . 2 . 90 . 42	... . 1.6 Cu. 300 10.7 5.2 Ci. S. 239 1.5 5.4 Ci. 7 1.7 .... 30.3 75 70 21 E. 30.2 74 74 15 E.	**H—3—12.** ... . 1.2 S. Cu. 119 4.6 4.2 S. Cu. 110 5. ... . 40 68 4 SE. .... 41 72 Lt. S.
Mar. 2 ° ° L . 3 . 65 . 43 H . 6 . 78 . 34 L . 5 . 93 . 37 H . 2 . 85 . 50	**H—6—13.** 8.6 A. Cu. 252 0.8 ... . 30.2 74 74 15 E.	**H—6—8.** **L—3—20.** ... . 1.2 Fr. Cu. 135 16.7 1.1 Cu. 131 15.2 1.3 Ci. 75 2.1 ... . 49 80 Lt. S. ....
Mar. 3 ° ° L . 3 . 78 . 44 H . 4 . 99 . 41 H . 6 . 78 . 31		**H—6—9.** **L—3—5.** ... . 1.5 A. Cu. 110 5.2 1.7 Fr. Cu. 124 16.7 4.1 A. S. 118 10.4 4.4 Ci. S. 117 3.9 4.6 A. Cu. 100 8.6 .... 48 90 11 SW. .... 52 84 6 S.
Mar. 4 ° ° L . 3 . 61 . 48 H . 3 . 80 . 40 L . 2 . 102 . 48		
Mar. 5 ° ° H . 3 . 68 . 42 L . 2 . 89 . 42		**H—3—12.** **L—2—15.** 8.2 S. Cu. 98 8.3 ... . 40 80 4 SE. ....
Mar. 6 ° ° L . 3 . 61 . 48 H . 1 . 112 . 51	... . 1.6 Ci. S. 59 2.3 ... . 30.2 79 68 15 SE.	
Mar. 7 ° ° H . 2 . 80 . 48		
Mar. 8 ° ° H . 3 . 64 . 44 L . 5 . 97 . 40		
Mar. 9 ° ° H . 3 . 61 . 45 L . 2 . 90 . 40 H . 1 . 109 . 52 H . 6 . 77 . 33	**H—6—20.** ... . 1.5 Cu. 254 5.6 ... . 30.1 78 67 14 NE.	
Mar. 10 ° ° L . 3 . 76 . 48 H . 1 . 108 . 51 H . 5 . 95 . 38	8.6 Cu. 250 2.7 1.6 Ci. 81 1.0 ... . 30.1 75 82 6 E. 30.1 81 61 9 SE.	**L—3—13.** 8.3 S. Cu. 125 5.9 1.1 Fr. Cu. 100 20.0 4.3 Cu. 79 6.8 4.6 Fr. Cu. 102 5.5 .... 51 80 Lt. S. .... 63 72 11 W. .... 62 52 4 W.
Mar. 11 ° ° L . 3 . 62 . 48 H . 6 . 75 . 35 L . 5 . 97 . 37	**H—6—20.** ... . 5.1 Cu. 264 5.8 .... 30.0 78 71 5 SE.	**H—6—8.** ... . 1.2 Ci. S. 98 5.9 ... . 46 62 3 S. ....

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 12 TO MARCH 25, 1897.

Date.	Key West.	Ocean City.
Mar. 12 ° ° H . 3 . 64 . 44 L . 2 . 82 . 45		**H—3—20.** **L—2— 6.** ... ... 1.0 A. Cu. 112 6.8 1.3 A. S. 116 5.5 1.4 Ci. S. 116 6.0 1.5 Ci. 112 5.5 ... . 58 86 7 W. ....
Mar. 13 ° ° L . 3 . 66 . 49 L . 5 . 102 . 30 H . 2 . 95 . 50 H . 1 . 108 . 51		**L—3—20.** **H—1—56.** 8.0 S. Cu. 98 8.3 3.8 Ci. 91 7.1 ... . 38 54 7 NW. .... 46 39 5 NE. ....
Mar. 14 ° ° H . 3 . 68 . 44 L . 2 . 81 . 43		
Mar. 15 ° ° L . 3 . 56 . 48 H . 2 . 83 . 40 H . 2 . 100 . 50	... . 5.6 Cu. 262 10.9 .... 30.2 79 68 12 SE.	**H—2— 7.** **H—2—39.** 8.2 Ci. 93 7.1 1.1 Ci. 90 6.7 ... . 40 56 9 NW. .... 47 44 Lt. N. ....
Mar. 16 ° ° H . 2 . 81 . 49 L . 1 . 108 . 52	... . 1.6 Cu. 253 7.0 5.6 Cu. 270 8.4 ... . 30.28 1 61 14 E. 30.2 78 63 12 E.	**H—2—18.** 8.3 Ci. 90 7.3 8.1 Ci. 70 7.7 8.4 Ci. 5 9 7.0 ... . 36 56 7 N. .... 39 48 5 N. .... 38 45 13 N.
Mar. 17 ° ° H . 3 . 75 . 42 L . 2 . 101 . 45	8.6 Cu. 266 13.8 1.6 Cu. 276 11.2 ... . 5.6 Cu. 267 4.2 30.2 77 71 13 E. 30.2 80 64 22 E. 30.2 77 71 14 E.	**H—3—1.** ... . 1.2 Ci. S. 55 5.4 1.4 A. Cu. 59 5.3 ... . 38 51 Lt. E. ....

Date.	Key West.	Ocean City.
Mar. 18 ° ° H . 3 . 70 . 43 H . 6 . 80 . 30 L . 1 . 106 . 46	**H—6—5.** 8.6 Cu. 228 6.2 ... . 30.2 79 68 10 SE.	
Mar. 19 ° ° H . 6 . 81 . 28 L . 2 . 94 . 41		
Mar. 20 ° ° L . 3 . 63 . 48 L . 2 . 84 . 45 H . 1 . 111 . 52		
Mar. 21 ° ° H . 6 . 82 . 39 L . 2 . 78 . 48		
Mar. 22 ° ° L . 5 . 95 . 30 L . 2 . 84 . 40 H . 1 . 107 . 50	**L—5—15.** 8.6 Cu. 230 15.5 ... . 30.0 79 71 12 SE.	**L—2—7.** 8.3 Ci. 83 4.4 1.4 Ci. Cu. 131 4.2 4.1 A. Cu. 110 4.2 .... 50 83 4 S. .... 52 87 7 S. .... 59 89 7 SW.
Mar. 23 ° ° L . 2 . 87 . 38 H . 2 . 89 . 52	8.6 Cu. 216 14.4 1.6 Ci. 65 2.2 ... . 30.0 79 79 .. SE. 30.0 81 68 9 SW.	
Mar. 24 ° ° L . 3 . 73 . 40 H . 2 . 100 . 50 H . 5 . 98 . 29	... . 1.8 A. Cu. 114 3.5 1.9 Cu. 271 12.1 ... . 5.6 Cu. 58 10.9 .... 29.9 81 72 9 SW. 29.9 77 83 14 NW.	**L—3—1.** 8.3 Fr. Cu. 114 25.0 1.3 Cu. 109 10.3 1.4 Fr. Cu. 107 10.4 1.4 A. Cu. 109 8.5 4.1 Cu. 102 6.3 .... 52 78 3 S. .... 56 46 11 W. .... 56 33 16 W.
Mar. 25 ° ° L . 3 . 70 . 45		**L—3—12.** ... . 1.1 Fr. Cu. 86 6.9 1.1 Cu. 86 6.9 1.2 Ci. 104 3.6 4.5 Fr. Cu. 89 7.2 4.6 Cu. 92 6.3 .... 46 37 11 W. .... 46 34 16 W.

TABLE 9.—*Summary of nephoscope observations*—Continued.

MARCH 26 TO APRIL 8, 1897.

Date.	Key West.	Ocean City.
Mar. 26 ° ° L . 3 . 65 . 46 H . 6 . 88 . 29 H . 2 . 96 . 50		**L—3—20.** 8.6 Ci. 56 2.1 8.7 Fr. Cu. 63 1.2 1.2 Cu. 55 5.8 4.8 Cu. 73 5.0 .... 37 57 9 W. .... 41 43 11 NW. .... 43 42 2 N.
Mar. 27 ° ° L . 3 . 58 . 42 H . 2 . 91 . 45 L . 4 . 106 . 41		... . 1.1 Cu. 60 6.2 4.7 Fr. Cu. 59 5.9 .... 40 60 4 NE. .... 45 35 13 NW.
Mar. 28 ° ° L . 3 . 58 . 46 H . 6 . 84 . 38		
Mar. 29 ° ° L . 3 . 57 . 48 H . 6 . 77 . 38 L . 1 . 110 . 50	8.6 Ci. 50 3.3 1.5 Cu. 234 14.4 1.6 Ci. 52 3.6 ... . 30.1 77 52 18 SE. 30.1 81 54 15 SE.	
Mar. 30 ° ° L . 3 . 54 . 48 H . 2 . 82 . 49 L . 4 . 104 . 38	... . 1.8 Cu. 229 6.1 1.9 Ci. 64 3.0 5.6 Cu. 237 13.4 .... 30.1 82 62 12 SE. 30.1 79 71 10 SE.	**H—2—14.** 8.2 Ci. Cu. 57 4.5 ... . 46 82 Lt. S. ....
Mar. 31 ° ° L . 3 . 54 . 48 H . 2 . 83 . 50 H . 1 . 111 . 52 L . 4 . 100 . 38	8.6 Cu. 209 12.4 1.6 Cu. 220 3.3 5.6 Cu. 265 11.1 5.7 Ci. 56 1.1 30.1 78 67 11 SE. 30.1 80 64 14 SE. 30.0 78 63 13 E.	
Apr. 1 ° ° H . 2 . 82 . 50 L . 5 . 98 . 39	8.6 Cu. 234 7.6 1.6 Cu. 251 1.4 ... . 30.0 77 59 11 SE. 30.0 80 57 8 SE.	
Apr. 2 ° ° H . 6 . 78 . 37 H . 2 . 85 . 50 H . 1 . 105 . 52	**H—6—13.** 8.8 A. Cu. 70 0.8 9.2 Ci. 74 0.6 1.6 Ci. 45 2.1 ... . 30.1 77 71 9 E.	**H—6—2.** ... . 1.2 Ci. 51 2.4 4.9 Ci. 67 2.4 .... 52 54 3 S. .... 55 34 Lt. W.
Apr. 3 ° ° H . 2 . 78 . 48 L . 5 . 98 . 39 H . 1 . 110 . 52	8.6 Cu. 233 11.2 1.6 Cu. 249 11.1 5.6 Cu. 234 10.0 30.1 77 67 14 E. 30.1 81 61 13 E. 30.0 77 67 14 E.	**H—2—13.** 8.3 A. Cu. 59 2.6 ... . 46 75 Lt. NE. ....
Apr. 4 ° ° H . 3 . 72 . 41 L . 2 . 95 . 44		
Apr. 5 ° ° H . 3 . 69 . 49 L . 2 . 87 . 41		
Apr. 6 ° ° L . 3 . 74 . 42 H . 1 . 101 . 41	8.6 Cu. 236 0.7 ... . 5.6 A. S. 71 3.2 30.0 79 75 6 SE. .... 29.9 79 68 6 E.	**L—3—18.** ... . 1.1 Fr. Cu. 120 6.2 1.1 Cu. 120 6.0 1.3 Ci. 120 5.5 4.9 S. Cu. 105 6.3 .... 56 82 Lt. S. .... 56 100 6 S.
Apr. 7 ° ° L . 3 . 56 . 47 H . 2 . 85 . 50 L . 4 . 105 . 38	8.6 A. S. 76 3.3 ... . 5.6 A. Cu. 64 4.4 30.0 77 74 17 E. .... 30.0 77 74 6 E.	**H—2—14.** 8.1 Ci. Cu. 110 4.2 8.4 Ci. S. 109 4.2 ... . 5.1 S. Cu. 104 4.5 .... 51 62 Lt. NW. .... 54 72 Lt. S.
Apr. 8 ° ° L . 5 . 94 . 33	**L—5—14.** 8.5 Ci. 58 2.9 ... . 5.6 Ci. 76 0.9 30.0 80 74 7 SE. .... 30.0 80 .. 10 SE.	8.4 Ci. 70 4.5 1.3 S. Cu. 97 7.0 ... . 52 70 Lt. NE. .... 52 78 Lt. E. ....

TABLE 9.—*Summary of nephoscope observations.*

APRIL 9 TO APRIL 24, 1897.

Date.	Key West.	Ocean City.
Apr. 9 ° ° H . 3 . 61 . 44 L . 6 . 81 . 38 H . 2 . 86 . 50	**L—6—13.** 8.6 Cu. 175 14.5 1.6 Ci. Cu. 46 3.6 5.6 S. Cu. 135 5.8 29.9 80 79 12 S. 29.9 75 82 11 S. 29.9 81 84 0	
Apr. 10 ° ° L . 3 . 69 . 44 H . 2 . 85 . 50 L . 6 . 81 . 24 H . 4 . 102 . 41		**L—3—12.** 8.2 Ci. 125 7.3 1.6 Cu. 59 4.1 5.2 S. Cu. 80 5.5 .... 44 54 11 NW. .... 54 54 4 W. .... 49 60 3 NE.
Apr. 11 ° ° L . 2 . 85 . 50		
Apr. 12 ° ° L . 3 . 54 . 47 H . 2 . 81 . 41 L . 4 . 93 . 40	8.6 A. Cu. 233 2.9 1.6 A. Cu. 233 2.3 ... . 30.2 70 68 24 NE. 30.2 74 70 23 NE.	
Apr. 13 ° ° H . 3 . 61 . 44 L . 2 . 89 . 43 H . 4 . 106 . 41	... . 1.6 Cu. 289 8.4 5.6 A. Cu. 239 3.1 .... 30.2 76 70 17 NE. 30.1 76 66 15 E.	
Apr. 14 ° ° H . 3 . 58 . 45 H . 6 . 77 . 33 H . 5 . 100 . 34 L . 2 . 86 . 52	**H—6—20.** ... . 1.8 Ci. S. 97 1.6 1.9 Cu. 258 5.6 5.6 A. Cu. 218 0.6 .... 30.1 79 68 13 E. 30.0 77 71 13 E.	
Apr. 15 ° ° L . 3 . 74 . 39 L . 2 . 88 . 48 H . 4 . 108 . 44	... . 1.8 Ci. 71 0.8 1.9 Ci. S. 231 0.9 5.8 Ci. S. 223 0.6 5.9 Ci. 106 2.2 .... 30.0 80 79 9 SW. 30.0 78 87 8 W.	
Apr. 16 ° ° L . 3 . 67 . 47 L . 2 . 85 . 43 H . 4 . 99 . 42	... . 1.6 Ci. 80 0.8 5.6 A. Cu. 255 2.3 .... 30.0 74 82 7 NW. 30.0 78 79 5 N.	
Apr. 17 ° ° L . 3 . 73 . 45 H . 5 . 94 . 39 L . 1 . 110 . 54		
Apr. 18 ° ° H . 6 . 79 . 37 L . 2 . 92 . 48		
Apr. 19 ° ° L . 3 . 75 . 48 H . 6 . 84 . 32 H . 2 . 93 . 48	**H—6—5.** 8.8 A. Cu. 81 0.8 8.9 Cu. 236 1.5 1.6 Cu. 71 0.6 ... . 30.17 3 82 5 E. 30.1 77 77 10 NE.	
Apr. 20 ° ° H . 2 . 84 . 41	8.6 Cu. 314 13.9 ... . 30 2 74 78 15 NE.	
Apr. 21 ° ° H . 6 . 75 . 37 L . 1 . 108 . 54	**H—6—20.** 8.6 Ci. 250 2.0 ... . 5.8 Cu. 351 3.1 5.9 S. 292 5.6 30.2 74 66 29 NE. .... 30.2 76 63 23 E.	
Apr. 22 ° ° H . 6 . 72 . 39 L . 2 . 85 . 51	... . 1.6 Cu. 285 3.3 ... . 30.2 76 52 17 E.	
Apr. 23 ° ° H . 6 . 75 . 36 L . 2 . 90 . 46		**H—6— 3.** **L—2—14.** ... . 5.6 Ci. 71 1.0 .... 54 70 3 S.
Apr. 24 ° ° H . 6 . 82 . 34 L . 1 . 102 . 53	**H—6—13.** 9.1 Cu. N. 305 2.8 ... . 30.2 77 56 21 E.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

APRIL 25 TO MAY 10, 1897.

Date.	Key West.	Ocean City.
Apr. 25 ° ° L. 3. 77. 48 H. 6. 80. 30 H. 4. 110. 43		
Apr. 26 ° ° L. 2. 81. 45 H. 5. 101. 34	8.6 Cu. 274 2.1 1.6 Cu. 9 1.1 ... . 30.1 76 66 4 NE. 30.1 78 63 5 N.	**L—2—6.** 8.2 S.Cu. 93 4.9 1.3 S.Cu. 113 3.0 1.4 A.Cu. 110 3.0 5.3 Ci. 118 3.3 .... 59 70 4 N. .... 60 70 Lt. S. .... 56 80 5 S.
Apr. 27 ° ° L. 3. 68. 44 H. 2. 85. 42 L. 2. 95. 50	8.6 Cu. 354 6.1 ... . 30.17 6 74 11 NW.	**L—2—12.** **H—2—6.** 8.3 Fr.Cu. 40 8.3 1.3 Fr.Cu. 42 6.9 ... . 48 45 20 NW. .... 54 35 16 NW. ....
Apr. 28 ° ° H. 2. 80. 39 L. 3. 68. 42 L. 5. 95. 38 H. 1. 103. 52	... . 1.6 Ci. 81 2.7 5.8 Cu. 264 3.0 5.9 Ci. 76 2.0 .... 30.1 79 50 10 NE. 30.0 79 64 9 SE.	**L—3—12.** **H—2—2.** ... . 1.3 Fr.Cu. 12 10.1 5.2 S.Cu. 22 8.0 ... . 60 40 16 N. .... 51 68 5 NE.
Apr. 29 ° ° L. 3. 69. 42 L. 5. 89. 37 H. 2. 90. 52	**L—5—14.** 8.6 A.S. 50 0.8 1.6 Cu. 208 6.0 5.6 A.Cu. 81 1.7 30.1 78 67 9 SE. 30.0 79 69 11 SE. 30.0 78 70 9 E.	
Apr. 30 ° ° L. 3. 62. 44 L. 6. 85. 37 H. 2. 85. 50	**L—6—13.** 8.8 Ci.Cu. 77 3.8 8.9 Cu. 215 6.7 1.6 A.Cu. 82 3.8 ... . 30.0 78 83 14 S. 29.9 79 83 15 S.	**L—3—20.** **L—6—7.** 8.3 A.Cu. 142 14.0 ... . 1.2 S. 215 11.3 ... . 56 70 Lt. NE. .... 57 69 3 SE. ....
May 1 ° ° H. 3. 67. 48 H. 5. 99. 33	... . 1.6 Ci. 80 4.0 ... . 29.9 77 67 16 NW.	
May 2 ° ° L. 4. 102. 38		
May 3 ° ° H. 3. 61. 47 L. 2. 77. 40 H. 4. 97. 42		
May 4 ° ° L. 3. 75. 43 H. 5. 95. 40 H. 3. 59. 47	8.7 Cu. 5 4.7 1.6 Cu. 3 2.5 5.6 Cu. 25 3.6 30.1 74 66 6 N. 30.1 77 59 5 NW. 30.0 76 59 13 NW.	
May 5 ° ° L. 6. 73. 37 H. 5. 90. 38 L. 2. 100. 46	... . 1.6 Cu. 3 2.0 ... . 30.0 77 56 9 N.	
May 6 ° ° L. 6. 73. 37 H. 5. 86. 38 H. 2. 82. 50	8.6 Ci. 26 1.0 1.8 A.Cu. 6 2.9 1.9 Cu. 202 2.0 5.6 Ci.Cu. 71 1.1 30.1 75 62 6 NE. 30.1 77 .. 6 N. 30.0 78 53 4 NE.	
May 7 ° ° L. 3. 55. 48 H. 2. 82. 48 H. 6. 94. 37	**H—6—13.** 8.9 A.S. 272 0.7 8.9 A.Cu. 104 1.7 1.6 A.S. 260 2.0 5.8 A.Cu. 2 3.9 5.9 A.S. 73 1.5 30.1 76 70 E. 18. 30.1 78 60 16 E. 30.1 77 59 12 E.	
May 8 ° ° H. 3. 75. 44 L. 2. 100. 54 L. 3. 55. 48		
May 9 ° ° L. 3. 60. 47 H. 6. 78. 35 L. 2. 92. 51		
May 10 ° ° L. 3. 74. 46 H. 6. 80. 31	**H—6—5.** 8.6 Cu. 255 4.9 1.6 Cu. 267 2.8 ... . 30.1 77 74 14 E. 30.0 81 65 14 E.	

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 11 TO MAY 26, 1897.

Date.	Key West.	Ocean City.
May 11 ° ° H . 6 . 77 . 32 L . 2 . 88 . 50	**H—6—12.** ... . 1.9 A. S. 98 2.0 1.9 Cu. 257 17.3 5.6 Ci. S. 72 1.7 .... 30.0 81 72 17 SE. 30.0 80 75 15 SE.	
May 12 ° ° H . 3 . 62 . 45 H . 6 . 77 . 32 L . 2 . 81 . 45		
May 13 ° ° H . 3 . 54 . 48 L . 2 . 90 . 47 H . 1 . 107 . 52	8.6 Ci. S. 78 3.7 ... . 5.8 Ci. 51 1.0 5.9 Ci. S. 77 0.9 30.1 81 84 8 SE. .... 30.0 83 69 5 E.	
May 14 ° ° H . 3 . 54 . 43 L . 2 . 80 . 45 H . 4 . 94 . 42	... . 1.6 Cu. 233 5.0 5.8 Cu. 278 0.4 5.9 Ci. S. 103 0.7 .... 30.0 83 73 5 W. 30.0 83 76 4 S.	
May 15 ° ° L . 3 . 68 . 49 H . 5 . 91 . 38 L . 1 . 102 . 54	8.6 Ci. S. 72 1.0 1.6 Cu. 233 0.7 ... . 30.0 80 75 4 SE. 30.0 82 76 5 SE.	
May 16 ° ° H . 2 . 86 . 39		
May 17 ° ° H . 2 . 85 . 40 L . 1 . 107 . 48	.. .. 1.6 Cu. 234 4.1 5.6 Cu. 292 2.8 .... 30.0 80 68 5 NW. 30.0 80 61 6 NE.	
May 18 ° ° L . 3 . 68 . 49 H . 6 . 85 . 38 H . 2 . 90 . 52		
May 19 ° ° L . 3 . 49 . 47 H . 6 . 85 . 37 L . 2 . 101 . 45	**H—6—13.** 8.6 Cu. 293 6.0 1.8 Ci. S. 270 1.7 1.9 Cu. N. 325 8.7 8.6 Cu. 295 7.1 30.1 76 74 18 NE. 30.1 80 68 18 NE. 30.0 79 68 23 NE.	
May 20 ° ° H . 3 . 61 . 44 L . 2 . 82 . 45 H . 6 . 86 . 30 H . 1 . 103 . 51	**H—6—6.** 8.6 Cu. 303 12.8 ... . 30.1 76 69 15 NE.	
May 21 ° ° L . 3 . 70 . 47 H . 2 . 91 . 45 H . 5 . 96 . 30	**H—5—15.** 8.6 Cu. 304 6.0 ... . 30.0 76 65 14 NE.	
May 22 ° ° L . 3 . 64 . 47 H . 2 . 81 . 40 L . 2 . 95 . 51		
May 23 ° ° H . 3 . 70 . 39 L . 2 . 90 . 50		
May 24 ° ° H . 3 . 57 . 46 L . 2 . 77 . 45 H . 2 . 96 . 44		
May 25 ° ° L . 3 . 72 . 42 H . 2 . 88 . 43 L . 1 . 107 . 48	8.6 A. Cu. 128 1.3 1.6 Cu. 317 5.8 5.6 A. S. 136 3.0 30.1 79 66 11 SE. 30.1 81 58 9 E. 30.0 80 68 12 E.	
May 26 ° ° L . 3 . 67 . 42 H . 2 . 83 . 50 L . 1 . 103 . 51		

TABLE 9.—*Summary of nephoscope observations*—Continued.

MAY 27 TO MAY 31, 1897.

Date.	Key West.	Ocean City.	Date.	Key West.	Ocean City.
May 27 ° ° L . 3 . 67 . 42 H . 2 . 80 . 40 H . 1 . 110 . 51	8.6 Cu. 262 4.7 1.6 Ci. 125 3.9 ... . 30.1 81 72 15 E. 30.1 83 62 15 E.		May 29 ° ° L . 3 . 71 . 49 L . 5 . 92 . 33 H . 4 . 102 . 38 H . 1 . 110 . 52		
May 28 ° ° L . 3 . 70 . 43 H . 6 . 84 . 29 H . 4 . 104 . 40 L . 1 . 106 . 59	H—6—5. 8.6 Cu. 262 6.7 1.6 Ci. 131 2.0 1.9 Cu. 272 10.0 5.8 Cu. 281 8.3 5.9 Ci. S. 95 1.3 30.1 82 62 14 E. 30.0 83 69 10 SE. 30.0 81 65 17 E.		May 30 ° ° L . 6 . 81 . 34		
			May 31 ° ° L . 3 . 73 . 48 H . 2 . 100 . 50 L . 4 . 111 . 42		

CHAPTER 5.

THE INTERNATIONAL TABULAR FORMS FOR STATIONS OF THE FIRST AND SECOND ORDER.

GENERAL REMARKS ON THE INTERPRETATION OF THE DATA INCLUDED IN THE TABLES.

In Circular No. 2, issued by the International Committee on Clouds, a series of tables of prescribed contents was proposed for the publication of the results of the observations at the first and second order stations. The following tables have therefore been prepared in exact accordance with these requirements, and they are so readily understood that only a few remarks are needed regarding them. A further discussion of the results is also presented elsewhere in this report under somewhat different aspects, as suggested by other considerations. It must be carefully borne in mind that the distribution of the clouds here tabulated refers only to the actual observations which were made at Washington, D. C. with the instruments. It can not be assumed that this represents perfectly the real frequency with which all the clouds develop in the sky, because the number of clouds observed depended so largely upon the possibility of successfully measuring the altitudes with the apparatus employed. Thus it is evident that the stratus and nimbus forms, especially when the sheet was continuous and presented no sharp points which could be agreed upon by the two observers, were by no means so frequently observed as they actually existed in the sky. In fact, our observers found it very difficult to do anything satisfactory with this numerous and important class of clouds. The cumulus forms were much more suitably observed with reference to their actual distribution, because the type was favorable for theodolite work, since they usually develop in isolated masses in the high areas or in the clearing-up portions of the low areas. Much caution must be exercised, therefore, by those who draw conclusions from these tabulations.

Furthermore, the objection is frequently raised that the apparent cloud velocities do not agree with that of the air itself, and this is certainly the case in many instances, as the Föhn cloud bank, the Tablecloth of Table Mountain, the Cloud Cap of the Helm Wind, or where the balloons are observed to pass through clouds while moving in a horizontal direction and in similar conditions. If the cloud is not as a body driven forward by the wind, but is the result of processes of formation and dissipation due to the expansion and contraction under dynamic forces, causing local condensation and evaporation, then it would be necessary to distinguish between these apparent movements and the real velocity of the air in their neighborhood. Of course it is impossible to do this in the present state of meteorology, though one might express an opinion regarding the relation between the apparent and the actual velocity of the air as indicated by cloud motions. It is certainly important to bear in mind that we are discussing exclusively the apparent motions of the clouds as more or less exact indications of the movements of the air itself.

The data for the formation of Tables 10 to 19 are taken from the Journal of the Theodolite Observations, and for Tables 20 and 21 from the Journal of the Nephoscope Observations. These journals are published as compactly as possible, some desirable details being omitted in order to reduce the dimensions of this report to reasonable limits. I may remark that generally it is very difficult to classify the results in these tables, except in certain obvious aspects, and I have therefore made little effort to do so. Very much depends upon the scheme of nomenclature, and the inclusion or exclusion of clouds in the prescribed types, determined by the judgment of the observer, as to how the mean values shall come out. Probably a repetition of such work for another year by the same observers would be most advantageous for securing a high degree of accuracy, because practical experience is important for fixing habits of uniform practice in the naming of

individual clouds and the association of them with their ideal types. Also, it seems that though we have a large number of observations, a great many more would be required to smooth out the irregularities from the tables, in consequence of the minute subdivision which has been adopted for clouds, whereby some of the types have only a few observations to their credit.

TABLE 10.—*Mean height of clouds.*

APRIL TO SEPTEMBER.

Forms	8 a. m.–12 m.		12 m.–4 p. m.		4 p. m.–8 p. m.		Means
	Mean height	No. of cases	Mean height	No. of cases	Mean height	No. of cases	
Cirrus	10166	216	9998	291	10777	346	10358
Cirro-stratus	10798	74	9883	63	11288	50	10620
Cirro-cumulus	8225	40	8765	65	9325	56	8826
Alto-stratus	5212	59	5642	58	6647	48	5772
Alto-cumulus	4586	298	5290	219	5448	180	5030
Strato-cumulus	3061	98	2603	118	2868	259	2870
Nimbus	2385	12	1503	21	2408	7	1926
Cumulus (dome)	2932	6	3061	81	3056	19	3068
Cumulus (top)	1607	178	1833	723	1862	58	1819
Cumulus (base)	1278	34	1150	101	1294	9	1182
Cumulo-nimbus (top)	2176	50	4473	114	7483	78	4965
Cumulo-nimbus (base)			2081	10	799	4	1750
Stratus	727	125	1031	47	1020	27	838

OCTOBER TO MARCH.

Cirrus	9567	162	9540	204	9414	152	9511
Cirro-stratus	9614	87	9145	48	10067	31	9526
Cirro-cumulus	6816	95	7661	76	7855	63	7413
Alto-stratus	4330	42	3938	13	5750	15	4801
Alto-cumulus	3861	161	3707	94	3964	83	3822
Strato-cumulus	2401	104	2185	99	2216	104	2399
Nimbus	1670	6	2212	9	1513	15	1804
Cumulus (dome)			2864	29	2913	13	2855
Cumulus (top)	1574	93	1687	237	1914	59	1694
Cumulus (base)	1381	13	1073	11	1096	10	1198
Cumulo-nimbus (top)	3412	9			3867	20	3730
Cumulo-nimbus (base)					2670	5	
Stratus	1136	23	1149	51	1100	30	1132

The mean height and frequency of clouds are so arranged as to give the annual and the diurnal ranges in elevation. (1) The summer system is higher than the winter for the upper clouds, cirrus to alto-cumulus, by 1,107 meters, and for the lower clouds, strato-cumulus to cumulus, by 183 meters. The cumulo-nimbus top is higher by 1,235 meters in summer than in winter, but the stratus is lower by 294 meters in summer than in winter. (2) There is a well-defined tendency for the summer clouds to increase their height from morning to night; in the winter this feature probably exists, but it is less plainly indicated. (3) It should be noted in this connection that the cirro-stratus type is higher than the cirrus on the average, though the indications are that this is a feature of the morning and evening hours rather than during midday.

TABLE 11.—*Velocity of clouds.*

APRIL TO SEPTEMBER.

Forms	8 a. m.–12 m.		12 m.–4 p. m.		4 p. m.–8 p. m.		Means
	Mean velocity	No. of cases	Mean velocity	No. of cases	Mean velocity	No. of cases	
Cirrus	23.0	54	31.6	46	34.3	83	30.3
Cirro-stratus	28.0	39	27.6	36	25.2	35	26.9
Cirro-cumulus	25.8	26	21.8	25	22.9	60	23.4
Alto-stratus	18.6	38	14.6	19	18.5	23	17.6
Alto-cumulus	16.0	117	16.4	90	18.0	51	16.5
Strato-cumulus	13.1	30	11.5	27	9.4	90	10.5
Nimbus	12.4	3	6.9	7	8.4	2	8.5
Cumulus (top)	9.1	64	6.8	238	6.5	33	7.0
Cumulus (base)							
Cumulo-nimbus (top)	13.6	8	13.0	49	16.2	36	15.3
Cumulo-nimbus (base)							
Stratus	5.7	8	6.6	5	6.2	2	6.0

OCTOBER TO MARCH.

Cirrus	30.6	89	35.6	98	39.4	71	34.9
Cirro-stratus	31.6	52	28.8	32	24.[illegible]	15	30.4
Cirro-cumulus	33.3	50	34.9	29	32.1	26	33.4
Alto-stratus	20.3	15	18.0	3	25.1	7	21.3
Alto-cumulus	17.8	28	22.4	35	21.7	26	21.1
Strato-cumulus	12.2	22	14.9	14	18.0	24	15.1
Nimbus	12.2	2			11.8	4	11.9
Cumulus (top)	10.3	22	11.1	48	10.6	27	10.9
Cumulus (base)							
Cumulo-nimbus (top)	6.4				23.2	9	21.1
Cumulo-nimbus (base)							
Stratus	16.4	4	6.2	4	4.2	1	10.5

The mean velocity of clouds is arranged to give the annual and the diurnal ranges. (1) For the upper and the lower clouds there is a general increase in the winter over the summer of 4.3 meters per second, which is very uniformally distributed from the highest to the lowest stratum. The exception is in the cirro-cumulus layer, where the winter increase over the summer seems to be 10.0 m. p. s., but there is no obvious reason for so marked a difference. (2) The diurnal velocity is slightly greater in the afternoon for the upper clouds; in the lower clouds there is a retardation in the middle of the day, though the results are not very decisive; and a small increase again toward night. (3) The velocities are marked off into three layers, the first including the cirrus, cirro-stratus, and cirro-cumulus forms; the second, the alto-stratus and alto-cumulus, and the third the strato-cumulus, nimbus, cumulus, and stratus, with average velocities, respectively, in summer 26.9, 17.1, 8.0, and in winter 32.9, 21.2, 12.1 m. p. s.

TABLE 12.—*Maxima.*

HEIGHT.

Month	Ci.	Ci. S.	Ci. Cu.	A. S.	A. Cu.	S. Cu.	N.	Cu.	Cu. N.
January	10939	8334	9074		5146	2270		2693	
February	11580	12450	10060	2958	7539	4412		1686	
March	14327	11653	9312	3085	6746	3253		3767	5895
April	16009	12850	10640	4168	6489	4451	1312	3819	4173
May	14082	13060	12196	8096	9422	4217	3684	3910	9375
June	15360	16144	13867	13158	9629	7285	1203	3246	8827
July	15583	15624	15411	13434	10167	4349	4022	3613	15903
August	15263	13526	11269	15552	6405	4157	2480	5242	5910
September	17182	12222	9419	8627	6262	5148	3395	2474	12419
October	13442	11354	12425	7419	4107	4110	1050	3279	
November	15810	13983	12202	9195	7371	4266	2495	2852	3439
December	12076	13674	12902	8086	7428	4402	699	2420	

VELOCITY.

January	78.9	51.8	49.0			15.8		18.7	
February	67.6	38.9	74.4		53.9	32.8		14.6	
March	83.7	55.3	50.0	21.6	27.7	25.3		21.0	35.5
April	65.9	33.8	64.9	30.5	29.9	23.5	5.9	17.5	15.7
May	69.3	50.2	29.9	25.4	35.9	31.6		40.3	25.7
June	60.9	49.9	45.0	47.5	40.3	26.0	9.3	16.9	25.3
July	49.6	24.8	44.2	40.2	31.1	19.3	11.5	21.6	37.5
August	57.4	37.0	57.8	30.0	25.0	18.0	8.6	8.8	11.5
September	42.2	55.5	33.7	15.0	40.4	11.3		9.7	27.1
October	59.7	37.8	48.9	23.3	26.6	13.0		19.2	
November	57.0	36.7	50.9	40.9	28.5	20.3	12.7	16.4	9.4
December	80.2	91.9	90.0	28.1	43.5	22.4		19.2	

The maximum heights and velocities in each month and for each cloud type are clearly displayed. The cirrus forms develop up to about 16,000 meters, and all the forms are higher in the summer months. The greatest velocities are about 90 meters per second, and they occurred in December, though this may have been accidental and merely a feature of that particular winter.

TABLE 13.—*Minima.*

HEIGHT.

Month	Ci.	Ci. S.	Ci. Cu.	A. S.	A. Cu.	S. Cu.	N.	Cu.	Cu. N.
January	6664	6808	3067		2217	1689		1107	
February	6291	8976	4954	2958	1524	1375		921	
March	5430	8782	3866	1935	2782	1419		1085	2618
April	5638	6846	4250	3659	2212	1520	1086	1110	1492
May	5872	6638	5482	2086	2476	1855	1036	676	2283
June	5354	6089	5339	1613	2419	1755	704	562	1743
July	5627	9656	5757	4646	2951	1818	634	545	1249
August	7689	6796	6624	2602	2494	1688	1713	909	3239
September	8537	7465	7951	2841	2673	1759	3395	1193	2448
October	7515	6433	3878	2624	2407	1832	1050	912	
November	7550	8865	5798	4088	2528	1406	1536	1071	2986
December	6631	5142	5759	2921	2504	1478	699	772	

VELOCITY.

January	2.6	4.5	2.1			3.1		15.7	
February	1.6	4.9	3.6		4.0	5.7		6.4	
March	7.7	22.3	14.8	21.6	13.0	6.2		4.7	9.8
April	9.8	11.7	12.7	21.2	6.4	2.6	5.9	2.7	12.8
May	1.0	12.6	8.1	6.4	1.7	1.8	10.8	1.6	5.4
June	5.6	12.4	11.0	2.7	2.8	3.3	4.5	1.2	2.9
July	5.9	1.5	6.1	7.5	5.5	3.6	11.5	0.5	2.5
August	1.1	5.1	6.5	4.4	1.2	2.4	8.1	0.4	1.5
September	7.1	12.2	8.0	6.0	2.9	6.2		3.0	8.0
October	1.5	18.0	9.4	11.7	1.6	5.5		3.0	
November	11.2	15.2	16.7	16.5	4.6	9.2	10.4	4.5	3.5
December	5.8	13.8	19.2	21.9	2.4	4.8		10.2	

The minimum heights and velocities are here collected together by months and by the types of clouds. The irregularities in this table are so great that it is not easy to generalize regarding the results. Reference is made to Chapter 6, page 354, where the subject of maximum and minimum heights is treated in another manner.

TABLE 14.—*Height of clouds at different temperatures.*

Temperature	Ci.		Ci. S.		Ci. Cu.		A. S.		A. Cu.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
Below 0	8971	30	9539	22	7259	17	5893	5	5042	28
0 to 9	9082	270	9351	60	7847	130	4762	37	3673	132
10 to 19	9752	418	9071	127	8054	77	4698	49	3783	229
20 to 29	10714	596	10157	123	8869	206	6051	159	5145	505
30 and above	9575	57	12997	19	8507	30	7608	26	5244	34

Temperature	S. Cu.		N.		Cu^{t}.		Cu^{b}.		Cu. N^{t}.		Cu. N^{b}.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
Below 0	2198	11			1335	15						
0 to 9	2055	220	735	3	1662	256	1392	41				
10 to 19	2701	230	1701	33	1734	308	1520	19	3719	48	2322	9
20 to 29	2680	237	1965	34	1941	651	1453	75	5356	177	1747	14
30 and above	3678	19			2552	107	1631	22	4351	29		

The heights of clouds at different temperatures conform perhaps to three types of curves: (1) The cirrus and cirro-cumulus, rising in height as the temperature increases from a minimum to about 25° C., and then falling lower again; (2) the cirro-stratus, alto-stratus, and alto-cumulus, falling in height while the temperature is rising to about 15° C., and then rising to the maximum height as the temperature continues to increase; (3) the strato-cumulus ,cumulus, and nimbus, rising steadily from the lowest to the highest elevations with the increase in temperature. It is not easy to see what connection exists between surface temperatures and the heights at which the upper clouds develop to give this nearly inverted law between the first and second groups. The rise in height of the lower clouds, due to vertical convection, is very obviously a consequence of the thermodynamic laws.

TABLE 15.—*Height of clouds at different pressures.*

APRIL TO SEPTEMBER.

Pressure	Ci.		Ci. S.		Ci. Cu.		A. S.		A. Cu.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
Below 755	9269	31			9133	5	5629	10	3256	5
755 to 759	10200	91	9991	16	8082	21	6545	18	4988	122
760 to 764	10063	349	10773	35	9368	151	5766	120	4762	420
765 to 769	9894	249	9990	18	9005	57	7275	46	5013	124
770 to 774	10986	92	8910	20	5409	2	5616	5	5143	14
775 and above	9688	19	7545	17						

TABLE 15.—*Height of clouds at different pressures*—Continued.

APRIL TO SEPTEMBER—Continued.

Pressure	S. Cu.		N.		Cu.		Cu^b.		Cu. N^t.		Cu. N^b.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
Below 775	3605	16			1806	34			3441	12		
755 to 759	2944	131	1396	19	1945	115	1477	19	5612	74	2200	6
760 to 764	2389	245	2566	14	1909	597	1420	95	4606	148	1405	8
765 to 769	2886	54	1014	7	1950	191	1268	32	6214	13		
770 to 774	2203	12			2119	20						
775 and above	1346	9			1658	14						

OCTOBER TO MARCH.

Pressure	Ci.		Ci. S.		Ci. Cu.		A. S.		A. Cu.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
Below 775	9480	12			6123	2	2208	1	3936	8
755 to 759	9011	50	9408	20	7420	52	5608	7	3644	43
760 to 764	9755	82	9226	60	6729	50	3480	17	3203	106
765 to 769	9278	151	9832	31	7459	44	5574	25	4556	105
770 to 774	9835	140	9857	34	7707	56	5049	26	4389	41
775 and above	9858	55	9408	21	8669	20	1971	1	3701	25

Pressure	S. Cu.		N.		Cu.		Cu^b.		Cu. N^t.		Cu. N^b.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
Below 755	2475	18			2404	49	2278	12	3290	10		
755 to 759	2647	72	875	5	1805	94	1553	14				
760 to 764	2528	99			1666	126	1575	25	3938	10	2700	6
765 to 769	2534	57	1990	25	1650	108			3202	9		
770 to 774	1835	46			1520	34						
775 and above	1329	10			1130	15						

In the heights of clouds at different pressures, there are possibly three different effects which may be detected: (1) The heights of the cirrus types are apparently indifferent to the surface pressures, as the curves show no harmony among themselves; (2) the middle cloud forms, alto-stratus, alto-cumulus, seem to have two maxima of height at pressures 757 mm. and 767 mm. respectively; (3) the lower forms, strato-cumulus and cumulus, tend to fall in height, while the pressure rises from a low to high barometer. This must be due to the higher temperature which accompanies the low pressures, and which would cause the clouds to form at a greater elevation when the barometer is low than when it is high.

TABLE 16.—*Height of clouds for different gradients.*

APRIL TO SEPTEMBER.

Gradient toward—	Ci.		Ci. S.		Ci. Cu.		A. S.		A. Cu.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
NE	9768	455	10890	58	8232	100	6501	126	4602	247
N	10060	119	11267	40	9554	41	6475	25	4848	112
NW	9915	136	11492	44	9516	65	6915	13	5262	116
W	9571	56	10235	8	8532	28	3090	17	5411	68
SW	10544	56	7842	21			5126	19	5076	20
S									5220	5
SE										
E	9769	20	8979	6	8784	6	5900	6	3804	44

Gradient toward—	S. Cu.		N.		Cu.^{t}		Cu^{b}.		Cu. N^{t}.		Cu. N^{b}.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
NE	2866	171	3213	13	1884	478	1353	81	4685	88		
N	2873	98	2408	7	2161	154	1690	17	8781	56	3938	10
NW	3369	53	858	10	1873	143	971	23	4146	34	3822	19
W	2148	35	853	7	1754	38	1110	3	4327	27		
SW	2047	30			2800	2						
S	3152	6			2004	4			3495	5		
SE					2140	57	2376	2				
E	2564	37			1923	107	1507	18				

TABLE 16.—*Height of clouds for different gradients*—Continued.

OCTOBER TO MARCH.

Gradient toward—	Ci.		Ci. S.		Ci. Cu.		A. S.		A. Cu.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
NE	9347	283	9275	46	7660	118	5845	14	3589	105
N	10122	10	9906	43	7589	19	2622	4	4467	8
NW	10067	65	9448	41	7894	34	4937	31	4856	62
W	9030	69	9834	10	9541	12	4659	23	4642	43
SW	10372	35	9577	15	5973	5	2916	1	2150	11
S	9263	14			6690	20	3157	2	4732	16
SE									3361	33
E	7668	9			6388	9			3782	39

Gradient toward—	S. Cu.		N.		Cu.[a]		Cu[b].		Cu. N[t].		Cu. N[b].	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
NE	1329	119	1983	10	1630	212	1187	12	1552	2		
N	2351	31			1654	29			1850	8	2700	6
NW	2901	59	1888	17	2244	44	2479	13	1403	7		
W	2444	30			1722	10			1220	2		
SW	2377	9										
S	3246	18	702	3	1480	2						
SE					1754	4						
E	3056	28					3156	30				

The results of this table are very rough and difficult to classify. It may possibly be concluded that when the gradients are toward the NW. or the SE., and for all types of clouds, the heights are greater than when the gradients are toward the NE. or the SW. This probably means that since the currents of air move at approximately right angles to the gradient—that is to say, parallel to the isobars—a NW. to SE. gradient implies a movement of air from SW. to NE., and hence a warmer supply of air, which would cause the clouds to form at greater heights. Also a SW. to NE. gradient means a movement of air from the NW., which would be colder, and develop the cloud system nearer the surface of the earth.

TABLE 17.—*Height of clouds from different directions.*

APRIL TO SEPTEMBER.

Direction from—	Ci.		Ci. S.		Ci. Cu.		A. S.		A. Cu.		S. Cu.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
N	9871	10	9782	1	12841	2			3487	2	3265	3
NNE	8591	12	9860	5			4036	2			2139	5
NE	9994	5	8931	2					5283	1	1949	5
ENE	12163	1					5274	3			2191	3
E	12070	1					8771	1			2836	2
ESE	9592	7							2837	1	2753	1
SE	12371	2							4033	1	1111	1
SSE	7482	3							6022	2	2463	4
S									4622	6	2508	4
SSW	11434	11	9080	6	10146	1	8410	2	7243	13	3467	2
SW	10627	27	9989	3	9584	8	7106	7	4633	17	2987	8
WSW	10178	79	9442	23	9385	29	6682	14	5025	31	3196	27
W	9395	95	9418	19	9343	28	7028	17	5491	81	3494	42
WNW	10312	116	11518	23	7980	26	7000	9	5171	67	2992	34
NW	9373	79	9940	14	12159	9	3666	5	5239	43	3182	11
NNW	10718	48	13785	4	10737	10	3361	3	3526	6	2679	9

Direction from—	N.		Cu^{t}.		Cu^{b}.		Cu. N^{t}.		Cu. N^{b}.		S.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
N			1922	23	1192	14	2184	4			855	4
NNE			1968	14	1841	5	5579	1			990	3
NE			1412	10	1064	3					1349	1
ENE			1707	7	1966	1						
E			1892	2							1226	2
ESE			2759	3								
SE	833	1	1552	4	984	3	3957	1	1013	1	602	1
SSE			1812	10			1640	1			800	5
S	840	2	1709	14	985	6	1297	2			496	1
SSW			1600	22	662	3	3239	6			877	1
SW	2651	3	1925	19	1184	3	7628	2			656	5
WSW	3033	5	2116	25	1581	3	5075	22	1944	7		
W			2245	35	1639	11	5553	29	827	1		
WNW			2119	25	646	1	9351	14	1605	1	922	2
NW	732	1	1896	61	1471	12	4148	8	1018	1	883	2
NNW			1927	40	1297	8	5473	6			869	2

TABLE 17.—*Height of clouds from different directions*—Continued.

OCTOBER TO MARCH.

Direction from—	Ci.		Ci. S.		Ci. Cu.		A. S.		A. Cu.		S. Cu.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
N	9040	6	9012	1								
NNE					8879	4			2682	1		
NE	11018	1							3081	1	1856	6
ENE	7845	4										
E	8225	3							2115	1		
ESE									2697	4		
SE	8136	1									1550	1
SSE									2211	1		
S									3884	1		
SSW									3324	2		
SW	8127	15			6237	7			4643	15	3092	4
WSW	8105	35	9364	41	7958	33	5215	17	4433	32	3050	23
W	9056	103	9423	32	8055	29	4646	11	4903	37	3016	19
WNW	9270	74	9800	19	8882	21	3142	1	4441	16	2162	14
NW	10716	40	12813	2	8744	4			2214	9		
NNW	8528	23							2752	3		

Direction from—	N,		Cu^{t}.		Cu^{b}.		Cu. N^{t}.		Cu. N^{b}.		S.	
	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases	Height	No. of cases
N												
NNE												
NE												
ENE												
E												
ESE											449	1
SE											878	1
SSE	1788	1	1077	4							931	5
S												
SSW			2519	2	2549	1	3707	4	2832	3		
SW			1635	5			5635	1	2450	1	1946	2
WSW			2007	10	1256	1						
W	2326	3	2268	9			3834	5				
WNW	1920	1	1893	29	1627	7	4290	1	2394	1	794	1
NW			1904	33	1130	10						
NNW			2115	6	1910	1					806	2

If there is any law in the distribution of the heights in relation to the direction from which the clouds are moving, evidently the data of this table is quite inadequate to detect what the law is.

TABLE 18.—*Velocity of clouds at different heights.*

Height.	April to September															
	Nim.		Strat.		Cu.		A. S.		A. Cu.		S. Cu.		Cu. N.		Means.	
	Vel.	No.	Vel.	No.	Vel.	No.	Vel.	No.	Vel.	No.	Vel.	No.	Vel.	No.	Vel.	No.
to 800	6.4	4	4.8	17											5.6	21
800 to	5.4	1	7.0	17	6.6	31							14.0	4	8.2	53
1200	5.9	1			7.4	60					5.3	5	16.6	6	8.8	72
1600					6.8	98					8.7	22	4.6	1	6.7	121
2000	8.6	1			7.8	65			9.5	11	12.3	19	20.3	2	11.7	98
2400	8.1	1			9.2	26	6.8	3	11.1	14	10.0	23	16.0	2	10.2	69
2800	12.5	3			9.6	19	7.7	4	10.8	14	14.2	11	9.0	3	10.6	40
3200	13.7	1			9.3	8	14.5	3	14.2	14	12.3	24	13.5	13	12.7	49
3600	11.5	1			12.3	3	17.0	4	19.0	9	14.7	21	10.7	13	14.2	51
4000	Ci.		Ci. S.		Ci. Cu.		10.2	5	13.4	31	16.2	11	17.2	9	16.2	56
4400							18.7	6	14.6	29	10.7	8	7.1	4	12.8	47
4800	Vel.	No.	Vel.	No.	Vel.	No.	20.3	3	17.0	18	15.7	1	9.3	3	15.6	25
5200	19.8	3			29.2	3	15.1	5	16.5	20	16.8	2	10.7	6	18.0	39
5600	34.1	3			6.1	1	10.4	7	21.4	17			15.8	6	19.4	34
6000	16.3	5	14.2	2	17.9	4	17.8	5	16.1	18			23.8	2	17.4	36
6400			21.2	1	18.9	8	11.2	5	17.5	10			23.5	3	18.4	27
6800	19.0	4	16.4	2	14.3	4	17.5	3	16.8	5	14.0	2	15.2	1	16.2	21
7200	24.8	9	20.3	6	12.4	6	26.5	3	15.8	5			22.0	1	20.3	28
7600	21.8	13	24.9	7	19.0	11	31.4	3	17.8	7					23.0	41
8000	22.5	22	22.5	6	20.7	7	11.6	4	19.2	7					19.3	46
8400	25.1	21	25.2	7	16.4	10	12.3	4	24.8	5					20.8	47
8800	27.8	39	37.8	6	22.0	6	47.4	1	22.3	3					31.5	55
9200	25.0	50	20.1	3	24.0	4			25.2	5					23.6	62
9600	25.7	50	25.1	11	30.8	7			26.4	8			15.3	1	24.7	77
10000	29.3	36	24.6	6	27.3	8	25.3	5					14.6	1	24.2	56
10400	26.2	43	28.2	6	27.5	5			30.3	2					28.0	56
10800	32.8	44	40.6	5	29.1	2	8.0	1							27.6	52
11200	27.5	34	30.9	7	43.9	3	9.8	1							28.0	45
11600	33.3	27	28.5	7	30.3	5	23.2	3							28.8	42
12000	25.7	18	28.7	5	30.2	2	36.4	1							30.2	26
12400	26.2	16	27.5	3	29.9	3	15.5	2							24.8	24
12800	26.2	27	21.7	6	27.6	3	25.4	2							25.2	38
13600	27.6	9	26.8	4	33.0	6	12.4	1							25.0	20
14400	20.3	11	22.7	6	36.8	2	12.2	1							25.5	20

Chart 11.

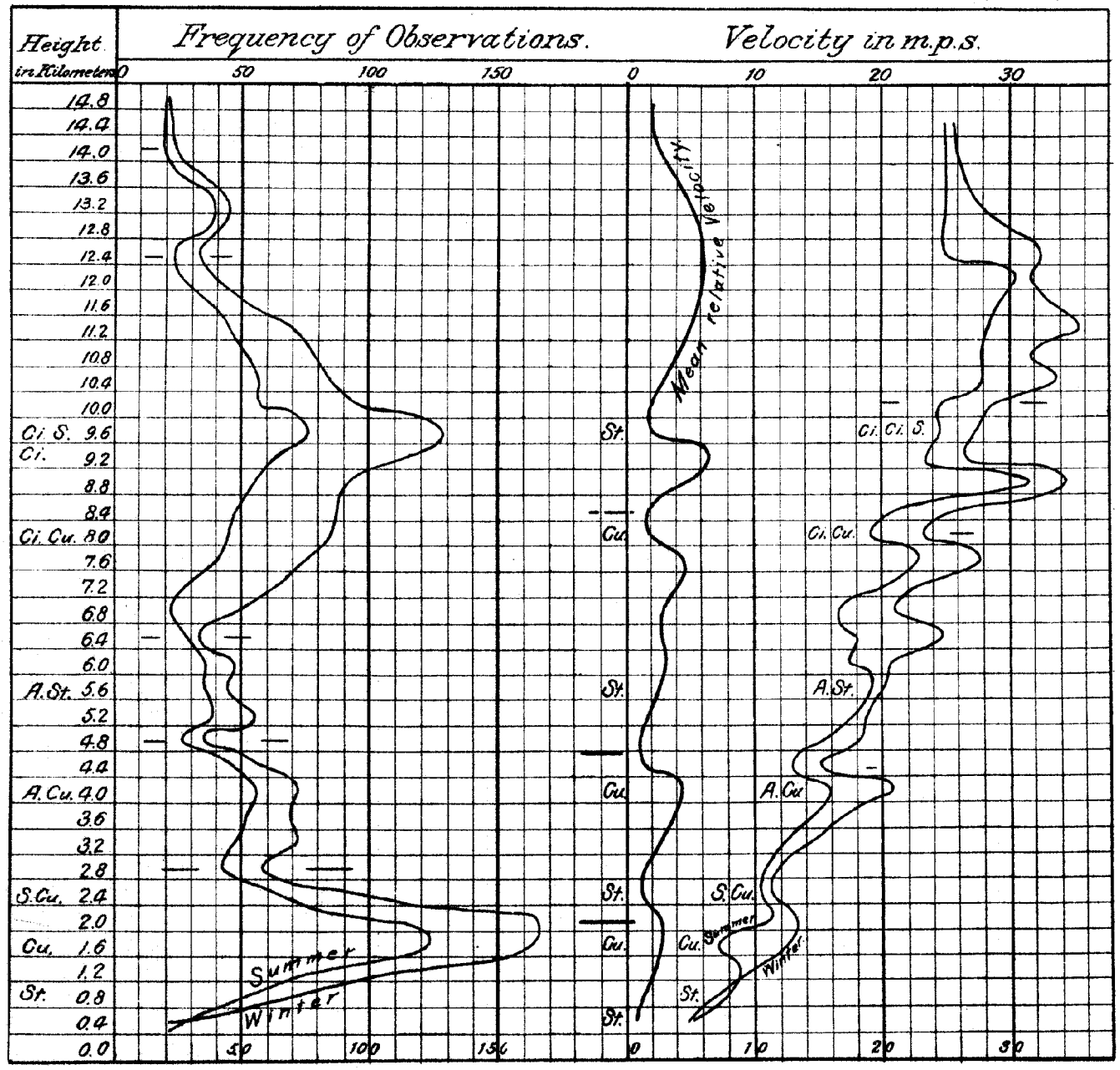

Height in Kilometers
Frequency of Observations.
Velocity in m.p.s.
0
50
100
150
0
10
20
30
14.8
14.4
14.0
13.6
13.2
12.8
12.4
12.0
11.6
11.2
10.8
10.4
10.0
Ci. S. 9.6
Ci. 9.2
8.8
8.4
Ci. Cu. 8.0
7.6
7.2
6.8
6.4
6.0
A. St. 5.6
5.2
4.8
4.4
A. Cu. 4.0
3.6
3.2
2.8
S. Cu. 2.4
2.0
Cu. 1.6
1.2
St. 0.8
0.4
0.0
Summer
Winter
Mean relative Velocity
St.
Cu.
St.
Cu.
St.
Cu.
St.
S. Cu.
Cu.
St.
Summer
Winter
Ci. Ci. S.
Ci. Cu.
A. St.
A. Cu.

TABLE 18.—*Velocity of clouds at different heights*—Continued.

Height.	October to March																Total means.	
	Nim.		Strat.		Cu.		A. S.		A. Cu.		S. Cu.		Cu. N.		Means.			
	Vel.	No.	Vel.	No.	Vel.	No.	Vel.	No.	Vel.	No.	Vel.	No.	Vel.	No.	Vel.	No.	Vel.	No.
to 800			4.2	1											4.2	1	4.9	22
800 to			6.2	4	7.7	5					8.8	3			7.6	12	8.0	65
1200					10.4	23					13.3	9			11.8	32	9.8	104
1600	11.2	3	19.4	2	11.1	32					12.3	7	22.0	1	17.2	45	13.3	166
2000	12.0	2			12.0	23			7.7	26	14.7	17	25.7	1	14.4	69	13.1	167
2400					11.0	2	11.9	2	12.3	11	16.4	8	9.4	1	11.8	24	10.9	93
2800							21.6	1	15.2	8	15.6	6	9.8	1	12.4	16	11.5	56
3200					14.1	3	21.9	1	17.1	14	16.2	4	10.2	2	15.9	24	14.3	73
3600							19.0	4	15.5	7	19.6	3	25.0	3	19.8	17	16.4	68
4000	Ci.		Ci. S.		Ci. Cu.		25.2	4	25.4	8	24.7	4	34.2	2	27.6	18	20.8	74
4400							21.1	2	20.2	7					20.6	9	15.4	56
4800	Vel.	No.	Vel.	No.	Vel.	No.	27.4	1	20.5	5					24.0	6	18.4	31
5200			21.0	2	15.2	4	19.7	4	19.8	6					18.9	16	18.4	55
5600					20.9	1	20.3	2	21.9	4					21.0	7	20.0	41
6000	23.0	3			25.8	4	28.1	1	32.1	4					25.0	12	20.6	48
6400	31.5	3	36.4	1	30.8	4	16.2	1	38.2	3					30.6	12	24.6	39
6800	16.7	6	37.2	4	35.5	8			27.9	8					29.3	26	21.0	47
7200	15.4	17	31.1	5	38.7	8			31.8	5					29.2	35	23.8	63
7600	27.3	25	37.3	5	29.3	7	38.0	1	39.3	5					32.8	33	27.9	74
8000	26.5	27	32.2	5	29.8	8									29.5	40	23.0	86
8400	33.1	25	24.8	6	36.1	7									31.3	38	24.7	85
8800	35.3	23	30.4	7	41.4	4									39.0	34	34.3	89
9200	34.1	27	31.3	11	21.3	11									28.9	49	26.0	111
9600	37.3	32	30.3	11	29.7	9									32.4	52	27.6	129
10000	38.4	24	25.3	11	40.5	6									34.7	41	28.2	97
10400	44.5	18	32.4	5	48.5	5									41.8	28	33.9	84
10800	42.5	14	27.3	9	38.7	4									36.2	27	31.7	79
11200	44.5	13	30.9	9	61.3	4									45.6	26	35.6	71
11600	36.2	11	31.4	1	48.9	1									38.8	13	33.4	55
12000	32.3	12													32.3	12	31.2	38
12400	40.1	4	38.9	1	50.9	1									43.3	6	32.6	30
12800	46.1	5													46.1	5	29.4	43
13600	37.2	3	21.4	2											29.3	5	26.4	25
14400																	25.5	20

The column "Mean number of observations" must be taken as the mean of the clouds actually measured, and not those really existing in the atmosphere. It is clearly shown on Chart 11 that both for the winter and the summer there is a heavy maximum in the cumulus region and another in the cirrus region. The former is thin and has one-third more observations than the latter, which is very deep. There are two small maxima, one in the alto-cumulus region and the other in the alto-stratus. The winter frequency exceeds the summer by about 30 per cent. Some evidence exists for a small maximum in the level 12 to 14 km. high, but no name has been assigned to such alto-cirrus clouds. On the chart the height is given in kilometers, and the number of observations,

shown on the column of means in Table 18, is plotted on the abscissas. The winter and summer frequencies are indicated by two lines which follow each other rather closely in a meandering fashion. These of course include all the clouds in the several strata, the types being taken all together indiscriminately. In the other columns of the table the several types are given individually, and they can readily be transferred to a diagram.

On the right side of the same chart is plotted the summer and winter velocities. While there is much irregularity, it is seen that the maximum of the velocities may be regarded as located nearly on the same level as those of the frequencies, except in the cirrus region, where the velocity maximum is too low in altitude. These crests may perhaps be considered as marking off several horizontal currents, which tend to stratify the atmosphere by their relative motions, the minima being at the following levels: 2,600 meters, 4,800 meters, 8,200 meters, 9,800 meters. There is a smaller maximum at 6,800 meters, and another at 12,400 meters. As mentioned in another place, there exists a tendency to produce stratus forms (stratus, strato-cumulus, alto-stratus, and cirro-stratus) near the places of minimum velocities. This indicates that the stratus are sheets at the contact surfaces of currents of different temperatures flowing over each other, the upper current being more rapid than the lower, while the cumulus are clouds produced by vertical convection within a single current of moving air, wherein the vapor rises toward the upper part while it is being transported in a horizontal direction. The wave line, marked "mean relative velocity," is found by taking the average of the summer and winter velocity lines, smoothing the curve somewhat, and omitting the average increase in velocity with the altitude. The fact that five crests occur between the ground and 10,000 meters shows that the air tends to flow in streams about 2,000 meters in thickness. These are the currents which prevail in cyclones or anticyclones, and the mixture of the layers at their surfaces helps restore the equilibrium or normal temperature of the air, which has been disturbed by the insolation.

An important fact is presented on the chart regarding the maximum velocities in the atmosphere. There is a gradual increase in the mean velocity up to 11,000 or 12,000 meters, and above this a distinct falling off up to 15,000 meters. That conclusion should be otherwise confirmed, but if true it shows that the maximum eastward drift of the atmosphere occurs at the height of 7 miles, and that above this level the velocity falls off again. Such a fact, once established, becomes important in discussing the general motions of the atmosphere, because it locates the place of the maximum velocity. Thus all velocities computed from theory exceeding that amount must be reduced by the use of additional terms in any analysis of motion of the atmosphere which is complete and satisfactory.

TABLE 19.—*Frequency of cloud directions at different heights.*

Direction from—	April to September						October to March					
	to 1000	1000 to	3000 to	5000 to	7000 to	10000 +	to 1000	1000 to	3000 to	5000 to	7000 to	10000 +
N	5	34	3	2	11	4	0	0	0	0	1	6
NNE	2	19	2	3	7	3	0	1	0	0	4	0
NE	0	15	0	1	4	2	0	0	0	0	0	0
ENE	0	11	1	1	0	1	0	1	0	0	0	0
E	0	7	0	0	1	1	0	0	0	0	0	0
ESE	0	2	0	1	4	3	0	0	0	0	0	0
SE	3	8	2	0	0	2	1	2	0	0	0	0
SSE	2	15	1	0	3	0	1	3	1	0	0	0
S	2	18	0	0	1	0	0	0	1	0	1	0
SSW	1	26	4	2	1	6	1	0	0	0	3	0
SW	0	30	10	5	13	29	0	17	1	10	23	0
WSW	2	37	46	41	70	75	0	33	33	24	48	27
W	0	55	70	55	88	59	2	15	42	22	62	46
WNW	3	63	44	34	78	81	3	28	1	14	38	25
NW	5	80	25	4	40	63	0	26	0	0	16	19
NNW	3	47	10	5	11	38	0	3	0	0	9	7
Mean	42° 15′	65° 38′	84° 12′	88° 39′	79° 53′	77° 22′	70° 51′	87° 29′	78° 35′	80° 22′	89° 51′	77° 09′
Direction	N W	N W	N W	N W	N W	N W	S W	N W	S W	S W	N W	N W

These are compiled from the Journal and arranged on the 16 compass points. From these numbers, resolving the components on the axes, N–S, W–E, we compute the mean directions at the heights indicated. In the summer the direction of mean motion is from the north of west at all levels; in winter it is from the south of west in the lower levels and from the north of west in the higher. This seasonal change is to be attributed to the situation of Washington itself on the eastern side of the Continent, because in winter the general drift is toward the NE., in consequence of the southward looping of the curves of flow over the North American Continent. For a station located on the Rocky Mountain slope the mean winter movement would be from the north of west in the lower strata as well as in the higher. One ought always to interpret resulting motions in view of the effect that continents and oceans exert in disturbing the average drift, which is what would occur if the surface of the earth were smooth and of a homogeneous character.

TABLE 20.—*Frequency of clouds from different directions.*

APRIL TO SEPTEMBER.

[All stations except Key West. Nephoscopes.]

Direction from—	Ci.	Ci. S.	Ci. Cu.	A. S.	A. Cu.	S. Cu.	N.	Cu.	Cu. N.	S.	Wind
N	10	5	1	12	11	19	14	58	2	29	293
NNE	5	2	5	5	8	9	4	34	2	21	
NE	5	4	2	10	0	7	4	34	2	20	225
ENE	4	7	3	1	10	9	5	20	1	8	
E	6	2	1	1	3	10	1	21	2	8	195
ESE	5	0	2	2	8	10	0	4	0	7	
SE	8	0	2	2	7	10	1	23	0	6	280
SSE	9	0	5	4	6	21	5	25	1	16	
S	15	6	5	8	12	28	3	51	2	26	441
SSW	26	7	3	7	15	26	3	48	2	6	
SW	75	35	22	20	59	61	9	87	5	12	484
WSW	82	48	38	38	74	54	9	102	6	20	
W	122	77	78	49	119	89	15	155	23	27	342
WNW	83	40	76	76	96	90	17	105	11	38	
NW	32	39	13	36	52	56	19	88	3	39	361
NNW	17	5	8	19	20	21	12	51	7	19	
Mean Direction	81° 41′ S W	88° 48′ N W	87° 22′ N W	78° 53′ N W	88° 44′ N W	86° 26′ S W	57° 56′ N W	85° 11′ N W	75° 51′ N W	52° 06′ N W	54° 45′ S W

OCTOBER TO MARCH.

Direction from—	Ci.	Ci. S.	Ci. Cu.	A. S.	A. Cu.	S. Cu.	N.	Cu.	Cu. N.	S.	Wind
N	4	2	0	5	19	29	11	24	3	24	291
NNE	3	3	1	4	5	12	2	6	0	12	
NE	3	0	2	4	4	7	1	4	0	8	200
ENE	1	0	2	2	1	6	2	2	1	5	
E	1	0	0	1	1	7	0	5	0	15	167
ESE	3	2	0	2	1	17	2	3	0	8	
SE	0	3	1	1	2	24	8	5	0	13	274
SSE	1	2	2	2	1	10	7	5	1	4	
S	9	2	1	1	3	25	12	6	1	24	345
SSW	20	1	1	3	9	30	9	25	0	6	
SW	30	14	11	11	22	83	9	47	3	19	350
WSW	77	30	22	15	34	85	16	59	0	20	
W	150	79	59	55	55	108	10	58	1	42	365
WNW	127	73	39	76	88	109	20	53	4	45	
NW	63	43	21	42	52	67	21	32	3	41	403
NNW	15	15	3	13	31	40	11	17	0	16	
Mean Direction	84° 58′ N W	77° 39′ N W	83° 38′ N W	71° 04′ N W	68° 54′ N W	89° 29′ N W	89° 43′ N W	89° 20′ S W	70° 40′ N W	70° 32′ N W	80° 07′ S W

Since the station Key West, Fla., is located on the southward side of the permanent high pressure belt which crosses the United States, it is proper to compute the mean directions of the different cloud forms separately for that place. The recent extension of the service of the United States Weather Bureau to the islands of the Caribbean Sea will enable us in a few years to determine accurately the mean flow of the atmosphere over those regions, as has now been done over the United States. Properly such a computation should always be carried out for groups of stations characterized by similar meteorological conditions, and not all combined together as was done in forming table 20, wherein the results are general averages over a very large territory. For the districts east of the Rocky Mountains in summer, the mean movement is from a point slightly north of west in all the cloud strata except the cirrus, which is from the SW. Also the wind in summer prevails from the SW. In the winter the motion is from the west or a little north of west in all the cloud levels, but in the surface wind it is from the WSW.

TABLE 21.—*Frequency of clouds from different directions.*

APRIL TO SEPTEMBER.

[Key West. Nephoscope.]

Direction from—	Ci.	Ci. S.	Ci. Cu.	A. S.	A. Cu.	S. Cu.	N.	Cu.	Cu. N.	S.	Wind
N	2	0	2	2	6	1	0	9	0	0	12
NNE	3	4	0	1	4	0	1	8	0	0	
NE	4	5	0	1	10	1	0	23	0	0	41
ENE	2	8	0	2	6	2	0	42	3	0	
E	4	8	3	4	8	0	0	41	6	0	105
ESE	3	11	1	3	2	0	0	27	5	2	
SE	3	9	1	2	3	0	0	8	1	0	85
SSE	5	5	0	1	1	0	0	8	0	0	
S	1	2	2	1	3	0	0	5	0	0	22
SSW	2	2	0	1	0	0	0	3	0	0	
SW	4	7	2	1	2	0	0	4	0	0	17
WSW	13	10	1	3	4	0	0	4	0	0	
W	6	7	1	1	3	0	0	0	0	0	6
WNW	2	9	4	0	2	0	0	2	0	0	
NW	3	10	0	3	7	1	0	3	0	0	15
NNW	0	1	1	3	4	0	0	5	0	1	
Mean	50° 46′	10° 58′	81° 14′	58° 56′	28° 15′	30° 11′	22° 27′	79° 47′	84° 0′	84° 10′	75° 35′
Direction	S W	S E	S W	N E	N E	N E	N E	N E	S E	N E	S E

OCTOBER TO MARCH.

Direction from—	Ci.	Ci. S.	Ci. Cu.	A. S.	A. Cu.	S. Cu.	N.	Cu.	Cu. N.	S.	Wind
N	0	0	0	0	4	0	0	7	0	1	13
NNE	0	0	0	0	1	0	0	7	0	0	
NE	0	0	0	0	1	1	0	16	0	0	66
ENE	0	1	0	0	3	0	0	14	0	0	
E	0	1	0	0	1	0	0	14	0	0	51
ESE	0	0	0	0	2	0	0	4	0	0	
SE	0	1	0	1	0	0	0	4	1	0	42
SSE	0	0	0	0	1	0	0	4	0	0	
S	1	2	0	2	0	0	0	2	0	0	8
SSW	0	1	0	0	0	0	0	1	0	1	
SW	1	3	0	0	0	0	0	4	0	0	14
WSW	5	8	1	0	3	0	0	2	1	0	
W	7	9	1	1	4	0	0	3	0	0	4
WNW	2	16	2	1	15	0	0	3	0	1	
NW	0	19	3	2	3	0	0	8	0	1	11
NNW	3	2	0	0	3	0	0	2	0	1	
Mean	89° 40′	74° 0′	67° 0′	70° 59′	47° 18′	61° 51′		8° 29′	15° 27′	53° 45′	79° 22′
Direction	S W	N W	N W	S W	N W	N W		N W	S W	N W	N E

The regularity which characterizes the direction of motion in the northern districts is much disturbed at Key West, showing that conflicting elements are operating upon one another over that station. In the summer the three upper cloud forms, Ci., Ci. S., Ci. Cu., agree in giving a direction of motion nearly from the south; the middle cloud forms A. S., A. Cu., S. Cu., N., Cu., all indicate a motion from the northeast; the lowest levels, Cu. N., S., wind, all come approximately from the east. This looks like a distinct stratification of the air motions in those layers, and indeed this is the first instance coming under our notice in this cloud work that such a divergence of mean direction really exists. In winter the clouds apparently move from the north of west throughout the stratum from the cirrus to the cumulus, inclusive. In the Cu. N., S., and wind the directions are conflicting. This result indicates that if in summer a stratification of direction prevails, it is superseded in winter by the overflow of the northwest system to the latitude of Key West, and dominates the movement of the air as far south as that at least. Such an outcome is quite in harmony with our general knowledge, that the winter circulation throws a deep circuit far to the southward, and embraces the Gulf States and the Northern Caribbean Sea. It will be an interesting study to determine by our future observations the limits of this typical stratification. One might conclude that the trade wind from the northeast and east extends up to the alto-stratus level at least 3 or 4 miles during the summer season when it is at its northern latitude. This stratified condition may have something to do with the generation of the early autumn hurricanes, when the winter circulation begins to overcome the type prevailing during the summer season.

TABLE 22.—*The total number of mean nephoscope observations in each cloud type, for summer, winter, and the year.*

Clouds	Summer	Winter	Year
Cirrus	561	526	1087
Cirro-stratus	375	332	707
Cirro-cumulus	282	172	454
Alto-stratus	319	243	562
Alto-cumulus	565	369	934
Strato-cumulus	525	660	1185
Nimbus	122	141	263
Cumulus	1098	446	1544
Cumulo-nimbus	84	19	103
Stratus	305	307	612
Total clouds	4236	3215	7451
Wind	2924	2604	5528
Totals	7160	5819	12979

Since each mean nephoscope vector recorded in Table 9, and distributed in various ways in Tables 10–21, consisted usually of three separate observations, the total number of cloud observations was about 22,000 to 23,000; adding to this the wind and the other meteorological elements at the surface, it is seen how large a number of observations were made during the nephoscope work preliminary to their discussion.

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CHAPTER 6.

DISCUSSION OF THE THEODOLITE OBSERVATIONS.

HEIGHTS OF THE SEVERAL CLOUD STRATA.

We shall now discuss the results of the theodolite observations in the order, height, azimuth, and velocity to somewhat greater length.

It is important to determine not only the annual mean height at which the several types of clouds form, but also the variation of the mean height from month to month throughout the year, the height at which the maximum frequency of the formation takes place, and the limits above and below the mean height at which the same cloud form ceases to be observed. This data becomes valuable in discussing those physical conditions of the atmosphere which are capable of producing the given cloud formations, also the laws according to which the pressure, the temperature, and the humidity change in order to produce specific cloud effects. For this purpose the cloud heights were assorted by months and collected within assigned levels, as 200, 400, 600, etc., meters for stratus, or 5,000, 6,000, 7,000, etc. meters for the cirrus. That is to say, every height which occurred between these levels was entered in a table, here omitted, together with the number of the observations. Since the effort was made during the year to observe daily every type of cloud visible at Washington, it may be supposed that a fair inventory was obtained of the relative distribution of the clouds as to height and frequency of formation during the twelve months. While one year's work is not sufficient to satisfactorily determine all the details of so intricate a phenomenon, yet it is certain that the methods here pursued, if extended to several years, would accomplish that purpose. It may be presumed, however, that even the data in hand will indicate the main features of the cloud formation in each type level. Having constructed columns of the number of observations and the heights for each month, the mean was taken out by assigning weights according to the number of the observations. These weighted means are transferred to Table 23, which is here reproduced.

TABLE 23.—*Number of observations and heights within each 200-meter stratum for every month.*

CUMULUS.

Year	Month	200	400	600	800	1000	1200	1400	1600
1897	Jan					5 1107	17 1304	14 1489	8 1657
	Feb				3 921	9 1040	10 1333	17 1492	7 1686
	Mar					7 1085	6 1287	8 1482	21 1740
	Apr					7 1110	11 1316	11 1518	20 1715
1896	May					4 1157	5 1300	5 1486	2 1680
1897	May			4 676	1 967	14 1088	14 1303	20 1499	29 1701
1896	June		1 562		4 931	14 1107	19 1307	22 1483	20 1690
1897	June			1 771	13 890	20 1093	16 1329	37 1504	25 1711
1896	July		3 545	8 741	5 921	28 1101	29 1308	39 1511	39 1706
	Aug				4 909	12 1128	20 1299	20 1517	45 1710
	Sept					1 1193	20 1299	14 1505	13 1762
	Oct				2 912	1 1144	19 1318	34 1496	31 1683
	Nov					10 1071	3 1288	9 1520	5 1684
	Dec			1 772		3 1063	11 1289	13 1499	9 1703

STRATUS.

1897	Jan				1 846				
	Feb		2 541	5 729	6 901				
	Mar	2 332	4 500	2 683	7 866				
	Apr	1 376	12 534	7 725	5 864		1 1296		
	May	11 363	3 440	17 690	11 911	6 1094	4 1356	1 1542	2 1722
1896	June		2 578	1 626	4 905				
1897	June	2 292	39 472	21 709	19 856	2 1044			
1896	July			1 776				1 1481	
	Aug				2 962		4 1306	2 1540	3 1761
	Sept		1 558	1 626	3 946	2 1043			4 1722
	Oct		1 560	8 699	11 857	17 1128	4 1315	4 1485	
	Nov			2 753	4 850	2 1145	1 1230	2 1571	1 1662
	Dec					1 1063	1 1263		2 1792

TABLE 23.—*Number of observations and heights within each 200-meter stratum for every month.*

CUMULUS.

1800	2000	2200	2400	2600	2800	3000	3600	Totals
5 1908	2 2096	5 2318	2 2347	2 2693				60 1625
								46 1579
22 1867	20 2098	16 2282	10 2491	9 2682	3 2912	7 3366	7 3767	137 2141
12 1891	4 2095	3 2345	1 2554	7 2732	10 2897	4 3203	4 3819	94 2022
5 1945	9 2106	2 2381	3 2500	4 2687	5 2908	2 3070		46 2050
20 1914	17 2071	17 2144	11 2474	6 2656	3 2900	11 3285	1 3910	168 *1895
26 1920	15 2100	11 2263	10 2481	5 2686	4 2895	7 3246		158 †1835
19 1820	17 2091	7 2278	6 2509	6 2673	2 2957	3 3075		172 1665
43 1880	32 2084	11 2277	7 2511	7 2683	4 2865	4 3155	1 3613	260 1704
42 1890	36 2097	23 2294	12 2483	9 2690	6 2869	4 3211	8 5242	241 2009
3 1975	2 2080	9 2292	4 2474					66 1692
27 1896	7 2070	2 2325	4 2496	1 2684	2 2841	2 3278		135 1702
8 1907	3 2118	3 2283	3 2477	1 2748	1 2852			46 1693
6 1882	2 2078		1 2420					46 1541
Totals for year								1675 1821

*Weighted mean for May 1928 †Weighted mean for June 1747

STRATUS.

1 1804	5 2285							7 2011
								13 779
								15 666
								26 672
1 1918	1 2142							57 844
								7 *772
								83 *629
								3 1243
1 1834								12 1445
1 1976								12 1250
								45 1021
								12 1102
6 1905	1 2034							11 1852
Totals for year								303 901

*Weighted mean for June 640

TABLE 23—Continued.—*Number of observations and heights within each 200-meter stratum for every month.*

NIMBUS.

Year	Month	200	400	600	800	1000	1200	1400	1600
1897	Jan								
	Feb								
	Mar								
	Apr					1 1086	2 1312		
1896	May								
1897	May					1 1036			
1896	June			3 718	3 836		1 1203		
1897	June			3 704	4 913				
	July			1 634	2 860				
	Aug								1 1713
	Sept								
	Oct					2 1050			
	Nov							3 1536	
	Dec			3 699					

Number of observations and heights within each 1,000-meter stratum for every month.

CUMULO-NIMBUS.

Year	Month	0	1	2	3	4	5	6	7
1897	Jan								
	Feb								
	Mar			9 2618	6 3422	10 4362	1 5895		
	Apr		3 1492		9 3519	1 4173			
1896	May			8 2695	14 3424	10 4349	3 5692	3 6358	3 7680
1897	May			5 2283			3 5434		
1896	June			4 2707	14 3537		3 4288		
1897	June		14 1743		5 3385	9 4360	7 5341		
1896	July		9 1249		14 3546	16 4498	11 5532	6 6449	4 7506
	Aug				2 3239	1 4917	1 5910		
	Sept			3 2448	4 3810		3 5797	3 6494	
	Oct								
	Nov			1 2986	8 3439				
	Dec								

TABLE 23—Continued.—*Number of observations and heights within each 200-meter strattum for every month.*

NIMBUS.

1800	2000	2200	2400	2600	2800	3000	3600	Totals
								3 1237
					6 2974	1 3276	1 3684	9 2871
								7 838
								7 *823
							3 4022	6 2402
			6 2480					7 2370
						1 3395		1 3395
								2 1050
11 1831	9 2123		2 2495					25 1831
								3 699
Totals for year								70 1808

*Weighted mean for June 831

Number of observations and heights within each 1,000-meter stratum for every month.

CUMULO-NIMBUS.

8	9	10	11	12	13	14	15	Totals
								26 3639
								13 3055
2 8290	1 9375							44 4503
								8 *3465
								21 3486
2 8827								37 †3665
6 8532	2 9778	4 10374	5 11335	2 12461	4 13433	2 14418	2 15903	87 6560
								4 4576
		2 10709	2 11714	4 12419				21 7285
								9 3389
Totals for year								270 4968

*Weighted mean for May 4343 † Weighted mean for June 3600

TABLE 23—Continued.—*Number of observations and heights within each 1,000-meter stratum for every month.*

ALTO-CUMULUS.

Year	Month	0	1	2	3	4	5	6	7
1897	Jan			4 2217			1 5146		
	Feb		8 1524			1 4382		10 6800	3 7539
	Mar			8 2782	19 3368	11 4442	13 5423	1 6746	
	Apr			5 2212	29 3525	17 4578	14 5588	4 6489	
1896	May			5 2476	7 3489	16 4593	9 5256	3 6365	7 7457
1897	May			1 2956	3 3585	17 4306	7 5552	12 6431	
1896	June			16 2589	20 3535	31 4454	16 5408	10 6364	4 7552
1897	June			15 2419	10 3609	33 4545	21 5812		2 7126
1896	July			4 2951	28 3547	33 4618	31 5517	13 6560	18 7593
	Aug			39 2494	17 3234	36 4356	7 5438	10 6405	
	Sept			23 2673	5 3052	2 4678	23 5500	9 6262	
	Oct			78 2407	17 3421	2 4107			
	Nov			13 2528	21 3344	11 4551	2 5042	3 6912	10 7371
	Dec			38 2504	12 3802	18 4528	14 5592	10 6410	12 7428

STRATO-CUMULUS.

1897	Jan		42 1689	12 2270					
	Feb		18 1375	22 2413		10 4412			
	Mar		9 1419	23 2705	11 3253				
	Apr		46 1520	33 2573	21 3280	4 4451			
1896	May			4 2431	14 3657	12 4217			
1897	May		16 1855	40 2395	7 3358				
1896	June		2 1755	19 2583	18 3606	4 4602	3 5580	2 6882	1 7285
1897	June		4 1813	19 2477	21 3419	16 4498			
1896	July		6 1818	8 2348	30 3569	7 4349			
	Aug		18 1688	38 2377	17 3469	5 4157			
	Sept		10 1759	13 2455	9 3565	1 4070	1 5148		
	Oct		5 1832	6 2441	1 3434	1 4110			
	Nov		11 1406	14 2730	17 3089	2 4266			
	Dec		41 1478	40 2442	18 3331	6 4402			

TABLE 23—Continued.—*Number of observations and heights within each 1,000-meter stratum for every month.*

ALTO-CUMULUS.

8	9	10	11	12	13	14	15	Totals
								5 2803
								22 4872
								52 4086
								69 4265
2 8270	2 9367							51 5180
	1 9422							41 *5180
8 8410	5 9629							110 4964
5 8797	5 9228							91 †4932
14 8445	10 9540	6 10167						157 5931
								109 3772
								62 4342
								97 2620
								60 4294
								104 4364
Totals for year								1030 4540

* Weighted mean for May 5180 † Weighted mean for June 4949

STRATO-CUMULUS.

								54 1817
								50 2439
								43 2574
								104 2322
								30 3718
								63 *2365
								49 3545
								60 †3302
								51 3278
								78 2570
								34 2377
								13 2412
								44 2971
								105 2383
Totals for year								778 2520

* Weighted mean for May 2801 † Weighted mean for June 3411

TABLE 23—Continued.—*Number of observations and heights within each 1,000-meter stratum for every month.*

CIRRO-CUMULUS.

Year	Month	0	1	2	3	4	5	6	7
1897	Jan				2 3067	8 4499			3 7315
	Feb					1 4954	3 5595	8 6772	15 7526
	ar				2 3866	3 4583	2 5468	6 6634	3 7690
	Apr					1 4250	5 5675	6 6440	3 7232
1896	May						2 5482	9 6654	8 7446
1897	May								2 7271
1896	June							2 6740	8 7556
1897	June						2 5339	1 6973	4 7626
1896	July						7 5757	13 6748	17 7652
	Aug							5 6624	7 7500
	Sept								1 7951
	Oct				2 3878	2 4934	7 5454	12 6595	6 7449
	Nov						1 5798	1 6040	6 7575
	Dec						3 5759	17 6461	15 7442

ALTO-STRATUS.

1897	Jan								
	Feb			1 2958					
	Mar		1 1935	3 2445	3 3085				
	Apr				2 3659	1 4168			
1896	May					1 4802	4 5429	3 6611	
1897	May			1 2086	2 3349	5 4366	1 5991	2 6282	1 7043
1896	June					6 4420	6 5586	5 6055	4 7448
1897	June		‡11 1613	2 2708	9 3607	4 4438	2 5572	2 6653	1 7048
1896	July					7 4646	8 5333	7 6574	9 7350
	Aug			4 2602	6 3534			9 6284	3 7775
	Sept			1 2841	10 3943	1 4645	14 5629	5 6472	3 7354
	Oct			6 2624		8 4371	4 5505	2 6468	2 7419
	Nov					12 4088	10 5483	2 6315	1 7550
	Dec			2 2921		5 4241		4 6482	

TABLE 23—Continued.—*Number of observations and heights within each 1,000-meter stratum for every month.*

CIRRO-CUMULUS.

8	9	10	11	12	13	14	15	Totals
1 8570	1 9074							15 5448
8 8492	7 9476	1 10060						43 7747
5 8276	1 9312							22 6635
6 8697	4 9438	1 10640						26 7439
1 8505	4 9529	3 10611	1 11249	1 12196				29 8012
1 8530								3 *7691
15 8711	14 9504	5 10387	5 11452	1 12399	1 13867			51 9276
1 8514								8 †7084
17 8329	3 9405	10 10288	12 11598	7 12508	4 13672	4 14334	2 15411	96 9379
5 8421	4 9467	1 10101	1 11269					23 8129
3 8476	1 9419							5 8560
4 8575	11 9431	1 10831	1 11350	1 12425				47 7482
4 8560	11 9546	5 10410	2 11228	2 12202				32 9234
9 8312	3 9614	11 10543	3 11181	1 12902				62 8142

Totals for year 462 8119

* Weighted mean for May 7981 † Weighted mean for June 8979

ALTO-STRATUS.

								1 2958
								7 2646
								3 3829
1 8096								12 4685
								9 *6050
4 8511	3 9449	3 10124		2 12271	1 13158			34 7370
								34 †3342
5 8272	1 9548	6 10559	3 11270	3 12622	1 13434			50 7732
1 8176				1 12190		3 14263	1 15552	28 6793
3 8627								37 5569
								22 5023
2 8131	1 9195							28 5340
1 8086								12 5088

Totals for year 273 5866

* Weighted mean for May 5270 † Weighted mean for June 5356

TABLE 23—Continued.—*Number of observations and heights within each 1,000-meter stratum for every month.*

CIRRUS.

Year	Month	0	1	2	3	4	5	6	7
1897	Jan							2 6664	11 7556
	Feb							3 6291	10 7595
	Mar						1 5430	11 6636	28 7485
	Apr						5 5638		9 7608
1896	May						1 5872	7 6589	13 7453
1897	May								14 7571
1896	June						1 5354	4 6630	7 7690
1897	June						6 5500	2 6641	8 7458
1896	July						2 5627	1 6098	2 7838
	Aug								1 7689
	Sept								
	Oct								9 7515
	Nov								6 7550
	Dec							2 6631	12 7709

CIRRO-STRATUS.

1897	Jan							1 6808	2 7792
	Feb								
	Mar								
	Apr							1 6846	5 7662
1896	May							3 6638	3 7644
1897	May								
1896	June							5 6571	10 7647
1897	June							1 6089	3 7553
	July								
	Aug							1 6796	
	Sept								2 7465
	Oct							3 6433	4 7350
	Nov								
	Dec						3 5142	2 6518	16 7519

TABLE 23—Continued.—*Number of observations and heights within each 1,000-meter stratum for every month.*

CIRRUS.

8		9		10		11		12		13		14		15		Totals	
18	8479	6	9445	2	10939											39	8659
6	8168	3	9766	4	10389	2	11580									28	8494
33	8459	51	9512	28	10469	21	11486	6	12357	2	13598	1	14327			183	9302
24	8497	44	9496	34	10434	20	11438	8	12644	13	13371	2	14714	3	16009	144	9744
16	8562	10	9593	10	10526	10	11477	5	12279	7						84	9932
22	8609	28	9557	23	10408	21	11453			1	13524	1	14082			110	*9732
12	8396	14	9412	23	10531	18	11443	10	12519	4	13368	2	14589	1	15360	96	10308
16	8430	22	9481	32	10479	15	11515	13	12531	6	13336					120	†10004
10	8670	36	9548	29	10532	33	11444	14	12523	7	13419	6	14557	1	15583	141	10672
6	8504	16	9457	7	10583	12	11419	7	12224	6	13598	8	14368	2	15263	65	10149
1	8537	15	9611	21	10584	20	11266	11	12449	1	13048			3	17182	78	10936
15	8490	16	9585	16	10501	9	11459	6	12283	1	13442					72	9815
18	8537	38	9528	16	10437	21	11505	15	12352	4	13376	1	14169	1	15810	120	10320
22	8560	16	9295	6	10441	2	11051	2	12076							62	8898
Totals for year																1342	9829

* Weighted mean for May 9818 † Weighted mean for June 10139

CIRRO-STRATUS.

2	8334															5	7812
1	8976	1	9332	3	10441	1	11392	1	12450							7	10496
2	8782	8	9590	2	10534	2	11653									14	9905
8	8445			1	10116			1	12850							16	8480
5	8188	4	9588													15	8142
9	8640	9	9499	7	10523	8	11415	1	12174	1	13060					35	*10099
8	8420	7	9577	3	10656	3	11702	1	12842	6	13680	1	14520	1	16144	45	9696
1	8758	8	9498	2	10301	4	11381	1	12637							20	†9612
		3	9656	4	10230	4	11732	6	12466	6	13470	1	14688	6	15624	30	12729
						1	11844	1	12254	1	13526					4	11105
3	8651	4	9543	8	10691	3	11259	3	12222							24	10346
2	8500	5	9676	19	10435	6	11345									39	9426
2	8865	12	9582	3	10319	6	11233	1	12314	1	13983					25	10294
18	8472	17	9424	6	10558	7	11410	1	12368	1	13674					71	8884
Totals for year																350	9775

* Weighted mean for May 9512 † Weighted mean for June 9671

GENERAL REMARKS ON TABLE 23.

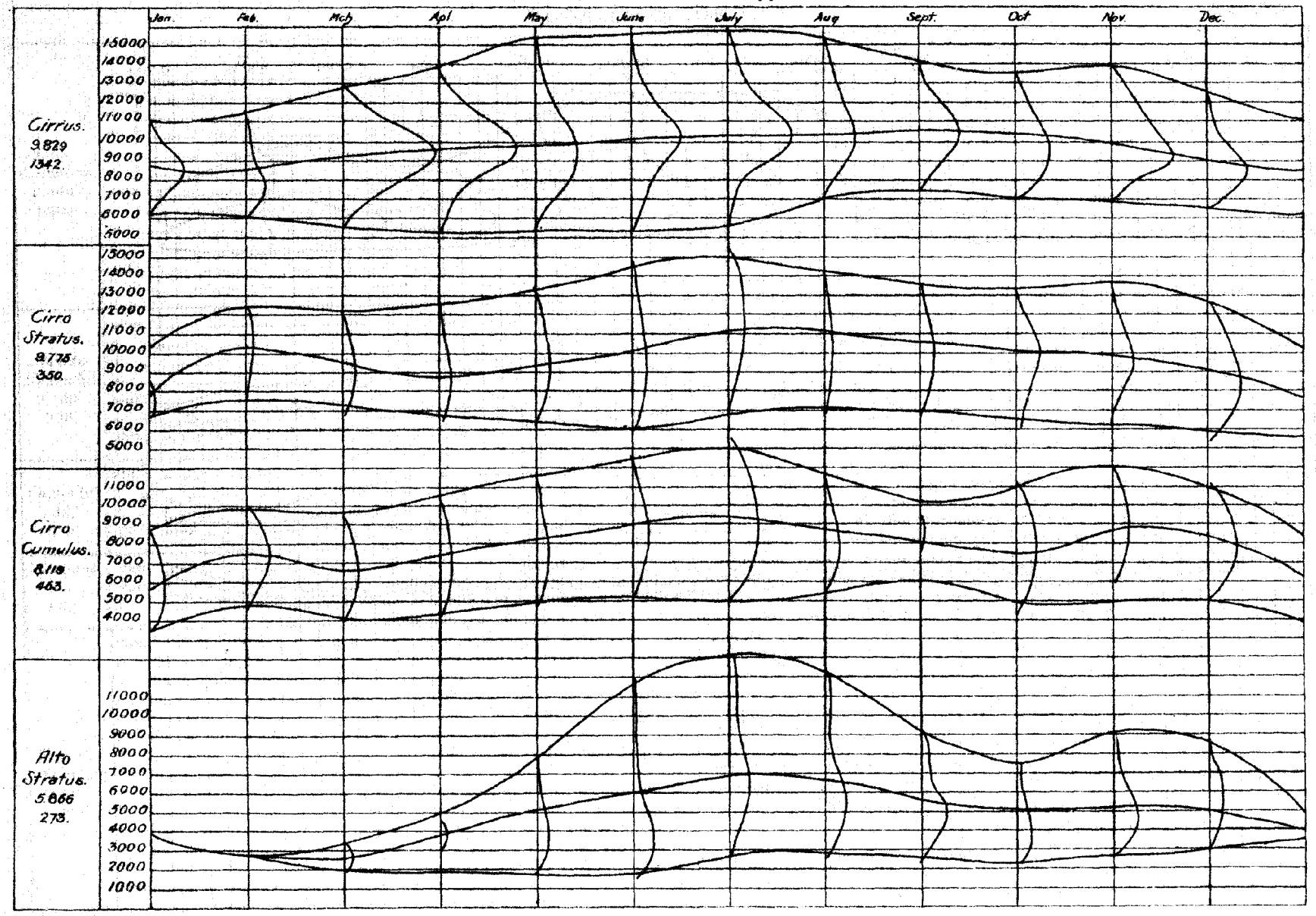
The scale of vertical distribution is different for the lower clouds from that adopted for the upper, being by 200 meter steps in the stratus, cumulus, nimbus, and by 1,000 meter steps in the cumulo-nimbus, strato-cumulus, alto-cumulus, alto-stratus, cirro-cumulus, cirro-stratus, and cirrus. The months of May and June occur in 1896 and 1897, since the theodolite observations were continued through fourteen months. It is interesting to note the fair conformity of the mean heights for May and June in all cases except cumulo-nimbus for May, strato-cumulus for May, alto-stratus for May and June, cirro-cumulus for June, and cirro-stratus for May. There must be evidently some uncertainty in the resulting mean height, due, as is seen by an inspection of the table, to the occurrence of the clouds of the given type observed at actually different levels on the days of observation collected for the years 1896 and 1897. It is not a reflection upon the accuracy of theodolite triangulation that these mean heights do not always agree from year to year, but it merely indicates that in the very wide stratum wherein a given cloud type develops those which happened to be observed on certain days were not uniformally distributed. Also, the difficulty of naming the cloud correctly appears very evident above and below the mean height. The weighted mean from the two available years is adopted in carrying forward the discussion. In the case of the cumulo-nimbus the observations were usually made on the top of the cloud, and the heights therefore refer to the elevation at which the diurnal convection carries this type of clouds in the warm season. There is one record of such a cloud having risen to 16,000 meters, or 10 miles, and several cases of elevations above 10,000 meters. This astonishing performance of an ascending convection current can hardly be questioned, because the clear edges of such clouds give favorable points for the sighting of the instruments. There are undoubtedly many instances of faulty naming of apparent cloud forms, as must have been the case, since by comparing the height with the other observations of that stratum they are evidently too high or too low to be properly included under the name originally assigned. An example of this is in the eleven alto-stratus observations of June, 1897, which gave 1,613 meters, entirely too low for the rest of the alto-stratus observations. It is probable that some cumulo-stratus clouds looked like the alto-stratus and were so called. No attempt was made to change these outstanding cases, but if another year's work is undertaken it would be proper to compare resulting heights and names of classification, relying upon the knowledge gained from the present series of observations, and then naming the cloud under observation in conformity with the computed heights. At the bottom of the last column of the table the number of observations and the mean height for each month is found, the means being weighted for the entire fourteen months in proportion to the total number of observations.

DESCRIPTION OF THE DIAGRAM OF THE DISTRIBUTION OF THE CLOUD TYPES.

In order to show graphically the distribution of the several types of clouds, as collected in the data of Table 23, which gives the relative frequency and the heights, these quantities are transferred to the diagrams of Chart 12. Each cloud type is treated separately, and the diagram, even if only approximately correct in some of the details, yet shows clearly what are the general laws controlling the formation of clouds in the different months of the year. Under the name of the cloud is placed the mean height in meters for the year and the number of observations. Under each month, for the several types, is plotted the curve of frequency, with heights as ordinates and the number of observations at the respective heights as abscissæ. The curves follow the mean line of the plotted points quite closely, though averaged a little in some places. Thus, under cirrus for January, the number of observations in the top line of Table 23 are plotted at the heights there given, 2 at 6,664, 11 at 7,556, 18 at 8,479, and so on. Under the assumption that the observed frequency corresponds with the actual frequency of cirrus formation at the given height, a discussion of these curves would give a full account of the results of the physical causes producing the clouds in every month of the year. The effort will be made in another chapter to assign the pressure, temperature, and humidity which thus produce cloudy condensations under the conditions observed to exist at the several levels throughout the year.

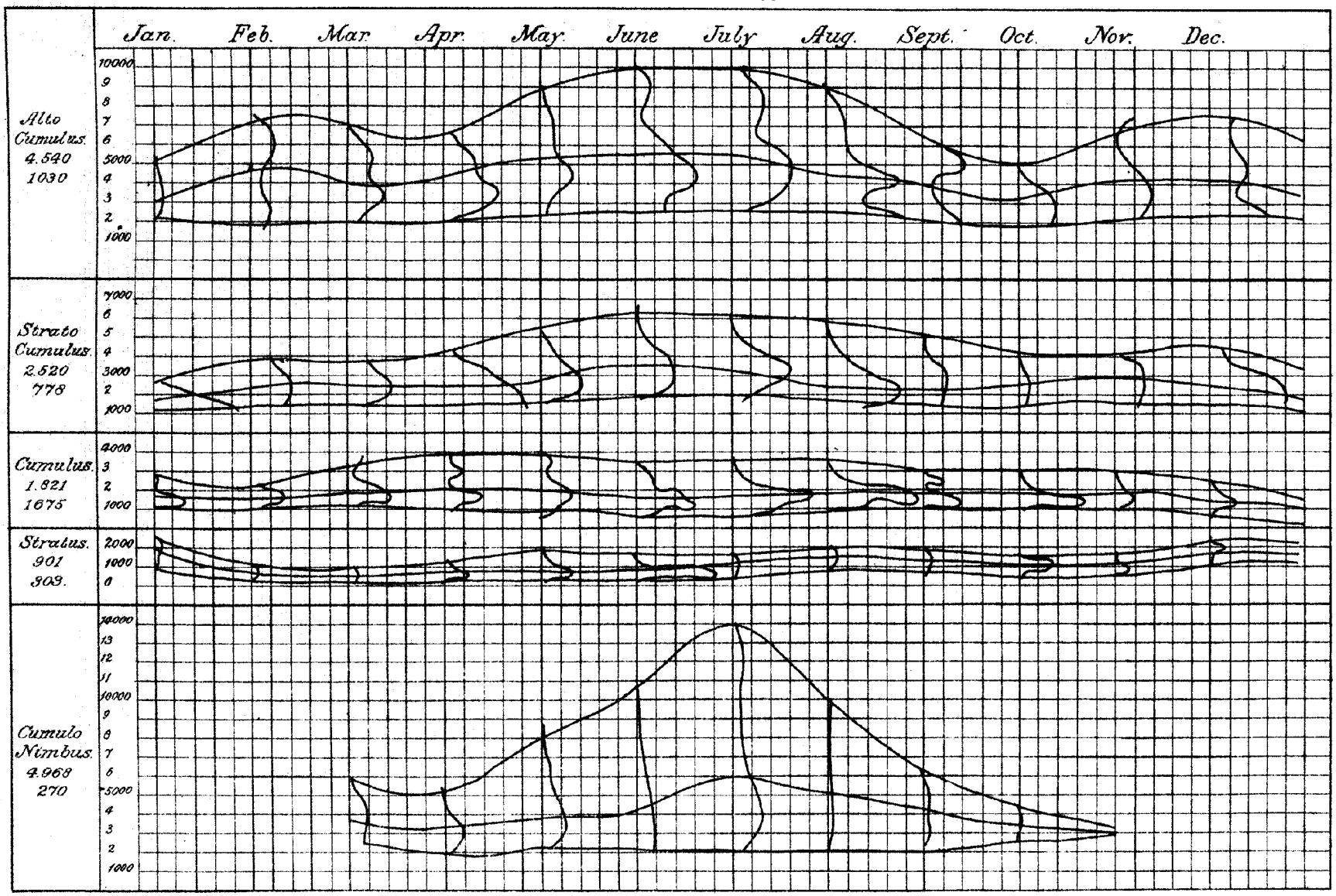
Distribution of the Cloud Types.

Chart 12, a.



Distribution of the Cloud Types.

Chart 12, b.



Average lines connect the mean heights for each month, and also boundary lines mark the upper and the lower limits at which these clouds occur. The diagrams, therefore, show the shape, thickness, and density of each cloud stratum, and as these depend upon the pressure, temperature, and humidity prevailing at the given height, they imply specific physical relations so far as the diagrams correctly represent the actual state of the atmosphere. A continuation of similar observations is evidently desirable in order to be able to carefully delineate these interesting details.

Looking at the diagrams broadly, it is seen that the five upper cloud levels are each from 8,000 to 10,000 meters (5 to 6 miles) deep. Hence the correct assignment of a name to a given cloud does not necessarily fix its height with much precision. The mean height is, however, correct within about 2,000 meters for the *majority* of the clouds, and therefore no great error will be committed in computing absolute velocities by assigning the mean height as the factor in transforming the relative nephoscope velocities. The three lower cloud strata are quite thin, 2,000 or 3,000 meters thick, except the cumulo-nimbus, which in midsummer may attain a depth of 12,000 meters (7.5 miles). The cumulus form is so important that a special section will be devoted to a description of it in Chapter 12, Chart 72. There is one characteristic which is well displayed in all the cloud strata except the stratus and cumulo-nimbus—namely, a tendency to form three maxima as to the height and the thickness of the layers. The principal maximum occurs in midsummer, but there are two subordinate maxima, one in February and one in November, respectively. There is greater height and thickness at these seasons. In other words, the tendency to form clouds is at a minimum in March and September to October. A study of the vertical temperature gradients throughout the year shows that a similar curvature takes place in the shape of the isotherms above the surface.

NOTES ON THE CHARACTERISTICS OF EACH TYPE.

A few notes may be made upon the features of each stratum. The cirrus clouds almost disappear in February, but there is a rapid increase in March, both as to frequency and depth, which then continues throughout the summer, falls off in September, rises again in November, and after that diminishes until February. The cirro-cumulus is quite similar, but seems to have been hardly seen by our observers in September. The alto-stratus develops very slightly in January and February, but after that rises rapidly until July, falls from August to October, rises again in November, and then disappears. We now observe that the base of this stratum and all the succeeding lower strata is very nearly horizontal, and that the top of the stratum is variable in height with the months of the year, showing certain relations of the seasonal temperature and vapor contents to the height in a distinct vertical convection. The alto-cumulus is rather thinner than the cirro-cumulus, but displays very similar features in the boundary and the mean-height lines. There is, however, a peculiar tendency to form a double maximum of frequency in each month. The same feature appears also in the cumulus level. The strato-cumulus is still thinner, but has the same formation as the cirro-cumulus and the alto-cumulus. There are many indications that the cumulus forms, being much firmer in their shape, give more satisfactory results from the observation than the stratus forms, which was perhaps to be expected. The stratus type is confined to a thin layer, which is thinnest and lowest in the spring, but rises generally in altitude in the early summer and remains nearly a thousand meters above the ground in the autumn and winter. The cumulo-nimbus do not appreciably exist from October to March, but attain marked prominence during the summer, the ascension being almost entirely due to the convectional rise of the upper boundary. The cumulus form will be reserved for a fuller discussion under the subject of the diurnal variations, which will be found in Chapter 12.

THE AZIMUTHS OF MOTION.

There is so great difficulty in discussing the azimuths in a comprehensive way, even for a single station such as Washington, that it has been decided to leave Table 6 for the inspection of the reader, wherein all the information available is to be found in a very convenient form. The perplexity arises from the excessive complication of the motions of the air in the several levels,

so far as azimuth angles referred to axes with fixed directions can record them, including the variations that these pass through from subarea to subarea, from month to month, and from anticyclone to cyclone. Topography, continental and oceanic temperatures, the interplay with the general circulation, are all so far involved that an *average* azimuth angle has no real meaning. Many remarks true of azimuths near the Atlantic coast should be greatly modified for the Rocky Mountain slope, though they bear almost precisely the same relations to the movement of storms. Furthermore, the charts of Chapters 7 and 8 will so far exhibit the subject of stream lines in a graphical form that it becomes superfluous to discuss in tabulations the information which is there satisfactorily presented to the eye. In the nephoscope computations the several vector tables contain the required data in the best shape for immediate use in the equations. This is one of the important advantages claimed to accrue from the adoption of the right-hand azimuth rotation, in place of the customary astronomical or left-hand rotation.

VELOCITY OF THE MOVEMENT OF THE CLOUDS AS DETERMINED AT WASHINGTON, D. C.

Having described the distribution of the several cloud forms in altitude, as determined at Washington, D. C., by the theodolite measures, we pass to an account of the velocity of the motion of the clouds, as computed from the same observations. The method of the calculation has been already indicated and illustrated in Chapter 2. The results are collected in column 6 of Table 6 and are expressed in meters per second. For the purpose of discussing these individual velocities they are summarized on Tables 24 and 25, the former being collected for the high areas and the latter for the low areas. The dates upon which the twenty subareas occurred at Washington, D. C., having been fixed, by reference to the weather maps, the corresponding tabulation was made on special sheets, here omitted, and the mean values entered on the final table. Thus on June 28, 1897, Washington occupied subarea 2 in an anticyclone, and there were made from 1.23 p. m. to 1.35 p. m. such consecutive pointings on stratus clouds as afforded eight pairs for the velocity computation. The mean of these was taken and entered in the second line under the stratus or high areas, as 8, 155°, 6.6—number, azimuth, and velocity of motion. In this way the table of velocities determined by the theodolites at Washington was formed. It shows 2,147 velocity values under the high areas and 1,564 under the low areas, a total of 3,711 of determinations.

TABLE 24.—*Direction and velocity of the motion of the air in high areas.*

[Observations taken with theodolites at Washington, D. C.]

Direction	Area No.	Cirrus 9.8			Ci. Strat. 9.8			Ci. Cum. 8.1			Alto. Strat. 5.9			Alto. Cum. 4.5			Strat. Cum. 2.5			Cumulus 1.5			Stratus 0.9		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	17	76	29.8	3	111	35.2	1	142	12.0							3	106	6.4	7	103	3.4	1	212	6.9
E	2	51	85	29.9	13	102	29.1	14	93	25.8	1	17	30.5	14	75	16.1	8	53	15.8	13	56	7.3	8	155	6.6
N	3	89	76	27.1	6	90	19.1	15	92	20.9	2	123	11.4	8	70	16.8	1	177	6.9	11	171	5.0			
W	4	9	75	24.2	19	106	27.0				15	92	19.2	14	83	17.3	6	101	8.1	13	142	10.3			
S	5	25	73	13.6				4	67	9.2	1	93	18.3	8	74	8.5				12	213	8.5			
SE	6	29	80	33.6				5	71	20.3	7	86	26.4	6	83	16.9	8	58	9.0	19	39	8.9			
E	7	17	90	63.3				4	72	70.5	1	22	6.4	2	107	22.2				30	32	6.4			
NE	8	42	73	22.4	19	78	22.5	8	104	24.9	2	100	27.2	33	73	16.9	10	74	12.2	37	70	9.8			
N	9	68	84	25.2	32	84	27.6	30	100	21.8	18	97	21.0	61	91	19.6	35	95	12.2	77	108	8.8	2	178	3.2
NW	10																5	100	12.4	2	130	9.4			
W	11	2	156	33.5				3	109	26.1	2	155	22.9	14	132	30.4	6	108	16.0	7	115	9.6			
SW	12							5	101	12.3				7	105	21.5	1	122	11.0	1	240	15.5	14	255	7.8
S	13	71	61	35.5				1	121	50.0	1	69	12.6	18	91	9.1	2	25	2.4	9	41	9.6			
SE	14	72	104	26.7	9	97	21.8	16	56	20.6	11	186	13.0	26	93	15.4	34	76	10.0	50	61	12.0	4	120	12.8
E	15	22	126	23.2	7	290	38.7	2	106	28.6	6	105	22.5	15	116	19.8	8	92	9.7	44	68	8.4	4	348	6.2
NE	16	116	65	26.4	12	66	31.1	28	63	23.5	18	78	14.4	44	77	14.6	21	85	15.8	100	71	9.8	4	169	1.5
N	17	14	62	18.9	8	86	17.2	7	93	37.0	3	107	16.6	18	86	16.9	8	76	16.3	12	69	8.6	4	208	5.0
NW	18																								
W	19	44	91	25.7	3	103	28.1	1	126	43.5	4	113	14.0	11	100	11.3	7	111	14.0	15	149	9.2	1	176	4.5
SW	20	33	76	23.9	15	82	25.8	21	88	22.8	5	105	13.7	25	89	11.6	7	145	13.4	28	87	7.0	3	245	12.5
Average		711		27.4	149		27.2	165		24.3	97		17.4	324		16.3	170		12.1	486		8.8	45		7.1

TABLE 25.—*Direction and velocity of the motion of the air in low areas.*

[Observations taken with theodolites at Washington, D. C.]

Direction.	Area No.	Cirrus 9.8			Ci. Strat. 9.8			Ci. Cum. 8.1			Alto. Strat. 5.9			Alto. Cum. 4.5			Strat. Cum. 2.5			Cumulus 1.5			Stratus 0.9		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1																			1	82	11.5	1	119	10.8
E	2	1	68	11.7													3	110	21.7						
N	3							4	114	35.9							3	251	8.9	9	131	10.6			
W	4	15	86	27.2				4	76	40.5				4	131	16.9	12	54	8.7	23	47	9.6	6	34	5.8
S	5	16	105	28.1	20	103	35.0	3	125	20.3	2	111	15.0	9	114	18.4	7	88	14.9	20	126	11.9	2	94	17.2
SE	6	15	115	30.6	10	109	29.7	3	111	28.3	1	125	22.3	9	119	18.4	13	94	13.0	18	104	13.9	2	131	19.4
E	7	7	105	27.9				1	131	14.8	3	128	21.5	12	144	22.6	8	105	18.0	6	129	15.1			
NE	8	3	195	46.9							1	105	38.0	5	187	9.3	3	206	8.3	1	194	8.5			
N	9	2	92	78.5																					
NW	10																								
W	11	30	122	25.4	1	353	4.9	5	87	9.3	2	57	25.0	9	39	19.0	2	122	27.5	28	29	8.5			
SW	12	30	61	32.6	1	141	55.5	8	85	24.9	2	30	11.7	12	82	22.6	14	54	7.8	35	73	11.7			
S	13	34	103	25.1	20	102	25.0	4	110	39.2	18	85	12.5	45	81	15.3	12	107	12.9	36	118	12.0	4	169	1.5
SE	14	67	84	25.1	45	78	24.1	30	93	22.3	6	100	16.9	40	77	19.3	14	94	14.5	25	122	8.7	9	129	4.8
E	15	43	74	28.0	7	108	25.3	16	104	21.2				12	63	15.9	1	98	23.8				3	239	10.5
NE	16	6	107	38.7	3	111	35.2	3	105	32.9				3	119	22.4	10	119	9.9	11	113	10.3	3	288	4.5
N	17	3	90	53.2																			2	271	13.5
NW	18																								
W	19	5	74	47.0				8	70	39.9	1	93	18.3	6	69	10.6				5	81	5.2			
SW	20	141	85	31.7	37	101	40.9	60	91	34.5	17	84	20.8	69	85	16.3	49	76	14.7	151	64	7.3	13	132	8.6
Average		418		29.6	144		30.8	149		22.2	53		17.5	235		17.3	151		13.3	369		9.4	45		7.8

DIRECTION AND VELOCITY OF MOTION IN HIGH AND LOW AREAS AS DETERMINED BY THE WASHINGTON NEPHOSCOPE.

It was thought important to institute a comparison between the values of the velocities resulting from the theodolites, which are direct measures, and those derived from the nephoscopes, which give indirect measures of the velocity through the assigned altitudes, all observations being taken at the same station. Since the velocities at other stations may have certain characteristics not identical with those prevailing at Washington, the nephoscope observations at this station were collected separately for the sake of such a comparison. The values appearing on Table 9, the summary of the nephoscope observations at Washington and all the other stations were collected on special auxiliary sheets, here omitted, in just the same manner as in the case of the theodolite observations, by high and low areas, by subareas, and by the type of cloud, the result being shown on Tables 26 and 27. There are 906 such observations for velocity in the high areas, 705 in the low areas, a total of 1,611. Each of these observations usually represents the mean value of the three individual readings, and this fact should always be remembered in connection with the nephoscope work.

The comparison of the velocities from the theodolites and the nephoscopes, if it were to be carried out in satisfactory details, would imply a sufficiently large number of observations in each of the twenty areas of the highs and lows, respectively, to give reliable results in these minor portions of the anticyclones and cyclones. But this is clearly impossible with only one year's work, and so we must be contented with the comparison of the average velocities taken over the entire area covered by the twenty subareas. The weighted mean values therefore are set down at the bottom of the four tables just described. These are collected together on Table 28, "Summary of the mean velocity of cloud movements;" some other data are found also on this table. Lines 1 and 5 give the results of Tables 24 and 25, lines 2 and 6 those of Tables 26 and 27; lines 3 and 7 are the results of the nephoscope velocities at all stations, and are taken from Tables 34 and 38; lines 4 and 8 give the results of the nephoscope observations made at the Blue Hill Observatory, found in the Report of 1896, Ann. Harv., Coll. Observatory, Vol. XXX, Part IV, p. 445. In the lower section of Table 28 are placed the mean values of the high and low areas, only the arithmetical mean of the velocities in the two preceding sections being taken. This was thought

amply sufficient to produce correct average mean velocities, for the reason that the components in highs and lows have been already sufficiently determined as the outcome of the large number of observations from which they were computed. Additional results for Blue Hill theodolities were derived from the Report of 1892, Ann. Harv. Coll. Observatory, Vol. XXX, Part III, p. 259. In that place the observations were collected for the winter half and the summer half of the year, respectively, and it seemed proper to weight the means by the number of observations in each season in order to make up the annual value. This now becomes comparable with our own result so far as the data suffices, because the means for theodolities and nephoscopes at Washington have been weighted already. The means as given in the Report of 1892 are found in line 9, and as modified by weighting them, in line 10.

TABLE 26.—*Direction and velocity of the motion of the air in high areas.*

[Observations taken with nephoscopes at Washington, D.C.]

Direction	Area No.	Cirrus 9.8			Ci. Strat. 9.8			Ci. Cum. 8.1			Alto. Strat. 5.9			Alto. Cum. 4.5			Strat. Cum. 2.5			Cumulus 1.5			Stratus 0.9		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	4	96	32.3	1	88	27.4	3	100	18.9	2	89	23.0	7	112	16.3	6	169	14.8	4	279	7.0	1	260	8.4
E	2	8	85	27.6	5	75	30.0	4	96	20.8	3	43	14.4	3	72	18.6	4	349	14.0	3	20	7.8			
N	3	19	71	30.5	5	88	30.6	7	95	25.5	1	93	27.1	2	68	26.0				2	168	5.2	2	114	5.3
W	4	3	82	21.3	2	96	28.9	3	78	35.9	6	100	30.3	8	83	20.8	7	103	14.3	1	119	6.9	7	110	12.6
S	5	3	64	15.4				3	67	17.5				3	28	18.9	2	62	10.4	6	345	10.5	3	114	7.4
SE	6	2	82	25.0	1	87	35.3	2	77	25.5	3	73	20.8	3	58	16.5				3	34	9.6			
E	7	5	79	80.9	3	84	64.3	4	78	60.9	1	10	28.9	2	69	40.2	2	49	16.1	8	24	7.1	1	22	11.5
NE	8	8	88	28.0	5	85	30.1	3	100	28.9	4	82	19.9	7	73	20.5	6	79	15.2	7	78	5.5	1	67	8.2
N	9	15	92	22.1	8	71	21.3	14	89	22.9	13	100	18.8	25	96	15.5	11	102	12.6	17	123	8.4	29	142	12.8
NW	10																								
W	11	7	87	39.6	5	73	32.1	3	106	35.9	5	101	26.7	8	115	21.0	5	140	21.1	1	125	5.8	6	165	16.5
SW	12										1	101	33.6	4	107	27.6	7	282	21.7				5	266	15.6
S	13	11	65	34.2	4	45	41.4	3	70	18.6	2	52	33.0	9	78	13.5	3	116	3.9	9	38	6.7	7	315	9.9
SE	14	15	93	37.5	5	58	30.7	11	89	29.5	9	102	19.2	13	75	20.8	23	88	15.2	18	36	9.6	8	85	5.9
E	15	7	108	40.2	5	101	37.4	4	114	37.5	2	178	24.5	10	114	17.5	9	109	18.8	15	63	7.8	9	360	20.1
NE	16	18	57	22.8	7	75	24.6	10	72	22.9	7	71	23.6	17	71	16.4	8	88	14.4	22	59	7.0	2	80	4.8
N	17	4	82	33.8	1	102	17.6	3	72	42.4	1	87	40.7	6	83	14.5	7	117	15.3	7	83	5.5	9	76	6.5
NW	18																								
W	19	10	92	22.8	1	70	10.8	3	87	31.6	6	107	29.7	6	106	28.4	8	111	19.7	5	129	6.8	8	170	17.4
SW	20	12	81	24.4	4	75	76.7	9	82	17.4	5	72	24.8	10	98	10.8	15	278	19.5	11	228	5.1	34	258	17.1
Average		151		30.6	62		34.1	88		27.2	69		23.2	142		18.0	123		16.1	139		8.3	132		14.0

TABLE 27.—*Direction and velocity of the motion of the air in low areas.*

[Observations taken with nephoscopes at Washington, D. C.]

Direction	Area No.	Cirrus 9.8			Ci. Strat. 9.8			Ci. Cum. 8.1			Alt. Strat. 5.9			Alt. Cum. 4.5			Strat. Cum. 2.5			Cumulus 1.5			Stratus 0.9		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1										1	233	6.9										3	129	8.5
E	2							1	91	42.9				2	108	16.3	4	78	28.5				5	77	20.9
N	3	1	210	67.6				1	125	54.9	1	204	4.7	3	128	23.7	2	124	23.2	1	198		6	230	22.3
W	4	2	95	40.2				1	57	26.7				4	73	17.6	7	56	20.7	3	67	10.2	11	351	20.9
S	5	8	100	27.1	4	90	26.2	2	87	32.7	5	124	27.0	9	100	19.0	8	97	14.7	10	114	10.2	9	128	16.7
SE	6	3	113	35.3	4	94	42.8	3	79	33.7	5	125	23.6	7	120	21.2	5	107	19.4	5	108	9.9	10	145	8.0
E	7	4	104	32.8	1	96	81.3	1	130	30.9	3	103	28.5	8	137	17.6	6	140	19.5				1	192	8.6
NE	8										2	179	22.4				2	206	9.2				2	252	11.0
N	9	2	95	71.0	1	97	62.7	1	95	57.5	2	142	26.6	2	130	32.0	1	120	18.5	1	70	15.0	6	104	9.7
NW	10							1	82	49.4							1	61	28.0	1	48	20.5			
W	11	5	92	28.0	2	46	21.6	6	80	48.8	1	113	52.5	6	77	23.0	4	111	13.2	11	34	9.8	1	360	9.9
SW	12	9	71	39.8	4	71	36.0	7	97	38.0	3	122	25.0	7	86	20.8	7	66	15.6	13	62	11.0	4	131	10.2
S	13	5	95	23.1	4	109	28.6	7	105	25.1	2	106	40.1	13	96	15.5	12	121	16.3	10	99	6.5	7	145	6.3
SE	14	9	85	24.0	7	86	26.3	4	70	24.3	5	107	37.5	7	81	18.3	10	91	17.9	10	92	12.5	20	138	15.0
E	15	11	86	34.3	1	103	37.2	4	84	23.8	2	97	28.6	6	77	19.4	7	80	16.4	1	79	7.3	8	143	21.7
NE	16	5	107	27.0	2	78	39.2	2	133	22.2	4	107	23.4	11	88	16.4	9	120	12.8	1	120	12.0	14	133	13.2
N	17										1	100	43.1				3	93	23.6	1	20	8.4	1	115	6.0
NW	18																								
W	19	3	71	72.8	2	71	76.9	7	71	42.1	1	63	6.6							5	56	7.8			
SW	20	30	88	36.0	16	93	35.3	15	108	37.8	10	97	27.2	24	83	19.6	18	90	15.3	34	62	8.7	20	82	9.4
Average		97		35.0	48		36.3	63		36.0	48		27.4	109		19.0	106		17.1	106		9.6	128		14.3

TABLE 28.—*Summary of the mean velocities of cloud movements.*

[Observations taken with theodolites and nephoscopes.]

Areas	Line	Ci. N.	Ci. V.	Ci. S. N.	Ci. S. V.	Ci. Cu. N.	Ci. Cu. V.	A. S. N.	A. S. V.	A. Cu. N.	A. Cu. V.	S. Cu. N.	S. Cu. V.	Cu. N.	Cu. V.	S. N.	S. V.	Wind N.	Wind V.	Reference to the observations
High areas	1	711	27.4	149	27.2	165	24.3	97	17.4	324	16.3	170	12.1	486	8.8	45	7.1			Theodolites at Washington
	2	151	30.6	62	34.1	88	27.2	69	23.2	142	18.0	123	16.1	139	8.3	132	(14.0)			Nephoscope at Washington
	3	736	34.9	446	39.1	323	33.5	310	30.2	676	23.5	686	23.3	1029	11.2	514	11.4	1879	4.8	Nephoscopes at all stations
	4		38.5				31.1				20.1				14.7				5.7	Nephoscope at Blue Hill (Rep. 1896, p. 445)
Low areas	5	418	29.6	144	30.8	149	22.2	53	17.5	235	17.3	151	13.3	369	9.4	45	7.8			Theodolites at Washington
	6	97	35.0	48	36.3	63	36.0	48	27.4	109	19.0	106	17.1	106	9.6	128	(14.3)			Nephoscope at Washington
	7	451	40.8	292	39.8	224	39.3	241	36.0	466	29.2	700	28.6	672	14.6	466	11.1	1592	5.4	Nephoscopes at all stations
	8		35.5				33.7				19.3				15.4				7.5	Nephoscope at Blue Hill (Rep. 1896, p. 445)
Means for high and low areas	9	69	39.8	19	31.5	19	36.6	8	21.7	25	15.3	24	10.0	130	11.5	14	7.0			Theodolites at Blue Hill Means (1892, p. 259)
	10	69	35.8	19	27.2	19	30.6	8	21.4	25	10.8	24	8.9	130	9.8	14	7.0			Theodolites at Blue Hill (weighted means)
	11		37.0				32.4				19.7				15.1				6.6	Nephoscopes at Blue Hill (1896, p. 445)
	12	1129	28.5	293	29.0	314	23.2	150	17.4	559	16.8	321	12.7	855	9.3	90	7.1			Theodolites at Washington (1 and 5)
	13	248	32.8	110	35.2	151	31.6	117	25.3	251	18.5	229	16.6	245	9.0	260	(14.2)			Nephoscopes at Washton (2 and 6)
	14	1187	37.8	738	39.5	547	36.4	551	33.1	1142	26.3	1386	26.0	1701	12.9	980	11.3	3471	5.1	Nephoscopes at all stations (3 and 7)

REMARKS ON THE COMPARISON OF THEODOLITE AND NEPHOSCOPE OBSERVATIONS.

We are now in a position to make some remarks on the results of our theodolite and nephoscope velocity observations. The mean values in the lower section of the table are not as accordant as might have been expected, though they embrace a very great variety of observations under widely different circumstances. While they show the prevailing features of the circulation of the air in different levels very distinctly, yet the lack of harmony between the several determinations requires some special consideration. The large number of observations involved indicates that there are causes inherent in cloud observations which tend to produce this kind of result. Blue Hill states that thousands of observations in each cloud level contributed to the values in lines 4 and 8. The most comparable data is evidently that of the theodolites and the nephoscopes at Washington, and these show that the nephoscopes run higher in both the highs and the lows, about 18 per cent for the highs and 29 per cent for the lows. Comparing the Washington theodolites with the nephoscopes at all stations, we have the nephoscopes higher by 32 per cent in the high areas and 68 per cent in the low areas; comparing the Blue Hill theodolite and nephoscope results, lines 10 and 11, the nephoscopes give greater velocities than the theodolites by about 20 per cent. In general, the velocities from nephoscopes are 20 to 30 per cent higher than those for the theodolites. Comparing the Washington theodolites in the high areas with those in the low, the latter exceeds the former by 5 per cent, and for the nephoscopes by 15 per cent. There is one fact which ought to have considerable weight in criticising these results, namely, that in the case of the cumulus clouds, in the high and low areas the resulting velocity is almost exactly the same for both forms of instruments. Now, since this is the type of cloud most certainly identified and correctly named, and the one in which the cloud point used for setting the sight line suffers the least deformation during the observation, it would seem to exclude the hypothesis that there is any systematic error attaching to the instruments themselves, or to the methods of computation. The same remark applies with almost equal force to the cirrus

cloud level, which is usually of good definition, and yet the highest type that is observed. Since the clouds at the highest and nearly the lowest levels, having the best forms for observing, give our most accordant results, we should look to some other source than the instruments themselves, or the computations, for an explanation of the difficulty.

TWO IMPORTANT SOURCES OF ERROR.

I am inclined to think that it lies in the incorrect *naming* of the clouds by the nephoscope observers. In the case of the theodolites, the two observers, one at each end of the base line, thus seeing a cloud from somewhat different points of view, after consultation, accepted a certain name for the cloud, so that there was always some check upon any merely individual impression as to the type under consideration. Furthermore, the persistent practice at the Washington station by the observers produced greater proficiency than prevailed at the other stations in the United States, where only nephoscopes were employed. Even at Washington the tendency appears to have been to name the clouds so as to give them too high an elevation. Mr. R. H. DEAN, one of the Washington observers with the theodolites, who also made most of the nephoscope observations, remarks as follows on this subject:

1. Stratus. The elevation 0.9 computed by the theodolite for stratus clouds seems to me too high for the stratus clouds observed with the nephoscope. To my mind, judging from the relative number of low clouds observed by the nephoscope, 0.6 is quite high enough and I think 0.5 is nearer correct.

2. Strato-cumulus. The same, in a less degree, is true of strato-cumulus. In revising the nomenclature after the elevations had been computed by the theodolites, some of the lower strato-cumulus, where the observers were doubtful as to the name and the description of the cloud permitted it, were put with the cumulus, and a few with the stratus. Again, as with stratus, the lower forms were difficult to observe with the theodolite, and many more observations of these lower clouds were taken with the nephoscope. An elevation not greater than 1.8 for the nephoscope observations of strato-cumulus is probably nearer correct.

3. Alto-cumulus. There is a low form of clouds persistently called alto-cumulus by me in the nephoscope work. The forms were good for alto-cumulus, but the elevation was low, sometimes in the stratus level. They were difficult for the theodolite and were eliminated from the theodolite observations in revising; 3.6 is better for nephoscopes.

If there is this tendency to assign the clouds which actually exist in lower levels to the higher levels, the disagreement in question will be partly explained. The remedy is a very difficult matter, unless the observers make special efforts by training to become very expert in this assignment of names.

There is another possible source of error in the same direction, though there is no other evidence than the result under discussion that it has occurred in the observations. The error may arise as follows: In following a cloud point on the nephoscope plate for a given interval of time, with the knob of the stylus in superposition upon it, there may have been some persistent tendency to *exaggerate the number* of scale divisions passed over by the cloud. If the point of the cloud taken has a dissolving nature this may occur, perhaps more readily than when it is very firm. The cumulus and the cirrus forms might thus be more correctly observed in general than the other types of clouds, which have not such distinct outlines and points of setting as these. Furthermore, the clouds which are favorable for the theodolites may tend to drift slower than the other clouds which the nephoscopes can more successfully observe. For the theodolite one would naturally seek a firm, steady cloud, and for the nephoscope a rapidly moving cloud, from the very nature of the apparatus. This is certainly true of the lower stratus and the scud, which can hardly be taken at all by the theodolite, but are very interesting objects to observe with the nephoscope. The introduction of several scud observations under the stratus form having velocities of from 40 to 60 meters per second is mainly responsible for the high values, 14.0 and 14.3, given for the stratus by the nephoscopes at Washington, line 6, Table 28, as can be verified by referring to the computation sheets.

These remarks on the discordant results may be of value to observers in the future as showing the necessity of correctly naming the clouds and placing them at their true levels and also guarding against the other sources of error mentioned. Because the clouds occupy zones of such great depths, as is shown in this chapter to be the case, it is certainly a crude mode of ascertaining the true height by means of assigning names to the form and appearance of the clouds, this being especially the case with the alto-stratus, the alto-cumulus, and the strato-cumulus levels.

ACTUAL DIFFERENCE OF VELOCITY AT DIFFERENT STATIONS.

It is proper also not to overlook the actual difference of velocity existing at different stations on comparing results, especially in the lower levels. Thus, in the northern circuit of the United States the velocity is really greater than in the southern at all levels, because the great permanent high-pressure belt passes over the Southern States, and in it, at least theoretically, the velocity in longitude vanishes. On the eastern side of a range of mountains the velocity in the lower levels is less than on the western, as can be seen near the Rocky Mountain divide. The configuration of the oceans and continents imposes such important forces in the development of wind currents, that the resulting velocity at different stations is decidedly influenced by these circumstances. This can be seen by examining the prevailing winds and the lower air currents on the Rocky Mountain slope. Hence, it is evident that one should not too hastily criticise such preliminary results for velocity as it was possible to secure in a single year's observation. Rather the entire subject should be deemed worthy of a permanent place in the work of the Weather Bureau, so that by means of further observations correct information can gradually be secured bearing upon these fundamental elements of the science of meteorology in the United States. Nor should one too hastily rely upon even so extensive a series of observations as has been already made for the quantitative values which may be inserted in the mathematical equations of condition prepared for the solution of the problem of the motion of the air in cyclones and anticyclones. It is believed, however, that the main features of the theory can even now be described with fair accuracy, yet it is most important to improve upon these facts in the interest of sound and permanent conclusions as rapidly as is practicable.

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CHAPTER 7.

DISCUSSION OF THE NEPHOSCOPE OBSERVATIONS.

ARRANGEMENT OF THE COMPUTATIONS.

The description of the further discussion of the nephoscope observations, which was begun in Chapter 4, will now be resumed in its most important details.

The next compilation of the observations is necessarily omitted, except for one specimen sheet here given as an example of the method of the computation. The eight levels are now arranged with the cumulus forms on the upper line of Table 29 and the stratus forms on the lower line. The data from the summary of the nephoscope observations, Table 9, are now transcribed so that all the observations falling on one minor area, as H.2.15, appear on a single page. They are selected and arranged so that all clouds of one type fall in the same column, the stratus being distinguished from the cumulus by giving the hour a heavy-faced type. Thus, we have the hour, azimuth, and velocity of the same type in a column throughout the year, so far as relates to this special subarea number. There are, of course, $6 \times 20 = 120$ such pages to be provided for, but the data is so distributed that some of these pages are very full, when observations are frequent in a given area, and quite scattering in other subareas unfavorable for observations.

TABLE 29.—*Discussion of nephoscope observations for diurnal and seasonal variations.*

H.2.15

Cloud	Cirrus			Cir. Cum.			Alt. Cum.			Cumulus			Meteorological data				
	Cir. Strat.			Alt. Strat.			Strat. Cum.			Stratus							
Date	H	φ	V	H	φ	V	H	φ	V	H	φ	V	B	T	H	W	
1896																	
June 1	10.1	85	3.1														
	2.6	85	3.8														
	5.8	80	5.0										30.2	60	59	10	NW.
										1.4	20	7.2	30.3	60	63	9	NE.
										8.6	23	3.9					
										1.6	39	4.2	30.0	54	66	11	NW.
10	**8.7**	10	3.3										29.8	59	83	18	NE.
26	12.5	45	0.9														
	8.8	56	2.2				12.4	50	3.7								
							3.6	53	4.4	3.8	54	4.8	30.1	69	95	4	S.
	9.6	105	3.1							9.7	55	5.9	30.2	73	57	12	NW.
	1.9	104	5.3	8.8	77	8.6				1.8	40	9.8					
	5.3	75	6.0										30.1	71	63	17	W.
July 7				12.7	128	3.3	**11.8**	133	8.1	1.0	120	8.0					
							12.0	130	2.6	1.7	120	7.3					
							5.8	88	2.7	1.9	65	—					
										5.7	135	3.1	30.2	73	84	4	N.
				9.3	45	4.4							30.1	68	58	12	N.
										8.6	130	10.0					
										1.9	66	9.3					
										5.2	150	5.7					
										5.3	130	5.3	30.0	63	70	12	NW.
8				**12.7**	195	5.3				**11.0**	294	14.0					
	8.7	116	5.0										30.0	66	60	10	NE.
9							**9.0**	180	15.1								
							10.5	175	3.6								

TABLE 29.—*Discussion of nephoscope observations for diurnal and seasonal variations*—Continued.

H.2.15

Cloud	Cirrus / Cir. Strat.			Cir. Cum. / Alt. Strat.			Alt. Cum. / Strat. Cum.			Cumulus / Stratus			Meteorological data.				
Date	H	φ	V	H	φ	V	H	φ	V	H	φ	V	B	T	H	W	
1896																	
July 9	7.1	160	2.8	**7.2**	160	3.0	1.9	170	3.3								
							2.0	170	12.3								
							6.1	160	3.9				30.1	76	83	6	S.
							8.7	116	5.2								
							1.7	114	5.2								
							5.7	115	5.6				30.0	77	58	12	S.
17	8.2	136	3.8	**8.3**	160	4.3				8.3	106	3.3					
										2.1	66	4.1	30.1	66	65	11	E.
25				8.8	96	4.4	8.7	96	4.7	8.6	4	9.3					
										4.0	19	3.8					
										6.2	1	2.4	30.0	72	67	1	NW.
										1.3	40	5.3	29.9	88	50	8	NW.
Aug. 12				**8.5**	54	2.0							30.0	71	86	9	NW.
27				3.1	112	4.7	8.9	83	3.2								
							12.9	96	4.1								
							3.2	112	4.7								
							5.8	110	—				30.1	69	68	4	E.
							8.5	133	6.0								
							1.3	54	7.7								
Sept. 1										2.0	93	3.3	30.2	61	70	18	NW.
11							**5.1**	128	4.8	1.6	113	9.8	29.9	82	63	6	E.
Oct. 1	2.2	153	1.8							**8.1**	131	8.0					
							5.2	30	2.7	2.2	35	4.3	28.8	64	68	17	NW.
Dec. 3										**7.9**	315	14.2	30.3	14	70	18	N.
24										2.3	35	4.0					
										4.9	58	8.5	30.5	18	73	12	W.
1897																	
Feb. 2										**10.5**	315	53.6					
										2.2	325	46.0					
										4.6	336	44.7	29.7	35	100	21	N.
										1.1	312	10.0					
										4.1	315	10.0	30.0	30	57	13	NE.
13										1.3	52	3.5	30.2	33	78	6	NE.
19										2.1	35	7.1	30.0	30	42	40	NW.
Mar. 15										8.1	58	13.3					
										3.9	59	14.9	30.2	28	42	25	NW.
27										10.3	52	5.2					
										1.0	49	5.9					
										5.3	27	5.6	30.0	27	53	5	N.
										1.5	110	12.7					
										4.1	111	11.0	30.0	33	69	22	NW.
Apr. 27				**8.2**	85	3.5	**8.2**	69	7.5								
							2.2	45	11.8				29.6	40	53	29	W.
May 16				**8.1**	145	4.3											
				2.1	143	3.6							30.2	49	77	20	NE.
17	**2.1**	158	4.0				7.9	191	1.9								
	5.7	173	5.3										30.2	59	52	11	E.
21							**8.6**	48	33.3								
							1.8	31	11.7				29.9	46	71	15	N.
24										**8.1**	110	5.1					
										5.9	355	22.1	30.0	53	76	11	W.
							1.8	58	6.2	**9.4**	63	13.0					
										4.4	38	12.1	30.0	53	74	9	NW.
							8.5	124	11.7								
							8.7	124	11.7				29.9	54	79	14	W.
25	**2.0**	160	4.9														
	5.8	167	4.6										29.9	63	82	21	S.

DIURNAL AND SEASONAL VARIATIONS IN EACH TYPE.

The next compilation provides for the distribution of each cloud type so as to secure the diurnal and the seasonal variations, Table 30. Thus, under cirrus, we have four rows, beginning June, September, December, March, respectively, which means that all the cirrus in the months June, July, August are summed up and placed in the first row; likewise the rest are grouped in the four trimonthly seasons, beginning with the several months indicated. Furthermore, in each seasonal group the morning (8 a. m.), midday (2 p. m.), and evening (6 a. m.) observations are summed by themselves, in order to obtain the diurnal variation of azimuth and velocity. Thus, we have the observations collected for three points during the day, and their sum weighted by the number of observations for the day; they are assembled for the four seasons of the year; they contain the eight cloud levels; they also are constructed for each of the 20 areas of the six groups of highs and the six groups of lows. It is evident that to carry out this logical compilation of the observations, in order to solve the many questions arising in the motions of the atmosphere, we should need the nephoscope observations for several years, and also a very laborious computation of the data. I do not see how we can secure a truly scientific answer to many questions that need to be settled until this is carefully done. In this report the data is not extensive enough to be fully satisfactory, and some important questions need postponement for their definite solution.

TABLE 30.—*Summary of each cloud stratum for diurnal and seasonal variations.*

H . 2 . 15

	8 a. m.				2 p. m.				6 p. m.				Day		
	H	No.	φ	V	H	No.	φ	V	H	No.	φ	V	No.	φ	V
Ci.															
June	8.9	3	117	3.0	1.7	3	78	3.3	5.5	2	78	5.5	8	91	3.8
Sept	...	..	...	...	2.2	1	153	1.8	...	..	..	...	1	153	1.8
Dec	...	..	...	...	...	..	...	...	...	..	...	...	..	...	...
March	...	..	...	...	...	..	...	...	5.8	1	167	4.6	1	167	4.6
Ci. S.															
June	8.5	3	87	4.0	3.3	1	56	2.2	...	..	...	...	4	72	3.1
Sept	...	..	...	...	...	..	...	...	...	..	...	...	..	...	...
Dec	...	..	...	...	2.0	1	128	...	...	..	...	...	1	128	...
March	...	..	...	...	2.0	2	159	4.4	5.7	1	173	5.3	3	166	4.8
Ci. Cu.															
June	9.0	3	73	5.8	1.9	2	120	4.0	...	..	...	...	5	96	4.9
Sept	...	..	...	...	...	..	...	...	5.4	1	153	1.8	1	153	1.8
Dec	...	..	...	...	...	..	...	...	...	..	...	...	..	...	...
March	...	..	...	...	...	..	...	...	...	..	...	...	..	...	...
A. S.															
June	8.0	3	125	3.1	12.7	1	195	5.3	...	..	...	...	4	160	4.2
Sept	...	..	...	...	...	..	...	...	...	..	...	...	..	...	...
Dec	...	..	...	...	...	..	...	...	...	..	...	...	..	...	...
March	8.1	2	115	3.9	2.1	1	143	3.6	...	..	...	...	3	129	3.7
A. Cu.															
June	8.7	3	104	4.6	1.5	7	106	4.3	6.0	2	135	3.9	12	115	4.3
Sept	...	..	...	...	...	..	...	...	...	..	...	...	..	...	...
Dec	...	..	...	...	...	..	...	...	...	..	...	...	..	...	...
March	8.3	2	158	6.8	...	..	...	...	...	..	...	...	2	158	6.8
S. Cu.															
June	8.9	2	148	10.1	12.7	6	113	7.3	5.8	2	101	4.1	10	121	7.2
Sept	8.1	1	44	12.9	1.6	4	28	12.2	5.2	7	38	9.7	12	37	11.6
Dec	...	..	...	...	...	..	...	...	...	..	...	...	..	...	...
March	8.4	3	80	17.5	1.9	3	45	9.9	...	..	...	...	6	62	13.7

TABLE 30.—*Summary of each cloud stratum for diurnal and seasonal variations*—Continued.

	8 a. m.				2 p. m.				6 p. m.				Day		
	H	No.	φ	V	H	No.	φ	V	H	No.	φ	V	No.	φ	V
Cu.															
June	8.8	4	47	5.6	1.8	9	69	6.3	5.0	2	10	3.1	15	42	5.0
Sept	8.4	1	41	32.9	2.0	4	61	6.0	5.5	1	356	10.0	6	33	16.3
Dec	...	..	...	...	1.9	3	41	4.9	4.9	1	58	8.5	4	49	6.7
March	9.3	3	58	10.5	2.5	2	54	10.4	5.3	1	27	5.6	6	46	8.8
S.															
June	8.6	1	130	10.0	12.9	2	0	11.6	5.4	3	138	4.7	6	89	8.8
Sept	8.6	3	62	11.4	2.3	1	20	8.6	...	..	...	...	4	41	10.0
Dec	9.2	2	315	33.9	1.7	2	318	28.0	4.4	2	326	27.8	6	320	29.9
March	8.1	1	110	5.1	1.5	1	110	12.7	4.8	3	48	15.1	5	89	11.0

COMPUTATION OF THE RESULTANT WIND VECTORS.

The resultant direction and velocity of the surface wind from the above data is computed only for the annual vector, since our work pertains chiefly to the clouds, and the laws of the wind are already known. Table 31 gives a specimen of the computation of the wind vector for the area H.2.15, and it is equivalent to Lambert's formula. The total number of miles per hour is counted out for the cardinal points, then resolved south-north, east-west, counting south + and east + The resultant azimuth, $\tan \varphi = \frac{E - W}{S - N}$, is found by reversing the direction of the computed vector to conform to our system, so that $\varphi = 31°$ is in the southeast quadrant. The velocity is given in two forms, (1) that obtained by dividing the total velocity by the number of observations V_1, and (2) by computing the true resultant V_2. The former is about 3/2 the latter, and it is the wind velocity adopted for the area under computation, since this gives the average velocity of the wind movement taken without regard to direction, rather than the mean resultant velocity of the observed winds. When the prevailing wind is steadily from nearly one direction, the resultant approaches the average velocity, but since this is not the case in nature, owing to local conditions, it is preferable to use the first rather than the second value as that of the wind comparable with the cloud motions obtained as above from the nephoscopes.

TABLE 31.—*Resultant wind vector.*

H.2.15	Wind		South + East +		Direction from
	Direction	Total miles	N S	E W	
	N	75	− 75	.....	
	NE	76	− 54	+ 54	
	E	32	.....	+ 32	
	SE	.....	.....	.....	
	S	43	+ 43	.....	
	SW	.....	.....	.....	
	W	83	.....	− 83	
	NW	194	−137	−137	
Number of observations 38		503	−223	−134	
			N 31° W		
Miles × hour		V_1=13.2		φ=31°	Direction toward
Meters × second		= 5.9		S 31° E	
Resultant		V_2= 7.4			

It should be stated that occasionally an apparently bad observation has been omitted in taking the sums—either an excessive velocity due probably to misnaming a cloud type, or a faulty angle due to some local current whirl. On the Rocky Mountain slope, especially in the case of cold waves, the area of the high pressure extends far beyond the diagram of the twenty minor areas. Another diagram was then used, extending these numbers in a south and east direction from the center and comprising fifteen new minor areas. The data in these auxiliary spaces were compiled on similar forms and will be utilized in a study of cold waves. These are, however, omitted from H . 2 . 15, given above, and this accounts for a few discrepancies in the number of observations there recorded for the lower clouds.

DIRECTION AND VELOCITY OF THE UPPER CLOUDS, GROUPED BY SEASONS.

The means for the day, such as are found in the right-hand column of Table 30, are now transcribed to tables of the form given in Table 32, only there was necessarily computed an extensive intermediate group of tables here omitted. In Table 32 we have the northern, southern, and mean groups for the four seasons. In the omitted table we had, separately, the Alberta, Lakes, and New England districts, but here combined into northern, and the Colorado, West Gulf, and South Atlantic districts, here combined into southern; also the mean of the northern and the southern in both sets of tables. This enables us to compute in detail the circulations peculiar to all the sections of the United States, and they should be carefully executed for a full understanding of our meteorological problems. Since the omitted tables differ from Table 32 simply in the particular of holding separate the three sections contributing to the northern and the southern circulations, respectively, we proceed to follow out here only the consequences of the circulation in the northern and the southern circuits, and the mean of both. The object of this is to determine the variation of the direction and velocity of motion in different latitudes, as well as in altitude, which is an essential element for the general motions of the atmosphere. In all cases the sums are weighted by the number of observations, a process adding much to the labor of the work, but yet increasing the accuracy of the result, since we assume that the value of the vector is proportional to the number of observations upon what may be assumed as the same observational quantity. The weighted means of the four upper clouds, and also for the four lower clouds, are taken, as well as the mean for each cloud in the several seasons. These means are finally weighted and combined into the annual means, so that these final sums are akin to true normals, from which departures or variations of several kinds may be found. This is actually the process adopted in this report for finding the velocity residuals for use in computations, and if such a compilation were to be continued for several years, very perfect data would be obtained for discovering the exact forces concerned in bringing about the several components of the circulation of the atmosphere.

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons.*

PRESSURE HIGH—AREA NO. 1.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	5	66	3.3	3	79	3.9	2	81	2.4	3	62	4.2
Southern	3	147	1.6	..	...	....	1	141	4.7	..	...	....
Means	8	96	2.7	3	79	3.9	3	101	3.2	3	62	4.2
Sept., Oct., Nov.												
Northern	6	66	3.8	6	111	3.4	2	70	3.3	1	65	5.0
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	6	66	3.8	6	111	3.4	2	70	3.3	1	65	5.0
Dec., Jan., Feb.												
Northern	3	114	2.8	1	111	3.0	1	137	2.2	..	...	....
Southern	1	118	3.8	2	135	3.9	..	...	....	1	121	3.1
Means	4	115	3.0	3	127	3.6	1	137	2.2	1	121	3.1
Mar., Apr., May												
Northern	4	55	6.4	1	55	3.3	..	...	....	2	56	4.9
Southern	3	100	2.7	1	95	1.7	..	...	....	..	...	....
Means	7	74	4.8	2	75	2.5	..	...	....	2	56	4.9
Annual												
Northern	18	71	4.0	11	97	3.5	5	88	2.7	6	61	4.6
Southern	7	123	2.4	3	122	3.2	1	141	1.7	1	121	3.1
Means	25	86	3.6	14	102	3.4	6	97	2.5	7	69	4.4

PRESSURE HIGH—AREA NO. 2.

June, July, Aug.												
Northern	3	23	4.1	2	94	3.6	3	97	2.5	..	...	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	1	68	3.3	..	...	....	..	...	....	..	...	....
Southern	..	...	...	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb												
Northern	8	79	5.0	1	72	9.0	1	60	5.7	..	...	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	4	42	4.6	6	5	3.6	1	15	2.0	1	10	7.3
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	16	57	4.4	9	32	4.2	5	73	3.1	1	10	7.3
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons.*

PRESSURE HIGH—AREA NO. 1.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
13	70	3.5	2	137	1.5	1	101	2.6	5	53	2.0	..	...	....	8	80	1.9
4	146	1.3	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
17	88	3.1	2	137	1.5	1	101	2.6	5	53	2.0	..	...	....	8	80	1.9
15	84	3.6	2	129	4.2	5	92	7.5	3	42	5.7	..	...	....	10	84	6.3
..	...	....	2	129	2.5	1	118	2.8	2	4	3.0	1	11	6.7	6	66	2.1
15	84	3.6	4	129	3.4	6	96	6.7	5	27	4.6	1	11	6.7	16	78	5.2
5	118	2.7	3	108	4.7	..	...	....	..	...	....	1	260	9.3	4	56	5.9
4	127	3.7	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
9	122	3.1	3	108	4.7	..	...	....	..	...	....	1	260	9.3	4	56	5.9
7	55	5.5	4	92	7.9	..	...	....	..	...	....	..	...	....	4	92	7.9
4	99	4.5	..	...	....	3	41	10.0	..	...	....	..	...	....	3	41	10.0
11	71	4.4	4	92	7.9	3	41	10.0	..	...	....	..	...	....	7	70	8.8
40	79	3.8	11	111	5.2	6	214	6.8	8	82	3.4	1	260	9.3	26	131	5.2
12	124	2.6	2	129	2.5	4	60	8.2	2	4	3.0	1	11	6.7	9	58	5.6
52	89	3.5	13	114	4.8	10	152	7.4	10	66	3.3	2	136	8.0	35	112	5.3

PRESSURE HIGH—AREA NO. 2.

8	64	2.9	6	102	2.3	..	...	....	2	133	2.4	..	...	....	8	109	2.3
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
1	68	3.3	1	70	5.0	1	70	5.0	1	95	8.1	1	115	7.2	4	88	6.3
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
10	76	5.5	..	...	....	6	48	6.9	..	...	...	..	...	....	6	48	6.9
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
12	17	4.1	4	23	8.0	13	20	10.1	2	16	10.1	1	59	29.5	20	22	11.0
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
31	51	4.2	11	70	5.0	20	31	8.9	5	79	6.6	2	87	18.4	38	51	8.0
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 3.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	7	89	3.7	2	114	4.5	6	89	3.6	..	...	....
Southern	5	95	2.5	5	100	3.0	2	104	2.8	..	...	....
Means	12	92	3.1	7	104	3.4	8	93	3.4	..	...	....
Sept., Oct., Nov.												
Northern	4	73	3.4	2	97	4.0	1	74	3.1	..	...	....
Southern	7	68	5.0	7	66	4.5	5	111	8.7	1	93	5.0
Means	11	70	4.4	9	73	4.4	6	105	7.8	1	93	5.0
Dec., Jan., Feb.												
Northern	1	63	6.5	..	...	....	..	...	....	..	...	....
Southern	5	98	3.3	4	104	5.9	2	102	2.0	..	...	....
Means	6	92	3.8	4	104	5.9	2	102	2.0	..	...	....
Mar., Apr., May												
Northern	7	60	3.2	10	57	4.2	..	...	....	1	58	4.0
Southern	13	69	2.6	5	95	5.3	4	79	2.7	1	93	4.6
Means	20	66	2.8	15	70	3.8	4	79	2.7	2	76	4.3
Annual												
Northern	19	74	3.6	14	71	4.2	7	87	3.5	1	58	4.0
Southern	30	78	2.9	21	88	4.6	13	99	4.9	2	93	4.8
Means	49	76	3.2	35	81	4.4	20	94	4.4	3	81	4.5

PRESSURE HIGH—AREA NO. 4.

June, July, Aug.												
Northern	7	67	2.9	3	67	5.5	5	82	5.7	2	111	3.6
Southern	6	105	3.0	3	118	3.0	1	90	2.6	5	113	7.0
Means	13	84	3.0	6	92	4.2	6	83	5.2	7	112	6.0
Sept., Oct., Nov.												
Northern	4	59	3.6	1	76	3.2	2	138	6.8	..	...	....
Southern	2	79	5.8	1	86	14.0	1	87	4.0	1	89	0.3
Means	6	66	4.3	2	81	8.6	3	121	5.9	1	89	0.3
Dec., Jan., Feb.												
Northern	4	48	4.2	1	33	2.0	2	33	4.3	2	98	8.9
Southern	2	110	3.8	2	112	3.4	1	69	5.0	4	96	6.9
Means	6	69	4.1	3	86	2.9	3	45	4.5	6	97	7.6
Mar., Apr., May												
Northern	5	88	4.5	3	93	4.1	1	134	8.1	3	120	12.6
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	5	88	4.5	3	93	4.1	1	134	8.1	3	120	12.6
Annual												
Northern	20	67	3.7	8	74	4.2	10	89	5.9	7	111	9.0
Southern	10	101	3.7	6	111	5.0	3	82	3.9	10	104	6.3
Means	30	78	3.7	14	89	4.6	13	87	5.4	17	107	7.4

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 3.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
15	92	3.8	2	96	6.4	..	...	....	..	...	....	1	131	4.9	3	108	5.9
12	99	2.7	..	...	....	3	173	2.4	5	196	3.5	6	137	10.8	14	166	6.4
27	95	3.3	2	96	6.4	3	173	2.4	5	196	3.5	7	136	10.0	17	156	6.3
7	80	3.6	2	133	....	..	...	....	2	94	4.6	..	...	....	4	113	2.3
20	79	5.7	3	97	15.3	2	100	10.0	1	123	12.2	..	...	....	6	102	13.0
27	79	5.2	5	107	15.3	2	100	10.0	3	103	7.2	..	...	....	10	107	8.7
1	63	6.5	1	105	10.0	..	...	....	..	...	....	..	...	....	1	105	10.0
11	101	4.0	1	88	7.1	3	129	13.6	1	129	18.2	1	121	4.0	6	121	11.7
12	98	4.2	2	96	8.5	3	129	13.6	1	129	18.2	1	121	4.0	7	119	11.4
18	58	3.8	5	38	6.3	3	159	6.9	4	65	7.3	2	120	2.8	14	98	6.5
23	77	2.9	1	70	3.5	1	18	6.7	..	...	....	..	...	....	2	44	5.1
41	69	3.3	6	43	5.8	4	124	6.9	4	65	7.3	2	120	2.8	16	91	6.4
41	75	3.8	10	75	5.4	3	159	6.9	6	108	7.1	3	124	3.5	22	102	5.8
66	86	3.9	5	90	11.3	9	125	7.2	7	176	6.8	7	135	9.8	28	134	8.8
107	81	3.9	15	80	7.4	12	134	7.1	13	145	6.9	10	131	7.9	50	120	7.5

PRESSURE HIGH—AREA NO. 4.

17	79	4.3	5	74	4.0	5	127	3.3	2	217	5.3	..	...	....	12	120	4.0
15	109	4.3	9	119	4.1	3	109	4.2	7	174	6.3	23	173	15.1	42	149	12.5
32	92	4.3	14	103	4.1	8	120	3.6	9	184	6.1	23	173	15.1	54	143	10.6
7	84	4.5	1	76	5.0	2	103	6.9	4	134	10.9	1	185	14.2	8	125	9.6
5	84	6.0	5	68	7.2	2	96	3.7	..	...	....	1	221	5.1	8	94	6.1
12	84	5.1	6	69	6.8	4	100	5.3	4	134	10.9	2	203	9.7	16	110	7.8
9	54	5.0	1	298	19.2	1	139	14.5	..	...	....	..	...	....	2	218	16.8
9	100	5.2	1	67	7.5	..	...	....	..	...	....	2	258	5.9	3	194	6.4
18	77	5.1	2	182	13.4	1	139	14.5	..	...	....	2	258	5.9	5	204	10.6
12	101	6.7	1	82	8.7	1	262	....	1	82	13.3	..	...	....	3	142	7.3
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
12	101	6.7	1	82	8.7	1	262	....	1	82	13.3	..	..	....	3	142	7.3
45	80	5.1	8	103	6.6	9	138	5.0	7	150	9.6	1	185	14.2	25	132	7.2
29	102	4.9	15	98	5.4	5	104	4.0	7	134	6.7	26	180	17.2	53	143	11.2
74	88	5.0	23	100	5.8	14	126	4.6	14	142	8.2	27	180	17.1	78	140	9.9

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 5.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	6	33	2.0	1	78	2.7	7	80	3.3	7	61	1.6
Southern	3	35	0.8	12	23	0.9	2	101	0.7	2	121	1.6
Means	9	34	1.6	13	27	1.0	9	85	2.7	9	74	1.6
Sept., Oct., Nov.												
Northern	10	114	4.2	..	...	....	4	94	3.8	2	94	6.9
Southern	1	58	2.0	3	126	1.1	..	...	....	..	...	....
Means	11	109	4.0	3	126	1.1	4	94	3.8	2	94	6.9
Dec., Jan., Feb.												
Northern	3	73	4.7	3	84	5.4	1	145	5.5	2	95	2.0
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	3	73	4.7	3	84	5.4	1	145	5.5	2	95	2.0
Mar., Apr., May												
Northern	14	51	3.3	2	68	2.1	1	145	5.5	2	56	7.9
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	14	51	3.3	2	68	2.1	1	145	5.5	2	56	7.9
Annual												
Northern	33	69	3.6	6	78	3.8	13	94	3.8	13	71	3.4
Southern	4	41	1.1	15	44	0.9	2	101	0.7	2	121	1.6
Means	37	66	3.8	21	53	1.8	15	95	3.4	15	77	3.2

PRESSURE HIGH—AREA NO. 6.

June, July, Aug.												
Northern	3	84	4.9	5	83	3.4	5	86	3.2	7	101	7.7
Southern	5	313	1.6	8	223	1.5	2	7	2.0	6	171	1.7
Means	8	2	2.9	13	169	2.2	7	63	2.8	13	133	4.9
Sept., Oct., Nov.												
Northern	3	121	2.3	..	...	....	..	...	....	1	112	....
Southern	2	254	3.4	3	11	2.8	..	...	....	..	...	....
Means	5	109	2.7	3	11	2.8	..	...	....	1	112	....
Dec., Jan., Feb.												
Northern	4	59	5.9	..	...	....	3	350	6.9	1	117	....
Southern	..	...	....	..	...	....	2	122	5.0	..	...	....
Means	4	59	5.9	..	...	....	5	43	6.1	1	117	....
Mar., Apr., May												
Northern	1	44	3.3	..	...	....	..	...	....	2	62	5.1
Southern	2	80	1.5	..	...	....	..	...	....	..	...	....
Means	3	68	2.1	..	...	....	..	...	....	2	62	5.1
Annual												
Northern	11	81	4.4	5	83	3.4	8	50	4.6	11	96	5.8
Southern	9	47	2.0	11	263	1.8	4	64	3.5	6	171	1.7
Means	20	67	3.3	16	181	2.3	12	55	4.2	17	122	4.4

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 5.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
21	60	2.3	7	77	2.8	8	20	3.7	11	8	2.9	..	...	....	26	30	3.1
19	43	0.9	4	180	2.0	1	232	1.1	22	279	1.4	2	108	12.0	29	301	7.2
40	52	1.7	11	114	2.5	9	4	3.4	33	309	1.4	2	108	12.0	55	343	5.3
16	106	4.4	4	37	4.2	11	10	5.8	9	34	11.2	6	329	17.7	30	17	11.9
4	109	1.3	3	236	2.0	..	...	....	5	233	4.3	..	...	....	8	234	3.4
20	107	2.8	7	122	3.3	11	10	5.8	14	330	8.8	6	329	17.7	38	347	10.1
9	89	4.2	3	79	7.9	17	7	15.0	1	128	4.4	11	16	16.0	32	21	14.7
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
9	89	4.2	3	79	7.9	17	7	15.0	1	128	4.4	11	16	16.0	32	21	14.7
19	58	3.8	8	76	5.0	3	23	4.5	5	58	6.1	3	62	7.1	19	61	5.5
..	...	....	..	...	....	..	...	....	2	253	3.5	..	...	....	2	253	3.5
19	58	3.8	8	76	5.0	3	23	4.5	7	11	5.4	3	62	7.1	21	45	5.3
65	75	3.5	22	69	4.5	39	12	9.3	26	40	6.3	20	67	18.6	107	29	9.3
23	55	1.0	6	86	2.4	2	222	1.4	29	269	7.0	2	108	12.0	39	304	6.2
88	70	2.9	28	73	4.1	41	6	8.9	55	330	6.7	22	175	18.0	146	6	8.4

PRESSURE HIGH—AREA NO. 6.

20	90	5.1	9	151	4.4	4	44	4.1	22	14	8.5	1	5	16.9	36	51	7.2
21	243	4.6	8	257	1.0	1	6	3.7	43	264	6.9	..	...	....	52	265	5.9
41	164	3.4	17	31	2.8	5	36	4.0	65	309	7.4	1	5	16.9	88	325	6.5
4	119	1.7	4	76	3.9	9	44	14.2	2	55	4.6	5	6	14.6	20	42	11.3
5	108	3.0	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
9	113	2.5	4	76	3.9	9	44	14.2	2	55	4.6	5	6	14.6	20	42	11.3
8	40	5.5	..	...	....	8	16	20.8	..	...	....	3	311	6.9	11	358	17.0
2	122	5.0	..	...	....	1	8	4.2	1	12	0.9	3	332	8.8	5	347	6.3
10	57	5.4	..	...	....	9	15	19.0	1	12	0.9	6	322	7.8	16	355	13.7
3	56	4.5	6	10	10.0	4	91	7.6	9	20	7.1	4	28	8.2	23	32	8.7
2	80	1.5	..	...	....	..	...	....	..	...	....	1	303	12.8	1	303	12.8
5	66	3.3	6	10	10.0	4	91	7.6	9	20	7.1	5	12	8.2	24	28	8.9
35	79	4.8	19	91	6.8	25	43	13.6	33	18	7.8	13	360	11.0	90	38	9.7
30	153	2.1	8	257	1.0	2	7	4.0	44	266	6.8	4	325	9.8	58	272	6.1
65	113	3.5	27	33	5.1	27	39	12.9	77	315	7.2	17	352	10.7	148	349	8.3

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 7.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	2	85	5.0	1	81	4.6	..	...	....	4	124	5.2
Southern	1	90	6.2	..	...	....	..	...	....	..	...	....
Means	3	87	8.1	1	81	4.6	..	...	....	4	124	5.2
Sept., Oct., Nov.												
Northern	3	106	4.6	1	101	2.7	..	...	....	..	...	....
Southern	..	...	....	..	...	....	..	...	....	1	60	2.1
Means	3	106	4.6	1	101	2.7	..	...	....	1	60	2.1
Dec., Jan., Feb.												
Northern	8	64	7.1	6	77	7.4	4	70	7.9	..	...	....
Southern	4	128	2.1	..	...	....	..	...	....	..	...	....
Means	12	86	5.4	6	77	7.4	4	70	7.9	..	...	....
Mar., Apr., May												
Northern	4	94	9.8	..	...	....	1	92	7.6	..	...	....
Southern	1	103	3.0	..	...	....	..	...	....	..	...	....
Means	5	96	8.4	..	...	....	1	92	7.6	..	...	....
Annual												
Northern	17	81	7.0	8	80	6.5	5	74	7.8	4	124	5.2
Southern	6	118	2.9	..	...	....	..	...	....	1	60	2.1
Means	23	90	6.0	8	80	6.5	5	74	7.8	5	111	4.6

PRESSURE HIGH—AREA NO. 8.

June, July, Aug.												
Northern	1	70	3.8	3	89	3.7	..	...	....	..	...	....
Southern	12	88	2.1	..	...	....	3	66	2.4	..	...	....
Means	13	87	2.2	3	89	3.7	3	66	2.4	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	10	82	3.2	5	85	3.4	3	69	2.5	5	88	2.8
Means	10	82	3.2	5	85	3.4	3	69	2.5	5	88	2.8
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	12	100	3.6	5	89	4.6	3	94	5.7	1	112	4.0
Means	12	100	3.6	5	89	4.6	3	94	5.7	1	112	4.0
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	8	86	3.0	2	246	1.4	2	187	4.0	1	45	11.7
Means	8	86	3.0	2	246	1.4	2	187	4.0	1	45	11.7
Annual												
Northern	1	70	3.8	3	267	11.1	..	...	....	..	...	....
Southern	42	90	3.0	12	114	3.6	11	98	3.6	7	85	4.2
Means	43	89	3.0	15	109	3.6	11	98	3.6	7	85	4.2

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 7.

Mean.			A. Cu.			S. Cu.			Cu.			S.			Mean.		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
7	107	5.1	3	130	7.8	4	106	13.0	8	58	9.2	..	...	....	15	85	9.9
1	90	6.2	2	192	2.4	..	...	....	4	59	4.9	2	78	4.0	8	97	4.0
8	105	5.2.	5	155	5.6	4	106	13.0	12	58	7.8	2	78	4.0	23	89	7.3
4	105	4.1	..	...	....	2	105	6.7	4	49	10.0	1	7	20.0	7	59	10.8
1	60	2.1	1	182	3.4	..	...	....	1	82	0.7	1	12	9.2	3	92	4.4
5	96	3.7	1	182	3.4	2	105	6.7	5	56	8.1	2	10	14.6	10	69	8.7
18	69	7.4	2	68	8.9	6	72	7.5	..	...	....	..	...	....	8	71	7.8
4	128	2.1	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
22	80	6.4	2	68	8.9	6	72	7.5	..	...	....	..	...	....	8	71	7.8
5	94	9.4	1	52	5.8	3	7	8.8	6	53	7.9	3	11	10.4	13	33	8.3
1	103	3.0	..	...	....	3	57	4.3	3	40	9.3	..	...	....	6	48	6.8
6	95	8.3	1	52	5.8	6	32	6.6	9	49	8.4	3	11	10.4	19	38	8.0
34	85	6.8	6	96	7.8	15	72	9.2	18	54	8.9	4	10	12.8	43	62	9.2
7	109	2.8	3	189	2.7	3	57	4.3	8	55	6.0	3	56	5.9	17	79	5.1
41	89	6.1	9	127	6.1	18	70	8.3	26	54	8.0	7	30	9.9	60	67	8.1

PRESSURE HIGH—AREA NO. 8.

4	84	3.7	..	...	....	..	...	....	3	80	10.4	..	...	....	3	80	10.4
15	84	2.1	5	89	3.0	6	101	7.6	24	40	6.0	11	54	9.8	46	57	6.8
19	84	2.5	5	89	3.0	6	101	7.6	27	44	6.5	11	54	9.8	49	58	7.0
..	...	....	1	60	7.7	2	104	12.0	..	...	....	..	...	....	3	89	10.6
23	82	3.1	5	87	3.6	7	93	10.4	3	82	4.9	..	...	....	15	89	7.0
23	82	3.1	6	82	4.3	9	95	10.8	3	82	4.9	..	...	....	18	89	7.6
..	...	....	13	93	10.0	4	64	8.7	..	...	....	..	...	....	17	86	8.7
21	97	4.2	4	79	5.9	5	71	7.8	1	94	7.0	4	68	6.2	14	74	7.8
21	97	4.2	17	90	9.0	9	68	8.2	1	94	7.0	4	68	6.2	31	81	8.4
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
13	121	3.6	5	52	7.2	2	50	15.1	5	111	10.4	2	58	6.2	14	74	9.5
13	121	3.6	5	52	7.2	2	50	15.1	5	111	10.4	2	58	6.2	14	74	9.5
4	84	3.7	14	91	9.8	6	77	9.8	3	80	10.4	..	...	....	23	86	9.9
72	94	3.3	19	77	4.9	20	86	9.4	33	56	6.6	17	58	8.5	89	67	7.2
76	94	3.3	33	83	7.0	26	84	9.5	36	58	7.3	17	58	8.5	112	71	7.8

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 9.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	21	80	1.7	12	97	2.1	14	90	2.3	17	129	4.2
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	15	77	5.9	..	...	....	2	90	5.9	2	99	3.0
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	6	85	5.7	6	87	5.7	4	87	5.7	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	9	90	2.4	5	90	2.8	12	103	5.5	5	82	6.8
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	51	81	3.5	23	92	3.2	32	94	4.2	24	63	4.6
Means	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE HIGH—AREA NO. 10.

June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	19	147	2.7	6	55	3.8	12	81	2.3	10	88	5.3
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	4	83	9.9	6	87	5.0	1	85	2.7	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	6	73	4.3	1	90	6.7	..	...	....	2	115	3.0
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern.	5	86	2.9	8	102	3.4	4	145	4.0	1	138	9.2
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	34	117	3.9	21	84	5.1	17	96	2.7	13	96	5.2
Means	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 9.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
64	78	2.6	31	77	2.6	7	112	3.8	56	94	8.5	9	137	12.9	103	94	6.8
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
19	81	5.6	7	116	3.6	20	66	13.6	11	102	12.3	15	115	15.8	53	94	13.3
..	...	....	..	...	....	..	..	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
16	86	5.9	5	94	6.0	9	106	13.8	..	...	....	4	163	20.3	18	115	13.1
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	...	..	...	....
31	94	4.4	12	103	5.5	7	100	7.0	8	113	8.1	11	136	16.1	38	114	9.4
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
130	84	3.8	55	89	3.7	43	87	11.6	75	97	9.0	39	131	15.7	212	99	9.1
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE HIGH—AREA NO. 10.

..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
47	106	3.3	22	111	3.5	14	152	8.8	56	160	4.8	7	88	5.8	99	143	5.1
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
11	85	6.6	2	104	13.9	10	109	12.0	6	118	15.9	3	82	5.3	21	107	12.3
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
9	84	4.3	2	160	3.5	2	156	27.8	..	...	....	2	225	32.9	6	180	21.4
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
18	109	3.7	8	93	5.5	4	135	14.6	3	97	8.1	6	125	6.8	21	111	8.0
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	..	....	..	...	....
85	102	3.9	34	109	4.6	30	136	11.9	65	153	6.0	18	115	9.1	147	135	7.2
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 11.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	8	86	3.3	7	78	3.2	9	98	2.7	4	122	4.0
Southern	4	46	3.8	3	352	1.5	3	95	4.8	3	48	1.9
Means	12	72	3.5	10	52	2.7	12	97	3.2	7	90	3.1
Sept., Oct., Nov.												
Northern	6	86	5.6	4	90	5.4	4	72	4.1	6	115	6.3
Southern	5	103	4.7	3	101	5.2	..	...	....	4	124	3.5
Means	11	94	5.2	7	95	5.3	4	72	4.1	10	119	5.2
Dec., Jan., Feb.												
Northern	7	82	2.8	5	111	3.8	..	...	....	8	86	4.1
Southern	4	84	5.5	..	...	....	1	110	6.0	1	103	3.7
Means	11	83	3.8	5	111	3.8	1	110	6.0	9	88	4.1
Mar., Apr., May												
Northern	6	88	3.6	6	82	2.9	1	85	5.1	5	108	4.4
Southern	2	58	0.6	1	351	0.2	..	...	....	..	...	....
Means	8	81	2.9	7	80	2.5	1	85	5.1	5	108	4.4
Annual												
Northern	27	82	3.6	22	89	3.7	14	89	3.3	23	105	4.7
Southern	15	77	4.1	7	39	2.9	4	99	5.1	8	93	2.9
Means	42	80	3.8	29	77	3.5	18	92	3.7	31	102	4.3

PRESSURE HIGH—AREA NO. 12.

June, July, Aug.												
Northern	3	76	5.8	5	69	4.2	5	70	3.7	2	154	3.5
Southern	6	151	1.5	7	130	4.3	1	268	1.2	2	288	10.2
Means	9	126	2.9	12	105	4.2	6	104	3.3	4	221	6.8
Sept., Oct., Nov.												
Northern	7	82	2.7	3	111	7.7	1	85	7.2	1	87	4.3
Southern	2	341	0.3	..	...	....	..	...	....	..	...	....
Means	9	60	2.2	3	111	7.7	1	85	7.2	1	87	4.3
Dec., Jan., Feb.												
Northern	6	115	2.6	2	98	6.0	3	121	7.6	5	114	3.0
Southern	3	119	2.5	2	93	2.1	1	86	3.8	..	...	....
Means	9	116	2.6	4	96	4.0	4	112	6.7	5	114	3.0
Mar., Apr., May												
Northern	2	132	5.2	..	...	....	2	40	4.4	3	237	4.7
Southern	1	60	2.7	1	72	1.7	..	...	....	1	98	2.0
Means	3	108	4.4	1	72	1.7	2	40	4.4	4	202	4.0
Annual												
Northern	18	98	3.5	10	87	5.6	11	80	5.2	11	153	3.7
Southern	12	107	1.5	10	117	3.6	2	177	2.5	3	225	7.5
Means	30	101	2.7	20	102	4.6	13	95	4.8	14	168	4.5

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 11.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean.		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
28	93	2.9	11	129	3.7	8	117	6.4	18	117	5.1	4	139	5.2	41	122	5.0
13	45	3.1	10	80	4.6	..	...	....	20	177	7.1	..	...	....	30	145	6.3
41	78	3.1	21	105	4.1	8	117	6.4	38	149	6.1	4	139	5.2	71	132	5.5
20	93	5.5	4	80	5.0	8	120	7.8	1	130	11.1	8	129	11.6	21	114	10.5
12	110	4.4	5	161	6.8	3	61	2.7	7	196	3.8	1	30	3.2	16	149	4.5
32	99	5.1	9	125	6.0	11	104	6.4	8	188	4.7	9	118	10.7	37	131	7.9
20	91	4.2	7	139	6.2	3	107	18.6	..	...	....	2	190	3.7	12	139	8.9
6	92	5.8	3	119	5.9	5	133	10.0	..	...	....	..	...	....	8	128	8.5
26	91	4.5	10	133	6.1	8	123	13.2	..	...	....	2	190	3.7	20	135	8.7
18	92	3.7	4	158	7.1	5	177	10.2	..	...	....	6	131	28.8	15	154	16.8
3	36	0.5	1	190	2.2	4	128	4.9	4	148	4.3	2	128	7.5	11	141	4.9
21	84	3.2	5	165	6.2	9	155	7.8	4	148	4.3	8	130	23.5	26	143	11.3
86	91	3.9	26	129	5.1	24	129	9.2	19	118	5.4	20	138	16.3	89	128	8.8
34	75	3.7	19	120	5.5	12	112	8.9	31	178	6.0	3	133	5.1	65	142	6.3
120	86	3.8	45	124	5.3	36	123	9.1	50	155	5.8	23	137	14.1	154	136	7.7

PRESSURE HIGH—AREA NO. 12.

15	87	4.3	7	108	6.5	3	146	9.4	9	101	7.6	6	110	8.7	25	111	7.8
16	166	3.8	2	48	1.5	1	86	3.9	16	247	9.9	8	274	10.8	27	274	9.3
31	126	4.0	9	95	5.4	4	131	8.0	25	324	9.1	14	358	9.8	52	9	8.6
12	90	4.4	4	83	7.2	10	217	16.4	7	9	9.1	8	275	23.6	27	314	13.4
2	341	0.3	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
14	74	3.9	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
16	114	4.1	1	108	6.1	8	218	7.4	2	249	14.4	9	18	6.0	20	307	7.4
6	105	2.6	3	90	1.4	2	286	4.8	..	...	....	..	...	....	5	24	2.8
22	111	3.7	4	94	2.6	10	234	6.9	2	249	14.4	9	18	6.0	25	322	6.5
7	151	4.8	8	92	4.4	6	112	7.4	6	53	6.2	8	264	20.0	28	40	9.9
3	77	2.1	2	104	1.7	..	...	....	2	240	9.0	..	...	....	4	352	5.4
10	128	4.0	10	93	3.8	6	112	7.4	8	10	9.2	8	264	20.0	32	34	9.3
50	104	4.3	20	97	5.8	27	319	10.4	24	45	8.3	29	349	13.6	100	16	9.8
27	129	3.1	7	82	1.5	3	339	6.8	18	247	9.8	8	274	10.8	36	298	8.0
77	111	3.9	27	93	4.7	30	321	9.8	42	337	8.9	37	333	12.8	136	355	9.3

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 13.

Clouds.	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	8	70	1.4	2	146	1.8	2	52	2.4	2	72	2.0
Southern	1	178	....	3	286	1.5	..	...	....	..	...	....
Means	9	82	1.2	5	14	1.0	2	52	2.4	2	72	2.0
Sept., Oct., Nov.												
Northern	1	100	6.4	..	...	....	..	...	....	..	...	....
Southern	4	166	2.1	15	121	1.8	2	122	1.1	3	87	2.2
Means	5	153	3.0	15	121	1.8	2	122	1.1	3	87	2.2
Dec., Jan., Feb.												
Northern	4	85	2.5	..	...	....	2	37	2.6	1	66	6.7
Southern	..	...	....	4	321	2.2	..	...	....	..	...	....
Means	4	85	2.5	4	321	2.2	2	37	2.6	1	66	6.7
Mar., Apr., May												
Northern	15	70	4.7	6	72	4.9	..	...	....	3	89	5.1
Southern	4	84	2.8	1	270	1.7	..	...	....	6	160	2.0
Means	19	73	4.3	7	49	4.4	..	...	....	9	136	3.0
Annual												
Northern	29	85	3.5	23	111	2.6	4	87	1.8	8	84	3.2
Southern	9	117	2.3	23	59	1.7	2	80	1.9	9	36	2.5
Means	38	95	3.2	46	85	2.2	6	83	1.8	17	57	2.9

PRESSURE HIGH—AREA NO. 14.

June, July, Aug.												
Northern	13	95	3.6	8	74	5.2	5	92	5.6	6	84	4.1
Southern	..	...	....	..	...	....	..	...	....	1	78	2.7
Means	13	95	3.6	8	74	5.2	5	92	5.6	7	83	3.9
Sept., Oct., Nov.												
Northern	5	94	5.7	3	93	7.1	3	31	3.6	4	137	2.8
Southern	..	...	....	3	127	4.1	1	194	0.3	2	44	3.9
Means	5	94	5.7	6	110	5.6	4	72	2.8	6	106	3.2
Dec., Jan., Feb.												
Northern	12	100	3.3	4	64	4.0	3	84	5.0	2	90	6.5
Southern	8	103	3.7	3	117	3.0	1	131	3.4	2	142	3.6
Means	20	101	3.5	7	87	3.6	4	96	4.6	4	116	5.0
Mar., Apr., May												
Northern	24	54	3.7	10	139	6.4	10	90	4.6	6	128	5.5
Southern	2	108	4.2	..	...	....	1	101	2.7	..	...	....
Means	26	58	3.3	10	139	6.4	11	91	4.4	6	128	5.5
Annual												
Northern	54	78	3.6	25	101	5.7	21	81	4.8	18	111	4.6
Southern	10	104	3.8	6	122	3.6	3	142	2.1	5	90	3.5
Means	64	82	3.6	31	105	5.3	24	89	4.4	23	106	4.3

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 13.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
14	79	1.7	10	81	6.0	2	24	5.4	28	17	4.1	11	87	9.8	51	45	5.9
4	349	1.5	1	249	1.0	..	...	....	3	271	12.4	..	...	....	4	266	9.6
18	59	1.4	11	24	5.4	2	24	5.4	31	67	4.9	11	87	9.8	55	35	6.0
1	100	6.4	7	52	4.7	8	142	1.2	4	295	3.5	2	65	12.4	21	44	3.9
24	123	1.8	6	162	1.9	..	...	....	16	238	4.4	4	239	3.9	26	304	3.7
25	124	2.0	13	103	3.4	8	142	1.2	20	250	4.2	6	301	6.7	47	358	3.8
7	69	3.1	9	78	3.7	1	111	2.4	6	40	6.6	7	307	9.4	23	31	5.4
4	321	2.2	3	146	3.7	..	...	....	1	16	0.9	..	...	....	4	114	3.0
11	29	2.8	12	95	3.7	1	111	2.4	7	37	5.4	7	307	9.4	27	43	6.7
24	73	4.8	9	58	5.0	4	113	6.4	9	24	6.6	1	138	2.0	23	58	5.7
11	25	2.2	7	32	2.3	..	...	....	7	275	7.5	1	319	12.7	15	27	5.4
35	58	4.0	16	47	3.8	4	113	6.4	16	336	7.0	2	48	7.4	38	24	5.6
64	94	3.1	35	69	4.8	15	116	3.2	47	14	4.8	21	42	11.3	118	48	5.8
43	71	2.0	17	90	2.3	..	...	....	27	257	6.0	5	255	5.7	49	324	4.7
107	84	2.6	52	72	3.4	15	116	3.2	74	331	5.2	26	13	10.2	167	23	5.4

PRESSURE HIGH—AREA NO. 14.

32	87	4.4	19	78	5.5	6	35	6.2	23	58	6.0	4	72	6.8	52	64	5.9
1	78	2.2	1	34	2.2	..	...	....	2	352	4.5	3	304	6.4	6	335	5.1
33	87	4.3	20	76	5.3	6	35	6.2	25	53	5.9	7	17	6.7	58	55	5.8
15	93	4.8	9	27	8.6	12	21	13.5	7	71	10.1	2	17	26.8	28	41	12.5
6	110	3.4	5	174	1.4	1	66	3.7	8	109	4.5	6	311	7.1	20	76	4.4
21	98	4.4	14	80	6.0	13	26	12.9	15	91	7.1	8	328	12.0	48	56	9.2
21	90	4.0	9	86	5.0	12	59	5.6	10	50	11.0	9	41	6.8	40	59	7.1
14	114	3.5	2	108	3.4	1	133	2.7	1	148	4.3	1	46	3.3	5	108	3.4
35	99	3.8	11	90	4.7	13	65	5.3	11	59	10.4	10	41	6.5	45	64	6.7
50	87	4.4	15	84	8.0	25	77	8.3	23	53	7.7	23	9	4.3	86	54	9.6
3	106	3.7	1	40	3.4	2	139	5.2	4	345	4.8	1	294	4.0	8	24	4.6
53	88	4.4	16	81	7.7	27	81	8.1	27	43	7.3	24	63	4.3	94	51	9.2
118	88	4.4	52	78	6.5	53	55	8.9	63	56	11.4	38	24	6.3	206	56	8.6
24	110	3.5	9	129	2.2	4	119	4.2	15	63	4.6	11	316	6.3	39	54	4.4
142	92	4.2	61	80	5.8	57	59	8.5	78	58	10.1	49	9	6.3	245	55	7.9

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 15.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	8	91	3.9	4	72	3.1	5	96	4.9	4	160	4.2
Southern	1	87	1.7	1	312	1.2	..	...	....	2	17	4.2
Means	9	91	3.7	5	48	2.7	5	96	4.9	6	112	4.2
Sept., Oct., Nov.												
Northern	1	153	1.8	..	...	....	1	153	1.8	..	...	....
Southern	4	60	5.3	5	36	4.1	2	107	11.7	3	103	5.9
Means	5	78	4.6	5	36	4.1	3	122	8.4	3	103	5.9
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	8	89	5.9	3	112	6.0	1	107	....	1	135	4.9
Means	8	89	5.9	3	112	6.0	1	107	....	1	135	4.9
Mar., Apr., May												
Northern	1	167	4.6	3	166	4.8	..	...	....	3	129	3.7
Southern	5	142	5.0	5	120	4.3	1	119	6.0	..	...	....
Means	6	149	4.9	8	137	4.5	1	119	6.0	3	129	3.7
Annual												
Northern	10	105	3.8	8	114	3.4	6	106	4.4	7	147	4.0
Southern	18	97	5.3	14	76	4.4	4	110	7.4	3	56	3.0
Means	28	100	4.7	22	90	4.0	10	107	5.6	10	120	3.7

PRESSURE HIGH—AREA NO. 16.

June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	29	86	2.1	10	68	2.6	19	75	3.6	7	73	4.6
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	9	86	3.5	7	101	11.2	3	108	3.7	8	92	5.1
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	12	82	4.1	4	98	7.1	7	95	6.0	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	8	85	2.9	8	86	2.7	6	94	6.7	4	94	5.6
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	58	85	2.9	29	85	5.3	35	85	4.6	19	86	5.0
Means	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA No. 15.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
21	102	4.0	12	115	4.3	10	121	7.2	15	42	5.0	6	89	8.8	43	87	2.1
4	18	1.8	2	15	2.4	1	55	6.6	6	59	5.5	1	67	21.8	10	51	6.6
25	88	3.7	14	101	4.0	11	115	7.1	21	47	5.1	7	85	10.7	53	80	6.0
2	153	1.8	..	...	....	12	37	11.6	6	47	11.1	4	52	10.7	22	37	12.4
11	58	5.9	14	99	8.1	12	92	8.4	8	66	16.2	15	60	17.3	49	80	12.5
13	72	5.3	14	99	8.1	24	64	10.0	14	58	14.0	19	58	15.9	71	66	12.5
..	...	....	..	...	....	..	...	....	4	49	6.7	6	320	29.9	10	356	20.6
13	99	5.3	3	92	3.9	2	92	9.4	3	83	7.2	..	...	....	8	89	6.5
13	99	5.3	3	92	3.9	2	92	9.4	7	64	6.9	6	320	29.9	18	39	14.4
7	150	4.3	2	158	6.8	6	62	13.7	6	46	8.8	5	89	11.0	19	74	10.7
11	130	4.8	1	123	3.0	20	72	13.2	14	74	8.5	13	68	12.6	48	73	11.5
18	138	4.6	3	146	5.5	26	70	13.3	20	66	8.6	18	74	12.1	67	73	11.3
31	117	3.8	14	121	4.7	28	72	10.5	31	42	8.1	21	43	15.6	94	63	10.0
39	88	5.0	20	90	6.6	35	79	11.2	31	69	10.5	29	66	11.4	115	75	11.1
70	101	4.5	34	103	5.8	63	76	10.9	62	55	9.3	50	56	15.2	209	70	10.6

PRESSURE HIGH—AREA No. 16.

..	...	....	..	...	...	..	...	....	..	...	....	..	...	....	..	...	....
65	79	2.9	33	71	5.1	6	122	15.0	52	65	7.5	5	49	32.8	96	70	8.5
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
27	94	6.0	9	79	8.6	10	77	14.7	9	85	8.0	13	100	17.2	41	86	12.7
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
23	89	5.2	5	79	7.3	15	85	16.5	6	71	15.7	6	117	9.7	32	87	13.6
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	...	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
26	89	4.1	4	139	4.0	10	82	9.8	10	66	14.8	2	66	8.8	26	83	10.8
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
141	85	4.1	51	80	5.8	41	71	14.2	77	68	9.2	26	91	17.8	195	78	10.5
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	....	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 17.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	21	87	3.0	16	84	4.4	16	92	5.6	12	105	10.5
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	3	82	6.2	1	89	12.4	3	82	9.3	4	114	4.0
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	3	98	6.4	4	109	5.2	4	96	5.6	6	119	12.9
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	5	103	4.8	1	80	4.7	1	122	4.7
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	27	88	3.7	26	92	4.9	24	91	6.0	23	111	6.7
Means	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE HIGH—AREA NO. 18.

June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	11	100	1.7	8	128	2.8	9	92	3.8	13	98	6.6
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	7	95	5.3	1	105	5.7	5	96	7.6	5	116	8.3
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	7	92	4.2	4	98	2.4	2	94	4.4	1	132	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	..	...	....	4	129	5.8	2	99	9.8
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	25	96	3.4	13	117	2.9	20	100	5.2	21	104	7.0
Means	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 17.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
65	91	4.3	38	82	5.2	42	87	9.8	61	98	5.9	4	92	8.3	145	90	6.9
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
11	94	6.8	10	79	6.9	19	83	13.1	1	130	6.7	10	88	15.2	40	84	11.9
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
17	108	8.2	2	84	6.4	6	91	21.7	2	104	9.8	7	70	15.2	17	83	15.8
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
7	102	4.8	6	105	6.9	12	83	14.7	11	89	10.6	17	103	13.5	46	93	12.3
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
100	95	5.3	56	80	5.7	79	86	12.2	75	97	6.7	38	92	11.1	248	90	9.3
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE HIGH—AREA NO. 18.

..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
41	103	3.4	7	102	6.4	10	117	4.4	41	105	11.0	7	113	16.9	65	107	10.1
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
18	102	6.8	7	86	12.1	7	95	14.6	8	95	14.5	7	118	7.3	29	98	12.2
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
14	97	3.4	2	124	11.2	3	111	7.8	2	127	10.1	..	...	....	7	119	9.5
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
6	119	7.1	7	104	6.2	7	52	10.5	12	116	9.8	2	150	10.9	28	99	9.1
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
79	103	4.7	23	99	8.5	27	94	9.0	63	107	11.2	16	120	11.3	120	104	10.3
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 19.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	12	98	3.5	9	98	4.8	10	101	3.0	7	120	7.6
Southern	8	97	1.9	4	118	1.8	3	151	1.8	7	114	2.6
Means	20	98	2.4	13	104	3.9	13	113	2.7	14	117	5.1
Sept., Oct., Nov.												
Northern	11	97	3.0	3	72	4.0	4	116	3.8	5	113	12.7
Southern	5	108	2.9	2	65	2.9	..	...	....	2	128	4.6
Means	16	100	2.9	5	69	3.6	4	116	3.8	7	117	10.4
Dec., Jan., Feb.												
Northern	2	54	1.7	..	...	....	1	77	2.5	..	...	....
Southern	3	80	2.0	..	...	....	..	...	....	1	94	4.2
Means	5	70	1.9	..	...	....	1	77	2.5	1	94	4.2
Mar., Apr., May												
Northern	6	104	4.2	6	82	5.5	3	126	6.2	6	97	6.2
Southern	4	103	1.4	3	104	3.8	2	226	0.7	..	...	....
Means	10	104	3.1	9	98	4.9	5	166	4.0	6	97	6.2
Annual												
Northern	31	96	3.4	18	93	4.9	18	107	3.6	18	110	8.6
Southern	20	100	2.6	9	99	3.8	5	160	3.2	10	108	4.3
Means	51	98	3.0	27	96	4.4	23	124	3.5	28	110	6.6

PRESSURE HIGH—AREA NO. 20.

June, July, Aug.												
Northern	8	86	1.5	7	99	3.4	6	87	3.2	7	107	5.2
Southern	3	291	6.4	5	310	0.9	1	33	1.8	4	114	1.3
Means	11	43	2.8	12	37	2.4	7	70	3.0	11	110	3.8
Sept., Oct., Nov.												
Northern	19	102	3.2	8	88	3.8	10	97	4.3	6	104	3.0
Southern	2	158	1.2	1	52	1.5	1	121	0.6	..	...	....
Means	21	107	3.0	9	84	3.5	11	99	4.0	6	104	3.0
Dec., Jan., Feb.												
Northern	11	123	3.9	8	98	5.3	4	116	6.1	6	125	3.5
Southern	1	145	5.3	1	137	4.5	..	...	....	..	...	....
Means	12	125	4.0	9	102	5.2	4	116	6.1	6	125	3.5
Mar., Apr., May												
Northern	18	125	2.3	6	144	8.9	3	159	2.4	3	186	17.0
Southern	1	250	2.0	1	97	1.6	..	...	....	..	...	....
Means	19	131	2.3	7	137	7.9	3	159	2.4	3	186	17.0
Annual												
Northern	56	111	2.8	29	105	5.2	23	106	4.1	22	122	5.7
Southern	7	103	4.0	8	51	3.4	2	103	4.5	4	121	2.6
Means	63	109	3.1	37	86	4.6	25	105	4.2	26	122	4.8

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE HIGH—AREA NO. 19.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
38	103	4.4	11	120	6.9	12	120	8.2	19	132	5.7	5	146	7.1	47	128	8.0
22	124	2.1	6	111	3.7	5	238	2.3	24	128	3.9	6	208	7.6	41	151	4.2
60	107	3.6	17	117	5.7	17	155	6.4	43	130	4.4	11	180	7.4	88	138	6.3
23	101	5.3	7	114	6.4	15	118	14.6	4	141	16.7	13	122	15.6	39	121	19.1
9	103	3.3	6	118	3.4	6	170	5.0	7	211	3.8	7	164	14.0	26	167	5.9
32	101	4.8	13	101	5.0	21	131	12.3	11	186	8.5	20	137	11.6	65	140	13.8
3	62	2.0	1	144	8.5	6	107	16.7	2	100	15.8	9	136	15.0	18	123	9.7
4	84	2.6	5	159	1.4	4	129	6.0	..	...	....	..	...	....	9	146	3.4
7	74	2.3	6	156	2.6	10	116	12.4	2	100	15.8	9	136	15.0	27	130	17.6
21	102	5.4	9	125	8.5	18	119	11.5	12	141	9.1	15	147	19.6	54	133	14.1
9	131	2.0	8	113	5.5	12	141	1.2	14	167	8.0	5	79	8.0	39	137	5.4
30	111	4.4	17	120	7.1	30	128	7.4	26	155	8.5	20	130	16.2	93	134	10.4
85	101	4.8	28	121	7.3	51	118	13.4	37	134	7.8	42	137	23.0	158	127	13.7
44	109	3.4	25	123	3.7	27	164	3.0	45	153	4.3	18	155	9.0	115	149	4.9
129	104	4.2	53	122	5.6	78	134	9.8	82	145	6.5	60	142	18.8	273	136	10.0

PRESSURE HIGH—AREA NO. 20.

28	95	3.3	13	112	2.4	7	187	5.4	24	182	4.0	7	232	5.3	51	172	4.0
13	2	2.4	3	196	1.5	..	...	....	14	283	7.2	..	...	....	17	268	6.2
41	65	3.0	16	127	2.2	7	187	5.4	38	220	5.2	7	232	5.3	68	196	4.5
43	98	3.5	15	100	4.0	19	193	11.9	15	161	10.9	27	188	12.4	76	166	10.2
4	122	1.1	..	...	....	..	...	....	5	240	2.4	..	...	....	5	240	2.4
47	100	3.3	15	100	4.0	19	193	11.9	20	180	8.8	27	188	12.4	81	171	9.8
29	116	4.5	3	51	3.8	13	251	11.9	2	182	3.4	12	169	15.5	30	193	15.4
2	142	4.9	2	286	7.4	1	156	4.1	1	171	7.5	1	162	8.6	5	212	7.0
31	117	4.6	5	145	5.2	14	244	11.4	3	178	4.7	13	168	15.1	35	196	14.2
30	138	5.1	8	117	3.7	6	179	14.3	9	191	5.1	9	176	19.9	32	166	10.6
2	174	1.8	1	218	0.6	..	...	....	4	282	5.0	1	292	25.6	6	273	7.7
32	140	4.9	9	128	3.3	6	179	14.3	13	219	5.0	10	188	20.4	38	183	10.2
130	111	4.1	39	103	3.4	45	207	11.2	50	177	6.6	55	187	15.3	189	172	9.5
21	90	3.6	7	197	2.8	1	156	4.1	24	269	5.8	2	227	17.1	34	248	5.8
151	105	3.9	46	118	3.3	46	206	11.1	74	207	6.1	57	189	15.3	223	184	8.9

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 1.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	3	83	3.1	3	123	5.0	2	94	13.5	3	100	9.7
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	1	133	5.0	..	...	....	..	...	....	1	17	9.2
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	1	75	9.0	1	91	....	..	...	....	1	109	13.5
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	2	160	6.4	3	85	2.3	7	86	4.9	5	92	7.5
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	7	111	5.2	7	102	3.1	9	89	6.8	10	89	8.9
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 2.

June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	1	121	3.9
Southern	..	...	....	..	...	....	1	112	....	..	...	....
Means	..	...	....	..	...	....	1	112	....	1	121	3.9
Sept., Oct., Nov.												
Northern	..	...	....	3	116	4.8	..	...	....	1	109	6.2
Southern	1	30	2.7	1	87	3.6	..	...	....	3	110	2.8
Means	1	30	2.7	4	109	4.5	..	...	....	4	110	3.6
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	1	98	5.0	..	...	....
Southern	3	118	4.6	..	...	....	..	...	....	2	108	4.6
Means	3	118	4.6	..	...	....	1	98	5.0	2	108	4.6
Annual												
Northern	..	...	....	3	116	4.8	1	98	5.0	2	115	5.0
Southern	4	96	4.1	1	87	3.6	1	112	....	5	109	3.5
Means	4	96	4.1	4	109	4.5	2	105	5.0	7	111	4.0

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 1.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
11	101	7.3	5	95	10.8	4	116	2.2	8	89	8.2	2	106	14.3	19	98	8.3
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
2	75	7.1	2	101	5.4	12	100	20.2	3	95	12.4	5	76	17.8	22	94	17.2
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
3	92	11.2	1	96	23.3	2	67	31.6	2	114	9.4	5	87	17.9	10	89	19.4
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
17	97	5.4	6	119	8.7	18	114	23.1	15	98	13.1	17	99	13.2	56	106	15.8
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
33	96	6.3	14	106	10.0	36	109	22.3	28	94	11.3	29	94	14.9	107	100	16.9
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 2.

1	121	3.9	2	170	9.8	9	115	12.0	4	134	6.3	3	101	5.4	18	123	9.4
1	112	....	..	...	....	1	172	....	..	...	....	3	190	....	4	186	....
2	116	3.9	2	170	9.8	10	121	12.0	4	134	6.3	6	146	5.4	22	134	9.4
4	114	5.2	1	116	4.2	4	133	22.1	..	...	....	3	136	43.0	8	131	27.7
5	89	2.9	3	113	4.7	7	77	13.5	2	88	8.4	2	46	10.4	14	82	10.4
9	100	3.9	4	114	4.6	11	97	16.6	2	88	8.4	5	99	30.0	22	100	16.7
..	...	....	..	...	....	2	60	12.0	..	...	....	3	60	16.8	5	60	14.9
..	...	....	1	92	2.9	..	...	....	2	59	3.9	3	142	3.8	6	106	3.7
..	...	....	1	92	2.9	2	60	12.0	2	59	3.9	6	101	10.3	11	85	8.8
1	98	5.0	..	...	....	6	124	14.7	1	118	11.6	3	145	9.4	10	130	12.8
5	114	4.6	2	114	8.1	5	143	14.3	2	204	5.2	1	150	11.5	10	150	11.0
6	111	4.7	2	114	8.1	11	133	14.5	3	175	7.3	4	146	9.9	20	140	11.9
6	113	4.9	3	152	7.9	21	116	14.7	5	131	7.4	12	110	18.6	41	119	14.5
11	103	3.4	6	110	5.5	13	110	12.8	6	117	5.8	9	138	4.9	34	118	8.2
17	106	4.0	9	124	6.3	34	113	14.0	11	123	6.5	21	122	12.7	75	118	11.6

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 3.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 4.

June, July, Aug.												
Northern	1	138	12.4	1	114	12.2	2	106	6.9	..	...	....
Southern	1	50	1.9	..	...	....	..	...	....	..	...	....
Means	2	94	7.2	1	114	12.2	2	106	6.9	..	...	....
Sept., Oct., Nov.												
Northern	2	94	6.9	..	...	....	..	...	....	..	...	....
Southern	1	90	2.7	2	171	1.4	1	57	3.3	..	...	....
Means	3	93	5.5	2	171	1.4	1	57	3.3	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	1	108	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	1	108	....
Mar., Apr., May												
Northern	1	160	5.1	1	146	4.1	..	...	....	2	60	9.8
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	4	122	7.8	2	130	8.2	2	106	6.9	2	60	9.8
Southern	2	70	2.3	2	171	1.4	1	57	3.3	1	108	....
Means	6	104	6.0	4	150	4.8	3	90	5.7	3	76	9.8

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 3.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 4.

4	116	9.6	3	78	15.7	2	81	10.0	4	50	13.9	..	...	....	9	66	13.6
1	50	1.9	2	60	4.9	2	57	3.9	4	342	4.1	..	...	....	8	20	4.2
5	103	8.1	5	71	11.4	4	69	6.9	8	16	9.0	..	...	....	17	45	9.2
2	94	6.9	1	128	8.6	1	58	24.4	2	18	19.6	3	95	8.5	7	73	14.0
4	124	2.2	3	87	4.9	3	5	8.1	2	284	5.6	5	354	6.0	13	6	6.2
6	113	3.8	4	95	3.8	4	18	12.2	4	331	12.6	8	32	6.9	20	30	8.9
1	108	....	3	84	7.2	7	65	8.1	3	46	10.1	1	136	28.9	14	70	9.8
..	...	....	..	...	....	..	...	....	..	...	....	4	3	25.8	4	3	25.8
1	108	....	3	84	7.2	7	65	8.1	3	46	10.1	5	30	26.4	18	55	13.4
4	106	7.2	6	56	11.2	20	44	18.4	4	32	18.6	6	58	18.6	36	47	17.3
..	...	....	1	334	2.4	1	2	7.0	4	36	6.2	3	326	9.4	9	20	6.9
..	...	....	7	44	9.9	21	42	17.8	8	34	12.1	9	27	15.5	45	38	15.2
10	108	8.1	13	73	11.1	30	53	15.6	13	39	15.3	10	77	16.6	66	57	14.8
6	108	1.8	6	58	4.5	6	22	6.5	10	352	5.2	12	350	13.4	34	8	8.2
16	108	5.7	19	68	9.0	36	47	14.1	23	18	10.9	22	29	14.9	100	40	12.6

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 5.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	18	86	2.5	11	94	2.9	10	111	4.2	10	130	13.3
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	10	97	3.2	8	97	3.4	6	106	8.4	5.	137	5.5
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	16	102	4.3	6	106	3.8	3	90	5.6	2	74	8.7
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	6	119	2.3	5	144	4.8	2	139	6.0	7	131	6.3
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	50	97	3.2	30	105	3.6	21	109	5.8	24	127	9.0
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 6.

June, July, Aug.												
Northern	5	78	3.2	4	86	2.7	3	94	4.0	4	77	4.3
Southern	..	...	....	..	...	....	1	33	1.8	..	...	....
Means	5	78	3.2	4	86	2.7	4	79	3.5	4	77	4.3
Sept., Oct., Nov.												
Northern	10	95	5.5	9	90	4.3	7	122	6.2	11	99	6.9
Southern	3	146	2.8	1	134	4.3	..	...	....	..	...	....
Means	13	107	4.9	10	94	4.3	7	122	6.2	11	99	6.9
Dec., Jan., Feb.												
Northern	6	97	7.7	7	96	7.2	4	98	5.4	4	109	16.2
Southern	1	120	2.0	..	...	....	..	...	....	..	...	....
Means	7	97	6.9	7	96	7.2	4	98	5.4	4	109	16.2
Mar., Apr., May												
Northern	8	111	2.8	7	80	2.8	5	112	3.9	6	115	4.3
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	29	96	4.8	27	88	4.4	19	110	5.1	25	101	7.3
Southern	4	140	2.6	1	134	4.3	1	33	1.8	..	...	....
Means	33	101	4.5	28	90	4.4	20	106	4.9	25	101	7.3

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 5.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
49	102	5.1	18	105	5.3	14	102	10.4	36	109	7.9	7	112	15.0	75	107	8.2
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
29	106	4.5	21	53	6.0	31	90	4.5	18	104	14.0	17	78	14.3	87	82	8.1
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
27	99	4.7	8	92	8.2	10	92	27.8	11	71	16.4	6	73	18.7	35	83	18.2
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
20	131	4.7	12	111	6.2	7	106	9.6	16	106	11.8	5	158	19.2	40	114	10.6
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	.	...	....	..	...	....	..	...	....
125	107	4.8	57	86	5.9	62	96	10.2	81	102	11.2	35	95	15.9	237	95	10.3
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 6.

16	83	3.5	8	90	9.2	8	89	13.7	15	107	9.6	3	120	9.6	34	88	10.4
1	33	1.8	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
17	80	3.4	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
37	100	5.8	14	125	9.7	17	111	12.8	5	143	10.4	19	134	14.2	55	125	12.3
4	143	3.2	1	160	4.5	2	212	14.7	8	187	13.7	..	...	....	11	189	13.0
41	104	5.5	15	127	9.4	19	122	13.0	13	170	12.4	19	134	14.2	66	136	12.4
21	98	8.7	2	105	6.1	11	103	20.6	5	140	14.1	8	125	15.1	26	113	16.5
1	120	2.0	1	140	20.0	1	84	9.7	1	113	9.4	2	191	4.0	5	144	9.4
22	99	8.4	3	117	10.7	12	93	19.7	6	136	13.3	10	138	12.9	31	118	15.4
26	104	3.4	12	113	5.6	16	102	10.0	11	105	6.0	14	132	13.4	53	113	9.4
..	...	....	..	...	....	7	177	7.0	1	105	5.0	..	...	....	8	168	6.8
..	...	....	12	113	5.6	23	125	9.1	12	105	5.9	14	132	13.4	61	120	8.8
100	98	5.4	36	112	8.0	52	101	13.7	36	105	9.2	44	130	13.4	168	112	11.6
6	121	2.8	2	150	12.2	10	175	8.8	10	171	12.4	2	191	4.0	24	173	10.2
106	99	5.2	38	114	8.2	62	113	12.9	46	119	9.9	46	133	13.4	192	114	11.4

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 7.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	2	116	2.5	2	83	3.9	..	...	....	2	105	3.3
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	3	118	4.8	1	103	4.7	..	...	....	..	...	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	1	145	2.3	3	96	4.4	..	...	....	3	94	6.5
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	4	90	3.8	6	102	4.8	4	132	4.4	4	123	5.2
Southern	..	...		..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	10	109	3.7	12	97	4.5	4	132	4.4	9	109	5.2
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 8.

June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	..	...	....	..	...	....	2	65	4.9
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	1	93	4.0	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	1	172	1.7	1	180	1.3	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	1	249	3.5	2	164	7.7	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	2	210	2.6	4	150	3.2	..	...	....	2	65	4.9
Means	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—**Continued.**

PRESSURE LOW—AREA NO. 7.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
6	101	3.2	4	154	3.8	10	118	13.2	1	120	12.2	2	140	4.2	17	129	9.9
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
4	114	4.8	..	...	....	4	151	14.6	2	139	27.5	2	144	39.9	8	146	21.6
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
7	102	5.0	1	145	3.5	4	158	16.6	..	...	....	2	122	13.5	7	146	13.8
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
18	111	4.6	6	137	8.8	6	141	7.5	2	154	15.5	15	159	16.1	29	150	12.8
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
35	108	4.5	11	144	6.5	24	136	12.6	5	141	19.6	21	152	12.2	61	140	13.6
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 8.

..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
2	65	4.9	..	...	....	..	...	....	2	94	3.2	..	...	....	2	94	3.2
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
1	93	4.0	..	...	....	7	95	13.5	3	101	4.8	1	30	3.2	11	91	10.2
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
2	176	1.5	..	...	....	5	112	4.9	..	...	....	1	210	2.3	6	128	4.5
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
3	192	6.3	1	220	23.1	2	10	9.4	2	262	26.5	3	238	11.0	8	185	16.0
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
8	144	4.5	1	220	23.1	14	89	9.2	7	145	10.5	5	191	7.7	27	127	10.1
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 9.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	1	93	3.6	3	120	4.8	1	101	0.3	4	135	4.0
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	2	94	3.9	..	...	....	2	94	2.7	3	138	4.6
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	3	92	7.1	1	97	6.4	1	95	7.1	2	109	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	1	72	2.5	3	139	2.2	1	105	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	7	90	5.0	7	125	3.9	5	98	2.8	9	130	3.2
Means	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 10.

June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	2	110	5.2	2	351	3.1	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	2	6	4.5	..	...	....	1	85	7.2	4	29	4.1
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	..	...	....	..	...	....	1	75	2.6
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	1	355	4.0	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	3	2	2.8	2	110	5.2	3	22	3.4	5	38	3.8
Means	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 9.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
9	122	3.8	2	145	6.6	..	...	....	3	308	5.8	..	...	....	5	27	6.1
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
7	113	3.9	2	116	17.7	3	44	11.0	2	78	18.4	8	119	12.4	15	98	13.6
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
7	98	7.0	1	91	7.0	3	129	7.1	1	70	10.0	7	94	9.8	12	100	8.9
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
5	149	2.1	1	146	5.5	1	140	6.6	1	193	3.3	2	130	8.1	5	148	5.3
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
28	113	3.8	6	126	10.2	7	94	8.7	7	38	9.6	17	110	10.8	37	96	10.1
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 10.

..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
4	55	4.2	1	9	4.3	..	...	....	5	12	11.4	2	8	20.7	9	11	12.6
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
7	30	4.7	..	...	....	2	219	4.9	2	139	8.7	7	0	11.0	11	0	9.5
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
1	75	2.6	1	275	12.7	..	...	....	..	...	....	..	...	....	1	275	12.7
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
1	355	4.0	2	33	5.6	1	309	8.3	1	42	4.2	..	...	....	4	14	5.9
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
13	37	4.3	4	358	7.0	3	249	6.0	8	48	9.8	9	2	13.2	24	2	10.1
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—**Continued.**

PRESSURE LOW—AREA NO. 11.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	2	80	....	2	55	3.6	3	92	4.0	1	20	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	2	66	5.8	..	...	....	2	79	7.7	1	55	3.3
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	11	87	5.7	1	44	3.8	4	84	8.3	2	66	11.1
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	8	66	3.8	7	65	4.4	..	...	....	2	5	6.6
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	23	77	4.6	10	61	4.2	9	86	6.7	6	36	6.4
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 12.

June, July, Aug.												
Northern	2	131	5.2	..	...	....	1	85	5.8	2	111	6.6
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	1	90	3.9	..	...	....	..	...	....	3	111	8.6
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	1	76	9.7	..	...	....	2	79	7.5	1	132	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	2	102	5.5	3	87	1.4	..	...	....	1	106	3.5
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	6	105	5.8	3	87	1.4	3	81	6.9	7	128	6.0
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 11.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
8	71	3.6	1	96	4.7	1	40	3.4	8	52	4.1	5	348	1.6	15	33	4.9
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
5	69	6.0	5	95	10.3	6	47	12.7	4	66	13.6	7	71	12.4	22	78	12.7
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
18	82	6.8	7	66	6.6	6	89	10.2	7	69	10.8	7	36	9.0	27	64	9.1
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
17	58	4.4	7	16	5.3	12	7	11.1	10	50	12.8	6	58	18.4	35	30	11.7
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
48	70	5.1	20	57	7.0	25	38	11.0	29	58	10.4	25	42	10.7	99	48	9.9
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 12.

5	114	4.6	3	90	11.9	1	128	....	3	56	6.3	3	71	10.3	10	78	8.6
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
4	106	7.4	2	98	....	11	103	17.5	6	99	17.3	11	73	17.3	30	91	17.3
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
4	92	6.2	2	98	....	2	39	5.0	..	...	....	2	82	22.0	6	73	13.5
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
6	93	3.1	4	94	6.8	5	33	16.2	7	74	13.3	4	40	11.9	20	61	12.4
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
19	101	5.0	11	85	9.0	19	79	15.8	16	79	13.5	20	67	15.6	66	78	14.3
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
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TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 13.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	7	106	3.4	2	106	4.0	1	112	....	6	86	9.3
Southern	1	51	1.3	1	110	1.3	2	86	3.0	..	...	....
Means	8	99	3.1	3	107	3.3	3	95	3.0	6	86	9.3
Sept., Oct., Nov.												
Northern	10	177	4.2	2	105	3.0	3	117	2.6	4	153	2.3
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	6	60	2.0	..	...	....	1	107	4.8	..	...	....
Southern	1	158	5.0	..	...	....	..	...	....	..	...	....
Means	7	74	2.4	..	...	....	1	107	4.8	..	...	....
Mar., Apr., May												
Northern	..	...	....	2	90	3.9	..	...	....	1	133	2.4
Southern	2	116	3.6	..	...	....	1	113	5.7	2	106	6.8
Means	2	116	3.6	2	90	3.9	1	113	5.7	3	115	5.3
Annual												
Northern	23	125	3.4	6	100	2.3	5	114	2.5	11	115	6.1
Southern	4	110	3.4	1	110	1.3	3	95	9.9	2	106	6.8
Means	27	123	3.4	7	102	2.2	8	107	3.0	13	113	6.2

PRESSURE LOW—AREA NO. 14.

June, July, Aug.												
Northern	15	92	1.4	10	74	5.0	18	92	4.2	5	109	7.9
Southern	2	58	0.8	2	66	0.9	..	...	....	3	166	2.7
Means	17	88	1.3	12	73	4.3	18	92	4.2	8	130	5.9
Sept., Oct., Nov.												
Northern	17	99	4.2	14	85	5.1	10	93	5.2	8	118	4.9
Southern	2	134	1.8	4	155	2.0	1	85	4.0	1	130	3.4
Means	19	103	4.0	18	102	4.4	11	92	5.1	9	120	4.7
Dec., Jan., Feb.												
Northern	18	94	4.2	9	99	5.9	5	81	5.7	3	98	8.8
Southern	5	82	3.5	3	104	3.5	1	57	5.7	3	119	4.1
Means	23	92	4.1	12	100	5.3	6	77	5.7	6	108	6.4
Mar., Apr., May												
Northern	9	91	3.8	8	103	4.6	2	86	1.0	3	86	5.3
Southern	2	67	1.9	3	135	5.6	1	152	7.0	1	50	0.8
Means	11	86	3.5	11	112	4.9	3	108	3.0	4	77	4.2
Annual												
Northern	59	95	3.5	41	90	5.6	35	90	4.2	19	108	6.4
Southern	11	84	2.2	12	123	3.0	3	98	5.6	8	129	3.1
Means	70	93	3.3	53	97	5.1	38	91	4.4	27	114	5.4

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 13.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
16	99	5.1	10	110	5.3	4	103	16.6	23	112	11.5	13	139	10.5	50	118	10.4
4	83	2.2	6	67	3.2	2	110	5.4	5	102	6.0	4	108	11.1	17	92	6.1
20	96	4.5	16	94	4.5	6	105	12.9	28	110	10.5	17	132	10.6	67	111	9.3
19	155	3.4	13	101	3.6	7	128	15.1	8	121	5.0	13	132	9.0	41	105	7.5
..	...	....	..	...	....	1	101	5.3	2	82	3.1	..	...	....	3	88	3.8
..	...	....	13	101	3.6	8	125	13.9	10	53	4.6	13	132	9.0	44	104	7.3
7	67	2.4	..	...	....	3	130	10.8	3	60	20.6	1	92	10.8	7	95	16.4
1	158	5.0	2	128	8.4	4	131	9.3	3	63	9.2	..	...	....	9	108	9.1
8	78	2.7	2	128	8.4	7	131	9.9	6	62	16.6	1	92	10.8	16	102	12.3
3	104	2.8	4	148	4.2	5	88	10.2	5	146	5.0	4	145	7.9	18	130	6.9
5	111	5.3	3	105	5.0	3	111	6.8	7	101	6.9	..	...	....	13	104	6.4
8	109	4.4	7	130	4.5	8	97	8.9	12	117	6.1	4	145	7.9	31	119	6.7
45	118	3.8	27	111	4.3	19	113	13.4	39	99	10.3	31	135	9.5	116	114	9.2
10	105	4.0	11	88	4.6	10	118	7.4	17	92	6.6	4	108	11.1	42	99	6.7
55	116	3.8	38	105	4.4	29	114	11.4	56	99	9.3	35	132	9.7	158	110	8.6

PRESSURE LOW—AREA NO. 14.

48	90	3.7	27	100	3.6	13	115	6.4	32	121	6.6	3	140	6.5	75	113	5.5
7	107	1.6	..	...	....	5	144	3.6	15	212	6.0	1	171	1.1	21	194	5.2
55	92	3.4	27	100	3.6	18	123	5.6	47	150	6.4	4	148	5.2	96	131	5.4
49	98	5.2	10	76	8.1	19	145	12.6	16	129	10.0	14	142	13.0	59	128	11.2
8	138	2.4	4	190	4.9	1	48	3.4	3	219	11.7	3	186	18.3	11	184	10.3
57	103	4.8	14	109	7.3	20	140	12.2	19	143	10.3	17	150	13.9	70	137	11.1
35	94	5.3	7	87	6.8	12	109	13.0	4	65	16.0	9	166	11.6	32	115	11.6
12	95	3.9	6	144	5.8	3	140	5.1	5	189	15.1	1	205	24.4	15	162	10.0
47	94	4.9	13	113	6.3	15	115	11.4	9	134	15.5	10	170	12.8	47	130	11.1
22	94	4.1	14	108	5.6	10	104	9.5	18	159	8.4	16	145	11.5	58	134	7.9
7	106	4.1	2	111	3.6	3	132	5.9	4	178	4.4	..	...	....	9	148	4.7
29	97	4.1	16	109	5.4	13	111	8.7	22	163	7.6	16	145	11.5	67	137	7.4
154	94	4.6	58	95	5.4	54	122	10.6	70	129	8.4	42	149	16.1	224	123	8.5
34	110	3.1	12	154	5.1	12	132	4.6	27	204	8.1	5	187	16.1	56	176	7.4
188	97	4.3	70	106	5.3	66	124	9.5	97	150	8.3	47	153	16.1	280	133	8.2

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 15.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	8	77	2.6	4	58	6.1	7	106	6.6	..	...	....
Southern	5	82	2.3	3	47	2.5	4	64	2.4	4	59	6.3
Means	13	78	2.5	7	53	4.6	11	91	5.1	4	59	6.3
Sept., Oct., Nov.												
Northern	9	80	3.5	5	90	3.1	1	74	3.1	2	148	4.9
Southern	7	100	3.2	1	90	3.3	2	64	3.6	1	42	2.8
Means	16	89	3.4	6	90	3.1	3	67	3.4	3	113	4.2
Dec., Jan., Feb.												
Northern	8	97	4.6	4	107	4.9	5	92	5.0	2	114	4.0
Southern	..	...	....	..	...	....	1	89	4.2	..	...	....
Means	8	97	4.6	4	107	4.9	6	91	4.9	2	114	4.0
Mar., Apr., May												
Northern	2	86	3.6	4	79	3.9	1	87	4.1	3	148	6.6
Southern	10	78	2.8	5	88	3.8	4	78	3.2	3	75	6.4
Means	12	79	2.9	9	84	3.8	5	80	3.4	6	112	6.5
Annual												
Northern	27	85	3.6	17	84	4.4	14	97	5.6	7	138	5.4
Southern	22	85	2.8	9	75	3.3	11	71	3.1	8	63	5.9
Means	49	85	3.3	26	81	4.0	25	86	4.5	15	98	5.7

PRESSURE LOW—AREA NO. 16.

June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	4	76	3.7	2	68	4.0	4	125	3.4	4	119	5.6
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	4	94	2.0	4	78	4.7	1	118	7.4	5	116	4.6
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	8	105	3.2	5	100	4.1	3	119	2.9	9	101	5.0
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	8	79	3.3	6	61	3.6	2	92	3.4	3	83	5.8
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	24	90	3.1	17	77	4.1	10	116	3.7	21	106	5.1
Means	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds, grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 15.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
19	84	4.8	6	78	4.9	2	89	4.9	5	119	3.4	..	...	....	13	95	4.3
16	65	3.4	10	55	4.2	2	122	2.5	14	107	7.1	6	102	4.0	32	90	5.3
35	75	4.2	16	63	4.5	4	106	3.7	19	110	6.1	6	102	4.0	45	94	5.0
17	91	3.4	3	103	8.2	10	87	12.5	4	121	16.3	6	155	20.0	23	113	14.5
11	87	3.2	5	82	4.2	7	94	4.9	6	127	6.4	4	104	6.7	22	102	5.5
28	89	3.3	8	90	5.7	17	90	9.4	10	125	10.4	10	135	14.7	45	107	10.1
19	100	4.7	6	85	7.1	6	105	16.0	3	183	16.4	2	138	9.0	17	116	12.1
1	89	4.2	..	...	....	2	107	6.8	1	160	9.7	..	...	....	3	125	7.8
20	99	4.7	6	85	7.1	8	106	13.7	4	177	14.7	2	138	9.0	20	117	11.5
10	102	4.7	2	105	10.3	4	157	6.8	1	129	4.3	9	174	30.4	16	158	20.4
22	80	3.5	8	63	5.5	1	104	3.2	4	121	11.4	6	115	4.2	19	94	6.2
32	86	3.9	10	72	6.4	5	146	6.1	5	123	10.0	15	151	19.7	35	123	12.7
65	93	4.4	17	88	6.9	22	105	11.7	13	135	13.5	17	163	24.2	69	121	13.9
50	77	5.2	23	63	4.7	12	102	4.7	25	116	7.7	16	108	4.8	76	96	5.7
115	86	4.8	40	74	5.6	34	104	9.3	38	122	9.7	35	136	13.9	145	108	9.6

PRESSURE LOW—AREA NO. 16.

..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
14	101	4.2	6	100	3.2	5	85	5.5	12	94	5.2	2	125	3.3	25	96	4.6
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
14	99	4.1	8	100	4.2	13	106	11.0	2	85	8.9	6	144	19.6	29	111	10.7
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
25	104	4.0	3	133	4.9	12	214	13.6	2	80	18.4	7	67	7.8	24	150	11.2
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
19	75	3.8	4	108	6.5	5	76	11.8	6	111	5.5	4	19	11.9	19	82	8.7
..	...	....	..	...	....	..	...	....	..	...	...	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
72	95	4.0	21	106	4.4	35	136	11.2	22	96	6.8	19	87	11.9	97	111	8.9
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 17.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	1	116	5.0	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	1	126	5.3	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	1	105	8.0	1	95	4.7	5	114	7.5
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	3	116	6.1	1	95	4.7	5	114	7.5
Means	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 18.

June, July, Aug.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	1	41	....	..	...	....	3	25	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	3	154	3.0	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	2	122	4.0	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	..	...	....	..	...	....	..	...	....	..	...	....
Southern	2	122	4.0	4	126	3.0	..	...	....	3	25	....
Means	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 17.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
1	116	5.0	..	...	....	1	50	5.7	4	20	6.8	1	222	7.3	6	59	6.7
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
1	126	5.3	2	158	4.9	7	182	14.6	4	69	7.7	11	133	12.3	24	139	11.6
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
7	110	7.2	..	...	....	7	334	13.8	3	63	5.7	4	354	12.5	14	282	11.7
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	...	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
9	112	6.9	2	158	4.9	15	244	13.6	11	50	6.8	16	193	12.0	44	173	10.9
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

PRESSURE LOW—AREA NO. 18.

..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
4	17	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
3	154	3.0	4	37	0.2	3	136	6.5	2	90	2.6	..	...	....	9	82	2.8
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	3	128	7.1	..	...	....	2	63	4.3	5	102	6.0
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
2	122	4.0	3	63	3.6	..	...	....	3	65	1.6	1	199	8.9	7	83	3.5
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
9	91	3.3	7	48	1.7	6	132	6.8	5	75	2.0	3	108	5.8	21	87	3.8
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 19.

Clouds	Ci.			Ci. S.			Ci. Cu.			A. S.		
Seasons	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
June, July, Aug.												
Northern	3	82	5.4	3	86	3.0	3	90	4.4	1	114	2.0
Southern	1	42	1.3	..	...	....	..	...	....	..	...	....
Means	4	72	4.4	3	86	3.0	3	90	4.4	1	114	2.0
Sept., Oct., Nov.												
Northern	4	97	8.9	3	80	4.9	2	78	4.3	3	31	8.4
Southern	..	...	....	2	120	5.5	..	...	....	3	267	5.9
Means	4	97	8.9	5	96	5.1	2	78	4.3	6	149	7.2
Dec., Jan., Feb,												
Northern	10	68	5.5	9	75	6.6	6	73	7.3	3	59	5.5
Southern	3	93	1.7	..	...	....	3	45	3.2	..	...	....
Means	13	74	4.6	9	75	6.6	9	64	5.9	3	59	5.5
Mar., Apr., May												
Northern	15	61	3.2	4	57	4.5	1	354	4.8	1	115	8.3
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	15	61	3.2	4	57	4.5	1	354	4.8	1	115	8.3
Annual												
Northern	32	70	4.8	19	74	5.3	12	102	5.9	8	62	6.5
Southern	4	80	1.6	2	120	5.5	3	45	3.2	3	267	5.9
Means	36	71	4.5	21	78	5.3	15	90	5.3	11	118	6.3

PRESSURE LOW—AREA NO. 20.

June, July, Aug.												
Northern	25	86	2.5	15	80	3.4	22	87	3.9	18	90	5.8
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Sept., Oct., Nov.												
Northern	16	98	3.4	9	97	4.1	10	106	4.5	8	108	4.8
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Dec., Jan., Feb.												
Northern	29	94	5.3	17	94	5.5	11	104	6.2	8	101	5.9
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Mar., Apr., May												
Northern	24	85	5.4	9	119	5.7	5	113	3.6	8	104	4.6
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....
Annual												
Northern	94	90	4.2	50	95	4.6	48	97	4.5	42	96	5.3
Southern	..	...	....	..	...	....	..	...	....	..	...	....
Means	..	...	....	..	...	....	..	...	....	..	...	....

TABLE 32.—*Direction and velocity of the upper and lower clouds grouped by seasons*—Continued.

PRESSURE LOW—AREA NO. 19.

Mean			A. Cu.			S. Cu.			Cu.			S.			Mean		
No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
10	89	4.0	3	38	5.3	4	35	7.0	7	89	9.5	1	51	6.9	15	62	7.9
1	42	1.3	..	..	...	..	...	....	2	283	2.0	..	...	....	2	283	2.0
11	85	3.8	3	38	5.3	4	35	7.0	9	132	8.0	1	51	6.9	17	88	7.2
12	71	7.0	5	83	8.7	18	51	10.6	8	39	12.7	11	56	15.8	42	54	12.1
5	208	5.7	3	39	7.8	2	30	15.6	5	47	23.2	2	358	11.0	11	94	16.1
17	113	6.6	8	67	8.4	20	49	11.1	13	42	16.7	13	44	15.1	54	63	13.0
28	70	6.2	3	87	5.6	17	51	13.2	8	99	17.2	5	35	11.4	33	64	13.2
6	69	2.5	2	101	1.5	2	5	4.7	1	40	1.0	1	160	2.0	6	69	2.6
34	70	5.6	5	93	4.0	19	46	12.3	9	92	15.4	6	56	9.8	39	64	11.6
21	77	3.8	9	109	6.3	23	86	10.0	14	67	9.5	13	97	9.3	59	87	9.2
..	...	....	1	57	2.8	..	...	....	..	...	....	..	...	....	1	57	2.8
21	77	3.8	10	104	6.0	23	86	10.0	14	67	9.5	13	97	9.3	60	87	9.1
71	75	5.3	20	89	6.6	62	63	10.9	37	72	11.9	30	70	11.9	149	70	10.8
12	126	3.7	6	63	4.9	4	18	10.2	8	105	15.1	3	292	8.0	21	103	10.2
83	83	5.1	26	83	6.2	66	61	10.8	45	78	12.5	33	90	11.6	170	74	10.7

PRESSURE LOW—AREA NO. 20.

80	85	3.7	43	74	5.1	30	81	6.3	78	61	7.6	7	80	12.0	158	69	6.8
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
43	102	4.1	15	85	4.8	54	66	9.5	7	60	7.5	19	62	12.2	95	69	9.1
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	.	...	....	..	...	....	..	...	....
65	97	5.6	7	102	7.2	18	71	10.0	16	79	10.6	14	75	10.3	55	78	9.8
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
46	119	5.0	8	95	6.6	25	86	7.8	36	63	9.5	7	67	8.6	76	74	8.5
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
234	98	4.5	73	81	5.4	127	74	8.5	137	64	8.4	47	69	11.1	384	71	8.2
..	...	....	..	...	....	..	...	....	..	...	....	..	..	....	..	...	....
..	...	....	..	...	....	..	...	....	..	...	....	..	..	....	..	...	....

TRANSFER OF THE VECTORS OF TABLE 32 TO CHARTS.

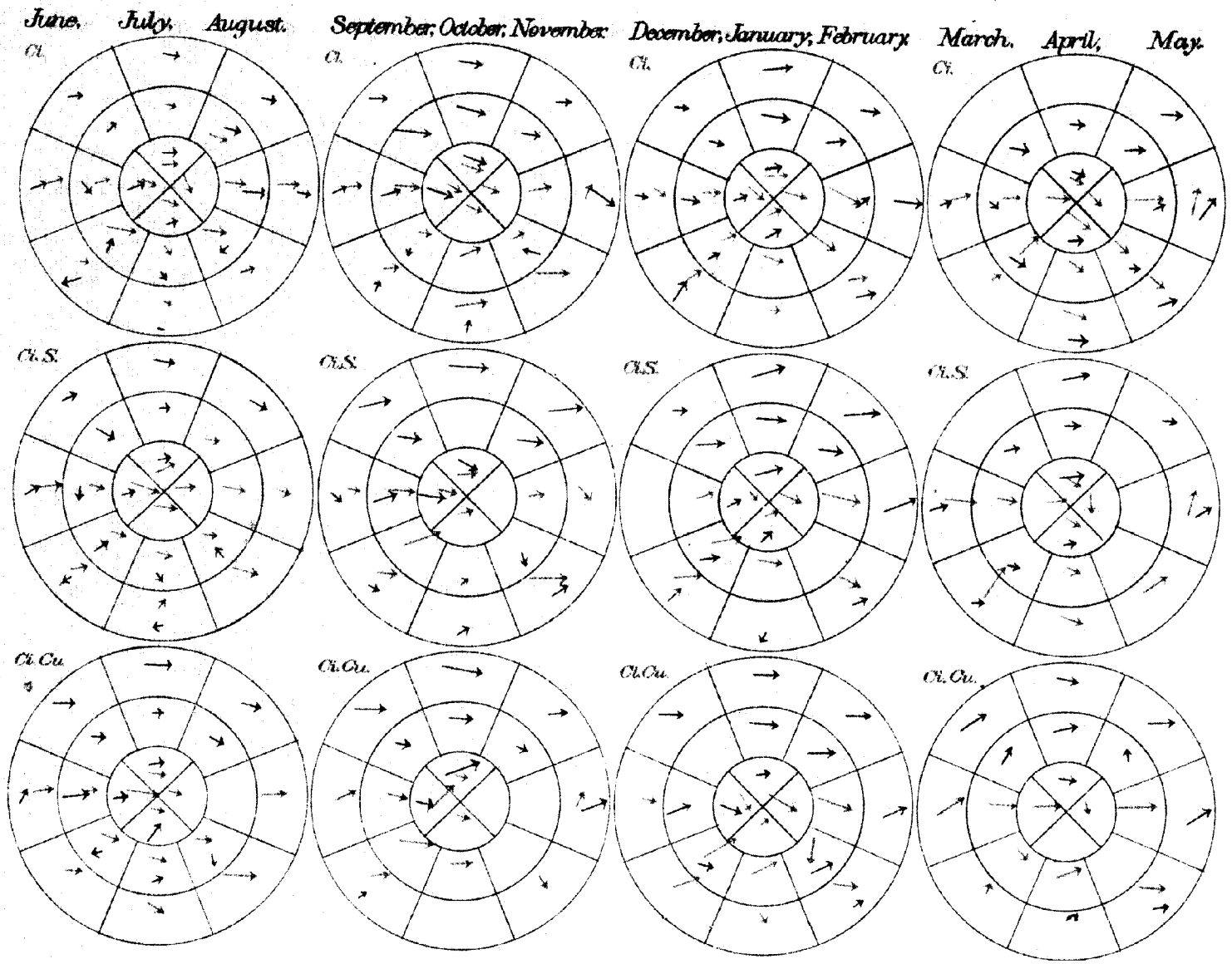
Table 32 therefore contains the seasonal vectors of the different cloud levels as projected upon the 1,000-meter plane, grouped in the northern, the southern, and the mean values for each level; also the four upper and the four lower combined together; and finally the entire system gathered up in a mean annual vector. As each minor area is collected separately, there are twenty tables for the highs and the lows, respectively. The sums are all weighted by the number of observations, and checked by arriving at the same mean by the up and down and the right and left summations. In order to exhibit the results graphically, these vector quantities are plotted on Charts 13, a, b, c, d, e, f, entitled "Seasonal vectors on the 1,000-meter plane in high and low areas." The northern vectors appear as red arrows and the southern as blue arrows; each cloud level is plainly marked, and the entire circulation can be readily inspected. Charts 13, a, b, c, are for high areas; and Charts 13, d, e, f, are for low areas. Table 32 shows the number of observations available in each circuit, and Chart 13 displays the areas which are entirely lacking. It is observed that the northern areas have no vectors in the highs and lows, as explained above, for lack of stations to the north of the average storm tracks, that is, chiefly in the Canadian provinces. One sees that while there is very considerable irregularity among the adjacent vectors as regards the ideal, smooth, and well-balanced system which we are seeking to obtain, yet the general laws of the circulation are very prominently exhibited. Thus (1) in the three upper levels the deflection from a simple eastward drift is very slight; (2) in the three intermediate levels the tendency to a distinct deflection is decidedly increased, and (3) in the three lower levels the anticyclonic and cyclonic circulation supersedes that of the eastward drift; (4) in the upper levels in each of the four seasons, for the northern and the southern circuits, there appears to be but little variation among the vector systems; (5) as approach is made to the ground the southern circuit produces smoother and better developed anticyclonic and cyclonic circulations than the northern; (6) in the winter months these circulations extend from the ground upward considerably higher, certainly to the alto-stratus, than in the summer, the gyratory components of the atmosphere being deeper in the colder months. It is quite noticeable that the vectors of the southern circuits come round from the eastward drift into the true anticyclonic gyration quicker than the northern, especially in the strato-cumulus and the cumulus region. It is also to be observed that the high areas present a much firmer circulation than the low areas, and that the cyclonic circulation of the surface winds is maintained in the upper levels but little above the ground before merging into the eastward drift.

REDUCTION OF THE RELATIVE VELOCITIES ON THE 1,000-METER PLANE TO THE ACTUAL VELOCITIES OF THE SEVERAL STRATA.

In order to exhibit the actual velocities as observed in the several cloud levels, without the preceding projection on the 1,000-meter plane, the velocities of Table 32 are to be multiplied by the factors of Table 8. This has been done, and the results are collected together in convenient form on Tables 34–51, where the outcome of the nephoscope work is summarized as briefly as possible. The description will follow the order of the introductory summary Table 33, the details of the same being found on the successive tables.

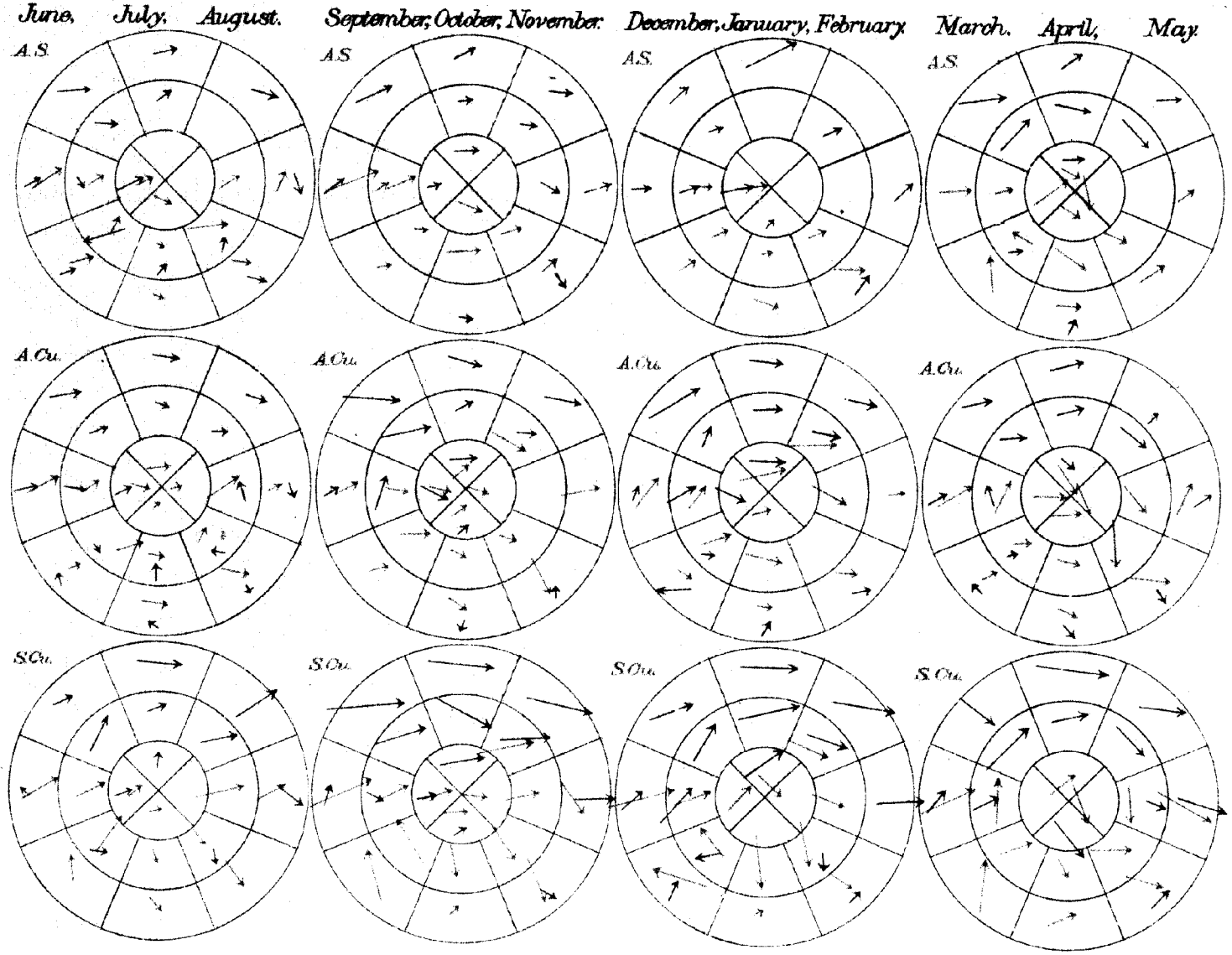
Seasonal Vectors on the 1,000 Meter Plane in High and Low Areas.

Chart 13. a.



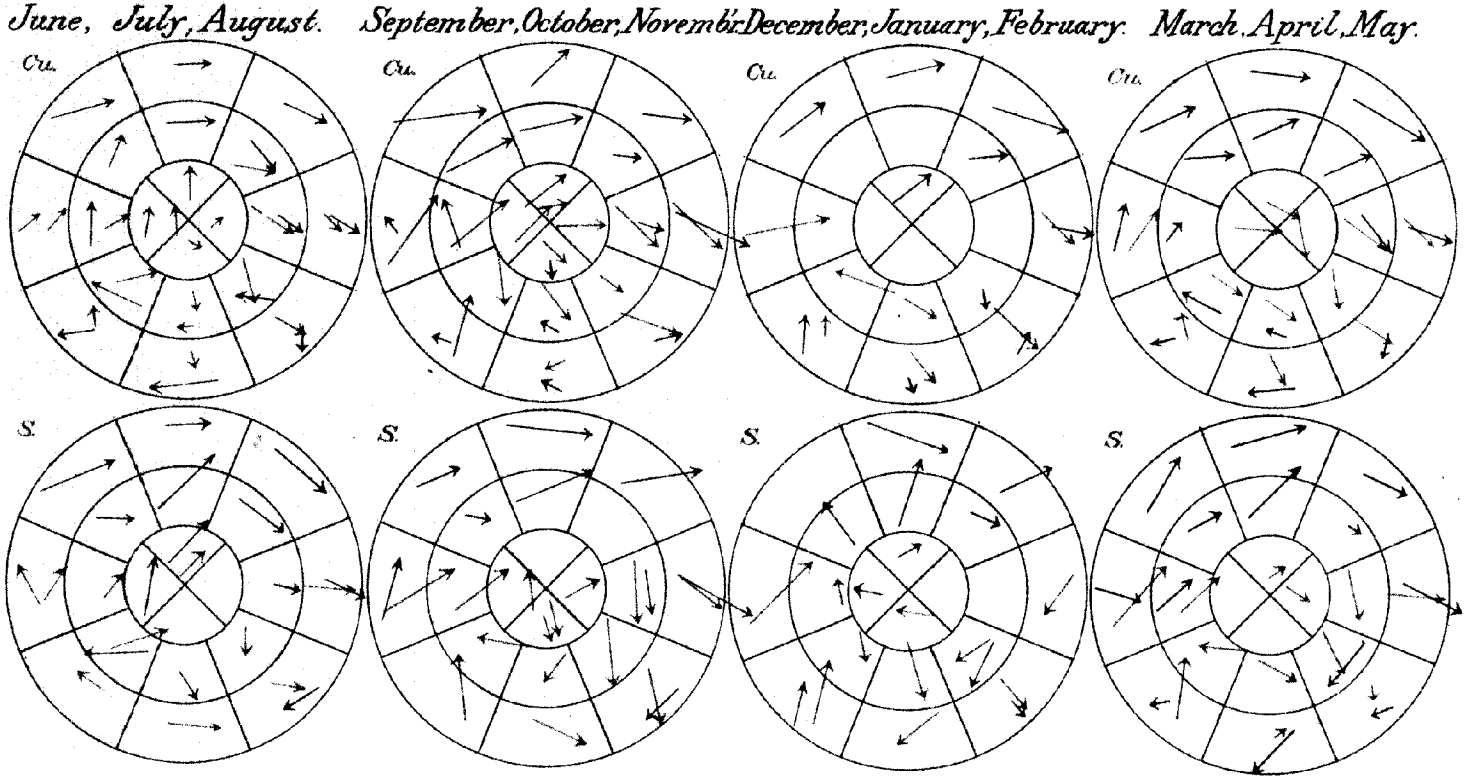
Seasonal Vectors on the 1,000 Meter Plane in High and Low Areas.

Chart 13, b.



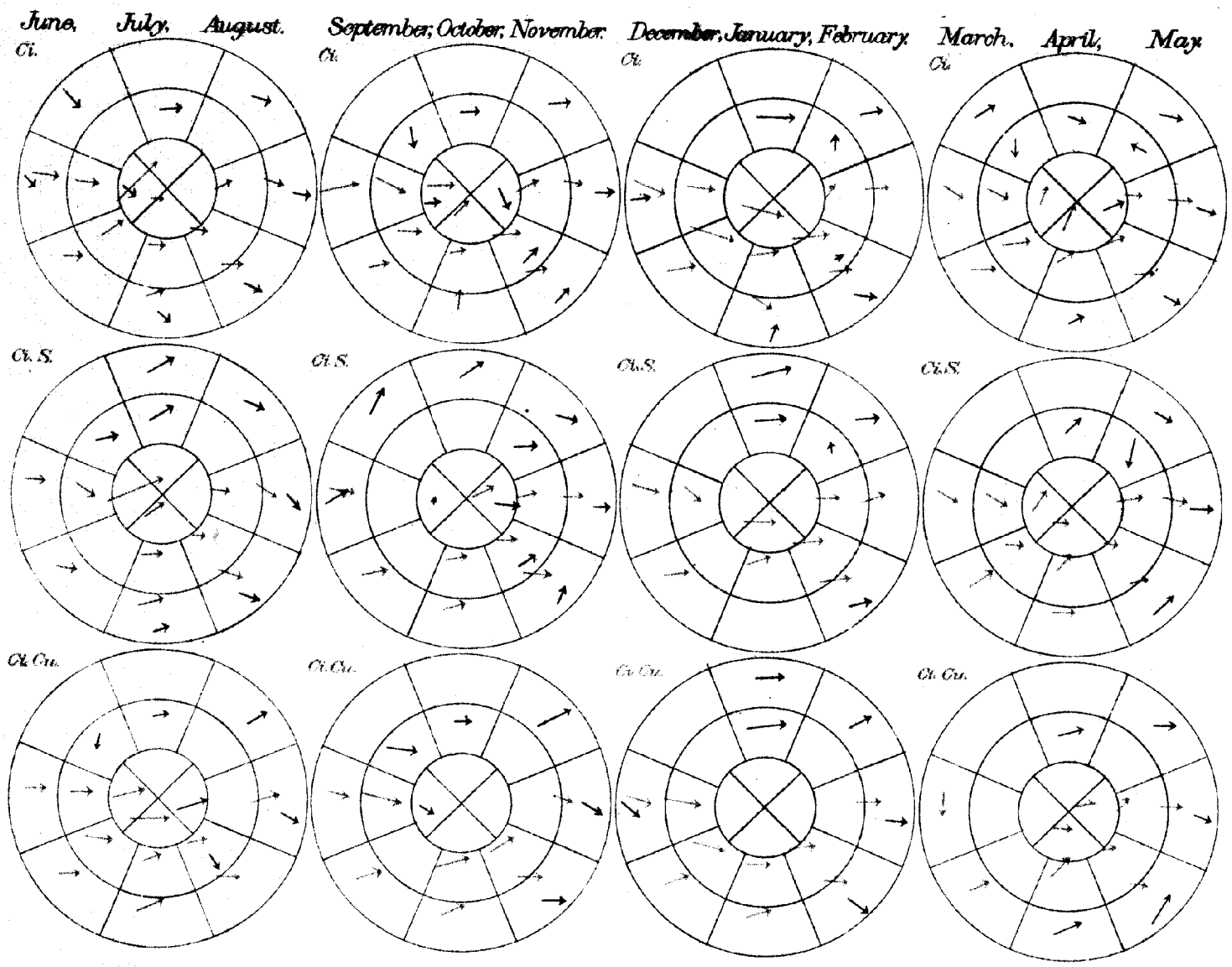
Seasonal Vectors on the 1,000 Meter Plane in High and Low Areas.

Chart 13. c.



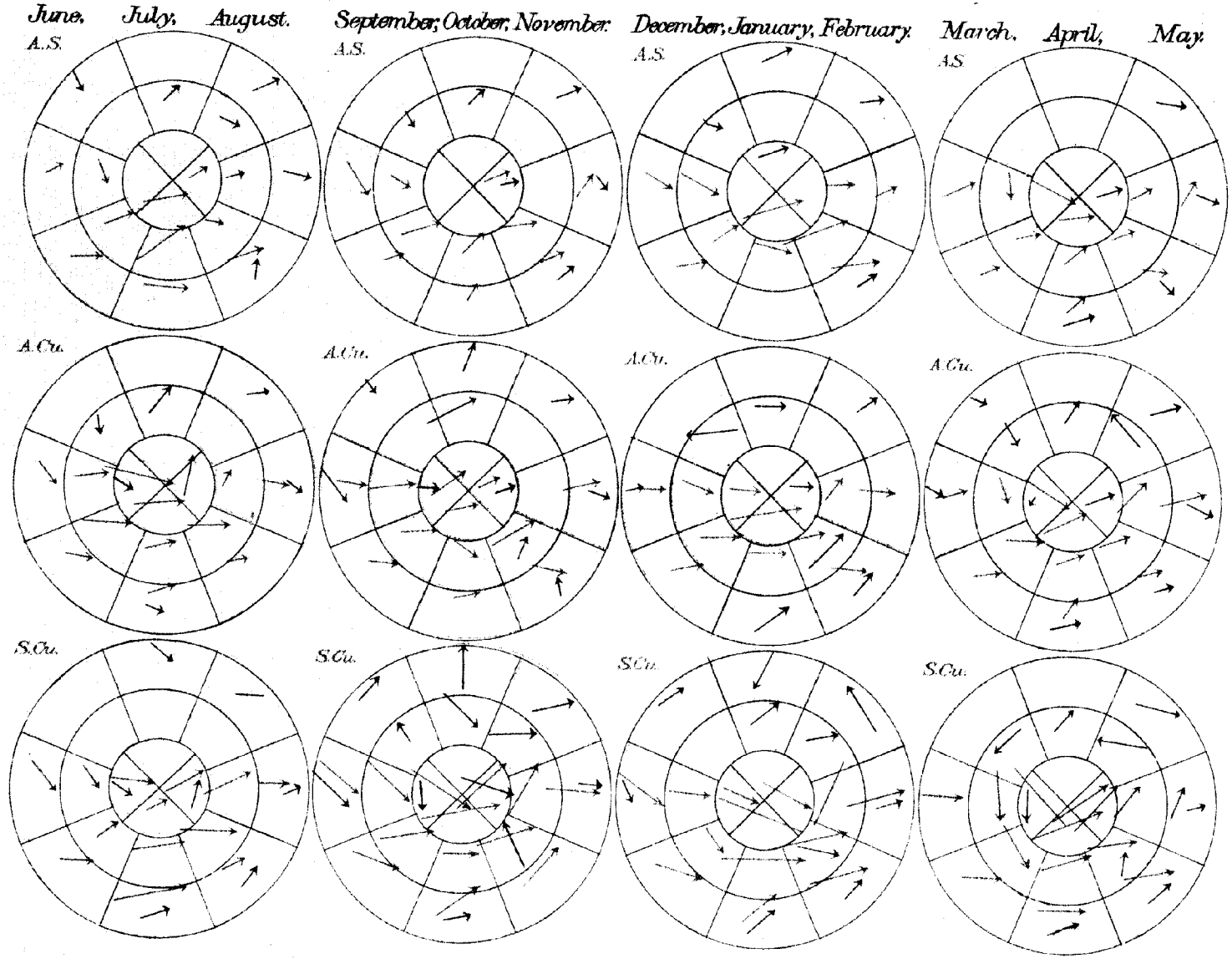
Seasonal Vectors on the 1,000 Meter Plane in High and Low Areas.

Chart 13, d.



Seasonal Vectors on the 1,000 Meter Plane in High and Low Areas.

Chart 13, e.



Seasonal Vectors on the 1,000 Meter Plane in High and Low Areas.

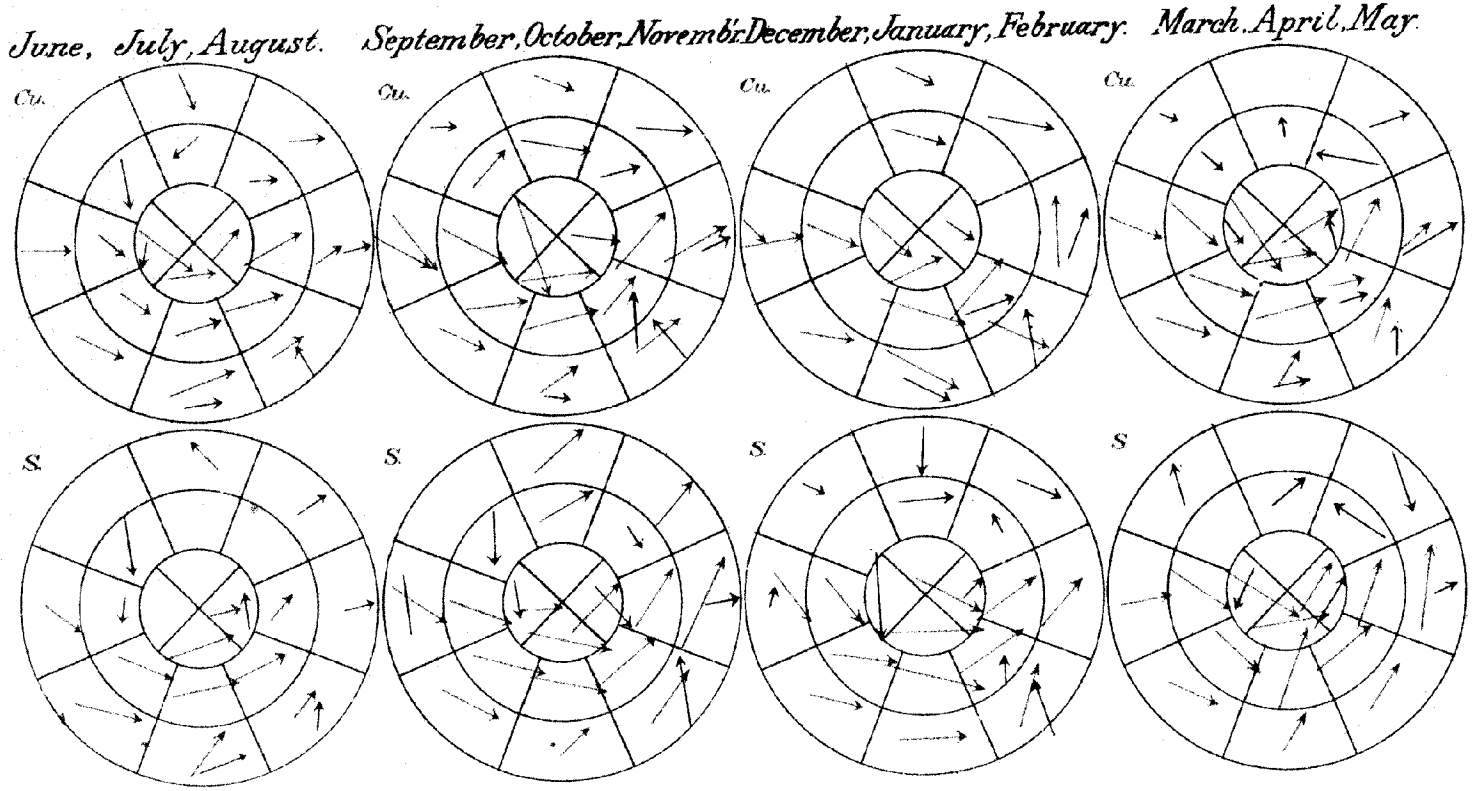


TABLE 33.—*Summary of the resulting general velocities.*

I.—TOTAL VELOCITY IN HIGHS AND LOWS WITHOUT REGARD TO DIRECTIONS.

Clouds	Ci.	Ci. S.	Ci. Cu.	A. S.	A. Cu.	S. Cu.	Cu.	S.	Wind	Range	From table—
Height in kilometers	9.8	9.8	8.1	5.9	4.5	2.5	1.5	0.9	0		
HIGH AREAS										*Per ct.*	
Total motion	34.9	39.1	33.5	30.2	23.5	23.3	11.2	11.4	4.8	.....	34
Northern	38.3	42.6	33.9	31.1	26.6	22.7	10.9	12.2	4.9	.....	35
Southern	30.4	34.8	30.5	24.1	19.7	18.5	10.4	9.5	4.8	19	36
LOW AREAS											
Total motion	40.8	39.8	39.3	36.0	29.2	28.6	14.6	11.1	5.4	15	38
Northern	44.6	42.5	43.8	39.4	32.6	32.9	17.4	13.2	5.3	.....	39
Southern	28.3	36.3	34.8	30.5	24.4	21.1	11.8	8.6	5.9	28	40

II.—SOUTHWARD AND EASTWARD COMPONENTS OF VELOCITIES IN HIGHS AND LOWS.

Clouds	Ci.	Ci. S.	Ci. Cu.	A. S.	A. Cu.	S. Cu.	Cu.	S.	Wind		From table—
HIGH AREAS											
+ S — N	+ 1.97	+ 1.65	− 0.60	− 0.37	− 0.07	− 0.32	− 0.13	−1.22	−0.69	.....	42
+ E — W	+33.7	+32.0	+32.6	+27.2	+22.1	+16.0	+ 5.1	+5.8	+1.1	.....	
LOW AREAS											
+ S — N	− 5.26	− 9.24	− 3.00	− 4.60	− 2.38	− 4.00	− 0.11	−1.32	−0.40	.....	43
+ E — W	+39.4	+35.9	+37.2	+31.3	+24.3	+24.3	+11.4	+7.8	+1.5	.....	

III.—MEAN NORMAL COMPONENTS OF VELOCITY FOR THE UNITED STATES.

Northward	− 1.6	− 3.8	− 1.8	− 2.5	− 1.2	− 2.2	−0.1	−1.3	−0.5	.....
Eastward	+36.6	+34.0	+34.9	+29.2	+23.2	+20.2	+8.3	+6.8	+1.3	.....

IV.—COMPONENT VELOCITIES IN SELECTED AREAS BETWEEN HIGH AND LOW CENTERS.

SELECTED AREAS											
Southward	+ 0.66	− 2.11	+ 4.95	+ 2.79	+ 6.24	+10.22	+6.52	+5.25	+2.23	.....	42
	+40.1	+36.9	+38.7	+26.5	+23.7	+22.1	+9.6	+7.5	+3.2	.....	
SELECTED AREAS											
Northward	− 3.75	− 3.89	− 7.34	− 7.47	− 7.78	−11.13	−8.13	−7.97	−3.25	.....	43
	+32.7	+38.9	+32.1	+31.0	+21.9	+17.1	+6.5	+5.1	+0.2	.....	

V.—SEASONAL VELOCITIES OF THE UPPER AND THE LOWER CLOUDS.

Clouds	Upper clouds 8.4					Lower clouds 2.4					From table—
Seasons	June	Sept.	Dec.	Nov.	Ann.	June	Sept.	Dec.	Nov.	Ann.	
HIGH AREAS											
Northern	30.8	33.7	37.5	41.7	35.5	12.8	23.2	24.9	21.8	20.0	48
Southern	24.2	35.6	36.0	27.7	29.1	16.3	17.8	20.0	18.2	17.2	49
LOW AREAS											
Northern	39.7	45.2	47.4	37.1	42.6	19.2	32.8	31.5	27.5	27.7	50
Southern	25.9	30.9	33.1	34.8	32.4	12.9	21.9	18.7	16.1	19.6	51

All velocities in meters per second (1 m. p. s = 2.2 miles per hour)

TABLE 34.—*Direction and velocity of the motion of the air in high areas—total.*

Direction	Area No.	Cirrus 9.8			Ci. Strat. 9.8			Ci. Cum. 8.1			Alto Strat. 5.9			Alto Cum. 4.5			Strat. Cu. 2.5			Cumulus 1.5			Stratus 0.9			Wind		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	25	86	35.3	14	102	33.3	6	83	20.3	7	69	26.1	13	114	21.6	10	152	18.5	10	66	4.9	2	136	7.2	40	255	3.3
E	2	16	57	43.1	9	32	41.2	5	73	25.1	1	70	43.0	11	70	22.5	20	31	22.3	5	79	9.9	2	87	16.6	45	71	3.6
N	3	49	76	31.4	35	81	43.1	20	94	35.6	3	81	26.5	15	80	33.3	12	134	17.8	13	145	10.3	10	131	7.1	67	157	4.0
W	4	30	78	36.3	14	89	45.1	13	87	43.7	17	107	43.7	23	100	26.1	14	126	11.5	14	142	12.3	27	180	15.4	53	209	4.0
S	5	37	66	37.2	21	53	17.6	15	95	27.5	15	77	18.9	28	73	18.5	41	6	22.3	55	330	10.1	22	355	16.2	102	304	4.7
SE	6	20	67	32.3	16	50	22.5	12	55	34.0	17	356	26.0	27	33	23.0	27	39	32.3	77	315	10.8	17	352	9.6	81	320	5.3
E	7	23	90	58.8	8	80	63.7	5	74	63.2	5	111	27.0	9	127	27.5	18	70	20.8	26	54	12.0	7	30	8.9	57	36	4.5
NE	8	43	89	29.4	15	109	35.3	11	98	29.2	7	85	24.8	33	83	31.5	26	84	23.8	36	58	10.9	17	58	7.7	73	98	6.1
N	9	51	81	34.3	23	92	31.4	32	94	34.0	24	63	27.0	55	89	16.7	43	87	29.0	75	97	13.5	39	131	14.1	96	138	4.6
NW	10	34	117	38.2	21	84	50.0	17	96	21.9	13	96	30.7	34	109	20.7	30	136	29.8	65	153	9.0	18	115	8.2	92	149	4.4
W	11	42	80	37.2	29	77	34.3	18	92	30.0	31	102	25.1	45	124	23.9	36	123	22.8	50	155	8.7	23	137	12.7	96	184	4.7
SW	12	12	107	14.7	10	117	35.3	2	107	20.3	3	115	44.2	7	82	6.8	3	339	17.0	18	247	14.7	8	274	9.7	93	262	4.0
S	13	38	95	31.4	46	85	21.6	6	83	14.6	17	57	17.1	52	72	15.3	15	116	8.0	74	331	7.8	26	13	9.2	102	327	4.3
SE	14	64	82	35.3	31	105	51.9	24	89	35.6	23	106	25.3	61	80	26.1	57	59	21.3	78	58	15.2	49	9	5.7	142	30	5.1
E	15	28	100	46.1	22	90	39.2	10	107	45.4	10	120	21.9	34	103	26.1	63	76	27.3	62	55	13.9	50	56	13.7	110	61	5.4
NE	16	58	85	28.4	29	85	51.9	35	85	37.3	19	86	29.5	51	80	26.1	41	71	35.5	77	68	13.8	26	91	16.0	102	103	6.2
N	17	27	88	36.3	26	92	48.0	24	91	48.6	23	111	39.5	56	80	25.7	79	86	30.5	75	97	10.1	38	92	10.0	143	121	4.7
NW	18	25	96	33.3	13	117	28.4	20	100	42.1	21	104	41.2	23	99	38.3	27	94	22.5	63	107	16.8	16	120	10.2	90	130	4.2
W	19	51	98	29.4	27	96	43.1	23	124	28.4	28	110	38.8	53	122	25.2	78	134	24.5	82	145	9.7	60	142	16.9	161	147	5.2
SW	20	63	109	30.4	37	86	45.1	25	105	34.0	26	122	28.3	46	118	14.9	46	206	27.8	74	207	9.2	57	189	13.8	134	197	4.2
Means		736	...	34.9	446	...	39.1	323	...	33.5	310	...	30.2	676	...	23.5	686	...	23.3	1029	..	11.2	514	...	11.4	1879	...	4.8
Adjusted vectors					**2**	**70**	**41.2**	**7**	**74**	**45.0**	**6**	**75**	**26.0**	**7**	**75**	**27.5**												
					7	**80**	**44.0**	**15**	**77**	**45.4**	**7**	**80**	**27.0**	**15**	**80**	**26.1**												
											15	**90**	**21.9**															

TABLE 35.—*Direction and velocity of the motion of the air in high areas—northern.*

Direction	Area No.	Cirrus 9.8			Ci. Strat. 9.8			Ci. Cum. 8.1			Alto Strat. 5.9			Alto Cum. 4.5			Strat. Cu. 2.5			Cumulus 1.5			Stratus 0.9			Wind		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	18	71	39.2	11	97	34.3	5	88	21.9	6	61	27.0	11	111	23.4	6	214	17.0	8	82	5.1	1	260	8.4	26	264	3.7
E	2	16	57	43.1	9	32	41.2	5	73	25.1	1	10	43.0	11	70	22.5	20	31	22.3	5	79	9.9	2	87	16.6	31	68	4.2
N	3	19	74	34.3	14	71	41.2	7	87	28.4	1	58	23.6	10	75	24.3	3	159	17.3	6	108	10.7	3	124	3.2	26	134	4.5
W	4	20	67	36.3	8	74	41.2	10	89	47.8	7	111	53.0	8	103	29.7	9	138	12.5	7	150	14.4	1	185	12.8	25	205	5.0
S	5	33	69	35.3	6	78	37.2	13	94	30.8	13	71	20.1	22	69	20.3	39	12	23.3	26	40	9.5	20	67	16.7	81	315	4.6
SE	6	11	81	43.1	5	83	33.3	8	50	37.3	11	96	34.1	19	91	30.6	25	43	34.0	33	18	11.7	13	0	9.9	51	2	5.5
E	7	17	81	68.6	8	80	63.7	5	74	63.2	4	124	30.7	6	96	35.1	15	72	23.0	18	54	13.4	4	10	11.5	35	41	4.5
NE	8	1	70	37.2	..	...	....	..	...	....	..	...	....	14	91	44.1	6	77	24.5	3	80	10.6	..	...	....	12	56	5.9
N	9	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	1	134	9.4
NW	10	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	11	194	4.9
W	11	27	82	35.3	22	89	36.3	14	89	26.5	23	105	27.7	26	129	23.0	24	129	23.0	19	118	8.1	20	138	14.7	62	192	5.2
SW	12	18	98	34.3	10	87	54.9	11	80	42.1	11	153	21.8	20	97	26.1	27	319	26.0	24	45	12.5	29	349	12.2	66	264	4.3
S	13	29	85	34.3	23	111	25.5	4	87	14.6	8	84	18.9	35	69	21.6	15	116	8.0	47	14	7.2	21	42	10.2	70	343	3.6
SE	14	54	78	35.3	25	101	55.9	21	81	38.9	18	111	27.1	52	78	29.3	53	55	22.3	63	56	17.1	38	24	5.7	111	32	5.4
E	15	10	105	37.2	8	114	33.3	6	106	35.6	7	147	23.6	14	121	21.2	28	72	26.3	31	42	12.2	21	43	14.0	50	35	6.1
NE	16	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
N	17	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....
NW	18	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	7	46	13.8
W	19	31	96	33.3	18	93	48.0	18	107	29.2	18	110	50.6	28	121	32.9	51	118	33.5	37	134	11.7	42	137	20.7	89	152	13.9
SW	20	56	111	27.4	29	105	51.0	23	106	33.2	22	122	33.6	39	103	15.3	45	207	28.0	50	177	9.9	55	187	13.8	112	189	25.2
Means		360	...	38.3	196	...	42.6	150	...	33.9	150	...	31.1	315	...	26.6	366	...	22.7	377	...	10.9	270	...	12.2	866	...	4.9

TABLE 36.—*Direction and velocity of the motion of the air in high areas—southern.*

Direction	Area No.	Cirrus 9.8			Ci. Strat. 9.8			Ci. Cum. 8.1			Alto Strat. 5.9			Alto Cum. 4.5			Strat. Cu. 2.5			Cumulus 1.5			Stratus 0.9			Wind		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	7	123	23.5	3	122	31.4	1	141	13.8	1	121	18.1	2	129	11.3	4	60	20.5	2	4	4.5	1	11	6.0	14	238	3.3
E	2	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	14	78	2.8
N	3	30	78	28.4	21	88	45.1	13	99	39.7	2	93	28.3	5	90	50.9	9	125	18.0	7	176	10.2	7	135	8.8	41	165	3.6
W	4	10	101	36.3	6	111	49.0	3	82	31.6	10	104	37.1	15	98	24.3	5	104	10.0	7	134	10.1	26	180	15.5	28	212	3.2
S	5	4	41	10.8	15	44	8.8	2	101	5.7	2	121	9.4	6	86	10.8	2	222	3.5	29	269	10.5	2	108	10.8	21	264	5.0
SE	6	9	47	19.6	11	263	17.6	4	64	28.4	6	171	10.0	8	257	4.5	2	7	10.0	44	266	10.2	4	325	8.8	30	250	4.5
E	7	6	118	28.4	..	...	....	..	...	....	1	60	12.3	3	189	12.2	3	57	10.8	8	55	9.0	3	56	5.3	22	28	4.5
NE	8	42	90	29.4	12	114	35.3	11	98	29.2	7	85	24.8	19	77	22.1	20	86	23.5	33	56	9.9	17	58	7.7	61	106	6.2
N	9	51	81	34.3	23	92	31.4	32	94	34.0	24	63	27.1	55	89	16.7	43	87	29.0	75	97	13.5	39	131	14.1	95	138	4.5
NW	10	34	117	38.2	21	84	50.0	17	96	21.9	13	96	30.7	34	109	20.7	30	136	29.8	65	153	9.0	18	115	8.2	81	143	4.3
W	11	15	77	40.2	7	39	28.4	4	99	41.3	8	93	17.0	19	120	24.8	12	112	22.3	31	178	9.0	3	133	4.6	34	168	3.9
SW	12	12	107	14.7	10	117	35.3	2	177	20.3	3	225	44.2	7	82	6.8	3	339	17.0	18	247	14.7	8	274	9.7	27	256	4.0
S	13	9	117	22.5	23	59	16.7	2	80	15.4	9	36	14.7	17	90	10.4	..	...	....	27	257	9.0	5	255	5.1	32	294	5.9
SE	14	10	104	37.2	6	122	35.3	3	142	17.0	5	90	20.6	9	129	9.9	4	119	10.5	15	63	6.9	11	316	5.7	31	22	4.2
E	15	18	97	51.9	14	76	43.1	4	110	59.9	3	56	17.7	20	90	29.7	35	79	28.0	31	69	15.8	29	66	10.3	60	85	4.8
NE	16	58	85	28.4	29	85	51.9	35	85	37.3	19	86	24.4	51	80	26.1	41	71	28.5	77	68	13.8	26	91	16.0	102	103	6.2
N	17	27	88	36.3	26	92	48.0	24	91	48.6	23	111	39.5	56	80	25.7	79	86	30.5	75	97	10.1	38	92	10.0	143	121	4.7
NW	18	25	96	33.3	13	117	28.4	20	100	42.1	21	104	41.2	23	99	38.3	27	94	22.5	63	107	16.8	16	120	10.2	83	138	4.3
W	19	20	100	25.5	9	99	37.2	5	160	25.9	10	108	25.3	25	123	16.7	27	164	7.5	45	153	6.5	18	155	9.1	72	141	3.9
SW	20	7	103	39.2	8	51	33.3	2	103	36.5	4	121	15.3	7	197	12.6	1	156	10.3	24	269	8.7	2	227	15.4	22	252	4.6
Means		374	...	30.4	257	...	34.8	184	...	30.5	171	...	24.1	381	...	19.7	347	...	18.5	676	...	10.4	273	...	9.5	1013	...	4.8

TABLE 37.—*Direction and velocity of the wind in high areas—means.*

Area No.	Alberta				Lakes				New England				Colorado				West Gulf				South Atlantic				Northern			Southern			Total		
	No.	φ	V_1	V_2	No.	φ	V_1	V_2	No.	φ	V_1	V_2	No.	φ	V_1	V_2	No.	φ	V_1	V_2	No.	φ	V_1	V_2	φ	V_1	V_2	φ	V_1	V_2	φ	V_1	V_2
1	1	314	0.9	0.5	12	281	3.6	2.0	13	245	4.0	2.4	1	0	4.0	4.0	7	248	2.9	1.3	6	206	3.7	2.1	264	3.7	1.6	238	3.3	2.5	255	3.3	2.1
2	..	...	...	..	23	59	3.6	1.4	8	95	6.0	0.1	2	28	3.1	2.7	4	238	2.4	1.1	8	69	2.9	0.8	68	4.2	1.6	78	2.8	1.5	71	3.6	1.5
3	..	...	...	...	18	142	4.0	1.9	8	117	5.5	1.8	..	...	...	...	4	124	4.4	4.0	37	169	3.5	2.6	134	4.5	1.9	165	3.6	3.3	157	4.0	2.6
4	..	...	...	...	10	239	4.5	3.0	15	182	5.4	3.6	1	90	4.5	4.5	4	212	3.7	3.1	23	202	3.0	1.7	205	5.0	3.3	212	3.2	3.1	209	4.0	3.2
5	2	45	4.1	2.9	66	315	4.2	3.3	13	299	6.5	4.0	2	335	9.8	7.2	1	45	4.0	4.0	18	248	4.5	3.1	315	4.6	3.4	264	5.0	4.8	304	4.7	4.1
6	..	...	...	...	50	2	5.4	3.6	1	0	8.0	8.0	2	341	8.5	6.3	8	180	2.7	2.3	20	264	4.7	4.0	2	5.5	5.8	250	4.5	4.2	320	5.3	4.8
7	1	45	2.2	1.8	34	41	4.5	2.5	..	...	...	...	3	42	11.4	8.1	14	25	3.0	2.0	5	25	4.4	2.4	41	4.5	2.1	28	4.5	4.2	36	4.5	3.4
8	..	...	...	...	11	57	5.1	2.9	1	45	14.3	14.3	3	49	8.6	7.9	9	194	3.9	0.2	49	94	6.5	3.3	56	5.9	8.6	106	6.2	3.9	98	6.1	5.8
9	..	...	...	...	..	...	...	...	1	134	9.4	6.7	..	...	...	...	5	134	3.3	2.5	90	138	4.6	2.4	134	9.4	6.7	138	4.5	1.6	138	4.6	3.3
10	..	...	...	...	6	171	5.9	4.9	5	222	3.9	2.3	2	214	4.7	4.0	4	162	5.0	4.8	75	140	4.2	1.5	194	4.9	3.6	143	4.3	3.4	149	4.4	3.5
11	..	...	...	...	14	203	4.0	2.4	48	189	5.5	3.8	2	23	4.5	4.0	4	206	5.2	4.7	28	163	3.7	1.7	192	5.2	3.1	168	3.9	3.5	184	4.7	3.3
12	3	0	1.0	0.8	32	260	4.0	2.2	31	260	4.9	2.8	..	...	...	...	8	246	3.8	2.0	19	261	3.9	3.1	264	4.3	1.9	256	4.0	2.5	262	4.0	2.1
13	..	...	...	...	67	344	3.6	1.4	3	320	2.8	1.4	9	303	3.2	1.8	..	...	...	...	23	290	7.0	6.6	343	3.6	1.4	294	5.9	4.2	327	4.3	2.8
14	26	66	4.1	2.0	85	22	5.8	3.2	..	...	...	...	27	14	4.0	1.8	1	318	8.9	6.3	3	90	4.5	2.3	32	5.4	2.6	22	4.2	3.5	30	5.1	3.1
15	5	64	4.7	3.3	44	29	6.3	3.6	1	134	4.5	3.1	43	90	5.1	3.2	17	72	4.2	1.5	..	...	...	...	35	6.1	3.3	85	4.8	2.4	61	5.4	2.9
16	..	...	...	...	..	...	...	...	..	...	...	...	4	62	5.6	2.2	22	71	5.1	3.0	76	115	6.5	4.0	...	...	...	103	6.2	3.1	103	6.2	3.1
17	..	...	...	...	..	...	...	...	..	...	...	...	..	...	...	...	9	175	3.7	1.2	134	117	4.7	3.0	...	...	...	121	4.7	2.1	121	4.7	2.1
18	..	...	...	...	5	355	4.2	2.4	2	174	3.6	2.4	1	270	4.5	4.5	..	...	...	...	82	136	4.3	2.2	46	4.1	2.4	138	4.3	3.8	130	4.2	3.1
19	..	...	...	...	11	193	4.0	2.5	78	146	6.6	4.3	3	66	2.1	1.0	..	...	...	...	69	145	4.0	2.4	152	6.2	3.4	141	3.9	2.7	147	5.2	3.0
20	1	45	0.6	0.4	45	204	4.2	1.2	66	181	4.1	0.9	..	...	..	...	3	119	3.1	1.4	19	268	4.8	3.8	189	4.1	0.8	252	4.6	2.6	197	4.2	1.5
Means	39	...	2.5	1.7	543	...	4.5	2.6	293	...	5.9	3.7	105	...	5.6	4.2	124	...	4.1	2.7	784	...	4.5	2.8	...	4.9	3.2	...	4.8	3.1	...	4.8	3.1

TABLE 38.—*Direction and velocity of the motion of the air in low areas—total.*

Direction	Area No.	Cirrus 9.8			Ci. Strat. 9.8			Ci. Cum. 8.1			Alto Strat. 5.9			Alto Cum. 4.5			Strat. Cu. 2.5			Cumulus 1.5			Stratus 0.9			Wind		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	7	111	51.0	7	102	30.4	9	89	55.1	10	89	52.4	14	106	45.0	36	109	55.8	28	94	16.8	29	94	13.4	60	108	7.8
E	2	4	96	40.2	4	109	44.1	2	105	40.5	7	111	23.6	9	124	28.4	34	113	35.0	11	123	9.7	2	122	11.4	36	151	5.9
N	3	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	20	277	5.0
W	4	6	104	58.8	4	150	47.0	3	90	46.2	3	76	57.7	19	68	40.5	36	47	35.3	23	18	16.3	22	29	13.4	50	36	5.7
S	5	50	97	31.4	30	105	35.3	21	109	47.0	24	127	52.0	57	86	26.6	62	96	25.5	81	102	16.8	35	95	14.3	123	110	5.6
SE	6	33	101	44.1	28	90	43.1	20	106	39.7	25	101	43.0	38	114	36.9	62	113	32.3	46	119	14.8	46	133	12.1	125	150	6.1
E	7	10	109	36.3	12	97	44.1	4	132	35.6	9	109	30.7	11	144	29.3	24	136	31.5	5	141	21.1	21	152	11.0	62	180	4.7
NE	8	..	...	....	4	150	31.4	..	...	....	2	65	28.9	..	...	....	14	89	23.0	7	145	15.7	5	191	6.9	31	304	4.0
N	9	7	90	49.0	7	125	38.2	5	98	22.7	9	130	18.9	6	126	45.9	7	94	21.8	7	38	14.4	17	110	9.7	29	349	4.4
NW	10	3	92	27.4	2	110	51.0	3	22	27.5	5	38	22.4	4	358	31.5	3	69	15.0	8	48	14.7	9	2	11.9	37	62	4.5
W	11	23	77	45.1	10	61	41.2	9	86	54.3	6	36	37.7	20	57	31.5	25	38	27.5	29	58	15.6	25	42	9.6	68	48	5.9
SW	12	6	105	56.8	3	87	13.7	3	81	55.9	7	128	35.3	11	85	40.5	19	79	39.5	16	79	20.3	20	67	14.0	121	71	5.1
S	13	27	123	33.3	7	102	21.6	8	107	24.3	13	113	36.5	38	105	19.8	29	114	28.5	56	99	13.9	35	132	8.7	76	145	4.1
SE	14	70	93	32.3	53	97	50.0	38	91	35.6	27	114	31.9	70	106	23.4	66	124	23.8	97	150	12.4	47	153	14.5	157	174	4.7
E	15	49	85	34.3	26	81	39.2	25	86	36.5	15	98	33.6	40	74	25.2	34	104	23.3	38	122	14.6	35	136	12.5	102	190	5.2
NE	16	24	90	30.4	17	77	40.2	10	116	30.0	21	106	30.0	21	106	19.8	35	136	28.0	22	96	10.2	19	87	10.7	75	210	4.5
N	17	..	...	....	3	116	59.8	1	95	38.1	5	114	44.2	2	158	22.1	15	154	34.0	11	50	10.2	16	193	10.1	31	332	4.5
NW	18	2	122	39.2	4	126	29.4	..	...	....	..	...	....	7	48	7.7	6	132	17.0	5	75	3.0	3	108	5.2	15	310	3.5
W	19	36	71	44.1	21	78	51.9	15	90	42.9	11	118	37.1	26	83	27.9	66	61	27.0	45	78	18.7	33	90	10.4	127	58	4.4
SW	20	94	90	41.2	50	95	45.1	48	97	36.5	42	96	31.2	73	81	24.3	127	74	21.3	137	64	12.6	47	69	10.0	247	82	4.7
Means		451	...	40.8	292	...	39.8	224	...	39.3	241	...	36.0	466	...	29.2	700	...	28.6	672	...	14.6	466	...	11.1	1592	...	5.4
Adjusted vectors					**4**	**80**	**47.0**	**10**	**90**	**27.5**	**5**	**97**	**52.0**	**9**	**126**	**26.0**	**8**	**119**	**23.0**									
								18	**107**	**34.5**	**8**	**115**	**28.9**	**10**	**40**	**31.5**	**9**	**124**	**21.8**									
											12	**90**	**35.3**	**15**	**105**	**25.2**	**15**	**154**	**24.0**									
											19	**78**	**37.1**															

TABLE 39.—*Direction and velocity of the motion of the air in low areas—northern.*

Direction	Area No.	Cirrus 9.8			Ci. Strat. 9.8			Ci. Cum. 8.1			Alto Strat. 5.9			Alto Cum. 4.5			Strat. Cu. 2.5			Cumulus 1.5			Stratus 0.9			Wind		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	7	111	51.0	7	102	30.4	9	89	55.1	10	89	52.5	14	106	45.6	36	109	55.8	28	94	17.0	29	94	13.4	53	105	7.1
E	2	..	...	....	3	116	47.0	1	98	40.5	2	115	29.5	3	152	35.6	21	116	36.8	5	131	11.1	12	110	16.7	20	142	6.6
N	3	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	9	342	6.5
W	4	4	122	76.4	2	130	80.4	2	106	55.9	2	60	57.7	13	73	50.0	30	53	39.0	13	39	23.0	10	77	14.9	35	48	6.0
S	5	50	97	31.4	30	105	35.3	21	109	47.0	24	127	53.0	57	86	26.6	62	96	25.5	81	102	16.8	35	95	14.3	106	109	5.8
SE	6	29	96	47.0	27	88	43.1	19	110	41.3	25	101	43.0	36	112	36.0	52	101	34.3	36	105	13.8	44	130	12.1	105	148	6.3
E	7	10	109	36.3	12	97	44.1	4	132	35.6	9	109	30.7	11	144	29.3	24	136	31.5	5	141	29.4	21	152	11.0	42	177	5.0
NE	8	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	3	304	3.7
N	9	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	...	...	...
NW	10	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	11	72	4.5
W	11	23	77	45.1	10	61	41.2	9	86	54.3	6	36	37.7	20	57	31.5	25	38	27.5	29	58	15.6	25	42	9.6	60	49	5.8
SW	12	6	105	56.8	3	87	13.7	3	81	55.9	7	128	35.3	11	85	40.5	19	79	39.5	16	79	20.3	20	67	14.0	112	75	5.0
S	13	23	125	33.3	6	100	22.5	5	114	20.3	11	115	35.9	27	111	19.4	19	113	33.5	39	99	15.5	31	135	8.6	65	144	3.8
SE	14	59	95	34.3	41	90	54.9	35	90	34.0	19	108	35.7	58	95	24.3	54	122	26.5	70	129	12.6	42	149	14.5	126	164	4.7
E	15	27	85	35.3	17	84	43.1	14	97	45.4	7	138	31.7	17	88	31.1	22	105	29.3	13	135	20.3	17	163	21.8	59	176	6.4
NE	16	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	2	360	4.0
N	17	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	...	...	...
NW	18	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	...	...	...
W	19	32	70	47.0	19	74	51.9	12	102	47.8	8	62	38.4	20	89	29.7	62	63	27.3	37	72	17.9	30	70	10.7	114	64	4.5
SW	20	94	90	41.2	50	95	45.1	48	97	36.5	42	96	31.2	73	81	24.3	127	74	21.3	137	64	12.6	47	69	10.0	240	83	4.7
Means		364	...	44.6	227	...	42.5	182	...	43.8	172	...	39.4	360	...	32.6	553	...	32.9	509	...	17.4	363	...	13.2	1162	...	5.3

TABLE 40.—*Direction and velocity of the motion of the air in low areas—southern.*

Direction	Area No.	Cirrus 9.8			Ci. Strat. 9.8			Ci. Cum. 8.1			Alto Strat. 5.9			Alto Cum. 4.5			Strat. Cu. 2.5			Cumulus 1.5			Stratus 0.9			Wind		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	..	....	..	...	....	..	...	....	7	132	8.8
E	2	4	96	40.2	1	87	35.3	..	...	....	5	109	20.6	6	110	24.8	13	110	32.0	6	117	8.7	9	138	4.4	19	161	5.1
N	3	..	...	....	..	...	....	..	...	....	.	...	....	..	...	....	..	...	....	..	...	....	..	...	....	11	214	3.9
W	4	2	70	22.5	2	171	13.7	1	57	26.7	..	...	....	6	58	20.3	6	22	16.3	10	352	7.8	12	350	12.1	15	9	5.1
S	5	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	17	118	5.2
SE	6	4	140	25.5	1	134	42.1	1	33	14.6	..	...	....	2	150	54.9	10	175	22.0	10	171	18.6	2	191	3.6	20	163	5.2
E	7	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	20	187	4.1
NE	8	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	28	304	4.4
N	9	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	29	349	4.4
NW	10	3	2	27.4	2	110	51.0	3	22	27.5	5	38	22.3	4	358	31.5	3	249	15.0	8	48	14.7	9	2	11.9	26	45	4.4
W	11	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	8	30	6.1
SW	12	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	9	31	6.8
S	13	4	110	33.3	1	110	12.7	3	95	80.2	2	106	40.0	11	88	20.7	10	118	18.5	17	92	9.9	4	108	10.0	11	150	5.9
SE	14	11	84	21.6	12	123	29.4	3	98	45.4	8	129	18.2	12	154	23.0	12	132	11.5	27	204	12.2	5	187	14.5	31	215	4.9
E	15	22	85	27.5	9	75	32.3	11	71	25.1	8	63	33.8	23	63	21.2	12	102	11.8	25	116	11.6	16	108	4.3	43	209	3.5
NE	16	24	90	30.4	17	77	40.2	10	116	30.0	21	106	30.0	21	106	19.8	35	136	28.0	22	96	10.2	19	87	10.7	73	216	4.5
N	17	..	...	....	3	116	59.8	1	95	38.1	5	114	44.3	2	158	22.1	15	244	34.0	11	50	10.2	16	193	10.8	31	332	4.5
NW	18	2	122	39.2	4	126	29.4	..	...	....	..	...	....	7	48	7.7	6	132	17.0	5	75	3.0	3	108	5.2	15	310	3.5
W	19	4	80	15.7	2	120	53.9	3	45	25.9	3	267	34.8	6	63	22.1	4	18	25.5	8	105	22.7	3	292	7.2	13	8	3.5
SW	20	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	..	...	....	7	46	4.5
Means		80	...	28.3	54	...	36.3	36	...	34.8	57	...	30.5	100	...	24.4	126	...	21.1	149	...	11.8	98	...	8.6	433	...	5.9

TABLE 41.—*Direction and velocity of the wind in low areas—means.*

Area No.	Alberta				Lakes				New England				Colorado				West Gulf				South Atlantic				Northern			Southern			Total		
	No.	φ	V_1	V_2	No.	φ	V_1	V_2	No.	φ	V_1	V_2	No.	φ	V_1	V_2	No.	φ	V_1	V_2	No.	φ	V_1	V_2	φ	V_1	V_2	φ	V_1	V_2	φ	V_1	V_2
1	2	154	2.0	1.0	42	106	7.9	6.8	9	85	8.1	7.2	..	...	...	...	4	113	5.4	5.0	3	157	5.5	4.1	105	7.1	5.0	132	8.8	4.6	108	7.8	4.8
2	..	...	...	...	16	141	6.1	3.9	4	145	8.8	5.4	3	151	5.6	5.4	15	172	4.7	1.9	1	32	9.8	9.8	142	6.6	4.7	161	5.1	5.7	151	5.9	5.3
3	..	...	...	...	6	32	3.8	0.7	3	343	11.9	8.9	..	...	...	...	7	187	4.1	1.0	4	261	3.5	2.4	342	6.5	4.8	214	3.9	1.7	277	5.0	2.6
4	..	...	...	...	15	56	4.8	4.0	20	42	6.9	4.2	..	...	...	...	4	46	5.5	4.9	11	356	4.9	3.2	48	6.0	4.1	9	5.1	4.0	36	5.7	4.0
5	1	135	3.1	3.1	69	109	4.6	3.3	36	108	8.1	6.7	5	177	5.0	3.7	9	100	4.8	2.8	3	72	6.7	2.3	109	5.8	4.4	118	5.2	2.9	110	5.6	3.3
6	5	147	3.5	3.1	94	149	6.3	4.7	6	131	8.6	7.2	6	155	6.5	3.9	12	157	4.7	3.0	2	225	4.9	4.9	148	6.3	5.0	163	5.2	3.9	150	6.1	4.5
7	6	201	4.1	2.5	36	173	5.2	3.5	..	...	...	...	6	197	5.5	4.6	9	200	4.2	3.0	5	153	2.3	0.9	177	5.0	3.0	187	4.1	2.8	180	4.7	2.9
8	..	...	...	...	3	304	3.7	3.0	..	...	...	...	5	310	4.1	2.3	16	306	4.3	1.6	7	295	4.9	3.3	304	3.7	3.0	304	4.4	2.4	304	4.0	2.6
9	..	...	...	...	..	...	...	...	..	...	...	...	..	...	...	...	9	19	3.1	2.4	20	335	5.0	2.0	...	...	...	349	4.4	2.2	349	4.4	2.2
10	..	...	...	...	4	64	4.2	3.6	7	76	4.7	1.3	1	45	0.9	0.4	3	0	4.5	4.5	22	319	4.5	2.5	72	4.5	2.5	45	4.4	2.5	62	4.5	2.5
11	..	...	...	...	11	39	5.1	3.8	49	51	6.0	3.1	..	...	...	...	5	23	5.6	4.5	3	41	7.0	1.8	49	5.8	3.5	30	6.1	3.1	48	5.9	3.3
12	2	0	2.4	2.4	35	89	3.9	2.7	75	70	5.6	4.2	..	...	...	...	6	26	6.8	3.3	3	45	6.7	3.2	75	5.0	3.1	31	6.8	3.2	71	5.1	3.2
13	1	225	5.4	5.4	53	150	3.8	2.3	11	75	3.9	1.9	6	164	5.7	4.5	..	...	...	...	5	134	6.2	3.5	144	3.8	3.2	150	5.9	4.0	145	4.1	3.5
14	23	198	4.0	2.4	103	157	4.8	3.1	..	...	...	...	18	195	5.3	4.0	11	224	4.2	2.8	2	339	5.1	1.9	164	4.7	0.9	215	4.9	1.1	174	4.7	1.0
15	5	216	3.3	1.5	54	172	6.7	3.7	..	...	...	...	18	185	3.0	1.4	24	220	3.9	2.0	1	360	1.3	1.3	176	6.4	2.6	209	3.5	1.6	190	5.2	2.0
16	..	...	...	...	2	0	4.0	0.9	..	...	...	...	7	341	3.1	0.3	49	194	4.2	0.8	17	80	6.0	2.2	360	4.0	0.9	216	4.5	1.1	210	4.5	1.0
17	..	...	...	...	..	...	...	...	..	...	...	...	1	45	4.0	2.7	6	52	3.6	0.8	24	309	4.8	2.0	...	...	...	332	4.5	1.8	332	4.5	1.8
18	..	...	...	...	..	...	...	...	..	...	...	...	..	...	...	...	..	...	...	...	15	310	3.5	1.0	...	...	...	310	3.5	1.0	310	3.5	1.0
19	2	45	2.2	2.2	11	79	4.9	3.9	101	63	4.5	2.0	..	...	...	...	2	18	1.8	1.3	11	6	3.8	2.2	64	4.5	2.7	8	3.5	1.8	58	4.4	2.3
20	5	202	3.8	1.5	45	45	4.1	2.0	190	89	4.9	3.0	..	...	...	...	2	142	3.3	1.3	5	7	5.2	2.3	83	4.7	2.2	46	4.5	1.8	82	4.7	2.0
Means	52	...	3.4	2.5	599	...	4.9	3.3	511	...	6.8	5.0	76	...	4.4	3.0	193	...	4.4	2.6	174	...	5.8	2.8	...	5.3	3.3	...	5.9	2.7	...	5.4	2.8

TABLE 42.—*Rectangular components of the velocities of motion in high areas—total.*

Direction	Area No.	Cirrus 9.8		Ci. Strat. 9.8		Ci. Cum. 8.1		Alto Strat. 5.9		Alto Cum. 4.9		Strat. Cu. 2.5		Cumulus 1.5		Stratus 0.9		Wind	
		S +	E +	S +	E +	S +	E +	S +	E +	S +	E +	S +	E +	S +	E +	S +	E +	S +	E +
S	1	+ 2.5	+35.2	− 6.9	+32.6	+ 2.5	+20.2	+ 9.3	+24.2	+ 8.8	+19.7	−16.3	+ 8.7	+ 4.5	+ 2.0	− 5.2	+ 5.0	− 0.9	− 3.2
E	2	+23.5	+36.2	+34.9	+21.8	+ 7.3	+24.0	+14.7	+41.4	+ 7.7	+21.2	+19.1	+11.5	+ 9.7	+ 1.9	+ 0.9	+16.6	+ 1.2	+ 3.4
N	3	+ 7.6	+30.5	+ 6.7	+42.6	− 2.5	+35.5	+ 4.1	+26.2	+ 5.8	+32.8	−12.4	+12.8	− 8.4	+ 5.9	− 4.7	+ 5.4	− 3.7	+ 1.6
W	4	+ 8.6	+35.5	+ 0.8	+45.1	+ 2.3	+43.7	−12.9	+41.8	− 4.5	+25.7	− 6.8	+ 9.4	− 9.7	+ 7.6	−15.4	0.0	− 3.6	− 2.0
S	5	+15.1	+34.0	+10.6	+14.1	− 2.4	+27.4	+ 4.3	+18.4	+ 5.4	+17.7	+22.2	+ 2.7	+ 8.7	− 5.1	+16.1	− 1.4	+ 2.6	− 3.9
SE	6	+12.6	+29.7	+14.5	+17.2	+19.6	+27.9	+26.0	− 1.7	+12.6	+19.4	+20.3	+25.1	+ 8.7	− 8.7	+ 9.6	− 1.3	+ 4.1	− 3.4
E	7	0.0	+58.8	+11.1	+62.7	+17.4	+60.7	− 9.7	+25.3	−16.6	+22.0	+ 7.1	+19.6	+ 9.8	+ 7.1	+ 7.7	+ 4.5	+ 3.6	+ 2.6
NE	8	+ 0.5	+29.4	−11.5	+33.4	− 4.0	+28.9	+ 2.1	+24.7	+ 3.8	+31.3	+ 2.5	+23.7	+ 9.2	+ 5.8	+ 4.1	+ 6.5	− 0.8	+ 6.0
N	9	+ 5.4	+33.9	− 1.1	+31.4	− 2.3	+34.0	+12.3	+24.0	+ 0.3	+16.7	+ 1.5	+29.0	− 2.9	+13.4	− 9.2	+10.6	− 3.4	+ 3.1
NW	10	−17.3	+34.0	+ 5.3	+49.8	− 2.3	+22.8	− 3.3	+30.6	− 6.7	+19.6	−21.4	+20.7	− 8.1	+ 4.1	− 3.4	+ 7.4	− 3.8	+ 2.3
W	11	+ 6.4	+36.6	+ 7.7	+33.4	− 1.1	+30.0	− 5.2	+24.8	−13.4	+19.8	−12.4	+19.1	− 7.9	+ 3.7	− 9.3	+ 8.7	− 4.7	− 0.1
SW	12	− 4.3	+14.1	−16.0	+31.5	− 5.9	+19.4	−18.7	+40.0	+ 9.4	+ 6.7	+16.0	− 6.1	− 5.7	−13.5	+ 0.7	− 9.7	− 0.1	− 4.0
S	13	− 2.7	+31.3	+ 1.9	+21.5	+ 1.8	+14.5	+ 9.4	+14.4	+ 4.7	+14.6	− 3.5	+ 7.3	+ 6.8	− 3.8	+ 2.1	+ 9.0	+ 3.6	− 2.3
SE	14	+ 4.9	+34.9	−13.4	+50.1	+ 0.6	+35.6	− 7.0	+24.3	+ 4.5	+25.7	+11.0	+18.3	+ 7.8	+12.9	+ 5.6	+ 0.9	+ 4.4	+ 2.6
E	15	− 8.0	+45.4	0.0	+39.2	−13.2	+43.4	−10.9	+19.0	− 5.9	+25.4	+ 6.6	+26.5	+ 8.0	+11.4	+ 7.7	+11.4	+ 2.6	+ 4.7
NE	16	+ 2.5	+28.3	+ 4.5	+51.7	+ 3.2	+37.2	+ 2.1	+29.5	+ 4.5	+25.7	+11.6	+33.6	+ 5.2	+13.8	− 0.3	+16.0	− 1.4	+ 6.0
N	17	+ 1.3	+36.3	− 1.7	+48.0	− 0.9	+48.6	+14.2	+36.9	+ 4.5	+25.3	+ 2.1	+30.4	− 1.2	+10.0	− 0.4	+10.0	− 2.4	+ 4.0
NW	18	− 5.2	+33.1	−12.9	+25.3	− 7.3	+41.5	− 9.9	+40.0	− 6.0	+37.8	− 1.6	+22.5	− 4.9	+16.2	− 5.1	+ 8.8	− 2.7	+ 3.2
W	19	− 4.1	+29.1	− 4.5	+43.0	−15.9	+23.5	−13.3	+36.0	−13.4	+21.4	−17.0	+17.8	− 7.9	+ 5.6	−13.3	+10.4	− 4.4	+ 2.8
SW	20	− 9.9	+28.8	+ 3.1	+45.1	− 8.8	+32.9	−14.9	+24.0	− 7.0	+13.2	−25.0	−12.2	− 8.2	− 4.2	−13.6	− 2.2	− 4.0	− 1.2
Means		+ 1.97	+33.7	+ 1.65	+32.0	− 0.60	+32.6	− 0.37	+27.2	− 0.07	+22.1	− 0.32	+16.0	− 0.13	+ 5.1	− 1.22	+ 5.8	− 0.69	+ 1.11
Normals		**− 1.6**	**+36.6**	**− 3.8**	**+34.0**	**− 1.8**	**+34.9**	**− 2.5**	**+29.2**	**− 1.2**	**+23.2**	**− 2.2**	**+20.2**	**− 0.1**	**+ 8.3**	**− 1.3**	**+ 6.8**	**− 0.5**	**+ 1.29**
Means		+ 0.66	+40.1	− 2.11	+36.9	+ 4.95	+38.7	+ 2.79	+26.5	+ 6.24	+23.7	+10.22	+22.1	+ 6.52	+ 9.6	+ 5.25	+ 7.5	+ 2.23	+ 3.2
Adjusted vectors				**2 +14.1**	**+38.7**			**6 +6.8**	**+25.2**										
				7 + 7.7	**+43.4**	**7 +12.4**	**+43.3**	**7 +4.7**	**+26.7**	**7 +7.1**	**+26.6**								
						15 +10.2	**+44.2**	**15 0.0**	**+21.9**	**15 +4.5**	**+25.7**								

H (1 to 20)

$\frac{H + L}{2}$ (1 to 20)

Southward

{H 16. 8. 2. 7. 15. 6. 14}
{L 18. 10. 4. 11. 19. 12. 20}

TABLE 43.—*Rectangular components of the velocities of motion in low areas—total.*

Direction	Area No.	Cirrus 9.8		Ci. Strat. 9.8		Ci. Cum. 8.1		Alto Strat. 5.9		Alto Cum. 4.5		Strat. Cu. 2.5		Cumulus 1.5		Stratus 0.9		Wind	
		S+	E+	S+	E+	S+	E+	S+	E+	S+	E+	S+	E+	S+	E+	S+	E+	S+	E+
S	1	−18.3	+47.7	− 6.3	+29.7	+ 1.0	+55.1	+ 1.0	+52.4	−12.4	+43.3	−18.2	+52.8	− 1.2	+16.8	− 0.9	+13.4	−2.4	+7.4
E	2	− 4.2	+40.0	−14.4	+41.7	−10.5	+39.9	− 8.4	+22.0	−15.9	+23.5	−13.7	+32.3	− 5.3	+ 8.2	− 6.0	+ 9.7	−5.2	+2.9
N	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+0.6	−5.0
W	4	−14.2	+57.0	−40.8	+23.5	0.0	+46.2	+14.0	+56.0	+15.2	+37.5	+24.1	+25.8	+15.5	+ 5.1	+11.7	+ 6.5	+4.6	+3.4
S	5	− 3.8	+31.2	− 9.1	+34.1	−15.4	+44.6	−32.0	+42.3	+ 1.9	+26.6	− 2.7	+25.4	− 3.5	+16.5	− 1.2	+14.2	−1.9	+5.3
SE	6	− 8.4	+43.3	0.0	+43.1	−11.0	+38.2	− 8.2	+42.2	−15.0	+33.7	−12.6	+29.7	− 7.2	+13.0	− 8.3	+ 8.8	−5.3	+3.1
E	7	−11.8	+34.3	− 5.4	+43.8	−23.8	+26.5	−10.0	+29.0	−23.7	+17.2	−22.6	+21.9	−16.4	+13.7	− 9.8	+ 5.2	−4.7	0.0
NE	8	....	....	−27.2	+15.7	....	....	+26.2	+12.2	....	....	+ 0.4	+23.0	−12.9	+ 9.0	− 6.8	− 1.3	+2.3	−3.4
N	9	0.0	+49.0	−21.9	+31.3	− 3.2	+22.5	−12.2	+14.5	−27.0	+37.1	− 1.5	+21.8	+11.3	+ 8.9	− 3.3	+ 9.1	+4.3	−0.8
NW	10	− 1.0	+27.4	−17.5	+48.0	+25.5	+10.3	+17.6	+13.7	+31.5	− 1.1	+ 5.4	+14.1	+ 9.8	+10.9	+11.9	+ 0.4	+2.1	+4.0
W	11	+10.1	+43.9	+20.0	+36.1	+ 3.8	+54.2	+30.5	+22.1	+17.2	+26.4	+21.7	+16.9	+ 8.2	+13.2	+ 7.1	+ 6.4	+3.9	+4.4
SW	12	−14.7	+54.9	+ 0.7	+13.7	+ 8.7	+55.2	−21.8	+27.8	+ 3.5	+40.3	+ 7.5	+38.8	+ 3.9	+19.9	+ 5.5	+13.0	+1.7	+4.8
S	13	−18.1	+27.9	− 4.5	+21.1	− 7.1	+23.2	−14.3	+33.7	− 5.1	+19.1	−11.6	+26.0	− 2.2	+13.7	− 5.8	+ 6.5	−3.4	+2.4
SE	14	− 1.6	+32.3	− 6.1	+49.7	− 0.6	+35.6	−13.0	+29.1	− 6.5	+22.5	−13.3	+19.7	−10.7	+ 6.2	−12.9	+ 6.6	−4.7	+0.5
E	15	+ 3.0	+34.2	+ 6.1	+38.7	+ 2.6	+36.4	− 4.7	+33.3	+ 7.0	+24.2	− 5.6	+22.6	− 7.7	+12.3	− 9.0	+ 8.7	−5.1	−0.9
NE	16	0.0	+30.4	+ 9.0	+39.2	−13.2	+27.1	− 8.3	+29.0	− 5.5	+19.0	−20.2	+19.5	− 1.1	+10.1	+ 0.6	+10.7	−3.9	−2.2
N	17	....	....	−26.1	+53.8	− 3.3	+37.9	−18.0	+40.4	−20.5	+ 8.3	−30.7	+14.9	+ 7.7	+ 6.5	− 9.8	− 2.3	+4.0	−2.1
NW	18	−20.8	+33.2	−17.3	+23.8	....	....	....	....	+ 5.2	+ 5.7	−11.4	+12.7	+ 0.7	+ 2.9	− 1.6	+ 4.9	+2.2	−2.7
W	19	+14.4	+41.7	−10.8	+50.8	0.0	+42.9	−18.0	+32.8	+ 3.4	+27.7	+13.1	+23.7	+ 3.9	+18.3	0.0	+10.4	+2.3	+3.7
SW	20	0.0	+41.2	− 3.9	+44.9	− 4.5	+36.2	− 3.3	+31.1	+ 3.8	+24.0	+ 5.9	+20.5	+ 5.5	+11.3	+ 3.6	+ 9.3	+0.7	+4.7
Means		− 5.26	+39.4	− 9.24	+35.9	− 3.00	+37.2	− 4.60	+31.3	− 2.38	+24.3	− 4.00	+24.3	− 0.11	+11.4	− 1.32	+ 7.8	−0.40	+1.47
Normals		**− 1.6**	**+36.6**	**− 3.8**	**+34.0**	**− 1.8**	**+34.9**	**− 2.5**	**+29.2**	**− 1.2**	**+28.2**	**− 2.2**	**+20.2**	**− 0.1**	**+ 8.3**	**− 1.3**	**+ 6.8**	**−0.5**	**+1.29**
Means		− 3.75	+32.7	− 3.89	+38.9	− 7.34	+32.1	− 7.47	+31.0	− 7.78	+21.9	−11.13	+17.1	− 8.13	+ 6.5	− 7.97	+ 5.1	−3.25	+0.24
Adjusted vectors				**4 +8.2**	**+46.4**	**10 0.0**	**+27.5**	**5 − 6.4**	**+51.7**	**9 −15.3**	**+21.1**	**8 −11.1**	**+20.0**						
						13 −10.1	**+33.0**	**8 −12.2**	**+26.2**	**10 +24.1**	**+20.8**	**9 −12.2**	**+18.1**						
								12 0	**+35.8**	**15 − 6.5**	**+24.8**	**17 −21.7**	**+10.6**						
								19 + 7.7	**+35.8**										

I_r (1 to 20)

$\frac{H+I_r}{2}$ (1 to 20)

Northward

{I, 16 . 8 . 2 . 7 . 15 . 6 . 14
H 18 . 10 . 4 . 11 . 19 . 12 . 20}

TABLE 44.—*Anticyclonic components—highs.*

Rectangular coordinates: $+u_1$ = south velocity; $+v_1$ = east velocity.

Area No.	Cirrus 9.8				Ci. Strat. 9.8				Ci. Cum. 8.1				Alto-Strat. 5.9			
	u_1	v_1	σ	β	u_1	v_1	σ	β	u_1	v_1	σ	β	u_1	v_1	σ	β
1	+ 4.1	− 1.4			− 3.1	− 1.4			+ 4.3	−14.7			+11.8	− 5.0		
2	+25.1	− 0.4			**+17.9**	**+ 4.7**			+ 9.1	−10.9			+17.2	+11.1		
3	+ 9.2	− 6.1			+10.5	+ 8.6			− 0.7	+ 0.6			+ 6.7	− 3.1		
4	+10.2	− 1.1			+ 4.6	+11.1			+ 4.1	+ 8.8			−10.4	+12.5		
5	+16.7	− 2.6			+14.4	−19.9			− 0.6	− 7.5			+ 6.8	−10.8		
6	+14.2	− 6.9	15.7	333	+18.3	−16.8	24.8	317	+21.4	− 7.0	22.6	342	**+ 9.3**	**− 4.0**	10.2	336
7	+ 1.6	+22.2			**+11.5**	**+ 9.4**			**+14.2**	**+ 8.4**			**+ 7.2**	**− 2.5**		
8	+ 2.1	− 7.2	7.5	286	− 7.7	− 0.6	7.7	181	− 2.2	− 6.0	6.4	250	+ 4.6	− 4.6	6.5	315
9	+ 7.0	− 2.7			+ 2.7	− 2.6			− 0.5	− 0.9			+14.8	− 5.0		
10	−15.7	− 2.6	16.0	190	+ 9.1	+15.8	18.2	60	− 0.5	−12.1	12.1	268	− 0.8	+ 1.3	1.5	135
11	+ 8.0	0.0			+11.5	− 0.6			+ 0.7	− 4.9			− 2.7	− 4.5		
12	− 2.7	−22.5	22.8	263	−12.2	− 2.5	12.5	191	− 4.1	−15.5	16.0	255	−16.1	+10.8	19.4	147
13	− 1.1	− 5.3			+ 5.7	−12.5			+ 3.6	−20.4			+11.9	−14.8		
14	+ 6.5	− 1.7	6.8	345	− 9.6	+16.1	18.8	121	+ 2.4	+ 0.7	2.5	19	− 4.5	− 4.9	6.7	229
15	− 7.4	+ 8.8			+ 3.8	+ 5.2			**+12.0**	**+ 9.3**			**+ 2.5**	**− 7.3**		
16	+ 4.1	− 8.3	9.2	296	+ 8.3	+17.7	19.6	65	+ 5.0	+ 2.3	5.6	25	+ 4.6	+ 0.2	4.6	2
17	+ 2.9	− 0.3			+ 2.1	+14.0			+ 0.9	+13.7			+16.7	+ 7.6		
18	− 3.6	− 3.5	5.0	225	− 9.1	− 8.7	12.6	223	− 5.5	+ 6.6	8.6	130	− 7.4	+10.8	13.1	125
19	− 2.5	− 7.5			− 0.7	+ 9.0			−14.1	−11.4			−10.8	+ 7.3		
20	− 8.3	− 7.8	11.4	223	+ 6.9	+11.1	13.1	58	− 7.0	− 2.0	7.3	196	−12.4	− 5.2	13.5	203

TABLE 45.—*Cyclonic components—lows.*

Rectangular coordinates: $+u_1$ = south velocity; $+v_1$ = east velocity.

Area No.	Cirrus 9.8				Ci. Strat. 9.8				Ci. Cum. 8.1				Alto Strat. 5.9			
	u_1	v_1	σ	β	u_1	v_1	σ	β	u_1	v_1	σ	β	u_1	v_1	σ	β
1	−16.7	+11.1			− 2.5	− 4.3			+ 2.8	+20.2			+ 3.6	+23.1		
2	− 2.6	+ 3.4			−10.6	+ 7.7			− 8.7	+ 5.0			− 5.9	− 7.2		
3	....	....			....	....			....	....			....	....		
4	−12.6	+20.4			**+12.0**	**+12.4**			+ 1.8	+11.3			+ 16.5	+ 26.7		
5	− 2.6	− 5.4			− 5.3	+ 0.1			−13.6	+ 9.7			**− 3.9**	**+22.5**		
6	− 6.8	+ 6.7	9.6	136	+ 3.8	+ 9.1	9.9	67	− 9.2	+ 3.3	9.7	161	− 5.7	+13.0	14.3	114
7	−10.2	− 2.3			− 1.6	+ 9.8			−22.0	− 8.4			− 7.5	− 0.2		
8	....	....	....	...	−23.4	−18.3	29.8	218	....	...	....	...	**− 9.7**	**− 3.0**	10.2	197
9	+ 1.6	+12.4			−18.1	− 2.7			− 1.4	−12.4			− 9.7	−14.7		
10	+ 0.6	− 9.2	9.3	274	−13.7	+14.0	19.7	135	**+ 1.8**	**− 7.4**	7.6	284	+ 19.9	− 15.5	25.2	322
11	+11.7	+ 7.3			+23.8	+ 2.1			+ 5.6	+19.3			+ 33.1	− 7.1		
12	−13.1	+18.3	22.6	127	+ 4.5	−20.3	20.6	282	+10.5	+20.3	22.8	63	**+ 2.5**	**+ 6.1**	6.6	68
13	−16.5	− 8.7			− 0.7	−12.9			**− 8.3**	**− 1.9**			− 11.8	+ 4.5		
14	0.0	− 4.3	4.3	270	− 2.3	+15.7	16.0	98	+ 1.2	+ 0.7	1.4	30	− 10.5	− 0.1	10.5	181
15	+ 4.6	− 2.4			+ 9.9	+ 4.7			+ 4.4	+ 1.5			− 2.2	+ 4.0		
16	+ 1.6	− 6.2	6.4	285	+12.8	+ 5.2	13.9	23	−11.4	− 7.8	13.8	215	− 5.8	− 0.4	5.9	183
17	....	....	....	...	−22.3	+19.8			− 1.5	+ 3.0			−15.5	+11.1		
18	−19.2	− 3.4	19.6	190	−13.5	−10.2	16.9	217	....	....	....	...	....	....	....	...
19	+16.0	+ 5.1			− 7.0	+16.8			+ 1.8	+ 8.0			**+10.2**	**+ 7.1**		
20	+ 1.6	+ 4.6	5.0	70	− 0.1	+10.9	10.9	91	− 2.7	+ 1.3	3.0	156	− 0.8	+ 1.9	2.1	114

TABLE 44.—*Anticyclonic components—highs.*

Rectangular coordinates: $+u_1$ = south velocity; $+v_1$ = east velocity.

Alto-Cum. 4.5				Strat. Cum. 2.5				Cumulus 1.5				Stratus 0.9				Wind			
u_1	v_1	σ	β	u_1	v_1	σ	β	u_1	v_1	σ	β	u_1	v_1	σ	β	u_1	v_1	σ	β
+10.0	−3.5			−14.1	−11.5			+4.6	−6.3			−3.9	−1.8			−0.4	−4.5		
+8.9	−2.0			+21.3	−8.7			+9.8	−6.4			+2.2	+9.8			+1.7	+2.1		
+7.0	+9.6			−10.2	−7.4			−8.3	−2.4			−3.4	−1.4			−3.2	+0.3		
−3.3	+2.5			−4.6	−10.8			−9.6	−0.7			−14.1	−6.8			−3.1	−3.3		
+6.6	−5.5			+24.4	−17.5			+8.8	−13.4			+17.4	−8.2			+3.1	−5.2		
+13.8	−3.8	14.4	344	+18.1	+4.9	18.8	15	+8.8	−17.0	19.2	297	+10.9	−8.1	13.6	323	+4.6	−4.7	6.7	314
+8.3	**+3.4**			+9.3	−0.6			+9.9	−1.2			+9.0	−2.3			+4.1	+1.3		
+5.0	+8.1	9.6	58	+4.7	+3.5	6.0	35	+9.3	−2.5	9.6	345	+5.4	−0.3	5.4	358	−0.3	+4.7	4.8	92
+1.5	−6.5			+3.7	+8.8			−2.8	+5.4			−7.9	+3.8			−2.9	+1.8		
−5.5	−3.6	6.6	214	−19.2	+0.5	19.2	179	−8.0	−4.2	9.0	208	−2.1	+0.6	2.2	160	−3.3	+1.0	3.4	164
−12.2	−3.4			−10.2	−1.1			−7.8	−4.6			−8.0	+1.9			−4.2	−1.4		
+10.6	−16.5	19.6	302	+18.2	−26.3	32.0	305	−5.6	−21.8	22.4	255	+2.0	−16.5	16.6	277	+0.4	−5.3	5.4	273
+5.9	−8.6			−1.3	−12.9			+6.9	−12.1			+3.4	+2.2			+4.1	−3.6		
+5.7	+2.5	6.3	23	+13.2	−1.9	13.3	352	+7.9	+4.6	9.2	31	+6.9	−5.9	9.0	320	+4.9	+1.3	5.5	318
+5.7	**+2.5**			+8.8	+6.3			+8.1	+3.1			+9.0	+4.6			+3.1	+3.4		
+5.7	+2.5	6.3	23	+13.8	+13.4	19.2	44	+5.3	+5.5	7.6	47	+1.0	+9.2	9.3	83	−0.9	+4.7	4.7	92
+5.7	+2.1			+4.3	+10.2			−1.1	+1.7			+0.9	+3.2			−1.9	+2.7		
−4.8	+14.6	15.3	108	+0.6	+2.3	2.4	75	−4.8	+7.9	9.3	122	−3.8	+2.0	4.3	151	−2.2	+1.9	2.9	140
−12.2	−1.8			−14.8	−2.6			−7.8	−2.7			−12.0	+3.6			−3.9	+1.5		
−5.8	−10.0	11.6	240	−22.8	−32.4	19.7	235	−8.1	−12.5	15.0	237	−12.3	−9.0	15.3	216	−3.5	−2.5	4.3	216

TABLE 45.—*Cyclonic components—lows.*

Rectangular coordinates: $+u_1$ = south velocity; $+v_1$ = east velocity.

Alto-Cum. 4.5				Strat. Cum. 2.5				Cumulus 1.5				Stratus 0.9				Wind			
u_1	v_1	σ	β	u_1	v_1	σ	β	u_1	v_1	σ	β	u_1	v_1	σ	β	u_1	v_1	σ	β
−11.4	+20.1			−16.0	+32.6			−1.1	+8.5			+0.4	+6.6			−1.9	+6.1		
−14.7	+0.3			−11.5	+12.1			−5.2	−0.1			−4.7	+2.9			−4.7	+1.6		
....	....			....	....			....	....			....	....			+1.1	−6.3		
+16.4	+14.3			+26.3	+5.6			+15.6	−3.2			+13.0	−0.3			+5.1	+2.1		
+3.1	+3.4			−0.5	+5.2			−3.4	+8.2			+0.1	+7.4			−1.4	+4.0		
−13.8	+10.5	17.4	143	−10.4	+9.5	14.1	137	−7.1	+4.7	8.6	146	−7.0	+2.0	7.3	164	−4.8	+1.8	5.2	159
−22.5	−6.0			−20.4	+1.7			−16.3	+5.4			−8.5	−1.6			−4.2	−1.3		
....	....	....	...	**−8.9**	**−0.2**	8.9	181	−12.8	+0.7	12.9	184	−5.5	−8.1	9.7	236	+2.8	−4.7	5.6	301
−14.2	**−2.1**			**−10.0**	**−2.1**			+11.4	+0.6			−2.0	+2.3			+4.8	−2.1		
+25.3	**−2.9**	25.6	354	+7.6	−6.1	9.7	322	+9.9	+2.6	10.2	15	+13.2	−6.4	14.7	334	+2.6	+2.7	3.8	46
+18.4	+3.2			+23.9	−3.3			+8.3	+4.9			+8.4	−0.4			+4.4	+3.1		
+4.7	+17.1	17.8	74	+9.7	+18.6	21.2	63	+4.0	+11.6	12.4	72	+6.8	+6.2	9.2	42	+2.2	+3.5	4.1	57
−3.9	−4.1			−9.4	+5.8			−2.1	+5.4			−4.5	−0.3			−2.9	+1.1		
−5.3	−0.7	5.4	188	−11.1	−0.5	11.2	183	−10.6	−2.1	10.8	192	−11.6	−0.2	11.6	181	−4.2	−0.8	4.3	192
−5.3	**+1.1**			−3.4	+2.4			−7.6	+4.0			−7.7	+1.9			−4.6	−2.2		
−4.3	−4.2	5.3	217	−18.0	−0.7	18.1	183	−1.0	+1.8	2.1	120	+1.9	+3.9	4.3	62	−3.4	−3.5	4.9	227
−19.3	−14.9			**−19.5**	**−9.6**			+7.8	−1.8			−8.5	−9.1			+4.5	−3.3		
+6.4	−17.5	18.7	290	−9.2	−7.5	11.8	219	+0.8	−5.4	5.5	280	−0.3	−1.9	2.0	264	+2.7	−4.0	4.8	305
+4.6	+4.5			+15.3	+3.5			+4.0	+10.0			+1.3	+3.6			+2.8	+2.4		
+5.0	+0.8	5.1	10	+8.1	+0.3	8.2	2	+5.6	+3.0	6.4	28	+4.9	+2.5	5.6	26	+1.2	+3.4	3.5	70

TABLE 46.—*Anticyclonic components resolved for cylindrical coordinates—highs.*

Cylindrical coordinates: u_2 = radial velocity; v_2 = tangential velocity.

Area No.	Cirrus 9.8				Ci. Strat. 9.8				Ci. Cum. 8.1			
	u_2	v_2	u_3	v_3	u_2	v_2	u_3	v_3	u_2	v_2	u_3	v_3
1	+ 4.1	− 1.4	+ 7.4	+ 3.1	− 3.1	− 1.4	+ 0.2	+ 3.1	+ 4.3	−14.7	+ 7.6	−10.2
2	− 0.4	−25.1	+ 2.9	−20.6	+ 4.7	−17.9	+ 8.0	−18.4	−10.9	− 9.1	− 7.6	− 4.6
3	− 9.2	+ 6.1	− 5.9	−10.6	−10.5	− 8.6	− 7.2	− 4.1	+ 0.7	− 0.6	+ 4.0	+ 3.9
4	+ 1.1	+10.2	+ 4.4	+14.7	−11.1	+ 4.6	− 7.8	+ 9.1	− 8.8	+ 4.1	− 5.5	+ 8.6
5	+16.7	− 2.6	+12.8	+ 2.6	+14.4	−19.9	+10.5	−14.7	− 0.6	− 7.5	− 4.5	− 2.3
6	+ 4.9	−14.9	+ 1.0	− 9.7	+ 0.1	−24.8	− 3.8	−19.6	+10.3	−20.1	+ 6.4	−14.9
7	+22.2	− 1.6	+18.3	+ 3.6	+ 9.4	−11.5	+ 5.5	− 6.3	+ 8.4	−14.2	+ 4.5	− 9.0
8	− 6.6	+ 3.6	−10.5	+ 8.8	+ 5.4	+ 5.5	+ 1.5	+10.7	− 2.7	+ 5.8	− 6.6	+11.0
9	− 7.0	+ 2.7	−10.9	+ 7.9	− 2.7	+ 2.6	− 6.6	+ 7.8	+ 0.5	+ 0.9	− 3.4	+ 6.1
10	+13.2	− 9.2	+ 9.3	− 4.0	−17.6	− 4.7	−21.5	+ 0.5	+ 8.8	+ 8.3	+ 4.9	+15.5
11	0.0	+ 8.0	− 3.9	+13.2	+ 0.6	+11.5	− 3.3	+16.7	+ 4.9	+ 0.7	+ 1.0	+ 6.9
12	+14.0	−18.0	+10.1	−12.8	− 7.0	−10.4	−10.9	− 5.2	+ 8.1	−13.9	+ 4.2	− 8.7
13	− 1.1	− 5.3	− 3.3	− 0.5	+ 5.7	−12.5	+ 3.5	− 7.7	+ 3.6	−20.4	+ 1.4	−15.6
14	+ 3.4	− 5.9	+ 1.2	− 1.1	+ 4.5	+18.2	+ 2.3	+23.0	+ 2.2	− 1.1	0.0	+ 3.7
15	+ 8.8	+ 7.4	+ 6.6	+12.2	+ 5.2	− 3.8	+ 3.0	+ 1.0	+ 9.3	−12.0	+ 7.1	− 7.2
16	− 8.7	+ 3.0	−10.9	+ 7.8	+ 6.7	−18.4	+ 4.5	−13.6	− 1.9	− 5.3	− 4.1	− 0.5
17	− 2.9	+ 0.3	− 5.1	+ 5.1	− 2.1	−14.0	− 4.3	− 9.2	− 0.9	−13.7	− 3.1	− 8.9
18	+ 5.0	0.0	+ 2.8	+ 4.8	+12.6	− 0.1	+10.4	+ 4.7	− 0.7	− 8.6	− 2.9	− 4.8
19	+ 7.5	− 2.5	+ 5.3	+ 2.3	− 9.0	− 0.7	−11.2	+ 4.1	+11.4	−14.1	+ 9.2	− 9.3
20	0.0	−11.4	− 2.2	− 6.6	− 2.9	+12.8	− 5.1	−17.6	− 3.5	− 6.4	− 5.7	− 1.6
I	− 1.1	− 2.6			− 5.0	− 5.7			− 3.7	− 5.1		
II	+ 7.2	− 4.0			− 0.3	− 6.5			+ 4.7	− 5.0		
III	+ 1.5	− 1.8			+ 2.6	− 2.3			+ 2.4	−10.2		
	+ 2.5	− 2.8			− 0.9	− 4.8			+ 1.1	− 6.8		
Normals I					− 3.3*	− 4.5						
Normals II					+ 3.9	− 5.2						
Normals III					+ 2.2	− 4.8						

Area No.	Alto Strat. 5.9				Alto Cum. 4.5				Strat. Cu. 2.5			
	u_2	v_2	u_3	v_3	u_2	v_2	u_3	v_3	u_2	v_2	u_3	v_3
1	+11.8	− 5.0	+11.8	+ 2.1	+10.0	− 3.5	+10.0	+ 3.6	−14.1	−11.5	−14.1	− 4.4
2	+11.1	−17.2	+11.1	−10.1	− 2.0	− 8.9	− 2.0	− 1.8	− 8.7	−21.3	− 8.7	−14.2
3	− 6.7	+ 3.1	− 6.7	+10.2	− 7.0	− 9.6	− 7.0	− 2.5	+10.2	+ 7.4	+10.2	+ 0.3
4	−12.5	−10.4	−12.5	− 3.3	− 2.5	− 3.3	− 2.5	+ 3.8	+10.8	− 4.6	+10.8	+ 2.5
5	+ 6.8	−10.8	+ 2.6	− 4.2	+ 6.6	− 5.5	+ 2.4	+ 1.1	+24.4	−17.5	+20.2	−10.9
6	+ 3.7	− 9.5	− 0.5	− 2.9	+ 7.0	−12.6	+ 2.8	− 6.0	+16.7	− 9.4	+12.5	− 2.8
7	− 2.5	− 7.2	− 6.7	− 0.6	+ 3.4	− 8.3	− 0.8	− 1.7	− 0.6	− 9.3	− 4.8	− 2.7
8	− 6.5	0.0	−10.7	+ 6.6	+ 2.2	− 9.4	− 2.0	− 2.8	− 1.1	− 6.0	− 5.3	+ 0.6
9	−14.8	+ 5.0	−19.0	+11.6	− 1.5	+ 6.5	− 5.7	+13.1	− 3.7	− 8.8	− 7.9	− 2.2
10	0.0	− 1.5	− 4.2	+ 5.1	+ 6.5	− 1.3	+ 2.3	+ 5.3	+13.3	−13.8	+ 9.1	− 7.2
11	+ 4.5	− 2.7	+ 0.8	+ 3.9	+ 3.4	−12.2	− 0.8	− 5.6	+ 1.1	−10.2	− 3.1	− 3.6
12	−19.0	− 4.0	−23.2	+ 2.6	+19.1	− 4.4	+14.9	+ 2.2	+31.7	− 5.6	+27.5	+ 1.0
13	+11.9	−14.8	+12.7	− 5.5	+ 5.9	− 8.6	+ 6.7	+ 0.7	− 1.3	−12.9	− 0.5	− 3.6
14	− 6.7	− 0.1	− 5.9	+ 9.2	+ 5.8	− 2.4	+ 6.6	− 6.9	+ 8.0	−10.6	+ 8.8	− 1.3
15	− 7.3	− 2.5	− 6.5	+ 6.8	+ 2.5	− 5.7	+ 3.3	+ 3.6	+ 6.3	− 8.8	+ 7.1	+ 0.5
16	− 3.1	− 3.4	− 2.3	+ 5.9	− 2.3	− 5.8	− 1.5	+ 3.5	− 0.1	−19.2	+ 0.7	− 9.9
17	−16.7	− 7.6	−15.9	+ 1.7	− 5.7	− 2.1	− 4.9	+ 7.2	− 4.3	−10.2	− 3.5	− 0.9
18	− 2.3	−12.9	− 1.5	− 3.6	− 6.9	−13.6	− 6.1	− 4.3	− 2.1	− 1.2	− 1.3	+ 8.1
19	− 7.3	−10.8	− 6.5	− 1.5	+ 1.8	−12.2	+ 2.6	− 2.9	+ 2.6	−14.8	+ 3.4	− 5.5
20	− 5.1	−12.5	− 4.3	− 3.2	+ 3.0	−11.2	+ 3.8	− 2.9	+ 3.4	−19.4	+ 4.2	−10.1
I	+ 0.9	− 7.4			− 0.4	− 6.3			− 0.5	− 7.5		
II	− 3.5	− 3.8			+ 5.8	− 5.9			+10.2	−10.1		
III	− 4.6	− 8.1			+ 0.5	− 7.7			+ 1.6	−12.1		
	− 2.4	− 6.4			+ 2.0	− 6.6			+ 3.8	− 9.9		
Normals I					0.0*	− 7.1						
Normals II					+ 4.2	− 6.6						
Normals III					− 0.8	− 9.2						

* Used in constructing chart 19.

u_3 v_3 found by subtracting the normals from u_2 v_2.

TABLE 46.—*Anticyclonic components resolved for cylindrical coordinates—highs*—Continued.

Cylindrical coordinates: u_2 = radial velocity, v_2 = tangential velocity.

Area No.	Cumulus 1.5				Stratus 0.9				Wind			
	u_2	v_2	u_3	v_3	u_2	v_2	u_3	v_3	u_2	v_2	u_3	v_3
1	+ 4.6	− 6.3	**+ 1.9**	**− 1.3**	− 3.9	− 1.8	**− 6.6**	**+ 3.2**	− 0.4	− 4.5	**− 4.5**	**− 2.1**
2	− 6.4	− 9.8	**− 9.1**	**− 4.8**	+ 9.8	− 2.2	**+ 7.1**	**+ 2.8**	+ 2.1	− 1.7	**− 2.0**	**+ 0.7**
3	+ 8.3	+ 2.4	**+ 5.6**	**+ 7.4**	+ 3.4	+ 1.4	**+ 0.7**	**+ 6.4**	+ 3.2	− 0.3	**− 0.9**	**+ 2.1**
4	+ 0.7	− 9.6	**− 2.0**	**− 4.6**	+ 6.8	−14.1	**+ 4.1**	**− 9.1**	+ 3.3	− 3.1	**− 0.8**	**− 0.7**
5	+ 8.8	−13.4	**+ 5.4**	**− 4.8**	+17.4	− 8.2	**+14.0**	**+ 0.4**	+ 3.1	− 5.2	**+ 0.9**	**− 1.2**
6	− 5.9	−18.3	**− 9.3**	**− 9.7**	+ 1.9	−13.5	**− 1.5**	**− 4.9**	0.0	− 6.7	**− 2.2**	**− 2.7**
7	− 1.2	− 9.9	**− 4.6**	**− 1.3**	− 2.3	− 9.0	**− 5.7**	**− 0.4**	+ 1.3	− 4.1	**− 0.9**	**− 0.1**
8	− 8.3	− 4.8	**−11.7**	**+ 3.8**	− 3.9	− 3.7	**− 7.3**	**+ 4.9**	+ 3.5	− 3.3	**+ 1.3**	**+ 0.7**
9	+ 2.8	− 5.4	**− 0.6**	**+ 3.2**	+ 7.9	− 3.8	**+ 4.5**	**+ 4.8**	+ 2.9	− 1.8	**+ 0.7**	**+ 2.2**
10	+ 8.7	− 2.7	**+ 5.3**	**+ 5.9**	+ 0.9	− 2.0	**− 2.5**	**+ 6.6**	+ 1.6	− 3.0	**− 0.6**	**+ 1.0**
11	+ 4.6	− 4.6	**+ 1.2**	**+ 4.0**	− 1.9	8.0	**− 5.3**	**+ 0.6**	+ 1.4	− 4.2	**− 0.8**	**− 0.2**
12	+11.2	−19.4	**+ 7.8**	**−10.8**	+13.1	−10.2	**+ 9.7**	**− 1.6**	+ 4.0	− 3.6	**+ 1.8**	**+ 0.4**
13	+ 6.9	−12.1	**+ 4.9**	**− 4.5**	+ 3.4	+ 2.2	**+ 1.4**	**+ 9.8**	+ 4.1	− 3.6	**+ 2.7**	**0.0**
14	+ 8.9	− 2.2	**+ 6.9**	**+ 5.4**	+ 0.1	− 9.0	**− 1.9**	**− 1.4**	− 0.1	− 5.5	**− 1.3**	**− 1.9**
15	+ 3.1	− 8.1	**+ 1.1**	**− 0.5**	+ 4.6	− 9.0	**+ 2.6**	**− 1.4**	+ 3.4	− 3.1	**+ 2.0**	**+ 0.5**
16	+ 0.2	− 7.6	**− 1.8**	**0.0**	+ 5.7	− 7.3	**+ 3.7**	**+ 0.3**	+ 3.4	− 3.2	**+ 2.0**	**+ 0.4**
17	+ 1.1	− 1.7	**− 0.9**	**+ 5.9**	− 0.9	− 3.2	**− 2.9**	**+ 4.4**	+ 1.9	− 2.7	**+ 0.5**	**+ 0.9**
18	− 2.1	− 9.1	**− 4.1**	**− 1.5**	+ 1.2	− 4.1	**− 0.8**	**+ 3.5**	+ 0.3	− 2.9	**− 1.1**	**+ 0.7**
19	+ 2.7	− 7.8	**+ 0.7**	**− 0.2**	− 3.6	−12.0	**− 5.6**	**− 4.4**	− 1.5	− 3.9	**− 2.9**	**− 0.3**
20	+ 3.1	−14.6	**+ 1.1**	**− 7.0**	− 2.4	−15.1	**− 4.4**	**− 7.5**	− 0.7	− 4.2	**− 2.1**	**− 0.6**
I	+ 1.8	− 5.8			+ 4.0	− 4.2			+ 4.1	− 2.4	**0.0**	**− 5.2**
II	+ 2.6	− 9.8			+ 4.1	− 7.3			+ 2.2	−*4.0	**+ 3.7**	**− 6.3**
III	+ 3.0	− 7.9			+ 1.0	− 7.2			+ 1.4	− 3.6	**+ 1.0**	**− 6.8**
	+ 2.5	**− 7.8**			**+ 3.0**	**− 6.2**			**+ 2.6**	**− 3.3**		
Normals I	**+ 2.7**	**− 5.0**							* **+ 3.3**	**− 4.1**		
Normals II	**+ 3.4**	**− 8.6**							**+ 3.0**	**− 7.0**		
Normals III	**+ 2.0**	**− 7.6**							**+ 1.8**	**− 6.2**		

* Used in constructing chart 19.

u_3 v_3 found by subtracting the normals from u_2 v_2.

TABLE 47.—*Cyclonic components resolved for cylindrical coordinates—lows.*

Cylindrical coordinates: u_2=radial velocity; v_2=tangential velocity.

Area No.	Cirrus 9.8		Ci. Strat. 9.8		Ci. Cum. 8.1			
	u_2	v_2	u_2	v_2	u_2	v_2	u_3	v_3
1	−16.7	+11.1	− 2.5	− 4.3	+ 2.8	+20.2	**+ 4.0**	**+10.0**
2	+ 3.4	+ 2.6	+ 7.7	+10.6	+ 5.0	+ 8.7	**+ 6.2**	**− 1.5**
3	....	....	....	....	....	....	....	....
4	−20.4	−12.6	−12.4	+12.0	−11.3	+ 1.8	**−10.1**	**− 8.4**
5	− 2.2	− 5.4	− 5.3	+ 0.1	−13.6	+ 9.7	**− 6.8**	**− 2.6**
6	− 0.1	+ 9.6	+ 9.1	+ 3.9	− 4.3	+ 8.7	**+ 2.5**	**− 3.6**
7	− 2.3	+10.2	+ 9.8	+ 1.6	− 8.4	+22.0	**− 1.6**	**+ 9.7**
8	....	....	+ 3.6	+29.6	....	....	....	....
9	− 1.6	−12.4	+18.1	+ 2.7	+ 1.4	+12.4	**+ 8.2**	**+ 0.1**
10	+ 6.1	+ 7.0	0.0	−19.7	+ 3.9	+ 6.3	**+10.7**	**− 6.0**
11	− 7.3	+11.7	− 2.1	+23.8	−19.3	+ 5.6	**−12.5**	**− 6.7**
12	−22.5	+ 3.2	+17.3	−11.2	− 7.0	+21.7	**− 0.2**	**+ 9.4**
13	−16.5	− 8.7	− 0.7	−12.9	− 8.3	− 1.9	**− 6.5**	**− 2.6**
14	− 3.0	− 3.0	+ 9.7	+12.9	+ 1.3	− 0.4	**+ 3.1**	**− 1.1**
15	− 2.4	− 4.6	+ 4.7	− 9.9	+ 1.5	− 4.4	**− 3.3**	**− 5.1**
16	− 5.5	+ 3.2	− 5.2	−12.9	+ 2.4	+13.6	**+ 4.2**	**+12.9**
17	....	....	+22.3	−19.8	+ 1.5	− 3.0	**+ 3.3**	**− 3.7**
18	+16.1	−11.3	+16.7	− 2.2	....	....	....	....
19	− 5.1	+16.0	−16.8	− 7.0	− 8.0	+ 1.8	**− 6.2**	**+ 1.1**
20	− 2.2	+ 4.6	− 7.8	+ 7.6	− 2.7	− 1.0	**− 0.9**	**− 1.7**
I	−11.2	+ 0.4	− 2.4	+ 6.1	− 1.2	+10.2		
II	− 4.4	+ 3.4	+ 6.3	+ 3.8	− 6.8	+12.3		
III	− 2.7	− 0.5	+ 2.9	− 5.5	− 1.8	+ 0.7		
	− 6.1	**+ 1.1**	**+ 2.3**	**+ 1.5**	**− 3.3**	**+ 7.7**		
Normals I			**−1.2**	**+10.2***	Omitting Ci. and Ci. S.			
Normals II			**−6.8**	**+12.3**				
Normals III			**−1.8**	**+ 0.7**				

Area No.	Alto-Strat. 5.9				Alto-Cum. 4.5				Strat. Cu. 2.5			
	u_2	v_2	u_3	v_3	u_2	v_2	u_3	v_3	u_2	v_2	u_3	v_3
1	+ 3.6	+23.1	**+10.9**	**+ 4.5**	−11.4	+20.1	**− 4.1**	**+ 1.5**	−16.0	+32.6	**− 8.7**	**+14.0**
2	− 7.2	+ 5.9	**+ 0.1**	**−12.7**	+ 0.3	+14.7	**+ 7.6**	**− 3.9**	+12.1	+11.5	**+19.4**	**− 7.1**
3	....	....	....	....	....	....	....	....	....	....	....	....
4	−26.7	+16.5	**−19.4**	**− 2.1**	−14.3	+16.4	**− 7.0**	**− 2.2**	− 5.6	+26.3	**+ 1.7**	**+ 7.7**
5	− 3.9	+22.5	**− 4.2**	**+ 8.1**	+ 3.1	+ 3.4	**+ 2.8**	**−11.0**	− 0.5	+ 5.2	**− 0.8**	**− 9.2**
6	+ 5.1	+13.4	**+ 4.8**	**− 1.0**	− 2.4	+17.2	**− 2.7**	**+ 2.8**	− 0.1	+14.1	**− 0.4**	**− 0.3**
7	− 0.2	+ 7.5	**− 0.5**	**− 6.9**	− 6.0	+22.5	**− 6.3**	**+ 8.1**	+ 1.7	+20.4	**+ 1.4**	**+ 6.0**
8	+ 4.8	+ 9.0	**+ 4.5**	**− 5.4**	....	....	....	....	+ 6.2	+ 6.4	**+ 5.9**	**− 8.0**
9	+ 9.7	+14.7	**+ 9.4**	**+ 0.3**	+14.2	+ 2.1	**+13.9**	**−12.3**	+10.0	+ 2.1	**+ 9.7**	**−12.3**
10	− 3.1	+25.0	**− 3.4**	**+10.6**	−16.1	+19.9	**−16.4**	**+ 5.5**	− 1.2	+ 9.6	**− 1.5**	**− 4.8**
11	+ 7.1	+33.1	**+ 6.8**	**+18.7**	− 3.2	+18.4	**− 3.5**	**+ 4.0**	+ 3.3	+23.9	**+ 3.0**	**+ 9.5**
12	− 2.6	+ 6.1	**− 2.9**	**− 8.3**	− 8.6	+15.6	**− 8.9**	**+ 1.2**	− 6.6	+20.2	**− 6.9**	**+ 5.8**
13	−11.8	+ 4.5	**−13.4**	**− 0.7**	− 3.9	− 4.1	**− 5.5**	**− 9.3**	− 9.4	+ 5.8	**−11.0**	**+ 0.6**
14	− 7.5	+ 7.3	**− 9.1**	**+ 2.1**	− 4.3	+ 3.3	**− 5.9**	**− 1.9**	− 8.3	+ 7.5	**− 9.9**	**+ 2.3**
15	+ 4.0	+ 2.2	**+ 2.4**	**− 3.0**	+ 1.1	+ 5.3	**− 0.5**	**+ 0.1**	+ 2.4	+ 3.4	**+ 0.8**	**− 1.8**
16	+ 3.9	+ 4.4	**+ 2.3**	**− 0.8**	+ 0.7	+ 5.2	**− 0.9**	**0.0**	+12.1	+13.4	**+10.5**	**+ 8.2**
17	+15.5	−11.1	**+13.9**	**−16.3**	+19.3	+14.9	**+17.7**	**+ 9.7**	+19.5	+ 9.6	**+17.9**	**+ 4.4**
18	....	....	....	....	+ 7.9	+16.9	**+ 6.3**	**+11.7**	+11.7	− 1.2	**+10.1**	**− 6.4**
19	− 7.1	+10.2	**− 8.7**	**+ 5.0**	− 4.5	+ 4.6	**− 6.1**	**− 0.6**	− 3.5	+15.3	**− 5.1**	**+10.1**
20	− 2.0	+ 0.8	**− 3.6**	**− 4.4**	+ 2.9	+ 4.2	**+ 1.3**	**− 1.0**	+ 0.7	+ 4.7	**− 0.9**	**− 0.5**
I	−10.1	+15.2			− 8.5	+17.1			− 3.2	+23.5		
II	+ 2.1	+16.4			− 2.7	+14.1			+ 1.6	+12.7		
III	− 0.7	+ 2.3			+ 2.4	+ 6.3			+ 3.2	+ 7.1		
	−2.9	**+11.3**			**− 2.9**	**+12.5**			**+ 0.5**	**+14.4**		
Normals I					**−7.3**	**+18.6***						
Normals II					**+0.3**	**+14.4**						
Normals III					**+1.6**	**+ 5.2**						

*Used in constructing chart 19.

u_3 v_3 found by subtracting the normals from u_2 v_2.

TABLE 47.—*Cyclonic components resolved for cylindrical coordinates—lows*—Continued.

Cylindrical coordinates: u_2=radial velocity, v_2=tangential velocity.

Area No.	Cumulus 1.5				Stratus 0.9				Wind.			
	u_2	v_2	u_3	v_3	u_2	v_2	u_3	v_3	u_2	v_2		
1	−1.1	+8.5	**−2.1**	**−0.5**	+0.4	+6.6	**−0.6**	**−2.4**	−1.9	+6.1		
2	−0.1	+5.2	**−1.1**	**−3.8**	+2.9	+4.7	**+1.9**	**−4.3**	+1.6	+4.7		
3	....	....	....	....	..	....	....	....	−1.1	+6.3		
4	+3.2	+15.6	**+2.2**	**+6.6**	+0.3	+13.0	**−0.7**	**+4.0**	−2.1	+5.1		
5	−3.4	+8.2	**−1.4**	**+0.2**	+0.1	+7.4	**+2.1**	**−0.6**	−1.4	+4.0		
6	−1.6	+8.4	**+0.4**	**+0.4**	−3.5	+6.4	**−1.5**	**−1.6**	−2.1	+4.8		
7	+5.4	+16.3	**+7.4**	**+8.3**	−1.6	+8.5	**+0.4**	**+0.5**	−4.2	+4.2		
8	+8.5	+9.7	**+10.5**	**+1.7**	−1.9	+9.5	**+0.1**	**+1.5**	−5.4	+1.4		
9	−11.4	−0.6	**−9.4**	**−8.6**	+2.0	−2.3	**+4.0**	**−10.3**	−4.8	+2.1		
10	−8.8	+5.1	**−6.8**	**−2.9**	−4.8	+13.9	**−2.8**	**+5.9**	−3.8	0.0		
11	−4.9	+8.3	**−2.9**	**+0.3**	+0.4	+8.4	**+2.4**	**+0.4**	−3.1	+4.4		
12	−5.6	+11.0	**−3.6**	**+3.0**	0.0	+9.2	**+2.0**	**+1.2**	−0.9	+4.0		
13	−2.1	+5.4	**−0.9**	**+1.4**	−4.5	−0.3	**−3.3**	**−4.3**	−2.9	+1.1		
14	−9.1	+5.9	**−7.9**	**+1.9**	−8.3	+8.1	**−7.1**	**+4.1**	−3.6	+2.3		
15	+4.0	+7.6	**+5.2**	**+3.6**	+1.9	+7.7	**+3.1**	**+3.7**	−2.2	+4.6		
16	+2.0	−0.5	**+3.2**	**−4.5**	+1.3	−4.1	**+2.5**	**−8.1**	−0.1	+4.9		
17	−7.8	+1.8	**−6.6**	**−2.2**	+8.5	+9.1	**+9.7**	**+5.1**	−4.5	+3.3		
18	+3.2	+4.5	**+4.4**	**+0.5**	+1.6	+1.3	**+2.8**	**−2.7**	−0.8	+4.7		
19	−10.0	+4.0	**−8.8**	**0.0**	−3.6	+1.3	**−2.4**	**−2.7**	−2.4	+2.8		
20	−1.9	+6.1	**+3.1**	**+2.1**	+1.8	+5.3	**+3.0**	**+1.3**	−1.5	+3.2		
I	+0.7	+9.8			+1.2	+8.1			−0.9	+5.6	**−4.0**	**+10.7**
II	−2.7	+8.3			−1.2	+7.6			−3.2	+3.1	**−1.2**	**+9.1**
III	−2.2	+4.4			−0.2	+3.6			−2.1	+3.4	**−0.1**	**+2.3**
	−1.4	**+7.6**			**−0.1**	**+6.4**			**−2.1**	**+4.0**		
Normals I			**+1.0**	**+9.0**					**+0.3**	*+7.0		
Normals II			**−2.0**	**+8.0**					**−2.4**	**+6.3**		
Normals III			**−1.2**	**+4.0**					**−1.5**	**+3.8**		

* Used in constructing chart 19.

u_3 v_3 found by subtracting the normals from u_2 v_2.

TABLE 48.—*High areas—seasonal direction and velocity of motion of the clouds—northern.*

Direction	Area No.	Upper Clouds 8.4														
		June–Aug.			Sept.–Nov.			Dec.–Feb.			Mar.–May			Annual		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	13	70	29.1	15	84	29.9	5	118	22.4	7	55	45.7	40	79	31.5
E	2	8	64	24.1	1	68	27.4	10	76	45.7	12	17	34.0	31	51	34.9
N	3	15	92	31.5	7	80	29.9	1	63	54.0	18	58	31.5	41	75	31.5
W	4	17	79	35.7	7	84	37.4	9	54	41.5	12	101	55.6	45	80	42.3
S	5	21	60	19.1	16	106	36.5	9	89	34.9	19	58	31.5	65	75	29.1
SE	6	20	90	42.3	4	119	14.1	8	40	45.7	3	56	37.4	35	79	39.8
E	7	7	107	42.3	4	105	34.0	18	69	61.4	5	94	78.0	34	85	56.4
NE	8	4	84	30.7	...	...	...	...	...	...	...	...	...	4	84	30.7
N	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
NW	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
W	11	28	93	24.1	20	93	45.7	20	91	34.9	18	92	30.7	86	91	32.4
SW	12	15	87	35.7	12	90	36.5	16	114	34.0	7	151	39.8	50	104	35.7
S	13	14	79	14.1	1	100	53.1	7	69	25.7	24	73	39.8	46	94	25.7
SE	14	32	87	36.5	15	93	39.8	21	90	33.2	50	87	36.5	118	88	36.5
E	15	21	102	33.2	2	153	14.9	...	...	...	7	150	35.7	30	117	31.5
NE	16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
N	17	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
NW	18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
W	19	38	103	36.5	23	101	44.0	3	62	16.6	21	102	44.8	85	101	39.8
SW	20	28	95	27.4	43	98	29.1	29	116	37.5	30	138	42.3	130	111	34.0
Means		281	86	30.8	170	98	33.7	156	81	37.5	233	88	41.7	840	88	35.5

Direction	Area No.	Lower Clouds 2.4														
		June–Aug.			Sept.–Nov.			Dec.–Feb.			Mar.–May			Annual		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	8	80	4.3	10	84	14.5	4	56	13.6	4	92	18.2	26	131	12.0
E	2	8	109	5.3	4	88	14.5	6	48	15.9	20	22	25.3	38	51	18.4
N	3	3	108	13.6	4	113	5.3	1	105	23.0	14	98	15.0	22	102	13.3
W	4	12	120	9.2	8	125	22.1	2	218	38.6	3	142	16.8	25	130	16.6
S	5	26	30	7.1	30	17	27.4	32	21	33.8	19	61	12.7	107	29	21.4
SE	6	36	51	16.6	20	42	26.0	11	358	39.1	23	32	20.0	90	38	22.3
E	7	15	85	22.8	7	59	24.8	8	71	17.9	13	33	19.1	43	62	21.2
NE	8	3	80	23.9	3	89	24.4	17	86	20.0	...	...	...	23	86	22.8
N	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
NW	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
W	11	41	122	11.5	21	114	24.2	12	139	20.5	15	154	38.6	89	128	20.2
SW	12	25	111	17.9	27	314	30.8	20	307	17.0	28	40	22.8	100	16	22.5
S	13	51	45	13.6	21	44	9.0	23	31	12.4	23	58	13.1	118	48	13.3
SE	14	52	64	13.6	28	41	28.8	40	59	16.3	86	54	22.1	206	56	19.8
E	15	43	87	4.8	22	37	28.5	10	356	47.4	19	74	24.6	94	63	23.0
NE	16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
N	17	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
NW	18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
W	19	47	128	18.4	39	121	43.9	18	123	22.3	54	133	32.4	158	127	31.5
SW	20	51	172	9.2	76	166	23.5	30	193	35.4	32	166	24.4	189	172	21.9
Means		421	93	12.8	320	100	23.2	234	145	24.9	353	84	21.8	1,328	83	20.0

TABLE 49.—*High areas—seasonal direction and velocity of motion of the clouds—southern.*

Direction	Area No.	Upper Clouds 8.4														
		June–Aug.			Sept.–Nov.			Dec.–Feb.			Mar.–May			Annual		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	4	146	10.8	...	...	...	4	127	30.7	4	99	37.4	12	124	21.6
E	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
N	3	12	99	22.4	20	79	47.3	11	101	33.2	23	77	24.1	66	86	32.4
W	4	15	109	35.7	5	84	49.8	9	100	43.2	...	...	...	29	102	40.7
S	5	19	43	7.5	4	109	10.8	...	...	...	...	...	...	23	55	8.3
SE	6	21	243	38.2	5	108	24.9	2	122	41.5	2	80	12.5	30	153	17.4
E	7	1	90	51.5	1	60	17.4	4	128	17.4	1	103	24.9	7	109	23.2
NE	8	15	84	17.4	23	82	25.7	21	97	34.9	13	121	29.9	72	94	27.4
N	9	64	78	21.6	19	81	46.5	16	86	49.0	31	94	36.5	130	84	31.5
NW	10	47	106	27.4	11	85	54.8	9	84	35.7	18	109	30.7	85	102	32.4
W	11	13	45	25.7	12	110	36.5	6	92	48.1	3	36	4.2	34	75	30.7
SW	12	16	166	31.5	...	...	...	6	105	21.6	3	77	17.4	25	129	25.7
S	13	4	349	12.5	24	123	14.9	4	321	18.3	11	25	18.3	43	71	16.6
SE	14	1	78	18.3	6	110	28.2	14	114	29.1	3	106	30.7	24	110	29.1
E	15	4	18	14.9	11	58	49.0	13	99	44.0	11	130	39.8	39	88	41.5
NE	16	65	79	24.1	27	94	49.8	23	89	43.2	26	89	34.0	141	85	34.0
N	17	65	91	35.7	11	94	56.4	17	108	68.1	7	102	39.8	100	95	44.0
NW	18	41	103	28.2	18	102	56.4	14	97	28.2	6	119	58.9	79	103	39.0
W	19	22	124	17.4	9	103	27.4	4	84	21.6	9	131	16.6	44	109	28.2
SW	20	13	2	19.9	4	122	9.1	2	142	40.7	2	174	14.9	21	90	29.9
Means		442	108	24.2	210	94	35.6	179	116	36.0	173	98	27.7	1,004	98	29.1

Direction	Area No.	Lower Clouds 2.4														
		June–Aug.			Sept.–Nov.			Dec.–Feb.			Mar.–May			Annual		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	...	...	...	6	66	4.8	...	...	...	3	41	23.0	9	58	12.9
E	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
N	3	14	166	14.7	6	102	29.9	6	121	26.9	2	44	11.7	28	134	20.2
W	4	42	149	28.8	8	94	14.0	3	194	14.7	...	...	...	53	143	25.8
S	5	29	301	16.6	8	234	7.8	...	...	...	2	253	8.1	39	304	14.3
SE	6	52	265	13.6	...	...	...	5	347	14.5	1	303	29.4	58	272	14.0
E	7	8	97	9.2	3	92	10.1	...	...	...	6	48	15.6	17	79	11.7
NE	8	46	57	15.6	15	89	16.1	14	74	15.4	14	74	21.9	89	67	16.6
N	9	103	94	15.6	53	94	30.6	18	115	30.1	38	114	21.6	212	99	20.9
NW	10	99	143	11.7	21	107	28.3	6	180	49.2	21	111	18.4	147	135	16.6
W	11	30	145	14.5	16	149	10.4	8	128	19.6	11	141	11.3	65	142	14.5
SW	12	27	274	21.4	...	...	...	5	24	6.4	4	352	12.4	36	298	18.4
S	13	4	266	22.1	26	304	8.5	4	114	6.9	15	27	12.4	49	324	10.8
SE	14	6	335	11.7	20	76	10.1	5	108	7.8	8	24	10.6	39	54	10.1
E	15	10	51	15.2	49	80	28.8	8	89	15.0	48	73	26.5	115	75	25.5
NE	16	96	70	19.6	41	86	29.2	32	87	31.3	26	83	24.8	195	78	24.2
N	17	145	90	15.9	40	84	27.4	17	83	36.3	46	93	28.3	248	90	21.4
NW	18	65	107	23.2	29	98	28.1	7	119	21.9	28	99	20.9	129	104	23.7
W	19	41	151	9.7	26	167	13.6	9	146	7.8	39	137	12.4	115	149	11.3
SW	20	17	268	14.3	5	240	5.5	5	212	16.1	6	273	17.7	33	248	13.3
Means		834	168	16.3	372	127	17.8	152	126	20.0	318	127	18.2	1,676	150	17.2

TABLE 50.—*Low areas—seasonal direction and velocity of motion of the clouds—northern.*

Direction	Area No.	Upper Clouds 8.4														
		June-Aug.			Sept.-Nov.			Dec.-Feb.			Mar.-May			Annual		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	11	101	60.6	2	75	58.9	3	92	59.8	17	97	44.8	33	96	52.3
E	2	1	121	32.4	4	114	43.2	...	...	...	1	98	41.5	6	113	40.7
N	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
W	4	4	116	79.7	2	94	57.3	...	...	...	4	106	59.8	10	108	67.2
S	5	49	102	42.3	29	106	37.4	27	29	39.0	20	131	39.0	125	107	39.8
SE	6	16	83	29.1	37	100	48.1	21	98	72.2	26	104	28.2	100	98	44.8
E	7	6	101	26.6	4	114	39.8	7	102	41.5	18	111	38.2	35	108	37.4
NE	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
N	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
NW	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
W	11	8	71	29.9	5	69	49.8	18	82	56.4	17	58	36.5	48	70	42.3
SW	12	5	114	38.2	4	106	61.4	4	92	51.5	6	93	25.7	19	101	41.5
S	13	16	99	42.3	19	155	28.2	7	67	19.9	3	104	23.2	45	118	31.5
SE	14	48	90	30.7	49	98	43.2	35	94	44.0	22	94	34.0	154	94	38.2
E	15	19	84	39.8	17	91	28.2	19	100	39.0	10	102	39.0	65	93	36.5
NE	16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
N	17	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
NW	18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
W	19	10	89	33.2	12	71	58.1	28	70	51.5	21	77	31.5	71	75	44.0
SW	20	80	85	30.7	43	102	34.0	65	97	46.5	46	119	41.5	234	98	37.4
Means		273	97	39.7	227	100	45.2	234	85	47.4	211	100	37.1	945	98	42.6

Direction	Area No.	Lower Clouds 2.4														
		June-Aug.			Sept.-Nov.			Dec.-Feb.			Mar.-May			Annual		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	19	98	19.1	22	94	39.6	10	89	44.6	56	106	36.3	107	100	38.9
E	2	18	123	21.6	8	131	63.7	5	60	34.3	10	130	29.4	41	119	33.4
N	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
W	4	9	66	31.3	7	73	32.2	14	70	22.5	36	47	39.8	66	57	34.0
S	5	75	107	18.9	87	82	18.6	35	83	41.9	40	114	24.4	237	95	23.7
SE	6	34	188	23.9	55	125	28.3	26	113	38.0	53	113	21.6	168	112	26.7
E	7	17	129	22.8	8	146	49.7	7	146	31.7	29	150	29.4	61	140	31.3
NE	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
N	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
NW	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
W	11	15	33	11.3	22	78	29.2	27	64	20.9	35	30	26.9	99	48	22.8
SW	12	10	78	19.8	30	91	39.8	6	73	31.1	20	61	28.5	66	78	32.9
S	13	50	118	23.9	41	105	17.3	7	95	37.7	18	130	15.9	116	114	21.2
SE	14	75	113	12.7	59	128	25.8	32	115	26.7	58	134	18.2	224	123	19.6
E	15	13	95	9.9	23	113	33.4	17	116	27.8	16	158	46.9	69	121	32.0
NE	16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
N	17	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
NW	18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
W	19	15	62	18.2	42	54	27.8	33	64	30.4	59	87	21.2	149	70	24.8
SW	20	158	69	15.6	95	69	20.9	55	78	22.5	76	74	19.6	384	71	18.9
Means		508	91	19.2	499	99	32.8	274	90	31.5	506	103	27.5	1787	96	27.7

TABLE 51.—*Low areas—seasonal direction and velocity of motion of the clouds—southern.*

Direction	Area No.	Upper Clouds, 8.4														
		June-Aug.			Sept.-Nov.			Dec.-Feb.			Mar.-May			Annual		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...
E	2	...	...	...	5	89	24.1	..	...	...	5	114	38.2	10	103	28.2
N	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
W	4	1	50	15.8	4	124	18.3	...	...	...	...	...	...	5	108	14.9
S	5	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...
SE	6	1	33	14.9	4	143	26.6	1	120	16.6	...	...	...	6	121	23.2
E	7	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...
NE	8	2	65	40.7	1	93	33.2	2	176	12.5	3	192	52.3	8	144	37.4
N	9	9	122	31.5	7	113	32.4	7	98	58.1	5	149	17.4	28	113	31.5
NW	10	4	55	34.9	7	30	39.9	1	75	21.6	1	355	33.2	13	37	35.7
W	11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
SW	12	...	...	...	...	...	...	...	...	...	...	..	...	..	...	...
S	13	4	83	18.3	...	...	...	1	158	41.5	5	111	44.0	10	105	33.2
SE	14	7	107	13.3	8	138	19.9	12	95	32.4	7	106	34.0	34	110	25.7
E	15	16	65	28.2	11	87	26.6	1	89	34.9	22	80	29.1	50	77	43.2
NE	16	14	101	34.9	14	99	34.0	25	104	33.2	19	75	31.5	72	95	33.2
N	17	1	116	41.5	1	126	44.0	7	110	59.8	...	...	...	9	112	57.3
NW	18	...	...	...	3	154	24.9	...	...	...	2	122	33.2	5	91	27.4
W	19	1	42	10.8	5	208	47.3	6	69	20.8	...	...	...	12	126	30.7
SW	20	...	...	..	...	...	...	...	...	...	...	...	...	..	...	...
Means		60	76	25.9	70	117	30.9	63	109	33.1	69	145	34.8	262	103	32.4

Direction	Area No.	Lower Clouds 2.4														
		June-Aug.			Sept.-Nov.			Dec.-Feb.			Mar.-May			Annual		
		No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V	No.	φ	V
S	1	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...
E	2	...	...	...	14	82	23.9	6	106	8.5	10	150	25.3	30	118	18.9
N	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
W	4	8	20	9.7	13	6	14.3	...	...	...	9	20	15.9	30	8	18.9
S	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
SE	6	...	...	...	11	189	29.9	5	144	21.6	8	168	15.6	24	173	23.5
E	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
NE	8	2	94	7.4	11	91	23.5	6	128	10.4	8	185	36.8	27	127	23.2
N	9	5	27	14.0	15	98	31.3	12	100	20.5	5	148	12.2	37	96	23.2
NW	10	9	11	29.0	11	0	21.9	1	275	29.2	4	14	13.6	25	2	23.2
W	11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
SW	12	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...
S	13	17	92	14.0	3	88	8.7	9	108	20.9	13	104	14.7	42	99	15.4
SE	14	21	194	12.0	11	184	23.7	15	162	23.0	9	148	10.8	56	176	17.0
E	15	32	90	12.2	22	102	12.7	3	125	17.9	19	94	14.3	76	96	13.1
NE	16	25	96	10.6	29	111	24.6	24	150	25.8	19	82	20.0	97	111	20.5
N	17	6	59	15.4	24	139	26.7	14	282	26.9	...	...	...	44	173	25.1
NW	18	...	...	...	9	82	6.4	5	102	13.8	7	83	8.1	21	87	8.7
W	19	2	283	4.6	12	94	37.0	6	69	6.0	1	57	6.4	21	103	23.5
SW	20	...	...	...	...	...	...	...	...	...	...	...	...	...	..	...
Means		127	97	12.9	185	97	21.9	106	146	18.7	112	104	16.1	530	105	19.6

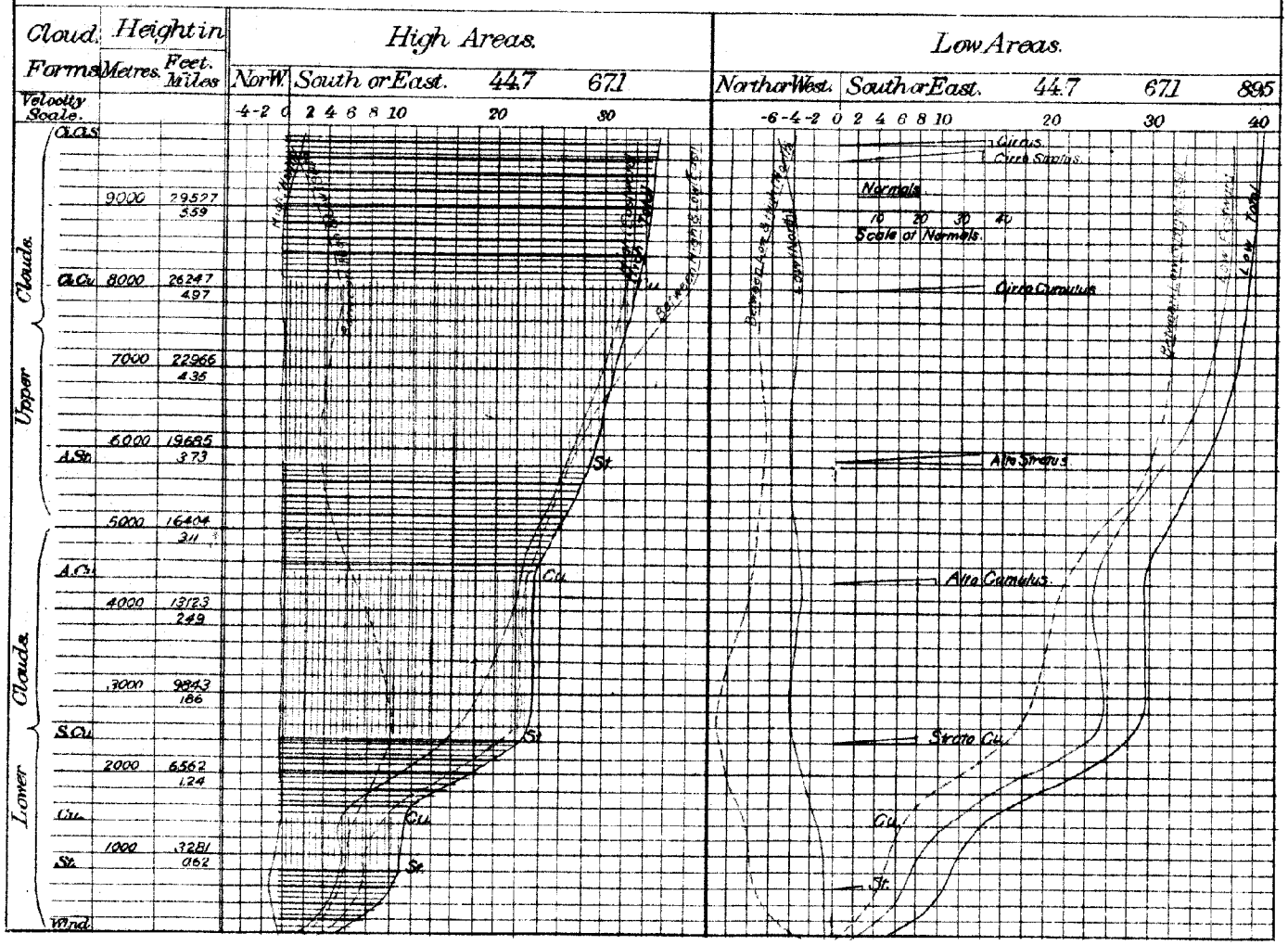
On Table 33 we have first the total velocities in highs and lows without regard to azimuths, designed to show in the several collections the mean velocities in the United States for the northern and the southern districts separately, which come by taking the arithmetical mean of the velocities given on Tables 34–41. In Tables 37 and 41 V_1 is the mean wind velocity without regard to direction, and it is this quantity which is transferred to Table 33; V_2 is the resultant velocity, having regard to the azimuth of motion, and it is always smaller than V_1, as already explained. The velocites in the respective tables are derived by multiplying the velocity in millimeters on the 1,000-meter plane given in Table 32 by the factors written just beneath the name of the cloud forms. It will be remembered that these are the mean annual velocities, and do not refer to the seasonal changes which have variations relatively to them. In order to facilitate our discussion, it will now be confined to statements regarding the mean annual velocity, the modifications required being readily supplied by the inspection of Table 33, which shows that the range between the northern and the southern districts is about one-fourth of the total velocity, the northern being greater than the mean. Had all our areas been equally filled with the observations, the differences might have been somewhat smoother, yet they are now sufficient to bring out the general laws. The range is very much greater in the upper strata and increases from the ground upward, but maintains approximately a nearly constant ratio between the range and the total velocity. The northern velocity over high and over low areas is more broken up into distinct layers of different velocity than the southern, in the latter the velocity gradient increasing quite regularly from the ground up to the Ci. S., where there is an abrupt drop to the Ci. It is evident that above the ground we have three systems of velocities, the lowest in the stratus and cumulus levels, 1,000 to 2,000 meters high; the second in strato-cumulus and the alto-cumulus levels, 3,000 to 4,000 meters high; and the third in the cirro-cumulus and the cirro-stratus levels, 8,000 to 9,000 meters high. Our theodolite measures make the velocities in the cirro-stratus and the cirrus levels about the same, but there appears to be a maximum velocity in the cirro-stratus rather than in cirrus, so that we may conclude that cirro-stratus formations are accompanied by an increase of velocity of circulation on those occasions. Low areas have a greater velocity than the high areas by 15 per cent. The range between northern and southern high-area velocities is 19 per cent of their mean velocity, and the range between northern and southern low-area velocities is 28 per cent of their mean velocity. Compare Chart 14, where several velocity gradients are shown, the abscissa being here the velocity, and the clouds being plotted at their respective levels. In this chart the total high-area and the total low-area velocities appear as solid black lines. They show clearly the enormous increase in the movement of the atmosphere above the ground, *which averages 40 meters per second, or 90 miles per hour, at the 10,000-meter or 6¼-mile level.*

CHART OF THE CIRCULATION IN HIGH AND LOW AREAS.

We may bring out more clearly the details of the circulation of the atmosphere by plotting the vectors of the total velocity in the highs and lows as collected on Tables 34, 38, omitting further consideration of the variations pertaining to the northern and the southern districts, these transcribed vectors, therefore, being the mean for the United States east of the Rocky Mountain plateau. This is done on Charts 15, a, b, c, where the data is repeated for the high area in the two outside systems, a low being placed between two adjacent highs in order to exhibit the entire circulation of the anticyclonic and cyclonic system. A glance at the chart shows us where the imperfections occur in our data of observations, but the vectors given on the tables are plotted exactly as they come from the observations and compilation. The scale is reduced one-half, so that 1 mm. = 2 meters per second. The diagrams tell their own story so clearly that but little description seems to be necessary. Taken as a whole it is seen that the rapid eastward drift in the upper strata drops off by stages, as just described, toward the ground, where it is about one-eighth as great as in the cirrus region. The eastward drift has very small north and south components in the cirrus level, but these increase in strength, producing a sinuous curvature, which gradually acquires distinctness and finally passes into purely anticyclonic and cyclonic motions in the lower strata. Over the northern areas of the highs and the southern areas of the lows there is an acceleration of velocity and on the opposite areas a retardation, showing that circular gyrations are superposed upon the purely eastward drift, which distort it into the observed lines

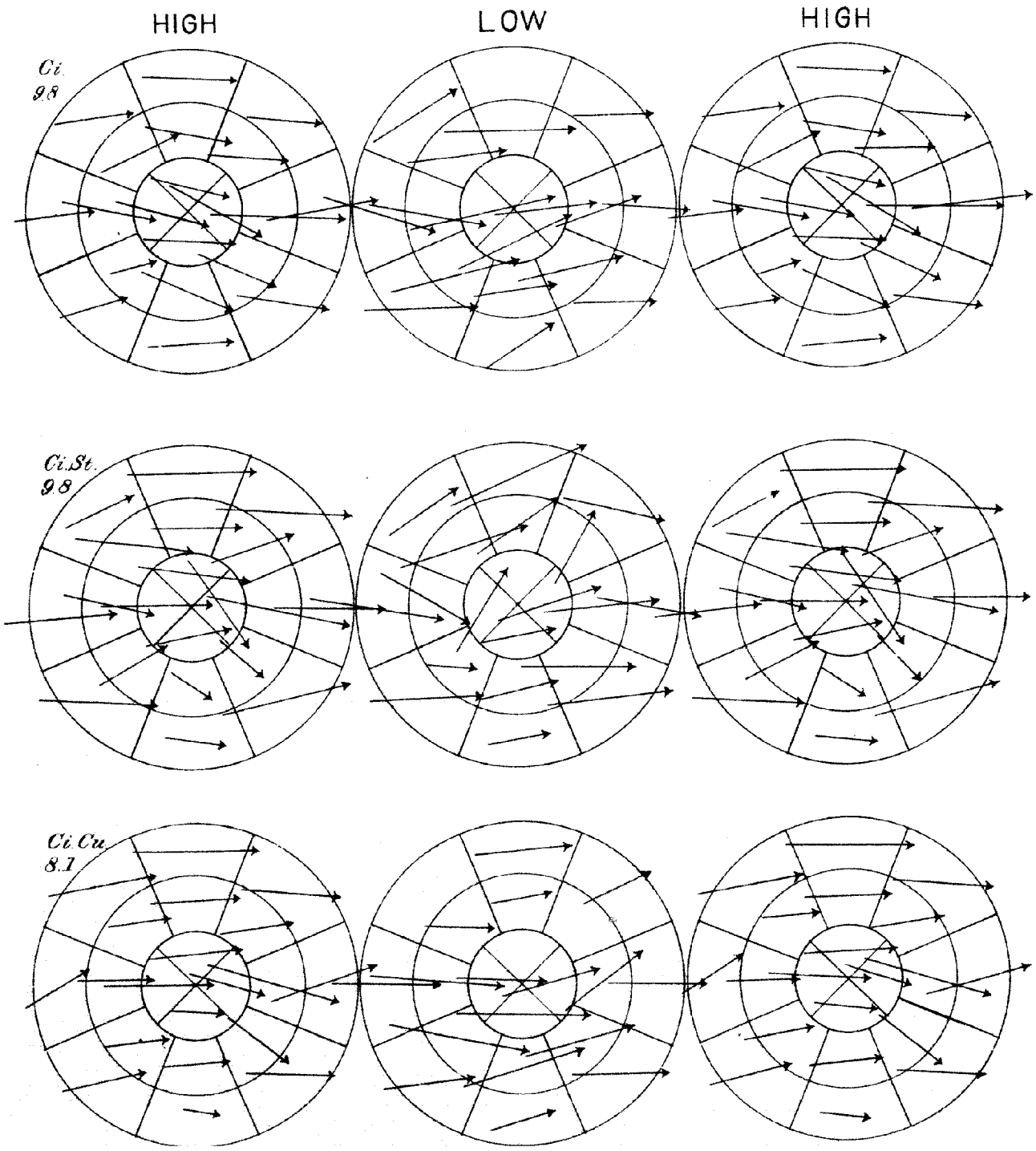
Chart 14.

Diagram of the Summary of the Resulting Velocities.



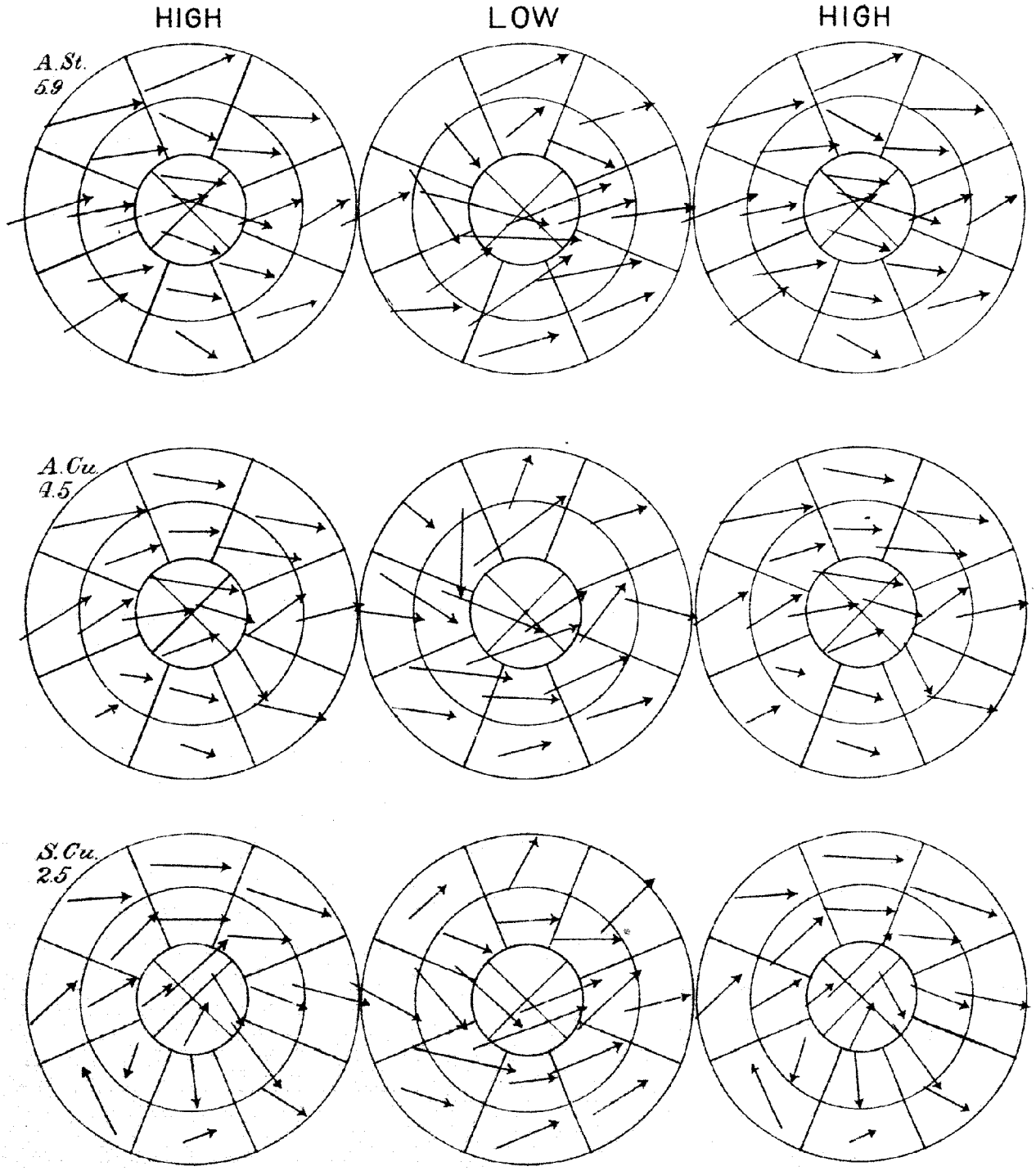
Annual Vectors on the Several Cloud Levels in High and Low Areas.

Chart 15, a.



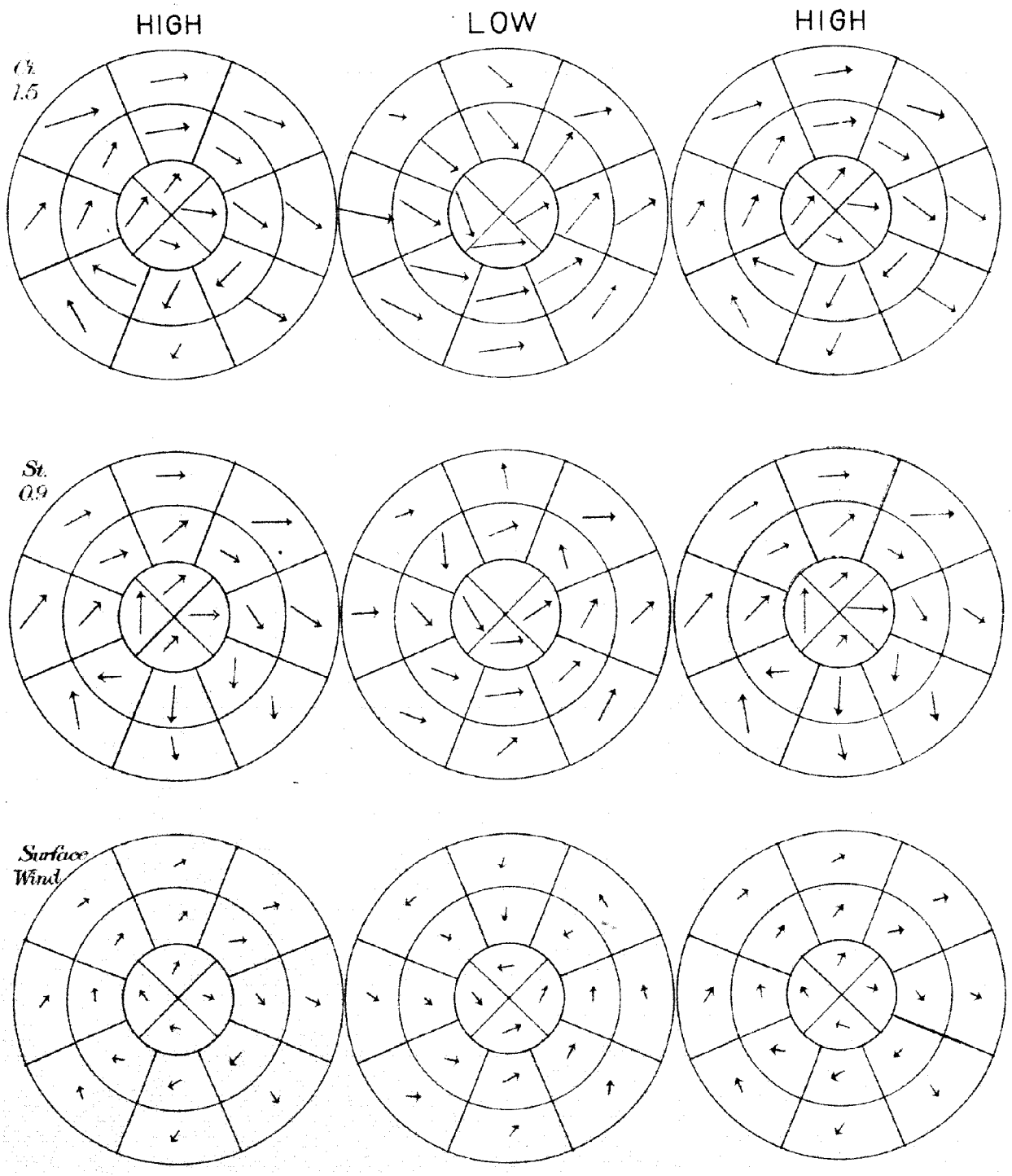
Annual Vectors on the Several Cloud Levels in High and Low Areas.

Chart 15. b



Annual Vectors on the Several Cloud Levels in High and Low Areas.

Chart 15, c.



of flow. In the three upper strata this deflection is small, in the middle three it is pronounced, and in the lowest strata it predominates.

We note in the case of the highs that the anticyclonic circulation is distinctly setting in at the alto-cumulus and the strato-cumulus levels, and that it is the prevailing circulation in the cumulus, the stratus, and at the surface. In the case of the lows the true cyclonic circulation at the surface is lost almost immediately upon leaving the ground, and the vectors of the northern areas do not throw around fully, not nearly so far as do the corresponding vectors in the highs. This remarkable phenomenon seems to indicate that the high areas predominate over the lows very decidedly in the vigor of their gyratory circulation, and it strengthens the view adopted in Bulletin No. 20, that the high area circulation takes the lead in the local movements of the atmosphere.

In his report of "Preparatory studies for deductive methods in storm and weather predictions," C. S. O., 1889, p. 96, Professor Abbe remarks, "The study of these maps in a few weeks enabled me to announce the general rule (entirely in accordance with Espy's, Redfield's and Ferrel's theories) that the lower clouds moved toward points to the right hand of the surface winds; the upper cloud directions trend to the right of the lower clouds; or, in general, the higher we ascend the more the movement of the air deviates to the right." An inspection of Chart 15 shows that on passing upward over the several subareas of the highs and lows that this rule is true to some extent in the southeast quadrant of the low, but it is not verified in the other quadrants, and is contradictory to the observations in many areas. The simple fact is that whatever may be the direction of the circulation near the ground, it tends to become eastward at some distance above it. The Blue Hill Observatory has also noticed this defect in Abbe's general rule. It may be here observed that our results as to the direction and velocity of circulation of the upper clouds are in accord generally with the Blue Hill work, and that they do not agree with the Hildebrandsson or the Clement-Ley figures, quoted by Sprung in Meteorologie, p. 251, and by Clayton in "Discussion of the cloud observations," 1896.

SEPARATION OF THE GENERAL FROM THE GYRATORY COMPONENTS.

The next step in our development is to disentangle the purely eastward drift from the observed stream lines, in order to obtain the components of the gyratory circulation. For this purpose it is necessary to establish a normal eastward movement, by means of which the gyratory residuals may be obtained. It is easy to perceive, by a careful examination of the vectors on Chart 15 or on the Tables 34, 38, that there are a few incorrect vectors which should be modified before proceeding to this process of separation. On the assumption that the changes from point to point of the diagram ought to be smooth and well balanced, the few vectors which are too long or too short or have a distinctly erroneous azimuth can be picked out. These cases generally arise when there are only a few observations, less than 10 in an area, and there is therefore little doubt that an addition to our observations would remedy these defects. I have decided to introduce a few modifications in the vector elements, which seem to be thus called for, rather than let the distortions accompanying them be carried further in the computations for the components. These changes are plainly marked in the subtables of Tables 34, 38, and are called adjusted vectors. Usually only one element of the vector was modified, and in most cases that was the azimuth. Thus in Table 34 under Ci. Strat. we find that area (2) has the azimuth changed from 32° to 70°, the length remaining the same, 41.2; area (7) has the same azimuth and the vector length altered from 63.7 to 44. These changes seem to be fully justified by an inspection of Chart 15. Under the corresponding table of lows, Table 38, the same kind of adjusted vectors are to be found.

THE COMPONENT VELOCITIES.

The general plan of this investigation consists in working out the south-north, east-west rectangular components of motion in each subarea of the high and low, then transforming them into the equivalent radial and tangential cylindrical coordinates for an analysis of the gyratory features in the circulation of the atmosphere. It is especially favorable to this object to have the nephoscope observations made with the right-hand rotation about a vertical axis positive upward, and counting zero azimuth in the south, which implies that southward is positive and eastward is

positive. Furthermore, the arrangement of the 20 minor areas, as given in the plan of Charts 9, 15, is well calculated to facilitate this computation, since the resulting vectors fall at once on three circles about the center, and are thus immediately in the best form for use in our analytic formulæ. The Blue Hill mode of collecting observations in the rectangles formed by the geographical meridians and parallels does not permit any exact combination about a center, except through a very annoying adjustment of the vectors, to prepare them for such a compilation. The tabular arrangements are so plain that but little further account is needed of the mode of the computing the components. Table 33 gives in the second, third, and fourth sections the summary of the mean rectangular component systems thus derived. In the first of these sections all of the 20 subareas in the highs and lows are employed, and Tables 42 and 43 gives the details of the work for the highs and lows, respectively. For an example, the vector in Table 34, under cirrus 1, is 86°.35.3, and since 86° is the angle from the south through the east, the south component is + 2.5, and the east component is + 35.2, which appears in position under cirrus 1 of Table 42. In the same way the remainder of these rectangular components are constructed. The word total in the heading refers to the fact that we are dealing with the data of Tables 34, 38, and not with the northern or the southern districts of the United States. At the bottom of the table marked "adjusted vector," are found those values which we suppose to be more correct than those derived from the uncorrected observations. These values are carried forward into the construction of the cylindrical components, but they were not used in taking the means of Tables 34, 38, though I presume it would be an improvement to have done so. There are three sets of means given on Tables 42, 43, the second being called normals, and which appears also in the second section of components, Table 33. The first gives the means of all the 20 subareas of the highs and lows, and they represent the average south-north east-west drift over a high or low, respectively, in each of the nine strata. They appear plotted on Chart 14 as solid red lines. Since these represent the average drift over highs and lows individually, the mean of them, Section III, Table 33, is taken as the *normal* drift of the atmosphere over the United States. This set of values, subtracted from the components of the Tables 42, 43, give the anticyclonic and the cyclonic gyratory systems, which we are seeking, and are recorded on Tables 44, 45. Finally, in order to show the most rapid movement of the atmosphere, which evidently occurs *between* the high and low centers, the following selected areas are taken together, and the means computed. For the most rapid southward and eastward components H (16 . 8 . 2 . 7 . 15 . 6 . 14) and L (18 . 10 . 4 . 11 . 19 . 12 . 20) are summed together algebraically and the mean taken; for the most rapid northward and eastward components L (16 . 8 . 2 . 7 . 15 . 6 . 14) and H (18 . 10 . 4 . 11 . 19 . 12 . 20) are similarly treated. These components appear on Tables 42, 43, and on Chart 14 as the dotted red lines. On the same chart the resultant directions of the normals are shown on a reduced scale, placed in the section of low areas, so as not to interfere with the other lines of the diagram. The mean components of these selected areas are also collected on Table 33, Section IV

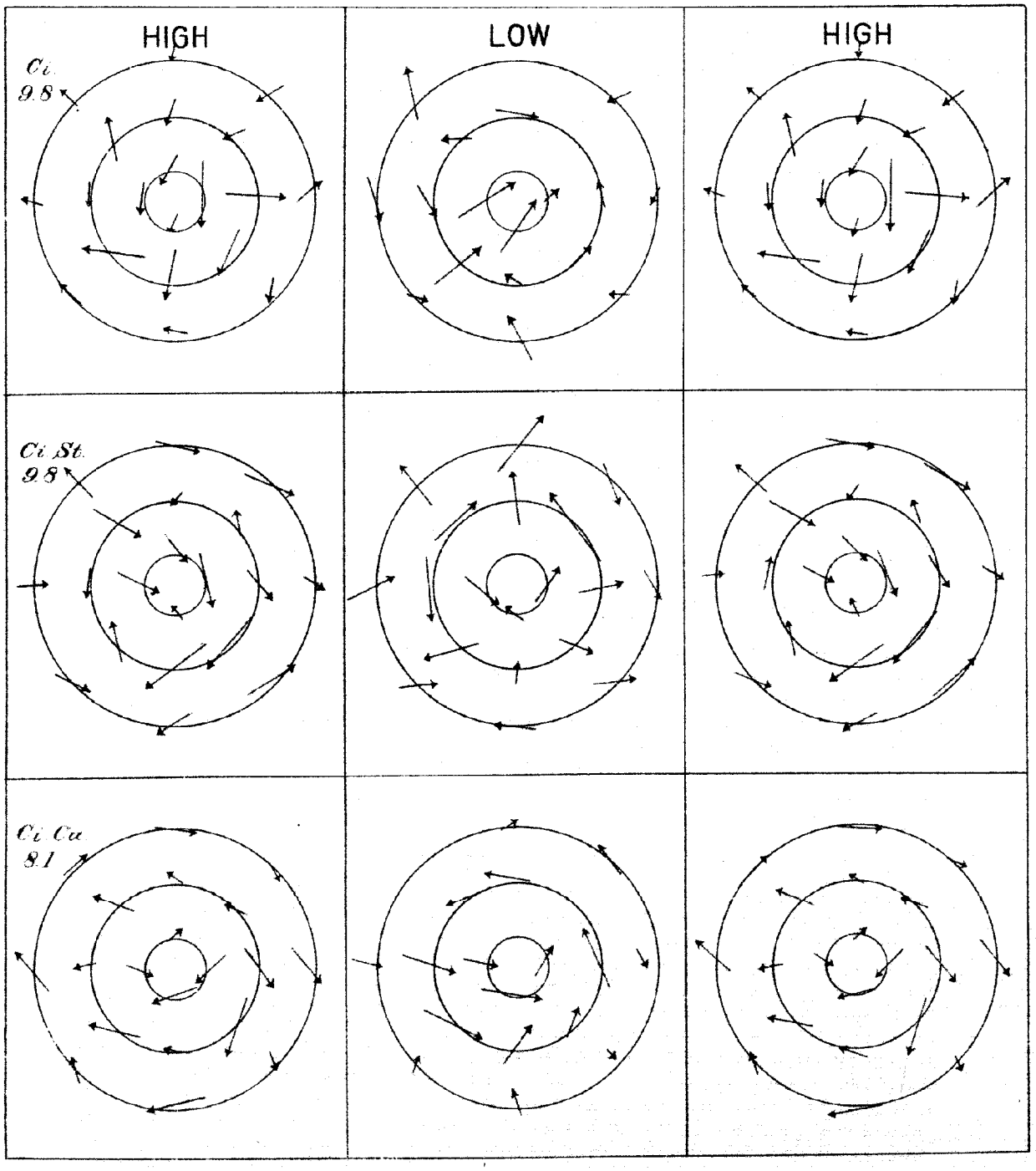
FURTHER DESCRIPTION OF CHART 14.

a. Formation of distinct currents.

The diagrams of resulting velocities on Chart 14 are certainly very instructive. They give the average velocities for the United States of the atmospheric circulation over high and low areas along the meridians and the parallels of latitude, respectively. This statement must, however, be modified, inasmuch as they apply chiefly to those centers which lie over the districts east of the Rocky Mountains, since our observations are almost entirely confined to this region. The remarkable increase in velocity from the ground upward to the cirrus level is to be noted; from 5 meters per second, or 11.2 miles per hour, up to 40 meters per second, or 90 miles per hour, as has already been stated. The metric and English scales of velocity are shown at the top and the two scales of altitudes at the side of the diagram. To the left of the zero line of velocity the components are negative, that is, north or west, as the case may be, and to the right of it positive, that is, south or east. The increase in vertical velocity takes place chiefly in two strata, the stratus to the cumulus, about 1,000 meters thick, and in the strato-cumulus to the alto-cumulus, about 2,000 meters thick; possibly the same is true for the third high level region, the alto-stratus to the cirro-cumulus, about 3,000 meters thick. If it is the fact that the atmosphere has three

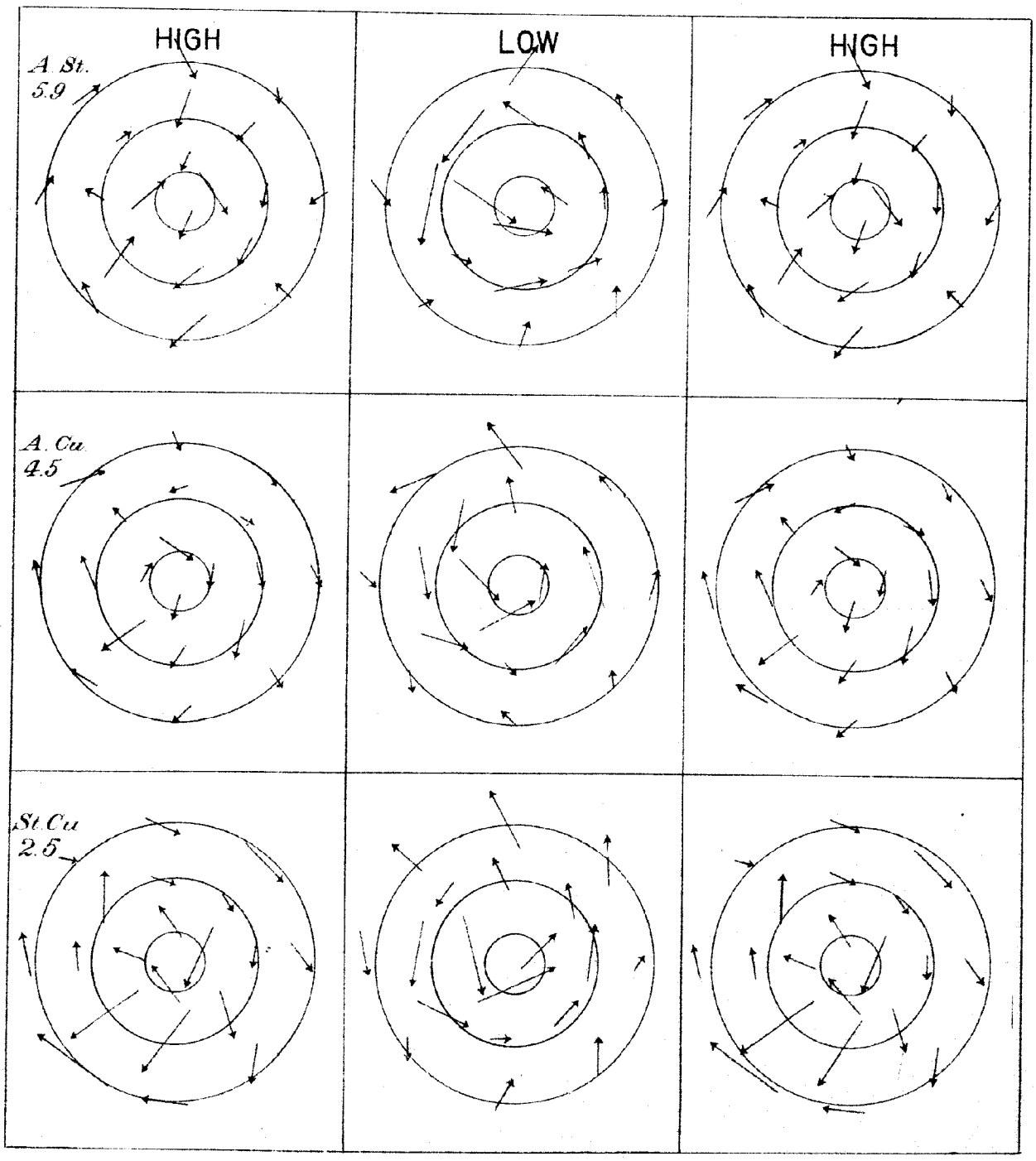
Anticyclonic and Cyclonic Components of the Annual Vectors in High and Low Areas.

Chart 16. a.



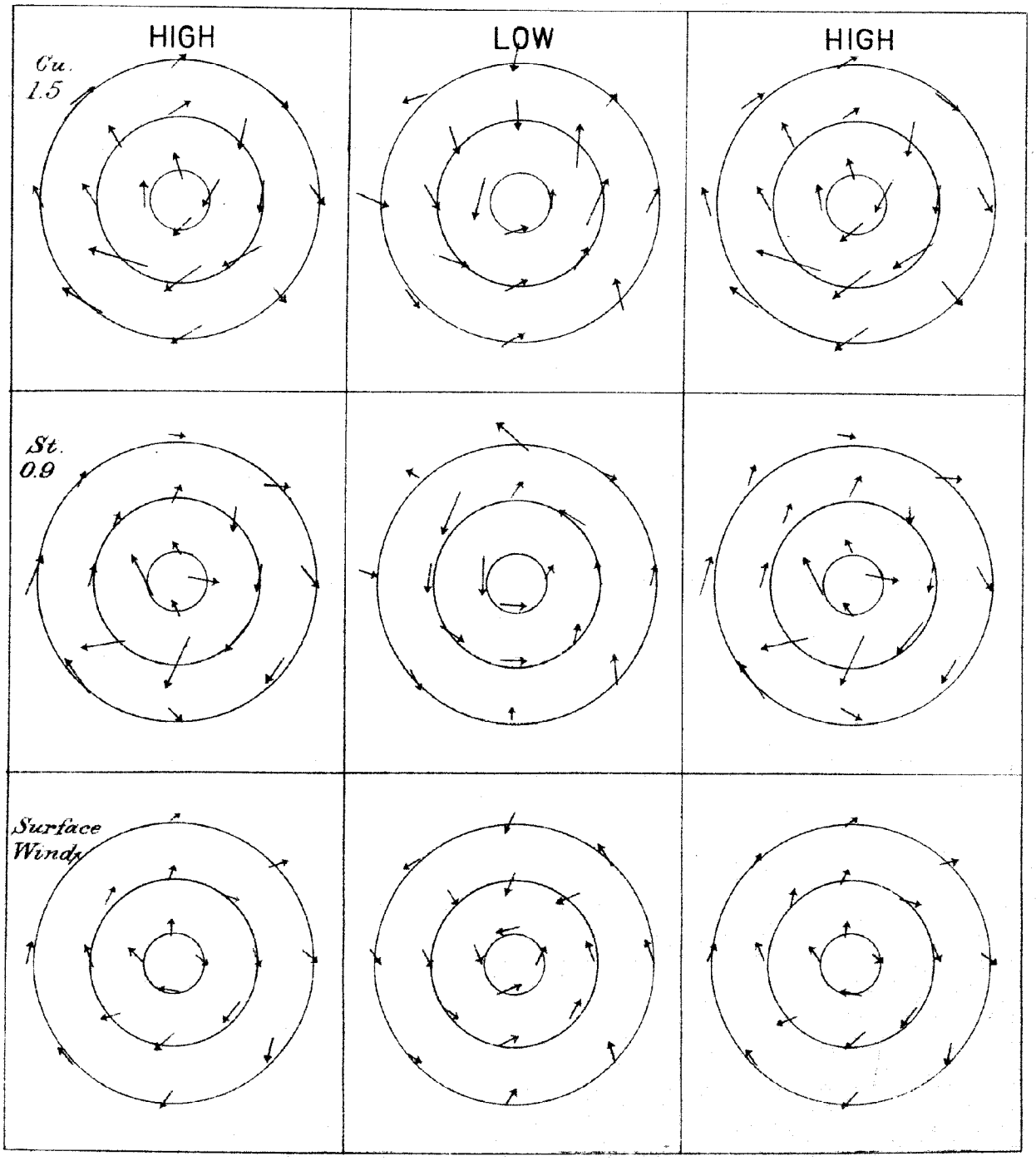
Anticyclonic and Cyclonic Components of the Annual Vectors in High and Low Areas.

Chart 16. b.



Anticyclonic and Cyclonic Components of the Annual Vectors in High and Low Areas.

Chart 16. c.



distinct eastward layers of velocity in it, 1,000 or 2,000 meters thick, with about 1,000 meters for the transition between them, then the inference is very interesting that *stratus types of clouds form at the bottom and cumulus types at the top of each one of these currents*, speaking in general terms.

b. Formation of the stratus and cumulus types.

I am inclined to think that this fact should be carefully remembered in discussing the physics of cloud formation. Attention is especially called to the beautiful classification of clouds shown on Chart 14, where the stratus are all at the bottom of those currents which flow with greater velocity than the next level underneath, and the cumulus are at the tops of each of these layers, which are moving with the same velocity from the bottom to the top of the current. Hence, stratus are produced by currents flowing over each other, where the relative velocity is great between adjacent strata; cumulus are formed within those currents which have the same velocity throughout and permit an ascensional motion of air by buoyancy due to temperature gradients. On reaching the tops of their respective strata the cumulus begin to topple over as soon as they feel the influence of the more rapidly moving currents into which they tend to intrude. These great streams are probably kept separate from each other by differences of temperature, characteristic of the layers individually.

c. The eastward and the southward components.

The atmosphere over high areas moves rapidly eastward, but less so than over the low areas; it has a minute northward movement over highs, and a well-defined northward component over the lows. This can only mean that highs are fed in by air moving from the west and not from the north or south, but that the lows have a distinct component from the south as well as from the west, as if the tropical warm air was conveyed toward the poles *in all levels*, though tending to increase in velocity a very little at the higher levels. Between the highs and lows the movements to the south in one case, that is, on the east of the center of the high, and to the north in the other case, that is, on the west of the center of the high, is *greatest in the strato-cumulus region*, namely, 2,000 to 3,000 meters above the ground. This is one of several pieces of evidence to show that this level is especially active in storm formations, a circumstance which will also be further emphasized in other connections. There is apparently a tendency to an increase of activity in the cirro-cumulus region also, but perhaps this will require further confirmation from future observations.

THE ANTICYCLONIC AND CYCLONIC COMPONENTS.

Thus far we have been discussing the total south-north, east-west, rectangular components, and have found the mean or normal values for them. Now, on the supposition that the actual observed vectors are compounded of two or more independent systems, after subtracting the normals from the observed values the residuals may be considered as forming one of these components. Thus Table 42, $+2.5$ and $+35.2$ are the total components of Ci. 1 in the high; the normals are -1.6, $+36.6$; substracting we have $+4.1$, -1.4, which are entered in Table 44, of anticyclonic components under cirrus 1, where $+u_1 =$ south velocity, and $+v_1 =$ east velocity; this method being pursued in constructing Tables 44, 45. These components are now plotted on Charts 16 *a*, *b*, *c*, the circles in this case being drawn through the centers of the areas of the diagram of the 20 subareas. While there is still some irregularity in the neighboring vectors, requiring more observations to improve them in the defective places, yet the main feature of the gyratory circulation in highs and lows is very clearly seen. From this Chart 16 many important deductions can be drawn for the discussion of the analytic theory of the atmospheric circulation.

Taking first the high area, we find the well-known anticyclonic circulation at the surface, almost perfectly free from the distortion superposed upon it by combination with the eastward drift of the atmosphere in the higher levels. The same circulation is well developed in the stratus and cumulus, but with a decided increase of velocity. The strato-cumulus shows the greatest anticyclonic actual velocity of any of the levels, and the same gyration is well developed at least to the cirro-stratus level. In the cirrus itself, at practically the same height as the cirro-stratus, the gyration has nearly disappeared, though it may be thought that symptoms of its action are to be detected there. We conclude *that a true anticyclonic gyration extends from the ground upward*

about 6 miles, and that its strongest development occurs in the strato-cumulus level at the height of 2,500 meters.

Beginning again at the ground in the low area, we see a well-formed cyclonic gyration, which extends upward with an increasing velocity to the strato-cumulus, where it is most firmly developed. There is not much difference, however, between the strato-cumulus, and the alto-cumulus levels, through a depth of 2,000 meters, though there is less regularity in the structure of the vectors in the higher strata. The alto-stratus and the cirro-cumulus still show plainly the true cyclonic gyration, but in both cirro-stratus and the cirrus it has quite disappeared. The vectors are there too irregular to assign any typical cyclonic circulation to them, and this fact seems to indicate merely a structureless discharge from the underlying vortex into the strata, with an aimless drifting about and disturbance of the eastward circulation at that high elevation.

DISCUSSION OF THE RESULTS OF CHART 16.

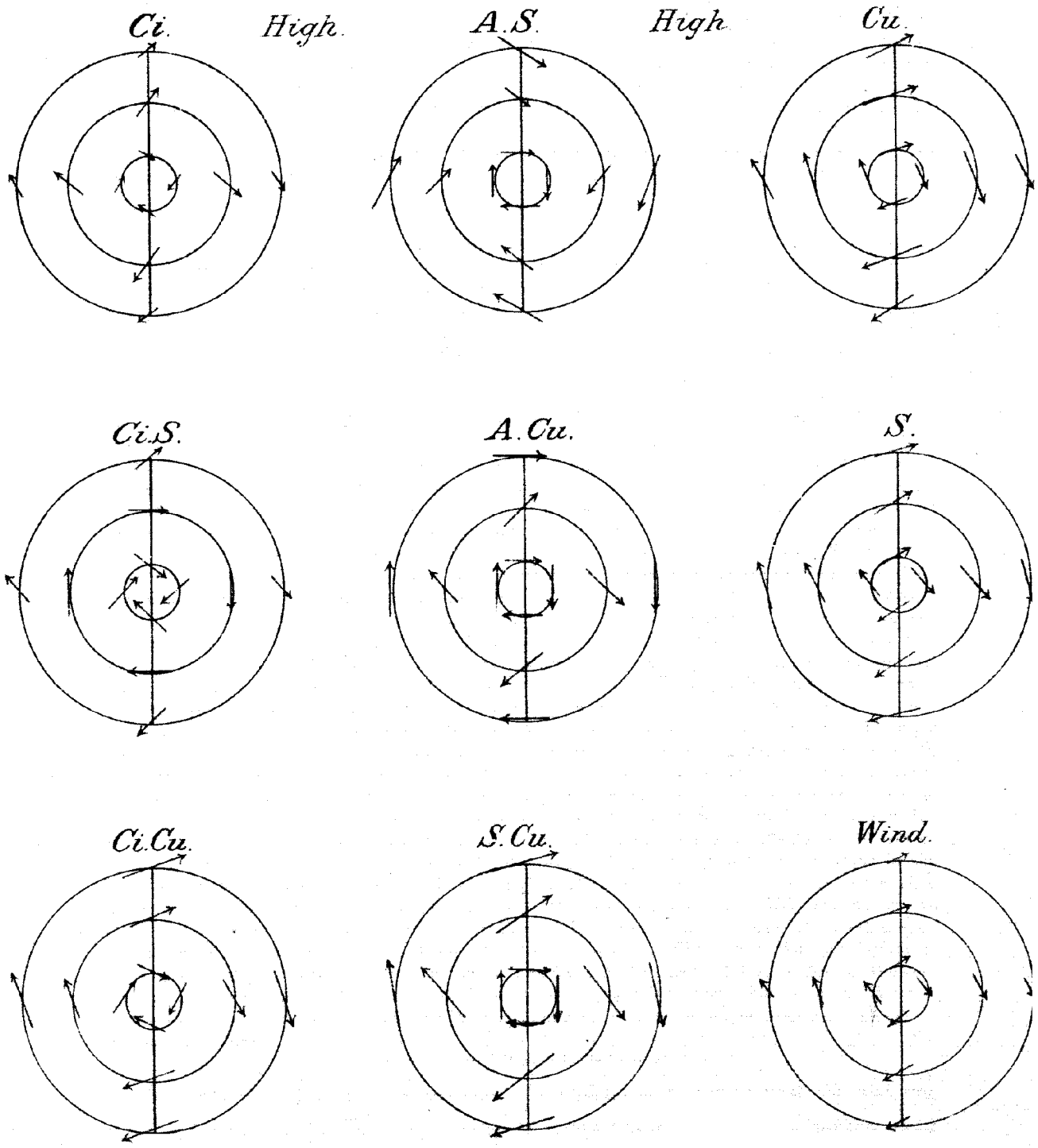
From this data we draw some important conclusions: (1) The high areas show a firm circulation higher up than do the low areas. *This contradicts Professor Ferrel's theory at the very root of it, since he taught that the vortex of the cyclone flows over, into, and builds up the anticyclonic circulation by its downward discharge.* We shall return to this point in discussing the analytic theory of the circulation; but this chart also strongly fortifies the position taken in Bulletin No. 20, that the high areas are the dominant and the low areas the subordinate features in the circulation, thus reversing the commonly received opinions in this regard. (2) The maximum strength of the gyratory circulation occurs at the height of 2 miles above the ground, and it *tends to propagate itself with diminishing energy above and also below that level. This is also inconsistent with Ferrel's view that locally heated convective currents of ascension are the source of the entire circulation of the highs and the lows.* On the other hand, we see that the gyrations of the cumulo-stratus and alto-cumulus levels tend to propagate themselves downward, more as a tornado is formed, though evidently in accordance with the vortex laws. (3) It may be noted that in nearly every case the diagrams formed from observations on cumulus cloud forms, Cu. or A. Cu. or Ci. Cu., are better determined than those from observations on stratus clouds, S. or S. Cu. or A. S. or Ci. S. Whether this is due to the fact that the setting of the instruments on stratus clouds, on account of their irregular shape, is so much more difficult and inaccurate as to really affect the value of the observations, or whether it is due to the increase of velocity which apparently takes place in every stratus level, may perhaps not be readily decided. (4) If the circulation of the upper strata consists, as it appears to, of a straight eastward drift with a circular gyration superposed upon it, and if the average movement is about 90 miles per hour in the cirrus, diminishing to 45 near the strato-cumulus, it is exceedingly difficult to see how such a combination is produced except as a resultant action depending upon a source partially independent of this combination. We have seen that the strato-cumulus and cumulus levels first show a complete gyration superseding the eastward component, and that this is the stratum where the greatest rotational energy exists. If temperature gradients in the lower cloud levels can sustain convectional *horizontal* currents which are thrown into gyration, especially at the levels 1 or 2 miles above the ground, like whirlpools in a rapid stream, we have a mechanism which is capable of giving the effects here observed. It will be shown that such streams do exist, and that they produce just these rotations in the lower atmosphere, while the upper air is but slightly deflected by their influence, except as they are compelled to avoid making a discontinuous system of stream lines. This scheme throws almost all the activity of anticyclones and cyclones upon the *horizontal* currents, the vertical component being chiefly the necessary result of the vortex motion. This mechanism is complete as to cause and effect, and does not call for the overworking in the theory of that feature of the convection due to the production of latent heat from condensation, which has been the favorite hypothesis in meteorology, to account for the existence of local cyclones and anticyclones in mid-latitude zones.

THE CYLINDRICAL COORDINATES.

We now seek to transform the rectangular coordinates u_1 v_1 positive south and east, into cylindrical coordinates, $u_2=\frac{d\varpi}{dt}$, positive along the radius outward, and $v_2=\varpi\frac{d\theta}{dt}$, positive along the tangent in right hand-rotation, where ϖ is the radius and θ the angle counted from the south

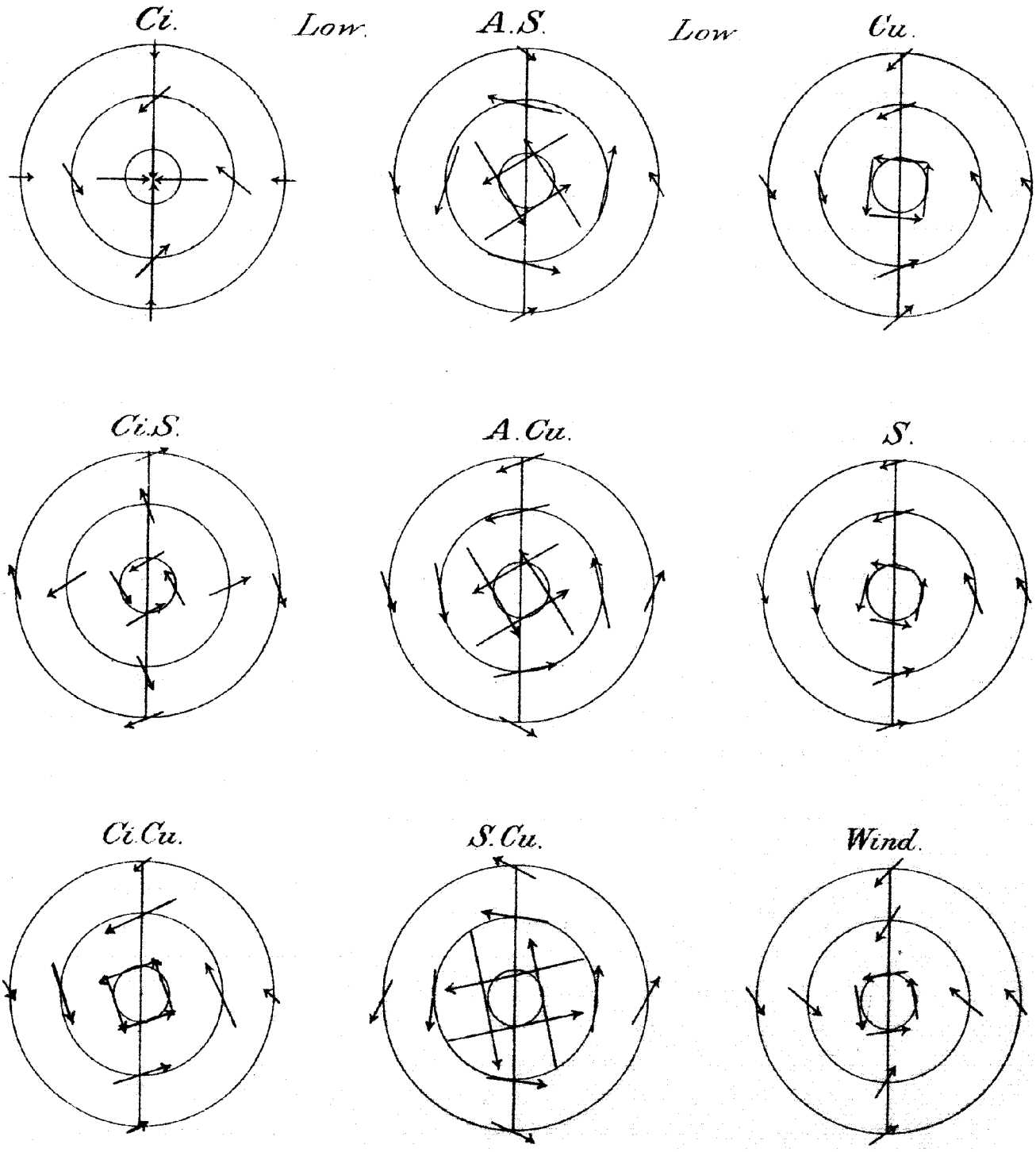
Typical Mean Vectors of the Anticyclonic Circulation in each Cloud Level.

Chart 17.



Typical Mean Vectors of the Cyclonic Circulation in each Cloud Level.

Chart 18.



point. The angles φ = azimuth, and θ = the angle of rotation in cylindrical coordinates are the same in fact, but it is convenient to have distinct notations for rectangular and cylindrical coordinates. The position of the subareas lying central on the cardinal points of the compass is such that all but eight areas can be transposed from rectangular and cylindrical coordinates by mere inspection, which involves a cyclical change of the signs and the order of writing the values of u_1 v_1 to become u_2, v_2. Those which do not lie on the north-south west-east lines are transformed as follows: The coordinates u_1, v_1 are compounded into the vector (σ, β), σ being the linear distance from the center, and β the angle from the south. Thus in cirrus 6, high, Table 44, $u_1 = 14.2$, $v_1 = -6.9$, and we find $\sigma = 15.7$, $\beta = 333°$, which can be verified by reference to Chart 16 *a*. In the same way all the vectors under subareas 6 . 8 . 10 . 12 . 14 . 16 . 18 . 20 which lie on the SE.-NW. and NE.-SW. diagonals have been reduced to vectors (σ, β).

To reduce these to the cylindrical coordinates, we subtract 45° from β in 6 and 14, 135° from β in 8 and 16, 225° from β in 10 and 18, 315° from β in 12 and 20. Then the vector $[\sigma\ (\beta - \alpha)]$ is resolved at once into u_2, v_2. Thus 15.7, 333° of Ci. 6, high, Table 44, becomes 15.7, 288°; thence $u_2 = 4.9$ $v_2 = -14.9$, cirrus 6, high, Table 46, as can also be verified on the Chart 16 *a*. In this way the coordinates of the anticyclonic and cyclonic components, Tables 46, 47, have been found. We have thus the data in such form that one more concentration can be made. If we assume that a symmetrical gyratory circulation is represented by the coordinates of Chart 16, it is now necessary simply to take the mean values of the cylindrical coordinates lying on each circle; that is to say, the mean of the areas 1–4, 5–12, 13–20, respectively. This has been done, and they are entered as I, II, III, in the next section of the same Tables 46, 47. The means of I, II, III, themselves, are also entered on the next line, as average values for the entire circulation in each cloud level. These can be most conveniently studied by reference to Charts 17, 18, where specimen vectors are plotted for the several levels.

DISCUSSION OF THE RESULTS OF CHARTS 17, 18.

These charts exhibit the result for which the work was planned; this is very valuable and instructive in that it throws a flood of light upon the long-sought answer to the problem of the construction of storms. Taking up first the high areas, we note that there is a well-defined structure, that each stratum is consistent with its neighbors, except only the two outer vectors in the alto-stratus level, which turn inward instead of outward, as do all the others. It would be quite impossible to search through the mass of observations profitably to find the source of this exception, and I therefore merely note it as a defect. Otherwise we have the following facts for the highs: (1) The two outer vectors have an *outward* component in every level from the cirrus to the ground; (2) the inner vector has an *inward* component from the cirrus to the cirro-cumulus, it is almostly exactly *tangential* from the alto-stratus to the strato-cumulus, and it has an *outward* component from the cumulus to the ground; (3) the maximum strength of the circulation is in the strato-cumulus level, and it diminishes in velocity upward and downward.

We find therein the exhibition of a complex circulation (1) containing a true downward vortex near the center of the high, apparently extending about 500 kilometers or 312 miles from the axis; (2) on the two outer circles all the vectors are outward, and represent a forced gyratory circulation like an eddy in a partially deflected stream, bent only part way around the axis, but not circulating inward toward the axis in any part of it. Apparently a stream of air moving rapidly at the strato-cumulus level tends to divide and curl up, the inner portion forming a true central vortex, the outer being drawn off to feed the circulation about the center of the adjacent cyclone. We shall in another chapter show fully the configuration of the streams which feed the highs of the United States and their peculiar structure in each of our six specified districts. Were it not for the exception in the alto-stratus level, one might regard this as a very perfect demonstration of the facts thus summarized; also, it shows that the anticyclonic circulation exists at higher levels than the corresponding cyclonic. Furthermore, on comparing the two systems side by side we see that the longest vectors occur on the outer circle of the highs, but on the inner circle of the lows, and that, too, in such proportion that the vortex strength of the anticyclone, product of the radius by the velocity, is greater than that of the cyclone.

The vectors of the low areas present quite different characteristics. Beginning with the

surface, it is seen (1) that all the vectors have an *inward* component up to the cumulus, the inner increasing in strength; (2) that they continue *inward* in the levels from strato-cumulus to the cirro-cumulus, except that there is a slight tendency to turn outward on the exterior circle, the alto-stratus again showing average conformity with the others; (3) that the tendency is still *inward* in the cirro-stratus and cirrus level in the interior, but is apparently lawless over the outer parts. These features characterize a forced vortex which is fed *inward* from bottom to top, except for a little escape outward along the edges. The gradients must all be inward throughout the extent of this vortex circulation. The distinctly inward component near the ground, which is so well known a feature of cyclones, becomes nearly tangential at a small altitude and remains so from the stratus through the strato-cumulus, but there again resumes its inward motion except on the outside. This may be considered to mean that the vortex is retarded by the friction on the ground; that it falls off above the strato-cumulus by impinging upon the rapid eastward drift of the upper strata, and dies out almost entirely on the outer parts, but maintains its gyration higher in elevation near the center.

THE GRADIENTS IN ANTICYCLONES AND CYCLONES.

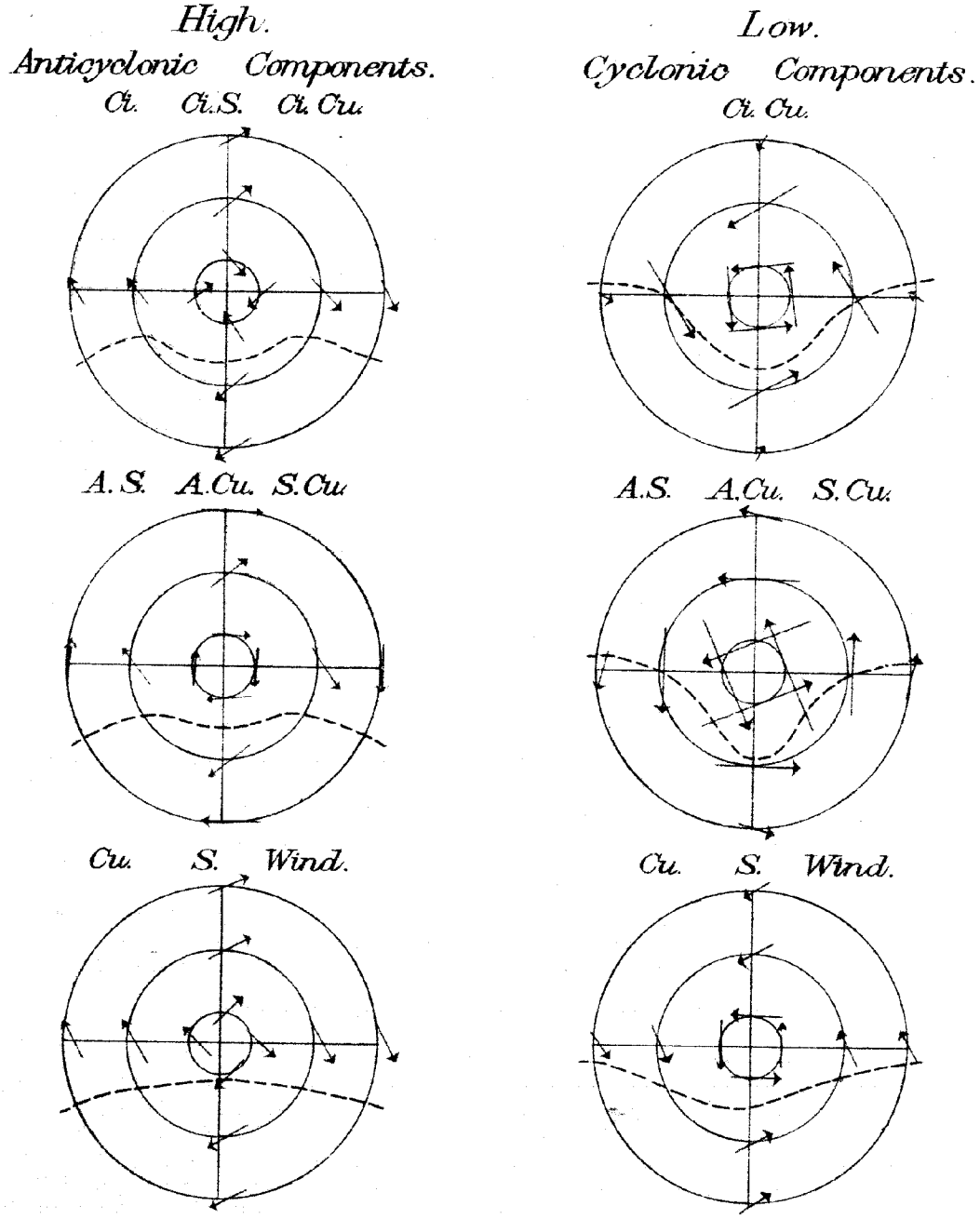
We may obtain an approximate idea of the systems of pressure gradients belonging to the anticyclonic and the cyclonic components of the high and low areas in the following manner: The three upper strata, Ci., Ci. S., Ci. Cu., agree closely together and form one type; the three middle strata, A. S., A. Cu., S. Cu., may also be so combined; likewise the three lower, Cu., S., Wind, having a very similar circulation, as indicated by our preceding charts and tables, the three mean values belonging to these groups have been taken. The only exception is that the Ci. and Ci. S. have not been combined with Ci. Cu. to make the upper cyclonic components, because there is little evidence to show that the upward cyclonic gyration holds its distinctive structure above the Ci. Cu. level. These means are indicated by a star and note on Tables 46, 47, and they are also transferred to Table 52. In this connection the cylindrical coordinates u_2, v_2 are transformed into the equivalents

TABLE 52.—*Mean anticyclonic components grouped in three levels.*

	Ci.	Ci. S.	Ci. Cu.		A. S.	A. Cu.	S. Cu.		Cu.	S.	Wind	
	u_2	v_2	σ	β	u_2	v_2	σ	β	u_2	v_2	σ	β
I	−3.3	−4.5	5.6	234	0.0	−7.1	7.1	270	−3.3	−4.1	5.3	308
II	+3.9	−5.2	6.5	307	+4.2	−6.6	7.9	303	−3.0	−7.0	7.6	294
III	+2.2	−4.8	5.3	294	−0.8	−9.3	9.3	265	+1.8	−6.2	6.4	287
Mean cyclonic components.												
I	−1.2	+10.2	10.3	96	−7.3	+18.6	20.0	111	+0.3	+7.9	8.0	88
II	−6.8	+12.3	14.0	119	+0.3	+14.4	14.4	89	−2.4	+6.3	6.7	111
III	−1.8	+0.7	2.0	161	+1.6	+5.2	5.5	73	−1.5	+3.8	4.2	112

σ, β, where σ is the length of the vector on the horizontal plane and β the angle that it makes with the radius, counted from its positive or outward direction in the same rotational direction. These vectors are also found plotted on Chart 19 in four radial positions, but it is to be understood that the same vector prevails around each circle. Proportional vectors may be interpolated into the intermediate spaces between the circles, and also between the different levels in a vertical direction. These three sections are, however, sufficient for specimen compilations, which otherwise would be too extensive, and it is unnecessary, in order to bring out the laws in operation, to go beyond a study of these typical and critical forms of the circulation. We shall employ these values when the analytic formulæ are to be put into practical examples.

It is seen by inspection that the surfaces of equal pressure must be very much like those



Typical Stream Line Vectors and Isobar Surfaces in High and Low Areas.

represented by the dotted lines, which are drawn across the areas at convenient places, and are of course simply relative curves. In the high area we have in the lower strata the curve arched throughout, since all the vectors flow outward; in the middle strata the arch is slightly concave at the crest to sustain the tangential vector near the center; in the upper strata it is more deeply depressed to deflect the vector inward near the center. Thus there is a true central convectional vortex of small dimensions, about 400 miles in diameter, with inflow at top and outflow at bottom. At the two outer circles, distant 750 and 1,250 kilometers from the center, the outflow is continuous, showing that the gradient is, as it were, banked up by the velocity of the stream line acted upon by the component of the earth's rotation, which presses the current generally toward the right.

In the low area the type of isobars is quite different. It begins in the lowest strata, with moderately depressed surfaces, all the vectors being inward except the innermost, which are tangential; in the middle strata the inward vectors increase toward the center and the isobars are most bent downwards, there being, however, possibly a very slight outflow at the edge of the area; in the Ci. Cu. level the inflow is still strongly maintained at the center with comparatively deep isobar curves, but they are nearly horizontal near the outer circle, and there the velocity is very feeble. The important feature to recognize is that an inflow is maintained throughout the vortex tube, showing that fresh material is drawn in at all levels, forced upward by vortex laws, and discharged above the Ci. Cu. level into the rapid eastward drift. There is no evidence to indicate that this air flows over into the adjacent highs and becomes immediately contributory to their construction.

All these features of the circulation confirm the general view expressed in Bulletin No. 20, Storms, Storm Tracks, and Weather Forecasting, as summarized on the last pages, which was to the effect that the general circulation first builds the highs in downward vortexes, and then that these tend to build the lows with an upward circulation in a forced vortex, the discharge from which is aimlessly destroyed in the eastward drift. The theory in Ferrel's treatise is in this respect reversed, since he supposed that the convective circulation from local heating first built the lows, and then that the overflow from these built the highs. We now see that the lows do not reach high enough to build the highs, but that they merely struggle up into the eastward drift. On the other hand, the outer part of the highs are chiefly devoted to constructing the lows, and the inner parts of the high constitute a true and complete vortex, with gradients inward above and outward below discharging to the surface. They are formed by the dynamic movements of the horizontal currents principally in the strato-cumulus level; they drag the air from above down into themselves, and push it farther downward to flow out along the ground. This tendency for a large current of air to divide into two parts with opposite gyrations is so uniformly characteristic of fluid motions as to be the most likely method of operation in natural movements, and the structure just described is thus merely a type of jet action on a large scale. We shall return to the discussion of these motions after bringing forward the rest of the material in our hands.

LINEAR CURRENTS OVER HIGH AND LOW AREAS.

It has been claimed by some, as in the Blue Hill publications, that there is a linear current from a temperature gradient passing over the high and low areas. To get some information on this point the following process was prosecuted. Take the means of I, II, and of III for such groups of cloud levels as seem to present a homogeneous system of coordinates, as Ci. to Ci. Cu., A. S. to S. Cu., Cu. and S., for normals in the combined layers, as given in the lower section of Tables 46, 47. Subtract these from the components u_2, v_2 for residuals, which ought to be the components of any other streams which may exist in the atmosphere. These residuals appear in the several columns marked u_3, v_3, all in heavy-faced type. They were then all plotted on a diagram, but the result is indecisive. There may be said to be a slight southward drift over the highs; over the lows the vectors have no distinct direction. Even if such a third system of currents exists we can not be permitted to secure their components except after the possession of very perfect original vectors from which to start the analysis, and those in our hands were evidently not sufficiently reliable for this third decomposition. Several years of nephoscope observations may give us this last set of residual components, but at present we can make no statement of interest founded on this experimental data.

The mean values of I, II, III from the cirrus level to the ground have been entered at the end of the section, and they show in their relative values the increase in the vectors of the high areas outward, and of the low areas inward, as just mentioned and displayed on Chart 19.

SEASONAL DIRECTIONS AND VELOCITIES.

In order to determine the velocities pertaining to the atmospheric circulation in the different seasons of the year, another combination of the nephoscope observations was made. Hitherto the discussion has been limited to the data on Table 32 in the horizontal rows under the final section marked "annual." We now proceed to the vertical columns marked "mean," which comprise the weighted sums of the Ci., Ci. S., Ci. Cu., A. S., or the upper clouds in one set, and the A. Cu., S. Cu., Cu., S., or the lower clouds in another set. The velocities given in millimeters, that is the movement on the scale of the nephoscope, are changed into miles per hour as in other cases, and the data is then transferred to Tables 48–51, for the northern and the southern districts, each in the high and low areas, thus forming a group of four tables. The mean velocities are now transferred to the lowest section of Table 33, which shows the velocities in the several seasons, each covering the three months of which the one indicated is the first. There are greater velocities in the northern districts than in the southern in all cases but two, and the average is one-fifth greater. The extreme difference of 14 m. p. s. between the northern and southern occurs in the June, September quarters for the upper clouds of the low areas; and the least difference, about 1 m. p. s., in the September, December quarters for the upper clouds of the high areas. Many other features appear by an inspection of this interesting table.

The mean azimuth angles were also computed on Tables 48–51, but they present no obvious conclusion, except in a general way that the southern areas move with a larger northern component than the northern areas. The conditions are much too complex to analyze in a simple manner, including as these means do the entire high and low areas which were observed in all parts of their complicated tracks east of the Rocky Mountain plateau, and the subject is therefore dismissed from further consideration.

CHAPTER 8.

THE TYPICAL LOCAL CIRCULATIONS OVER THE UNITED STATES.

CONSTRUCTION OF THE LOCAL COMPOSITE CHARTS.

The process of combining the nephoscope observations described in the last chapter resulted in constructing in detail the average type of circulation prevailing in each cloud level of high and low areas so far as the material used permitted. The result was so far a general composite that little information remained regarding the local variations caused by special characteristics of the movements of the air over the United States, arising from the configuration of the ocean and land areas and from the topography of the country. While this general picture of anticyclonic and cyclonic circulation is of great interest in the prosecution of analytic researches, yet in the art of forecasting it is the local features which are especially important. Since our main object in this investigation is to improve the methods of forecasting and produce greater efficiency by supplying definite knowledge upon those parts of the circulation of the air which have not been well understood, I propose to extend the study to each of the six districts into which the United States is subdivided, and construct the stream lines which contribute to make up the highs and the lows in each of these districts. It is not possible to carry out such a compilation for each of the eight cloud levels which have been worked out, but we can properly group, as before, the four high levels into a common upper-cloud group, and the four low levels into a lower-cloud group. The cirrus are especially the clouds which contribute to make up the former, and the cumulus the latter, and hence we may speak of the upper as the cirrus group and the lower as the cumulus group. The wind, the cumulus, and the cirrus levels will in this chapter comprehend all the data at our disposal. The outcome, besides showing the local features of the circulation, throws much light upon the sources of the air movements which build up the high and low areas in the several levels; to the general knowledge here supplied in three levels the special changes required for each of the nine levels may be quite readily added.

The daily telegraphic reports from 140 stations of the Weather Bureau service, with the other parts of the observations, include the wind direction and velocity, the kind and direction of motion of the clouds visible at 8 a. m. and 8 p. m., but no velocity of cloud movement. The cloud data are entered upon a special auxiliary chart for forecasting, the upper clouds in red lines, the lower clouds in blue lines, and the wind in black lines. The number of arrows present on such maps shows the number of observations made at a given hour, and they represent the state of the sky over the entire United States. It is now easy to select a number of maps exhibiting entirely similar features of circulation, and by transference to a single map construct a composite of the typical circulation pertaining to that type. Thus the series of maps may be taken for high areas whose centers always lie within the Alberta district and put together on a single chart, from which, as components, resultants may be built up at regular intervals over the United States. This may be done for the wind, the cumulus, and the cirrus levels separately, by collecting the black, the blue, and the red arrows on three separate maps. Practically we proceeded as follows: Taking a large sheet of tracing paper, a center was marked for a given district, the same center being retained for the three levels and laid, successively, on the local center of each pressure area within the district, while the short arrows visible were plotted on it till a large number of vectors had been thus collected on the same chart. Then the chart of traced vectors was laid upon a scale of arbitrary but equal squares, so that the number of arrows comprised in equal areas of the weather map could be readily counted as to direction. The number of maps used in thus constructing our charts is shown on Table 53, which gives the season, the district and type, the three levels, and the brief symbol of the several groups. In constructing the winter Alberta high, Chart 20 $(1)_1$, we used 40 original weather maps for the composite of the wind, 48 for the

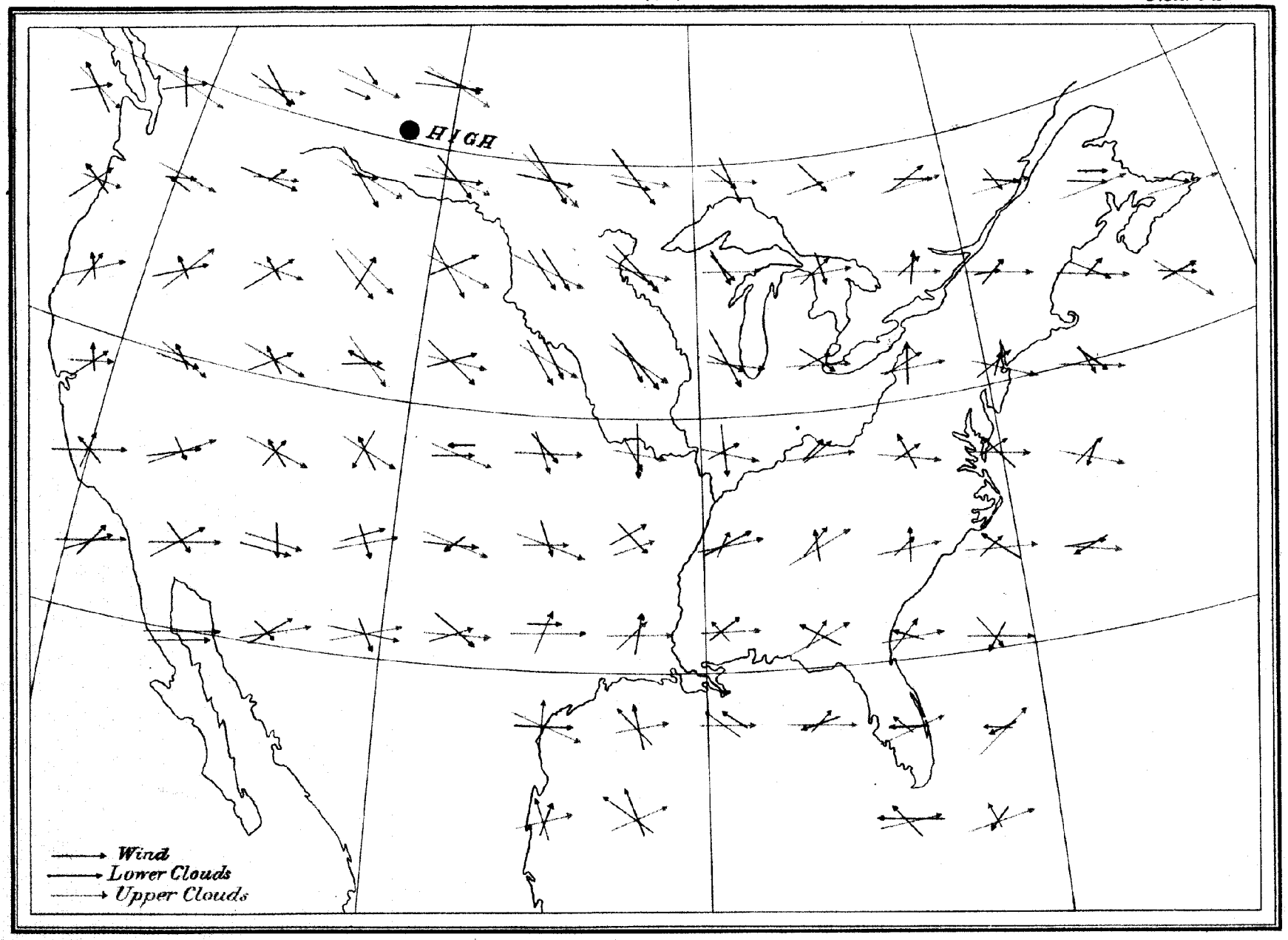
cumulus, and 103 for the cirrus. The number of charts differs for the several districts on account of the prevailing cloudiness and for other causes, the series of selected charts stopping when the composite was full enough for practical purposes. Winter signifies the months January, February, and March; summer signifies July and August. There are in all 16 types of 3 levels each; 365 wind charts, 631 lower-cloud charts, and 920 upper-cloud charts; the average wind charts 23, lower clouds 39, and upper clouds 58; total, 1,916 employed. The great number of cirrus required to get enough material is due largely to the fact that the sky was either clear or else that the cirrus level was obscured by the cumulus level, since the cirrus are generally seen on the edges of the cumulus cloud sheet in the process of formation or dissolution. It will be observed that the resultant vectors on the charts overlap the oceans, but this is due simply to the fact that the adopted center on the composite chart is placed anywhere within the large district under investigation (compare Chart 10), and thus the vectors transcribed when the center is near the side of the district will cause the map to overlap the oceans when brought back to the district center. The squares of the scale were 4 centimeters on the side; squares were used instead of the areas made by the meridians and parallels of the map, because in moving the center about there was thus no question introduced of the varying scale area; also because the symmetry of the square made it easier to work up the combinations. The resultant was formed by the principle of the Lambert formula, namely, counting the number of arrows directed along each of the eight points of the squares, combining at right angles along two axes by graphic projection on a diagram, instead of by trigonometric computation, and then taking the angle representing the mean rectangular components. It was convenient to reduce the system to the average of 40 vectors in each square, and the resultant actually obtained by the counted number of arrows was lengthened or shortened proportionally to make this equal to the resultant of 40 observations. If 20 arrows were actually used in making the resultant, the vector was doubled in length. It is assumed that the mean direction and velocity within a square is proportional to the resultant of the number of observed vectors in different directions. The final charts therefore give the directions with precision and the *relative* velocities on the scale adopted. The true velocities may be found from the theodolite and nephoscope transformation factors.

TABLE 53.—*The number of daily weather maps used in constructing the typical local circulations.*

Season	District and type		Wind	L. C.	U. C.	Symbol
Winter	Alberta	High	40	48	103	$(1)_1$
		Low	26	50	81	$(1)_2$
	Lakes	High	17	38	37	$(2)_1$
		Low	24	48	60	$(2)_2$
	New England	High	19	35	69	$(3)_1$
		Low	26	37	72	$(3)_2$
	Colorado	High	20	56	73	$(4)_1$
		Low	31	39	54	$(4)_2$
	West Gulf	High	20	31	34	$(5)_1$
		Low	22	36	52	$(5)_2$
	South Atlantic	High	16	44	61	$(6)_1$
		Low	17	23	51	$(6)_2$
	Alberta	Cold wave	33	43	53	(7)
Summer	N. Pac. and So. Atl.	High	14	31	35	(8)
	Lakes	High	11	16	19	(9)
	So. Atlantic	Hurricane	29	56	66	(10)
Sums			365	631	920	
Average			23	39	58	
Total					1916	

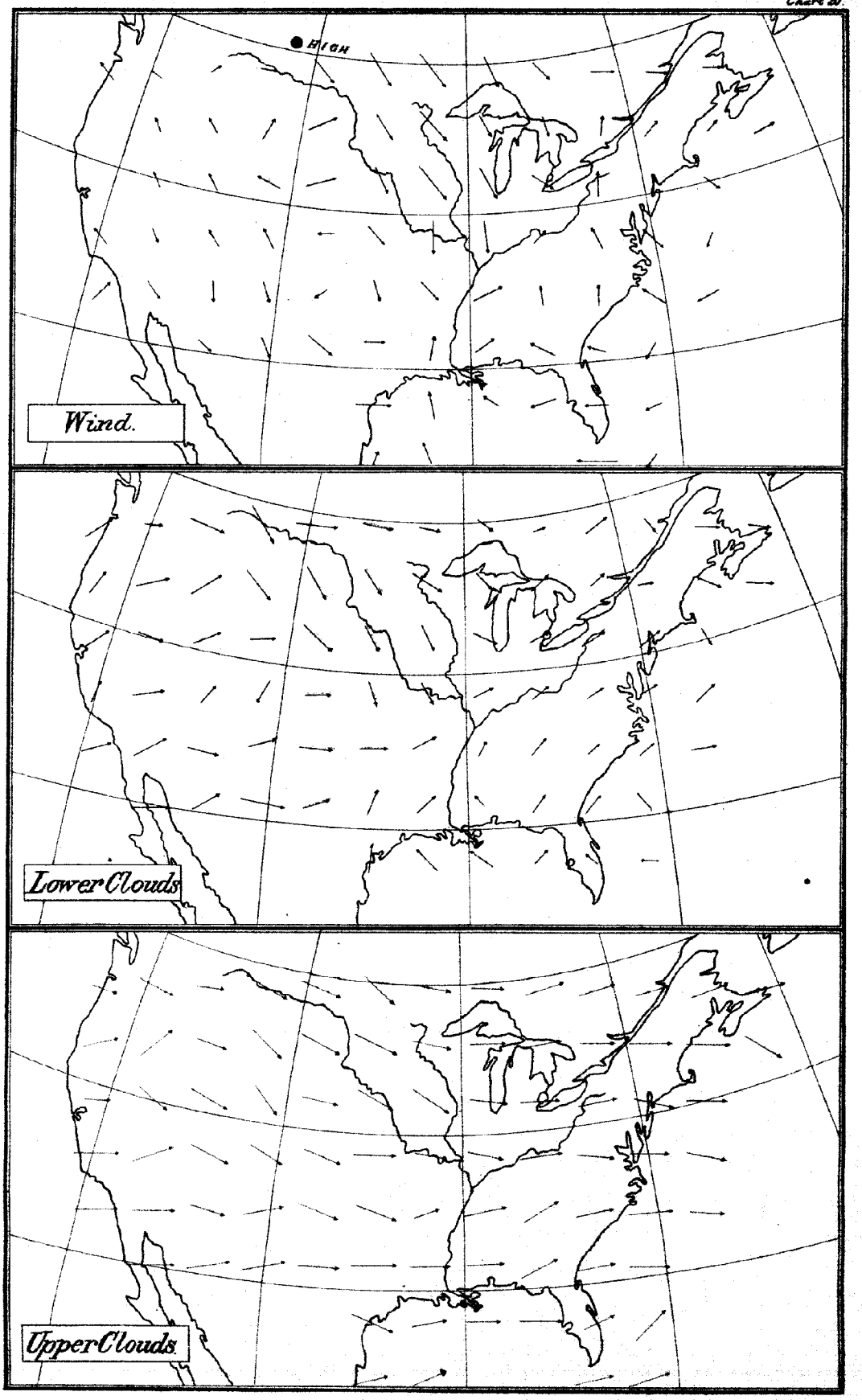
Alberta High (I)$_{I}$, Winter.

Chart 20



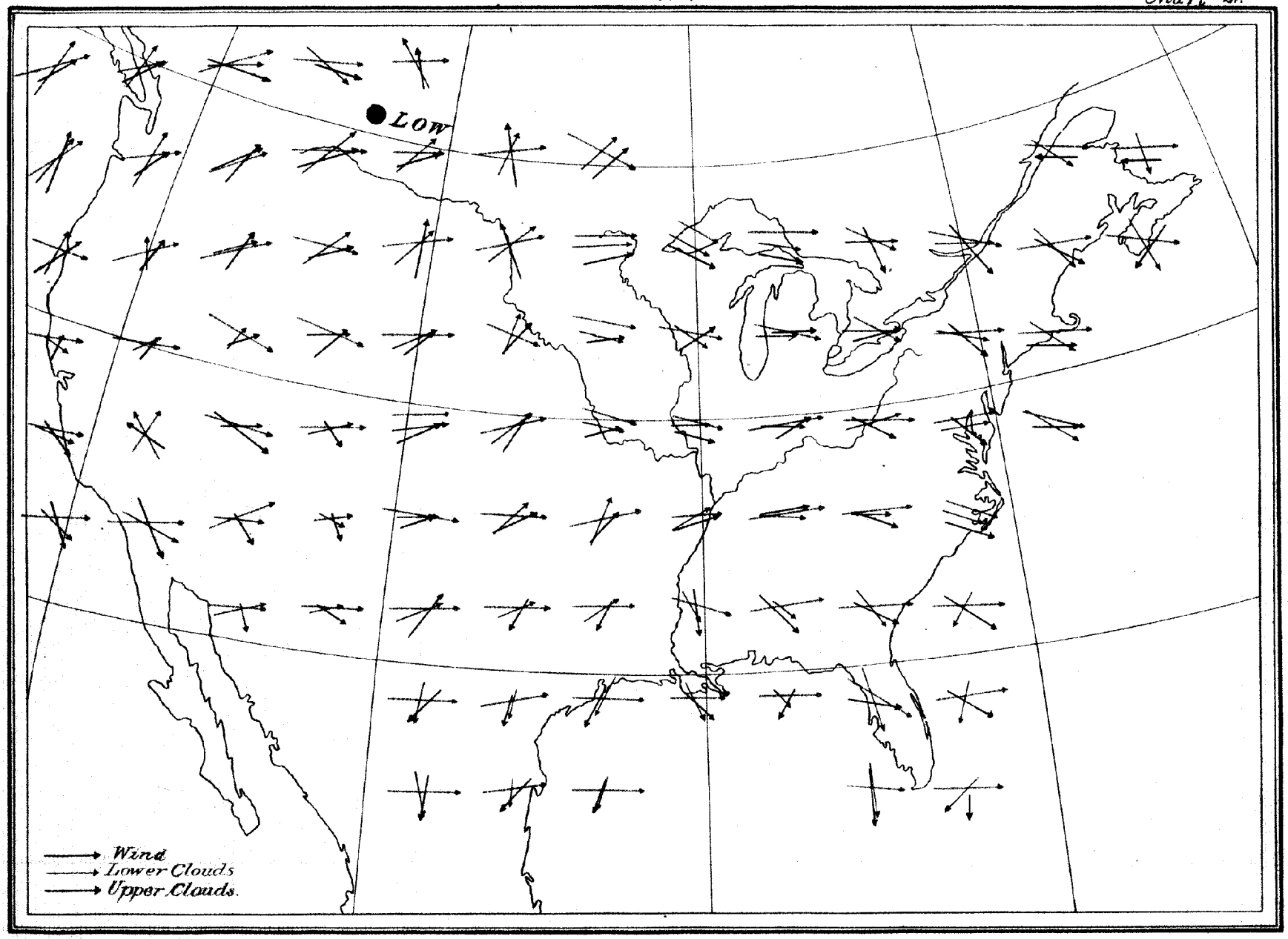
Alberta High (i)$_t$, Winter

Chart 20.



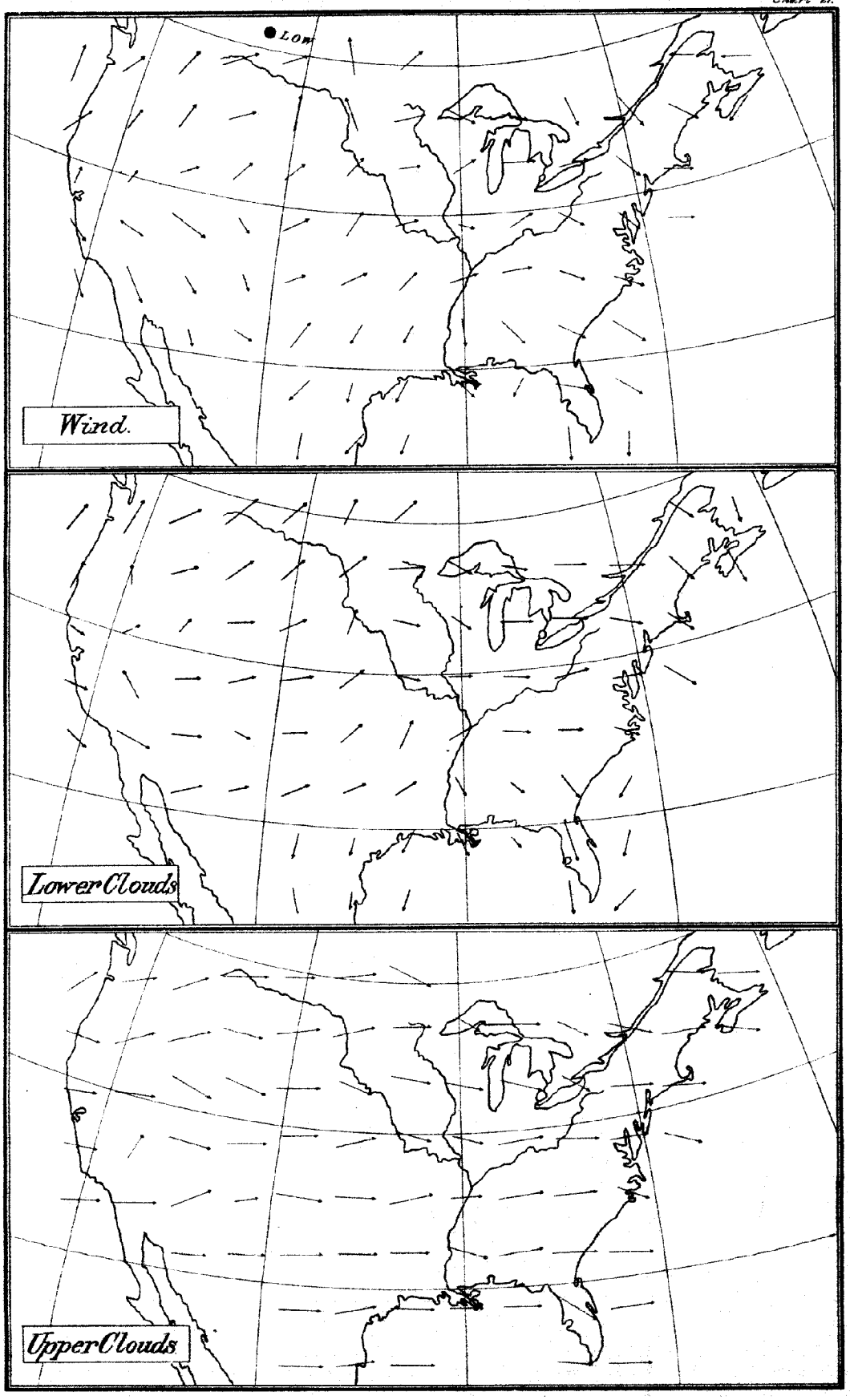
Alberta Low $(1)_2$, Winter.

Chart 21.



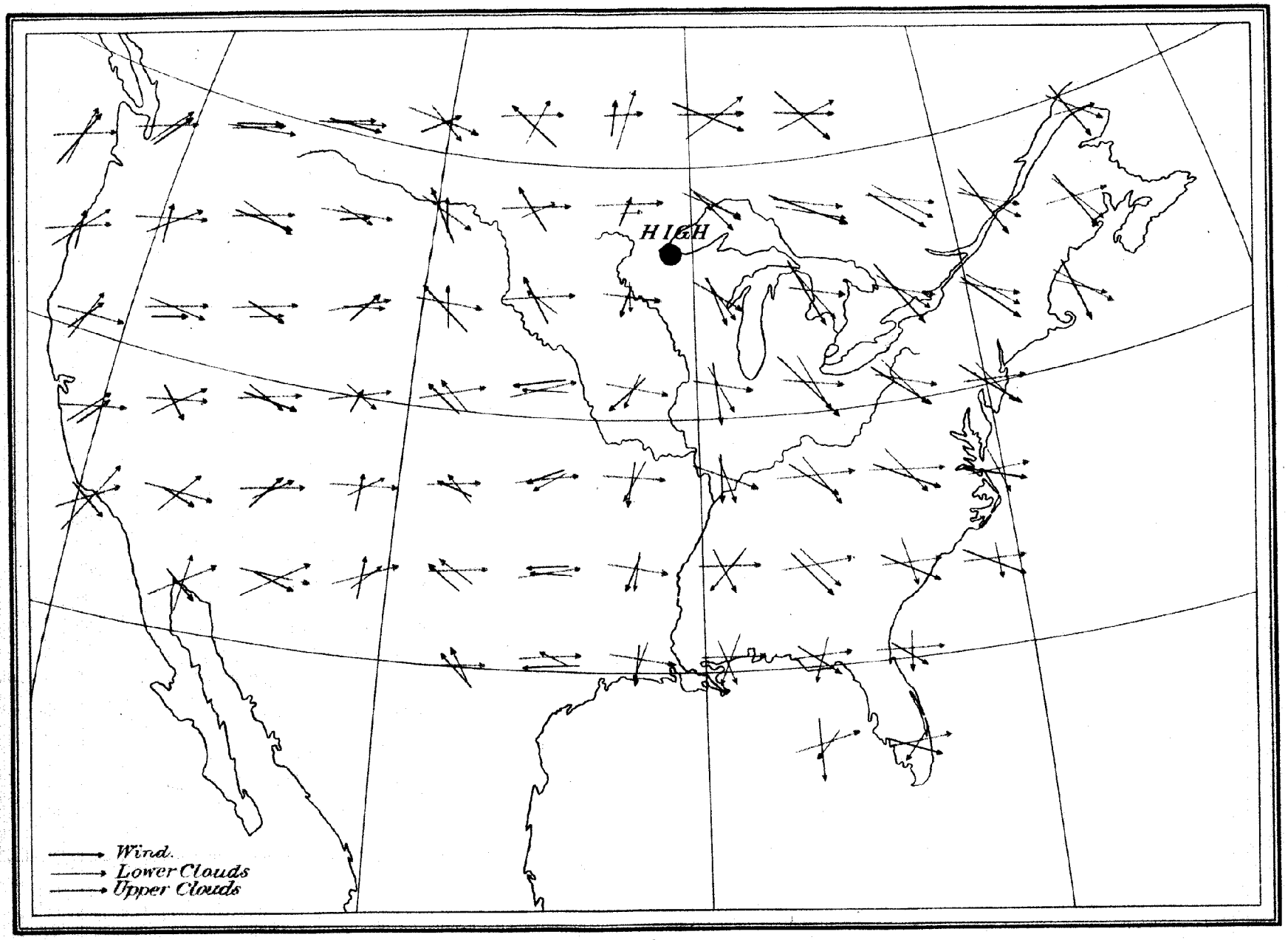
Alberta Low $(1)_2$, Winter.

Chart 21.



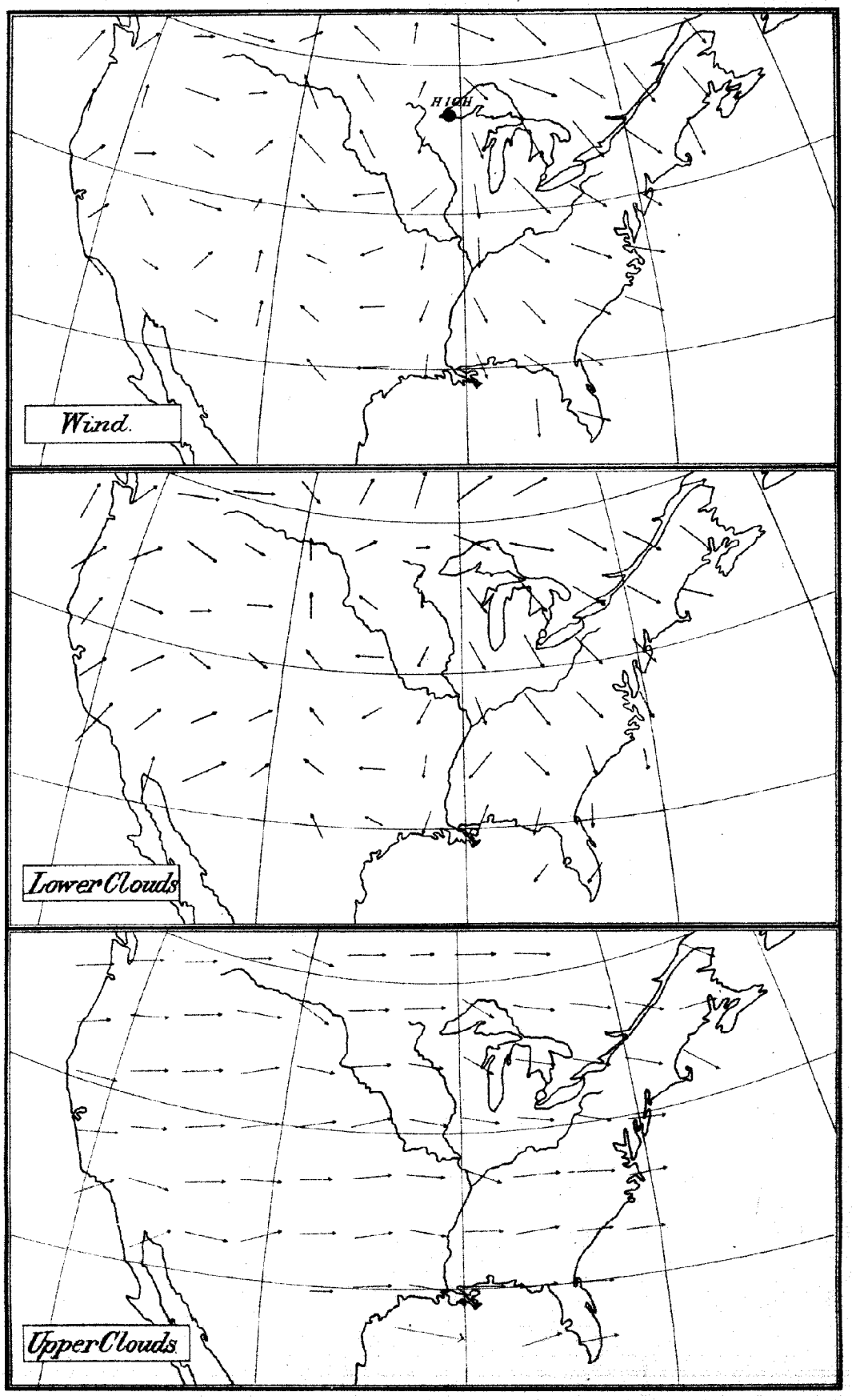
Lake Region High $(2)_1$, Winter.

Chart 22.



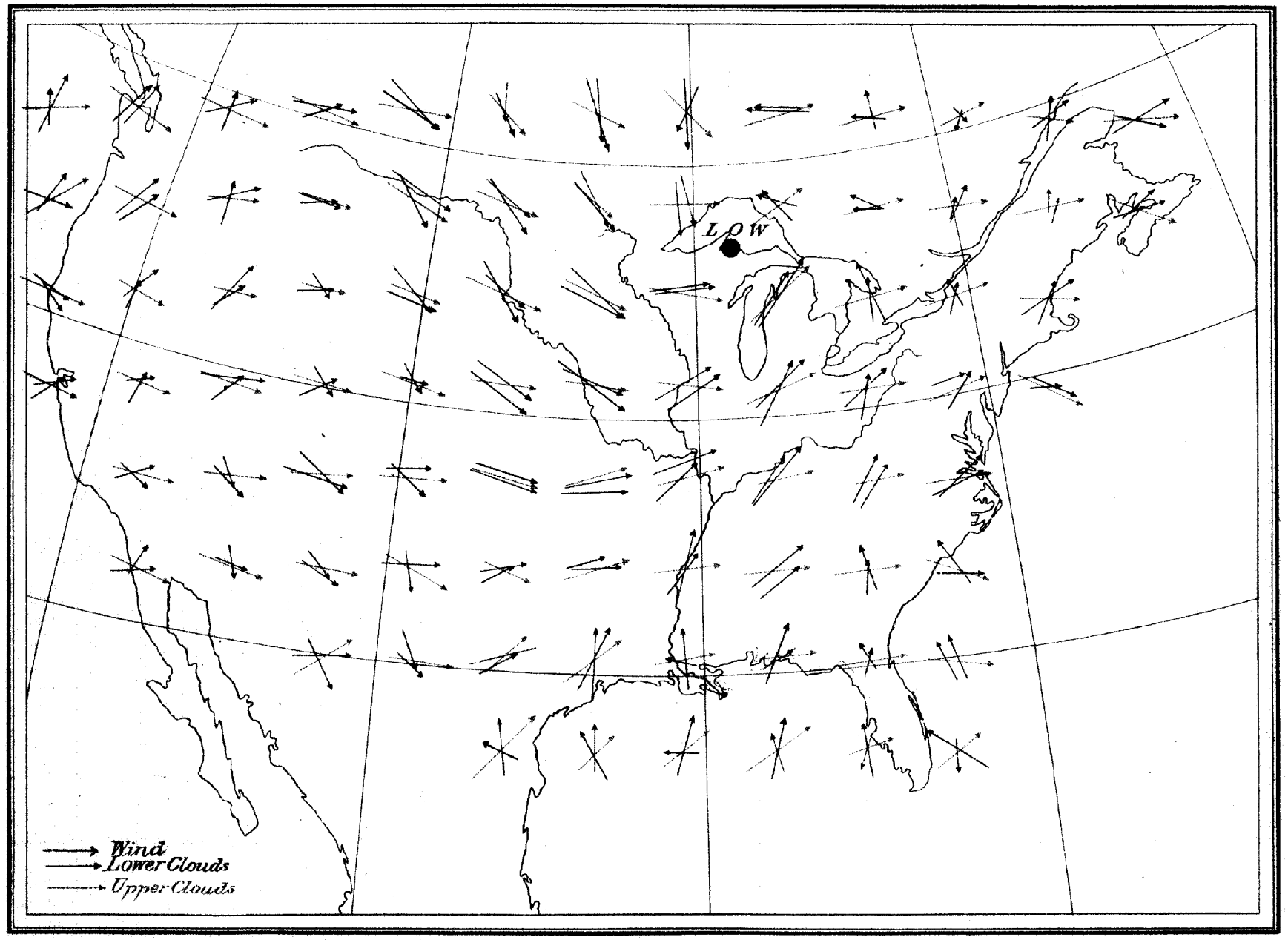
Lake Region High $(2)_1$, Winter.

Chart 22.



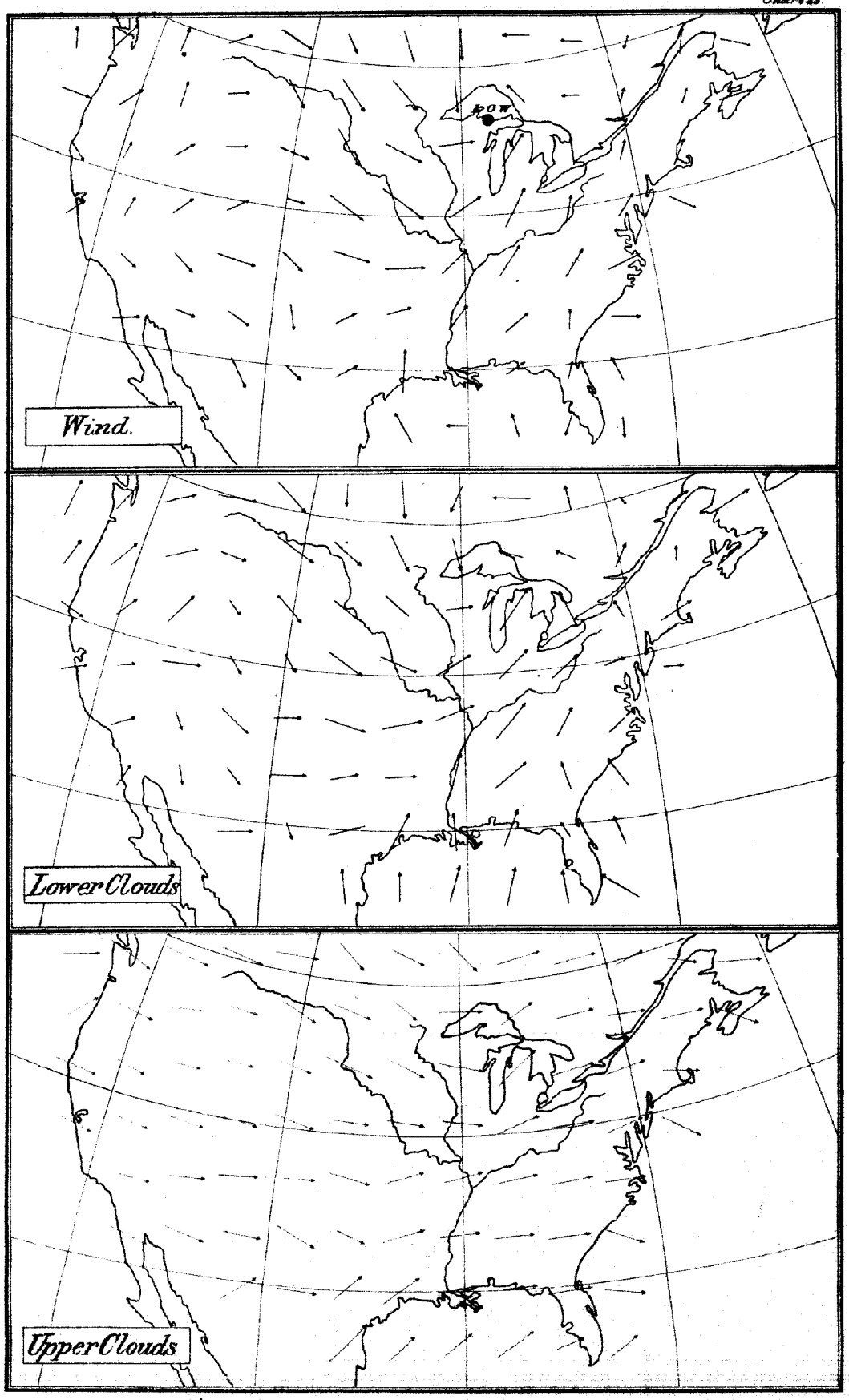
Lake Region Low $(2)_2$, Winter.

Chart 23



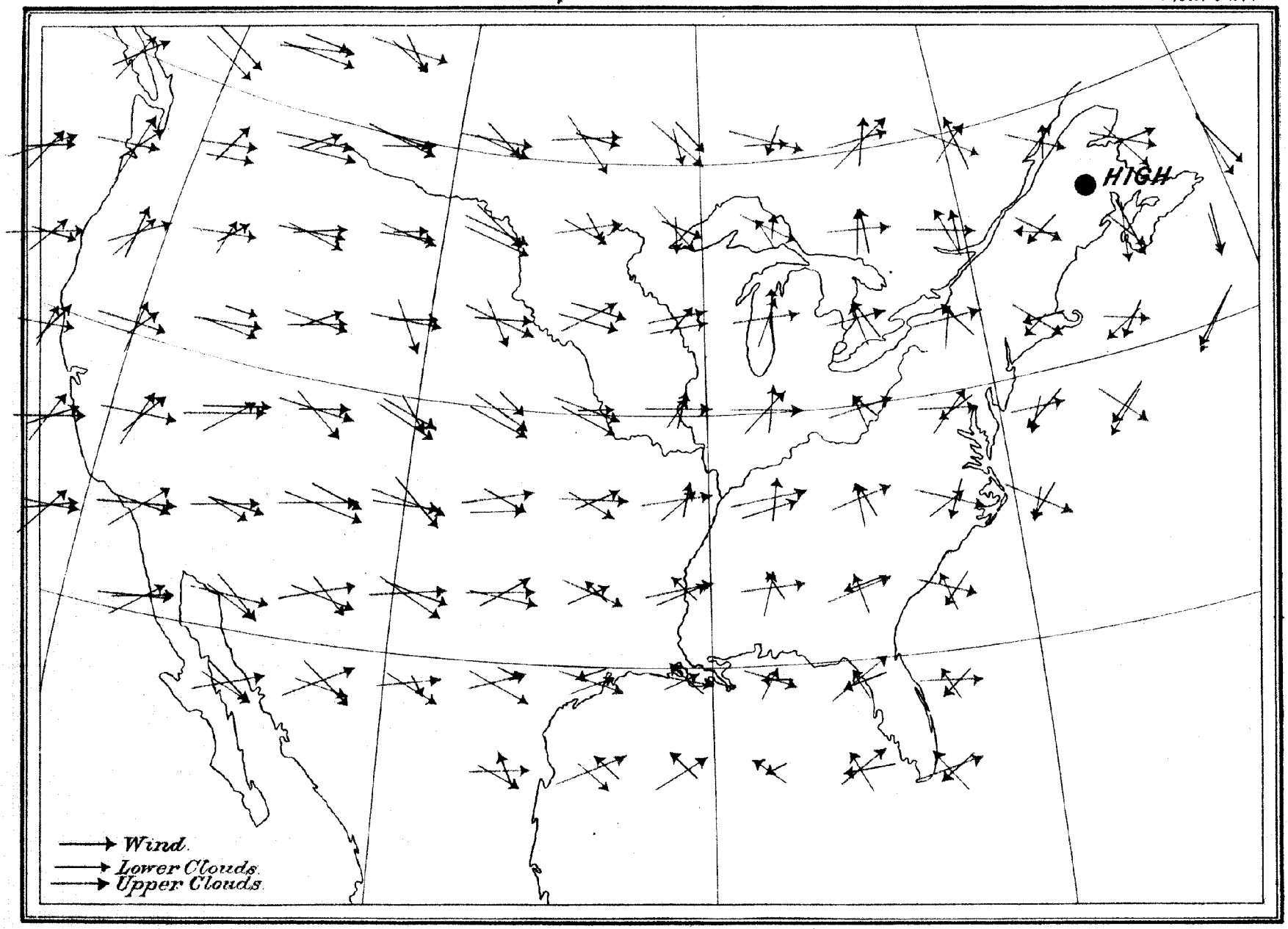
Lake Region Low $(z)_s$, Winter.

Chart 23.



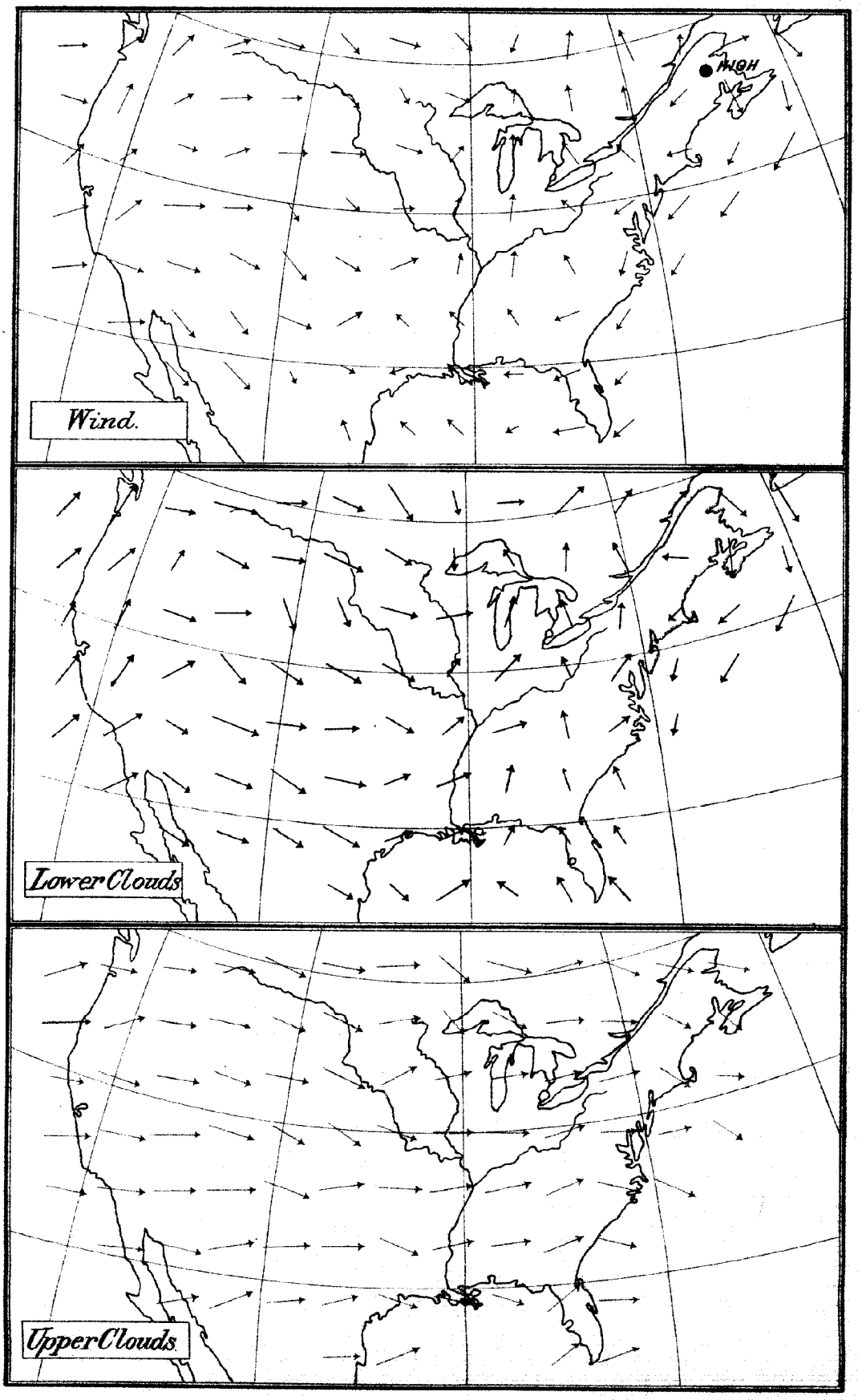
New England High $(3)_1$, Winter.

Chart 24.



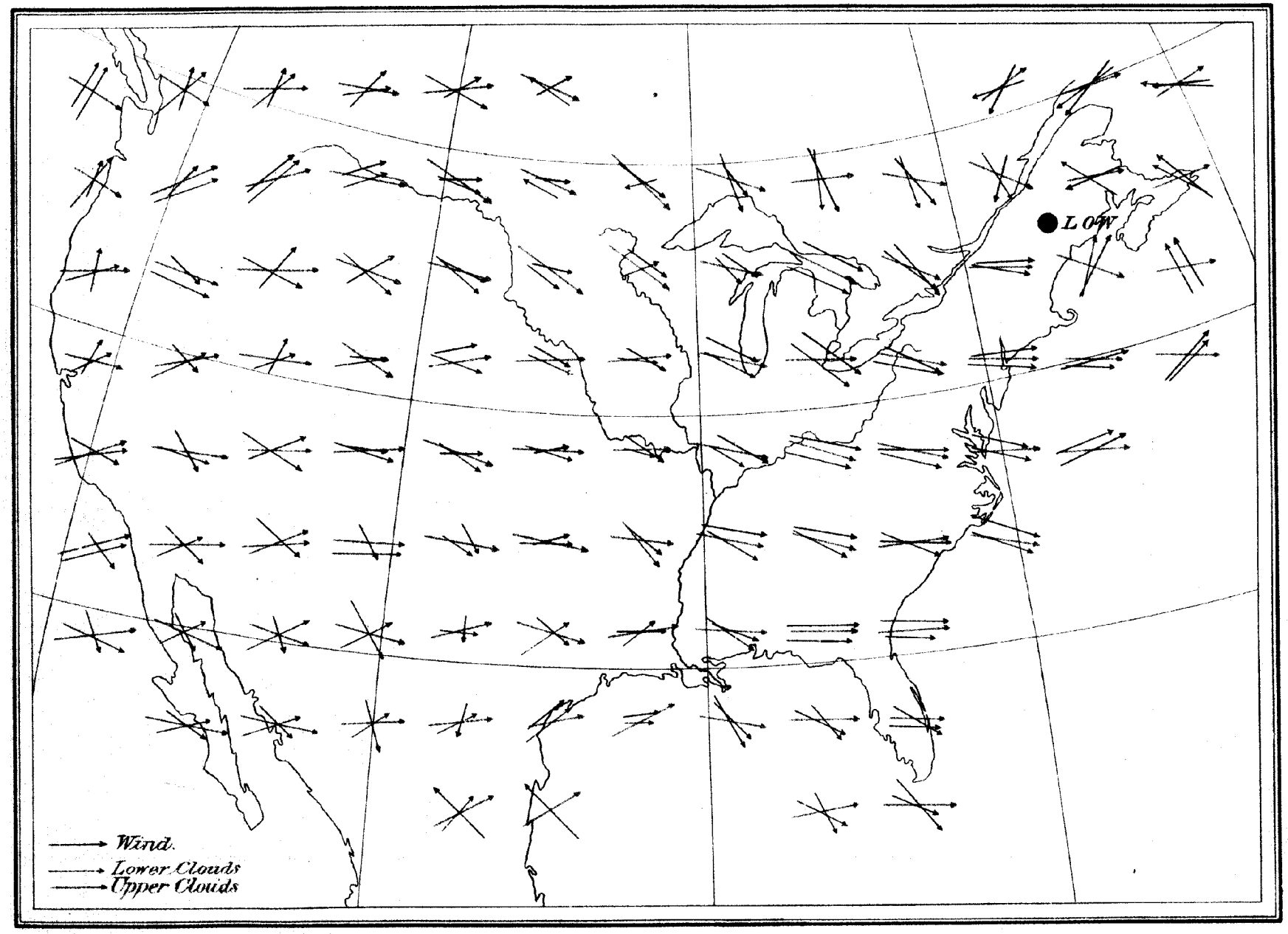
New England High $(3)_1$, Winter.

Chart 24.



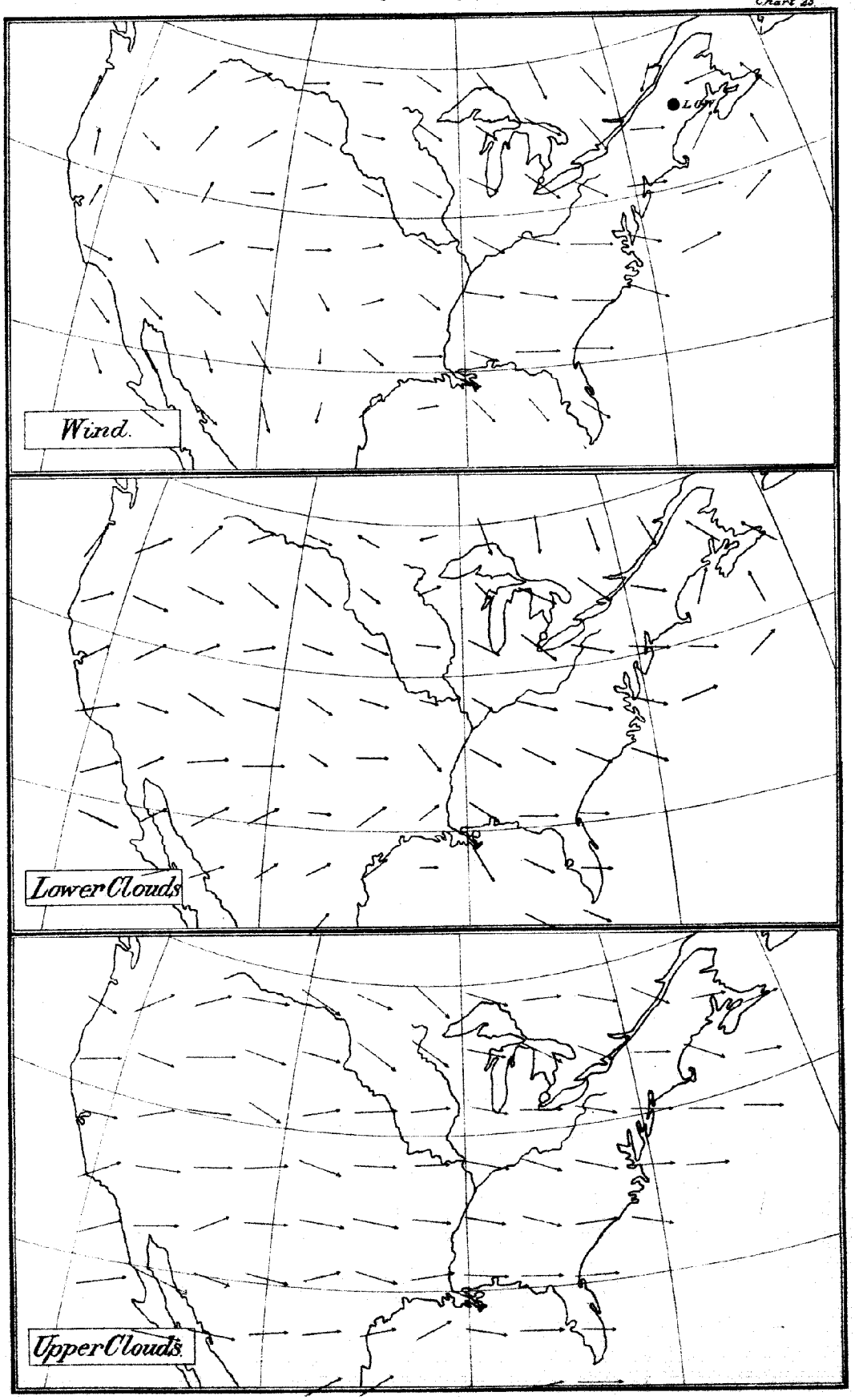
New England Low $(3)_2$, Winter.

Chart 25.



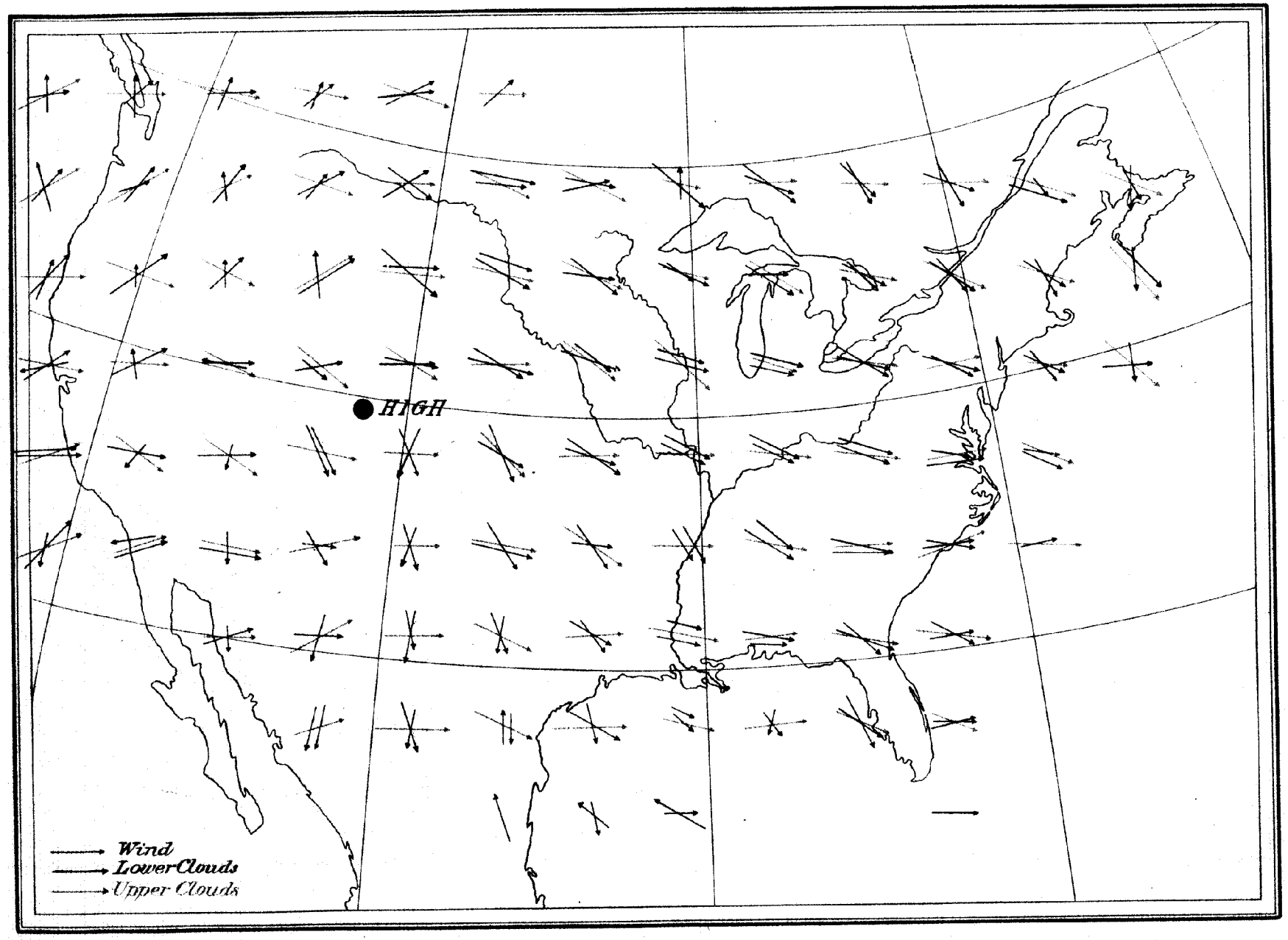
New England Low $(3)_2$, Winter.

Chart 25

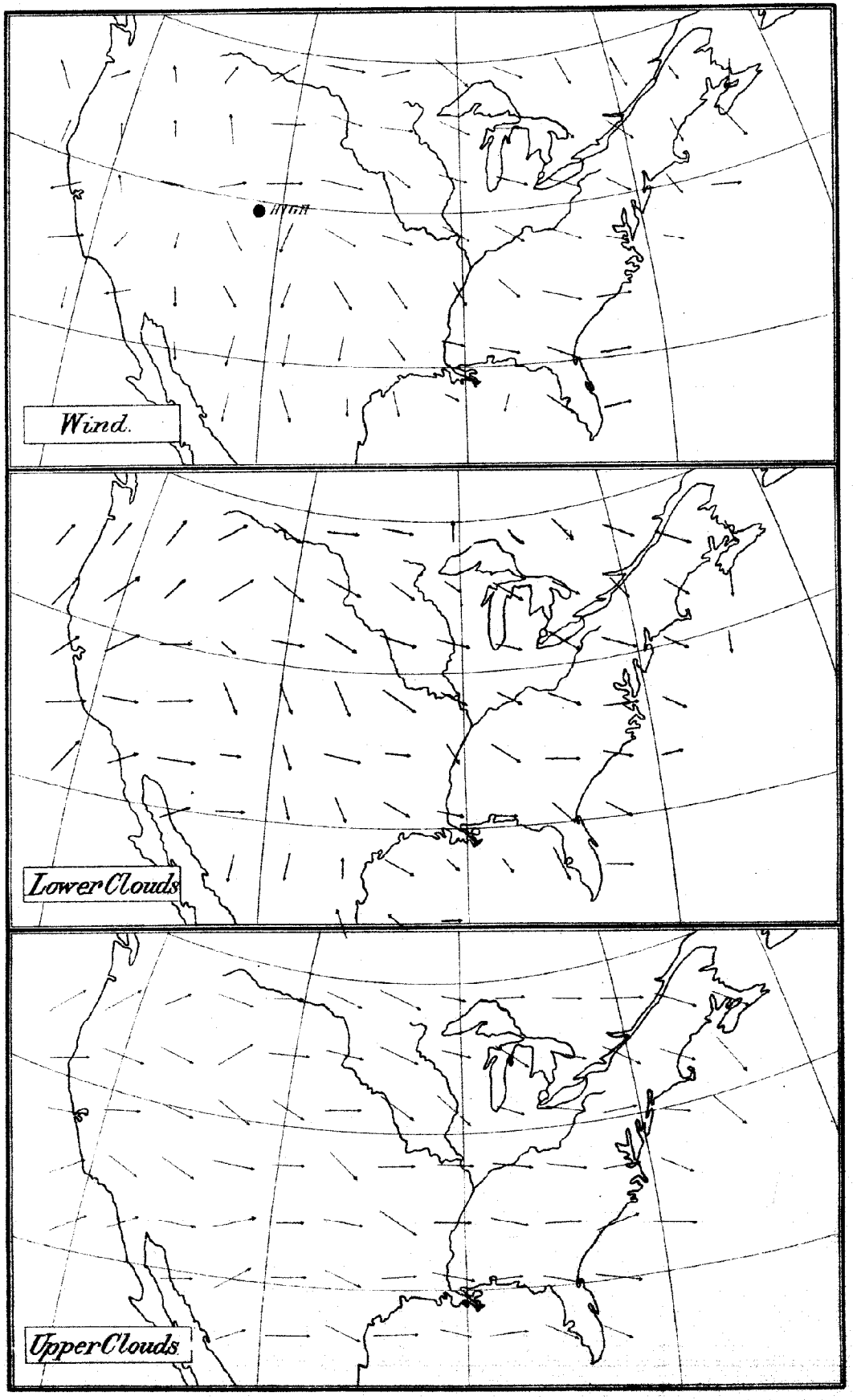


Colorado High $(4)_1$, Winter.

Chart 26.

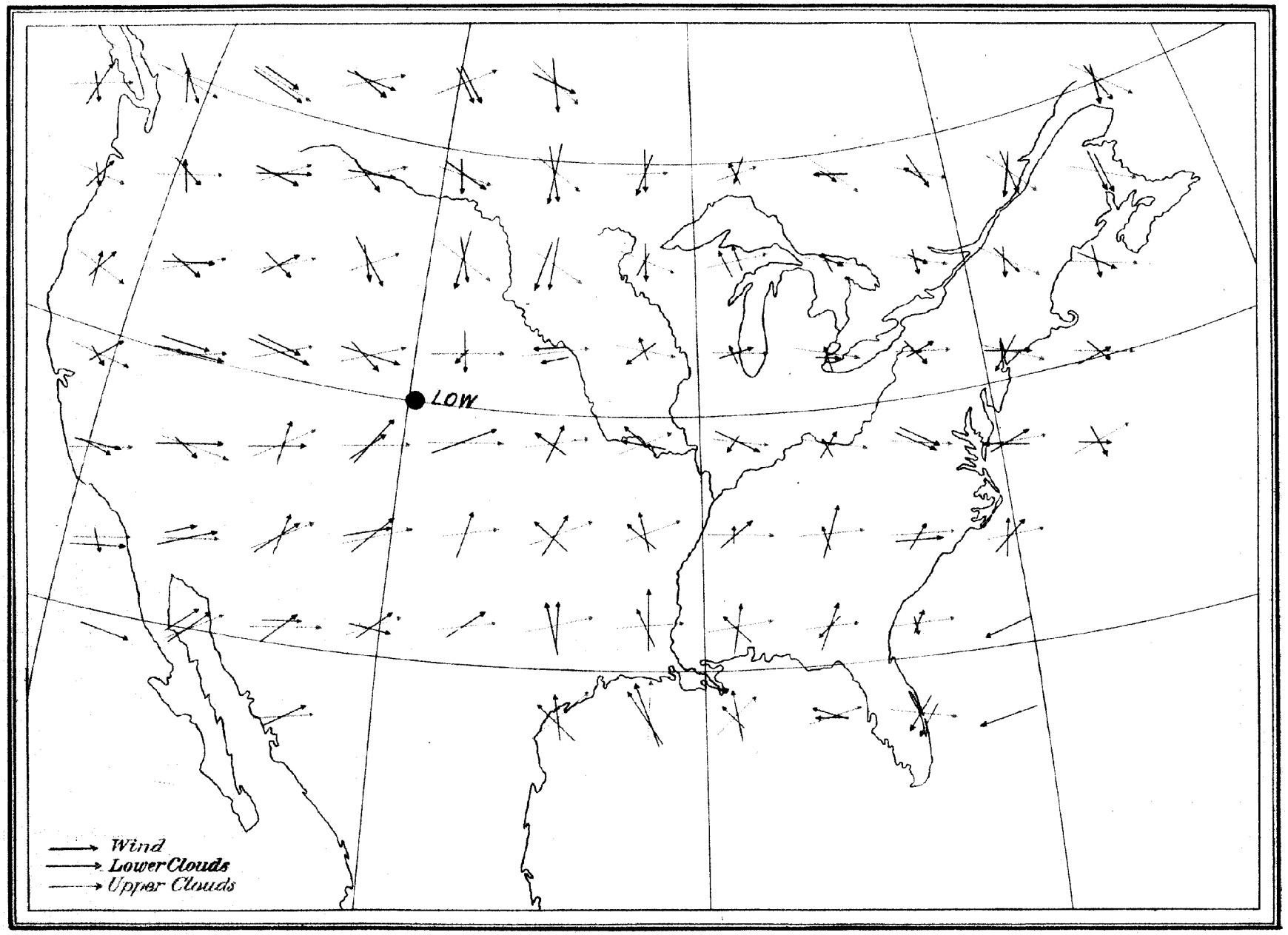


Colorado High $(4)_1$, Winter.



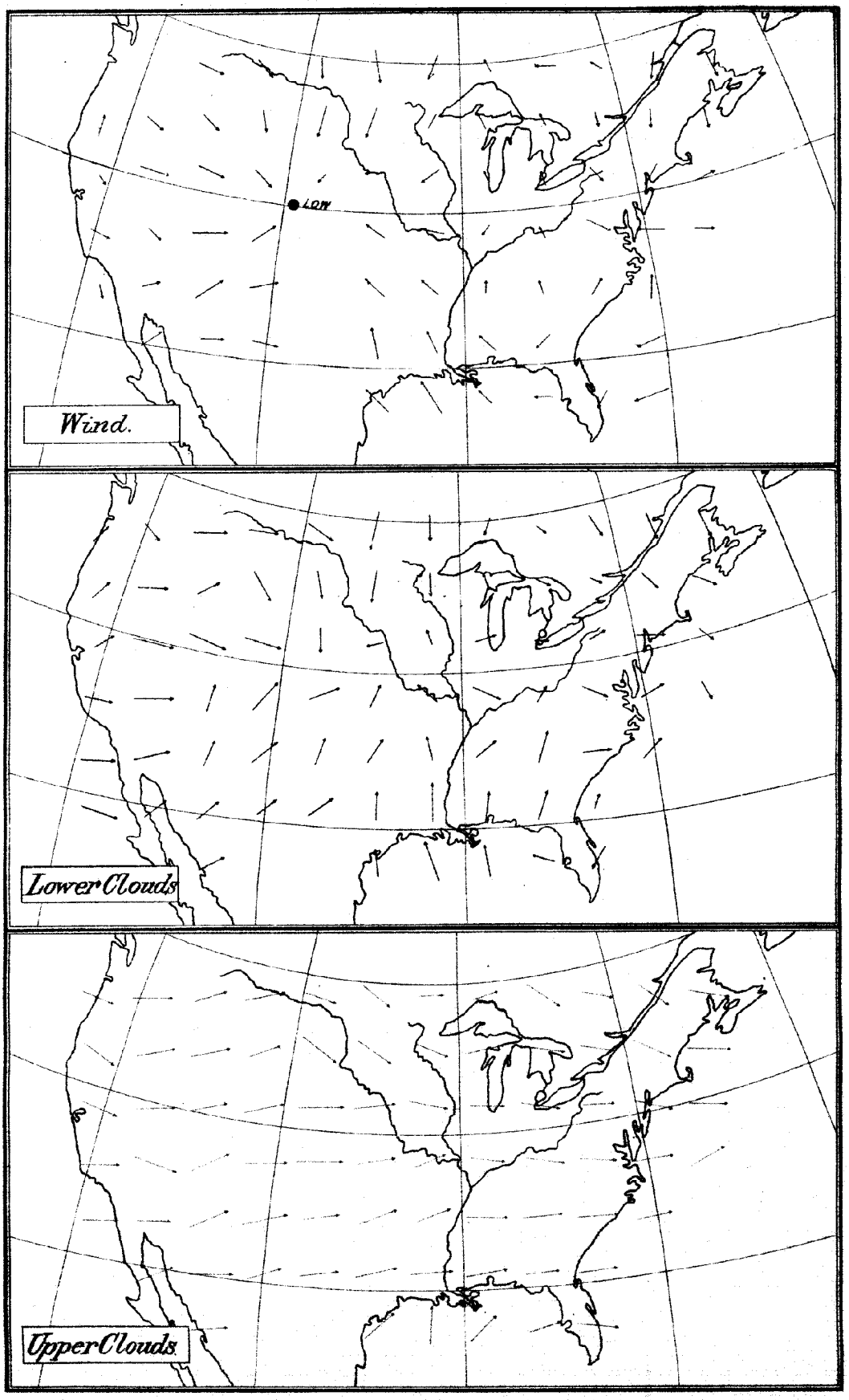
Colorado Low $(4)_2$, Winter.

Chart 27.



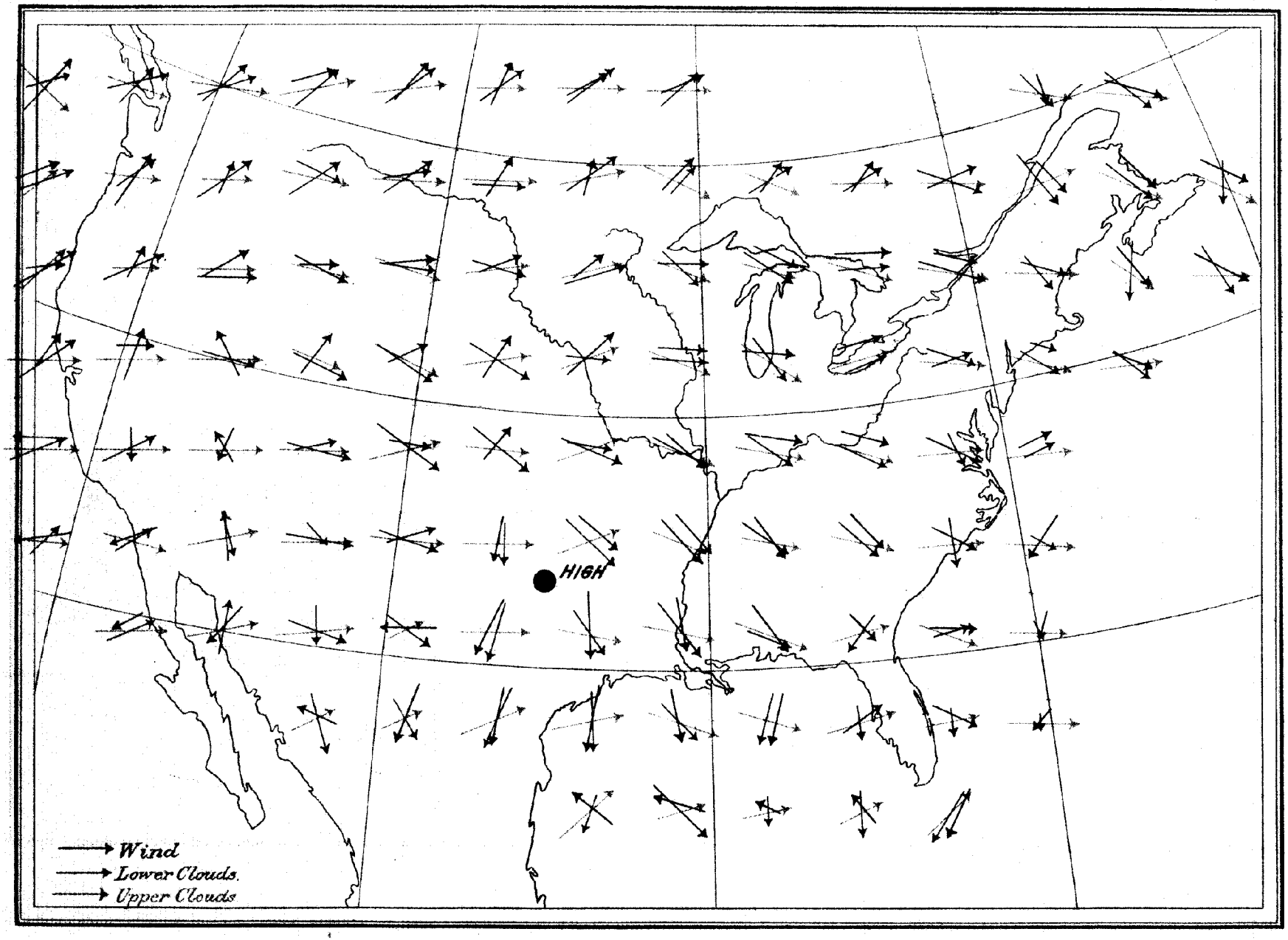
Colorado Low $(4)_2$, Winter.

Chart 27.



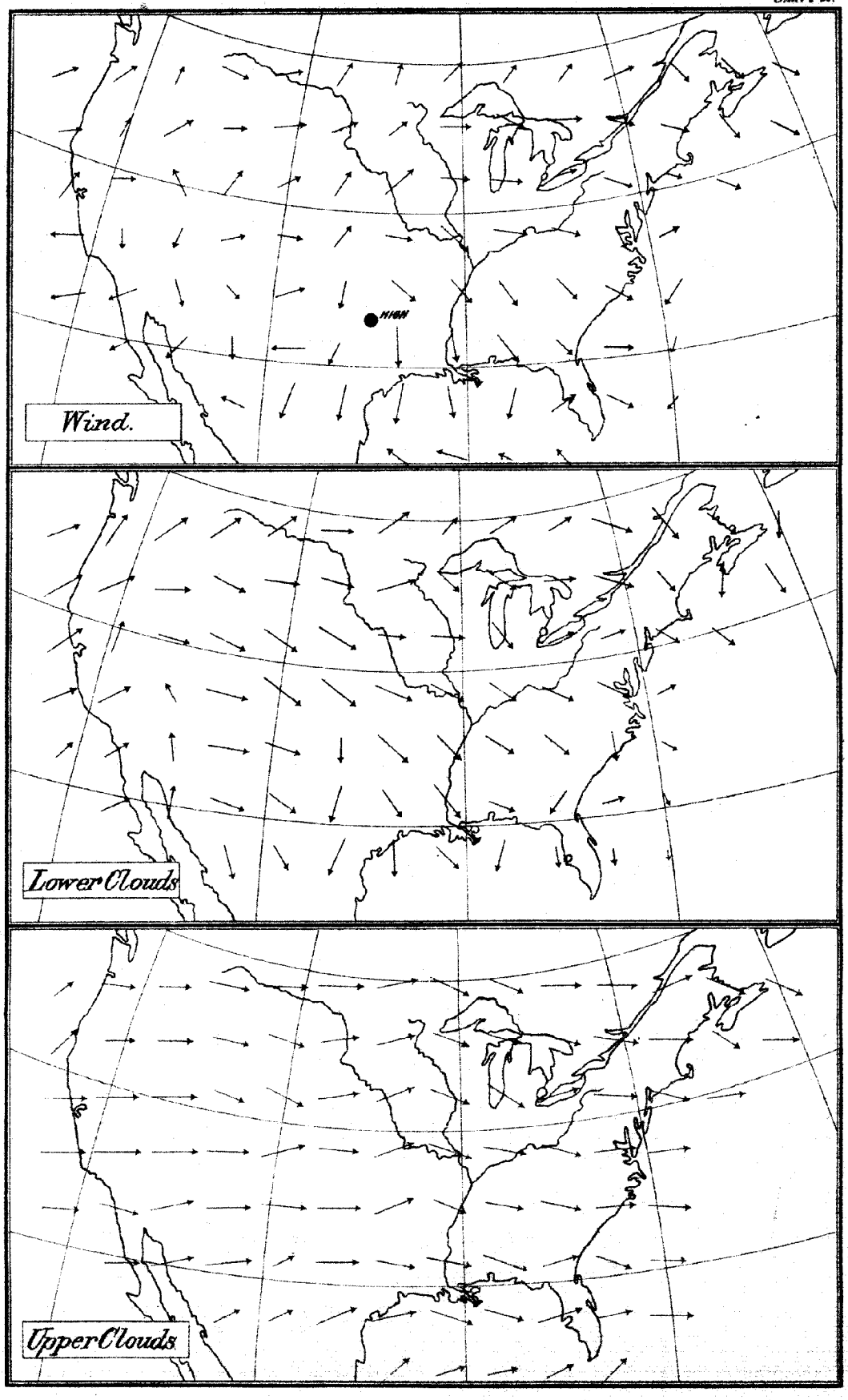
West Gulf High $(5)_1$, Winter.

Chart 28.



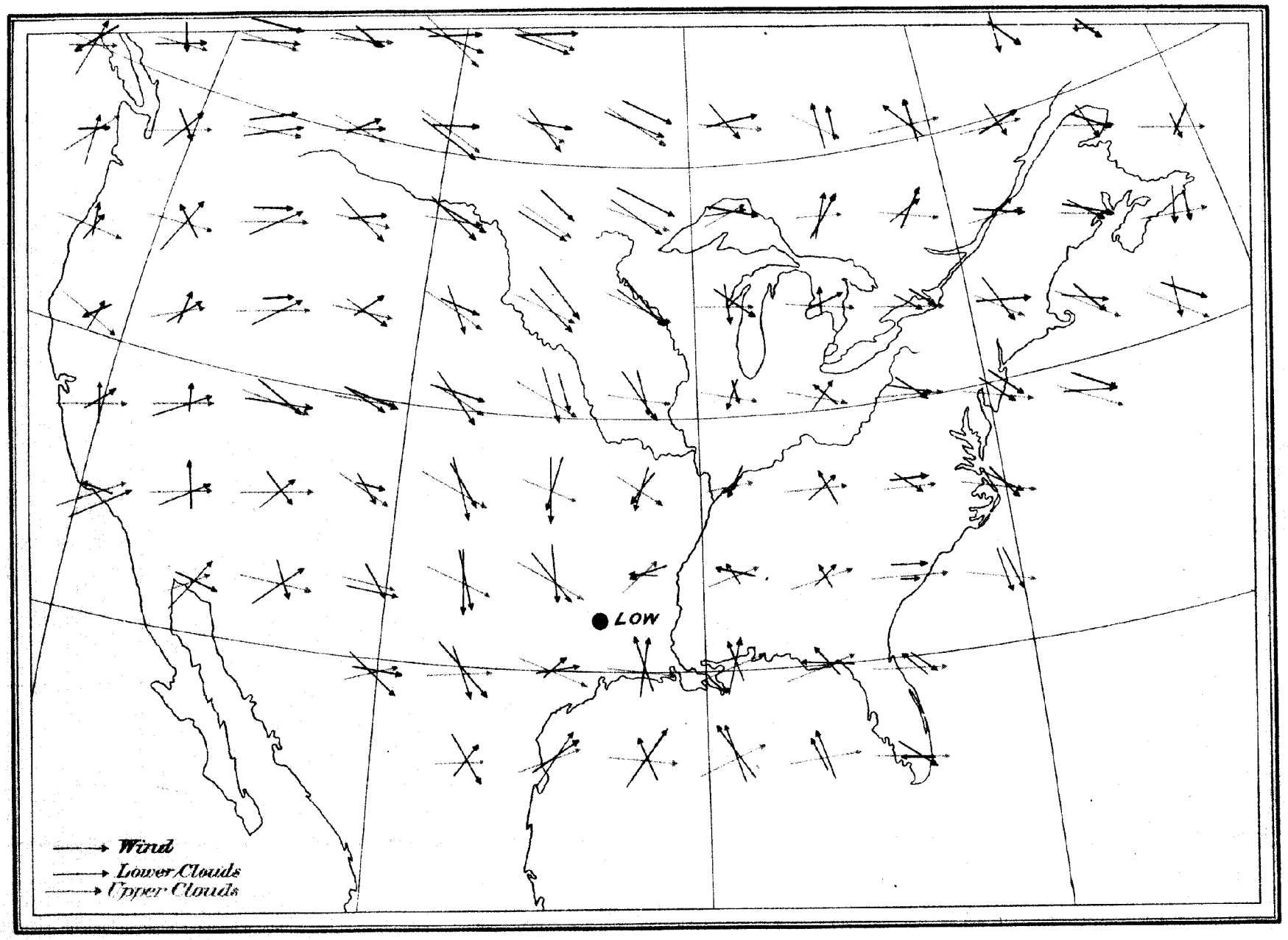
West Gulf High $(5)_1$, Winter.

Chart 30.

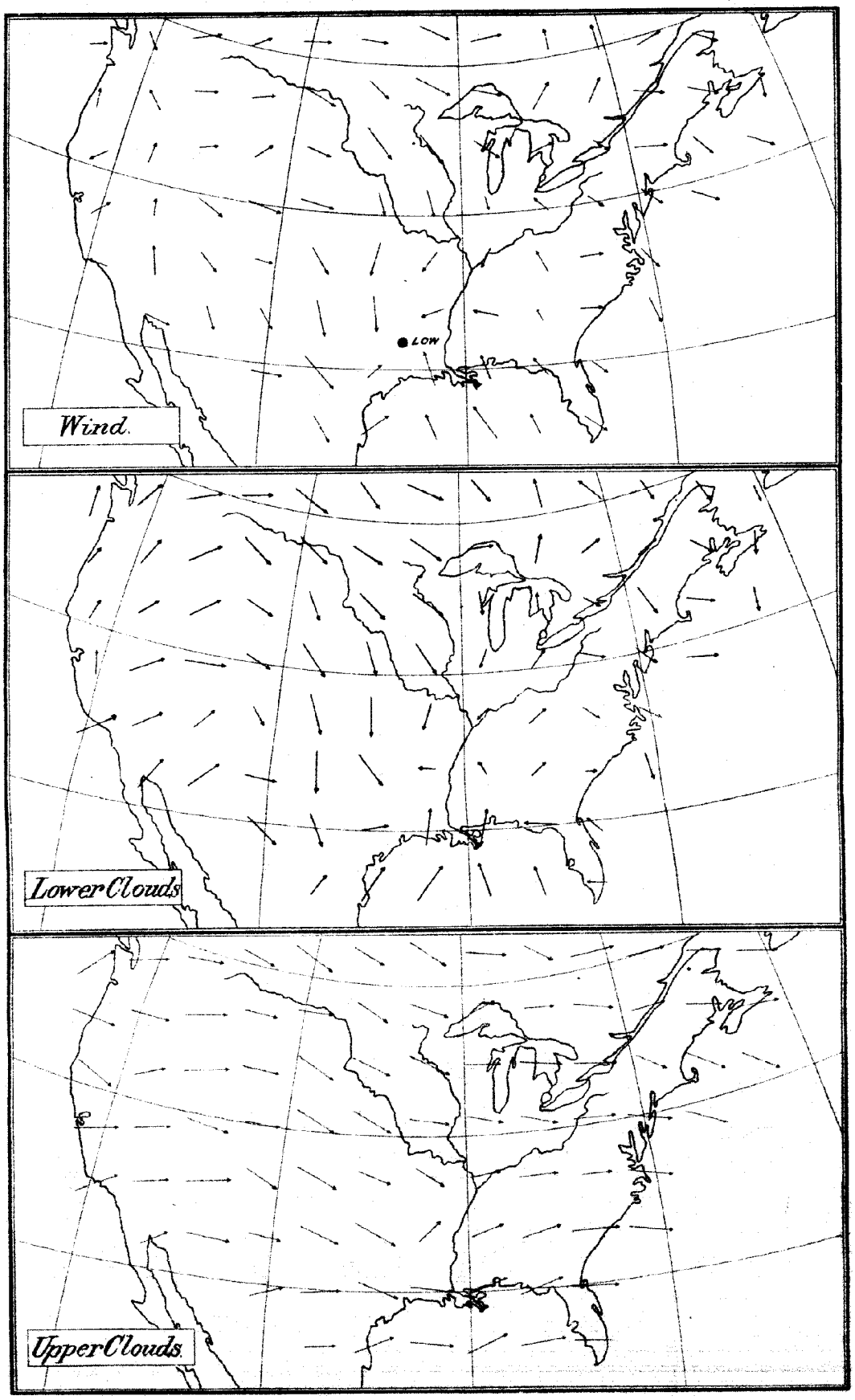


West Gulf Low $(5)_2$, Winter.

Chart 29.

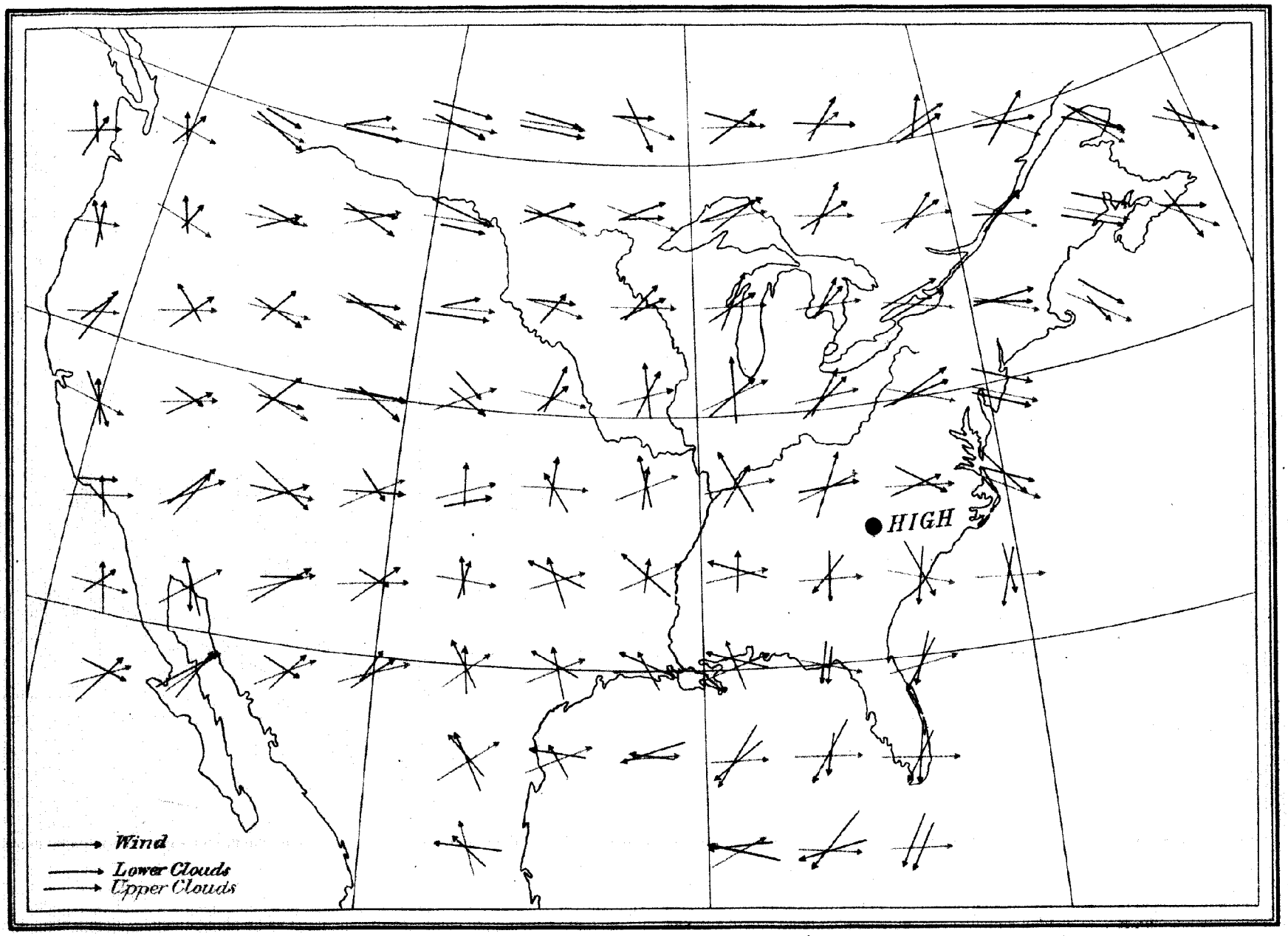


West Gulf Low $(5)_2$. Winter.



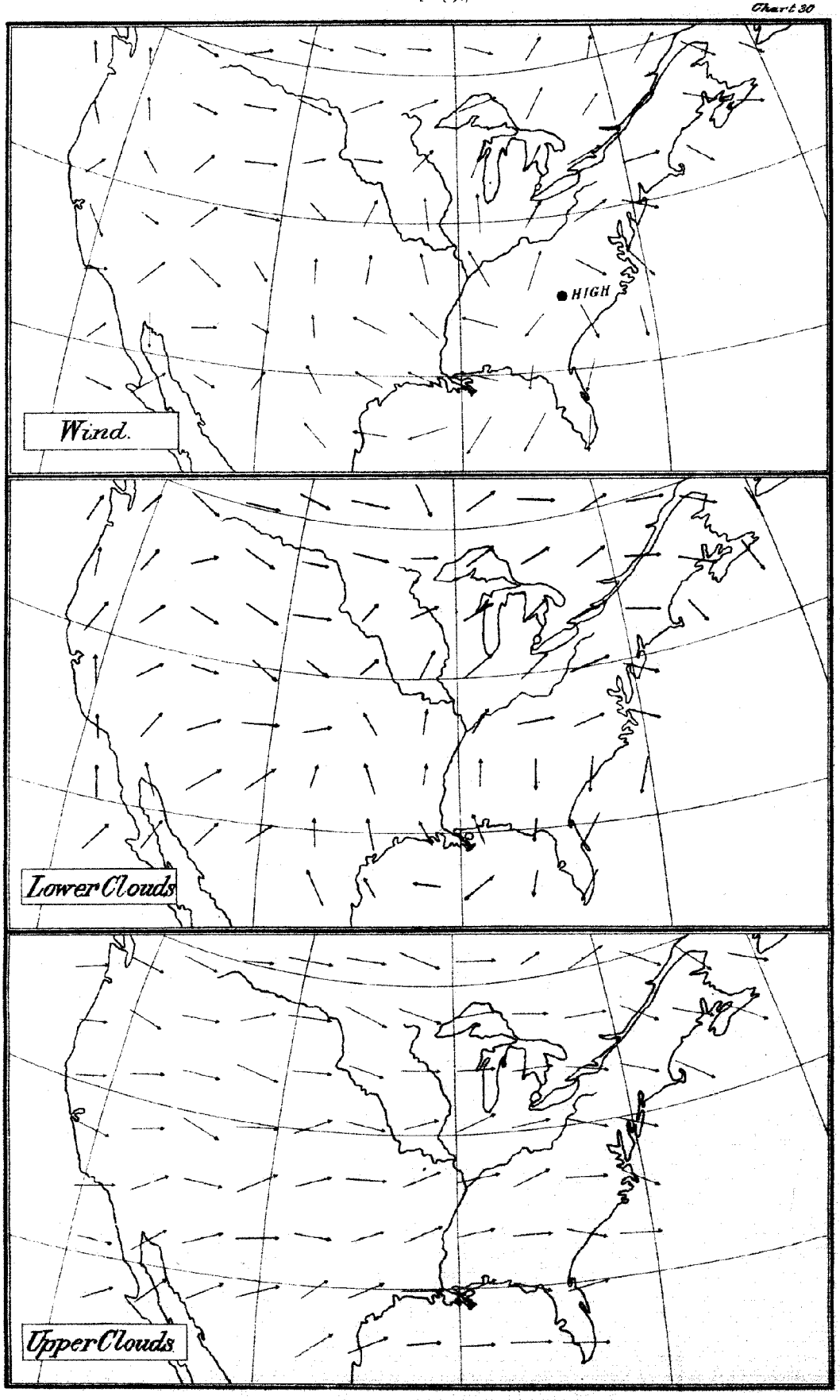
South Atlantic High $(6)_1$, Winter.

Chart 30.



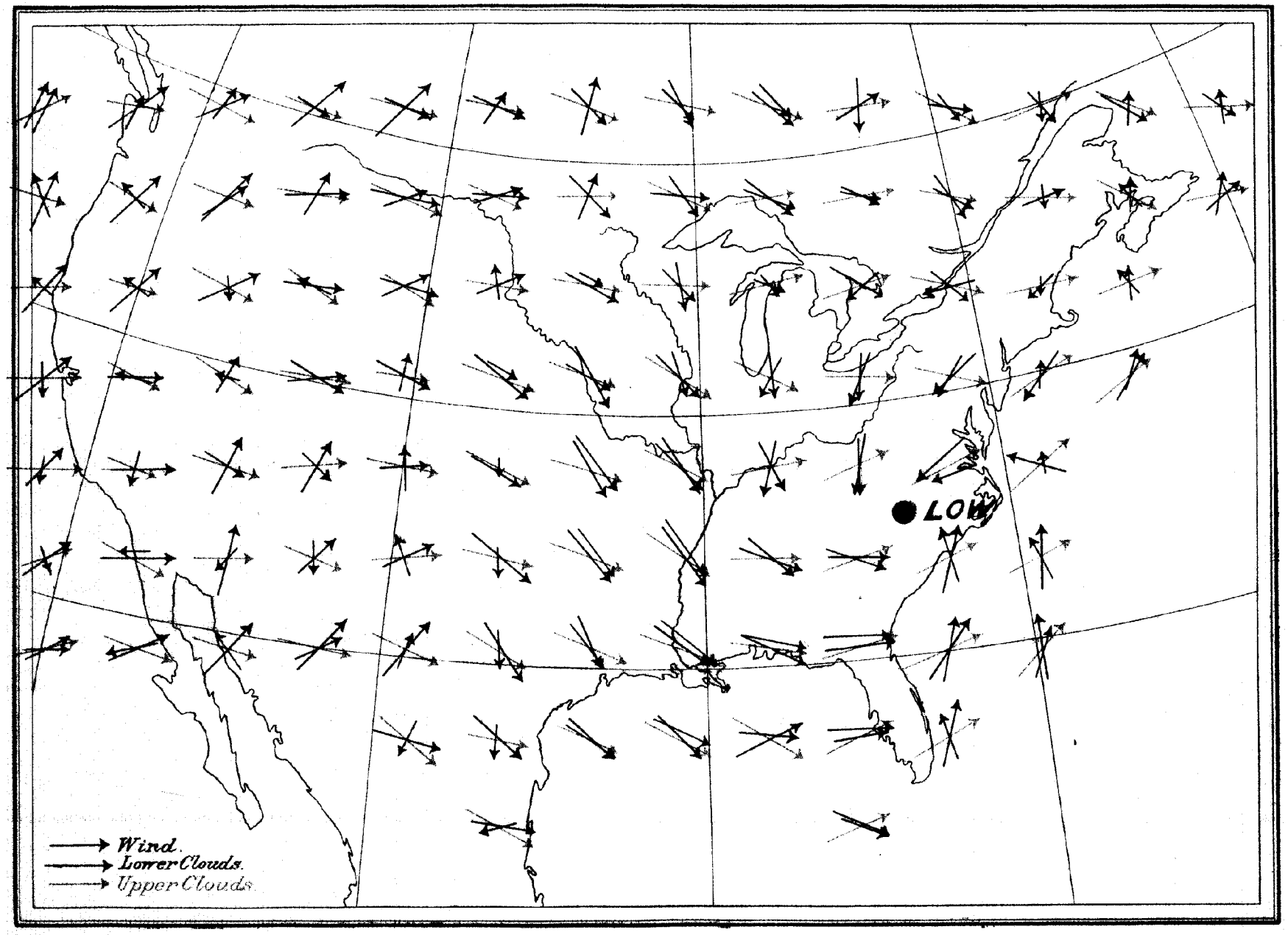
South Atlantic High (6)$_1$, Winter.

Chart 30



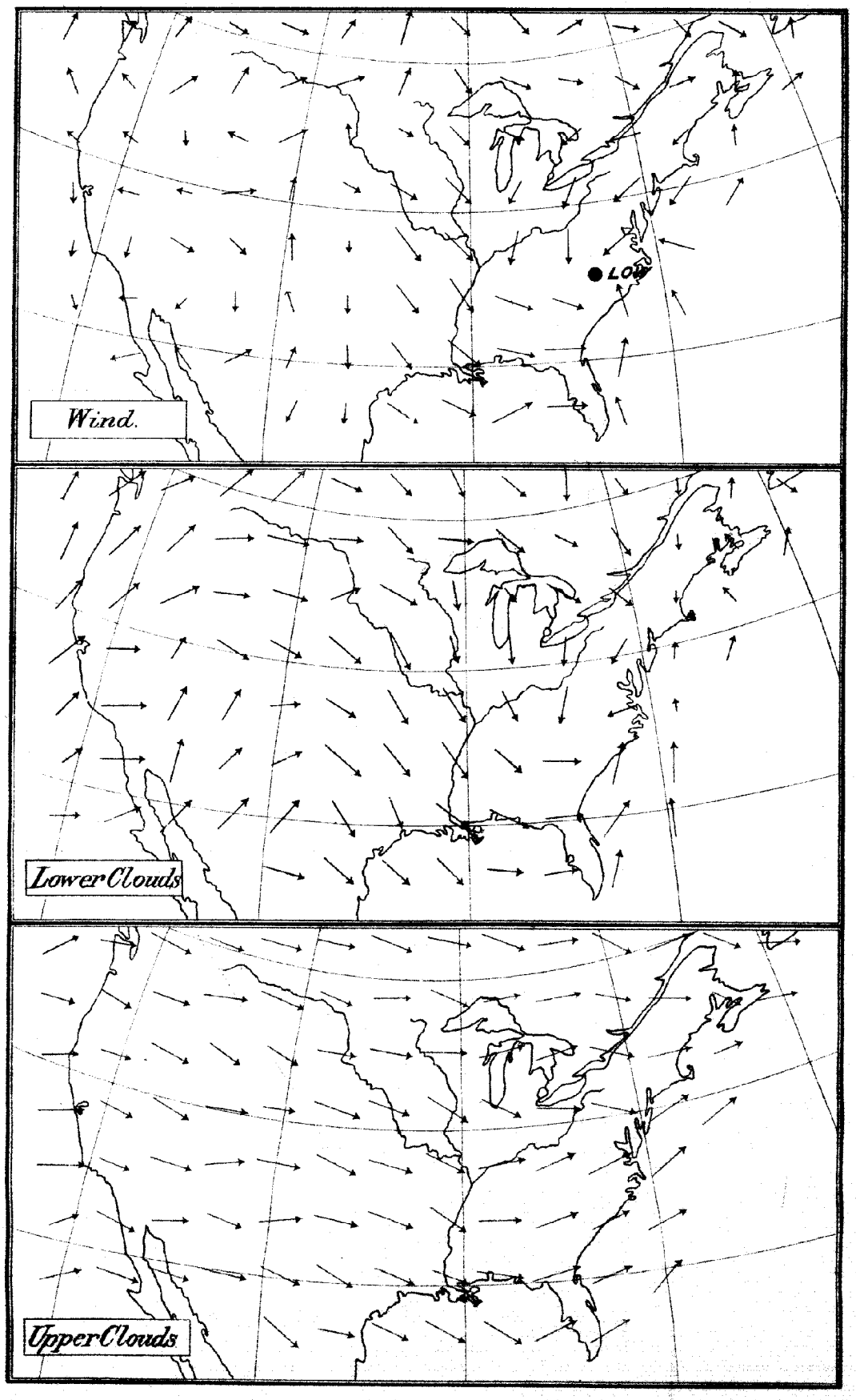
South Atlantic Low $(6)_2$, Winter.

Chart 31.



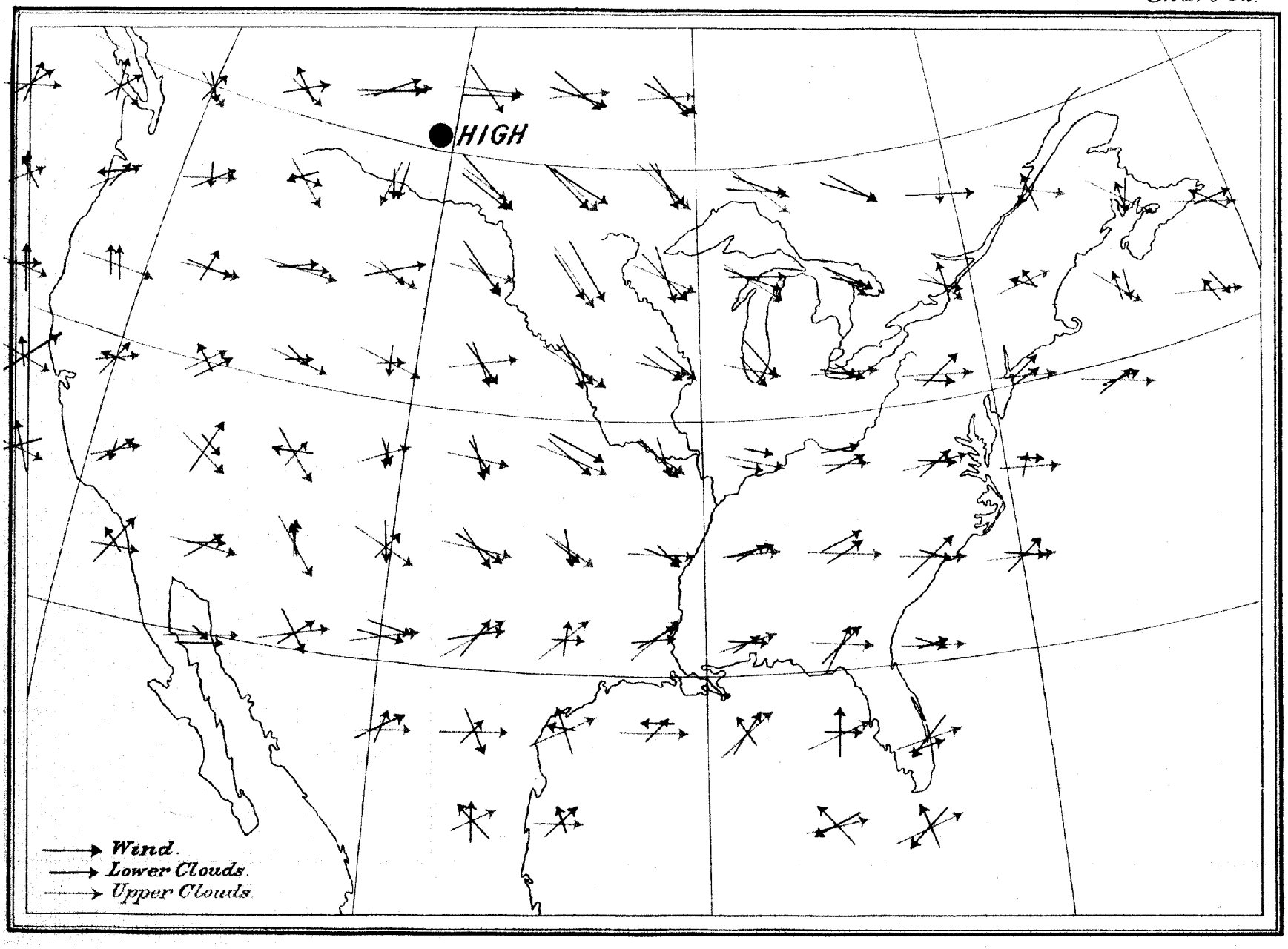
South Atlantic Low $(6)_2$. Winter.

Chart 31.



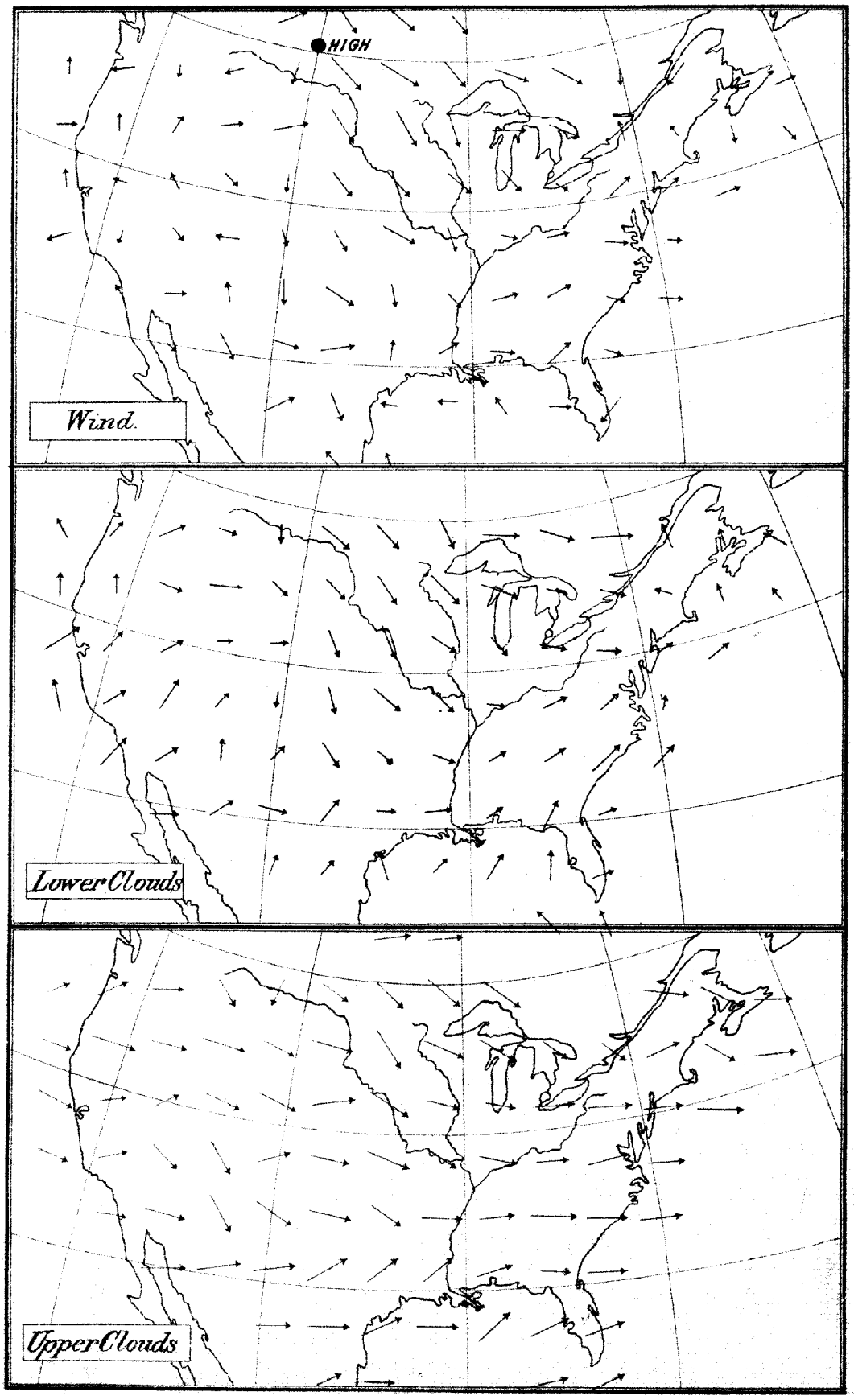
Alberta Cold Wave, Winter.(7)

Chart 32.



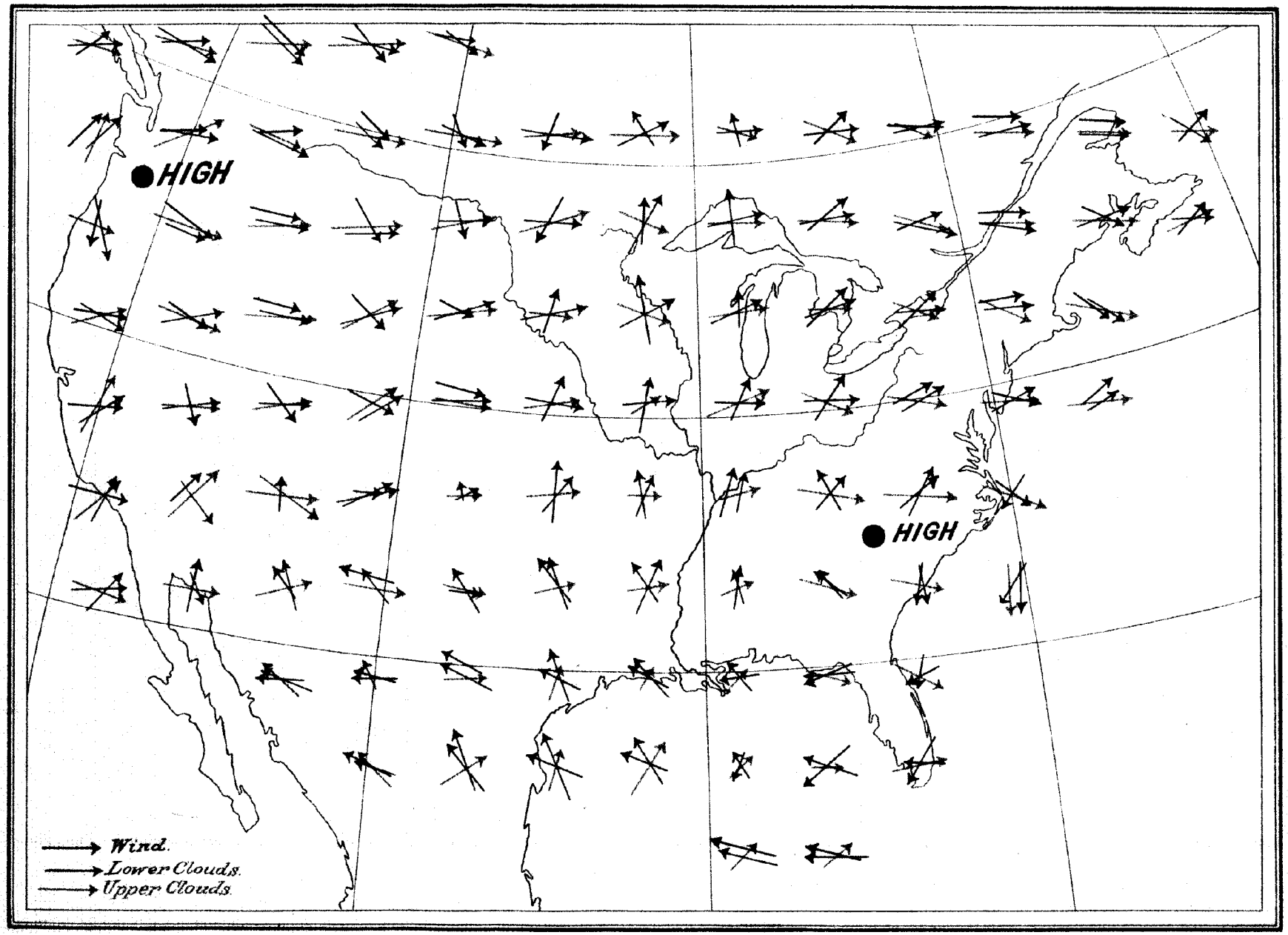
Alberta Cold Wave, Winter.(7).

Chart 32.



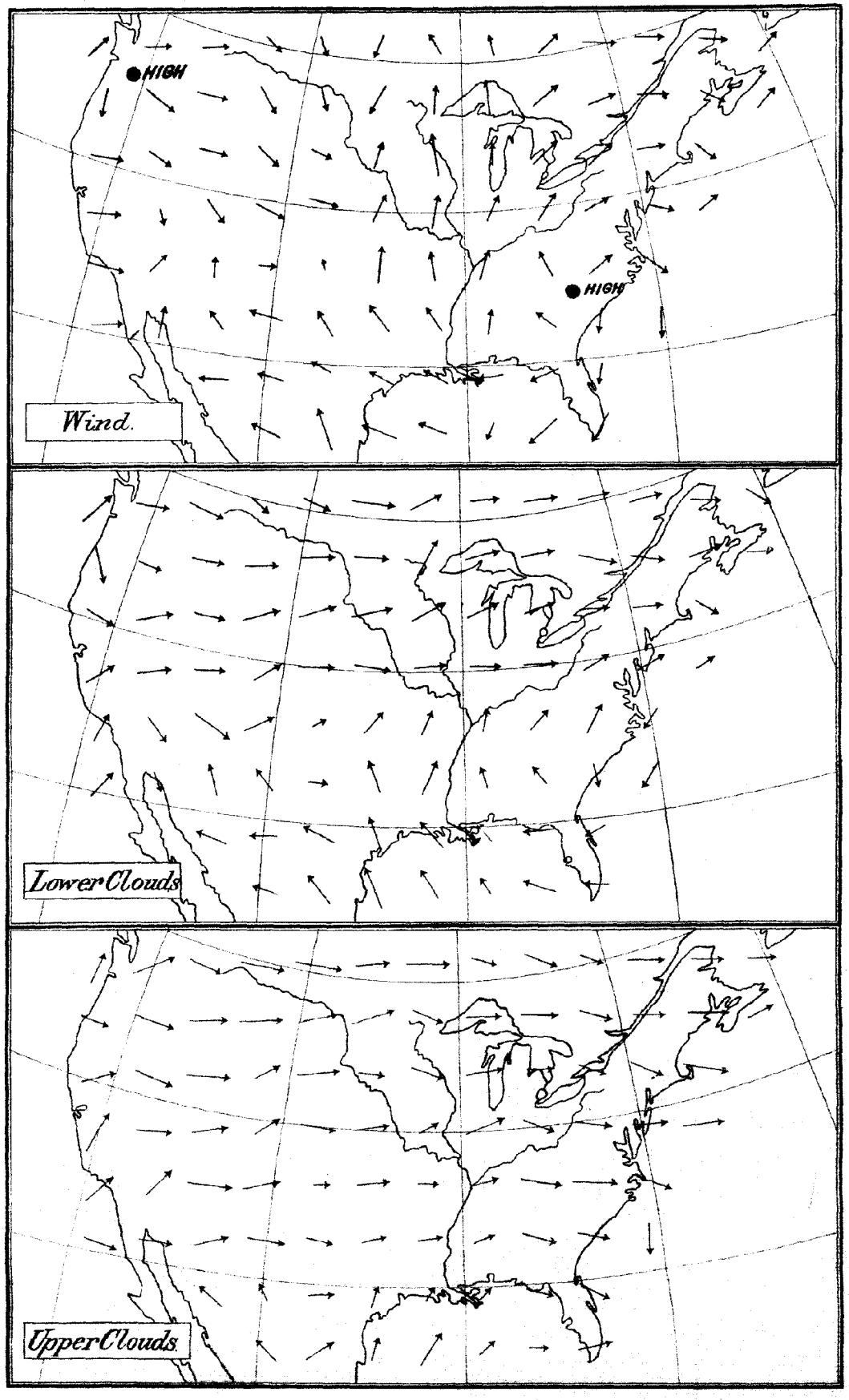
Highs in Northwest and Southeast (1), Summer.(8).

Chart 33.



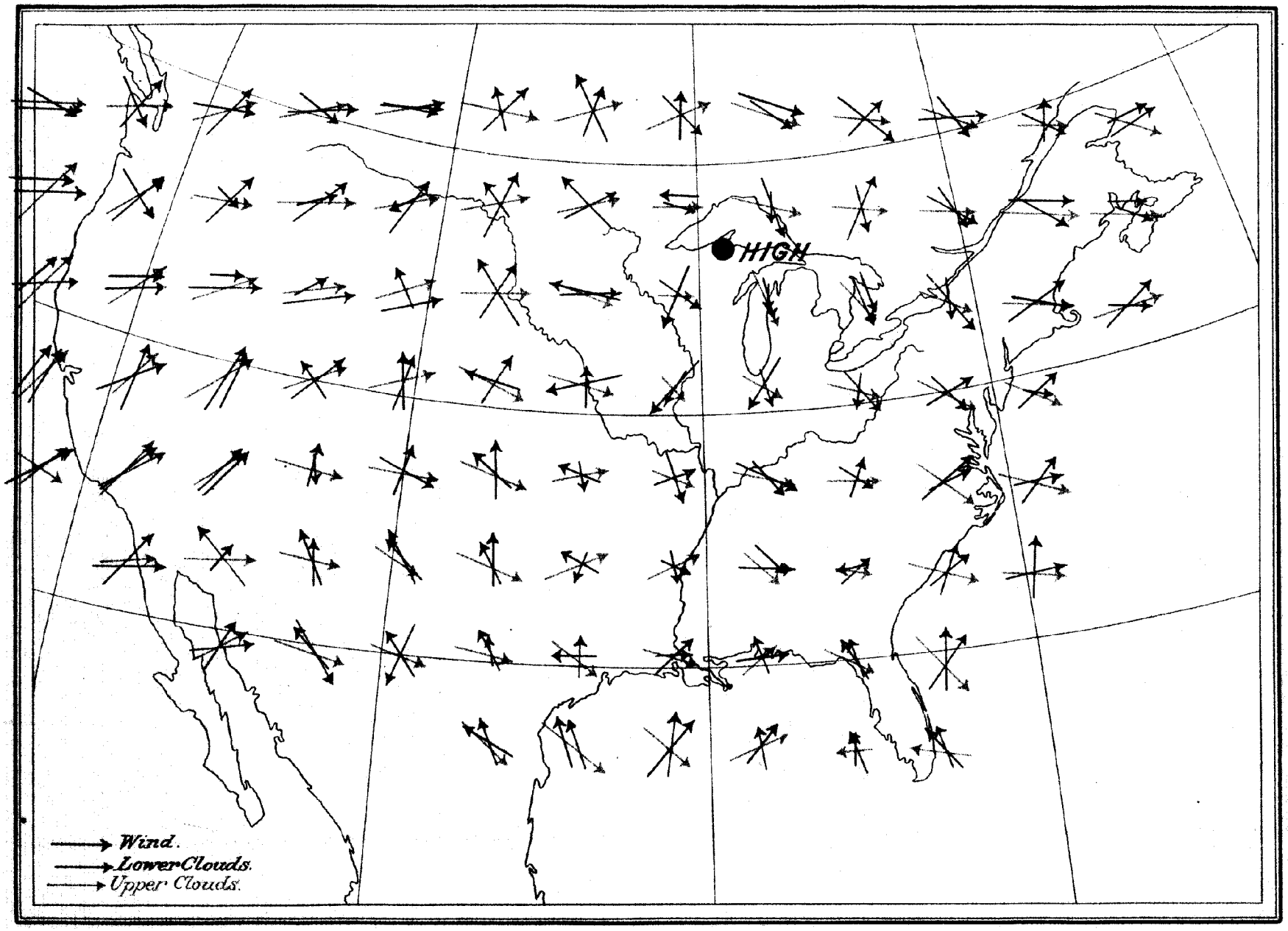
Highs in Northwest and Southeast (1), Summer.(8)

Chart 33.



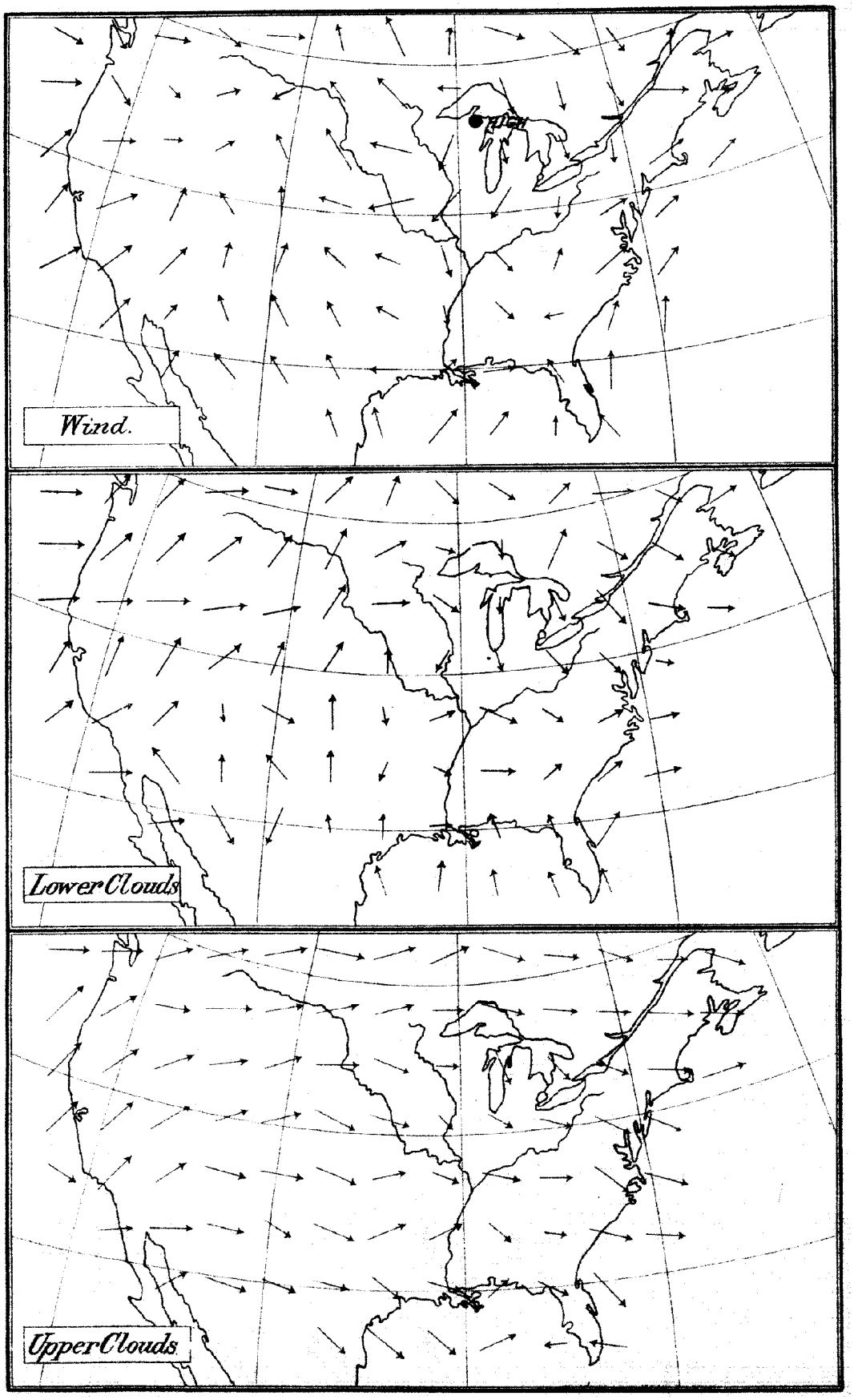
High over the Lakes, Summer. (9)

Chart 34



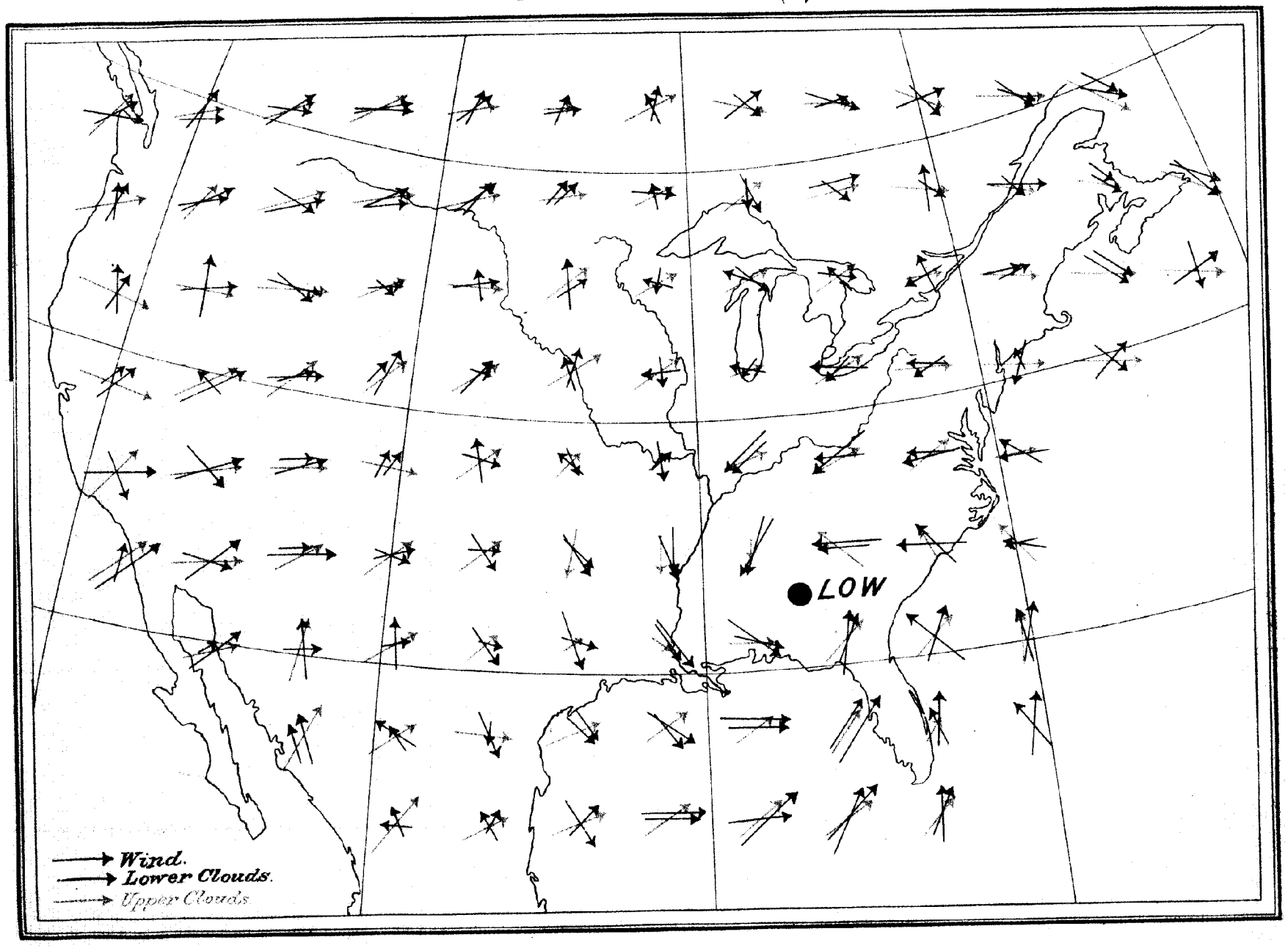
High over the Lakes, Summer. (9)

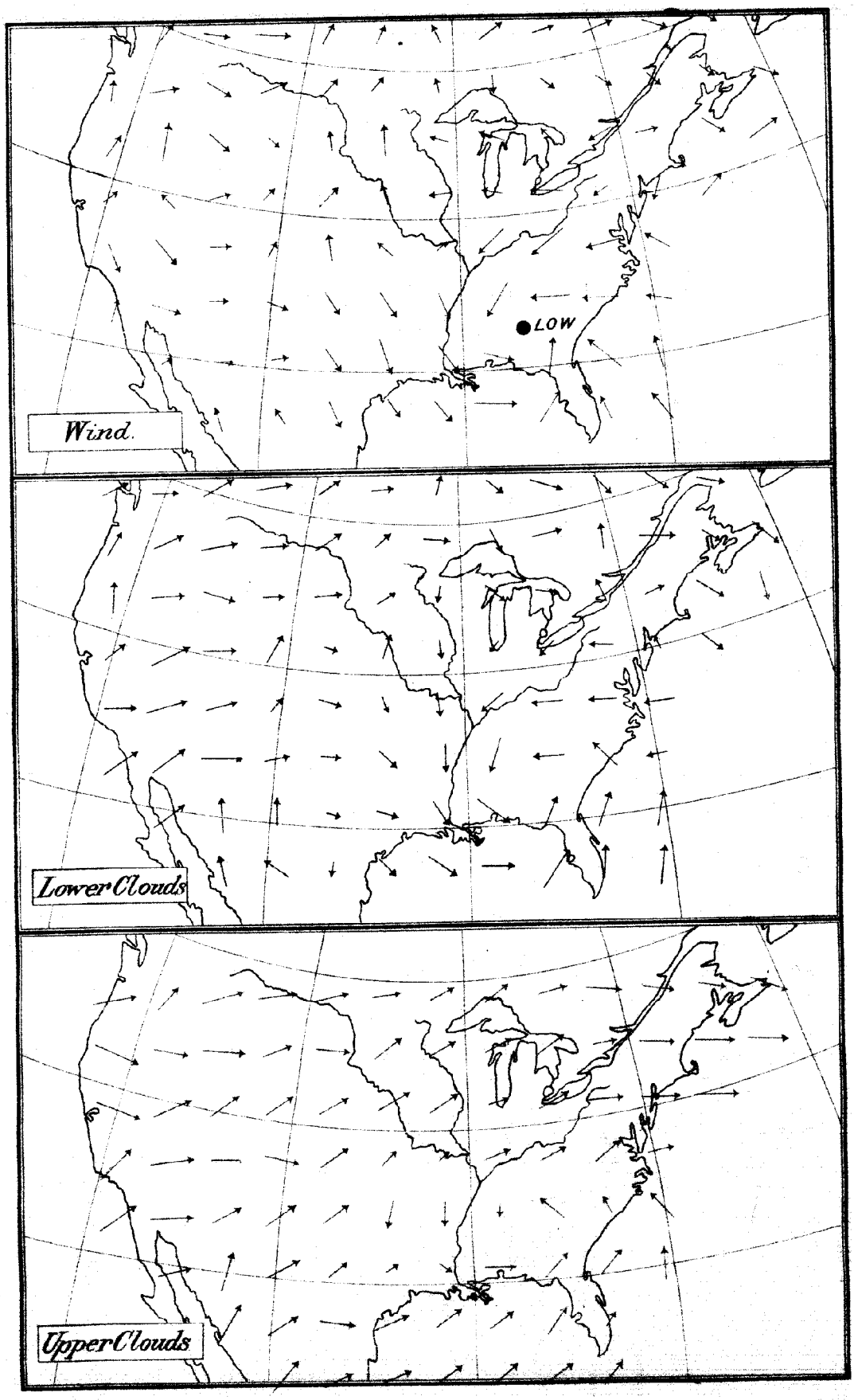
Chart 34.



Tropical Hurricane, Summer.(10)

Chart 35.




LOW
Wind.
Lower Clouds
Upper Clouds

DESCRIPTION OF THE SEVERAL CHARTS.

The following charts constructed in this way contain many interesting and instructive features, and will now be briefly described.

Alberta high, Chart 20 $(1)_1$.—The adopted center is located by the mean distribution of the vectors representing the movement of the atmosphere in the wind, cumulus, and cirrus levels, and it is very near Swift Current, Canada. The isobar center as marked is that described by the isobars drawn on the daily weather maps, and this point is always placed in coincidence with the adopted center on the composite chart. On the Rocky Mountain plateau it is the center of the isobar system, which results from the reduced barometric observations; on the maps used this reduction was made to sea level by Hazen's empirical arguments and tables, described in Chapter 10. The center found on the map therefore embodies all the defects of that system of reduction employed in changing the actual barometric readings at given heights to the computed sea level readings. Now, an inspection of Chart 20 $(1)_1$ exhibits this remarkable feature in the wind circulation, that while the isobar center of barometric pressure is in the midst of the strong vectors of the current which moves southeastward over the Rocky Mountain slope, the apparent center of the high area, as determined by the surface winds, is about 500 miles to the southwest, in Wyoming and Idaho. This dislocation of the center of the isobars from the center of the winds is not unexpected, because it has been well-known that the winds do not hold their proper relations to the barometric gradients in the case of very cold surface temperatures on the northern plateau. There are many maps showing very steep pressure gradients and light winds, and many others in which the winds are apparently blowing up the gradient and into the center of the high area. This difficulty is unquestionably due primarily to the employment of an improper temperature argument for reducing the pressures from the station altitude to the sea level, because it was assumed in the reductions used in constructing the maps that the cold surface temperature at the station is that of the mean air column to be substituted for the plateau itself. The error in this view is clearly demonstrated by inspecting the vectors of the cumulus level, which show that at a very moderate height above the ground there is a current of air blowing northeastward near the Pacific coast, which then turns eastward over the northern plateau, *blows directly across* the high area, and then turns southeastward along the slope. This air evidently must be much warmer than the surface air on the east of the mountain divide, so that in the Alberta region there should be a marked *inversion* of the temperature gradients, very cold at the ground and much warmer at an elevation of a few hundred feet. Hence, the substitution of this cold dense air on the plateau for the mean column to the sea level must exaggerate the weight of the total air column and give the excessive high-pressure areas in the Alberta district in the winter months as reduced to sea level, which so characterizes that region and embarrasses the forecasts of cold waves and movements of the highs. The importance of giving a satisfactory interpretation to the observations on the Rocky Mountain plateau has induced me to undertake a specific discussion of the observations, with the view of discovering a practical general rule for obtaining the mean temperature argument, and the results of this work will be described in another report on this subject.

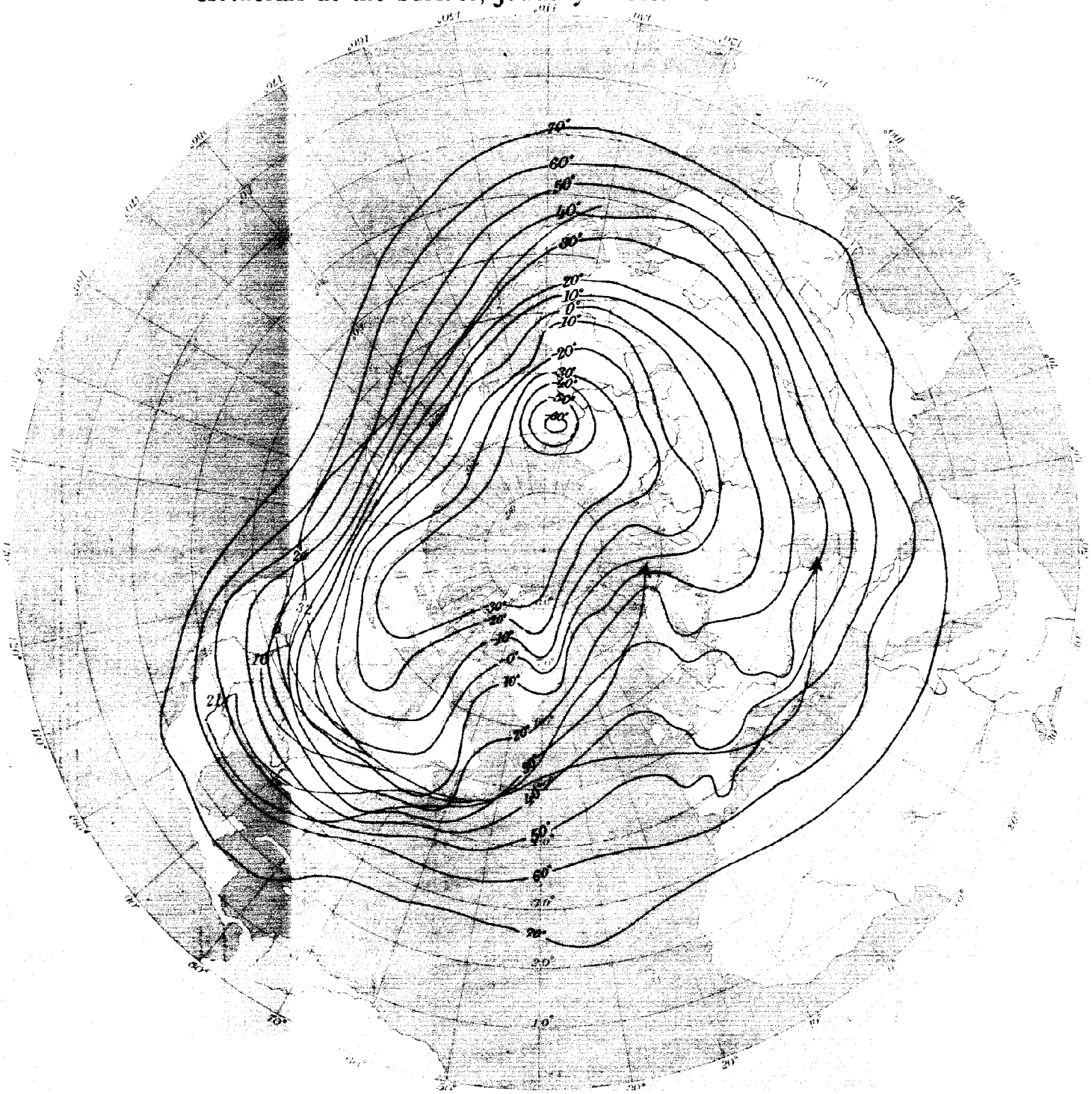
It may here be noted that the configuration of the circulation in the wind and the cumulus levels suggests that the true center of the high area circulation is usually on the north central plateau and not in the Alberta district. On the southern plateau there is a southeastward movement of the air, which, in conflict with the anticyclonic action bringing air from the northeast, makes the winds very variable in that region. The central plateau at the high levels is generally a district of light variable winds, since the atmospheric currents from the Pacific Ocean tend to blow around it, to the north and to the south, as if seeking to avoid this high table-land. On the mountain slope the vectors are all very strong as far as the Mississippi Valley; there the prevailing winds to a depth of 3,000 meters are from the southward; that is, from the Gulf of Mexico. Thus, in the central valley occurs a counter flow of currents from the northwest and from the southwest, and the formation of a cyclonic gyration is to a large extent caused merely by these two currents acting as the forces of a couple tending to rotate about a vertical axis the air thus brought into contact. Hence, along the edge of the current from the northwest, which is cold and tends to underflow the warm current from the south, the causes prevail that produce precipitation of the moisture in the air. The warm current from the Gulf is cooled by rising near the

edges of the underflowing stream from the northwest, and also by the intermixture of masses at different temperatures. These circumstances are repeated throughout the winter and the summer, and are a general feature of the circulation all over the United States where such counter currents meet together.

The strong southeastward deflection of the vectors shows itself up to the cirrus level, at which altitude there is also a firm southward component added to the eastward drift, which normally should follow the parallels of latitude very closely. After describing in detail the vectors of the sixteen charts before us, we will attempt to gather up into one statement the relations which these high and low areas bear to the general circulation over the North American continent, with the view of showing how they are to a great extent the natural outcome of the oceanic and continental distributions of temperature. These gradients are confined to the lower strata, 4,000 meters in depth, and influence the higher levels only by the resultant action of forced gyrations which are propagated into them. In general, as we have seen, the cirrus level moves eastward, and we may assume without error that its isobars and isotherms are parallel to each other, all being normally nearly eastward. The continental oceanic differences of temperature produce disturbing temperature gradients and their resultants are almost parallel to the vectors of the circulation in the cumulus level. Near the ground, however, the divergence between the systems of isobars and of isotherms becomes pronounced, as shown on the weather maps. It will be observed from a study of these charts that the cumulus vectors run in a smoother system than the surface winds, but that the two sets of vectors conform closely to each other. It is necessary to go to a height of 2,500 meters before the effect of the eastward drift begins to supersede the gyratory components of the lower levels. On these composite charts it is only comparatively near the center of the selected type that the resultant vectors are to be found in full vigor, and this is the case because the formation varies so much from map to map, even of the same series at considerable distances from the center, that we encounter much irregularity and important local divergences. If a prevailing system of stream lines survives in spite of these local variations, it shows that this must be a real part of the typical circulation pertaining to a center placed in a given district. Hence these charts become of great value in giving the clue to the interpretation of all sorts of peculiarities of the movements of the atmosphere, by comparing them with the local normal circulation.

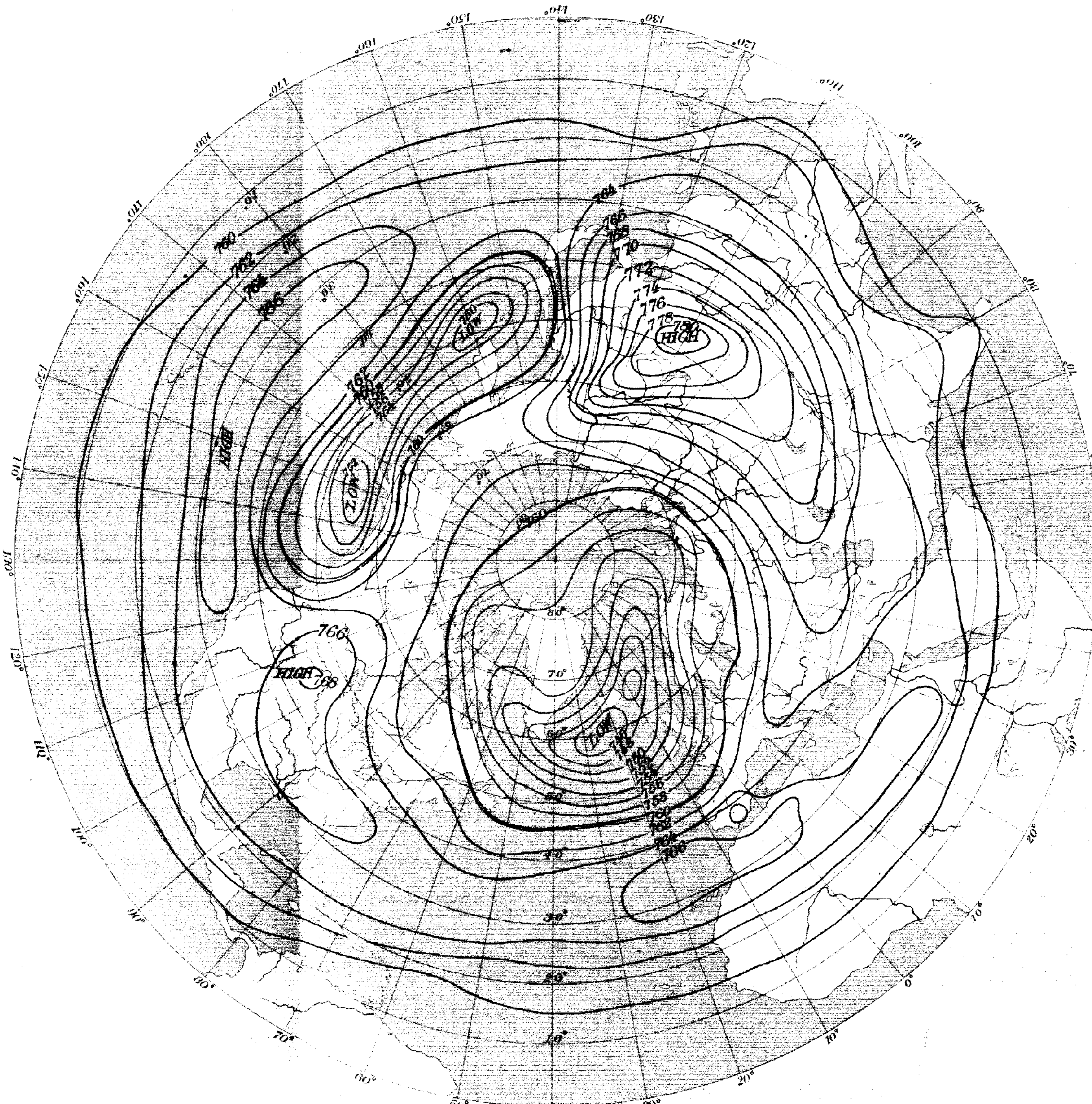
Alberta cold wave, Chart 32 (7).—Since the cold-wave system differs but little from the Alberta high, this may properly be next considered. On comparing the Charts 20 (1), and 32 (7) the similar features are readily perceived, the chief difference being that the cold-wave type is more firmly spread out eastward in the central valleys, extending in an unbroken circulation even to the Atlantic coast. That is to say, the southern currents from the Gulf of Mexico, which meet the northern currents of the Alberta high in the Mississippi Valley, are shoved eastward and cover only the Atlantic States in cold waves, but there they are fully developed and flow alongside the recurved or northeastward drift, especially in the cumulus region. Forecasters know of the strong tendency that exists for a sudden rise in temperature along the southern and eastern edges of a high area as a cold wave comes forward, which thus largely magnifies the sudden drop of the temperature at the front and is the first change that foreruns the cold wave. There is no clear reason for this increase in heat except in the existence of the strong current from the south over the Atlantic States, which is shown so clearly in the cumulus level of Chart 32 (7). The curling around to the southwest in the lower strata, just to the south of the cold wave center and over the central plateau, is feebly marked when we consider that in the case of these cold waves the pressures in the Alberta district are usually very high on the weather maps, often as much as 31.00 inches of mercury. This is another indication that the reductions to sea level are faulty, because there is no wind motion in the least comparable with such steep gradients. Perhaps the most remarkable fact in the case of cold waves is that the cumulus level currents all come in from the Pacific Ocean, and not, as one might expect, from the interior of the continent. Now these currents from west and southwest must be quite warm, since they are ocean winds from the Japan current, and the vertical temperature gradients are probably very little distorted from their ordinary rates of change as far west as the ocean itself. On the other hand the ground temperature east of the mountains is very low, and this depression, chiefly due to surface radiation, does not extend upward far from the ground. Therefore, there evidently exists in this region an extreme

Isotherms at the Surface, January. Mean Storm Tracks. *Chart 36.*

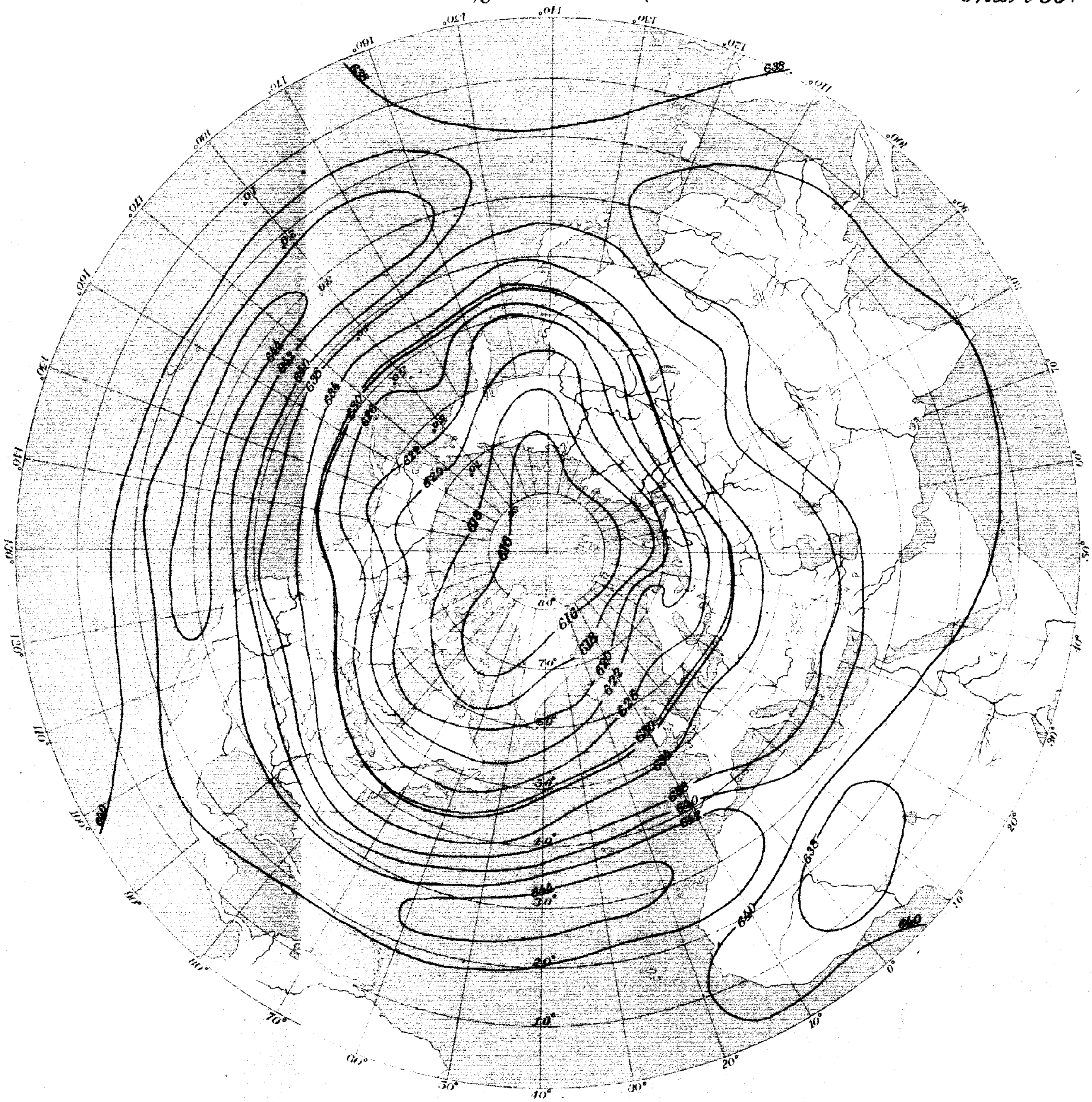


Isobars at Sea Level.

Chart 37.

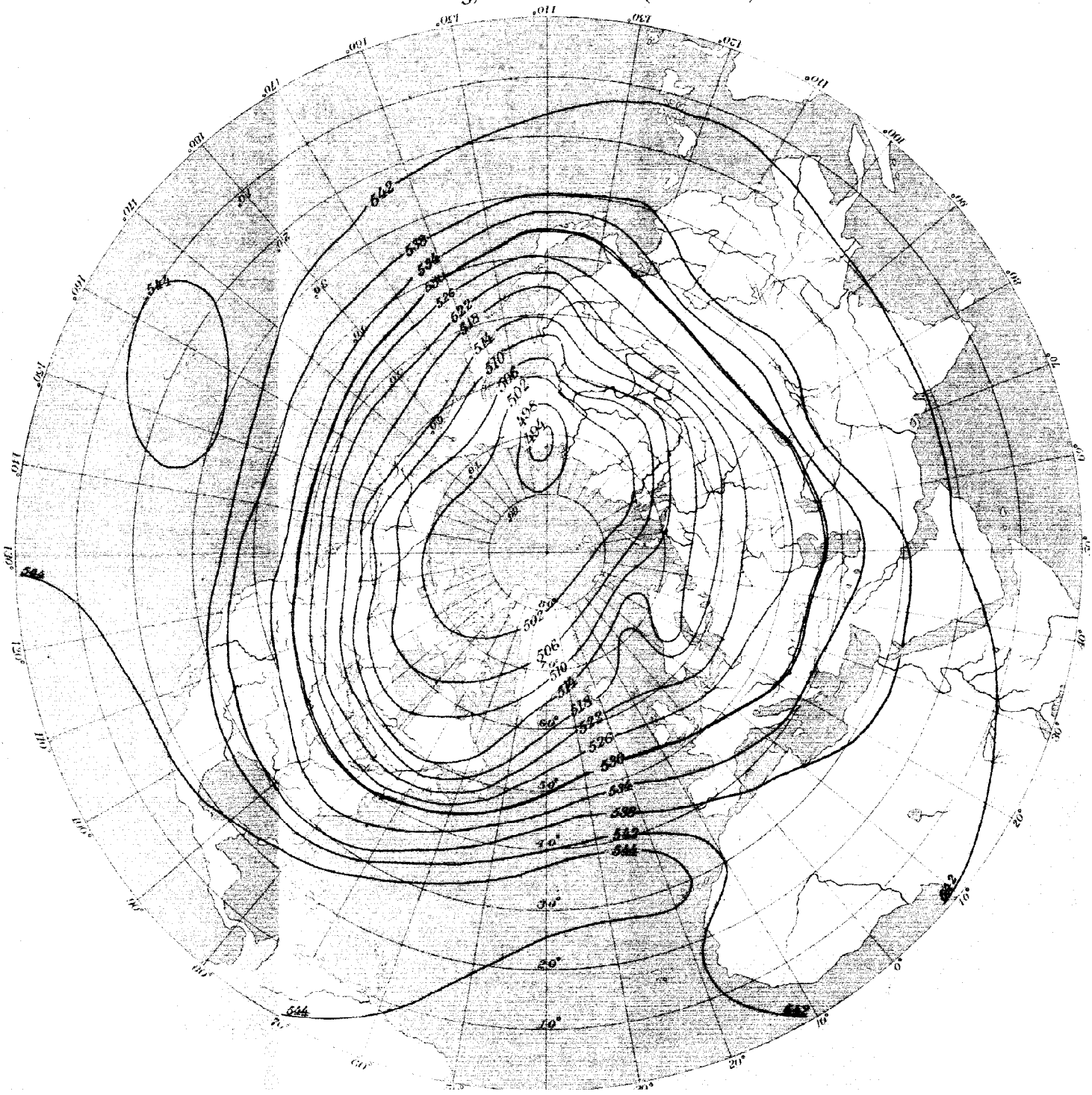


Isobars at 1,500 Meters. (T. de B.) *Chart 38.*



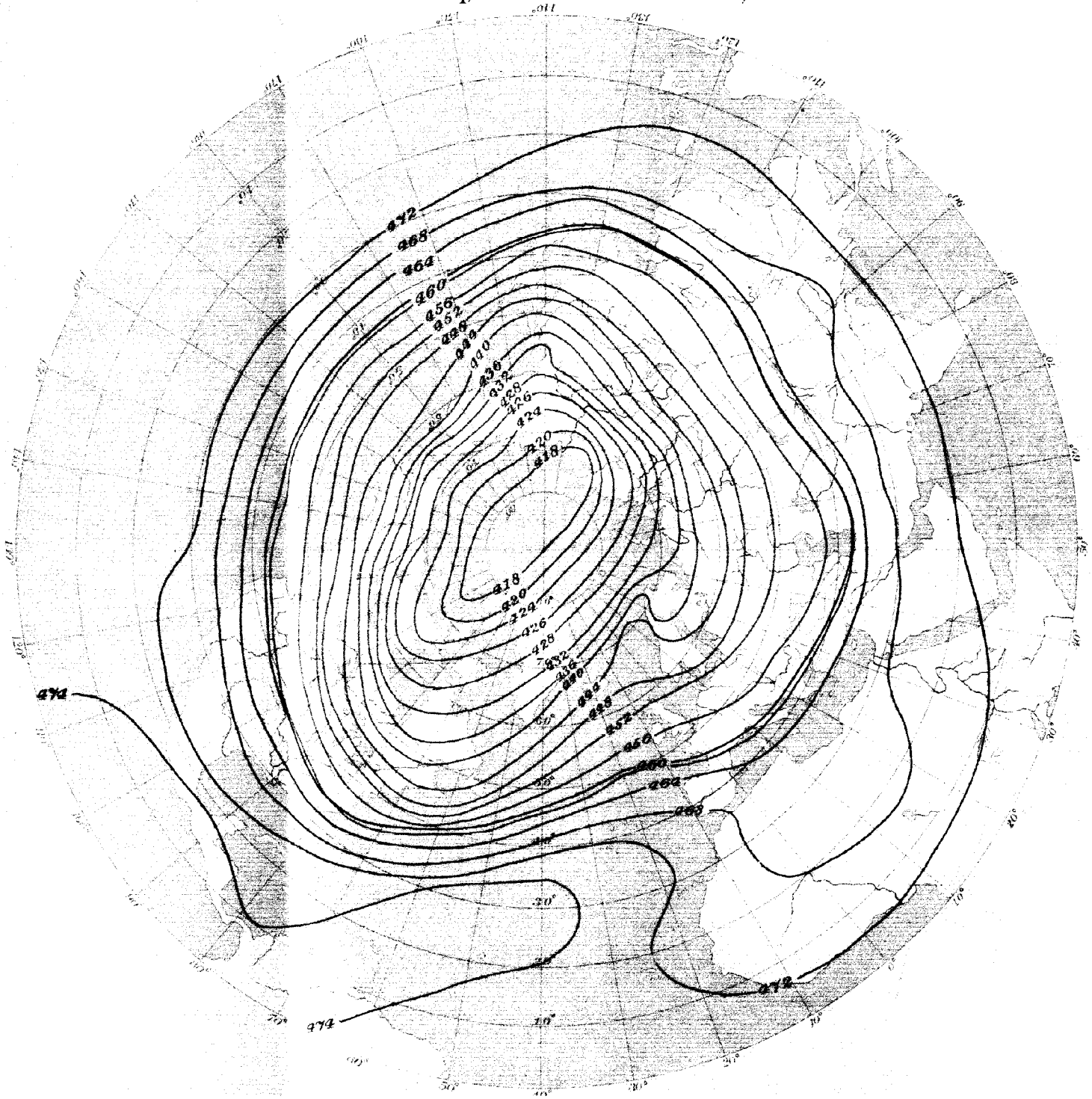
Isobars at 3,000 Meters. (T. de B.)

Chart 39.



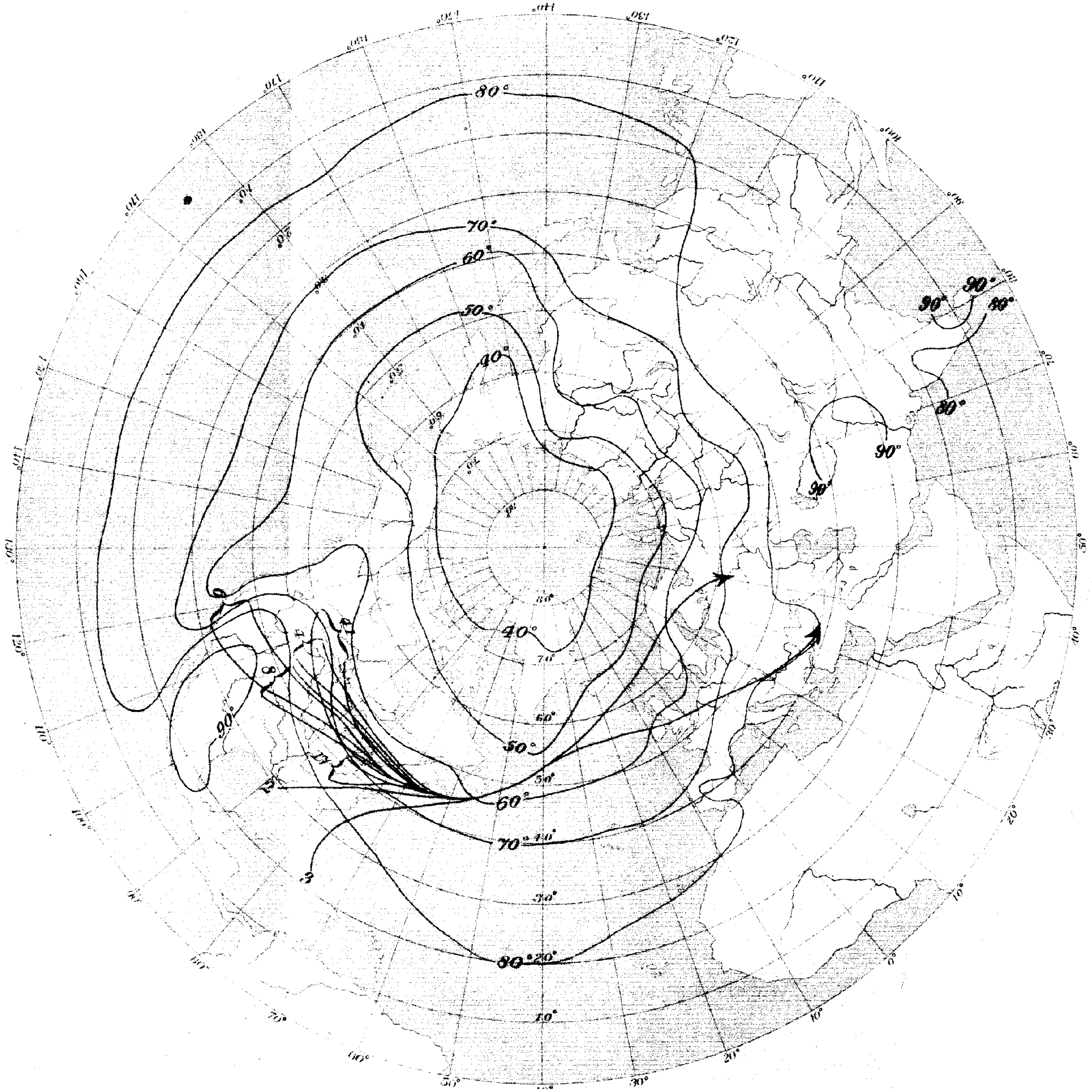
Isobars at 4,000 Meters. (T. de B.)

Chart 40.



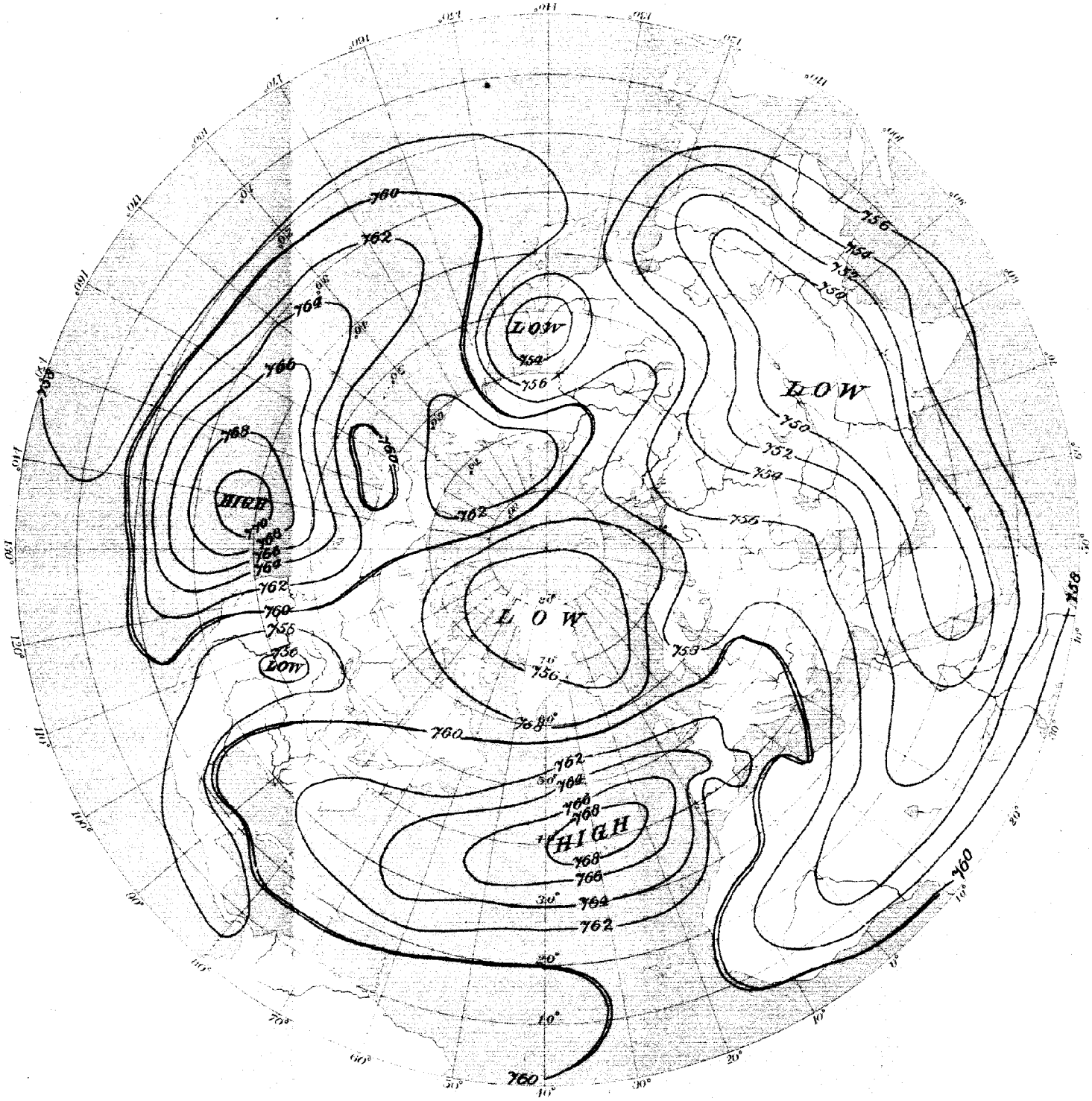
Isotherms at the Surface. July.

Chart 41



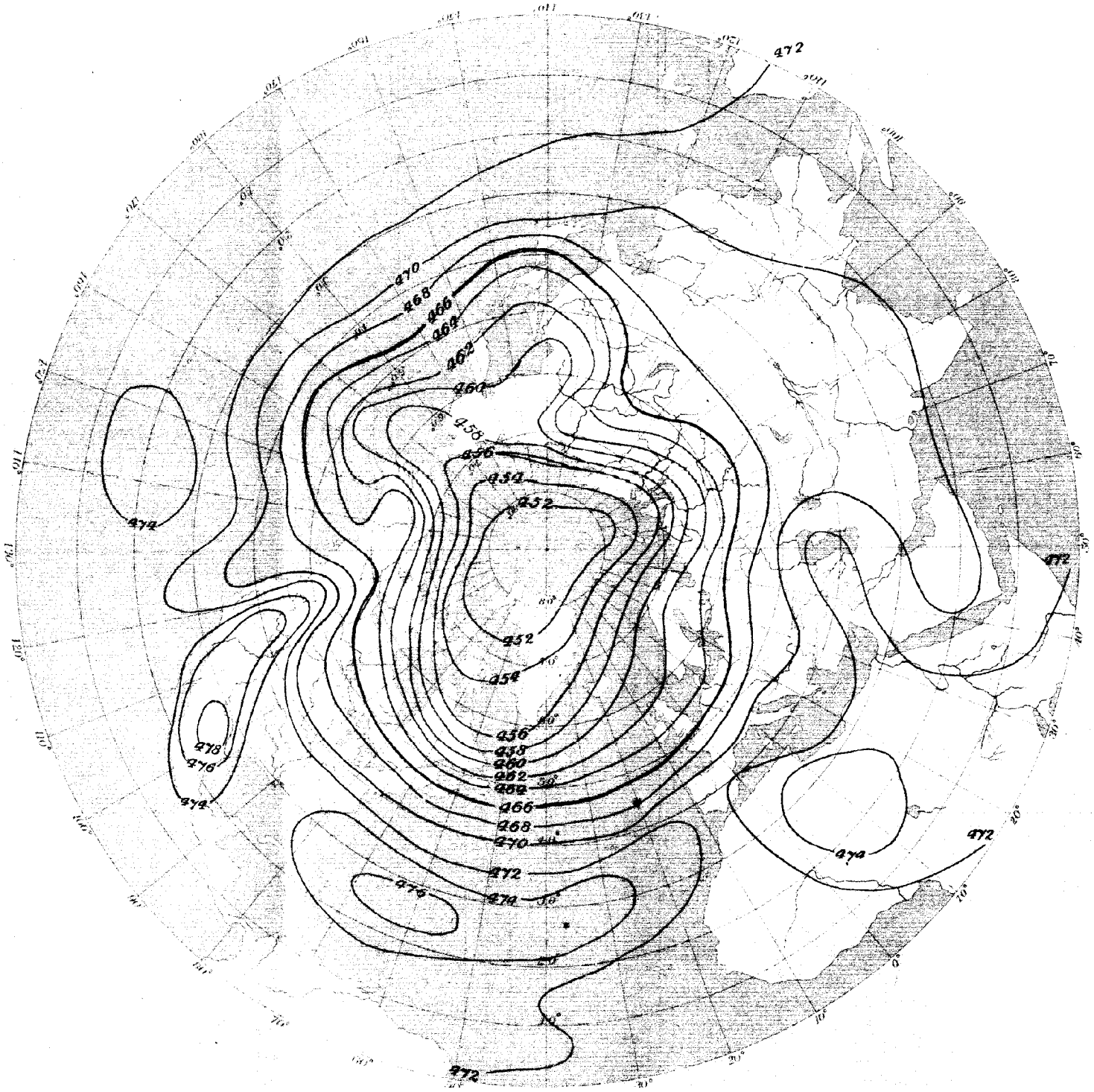
Isobars at Sea Level.

Chart 42.



Isobars at 4,000 Meters. (T. de B.)

Chart 43.



case of inversion of temperature, amounting possibly to as much as 40°, caused by the warm Pacific winds overflowing the mountain crest above a thin stratum at a very low temperature, which shelters itself on the slope just under the lee of the mountain crest. Here we see a serious criticism against using the surface temperatures in cold waves as data for the barometric reductions to sea level, especially in view of the fact that the results of such computations do not give gradients conforming to the surface winds, but exaggerate the reduced pressures and show steep gradients with no winds conforming to them.

DESCRIPTION OF THE JANUARY AND JULY ISOBARS IN DIFFERENT LEVELS AND THE ISOTHERMS AT THE SURFACE.

It will be observed that the cirrus strata are strongly deflected southward over the mountain slope, proving that the conditions accompanying the cold-wave circulation give unusually deep currents. This leads me to introduce some typical temperature and pressure charts for January and July, which have a very important bearing upon the causes of the formations of the high and low area circulations. The first of these is the Chart 36, "Isotherms at the surface, January. Mean Storm Tracks," compiled from well-known sources. The important feature, as pertaining to the general circulation, is contained in the fact that the isotherms are greatly crowded together near the north Pacific coast. This is due to the effect of the Japan currents, on the one hand maintaining temperatures which are high for the winter on the coast, and to the continental cooling, on the other hand, which depresses the land temperatures excessively. The close juxtaposition of these two causes acting in the winter makes a steep system of gradients of temperature and pressure very favorable to the production of violent circulations. No other part of the Northern Hemisphere presents anything like so strong a system of normal-temperature gradients as the western Canadian Provinces, and at the same time there is no place in the world where storms so persistently originate as in this region, a fact which has been abundantly explained in Bulletin No. 20, Storms, Storm Tracks and Weather Forecasting.

We also take the charts given by TEISSERENC DE BORT in his paper on the "Circulation of the Atmosphere," which were originally drawn on the Mercator projection, and transpose them into circular charts of the Northern Hemisphere.

Chart 36.	January.	Isotherms, surface.		
Chart 37.		Isobars,	sea level.	
Chart 38.		Isobars,	1,500 meters	(T. de B.).
Chart 39.		Isobars,	3,000	(T. de B.).
Chart 40.		Isobars,	4,000	(T. de B.).
Chart 41.	July.	Isotherms, surface.		
Chart 42.		Isobars,	sea level.	
Chart 43.		Isobars,	4,000 meters	(T. de B.).

These charts give the isobars for January at sea level, at 1,500 meters, at 3,000 meters, and at 4,000 meters respectively, and they are most instructive for our present purposes. On Chart 37 are shown the oceanic low and continental high areas which are such conspicuous features of the winter season. These closed isobar systems indicate the circulation of the general winds at the ground, and they are quite detached from the great sweep of the general movement about the poles. Chart 38 gives the isobars at the average height of the cumulus cloud level and there they have already changed into a single oval, which implies a continuous set of currents circulating around the north pole. These isobars are nearly parallel with the isotherms of the surface already displayed on Chart 36. On the two following charts 39 and 40, the isobars at 3,000 and 4,000 meters possess steeper gradients in an oval whose axis is laid over the great land masses of Eastern Asia and of North America. We are therefore enabled to infer from the charts that at a short distance above the ground the isobars, the isotherms, and the general circulation follow closely the same lines, and that the divergence between them, which is so characteristic of the lowest stratum of the atmosphere, quickly disappears in the actual movements of the air at a moderate elevation.

In order to bring out the contrast between the winter and the summer circulation, Charts 41, 42 and 43 are added, showing the isotherms at the surface for July, the isobars at sea level and at 4,000 meters for the same month. The temperature conditions are now relatively inverted, and

the continents are actually warmer than the ocean; the continent contains the low pressure area at sea level, and the ocean the high pressure; at the 4,000-meter level the system of pressure gradients is still affected by these conditions. Here the Pacific coast continues to be the axis of the system of closest isobars, but it has been transferred from Alaska, with a southeastward trend, to California, with a northeastward trend. Applying identical principles regarding the direction of storm propagation, namely, that the movement is parallel to the higher isotherms, we see that in winter the high and low areas should advance into the United States from the northwest, and in summer from the southwest. This is precisely the observed fact, and we conclude that the trend of the isotherms and isobars of the strata between the levels of 1,000 and 4,000 meters is chiefly influential in determining the direction of motion of the center of the areas of local low and high pressure. This, too, is in harmony with the fact which has been established by our nephoscope observations, that the stratum of the circulation most concerned in forming anticyclones and cyclones is in the strato-cumulus and in the alto cumulus levels. Since the smooth normal gradients of the middle strata must at intervals suffer changes on account of variations in insolation or peculiar configuration, they have impressed upon them a tendency to be deflected according to the components whose types have been constructed in this paper, and thus there is actually in operation a combined interworking (1) of the general smooth flow of the high strata and (2) the variations due to local conditions at the surface. The main power which goes into anticyclones and cyclones is evidently due to the long horizontal currents flowing from the great distances, but deflected at special places into the gyratory circulations that are observed. There are two chief causes tending to produce such gyrations: (1) The meeting of two currents at an obtuse angle to form an efficient couple between them working upon the masses of air in contact; (2) the flowing of a single current over a high mountain divide, or following a coast line which changes its direction materially. In the case of the United States the two prevailing currents which conform to the first cause are one from the North Pacific and one from the Gulf of Mexico. These are persistent, and, meeting along the Rocky Mountain slope, cause a large percentage of the local high and low centers observed to originate in that neighborhood. The trend of the upper isobars is mainly responsible for the first source, and the inflow of warm air upon the continent is the cause of the second. Indeed, it may be remarked that the principal mode of the interchange of air at different temperatures between the tropics and the polar regions is by means of these long streams of air which meet as counter currents near the surface of the earth. There is very little indication of such an overflow in the upper strata of the atmosphere from the equator to the poles, as Professor FERREL assumed, since in the high levels the prevailing drift is persistently eastward. The necessary gradients of pressure and temperature are maintained by tropical insolation and the deflection due to the rotation of the earth, being parallel to the movement of the atmosphere. There might be no anticyclonic and cyclonic component if it were not for the great irregularities in the lowest strata, which suffers so much more from unequal diurnal insolation and the difference of radiation on the land and water areas, except for the fact that fluid motions always tend to curl up along the edges.

CONCLUSION OF THE DISCUSSION OF THE CHARACTERISTICS OF COLD WAVES.

This explanation has been introduced here in order to be able to illustrate these principles in the series of the charts which are now being discussed. In the case of the cold-wave chart, if we compare the trend of vectors with the isobars and isotherms of the strata from 1,000 to 4,000 meters high, we see that they are very nearly parallel, bending down over the central valleys to recurve toward the northeastward over the Atlantic States. This leads to an important deduction regarding the prevailing winds from the northwest over the Rocky Mountain slope and the winds from the south in the central valleys and the Atlantic States. Since the great recurve of the upper strata oval lies over the United States, the general circulation is necessarily from the northwest over the west Canadian districts and the mountain slope and it is from the southwest in the Southern and Eastern States. This general movement of the upper air therefore continuously favors the formation of just those surface winds which prevail near the ground. The other function of these winds is, as already mentioned, to facilitate the interchange of masses of air of different temperatures between the tropics and the pole, especially in the lower strata, and hence

these two operations go on in conjunction with each other. It is most important to note clearly the causes which persistently sustain the long currents of air whose flow is mainly horizontal, because the counterflow from the two branches of these broken oval currents, having independent sources at a great distance, and being sustained throughout their course by upper level and middle level gradients, is the chief cause of the formation of the highs and lows on the weather maps of the United States. A study of these charts convinces us that highs and lows do not have such a local origin as the convection hypothesis supposes, but that they are subordinate features in a general circulation which embraces very large areas. According to this we should say that cold waves are propelled southeastward by the upper general circulation which *temporarily drops to or toward the ground*, especially on the mountain slope; that a current of warm Pacific Ocean air feeds into them across the divide at a moderate height, and that the intense cold is confined to a thin stratum near the surface. The reduction of the barometric pressures on the plateau must take full account of these conditions, which imply (1) a strong inversion of temperature, and (2) a steep pressure gradient due to movements in the upper strata.

Many of the principles of this discussion will find abundant support in the study of the series of Charts 20–35.

THE WINTER ALBERTA LOW.

Alberta low, Chart 21 $(1)_2$.—The low-pressure areas which develop on the northern Rocky Mountain plateau are generally accompanied by light and even indecisively directed winds, and it is shown by Tables 37 and 41 that the wind velocities in the northern circuit increase steadily from the Pacific toward the Atlantic coast. While the uncertainty remains regarding the reductions to sea level of the plateau barometric observations, the question of the gradients must be held in abeyance. As regards the center of the low pressure, the most probable inference concerning the cause of that local gyratory circulation may be drawn from the cumulus vectors of Chart 20 $(1)_2$. These show, so far as the limits of the map extends, that a current from the southwest blows up the Pacific coast, curves to the eastward, and near the center of the low is deflected in a cyclonic rotation. Part of the current enters the low area and the remainder streams off eastward over the lakes to the Atlantic coast; in New England it continues directly eastward; over the south Atlantic States it turns southward. On the central plateau the tendency is again observed to avoid it, by dividing the eastward drift, partly to the north and partly to the south of the highest elevation, evidently preferring to flow over regions of less altitude. On the whole, the wind and cumulus charts are quite similar, but the circulation is rather feeble and in some districts much broken up. The cirrus currents flow directly eastward over the entire map with hardly a visible deflection. The remarkable feature pertaining to the high and low areas, also to the cold waves of the Alberta district, is the persistency with which the circulation originates from the Pacific Ocean, in the case of the high coming from the west or northwest and in the case of the low from the southwest.

THE WINTER LAKES HIGH.

Lakes high, Chart 22 $(2)_1$.—The high areas of the lake region present a marked typical circulation, similar to that of the Alberta high, but with the strong vectors on the east and south much more inclined to bend about westward in the Southern States and northwestward over the mountain slope. It is seen that an immense volume of air passes either over or just eastward of the center, deflects southward strongly, but finally discharges on the Atlantic coast, where of course a vigorous low area exists to receive it. On the mountain slope there are distinct indications of the formation of a low area, fed by the anticyclonic component from the high flowing northwestward and a fresh Pacific current flowing northeastward, which meet on the mountain divide. In this instance the Pacific current overflows the central plateau vigorously, being largely compelled to do so by the cyclonic tendency in the cumulus level. The wind and cumulus levels show the same circulation, with the stream lines of the cumulus more rounded, especially in the southern districts; the cirrus level has a distinct deflection to the southward over the lake region, which extends to the Appalachian Mountains, but the vectors of the Gulf States do not seem to be in the least disturbed. It may be observed that the mean types of circulation in high and low areas, as constructed on the charts of Chapter 7, are very much modified by the local configurations of the

areas in which they are formed, and that the set of charts in this chapter are likely to be of more value for study by forecasters. It is quite probable that if nephoscope observations were made regularly of the movements of the clouds, and collected in the main types here discussed, we might obtain many important indications as to the intensity of any given circulation of the air, especially by comparing the vectors of an individual date with the mean type worked out in the given region. The visible type of cloud will indicate approximately the height of the moving stratum, and the velocity and direction will thus be found and can be compared with the normal mean vectors.

THE WINTER LAKES LOW.

Lakes low, Chart 23 $(2)_2$.—The low area, which was in its incipient stages over the mountain districts while a high area occupied the lake region, has now moved to the lakes and become fully developed, not only as to the cyclonic circulation, but also as to the sources of the air which contribute to its maintenance. This chart is of much interest and importance as regards the theory of the constitution of a cyclone in the United States. Beginning again with the currents in the cumulus levels we perceive that there are two main sources of supply, the first from the Pacific and the second from the Gulf and South Atlantic. The former has, however, two branches, one flowing eastward over the northern slope and reaching the low area as a northwest current; the second flowing southeastward over the southern slope, bending northeastward, and reaching the low area as a current from the southwest. These two Pacific currents thus avoid to some extent an eastward movement directly over the elevated central plateau region. The other current from the south flows alongside the Pacific southwest stream, and approaches the center of the low on the eastward side, where it is deflected in the ordinary cyclonic rotation, though indecisively to the northeast of the center except near it.

DISCUSSION OF THE CAUSES OF LOCAL CYCLONIC GYRATION.

The general aspect of these charts is, it must be claimed, strongly in favor of the view that the cyclonic circulation is the product of two or more long horizontal streams, which are maintained by extensive horizontal gradients of temperature, located far beyond the territory of the cyclone, meeting together in a counterflow, which, by an action similar to that of a couple, rotates the air brought into contact in a whirlpool of gyration. The sources of supply are at least two thousand miles distant and it is inconceivable that any local vertical convection at the lakes should have so enormous a reach as is here shown to exist in the cumulus level. Furthermore, if vertical convection is the cause in the wind and cumulus levels, why does it not show much more decisively in the cirrus levels as a cyclonic rotation, where we perceive on the other hand only a very moderate deflection. Also, it will be remembered that the nephoscope measures give very feeble indications of a true cyclonic component above the cirro-cumulus level, or 8,000 meters. We shall show that in the case of the hurricanes of the South Atlantic States there is a much more strongly marked cyclonic deflection in the cirrus level, indicating that in those violent gyrations of the air the upward convection becomes vigorous. It is known that many cyclonic formations are well developed in the northern districts of the United States, and pass from the Pacific to the Atlantic coasts with scarcely any distinct rainfall, and from this but little latent heat could be obtained for vertical convectional action. Again, in most low areas the eastern side is warm and the western cold, so that in the former air would naturally rise by its buoyancy, but in the latter would fall by its density. Hence vertical components near the center should produce only a disturbing effect, tending to disrupt rather than build the cyclonic circulation.

The cause of a vertical component is, however, readily accounted for without convection, as we shall show analytically, by simple vortex motion, provided a gyration is set in operation and maintained from other sources. A vortex consists of a rotation about an axis, accompanied by a current along the axis proportional to twice the angular velocity of the gyration. The magnetic whirl with an electric current through it is an example of a similar kind, and the mathematical principles of one apply generally to the other. While the air flows eastward, it is sinuously deflected to the north of a high and to the south of a low, and there is developed from the bottom to the top of a low area a whirl with only inward gradients, whose gyrations are necessarily accompanied by a vertical component due to the purely vortex motion. The analogy is quite good

between the battery, the magnetic field surrounding a wire, and the electric current along the wire on the one hand, and on the other hand those meteorological formations here described. For the temperature gradients produced by solar insolation, and the constant tendency to preserve a normal equilibrium on the rotating earth, guided and modified by the mutual action of the air lying over the continents and oceans acting upon each other, is like the battery which is the source of energy; the rotating components about the axis of the low, caused by the counterflow and interference of streams from different directions impinging upon each other, are like the circular magnetic lines of force about the conductor; and the vertical component lifting the air of the central region, where *closed isobars* are developed, is the analogue of the electric current itself. Those who are familiar with the theory of electricity and magnetion, as well as the hydrodynamic equations of vortex motion, will recognize that we deal with the same theoretical principles under two aspects. In fact, the equations of motion of these two subjects are practically identical—one being concerned with lines of force in the ether, and the other with stream lines in the atmosphere. While, therefore, local heating of the lower air may have much to do with causing vertical convection in summer, during the winter, since the ground is relatively too cool for true adiabatic gradients, we must look to the mechanical cause just described for the raising of the air near the center of the low, rather than to pure convection. This vortex vertical component lifts the air, causes cooling by expansion, and it is thus a most efficient cause of precipitation, which is chiefly an effect; of course the generation of its latent heat also assists the vertical action. The intermixture of masses of cold and warm air from different regions also aids in the process of condensing the aqueous vapor, and hence to precipitation. This general view seems to be supported not only by the components and gradients derived from the nephoscope vectors, but also by the configuration of this set of charts; it is entirely efficient in its mechanical details, and so easily overcomes the difficulties inherent in the purely vertical convectional theory that we have not hesitated to accept it in our discussion as having the evidence of truth. It accepts the Ferrel vertical convectional action at its real value; it also admits the general validity of Dr. HANN'S explanations of the formation of cyclones and anticyclones in middle latitudes; but it is now sought to supply in detail the facts that will produce a clear working hypothesis, suitable to make meteorology a science of considerable precision.

THE WINTER NEW ENGLAND HIGH.

New England high, Chart 24 $(3)_1$. The chart of the New England high area shows a remarkable characteristic when compared with the Alberta high—that is to say, the firmly developed northward current on the western side of the center. On the mountain plateau the vectors on the western quadrants of the high are all feeble at the surface, though they come in vigorously from the Pacific at the cumulus level. In the lake region, to the westward of the high, the surface and lower cloud strata flow as one deep stream, with an increasing component from the south. In the New England high the southern current of the cumulus level is strongest, and it seems to dominate the circulation of the lower strata, although the surface wind lags behind it with vectors more from the east or northeast. This is due to the prevailing wind along the Atlantic coast from the northeast, which extends from New England to Florida, near the ground. In the cumulus level the northeast current is maintained in the New England districts, but it is superseded by the southeast current blowing upon the land over the South-Atlantic States. Thus on the South-Atlantic coast the prevailing wind is from the northeast and the current of the lower clouds from the southeast—that is, these two lower currents are at right angles to each, one overflowing the other. Herein exists an abundant reason for the formation of the small coast storms on the edge of the high area, which often spring up suddenly on the Atlantic coast and assume destructive velocities, though they may be of very small dimensions. This is also the reason why forecasting of their development is very difficult, and is likely to continue so as long as but little attention is paid to the direction of the motions of the cumulus level.

DISCUSSION OF THE CAUSES OF LOCAL ANTICYCLONIC GYRATION.

We are also led to the remark that the apparent anticyclonic movement at the ground has its source to a large extent in these northern and southern currents flowing past each other, the circular adjustment being natural in such fluid motions. Also the rotation of the earth adds a

component which deflects all currents of the northern hemisphere in a clock-wise direction about a vertical axis, when looking down upon the ground. Thus two such northern and southern currents flowing past each other tend to bank up together at the center, when the northern is on the east side and the southern on the west side of the center. The same cause, namely, the component from the earth's rotation, tends to draw two currents apart when the southern is to the east and the northern to the west of a center, the effect being to facilitate the formation of a low pressure center. These long currents flowing past one another in the lower strata, with the component of the earth's rotation and the centrifugal force of gyration, together with the gradient of temperature, go to make the system of high and low pressure observed at the surface of the ground. Evidently the entire system is an exceedingly complex circulation, and the resultant is the combined effect of several independent motions. According to the preceding analysis of the anticyclonic and cyclonic components, shown on Charts 17, 18, the center of the high is transformed into a true downward vortex, while the outer edge of the area shows simply a deflection or bend in the eastward drift toward a center which only partially controls it. In the case of the low-pressure area the deflection toward the center is developed throughout the vortex from the bottom to the top, and this must be accompanied, as already explained, by a mechanically produced upward current all over the system of closed isobar surfaces.

While a high area covers New England, a low area is usually formed in the central valleys, and a high area is located on the Rocky Mountain plateau; meanwhile the Pacific current flows eastward, separating to the north and south of the central and most elevated land masses. In the cirrus level we have a deflection toward the south along the mountain slope, toward the north in the central valleys, and to the south on the Atlantic coast, which shows the sinuous direction of the eastward drift in the upper strata. The atmosphere may evidently be divided into two regions—the upper, which is quite independent of small temperature changes, and the lower, which is subject to the incessant changes of temperature due to insolation and all kinds of convectional currents. The former is only partially deflected from its rapid eastward movements, but the latter is thrown into locally changing circular gyrations, which tend to readjust the temperature conditions whose equilibrium has been disturbed. The thinness of this active stratum should be carefully remembered. If three miles is the average limit of the depth of the easily disturbed stratum, and the average diameter of the high and low areas is about 1,500 miles, then the active layer is thick only in the ratio of 1 to 500. For instance, 1 to 500 millimeters or 1 millimeter to half a meter gives the proportion. One should not fail to interpret the charts of the several cloud layers in this ratio, lest an erroneous conception of the relative depth of the disturbed atmosphere involved should be permitted to enter the mind. There is a very turbulent surf a few hundred meters deep near the ground; above this a stratum of 2½ miles deep wherein great horizontal currents circulate, as they are governed by oceanic-continental temperature gradients, and the interchange of warm and cold air between the tropics and the poles; above this is the great eastward drift controlled by the general, nearly undisturbed temperature gradients of the hemisphere, subject to slow annual periodic changes, and sustaining their normal slope which balances against the components of the eastward drift, this being primarily due to the rotation of the earth. It should be observed that were it not for the deflections superposed upon the upper stratum, and the tendency to produce downward and upward vortex gyrations, the eastward drift instead of being 90 miles per hour in the cirrus level would become enormously greater than it is. This expenditure of energy in slowing down the eastward drift, by contributing to the confused circulation at the ground, which is attached to the movement of the upper strata by means of the components already analyzed, accounts for a part of the work done in producing the violent winds sometimes generated in the lowest strata. At such times it seems as if the upper strata make themselves felt down to the ground—for example, in the highs of the Northwest and the lake regions, when there are generated very strong northwest or west winds in the western quadrants of a low area. The immense power in this current is doubtless due to the upper drift *dipping down* toward the ground through the lower strata and temporarily dominating the entire circulation. The southerly winds in general are less vigorous, because they flow into and check the eastward drift by their opposite components.

Remarks on Dr. Hann's temperature distribution over low and high areas.

Dr. HANN has noted that the temperature gradients over high areas are too warm at a distance above the ground, and over low areas too cold, for conformity to normal vertical temperature gradients, starting with the data at the ground to compute upward. There are two remarks to be offered: (1) The high area presents a case of complete or partial inversion of temperature, caused by surface radiation; and the low produces an excessive gradient fall by overheating at the ground; (2) it has been shown that the high and low areas as independent circulations merge into the eastward drift at relatively short distances above the ground, and, therefore, at moderate elevations the entire stratum over highs and lows possesses a nearly uniform temperature, as is shown to be the case by the substantial agreement in direction of the isobars, isotherms, and wind vectors at the height of 3,000 meters, as on Charts 39, 40, 43. Hence, if this current has its own average temperature, and the surface temperature of the high is too low—that is, below normal conditions—the result is a relatively slow temperature fall with the height; in the opposite sense, if the surface temperature in the low area is great and above the normal, in order to reach that same temperature which prevails at 3,000 meters in the eastward drift, the gradient of the temperature fall is above the average. We have seen that the high and low areas lose their individuality at no great distances above the ground in the prevailing eastward drift, and that all the vertical temperature gradients are controlled by passing into this stratum, which possesses practically a uniform temperature, whether the local surface temperature was above or below the normal. It does not appear that Dr. HANN has done more than to indicate this condition from a different point of view, and hence his theory of individual anticyclones and cyclones penetrating far up into the upper strata does not give due weight to the observed fact of the persistent overflowing of the strata at the 3,000–4,000 meters level by the permanent eastward drift, and to the fact that this maintains a nearly uniform temperature in a west-east direction. The simple inversion of temperature, either in excess or defect of the normal gradient, is a phenomenon due not to circulation about a center, but (1) to surface radiation, and (2) to the transportation of masses of air from one parallel of latitude to the other. Such an underrunning of lower currents of air in the direction of the meridians, in relation to the permanent movements of the upper strata in the eastward direction of the parallels, is a genuine cause of vertical convection, because it disturbs the normal gradients. We wish, however, to impress the view that the vertical interchange is largely a mechanical action rather than a thermodynamic, and in this respect it favors Dr. HANN'S ideas rather than Professor FERREL'S, since the latter has given too much weight to pure vertical convection, considering the slight basis that this theory rests upon. It is most important to endeavor to give due value to the facts advanced by each of these writers, because the circulation of the air over high and low centers must to some extent depend upon the energy derived from each of these sources. Dr. HANN has not specified his conception of the details of the vertical mechanism involved in the anticyclonic and cyclonic circulation far enough to make his theory accessible to specific criticism. Indeed, Professor FERREL made that complaint in the last days of his life, and felt that Dr. HANN'S theory was not as definite as his own, and that therefore the vertical convectional theory had a right to continue to hold the field, at least till the dynamic mechanical theory had advanced to such a stage of definition that its details could be distinctly described. There is no doubt that the international cloud observations will tend to elucidate the merits of these two rival views, and thus will advance the science of meteorology.

THE WINTER NEW ENGLAND LOW.

New England low, Chart 25 $(3)_2$.—It has been shown on Tables 37, 41 that there is a marked increase in the velocity of the air in the winds and the lower cloud strata from Alberta to New England, where the velocity is twice as great, on the average. The Charts 25 $(3)_2$ of this region show that the vectors are under the influence of very strong forces, because they assume an exceptionally well-defined formation in the surface winds and in the lower clouds. These two systems are almost exactly parallel to each other from the lake region to the Atlantic coast in all their features. East of the Mississippi, except over New England, the cirrus strata are deflected to the southeast, and the vectors of the upper clouds, the lower clouds, and the surface winds are

very nearly parallel to one another and are all firmly developed. Over New England the case is entirely different, for while the cirrus maintains the eastward course the cumulus and the surface winds together are deflected about the center of the low with almost perfect cyclonic components. Nothing could show more clearly that the active gyratory circulation over a low center is confined to a layer 2 or 3 miles thick, and that it extends upward beyond this only by secondary propagation. If the real strength of the cyclone is in the strato-cumulus and cumulus region, the New England type presents a case of strong downward development, involving the surface winds in one system of stream lines.

Remarks on the two branches of the North American oval.

We can now call attention to an interesting and probably important feature in the general circulation as relates to the formation of the storms of the United States. It is shown on Charts 37–40 that the American oval of the polar circulation in the cloud strata during the winter projects strongly to the southward, and that the bend takes place somewhere near the Southern States. Now, it is to be admitted that these oval lines are not always continuously followed by the movements of the atmosphere. They do, however, represent the prevailing current directions, which are from the northwest in the mountain districts and from the southwest in the central valleys. These movements are the outcomes of the general circulation seeking to make the abrupt turn in direction near the ends of the oval in North America. Furthermore, it has been indicated that these two counter currents are almost always concerned in the formation of a cyclone with low pressure, the gyrations building up inward gradients exclusively throughout the entire vertical extent, with the usual vortex discharge at the top into the eastward drift. It now seems quite clear that when a low area forms in Alberta and moves eastward to New England, gathering strength on the way, it is really in the apex of the oval and marks its locality for the time being. This progressive movement of the oval eastward may in other words be described as the swing of the axis of the continental circuit prevailing in winter, from the western to the eastern districts of North America. It is not probable that this axis is stationary, as one might suppose by the aspect of a single map, and its oscillation across the continent suggests a sort of meteorological pendulum on a large scale. These vibratory, periodic, or aperiodic movements in the configuration of the general circulation, if established to exist in a general way, may become the means of grouping meteorological data on a larger scale than heretofore possible. At any rate, the conception that the progressive movement of a cyclone at the apex of the oval, being fed in by the two branches which suffer discontinuity at intervals, seems to hold several facts together that are otherwise quite isolated from each other.

Remarks on the relations of the solar magnetic field to this oval.

Before leaving the study of the northern circuit, I shall mention the conclusion elucidated in Bulletin No. 21, Solar and Terrestrial Magnetism in Their Relations to Meteorology, so far as it applies to this topic. By comparing the continental outlines of the oval circulation with those of the auroral belt, which we have there shown is identical with that of the maximum intensity of the solar magnetic field, where the exflected branch touches the surface of the earth, we see that the location of the two is practically the same throughout the path traced on the hemisphere. This conformity of the place of the maximum impressed force of the external field of the auroral belt and the oval of the current circulation, whatever causes produce such a result, shows that they are in position to act upon each other by an interchange of energy. We also noted that the energy of the solar magnetic field is periodically intermittent, and that an increase of magnetic force corresponds with a decrease of temperature. A synchronism has also been established between the order of the movement of high and low areas in the Dakota regions where these ovals trend into the United States, and the impressed energy of the external magnetic field. Now, while it is not possible in the present state of science to trace out the details of this interchange of energy between the magnetic field, temperature, pressure, and currents of the atmosphere, yet the mere facts of synchronism and geographical superposition of these forces makes the inference natural that they are working upon one another. The departure of the earth's atmosphere from

magnetic force superposed upon the meteorological conditions give a sort of rythmic sequence to the train of highs and lows passing over the northern portions of the United States. The energy of the circulation is undoubtedly in the horizontal convection currents of the atmosphere, but the actual formations may also properly be localized and thrown into a sequence dictated to some extent by this intermittent cooling on the continental polar regions, especially along the auroral belt, where there occurs the maximum concentration of the solar magnetic energy.

The other portions of the chart of the New England lows presents no important feature beyond the general tendency for a high-pressure area to be formed on the Rocky Mountain districts. Too great stress should not be laid on the features of these charts at great distances from the center of special construction, yet if one would build up a true continuous circulation, the order of the northern charts may be studied as follows:

Alberta high,	Lake low,	New England high.
Alberta low,	Lake high,	New England low.

The combination of other charts in a similar manner for the various local centers of the United States will produce practically those typical normal circulations, with which the features presented by a given map may be compared in order to study any unusual conditions.

THE WINTER COLORADO HIGH.

Colorado high, Chart 26 $(4)_1$.—Having set forth several views suggested by the charts here described and those placed in the preceding chapter, we may advance more rapidly in the description of the remaining charts of this series. Chart 26 $(4)_1$, Colorado high area, shows the system of currents operating to produce the pressure with anticyclonic components in the Central Rocky Mountain region. The center of the surface winds, like the case of the Alberta district, does not exactly correspond to the center indicated by the isobars of the high pressure, since in the case of the winds it is located more to the westward on the middle plateau. The cumulus chart is exceedingly instructive, and practically contradicts the interpretation of that high as a center of pressure, since the air at this level moves directly and firmly in from the Pacific coast across the plateau, and is merely deflected southward in the Colorado region. More explicitly, the cumulus movements show that the greater part of the Pacific air moves northeastward from the coast, recurves on the northern plateau, flows southeast over the slope, and then gradually inclines eastward toward the Atlantic coast. The rest of the Pacific current moves eastward directly across the region of the high area, and joins the southward stream in that district. At the ground near the South Pacific coast there is a feeble westward current moving directly opposite to that of the cumulus level. It is supposed that a part of the discrepancy disclosed on these charts between the centers of pressure and of circulation, respectively, may be due to a faulty treatment of the plateau barometric reductions; that is, by the employment of wrong temperature arguments at the several stations. At any rate much doubt is thrown upon the theory that the high exists as a great center of action extending far up into the atmosphere, though there may be an anticyclonic component which is displayed in the resultant as a deflection in the eastward drift whose direction the cirrus so clearly designates.

THE WINTER COLORADO LOW.

Colorado low, Chart 27 $(4)_2$.—The leading feature of this interesting chart is the very distinct testimony that it offers regarding the formation of cyclonic circulations. Its center lies about midway between the North Pacific coast and the Gulf of Mexico; that is to say, directly between the two great sources of currents flowing upon the interior of the continent. In this case the cumulus stratum shows that the Pacific stream flows in upon the northern plateau, is reenforced by more air from the main circuit of the ovals from the northwest, the combined stream trending southward on the mountain slope; simultaneously the current from the Gulf flows northward into the central valleys, the main stream curving over toward the Atlantic coast, only a part of it being deflected westward into the cyclonic whirl at the junction of these two countercurrents; over the south California districts there is also another stream from the southwest which flows directly into the cyclonic center. Now there must be an escape for all the air thus flowing together, and this is afforded in the upward current mechanically formed by and attend-

ing the vortex which is maintained at the point of counterflow of these long streams, acting primarily like the arms of a couple on the central mass of air. The other proposition, which has been commonly accepted as the true theory, does not seem in the least calculated to explain the system of currents shown in the cumulus levels of Chart 27, namely, that there is a local overheating at the surface of the ground, causing an upward convectional movement which draws in air to supply the updraft. Dr. HANN'S objection is perfectly valid, namely, that the temperature above a low area is such as to permit no decided vertical updraft by pure convection. Our contention here is that these long feeders, stretching out hundreds of miles beyond any gyratory circulation due to cyclonic action, can not possibly be sustained by vertical convection from local centers, even if it could be shown that surface heating were an important fact. But this can not be done, especially in winter, where one-half of the cyclone is below normal temperature, on the westward side, and consequently no simple updraft could conceivably drag in these immense masses of air from such great distances. The progressive movements of cyclones is also an argument against that theory of local convection, because the source of such a migratory supply of heat can not be accounted for, certainly not in those cases of cyclones where little precipitation occurs. Now we have shown that Dr. HANN'S phenomenon of warmer gradients above high centers, and cooler above low centers, is due chiefly to the lower currents underrunning the upper eastward flowing drift, which maintains nearly uniform and normal temperature conditions. A discussion of temperature gradients from balloon ascensions, in another chapter, will more fully illustrate this point. As regarding the progressive movements of cyclones, if we ascribe it to the continuous action of these long streams in the cumulus level, counter flowing upon one another, then by the ordinary laws of fluid motion the center of gyration will travel along the bounding or discontinuous surface of the streams, deflecting a portion of the same into the vortex, while the remainder flows onward in the general circulation as determined by the temperatures of the continent, the two oceans, and the movement of the upper strata, to which all downward and upward vortices are in a sense subordinate or tributary.

Remarks on the causes of local circulation and forecasting.

The cumulus level shows plainly the streams contributing to the structure of the cyclone, but as this stratum feels the influence of the eastward drift more strongly than the surface, we see in the circulation of the winds the more familiar cyclonic flow, as in the Colorado district, wherever the isobars become closed lines. It will be a most interesting point to determine how high up it is necessary to ascend before these closed isobars begin to open into long, sinuous waves, which gradually expand into sweeps nearly in the direction of the parallels of latitude, but it can not be far from the 2,000-meter level, judging by the vectors of the several cloud levels. In the case of hurricanes, however, this is certainly very much higher, as will be shown on Chart 35. The cirrus level is deflected by the Colorado low, though there are signs that on the mountain slope the strong southward component is derived from the prevailing trend of the general oval circulation, as already described. The construction of the Colorado highs and lows is so suggestive as to merit the careful consideration of meteorologists seeking to explain working theories of the movements of the atmosphere about local centers. As regards forecasting, it is perceived that, having only the surface conditions before us, one is at a great disadvantage in making the forecast, because there are three sources of supply to this low—the first from the north along the mountain slope, the second from the South California coast, and the third from the Gulf of Mexico. Furthermore, as only a portion of these great streams, except from the southwest, deflects into the cyclonic gyration, we can only conjecture what the relative intensity and rate of movement of the storm will be. The path of least resistance is clearly toward the lakes, and the majority of Colorado storms move in that direction, but the northern currents are sometimes so powerful as to drive the low area southward toward the Gulf of Mexico. It may be said generally that in the winter the looping southward of the storm tracks along the mountain slope is due to the pushing power of the great oval, sending the currents far to the south, and to a temporary weakness of the southerly branch to resist that action. The interplay of these streams in the mountain region is a proper object of study for the Weather Bureau, especially in view of the improvement of our forecasts which is desired for those districts. The cold-wave propagation to the southward, the

looping of the storm tracks southeastward, the swift movement of some storms from the southern slope to the lakes and the slow advance of others, all indicate the unequal action of these three primary branches of our continental circulation. These should be worked out fully by means of nephoscope, theodolite, and kite observations as far as practicable.

THE WINTER WEST GULF HIGH.

West Gulf high, Chart 28 $(5)_1$.—The cumulus level is again the most instructive to consider in the case of the high areas central in the West Gulf States, especially in Texas. The surprising fact is again clearly displayed that a little above the ground there is no trace of the true anticyclonic circulation, beyond a slight deflection of a great stream which gives up a portion of its contents in the lowest stratum to such a system of components. In the surface winds there is to be seen the anticyclonic outflow, strongly on the southeast and feebly on the west. In the cumulus levels there is only one flow from the North Pacific, eastward toward the Atlantic and southeastward toward the Gulf of Mexico coasts. It was shown in our discussion of the anticyclonic components, Charts 16, 17, and 18, freed from the eastward drift, that the two outer circles 300 to 800 miles from the center have a continuous outflow with an outward radial component from the top to the bottom, while there is near the center a small area of inflow at the cirrus levels, reversing to an outflow at the bottom. Now it must be by means of such combinations as the West Gulf and the other charts of high areas display that this is accomplished. The apparent deflection can be accounted for by adding to the normal eastward drift the anticyclonic components thus described, and hence, on the other hand, such deflections in the general circulation, caused by the temperature configurations over the oceans and continents in the lower strata, must be the cause of the components in question. Whenever high areas occupy the interior of the continent, there is a decided drift from northwest to southeast, with a slight anticyclonic deflection near the axis. In the case of low areas within the continental districts, there is usually, if not always, an inflow toward the continent from at least two different directions. This seems to be the rule, and it makes the anticyclonic components due to a simple deflection or side whirl of a single current; but the cyclonic components are due to the conflict of the counterflow of two or more currents. The first system produces a true vortex, with inflow at top and outflow at bottom, near the center; the second system gives a forced vortex, with an inflow at all heights, and no reversal. This analysis is not in harmony with Dr. HANN'S view that the excess of pressure does not diminish at the center of the anticyclone, for we have in the upper levels a central inward component, and an outward component at some distance from the center, thus indicating a depression of the isobar near the center. There are so many minor details which might be mentioned in connection with these charts that the descriptive text would become unduly expanded, and the reader may therefore be trusted to examine the vectors of the three strata in each area in order to bring other points to mind. The forecaster stationed in any given locality will be especially interested to study the circulation pertaining to his own region. He may be expected to indicate improved methods of forecasting as the result of such studies.

THE WINTER WEST GULF LOW.

West Gulf low, Chart 29 $(5)_2$.—This set of charts also illustrates very clearly the formation of a cyclone area by means of the counterflow of two independent streams, especially in the cumulus region. There we have the Pacific current pouring over the northern plateau, bending sharply southward along the entire length of the mountain slope to Texas. It is somewhat reenforced from the north and from the southwest, but the main stream is the one described. Simultaneously we find a distinct current from the South Atlantic and the Gulf of Mexico blowing inward to the Mississippi Valley, and encountering the northern current just where the cyclonic whirl is formed. It seems impossible to maintain that any local heating with vertical convection of the lower air is the cause of such a current extending in an unbroken sweep from Oregon through the Dakotas to Texas, a distance of 2,000 miles. The cirrus level shows the similar general deflection from its usual eastward drift as in the other low areas, but there is little evidence of gyratory components, and an updraught through a couple of miles, even if of some importance to the cyclone, could not cause such a vast inflow through a stratum 2,000 miles long.

In the Texas storms, often called southwesters, if anywhere, the latent heat of condensation ought to be efficient, for the violence of the cyclonic circulation in these storms is well known, and immense downfalls of rain occur in connection with them. They travel rapidly and usually advance to New England in forty-eight hours. Our explanation of the phenomenon is that the southern winds are laden with moisture; that these, by counterflow with the northern winds, produce cyclone gyrations; that this mechanically lifts the air included within the closed isobars and cools it to saturation; that the latent heat evolved strengthens the vortex circulation by an increase of buoyancy near the center, and that thus the vigorous circulation and precipitation beginning in the southwest continues to operate during the entire course of the propagation of the cyclone to New England, near the line of counterflow of these two primary currents. These streams, of course, contribute at the same time to the formation of high areas, as elsewhere explained. In the West Gulf cyclones the gyratory components are well defined in the surface winds and also in the cumulus level. Indeed, it is to be remarked that the cyclonic components are especially well developed in the low areas of the West Gulf and South Atlantic districts, and also in the hurricanes of the same region. This is probably due to the fact that the eastward drift is less distorting because it is of lower velocity in that region; that the higher humidity of these districts generates more latent heat from condensation, as soon as the least upward current is produced by the vortex action, and that this carries the cyclonic action higher in its circular shape. In the case of the hurricanes we shall show that the gyratory motion penetrates even to the cirrus region, which it can hardly be said to do in the West Gulf storms, though this effect is unmistakably seen in the cirrus stratum over the South Atlantic lows.

THE WINTER SOUTH ATLANTIC HIGH.

South Atlantic high, Chart 30 $(6)_1$.—The chart of the South Atlantic high area at the surface is about the best example we have of a well-developed anticyclonic circulation at the surface, so far as an evenly balanced system of vectors would indicate that fact. The cumulus level, while sharing to a considerable extent this typical form, yet indicates the manner in which it is built up much better than the ground strata does. When the high was central in the west Gulf States the great northern stream came down the mountain slope on the east side of it; with the center in the South Atlantic States, the configuration is entirely different, since now there is an equally strong current which flows from the southward over the central valleys toward the North Atlantic coast. There is a remnant of the northern current along the Atlantic coast, but the main circulation is transferred from the east side of the center when the high is in the west Gulf district to the west of the center when the high is in the South Atlantic. The northern and southern currents in this instance possess more of the features of a counterflow system and produce an anticyclonic gyration between them; the opposite side of the same currents produces a cyclonic circulation. Thus, simultaneously in the Rocky Mountain districts there is formed a high area, in the central valleys a low area, which together with the southeastern high area displays the entire scheme of mutual deflections and counter currents that dominates the circulation over the United States. This particular type has been discussed somewhat in Bulletin No. 20, on pages 29 and 30, where the corresponding isobars are also shown. The great sweep of the cumulus southern current from the Gulf is very impressive with its smooth curves toward the northeast, pivoted upon the center of the high in the southeast. On the surface chart this curve is extended backward to the South Atlantic coast, but it is doubtless an effect in conjunction with the northern stream on the east side of the high area. The cirrus level is somewhat inclined southward over the mountain slope, but is little deflected near the center of the high.

THE WINTER SOUTH ATLANTIC LOW.

South Atlantic low, Chart 31 $(6)_2$.—These charts, especially in the cumulus levels, exhibit another elegant sweep of currents from the Pacific to the South Atlantic, which is so prominent a feature in the construction of high and low areas. The reflex curve on the northern plateau, the sweep over the mountain slope, and the sharp bend to the southwest and south of the low area center, before the final turn in the northern quadrants of the same, are very well exhibited. The counter current upon the eastern side of the low area is not shown, or only slightly so, on the

Southern coast; just as in the case of the southeastern high area it had nearly disappeared from the field of the map. The cirrus, the cumulus, and the surface winds all flow nearly parallel to each other along the mountain slope and through the central valleys, but begin to diverge in the southern areas of the low. Here is an illustration of the idea that the clouds move more to the right in proportion to the height above the ground in the southeast quadrant, but the opposite is true in the northwest quadrant, and evidently the entire arrangement is due not to true cyclonic gradients, but merely to the necessity of reaching an eastward drift in the upper strata. The feeble tendency of the northern vectors to assume the full cyclonic gyration is well illustrated in these charts and should be compared with the vigorous action of the southern vectors. In the first case the eastward drift hinders and in the second case it assists the natural tendency of the circulation. The greater vigor of the cyclonic components at the ground should be noted in contrast with the fact that the movement on the mountain slope is almost entirely broken up. On the other hand, the continuous stream from the Pacific over the slope is so clearly seen in the cumulus as to be of especial significance to the forecaster. The cirrus deflections over the low area are well marked and would give distinct incurved cyclonic gyrations if separated from the eastward drift. It is quite certain that a complete knowledge of the velocity of movement of these upper currents would add greatly to the accuracy of the judgment of the forecaster in his estimate of the movement of storms.

THE SUMMER NORTHWEST AND SOUTHEAST HIGHS.

Summer northwest and southeast highs, Chart 33 (8).—The type South Atlantic high, Chart 30 $(6)_1$, which has been described, is also found in the summer, and it possesses in both seasons precisely the same configuration as shown on Chart 33 (8). There exists simultaneously a well-developed high area over the Southeastern States with clearly marked anticyclonic components in the cumulus and the surface strata, and a second high area central over the northern Rocky Mountain plateau. In the winter the high pressures move rapidly away from these localities in the violent general circulation, but in the summer there is a marked tendency for them to persist in the same places. This is due to two causes, (1) the fact that they lie directly on the high-pressure belt formed around the hemisphere by the general circulation, and (2) from the relative temperatures of the oceanic and land areas whereby the high pressures are more readily formed on the borders of the continent in the summer. At any rate, a high-pressure center may often in summer remain in these districts for a week at a time, slightly oscillating up and down the coast line. On the surface chart these two high areas are separated by the counterflow currents in the central valleys, but on the cumulus chart they are connected across the northern districts in the general eastward drift, and there are seen the feeders from the south on the western side of each center of high pressure. The combined effect of these streams is a circular anticyclonic whirl, so far as the territory of the map extends, the southeastern quadrant not being well represented over the Atlantic Ocean. It is probable that the high area extends eastward to Africa on the southeast, that the northwest high protrudes upon the continent from the Pacific Ocean, and that the west-east diameters are much longer than the south-north dimensions.

REMARKS ON THE SUMMER CONDITIONS IN THE CENTRAL VALLEYS.

The effect of the counterflow from these two circulations is very important in producing the weather conditions which prevail in the central valleys during the summer. In the winter the strong southwest Texas storms are formed, which move rapidly north and northeast toward the St. Lawrence River, and are distinguished by their heavy precipitation. In the summer the Mississippi Valley is, during the continuance of this type of pressure distribution, especially fertile in local storms of all kinds, frequent thunderstorms, and tornadoes. The warm moist air from the south in the lowest stratum moves northward up the Mississippi Valley near the ground, but the current in the cumulus level flows eastward and overlays it. Thus we have comparatively cool, dry air from the northwest overflowing the warm moist air from the southeast, and this is the most perfect condition for producing unstable vertical temperature gradients, which must be followed by an overturning of these strata. The southeastern quadrant of the low area which now occupies the central valley is the place where the overflow most persistently occurs, and it is,

therefore, the locus of the majority of the thunderstorms and tornadoes that are observed. In this case the partially independent movement of the eastward drift, flowing over the lower stratum, is the cause preceding the development of local storms. It is nearly always observed that a tornado is formed upon the approach of two threatening clouds, one from the northwest and one from the south, which are evidently borne along by these two streams. The fact that tornadoes occur on hot sultry days is probably to be explained by the need that the lower strata of the atmosphere should be quiet and stagnant in order that a vortex tube forming at the height of a half mile or more, may penetrate to the ground without breaking up its circulation. If the lower strata are turbulent, the overturning produces a thunderstorm with its horizontal roll of cool air flowing along the ground; if quiet, the vertical convection, added to the gyration produced by the horizontal counter currents, makes a vertical vortex tube which will extend to the surface if of sufficient rotatory velocity. Thus, all the features distinguishing the local storms are accounted for by the currents in the cumulus level from the northwest drifting above and over the surface winds which blow from the south.

Another important effect in the summer of the South Atlantic high area is the production of the excessively high surface temperatures which prevail in the Southern and the Atlantic States. Beyond the fact that large masses of heated air are transported from the south northward to New England, thus transferring the isobars normally in the southern districts far toward the north, it is difficult to enlarge upon the description of this phenomenon without more observations. Apparently the circulation of the air is relatively feeble and stagnant around the anticyclone, and thus the lower atmosphere, becoming heated above the normal temperature at the ground, gradually extends the overheating to the cumulus level, there being no sufficiently vigorous action of the upper strata to disturb the surface stratum. There may be some action after the nature of a high "potential temperature" in the upper levels which is brought down to the ground, but we need data derived from balloon ascensions in this type of high areas to suitably study this phenomenon.

THE SUMMER HIGHS NEAR THE LAKES.

Summer high near the lakes, Chart 34 (9).—As a companion chart to the preceding Chart 33 (8) we introduced the high-area type over the lakes in the summer, which may also be compared with Chart 22 $(2)_1$. While the same general features may be traced out, yet the summer high is distinctly the type of a very feeble, indecisive circulation, especially in the cumulus region, the surface anticyclonic components being much better defined, though even at the ground the winds are irregular in a marked degree. Perhaps the most significant feature of these charts is the tendency that is shown to overflow in all parts of the high area, that is to say, the prevalent circumstance that the cumulus and the wind strata do not flow together in parallel, as they almost always do in winter, but in summer have different directions. This system of cross circulation in adjacent strata is doubtless an important cause of the production of showers and local storms which occur quite generally when a high area occupies the central valleys in the summer. In the winter season precipitation is practically confined to the edges of the high areas, where the long horizontal currents from different directions tend to flow alongside of each other in opposite directions; in the summer season showers occur freely within the high area, and are no doubt due to this irregular overflowing of the shallow strata, since they have not depth and strength enough to exclude each other from the same territory. Hence *horizontal counterflows in winter* and *horizontal overflows in summer* may properly be regarded as the key to the phenomena respectively characteristic of these seasons. The cirrus region also shows the effect of the sluggish circulation prevailing in the summer season, not that the eastward drift is destroyed, but that only an irregular or loose structure is found among its vectors, especially over the area occupied by the anticyclone. In the summer it is clear that forecasts must depend upon local conditions and slow circulation, and that the configuration of high and low areas is but an inferior guide for the forecast of showers and local precipitation.

THE SUMMER AND AUTUMN HURRICANES.

Tropical hurricane, Chart 35 (10).—The last of the series of charts prepared for this discussion is the tropical hurricane which falls upon the Gulf and South Atlantic States in the late summer

and autumn of each year. These violent cyclonic storms are generally first observed to the southeastward of Cuba, on the southern edge of the great high-pressure belt, in the calm doldrum districts, whence they first move westward in the trade-wind belt, recurve northward around the western edge of the South Atlantic high area, and advance toward the northeast near the coast line. We can study only those which have the center in the Lower Mississippi Valley, or in the East Gulf States, since the clouds must be observed on all sides. An inspection of the selected charts shows clearly what an efficient means the cloud observations made daily at the stations of the Weather Bureau really become for the construction of the stream lines of circulation in all levels of the area involved. This is especially the case with the hurricane, and it suggests the importance of making more use of this method of collecting cloud observations for meteorological studies. The structure of the hurricane is readily seen from the Chart 35. The true cyclonic components are fully developed at the surface, with very slight eastward components, and strong feeders from the southeast quadrant; in the cumulus level the cyclonic circulation is equally well defined, but the eastward drift is making itself felt by lengthening the vectors on the south and shortening them on the north, while the feeding stream gradually swings to the southwest; in the cirrus level the cyclonic components still persist with great activity, producing a marked deflection in the eastward drift, the feeding vectors now coming from the west. In the cirrus level the cyclonic components disturb the eastward vectors over the northern areas of the low, not only near the center but also as far north as the Lake region; in the cumulus level they break up the eastward flow from New England to the Ohio Valley, and at the surface the vectors of the Upper Mississippi Valley are turned westward.

This configuration suggests the view that in the case of hurricanes we have an extreme case of vertical convective action, and that this is brought about by the overflow of the cooler air of the upper atmosphere accompanying the first approach of autumn upon the warm air near the ground. The supply of energy, when once the cyclonic circulation has begun, is kept up by the inflow from the Atlantic and the overflow in the cirrus and cumulus from the westward. There can be no clearer evidence of the fact that most of our ordinary cyclones are very shallow, about 2 miles deep, since the hurricane must be projected upward at least 5 miles high in order to deflect the cirrus stratum so vigorously. Another fact must be remembered, that these cyclones in the south are in the region of the minimum eastward drift in the lower strata, since by theory there is no eastward component of the general circulation eastward at the latitude of 35°. When the top of the cyclone protrudes above the cumulus it begins to feel the distortion of the eastward movement of the upper air, as shown on the chart. It will be important to make cloud observations with the utmost care in the case of high and lows centered over the South Atlantic States, because the gyratory action comes out most distinctly in that region by reason of the greatly reduced component of the eastward drift. Especially such observations for the hurricanes should be collected carefully for all the cloud levels, because from such data we could compute accurately the forces and the energy involved in this circulation. I hope to make a special study of the mechanism of cyclones by comparing the date of well formed tornadoes and southern hurricanes, and would urge that the cloud observations should be considered very valuable in studying the cause of the development of these storms. This numerical computation must be postponed to another report.

CHAPTER 9.

DIURNAL OSCILLATION OF THE BAROMETRIC PRESSURE IN RELATION TO THE DIURNAL WINDS.

RECAPITULATION OF THE CHARACTERISTICS OF THE THREE DIURNAL PERIODS.

Several important papers have appeared in recent years on the subject of the diurnal oscillation of the barometer, notably those of HANN, ANGOT, BUCHAN, RYKATCHEW, AD. SCHMIDT.

HANN$_1$, Tägliche Oscillation des Barometers; Wien, 1889.
HANN$_2$, Weitere Untersuchungen über die tägliche Oscillation des Barometers; Wien, 1892.
HANN$_3$, Weitere Beiträge zu den Grundlagen für eine Theorie der täglichen Oscillation des Barometers; Wien, 1898.
HANN$_4$, Zur Meteorologie der Alpengipfel; Wien, 1878.
HANN$_5$, Über den täglichen Gang des Luftdruckes auf dem Plateaux der Rocky Mountains; Wien, 1881.
ANGOT, Marche diurne du baromètre; Paris, 1887.
BUCHAN, Report of the Challenger, Vol. II, Pt. V., 1889.
RYKATCHEW, Recherches sur le 3d Maximum; Petersburg, 1879.
AD. SCHMIDT, Verhältnisse in hoher Breite, Met. Zeit, 1890.

The outcome of these researches may be summarized as follows:

Analyzing the observed diurnal barometric pressure by the harmonic series,

$$\Delta b = a_1 \sin (A_1 + x) + a_2 \sin (A_2 + 2x) + a_3 \sin (A_3 + 3x),$$

and discussing the constants in respect to the observations, it is noted:

1. The normal value of the amplitude of the single daily oscillation a_1 is contained within the limits 0.00 and 0.50 mm. It is one-fourth to one-half the amount of a_2; its range is wide, being two or three times the normal value; it is very different at neighboring stations, and on the same parallel of latitude; it has greater amplitudes in mountain valleys, but smaller on the seacoast and in higher latitudes; it shows a reversal of phaze in the polar regions, also above a certain neutral plane at a given elevation from the ground, produced by interference with the "thermic" wave; it has a yearly period, with maxima at June in higher latitudes, and in March and September on the equator.

2. The normal value of the phase A_1 is near 0°, where x is counted from midnight, and is the hour angle; it varies widely, from 277° to 55°. a_1 and A_1 must have a general and a local cause. The general cause varies with the latitude and also in the year; the local cause varies with the minor convection currents, and depends upon all the meteorological features which tend to produce variable local convection.

3. The amplitude of the double daily wave, a_2, is the principal term, and covers the limits 0.00 to 1.00 mm. of pressure. Its range is very narrow; it decreases regularly with the height proportionally to the pressure $\frac{b}{760}$; it is very constant over the entire earth up to latitude 55°; it varies with the latitude by a formula which requires an inversion of phase in the polar regions; it has a distinct variation with the year, but the following peculiarity, namely, that while the maximum insolation is in January at perihelion, the maximum of the semidiurnal wave is at the equinoxes in March and September; also the fact is remarkable that the sun in one hemisphere does not change the amplitude of the wave in the other hemisphere; it combines with the single "thermic" wave, but it is not controlled by it to any appreciable extent; it is smaller on seacoasts, islands,

and on mountain tops, and is diminished a little by land and sea breezes; it is very large in mountain valleys.

4. The normal value of the phase of the double diurnal wave A_2 is 155°, corresponding to $9^h\ 50^m$ a. m.; its range is very small, 148° to 163°; it diminishes a little with the height, is retarded to 145° in higher latitudes, varies a little with the year, though in an opposite sense in the two hemispheres, and it is very independent of local meteorological influences.

5. The amplitude of the triple diurnal wave, a_3, is a very small quantity, being generally less than 0.10 mm. pressure. It diminishes a little with the latitude; its yearly period is very marked, and has maxima in winter and summer in both hemispheres, with minima at the equinoxes; its maximum is, however, in June, when the earth crosses the sun's equator, and not in July, when the heat is greatest in the Northern Hemisphere.

6. The phase of the triple daily period, A_3, has a normal value of 355°, with very small range, and with a small but very well marked yearly period.

GENERAL REMARKS ON THESE THREE PERIODS.

The peculiarities of these waves are that the largest, the semidiurnal, is in many respects quite independent of the variations caused by solar isolation as distributed by hemispheres and as determined by the perihelion and aphelion points in the orbit; this wave is very constant up to latitudes 55° or 60°, and then it continues into the polar regions with an inversion of phase. It seems impossible to explain the cause of such a wave by solar isolation in the lowest strata of the atmosphere, working by the manometric process, because it is independent of the observed variations in such surface heating as between continents and ocean areas; nor do the yearly changes match with the variation in the isolation due to the place of the earth in the orbit. If, as HANN remarks, it is sought to get over this difficulty by referring the action to heating the upper strata as well as the lower, then there can be no true disturbance of vertical equilibrium, nor differential pressures, and therefore no working manometric theory left to discuss. In fact, the entire atmosphere does absorb heat from top to bottom, and thus the semidiurnal wave is left without explanation, so long as it is not observed to be dependent upon at least the broad variations in surface temperature effects, especially since the daily heating begins above and extends down, and not at the bottom to extend upward, as the "surface-heating theory" demands.

In view of the peculiarities in the components of the diurnal wave, by which we are to a considerable extent prohibited from referring it to the thermal variations in the atmosphere, also in consideration of the fact that but little has been done of a satisfactory kind in treating the observations in the polar regions, I have though it worth while to attempt to discuss the same observations on a somewhat different plan. In previous studies, especially those summarized in Bulletin No. 21, United States Weather Bureau, 1898, Solar and Terrestrial Magnetism in Their Relation to Meteorology, it has been shown that there is a synchronism between the phenomena observed in the solar and terrestrial envelopes, continuous in its action and extending to all classes of magnetic and meteorological processes. The question now arises whether a similar connection can be traced in the diurnal variations of these elements, and whether there is anything in the nature of such connection to aid us in explaining the anomalies which have been raised by the preceding attempts to refer back the diurnal variations of the barometer to thermal causes. My view, broadly expressed, is that the earth is surrounded by an electromagnetic (equatorial) and also a magnetic (polar) field, and that these may well have a direct action upon the barometric diurnal pressures, as they have been already shown in other connections to have upon the pressures in the northwest of the North American Continent. With this object in view the diurnal variations have been collected together, not by the argument of geographical latitudes, but by the magnetic inclinations and magnetic latitudes. It may be thought that this is a mere conceit, since the magnetic isoclinals run about parallel to the circles of latitude on the earth taken as a whole, but this is not so, because it is now possible to unite together stations having the same magnetic intensity while they are often separated by many degrees in latitude. Especially is this the case in the polar regions, where the chief difficulty exists in discussing the results of observations, and it will be seen in the following tables that such a treatment of the observations is for this purpose desirable.

DETERMINATION OF THE NORMAL VALUES OF THESE PERIODS.

It has also become important to obtain the normal coordinates of these waves in all latitudes, quite free from the local disturbances. In order to accomplish this, one must evidently resort to a balanced network of graphic construction, such as is used in a later chapter in determining the normal vertical gradients of temperature. The same plan has, therefore, been followed in this connection, and the smoothness of the resulting constituent periods is evidence that the process has been quite successful. By means of these normals the local variations can be investigated, and it would be advantageous to study each typical locality of the earth, as the United States, in respect to the normal values thus established. The following set of tables summarizes the result of this study, as briefly as possible:

TABLE 54.—*List of stations and authorities.*

	Station	Longitude	Latitude	Height	Inclination	Authority
1	Wellington Channel	+ 92.2	+75.5	0	+88	B
2	Port Leopold	+ 90.2	+73.8	0	+88	B
3	Griffith Island	+ 95.3	+74.6	0	+88	B
4	Princess Royal	+117.9	+72.8	0	+88	B
5	Hudson Strait	+ 86.9	+66.5	0	+87	B
6	Mercy Bay	+117.9	+74.1	0	+87	B
7	Van Rensselaer Harbor	+ 70.6	+78.6	0	+85	B
8	Kingua Fjord	+ 67.2	+66.6	9	+84	B
9	Ssegastar	−124.1	+73.4	5	+83	B
10	Fort Rae	+115.7	+62.7	162	+82	B
11	Uglaamie	+156.7	+71.4	5	+82	B
12	Godthaab	+ 51.8	+64.2	11	+81	B
13	On the Fox	− 65.1	+72.1	0	+80	B
14	Sabine Island	+ 18.8	+74.5	0	+80	B
15	Kleine Karmakul	− 52.7	+72.4	7	+79	B
16	Jan Mayen	+ 8.5	+71.0	11	+78	B
17	Camisso Island	+161.8	+66.2	0	+78	B
18	Bossekop	− 23.3	+70.0	30	+77	B
19	Sodankyla	− 26.6	+67.5	188	+76	B
20	New Archangel-Sitka	+135.3	+57.1	9	+75	A
21	Toronto	+ 79.4	+43.7	104	+75	A, B
22	Blue Hill	+ 71.1	+42.2	195	+74	B
23	Albany	+ 73.8	+42.7	46	+74	A
24	Bergen	− 5.3	+60.4	16	+72	B
25	Philadelphia	+ 75.2	+39.7	34	+72	B
26	Christiansand	+ 8.0	+58.5	5	+72	B
27	Washington	+ 77.1	+38.9	31	+71	A, B
28	Armagh	+ 6.7	+54.4	63	+71	A, B
29	Glasgow	+ 4.3	+55.9	56	+71	A, B
30	Aberdeen	+ 2.1	+57.2	27	+71	A, B
31	Upsala	− 17.6	+59.9	24	+71	A, B
32	Helsingfors	− 25.0	+60.2	12	+71	A, B
33	Liverpool	+ 3.0	+53.4	9	+71	B
34	Culloden	+ 4.1	+57.5	32	+71	B
35	Ben Nevis	+ 5.1	+56.8	1,343	+71	B
36	Christiania	− 10.7	+59.9	23	+71	B

TABLE 54.—*List of stations and authorities*—Continued.

	Station	Longitude	Latitude	Height	Inclination	Authority
37	North Sea	....	....	0	+70	H_1
38	Irkutsk	−104.3	+52.3	468	+70	H_2, B
39	Katherinburg	− 60.6	+56.8	272	+70	A, B
40	St. Petersburg	− 30.3	+59.9	5	+70	A, B
41	Makerstoun	+ 2.7	+55.6	65	+70	B
42	Astoria	+123.8	+46.2	16	+70	B
43	Dublin	+ 6.4	+53.4	49	+70	B
44	Valencia	+ 10.3	+51.9	6	+69	A, B
45	Barnoul	− 83.8	+53.3	140	+69	A, B
46	Bidston	+ 3.1	+53.4	0	+69	A
47	Hamburg	− 10.0	+53.6	23	+69	A, B
48	Stonyhurst	+ 2.5	+53.5	110	+69	A, B
49	Keitum	− 8.4	+54.9	9	+69	A, B
50	Neufahrwasser	− 18.7	+54.4	5	+69	B
51	Zlalouste	− 59.7	+55.2	415	+69	B
52	Dorpat	− 26.7	+58.4	68	+69	B
53	Atlantic (35° N–39° N)	40 to −5	+37.0	0	+68	H_1
54	Falmouth	+ 5.1	+50.2	60	+68	A, B
55	Kew	+ 0.2	+51.5	10	+68	A, B
56	Greenwich	0.0	+51.5	48	+68	A, B
57	Moscow	− 37.6	+55.8	156	+68	A, B
58	Oxford	+ 1.3	+51.8	65	+68	B
59	Geldeston	− 1.5	+52.5	12	+68	B
60	Helder	− 4.8	+53.0	4	+68	B
61	Kazan	− 49.1	+55.8	75	+68	B
62	Vamdrup	− 9.3	+55.4	40	+68	B
63	Amsterdam	− 4.9	+52.4	5	+67	A, B
64	Grüningen	− 6.6	+53.2	15	+67	A, B
65	Honorine-du-Fay	− 0.5	+49.1	118	+66	A
66	Brussells	− 4.4	+50.9	57	+66	A, B
67	Swinemunde	− 14.3	+53.9	9	+67	A
68	Utrecht	− 5.1	+52.1	13	+66	A, B
69	Halle	− 12.0	+51.5	110	+66	B
70	Namur	− 4.8	+50.5	150	+66	B
71	Eger	− 12.4	+50.1	463	+65	H_2, B
72	Leipzig	− 12.4	+51.3	119	+65	A, B, H_1
73	Vendôme	− 1.1	+47.8	86	+65	B
74	Magdeburg	− 11.6	+52.1	. . .	+65	H_1, B
75	Paris	− 2.5	+48.8	49	+64	H_1, A, B
76	Barisch-Zell	− 12.0	+47.7	802	+64	H_2
77	Wendelstein	− 12.0	+47.7	1727	+64	H_2
78	Portiers	− 4.3	+46.6	117	+64	A
79	Nantes	+ 1.6	+47.2	41	+64	A
80	Santis	− 9.3	+47.3	2467	+64	A, B
81	Prague	− 14.4	+50.1	201	+64	A, B
82	Crakow	− 19.9	+50.1	215	+64	B

TABLE 54.—*List of stations and authorities*—Continued.

	Station	Longitude	Latitude	Height	Inclination	Authority
83	Vienna	− 16.4	+48.3	203	+63	H_1, A, B
84	Salzburg	− 13.1	+47.8	430	+63	H_2, B
85	Fort Churchill	+119.3	+39.3	1317	+65	B
86	Munich	− 11.6	+48.2	529	+63	H_2, A, B
87	Berne	− 7.4	+47.0	573	+63	A, B
88	Kremunster	− 14.1	+48.1	384	+63	B
89	Lugan	− 39.3	+48.6	62	+63	B
90	Klagenfurt	− 14.3	+46.6	. . .	+62	H_1
91	Martin de Hinx	+ 1.3	+43.6	40	+62	H_1, B
92	Lyon (S. Genis-Laval)	− 4.8	+45.7	299	+62	A, B
93	Lyon (Parc Tete-d'or)	− 4.8	+45.8	175	+62	A, B
94	Puy-de-dome	− 3.0	+45.8	1467	+62	A
95	Clermont-Ferrand	− 3.1	+45.8	388	+62	A
96	St. Bernard	− 7.2	+45.9	2478	+62	A, B
97	Geneva	− 6.2	+46.2	405	+62	A, B
98	Obir	− 14.5	+46.5	2041	+62	A
99	Klagenfurt	− 14.3	+46.6	448	+62	A, B
100	Gries	− 11.3	+46.5	293	+62	B
101	Schafburg	− 13.4	+47.8	1776	+62	B
102	San Francisco	+122.6	+37.8	7	+62	B
103	Sacramento	+121.3	+38.6	25	+62	B
104	Coimbra	+ 8.4	+40.2	141	+61	H_1, A, B
105	Pola	− 13.9	+44.9	32	+61	H_1, A, B
106	Triest	− 13.8	+45.7	26	+61	H_2, A, B
107	Marseilles	− 5.4	+43.3	75	+61	A
108	Toulouse	− 1.4	+43.6	194	+61	A
109	Moncalieri	− 7.7	+45.0	260	+61	A
110	Turin	− 7.7	+45.1	276	+61	B
111	Milan	− 9.2	+45.5	147	+61	B
112	Obir-gipfel	− 14.5	+46.5	2044	+61	B
113	Madrid	+ 3.7	+40.4	655	+60	A, B
114	Perpignon	− 2.9	+42.7	32	+60	A
115	Bucharest	− 26.8	+44.4	93	+59	H_1, B
116	Lesina	− 16.2	+43.1	20	+59	H_1
117	Lisbon	+ 9.1	+38.7	103	+59	A, B
118	Nertschinsk	−119.6	+51.3	660	+59	A, B
119	San Fernando	+ 6.1	+36.5	29	+57	H_1, A, B
120	Pekin	−116.5	+40.0	38	+57	A, B
121	Naples	− 14.3	+40.9	149	+57	A, B
122	Tiflis	− 44.8	+41.7	442	+57	A, B
123	Mediterranean	− 5.0	+37.0	0	+56	H_1
124	Nukuss	− 59.6	+42.5	65	+56	B
125	Great Ararat	. . .	. . .	. . .	+55	H_1
126	Teneriffe	− 22.8	+28.0	. . .	+52	H_1
127	Havana	+ 82.4	+23.1	19	+52	A, B
128	Allahabad	− 81.9	+25.4	94	+50	A
129	Cape Borda	−136.6	+35.8	154	+49	B

TABLE 54.—*List of stations and authorities*—Continued.

	Station	Longitude	Latitude	Height	Inclination	Authority
130	Tokyo	−139.8	+35.7	21	+49	H_1, H_2, A
131	Port au Prince	+ 72.4	+18.6	36	+48	H_2
132	Zi-ka-wei	−121.4	+31.2	7	−46	H_1, A, B
133	Mexico	+ 99.7	+19.4	2283	+44	H_1, H_2, A, B
134	Simla	− 77.2	+31.6	. . .	+43	H_1, B
135	Hongkong	−114.2	+22.3	34	+34	H_1, B
136	San Jose, Costa Rica	+ 84.1	+ 9.9	1135	+30	H_2
137	Lucknow	− 80.9	+26.9	5	+36	B
138	Calcutta	− 88.4	+22.6	5	+30	A, B
139	Bombay	− 78.8	+18.9	11	+19	A, B
140	Manila	−129.0	+14.6	14	+18	H_2
141	Atlantic (20° N–20° S)	. . .	. . .	0	+20	H_1
142	Madras	− 80.2	+13.1	7	+ 8	H_1, A, B
143	Caroline Islands	−150.0	+ 3.2	0	+ 6	H_1
144	Aden	− 45.9	+12.8	60	+ 5	B
145	Dodabetta Peak	− 76.7	+11.4	. . .	+ 4	H_1, B
146	Nikobaren, Indian Ocean	. . .	. . .	0	. . .	H_1
147	Ocean (10° N–10° S)	. . .	. . .	0	. . .	H_1
148	Christianborg	− 0.7	+ 5.4	18	. . .	B
149	Trevandrum	− 77.0	+ 8.5	40	− 2	B
150	Ascension	+ 14.4	− 7.9	15	− 8	H_1, B
151	Ocean (2° N–16° S)	. . .	. . .	0	−10	H_1
152	Kamerum	− 9.7	+ 4.1	12	−10	H_2
153	Rio de Janeiro	+ 43.1	−23.0	68	−10	H_2, B
154	Singapore	−103.9	+ 1.3	5	−14	H_1, A, B
155	Finschlafen	−147.8	− 6.6	5	−22	H_2
156	Batavia	−106.8	− 6.2	8	−27	H_1, A, B
157	Cordova	+ 64.2	−31.4	437	−27	H_1, H_2, A, B
158	St. Helena	+ 5.7	−15.9	538	−28	H_1, A, B
159	Society Islands	. . .	−16.3	0	−29	H_1
160	Ocean voyage	. . .	. . .	0	−29	H_1
161	M'Boma	− 13.2	− 5.8	22	−29	B
162	Buenos Aires	+ 58.4	−34.7	4	−30	B
163	Santiago	+ 70.6	−33.4	546	−31	H_1 B,
164	Port Darwin	−130.9	−12.5	21	−37	H_2
165	Süd-Georgien	+ 36.1	−54.5	9	−49	B
166	Port Louis	+ 70.9	−53.6	0	−53	B
167	Mauritius	− 57.6	−20.1	55	−54	H_1, B, A
168	Tananariva	− 47.6	−18.9	1400	−54	H_2
169	Ocean (30°–36° S)	. . .	. . .	0	−55	H_1
170	Cape Town	− 18.5	−33.9	10	−56	H_1, A, B
171	Sydney	−151.2	−35.9	47	−63	H_2, B
172	Melbourne	−145.0	−37.8	37	−67	H_1, A, B
173	Hobarton	−147.5	−42.9	32	−71	H_1, B
174	Kerguelen	− 70.0	−50.0	0	−71	B

TABLE 55.—*Diurnal oscillation of the barometer, distributed by the magnetic inclination.*

Unit = 0.001 millimeter pressure.

M. Lat.	Incl.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid.	Stations
°	°																										
86	88.0	−38	−41	−9	+32	+60	+67	+76	+38	+6	−38	−86	−96	−99	−70	−32	+15	+63	+77	+79	+70	+51	+16	−22	−22	−38	1 2 3 4
82	85.8	−19	0	+19	+25	+44	+50	+57	+60	+19	+9	+12	−20	−70	−119	−108	−66	−25	+4	+26	+38	+45	+45	+38	+16	−19	5− 8
74	82.0	−13	−7	−32	−44	−19	0	+6	0	+26	+32	+38	+38	0	−25	−19	−25	−13	+13	+18	+26	+7	+7	+6	0	−13	9− 12
68	78.8	+38	+57	+32	−6	−76	−32	−38	−26	−39	−6	+6	+44	+68	+60	+63	+10	−26	−41	−45	−41	−26	−1	+26	+25	+38	13− 16
64	76.0	+96	+93	+71	+26	−8	−48	−60	−86	−67	−22	+19	+67	+60	+35	+16	−36	−61	−66	−76	−42	−24	+15	+68	+88	+96	17− 20
60	73.8	+33	−11	−29	−74	−59	−34	+18	+33	+43	+51	+48	+35	+12	−15	−34	−44	−48	−43	−33	−21	−7	+27	+65	+60	+33	21− 24
56	71.5	+73	+20	−48	−91	−112	−30	+11	+26	+40	+48	+49	+36	+14	−12	−32	−45	−48	−44	−32	−19	+18	+78	+128	+130	+73	25− 28
55	71.0	+123	+63	−5	−90	−150	−170	−168	−88	+3	+88	+143	+153	+95	+13	−65	−123	−145	−133	−80	−5	+78	+133	+155	+150	+123	29− 32
55	71.0	+127	+83	+19	−64	−127	−152	−117	−38	+82	+140	+165	+159	+89	0	−70	−133	−159	−178	−115	−45	+38	+95	+134	+149	+127	33− 36
54	70.0	+62	+23	−14	−49	−70	−53	−8	+43	+117	+148	+162	+126	+68	−15	−83	−150	−152	−158	−121	−73	0	+26	+84	+88	+62	37− 40
54	69.8	+83	−12	−104	−201	−254	−232	−128	−6	+126	+233	+286	+266	+169	+49	−91	−189	−221	−216	−134	−20	+98	+176	+193	+182	+83	41− 44
53	69.0	+93	+23	−50	−125	−178	−173	−115	−23	+93	+185	+228	+205	+113	0	−103	−170	−193	−168	−105	−22	+65	+130	+150	+150	+93	45− 48
53	69.0	+72	+8	−68	−121	−171	−171	−134	−58	+11	+76	+103	+109	+81	+20	−43	−64	−63	−71	−42	+30	+82	+126	+144	+126	+72	49− 52
52	68.0	+168	+48	−180	−265	−358	−288	−215	−73	+52	+193	+285	+315	+145	+55	−95	−243	−233	−173	−123	+8	+193	+318	+290	+223	+168	53− 56
52	68.0	+89	+8	−71	−152	−208	−201	−159	−58	+43	+145	+197	+184	+106	+7	−78	−126	−142	−123	−72	+18	+93	+154	+171	+148	+89	57− 60
51	67.5	+99	+19	−66	−146	−186	−211	−176	−89	+28	+121	+173	+175	+118	+37	−38	−103	−126	−121	−67	+12	+92	+153	+168	+147	+99	61− 64
49	66.3	+123	+40	−45	−148	−213	−218	−140	−40	+98	+210	+260	+235	+130	+3	−115	−185	−218	−205	−133	−28	+83	+160	+185	+165	+123	65− 68
47	65.5	+120	+63	−15	−78	−112	−79	−9	+108	+220	+300	+325	+254	+125	−35	−196	−295	−346	−321	−270	−154	−20	+112	+160	+162	+120	69− 72
46	64.7	+159	+62	−2	−65	−117	−84	+5	+123	+244	+309	+342	+252	+77	−119	−289	−365	−404	−361	−265	−111	+41	+154	+211	+199	+159	73− 76
45	64.0	+112	+22	−68	−172	−223	−213	−150	−29	+89	+190	+244	+205	+108	−19	−131	−188	−208	−179	−109	+5	+116	+190	+219	+179	+112	77− 80
45	63.5	+175	+134	+82	+17	−23	−26	+31	+133	+260	+323	+316	+283	+108	−93	−273	−372	−417	−411	−337	−214	−68	+44	+149	+177	+175	81− 84
44	63.0	+176	+125	+79	+17	−16	+29	+143	+299	+397	+508	+470	+349	+105	−166	−383	−508	−565	−552	−453	−285	−108	+60	+152	+182	+176	85− 88
44	62.3	+176	+119	+67	+25	+15	+54	+153	+262	+336	+371	+339	+212	+19	−189	−366	−473	−515	−482	−374	−217	−41	+112	+189	+208	+176	89− 92
43	62.0	+203	+113	+10	−100	−188	−210	−155	−30	+98	+200	+258	+223	+38	−93	−215	−278	−285	−250	−153	−38	+98	+218	+263	+255	+203	93− 96
43	62.0	+286	+247	+199	+148	+100	+124	+200	+285	+386	+419	+371	+240	−3	−271	−498	−631	−682	−649	−514	−318	−82	+127	+230	+273	+286	97−100
42	61.7	+96	−17	−106	−178	−218	−158	−11	+221	+422	+576	+641	+521	+208	−57	−287	−428	−492	−491	−382	−232	−78	+51	+118	+131	+96	101−104
42	61.0	+178	+115	+35	−105	−133	−135	−70	+52	+198	+310	+363	+310	+158	−35	−210	−312	−370	−378	−312	−185	+50	+112	+193	+210	+178	105−108
42	61.0	+205	+102	+4	−95	−143	−114	+3	+151	+301	+412	+456	+371	+163	−64	−286	−419	−495	−502	−384	−212	−26	+137	+230	+250	+205	109−112
41	59.5	+160	+74	0	−83	−123	−76	+33	+205	+379	+505	+542	+437	+202	−79	−324	−474	−542	−543	−445	−275	−74	+103	+185	+230	+160	113−116
39	58.0	+168	+63	−20	−100	−140	−93	+48	+248	+453	+608	+643	+505	+195	−115	−415	−570	−633	−610	−488	−285	−55	+148	+228	+240	+168	117−120
37	56.5	+89	+33	−38	−98	−148	−104	+51	+202	+377	+525	+565	+447	+236	−18	−227	−418	−496	−521	−445	−251	−68	+79	+157	+149	+89	121−124
32	51.3	+140	−68	−248	−358	−395	−303	−90	+210	+448	+612	+703	+550	+280	−30	−295	−533	−573	−533	−373	−160	+58	+295	+335	+300	+140	125−128
29	48.0	+238	+38	−155	−309	−292	−125	+93	+372	+613	+749	+670	+404	+24	−401	−692	−841	−804	−642	−398	−121	+205	+444	+491	+411	+238	129−132
21	37.8	+360	+94	−158	−339	−374	−233	+45	+423	+725	+941	+936	+699	+272	−242	−695	−984	−1075	−948	−659	−281	+101	+386	+546	+514	+360	133−136
14	26.0	+176	−105	−386	−537	−522	−293	+171	+652	+1117	+1379	+1339	+990	+449	−209	−805	−1193	−1311	−1169	−800	−363	+82	+419	+542	+435	+176	137−140
5	10.0	+289	−123	−419	−623	−558	−276	+100	+610	+960	+1157	+1066	+705	+106	−445	−922	−1229	−1191	−945	−602	−130	+279	+567	+796	+594	+289	141−144
0	1.0	+235	−118	−493	−780	−765	−504	−117	+381	+859	+1149	+1173	+906	+421	−167	−699	−995	−1085	−874	−565	−130	+276	+581	+718	+564	+235	145−148
−4	−7.5	+435	+142	−264	−499	−582	−338	−24	+420	+825	+1059	+1106	+827	+358	−246	−771	−1145	−1308	−1071	−735	−274	+143	+516	+743	+690	+436	149−152
−9	−18.5	+513	+129	−194	−411	−419	−228	+124	+559	+921	+1087	+972	+590	+74	−526	−1039	−1351	−1376	−1105	−688	−196	+287	+657	+835	+776	+513	153−156
−16	−29.5	+330	+88	−103	−295	−320	−163	+120	+408	+685	+818	+770	+523	+160	−295	−660	−890	−890	−800	−588	−280	+45	+338	+525	+483	+330	157−162
−18	−32.0	+260	+95	−85	−190	−104	+83	+327	+629	+916	+1110	+920	+624	+207	−253	−731	−1096	−1145	−1013	−771	−437	−65	+226	+313	+322	+260	163−166
−32	−52.5	+333	+173	−10	−144	−204	−149	+27	+209	+362	+457	+407	+236	−47	−391	−624	−694	−666	−508	−274	+16	+236	+399	+447	+435	+333	167−170
−40	−60.0	+149	−123	−330	−443	−417	−203	+100	+387	+598	+696	+633	+393	+77	−240	−473	−615	−393	−549	−298	+2	+212	+383	+394	+316	+149	171−174
−56	−71.0	+84	+7	−81	−179	−235	−124	+35	+143	+268	+316	+279	+134	−100	−263	−340	−347	−299	−227	−103	+68	+195	+291	+283	+233	+84	175−176

TABLE 56.—*Adjusted values of the diurnal oscillation of the barometer, distributed by the magnetic latitude or inclination.*

Unit = 0.01 millimeter pressure.

M. Lat.	Incl.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid.
°	° ′																									
90	90 00	−4	−4	−2	+2	+5	+7	+6	+4	+1	−2	−5	−8	−10	−9	−4	+1	+6	+8	+7	+6	+4	0	−3	−4	−4
85	87 30	−3	−4	−5	−4	−1	+3	+5	+6	+5	+3	−1	−3	−5	−6	−6	−3	0	+4	+6	+7	+6	+3	+1	−1	−3
80	84 58	−1	−3	−5	−6	−6	−5	−2	+2	+5	+6	+5	+3	+1	−1	−4	−6	−7	−6	−3	+1	+5	+6	+6	+4	−1
75	82 22	+3	+2	−1	−4	−6	−7	−7	−5	−2	+1	+5	+7	+7	+3	0	−3	−7	−9	−8	−6	−2	+2	+5	+6	+3
70	79 41	+5	+3	+1	−3	−5	−6	−5	−3	−1	+2	+5	+6	+5	+2	0	−3	−6	−6	−5	−3	−1	+3	+6	+6	+5
65	76 53	+3	+3	+1	−3	−5	−7	−6	−4	−1	+2	+5	+5	+4	+2	0	−3	−6	−6	−5	−3	−1	+2	+5	+4	+3
60	73 54	+4	+5	+2	−5	−7	−8	−7	−5	−2	+2	+8	+11	+5	+2	−4	−13	−11	−11	−8	−4	−2	+4	+8	+7	+4
55	70 42	+6	+5	+1	−8	−14	−12	−9	−3	+4	+8	+13	+15	+8	+1	−8	−19	−16	−18	−11	−8	−2	+7	+11	+9	+6
50	67 15	+9	+5	0	−11	−15	−16	−9	0	+9	+17	+23	+20	+10	−1	−11	−25	−25	−25	−16	−12	−2	+10	+14	+13	+9
45	63 26	+12	+6	−4	−14	−18	−18	−8	+6	+17	+30	+34	+27	+13	−4	−18	−34	−36	−34	−24	−16	−1	+13	+18	+17	+12
40	59 13	+14	+5	−6	−17	−19	−18	−6	+13	+27	+46	+48	+35	+16	−8	−28	−43	−50	−44	−33	−19	+1	+19	+24	+21	+14
35	54 28	+16	+4	−10	−21	−22	−19	−3	+22	+38	+62	+62	+43	+20	−13	−39	−53	−65	−54	−42	−21	+4	+24	+30	+27	+16
30	49 7	+18	+2	−15	−26	−25	−20	−2	+30	+51	+75	+73	+53	+25	−18	−51	−64	−79	−65	−52	−23	+6	+30	+39	+33	+18
25	43 0	+20	−1	−20	−32	−30	−22	−1	+38	+63	+88	+85	+60	+28	−24	−61	−76	−92	−77	−61	−24	+9	+36	+49	+39	+20
20	36 3	+22	−4	−25	−38	−36	−26	0	+45	+74	+98	+95	+69	+31	−30	−70	−88	−105	−87	−68	−24	+12	+40	+55	+45	+22
15	28 11	+24	−8	−32	−46	−43	−30	+2	+51	+82	+107	+103	+76	+35	−36	−77	−99	−116	−96	−74	−25	+15	+47	+63	+52	+24
10	19 26	+24	−11	−36	−51	−50	−33	+6	+54	+87	+113	+109	+81	+39	−42	−82	−106	−122	−102	−76	−26	+18	+51	+68	+54	+24
5	9 55	+24	−12	−38	−53	−54	−36	+6	+54	+89	+114	+110	+82	+39	−47	−89	−113	−125	−106	−78	−26	+20	+53	+73	+56	+24
0	0 0	+24	−11	−36	−53	−56	−36	+8	+55	+91	+112	+108	+80	+38	−50	−91	−116	−127	−108	−77	−26	+21	+56	+75	+58	+24
−5	−9 55	+25	−4	−32	−50	−55	−34	+8	+53	+90	+108	+105	+75	+36	−51	−92	−116	−127	−109	−74	−25	+20	+52	+74	+56	+25
−10	−19 26	+27	+1	−25	−44	−49	−31	+10	+52	+86	+98	+97	+67	+31	−50	−91	−111	−122	−106	−72	−23	+19	+51	+70	+54	+27
−15	−28 11	+30	+6	−19	−37	−42	−26	+11	+49	+81	+86	+83	+56	+23	−48	−85	−104	−115	−102	−68	−21	+19	+48	+62	+50	+30
−20	−36 3	+32	+10	−12	−31	−34	−21	+11	+45	+74	+72	+70	+46	+18	−43	−79	−96	−106	−96	−63	−19	+19	+45	+54	+45	+32
−25	−43 0	+33	+13	−7	−24	−28	−17	+11	+42	+65	+61	+56	+37	+13	−38	−68	−85	−93	−86	−57	−16	+18	+42	+48	+40	+33
−30	−49 7	+31	+14	−4	−18	−25	−16	+10	+37	+57	+51	+46	+29	+7	−33	−61	−75	−81	−76	−51	−13	+16	+38	+43	+36	+31
−35	−54 28	+27	+14	−3	−16	−23	−16	+8	+33	+49	+43	+37	+24	+4	−29	−54	−65	−64	−62	−43	−9	+15	+34	+40	+31	+27
−40	−59 13	+25	+14	−2	−15	−23	−16	+7	+30	+43	+38	+34	+21	0	−26	−48	−58	−54	−51	−35	−4	+15	+31	+36	+29	+25
−45	−63 26	+22	+13	−2	−14	−22	−15	+7	+26	+36	+33	+31	+17	−3	−24	−42	−51	−45	−40	−26	+1	+16	+29	+33	+26	+22
−50	−67 15	+16	+11	−3	−15	−22	−15	+6	+22	+32	+30	+29	+14	−5	−22	−38	−45	−36	−32	−18	+5	+18	+28	+31	+24	+16
−55	−70 42	+12	+10	−5	−16	−24	−14	+6	+18	+28	+27	+28	+13	−6	−22	−34	−39	−30	−25	−11	+11	+19	+28	+31	+24	+12
−60	−73 54	+7	+9	−7	−18	−24	−14	+5	+15	+26	+23	+28	+12	−7	−22	−32	−36	−26	−22	−7	+14	+21	+28	+30	+23	+7

Table 54 gives the list of stations whose observations of the diurnal variation of the barometer were discussed, the geographic longitude and latitude, elevation of the station, magnetic inclination, and the papers from which the data were extracted, wherein H_1 refers to Dr. HANN'S paper of 1889, H_2 to that of 1892, H_3 to that of 1898, A to ANGOT'S paper of 1887, and B to BUCHAN'S Challenger Report, 1889. It will be noted that the stations are arranged in the order of the magnetic inclination. Transference between magnetic polar distance θ, and magnetic inclination I, is accomplished by the formula, $2 \cot \theta = \tan I$. On comparing the columns of geographical latitude and magnetic inclination, it must be concluded that only within a wide range is it possible to correlate the two systems of latitudes, because the proximity of the North American stations having low latitudes to the magnetic pole, in comparison with those of Europe and Asia in the same geographical latitude, makes it altogether dependent upon the stations that happen to fall within the group, what geographical latitude the group will have in comparison with the computed magnetic latitude. Hence the following tables are quite strictly referred to the system of distribution determined by the magnetic field surrounding the earth rather than to the system which is due to the rotation of the earth on its axis.

Table 55 gives the diurnal oscillation of the barometer, distributed by the inclination of the magnetic field, each unit being the one-thousandth of a millimeter of pressure. The several lines are each the *mean values of four* successive stations, where the preceding list of stations was divided into groups of four, and the means taken for every hour. Thus, the means for Wellington Channel, Port Leopold, Griffith Island, Princess Royal, make the first line of Table 55. These numbers were next plotted upon a large diagram, and then sets of lines were drawn, crossing each other in two directions at about right angles at points of intersection, thus serving to control and to smooth out the irregularities pertaining to the Table 55. (Compare Chart 44.) The vertical lines are those of maximum, minimum, and of zero values, enough in number to check and graduate the mutual relation between the diurnal lines. Finally, diurnal lines were interpolated within these adjusted lines, parallel to them, but starting at the 5° intervals, for the sake of having the component tables, giving the I, II, III harmonic terms, proceed by equal steps of magnetic latitude.

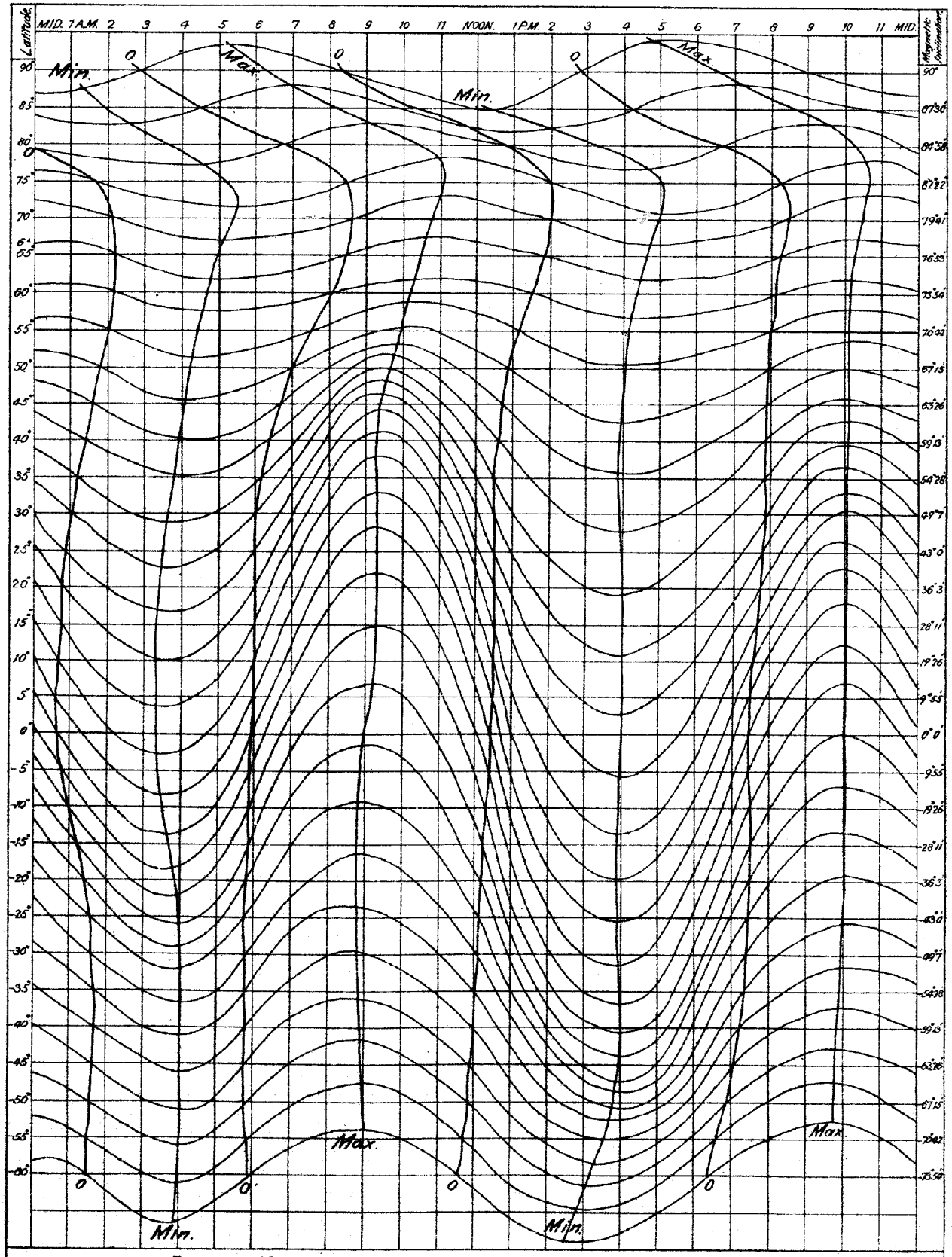
Table 56 gives the result of this adjustment in a graded distribution, and it should be compared with Table 55 to show how far the local individual values are affected by running a normal wave through them. It will be seen that there are many large changes, but yet a strict conformity to the type curves prevails. A similar construction for strictly geographical distribution should be executed as well, for the sake of testing the variations from that point of view. The units in Table 56 are the one-hundredth of a millimeter pressure.

DISCUSSION OF THE RESULTS OF TABLE 56.

As our purpose at present is not any discussion of local causes and effects upon the diurnal barometric wave, but rather the main features of the three components, no violence can have been done to the general laws which underlie these three components, though some additional light may hereby be thrown upon the question as to whether this wave has components derived from magnetic sources as well as from the acknowledged convectional air movements. The interest of Tables 55 and 56 centers in the peculiar break in the values near magnetic latitude 60°, where the double diurnal component is ordinarily supposed to stop in that geographical latitude; its restoration in the polar regions occurs with an inverse phase of the same wave, or, as may be said, with a six-hour shift approximately of the center of action. The data in these regions is very poor, as Dr. HANN notes, but it does not seem necessary to come to his conclusion that nothing can be made of the observations, since in the individual stations 1–24, Table 54, there are numerous indications of the reversal of phase, such as the formula for the variation with the latitude requires even in middle and lower latitudes. To save repetition, the word latitude will refer exclusively to magnetic latitude in the remainder of this section. In order to bring out more prominently the method of this procedure, the data of Table 56 is transferred to Chart 44, the diurnal oscillations of the barometer being referred to in the magnetic poles. In this diagram the scale is as follows: From 90° to 65°, 0.01 mm. pressure=1 mm. ordinate, and from +60° to −60°, 0.02 mm. pressure= 1 mm. ordinate. This shows more clearly the waves in the polar belt. In order to identify the curves relatively to the axis of abscissas, which belongs to a given magnetic latitude or inclination,

The Diurnal Oscillations of the Barometer Referred to the Magnetic Poles.

Chart 44.



From 90° to 65°; 0.01 m.m. pressure = 1 m.m. on vertical ordinate.
From 60° to −60°; 0.02 m.m. pressure = 1 m.m. on vertical ordinate.

vertical curved lines are drawn through the zero points where the diurnal curves cross the horizontal lines; that is to say, the diurnal curve for a given latitude meets the four vertical curves on the same horizontal line. For example, on the equator the diurnal curve meets the vertical curves at 0.30 a. m., 5.50 a. m.; 12.30 p. m. and 7. 30 p. m. Four other verticals are drawn—two through the maxima points and two through the minima points. These eight lines form an adjusting system with the diurnal curves, and the balanced network with smooth gradations must give a very close mean result for normal values of the diurnal system. Chart 44 shows clearly that in the neighborhood of 70° magnetic latitude a shifting of the diurnal curve in hour angle begins, and that the oscillation continues into the polar regions under an inversion of phase. The amplitude drops to a small value at about 65°, and continues through the polar belt at about equal values in both of the semidiurnal waves, indicating a disappearance of a component which distorts these two waves in the middle latitudes.

ANALYSIS OF THE DIURNAL WAVE INTO THREE COMPONENTS.

In order to yet further inspect this variation of phase the data of Table 56 has been separated into the single daily, the double daily, and the triple daily components, by the following simple arithmetical process, which is exact so far as the original curve is strictly harmonic to three terms. To obtain the double daily component, take the mean of all the pairs of values twelve hours apart in time, as $\frac{\text{mid.}+\text{noon}}{2}=$mid. of the double daily, and also noon; $\frac{1\text{ a. m.}+1\text{ p. m.}}{2}=1$ a. m. of double daily, and also 1 p. m., and so on. Subtract this series from the original diurnal series, hour by hour, and it gives the harmonic terms of the single and triple daily components as a sum. To separate these proceed as follows: Take the means of all the triples which are eight hours apart in time for the component of the triple diurnal term.

$$\text{As, } \frac{\text{mid.}+8\text{ a. m.}+4\text{ p. m.}}{3}=\text{mid. of triple daily.}$$

$$\frac{1\text{ a. m.}+9\text{ a. m.}+5\text{ p. m.}}{3}=1\text{ a. m. of triple daily.}$$

These terms repeat three times in the course of the day. Subtract this series from the preceding sums, which contained the sum of the components of the single and triple waves, and the result is the single diurnal component. This process gives the values of each harmonic component for each hour in all latitudes, and the discussion of them is more instructive than a description of the coefficients a_1, a_2, a_3, A_1, A_2, A_3; certainly it requires little work to reach such a result. One readily obtains the values of these coefficients at individual points by interpolation from the series, and then the analytical law can be worked out which expresses the variation of the coefficients in latitude. But it is my judgment that the primary conditions are too complex to expect to obtain a simple and yet valuable formula for the variation of the coefficients of amplitude and the phase constants. I am proposing before long to execute a similar construction and development for the available data, distributed by the geographical latitudes, instead of by the magnetic latitudes, as in this case.

TABLE 57 (I).—*Single daily components.* $a_1 \sin (A_1 + x)$.

Unit = 0.01 millimeter pressure.

M-Lat.	Incl.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid.
°	° ′																									
90	90 00	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0
85	87 30	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0
80	84 58	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0
75	82 22	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0
70	79 41	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0
65	76 53	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0
60	73 54	0	+1	+2	+2	+1	+2	+2	+2	+1	−1	−1	0	−1	−2	−2	−2	−1	−1	−1	−1	−1	+1	+1	0	0
55	70 42	−1	+2	+3	+4	+1	+3	+2	+5	+3	0	0	+1	+1	−2	−3	−3	−1	−3	−3	−4	−1	−1	0	−1	−1
50	67 15	−1	+2	+4	+6	+4	+5	+6	+8	+5	+2	+2	+2	−1	−1	−3	−5	−5	−5	−5	−7	−3	−4	−3	−2	−1
45	63 26	−1	+3	+5	+9	+9	+10	+10	+12	+9	+6	+6	+4	0	−3	−5	−9	−9	−10	−10	−12	−9	−7	−6	−4	−1
40	59 13	0	+5	+8	+12	+15	+15	+17	+17	+14	+11	+9	+6	0	−4	−8	−12	−14	−15	−16	−17	−14	−12	−9	−6	0
35	54 28	0	+5	+9	+15	+20	+21	+27	+22	+19	+15	+10	+7	0	−5	−12	−15	−19	−21	−20	−23	−19	−16	−14	−7	0
30	49 7	−1	+7	+15	+18	+25	+26	+28	+26	+25	+19	+14	+9	+1	−7	−15	−18	−24	−25	−28	−28	−25	−20	−14	−9	−1
25	43 0	−1	+8	+18	+22	+28	+31	+33	+31	+30	+22	+15	+10	+1	−8	−17	−21	−28	−23	−33	−31	−30	−23	−15	−10	−1
20	36 3	−2	+9	+20	+24	+32	+35	+37	+35	+34	+25	+17	+11	+1	−9	−19	−24	−31	−34	−37	−36	−34	−25	−17	−11	−2
15	28 11	−3	+10	+21	+27	+34	+37	+39	+38	+36	+26	+18	+12	+2	−10	−21	−26	−33	−37	−40	−38	−37	−26	−19	−12	−3
10	19 26	−5	+12	+22	+28	+33	+39	+42	+40	+37	+27	+19	+13	+4	−11	−22	−27	−33	−38	−42	−40	−38	−27	−20	−14	−5
5	9 55	−5	+14	+25	+29	+33	+39	+43	+41	+37	+26	+17	+12	+4	−13	−24	−29	−32	−39	−43	−41	−38	−27	−18	−12	−5
•	0 0	−5	+16	+27	+31	+38	+40	+43	+41	+37	+24	+15	+10	+4	−15	−27	−30	−33	−40	−43	−42	−38	−24	−17	−10	−5
−5	−9 55	−4	+19	+29	+32	+34	+42	+43	+40	+37	+23	+14	+8	+3	−19	−28	−32	−34	−42	−42	−40	−37	−24	−14	−9	−4
−10	−19 26	0	+22	+31	+33	+35	+41	+43	+38	+35	+19	+11	+5	0	−21	−31	−32	−34	−42	−43	−39	−36	−20	−12	−6	0
−15	−28 11	+3	+24	+32	+34	+36	+41	+41	+35	+31	+16	+9	+2	−5	−24	−32	−32	−34	−41	−40	−36	−32	−16	−10	−3	+3
−20	−36 3	+8	+26	+32	+33	+36	+39	+38	+32	+28	+12	+6	+0	−7	−25	−32	−32	−35	−38	−39	−32	−28	−13	−7	−1	+8
−25	−43 0	+10	+26	+31	+31	+33	+35	+35	+29	+23	+9	+4	−2	−10	−25	−29	−30	−32	−34	−34	−29	−24	−10	−5	+1	+10
−30	−49 7	+11	+24	+29	+29	+30	+30	+31	+25	+19	+6	+1	−4	−10	−23	−28	−28	−29	−30	−30	−25	−19	−7	−2	+3	+11
−35	−54 28	+8	+21	+26	+25	+24	+24	+26	+21	+14	+3	−2	−4	−9	−20	−25	−24	−23	−24	−25	−21	−14	−4	−1	+2	+8
−40	−59 13	+8	+18	+23	+22	+20	+20	+21	+17	+10	+1	−1	−4	−9	−18	−23	−21	−19	−19	−21	−17	−10	−2	+1	+4	+8
−45	−63 26	+8	+16	+19	+19	+16	+15	+18	+13	+6	−1	−1	−5	−9	−16	−21	−17	−15	−15	−17	−13	−6	0	+2	+5	+8
−50	−67 15	+7	+14	+17	+15	+11	+12	+13	+9	+4	−2	−3	−5	−7	−13	−15	−14	−10	−11	−14	−9	−3	+2	+2	+6	+7
−55	−70 42	+6	+13	+13	+11	+7	+9	+10	+4	+1	−4	−4	−7	−5	−13	−13	−10	−6	−8	−10	−5	−1	+3	+2	+6	+6
−60	−73 54	+4	+12	+11	+8	+4	+7	+8	+1	−1	−6	−3	−7	−4	−13	−10	−8	−4	−7	−8	−2	0	+5	+3	+6	+4

TABLE 58 (II).—*Double daily components.* $a_2 \sin (A_2 + 2x)$.

Units = 0.01 millimeter pressure.

M. Lat.	Incl.		Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid.
°	°	′																									
90	90	00	−8	−7	−3	+2	+6	+8	+7	+5	+3	−1	−4	−7	−8	−7	−3	+2	+6	+8	+7	+5	+3	−1	−4	−7	−8
85	87	30	−4	−5	−6	−4	−1	+4	+6	+7	+6	+3	0	−2	−4	−5	−6	−4	−1	+4	+6	+7	+6	+3	0	−2	−4
80	84	58	0	−2	−5	−6	−7	−6	−3	+2	+5	+6	+6	+4	0	−2	−5	−6	−7	−6	−3	+2	+5	+6	+6	+4	0
75	82	22	+5	+3	−1	−4	−7	−8	−8	−6	−2	+2	+5	+7	+5	+3	−1	−4	−7	−8	−8	−6	−2	+2	+5	+7	+5
70	79	41	+5	+3	+1	−3	−6	−6	−5	−3	−1	+3	+6	+6	+5	+3	+1	−3	−6	−6	−5	−3	−1	+3	+6	+6	+5
65	76	53	+4	+3	+1	−3	−6	−7	−6	−4	−1	+2	+5	+5	+4	+3	+1	−3	−6	−7	−6	−4	−1	+2	+5	+5	+4
60	73	54	+5	+4	−1	−9	−9	−10	−8	−5	−2	+3	+8	+9	+5	+4	−1	−9	−9	−10	−8	−5	−2	+3	+8	+9	+5
55	70	42	+7	+3	−4	−14	−15	−15	−10	−6	+1	+8	+12	+12	+7	+3	−4	−14	−15	−15	−10	−6	+1	+8	+12	+12	+7
50	67	15	+10	+2	−6	−18	−20	−20	−13	−6	+4	+14	+19	+17	+10	+2	−6	−18	−20	−20	−13	−6	+4	+14	+19	+17	+10
45	63	26	+13	+1	−11	−24	−27	−26	−16	−5	+8	+22	+26	+22	+13	+1	−11	−24	−27	−26	−16	−5	+8	+22	+26	+22	+13
40	59	13	+15	−2	−17	−30	−35	−31	−20	−3	+14	+33	+36	+28	+15	−2	−17	−30	−35	−31	−20	−3	+14	+33	+36	+28	+15
35	54	28	+18	−5	−25	−37	−44	−37	−28	+1	+21	+43	+46	+35	+18	−5	−25	−37	−44	−37	−28	+1	+21	+43	+46	+35	+18
30	49	7	+22	−8	−33	−45	−52	−43	−27	+4	+29	+53	+56	+43	+22	−8	−33	−45	−52	−43	−27	+4	+29	+53	+56	+43	+22
25	43	0	+24	−13	−41	−54	−61	−50	−31	+7	+36	+62	+67	+50	+24	−13	−41	−54	−61	−50	−31	+7	+36	+62	+67	+50	+24
20	36	3	+27	−17	−48	−63	−71	−57	−34	+11	+43	+69	+75	+57	+27	−17	−48	−63	−71	−57	−34	+11	+43	+69	+75	+57	+27
15	28	11	+30	−22	−55	−73	−80	−63	−36	+13	+49	+77	+83	+64	+30	−22	−55	−73	−80	−63	−36	+13	+49	+77	+83	+64	+30
10	19	26	+32	−27	−59	−79	−86	−68	−35	+14	+53	+82	+89	+68	+32	−27	−59	−79	−86	−68	−35	+14	+53	+82	+89	+68	+32
5	9	55	+32	−30	−64	−83	−90	−71	−36	+14	+55	+84	+92	+69	+32	−30	−64	−83	−90	−71	−36	+14	+55	+84	+92	+69	+32
0	0	0	+31	−31	−64	−85	−92	−72	−35	+15	+56	+84	+92	+69	+31	−31	−64	−85	−92	−72	−35	+15	+56	+84	+92	+69	+31
−5	−9	55	+31	−28	−62	−83	−91	−72	−33	+14	+55	+80	+90	+66	+31	−28	−62	−83	−91	−72	−33	+14	+55	+80	+90	+66	+31
−10	−19	26	+29	−25	−58	−78	−86	−68	−31	+15	+53	+75	+84	+61	+29	−25	−58	−78	−86	−68	−31	+15	+53	+75	+84	+61	+29
−15	−28	11	+27	−21	−52	−72	−79	−64	−29	+14	+50	+67	+73	+53	+27	−21	−52	−72	−79	−64	−29	+14	+50	+67	+73	+53	+27
−20	−36	3	+25	−17	−46	−64	−70	−59	−26	+13	+47	+59	+62	+46	+25	−17	−46	−64	−70	−59	−26	+13	+47	+59	+62	+46	+25
−25	−43	0	+23	−13	−38	−55	−61	−52	−23	+13	+42	+52	+52	+39	+23	−13	−38	−55	−61	−52	−23	+13	+42	+52	+52	+39	+23
−30	−49	7	+19	−10	−33	−47	−53	−46	−21	+12	+37	+45	+45	+33	+19	−10	−33	−47	−53	−46	−21	+12	+37	+45	+45	+33	+19
−35	−54	28	+16	−8	−29	−41	−44	−39	−18	+12	+32	+39	+39	+28	+16	−8	−29	−41	−44	−39	−18	+12	+32	+39	+39	+28	+16
−40	−59	13	+13	−6	−25	−37	−39	−34	−14	+13	+29	+35	+35	+25	+13	−6	−25	−37	−39	−34	−14	+13	+29	+35	+35	+25	+13
−45	−63	26	+10	−6	−22	−33	−34	−28	−10	+14	+26	+31	+32	+22	+10	−6	−22	−33	−34	−28	−10	+14	+26	+31	+32	+22	+10
−50	−67	15	+6	−6	−22	−30	−29	−24	−6	+14	+25	+29	+30	+19	+6	−6	−22	−30	−29	−24	−6	+14	+25	+29	+30	+19	+6
−55	−70	42	+3	−6	−20	−28	−27	−20	−3	+15	+24	+28	+30	+19	+3	−6	−20	−28	−27	−20	−3	+15	+24	+28	+30	+19	+3
−60	−73	54	0	−6	−20	−27	−25	−18	−1	+15	+24	+26	+29	+18	0	−6	−20	−27	−25	−18	−1	+15	+24	+26	+29	+18	0

TABLE 59 (III).—*Triple daily components.* $a_3 \sin (A_3 + 3x)$.

Units = 0.01 millimeter pressure.

M. Lat.	Incl.		Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid.
°	°	′																									
90	90	00	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.	..	..	0
85	87	30	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0
80	84	58	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0
75	82	22	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0
70	79	41	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0
65	76	53	0	..	..	..	..	..	..	.	..	..	..	..	..	..	..	..	..	.	..	..	..	..	..	..	0
60	73	54	−1	0	+1	+2	+1	0	−1	−2	−1	0	+1	+2	+1	0	−1	−2	−1	0	+1	+2	+1	0	−1	−2	−1
55	70	42	0	0	+2	+2	0	0	−1	−2	0	0	+1	+2	0	0	−1	−2	0	0	+2	+2	0	0	−1	−2	0
50	67	15	0	+1	+2	+1	+1	0	−2	−2	0	+1	+2	+1	+1	0	−2	−2	0	+1	+2	+1	+1	0	−2	−2	0
45	63	26	0	+2	+2	+1	0	−2	−2	−1	0	+2	+2	+1	0	−2	−2	−1	0	+2	+2	+1	0	−2	−2	−1	0
40	59	13	−1	+2	+3	+1	+1	−2	−3	−1	−1	+2	+3	+1	+1	−2	−3	−1	−1	+2	+3	+1	+1	−2	−3	−1	−1
35	54	26	−2	+4	+6	+1	+2	−3	−2	−1	−2	+4	+6	+1	+2	−3	−2	−1	−2	+4	+6	+1	+2	−3	−2	−1	−2
30	49	7	−3	+3	+3	+1	+2	−3	−3	−1	−3	+3	+3	+1	+2	−3	−3	−1	−3	+3	+3	+1	+2	−3	−3	−1	−3
25	43	0	−3	+4	+3	0	+3	−3	−3	−1	−3	+4	+3	0	+3	−3	−3	−1	−3	+4	+3	0	+3	−3	−3	−1	−3
20	36	3	−3	+4	+3	+1	+3	−4	−3	−1	−3	+4	+3	+1	+3	−4	−3	−1	−3	+4	+3	+1	+3	−4	−3	−1	−3
15	28	11	−3	+4	+2	0	+3	−4	−1	0	−3	+4	+2	0	+3	−4	−1	0	−3	+4	+2	0	+3	−4	−1	0	−3
10	19	26	−3	+4	+1	0	+3	−4	−1	0	−3	+4	+1	0	+3	−4	−1	0	−3	+4	+1	0	+3	−4	−1	0	−3
5	9	55	−3	+4	+1	+1	+3	−4	−1	−1	−3	+4	+1	+1	+3	−4	−1	1	−3	+4	+1	+1	+3	−4	−1	−1	−3
0	0	0	−2	+4	+1	+1	+3	−4	0	−1	−2	+4	+1	+1	+3	−4	0	1	−2	+4	+1	+1	+3	−4	0	−1	−2
−5	−9	55	−2	+5	+1	+1	+2	−4	−2	−1	−2	+5	+1	+1	+2	−4	−2	−1	−2	+5	+1	+1	+2	−4	−2	−1	−2
−10	−19	26	−2	+4	+2	+1	+2	−4	−2	−1	−2	+4	+2	+1	+2	−4	−2	−1	−2	+4	+2	+1	+2	−4	−2	−1	−2
−15	−28	11	0	+3	+1	+1	+1	−3	−1	0	0	+3	+1	+1	+1	−3	−1	0	0	+3	+1	+1	+1	−3	−1	0	0
−20	−36	3	−1	+1	+2	0	0	−1	−1	0	−1	+1	+2	0	0	−1	−1	0	−1	+1	+2	0	0	−1	−1	0	−1
−25	−43	0	0	0	0	0	0	0	+1	0	0	0	0	0	0	0	+1	0	0	0	0	0	0	0	+1	0	0
−30	−49	7	+1	0	0	0	−2	0	0	0	+1	0	0	0	−2	0	0	0	+1	0	0	0	−2	0	0	0	+1
−35	−54	28	+3	+1	0	0	−3	−1	0	0	+3	1	0	0	−3	−1	0	0	−3	+1	0	0	−3	−1	0	0	+3
−40	−59	13	+4	+2	0	0	−4	−2	0	0	+4	+2	0	0	−4	−2	0	0	+4	+2	0	0	−4	−2	0	0	+4
−45	−63	26	+4	+3	+1	0	−4	−2	1	−1	+4	+3	+1	0	−4	−2	−1	−1	+4	+3	+1	0	−4	−2	−1	−1	+4
−50	−67	15	+3	+3	+2	0	−4	−3	−1	−1	+3	+3	+2	0	−4	−3	−1	−1	+3	+3	+2	0	−4	−3	−1	−1	+3
−55	−70	42	+3	+3	+2	+1	−4	−3	−1	−1	+3	+3	+2	+1	−4	−3	−1	−1	+3	+3	+2	+1	−4	−3	−1	−1	+3
−60	−73	54	+3	+3	+2	+1	−3	−3	−2	−1	+3	+3	+2	+1	−3	−3	−2	−1	+3	+3	+2	+1	−3	−3	−2	−1	+3

DISCUSSION OF TABLES 57, 58, AND 59.

Tables 57, 58, and 59 give the results of this separation of the components I, II, III, respectively, and the mere inspection of them is most interesting. Table 57 shows the distribution of the single daily component in latitude. The elimination of the harmonic terms was not quite perfect, as can be seen by comparing the values twelve hours apart at any latitude, but the discrepancy is small and unimportant for the object in view. The most conspicuous feature of this component is the gradual change in the phase, which has the maximum at 6 o'clock in the morning on the equator, but retreats toward midnight at latitude 60°; the minimum is at 6 p. m. on the equator and at noon when it disappears. The polar wave is lacking and the quatorial wave is thus at right angles to a line drawn to the sun. The amplitude falls off from the equator to the zone of 65° or 70°.

Table 58 is so nearly like Table 56 in aspect, that the distribution of the double diurnal wave in latitude would be described in about the same words as those expressing the distribution of the total wave. There occurs again the 90° change of phase in the polar regions from that in the middle and the tropic latitudes; also the amplitude falls very low at latitude 70°, and continues to shift till again it reaches the maxima at the 6 a. m. and 6 p. m. hours near the pole itself. It is very important that observations be secured near the south magnetic pole, in order that the remainder of this distribution may be mapped out.

Table 59 gives the distribution of the triple daily component in latitude, and it sets forth several characteristics: (1) There is a slight slope of the positive and the negative values to the left, in passing from the north to the south, being apparently a retreat of two hours from the north +60° to the south −60°; (2) the maximum values of the amplitude are not symmetrically distributed in latitude, since they average larger in the northern hemisphere than in the southern; (3) there is a maximum in the tropics extending from + 40° north to − 15° south latitude; (4) the wave disappears at the zones 65° to 70° north and south, as was the case with the single daily component. The peculiar fall of the amplitude to zero at − 25° to − 35° south, may be only accidental, since it is not matched by a corresponding loss in the northern zone.

TABLE 60.—*Deflecting vectors of equatorial electro-magnetic field—the force s.*

Units fifth decimal C. G. S.

M. Lat.	M. incl.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid.
°	° ′																									
90	90 00	+55	+54	+56	+60	+72	+85	+88	+ 83	+81	+78	+77	−72	−74	−81	− 90	−93	− 89	−85	−75	−60	−48	−47	−46	+50	+55
85	87 30	+58	+56	+58	+65	+76	+89	+90	+ 84	+83	+80	+76	−70	−76	−86	− 95	−96	− 90	−87	−76	−63	−52	−52	−48	+48	+58
80	84 58	+58	+58	+60	+70	+80	+90	+92	+ 88	+84	+80	+74	−68	−76	−90	−100	−99	− 92	−89	−78	−66	−56	−54	−50	+42	+58
75	82 22	+59	+63	+71	+77	+83	+90	+95	+102	+89	+74	−50	−61	−69	−72	− 79	−93	− 94	−92	−82	−71	−61	−56	+54	+52	+59
70	79 41	+57	+67	+75	+81	+86	+91	+92	+ 86	+70	+47	−35	−42	−55	−65	− 75	−90	−101	−95	−85	−65	−58	−54	+54	+57	+57
65	76 53	+60	+64	+70	+75	+60	+50	+46	+ 40	+35	−33	−26	−38	−48	−30	− 35	−35	− 30	−30	−72	−50	−45	+43	+44	+50	+60
60	73 54	+11	+12	+12	+15	+17	+19	−21	− 25	−26	−26	−27	−24	−26	−27	− 26	−26	− 24	−18	−15	−12	−11	+11	+10	+ 9	+11
55	70 42	+18	+18	+18	+18	+18	+19	−20	− 22	−24	−26	−28	−23	−30	−31	− 29	+27	+ 26	+24	+24	+20	+20	+18	+17	+16	+18
50	67 15	+16	+14	+12	+12	+14	+16	+18	+ 23	−26	−27	−27	−27	−37	−36	− 33	+25	+ 21	+18	+18	+19	+19	+18	+19	+18	+16
45	63 26	+15	+13	+13	+12	+15	+18	+25	+ 22	−24	−26	−27	−27	−36	−35	− 30	+26	+ 22	+18	+16	+16	+15	+14	+15	+15	+15
40	59 13	+13	+13	+12	+12	+14	+17	+19	+ 21	+25	−27	−26	−26	−35	−33	− 30	+25	+ 21	+17	+12	+11	+ 9	+ 9	+ 9	+ 8	+13
35	54 28	+11	+12	+13	+14	+15	+17	+19	+ 21	+25	−27	−27	−27	−34	−32	− 29	+23	+ 19	+16	+12	+13	+11	+ 9	+ 8	+ 8	+11
30	49 7	+10	+ 9	+10	+11	+12	+14	+16	+ 19	+23	−24	−24	−25	−29	−28	− 25	+21	+ 15	+15	+15	+17	+14	+10	+10	+ 9	+10
25	43 0	+ 9	+ 8	+10	+10	+12	+13	+15	+ 18	+22	−23	−24	−26	−30	−29	− 26	+20	+ 14	+15	+16	+18	+17	+12	+12	+11	+ 9
20	36 3	+13	+15	+16	+16	+16	+17	+17	+ 19	+22	−23	−28	−33	−36	−36	− 32	+19	+ 15	+15	+16	+18	+19	+18	+16	+15	+13
15	28 11	+17	+20	+19	+19	+18	+18	+19	+ 21	+22	−24	−31	−39	−40	−39	− 35	−19	+ 16	+15	+17	+19	+20	+19	+18	+17	+17
10	19 26	+23	+22	+22	+22	+21	+20	+22	+ 23	+23	−24	−34	−43	−44	−40	− 37	−19	+ 16	+15	+17	+19	+21	+21	+20	+20	+23
5	9 55	+21	+22	+23	+21	+20	+20	+22	+ 23	+23	−24	−35	−44	−44	−40	− 35	−18	+ 17	+16	+18	+21	+22	+22	+23	+24	+21
0	0 0	+20	+21	+22	+21	+20	+20	+21	+ 22	+23	−25	−36	−44	−44	−40	− 34	−17	+ 17	+17	+18	+21	+22	+23	+23	+24	+20
− 5	− 9 55	+20	+21	+22	+21	+20	+19	+19	+ 20	+24	−27	−37	−45	−44	−40	− 33	−17	+ 17	+17	+19	+21	+23	+24	+24	+24	+20
−10	−19 26	+18	+17	+19	+20	+17	+16	+18	+ 20	+24	−28	−35	−45	−43	−40	− 32	−15	+ 16	+16	+19	+22	+24	+25	+24	+24	+18
−15	−28 11	+16	+14	+16	+18	+13	+12	+15	+ 20	−25	−28	−33	−40	−41	−38	− 32	−15	+ 16	+17	+20	+22	+23	+24	+24	+24	+16
−20	−36 3	−17	−16	−17	−18	−15	−14	−18	− 22	−25	+28	+31	+36	+37	+36	+ 32	+20	− 20	−19	−20	−21	−21	−23	−23	−23	−17
−25	−43 0	−19	−18	−17	−17	−17	−18	−21	− 24	−26	+28	+30	+31	+34	+33	+ 32	+26	− 24	−22	−21	−19	−20	−21	−21	−21	−19
−30	−49 7	−20	−20	−18	−17	−19	−21	−24	− 26	−27	+28	+28	+27	+30	+31	+ 32	+32	− 28	−24	−21	−18	−18	−20	−20	−20	−20
−35	−54 28	−20	−20	−19	−19	−20	−23	−25	− 27	−29	+29	+28	+26	+28	+30	+ 30	+30	− 28	−25	−20	−18	−18	−17	−18	−18	−20
−40	−59 13	−20	−20	−19	−19	−20	−23	−24	− 26	−28	+29	+27	+25	+28	+31	+ 30	+30	− 28	−25	−20	−18	−17	−17	−18	−18	−20
−45	−63 26	−19	−19	−18	−19	−20	−22	−24	− 26	−27	+28	+27	+25	+27	+31	+ 30	+30	− 27	−24	−20	−17	−17	−16	−17	−18	−19
−50	−67 15	−18	−18	−17	−19	−20	−21	−23	− 25	−26	+27	+26	+24	+27	+32	+ 30	+30	− 27	−24	−20	−17	−16	−16	−17	−18	−18
−55	−70 42	−16	−16	−15	−17	−20	−21	−22	− 25	−28	+27	+25	+23	+25	+33	+ 28	+30	− 26	−21	−19	−16	−16	−16	−17	−17	−16
−60	−73 54	−12	−15	−14	−16	−19	−20	−21	− 24	−27	+27	+25	+22	+24	+34	+ 28	+30	− 26	−19	−18	−15	−15	−15	−16	−15	−12

TABLE 61.—*Diurnal variations of s on the mean intensity without regard to the direction of the force.*

M. Lat.	Incl.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid.
°	° ′																									
90	90 00	−15	−16	−14	−10	+2	+15	+18	+13	+11	+8	+7	+2	+4	+11	+20	+23	+19	+15	+5	−10	−22	−23	−24	−20	−15
85	87 30	−14	−16	−14	−7	+4	+17	+18	+12	+11	+8	+4	−2	+4	+14	+23	+24	+18	+15	+4	−9	−20	−20	−24	−24	−14
80	84 58	−16	−16	−14	−4	+6	+16	+18	+14	+10	+6	0	−6	+2	+16	+26	+25	+18	+15	+4	−8	−18	−20	−24	−32	−16
75	82 22	−15	−11	−3	+3	+9	+16	+21	+28	+15	0	−24	−13	−5	−2	+5	+18	+20	+18	+8	−3	−13	−18	−20	−22	−15
70	79 41	−13	−3	+5	+11	+16	+21	+22	+16	0	−23	−35	−28	−15	−5	+5	+20	+31	+25	+15	−5	−12	−16	−16	−13	−13
65	76 53	+13	+17	+23	+28	+13	+3	−1	−7	−12	−14	−21	−9	+1	−17	−12	−12	−17	−17	+25	+3	−2	−4	−3	+3	+13
60	73 54	−7	−6	−6	−3	−1	+1	+3	+7	+8	+8	+9	+6	+8	+9	+8	+8	+6	0	−3	−6	−7	−7	−8	−9	−7
55	70 42	−4	−4	−4	−4	−4	−3	−2	0	+2	+4	+6	+1	+8	+9	+7	+5	+4	+2	+2	−2	−2	−4	−5	−6	−4
50	67 15	−5	−7	−9	−9	−7	−5	−3	+2	+5	+6	+6	+6	+10	+15	+12	+4	0	−3	−3	−2	−2	−3	−2	−3	−5
45	63 26	−5	−7	−7	−8	−5	−2	+5	+2	+4	+6	+7	+7	+10	+15	+10	+6	+2	−2	−4	−4	−5	−6	−5	−5	−5
40	59 13	−5	−5	−6	−6	−4	−1	+1	+3	+7	+9	+8	+8	+17	+15	+12	+7	+3	−1	−6	−7	−9	−9	−9	−10	−5
35	54 28	−7	−6	−5	−4	−3	−1	+1	+3	+7	+9	+9	+9	+16	+14	+11	+5	+1	−2	−6	−5	−7	−9	−10	−10	−7
30	49 7	−7	−8	−7	−6	−5	−3	−1	+2	+6	+7	+7	+8	+12	+11	+8	+4	−2	−2	−2	0	−3	−7	−7	−8	−7
25	43 0	−8	−9	−7	−7	−5	−4	−2	+1	+5	+6	+7	+9	+13	+12	+9	+3	−3	−2	−1	+1	0	−5	−5	−6	−8
20	36 3	−7	−5	−4	−4	−4	−3	−3	−1	+2	+3	+8	+13	+16	+16	+12	−1	−5	−5	−4	−2	−1	−2	−4	−5	−7
15	28 11	−5	−2	−3	−3	−4	−4	−3	−1	0	+2	+9	+17	+18	+17	+13	−3	−6	−7	−5	−3	−2	−3	−4	−5	−5
10	19 26	−1	−2	−2	−2	−3	−4	−2	−1	1	0	+10	+19	+20	+16	+13	−5	−8	−9	−7	−5	−3	−3	−4	−4	−1
5	9 55	−4	−3	−2	−4	−5	−5	−3	−2	−2	−1	+11	+19	+19	+15	+10	−7	−8	−9	−7	−4	−3	−3	−2	−1	−4
0	0 0	−5	−4	−3	−4	−5	−5	−4	−3	−2	0	+11	+19	+19	+15	+9	−8	−8	−8	−7	−4	−3	−2	−2	−1	−5
−5	−9 55	−5	−4	−3	−4	−5	−6	−6	−5	−1	+2	+12	+20	+19	+15	+8	−8	−8	−8	−6	−4	−2	−1	−1	−1	−5
−10	−19 26	−6	−7	−5	−4	−7	−8	−6	−4	0	+4	+11	+21	+19	+16	+8	−9	−8	−8	−5	−2	0	+1	0	0	−6
−15	−28 11	−7	−9	−7	−5	−10	−11	−8	−3	+2	+5	+10	+17	+18	+15	+9	−8	−7	−6	−3	−1	0	+1	+1	+1	−7
−20	−36 3	−6	−7	−6	−5	−8	−9	−5	−1	+2	+5	+8	+13	+14	+13	+9	−3	−3	−4	−3	−2	−2	0	0	0	−6
−25	−43 0	−4	−5	−6	−6	−6	−5	−2	+1	+3	+5	+7	+	+11	+10	+9	+3	+1	−1	−2	−4	−3	−2	−2	−2	−4
−30	−49 7	−4	−4	−6	−7	−5	−3	0	+2	+3	+4	+4	+3	+6	+7	+8	+8	+4	0	−3	−6	−6	−4	−4	−4	−4
−35	−54 28	−3	−3	−4	−4	−3	0	+2	+4	+6	+6	+5	+3	+5	+7	+7	+7	+5	+2	−3	−5	−5	−6	−5	−5	−3
−40	−59 13	−3	−3	−4	−4	−3	0	+1	+3	+5	+6	+4	+2	+5	+8	+7	+7	+5	+2	−3	−5	−6	−6	−5	−5	−3
−45	−63 26	−4	−4	−5	−4	−3	−1	+1	+3	+4	+5	+4	+2	+4	+8	+7	+7	+4	+1	−3	−6	−6	−7	−6	−5	−4
−50	−67 15	−4	−4	−5	−3	−2	−1	+1	+3	+4	+5	+4	+2	+5	+10	+8	+8	+5	+2	−2	−5	−6	−6	−5	−4	−4
−55	−70 42	−5	−5	−6	−4	−1	0	+1	+4	+7	+6	+4	+2	+4	+12	+7	+9	+5	0	−2	−5	−5	−5	−4	−4	−4
−60	−73 54	−8	−5	−6	−4	−1	0	+1	+4	+7	+7	+5	+2	+4	+14	+8	+10	+6	−1	−2	−5	−5	−5	−4	−5	−8

THE DIURNAL MAGNETIC FIELD.

Instead of speculating here upon the nature of these phenomena, I will show the distribution of the diurnal magnetic deflecting forces, which was developed some years ago, and published in Astrophysics, October, 1893, and also in Bulletin No. 21, 1898. On pages 87, 88 of the latter paper, are given the vectors of the deflecting forces which, impressed upon the normal field at thirty different stations, produce the field actually observed at each hour. The vector contains the strength of the force s, and its direction in space (α . β .), α being the inclination to the horizon, and β the angle with the meridian. It was built up out of the rectangular deflecting components of the horizontal force, the declination and the vertical force. The diagrams on pages 88, 89, 90 of Bulletin No. 21, give some idea of the distribution of these forces over the earth, referred to the magnetic poles. The values of s for the magnetic latitudes which are used in the Tables 60, 61, have been interpolated from Table 19, Bulletin No. 21, as can readily be done. According to my notation the plus sign means that the deflecting force s is directed downward relative to the surface of the earth, that is, the vertical component is plus inward; and the minus sign that the vertical component is directed outward. In regard to the purely physical conditions, that the southern geographical hemisphere is magnetically positive and the northern negative, my system of signs for the vertical component is wrong, and should be reversed to make the upward direction plus. In originally working out this vector system I followed the notation usually adopted in the Reports on Magnetic Observations, making the magnetic inclination or dip in the northern hemisphere positive; yet is is clearly an erroneous procedure considering the laws of physics governing magnetic lines of force on a sphere. This mistake has impressed upon me the importance of rectifying the coordinate notation, now adopted by magneticians, and I have called attention to the resolution of the Paris Meteorological Conference of 1896 on this subject, in my paper on the "Standard system of coordinate axes," W. B., No 124, 1897, because I consider the coordinate system then recommended very objectionable for fundamental work in terrestrial magnetism. A similar criticism would show that the astronomical azimuth, with rotation from the east through the south as positive, has very little claim upon the sciences of terrestrial magnetism and meteorology, where the natural azimuth rotation is from the south through the east. If my own notation is properly revised, the signs of Table 60 should all be reversed for strictly physical interpretations

The peculiar distribution of this vector system has been suitably described in Bulletin No. 21 and will not be repeated here. This Table 60 should, however, be compared with Prof. A. SCHUSTER'S Diagram of the Magnetic Potential on the Earth, in his paper on the "Diurnal variation of terrestrial magnetism," Phil. Trans. R. Soc. London, 1889, p. 508; also with W. VON BEZOLD'S paper "Zur Theorie des Erdmagnetismus," Sitz. K. Ak. Wiss., Berlin, 1897, Table III, which is reproduced in Terrestrial Magnetism, September, 1898, p. 111. It is readily perceived that whether in the form of magnetic potential or lines of equal intensity or deflecting vectors, we have the same distribution of magnetic forces. It is evident, however, that since our *vector system gives not only the intensity, but also the direction in space of each vector*, it is therefore the most complete and instructive form for discussing the facts. Furthermore, for any theory based upon the SCHUSTER or the V. BEZOLD diagram, it must be carefully considered that it deals *only with the vertical components*, and that this must lead to a partial view. The general interpretation of Table 60 is that of a sphere under the action of a couple due to an external magnetic field.

To carry the presentation one step further, I have reasoned as follows: If the signs of the magnetic vectors are kept in view, we have to deal apparently with all the peculiarities of a field which is produced by induction under the following restriction, namely, a permeable sphere, plunged in an external field, at nearly right angles to its axis of the magnetization. The result shows that these forces act toward the sun in the northern hemisphere and away from it in the southern, and tend to turn the earth's north pole toward the sun. Now, it can hardly be supposed that the mere *direction* of the vector has a primary relation to meteorological processes, but the *intensity* of the magnetic force does have direct relation to temperatures, because these always vary in some inverse ratio. The higher the temperature of the medium surrounding a magnet, the weaker its lines. The contrary proposition is also probably true: the stronger the magnetic field the colder the surrounding medium, provided the lines are generated independently of the medium. Hence I have taken the mean of the vectors of Table 60 without regard to the direction of the

force, that is, without regard to signs; then the variations of the hourly values on this mean, and the result is given in Table 61, where the plus sign indicates that the hourly values are greater than the mean for the twenty-four hours. This table shows some remarkable features: (1) The maximum positive values in middle latitudes are distributed about midday; in the polar regions they are displaced about six hours, to 6 a. m. and to 4 p. m.; (2) the belt of transition is distinct, and even abrupt, along the zone 65° to 70°. This is also shown graphically on Charts 14, 15, 16 of Bulletin No. 21.

Two suggestive and perhaps important comparisons can now be made: (1) Tables 58 and 61 of the double daily component of the barometric oscillation and the intensity of the diurnal deflecting vectors of the magnetic field have remarkable similarities regarding the two fields in the polar regions, namely, a transition at latitudes 65°–70°, and a displacement of phase of about six hours; (2) Tables 59 and 60, of the triple component of the barometric oscillation and the deflecting vectors of the magnetic field, taken with regard to sign, show that the distribution from north to south is turned westward in both cases, though not by the same amount; (3) the effect exhibited in Table 57 of the gradual change in phase from the equator to the poles may possibly be related to the six-hour change of phase, shown on Table 61, but produced in some complicated way.

DISCUSSION OF THE BAROMETRIC AND THE MAGNETIC DIURNAL PERIODS.

These comparisons are without doubt valuable from several points of view. (1) The explanation of the independence of the double daily component of the barometric wave, as regards the thermic wave, at least near the surface of the ground, has never been satisfactory. Dr. HANN, in his latest paper, Meteorol. Ziet, October, 1898, "Weitere Beiträge zu den Grundlagen für eine Theorie der täglichen Oscillation des Barometers," is so far convinced of the impossibility of bringing about harmony between these two systems, barometric and thermal, that he appears to be willing to accept Lord KELVIN'S view, that the barometric wave is due to the forced oscillation of the free atmosphere, under the absorption of solar heat in the *upper* strata of the atmosphere. If this latter explanation is the true one, is there any evidence from it of the phenomena herein described for the polar regions, namely, the transition at zone 65°–70° and change of phase by six hours? If not, that theory is apparently inadequate. (2) Professor SCHUSTER is inclined to think that the diurnal variations of the magnetic field are due to the variations in the barometric pressure (Phil. Trans., vol. 180, page 510), though he very cautiously limits his remarks to suggestions. Indeed, the peculiar parallelism which seems to exist between the diurnal magnetic and meteorological phenomena might well excuse any student for concluding that either one was the cause of the other. This uncertainty is so great, however, that I have for a long while hesitated to express any view on the subject. But, after reflecting upon the several features of this complex problem, it seems to be quite likely that it is the magnetic system which, as cause, precedes but is somewhat modified by the meteorological system, making these effects which are expressed in the barometric waves; or else that the barometric and magnetic waves are respectively and mutually dependent upon the same cause, namely, the electro-magnetic field of the sun, which produces these two effects. There are two main arguments: (1) The local thermal effects do not possess much efficiency in modifying the double diurnal barometric wave at the surface; these thermal waves must diminish rapidly in power with the height, as the mountain and the balloon temperature observations show that they do, while the main mass of the atmosphere, which is heated up daily, remains in the lower strata; the upper strata of the atmosphere are more vigorously in motion than the lower, as the cloud observations indicate; they have much less mass and they receive their due proportion of insolation, but only retain a small total amount compared with what the lower strata receive; thus the general subject becomes intractable, and the problem is really placed beyond the range of practical discussion, because the thermal and barometric waves at the surface do not match in details as to synchronism. (2) The primary distribution of the terrestrial magnetic deflecting vectors is such as must exist independently of any atmosphere, or any thermal variations whatsoever, since it is due solely to the shape of the material of the earth and the angular relations of the axes of the internal and external magnetic fields. Now, it has just been shown that the barometric double wave has some features in distribution similar to this magnetic field, and it is therefore allowable to infer that there is some form of action going on which simultaneously causes

these two phenomena. If the magnetic field has a given configuration, and the air tends to be drawn into that form, then the phenomenon is due to the *magnetic attraction*, not to a *gravitational tide*, nor to a *thermic manometric process*. It may be remarked that the solar radiation would thus be called upon, besides producing thermic effects by the absorption and radiation of energy in *irreversible* forms, to cause true *reversible* pressures at the earth. The most promising working theory is that there are two external magnetic fields which have definite configurations impressed upon them by the original distribution of their forces outside the atmosphere and the magnetic material of the earth. These fields, however, traverse an atmosphere in motion which is highly charged with electricity, and which by its motion makes convective currents of electricity that in turn are surrounded by induced magnetic currents or forces which enter into composition with the original external magnetic fields. It is the resultants of these two systems that are observed at the several stations. One illustration follows here in regard to the diurnal field; others will be given in a future report relating to the polar field, which was partially described on page 71, Bulletin No. 21. There is unquestionably a mutual interrelation between the two solar magnetic fields and the meteorological distributions of pressure and temperature which is gradually being understood and explained.

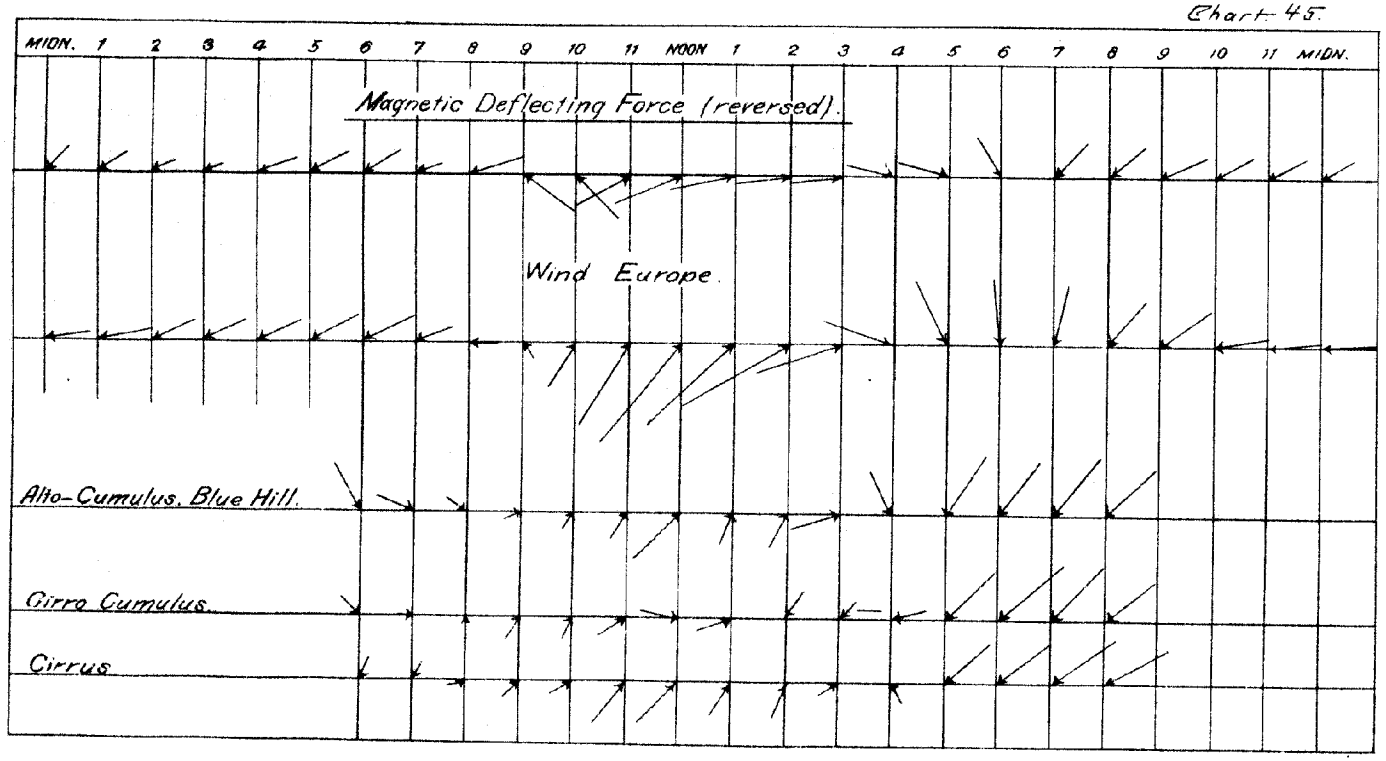
COINCIDENT RELATIONS BETWEEN DIURNAL WIND DIRECTIONS AND THE DISTURBING MAGNETIC VECTORS IN THE MIDDLE LATITUDE ZONES.

On Plate VII of the "Discussion of Observations," Blue Hill Observatory, 1896, are shown the diurnal components, north-south, and west-east, of the currents of air at the surface and in the several cloud levels. In order to study them more effectively, the several hourly components were scaled off, and the resultant vector computed, which is equivalent to them on the horizontal plane. The Blue Hill Observatory is so near the ocean that it is favorably located to feel the full influence of the land and sea breeze, and this so far disturbs the diurnal curves of the wind components, when compared with inland Europe and other Continental places, that it is not suitable for use in the connection here contemplated. The sea breeze extends far enough upward from the ground to include the cumulus level, and this, too, has been excluded from consideration for the same reason. The wind of Europe is taken in the comparison, and the clouds at Blue Hill in the alto-cumulus, cirro-cumulus, and the cirrus levels. The discussion of the original observations begins on page 412 of that report.

As modified by composition, the same result which is given in the account of the data may be seen on Chart 45. "Comparison of the magnetic deflecting vectors, and the direction of the diurnal components of the motions of the air," in the second, third, fourth, and fifth lines of vectors, respectively. The wind has a maximum NE. from 2 a. m. to 7 a. m., a transition at 8 a. m., 9 a. m., and stronger SW. winds from 10 a. m. to 2 p. m., when a transition occurs again at 3 p. m. to a system of northerly winds from 4 p. m. to 10 p. m., becoming easterly at midnight. The vectors in the cloud levels are more irregular among themselves, and this may well be accounted for by the comparative difficulty of determining the resultant direction at each hour from the cloud observations of only two years. Evidently many more series of such hourly cloud directions are desired and much needed in order to separate successfully the true diurnal vectors from the cyclonic and the anticyclonic components. The Rev. F. L. ODENBACH, S. J., at St. Ignatius College, Cleveland, Ohio, executed a good series of hourly observations of the cloud motions in all levels, which will be used in a further discussion of this subject. Our thanks are due him for this valuable cooperation during the year 1898. Nevertheless, it is seen on Chart 45 that the cloud levels conform quite closely to the wind, having transition hours 8 a. m. to 9 a. m., and 3 p. m. to 4 p. m., with southwesterly components during the middle of the day, and northeasterly components during the first half of the night. The cloud vectors in the morning hours are wanting.

For comparison with these wind directions, the vectors of the diurnal magnetic deflecting forces are extracted from Bulletin No. 21, page 87 and Charts 14, 15, as seen projected on the surface of the earth, and reproduced with one alteration, namely, that the direction of the magnetic vectors is *reversed* throughout the twenty-four hours. In other words, the arrows of the magnetic charts point in the opposite direction to the one here given. By following the five outer circles on Chart 15, Bulletin No. 21, and comparing with the first line of Chart 45, here under dis-

Chart 45.



THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON, D. C.

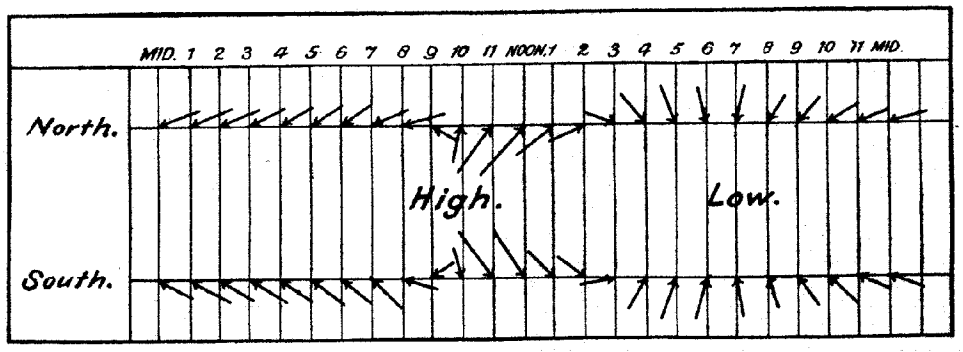


CHART 46.—Scheme of the diurnal wind components in the North and South Temperate zones.

cussion, this will appear evident. Now, a comparison of lines 1 and 2 of Chart 45 discloses a most remarkable agreement in nearly all particulars, so close as to suggest the relations, either of cause and effect, or else the simultaneous product of a cause common to both of them. It is this remarkable circumstance which might have tempted me to assume that the magnetic field is a product of the meteorological convectional movements, and from this particular exhibit it may well appear to be so. However, before going so far as that it would be necessary to show that the convectional movements in the polar region, and also in the Tropics, since the result just described is here confined to the north temperate zone, *likewise have the same correspondence in direction.* The meteorological data in the other zones are not so readily accessible as to make it easy to say what the fact is. Furthermore, the magnetic vectors in the north and the south temperate zones point in directions practically the opposite of one another, as referred to the position of the sun, while the winds act as if they were related to one common circulation of the tropic and temperate zones combined; for, as shown on Chart 46, if the diurnal wind directions in middle latitudes and in both hemispheres be transferred to a sphere and located hour by hour, the northern and southern winds are seen to be connected with each other, as if an area of high pressure was central about the hour 10 a. m. and an area of low pressure about 5 or 6 p. m. The diurnal wind components form a system, and flow out from the 10 a. m. high toward the 6 p. m. low over the noon meridian with greatest strength; also over the midnight meridian by a longer path and with less vigor. Now, these vectors indicate a real sliding of the atmosphere locally toward certain directions in the course of the day; the northern vectors rotate about a center clockwise, looking down upon the face of a watch, and the southern winds anticlockwise. The fragments of observations leading to this result are found in the several descriptions of diurnal winds given in different meteorological reports. Inasmuch as the magnetic vectors in the Tropics and the polar zones probably do not match the wind vectors, and since the magnetic system has characteristics which belong only to the conditions producing it, as mentioned in Bulletin No. 21, and also since the meteorological elements have features connecting them strictly with the thermal state of the atmosphere due to insolation, we may perhaps be compelled to come to the following conclusion: Neither the magnetic nor the meteorological systems are strictly causes of one another, but they have a common origin in the electro-magnetic field of solar radiation. My idea is that this field produces heat by transference of vibration energy to the constituents of the atmosphere, and at the same time it deflects the curves of the normal magnetic field surrounding the earth into the new shapes that are observed at the surface. The magnetic and the meteorological components no doubt react upon one another, but one does not exclusively produce the other, else it would be necessary to find the remarkable parallelism which has been pointed out for the temperate zones extending itself to many other features of each field, namely, the polar and tropic zones and all localities within each zone, respectively. My belief is that yet further evidences of the truth of this general point of view will be discovered as the subject is approached from directions favorable for its development.

NOTES ON "SOLAR AND TERRESTRIAL MAGNETISM IN THEIR RELATIONS TO METEOROLOGY."

It would be advantageous for several reasons to publish a complete report of my research on the subject of Solar and Terrestrial Magnetism in their Relations to Meteorology, but since Bulletin No. 21, United States Weather Bureau, 1898, is merely an abstract of the same, it greatly curtails the display of the details of the computations of the observations. These would be of permanent value if printed *in extenso*, and the exposition of the theories adopted in the report would have gained in clearness by a further expansion of the argument, since it omits all auxiliary matter touching the subject, and especially many reasons for arriving at certain conclusions. These defects have perhaps deterred some students from taking such interest in the subject as it justly merits, and from forming correct opinions regarding the problems discussed.

The following notes may tend to supplement that paper generally, and especially in such points as criticisms have already suggested that further explanation is needed. The reader must be assumed to be familiar with the following papers: (1) Lord KELVIN'S Presidential Address on Solar Magnetism, Nature, December 1, 1892, Vol. XLVII, page 108; (2) Solar and Terrestrial Magnetism in their Relations to Meteorology, United States Weather Bureau, 1898; (3) Possible

Effects of Solar Magnetization on Periodic Variations of Terrestrial Magnetism, Phil. Mag., No. 281, October, 1898, page 395, by ARTHUR SCHUSTER; (4) BIGELOW'S Solar and Terrestrial Magnetism, reviewed by ARTHUR SCHUSTER, Terr. Mag., December, 1898, page 179.

There are two noteworthy lines in which development appears to be going on regarding theories relating to the action of the sun on the planets: First, by the addition of several physical cosmical forces to the simple type of geometrical astronomy in vogue twenty-five years ago, such as a supposed slight variation of the Newtonian law of attraction, the small frictional resistance of the interstellar medium, the slow operation of the planetary tides upon the times of revolution and the distances of the other bodies, and the magnetic forces connecting the planets with one another and with the sun; second, by the growth of the belief that the variations of the earth's magnetic field in secular and short periods is so closely connected with the temperature and the motions of the atmosphere as to become essentially a meteorological rather than an electric-current phenomenon. It is contended that there can be no more intrinsic difficulty in ascribing to the sun a magnetic field, depending upon its own magnetization or electro-magnetic circulation, than in accounting for the observed magnetism of the earth in a similar manner. It is also very probable that the solar magnetic field is stronger than that of a saturated steel magnet. What, therefore, seemed to be a mere speculation to the astronomers and the meteorologists of a generation ago is fast advancing to a firm place among the working hypotheses of science. Much that then appeared to be improbable must now be carefully investigated, since the observations already point to a specific theory.

The problem of terrestrial magnetism is divided into three parts, though these are interdependent in some connections. They are: (1) The long secular variation, with terms ascribed to the earth's internal magnetic field, its external field, and to hypothetical earth-air currents; (2) the diurnal disturbing vectors, with the axis of this secondary field on the plane of the ecliptic, depending upon the electro-magnetic field of the sun, and exhibiting the phenomena of couples, magnetic refraction, and a permeable outer shell of the earth; (3) the magnetic solar field with its direction at the earth perpendicular to the ecliptic, exhibiting the phenomena of long and short variations in the deflecting forces, as well as a semiannual variation in the station elements. My investigation is concerned with the second and the third problems, and is content to adopt such conclusions as may be reached by magneticians regarding the cause and the process of the first or secular variation.

My report narrates in regard to the two fields of force which are discussed, without any attempt to sustain a preconceived theory, the facts as they came from the observations. In consequence of these I found myself confronted with several new conditions that demanded explanation. Whether those proposed in the report are correct, or are approximately true, or are untrue, remains to be seen. Some critics have thought it necessary to remind me of the objections which have been well known for the last fifty years, and in subjection to which the science of terrestrial magnetism has made no theoretical advances for a long time; others have ascribed to me certain objectionable views which are not found in my writings and for which I have no responsibility.

(1) *The 26.68-day period.*—Lord KELVIN finds for the sun magnetized *along its axis of rotation* theoretical components at the earth in the sidereal and in the annual periods, which, of course, become equivalent after composition to a synodic period. Professor SCHUSTER derives periods belonging to its *transverse* magnetization—that is, at right angles to the sun's axis of rotation—in about 24.9 and 28.5 days, respectively, the mean of which is 26.7, and concludes that therefore no synodic period is possible. But it is evidently not proper for him to apply this proposition regarding the *transverse* type of magnetization to the former or *direct* type in respect of my work, because there is almost no evidence to show that the sun has any important term in the transverse magnetization, while the entire geometry of my own treatment of the problem retains the axis of the sun's magnetization within a few degrees of the axis of rotation. If Professor SCHUSTER should appeal from this to his general case, then we remark that this reduces practically to the first case with a resultant synodic period, which I determined to be 26.68 days; and the necessary addition of the earth's magnetic axis in the analysis to the direct and transverse axes of the sun's magnetization already treated by him also involves a long series of component terms, because the earth's axis of magnetization does not coincide with that of its rotation. The further effect of these many components upon the given normal station elements H . D . V., which is the required goal of the

research, leads to further serious complexity. Indeed, after much work of my own on these elements, the task was abandoned as impracticable, and the seeking for all these subordinate terms is considered useless for present purposes.

Furthermore, the argument that because a given period is not found among its components it therefore does not exist, is not a reason for excluding it if it is a resultant period compounded from subordinates. None of the fictitious suns and moons utilized in analyzing the tidal waves at a given port correspond with the observed tide, nor do the periods of component perturbations in an orbit match the orbit itself. Now, my computations persistently give back the synodic period, 26.68 days, in so many different ways, through the interval of a half century, that it is not possible to have reached such a solution except it is a natural fact. Indeed, this period was in hand some time before it was realized that it corresponded so perfectly with the sun's equatorial rotation. The original magnetic observations are in themselves no doubt very unsatisfactory for discussion because of the looseness of their action and the unsteadiness of the derived results. There are probably some components involved which, if disentangled, would clear up many of the difficulties now felt, and I hope this may yet be done. Those students who are contented with any brief examination of this sort of data may well be careful about reaching opinions on this subject. Only a persistent study of the observations will serve to modify the first impression of doubt and even of discouragement natural to anyone entering upon this task. Only the immense importance of the correct solution of this branch of solar physics could justify the expenditure of the labor necessary to prosecute this research.

(2) *Inversion in the 26.68-day period.*—The phenomenon of inversion described in Bulletin No. 21 might be produced in three different ways: (1) By the physical inversion of the cause at its source, namely, the impressed external field itself; (2) by the interference of two periods of different lengths; (3) by the geometrical formation of opposite couples.

The 26.68 day periodic curve, when applied to the current observations of meteorology and magnetism, does not follow directly in its comparison throughout the year, but the curve is semiannually inverted, as shown in Bulletin No. 21. An effort was made to discover evidence of an inversion of some kind on the sun's surface by arranging the spots for 38 years in the 26.68-day period, and the result was that the sun-spot frequency in solar longitude produces the same curve as that already found in the terrestrial elements, together with an inversion between the two solar hemispheres, even to reproducing the representative curve in its details. This remarkable conclusion might have tempted me to ascribe the effect at the earth to some connection with this as a cause on the sun, and yet the report said, page 146:

> When this result was first obtained I hoped to find in it a clew to the law of the inversion of the type curve detected in the earth's field, but a persistent study of the possible physical relations of such curves to positive and negative fields failed to disclose any rational explanation of the connection along these lines, and this phenomenon is therefore left to stand by itself for what it is worth.

Again, two papers were read before the Washington Philosophical Society in 1894 on the inversion of type curves through the interference of two or more forces having unequal periods, but after discussion it was decided to make no mention of this method in my bulletin. The third method of couples is, however, carefully described there, and it is summed up as follows, page 164:

> The important deduction is that for the same external field the horizontal force of the earth's field is changed in one direction under one couple and in the opposite direction for the other couple, when measured at any station as compared with the normal field at that place. The phenomenon of inversion is therefore an effect within the earth's field, of presenting its lines to the direction of an impressed external field from the opposite sides, these couples being generated by the combined aspects of the axes of the earth and sun, together with the peculiar shape of the magnetic ovals.

The curve on page 119 is persistent so far as the sun is concerned; the types on page 44 are terrestrial effects, and they invert at certain epochs semiannually, as shown on page 106. There is no such view allowed in my paper as that the solar maxima and minima interchange to produce opposite terrestrial effects; and there is no evidence of a confusion of terms on my part in connection with interference periods. Indeed, it seems like irony instead of criticism to have a long section of Professor SCHUSTER'S review devoted to describing an objectionable theory which I scrupulously avoided at the expense of much labor, at the same time entirely omitting to even remotely mention the theory which was actually adopted by me.

(3) *The vectors of the coronal field at the surface of the earth.*—An objection is taken to the curved line on Chart 11, page 71, which marks the length of the impressed vectors upon their paths, determined by the concentration of the lines of force into a permeable shell, while apparently avoiding an impenetrable nucleus. It is true that no description was given of this line in the Bulletin, and for the sufficient reason that I had not decided what to say. The description of this curve through the theory of "the horizontal components varying as the cosine of the latitude, while the vertical components vary as the sines," is evidently inadequate although it was fully summarized on page 67. If one draws a mean curve through the waves of Chart 11 it is clear that the curve which Professor SCHUSTER requires is obtained with much accuracy. There is, however, superposed upon this a secondary curve probably similar to the curve which L. A. BAUER obtained by the use of other data and in another connection, Terr. Mag. II, 1, p. 22. I hope before long to render a report on this subject, which is much more interesting and important than is perhaps supposed, but the fact of withholding my work so long need not be used by a critic as evidence against the other statements in that connection.

(4) *The cause of the diurnal deflecting field.*—This field is displayed on Charts 14, 15, 16 of Bulletin No. 21. If any magnetician is able to construct a system of electric currents and explain the physical cause sustaining them, which is equivalent to these diurnal vectors as derived from the magnetic observations, then we shall be relieved of some very perplexing problems. After that is done we shall also be able to say how nearly my hypothesis has reached the mark. Meanwhile there are two or three prominent facts to be remembered: (1) the earth's field is under a system of couples depending absolutely upon the direction of the radius from the sun to the earth, because they move up and down the earth with the sun's seasonal change in declination; (2) if the earth is exclusively an electro-magnet, why are the surface electric currents, which alone can be observed by us, devoid of any pronounced east and west circulation, but are, as they seem to be, merely adjustment currents corresponding to temporary magnetic disturbances? (3) if earth-air electric currents can hardly, if at all, be detached at the earth's surface, why are these so confidently assumed to exist in the air above and in the earth beneath, and why are they also supposed to be capable of producing the definite magnetic values which are observed at the several stations? (4) since the station elements H. D. V. change simultaneously in long, also in short, waves at all stations of the earth in *both* hemispheres and in all longitudes, and in such a way that the *deflecting field lies athwart the normal field* in a direction nearly perpendicular to the ecliptic, how can this be so without there also existing an external field which is not the same as that one producing the diurnal variations? (5) if these two independent fields show that their vectors bend about at great expense to themselves in order to avoid an interior nucleus of the earth, how can we escape the conclusion that the interior of the earth is practically impermeable to these two external fields?

When these questions are fairly answered we may perhaps make further progress than has been outlined in my research. There is one thing certain, namely, that no greater waste of mental energy is possible than that consumed in constructing systems of electric currents equivalent to magnetic fields which depend upon only one of the three primary rectangular components, as the vertical. The horizontal, south-north, and the east-west components must likewise be incorporated in a scheme for the resultant system. The probability is that no system of electric currents will be found adequate to this large demand, in view of the very great complexity of the observed deflecting vectors of magnetic force. Furthermore, the nonconductivity of the air as to electricity is a barrier to widely extended systems of closed electric currents, embracing the space of a hemisphere of the earth in their operation. The phenomena of atmospheric electricity which is local and static, as well as that of thunderstorms, prove this point. On the other hand convective electricity in the great currents of the circulating atmosphere must induce magnetic fields which tend to modify the earth's fields depending upon other causes. This is evidently a meteorological component.

(5) *Temperature effects.*—Professor SCHUSTER observes in his review that the following assertion was made in my paper: that "the interplanetary medium is cooled down by the passage of electro-magnetic waves." I am not aware that any such idea can be found in it, and I do not entertain such a view. What I have maintained is, that an increase in the above-mentioned polar magnetic field—not the electro-magnetic field—synchronizes with an increase in the pressure and

a decrease in the temperature of the earth's atmosphere as measured at the surface, especially in the northwestern portions of the United States. One might endeavor to account for this important phenomenon by employing the proposition that a change in the permeability or the susceptibility of the earth is the means employed in nature for accomplishing this result. After weighing the evidence I refer to my conclusion as follows, on page 172:

The chapter of J. J. THOMSON, "Applications of dynamics to physics," on temperature, No. VI, is very instructive and should be carefully considered. Till this subject is fully worked up in the laboratory we may refer to it as one of the unsolved problems as regards the principles of radiation.

Other references to the variations of μ and κ with the temperature and the pressure might also have been made, but to no further purpose. The difficulty in the problem consists in knowing whether magnetic variations and the corresponding heat changes are a strictly reversible phenomenon. Changes of temperature and pressure do make changes in magnetic field, that we know; but the converse statement is at least much less simple. On the other hand we are confronted with the fact above stated, that solar magnetic energy is transmitted from the sun to the earth through a strictly polar magnetic field, wherein transient magneto-electric waves are formed, which on contact with the earth's atmosphere are followed by synchronous changes in the meteorological elements. The trouble with arriving at a solution is twofold: (1) The solar output is unsteady, so that it is difficult to clearly classify the periodicity of the observations; and (2) any external field affecting the whole atmosphere of the earth modifies the circulation as an entirety, and in consequence the formation of the cyclones and the anticyclones, while at the same time our observations of temperature and pressure are necessarily made in the lowest stratum of the air, and therefore several steps removed in the process away from the sources. Whether the observed temperature and pressure changes are chiefly produced by the transportation of air from one place to the other through variations in the general circulation on a large scale, as in modifying the progressive movement of high and low areas of pressure, with an attendant train of subordinate currents of air of considerable dimensions, or whether there is also a direct physical production of heat by the degeneration and transformation of this magnetic energy is the question. I have inclined to the belief that the external magnetic field modifies the general circulation, and that in this manner it partially regulates the order in which the high and low areas of pressure advance over a given locality. This is the position advocated in Bulletin No. 21, and I have never stated that the same maximum impulse from outside sometimes produces a high and sometimes a low area, as one critic feels at liberty to misinterpret my report. The entire question is so extremely complex that at least moderation is essential on the part of all those who choose to discuss the problem, in order that confusion in interpretation be not added to the intrinsic difficulties of the subject.

(6) *Potentials of high inverse powers in the sun.*—It is objected by Professor SCHUSTER that a nine-crested magnetic field from the sun involves terms of the form cos 9λ or sin 9λ, and a solar potential of the form $\frac{1}{r^n} \cdot S_n^9$, and as a consequence an absurd system of enormously great positive and negative values arranged like a sliced orange. I have not advanced this theory, and if it is supposed that it is a necessary consequence of Chart 23, I do not admit the inference, and claim also that it proves too much. The nine-crested curve is itself the representative of a very complex system depending upon solar action, of which at least three components can be distinguished, as follows: (1) There is the long sweep having one maximum and minimum only. The interpretation of this is that the magnetic forces on the sun are stronger on one side than on the other side of it, and this fact has been so well known for many years that few will care to controvert it. (2) There is a nine-crested wave superposed upon the first, which is a *mean or average* value derived by putting together the observations of many years, perhaps 225 revolutions of the sun. It is built up out of a long series of quite irregular impulses in the solar output, which after a while by dint of approximate repetition in the same solar longitudes gradually constructs the curve under discussion. By means of the compilation of the sun spots in the 26.68 day periods, pages 140–146, precisely the same type curve in its distinguishing features was obtained. There must be some prevailing substructure in the body of the sun which simultaneously produces these two phenomena, and one might as logically conclude that the sun spots do not exist at all as to

allow that Professor SCHUSTER'S *reductio ad absurdum* excludes the external magnetic field at the earth from further consideration. (3) Furthermore, the same curve consists actually of an unnumbered multitude of minor waves, such as are shown in the diurnal traces on our photograms. The diurnal mean of all the irregular variations which occur during a single day at any observatory was first obtained in the computations by the addition together of 24 ordinates selected from the hundreds which could be measured from a given photographic trace, and the mean of these values gives the ordinate for that day. These day ordinates are then combined into periods, and the average of many rotations is taken. This process was repeated from the observations of several observatories and the final mean is the resultant curve. To make this complex curve the basis for a solar potential *reductio ad absurdum* is a very short cut to an objection to my position Again, if by any line of reasoning one is compelled to admit that the sun emits an irregular external magnetic field, produced by its internal magnetization or by complex systems of electric currents, then, *whether it conforms to any period or not*, one is forced to account for the existing complex field surrounding the sun at a given epoch, wherein the alternations from positive to negative on each side of a mean normal field may be counted by the hundreds, and consequently the solar potential must be assumed to have exponential powers in proportion. I am certainly of opinion that the sun does possess such an external field, in spite of its high temperature. The cause may be electric currents or it may be magnetization. The earth and the sun are both in the same category in that respect, so far as the argument goes, and we are in fact obliged to infer from observations on the surface of the earth what must be the physical condition of the sun and the other planets. The sun is in an unsteady state and it is undergoing spasmodic local changes in temperature and pressure along all its meridians and in different latitudes. That the sun has a structure and a quasi-permanent nucleus, as opposed to the old astronomical view that the sun is merely a vaporous body, is undoubtedly asserting itself as a working hypothesis, and it is supported by the observed arrangement of the coronal prominences, faculæ, and spots in latitude and in longitude. The sun's physical energy is apparently more pronounced in one longitude than in another, the outbursts must be propagated more vigorously not only through the body of the sun, but also through surrounding spaces along given meridians, and it is this special type of impulses that finally integrates into the curves that have been found by compiling the magnetic and the meteorological observations. In one sense this is of course a potential problem, and so far from regarding Professor SCHUSTER'S statement as an argument against discussing it, one readily sees that he is only somewhat incomplete, proves too much, and ascribes to me the orange theory, which is not in my report, and which excludes some other facts of equal importance.

Professor SCHUSTER evidently does not believe that the sun acts like a revolving magnet, and he holds an interesting brief to his thesis. He might, however, about as well have written it without regard to my paper, which he assumes contains some views not admitted by the author to be there.

Lord KELVIN'S presidential address regarding terrestrial magnetic storms and the hypothesis that they are due to magnetic waves emanating from the sun, published in Nature December 1, 1892, contains a computation of the work which must be done in the sun in order to produce a certain terrestrial magnetic storm. The amount is so excessive that he sums up as follows:

> It seems as if we may also be forced to conclude that the supposed connection between magnetic storms and sun spots is unreal, and that the seeming agreement between the periods has been a mere coincidence.

To quote one recent result, Mr. G. W. LITTLEHALES, in his notice of the paper by WILLIAM ELLIS "On the relation between the diurnal range of the magnetic declination and horizontal force and the period of sun-spot frequency," Terr. Mag., Dec., 1898, p. 184, says:

> Throughout this period, 1841-1896, the results show an entire synchronism between the irregularities in the length of the sun-spot period and the magnetic period. The accord between the two phenomena, both in period and activity, is so complete as to indicate either a direct relationship between them or the existence of some common cause producing them.

Circumstantial testimony might be brought forward in unlimited quantities to show that the entire drift of our observations is contradictory to Lord KELVIN'S supposition that the apparent connection is a mere coincidence. It is possible that Lord KELVIN intended to limit his statement to the few magnetic storms showing simultaneous physical solar changes visibly, and did not exclude

the more ordinary states of the earth's magnetic field. My own study of disturbances leads me to suspect that the disturbances have some peculiar modifying features in their history, and I hope to continue my research in that direction. However that may be, this address has been widely quoted as conclusive against the theory of direct magnetic action of the sun penetrating to the distance of the earth. But when a strong body of facts is opposed to the general conclusion of a single theoretical investigation, that result must be held in judgment till the discrepancy is cleared up. My own impression regarding the development of this problem in solar physics is that magneticians are gradually being forced to abandon some of the old arguments against it. Since such physicists as ROWLAND, EBERT, H. POINCARÉ, and others, see no real reason for not considering the sun as a strong magnetic body, it is clear that this hypothesis is worth patient consideration, in view of the large amount of testimony in favor of it.

If the sun's direct magnetic action were to be excluded from investigation then we should come upon several apparently insuperable difficulties. Since it must be admitted that solar energy does affect the earth in other ways than through simple electro-magnetic radiation, then, without the hypothesis of magnetic direct action, we must discover "some other way." Now, after a search for such another way during the past fifty years, it is not too much to say that nothing of the kind has been detected, or even suggested, except as a sheer speculation. The nearest to such a working hypothesis is that the sun as an electrostatic body touches the earth through an electric field. There are, however, the following fundamental difficulties to be overcome: (1) The sun as an electrostatic body must do very much more work than as a magnetic body to produce the observed variations. (2) The electrostatic rays must come to the earth along the plane of the ecliptic, but the deflecting vectors have been shown by BIGELOW'S and also by VAN BEMMELEN'S computations on the disturbances to come upon the earth perpendicular to that plane. (3) The diurnal and the 26.68-day periodic variations, as well as the disturbances, if in their origin they are radially directed from the sun, should possess one common type of distribution, but in fact two totally distinct vector systems are found to exist. (4) No observations on the sun's insolation have ever detected periodic variations in the electro-magnetic field. (5) Even if it were possible to construct a system of independent electric closed currents in the atmosphere of the earth which would in themselves account for all the observed variations in the earth's magnetic field, then we should be compelled to assert that the earth's magnetic changes are so powerful as to cause the synchronous disturbances observed on the sun, or else to deny such synchronism.

Not only the facts, so far as now known, but also simplicity of construction are all in favor of the view of direct solar magnetic action for the secular, 11-year, and the other long periods, the 26.68-day period, the long and short irregularities, such as the disturbances and the Eschenhagen minute waves; and they are likewise in favor of attributing the diurnal and annual variations to the action of the electro-magnetic radiation. It may be quite true that we do not understand the exact mechanism operating in these two fields, but in view of the growing tendency among scientists to dispense with mechanical analogies in thermodynamics, in electricity and magnetism, also in the theory of the substructure of matter itself, that is, in the molecules and atoms, we are justified in continuing such researches as these, even if we do not comprehend the mechanics of Nature. Unfortunately, the subject is large and complex; the observations themselves show such looseness and irregularity and they are so involved as not to be able to compel unquestioned assent to several very probable conclusions; the subject of solar terrestrial magnetism in its relation to meteorology will for a long while afford occupation for physicists; and I suppose that under these circumstances we must allow for inadequate statements about the results of research work. The lack of agreement among magneticians for two or three generations shows how difficult the subject really is, but it also indicates that those who are honestly contributing what they can to advance it should be mutually considerate of each other.

CHAPTER 10.

A SYSTEM OF FUNDAMENTAL CONSTANTS AND FORMULÆ.

NEED OF A STANDARD SYSTEM FOR METEOROLOGY.

A comparative study of the leading papers that have been published on the problems of meteorology, including the works of FERREL, OBERBECK, HANN, SPRUNG, HERTZ, and VON BEZOLD, in particular, has convinced me that we have now arrived at a stage of development where a compact system of fundamental constants and working formalæ should be prepared. Taking up any special part of the subject, it is easily shown that there is among the authors a good deal of repetition of the same principles, in such variations of notation, with slightly differing constants, and comprising several aspects of the problems, so that the exposition of the primary facts in analytic meteorology has become much more obscure than it need be. The matter of notation is one to which little attention has been paid by the authors with reference to what others had done, and the consequence is that in passing from one paper to another we have the annoyance of recasting the ideas in other symbols, to the great detriment of clear and progressive scholarship. Accordingly, I have been induced to adopt a standard system of notation differing as little as possible from the main trend of existing symbols, and into this the formulæ of the several authors have been transposed. The result shows that while there are many *equivalent expressions* for the same thing the body of independent material is not very great. The use of this system has so far commended itself in practice that it is thought it may be of advantage to lay at the basis of our analytic discussion of the cloud observations this set of constants and formulæ, and also to compile tables putting their expansion in working order for general computations.

There is another important object to be obtained in the construction of these formulæ and the corresponding tabulations, namely, the analysis of the terms of the equations of motion in such a way that they shall lend themselves to a convenient and exact discussion of the meteorological data. This consists essentially in the formation of the equations of condition, and the residuals from observation for the correction of the assumed constants entering into the equations. If this process can once be systematically introduced into meteorology it will do much to take the subject out of the field of empiricism and place it among the exact sciences, where, in my judgment, it properly belongs. It was probably necessary that the first contributions to the physics of the atmosphere should have been rather detached and even desultory in their character, but it is believed that the time has come to construct a central definite body of laws, which shall gradually be refined by continuous study. A student who masters one such system has an unquestioned advantage in reviewing the papers of a more special nature. In thus attempting to coordinate our knowledge I have found it necessary to introduce some original mathematical developments, chiefly with the ultimate view of reaching the residuals above mentioned. The places where these differ from the well-known formulæ will be briefly developed. Since it is not our purpose to write an extensive text on analytic meteorology, I have curtailed the running instructions as to the successive steps so that they are comprised within a comparatively small space. While this is not advantageous for the nonmathematical reader, such a body of formulæ in this shape is most convenient for reference by students who have otherwise considered the problems.

A STANDARD SYSTEM OF CONSTANTS, BAROMETRIC, AND THERMODYNAMIC EQUATIONS.

TABLE 62.—*The primary fundamental constants and units.*

RADIUS OF THE EARTH.

International Meteorological Tables. B. 10.

		Meters.	Logs.	Feet.	Logs.
1. Bessel's Spheroid.	a	6377397	6.8046435	20923240	7.3206290
	b	6356079	6.8031893	20853300	7.3191748
	$\varphi=45°$	6366787	6.8039203	20888430	7.3199058
	R	6370191	6.8041525	20899600	7.3201380
Clarke's Spheroid.	a′	6378294	6.8047045	20926180	7.3206900
	a″	6376350	6.8045722	20919810	7.3205577
	b	6356068	6.8031885	20853270	7.3191740
	a	6378253	6.8047017	20926050	7.3206872
	b	6356521	6.8032195	20854750	7.3192050
	R	6367324	6.8039569	20890190	7.3199424
Adopted R (Bessel's).	R	6370191	6.8041525	20899600	7.3201380

METER-FEET EQUIVALENT.

2. International Bureau, September, 1896.

	1 meter	=1.0936143	yards.	0.0388642
		=3.2808429	feet.	0.5159855
		=39.370113	inches.	1.5951666
Adopted meter.	1 meter	=39.37011	inches.	1.5951666

KILOGRAM-POUNDS EQUIVALENT.

3. U. S. Coast and Geodetic Survey, 1893.

	1 kilogram	=15432.35639	grains troy.	4.1884322
		=2.204622627	pounds av.	0.3433343
		=980,600	dynes.	5.9914919
	1 grain troy	=0.06479891824	gram.	8.8115677
	1 pound av.	=453.5924277	grams.	2.6566658
Adopted kilogram.	1 kilogram	=15432.350	grains troy.	4.1884321
Adopted grain troy.	1 grain troy	=0.06479894	gram.	8.8115679

GRAVITATION CONSTANTS.

4. Helmert. "Higher Geodesy."	g=980.597	k=.002648
Broch. "International Table."	980.6056	.00259
Harkness. "Solar Parallax."	980.60	.00266
Adopted, g and k.	980.60	.00260

SPECIFIC GRAVITY OF DRY AIR.

At 0°C, 760 mm. with .0004 parts carbonic acid.

5. International Bureau of Weights and Measures.

Adopted, ρ_o.	1 cu. cm.=0.00129305 gram.	7.1116153

TABLE 63.

6. *Weights per unit volume.*

Weight of—	Water.		Mercury.		Dry air.		Aqueous vapor.	
1 cu. cm. —grams.	1	0.00000	13.5958	1.13340	.00129305	7.11162	.00080427	6.90540
1 cu. meter—kilos.	1000	3.00000	13595.8	4.13340	1.29305	0.11162	.80427	9.90540
1 cu. inch —lbs.	0.036041	8.55679	.490003	9.69020	.0000466	5.66841	.0000290	5.46220
1 cu. foot —lbs.	62.2786	1.79434	846.728	2.92774	.080529	8.90595	.050089	8.69974

7. *Weight of the atmosphere.*

Units.	Grams × [cm.]².		Kilograms × [meter]².		Pounds × [inch]².		Pounds × [foot]².	
Unit weight.	1		1000		.036041		62.2786	
Density.	13.5958		13.5958		13.5958		13.5958	
Height of mercury.	76		.76		29.921		2.493	
Atmosphere.	1033.3	3.01422	10333	4.01422	14.661	1.16616	2111.25	3.32455
Unit weight.	1		1000		.036041		62.2786	
Density.	.00129305		.00129305		.00129305		.00129305	
Height of hom. atmos.	799100		7991		814608		26217.3	
Atmosphere.	1033.3	3.01422	10333	4.01422	14.661	1.16616	2111.25	3.32455

TABLE 64.—*Fundamental constants.*

Quantities and formulæ		Metric system Kilogram-meter-second-C°		English system Pound-foot-second-F°	
		At 0°C.		At 62° F.	
8. Mass		1 kilogram		15432.350 gr. troy	4.1884321
				2.20462 lbs.	0.3433337
9. Length		1 Meter		1.0936143 yd.	0.0388642
				3.2808429 ft.	0.5159855
				39.3701100 in.	1.5951666
		0.06479894 gram	8.8115679−10	1 grain troy	
10. Radius of earth	R	6370191 m.	6.8041525	20899600 ft.	7.3201380
11. Gravity	g_0	9.8060	0.9914919	32.172	1.5074774
12. Coef. in lat.	k	0.00260	7.41497 −10	0.00260	7.41497 −10
13. Coef. in alt.	$1+\eta=1+\frac{5}{4}\frac{KM}{R}$	1.00157	0.00068	1.00157	0.00068
14. Angular velocity	n	0.00007292	5.86285 −10	0.00007292	5.86285 −10
	$2n$	0.00014584	6.16388 −10	0.00014584	6.16388 −10
	Rn	464.52	2.66700	1524.0	3.18299
	R^2n	2.959×10^9	9.47115	3.1851×10^{10}	10.50313
	Rn^2	0.033873	8.52985 −10	0.11113	9.04584 −10
	$\frac{Rn^2}{g_0}$	0.0034543	7.53836 −10	0.0034543	7.53836 −10
	$\frac{2n}{g_0}$	0.000014873	5.17239 −10	0.000004533	4.65640 −10
	$2gl$	156720.	5.1951250	1686901.	6.2270896
	$\frac{2gl}{M}$	360862.	5.5573407	3884234.	6.5893053
15. Modulus	M	0.4342945	9.6377843−10	0.4342945	9.6377843−10
	$\frac{1}{M}$	2.3025850	0.3622157	2.3025850	0.3622157
16. Naperian base	e ε	2.7182818	0.4342945	2.7182818	0.4342945
17. Weight per unit volume — Mercury	σ_m (Kilog. per cu. meter)	13595.8 kilo.	4.1334048	846.728 lbs.	2.9277436
Water	σ_1	1000.	3.00000	62.2786	1.7943388
Air	$\sigma_0=\left(\frac{N}{v}\mu\right)_0$	1.29305	0.1116153	0.080529	8.9059541−10
Aq. vapor	σ'	0.80427	9.9054019−10	0.050089	8.6997407−10
Ice	σ_2	916.74	2.96225	57.094	1.75659
18. Specific weight — Mercury	$\rho_m=\frac{\sigma_m}{\sigma_1}$	13.5958	1.1334048	13.5958	1.1334048
Water	ρ_1	1.0000	0.00000	1.0000	0.00000
Air	ρ_0	0.00129305	7.1116153−10	0.00129305	7.1116153−10
Aq. vapor	ρ'	0.00080427	6.9054019−10	0.00080427	6.9054019−10
Ice	ρ_2	0.91674	9.96225 −10	0.91674	9.96225 −10
19. Barom. pressure	$B_n=\frac{p_0}{\sigma_m}$	0.760 m	9.8808136−10	2.4934 ft.	0.3967991
		760. mm	2.8808136	29.921 in.	1.4759761
20. Height Hom. Atmos.	$l=\frac{\rho_m B_n}{\rho_0}=\frac{\sigma_m B_n}{\sigma_0}=RT$	7991.04	3.9026031	26217.3	4.4185886
	$\frac{1}{l}$	0.00012514	6.0973969−10	0.000038143	5.5814114−10
21. Barom. Constant	$K=\frac{l}{M}=\frac{\sigma_m B_n}{\sigma_0 M}$	18400.	4.2648188	60367.7	4.7808043
	$\frac{1}{K}$	0.00005435	5.7351812−10	0.00001657	5.2191957−10
22. Newt. Vel. Sound	c	279.93	2.44705	918.4	2.96303
23. Coef. of expansion $a_0=a(1+at)$	$c^2=g_0l=\frac{1}{a_0}$	78359.	4.89409	843450.	5.92606
	$a_0=\frac{1}{g_0l}=\frac{1}{c^2}=\frac{\rho_0}{P_0}=\frac{\rho_0}{\rho_m g_0 B_n}$	0.000012762	5.10591 −10	0.0000011856	4.07394 −10
24. Pressure, units of force	$P_0=g_0\rho_0 l=g_0\rho_m B_n$				
	$=g_0\rho_0 p_0 v_0=\frac{g_0 p_0}{\sigma_1}$	101.324	2.00571	1090.63	3.03768
25. Pressure, units of weight	$p_0=\sigma_1\rho_0 l=\sigma_m B_n=\sigma_1\rho_m B_n$				
	$=\frac{\sigma_1}{g_0}P_0$	10333.	4.0142184	2111.23	3.3245356
26. Volume of air	$v_0=\frac{1}{\sigma_0}$	0.77336	9.8883847−10	12.4178	1.0940459
27. Equ. of elasticity	$p_0v_0=RT=l$	7991.04	3.9026031	26217.3	4.4185886

TABLE 64.—*Fundamental constants*—Continued.

Quantities and formulæ			Metric system Kilogram-meter-second-C°		English system Pound-foot-second-F°	
28. Unit mass		$\sigma_o v_o = \sigma v = m$	**1.000**	0.00000	**1.000**	0.00000
29. Coef. of expn.		α	**0.00367**	7.56457 −10	**0.002039**	7.30942 −10
30. Humidity const.		β	**0.378**	9.57749 −10	**0.378**	9.57749 −10
31. Absolute temp.		$T = T_0 + t$	**273.C° + t**	2.43616	**459.4 F° + t.**	2.66219
32. Heat units		Θ	**1 calorie**		**3.968 Br. Th. U.**	0.59856
33. Heat equiv. work		A	**0.002342**	7.36978 −10	**0.0012855**	7.10906 −10
Mech. equiv. heat		$\frac{1}{A}$	**426.8**	2.63022	**777.9**	2.89094
34. Spec. grav.	Mercury	ρ_m	**13.5958**	1.13340	**13.5958**	1.13340
	Water	ρ_1	**1.000**	0.00000	**1.000**	0.00000
	Air	ρ_0	**0.00129305**	7.11162 −10	**0.00129305**	7.11162 −10
	Aq. vapor	ρ'	**0.622** $\times \rho_0$	9.79379 $\times \rho_0$	**0.622** $\times \rho_0$	9.79379 $\times \rho_0$
	Ice	ρ_2	**708.97** $\times \rho_0$	2.85063 $\times \rho_0$	**708.97** $\times \rho_0$	2.85063 $\times \rho_0$
	Carb. acid	ρ_3	**1.529** $\times \rho_0$	0.18441 $\times \rho_0$	**1.529** $\times \rho_0$	0.18441 $\times \rho_0$
35. Gas const.	Air	$R = \frac{p_0 v_0}{T_0} = \frac{\rho_m}{\rho_0} \frac{B_m}{T_0}$	**29.2713**	1.46644	**57.068**	1.75639
	Aq. vap.	$R_1 = \frac{R}{.622}$	**47.060**	1.67265	**91.748**	1.96260
	Water	R_w	**0.03785**	8.57806 −10	**0.622**	9.79379 −10
36. Products		$AR = C_p - C_v$	**0.068584**	8.83622 −10	**0.073358**	8.86546
		$RT_0 = p_0 v_0 = l$	**7991.04**	3.90260	**26217.3**	4.41859
		ART_0	**18.7232**	1.27238	**33.7008**	1.52765
		$AR_1 = C'_p - C'_v$	**0.1103**	9.04243 −10	**0.11794**	9.07166
37. Quant. heat	Water	Q_1	**1000.0 calories**	3.00000	**62.2786 Br. Th.**	1.79434
	Air	Q_0	**0.3070**	9.48711 −10	**0.01912**	8.28144 −10
	Aq. vap.	Q'	**0.3864**	9.58709 −10	**0.02407**	8.38143 −10
38. Spec. heat	Water	C_1	**1.0000**		**1.0000**	
	Air	$C_p = C_v + AR$	**0.2374 + .00024μ**	9.37549 −10	**0.9420**	9.97405 −10
		$C_v = C_p - AR$	**0.1688**	9.22742 −10	**0.8686**	9.93882 −10
	Aq. vap.	$C'_p = C'_v + AR_1$	**0.4805**	9.68169 −10	**1.9066**	0.28026
		$C'_v = C'_p - AR_1$	**0.3072**	9.56844 −10	**1.7887**	0.25254
39. Ratios		$\frac{C_p}{C_v} = k$	**1.4063**	0.14807	**1.0845**	0.03523
		$\frac{C'_p}{C'_v} = k'$	**1.2979**	0.11325	**1.0659**	0.02772
40. Exponents		$\varepsilon_p = \frac{C_p}{AR} = \varepsilon_v + 1$	**3.4615**	0.53927	**12.8401**	1.10859
		$\varepsilon_v = \frac{C_v}{AR} = \varepsilon_p - 1$	**2.4615**	0.39120	**11.8401**	1.07336
41. Gradients		$-\frac{dh}{dt} = \frac{\varepsilon_p l}{T_0} \frac{1}{\Theta} = \frac{C_p}{A} \cdot \frac{1}{\Theta} = P_0$	**101.324**	2.00571	**184.683**	2.26643
		$-\frac{dt}{dh} = -\theta_\varepsilon$	**0.009869**	7.99429	**0.0054146 Cal.**	7.73357 −10
42. Latent heat	Water	r_0	**606.5 − 0.708t**	2.78283	**1091.7 − 1.274t.**	3.03810
	Ice	q	**80.025**	1.90323	**144.045**	2.15850
43. Vapor pressure		e_0 at 0°C	**4.5687**mm	0.65979	**0.180 in (32° F.)**	9.25527 −10
44. Gradient distance		D 1 *degree*	**111 111.(meters)**	5.04575	**364525.**	5.56174
45. Gradient constant in terms of P		$\mu = \frac{\rho_m g_0}{111\ 111\ 111}(P)$	**0.00000126**mm	4.07914 −10	**0.00000472 G (.01in.)**	4.67431 −10
46. And of p		$\mu' = \frac{\sigma_m}{111\ 111\ 111}(p)$	**0.00012266**mm	6.08765 −10	**0.00048178 G (.01in.)**	6.68282 −10

TABLE 65.—*Equivalent expressions for variations of pressure and horizontal gradient force with the temperature.*

47a.

$$\frac{P}{\rho}=\frac{P_o}{\rho_o}\frac{T}{T_o}=\frac{P_o}{\rho_o}(1+\alpha t).$$
$$=g_o l\,(1+\alpha t).$$
$$=\frac{1}{a_o}(1+\alpha t).$$
$$=\frac{1}{a}.$$
$$=\frac{\rho_m}{\rho_o}B_n g_o\,(1+\alpha t).$$
$$=\frac{p_o}{\rho_o\sigma_1}g_o\,(1+\alpha t).$$
$$=p_o v_o g_o\,(1+\alpha t).$$
$$=RTg_o\,(1+\alpha t).$$
$$=c^2\,(1+\alpha t).$$

$$=78360\,(1+\alpha t).\quad\text{[Metric.]}$$
$$=843450\,(1+\alpha t).\quad\text{[English.]}$$

47b.

$$-\frac{1}{\rho}\frac{\partial P}{\partial x}=-\frac{P_o}{\rho_o}(1+\alpha t)\,\frac{1}{P}\frac{\partial P}{\partial x}.$$
$$=-g_o l\,(1+\alpha t)\,\frac{\partial \log P}{\partial x}.$$
$$=-\frac{1}{a_o}(1+\alpha t)\,\frac{\partial \log P}{\partial x}.$$
$$=-\frac{1}{a}\cdot\frac{\partial \log P}{\partial x}.$$
$$=-\frac{\rho_m}{\rho_o}B_n g_o\,(1+\alpha t)\,\frac{\partial \log P}{\partial x}.$$
$$=-\frac{p_o}{\rho_o\sigma_1}g_o\,(1+\alpha t)\,\frac{\partial \log P}{\partial x}.$$
$$=-p_o v_o g_o\,(1+\alpha t)\,\frac{\partial \log P}{\partial x}.$$
$$=-RTg_o\,(1+\alpha t)\,\frac{\partial \log P}{\partial x}.$$
$$=-c^2\,(1+\alpha t)\,\frac{\partial \log P}{\partial x}.$$

$$=-\frac{1}{\rho}\cdot\rho_m g_o\frac{\partial B}{\partial x}.$$
$$=-\frac{1}{\rho}\rho_m g_o\frac{G}{111111}.\quad\text{(Meters.)}$$
$$=-\frac{1}{\rho}\mu\,G.\quad\text{(Metric.)}$$
$$=-\frac{1}{\rho}0.0000012\,G.\quad\text{(Millimeters.)}$$
$$=-\frac{1}{\rho}\cdot\rho_m g_o\frac{G'}{364525}.\quad\text{(English.)}$$
$$=-\frac{1}{\rho}0.00000472\,G'.\quad\text{(Hund. in.)}$$
$$=-78360\,(1+\alpha t)\,\frac{\partial \log P}{\partial x}.\quad\text{(Metric.)}$$
$$=-843450\,(1+\alpha t)\,\frac{\partial \log P}{\partial x}.\quad\text{(English.)}$$

$$-\frac{1}{\rho}\frac{\partial p}{\partial x}=-\frac{1}{\rho}\sigma_m\frac{\partial B}{\partial x}=-\frac{1}{\rho}\frac{\sigma_m G}{111111111}.$$
$$=-\frac{1}{\rho}0.00012236\,G.\quad\text{(Millimeters).}$$
$$=-\frac{1}{\rho}0.00048178\,G'.\quad\text{(Hund. inches.)}$$

48. G=the barometer difference for the distance of 111111 meters.

ΔB=the barometer difference for the distance of 1 meter. $\frac{\Delta B}{\partial x}=\frac{G}{111111}$.

Γ=the gradient force per meter=ΔP in terms of P, units of force.
=Δp in terms of p, units of weight.

$$P_o=g_o\rho_m B_n.\qquad p_o=\sigma_m B_n.$$
$$\frac{\Delta P}{\partial x}=g_o\rho_m\frac{\Delta B}{\partial x}.\qquad \frac{\Delta p}{\partial x}=\sigma_m\frac{\Delta B}{\partial x}.$$
$$=\frac{g_o\rho_m}{111111}G.\qquad =\frac{\sigma_m}{111111}G.$$
$$=0.0012\,G\ \text{(meter)}.\qquad =0.12237\,G\ \text{(meter)}.$$

p in kilograms per square meter.
σ in kilograms per cubic meter.

$P=\frac{g_o}{\sigma_1}\cdot p$, in units of force per square meter.

TABLE 66.—*Relations leading to the hypsometric formulæ.*

49. Gravity:

$$g=g_o\cdot\frac{1}{(1+\gamma)\left(1+\frac{h+h_o}{R}\right)}=g_on_1.$$

$$n_1=\frac{1}{(1+\gamma)\left(1+\frac{h+h_o}{R}\right)}.\quad\text{Gravity, height.}$$

50. Weight:

$$p_o=\sigma h=\sigma_o l=\sigma_m B_n=\rho_o\sigma_1 l.$$

51. Density:

$$\sigma=\frac{\sigma_m B_n}{h}=\frac{\sigma_o l}{h}=\frac{P}{P_o}\frac{\sigma_o}{(1+\alpha t)(1+\beta)}.$$

$$n=n_1n_2.$$

52. Pressure:

$$P_o=P\frac{\rho_o}{\rho}\cdot\frac{1}{(1+\alpha t)(1+\beta)}=P\cdot\frac{h}{l}\cdot n_2.$$

$$n_2=\frac{1}{(1+\alpha t)(1+\beta)}\quad\text{Temperature, humidity.}$$

53. Homogeneous atmosphere:

$$l=p_ov_o=RT=\frac{\rho_m}{\rho_o}B_n=\frac{\sigma_m}{\sigma_o}B_n=\frac{p_o}{\rho_o\sigma_1}.$$

54. Pressure differential:

$$P=\frac{pg}{\sigma_1}=\frac{\sigma h}{\sigma_1}\cdot g_on_1.$$

$$dP=-\frac{\sigma}{\sigma_1}g_on_1dh=-\frac{\sigma_mB_n}{\sigma_1h}g_on_1dh=-\frac{p_o}{\sigma_1h}g_on_1dh=-\frac{\sigma_ol}{\sigma_1h}g_on_1dh.$$

$$dP=-\frac{\sigma_o}{\sigma_1}\cdot\frac{P}{P_o}g_on_1n_2dh=-\frac{\sigma_oP}{\sigma_mB_n}\cdot ndh.$$

55. Difference of height:

$$-dh=\frac{\sigma_mB_n}{\sigma_o}\cdot\frac{1}{n_1n_2}\cdot\frac{dP}{P}=\frac{p_ov_o}{n}\cdot\frac{dp}{p}=\frac{RT}{n}\cdot\frac{dp}{p}.$$

56. Integral:

$$h-h_o=\frac{\sigma_mB_n}{\sigma_o}\cdot\frac{1}{n_1n_2}(\text{nap. log})\frac{P_o}{P}=\frac{\sigma_mB_n}{\sigma_oM}\cdot\frac{1}{n}(\text{com. log})\frac{P_o}{P}=\frac{K}{n}(\text{com. log})\frac{P_o}{P}.$$

57. Barometric pressure and auxiliary formulæ:

$$\frac{P_o}{P}=\frac{B_o}{B}\left(1+1.25\frac{h-h_o}{R}\right)=\frac{B_o}{B}\left(1+\mu\frac{h-h_o}{R}\right).$$

$$\log\frac{P_o}{P}=\log\frac{B_o}{B}+\log\left(1+\mu\frac{h-h_o}{R}\right).$$

$$\log\frac{P_o}{P}=\log\frac{B_o}{B}+\frac{\mu KM}{R}\log\frac{B_o}{B}.$$

$$\log\frac{P_o}{P}=\left(1+\frac{\mu KM}{R}\right)\log\frac{B_o}{B}=(1+\eta)\log\frac{B_o}{B}.$$

$$\left[\begin{array}{l}\text{Com. log}(1+x)=M\left(x-\tfrac{1}{2}x^2+\tfrac{1}{3}x^3-\ldots\right)\\ \mu\cdot\frac{h-h_o}{R}=\mu\frac{K}{R}\log\frac{B_o}{B}=x\ (\text{approx.})\end{array}\right]$$

58. General formula:

$$h-h_o=K(1+\alpha\theta)\cdot(1+\beta)\cdot(1+\gamma)\cdot\left(1+\frac{h+h_o}{R}\right)\cdot(1+\eta)\cdot\log\frac{B_o}{B}.$$

59. Metric:

$$h-h_o=18400(1+.00367\theta)\left(1+.378\frac{e}{B}\right)(1+.0026\cos 2\varphi)\left(1+\frac{h+h_o}{6370191}\right)(1+.00157)\log\frac{B_o}{B}.$$

$$=(18429+67.6\theta^oC+0.003h)\left(1+.378\frac{e}{B}\right)(1+.0026\cos 2\varphi)\log\frac{B_o}{B}.\ (\text{in meters.})$$

60. English:

$$h-h_o=60367.7[1+.002039(\theta-32)]\left(1+.378\frac{e}{B}\right)(1+.0026\cos 2\varphi)\left(1+\frac{h+h_o}{20899600}\right)(1+.00157)\log\frac{B_o}{B}.$$

$$=(56517+123.3\theta^oF+0.003h)\left(1+.378\frac{e}{B}\right)(1+.0026\cos 2\varphi)\log\frac{B_o}{B}.\ (\text{in feet}).$$

TABLE 66.—*Relations leading to the hypsometric formulæ*—Continued.

61. Metric:

$$\log B_o = \log B + \frac{h-h_o}{18429+67.6\,\theta^o+0.003h}\cdot(1-\beta)\,(1-\gamma) = \log B + m - m\,\beta - m\gamma.$$

62. English:

$$\log B'_o = \log B' + \frac{h-h_o}{56517+123.3\,\theta^o+0.003h}\cdot(1-\beta)\,(1-\gamma) = \log B' + m' - m'\,\beta' - m'\gamma'.$$

θ=mean temperature of the air column $h-h_o$.
e=vapor tension.
B=barometric pressure. } at *one* point of the column.

TABLE 67.—*Development of* $\beta = .378\,\frac{e}{B}$ *in the integral mean.*

	Meters.	Feet.	Meters.	Feet.	
63.	$e = e_o\,10^{-\frac{h}{6517}}$	$= e_o\,10^{-\frac{h}{21381}}$	$= e_o\,\varepsilon^{-\frac{h}{2830}}$	$= e_o\,\varepsilon^{-\frac{h}{9286}}$.	
64.	$B = B_o\,10^{-\frac{h}{18400}}$	$= B_o\,10^{-\frac{h}{60367}}$	$= B_o\,\varepsilon^{-\frac{h}{7881}}$	$= B_o\,\varepsilon^{-\frac{h}{25217}}$.	
65.	$\frac{e}{B} = \frac{e_o}{B_o}\,10^{-\frac{h}{10091}}$	$= \frac{e_o}{B_o}\,10^{-\frac{h}{33108}}$	$= \frac{e_o}{B_o}\,\varepsilon^{-\frac{h}{4383}}$	$= \frac{e_o}{B_o}\,\varepsilon^{-\frac{h}{14378}}$.	$33108 = C'$ $4383 = C$

Integral mean, $\underline{\beta}$.

66. $$\underline{\beta} = \frac{1}{h}\cdot.378\frac{e_o}{B_o}\int_o^h 10^{-\frac{h}{33108}}\,dh \quad = \frac{1}{h}\cdot.378\frac{e_o}{B_o}\int_o^h \varepsilon^{-\frac{h}{4383}}\,dh.$$

$$= -.378\frac{e_o}{B_o}\frac{C'M}{h}\left[10^{-\frac{h}{C'}}\right]_o^h \quad = -.378\frac{e_o}{B_o}\frac{C}{h}\left[\varepsilon^{-\frac{h}{C}}\right]_o^h.$$

$$= +.378\frac{e_o}{B_o}\frac{C'M}{h}\left(1-10^{-\frac{h}{C'}}\right) = +.378\frac{e_o}{B_o}\frac{C}{h}\left(1-\varepsilon^{-\frac{h}{C}}\right).$$

67. $$1-\frac{1}{\varepsilon^{\frac{x}{M}}} = 1-\frac{1}{10^x} = \frac{x}{M} - \frac{1}{2!}\left(\frac{x}{M}\right)^2 + \frac{1}{3!}\left(\frac{x}{M}\right)^3 - \cdots$$ Auxiliary formula.

68. $$\underline{\beta} = .378\frac{e_o}{B_o}\frac{C'M}{h}\left[\frac{h}{C'M} - \frac{1}{2!}\left(\frac{h}{C'M}\right)^2 + \frac{1}{3!}\left(\frac{h}{C'M}\right)^3 - \cdots\right]$$

$$= .378\frac{e_o}{B_o}\left[1 - \frac{1}{2!}\left(\frac{h}{C'M}\right) + \frac{1}{3!}\left(\frac{h}{C'M}\right)^2 - \cdots\right]$$ feet and base 10.

$$= .378\frac{e_o}{B_o}\left[1 - \frac{1}{2!}\left(\frac{h}{C}\right) + \frac{1}{3!}\left(\frac{h}{C}\right)^2 - \cdots\right]$$ meters and base ε.

69. $$\underline{\beta} = .378\frac{e_o}{B_o}\left[1 - \frac{1}{2!}\left(\frac{h}{14378}\right) + \frac{1}{3!}\left(\frac{h}{14378}\right)^2 - \frac{1}{4!}\left(\frac{h}{14378}\right)^3 + \cdots\right]$$ English.

70. $$\underline{\beta} = .378\frac{e_o}{B_o}\left[1 - \frac{1}{2!}\left(\frac{h}{4383}\right) + \frac{1}{3!}\left(\frac{h}{4383}\right)^2 - \frac{1}{4!}\left(\frac{h}{4383}\right)^3 + \cdots\right]$$ metric.

e_o Take values from Broch's, and Marvin's Tables; argument = dewpoint.
B_o Observed barometer at base of the air column h.

The ratio $\frac{e_o}{B_o}$ must be found for the base of the air column.

TABLE 68.—*General thermodynamic formulæ.*

Thermodynamic relations. (Heat units.)

Dry air.

71. $dQ=C_v dt+Apdv=C_v dt+ART\frac{dv}{v}$.

72. $dQ=(C_p dt-ARdt)+(ARdt-Avdp)$.

73. $dQ=C_p dt-Avdp=C_p dt-ART\frac{dp}{p}$.

74. $dQ=C_v\,.\,\frac{pdv+vdp}{R}+Apdv=\frac{C_v}{R}\,.\,vdp+\frac{C_p}{R}\,.\,pdv$.

$c_v=\frac{C_v}{A}$, and $c_p=\frac{C_p}{A}$, in mechanical units.

Auxiliary formulæ.

75. $pv=RT$.

76. $Apv=ART=AR\,(273^o+t)$.

77. $pdv+vdp=Rdt$.

78. $C_p-C_v=AR$.

$=\frac{A}{dt}\,(pdv+vdp)$.

Exponential relations.

	Volume.	Pressure.	Auxiliary formulæ.
79.	$\frac{dQ}{ART}=\frac{C_v dT}{ART}+\frac{dv}{v}$.	$\frac{dQ}{ART}=\frac{C_p dT}{ART}-\frac{dp}{p}$.	
80.	$-\frac{dv}{v}=\frac{C_v}{AR}\cdot\frac{dT}{T}$.	$+\frac{dp}{p}=\frac{C_p}{AR}\cdot\frac{dT}{T}$.	85. Adiabatic. $dQ=o$.
81.	$-\log v\Big]_{v_o}^{v}=\frac{C_v}{AR}\cdot\log T\Big]_{T_o}^{T}$.	$\log p\Big]_{p_o}^{p}=\frac{C_p}{AR}\cdot\log T\Big]_{T_o}^{T}$.	86. $\frac{C_v}{AR}=\frac{C_p}{AR}-1=\varepsilon_v$ $=\varepsilon_p-1=2.4615$.
82.	$\log\frac{v_o}{v}=\frac{C_v}{AR}\cdot\log\frac{T}{T_o}$.	$\log\frac{p}{p_o}=\frac{C_p}{AR}\cdot\log\frac{T}{T_o}$.	87. $\frac{C_p}{AR}=\frac{C_v}{AR}+1=\varepsilon_p$ $=\varepsilon_v+1=3.4615$.
83.	$\frac{v_o}{v}=\left(\frac{T}{T_o}\right)^{\varepsilon_v}=\left(\frac{273^o+t}{273^o+t_o}\right)^{\varepsilon_v}$.	$\frac{p}{p_o}=\left(\frac{T}{T_o}\right)^{\varepsilon_p}=\left(\frac{273^o+t}{273^o+t_o}\right)^{\varepsilon_p}$.	88. $k=\frac{C_p}{C_v}$. $\varepsilon_v=\frac{1}{k-1}$. $\varepsilon_p=\frac{k}{k-1}$.
84.	$\frac{v_o}{v}=\left(\frac{T}{T_o}\right)^{\frac{1}{k-1}}=\left(\frac{p}{p_o}\right)^{\frac{1}{k}}=\frac{\rho}{\rho_o}$.	$\frac{p}{p_o}=\left(\frac{T}{T_o}\right)^{\frac{k}{k-1}}=\left(\frac{v_o}{v}\right)^{k}=\left(\frac{\rho}{\rho_o}\right)^{k}$.	

Vertical gradient relations.

89. Temperature to height:

$$\frac{dp}{p}=\frac{k}{k-1}\frac{dT}{T}. \qquad dp=\frac{k}{k-1}p\frac{dT}{T}=\frac{k}{k-1}p_o\left(\frac{T}{T_o}\right)^{\frac{1}{k-1}}\frac{dT}{T_o}=\frac{k}{k-1}p_o\frac{\rho}{\rho_o}\frac{dT}{T_o}=-\rho dh.$$

$$\frac{dt}{dh}=-\frac{1}{\varepsilon_p}\cdot\frac{T_o\rho_o}{p_o}=-\frac{AR}{C_p}\cdot\frac{1}{R}=-\frac{A}{C_p}\quad=-0.00987\ C^o \text{ per meter.}\quad=6_\varepsilon.$$

90. Temperature to pressure:

$$\frac{dt}{dp}=+\frac{k-1}{k}\cdot\frac{T_o}{p_o}=+\frac{AR}{C_p}\cdot\frac{v_o}{R}=+\frac{A}{C_p}v_o=+0.10377\ C^o \text{ per millimeter.}$$

91. Density to height:

$$d\rho=\frac{dp}{RT}-\frac{pdT}{RT^2}=-\frac{p}{RT}\left(\frac{ndh}{RT}+\frac{dt}{T}\right). \quad \text{Since } \frac{dp}{p}=-\frac{n}{RT}dh. \qquad (55.)$$

$$\frac{d\rho}{dh}=-\frac{p}{RT^2}\left(\frac{n}{R}+\frac{dt}{dh}\right)=-\frac{p}{RT^2}\left(\frac{n}{R}-\frac{A}{C_p}\cdot n\right)=-\frac{p}{RT^2}\left(\frac{1}{R}-\frac{A}{C_p}\right)n=-0.0001151.$$

TABLE 69.—*Adiabatic relations in the exponential form.*

(Ferrel, Hann, Sprung, Sohncke.)

92. Adopted notation.

	Dry air.	Aqueous vapor.	Water.	Ice.	Vapor pressure.	
Unit = 1000 grams.						
α Unsaturated stage.	λ	μ	—	—	e	
β Saturated stage	λ	ν	ν_1	—	e'	$\nu+\nu_1 \quad =\mu.$
γ Freezing stage.		ν	ν_1	σ	e_o	$\nu+\nu_1+\sigma=\mu.$
δ Ice stage	λ	ν	—	σ	e''	$\nu \quad +\sigma=\mu.$

Development of the formulæ for vertical gradients.

93. $\lambda=\dfrac{p-e}{p-.378e}$. $\quad \mu=\dfrac{R}{R_1}\dfrac{e}{p-.378e}$. $\quad r=r_o+q=686.53-0.708t.$

94. $\mu=.622\dfrac{e}{p}$ (Approx.). $\quad \bar{C}_p=\lambda C_p+\mu C'_p.$ $\quad \bar{R}=\lambda R+\mu R'.$

95. $d\mu=\dfrac{.622\,de}{p}-\dfrac{.622\,e}{p}\cdot\dfrac{dp}{p}=\mu\dfrac{de}{e}-\mu\dfrac{dp}{p}.$ $\quad$ **102.** $\dfrac{d\mu}{\mu}=\dfrac{de}{e}-\dfrac{dp}{p}$ (Approx.).

96. $dQ_1=-rd\mu=-r\mu\dfrac{de}{e}+r\mu\dfrac{dp}{p}$. Latent heat from condensation which retards cooling.

97. $\dfrac{dp}{p}=\dfrac{C_p}{AR}\dfrac{dT}{T}-\dfrac{dQ_1}{ART}=\dfrac{C_p}{AR}\dfrac{dT}{T}+\dfrac{r\mu}{ART}\dfrac{de}{e}-\dfrac{r\mu}{ART}\dfrac{dp}{p}$. Adiabatic in β stage.

98. $\dfrac{dp}{p}\left(1+\dfrac{r\mu}{ART}\right)=\dfrac{1}{ART}\left(C_p+\dfrac{r\mu}{e}\dfrac{de}{dt}\right)dt.$

99. $\dfrac{dp}{p}\left(ART+r\mu\right)=\left(C_p+\dfrac{r\mu}{e}\dfrac{de}{dt}\right)dt.$

Auxiliary formulæ.

103. $pv=RT.$
$ev=\mu R_1T.$
$\dfrac{de}{dt}=\dfrac{\mu R_1}{v}$

104. $\dfrac{dp}{p}=-\dfrac{n\rho_o}{\rho_m B_n}dh.$
$=-\dfrac{n}{p_o v_o}dh.$
$=-\dfrac{n}{RT}dh.$

105. $\dfrac{1}{e}\dfrac{de}{dt}=\dfrac{1}{T}.$

100. $-\dfrac{ndh}{RT}\left(ART+r\mu\right)=\left(C_p+\dfrac{r\mu}{T}\right)dt.$

101. $\dfrac{dt}{dh}=-\dfrac{A+\dfrac{r\mu}{RT}}{C_p+\dfrac{r\mu}{T}}\cdot n=\theta_\epsilon\cdot n$ (Approx.). $\quad \dfrac{dt}{dh}=-\dfrac{A\left(1-.378\dfrac{e}{p}\right)+\dfrac{r\mu}{RT}}{\bar{C}_p\left(1-.378\dfrac{e}{p}\right)+\dfrac{r\mu}{T}}\cdot n.$ Rigorous solution.

Summary of the exponential formulæ.

106. α.

Abnormal gradient in dry air.	$\dfrac{dp}{p}=\dfrac{1}{R\theta_m}\cdot\dfrac{d\bar{T}}{\bar{T}}=m\cdot\dfrac{dT}{T}.$	$\theta_m=\dfrac{A}{(C_p)_m}.$
Normal gradient in dry air.	$\dfrac{dp}{p}=\dfrac{1}{R\theta_\varepsilon}\cdot\dfrac{dT}{T}=\varepsilon\cdot\dfrac{dT}{T}.$	$\theta_\varepsilon=\dfrac{A}{C_p}=0.00987.$
Gradient in unsaturated air.	$\dfrac{dp}{p}=\dfrac{1}{R\theta_{\varepsilon'}}\cdot\dfrac{dT'}{T'}=\varepsilon'\dfrac{dT'}{T'}.$	$\theta_{\varepsilon'}=\dfrac{A}{C_p\left(1+.259\dfrac{e}{p}\right)}.$

107. β. Gradient in saturated air. $\quad \dfrac{dp}{p}=\dfrac{1}{R\theta_{\varepsilon''}}\cdot\dfrac{dT''}{T''}=\varepsilon''\dfrac{dT''}{T''}.$ $\quad \theta_{\varepsilon''}=\dfrac{A+\dfrac{r\mu}{RT}}{C_p+\dfrac{r\mu}{T}}.$

108. α.

Abnormal—dry.	$\dfrac{p}{p_o}=\left(\dfrac{T_o-\theta_m h}{T_o}\right)^m.$	m is undetermined.
Normal—dry.	$\dfrac{p}{p_o}=\left(\dfrac{T_o-\theta_\varepsilon h}{T_o}\right)^\varepsilon.$	$\varepsilon=\dfrac{C_p}{AR}=3.4615.$
Normal—unsaturated.	$\dfrac{p}{p_o}=\left(\dfrac{T_o'-\theta_{\varepsilon'} h}{T_o'}\right)^{\varepsilon'}.$	$\varepsilon'=\dfrac{C_p}{AR}\left(1+.259\dfrac{e}{p}\right).$

109. β. Normal—saturated. $\quad \dfrac{p}{p_o}=\left(\dfrac{T_o''-\theta_{\varepsilon''} h}{T_o''}\right)^{\varepsilon''}.$ $\quad \varepsilon''=\dfrac{\bar{C}_p+\dfrac{r\mu}{T}}{A\bar{R}+\dfrac{r\mu}{T}}.$

TABLE 70.—*Adiabatic relations in the logarithmic form.*

(Hertz, Von Bezold.)

α Stage. Unsaturated air.

Auxiliaries.

110. $dQ_1=\lambda(C_v dT+Apdv)=\lambda\left(C_v dT+ART\frac{dv}{v}\right)$ dry air. $(p-e)v=\lambda RT.$

111. $dQ_2=\qquad=\mu\left(C_1 dT+AR_1T\frac{dv}{v}\right)$ vapor. $ev=\mu R_1T.$

112. $dQ=(\lambda C_v+\mu C_v')dT\quad+A(\lambda R+\mu R_1)T\frac{dv}{v}$ mixture. $pv=\lambda RT+\mu R_1T.$

113. $0=(\lambda C_v+\mu C_v')\frac{dT}{T}\quad+A(\lambda R+\mu R_1)\frac{dv}{v}.$ $C_v=C_p-AR.\quad C_v'=C_p'-AR_1.$

114. $0=(\lambda C_p+\mu C_p')\frac{dT}{T}\quad-A(\lambda R+\mu R_1)\frac{dT}{T}+A(\lambda R+\mu R_1)\frac{dT}{T}-A(\lambda R+\mu R_1)\frac{dp}{p}.$

115. $0=(\lambda C_p+\mu C_p')\log\frac{T}{T_o}-A(\lambda R+\mu R_1)\log\frac{p}{p_o}.$ $T_o>273°.$

β Stage. Saturated air.

Auxiliaries.

116. $dQ_1=\lambda\left(C_v dT+ART\frac{dv}{v}\right).$ $\frac{dv}{v}=\frac{dT}{T}-\frac{d(p-e')}{p-e'}.\quad (p-e')v=\lambda RT.$

117. $dQ_2=Td\left(\frac{\nu r}{T}\right)+\mu C_1 dT.$ $C_v=C_p-AR.\quad \nu=\frac{ve'}{R_1T}=\lambda\frac{R}{R_1}\cdot\frac{e'}{p-e'}.$

118. $dQ=\lambda C_v dT+\lambda ART\frac{dv}{v}+T\,d.\lambda\frac{R}{R_1}\frac{e'}{p-e'}\frac{r}{T}+\mu C_1 dT.$

119. $0=\left(\lambda C_p\frac{dT}{T}-\lambda AR\frac{dT}{T}\right)+\left(\lambda AR\frac{dT}{T}-\lambda AR\frac{d(p-e')}{p-e'}\right)+d\left(\lambda\frac{R}{R_1}\cdot\frac{e'}{p-e'}\cdot\frac{r}{T}\right)+\mu C_1\frac{dT}{T}.$

120. $0=(\lambda C_p+\mu C_1)\log\frac{T}{T_o}-\lambda AR\log\frac{p-e'}{p_o-e'_o}+\lambda\frac{R}{R_1}\left[\frac{r}{T}\cdot\frac{e'}{p-e'}-\frac{r_o}{T_o}\cdot\frac{e'_o}{p_o-e'_o}\right].$

e_1 ranges between e and $e_o=4.57$ mm. $T_o>273°.$

γ Stage. Freezing temperature.

Auxiliaries.

121. $dQ=\lambda ART_o\frac{dv}{v}+r_o d\nu-qd\sigma.$ $(p-e_o)v=\lambda RT_o.\quad \frac{v}{T_o}=\frac{\lambda R}{p-e_o}.$

122. $0=\lambda AR\frac{dT_o}{T_o}-\lambda AR\frac{d(p-e_o)}{p-e_o}+\frac{r_o d\nu}{T_o}-\frac{q}{T_o}d\sigma.$ $\nu=\frac{ve_o}{R_1T_o}=\lambda\frac{R}{R_1}\frac{e_o}{p-e_o}.$

123. $0=\qquad-\lambda AR\log\frac{p-e_o}{p_o-e_o}+\frac{r_o}{T_o}(\nu-\nu_0)-\frac{q}{T_o}(\sigma-\sigma_o).$ $\frac{dv}{v}=\frac{dT_o}{T_o}-\frac{d(p-e_o)}{p-e_o}.$

$\sigma=\mu-\nu\qquad\sigma_o=0.$

124. $0=\qquad-\lambda AR\log\frac{p-e_o}{p_o-e_o}+\frac{r_o\nu}{T_o}-\frac{r_o\nu_o}{T_o}+\frac{q\nu}{T_o}-\frac{q\mu}{T_o}.$

125. $0=\qquad-\lambda AR\log\frac{p-e_o}{p_o-e_o}+\lambda\frac{R}{R_1}\frac{e_o}{p-e_o}\frac{r_o+q}{T_o}-\lambda\frac{R}{R_1}\frac{e_o}{p_o-e_o}\cdot\frac{r_o}{T_o}-\frac{q}{T_o}\mu.$

126. $0=\qquad-\lambda AR\log\frac{p-e_o}{p_o-e_o}+\lambda\frac{R}{R_1}\left[\frac{r_o+q}{T_o}\cdot\frac{e_o}{p-e_o}-\frac{r_o}{T_o}\frac{e_o}{p_o-e_o}\right]-\frac{q}{T_o}\mu.$

$e_o=4.57$ mm. $T_o=273°.$

δ Stage. Below freezing temperature.

Auxiliary.

127. $0=(\lambda C_p+\mu C_1)\log\frac{T}{T_o}-\lambda AR\log\frac{p-e''}{p_o-e_o''}+\lambda\frac{R}{R_1}\left[\frac{r+q}{T}\cdot\frac{e''}{p-e''}-\frac{r_o+q}{T_o}\frac{e_o''}{p_o-e_o''}\right].$ $\nu=\lambda\frac{R}{R_1}\frac{e''}{p-e''}.$

e'' ranges between $e_o=4.57$ mm. and 0. $T_o<273°.$

TABLE 71.—*Transformation from the exponential to the logarithmic form.*

Example in the β stage.

128. $\frac{dp}{p}(ART+r\mu)=\left(C_p+\frac{r\mu}{e}\frac{de}{dt}\right)dt.$

129. $C_p\frac{dT}{T}-AR\frac{dp}{p}+\frac{r\mu}{T}\left(\frac{de}{e}-\frac{dp}{p}\right)=0.$ $\qquad \frac{d\mu}{\mu}=\frac{de}{e}-\frac{dp}{p}.$

130. $C_p\frac{dT}{T}-AR\frac{dp}{p}+\frac{r\mu}{T}\frac{d\mu}{\mu}=0.$

131. $C_p\log T-AR\log p+\frac{r}{T}\mu\Big]_o=0.$ $\qquad \mu=\frac{R}{R_1}\frac{e}{p-e}$ (approx.).

132. $C_p\log\frac{T}{T_o}-AR\log\frac{p}{p_o}+\frac{r}{T}\frac{R}{R_1}\frac{e}{p-e}-\frac{r_o}{T_o}\frac{R}{R_1}\frac{e_o}{p_o-e_o}=0.$

133. $C_p\log T-AR\log p+\frac{R}{R_1}\frac{r}{T}\frac{e}{p-e}=C_p\log T_o-AR\log p_o+\frac{R}{R_1}\frac{e_o}{p_o-e_o}=\text{Constant}.$

For the stage of saturation the C_p of the exponential form is that of the mixture $\overline{C}_p=\lambda C_p+\mu C_1$; in the second term the pressure is $p-e'$; the variations expressed by n are omitted in this comparison. Hence,

$$(\lambda C_p+\mu C_1)\log T-AR\log(p-e')+\frac{R}{R_1}\frac{r}{T}\frac{e'}{p-e'}=\text{Constant}.$$

This agrees with the Hertz form (120), since the constant is formed from the lower limit terms in the integration.

TABLE 72.—*Bigelow's development of the adiabatic formulæ.*

Auxiliary formulæ.

134. $\lambda=\frac{B-e}{B-.378e}=\left(1-\frac{e}{B}\right)\left(1+.378\frac{e}{B}\right)=\left(1-.622\frac{e}{B}-.378\frac{e^2}{B^2}\right)$. Dry air.

135. $\mu=\frac{R}{R_1}\frac{e}{B-.378e}=.622\frac{e}{B}\left(1+.378\frac{e}{B}\right)=\left(+.622\frac{e}{B}+.235\frac{e^2}{B^2}\right)$. Aqueous vapor.

136. $C_1=1.000 \quad C_p=.2374 \quad C_p'=0.4805 \quad \frac{R}{R_1}=.622 \quad r=799.8-.708T.$

137. $\bar{C}_p=\lambda C_p+\mu C_p'=C_p\left(1+.259\frac{e}{B}\right)\left(1+.378\frac{e}{B}\right)=C_p\left(1+.637\frac{e}{B}+\cdots\right)$

$=.2374+.1512\frac{e}{B}+.0232\frac{e^2}{B^2}.$

138. $\bar{\bar{C}}_p=\lambda C_p+\mu C_1=C_p\left(1-\frac{e}{B}+2.620\frac{e}{B}\right)\left(1+.378\frac{e}{B}\right)=C_p\left(1+1.998\frac{e}{B}\right)$

$=.2374+.4743\frac{e}{B}+.145\frac{e^2}{B^2}.$

139. $AR=\lambda AR+\mu AR_1=AR\left(1-\frac{e}{B}+\frac{e}{B}\right)\left(1+.378\frac{e}{B}\right)=AR\left(1+.378\frac{e}{B}\right)$

$=.06858+.02592\frac{e}{B}.$

140. $\lambda AR=AR\left(1-\frac{e}{B}\right)\left(1+.378\frac{e}{B}\right)=AR\left(1-.622\frac{e}{B}\right)$

$=.06858-.04266\frac{e}{B}.$

141. $\lambda\frac{R}{R_1}r=\left(1-\frac{e}{B}\right)\left(1+.378\frac{e}{B}\right).622\,(799.8-.708)\,T$

$=497.5-.4404T-(309.4-.2739\,T)\frac{e}{B}.$

142. $\lambda\frac{R}{R_1}(r+q)=\left(1-\frac{e}{B}\right)\left(1+.378\frac{e}{B}\right).622\,(879.8-.708)\,T$

$=547.2-4404\,T-(340.4-.2739\,T)\frac{e}{B}.$

143. $\mu q=r_{1\cdot0}\,q=.622\frac{e}{B}\left(1+.378\frac{e}{B}\right)80.025$

$=49.78\frac{e}{B}+18.82\frac{e^2}{B^2}.$

The adiabatics of five stages in terms of B. T. e.

144. Dry.

$.2374\log T-.06858\log B \qquad =C_a.$

145. Dry+vapor. (Unsaturated.)

$\left(.2374+.1512\frac{e}{B}+.0232\frac{e^2}{B^2}\right)\log T-\left(.06858+.02592\frac{e}{B}\right)\log B \qquad =C_{a_1}.$

146. Dry+vapor+water. (Saturated.)

$\left(.2374+.4743\frac{e}{B}+.145\frac{e^2}{B^2}\right)\log T-\left(.06858-.04266\frac{e}{B}\right)\log(B-e')$

$+\left[\frac{497.5}{T}-.4404-\left(\frac{309.4}{T}-.2739\right)\frac{e}{B}\right]\frac{e'}{(B-e')}. \qquad =C_\beta.$

147. Vapor+water+ice. (Freezing.)

$-\left(.06858-.04266\frac{e}{B}\right)\log(B-e_0)$

$+\left[\frac{547.2}{T}-.4404-\left(\frac{340.4}{T}-.2739\right)\frac{e}{B}\right]\frac{e_0}{(B-e_0)}-\left(49.78\frac{e}{B}+18.82\frac{e^2}{B^2}\right)\frac{1}{T}=C_\gamma.$

148. Dry+vapor+ice. (Below freezing.)

$\left(.2374+.4743\frac{e}{B}+.145\frac{e^2}{B^2}\right)\log T-\left(.06858-.04266\frac{e}{B}\right)\log(B-e'')$

$+\left[\frac{547.2}{T}-.4404-\left(\frac{340.4}{T}-.2739\right)\frac{e}{B}\right]\frac{e''}{B-e''} \qquad =C_\delta.$

A STANDARD SYSTEM OF HYDRODYNAMIC EQUATIONS.

TABLE 73.—*Notation and equivalents for the three coordinate systems.*

Auxiliary diagrams for moving axes relative to fixed axes.

		Fixed axes.				Moving axes.			
149.	Axes.	X_1	Y_1	Z_1		X	Y	Z	
	Displacements.	$(x_1$	y_1	$z_1)$	s_1.	$(x$	y	$z)$	s.
	Velocities.	$(u_1$	v_1	$w_1)$	q_1.	$(u$	v	$w)$	q.
	Accelerations.	$(\dot{u}_1$	$\dot{v}_1$	$\dot{w}_1)$	f_1.	$(\dot{u}$	$\dot{v}$	$\dot{w})$	f.

150. Positive direction $+X_1$=southward. $+Y_1$=eastward. $+Z_1$=zenithward.

151.	Rectangular coordinates.	$\partial x = u\partial t$.	$\partial y = v\partial t$.	$\partial z = w\partial t$.
152.	Cylindrical coordinates.	$\partial x = u\partial t = \partial\varpi$.	$\partial y = v\partial t = \varpi\partial\varphi$.	$\partial z = w\partial t = \partial z$.
153.	Polar coordinates.	$\partial x = u\partial t = r\partial\theta$.	$\partial y = v\partial t = r \sin\theta\partial\lambda$.	$\partial z = w\partial t = \partial r$.

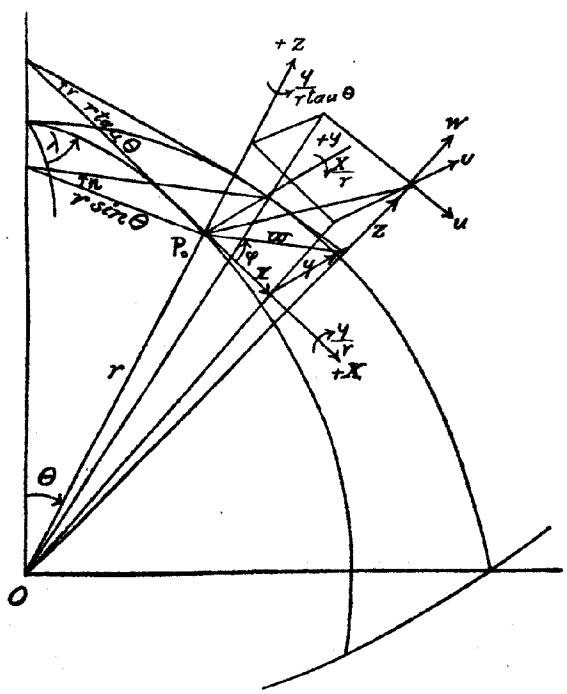


CHART 47.—Moving axes relative to fixed axes.

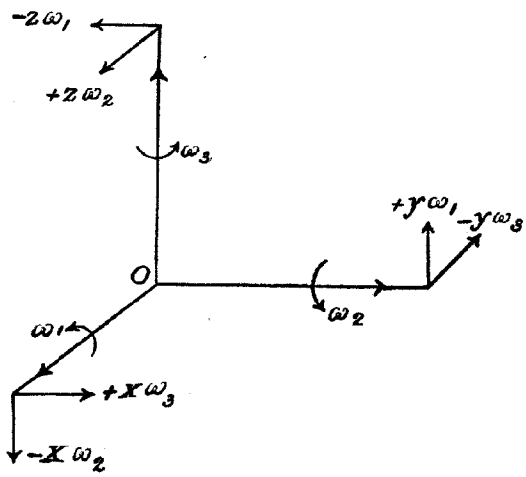


CHART 48.—Angular velocities of moving about fixed axes. Type I.

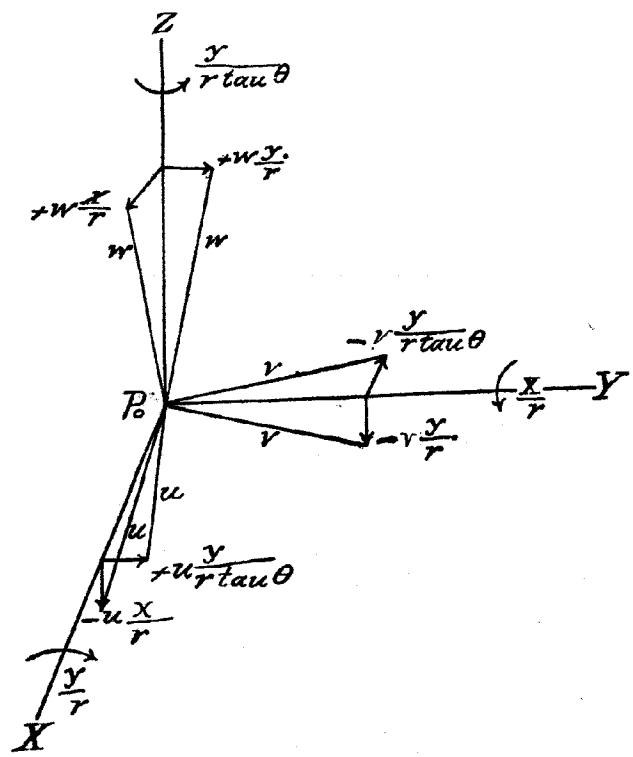


CHART 49.—Angular velocities of moving about fixed axes. Type II.

NOTE: $\left[\begin{smallmatrix} x \cdot y \cdot z \\ u \cdot v \cdot w \end{smallmatrix}\right]$ have different meanings in the three systems, respectively, but they denote increase of value along the positive coordinate directions.

Right-hand rotation about an outward drawn normal determines the positive direction of the coordinates.

TABLE 74.—*General equations of motion relative to moving axes.*

(The fixed axes have the origin at the center of a nonrotating earth.)

Rectangular coordinates.

154. Linear velocities.

$$u_1=u-y\omega_3+z\omega_2.$$
$$v_1=v-z\omega_1+x\omega_3.$$
$$w_1=w-x\omega_2+y\omega_1.$$

Angular velocity for fixed axes. $\omega_1=0.$ $\omega_2=0.$ $\omega_3=0.$

155. Accelerations.

$$\dot{u}_1=\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}-v\omega_3+w\omega_2=-\frac{1}{\rho}\frac{\partial P}{\partial x}-\frac{\partial V}{\partial x}=\frac{\partial Q}{\partial x}.$$
$$\dot{v}_1=\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+w\frac{\partial v}{\partial z}-w\omega_1+u\omega_3=-\frac{1}{\rho}\frac{\partial P}{\partial y}-\frac{\partial V}{\partial y}=\frac{\partial Q}{\partial y}.$$
$$\dot{w}_1=\frac{\partial w}{\partial t}+u\frac{\partial w}{\partial x}+v\frac{\partial w}{\partial y}+w\frac{\partial w}{\partial z}-u\omega_2+v\omega_1=-\frac{1}{\rho}\frac{\partial P}{\partial z}-\frac{\partial V}{\partial z}=\frac{\partial Q}{\partial z}.$$

156. Angular velocities.

$$2\omega_1=\frac{\partial w}{\partial y}-\frac{\partial v}{\partial z}.$$
$$2\omega_2=\frac{\partial u}{\partial z}-\frac{\partial w}{\partial x}.$$
$$2\omega_3=\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}.$$

157. Equation of continuity.

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}=0. \qquad \frac{\partial \rho}{\partial t}+\frac{\partial(\rho u)}{\partial x}+\frac{\partial(\rho v)}{\partial y}+\frac{\partial(\rho w)}{\partial z}=0.$$

158. Operator.

$$\nabla^2=\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}.$$

159. Rectangular general equations of motion.

$$\frac{du}{dt}=-\frac{\partial V}{\partial x}-\frac{1}{\rho}\frac{\partial P}{\partial x}+\frac{\mu}{\rho}\left[\nabla^2 u+\tfrac{1}{3}\frac{\partial\Theta}{\partial x}\right].$$
$$\frac{dv}{dt}=-\frac{\partial V}{\partial y}-\frac{1}{\rho}\frac{\partial P}{\partial y}+\frac{\mu}{\rho}\left[\nabla^2 v+\tfrac{1}{3}\frac{\partial\Theta}{\partial y}\right].$$
$$\frac{dw}{dt}=-\frac{\partial V}{\partial z}-\frac{1}{\rho}\frac{\partial P}{\partial z}+\frac{\mu}{\rho}\left[\nabla^2 w+\tfrac{1}{3}\frac{\partial\Theta}{\partial z}\right].$$

For incompressible fluids, $\Theta=0$.

Cylindrical coordinates.

160. Linear velocities.

$$u_1=\frac{\partial\varpi}{\partial t}-y\omega_3+z\omega_2.$$
$$v_1=\varpi\frac{\partial\varphi}{\partial t}-z\omega_1+x\omega_3.$$
$$w_1=\frac{\partial z}{\partial t}-x\omega_2+y\omega_1.$$

Angular velocities. $\omega_1=0.$ $\omega_2=0.$ $\omega_3=+\frac{v}{\varpi}.$

Forces. $-\frac{\partial V}{\partial x}=0.$ $-\frac{\partial V}{\partial y}=0.$ $-\frac{\partial V}{\partial z}=-g.$

161. Accelerations.

$$\dot{u}_1=\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial\varpi}+v\frac{\partial u}{\varpi\partial\varphi}+w\frac{\partial u}{\partial z}-\frac{v^2}{\varpi}=-\frac{1}{\rho}\frac{\partial P}{\partial x}.$$
$$\dot{v}_1=\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial\varpi}+v\frac{\partial v}{\varpi\partial\varphi}+w\frac{\partial v}{\partial z}+\frac{uv}{\varpi}=-\frac{1}{\rho}\frac{\partial P}{\partial y}.$$
$$\dot{w}_1=\frac{\partial w}{\partial t}+u\frac{\partial w}{\partial\varpi}+v\frac{\partial w}{\varpi\partial\varphi}+w\frac{\partial w}{\partial z}=-\frac{1}{\rho}\frac{\partial P}{\partial z}-g.$$

162. Angular velocities.

$$2\omega_1=\frac{\partial w}{\varpi\partial\varphi}-\frac{\partial v}{\partial z}.$$
$$2\omega_2=\frac{\partial u}{\partial z}-\frac{\partial w}{\partial\varpi}.$$
$$2\omega_3=\frac{\partial v}{\partial\varpi}-\frac{\partial u}{\varpi\partial\varphi}+\frac{v}{\varpi}.$$

TABLE 74.—*General equations of motion relative to moving axes*—Continued.

(The fixed axes have the origin at the center of a nonrotating earth.)

163. Equation of continuity. $$\frac{\partial(\varpi u)}{\partial\varpi}+\frac{\partial v}{\partial\varphi}+\varpi\frac{\partial w}{\partial z}=\frac{\partial u}{\partial\varpi}+\frac{u}{\varpi}+\frac{\partial w}{\partial z}=0.$$

164. Operator. $$\nabla^2=\frac{\partial^2}{\partial\varpi^2}+\frac{1}{\varpi}\frac{\partial}{\partial\varpi}+\frac{1}{\varpi^2}\frac{\partial^2}{\partial\varphi^2}+\frac{\partial^2}{\partial z^2}.$$

165. Cylindrical general equations of motion.

$$\frac{du}{dt}-\frac{v^2}{\varpi}=-\frac{1}{\rho}\frac{dP}{\partial\varpi}+\frac{\mu}{\rho}\left[\nabla^2u-\frac{u}{\varpi^2}-\frac{2}{\varpi^2}\frac{\partial v}{\partial\varphi}+\tfrac{1}{3}\frac{\partial\Theta}{\partial\varpi}\right].$$

$$\frac{dv}{dt}+\frac{uv}{\varpi}=-\frac{1}{\rho}\frac{\partial P}{\varpi\partial\varphi}+\frac{\mu}{\rho}\left[\nabla^2v-\frac{v}{\varpi^2}+\frac{2}{\varpi^2}\frac{\partial u}{\partial\varphi}+\tfrac{1}{3}\frac{\partial\Theta}{\varpi\partial\varphi}\right].$$

$$\frac{dw}{dt}+g=-\frac{1}{\rho}\frac{\partial P}{\partial z}+\frac{\mu}{\rho}\left[\nabla^2w+\tfrac{1}{3}\frac{\partial\Theta}{\partial z}\right].$$

Polar coordinates.

166. Linear velocities.

$$u_1=u-y\frac{v}{r\tan\theta}+z\frac{u}{r}=u-v\frac{y}{r\tan\theta}+w\frac{x}{r}.$$

$$v_1=v+x\frac{v}{r\tan\theta}+z\frac{v}{r}=v+u\frac{y}{r\tan\theta}+w\frac{y}{r}.$$

$$w_1=w-x\frac{u}{r}-y\frac{v}{r}\qquad=w-u\frac{x}{r}-v\frac{y}{r}.$$

Angular velocities.

$$\omega_1=-\frac{v}{r}.$$

$$\omega_2=+\frac{u}{r}.$$

$$\omega_3=+\frac{v}{r\tan\theta}$$

167. Accelerations.

$$\dot{u}_1=\frac{\partial u}{\partial t}+u\frac{\partial u}{r\partial\theta}+v\frac{\partial u}{r\sin\theta\partial\lambda}+w\frac{\partial u}{\partial r}-\frac{v^2}{r}\cot\theta+\frac{wu}{r}=-\frac{1}{\rho}\frac{\partial P}{r d\theta}.$$

$$\dot{v}_1=\frac{\partial v}{\partial t}+u\frac{\partial v}{r\partial\theta}+v\frac{\partial v}{r\sin\theta\partial\lambda}+w\frac{\partial v}{\partial r}+\frac{uv}{r}\cot\theta+\frac{wv}{r}=-\frac{1}{\rho}\frac{\partial P}{r\sin\theta d\lambda}.$$

$$\dot{w}_1=\frac{\partial w}{\partial t}+u\frac{\partial w}{r\partial\theta}+v\frac{\partial w}{r\sin\theta\partial\lambda}+w\frac{\partial w}{\partial r}-\frac{u^2}{r}\qquad-\frac{v^2}{r}=-\frac{1}{\rho}\frac{\partial P}{\partial r}-g.$$

168. Angular velocities.

$$2\omega_1=\frac{\partial w}{r\sin\theta d\lambda}-\frac{\partial v}{\partial r}-\qquad\frac{v}{r}.$$

$$2\omega_2=\frac{\partial u}{\partial r}-\qquad\frac{\partial w}{r\partial\theta}+\qquad\frac{u}{r}.$$

$$2\omega_3=\frac{\partial v}{r\partial\theta}-\qquad\frac{\partial u}{r\sin\theta\partial\lambda}+\frac{v}{r}\cot\theta.$$

169. Equation of continuity. $$r\frac{\partial(u\sin\theta)}{\partial\theta}+r\frac{\partial v}{\partial\lambda}+\sin\theta\frac{\partial(r^2w)}{\partial r}=0.$$

170. Stretches.

$$s_\theta=\frac{\partial u_1}{\partial x}=\frac{\partial u}{\partial x}+\frac{w}{r}.$$

$$s_\lambda=\frac{\partial v_1}{\partial y}=\frac{\partial v}{\partial y}+\frac{u}{r}\cot\theta+\frac{w}{r}.$$

$$s_r=\frac{\partial w_1}{\partial z}=\frac{\partial w}{\partial z}.$$

171. Shears.

$$\sigma_{\lambda r}=\sigma_{r\lambda}=\frac{\partial w_1}{\partial y}+\frac{\partial v_1}{\partial z}=\frac{\partial w}{\partial y}+\frac{\partial v}{\partial z}-\frac{v}{r}.$$

$$\sigma_{r\theta}=\sigma_{\theta r}=\frac{\partial u_1}{\partial z}+\frac{\partial w_1}{\partial x}=\frac{\partial u}{\partial z}+\frac{\partial w}{\partial x}-\frac{u}{r}.$$

$$\sigma_{\theta\lambda}=\sigma_{\lambda\theta}=\frac{\partial v_1}{\partial x}+\frac{\partial u_1}{\partial y}=\frac{\partial v}{\partial x}+\frac{\partial u}{\partial y}-\frac{v}{r}\cot\theta.$$

172. Dilatation. $$\Theta=s+s_\lambda+s_r=\frac{\partial u_1}{\partial x}+\frac{\partial v_1}{\partial y}+\frac{\partial w_1}{\partial z}=\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}+\frac{2w}{r}+\frac{u}{r}\cot\theta.$$

TABLE 74.—*General equations of motion relative to moving axes*—Continued.

(The fixed axes have the origin at the center of a nonrotating earth.)

173. Normal traction.

$$t_{\theta\theta}=-p-\tfrac{2}{3}\mu\Theta+2\mu s_\theta\,.$$

$$t_{\lambda\lambda}=-p-\tfrac{2}{3}\mu\Theta+2\mu s_\lambda\,.$$

$$t_{rr}=-p-\tfrac{2}{3}\mu\Theta+2\mu s_r\,.$$

Tangential traction.

$$t_{\lambda r}=t_{r\lambda}=\mu\sigma_{\lambda r}\,.$$

$$t_{r\theta}=t_{\theta r}=\mu\sigma_{r\theta}\,.$$

$$t_{\theta\lambda}=t_{\lambda\theta}=\mu\sigma_{\theta\lambda}\,.$$

Coefficient of viscosity $\mu=0.0000125$ pounds / foot sec. $=0.000185$ grams / cm. sec.

174. Operator.

$$\nabla^2=\frac{\partial^2}{\partial r^2}+\frac{2}{r}\frac{\partial}{\partial r}+\frac{1}{r^2}\frac{\partial^2}{\partial\theta^2}+\frac{\cot\theta}{r^2}\frac{\partial}{\partial\theta}+\frac{1}{r^2\sin^2\theta}\frac{\partial^2}{\partial\lambda^2}\,.$$

175. Total force due to surface tractions.

$$f_\theta=\frac{\mu}{\rho}\left[\tfrac{1}{3}\frac{\partial\Theta}{r\partial\theta}+\nabla^2\left(r\frac{\partial\theta}{\partial t}\right)+\frac{2}{r}\cdot\frac{\partial w}{r\partial\theta}-\frac{1}{r\sin^2\theta}\cdot\frac{\partial\theta}{\partial t}-\frac{2\cot\theta\,.\,\partial v}{r^2\sin\theta\partial\lambda}\right].$$

$$f_\lambda=\frac{\mu}{\rho}\left[\tfrac{1}{3}\frac{\partial\Theta}{r\sin\theta\partial\lambda}+\nabla^2\left(r\sin\theta\cdot\frac{\partial\lambda}{\partial t}\right)+\frac{2}{r}\cdot\frac{\partial w}{r\sin\theta\partial\lambda}-\frac{1}{r\sin\theta}\cdot\frac{\partial\lambda}{\partial t}+\frac{2\cot\theta\,.\,\partial u}{r^2\sin\theta\partial\lambda}\right].$$

$$f_r=\frac{\mu}{\rho}\left[\tfrac{1}{3}\frac{\partial\Theta}{\partial r}+\nabla^2\left(\frac{\partial r}{\partial t}\right)-\frac{2w}{r^2}-\frac{2}{r}\cdot\frac{\partial u}{r\partial\theta}-\frac{2\cot\theta}{r}\cdot\frac{\partial\theta}{\partial t}-\frac{2\,.\,\partial v}{r^2\sin\theta\partial\lambda}\right].$$

176. Polar general equations of motion.

$$\frac{du}{dt}-\frac{v^2}{r}\cot\theta+\frac{uw}{r}=-\frac{1}{\rho}\frac{\partial P}{r\partial\theta}+f_\theta\,.$$

$$\frac{dv}{dt}+\frac{uv}{r}\cot\theta+\frac{vw}{r}=-\frac{1}{\rho}\frac{\partial P}{r\sin\theta\partial\lambda}+f_\lambda\,.$$

$$\frac{dw}{dt}-\frac{u^2+v^2}{r}+g=-\frac{1}{\rho}\frac{\partial P}{\partial r}+f_r\,.$$

TABLE 75.—*Equations of motion for the rotating earth.*

Polar coordinates.

If the earth rotates with the constant angular velocity n, carrying the fixed axes with it, we have the following results:

177. Liner velocities, southward $u'=u.$
eastward $v'=v+n\,.\,r\sin\theta.$
zenithward $w'=w.$

178. Angular velocities,

$$\omega'_1=-\frac{v+n\,.\,r\sin\theta}{r}.$$

$$\omega'_2=+\frac{u}{r}.$$

$$\omega'_3=+\frac{v+n\,.\,r\sin\theta}{r\tan\theta}.$$

179. Differentials.

$$\frac{du'}{dt}=\frac{du}{dt}.$$

$$\frac{dv'}{dt}=\frac{d\,(v+n\,.\,r\sin\theta)}{dt}=\frac{dv}{dt}+u\,.\,n\cos\theta+w\,.\,n\sin\theta.$$

$$\frac{dw'}{dt}=\frac{dw}{dt}.$$

180.

$$-\frac{1}{\rho}\frac{\partial P}{r\partial\theta}=\frac{du'}{dt}-v'\omega'_3+w'\omega'_2=\frac{du'}{dt}-(v+n\,.\,r\sin\theta)\frac{(v+n\,.\,r\sin\theta)}{r\tan\theta}+w\frac{u}{r}.$$

$$-\frac{1}{\rho}\frac{\partial P}{r\sin\theta\partial\lambda}=\frac{dv'}{dt}-w'\omega'_1+u'\omega'_3=\frac{dv'}{dt}+w\frac{(v+n\,.\,r\sin\theta)}{r}+u\frac{(v+n\,.\,r\sin\theta)}{r\tan\theta}.$$

$$-\frac{1}{\rho}\frac{\partial P}{\partial r}-g=\frac{dw'}{dt}-u'\omega'_2+v'\omega'_1=\frac{dw'}{dt}-u\,.\,\frac{u}{r}-(v+n\,.\,r\sin\theta)\frac{(v+n\,.\,r\sin\theta)}{r}.$$

181. Polar equations of motion on the rotating earth.

$$-\frac{1}{\rho}\frac{\partial P}{r\partial\theta}=\frac{du}{dt}-\frac{v^2}{r}\,.\cot\theta+\frac{uw}{r}-2n\cos\theta\,.\,v-rn^2\sin\theta\cos\theta.$$

$$-\frac{1}{\rho}\frac{\partial P}{r\sin\theta\partial\lambda}=\frac{dv}{dt}+\frac{uv}{r}\cot\theta+\frac{vw}{r}+2n\cos\theta\,.\,u+2n\sin\theta\,.\,w.$$

$$-\frac{1}{\rho}\frac{\partial P}{\partial r}-g=\frac{dw}{dt}-\frac{u^2+v^2}{r}-2n\sin\theta\,.\,v-rn^2\sin^2\theta.$$

First form of the polar equations.

Cylindrical coordinates.

182. Radial. $u'=u.$
Tangential. $v'=v+n\,.\,\varpi\cos\theta.$
Vertical. $w'=w.$

Angular Velocities. $\omega'_1=0.$ $\omega'_2=0.$ $\omega'_3=n\cos\theta+\frac{v}{\varpi}.$

183. Differentials.

$$\frac{du'}{dt}=\frac{du}{dt}.$$

$$\frac{dv'}{dt}=\frac{d\,(v+n\,\varpi\cos\theta)}{dt}=\frac{dv}{dt}+u\,.\,n\cos\theta.$$

$$\frac{dw'}{dt}=\frac{dw}{dt}.$$

184.

$$-\frac{1}{\rho}\frac{\partial P}{\partial\varpi}=\frac{du'}{dt}-v'\omega'_3+w'\omega'_2=\frac{du'}{dt}-(n\,.\,\varpi\cos\theta+v)\left(n\cos\theta+\frac{v}{\varpi}\right).$$

$$-\frac{1}{\rho}\frac{\partial P}{\varpi\partial\varphi}=\frac{dv'}{dt}-w'\omega'_1+u'\omega'_3=\frac{dv'}{dt}+u\,.\,n\cos\theta+u\left(n\cos\theta+\frac{v}{\varpi}\right).$$

$$-\frac{1}{\rho}\frac{\partial P}{\partial z}-g=\frac{dw'}{dt}-u'\omega'_2+v'\omega'_1=\frac{dw'}{dt}.$$

185. Cylindrical equations of motion on the rotating earth.

$$-\frac{1}{\rho}\frac{\partial P}{\partial\varpi}=\frac{du}{dt}-2n\cos\theta\,.\,v-\frac{v^2}{\varpi}=\frac{du}{dt}-(2n\cos\theta+\nu_1)\,v.$$

$$-\frac{1}{\rho}\frac{\partial P}{\varpi\partial\varphi}=\frac{dv}{dt}+2n\cos\theta\,.\,u+\frac{uv}{\varpi}=\frac{dv}{dt}+(2n\cos\theta+\nu_1)\,u.$$

$$-\frac{1}{\rho}\frac{\partial P}{\partial z}-g=\frac{dw}{dt}.\qquad=\frac{dw}{dt}.$$

TABLE 76.—*Progressive motion of cyclones and anticyclones.*

When the axis z of cylindrical coordinates wanders over the surface of the earth, as in cyclones and anticyclones, carrying the local circulation with it, we have these results:

186. Linear velocities of the origin.	Moving point.	Angular velocities.
Southward U	u	$\omega'_1=-\frac{V}{R}$
Eastward V	v	$\omega'_2=+\frac{U}{R}$
Zenithward $W=0$	w	$\omega'_3=\left(n\cos\theta+\frac{v}{\varpi}\right)$

Take R=radius of the earth.
ϖ=radius of local gyration.
φ=angle that ϖ makes with the meridian.

187. Component velocities.

$$u'=u+U\cos\varphi+V\sin\varphi.$$
$$v'=v-U\sin\varphi+V\cos\varphi.$$
$$w'=w.$$

188.
$$-v'\omega'_3+w'\omega'_2=(v-U\sin\varphi+V\cos\varphi+\varpi\,.\,n\cos\theta)\left(n\cos\theta+\frac{v}{\varpi}\right)+w\frac{U}{R}.$$
$$-w'\omega'_1+u'\omega'_3=+(u+U\cos\varphi+V\sin\varphi)\left(n\cos\theta+\frac{v}{\varpi}\right)+w\frac{V}{R}.$$
$$-u'\omega'_2+v'\omega'_1=-(u+U\cos\varphi+V\sin\varphi)\frac{U}{R}-(v-U\sin\varphi+V\cos\varphi+\varpi\,.\,n\cos\theta)\frac{V}{R}.$$

189.
$$-\frac{1}{\rho}\frac{\partial P}{\partial\varpi}=\frac{du}{dt}-2\,n\cos\theta\,.\,v-\frac{v^2}{\varpi}+U\sin\varphi\left(n\cos\theta+\frac{v}{\varpi}\right)-V\cos\varphi\left(n\cos\theta+\frac{v}{\varpi}\right)+w\frac{U}{R}.$$
$$-\frac{1}{\rho}\frac{\partial P}{\varpi\partial\varphi}=\frac{dv}{dt}+2\,n\cos\theta\,.\,u+\frac{uv}{\varpi}-U\cos\varphi\left(n\cos\theta+\frac{v}{\varpi}\right)+V\sin\varphi\left(n\cos\theta+\frac{v}{\varpi}\right)+w\frac{V}{R}.$$
$$-\frac{1}{\rho}\frac{\partial P}{\partial z}=\frac{dw}{dt}-\frac{uU+vV}{R}-\frac{U^2+V^2}{R}\cos\varphi-\frac{V}{R}\varpi\,.\,n\cos\theta+g.$$

For the case $\varphi=0$ and ϖ is on the meridian.

190.
$$-\frac{1}{\rho}\frac{\partial P}{\partial\varpi}=\frac{du}{dt}-2\,n\cos\theta\,.\,v-\frac{v^2}{\varpi}-V\left(n\cos\theta+\frac{v}{\varpi}\right)+w\frac{U}{R}.$$
$$-\frac{1}{\rho}\frac{\partial P}{\varpi\partial\varphi}=\frac{dv}{dt}+2\,n\cos\theta\,.\,u+\frac{uv}{\varpi}-U\left(n\cos\theta+\frac{v}{\varpi}\right)+w\frac{V}{R}.$$
$$-\frac{1}{\rho}\frac{\partial P}{\partial z}=\frac{dw}{dt}-\frac{uU+vV}{R}-\frac{U^2+V^2}{R}-\frac{V}{R}\varpi\,.\,n\cos\theta+g.$$

For the case $\varphi=90°$ and ϖ is on the parallel.

191.
$$-\frac{1}{\rho}\frac{\partial P}{\partial\varpi}=\frac{du}{dt}-2\,n\cos\theta\,.\,v-\frac{v^2}{\varpi}+U\left(n\cos\theta+\frac{v}{\varpi}\right)+w\frac{V}{R}.$$
$$-\frac{1}{\rho}\frac{\partial P}{\varpi\partial\varphi}=\frac{dv}{dt}+2\,n\cos\theta\,.\,u+\frac{uv}{\varpi}+V\left(n\cos\theta+\frac{v}{\varpi}\right)+w\frac{U}{R}.$$
$$-\frac{1}{\rho}\frac{\partial P}{\partial z}=\frac{dw}{dt}-\frac{uU+vV}{R}-\frac{V}{R}\varpi\,.\,n\cos\theta+w\frac{V}{R}+g.$$

TABLE 77.—*Integrations.*

Velocity and displacement.

The absolute linear eastward velocity of the earth$=v'$, at the $N.\ P.\ D.=\theta$.

192. The angular velocity $n=\frac{v'}{r \sin \theta}$, where $r=6370191\ [6.80415]+h$.

193. Hence, $n \cos \theta=\frac{v' \cot \theta}{r}$. $n=0.00007292\ [5.86285-10]$.

The polar equations for the general motions assume these forms (omitting the terms which give permanent figure to the earth, and assuming that there are no pressure gradients):

194.
$$\frac{d^2 (r\partial\theta)}{dt^2}=\frac{d^2x}{dt^2}=\frac{du_1}{dt}=+\cot \theta\ (2v'+v)\ \frac{v}{r}-\frac{uw}{r}.$$
$$\frac{d^2 (r \sin \theta\partial\lambda)}{dt^2}=\frac{d^2y}{dt^2}=\frac{dv_1}{dt}=-\cot \theta\ (2v'+v)\ \frac{u}{r}-(2v'+v)\ \frac{w}{r}.$$
$$\frac{d^2r}{dt^2}=\frac{d^2z}{dt^2}=\frac{dw_1}{dt}=+\qquad (2v'+v)\ \frac{v}{r}-\frac{u^2}{r}-g.$$

Second form of the polar equations.

Unaccented letters=initial; subscripts=final velocities at the time t_1.

Velocities.

195.
$$\frac{d\ (r\partial\theta)}{dt}=\frac{dx}{dt}=u_1=u+\cot\ \theta\ (2v'+v)\ \frac{v}{r}\cdot t-\frac{uw}{r}\cdot t\qquad +2g\frac{u}{r}\cdot t^2.$$
$$\frac{d\ (r \sin \theta\partial\lambda)}{dt}=\frac{dy}{dt}=v_1=v-\cot\ \theta\ (2v'+v)\ \frac{u}{r}\cdot t-\quad (2v'+v)\frac{w}{r}\cdot t+2g\frac{(v'+v)}{r}\cdot t^2.$$
$$\frac{dr}{dt}=\frac{dz}{dt}=w_1=w+\qquad (2v'+v)\ \frac{v}{r}\cdot t-\frac{u^2}{r}\cdot t\qquad -gt.$$

Displacements.

196.
$$r\partial\theta=x\qquad =ut+\cot\theta\ (2v'+v)\frac{v}{2r}\cdot t^2-\frac{uw}{2r}\cdot t^2\qquad +\frac{2gu}{3r}\cdot t^3.$$
$$r \sin \theta\partial\lambda=y\qquad =vt-\cot\theta\ (2v'+v)\ \frac{u}{2r}\cdot t^2-(2v'+v)\ \frac{w}{2r}\cdot t^2+\frac{2g(v'+v)}{3r}\cdot t^3.$$
$$r=z\qquad =wt+\qquad (2v'+v)\frac{v}{2r}\cdot t^2-\frac{u^2}{2r}\cdot t^2\qquad -\frac{gt^2}{2}.$$

Pressure.

From the first form of polar equations of motion we derive by the following substitutions:

197. $\frac{v}{r}=\nu \sin \theta$ $\qquad \frac{v^2 \cot \theta}{r}=v \cos \theta\ .\ \nu.$ $\qquad \frac{uv \cot \theta}{r}=u \cos \theta\ .\ \nu.$

200.
$$-\frac{1}{\rho}\frac{\partial P}{dx}=\frac{du}{dt}-\cos \theta\ (2n+\nu)v+\frac{uw}{r}.$$
$$-\frac{1}{\rho}\frac{\partial P}{\partial y}=\frac{dv}{dt}+\sin \theta\ (2n+\nu)\ w+\cos \theta\ (2n+\nu)\ u.$$
$$-\frac{1}{\rho}\frac{\partial P}{\partial z}=\frac{dw}{dt}-\sin \theta\ (2n+\nu)\ v-\frac{u^2}{r}+g.$$

Third form of the polar equations.

TABLE 77.—*Integrations*—Continued.

201. $-\frac{\partial P}{\rho} = \frac{dx}{dt} \cdot \partial u - 2n \cos\theta\, v \,.\, \partial x - \frac{\cot\theta}{r} v^2 \,.\, \partial x + \frac{1}{r} u \,.\, w \,.\, \partial x.$

$-\frac{\partial P}{\rho} = \frac{dy}{dt} \cdot \partial v + 2n \sin\theta\, w \,.\, \partial y + \frac{1}{r} v \,.\, w \,.\, \partial y + 2n \cos\theta\, u \,.\, \partial y + \frac{\cot\theta}{r} u\, v \,.\, \partial y.$

$-\frac{\partial P}{\rho} = \frac{dz}{dt} \cdot \partial w - 2n \sin\theta\, v \,.\, \partial z - \frac{1}{r} v^2 \,.\, \partial z - \frac{1}{r} u^2 \,.\, \partial z + g\, \partial z.$

202. Since $v\,\partial x = u\,\partial y, \qquad w\,\partial x = u\,\partial z, \qquad w\,\partial y = v\,\partial z.$

We take the sum of the partial differentials with the result:

203. $-\frac{\partial P}{\rho} = u\,\partial u + v\,\partial v + w\,\partial w + g\,\partial z.$

204. Since $\frac{1}{\rho} = \frac{1}{\rho_0} \cdot \frac{P_0}{P}(1+\alpha t) = \frac{1}{P.\,a}$, then $-\frac{\partial P}{\rho} = -\frac{\partial P}{P} \cdot \frac{1}{a} = -\partial \log P \cdot \frac{1}{a}.$

205. $-\partial \log P = a\,(u\,\partial u + v\,\partial v + w\,\partial w) + a\,g\,\partial z.$

206. $-\log P\Big]_0 = \frac{a}{2}(u^2+v^2+w^2) + a\,g\,z. = \frac{a}{2}\,q^2 + a\,g\,z.$

207. $\log P_0 - \log P = \frac{a}{2}(q^2 - q_0^2) + a\,g\,(z - z_0).$

$= \frac{(q^2 - q^2{}_0) + 2g\,(z - z_0)}{360862\,(1+\alpha t)}.$ For common logarithms.

208. $(\log P_0 - \log P) = \frac{(q^2 - q_0^2) + 2g\,(z - z_0)}{156720\,(1+\alpha t)}.$ For natural logarithms.

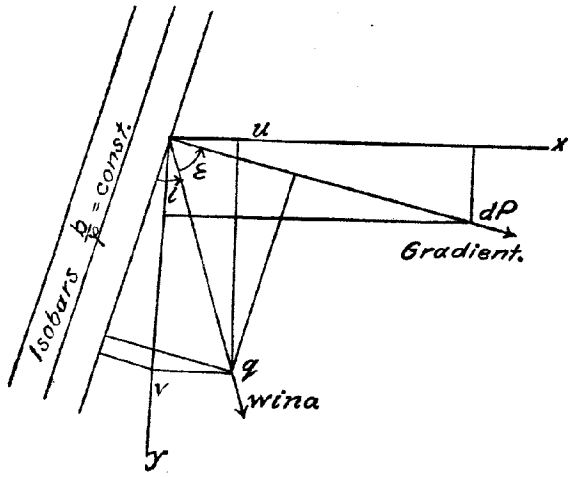
208*a*. $\frac{P_0 - P}{P_0} = \frac{w^2 - w_0^2}{156720\,(1+\alpha t)}.$ **208*b*.** $P_0 - P = \frac{w^2}{206.2\,(1+\alpha t)}.$ Vertical currents.

P_0 is the undisturbed pressure where $q=0$.

TABLE 78.—*Relation between gradient, wind, and isobars.*

CHART 50.—Gradients, isobars, and wind lines.

In the general and local cyclones of the northern hemisphere, u is negative when the pressures decrease towards the centre; u generally coincides with $d\,P$.



Let Γ=the diminishing pressure gradient.

209. $$-\frac{1}{\rho}\frac{\partial P}{\partial n}=-\frac{1}{\rho}\sqrt{\left(\frac{\partial P}{\partial x}\right)^2+\left(\frac{\partial P}{\partial y}\right)^2}=-\frac{1}{\rho}\mu G=-\frac{1}{\rho}\Gamma. \qquad q^2=u^2+v^2.$$

210. $$-q\cos\varepsilon\frac{\partial P}{\partial n}=u\frac{\partial P}{\partial x}+v\frac{\partial P}{\partial y}$$

211. $$q\frac{\partial q}{\partial x}=u\frac{\partial u}{\partial x}+v\frac{\partial v}{\partial x} \qquad q\frac{\partial q}{\partial y}=u\frac{\partial u}{\partial y}+v\frac{\partial v}{\partial y}.$$

212. $$qu\frac{\partial q}{\partial x}+qv\frac{\partial q}{\partial y}=u^2\frac{\partial u}{\partial x}+uv\frac{\partial u}{\partial y}+v^2\frac{\partial v}{\partial y}+uv\frac{\partial v}{\partial x}.$$

Taking the important terms in the horizontal plane from the equations of motion and adding the friction terms:

213. $$-\frac{1}{\rho}\frac{\partial P}{\partial x}=\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}-\cos\theta\,(2n+\nu)\,v+ku.$$
$$-\frac{1}{\rho}\frac{\partial P}{\partial y}=\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+\cos\theta\,(2n+\nu)\,u+kv.$$

214. $$-\frac{1}{\rho}u\frac{\partial P}{\partial x}=u\frac{\partial u}{\partial t}+u^2\frac{\partial u}{\partial x}+uv\frac{\partial u}{\partial y}-\cos\theta\,(2n+\nu)\,uv+ku^2.$$
$$-\frac{1}{\rho}v\frac{\partial P}{\partial y}=v\frac{\partial v}{\partial t}+v^2\frac{\partial v}{\partial y}+uv\frac{\partial v}{\partial x}+\cos\theta\,(2n+\nu)\,uv+kv^2.$$

215. $$-\frac{1}{\rho}\left(u\frac{\partial P}{\partial x}+v\frac{\partial P}{\partial y}\right)=u\frac{\partial u}{\partial t}+v\frac{\partial v}{\partial t}+qu\frac{\partial q}{\partial x}+qv\frac{\partial q}{\partial y}+kq^2.$$

216. $$+q\cos\varepsilon\,.\,\frac{1}{\rho}\frac{\partial P}{\partial n}=q\frac{\partial q}{\partial t}+q\left(u\frac{\partial q}{\partial x}+v\frac{\partial q}{\partial y}\right)+kq^2.$$
$$+\cos\varepsilon\,.\,\frac{1}{\rho}\frac{\partial P}{\partial n}=\frac{\partial q}{\partial t}+u\frac{\partial q}{\partial x}+v\frac{\partial q}{\partial y}+kq=\frac{dq}{dt}+kq=\frac{\mu G}{\rho}\cdot\cos\varepsilon.$$

217. $$\cos\varepsilon=\frac{\frac{dq}{dt}+kq}{\frac{\mu G}{\rho}}. \qquad \text{If } \frac{dq}{dt}=0. \qquad q=\frac{\mu G}{\rho k}\,.\,\cos\varepsilon. \qquad \text{velocity.}$$
$$q=\frac{\mu G}{\partial k}\,.\,\sin i.$$

TABLE 79.—*Angle between a stream line and a vortex line.*

218. Since $\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}=\frac{\partial u}{\partial t}-2v\omega_3+2w.\omega_2+u\frac{\partial u}{\partial x}+v\frac{\partial v}{\partial x}+w\frac{\partial w}{\partial x}$,

219. And $\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial w}{\partial z}=-\frac{1}{\rho}\frac{\partial P}{\partial x}-\frac{\partial V}{\partial x}$,

220. Then $\frac{\partial u}{\partial t}-2v\omega_3+2w\omega_2=-\frac{1}{\rho}\frac{\partial P}{\partial x}-\frac{u\partial u}{\partial x}-\frac{v\partial v}{\partial x}-\frac{w\partial w}{\partial x}-\frac{\partial V}{\partial x}=-\frac{\partial \chi'}{\partial x}$.

221. Where $\chi'=\int\frac{\partial P}{\rho}+\frac{1}{2}q^2+V.$ and $q^2=u^2+v^2+w^2$,

222. For steady motion $\frac{\partial u}{\partial t}=\frac{\partial v}{\partial t}=\frac{\partial w}{\partial t}=0.$

223. Hence $\frac{\partial \chi'}{\partial x}=+2v\omega_3-2w\omega_2.$ and $u\frac{\partial \chi'}{\partial x}+v\frac{\partial \chi'}{\partial y}+w\frac{\partial \chi'}{\partial z}=0.$

$\frac{\partial \chi'}{\partial y}=+2w\omega_1-2u\omega_3.$ $\omega_1\frac{\partial \chi'}{\partial x}+\omega_2\frac{\partial \chi'}{\partial y}+\omega_3\frac{\partial \chi'}{\partial z}=0.$

$\frac{\partial \chi'}{\partial z}=+2u\omega_2-2v\omega_1.$

Each of the surfaces χ'=constant contains both stream lines and vortex lines. If ∂n is an element of the normal to this surface, q= the current velocity, ω=the angular velocity, i= the angle between the stream line and the vortex line at that point,

224. $\frac{\partial \chi'}{\partial n}=+\frac{1}{\rho}\frac{\partial P}{\partial n}+q\frac{\partial q}{\partial n}+\frac{\partial V}{\partial n}=2\omega_3.q\sin i \quad =2\frac{uv}{\varpi} \quad =2u.\omega_3.$

TABLE 80.—*Equations of motion for parabolic and hyperbolic free surfaces.*

General equations.

For a compressible fluid under steady motion the integral form of the equations of motion, with only the external force g:

225. $$-\int\frac{\partial P}{\rho}=\int(u\partial u+v\partial v+w\partial w+g\partial z).$$

226. $$\frac{P}{\rho}=-\tfrac{1}{2}q^2-gz+C.,$$ where the constant varies from one stream-line to another.

227. $$\frac{P}{\rho}=-\tfrac{1}{2}q^2-gz+const.,$$ where the constant is absolute for the system.

CASE I. $2\omega_3=\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}.$ $\frac{v}{\varpi}=const.$

In the case of a mass of liquid rotating with *uniform* angular velocity ω_3 about the axis z.

228.

$X=0.$	$u=-\omega_3 y.$	$-\frac{1}{\rho}\frac{\partial P}{\partial x}=-v\omega_3=-\omega_3^2 x.$	$\frac{v}{\varpi}=$ const.
$Y=0.$	$v=+\omega_3 x.$	$-\frac{1}{\rho}\frac{\partial P}{\partial y}=+u\omega_3=-\omega_3^2 y.$	$v=\varpi$. const.
$Z=-g.$	$w=0.$	$-\frac{1}{\rho}\frac{\partial P}{\partial z}=+g\quad=+g.$	$\omega_3=\frac{v}{\varpi}=$const.

229 Hence $$\frac{P}{\rho}=\tfrac{1}{2}\omega^2(x^2+y^2)-gz+const.=\tfrac{1}{2}\omega^2\varpi^2-gz+const.$$

CASE II. $2\omega_3=\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}-\varpi\frac{\partial\omega_3}{\partial\varpi}.$ $v\varpi=const.=\mu$

In case of a mass of liquid rotating with an angular velocity which is *not constant*, but a function of the distance from the center. φ=velocity potential.

The above equation is satisfied by making $v\varpi=$const.$=\mu$.

230.

$X=0.$	$u=-\frac{\partial\varphi}{\partial x}=0.$	$-\frac{1}{\rho}\frac{\partial P}{\partial x}=-v\omega_3=-\frac{\mu^2}{\varpi^3}.$	$v\varpi=$const.
$Y=0.$	$v=-\frac{\partial\varphi}{\partial y}=\frac{\mu}{\varpi}.$	$-\frac{1}{\rho}\frac{\partial P}{\partial y}=+u\omega_3=\quad 0.$	$v=\frac{\text{const.}}{\varpi}=\frac{\mu}{\varpi}.$
$Z=-g.$	$w=-\frac{\partial\varphi}{\partial z}=f(v).$	$-\frac{1}{\rho}\frac{\partial P}{\partial z}=+g\quad=+g.$	$\omega_3=\frac{v}{\varpi}\quad=\frac{\mu}{\varpi^2}.$

231. Hence $$\frac{P}{\rho}=+\int\frac{\mu^2}{\varpi^3}\partial\varpi-gz+\text{const.}=-\tfrac{1}{2}\frac{\mu^2}{\varpi^2}-gz+\text{const.}$$

TABLE 81.—*The current function ψ for the parabolic and the hyperbolic free surfaces.*

	Parabolic. $\omega=\frac{v}{\varpi}=\text{const.}$	*Hyperbolic.* $\mu=\omega\,\varpi^2=v\varpi=\text{const.}$
232b.	$\frac{P}{\rho}=\frac{1}{2}\omega^2\varpi^2-gz+\text{const.}$	$\frac{P}{\rho}=\text{const.}-\frac{1}{2}\frac{\mu^2}{\varpi^2}-gz.$
233.	$\frac{P}{\rho}=\frac{1}{2}v^2-gz+\text{const.}$	$\frac{P}{\rho}=\text{const.}-\frac{1}{2}v^2-gz.$
	For $\frac{P}{\rho}=\Pi$ and $z=(h-h_o)=0.$	For $\frac{P}{\rho}=\Pi$ and $z=(h-h_o)=0.$
234.	$(\Pi-\text{const.})+0\ =\frac{\omega^2}{2}\varpi_0^2=\frac{v_o^2}{2}.$	$(\text{const.}-\Pi)-0=\frac{1}{2}\frac{\mu^2}{\varpi_o^2}=\frac{v_o^2}{2}.$
235.	$(\Pi-\text{const.})+gz=\frac{\omega^2}{2}\varpi^2=\frac{v^2}{2}.$	$(\text{const.}-\Pi)-gz=\frac{1}{2}\frac{\mu^2}{\varpi^2}=\frac{v^2}{2}.$
236.	$\frac{v_o^2}{2}+gz=\frac{v^2}{2}.$	$\frac{v_o^2}{2}-gz=\frac{v^2}{2}.$
237.	$v^2=-2g(h_o-h)+v_o^2.$	$v^2=+2g(h_o-h)+v_o^2.$
	Velocity decreases to center.	Velocity increases to center.
238.	$\varpi^2=-\frac{2g}{\omega^2}(h_o-h)+\varpi_0^2.$	$\frac{1}{\varpi^2}=\frac{2g}{\ }(h_o-h)+\frac{1}{\varpi_o^2}.$
239.	$\frac{\omega^2}{2g}=-\frac{1}{\varpi^2}(h_o-h)+\frac{\varpi_0^2}{\varpi^2}\cdot\frac{\omega^2}{2g}.$	$\frac{\mu^2}{2g}=\varpi^2(h_o-h)+\frac{\varpi^2}{\varpi_o^2}\cdot\frac{\mu^2}{2g}.$
240.	$\frac{\omega^2}{2g}=\frac{1}{\varpi^2}\left(\frac{v_o^2}{2g}+h-h_o\right).\quad H_o=\frac{v_o^2}{2g}-h_o.$	$\frac{\mu^2}{2g}=\varpi^2\left(\frac{v_o^2}{2g}+h_o-h\right).\quad H_o=\frac{v_o^2}{2g}+h_o.$
241.	$\frac{\omega^2}{2g}=\frac{1}{\varpi^2}(H_o+h)=\frac{1}{\varpi^2}\cdot\frac{v^2}{2g}=\psi_p.$	$\frac{\mu^2}{2g}=\varpi^2(H_o-h)=\varpi_2\cdot\frac{v^2}{2g}=\psi_h.$

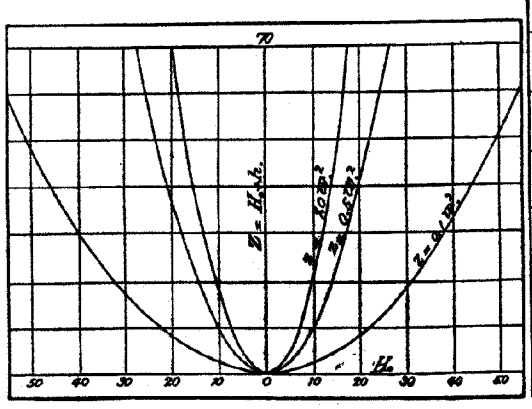


CHART 51.—Parabolic surfaces.

Examples of three parabolas with $\psi_p=0.1$, 0.5, 1.0, respectively. H_o is the height of the reference plane from which a body falls (figure is inverted) to have the velocity v_o at the radius ϖ_o on the initial plane.

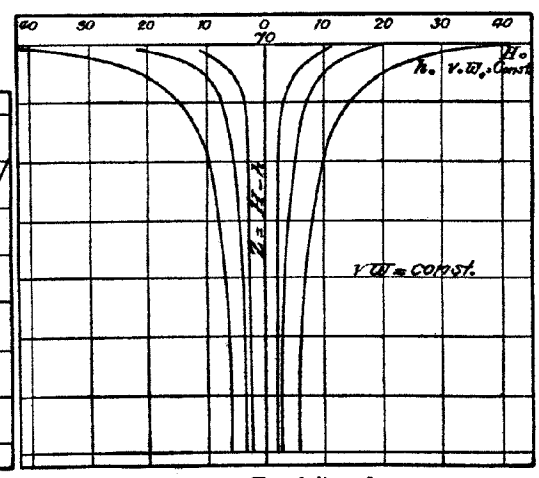


CHART 52.—Hyperbolic surfaces.

Examples of three hyperbolas with $\psi_h=120$ and $\varpi_o=11$, 22, 44, respectively. H_o is the hight of the reference plane from which a body falls to have the velocity v_o at the radius ϖ_o on the initial plane. H_o = axis of curve.

RANKINE's combined vortex makes the lower part of the hyperbola merge into the lower part of the parabola as here drawn. The question is raised whether, as cyclones and tornadoes are generated by the interaction of counter currents of horizontal convection, the parabolic curve is not also found approximately at the top of the hyperbolic curve to represent the actual stream lines.

TABLE 82.—*Stream lines and current function ψ.*

When a velocity potential exists, the equation of a family of surfaces of equivelocity potential is $u\partial x+v\partial y+w\partial z=0$. φ=constant is the surface, and dn the normal to it; the lines of flow cut the surfaces of equivelocity potential at right angles in case of no friction.

CASE 1. The motion of the liquid is *parallel to* the plane xy.

242. Lines of flow. $$u\partial y-v\partial x=0.$$

243. Continuity. $$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0.$$

244. Current function ψ (Ernshaw's). $$u=\frac{\partial\psi}{\partial y}. \qquad v=-\frac{\partial\psi}{\partial x}.$$

CASE 2. The motion of the liquid is in *planes through* the axis z.

245. Lines of flow. $$\varpi(w\partial\varpi-u\partial z)=0.$$

246. Continuity. $$\frac{\partial(\varpi u)}{\partial\varpi}+\varpi\frac{\partial w}{\partial z}=0.$$

247. Current function ψ (Stoke's). $$u=\frac{1}{\varpi}\frac{\partial\psi}{\partial z}. \qquad w=-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}.$$

CASE 3. The motion of the liquid is *symmetrical* to the axis z.

The vortex lines are perpendicular to every plane through z.

248. Rotation about y. $$2\,\omega_2=\frac{\partial u}{\partial z}-\frac{\partial w}{\partial\varpi}.$$

249. Substitute Stoke's (ψ, u. w), $$\frac{\partial^2\psi}{\partial\varpi^2}-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}+\frac{\partial\psi}{\partial z^2}+2\,\varpi\omega^2=0.$$

250. Equations of motion. $$\frac{u\partial u}{\partial\varpi}+w\frac{\partial u}{\partial z}=\tfrac{1}{2}\frac{\partial(q^2)}{\partial\varpi}+2\,\omega_2.u=\frac{\partial Q}{\partial\varpi}.$$
$$u\frac{\partial w}{\partial\varpi}+w\frac{\partial w}{\partial z}=\tfrac{1}{2}\frac{\partial(q^2)}{\partial z}-2\,\omega_2.u=\frac{\partial Q}{\partial z}.$$
Eliminate $Q-\frac{1}{2}q^2$ and use

251. $$u\frac{\partial\omega}{\partial\varpi}+w\frac{\partial\omega}{\partial z}+\omega\frac{\partial u}{\partial\varpi}+\omega\frac{\partial w}{\partial z}=0.$$

252. Equation of continuity. $$\frac{\partial u}{\partial\varpi}+\frac{\partial w}{\partial z}+\frac{u}{\varpi}=0.$$

253. Hence it becomes. $$\frac{u\partial\omega_2}{\partial\varpi}+\frac{w\partial\omega_2}{\partial z}-\frac{u\omega_2}{\varpi}=0.$$

254. Or, $$\left(u\frac{\partial}{\partial\varpi}+w\frac{\partial}{\partial z}\right)\frac{\omega_2}{\varpi}=0.$$

255. By substituting (u . w . ω_2) $$\left(\frac{\partial\psi}{\partial z}\frac{\partial}{\partial\varpi}-\frac{\partial\psi}{\partial\varpi}\frac{\partial}{\partial z}\right)\left\{\frac{1}{\varpi^2}\left(\frac{\partial^2\psi}{\partial\varpi^2}-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}+\frac{\partial^2\psi}{\partial z^2}\right)\right\}=0.$$

256. First integral. $$\frac{\partial^2\psi}{\partial\varpi^2}-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}+\frac{\partial^2\psi}{\partial z^2}=\varpi^2 f(\psi)=-2\,\varpi\omega_2.$$

CASE 4. The vortex motion is in two dimensions.

257. $$u\frac{\partial\omega_3}{\partial x}+v\frac{\partial\omega_3}{\partial y}=0.$$

258. $$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}+2\,\omega_3=0. \qquad \left(\frac{\partial\psi}{\partial y}\cdot\frac{\partial}{\partial x}-\frac{\partial\psi}{\partial y}\frac{\partial}{\partial y}\right)\left(\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}\right)=0.$$

259. First integral. $$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}=f(\psi)=-2\,\omega_3.$$

TABLE 83.—*Stream lines and equipotential surfaces.*

ψ=current function. φ=velocity potential.

CASE 1. Two dimensions, parallel to plane (xy). $\frac{v}{\varpi}=\omega_3=\text{const.}=\mu$. $2\,\omega_3=-f(\psi)$.

260. $u=-\frac{\partial\psi}{\partial y}=-\frac{\partial\varphi}{\partial x}$ $\omega_1=.0$

261. $v=+\frac{\partial\psi}{\partial x}=-\frac{\partial\varphi}{\partial y}$ $\omega_2=0.$

262. $$2\omega_3=\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}=\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}=\frac{\partial^2\psi}{\partial\varpi^2}+\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}+\frac{1}{\varpi^2}\frac{\partial^2\psi}{\partial\phi^2}=-k^2\psi.$$

263. Continuity. $$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=\frac{\partial^2\varphi}{\partial x^2}+\frac{\partial^2\varphi}{\partial y^2}=0.$$

CASE 2. Three dimensions.

This subject must be studied in general treatises on hydrodynamics, or electricity and magnetism. Some special cases may be considered here.

CASE 3. Two dimensions, parallel to the plane (ϖz). $\frac{v}{\varpi^2}=\frac{\omega_2}{\varpi}=\text{const.}$ $-2\,\omega_2=\varpi f(\psi)$.

264. Velocities. $u=+\frac{1}{\varpi}\frac{\partial\psi}{\partial z}.$ $w=-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}.$

265. Differential equation. $\varpi u\,.\,\partial z-\varpi w\partial\varpi=\partial\psi.$

266. Irrotational motion. $\frac{\partial u}{\partial z}-\frac{\partial w}{\partial\varpi}=2\,\omega_2=0.$

267. *Stream lines.* $$\frac{\partial^2\psi}{\partial\varpi^2}-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}+\frac{\partial^2\psi}{\partial z^2}=-2\,\varpi\omega_2=\varpi\left(\frac{\partial u}{\partial z}-\frac{\partial w}{\partial\varpi}\right)=\varpi^2 f(\psi).$$

268. Velocities. $u=-\frac{\partial\varphi}{\partial\varpi}.$ $v=-\frac{\partial\varphi}{\partial z}.$

269. Differential equation. $u\partial\varpi+w\partial z=-\partial\varphi.$

270. *Equipotentials.* $$\frac{\partial^2\varphi}{\partial\varpi^2}+\frac{1}{\varpi}\frac{\partial\varphi}{\partial\varpi}+\frac{\partial^2\varphi}{\partial z^2}=0.$$

Developments in series of *Bessel's functions.* $\psi=c\,.\,\varphi.$

271. $\frac{\partial^2\varphi}{\partial x^2}+\frac{1}{x}\frac{\partial\varphi}{\partial x}+\varphi=0.$ $\frac{\partial^2\varphi}{\partial x^2}-\frac{1}{x}\frac{\partial\varphi}{\partial x}+\varphi=0.$

272. Assume $\varphi=\Sigma b_n x^n$. Hence $\frac{\partial\varphi}{\partial x}=nb_n x^{n-1}$. $\frac{\partial^2\varphi}{\partial x^2}=n(n-1)\,b_n x^{n-2}.$

273. $n\,(n-1)\,b_n x^{n-2}+nb_n x^{n-2}+b_n x^n=0.$ $n(n-1)b_n x^{n-2}-nb_n x^{n-2}+b_n x^n=0.$

274. $n(n-1)b_n \quad +nb_n \quad +b_{n-2}=0.$ $n(n-1)b_n \quad -nb_n \quad +b_{n-2}=0.$

275. $x=1.$ $b_n=-\frac{b_{n-2}}{n^2}$ $x=1.$ $b_n=-\frac{b_{n-2}}{n^2-2n}.$

276. $\varphi=b_o\,.\,1-\frac{b_o x^2}{2^2}+\frac{b_o x^4}{2^2.\,4^2}-\frac{b_o x^6}{2^2.\,4^2.\,6^2}+\cdots$ $\varphi=b_2x^2-\frac{b_2x^4}{2\,.\,4}+\frac{b_2x^6}{2\,.\,4^2.\,6}-\frac{b_2x^8}{2\,.\,4^2.\,6^2.\,8}+\cdots$

Take $b_o=1.$ $x=a\varpi.$ Take $b_2=1.$ $x=a\varpi.$

277. $\varphi=\left(1-\frac{a^2\varpi^2}{4}+\frac{a^4\varpi^4}{64}-\frac{a^6\varpi^6}{2304}+\frac{a^8\varpi^8}{147456}\cdots\right).$ $\varphi=a^2\varpi^2\left(1-\frac{a^2\varpi^2}{8}+\frac{a^4\varpi^4}{192}-\frac{a^6\varpi^6}{9216}+\frac{a^8\varpi^8}{737280}\cdots\right).$

278. Root $\varphi=0.$ $a\varpi_o=2.405=\gamma.$ $a\varpi_o=3.832.$

The roots of BESSEL'S functions are found in "Fourier's Series and Spherical Harmonics," BYERLY, page 286.

TABLE 84.—*Special circulations.*

CASE 1. The gyration does not depend upon z. (Wien.)

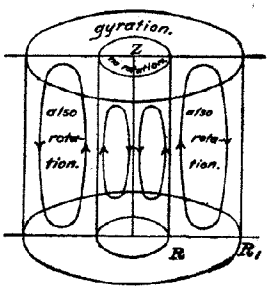


CHART 53.—Circulation in a closed cylinder, independent of z.

279. $f(\psi)=0.$ $\qquad \dfrac{\partial f(\psi)}{\partial(\psi)}=0.$ $\qquad \psi=\varphi \sin mz.$

$$F(\psi)=-k\psi.$$

280. $$\frac{\partial^2\psi}{\partial\varpi^2}-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}+\frac{\partial^2\psi}{\partial z^2}=-\varpi^2 k\psi$$

281. $$\frac{\partial^2\varphi}{\partial\varpi^2}-\frac{1}{\varpi}\frac{\partial\varphi}{\partial\varpi}-(m^2-k\varpi^2)\,\varphi=0.$$

Inner region.

282. $\psi_1=\varphi_1 \,.\, \sin mz=\text{const.}$

283. $\varphi_1=C_1 \sin\left(\frac{1}{2}\sqrt{k}\varpi^2\right).$

284. $\sqrt{k_1}=\dfrac{2\pi}{R^2}.$

285. $\dfrac{\partial\varphi_1}{\partial\varpi}=\sqrt{k_1}\varpi C_1 \cos\left(\frac{1}{2}\sqrt{k_1}\varpi^2\right).$

286. $$u_1=\frac{1}{\varpi}\frac{\partial\psi_1}{\partial z}=\frac{\varphi_1}{\varpi}m \,.\, \cos mz.$$

$$v_1=\frac{a\psi_1}{\varpi}=\frac{a\varphi_1 \,.\, \sin mz}{\varpi}.$$

$$w_1=-\frac{1}{\varpi}\frac{\partial\psi_1}{\partial\varpi}=-\frac{1}{\varpi}\frac{\partial\varphi_1}{\partial\varpi}\sqrt{k_1}\sin mz.$$

Outer region.

287. $\psi=\varphi \,.\, \sin mz=\text{const.}$

288. $\varphi=C \sin\left(\frac{1}{2}\sqrt{k} \,.\, \varpi^2\right)-C_1 \cos\left(\frac{1}{2}\sqrt{k} \,.\, \varpi^2\right).$

289. $\sqrt{k}=\dfrac{2\pi}{R_1^2-R^2}.$

290. $\dfrac{\partial\varphi}{\partial\varpi}=\sqrt{k}\varpi\left(C \cos\frac{1}{2}\sqrt{k} \,.\, \varpi^2+C_1 \sin\frac{1}{2}\sqrt{k} \,.\, \varpi^2\right).$

291. $$u=\frac{1}{\varpi}\frac{\partial\psi}{\partial z}=\frac{\varphi}{\varpi} \,.\, m \cos mz.$$

$$v=\frac{a}{\varpi}\psi=\frac{a\varphi \,.\, \sin mz}{\varpi}.$$

$$w=-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}=-\frac{1}{\varpi}\frac{\partial\varphi}{\partial\varpi} \,.\, \sqrt{k}\sin mz.$$

CASE 2. The gyration depends upon z. (Wien.)

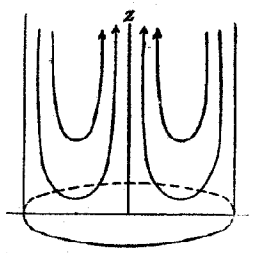


CHART 54.—Circulation in a cylinder open at one end, dependent upon z.

292. $f(\psi)=a\psi.$ $\qquad \psi=\varphi z-\chi.$ $\qquad \varphi$ and χ=functions of ϖ.

293. $$\frac{\partial^2\psi}{\partial\varpi^2}-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}+\frac{\partial^2\psi}{\partial z^2}=\varpi^2 f(\psi)=\varpi^2 a\psi.$$

294. $$\frac{\partial^2\varphi}{\partial\varpi^2}-\frac{1}{\varpi}\frac{\partial\varphi}{\partial\varpi}+a^2\varphi=0.$$

295. $$\frac{\partial^2\chi}{\partial\varpi^2}-\frac{1}{\varpi}\frac{\partial\chi}{\partial\varpi}+a^2\chi=\text{const} \,.\, \varpi^2.$$

296. $\psi=\varphi(z-B)=\text{const.}$

297. $$\varphi=C\varpi^2\left(1-\frac{a^2\varpi^2}{2\,.\,4}+\frac{a^4\varpi^4}{2\,.\,4^2\,.\,6}-\frac{a^6\varpi^6}{2\,.\,4^2\,.\,6^2\,.\,8}+\;.\;.\right).$$

298. $$u=\frac{1}{\varpi}\frac{\partial\psi}{\partial z}=\frac{\varphi}{\varpi}.$$

$$v=\frac{a\psi}{\varpi}=\frac{a\varphi(z-B)}{\varpi}. \qquad \varpi v=a\varphi(z-B).$$

$$w=-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}=-\frac{1}{\varpi}\frac{\partial\varphi}{\partial\varpi}(z-B).$$

TABLE 84.—*Special circulations*—Continued.

CASE 3. Bounded by two parallel planes. (Wien.)

299. $f(\psi)=-\frac{n^2}{\varpi^2}\psi.$ $\quad \psi=A\varpi^2 \,.\, \sin nz \,.$ $\quad z=\frac{\pi}{n}\cdot$

$\varphi=A\varpi^2.$

300. $\frac{\partial^2\psi}{\partial\varpi^2}-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}+\frac{\partial^2\psi}{\partial z^2}=\varpi^2 f(\psi)=-n^2A\varpi^2 \,.\, \sin nz.$

301. $\psi= A\varpi^2 \,.\, \sin az=\varphi \,.\, \sin az=\text{const.}$

302. $u= \frac{1}{\varpi}\frac{\partial\psi}{\partial z}=\varpi aA \cos az.$

$v= \frac{a\psi}{\varpi} =\varpi aA \sin az. \qquad \varpi v=aA \sin nz.$

$w=-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}=-2A \,.\, \sin az.$

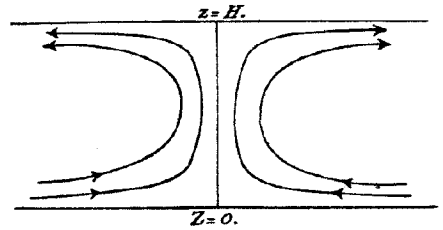


CHART 55.—Circulation beween two planes.

CASE 4. Bounded by one plane. (Bigelow.)

303. $\psi= \frac{c}{2}\varpi^2 z=\text{const.} \qquad +z$ is downward.

304. $\varphi= \frac{c}{2}\varpi^2. \qquad a=1. \qquad \frac{c}{2}=\frac{2g}{v\varpi}=\frac{v}{\varpi z}.$

305. $u=+\frac{1}{\varpi}\frac{\partial\psi}{\partial z}= \frac{c}{2}\varpi=\frac{2g}{v}\cdot=\frac{v}{z}.$

$v= \frac{a\psi}{\varpi} = \frac{c}{2}\varpi z =\frac{2g}{v}\cdot z=uz.$

$w=-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}=-c \,.\, z =\frac{2v}{\varpi}=\frac{\text{const}}{\pi\varpi^2}=\frac{\text{const}}{\pi u^2}.$

306. $v^2= 2gz \,.\, =\frac{2}{c}wg \,.\, =\frac{v_0^2\varpi_0^2}{\varpi^2}.$

307. $v\varpi= \frac{c}{2}\varpi^2 z=2g\frac{\varpi z}{v}=\varpi uz=\text{const.}$

308. $w\pi\varpi^2=\text{const.}$

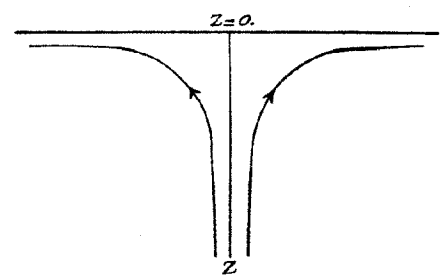


CHART 56.—Circulation bounded by one plane.

The constant (a) has been assumed equal to unity for the tornado. The fundamental law is that of the velocity of falling bodies, $v^2=gz$.

TABLE 85.—*Diagrams and definitions for polar curves.*

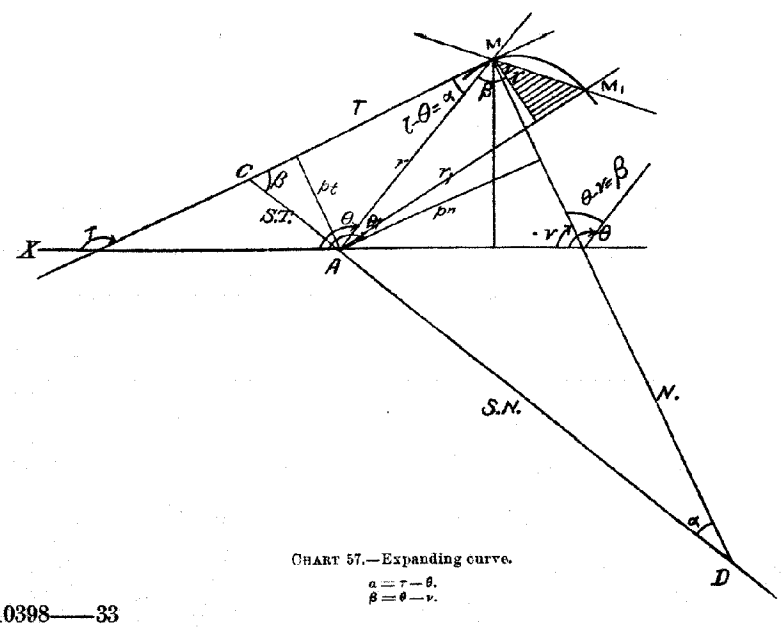


CHART 57.—Expanding curve.

$\alpha=\tau-\theta.$
$\beta=\theta-\nu.$

TABLE 85.—*Diagrams and definitions for polar curves*—Continued.

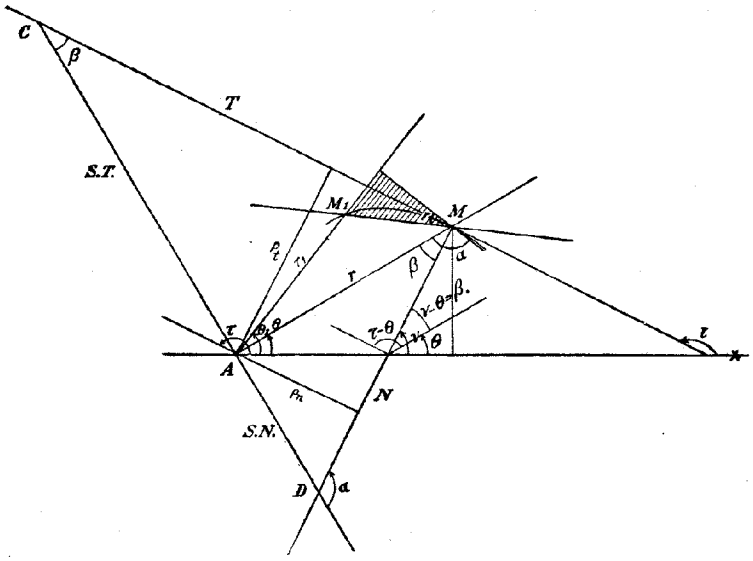


CHART 58.—Contracting curve.
$\alpha = \tau - \theta.$
$\beta = \nu - \theta.$

310. Notation for expanding and contracting polar curves (r . θ .).
M . M_1 . the first and second contiguous points on the curve.
T tangent, N normal, $S.T.$ subtangent, $S.N.$ subnormal to M.
$\alpha =$ angle (r . T .) = angle ($S.N.$ $N.$). $\beta =$ angle (r . $N.$) = angle ($S.T.$ $T.$).
$\theta =$ angle (x . $r.$). $T =$ angle (x . T .). $\nu =$ angle (x . N .).
p_t . p_n . perpendiculars on the tangent and the normal respectively.

The functions ψ and φ in logarithmic spirals.

311. $F(x + iy) = m \log (x + iy) = \varphi + i\psi. \qquad x = r \cos \theta. \qquad y = r \sin \theta.$

312. $$(x+iy) = e^{\left(\frac{\varphi}{m} + \frac{i.\psi}{m}\right)} = e^{\frac{\varphi}{m}}\left(\cos \frac{\psi}{m} + i \sin \frac{\psi}{m}\right) = r(\cos \theta + i \sin \theta) = r e^{i\theta}.$$

313. $$e^{\frac{\varphi}{m}} = r. \qquad \frac{\varphi}{m} = \log r. \qquad \varphi = m \log r. \qquad \psi = m\,\theta + \text{const.} = m \tan^{-1}\frac{y}{x} + \text{const.}$$

314. $$\varphi + i\,\psi = m \log r\, e^{i\theta}.$$

315. $$m\,\theta - m \log r = \text{const.}$$

316. $$\theta - \log r = \text{const.} = a.$$

TABLE 86.—*Formulæ and figures for three spiral curves.*

	Equations.	Archimedean.	
317.		$r=a\theta.$	
318.		$\frac{dr}{d\theta}=a$	$=a.$
319.		$\frac{ds}{d\theta}=a(1+\theta^2)^{1/2}$	$=(a^2+r^2)^{1/2}.$
320.		$\frac{dr}{ds}=\frac{1}{(1+\theta^2)^{1/2}}$	$=\frac{a}{(a^2+r^2)^{1/2}}.$
321.	$ds^2=dr^2+r^2d\theta^2.$	$ds=a(1+\theta^2)^{1/2}d\theta=\frac{(a^2+r^2)^{1/2}}{a}dr.$	
322.	$\sin\alpha=\frac{rd\theta}{ds}.$	$\sin\alpha=\frac{\theta}{(1+\theta^2)^{1/2}}$	$=\frac{r}{(a^2+r^2)^{1/2}}.$
323.	$\cos\alpha=\frac{dr}{ds}.$	$\cos\alpha=\frac{1}{(1+\theta^2)^{1/2}}$	$=\frac{a}{(a^2+r^2)^{1/2}}.$
324	$\tan\alpha=\frac{rd\theta}{dr}.$	$\tan\alpha=\theta$	$=\frac{r}{a}.$
325.	$T=r\frac{ds}{dr}.$	$T=a\theta(1+\theta^2)^{1/2}$	$=\frac{r}{a}(a^2+r^2)^{1/2}.$
326.	$N=\frac{ds}{d\theta}.$	$N=a(1+\theta^2)^{1/2}$	$=(a^2+r^2)^{1/2}.$
327.	$S.T.=r^2\frac{d\theta}{dr}.$	$S.T.=a\theta^2$	$=\frac{r^2}{a}.$
328.	$S.N.=\frac{dr}{d\theta}.$	$S.N.=a$	$=a.$
329.	$p_t=r^2\frac{d\theta}{ds}.$	$p_t=\frac{a\theta^2}{(1+\theta^2)^{1/2}}$	$=\frac{r^2}{(a^2+r^2)^{1/2}}.$
330.	$p_n=r\frac{dr}{ds}.$	$p_n=\frac{a\theta}{(1+\theta^2)^{1/2}}$	$=\frac{ar}{(a^2+r^2)^{1/2}}.$

	Hyperbolic.		Logarithmic.	
317.	$r=\frac{a}{\theta}.$		$r=e^{a\theta}.$	
318.	$\frac{dr}{d\theta}=-\frac{a}{\theta^2}$	$=-\frac{r^2}{a}.$	$\frac{dr}{d\theta}=ae^{a\theta}$	$=ar.$
319	$\frac{ds}{d\theta}=\frac{a}{\theta^2}(1+\theta^2)^{1/2}$	$=\frac{r}{a}(a^2+r^2)^{1/2}.$	$\frac{ds}{d\theta}=e^{a\theta}(1+a^2)^{1/2}$	$=r(1+a^2)^{1/2}.$
320.	$\frac{dr}{ds}=-\frac{1}{(1+\theta^2)^{1/2}}$	$=-\frac{r}{(a^2+r^2)^{1/2}}.$	$\frac{dr}{ds}=\frac{a}{(1+a^2)^{1/2}}$	$=\frac{a}{(1+a^2)^{1/2}}.$
321.	$ds=\frac{a}{\theta^2}(1+\theta^2)^{1/2}d\theta=\frac{(a^2+r^2)^{1/2}}{r}dr.$		$ds=e^{a\theta}(1+a^2)^{1/2}d\theta=\frac{(1+a^2)^{1/2}}{a}dr.$	
322.	$\sin\alpha=\frac{\theta}{(1+\theta^2)^{1/2}}$	$=\frac{a}{(a^2+r^2)^{1/2}}.$	$\sin\alpha=\frac{1}{(1+a^2)^{1/2}}$	$=\frac{1}{(1+a^2)^{1/2}}.$
323.	$\cos\alpha=-\frac{1}{(1+\theta^2)^{1/2}}$	$=-\frac{r}{(a^2+r^2)^{1/2}}.$	$\cos\alpha=\frac{a}{(1+a^2)^{1/2}}$	$=\frac{a}{(1+a^2)^{1/2}}.$
324.	$\tan\alpha=-\theta$	$=-\frac{a}{r}.$	$\tan\alpha=\frac{1}{a}$	$=\frac{1}{a}.$
325.	$T=-\frac{a}{\theta}(1+\theta^2)^{1/2}=-(a^2+r^2)^{1/2}.$		$T=\frac{e^{a\theta}}{a}(1+a^2)^{1/2}$	$=\frac{r}{a}(1+a^2)^{1/2}.$
326.	$N=\frac{a}{\theta^2}(1+\theta^2)^{1/2}$	$=\frac{r}{a}(a^2+r^2)^{1/2}.$	$N=e^{a\theta}(1+a^2)^{1/2}$	$=r(1+a^2)^{1/2}.$
327.	$S.T.=-a$	$=-a.$	$S.T.=\frac{e^{a\theta}}{a}$	$=\frac{r}{a}.$
328.	$S.N.=-\frac{a}{\theta^2}$	$=-\frac{r^2}{a}.$	$S.N.=ae^{a\theta}$	$=ar.$
329.	$p_t=\frac{a}{(1+\theta^2)^{1/2}}$	$=\frac{ra}{(a^2+r^2)^{1/2}}.$	$p_t=\frac{e^{a\theta}}{(1+a^2)^{1/2}}$	$=\frac{r}{(1+a^2)^{1/2}}.$
330.	$p_n=-\frac{a}{\theta(1+\theta^2)^{1/2}}$	$=-\frac{r^2}{(a^2+r^2)^{1/2}}.$	$p_n=\frac{ae^{a\theta}}{(1+a^2)^{1/2}}$	$=\frac{ar}{(1+a^2)^{1/2}}.$

TABLE 86.—*Formulæ and figures for three spiral curves*—Continued.

CHART 59.—Spiral of Archimedes.

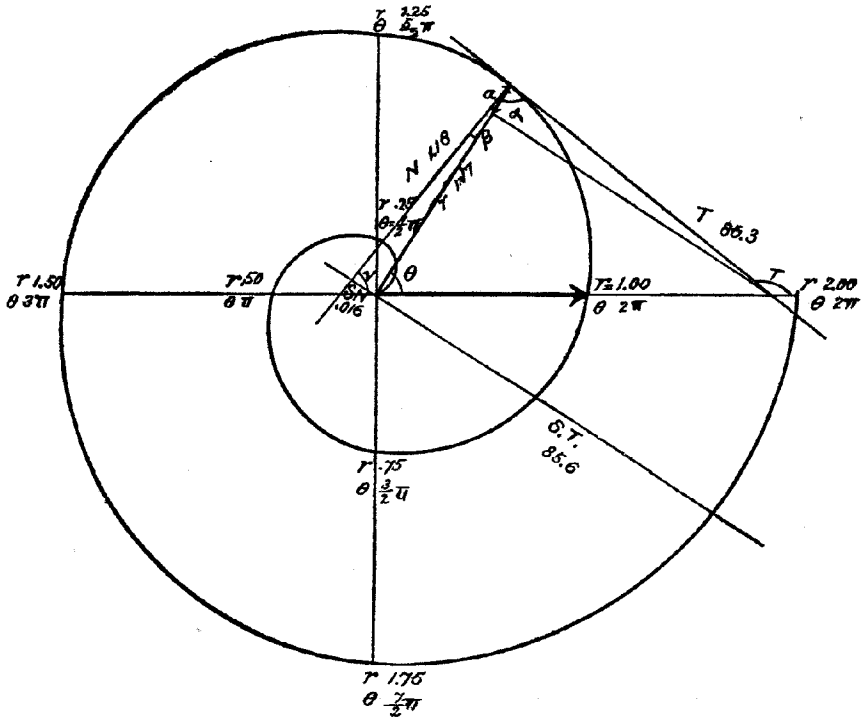


CHART 60.—Hyperbolic spiral.

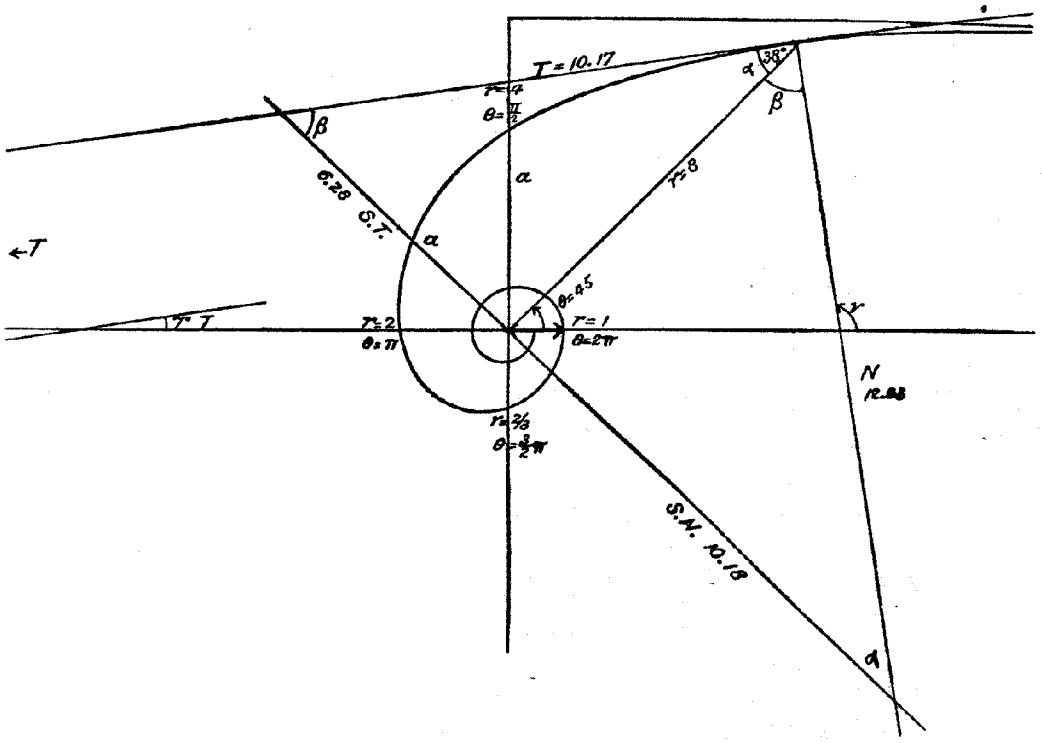


TABLE 86.—*Formulæ and figures for three spiral curves*—Continued.

CHART 61.—Three logarithmic spirals. 1. $\alpha = 30°$ 2. $\alpha = 45°$ 3. $\alpha = 60°$.

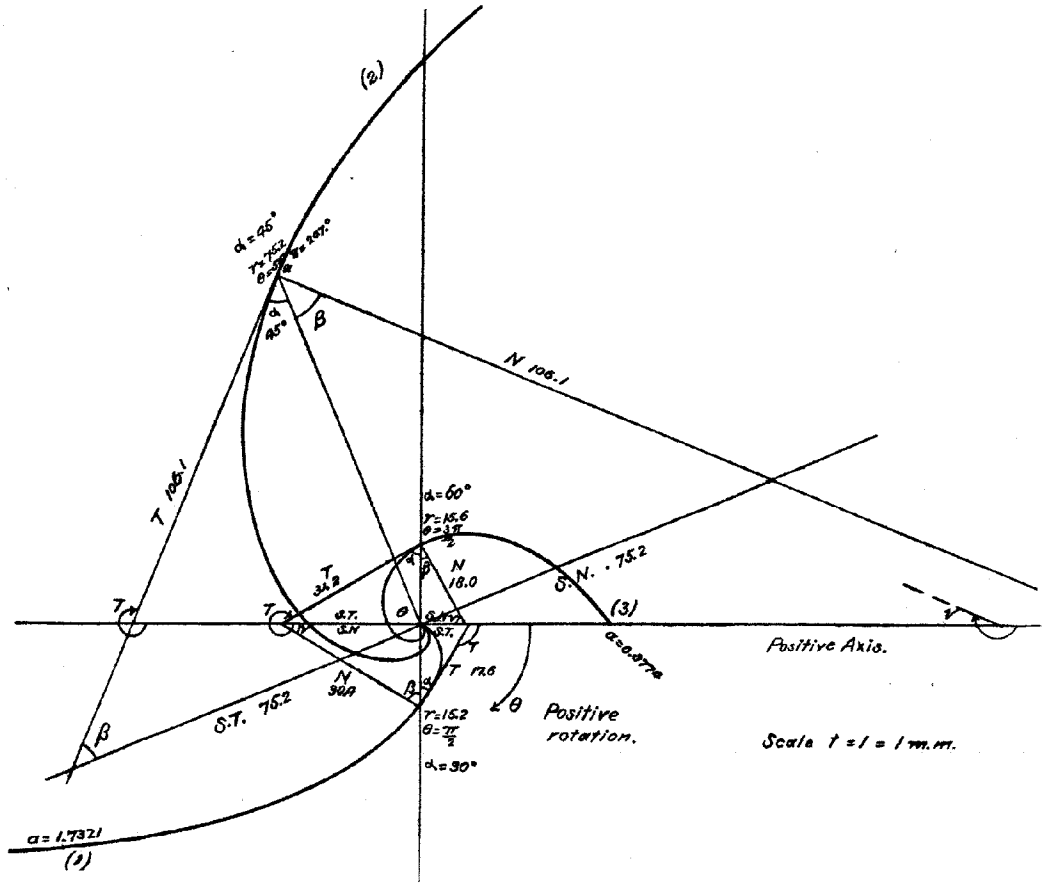


TABLE 87.—*Table of coordinates (r. θ.) for logarithmic spirals of different degrees, from α=30° to α=90°.*

Computed from $r = e^{a\theta}$. $N. \log r = a\theta$.

Since $\tan \alpha = \frac{1}{a}$ $a = \cot \alpha$.

Assume a series of angular values θ, and compute natural log r.

r is also given in the same table; hence the points ($r.\ \theta.$) are found.

If a diagram containing several of these spirals with successive values of α be constructed from the same pole and axis, one can apply this scale to any given curve, as the wind lines on the weather map, and thus interpolate by inspection the pitch of the stream line at every part of it. Such a matching of scale and wind lines shows that generally the spiral pitch ranges widely, 30° to 50°, in a given cyclone. Even with elimination of the eastward drift, the counter flow from independent streams so far distorts the logarithmic vortex curves as to leave but rough approximations to the simple vortex law.

Angle to polar axis		α=30° a=1.7321		α=35° a=1.4281		α=40° a=1.1918		α=45° a=1.0000		α=50° a=0.8391		α=55° a=0.7002		α=60° a=0.5774		
θ		N. log r	r	N. log r	r	N. log r	r	N. log r	r	N. log r	r	N. log r	r	N. log r	r	
0	0	0	1.0	0	1.0	0	1.0	0	1.0	0	1.0	0	1.0	0	1.0	
45	$\frac{\pi}{4}$	1.360	4.0	1.121	3.2	0.963	2.8	0.7854	2.2	0.659	1.9	0.550	1.6	0.453	1.4	
90	$\frac{2\pi}{4}$	2.721	15.2	2.243	9.6	1.672	6.6	1.5708	4.9	1.318	3.9	1.100	3.0	0.907	2.6	
135	$\frac{3\pi}{4}$	4.081	59.2	3.365	29.0	2.808	16.5	2.3561	10.6	1.977	7.3	1.650	5.4	1.360	3.9	
180	$\frac{4\pi}{4}$	5.441	231.0	4.486	89.0	3.744	42.2	3.1415	23.2	2.636	14.0	2.200	9.0	1.814	6.1	
225	$\frac{5\pi}{4}$			5.739	311.0	4.680	107.8	3.9270	50.8	3.295	27.0	2.750	15.7	2.267	9.6	
247.5	$\frac{5.5\pi}{4}$					5.148	172.0	4.3197	75.1	3.625	37.6	3.025	20.6	2.494	12.1	
270	$\frac{6.0\pi}{4}$					5.616	275.0	4.7123	111.7	3.954	52.1	3.300	27.1	2.721	15.2	
292.5	$\frac{6.5\pi}{4}$							5.1050	165.0	4.283	72.5	3.574	35.7	2.947	19.1	
315	$\frac{7.0\pi}{4}$							5.4979	244.0	4.613	100.9	3.850	47.0	3.174	24.1	
360	$\frac{8\pi}{4}$									5.272	195.0	4.400	81.5	3.628	37.6	1 rev.
405	$\frac{9\pi}{4}$											4.949	141.0	4.081	59.2	
450	$\frac{10\pi}{4}$											5.500	244.0	4.534	93.0	
495	$\frac{11\pi}{4}$													4.988	147.0	
540	$\frac{12\pi}{4}$													5.441	231.0	

Angle to polar axis.		$\alpha=65^\circ$ $a=0.4663$		$\alpha=70^\circ$ $a=0.3640$		$\alpha=75^\circ$ $a=0.2679$		$\alpha=80^\circ$ $a=0.1763$		$\alpha=85^\circ$ $a=0.0875$		$\alpha=90^\circ$ $a=0.0000$		Com. log. $n \cdot \frac{\pi}{4}$	
θ		$N.$ log r	r	$N.$ log r	r	$N.$ log r	r	$N.$ log r	r	$N.$ log r	r	$N.$ log r	r		
0°	0	0	1.0	0	1.0	0	1.0	0	1.0	0	1.0	0	1.0		
45	$\frac{\pi}{4}$	0.366	1.5	0.286	1.4	0.211	1.3	0.139	1.2	0.069	1.1	0	1.0	9.89509	
90	$2\frac{\pi}{4}$	0.732	2.1	0.572	1.8	0.421	1.6	0.259	1.4	0.137	1.2	0	1.0	0.19612	
135	$3\frac{\pi}{4}$	1.099	3.0	0.858	2.4	0.631	1.9	0.416	1.6	0.206	1.3	0	1.0	0.37221	
180	$4\frac{\pi}{4}$	1.465	4.3	1.143	3.1	0.842	2.4	0.554	1.8	0.275	1.4	0	1.0	0.49715	
225	$5\frac{\pi}{4}$	1.831	6.2	1.429	4.1	1.052	2.9	0.692	2.0	0.344	1.5	0	1.0	0.59406	
270	$6\frac{\pi}{4}$	2.197	9.0	1.715	5.8	1.263	3.8	0.831	2.3	0.412	1.6	0	1.0	0.67324	
315	$7\frac{\pi}{4}$	2.564	13.0	2.001	7.5	1.473	4.4	0.969	2.8	0.481	1.7	0	1.0	0.74019	
360	$8\frac{\pi}{4}$	2.930	18.8	2.287	9.9	1.684	5.3	1.108	2.9	0.550	1.8	0	1.0	0.79818	1 rev.
405	$9\frac{\pi}{4}$	3.296	27.0	2.573	13.1	1.894	6.3	1.246	3.8	0.618	1.9	0	1.0	0.84933	
450	$10\frac{\pi}{4}$	3.662	39.0	2.859	17.4	2.104	8.2	1.385	4.0	0.687	2.0	0	1.0	0.89509	
495	$11\frac{\pi}{4}$	4.029	56.0	3.144	23.1	2.315	10.1	1.523	4.4	0.756	2.1	0	1.0	0.93648	
540	$12\frac{\pi}{4}$	4.395	81.0	3.430	31.0	2.525	12.5	1.662	5.3	0.825	2.3	0	1.0	0.97427	
585	$13\frac{\pi}{4}$	4.761	117.0	3.716	41.0	2.736	15.4	1.800	6.0	0.893	2.5	0	1.0	1.00903	
630	$14\frac{\pi}{4}$	5.127	166.6	4.002	55.0	2.946	19.0	1.939	6.9	0.962	2.7	0	1.0	1.04122	
675	$15\frac{\pi}{4}$	5.495	243.0	4.288	72.8	3.157	23.5	2.077	8.0	1.031	2.9	0	1.0	1.07118	
720	$16\frac{\pi}{4}$			4.574	97.0	3.367	29.0	2.216	9.2	1.099	3.0	0	1.0	1.09921	2 rev.
810	$18\frac{\pi}{4}$			5.145	172.0	3.788	44.2	2.493	12.1	1.237	3.3	0	1.0	1.15036	
900	$20\frac{\pi}{4}$			5.717	304.0	4.209	67.1	2.770	16.0	1.374	3.9	0	1.0	1.19612	
990	$22\frac{\pi}{4}$					4.630	102.4	3.047	21.0	1.512	4.6	0	1.0	1.23751	
1080	$24\frac{\pi}{4}$					5.051	156.1	3.324	27.8	1.649	5.2	0	1.0	1.27530	3 rev.
1170	$26\frac{\pi}{4}$					5.471	238.0	3.601	36.7	1.787	5.9	0	1.0	1.31006	
1260	$28\frac{\pi}{4}$							3.878	48.2	1.924	6.9	0	1.0	1.34225	
1350	$30\frac{\pi}{4}$							4.155	63.9	2.062	7.9	0	1.0	1.37221	
1440	$32\frac{\pi}{4}$							4.432	84.1	2.199	9.0	0	1.0	1.40024	4 rev.
1530	$34\frac{\pi}{4}$							4.708	110.8	2.336	10.3	0	1.0	1.42657	
1620	$36\frac{\pi}{4}$							4.985	146.2	2.474	11.9	0	1.0	1.45139	
1710	$38\frac{\pi}{4}$							5.262	193.0	2.611	13.7	0	1.0	1.47487	
1800	$40\frac{\pi}{4}$							5.540	255.0	2.748	15.6	0	1.0	1.49715	5 rev.
	$48\frac{\pi}{4}$									3.298	27.2	0	1.0	1.57631	6 rev.
	$56\frac{\pi}{4}$									3.848	46.9	0	1.0	1.64328	7 rev.
	$64\frac{\pi}{4}$									4.398	81.2	0	1.0	1.70127	8 rev.
	$72\frac{\pi}{4}$									4.947	141.0	0	1.0	1.75242	9 rev.
	$80\frac{\pi}{4}$									5.497	244.0	0	1.0	1.79818	10 rev.

TABLE 88.—*Cross connection between currents and vortices, deduced from the analogue of the electric current and magnetic whirl.*

Velocities due to dilatation and vortex motion of the liquid.

331. Density$=\rho$. Volume$=d\tau$. ($\rho=1$ for a homogeneous medium.)

332. Velocity potential. $\varphi=\iiint\frac{\rho}{r}d\tau$. to be integrated through the volume.

333. Vortical potential.

$$\begin{cases} F=\iiint\frac{u}{r}\cdot d\tau. & (u\,.\,v\,.\,w\,.)=\text{Electric current.} \\ G=\iiint\frac{v}{r}\cdot d\tau. & (\alpha_1\ \beta_1\ \gamma_1)=\text{Magnetic divergence.} \\ H=\iiint\frac{w}{r}\cdot d\tau. & (\alpha_2\ \beta_2\ \gamma_2)=\text{Magnetic vortex.} \end{cases}$$

334. Dilatation or Expansion or Divergence.

$$\begin{cases} \alpha_1=-\frac{\partial\varphi}{\partial x} \\ \beta_1=-\frac{\partial\varphi}{\partial y} \\ \gamma_1=-\frac{\partial\varphi}{\partial z} \end{cases}$$

335. Vortices.

$$\alpha_2=\frac{\partial H}{\partial y}-\frac{\partial G}{\partial z}.\qquad \beta_2=\frac{\partial F}{\partial z}-\frac{\partial H}{\partial x}.\qquad \gamma_2=\frac{\partial G}{\partial x}-\frac{\partial F}{\partial y}.$$

336. Total magnetic force.

$$\alpha=\alpha_1+\alpha_2=-\frac{\partial\varphi}{\partial x}+\frac{\partial H}{\partial y}-\frac{\partial G}{\partial z}.$$

$$\beta=\beta_1+\beta_2=-\frac{\partial\varphi}{\partial y}+\frac{\partial F}{\partial z}-\frac{\partial H}{\partial x}.$$

$$\gamma=\gamma_1+\gamma_2=-\frac{\partial\varphi}{\partial z}+\frac{\partial G}{\partial x}-\frac{\partial F}{\partial y}.$$

337. Density.

$$\Theta=\frac{\partial\alpha_1}{\partial x}+\frac{\partial\beta_1}{\partial y}+\frac{\partial\gamma_1}{\partial z}=-\nabla^2\varphi=4\pi\rho.$$

338. Rotation.

$$2\omega_1=\frac{\partial\gamma}{\partial y}-\frac{\partial\beta}{\partial z}=\frac{\partial}{\partial x}\left(\frac{\partial F}{\partial x}+\frac{\partial G}{\partial y}+\frac{\partial H}{\partial z}\right)-\nabla^2F=4\pi u.$$

$$2\omega_2=\frac{\partial\alpha}{\partial z}-\frac{\partial\gamma}{\partial x}=\frac{\partial}{\partial y}\left(\frac{\partial F}{\partial x}+\frac{\partial G}{\partial y}+\frac{\partial H}{\partial z}\right)-\nabla^2G=4\pi v.$$

$$2\omega_3=\frac{\partial\beta}{\partial x}-\frac{\partial\alpha}{\partial y}=\frac{\partial}{\partial z}\left(\frac{\partial F}{\partial x}+\frac{\partial G}{\partial y}+\frac{\partial H}{\partial z}\right)-\nabla^2H=4\pi w=e.$$

339. Continuity.

$$\frac{\partial\alpha}{\partial x}+\frac{\partial\beta}{\partial y}+\frac{\partial\gamma}{\partial z}=0.\qquad \frac{\partial F}{\partial x}+\frac{\partial G}{\partial y}+\frac{\partial H}{\partial z}=0.$$

Make the following analogues:

340. $(u\,.\,v\,.\,w)$ Electric current $=$vortex-filaments or molecular rotation $\left(\frac{\omega_1}{2\pi},\frac{\omega_2}{2\pi},\frac{\omega_3}{2\pi}\right)$

$(\alpha\,.\,\beta\,.\,\gamma)$ Magnetic force $=$fluid velocity. $(u\,.\,v\,.\,w)$

Ω Magnetic potential of the current $=$velocity potential of the vortex, φ.

$(F\,.\,G\,.\,H)$ Electromagnetic momentum$=$rotational potential. $(L\,.\,M\,.\,N)$

Special case. Rectilinear vortices parallel to z.

341. Assume $u=v=0$. $\rho=1$.

$(F\,.\,G\,.\,H)$ becomes limited to H, the component parallel to z.

$$\alpha=+\frac{\partial H}{\partial y}.\qquad H=\int\frac{w}{\varpi}\cdot d\tau.$$

$$\beta=-\frac{\partial H}{\partial x}.\qquad H'=(\alpha^2+\beta^2)^{\frac{1}{2}}=-\frac{\partial H}{\partial\varpi}.$$

$$\gamma=0\qquad H'd\varpi dz\qquad =-\frac{\partial H}{\partial\varpi}d\varpi dz.$$

$$\alpha\partial y-\beta\partial x=0$$

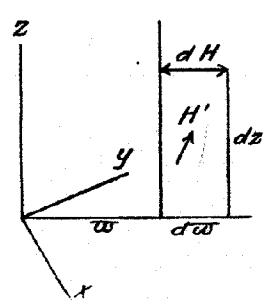


CHART 62.—Velocity area for potential.

TABLE 89.—*Application to cases; (1) no vertical current, (2) vertical current in a cylinder.*

342. Gauss' theorem. $$\int \frac{\partial H}{\partial \varpi} d\varpi dz = \int \frac{\partial H}{\partial \varpi} dS = -4\pi \int w d\tau.$$

343. Expanding the integrations. $$\left.\frac{dH}{d\varpi}\right]_{\varpi+d\varpi} 2\pi(\varpi+d\varpi)dz - \left.\frac{dH}{d\varpi}\right]_{\varpi} 2\pi\varpi dz = -4\pi w \,.\, 2\pi\varpi d\varpi dz.$$

344. By Taylor's theorem. $$\left.\frac{dH}{d\varpi}\right]_{\varpi+d\varpi} 2\pi(\varpi+d\varpi)dz = \varpi \left.\frac{dH}{d\varpi}\right]_{\varpi-d\varpi} dz = \left.\frac{dH}{d\varpi}\right]_{\varpi} 2\pi\varpi dz + \frac{d}{d\varpi}\left[\varpi \frac{dH}{d\varpi}\right]_{\varpi} 2\pi d\varpi dz.$$

345. Substituting. $$\frac{d}{d\varpi}\left(\varpi \frac{dH}{\partial \varpi}\right) 2\pi d\varpi dz = -4\pi w \,.\, 2\pi\varpi d\varpi dz.$$

346. Integrating. $$\frac{d}{d\varpi}\left(\varpi \frac{dH}{d\varpi}\right) = \frac{d}{d\varpi}\left(-\varpi H'\right) = -4\pi w \,.\, \varpi.$$

347. $H' = 2\pi w \,.\, \varpi = -\frac{\partial H}{\partial \varpi} = v.$ $\qquad w = -\frac{1}{2\pi\varpi} \cdot \frac{\partial H}{\partial \varpi} = \frac{v}{2\pi\varpi}.$

H' is the flux parallel to the horizontal plane $(x \,.\, y)$ which flows in circles about the axis z, and therefore depends upon the velocity v. This equation connects the velocities v and w.

348. CASE I. $w=0.$ No vertical current. $F=G=0.$

349. $\varpi \frac{\partial H}{\partial \varpi} = C_1.$

350. $\frac{C_1}{\varpi} \,.\, 2\pi\varpi = -4\pi \int w dS = -4\pi i.$

352. $\partial H = C_1 \frac{\partial \varpi}{\varpi}.$

351. $C_1 = -2i.$

353. $H = C_1 \log \varpi + C_2.$

354. Current function. (External.) $H_e = -2i \log \varpi + C_2.$ (Internal.) $H_i = C.$

355. Vortex current. $H_e = \frac{2i}{\varpi}.$ $H_i = o.$

355. CASE II. w = current in a cylinder.

356. $\varpi \frac{\partial H}{\partial \varpi} = -2\pi\varpi^2 \,.\, w + C_1.$

357. $\partial H = -2\pi w \,.\, \varpi \partial \varpi + C_1 \frac{\partial \varpi}{\varpi}.$

358. $H = -\pi\varpi^2 \,.\, w + C_1 \log \varpi + C_2.$

359. If $w=0.$ $H_e = C_1 \log \varpi + C_2 \qquad C_1 = -2\pi R^2 w.$
$= -2\pi R^2 w \log \varpi + C.$

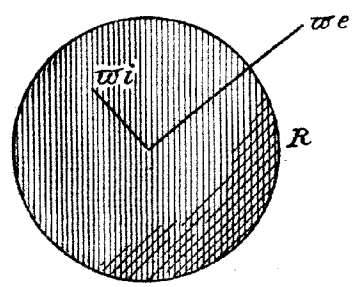


CHART 63.—Inner and outer region.

360. If $C_1=0.$ $H_i = -\pi\varpi^2 w + C_2. \qquad -2\pi R^2 w \log R + C = -\pi R^2 w + C_2. \left[\begin{matrix} H_e = H_i \\ \varpi = R \end{matrix}\right]$
$= -2\pi R^2 w \,.\, \log R + \pi(R^2 - \varpi^2) w + C.$

361. $H_o = -\pi R^2 w + C_2 = -2\pi R^2 w \,.\, \log R.$

362. $i = \int w ds = \pi R^2 .\, w = \frac{c}{4} R^2. \qquad c = 4\pi w = 2\omega_3 = 2 \,.\, \frac{v}{\varpi}.$

363. Current functions.
$$H_e = -2w \,.\, \pi R^2 \,.\, \log \varpi = -2i \log \varpi = -\frac{c}{2} R^2 \log \varpi.$$
$$H_i = -\pi R^2 w \left[2 \log R - \frac{(R^2 - \varpi^2)}{R^2}\right] = -i\left[2 \log R - \left(1 - \frac{\varpi^2}{R^2}\right)\right] = -\frac{c}{4}\left[R^2(2 \log R - 1) + \varpi^2\right].$$

TABLE 89.—*Application to cases; (1) no vertical current, (2) vertical current in a cylinder*—Cont'd.

364. Vortex current.

$$\left\{\begin{array}{l} H_e=-\dfrac{\partial H_e}{\partial \varpi}=v_e=+2\pi\dfrac{R^2}{\varpi}\,.\,w \\ H_i=-\dfrac{\partial H_i}{\partial \varpi}=v_i=+2\pi\varpi\,.\,w \end{array}\right. \qquad \begin{array}{l} =+\dfrac{2i}{\varpi} \\ =+2i\,.\,\dfrac{\varpi}{R^2} \end{array} \qquad \begin{array}{l} =+\dfrac{c}{2}\dfrac{R^2}{\varpi}. \\ =+\dfrac{c}{2}\varpi. \end{array}$$

See (345–349).

Another treatment of motion inside and outside the vortex.

365. $\dfrac{\partial u}{\partial z}=0.$ $\qquad \omega_1=0.$

$\dfrac{\partial v}{\partial z}=0.$ $\qquad \omega_2=0.$

$w=0.$ $\qquad 2\omega_3=\dfrac{\partial v}{\partial x}-\dfrac{\partial u}{\partial y}$ $\qquad \dfrac{\partial \omega_3}{\partial t}=0.$

366. ψ is the function of long cylinders of matter of density $\dfrac{\omega_3}{2\pi}$.

$u=\dfrac{\partial \psi}{\partial y}.$ $\qquad \dfrac{\partial v}{\partial x}=-\dfrac{\partial^2\psi}{\partial x^2}.$

$v=-\dfrac{\partial \psi}{\partial x}.$ $\qquad -\dfrac{\partial u}{\partial y}=-\dfrac{\partial^2\psi}{\partial y^2}.$

Inside the vortex.	Outside the vortex.	
367. $\dfrac{\partial^2\psi_i}{\partial x^2}+\dfrac{\partial^2\psi_i}{\partial y^2}+2\varpi_3=0.$	$\dfrac{\partial^2\psi_e}{\partial x^2}+\dfrac{\partial^2\psi_e}{\partial y^2}=0.$	See (259).
$\dfrac{\partial^2\psi_i}{\partial \varpi_2}+\dfrac{1}{\varpi}\dfrac{\partial\psi_i}{\partial\varpi}+2\varpi_3=0.$	$\dfrac{\partial^2\psi_e}{\partial\varpi^2}+\dfrac{1}{\varpi}\dfrac{\partial\psi_e}{\partial\varpi}=0.$	

368. $\psi_i=A\log\varpi+B-\dfrac{1}{2}\omega_3\varpi^2.$ $\qquad \psi_e=C\log\varpi+D.$

At the boundary of the vortex.

369. $\varpi=R.$ $\qquad \psi_i=\psi_e.$ $\qquad \dfrac{\partial\psi_i}{\partial\varpi}=\dfrac{\partial\psi_e}{\partial\varpi}.$

		Auxiliaries.
$A=0.$	$B-\dfrac{1}{2}\omega_3R^2=C\log R+D.$	D is to be omitted.
	$-\omega_3R^2=C=-\omega_3\dfrac{\sigma}{\pi}=-m.$	Since $\sigma=\pi R^2$.
	$B=\dfrac{1}{2}\omega_3R_2-m\log R.$	The vortex strength.$=\omega_3\sigma=\pi R^2\omega_3=\pi m.$

370. $\psi_i=\dfrac{1}{2}\omega_3(R^2-\varpi^2)-\omega_3R^2\log R.$ $\qquad \psi_e=-\omega_3R^2\log\varpi.$

371. By comparing with 363, $\quad \omega_3=2\pi w=\dfrac{v}{\varpi}.$ $\qquad v=2\pi w\,.\,\varpi\,.$

which agrees also with 347, if $H'=v$.

Hence we conclude that the primary relation between the velocities in cyclones is:

372. $v=\sqrt{2g(H_o-h)}$, where (H_o-h) is the height of the depression of the isobar surface.

$w=\dfrac{v}{2\pi\varpi}=\dfrac{1}{2\pi}\cdot\sqrt{\dfrac{2g(H_o-h)}{\varpi^2}}$, omitting the constant.

$u=q\sin i=\dfrac{1}{2\omega_3}\left(\dfrac{1}{\rho}\dfrac{\partial P}{\partial n}+q\dfrac{\partial q}{\partial n}+\dfrac{\partial V}{\partial n}.\right)$ $\qquad$ (224).

TABLE 90.—*Force of the wind pressure. Ferrel (C. S. O. § 230–233; C. & G. S. § 100).*

373. v=velocity of the wind in meters per second.
p=pressure in grams per square centimeter.
S=surface in square centimeters normally exposed.
$\Delta p_o = p_o - p$=pressure of a column of water equivalent to the pressure of the wind.
$=(p_o - p)\,\rho_m$=pressure of an equivalent column of mercury.

374. Pressure in grams × sq. cm. $p_1 = \Delta p_o \rho_m S = \frac{13.596}{2062.} v^2 \cdot \frac{p}{p_o} S = \frac{0.006593}{1+\alpha t} \cdot v^2 \cdot \frac{p}{p_o} S.$ (208. *b*).

375. 1 gram × sq. cm.=2.04830 pounds × sq. foot.
1 meter × sec. =2.2370 miles × hour.

376. Pressure in pounds × sq. foot. *Normal.* $p_2 = \frac{0.0026987}{1+\alpha t} \cdot v^2 \cdot \frac{p}{p_o} S.$ $0.006593 \times \frac{2.0483}{(2.2370)^2} = 0.0026987.$

377. At angle i to the normal. $p_i = \frac{0.0026987}{1+\alpha t} \cdot v^2 \cdot \frac{p}{p_o} S \cdot \cos^2 i.$

378. On a cylinder. ($D.\ L.$) $p_c = \frac{0.0026987}{1+\alpha t} \cdot v^2 \frac{p}{p_o} \cdot \frac{4}{3} \cdot \frac{D}{2} \cdot L.$

379. On a sphere. ($D.$) $p_s = \frac{0.0026987}{1+\alpha t} \cdot v^2 \frac{p}{p_o} \cdot \frac{1}{2} \pi \frac{D^2}{4}.$

The radial velocity which will be equal to the centrifugal force, and the vertical velocity which will just sustain a falling body.

380. q=the relative velocity of the air to the body; $q\ (u\ .\ v\ .\ w).$
D=diameter of the sphere in cm.
ρ_w=specific gravity of the body; ρ_1=1, water; ρ_2=0.917, ice. $\frac{\rho_w}{\rho_1} = \sigma.$
ρ=air at stratum above ground; ρ_o=air at ground. $\frac{\rho}{\rho_o} = \sigma_o.$
W=weight in grams. A water sphere (D=1 cm.) weighs 0.5238 grams.
$f = \frac{v^2}{2\varpi}$= centrifugal force in a radial direction. g= gravity acceleration in a vertical direction. =9.806

381. Resistance. $R = .0000606\ q^2 D^2 \sigma_o$ (ounces, feet)$=.002859\ q^2 D \sigma^2_o$ (met., cm., grm.).

382. Weight. $W_g = 0.5238\ D^3 \sigma.$ Sphere of diameter D and sp. gr. ρ_w.

383. Auxiliaries. $f \cdot \frac{1}{g} = \frac{v^2}{2\varpi} \cdot \frac{1}{g} = \frac{v^2}{19.61\varpi}.$ $v = v_o \frac{\varpi_o}{\varpi}.$

384. Lateral pressure. $P_f = W_g f \cdot \frac{1}{g} = \frac{0.5238}{19.61} D^3 \sigma \cdot \frac{v^2}{\varpi} = .0267\ D^3 \sigma \cdot \frac{\varpi_o^2}{\varpi^2} \cdot \frac{v_o^2}{\varpi}.$

385. To find u. $R = P_f = .002859\ D^2 \sigma_o \cdot u^2 = .0267\ D^3 \sigma \cdot \frac{v^2}{\varpi}.$

386. To find w. $R = W_g = .002859\ D^2 \sigma_o \cdot w^2 = .5238\ D^3 \sigma.$

387. Lateral velocity. $u = 3.056 \sqrt{D \cdot \frac{\sigma}{\sigma_o}} \cdot \frac{v}{\sqrt{\varpi}}.$

388. Vertical velocity. $w_1 = 13.54 \sqrt{D \cdot \frac{\sigma}{\sigma_o}} = 13.54 \sqrt{D \cdot \frac{\rho_w}{\rho_1} \cdot \frac{\rho_o}{\rho}}$. for water.

$w_2 = 12.96 \sqrt{\frac{D}{\sigma_o}}$. for ice.

For a water spout near the surface of the ocean $\frac{\rho_w}{\rho_1} = 1, \frac{\rho_o}{\rho} = 1.$

TABLE 91.—*Table for m.—Metric measures.*

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	—40	—39	—38	—37	—36	—35	—34	—33	—32	—31
	.636	633	630	628	625	622	620	618	615	613
H 100	.00636	.00633	.00631	.00628	.00625	.00623	.00620	.00618	.00616	.00613
200	1273	1267	1262	1256	1251	1245	1240	1236	1230	1225
300	1908	1899	1892	1883	1875	1867	1859	1854	1844	1837
400	2544	2533	2522	2511	2500	2489	2478	2462	2459	2449
500	3180	3166	3152	3138	3125	3112	3098	3080	3073	3061
	636	633	630	628	625	622	620	618	615	613
600	.03816	.03799	.03783	.03766	.03750	.03734	.03718	.03699	.03688	.03673
700	4452	4432	4413	4393	4375	4356	4338	4317	4303	4285
800	5087	5065	5044	5021	5000	4978	4958	4935	4918	4897
900	5722	5698	5674	5649	5625	5601	5578	5554	5532	5509
1000	6358	6331	6304	6277	6250	6224	6198	6172	6146	6121
	636	633	630	628	625	622	620	617	615	612
1100	.06994	.06964	.06935	.06904	.06875	.06846	.06818	.06789	.06761	.06733
1200	7629	7596	7565	7532	7500	7469	7437	7406	7375	7345
1300	8265	8229	8195	8160	8125	8091	8057	8023	7990	7957
1400	8900	8862	8825	8787	8750	8613	8676	8640	8605	8569
1500	9536	9495	9455	9414	9375	9235	9296	9257	9219	9181
	636	633	630	628	625	622	620	617	615	612
1600	.10172	.10128	.10085	.10041	.10000	.09857	.09916	.09874	.09834	.09793
1700	.10807	.10761	.10715	.10669	.10625	.10480	.10536	.10491	.10449	.10405
1800	.11443	.11394	.11345	.11297	.11250	.11103	.11156	.11108	.11063	.11017
1900	.12078	.12027	.11976	.11925	.11875	.11725	.11775	.11726	.11678	.11629
2000	.12714	.12660	.12606	.12553	.12500	.12447	.12395	.12343	.12292	.12241
	.636	633	630	627	624	622	619	617	614	612
2100	.13349	.13293	.13236	.13180	.13125	.13069	.13015	.12960	.12907	.12854
2200	.13985	.13925	.13866	.13807	.13749	.13691	.13634	.13576	.13521	.13465
2300	.14620	.14558	.14496	.14434	.14373	.14313	.14253	.14193	.14135	.14077
2400	.15255	.15190	.15126	.15062	.14998	.14935	.14872	.14810	.14749	.14688
2500	.15890	.15823	.15755	.15689	.15622	.15557	.15491	.15427	.15363	.15300
	636	633	630	627	624	622	619	617	614	612
2600	.16526	.16456	.16385	.16316	.16247	.16178	.16110	.16043	.15977	.15912
2700	.17161	.17088	.17015	.16943	.16871	.16800	.16730	.16660	.16591	.16523
2800	.17796	.17721	.17645	.17570	.17496	.17422	.17350	.17276	.17205	.17135
2900	.18432	.18353	.18275	.18198	.18120	.18044	.17969	.17893	.17819	.17746
3000	.19067	.18986	.18905	.18825	.18745	.18666	.18588	.18510	.18433	.18357
	.635	632	630	627	624	622	619	617	614	612
3100	.19702	.19618	.19534	.19452	.19370	.19288	.19207	.19126	.19047	.18968
3200	.20337	.20251	.20164	.20079	.19994	.19909	.19827	.19743	.19661	.19580
3300	.20972	.20883	.20794	.20706	.20618	.20531	.20446	.20360	.20275	.20192
3400	.21607	.21516	.21424	.21333	.21242	.21153	.21065	.20977	.20889	.20803
3500	.22242	.22148	.22054	.21960	.21866	.21775	.21684	.21594	.21503	.21415
	635	632	630	627	624	622	619	617	614	612
3600	.22878	.22781	.22683	.22587	.22491	.22397	.22303	.22210	.22117	.22026
3700	.23513	.23413	.23313	.23214	.23115	.23019	.22922	.22827	.22731	.22638
3800	.24148	.24046	.23943	.23841	.23739	.23640	.23541	.23444	.23346	.23249
3900	.24783	.24678	.24572	.24468	.24364	.24262	.24161	.24061	.23960	.23861
4000	.25418	.25310	.25202	.25095	.24989	.24884	.24780	.24677	.24574	.24472
	635	632	629	627	624	621	619	616	614	611
4100	.26053	.25942	.25832	.25721	.25613	.25506	.25398	.25294	.25187	.25084
4200	.26688	.26574	.26461	.26348	.26237	.26127	.26017	.25910	.25801	.25696
4300	.27322	.27206	.27090	.26975	.26861	.26748	.26636	.26526	.26415	.26307
4400	.27957	.27838	.27719	.27602	.27485	.27369	.27255	.27142	.27029	.26918
4500	.28592	.28470	.28348	.28229	.28108	.27990	.27874	.27758	.27643	.27529
	.635	632	629	627	624	621	619	616	614	611
4600	.29227	.29102	.28978	.28855	.28732	.28612	.28492	.28374	.28256	.28140
4700	.29862	.29734	.29607	.29482	.29356	.29233	.29111	.28990	.28870	.28751
4800	.30496	.30366	.30236	.30109	.29980	.29854	.29730	.29606	.29484	.29362
4900	.31131	.30998	.30865	.30735	.30604	.30475	.30349	.30222	.30098	.29973
5000	.31766	.31630	.31495	.31361	.31228	.31097	.30967	.30838	.30711	.30584

	636	633
1	64	63
2	127	126
3	191	190
4	254	253
5	318	317
6	382	380
7	445	443
8	509	506
9	572	570
	630	627
1	63	63
2	126	125
3	189	188
4	252	251
5	315	314
6	378	376
7	441	439
8	504	502
9	567	564
	624	622
1	62	62
2	125	124
3	187	187
4	250	249
5	312	311
6	374	373
7	437	435
8	499	498
9	562	560
	619	617
1	62	62
2	124	123
3	186	185
4	248	247
5	310	309
6	371	370
7	433	432
8	495	494
9	557	555
	614	612
1	61	61
2	123	122
3	184	184
4	246	245
5	307	306
6	368	367
7	430	428
8	491	490
9	553	551

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	−30	−29	−28	−27	−26	−25	−24	−23	−22	−21
	.610	607	604	602	600	597	595	592	590	588
H 100	.00610	.00608	.00605	.00603	.00600	.00598	.00596	.00593	.00591	.00589
200	1218	1215	1209	1205	1200	1196	1190	1186	1181	1177
300	1828	1822	1814	1807	1799	1793	1785	1778	1771	1764
400	2437	2429	2418	2409	2398	2390	2380	2370	2361	2352
500	3047	3036	3023	3011	2998	2987	2975	2963	2951	2939
	610	607	604	602	600	597	595	592	590	588
600	.03657	.03643	.03628	.03613	.03598	.03584	.03569	.03555	.03541	.03527
700	4266	4250	4233	4215	4198	4171	4164	4148	4131	4114
800	4876	4857	4837	4817	4798	4778	4759	4741	4721	4702
900	5486	5464	5441	5419	5397	5376	5354	5333	5311	5290
1000	6096	6071	6046	6021	5997	5973	5949	5925	5901	5878
	609	607	604	602	600	597	595	592	590	588
1100	.06705	.06678	.06649	.06623	.06597	.06570	.06544	.06518	.06491	.06465
1200	7315	7285	7253	7226	7196	7168	7139	7110	7081	7053
1300	7924	7891	7856	7828	7796	7765	7733	7702	7671	7641
1400	8534	8498	8460	8430	8396	8362	8328	8295	8262	8229
1500	9143	9105	9064	9032	8995	8959	8923	8887	8852	8817
	609	607	604	602	600	597	595	592	590	588
1600	.09752	.09712	.09667	.09634	.09595	.09556	.09518	9479	.09442	.09405
1700	.10362	.10319	.10271	.10236	.10195	.10153	.10113	.10071	.10032	9992
1800	.10971	.10926	.10875	.10838	.10794	.10750	.10707	.10664	.10622	.10580
1900	.11581	.11533	.11488	.11440	.11394	.11348	.11302	.11256	.11212	.11167
2000	.12190	.12140	.12091	.12042	.11993	.11945	.11897	.11849	.11802	.11755
	609	607	604	602	600	597	594	592	590	587
2100	.12799	.12746	.12696	.12644	.12593	.12542	.12492	.12441	.12392	.12342
2200	.13408	.13353	.13300	.13245	.13192	.13138	.13086	.13033	.12981	.12929
2300	.14017	.13960	.13904	.13847	.13791	.13735	.13680	.13625	.13571	.13517
2400	.14626	.14567	.14508	.14449	.14390	.14332	.14274	.14217	.14160	.14104
2500	.15236	.15174	.15112	.15051	.14989	.14929	.14869	.14809	.14750	.14691
	609	607	604	602	599	597	594	592	590	587
2600	.15845	.15780	.15716	.15653	.15589	.15526	.15463	.15401	.15340	.15279
2700	.16454	.16387	.16320	.16254	.16188	.16123	.16058	.15993	.15930	.15866
2800	.17063	.16994	.16924	.16856	.16787	.16720	.16652	.16585	.16519	.16453
2900	.17672	.17601	.17529	.17458	.17386	.17317	.17246	.17177	.17108	.17040
3000	.18281	.18207	.18133	.18059	.17986	.17913	.17841	.17769	.17698	.17628
	609	606	604	602	599	597	594	592	590	587
3100	.18890	.18814	.18736	.18661	.18586	.18509	.18436	.18361	.18288	.18216
3200	.19499	.19420	.19340	.19262	.19185	.19106	.19031	.18953	.18878	.18804
3300	.20108	.20026	.19944	.19864	.19784	.19703	.19626	.19545	.19468	.19391
3400	.20717	.20633	.20548	.20465	.20383	.20300	.20220	.20137	.20058	.19978
3500	.21326	.21239	.21152	.21067	.20982	.20896	.20814	.20729	.20648	.20565
	609	606	604	602	599	597	594	592	589	587
3600	.21935	.21845	.21756	.21668	.21581	.21493	.21408	.21321	.21238	.21152
3700	.22544	.22452	.22360	.22270	.22180	.22090	.22002	.21913	.21827	.21739
3800	.23153	.23058	.22964	.22871	.22779	.22687	.22596	.22505	.22416	.22326
3900	.23762	.23665	.23568	.23473	.23378	.23283	.23190	.23097	.23005	.22913
4000	.24371	.24271	.24172	.24074	.23977	.23880	.23784	.23689	.23594	.23500
	609	606	604	601	599	597	594	592	589	587
4100	.24980	.24878	.24776	.24676	.24576	.24477	.24378	.24281	.24184	.24087
4200	.25588	.25485	.25380	.25278	.25175	.25074	.24972	.24873	.24774	.24674
4300	.26197	.26092	.25984	.25879	.25774	.25671	.25566	.25465	.25364	.25261
4400	.26806	.26698	.26587	.26480	.26373	.26268	.26160	.26057	.25953	.25848
4500	.27414	.27304	.27192	.27081	.26972	.26864	.26754	.26649	.26542	.26435
	609	606	604	601	599	596	594	591	589	587
4600	.28023	.27910	.27796	.27682	.27571	.27460	.27348	.27241	.27131	.27022
4700	.28632	.28516	.28400	.28283	.28170	.28056	.27942	.27833	.27720	.27609
4800	.29241	.29122	.29003	.28884	.28769	.28652	.28536	.28424	.28309	.28196
4900	.29849	.29728	.29606	.29485	.29367	.29248	.29130	.29015	.28898	.28783
5000	.30458	.30334	.30210	.30087	.29965	.29844	.29724	.29605	.29487	.29370

	609	607
1	61	61
2	122	121
3	183	182
4	244	243
5	305	304
6	365	364
7	426	425
8	487	486
9	548	546
	604	602
1	60	60
2	121	120
3	181	181
4	242	241
5	302	301
6	362	361
7	423	421
8	483	482
9	544	542
	599	597
1	60	60
2	120	119
3	180	179
4	240	239
5	300	299
6	359	358
7	419	418
8	479	478
9	539	537
	594	592
1	59	59
2	119	118
3	178	178
4	238	237
5	297	296
6	356	355
7	416	414
8	475	474
9	535	533
	590	587
1	59	59
2	118	117
3	177	176
4	236	235
5	295	294
6	354	352
7	413	411
8	472	470
9	531	528

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	−20	−19	−18	−17	−16	−15	−14	−13	−12	−11
	.586	583	581	579	577	574	572	570	568	566
H 100	.00586	.00583	.00581	.00578	.00576	.00573	.00570	.00568	.00566	.00564
200	1171	1166	1162	1157	1153	1147	1142	1138	1134	1130
300	1756	1749	1743	1736	1730	1722	1714	1708	1702	1696
400	2342	2332	2324	2315	2307	2296	2286	2278	2270	2262
500	2928	2915	2905	2894	2883	2870	2858	2848	2838	2827
	586	583	581	579	576	574	572	570	567	565
600	.03513	.03498	.03486	.03473	.03459	.03444	.03430	.03418	.03406	.03392
700	4098	4081	4067	4052	4035	4018	4002	3988	3973	3957
800	4684	4664	4648	4630	4611	4592	4574	4558	4540	4522
900	5270	5248	5229	5208	5187	5166	5146	5128	5107	5087
1000	5855	5832	5809	5786	5763	5741	5719	5697	5675	5653
	585	583	581	579	576	574	572	570	568	565
1100	.06440	.06415	.06390	.06365	.06340	.06315	.06291	.06267	.06243	.06219
1200	7026	6998	6971	6944	6917	6889	6863	6837	6811	6785
1300	7611	7581	7552	7523	7493	7463	7435	7407	7379	7350
1400	8196	8164	8133	8102	8069	8037	8007	7977	7946	7915
1500	8782	8747	8714	8681	8645	8611	8579	8547	8513	8480
	585	583	580	578	576	574	571	569	567	565
1600	.09367	.09330	.09295	.09259	.09222	.09185	.09151	.09116	.09080	.09045
1700	9952	9913	9876	9837	9798	9759	9723	9685	9647	9610
1800	.10537	.10496	.10456	.10415	.10374	.10333	.10294	.10254	.10214	.10175
1900	.11123	.11079	.11036	.10993	.10950	.10907	.10865	.10823	.10781	.10740
2000	.11708	.11662	.11616	.11571	.11526	.11481	.11436	.11392	.11348	.11305
	585	583	580	578	576	574	571	569	567	565
2100	.12293	.12245	.12197	.12150	.12102	.12055	.12008	.11962	.11915	.11870
2200	.12878	.12828	.12778	.12729	.12678	.12629	.12579	.12531	.12482	.12435
2300	.13463	.13411	.13358	.13307	.13254	.13203	.13151	.13100	.13050	.13000
2400	.14048	.13994	.13938	.13885	.13830	.13777	.13723	.13670	.13618	.13565
2500	.14633	.14577	.14519	.14463	.14406	.14351	.14294	.14239	.14185	.14130
	585	583	580	578	576	574	571	569	567	565
2600	.15218	.15160	.15099	.15041	.14982	.14925	.14866	.14809	.14752	.14695
2700	.15803	.15743	.15680	.15619	.15558	.15499	.15438	.15378	.15319	.15260
2800	.16388	.16325	.16261	.16197	.16134	.16073	.16009	.15948	.15886	.15825
2900	.16973	.16907	.16841	.16775	.16710	.16646	.16580	.16517	.16453	.16390
3000	.17558	.17489	.17421	.17353	.17286	.17219	.17152	.17086	.17020	.16955
	585	583	580	578	576	574	571	569	567	565
3100	.18143	.18072	.18002	.17931	.17862	.17793	.17724	.17656	.17587	.17520
3200	.18728	.18655	.18582	.18509	.18438	.18367	.18296	.18225	.18154	.18085
3300	.19313	.19238	.19163	.19087	.19014	.18941	.18867	.18794	.18721	.18650
3400	.19898	.19821	.19743	.19665	.19590	.19515	.19438	.19363	.19288	.19215
3500	.20482	.20404	.20324	.20243	.20166	.20089	.20010	.19932	.19855	.19780
	585	582	580	578	576	573	571	569	567	565
3600	.21067	.20987	.20904	.20821	.20742	.20662	.20581	.20501	.20422	.20345
3700	.21652	.21569	.21484	.21399	.21318	.21235	.21152	.21070	.20989	.20910
3800	.22237	.22151	.22064	.21977	.21893	.21808	.21723	.21639	.21556	.21474
3900	.22822	.22733	.22644	.22555	.22468	.22381	.22294	.22208	.22123	.22038
4000	.23407	.23315	.23224	.23133	.23043	.22954	.22865	.22777	.22689	.22602
	585	582	580	578	576	573	571	569	567	565
4100	.23912	.23898	.23805	.23711	.23619	.23528	.23436	.23346	.23256	.23167
4200	.24576	.24481	.24385	.24289	.24195	.24101	.24007	.23915	.23823	.23732
4300	.25161	.25063	.24965	.24867	.24771	.24674	.24579	.24484	.24390	.24297
4400	.25746	.25646	.25545	.25445	.25347	.25247	.25150	.25053	.24957	.24861
4500	.26330	.26228	.26125	.26023	.25922	.25820	.25721	.25622	.25524	.25426
	585	582	580	578	576	573	571	569	567	565
4600	.26915	.26810	.26705	.26601	.26498	.26394	.26292	.26191	.26091	.25991
4700	.27500	.27393	.27285	.27179	.27074	.26967	.26863	.26760	.26658	.26555
4800	.28085	.27975	.27865	.27757	.27649	.27540	.27434	.27329	.27225	.27120
4900	.28669	.28557	.28445	.28335	.28224	.28113	.28005	.27898	.27792	.27685
5000	.29254	.29139	.29025	.28912	.28799	.28687	.28576	.28466	.28358	.28249

	585	583
1	58	58
2	117	116
3	176	175
4	234	233
5	293	292
6	351	350
7	410	408
8	468	466
9	526	524
	580	578
1	58	58
2	116	116
3	174	173
4	232	231
5	290	289
6	348	347
7	406	405
8	464	462
9	522	520
	576	574
1	58	57
2	115	115
3	173	172
4	230	230
5	288	287
6	346	344
7	403	402
8	461	459
9	518	517
	571	569
1	57	57
2	114	114
3	171	171
4	228	228
5	286	285
6	343	341
7	400	398
8	457	455
9	514	512
	567	565
1	57	57
2	113	113
3	170	170
4	227	226
5	284	283
6	340	339
7	397	396
8	453	452
9	510	509

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	−10	−9	−8	−7	−6	−5	−4	−3	−2	−1
	563	561	559	557	555	553	551	549	547	545
H 100	.00563	.00561	.00559	.00557	.00555	.00553	.00551	.00549	.00547	.00545
200	1126	1122	1118	1114	1110	1106	1102	1097	1093	1090
300	1690	1683	1677	1671	1664	1659	1652	1646	1640	1634
400	2253	2244	2236	2228	2219	2212	2202	2194	2186	2178
500	2816	2805	2795	2784	2774	2764	2753	2743	2733	2723
	563	561	559	557	555	553	551	549	547	545
600	.03379	.03366	.03354	.03341	.03328	.03317	.03304	.03291	.03280	.03268
700	3942	3927	3913	3897	3883	3869	3854	3839	3827	3812
800	4506	4488	4472	4454	4438	4422	4404	4388	4373	4357
900	5069	5049	5031	5011	4993	4974	4955	4937	4919	4901
1000	5632	5610	5589	5568	5547	5526	5505	5485	5465	5445
	563	561	559	557	555	553	551	549	547	545
1100	.06195	.06171	.06148	.06125	.06102	.06079	.06056	.06034	.06012	.5990
1200	6758	6732	6706	6682	6657	6631	6606	6583	6558	6535
1300	7321	7293	7265	7238	7211	7184	7157	7131	7105	7079
1400	7884	7854	7824	7794	7766	7736	7707	7679	7652	7624
1500	8447	8415	8383	8351	8321	8288	8258	8228	8199	8169
	563	561	559	557	555	553	551	549	546	544
1600	.09010	.08976	.08942	.08908	.08876	.08841	.08808	.08776	.08745	.08713
1700	9573	9537	9501	9464	9430	9394	9359	9325	9291	9257
1800	.10136	.10097	.10059	.10021	9985	9946	9910	9873	9837	9801
1900	.10699	.10658	.10618	.10578	.10539	.10499	.10461	.10422	.10383	.10345
2000	.11262	.11219	.11177	.11135	.11093	.11052	.11011	.10970	.10929	.10889
	563	561	559	557	555	553	550	548	546	544
2100	.11825	.11780	.11736	.11692	.11648	.11605	.11562	.11519	.11476	.11434
2200	.12388	.12340	.12294	.12249	.12203	.12157	.12112	.12067	.12022	.11978
2300	.12950	.12901	.12853	.12806	.12757	.12710	.12663	.12616	.12569	.12523
2400	.13513	.13462	.13411	.13363	.13312	.13263	.13213	.13164	.13115	.13067
2500	.14076	.14023	.13969	.13920	.13867	.13815	.13763	.13712	.13661	.13612
	563	561	559	556	554	552	550	548	546	544
2600	.14639	.14584	.14528	.14476	.14421	.14367	.14313	.14260	.14207	.14156
2700	.15202	.15144	.15086	.15032	.14975	.14919	.14863	.14808	.14753	.14700
2800	.15764	.15705	.15645	.15588	.15529	.15471	.15413	.15356	.15299	.15244
2900	.16327	.16265	.16204	.16144	.16083	.16023	.15963	.15904	.15845	.15788
3000	.16890	.16826	.16763	.16700	.16637	.16575	.16513	.16452	.16391	.16331
	563	561	559	556	554	552	550	548	546	544
3100	.17453	.17387	.17322	.17257	.17192	.17128	.17064	.17001	.16938	.16875
3200	.18015	.17948	.17881	.17814	.17746	.17681	.17614	.17549	.17484	.17419
3300	.18578	.18509	.18440	.18371	.18301	.18233	.18165	.18097	.18030	.17963
3400	.19140	.19070	.18999	.18927	.18855	.18785	.18715	.18645	.18576	.18507
3500	.19703	.19631	.19557	.19483	.19409	.19337	.19265	.19193	.19122	.19051
	563	560	558	556	554	552	550	548	546	544
3600	.20266	.20191	.20115	.20039	.19964	.19889	.19815	.19741	.19668	.19595
3700	.20828	.20751	.20673	.20595	.20518	.20441	.20365	.20289	.20214	.20139
3800	.21391	.21311	.21231	.21151	.21072	.20993	.20915	.20837	.20760	.20683
3900	.21953	.21871	.21789	.21707	.21626	.21545	.21465	.21385	.21306	.21227
4000	.22516	.22431	.22347	.22263	.22180	.22097	.22015	.21933	.21852	.21771
	563	560	558	556	554	552	550	548	546	544
4100	.23078	.22992	.22906	.22820	.22734	.22649	.22565	.22481	.22398	.22315
4200	.23641	.23553	.23464	.23376	.23288	.23201	.23115	.23029	.22944	.22859
4300	.24204	.24113	.24022	.23932	.23842	.23753	.23665	.23577	.23489	.23402
4400	.24766	.24673	.24580	.24488	.24396	.24305	.24215	.24125	.24035	.23946
4500	.25328	.25234	.25139	.25044	.24950	.24857	.24765	.24673	.24581	.24490
	563	560	558	556	554	552	550	548	546	544
4600	.25891	.25794	.25697	.25600	.25504	.25409	.25315	.25221	.25127	.25034
4700	.26454	.26355	.26255	.26156	.26058	.25961	.25865	.25769	.25672	.25577
4800	.27016	.26915	.26813	.26712	.26612	.26513	.26415	.26317	.26218	.26121
4900	.27578	.27475	.27371	.27268	.27166	.27065	.26965	.26865	.26764	.26665
5000	.28141	.28035	.27929	.27824	.27720	.27617	.27514	.27412	.27310	.27209

	563	561
1	56	56
2	113	112
3	169	168
4	225	224
5	282	281
6	338	337
7	394	393
8	450	449
9	506	505
	559	556
1	56	56
2	112	111
3	168	167
4	224	222
5	280	278
6	335	334
7	391	389
8	447	444
9	503	500
	554	552
1	55	55
2	111	110
3	166	166
4	222	221
5	277	276
6	332	331
7	388	386
8	443	442
9	499	497
	550	548
1	55	55
2	110	110
3	165	164
4	220	219
5	275	274
6	330	329
7	385	384
8	440	438
9	495	493
	546	544
1	55	54
2	109	109
3	164	163
4	218	218
5	273	272
6	328	326
7	382	381
8	437	435
9	491	490

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	0	1	2	3	4	5	6	7	8	9
	543	541	539	537	535	533	531	529	527	525
H 100	.00543	.00541	.00539	.00537	.00535	.00533	.00531	.00529	.00527	.00525
200	1085	1082	1078	1074	1070	1066	1062	1058	1054	1050
300	1628	1623	1617	1611	1605	1599	1593	1587	1581	1575
400	2170	2164	2156	2148	2140	2132	2124	2116	2108	2100
500	2712	2705	2695	2685	2675	2664	2655	2645	2635	2626
	543	540	538	536	534	533	531	529	527	525
600	.03255	.03245	.03233	.03221	.03209	.03197	.03186	.03174	.03162	.03151
700	3798	3785	3771	3757	3743	3730	3716	3703	3689	3676
800	4340	4325	4309	4293	4277	4263	4247	4231	4216	4201
900	4882	4865	4847	4829	4811	4795	4778	4760	4743	4726
1000	5425	5405	5385	5365	5346	5327	5308	5289	5270	5251
	543	540	538	536	534	533	531	529	527	525
1100	.05967	.05946	.05924	.05902	.05881	.05860	.05839	.05818	.05797	.05777
1200	6510	6486	6462	6439	6416	6393	6370	6347	6324	6302
1300	7052	7026	7001	6976	6951	6926	6901	6876	6851	6827
1400	7595	7567	7539	7512	7485	7458	7432	7405	7378	7352
1500	8137	8107	8078	8048	8019	7990	7962	7933	7905	7877
	543	540	538	536	534	533	531	529	527	525
1600	.08679	.08647	.08616	.08585	.08554	.08523	.08493	.08462	.08432	.08402
1700	9222	9188	9155	9122	9089	9056	9024	8991	8959	8927
1800	9764	9728	9694	9658	9623	9589	9555	9520	9486	9452
1900	.10307	.10269	.10232	.10194	10157	.10121	10085	.10048	10013	9977
2000	.10849	.10809	.10770	.10731	.10692	.10653	.10615	.10577	.10539	.10502
	542	540	538	536	534	532	531	529	527	525
2100	.11391	.11350	.11309	.11267	.11227	.11186	.11146	.11106	.11066	.11027
2200	.11933	.11890	.11847	.11804	.11761	.11718	.11677	.11635	.11593	.11552
2300	.12476	.12430	.12385	.12340	.12295	.12250	.12208	.12164	.12120	.12077
2400	.13018	.12970	.12923	.12876	.12830	.12783	.12739	.12692	.12647	.12602
2500	13560	.13510	.13461	.13412	.13364	.13315	.13270	.13220	.13173	.13127
	542	540	538	536	534	532	530	529	527	525
2600	.14102	.14050	.13999	.13948	.13898	.13847	.13800	.13749	.13700	.13652
2700	.14644	.14590	.14537	.14484	.14432	.14380	.14330	.14278	.14227	.14177
2800	.15187	.15130	.15075	.15020	.14966	.14912	.14860	.14807	.14754	.14702
2900	.15729	.15670	.15613	.15556	.15500	.15445	.15390	.15335	.15280	.15227
3000	.16271	.16211	.16152	.16093	.16035	.15977	.15920	.15863	.15807	.15751
	542	540	538	536	534	532	530	528	527	525
3100	.16813	.16752	.16691	.16630	.16570	.16510	.16451	.16392	.16334	.16275
3200	.17355	.17292	.17229	.17166	.17104	.17043	.16981	.16921	.16861	.16800
3300	.17897	.17832	.17767	.17702	.17638	.17575	.17511	.17449	.17388	.17325
3400	.18439	.18372	.18305	.18239	.18172	.18107	.18042	.17978	.17915	.17850
3500	.18981	.18912	.18843	.18775	.18706	.18639	.18572	.18507	.18442	.18375
	542	540	538	536	534	532	530	528	526	525
3600	.19523	.19452	.19381	.19311	.19240	.19171	.19103	.19035	.18969	.18900
3700	.20065	.19992	.19919	.19848	.19774	.19704	.19633	.19564	.19495	.19425
3800	.20607	.20532	.20457	.20384	.20308	.20236	.20164	.20092	.20021	.19950
3900	.21149	.20072	.20995	.20920	.20842	.20768	.20694	.20620	.20547	.20474
4000	.21691	.21612	.21533	.21455	.21377	.21300	.21224	.21148	.21073	.20998
	542	540	538	536	534	532	530	528	526	525
4100	.22233	.22152	.22071	.21991	.21912	.21833	.21755	.21676	.21600	.21523
4200	.22775	.22692	.22609	.22527	.22446	.22365	.22285	.22205	.22126	.22048
4300	.23316	.23232	.23147	.23063	.22980	.22898	.22815	.22733	.22652	.22572
4400	.23858	.23772	.23685	.23599	.23514	.23430	.23345	.23261	.23179	.23096
4500	.24400	.24312	.24223	.24135	.24048	.23962	.23875	.23789	.23705	.23621
	542	540	538	536	534	532	530	528	526	525
4600	.24942	.24852	.24761	.24671	.24582	.24494	.24406	.24317	.24231	.24146
4700	.25484	.25392	.25299	.25207	.25116	.25026	.24936	.24846	.24758	.24670
4800	.26025	.25932	.25837	.25743	.25650	.25558	.25466	.25374	.25284	.25195
4900	.26567	.26472	.26375	.26279	.26184	.26090	.25996	.25902	.25810	.25719
5000	.27109	.27011	.26913	.26815	.26718	.26622	.26526	.26431	.26337	.26244

	542	540
1	54	54
2	108	108
3	163	162
4	217	216
5	271	270
6	325	324
7	379	378
8	434	432
9	488	486
	538	536
1	54	54
2	108	107
3	161	161
4	215	214
5	269	268
6	323	322
7	377	375
8	430	429
9	484	482
	534	532
1	53	53
2	107	107
3	160	160
4	214	213
5	267	267
6	320	320
7	373	373
8	427	426
9	481	480
	530	529
1	53	53
2	106	106
3	159	159
4	212	212
5	265	265
6	318	317
7	371	370
8	424	423
9	477	476
	527	525
1	53	53
2	105	105
3	158	158
4	211	210
5	264	263
6	316	315
7	369	368
8	422	420
9	474	473

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	10	11	12	13	14	15	16	17	18	19
	523	522	520	518	516	514	513	511	509	507
H 100	.00523	.00521	.00519	.00517	.00515	.00513	.00511	.00509	.00508	.00507
200	1047	1043	1039	1035	1031	1027	1024	1020	1017	1014
300	1570	1565	1559	1553	1548	1542	1537	1531	1526	1522
400	2093	2087	2079	2071	2064	2057	2050	2042	2035	2029
500	2616	2609	2599	2589	2580	2571	2562	2553	2544	2536
	523	521	520	518	516	514	513	511	509	507
600	.03140	.03130	.03119	.03107	.03096	.03085	.03075	.03064	.03053	.03043
700	3663	3651	3639	3625	3612	3599	3588	3575	3562	3550
800	4186	4172	4158	4143	4128	4114	4100	4086	4071	4058
900	4710	4693	4677	4661	4645	4629	4613	4597	4580	4565
1000	5233	5215	5197	5179	5161	5143	5125	5107	5089	5072
	523	521	520	518	516	514	512	511	509	507
1100	.05756	.05737	.05717	.05697	.05677	.05658	.05638	.05618	.05598	.05580
1200	6279	6258	6237	6215	6193	6172	6150	6129	6107	6087
1300	6803	6779	6757	6733	6709	6686	6662	6640	6616	6594
1400	7326	7301	7277	7250	7225	7200	7174	7150	7125	7101
1500	7849	7822	7797	7768	7741	7714	7687	7660	7634	7608
	523	521	519	518	516	514	512	511	509	507
1600	.08372	.08343	.08316	.08286	.08257	.08228	.08199	.08171	.08143	.08115
1700	8895	8864	8835	8803	8773	8742	8711	8682	8652	8622
1800	9419	9386	9354	9321	9289	9256	9224	9192	9161	9129
1900	9942	9907	9873	9839	9805	9770	9736	9703	9670	9636
2000	.10465	.10428	.10392	.10356	.10320	.10284	.10248	.10213	.10178	.10143
	523	521	519	518	516	514	512	510	509	507
2100	.10988	.10949	.10912	.10874	.10836	.10798	.10760	.10724	.10687	.10650
2200	.11511	.11471	.11431	.11392	.11352	.11312	.11272	.11234	.11196	.11157
2300	.12034	.11992	.11951	.11910	.11868	.11826	.11784	.11744	.11705	.11664
2400	.12557	.12513	.12470	.12428	.12384	.12340	.12296	.12255	.12214	.12171
2500	.13080	.13034	.12989	.12946	.12899	.12854	.12808	.12765	.12722	.12678
	523	521	519	517	516	514	512	510	509	507
2600	.13603	.13556	.13509	.13463	.13415	.13368	.13320	.13276	.13231	.13185
2700	.14126	.14077	.14028	.13980	.13931	.13882	.13833	.13786	.13740	.13691
2800	.14649	.14598	.14547	.14497	.14447	.14396	.14345	.14296	.14248	.14197
2900	.15172	.15119	.15066	.15014	.14962	.14910	.14857	.14806	.14756	.14704
3000	.15695	.15640	.15585	.15531	.15477	.15423	.15369	.15316	.15263	.15211
	523	521	519	517	516	514	512	510	509	507
3100	.16218	.16162	.16105	.16049	.15993	.15937	.15881	.15827	.15772	.15718
3200	.16741	.16683	.16624	.16567	.16508	.16451	.16393	.16337	.16281	.16225
3300	.17264	.17204	.17133	.17084	.17023	.16965	.16905	.16847	.16790	.16731
3400	.17787	.17725	.17652	.17601	.17539	.17479	.17417	.17357	.17299	.17238
3500	.18310	.18246	.18171	.18118	.18055	.17992	.17929	.17867	.17808	.17745
	523	521	519	517	516	514	512	510	508	507
3600	.18832	.18767	.18691	.18636	.18571	.18506	.18441	.18378	.18316	.18252
3700	.19355	.19288	.19210	.19154	.19086	.19020	.18953	.18888	.18824	.18758
3800	.19878	.19809	.19739	.19671	.19502	.19534	.19465	.19398	.19332	.19265
3900	.20401	.20330	.20258	.20188	.20118	.20048	.19977	.19908	.19840	.19771
4000	.20924	.20851	.20778	.20705	.20633	.20561	.20489	.20418	.20348	.20278
	523	521	519	517	516	514	512	510	508	507
4100	.21447	.21372	.21298	.21223	.21149	.21075	.21001	.20929	.20857	.20785
4200	.21969	.21893	.21817	.21740	.21665	.21589	.21513	.21439	.21365	.21291
4300	.22492	.22414	.22336	.22257	.22181	.22103	.22025	.21949	.21873	.21798
4400	.23015	.22935	.22855	.22774	.22697	.22616	.22537	.22459	.22381	.22305
4500	.23538	.23456	.23374	.23292	.23213	.23130	.23049	.22969	.22890	.22812
	523	521	519	517	515	514	512	510	508	507
4600	.24060	.23977	.23893	.23809	.23728	.23644	.23561	.23479	.23398	.23319
4700	.24583	.24498	.24412	.24326	.24243	.24157	.24073	.23990	.23907	.23826
4800	.25106	.25019	.24931	.24843	.24758	.24671	.24585	.24500	.24416	.24332
4900	.25628	.25540	.25450	.25361	.25273	.25185	.25097	.25010	.24924	.24839
5000	.26151	.26060	.25969	.25878	.25788	.25698	.25609	.25520	.25432	.25345

	523	521
1	52	52
2	105	104
3	157	156
4	209	208
5	262	261
6	314	313
7	366	365
8	418	417
9	471	469
	519	517
1	52	52
2	104	103
3	156	155
4	208	207
5	260	259
6	311	310
7	363	362
8	415	414
9	467	465
	516	514
1	52	51
2	103	103
3	155	154
4	206	206
5	258	257
6	310	308
7	361	360
8	413	411
9	464	463
	512	510
1	51	51
2	102	102
3	154	153
4	205	204
5	256	255
6	307	306
7	358	357
8	410	408
9	461	459
	509	507
1	51	51
2	102	101
3	153	152
4	204	203
5	255	254
6	305	304
7	356	355
8	407	405
9	458	456

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta B - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	20	21	22	23	24	25	26	27	28	29
	505	504	502	500	499	497	495	494	492	490
H 100	.00506	.00504	.00502	.00500	.00499	.00497	.00495	.00494	.00492	.00490
200	1011	1008	1005	1001	0998	0994	0991	0988	0984	0981
300	1516	1512	1507	1501	1497	1491	1486	1481	1476	1471
400	2022	2016	2009	2001	1996	1988	1981	1975	1968	1961
500	2528	2519	2511	2502	2495	2485	2477	2468	2460	2452
	505	504	502	500	498	497	495	491	492	490
600	.03033	.03023	.03013	.03002	.02993	.02982	.02972	.02961	.02952	.02942
700	3538	3527	3515	3503	3492	3479	3467	3455	3444	3433
800	4044	4030	4017	4003	3990	3976	3962	3948	3936	3923
900	4550	4534	4519	4504	4489	4473	4457	4442	4428	4414
1000	5055	5038	5021	5004	4987	4970	4953	4936	4920	4904
	505	504	502	500	498	497	495	494	492	490
1100	.05560	.05542	.05523	.05504	.05485	.05467	.05449	.05430	.05412	.05395
1200	6066	6045	6025	6004	5983	5964	5944	5924	5904	5885
1300	6571	6549	6527	6504	6481	6460	6439	6418	6396	6375
1400	7076	7052	7029	7004	6979	6957	6934	6912	6888	6865
1500	7582	7556	7530	7504	7478	7454	7429	7406	7380	7355
	505	504	502	500	498	497	495	493	492	490
1600	.08087	.08059	.08032	.08004	.07977	.07951	.07924	.07899	.07872	.07846
1700	8592	8562	8533	8504	8475	8447	8419	8392	8363	8336
1800	9097	9065	9035	9004	8974	8944	8914	8885	8855	8826
1900	9603	9569	9537	9504	9473	9441	9409	9378	9347	9316
2000	.10108	.10073	.10038	.10004	9971	9937	9904	9871	9838	9806
	505	504	502	500	498	497	495	493	492	490
2100	.10613	.10577	.10540	.10505	.10470	.10434	.10400	.10365	.10330	.10297
2200	.11118	.11081	.11042	.11005	.10968	.10931	.10895	.10858	.10822	.10787
2300	.11623	.11585	.11544	.11505	.11466	.11428	.11390	.11351	.11314	.11277
2400	.12128	.12089	.12046	.12005	.11965	.11925	.11885	.11845	.11806	.11767
2500	.12634	.12593	.12548	.12506	.12464	.12422	.12380	.12338	.12298	.12257
	505	503	502	500	498	497	495	493	492	490
2600	.13139	.13096	.13050	.13006	.12962	.12919	.12875	.12831	.12790	.12747
2700	.13644	.13599	.13552	.13506	.13461	.13416	.13370	.13325	.13282	.13238
2800	.14149	.14102	.14054	.14006	.13960	.13913	.13865	.13818	.13774	.13728
2900	.14654	.14605	.14556	.14506	.14458	.14409	.14361	.14312	.14266	.14218
3000	.15159	.15108	.15057	.15006	.14956	.14906	.14856	.14806	.14757	.14708
	505	503	502	500	498	497	495	493	492	490
3100	.15664	.15612	.15559	.15506	.15454	.15403	.15351	.15300	.15249	.15198
3200	.16169	.16115	.16061	.16006	.15952	.15900	.15845	.15793	.15741	.15688
3300	.16674	.16618	.16563	.16506	.16451	.16397	.16340	.16286	.16233	.16178
3400	.17179	.17121	.17065	.17005	.16949	.16893	.16835	.16779	.16725	.16668
3500	.17684	.17624	.17567	.17505	.17447	.17390	.17330	.17272	.17217	.17158
	504	503	501	500	498	496	495	493	491	490
3600	.18189	.18127	.18068	.18005	.17945	.17886	.17825	.17766	.17708	.17647
3700	.18694	.18631	.18569	.18504	.18443	.18382	.18320	.18259	.18199	.18137
3800	.19199	.19134	.19070	.19004	.18941	.18878	.18815	.18752	.18690	.18627
3900	.19704	.19637	.19571	.19504	.19439	.19374	.19310	.19245	.19181	.19117
4000	.20209	.20140	.20072	.20004	.19937	.19870	.19804	.19738	.19672	.19607
	504	503	501	500	498	496	495	493	491	490
4100	.20714	.20643	.20574	.20504	.20435	.20366	.20299	.20231	.20163	.20097
4200	.21219	.21146	.21075	.21003	.20933	.20863	.20794	.20724	.20654	.20586
4300	.21724	.21649	.21576	.21503	.21431	.21359	.21289	.21217	.21145	.21076
4400	.22229	.22152	.22078	.22003	.21929	.21855	.21784	.21710	.21636	.21566
4500	.22734	.22656	.22579	.22502	.22427	.22351	.22279	.22203	.22128	.22055
	504	503	501	500	498	496	494	493	491	490
4600	.23238	.23159	.23080	.23002	.22925	.22848	.22773	.22696	.22620	.22545
4700	.23743	.23662	.23581	.23501	.23423	.23344	.23267	.23189	.23111	.23034
4800	.24248	.24165	.24083	.24000	.23920	.23840	.23761	.23682	.23602	.23524
4900	.24753	.24668	.24584	.24500	.24418	.24336	.24255	.24175	.24094	.24014
5000	.25258	.25171	.25085	.25000	.24916	.24832	.24749	.24667	.24585	.24504

	505	503
1	51	50
2	101	101
3	152	151
4	202	201
5	253	252
6	303	302
7	354	352
8	404	402
9	455	453

	502	506
1	50	50
2	100	100
3	151	150
4	201	200
5	251	250
6	301	300
7	351	350
8	402	400
9	452	450

	498	497
1	50	50
2	100	99
3	149	149
4	199	199
5	249	249
6	299	298
7	349	348
8	398	398
9	448	447

	495	493
1	50	49
2	99	99
3	149	148
4	198	197
5	248	247
6	297	296
7	347	345
8	396	394
9	446	444

	492	490
1	49	49
2	98	98
3	148	147
4	197	196
5	246	245
6	295	294
7	344	343
8	394	392
9	443	441

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	30	31	32	33	34	35	36	37	38	39
	489	487	486	484	483	481	479	478	476	475
H 100	.00489	.00487	.00485	.00483	.00481	.00480	.00479	.00477	.00475	.00474
200	978	0975	0971	0968	0964	0961	0959	0955	0952	0949
300	1466	1462	1456	1452	1447	1441	1438	1432	1428	1424
400	1955	1949	1942	1936	1930	1922	1917	1910	1904	1899
500	2444	2436	2428	2420	2413	2403	2396	2388	2381	2373
	489	487	486	484	482	481	479	478	476	475
600	.02933	.02924	.02914	.02904	.02896	.02884	.02876	.02865	.02857	.02848
700	3422	3411	3399	3388	3378	3365	3355	3343	3333	3323
800	3910	3898	3884	3872	3860	3846	3834	3820	3809	3797
900	4399	4385	4370	4356	4342	4327	4313	4298	4285	4271
1000	4888	4872	4856	4840	4824	4808	4792	4776	4761	4746
	489	487	485	484	482	481	479	478	476	475
1100	.05377	.05359	.05342	.05324	.05307	.05289	.05272	.05254	.05238	.05220
1200	5865	5846	5827	5807	5789	5769	5751	5731	5714	5695
1300	6354	6333	6312	6291	6271	6250	6230	6209	6190	6169
1400	6842	6820	6798	6775	6753	6730	6709	6687	6666	6644
1500	7331	7307	7283	7258	7235	7211	7188	7165	7142	7118
	489	487	485	484	482	481	479	478	476	475
1600	.07820	.07794	.07768	.07741	.07717	.07692	.07667	.07643	.07618	.07592
1700	8308	8281	8254	8225	8200	8173	8147	8120	8094	8066
1800	8797	8768	8740	8709	8682	8654	8626	8598	8570	8541
1900	9285	9255	9225	9194	9164	9135	9105	9075	9046	9016
2000	9774	9742	9710	9678	9646	9615	9584	9553	9522	9491
	489	487	485	484	482	481	479	478	476	475
2100	.10262	.10229	.10196	.10162	.10129	.10096	.10063	.10031	9998	9966
2200	.10751	.10716	.10681	.10645	.10611	.10577	.10542	.10509	.10474	.10441
2300	.11240	.11203	.11166	.11129	.11093	.11058	.11021	.10987	.10950	.10916
2400	.11728	.11790	.11652	.11613	.11575	.11539	.11500	.11465	.11426	.11391
2500	.12216	.12277	.12137	.12097	.12057	.12020	.11979	.11943	.11902	.11866
	489	487	485	484	482	480	479	477	476	474
2600	.12705	.12764	.12622	.12580	.12539	.12500	.12458	.12420	.12378	.12340
2700	.13194	.13251	.13108	.13064	.13021	.12981	.12937	.12897	.12854	.12814
2800	.13682	.13738	.13593	.13547	.13504	.13461	.13416	.13374	.13330	.13288
2900	.14170	.14225	.14078	.14031	.13986	.13941	.13895	.13851	.13806	.13762
3000	.14659	.14611	.14563	.14515	.14468	.14421	.14374	.14328	.14282	.14236
	488	487	485	484	482	480	479	477	476	474
3100	.15147	.15098	.15049	.14999	.14950	.14902	.14853	.14806	.14758	.14711
3200	.15636	.15585	.15534	.15483	.15432	.15382	.15331	.15283	.15233	.15185
3300	.16124	.16071	.16019	.15967	.15914	.15862	.15810	.15760	.15709	.15659
3400	.16612	.16558	.16504	.16451	.16396	.16343	.16289	.16237	.16184	.16133
3500	.17100	.17045	.16989	.16935	.16878	.16823	.16768	.16714	.16660	.16607
	488	487	485	483	482	480	479	477	476	474
3600	.17589	.17532	.17474	.17419	.17360	.17303	.17246	.17191	.17135	.17081
3700	.18077	.18018	.17959	.17902	.17842	.17783	.17725	.17669	.17611	.17555
3800	.18565	.18505	.18444	.18385	.18324	.18264	.18204	.18146	.18086	.18029
3900	.19054	.18992	.18929	.18868	.18806	.18744	.18683	.18623	.18562	.18503
4000	.19542	.19478	.19414	.19351	.19288	.19225	.19162	.19100	.19038	.18977
	488	487	485	483	482	480	479	477	476	474
4100	.20030	.19965	.19899	.19835	.19770	.19706	.19641	.19578	.19514	.19452
4200	.20518	.20452	.20384	.20318	.20252	.20186	.20119	.20055	.19990	.19926
4300	.21007	.20939	.20869	.20801	.20734	.20666	.20598	.20532	.20466	.20400
4400	.21495	.21426	.21354	.21284	.21216	.21146	.21077	.21009	.20942	.20874
4500	.21983	.21913	.21839	.21767	.21698	.21626	.21556	.21486	.21418	.21349
	488	486	485	483	481	480	479	477	475	474
4600	.22471	.22400	.22324	.22251	.22180	.22107	.22034	.21963	.21894	.21823
4700	.22959	.22886	.22809	.22734	.22661	.22587	.22513	.22441	.22369	.22297
4800	.23448	.23372	.23294	.23217	.23143	23067	.22992	.22918	.22844	.22771
4900	.23936	.23858	.23779	.23701	.23624	.23547	.23471	.23395	.23319	.23245
5000	.24424	.24344	.24264	.24184	.24105	.24027	.23949	.23872	.23795	.23719

	489	487
1	49	49
2	98	97
3	147	146
4	196	195
5	245	244
6	293	292
7	342	341
8	391	390
9	440	438
	485	484
1	49	48
2	97	97
3	145	145
4	194	194
5	243	242
6	291	290
7	339	339
8	388	387
9	437	436
	482	480
1	48	48
2	96	96
3	145	144
4	193	192
5	241	240
6	289	288
7	337	336
8	386	384
9	434	432
	479	477
1	49	48
2	96	95
3	144	143
4	192	191
5	240	239
6	287	286
7	335	334
8	383	382
9	431	429
	476	474
1	48	47
2	95	95
3	143	142
4	190	190
5	238	237
6	286	284
7	333	332
8	381	379
9	428	427

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m_1 = m - \beta m = \gamma m.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	—50	—49	—48	—47	—46	—45	—44	—43	—42	—41
H 5000	.33192	.33044	.32897	.32751	.32607	.32464	.32322	.32181	.32041	.31903
	663	660	657	655	652	649	646	643	640	638
5100	.33855	.33705	.33555	.33406	.33259	.33113	.32968	.32824	.32682	.32541
5200	.34518	.34365	.34213	.34061	.33911	.33762	.33614	.33467	.33323	.33179
5300	.35182	.35026	.34871	.34716	.34563	.34411	.34260	.34110	.33963	.33817
5400	.35845	.35686	.35528	.35371	.35215	.35060	.34906	.34753	.34603	.34455
5500	.36508	.36346	.36085	.36025	.35867	.35709	.35551	.35396	.35243	.35092
	663	660	657	654	651	648	646	643	640	637
5600	.37171	.37006	.36742	.36679	.36518	.36358	.36197	.36039	.35883	.35729
5700	.37834	.37666	.37399	.37333	.37169	.37006	.36843	.36682	.36523	.36366
5800	.38497	.38326	.38056	.37987	.37820	.37654	.37489	.37325	.37163	.37003
5900	.39161	.38986	.38713	.38641	.38471	.38302	.38135	.37968	.37803	.37640
6000	.39824	.39646	.39470	.39295	.39122	.38950	.38780	.38611	.38443	.38277
	663	660	657	654	651	648	646	643	640	637
6100	.40487	.40306	.40127	.39949	.39773	.39598	.39426	.39254	.39083	.38915
6200	.41150	.40966	.40784	.40603	.40424	.40247	.40072	.39897	.39723	.39552
6300	.41812	.41626	.41431	.41257	.41075	.40896	.40718	.40540	.40363	.40189
6400	.42475	.42286	.42088	.41911	.41727	.41544	.41364	.41183	.41003	.40826
6500	.43138	.42946	.42745	.42565	.42378	.42192	.42010	.41826	.41643	.41463
	663	660	657	654	651	648	645	642	640	637
6600	.43801	.43606	.43402	.43219	.43029	.42841	.42655	.42468	.42283	.42100
6700	.44464	.44266	.44059	.43873	.43680	.43489	.43300	.43111	.42923	.42737
6800	.45126	.44926	.44716	.44527	.44331	.44137	.43945	.43753	.43563	.43374
6900	.45789	.45585	.45373	.45181	.44982	.44785	.44590	.44396	.44202	.44011
7000	.46452	.46245	.46039	.45835	.45633	.45433	.45235	.45038	.44842	.44648
	662	660	657	654	651	648	645	642	640	637
7100	.47114	.46905	.46696	.46489	.46284	.46081	.45880	.45681	.45482	.45285
7200	.47777	.47565	.47353	.47143	.46935	.46729	.46525	.46324	.46122	.45922
7300	.48440	.48225	.48010	.47797	.47586	.47377	.47170	.46966	.46762	.46559
7400	.49102	.48885	.48667	.48451	.48237	.48025	.47815	.47608	.47402	.47196
7500	.49764	.49545	.49324	.49104	.48888	.48673	.48460	.48250	.48042	.47832
	662	659	656	654	651	648	645	642	639	637
7600	.50427	.50204	.49981	.49758	.49539	.49321	.49105	.48892	.48681	.48469
7700	.51090	.50863	.50637	.50412	.50190	.49969	.49750	.49534	.49320	.49106
7800	.51752	.51522	.51293	.51066	.50841	.50617	.50395	.50176	.49959	.49743
7900	.52414	.52181	.51949	.51719	.51491	.51265	.51040	.50818	.50598	.50380
8000	.53077	.52840	.52605	.52372	.52141	.51912	.51685	.51460	.51237	.51016
	662	659	657	654	651	648	645	642	639	637
8100	.53739	.53500	.53262	.53026	.52792	.52560	.52331	.52103	.51877	.51653
8200	.54401	.54159	.53919	.53680	.53443	.53208	.52976	.52745	.52517	.52290
8300	.55064	.54819	.54576	.54334	.54094	.53856	.53621	.53388	.53156	.52927
8400	.55726	.55478	.55233	.54988	.54745	.54504	.54266	.54030	.53795	.53564
8500	.56388	.56137	.55889	.55642	.55396	.55152	.54911	.54672	.54434	.54201
	662	659	656	653	650	648	645	642	639	636
8600	.57050	.56897	.56545	.56295	.56047	.55800	.55556	.55315	.55074	.54838
8700	.57712	.57456	.57201	.56948	.56698	.56448	.56201	.55957	.55713	.55474
8800	.58375	.58115	.57857	.57601	.57348	.57096	.56846	.56599	.56352	.56110
8900	.59037	.58774	.58513	.58254	.57998	.57744	.57491	.57241	.56992	.56746
9000	.59699	.59433	.59169	.58907	.58648	.58391	.58136	.57883	.57631	.57382
	662	659	656	653	650	648	645	642	639	636
9100	.60361	.60092	.59825	.59561	.59299	.59039	.58781	.58525	.58271	.58019
9200	.61023	.60751	.60481	.60214	.59950	.59687	.59426	.59167	.58911	.58655
9300	.61685	.61410	.61137	.60868	.60600	.60335	.60071	.59809	.59550	.59292
9400	.62347	.62069	.61793	.61521	.61250	.60983	.60716	.60451	.60189	.59928
9500	.63008	.62728	.62449	.62174	.61900	.61631	.61361	.61093	.60828	.60564
	662	659	656	653	650	647	644	642	639	636
9600	.63670	.63387	.63106	.62828	.62551	.62278	.62005	.61735	.61467	.61200
9700	.64332	.64046	.63762	.63481	.63202	.62925	.62650	.62377	.62106	.61837
9800	.64994	.64705	.64418	.64134	.63852	.63572	.63295	.63019	.62745	.62474
9900	.65656	.65364	.65074	.64787	.64502	.64219	.63939	.63661	.63384	.63110
10000	.66318	.66023	.65730	.65440	.65152	.64866	.64583	.64302	.64023	.63746

	662	659
1	66	66
2	132	132
3	199	198
4	265	264
5	331	330
6	397	395
7	463	461
8	530	527
9	596	593
	656	654
1	66	65
2	131	131
3	197	196
4	262	262
5	328	327
6	394	392
7	459	458
8	525	523
9	590	589
	651	648
1	65	65
2	130	130
3	195	194
4	260	259
5	326	324
6	391	389
7	456	454
8	521	518
9	586	583
	645	642
1	65	64
2	129	128
3	194	193
4	258	257
5	323	321
6	387	385
7	452	449
8	516	514
9	581	578
	639	637
1	64	64
2	128	127
3	192	191
4	256	255
5	320	319
6	383	382
7	447	446
8	511	510
9	575	573

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	−40	−39	−38	−37	−36	−35	−34	−33	−32	−31
H 5000	.31766	.31630	.31495	.31361	.31228	.31097	.30967	.30838	.30711	.30584
	635	632	629	627	624	622	619	617	614	611
5100	.32401	.32262	.32125	.31988	.31853	.31719	.31586	.31455	.31325	.31196
5200	.33035	.32894	.32755	.32615	.32478	.32341	.32205	.32072	.31939	.31807
5300	.33670	.33526	.33384	.33242	.33102	.32963	.32824	.32689	.32552	.32418
5400	.34304	.34158	.34013	.33869	.33726	.33585	.33443	.33306	.33266	.33029
5500	.34939	.34790	.34642	.34495	.34350	.34207	.34062	.33922	.33880	.33640
	634	632	629	627	624	621	619	616	614	611
5600	.35574	.35422	.35271	.35122	.34974	.34828	.34681	.34538	.34493	.34251
5700	.36208	.36054	.35900	.35749	.35598	.35449	.35300	.35154	.35007	.34862
5800	.36843	.36786	.36529	.36376	.36222	.36070	.35919	.35770	.35621	.35473
5900	.37477	.37318	.37158	.37002	.36846	.36692	.36538	.36386	.35234	.36084
6000	.38112	.37949	.37787	.37628	.37470	.37313	.37157	.37002	.36848	.36695
	634	632	629	627	624	621	619	616	614	611
6100	.38746	.38581	.38417	.38255	.38094	.37934	.37776	.37618	.37462	.37306
6200	.39381	.39213	.39046	.38882	.38717	.38555	.38395	.38233	.38076	.37917
6300	.40015	.39845	.39675	.39509	.39341	.39176	.39014	.38849	.38690	.38528
6400	.40649	.40476	.40304	.40135	.39964	.39797	.39633	.39465	.39303	.39139
6500	.41284	.41108	.40933	.40761	.40587	.40418	.40251	.40081	.39916	.39750
	634	632	629	626	624	621	618	616	613	611
6600	.41918	.41740	.41562	.41387	.41211	.41039	.40869	.40697	.40529	.40361
6700	.42552	.42372	.42191	.42013	.41834	.41660	.41487	.41312	.41142	.40972
6800	.43186	.43004	.42820	.42649	.42458	.42281	.42105	.41928	.41755	.41583
6900	.43821	.43635	.43449	.43265	.43082	.42902	.42723	.42544	.42368	.42193
7000	.44455	.44266	.44078	.43891	.43706	.43523	.43341	.43160	.42981	.42803
	634	632	629	626	624	621	618	616	613	611
7100	.45089	.44898	.44707	.44518	.44331	.44144	.43960	.43776	.43595	.43414
7200	.45723	.45530	.45336	.45144	.44955	.44764	.44579	.44392	.44208	.44025
7300	.46357	.46162	.45965	.45770	.45579	.45385	.45197	.45008	.44821	.44636
7400	.46991	.46794	.46594	.46396	.46203	.46006	.45815	.45623	.45434	.45247
7500	.47626	.47425	.47222	.47022	.46827	.46627	.46433	.46239	.46047	.45858
	634	631	629	626	623	621	618	616	613	610
7600	.48260	.48056	.47851	.47648	.47450	.47248	.47051	.46854	.46660	.46469
7700	.48894	.48687	.48480	.48274	.48073	.47868	.47669	.47470	.47273	.47079
7800	.49528	.49318	.49008	.48900	.48696	.48489	.48287	.48085	.47886	.47689
7900	.50162	.49949	.49737	.49526	.49319	.49110	.48905	.48701	.48499	.48299
8000	.50796	.50580	.50365	.50152	.49941	.49731	.49523	.49317	.49112	.48909
	634	631	629	626	623	621	618	616	613	610
8100	.51430	.51211	.50994	.50778	.50564	.50352	.50142	.49933	.49725	.49520
8200	.52064	.51842	.51623	.51404	.51188	.50973	.50760	.50549	.50338	.50130
8300	.52698	.52473	.52252	.52030	.51811	.51594	.51378	.51165	.50951	.50741
8400	.53332	.53104	.52881	.52656	.52435	.52215	.51996	.51781	.51564	.51351
8500	.53966	.53736	.53510	.53282	.53058	.52836	.52614	.52397	.52177	.51961
	634	631	628	626	623	620	616	615	613	610
8600	.54599	.54368	.54139	.53908	.53682	.53457	.53232	.53012	.52790	.52571
8700	.55233	.54999	.54767	.54534	.54305	.54078	.53850	.53627	.53403	.53181
8800	.55867	.55630	.55395	.55160	.54928	.54698	.54468	.54242	.54016	.53792
8900	.56501	.56261	.56023	.55786	.55551	.55318	.55086	.54857	.54629	.54402
9000	.57135	.56892	.56651	.56412	.56174	.55938	.55704	.55472	.55241	.55012
	634	631	628	626	623	620	618	615	613	610
9100	.57769	.57523	.57280	.57038	.56797	.56558	.56322	.56087	.55854	.55622
9200	.58402	.58154	.57908	.57664	.57420	.57178	.56940	.56702	.56467	.56232
9300	.59036	.58785	.58536	.58290	.58043	.57798	.57558	.57317	.57080	.56842
9400	.59669	.59416	.59164	.58916	.58666	.58419	.58176	.57932	.57693	.57452
9500	.60303	.60047	.59792	.59541	.59289	.59040	.58794	.58547	.58306	.58062
	634	631	628	625	623	620	617	615	612	610
9600	.60937	.60678	.60420	.60166	.59912	.59660	.59411	.59162	.58918	.58672
9700	.61570	.61309	.61048	.60791	.60535	.60280	.60029	.59777	.59530	.59282
9800	.62204	.61940	.61676	.61416	.61158	.60900	.60646	.60392	.60142	.59892
9900	.62837	.62570	.62304	.62041	.61780	.61520	.61263	.61007	.60754	.60502
10000	.63471	.63200	.62932	.62666	.62402	.62140	.61880	.61622	.61366	.61112

	634	631
1	63	63
2	127	126
3	190	189
4	254	252
5	317	316
6	380	379
7	444	442
8	507	505
9	571	568

	629	626
1	63	63
2	126	125
3	189	188
4	252	250
5	315	313
6	378	376
7	440	438
8	503	501
9	566	563

	623	621
1	62	62
2	125	124
3	187	186
4	249	248
5	312	311
6	374	373
7	436	435
8	498	497
9	561	559

	618	616
1	62	62
2	124	123
3	185	185
4	247	246
5	309	308
6	371	370
7	433	431
8	494	493
9	556	554

	613	610
1	61	61
2	123	122
3	184	183
4	245	244
5	307	305
6	368	366
7	429	427
8	490	488
9	552	549

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	−30	−29	−28	−27	−26	−25	−24	−23	−22	−21
H 5000	.30458	.30334	.30210	.30087	.29965	.29844	.29724	.29605	.29487	.29370
	608	606	604	601	599	597	594	592	589	587
5100	.31066	.30940	.30814	.30689	.30564	.30441	.30318	.30197	.30077	.29957
5200	.31675	.31546	.31418	.31290	.31162	.31038	.30912	.30789	.30666	.30544
5300	.32284	.32152	.32022	.31892	.31761	.31635	.31506	.31381	.31256	.31131
5400	.32892	.32758	.32626	.32493	.32360	.32232	.32100	.31973	.31845	.31718
5500	.33500	.33364	.33230	.33094	.32959	.32828	.32694	.32565	.32434	.32305
	608	606	603	601	599	596	594	591	589	587
5600	.34109	.33970	.33834	.33695	.33558	.33424	.33288	.33157	.33023	.32891
5700	.34718	.34576	.34437	.34296	.34156	.34020	.33882	.33748	.33612	.33478
5800	.35326	.35182	.35040	.34897	.34755	.34616	.34466	.34339	.34201	.34064
5900	.35934	.35788	.35643	.35498	.35354	.35212	.35060	.34930	.34790	.34651
6000	.36543	.36394	.36246	.36099	.35953	.35808	.35664	.35521	.35379	.35238
	608	606	603	601	599	596	594	591	589	587
6100	.37151	.37000	.36850	.36700	.36552	.36405	.36258	.36113	.35968	.35825
6200	.37760	.37605	.37453	.37301	.37151	.37001	.36852	.36704	.36557	.36411
6300	.38368	.38211	.38056	.37902	.37750	.37597	.37445	.37295	.37146	.36998
6400	.38976	.38817	.38660	.38503	.38349	.38193	.38039	.37887	.37735	.37584
6500	.39584	.39423	.39263	.39104	.38948	.38789	.38633	.38478	.38324	.38171
	608	606	603	601	598	596	594	591	589	587
6600	.40193	.40029	.39866	.39705	.39546	.39385	.39227	.39069	.38913	.38757
6700	.40801	.40635	.40470	.40306	.40144	.39981	.39820	.39661	.39502	.39344
6800	.41409	.41240	.41073	.40906	.40742	.40577	.40414	.40252	.40090	.39930
6900	.42018	.41846	.41676	.41507	.41340	.41173	.41008	.40843	.40679	.40517
7000	.42626	.42452	.42279	.42108	.41938	.41769	.41601	.41434	.41268	.41104
	608	606	603	601	598	596	594	591	589	587
7100	.43234	.43058	.42883	.42709	.42537	.42365	.42195	.42025	.41856	.41691
7200	.43842	.43664	.43486	.43309	.43135	.42961	.42789	.42616	.42445	.42278
7300	.44450	.44270	.44089	.43910	.43733	.43557	.43384	.43207	.43034	.42865
7400	.45058	.44876	.44692	.44510	.44331	.44153	.43978	.43798	.43623	.43451
7500	.45666	.45482	.45295	.45111	.44929	.44749	.44571	.44389	.44212	.44038
	608	605	603	601	598	596	593	591	589	586
7600	.46275	.46088	.45898	.45712	.45527	.45345	.45164	.44980	.44801	.44624
7700	.46883	.46693	.46501	.46312	.46126	.45940	.45757	.45571	.45389	.45210
7800	.47491	.47298	.47104	.46913	.46724	.46536	.46350	.46162	.45978	.45796
7900	.48099	.47903	.47707	.47514	.47322	.47131	.46948	.46753	.46567	.46382
8000	.48707	.48508	.48310	.48114	.47920	.47727	.47535	.47344	.47155	.46968
	608	605	603	601	598	596	593	591	586	586
8100	.49315	.49113	.48913	.48715	.48518	.48323	.48129	.47935	.47744	.47555
8200	.49923	.49719	.49516	.49316	.49116	.48919	.48722	.48526	.48333	.48141
8300	.50530	.50324	.50119	.49917	.49714	.49515	.49315	.49117	.48922	.48727
8400	.51138	.50929	.50722	.50518	.50312	.50111	.49908	.49708	.49511	.49313
8500	.51746	.51535	.51325	.51119	.50910	.50707	.50501	.50299	.50100	.49899
	608	605	603	600	598	595	593	591	588	586
8600	.52354	.52141	.51928	.51719	.51508	.51302	.51094	.50889	.50688	.50485
8700	.52962	.52746	.52531	.52319	.52106	.51897	.51687	.51480	.51276	.51071
8800	.53569	.53351	.53134	.52919	.52704	.52492	.52280	.52071	.51864	.51657
8900	.54177	.53956	.53737	.53519	.53302	.53087	.52873	.52662	.52452	.52243
9000	.54785	.54561	.54339	.54119	.53900	.53682	.53466	.53252	.53040	.52829
	608	605	603	600	598	595	593	591	588	586
9100	.55393	.55167	.54942	.54719	.54498	.54278	.54059	.53843	.53629	.53415
9200	.56000	.55772	.55545	.55319	.55096	.54874	.54652	.54434	.54217	.54001
9300	.56608	.56377	.56148	.55919	.55694	.55469	.55245	.55025	.54805	.54587
9400	.57215	.56982	.56751	.56519	.56292	.56064	.55838	.55616	.55393	.55173
9500	.57823	.57587	.57354	.57119	.56890	.56659	.56431	.56207	.55981	.55759
	608	605	602	600	597	595	593	590	588	586
9600	.58431	.58192	.57957	.57720	.57488	.57255	.57024	.56797	.56569	.56345
9700	.59038	.58797	.58559	.58320	.58086	.57850	.57617	.57387	.57157	.56931
9800	.59646	.59402	.59161	.58920	.58683	.58445	.58210	.57977	.57745	.57517
9900	.60253	.60007	.59763	.59520	.59280	.59040	.58802	.58567	.58333	.58103
10000	.60861	.60612	.60365	.60120	.59877	.59635	.59395	.59157	.58921	.58688

	608	605
1	61	61
2	122	121
3	182	182
4	243	242
5	304	303
6	365	363
7	426	423
8	486	484
9	547	545
	603	601
1	60	60
2	121	120
3	181	180
4	241	240
5	302	301
6	362	361
7	422	421
8	482	481
9	543	541
	598	596
1	60	60
2	120	119
3	179	179
4	239	238
5	299	298
6	359	358
7	419	417
8	478	477
9	538	536
	593	591
1	59	59
2	119	118
3	178	177
4	237	236
5	297	296
6	356	355
7	415	414
8	474	473
9	534	532
	589	586
1	59	59
2	118	117
3	177	176
4	236	234
5	295	293
6	353	352
7	412	410
8	471	469
9	530	527

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_0 > B.$ $\log B_0 = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_0 - m + \beta m + \gamma m = \log B_0 - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	−20	−19	−18	−17	−16	−15	−14	−13	−12	−11			
H 5000	.29254	.29139	.29025	.28912	.28799	.28687	.28576	.28466	.28358	.28249			
	585	582	580	578	576	573	571	569	567	565			
5100	.29838	.29722	.29605	.29490	.29375	.29261	.29147	.29035	.28925	.28814			
5200	.30423	.30305	.30185	.30067	.29951	.29834	.29718	.29604	.29492	.29379			
5300	.31008	.30887	.30765	.30645	.30527	.30408	.30289	.30173	.30059	.29944			
5400	.31592	.31469	.31345	.31222	.31103	.30981	.30860	.30742	.30626	.30509		584	582
5500	.32176	.32051	.31925	.31799	.31678	.31554	.31431	.31310	.31193	.31073			
	585	582	580	578	575	573	571	569	566	564	1	58	58
5600	.32761	.32633	.32505	.32377	.32253	.32127	.32002	.31879	.31759	.31637	2	117	116
5700	.33346	.33215	.33085	.32955	.32828	.32700	.32573	.32447	.32325	.32201	3	175	175
5800	.33930	.33797	.33665	.33532	.33403	.33273	.33144	.33016	.32891	.32765	4	234	233
5900	.34514	.34379	.34244	.34110	.33978	.33846	.33715	.33585	.33457	.33329	5	292	291
6000	.35099	.34961	.34824	.34688	.34553	.34419	.34286	.34154	.34023	.33893	6	350	349
											7	409	407
											8	467	466
											9	526	524
	584	582	580	578	575	573	571	569	566	564			
6100	.35683	.35543	.35404	.35266	.35129	.34992	.34857	.34723	.34590	.34458		579	577
6200	.36268	.36125	.35983	.35844	.35704	.35565	.35428	.35292	.35156	.35022			
6300	.36852	.36707	.36563	.36422	.36280	.36138	.35999	.35861	.35722	.35586			
6400	.37436	.37289	.37143	.37000	.36855	.36711	.36570	.36430	.36289	.36151	1	58	58
6500	.38020	.37871	.37723	.37577	.37430	.37284	.37140	.36999	.36855	.36715	2	116	115
											3	174	173
	584	582	580	577	575	573	571	568	566	564	4	232	231
6600	.38605	.38453	.38302	.38154	.38005	.37857	.37711	.37568	.37421	.37279	5	290	289
6700	.39189	.39035	.38882	.38731	.38580	.38430	.38282	.38136	.37988	.37843	6	347	346
6800	.39773	.39617	.39462	.39308	.39155	.39003	.38852	.38704	.38554	.38407	7	405	404
6900	.40358	.40199	.40041	.39885	.39730	.39576	.39423	.39272	.39121	.38971	8	463	462
7000	.40942	.40781	.40621	.40462	.40305	.40149	.39994	.39840	.39687	.39535	9	521	519
												575	573
	584	582	580	577	575	573	571	568	566	564			
7100	.41526	.41363	.41201	.41040	.40881	.40722	.40565	.40408	.40254	.40100			
7200	.42110	.41945	.41781	.41617	.41456	.41295	.41136	.40977	.40820	.40664	1	58	57
7300	.42694	.42527	.42361	.42195	.42031	.41868	.41707	.41545	.41387	.41228	2	115	115
7400	.43278	.43109	.42941	.42772	.42606	.42441	.42278	.42113	.41953	.41792	3	173	172
7500	.43862	.43691	.43521	.43350	.43181	.43013	.42849	.42682	.42519	.42356	4	230	229
											5	288	287
	584	582	579	577	575	573	570	568	566	564	6	345	344
7600	.44446	.44272	.44101	.43927	.43756	.43586	.43420	.43251	.43085	.42920	7	403	401
7700	.45030	.44854	.44680	.44505	.44331	.44159	.43990	.43820	.43651	.43484	8	460	458
7800	.45614	.45436	.45259	.45082	.44906	.44732	.44560	.44388	.44217	.44048	9	518	516
7900	.46198	.46017	.45838	.45659	.45481	.45304	.45130	.44956	.44783	.44612		570	568
8000	.46782	.46599	.46417	.46237	.46056	.45877	.45700	.45524	.45349	.45176			
	584	582	579	577	575	573	570	568	566	564	1	57	57
8100	.47366	.47181	.46997	.46814	.46631	.46450	.46271	.46093	.45915	.45740	2	114	114
8200	.47950	.47763	.47576	.47391	.47206	.47023	.46841	.46661	.46481	.46304	3	171	170
8300	.48533	.48345	.48155	.47968	.47781	.47596	.47411	.47229	.47047	.46867	4	228	227
8400	.49117	.48927	.48735	.48545	.48356	.48169	.47982	.47797	.47613	.47431	5	285	284
8500	.49701	.49509	.49314	.49122	.48930	.48742	.48552	.48365	.48179	.47995	6	342	341
											7	399	398
											8	456	454
											9	513	511
	584	581	579	577	575	572	570	568	566	564			
8600	.50285	.50090	.49894	.49699	.49505	.49314	.49123	.48933	.48745	.48558		566	564
8700	.50869	.50671	.50473	.50276	.50080	.49887	.49693	.49501	.49311	.49122			
8800	.51452	.51252	.51052	.50853	.50655	.50459	.50263	.50069	.49877	.49686			
8900	.52036	.51833	.51630	.51430	.51230	.51031	.50833	.50637	.50442	.50250	1	57	56
9000	.52620	.52414	.52209	.52006	.51804	.51603	.51403	.51205	.51008	.50813	2	113	113
											3	170	169
	584	581	579	577	575	572	570	568	566	564	4	226	226
9100	.53204	.52996	.52789	.52583	.52379	.52176	.51974	.51773	.51574	.51377	5	283	282
9200	.53787	.53577	.53368	.53159	.52954	.52748	.52545	.52341	.52140	.51941	6	340	338
9300	.54371	.54158	.53947	.53736	.53529	.53320	.53115	.52909	.52706	.52505	7	396	395
9400	.54954	.54740	.54526	.54313	.54104	.53893	.53685	.53477	.53272	.53069	8	453	451
9500	.55538	.55321	.55105	.54890	.54679	.54465	.54255	.54045	.53838	.53633	9	509	508
	584	581	579	577	574	572	570	568	566	563			
9600	.56122	.55903	.55684	.55466	.55253	.55038	.54825	.54613	.54404	.54197			
9700	.56705	.56484	.56263	.56043	.55827	.55610	.55395	.55181	.54970	.54760			
9800	.57289	.57065	.56842	.56620	.56401	.56182	.55965	.55749	.55536	.55323			
9900	.57872	.57646	.57421	.57197	.56975	.56754	.56535	.56317	.56101	.55886			
10000	.58456	.58227	.58000	.57774	.57549	.57326	.57105	.56885	.56666	.56449			

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	−10	−9	−8	−7	−6	−5	−4	−3	−2	−1
H 5000	.28141	.28035	.27929	.27824	.27720	.27617	.27514	.27412	.27310	.27209
	562	560	558	556	554	552	550	548	546	544
5100	.28703	.28596	.28487	.28380	.28274	.28169	.28064	.27959	.27856	.27753
5200	.29266	.29156	.29045	.28935	.28828	.28720	.28613	.28507	.28401	.28297
5300	.29828	.29716	.29603	.29491	.29381	.29272	.29163	.29055	.28947	.28841
5400	.30390	.30276	.30161	.30047	.29935	.29823	.29712	.29603	.29493	.29384
5500	.30952	.30836	.30719	.30603	.30489	.30375	.30262	.30150	.30039	.29928
	562	560	558	556	554	552	550	548	546	544
5600	.31515	.31396	.31277	.31159	.31043	.30926	.30811	.30698	.30585	.30471
5700	.32077	.31956	.31835	.31714	.31596	.31478	.31361	.31246	.31130	.31015
5800	.32639	.32516	.32393	.32270	.32150	.32030	.31910	.31794	.31676	.31559
5900	.33202	.33076	.32951	.32826	.32704	.32581	.32460	.32341	.32221	.32102
6000	.33764	.33636	.33509	.33382	.33257	.33133	.33010	.32888	.32767	.32646
	562	560	558	556	554	552	550	548	546	544
6100	.34326	.34196	.34067	.33938	.33811	.33685	.33559	.33436	.33313	.33190
6200	.34888	.34756	.34625	.34494	.34365	.34237	.34109	.33984	.33859	.33734
6300	.35450	.35316	.35183	.35050	.34919	.34789	.34658	.34532	.34405	.34278
6400	.36012	.35876	.35741	.35606	.35472	.35341	.35208	.35079	.34951	.34822
6500	.36574	.36436	.36299	.36162	.36026	.35892	.35758	.35626	.35496	.35365
	562	560	558	556	554	552	550	547	545	543
6600	.37137	.36996	.36857	.36718	.36580	.36443	.36307	.36174	.36041	.35908
6700	.37699	.37556	.37414	.37274	.37134	.36995	.36857	.36721	.36586	.36451
6800	.38261	.38116	.37972	.37830	.37688	.37546	.37406	.37268	.37131	.36994
6900	.38823	.38676	.38530	.38385	.38242	.38098	.37956	.37816	.37676	.37537
7000	.39385	.39236	.39088	.38941	.38795	.38650	.38506	.38363	.38221	.38080
	562	560	558	556	554	552	550	547	545	543
7100	.39947	.39796	.39646	.39497	.39349	.39202	.39056	.38911	.38767	.38624
7200	.40509	.40356	.40203	.40053	.39903	.39754	.39606	.39458	.39312	.39167
7300	.41071	.40916	.40761	.40609	.40457	.40306	.40156	.40005	.39857	.39710
7400	.41633	.41476	.41319	.41165	.41011	.40858	.40705	.40553	.40403	.40254
7500	.42194	.42035	.41877	.41721	.41565	.41409	.41255	.41100	.40948	.40797
	562	560	558	555	553	551	549	547	545	543
7600	.42756	.42595	.42435	.42277	.42118	.41960	.41804	.41648	.41494	.41341
7700	.43318	.43155	.42993	.42832	.42671	.42511	.42353	.42195	.42039	.41884
7800	.43880	.43714	.43550	.43387	.43224	.43062	.42902	.42742	.42585	.42427
7900	.44442	.44274	.44107	.43942	.43777	.43613	.43451	.43289	.43130	.42970
8000	.45004	.44834	.44665	.44497	.44330	.44164	.44000	.43837	.43675	.43514
	562	560	558	555	553	551	549	547	545	543
8100	.45566	.45394	.45223	.45053	.44884	.44716	.44549	.44384	.44220	.44057
8200	.46127	.45954	.45781	.45608	.45437	.45267	.45099	.44931	.44765	.44600
8300	.46689	.46514	.46339	.46164	.45990	.45818	.45648	.45478	.45310	.45143
8400	.47250	.47074	.46896	.46719	.46543	.46369	.46197	.46025	.45855	.45686
8500	.47812	.47633	.47453	.47274	.47096	.46920	.46746	.46572	.46400	.46229
	562	559	557	555	553	551	549	547	545	543
8600	.48374	.48192	.48010	.47829	.47650	.47472	.47295	.47119	.46945	.46772
8700	.48935	.48751	.48567	.48384	.48203	.48023	.47844	.47666	.47490	.47315
8800	.49497	.49310	.49124	.48939	.48756	.48574	.48393	.48213	.48035	.47858
8900	.50058	.49869	.49681	.49494	.49309	.49125	.48942	.48760	.48580	.48401
9000	.50620	.50428	.50238	.50049	.49862	.49676	.49491	.49307	.49125	.48944
	561	559	557	555	553	551	549	547	545	543
9100	.51181	.50988	.50796	.50605	.50416	.50227	.50040	.49854	.49670	.49487
9200	.51743	.51547	.51353	.51160	.50969	.50778	.50589	.50401	.50215	.50030
9300	.52304	.52106	.51910	.51716	.51522	.51329	.51138	.50948	.50760	.50573
9400	.52866	.52666	.52468	.52271	.52075	.51880	.51687	.51495	.51305	.51116
9500	.53427	.53225	.53025	.52826	.52628	.52431	.52236	.52042	.51850	.51659
	561	559	557	555	553	551	549	547	545	543
9600	.53988	.53785	.53583	.53381	.53181	.52982	.52785	.52589	.52395	.52202
9700	.54550	.54344	.54140	.53936	.53734	.53533	.53334	.53136	.52940	.52745
9800	.55111	.54904	.54697	.54491	.54287	.54084	.53883	.53683	.53485	.53288
9900	.55673	.55463	.55254	.55046	.54840	.54635	.54432	.54230	.54030	.53831
10000	.56234	.56022	.55811	.55601	.55393	.55186	.54981	.54777	.54575	.54374

	562	560
1	56	56
2	112	112
3	169	168
4	225	224
5	281	280
6	337	336
7	393	392
8	450	448
9	506	504

	558	555
1	56	56
2	112	111
3	167	167
4	223	222
5	279	278
6	335	333
7	391	389
8	446	444
9	502	500

	553	551
1	55	55
2	111	110
3	166	165
4	221	220
5	277	276
6	332	331
7	387	386
8	442	441
9	498	496

	549	547
1	55	55
2	110	109
3	165	164
4	220	219
5	275	274
6	329	328
7	384	383
8	439	438
9	494	492

	545	543
1	55	54
2	109	109
3	164	163
4	218	217
5	273	272
6	327	326
7	382	380
8	436	434
9	491	489

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m_1.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	0	1	2	3	4	5	6	7	8	9
H 5000	.27109	.27011	.26913	.26815	.26718	.26622	.26526	.26431	.26337	.26244
	542	540	538	536	534	532	530	528	526	524
5100	.27651	.27551	.27451	.27350	.27252	.27154	.27056	.26960	.26864	.26769
5200	.28192	.28090	.27988	.27886	.27785	.27685	.27586	.27488	.27390	.27293
5300	.28734	.28630	.28525	.28422	.28319	.28217	.28116	.28016	.27916	.27817
5400	.29276	.29169	.29062	.28957	.28852	.28749	.28646	.28544	.28442	.28341
5500	.29818	.29708	.29599	.29493	.29386	.29281	.29176	.29072	.28968	.28865
	542	540	538	536	534	532	530	528	526	524
5600	.30359	.30247	.30136	.30028	.29920	.29812	.29706	.29600	.29495	.29390
5700	.30901	.30787	.30674	.30564	.30453	.30344	.30235	.30128	.30021	.29914
5800	.31443	.31326	.31211	.31099	.30987	.30875	.30765	.30656	.30547	.30438
5900	.31984	.31866	.31749	.31635	.31520	.31407	.31295	.31184	.31073	.30963
6000	.32526	.32406	.32287	.32170	.32054	.31939	.31825	.31712	.31599	.31487
	542	540	538	536	534	532	530	528	526	524
6100	.33068	.32946	.32825	.32706	.32588	.32471	.32355	.32240	.32126	.32012
6200	.33609	.33486	.33363	.33242	.33122	.33003	.32885	.32768	.32652	.32536
6300	.34150	.34026	.33901	.33778	.33656	.33534	.33415	.33296	.33178	.33060
6400	.34692	.34566	.34439	.34314	.34190	.34066	.33945	.33824	.33704	.33585
6500	.35234	.35106	.34977	.34850	.34724	.34598	.34475	.34352	.34230	.34109
	541	539	538	536	534	532	530	528	526	524
6600	.35775	.35645	.35515	.35386	.35258	.35130	.35005	.34880	.34756	.34634
6700	.36316	.36185	.36053	.35922	.35792	.35662	.35535	.35408	.35282	.35158
6800	.36858	.36724	.36591	.36458	.36326	.36194	.36065	.35936	.35809	.35682
6900	.37400	.37263	.37128	.36994	.36860	.36727	.36595	.36464	.36335	.36206
7000	.37941	.37803	.37666	.37530	.37394	.37259	.37125	.36992	.36861	.36730
	541	539	537	535	534	532	530	528	526	524
7100	.38482	.38342	.38204	.38065	.37928	.37791	.37655	.37520	.37387	.37255
7200	.39024	.38882	.38741	.38501	.38462	.38323	.38185	.38048	.37913	.37779
7300	.39565	.39421	.39278	.39136	.38996	.38855	.38715	.38576	.38439	.38303
7400	.40106	.39960	.39816	.39672	.39530	.39387	.39244	.39104	.38965	.38827
7500	.40648	.40500	.40353	.40207	.40064	.39919	.39774	.39632	.39491	.39351
	541	539	537	535	533	531	530	528	526	524
7600	.41189	.41039	.40891	.40743	.40597	.40451	.40304	.40160	.40017	.39875
7700	.41730	.41578	.41428	.41278	.41130	.40983	.40834	.40688	.40543	.40399
7800	.42271	.42117	.41966	.41813	.41663	.41514	.41364	.41216	.41069	.40923
7900	.42813	.42656	.42503	.42349	.42196	.42045	.41893	.41744	.41595	.41447
8000	.43354	.43196	.43040	.42884	.42729	.42576	.42423	.42271	.42121	.41971
	541	539	537	535	533	531	529	528	526	524
8100	.43895	.43736	.43578	.43420	.43263	.43108	.42953	.42799	.42647	.42495
8200	.44436	.44275	.44115	.43955	.43796	.43640	.43482	.43327	.43172	.43018
8300	.44977	.44814	.44652	.44490	.44329	.44171	.44002	.43855	.43697	.43542
8400	.45518	.45353	.45189	.45025	.44862	.44702	.44531	.44383	.44223	.44066
8500	.46060	.45892	.45726	.45560	.45395	.45233	.45060	.44911	.44748	.44590
	541	539	537	535	533	531	529	527	526	524
8600	.46601	.46431	.46263	.46096	.45929	.45765	.45589	.45438	.45274	.45113
8700	.47142	.46970	.46800	.46631	.46462	.46296	.46119	.45965	.45799	.45637
8800	.47683	.47509	.47337	.47166	.46996	.46827	.46648	.46492	.46325	.46160
8900	.48224	.48048	.47874	.47701	.47529	.47358	.47178	.47019	.46850	.46684
9000	.48765	.48587	.48411	.48236	.48062	.47889	.47717	.47546	.47376	.47208
	541	539	537	535	533	531	529	527	526	524
9100	.49306	.49126	.48948	.48771	.48595	.48420	.48247	.48074	.47902	.47732
9200	.49847	.49665	.49485	.49306	.49128	.48951	.48777	.48601	.48428	.48256
9300	.50388	.50204	.50022	.49841	.49661	.49482	.49306	.49128	.48954	.48780
9400	.50929	.50743	.50559	.50376	.50194	.50013	.49835	.49656	.49480	.49304
9500	.51470	.51282	.51096	.50911	.50727	.50544	.50364	.50183	.50006	.49828
	541	539	537	535	533	531	529	527	525	523
9600	.52010	.51821	.51633	.51446	.51260	.51076	.50894	.50710	.50532	.50352
9700	.52551	.52359	.52170	.51981	.51793	.51607	.51423	.51237	.51057	.50876
9800	.53092	.52898	.52707	.52516	.52326	.52138	.51952	.51764	.51582	.51399
9900	.53633	.53437	.53244	.53051	.52859	.52669	.52480	.52292	.52107	.51922
10000	.54174	.53976	.53780	.53585	.53392	.53200	.53009	.52820	.52632	.52445

	541	539
1	54	54
2	108	108
3	162	162
4	216	216
5	271	270
6	325	323
7	379	377
8	433	431
9	487	485
	537	535
1	54	53
2	107	107
3	161	161
4	215	214
5	269	268
6	322	321
7	376	375
8	430	428
9	483	482
	533	531
1	53	53
2	107	106
3	160	159
4	213	212
5	267	266
6	320	319
7	373	372
8	426	425
9	480	478
	530	528
1	53	53
2	106	106
3	159	158
4	212	211
5	265	264
6	318	317
7	371	370
8	424	422
9	477	475
	526	524
1	53	52
2	105	105
3	158	157
4	210	210
5	263	262
6	316	314
7	368	367
8	421	419
9	473	472

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	10	11	12	13	14	15	16	17	18	19
H 5000	.26151	.26060	.25969	.25879	.25788	.25698	.25609	.25520	.25432	.25345
	523	521	519	517	515	513	512	510	508	506
5100	.26674	.26581	.26488	.26396	.26304	.26212	.26121	.26030	.25941	.25852
5200	.27196	.27101	.27007	.26913	.26819	.26725	.26632	.26540	.26449	.26358
5300	.27718	.27622	.27526	.27430	.27334	.27238	.27144	.27050	.26957	.26865
5400	.28241	.28142	.28045	.27947	.27849	.27752	.27655	.27560	.27466	.27371
5500	.28764	.28664	.28563	.28463	.28364	.28265	.28167	.28070	.27974	.27877
	522	521	519	517	515	513	512	510	508	506
5600	.29286	.29185	.29082	.28980	.28879	.28778	.28679	.28579	.28482	.28384
5700	.29808	.29705	.29600	.29497	.29394	.29292	.29191	.29089	.28990	.28890
5800	.30331	.30226	.30119	.30014	.29909	.29805	.29703	.29599	.29498	.29397
5900	.30854	.30746	.30637	.30531	.30424	.30318	.30214	.30109	.30006	.29903
6000	.31376	.31266	.31156	.31047	.30939	.30832	.30725	.30619	.30514	.30409
	522	521	519	517	515	513	511	510	508	506
6100	.31898	.31787	.31675	.31564	.31454	.31346	.31238	.31129	.31022	.30916
6200	.32421	.32308	.32194	.32081	.31969	.31859	.31749	.31638	.31530	.31422
6300	.32943	.32829	.32713	.32598	.32484	.32372	.32260	.32148	.32038	.31928
6400	.33466	.33350	.33232	.33115	.32999	.32886	.32772	.32657	.32546	.32434
6500	.33988	.33871	.33750	.33632	.33514	.33399	.33288	.33167	.33054	.32941
	522	520	519	517	515	513	511	510	508	506
6600	.34510	.34391	.34269	.34149	.34029	.33912	.33794	.33676	.33562	.33447
6700	.35033	.34911	.34787	.34666	.34544	.34425	.34306	.34186	.34070	.33953
6800	.35555	.35431	.35306	.35183	.35059	.34938	.34817	.34695	.34578	.34459
6900	.36078	.35951	.35824	.35700	.35574	.35451	.35328	.35205	.35085	.34965
7000	.36600	.36471	.36343	.36216	.36089	.35964	.35839	.35715	.35593	.35471
	522	520	519	517	515	513	511	510	508	506
7100	.37122	.36992	.36861	.36732	.36605	.36478	.36350	.36224	.36101	.35978
7200	.37644	.37513	.37380	.37249	.37120	.36991	.36861	.36734	.36609	.36484
7300	.38167	.38033	.37898	.37765	.37635	.37504	.37373	.37244	.37117	.36990
7400	.38689	.38553	.38416	.38282	.38150	.38017	.37884	.37754	.37625	.37496
7500	.39211	.39073	.38935	.38799	.38665	.38530	.38396	.38264	.38133	.38002
	522	520	519	517	515	513	511	510	508	506
7600	.39733	.39593	.39453	.39316	.39179	.39043	.38908	.38773	.38641	.38508
7700	.40255	.40113	.39972	.39832	.39694	.39556	.39419	.39283	.39149	.39014
7800	.40788	.40634	.40490	.40349	.40209	.40069	.39930	.39793	.39657	.39520
7900	.41300	.41154	.41008	.40865	.40723	.40582	.40441	.40302	.40165	.40026
8000	.41822	.41674	.41527	.41382	.41238	.41095	.40953	.40812	.40672	.40532
	522	520	519	517	515	513	511	510	508	506
8100	.42344	.42195	.42046	.41898	.41753	.41609	.41465	.41322	.41180	.41038
8200	.42866	.42715	.42565	.42415	.42268	.42122	.41976	.41832	.41688	.41544
8300	.43388	.43235	.43084	.42931	.42783	.42635	.42487	.42342	.42196	.42050
8400	.43910	.43756	.43603	.43448	.43298	.43148	.42998	.42852	.42704	.42556
8500	.44432	.44276	.44122	.43965	.43813	.43661	.43510	.43362	.43212	.43062
	522	520	518	517	515	513	511	509	507	506
8600	.44954	.44796	.44641	.44482	.44328	.44174	.44022	.43871	.43719	.43568
8700	.45476	.45217	.45159	.44998	.44843	.44687	.44533	.44380	.44226	.44074
8800	.45998	.45737	.45677	.45515	.45358	.45200	.45044	.44889	.44733	.44579
8900	.46520	.46257	.46195	.46032	.45873	.45713	.45555	.45398	.45240	.45085
9000	.47042	.46877	.46713	.46549	.46387	.46226	.46066	.45907	.45748	.45591
	522	520	518	517	515	513	511	509	507	506
9100	.47564	.47397	.47232	.47066	.46902	.46739	.46577	.46417	.46256	.46097
9200	.48086	.47917	.47750	.47583	.47416	.47251	.47088	.46926	.46763	.46603
9300	.48607	.48437	.48268	.48100	.47931	.47764	.47599	.47435	.47271	.47109
9400	.49129	.48957	.48786	.48617	.48445	.48277	.48110	.47944	.47778	.47615
9500	.49651	.49477	.49304	.49133	.48960	.48790	.48621	.48453	.48286	.48121
	522	520	518	516	515	513	511	509	507	506
9600	.50173	.49997	.49822	.49649	.49474	.49303	.49132	.48963	.48794	.48627
9700	.50695	.50517	.50340	.50165	.49989	.49816	.49643	.49472	.49301	.49133
9800	.51216	.51037	.50858	.50681	.50503	.50329	.50154	.49981	.49809	.49639
9900	.51738	.51557	.51376	.51197	.51018	.50842	.50665	.50489	.50317	.50145
10000	.52260	.52076	.51894	.51713	.51533	.51354	.51176	.50999	.50824	.50650

	522	520
1	52	52
2	104	104
3	157	156
4	209	208
5	261	260
6	313	312
7	365	364
8	418	416
9	470	468
	519	517
1	52	52
2	104	103
3	156	155
4	208	207
5	260	259
6	311	310
7	363	362
8	415	414
9	467	465
	515	513
1	52	51
2	103	102
3	155	154
4	206	205
5	258	257
6	309	308
7	361	359
8	412	410
9	464	462
	511	510
1	51	51
2	102	102
3	153	153
4	204	204
5	256	255
6	307	306
7	358	357
8	409	408
9	460	459
	508	506
1	51	51
2	102	101
3	152	152
4	203	202
5	254	253
6	305	304
7	356	354
8	406	405
9	457	455

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	20	21	22	23	24	25	26	27	28	29
H 5000	.25258	.25171	.25085	.25000	.24916	.24832	.24749	.24667	.24585	.24504
	505	503	501	500	498	497	495	493	492	490
5100	.25763	.25675	.25587	.25500	.25414	.25329	.25244	.25160	.25077	.24994
5200	.26267	.26178	.26088	.26000	.25912	.25826	.25739	.25653	.25569	.25484
5300	.26772	.26681	.26589	.26500	.26410	.26323	.26233	.26147	.26061	.25974
5400	.27277	.27184	.27090	.27000	.26908	.26820	.26728	.26640	.26553	.26463
5500	.27782	.27687	.27592	.27499	.27406	.27316	.27223	.27133	.27045	.26953
	505	503	501	500	498	496	495	493	491	490
5600	.28286	.28190	.28094	.27999	.27904	.27812	.27718	.27626	.27536	.27443
5700	.28791	.28693	.28595	.28498	.28402	.28308	.28212	.28119	.28027	.27933
5800	.29296	.29196	.29096	.28998	.28900	.28804	.28707	.28612	.28518	.28423
5900	.29800	.29699	.29597	.29498	.29398	.29300	.29202	.29105	.29009	.28913
6000	.30305	.30202	.30099	.29997	.29896	.29796	.29697	.29598	.29500	.29402
	505	503	501	500	498	496	495	493	491	490
6100	.30810	.30705	.30601	.30497	.30394	.30293	.30192	.30091	.29992	.29892
6200	.31314	.31208	.31102	.30997	.30892	.30789	.30687	.30584	.30483	.30382
6300	.31818	.31711	.31603	.31497	.31390	.31285	.31182	.31077	.30974	.30872
6400	.32323	.32214	.32104	.31997	.31888	.31781	.31677	.31570	.31465	.31362
6500	.32828	.32717	.32605	.32497	.32385	.32277	.32171	.32062	.31956	.31852
	504	503	501	499	498	496	494	493	491	489
6600	.33332	.33219	.33107	.32996	.32883	.32773	.32665	.32555	.32447	.32341
6700	.33836	.33722	.33608	.33495	.33381	.33269	.33159	.33048	.32938	.32830
6800	.34341	.34225	.34109	.33994	.33878	.33765	.33653	.33540	.33429	.33319
6900	.34846	.34728	.34610	.34493	.34376	.34261	.34147	.34033	.33920	.33808
7000	.35350	.35230	.35111	.34992	.34874	.34757	.34641	.34526	.34411	.34297
	504	503	501	499	498	496	494	493	491	489
7100	.35854	.35733	.35612	.35492	.35372	.35253	.35136	.35019	.34902	.34787
7200	.36359	.36235	.36113	.35991	.35870	.35749	.35630	.35512	.35393	.35276
7300	.36863	.36738	.36614	.36490	.36367	.36245	.36124	.36005	.35884	.35765
7400	.37367	.37240	.37115	.36990	.36865	.36741	.36619	.36498	.36375	.36255
7500	.37872	.37742	.37616	.37489	.37363	.37237	.37113	.36991	.36866	.36744
	504	503	501	499	498	496	494	492	491	489
7600	.38376	.38245	.38116	.37989	.37861	.37733	.37608	.37484	.37357	.37234
7700	.38880	.38748	.38617	.38488	.38358	.38229	.38102	.37976	.37848	.37723
7800	.39384	.39250	.39118	.38987	.38856	.38725	.38596	.38468	.38339	.38212
7900	.39889	.39753	.39614	.39486	.39353	.39221	.39090	.38960	.38830	.38701
8000	.40393	.40256	.40120	.39985	.39851	.39717	.39584	.39452	.39321	.39191
	504	502	501	499	497	496	494	492	491	489
8100	.40897	.40759	.40621	.40484	.40348	.40213	.40078	.39945	.39812	.39681
8200	.41401	.41261	.41121	.40983	.40846	.40708	.40572	.40437	.40303	.40170
8300	.41906	.41763	.41622	.41482	.41343	.41204	.41066	.40929	.40794	.40659
8400	.42410	.42266	.42122	.41980	.41840	.41699	.41560	.41422	.41285	.41148
8500	.42914	.42768	.42623	.42479	.42337	.42195	.42054	.41914	.41775	.41637
	504	502	501	499	497	496	494	492	491	489
8600	.43418	.43271	.43124	.42978	.42834	.42690	.42548	.42406	.42266	.42126
8700	.43922	.43773	.43625	.43477	.43331	.43186	.43042	.42899	.42757	.42615
8800	.44427	.44275	.44125	.43976	.43828	.43681	.43536	.43391	.43247	.43104
8900	.44931	.44778	.44626	.44475	.44325	.44176	.44030	.43883	.43737	.43593
9000	.45435	.45280	.45126	.44973	.44822	.44672	.44523	.44375	.44228	.44082
	504	502	501	499	497	496	494	492	491	489
9100	.45939	.45783	.45627	.45473	.45320	.45168	.45017	.44868	.44719	.44571
9200	.46443	.46285	.46128	.45973	.45817	.45664	.45511	.45360	.45210	.45060
9300	.46947	.46789	.46629	.46472	.46315	.46160	.46006	.45852	.45701	.45549
9400	.47451	.47291	.47130	.46971	.46812	.46656	.46500	.46345	.46192	.46038
9500	.47955	.47794	.47630	.47470	.47310	.47152	.46994	.46837	.46682	.46527
	504	502	501	499	497	496	494	492	491	489
9600	.48459	.48296	.48131	.47969	.47808	.47648	.47488	.47330	.47172	.47016
9700	.48963	.48799	.48631	.48468	.48305	.48144	.47982	.47822	.47663	.47505
9800	.49467	.49301	.49132	.48967	.48803	.48640	.48476	.48314	.48153	.47994
9900	.49971	.49803	.49633	.49466	.49300	.49135	.48970	.48807	.48644	.48483
10000	.50477	.50305	.50134	.49965	.49797	.49630	.49464	.49299	.49135	.48972

	504	503
1	50	50
2	101	101
3	151	151
4	202	201
5	252	252
6	302	302
7	353	352
8	403	402
9	454	453
	501	499
1	50	50
2	100	100
3	150	150
4	200	200
5	251	250
6	301	299
7	351	349
8	401	399
9	451	449
	498	496
1	50	50
2	100	99
3	149	149
4	199	198
5	249	248
6	299	298
7	349	347
8	398	397
9	448	446
	494	492
1	49	49
2	99	98
3	148	148
4	198	197
5	247	246
6	296	295
7	346	344
8	395	394
9	445	443
	491	489
1	49	49
2	98	98
3	147	147
4	196	196
5	246	245
6	295	293
7	344	342
8	393	391
9	442	440

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_1 = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	−60	−59	−58	−57	−56	−55	−54	−53	−52	−51
H 10000	.69430	.69109	.68790	.68474	.68160	.67848	.67538	.67230	.66924	.66620
	693	690	686	683	680	677	673	670	667	664
10100	.70123	.69799	.69476	.69157	.68840	.68525	.68212	.68001	.67592	.67285
10200	.70815	.70489	.70162	.69839	.69520	.69202	.68885	.68671	.68259	.67949
10300	.71508	.71178	.70848	.70522	.70200	.69879	.69558	.69241	.68926	.68614
10400	.72201	.71867	.71534	.71204	.70879	.70555	.70232	.69912	.69593	.69278
10500	.72894	.72556	.72220	.71887	.71559	.71231	.70905	.70582	.70261	.69942
	693	689	686	683	679	676	673	670	667	664
10600	.73586	.73245	.72906	.72569	.72238	.71907	.71578	.71252	.70928	.70607
10700	.74279	.73934	.73592	.73252	.72917	.72583	.72251	.71922	.71595	.71271
10800	.74972	.74623	.74278	.73934	.73596	.73259	.72924	.72592	.72262	.71935
10900	.75664	.75312	.74964	.74617	.74275	.73935	.73597	.73262	.72929	.72599
11000	.76357	.76001	.75649	.75300	.74954	.74611	.74270	.73932	.73596	.73268
	692	689	686	683	679	676	673	670	667	664
11100	.77050	.76691	.76335	.75983	.75634	.75288	.74944	.74603	.74264	.73928
11200	.77742	.77381	.77021	.76665	.76313	.75964	.75617	.75273	.74931	.74592
11300	.78434	.78070	.77707	.77348	.76992	.76640	.76290	.75943	.75598	.75256
11400	.79127	.78759	.78393	.78030	.77672	.77317	.76963	.76613	.76266	.75921
11500	.79820	.79448	.79079	.78713	.78351	.77993	.77636	.77284	.76933	.76585
	692	689	686	683	679	676	673	670	667	664
11600	.80512	.80137	.79765	.79396	.79030	.78669	.78310	.77954	.77601	.77250
11700	.81204	.80826	.80451	.80078	.79710	.79345	.78983	.78624	.78268	.77914
11800	.81897	.81515	.81137	.80761	.80389	.80021	.79656	.79294	.78935	.78579
11900	.82590	.82204	.81823	.81444	.81069	.80697	.80329	.80964	.79602	.79243
12000	.83282	.82893	.82508	.82126	.81748	.81373	.81002	.80634	.80269	.79907
	692	689	686	683	679	676	673	670	667	664
12100	.83974	.83582	.83194	.82809	.82428	.82050	.81676	.81305	.80937	.80571
12200	.84666	.84271	.83880	.83492	.83107	.82726	.82349	.81975	.81604	.81235
12300	.85358	.84960	.84566	.84175	.83786	.83402	.83022	.82645	.82271	.81899
12400	.86050	.85649	.85252	.84858	.84466	.84078	.83695	.83315	.82938	.82563
12500	.86742	.86338	.85938	.85541	.85145	.84755	.84368	.83985	.83605	.83228
	692	689	685	682	679	676	673	670	667	664
12600	.87434	.87027	.86624	.86223	.85825	.85431	.85042	.84656	.84273	.83892
12700	.88126	.87716	.87309	.86905	.86504	.86107	.85715	.85326	.84940	.84556
12800	.88818	.88405	.87994	.87587	.87183	.86784	.86388	.85996	.85607	.85221
12900	.89510	.89093	.88679	.88269	.87863	.87460	.87061	.86666	.86274	.85885
13000	.90202	.89781	.89364	.88951	.88542	.88136	.87734	.87336	.86941	.86549
	692	689	685	682	679	676	673	670	667	664
13100	.90894	.90470	.90050	.89634	.89222	.88812	.88407	.88006	.87608	.87213
13200	.91586	.91159	.90735	.90316	.89901	.89488	.89080	.88676	.88275	.87877
13300	.92278	.91848	.91421	.90998	.90580	.90164	.89753	.89346	.88941	.88541
13400	.92970	.92537	.92106	.91681	.91259	.90840	.90426	.90016	.89608	.89205
13500	.93662	.93226	.92791	.92363	.91938	.91516	.91099	.90686	.90275	.89869
	692	688	685	682	679	676	673	670	667	664
13600	.94354	.93915	.93476	.93045	.92617	.92192	.91772	.91356	.90942	.90533
13700	.95046	.94604	.94162	.93728	.93296	.92868	.92445	.92026	.91609	.91197
13800	.95738	.95292	.94847	.94410	.93975	.93544	.93118	.92696	.92276	.91861
13900	.96430	.95980	.95533	.95092	.94654	.94220	.93790	.93366	.92942	.92525
14000	.97122	.96668	.96219	.95774	.95333	.94896	.94463	.94034	.93609	.93188
	691	688	685	682	679	676	673	670	667	664
14100	.97814	.97357	.96905	.96456	.96013	.95573	.95137	.94705	.94276	.93852
14200	.98505	.98046	.97590	.97138	.96692	.96249	.95810	.95375	.94943	.94516
14300	.99196	.98735	.98276	.97821	.97371	.96925	.96483	.96045	.95610	.95180
14400	.99888	.99424	.98961	.98503	.98050	.97601	.97156	.96715	.96277	.95844
14500	1.00580	1.00112	.99646	.99186	.98729	.98277	.97829	.97385	.96944	.96508
	691	688	685	682	679	676	673	670	667	664
14600	1.01271	1.00800	1.00331	.99868	.99408	.98953	.98502	.98055	.97611	.97172
14700	1.01962	1.01488	1.01017	1.00550	1.00087	.99629	.99175	.98725	.98278	.97836
14800	1.02654	1.02176	1.01702	1.01232	1.00766	1.00305	.99848	.99395	.98945	.98500
14900	1.03346	1.02864	1.02387	1.01914	1.01445	1.00981	1.00521	1.00065	.99612	.99164
15000	1.04037	1.03552	1.03072	1.02596	1.02124	1.01657	1.01194	1.00735	1.00279	.99827

	692	689
1	69	69
2	138	138
3	208	207
4	277	276
5	346	345
6	415	413
7	484	482
8	554	551
9	623	620
	685	682
1	69	68
2	137	136
3	206	205
4	274	273
5	343	341
6	411	409
7	480	477
8	548	546
9	617	614
	679	676
1	68	68
2	136	135
3	204	203
4	272	270
5	340	338
6	407	406
7	475	473
8	543	541
9	611	608
	673	670
1	67	67
2	135	134
3	202	201
4	269	268
5	337	335
6	404	402
7	471	469
8	538	536
9	606	603
	667	664
1	67	66
2	133	133
3	200	199
4	267	266
5	334	332
6	400	398
7	467	465
8	534	531
9	600	598

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1$

T	−50	−49	−48	−47	−46	−45	−44	−43	−42	−41
H 10000	.66318	.66023	.65730	.65440	.65152	.64866	.64583	.64302	.64023	.63746
	662	659	656	653	650	647	644	641	639	636
10100	.66980	.66682	.66386	.66093	.65802	.65513	.65227	.64944	.64662	.64382
10200	.67641	.67341	.67042	.66746	.66451	.66160	.65870	.65585	.65300	.65018
10300	.68302	.68000	.67698	.67399	.67101	.66807	.66514	.66226	.65939	.65654
10400	.68964	.68659	.68354	.68052	.67750	.67454	.67158	.66868	.66577	.66290
10500	.69626	.69317	.69009	.68704	.68400	.68100	.67802	.67509	.67216	.66926
	661	658	655	652	650	647	644	641	639	636
10600	.70287	.69975	.69664	.69356	.69049	.68747	.68446	.68150	.67854	.67562
10700	.70948	.70633	.70319	.70008	.69699	.69393	.69090	.68791	.68493	.68198
10800	.71610	.71291	.70974	.70660	.70349	.70040	.69734	.69432	.69131	.68834
10900	.72272	.71949	.71629	.71312	.70998	.70686	.70378	.70073	.69770	.69470
11000	.72933	.72607	.72284	.71964	.71647	.71333	.71022	.70714	.70408	.70105
	661	658	655	652	650	647	644	641	639	636
11100	.73594	.73265	.72940	.72617	.72297	.71980	.71667	.71356	.71047	.70741
11200	.74256	.73924	.73595	.73269	.72947	.72627	.72311	.71997	.71686	.71377
11300	.74918	.74583	.74251	.73922	.73597	.73274	.72955	.72638	.72325	.72013
11400	.75579	.75241	.74906	.74575	.74246	.73921	.73599	.73280	.72964	.72649
11500	.76240	.75900	.75562	.75228	.74896	.74568	.74243	.73921	.73602	.73285
	661	658	655	652	650	647	644	641	639	636
11600	.76902	.76559	.76217	.75881	.75545	.75215	.74887	.74563	.74240	.73921
11700	.77564	.77217	.76873	.76533	.76195	.75862	.75532	.75204	.74879	.74557
11800	.78225	.77876	.77529	.77186	.76845	.76509	.76176	.75846	.75517	.75193
11900	.78886	.78534	.78184	.77839	.77495	.77156	.76820	.76487	.76156	.75829
12000	.79548	.79192	.78840	.78491	.78145	.77803	.77464	.77128	.76795	.76465
	661	658	655	652	650	647	644	641	638	636
12100	.80209	.79850	.79495	.79143	.78795	.78449	.78108	.77769	.77434	.77101
12200	.80870	.80509	.80150	.79796	.79444	.79096	.78752	.78410	.78072	.77736
12300	.81532	.81167	.80806	.80448	.80093	.79742	.79396	.79051	.78710	.78372
12400	.82193	.81826	.81461	.81100	.80743	.80389	.80039	.79692	.79349	.79007
12500	.82854	.82484	.82117	.81753	.81392	.81035	.80683	.80333	.79989	.79643
	661	658	655	652	650	647	644	641	638	636
12600	.83515	.83142	.82772	.82405	.82042	.81682	.81327	.80974	.80625	.80278
12700	.84176	.83800	.83427	.83058	.82691	.82328	.81970	.81615	.81264	.80914
12800	.84838	.84458	.84082	.83710	.83340	.82975	.82614	.82256	.81902	.81549
12900	.85499	.85116	.84737	.84362	.83990	.83622	.83257	.82897	.82540	.82185
13000	.86160	.85774	.85392	.85014	.84639	.84268	.83901	.83538	.83178	.82821
	661	658	655	652	650	647	644	641	638	636
13100	.86821	.86432	.86048	.85667	.85289	.84915	.84546	.84179	.83817	.83456
13200	.87482	.87090	.86703	.86319	.85938	.85562	.85190	.84821	.84455	.84092
13300	.88143	.87748	.87359	.86972	.86587	.86209	.85834	.85462	.85094	.84728
13400	.88804	.88407	.88014	.87625	.87237	.86856	.86478	.86104	.85732	.85363
13500	.89465	.89065	.88669	.88277	.87887	.87503	.87122	.86745	.86370	.85999
	661	658	655	652	650	647	644	641	638	636
13600	.90126	.89723	.89325	.88930	.88537	.88150	.87767	.87385	.87009	.86634
13700	.90787	.90381	.89980	.89582	.89187	.88797	.88411	.88026	.87647	.87270
13800	.91448	.91039	.90635	.90235	.89837	.89444	.89055	.88668	.88285	.87906
13900	.92109	.91697	.91290	.90887	.90487	.90091	.89699	.89309	.88923	.88542
14000	.92770	.92356	.91946	.91540	.91137	.90738	.90343	.89951	.89562	.89177
	661	658	655	652	649	647	644	641	638	635
14100	.93431	.93014	.92601	.92192	.91786	.91385	.90987	.90592	.90200	.89813
14200	.94092	.93672	.93256	.92844	.92435	.92031	.91631	.91233	.90838	.90448
14300	.94752	.94330	.93911	.93496	.93085	.92678	.92275	.91873	.91476	.91083
14400	.95413	.94988	.94566	.94148	.93734	.93324	.92919	.92514	.92114	.91718
14500	.96074	.95645	.95221	.94800	.94384	.93971	.93562	.93154	.92752	.92353
	661	658	655	652	649	646	643	641	638	635
14600	.96735	.96303	.95876	.95452	.95033	.94617	.94205	.93795	.93390	.92988
14700	.97396	.96961	.96531	.96104	.95682	.95263	.94848	.94435	.94028	.93623
14800	.98056	.97618	.97186	.96756	.96331	.95909	.95491	.95076	.94666	.94258
14900	.98717	.98276	.97841	.97408	.96980	.96555	.96134	.95716	.95304	.94893
15000	.99378	.98934	.98495	.98060	.97629	.97201	.96777	.96357	.95941	.95528

	661	658
1	66	66
2	132	132
3	198	197
4	264	263
5	331	329
6	397	395
7	463	461
8	529	526
9	595	592
	655	652
1	66	65
2	131	130
3	197	196
4	262	261
5	328	326
6	393	391
7	459	456
8	524	522
9	590	587
	650	647
1	65	65
2	130	129
3	195	194
4	260	259
5	325	324
6	390	388
7	455	453
8	520	518
9	585	582
	644	641
1	64	64
2	129	128
3	193	192
4	258	256
5	322	321
6	386	385
7	451	449
8	515	513
9	580	577
	638	636
1	64	64
2	128	127
3	191	191
4	255	254
5	319	318
6	383	382
7	447	445
8	510	509
9	574	572

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	—40	—39	—38	—37	—36	—35	—34	—33	—32	—31
H 10000	.63471	.63200	.62932	.62666	.62402	.62140	.61880	.61622	.61366	.61112
	633	631	628	625	623	620	617	615	612	610
10100	.64104	.63831	.63560	.63292	.63025	.62760	.62498	.62237	.61979	.61722
10200	.64738	.64462	.64188	.63917	.63648	.63380	.63115	.62852	.62591	.62332
10300	.65371	.65093	.64816	.64542	.64270	.64000	.63732	.63467	.63203	.62942
10400	.66005	.65724	.65444	.65167	.64892	.64619	.64349	.64082	.63815	.63552
10500	.66638	.66354	.66072	.65792	.65514	.65239	.64966	.64696	.64427	.64161
	633	631	628	625	623	620	617	615	612	610
10600	.67271	.66985	.66700	.66417	.66136	.65859	.65584	.65311	.65040	.64771
10700	.67905	.67615	.67328	.67042	.66759	.66479	.66201	.65925	.65652	.65381
10800	.68538	.68246	.67956	.67667	.67381	.67099	.66818	.66540	.66264	.65991
10900	.69172	.68876	.68584	.68292	.68004	.67718	.67435	.67154	.66876	.66601
11000	.69805	.69507	.69211	.68917	.68626	.68338	.68052	.67769	.67488	.67210
	633	631	628	625	623	620	617	615	612	610
11100	.70438	.70138	.69839	.69543	.69249	.68959	.68669	.68385	.68101	.67820
11200	.71072	.70768	.70467	.70168	.69872	.69579	.69287	.69000	.68713	.68430
11300	.71705	.71399	.71095	.70794	.70495	.70199	.69905	.69615	.69325	.69040
11400	.72338	.72029	.71723	.71419	.71118	.70820	.70523	.70230	.69938	.69650
11500	.72972	.72660	.72351	.72045	.71741	.71440	.71140	.70845	.70551	.70259
	633	631	628	625	623	620	617	615	612	610
11600	.73605	.73290	.72979	.72670	.72364	.72060	.71758	.71460	.71163	.70869
11700	.74238	.73921	.73607	.73296	.72987	.72680	.72376	.72075	.71776	.71479
11800	.74871	.74552	.74235	.73921	.73609	.73300	.72994	.72690	.72388	.72089
11900	.75505	.75182	.74863	.74547	.74232	.73921	.73612	.73305	.73001	.72699
12000	.76138	.75813	.75491	.75172	.74855	.74541	.74229	.73920	.73613	.73309
	633	630	628	625	622	620	617	615	612	610
12100	.76771	.76444	.76118	.75797	.75478	.75161	.74846	.74535	.74225	.73919
12200	.77404	.77074	.76746	.76422	.76100	.75781	.75463	.75150	.74837	.74529
12300	.78037	.77704	.77373	.77047	.76722	.76400	.76080	.75765	.75449	.75138
12400	.78670	.78335	.77991	.77672	.77345	.77020	.76697	.76380	.76061	.75748
12500	.79302	.78965	.78628	.78296	.77967	.77639	.77314	.76994	.76673	.76357
	633	630	628	625	622	620	617	614	612	609
12600	.79935	.79595	.79255	.78921	.78589	.78258	.77931	.77608	.77285	.76967
12700	.80568	.80225	.79883	.79546	.79211	.78878	.78548	.78222	.77897	.77576
12800	.81201	.80855	.80510	.80171	.79833	.79497	.79165	.78836	.78509	.78185
12900	.81834	.81485	.81138	.80796	.80455	.80117	.79782	.79450	.79121	.78794
13000	.82467	.82115	.81766	.81420	.81077	.80737	.80399	.80064	.79732	.79403
	633	630	627	625	622	619	617	614	612	609
13100	.83100	.82745	.82394	.82045	.81699	.81357	.81016	.80679	.80344	.80013
13200	.83732	.83375	.83021	.82670	.82321	.81976	.81633	.81293	.80956	.80622
13300	.84365	.84005	.83648	.83295	.82943	.82595	.82250	.81908	.81568	.81232
13400	.84998	.84635	.84276	.83920	.83565	.83214	.82867	.82522	.82180	.81841
13500	.85630	.85265	.84903	.84545	.84187	.83833	.83483	.83136	.82791	.82450
	633	630	627	624	622	619	617	614	612	609
13600	.86263	.85895	.85530	.85169	.84809	.84453	.84100	.83750	.83403	.83059
13700	.86896	.86525	.86157	.85793	.85431	.85072	.84716	.84364	.84014	.83668
13800	.87528	.87155	.86784	.86417	.86053	.85691	.85333	.84978	.84626	.84277
13900	.88161	.87785	.87411	.87041	.86674	.86310	.85950	.85592	.85238	.84886
14000	.88794	.88414	.88038	.87665	.87295	.86929	.86566	.86206	.85849	.85495
	632	630	627	624	622	619	617	614	612	609
14100	.89426	.89044	.88665	.88290	.87917	.87549	.87183	.86820	.86461	.86104
14200	.90059	.89673	.89292	.88914	.88539	.88168	.87800	.87434	.87073	.86713
14300	.90691	.90303	.89919	.89539	.89161	.88787	.88417	.88048	.87685	.87322
14400	.91324	.90933	.90546	.90163	.89783	.89407	.89034	.88662	.88297	.87931
14500	.91956	.91563	.91173	.90787	.90404	.90026	.89651	.89276	.88908	.88540
	632	630	627	624	622	619	616	614	611	609
14600	.92588	.92192	.91800	.91412	.91026	.90645	.90268	.89890	.89519	.89149
14700	.93221	.92822	.92427	.92036	.91648	.91264	.90884	.90504	.90130	.89758
14800	.93853	.93451	.93054	.92660	.92270	.91883	.91500	.91118	.90741	.90367
14900	.94486	.94081	.93681	.93285	.92891	.92502	.92116	.91732	.91352	.90976
15000	.95118	.94711	.94308	.93909	.93513	.93121	.92732	.92346	.91963	.91584

	633	630
1	63	63
2	127	126
3	190	189
4	253	252
5	317	315
6	380	378
7	443	441
8	506	504
9	570	567

	628	625
1	63	63
2	126	125
3	188	188
4	251	250
5	314	313
6	377	375
7	440	438
8	502	500
9	565	563

	622	620
1	62	62
2	124	124
3	187	186
4	249	248
5	311	310
6	373	372
7	435	434
8	498	496
9	560	558

	617	614
1	62	61
2	123	123
3	185	184
4	247	246
5	309	307
6	370	368
7	432	430
8	494	491
9	555	553

	612	609
1	61	61
2	122	122
3	184	183
4	245	244
5	306	305
6	367	365
7	428	426
8	490	487
9	551	548

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m + \gamma m_1.$

T	−30	−29	−28	−27	−26	−25	−24	−23	−22	−21
H 10000	.60861	.60612	.60365	.60120	.59877	.59635	.59395	.59157	.58921	.58688
	607	605	602	600	597	595	593	591	588	586
10100	.61468	.61217	.60968	.60720	.60475	.60230	.59988	.59748	.59510	.59274
10200	.62076	.61822	.61570	.61320	.61072	.60825	.60581	.60339	.60098	.59860
10300	.62683	.62427	.62173	.61920	.61669	.61420	.61173	.60930	.60686	.60445
10400	.63290	.63032	.62775	.62520	.62267	.62015	.61766	.61521	.61274	.61031
10500	.63898	.63636	.63377	.63119	.62864	.62610	.62359	.62111	.61862	.61617
	607	605	602	600	597	595	593	590	588	586
10600	.64505	.64241	.63979	.63719	.63461	.63205	.62952	.62701	.62450	.62203
10700	.65112	.64846	.64582	.64319	.64058	.63800	.63544	.63291	.63038	.62789
10800	.65719	.65451	.65184	.64919	.64655	.64395	.64137	.63881	.63626	.63375
10900	.66327	.66056	.65786	.65519	.65252	.64990	.64729	.64471	.64214	.63960
11000	.66934	.66660	.66388	.66118	.65850	.65585	.65322	.65061	.64802	.64545
	607	605	602	600	597	595	593	590	588	586
11100	.67541	.67265	.66990	.66718	.66448	.66180	.65914	.65652	.65390	.65131
11200	.68149	.67870	.67593	.67318	.67045	.66775	.66507	.66242	.65978	.65717
11300	.68756	.68475	.68195	.67918	.67642	.67370	.67099	.66832	.66566	.66303
11400	.69363	.69080	.68798	.68518	.68240	.67965	.67692	.67423	.67154	.66889
11500	.69970	.69685	.69400	.69117	.68837	.68560	.68285	.68013	.67742	.67475
	607	605	602	600	597	595	593	590	588	585
11600	.70578	.70290	.70002	.69717	.69435	.69155	.68877	.68603	.68330	.68060
11700	.71185	.70895	.70605	.70317	.70032	.69750	.69470	.69193	.68917	.68645
11800	.71792	.71499	.71207	.70917	.70629	.70345	.70062	.69783	.69505	.69230
11900	.72400	.72104	.71809	.71517	.71227	.70940	.70655	.70373	.70092	.69815
12000	.73007	.72708	.72411	.72116	.71824	.71535	.71248	.70963	.70680	.70400
	607	605	602	600	597	595	593	590	588	585
12100	.73614	.73313	.73013	.72716	.72422	.72130	.71841	.71554	.71268	.70986
12200	.74221	.73917	.73615	.73315	.73019	.72725	.72434	.72144	.71856	.71571
12300	.74828	.74522	.74217	.73915	.73616	.73320	.73027	.72734	.72443	.72156
12400	.75435	.75127	.74819	.74515	.74214	.73915	.73620	.73324	.73031	.72742
12500	.76042	.75732	.75421	.75114	.74811	.74510	.74213	.73914	.73619	.73327
	607	604	602	600	597	595	592	590	588	585
12600	.76648	.76336	.76023	.75714	.75408	.75105	.74805	.74504	.74207	.73912
12700	.77255	.76940	.76625	.76314	.76006	.75700	.75397	.75094	.74794	.74498
12800	.77862	.77544	.77227	.76913	.76603	.76295	.75989	.75684	.75382	.75083
12900	.78469	.78148	.77829	.77513	.77200	.76890	.76581	.76274	.75970	.75668
13000	.79076	.78752	.78431	.78113	.77797	.77484	.77173	.76864	.76558	.76254
	607	604	602	600	597	595	592	590	588	585
13100	.79683	.79356	.79033	.78713	.78395	.78079	.77766	.77454	.77146	.76840
13200	.80290	.79961	.79635	.79313	.78992	.78674	.78358	.78044	.77734	.77425
13300	.80896	.80565	.80237	.79913	.79589	.79269	.78950	.78633	.78321	.78010
13400	.81503	.81170	.80839	.80513	.80186	.79864	.79543	.79223	.78909	.78595
13500	.82110	.81774	.81441	.81113	.80783	.80459	.80135	.79813	.79497	.79180
	607	604	602	599	597	594	592	590	587	585
13600	.82717	.82378	.82043	.81712	.81380	.81055	.80727	.80403	.80084	.79765
13700	.83324	.82983	.82645	.82311	.81977	.81649	.81319	.80993	.80671	.80350
13800	.83930	.83587	.83247	.82910	.82571	.82243	.81911	.81582	.81258	.80935
13900	.84537	.84192	.83849	.83509	.83171	.82837	.82503	.82172	.81845	.81520
14000	.85144	.84796	.84451	.84108	.83768	.83430	.83095	.82762	.82432	.82105
	606	604	602	599	597	594	592	590	587	585
14100	.85750	.85400	.85053	.84707	.84365	.84025	.83687	.83352	.83020	.82691
14200	.86357	.86004	.85654	.85306	.84962	.84619	.84279	.83941	.83607	.83276
14300	.86963	.86607	.86256	.85905	.85559	.85213	.84871	.84531	.84194	.83861
14400	.87570	.87211	.86858	.86504	.86156	.85807	.85463	.85121	.84782	.84446
14500	.88176	.87815	.87459	.87103	.86753	.86401	.86055	.85711	.85369	.85031
	606	604	601	599	596	594	592	590	587	585
14600	.88782	.88419	.88060	.87702	.87349	.86995	.86647	.86300	.85957	.85616
14700	.89389	.89022	.88661	.88301	.87945	.87590	.87239	.86890	.86544	.86201
14800	.89995	.89626	.89262	.88900	.88541	.88184	.87830	.87480	.87132	.86786
14900	.90602	.90230	.89863	.89499	.89137	.88778	.88422	.88069	.87719	.87371
15000	.91208	.90834	.90464	.90097	.89733	.89372	.89014	.88659	.88306	.87956

	607	604
1	61	60
2	121	121
3	182	181
4	243	242
5	304	302
6	364	362
7	425	423
8	486	483
9	546	544

	602	600
1	60	60
2	120	120
3	181	180
4	241	240
5	301	300
6	361	360
7	421	420
8	482	480
9	542	540

	597	595
1	60	60
2	119	119
3	179	179
4	239	238
5	299	298
6	358	357
7	418	417
8	478	476
9	537	536

	592	590
1	59	59
2	118	118
3	178	177
4	237	236
5	296	295
6	355	354
7	414	413
8	474	472
9	533	531

	588	585
1	59	59
2	118	117
3	176	176
4	235	234
5	294	293
6	353	351
7	412	410
8	470	468
9	529	527

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$

$\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$
$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$

$m_1 = m - \beta m - \gamma m.$
$m = m_1 + \beta m_1 + \gamma m_1.$

T	−20	−19	−18	−17	−16	−15	−14	−13	−12	−11
H 10000	.58456	.58227	.58000	.57774	.57549	.57326	.57105	.56885	.56666	.56449
	583	581	579	577	575	572	570	568	566	564
10100	.59039	.58809	.58579	.58351	.58124	.57899	.57675	.57453	.57232	.57013
10200	.59623	.59390	.59158	.58928	.58699	.58471	.58245	.58021	.57797	.57577
10300	.60206	.59971	.59737	.59505	.59274	.59043	.58815	.58589	.58363	.58141
10400	.60790	.60552	.60316	.60082	.59849	.59616	.59385	.59157	.58928	.58705
10500	.61373	.61133	.60894	.60659	.60423	.60188	.59955	.59724	.59494	.59268
	583	581	579	576	574	572	570	568	566	563
10600	.61956	.61714	.61473	.61236	.60997	.60760	.60525	.60292	.60059	.59831
10700	.62540	.62295	.62051	.61812	.61571	.61332	.61095	.60860	.60625	.60394
10800	.63123	.62876	.62630	.62388	.62145	.61904	.61665	.61428	.61191	.60957
10900	.63707	.63457	.63209	.62964	.62719	.62476	.62235	.61996	.61756	.61520
11000	.64290	.64038	.63788	.63540	.63293	.63048	.62805	.62563	.62322	.62083
	583	581	579	576	574	572	570	567	565	563
11100	.64873	.64619	.64367	.64117	.63867	.63620	.63375	.63131	.62887	.62647
11200	.65456	.65200	.64946	.64693	.64441	.64192	.63945	.63698	.63453	.63210
11300	.66040	.65781	.65525	.65269	.65015	.64764	.64515	.64265	.64018	.63774
11400	.66623	.66362	.66104	.65845	.65589	.65336	.65085	.64833	.64584	.64337
11500	.67206	.66943	.66682	.66421	.66163	.65907	.65655	.65400	.65149	.64900
	583	581	578	576	574	572	569	567	565	563
11600	.67789	.67524	.67260	.66997	.66737	.66479	.66224	.65968	.65714	.65463
11700	.68372	.68105	.67838	.67573	.67311	.67050	.66793	.66535	.66280	.66026
11800	.68956	.68686	.68416	.68149	.67885	.67622	.67362	.67103	.66845	.66589
11900	.69539	.69267	.68994	.68725	.68459	.68193	.67931	.67670	.67410	.67152
12000	.70122	.69846	.69572	.69301	.69032	.68765	.68500	.68237	.67975	.67715
	583	581	578	576	574	572	569	567	565	563
12100	.70705	.70427	.70151	.69877	.69606	.69337	.69070	.68804	.68540	.68278
12200	.71288	.71007	.70729	.70453	.70179	.69908	.69639	.69371	.69105	.68841
12300	.71871	.71588	.71308	.71029	.70753	.70479	.70199	.69938	.69670	.69404
12400	.72454	.72168	.71886	.71605	.71327	.71051	.70768	.70505	.70235	.69967
12500	.73037	.72749	.72464	.72181	.71900	.71623	.71337	.71072	.70800	.70530
	583	581	578	576	574	572	569	567	565	563
12600	.73620	.73329	.73043	.72757	.72474	.72194	.71905	.71639	.71365	.71093
12700	.74203	.73910	.73621	.73333	.73047	.72765	.72474	.72206	.71930	.71656
12800	.74786	.74491	.74199	.73909	.73611	.73336	.73043	.72773	.72495	.72219
12900	.75369	.75071	.74777	.74485	.74195	.73907	.73612	.73340	.73060	.72782
13000	.75952	.75652	.75355	.75060	.74768	.74478	.74191	.73907	.73625	.73345
	583	581	578	576	574	572	569	567	565	563
13100	.76535	.76233	.75933	.75636	.75842	.75050	.74761	.74475	.74191	.73908
13200	.77118	.76814	.76511	.76213	.75916	.75622	.75330	.75042	.74756	.74471
13300	.77700	.77395	.77089	.76789	.76490	.76194	.75900	.75610	.75321	.75034
13400	.78283	.77976	.77668	.77365	.77064	.76766	.76479	.76177	.75886	.75597
13500	.78866	.78557	.78247	.77941	.77638	.77337	.77049	.76744	.76451	.76160
	583	580	578	576	574	572	569	567	565	563
13600	.79449	.79138	.78825	.78518	.78212	.77909	.77618	.77311	.77016	.76723
13700	.80032	.79718	.79405	.79094	.78786	.78481	.78188	.77879	.77581	.77286
13800	.80614	.80298	.79983	.79670	.79360	.79053	.78757	.78446	.78146	.77849
13900	.81197	.80878	.80561	.80246	.79934	.79625	.79327	.79013	.78711	.78411
14000	.81780	.81458	.81139	.80822	.80508	.80196	.79887	.79580	.79276	.78974
	583	580	578	576	574	572	569	567	565	563
14100	.82363	.82039	.81718	.81398	.81082	.80768	.80457	.80148	.79841	.79537
14200	.82946	.82619	.82296	.81974	.81656	.81340	.81026	.80715	.80406	.80100
14300	.83528	.83200	.82874	.82550	.82230	.81912	.81596	.81282	.80971	.80663
14400	.84111	.83780	.83452	.83126	.82804	.82484	.82165	.81849	.81536	.81226
14500	.84694	.84361	.84030	.83702	.83377	.83056	.82734	.82416	.82101	.81788
	583	580	578	576	574	571	569	567	565	563
14600	.85277	.84941	.84609	.84278	.83951	.83628	.83303	.82983	.82666	.82351
14700	.85860	.85522	.85187	.84854	.84525	.84199	.83873	.83550	.83231	.82913
14800	.86442	.86102	.85765	.85430	.85099	.84770	.84442	.84117	.83796	.83476
14900	.87025	.86682	.86343	.86006	.85673	.85341	.85011	.84684	.84361	.84038
15000	.87608	.87263	.86921	.86582	.86246	.85912	.85580	.85251	.84925	.84601

	583	581
1	58	58
2	117	116
3	175	174
4	233	232
5	292	291
6	350	349
7	408	407
8	466	465
9	525	523
	578	576
1	58	58
2	116	115
3	173	173
4	231	230
5	289	288
6	347	346
7	405	403
8	462	461
9	520	518
	574	572
1	57	57
2	115	114
3	172	172
4	230	229
5	287	286
6	344	343
7	402	400
8	459	458
9	517	515
	569	567
1	57	57
2	114	113
3	171	170
4	228	227
5	288	284
6	341	340
7	398	397
8	455	454
9	512	510
	565	563
1	57	56
2	113	113
3	170	169
4	226	225
5	283	282
6	339	338
7	396	394
8	452	450
9	509	507

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	−10	−9	−8	−7	−6	−5	−4	−3	−2	−1
H 10000	.56234	.56022	.55811	.55601	.55393	.55186	.54981	.54777	.54575	.54374
	561	559	557	555	553	551	549	547	545	543
10100	.56795	.56581	.56368	.56156	.55946	.55737	.55530	.55324	.55120	.54917
10200	.57356	.57140	.56925	.56711	.56499	.56288	.56078	.55871	.55665	.55459
10300	.57918	.57699	.57482	.57266	.57052	.56839	.56627	.56418	.56200	.56002
10400	.58479	.58258	.58039	.57821	.57605	.57390	.57176	.56965	.56744	.56544
10500	.59040	.58817	.58595	.58376	.58157	.57940	.57725	.57511	.57288	.57087
	561	559	557	555	553	551	549	547	545	543
10600	.59601	.59376	.59152	.58931	.58710	.58491	.58274	.58057	.57832	.57629
10700	.60162	.59935	.59709	.59486	.59262	.59041	.58822	.58604	.58377	.58172
10800	.60724	.60494	.60266	.60041	.59815	.59592	.59371	.59150	.58922	.58714
10900	.61285	.61053	.60823	.60596	.60368	.60143	.59920	.59697	.59466	.59257
11000	.61846	.61612	.61380	.61150	.60921	.60694	.60468	.60244	.60021	.59800
	561	559	557	555	553	551	549	547	545	543
11100	.62407	.62171	.61937	.61705	.61473	.61244	.61017	.60790	.60566	.60342
11200	.62968	.62730	.62493	.62259	.62026	.61795	.61565	.61336	.61110	.60885
11300	.63529	.63289	.63050	.62813	.62578	.62345	.62113	.61883	.61654	.61427
11400	.64090	.63848	.63607	.63368	.63131	.62895	.62662	.62429	.62199	.61970
11500	.64652	.64407	.64164	.63922	.63683	.63446	.63210	.62975	.62743	.62512
	561	559	557	555	553	551	549	547	545	543
11600	.65213	.64966	.64721	.64476	.64235	.63997	.63759	.63522	.63287	.63054
11700	.65774	.65525	.65277	.65031	.64788	.64547	.64307	.64068	.63831	.63597
11800	.66335	.66083	.65834	.65585	.65340	.65097	.64855	.64614	.64375	.64139
11900	.66896	.66642	.66390	.66140	.65892	.65647	.65403	.65161	.64920	.64682
12000	.67457	.67201	.66947	.66695	.66445	.66197	.65951	.65707	.65465	.65225
	561	559	557	555	553	551	549	547	545	543
12100	.68018	.67760	.67504	.67250	.66998	.66748	.66500	.66254	.66010	.65768
12200	.68579	.68319	.68061	.67805	.67551	.67299	.67049	.66800	.66555	.66310
12300	.69140	.68878	.68618	.68360	.68104	.67850	.67598	.67347	.67100	.66852
12400	.69701	.69437	.69175	.68915	.68657	.68401	.68147	.67894	.67645	.67395
12500	.70262	.69996	.69732	.69470	.69210	.68952	.68696	.68441	.68189	.67938
	561	559	557	555	553	551	549	547	545	543
12600	.70823	.70555	.70289	.70025	.69763	.69503	.69245	.68987	.68733	.68480
12700	.71384	.71114	.70846	.70580	.70316	.70054	.69794	.69534	.69278	.69023
12800	.71945	.71673	.71403	.71135	.70869	.70605	.70342	.70081	.69823	.69566
12900	.72506	.72232	.71960	.71690	.71422	.71156	.70891	.70628	.69367	.70108
13000	.73067	.72791	.72517	.72245	.71975	.71707	.71440	.71175	.70912	.70651
	561	559	557	555	553	551	549	547	545	543
13100	.73628	.73350	.73074	.72799	.72528	.72258	.71988	.71721	.71456	.71194
13200	.74188	.73909	.73630	.73354	.73080	.72808	.72537	.72268	.72001	.71737
13300	.74749	.74468	.74187	.73909	.73633	.73359	.73086	.72814	.72546	.72280
13400	.75310	.75026	.74743	.74464	.74185	.73910	.73634	.73361	.73090	.72823
13500	.75870	.75585	.75300	.75018	.74738	.74460	.74183	.73908	.73634	.73365
	561	559	557	555	553	551	549	547	545	542
13600	.76431	.76144	.75856	.75572	.75290	.75011	.74731	.74454	.74178	.73907
13700	.76992	.76703	.76413	.76127	.75843	.75561	.75280	.75001	.74723	.74449
13800	.77553	.77261	.76970	.76681	.76395	.76112	.75828	.75548	.75267	.75991
13900	.78113	.77819	.77526	.77236	.76948	.76662	.76377	.76094	.75812	.75533
14000	.78674	.78377	.78083	.77791	.77501	.77213	.76926	.76641	.76357	.76075
	561	559	556	554	552	550	548	546	544	542
14100	.79235	.78936	.78640	.78345	.78053	.77762	.77474	.77187	.76901	.76617
14200	.79795	.79495	.79196	.78899	.78605	.78312	.78021	.77732	.77445	.77159
14300	.80356	.80054	.79752	.79453	.79157	.78862	.78569	.78278	.77989	.77701
14400	.80916	.80612	.80308	.80007	.79708	.79412	.79116	.78824	.78533	.78243
14500	.81477	.81171	.80865	.80561	.80260	.79962	.79664	.79370	.79077	.78785
	561	558	556	554	552	550	548	546	544	542
14600	.82038	.81729	.81421	.81115	.80812	.80512	.80211	.79915	.79620	.79327
14700	.82598	.82287	.81977	.81669	.81364	.81061	.80759	.80461	.80164	.79869
14800	.83159	.82845	.82533	.82223	.81915	.81611	.81307	.81006	.80707	.80411
14900	.83719	.83403	.83189	.82777	.82467	.82160	.81855	.81552	.81251	.80953
15000	.84280	.83961	.83645	.83331	.83019	.82710	.82403	.82098	.81795	.81494

	561	559
1	56	56
2	112	112
3	168	168
4	224	224
5	281	280
6	337	335
7	393	391
8	449	447
9	505	503
	557	555
1	56	56
2	111	111
3	167	167
4	223	222
5	279	278
6	334	333
7	390	389
8	446	444
9	501	500
	553	551
1	55	55
2	111	110
3	166	165
4	221	220
5	277	276
6	332	331
7	387	386
8	442	441
9	498	496
	549	547
1	55	55
2	110	109
3	165	164
4	220	219
5	275	274
6	329	328
7	384	383
8	439	438
9	494	492
	545	543
1	55	54
2	109	109
3	164	163
4	218	217
5	273	272
6	327	326
7	382	380
8	436	434
9	491	489

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	0	1	2	3	4	5	6	7	8	9
H 10000	.54174	.53976	.53780	.53585	.53392	.53200	.53009	.52820	.52632	.52445
	541	539	537	535	533	531	529	527	525	524
10100	.54715	.54515	.54317	.54120	.53925	.53731	.53538	.53348	.53158	.52969
10200	.55255	.55054	.54854	.54655	.54458	.54262	.54068	.53875	.53683	.53492
10300	.55796	.55593	.55391	.55190	.54991	.54793	.54597	.54403	.54209	.54016
10400	.56337	.56131	.55928	.55725	.55524	.55324	.55126	.54930	.54734	.54540
10500	.56878	.56670	.56464	.56260	.56056	.55854	.55655	.55457	.55260	.55063
	541	539	537	535	533	531	529	527	525	524
10600	.57418	.57208	.57001	.56794	.56589	.56385	.56184	.55984	.55785	.55587
10700	.57959	.57747	.57537	.57329	.57122	.56916	.56713	.56511	.56311	.56110
10800	.58500	.58286	.58074	.57864	.57655	.57447	.57242	.57038	.56836	.56634
10900	.59040	.58825	.58610	.58399	.58187	.57978	.57771	.57565	.57361	.57158
11000	.59581	.59363	.59147	.58933	.58720	.58509	.58300	.58092	.57886	.57681
	541	539	537	535	533	531	529	527	525	524
11100	.60122	.59902	.59684	.59468	.59254	.59041	.58830	.58620	.58412	.58205
11200	.60662	.60440	.60220	.60003	.59787	.59572	.59359	.59147	.58937	.58729
11300	.61203	.60978	.60757	.60538	.60320	.60104	.59888	.59674	.59462	.59253
11400	.61743	.61517	.61294	.61073	.60853	.60635	.60418	.60201	.59988	.59777
11500	.62284	.62056	.61831	.61608	.61386	.61166	.60947	.60728	.60513	.60301
	541	539	537	535	533	531	529	527	525	523
11600	.62825	.62595	.62368	.62143	.61919	.61697	.61477	.61256	.61039	.60824
11700	.63365	.63134	.62905	.62678	.62452	.62228	.62006	.61783	.61564	.61347
11800	.63906	.63673	.63442	.63213	.62985	.62759	.62535	.62311	.62090	.61860
11900	.64446	.64211	.63979	.63748	.63518	.63290	.63064	.62839	.62615	.62393
12000	.64987	.64750	.64515	.64282	.64051	.63821	.63593	.63366	.63140	.62916
	541	539	537	535	533	531	529	527	525	523
12100	.65528	.65289	.65052	.64817	.64584	.64352	.64122	.63893	.63666	.63440
12200	.66068	.65828	.65589	.65352	.65117	.64883	.64651	.64420	.64191	.63963
12300	.66608	.66367	.66126	.65887	.65650	.65414	.65180	.64947	.64716	.64486
12400	.67149	.66906	.66663	.66422	.66183	.65945	.65709	.65474	.65241	.65009
12500	.67690	.67445	.67200	.66957	.66716	.66476	.66238	.66001	.65766	.65532
	540	538	536	534	532	530	528	527	525	523
12600	.68230	.67983	.67736	.67491	.67248	.67007	.66767	.66528	.66291	.66056
12700	.68770	.68521	.68272	.68025	.67780	.67537	.67295	.67054	.66816	.66579
12800	.69311	.69059	.68808	.68559	.68312	.68067	.67824	.67581	.67341	.67102
12900	.69852	.69597	.69344	.69093	.68844	.68597	.68352	.68108	.67866	.67625
13000	.70392	.70135	.69880	.69627	.69376	.69127	.68880	.68635	.68391	.68148
	540	538	536	534	532	530	528	527	525	523
13100	.70932	.70674	.70417	.70161	.69909	.69658	.69408	.69162	.68916	.68671
13200	.71473	.71212	.70953	.70696	.70441	.70188	.69937	.69688	.69441	.69194
13300	.72013	.71750	.71489	.71230	.70973	.70718	.70466	.70215	.69966	.69717
13400	.72553	.72288	.72025	.71764	.71506	.71249	.70994	.70742	.70491	.70240
13500	.73094	.72826	.72562	.72299	.72038	.71779	.71523	.71268	.71015	.70763
	540	538	536	534	532	530	528	527	525	523
13600	.73634	.73365	.73098	.72834	.72571	.72309	.72051	.71795	.71540	.71286
13700	.74174	.73903	.73634	.73368	.73103	.72840	.72580	.72321	.72064	.71808
13800	.74714	.74442	.74170	.73902	.73635	.73370	.73108	.72848	.72588	.72331
13900	.75255	.74980	.74707	.74436	.74167	.73901	.73636	.73374	.73113	.72854
14000	.75795	.75518	.75243	.74970	.74699	.74431	.74165	.73901	.73638	.73377
	540	538	536	534	532	530	528	527	525	523
14100	.76335	.76057	.75779	.75505	.75232	.74962	.74694	.74428	.74163	.73900
14200	.76875	.76595	.76316	.76039	.75764	.75492	.75222	.74954	.74687	.74423
14300	.77415	.77133	.76852	.76573	.76296	.76023	.75751	.75481	.75212	.74946
14400	.77955	.77671	.77388	.77108	.76828	.76553	.76280	.76007	.75737	.75469
14500	.78495	.78209	.77924	.77642	.77361	.77084	.76809	.76534	.76261	.75992
	540	538	536	534	532	530	528	527	525	523
14600	.79035	.78747	.78460	.78177	.77893	.77615	.77338	.77061	.76786	.76515
14700	.79575	.79285	.78997	.78711	.78426	.78146	.77866	.77587	.77311	.77038
14800	.80115	.79823	.79533	.79245	.78958	.78676	.78395	.78114	.77836	.77561
14900	.80655	.80361	.80069	.79779	.79491	.79207	.78924	.78641	.78361	.78084
15000	.81195	.80899	.80605	.80313	.80024	.79737	.79452	.79168	.78886	.78606

	540	538
1	54	54
2	108	108
3	162	161
4	216	215
5	270	269
6	324	323
7	378	377
8	432	430
9	486	484
	536	534
1	54	53
2	107	107
3	161	160
4	214	214
5	268	267
6	322	320
7	375	374
8	429	427
9	482	481
	532	530
1	53	53
2	106	106
3	160	159
4	213	212
5	266	265
6	319	318
7	372	371
8	426	424
9	479	477
	528	527
1	53	53
2	106	105
3	158	158
4	211	211
5	264	264
6	317	316
7	370	369
8	422	422
9	475	474
	525	523
1	53	52
2	105	105
3	158	157
4	210	209
5	263	262
6	315	314
7	368	366
8	420	418
9	473	471

TABLE 91.—*Table for m.—Metric measures*—Continued.

$B_o > B.$ $\log B_o = \log B + m - \beta m - \gamma m = \log B + m_1.$ $m_1 = m - \beta m - \gamma m.$

$\log B = \log B_o - m + \beta m + \gamma m = \log B_o - m_1.$ $m = m_1 + \beta m_1 + \gamma m_1.$

T	10	11	12	13	14	15	16	17	18	19
H 10000	.52260	.52076	.51894	.51713	.51533	.51354	.51176	.50999	.50824	.50650
	522	520	518	516	514	513	511	509	507	506
10100	.52782	.52596	.52412	.52229	.52048	.51867	.51687	.51508	.51332	.51156
10200	.53303	.53116	.52930	.52745	.52562	.52380	.52198	.52017	.51839	.51661
10300	.53825	.53636	.53448	.53261	.53076	.52892	.52709	.52526	.52347	.52167
10400	.54347	.54155	.53966	.53777	.53590	.53404	.53220	.53035	.52854	.52672
10500	.54868	.54675	.54484	.54293	.54104	.53916	.53730	.53544	.53361	.53178
	522	520	518	516	514	513	511	509	507	506
10600	.55390	.55195	.55002	.54809	.54619	.54429	.54240	.54053	.53868	.53683
10700	.55912	.55715	.55520	.55325	.55133	.54941	.54751	.54562	.54376	.54189
10800	.56434	.56234	.56038	.55841	.55647	.55454	.55261	.55071	.54883	.54694
10900	.56955	.56754	.56556	.56357	.56161	.55966	.55772	.55580	.55390	.55200
11000	.57477	.57274	.57073	.56873	.56675	.56478	.56283	.56089	.55897	.55706
	522	520	518	516	514	513	511	509	507	506
11100	.57999	.57794	.57591	.57389	.57190	.56991	.56794	.56598	.56405	.56212
11200	.58520	.58314	.58109	.57905	.57704	.57503	.57305	.57107	.56912	.56718
11300	.59042	.58834	.58627	.58421	.58218	.58016	.57816	.57616	.57419	.57224
11400	.59563	.59353	.59145	.58937	.58732	.58529	.58327	.58125	.57926	.57730
11500	.60085	.59873	.59663	.59453	.59246	.59041	.58837	.58634	.58433	.58236
	522	520	518	516	514	513	511	509	507	505
11600	.60607	.60393	.60181	.59969	.59761	.59554	.59348	.59143	.58941	.58741
11700	.61128	.60912	.60698	.60485	.60275	.60066	.59859	.59652	.59448	.59246
11800	.61650	.61432	.61216	.61001	.60789	.60579	.60370	.60161	.59955	.59751
11900	.62171	.61951	.61733	.61517	.61303	.61081	.60880	.60670	.60462	.60256
12000	.62693	.62471	.62251	.62033	.61817	.61603	.61390	.61179	.60969	.60761
	521	520	518	516	514	513	511	509	507	505
12100	.63214	.62991	.62769	.62550	.62332	.62117	.61901	.61689	.61477	.61267
12200	.63736	.63511	.63287	.63066	.62846	.62630	.62412	.62198	.61984	.61772
12300	.64257	.64030	.63805	.63583	.63360	.63143	.62923	.62707	.62491	.62277
12400	.64779	.64550	.64323	.64099	.63875	.63655	.63434	.63216	.62999	.62783
12500	.65300	.65070	.64841	.64615	.64390	.64168	.63945	.63725	.63506	.63288
	521	520	518	516	514	513	511	509	507	505
12600	.65821	.65590	.65359	.65132	.64904	.64681	.64456	.64234	.64013	.63794
12700	.66343	.66109	.65877	.65648	.65418	.65193	.64967	.64743	.64521	.64299
12800	.66864	.66629	.66395	.66164	.65933	.65706	.65478	.65252	.65028	.64805
12900	.67386	.67148	.66913	.66680	.66447	.66218	.65989	.65761	.65535	.65310
13000	.67907	.67668	.67431	.67196	.66962	.66730	.66499	.66270	.66042	.65815
	521	519	518	516	514	513	511	509	507	505
13100	.68428	.68188	.67949	.67712	.67476	.67243	.67010	.66779	.66550	.66321
13200	.68949	.68707	.68467	.68228	.67991	.67756	.67521	.67288	.67057	.66827
13300	.69470	.69226	.68985	.68744	.68505	.68269	.68032	.67797	.67564	.67332
13400	.69991	.69745	.69503	.69260	.69019	.68782	.68543	.68306	.68071	.67837
13500	.70512	.70265	.70020	.69776	.69533	.69295	.69054	.68815	.68578	.68342
	521	519	518	516	514	512	511	509	507	505
13600	.71034	.70785	.70538	.70292	.70048	.69807	.69565	.69324	.69086	.68848
13700	.71555	.71304	.71055	.70808	.70562	.70319	.70075	.69833	.69593	.69353
13800	.72076	.71823	.71573	.71324	.71077	.70831	.70586	.70342	.70100	.69859
13900	.72597	.72343	.72090	.71840	.71590	.71343	.71097	.70851	.70607	.70364
14000	.73118	.72862	.72608	.72356	.72105	.71855	.71607	.71360	.71114	.70869
	521	519	517	515	513	512	510	508	507	505
14100	.73639	.73382	.73126	.72871	.72619	.72367	.72117	.71869	.71621	.71374
14200	.74160	.73901	.73644	.73387	.73132	.72878	.72627	.72377	.72128	.71879
14300	.74681	.74420	.74161	.73902	.73645	.73390	.73137	.72885	.72635	.72384
14400	.75202	.74939	.74678	.74418	.74159	.73901	.73646	.73393	.73142	.72889
14500	.75723	.75458	.75195	.74933	.74672	.74413	.74156	.73901	.73648	.73394
	521	519	517	515	513	512	510	508	506	505
14600	.76244	.75977	.75712	.75448	.75186	.74924	.74666	.74409	.74154	.73899
14700	.76765	.76496	.76229	.75964	.75699	.75436	.75176	.74917	.74660	.74404
14800	.77286	.77015	.76746	.76479	.76212	.75947	.75686	.75425	.75166	.74909
14900	.77807	.77534	.77263	.76994	.76725	.76459	.76195	.75933	.75672	.75413
15000	.78328	.78053	.77780	.77509	.77239	.76971	.76705	.76441	.76178	.75917

	521	520
1	52	52
2	104	104
3	156	156
4	208	208
5	261	260
6	313	312
7	365	364
8	417	416
9	469	468
	518	516
1	52	52
2	104	103
3	155	155
4	207	206
5	259	258
6	311	310
7	363	361
8	414	413
9	466	464
	514	513
1	51	51
2	103	103
3	154	154
4	206	205
5	257	257
6	308	308
7	360	359
8	411	410
9	463	462
	511	509
1	51	51
2	102	102
3	153	153
4	204	204
5	256	255
6	307	305
7	358	356
8	409	407
9	460	458
	507	505
1	51	51
2	101	101
3	152	152
4	203	202
5	254	253
6	304	303
7	355	354
8	406	404
9	456	455

TABLE 92.—*The humidity correction in metric measure.*

TABLE 92A.—FIRST ARGUMENT. $.378 \frac{e_0}{B_0}$.

e_0	B_0								
	100	200	300	400	500	600	700	760	800
1	.0038	.0019	.0013	.0009	.0008	.0006	.0005	.0005	.0005
2	76	38	25	19	15	13	11	10	9
3	113	57	38	29	23	19	16	15	14
4	151	76	50	38	30	25	22	20	19
5	189	94	63	47	38	32	27	25	24
6	227	113	76	57	45	38	32	30	28
7	265	132	88	66	53	44	38	35	33
8	302	151	101	76	60	50	43	40	38
9	340	170	113	85	68	57	49	45	43
10	.0378	189	126	94	76	63	54	50	47
11		208	138	104	84	69	60	55	52
12		227	151	113	91	75	65	60	56
13		246	163	122	99	82	70	65	61
14		265	176	132	106	88	75	69	65
15		284	188	141	114	94	81	74	70
16		.0302	201	151	121	100	86	79	74
17			213	160	129	107	92	84	79
18			226	170	136	113	97	89	84
19			239	179	144	120	102	94	89
20			252	189	151	126	108	100	95
21			265	199	159	132	113	105	100
22			277	208	166	138	118	110	104
23			290	218	174	145	124	115	109
24			.0303	227	181	151	129	120	114
25				236	189	157	134	125	119
26				246	196	163	140	130	123
27				255	204	169	145	135	128
28				265	211	175	151	140	132
29				274	219	182	156	145	137
30				.0284	.0227	.0189	.0162	150	.0142

TABLE 92B.—SECOND ARGUMENT. β.

$$\beta = .378 \frac{e_0}{B_0}\left[1 - \frac{1}{2!}\left(\frac{h}{4383}\right) + \frac{1}{3!}\left(\frac{h}{4383}\right)^2 - \frac{1}{4!}\left(\frac{h}{4383}\right)^3 + \cdot\cdot\right].$$

[The height in meters = h.]

$.378 \frac{e_0}{B_0}$	0000	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	13000	14000	15000
.0010	.0010	.0009	.0008	.0007	.0007	.0006	.0005	.0005	.0005	.0004	.0004	.0004	.0003	.0003	.0003	.0003
20	20	18	16	15	13	12	11	10	9	9	8	7	7	6	6	6
30	30	27	24	22	20	18	16	15	14	13	12	11	10	10	9	9
40	40	36	32	29	26	24	22	20	18	17	16	15	14	13	12	11
50	50	45	40	36	33	30	27	25	23	21	20	18	17	16	15	14
60	60	54	48	44	39	36	33	30	28	26	24	22	21	19	18	17
70	70	63	56	51	46	42	38	35	32	30	28	26	24	22	21	20
80	80	72	64	58	53	48	43	40	37	34	32	29	27	26	24	23
90	90	81	72	65	59	54	49	45	41	38	35	33	31	29	27	25
100	100	89	80	72	66	60	54	50	46	42	39	37	34	32	30	28
110	110	98	88	80	72	66	60	55	51	47	43	40	38	35	33	31
120	120	107	96	87	79	72	65	60	55	51	47	44	41	38	36	34
130	130	116	104	94	85	78	71	65	60	55	51	48	44	42	39	37
140	140	125	112	101	92	84	76	70	64	59	55	51	48	45	42	40
150	.0150	.0134	.0120	.0109	.0098	.0090	.0081	.0075	.0069	.0064	.0059	.0055	.0051	.0048	.0045	.0042

TABLE 92.—*The humidity correction in metric measure*—Continued.

TABLE 92C.—HUMIDITY CORRECTION.

βm.

β	m									
	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
.0010	.00001	.00002	.00003	.00004	.00005	.00006	.00007	.00008	.00009	.00010
20	2	4	6	8	10	12	14	16	18	20
30	3	6	9	12	15	18	21	24	27	30
40	4	8	12	16	20	24	28	32	36	40
50	5	10	15	20	25	30	35	40	45	50
60	6	12	18	24	30	36	42	48	54	60
70	7	14	21	28	35	42	49	56	63	70
80	8	16	24	32	40	48	56	64	72	80
90	9	18	27	36	45	54	63	72	81	90
100	10	20	30	40	50	60	70	80	90	100
110	11	22	33	44	55	66	77	88	99	110
120	12	24	36	48	60	72	84	96	108	120
130	13	26	39	52	65	78	91	104	117	130
140	14	28	42	56	70	84	98	112	126	140
150	.00015	.00030	.00045	.00060	.00075	.00090	.00105	.00120	.00135	.00150

TABLE 93.—*The gravity correction in metric measure.*

Subtract from m for $\varphi = 0°$ to $45°$. Add to m for $\varphi = 45°$ to $90°$.

γm.

φ		m									
		0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
− °	+ °										
90	0	.00003	.00005	.00008	.00010	.00013	.00016	.00018	.00021	.00023	.00026
88	2	3	5	8	10	13	16	18	21	23	26
86	4	3	5	8	10	13	15	18	21	23	26
84	6	3	5	8	10	13	15	18	20	23	25
82	8	3	5	8	10	13	15	18	20	23	25
80	10	2	5	7	10	12	15	17	20	22	24
78	12	2	5	7	10	12	14	17	19	21	24
76	14	2	5	7	9	12	14	16	18	21	23
74	16	2	4	7	9	11	13	15	18	20	22
72	18	2	4	6	8	11	13	15	17	19	21
70	20	2	4	6	8	10	12	14	16	18	20
68	22	2	4	6	8	9	11	13	15	17	19
66	24	2	4	5	7	9	10	12	14	16	17
64	26	2	3	5	6	8	10	11	13	14	16
62	28	2	3	4	6	7	9	10	12	13	15
60	30	1	3	4	5	7	8	9	10	12	13
58	32	1	2	3	5	6	7	8	9	10	11
56	34	1	2	3	4	5	6	7	8	9	10
54	36	1	2	2	3	4	5	6	6	7	8
52	38	1	1	2	3	3	4	4	5	6	6
50	40	1	1	1	2	2	3	3	4	4	5
48	42	0	1	1	1	1	2	2	2	2	3
46	44	0	0	0	0	0	1	1	1	1	1
45	45	0	0	0	0	0	0	0	0	0	0

For $\varphi = 0°$ to $45°$ Latitude, $\gamma = (0.0026 \cos. 2\varphi)$ is plus.
$\varphi = 45°$ to $90°$ Latitude, γ is minus.

TABLE 94.—*Unsaturated or α stage, e unsaturated.*

Iα.

Ia. IIa.

$$\left(.2374+.1512\frac{e}{B}+.0232\frac{e^2}{B^2}\right)\log T-\left(.06858+.02592\frac{e}{B}\right)\log B=Ca.$$

t=T−273	$\frac{e}{B}$						
	0.00	0.01	0.02	0.03	0.04	0.05	0.06
	$\left(.2374+.1512\frac{e}{B}+.0232\frac{e^2}{B^2}\right)\log T$						
−100	1.2234	1.2311					
− 90	367	445					
− 80	494	573					
− 70	614	694					
− 60	728	809					
− 50	837	2919					
− 40	2941	3023					
− 30	3041	124					
− 20	136	220	1.3304				
− 10	228	312	397	1.3482	1.3567		
0	317	402	488	572	658	1.3744	1.3831
+ 10	403	488	575	660	746	833	3920
20	485	571	658	744	831	917	4005
30	565	651	739	825	913	3999	4088
40	1.3642	1.3729	1.3817	1.3904	1.3992	1.4079	1.4168

For expanded part of this Table see pages 551, 552.

NOTE.—The ratio $\frac{e}{B}$ is constant through all stages.

PROPORTIONAL PARTS.

	77	78	79	80	81	82	83	84	85	86	87	88	89	
1	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	1
2	15.4	15.6	15.8	16.0	16.2	16.4	16.6	16.8	17.0	17.2	17.4	17.6	17.8	2
3	23.1	23.4	23.7	24.0	24.3	24.6	24.9	25.2	25.5	25.8	26.1	26.4	26.7	3
4	30.8	31.2	31.6	32.0	32.4	32.8	33.2	33.6	34.0	34.4	34.8	35.2	35.6	4
5	38.5	39.0	39.5	40.0	40.5	41.0	41.5	42.0	42.5	43.0	43.5	44.0	44.5	5
6	46.2	46.8	47.4	48.0	48.6	49.2	49.8	50.4	51.0	51.6	52.2	52.8	53.4	6
7	53.9	54.6	55.3	56.0	56.7	57.4	58.1	58.8	59.5	60.2	60.9	61.6	62.3	7
8	61.6	62.4	63.2	64.0	64.8	65.6	66.4	67.2	68.0	68.8	69.6	70.4	71.2	8
9	69.3	70.2	71.1	72.0	72.9	73.8	74.7	75.6	76.5	77.4	78.3	79.2	80.1	9

	90	91	92	93	94	95	96	97	98	99	100	101	102	
1	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	10.0	10.1	10.2	1
2	18.0	18.2	18.4	18.6	18.8	19.0	19.2	19.4	19.6	19.8	20.0	20.2	20.4	2
3	27.0	27.3	27.6	27.9	28.2	28.5	28.8	29.1	29.4	29.7	30.0	30.3	30.6	3
4	36.0	36.4	36.8	37.2	37.6	38.0	38.4	38.8	39.2	39.6	40.0	40.4	40.8	4
5	45.0	45.5	46.0	46.5	47.0	47.5	48.0	48.5	49.0	49.5	50.0	50.5	51.0	5
6	54.0	54.6	55.2	55.8	56.4	57.0	57.6	58.2	58.8	59.4	60.0	60.6	61.2	6
7	63.0	63.7	64.4	65.1	65.8	66.5	67.2	67.9	68.6	69.3	70.0	70.7	71.4	7
8	72.0	72.8	73.6	74.4	75.2	76.0	76.8	77.6	78.4	79.2	80.0	80.8	81.6	8
9	81.0	81.9	82.8	83.7	84.6	85.5	86.4	87.3	88.2	89.1	90.0	90.9	91.8	9

	103	104	105	106	107	108	109	110	111	112	113	114	115	
1	10.3	10.4	10.5	10.6	10.7	10.8	10.9	11.0	11.1	11.2	11.3	11.4	11.5	1
2	20.6	20.8	21.0	21.2	21.4	21.6	21.8	22.0	22.2	22.4	22.6	22.8	23.0	2
3	30.9	31.2	31.5	31.8	32.1	32.4	32.7	33.0	33.3	33.6	33.9	34.2	34.5	3
4	41.2	41.6	42.0	42.4	42.8	43.2	43.6	44.0	44.4	44.8	45.2	45.6	46.0	4
5	51.5	52.0	52.5	53.0	53.5	54.0	54.5	55.0	55.5	56.0	56.5	57.0	57.5	5
6	61.8	62.4	63.0	63.6	64.2	64.8	65.4	66.0	66.6	67.2	67.8	68.4	69.0	6
7	72.1	72.8	73.5	74.2	74.9	75.6	76.3	77.0	77.7	78.4	79.1	79.8	80.5	7
8	82.4	83.2	84.0	84.8	85.6	86.4	87.2	88.0	88.8	89.6	90.4	91.2	92.0	8
9	92.7	93.6	94.5	93.4	96.3	97.2	98.1	99.0	99.9	100.8	101.7	102.6	103.5	9

TABLE 95.

TABLE Iα EXPANDED.

e / B	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009	.010	.011	.012	.013	.014
t=−15	1.3182	1.3191	1.3200	1.3209	1.3218	1.3226	1.3234	1.3242	1.3250	1.3258	1.3266	1.3275	1.3284	1.3293	1.3302
−14	191	200	209	218	227	235	243	251	259	267	275	284	293	301	311
−13	200	209	218	227	236	245	252	260	268	277	285	293	302	310	320
−12	210	219	228	237	246	254	262	270	278	286	294	303	312	320	329
−11	219	228	237	246	255	263	271	279	287	295	303	312	321	329	339
−10	228	237	246	255	264	272	280	288	296	304	312	321	330	339	348
− 9	237	246	255	264	273	281	289	297	305	313	321	330	339	348	357
− 8	246	255	264	273	282	290	298	306	314	322	330	339	348	357	366
− 7	255	264	273	282	291	299	307	315	323	331	339	348	357	366	375
− 6	264	273	282	291	300	308	316	324	332	340	348	357	366	375	384
− 5	273	282	291	300	309	317	325	333	341	349	357	366	375	384	393
− 4	282	291	300	309	318	326	334	342	350	358	366	375	384	393	402
− 3	291	300	309	318	327	335	343	351	359	367	375	384	393	402	411
− 2	300	309	318	327	336	344	352	360	368	376	384	393	402	411	420
− 1	309	318	327	336	345	353	361	369	377	385	393	402	411	420	429
0	317	326	335	344	353	361	369	377	385	393	402	411	420	429	438
1	326	335	344	353	362	370	378	386	394	402	411	420	429	438	447
2	335	344	353	362	371	379	387	395	403	411	420	429	438	447	456
3	344	353	362	371	380	388	396	404	412	420	429	438	447	456	465
4	353	362	371	380	389	397	405	413	421	429	438	447	456	465	474
5	362	371	380	389	398	406	414	422	430	438	447	456	465	474	483
6	371	380	389	398	407	415	423	431	439	447	456	465	474	483	492
7	379	388	397	406	415	423	431	439	447	455	464	473	482	491	500
8	387	396	405	414	423	431	439	447	455	463	472	481	490	499	508
9	395	404	413	422	431	439	447	455	463	471	480	489	498	507	516
10	403	412	421	430	439	447	455	463	471	479	488	497	506	515	524
11	412	421	430	439	448	456	464	472	480	488	497	506	515	524	533
12	421	430	439	448	457	465	473	481	489	497	506	515	524	533	542
13	429	438	447	456	465	473	481	489	497	505	514	524	533	542	551
14	437	446	455	464	473	481	489	497	505	513	522	532	541	550	559
15	445	454	463	472	481	489	497	505	513	521	530	540	549	558	567
16	453	462	471	480	489	497	505	513	521	529	539	548	557	566	575
17	461	470	479	488	497	505	513	521	529	537	547	556	565	574	583
18	469	478	487	496	505	513	521	529	537	545	555	564	573	582	591
19	477	486	495	504	513	521	529	538	545	553	563	572	581	590	599
20	485	494	503	512	521	529	537	545	553	561	571	580	589	598	607
21	493	502	511	520	529	538	546	554	562	570	579	588	597	606	615
22	501	510	519	528	537	546	555	563	571	579	587	596	605	614	623
23	509	518	527	536	545	554	563	571	579	587	595	604	613	622	631
24	517	526	535	544	553	562	571	579	587	595	603	612	621	630	639
25	525	534	543	552	561	570	579	587	595	603	611	620	629	638	647
26	533	542	551	560	569	578	587	595	603	611	619	628	637	646	655
27	541	550	559	568	577	586	595	603	611	619	627	636	645	654	663
28	549	558	567	576	585	594	603	611	619	627	635	644	653	662	671
29	557	566	575	584	593	602	611	619	627	635	643	652	661	670	679
30	565	574	583	592	601	610	619	627	635	643	651	660	669	678	687
31	573	582	591	600	609	618	627	635	643	651	659	668	677	686	695
32	581	590	599	608	617	626	635	643	651	659	667	676	685	694	703

TABLE 95—Continued.

TABLE Iα EXPANDED—Continued.

e/B	.015	.016	.017	.018	.019	.020	.021	.022	.023	.024	.025	.026	.027	.028	.029
t=−10	1.3356	1.3365	1.3373	1.3381	1.3389	1.3397	1.3406	1.3415	1.3424	1.3433	1.3442	1.3450	1.3458	1.3466	1.3474
−9	366	375	383	391	399	407	416	425	434	443	452	460	468	476	484
−8	375	384	392	400	408	416	425	434	443	452	461	469	477	485	493
−7	384	393	401	409	417	425	434	443	452	461	470	478	486	494	502
−6	393	402	410	418	426	434	443	452	461	470	479	487	495	503	511
−5	402	411	419	427	435	443	452	461	470	479	488	496	504	512	520
−4	411	420	428	436	444	452	461	470	479	488	497	505	513	521	529
−3	420	429	437	445	453	461	470	479	488	497	506	514	522	530	538
−2	429	438	446	454	462	470	479	488	497	506	515	523	531	539	547
−1	438	447	455	463	471	479	488	497	506	515	524	532	540	548	556
0	**447**	**456**	**464**	**472**	**480**	**488**	**497**	**506**	**515**	**524**	**533**	**541**	**549**	**557**	**565**
1	456	465	473	481	489	497	506	515	524	533	542	550	558	566	574
2	465	474	482	490	498	506	515	524	533	542	551	559	567	575	583
3	474	483	491	499	507	515	524	533	542	551	560	568	576	584	592
4	483	492	500	508	516	524	533	542	551	560	569	577	585	593	601
5	492	501	509	517	525	533	542	551	560	569	578	586	594	602	610
6	501	510	518	526	534	542	551	560	569	578	587	595	603	611	619
7	509	518	526	534	542	550	559	568	577	586	595	603	611	619	627
8	517	526	534	542	550	558	567	576	585	594	603	611	619	627	635
9	525	534	542	550	558	566	575	584	593	602	611	619	627	635	643
10	**533**	**542**	**550**	**558**	**566**	**575**	**584**	**593**	**602**	**611**	**620**	**628**	**636**	**644**	**652**
11	542	551	559	567	575	584	593	602	611	620	629	637	645	653	661
12	551	560	568	576	584	593	602	611	620	629	638	646	654	662	670
13	560	569	577	585	593	602	611	620	629	638	647	655	663	671	679
14	568	577	585	593	601	610	619	628	637	646	655	663	671	679	687
15	576	585	593	601	609	618	627	636	645	654	663	671	679	687	695
16	584	593	601	609	617	626	635	644	653	662	671	679	687	695	703
17	592	601	609	617	625	634	643	652	661	670	679	687	695	703	711
18	600	609	617	625	633	642	651	660	669	678	687	695	703	711	719
19	608	617	625	633	641	650	659	668	677	686	695	703	711	719	727
20	**616**	**625**	**633**	**641**	**649**	**658**	**667**	**676**	**685**	**694**	**703**	**711**	**719**	**727**	**735**
21	624	633	641	649	658	666	675	684	693	702	711	719	727	735	743
22	632	641	649	657	666	674	683	692	701	710	719	727	735	743	751
23	640	649	658	666	675	683	691	701	710	719	728	736	744	752	760
24	648	657	666	675	683	691	699	709	718	727	736	745	753	761	769
25	656	665	674	683	691	699	708	717	726	735	744	753	761	769	777
26	664	673	682	691	699	707	716	725	734	743	752	761	769	777	785
27	672	681	690	699	707	715	724	733	742	751	760	769	777	785	793
28	680	689	698	707	715	723	732	741	750	759	768	777	785	793	801
29	688	697	706	715	723	731	740	749	758	767	776	785	793	801	809
30	**696**	**705**	**714**	**723**	**731**	**739**	**748**	**757**	**766**	**775**	**784**	**793**	**801**	**809**	**817**
31	704	713	722	731	739	747	756	765	774	783	792	801	809	817	825
32	712	721	730	739	747	755	764	773	782	791	800	809	817	825	833

TABLE 96.—*Unsaturated or α stage.*

IIα.

B	$\frac{e}{B}$ .00	.01	.02	.03	.04	.05	.06
	$-(.06858 + .02592 \frac{e}{B}) \log B.$						
790	.4576	.4593	.4611	.4628	.4645	.4662	.4680
780	67	84	.4602	19	36	53	71
770	58	75	.4592	10	27	44	61
760	49	66	83	.4601	18	35	52
750	40	57	74	.4591	09	26	43
740	31	48	65	82	.4600	17	34
730	22	39	56	73	.4590	.4607	24
720	12	29	46	63	80	.4597	14
710	.4502	19	36	53	70	87	.4604
700	.4493	10	27	44	61	78	.4594
690	83	.4500	17	34	51	68	84
680	73	.4490	.4507	24	41	58	74
670	63	80	.4497	13	30	47	63
660	52	69	86	.4502	19	36	53
650	42	59	76	.4492	.4509	26	43
640	31	48	65	81	.4498	15	32
630	20	37	53	70	87	.4504	20
620	.4409	26	42	59	76	.4492	.4509
610	.4398	15	31	48	65	81	.4498
600	87	.4404	20	37	53	70	86
590	76	.4392	.4409	25	42	58	75
580	64	80	.4397	13	30	46	63
570	52	68	85	.4401	18	34	51
560	40	56	73	.4389	.4406	22	38
550	27	43	60	76	.4393	.4409	25
540	15	31	48	64	80	.4396	13
530	.4302	18	35	51	67	83	.4400
520	.4289	.4305	21	38	54	70	.4386
510	76	.4292	.4308	24	40	57	73
500	62	78	.4294	.4310	26	43	59
490	48	64	80	.4296	.4312	29	45
480	34	50	66	82	.4298	14	30
470	20	36	52	68	84	.4300	16
460	.4205	21	37	53	69	.4284	.4300
450	.4190	.4206	.4222	.4238	.4253	.4268	.4284

B	$\frac{e}{B}$ .00	.01	.02	.03	.04	.05	.06
	$-(.06858 + .02592 \frac{e}{B}) \log B.$						
440	.4174	.4190	.4206	.4222	.4237	.4253	.4269
430	59	75	.4190	.4206	22	38	53
420	43	59	74	.4190	.4206	21	37
410	26	42	57	73	.4188	.4204	19
400	.4109	24	40	56	71	.4187	.4202
390	.4092	.4107	23	38	54	69	.4185
380	74	.4089	.4105	20	36	51	66
370	56	71	.4087	.4102	.4117	33	48
360	37	52	68	.4083	.4098	.4113	28
350	.4017	32	48	63	78	.4093	.4108
340	.3997	.4012	28	43	58	73	.4088
330	77	.3992	.4007	22	37	52	67
320	56	71	.3986	.4001	.4016	31	46
310	34	49	64	.3979	.3993	.4008	23
300	.3912	26	41	56	70	.3985	.4000
290	.3888	.3903	.3917	32	47	61	.3976
280	64	.3879	.3893	.3908	.3922	37	52
270	39	54	68	.3883	.3897	.3912	.3926
260	.3813	27	42	56	71	.3885	.3899
250	.3787	.3801	.3816	30	44	58	72
240	59	.3773	.3787	.3801	.3816	30	44
230	.3730	44	58	.3772	.3786	.3800	.3815
220	.3699	.3713	.3727	41	55	.3769	.3783
210	67	.3681	.3695	.3709	.3722	36	50
200	.3634	.3648	.3661	.3675	.3689	.3702	.3716
190	.3598	.3612	.3626	.3639	.3653	.3666	.3680
180	61	.3575	.3588	.3602	.3615	.3629	.3642
170	.3522	.3535	.3549	.3562	.3575	.3589	.3602
160	.3481	.3494	.3507	.3520	.3533	.3546	.3560
150	.3436	.3449	.3462	.3475	.3488	.3501	.3514

PROPORTIONAL PARTS.

	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1	.8	.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	1
2	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	2
3	2.4	2.7	3.0	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6.0	6.3	3
4	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0	8.4	4
5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	5
6	4.8	5.4	6.0	6.6	7.2	7.8	8.4	9.0	9.6	10.2	10.8	11.4	12.0	12.6	6
7	5.6	6.3	7.0	7.7	8.4	9.1	9.8	10.5	11.2	11.9	12.6	13.3	14.0	14.7	7
8	6.4	7.2	8.0	8.8	9.6	10.4	11.2	12.0	12.8	13.6	14.4	15.2	16.0	16.8	8
9	7.2	8.1	9.0	9.9	10.8	11.7	12.6	13.5	14.4	15.3	16.2	17.1	18.0	18.9	9

	22	23	24	25	26	27	28	29	30	31	32	33	34	
1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	1
2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	6.2	6.4	6.6	6.8	2
3	6.6	6.9	7.2	7.5	7.8	8.1	8.4	8.7	9.0	9.3	9.6	9.9	10.2	3
4	8.8	9.2	9.6	10.0	10.4	10.8	11.2	11.6	12.0	12.4	12.8	13.2	13.6	4
5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	5
6	13.2	13.8	14.4	15.0	15.6	16.2	16.8	17.4	18.0	18.6	19.2	19.8	20.4	6
7	15.4	16.1	16.8	17.5	18.2	18.9	19.6	20.3	21.0	21.7	22.4	23.1	23.8	7
8	17.6	18.4	19.2	20.0	20.8	21.6	22.4	23.2	24.0	24.8	25.6	26.4	27.2	8
9	19.8	20.7	21.6	22.5	23.4	24.3	25.2	26.1	27.0	27.9	28.8	29.7	30.6	9

TABLE 97.—*Saturated or β stage, $e' > 4.57$, and saturated.*

Iβ.

$$\overset{\text{I}\beta.}{\left(.2374+.4743\frac{e}{B}+.145\frac{e^2}{B^2}\right)\log T}-\overset{\text{II}\beta.}{\left(.06858-.04266\frac{e}{B}\right)\log(B-e')}+\overset{\text{III}\beta.}{\left[\frac{497.5}{T}-.4404-\left(\frac{309.4}{T}-.2739\right)\frac{e}{B}\right]\frac{e'}{B-e'}}=C_\beta.$$

t=T−273	$\frac{e}{B}$ .00	.01	.02	.03	.04	.05	.06	t=T−273	$\frac{e}{B}$ .00	.01	.02	.03	.04	.05	.06
	$\left(.2374+.4743\frac{e}{B}+.145\frac{e^2}{B^2}\right)\log T.$								$\left(.2374+.4743\frac{e}{B}+.145\frac{e^2}{B^2}\right)\log T.$						
0	1.3317	1.3584	1.3852	1.4122	1.4394	1.4667	1.4942	15		1.3714	1.3985	1.4257	1.4532	1.4808	1.5086
1	326	593	861	132	403	677	952	16		722	1.3993	266	541	817	095
2	335	602	870	141	413	686	961	17		730	1.4001	274	549	826	104
3	343	611	879	150	422	696	971	18		739	010	283	558	835	113
4	352	620	889	159	432	706	981	19		1.3747	018	292	567	844	122
5	360	628	897	168	441	715	1.4990	20			027	300	576	853	131
6	369	637	906	177	450	724	1.5000	21			035	309	584	862	140
7	377	646	915	186	459	734	010	22			043	317	593	871	149
8	386	654	923	195	468	743	019	23			052	326	602	879	158
9	1.3394	663	932	204	477	752	028	24			060	334	610	888	167
10		672	941	213	487	761	038	25			069	343	619	897	176
11		680	950	222	496	771	048	26			1.4077	351	627	906	185
12		688	959	231	505	780	058	27				359	636	914	194
13		697	967	239	514	789	067	28				368	645	923	203
14		1.3705	1.3976	1.4248	1.4523	1.4799	1.5077	29				376	653	932	212
								30				1.4385	1.4662	941	221
								35						1.4983	1.5264

PROPORTIONAL PARTS.

	8	9	10	267	268	269	270	271	272	
1	.8	.9	1.0	26.7	26.8	26.9	27.0	27.1	27.2	1
2	1.6	1.8	2.0	53.4	53.6	53.8	54.0	54.2	54.4	2
3	2.4	2.7	3.0	80.1	80.4	80.7	81.0	81.3	81.6	3
4	3.2	3.6	4.0	106.8	107.2	107.6	108.0	108.4	108.8	4
5	4.0	4.5	5.0	133.5	134.0	134.5	135.0	135.5	136.0	5
6	4.8	5.4	6.0	160.2	160.8	161.4	162.0	162.6	163.2	6
7	5.6	6.3	7.0	186.9	187.6	188.3	189.0	189.7	190.4	7
8	6.4	7.2	8.0	213.6	214.4	215.2	216.0	216.8	217.6	8
9	7.2	8.1	9.0	240.3	241.2	242.1	243.0	243.9	244.8	9

	273	274	275	276	277	278	279	280	281	
1	27.3	27.4	27.5	27.6	27.7	27.8	27.9	28.0	28.1	1
2	54.6	54.8	55.0	55.2	55.4	55.6	55.8	56.0	56.2	2
3	81.9	82.2	82.5	82.8	83.1	83.4	83.7	84.0	84.3	3
4	109.2	109.6	110.0	110.4	110.8	111.2	111.6	112.0	112.4	4
5	136.5	137.0	137.5	138.0	138.5	139.0	139.5	140.0	140.5	5
6	163.8	164.4	165.0	165.6	166.2	166.8	167.4	168.0	168.6	6
7	191.1	191.8	192.5	193.2	193.9	194.6	195.3	196.0	196.7	7
8	218.4	219.2	220.0	220.8	221.6	222.4	223.2	224.0	224.8	8
9	245.7	246.6	247.5	248.4	249.3	250.2	251.1	252.0	252.9	9

TABLE 98.—*Saturated or β stage.*

IIβ.

B−e′	$\frac{e}{B}$ .00	.01	.02	.03	.04	.05	.06	B−e′	$\frac{e}{B}$ .00	.01	.02	.03	.04	.05	.06
	$-\left(.06858-.04266\frac{e}{B}\right)\log(B-e')$								$-\left(.06858-.04266\frac{e}{B}\right)\log(B-e')$						
790	.4576	.4548	.4519	.4491	.4462	.4434	.4405	**440**	.4174	.4148	.4122	.4096	.4070	.4044	.4018
780	67	39	10	82	53	25	.4397	**430**	59	33	.4107	81	55	29	.4003
770	58	30	.4501	73	45	16	88	**420**	43	17	.4091	65	40	.4014	.3988
760	49	21	.4492	64	36	.4408	79	**410**	26	.4100	75	49	23	.3998	72
750	40	12	84	55	27	.4399	71	**400**	.4109	.4083	58	32	.4006	81	56
740	31	.4503	75	46	18	90	62	**390**	.4092	66	41	.4015	.3990	64	39
730	22	.4494	66	37	09	81	53	**380**	74	49	23	.3998	73	47	22
720	12	84	56	28	.4400	72	44	**370**	56	31	.4005	80	55	30	.3904
710	.4502	74	46	18	.4390	62	34	**360**	37	.4012	.3987	61	36	.3911	.3886
700	.4493	65	37	.4409	81	53	25	**350**	.4017	.3992	67	42	17	.3892	67
690	83	55	27	.4399	71	44	16	**340**	.3997	72	47	23	.3898	73	48
680	73	45	17	90	62	34	.4306	**330**	77	52	27	.3903	78	53	28
670	63	35	.4407	80	52	24	.4296	**320**	56	31	.3907	.3882	57	33	.3808
660	52	24	.4397	69	41	14	86	**310**	34	.3909	.3885	60	36	.3811	.3787
650	42	14	87	59	31	.4304	76	**300**	.3912	.3887	63	39	.3814	.3790	66
640	31	.4403	76	48	21	.4293	66	**290**	.3888	64	40	.3816	.3791	67	43
630	20	.4392	65	37	.4310	82	55	**280**	64	40	.3816	.3792	68	44	.3720
620	.4409	82	54	27	.4299	72	44	**270**	39	.3815	.3791	67	43	.3720	.3696
610	.4398	71	43	16	89	61	34	**260**	.3813	.3789	66	42	.3718	.3694	71
600	87	60	33	.4305	78	51	23	**250**	.3787	63	40	.3716	.3693	69	46
590	76	49	22	.4294	67	40	13	**240**	59	36	.3712	.3689	66	42	.3619
580	64	37	.4310	83	55	28	.4201	**230**	.3730	.3707	.3683	60	37	.3614	.3591
570	52	25	.4298	71	44	17	.4190	**220**	.3699	.3676	53	.3630	.3607	.3584	61
560	40	13	86	59	32	.4205	78	**210**	67	44	.3621	.3599	.3576	53	30
550	27	.4300	73	46	19	.4193	66	**200**	34	11	.3589	66	43	21	.3498
540	15	.4288	61	34	.4207	81	54	**190**	.3598	.3576	54	.3531	.3509	.3487	.3464
530	.4302	75	48	22	.4195	68	41	**180**	61	39	17	.3495	.3473	51	29
520	.4289	62	36	.4209	82	56	29	**170**	22	.3500	.3478	56	34	13	.3391
510	76	49	23	.4196	69	43	16	**160**	.3481	.3459	37	16	.3395	.3374	52
500	62	35	.4209	82	56	29	.4103	**150**	36	15	.3394	.3372	51	29	08
490	48	22	.4195	69	42	16	.4089	**140**	.3359	.3368	47	26	05	.3284	.3263
480	34	.4208	81	55	29	.4103	76	**130**	38	17	.3297	.3277	.3257	37	17
470	20	.4194	67	41	15	.4089	62	**120**	.3283	.3263	43	23	03	.3183	.3163
460	.4205	79	53	27	.4100	74	48	**110**	24	04	.3183	.3163	.3143	23	03
450	.4190	.4164	.4138	.4112	.4085	.4059	.4033	**100**	.3158	.3138	.3118	.3098	.3078	.3058	.3038

PROPORTIONAL PARTS.

	8	9	10	11	12	13	14	15	16	17	18	19	20	
1	.8	.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	1
2	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	2
3	2.4	2.7	3.0	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6.0	3
4	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0	4
5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	5
6	4.8	5.4	6.0	6.6	7.2	7.8	8.4	9.0	9.6	10.2	10.8	11.4	12.0	6
7	5.6	6.3	7.0	7.7	8.4	9.1	9.8	10.5	11.2	11.9	12.6	13.3	14.0	7
8	6.4	7.2	8.0	8.8	9.6	10.4	11.2	12.0	12.8	13.6	14.4	15.2	16.0	8
9	7.2	8.1	9.0	9.9	10.8	11.7	12.6	13.5	14.4	15.3	16.2	17.1	18.0	9

	21	22	23	24	25	26	27	28	29	30	31	32	33	
1	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	1
2	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	6.2	6.4	6.6	2
3	6.3	6.6	6.9	7.2	7.5	7.8	8.1	8.4	8.7	9.0	9.3	9.6	9.9	3
4	8.4	8.8	9.2	9.6	10.0	10.4	10.8	11.2	11.6	12.0	12.4	12.8	13.2	4
5	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	5
6	12.6	13.2	13.8	14.4	15.0	15.6	16.2	16.8	17.4	18.0	18.6	19.2	19.8	6
7	14.7	15.4	16.1	16.8	17.5	18.2	18.9	19.6	20.3	21.0	21.7	22.4	23.1	7
8	16.8	17.6	18.4	19.2	20.0	20.8	21.6	22.4	23.2	24.0	24.8	25.6	26.4	8
9	18.9	19.8	20.7	21.6	22.5	23.4	24.3	25.2	26.1	27.0	27.9	28.8	29.7	9

TABLE 99.—*Saturated or β stage.*

IIIβ.

t=T−273	$\frac{e'}{B-e'}$ .00	.01	.02	.03	.04	.05	.06
	$+\left[\frac{497.5}{T}-.4404-\left(\frac{309.4}{T}-.2739\right)\frac{e}{B}\right]\frac{e'}{B-e'}$						
0	.0000	.0137	.0273	.0407			
1	0	137	272	405			
2	0	136	270	403			
3	0	135	269	401			
4	0	135	268	399			
5	0	134	266	397	.0526		
6	0	133	265	395	524		
7	0	133	264	393	521		
8	0	132	263	392	519		
9	.0000	132	261	390	516	.0641	
10		131	260	388	514	638	
11		130	259	386	512	635	
12		130	258	384	509	632	.0754
13		129	257	382	507	629	750
14		128	255	381	504	626	747
15		128	254	379	502	624	743
16		127	253	377	500	621	740
17		127	252	375	497	618	736
18		126	251	374	495	615	733
19		.0125	250	372	493	612	730
20			248	370	490	609	726
21			247	369	488	606	723
22			246	367	486	604	720
23			245	365	484	601	717
24			244	363	482	598	713
25			243	362	479	595	710
26			.0242	360	477	593	407
27				359	475	590	703
28				357	473	587	700
29				355	471	585	697
30				.0354	.0469	582	694
35						.0569	.0679

CORRECTION TO BE SUBTRACTED FROM IIIβ WHEN $\frac{e'}{B-e'} < \frac{e}{B}$

$\frac{e'}{B-e'}$	$\frac{e}{B}$ .00	.01	.02	.03	.04	.05	.06
.00	.0000	.0001	.0002	.0002			
.01		0	1	2	.0002	.0003	
.02			0	2	3	5	.0006
.03				0	2	5	7
.04					0	3	8
.05						0	4
.06							0

PROPORTIONAL PARTS

	137	136	135	134	133	132	131
1	13.7	13.6	13.5	13.4	13.3	13.2	13.1
2	27.4	27.2	27.0	26.8	26.6	26.4	26.2
3	41.1	40.8	40.5	40.2	39.9	39.6	39.3
4	54.8	54.4	54.0	53.6	53.2	52.8	52.4
5	68.5	68.0	67.5	67.0	66.5	66.0	65.5
6	82.2	81.6	81.0	80.4	79.8	79.2	78.6
7	95.9	95.2	94.5	93.8	93.1	92.4	91.7
8	109.6	108.8	108.0	107.2	106.4	105.6	104.8
9	123.3	122.4	121.5	120.6	119.7	118.8	117.9

	130	129	128	127	126	125	124
1	13.0	12.9	12.8	12.7	12.6	12.5	12.4
2	26.0	25.8	25.6	25.4	25.2	25.0	24.8
3	39.0	38.7	38.4	38.1	37.8	37.5	37.2
4	52.0	51.6	51.2	50.8	50.4	50.0	49.6
5	65.0	64.5	64.0	63.5	63.0	62.5	62.0
6	78.0	77.4	76.8	76.2	75.6	75.0	74.4
7	91.0	90.3	89.6	88.9	88.2	87.5	86.8
8	104.0	103.2	102.4	101.6	100.8	100.0	99.2
9	117.0	116.1	115.1	114.3	113.4	112.5	111.6

	123	122	121	120	119	118	117
1	12.3	12.2	12.1	12.0	11.9	11.8	11.7
2	24.6	24.4	24.2	24.0	23.8	23.6	23.4
3	36.9	36.6	36.3	36.0	35.7	35.4	35.1
4	49.2	48.8	48.4	48.0	47.6	47.2	46.8
5	61.5	61.0	60.5	60.0	59.5	59.0	58.5
6	73.8	73.2	72.6	72.0	71.4	70.8	70.2
7	86.1	85.4	84.7	84.0	83.3	82.6	81.9
8	98.4	97.6	96.8	96.0	95.2	94.4	93.6
9	110.7	109.8	108.9	108.0	107.1	106.2	105.3

	116	115	114	113	112	111	110
1	11.6	11.5	11.4	11.3	11.2	11.1	11.0
2	23.2	23.0	22.8	22.6	22.4	22.2	22.0
3	34.8	34.5	34.2	33.9	33.6	33.3	33.0
4	46.4	46.0	45.6	45.2	44.8	44.4	44.0
5	58.0	57.5	57.0	56.5	56.0	55.5	55.0
6	69.6	69.0	68.4	67.8	67.2	66.6	66.0
7	81.2	80.5	79.8	79.1	78.4	77.7	77.0
8	92.8	92.0	91.2	90.4	89.6	88.8	88.0
9	104.4	103.5	102.6	101.7	100.8	99.9	99.0

TABLE 100.—*Freezing or γ stage, e_0=4.57, and saturated.*

$$-\overset{\mathrm{II}\gamma}{\left(.06858-.04266\frac{e}{B}\right)}\log(B-e_0)+\overset{\mathrm{III}\gamma}{\left[\frac{547.2}{T}-.4404-\left(\frac{340.4}{T}-.2739\right)\frac{e}{B}\right]\frac{e_0}{B-e_0}}-\overset{\mathrm{IV}\gamma}{\left[49.78\frac{e}{B}+18.82\frac{e^2}{B^2}\right]\frac{1}{T}}=C\gamma$$

II γ.

[NOTE.—IIγ is identical with IIβ.]

III γ.

t=T−273	$\frac{e_0}{B-e_0}$						
	.005	.006	.007	.008	.009	.010	.020
	$+\left[\frac{547.2}{T}-.4404-\left(\frac{340.4}{T}-.2739\right)\frac{e}{B}\right]\frac{e_0}{B-e_0}$						
0	.0078	.0093	.0109	.0124	.0140	.0155	.0309

CORRECTION TO BE SUBTRACTED FROM IIγ WHEN $\frac{e_0}{B-e_0}<\frac{e}{B}$

$\frac{e_0}{B-e_0}$	$\frac{e}{B}$						
	.00	.01	.02	.03	.04	.05	.06
.00	.0000	.0001	.0002	.0003	.0005	.0006	.0007
.01		0	1	2	3	4	6
.02			0	2	4	7	10
.03				0	3	7	11

IV γ.

t=B−273	$\frac{e}{B}$						
	.00	.01	.02	.03	.04	.05	.06
	$-\left[49.78\frac{e}{B}+18.82\frac{e^2}{B^2}\right]\frac{1}{T}$						
0	.0000	.0018	.0037	.0055	.0074	.0093	.0112

PROPORTIONAL PARTS.

	15	16	18	19
1	1.5	1.6	1.8	1.9
2	3.0	3.2	3.6	3.8
3	4.5	4.8	5.4	5.7
4	6.0	6.4	7.2	7.6
5	7.5	8.0	9.0	9.5
6	9.0	9.6	10.8	11.4
7	10.5	11.2	12.6	13.3
8	12.0	12.8	14.4	15.2
9	13.5	14.4	16.2	17.1

TABLE 101.—*Frozen or δ stage, e″ <4.57, and saturated.*

Iδ. IIδ. IIIδ.

$$\left(.2374+.4743\frac{e}{B}+.145\frac{e^2}{B^2}\right)\log T-\left(.06858-.04266\frac{e}{B}\right)\log(B-e'')+\left[\frac{547.2}{T}-.4404-\left(\frac{349.4}{T}-.2739\right)\frac{e}{B}\right]\frac{e''}{B-e''}=C\delta.$$

t=T−273	e/B .00	.01	.02	.03	.04	.05	.06	t=T−273	e/B .00	.01	.02	.03	.04	.05	.06
	$\left(.2374+.4743\frac{e}{B}+.145\frac{e^2}{B^2}\right)\log T$								$\left(.2374+.4743\frac{e}{B}+.145\frac{e^2}{B^2}\right)\log T$						
−70	1.2613	1.2866	1.3120	1.3376	1.3633	1.3892	1.4153								
−60	728	983	240	498	757	1.4018	282								
−59	739	1.2994	251	509	769	030	294	−29	1.3051	1.3312	1.3575	1.3840	1.4106	1.4374	1.4644
−58	750	1.3006	262	521	781	043	306	−28	060	322	585	850	117	385	655
−57	761	017	274	533	793	055	319	−27	070	332	595	860	127	396	666
−56	772	028	285	544	805	067	331	−26	080	342	605	871	138	406	677
−55	783	039	297	556	816	079	343	−25	089	352	615	881	148	417	687
−54	794	051	308	568	828	091	355	−24	099	362	625	891	159	427	698
−53	805	062	319	579	840	103	367	−23	108	371	635	901	169	437	708
−52	815	072	330	590	852	115	379	−22	118	381	645	911	179	448	719
−51	826	083	341	602	864	127	391	−21	128	391	655	921	190	459	730
−50	837	094	353	613	876	139	403	−20	137	400	665	931	200	469	741
−49	848	105	364	624	887	151	415	−19	146	410	674	941	210	479	751
−48	858	116	375	635	898	162	427	−18	155	419	684	951	220	489	761
−47	869	127	386	647	910	174	439	−17	165	429	694	961	230	500	772
−46	879	137	397	658	921	186	451	−16	174	438	703	970	239	510	782
−45	890	148	408	669	933	197	463	−15	183	447	713	980	249	520	792
−44	900	159	419	680	944	209	475	−14	192	456	722	1.3990	259	530	803
−43	910	169	429	691	955	220	486	−13	202	466	732	1.4000	269	540	813
−42	921	180	440	702	966	231	497	−12	211	476	741	009	279	550	823
−41	931	190	451	713	977	243	509	−11	220	485	751	019	289	560	833
−40	941	200	461	723	988	254	520	−10	229	494	760	028	299	570	843
−39	951	211	472	734	1.3999	265	531	−9	238	503	770	038	309	580	853
−38	961	221	482	745	1.4010	276	543	−8	247	512	779	047	318	590	863
−37	971	232	493	756	021	287	555	−7	256	521	788	057	328	600	873
−36	981	242	503	766	032	298	566	−6	265	530	797	066	337	609	883
−35	1.2991	252	513	777	042	309	577	−5	273	539	807	076	347	619	893
−34	1.3001	262	523	787	053	320	588	−4	282	548	816	085	356	629	903
−33	011	272	534	797	064	331	600	−3	291	557	825	094	366	638	913
−32	021	282	544	808	075	342	611	−2	300	566	834	104	376	648	923
−31	031	292	555	819	085	353	622	−1	308	575	843	113	385	658	933
−30	1.3041	1.3302	1.3565	1.3829	1.4096	1.4363	1.4633	0	1.3317	1.3584	1.3852	1.4122	1.4394	1.4667	1.4943

PROPORTIONAL PARTS.

	8	9	10	11	12	13	253	254	255	256	257	258	259	260	261	
1	.8	.9	1.0	1.1	1.2	1.3	25.3	25.4	25.5	25.6	25.7	25.8	25.9	26.0	26.1	1
2	1.6	1.8	2.0	2.2	2.4	2.6	50.6	50.8	51.0	51.2	51.4	51.6	51.8	52.0	52.2	2
3	2.4	2.7	3.0	3.3	3.6	3.9	75.9	76.2	76.5	76.8	77.1	77.4	77.7	78.0	78.3	3
4	3.2	3.6	4.0	4.4	4.8	5.2	101.2	101.6	102.0	102.4	102.8	103.2	103.6	104.0	104.4	4
5	4.0	4.5	5.0	5.5	6.0	6.5	126.5	127.0	127.5	128.0	128.5	129.0	129.5	130.0	130.5	5
6	4.8	5.4	6.0	6.6	7.2	7.8	151.8	152.4	153.0	153.6	154.2	154.8	155.4	156.0	156.6	6
7	5.6	6.3	7.0	7.7	8.4	9.1	177.1	177.8	178.5	179.2	179.9	180.6	181.3	182.0	182.7	7
8	6.4	7.2	8.0	8.8	9.6	10.4	202.4	203.2	204.0	204.8	205.6	206.4	207.2	208.0	208.8	8
9	7.2	8.1	9.0	9.9	10.8	11.7	227.7	228.6	229.5	230.4	231.3	232.2	233.1	234.0	234.9	9

	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	
1	26.2	26.3	26.4	26.5	26.6	26.7	26.8	26.9	27.0	27.1	27.2	27.3	27.4	27.5	27.6	1
2	52.4	52.6	52.8	53.0	53.2	53.4	53.6	53.8	54.0	54.2	54.4	54.6	54.8	55.0	55.2	2
3	78.6	78.9	79.2	79.5	79.8	80.1	80.4	80.7	81.0	81.3	81.6	81.9	82.2	82.5	82.8	3
4	104.8	105.2	105.6	106.0	106.4	106.8	107.2	107.6	108.0	108.4	108.8	109.2	109.6	110.0	110.4	4
5	131.0	131.5	132.0	132.5	133.0	133.5	134.0	134.5	135.0	135.5	136.0	136.5	137.0	137.5	138.0	5
6	157.2	157.8	158.4	159.0	159.6	160.2	160.8	161.4	162.0	162.6	163.2	163.8	164.4	165.0	165.6	6
7	183.4	184.1	184.8	185.5	186.2	186.9	187.6	188.3	189.0	189.7	190.4	191.1	191.8	192.5	193.2	7
8	209.6	210.4	211.2	212.0	212.8	213.6	214.4	215.2	216.0	216.8	217.6	218.4	219.2	220.0	220.8	8
9	235.8	236.7	237.6	238.5	239.4	240.3	241.2	242.1	243.0	243.9	244.8	245.7	246.6	247.5	248.4	9

TABLE 102.—*Frozen or δ stage.*

IIδ.

[NOTE.—IIδ is identical with IIβ.]

IIIδ.

t=T−273	$\frac{e''}{B-e''}$ .001	.002	.003	.004	.005	.006	.007	.008	.009	.010	.020
	$+\left[\frac{547.2}{T}-.4404-\left(\frac{340.4}{T}-.2739\right)\frac{e}{B}\right]\frac{e''}{B-e''}$										
−70	.0023										
−60	21										
−50	20										
−40	19	.0038									
−30	18	36	.0054	.0072	.0090						
−20	17	34	52	69	86	.0103	.0120	.0137	.0154	.0171	.0340
−10	16	33	49	65	82	98	114	130	147	163	324
0	.0016	.0031	.0047	.0062	.0078	.0093	.0109	.0124	.0140	.0155	.0309

CORRECTION TO BE SUBTRACTED FROM IIIδ WHEN $\frac{e''}{B-e''} < \frac{e}{B}$

$\frac{e''}{B-e''}$	$\frac{e}{B}$ .00	.01	.02	.03	.04	.05	.06
.00	.0000	.0001	.0002	.0003	.0005	.0006	.0007
.01		0	1	2	3	4	6
.02			0	2	4	7	10
.03				0	3	7	11

PROPORTIONAL PARTS.

	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
1	.6	.7	.8	.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	1
2	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	2
3	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6.0	6.3	6.6	6.9	3
4	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0	8.4	8.8	9.2	4
5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	5
6	3.6	4.2	4.8	5.4	6.0	6.6	7.2	7.8	8.4	9.0	9.6	10.2	10.8	11.4	12.0	12.6	13.2	13.8	6
7	4.2	4.9	5.6	6.3	7.0	7.7	8.4	9.1	9.8	10.5	11.2	11.9	12.6	13.3	14.0	14.7	15.4	16.1	7
8	4.8	5.6	6.4	7.2	8.0	8.8	9.6	10.4	11.2	12.0	12.8	13.6	14.4	15.2	16.0	16.8	17.6	18.4	8
9	5.4	6.3	7.2	8.1	9.0	9.9	10.8	11.7	12.6	13.5	14.4	15.3	16.2	17.1	18.0	18.9	19.8	20.7	9

TABLE 103.—*Grams of aqueous vapor in a kilogram of saturated air.*

$$\mu = 622\frac{e}{B} + 235\frac{e^2}{B^2}$$

t	e	B							e
		800	700	600	500	400	300	200	
−50	.03	.023	.027	.031	.037	.047	.062	.093	.030
−49	.03	.026	.030	.035	.042	.053	.070	.106	.034
−48	.04	.030	.035	.040	.049	.061	.081	.121	.039
−47	.04	.034	.039	.046	.055	.068	.091	.137	.044
−46	.05	.039	.044	.052	.062	.078	.104	.156	.050
−45	.06	.044	.051	.059	.071	.088	.118	.177	.057
−44	.06	.050	.057	.066	.080	.100	.132	.199	.064
−43	.07	.056	.064	.075	.090	.112	.149	.224	.072
−42	.08	.063	.072	.084	.101	.126	.168	.252	.081
−41	.09	.070	.080	.093	.112	.140	.187	.280	.090
−40	.10	.078	.089	.103	.124	.155	.207	.311	.100
−39	.11	.085	.097	.113	.136	.169	.226	.339	.109
−38	.12	.093	.106	.124	.149	.187	.249	.373	.120
−37	.13	.103	.118	.138	.165	.207	.276	.414	.133
−36	.15	.114	.131	.152	.183	.229	.305	.457	.147
−35	.17	.128	.147	.171	.205	.256	.342	.513	.165
−34	.19	.144	.164	.192	.230	.287	.384	.575	.185
−33	.21	.161	.184	.215	.258	.322	.429	.644	.207
−32	.23	.179	.205	.238	.286	.358	.477	.715	.230
−31	.26	.199	.228	.266	.318	.398	.531	.796	.256
−30	.28	.221	.253	.294	.353	.442	.589	.883	.284
−29	.32	.245	.280	.327	.392	.490	.653	.980	.315
−28	.35	.272	.311	.363	.435	.544	.728	1.09	.350
−27	.39	.302	.346	.403	.484	.605	.809	1.21	.389
−26	.43	.336	.384	.448	.537	.672	.896	1.34	.432
−25	.48	.372	.425	.496	.595	.746	.990	1.49	.478
−24	.53	.411	.469	.547	.657	.821	1.10	1.64	.528
−23	.58	.453	.517	.603	.724	.906	1.21	1.81	.582
−22	.64	.498	.569	.666	.796	.996	1.33	1.99	.640
−21	.71	.549	.628	.734	.877	1.10	1.46	2.20	.706
−20	.78	.607	.694	.809	.971	1.21	1.62	2.43	.781
−19	.86	.671	.767	.896	1.08	1.34	1.79	2.69	.863
−18	.95	.740	.846	.990	1.18	1.48	1.97	2.97	.952
−17	1.04	.811	.927	1.08	1.30	1.62	2.17	3.25	1.043
−16	1.14	.884	1.01	1.18	1.42	1.78	2.37	3.55	1.140
−15	1.25	.971	1.11	1.29	1.55	1.94	2.59	3.88	1.246
−14	1.36	1.06	1.21	1.41	1.69	2.12	2.83	4.25	1.362
−13	1.49	1.16	1.33	1.55	1.86	2.32	3.10	4.65	1.492
−12	1.64	1.27	1.46	1.70	2.04	2.55	3.40	5.10	1.636
−11	1.79	1.39	1.59	1.86	2.24	2.79	3.73	5.60	1.794
−10	1.96	1.52	1.74	2.04	2.44	3.05	4.08	6.10	1.961
− 9	2.14	1.66	1.90	2.22	2.66	3.33	4.45	6.68	2.138
− 8	2.33	1.81	2.07	2.42	2.90	3.63	4.84	7.25	2.327
− 7	2.53	1.97	2.26	2.63	3.16	3.95	5.27	7.94	2.534
− 6	2.76	2.15	2.45	2.87	3.44	4.30	5.74	8.63	2.761
− 5	3.01	2.34	2.68	3.12	3.75	4.69	6.24	9.38	3.009
− 4	3.28	2.55	2.92	3.40	4.08	5.11	6.81	10.25	3.276
− 3	3.56	2.78	3.17	3.70	4.44	5.56	7.43	11.15	3.564
− 2	3.87	3.02	3.44	4.03	4.83	6.04	8.07	12.13	3.874
− 1	4.21	3.28	3.75	4.37	5.25	6.56	8.75	13.19	4.207
0	4.57	3.56	4.07	4.75	5.70	7.12	9.51	14.30	4.568

The vapor pressure *e* is taken from Marvin's Tables below 0°C.

TABLE 103.—*Grams of aqueous vapor in a kilogram of saturated air*—Continued.

$$\mu = 622\frac{e}{B} + 235\frac{e^2}{B^2}$$

t	e	B					
		800	700	600	500	400	300
0	4.57	3.56	4.07	4.75	5.70	7.12	9.51
1	4.91	3.83	4.37	5.10	6.13	7.67	10.24
2	5.27	4.11	4.69	5.48	6.58	8.24	11.00
3	5.66	4.41	5.04	5.88	7.07	8.85	11.81
4	6.07	4.73	5.41	6.31	7.58	9.49	12.68
5	6.51	5.08	5.80	6.77	8.13	10.18	13.60
6	6.97	5.44	6.22	7.26	8.72	10.91	
7	7.47	5.83	6.66	7.77	9.34	11.69	
8	7.99	6.23	7.13	8.32	10.00	12.52	
9	8.55	6.68	7.63	8.91	10.70	13.40	
10	9.14	7.14	8.16	9.53	11.44	14.33	
11	9.77	7.62	8.72	10.18	12.24	15.32	
12	10.43	8.15	9.32	10.88	13.08	16.38	
13	11.14	8.71	9.96	11.62	13.97	17.50	
14	11.88	9.29	10.63	12.41	14.91	18.69	
15	12.67	9.91	11.34	13.24	15.91	19.94	
16	13.51	10.58	12.09	14.12	16.97		
17	14.40	11.28	12.89	15.05	18.10		
18	15.33	12.01	13.73	16.04	19.29		
19	16.32	12.79	14.62	17.09	20.55		
20	17.36	13.61	15.57	18.20	21.88		
21	18.47	14.49	16.57	19.37			
22	19.63	15.40	17.63	20.60			
23	20.86	16.37	18.75	21.90			
24	22.15	17.40	19.93	23.28			
25	23.53	18.49	21.17	24.73			
26	24.96	19.64	22.48				
27	26.47	20.84	23.86				
28	28.07	22.12	25.31				
29	29.74	23.44	26.84				
30	31.51	24.86	28.46				
31	33.37	26.35	30.17				
32	35.32	27.92	31.98				
33	37.37	29.56	33.88				
34	39.52	31.30	35.87				
35	41.78	33.12	37.97				
36	44.16	35.04	40.18				
37	46.65	37.07	42.50				
38	49.26	39.19	44.94				
39	52.00	41.42	47.51				
40	54.87	43.76	50.20				

The vapor pressure e is taken from Broch's Tables above 0°C.

TABLE 104.—*Tabulated values of* $\frac{v'}{R}\,2v$, *and* $\frac{v'}{R}\cot\theta\,2v$.

$$\frac{v'}{R}\,.\,2v = n\sin\theta\,.\,2v = S.$$

$$\frac{v'}{R}\,.\,\cot\theta\,.\,2v = n\cos\theta\,.\,2v = n\sin(90^\circ-\theta)\,.\,2v = S.$$

[For equations 194 and 200.]

North polar distance. θ		2v									
		10	20	30	40	50	60	70	80	90	100
		S									
°	°										
90	0	.000729	.001458	.002188	.002917	.003646	.004375	.005104	.005834	.006563	.007292
89	1	729	1458	2187	2916	3646	4375	5104	5833	6562	7291
88	2	729	1458	2186	2915	3644	4373	5102	5830	6559	7288
87	3	728	1456	2185	2913	3641	4369	5097	5826	6554	7282
86	4	727	1455	2182	2910	3637	4364	5091	5819	6547	7274
85	5	726	1453	2179	2906	3632	4358	5085	5811	6538	7264
84	6	725	1450	2176	2901	3626	4351	5076	5802	6527	7252
83	7	724	1448	2171	2895	3619	4343	5067	5790	6514	7238
82	8	722	1444	2166	2888	3610	4333	5055	5777	6499	7221
81	9	720	1440	2161	2881	3601	4321	5041	5762	6482	7202
80	10	718	1436	2154	2872	3590	4309	5027	5745	6463	7181
79	11	716	1432	2147	2863	3579	4295	5011	5726	6442	7158
78	12	713	1427	2140	2853	3566	4280	4993	5706	6420	7133
77	13	710	1421	2132	2842	3552	4263	4974	5684	6394	7105
76	14	707	1415	2123	2830	3538	4245	4953	5660	6368	7075
75	15	704	1409	2113	2817	3522	4226	4931	5635	6340	7044
74	16	701	1402	2103	2804	3505	4206	4907	5608	6309	7010
73	17	697	1395	2092	2790	3487	4184	4882	5579	6277	6974
72	18	693	1387	2080	2774	3468	4161	4854	5548	6242	6935
71	19	689	1379	2068	2758	3448	4137	4826	5516	6206	6895
70	20	685	1370	2056	2741	3426	4111	4796	5482	6167	6852
69	21	681	1362	2042	2723	3404	4085	4766	5446	6127	6808
68	22	676	1352	2028	2704	3380	4057	4733	5409	6085	6761
67	23	671	1342	2014	2685	3356	4027	4698	5370	6041	6712
66	24	666	1332	1999	2665	3331	3997	4663	5330	5996	6662
65	25	661	1322	1983	2644	3304	3965	4626	5287	5948	6609
64	26	655	1311	1966	2622	3277	3932	4588	5243	5899	6554
63	27	650	1299	1949	2599	3248	3898	4548	5198	5847	6497
62	28	644	1288	1931	2575	3219	3863	4507	5150	5794	6438
61	29	638	1276	1913	2551	3189	3827	4465	5102	5740	6378
60	30	632	1263	1894	2526	3158	3789	4421	5052	5683	6315
59	31	625	1250	1875	2500	3126	3751	4376	5001	5626	6251
58	32	618	1237	1855	2474	3092	3710	4329	4947	5566	6184
57	33	612	1223	1835	2446	3058	3669	4281	4893	5504	6116
56	34	605	1209	1814	2418	3022	3627	4232	4836	5440	6045
55	35	597	1195	1792	2389	2986	3584	4181	4778	5376	5973
54	36	590	1180	1770	2360	2950	3539	4129	4719	5309	5899
53	37	582	1165	1747	2330	2912	3494	4077	4658	5242	5824
52	38	575	1149	1724	2298	2873	3448	4022	4597	5171	5746
51	39	567	1133	1700	2267	2834	3400	3967	4534	5100	5667
50	40	559	1117	1676	2234	2793	3352	3910	4469	5027	5586
49	41	550	1101	1651	2201	2752	3302	3852	4402	4953	5503
48	42	542	1084	1626	2168	2710	3251	3793	4335	4877	5419
47	43	533	1067	1600	2133	2666	3200	3733	4266	4800	5333
46	44	524	1049	1574	2098	2622	3147	3672	4196	4720	5245
45	45	.000516	.001031	.001547	.002062	.002578	.003094	.003609	.004125	.004640	.005156

TABLE 104.—*Tabulated values of* $\frac{v'}{R}\,2v$, *and* $\frac{v'}{R}\cot\theta\,2v$.—Continued.

$$\frac{v'}{R}\,.\,2v = n\sin\theta\,.\,2v = S.$$

$$\frac{v'}{R}\,.\,\cot\theta\,.\,2v = n\cos\theta\,.\,2v = n\sin(90^\circ-\theta)\,.\,2v = S.$$

[For equations 194 and 200.]

North polar distance. θ		2v									
		10	20	30	40	50	60	70	80	90	100
		S									
°	°										
45	45	.000516	.001031	.001547	.002062	.002578	.003094	.003609	.004125	.004640	.005156
44	46	506	1013	1520	2026	2532	3039	3546	4052	4558	5065
43	47	497	995	1492	1989	2486	2984	3481	3978	4476	4973
42	48	488	976	1464	1952	2440	2927	3415	3903	4391	4879
41	49	478	957	1435	1914	2392	2870	3349	3827	4306	4784
40	50	469	937	1406	1875	2344	2812	3281	3749	4218	4687
39	51	459	918	1377	1836	2294	2753	3212	3671	4130	4589
38	52	449	898	1347	1796	2244	2693	3142	3591	4040	4489
37	53	439	878	1316	1755	2194	2632	3071	3510	3949	4388
36	54	429	857	1286	1714	2143	2571	3000	3429	3857	4286
35	55	418	837	1255	1673	2092	2510	2928	3346	3765	4183
34	56	408	816	1223	1631	2039	2447	2855	3262	3670	4078
33	57	397	794	1192	1589	1986	2383	2780	3178	3575	3972
32	58	386	773	1159	1546	1932	2318	2705	3091	3478	3864
31	59	376	751	1127	1502	1878	2254	2629	3005	3380	3756
30	60	365	729	1094	1458	1823	2188	2552	2917	3281	3646
29	61	354	707	1060	1414	1768	2121	2474	2828	3181	3535
28	62	342	685	1027	1369	1712	2054	2396	2738	3081	3423
27	63	331	662	993	1324	1656	1987	2318	2649	2980	3311
26	64	320	639	957	1279	1598	1918	2238	2558	2877	3197
25	65	308	616	924	1233	1541	1849	2157	2466	2774	3082
24	66	297	593	890	1186	1483	1780	2076	2373	2669	2966
23	67	285	570	855	1140	1424	1709	1994	2279	2564	2849
22	68	273	546	820	1093	1366	1639	1912	2185	2459	2732
21	69	261	523	784	1045	1306	1568	1829	2090	2352	2613
20	70	249	499	748	998	1247	1496	1746	1995	2245	2494
19	71	237	475	712	950	1187	1424	1662	1899	2137	2374
18	72	225	451	676	901	1126	1352	1577	1802	2028	2253
17	73	213	426	640	853	1066	1279	1492	1705	1919	2132
16	74	201	402	603	804	1005	1206	1407	1608	1809	2010
15	75	189	377	566	755	944	1132	1321	1510	1698	1887
14	76	176	353	529	706	882	1058	1235	1411	1587	1764
13	77	164	328	492	656	820	984	1148	1312	1476	1640
12	78	152	303	455	606	758	910	1061	1213	1364	1516
11	79	139	278	417	556	696	835	974	1113	1252	1391
10	80	127	253	380	506	633	760	886	1013	1139	1266
9	81	114	228	342	456	570	685	799	913	1027	1141
8	82	102	203	304	406	508	609	711	812	914	1015
7	83	89	178	267	356	444	533	622	711	800	889
6	84	76	152	229	305	381	457	533	610	686	762
5	85	64	127	191	254	318	381	445	509	572	636
4	86	51	102	153	204	254	305	356	407	458	509
3	87	38	76	115	153	191	229	267	305	344	382
2	88	25	51	76	102	127	152	178	203	229	254
1	89	13	25	38	51	64	76	89	102	114	127
0	90	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000

TABLE 105.—*Tabulated values of* $\frac{uv}{R}$.

u	v									
	10	20	30	40	50	60	70	80	90	100
10	.000016	.000031	.000047	.000063	.000078	.000094	.000110	.000126	.000141	.000157
20	31	63	94	126	157	188	220	251	283	314
30	47	94	141	188	235	283	330	377	424	471
40	63	126	188	251	314	377	440	502	565	628
50	78	157	235	314	392	471	549	628	706	785
60	94	188	283	377	471	565	659	754	848	942
70	110	220	330	440	549	659	769	879	989	1099
80	126	251	377	502	628	754	879	1005	1130	1256
90	141	283	424	565	706	848	989	1130	1272	1413
100	.000157	.000314	.000471	.000628	.000785	000942	.001099	.001256	.001413	.001570

TABLE 106.—*Tabulated values of* $\frac{\cot\ \theta}{R}\ u\ v$.

$u\ v$	θ									
	1°	10°	20°	30°	40°	50°	60°	70°	80°	90°
100	.000899	.000089	.000043	.000027	.000019	.000013	.000009	.000006	.000003	.000000
200	1799	178	86	54	37	26	018	11	6	
300	2698	267	129	82	56	40	27	17	8	
400	3597	356	173	109	75	53	36	23	11	
500	4497	445	216	136	94	66	45	29	14	
600	5396	534	259	163	112	79	54	34	17	
700	6295	623	302	190	131	92	63	40	19	
800	7195	712	345	218	150	105	72	46	22	
900	8094	801	388	245	168	119	82	51	25	
1000	8994	890	431	272	187	132	91	57	28	
1100	9893	979	474	299	206	145	100	63	30	
1200	10792	1068	517	326	224	158	109	69	33	
1300	11692	1157	560	354	243	171	118	74	36	
1400	12591	1246	604	381	262	184	127	80	39	
1500	13490	1335	647	408	281	198	136	86	42	
1600	14390	1424	690	435	299	211	145	91	44	
1700	15289	1514	733	462	318	224	154	97	47	
1800	16188	1603	776	490	337	237	163	103	50	
1900	17088	1692	819	517	355	250	172	108	53	
2000	17987	1781	863	544	374	263	181	114	55	
2100	18886	1870	906	571	393	277	190	120	58	
2200	19786	1959	949	598	411	290	199	126	61	
2300	20685	2048	992	625	430	303	208	131	64	
2400	21584	2137	1035	653	449	316	217	137	66	
2500	.022484	.002226	.001078	.000680	.000468	.000329	.000226	.000143	.000069	.000000

THE PRIMARY FUNDAMENTAL CONSTANTS.

1–46. In Tables 62–64 are presented the adopted notation and the constants in tabular form for the metric (kilogram-meter-second-centigrade degree) system, and also for the English (pound-foot-second Fahrenheit degree) system, in parallel columns. After the selection of the primary constants, upon which everything else depends, there are a series of derived constants (8–46, Tables 63, 64), whose definition and construction are indicated by formulæ. This is, in fact, more exact by way of definition than any verbal description can be, and it serves to condense our knowledge into the most compact form. These defining formulæ are therefore relied upon to take the place here of the extended descriptions occurring in the general treatises. These two tables contain about all the fundamental definitions needed in meteorology. For convenience, the logarithms of

the constants are placed beside them, as it will generally be their logarithms that the computer uses in his combinations.

It is seen that the constants adopted conform very closely to those of the International Tables, which will probably remain standard until the definitive values are reached. These constants will, however, serve for practical computations, even if the last decimals of the final constants are slightly modified from those here accepted. The references for the fundamental constants are recapitulated on Table 62. A convenient summary of the present status of the determination of the "Constants and units" used in meteorology may be found in the Monthly Weather Review for December, 1896, by Prof. CLEVELAND ABBE.

6, 7 (Table 63). The weights per unit volume of water, mercury, dry air, and aqueous vapor, and also the weight of the atmosphere in four systems, computed in two ways, namely, through the height of the mercury column and also through that of the homogeneous atmosphere, are given in Table 63. From the adopted constants for mass and length, the size, gravitation, and angular velocity of rotation of the earth (8-16) are developed in Table 64, with some forms that frequently occur in the dynamic equations; from the mass per unit volume and specific weight (17, 18) are found the barometric pressure (19), the height of the homogeneous atmosphere (20), the barometric constant (21), the Newtonian velocity of sound in air (22), the coefficient of expansion varying with the density (23), the pressure of the atmosphere in units of force and in units of weight (24, 25), the volume of air per unit mass, the equation of elasticity, and the mass of air (26-28). In Table 64 are also given the thermodynamic quantities used in connection with the atmosphere, namely, the coefficient of expansion (29), the humidity constant (30), the absolute temperature (31), the heat units (32), the heat equivalent of work and the mechanical equivalent of heat (33), some specific gravities (34), gas constants (35), certain products (36), the total quantities of heat required to raise the mass of the unit volume through one degree (37), the specific heats (38), some ratios (39), exponents (40), vertical temperature gradients (41), latent heats (42), vapor pressures and constants for the horizontal gradients (43-46). In the gradient formulæ (41) for English measures the British thermal units have been reduced to calories, because this heat unit is alone practically in use among meteorologists. Such cross connections between the two systems are unscientific. In Table 65 are collected numerous equivalent expressions for ratios of the variations of the pressure to density, 47*a*-47*b*; also a series for the variations of gradient force in terms of the constants (48). The gradients in terms of the units of force are arranged by themselves, the seventeen expressions there recorded being each equivalent to $-\frac{1}{\rho}\frac{dP}{dx}$, and mutually to one another in many combinations. The same is true of the gradient in terms of the units of weight, though only a few expressions are inserted, since this form of computation is much less frequently employed. The detailed steps for finding the barometric gradient constants per degree of the great circle, 111111 meters, are given for P and p in the metric system. The corresponding English constants are found by multiplying these by 3.937, since 1 millimeter = 3.937 hundredths inches.

THE HYPSOMETRIC FORMULÆ AND THE TABLES 91, 92, 93.

In view of the fact that there are already many forms of formulæ for reducing pressures from one height to another, differing among themselves only in minor points, it is important to justify the introduction of new formulæ for this purpose by some criticism of those now accessible. It may be said in general that none of the published tables are quite in form for efficient service in analytical discussions of the cloud problem now before us. Their defects are twofold—that (1) they do not extend to sufficient altitudes, and (2) the humidity correction is not worked out and treated separately by itself. Since it has been decided to adhere closely to the system of constants adopted by the international committee, it is necessary to allude chiefly to the International Tables of 1890 and the Smithsonian Tables of 1893. As to height, the International Table VII (A) ends at 2,000 meters and VIII (A) at 6,750 feet. But it is necessary to be able to make the reductions for pressure in the cloud work at least up to 15,000 meters, or 49,000 feet. In the same way Smithsonian Table 17 ends at 3,000 meters and Table 14 at 9,000 feet These have been sufficient for the Rocky Mountain plateau reductions, but the extension of our investigation to the upper cloud levels demands larger facilities.

There is another serious inconvenience which may be mentioned by way of introduction to the second objection, namely, that since the fundamental formula is essentially exponental, $B_o = B\,10^m$, or $\log B_o = \log B + m$, where m is the exponent depending upon the height of the air column and the variations of its density with the temperature, humidity, and gravity, this term should always be kept as a correction to the logarithm, and not be employed merely as an intermediate argument in finding the correction, $B_o - B$. Now, the International and the Smithsonian Tables not only make m an intermediate argument and thus obscure its evaluation as a direct function in practical work, but they further cover it up in constructing the tables by multiplying it with an arbitrary factor which wholly destroys its natural values. Thus International Tables VII (D) and VIII (D) use 1,000 meters, and the Smithsonian Tables 17 and 14 use 2,000 meters. It is believed to be important to adhere to the simple formula as closely as possible, so that in practice its proper working shall be immediately before the mind.

The other objection mentioned is that the humidity and gravity terms are constructed as corrections to the arguments 1,000 meters and 2,000 meters rather than as corrections immediately applicable to the log B. In this way it becomes impossible to follow the β and the γ function as direct functions of the pressure change. Especially is it important to so construct these terms that the amount by which they separately affect the pressure reduction may be known. Whatever law is adopted for the humidity variation with the altitude, we ought to treat it in such a way, as a term by itself in the equation of condition, that in the course of research residuals can be found from which a correction to the assumed law may be computed. As a result of my discussion of this subject an equation of the following form has been constructed (see Table 91):

$$\log B_o = \log B + m - \beta m - \gamma m$$

where m is a function of the difference of the height and the mean temperature of the corresponding air column, β a function of the height, pressure, and vapor tension, and γ a function of gravity, depending upon the latitude and altitude. I desire to acknowledge here the profit I have derived from the studies of the first barometer board of the Weather Bureau, and also the other authorities already cited.

Two or three other points should also be mentioned in favor of these new tables:

(1) There has always been much difficulty in discussing the effect of the vapor tension upon the pressure of an air column, because of the impractical task of observing what the vapor contents is at different points through the column from top to bottom, which can be integrated into a summation of such pressure. It has been customary to take the mean of the values for the vapor observed at the upper and the lower station, or else to take merely an average value for the column without attempting to specify particular points. When there are no observations at an upper station on the above theory there is nothing to be done with the vapor term, and this often is the case even when barometric reductions must be made, as on the Rocky Mountain plateau, to the sea level. There is, however, a principle which greatly facilitates the practical treatment of this question. It will be shown that the ratio $\frac{e}{B}$ changes from the ground upward by a well-defined law, which can be determined by ascensions with meteorographs or even by computations on cloud heights, so that a ratio $\frac{e_1}{B_1}$ for a level at a given height above the lower level can be taken out from a table. (See Chapter 12, Table 136, III.) Thus if $\frac{e_1}{B_1}$ is observed at a higher station, $\frac{e}{B}$ can be at once found for the lower station, and this is the ratio $\frac{e_o}{B_o}$ which enters into the auxiliary formulæ 69, 70. Most of the practical work of reduction from a higher to a lower station is done within the limits of that table, namely, 2,500 meters, but there is no reason why the limits should not be greatly extended if required. Since these corrections were determined directly from the results of the kite ascensions, it is purely an empirical correction, and applies strictly to the conditions which actually occur within the lower layers of the atmosphere. This method opens up a new way for attacking that very difficult part of the problem of hypsometry.

(2) Another practical point to improve upon consists in avoiding the restricted character given to hypsometric tables when put in the form of correction of the actual barometric reading to the sea level, $B_o - B = B\,(10^m - 1)$. (Smithsonian Tables 16, 17, and International Table VIII, D.) When one starts from an upper station whose pressure is B, and reduces to a lower level B_o, the table works on its own merits. But when, on the other hand, it is necessary to reduce from the sea level B_o up to the level B, then one is required to go through the process at least twice, first approximately to obtain B near enough for an entry argument, and then again more closely for final reduction. Besides doubling the labor of reducing upward, the whole aspect of these tables is very awkward when the purpose for which they were especially constructed is not strictly followed. In a word, these tables *reduce downward but not upward*, and they have not the flexibility which adheres to the logarithmic construction, where

$$\log B_o = \log B + m - \beta m - \gamma m$$
$$\log B = \log B_o - m + \beta m + \gamma m$$

Under this type of formation, however, the same table serves with equal precision for reductions at once upward and downward, since it makes no difference whether the ratio $\frac{e}{B}$ to determine β is made at the upper or the lower station, since the ratio at the lower station can always be readily found.

(3) Another advantage of the tables which have here been constructed consists in the following fact: The quantities h = height, θ = temperature, m = logarithmic exponent, are so interrelated that when two are given the other can be found.

$$\log B_o = \log B + m_1 \qquad m_1 = m - \beta m - \gamma m$$
$$\log B = \log B_o - m_1 \qquad m = m_1 + \beta m_1 + \gamma m_1$$

Now, since m can be computed when the two B's are given, the height can be extracted from the Table m through the arguments (θ, m); when h and m are given we can find θ, the mean temperature of the air column. Hence it is obvious that we do not need such Tables as 20 to 34, inclusive, given in the Smithsonian collection. Where the two pressures are given, and the height between the points at which they occur is required, we have $\log B_o - \log B = m_1$, and the formula is conveniently taken for determining the tabular m, as $m = m_1 + \beta m_1 + \gamma m_1$, which is approximately correct, instead of $m = m_1 + \beta m + \gamma m$, from which it differs but very little in practical work. Entering Table 91 with $(\theta\,.\,m)$ as arguments the corresponding h is found. In fact, the m table, with the subordinate tables βm, γm, are competent to do all the work that the Laplace formula is capable of without further minute modifications. Our m table has been so far expanded as to make the second differences disappear and the interpolation very easy. In short, it is considered advantageous to be able to compress into these three tables, besides the ordinary table of common logarithms, all the reductions which can arise in the extensive computations comprised in the discussion of cloud observations.

49–62, Table 66, gives the orderly development of the hypsometric formulæ, which can be readily followed by those familiar with this subject. In connection with the auxiliary formulæ in the table of fundamental constants, the several equivalent expressions can be readily verified, and by easy transformations and substitutions the successive sets of formulæ are derived.

The resulting forms are for—

The Metric System:

$$\log B_o = \log B + \frac{h - h_o}{18429 + 67.6\,\theta^o + 0.003\,h}(1-\beta)(1-\gamma) = \log B + m - m\beta - m\gamma.$$

The English System:

$$\log B'_o = \log B' + \frac{h - h_o}{56517 + 123.3\,\theta^o + 0.003\,h}(1-\beta)(1-\gamma) = \log B' + m' - m'\beta' - m'\gamma'.$$

THE HUMIDITY TERM.

As already mentioned the term expressing the pressure of the aqueous vapor in the air column should be so treated as to contribute its part directly to the reduction of the pressure from one station to another, rather than as a slight modification of the argument intervening in the auxiliary tables, as was done in the International and in the Smithsonian Tables. The general law adopted to express the diminution of vapor tension with the altitude is HANN'S formula, $e=e_o\,10^{-\frac{h}{6517}}$, e_o being the vapor tension at the ground and h the height expressed in meters. This may be modified as the result of the cloud work, but it can be assumed as the average variation, subject to modification upon sufficient evidence. It is not, however, closely applicable to special cases in the lower strata of the atmosphere, arising from inversion of temperature and overheating. The formula $B=B_o\,10^{-\frac{h}{18400}}$ has just been deduced for the diminution of the air pressure with the altitude. Four forms are given (63–65, Table 67) referring these laws to meters and feet; also to the bases of common and Napierian logarithms, together with the four expressions for the ratio $\frac{e}{B}$. The values of e_o are to be taken with the argument of the dew point temperature at the lower station from BROCH'S Tables for temperatures above the freezing point; and from MARVIN'S Tables for temperatures below the freezing point. Since the MARVIN vapor pressures differ from the JUHLIN values by nearly a constant, from 0° temperature to the lowest, it was decided to use MARVIN'S determination in preference to JUHLIN'S, for this reason, namely, that MARVIN'S observed vapor pressure at zero degrees join on to the BROCH value, $e_o=4.568$ *m.m.*, for $t_s=0°$C, the temperature of saturation without any discontinuity, while the JUHLIN value shows a sharp dislocation in the series at that point, as his value for e_o is 4.602. It is better also to lay at the basis of the development of the humidity term these tables rather than any values of e_o derived from observations made at the several stations in the United States, as has been proposed, because the local conditions play so important a part in the observed values that a general formulæ can not be satisfactorily constructed to cover them completely. The local vertical gradients of vapor pressure should be expressed, when known, as a variation of the adopted constant in the exponent. From these formulæ the ratio $\frac{e}{B}$ can be found for any given height h, and hence for every point in the air column whose length is h. Compare, however, the results of the cloud work, in Chapter 12. The integral mean, 66, is therefore taken for two cases, base 10 and h in feet, base ε and h in meters, for $\beta=.378\frac{e}{B}$. The development is shown in detail for the forms in the English and the metric systems. The series converges rather slowly (67–70) but in forming the Table 92 it was carried out beyond the possibility of any important error. Evidently two tables (92*a*, 92*b*), suffice for forming β, the first for $.378\frac{e_o}{B_o}$ with the arguments e_o and B_o; and the second with the arguments $.378\frac{e_o}{B_o}$ and h in $\left[1-\frac{1}{2!}\left(\frac{h}{4383}\right)+\frac{1}{3!}\left(\frac{h}{4383}\right)^2-\ldots\right]$. This value of β is multiplied into m, and a table (92*c*) is constructed for βm, which is the correction to the logarithm of the pressure B, due to the vapor tension in the column. It always tends to diminish the total pressure of the atmosphere. A very close value of this vapor tension in millimeters or hundredths inch may be obtained in the following manner: Inspect the number of units in the fifth place of logarithms in the ordinary tables required to pass on the average through 1 millimeter or hundredth inch from the log B to the log B_o, say 16, 15, or 14 in English measures in the lower atmosphere, and divide the value of βm by this number for the vapor pressure.

THE GRAVITY TERM.

The gravity term has been treated in the manner indicated in the formulæ, and with the usual precept for latitude, needs no further explanation here (Table 93). The metric tables have been constructed for use up to 15,000 meters, and the English up to 10,000 feet, the former being intended to be used generally in the cloud work, and the latter on the Rocky Mountain plateau

and in the Weather Bureau service, whenever English units are employed. These tables, in the form here given, have been expanded into shape for easy interpolation. The 1 degree and the 100 meter intervals in Table 91 are suitable for easy use, the second differences being unimportant. The second differences in the vertical columns are very small and are not needed in interpolating. These tables are intended for definitive work, when exact results are needed. Whenever approximate reductions are sufficient, the Smithsonian Tables seem to be convenient within the limits to which they extend, since they include an average humidity correction, and are so expanded as to make interpolation easy. It is, however, impossible to disentangle the humidity term, or know what weight it has in the reduction and this is unfavorable to their use in our cloud reductions. It may be remarked that in the case of using the humidity term in the unsaturated stage—that is, between the ground and the base of a cloud, or in the hypothetical air column substituted for a plateau, since $\frac{e_o}{B_o}=\frac{e}{B}$ approximately, we may use the observed ratio $\frac{e}{B}$ at the plateau station, instead of computing $\frac{e_o}{B_o}$ for the sea level. That is, any one value of $\frac{e}{B}$ serves usually for that of the mean air column $h-h_o$.

EXAMPLES OF REDUCTION TO SEA LEVEL BY THE INTERNATIONAL, SMITHSONIAN, WEATHER BUREAU, AND HAZEN TABLES.

Some examples of reduction to the sea level by the International, Smithsonian, Weather Bureau, and the HAZEN Tables, in the English and the metric systems of measures, respectively, are given in detail, to illustrate the methods employed, especially in the operation of the arguments. It will be observed that the results in the Weather Bureau Tables agree with the International Tables, but tend to give slightly higher values of the sea level pressures than the Smithsonian Tables. It may be remarked that the original data, in the case of the humidity term does not play precisely the same function in the Weather Bureau formulæ as in the Smithsonian Tables. In the former case it is the value at one station from which reduction begins; in the latter it is the assumed mean value for the entire air column. It is thought that this use of the observed value of the vapor pressure at one station, instead of a conjectural value for the column, may prove to be an advantage in studying the humidity problem, since only the general law of vertical variation is assumed in the actual variation from the adiabatic law. It may sometimes be necessary to modify the HANN law, especially in the peculiar conditions attending high and low pressure areas, in summer and and winter, in the forenoon and afternoon, in warm and cold waves, as our knowledge of these subjects is gradually extended. It is especially to be noted in the case of the Weather Bureau Tables that the humidity term stands apart by itself, and its value in contributing to the reduction is immediately available for discussion by comparing the computed values with observations and analyzing the residuals. This is of the utmost importance in the ultimate solution of the cloud and the hypsomectric problems.

TABLE 107.—*Examples of reduction to the sea level by the International, Smithsonian, Weather Bureau, and the Hazen Tables, in the English measures and the metric measures.*

h	2200	3250	4439	5290	7000	670.6	990.6	1353.0	1612.4	2133.6
B	27.38	26.78	25.54	24.59	23.22	695.5	680.2	648.7	624.6	589.8
θ	36°.2	22°.4	57°.74	19°.5	13°.5	2°.3	−5°.3	14°.3	−6°.9	−10°.3
e	0.155	0.077	0.477	0.052	0.043	3.98	2.15	12.12	1.51	1.28
φ	54°	44°	32°	40°	35°	54°	44°	32°	40°	35°
Tables and arguments.	ENGLISH.				INTERNATIONAL TABLES.				METRIC.	
VIII (A) (θ . h .)	86.58	134.53	174.23	229.59		86.59	134.60	174.22	229.54	
VIII (D) (m . β .)	2.37	3.60	4.45	5.65		60.2	91.5	113.0	143.4	
B_o	29.75	30.38	29.99	30.24		755.7	771.7	761.7	768.0	
$B_\theta = \frac{B+B_o}{2}$	28.57	28.58	27.77	27.42		725.6	726.0	705.2	696.3	
VIII (B) (B_θ . e .)	2.05	1.04	6.50	0.69		2.1	1.1	6.5	0.8	
VIII (B') (m . A .)	−0.18	−0.145	−1.23	−0.18		−0.2	−0.2	−1.3	−0.2	
VIII (C) (m . φ)	+0.07	−0.013	−0.21	−0.11		+0.1	0.0	−0.2	−0.1	
m_o	86.47	134.37	172.79	229.30		86.5	134.3	172.7	229.2	
(m_o . B_θ)	2.37	3.60	4.41	5.64		60.2	91.3	112.1	143.2	
B_o	29.75	30.38	29.95	30.23		755.7	771.5	760.8	767.8	
Tables and arguments.	ENGLISH.				SMITHSONIAN TABLES.				METRIC.	
Table 14. (θ . h .)	71.8	109.4	138.5	179.1	240.1	71.8	109.4	138.5	179.1	24.00
Table 15. (m . φ)	+0.1	0.0	−0.2	−0.1	−0.2	+0.1	0.0	−0.2	−0.1	−0.2
Table 16. ($m_o B$)	2.36	3.60	4.41	5.63	7.39	60.0	91.3	112.0	143.0	187.5
B_o	29.74	30.38	29.95	30.22	30.61	755.5	771.5	760.7	767.6	777.3
Tables and arguments.	ENGLISH.				WEATHER BUREAU TABLES.				METRIC.	
log B	1.43743	1.42781	1.40722	1.39076	1.36586	2.84230	2.83264	2.81204	2.79560	2.77070
(θ . h) m	+.03607	+.05482	+.06974	+.08977	+.12028	+.03608	+.05483	+.06974	+.08974	+.12027
Arguments. (e . B) α	.0022	.0011	.0071	.0008	.0007	.0022	.0012	.0070	.0009	.0008
Arguments. (α . h) β	.0021	.0010	.0061	.0007	.0006	.0020	.0011	.0061	.0008	.0006
β . m	−.00007	−.00005	−.00043	−.00006	−.00007	−.00007	−.00006	−.00043	−.00007	−.00007
γ . m	+.00003	.00000	−.00008	−.00004	−.00011	+.00002	.00000	−.00008	−.00004	−.00011
log B_o	1.47346	1.48258	1.47645	1.48044	1.48596	2.87833	2.88741	2.88127	2.88523	2.89079
B_o	29.75	30.38	29.95	30.23	30.62	755.7	771.6	760.8	767.8	777.7
Tables and arguments.	ENGLISH.				HAZEN'S TABLES.					
(θ . h)	2.38	3.54	4.43	5.55	7.16					
B_o	29.76	30.32	29.97	30.14	30.38					

The reduction by the HAZEN Tables, Professional Tables of the Signal Service, No. VI, 1882, which are still used by the Weather Bureau in forming the daily weather maps, is seen to differ widely from all the others. As already pointed out by Mr. PARK MORRILL, this is due to the fact that in order to reduce all the corrections to a single table with the arguments (θ . h .), the variation with the pressure has been sacrificed, so that only along one diagonal can the tables be correct; that is to say, where the reduced sea-level value is 30.00 inches. Furthermore, the HAZEN formula is deduced from a few individual cases obtained by comparing the observed values at neighboring high mountain and low valley stations, and it is an *empirical formula* rather than one deduced from a general law and fundamental constants. In this formula the humidity term can not be set apart for discussion. Also in the practice of the Weather Bureau reductions certain of the Rocky Mountain plateau stations have received such arbitrary corrections to the observed temperatures which serve as the argument for the table as will make the reduced pressures produce a smooth system of isobars in those districts. The adopted reduction temperature argument is the mean of the surface current observation and the one preceding it by twelve hours, as $\frac{8\text{ p. m.}+8\text{ a. m.}}{2}$ for the morning map, and $\frac{8\text{ a. m.}+8\text{ p. m.}}{2}$ for the evening map, plus

an empirical and arbitrary correction. In consequence of the employment of this empirical method of reducing the barometer readings to sea level, the values given on weather maps are not available for immediate employment in accurate scientific discussions, though they serve fairly well in forecasting.

THE GENERAL THERMODYNAMIC FORMULÆ.

A compact body of the thermodynamic formulæ (71–78, Table 68) employed in meteorology has been collected, depending upon the constants (29–46, Table 64). The construction of the primary equation

$$dQ = C_v\ dt + A\ p\ dv.$$

is well understood to express the quantity of heat energy consumed in the change of the internal temperature of the mass, plus the heat energy employed in expansion against an outside pressure. For the adiabatic changes $dQ=0$. Thence are found the leading relations by means of the auxiliary formulæ, which are successively substituted in the equations. Under exponential relations (79–84) are given in parallel columns, for volume and for pressure, the systems of exponential formulæ commonly developed, referring to 29–46, for the notation. The system begins by using the first of the thermodynamic relations. A few vertical gradient relations follow (89–91), showing the variations of temperature with the height, temperature with the pressure, and density with the height, in dry air. Others might be added, but meteorological problems must generally be treated specifically, to suit the conditions of the atmosphere.

Next are given the adiabatic relations in the exponential form. To designate the constituents of the atmosphere the notation of HERTZ has been generally adopted, though somewhat modified, and is set forth in detail in 92, Table 69. Let us assume an *exploring kilogram* 1,000 grams, containing a mixture of dry air λ, and aqueous vapor μ, in the unsaturated stage α. The number of thousandths of a kilogram of λ and μ, respectively, or grams, are given in terms of the pressure of the atmosphere p, and of the aqueous vapor e, these being the barometric pressures. Since these values of p . e . define the number of grams λ . μ . in the original kilogram, they are constant throughout the series of changes, no matter what subsequent variable states the contents of the exploring kilogram may pass through, provided it does not lose or gain material, and that pseudo-adiabatic conditions are excluded. It may be noted that since (24, 25)

$$P = g_o \rho_m B = \quad 133.32 B = C.B$$
$$p = \quad \sigma_m B = 13595.8\ B = C'.B, \qquad \text{We have, } \frac{dP}{P} = \frac{dp}{p} = \frac{dB}{B}.$$

Hence the transformation from one system of pressure to another is readily made. We will carry through the formulæ in terms of p, and transfer to terms of B in constructing the working tables. The symbols used are carefully defined in connection with the formulæ where they are first employed (93–101, Table 69).

If this system of notation be substituted in the formulæ of the following papers—

Zeit. Oest. Gesell. Met. 1874, IX, pp. 321 et seq. J. HANN.
Zeitschrift für Met. 1875, X, pp. 56–58. L. SOHNCKE.
Lehrbuch der Meteorologie, 1885, p. 166 et seq. A. SPRUNG.
Report C. S. O. 1885. Recent Advances in Meteorology, p. 43 et seq. W. FERREL—

it will be found that they all reduce to the exponential forms given, 106–109. Thus the results of the work of FERREL, HANN, SPRUNG, and SOHNCKE may be taken as equivalent the one to the other. On the other hand the logarithmic development shown (110–127, Table 70) represents the results of these two other important papers—

Meteorologische Zeitschrift, 1884, vol. 1, pp. 421–431. H. HERTZ.
Sitzungsberichte der König Preuss. Akademie der Wissenschaften zu Berlin: 1888, April 26, pp. 485–522. W. VON BEZOLD—

reduced to the same notation and expanded through all the important steps, together with the necessary auxiliary formulæ. This does not include the pseudo-adiabatic conditions, which, as VON

BEZOLD shows, require an additional term in the several stages from that of saturation upward, though it is very difficult to evaluate it.

It is necessary to call attention only to one point beyond the explanations given in the original papers. The notation for the vapor pressure is as follows, as shown in 92:

e is the vapor pressure of the mass μ within the kilogram in its initial condition, and μ remains constant throughout the transformations, the contents being retained. $\frac{e}{B}$ is a constant, and this ratio defines the mixture within the exploring kilogram. As this kilogram rises up through the unsaturated stage, the vapor pressure becomes e', on entering the saturated stage, and then μ begins to turn into water. Throughout this stage e' falls till it reaches the value $e_0=4.57$ at freezing temperature, and $\mu=\nu+\nu_1=$the vapor plus the water (92). In the freezing stage e_0 is constant, and ν_1 is turning into ice, so that $\mu=\nu+\nu_1+\sigma=$vapor, plus water, plus ice. Below freezing temperatures we use e'' for the vapor pressure, and have $\mu=\nu+\sigma=$vapor plus ice. This employment of e . e' . e_0 . e'' in the α . β . γ . δ stages is very convenient, as it tends to avoid any confusion in the determination of λ . μ . ν . σ . Other details in the formation of these equations may be readily obtained from the HERTZ and the VON BEZOLD papers.

It can be shown that the exponential forms are transposed into the logarithmic forms by simple substitutions (128–133, Table 71), an example of which is given for the β stage. Hence we conclude that *all the papers reviewed come to the same result* in treating the adiabatic transformations of the atmospheric. This is interesting, since we are enabled to make one system of formulæ the substitute for such an extensive discussion as is given in the original papers.

BIGELOW'S DEVELOPMENT OF FORMULÆ AND TABLES FOR PRACTICAL WORK.

It is to be observed that comparatively little use has been made of this strong body of meteorological formulæ in practical work. In the exponential forms, 92–109, they are not convenient, and in the HERTZ logarithmic forms, 110–127, the formulæ are very laborious to employ in specific cases. I have therefore sought a simple form of development, and have constructed some tables to facilitate their use. The laborious computations necessary to form tables 94–103 have been very skillfully and zealously performed by Mr. H. H. KIMBALL of the Weather Bureau, whose services are hereby cordially acknowledged. To him also belongs the credit of computing, at certain wide intervals, the hypsometric tables from the formulæ above deduced, and generally assisting in developing the new tables. In applications to cloud work the vapor pressure terms and the quantities μ . ν . ν_1 . σ must all be rigorously treated. Now, unfortunately, the HERTZ diagram was constructed by neglecting certain terms, notably μ in comparison with λ, and e in comparison with p, in certain places, whereby the accuracy of the diagram is sacrificed, so that it can not be employed in precise determinations.

Passing now to the use of the barometric pressures in millimeters B e, it is shown (134–143, Table 72) how all the auxiliary terms in the logarithmic forms can be reduced to functions of B . T . e, barometric pressure, absolute temperature, and vapor pressure. These being substituted in the formulæ of the several stages, we find the adiabatic equations there given for the five stages as defined (144–148). It was found necessary to use $\frac{e^2}{B^2}$ in the formulæ, in order to insure accuracy to the fourth place of the decimals in the constants. The construction of the tables is clear, since the successive terms of the formulæ are called Iα IIα in the unsaturated stage, Iβ IIβ IIIβ in the saturated stage, IIγ IIIγ IVγ in the freezing stage, and Iδ IIδ IIIδ in the frozen stage.

TABLE 108.

Unsaturated or α stage.

$$\overset{\text{Ia}}{(\lambda\, C_p+\mu\, C_p)} \log T-\overset{\text{IIa}}{(\lambda\, AR+\mu\, AR_1)} \log B=\text{Constant.}$$

[TO COMPUTE THE CONSTANT FOR THE α STAGE.]

	Hertz formula		W. B. tables	Hertz diagram	Hertz formula		W. B. tables	Hertz diagram	Hertz formula		W. B. tables	Hertz diagram
h	0				0				0			
t	30°				20				10			
T	303°				293				283			
B	760 mm				760				760			
e $RH=50\%$	15.76 mm				8.68				4.57			
$\frac{e}{B}$			.02074				.0114				.0060	
μ 13.00					7.13				3.74			
	log	Number			log	Number			log	Number		
λ	2.99432	987.00			2.99690	992.87			2.99837	996.26		
C_p	9.37549				9.37549				9.37549			
$\lambda\, C_p$	2.36981	234.32			2.37239	235.72			2.37386	236.52		
μ	1.11394	13.00			0.85309	7.13			0.57287	3.74		
C_p	9.68169				9.68169				9.68169			
$\mu\, C_p$	0.79563	6.25			0.53478	3.43			0.25456	1.80		
$\lambda\, C_p+\mu\, C_p$	2.38125	240.57			2.37667	239.15			2.37716	238.32		
$N \log T$	0.75692	5.71373			0.75436	5.68017			0.75170	5.64545		
I	3.13817	+1374.58	+1.3745		3.13303	+1358.41	+1.3583		3.12886	+1345.42	+1.3454	
AR	8.83622				8.83622				8.83622			
$\lambda\, AR$	1.83054	67.693			1.83312	68.096			1.83459	68.327		
AR_1	9.04243				9.04243				9.04243			
$\mu\, AR_1$	0.15637	1.433			9.89552	.786			9.61530	.417		
$\lambda\, AR+\mu\, AR_1$	1.83964	69.126			1.83810	69.882			1.83720	68.739		
$N \log B$	0.82173	6.63332			0.82173				0.82173			
II	2.66137	− 458.53	− .4584		2.65983	−456.91	− .4568		2.65893	− 455.97	− .4559	
Constant		+ 916.05	+ .9161			+901.5	+ .9015			+ 889.5	+ .8895	
TO FIND THE SATURATION TEMPERATURE t_s.												
Assume:												
$t_s=16°$, $e=13.51$					$t_s=7$, $e=7.47$				$t_s=-2$, $e=3.874$			
I			+1.3631				+1.3474				+1.3349	
			+ .9161				+ .9015				+ .8895	
II			− .4470				− .4459				− .4454	
B			643.5				648.2				652.0	
$\frac{e}{B}$			.0210				.0115				.0059	
Assume:												
$t_s=15°$, $e=12.67$					$t_s=6$, $e=6.97$				$t_s=-1$, $e=4.207$			
I			+1.3622				+1.3466				+1.3359	
			+ .9161				+ .9015				+ .8895	
II			− .4461				− .4451				− .4464	
B			635.8				640.9				662.0	
$\frac{e}{B}$			.0199				.0109				.0064	
Interpolate:												
26÷110=0.2					10÷64=.2				1÷5=.2			
$t_s=15.80$ $e=13.34$			15.8	16.0	$t_s=6.8$	$e=7.36$	6.8	7.0	$t_s=-1.8$	$e=3.940$	−1.8	−2.4
$T=288.8$					$T=279.8$				$T_s=271.2$			
$N \log T_s$	0.75326	5.66574			0.75082	5.63407			0.74841	5.60286		
I	3.13451	1363.0	+1.3629		3.12949	1347.4	+1.3473		3.12557	1335.3	+1.3352	
		916.0	+ .9161			901.5	+ .9015			889.5	+ .8895	
II	2.65031	−447.0	− .4468		2.64924	−445.9	− .4458		2.64914	−445.8	− .4457	
$N \log B$	0.81067	6.46650			0.81114	6.47350			0.81194	6.48543		
B		643.2	643	650.0		647.7	467	650		655.6	655	654
$\frac{e}{B}$			.02074				.0114				.0060	

TABLE 108—Continued.

Saturated or β Stage.

I β II β III β

$$(\lambda C_p+\mu C_1)\log T-\lambda AR\log(B-e')+\lambda\frac{R}{R_1}\left[\frac{r}{T}\frac{e'}{B-e'}\right]=\text{Constant.}$$

TO COMPUTE THE CONSTANT FOR THE β STAGE.

	Hertz formula		W. B. Tables	Hertz diagram	Hertz formula		W. B. Tables	Hertz diagram	Hertz formula	W. B. Tables	Hertz diagram
t		15.8				6.8					
T		288.8				279.8					
B		643				647					
e'		13.34				7.36					
$\frac{e}{B}$			**.02074**				**.0114**				
$\frac{e'}{B-e'}$			**.0212**				**.0115**				
	log	Number			log	Number					
λ	2.99432	987.00			2.99690	992.87					
C_p	9.37549				9.37549						
λC_p	2.36981	234.32			2.37239	235.72					
μC_1		13.00				7.13					
$\lambda C_p+\mu C_1$	2.39326	247.32			2.38534	242.85					
$N\log T$	0.75326	5.66574			0.75082	5.63407					
I	3.14652	+1401.26	+1.4011		3.13616	+1368.22	+ 1.3682				
AR	8.83622				8.83622						
λAR	1.83054				1.83312						
$N\log(B-e')$	0.80927	6.44572	− .4363		0.81033	6.46147					
II	2.63981	− 436.32			2.64345	− 440.0	− .4399				
λ	2.99432				2.99690						
$\frac{R}{R_1}$	9.79379				9.79379						
r	2.77474	595.3			2.77873	600.8					
e'	1.12516				0.86688						
$\lambda\frac{R}{R_1}re'$	6.68801				6.43630						
T	2.46060				2.44685						
$B-e'$	2.79934				2.80618						
$T(B-e')$	5.25994				5.25303						
III	1.42807	+ 26.80	+ .0268		1.18327	+ 15.25	+ .0153				
Constant		+ 991.7	+ .9916			+ 943.5	+ .9436				

TO FIND THE PRESSURE ON ENTERING THE FREEZING STAGE.

$t=0$, $e=4.57$											
$T=273$											
$N\log T$	0.74892	5.60947			0.74892						
I	3.14218	+1387.32	+1.3872		3.13426	+1362.3	+ 1.3622				
Constant		+ 991.7	+ .9916			+ 943.5	+ .9436				
II+III		− 395.6	− .3956			− 418.8	− .4186				
Assume:											
$B-e'$			430				554				
$\frac{e'}{B-e'}$			**.0106**				**.0083**				
$N\log(B-e')$	0.78275	6.06379	− .4105		0.80052	6.31716					
II	2.61329	− 410.5			2.63364	− 430.2	− .4301				
r	2.76283	606.5			2.78283	606.5					
e'	0.65992				0.65992						
$\lambda\frac{R}{R_1}re'$	6.23086				6.23344						
T	2.43616				2.43616						
$B-e'$	2.63347				2.74351						
$T(B-e')$	5.06963				5.17967						
III	1.16123	+ 14.5	+ .0145		1.05377	+ 11.3	+ .0113				
II+III		− 396.0	− .3960			− 418.9	− .4188				
Assume:											
$B-e'$			428				553				
$\frac{e'}{B-e'}$			**.0107**				**.0083**				
$N\log(B-e')$	0.78242	6.05912			0.80040	6.31536					
II	2.61296	− 410.2	− .4102		2.63352	− 430.0	− .4300				
$B-e'$	2.63144				2.74273						
III	1.16326	+ 14.6	+ .0146		1.05299	11.3	+ .0113				
II+III		− 395.6	− .3956			− 418.7	− .4187				
Interpolate B		432.5	432.5	440		557.5	557.5	557			

TABLE 108—Continued.

Freezing or γ stage.

$$\overset{\text{II}\,\gamma}{-\lambda\, A\, R \log (B-e_0)} + \overset{\text{III}\,\gamma}{\lambda \frac{R}{R_1}\left(\frac{r_0+q}{T_0}\,\frac{e_0}{B-e_0}\right)} - \overset{\text{IV}\,\gamma}{\frac{\mu q}{T_0}} = \text{Constant.}$$

TO FIND THE PRESSURE AT THE END OF THE γ STAGE.

	Hertz formula		W. B. tables	Hertz diagram	Hertz formula		W. B. tables	Hertz diagram	Hertz formula	W. B. tables	Hertz diagram
Const. = IIβ+IIIβ		−395.6	−.3956			−418.8	−.4186				
t		0				0					
T_0		273				273					
B		432.5				557.5			At the beginning of the γstage q is taken =0.		
$B-e_0$		428.0				553					
e_0		4.57				4.57					
$\frac{e}{B}$			**.0207**				**.0114**				
Assume:											
$B-e_0$			420				550				
$\frac{e_0}{B-e_0}$			**.0109**				**.0083**				
λ	2.99432				2.99690						
AR	8.83622				8.83622						
$N \log (B-e_0)$	0.78106	6.04025			0.80002	6.30992					
II	2.61160	−408.9	−.4089		2.63314	−429.7	−.4296				
λ	2.99432				2.99690						
$\frac{R}{R_1}$	9.79379				9.79379						
r_0+q	2.83666	686.525			2.83666						
e_0	0.65992				0.65992						
$\lambda \frac{R}{R_1}(r_0+q)\, e_0$	6.28469				6.28727						
T_0	2.43616				2.43616						
$B-e_0$	2.62325				2.74036						
$T(B-e_0)$	5.05941				5.17652						
III	1.22528	+ 16.8	+.0168		1.11075	+ 12.9	+.0129				
μ	1.11394				0.85309						
q	1.90323				1.90323						
μq	3.01717				2.75632						
T_0	2.43616				2.43616						
IV	0.58101	− 3.8	−.0038		0.32016	− 2.1	−.0021				
Constant		−395.9	−.3959			−418.9	−.4188				
Assume:											
$B-e_0$			419				549				
$\frac{e_0}{B-e_0}$			**.0109**				**.0083**				
$N \log (B-e_0)$	0.78088	6.03787			0.79990	6.30810					
II	2.61142	− 408.7	−.4087		2.63302	−429.6	−.4295				
T_0	2.43616				2.43616						
$B-e_0$	2.62221				2.73957						
$T(B-e_0)$	5.05837				5.17573						
III	1.22632	+ 16.8	+.0168		1.11154	+ 12.9	+.0129				
IV		− 3.8	−.0038			− 2.1	−.0021				
Constant		−395.7	−.3957			−418.8	−.4187				
B		423.0	423.0	430		552.5	552.5	552			

TABLE 108—Continued.

Frozen or δ stage.

I δ II δ III δ

$$(\lambda\, C_p+\mu\, C_1)\log T-\lambda\, AR\log(B-e'')+\lambda\frac{R}{R_1}\left(\frac{r+q}{T}\,\frac{e''}{B-e''}\right)=\text{Constant.}$$

TO COMPUTE THE CONSTANT FOR THE δ STAGE.

	Hertz formula		W. B. tables	Hertz diagram	Hertz formula		W. B. tables	Hertz diagram	Hertz formula		W. B. tables	Hertz diagram
t		0				0				−1.8		
T		273				273				271.2		
B		423.0				552.5				555.3		
$B-e''$		419				548				651.4		
e''		4.57				4.57				3.940		
$\frac{e}{B}$			**.02074**				**.0114**				**.0060**	
$\frac{e''}{B-e''}$			**.0109**				**.0083**				.0061	
	log	Number			log	Number			log	Number		
λ									2.99837			
C_p									9.37549			
$\lambda\, C_p$									2.37386	236.52		
$\mu\, C_1$										3.74		
$\lambda\, C_p+\mu\, C_1$	2.39326				2.38534				2.38068	240.26		
$N\log T$									0.74841	5.60286		
I	From Iβ	+1387.2	+1.3872		From Iβ	+1362.3	+1.3622		3.12909	+1346.1	+1.3461	
AR									8.83622			
$\lambda\, AR$	1.83054				1.83312				1.83459			
$N\log(B-e'')$									0.81152	6.47912		
II	From Iγ	− 408.7	− .4087		From Iγ	− 429.6	−.4295		2.64611	− 442.7	− .4427	
λ									2.99837			
$\frac{R}{R_1}$									9.79379			
$r+q$									2.83746	687.8		
e''									0.59550			
$\lambda\frac{R}{R_1}(r+q)\,e''$									6.22512			
T									2.43329			
$B-e''$									2.81385			
$T(B-e'')$									5.24714			
III	From IIγ	+ 16.8	+ .0168		From IIγ	+ 12.9	+.0129		0.97798	+ 9.5	+ .0095	
Constant.		+ 995.3	+ .9953			+ 945.6	+.9456			+ 912.9	+ .9129	

TO FIND THE PRESSURE FOR A GIVEN TEMPERATURE t.

Assume:												
t	−15°				−20°				−20°			
T	258				253				253			
e''	1.246				.781				.781			
$N\log T$	0.74453	5.55296			0.74299	5.53339			0.74299	5.53339		
I	3.13779	+1373.4	+1.3733		3.12833	+1343.8	+1.3437		3.12367	+1329.5	+1.3295	
II+III		− 378.0	− .3780			− 398.2	− .3981			− 416.6	− .4166	
Assume:												
$B-e''$	300				360				460			
$\frac{e''}{B-e''}$			**.00415**				**.0022**				**.0017**	
$N\log(B-e'')$	0.75616	5.70378			0.76983	5.88610			0.78755	6.13123		
II	2.58670	− 386.1	− .3861		2.60295	− 400.8	− .4008		2.62214	− 418.9	− .4189	
$\lambda\frac{R}{R_1}$	2.78811				2.79069				2.79216			
$r+q$	2.84333	697.147			2.84552	700.685			2.84552	700.685		
e''	0.09552				9.89265				9.89265			
$\lambda\frac{R}{R_1}(r+q)\,e''$	5.72696				5.52886				5.53033			
T	2.41162				2.40312				2.40312			
$B-e''$	2.47712				2.55630				2.66276			
$T(B-e'')$	4.88874				4.95942				5.06588			
III	0.83822	+ 6.9	+ .0069		0.56944	+ 3.7	+ .0037		0.46445	+ 2.9	+ .0029	
II+III		− 379.2	− .3792			− 397.1	− 397.1			− 416.0	− .4160	

TABLE 108—Continued.

Frozen or δ stage—Continued.

I δ II δ III δ

$$(\lambda C_p+\mu C_1)\log T-\lambda AR\log(B-e'')+\lambda\frac{R}{R_1}\left(\frac{r+q}{T}\frac{e''}{B-e''}\right)=\text{Constant.}$$

TO FIND THE PRESSURE FOR A GIVEN TEMPERATURE t—Continued.

	Hertz formula		W. B. tables	Hertz diagram	Hertz formula		W. B. tables	Hertz diagram	Hertz formula		W. B. tables	Hertz diagram
Assume:	log	Number			log	Number			log	Number		
$B-e''$	295				365				464			
$\frac{e''}{B-e''}$			.00422				.00214				.00168	
$N\log(B-e'')$	0.75488	.568696			0.77085	5.89990			0.76816	6.13988		
II	2.58542	− 385.0	− .3850		2.60397	− 401.8	− .4018		2.62275	− 419.5	− .4195	
$(B-e'')$	2.46982				2.56229				2.66652			
$T(B-e'')$	4.88144				4.96541				5.06964			
III	0.84552	+ 7.0	+ .0070		0.56345	+ 3.7	+ .0036		0.46069	+ 2.9	+ .0029	
II+III		− 378.0	− .3780			− 398.1	− .3982			− 416.6	− .4166	
B		296.2	296.2	302		365.8	365.8	372		464.8	464.8	470

EXAMPLES OF THE COMPUTATION OF THE α β γ δ STAGES BY THE LOGARITHMIC FORMULÆ, AND BY THE WEATHER BUREAU TABLES.

The unsaturated or α stage.

Three examples, the data for which are given at the head of the columns, are taken to illustrate the use of the Tables 94–103, in comparison with the extended computation which is required by the HERTZ logarithmic formulæ. Confining our exposition to the first example, we begin with $t=30°$, $T=303°$, $B=760$ mm., and $RH=50\%$. From the Smithsonian Table 43, $e=15.76$; hence $\frac{e}{B}=0.02074$. This ratio should be found with accuracy, because it remains constant through all the stages, and upon it the interpolation in the tables depends. The value of μ in grams for the logarithmic formulæ, but in thousandths of a kilogram for the tables, may be taken from Table 103, but the interpolation, on account of the large second differences, is not satisfactory, and μ should generally be computed by the formula,

$$\mu=.622\,\frac{e}{B}+.235\,\frac{e^2}{B^2}.$$

Table 103 serves to show the approximate relations between B . t . e . μ . and is very useful for inspection. Above zero degrees it is the same as the VON BEZOLD table on page 287 of ABBE'S translations, but below zero it varies from that, because Table 103 depends upon the MARVIN values of the vapor pressure. In the example $\lambda=987.00$ and $\mu=13.00$. The logarithms in the formulæ are naperian in all cases. By interpolation from Iα and IIα of the Tables 94 or 95 and 96, the constant is .9161, agreeing with that computed by the formula in the α stage.

To find the saturation temperature.

Instead of adopting the SPRUNG formula, Meteorologie, pp. 52 and 179, which depends upon the MAGNUS Law, we proceed as follows, from the data in hand. It is necessary to find such a value of t_s as substituted in the formulæ of the tables shall produce the constants .02074 and .9161 in the α stage. Assume $t_s=16°$; from this $e=13.51$ at the saturation temperature; interpolate in Iα with arguments $t_s=16$, and $\frac{e}{B}=.02074$, which gives 1.3631; subtract this from .9161 and the difference (−.4470) is the quantity in IIα from which to find the argument $B=643.5$; the ratio

$\frac{e}{B}=.0210$ does not yet agree with .02074. Repeat this process assuming $t_s=15°$, and find $\frac{e}{B}=.0119$. We have,

$$t_s=16°,\ \frac{e}{B}=.02100$$

$$\frac{e}{B}=.02074$$

$$t_s=15°,\ \frac{e}{B}=.01990$$

from which to interpolate the value of t_s corresponding to $\frac{e}{B}=.02074$, $\left(\frac{26}{110}\times 1°=0°.2\right)$; the true $t_s=15.8$. Thence proceed to repeat the process and find confirmation of this value of t_s which gives $\frac{e}{B}=.02074$, and $B=643$.

The saturated or β stage.

These data, $t=15.8$, $B=643$, $e'=13.34$, begins the β stage. It is noted that e has fallen from 15.76 mm. to $e'=13.34$ mm., and that e' will fall from 13.34 mm. to 4.57 mm. in this stage. In the same manner as in the α stage the successive terms are found from the formula and the tables Iβ, IIβ, IIIβ, and produce the constant .9916 for the β stage. Thence to find the pressure on entering the freezing or γ stage, we proceed by trials, as follows: For $t=0$ and $e'=4.57$ from Iβ, we find with the arguments $t=0$ $\frac{e}{B}=.02074$, the value 1.3872; substract this from .9916, and the remainder (−.3956) is the sum of the terms IIβ+IIIβ, which involve the value of the B sought. Assume $B-e'=430$ and compute $\frac{e'}{B-e'}=.0106$; with the arguments $B-e'$ and $\frac{e}{B}$, in IIβ find −.4105, and with $t=0$ and $\frac{e'}{B-e'}=.0106$ in IIIβ find +.0145; the sum is −.3960, but it should be −.3956. Repeat this process with the assumed $B-e'=428$ and the result is −.3956, which is correct, and gives $B=432.5$ as the pressure on entering the freezing temperature. If this assumed value of $B-e'$ were not correct, a simple proportion would give the value by interpolating from the values of IIβ, IIIβ, thus found. This process is rigorous. In the α stage the tables gave $B=643$ and the HERTZ diagram 650, being higher by 7 millimeters, due to the approximations which were introduced in constructing the diagram formulæ. In the β stage the values of B are 432.5 and 440, respectively, a difference of 7.5 mm. These differences are less in the other examples because the the vapor contents there is much less.

The freezing or γ stage.

We enter upon the γ stage with the constant IIβ+IIIβ=−.3956, and the elements found at the end of the β stage. Assume the value of $B-e_o=420$ as the final pressure in the γ stage, and find the component terms from Tables IIγ, IIIγ, IVγ. First compute $\frac{e_o}{B-e_o}=.0109$. Since IIγ=IIβ enter the latter with the arguments $B-e_o$ and $\frac{e}{B}$, which gives −.4089; enter IIIγ with $\frac{e_o}{B-e_o}$ and $t=0$, which gives +.0168; enter IVγ with $\frac{e}{B}$ and $t=0$, and find −.0038. This sum is −.3959, and we needed −.3956. Again assume $B-e_o=419$, and repeat these steps, arriving at the constant −.3957. Interpolating from −.3959 and −.3957, we find $B-e_o=418.5$ for the constant −.3956. This gives $B=423$. The value by the HERTZ diagram is 430, and is an increase of 7 millimeters.

The frozen or δ stage.

The elements $t=0$, $B=423$, $e''=4.57$ are those for entering upon the frozen or δ stage. The ratio $\frac{e}{B}$ is still .02074, and $\frac{e''}{B-e''}$ is .0109. With this data and the arguments $t=0$ and

$\frac{e}{B}$=.02074 enter Iδ and find 1.3872; with the argument $B-e''$ and $\frac{e}{B}$ enter IIδ, which is identical with the IIβ, and find −.4087; with the arguments t and $\frac{e''}{B-e''}$ enter IIIδ and find +.0168. The sum is +.9953, which is the constant for the δ stage. Now, for any given temperature we compute the corresponding pressure by trials and interpolation. Assume $t=-15°$, enter Iδ and find 1.3733; substract from this the constant .9953, and the remainder is the sum of the terms IIδ+IIIδ, to be separated by trial values of $B-e''$. Assume $B-e''=300$ mm., compute $\frac{e''}{B-e''}$=.00415, and enter IIδ and IIIδ, respectively, with the resulting constant −.3792 while we seek to make it −.3780. Assume $B-e''=295$ and find IIδ+IIIδ=−.3780, which agrees with the constant required. Hence $B=295.0+1.2=296.2$. The HERTZ diagram gives $B=302$, greater than the formulæ by 6 mm. in this example.

General remarks.

At all temperatures the value of e, which is a function of t only, is found on Table 103, or Smithsonian Table 43, for the adopted value of the vapor pressures. The corresponding values of μ in grams can be found approximately by interpolation, but it is generally better to compute it accurately at the outset of the computation. Also v v_1 can be found from the formulæ. It will be observed that we have in these tables a rigorous and simple application of the formulæ, depending upon the system of fundamental constants, and that it is well adapted practically for the careful discussion of all features of the cloud problem. This is especially evident from the fact that each term of the constant involving the specific heat, the heat equivalent of work, and the latent heat, is computed separately, so that in forming equations of condition no error need be admitted at these points. If, from observations, the elements B . t . e are determined at various altitudes, as in balloon ascensions, kite ascents, and from theodolite triangulations, we shall be enabled to pass from the strictly adiabatic stage, and obtain the residuals for the energy dQ which has been heretofore taken equal to zero in the adiabatic stages. This is in reality the most interesting feature of the results to be derived from cloud work, so far as the static conditions of the atmosphere are concerned. It also leads up to the construction of such layers in the superposed strata in the actual atmosphere as ultimately give rise to the gradients and the consequent circulation. Some applications of this method will be made in Chapter 12.

A STANDARD SYSTEM OF HYDRODYNAMIC EQUATIONS.

The convenience and importance of summarizing, in a uniform notation, the hydrodynamic equations, which find a useful application in meteorology, is so evident that an attempt has been made to comply with this demand. The equations have been derived chiefly from a study of BASSET'S Treatise on Hydrodynamics, LAMB'S Hydrodynamics, COTTIER'S Equations of Hydrodynamics, FERREL'S Report, C. S. O., Part 2, 1887; FERREL'S Motions of Fluids and Solids, FERREL'S Coast Survey Papers, ABBE'S Collection of Translations, SPRUNG'S Meteorologie, and also treatises in electricity and magnetism, which pass over analogous analytic ground. It would be unprofitable to attempt to ascribe these fundamental equations to any one source, since they have become a sort of common property, and they will be accepted as such with the above acknowledgment. I have, however, added a number of original transformations, and have sought especially to carry a simple notation consistently through the entire range of formulæ, the symbols selected being as closely as possible in conformity with the recognized standards. As it is no part of our purpose to write a treatise on this subject, the descriptions of the derivation of the formulæ will be as brief as possible. It is supposed that this collection will be chiefly of use to students who, being familiar with hydrodynamic theories, seek to extend their application to the numerous problems pertaining to the motions of the atmosphere.

149–153, Table 73. These contain the primary definitions and relations upon which the system depends, and they conform to the notation and canons, whose adoption has been already advocated. The displacements, velocities, and accelerations have different meanings in the rectangular, cylindrical, and polar coordinates, respectively, but they always denote increase along the

positively developed fundamental coordinates. These are carefully laid down in the accompanying diagrams, and are the ones in common use. (Chart 47.) The EULERIAN device of moving axes relative to fixed axes is adopted in deriving the equations of motion, and the angular velocities of the moving about the fixed axes, as well as the component velocities of the same, parallel to the fixed axes, in two types of components. (Charts 48, 49.) 154–159, Table 74, give for the rectangular system, the linear velocities, accelerations, angular velocities, equation of continuity, the operator ∇^2, and the general equations of motion. $\frac{d}{dt}$ is the total differential, P the pressure, ρ the density, V the force-potential, and Q total force symbol. By limitation, or imposing conditions, these general forms are reduced to simple cases. 160–165 give similar equations for cylindrical coordinates. This set is especially applicable to the study of cyclonic and anticyclonic circulations, which are wandering over the surface of the earth, and hence values are assigned to the angular velocities and the fixed force of gravitation. 166–176 give the same equations transformed to polar coordinates. In addition, definitions in the form of equations, for stretches, shears, dilatation, normal and tangential traction, coefficient of viscosity, and the total force due to surface tractions. This last type of forces must have a very limited use in the meteorology of our day, in consequence of the great difficulty of securing exact measurements of all the physical quantities involved, but they should be readily accessible for prompt application in those cases where the data warrants. 177–181, Table 75, contains the polar equations of motion adjusted to the rotating earth, which now carries with it the fixed axes, and the axes moving with reference to them, thus introducing an additional constant angular rotation about the axis. This changes the linear eastward velocity from v to $v'=v+n.r \sin \theta$. The transformation here published for the first time is especially satisfactory for its brevity and its rigorous development. Starting with equations 155, expressed in polar coordinates from 153, and using the new velocities $u'.\ v'.\ w'.$ make the substitutions indicated and develop algebraically. This gives 180 and 181, which conform to the well-known equations otherwise deduced. 182–185 apply the same principles for the cylindrical coordinates, and with equal success. Beginning with 155, transformed to a cylindrical system by means of 152, and make the substitutions (182, 183) in 184. Develop algebraically to produce 185. 186–191, Table 76, gives the equations of motion in case the center of gyration moves over the surface of the earth with linear velocities $U.\ V.$ If these are resolved upon the radius of gyration and tangent to the path of the particle moving about a center, we have a new set of velocities $u'.\ v'.\ w'.\ \omega'_1.\ \omega'_2.\ \omega'_3.$, which, substituted in the terms arising from the motion and developed, produces 189. Two extreme cases, for the meridian and for a parallel of latitude, are developed in 190, 191.

192–196, Table 77, contain the integrations for velocities and displacements, or distances passed over in the time t_1, when starting from rest. They are integrated from the *second* form of the polar general equations of motion deduced by substituting the angular velocity of 192 in 181. From 195 is found the velocity with which a particle is moving at the time t_1; and from 196 is obtained the distance passed over. Differentiating from 196, we find 194, including omitted terms of gravity.

197–208 present the integrations of pressure, that is the total pressure change between two points having different velocities, and hence the pressure gradients due to the relative motion of the air. By substituting the equations 197 in 181 there results 200, which is the third form of the polar equations of general motion. This set is the same in form as the one used by FERREL in his discussion, Chapter III, C. S. O. Report, 1887, except that the friction and temperature gradients are not yet added. The partial differentials $-\frac{\partial P}{\rho}$ of 201 are transformed by means of 202 into the total differential 203, or the equivalent form 205, the integral being given in 206, or 207, for common logarithms. The special cases of variation in pressure for cyclones, anticyclones, hurricanes, tornadoes are drawn from 207 or 208.

209–217, Table 78, give the angles between the wind and the isobars, or the wind and the gradient, when the element of friction is introduced into the general equations of motion in the plane xy. 209 gives the elements, 210 the differential equation for the angle between the wind and the gradient, 211 and 212 the auxiliary equations, 213 the leading terms of the equations of

motion 200, with friction assumed proportional to the velocity, 214 the forms found by multiplication, 215 the sum of the two equations 214, 216 the forms by substitution from 210, 211, whence 217 gives the angle, and the velocity for steady motion. The value of 209 is found in 47. (Compare chart 50.)

218–224, Table 79, contains the relations between stream line, vortex line, and the potential of the motion combined of pressure, velocity, and force variations. 218 is derived from 155, 156; 219 from 155 for no rotational motion, as in wind streams; 220 is the equation between 218 and 219. The second forms in 223 are shown to be true by multiplying the first forms as indicated and then adding. Hence, since the second forms determine lines perpendicular to one another (CARR'S Synopsis, 4620) the stream line (u . v . w .) and the normal variation are mutually perpendicular, likewise the vortex lines (w_1 . w_2 . w_3 .) and the normal variation. Then the stream lines and the vortex lines lie in the same plane to which dn is an element of the normal. 224 is the equation of the angle i, which the stream line makes with the vortex line. (LAMB, p. 263.) We thus have two equations (217 and 224) to determine the angle i from two points of view, namely the pressure gradients in the horizontal plane and from the rotational velocity. The combined equation will enable us, therefore, to discuss the gradient problem in connection with the angular velocity—a procedure which is most important in analyzing the action of cyclones and anticyclones.

225–231, Table 80, contain the equations for the two cases of fluid motion about a vertical axis under the force of gravity only, which are chiefly applicable to the motions of the air in cyclones. There are two fundamental laws which condition such motion, namely, $\frac{v}{\varpi}=$ constant, which leads to a parabolic free surface of the isobars; and $v\varpi=$ constant, which leads to a hyperbolic free surface. The former is illustrated in the surface of water contained in a closed cylindrical vessel and rotating on a turntable; the latter in the tubular vortex or tornado. Generally the vortex motions of the atmosphere do not comply strictly with the conditions of either case in their simplicity, but the free isobar surfaces are sometimes constructed by combinations, chiefly of these two leading cases, or such other forms as are imposed upon the vortex by the prescribed boundaries. A few vortex problems must, therefore, be here considered. 225 is repeated from 203, and integrated in 226 and 227, for the constant belonging to each stream line, as well as for the absolute constant. The conditions for case I are $2\omega_3=\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}$ and $\frac{v}{\varpi}=$ const. Substituting in 154, 155 we find the relations 228, which gives the integral 229, a parabolic surface. Similarly 230 contains the conditions prescribed for motion under $2\omega_3=\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}-\varpi\frac{\partial\omega_3}{\partial\varpi}$, and $v\varpi=$ const.; 231 contains the integral equation.

In case I there is a gradient of pressure along the radius, and also in circles about the central axis z; in case II there is a gradient along the radius, but none along the circles. The latter is pure vortex motion, and the question is raised whether the assumption of $w=0$, no vertical motion here made as with case I, is correct. It will be shown that another law enables us to pass from this proposition to that which applies to cyclonic action.

232–241, Table 81, contain the developments which lead to the form of the current function ψ, for the two cases just considered, one of which gives the parabolic and the other the hyperbolic free surface. 232 repeats 229 and 231, while 233 is simply transformed. Here the plane to which the development is properly referred is located at some distance above the surface of the ground, such that the height $h=\frac{v^2}{2g}$ denotes the distance of the free fall required to produce the given linear velocity about the center. In short, the free surfaces are drawn relative to a plane at the altitude h_o, $z=(h-h_o)$. If $h=h_o$, $z=0$, and the value for the constant ψ is determined on that plane of reference. Also substituting $v=\varpi_o\omega$ and $v=\frac{\mu}{\varpi_o}$ respectively, and dropping the subscript to ω_3, 234 results for the reference plane, and 235 for some other elevation h. 236 is found by subtracting 234 from 235, whence 237 by substituting $z=h-h_o$. In the parabolic type the linear velocity v decreases to the center, as might be inferred from the assumed law of angular motion; in the hyperbolic type the linear velocity v increases toward the center, as might be similarly

concluded (charts 51, 52). Herein it is shown that the velocity at a given height h_o is changed into the velocity prevailing at the height h by subtracting or adding, respectively, the velocity $2g\,(h_o - h)$, due to the body falling freely through the height $h_o - h$. This is the law which fundamentally prevails in cyclones, hurricanes, and tornadoes. The transformations 238, 239, 240 lead to 241, which gives the forms for the current function $\psi_p = \frac{1}{\varpi^2} = \frac{v^2}{2g}$ for parabolic surfaces, and $\psi_h = \varpi^2 \cdot \frac{v^2}{2g}$ for hyperbolic surfaces. There is probably a combination of these required in nature to pass from the upper to the lower portions of a cyclone. but in the tornado the second form is very closely reproduced.

242–259, Table 82, contain several important cross connections between stream lines ($u \,.\, v \,.\, w$.) and the current function ψ. (Case 1). When the motion of the fluid is parallel to the plane ($x \,.\, y$.) the lines of flow, equation of continuity, and EARNSHAW'S current function are given. (Case 2). When the motion is in planes ($\varpi\, z$), the same quantities with STOKES'S current function are shown. (Case 3). When the motion is in vortex rings or tubes arranged symmetrically about the axis z, the angular velocity being about the axis y of cylindrical coordinates, we have the rotation, the equations of motion, the equation of continuity, and by the indicated steps arrive at equation 255, which is the differential equation of motion in terms of the current function ψ. This equation can be derived from the general equations of motion by cross multiplication and addition, as WILLY WIEN has done (Meteorol. Zeit., Nov., 1897, p. 416), where it occurs with the addition of a single term, $\varpi^2\, \omega_3 = f(\psi) =$ constant, which defines the rotation about the axis z. Hence results the first integral 256, used in the problems of cyclonic motion. Case 4 carries out the similar equations for motion in two dimensions parallel to the plane ($x \,.\, y$).

260–270, Table 83, show the cross connections between the current function ψ and the velocity potential φ. Case 1, for two dimensions and parallel to the plane ($x \,.\, y$.) with rotation about the axis z. Case 2, of three dimensions, is too complex for development in this place. Case 3, of two dimensions in the plane ($\varpi\, z$), arrives again at the stream lines of 256, and also at the corresponding equipotentials in 270.

271–278. The two fundamental forms of equations in 271 are developed through the successive steps to the solutions for φ in 277, which give the series known as BESSEL'S functions, the roots here taken being the first roots of the zero and first order.

279–302. Special cases of circulation may be constructed, as W. WIEN has done, by imposing certain boundary or limiting conditions upon the movement of the fluid. The question whether these correspond with the observed circulation of the free atmosphere in cyclones and anticyclones becomes simply a matter of identification. It is believed that too many assumptions of this nature have been made by meteorologists, without testing the validity of their *ideal* circulations as corresponding to those existing in the atmosphere, by a comparison with observed movements. An exhibit of a few of these special cases will, therefore, assist us in the criticism of such meteorological literature. Without going into any details regarding the derivation of results, we present the following cases.

Case 1, Chart 53. Suppose a liquid inclosed in a cylindrical vessel with top and bottom planes, as water in a cylindrical dish, and that it is set in circulation by any means, as heat under the bottom, or a mechanical contrivance producing a gyration about the vertical axis, then figure 1 shows the stream lines in the planes ($\varpi \,.\, z$.). In the inner region, bounded by R_1 there is vertical circulation and no gyration; in the outer region, between R and R_1 there is vertical circulation and also gyration. 279–281 gives the imposed conditions; 282–286, the solution for the inner region; 287–291, that for the outer region. It may be stated that no such limiting conditions are found to exist in the case of cyclones or anticyclones, however fascinating it may be to watch this circulation in a laboratory.

Case 2, Chart 54. If the upper bounding plane is removed, and the gyration made to depend upon the height z, the figure 2 indicates the form of the stream lines, while 292–298 give the several consequent relations. While this figure when inverted in its central parts resembles the stream lines in a tornado, the lines do not correspond exactly enough to regard this as a typical solution of the movements of the atmopshere. If however χ is omitted, and $\varphi = \varpi^2$, we have

$\psi=\varpi^2 z=$const., which by 241 is the equation for a hyperbolic free surface, with gyration about the axis z, and this conforms almost exactly with the forms found in tornadoes.

Case 3, Chart 55. If the movement is bounded by two parallel planes at the heights $z=0$ and $z=H$, the chart shows the stream lines, the gyration being about z and depending upon it. 299–302 give the several quantities in this relation. This is the conception which has been assumed by FERREL to explain tornado circulation, but it is probably not correct, as will be shown in another place.

Case 4, Chart 56. For the case of a one-plane boundary which is asymptote to the stream lines, where $z=0$, the equations 303–308 give the required relations. This conforms almost exactly to the conditions found in well-developed tornadoes, and is more nearly adapted to the solution of that problem than the relations of the Case 3, which have been used for that purpose.

310–330, Table 85. The subject of polar curves and spirals is so frequently utilized in meteorology in the analysis of air-current lines, that it is important to have the elements of these curves conveniently at hand, especially in a comprehensive notation in harmony with the rest of the subject. Charts 57, 58, contain the figures for the expanding and the contracting curves M . M_1 ., respectively, with diagram definitions of the lines T, N, $S.T.$, $S.N.$, and the angles θ . τ . ν . α . β . They are all clearly marked, and need no further explanation. The logarithmic spiral equation is developed through the current function ψ, and the velocity potential ϕ. 311 gives the assumed values of the parts of the complex variable; 312–313, the several derived equivalent forms; 314–316, the complex variable in terms of (r . θ) the coordinates of the point. When the curve is in the horizontal plane of cyclonic motion, then (r . θ) is the same as (ϖ . ϕ) of cylindrical coordinates. 317–330 contains the developments for the spiral of Archimedes, the hyperbolic spiral, and the logarithmic spiral. The latter has been chiefly employed by meteorologists, but it is thought better to have the three primary spirals equally accessible, because it has not been proved yet that the logarithmic spiral matches the actual observed air-stream lines. Charts 59, 60, 61 show the parts of these three spirals worked out in detail. In the spirals of Archimedes and the hyperbolic spiral the angle α, at which a stream line crosses the radius, changes by two different laws from one value of θ to another, while the angle α is constant for the logarithmic spiral. If pure vortex motion under special values of ψ . ϕ. occurs, then α may be constant. If this motion is not pure, but built up out of conflicting streams of air, then it may be necessary to resort to other spiral or polar curves to strictly conform to the observed motions of the air. It is to be questioned at present whether it can be shown by the observations that α is sufficiently constant in cyclones to warrant the conclusion that we have to deal with pure logarithmic vortex motion. It has been found useful to construct a diagram, as Chart 61, containing logarithmic spirals of different pitches—that is, values of α, with which the stream lines on the daily weather map may be compared. By drawing wind lines on the maps—that is, continuous lines tangent to the arrows at the several stations, the map will be covered with curves more or less resembling these spirals. On matching with this scale, the actual pitch α can be interpolated with much accuracy. It is surprising to see how far from a constant the angle α really is, since the stream lines vary from one quadrant to another, even after eliminating the distortion due to the eastward drift. Table 87 contains the values of (r . θ.) for the different angles α, and will facilitate the construction of such spiral diagrams.

The analogous relations between the hydrodynamic equations of the motions of fluids and the theorems of MAXWELL or HELMHOLTZ and their followers, applicable to electricity and magnetism, have been pointed out so many times, and have been utilized so frequently, that one is completely authorized in passing from the equations of one of those subjects to those of the other without further explanation. These branches of mathematics are so well known that it is necessary only to adapt them to the form most useful to the meteorologist, in order to incorporate them in this system of equations. It is readily perceived that the comparatively few *fundamental* equations which exist in these subjects have been so clothed in divergent notations and arrangements by different authors that the literature is already expanded to enormous proportions to express relatively few concepts. But in fact, the primary ideas and relations can be reduced to modest dimensions before losing anything substantial, and it would be a most useful procedure to construct one system of general theorems which should be in common use among authors before their

employment in the special cases. Compare MAXWELL, Vol. II, p. 237; LAMB, p. 231; BASSETT, I, p. 88. Out of the whole mass of discussions there seems to be but two essential ground ideas:

(1) Variation can be caused by the process of expansion or contraction, which is equivalent to dilatation, and which is again equivalent to divergence or convergence.

(2) Variation can be caused by rotation of the small parts of the material, as molecular rotation. The former gives rise to a so-called polar potential φ, which is equivalent to a magnetic potential. The latter gives rise to a velocity potential, which is equivalent to the electro-magnetic momentum. The cross connection between the current and the vortex velocity is expressed in HEAVISIDE'S two Laws of Circuitation.

(1) The line integral of the fluid velocity in any closed circuit measures the vortex stream through the surface bounded by the circuit.

(2) The negative line integral of the vortex filament in any circuit measures the velocity of the liquid through the circuit. Applying this to the phenomenon of the cyclone, we find that the vertical stream, $i=\pi\varpi^2 . w$, is a function of the velocity in circulation about the axis z. That is, $v\varpi=2i=2\pi\varpi^2 . w=$constant. This function connects the vertical velocity w with the horizontal velocity v.

In order to reach this result more specifically, we have the following formulæ (Tables 88,89):

331, Table 88. To avoid unnecessary complication, the medium is assumed to be homogeneous, and the density $\rho=1$.

332–333 contain definitions of the velocity potential φ and the current vortex function ($F . G . H .$), keeping to the electro-magnetic symbols. The magnetic force consists of two parts (1), the divergence $\alpha_1 \beta_1 \gamma_1$, and (2) the vortex or current curl $\alpha_2 \beta_2 \gamma_2$.

334, 335, 336 give the expressions for these.

337. This is the definition of the density.

338. This gives several expressions for the rotation and the cross connection between the whirl and the current through the circuit bounded by the same.

339. This is the condition of continuity for verifying the term expressed in 338, and this step is proved in other places to be true and necessary.

340 states the analogues between the two subjects, and enables us to apply these equations to meteorology.

341 contains the conditions applicable to a very special case, namely, rectilinear vortices parallel to the axis z. If H is the vortex function parallel to z, the variations in H—that is, dH—are in the direction of the radius ϖ. The flux through the limit-surface $dS=d\varpi\, dz$ is $H'=-\frac{\partial H}{\partial \varpi}$. Now since this circular flux can not occur without another flux parallel to the axis z, which is analogous to the electric current through the magnetic whirl, it is necessary to discover the relations between H' and w.

342, Table 89. This is the GAUSSIAN theorem connecting the surface and the volume integral, and it is expressed in form ready for integration in 343.

344. Also the first term can be expanded by TAYLOR'S theorem, which substituted in 343 reduces it to the form 345.

346. This is equivalent to 345, and is the equation from which integrations are to be made under further assumptions.

347. $H'=2\pi\varpi . w$. $w=-\frac{1}{2\pi\varpi}\cdot\frac{\partial H}{\partial \varpi}$. This should be compared with 305, from which it differs by the factor $\frac{1}{2\pi}$, showing that the case is different.

Since circulation in a cyclone is divided by some authors into the outer region with no vertical current $w=0$, and an inner region with a vertical current, these may be separately considered.

348–354. This is the case for no vertical current. (DRUDE, Physik des Aethers, p. 96.) The expressions are given for the constant, the current function, and the vortex current, which is the flow in circles about the axis z. Beginning with 346, put $w=0$, and integrate twice to find H, in the external and internal parts.

355–364. Suppose now, for a second case, that the current is rising in a circular cylinder of radius R within which w is not equal to zero. Beginning again with 346, and integrating twice for H, we assign $w=0$ as the condition for the exterior region $\varpi > R$; and $C_1=0$ for the interior region $\varpi < R$, and obtain H_e, H_i, and H_o on the surface R. 362 contains some definitions which substituted give alternate forms of the current function 363, and the vortex current 364. The third set will be recognized as those which OBERBECK used (ABBE'S Trans., p. 162) in his discussion of the cyclone.

365–370. Another method of treating this vortex problem is shown in these equations. The conditions are stated again in 365 and the resulting quantities in 366. From 259, by integrating these results, the values of the current function are given in 368. By means of the considerations in 369, we find the solution for ψ_i and ψ_e in 370, which are equivalent to H_i and H_e respectively.

Now if these equations are compared with 363, it is found that $2\pi w = \omega_3 = \frac{v}{\varpi}$, and hence $v = 2\pi\varpi \,.\, w$, which agrees with 347 if we identify H' with v, as should be done. The equation 241 gives $v^2 = 2g\,(H_o - h)$, where $(H_o - h)$ is the depression of the isobaric surfaces below that plane where the gyratory velocity is zero. Hence by this equation the form of the isobar can be computed, since $\psi_h = \varpi^2 \frac{v^2}{2g} = \text{constant}$. Then having found v at any point $\varpi\,(H_o - h)$, we compute the vertical velocity by the formula $w = \frac{v}{2\pi\varpi}$.

373–379, Table 90, determine the force of the wind when blowing upon objects of different shapes. 373 gives the definitions, 374 the normal pressure in grams per square centimeter, 376 in pounds per square foot, 377 when blowing obliquely on a plane, 378 when blowing on a cylinder, and 379 on a sphere of diameter D.

380–388, give the relative velocities of the air blowing past a body which will just counterbalance the weight when freely falling; or the centrifugal force with which it is driven from the center. 380 contains the definitions, 381 the experimental value for resistance, which is to be put equal to P, the lateral pressure in 384, to determine u in 387; or else to the weight w_g in 383 to find w in 388. These experimental velocities may be used to check the values of $(u \,.\, v \,.\, w\,.)$ which are otherwise derived from the equations of motion. Especially it is sometimes possible to do this in tornadoes, when photographs showing the details on a large scale are at hand.

Tables 104, 105. In order to facilitate the use of the second (194) and the third (200) forms of the general equations of motion on the rotating earth, tables have been computed which contain all the terms entering into these equations. $\frac{v'}{R} \,.\, 2v = n \sin\theta \,.\, 2v$, where v' is the absolute velocity at the north polar distance θ, due to the rotation of the earth on its axis with the angular velocity $n = 0.00007292$, the value of R at the surface being 6370191 meters, and v the relative motion eastward of a body moving along the same parallel of latitude. Also $\frac{v'}{R} \cot\theta \,.\, 2v = n \cos\theta \,.\, 2v = n \sin(90 - \theta) \,.\, 2v$, and hence evidently all these forms can be included in one table with the arguments θ = north-polar distance and $2v$, the double eastward relative velocity. These terms contribute to the accelerations, and hence to the force measured in the fundamental units. The other terms occurring of the forms $\frac{uv}{R}$, $\frac{\cot\theta}{R} \,.\, uv$ are also found in the tables with the proper arguments.

CHAPTER 11.

THE THEORY OF CYCLONES AND ANTICYCLONES.

GENERAL REMARKS.

It has been felt by meteorologists that, in spite of the labor of the able students who have devoted much time and energy to the mathematical analysis of the problems of the motions of the atmosphere, there remains a serious discrepancy between the analytical expressions and the observed movements of the air. An important part of the work undertaken by the International Cloud Commission is the systematic collection of such data as would give the analyst a firmer ground upon which to build his fundamental conceptions, so that in the future mathematical research should be more intelligently directed to these problems. This has been the plan kept in view for the area surveyed by the United States Weather Bureau, where the operations have been executed on a considerable scale and the computations planned in a manner contributing to this object. The unfolding of these results up to the present point in this paper has been controlled by the purpose of preparing them for such discussion as may seem most profitable to students who care to use them. It is believed that another service, furthering the same object, has been accomplished by subjecting to a critical comparative study the analyses and theories which have been previously followed, setting them alongside the results of the observations and drawing such conclusions as seem to be warranted by the facts thus presented. Although the difficulty of the task might well be an excuse for omitting the attempt, yet it is believed that some important light has been thrown upon the ideas which are necessarily involved in building up a perfect scientific system. The large amount of the published material available will make it necessary to take for granted that others have equal access to the original papers and are sufficiently familiar with them to render detailed explanations in general unnecessary. It need not be doubted that I have conceived a great admiration for the unusual skill and learning of the several authors, and that all critical remarks are made solely with the view of hoping to advance the subject of meteorology one stage nearer its final development. It is most important at present to construct a general theory entirely in harmony with the trend of the observations, and it must be confessed that none of the solutions of the problem hitherto accessible are free from important objections.

1. *Ideal systems.*—The first general remark which ought to be made about these discussions of the circulation of the free air is that they have been idealized by imposing certain restricting conditions upon the general equations. The difficulty of handling the mathematics involved is to a large extent the cause of this procedure, in order that easy working equations may be secured. These limiting conditions often seem very simple and unimportant in themselves, such as the reader passes over as of little significance in comparison with the mass of formula surrounding them, but nevertheless these minor steps often really involve the entire theory of the subject and are also the chief cause why the solution does not conform to the operations of nature. These restrictive passages merit the strictest scrutiny, especially in view of the influence they have on the result. They are like the rudder to a ship, which, though small, yet governs its course. The temptation to insert limitations is very great, and yet it must be resisted unless one is certain that they represent the facts in nature. Any form of circulation which is thus made to depart by artificial conditions from the strictly natural one under observation becomes merely an ideal object of study, and although the mathematics may be correct and fascinating, yet it is useless for the purpose in hand. An effort will be made to indicate some of these assumptions which have been added to the equations of motion and which invalidate the resulting form of the circulation as a true type.

2. *Many types of vortices.*—In fluid motions vortices of various types form in accordance with the boundary conditions. Thus we have already summarized the vortex within a cylindrical surface having top and bottom planes (279–291); in a cylindrical surface with one plane end and one open end (292–298); between two parallel planes (299–302); bounded by one plane (303–308). These boundary conditions may be made to vary, and the circulation will change in accordance with them. Hence it is not proof in itself that because certain prescribed conditions afford a vortex motion that therefore the true solution is found which matches the observed circulation. If, as in Case I, the boundaries are complete, then the *same* mass of air taken in its entirety is compelled to pursue similar paths over and over again, and this it will continue to do as long as a cause for motion exists. If the boundaries are not complete, as in Cases II, III, IV, then the same mass does not repeat the circulation, but *new* masses are drawn through the typical stream lines, and this motion through the type system will continue as long as the source of energy persists.

In my judgment this distinction is very important in the case of the motions of the atmosphere. For, by every consideration, the mass of air over one hemisphere of the earth is practically the same through relatively long periods of time, since the exchange of air between the two hemispheres, which may to some extent be the outcome of the sun's seasonal change in latitude, is undoubtedly a subordinate feature of the circulation. As long as the solar insolation maintains a difference of temperature between the tropical and the polar regions the system is conservative from this point of view. The application of the general equations of motion on the rotating earth to a hemisphere of the atmosphere has certainly matched the main features of the observed circulation. The subordinate features may need modification, but, on the whole, theory and practice are fairly good companions in this case, which is that of a vortex within complete boundaries, namely, the surface of the earth, the upper limit of the atmosphere, the pole, and the plane of the equator. This resembles Case I in that it is conservative; but the boundaries have a different shape, and the vortex must be treated on its own merits.

The success of the procedure respecting the general cyclone was so gratifying that it was quite naturally applied to the local cyclone by Professor FERREL, who regards the local cyclone as a miniature of the general cyclone, having similar conditions and characteristics. That was probably the fundamental mistake, and its influence has been one cause of the very slow progress which has attended theoretical researches in this subject. It is my purpose to show that the local cyclone is not a conservative system like the general cyclone of the hemisphere; that it is merely a configuration of vortex circulation *through which air streams*, and that therefore it is not possible to apply to it directly the modified equations of the general cyclone as FERREL did. It comes under the classification of the Cases II, III, IV, but yet is unlike them, having its own peculiar characteristics. In order that it may be seen how strictly the parallelism between the general and the local cyclone has been followed in FERREL'S works,* I have reduced his system to a brief but comprehensive synopsis, in conformity with the notation adopted in this report. His text consists in discussions of the significance of these equations, and is very clearly performed. In order to emphasize the fact of the parallel development in FERREL'S theory of the general and local cyclones, the numbering of the equations and the text is made as much alike as possible, each of the equations having two parts, (*a*) for the general and (*b*) for the local cyclone, which should be carefully compared throughout. The chief and necessary differences consist in the terms involving the angular motion, and the assumed laws of temperature variation, which are implied in the physical aspect of the case. Thus $\cos\theta(2n+\nu)$ and $(2n\cos\theta+\nu_1)$ for the former, $t=\Sigma A_s\cos s\theta$, and $t=A_0+A_2\cos\frac{\varpi}{\varpi_0}\pi$, for the latter, are practically the only variations needed to pass from one set of equations to the other.

THE GENERAL CYCLONE (FERREL).

A brief description of the development pursued by Professor FERREL, first having reduced his equations to the notations adopted in this paper, will be given for the sake of recalling the exact theory proposed by him for the solution of the problem of the general circulation of the atmosphere over the hemisphere. Reference will be made exclusively to the phenomena observed

* U. S. Coast and Geodetic Survey, 1877. C. S. O.; Recent Advances in Meteorology, 1886.

in the northern hemisphere, which is somewhat more complex and difficult to treat successfully than the southern, on account of the peculiar distribution of the land and water areas. It is very necessary to keep in mind the facts derived from observations and enumerated in the preceding pages, since it is proposed at all points to contrast the several theoretical solutions with the results thus obtained. It is, perhaps, the first time that the observations are sufficiently explicit in their meaning to permit this being done with any considerable accuracy. As already stated, it is intended to show to what an important extent the theories have been constructed, independently of and often without regard to the observed circulations. Beginning with the third form of the polar equations of motion, applied to the rotating earth (200), the symbols employed are stated once more. Such additions must be made as will suitably express the other conditions supposed to exist. This involves a series of assumptions and transformations, enumerated 389–396, Table 109.

SEVERAL SYSTEMS OF EQUATIONS FOR THE DISCUSSION OF THE GENERAL AND LOCAL CYCLONE, TRANSFORMED TO THE STANDARD NOTATION.

(Ferrel; Sprung; Guldberg and Mohn; Oberbeck; Pockels; and Bigelow.)

TABLE 109.—*General Cyclone* (*Ferrel*).

Applied to the *general* circulation over a hemisphere.

200. Third form of polar equations:

$$-\frac{1}{\rho}\frac{\partial P}{\partial x}=\frac{du}{dt}-\cos\theta\,(2n+\nu)\,v+\frac{uw}{r}.$$

$$-\frac{1}{\rho}\frac{\partial P}{\partial y}=\frac{dv}{dt}+\cos\theta\,(2n+\nu)\,u+\sin\theta\,(2n+\nu)\,w.$$

$$-\frac{1}{\rho}\frac{\partial P}{\partial z}=\frac{dw}{dt}-\sin\theta\,(2n+\nu)\,v-\frac{u^2}{r}+g.$$

x is directed southward on the meridian.
y is directed eastward on the parallel.
z is directed zenithward.
n is the angular velocity of the rotating earth.
ν is the gyratory velocity about axis of the earth. $\nu=\frac{v}{r\sin\theta}$.
θ is the north polar distance of the moving particle.

Assumptions and *transformations.*

389a. 1. The temperature is a function of x only. It is symmetrical about the pole, varies along the meridian, but not along the parallels of latitude.

$$-\frac{1}{\rho}\frac{\partial P}{\partial x}=-\frac{\partial\log P}{a\partial x}=-\frac{\partial\log P_o}{a\partial x}+\frac{g\,(h-h_o)\,\partial a}{a\partial x}=-\frac{\partial\log P_o}{a\partial x}+g\,(h-h_o)\,\frac{\partial\log a}{\partial x}.$$

Since by 47*b*, $\frac{1}{l\,(1+\alpha t)}=ag.$ (P_o=pressure for h_o=0.).

And by 61, 21, $-\log P=-\log P_o+\frac{(h-h_o)}{l\,(1+\alpha t)}=-\log P_o+ga\,(h-h_o)$, (com. logs.).

390a. 2. The general cyclone is symmetrical on all sides of the pole, and it is bounded by the circular limit of the plane of the equator extended.

Hence the term $-\frac{1}{\rho}\frac{\partial P}{\partial y}=0.$

391a. 3. Friction is proportional to the relative velocity of two adjacent strata.

$$F_q=kq\,(u\,.\,v\,.\,w).$$

392a. 4. The assumed law of the variation of the temperature along the meridian is as follows:

$$t=\Sigma A_s \cos s\,\theta = \text{the normal temperature at the earth.}$$

393a. $\frac{\partial t}{\partial x}=\frac{\partial t}{r\partial\theta}=-\frac{1}{r}\Sigma\, s\,.\,A_s \sin s\theta.$ $\quad A_o=8^\circ 50 \quad A_1=-1^\circ 75 \quad A_2=-20^\circ 95 \quad A_3=-1^\circ 00 \quad A_4=-2^\circ 66$

394a. $gh\,.\,\frac{\partial \log a}{\partial x}=-\frac{gh\,.\,\alpha}{(1+\alpha t)}\cdot\frac{\partial t}{\partial x}=\frac{gh\,.\,\alpha}{r\,(1+\alpha t)}\,(A_o+A_1 \sin\theta+2A_2 \sin 2\theta+3A_3 \sin 3\theta+\,..\,).$

The third term is of much more importance than the others in determining the meridian variations in temperature.

395a. 5. In integrating for the law of the conservation of areas it is supposed that there is no friction between the air and the surface of the earth.

396a. 6. All forces depending upon the velocity of vertical currents are negligible. $w=0$. Also omit the terms, $-\sin\theta\,(2n+\nu)\,v$ and $-\frac{u^2}{r}$.

The equations 200, by applying these conditions, become,

397a. Equations of general motion in a hemisphere:

$$-\frac{\partial \log P_o}{a\partial x}=\frac{du}{dt}-\cos\theta\,(2n+\nu)\,v+k\,.\,u-\frac{gh\,.\,\alpha}{r\,(1+\alpha t)}\,.\,4A_2 \sin\theta\cos\theta.$$

$$0=\frac{dv}{dt}+\cos\theta\,(2n+\nu)\,u+k\,.\,v.$$

FERREL takes $\alpha=0.004$ to allow for the humidity effect.

TABLE 110.—*General cyclone (Ferrel).*

397*a*. 2. Discussion of the *second* equation, $0=\frac{dv}{dt}+\cos\theta\,(2n+\nu)\,u+k\,v.$

In case of no friction the equation becomes:

398a. $\cos\theta\,(2n+\nu)\,u+\frac{dv}{dt}=2\cos\theta\,(n+\nu)\,u+\frac{dv}{dt}-\nu\cos\theta\,.\,u=0.$ Mult. by $r\sin\theta$.

$$2\,r\sin\theta\,(n+\nu)\,r\cos\theta\,\frac{\partial\theta}{\partial t}+(r\sin\theta)^2\frac{\partial\nu}{\partial t}=0. \quad \text{Since } \frac{dv}{dt}-\nu\cos\theta\,.\,u=r\sin\theta\,\frac{\partial\nu}{\partial t}.$$

399a. Integrating. $r^2\sin^2\theta\,(n+\nu)=c$, for *each* gyrating particle.

400a. C=constant for the *entire* rotating mass, if ν_o is the initial ν.

$C=\frac{\int c\,dm}{m}=\frac{\int r^2\sin^2\theta\,(n+\nu_o)\,d\,m}{m}=\frac{2}{3}r^2\,(n+\nu'_o)$. This is equal to the moment of inertia of the entire mass at the distance $\frac{2}{3}r$.

If the initial state is that of rest on the rotating earth, $\nu'_o=0$.

401a. Hence $r^2\sin^2\theta\left(n+\frac{v}{r\sin\theta}\right)=\frac{2}{3}r^2 n.$ $\qquad r\,n\sin\theta+v=\frac{2}{3}\frac{rn}{\sin\theta}.$

$$+v=\left(\frac{2}{3}\frac{1}{\sin\theta}-\sin\theta\right)r\,n.$$ Eastward velocity at all latitudes, θ.

402a. If $v=0$, $\quad \text{Sin}^2\,\theta=\frac{2}{3}.$ $\quad \text{Sin}\,\theta=0.8165.$ $\quad \theta=54^\circ\,44'.$

At the latitude $35^\circ\,16'$ the eastward velocity vanishes at the surface.

Value of $\log P_o-\log P$, where P_o is the pressure at the equator.

403a. $v^2=\left(\frac{4}{9}\frac{1}{\sin^2\theta}-\frac{4}{3}+\sin\theta^2\right)n^2 r^2.$ $\qquad$ For $\sin\theta=1$, $v_o=-\frac{1}{3}n\,r.$ $\qquad v_o^2=+\frac{1}{9}n^2r^2$

404a. From 207, $\log P_o - \log P = \frac{v^2 - v_o^2}{360862\,(1+\alpha t)}$, for $u=w=0$, and $z=z_o$.

$$=\frac{1.1959}{1+\alpha t}\left(\frac{2}{9\sin^2\theta}-\frac{13}{18}+\frac{\sin^2\theta}{2}\right), \text{ common logs.}$$

TABLE 111.—*General cyclone (Ferrel).*

397a. 1. Discussion of the *first* equation, $-\frac{\partial \log P_o}{a\partial x}=\frac{du}{dt}-\cos\theta\,(2n+\nu)\,v+ku-gh\,.\,\frac{\partial \log a}{\partial x}$.

Surface gradients in terms of the angle of inclination i, which the wind direction makes on the left of the parallel y.

405a. $\tan i=-\frac{\frac{du}{dt}+k.u}{\frac{dv}{dt}+k.v}=+\frac{\frac{du}{dt}+k.u}{\cos\theta\,(2n+\nu)\,u}$, from 397a. $\quad -u=q\sin i.$ $\quad +v=q\cos i.$

$$\tan i=\frac{k.u}{\cos\theta\,(2n+\nu)\,u}=\frac{k}{\cos\theta\,(2n+\nu)}=\frac{k}{\lambda+\frac{v\cos\theta}{r}}, \text{ for } \frac{du}{dt}=0.$$

Compare 217, 224.

406a. $\frac{\partial \log P_o}{a\partial x}=\frac{1}{\rho}\frac{\partial P_o}{\partial x}=\cos\theta\,(2n+\nu)\,v-\left(\frac{du}{dt}+ku\right)$, for $h=0$. See 47b.

$$\frac{\mu G}{\rho}=\cos\theta\,(2n+\nu)\,q\cos i+\cos\theta\,(2n+\nu)\,q\sin i\tan i.$$

$$=\cos\theta\,(2n+\nu)\frac{q}{\cos i}=\cos\theta\,(2n+\nu)\frac{v}{\cos^2 i}.$$

407a. From (48, 24, 47) $G=111\,111\,111\cos\theta\,(2n+\nu)\cdot\frac{q}{\cos i}\cdot\frac{0.760}{gl\,(1+\alpha t)}\cdot\frac{P}{P_o}=\frac{1077.6\cos\theta\,(2n+\nu)}{\cos^2 i\,(1+\alpha t)}v\cdot\frac{P}{P_o}$.

$$G=\frac{0.15716\,q\cos\theta}{\cos i\,(1+\alpha t)}\cdot\frac{P}{P_o}=\frac{0.15716\,v\cos\theta}{\cos^2 i\,(1+\alpha t)}\cdot\frac{P}{P_o}, \text{ for } \nu=0.$$

Conditions above the surface (approximately).

In 397a. 1. Assume $u=0$, $v=$constant. Take $v=v_o$ for $h=0$. Subtract.

408a. $v_o-v=+\frac{gh\,\partial \log a}{\cos\theta\,(2n+\nu)\,\partial x}=-gh\,\frac{\alpha}{(1+\alpha t)}\cdot\frac{\partial t}{\partial x}\cdot\frac{1}{\cos\theta\,(2n+\nu)}$. From 394.

$v_o-v=\frac{0.016}{(2n+\nu)}\,\frac{gh}{r}\,\frac{A_2\sin\theta}{(1+\alpha t)}$, using only $s=2$. From 393.

409a. Gradient. $G=\frac{.15716\cos\theta}{\cos^2 i\,(1+\alpha t)}\cdot\frac{P}{P_o}\left[v_o-\frac{.016\,gh\,A_2\sin\theta}{r\,(2n+\nu)\,(1+\alpha t)}\right]$. Subst. 408a in 407a.

$$G_o-G=+\frac{.00001327}{(1+\alpha t)^2}\cdot\frac{A_2\sin 2\theta}{\cos^2 i}\cdot\frac{P}{P_o}\cdot h.$$

Velocity above the surface. $u=$const. $v=$const.

410a. Velocity. $v=\frac{\partial \log P_o}{\cos\theta\,(2n+\nu)\,a\partial x}-\frac{.008\,gh\,A_2\sin 2\theta}{\cos\theta\,(2n+\nu)\,r\,(1+\alpha t)}+\frac{\frac{du}{dt}+k.u}{\cos\theta\,(2n+\nu)}$.

$$v=\frac{v_o}{\cos^2 i}\cdot-\frac{.0001689\,A_2\sin\theta}{(1+\alpha t)}\cdot h+(\text{neglect}), \text{ for } \nu=0.$$

TABLE 112.—*General cyclone (Oberbeck).*

The origin of coordinates is at the center of the earth.

411. Component equations in x:

1. $g_o R^2 \frac{\partial}{\partial x}\left(\frac{1}{r}-\alpha\frac{t_1}{r}+\alpha\int\frac{t_o}{r^2}\,dr\right) \quad =0.$ Normal distributions of temperature and pressure.

2. $-c^2\frac{\partial\gamma_1}{\partial x}+\alpha\ g_o\frac{R^2}{r}\cdot\frac{\partial t_1}{\partial x}+k\,\Delta^2 u_1 \quad =0.$ Meridian-vertical currents, due to temperature; no rotation.

3. $-c^2\frac{\partial\gamma_2}{\partial x}+2nv_1 \quad +k\,\Delta^2 u_2 \quad =0.$ East-west currents, due to the rotation of the earth.

4. $-c^2\frac{\partial\gamma_3}{\partial x}+(2n+\nu)v_2 \quad +k\Delta^2 u_3-\frac{du}{dt}=0.$ Currents due to variable relative angular velocity.

Notation. B_o=normal pressure. $\gamma=\frac{B-B_o}{B_o}$.

t =temperature$=t_o+t_1$.

t_o =a function of r only; vertical distribution.

t_1 =a function of $(r\,.\,\theta\,.\,\lambda)$; distribution in latitude and longitude.

In this solution t_1 is a function of $(r\,.\,\theta)$ only.

t_e =temperature at the equator; t_p at the poles. $(t_e-t_p)=42°$ C.

r $=R+R\,\sigma$=distance from center to the stratum σ.

r $=R+Rh=R+H$=the upper boundary of the air in effective motion=39.6 miles=63700 meters.

k =the coefficient of friction $=0.00012$
ρ_o=the specific density of the air$=0.0001293$ $\Big\}\ \kappa=\frac{k}{\rho_o}=0.9281.$

412. Solution. $C=\frac{\alpha\,g_o\,R^2}{\kappa}\cdot\frac{1}{3}(t_e-t_p)=0.5429\ R^2.$ $\quad D=\frac{\alpha\,g\,R^4}{\kappa^2}\,.\,2n\,.\,\frac{1}{3}(t_e-t_p)=0.00008532\ R^4.$

Zenith. $w=C\,(1-3\cos^2\theta)\,\frac{\sigma}{8}\,(h-\sigma)\,(3h\,\sigma-2\,\sigma^2).$ $\quad h=\frac{H}{R}=\frac{1}{100}.$

South. $u=C\,.\,6\cos\theta\sin\theta\,.\,\frac{\sigma}{48}\,(6h^2-15h\,\sigma+8\sigma^2).$ $\quad \sigma=\left(\frac{0}{10},\frac{1}{10}\cdots\frac{10}{10}\right)h.$

East. $$v=D\left\{\begin{array}{l}\sin\theta\,(1-3\cos^2\theta)\,\frac{\sigma}{480}\left(-9h^5+15h^2\sigma^3-15h\sigma^4+4\sigma^5\right)\\ \qquad +6\cos^2\theta\,.\,\frac{\sigma}{960}\left(20h^2\sigma^2-25h\sigma^3+8\sigma^4\right)\end{array}\right\}.$$

413. Values of σ.

	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	
					$\frac{\sigma}{8}(h-\sigma)(3h\sigma-2\sigma^2)$.							
I.	.0000	+.0032	+.0104	+.0189	+.0264	+.0312	+.0324	+.0294	+.0224	+.0122	.0000	$\frac{H^4}{R^4}$.
					$\frac{\sigma}{48}(6h^2-15h\sigma+8\sigma^2)$.							
II.	.0000	+.0095	+.0138	+.0139	+.0107	+.0052	−.0015	−.0085	−.0147	−.0191	−.0208	$\frac{H^3}{R^3}$.
					$\frac{\sigma}{480}(-9h^5+15h^2\sigma^3-15h\sigma^4+4\sigma^5)$.							
III.	.0000	−.0019	−.0037	−.0054	−.0070	−.0083	−.0092	−.0099	−.0103	−.0104	−.0104	$\frac{H^6}{R^6}$.
					$\frac{\sigma}{960}(20h^2\sigma^2-25h\sigma^3+8\sigma^4)$.							
IV.	.0000	.0000	+.0001	+.0004	+.0008	+.0012	+.0018	+.0023	+.0027	+.0030	+.0031	$\frac{H^5}{R^5}$.

414. COEFFICIENTS OF THE COMPONENT CURRENTS.

θ	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
I.	Coefficients of C. $\frac{H^3}{R^4}=.5429\,\frac{H^4}{R^2}=\begin{cases}2.203\times10^5 \text{ for } H=63700^m.\\2.203\times10 \text{ for } H=6370.\end{cases}$									
	w=vertical currents. +=ascending, −=descending.									
σ=1.0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.9	−244	−233	−202	−152	93	−29	+30	+ 79	+111	+122
.8	448	428	370	280	170	54	56	145	204	224
.7	588	562	486	368	224	70	74	191	268	294
.6	648	619	535	405	247	78	81	210	295	324
.5	624	596	515	390	237	75	78	202	284	312
.4	528	504	436	330	201	63	66	171	240	264
.3	378	361	312	236	144	45	47	123	172	189
.2	208	199	172	130	79	24	26	68	95	104
.1	− 64	− 61	− 53	− 40	− 24	− 8	+ 8	+ 21	+ 29	+ 32
.0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
II.	Coefficients of C. $\frac{H^3}{R^3}=.5429\,\frac{H^3}{R}=\begin{cases}2.203\times10^7 \text{ for } H=63700^m.\\2.203\times10^4 \text{ for } H=6370.\end{cases}$									
	u=horizontal currents on meridians. +=south, −=north.									
σ=1.0	.0000	−.0213	−.0401	−.0540	−.0614	−.614	−.0540	−.0401	−.0213	.0000
.9	.0000	196	368	496	564	564	496	368	196	.0000
.8	.0000	151	283	382	434	434	382	283	151	.0000
.7	.0000	87	164	221	251	251	221	164	87	.0000
.6	.0000	− 15	− 29	− 39	− 44	− 44	− 39	− 29	− 15	.0000
.5	.0000	+ 53	+ 100	+ 135	+ 154	+ 154	+ 135	+ 100	+ 53	.0000
.4	.0000	110	206	278	316	316	278	206	110	.0000
.3	.0000	143	268	361	411	411	361	268	143	.0000
.2	.0000	142	266	359	408	408	359	266	142	.0100
.1	.0000	+ 97	+ 183	+ 247	+ 281	+ 281	+ 247	+ 183	+ 97	.0000
.0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
III.	Coefficients of D. $\frac{H^6}{R^6}=.8532\times10^{-4}\,\frac{H^6}{R^2}=\begin{cases}1.405\times10^{11} \text{ for } H=63700^m.\\1.405\times10^5 \text{ for } H=6370.\end{cases}$									
	v_1=horizontal currents on parallels. +=east, −=west.									
σ=1.0	.00000	−.00346	−.00589	+.00651	+.00509	+.00191	−.00226	−.00636	−.00934	−.01042
.9	.00000	345	588	650	510	190	226	634	932	1040
.8	.00000	341	580	641	502	188	223	626	919	1026
.7	.00000	328	559	618	484	181	215	603	884	989
.6	.00000	307	522	578	452	169	201	564	828	924
.5	.00000	275	467	517	404	151	179	504	741	827
.4	.00000	231	395	437	342	128	152	426	626	699
.3	.00000	181	307	340	266	100	118	332	487	544
.2	.00000	123	210	232	181	68	81	226	332	371
.1	.00000	+ 62	+ 106	+ 117	+ 91	+ 34	− 41	− 114	− 168	− 187
.0	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000

COEFFICIENTS OF THE COMPONENT CURRENTS—Continued.

θ	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
IV.	Coefficients of $D \cdot \frac{H^5}{R^5} = .8532 \times 10^{-4} \frac{H^5}{R} = \begin{cases} 1.405 \times 10^{13} \text{ for } H = 63700^m. \\ 1.405 \times 10^{8} \text{ for } H = 6370. \end{cases}$									
	v_2=horizontal currents on parallels. +=east, −=west.									
σ=1.0	.00000	+.00315	+.00565	+.00702	+.00706	+.00592	+.00404	+.00206	+.00056	
.9	.00000	305	547	680	683	573	391	199	54	
.8	.00000	276	495	614	618	518	354	180	49	
.7	.00000	231	415	515	518	435	297	157	41	
.6	.00000	179	321	398	401	336	229	117	32	
.5	.00000	125	225	279	281	235	161	82	22	
.4	.00000	76	136	169	170	142	97	50	13	
.3	.00000	37	67	83	84	70	48	24	7	
.2	.00000	13	24	29	29	25	17	9	+2	
.1	.00000	+2	+4	+4	5	4	+3	+1	0	
.0	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000

Apparently this assumed value of $H = \frac{R}{100} = 63700$ meters is much too great. Indeed for $H = \frac{R}{1000} = 6370$ meters the circulation is more rapid than given by the observations. It is pointed out that the adoption by trial of a value of H to match the observed $(u \cdot v \cdot w)$ involves a method for computing the total height of the air in effective movement. But it is probable that the OBERBECK as well as the FERREL circulation does not conform to the actual stream lines in the atmosphere, and that the "Canal theory" is only approximately applicable.

After the assumption regarding the relative angular velocity, $\nu = \nu_1 \cos^2\theta - \nu_2 = \frac{1}{R^2}(\nu_1 z^2 - \nu_2 r^2)$, the solution for the most important part of the meridional variation in pressure due to the rotations and the currents $(w_3 \cdot u_3)$ is as follows:

415. Zenith. $w_3 = \frac{2n}{\kappa} R^3 \left\{ \nu_1 + 2\nu_2 - 6(4\nu_1 + \nu_2)\cos^2\theta + 35\nu_1 \cos^4\theta \right\} \left[\frac{\sigma^2}{48}(h-\sigma)(3h-2\sigma) \right].$

South. $u_3 = \frac{2n}{\kappa} R^3 \sin\theta \cos\theta \left\{ \nu_1 + 2\nu_2 - 7\nu_1 \cdot \cos^2\theta \right\} \left[\frac{\sigma}{48}(6h^2 - 15h\sigma + 8\sigma^2) \right].$

416. Values of σ.

	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
	$\frac{\sigma^2}{48}(h-\sigma)(3h-2\sigma)$.										
V.	.0000	+.0005	+.0017	+.0032	+.0044	+.0052	+.0054	+.0049	+.0037	+.0020	.0000 $\frac{H^4}{R^4}$.
	$\frac{\sigma}{48}(6h^2 - 15h\sigma + 8\sigma^2)$.										
VI.	.0000	+.0095	+.0138	+.0139	+.0107	+.0052	−.0015	−.0085	−.0147	−.0191	−.0208 $\frac{H^3}{R^3}$.

417. COEFFICIENTS OF THE COMPONENT CURRENTS.

θ	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
V.	Coefficients of $\frac{2n}{\kappa} R^3 \cdot \frac{H^4}{R^4} = .1571 \times 10^{-9} \frac{H^4}{R} = \begin{cases} .4062 \times 10^3 & \text{for } H = 63700^m. \\ .4062 \times 10^{-1} & \text{for } H = 6370. \end{cases}$									
	w_3=vertical currents. +=ascending, −=descending.									
σ=1.0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.9	+ 502	+ 444	+294	−106	− 50	−128	−119	− 53	+20	+ 50
.8	927	820	542	197	92	237	220	97	37	93
.7	.1217	.1077	712	258	121	311	289	127	49	122
.6	.1341	.1187	785	285	133	343	319	140	53	134
.5	.1294	.1145	757	275	129	331	307	135	52	130
.4	.1093	967	639	232	109	279	260	114	44	110
.3	782	692	458	166	78	200	186	82	31	78
.2	430	380	251	91	43	110	102	45	17	43
.1	+ 132	+ 117	+ 77	+ 28	− 13	− 34	− 31	− 14	− 5	+ 13
.0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
VI.	Coefficients of $\frac{2n}{\kappa} R^3 \cdot \frac{H^3}{R^3} = .1571 \times 10^{-9} H^3 = \begin{cases} .4062 \times 10^5 & \text{for } H = 63700^m. \\ .4062 \times 10^2 & \text{for } H = 6370. \end{cases}$									
	u_3=horizontal currents on meridians. +=south, −=north.									
σ=1.0	.0000	−.0426	−.0713	−.0782	−.0641	−.0376	−.0112	+.0050	+.0073	.0000
.9	.0000	392	655	718	588	346	103	46	67	.0000
.8	.0000	301	504	553	452	266	79	35	51	.0000
.7	.0000	174	292	320	262	154	46	20	30	.0000
.6	.0000	− 31	− 51	− 56	− 46	− 27	− 8	+ 4	+ 5	.0000
.5	.0000	+ 107	+ 178	+ 196	+ 160	+ 94	+ 28	− 12	− 18	.0000
.4	.0000	219	367	402	330	194	58	26	37	.0000
.3	.0000	285	477	523	428	252	75	33	49	.0000
.2	.0000	283	473	519	425	250	75	33	48	.0000
.1	.0000	+ 195	+ 327	+ 357	+ 293	+ 172	+ 51	− 23	− 33	.0000
.0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

418. $B = B_e \cdot \gamma_3 = B_e \cdot \frac{nR^2}{c^2} \cos^2\theta \left(\frac{3}{7}\nu_1 + \nu_2 - \nu_1 \cos^2\theta\right) = B_e \cdot (0.0413 \cos^2\theta - 0.0806 \cos^4\theta).$

419. $\nu = \nu_1 \cos^2\theta - \nu_2 = 0.00000213 \cos^2\theta - 0.00000018.$

420. VALUES OF PRESSURE, ANGULAR VELOCITY, AND EASTWARD VELOCITY.

θ	Pressure B			Relative angular velocity	Eastward velocity $v_3 = R \sin\theta \cdot \nu$	
	Comp.	Obs.	C−O			
0	728.2	.....	.....	+.00000195	+0.00	
10	730.8	.....	.....	189	2.09	
20	738.1	738.0	+0.1	170	3.70	
30	747.1	743.4	+3.7	142	4.52	4.58 at 33°33′
40	755.5	753.2	+2.3	107	4.38	
50	760.5	760.5	0	70	3.42	
60	762.0	763.5	−1.2	35	1.93	
70	760.8	761.7	−0.9	+ 7	+0.42	0.00 at 73°11′
80	758.9	759.1	−0.2	− 12	−0.75	
90	758.0	758.0	0	−.00000018	−1.15	

TABLE 113.—*Local cyclone* (*Ferrel*).

Applicable to the *local* circulation in Cyclones.

185. Cylindrical Equations:

$$-\frac{1}{\rho}\frac{\partial P}{\partial \varpi}=\frac{du}{dt}-(2n\cos\theta+\nu_1)\,v.$$

$$-\frac{1}{\rho}\frac{\partial P}{\varpi\partial\varphi}=\frac{dv}{dt}+(2n\cos\theta+\nu_1)\,u.$$

$$-\frac{1}{\rho}\frac{\partial P}{\partial z}=\frac{dw}{dt}+g.$$

ϖ is directed outward from the center.

$\varpi\partial\varphi$ is directed along the tangent on the left of $+\varpi$ (anticlockwise).

z is directed zenithward.

n is the angular velocity of the rotating earth.

ν_1 is the gyratory velocity about the axis z. $\nu_1=\frac{v}{\varpi}$.

θ is the north polar distance of the moving mass.

Assumptions and *transformations.*

389b. 1. The temperature is a function of ϖ only. It is symmetrical about the center, varies along the radius, but not along the circles coaxial with z.

$$-\frac{1}{\rho}\frac{\partial P}{\partial\varpi}=-\frac{\partial\log P}{a\partial\varpi}=-\frac{\partial\log P_o}{a\partial\varpi}+g\,(h-h_o)\frac{\partial a}{a\partial\varpi}=-\frac{\partial\log P_o}{a\partial\varpi}+g\,(h-h_o)\,\frac{\partial\log a}{\partial\varpi}.$$

Since by 47b, $\frac{1}{a}=gl\,(1+\alpha t)$, ($P_o$=pressure for $h_o=0$).

And by 61, 21, $-\log P=-\log P_o+\frac{h-h_o}{l\,(1+\alpha t)}=-\log P_o+ga\,(h-h_o)$. (com. logs).

390b. 2. The local cyclone is symmetrical on all sides of the center, and is bounded by a cylindrical surface whose constant radius is ϖ_o.

Hence the term $-\frac{1}{\rho}\frac{\partial P}{\varpi\partial\varphi}=0$.

391b. 3. Friction is proportional to the relative velocity of two adjacent strata.

$$Fq=kq\,(u\,.\,v\,.\,w\,.).$$

392b. 4. The assumed law of the variation of temperature along the radius, from center t_c to the outer limit t_o, is as follows:

$$t=A_o+A_2\cos 2\,\varphi=A_o+A_2\cos\frac{\varpi}{\varpi_o}\,\pi.\qquad A_2=\frac{1}{2}(t_c-t_o).\qquad 2\,\varphi=\frac{\varpi}{\varpi_o}\,\pi.$$

393b. $$\frac{\partial t}{\partial\varpi}=-A_2\frac{\pi}{\varpi_o}\sin\frac{\varpi}{\varpi_o}\,\pi=-\frac{1}{2}\,(t_c-t_o)\,\frac{\pi}{\varpi_o}\sin\frac{\varpi}{\varpi_o}\,\pi.$$

394b. $$gh\cdot\frac{\partial\log a}{\partial\varpi}=-\frac{gh\,.\,\alpha}{(1+\alpha t)}\cdot\frac{\partial t}{\partial\varpi}=+\frac{gh\,.\,\alpha}{(1+\alpha t)}\cdot\frac{1}{2}\,(t_c-t_o)\,\frac{\pi}{\varpi_o}\sin\frac{\varpi}{\varpi_o}\,\pi.$$

The isotherms are supposed to be circles about the center of the cyclone.

395b. 5. In integrating for the law of the preservation of areas it is assumed that there is no friction between the air and the surface of the earth.

396b. 6. All forces depending upon the velocity of vertical currents can be neglected. $w=0$.

The equations 185, by applying these conditions, become,

397b. Equations of local cyclonic motion:

$$-\frac{\partial\log P_o}{a\partial\varpi}=\frac{du}{dt}-(2n\cos\theta+\nu_1)\,v+ku-\frac{gh\,.\,a}{\varpi_o\,(1+\alpha t)}\cdot\frac{1}{2}\,(t_c-t_o)\,\pi\,.\,\sin\frac{\varpi}{\varpi_o}\pi.$$

$$0=\frac{dv}{dt}+(2n\cos\theta+\nu_1)\,u+kv.$$

TABLE 114.—*Local cyclone (Ferrel).*

397b. 2. Discussion of the *second* equation, $0=\frac{dv}{dt}+(2n\cos\theta+\nu_1)\,u+kv$.

In case of no friction the equation becomes:

398b. $(2n\cos\theta+\nu_1)\,u+\frac{dv}{dt}=2n\cos\theta\,.\,\varpi\frac{d\varpi}{dt}+\varpi\frac{dv}{dt}+v\,.\,\frac{d\varpi}{dt}=0.$

399b. Integrating. $\varpi^2 n\cos\theta+\varpi v=c.$

$\varpi^2(n\cos\theta+\nu_1)=c$, for *each* gyrating particle.

400b. C=constant for the *entire* rotating mass if $\nu_{1,0}$ is the initial ν_1.

$C=\frac{\int c\,dm}{m}=\frac{\int\varpi^2\,(n\cos\theta+\nu_{1,0})\,dm}{m}=\frac{1}{2}\,\varpi^2_o\,(n\cos\theta+\nu'_{1,0})$. This is equal to the moment of inertia of the entire mass at the distance $\frac{1}{2}\,\varpi_o$. If the initial state is that of rest on the rotating earth, $\nu'_{1,0}=0$.

401b. Hence $\varpi^2\left(n\cos\theta+\frac{v}{\varpi}\right)=\frac{1}{2}\,\varpi^2_o\,n\cos\theta.$ $\frac{v}{\varpi}=\frac{\varpi^2_o}{2\varpi^2}\,n\cos\theta-n\cos\theta.$

$v=\left(\frac{\varpi^2_o}{2\varpi^2}-1\right)\varpi\,n\cos\theta.$ Tangential velocity at the distance ϖ.

402b. If $v=0.$ $R^2=\frac{\varpi^2_o}{2}.$ $R=0.707\,\varpi_o.$ ϖ_o=radius of the boundary.

At the distance from the center 0.707, the tangential velocity vanishes.

Value of $\log P_o-\log P$, where P is the pressure at ϖ_o.

403b. $v^2=\left(\frac{\varpi^4_o}{4\varpi^4}-\varpi^2_o+\varpi^2\right)n^2\cos^2\theta.$ $v^2_o=\frac{\varpi^2_o}{4}\,n^2\cos^2\theta.$ For $\varpi=\varpi_o$.

404b. From 207. $\log P_o-\log P=\frac{v^2-v^2_o}{360862\,(1+\alpha t)}$. for $u=w=0$, and $z=z_o$.

$=\frac{14735\times10^{-18}}{1+\alpha t}\cos^2\theta\left(\frac{\varpi^4_o}{4\varpi^4}-\frac{5}{4}\,\varpi^2_o+\varpi^2\right)$. com. logs.

TABLE 115.—*Local cyclone (Ferrel).*

397b. 1. Discussion of the *first* equation, $-\frac{\partial\log P_o}{a\partial\varpi}=\frac{du}{dt}-(2n\cos\theta+\nu_1)\,v+ku-gh\,.\,\frac{\partial\log a}{\partial\varpi}.$

Surface gradients in terms of the angle of the inclination i, which the wind direction makes on the left of the tangent:

405b. $\tan i=-\frac{\frac{du}{dt}+k.u}{\frac{dv}{dt}+k.v}=+\frac{\frac{du}{dt}+k.u}{(2n\cos\theta+\nu_1)\,u}$. from 397b. $-u=q\sin i.$ $+v=q\cos i.$

$\tan i=\frac{k.u}{(2n\cos\theta+\nu_1)u}=\frac{k}{2n\cos\theta+\nu_1}=\frac{k}{\lambda+\frac{v}{\varpi}}$, for $\frac{du}{dt}=0.$ Compare 217, 224.

406b. $\frac{\partial\log P_o}{a\partial\varpi}=\frac{1}{\rho}\,.\,\frac{\partial P_o}{\partial\varpi}=(2n\cos\theta+\nu_1)\,v-\left(\frac{du}{dt}+k.u\right)$, for $h=0$. See 47b.

$\frac{\mu G}{\rho}=(2n\cos\theta+\nu_1)\,q\cos i+(2n\cos\theta+\nu_1)\,q\sin i\,.\tan i.$

$=(2n\cos\theta+\nu_1)\frac{q}{\cos i}=(2n\cos\theta+\nu_1)\frac{v}{\cos^2 i}.$

407b. From 48, 24, 47. $G=111\,111\,111(2n\cos\theta+\nu_1)\cdot\frac{q}{\cos i}\cdot\frac{0.760}{gl\,(1+\alpha t)}\cdot\frac{P}{P_o}=\frac{1077.6\,(2n\cos\theta+\nu_1)}{\cos^2 i\,(1+\alpha t)}\cdot v\cdot\frac{P}{P_o}$.

$$G=\frac{0.15716\,q\cos\theta}{\cos i\,(1+\alpha t)}\cdot\frac{P}{P_o}=\frac{0.15716\,v\cos\theta}{\cos^2 i\,(1+\alpha t)}\,\frac{P}{P_o},\text{ for }\nu_1=0.$$

Conditions above the surface (approximately).

In 397b. 1. Assume $u=0$, $v=$constant. Take $v=v_o$ for $h=0$. Subtract.

408b. $v_o-v=+\frac{gh\,\partial\log a}{(2n\cos\theta+\nu_1)\,\partial\varpi}=-\frac{gh\,.\,\alpha}{(1+\alpha t)}\frac{\partial t}{\partial\varpi}\frac{1}{(2n\cos\theta+\nu_1)}$. From 394.

$v_o-v=+\frac{0.1232}{(2n\cos\theta+\nu_1)}\cdot\frac{t_c-t_o}{2\,(1+\alpha t)}\cdot\frac{h}{\varpi_o}\sin\frac{\varpi}{\varpi_o}\pi$. From 393.

409b. Gradient. $G=\frac{0.15716\cos\theta}{\cos^2 i\,(1+\alpha t)}\cdot\frac{P}{P_o}\left[v_o-\frac{0.1232}{(2n\cos\theta+\nu_1)}\cdot\frac{t_c-t_o}{2\,(1+\alpha t)}\cdot\frac{h}{\varpi_o}\sin\frac{\varpi}{\varpi_o}\pi\right]$. 408b. in. 407b.

$$G_o-G=+\frac{.01937}{(1+\alpha t)^2}\cdot\frac{\cos\theta}{\cos^2 i}\cdot\frac{t_c-t_o}{2\,(2n\cos\theta+\nu_1)}\cdot\sin\frac{\varpi}{\varpi_o}\pi\cdot\frac{P}{P_o}\cdot\frac{h}{\varpi_o}.$$

Velocity above the surface. $u=$const. $v=$const.

410b. Velocity. $v=\frac{\partial\log P_o}{(2n\cos\theta+\nu_1)\,\alpha\partial\varpi}-\frac{gh\,\alpha}{(2n\cos\theta+\nu_1)\,(1+\alpha t)}\cdot\frac{t_c-t_o}{2}\,\frac{\pi}{\varpi_o}\sin\frac{\varpi}{\varpi_o}\pi+\frac{\frac{du}{dt}+ku}{2n\cos\theta+\nu_1}$.

$v=\frac{v_o}{\cos_2 i}-\frac{.1232}{v}\cdot\frac{h}{(1+\alpha t)}\cdot\frac{t_c-t_o}{2}\cdot\frac{\varpi}{\varpi_o}\sin\frac{\varpi}{\varpi_o}\pi+$(neglect). For $2n\cos\theta=0$ in respect to ν_1.

TABLE 116.—*Local cyclone (Sprung).*

421. For motion in the plane xy only and including friction, where $+u=$ radial velocity outwards, $+v=$tangential velocity on the left of ϖ.

Take $\frac{P}{\rho}+\frac{1}{2}(u^2+v^2)=P'$, and $-\frac{1}{\rho}\frac{\partial P}{\varpi\partial\varphi}=0$.

422. General equations. $-\frac{\partial P'}{\partial\varpi}=\frac{\partial u}{\partial t}-\frac{v^2}{\varpi}-\lambda v+ku$. (1) $0=\frac{\partial v}{\partial t}+\frac{uv}{\varpi}+\lambda u+kv$. (2). 185.

Discussion of the second equation.

423. Auxiliaries. $u=\frac{\partial\varpi}{\partial t}$. $v=\varpi\frac{\partial\varphi}{\partial t}$. $\frac{\partial v}{\partial t}=\frac{\partial\varpi}{\partial t}.\frac{\partial\varphi}{\partial t}+\varpi\frac{\partial^2\varphi}{\partial t^2}$. $2S=\varpi.v$. Sector area in vortex motion.

$$2\frac{\partial S}{\partial t}=\varpi\frac{\partial v}{\partial t}+v.\frac{\partial\varpi}{\partial t}=\varpi\frac{\partial v}{\partial t}+u.v=-\varpi\lambda u-\varpi kv=2\varpi\frac{\partial\varpi}{\partial t}.\frac{\partial\varphi}{\partial t}+\varpi^2.\frac{\partial^2\varphi}{\partial t^2}.$$

424. Transformed equation. $2\frac{\partial S}{\partial t}=-\frac{\lambda}{2}\frac{\partial\,\varpi^2}{\partial t}-2kS=-\varpi\lambda u-\varpi kv$.

425. CASE 1. $\lambda=k=0$. $2\frac{\partial S}{\partial t}=0$. $2S=\varpi.v=$constant.

In the cyclone. $u=-\frac{\partial\varpi}{\partial t}$. $v=+\varpi\frac{\partial\varphi}{dt}$.

In the anticyclone. $u=+\frac{\partial\varpi}{\partial t}$. $v=-\varpi\frac{\partial\varphi}{\partial t}$.

Assumed equation of continuity for vertical motions.

426. Equations of continuity.

$$\begin{cases}2\pi\varpi\,.\,z\,.\,u\rho=2\pi\,.\,z\rho\,.\,\varpi u=\text{const.}\\ \varpi u=C_1.\qquad\text{Or } z\rho=C_2.\\ z\rho=\frac{\text{const.}}{\varpi u}=\frac{\text{const.}}{\varpi^2},\text{ for } u=\varpi C;\text{ in the } \textit{inner} \text{ region.}\\ z\rho=\frac{\text{const.}}{\varpi u}=\text{const.},\text{ for } u=\frac{C}{\varpi};\text{ in the } \textit{outer} \text{ region.}\end{cases}$$

427. CASE 2. $\lambda=0.$ $\quad 2\frac{\partial S}{\partial t}=-2kS.$ $\quad \log S=-kt.$ $\quad S=S_0e^{-kt}.$

428. CASE 3. $k=0.$ $\quad 2\frac{\partial S}{\partial t}=-\frac{\lambda}{2}\frac{\partial.\varpi^2}{\partial t}.$ $\quad 2S\Big]_0=-\frac{\lambda}{2}\varpi^2\Big]_0.$ $\quad 2S=2S_0+\frac{\lambda}{2}(\varpi^2{}_0-\varpi^2).$

429. CASE 4. $S=\frac{\partial F}{\partial t}.$ $\quad 2\frac{\partial S}{\partial t}=-\frac{\lambda}{2}\frac{\partial.\varpi^2}{\partial t}-2k\frac{\partial F}{\partial t}.$ $\quad 2S=2S_0+\frac{\lambda}{2}(\varpi^2{}_0-\varpi^2)-2kF.$

430. CASE 5. $\frac{\partial S}{\partial t}=0.$ $\quad -\varpi\lambda u=\varpi kv.$ $\quad \tan i=\cot\varepsilon=-\frac{u}{v}=\frac{k}{\lambda}.$ Logarithmic spiral.

431. CASE 6. $\varpi v=\text{const.}$ $\quad -u=\frac{C_1}{\varpi}.$ $\quad v=+\frac{\lambda}{k}\cdot\frac{C_1}{\varpi}$ for the outer region of cyclone.

$$q=(u^2+v^2)^{\frac{1}{2}}=\frac{C}{\varpi}\sqrt{1+\frac{\lambda^2}{k^2}}=\frac{M}{\varpi}.$$

$$-u=q\sin i=\frac{M}{\varpi}\sin i. \qquad v=q\cos i=\frac{M}{\varpi}\cos i.$$

Discussion of the first equation.

432. Auxiliaries. $\quad -\frac{\partial u}{\partial t}=+\frac{M^2}{\varpi^3}\sin^2 i. \qquad +\frac{v^2}{\varpi}=+\frac{M^2}{\varpi^3}\cos^2 i.$

433. Gradients.

$$\frac{\mu G}{\rho}=\frac{\partial P'}{\partial\varpi}=-\frac{\partial u}{\partial t}+\frac{v^2}{\varpi}+\lambda v-ku=\frac{M^2}{\varpi^2}+\lambda\cdot\frac{M}{\varpi}\cos i+k\cdot\frac{M}{\varpi}\sin i.$$

$$\frac{\mu G}{\rho}=\frac{1}{\rho}\frac{\partial P}{\partial\varpi}+u\frac{\partial u}{\partial\varpi}=\frac{M^2}{\varpi^3}+\frac{M}{\varpi}\left(\frac{\lambda\cos i\sin i+k\sin^2 i}{\sin i}\right).$$

$$=\frac{M^2}{\varpi^3}+\frac{M}{\varpi}\cdot\frac{k}{\sin i}.$$

Auxili

$$\lambda\sin i=k\cos i.$$

434. Cyclone. $\quad \frac{\mu G}{\rho}=\frac{q^2}{\varpi}+q\cdot\frac{k}{\sin i}=\frac{C^2}{\varpi^3}\left(1+\frac{\lambda^2}{k^2}\right)+\frac{C}{\varpi}\left(1+\frac{\lambda^2}{k^2}\right)^{\frac{1}{2}}\cdot\frac{k}{\sin i}.$

435. Anticyclone. $\quad \frac{\mu G}{\rho}=-\frac{q^2}{\varpi}+q\cdot\frac{k}{\sin i}.$

TABLE 117.—*The two solutions of the second equation.*

397b. 2. $\quad 0=\frac{\partial v}{\partial t}+\frac{uv}{\varpi}+\lambda u+kv.$

436. Auxiliaries. $\quad \frac{\partial v}{\partial t}=\frac{\partial v}{\partial\varpi}\cdot\frac{\partial\varpi}{\partial t}=u\cdot\frac{\partial v}{\partial\varpi}.$

437. Equation of motion. $\quad 0=u\cdot\frac{\partial v}{\partial\varpi}+\frac{uv}{\varpi}+\lambda u+kv.$

	First solution (inner).	Second solution (outer).
438. Velocities.	$u=-\frac{c}{2}\varpi.$	$u=-\frac{c}{\varpi}.$
	$v=+\frac{\lambda}{k-c}\cdot\frac{c}{2}\varpi=-\frac{\lambda}{k-c}\cdot u.$	$v=+\frac{\lambda}{k}\cdot\frac{c}{\varpi}=-\frac{\lambda}{k}u.$
439. Laws.	$\frac{u}{\varpi}=-\frac{c}{2}=\text{const.}$	$u\varpi=-c=\text{const.}$
	$\frac{v}{\varpi}=+\frac{\lambda}{k-c}\cdot\frac{c}{2}=\text{const.}$	$v\varpi=+\frac{\lambda}{k}c=\text{const.}$
440. Auxiliaries.	$\frac{\partial u}{\partial\varpi}=-\frac{c}{2}.$	$\frac{\partial u}{\partial\varpi}=\frac{c}{\varpi}\cdot\frac{1}{\varpi}=-\frac{u}{\varpi}.$
	$\frac{\partial v}{\partial\varpi}=+\frac{\lambda}{k-c}\cdot\frac{c}{2}.$	$\frac{\partial v}{\partial\varpi}=-\frac{\lambda}{k}\cdot\frac{2}{\varpi}=-\frac{v}{\varpi}.$
	$-v(k-c)=+\lambda u.$	$-vk=\lambda u.$

441. $0=-\frac{\lambda}{k-c}\left(\frac{c}{2}\right)^2\varpi-\frac{\lambda}{k-c}\left(\frac{c}{2}\right)^2-\lambda\frac{c}{2}\varpi+\frac{\lambda k}{k-c}\cdot\frac{c}{2}\varpi.$ $\quad 0=+\frac{c}{\varpi}\cdot\frac{\lambda}{k}\frac{c}{\varpi^2}-\frac{c}{\varpi}\cdot\frac{\lambda}{k}\frac{c}{\varpi^2}-\frac{\lambda c}{\varpi}+\frac{\lambda c}{\varpi}.$

$$0=\frac{-\lambda c-\lambda k+\lambda c+\lambda k}{k-c}.$$

	Parabolic solution.	Hyberbolic solution.
442. Fundamental law. See (232–241.)	$\frac{v}{\varpi}=\text{const.}$	$v\varpi=\text{const.}$

443. Equation of continuity. $2\pi\varpi\,.\,z\,.\,u\rho=2\pi\,.\,z\rho\,.\,\varpi u=\text{const.}$ $\quad \varpi u=\text{const.}$

	Inner.	Outer.	
444.	$z\rho=\frac{\text{const.}}{\varpi u}=-\frac{\text{const.}}{c/2}\cdot\frac{1}{\varpi^2}.$	$z\rho=\text{const.}$	$\rho=1.$
	$w=\frac{\partial z}{\partial t}=-2z\frac{u}{\varpi}=cz.$	$w=\frac{\partial z}{\partial t}=0.$	

445. Analogue of the magnetic force and the electric current in a cylindrical wire.

446. Common difference and ratio.	$d=R^2-\varpi_i^2.$ Inside.	$\rho=\frac{\varpi_e}{R}.$ Outside.
447. General equation.	$\frac{H_i}{R-\varpi_i}=\frac{1}{R-\varpi_i}\int_{\varpi_i}^{R}\frac{2i}{R^2}\varpi_i\,\partial\varpi_i.$	$\frac{H_e}{\varpi_e-R}=\frac{1}{\varpi_e-R}\int_{R}^{\varpi_e}2i\frac{\partial\varpi_e}{\varpi_e}.$
448. Integral.	$H_i=\text{const.}=i\,.\,\frac{R^2-\varpi_i^2}{R^2}=\pi w\,(R^2-\varpi_i^2).$	$H_e=\text{const.}=-2i\,.\log\frac{\varpi_e}{R}=-2\pi R^2 w\,.\log\frac{\varpi_e}{R}.$
449. Velocities.	$-\frac{\partial H_i}{\partial\varpi_i}=v_i=+2\pi\varpi_i\,.\,w_i=+\frac{c}{2}\varpi_i.$	$-\frac{\partial H_e}{\partial\varpi_e}=v_e=+2\pi\frac{R^2}{\varpi_e}\cdot w_i=+\frac{c}{2}\cdot\frac{R^2}{\varpi_e}.$
	$u_i=-2\pi\varpi_i=-\frac{c}{2}\varpi_i.$	$u_e=-2\pi\frac{R^2}{\varpi_e}\cdot w_i=-\frac{c}{2}\frac{R^2}{\varpi_e}.$
	$w_i=\frac{v_i}{2\pi\varpi_i}=\text{const.}$	$w_e=0.$

Compare (362–364).

This solution does not include the deflection λ nor the friction k.

Compare: Heaviside, Physical papers, Vol. I, p. 197. Ebert, Magnetische Kraftfelder, p. 87 and p. 178. Drude, Physik des Aethers, pp. 94–98.

TABLE 118.—*Local cyclone (Guldberg and Mohn).*

450. Velocities.	$u=-\frac{c}{2}\varpi.=-\frac{\partial\varpi}{\partial t}.$ *Inner.*	$u=-\frac{c}{\varpi}.$ *Outer.*
	$v=+\frac{\lambda}{k-c}\cdot\frac{c}{2}\varpi.$	$v=+\frac{\lambda}{k}\cdot\frac{c}{\varpi}.$
	$q^2=\frac{c}{2}\varpi\sqrt{1+\left(\frac{\lambda}{k-c}\right)^2}.$	$q^2=\frac{c^2}{\varpi^2}\left(1+\frac{\lambda^2}{k^2}\right).$

451. Equation of continuity. $2\pi\varpi\,.\,z\rho\,.\,u=\text{const.}$ $\quad z\rho=\frac{\text{const}}{\varpi^2}.$ For the inner region.

452. Auxiliaries. $\frac{\partial u}{\partial t}=-\frac{c}{2}\frac{\partial\varpi}{\partial t}=-\frac{c}{2}u=+\frac{c^2}{4}\varpi.$

$$\frac{\partial v}{\partial t}=+\frac{\lambda}{k-c}\cdot\frac{c}{2}\cdot\frac{\partial\varpi}{\partial t}=+\frac{\lambda}{k-c}\cdot\frac{c^2}{4}\varpi=-\frac{\lambda}{k-c}\cdot\frac{c}{2}u.$$

453. Gradient. $\frac{\mu}{\rho}\,.\,G=+\frac{1}{\rho}\frac{\partial P}{\partial\varpi}=-\frac{\partial u}{\partial t}+\frac{v^2}{\varpi}+\lambda v-ku.$

$$=\frac{c}{2}\varpi\left(-\frac{c}{2}+\left(\frac{\lambda}{k-c}\right)^2\cdot\frac{c}{2}+\frac{\lambda^2}{k-c}+k\right).$$

$$=\frac{c}{2}\varpi\frac{\left(-\frac{c}{2}\sin^2 i+\frac{c}{2}\cos^2 i+\lambda\sin i\cos i+k\sin^2 i\right)}{\sin^2 i}.$$

454. Cyclone. $\frac{\mu}{\rho} G. \quad = \frac{c}{2} \varpi . \frac{k-\frac{c}{2}}{\sin^2 i}.$ (Since $\lambda \sin i = k \cos i - c \cos i$.)

455. Anticyclone. $\frac{\mu}{\rho} G. \quad = -\frac{c}{2} \varpi . \frac{k+\frac{c}{2}}{\sin^2 i}.$ $\frac{c}{2}$ is the radial velocity at the unit distance.

456. $\tan \varepsilon = \cot i = \frac{\lambda}{k-c}$ inner region. $\tan \varepsilon = \cot i = \frac{\lambda}{k}$ outer region.

TABLE 119.—*Local cyclone (Oberbeck).*

For motion in the plane xy only and including friction, where $+x$ is south, and $+y$ is east, equations 185 become:

457. General equations.

$$\frac{\partial}{\partial x}\left[\frac{P}{\rho}+\frac{1}{2}(u^2+v^2)\right]+\frac{\partial u}{\partial t}+ku=+(2n \cos \theta+\nu_1)\, v=+(\lambda+\nu_1)\, v=+\lambda v+\frac{v^2}{\varpi^2}. \quad \text{South.}$$

$$\frac{\partial}{\partial y}\left[\frac{P}{\rho}+\frac{1}{2}(u^2+v^2)\right]+\frac{\partial v}{\partial t}+kv=-(2n \cos \theta+\nu_1)\, u=-(\lambda+\nu_1)\, u=-\lambda u-\frac{uv}{\varpi}. \quad \text{East.}$$

458. Potential equations.

$$+u=\frac{\partial H}{\partial x}+\frac{\partial W}{\partial y}=+\frac{x}{\varpi}\cdot\frac{\partial H}{\partial \varpi}+\frac{y}{\varpi}\cdot\frac{\partial W}{\partial y}.$$

$$+v=\frac{\partial H}{\partial y}-\frac{\partial W}{\partial x}=+\frac{y}{\varpi}\cdot\frac{\partial H}{\partial \varpi}-\frac{x}{\varpi}\cdot\frac{\partial W}{\partial \varpi}.$$

459. Assumptions.

Inner region.	Outer region.
$\nabla^2 H_i = -c = \text{constant}.$	$\nabla^2 H_e = 0.$
$-\nabla^2 W_i = 2\omega_3 = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}.$	$-\nabla^2 W_e = 2\omega_3.$

460. CASE I. $c=0$. No vertical motion for the entire region.

$$\nabla^2 H_i = \nabla^2 H_e = 0.$$

461. Logarithmic potential in equivalent notations.

H_e	Bigelow,	363.
φ	Oberbeck,	p. 160.
$-\psi$	Lamb,	p. 243.
H_a	Drude,	p. 96.
W	Kirchhoff,	p. 257.
φ	Basset,	p. I, 49.

462. Potentials.

$$H_e = -\frac{c}{2\pi}\int dS . \log \varpi. \qquad \frac{c}{2\pi} = 2w = \frac{\omega_3}{\pi} = \frac{v}{\pi\varpi}.$$

$$= -\frac{m}{\pi} \log \varpi. \qquad \frac{c}{2\pi}\int dS = \frac{m}{\pi}.$$

463. $W_e = -\frac{\lambda}{k} H_e.$

464. $W_i = -\frac{\lambda}{k-c} . H_i.$

465. Velocities.

$$u = \frac{\partial H}{\partial x} - \frac{\lambda}{k}\frac{\partial H}{\partial y}. \qquad v = \frac{\partial H}{\partial y} + \frac{\lambda}{k}\frac{\partial H}{\partial x}.$$

$$q^2 = u^2 + v^2 = \left[\left(\frac{\partial H}{\partial x}\right)^2 + \left(\frac{\partial H}{\partial y}\right)^2\right]\left(1+\frac{\lambda^2}{k^2}\right).$$

466. Pressures.

$$P' = \frac{P}{\rho} + \frac{1}{2}(u^2+v^2) = \text{constant} - kH\left(1+\frac{\lambda^2}{k^2}\right).$$

467.

$$\frac{P}{\rho} = \text{const.} - \frac{1}{2}(u^2+v^2) - kH\left(1+\frac{\lambda^2}{k^2}\right).$$

Compare 233.

468. CASE II. c=coefficient of vertical motion in the inner region.

	Inner region.	Outer region.	
469. Potentials.	$H_i=-\frac{c}{4}\left[2R^2\log R-(R^2-\varpi^2)\right].$	$H_e=-\frac{c}{2}R^2\log\varpi.$	363.
470. Radial.	$u_2=\frac{\partial H_i}{\partial\varpi}=-\frac{c}{2}\varpi.$	$u_2=\frac{\partial H_e}{\partial\varpi}=-\frac{c}{2}\frac{R^2}{\varpi}.$	
471. Tangential.	$v_2=\frac{\partial W_i}{\partial\varpi}=\frac{\lambda}{k-c}\cdot\frac{c}{2}\cdot\varpi\left[1-\frac{c}{k}\left(\frac{\varpi}{R}\right)^{\frac{2(k-c)}{c}}\right].$	$v_2=\frac{\partial W_e}{\partial\varpi}=+\frac{\lambda}{k}\cdot\frac{c}{2}\frac{R^2}{\varpi}.$	
472. South.	$u_1=-\frac{c}{2}\varpi\left(\frac{x}{\varpi}-\frac{\lambda}{k-c}\cdot\frac{\lambda}{\varpi}.f(\varpi)\right).$	$u_1=-\frac{c}{2}\frac{R^2}{\varpi}\left(\frac{x}{\varpi}-\frac{\lambda}{k}\frac{y}{\varpi}\right).$	
East.	$v_1=+\frac{c}{2}\varpi\left(\frac{y}{\varpi}+\frac{\lambda}{k-c}\cdot\frac{x}{\varpi}.f(\varpi)\right).$	$v_1=+\frac{c}{2}\frac{R^2}{\varpi}\left(\frac{y}{\varpi}+\frac{\lambda}{k}\frac{x}{\varpi}\right).$	
Vertical.	$w_1=+cz.$	$w_1=0.$	
473. Pressures.	$P'_i=\text{const.}+F(\varpi).$	$P'_e=\text{const.}+\frac{c}{2}k\left(1+\frac{\lambda^2}{k^2}\right)R^2\log\varpi.$	

474.

$$P'_i=P'_o+\frac{ck}{4}\varpi^2\left[1+\left(\frac{\lambda}{k-c}\right)^2\left[1-\frac{2c^2}{k^2}\left(\frac{\varpi}{R}\right)^{\frac{2k}{c}-2}+\frac{c^3}{k^2(2k-c)}\left(\frac{\varpi}{R}\right)^{\frac{4k}{c}-4}\right]\right].$$

$$P'_e=P'_o+F(R)+\frac{c}{2}k\left(1+\frac{\lambda^2}{k^2}\right)R^2\log\frac{\varpi}{R}.$$

475. $\frac{P-P_o}{\rho}=F(\varpi)-\frac{1}{2}q^2.$ $\qquad$ $\frac{P-P_o}{\rho}=F(R)+\frac{c}{2}k\left(1+\frac{\lambda^2}{k^2}\right)R^2\log\frac{\varpi}{R}-\frac{1}{2}q^2.$

P_o is the pressure at the center of the cyclone.

476. Inclination. $\tan\varepsilon=\cot i=\frac{\lambda}{k-c}.f'(\varpi).$ $\qquad$ $\tan\varepsilon=\cot i=\frac{\lambda}{k}.$

TABLE 120.—*Local anticyclone* (*Pockels*).

477a. Equation of continuity. $-2\pi\varpi\,.\,u\,.\,z\rho=\pi\varpi^2\,.\,w.$ $\qquad$ ρ=Const. for the current in depth$=z$.

$$-\varpi uz=\varpi^2\cdot\frac{w}{2}. \qquad -u=\varpi\cdot\frac{w}{2}\cdot\frac{1}{z}.$$

477b. Pockels's form. $-\frac{\partial}{\partial\varpi}(\varpi u)=\varpi\,.\,w.$ $\qquad$ $w=cz=\gamma\varpi.$

$-\varpi u=\varpi^2\cdot\frac{w}{2}.$ $\qquad$ $w=c=\gamma$ (for $z=\varpi=1$) at unit distance.

478. Law of continuity. $-u=\varpi\cdot\frac{w}{2}=\frac{c}{2}\cdot\varpi.$

479. Auxiliaries. $-\frac{\partial u}{\partial t}=-\frac{\partial u}{\partial\varpi}\cdot\frac{\partial\varpi}{\partial t}=-u\frac{\partial u}{\partial\varpi}.$ $\qquad$ $\frac{\partial v}{\partial t}=\frac{\partial v}{\partial\varpi}\cdot\frac{\partial\varpi}{\partial t}=+u\frac{\partial v}{\partial\varpi}.$

480. Equations of motion. $-\frac{1}{\rho}\frac{\partial P}{\partial\varpi}=-u\frac{\partial u}{\partial\varpi}-\frac{v^2}{\varpi}-\lambda v+ku.$

$$0=+u\frac{\partial v}{\partial\varpi}+\frac{uv}{\varpi}+\lambda u+kv.$$

	Inner region.	Outer region.
481. Equation.	$0=\frac{c}{2}\left(\frac{\partial v}{\partial\varpi}\cdot\varpi+v\right)+\lambda\frac{c}{2}\varpi+kv.$	$0=\frac{c}{2}R^2\left(\frac{\partial v}{\partial\varpi}\cdot\frac{1}{\varpi}+\frac{v}{\varpi^2}\right)+\lambda\frac{c}{2}\frac{R^2}{\varpi}+kv.$
482. Velocities.	$u=+\frac{c}{2}\varpi.$	$u=+\frac{c}{2}\frac{R^2}{\varpi}.$
	$v=-\frac{c}{2}\cdot\frac{\lambda}{k+c}\cdot\varpi$	$v=-\frac{c}{2}\frac{\lambda}{k}\frac{R^2}{\varpi}\left[1-\frac{c}{k+c}e^{-\frac{k}{c}\left(\frac{\varpi^2}{R^2}-1\right)}\right]$
	$w=cz=\gamma\varpi.$	$w=0.$

POCKELS derived this result from OBERBECK'S equations by evaluating the constant o integration.

In this case the equations for the local cyclone are found by simply changing the sign of c.

483. Inclination. $\tan\varepsilon=\cot i=\frac{\lambda}{k+c}.$ $\qquad$ $\tan\varepsilon=\cot i=\frac{\lambda}{k}.f'(\varpi).$

TABLE 121.—*Local cyclone (Bigelow).*

484. Equations of motion.

$$-\frac{1}{\rho}\frac{\partial P}{\partial x}=\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial \varpi}+v\frac{\partial u}{\varpi\partial \varphi}+w\frac{\partial u}{\partial z}-2n\cos\theta\,.\,v-\frac{v^2}{\varpi}+ku+f(t_x).$$

$$-\frac{1}{\rho}\frac{\partial P}{\partial y}=\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial \varpi}+v\frac{\partial v}{\varpi\partial \varphi}+w\frac{\partial v}{\partial z}+2n\cos\theta\,.\,u+\frac{uv}{\varpi}+kv+f(t_y).$$

$$-\frac{1}{\rho}\frac{\partial P}{\partial z}=\frac{\partial w}{\partial t}+u\frac{\partial w}{\partial \varpi}+v\frac{\partial w}{\varpi\partial \varphi}+w\frac{\partial w}{\partial z}+g+f(t_z).$$

Omitting the unimportant terms.

485. Cylindrical equations of motion.

$$-\frac{1}{\rho}\frac{\partial P}{\partial \varpi}=\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial \varpi}-\frac{v^2}{\varpi}-\lambda v+ku+f(t_x).=-\frac{1}{\rho}\mu G_x.$$

$$-\frac{1}{\rho}\frac{\partial P}{\varpi\partial \varphi}=\frac{\partial v}{\partial t}+v\frac{\partial v}{\varpi\partial \varphi}+\frac{uv}{\varpi}+\lambda u+kv+f(t_y).=-\frac{1}{\rho}\mu G_y.$$

$$-\frac{1}{\rho}\frac{\partial P}{\partial z}=\frac{\partial w}{\partial t}+g\qquad\qquad +f(t_z).=-\frac{1}{\rho}\mu G_z.$$

486. Equation of continuity.

$$-2\pi\varpi\,.\,z\,.\,u\rho=\pi\varpi^2 w\,.\,\rho=\text{const.}$$

$$-u=\varpi\frac{w}{2}\cdot\frac{1}{z}\cdot=\frac{c}{2}\cdot\varpi.\qquad\text{for }\rho=1.$$

487. Derived relations.

$$z=+\frac{\text{const.}}{\varpi u}=-\frac{\text{const.}}{c/2}\,\frac{1}{\varpi^2}.\qquad \partial z=-2z\cdot\frac{\partial\varpi}{\varpi}.$$

$$\varpi\frac{\partial z}{\partial t}=-2z\cdot\frac{\partial\varpi}{\partial t}.\qquad \varpi w=-2z.u.\qquad w=-\frac{2zu}{\varpi}=+cz.$$

	CASE I. (Compare 303—308.)	CASE II.
488. Current function.	$\psi=-\frac{c}{2}\varpi^2 z.\ =\varphi\,.\,z=u\varpi z$	$\psi=-cz.$
489. Auxiliaries.	$\varphi=-\frac{c}{2}\varpi^2.\quad a=\frac{\lambda}{k-c}.$	$\varphi=-c.\qquad a=\frac{\lambda}{k}.$
490. Velocities.	$u=+\frac{1}{\varpi}\frac{\partial\psi}{\partial z}=\frac{\varphi}{\varpi}=-\frac{c}{2}\varpi.$	$u=+\frac{1}{\varpi}\cdot\frac{\partial\psi}{\partial z}=\frac{\varphi}{\varpi}=-\frac{c}{\varpi}.$
	$v=\frac{a\psi}{\varpi}=+\frac{\lambda z}{k-c}\cdot\frac{c}{2}\varpi.$	$v=\frac{a\psi}{\varpi}=\frac{\lambda}{k}\cdot\frac{c}{\varpi}z.$
	$w=-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}=cz=-\frac{2u}{\varpi}\cdot z.$	$w=-\frac{1}{\varpi}\cdot\frac{\partial\psi}{\partial\varpi}=0.$
	$=+\frac{2v}{\varpi}\cdot\frac{k-c}{\lambda}.$	
491. Inclination.	$\cot i=+\frac{\lambda z}{k-c}.$	$\cot i=+\frac{\lambda z}{k}.$
492. Vortex law.	$\varpi v=\frac{\lambda}{k-c}\cdot\frac{c}{2}\cdot\varpi^2 z=-\text{const.}$	$\varpi v=\frac{\lambda}{k}\cdot cz=-\text{const.}$

493. Equation of continuity.

$$\frac{\partial u}{\partial\varpi}+\frac{u}{\varpi}+\frac{\partial w}{\partial z}=-\frac{c}{2}-\frac{c}{2}+c=0.$$

See 163

494. Gradients.

$$-\frac{\mu G_x}{\rho}=-\frac{1}{\rho}\frac{\partial P}{\partial\varpi}=-\frac{c}{2}\varpi\left(k-c+\lambda\cdot\frac{\lambda z}{k-c}+\frac{c}{2}\left(\frac{\lambda z}{k-c}\right)^2\right]+f(t_x).$$

$$=+u\left(k-c+\lambda\,.\,\cot i+\frac{c}{2}\cdot\cot^2 i\right)+f(t_x).$$

495. Total velocity. $$q^2=u^2+v^2+w^2=\frac{u^2}{\sin^2 i}+w^2=u^2\left(\frac{1}{\sin^2 i}+\frac{4z^2}{\varpi^2}\right)\cdot+f(t).$$

496. Pressure changes. $$\log P_o-\log P=\frac{(q^2-q^2_o)+2g\,(z-z_o)}{360862\,(1+\alpha t)}+f_1(k)+f_2(t).$$ See 207.

389a. By 47b, $-\frac{1}{\rho}\frac{\partial P}{\partial x}=-g_o l(1+\alpha t)\frac{\partial \log P}{\partial x}=-\frac{1}{a}\frac{\partial \log P}{\partial x}$.

By 61, $-\log P=-\log P_o+\frac{h-h_o}{18429+67.6\theta+0.003h}$, approximately. By 21 and 23,

$-\log P=-\log P_o+\frac{h-h_o}{l(1+\alpha t)}=-\log P_o+ag(h-h_o)$ in common logarithms. Hence by substitution,

$$-\frac{1}{\rho}\frac{\partial P}{\partial x}=-\frac{\partial \log P_o}{a\partial x}+g(h-h_o)\frac{\partial \log a}{\partial x}.$$

The first term gives the variation of pressure at the surface along the meridian, and the second the variation with the altitude and the changes of temperature in a north and south direction. The latter must be evaluated by assigning some law to the temperature changes between the equator and the poles.

390a. Similar equations in the dy (west–east) and dz (nadir–zenith) directions should be formed to give a complete solution. FERREL, however, omits the third or vertical equation, and thus limits the motion to horizontal planes parallel to the surface of the earth. The second equation is assumed to have no temperature variations in longitude at the same polar distance, so that thus the temperature distribution is symmetrical around the poles. Also the term $-\frac{1}{\rho}\frac{\partial P}{\partial y}$ is assumed to vanish, and therefore the pressure gradients in a west–east direction are neglected.

391a. The law of friction is taken proportional to the relative velocity at the point of motion.

392–396a. These state briefly the other assumptions which are made to build up FERREL'S working equations of motion (397a).

They idealize the problem and restrict it to motions on a smooth globe, with no vertical pressure except that which is due to gravity, with no pressure variations and no temperature changes in longitude, the latter being symmetrical to the axis of rotation of the earth, warm at the equator and cold at the poles. Applying the law of the conservation of areas as swept by the radius vector of a particle in relative motion north–south, west–east (399a), FERREL encounters a serious difficulty in the fact that the eastward velocities near the poles should become enormous. Under the circumstances the west–east velocity in different latitudes would be as follows:

TABLE 122.—*Theoretical west–east velocities.*

$\varphi=90°$	$v=+\infty$	miles per hour.
80°	+3807	eastward.
70°	+1669	"
60°	+ 865	"
50°	+ 410	"
40°	+ 108	"
35° 16′	0	"
30°	− 100	westward.
20°	− 239	"
10°	− 320	"
Equator 0°	− 346	"

This is found by integrating the second equation of 397a, as indicated in 398–402a (Table 110), where the algebraic processes are distinctly shown. FERREL seeks to explain the wide discrepancy between these theoretical results and the observed velocities such as are given in Table 28, where the eastward drift at the cirrus level is about 40 meters per second in latitude 40, also with

the other observations that the westward velocity at the equator and the eastward velocity near the poles is not very great, by two methods of argument.

FERREL'S circulation is so well known to meteorologists that it is not necessary to further describe its details in this place than by reference to fig. 1, Chart 64, which shows the streams in different latitudes and altitudes. There is an ascending current in the tropics and a descending component in the polar regions; a southward current near the ground and a northward current in the upper strata; a rapid eastward drift in the middle latitudes increasing from the ground upward, and a westward drift in lower strata of the tropics. The eastward velocity disappears along an arch resting on the parallel of latitude 35° north and south and spanning the tropics at a considerable altitude. Beneath this the velocity component is westward and above it eastward. There must also be turning points in the eastward velocity at or near the poles, probably at several degrees from the poles. Therefore the circulation marks off three distinct zones, the polar, the middle latitude, and the tropical. The sum of the positive and negative momenta of gyration must be equal to zero, or else the angular velocity of rotation of the earth will be changing, which has not been observed to be the case. The amount of energy radiated from the atmosphere must therefore equal that received by insolation. The solar energy falls upon the sunny side of the earth and radiates from the shaded side. The rotation of the earth, combined with the lag in this convective action, places the effective heated area about two hours behind the sun in the lower strata.

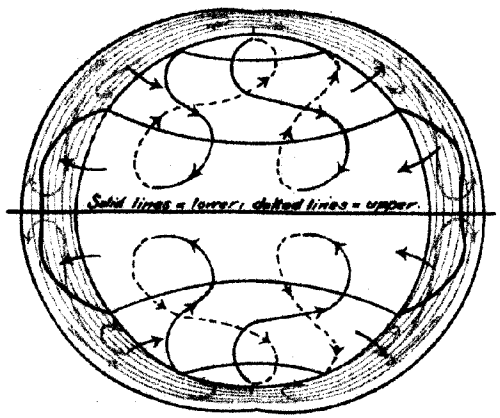
This result of FERREL'S is deduced from the assumption that there is no friction to modify the motion of the atmosphere. When friction is introduced, FERREL makes the following statement of his position (Report C. S. O., 1886, pp. 202, 203):

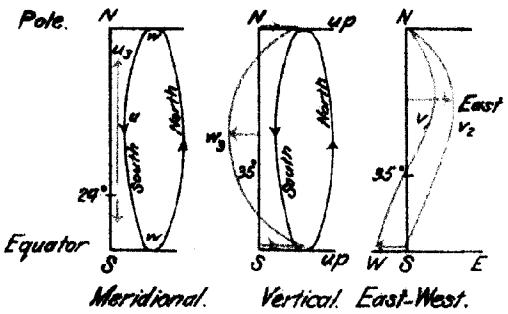
In case of friction between the atmosphere and the earth's surface, we of course have a torsional force due to the earth's rotation, but on account of the weakness of the deflecting forces the effects are mostly counteracted by friction, so that instead of very large eastward velocities in the higher latitudes and westward ones in the lower latitudes, as in the case of no friction, we have only comparatively small ones, especially at the earth's surface, and instead of a bringing of the higher strata down to the earth's surface near the poles and depressing them considerably at the equator, causing a maximum pressure in the middle latitudes, we have in comparison only a very small diminution of pressure at the poles and the equator, with a maximum about the parallels of 30. Although friction tends to limit these large velocities and the effects depending upon them, yet it can not entirely destroy or prevent them, since there must be some velocity before friction comes into play. If kv_o is the force required to overcome the friction between the atmosphere and the earth's surface and m = the mass of a column of air with unit base, $kv_o = \int kv\,dm = -\int \cos\theta\,(2n+\nu)\,u\,dm - \int \frac{dv}{dt}\,dm$ (from 397a). Since $\int u\,dm = 0$, $kv_o = -\int \frac{dv}{dt}\,dm$. This force arises from the moment of inertia acquired by air in going from the lower to the higher latitudes, and *vice versa*. As the air in the higher latitudes gradually sinks this moment is lost, and is spent in overcoming the friction of these latitudes. In passing in the higher latitudes toward the poles it has at any given latitude an eastward velocity v, and on returning in the lower strata it has an eastward velocity v_o less than the other. The momentum lost by a mass m from the time it passes the given latitude toward the pole until it returns to the latitude is $m\,(v-v_o)$, and hence this amount has been spent in overcoming the friction in the higher latitudes. But the amount of momentum gained in passing around toward the equator and back to that latitude is $m\,(v_o-v)$, which is a negative quantity, since by (408a) v is greater than v_o at all latitudes, and consequently this momentum has been spent in overcoming the friction of the westerly motion in the lower latitudes. The force, then, which overcomes the surface friction, $kv_o = -\int \frac{dv}{dt}\,dm$, depends upon the difference between the easterly velocities of the upper and lower strata, and that upon the difference of temperature between the equator and the poles.

THE GENERAL CYCLONE (OBERBECK).

Before finishing the exposition of FERREL'S theory or making comment upon it I will also recapitulate OBERBECK'S theory of the general cyclone, Table 112, 411–420. OBERBECK'S equations and assumptions are much like those of FERREL, and although his method of analysis is more comprehensive and exact, the result is theoretically the same. In his polar equations for the rotating earth it is to be noted that the factor $\cos\theta$ is omitted from the terms expressing the deflection force, $+2nv$ occurring for $2n\cos\theta\,.\,v$, and $-2nu$ for $-2n\cos\theta\,.\,u$, because the equations of motion have the origin of coordinates at the center of the earth, whereas FERREL transfers it to the surface. In his first paper on the motion of the atmosphere the relative angular velocity of the air is neglected, but in the second paper this is taken into the account.

Chart 68.





Black = non-rotating; red = rotating Earth.

THE HURRIS PETERS CO. PHOTO-LITHO. WASHINGTON D. C.

411. His method of subdividing the general equations into components is admirable and should be usually employed. Provision has been made for the effect upon the pressure of temperature departures from the normal in all coordinates, but in the solution only the temperature difference between the equator and the poles is introduced, thus making the same restriction as FERREL'S in the computation of the coefficients. The four components of the pressure are given in the form of the differential equations, and the notation 411 is suitably described. 412 contains the solution as given by OBERBECK. The actual velocities are dependent upon the assumed value given to the height of the atmosphere in effective motion, which is considered as a shell bounded by two spherical surfaces at the distance h apart. For a trial I have taken this as 39.6 miles, one-hundredth of the radius of the earth. This is evidently too great for two reasons. The density of the air falls off rapidly, as shown by Table 123.

TABLE 123.—*Vertical diminution of pressure.*

Height. H.	Pressure. B.	Per cent.	Height. H.	Pressure. B.	Per cent.
km.	*mm.*		*km.*	*mm.*	
0	760	100.0	8	280	36.9
1	671	88.3	9	247	32.6
2	591	77.8	10 (Cirrus)	218	28.7
3	523	68.9	11	193	25.3
4	461	60.7	12	170	22.4
5	407	53.6	13	150	19.8
6 (A. Cu.)	359	47.3	14	133	17.5
7	317	41.8	15	117	15.4

The height is given in kilometers, the pressure at the several heights in millimeters, assuming the mean temperature of the air column to be 0° C., and the percentage of the pressure above the given height is indicated. At about 5,500 meters, or 3½ miles, half of the mass of the air is above and half below; at 9,600 meters, or 6 miles, two-thirds of the air is below and one-third above. The former is at the level where the eastward drift largely supersedes the turbulent circulation in the lower strata, and where the alto-cumulus clouds chiefly develop; the latter is at the cirrus cloud level, and apparently in the midst of the nearly undisturbed eastward drift, this name designating the strong easterly current above the 3-mile level. At the height of 15,000 meters there remains only one-seventh of the air above it, and this is in a state of such decided tenuity that its momentum is very small. Hence, it follows that (1) although the observed velocity is great the momentum mv is small above the 10-mile limit; (2) the interchanging velocity between the equator and the poles is very slow in the upper strata, since it will later be shown to be in fact largely a phenomenon of the lower strata, and the difference of momentum $m\,(v_0 - v)$ is not so great as generally assumed. The 10-mile limit seems to me to be near the boundary of effective circulation. Whatever the truth may be in this respect, the assumed value of the height has not gone into the formation of the coefficient of the equations, and these can be considered as exhibiting approximately the relative velocities of the components among themselves.

These component velocities form three pairs, $(w\,u)$, $(v_1\,v_2)$, $(w_3\,u_3)$, (414, 417, Table 112.) They have the following ratios when the members of each pair are compared together:

$$\frac{w}{u} = \frac{H^4}{R^2} \Big/ \frac{H^3}{R} = \frac{H}{R}.$$

$$\frac{v_1}{v_2} = \frac{H^6}{R^2} \Big/ \frac{H^5}{R} = \frac{H}{R}.$$

$$\frac{w_3}{u_3} = \frac{H^4}{R} \Big/ H^3 = \frac{H}{R}.$$

Fig. 2, Chart 64, gives an idea of the distribution of these six currents, but not their relative strength. (u . w.) makes the oval figure in the meridian; (u_3 . w_3.) gives the additional meridianal and vertical currents in red; (v_1 . v_2.) shows the east-west currents; (u . w.) are due to heating of the tropical regions, (v_1, v_2.) and (u_3, w_3.) to the rotation of the earth, and the additional relative angular volocity of the currents of the air. OBERBECK'S solution, taken in connection with FERREL'S, constitutes the theory commonly taught by meteorologists. That it is partially correct, even admitting the limitations with which the solution was executed, is apparent, as it is verified by the general features of the circulation of the atmosphere. But there are, nevertheless, some important modifications which must be incorporated into this theory before it reaches a satisfactory statement. The first concerns the *return current* from the tropics toward the poles; the second the process of *checking the excessive eastward drift* in higher latitudes; and the third the evaluation of the *friction coefficient.*

1. *The return current from the tropics toward the higher latitudes.*—In accordance with FERREL'S descriptions, with OBERBECK'S coefficients, Table 112, 414, II, and the Chart 64, it is agreed by them that the circulation in the northern hemisphere, in latitudes 30° to 60°, at a short distance above the ground, 1 to 5 miles if we assume that the height of the effective moving stratum is about 10 miles, consists of a *sheet* of air flowing from northwest to southeast; that in the high levels, 5 to 10 miles above the ground there is a strong component of motion from south to north. Thus up to the alto cumulus level southward components alone prevail, in the cirrus the south-north components are very small, and in the highest accessible levels to which the unmanned balloons attain there is a decided northward component. It is seen that the components u_3, 414, VI are so small as compared with u, as to leave that statement practically without modification.

Now what are the facts derived from the cloud observations made in the United States? Instead of only a current sheet drifting down from the northwest near the ground, there exists a system of two alternate current streams, one from the northwest and the other from the south or southwest. This is abundantly attested by the daily weather maps and by the typical Charts 20–35, which are compiled from these maps. In Table 33 the "summary of the resulting general velocities," under the section "southward and eastward components of velocities in highs and lows," which is repeated in this connection for convenience (Table 124), the following facts are displayed:

TABLE 124.—*Resulting velocity components.*

[From Table 28.]

Clouds	Height	Highs		Lows		Normal		Southward		Northward	
		u_1	v_1	u_1	v_1	u_1	v_1	u_1	v_1	u_1	v_1
	km.										
Cirrus	9.8	+1.97	+33.7	−5.26	+39.4	−1.6	+36.6	+ 0.66	+40.1	− 3.75	+32.7
Cirro-stratus	9.8	+1.65	−32.0	−9.24	+35.9	−3.8	+34.0	− 2.11	+36.9	− 3.89	+38.9
Cirro-cumulus	8.1	−0.60	+32.5	−3.00	+37.2	−1.8	+34.9	+ 4.95	+38.7	− 7.34	+32.1
Alto stratus	5.9	−0.37	+27.2	−4.60	+31.3	−2.5	+29.2	+ 2.79	+26.5	− 7.47	+31.0
Alto cumulus	4.5	−0.07	+22.1	−2.38	+24.3	−1.2	+23.2	+ 6.24	+23.7	− 7.78	+21.9
Strato cumulus	2.5	−0.32	+16.0	−4.00	+24.3	−2.2	+20.2	+10.22	+22.1	−11.13	+17.1
Cumulus	1.5	−0.13	+ 5.1	−0.11	+11.4	−0.1	+ 8.3	+ 6.52	+ 9.6	− 8.13	+ 6.5
Stratus	0.9	−1.22	+ 5.8	−1.32	+ 7.8	−1.3	+ 6.8	+ 5.25	+ 7.5	− 7.97	+ 5.1
Wind	0.0	−0.69	+ 1.1	−0.40	+ 1.5	−0.5	+ 1.3	+ 2.23	+ 3.2	− 3.25	+ 0.2

$+u_1$=south. $+v_1$=east.

The first column gives the cloud stratum; the second, the mean height in kilometers; the third, the north-south and west-east velocities over the high areas; the fourth, the same data over the low areas; the fifth, the means of the third and fourth columns; the sixth, the velocities in the selected areas between the high and low centers—that is, to the east of the high where the southward component is most vigorous; the seventh, the same data between the low and high centers, just to the east of the low where the northerly component is strongest; the last two columns give the components of the two counter streams above mentioned, one from the north and the other from the south, the *easterly velocity being practically the same* in each of them. From the third

and fourth columns we see the remarkable result that there is a distinct *northward drift over both the high and the low areas*, except in the cirrus region over the high areas. The normal in the fifth column is the mean of the preceding two, and the *mean drift is northward*. The same is true for the mean of the sixth and seventh columns from the ground to the cirrus level.

Here are two facts of primary importance in the theory of the general circulation of the atmosphere. According to the FERREL-OBERBECK theory, the interchanging motion between the tropics and the poles is southward near the surface and northward in the upper strata. There is no confirmation of this view in the observations made in the United States. In this region the northward motion is *common to all the strata from the ground upward*, but the results of columns 6 and 7 show that it is most vigorous in the strato-cumulus level—that is, 1 to 2 miles above the surface of the earth. At that level the friction arising from the surface obstructions is sufficiently reduced to permit the air to flow in nearly smooth streams, only very slightly disturbed by local retardation, and from that level upward the coefficient of friction k must be a very small quantity. This feature is exhibited clearly on Chart 14, where also all the components of Table 124 are shown graphically. It is also easily perceived by observing the cloud motions that the flow of the atmosphere in the cumulus level is much less disturbed than at the ground. The same result is noted on the series of Charts 20–35, where the stream lines in the cumulus level have a more rounded curvature than those at the ground, as determined by the local winds. The theory calls for components which in a measure conform to the system of coefficients in 414, II, Table 112, +, or southward, below, and −, or northward, above. The result of observations is, however, that it is the countercurrents in the lower levels which are chiefly concerned in the restoration of the temperature equilibrium, constantly disturbed as it is by insolation upon the tropics over the sunny hemisphere with radiations from the polar regions and the shady hemisphere. The atmosphere therefore may be divided into two portions: (1) The upper stratum above the alto-cumulus, which flows rapidly eastward and is but slightly distorted by any interchanging currents; (2) the lower stratum below the alto-cumulus, which is composed almost exclusively of interchanging countercurrents of different temperatures. These alternately pass over the same districts, advancing as cold air from the north or as warm air from the south, and by this interaction cause the further phenomena of anticyclones and cyclones.

THE PROCESS OF CHECKING THE EXCESSIVE EASTWARD DRIFT IN THE HIGHER LATITUDES.

The second fact of importance is connected with the momentum $m\,(v-v_o)$, upon which FERREL relies to check the enormous velocities to which gyration unretarded by friction or dynamic interference would give rise. His view is that the eastward velocity of the upper strata v, on a given parallel of latitude, differs from that in the lower strata at the same latitude v_o by the amount $v-v_o$. As the air moves north past that plane and returns, after sinking at the polar regions, southward in lower levels, this amount of momentum $m\,(v-v_o)$ is expended in overcoming frictional resistances of one kind or another. Of course the general theory is correct that the sum of the momenta over the whole earth is zero; $\Sigma\, mv=0$, or else an effect would be apparent in the changing angular velocity of the rotation of the earth. The true statement of the process of restoring equilibrium should, however, be somewhat different in its details. We have shown that the interchanging motions are confined chiefly to the lower strata, and that there the eastward velocity is almost exactly the same in the southward and northward currents. FERREL'S v_o corresponds with v_1 in column 6, and v with v_1 in column 7, Table 124. It is not, according to this Table, permissible to contrast the v_1 of the upper strata with the v_1 of the lower strata because the signs of u, the velocity in the meridian, do not justify it, but the eastward velocities *must be compared with each other at the same levels*. Now it is readily seen that these are almost exactly the same, level for level, as shown by the computation; also the same inference might have been drawn from the various charts of the cloud motions in the previous pages. If the source of retardation conceived by Professor FERREL is not correct, is it possible to give another statement agreeing with the facts, and yet efficient in its operation to produce the required results? For it must be admitted that a very effective agency is in operation to act as a brake or check of sufficient power to reduce the theoretical eastward drift from the velocities of Table 122 to those of Table 124.

The general theory which has already been mentioned in my previous paper, Storms, Storm Tracks, and Weather Forecasting, Bulletin No. 20, Weather Bureau, 1897, is practically as follows: There is a sheet of the atmosphere flowing quite steadily eastward over the United States at the levels from 2 miles upward. Beneath this flows north and south, quite independently of the upper drift, a series of countercurrents which are cold and warm, respectively. The interaction of these currents sets up the anticyclonic and cyclonic whirls chiefly by dynamic action, the former causing a downward component and the latter an upward component. The cyclone receives its supply from the northwest and from the south, and thus *discharges great masses of air through itself*, so that the cyclonic configuration constitutes a type of persistent circulation in a vortical form of stream lines. This gyratory rotation lifts the air from one level to another, purely by its mechanical action, and thus raises the mass from the strata of lower to those of higher eastward velocity. This rapid change of eastward motion, if imparted to the air raised up, can take place only by an interchange of inertia, that which is gained by the rising air being lost by the upper eastward drift. Also the gyration of the lower strata causes deflection in the eastward drift by the composition of forces, as must be the case, since the method followed in our discussion has been to subtract the normal west-east and north-south velocities from those actually observed, the residuals being the circular cyclonic movements that are now described.

The point of view for the consideration of the theory of the general cyclone is thus considerably altered. (1) Instead of a circulation as in a canal, northward above and southward below, we find that the interchanging motion is largely confined to the lower strata, by means of currents not flowing above one another, but on the same level. (2) Instead of the momentum $m\ (v_o - v)$ being determined by the difference between the eastward flow at different levels of the same latitude, we prefer the statement that cyclonic gyrations are produced by the counterflow of independent streams, and that the rapid eastward drift is retarded by mechanical inflows, from above toward the base of the anticyclone, and from below through the stream lines of the cyclone into the eastward drift. The energy upon which cyclones and anticyclones depend for their activity is to be traced to a different source from that generally assigned to it by meteorologists. The common theory is that the cyclone is due to some form of *vertical convection*, caused by overheating a local region, and by the latent heat produced in precipitation. Our theory would more naturally depend upon *horizontal convection*, by means of which temperature gradients thousands of miles in extent produce comparatively shallow streams, which flow from the north and from the south, sustaining them for considerable intervals of time. The upward and the downward discharges, together with the rotary components which make the sinuous flow of the air in the upper levels, practically tie together the upper and the lower strata, retard the eastward drift in the higher strata, and accelerate the eastward motion in the lower. This effect is readily perceived in the eastward propagation of high and low pressure areas over the United States, which is the basis of our system of forecasting, and renders it possible.

It is by no means to be concluded that by suggesting this modification of the FERREL theory, any intention exists of not recognizing fully the fact that it remains substantially correct in some of its features. There exists the eastward drift throughout the middle latitudes and the westward drift in lower levels of the tropical zone. But there is yet another reservation to be introduced. The heating of the tropical belt raises the isobars adjacent to the equator so that they slope toward the poles, and to such an extent that they almost exactly counterbalance the deflective force $2n \cos \theta . v$ which is directed southward. It may properly be assumed from this that in the upper strata the directions of the isobars, the isotherms, and the stream lines of the wind motion are very nearly parallel to each other, if not coincident. The friction is evidently small, judging from theoretical conditions, and from the results of the observations, or else this could not be the case.

There is another important deduction to be drawn from this discussion regarding the flow of currents from the tropics toward the poles in the lower strata. According to the FERREL theory, the overheating of the tropics is relieved by the *upward expansion and overflow*, but in accordance with the present view the tropical congestion is relieved by *irregular streams which flow outward from the lower levels*. This being the case, the poleward gradients in the upper levels are called upon to sustain much less pressure from the deflection, and evidently the tendency to excessive eastward velocities is much diminished, just because the equatorial lift of the strata can not be so

great, since the expansion force, as stated, leaks off sidewise in the lower levels. The eastward drift does not therefore increase to excessive values for these two reasons: (1) The tropical strata are not elevated up to the theoretical amount because of the escape of the currents poleward near the surface of the ground; (2) the momentum is diminished by the operation of the vertical discharges between the lower and the higher levels produced by the purely mechanical vortex motion in the cyclones and the anticyclones.

There is a very important characteristic feature of the circulation over the United States which finds an explanation in the views thus outlined. From the observations it is inferred that the cyclonic and the anticyclonic circulation is properly limited to a thin stratum about 3 miles thick, each type being from one to two thousand miles in diameter. Herein the counterflowing streams simultaneously set up two opposite gyrations, since the alternate streams are arranged in longitude so that every other one comes from the northwest, and the intermediate ones from the southwest, considering now the resultant of the u v components. Hence every northward stream, by the deflective force of the earth's rotation, is pressed toward the east, and the adjacent southward stream toward the west, so that a low-pressure area is developed on one side and a high-pressure area on the other side of each. The currents from the northwest are in a peculiar manner connected with the eastward drift, as shown by the series of charts which exhibit the flow of the air in the several levels. In the northwest of the United States, during the colder season of the year, when the tendency of the rapidly radiating land areas is to favor the production of a permanent high over the continent, the general movement of the air, including the progressive motion of the high areas and the cold waves, is from the northwest along the continental curves. This is largely due to the circumstance that the cold atmosphere occupies a large oval-shaped region stretching southward over the continent of North America between the Pacific and Atlantic oceans, because the warmer contents of the water areas carry their isothermal lines to the northward over them. As explained in Chapter 8, the isobars in the strata above the surface enter the United States from the northwest, and thus control the direction of the movements of the atmosphere. There is a decided impulse for the upper air not only to follow this direction, *but to sink downward*, and in a deep current to flow southeastward, passing along the eastern edge of an anticyclonic area and discharging into the adjacent cyclone, which is formed on the opposite side of it. (Chart 15, 16, H. & L.) The air does not blow out of the anticyclone as a center, as is shown by the Charts 17, 18 of the Typical Mean Vectors. This deep current extends from the cirrus level to the ground in the eastern parts of the anticyclone, and does not reach quite to the center. The gyratory motion near the axis is apparently the product of the counterflow, which is most active in the strato-cumulus region, and there produces a clearly defined rotation with an outflow at the center downward to the ground. The inflow from above to the strato-cumulus level at the center is of the nature of a vertical supply current for the air, which by vortex motion is driven away toward the ground. This causes the low pressure in the upper part of the anticyclone with inflow near the axis, as shown in the Chart 19 on "Typical stream-line vectors and isobar surfaces in high and low areas." The consequent effect upon the isobars is a reversal of the gradients from concave to convex at the axis of the anticyclone, as there indicated in the several levels. It is not so much a temperature effect as a purely mechanical effect of the stream lines producing a small central gyratory vortex. In contrast with this is the set of isobars in the cyclonic area, which are concave from the ground to the highest level reached, at least to the cirro-cumulus. The difficulty of observing the cloud motion in the upper strata through the dense cloud sheet which prevails in the lower levels of the cyclone renders somewhat less perfect than could be wished the construction of the components in the cirrus or cirro stratus levels. There is, however, no evidence that there is any reversal of the isobar surfaces from the bottom to the top of the cyclonic components. This means that there is an inflow throughout the cyclone toward the axis, and that there is no reversal of gradient such as was assumed by Professor FERREL. The cyclone is therefore adapted to the discharge of all the material which may be furnished to it, including the strong persistent current from the northwest so closely associated with the movement of the upper strata in direction, and also the southerly currents escaping from the tropics, which flow practically at right angles to the eastward drift of the higher levels.

THE DIPPING DOWN OF THE UPPER STRATA.

The peculiarity referred to at the opening of this paragraph consists in what may be termed the dipping down of the upper strata toward the ground in the flow from the north over the eastern portions of the anticyclone, especially when the cyclone exists in the neighborhood of the Great Lakes. During the passage of successive highs and lows from the northwest toward the Atlantic coast or the Gulf of St. Lawrence there is a dipping down of the upper strata in the front of a high area and a rising over the low area. Along the belt which lies over the northern portions of the United States there must be produced a sinuous or wave-like flow in the *vertical* direction, as well as in the north and south direction. A single vertical wave would about span the continent, since there usually exists a high area on the plateau, a low area over the lakes, and a high area over New England; or else a low area over the plateau, a high area over the lakes, with a low area over the Gulf of St. Lawrence.

Turning next to the consideration of the circulation during the warm season of the year, it has been shown that in the summer, when the continent is comparatively warm and the ocean areas cool, the movement of the high areas is quite different. They now approach the Pacific coast from the southwest, and this shows that the isobars of the alto-cumulus level have changed their direction and trend from the southwest toward the northeast in that region, instead of from the northwest toward the southeast. The movements of the high and low areas follow this direction in the summer for precisely the same reasons they pursued the other directions in the winter. This illustrates the entire dependence of the progressive motion of the anticyclones upon the movement of the atmosphere 1 or 2 miles above the ground. It is to be remarked that this decided shifting of the direction of the flow of the lower atmosphere does not occur in the strata which are 3 or 4 miles above the ground, at least to any important extent, since the movement in the higher levels continues nearly eastward winter and summer, flowing over the tops of the high and the low areas, except so far as they are locally deflected by rotatory components injected into them.

It is somewhat different with the great anticyclonic areas which occupy the ocean areas, in the neighborhood of the parallel of 30° latitude. These are portions of the permanent high-pressure areas, and depend upon the general circulation as developed in the FERREL-OBERBECK theory. The trade winds of the Northern Hemisphere on the southern edge of the North Atlantic and the North Pacific highs are sufficient evidence of that fact. The discontinuity in this high-pressure belt over the Gulf States, which is chiefly responsible for the inflow from the south upon the continent, is a marked feature of the distribution of the pressure, but it shows that there does not exist enough power over the general circulation arising from expansion in the tropics to build the high-pressure belt continuously around the globe, as the theory requires. Apparently so much of the available energy, which is generated in the tropics by insolation, has escaped through the underflowing currents from the south toward the north as to bring about this result. In fact the permanent high pressure usually exists over the Atlantic Ocean and over the Rocky Mountain Plateau, leaving a gap in the Gulf States, through which the numerous streams of air enter from the south. This is the fruitful source of the generation of cyclones on the Rocky Mountain slope and in the central valleys, where it has been shown that about two-thirds of all the storms of the Northern Hemisphere first appear. Indeed, the North American continent is peculiarly the area upon which the interchanging circulation in the lower strata between the tropics and the polar regions takes place. This is why the climate is so variable and subject to sudden changes attending the procession of cold and warm areas which drift eastward over this country.

A study of the lower circulation only emphasizes the importance of recognizing the fact that the lower 2 or 3 miles are those almost exclusively concerned with the production and support of anticyclones and cyclones. It is, therefore, a great mistake, as has usually been done in theoretical treatments, to obliterate the variations of the temperature in longitude along the same parallel of latitude by assuming that the temperature distribution is symmetrical to the axis of rotation of the earth. The alternations of temperature between the land and the ocean areas is probably the most important immediate cause of the special local conditions of the lower strata circulation. This is seen to be so in view of the fact that this circulation is practically limited to the stratum 2 or 3

miles thick. The lowest or surface circulation is very turbulent, and because of the irregularities which attend the interaction of these streams of air coming from different quarters, the forecasting of special conditions in small districts is often very difficult. When the gyratory movement in anticyclones and cyclones is vigorously developed as in severe storms, it is much easier to foresee the exact features which will attend them in moving from one place to another. As long as the local temperature and the precipitation depend chiefly upon the counterflow of these streams having their sources thousands of miles apart, it must be admitted that the forecaster will always have to content himself with a less perfect foreknowledge of the events than he could wish, owing to the fact that new forces and masses of air will be imported into the central region, or else new combinations may occur by the process of the composition of forces, thus producing unexpected resultants.

THE DEPTH OF THE STRATUM LOCALLY HEATED BY INSOLATION.

Some remarks are also suggested regarding the depth of the atmosphere which is locally heated up by the insolation to an appreciable amount. The evidence before us is to the effect that this heating is generally confined to a layer less than 5,000 meters, or 3 miles, thick. It is not intended to allude now to the annual range in temperature with the sun's change in latitude, but rather to the shorter periods of only a few days which contribute to the impulse of a stream from the south. There are several reasons which lead to this conclusion: (1) The trend of the preceding argument has been to show that the readjustments of disturbed temperature equilibrium take place in the lower layers of the atmosphere by means of rather spasmodic impulses, controlled partly by the temperature energy in the tropic and the polar regions, partly by the distribution of land and ocean temperatures, and by the relative radiation which takes place from them in the winter and summer season, respectively. (2) Half of the mass of the atmosphere is contained below the 5,000-meter level, and this is the layer within which the greater part of the aqueous vapor is also collected, since the vapor contents of the higher levels is in the form of fine ice crystals, which drift eastward, encircling the earth, and perhaps seldom finding their way to the ground. The fact that the dust of the Krakatoa volcano was thus carried about the earth for two or three years shows that the upper current has a history of its own, to a considerable extent independent of the 3-mile layer nearest the earth. Now, the important part which the aqueous vapor plays in the absorption of heat is well understood, and it depends upon the very high latent heat of water, being 606.5 calories per kilogram at 0° C. The evaporation and condensation of water in precipitation is certainly confined to the lower stratum, and hence it is in harmony with this view to limit the effective heating of the air by the sun to the lowest 3 miles. (3) The diurnal variation of the temperature at the surface of the ground takes on a wide range; it is greater than the normal in low areas in the summer season and in the middle of the day; it is less than the normal in high areas, especially in the case of cold waves in the winter and in the nighttime. These ranges at the ground generally amount to 10° or 20° F., but they diminish upward with the height and disappear at the 5,000-foot level, or even considerably below that height. This is shown very clearly in the study of the changes in the vertical temperatures, as explored by means of balloon ascensions, Charts 78, 79, Chapter 14, where the 5,000-foot level marked the convergence of the lines which represent the gradients in the forenoon and afternoon. It is there stated that under the forenoon hours were included several night ascensions in the winter, when the temperature was low, and also some ascensions in the high areas. The range in the United States is usually greater than in Europe at the ground, owing to the more pronounced nature of the cold and warm waves that move eastward over the region, but the evidence is that the diurnal lines converge at 2 or 3 miles above the ground. The weather of the North American Continent is in general connected with the conditions which originate cyclonic movements in the Northern Hemisphere, while in Europe and Western Asia such storms as are formed elsewhere tend to break up and dissipate. The interchanging action is therefore much more pronounced in the former than in the latter district. This was proven by the study of the storm tracks of the Northern Hemisphere. Compare Summary of International Meteorological Observations, W. B., 1893; Storms, Storm Tracks, W. B., 1897. At the Blue Hill Observatory the kite ascensions seem to indicate that the diurnal range vanishes at 1,500 meters, 1 mile high, though I believe that this will be

found lower than the effective level in many other places. (Explorations of the Air by Means of Kites, B. H., 1897.) (4) The fact that the great eastward drift of the upper levels is underrun by a series of comparatively thin currents, which move about in every possible direction, shows that the disturbance of equilibrium is local and confined to a shallow skin near the ground, the most rapid currents belonging to the cumulus and strato-cumulus levels, which also shows that the upper regions of the atmosphere are much less affected than the lower. (5) In a very clear way the same conclusion is indicated by the seasonal change in the drift of the high areas upon the northwestern portions of the United States, from the northwest in winter and from the southwest in summer, in conformity with the location of the permanent high areas in winter over the continent and in summer over the ocean.

From these considerations it seems evident that the upper atmosphere is but slightly disturbed in its temperature equilibrium by the effects of the solar radiation, but the solar rays pass through it with comparatively little absorption, while the great percentage of the heat produced is in the lower strata, where it is due to the transformation of energy. This conclusion is very important for two reasons: (1) It shows why the general circulation of the atmosphere prescribed by the FERREL-OBERBECK theory does not seem to be confirmed by the observations. (2) It also indicates where the energy comes from which is finally expended in the generation of cyclonic circulations and in the retardation of the eastward drift by the agency of inertia rather than by friction; for if the total amount of energy falling upon the Tropics does not expend itself in an upper poleward current, because the higher strata retain a temperature of equilibrium almost undisturbed, then this energy must give rise to a series of comparatively small currents moving poleward in the lower strata—a fact which is abundantly confirmed by the observations. Also, if the friction of the upper atmosphere upon itself is very slight, then there will be but little retardation to an excessive eastward drift, tending under a steady force to have a constant acceleration. The only other available agency which will produce the same effect is the intrusion into the higher strata from the lower, or vice versa, of air moving eastward with a different velocity, which must suddenly be subject to acceleration. The discharge of the product passing through cyclonic circulations is perfectly fitted to perform this office. Hence the theory here expounded consists of two parts as regards the eastward drift: (1) The upper poleward gradients are not built up to the amount supposed by FERREL, because of the lateral escape poleward of currents from the tropical belt; (2) The agency of friction as a retarder is replaced by the interchange of inertia derived from a compound circulation, the sources of the separate parts having different and independent causes.) It has been important to thus carefully clear the ground for the theory of local cyclones, which will be advanced to take the place of the type proposed by Professor FERREL on the one hand, or that advocated by the German school on the other hand. These two theories are not in harmony with each other, and neither of them seems to be in agreement with the observations. To attempt to pursue the criticism involved in the position just explained through all the details, since it would be required to consider in a close study the works of all these authors would be a task beyond the limits of this report. Indeed, it is only intended to suggest the line of research which it seems to be most promising to pursue in future studies. It is very evident that the six assumptions, 389–396, which have been made in order to pass from the general equations of motion, 200, to the working system employed by FERREL, 397a, must be carefully revised before we can expect to put this branch of meteorology upon a correct working basis. In particular it is not suitable to omit the variations of temperature in longitude, because in so doing the turbulence of the lower strata and the alternate streams which are implied in this variation profoundly modify the general and the local circulation. It is also necessary to correct the statement regarding the friction as the special agency of retarding accelerated flows and substitute, or rather add thereto, the inertia of currents which are rapidly changing their velocities. The conflict of turbulent countercurrents, especially at a short distance above the ground, must be rigorously considered in studying the resultant effects. Likewise the direct application of the law of conservation of areas passed over by the rotating radius vector can not apply immediately to the lower strata, though it may be much more nearly correct above the 3-mile level.

It is necessary to make one reservation regarding the results given in Table 124 of the velocity components. The meridian component u shows that there is a decided northerly drift over the

stations at which observations were made. These are the fourteen nephoscope stations of the Weather Bureau, and they were distributed quite regularly over the territory from the Rocky Mountain slope to the Atlantic coast. This is the region where the general drift of the circulation as determined by the configuration of the North American continent is toward the east and northeast, since the exit of all the storm tracks is over New England and the Gulf of St. Lawrence. If the stations had been confined to the territory west of the Mississippi River, the drift would have been eastward and more to the southward. This accounts for the fact that in the observations actually made even the high areas drift slightly toward the north. Evidently the final conclusion regarding the north and south components must be drawn from a uniform system of similar observations embracing the entire hemisphere. Still, even with this consideration in view, there can be no question of the persistent operation of currents from the Tropics near the ground, and the absence of the expected conformity between the observed components and those required by OBERBECK'S coefficients, 414 II.

THE ENERGY FROM THE ELECTRO-MAGNETIC RADIATION AND THE POLAR MAGNETIC FIELD.

There is another consideration which should be kept in mind. As the outcome of the discussion of magnetic and meteorological observations, Solar and Terrestial Magnetism in Their Relations to Meteorology, W. B., 1898, it was shown that there exists a synchronism, which is rough, yet persistent, between the variations of these two systems of elements. The view was advocated that the effect of the electro-magnetic radiation upon the Tropics was that of a practically steady source of heat, since no quick variations in the intensity of that field have ever been observed. On the other hand, the polar magnetic field from the sun upon the earth's polar regions is an intermittent source of energy. This variable influence is most vigorously in operation along the aurora belt, and it is to be noted that from this district the northwest current of air proceeds, the two being in a favorable position locally to interchange energy from the magnetic field to the atmospheric currents. We have also shown that there is a tendency for the higher strata to dip toward the ground in the formation of the high areas, and to flow past the center of the high pressure in about the same direction above as below in passing from the high to the low area. It seems, therefore, a good working hypothesis to suppose that the action of the external polar magnetic field tends to depress the upper strata, attended by the local cooling of the atmosphere in the subpolar belt from top to the ground. Instead of conceiving the return in the polar regions to take place by means of a gradual settling down of the mass of air over the entire polar cap, it is much more probable that this is accomplished to a considerable extent by means of the formation of the local northwest currents which flow in upon the United States. These are constructed, according to this view, partly by the depression of this portion of the polar eastward drift and in part by the superposition of local cooling, which is to some extent controlled by the intensity of the magnetic field which is impressed upon the earth from the sun. Since the general view, which is being explained in this chapter, emphasizes the action of local currents in the lower atmosphere, it is important to insist upon the causes tending to the separation of local currents from the more general movements to which the name drift more specifically applies. There is certainly much to commend this point of view to careful consideration, inasmuch as the synchronous operation of the solar magnetic and the terrestial meteorological elements rest upon observations extending over a very long period of time—as much as half a century. While it is difficult at present to trace the action in detail, it is yet indispensable to take it into account as a fact to be considered.

THE FERREL AND THE OBERBECK EQUATIONS RESUMED.

Having given some account of the relations between the FERREL-OBERBECK theory of the general cyclone and the results of our observations, it is proper to resume a brief account of the rest of the analytic work of these authors, because many of the equations are of permanent value, upon any theory of the general circulation.

403a–404a, Table 110. The variation in pressure produced by the relative motions of the atmosphere in an easterly direction, under the above enumerated assumptions, is found by substitution of 403a, derived from 401a, in 207, and is given in common logarithms. This formula assumes no retardation on the pure law of conservation of areas from which 401 is deduced, and

consequently on evaluation it does not in the least represent the actual distribution. It indicates in a general way, however, an increase of pressure in the middle latitudes, a small diminution at the equator, and a fall in pressure to less than zero near the poles.

418–420, Table 112. On the other hand, OBERBECK assumes a law somewhat modified from that given by theory for the relative eastward angular velocity, 419, and from 418 computes the pressures in the different latitudes. This result conforms quite closely to the observed pressures, but since the law itself is assumed, the numerical values merely test the accuracy of the assumption, but the equations do not show fully the natural process of constructing such relative angular velocities on the rotating earth. 420 gives the pressure B, the relative angular velocity r, the corresponding eastward velocity $v_3 = R \sin \theta \, . \, r$.

FERREL'S discussion of the gradients, Table 111, is based upon the first of equations 397a, and is determined in a north-south direction only, in terms of the angle of inclination i, which is counted from the positive direction of v, that is on the parallel of latitude eastward, in an anticlockwise rotation for the northern hemisphere. 405a defines tan i in terms of the inertia and friction components; the denominator of the second form is substituted from 397a by putting $h=0$, that is, by limiting the solution to the surface, and the several forms follow by simple substitutions.

407a. Since the definition of gradient by 48 and 24 is

$$\frac{\partial P}{\partial x} = g_o \rho_m \frac{G}{\text{III III}} = \frac{P_o}{B_n} \cdot \frac{G}{\text{III III}}, \text{ and } \frac{1}{\rho} = \frac{g_o l\,(1+\alpha t)}{P} \text{ by 47}$$

we have the first form for the gradient; the several forms are easily obtained by substitution from 406a. This gives the gradient along the surface, with and without the relative angular velocity r.

It is to be observed that in deriving 406a and 407a from 405a, the angle of the inclination i, which is rotated anticlockwise from the eastward direction $+v$, depends upon the inertia and friction only, according to FERREL'S statement. The truth of this can well be doubted in view of the necessary relation existing in the angles between stream lines and vortex-lines, or between stream lines and gradients, which include a term in gradient as well as in inertia and friction. (Compare 217, 224.) It may be observed that Professor FERREL'S discussion of his fundamental working equations consists usually in cutting out special terms by arbitrary assumptions, which course seriously invalidates the practical use of the result. He did not succeed in reaching the relations of the three coordinate velocities (u, v, w) which depend upon vortex motions, and therefore his analysis covers only some of the ruder connections in the general relation of the several terms involved.

408a. To find an approximate expression for the change in the eastward velocity with the height, FERREL assumes $u=0$; that is, no north-south velocity, and v=constant, which is quite permissible. Then, if v_o is the value of v at the surface, and v the west-east velocity at the height h, we make these substitutions successively in 397a (1) for $h=0$, and h, which gives 408a, the two following forms being found by the use of 394 and 393. The eastward velocity increases with the height, since $A_2 = -20°.95$ and the other factors are all positive. Therefore, in the tropics the westward velocity at the surface, $-v_o$, is changed to an eastward velocity at some height, depending upon the factors in the expression. This is shown by the arch over the equator on fig. 1, Chart 64.

409a. To find the gradients above the surface, substitute v from the third form of 408a in the last form of 407a and evaluate, the first term being the gradient along the meridian at the surface of the earth. Since A_2 is negative and all the other terms positive, $G > G_o$, and the gradients are more steeply sloped above the surface proportionally to the height.

410a. The velocity above the ground in 408a was found by neglecting the meridian velocity u. But if we retain this, making u=constant and v=constant, the equation 397a (1) gives the first form of 410a directly. From 406a the last form of the first term is derived; the second comes by taking $v=0$, and the third may usually be neglected. This is more accurate than 408a (2), while the general interpretation is the same, that the velocity increases with the height.

Fuller descriptions of these equations may be found in Professor FERREL'S works. The chief impression regarding them is that they are detached in the discussion, one feature at a time alone being considered. OBERBECK'S analysis has the advantage of much greater coherence and completeness, and in that respect is more satisfactory. At the same time it must be admitted that both systems give about the same picture of the general cyclone, if the assumptions introduced

into the discussion are taken to be correct. Our criticism shows that these must be modified before the observed motions of the atmosphere are completely accounted for. It still remains, however, a very hard problem to solve practically.

THE LOCAL CYCLONE (FERREL).

My purpose in recapitulating Professor FERREL'S system of equations has not been to discuss them any further than has been done already, but rather to call attention to the perfect parallelism which exists between his treatment of the general and the local cyclones. This has so far influenced his theory of the generation of storms as to have imposed on meteorolgy the burden of unnecessary difficulties, which have arisen from his attempt to explain the physical features of storms in accordance with a presupposed theory. Having met with considerable success in analyzing the general motions of the atmosphere in the manner already described, it is not at all unnatural that he should have supposed that similar principles would also explain the local cyclone. There has been just enough plausibility in this position to have given rise to the long controversy which is recorded in meteorological literature, and although the discrepancies between the observed details and the theoretical requirements are quite pronounced, yet there has been no decisive criticism advanced which was strong enough to give a new direction to meteorological research. It is believed that the results of the cloud observations has placed this advantage in our hands for the first time, and we shall therefore attempt to point out some of the difficulties in the analysis of the stream lines in storms as given by the authors quoted, and shall point out the way which promises decided improvements. All these problems of motion in the free air have been so difficult, in view of the uncertainty which has accompanied the mere understanding and knowledge of the real paths of the motions of the air, because they could be observed only in a desultory manner, and it is not to be wondered at that meteorology should have gone through a long period of preparation before satisfactory ideas could be constructed.

THE COLD AND THE WARM CENTER CYCLONE.

The most important physical objections regarding the so called vertical convectional theory of the generation of storms consists in attempting to account for the local supply of energy which must be expended in the work done by the winds. FERREL conceived of the general cyclone on the hemisphere as one with a cold center, since the poles are cold and the Tropics warm, and then the modification was made that the local cyclone is one with a warm center with the edges cooler than the middle portions. If a quantity of water be placed in a cylindrical vessel, and sawdust or some other material be scattered in it to show the lines of the circulation, and if this be rotated on a turntable a form of motion can be produced quite similar to the one FERREL proposed to explain the mechanism of storms. This circulation can be generated by any agency which will make a vertical current in the center of the fluid, as a lamp on the lower side, or a paddle screw at the top. A lump of ice on the center of a rotating plane will give a circulation which is like that of the general cyclone over the hemisphere. Now this experiment is open to at least three objections of a very serious nature when it is attempted to apply the lines of the model to the processes in nature. It is not enough to show that there is an inflow at the bottom and an outflow at the top, in logarithmic spiral curves, to conclude that the analogue is satisfactory. Therein lies an assumption which in fact begs the entire question. The first difficulty is that the circulation in the general cyclone consists of the *same mass of air*, which repeatedly passes through certain paths in consequence of the boundary conditions. The limited mass of fluid in the cylindrical vessel is also the same mass set in circulation, being bounded by the top and bottom surfaces and the curved sides, corresponding with the ground and top of the moving air and the plane of the equator. It has by no means been shown that the air concerned in the local cyclone consists of the same air moving over and over again in similar paths, and it is first necessary to do this in order to establish an analogue of that kind. The evidence from the cloud circulations proves that the cyclone is a form of circulation of the stationary type of configuration, *through which fresh portions of the atmosphere continue to stream.* If such is the case the analogue described above is inapplicable, and the deductions which have been so commonly drawn from it quite incorrect. The second difficulty is regarding the distribution of the heat energy. FERREL supposed that this is arranged *systematically about the center*, just as the isotherms on the hemisphere are assumed to be small circles of latitude. But a very brief study of the isotherms in cyclones shows that this is

not the case, since they usually trend from southwest to northeast in the United States, crossing the cyclone by quite regular steps instead of being circular about the center. This is also fatal to the verification of the analogue. The third difficulty consists in accounting for the *local supply of heat*, which is supposed to set the vertical convection in operation. There are no visible sources of local heating in cyclones beyond the latent heat of precipitation. In storms from the southern districts the rainfall is often of large amounts, and the latent heat may well assist any vertical buoyancy in the center of the cyclone. On the other hand there are many deep, fully developed storms, which form near the North Pacific coast and advance to the Gulf of St. Lawrence, without any precipitation worth mentioning. These prove that rainfall is not a necessity to the formation and propagation of cyclones, and if this is the case in a numerous class of cyclones, then it follows that rainfall is always a secondary phenomenon, and that it can not be sufficient of itself to produce the true cyclonic gyrations. Furthermore it is well known that the front of a high area advancing over the United States, stretching from the Lake region to the West Gulf States, is often the place of heavy precipitation, though there may be no true cyclonic gyrations in sight. The occurrence of precipitation can be readily explained in just the places observed, but it is contended here that the latent heat derived from the condensation of aqueous vapor into water is not the primary cause of cyclonic action. (Compare FERREL, C. and G. S. Report, p. 201.)

While these physical difficulties have often been raised and have in effect produced a general defection among meteorologists from the adherents of the vertical convection theory, there are other troubles in connection with the mathematical solution which renders this conception of cyclonic circulation quite untenable. In order to bring out as clearly as possible the strict parallelism between FERREL'S solution of the general and the local cyclone, the equations pertaining to the local cyclone have been arranged and numbered in the same order as for the general cyclone (389b–410b. Table 113). By comparing the two sets of equations this will be evident, and we need only call attention to the leading features of the solution, and contrast them with the requirements as set forth by the results of the observations given in the preceding pages.

Beginning with the cylindrical equations (185) applicable to the rotating earth, which is the most convenient form for discussing motions about a local center, such as occur in the case of cyclonic movements, the notation is used as defined. The direct process of deducing these equations already described (182–185) is preferable to the other methods heretofore given, as it shows rigorously the elements of which they are constructed and the simple relations existing in nature. The assumptions and necessary transformations now follow. 389b is the assumption regarding the temperature distribution, namely, that it is symmetrical about the center and a function of the distance from the axis of rotation. Hence the temperature variations vanish in 185.2, and it is the first equation only which contains them. This implies that local cyclones possess a circular isothermal system, but this can not be found on the weather maps, as already pointed out. The transformation is made as indicated, from $\frac{\partial \log P}{a\partial\varpi}$ to $\frac{\partial \log P_o}{a\partial\varpi}+g(h-h_o)\frac{\partial a}{a\partial\varpi}$, the last term of which gives the changes due to variations of temperature along the radius, and with the height, where P_o is the pressure at the ground. 390b. The system of circular isobars about the axis z may properly be admitted, though much distorted in many observed cyclones, since it permits us to lead up to a theory of the circulation in the most simple way, and therefore the term $-\frac{1}{\rho}\frac{\partial P}{\varpi\partial\varphi}$ is put equal to zero. 391b. The assumed law of friction is possibly approximately true, but many of the effects attributed by FERREL to friction and deflection belong more properly to the turbulent interaction of currents and eddies, having their base in distant and independent sources of action. 392b. The assumed law of the variation of temperature depends upon assigning an outer boundary to the cyclonic circulation. This boundary is a cylindrical surface and performs the same functions in the local cyclone that the plane of the equator does in the general cyclone. This is the most injurious assumption that has been made, since it distorts the theory, from this point onward, away from an agreement with natural conditions. One has only to consider the series of Charts 20–35, which show the actual location of the stream lines flowing into the cyclones of the United States. They are by no means confined to circular areas, not even so approximately. The cyclones of the central valleys have one branch arising near the North Pacific States and the other in the Gulf States or the Gulf of Mexico. The hurricanes as observed over the South

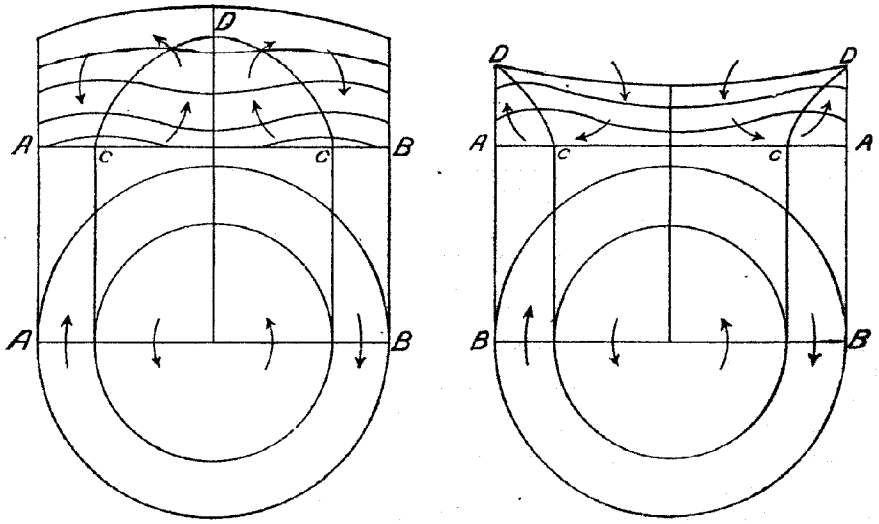


CHART 66.—Ferrel's warm and cold center cyclones.

Atlantic States are much more rounded in their configuration than the ordinary cyclones, also they are much deeper than the cyclones in the same region, but in all cases the feeding currents come in from immense distances. Beginning with this point FERREL'S exposition is distinctly at variance with the observations, and can be considered to have only an historical value. The law of the variation of the temperature which FERREL assumes is,

$$t=\tfrac{1}{2}(t_c+t_o)+\tfrac{1}{2}(t_c-t_o)\cos\frac{\varpi}{\varpi_o}\pi. \quad \text{Negative gradient.}$$

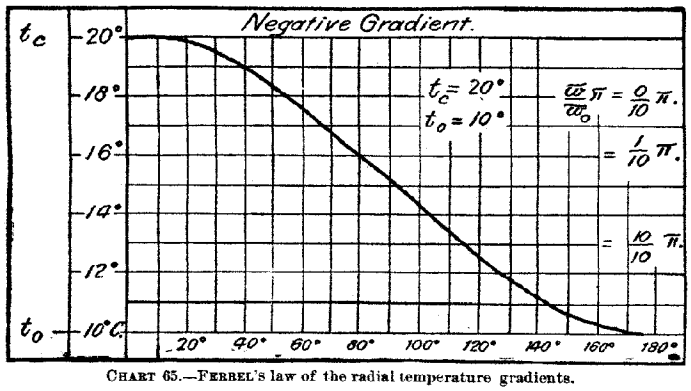


CHART 65.—FERREL'S law of the radial temperature gradients.

As an example take at the center $t_c=20°$ C., and at the exterior limit where $\varpi=\varpi_o$, $t_o=10°$ C., then the curve of distribution of temperature from the center to the boundary is given by the line on Chart 65, and this illustrates the cyclone with a warm center. If the center is cold and the boundary warm, the curve is inverted. These two cases therefore occur theoretically and produce two circulations the inverse of each other. 394b gives the temperature variation along the radius, and with the altitude which forms a term in the working equations. The limitation of 395b is very exacting, and applies to the ideal circulation under consideration, but by no means to the observations. 396b indicates a weak part in FERREL'S solution, especially for tornadoes, because he takes no definite account of the vertical currents, but limits the motions to the horizontal planes. In fact one misses the comprehensive symmetry with which the hydrodynamic solutions should be carried out in three dimensions, and apparently the theory of the velocity potential and the current function were not utilized by him as they should have been. Introducing these assumptions into the cylindrical equations 185, we have FERREL'S working equations for the cyclone, 397b, limited to horizontal motions. No equation of the continuity of motion seems to have been employed to control the possible solution, though it is perhaps implied in the adopted form of motion, as described in the text. Comparing 397a and 397b, it is seen that they differ from each other in the coefficient of deflection and the assumed law of the temperature distribution.

DISCUSSION OF THE SECOND EQUATION OF MOTION.

The discussion of the second equation for the isobars is conducted in precisely the same way as under the general cyclone. Table 114, 398b. This expands the equation and prepares it for integration. 399b gives the integral, and the law of the conservation of areas for each particle gyrating about the axis z. 400b evaluates the constant for the entire rotating mass, and determines the laws of the interchanging motion. 401b is the law of the tangential velocities at all distances from the center. 402b. If $v=0$, then the value of the corresponding ϖ is $R=0.707\ \varpi_o$, where ϖ_o is the radius of the fixed boundary. This divides the FERREL circulation into two parts, the inner which is inside the radius R, and the outer which is between R and ϖ_o. The velocity v in the inner region is in one direction, and in the outer region in the opposite direction, this being necessary in order to maintain the law of the sum of the moments of inertia a constant. Chart 66, fig. 1 and fig. 2, show FERREL'S warm-center and cold-center cyclone respectively, the upper part of the diagrams giving an idea of the form of the isobar surfaces. In the warm-center cyclone "there must be an ascending motion in the interior part and a descending one in the exterior part, both generally very small in comparison with the horizontal motions toward and from the center." In the cold-center cyclone "these interchanging motions are reversed, being from the

center below, and toward it above, with a comparatively small descending motion in the central part, and an ascending motion in the exterior part." "These interior gyrations are more rapid and their effects upon the barometric pressure are often alone observed, while the comparatively moderate gyrations of the exterior part and their small effect upon the barometric pressure often pass unnoticed, especially on land where there are a great many disturbing causes to interfere with the development of a regular and complete cyclone. The former gyrations form the cyclone proper, and the latter the anticyclone. Hence, every cyclone is accompanied by a corresponding anticyclone, and the former can not exist without the latter." FERREL describes at length the analogy between the general and the local cyclone. Thus the radius where $v=0$, at $R=0.707\ \varpi_o$, corresponds with the $v=0$ at the polar distance $\theta=54° 44'$. The arch in the cold center, CD, spreads outward; and this matches the arch over the tropics in Chart 64, fig. 1. In the warm-center cyclone, however, the arch is over the center of the cyclone. This causes a reversal of the gradients above the center, with an inflow below and an outflow above.

There are two fatal objections derived from our observations: (1) There is *no pericyclone discoverable* in the records based upon many storms. FERREL tried to show that the high-area pressures observed on the maps are the resultants of two or more overlapping pericyclones. But the detailed construction shown in Charts 15–35 gives no support to this form of circulation. (2) Evidence of true cyclonic *outflow* at the top at some distance above the ground is probably *entirely lacking*. The cyclonic components of Table 47 prove that the radial velocity is *inward* from the ground to the top of the cyclone. It is not our purpose at this point to explain the principles of the circulation that actually exists, but simply to indicate that the FERREL cyclone, though perfectly possible under certain conditions, is not the type which storms follow in their construction. It is certain that the supposed analogue between the local and the general cyclone is not sustained by the evidence, and if it be otherwise explained how the observed movement of the atmosphere may be accounted for on other principles, in conformity with the observations, it will only add to the force of the position here taken that the FERREL local cyclone is merely one of many idealized cases.

DISCUSSION OF THE FIRST EQUATION OF MOTION.

We will briefly conclude this review of FERREL'S equations in order to finish out the statement of this portion of the argument (Table 115). 404b gives the effect of the relative rotation velocities upon the pressures. It is derived from 403b, which depends upon 402b by substitution in 207. Formula 207 is very useful in meteorology, and 404b is a special case under it, which depends upon the assumed conditions controlling the cyclonic circulation.

From a discussion of 397b (1) are obtained the expressions for the gradients and the difference of velocities at and above the surface. The angle of inclination i is counted from the positive tangential velocity in the anticlockwise direction. Several equivalents for it are given under 405b. Under 406b are found different forms for the variation of the pressure at the surface along the radius of the cyclone. By means of 48, 24, 47, the gradient G is found from 406b, and expressions for it occur in 407b, with and without the relative angular velocity. To obtain the equations for variation of the velocities and the gradients above the surface, assume $u=0$ and $v=$constant, taking $v=v_o$ for $h=0$. Subtract the two values (v_o-v) in 397b (1) and substitute from 394 and 393 for the results in 408b. Substitute the value of v from 408b in the third form of 407b, and we obtain the variations of the gradients with the height. If it is desired to include $u=$constant, instead of excluding it entirely, we may transpose 397b (1) into the first form of 410b; reduce the first term by 407b, and the second by evaluation, neglecting the third. These results have been discussed by Professor FERREL very fully, and the outcome appears in the circulation already described, and which he thought would account for the observed circulation.

THE LOCAL CYCLONE (SPRUNG).

In Lehrbuch der Meteorologie, A. SPRUNG, 1885, some special solutions of equations 185 are given, which are proposed for the study of cyclones and anticyclones. These are transformed so as to use the partial differentials (Table 116). If in 185 the following substitutions are made

$$\left[\frac{P}{\rho}+\frac{1}{2}(u^2+v^2)\right]=P', \quad \frac{du}{dt}=\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial \varpi}, \quad \frac{dv}{dt}=\frac{\partial v}{\partial t}+v\frac{\partial v}{\varpi\partial \varphi},$$

then,

$$\frac{1}{\rho}\frac{\partial P}{\partial \varpi}+\frac{du}{dt}=\frac{1}{\rho}\frac{\partial}{\partial \varpi}\left[P+\frac{1}{2}(u^2+v^2)\right]+\frac{\partial u}{\partial t}=\frac{1}{\rho}\frac{\partial P'}{\partial \varpi}+\frac{\partial u}{\partial t}.$$

Also take $-\frac{1}{\rho}\frac{\partial P'}{\varpi \partial \varphi}=0$ for the isobars, which thus become symmetrical about the axis of rotation. From the auxiliaries in 421, we find the general equations 422. The auxiliaries of 423 are determined from definitions. $2S=\varpi v=$ constant is the double area swept over by the radius vector of the moving particle in vortex motion. (See 232a.) Hence further transformations are introduced to give us the working equation 424, which is identical, except in form, with the one previously discussed by Professor FERREL. It should be noted that FERREL did not carefully distinguish between the total and the partial differentials of the velocity, and that he consequently considered $\frac{du}{dt}=\frac{\partial u}{\partial t}$.

Several special cases of the general equation 424 are now given, which are sufficiently stated from 425–431, and need no further explanation, except the law of continuity, 426. This introduces us to a form of solution which is different from FERREL'S, and is characteristic of the German school of meteorologists, being originally derived from GULDBERG and MOHN. The underlying conception permits the air to stream toward the center of a cyclone from a distance, and it does not impose a fixed boundary to the circulation, with the inner and outer parts having velocities in *opposite* directions such as FERREL used. This conditional equation makes the velocity v always in the same direction about the axis, but it regulates the angular velocity by certain laws which will be fully explained later. The continuity is expressed as follows: If concentric cylindrical surfaces are formed about the axis, the radial component u must be so related to the change in the height z, that the same mass shall pass each cylindrical surface. Hence $2\pi\varpi \,.\, z \,.\, u\rho=$constant. SPRUNG discusses the equation as follows: $2\pi \,.\, z\rho \,.\, \varpi u=$const. Hence $\varpi u=$const., or $z\rho=$const.; $u=c\varpi$, $z\rho=\frac{\text{const.}}{\varpi u}=\frac{\text{const.}}{\varpi^2}$ for the inner region, $u=\frac{c}{\varpi}$, $z\rho=$const. for the outer region. We might pursue the development suggested by these equations in a different way from that employed by SPRUNG (Compare 303, 241), but will proceed along his own lines.

Cases 1, 2, 3, 4 are not applicable to the actual motions in the air, because too restricted. Case 4 is, however, an interesting solution of the equation, since F is a function of ϖ. Case 5 develops the logarithmic spiral, when the radius sweeps equal areas in equal times. (Compare 405b.) Case 6 is more valuable because it expresses free vortex motion, and implies hyperbolic surfaces, which undoubtedly conform most closely to the natural conditions, in so far as they are not distorted by additional forces which must be further considered. It is, however, the same as Case 5, and at once reduces to it when $w=0$, and the motion is confined to the horizontal plane, as stated in 426. The velocity w is so small that this has been commonly done.

In order to determine the gradients, the first equation of 422 is discussed; 432 gives the auxiliaries, 433 the gradients generally, 434 the gradients for the cyclone, and 435 for the anticyclone.

THE TWO SOLUTIONS OF THE SECOND EQUATION.

It will be observed that the cyclone has been divided into two parts, the inner and the outer, but upon very different principles from those introduced by FERREL. That author made the rotation take opposite directions in the two parts, the radius of separation R being the place of zero velocity, $v=0$. In this case the difference is due to the assignment of a radial velocity $u=\varpi c$ in the inner part, and a radial velocity $u=\frac{c}{\varpi}$ in the outer part. These are possible solutions, but the point raised here is whether it conforms to the circulation developed by our cloud observations. In order to bring this criticism as clearly to view as possible, the equations 436 to 449, Table 117, have been introduced. This is especially important because the theory of GULDBERG and MOHN, OBERBECK, POCKELS, and their treatment of the cyclonic circulation really depends upon it.

The equation $0=\frac{\partial u}{\partial t}+\frac{uv}{\varpi}+\lambda u+kv$ has two solutions, the employment of which has given rise to this division of the cyclone into the inner and the outer parts. By means of the auxiliaries of 436, it is converted into the form of 437. The two solutions are expressed in 438, and are carried

onward through 440 to the proof in 441. The fundamental laws are, for the first solution, $\frac{u}{\varpi}$=const., $\frac{v}{\varpi}$=const.; and for the second solution, ϖu=const., ϖv=const.

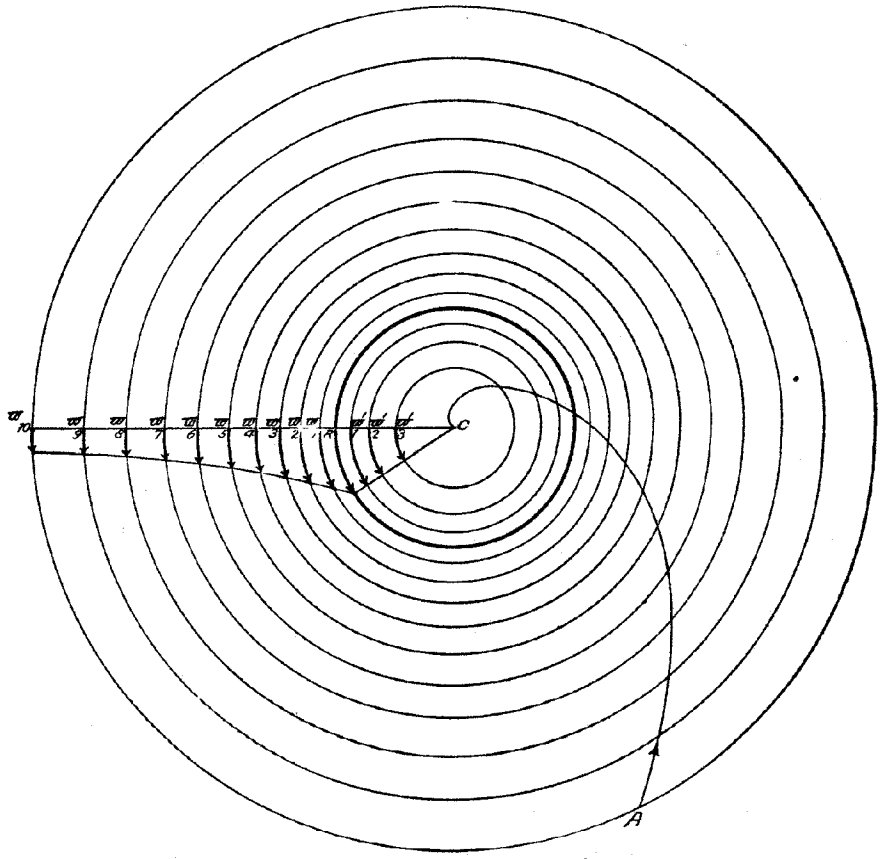


CHART 67.—Analogue of the electric current and the magnetic whirl.

Inner region.

$d_i = R^2 - \varpi^2_i = 1. \qquad R = 2.$

$$\begin{cases} u = -2\pi\varpi \,.\, w_i. \\ v = +2\pi\varpi \,.\, w_i. \\ w_i = 1. \end{cases}$$

$\varpi_3 = \sqrt{1} = 1.00 \quad u_3 = -6.28 \quad v_3 = 6.28 \quad w_3 = 1.0$

$\varpi_2 = \sqrt{2} = 1.42 \quad u_2 = -8.91 \quad v_2 = 8.91 \quad w_2 = 1.0$

$\varpi_1 = \sqrt{3} = 1.73 \quad u_1 = -10.86 \quad v_1 = 10.86 \quad w_1 = 1.0$

$R = \varpi_0 = \sqrt{4} = 2.00 \quad u_0 = -12.57 \quad v_0 = 12.57 \quad w_0 = 1.0$

Outer region.

$d_e = 2R^2 \log \frac{\varpi_e}{R} = 8 \log \rho = 1.$

$$\begin{cases} u = -2\pi w \cdot \frac{R^2}{\varpi} = -\frac{8\pi w}{\varpi}. \\ v = +2\pi w \cdot \frac{R^2}{\varpi} = +\frac{8\pi w}{\varpi}. \\ w_e = 0. \end{cases}$$

$\varpi_0 = 2\rho^0 = 2.000 \quad u_0 = -12.57 \quad v_0 = 12.57 \quad w_0 = 0$

$\varpi_1 = 2\rho^1 = 2.266 \quad u_1 = -11.1 \quad v_1 = 11.1 \quad w_1 = 0$

$\varpi_2 = 2\rho^2 = 2.568 \quad u_2 = -9.8 \quad v_2 = 9.8 \quad w_2 = 0$

$\varpi_3 = 2\rho^3 = 2.910 \quad u_3 = -8.6 \quad v_3 = 8.6 \quad w_3 = 0$

$\varpi_4 = 2\rho^4 = 3.297 \quad u_4 = -7.6 \quad v_4 = 7.6 \quad w_4 = 0$

$\varpi_5 = 2\rho^5 = 3.737 \quad u_5 = -6.7 \quad v_5 = 6.7 \quad w_5 = 0$

$\varpi_6 = 2\rho^6 = 4.234 \quad u_6 = -5.9 \quad v_6 = 5.9 \quad w_6 = 0$

$\varpi_7 = 2\rho^7 = 4.798 \quad u_7 = -5.2 \quad v_7 = 5.2 \quad w_7 = 0$

$\varpi_8 = 2\rho^8 = 5.438 \quad u_8 = -4.6 \quad v_8 = 4.6 \quad w_8 = 0$

$\varpi_9 = 2\rho^9 = 6.161 \quad u_9 = -4.1 \quad v_9 = 4.1 \quad w_9 = 0$

$\varpi_{10} = 2\rho^{10} = 6.981 \quad u_{10} = -3.6 \quad v_{10} = 3.6 \quad w_{10} = 0$

Auxiliaries.

$$\left[\begin{array}{l} i = \pi R^2 \,.\, w = \frac{c}{4} R^2. \\ c = 4\pi w \qquad = 2w_3 = 2 \cdot \frac{v}{\varpi}. \\ \varpi_n = R\rho^n. \end{array}\right]$$

$\tan i = 1 \qquad i = 45°$ Curve is a 45-degree log-spiral.

By reference to 232 and 241, these are seen to be the parabolic and the hyperbolic solutions, respectively. The vertical velocity is found for the two solutions as follows:

First solution.	Second solution.
$u=-\frac{c}{2}\varpi.$	$u=-\frac{c}{\varpi}.$
$z=+\frac{\text{const.}}{\varpi u}=-\frac{\text{const.}}{\frac{c}{2}}\cdot\frac{1}{\varpi^2}.$	$z=+\frac{\text{const.}}{\varpi u}=-\text{const.}$
$dz=\frac{\text{const.}}{\frac{c}{2}}\cdot\frac{2}{\varpi^2}\cdot\frac{d\varpi}{\varpi}=-2z\cdot\frac{d\varpi}{\varpi}.$	$dz=0.$
$\varpi dz=-2z\,.\,d\varpi.$	
$\varpi\frac{dz}{dt}=-2z\,.\,\frac{d\varpi}{dt}.$	
$\varpi\,.\,w=-2z\,.\,u.$	
$w=-\frac{2zu}{\varpi}=+cz.$	$w=0.$

The fact that FERREL and SPRUNG limited their solutions to horizontal motions and did not derive the vertical velocity involved in the equation of continuity, leaves their discussion of the cyclone in an unfinished state. Even with the result found in 444, added to that of 438, the solution is not complete, as will be presently shown.

THE ANALOGUE OF THE ELECTRIC CURRENT AND MAGNETIC WHIRL.

It will be advantageous to consider for a moment the analogue of the electric current and the accompanying magnetic field, which is possibly responsible for the solution adopted by those who divide the cyclone into an inner and an outer part, in accordance with these two solutions of the second equation of motion. In Chart 67 is shown the distribution of the magnetic field inside and outside the wire, whose radius is R. Within there is an electric current $i=\pi R^2 w$ (362), and outside there is no current. The magnetic equipotentials inside are so distributed in distance apart that $d=R^2-\varpi_1^2=\varpi_1^2-\varpi_2^2=\varpi_2^2-\varpi_3^2=\ .\ .\ .\ .$ Those outside are so distributed that $\rho=\frac{\varpi_1}{R}=\frac{\varpi_2}{\varpi_1}=\frac{\varpi_3}{\varpi_2}=\ .\ .\ .$, which is expressed by 446. The general equation inside and outside is given in 447 and the integral in 448. If $-\frac{\partial H_i}{\partial\varpi_i}=v_i$ inside, and $+\frac{\partial H_e}{\partial\varpi_e}=v_e$ outside, also adopting the solution for u, which is implied in 438, we have:

Inside.	Outside.
$u_i=-2\pi\varpi_i\,.\,w_i=-\frac{c}{2}\varpi_i.$	$u_e=-2\pi\frac{R^2}{\varpi_i}\cdot w_i=-\frac{c}{2}\frac{R^2}{\varpi_e}.$
$v_i=+2\pi\varpi_i\,.\,w_i=+\frac{c}{2}\varpi_i.$	$v_e=+2\pi\frac{R^2}{\varpi_e}\cdot w_i=+\frac{c}{2}\frac{R^2}{\varpi_e}.$
$w_i=\frac{v_i}{2\pi\varpi_i}.$	$w_e=0.$

Comparing these with 362–364, it is seen that 447–449 reach the same solution by another method. They may be compared with 437–440 on the supposition that $\lambda=k$ and that c is small. The important point to note is that the inside conforms to the parabolic and the outside to the hyperbolic law.

In order to illustrate this distribution, a simple example was worked out, from which Chart 67 was constructed. The velocity v is a maximum on the circle R, which bounds the cylinder, and within it the current is rising with the velocity $w=$const. The circulation diminishes by one law on the inside, such as to make $\frac{v}{\varpi}=$const.$=6.28$, and by another law on the outside, such as to make $v\varpi=$

const.=25.14. If the velocity on the successive circles is counted from the same radius, then on the inside the extremity of the representative lines, which, after the lapse of an interval of time gives the position of the moving particles, lies on a radius; but on the outside it is a curve which becomes tangent to the initial radius at the distance where $v=0$. The velocity u increases from the center, where it is zero, to the circle R, where it is a maximum on the inside. From that point the velocities u . v fall off gradually to zero. The vertical velocity is a constant inside, $w=1$; it is discontinuous at the circle R, and there drops to zero. Thus the circle R is a locus of maximum velocity for v and of discontinuity for w. Drawing the corresponding stream lines, there is a 45 degree logarithmic spiral AB from the outer limit to the center. The electric current with magnetic field analogue can be at once adapted to the two solutions of 397b (2) by adjustment of the constants. It is a convenient method of transition to the German school, which began with GULDBERG and MOHN, "Etudes sur les mouvements de l'atmosphere," 1876–1880, and was continued by OBERBECK, "Uber die Bewegungen der Luft an der Erdoberfläche," 1882, and POCKELS "Zur theorie der Luftbewegung in stationäre Anticyklonen," 1893. The primary principle is the same in each, modified by special analytical considerations.

THE LOCAL CYCLONE (GULDBERG AND MOHN).

450–456, Table 118. 450 shows that GULDBERG and MOHN adopted the forms of solution which are imposed by the equation 437; 451 is the same equation of continuity. By means of the auxiliaries 452 the solution for the gradients in the inner region is given in 453, with the reduced form for the cyclone in 454, and for the anticyclone in 455. The values for the inclination in 456 agree with those derivable from 438.

THE LOCAL CYCLONE (OBERBECK).

The leading theoretical objection to this double solution is the discontinuity at the boundary R of the inner circle. In order to obviate this difficulty, OBERBECK introduced a modification in the treatment. 457–476, Table 119. OBERBECK in the original paper discusses the problem of the motion in terms of the equations with $+u$ to the east and $+v$ to the south. This order changes the adopted rotation of the system of equations here employed, and the OBERBECK equations are changed to read for $+u$=south and $+v$=east. After the same manner as in 421 the original equations of motion (185) are given the form 457, to which the friction term is added. 458 contains the velocity potentials, the first term being for the linear and the second for rotational potentials. 459 gives the assumed forms of these potentials for the inner and the outer region. There are two cases, I for no vertical motion in the entire region, and II for vertical motion in the inner region.

Case I, 460–467. $c=0$. 460 gives the differential equation which leads to the logarithmic spiral. The treatment of this subject is referred to in several treatises. Attention is called to the desirability of agreeing upon one form of notation rather than perpetuate so many different presentations of one subject. 462–464 give the potentials which occur for H_e, for W_e in terms of H_e, and W_i in terms of H_i, which are the same as those of the two solutions already studied. 468 gives the velocities in terms of the potential H; 466 and 467 are the pressure equations. 467 should be now compared with 233.

Case II. The coefficient c is not zero, and there is vertical motion in the inner region. Case I was treated in the analogue in 348–354, and Case II in 355–364, so that no further explanation need be added in this place. 469 gives the resulting potentials, 470 the radial, and 471 the tangential velocity. The former agrees with the solutions already found for the fundamental analogue, except that the tangential velocity in the inner region is made a function of the radius. This avoids the discontinuity found by GULDBERG and MOHN. They used the two solutions of the second equation 397b, as shown in 437, and encountered a discontinuity. OBERBECK uses the solution of the electric current analogue—that is, the logarithmic velocity potential—and succeeds in avoiding any discontinuity for $\varpi=R$. This is shown by the velocities of 470, 471 in cylindrical coordinates, which may be converted into south and east velocities, 472, in agreement with

OBERBECK'S solution. The only discontinuity now remaining is in the vertical velocity at the boundary of the inner region. 473–475 give the equations for the pressures, and 476 for the inclination, the latter agreeing with GULDBERG and MOHN'S values, except for the $f(\varpi)$.

THE LOCAL ANTICYCLONE (POCKELS).

OBERBECK expected to find the solution for the anticyclone by changing the sign of c, but this led to an insoluble expression. In order to improve that point, POCKELS discussed the anticyclone and discovered that the difficulty found by OBERBECK was produced by failing to evaluate the constant of integration. Introducing this, and modifying OBERBECK'S expression for $f(\varpi)$, the solutions for the cyclone and anticyclone became interchangeable by changing the sign of the constant c. 477–483, Table 120. These contain the chief points of interest for our study. The equation of continuity can be conceived in another manner, as follows: A cylinder of height z has the bounding surface $2\pi\varpi \,.\, z$, and the area of its top is $\pi\varpi^2$. As much air escapes from the top at the height z as enters through the cylindrical surface, in order that there may be no congestion within the same. Hence, $-2\pi\varpi \,.\, u \,.\, z\rho = \pi\varpi^2 \,.\, w \,.\, \rho = \text{const}$; $-u = +\varpi \,.\, \frac{w}{2} z$. POCKELS employs the following form: $-\frac{\partial}{\partial\varpi}(\varpi u) = \varpi\, w$. Therefore, $-\varpi u = \varpi^2 \frac{w}{2}$, $-u = \varpi \,.\, \frac{w}{2}$. Hence, $w = cz = \gamma\,\varpi$. At the unit distance $z = \varpi = 1$. Now by putting $z = 1$ this form misses the important step of making u vary with the height, as it should in three dimensional motions, and this seems to be a fault in the equation of continuity. The result should be $-u = \varpi \,.\, \frac{w}{2} \,.\, \frac{1}{z}$ instead of $-u = \varpi \,.\, \frac{w}{2}$. This has already been shown on page 602 to be the true solution of the equation of continuity. It was rendered necessary in consequence of following the solution implied in the electric-current analogue. POCKELS makes w the same function of the radial distance, $w = \gamma\varpi$, that OBERBECK does of the vertical distance, $w = cz$. This is evidently an equivalent mode of expression.

By means of the auxiliaries 479 the equations of motion, 185 or 422 or 457, take the form 480 for the anticyclone. If $u = \frac{c}{2}\varpi$ for the inner region, and $u = \frac{c}{2}\frac{R^2}{\varpi}$ for the outer region, the equations of motion are further transformed to 481. The solution is given in 482, and is the same as 470–474, except that the sign of c is changed in consequence of solving for the anticyclone instead of the cyclone, and the functions of the radius $f(\varpi) = -\frac{c}{k+c} \cdot e^{-\frac{k}{c}\left(\frac{\varpi^2}{R^2}-1\right)}$. This is doubtless an improvement on OBERBECK'S form $f(\varpi) = -\frac{c}{k}\left(\frac{\varpi}{R}\right)^{\frac{2(k-c)}{c}}$. POCKELS'S results are not further reproduced, as this suffices for the general discussion, which is our chief purpose in this connection.

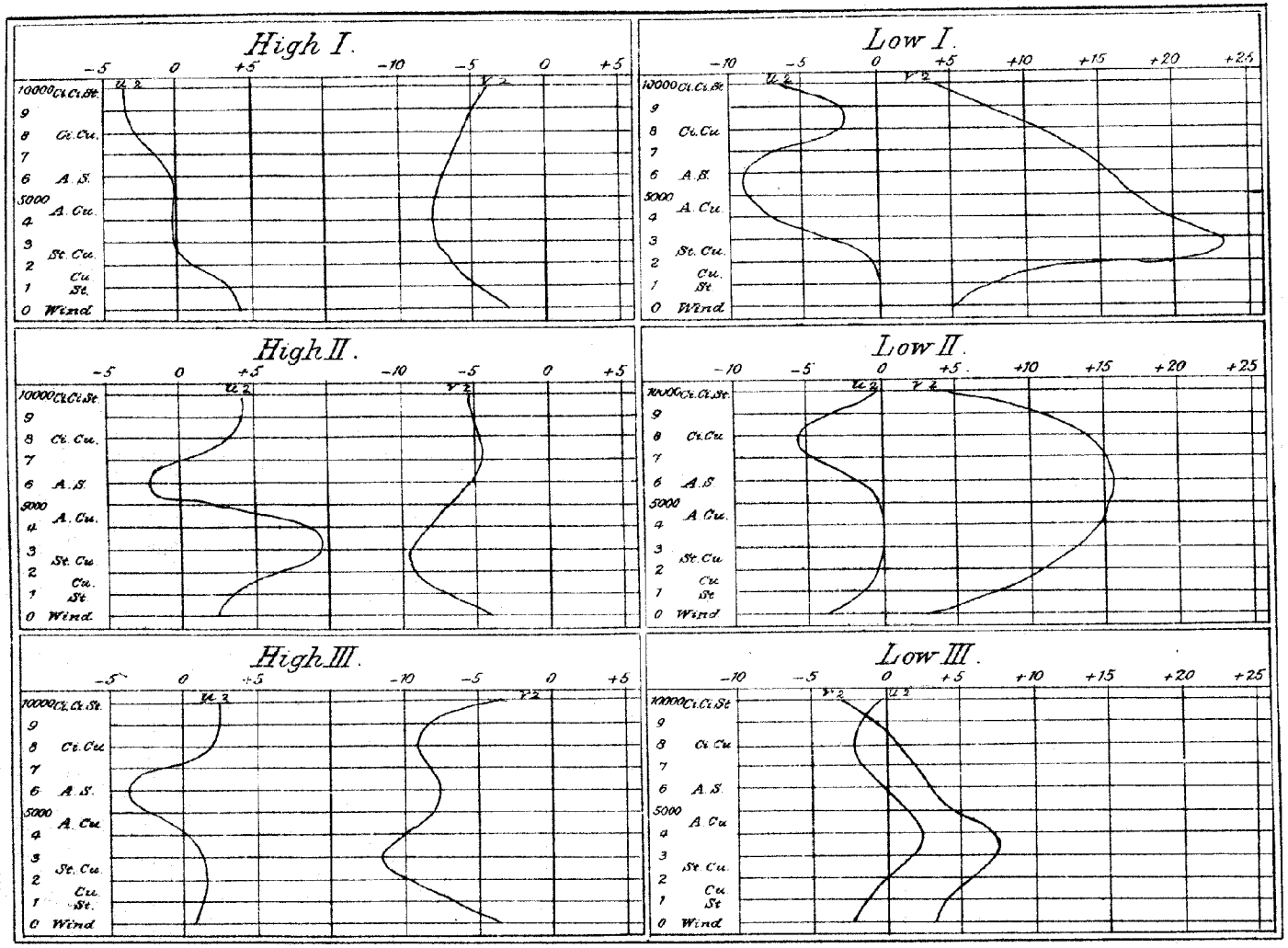
The theory which is common to the German school of meteorologists is, as we have shown, founded upon the assumption of a vertical central current, like the electric current in a wire, which generates the cyclonic circulation in the inner and the outer parts. Now, there are a series of difficulties and objections to this view, when it is attempted to apply it to the observations of the actual air motions, fully as serious as those which have been urged against Professor FERREL'S theory. (1) There is no sufficient evidence that the vertical current is of definite *local* origin and powerful enough to influence the enormous cyclonic disturbances extending horizontally to 1,000 miles in radius. These storms are very shallow compared with their width, say 3 or 4 to 1,000 at the greatest depth. An upward central current in a small inner region of 200 miles radius, even if locally produced, could hardly cause the disturbances observed on the weather maps. The chief difficulty has been to show that there is any sufficient cause for the existence of such a current, and the reasons already urged against that view hold here also, namely, that the disturbing isotherms are not circles, but their gradients lie athwart the cyclone, generally from SW. to NE.; that cylones exist without precipitation; that rainfall does not necessarily produce cyclonic action; and that countercurrents from two specific directions, as NW. and S., feed into the cyclone, which is not sustained from a supply equally distributed around a center. (2) The adoption of the inner

and outer parts of the cyclone was due to the supposed necessity of avoiding infinitely great velocities at the center, if $u=-\frac{c}{\varpi}$ and $v=+\frac{\lambda}{k}\cdot\frac{c}{\varpi}$, as would occur for small values of ϖ. It will, of course, be necessary to show how this can be done by any other solution. Even if that is accomplished we find some other practical difficulties in the resulting solution having an inner and an outer part. This requires a *maximum rotational velocity v at the boundary* $\varpi=R$. (See Chart 67.) But our observations give no support to this position any more than to FERREL'S theory *that* $v=0$ *at the boundary of the inner and the outer parts.* A careful examination of our wind velocities shows that they increase steadily from the outer boundary toward the center when a surface of discontinuity surrounding a calm center suddenly terminates the radial and tangential velocities. The common occurrence of the sudden calm in hurricanes is sufficient proof of this point. Furthermore, an examination of the cyclonic components (u_2 v_2), Table 125 and Chart 68, shows that the tangential velocity v increases from the outside toward the center without any tendency to fall off. Certainly, in forecasting, no one expects to find the maximum velocities at 100 or 200 miles from the center. The two-part theory itself, although gradually reducing the velocity from a maximum at the boundary R to zero at the center, has no way to explain the existence of the central calm. (3) While the differential equation has two solutions which afford some aspects plausible for this application, yet it is improbable that in such processes of nature as the circulation of the air there should be more than one law actually in operation. That the movement should suddenly jump from one system of forces to another is quite unlikely, unless cause can be shown for it. In the analogue of the electric current in the cylindrical wire there are two special circumstances to be noticed. The first is that the solution depends upon having a long wire, and thus the current in passing a given place generates its magnetic field by mere vortex rotations, but with inflow unlike the air sheet in a cyclone. In the case of the wire and current there is discontinuity and therefore curl in passing across the surface of the wire. The second is that in the case of the solution for the cyclone to which this was applied there is a continuous feeding of fresh material from outside toward the boundary, which, of course, makes the physical conditions of the problem very different. (4) In spite of skillful devices by which discontinuity in the rotation velocity was overcome, it is evident that there still remains a definite vertical discontinuity at the boundary, which becomes more and more pronounced with the increase in height above the surface, since $w=cz$. While it is hardly possible to actually observe the vertical components, yet the probabilities are that vertical motion sets in as soon as the isobars which surround the cyclone are closed up, and that all over this area there is a rising current. It may well be laid down as a principle that where closed isobars exist there is an ascending or a descending current, according to the direction of the rotation. Where the isobars wander about without closing up, it may be assumed that there is no rising or descending air. In the case of cyclones this is confirmed by the general tendency of precipitation to occur over the entire region of the closed isobars. The preponderance on the eastern side over the western is due to the action of the general drift in the upper strata upon the circulation.

PROPOSED NEW SOLUTION FOR THE CYCLONIC MOTIONS.

While it is proper to thus state the difficulties associated with the theories now in vogue to account for meteorological phenomena, even if no better theory could be proposed, yet it is somewhat incumbent upon us to show what can be done to improve these matters. I shall accordingly attempt to state the details of a solution, which appears to be more suitable for explaining the facts presented to us by the cloud observations recently made in the United States. It will be necessary in such a solution to avoid two or three primary difficulties. In the observed circulation the stream lines are not to be reentrant, as in FERREL'S theory, but they simply pass through the cyclonic configuration, beginning at some point and extending many hundred miles. The distinction between the inner and outer parts of the cyclone is unnecessary, and is to be abandoned, the cyclone or anticyclone being limited to regions having closed isobars. The solution must satisfy the equation of continuity, and the second of 397b simultaneously; also it must be a solution in three dimensions, holding the velocities (u . v . w.) bound together in a scheme of mutual interrelations. It must be furthermore fitted to secure the connection between the local and the general

Chart 68.


High I.
Low I.
High II.
Low II.
High III.
Low III.
10000 Ci. Ci. St.
9
8 Ci. Cu.
7
6 A. S.
5000 A. Cu.
4
3 St. Cu.
2 Cu.
1 St.
0 Wind.
u 2
v 2
-5 0 +5 -10 -5 0 +5
-10 -5 0 +5 +10 +15 +20 +25

circulation, and to apply the force of retardation by inertia, so that the rapid eastward drift of the higher levels shall be efficiently regulated. The calm center, or core, must be a simple feature of the movement when it attains high velocities. This circulation must also account for the occurrence of precipitation in the low areas and for clear weather in the high areas.

As a preliminary remark it should be stated that, although a single year's observation with nephoscopes seems to have been sufficient to afford a clear view of the leading features of the circulation, yet it may well be the case that some of the details of the component velocities would be somewhat modified by longer continuance of such work. Indeed, it is most desirable to prosecute these observations regularly, as they will certainly enable us eventually to solve the problems of motion which occur in meteorology. In order to obtain component velocities which will be practically an improvement on the first residuals, by a slight adjustment, we proceed as follows:

TABLE 125.—*Summary of the resulting anticyclonic and cyclonic velocities.*

Height	Cloud stratum	High areas								Low areas							
		I		II		III		Means		I		II		III		Means.	
		u_2	v_2	u_2	v_2	u_2	v_2	u_2	v_2	u_2	v_2	u_2	v_2	u_2	v_2	u_2	v_2
9.8	Cirrus	−1.1	−2.6	+ 7.2	− 4.0	+1.5	− 1.8	+2.5	−2.8	−11.2	+ 0.4	−4.4	+ 3.4	−2.7	−0.5	−6.1	+ 1.1
9.8	Ci. Strat.	−5.0	−5.7	− 0.3	− 6.5	+2.6	− 2.3	−0.9	−4.8	− 2.4	+ 6.1	+6.3	+ 3.8	+2.9	−5.5	+2.3	+ 1.5
8.1	Ci. Cu.	−3.7	−5.1	+ 4.7	− 5.0	+2.4	−10.2	+1.1	−6.8	− 1.2	+10.2	−6.8	+12.3	−1.8	+0.7	−3.3	+ 7.7
	***Normals**	**−3.3**	**−4.5**	**+ 3.9**	**− 5.2**	**+2.2**	**− 4.8**			**− 4.9**	**+ 5.6**	**−1.6**	**+ 6.5**	**−0.5**	**−1.8**		
5.9	Alto Strat.	+0.9	−7.4	− 3.5	− 3.8	−4.6	− 8.1	−2.4	−6.4	−10.1	+15.2	+2.1	+16.4	−0.7	+2.3	−2.9	+11.3
4.5	Alto Cum.	−0.4	−6.3	+ 5.8	− 5.9	+0.5	− 7.7	+2.0	−6.6	− 8.5	+17.1	−2.7	+14.1	+2.4	+6.3	−2.9	+12.5
2.5	Strat. Cum.	−0.5	−7.5	+10.2	−10.1	+1.6	−12.1	+3.8	−9.9	− 3.2	+23.5	+1.6	−12.7	+3.2	+7.1	+0.5	+14.4
	***Normals**	**0.0**	**−7.1**	**+ 4.2**	**− 6.6**	**−0.8**	**− 9.3**			**− 7.3**	**+18.6**	**+0.3**	**+14.4**	**+1.6**	**+5.2**		
1.5	Cumulus	+1.8	−5.8	+ 2.6	− 9.8	+3.0	− 7.9	+2.5	−7.8	+ 0.7	+ 9.8	−2.7	+ 8.3	−2.2	+4.4	−1.4	+ 7.6
0.9	Stratus	+4.0	−4.2	+ 4.1	− 7.3	+1.0	− 7.2	+3.0	−6.2	+ 1.2	+ 8.1	−1.2	+ 7.6	−0.2	+3.6	−0.1	+ 6.4
	Normals	**+2.9**	**−5.0**	**+ 3.4**	**− 8.6**	**+2.0**	**− 7.6**			**+ 1.0**	**+ 9.0**	**−2.0**	**+ 8.0**	**−1.2**	**+4.0**		
0.0	Wind	+4.1	−2.4	+ 2.2	− 4.0	+1.4	− 3.6	+2.6	−3.3	− 0.9	+ 5.6	−3.2	+ 3.1	−2.1	+3.4	−2.1	+ 4.0
	***Normals**	**+3.3**	**−4.1**	**+ 3.0**	**− 7.0**	**+1.8**	**− 6.2**			**+ 0.3**	**+ 7.9**	**−2.4**	**+ 6.3**	**−1.5**	**+3.8**		
	Means	0.0	−5.2	+ 3.7	− 6.3	+1.0	− 6.8	**+1.6**	**−6.1**	− 4.0	+10.7	−1.2	+ 9.1	−0.1	+2.3	**−1.8**	**+ 7.4**

I, II, III. The circles at 250, 750, 1250 kilometers from the center.
u_2 v_2. The velocity components after eliminating the general velocities u_1 v_1.
$+u_2$=radial outward. $+v_2$=tangential anticlockwise.
The normal values are the means for the adjacent strata in groups.
* These groups, three strata each, were used in constructing Chart 19.

First, plot from Table 125 the actual values of $(u_2 . v_2)$ at each cloud stratum and for each mean distance, I=250 km=155 miles, II=750 km=466 miles, III=1,250 km=777 miles, as on Chart 68. Draw average lines, having regard to a general adjustment and balance of the mutual changes of $u_2 . v_2$. at any given place. From these curves, read off the values of $(u_2\ v_2)$ at each 1,000-meter level, and the result appears in Table 126. By inspection we see that the strato-cumulus to alto cumulus level is approximately that of the maximum value of the gyratory velocity v_2, which falls off in either direction to the cirrus and to the ground. In *the high areas this velocity increases gradually from the center to the outer limits;* in the *low areas it decreases from the center to the outside.* There is no evidence of maximum or minimum within these limits of observation. The velocity in the low areas is about 1.5 times that in the high areas. In the highs the velocity v on III is 1.3 times that on I; and in the lows the velocity on I is 3.4 times that on III.

The radius corresponding to I, II, III is as 1 : 3 : 5.

The velocity corresponding to I, II, III is as 3.4 : 3.0 : 1.0 in the cyclone.

The product ϖv corresponding to I, II, III is as 3.4 : 9.0 : 5.0.

This indicates approximately a vortex law for the low area. In the high area the velocity v corresponding to I, II, III is as 1.0:1.1:1.3; the product ϖv corresponding to I, II, III, is as 1.0:3.3:6.5 and this does not give any conformity to the vortex law. Hence we must look for different principles in the construction of highs and lows, and not consider them interconvertible, as OBERBECK and POCKELS assumed.

TABLE 126.—*Anticyclonic and cyclonic velocities at each 1000-meter level.*

Cloud forms	Height in meters.	High areas						Low areas						Velocities in the general cyclone	
		I		II		III		I		II		III			
		u_2	v_2	u_2	v_2	u_2	v_2	u_2	v_2	u_2	v_2	u_2	v_2	u_1	v_1
Ci-Ci. St.	10000	−3.5	−4.0	+ 4.5	−5.5	+2.5	− 3.0	−6.5	+ 3.0	−1.0	+ 3.5	0.0	− 3.0	−2.8	+35.4
	9000	−3.5	−5.0	+ 4.5	−5.0	+2.5	− 8.0	−3.0	+ 8.0	−3.0	+11.0	−1.5	− 1.0	−2.6	+35.0
Ci. Cu.	8000	−3.0	−6.0	+ 3.5	−4.5	+2.0	− 9.0	−2.5	+11.0	−5.5	+13.5	−2.0	+ 1.0	−2.4	+34.6
	7000	−1.5	−6.5	0.0	−4.5	−1.5	− 8.0	−6.5	+13.5	−5.0	+15.0	−2.0	+ 2.0	−2.2	+30.0
A. St.	6000	0.0	−7.0	− 2.5	−4.5	−4.0	− 7.5	−9.0	+15.0	−2.0	+15.5	−0.5	+ 3.0	−2.0	+25.0
	5000	0.0	−7.5	+ 2.5	−6.0	−2.5	− 8.0	−9.0	+17.0	0.0	+15.5	+1.5	+ 5.0	−1.8	+23.6
A. Cu.	4000	0.0	−7.5	+ 8.5	−8.0	0.0	−10.0	−7.5	+20.0	0.0	+14.5	+2.5	+ 7.0	−1.6	+22.6
	3000	0.0	−7.0	+10.0	−9.5	+2.0	−12.0	−3.5	+23.0	0.0	+13.0	+2.0	+ 7.5	−1.3	+21.0
S. Cu.	2000	+1.0	−6.0	+ 7.5	−9.5	+2.0	−11.0	−1.0	+20.0	0.0	+11.0	0.0	+ 5.0	−1.0	+14.0
Cu. St.	1000	+3.5	−4.5	+ 5.0	−7.5	+1.5	− 7.0	0.0	+ 8.0	−1.5	+ 8.0	−1.5	+ 4.0	−0.8	+ 6.4
Wind	0000	+4.0	−2.5	+ 2.5	−4.0	+1.0	0.0	0.0	+ 6.0	−3.5	+ 3.0	−2.0	+ 3.0	−0.5	+ 1.3
Means of the velocities. u_2, v_2.		−0.3	−5.8	+ 4.2	−6.2	+0.5	− 7.6	−4.4	+13.1	−2.0	+11.2	−0.3	+ 3.8		
Radius. ϖ.			1		3		5		1		3		5		
Product. ϖv_2.			−5.8		−18.6		−38.0		13.1		33.6		19.0		

$+u_2$=outward on radius.
$+v_2$=anticlockwise about center.

I. ϖ_1 = 250000 meters.
II. ϖ_{11} = 750000 meters.
III. ϖ_{111}=1250000 meters.

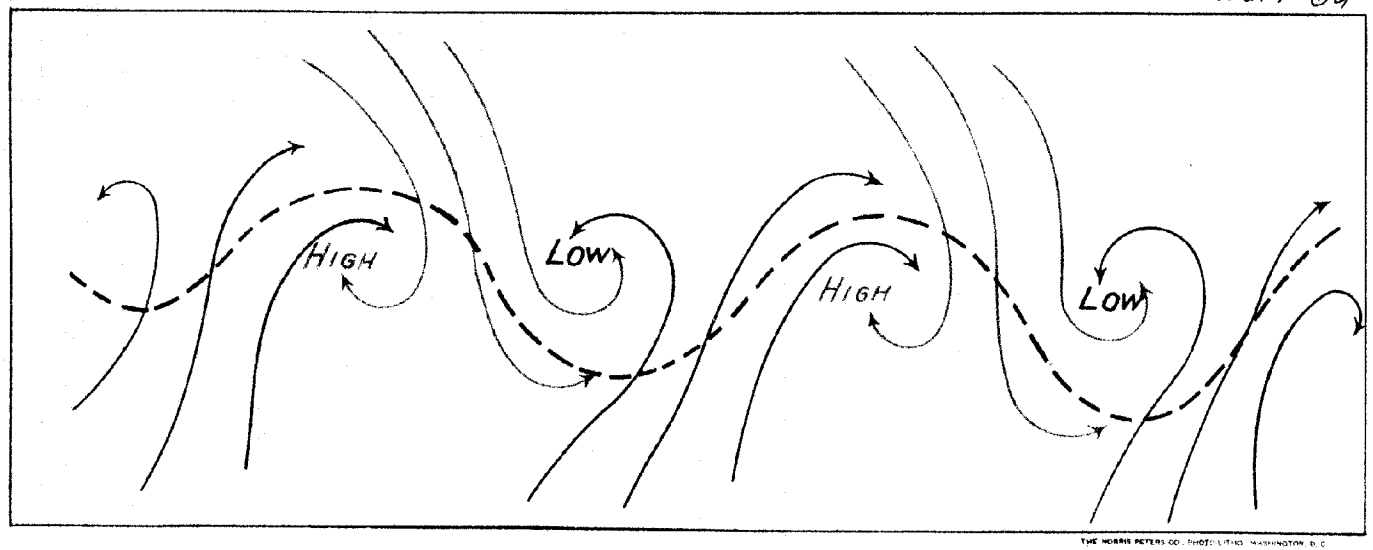
$+u_1$=south.
$+v_1$=east.

In the high areas the radial velocity u_2 on circle I is inward at the top, tangential at the middle heights, and outward at the base. In II and III it is outward at the top and bottom but inward in the alto-cumulus and alto-stratus levels. This exception depends almost entirely upon the observations in the alto-stratus level, and as these are difficult clouds to observe there may be some doubt about the correctness of them, though I shall proceed as if they were true. In the low areas the radial velocities are all inward from the ground to the cirrus level, except for the middle altitudes of circle III. This does not confirm FERREL'S theory, which requires v_2 to be outward throughout the top of the cyclone; also the direction of the rotation v_2 should be reversed, which is not the case, except possibly at the 10,000 meter level of circle III, though this seems more like the result of imperfect observations.

THE RESULTING FEATURES OF THE CIRCULATION FROM THE OBSERVED COMPONENTS u_2, v_2, IN ANTICYCLONES.

Taking these facts into consideration the main features of the circulation suggested by them are as follows: A current of air from the northwest at about the strato-cumulus level shows a tendency to split into two parts (see Chart 69), the southern curling about into a high area, and the northern curling in the opposite direction into the low area. This splitting and the curling tendency is greatly reinforced by a current of air from the south, which does precisely the same thing, the western branch curling into the low area and the eastern branch curling into the high area. The outer branch from the northwest does not enter the high area, but blows around the outer edge of it; the inner branch in connection with the corresponding branch from the south feeds a small vortex in the strato-cumulus level which drives the air toward the ground. This causes a depression at the top of the high area, and an inflow from the upper strata, much as a rotating electric fan pushes air forward, by drawing a current through its area of rotation. The small central vortex has the same effect in a high area, the outflow at the ground being the resultant of this discharge; it there operates in connection with the continuous branch which flows around the high pressure center toward the low area. In the lower levels the deflection caused by the earth's rotation and the friction constant k may suffice to detach larger masses from the original current, as is seen in the cumulus and stratus levels. This circulation in the anticyclone is too complex to reduce to any simple system of analytic expressions, though the general idea seems quite clear. Successive currents from the northwest, alternating with the southerly currents, appear to be the scheme upon which is built up the local circulations of the middle latitudes.

Chart 69



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THE CIRCULATION THROUGH CYCLONES.

The inflow to the cyclonic areas can be more definitely analyzed. They form a type of impure vortex tubes, which discharge upward into the eastward flowing upper strata, and cause there the observed deflection, together with the long trail of condensed vapor seen as clouds to the eastward of the center of the low area. It is impossible to construct any diagram representing on a true scale the relations which exist between the local cyclone and the general motions of the atmosphere. For if a cyclone is 1,500 miles in diameter, and its action reaches even to the height of 5 miles, then the horizontal scale must be to the vertical scale in the ratio of 300 to 1. If the vertical scale be exaggerated fifty times, the result may be seen approximately in Chart 70. Therein the horizontal scale gives the horizontal distances from the center in miles and in kilometers, and the vertical the height in meters, with the position of the cloud levels. When the two branches of air flowing from contrary directions, principally within the lower 4,000 meters, encounter, they are forced into a vortex circulation which discharges upward into the levels between 4,000 and 10,000 meters. But since this operation does not take place independently of all other movements of the atmosphere, the ideal vortex is continuously undergoing distortion. The most important disturbing element is the eastward drift, whose components are represented on the axis of Chart 70, fig. 1. The inward and upward motion, meeting these eastward components, will be changed into forms similar to those represented in Chart 70, fig. 2. The western side of the circulation will be deflected upward and eastward; the eastern branch will be curved backward upon itself in the higher levels and trail to the eastward in the upper strata, beyond the boundary of the cyclone in the lower strata. It must not be overlooked that this diagram represents the stream lines only in a plane perpendicular to the meridian, and that the rotational velocity v_2, which is circular about the axis, is omitted. If this be added, then the stream lines will suffer the deflections in horizontal planes which are fully indicated in the preceding Charts 15–18, and thus complete the picture. When taken in conjunction with neighboring anticyclones, which have features similar to the cyclone, but rotating in the opposite direction and discharge downward, the sinuous eastward movements in the upper strata are completely accounted for by the simple composition of forces.

A consideration of these facts shows that it is only necessary to construct from direct nephoscope and theodolite cloud observations the vectors of motion, and then discuss them along the lines indicated in this report, in order to arrive at such data as will permit an exact computation of all the forces and constants which are concerned in the meteorological problems of motion of the atmosphere. The results obtained by the observations of one year are necessarily imperfect, especially in view of the fact that many of the local cyclones are only partially developed, where the counterflow currents may be irregularly diverted, and therefore the putting together of all the observations of a year in one summation, thus uniting good and bad cyclonic movements all together, tends to degrade the resulting velocity components from a pure type. It would be much better to observe the clouds continuously for some years, then select the more rigorous types and discuss them by themselves according to the plan here laid down. *It seems quite plain that the addition of the nephoscope to the regular equipment of our stations, and the inclusion of the accurate direction and the relative velocity of motion in the semidaily observations, is the right step to take in practical meteorology.* The study of the behavior of these countercurrents coming from independent sources is probably the best way to improve our knowledge of forecasting. A very conspicuous case of failure to predict precipitation comes from a neglect of this principle. For instance, when an area of high pressure advancing over the United States from the northwest approaches the Atlantic States two developments may occur. Either the high may pass over to the eastward at once and give clear weather, or else heavy precipitation will fall in the Atlantic States, along the front of the high area, when the area hangs in the eastern districts. In the former case there is absence of the current from the south near the Gulf Stream and coast, and in the latter this current is in operation. If this southerly current is vigorous, it may roll up a cyclone on the front of the high, and carry it from the Gulf States to the Gulf of St. Lawrence. Even two or three such storms may quickly succeed one another. This was what happened from February 6 to February 15, 1899, when two or three of these coast storms succeeded each other over the Atlantic States in the front of the same high area. There was at that time a powerful cold wave covering

the western and central districts, with clear and intensely cold weather, but there was a persistent south wind near the Atlantic coast, the effect of the two counter circulations being to whirl up these three storms one after the other. Forecasting was, of course, very difficult under such circumstances, the probable conditions being that the clear weather would fill in behind each storm as it moved northward. Instead of this, heavy precipitation and very cold weather prevailed throughout the Gulf and Atlantic States. It is possible that if more attention were paid to the currents in the cumulus to the alto-cumulus levels it would guide the forecaster to a more accurate judgment of the probable course of events.

THE LOCAL CYCLONE (BIGELOW).

The analytic expression for the theory here proposed is contained in the system of equations 484–496, Table 121. Resuming the equations 200, omitting the unimportant terms, adding the terms for friction and a function for the effect of variations in temperature, we obtain 484. It should be observed that FERREL was right in an attempt to introduce into the equations of motion the terms depending on temperature, and that the German School have not paid enough attention to this point. The solutions of GULDBERG and MOHN, SPRUNG, OBERBECK, and POCKELS in the local cyclone, as recapitulated above, do not contain this term, and thereby their solution is very much idealized. FERREL'S assumed law of the variation of the temperature, 392b, will need modification, yet this should not be done arbitrarily, but only as the result of observations by means of kite and balloon ascensions. No attempt is made in this connection to evaluate the term, as it is complex, though its presence in the equation is indicated. Some of the terms in 484 may be dropped from the partial differentials, which then take the form 485. The equation of continuity is put in the form 486, for the sake of developing the relations between $u \,.\, w \,.\, \varpi \,.\, z$. As much mass must escape from the top of the tube included between two lines of flow as enters through the cylinder $2\pi\varpi \,.\, z$. (Compare 426, 443, 451, 477.) By differentiating the form for z in 487, the following forms are derived, so that $\varpi w = -2zu$ is the fundamental relation to be fulfilled.

The cyclone proper begins at the first closed isobar and extends inward and upward till dissipated in the upper strata. Outside this isobar, and independent of it, there occur sets of isobars which wander about irregularly, or else stretch over the country in nearly parallel lines, and in this region there exists no tendency for the air to be forced upward by the dynamic circulation. This is the locality of horizontal currents, strictly speaking, and in it there is no special cause for precipitation, except such as occurs from cooling the air by contact, or else by the underflow of a mass of cold air which raises an overlying mass of warm air, yet so acting that they do not produce a cyclonic gyration. This is seen to be the case frequently along the front of a high area, where often long regions of precipitation occur, stretching in an irregular band from the lakes to the Gulf States, and where no rotary motion can be seen. This is hardly an instance of cooling by mixture, as much as local lifting, somewhat as a mountain range raises the warm wind which blows over it and condenses its vapor contents. These regions of horizontal flow occur to a greater or lesser extent between high and low areas, but usually it is of very narrow dimensions in the direct line of the centers. To the north and the south of this line there are much larger spaces with no vertical ascending or descending components. We may properly use two cases of the current function ψ with this understanding, that the case leading to $w=0$ does not belong properly to the cyclonic circulation. There is practically no discontinuity at this distance from the center, because the true cyclonic motion only gradually arises out of the currents which begin at great distances. 488 contains the assumed forms of ψ, the current function. Following now W. WIEN'S method and using STOKE'S current functions for the velocities, we obtain directly the auxiliaries of 489 and the velocities of 490. These satisfy the equation of continuity and all the other check relations. They differ chiefly from the preceding solutions by the occurrence of z in the expression for the rotating velocity $v = +\frac{\lambda}{k-c} \cdot \frac{2}{c}\, \varpi \,.\, z$, and thus introduce the third dimension which is important in the solution of the problem of the cyclone. The vertical velocity is $w = cz = -\frac{2u}{\varpi} \cdot z = +\frac{2v}{\varpi} \cdot \frac{k-c}{\lambda}$, which gives the relation needed between v and w. It is similar to that in the analogue of 347, and would be the same if $\frac{\lambda}{k-c} = 4\pi$, which may sometimes be the case approximately.

The inclination is given in 491, and also depends upon the height. It should be carefully noted that $z=h-H_0$, and it represents the altitude to which a line of flow rises above the height it had at the distance where rotation began. Thus, if a current enters the vortex at the altitude of 3,000 meters, the height z is counted upward beginning at that elevation. The vortex law is satisfied in 492, and the general equation of continuity in cylindrical coordinates in 493. An expression for the gradient is given in 494, for the total velocity in 495, and for the change in pressure from one point to another in 496. These are all imperfect for two reasons: (1) That they do not include the terms depending upon the temperature differences in the several portions of the cyclone; and (2) because none of the cyclones in nature are pure, but only incomplete vortices, owing to the fact that they are built up under such conditions as can only produce partially complete vortex flows, and they do not therefore strictly conform to the general equations. Still, it is important to get an idea of the status of the problem in order to make more thorough preparation for its solution with the progress of meteorology.

EXAMPLE OF THE VELOCITIES IN A CYCLONE.

The following example of the relations which should exist in a pure vortex are deduced for comparison with the data of Table 126 under low areas. Taking the inward radial velocity $u=-1.25$, at the distance 1,250 kilometers, computing $\lambda=.000100$ for $\theta=46°17'$, and $c=.000002$, also $k=.000050$, their introduction into the several formulæ gives the values found in Table 127.

TABLE 127.—*Application of the formulæ for a cyclone.*

CONSTANTS AND FORMULÆ.

$$\lambda=2n\,.\,\cos\theta \qquad \theta=46°\ 17' \qquad \lambda=.000100$$

$$c=-\frac{2u}{\varpi} \qquad u=-1.25 \qquad c=.000002 \qquad \frac{\lambda}{k-c}\cdot\frac{c}{2}=.000002$$

$$\varpi=1250000 \text{ meters} \qquad k=.000050$$

$$\psi=-\frac{c}{2}\varpi^2 z. \qquad u=-\frac{c}{2}\varpi. \qquad v=+\frac{\lambda}{k-c}\cdot\frac{c}{2}\varpi\cdot z. \qquad w=+cz. \qquad \cot i=\frac{\lambda}{k-c}\cdot z.$$

DERIVED DISTANCES, VELOCITIES, CHECKS, AND INCLINATION.

ϖ		z	ϖz	u	v	w	ϖv	$\varpi w=-2uz$	$\cot i$	i	G
km.	*miles.*									°	*mm.*
1250.000	=777	1.00	1250000	—1.25	2.50	.0000020	3125000	2.5	2.00	26.6	0.34
1000	621	1.56	1560	—1.0	3.125	31	3125	3.1	3.12	17.6	0.40
750	466	2.78	2085	—0.8	4.17	56	3125	4.2	5.56	10.2	0.55
500	311	6.25	3125	—0.5	6.25	125	3125	6.3	12.50	4.6	0.78
250	155	25.00	6250	—0.25	12.50	500	3125	12.5	50.00	1.2	2.03
200	124	39.06	7812	—0.20	15.62	781	3125	15.6	78.12	0.7	3.00
150	93	69.40	10412	—0.15	20.82	1388	3125	20.8	138.80	0.4	5.37
100	62	156.30	15630	—0.10	31.26	3126	3125	31.3	312.60	0.2	13.90
50	31	625.00	31250	—0.05	62.50	12500	3125	62.5			
40	25	977.00	39080	—0.04	78.16	19540	3125	78.2			
30	19	1736.00	52080	—0.03	104.16	34720	3125	104.2			
20	12	3906.00	78120	—0.02	156.24	78120	3125	156.2			
10	6	15625.00	156250000	—0.005	312.50	.0312500	3125	312.5			

It is seen that the rotating velocity v is about the same as that given by the observations to the circle whose radius is 150 km=93 miles from the center, as seen under v_2 of Table 126. The values of the radial velocity agree fairly well, if we admit that the observations may be somewhat imperfect for this component up to the region of the inner circle I whose radius is 250 km. There the

component u is much larger than expected in the upper strata, and this indicates some opposition to the free development of the vortex near the core. It is presumed that this implies a struggle to intrude into the rapid eastward drift, accompanied by a broadening of the vortex tube through the resistance, v being smaller than it should be, and u greater, making the angle of the inclination i much greater than it ought to be in pure vortex motion. As the computation of the vortex goes to the height of 10 miles, far beyond the altitude to which the ordinary cyclonic motion penetrates, this being only 3 or 4 miles in the moderate movements of the air, it is seen that v should theoretically attain enormous velocities very near the center. The difference between these and such as are actually observed may be regarded as measuring the energy expended in breaking up the cyclone in the higher levels, and which can be balanced only by retarding the movements of the general cyclone. The vertical velocity w is extraordinarily small from the bottom to the top, and in a measure justifies the method of discussing the motions of the air in the cyclone as a case of horizontal movement. It is impossible theoretically, however, that such a cyclonic motion without a vertical component should exist at all. The fact is that a slow vertical movement is acting over the very large area covered by the cyclone, and is sufficient to carry off all the air which flows into it through a thin disk at the outside in horizontal directions toward the center. The checks ϖv and $\varpi w = -2uz$ hold throughout the cyclone, thus proving that our data are at least approximately correct. The angle i, between the tangential direction and the current, theoretically becomes very small within 300 miles of the center. It was shown by the results of the observations that the movement at the cumulus level is much more rounded than in the lower strata, the difference being caused by the retardation of the air operating upon the surface irregularities of the ground. A congested or irregular inflow near the center will similarly increase the angle i, since the component u is increased and v diminished by it. The observations given on the weather maps do not record the conditions within 60 miles of the center with any definiteness. In hurricanes the core is about 30 miles broad and its boundary is quite sharp, which shows that the component v is highly developed while u is small. But the hurricane also penetrates to much greater altitudes, as already mentioned. Finally, the gradient shows that there is a slow change near the outer limit, but that it increases very rapidly on approaching close to the center.

THE SPECIAL FEATURES OF CHART 70.

The special features of the circulation indicated on Chart 70, which may be mentioned are as follows: (1) It is evident that this scheme avoids entirely the primary difficulties attending the FERREL and also the German types of circulation. Each of these divided the cyclone into two parts having special properties. FERREL divided his cyclone at a vanishing rotational velocity, $v=0$, which involved a circulation in opposite directions on either side of it; the German type consists of two parts, separated by a discontinuous movement at the circle of the maximum velocity for v. The pure vortex, on the other hand, has only one law to deal with, and that, too, the simplest of all, in accordance with which the motion is generated. (2) Neither of the other types provide for a true calm region at the center of the cyclone, commonly observed in hurricanes as the eye of the storm. FERREL'S formula 402*b* shows that v increases from the circle $R=0.707$ to the very center; the formula 450 and 471 show that the velocity v decreases gradually from the circle bounding the inner region toward the center, but does not vanish till reaching it. The construction here proposed indicates that since v is a function of the height z as well as of the radial distance ϖ, the air in streaming toward the center is gradually lifted above the ground by purely dynamic action, and leaves a core without gyratory circulation. (3) The chief physical difficulty in accounting for the origin of storms has been the exact cause of the assumed local vertical current in the inner part to which the rest of the circulation is tributary. Given such an ascending current and under the other prescribed conditions the FERREL type or the German type of circulation are entirely possible. But it is not in accordance with the facts of observation to discover any such cause except in the latent heat of precipitation. FERREL felt this difficulty himself, and although he finally adopted it as the source of energy in the local cyclone, he probably was never satisfied with it as a complete account of the origin of these air movements. Meteorologists have generally admitted that this theory is inadequate, especially in view of the fact that fully developed storms occur without any evolution of latent heat from the condensation of aqueous vapor. As a

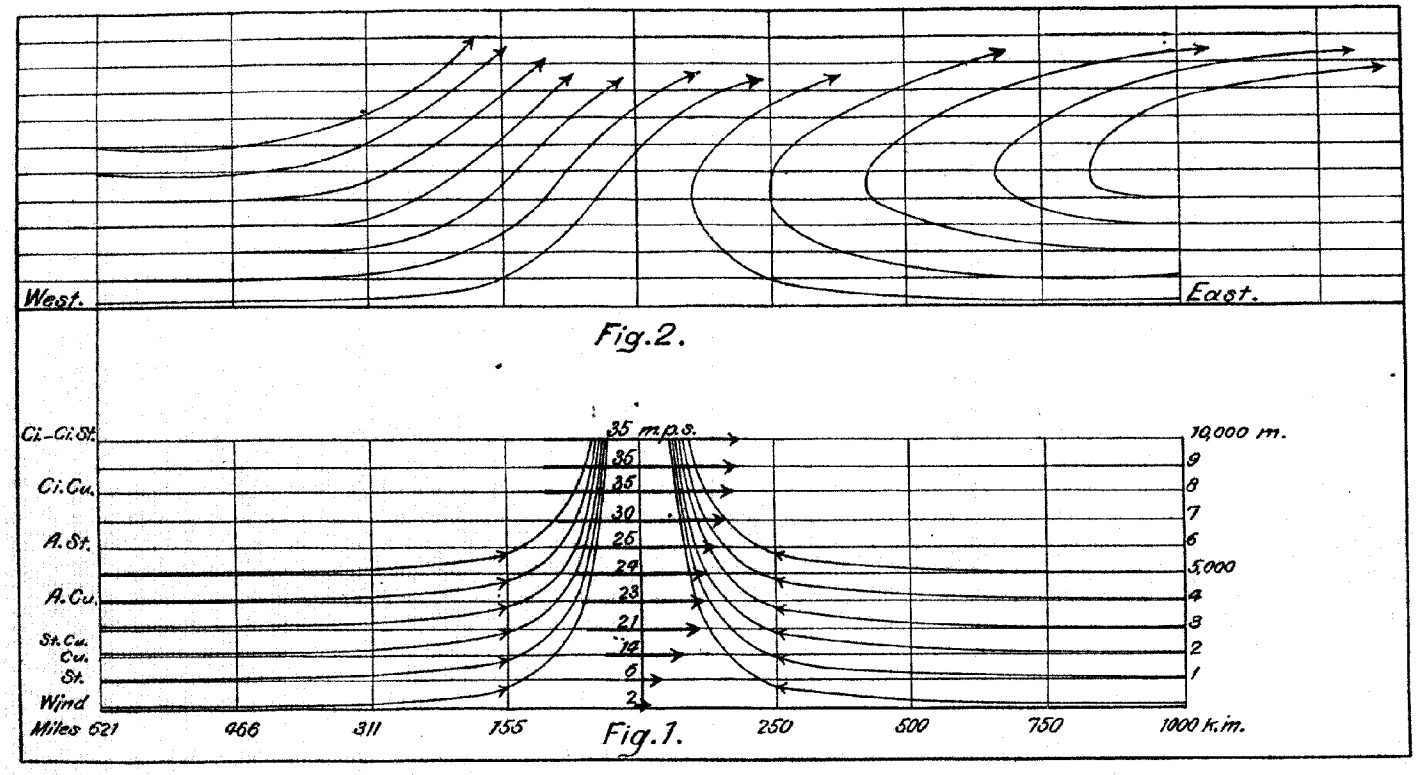

CHART 70.—General scheme of the structure of cyclones.

substitute proposition, it is now to be observed that the course of the stream lines moving toward the axis is continuously upward, being lifted by the mere mechanical action of the vortex motion, so that the tendency is for the air to expand, cool, and condense the aqueous vapor to the point of saturation. As already stated these currents depend upon long general gradients, having their most distant sources in the polar regions and the Tropics, respectively, or on the continents and the oceans, and they are not caused to any important extent by the sucking effect of a buoyant local central vertical current. Hence the vapor borne along in these currents from the south or the ocean is being gradually lifted to higher strata, and it is thus especially prepared to produce precipitation. The generation of latent heat, evolved during the formation of rain or snow of course assists the upward movement by its buoyancy, and thus supplements the cause of the cyclone, adding to its vigor, particularly so, when the cyclones form in the Gulf States or over the southern waters. (4) The approach of a moving particle to the axis of the cyclone is attended by an increase of the velocity of rotation, which accelerates rapidly as it passes into the upper strata. There it accomplishes the work of deflecting the eastward drift, and it expends some of its energy in that way. The result of this opposition to free motion is to spread out the top of the vortex, reduce its gyratory velocity, and change the relations of v_2 and u_2. In the undisturbed gyratory component v_2 becomes very great in comparison with u_2, and u_2 is always a small quantity. An inspection of Table 126 shows, however, that in the strata, from 5,000 to 10,000 meters the radial velocity u_2 is relatively large, and the angle of the inclination instead of being nearly 0° is from 25° to 35° on the inner circle II. This means that the original coefficient upon which the dimensions of the cyclone depend, namely $c=-\frac{2u}{\varpi}$, *does not remain a constant*, but it increases from the boundary toward the axis of the gyration.

$$C_{\text{I}}=.0000352=\frac{0.6}{1250000}$$

$$C_{\text{II}}=.0000053=\frac{4.0}{750000}$$

$$C_{\text{III}}=.0000005=\frac{8.8}{250000}$$

This involves an expenditure of energy in the struggle attendant upon intruding into the swiftly moving upper stratum. Furthermore, as was previously pointed out, page 607, FERREL'S theory of the slowing down of the excessive eastward velocities which would arise from the pure vortex law of the conservation of areas applied to the general cyclone is that friction is largely concerned with the operation. It seems, however, that a much more efficient cause of retardation is the interaction between these two types of motion, namely, the linear and the rotary, by which the lower strata thrust themselves into the higher. The effect is to enlarge the size of the vortex tube at the top by the resistance, deflect the eastward drift into sinuous curves, slow down the eastward velocity, and thus restrain the general cyclonic movement from excessive values. (5) The resultant of these component forces and velocities is to produce a circulation along the parallels of latitude which may be represented by Chart 70, fig. 2. The upper clouds of the cirrus region precede the cyclone proper as forerunners of this type of circulation; the lower clouds follow in succession, till precipitation is produced at the elevation of 1,000–3,000 meters; in very rapid circulations the eye of the storm is fully developed; the clearing up is more abrupt on the westward than on the eastward side of the cyclone. (6) The progressive movement of storms is partly an effect of the cyclone covering an area of sufficient extent to be in different latitudes so that variations in cos θ amount to something. But other circumstances are more important. On Table 33 it is seen that the northward components for the group of areas which are covered by the currents of air from the south are greater than those from the north. That is to say, the movement in the streams from the Tropics is more rapid than those from the polar regions, and the result is to roll up the eastward side of the cyclone to the north more than the westward to the south. The cyclone tends to rotate along the front of a high area toward the north. At the same time its top is fastened by means of the circulation into the eastward drift at 4,000 meters elevation, and these two components make the storm move northeastward in the central and eastern

portions of the United States. If the general cyclone has other directions, as when hurricanes form in the Caribean Sea, the same principles hold, and the storm there first moves westward, then northward and northeastward, because the general circulation is controlled in that region by the anticyclone in the southern portions of the North Atlantic Ocean. (7) It has been shown that the currents which feed the cyclone have different velocities at different altitudes, being greatest from 2,000–5,000 meters above the ground. Each stratum forms a stream for itself conforming to the general law, but modifies its dimensions according to the constants pertaining to the special locality. Since these different strata have thus distinct local movements, especially considering the variable temperatures and densities of the currents from the north and south respectively, it follows that the conditions are favorable for the formation of turbulent minor circulations of all kinds. The movement of the air is therefore partly congested, and partly runs in free whirls, the difference of equilibrium in temperature being thus gradually reduced to a proper value normal to the latitude and altitude by this forced intermingling of the subordinate parts of the cyclone. This process of restoring to an equilibrium the temperature of masses, bearing with them the status of the region from which they came, is generally accomplished by the time the 5,000-meter level is reached, judging from the records of the balloon observations. In summer, when the eastward drift is relatively slow, the pure vertical convective ascension may extend up to 10,000 meters. This is much more likely to happen on the eastward than on the westward side of a cyclone, because the vortex components throw back the eastward movement upon itself, and thus make the strata more stagnant in vertical directions. It has also been found practically very difficult to make the kites fly on the east of the low center, the best ascensions being made on the southerly and westerly quadrants. (8) The entire problem of analyzing the movements of the air in their details is so exceedingly complicated that only slow improvements in dynamic meteorology can be expected. A clearer idea of the fundamental conditions may, however, enable us to advance more rapidly than is expected. It will be a very important gain if meteorology can free itself from some of the theories which have so long prevailed, but which now are seen to be quite untenable.

THE VELOCITIES IN TORNADOES.

The motions in tornadoes are of course similar, yet the tube is not only inverted in position, but the stream lines occupy only the central portions, and the lines of ψ become tangent to the plane whose height is H_0 at distances from the center. The fundamental equations for the tornado are 303–308. $\psi=+\frac{c}{2}\varpi^2 z$ holds for the tornado with vertical axis positive downward, and the single bounding plane at the distance H_0 above the ground. $\psi=-\frac{c}{2}\varpi^2 z$ is the equation for the cyclone with the vertical axis positive upward. A multitude of minor relations and comparisons can be drawn from the two sets of equations 303–308 and 488–490. If Chart 70, fig. 1, be looked at as if the horizontal axis were the vertical, we have a picture of the tornado tube. The diagram is not good because not drawn to scale, but the idea is easily understood. Hence, one law serves for all types of local storms, cyclones, hurricanes, and tornadoes, which thus theoretically differ from each other only in their dimensions and in the process by which they are formed. Cyclones are generated chiefly by horizontal convection currents; hurricanes have a strong vertical convection current and also horizontal convection currents; tornadoes arise chiefly from vertical convection, assisted by some horizontal currents which counterflow in the cumulus levels.

It may be remarked that the stream lines indicated by FERREL, page 300, Recent Advances, are conjectural only, and do not conform to the theory of stream lines in a vertical vortex tube, nor to experience, which shows that the air is quiet close up to the boundary of the tornado tube.

We shall postpone more complete computations on the cyclone, hurricane, and tornado till time permits us to perfect some of the data which have been collected for that purpose, because this detailed discussion would overrun the limit of this report.

The theory which has thus been drawn from the cloud observations substantiates closely the outline of the circulation of the air in middle latitudes, sketched in Bulletin No. 20, Storms, Storm Tracks, and Weather Forecasting. (W. B. No. 114, 1897.) The connection between the

solar magnetic field and storm action, of which the evidence, though not very satisfactory, is persistent and cumulative, needs to be further worked out, but this can not be finally done until a suitable series of magnetic observations has been made on the North American Continent.

THE WATERSPOUT OFF COTTAGE CITY, AUGUST 19, 1896.

The result of the computation on this interesting waterspout is added and it shows the dimensions and velocities in metric and English measures which were derived from the observed distances and the formulæ. The most interesting feature is the value of the vertical velocity of 35 miles per hour at the sea level.

TABLE 128.—*Dimensions and velocities in the waterspout off Cottage City, Vineyard Sound, Mass., August 19, 1896.*

Working formulæ: $v^2=2gz$; $u=\frac{v}{z}$; $w=\frac{2v}{\varpi}$; $\varpi v=\text{Const.}$; $2zu=\varpi w$; $\frac{c}{z}=\frac{4g}{v\varpi}$.

Dimensions in meters.			Velocities in meters per second.				Dimensions in feet.			Velocity in miles per hour.		
h	z	ϖ	u	v	w	$2zu=\varpi w$	h	z	ϖ	u	v	w
1280	0	∞	—	0	0	0	4200	0	∞	—	0	0
1278	2	518.4	3.13	6.26	0.02	12.53	4193	7	1701	7.0	14.1	0.04
1189	91	76.9	0.46	42.24	1.10	84.49	3901	299	253	1.0	94.4	2.5
1097	183	60.8	0.29	53.39	1.76	106.79	3599	601	200	0.6	119.5	3.9
1006	274	44.3	0.27	73.31	3.31	146.61	3301	899	145	0.6	164.	7.4
914	366	38.3	0.23	84.72	4.42	169.45	2999	1201	125	0.5	189.	9.9
731	549	31.3	0.19	103.77	6.63	207.53	2398	1802	102	0.4	233.	14.9
549	731	27.1	0.16	119.73	8.83	239.47	1802	2398	89	0.4	268.	19.8
457	823	25.5	0.15	127.04	9.94	254.10	1499	2701	84	0.3	284.	22.2
366	914	24.3	0.15	133.89	11.04	267.78	1201	2999	79	0.3	300.	24.7
183	1097	22.1	0.13	146.68	13.25	293.36	601	3599	72	0.3	328.	29.6
146	1134	21.8	0.13	149.13	13.70	298.26	479	3721	72	0.3	333.	29.7
0	1280	20.5	0.13	158.44	15.46	316.89	0	4200	67	0.3	354.	34.6

$c=0.01208$

CHAPTER 12.

DISCUSSION OF THE CUMULUS AND CUMULO-NIMBUS CLOUDS.

GENERAL REMARKS.

The general cloud types can generally be separated into two divisions, (1) the cumulus clouds, which are formed by vertical convection—that is, the transportation of air from one level to another; and (2) the stratus clouds, which are due usually to the flowing of two currents of air over each other, while the temperatures are different in the adjacent layers. The former type indicates an effort to restore the normal equilibrium proper to the season and the locality by carrying the excess of heat from lower to higher levels; the latter shows that there is a stratified condition of the atmosphere, with strata of distinctly different temperatures, which are being transported by horizontal convection gradients from one place to another. The two processes include all the general actions that operate in the readjustment of temperature equilibrium when the differences have been caused originally by insolation and radiation.

The several intermediate types are evidently caused by the interaction of these primary processes in greater or less proportions, and it is not difficult to analyze them approximately on this basis. The alto-cumulus type indicates the presence of a warm stratum at a high level, within which vertical convection occurs to a moderate amount; the ordinary cumulus must be the result of more extensive vertical movements, and these occur in the warm parts of the day, especially in the summer, when there is much heat accumulated by insolation at the surface to be disposed of in a higher stratum; the cumulo-nimbus are caused by exaggerated heat conditions in the lower levels, and the towering domes with boiling vortex motions so characteristic of them show also that the general circulation is on such occasions quite stagnant from the ground to the cirrus region, and that the eastward drift is then locally much diminished, which condition occurs chiefly in the hot days of the summer.

If the preceding chapter was concerned for the most part with the horizontal convective movements of the air and the production of cyclonic circulations, we shall devote this one to a study of the vertical convection, the product of which is the cumulus and cumulo-nimbus clouds, with local showers, thunderstorms, and occasionally tornadoes. The descriptive narrative of the characteristics of these several types of clouds have been so fully worked out by other authors that we may properly confine ourselves to the discussion of some of the questions of physics which enter specifically into their production. It is very desirable that an accurate method should be devised which can be utilized by meteorologists in bringing the observations into a strictly scientific form of discussion, especially with the view of multiplying such studies in the future and finally extracting from them very precise data regarding the pressures, temperatures, and vapor tensions in the different levels and the gradients which connect them. While the following results give very approximate values regarding these quantities, yet it is to be expected that improvements can be made by further experience. It will be seen that the theodolite observations and the kite ascensions have each done good service, and that they mutually supplement the deficiencies of the respective methods to a considerable extent. A prosecution of such studies will doubtless enable us to construct quite accurate daily weather maps at the 3,500-foot level and also at the 10,000-foot level, even if the present data is not already exact enough for that purpose.

THE METEOROLOGICAL DATA FOR WASHINGTON, D. C., ON THE DATES WHEN CLOUDS WERE OBSERVED.

As a foundation for the discussion just mentioned we have first collected together the surface conditions of the pressure, temperature, and vapor tension at the hours 8 a. m., 2 p. m., 8 p. m. on all the dates during which any of the cloud types were observed at Washington, D. C., during the interval of time from May 1, 1896, to July 1, 1897, covering the fourteen months. Properly this data should be given for the exact hour when the cloud was observed and included in the journal of the daily observations, but the method shown by Table 129 is substituted for it in order to economize space in publication, and in fact for greater convenience in reference. It is easy to interpolate the intermediate values with sufficient precision for the purposes of our computation, especially in view of the fact that we shall deal generally with the mean values of all those days in the month when observations of a given type of cloud were made, rather than with individual clouds. A few of these are computed as individuals in the cumulo-nimbus type, for the sake of discovering the conditions prevailing at the top of the towering domes, and in that case the special surface conditions prevailing at the hours of observation were extracted from the proper records.

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites.*

Dates	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1896												
May 6	30.10	63.0	54.0	.318	30.15	56.0	49.5	.280	30.20	62.8	56.5	.386
	764.5	**17.2**	**12.2**	**8.03**	**765.8**	**13.3**	**10.2**	**7.72**	**767.1**	**17.1**	**13.6**	**9.80**
7	30.41	50.5	46.0	.259	30.31	63.0	52.0	.264	30.36	57.5	51.0	.300
	772.4	**10.4**	**7.8**	**6.53**	**770.9**	**17.2**	**11.1**	**6.71**	**771.2**	**14.2**	**10.6**	**8.18**
8	30.38	52.0	49.5	.325	30.31	64.0	.....	.....	30.24	61.5	54.0	.335
	771.7	**11.1**	**9.7**	**8.23**	**769.9**	**17.8**	.....	.....	**768.1**	**16.6**	**12.2**	**8.34**
9	30.20	56.0	50.5	.306	30.05	87.5	69.0	.501	29.99	82.0	66.0	.460
	767.1	**13.3**	**10.2**	**7.73**	**763.3**	**30.8**	**20.6**	**12.82**	**761.8**	**27.8**	**18.9**	**12.29**
11	29.95	76.5	65.0	.488	29.89	91.5	68.0	.422	29.87	84.8	65.8	.423
	760.7	**24.7**	**18.3**	**12.39**	**759.2**	**33.0**	**20.0**	**10.75**	**758.7**	**29.3**	**18.8**	**10.80**
12	29.94	70.5	64.5	.540	29.94	86.0	66.0	.416	29.98	70.0	65.5	.577
	760.5	**21.4**	**18.0**	**13.61**	**760.5**	**30.0**	**18.9**	**10.62**	**761.5**	**21.1**	**18.6**	**14.66**
13	30.05	68.5	63.5	.530	30.05	77.8	66.2	.415	30.06	70.0	65.0	.561
	763.3	**20.2**	**17.5**	**13.49**	**763.3**	**25.4**	**19.0**	**13.08**	**763.5**	**21.1**	**18.3**	**14.57**
14	30.05	63.0	61.5	.528	29.96	74.0	69.0	.652	29.91	74.5	70.5	.700
	763.3	**17.2**	**16.4**	**13.46**	**760.7**	**23.3**	**20.6**	**16.66**	**759.7**	**23.6**	**21.4**	**17.81**
15	30.01	74.0	64.0	.484	30.09	81.0	.....	.....	30.10	75.5	57.0	.258
	762.3	**23.3**	**17.8**	**12.35**	**764.3**	**27.2**	.....	.....	**764.5**	**24.2**	**13.9**	**6.55**
16	30.26	67.0	56.0	.325	30.16	77.0	57.5	.254	30.11	74.0	61.5	.406
	768.6	**19.4**	**13.3**	**8.25**	**766.1**	**25.0**	**14.2**	**7.52**	**764.8**	**23.3**	**16.4**	**10.35**
18	30.00	71.0	62.5	.471	29.90	91.0	68.0	.428	29.92	67.0	65.0	.594
	762.0	**21.7**	**17.0**	**12.03**	**759.5**	**32.8**	**20.0**	**10.84**	**757.4**	**19.4**	**18.3**	**15.06**
19	29.95	73.0	66.0	.561	29.88	70.0	.....	.....	29.94	78.0	65.0	.472
	758.2	**22.8**	**18.9**	**14.25**	**759.0**	**21.1**	.....	.....	**760.5**	**25.5**	**18.3**	**11.98**
22	30.10	68.0	67.0	.650	30.06	76.0	71.8	.732	30.07	74.0	70.0	.688
	764.5	**20.0**	**19.4**	**16.43**	**763.5**	**24.4**	**21.1**	**16.90**	**763.8**	**23.3**	**21.1**	**17.47**
26	29.97	69.5	67.5	.650	29.89	80.0	71.5	.676	29.88	71.0	67.0	.617
	761.2	**20.8**	**19.7**	**16.48**	**759.2**	**26.7**	**22.0**	**16.26**	**759.0**	**21.7**	**19.4**	**15.57**
27	30.01	70.0	66.0	.594	30.01	79.0	65.0	.460	29.99	72.0	64.0	.507
	762.3	**21.1**	**18.9**	**15.11**	**762.3**	**25.9**	**18.3**	**11.76**	**761.8**	**22.3**	**17.8**	**12.87**
28	29.90	70.0	68.0	.662	29.70	85.5	73.5	.692	29.73	69.0	67.5	.655
	759.5	**21.1**	**20.0**	**16.80**	**754.4**	**29.7**	**23.0**	**17.49**	**755.1**	**20.5**	**19.7**	**16.12**
29	29.96	65.0	56.0	.349	29.96	73.0	58.0	.315	29.97	69.0	56.0	.304
	761.0	**18.3**	**13.3**	**8.84**	**761.0**	**22.8**	**14.4**	**7.93**	**761.2**	**20.6**	**13.3**	**7.66**
June 1	30.03	60.5	53.0	.319	30.05	72.0	57.6	.315	30.06	67.0	56.5	.339
	762.8	**15.8**	**11.7**	**8.15**	**763.3**	**22.2**	**14.2**	**7.97**	**763.5**	**19.4**	**13.6**	**8.64**
2	30.20	63.0	54.0	.317	30.19	71.7	57.0	.302	30.18	66.5	58.0	.387
	767.1	**17.2**	**12.2**	**8.02**	**766.8**	**22.0**	**13.9**	**7.67**	**766.6**	**19.1**	**14.4**	**9.81**
3	30.27	63.5	57.5	.406	30.22	74.0	60.0	.360	30.17	70.0	62.5	.481
	768.9	**17.4**	**14.2**	**10.40**	**767.6**	**23.3**	**15.6**	**9.24**	**766.3**	**21.1**	**17.0**	**12.32**
4	30.17	61.0	59.0	.477	30.12	66.0	64.0	.573	30.11	65.5	63.5	.563
	766.3	**16.1**	**15.0**	**12.10**	**765.1**	**18.9**	**17.8**	**14.57**	**764.8**	**18.6**	**17.5**	**14.29**
5	30.14	67.0	64.5	.578	30.15	73.8	65.8	.545	30.10	66.5	63.0	.536
	765.6	**19.4**	**18.1**	**14.76**	**765.8**	**23.2**	**18.8**	**13.39**	**764.5**	**19.2**	**17.2**	**12.56**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites.*

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu.	Ci. S.	Ci.				
.....	2	.....	.....	.....	.....	.....	.....	.....	4	3–20	.....	NW	2
.....	2	.....	.....	.....	.....	.....	.....	.....	.....	3–20	.....	W	3
.....	.....	.....	.....	4	.....	9	.....	.....	.....	3–4	.....	W	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	16	6–9	.....	NW	3
.....	8	.....	.....	.....	.....	.....	6	.....	8	6–16	.....	NE	7
.....	.....	.....	10	.....	.....	13	.....	.....	12	2–13	3–20	NE	2
.....	9	.....	2	.....	.....	9	5	.....	.....	3–5	.....	W	2
.....	.....	.....	.....	.....	.....	.....	10	.....	.....	3–12	2–15	NW	4
.....	9	.....	.....	.....	.....	.....	.....	.....	11	6–7	.....	NE	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	14	6–4	.....	W	2
.....	.....	.....	7	7	.....	7	.....	.....	4	6–17	3–20	NE	4
.....	2	.....	.....	3	3	.....	.....	2	2	6–16	3–20	NE	3
.....	.....	.....	17	.....	.....	5	8	.....	.....	6–9	3–20	N	3
.....	4	.....	.....	2	.....	8	.....	13	10	6–17	2–13	N	9
.....	5	.....	.....	9	6	.....	.....	.....	.....	.....	3–20	NE	3
.....	7	.....	8	5	.....	.....	.....	.....	4	.....	2–6	NW	9
.....	4	.....	.....	.....	.....	.....	.....	.....	.....	5–15	5–13	N	1
.....	4	.....	.....	3	.....	3	4	.....	6	.....	5–16 3–20	NE	5
.....	.....	.....	.....	.....	11	.....	.....	.....	21	2–6	.....	NE	5
.....	9	.....	.....	9	.....	2	.....	21	.....	3–4	.....	SW	3
2	.....	.....	.....	.....	.....	.....	.....	.....	.....	6–4	.....	W	2
.....	10	.....	.....	.....	.....	.....	.....	.....	.....	3–1	2–14	NW	2

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1896												
June 9	29.71	69.0	67.5	.655	29.63	77.0	68.5	.602	29.61	68.0	65.5	.599
	754.6	**20.6**	**19.5**	**16.27**	**752.6**	**25.0**	**20.2**	**15.18**	**752.1**	**20.0**	**18.6**	**15.22**
10	29.60	68.0	64.5	.568	29.65	76.5	66.0	.523	29.74	69.3	63.3	.516
	751.8	**20.0**	**18.1**	**14.48**	**753.1**	**24.7**	**18.9**	**13.32**	**755.4**	**20.7**	**17.4**	**13.10**
12	29.80	67.5	57.0	.349	29.70	81.5	61.5	.324	29.66	75.3	63.3	.449
	756.9	**19.7**	**13.9**	**8.90**	**754.4**	**27.5**	**16.4**	**8.27**	**753.4**	**24.1**	**17.4**	**11.41**
13	29.69	68.0	64.0	.552	29.72	72.3	65.8	.563	29.75	62.0	60.0	.495
	754.1	**20.0**	**17.8**	**14.14**	**754.9**	**22.4**	**18.8**	**14.02**	**755.7**	**16.7**	**15.6**	**12.60**
15	30.26	60.0	56.5	.416	30.23	68.5	62.5	.499	30.24	66.5	60.0	.444
	768.6	**15.6**	**13.6**	**10.55**	**767.8**	**20.3**	**16.9**	**12.57**	**768.1**	**19.2**	**15.6**	**11.33**
16	30.23	63.0	62.0	.544	30.15	72.5	67.5	.617	30.12	67.0	65.0	.561
	767.8	**17.2**	**16.7**	**13.86**	**765.8**	**22.5**	**19.7**	**15.62**	**765.1**	**19.4**	**18.3**	**15.05**
17	30.07	68.0	66.5	.632	30.01	74.5	68.5	.629	29.98	71.0	68.0	.651
	763.8	**20.0**	**19.2**	**16.11**	**762.3**	**23.6**	**20.3**	**16.02**	**761.5**	**21.7**	**20.0**	**16.51**
18	30.02	64.5	63.5	.574	30.03	79.4	69.0	.592	30.02	75.0	71.0	.713
	762.5	**18.1**	**17.5**	**14.56**	**762.8**	**26.3**	**20.6**	**15.13**	**762.5**	**23.9**	**21.7**	**18.16**
19	30.08	72.5	70.0	.704	30.03	84.0	70.0	.576	29.99	80.0	71.5	.676
	764.0	**22.5**	**21.1**	**17.86**	**762.8**	**28.9**	**21.1**	**14.62**	**761.8**	**26.7**	**21.9**	**17.09**
20	30.05	76.0	70.5	.683	30.01	90.3	72.0	.580	30.00	83.0	74.5	.758
	763.3	**24.4**	**21.4**	**17.39**	**762.3**	**32.4**	**22.2**	**14.69**	**762.0**	**28.3**	**23.6**	**19.26**
22	29.93	76.5	70.0	.660	29.93	80.0	72.5	.714	29.89	78.0	73.5	.774
	760.2	**24.7**	**21.1**	**16.76**	**760.2**	**26.7**	**22.5**	**18.12**	**759.2**	**25.6**	**20.1**	**14.70**
23	30.07	72.0	60.0	.384	30.09	76.0	63.0	.431	30.10	74.0	63.0	.453
	763.8	**22.2**	**15.6**	**9.82**	**764.3**	**24.4**	**17.2**	**10.92**	**764.5**	**23.3**	**17.2**	**11.52**
24	30.17	66.0	62.2	.517	30.16	70.5	65.0	.555	30.15	68.0	67.0	.650
	766.3	**18.9**	**16.8**	**13.09**	**766.1**	**21.4**	**18.3**	**13.99**	**765.8**	**20.0**	**19.4**	**16.42**
26	30.18	68.6	68.0	.660	30.09	84.0	76.0	.808	30.09	70.3	68.8	.684
	766.6	**20.3**	**20.0**	**17.20**	**764.3**	**28.9**	**24.4**	**20.41**	**764.3**	**21.3**	**20.4**	**17.34**
27	30.14	71.1	64.0	.517	30.04	79.0	65.0	.460	29.94	76.0	68.5	.612
	765.6	**21.7**	**17.8**	**13.16**	**763.0**	**25.9**	**17.3**	**10.29**	**760.5**	**24.4**	**20.5**	**15.94**
29	29.92	73.6	66.0	.555	29.95	84.1	67.5	.488	30.04	77.0	63.5	.435
	760.0	**23.1**	**18.9**	**14.10**	**760.7**	**28.9**	**19.7**	**12.38**	**763.0**	**25.0**	**17.5**	**11.05**
30	30.28	70.0	57.0	.319	30.26	79.0	61.0	.333	30.25	74.0	60.0	.360
	769.1	**21.1**	**13.9**	**8.12**	**768.6**	**26.1**	**16.1**	**8.46**	**768.4**	**22.8**	**15.6**	**9.49**
July 1	30.30	71.2	66.3	.591	30.24	83.0	69.5	.569	30.23	79.0	69.0	.595
	769.6	**21.8**	**19.1**	**15.04**	**768.1**	**28.3**	**20.8**	**14.26**	**767.8**	**26.1**	**20.6**	**15.25**
2	30.25	71.0	65.5	.566	30.18	85.0	65.0	.391	30.13	80.5	69.0	.579
	768.4	**21.7**	**18.6**	**14.28**	**766.6**	**29.4**	**18.3**	**15.06**	**765.3**	**26.9**	**20.6**	**14.82**
3	30.17	74.0	70.0	.688	30.09	86.0	71.0	.589	30.10	73.0	70.5	.716
	766.3	**23.3**	**21.1**	**17.46**	**764.3**	**30.0**	**21.7**	**15.05**	**764.5**	**22.8**	**21.4**	**18.21**
6	29.97	74.0	71.2	.732	29.93	82.5	76.0	.824	29.94	73.8	71.8	.757
	761.2	**23.3**	**21.8**	**18.63**	**760.2**	**28.1**	**24.4**	**20.82**	**760.5**	**23.2**	**22.1**	**19.19**
7	29.95	73.5	72.0	.766	29.93	82.0	74.0	.750	30.00	71.5	66.0	.577
	760.5	**23.1**	**22.2**	**19.42**	**760.2**	**28.8**	**23.3**	**18.47**	**762.0**	**21.9**	**18.9**	**14.70**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu	Ci. S.	Ci.				
.....	.....	.....	.....	.....	4	5	.....	.....	.....	6-17	3-5	N	2
.....	26	.....	8	.....	3	.....	.....	.....	4	2-14	3-12	NE	8
.....	.....	.....	.....	.....	.....	.....	6	.....	15	.....	3-20	NE	5
.....	.....	.....	.....	9	.....	.....	.....	.....	.....	.....	6-3	E	2
2	4	.....	.....	4	.....	5	.....	.....	2	6-1	.....	W	1
1	6	.....	4	.....	.....	5	.....	.....	.....	6-4	.....	NW	1
.....	7	.....	1	.....	.....	13	5	.....	.....	3-11	.....	NW	1
.....	11	.....	.....	.....	.....	6	10	4	6	6-2	.....	NW	1
.....	17	.....	.....	3	.....	15	.....	.....	4	6-9	2-14	NW	2
.....	26	.....	.....	.....	.....	.....	.....	.....	2	6-9	3-20	NE	3
.....	3	.....	.....	4	2	23	4	3	2	6-9	3-20	NE	3
.....	.....	.....	.....	11	9	4	9	.....	5	2-6 6-9	.....	NE	2
2	3	7	.....	.....	.....	.....	.....	.....	.....	3-12	.....	NW	3
.....	4	.....	7	2	5	9	6	3	.....	6-16 2-15	3-20	NE	4
.....	.....	.....	.....	4	.....	16	4	5	5	2- 2	.....	NE	3
.....	23	.....	.....	.....	.....	4	.....	.....	4	.....	3-20	NE	4
.....	.....	.....	.....	.....	.....	.....	3	9	20	6- 2	.....	NE	2
.....	21	.....	.....	.....	.....	.....	.....	.....	12	6- 3	.....	NE	2
.....	.....	.....	.....	.....	2	7	11	4	17	6- 3	.....	W	3
.....	2	.....	18	3	.....	8	.....	.....	.....	6- 9 3-20	.....	W	2
.....	10	.....	2	.....	.....	4	3	.....	3	6- 9	2- 5	N	2
.....	.....	.....	14	6	.....	3	.....	.....	.....	2-15	6-16 3-13	N	1

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1896												
July 9	30.10	74.0	72.4	.777	30.12	81.0	73.0	.722	30.14	78.0	71.5	.698
	764.5	**23.3**	**22.4**	**19.65**	**765.1**	**27.2**	**22.8**	**17.38**	**765.6**	**25.6**	**21.9**	**17.63**
10	30.29	73.2	72.0	.770	30.27	80.0	72.5	.713	30.24	74.0	71.5	.742
	769.4	**22.9**	**22.2**	**19.51**	**768.9**	**26.7**	**22.5**	**18.10**	**768.1**	**23.3**	**21.9**	**18.79**
11	30.25	74.2	71.0	.722	30.22	84.5	69.5	.552	30.18	80.0	72.0	.694
	768.4	**23.4**	**21.7**	**18.47**	**767.6**	**29.2**	**20.8**	**13.94**	**766.6**	**26.7**	**22.2**	**17.59**
13	30.04	78.5	71.0	.674	30.00	88.0	71.0	.568	29.95	83.5	73.5	.713
	763.0	**25.8**	**21.7**	**17.14**	**762.0**	**31.1**	**21.7**	**14.50**	**760.7**	**28.6**	**23.1**	**18.21**
14	29.99	78.5	72.5	.732	29.97	87.0	74.0	.694	29.91	77.8	74.8	.828
	761.8	**25.8**	**22.5**	**18.57**	**761.2**	**30.6**	**23.3**	**17.86**	**759.7**	**25.4**	**23.8**	**21.08**
15	29.87	79.3	74.3	.791	29.78	86.2	75.5	.765	29.76	82.0	80.0	1.000
	758.7	**26.3**	**23.5**	**20.09**	**756.4**	**30.1**	**24.2**	**19.46**	**759.9**	**28.8**	**26.7**	**24.90**
16	29.79	76.0	71.0	.702	29.87	70.0	68.0	.662	29.90	68.5	65.0	.577
	756.7	**24.4**	**21.7**	**17.91**	**758.7**	**21.1**	**20.0**	**16.75**	**759.5**	**20.3**	**18.3**	**14.61**
17	30.11	66.0	58.0	.394	30.14	75.3	61.0	.377	30.20	69.0	61.0	.447
	764.8	**18.9**	**14.4**	**9.91**	**765.6**	**23.9**	**16.2**	**9.75**	**767.1**	**20.6**	**16.1**	**11.32**
18	30.34	68.5	59.0	.393	30.33	78.0	63.0	.407	30.32	75.0	63.5	.456
	770.6	**20.3**	**15.0**	**9.96**	**770.4**	**25.6**	**17.2**	**10.27**	**770.1**	**23.9**	**17.5**	**11.59**
20	30.17	77.6	73.2	.772	30.07	86.2	75.2	.750	30.05	82.0	75.0	.789
	766.3	**25.3**	**22.9**	**19.51**	**763.8**	**30.1**	**24.0**	**19.00**	**763.5**	**28.8**	**23.9**	**19.54**
21	30.09	78.0	73.5	.774	30.10	83.2	76.0	.817	30.06	76.5	74.0	.810
	764.3	**25.6**	**23.1**	**19.76**	**764.5**	**28.4**	**24.4**	**20.66**	**763.5**	**24.7**	**23.3**	**20.53**
22	30.10	75.5	74.0	.821	29.92	87.0	77.0	.815	29.87	78.0	74.5	.813
	764.5	**24.2**	**23.3**	**20.78**	**760.0**	**30.6**	**25.0**	**20.70**	**758.7**	**25.6**	**23.6**	**20.62**
23	29.96	76.8	70.0	.658	30.04	80.0	62.6	.374	30.07	75.5	64.0	.467
	761.0	**24.9**	**21.1**	**16.66**	**763.0**	**26.7**	**17.0**	**9.47**	**763.8**	**24.2**	**17.8**	**11.90**
24	30.01	70.0	65.0	.561	29.89	68.0	68.0	.684	29.79	73.0	71.5	.753
	762.3	**21.1**	**18.3**	**14.21**	**759.2**	**20.0**	**20.0**	**17.36**	**756.7**	**22.8**	**21.9**	**19.06**
25	30.00	69.5	63.0	.502	30.08	77.0	64.0	.451	30.10	74.5	66.0	.544
	762.0	**20.8**	**17.2**	**12.75**	**764.0**	**25.0**	**17.8**	**12.48**	**764.5**	**23.6**	**18.9**	**13.84**
27	30.03	75.1	71.0	.712	29.95	92.8	81.0	.926	29.90	86.5	80.0	.950
	762.8	**23.9**	**21.7**	**18.16**	**760.7**	**33.8**	**27.2**	**23.45**	**759.5**	**30.3**	**26.7**	**24.18**
28	30.04	78.2	70.6	.664	30.06	89.8	77.0	.785	30.03	80.3	76.3	.861
	763.0	**25.7**	**21.4**	**16.74**	**763.5**	**32.1**	**25.0**	**19.92**	**762.8**	**26.8**	**24.6**	**21.85**
29	30.11	78.0	74.5	.813	30.06	90.0	77.5	.802	30.01	78.0	75.0	.838
	764.8	**25.6**	**23.6**	**20.61**	**763.5**	**32.2**	**25.3**	**20.44**	**762.3**	**25.6**	**23.9**	**21.16**
30	29.96	77.8	71.3	.671	29.91	87.0	74.8	.726	29.88	81.0	70.0	.610
	761.0	**25.6**	**21.8**	**17.47**	**759.7**	**30.6**	**23.7**	**18.43**	**759.0**	**27.2**	**21.1**	**15.50**
31	30.00	76.0	69.0	.630	30.07	81.2	67.0	.503	30.11	73.0	61.0	.402
	762.0	**24.4**	**20.6**	**16.10**	**763.8**	**27.3**	**19.4**	**12.72**	**764.8**	**22.8**	**16.1**	**10.20**
Aug. 1	30.22	67.0	61.0	.470	30.12	77.8	65.8	.501	30.00	75.0	66.5	.555
	767.6	**19.4**	**16.1**	**11.91**	**765.1**	**25.4**	**18.8**	**12.77**	**762.0**	**23.9**	**19.2**	**14.15**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu.	Ci. S.	Ci.				
.....	23	3	.....	.....	3	14	1	.....	3	3-11 2-15	2- 7	NW	5
1	15	.....	.....	.....	2	10	3	.....	.....	6- 9	.....	NW	3
.....	6	.....	.....	.....	4	10	11	.....	22	6- 9	.....	N	3
.....	16	.....	.....	.....	.....	.....	4	4	11	6-16	.....	NE	4
.....	*6 7	.....	.....	.....	2	16	6	.....	3	6-16 2- 5	3-19	NE	2
.....	.....	.....	10	8	4	2	.....	.....	2	6-16	3-13	N	4
.....	.....	.....	.....	.....	.....	6	.....	.....	.....	2-14	.....	NE	3
.....	30	.....	.....	.....	.....	.....	.....	.....	.....	6-16 2- 6	.....	E	3
.....	8	.....	.....	.....	.....	3	6	.....	20	3-20	.....	NW	1
.....	3	.....	.....	.....	5	20	9	7	2	6- 9	2-14	NW	5
.....	3	3	6	6	9	4	2	.....	.....	6- 9	3-20	NE	3
1	9	.....	.....	7	3	13	3	.....	7	6-16	2-14	N	3
.....	.....	.....	.....	.....	.....	.....	16	.....	12	6-16	3-20	NE	5
.....	1	.....	.....	7	5	.....	.....	.....	3	6-16	2- 7	NW	5
1	30	.....	.....	.....	4	4	2	.....	.....	6-16 2-15	3-11	NE	5
.....	12	.....	.....	.....	1	11	4	12	3	.....	2-14	N	3
.....	2	.....	5	5	1	6	11	.....	6	6-16	.....	NE	2
.....	6	.....	19	.....	.....	9	.....	.....	12	6-16	.....	NE	1
.....	.....	.....	3	1	3	23	4	.....	3	.....	3-13	N	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	3	2-13	3-20	NE	4
.....	.....	.....	.....	9	.....	7	.....	.....	.....	6- 4	2-15	W	4

* M Cu.

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1896												
Aug. 3	30.02	76.0	69.2	.638	30.03	84.0	71.0	.613	30.02	80.2	70.7	.643
	762.5	**24.4**	**20.7**	**16.25**	**762.8**	**28.9**	**21.7**	**15.62**	**762.5**	**26.8**	**21.5**	**16.36**
4	30.09	74.3	70.8	.713	30.06	89.0	72.2	.603	30.01	82.0	74.0	.750
	764.3	**23.5**	**21.6**	**18.20**	**763.5**	**31.7**	**22.3**	**15.21**	**762.3**	**28.8**	**23.3**	**18.46**
6	30.08	80.3	74.8	.800	30.08	96.7	77.0	.707	30.05	87.5	76.0	.768
	764.0	**26.3**	**23.8**	**20.62**	**764.0**	**36.0**	**25.0**	**17.90**	**763.3**	**30.8**	**24.4**	**19.45**
7	30.06	80.0	74.0	.772	30.00	95.0	75.0	.643	29.99	84.5	74.5	.741
	763.5	**26.7**	**23.3**	**19.51**	**762.0**	**35.0**	**23.9**	**21.46**	**761.8**	**29.2**	**23.6**	**18.80**
8	30.04	80.0	73.5	.752	30.00	91.0	76.0	.729	29.98	86.8	76.8	.809
	763.0	**26.7**	**23.1**	**19.15**	**762.0**	**32.8**	**24.4**	**18.43**	**761.5**	**30.4**	**24.9**	**20.60**
10	30.06	84.0	72.0	.650	30.04	91.6	78.0	.807	30.03	77.2	73.0	.764
	763.5	**28.9**	**22.2**	**16.47**	**763.0**	**33.1**	**25.6**	**20.57**	**762.8**	**25.1**	**22.8**	**19.45**
11	30.02	80.0	74.0	.772	30.02	91.0	74.3	.662	30.02	84.5	75.5	.782
	762.5	**26.7**	**23.3**	**19.52**	**762.5**	**32.8**	**23.5**	**16.77**	**762.5**	**29.2**	**24.2**	**19.89**
12	30.07	82.0	73.0	.711	30.03	93.0	76.0	.707	30.02	88.5	77.5	8.19
	763.8	**28.8**	**22.8**	**17.56**	**762.8**	**33.9**	**24.4**	**17.86**	**762.5**	**31.4**	**25.3**	**20.85**
13	30.06	78.8	73.0	.747	30.01	93.0	76.0	.707	30.07	70.2	70.2	.737
	763.5	**26.0**	**22.8**	**18.98**	**762.5**	**33.9**	**24.4**	**17.86**	**763.8**	**21.2**	**21.2**	**18.69**
14	30.06	74.0	71.0	.724	30.05	83.0	73.0	.699	30.04	78.0	72.0	.717
	763.5	**23.3**	**21.7**	**18.46**	**763.3**	**28.3**	**22.8**	**17.83**	**763.0**	**25.6**	**22.2**	**18.14**
15	30.14	76.0	73.0	.777	30.14	84.0	72.5	.669	30.11	80.5	71.5	.671
	765.6	**24.4**	**22.8**	**19.80**	**765.6**	**28.9**	**22.5**	**16.99**	**764.8**	**26.9**	**21.9**	**16.97**
17	30.05	72.0	65.0	.539	30.05	78.5	63.5	.418	30.06	71.8	62.0	.448
	763.3	**22.2**	**18.3**	**13.64**	**763.3**	**25.8**	**17.5**	**10.44**	**763.5**	**22.1**	**16.7**	**11.39**
18	30.09	67.3	59.0	.408	30.04	77.3	60.3	.334	30.06	70.2	60.0	.404
	764.3	**19.6**	**15.0**	**10.45**	**763.0**	**25.2**	**15.7**	**8.43**	**763.5**	**21.2**	**15.7**	**10.46**
19	30.19	64.3	56.0	.356	30.22	73.0	57.0	.286	30.27	64.8	56.3	.358
	766.8	**17.9**	**13.3**	**9.03**	**767.6**	**22.8**	**13.9**	**7.27**	**768.9**	**18.2**	**13.5**	**9.11**
20	30.33	59.5	54.5	.368	30.22	75.0	63.0	.441	30.18	69.5	58.5	.367
	770.4	**14.7**	**12.5**	**9.65**	**767.6**	**23.9**	**17.2**	**11.17**	**766.6**	**20.8**	**14.7**	**9.35**
21	30.10	66.0	61.5	.495	29.98	80.2	66.3	.492	29.96	75.2	65.0	.503
	764.5	**18.9**	**16.4**	**12.59**	**761.5**	**26.8**	**19.1**	**12.52**	**761.0**	**24.0**	**18.3**	**12.75**
22	29.94	68.7	67.5	.648	29.96	77.0	72.0	.728	29.94	75.5	72.0	.744
	760.5	**20.4**	**19.7**	**16.69**	**761.0**	**25.0**	**22.2**	**18.46**	**760.5**	**24.2**	**22.2**	**18.86**
24	30.03	74.0	70.7	.714	30.05	67.0	66.0	.627	30.05	63.5	62.5	.555
	762.8	**23.3**	**21.5**	**18.12**	**763.3**	**19.4**	**18.9**	**15.97**	**763.3**	**17.5**	**16.9**	**14.00**
25	30.10	67.0	64.5	.578	30.08	80.0	65.0	.449	30.06	71.5	65.0	.543
	764.5	**19.4**	**18.1**	**14.78**	**764.0**	**26.7**	**18.3**	**11.35**	**763.5**	**21.9**	**18.3**	**13.80**
26	30.12	69.0	64.0	.540	30.08	80.0	66.0	.482	30.05	75.3	66.3	.546
	765.1	**20.6**	**17.8**	**13.72**	**764.0**	**26.7**	**18.9**	**12.26**	**763.3**	**24.1**	**19.1**	**13.89**
27	30.07	70.0	68.0	.662	30.12	76.0	61.0	.369	30.20	69.0	56.5	.322
	763.8	**21.1**	**20.0**	**16.81**	**765.1**	**24.4**	**16.1**	**9.37**	**767.1**	**20.6**	**13.6**	**8.01**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu.	Ci. S.	Ci.				
.....	23	.....	.....	9	.....	1	.....	.....	.....	6–16	.....	E	1
.....	4	.....	.....	.....	.....	.....	.....	.....	.....	6–16	3–20	NE	2
.....	14	.....	.....	.....	.....	.....	.....	.....	.....	6– 9	.....	N	2
.....	2	.....	.....	.....	.....	.....	1	.....	4	6– 9	3–20	N	2
.....	10	.....	.....	.....	.....	.....	.....	.....	8	6–17	.....	NW	2
.....	2	.....	.....	.....	5	13	.....	.....	4	6–16	.....	NE	3
.....	3	.....	.....	.....	3	23	2	.....	5	.....	.....	NW	2
.....	23	.....	.....	.....	.....	.....	.....	.....	.....	6–16 2–14	3–20	NE	1
.....	29	.....	.....	.....	4	11	.....	.....	.....	2–13	.....	E	1
.....	11	.....	.....	*6 10	.....	10	.....	.....	.....	6–17 3–13	.....	E	1
14	11	.....	.....	.....	.....	2	.....	.....	10	6–17	.....	NW	2
.....	14	.....	.....	.....	7	2	4	.....	13	.....	3–20	NE	3
.....	4	.....	.....	11	6	.....	6	.....	.....	.....	.....	NE	2
.....	14	.....	.....	.....	.....	.....	.....	.....	.....	2–14	.....	SE	3
.....	15	.....	.....	9	.....	.....	.....	.....	3	2–1	.....	NE	4
.....	6	7	.....	9	.....	4	1	.....	8	6–3	.....	W	3
.....	.....	.....	.....	.....	.....	10	5	.....	.....	3–20 6–17	2–14	NW	3
.....	.....	.....	.....	4	.....	.....	.....	.....	.....	.....	3–20	NE	4
.....	14	.....	.....	.....	.....	.....	.....	.....	.....	3–5	.....	NW	3
.....	16	.....	.....	.....	.....	.....	.....	3	11	3–19	2–5	N	5
.....	.....	.....	.....	9	.....	13	4	1	.....	6–9 2–15	3–20	E	2

* Scud.

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1896												
Aug. 29	30.31	61.5	56.0	.387	30.23	74.0	58.0	.303	30.17	64.7	57.7	.398
	769.9	**16.4**	**13.3**	**9.77**	**767.8**	**23.3**	**14.4**	**7.64**	**766.3**	**18.2**	**14.3**	**10.14**
31	29.86	64.3	61.0	.499	29.79	86.0	67.0	.451	29.95	69.0	61.0	.448
	758.4	**17.9**	**16.1**	**12.69**	**756.7**	**30.0**	**19.4**	**11.36**	**760.7**	**20.6**	**16.1**	**11.33**
Sept. 1	30.21	61.2	52.0	.285	30.24	73.5	56.0	.252	30.27	63.5	56.0	.366
	767.3	**16.2**	**11.1**	**7.23**	**768.1**	**23.1**	**13.3**	**6.35**	**768.9**	**17.5**	**13.3**	**9.22**
2	30.33	62.5	57.5	.417	30.25	75.0	62.0	.410	30.19	70.8	62.8	.481
	770.4	**16.9**	**14.2**	**9.64**	**768.4**	**23.9**	**16.7**	**10.44**	**766.8**	**21.6**	**17.1**	**12.21**
3	30.03	71.4	67.3	.622	29.87	91.0	73.5	.630	29.96	72.0	69.5	.692
	762.8	**21.9**	**19.6**	**15.78**	**758.7**	**32.8**	**23.1**	**16.01**	**761.0**	**22.2**	**20.8**	**17.53**
4	30.17	61.7	55.0	.359	30.15	72.0	59.5	.368	30.13	65.3	56.8	.367
	766.3	**16.5**	**12.8**	**9.10**	**765.8**	**22.2**	**15.3**	**9.42**	**765.3**	**18.5**	**13.8**	**9.35**
5	30.09	63.0	59.0	.455	29.96	64.0	64.0	.595	29.88	67.0	66.0	.627
	764.3	**17.2**	**15.0**	**11.55**	**761.0**	**17.8**	**17.8**	**15.14**	**759.0**	**19.4**	**18.9**	**15.97**
8	30.18	64.2	58.0	.414	30.15	75.0	62.0	.410	30.13	65.0	60.5	.476
	766.6	**17.9**	**14.4**	**10.41**	**765.8**	**23.9**	**16.7**	**10.45**	**765.3**	**18.3**	**15.8**	**12.07**
12	30.13	68.0	66.0	.616	30.16	90.0	74.0	.659	30.17	74.0	67.0	.583
	765.3	**20.0**	**18.9**	**15.66**	**766.1**	**32.2**	**23.3**	**16.70**	**766.3**	**23.3**	**19.4**	**14.75**
15	29.97	69.6	69.0	.701	29.93	73.8	72.5	.783	29.92	70.0	69.0	.696
	761.2	**20.9**	**20.6**	**17.82**	**760.2**	**23.2**	**22.5**	**18.89**	**760.0**	**21.1**	**20.6**	**17.77**
16	29.95	65.0	63.5	.568	29.90	73.5	66.0	.555	29.89	69.5	66.0	.598
	760.7	**18.3**	**17.5**	**14.46**	**759.5**	**23.1**	**18.9**	**14.10**	**759.2**	**20.8**	**18.9**	**15.26**
17	29.82	68.2	67.3	.658	29.75	80.0	74.0	.772	29.77	76.0	72.0	.739
	757.4	**20.1**	**19.6**	**16.69**	**755.7**	**26.7**	**23.3**	**19.53**	**756.2**	**24.4**	**22.2**	**18.76**
18	29.92	73.0	69.0	.663	29.95	81.0	71.0	.646	29.98	74.5	69.5	.665
	760.0	**22.8**	**20.6**	**16.91**	**760.7**	**27.2**	**21.7**	**16.49**	**761.5**	**23.6**	**20.8**	**16.83**
19	29.81	75.2	71.8	.741	29.66	93.5	76.0	.703	29.82	64.0	56.5	.373
	757.2	**24.0**	**22.1**	**18.80**	**753.4**	**34.2**	**24.4**	**17.78**	**757.4**	**17.8**	**13.6**	**9.47**
21	30.11	56.0	54.0	.395	29.98	68.0	57.0	.343	29.94	64.0	59.0	.444
	764.8	**13.3**	**12.2**	**9.51**	**761.5**	**20.0**	**13.9**	**8.73**	**760.5**	**17.8**	**15.0**	**11.26**
22	29.88	60.5	57.5	.440	29.84	66.5	58.0	.388	29.90	59.0	53.0	.336
	759.0	**15.8**	**14.2**	**11.23**	**757.9**	**19.2**	**14.7**	**10.17**	**759.5**	**15.0**	**11.7**	**8.56**
23	30.24	48.0	43.0	.211	30.23	57.0	45.0	.164	30.27	49.0	44.0	.231
	768.1	**8.9**	**6.1**	**5.65**	**767.8**	**13.9**	**7.2**	**4.16**	**768.9**	**9.4**	**6.7**	**5.95**
24	30.38	50.0	47.0	.287	30.32	68.0	54.5	.272	30.29	57.0	52.0	.331
	771.7	**10.0**	**8.3**	**7.28**	**770.1**	**20.0**	**12.5**	**6.93**	**769.4**	**13.9**	**11.1**	**8.40**
25	30.34	54.0	51.0	.339	30.28	73.0	60.0	.371	30.29	63.0	57.0	.398
	770.6	**12.2**	**10.6**	**8.70**	**769.1**	**22.8**	**15.6**	**9.58**	**769.4**	**17.2**	**13.9**	**10.12**
26	30.35	59.3	57.1	.442	30.29	73.0	64.0	.495	30.28	66.0	61.0	.480
	770.9	**15.2**	**13.9**	**10.63**	**769.4**	**22.8**	**17.8**	**12.58**	**769.1**	**18.9**	**16.1**	**12.17**
28	30.13	66.5	65.0	.599	30.10	76.0	69.0	.630	30.12	70.0	68.0	.662
	765.3	**19.2**	**18.3**	**15.16**	**764.5**	**24.4**	**20.6**	**16.09**	**765.1**	**21.1**	**20.0**	**16.80**
30	29.77	64.0	58.0	.417	29.72	68.0	55.0	.289	29.73	67.0	59.0	.412
	756.2	**17.8**	**14.4**	**10.48**	**754.9**	**20.0**	**12.8**	**7.45**	**755.1**	**19.4**	**15.0**	**10.46**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu.	Ci. S.	Ci.				
.....	9	.....	.....	.....	.....	.....	.....	.....	.....	**3-1**	.....	SE	3
.....	.....	.....	4	8	3	12	.....	.....	.....	.....	**3-20**	N	3
.....	9	.....	.....	.....	.....	14	.....	.....	8	**2-6**	.....	NE	3
.....	.....	.....	.....	12	.....	.....	.....	.....	2	**3-4**	**2-14**	W	4
.....	5	.....	8	6	.....	.....	.....	.....	.....	**6-8**	**3-13**	N	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	11	**2-6**	.....	NE	4
6	.....	.....	.....	.....	.....	.....	.....	.....	.....	**3-20**	**2-14**	NW	7
.....	14	.....	.....	.....	.....	.....	.....	.....	.....	**3-5**	.....	W	2
.....	.....	.....	.....	.....	19	.....	.....	.....	.....	**2-14**	.....	SW	1
.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	**5-15**	NE	1
1	.....	.....	.....	.....	.....	10	2	.....	4	**3-20**	**6-4**	E	3
.....	9	.....	.....	.....	.....	4	.....	.....	.....	**6-16**	**2-13**	N	2
.....	7	.....	6	.....	2	4	.....	6	18	**6-16**	.....	NE	5
.....	.....	.....	.....	.....	.....	.....	.....	10	6	.....	**2-5**	NW	5
.....	.....	.....	.....	.....	11	.....	.....	3	21	**6-4**	.....	NE	2
6	.....	.....	2	7	.....	13	.....	3	.....	.....	**3-12**	NE	1
.....	8	.....	.....	.....	.....	.....	.....	.....	.....	**2-7**	.....	NE	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	11	**6-3**	.....	NE	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	16	**3-11**	.....	NW	5
.....	.....	.....	.....	.....	5	13	.....	2	13	3-19	**3-13**	N	5
.....	4	.....	5	6	.....	4	.....	.....	.....	.....	**6-16**	S	3
.....	10	.....	.....	3	.....	.....	.....	.....	.....	.....	**2-6**	NW	4

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1896												
Oct. 1	29.93	60.4	55.0	.373	30.00	66.5	58.0	.388	30.04	60.0	56.0	.404
	760.2	**15.8**	**12.8**	**9.55**	**762.0**	**19.2**	**14.4**	**9.77**	**763.0**	**15.6**	**13.3**	**10.20**
2	30.08	56.5	53.0	.363	30.01	63.0	54.0	.318	30.01	57.5	52.0	.326
	764.0	**13.6**	**11.7**	**9.27**	**762.3**	**17.2**	**12.2**	**8.04**	**762.3**	**14.2**	**11.1**	**8.26**
3	30.09	53.0	50.0	.327	30.12	64.0	54.0	.306	30.10	57.5	55.0	.404
	764.3	**11.7**	**10.0**	**8.28**	**765.1**	**17.8**	**12.2**	**7.73**	**764.5**	**14.2**	**12.8**	**10.28**
5	30.20	52.5	50.5	.345	30.14	62.0	55.0	.355	30.15	52.0	50.5	.350
	767.1	**13.4**	**10.3**	**7.74**	**765.6**	**16.7**	**12.8**	**9.01**	**765.8**	**11.1**	**10.3**	**8.91**
6	30.17	48.4	46.4	.293	30.07	66.5	54.0	.278	30.10	59.0	55.0	.387
	766.3	**9.1**	**8.0**	**7.42**	**763.8**	**19.2**	**12.2**	**7.01**	**764.5**	**15.0**	**12.8**	**9.88**
7	30.05	55.2	48.0	.256	30.07	57.0	45.3	.173	30.15	48.0	43.0	.222
	763.3	**12.9**	**8.9**	**6.37**	**763.8**	**13.9**	**7.4**	**4.37**	**765.8**	**8.9**	**6.1**	**5.60**
8	30.31	45.0	40.0	.191	30.27	54.5	44.5	.181	30.34	44.5	42.0	.237
	769.9	**7.2**	**4.4**	**4.80**	**768.9**	**12.2**	**6.9**	**4.71**	**770.6**	**6.9**	**5.6**	**6.11**
9	30.49	43.0	40.0	.213	30.43	54.5	45.0	.191	30.45	44.0	40.5	.207
	774.4	**6.1**	**4.4**	**5.37**	**772.9**	**12.2**	**7.2**	**5.01**	**773.4**	**6.7**	**4.7**	**5.34**
10	30.47	46.0	43.0	.243	30.41	56.0	49.0	2.68	30.36	53.0	48.0	.277
	773.9	**7.8**	**6.1**	**6.14**	**772.4**	**13.3**	**9.4**	**6.83**	**771.2**	**11.7**	**8.9**	**7.04**
13	29.96	48.0	47.8	.330	29.86	53.0	48.0	.279	29.81	52.0	49.0	.314
	761.0	**8.9**	**8.8**	**8.00**	**758.4**	**11.7**	**8.9**	**6.79**	**757.2**	**11.1**	**9.4**	**7.93**
14	29.80	48.0	47.2	.316	29.76	56.0	50.4	.304	29.81	53.5	47.0	.250
	756.9	**8.9**	**8.4**	**7.96**	**755.9**	**13.3**	**10.2**	**7.70**	**757.2**	**11.9**	**8.3**	**6.25**
15	29.83	53.5	46.5	.237	29.79	67.0	51.0	.307	29.79	60.0	49.5	.237
	757.7	**11.9**	**8.1**	**6.34**	**756.7**	**19.4**	**10.6**	**5.08**	**756.7**	**15.6**	**9.7**	**6.00**
16	29.77	51.0	47.0	.277	29.69	71.0	57.0	.311	29.79	57.5	51.0	.301
	756.2	**10.6**	**8.3**	**7.00**	**754.1**	**21.7**	**13.9**	**7.91**	**756.7**	**13.6**	**10.6**	**8.00**
17	29.87	52.0	48.0	.290	29.84	60.0	52.0	.299	29.88	51.5	46.5	.261
	758.7	**11.1**	**8.9**	**7.39**	**757.9**	**15.6**	**11.1**	**7.59**	**759.0**	**10.8**	**8.1**	**6.69**
19	30.22	41.0	38.0	.195	30.17	53.0	47.0	.256	30.16	47.0	42.0	.211
	767.6	**5.0**	**3.3**	**4.91**	**766.3**	**11.7**	**8.3**	**6.42**	**766.1**	**8.3**	**5.6**	**5.41**
20	30.10	48.0	42.5	.211	29.99	64.0	49.5	.191	29.99	57.0	48.5	.246
	764.5	**8.9**	**5.8**	**5.31**	**761.8**	**17.8**	**9.7**	**4.86**	**761.8**	**13.9**	**9.2**	**6.29**
21	29.94	54.0	48.0	.266	29.90	69.0	56.0	.304	30.05	51.2	39.2	.108
	760.5	**12.2**	**8.9**	**6.82**	**759.5**	**20.6**	**13.3**	**7.67**	**763.3**	**10.7**	**4.0**	**2.68**
22	30.23	42.0	38.5	.195	30.13	60.0	47.0	.178	30.08	52.0	44.5	.211
	767.8	**5.6**	**3.6**	**4.88**	**765.3**	**15.6**	**8.3**	**4.43**	**764.0**	**11.1**	**6.9**	**5.29**
23	29.97	50.8	47.0	.281	29.79	66.3	57.5	.377	29.69	58.8	56.3	.425
	761.2	**10.4**	**8.3**	**7.09**	**756.7**	**19.1**	**14.2**	**6.58**	**754.1**	**14.9**	**13.5**	**10.80**
24	29.72	48.5	44.0	.237	29.79	53.0	43.0	.166	29.94	46.7	38.7	.146
	754.9	**9.2**	**6.7**	**6.06**	**756.7**	**11.7**	**6.1**	**4.21**	**761.8**	**8.2**	**3.7**	**3.67**
28	30.34	44.0	44.0	.287	30.31	70.0	61.0	.427	30.31	63.0	56.5	.383
	770.6	**6.7**	**6.7**	**7.31**	**769.9**	**21.1**	**16.1**	**11.04**	**769.9**	**17.2**	**13.5**	**9.61**
29	30.33	57.0	55.0	.409	30.27	72.0	66.0	.570	30.26	67.0	60.0	.439
	770.4	**13.9**	**12.8**	**10.42**	**768.9**	**22.2**	**18.9**	**14.53**	**768.6**	**19.4**	**15.6**	**11.23**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu.	Ci. S.	Ci.				
.....	2	.....	.....	.....	.....	11	4	.....	4	2-14	3-20	NE	4
.....	11	.....	.....	.....	.....	2	.....	.....	14	2-5	.....	NE	3
.....	4	.....	.....	3	.....	14	.....	.....	.....	2-13	.....	SE	3
.....	9	.....	.....	.....	.....	11	.....	.....	.....	3-20	2-14	E	3
.....	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	3-19	NE	3
.....	3	.....	.....	.....	.....	.....	6	.....	10	.....	3-20	NE	7
.....	10	.....	.....	.....	.....	.....	.....	.....	.....	2-14	3-20	NE	4
.....	2	.....	.....	.....	.....	.....	.....	.....	.....	2-5	.....	S	3
14	.....	.....	.....	.....	.....	.....	2	.....	.....	3-20	2-15 6-17	S	8
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6-4	E	7
8	.....	.....	.....	.....	.....	5	.....	.....	.....	.....	3-20	NE	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	10	.....	3-11	NE	6
.....	8	.....	.....	.....	.....	.....	2	3	10	.....	.....	NE	3
.....	.....	.....	.....	.....	.....	19	9	.....	.....	.....	6-3	SE	4
.....	26	.....	.....	.....	.....	.....	.....	.....	.....	6-8	3-20	NE	4
.....	.....	.....	.....	.....	.....	8	.....	15	2	.....	2-13	N	7
.....	9	.....	.....	.....	.....	.....	2	6	1	6-16	2-13	N	4
.....	.....	.....	.....	.....	.....	10	.....	.....	.....	6-3	3-20	NE	4
.....	.....	2	.....	.....	12	8	.....	.....	.....	.....	2-13	NW	5
.....	10	.....	.....	.....	.....	2	8	.....	.....	.....	3-12	NE	5
.....	.....	.....	.....	.....	.....	.....	15	15	.....	3-20	2-14	NW	2
.....	10	.....	.....	7	.....	4	.....	.....	10	3-19	.....	W	2

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1896												
Oct. 30	30.11	60.0	58.0	.460	29.97	74.0	64.0	.484	29.92	71.0	64.0	.517
	764.8	**15.6**	**14.4**	**11.71**	**761.2**	**23.3**	**17.8**	**11.08**	**760.0**	**21.7**	**17.8**	**13.17**
31	29.97	65.3	60.0	.459	29.93	74.0	57.0	.276	29.93	60.0	52.0	.298
	761.2	**18.5**	**15.6**	**11.71**	**760.2**	**23.3**	**13.9**	**7.05**	**760.2**	**15.6**	**11.1**	**7.56**
Nov. 2	30.27	46.0	43.0	.243	30.23	71.5	54.5	.234	30.24	60.0	51.0	.273
	768.9	**7.8**	**6.1**	**6.14**	**767.8**	**21.9**	**12.5**	**5.96**	**768.1**	**15.6**	**10.6**	**6.96**
3	30.32	49.0	46.5	.276	30.27	70.0	54.5	.248	30.29	60.7	51.2	.269
	770.1	**9.4**	**8.1**	**7.38**	**768.9**	**21.1**	**12.5**	**6.46**	**769.4**	**15.9**	**10.7**	**6.92**
4	30.23	56.0	53.3	.377	30.12	68.0	61.0	.459	30.01	64.5	62.0	.527
	767.8	**13.3**	**11.8**	**9.53**	**765.1**	**20.0**	**16.1**	**11.62**	**762.3**	**18.1**	**16.7**	**13.41**
5	29.63	66.0	66.0	.638	29.56	70.5	66.5	.606	29.68	64.3	57.3	.394
	752.6	**18.9**	**18.9**	**16.22**	**750.8**	**21.4**	**19.2**	**15.42**	**753.9**	**17.9**	**14.1**	**10.06**
7	30.08	39.2	38.2	.219	29.94	66.0	50.5	.194	29.91	58.0	49.0	.248
	764.0	**4.0**	**3.4**	**5.51**	**760.5**	**18.9**	**10.3**	**4.96**	**759.7**	**14.4**	**9.4**	**6.26**
9	30.12	35.1	32.0	.146	30.15	41.5	34.5	.121	30.22	35.5	32.0	.141
	765.1	**1.7**	**0.0**	**3.71**	**765.8**	**5.3**	**1.4**	**3.07**	**767.6**	**1.9**	**0.0**	**3.60**
10	30.37	33.0	31.0	.150	30.33	50.0	43.0	.199	30.30	47.5	41.0	.183
	771.4	**0.6**	**—0.6**	**3.77**	**770.4**	**10.0**	**6.1**	**5.03**	**769.6**	**8.6**	**5.0**	**4.67**
11	30.08	49.5	48.5	.329	30.00	59.0	57.0	.443	30.08	60.0	58.5	.473
	764.0	**9.7**	**9.2**	**8.41**	**762.0**	**15.0**	**13.9**	**10.65**	**764.0**	**15.6**	**14.7**	**11.98**
13	30.07	39.5	38.0	.211	30.04	44.0	37.0	.142	30.16	35.5	30.0	.103
	763.8	**4.2**	**3.3**	**5.33**	**763.0**	**6.7**	**2.8**	**3.63**	**766.1**	**1.9**	**—1.1**	**2.69**
14	30.37	33.0	29.0	.112	30.37	42.0	35.0	.124	30.37	35.0	32.0	.146
	771.4	**0.6**	**—1.7**	**2.86**	**771.4**	**5.6**	**1.7**	**3.17**	**771.4**	**1.7**	**0.0**	**3.70**
16	30.32	42.6	39.0	.203	30.27	70.0	54.0	.237	30.28	60.0	49.0	.224
	770.1	**5.9**	**3.9**	**5.00**	**768.9**	**21.1**	**12.2**	**6.11**	**769.1**	**15.6**	**9.4**	**5.49**
17	30.31	41.0	39.0	.215	30.22	76.0	60.0	.338	30.24	63.0	55.0	.343
	769.9	**5.0**	**3.9**	**5.41**	**767.2**	**24.4**	**15.6**	**8.68**	**768.1**	**17.2**	**12.8**	**8.75**
18	30.25	53.0	50.0	.327	30.18	73.1	58.0	.312	30.10	53.3	45.0	.208
	768.4	**11.7**	**10.0**	**7.27**	**766.6**	**22.8**	**14.4**	**7.90**	**764.5**	**11.8**	**7.2**	**5.04**
19	30.10	50.0	47.0	.289	30.17	61.8	54.8	.351	30.33	51.0	44.0	.208
	764.5	**10.0**	**8.3**	**7.28**	**766.3**	**16.6**	**12.7**	**8.94**	**770.4**	**10.6**	**6.7**	**5.32**
20	30.54	37.2	34.0	.160	30.53	40.0	35.0	.147	30.53	41.0	37.0	.174
	775.7	**2.9**	**1.1**	**4.01**	**775.5**	**4.4**	**1.7**	**3.77**	**775.5**	**5.0**	**2.8**	**4.44**
23	30.76	30.5	28.0	.120	30.67	49.5	43.0	.202	30.62	48.2	43.7	.232
	781.3	**—0.8**	**—2.2**	**3.20**	**779.0**	**9.7**	**6.1**	**5.16**	**777.8**	**9.0**	**6.5**	**5.93**
24	30.47	47.3	45.0	.270	30.42	66.0	56.0	.335	30.47	60.0	55.5	.389
	773.9	**8.5**	**7.2**	**6.90**	**772.7**	**18.9**	**13.3**	**8.49**	**773.9**	**15.6**	**13.1**	**9.92**
25	30.52	53.0	51.0	.351	30.45	66.5	59.0	.414	30.42	60.0	56.5	.417
	775.2	**11.7**	**10.6**	**8.93**	**773.4**	**19.2**	**15.0**	**10.55**	**772.7**	**15.6**	**13.6**	**10.54**
27	30.20	60.0	58.0	.460	30.10	74.0	63.2	.460	30.10	67.5	61.5	.479
	767.1	**15.6**	**14.4**	**11.57**	**764.5**	**23.3**	**17.8**	**11.68**	**764.5**	**19.7**	**16.4**	**12.19**
28	30.11	65.2	63.0	.547	30.09	67.2	65.0	.592	30.17	52.5	52.0	.381
	764.8	**18.4**	**17.2**	**13.97**	**764.3**	**19.6**	**18.3**	**14.96**	**766.3**	**11.4**	**11.1**	**9.68**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu.	Ci. S.	Ci.				
8	.....	.....	.....	2	10	3	.....	.....	.....	6-9	.....	NW	6
.....	7	.....	.....	.....	.....	.....	.....	.....	11	6-16	2-14	NW	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	19	6-3	2-15	NW	6
.....	.....	.....	.....	.....	.....	10	10	5	5	3-20	.....	W	3
2	.....	15	.....	.....	.....	.....	.....	.....	.....	3-20	2-14	NW	1
2	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	2-6	NW	8
.....	.....	.....	.....	.....	.....	.....	7	.....	7	.....	3-20 2-14	N	3
.....	.....	.....	.....	.....	3	.....	2	.....	7	6-8	3-20	NE	3
.....	.....	.....	.....	.....	22	.....	.....	.....	.....	3-4	.....	W	4
1	.....	.....	.....	9	.....	.....	.....	.....	.....	3-20	2-14	NW	6
.....	19	.....	.....	4	.....	6	.....	.....	.....	.....	3-11	NE	8
.....	4	.....	.....	.....	.....	.....	8	.....	8	6-2	.....	NE	6
.....	.....	.....	.....	.....	.....	.....	.....	10	17	6-8 3-20	.....	NW	5
.....	.....	.....	.....	.....	3	17	3	1	13	6-8 3-20	.....	NE	3
.....	.....	.....	9	.....	.....	.....	.....	.....	10	6-8	2-4	NW	2
2	.....	10	.....	4	.....	11	.....	5	.....	.....	.....	NE	4
.....	.....	.....	.....	.....	.....	8	2	.....	.....	.....	.....	S	4
.....	10	.....	.....	9	.....	.....	.....	.....	.....	3-20	.....	NW	12
.....	2	.....	.....	8	.....	8	.....	9	.....	6-8	3-20	N	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	25	3-13	.....	SW	3
5	4	.....	.....	.....	.....	.....	.....	.....	16	6-9	2-14	NW	8
.....	.....	.....	.....	10	.....	.....	.....	.....	.....	6-9	6-16 3-20	NW	8

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates.	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1896												
Dec. 1	30.54	19.0	17.0	.063	30.49	28.3	24.0	.079	30.50	27.2	23.2	.077
	775.7	**−7.2**	**−8.3**	**1.88**	**774.4**	**−2.1**	**−4.4**	**2.12**	**774.7**	**−2.7**	**−4.9**	**2.05**
3	30.37	21.0	18.0	.060	30.35	29.4	24.0	.067	30.44	25.5	23.0	.093
	771.4	**−6.1**	**−7.8**	**1.68**	**770.9**	**−1.4**	**−4.4**	**1.77**	**773.2**	**−3.6**	**−5.0**	**2.44**
4	30.45	19.0	17.0	.063	30.29	34.5	32.0	.152	30.21	33.2	30.0	.128
	773.4	**−7.2**	**−8.3**	**1.89**	**769.4**	**1.4**	**0.0**	**3.85**	**767.3**	**0.1**	**−1.1**	**3.60**
5	30.20	25.0	24.0	.116	30.18	53.0	42.0	.143	30.16	44.0	37.0	.141
	767.1	**−3.9**	**−4.4**	**3.05**	**766.6**	**11.7**	**5.6**	**3.88**	**766.1**	**−6.7**	**2.8**	**3.60**
7	30.16	35.0	33.0	.164	30.14	62.0	51.0	.250	30.23	53.0	47.0	.256
	766.1	**1.7**	**0.6**	**4.20**	**765.6**	**16.7**	**10.6**	**6.40**	**767.8**	**11.7**	**8.3**	**6.42**
8	30.28	42.0	40.0	.225	30.15	55.0	48.5	.268	30.02	52.2	48.2	.293
	769.1	**5.6**	**4.4**	**5.43**	**765.8**	**12.8**	**9.2**	**6.83**	**762.5**	**11.2**	**9.0**	**7.44**
9	29.82	52.0	44.0	.199	29.84	53.0	43.0	.167	29.79	48.5	38.5	.125
	757.4	**11.1**	**6.7**	**5.10**	**757.9**	**11.7**	**6.1**	**4.21**	**756.7**	**9.2**	**3.6**	**3.09**
10	29.88	43.5	37.5	.158	29.88	59.8	47.0	.182	29.79	49.5	42.5	.195
	759.0	**6.4**	**3.1**	**4.03**	**759.0**	**15.4**	**8.3**	**4.56**	**756.7**	**9.7**	**5.8**	**4.92**
11	30.00	47.5	40.0	.164	30.12	48.3	40.5	.168	30.18	39.0	36.0	.180
	762.0	**8.6**	**4.4**	**4.11**	**765.1**	**9.1**	**4.7**	**4.67**	**766.6**	**3.9**	**2.2**	**4.44**
12	30.17	34.0	32.8	.169	30.07	49.2	42.5	.198	30.00	45.5	41.5	.217
	766.3	**1.1**	**0.4**	**4.35**	**763.8**	**9.6**	**5.8**	**4.95**	**762.0**	**7.5**	**5.3**	**5.53**
14	30.04	43.0	40.0	.211	30.05	52.0	42.0	.155	30.08	45.2	39.2	.172
	763.0	**6.1**	**4.4**	**5.38**	**763.3**	**11.1**	**5.6**	**3.99**	**764.0**	**7.3**	**4.0**	**4.40**
15	30.01	36.0	32.0	.137	29.88	36.0	32.5	.145	29.86	32.0	32.0	.180
	762.3	**2.2**	**0.0**	**3.46**	**759.0**	**2.2**	**0.3**	**3.71**	**758.4**	**0.0**	**0.0**	**4.57**
16	29.86	34.5	29.5	.101	29.90	40.0	32.0	.092	30.04	36.0	29.0	.081
	758.4	**1.4**	**−1.4**	**2.72**	**759.5**	**4.4**	**0.0**	**2.35**	**763.0**	**2.2**	**−1.7**	**2.07**
17	30.28	29.0	25.0	.089	30.26	42.5	34.0	.100	30.26	35.3	30.3	.110
	769.1	**−1.7**	**−3.9**	**2.25**	**768.6**	**5.8**	**1.1**	**2.55**	**768.6**	**1.8**	**−0.9**	**2.91**
18	30.11	34.0	31.0	.137	29.94	41.0	36.1	.159	29.98	39.0	36.5	.187
	764.8	**1.1**	**−0.6**	**3.52**	**760.5**	**5.0**	**2.3**	**4.03**	**761.5**	**3.9**	**2.5**	**4.75**
19	30.25	31.0	26.0	.084	30.26	35.0	28.0	.072	30.24	31.5	28.5	.121
	768.4	**−0.6**	**−3.3**	**1.60**	**768.6**	**1.7**	**−2.2**	**1.90**	**768.1**	**−0.3**	**−1.9**	**3.10**
21	30.03	27.0	26.0	.125	29.96	38.0	32.0	.114	30.02	35.2	30.2	.111
	762.8	**−2.8**	**−3.3**	**3.33**	**761.0**	**3.3**	**0.0**	**2.90**	**762.5**	**1.8**	**−1.0**	**2.84**
22	30.11	29.0	26.0	.103	29.97	36.0	30.8	.124	29.85	32.0	32.0	.180
	764.8	**−1.7**	**−3.3**	**2.78**	**761.2**	**2.2**	**−0.7**	**2.89**	**758.2**	**0.0**	**0.0**	**4.57**
23	29.89	34.0	28.0	.084	30.04	32.5	28.0	.100	30.28	25.0	22.0	.080
	759.2	**1.1**	**−2.2**	**2.22**	**763.0**	**0.3**	**−2.2**	**2.73**	**769.1**	**−3.9**	**−5.6**	**2.16**
26	30.37	24.0	22.0	.091	30.36	32.0	28.5	.114	30.46	32.0	29.0	.125
	771.4	**−4.4**	**−5.6**	**2.45**	**771.2**	**0.0**	**−1.9**	**3.01**	**773.7**	**0.0**	**−1.7**	**3.16**
29	30.63	22.5	21.5	.099	30.51	39.0	34.0	.140	30.52	32.5	29.5	.125
	778.0	**−5.3**	**−5.8**	**2.72**	**775.0**	**3.9**	**1.1**	**3.49**	**775.2**	**0.3**	**−1.4**	**3.25**
30	30.47	37.2	35.2	.180	30.40	51.0	45.0	.182	30.37	41.5	39.0	.209
	773.9	**2.9**	**1.8**	**4.63**	**772.2**	**10.6**	**7.2**	**5.83**	**771.7**	**5.3**	**3.9**	**5.31**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu.	Ci. S.	Ci.				
.....	.....	.....	.....	.....	.....	.....	8	6	3	.....	3-20	NE	6
.....	.....	.....	.....	.....	.....	5	.....	.....	.....	2-7	.....	E	4
.....	.....	.....	.....	.....	6	6	.....	10	2	6-4	2-14	E	4
.....	.....	.....	.....	.....	.....	.....	9	9	12	6-8	3-20 2-15	NW	3
.....	.....	.....	.....	14	.....	7	3	.....	4	6-9	.....	NE	1
.....	.....	.....	.....	18	.....	10	.....	.....	.....	6-11	.....	NW	2
.....	14	.....	.....	.....	.....	.....	4	.....	6	.....	3-12 2-14	NE	10
.....	.....	.....	.....	.....	.....	.....	10	.....	.....	.....	.....	NE	5
.....	6	.....	.....	13	.....	.....	.....	.....	.....	.....	.....	NE	11
.....	.....	.....	.....	.....	1	.....	.....	29	.....	6-9	3-20	NE	3
.....	.....	.....	.....	9	.....	10	1	10	.....	2-14	.....	SW	2
.....	.....	3	.....	.....	.....	.....	.....	.....	.....	2-13	6-9	S	10
.....	.....	.....	.....	.....	.....	13	4	.....	3	2-13	3-11	E	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	10	2-13	.....	NE	5
3	.....	.....	.....	18	.....	9	.....	.....	.....	3-12	2-6	NW	8
.....	.....	.....	.....	.....	1	.....	6	1	10	2-14	.....	NE	5
.....	.....	.....	.....	6	.....	14	.....	.....	.....	2-14	.....	NE	2
.....	.....	.....	.....	5	.....	14	.....	.....	.....	6-16	2-15	NW	4
.....	24	.....	.....	.....	.....	.....	5	.....	.....	2-14	3-4	E	8
.....	.....	.....	.....	16	.....	10	4	.....	.....	6-8	3-20	NE	4
.....	.....	.....	.....	.....	.....	.....	8	6	12	6-8	.....	NW	4
8	2	.....	.....	6	.....	7	.....	.....	.....	6-8	2-14	NW	2

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1897												
Jan. 2	30.66	32.0	31.0	.161	30.59	53.0	46.0	.231	30.57	43.5	43.0	.271
	778.8	**0.0**	**— 0.6**	**4.09**	**777.0**	**11.7**	**7.8**	**5.07**	**776.5**	**6.4**	**6.1**	**6.87**
5	29.82	41.0	38.0	.195	29.74	44.0	38.5	.172	29.79	40.5	36.5	.172
	757.4	**5.0**	**3.3**	**4.93**	**755.4**	**6.7**	**3.6**	**4.34**	**756.7**	**4.7**	**2.5**	**4.37**
6	30.04	22.0	20.0	.081	30.06	31.0	23.5	.038	30.20	26.5	22.0	.063
	763.0	**— 5.6**	**— 6.7**	**2.22**	**763.5**	**— 0.6**	**— 4.8**	**1.08**	**767.1**	**— 3.1**	**— 5.6**	**1.80**
7	30.39	23.3	20.3	.071	30.36	34.5	30.0	.114	30.38	28.0	25.0	.098
	771.9	**— 4.8**	**— 6.5**	**1.95**	**771.2**	**1.4**	**— 1.1**	**2.93**	**771.7**	**— 2.2**	**— 3.9**	**2.57**
8	30.40	22.0	20.0	.081	30.34	36.2	30.5	.106	30.38	29.2	26.7	.113
	772.2	**— 5.6**	**— 6.7**	**2.21**	**770.6**	**2.2**	**— 0.8**	**2.79**	**771.7**	**— 1.6**	**— 2.9**	**3.03**
11	29.85	27.4	25.8	.119	29.79	44.0	36.0	.123	29.96	36.0	31.0	.119
	758.2	**— 2.6**	**— 3.4**	**3.17**	**759.2**	**6.7**	**2.2**	**3.23**	**761.0**	**2.2**	**— 0.6**	**2.96**
12	30.09	27.1	24.0	.089	30.15	30.0	26.5	.099	30.31	27.0	22.0	.060
	764.3	**— 2.7**	**— 4.4**	**2.45**	**765.8**	**— 1.1**	**— 3.1**	**2.62**	**769.9**	**— 2.8**	**— 5.6**	**1.58**
16	30.28	25.2	24.0	.111	30.28	34.0	33.0	.176	30.31	32.8	31.8	.167
	769.1	**— 3.8**	**— 4.4**	**3.01**	**769.1**	**1.1**	**0.6**	**4.52**	**769.9**	**0.4**	**— 0.1**	**4.29**
18	29.87	40.2	35.0	.146	30.03	40.0	32.0	.092	30.16	34.5	28.0	.078
	758.7	**4.6**	**1.7**	**3.18**	**762.8**	**4.4**	**0.0**	**2.35**	**766.1**	**1.4**	**— 2.2**	**2.05**
19	30.38	28.2	24.0	.077	30.44	30.0	24.5	.054	30.52	25.5	23.0	.090
	771.7	**— 2.1**	**— 4.4**	**2.13**	**773.2**	**— 1.1**	**— 4.2**	**1.76**	**775.2**	**— 3.6**	**— 5.0**	**2.44**
20	30.49	25.2	23.1	.095	30.35	35.0	32.0	.146	30.09	34.0	33.5	.185
	774.4	**— 3.8**	**— 4.9**	**2.61**	**770.9**	**1.7**	**0.0**	**3.69**	**764.3**	**1.1**	**0.8**	**4.69**
21	29.76	34.0	33.0	.169	29.78	47.0	41.0	.244	29.87	41.5	36.5	.160
	755.9	**1.1**	**0.6**	**4.52**	**756.4**	**8.3**	**5.0**	**4.35**	**758.7**	**5.3**	**2.5**	**3.20**
22	29.94	34.0	31.0	.139	29.74	46.0	40.0	.181	29.72	43.5	38.0	.168
	760.5	**1.1**	**— 0.6**	**3.53**	**755.4**	**7.8**	**4.4**	**4.54**	**754.9**	**6.4**	**3.3**	**4.28**
23	29.95	25.0	21.0	.064	30.05	31.4	24.6	.054	30.10	30.0	24.0	.058
	760.7	**— 3.9**	**— 6.1**	**1.80**	**763.3**	**— 0.3**	**— 4.1**	**1.45**	**764.5**	**— 1.1**	**— 4.4**	**1.63**
25	30.18	9.0	7.4	.038	30.10	13.5	10.9	.037	30.14	11.0	8.5	.032
	766.6	**—12.8**	**—13.8**	**1.07**	**764.5**	**—10.3**	**—11.8**	**1.10**	**765.6**	**—11.7**	**—13.1**	**0.96**
26	30.16	8.3	6.7	.036	30.11	20.8	17.1	.049	30.14	20.0	16.5	.048
	766.1	**—13.2**	**—14.1**	**1.10**	**764.8**	**— 6.2**	**— 8.3**	**1.38**	**765.6**	**— 6.7**	**— 8.6**	**1.43**
29	30.25	14.2	12.4	.052	30.33	25.0	21.0	.063	30.43	21.2	18.2	.060
	768.4	**10.0**	**—11.0**	**1.47**	**770.4**	**— 3.9**	**— 6.1**	**1.78**	**772.9**	**— 6.0**	**— 7.7**	**1.70**
Feb. 1	30.57	24.2	22.3	.094	30.34	36.5	32.0	.129	30.24	35.0	33.0	.165
	776.5	**— 4.3**	**— 5.4**	**2.50**	**770.6**	**2.5**	**0.0**	**3.29**	**768.1**	**1.7**	**0.6**	**4.20**
3	29.84	34.0	30.0	120	29.89	38.0	32.0	.114	29.98	36.5	31.5	.121
	757.9	**1.1**	**— 1.1**	**2.62**	**759.2**	**3.3**	**0.0**	**2.92**	**761.5**	**2.5**	**— 0.3**	**3.06**
5	30.45	24.0	23.5	.115	30.39	35.0	32.0	.146	30.34	33.0	32.0	.169
	773.4	**— 4.4**	**— 4.7**	**3.10**	**771.9**	**1.7**	**0.0**	**3.70**	**770.6**	**0.6**	**0.0**	**4.27**
9	30.17	35.2	33.2	.167	30.24	37.0	33.0	.144	30.27	33.0	30.0	.130
	766.3	**1.8**	**0.7**	**4.23**	**768.1**	**2.8**	**0.6**	**3.64**	**768.9**	**0.6**	**— 1.1**	**3.34**
10	30.34	27.2	26.2	.126	30.29	37.2	33.7	.150	30.28	33.5	31.5	.154
	770.6	**— 2.7**	**— 3.2**	**3.37**	**769.4**	**2.9**	**0.9**	**3.84**	**769.1**	**0.8**	**— 0.3**	**3.90**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu	Ci. S.	Ci.				
									9	3-19	2-14	SW	3
				10							3-13	NE	3
						4					3-20	NE	9
									17	6-2		NE	6
							8		6	3-20		S	6
	9			7		1	2					NE	2
	12									2-14	3-19	NE	6
1										6-4		W	1
				18							3-20	NE	9
	7			4						2-14		NE	4
6										3-11	2-14 5-16	W	5
	10			15							2-5	N	7
							5	5			3-20 2-6	NW	4
	7											NE	12
	5								3		6-9	NE	5
									5		3-20 6-7	NE	8
	10									2-14	3-20	NE	10
2						1	4	5	6	5-1	6-16	SW	5
							5	2	15	2-14	3-11	NE	6
11										3-12	5-16	SW	3
	10			7						6-7		NE	5
				2						2-14		NE	1

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1897												
Feb. 15	30.00	38.2	36.0	.187	29.80	50.5	45.0	.237	29.72	48.0	44.5	.254
	762.0	**3.4**	**2.2**	**4.73**	**756.9**	**10.3**	**7.2**	**6.02**	**754.9**	**8.9**	**6.7**	**6.21**
16	29.79	41.8	37.2	.171	29.88	43.2	37.0	.151	30.01	40.0	35.5	.157
	756.7	**5.4**	**2.9**	**4.36**	**759.0**	**6.2**	**2.8**	**3.86**	**762.3**	**4.4**	**1.9**	**4.27**
17	30.07	34.4	34.0	.191	29.94	57.0	46.0	.188	29.87	54.7	45.2	.196
	763.8	**1.3**	**1.1**	**4.84**	**760.5**	**13.9**	**7.8**	**4.80**	**758.7**	**12.6**	**7.3**	**4.95**
18	29.94	44.5	41.0	.217	29.96	51.2	44.0	.208	30.09	39.5	38.0	.211
	760.5	**6.9**	**5.0**	**5.55**	**761.0**	**10.7**	**6.7**	**5.29**	**764.3**	**4.2**	**3.3**	**5.33**
19	30.30	33.0	30.7	.144	30.34	41.0	35.0	.136	30.43	38.0	32.0	.113
	769.6	**0.6**	**— 0.7**	**2.05**	**770.6**	**5.0**	**1.7**	**3.68**	**772.9**	**3.3**	**0.0**	**2.78**
23	29.77	38.8	38.0	.220	29.89	47.0	41.0	.190	30.00	41.0	36.0	.156
	756.2	**3.8**	**3.3**	**5.53**	**759.2**	**8.3**	**5.0**	**4.80**	**762.0**	**5.0**	**2.2**	**3.93**
24	30.30	32.0	27.8	.102	30.28	39.0	32.0	.102	30.28	37.5	33.0	.136
	769.6	**0.0**	**— 2.3**	**2.71**	**769.1**	**3.9**	**0.0**	**2.58**	**769.1**	**3.1**	**0.6**	**3.49**
25	30.19	31.0	30.0	.153	30.04	41.0	.....	.....	30.04	42.0	38.0	.184
	766.8	**— 0.6**	**— 1.1**	**3.97**	**763.0**	**5.0**	.....	.....	**763.0**	**5.6**	**3.3**	**4.61**
26	30.20	32.0	29.5	.132	30.17	42.0	37.0	.164	30.31	28.0	27.5	.140
	767.1	**0.0**	**— 1.4**	**3.42**	**766.3**	**5.6**	**2.8**	**4.15**	**769.9**	**— 2.2**	**— 2.5**	**3.66**
Mar. 1	30.73	33.2	32.0	.163	30.60	40.0	35.0	.147	30.47	40.2	36.7	.177
	780.5	**0.7**	**0.0**	**4.22**	**777.2**	**4.4**	**1.7**	**3.76**	**773.9**	**4.6**	**2.6**	**4.46**
2	30.29	46.3	43.0	.240	30.18	62.2	52.0	.273	30.14	58.0	51.0	.296
	769.4	**7.9**	**6.1**	**6.09**	**766.6**	**16.7**	**11.1**	**6.98**	**765.6**	**14.4**	**10.6**	**7.58**
3	29.97	55.3	53.3	.384	29.87	58.0	56.0	.426	29.95	58.0	52.0	.321
	761.2	**12.9**	**11.8**	**9.74**	**758.7**	**14.4**	**13.3**	**10.80**	**760.7**	**14.4**	**11.1**	**8.16**
8	30.62	31.0	30.5	.162	30.48	38.0	35.0	.169	30.40	37.8	35.8	.187
	777.8	**— 0.6**	**— 0.8**	**4.21**	**774.2**	**3.3**	**1.7**	**4.28**	**772.2**	**3.2**	**2.1**	**4.74**
10	29.75	51.2	50.2	.349	29.76	62.0	53.0	.303	30.02	49.2	43.7	.223
	755.7	**10.7**	**10.1**	**8.90**	**755.9**	**16.7**	**11.7**	**7.73**	**762.5**	**9.6**	**6.5**	**5.65**
11	30.19	36.8	35.0	.184	30.14	58.0	45.0	.154	30.10	52.0	43.0	.178
	766.8	**2.7**	**1.7**	**4.64**	**765.6**	**14.4**	**7.2**	**3.89**	**764.5**	**11.1**	**6.1**	**4.49**
12	29.82	40.0	39.0	.226	29.64	54.3	50.0	.314	29.70	58.0	54.0	.374
	757.4	**4.4**	**3.9**	**5.78**	**752.9**	**11.8**	**10.0**	**8.24**	**754.4**	**14.4**	**12.2**	**9.47**
13	30.15	35.5	31.7	.136	30.23	45.7	39.0	.164	30.28	42.0	37.0	.163
	765.8	**1.9**	**— 0.2**	**3.44**	**767.8**	**7.6**	**3.9**	**4.15**	**769.1**	**5.6**	**2.8**	**4.15**
15	30.44	37.0	33.0	.142	30.45	45.6	38.0	.143	30.44	45.5	39.0	.164
	773.2	**2.8**	**0.6**	**3.63**	**773.4**	**7.6**	**3.3**	**3.58**	**773.2**	**7.5**	**3.9**	**4.18**
16	30.60	36.0	32.0	.135	30.59	44.0	37.0	.140	30.60	38.0	32.0	.113
	777.2	**2.2**	**0.0**	**3.43**	**777.0**	**6.7**	**2.8**	**3.57**	**777.2**	**3.3**	**0.0**	**2.87**
17	30.61	31.2	28.7	.131	30.46	45.0	40.0	.191	30.34	44.0	40.5	.211
	777.5	**— 0.4**	**— 1.8**	**3.28**	**773.7**	**7.2**	**4.4**	**4.80**	**770.6**	**6.7**	**4.7**	**5.34**
20	29.55	46.4	46.4	.315	29.53	72.0	66.0	.573	29.66	55.5	54.0	.406
	750.6	**8.0**	**8.0**	**7.99**	**750.1**	**22.2**	**18.9**	**14.58**	**753.4**	**13.1**	**12.2**	**10.12**
22	29.93	50.0	48.0	.312	29.83	77.0	65.0	.516	29.88	65.7	59.2	.431
	760.2	**10.0**	**8.9**	**7.93**	**757.7**	**25.0**	**18.3**	**12.24**	**759.0**	**18.7**	**15.1**	**10.94**

Table 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu.	Ci. S.	Ci.				
.....	.....	.....	.....	10	.....	.....	.....	.....	.....	.....	6–7	W	4
.....	13	.....	.....	10	.....	.....	.....	.....	.....	.....	3–11	E	6
.....	.....	.....	.....	.....	.....	5	.....	.....	.....	6–9	2–14	NW	8
.....	.....	.....	.....	10	.....	.....	10	.....	.....	6–17	3–20	NE	2
.....	.....	.....	.....	.....	.....	.....	21	.....	4	2–7	3–19	NE	4
.....	15	.....	.....	.....	.....	.....	3	.....	3	.....	3–11	NE	5
.....	9	.....	.....	.....	.....	.....	.....	.....	.....	2–7	3–20 2–14	NE	6
.....	.....	.....	.....	.....	.....	9	.....	.....	.....	.....	6–9	N	2
.....	.....	.....	.....	10	1	7	.....	.....	.....	.....	.....	NE	2
.....	.....	.....	.....	1	1	17	.....	.....	.....	3–12	2–14	W	9
.....	.....	.....	.....	.....	.....	10	2	4	13	6–9 2–14	3–20 5–15	W	2
3	.....	.....	10	.....	3	.....	.....	.....	.....	6–9	3–5	N	8
6	.....	.....	.....	3	.....	.....	.....	.....	7	3–20	.....	W	4
3	1	.....	.....	7	.....	.....	.....	10	.....	.....	3–5	N	3
.....	.....	.....	.....	.....	.....	.....	7	.....	11	6–3	.....	NE	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	1	3–19	2–6	N	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	19	.....	3–20	NE	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	18	2–7	.....	NE	3
.....	3	.....	.....	.....	.....	.....	2	.....	25	2–13	.....	NE	4
.....	7	.....	.....	.....	.....	.....	.....	.....	10	3–1	.....	W	4
.....	20	.....	10	.....	.....	.....	.....	.....	.....	.....	2–6	NW	5
.....	4	.....	.....	5	.....	6	2	.....	5	.....	2–7	NW	4

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates.	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1897												
Mar. 23	29.78	58.0	55.0	.399	29.63	65.0	59.0	.434	29.53	62.5	59.5	.475
	756.4	**14.4**	**12.8**	**10.18**	**752.6**	**18.3**	**15.0**	**11.02**	**750.1**	**16.9**	**15.3**	**12.12**
24	29.39	45.0	43.0	.255	29.38	50.0	41.0	.158	29.47	46.0	37.5	.131
	746.5	**7.2**	**6.1**	**6.47**	**746.2**	**10.0**	**5.0**	**4.03**	**748.5**	**7.8**	**3.1**	**3.36**
25	29.64	37.0	31.0	.107	29.62	44.0	35.0	.105	29.72	39.7	31.2	.080
	752.9	**2.8**	**— 0.6**	**2.68**	**752.4**	**6.7**	**1.7**	**2.66**	**754.9**	**4.3**	**— 0.4**	**2.10**
26	29.81	35.0	31.0	.128	29.80	43.0	36.0	.134	29.89	40.0	33.0	.110
	757.2	**1.7**	**0.6**	**3.22**	**756.9**	**6.1**	**2.2**	**3.39**	**759.2**	**4.4**	**0.6**	**2.85**
27	29.96	34.2	30.2	.122	29.97	46.0	38.0	.140	30.08	40.0	33.0	.110
	761.0	**1.2**	**— 1.0**	**3.14**	**761.2**	**7.8**	**3.3**	**3.51**	**764.0**	**4.4**	**0.6**	**2.84**
29	30.41	38.0	33.0	.131	30.32	56.0	45.0	.174	30.30	50.2	40.7	.147
	772.4	**3.3**	**0.6**	**3.39**	**770.1**	**13.3**	**7.2**	**4.45**	**769.6**	**10.1**	**4.8**	**3.71**
30	30.31	43.6	40.0	.207	30.21	64.0	49.0	.180	30.19	59.5	48.5	.217
	769.9	**6.4**	**4.4**	**5.21**	**767.3**	**17.8**	**9.4**	**4.49**	**766.8**	**15.3**	**9.2**	**5.55**
31	30.28	45.3	43.0	.252	30.29	55.0	43.0	.143	30.26	52.8	39.8	.099
	769.1	**7.4**	**6.1**	**6.35**	**769.4**	**12.8**	**6.1**	**3.59**	**768.6**	**11.6**	**4.3**	**2.47**
Apr. 1	30.47	40.0	33.0	.108	30.43	50.0	38.0	.093	30.42	48.0	39.0	.136
	773.9	**4.4**	**0.6**	**2.82**	**772.9**	**10.0**	**3.3**	**2.34**	**772.7**	**8.9**	**3.9**	**3.46**
2	30.38	42.2	36.0	.043	30.22	61.0	48.0	.189	30.20	54.0	42.5	.143
	771.7	**5.7**	**2.2**	**3.56**	**767.6**	**16.1**	**8.9**	**4.81**	**767.1**	**12.2**	**5.8**	**3.62**
3	30.31	48.0	40.0	.158	30.34	59.0	46.0	.164	30.41	50.0	41.0	.156
	769.9	**8.9**	**4.4**	**3.95**	**770.6**	**15.0**	**7.8**	**4.18**	**772.4**	**10.0**	**5.0**	**3.95**
5	29.88	47.0	47.0	.322	29.75	66.0	58.0	.383	29.68	65.0	55.0	.323
	759.0	**8.3**	**8.3**	**8.15**	**755.7**	**18.9**	**14.4**	**9.99**	**753.9**	**18.3**	**12.8**	**8.24**
6	29.81	53.8	50.0	.319	29.83	59.0	50.0	.271	29.95	52.3	44.0	.196
	757.2	**12.1**	**10.0**	**8.08**	**757.7**	**15.0**	**10.0**	**6.63**	**760.7**	**11.3**	**6.7**	**5.09**
7	30.06	47.6	44.0	.248	30.04	55.3	47.0	.231	30.07	56.0	48.5	.257
	763.5	**8.7**	**6.7**	**6.29**	**763.0**	**12.9**	**8.3**	**5.82**	**763.8**	**13.3**	**9.2**	**6.58**
8	30.17	48.5	45.0	.259	30.14	49.5	47.0	.294	29.99	46.5	45.5	.293
	766.3	**9.2**	**7.2**	**6.55**	**765.6**	**9.2**	**8.3**	**7.70**	**761.8**	**8.1**	**7.5**	**7.42**
9	29.62	46.0	46.0	.310	29.47	57.0	55.0	.410	29.62	54.5	47.0	.229
	752.4	**7.8**	**7.8**	**7.88**	**748.5**	**13.9**	**12.8**	**10.44**	**752.4**	**12.5**	**8.3**	**6.05**
10	29.95	42.4	38.0	.180	30.03	48.2	40.0	.157	30.08	47.2	39.2	.151
	760.7	**5.8**	**3.3**	**4.52**	**762.8**	**9.0**	**4.4**	**3.92**	**764.0**	**8.4**	**4.0**	**3.84**
12	30.42	45.0	42.2	.238	30.53	50.0	44.0	.222	30.58	47.0	42.0	.212
	772.7	**7.2**	**5.7**	**6.06**	**775.5**	**10.0**	**6.7**	**5.61**	**776.7**	**8.3**	**5.6**	**5.38**
13	30.57	42.0	40.0	.225	30.41	56.0	48.0	.247	30.26	54.5	48.5	.273
	776.5	**5.6**	**4.4**	**5.61**	**772.4**	**13.3**	**8.9**	**6.26**	**768.6**	**12.5**	**9.2**	**6.26**
14	30.13	60.0	56.0	.404	29.99	75.2	58.7	.310	29.96	65.0	57.5	.390
	765.3	**15.6**	**13.3**	**10.20**	**761.8**	**24.0**	**14.8**	**7.84**	**761.0**	**18.3**	**14.2**	**9.97**
15	29.84	50.5	50.0	.354	29.86	60.0	55.0	.377	29.98	50.5	44.5	.227
	757.9	**10.3**	**10.0**	**8.99**	**758.4**	**15.6**	**12.8**	**9.57**	**761.5**	**10.3**	**6.9**	**5.70**
16	30.03	46.5	40.0	.175	29.93	60.0	50.0	.249	29.88	58.0	51.0	.296
	762.8	**8.1**	**4.4**	**4.37**	**760.2**	**15.6**	**10.0**	**6.32**	**759.0**	**14.4**	**10.6**	**7.59**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu.	Ci. S.	Ci.				
3				9		7					**2–7**	W	1
	7			18		4					**3–4**	E	7
	27								2		**3–12**	NE	9
	30								6	**6–16**	**3–20**	NE	7
	41								3	**2–16**		E	3
									18	**6–3**		NE	5
									30	**2–13**		W	4
					2	8	6		14	**2–14**		S	4
									14	**2–13**		SW	8
							5		23	**6–3** **2–14**		NE	3
						2		1		**2–13**		SW	2
2	10			4					2	**3–19**	**2–14**	NW	3
	4			14			6		5		**3–13**	N	2
	5			7		10				**2–14**		NE	2
						6						SW	1
				7					3	**3–19** **2–14**	**6–2**	N	5
	10			10			4		10	**2–14**	**3–12**	NE	5
				9				3		**2–2**		W	2
11	2						2		16	**3–19**	**2–15**	NW	5
			10	8		10				**6–9**		NW	5
5		3									**3–4** **2–14**	E	4
	9			7		4			9		**2–6** **3–20**	NE	3

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1897												
Apr. 17	29.94	48.0	45.0	.265	29.96	53.0	45.0	.210	30.09	46.5	40.0	.175
	760.5	**8.9**	**7.2**	**6.71**	**761.0**	**11.7**	**7.2**	**5.30**	**764.3**	**8.1**	**4.4**	**4.36**
19	30.10	54.0	48.0	.268	30.00	71.0	55.0	.254	30.17	54.5	42.5	.137
	764.5	**12.2**	**8.9**	**6.70**	**762.0**	**21.7**	**12.8**	**6.82**	**766.3**	**12.5**	**5.8**	**3.48**
21	30.66	43.0	37.0	.152	30.57	57.0	44.0	.140	30.54	54.0	45.0	.197
	778.8	**6.1**	**2.8**	**3.87**	**776.5**	**13.9**	**6.7**	**3.59**	**775.7**	**12.2**	**7.2**	**4.99**
23	30.38	52.5	48.5	.295	30.27	75.0	56.0	.234	30.21	67.8	56.3	.324
	771.7	**11.4**	**9.2**	**7.53**	**768.9**	**23.9**	**13.3**	**5.92**	**767.3**	**19.9**	**13.5**	**8.24**
24	30.20	57.6	54.0	.378	30.09	83.5	64.0	.377	30.07	73.8	60.8	.388
	767.1	**14.2**	**12.2**	**9.55**	**764.3**	**28.6**	**17.8**	**9.62**	**763.8**	**23.2**	**16.0**	**9.85**
26	29.88	57.5	51.0	.301	29.79	69.0	54.0	.251	29.77	58.0	48.0	.224
	759.0	**14.2**	**10.6**	**7.69**	**756.7**	**20.6**	**12.2**	**6.34**	**756.2**	**14.4**	**8.9**	**5.74**
27	30.00	45.0	38.0	.151	29.99	55.0	41.3	.109	29.99	54.0	42.0	.133
	762.0	**7.2**	**3.3**	**3.81**	**761.8**	**12.8**	**5.2**	**2.75**	**761.8**	**12.2**	**5.6**	**3.44**
28	30.07	51.0	40.2	.131	29.96	67.5	49.0	.141	29.93	62.0	49.0	.203
	763.8	**10.6**	**4.6**	**3.29**	**761.0**	**19.7**	**9.4**	**3.55**	**760.2**	**16.7**	**9.4**	**5.13**
29	30.00	53.3	48.0	.276	29.93	68.0	53.5	.247	29.94	63.5	52.0	.259
	762.0	**11.8**	**8.9**	**7.03**	**760.2**	**20.0**	**11.9**	**6.26**	**760.5**	**17.5**	**11.1**	**6.60**
30	30.00	57.2	52.0	.330	29.97	72.0	63.0	.477	29.90	68.5	61.5	.468
	762.0	**14.0**	**11.1**	**8.37**	**761.2**	**22.2**	**17.2**	**12.06**	**759.5**	**20.3**	**16.4**	**11.89**
May 1	29.85	64.5	61.0	.497	29.68	62.2	62.0	.553	29.63	01.3	60.0	.413
	758.2	**18.1**	**16.1**	**12.59**	**753.9**	**16.8**	**16.7**	**14.07**	**752.6**	**16.3**	**15.6**	**12.82**
3	29.75	47.0	45.0	.276	29.75	47.0	45.0	.276	29.84	47.2	45.2	.279
	755.7	**8.3**	**7.2**	**7.02**	**755.7**	**8.3**	**7.2**	**7.02**	**757.9**	**8.4**	**7.3**	**7.06**
4	29.92	52.0	46.5	.255	29.92	60.0	53.0	.325	29.92	56.0	50.5	.306
	760.0	**11.1**	**8.1**	**6.53**	**760.0**	**15.6**	**11.7**	**8.26**	**760.0**	**13.3**	**10.3**	**7.80**
5	29.94	52.0	50.0	.338	29.96	59.0	53.0	.336	29.95	60.0	52.5	.312
	760.5	**11.1**	**10.0**	**8.58**	**761.0**	**15.0**	**11.7**	**8.56**	**760.7**	**15.6**	**11.4**	**7.91**
7	30.03	61.6	57.5	.428	30.02	74.0	62.0	.422	30.13	65.5	53.0	.269
	762.8	**16.4**	**14.2**	**10.93**	**762.8**	**23.3**	**16.7**	**10.78**	**765.3**	**18.6**	**11.7**	**6.72**
8	30.41	51.0	42.5	.172	30.37	63.0	52.0	.263	30.33	60.2	46.7	.166
	772.4	**10.6**	**5.8**	**4.43**	**771.4**	**17.2**	**11.1**	**6.71**	**770.4**	**15.7**	**8.2**	**4.25**
10	29.93	67.0	61.5	.484	29.80	80.0	64.0	.418	29.90	72.5	63.0	.476
	760.2	**19.4**	**16.4**	**12.34**	**756.9**	**26.7**	**17.8**	**10.66**	**759.5**	**22.5**	**17.2**	**11.91**
11	30.02	66.0	60.0	.451	30.02	71.0	64.0	.518	29.94	69.0	63.0	.509
	762.5	**18.9**	**15.6**	**11.50**	**762.5**	**21.7**	**17.8**	**13.16**	**760.5**	**20.6**	**17.2**	**12.86**
12	29.90	66.0	65.0	.605	29.83	76.0	69.0	.630	29.85	71.0	67.0	.617
	759.5	**18.9**	**18.3**	**15.32**	**757.7**	**24.4**	**20.6**	**16.11**	**758.2**	**21.7**	**19.4**	**15.57**
13	29.78	66.5	65.5	.616	29.82	61.5	61.0	.530	29.92	63.0	61.5	.528
	756.4	**19.2**	**18.6**	**15.62**	**757.4**	**18.4**	**16.1**	**12.44**	**760.0**	**17.2**	**16.4**	**13.46**
14	29.91	61.0	60.0	.506	29.83	73.0	.....	.....	29.89	61.0	60.5	.520
	759.7	**16.1**	**15.6**	**12.92**	**757.7**	**22.8**	.....	.....	**759.2**	**16.1**	**15.8**	**13.19**
15	30.10	56.0	53.0	.369	30.11	66.0	57.0	.366	30.08	60.0	54.0	.351
	764.5	**13.3**	**11.7**	**9.42**	**764.8**	**18.9**	**13.9**	**9.27**	**766.6**	**15.6**	**12.2**	**8.34**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu.	Ci. S.	Ci.				
.....	20	.....	.....	5	.....	3	.....	.....	.....	5-15	3-12	N	3
.....	3	.....	.....	15	1	.....	.....	.....	.....	6-16	3-13	N	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	19	6-3	.....	W	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	18	6-3	2-14	NW	4
.....	20	.....	.....	.....	.....	.....	.....	.....	.....	6-8	.....	NW	4
.....	.....	.....	.....	8	.....	.....	4	26	4	.....	2-6	NW	3
.....	10	.....	.....	.....	.....	.....	.....	.....	.....	2-6	3-12	N	5
.....	.....	.....	.....	.....	2	7	.....	1	20	2-2	3-11	NE	6
.....	.....	.....	.....	.....	.....	17	8	.....	5	.....	3-12 5-15	W	7
6	2	.....	.....	10	.....	10	.....	.....	.....	2-14	6-8	SW	4
1	.....	.....	.....	11	.....	.....	.....	.....	.....	3-20	.....	SW	5
3	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	2-1	NW	1
.....	.....	.....	3	7	.....	.....	.....	.....	10	5-15	3-12	NE	8
10	10	.....	.....	2	.....	.....	.....	.....	12	5-15	6-4	E	4
.....	2	.....	.....	2	.....	18	.....	.....	8	6-8 2-13	.....	NE	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	20	3-5	.....	SW	4
.....	10	.....	.....	10	2	6	.....	.....	2	6-9	3-5	N	4
.....	.....	.....	.....	10	.....	.....	.....	10	.....	6-9	2-14	NW	3
13	4	.....	.....	.....	2	12	1	.....	2	3-20 6-9	2-6	NW	7
9	.....	.....	.....	.....	.....	2	.....	3	.....	.....	2-14	NW	9
11	.....	.....	.....	.....	.....	.....	2	3	5	.....	2-5	N	6
.....	14	.....	.....	.....	.....	.....	.....	9	2	5-15	3-20	NE	2

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates.	8. a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1897												
May 17	30.27	59.0	52.0	.309	30.24	68.0	53.0	.233	30.23	62.0	54.5	.340
	768.9	**15.0**	**11.1**	**7.84**	**768.1**	**20.0**	**11.7**	**5.98**	**767.8**	**16.7**	**12.5**	**8.65**
18	30.28	59.0	52.5	.321	30.25	73.0	59.0	.342	30.21	70.0	59.0	.376
	769.1	**15.0**	**11.4**	**8.19**	**768.4**	**22.8**	**15.0**	**8.66**	**767.3**	**21.1**	**15.0**	**9.70**
19	30.31	67.0	58.0	.382	30.26	78.0	65.0	.470	30.23	71.5	61.5	.433
	769.9	**19.4**	**14.4**	**9.63**	**768.6**	**25.6**	**18.3**	**11.88**	**767.8**	**21.9**	**16.4**	**11.06**
20	30.16	64.0	58.0	.416	29.96	80.5	66.5	.493	29.86	75.1	65.1	.508
	766.1	**17.8**	**14.4**	**10.46**	**761.0**	**26.9**	**19.2**	**12.63**	**758.4**	**23.9**	**18.4**	**12.96**
21	29.77	67.0	61.5	.484	29.72	75.0	65.0	.506	29.83	64.0	56.5	.373
	756.2	**19.4**	**16.4**	**12.35**	**754.9**	**23.9**	**18.3**	**12.82**	**757.7**	**17.8**	**13.6**	**9.47**
24	29.94	64.0	62.5	.548	29.90	74.5	68.0	.612	29.92	59.0	59.0	.499
	760.5	**17.8**	**16.9**	**13.85**	**759.5**	**23.6**	**20.0**	**15.54**	**760.0**	**15.0**	**15.0**	**12.67**
25	30.02	58.0	53.0	.347	30.08	64.0	57.0	.388	30.14	58.0	51.5	.308
	762.5	**14.4**	**11.7**	**8.87**	**764.0**	**17.8**	**13.9**	**9.83**	**765.6**	**14.4**	**10.8**	**7.81**
26	30.23	54.6	49.0	.286	30.21	63.5	52.0	.258	30.17	59.0	52.0	.310
	767.8	**12.6**	**9.4**	**7.15**	**767.3**	**17.5**	**11.1**	**6.57**	**766.3**	**15.0**	**11.1**	**7.85**
28	29.98	59.0	52.0	.310	29.85	74.0	57.0	.277	29.79	71.0	59.0	.367
	761.5	**15.0**	**11.1**	**7.86**	**758.2**	**23.3**	**13.9**	**7.05**	**756.7**	**21.7**	**15.0**	**9.32**
29	29.81	59.0	51.0	.174	29.86	63.5	53.0	.286	29.90	59.5	52.0	.310
	757.2	**15.0**	**10.6**	**7.30**	**758.4**	**17.5**	**11.7**	**7.32**	**759.5**	**15.3**	**11.1**	**7.71**
June 1	30.04	62.0	57.0	.410	30.09	68.0	60.0	.429	30.12	63.2	52.0	.263
	763.0	**16.7**	**13.9**	**10.41**	**764.3**	**20.0**	**15.6**	**10.94**	**765.1**	**17.3**	**11.1**	**6.68**
2	30.29	56.5	51.0	.311	30.21	70.0	60.0	.405	30.14	67.3	59.3	.416
	769.4	**13.6**	**10.6**	**7.97**	**767.3**	**21.1**	**15.6**	**10.38**	**765.6**	**19.6**	**15.2**	**10.61**
3	30.05	68.5	65.0	.577	29.94	82.0	73.0	.721	29.92	73.0	70.0	.699
	763.3	**20.3**	**18.3**	**14.61**	**760.5**	**28.8**	**22.8**	**17.58**	**760.0**	**22.8**	**21.1**	**17.72**
4	29.91	73.5	70.0	.693	29.83	84.0	72.0	.651	29.86	69.3	68.8	.697
	759.7	**23.1**	**21.1**	**17.57**	**757.7**	**28.9**	**22.2**	**17.50**	**758.4**	**20.7**	**20.4**	**17.65**
5	29.94	62.5	61.5	.534	29.95	71.0	63.0	.487	29.96	67.5	63.0	.525
	760.5	**16.9**	**16.4**	**13.61**	**760.7**	**21.7**	**17.2**	**12.31**	**761.0**	**19.7**	**17.2**	**13.22**
7	30.21	58.0	56.5	.439	30.17	58.0	57.5	.484	30.16	58.2	55.2	.402
	767.8	**14.4**	**13.6**	**11.18**	**766.3**	**14.4**	**14.2**	**11.94**	**766.1**	**14.6**	**12.9**	**10.20**
9	30.06	60.0	59.0	.488	30.04	67.0	65.0	.594	30.04	66.0	63.0	.542
	763.5	**15.6**	**15.0**	**12.37**	**763.0**	**19.4**	**18.3**	**15.06**	**763.0**	**18.9**	**17.2**	**13.72**
10	30.07	62.5	59.0	.460	30.05	70.0	62.0	.467	30.04	69.0	62.0	.478
	763.8	**16.9**	**15.0**	**11.71**	**763.3**	**21.1**	**16.7**	**11.89**	**763.0**	**20.6**	**16.7**	**12.15**
11	30.09	65.0	60.0	.462	30.01	76.0	62.0	.399	29.96	72.5	65.5	.550
	764.3	**18.3**	**15.6**	**11.80**	**762.3**	**24.4**	**16.7**	**10.21**	**761.0**	**22.5**	**18.6**	**13.95**
12	29.85	73.5	68.0	.623	29.82	82.0	67.0	.495	29.81	75.0	61.0	.381
	758.2	**23.1**	**20.0**	**15.80**	**757.4**	**28.8**	**19.4**	**12.17**	**757.2**	**23.9**	**16.1**	**9.67**
14	29.88	68.5	65.5	.594	29.91	81.0	65.0	.449	29.91	75.2	65.2	.511
	759.0	**20.3**	**18.6**	**15.06**	**759.7**	**27.2**	**18.3**	**11.11**	**759.7**	**24.0**	**18.4**	**12.89**
15	29.97	68.5	63.0	.514	29.89	87.5	71.0	.574	29.89	70.0	67.0	.628
	761.2	**20.3**	**17.2**	**13.01**	**759.2**	**30.8**	**21.7**	**14.66**	**759.2**	**21.1**	**19.4**	**15.87**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu.	Ci. S.	Ci.				
.....	17	.....	.....	.....	.....	.....	.....	.....	.....	2–7	.....	SE	2
.....	21	.....	.....	.....	2	.....	.....	.....	.....	6–7	3–20	NE	3
.....	10	.....	.....	.....	1	.....	.....	.....	.....	6–7	.....	NE	3
.....	.....	.....	.....	.....	.....	.....	.....	1	8	3–19 6–16	2–6	N	6
4	2	9	5	.....	2	.....	.....	6	3	2–14	3–20	NE	4
6	11	.....	.....	.....	3	3	.....	.....	.....	.....	2–5	N	3
.....	26	.....	.....	10	.....	.....	.....	.....	.....	2–14	3–4	NE	20
.....	28	.....	.....	.....	.....	.....	.....	.....	.....	2–14	3–11	E	4
.....	.....	.....	.....	6	.....	.....	.....	.....	21	6–16	3–12	NE	6
.....	3	.....	.....	.....	.....	.....	.....	3	19	.....	3–20	N	4
.....	10	.....	.....	5	.....	4	.....	.....	10	2–14	3–20	NE	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	7	6–1 2–15	3–20	NE	1
11	9	.....	.....	10	.....	.....	.....	.....	.....	6–10	2–6	NW	8
4	3	.....	4	.....	.....	6	.....	.....	4	.....	2–14	N	2
.....	10	.....	.....	.....	3	4	2	.....	10	3–20	.....	NE	2
6	.....	.....	.....	.....	.....	.....	.....	.....	.....	3–20	6–8	W	6
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	3–12	.....	S	1
.....	20	.....	.....	5	.....	.....	.....	.....	6	2–6	3–12	NE	7
.....	25	.....	.....	6	.....	.....	.....	.....	.....	6–2	3–20	NE	4
.....	2	.....	.....	6	.....	12	.....	.....	10	6–16	.....	NE	2
.....	18	.....	.....	.....	.....	.....	.....	5	2	6–16	.....	NE	4
.....	.....	.....	1	.....	.....	14	.....	3	3	6–8	3–20	NE	4

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Dates	8 a. m.				2 p. m.				8 p. m.			
	B	*t*	t_1	*e*	*B*	*t*	t_1	*e*	*B*	*t*	t_1	*e*
1897												
June 16	29.90	75.0	69.5	.646	29.88	86.5	73.0	.650	29.89	76.0	71.0	.702
	759.5	**23.9**	**20.8**	**16.67**	**759.0**	**30.3**	**22.8**	**16.82**	**759.2**	**24.4**	**21.6**	**17.75**
17	29.89	71.0	65.0	.550	29.77	74.5	70.0	.682	29.78	65.0	64.5	.600
	759.2	**21.7**	**18.3**	**13.90**	**756.2**	**23.6**	**21.1**	**17.34**	**756.4**	**18.3**	**18.1**	**15.33**
18	29.87	64.5	63.5	.574	29.94	75.0	68.0	.607	29.99	72.7	67.2	.604
	758.7	**18.1**	**17.5**	**14.56**	**760.5**	**23.9**	**20.0**	**15.39**	**761.8**	**22.6**	**19.6**	**15.42**
19	30.09	68.0	65.0	.583	30.04	79.0	63.0	.397	29.99	75.0	66.0	.538
	764.3	**20.0**	**18.3**	**14.76**	**763.0**	**26.1**	**17.2**	**10.06**	**761.8**	**23.9**	**18.9**	**13.70**
21	30.00	59.0	52.0	.310	30.00	69.0	57.0	.332	29.97	67.0	58.0	.383
	762.0	**15.0**	**11.1**	**7.86**	**762.0**	**20.6**	**13.9**	**8.43**	**761.2**	**19.4**	**14.4**	**9.67**
22	30.05	63.0	57.0	.399	30.03	72.0	61.0	.414	29.98	72.0	63.0	.476
	763.3	**17.2**	**13.9**	**10.13**	**762.8**	**22.2**	**16.1**	**10.51**	**761.5**	**22.2**	**17.2**	**12.05**
23	30.01	69.0	61.0	.448	29.97	76.0	71.0	.702	30.01	72.5	67.0	.600
	762.3	**20.6**	**16.1**	**11.33**	**761.2**	**24.4**	**21.7**	**17.89**	**761.3**	**22.5**	**19.4**	**15.16**
24	29.99	71.0	68.0	.651	29.88	84.0	78.0	.891	29.90	75.0	72.0	.750
	761.8	**21.7**	**20.0**	**16.50**	**759.0**	**28.9**	**25.6**	**22.70**	**759.5**	**23.9**	**22.2**	**19.01**
25	29.87	78.0	72.5	.736	29.84	90.0	74.0	.662	29.82	85.0	72.0	.640
	758.7	**25.6**	**22.5**	**18.67**	**757.9**	**32.2**	**23.3**	**16.75**	**757.4**	**29.4**	**22.2**	**16.24**
26	29.98	69.0	62.0	.478	30.01	77.0	64.0	.451	30.03	72.5	63.0	.470
	761.5	**20.6**	**16.7**	**12.15**	**762.3**	**25.0**	**17.8**	**11.49**	**762.8**	**22.5**	**17.2**	**11.90**
28	30.22	64.5	60.5	.482	30.07	69.5	64.5	.551	30.14	70.2	65.2	.566
	767.6	**18.1**	**15.8**	**12.18**	**763.8**	**20.8**	**18.1**	**14.06**	**765.6**	**21.2**	**18.4**	**14.40**
29	30.13	73.0	69.0	.663	30.04	81.0	73.0	.722	29.98	80.0	73.0	.733
	765.3	**22.8**	**20.6**	**16.89**	**763.0**	**27.2**	**22.8**	**18.38**	**761.5**	**26.7**	**22.8**	**18.64**
30	29.85	81.5	73.5	.736	29.82	90.3	74.0	.661	29.82	84.5	71.0	.608
	758.2	**27.5**	**23.1**	**18.77**	**757.4**	**32.4**	**23.3**	**16.85**	**757.4**	**29.2**	**21.7**	**15.49**

TABLE 129.—*Meteorological data for Washington, D. C., in English and metric measures—Dates of the cloud observations with the theodolites*—Continued.

Kind of cloud and number of observations taken.										High.	Low.	Gradient.	
S.	Cu.	N.	Cu. N.	S. Cu.	A. S.	A. Cu.	Ci. Cu.	Ci. S.	Ci.				
.....	6	.....	2	8	1	5	1	3	6	2–14	3–20	NE	3
.....	.....	7	.....	2	5	4	.....	.....	.....	6–17	2–14	W	2
8	4	.....	.....	.....	.....	3	3	.....	10	2–14	3–20	W	2
.....	3	.....	8	.....	11	11	.....	.....	.....	2–4	.....	W	3
.....	20	.....	.....	.....	.....	.....	.....	.....	.....	2–7	3–20	NE	3
.....	5	.....	.....	.....	.....	.....	.....	.....	15	3–2	.....	NW	2
5	10	.....	.....	.....	1	.....	.....	.....	11	6–9	.....	NW	4
9	.....	.....	11	.....	8	7	2	.....	9	6–16	2–13	NW	3
.....	5	.....	7	.....	.....	4	.....	.....	2	.....	3–20	NE	3
.....	8	.....	.....	11	2	4	.....	.....	6	2–14	3–20	E	4
13	.....	.....	.....	.....	.....	.....	.....	.....	.....	6–2	3–20	W	2
10	.....	.....	.....	5	.....	13	.....	.....	2	6–9	2–14	NW	4
.....	9	.....	.....	2	3	.....	.....	9	6	3–20	3–13	N	4

Table 129 of this meteorological data gives, for the selected hours 8 a. m., 2 p. m. and 8 p. m., in the first column the dates upon which any clouds were observed with the theolodites; in the columns headed $B.t.t_1.e.$ the pressure, the dry-bulb temperature, the wet-bulb temperature, and the vapor tension in both English and metric measures, the latter alone being adapted to the tables through which the computations are conducted; under the columns headed "Kind of cloud" and "Number of observations," the cloud types and the number of individual heights determined, as for example on May 6, 1896, two cumulus and four cirrus settings; in the columns headed "High," "Low," the area occupied by the Washington station with reference to the barometric center, as previously explained, where the United States is subdivided into six districts, Chart 10, and the region surrounding a high or low center into twenty subareas, Chart 9; thus May, 6, 1896, high 3–20, means that the high barometer center was in the New England district, and that Washington was located in the area 20. On other dates similar positions are shown, and a further collection of similar recurrent data could be taken together, as for instance, all the high 3–20 for cumulus, which might be assembled and discussed as a problem pertaining to that special area. The last column under the heading "Gradient," requires a further explanation. By gradient is understood the direction and the amount by which barometric pressure diminishes in going from a high toward a low area. The letters NW., W., etc., show the direction of the maximum pressure fall from Washington on the given date. On May 6, 1896, the pressure fell most rapidly to the northwest of Washington, showing that a low area was somewhere to the west or northwest. It is often very difficult to decide what direction and what amount of gradient should be assigned, from among the many interpretations of a map which are rendered possible by the irregular configurations occurring in the trend of the isobars at the station, and the position of the high and low centers. On May 6, 1896, a high area was central in New England, and a low area was on the northern Rocky Mountain slope, while Washington was on the southern edge of the curving isobars, and the direction might there have been taken SE., on the supposition that another low area was located over the South Atlantic Ocean. However, there is some reason always for the direction selected, and in this case it was to show that the gradient trended toward the visible low area on the maps.

The scale of the gradient numbers has been selected for convenience, and is determined by the definition of gradient as $\frac{\Delta B}{dx}=\frac{G}{111}$ given in (48). If the gradient is 0.10 inch for 111 kilometers on the surface of the earth, this is the same as 0.10 inch for 11.1 millimeters on the weather map. Hence, for example, we have—

$$\frac{0.10}{11.1}=\frac{0.10}{11.1}$$
$$\frac{0.10}{22.2}=\frac{0.05}{11.1}$$
$$\frac{0.10}{28.0}=\frac{0.04}{1.11}$$
$$\frac{0.10}{37.0}=\frac{0.03}{11.1}$$

Thus the denominators of the first fraction are the scale distances for the interval between two successive isobars on the map, having the gradient per 11.1 millimeters expressed by the numerator of the second fraction. Therefore the rule is, divide 111 by 1, 2, 3, 4, 5, etc., to obtain the scale distances corresponding to 0.01, 0.02, 0.03 inch gradient respectively. The following scale and precept give the practical working of this system of gradient numbers; the results for Washington, D. C., are found in the last column of Table 129 for all of the dates of the cloud observations.

SCALE FOR MEASURING BAROMETRIC GRADIENTS ON THE UNITED STATES WEATHER MAP.

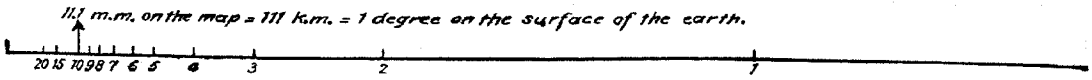

CHART 71.—Scale of relative gradient numbers.

The gradient=the barometer change in inches per 111 kilometers.
Scale number 10=0.10 inch per 11.1 millimeters.
Scale number 1=0.01 inch per 111 millimeters.

TABLE 130.—*Gradient numbers.*

Inch.	mm.	Inch.	mm.	Inch.	mm.	Inch.	mm.
0.01	111.0	0.06	18.5	0.11	10.0	0.16	6.9
.02	56.0	.07	16.0	.12	9.3	.17	6.5
.03	37.0	.08	14.0	.13	8.5	.18	6.2
.04	28.0	.09	12.3	.14	7.9	.19	5.8
.05	22.2	.10	11.1	.15	7.4	.20	5.6

Precept.—The isobars on the weather map are drawn 0.10 inch apart. If the perpendicular distance between two isobars is 11.1 mm. call the gradient number 10; if 22.2 mm. the gradient number is 5. Apply the end of this scale to an isobar, and read off the figure over the next isobar for the gradient number.

The gradient numbers express the hundredths of an inch barometer change per 111 kilometers on the surface of the earth, when the scale is laid perpendicular to two successive isobars on the map.

THE MEAN METEOROLOGICAL ELEMENTS AT WASHINGTON, D. C.

The mean meteorological element at Washington, D. C., for the days on which the several cloud types were observed, was next computed, putting the months in groups, as given by the dates indicated on Table 129. Thus for May, 1896, the cumulus were observed on May 6, 7, 11, 13, 15, 19, 26, 27, 28, 29; and for May, 1897, on May 3, 5, 7, 10, 12, 15, 17, 18, 19, 21, 24, 25, 26, 29, so that the mean values for all these dates were taken out for each of the three standard hours, and they were then transferred to the column for May under cumulus in Table 131. The other parts of this table were filled up in the same manner. The 2 p. m. data was omitted except from the cumulus, because it was not needed in the discussions of the other types of clouds. Then the mean of the 8 a. m. and 8 p. m. data was taken, and this gives a close approximation to the mean for the twenty-four hourly observations, which might otherwise have been extracted from the continuous registers, and specifies the average conditions for the day, or the series of days under consideration. What we want is the average meteorological condition prevailing during the formation of a given type of clouds from which to begin the computations pertaining to the α. β. γ. δ. stages of the vapor contents. The data for this table is therefore now ready for use in the calculations which follow in this chapter.

TABLE 131.—*The mean meteorological elements at Washington, D. C., for the days on which the several cloud types were observed.*

STRATUS.

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
8 a. m.	B	771.8	775.0	760.3	763.8	758.3	764.5	765.3	765.6	761.3	764.2	763.2	769.4
	t	−3.8	−4.4	9.4	9.6	16.1	18.7	22.6	24.4	17.1	10.3	13.5	2.0
	e	2.81	2.80	8.26	7.78	12.28	13.60	17.68	19.80	12.41	8.45	10.60	4.08
8 p. m.	B	767.1	769.4	761.4	760.9	758.3	763.2	763.8	764.8	759.2	761.4	763.0	766.6
	t	0.8	1.2	11.0	15.4	16.0	20.8	24.2	26.9	18.4	14.1	16.4	4.6
	e	4.49	4.24	7.67	8.02	11.52	15.31	17.75	16.97	13.26	8.60	10.59	5.03
Mean	B	769.4	772.2	760.8	762.4	758.3	763.8	764.6	765.2	760.2	762.8	763.1	768.0
	t	−1.5	−1.6	10.2	12.5	16.0	19.8	23.4	25.6	17.8	12.2	15.0	3.3
	e	3.65	3.52	7.96	7.90	11.90	14.46	17.72	18.38	12.84	8.52	10.60	4.56

TABLE 131.—*The mean meteorological elements at Washington, D. C., for the days on which the several cloud types were observed*—Continued.

CUMULUS.

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
8 a. m.	B	763.7	762.2	759.9	763.3	762.5	762.3	765.0	765.1	763.0	764.3	768.4	763.1
	t	−4.7	2.8	4.8	9.6	17.3	20.0	23.4	23.9	18.1	11.4	7.8	5.9
	e	2.37	4.21	5.23	6.11	10.96	14.02	17.05	16.32	12.29	7.55	7.68	4.02
2 p. m.	B	764.7	763.9	759.0	762.0	762.0	761.8	764.0	764.1	762.0	763.6	766.9	764.6
	t	−0.4	5.3	12.0	16.5	22.0	25.5	28.5	30.6	24.0	17.1	14.3	7.9
	e	2.33	3.72	6.28	6.86	10.58	13.73	17.00	15.28	12.07	7.39	7.92	4.36
8 p. m.	B	766.8	765.6	761.0	762.3	762.6	761.7	763.5	763.7	762.8	764.8	767.9	766.0
	t	−2.5	3.3	8.0	14.0	19.0	22.6	25.2	26.3	19.5	12.0	11.0	3.6
	e	2.07	3.76	5.12	6.42	10.29	14.03	18.32	16.46	13.45	7.37	7.42	3.75
Mean	B	765.2	763.9	760.4	762.8	762.6	762.0	764.2	764.4	762.9	764.6	768.2	764.6
	t	−3.6	3.0	6.4	11.8	18.2	21.3	24.3	25.1	18.8	11.7	9.4	4.8
	e	2.22	3.98	5.18	6.26	10.62	14.02	17.68	16.39	12.87	7.46	7.65	3.88

NIMBUS.

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
8 a. m.	B	.....	.....	.....	757.9	756.2	762.8	764.4	764.5	761.2	761.2	766.2	762.3
	t	.....	.....	.....	10.3	19.4	20.3	24.4	18.9	20.9	10.4	11.6	2.2
	e	.....	.....	.....	8.99	12.35	13.50	19.70	12.59	17.82	7.09	8.40	3.46
8 p. m.	B	.....	.....	.....	761.5	757.7	761.1	764.6	761.0	760.0	754.1	766.4	758.4
	t	.....	.....	.....	10.3	17.8	19.2	25.2	24.0	21.1	14.9	14.4	0.0
	e	.....	.....	.....	5.70	9.47	15.88	19.08	12.75	17.77	10.80	9.36	4.57
Mean	B	.....	.....	.....	759.7	757.0	762.0	764.5	762.8	760.6	757.6	766.3	760.4
	t	.....	.....	.....	10.3	18.6	19.8	24.8	21.4	21.0	12.6	13.0	1.1
	e	.....	.....	.....	7.34	10.91	14.69	19.39	12.67	17.80	8.94	8.88	4.02

CUMULO NIMBUS.

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
8 a. m.	B	.....	.....	755.5	765.3	760.9	761.5	762.5	758.4	761.1	.....	768.4	.....
	t	.....	.....	10.4	15.6	19.3	21.2	24.8	17.9	19.5	.....	11.7	.....
	e	.....	.....	8.86	10.20	13.03	15.88	18.77	12.69	14.35	.....	7.27	.....
8 p. m.	B	.....	.....	757.0	761.0	759.9	760.2	761.8	760.7	761.6	.....	764.5	.....
	t	.....	.....	13.8	18.3	19.5	22.6	25.1	20.6	20.5	.....	11.8	.....
	e	.....	.....	9.14	9.97	13.59	16.22	19.50	11.33	14.25	.....	5.04	.....
Mean	B	.....	.....	756.4	763.2	760.4	760.8	762.2	759.6	761.4	.....	766.4	.....
	t	.....	.....	12.1	17.0	19.4	21.9	25.0	19.2	20.0	.....	11.8	.....
	e	.....	.....	9.00	10.08	13.31	16.05	19.18	12.01	14.30	.....	6.16	.....

STRATO CUMULUS.

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
8 a. m.	B	758.4	763.9	762.8	761.6	761.6	762.7	762.8	764.2	762.7	766.5	768.7	765.5
	t	1.2	2.5	7.1	10.2	17.4	20.6	24.4	20.3	18.3	13.7	8.2	1.8
	e	3.59	4.28	6.98	7.08	11.58	13.72	18.24	14.10	12.46	10.14	7.52	3.90
8 p. m.	B	763.5	764.9	761.0	761.5	760.2	761.4	760.9	763.3	761.5	764.4	769.8	764.6
	t	2.0	2.8	10.1	13.3	19.2	22.4	25.1	22.3	19.9	18.4	10.7	5.0
	e	3.01	4.45	6.88	6.52	11.22	13.72	19.42	12.73	13.11	11.56	7.59	4.75
Mean	B	761.0	764.4	761.9	761.6	760.9	762.0	761.8	763.8	762.1	765.4	769.2	765.0
	t	1.6	2.6	8.6	11.8	18.3	21.5	24.8	21.3	19.1	16.0	9.4	3.4
	e	3.30	4.36	6.93	6.80	11.40	13.72	18.83	13.42	12.78	10.85	7.56	4.32

ALTO STRATUS.

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
8 a. m.	B	.....	767.1	767.0	764.2	762.0	760.8	764.1	762.6	765.2	763.0	768.8	769.4
	t	.....	0.0	6.4	11.4	19.2	21.3	24.0	23.6	17.8	13.0	2.4	−2.2
	e	.....	3.42	6.52	5.00	12.63	14.30	17.85	15.29	13.18	9.38	4.30	2.61
8 p. m.	B	.....	769.9	764.4	763.2	761.6	760.1	762.4	762.8	764.4	757.0	768.4	765.8
	t	.....	−2.2	11.2	14.6	21.0	22.5	26.2	23.2	20.9	18.3	3.9	2.4
	e	.....	3.66	6.14	4.30	11.90	14.52	19.28	15.20	11.25	11.98	5.67	4.08
Mean	B	.....	768.5	765.7	763.7	761.8	760.4	763.2	762.7	764.8	760.0	768.6	767.6
	t	.....	−1.1	8.8	13.0	20.1	21.9	25.1	23.4	19.4	15.6	3.2	−0.1
	e	.....	3.54	6.33	4.65	12.26	14.41	18.56	15.24	12.22	10.68	3.98	3.34

TABLE 131.—*The mean metecrological elements at Washington, D. C., for the days on which the several cloud types were observed*—Continued.

ALTO CUMULUS.

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
8 a. m.	*B*	760.6	768.6	763.7	764.0	762.1	762.3	764.0	763.3	762.9	762.9	769.6	767.2
	t	−4.1	−0.9	7.9	10.6	18.8	20.4	23.9	22.8	18.2	11.5	6.7	−0.3
	e	2.69	3.68	6.87	6.31	13.48	14.42	17.88	16.15	13.19	7.97	6.05	3.46
8 p. m.	*B*	764.0	764.9	761.0	762.5	761.5	761.3	762.9	762.8	762.8	761.8	770.6	765.9
	t	−0.4	4.4	12.3	14.1	19.8	22.3	25.3	24.2	20.2	13.9	11.0	3.6
	e	2.38	4.36	6.82	7.05	13.27	14.54	18.44	15.50	13.94	8.42	6.34	4.27
Mean	*B*	762.3	766.8	762.4	763.2	761.8	761.8	763.4	763.0	762.8	762.4	770.1	766.8
	t	−4.3	1.8	10.1	12.4	19.3	21.4	24.6	23.6	19.2	12.7	8.8	1.6
	e	2.54	4.02	6.84	6.68	13.38	14.48	18.16	15.82	13.56	8.20	6.20	3.86

CIRRO CUMULUS.

8 a. m.	*B*	763.6	764.1	768.5	764.5	761.8	762.4	764.5	763.2	760.7	762.3	769.4	765.8
	t	−2.4	1.6	6.0	9.2	19.5	20.3	23.9	22.2	18.3	10.8	3.9	0.6
	e	2.97	3.65	5.69	6.08	14.00	13.39	17.38	15.60	14.46	7.08	4.81	3.21
8 p. m.	*B*	765.9	765.8	767.0	762.8	760.5	761.5	763.2	762.9	759.2	763.8	768.6	766.8
	t	2.3	3.3	11.8	12.7	22.5	22.9	25.9	24.4	20.8	12.1	9.2	3.7
	e	3.42	3.86	5.67	5.19	14.90	14.55	17.93	14.31	15.26	6.69	5.61	3.47
Mean	*B*	764.8	765.0	767.8	763.6	761.2	762.0	763.8	763.0	760.0	763.0	769.0	766.3
	t	0.0	2.4	8.9	11.0	21.0	21.6	24.9	23.3	19.6	11.4	6.6	2.2
	e	3.20	3.76	5.68	5.64	14.45	13.97	17.66	14.96	14.86	6.88	5.21	3.34

CIRRO STRATUS.

8 a. m.	*B*	760.5	767.2	762.6	766.4	760.2	762.0	765.1	764.4	762.4	763.0	769.7	770.3
	t	1.1	−1.6	9.3	10.2	18.1	21.6	24.2	20.8	18.2	9.6	7.8	−2.4
	e	3.53	2.56	7.50	5.25	12.26	15.30	17.27	15.26	13.42	6.61	6.39	2.98
8 p. m.	*B*	754.9	764.8	764.0	766.4	760.2	761.0	762.2	765.2	761.6	762.9	770.2	768.2
	t	6.4	2.1	12.0	12.4	19.3	23.8	28.6	22.4	18.6	13.8	15.0	2.7
	e	4.28	3.63	6.62	5.05	11.78	15.57	19.19	10.95	11.66	6.64	7.28	3.65
Mean	*B*	757.7	766.0	763.3	766.4	760.2	761.5	763.6	764.8	762.0	763.0	770.0	769.2
	t	3.8	0.2	10.6	11.3	18.7	22.7	26.4	21.6	18.4	11.7	11.4	0.2
	e	3.90	3.10	7.06	5.15	12.02	15.44	18.23	13.10	12.54	6.62	6.84	3.32

CIRRUS.

8 a. m.	*B*	771.1	765.0	767.2	765.3	762.0	762.0	764.1	764.6	766.0	762.0	769.0	768.2
	t	−7.3	0.3	3.6	8.6	17.7	20.5	24.0	23.3	16.5	13.1	7.3	−1.3
	e	2.08	3.18	4.43	5.72	10.47	13.42	17.34	16.01	11.23	8.09	6.38	2.82
8 p. m.	*B*	770.2	766.1	765.9	762.9	761.0	761.4	762.6	763.1	764.8	762.0	767.5	767.5
	t	−3.2	3.1	9.0	13.8	20.4	23.1	26.1	25.8	18.8	14.2	12.9	2.2
	e	2.97	3.49	4.89	5.76	10.86	13.97	18.02	15.90	11.43	9.31	6.94	3.34
Mean	*B*	770.6	765.6	766.6	764.1	761.5	761.7	763.4	763.8	765.4	762.0	768.2	767.8
	t	−5.2	1.7	6.3	11.2	19.0	21.8	25.0	24.6	17.6	13.6	10.1	0.4
	e	2.52	3.34	4.66	5.74	10.66	13.70	17.68	15.96	11.33	8.70	6.66	3.08

THE CUMULUS CLOUDS. THE ADIABATIC AND THE ACTUAL CONDITIONS OF THE ATMOSPHERE.

We next collect together the cumulus observations already given in Table 6 in such a form as will facilitate the detailed analysis in the computation of the pressure, temperature, vapor tension at the base of the cloud, at the freezing stage, and at the top of the cloud, together with the heights at which the transitions from one stage to another take place, and the gradients connecting the same. Also the constants belonging to each stage will be found, and their constituent parts, so that by further computation from the analytic terms of the formulæ the several physical quantities which are involved can be determined accurately. Furthermore, it is proposed to obtain such data as will enable us with a minimum of work to set out from the surface conditions and arrive at the conditions prevailing at the cloud in the actual state of the atmosphere, so as to construct a regular daily weather map at the 3,500-foot level or other levels. Since it is hardly practicable to make daily kite ascensions regularly and simultaneously at any large number of stations, because these depend upon the prevailing wind and weather, including the high winds and calms, the freezing weather and rain, it is proper to utilize the occasional results obtained by means of direct observations with the meteorographs transported aloft by kites or balloons to determine the average laws of the air, which will always approximately give us the required elements at the assigned level. In order to accomplish this purpose it is not possible to apply the Weather Bureau Tables 94–102, which are developed from the thermodynamic theory under the adiabatic limitations directly to the atmosphere, because this would imply that adiabatic conditions really prevail in the vertical direction, and such is by no means the fact. The computation of the divergence between the adiabatic laws and the average laws prevailing in the atmosphere under the existing very complicated surface conditions has been a work of considerable labor and difficulty. The cause of this is that it was possible only by a series of approximations involving two or three repetitions of the complex computations to arrive at such self-consistent data as could be checked and proved to be correct by independent processes. The practical value of such results, however, would justify a much larger effort than has actually been spent up to this time. It is thought that the processes here presented have been so far tested and proved, and that a first survey at least of the aspects of the problem and the relations of the several quantities to each other have been so far developed, as to render it comparatively simple hereafter to bring the subject to a state of great refinement by means of additional observations and computations. For this purpose it is most important to secure direct observations of the pressure, temperature, and vapor tension at the base of the cumulus clouds, since this is the key to the solution of these allied problems. Some practical remarks will be added when the details of the subject have been more fully developed in the following pages.

TABLE 132.—*Cumulus.*

Date	A. M.												Midday												P. M.											
	Base			Top			Dome			Vel.			Base			Top			Dome			Vel.			Base			Top			Dome			Vel.		
	T	N	H	T	N	H	T	N	H	N	V		T	N	H	T	N	H	T	N	H	N	V		T	N	H	T	N	H	T	N	H	N	V	
1897																																				
Jan. 11																2.0	6	2161	1.4	3	2621	1	15.9													
12				10.9	7	1818																						3.4	5	1954						
19																1.6	7	1629																		
21																1.3	10	1419				2	17.2													
23				9.0	7	1344																														
25				10.3	5	1293																														
29													1.00	1	1028	1.3	9	1332																		
				10.1	19	1500							1.0	1	1028	1.5	32	1580	1.4	3	2621	3	16.8					3.4	5	1954						
Feb. 9																									4.5	10	1096									
16																1.5	9	1470				1	6.4					4.6	4	1526				1	12.1	
23													11.6	5	1085	11.6	10	1426				1	14.6													
24				9.0	9	1567																														
				9.0	9	1567							11.6	5	1085	12.5	19	1447				2	10.5		4.5	10	1096	4.6	4	1526				1	12.1	
Mar. 10																			1.5	1	3357															
16																1.6	3	1892																		
17																1.3	7	1158																		
20																1.4	10	2364	1.4	10	3440															
22																															5.5	4	3793	2	12.1	
24																			1.4	3	2501															
25				8.8	9	1731										1.6	6	2166				2	17.4					5.7	10	2146	5.5	2	2568	4	14.1	
26	8.9	6	1291	8.9	10	1777				5	14.6					1.6	4	1873				1	10.6					5.6	10	2158				4	9.7	
27	10.5	7	1458	10.6	9	1822				4	7.5					1.5	8	1916	1.4	10	2438	5	13.6								5.6	7	2508	3	11.8	
	9.7	13	1381	9.4	28	1777				9	11.4		(Chart) 11.00			1.5	38	1927	1.4	24	2900	8	14.2		(Chart) 1150			5.6	20	2152	5.5	13	2913	13	11.9	
Apr. 5													2.2	6	1300							3	5.1					6.2	2	1962	6.1	2	3547	2	12.8	
6																1.8	4	2432				1	14.1													
7																2.0	5	1728				2	10.9													
10	9.0	1	1176	9.2	8	1403				2	8.2					1.5	1	1592																		
13																												5.9	2	1726						
16				9.7	2	2155				1	15.1					1.6	7	1711				2	5.4													
17	8.7	4	1123	8.9	6	1642				2	10.9					1.6	8	1783				3	9.5					6.3	2	1518				1	12.3	
19																1.1	3	2533																		
24																			2.5	10	3215	6	7.4		2.5	2	1227				6.2	10	2888	5	10.9	
27				8.8	10	1789				2	17.3																									
30																			1.6	2	3264	1	8.5													
	8.9	5	1134	9.1	26	1664				7	12.6		2.2	6	1300	1.7	28	1915	2.0	12	3223	18	8.0		2.5	2	1227	6.4	6	1735	6.2	12	2997	8	11.6	

TABLE 132.—*Cumulus*—Continued.

Date	A. M.												Midday												P. M.											
	Base			Top			Dome			Vel.			Base			Top			Dome			Vel.			Base			Top			Dome			Vel.		
	T	N	H	T	N	H	T	N	H	N	V		T	N	H	T	N	H	T	N	H	N	V		T	N	H	T	N	H	T	N	H	N	V	
1896																																				
May 6																1.4	2	1584				1	1.9													
7																												7.0	2	1164				1	3.3	
11																12.8	8	2349				2	14.3													
13							8.7	3	2980	1	9.2		1.3	2	1147	1.6	4	1380				1	3.0													
15				8.7	9	2339				4	14.2																									
19				8.5	2	2021				1	15.7																									
26																1.2	4	2048				1	12.0													
27				8.7	5	2004				3	11.3																									
28																2.6	4	1376				2	25.9													
29																												6.1	1	2374						
1897																																				
May 3													2.9	3	603	3.0	6	1382				1	11.5													
5													1.5	2	1067	1.4	8	1741				4	7.4													
7																1.3	2	2128																		
10																1.4	7	2509	1.6	3	3458	2	18.1													
12																									6.5	2	1085				6.6	2	2541	1	20.4	
15																1.8	4	2002				1	3.2					6.3	10	1909				4	3.6	
17													1.4	3	1601	1.2	6	2761	1.5	3	3237	5	6.1								6.3	5	3385	2	7.2	
18													11.2	3	1476	12.3	18	2250				11	9.5													
19													1.3	1	1463	12.7	9	1881				3	6.3													
21																1.4	2	2444				1	6.9													
24													1.6	4	1130	1.6	7	1463				2	7.6													
25				9.7	9	1189				4	9.7					1.8	11	1730	1.6	6	2434	7	6.1													
26	10.8	8	800	10.8	10	1600				5	8.9					1.3	10	1672				4	8.5													
29																1.9	3	1620				1	9.5													
	10.8	8	800	9.2	35	1766	8.7	3	2980	18	11.0		1.3	18	1192	1.5	115	1938	1.6	12	2900	49	9.0		6.6	2	1085	6.5	13	1830	6.4	7	3144	8	6.6	
1896																																				
June 1																												6.6	4	2476				2	4.8	
3																3.3	9	1780				4	7.3													
5				9.1	10	1313				3	3.5																									
10				9.0	13	1727				3	6.8					3.1	8	1519				1	5.5					6.3	5	1316				2	11.6	
15																3.7	2	2314										6.6	2	1971						
16																1.9	2	1032				1	7.3					6.4	4	1581						
17																3.7	7	1287				3	1.3													
18																2.3	11	1483				2	3.0													
19							9.2	3	3040	2	6.1		2.8	3	1174	1.9	11	1627				5	4.9													
20													1.7	7	1876	3.0	11	2435	1.4	5	3001	6	5.6					6.3	8	2016				4	5.5	

22						3.6 1 2911				6.8 2 2619		1 6.3
24						2.9 3 1548		1 15.5				
26						1.3 4 1385		2 3.6				
29					1.8 5 1430	2.5 18 2291		8 9.0				
1897 June 1						1.4 8 2300		5 19.4				
3					12.9 1 959	1.0 8 1189		2 9.3				
4					1.3 1 1370	1.3 2 1925		1 7.8				
5	9.3 2 756	9.4 1 1084		1 7.3		1.0 7 1512		2 3.8				
10	8.9 10 880			4 8.8	1.9 1 1328	1.6 9 1442		2 12.1				
11	9.9 3 822	10.2 10 1821		4 6.8	1.2 2 1456	1.3 10 1733		4 7.8				
12						11.1 2 1664		1 10.1				
14	10.2 6 796	10.2 10 2102		5 10.8		1.6 2 2653		1 8.9				
16					1.2 3 1160	1.2 3 2015		2 6.4				
18					1.6 2 963	1.6 2 1471		1 10.0				
19						1.7 3 1367		1 7.4				
21		8.8 10 1397		4 7.0		1.3 10 1859		5 4.1				
22						1.4 5 2134		3 10.3				
23					1.7 1 771	1.5 9 1190		5 6.5				
25						1.4 5 1624		3 6.1				
26						1.3 8 1715		4 7.7				
30		9.0 4 1286		2 11.6	1.3 3 2471	1.3 5 2883	1.3 2 3020	3 13.3				
	9.8 21 837	9.4 58 1638	9.2 3 2010	28 7.8	1.6 29 1175	1.4 185 1783	1.3 9 3010	78 7.8		6.5 25 1921		9 6.6
1896 July 1					3.9 1 944	2.8 20 1745		8 3.9				
3							1.3 2 2684	1 0.5				
6					1.5 3 753	1.5 7 1610		4 3.5				
9		9.0 2 1497			2.3 8 849	1.9 13 2173		4 16.5				
10					2.1 3 545	2.9 12 1218		7 5.0				
11					2.3 1 1151	2.5 5 2075		2 6.9				
13						2.6 12 2244	3.6 4 3165	7 8.6				
14						2.0 7 1720		2 6.2				
17		8.6 10 1800		5 6.4		2.5 19 2006		7 5.2		6.4 1 2069		
18						2.7 8 2150		4 5.0				
20		8.7 2 995			1.4 1 776	2.6 12 1699		2 9.9				
21						1.4 3 1375		1 4.3				
22		9.4 2 1995				1.5 7 2035		1 5.2				
24		8.6 1 1086										
25		8.5 1 1135			3.8 2 1364	3.0 20 1746		5 6.5	6.3 7 1193	6.3 9 1882		
27						2.7 12 1431						
28						1.8 2 1597						
29					2.6 6 1136	3.1 7 1651		1 5.3				
30										7.0 1 1879		
31		9.4 8 1318			2.0 5 1274	1.9 14 2039		1 5.6				
		8.9 26 1523		5 6.4	2.4 30 979	2.3 180 1832	2.5 6 2904	57 6.3	6.3 7 1193	6.6 11 1899		

TABLE 132.—*Cumulus*—Continued.

Date	A. M.				Midday				P. M.			
	Base	Top	Dome	Vel.	Base	Top	Dome	Vel.	Base	Top	Dome	Vel.
	T N H	T N H	T N H	N V	T N H	T N H	T N H	N V	T N H	T N H	T N H	N V
1896												
Aug. 3		8.3 2 1695		1 4.4	3.1 5 1183	1.2 16 2355		3 4.3				
4					1.3 4 1168	2.3 19 1718		5 3.4				
6						1.5 7 1965	1.6 7 (5101)	2 3.5				
7						1.6 2 2054		1 1.5				
8						2.2 5 1715	2.4 5 2418	4 3.3				
10						1.6 2 1667						
11						3.9 3 1947						
12					1.6 1 1039	1.4 15 1867	3.6 7 2593	1 3.3				
13					1.3 2 1242	2.0 15 1747	2.7 12 2994	4 1.1				
14						3.5 1 1308		2 4.3				
15		9.2 6 1429				3.1 3 1903	1.8 2 2692	2 4.3				
17					1.4 2 1155	3.5 7 2074	1.4 4 2249					
18							1.4 4 2506					
19						2.8 14 2135		3 7.5				
20					1.3 3 982	2.0 11 1902	3.7 1 2451	4 1.9				
21						1.0 6 1718		1 6.1				
25						2.3 14 1663		2 4.3				
26					1.1 1 996	2.1 15 1928		6 3.4				
29						10.5 9 1781						
31				2 15.8		1.4 3 2186		1 7.3				
		8.7 8 1495		3 6.7	1.6 18 1126	1.8 177 1869	2.3 42 3065	41 3.7				
Sept. 1						3.0 9 2385						
3						1.4 5 2111						
8		11.2 7 1548		1 7.2		1.3 7 1699		2 5.5				
17						1.5 9 1549						
18						1.4 7 1529						
23		8.6 8 1304										
28						1.3 1 2223				5.3 3 1892		1 6.0
30		10.1 10 1342		3 6.6								
		10.0 25 1387		4 6.7		1.6 38 1863		2 5.5		5.3 3 1892		1 6.0
Oct. 1					1.4 2 1022	1.4 11 1571		3 12.3				
2		9.2 4 1278		1 8.4		1.5 6 1406				5.0 1 1592		
3						1.2 4 1718						
5						1.4 9 1681		4 6.8				
6						1.3 10 1395		1 3.4				
7		9.2 3 1499										

8						1.3 10 1618		3 4.2					
9						1.9 2 1444							
16						1.3 8 2592		3 14.9					
19		8.6 10 1415		7 8.0		1.5 9 1807	1.3 3 2850	6 8.4		4.2 7 1852		4 6.2
21						1.3 9 1961		3 11.5				
24						2.6 10 1846						
29										4.6 10 1691		4 9.5
31		9.4 7 1327		2 5.8								
		9.1 24 1377		10 7.6	1.4 2 1022	1.5 88 1745	1.3 3 2850	23 9.1		4.6 18 1748		8 7.8
Nov. 5						1.7 7 1598		1 16.4				
13						1.4 7 2339	1.3 2 2800	2 15.6		4.2 10 1898		3 14.7
14						1.3 4 1545						
17												
23						1.4 10 1071		4 6.1				
24										4.3 2 1794		1 4.5
27						1.4 4 1362						
						1.4 32 1559	1.3 2 2800	7 10.3		4.2 12 1881		4 12.1
Dec. 9		8.4 4 1631				1.3 10 1809		2 14.2				
11						1.4 6 1323						
23		8.5 9 1609		2 18.0	1.3 5 1077	1.3 10 1427		4 14.9				
30						1.5 2 2079		1 10.2				
		8.5 13 1616		2 18.0	1.3 5 1077	1.4 28 1609		7 14.0				

THE CLASSIFICATION OF THE CUMULUS CLOUDS.

The observations of the cumulus clouds have therefore been classified by the forenoon (a. m.), midday, and afternoon (p. m.) hours, in order to get at the laws of the diurnal variations of the vertical convection in the several stages. Each of these parts of the day has also been given three divisions, the base, top, and the dome, so that observations on the height of the base of the cloud, on the top of the thin cumulus, and on the top of the high cumulus or dome may be entered in an appropriate space. The domes do not include heights much above 3,000 meters, but those cumulus forms which rise to greater elevations are regarded as cumulo-nimbus, and they are discussed separately. We have at present to deal with the base, top, and domes of the cumulus lying between 1,000 and 3,000 meters. (Compare Chart 72.) The first column of Table 132 gives the date; under T is the hour of observations, as 10.9, which means about January $12^d\ 10^h\ 54^m$; under N is the number of settings taken on that particular cloud stratum near the given time; as 7, that there were seven such observations, not necessarily on the same cloud, but on the clouds which appeared to belong to one approximate level; under H is given the mean height for this set of observations, all the data being extracted from the Journal of Elevations, Table 6. In the column headed Vel. is given the number, N, of determinations of the velocity, and also the mean velocity, V. Finally, at the end of each month the mean values of all these quantities are taken and these constitute the result which belongs to the month. May, 1896, and May, 1897, and June, 1896, and June, 1897, are put together in one mean for the month. It may be confessed that in making the observations, and before the discussion to which they lead was developed, it was not realized that special efforts should have been made to secure the heights of the top and bottom of every cloud stratum at each observation. We generally made the settings on the top of the cumulus, as the real object in mind was to determine the velocity and direction of motion in the several cloud levels, the cloud points being sharper and firmer at the top of the cumulus than at the bottom, and better adapted to fulfill this purpose. Hence we now perceive that more base observations should have been obtained. Differential measures, by means of the scale distance on the reticle, could generally be read off and recorded, and from this by computations the heights at the top and the base for individual clouds could be found. It will be desirable, in case of the repetition of such a series of observations, to plan the work so as to always find the elevations of the lowest and the highest points on individual clouds as far as possible. It is perfectly practicable for the observers with the theolodites to make the record so extensive as to cover all these parts, especially in case skillful and interested men are handling the instruments.

DIAGRAM OF THE DISTRIBUTION OF THE CUMULUS CLOUDS.

The cumulus cloud system, which has its base at about 1,000 meters above the ground, condenses at that elevation in consequence of the vapor contents actually present in the air having certain definite physical relations to the conditions that bring about complete saturation. If the base of these clouds is developed quite uniformly at a given height, the case is by no means the same with the tops of the clouds, which reach very different elevations and thus extend through a great range in thickness. A very proper classification of the cumulus clouds, depending upon the actual circumstances, would divide the type into (1) thin cumulus, (2) cumulus domes, and (3) cumulo-nimbus. The tops of the first class range from 1,500 to 2,000 meters; the second ascend to about 3,000 meters; and in the third the tops reach up as high as 10,000 meters or more, while all the intermediate elevations may also occur. It is evident that these clouds may be regarded as natural measuring lines, or gauges, extending from the ground up to the highest elevations accessible to balloons, and that a complete knowledge of the pressure, temperature, and vapor tension can be found at these elevations, by a careful consideration of the physics of the problem. The difficulty of securing direct measures of the meteorological conditions of the upper air in any large or regular way renders it very desirable to develop a method of computation which will be capable of producing the required results from observations at the surface, on the height of the cloud summits, by theodolites. Such an addition to our resources for exploring the upper air will therefore be welcome to meteorologists, not only as less expensive, but also as more frequently applicable. When once the system of seasonal elevations of the isotherms has been

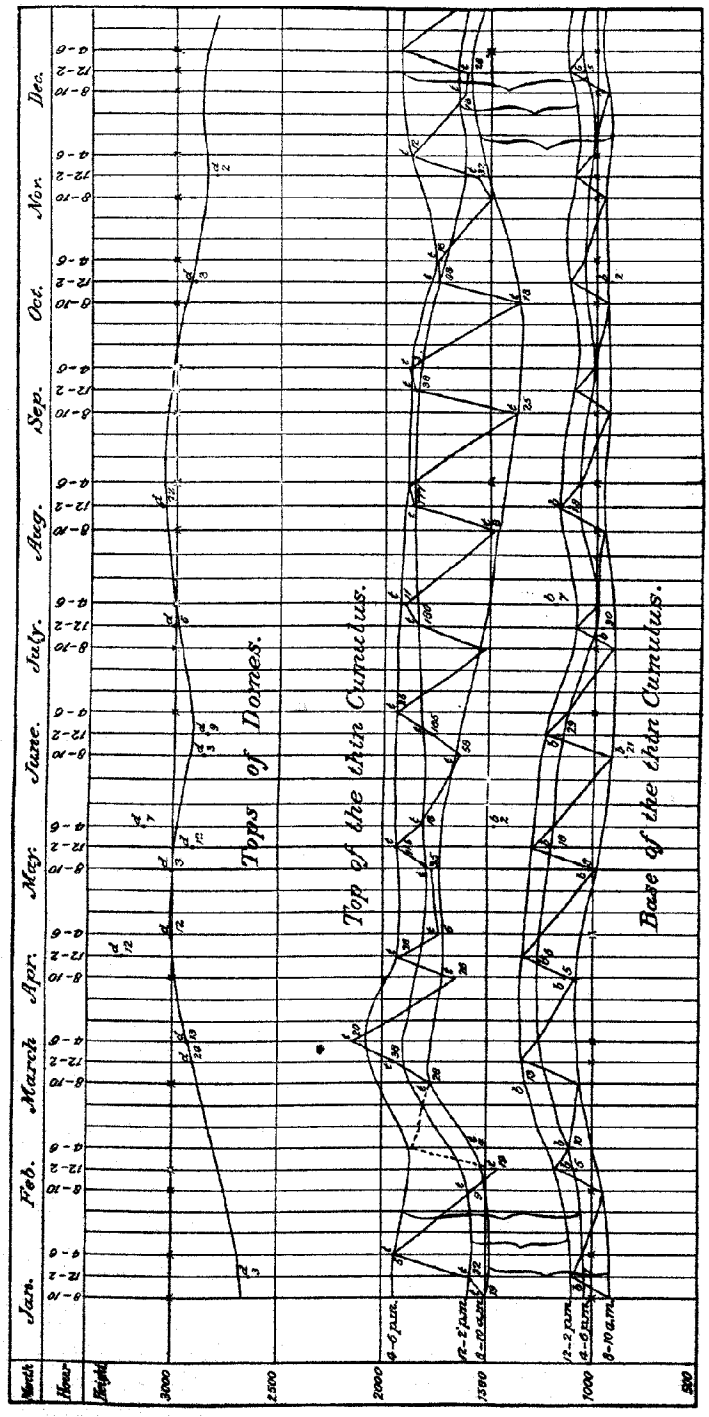

Chart 72. Distribution of the cumulus clouds.

determined, and the gradients connecting the pressures, temperatures, and vapor tensions from one stage to another in the cumulus cloud system, it is evident that a host of problems are already capable of definite solution. The purpose of this chapter is, therefore, in particular, to produce such a scheme of computation, and to calculate the first approximation to the physical quantities connecting the several stages, from which may be calculated the normal values prevailing in the different months of the year at certain definite altitudes. This produces a sketch of the meteorological topography of the atmosphere. We shall therefore discuss the thin cumulus clouds for the three selected parts of the day, namely, 8–10 a. m., 12–2 p. m., and 4–6 p. m., for each month of the year; then the dome cumulus for certain dates ranging throughout the year, and finally a series of cumulo-nimbus forms which reach great elevations. As already remarked, it is not possible to apply the adiabatic formulæ directly, because the atmosphere diverges considerably from that ideal condition, but it is necessary to determine first the laws which define the existing difference between the normal thermodynamic and the actual state of the air, and then carry the reduction to the top of the cloud. It will be necessary to exhibit the details of this computation, as it is rather complex, and the formulæ are very sensitive to imperfect treatment. Besides, it is desirable to show other students how to readily follow that procedure which has been found to work best as the result of our own experience up to this time.

First, the thin cumulus system will be treated at length, since the general conditions of the problem can be determined from it, and after that the two other classes of cumulus. Extracting the results from Tables 131, 132, Chart 72 is formed, which shows the positions of the base and the tops of the cumulus for the three stated hours, and for each month in the year. The first verticle or ordinate line under the name of the month is devoted to the 8–10 a. m. observations, so that the numbers placed near the dots on that line indicate the height, as derived from the observations given in Table 132, at which the base or the top of the cloud was found on the average for the enumerated dates; in the same way the second line records the heights and the number of settings for the 12–2 p. m., and the third line for the 4–6 p. m. observations. By joining up these points with lines passing from one position to another in succession, the diurnal rise and fall of the cloud is marked off, as it appears to have occurred during the day. This varies with the seasons of the year. Then the nearly horizontal lines connecting the points of the same kind give the average heights as they change with the season of the year. These lines are probably quite accurate for the tops of the cumulus where there were many observations. For the bases the lines are drawn partly as the result of the computations, which depend upon the surface conditions, so that the lines for the base are derived from two sources, namely, the direct observations, and also the computations, and they are probably fairly accurate. A larger number of observations would enable us to determine the mean positions of the tops and bottoms of the average cumulus clouds with much precision, and these should be made because of the great value of this data in studying the physical conditions of the atmosphere. For the tops of the domes it was only possible to draw the line of the average elevation.

An inspection of the lines of Chart 72 brings out two facts prominently (1), that the base of the cumulus rises in height from the morning hour till the warmest part of the day, and then falls again toward the evening; and (2) that the tops of the same clouds rise continuously from the morning to the evening hours. When the cumulus clouds form in the morning they are quite thin, that is, 500 or 600 meters thick; when they disappear toward night they are at their greatest thickness, 800 or 900 meters, and it is in this condition that they dissipate after sundown, as the vapor settles back to the surface of the ground. This is in agreement with the results found by other observers, and in harmony with the explanation that the cumulus type forms by vertical convection of the air, which is overheated at the surface by insolation during the day. On Chart 72 it is noticed that the depth of the stratum occupied by the cumulus clouds in the course of the year is characterized by two maxima and two minima, being thickest during summer and midwinter, and thinnest in March and November. The same semiannual period has been shown to pertain to the entire cloud system, and it is therefore a characteristic of the atmosphere in general, as indicated on Chart 12. I have not yet determined precisely what is the cause of this seasonal distribution of the saturated aqueous vapor—that is to say, have not found quantitively the exact connection between it and the temperature, but it is evidently distributed with maxima at the solstices, December and June, and with minima at the equinoxes. More correctly there is a

lag in each formation, which shows that the lagging temperature effects upon the ground and the lower atmosphere are also to be considered. These problems are intimately associated with the distribution of the three diurnal barometric waves, and it is possible that through such studies of cloud phenomena much light may be thrown upon that obscure subject. My data are not now good enough to decisively state the fact, but it looks as if the vertical space covered by the base formation is the converse of that occupied by the tops, being greater in spring and less in summer. This is only a resultant effect of the constituent vapor contents, and may be partly local as caused by the prevailing winds bearing moisture from the ocean to the land areas in summer, and in opposite direction in the winter. If we consider the 12–2 p. m. line for the cumulus tops, its place is found near the 8–10 a. m. line in the cold portions of the year, but near the 4–6 p. m. line in the warm season, showing that in winter the air is not sufficiently warmed up till late in the day to cause the vertical convection to take place effectively, but that it occurs readily in summer in the morning hours, before the maximum heat of the day is developed. This is due to the fact that the air is cold and dry in winter, so that convective buoyancy is harder to develop; on the other hand, that the air is warm and moist in summer, from whence buoyant conditions are readily produced. Something more accurate regarding these circumstances can be inferred by studying the detals of the computations which follow. It has been thought best to present these reductions fully, because they illustrate the use of the thermodynamic tables, and also a general description of the results would not convey any adequate idea of the mutual relations of the quantities entering this discussion.

THE NOTATION ADOPTED IN THE COMPUTATIONS.

It is very important to adopt a notation which will be convenient as well as self-explanatory of the several stages with which the computation is concerned, and the following has been found to be generally satisfactory:

TABLE 133.—*Notation adopted in the computations.*

Stage and parts.	Notation.	Constituent tables in forming constants.
δ Stage top	h'' . B$''$. t'' . e'' .	$(\mathrm{I}_{\mathrm{II}}=\mathrm{I}\delta)+(\mathrm{II}_{\mathrm{II}}=\mathrm{II}\beta)+(\mathrm{III}_{\mathrm{II}}=\mathrm{III}\delta)$ $=\delta$ const.
δ Stage bottom	h_{II} . B$_{\mathrm{II}}$. t_{II} . e_{II} .	$=\mathrm{II}\delta$
γ Stage top	h^{o} . B^{o} . t^{o} . e^{o} .	$(\mathrm{II}_{o}=\mathrm{II}\beta)+(\mathrm{III}_{o}=\mathrm{III}\gamma)+(\mathrm{IV}_{o}=\mathrm{IV}\gamma)=\gamma$ const.
γ Stage bottom	h_{o} . B$_{o}$. t_{o} . e_{o} .	$=\mathrm{II}\gamma$
β Stage top	h' . B$'$. t' . e' .	$(\mathrm{I}_{\mathrm{I}}=\mathrm{I}\beta)+(\mathrm{II}_{\mathrm{I}}=\mathrm{II}\beta)+(\mathrm{III}_{\mathrm{I}}=\mathrm{III}\beta)$ $=\beta$ const.
β Stage bottom	h_{I} . B$_{\mathrm{I}}$. t_{I} . e_{I} .	
α Stage saturation	h_{s} . B$_{s}$. t_{s} . e_{s} .	$(\mathrm{I}=\mathrm{I}\alpha)+(\mathrm{II}=\mathrm{II}\alpha)$ $=\alpha$ const.
α Stage surface	h . B . t . e .	

h_{s} . B$_{s}$. t_{s} . e_{s} . refer to the adiabatic saturation, and they do not usually coincide with the conditions observed at the cloud base.

h' . B$'$. t' . e' . are the same as h_{o} . B$_{o}$. t_{o} . e_{o} . at the point where the cloud enters into the freezing stage, t_{o}=0°C.

h^{o} . B^{o} . t^{o} . e^{o} . are the same as h_{II} . B$_{\mathrm{II}}$. t_{II} . e_{II} . where the cloud enters the δ stage, still at 0°C.

DISCUSSION OF THE DIVERGENCE OF THE UNSATURATED α STAGE FROM THE ADIABATIC GRADIENT CONDITIONS.

The most difficult part of the task of applying the adiabatic tables to the actual conditions of the atmosphere, has been that of determining just how far, and in exactly what way the lower layers of the air are disturbed from the true adiabatic laws. The Tables 94–102 were constructed on the theory that dQ in formulæ 112, 118, 121, becomes equal to zero, and that no heat is added to or subtracted from this normal state. If the air corresponded exactly with that condition, we should have it so arranged in layers, that a "pilot" kilogram, taken from the surface layer and transported upward, passes through such changes as will keep it in exact equilibrium with the

strata at the several heights where the comparison is made. If this were the actual state of the air, the problem would present no special difficulty. As a matter of fact, however, the atmosphere is never steadily in such equilibrium, but it is disturbed from that type of equilibrium by the addition of heat through insolation, by the subtraction of heat through radiation, and by the stratified overflow of currents borne along by horizontal convection. The result is a perpetual variation on either side of adiabatic equilibrium, and it is the task of the meteorologist to discover and discuss the amount and nature of this perturbation. Since the pressure, temperature, and vapor tension, $B.t.e.$ are bound together in a mutual interdependence, the problem includes all these quantities, and they must be considered simultaneously in this connection. It may be assumed that when the air reaches the stage of saturation at the base of the cloud, it then passes through strictly adiabatic changes up to the top. Hence we are chiefly concerned in studying the divergences from the normal, from the ground up to the base of the cloud. The exact values of $B.t.e.$ which enter a cloud base must be in harmony with those existing at the surface, except so far as the intermediate strata are distorted by mixing currents which move in horizontal directions. Since

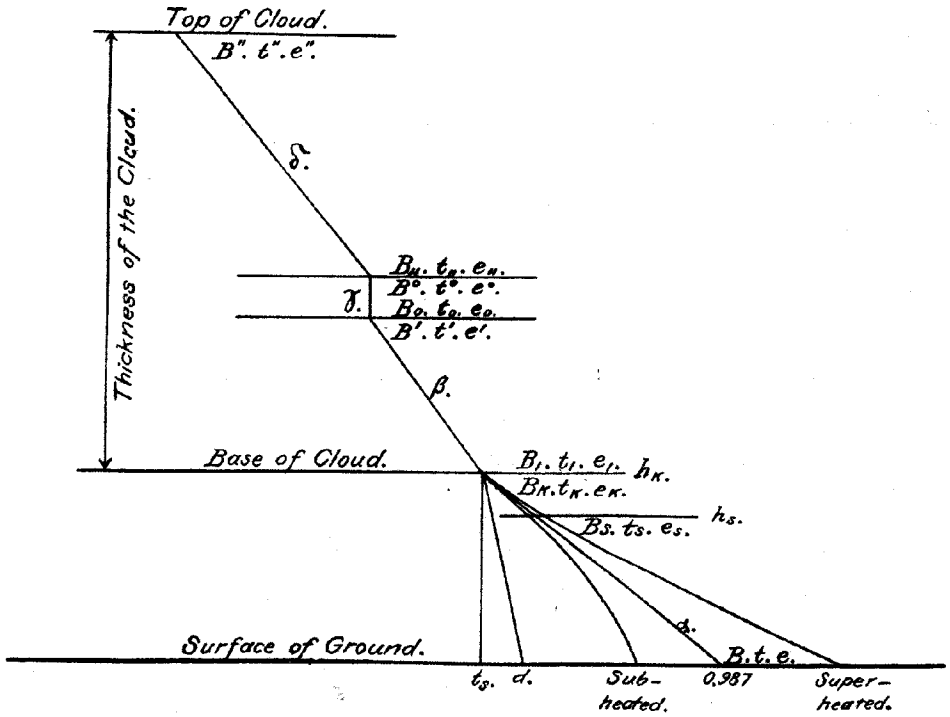

Chart 73.—Temperature gradients in the four stages.

the formation of cumulus clouds generally occurs in a relatively quiet air, and constitute a typical normal vertical convection, these clouds are the proper objects of such an investigation.

Chart 73 of the temperature gradients in the four stages illustrates the location of the symbols used in the notation, and the relative slope of the gradient lines in the various portions of the ascent. Now if we start with the surface conditions $B.t.e.$ and compute by means of the α constant the $B_s.t_s.e_s.$ of the adiabatic saturation, we can also determine the height h_s at which this takes place. If the height h_s coincides with the measured height of the cloud base $h_k=h_1$ the vertical convection would be strictly adiabatic, and we should need simply to carry the surface conditions through the several stages as developed by the tables.

A first set of computations was made for the α stage upon this supposition, namely, that adiabatic saturation took place at the height of the cloud base h_1. The accuracy of this theory could be tested only by direct observations of the $B_1.t_1.e_1.$ at the cloud level. Fortunately it has been possible to make this very important and interesting comparison, by means of the observations secured by the United States Weather Bureau in the course of the extensive series of kite

ascensions which were made during the summer and the autumn of the year 1898. The value of such contributions to these studies of cloud formation is very great, and the only regret is that we have not a much larger amount of such data to use in the discussion. It would be most desirable to extend the series of kite ascensions to cover an entire year, in order that increased accuracy may be gained in the final results. This would be so serviceable in all the computations depending upon gradients, that they should be made as perfectly as possible, and to a considerably greater extent than has heretofore been done. Indeed, it will be hard to indicate any set of observations having a more far reaching utility than the exact determination of the pressure, temperature, and vapor tension at the lower surface of the clouds. They have an immediate bearing upon the problems of hypsometry, and the construction of daily weather maps at a moderate elevation of 3,500 feet; that is, two-thirds of a mile above the surface in the eastern districts and at other greater heights. These views will be illustrated in the course of this report.

THE WEATHER BUREAU OBSERVATIONS AT THE BASE OF CLOUDS.

For the purpose of executing the comparison between the adiabatic conditions of saturation on leaving the α stage and those actually at the cloud, the observers of the Weather Bureau stations were requested to especially record the conditions whenever the kite bearing the MARVIN meteorograph, an automatic self-register for pressure, temperature, and humidity, just entered the cloud base. It was found on examining the reports that there were 104 cases where the observation was of the kind needed for this particular investigation. These have accordingly been computed, and the difference between observation and computation taken. In order to show the form of this computation, which is confined to the α stage, the following specimen is given for Washington, D. C., on Table 134. The dates and the time of the kite entering the cloud base are

TABLE 134.—*Comparison between the adiabatic and observed conditions at the base of cumulus clouds, at Washington, D. C.*

Date	May 27, 1898.	May 27, 1898.	July 13, 1898.	Aug. 10, 1898.	Aug. 10, 1898.	Aug. 27, 1898.	Aug. 27, 1898.	Oct. 6, 1898.	Oct. 8, 1898.	Oct. 8, 1898.
Time	9.45 a. m.	9.55 a. m.	5.45 a. m.	8.50 a. m.	9.34 a. m.	6.25 a. m.	8.38 a. m.	8.47 a. m.	8.30 a. m.	8.35 a. m.
B_k	698.5	690.1	715.0	613.4	696	744.7	721.4	727.2	706.1	705.1
t_k	11.7	10.7	16.1	16.2	20.0	18.9	13.9	15.9	17.5	17.2
e_k	10.21	9.55	13.61	13.69	17.37	16.20	11.33	13.41	14.86	14.60
$\frac{e_k}{B_k}$	.0146	.0139	.0190	.0223	.0250	.0218	.0157	.0185	.0210	.0207
B	754.9	754.6	762.7	756.4	756.7	758.2	760.5	763.8	762.0	762.0
t	17.8	18.3	17.7	25.2	26.4	19.4	21.7	22.2	18.9	19.2
e	11.68	12.14	10.82	20.65	22.30	14.68	15.22	15.80	13.77	13.61
d	**18.7**	**14.3**	**12.6**	**22.8**	**24.1**	**17.3**	**17.9**	**18.5**	**16.3**	**16.1**
$\frac{e}{B}$	.0155	.0161	.0142	.0273	.0295	.0194	.0200	.0207	.0181	.0179
I	1.3603	1.3612	1.3590	1.3765	1.3793	1.3648	1.3664	1.3682	1.3632	1.3634
II	−.4570	−.4571	−.4574	−.4591	−.4596	−.4579	−.4583	−.4587	−.4581	−.4581
α const.	.9033	.9041	.9016	.9174	.9197	.9069	.9081	.9095	.9051	.9053
Trial t_s	12.9	13.5	11.5	22.2	23.5	16.8	17.2	17.7	15.7	15.5
I	1.3564	1.3574	1.3539	1.3740	1.3769	1.3627	1.3636	1.3646	1.3607	1.3604
Const. − I = II	−.4531	−.4533	−.4523	−.4566	−.4572	−.4558	−.4556	−.4551	−.4556	−.4551
B_s	714	714	711	729	730	734	730	726	733	731
e_s	11.07	11.50	10.09	19.87	21.50	14.21	14.58	15.04	13.25	13.09
$\frac{e_s}{B_s}$	.0155	.0161	.0142	.0273	.0295	.0194	.0200	.0207	.0181	.0179
Log B	2.87789	2.87772	2.88235	2.87875	2.87892	2.87978	2.88110	2.88298	2.88196	2.88196
Log B_s	2.85370	2.85370	2.85187	2.86273	2.86332	2.86570	2.86332	2.86094	2.86510	2.86392
m_1	2419	2402	3048	1602	1560	1408	1778	2204	1686	1804
$+\beta m$	11	11	16	16	16	12	12	20	11	12
$+\gamma m$	2	2	2	2	2	1	1	1	1	1
m	2432	2415	3066	1620	1578	1421	1791	2225	1698	1817
$\frac{t_s+t}{2}=\theta_s$	15.4	15.9	14.6	23.7	25.0	18.1	19.5	20.0	17.3	17.3
h_s	473	471	595	324	313	280	353	440	333	356
Obser'd h_k	631.5	878.4	749.6	2033.0	725.6	266.7	571.2	798.3	1109.2	1135.7

placed at the top of each column; $B_k . t_k . e_k .$ are the observed elements at the kite; $B . t . e .$ are those at the surface. Since the ratio $\frac{e}{B}$ is constant through the α stage, because it determines the initial vapor contents, the problem is: "Does the ratio $\frac{e}{B}$ remain the same in the actual observations; and if not, by what quantities does it differ from $\frac{e_k}{B_k}$?" If the equilibrium were strictly adiabatic it would agree, but it is evident that the temperature gradient in the lower atmosphere sometimes exceeds and sometimes falls short of that rate, namely, 0°.987 C. per 100 meters. The general result is that $\frac{e_k}{B_k}$ is usually smaller than $\frac{e}{B}$, and that the ratio falls off from the surface value; in other words, that the cloud base forms higher than the surface conditions would imply in adiabatic expansion, and thus that usually subheating is the rule, though in hot days superheating may occur near the ground.

From Tables I_α, II_α the α constant at the surface is found. Then a trial t_s, temperature of saturation, is assumed, from which I is found. Subtracting I from the α constant we have II; and from the Table II_α is found the corresponding B_s, using the same value of the ratio $\frac{e}{B}$ in both tables. Since t_s is saturation, Smithsonian Table 43 for the metric measures gives the corresponding e_s, and the ratio $\frac{e_s}{B_s}$ should agree with $\frac{e}{B}$. In case such a value of t_s was assumed that the resulting ratio $\frac{e_s}{B_s}$ is not the same as $\frac{e}{B}$, then a second trial t_s must be assumed, and the computation repeated. A third trial, by interpolation from the first and second trial values of t_s, is always successful. It is found that with some experience one can usually find the correct t_s at the second trial. Only the final trial computation is transcribed here in the examples. Utilizing the adiabatic values $B_s . t_s . e_s .$ for a computation of the height h_s, we find $m_1 = \log B - \log B_s$. With m_1, by mere inspection of the m table of barometric reductions, a close value of the height can be at once approximated, since we have for use the arguments m_1 and $\theta_s = \frac{t_s + t}{2}$. From this approximate value of h_s, the corrections to m_1, namely, $+\beta m + \gamma m$, are formed. Then $m = m_1 + \beta m + \gamma m$. For the purpose of forming $\beta m + \gamma m$, m_1 is practically the same as m in the auxiliary Tables 92, 93. From m and θ_s as arguments h_s is taken out of the Table 91. The observed value of the height h_k is placed beneath it. The wide difference between the heights and h_s and h_k is at once evident, and it is this failure of the adiabatic process to coincide with the saturation measured at the height of the lower surface of the cloud, which compels the following investigation regarding the amounts which systematically enter into this divergence between the adiabatic and the actual process in the atmosphere. It is pointed out here that since this is due to the fact that the dQ of the formulæ have real values, through insolation and radiation, the observed variations from the adiabatic law affords a valuable method for studying the actinometry problems of the lower layers of the air.

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COMPARISON BETWEEN THE KITE AND COMPUTED OBSERVATIONS.

TABLE 135.—*Comparison with the kite observations.*

Station	Kite				Saturation				Surface				Ratios		
	h_k	B_k	t_k	e_k	h_s	B_s	t_s	e_s	B	t	e	d	$\frac{e_k}{B_k}$	$\frac{e_s}{B_s}$	$\frac{e}{B}$
Dodge	253	669.6	15.1	12.78	151	678	15.4	13.00	690.1	16.9	13.23	15.7	.0191	.0192	.0192
	256	678.2	19.0	16.33	245	678	18.6	15.92	697.5	21.1	16.43	19.1	.0241	.0235	.0235
Washington	267	744.7	18.9	16.20	280	734	16.8	14.21	758.2	19.4	14.68	17.3	.0218	.0194	.0194
Duluth	301	708.7	− 5.0	3.00	281	706	0.5	4.74	731.0	3.2	4.90	1.0	.0042	.0067	.0067
Dodge	360	677.7	10.4	9.37	140	685	10.5	9.45	696.5	11.7	9.58	10.7	.0138	.0138	.0138
	360	662.9	14.7	12.45	151	678	15.4	13.00	690.1	16.9	13.23	15.7	.0188	.0192	.0192
Duluth	376	706.6	1.1	4.95	417	698	1.3	5.02	734.8	5.0	5.26	2.0	.0070	.0072	.0072
Dodge	384	666.2	1.0	4.90	309	669	1.5	5.09	695.0	4.4	5.28	2.0	.0074	.0076	.0076
Springfield	397	711.2	21.1	18.59	375	714	22.4	20.11	745.2	25.6	20.98	23.1	.0261	.0282	.0282
Dodge	408	666.5	20.7	18.16	190	682	18.4	15.72	697.2	20.0	16.10	18.8	.0272	.0231	.0231
	423	676.2	10.6	9.47	270	675	10.1	9.20	697.2	12.5	9.50	10.6	.0140	.0136	.0136
Springfield	424	713.7	− 1.1	4.17	247	728	0.7	4.80	750.6	3.1	4.95	1.1	.0059	.0066	.0066
	436	715.0	11.3	9.98	428	713	12.3	10.64	750.6	16.7	11.15	13.0	.0140	.0149	.0149
	454	708.7	21.7	19.23	540	701	23.0	20.86	745.2	27.8	22.17	24.0	.0271	.0298	.0298
Duluth	483	701.0	10.0	9.14	272	697	10.3	9.32	720.9	12.8	9.68	10.9	.0130	.0134	.0134
	490	701.0	− 7.2	2.49	295	717	− 6.7	2.59	743.2	− 3.9	2.68	− 6.3	.0036	.0036	.0036
Dodge	490	660.4	2.5	5.46	288	676	3.4	5.82	700.3	6.1	6.02	3.9	.0083	.0086	.0086
	499	664.0	14.4	12.19	424	665	15.1	12.76	698.8	19.2	13.39	15.9	.0185	.0192	.0192
Springfield	499	706.1	− 2.1	3.84	334	721	− 0.5	4.38	751.6	2.7	4.60	0.1	.0055	.0061	.0061
Duluth	523	683.4	15.6	13.13	280	698	15.8	13.34	721.4	18.6	13.79	16.3	.0192	.0191	.0191
	531	682.0	7.2	7.57	334	689	6.7	7.31	726.7	11.1	7.72	7.5	.0111	.0106	.0106
Cairo	545	713.7	23.3	21.29	638	702	23.1	20.98	754.4	29.2	22.50	24.3	.0298	.0299	.0299
Dodge	547	660.4	18.2	15.54	183	683	20.3	17.69	697.5	22.2	18.09	20.7	.0235	.0259	.0259
Washington	571	721.4	13.9	11.33	353	730	17.2	14.58	760.5	21.7	15.22	17.9	.0157	.0200	.0200
Springfield	565	706.1	10.4	9.42	511	706	11.3	9.96	750.6	16.4	10.59	12.2	.0134	.0141	.0141
Memphis	591	711.2	22.2	19.89	416	720	21.4	18.92	755.1	24.2	19.86	22.2	.0280	.0263	.0263
Cleveland	596	695.5	15.3	12.90	586	692	17.0	14.40	740.9	21.4	15.39	18.1	.0185	.0208	.0208
Lansing	599	691.4	5.6	6.76	365	701	7.6	7.78	732.5	11.1	8.00	8.0	.0098	.0110	.0110
Dodge	604	656.6	18.0	15.34	597	653	18.6	15.92	699.3	24.4	17.04	19.7	.0234	.0244	.0244
	612	649.7	18.9	16.20	594	650	17.8	15.14	696.2	23.3	16.23	18.9	.0250	.0233	.0233
Duluth	630	690.9	8.3	8.18	271	697	10.3	9.32	720.9	12.8	9.68	10.9	.0118	.0134	.0134
Cairo	632	703.6	22.2	19.89	626	703	23.5	21.50	754.4	29.2	23.06	24.7	.0283	.0306	.0306
Washington	632	698.5	11.7	10.21	473	714	12.9	11.07	754.9	17.8	11.68	13.7	.0146	.0155	.0155
Cairo	646	698.5	15.6	13.13	536	705	18.8	16.12	749.8	23.9	17.22	19.9	.0188	.0229	.0229
	650	696.0	17.8	15.11	611	702	21.5	19.04	752.6	26.1	20.40	22.6	.0217	.0271	.0271
Cleveland	654	696.0	7.9	7.87	631	690	7.8	7.88	744.2	13.9	8.46	8.9	.0113	.0114	.0114
Springfield	678	692.2	15.6	13.13	294	721	17.5	14.86	746.0	20.6	15.38	18.0	.0190	.0206	.0206
	693	694.7	17.9	15.27	390	715	19.3	16.63	747.8	23.1	17.45	20.1	.0220	.0233	.0233
Duluth	693	675.6	− 7.2	2.49	295	700	− 5.0	3.01	726.7	− 2.2	3.15	− 4.5	.0037	.0043	.0043
Memphis	702	696.0	25.0	23.50	333	727	23.7	21.76	754.9	26.9	22.56	24.3	.0338	.0299	.0299
Pierre	707	653.0	− 4.4	3.17	386	687	− 2.8	3.63	720.9	1.0	3.79	− 2.3	.0048	.0053	.0053
Washington	726	696.0	20.0	17.37	318	730	23.5	21.50	756.7	26.4	22.30	24.1	.0250	.0295	.0295
	749	715.0	16.1	13.61	595	711	11.5	10.09	762.7	17.7	10.82	12.6	.0190	.0142	.0142
Springfield	751	683.3	17.4	14.86	533	701	18.3	15.62	745.5	23.3	16.61	19.3	.0218	.0223	.0223
Cairo	754	690.9	21.7	19.23	466	714	23.4	21.37	754.4	28.1	22.53	24.3	.0278	.0299	.0299
Dodge	792	657.9	15.6	13.13	140	679	16.8	14.21	690.1	18.3	14.49	17.1	.0200	.0209	.0209
Washington	798	727.2	15.9	13.41	440	726	17.7	15.04	763.8	22.2	15.80	18.5	.0185	.0207	.0207
Pierre	800	657.9	7.8	7.87	513	664	5.4	6.69	706.6	10.6	7.14	6.3	.0120	.0101	.0101
North Platte	812	645.2	4.2	6.15	252	680	5.2	6.60	701.6	7.8	6.78	5.6	.0095	.0097	.0097
Springfield	814	689.6	5.0	6.48	511	703	5.4	6.69	748.0	10.6	7.09	6.2	.0094	.0095	.0095
	818	685.8	14.9	12.57	390	713	17.1	14.49	746.0	21.1	15.11	17.8	.0183	.0203	.0203
North Platte	827	642.6	− 3.3	3.45	300	663	− 0.7	4.30	688.3	2.2	4.45	− 0.3	.0054	.0065	.0065
Springfield	828	683.3	− 4.3	3.20	281	725	0.4	4.71	750.8	3.2	4.90	1.0	.0047	.0065	.0065
Lansing	862	676.9	1.7	5.16	716	678	4.4	6.24	739.7	10.6	6.81	5.6	.0076	.0092	.0092
Duluth	866	670.6	− 7.2	2.49	440	698	− 2.8	3.61	737.6	1.6	3.84	− 2.1	.0037	.0052	.0052
Fort Smith	869	688.6	20.0	17.37	690	689	21.9	19.51	745.0	29.4	21.11	23.2	.0252	.0283	.0283
Washington	878	690.1	10.7	9.55	471	714	13.5	11.50	754.6	18.3	12.14	14.3	.0139	.0161	.0161
Cairo	890	678.2	13.3	11.38	450	712	20.0	17.36	749.8	24.4	18.31	20.9	.0168	.0244	.0244

COMPARISON BETWEEN THE KITE AND COMPUTED OBSERVATIONS.

TABLE 135.—*Comparison with the kite observations.*

t_k-t_s	t_k-d	$t_1=d-ch_1$	$t_1=t_s-C$	$\theta_s=\frac{t+t_1}{2}$	$\theta_d=\frac{t+t_1}{2}$	$-m$	$(\beta+\gamma)m$	log B	log B_1	B_1	e_1	B_k-B_1	t_k-t_1	e_k-e_1	$\frac{e_1}{B_1}$	t_1 by $\frac{e_1}{B_1}$
−0.3	−0.6	14.9	15.1	16.0	15.	−01295	+00009	.83891	.82605	670.0	12.59	− 0.4	+0.2	+0.19	.0188	14.9
+0.4	−0.1	18.3	18.3	19.7	19.7	1297	11	.84354	.83068	677.2	15.62	+ 1.0	+0.7	−0.29	.0231	18.3
+2.1	+1.6	16.5	16.5	17.9	18.0	1358	10	.87978	.86630	735.0	13.95	+ 9.7	+2.4	+2.25	.0190	16.5
−5.5	−6.0	0.2	0.0	1.6	1.7	1625	4	.86392	.84771	704.2	4.64	+ 4.5	−5.2	−1.64	.0064	0.0
−0.1	−0.3	9.6	9.9	10.8	10.7	1880	10	.84292	.82412	667.0	8.90	+10.7	+0.8	+0.47	.0133	9.7
−0.7	−1.0	14.6	14.8	15.8	15.8	1846	11	.83891	.82066	661.7	12.35	+ 1.2	+0.1	+0.10	.0187	14.6
−0.2	−0.9	0.9	0.6	2.8	3.0	2018	3	.86617	.84602	701.5	4.87	+ 5.1	+0.2	+0.08	.0069	0.8
−0.5	−1.0	0.9	0.8	2.6	2.7	2064	3	.84198	.82137	662.8	4.87	+ 3.4	+0.2	+0.03	.0074	0.8
−1.3	−3.5	21.9	21.8	23.7	23.7	1982	23	.87227	.85268	712.3	19.51	− 1.1	−0.8	−0.92	.0274	21.8
+2.3	+1.9	17.6	17.8	18.9	18.8	2071	17	.84336	.82282	665.0	14.95	+ 1.5	+3.1	+3.21	.0225	17.6
+0.5	0.0	9.3	9.5	11.0	10.9	2209	10	.84336	.82137	662.8	8.72	+14.4	+1.3	+0.75	.0132	9.4
−1.8	−2.2	− 0.2	0.0	1.6	1.5	2290	3	.87541	.85264	712.3	4.48	+ 1.4	−0.9	−0.31	.0063	− 0.2
−1.0	−1.7	11.7	11.7	14.2	14.2	2248	13	87541	.85306	713.0	10.23	− 2.0	−0.3	−0.24	.0144	11.8
−1.3	−2.3	22.6	22.3	25.0	25.2	2256	24	.87227	.84995	707.9	20.36	+ 0.8	−0.9	−1.10	.0288	22.6
−0.3	−0.9	9.5	9.6	11.2	11.2	2518	12	.85786	.83280	680.5	8.84	+21.5	+0.5	+0.30	.0129	9.4
−0.5	−0.9	− 7.7	− 7.7	− 5.8	− 5.8	2717	4	.87111	.84398	698.2	2.38	+ 2.8	+0.5	+0.11	.0034	− 7.6
−0.9	−1.4	2.5	2.7	4.4	4.3	2619	5	.84528	.81914	659.4	5.46	+ 1.0	0.0	0.00	.0083	2.3
−0.7	−1.5	14.4	14.4	16.8	16.8	2561	21	.84435	.81895	659.1	12.19	+ 5.9	0.0	+0.00	.0185	14.5
−1.6	−2.2	− 1.4	− 1.4	0.7	0.7	2701	5	.87599	.84903	706.4	4.07	− 0.3	−0.7	−0.23	.0058	− 1.3
−0.2	−0.7	14.7	15.1	16.8	16.6	2672	19	.85818	.83165	678.7	12.43	+ 4.7	+0.9	+0.69	.0183	14.9
+0.5	−0.3	5.9	6.0	8.5	8.5	2783	15	.86136	.83368	681.8	6.92	+ 0.2	+1.3	+0.65	.0101	6.0
+0.2	−1.0	22.7	22.3	25.8	26.0	2695	29	.87760	.85094	709.6	20.48	+ 4.2	+0.6	+0.81	.0289	22.6
−2.1	−2.5	19.1	19.6	20.9	20.7	2759	27	.84354	.81622	655.0	16.42	− 4.6	−0.9	−0.88	.0251	18.9
−3.3	−4.0	16.2	16.4	19.0	19.0	2896	24	.88110	.85248	712.0	13.68	+ 9.4	−2.3	−2.35	.0192	16.2
−0.9	−1.8	10.5	10.5	13.4	13.4	2921	19	.87541	.84639	702.1	9.45	+ 4.0	−0.1	−0.03	.0135	10.5
+0.8	0.0	20.4	20.6	22.4	22.3	2965	31	.87800	.84866	705.8	17.80	+ 5.4	+1.8	+2.09	.0252	20.4
−1.7	−2.8	16.2	16.2	18.8	18.8	3027	23	.86976	.83972	691.4	13.68	+ 4.1	−0.9	−0.78	.0198	16.3
−2.0	−2.4	6.2	6.7	8.9	8.7	3150	12	.86451	.83343	681.4	7.07	+10.0	−0.6	−0.31	.0104	6.4
−0.6	−1.7	17.9	17.8	21.1	21.2	3041	26	.84466	.81451	652.4	15.23	+ 4.2	+0.1	+0.11	.0233	17.9
+1.1	0.0	17.1	17.0	20.2	20.2	3087	25	.84273	.81211	648.8	14.49	+ 0.9	+1.8	+1.74	.0223	17.1
−2.0	−2.6	9.1	9.4	11.1	11.0	3286	15	.85786	.82515	668.6	8.61	+21.3	−0.8	−0.43	.0129	9.0
−1.3	−2.5	22.8	22.6	25.9	26.0	3131	34	.87769	.84663	702.5	20.61	+ 1.1	−0.6	−0.73	.0293	22.7
−1.2	−2.0	11.8	12.1	15.0	14.8	3252	18	.87789	.84555	700.7	10.30	− 2.2	−0.1	−0.09	.0147	11.9
−3.2	−4.3	18.0	18.0	21.0	21.0	3254	26	.87495	.84267	696.1	15.33	+ 2.4	−2.4	−2.20	.0220	17.9
−3.7	−4.8	20.7	20.7	23.4	23.4	3248	30	.87656	.84438	698.8	18.13	− 2.8	−2.9	−3.12	.0259	20.7
+0.1	−1.0	6.9	6.9	10.4	10.4	3409	14	.87169	.83774	688.2	7.42	+ 7.8	+1.0	+0.45	.0108	6.9
−1.9	−2.4	16.0	16.6	18.6	18.3	3447	22	.87274	.83849	689.4	13.51	+ 2.8	−0.4	−0.38	.0196	16.0
−1.4	−2.2	18.0	18.4	20.8	20.6	3497	31	.87379	.83913	690.5	15.33	+ 4.2	−0.1	−0.06	.0222	18.0
−2.2	−2.7	− 6.6	− 6.4	− 4.3	− 4.4	3821	4	.86136	.82319	665.6	2.62	+10.0	−0.6	−0.13	.0039	− 6.7
+1.3	+0.7	22.2	22.7	24.8	24.6	3494	37	.87789	.84332	697.1	19.87	− 1.1	+2.8	+3.63	.0285	22.2
−1.6	−2.1	− 4.4	− 5.2	− 2.1	− 1.7	3853	7	.85788	.81942	659.8	3.17	− 6.8	0.0	0.00	.0048	− 4.4
−3.5	−4.1	21.9	22.3	54.4	24.2	3618	38	.87892	.84312	696.8	19.51	− 0.8	−1.9	−2.14	.0280	21.9
+4.6	+3.5	10.4	10.4	14.0	14.1	3863	19	.88235	.84391	698.1	9.39	+16.9	+5.7	+4.22	.0134	10.3
−0.9	−1.9	17.0	17.2	20.2	20.2	3793	28	.87245	.83480	683.6	14.40	− 0.3	+0.4	+0.46	.0210	17.0
−1.7	−2.6	22.0	22.1	25.1	25.1	3747	39	.87760	.84052	692.7	19.63	− 1.8	−0.3	−0.40	.0283	22.0
−1.2	−1.5	14.7	15.5	16.9	16.5	4068	30	.83891	.79853	628.8	12.43	+29.1	+0.9	+0.70	.0198	14.7
−1.8	−2.6	16.1	16.5	19.4	19.2	4045	30	.88298	.84283	696.4	13.60	+30.8	−0.2	−0.19	.0195	16.1
+2.4	+1.5	3.9	4.1	7.4	7.3	4224	14	.84917	.80707	641.3	6.03	+16.6	+3.9	+1.84	.0094	3.9
−1.0	−1.4	3.1	3.9	5.8	5.5	4319	11	.84609	.80301	635.4	5.70	+ 9.8	+1.1	+0.45	.0090	3.3
−0.4	−1.2	3.7	4.1	7.4	7.2	4302	14	.87390	.83102	677.7	5.94	+11.9	+1.3	+0.54	.0088	3.9
−2.2	−2.9	15.3	15.9	18.5	18.2	4160	28	.87274	.83132	678.1	12.92	+ 7.7	−0.4	−0.35	.0191	15.3
−2.6	−3.0	− 2.8	− 2.3	− 0.0	− 0.3	4491	9	.83778	.79296	620.8	3.62	+21.8	−0.5	−0.17	.0058	− 2.7
−4.7	−5.3	− 1.5	− 1.1	1.0	0.9	4475	9	.87552	.83086	677.4	4.04	+ 5.9	−2.8	−0.84	.0060	− 1.7
−2.7	−3.9	3.0	3.0	6.8	6.8	4564	15	.86906	.82357	666.2	5.66	+10.7	−1.3	−0.50	.0085	3.0
−4.4	−5.1	− 4.7	− 4.5	− 1.5	− 1.6	4720	9	.86782	.82071	661.8	3.09	+ 8.8	−2.5	−0.69	.0047	− 4.6
−1.9	−3.2	20.6	20.5	25.0	25.0	4319	42	.87216	.82939	675.1	18.02	+13.5	−0.6	−0.65	.0267	20.5
−2.8	−3.6	11.7	12.2	15.2	15.0	4515	25	.87772	.83282	680.5	10.23	+ 9.6	−1.7	−0.78	.0150	11.8
−6.7	−7.6	18.3	18.5	21.4	21.4	4478	36	.87498	.83052	676.9	15.62	+ 1.3	−5.1	−3.24	.0231	18.3

TABLE 135.—*Comparison with the kite observations*—Continued.

Station.	Kite				Saturation				Surface				Ratios		
	h_k	B_k	t_k	e_k	h_s	B_s	t_s	e_s	B	t	e	d	$\frac{e_k}{B_k}$	$\frac{e_s}{B_s}$	$\frac{e}{B}$
Springfield	896	665.5	3.3	5.79	639	678	1.8	5.22	733.3	7.8	5.64	2.9	.0087	.0077	.0077
	918	679.5	1.5	5.08	388	716	5.8	6.88	750.6	9.9	7.21	6.5	.0075	.0096	.0096
Lansing	924	674.1	19.4	16.79	706	681	20.5	17.91	738.1	27.2	19.38	21.8	.0249	.0263	.0263
Cairo	929	675.6	21.1	18.59	632	702	23.7	21.76	753.9	29.7	23.34	24.9	.0275	.0310	.0310
Springfield	938	674.4	16.3	13.74	733	684	18.6	15.92	744.2	25.6	17.30	19.9	.0204	.0233	.0233
Dodge	950	624.8	13.3	11.38	292	669	11.6	10.16	692.7	14.4	10.54	12.2	.0182	.0152	.0152
Cairo	951	670.6	20.0	17.37	670	699	23.2	21.11	753.9	29.7	22.78	24.5	.0259	.0302	.0302
Dodge	952	629.9	13.9	11.81	243	673	11.9	10.36	692.7	14.2	10.67	12.3	.0187	.0154	.0154
Springfield	952	654.3	12.2	10.59	642	689	16.0	13.51	742.4	22.2	14.55	17.2	.0169	.0196	.0196
	969	670.6	19.4	16.79	848	677	22.0	19.63	745.2	30.0	21.59	23.6	.0250	.0290	.0290
North Platte	1012	631.2	− 7.8	2.36	603	639	− 6.3	2.68	689.6	− 0.3	2.92	− 5.3	.0037	.0042	.0042
Springfield	1019	652.8	0.3	4.67	656	677	0.5	4.74	734.1	6.7	5.18	1.7	.0071	.0070	.0070
Pierre	1029	675.6	13.9	11.81	839	645	14.5	12.27	711.2	22.8	13.54	16.0	.0175	.0190	.0190
Springfield	1067	669.3	7.1	7.52	521	703	6.3	7.12	748.8	11.3	7.52	7.1	.0112	.0101	.0101
Pierre	1068	646.7	14.1	11.96	839	645	14.5	12.27	711.2	22.8	13.54	16.0	.0185	.0190	.0190
Springfield	1086	666.8	0.7	4.83	547	702	4.7	6.37	750.3	10.1	6.83	5.7	.0073	.0091	.0091
Pierre	1107	643.9	15.0	12.68	892	641	14.3	12.12	711.2	23.3	13.46	15.9	.0197	.0189	.0189
Washington	1109	706.1	17.5	14.86	333	733	15.7	13.25	762.0	18.9	13.77	16.3	.0210	.0181	.0181
	1136	705.1	17.2	14.60	356	731	15.5	13.09	762.0	19.2	13.61	16.1	.0207	.0179	.0179
North Platte	1144	624.8	− 1.2	4.14	938	614	− 1.6	4.00	689.4	7.8	4.50	− 0.2	.0066	.0065	.0065
Springfield	1141	645.2	0.0	4.57	645	678	0.9	4.87	734.1	7.2	5.31	2.1	.0071	.0072	.0072
	1160	642.6	1.4	5.06	626	679	1.7	5.16	733.3	7.9	5.59	2.8	.0079	.0076	.0076
Cairo	1220	657.9	18.3	16.20	654	700	22.8	20.61	753.4	28.9	22.12	24.0	.0246	.0294	.0294
Springfield	1223	638.8	0.0	4.57	634	679	1.5	5.09	734.1	7.8	5.51	2.6	.0072	.0075	.0075
	1227	657.1	0.1	4.60	680	690	5.1	6.55	749.3	11.7	7.09	6.2	.0070	.0095	.0095
	1274	637.5	18.3	15.65	635	693	21.4	18.92	745.0	27.3	20.32	22.6	.0245	.0273	.0273
Topeka	1275	640.1	16.9	14.35	912	663	18.0	15.33	736.1	27.2	16.99	19.7	.0224	.0231	.0231
Springfield	1281	650.2	− 7.8	2.36	864	676	− 3.2	3.52	752.9	5.1	3.94	− 1.8	.0036	.0052	.0052
	1309	632.5	0.6	4.75	626	679	1.7	5.16	733.3	7.9	5.59	2.8	.0076	.0076	.0076
	1329	649.0	− 0.6	4.34	766	683	4.2	6.15	749.6	11.8	6.76	5.6	.0067	.0090	.0090
	1345	646.4	− 7.9	2.34	864	676	− 3.2	3.52	752.9	5.1	3.94	− 1.8	.0036	.0052	.0052
Cleveland	1352	638.8	17.5	14.86	915	665	18.7	16.02	738.4	27.5	17.81	20.4	.0233	.0241	.0241
Lansing	1385	635.0	5.3	6.63	994	656	10.0	9.14	738.1	20.0	10.24	11.7	.0104	.0139	.0139
Washington	1411	680.7	4.4	6.27	876	682	3.5	5.86	759.0	12.2	6.55	5.1	.0092	.0086	.0086
Dodge	1412	599.4	13.3	11.38	480	660	19.1	16.42	697.5	23.9	17.30	19.9	.0190	.0248	.0248
	1413	594.4	− 3.3	3.45	1356	589	− 6.0	2.76	697.7	7.2	3.28	− 4.0	.0058	.0047	.0047
	1426	594.4	12.5	10.77	1558	581	12.1	10.50	696.7	27.5	12.60	14.9	.0181	.0181	.0181
Springfield	1434	636.3	− 7.9	2.34	864	676	− 3.2	3.52	752.9	5.1	3.94	− 1.8	.0037	.0052	.0052
	1532	631.2	− 8.3	2.26	825	679	− 3.3	3.43	752.9	4.4	3.84	− 2.1	.0036	.0051	.0051
	1582	626.1	17.1	14.50	635	693	21.7	19.27	745.0	27.8	20.73	22.9	.0232	.0278	.0278
Lansing	1612	619.8	4.4	6.27	690	680	11.0	9.77	738.1	17.8	10.62	12.3	.0101	.0144	.0144
Springfield	1682	619.0	16.9	14.35	520	702	22.4	20.11	745.0	27.2	21.39	23.4	.0232	.0287	.0287
	1688	618.5	16.3	13.74	686	689	21.9	19.51	745.0	28.2	21.11	23.2	.0222	.0283	.0283
	1712	612.1	16.4	13.84	559	699	22.3	19.99	745.0	27.4	21.31	23.3	.0226	.0286	.0286
	1744	622.3	6.9	7.44	909	676	9.6	8.90	753.1	18.8	9.93	11.2	.0120	.0132	.0132
Washington	2033	613.4	16.2	13.69	324	729	22.2	19.87	756.4	25.2	20.65	22.8	.0223	.0273	.0273

TABLE 135.—*Comparison with the kite observations*—Continued.

t_k-t_s	t_k-d	$t_1=d-ch_1$	$t_1=t_s-C$	$\theta_s=\frac{t+t_1}{2}$	$\theta_d=\frac{t+t_1}{2}$	$-m$	$(\beta+\gamma)m$	log B	log B_1	B_1	e_1	B_k-B_1	t_k-t_1	e_k-e_1	$\frac{e_1}{B_1}$	t_1 by $\frac{e_1}{B_1}$
+1.5	+0.4	0.2	0.2	4.0	4.0	4790	18	.86528	.81756	657.0	4.64	+ 8.5	+3.1	+1.15	.0071	0.2
−4.3	−5.0	3.7	4.3	7.1	6.8	4859	16	.87541	.88698	671.4	5.94	+ 8.1	−2.1	−0.86	.0089	3.6
−1.1	−2.4	19.0	19.0	23.1	23.1	4622	41	.86812	.82231	664.2	16.32	+ 9.9	+0.4	+0.47	.0246	19.1
−2.6	−3.8	22.1	22.0	25.9	25.9	4602	50	.87731	.83179	678.9	19.75	− 3.3	−1.1	−0.16	.0291	22.1
−2.3	−3.6	17.1	17.1	21.4	21.4	4719	35	.87169	.82485	668.1	14.49	+ 6.3	+0.8	+0.75	.0217	17.2
+1.7	+1.1	9.4	10.1	12.2	11.9	4940	25	.84054	.79139	618.6	8.78	+ 6.2	+3.9	+2.60	.0142	9.4
−3.2	−4.5	21.6	21.5	25.6	25.7	4716	50	.87731	.83065	677.1	19.16	− 3.5	−1.6	−1.79	.0283	21.6
−2.0	−1.6	9.4	9.4	11.8	11.8	4952	25	.84055	.79128	618.4	8.78	+11.5	+4.5	+3.03	.0142	9.5
−3.8	−5.0	14.3	14.5	18.4	18.3	4890	33	.87064	.82207	663.8	12.12	− 9.5	−2.1	−1.53	.0183	14.4
−2.6	−4.2	20.7	20.3	25.2	25.4	4810	48	.87227	.82465	667.8	18.13	+ 2.8	−1.3	−1.34	.0271	20.7
−1.5	−2.5	− 8.4	− 8.4	− 4.4	− 4.4	−.05579	+00008	.83880	.78289	606.6	2.25	+24.6	+0.6	+0.11	.0037	− 8.7
−0.2	−1.4	− 1.4	− 1.5	2.6	2.7	5473	13	.86576	.81116	647.4	4.07	+ 5.4	+1.7	+0.60	.0063	− 1.4
−0.6	−2.1	12.9	12.9	17.9	17.9	5239	38	.85199	.79998	630.9	11.07	+44.7	+1.0	+0.74	.0175	12.9
+0.8	0.0	3.9	4.5	7.9	7.6	5632	16	.87437	.81824	658.0	6.03	+11.3	+3.2	+1.49	.0092	4.0
−0.4	−1.9	12.8	12.8	17.8	17.8	5440	35	.85199	.79794	628.0	10.99	+18.7	+1.3	+0.97	.0175	12.9
−4.0	−5.0	2.5	2.7	6.4	6.3	5759	18	.87581	.81841	658.3	5.46	+ 8.5	−1.8	−0.63	.0083	2.3
+0.7	−0.9	12.6	12.5	17.9	18.0	5634	37	.85199	.79602	625.2	10.85	+18.7	+2.4	+1.83	.0174	12.6
+1.8	+1.2	13.0	13.9	16.4	16.0	5684	34	.88196	.82546	669.1	11.14	+ 7.0	+4.5	+3.72	.0167	23.0
+1.7	+1.1	12.7	13.6	16.4	16.0	5823	35	.88196	.82408	666.9	10.92	+38.2	+4.5	+3.65	.0164	12.7
+0.4	−1.0	− 3.2	− 3.9	2.4	2.4	6152	13	.82847	.77708	598.5	8.50	+26.3	+2.0	+0.64	.0059	− 3.5
−0.9	−2.1	− 1.3	− 1.4	2.9	3.0	6112	15	.86576	.80479	637.9	4.10	+ 7.3	+1.3	+0.47	.0064	− 1.3
−0.3	−1.4	− 0.7	− 0.6	3.6	3.6	6211	8	.86528	.80325	635.7	4.30	+ 6.9	+2.1	+0.76	.0068	− 0.7
−4.5	−5.7	20.4	20.4	24.7	24.7	6070	59	.87702	.81691	656.0	17.80	+ 1.9	−2.1	−1.60	.0271	20.3
−1.5	−2.6	− 1.0	− 0.9	3.4	3.4	6553	8	.86576	.80031	631.4	4.21	+ 7.4	+1.0	+0.36	.0067	− 0.9
−5.0	−6.1	2.6	2.8	7.2	7.2	6485	20	.87466	.81001	645.7	5.50	+11.4	−2.5	−0.90	.0085	2.6
−3.1	−4.3	18.8	19.0	23.2	23.1	6372	65	.87216	.80909	644.3	16.12	− 6.8	−0.5	−0.47	.0250	18.8
−1.1	−2.8	15.9	15.8	21.5	21.6	6410	48	.86694	.80332	635.8	13.42	+ 4.3	+1.0	+0.93	.0211	15.9
−4.6	−6.0	− 5.6	− 5.9	− 0.4	− 0.3	6956	16	.87674	.80734	641.7	2.86	+ 8.5	−2.2	−0.50	.0045	−5.8
−1.1	−2.2	− 1.1	− 1.0	3.4	3.4	7015	9	.86528	.79522	124.1	4.17	+ 8.4	+1.7	+0.58	.0067	− 1.3
−4.8	−6.2	1.6	1.6	6.7	6.7	7093	21	.87483	.80411	637.0	5.12	+12.0	−2.2	−0.78	.0080	1.5
−4.7	−6.1	− 5.8	− 6.0	− 0.4	− 0.4	7306	17	.87674	.80385	636.6	2.81	+ 9.8	−2.1	−0.47	.0044	− 5.8
−1.2	−2.9	16.3	16.2	21.8	21.9	6791	51	.86829	.80089	632.3	13.77	+ 6.5	+1.2	+1.09	.0218	16.5
−4.7	−6.4	7.6	7.5	13.8	13.8	7158	33	.86812	.79687	626.4	7.78	+ 8.6	−2.3	−1.15	.0124	7.6
+0.9	−0.7	0.9	0.5	6.4	6.6	7474	22	.88024	.80572	639.3	4.87	+41.4	+3.5	+1.40	.0076	0.7
−5.8	−6.6	15.7	16.4	20.2	19.8	7142	58	.84354	.77270	592.5	13.23	+ 6.9	−2.4	−1.87	.0223	15.8
+2.7	+0.7	− 8.2	− 9.2	− 1.0	− 0.5	7679	10	.84367	.76698	584.8	2.28	+ 9.6	+4.4	+1.17	.0039	− 8.5
+0.4	−2.4	10.7	10.3	18.9	19.1	7230	43	.84305	.77118	590.4	9.58	+ 4.0	+1.8	+1.19	.0162	10.7
−4.7	−6.1	− 6.1	− 6.3	− 0.6	− 0.5	7794	14	.87674	.79894	629.4	2.74	+ 6.9	−1.8	−0.40	.0043	− 6.2
−5.0	−6.2	− 6.7	− 6.8	− 1.2	− 1.2	8349	14	.87674	.79339	621.4	2.61	+ 9.8	−1.6	−0.35	.0042	− 6.9
−4.6	−5.8	18.2	18.4	23.0	23.0	7914	70	.87216	.79372	621.9	15.52	+ 4.2	−1.1	−1.02	.0249	18.2
−6.6	−7.9	7.4	7.8	12.8	12.6	8360	64	.86812	.78516	609.8	7.67	+10.0	−3.0	−1.40	.0126	7.4
−5.5	−6.5	18.4	18.8	23.0	22.8	8422	76	.87216	.78870	614.8	15.72	+ 4.2	−1.5	−1.37	.0256	18.5
−5.6	−6.9	18.2	18.3	23.2	23.2	8439	75	.87216	.78852	614.5	15.52	+ 4.0	−1.9	−1.78	.0253	18.3
−5.9	−6.9	18.2	18.5	22.9	22.8	8570	76	.87216	.78722	612.7	15.52	− 0.6	−1.8	−1.68	.0253	18.4
−2.7	−4.3	6.0	6.0	12.4	12.4	9057	36	.87685	.78670	611.9	6.97	−10.4	+0.9	+0.47	.0114	5.9
−6.0	−6.6	16.7	17.3	21.2	21.0	.10239	81	.87875	.77717	598.6	14.12	+14.8	−0.5	−0.43	.0236	17.5

The Table 135, "Comparison with the kite observations," contains the data for the discussion of the laws which actually control the variations of $B.t.e$. The first column contains the names of the stations arranged in the order of the observed height of the cloud base h_k, so that the variations with the altitude may be readily studied. Under the section headed "kite," $h_k.B_k.t_k.e_k.$ give the observed conditions; under "saturation," $h_s.B_s.t_s.e_s.$ give the computed conditions which would result from strictly adiabatic expansion if a surface kilogram is transported upward to the height of saturation by vertical convection, and they have been transcribed from the sheets of which a specimen was shown in Table 134; under "surface," $B.t.e.d.$ give the pressure, temperature, vapor tension, and dewpoint near the ground at the time the kite entered the cloud base. The working hypothesis here is, that on the average the air at the surface, rising to the cloud by convection, goes though such changes in its state as correspond with the layers of air through which in succession our assumed "exploring" kilogram would pass. Under the heading "ratios" is found the observed ratio $\frac{e_k}{B_k}$ at the kite, and the check ratios $\frac{e_s}{B_s}=\frac{e}{B}$. The former is generally less than the latter, and this implies the same problem that the fact of h_k being greater than h_s has already indicated.

THE NECESSITY OF DETERMINING THE NORMAL VALUES $B_1.t_1.e_1.$

Instituting a comparison of these results, the difference t_k-t_s is formed, that is between the kite temperature and adiabatic saturation. Not a little labor has been expended in taking the next step, namely, in determining from these observations what is the *normal* set of values $B_1.t_1.e_1.$ which are to be adopted on the average in entering the β stage. It is evident that the kite observations contain two sources of divergence from the *normal air conditions* as distinguished from the strictly adiabatic conditions. From $B_k.t_k.e_k.$ must be formed the normal $B_1.t_1.e_1.$ with which $B_s.t_s.e_s.$ can be compared, in order to construct correction tables. In short, we want to know what changes must be made in $B.t.e.$ at the surface to give $B_1.t_1.e_1.$ at the cloud under average conditions, and it should be determined for practical uses with a minimum of computing labor. It is clear that if this can be done we shall have in hand all that is needed to construct a *daily weather map* at the level of the cumulus clouds, namely, at 3,500 feet. This altitude happens to be also that of a plane which passes through the average elevations of the Rocky Mountain plateau region, and it requires a minimum of barometric reduction for the entire system of stations located in that region, a portion being reduced downward and the remainder upward to the 3,500-foot plane, to reduce all readings to one plane. It is also the plane near which the manometric temperature expansion has the least disturbing effect upon normal pressures; and it is the plane to which temperature reductions occur by vertical gradients practically free from the effects of surface subheating and superheating. This plane being the mean elevation for the surface conditions of the plateau, and also that of the cumulus-cloud base level over the central and the eastern portions of the United States, offers the greatest advantage for the *proposed elevated daily weather maps*, since to it the reductions can be made with the greatest precision. It is high enough above the ground to record approximately the undistorted form of the unobstructed storm action east of the mountains, and yet not so high but that the kites can frequently reach it with the meteorographs. The difficulties in the way of daily simultaneous kite ascensions at many stations are so great, considering the feeble winds which frequently prevail in the lowest stratum, that it will be more practicable to procure *occasional* ascensions, for the sake of determining the laws by means of which we can compute upward from the surface to that moderate elevation. It will be shown that these computations are extremely simple, by employing the gradient tables which have resulted from this study, and that we can obtain the pressure, temperature, and vapor tension at the 3,500-foot level under ordinary circumstances with sufficient accuracy for map construction. Besides giving to the air a much freer sweep, so that the exact statistics of the state of a storm will be more definitely shown on 3,500-foot-level maps, a fact which ought to contribute materially to the accuracy of forecasting, we shall avoid much of the difficulty of reductions to the sea level, which has hitherto rendered the drawing of our maps in the plateau region unsatisfactory. At any rate it will be well to give a trial to such elevated daily maps as auxiliaries to the forecast official, since they are easily constructed.

The two causes alluded to which render it necessary to determine the normal $B_1.t_1.e_1.$ from

$B_k . t_k . e_k .$ at the same elevation are as follows: (1) In the present type of our self-registering meteorographs having sufficient lightness to be carried aloft by kites, it is by no means certain that all the instruments record the exact state of the air surrounding them. The thermograph is believed to be quite accurate; the barograph is irregular in its action, and its readings are in many cases inconsistent with the heights which are simultaneously determined by the length of the line run out and the angle it makes with the vertical; the hygrograph is less reliable than either of the other pieces of apparatus. The heights as computed from the catenary of the line are probably reliable to within 1 or 2 per cent, and they have been adopted as the basis of this discussion. The temperatures are also taken as closely representing those at the cloud base itself, and the heights and the temperatures together are sufficient for a close solution of the problem. It is, however, very important to secure more kite observations of this kind just at the cloud base, for the sake of improving this portion of the discussion. (2) The second cause for the divergence of $B_k . t_k . e_k .$ from the normal $B_1 . t_1 . e_1 .$ is the actual departure of the elements at a given time from the average law. This is a real phenomenon and one to be most carefully studied in the future, as soon as sufficient data can be collected. This divergence is due to the existing stratified condition of the air, which is brought about by the horizontal flow of currents of air, too warm or too cold for normal equilibrium at the given elevation. As long as horizontal convection exists, with currents which are gradually mixing while their temperatures are not in equilibrium with the stratum at which they are found, this temperature stratification must be expected. Thus a cold current overflows a warm, causing a cloud formation at the surface of contact, or a warm current is found above a cold, using warm and cold in the relative sense. Of course any map construction at the 3,500-foot level which is based upon surface conditions and average corrections to that elevation can not be expected to take account of the abnormal departures due to stratification, and so far as that goes some imperfection must be admitted in all attempts to reduce to any level from the surface upward. The logical procedure is to discover how much these divergences really are, as shown by the data in hand, so that we may judge what sort of errors must be expected; then we should collect kite data from every subarea in the high and low pressure areas so far as practical, and finally discuss the changes which must be made in the normal reductions to match more closely the actual stratified conditions of the air. The policy of making daily normal weather maps at the 3,500-foot level is possible with only very slight additional expense and labor, and therefore these resulting gradients of $B . t . e .$ will be immediately valuable for forecasting, even if they are at present only approximately known. But they can be gradually improved, as fast as reliable observations are made directly at the cumulus-cloud level. With this explanation we proceed to determine the normal air system.

It would, of course, be possible to adjust the residuals and $t_k - t_s$ by least square methods, but this may more properly be postponed till the meteorographs used in kite ascensions have been improved, so far as to be able to distinguish between the instrumental errors and the real divergence in the local air strata from the normal conditions. Nor have we time at present for such an exhaustive discussion as is involved in a least square adjustment. It may be said generally that we regard the work described in this report more as the mapping out of a plan of procedure for future operations than as the setting forth of final results, which can ultimately be satisfactorily secured only by extensive labor along these lines. Now it is clear that the most important element of the normal $B_1 . t_1 . e_1 .$ which we seek to obtain at the base of the cumulus cloud is the temperature t_1, because B_1 can be computed from it with great accuracy, and e_1 is a direct function of t_1, and is given in the Smithsonian and other tables. It will be shown in this connection that there are three methods which may be used for obtaining t_1, namely, (1) From the surface dew point d; (2) from the surface ratio $\frac{e}{B}$, and (3) from the computed adiabatic saturation temperature t_s. These three methods agree so closely in giving the same value of t_1 that the $B_1 . e_1 .$ dependent upon it are to be taken as also quite accurate. Comparing $B_k . t_k . e_k .$, given directly by the kite observations, with the computed normal $B_1 . t_1 . e_1 .$, we shall see what divergences exist between the systems, part of which must be due to instrumental errors and part to local real departures. From these residuals a criterion can be found for judging as to the average performance of the meteorographs, and also as to the practicability of utilizing the surface conditions in constructing a daily weather map at the 3,500-foot level, by means of simple compu-

tation alone. It will be found that the barograph and the hydrograph need decided improvements, while the thermograph seems to be sufficiently reliable; and also that the map can be built up daily with very considerable precision, and that this must be the most practical method of working daily upon the higher level.

I. *The dew-point method.*—The column t_k-d gives the difference in temperature between the observed temperature at the base of the cloud and the dew point computed at the ground. These are both saturation temperatures, such as actually occur under the existing conditions in the atmosphere, and they are connected by a simple function proportional to the height at which t_k is taken above the surface; $t_k=d-c\,.\,h_k$, where c is a constant depending upon the state of the lower atmosphere. The adiabatic rate does not obtain in the atmosphere. If for the given surface condition $B\,.\,t\,.\,e\,.$ we find the dew point d, there will correspond with this a certain number of grams μ to be found by the use of Table 103. When we start at the surface with a given d and its μ, and ascend along the line of constant μ the d or saturation temperature decreases, directly proportional to the height throughout the α stage, that is, up to the base of the cloud. Compare the dotted lines of the HERTZ diagram. It is noted that whenever we start at the surface, that is to say, whatever the value of d may be, the rate of decrease of d with the height is the same. $\frac{d-t_s}{h}=\alpha$ constant. The dotted lines of the diagram are all parallel to each other, although the positions of μ which differ from each other by 1 gram are not separated by equal intervals, and they have such a slope with the base, or temperature line of abscissas, that $\frac{d-t_s}{h}=\cot\varepsilon$ where ε is the angle that the μ-gram line makes with the axis, and h the number of 100-meters ascent. I shall always regard the temperature line as the axis of abscissas, and the pressure line as the axis of the ordinates. $\frac{d-t_s}{h}=0.21$ approximately for the adiabatic process, but it is equal to 0.30 for the atmosphere. The adiabatic rate gives $\varepsilon=78°$, and the real atmosphere, $\varepsilon=73.3°$. Hence in the atmosphere these lines are less inclined, and the saturation temperature fall per 100 meters is greater—namely, 0.30—than in an adiabatic atmosphere.

The result was obtained as follows: From the data observed at the kite station itself during an ascension, the values B surface pressure, t the dry-bulb temperature, and t' the wet-bulb temperature, were taken for the time at which the kite was noted as soaring just at the cloud base. From $B\,.\,t\,.\,t'\,.$ by the usual methods of reduction, and by the use of the Smithsonian Tables 43, 44, the corresponding values of d and e were computed. All the Weather Bureau observations were made in English measures, but they have been translated into metric measures for the purpose of this discussion. These values of $d\,.\,e$ are to be found under the section with the heading "Surface." Take next the residuals and classify them by the two arguments h_k=height, and t_k-d. The values are then combined in groups corresponding to certain height intervals, for every 100 meters, and the mean heights with the mean (t_k-d) are plotted on a diagram. This enables us to obtain a slope with some accuracy, and thence an approximate value of the actual saturation temperature t_1 at the height h_1 was found by computation. Then residuals t_1-d were formed at the given heights h_k, and grouped now by the values d, so that in a single group should occur all the d values of the same degree at the surface, but with (t_1-d) differing according to the height. We had twenty-nine such groups, ranging from $d=23°$ to $d=-6°$. These were next plotted in a new diagram, with the ordinate h and the abscissa d. The values (t_1-d) were copied on the diagram, and from an inspection it was easy to draw lines through the points where (t_1-d) are integral numbers. Within the limits of the diagram there are six such lines, which are parallel to each other, and at equal distances apart, so that at the height 2,000 meters the difference t_1-d is $-6°$. Hence $\frac{t_1-d}{h}=\frac{-6.0}{2,000}=-0.30$ per 100 meters. In this way a value of t_1 can be found which eliminates the irregularities of local and temporary departures of the saturation temperature, from whatever cause these may have arisen, and this may be used conversely to construct the further residual t_k-t_1 which measures these temporary departures.

This result is embodied in Section I of Table 136, where h_1 is the height of the cloud base, and ch the correction to be subtracted from the surface dewpoint d, to obtain the temperature t_1 which should normally be found at that elevation. The extreme simplicity of obtaining this result may

be noted, and its easy applicability to the computation of a daily map at the elevation 3,500 feet =1,067 meters. Thus for this height $t_1=d-3.^{\circ}2$ C. It is only necessary to compute the dewpoint accurately for the surface conditions, and subtract from that 3°.2 to obtain the temperature at the top of the air column, of course for average unstratified conditions. If we want the barometric pressure at the same height, 3,500 feet, take $\theta=\frac{t+t_1}{2}$, the mean of the surface, and the t_1 temperature, whence by the m table or any special tables the pressure B_1 can be taken out at once. A considerable range in the temperature θ makes so little difference in the resulting value of the B_1 that it will be sufficiently accurate in map drawing, especially in a short run like 1,100 meters. This can be verified by inspecting the m table at that elevation. It is probable that computed values of the pressure B_1 at all the elevations accessible to kites is likely to be much more reliable than the direct measures, in the present state of aneroid barometers. It should be remembered that in thus starting with the surface dewpoint almost all the eccentricities of the lower air, which make up the phenomenon of the inversion of the temperature gradients, whether the departures be above or below the normal rate, are approximately accounted for, except so far as distinctly strange currents of the air flow in horizontal sheet of stratified temperatures. It is now important to know to what extent this occurs and how far it is likely in practical work to injure the formation of a cloud map at a moderate elevation.

TABLE 136.

I.—TEMPERATURE t_1, AT THE HEIGHT h_1, DERIVED FROM THE DEWPOINT d.

$t_1=d-ch_1$. $c=0.30$ (0.17=adiabatic rate)

h	ch	h	ch	h	ch	h	ch	h	ch	h	ch	h	ch
0	0.0	500	1.5	1000	3.0	1500	4.5	2000	6.0	2500	7.5	3000	9.0
100	0.3	600	1.8	1100	3.3	1600	4.8	2100	6.3	2600	7.8	3100	9.3
200	0.6	700	2.1	1200	3.6	1700	5.1	2200	6.6	2700	8.1	3200	9.6
300	0.9	800	2.4	1300	3.9	1800	5.4	2300	6.9	2800	8.4	3300	9.9
400	1.2	900	2.7	1400	4.2	1900	5.7	2400	7.2	2900	8.7	3400	10.2

II.—TEMPERATURE t_1, AT THE HEIGHT h_1, DERIVED FROM ADIABATIC SATURATION t_s.

$t_1=t_s-C$ C=correction to t_s.

$\frac{e}{B}$	.0030	.0050	.0070	.0090	.0110	.0130	.0150	.0170	.0190	.0210	.0230	.0250	.0270	.0290	.0310
h_1=100	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
200	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
300	0.6	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.6
400	0.8	0.8	0.7	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7
500	1.0	1.0	0.9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8
600	1.2	1.2	1.0	0.8	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	1.0
700	1.4	1.4	1.2	1.1	1.1	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.2
800	1.6	1.6	1.4	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.4	1.5
900	1.8	1.8	1.6	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.6	1.6	1.7
1000	2.0	2.0	1.8	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.8	1.9	2.0
1100	2.3	2.2	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.9	1.9	2.0	2.2	2.3
1200	2.6	2.5	2.4	2.2	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.3	2.5	2.6
1300	2.9	2.8	2.6	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.7	2.8	3.0
1400	3.2	3.1	3.0	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.8	3.0	3.2	3.4
1500	3.6	3.4	3.2	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.1	3.3	3.6	3.8
1600	3.8	3.6	3.4	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.3	3.4	3.6	3.9	4.2
1700	4.0	3.8	3.6	3.6	3.5	3.5	3.4	3.4	3.4	3.4	3.6	3.7	4.0	4.3	4.6
1800	4.3	4.1	4.0	4.0	3.9	3.9	3.8	3.8	3.8	3.8	4.0	4.1	4.4	4.7	5.0
1900	4.6	4.4	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.4	4.5	4.8	5.1	5.4
2000	5.0	4.7	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.8	4.9	5.2	5.5	5.8
2100	5.4	5.0	5.0	4.8	4.8	4.8	4.8	4.8	4.8	4.9	5.2	5.3	5.6	5.9	6.2
2200				5.1	5.2	5.2	5.2	5.2	5.2	5.4	5.6	5.7			
2300						5.5	5.5	5.5	5.6	5.8	6.0				
2400							5.8	6.0	6.6	6.2					
2500								6.5	6.5						
Correction.	−0.1	0.0	+0.1	+0.1	+0.2	+0.2	+0.2	+0.3	+0.3	+0.3	+0.2	+0.1	+0.1	0.0	−0.1

TABLE 136—Continued.

III.—RATIO $\frac{e_1}{B_1}$, AT THE HEIGHT h_1, DERIVED FROM $\frac{e}{B}$ AT THE SURFACE.

$\frac{e}{B}-C=\frac{e_1}{B_1}$. C=correction to $\frac{e}{B}$.

$\frac{e}{B}$	.0030	.0050	.0070	.0090	.0110	.0130	.0150	.0170	.0190	.0210	.0230	.0250	.0270	.0290	.0310
h_1=100	0	0	1	1	1	1	2	2	2	3	3	3	4	4	4
200	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5
300	1	2	2	2	3	3	4	4	4	5	5	5	6	7	7
400	2	2	3	3	4	4	5	5	5	6	6	7	8	9	9
500	2	3	3	4	4	5	5	6	6	7	8	8	9	10	11
600	3	4	4	5	5	6	6	7	8	9	9	10	11	12	13
700	4	5	5	5	6	7	8	8	9	10	11	12	13	14	15
800	4	5	6	6	7	8	9	10	11	12	13	14	15	16	17
900	5	5	6	7	8	9	10	11	12	13	14	15	17	18	19
1000	5	6	7	8	9	10	11	12	13	14	16	17	19	20	21
1100	6	7	8	9	10	11	13	14	15	16	17	19	20	21	23
1200	7	7	8	9	11	12	14	15	16	18	19	20	22	23	24
1300	7	8	9	10	12	14	15	16	18	19	20	22	23	25	26
1400	8	9	10	11	13	15	16	18	19	20	22	23	25	26	27
1500	9	9	11	12	14	16	17	19	20	22	23	24	26	28	29
1600	9	10	12	13	15	17	19	20	21	23	25	26	28	29	31
1700	9	11	12	14	16	18	20	21	23	24	26	28	29	31	32
1800	10	11	13	15	17	19	21	22	24	25	27	29	31	32	34
1900												31	32	34	35
2000													34	36	37
2100													36	37	39
2200														39	41
2300														41	43
2400														43	45
2500															47

COMPARISON OF THE OBSERVED AND COMPUTED VALUES.

The temperature marked $t_1=d-ch_1$ is found by applying the corrections of Table 136, I, to the values of d at the several heights. We may anticipate the results by the two other methods mentioned, and refer to the departures (t_k-t_1) the difference in temperature between the kite observations and the mean normal system. Since the work was done at about fifteen different kite stations, situated on the Rocky Mountain slope and in the lake region, that is, under a great variety of local conditions and by as many thermographs, it is evident that there are not likely to be any important systematic errors left in these residuals. This is tested by taking the sum of the residuals (t_k-t_1). Up to the height 1,000 meters, the sum=0; for a whole series of 104 observations the sum is +10.0, and the average departure for each observation is +0°.096, less than one-tenth of a degree. This error is confined entirely to the level between 1,000 and 2,000 meters and would probably disappear if there were many more observations to make use of in the discussion. The average error for a single observation is 1°.6; and the probable error of a single observation is ±1°.378. The errors are distributed as follows:

Between 0° and 1° the number is 48.
Between 1°.1 and 2° the number is 25.
Between 2°.1 and 3° the number is 18.
Between 3°.1 and 4° the number is 6.
Between 4°.1 and 5° the number is 4.
Between 5°.1 and 6° the number is 3.

About half the actual observations are less than 1° from the normal, and three-fourths are within 2° of the normal; only one in nine has a departure greater than 3°. These figures represent the relative frequency with which the distinctly stratified condition of the atmosphere occurs, probably in consequence of warm and cold currents overflowing each other. This classification

reaches from the ground to 2,000 meters, or 6,562 feet, and as the departures increase with altitude the reduction to the moderate elevation, the 3,500-foot plane will be usually quite accurate. The average departure is 1°.36 for the lower 1,000 meters, and 2° for the level 1,000 to 2,000 meters. When we consider that the reduction for the pressure has for its argument the temperature at half the required elevation, it is seen that the mean temperature of the air column will certainly be correct in 75 per cent of the cases to 1°, and in 93 per cent to 2°. This difference of 2° in the temperature argument at the elevation of 1,100 meters can change the resulting pressure only 0.7 mm.—that is, 0.03 inch, an amount which is unimportant for constructing a forecast map. We may therefore expect to get a very good result at the 3,500-foot level, both on the Rocky Mountain plateau and in the districts east of the Mississippi River. This discussion as here stated assumes that the kite meteorograph record was perfectly accurate, but since it is probable that occasional errors of observation occurred at some of the ascensions, the final and correct result when obtained will be even more favorable to this plan of computing upward from the surface to the 3,500-foot level.

II. *The temperature t_1, at the height h_1 derived from the adiabatic saturation temperature t_s.*—The second method of obtaining the temperature t_1 at the base of the cumulus cloud depends upon the adiabatic laws of expansion. This temperature has already been obtained, as described in Table 134, and it is entered in the column headed "Saturation," Table 135. The residuals t_k-t_s are those which are to be discussed. An investigation of these residuals shows that they are not dependent upon the height alone, as in the preceding case, but that they depend upon the ratio $\frac{e}{B}$ also, which determines the vapor contents in the atmosphere at the time of the observation. It would be a more direct procedure to analyze these residuals exactly as they stand, but since we have seen that there occur some wide departures from the normal system already obtained by means of d, it is simpler to take the residuals t_1-t_s where the t_1 is $t_1=d-ch$ in the third column. In a manner similar to the preceding case these residuals t_1-t_s are collected in groups which are selected so that each group contains all the data pertaining to the same value of h_1. For example, the first group is as follows:

TABLE 137.—*Example of group of residuals.*

h_1	t_1	$\frac{e_1}{B_1}$	t_1-t_s
454	22.6	288	−0.4
545	22.6	288	−0.5
632	22.8	293	−0.7
702	22.2	285	−1.5
929	22.1	291	−1.6
Means	22.5	289	

There are 31 such groups, each containing from 9 to 1 components. With the arguments h_1 and $\frac{e_1}{B_1}$ the residuals t_1-t_s are transcribed on a diagram, the numbers in a single group occurring on an ordinate whose base is the given $\frac{e_1}{B_1}$. From previous computations soon to be described, the relations of $\frac{e_1}{B_1}$ to $\frac{e}{B}$ at the cloud and at the surface, respectively, had been found, so that it is always possible to use the $\frac{e_1}{B_1}$ ratio at the cloud, and as the question concerns a reduction at an elevation h_1 it is better to employ this argument at once. Having constructed such a diagram, it was possible to draw a set of lines through points of equal correction to t_s, required to produce t_1. These lines are curves concave to the axis of abscissas, and they are drawn nearer together as the height increases. The result shows that there is some law connecting the two temperatures

t_s and t_1, but I have not been able to detect and discuss it. Indeed, much more data of this kind should be constructed for the analysis of the problem. The range in $\frac{e_1}{B_1}$ is from 0 to 0.0320, and it may be said generally that the corrections are greatest along the middle portions and smaller toward the ends of this series of values of $\frac{e}{B}$. The section II of Table 136 was scaled from this diagram and gives the result. Finally applying these corrections to t_s we find $t_1=t_s-C$, where C is the correction in this table.

COMPARISON OF THE OBSERVED AND COMPUTED VALUES.

It will be seen on inspecting the two columns $t_1=d-ch_1$ and $t_1=t_s-c$ of Table 135 that they generally agree together very closely, though not exactly, which shows that there may be some part of the t_s correction table needing further modification. In order to test this an auxiliary diagram containing the difference between these two results is constructed with the same arguments to show whether there is any tendency to accumulate the errors in special parts of the table. There is a small accumulation of plus differences in the middle portions of the argument, amounting to $+0°.3$; at the ends of the table the mean difference is either $-0°.1$ or zero. The result of this comparison is placed in the lowest line of the Section II, Table 136, and is called "correction." This discussion is not comprehensive enough to conclude that one of these methods of obtaining the temperature at the cloud base is correct and the other wrong. Accordingly we only point out the slight discrepancy between them. If the t_s method is to be reduced to the d method, it will be necessary to add these corrections to the figures in the body of the table. There is very little indication that the differences increases with the height, though this may be true to a slight extent. It is seen that by both methods we can obtain a value of $\theta=\frac{t_1+t}{2}$, which is very accurate, and is available in computations for difference of pressure between two levels. The simplicity of the d method in comparison with the t_s method, on account of the considerable labor of obtaining t_s through the adiabatic formulæ, has induced me to use the former value of t_1 in the succeeding computations, the t_s method being taken rather as a check upon it. Of course a direct comparison of the value of t_1 from the t_s method, with the observed kite temperature t_k, would result in exactly the same remarks that have been already made in describing the value of t_1 from the d method.

III. *Temperature t_1 at the base of the cumulus cloud determined by means of the ratio $\frac{e_1}{B_1}$.*—There is a third method of finding the temperature t_1 which may be called the ratio $\frac{e_1}{B_1}$ method. It consists in computing the ratio $\frac{e}{B}$ and then finding a system of corrections which applied to $\frac{e}{B}$ at the surface will give $\frac{e_1}{B_1}$ at the cloud base. By means of even an approximate value of B_1, which may be found at once by the general gradient with sufficient precision for this immediate purpose, the ratio $\frac{e_1}{B_1}$ is multiplied by B_1 which gives e_1; and as this is a direct function of t_1, the temperature of saturation at the cloud base is found. Table 135 shows this computation *in extenso*. The two values of θ, the mean temperature of the air column, is taken for the t_s method and also the d method, and they are nearly identical; from the arguments h_1 and θ_1 the m table gives $-m$, and the corrections for humidity and gravity $+(\beta+\gamma)m$; to the log B add $-m+(\beta+\gamma)m$; from the log B_1 which it gives take B_1. Also from the t_1 by the d method, using Smithsonian Table 43, take e_1. Form the ratio $\frac{e_1}{B_1}$ which is placed in the last column but one.

We next compare this $\frac{e_1}{B_1}$ with $\frac{e}{B}=\frac{e_s}{B_s}$ already given, and take the residuals $\frac{e}{B}-\frac{e_1}{B_1}$. These are collected into groups for the sake of making a diagram. As an example of a group, we have—

TABLE 138.—*Example of group of the residuals* $\frac{e}{B}-\frac{e_1}{B_1}$.

h_1	$\frac{e}{B}$	$\frac{e}{B}-\frac{e_1}{B_1}$
812	.0097	+7
812	95	+7
827	65	+7
828	65	+5
862	92	+7
866	52	+5
896	77	+6
844	.0078	+6.3

The grouping is by heights and the ratio $\frac{e}{B}$. With these as arguments transfer to a diagram the residual numbers and draw lines through the points having the same value. These form a well distributed system of curves, such that for low values of the ratio the correction is small even up to 2,000 meters, but with large values of the ratio the correction is much greater. From this diagram the Section III of Table 136 has been constructed, and gives the numbers, in units of the fourth decimal, to be substracted from $\frac{e}{B}$ to produce $\frac{e_1}{B_1}$. The smoothness with which curves of this diagram are graded on the chart is an indication of the systematic character of the correction which is found. The law of this change needs investigation with much care, since it indicates the method of the departure from the normal atmosphere from an ideal adiabatic system.

COMPARISON OF THE TWO SETS OF VALUES.

In order to test this $\frac{e_1}{B_1}$ method of reduction, we have done the following work: Substract from $\frac{e}{B}$ the correction as given by the Table 136, III, with the arguments h_1 and $\frac{e}{B}$, and find $\frac{e_1}{B_1}$; multiply this by B_1 and obtain e_1; take the corresponding t_1 from the Smithsonian Table 43, and this is given in the last column. We have thus in conclusion found t_1 by the d method, and the t_s method, and the $\frac{e_1}{B_1}$ method, and the several values can be at once compared together. They are also collected on Table 135. The first and third agree together very closely, not only here, but also in all the other work which has been done in connection with these problems; the t_s method is slightly divergent, generally a little in excess. Each method has its advantages, under given conditions, but we are chiefly interested here in their concurrent testimony to the fact that the $B_1 . t_1 . e_1$. thus found for the base of a cumulus cloud, which is normally in conformity with that existing at the ground at the same time, is quite accurate. This gives us, therefore, a secure set of values with which to compare the instrumental readings as made by the kite observations. The residuals (B_k-B_1) (t_k-t_1) (e_k-e_1) have been taken out and appear in their respective columns. The residual (t_k-t_1) has been already discussed.

DISCUSSION OF THE PRESSURE RESIDUALS (B_k-B_1).

The residual (B_k-B_1), the barometric pressure, requires some remark, as this shows the accuracy with which the aneroid barograph operates in practical work. It is to be remembered that our results depend upon accepting as generally correct the measured height h_k and the observed temperature t_k. The question is, how far the observed B_k is consistent with them, and hence with B_1, and what the average and the probable error of a single observation is as determined by the kite series of results. The sum of the residuals (B_k-B_1), taken algebraically, is

+785.2 for 104 observations. Hence 1 observation is +7.55 mm., on the average, too great for a balance in the arithmetical sum. This shows that the kite aneroid barographs tend to register +7.55 mm. too large, and that therefore the barograph practically is suspended in an atmosphere 7.55 mm. heavier than that indicated by the computation from the kite line. This may occur in consequence of a systematic error in the registration of the instrument, due to a lag in the action of the same, by reason of which the pen does not promptly indicate the pressure of the air, or else to some other defect; or it may be due to an error of about 100 meters in the height derived from the catenary of the line. As matters stand, the two observations are inconsistent with each other, for either the barograph must read 7.55 mm. lower if the height is correct, or else the height must be reduced 100 meters on the average. I think the former supposition is the proper one to assume, since it is quite probable that the error of height from the line is only 1 or 2 per cent of the total height. The wild registration of the barographs, seen by comparing the residuals with each other, is also an argument leading to the same conclusion.

The average departure of an observation given by these residuals is 8.63 mm.; and the probable error of a single observation is ±8.27 mm. or ±0.326 inch. These are distributed as follows:

Between	0	and	5.0	mm.	42	observations.
"	5.1	"	10.0	"	37	"
"	10.1	"	15.0	"	11	"
"	15.1	"	20.0	"	4	"
"	20.1	"	25.0	"	4	"
"	25.1	"	30.0	"	2	"
"	30.1	"	35.0	"	1	"
"	35.1	"	40.0	"	1	"
"	40.1	"	50.0	"	2	"

Hence 76 per cent of the observations have an error between 0 and 10 mm., and 90 per cent between 0 and 20 mm.

DISCUSSION OF THE VAPOR TENSION RESIDUALS $e_k - e_1$.

Discussing the vapor tension residuals ($e_k - e_1$) in the same way, it is found that the sum of the residuals is +7.42 mm. for 104 observations, and that there is an average departure of +0.071 for e on the positive side of the arithmetical mean. The average error of the observations is 1.007 mm., and the probable error of a single observation is ±0.932 mm. = ±0.0367 inch.

The distribution is:

Between	0	and	0.50	mm.	42	observations.
"	0.51	"	1.00	"	27	"
"	1.01	"	1.50	"	11	"
"	1.51	"	2.00	"	10	"
"	2.01	"	2.50	"	5	"
"	2.51	"	3.00	"	1	"
"	3.01	"	3.50	"	4	"
"	3.51	"	4.00	"	3	"
"	4.01	"	5.00	"	1	"

Recapitulation of kite results.

Element.	Average departure.	Average error.	Probable error.
Pressure	+7.55 mm.	8.63 mm.	±8.27 mm. = ±0.306 inch.
Temperature	+0°.096 C.	1°.60 C.	±1°.378 C. = ±2°.48 F.
Vapor tension	+0.071 mm.	1.007 mm.	±0.93 mm. = ±0.037 inch.

The errors in temperature are real, and generally due to local air currents; those in pressure and vapor tension are chiefly instrumental, and may be eliminated by better construction of the apparatus. The error in computation of the pressure from the surface conditions at 1,100 meters height is about 0.7 mm., or 0.03 inch, which would imply an error of 10 meters in the height. This is equal to the maximum accuracy possible to obtain by the best kite-line observation. We may conclude that the improvement of such data by means of occasional kite ascensions will yield results of value in practical map construction at the moderate elevation of the base of the cumulus cloud system over the eastern districts of the United States. The barograph, especially, needs to be made more sensitive and accurate. The probable error of a single measure of the pressure by means of the aneroid barograph is ± 8.3 mm. $=0.31$ inch; the extreme errors recorded were 41 mm. $=1.57$ inch. Since the probable error of obtaining the mean temperature of the air column is less than 1°.5 C. under all conditions for moderate heights, and the extreme error is 3°.0 C., being half the error at the top, it follows that the error of computing the pressure at the height h by the formula will not generally be greater than 0.02 inch, and will very seldom exceed 0.04 inch. This holds true up to the altitude of 1 mile, and under all the variable surface conditions which occur, either of temperature or motion.

COMPUTATIONS OF THE $B.t.e.$ FOR THE $\alpha.\beta.\gamma.\delta.$ STAGES IN CUMULUS AND CUMULO-NIMBUS CLOUDS.

TABLE 139.—*Cumulus clouds, 8 to 10 a. m.*

α STAGE.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
10 a. m.	764.0	762.8	759.6	762.9	762.3	762.1	764.7	764.8	762.7	764.1	767.9	763.4
t	−3.0	3.6	6.6	11.9	18.9	21.8	25.1	26.1	20.1	13.3	10.0	6.6
e	2.36	4.05	5.58	6.36	10.83	13.92	17.04	15.97	12.21	7.50	7.76	4.13
d	−7.2	−1.5	2.8	4.7	12.6	16.5	19.7	18.7	14.4	7.1	7.6	−1.2
$\frac{e}{B}$	.0031	.0053	.0074	.0084	.0142	.0183	.0223	.0206	.0160	.0098	.0101	.0054
Table I	1.3314	1.3393	1.3437	1.3489	1.3599	1.3657	1.3719	1.3712	1.3624	1.3513	1.3488	1.3420
II	−.4558	−.4561	−.4561	−.4566	−.4575	−.4582	−.4591	−.4588	−.4579	−.4570	−.4574	−.4561
α const.	.8756	.8832	.8876	.8923	.9024	.9075	.9128	.9124	.9045	.8943	.8914	.8859
t_s	−8.8	−2.5	2.0	3.2	11.2	15.3	18.5	16.7	13.2	5.7	7.0	−2.5
I	1.3267	1.3343	1.3399	1.3417	1.3537	1.3606	1.3667	1.3636	1.3571	1.3453	1.3465	1.3342
α const−I=II	.4511	.4511	.4523	.4494	.4513	.4531	.4539	.4512	.4526	.4510	.4551	.4483
B_s	714	710	719	687	696	708	709	684	706	700	743	681
e_s	2.18	3.72	5.27	5.74	9.90	12.92	15.83	14.13	11.29	6.83	7.47	3.72
$\frac{e_s}{B_s}$	.0031	.0053	.0074	.0084	.0142	.0183	.0223	.0206	.0160	.0098	.0101	.0054
Obs'vd base h_1	910	950	1060	1090	980	910	930	970	930	940	940	940
From d t_1	−9.9	−4.4	−0.4	1.4	9.7	13.8	16.9	15.8	11.6	4.3	4.8	−4.0
From t_s t_1	−10.8	−4.4	0.0	1.0	9.6	14.2	17.3	15.5	11.8	3.7	5.0	−4.4
$(t_1)\ d\ \theta_{-=}\frac{t+t_1}{2}$	−6.5	−0.4	3.1	6.6	14.3	17.8	21.0	21.0	15.9	8.8	7.4	1.3
$-m$	−5057	−5159	−5687	−5774	−5053	−4634	−4684	−4886	−4769	−4939	−4966	−5076
$+\beta m+\gamma m$	+9	+12	+15	+19	+37	+35	+40	+40	+31	+22	+21	+13
Log B	2.88309	2.88241	2.88058	2.88247	2.88213	2.88201	2.88349	2.88355	2.88235	2.88315	2.88530	2.88275
Log B_1	2.83161	2.83094	2.82386	2.82492	2.83197	2.83502	2.83705	2.83509	2.83497	2.83398	2.83585	2.83209
B_1	678.6	677.6	666.4	668.2	679.2	683.9	687.2	684.0	683.9	682.3	685.2	679.3
From $\frac{e_1}{B_1}$ t_1	−11.2	−4.3	−0.4	1.5	9.6	13.7	16.9	15.6	11.6	4.2	4.7	−4.1
e_1	1.77	3.18	4.40	5.08	8.89	11.69	14.35	13.20	10.19	6.13	6.37	3.25
$\frac{e_1}{B_1}$	.0026	.0047	.0066	.0076	.0131	.0171	.0209	.0193	.0149	.0090	.0093	.0048
I	1.3242	1.3321	1.3370	1.3396	1.3513	1.3584	1.3641	1.3617	1.3546	1.3431	1.3438	1.3323
II	−.4477	−.4479	−.4470	−.4474	−.4494	−.4506	−.4516	−.4510	−.4502	−.4490	−.4495	−.4480
α const.	.8765	.8842	.8900	.8922	.9019	.9078	.9125	.9107	.9044	.8941	.8943	.8843
Gradients per 100m: $G.B$	−9.3mm	−9.0	−8.9	−8.7	−8.5	−8.6	−8.4	−8.3	−8.5	−8.8	−8.9	−9.0
Gradients per 100m: $G.t$	−0.91	−0.84	−0.66	−0.96	−0.95	−0.90	−0.89	−1.09	−0.92	−0.97	−0.57	−1.14
Gradients per 100m: $G.e$	−.065	−.092	−.112	−.118	−.198	−.246	−.287	−.283	−.218	−.146	−.148	−.094
Gradients per 100m: $G.\alpha$	+1.0	+1.1	+2.3	−0.1	−0.6	+0.4	−0.4	−1.8	−0.1	−0.3	+3.1	−1.8

TABLE 139.—*Cumulus clouds, 8 to 10 a. m.*—Continued.

β STAGE I.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
B_1-e_1	.....	.....	.....	663.1	670.3	672.2	672.8	670.8	673.7	676.2	678.8	.....
$\frac{e_1}{B_1-e_1}$	.....	.....	.....	.0077	.0133	.0174	.0213	.0197	.0151	.0091	.0094	.....
h'	.....	.....	.....	.....	1720	1660	1550	1470	1380	1370	1480	.....
$h'-h_1$	.....	.....	.....	.....	740	750	620	500	450	430	540	.....
θ_1	.....	.....	.....	.....	7.5	11.7	15.1	14.1	10.3	3.0	3.2	.....
$-m$	.....	.....	.....	.....	−3908	−3904	−3187	−2579	−2248	−2309	−2897	.....
$+\beta m+\gamma m$	.....	.....	.....	.....	+18	+26	+23	+20	+14	+11	+13	.....
Log B'	.....	.....	.....	.....	2.79307	2.79624	2.80541	2.80950	2.81263	2.81100	2.80701	.....
B'	.....	.....	.....	.....	621.0	625.5	638.9	644.9	649.6	647.1	641.2	.....
I_1	.....	.....	.....	1.3535	1.3752	1.3895	1.4025	1.3971	1.3818	1.3595	1.3608	.....
II_1	.....	.....	.....	−.4435	−.4426	−.4418	−.4407	−.4410	−.4425	−.4444	−.4446	.....
III_1	.....	.....	.....	.0105	.0173	.0222	.0268	.0249	.0195	.0123	.0126	.....
β const.	.....	.....	.....	.9205	.9499	.9699	.9886	.9810	.9588	.9274	.9288	.....
Approx. t'	.....	.....	.....	.....	5.7	10.2	14.1	13.2	9.4	1.5	1.8	.....
Approx. $'e$	.....	.....	.....	.....	6.83	9.26	11.96	11.28	8.78	5.09	5.20	.....
$B'-e'$	.....	.....	.....	.....	614.2	616.2	626.9	633.6	640.8	642.0	636.0	.....
$\frac{e'}{B'-e'}$	.....	.....	.....	.....	.0111	.0150	.0191	.0178	.0137	.0079	.0082	.....
II'	.....	.....	.....	.....	−.4368	−.4358	−.4359	−.4370	−.4391	−.4408	−.4401	.....
III'	.....	.....	.....	.....	.0149	.0194	.0243	.0229	.0180	.0108	.0109	.....
I'	.....	.....	.....	.....	1.3718	1.3863	1.4002	1.3951	1.3799	1.3572	1.3580	.....
t'	.....	.....	.....	.....	5.8	10.1	14.1	13.2	9.4	1.7	1.7	.....
e'	.....	.....	.....	.....	6.88	9.20	11.96	11.28	8.78	5.16	5.16	.....
$G.B_1$	.....	.....	.....	.....	−7.9	−7.9	−7.8	−7.7	−7.6	−8.2	−8.2	.....
$G.t_1$	.....	.....	.....	.....	−0.52	−0.48	−0.46	−0.48	−0.49	−0.59	−0.56	.....
$G.e_1$	.....	.....	.....	.....	−.272	−0.328	−0.386	−0.377	−0.314	−0.226	−0.225	.....

β STAGE II.

$\frac{e_1}{B_1}$	.....	.....	.....	.0076	.....	.....	.....	.....	.....	.....	.....	.....
t'	.....	.....	.....	0	.....	.....	.....	.....	.....	.....	.....	.....
β const.	.....	.....	.....	.9205	.....	.....	.....	.....	.....	.....	.....	.....
I'	.....	.....	.....	1.3520	.....	.....	.....	.....	.....	.....	.....	.....
$II'+III'$	.....	.....	.....	−.4315	.....	.....	.....	.....	.....	.....	.....	.....
Approx. $B'-e'$	.....	.....	.....	642	.....	.....	.....	.....	.....	.....	.....	.....
$\frac{e'}{B'-e'}$	.....	.....	.....	.0071	.....	.....	.....	.....	.....	.....	.....	.....
III'	.....	.....	.....	.0097	.....	.....	.....	.....	.....	.....	.....	.....
II'	.....	.....	.....	−4412	.....	.....	.....	.....	.....	.....	.....	.....
$B'-e'$	.....	.....	.....	642.0	.....	.....	.....	.....	.....	.....	.....	.....
B'	.....	.....	.....	646.6	.....	.....	.....	.....	.....	.....	.....	.....
Log B'	.....	.....	.....	2.81064	.....	.....	.....	.....	.....	.....	.....	.....
Log B_1	.....	.....	.....	2.82492	.....	.....	.....	.....	.....	.....	.....	.....
$+m_1$	.....	.....	.....	1428	.....	.....	.....	.....	.....	.....	.....	.....
$+\beta m+\gamma m$	.....	.....	.....	+5	.....	.....	.....	.....	.....	.....	.....	.....
m	.....	.....	.....	1433	.....	.....	.....	.....	.....	.....	.....	.....
θ_1	.....	.....	.....	0.7	.....	.....	.....	.....	.....	.....	.....	.....
$h'-h_1=\Delta h_1$	.....	.....	.....	265	.....	.....	.....	.....	.....	.....	.....	.....
h'	.....	.....	.....	1355	.....	.....	.....	.....	.....	.....	.....	.....
B_1	.....	.....	.....	668.2	.....	.....	.....	.....	.....	.....	.....	.....
t_1	.....	.....	.....	1.5	.....	.....	.....	.....	.....	.....	.....	.....
e_1	.....	.....	.....	5.08	.....	.....	.....	.....	.....	.....	.....	.....
$G.B_1$	.....	.....	.....	−8.2	.....	.....	.....	.....	.....	.....	.....	.....
$G.t_1$	.....	.....	.....	−0.57	.....	.....	.....	.....	.....	.....	.....	.....
$G.e_1$	.....	.....	.....	−0.193	.....	.....	.....	.....	.....	.....	.....	.....

TABLE 139.—*Cumulus clouds, 8 to 10 a. m.*—Continued.

γ STAGE.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
γ const. II′+III′				−.4315								
Approx. B^0				646								
B^0-e^0				641								
$\frac{e^0}{B^0-e^0}$				.0071								
III°				+.0111								
IV°				−.0014								
II°				−.4412								
B^0-e^0				642								
B^0				646.6								
Log B^0												
Log B_0												
$+m_1$												
$+\beta m_1+\gamma m_1$												
m												
$\theta_0=0$				0								
$h^0-h_0=\Delta h_0$				0								
h^0				1355								
$G\,.\,B_0$												

δ STAGE.

t_{11}	−11.2	−4.3	−0.4	0								−4.1
$\frac{e_1}{B_1}$	.0026	.0047	.0066	.0076								.0048
$B_{11}-e_{11}$	676.8	674.4	662.0	642.0								676.0
$\frac{e_{11}}{B_{11}-e_{11}}$	.0026	.0047	.0066	.0071								.0048
I_{11}	1.3288	1.3404	1.3489	1.3520								1.3408
II_{11}	−.4463	−.4454	−.4436	−.4412								−.4456
III_{11}	+.0041	+.0073	+.0103	+.0111								+.0075
δ const.	.8866	.9023	.9156	.9219								.9027
Obs'vd h''	1500	1500	1770	1700								1600
$h''-h_{11}$	590	550	710	345								660
θ_{11}	−13.2	−5.4	−2.5	−1.0								−6.1
$-m$	−3358	−3036	−3876	−1879								−3659
$+\beta m+\gamma m$	+3	+5	+8	+4								+7
Log B_{11}	2.83161	2.83097	2.82373	2.81064								2.83206
Log B''	2.79806	2.80066	2.78505	2.79189								2.79554
B''	628.2	631.9	609.6	619.3								624.5
Approx. t''	−15.8	−8.0	−4.7	−1.7								−8.6
Approx. e''	1.16	2.32	3.09	3.96								2.21
$B''-e''$	627.0	629.6	606.5	615.3								621.3
$\frac{e''}{B''-e''}$	.0019	.0037	.0051	.0064								.0036
II″	−.4410	−.4406	−.4376	−.4384								−.4397
III″	+30	+60	+82	+100								+58
I″	1.3246	1.3369	1.3450	1.3503								1.3366
t''	−15.7	−8.3	−4.9	−1.9								−8.9
e''	1.16	2.26	3.03	3.91								2.16
$G\,.\,B_{11}$	−8.6	−8.3	−8.1	−7.9								−8.3
$G\,.\,t_{11}$	−0.77	−0.73	−0.64	−0.55								−0.73
$G\,.\,e_{11}$	−.104	−.168	−.194	−.191								−.166

COMPUTATIONS OF THE $B.t.e.$ FOR THE $\alpha.\beta.\gamma.\delta.$ STAGES IN CUMULUS AND CUMULO-NIMBUS CLOUDS—continued.

TABLE 140.—*Cumulus clouds, 12 to 2 p. m.*

α STAGE.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2 p. m. B	764.7	763.9	759.0	762.0	762.0	761.8	764.0	764.1	762.0	763.6	766.9	764.6
t	−0.4	5.3	12.0	16.5	22.0	25.5	28.5	30.6	24.0	17.1	14.3	7.9
e	2.33	3.72	6.28	6.86	10.58	13.73	17.00	15.28	12.07	7.39	7.92	4.36
d	−8.0	−2.5	4.5	5.8	12.2	16.3	19.7	18.0	14.2	6.9	7.9	−0.6
$\frac{e}{B}$	.0031	.0049	.0083	.0090	.0139	.0180	.0223	.0200	.0159	.0097	.0103	.0057
Table I	1.3342	1.3408	1.3491	1.3533	1.3621	1.3685	1.3747	1.3744	1.3654	1.3545	1.3525	1.3426
II	−.4558	−.4561	−.4562	−.4566	−.4575	−.4581	−.4591	−.4587	−.4578	−.4569	−.4573	−.4563
α const.	.8784	.8847	.8929	.8967	.9046	.9104	.9156	.9157	.9076	.8976	.8952	.8873
t_s	−9.0	−3.7	3.0	3.5	10.1	14.4	17.6	15.1	12.2	4.8	6.5	−2.0
I	1.3265	1.3328	1.3414	1.3424	1.3524	1.3596	1.3660	1.3619	1.3561	1.3442	1.3463	1.3350
α const.−I=II	.4481	.4481	.4485	.4457	.4478	.4492	.4504	.4462	.4485	.4466	.4411	.4477
B_s	683	680	678	650	662	678	673	637	665	658	700	674
e_s	2.14	3.36	5.66	5.87	9.20	12.20	14.96	12.74	10.57	6.42	7.22	3.87
$\frac{e}{B_s}$	.0031	.0049	.0083	.0090	.0139	.0180	.0223	.0200	.0159	.0097	.0103	.0057
h_1	1100	1140	1320	1340	1300	1250	1100	1170	1120	1110	1110	1110
From d t_1	−11.3	−5.9	0.5	1.8	8.3	12.6	16.4	14.5	10.8	3.6	4.6	−3.9
From t_s t_1	−11.3	−6.0	0.4	0.8	7.8	12.3	15.7	13.1	10.2	2.8	4.5	−4.1
θ	−5.9	−0.3	6.3	9.2	15.2	19.1	22.5	22.6	17.4	10.4	9.5	2.0
$-m$	−6010	−6190	−7000	−7032	−6681	−6339	−5513	−5863	−5712	−5801	−5820	−5978
$+\beta m+\gamma m$	+9	+11	+24	+24	+35	+42	+45	+43	+36	+22	+24	+15
Log B	2.88349	2.88304	2.88024	2.88195	2.88195	2.88184	2.88309	2.88315	2.88195	2.88287	2.88474	2.88343
Log B_1	2.82349	2.82125	2.81048	2.81187	2.81549	2.81887	2.82841	2.82495	2.82519	2.82508	2.82678	2.82380
B_1	666.0	662.6	646.4	648.4	653.9	659.0	673.6	668.3	668.6	668.5	671.1	666.5
From $\frac{e_1}{B_1}$ t_1	−11.8	−5.9	0.4	1.7	8.3	12.5	16.4	14.4	10.9	3.4	4.4	−3.8
e_1	1.66	2.78	4.71	5.18	8.17	10.80	13.88	12.22	9.70	5.82	6.24	3.32
$\frac{e_1}{B_1}$	.0025	.0042	.0073	.0080	.0125	.0164	.0206	.0183	.0145	.0087	.0093	.0050
I	1.3235	1.3303	1.3383	1.3400	1.3497	1.3568	1.3634	1.3599	1.3537	1.3422	1.3436	1.3328
II	−.4462	−.4461	−.4449	−.4452	−.4466	−.4479	−.4502	−.4491	−.4485	−.4475	−.4480	−.4467
α const.	.8773	.8842	.8934	.8948	.9031	.9089	.9132	.9108	.9052	.8947	.8956	.8861
$G.B$	−9.0	−8.9	−8.6	−8.6	−8.3	−8.3	−8.2	−8.2	−8.3	−8.6	−8.7	−8.9
$G.t$	−1.03	−0.99	−0.88	−1.12	−1.05	−1.04	−1.10	−1.39	−1.17	−1.24	−0.90	−1.06
$G.e$	−.061	−.094	−.119	−.127	−.184	−.235	−.281	−.262	−.212	−.142	−.152	−.094
$G.\alpha$	−0.9	−0.5	+0.5	−1.5	−1.2	−1.2	−2.2	−4.2	−2.2	−2.7	+0.4	−1.1

TABLE 140.—*Cumulus clouds, 12 to 2 p. m.*—Continued.

β STAGE I.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
B_1-e_1	.....	.....	641.7	643.2	645.7	648.2	659.7	656.1	658.9	662.7	664.9	.....
$\frac{e_1}{B_1-e_1}$	.....	.....	.0074	.0081	.0126	.0167	.0210	.0186	.0147	.0088	.0094	.....
h'	.....	.....	.....	.....	1800	1810	1840	1860	1850	.....	1610	.....
$h'-h_1$	.....	.....	.....	.....	500	560	740	690	730	.....	500	.....
θ_1	.....	.....	.....	.....	6.9	10.9	14.3	12.4	8.4	.....	2.9	.....
$-m$	.....	.....	.....	.....	−2644	−2924	−3814	−3581	−3843	.....	−2686	.....
$+\beta m+\gamma m$	.....	.....	.....	.....	+13	+19	+25	+25	+21	.....	+9	.....
Log B'	.....	.....	.....	.....	2.78918	2.78982	2.79052	2.78939	2.78697	.....	2.80001	.....
B'	.....	.....	.....	.....	615.4	616.3	617.3	615.7	612.3	.....	631.0	.....
I_1	.....	.....	1.3516	1.3546	1.3724	1.3866	1.4012	1.3934	1.3801	1.3580	1.3604	.....
II_1	.....	.....	−.4413	−.4412	−.4401	−.4395	−.4396	−.4395	−.4410	−.4431	−.4430	.....
III_1	.....	.....	.0101	.0111	.0166	.0216	.0265	.0237	.0191	.0119	.0127	.....
β const.	.....	.....	.9204	.9245	.9489	.9687	.9881	.9776	.9582	.9268	.9301	.....
Approx. t'	.....	.....	.....	.....	5.7	10.0	12.9	11.3	7.4	.....	1.5	.....
Approx. e'	.....	.....	.....	.....	6.83	9.14	11.07	9.96	7.67	.....	5.09	.....
$B'-e'$	.....	.....	.....	.....	608.6	607.2	606.2	604.7	604.6	.....	625.9	.....
$\frac{e'}{B'-e'}$	.....	.....	.....	.....	.0112	.0151	.0183	.0165	.0127	.....	.0081	.....
II'	.....	.....	.....	.....	−.4362	−.4351	−.4336	−.4343	−.4353	.....	−.4390	.....
III'	.....	.....	.....	.....	.0150	.0197	.0236	.0216	.0169	.....	.0111	.....
I'	.....	.....	.....	.....	1.3701	1.3841	1.3981	1.3903	1.3766	.....	1.3580	.....
t'	.....	.....	.....	.....	5.7	9.8	12.8	11.0	7.0	.....	1.7	.....
e'	.....	.....	.....	.....	6.83	9.02	10.99	9.77	7.47	.....	5.16	.....
$G.B_1$	.....	.....	.....	.....	−7.5	−7.6	−7.6	−7.6	−7.7	.....	−7.9	.....
$G.t_1$	.....	.....	.....	.....	−0.51	−0.49	−0.49	−0.50	−0.53	.....	−0.53	.....
$G.e_1$	.....	.....	.....	.....	−0.263	−0.318	−0.391	−0.356	−0.302	.....	−0.210	.....

β STAGE II.

$\frac{e_1}{B_1}$	.....	.....	.0073	.0080	.....	.....	.....	.....	.....	.0087	.....	.....
t'	.....	.....	0	0	.....	.....	.....	.....	.....	0	.....	.....
β const.	.....	.....	.9204	.9245	.....	.....	.....	.....	.....	.9268	.....	.....
I'	.....	.....	1.3512	1.3531	.....	.....	.....	.....	.....	1.3549	.....	.....
$II'+III'$	.....	.....	−.4308	−.4286	.....	.....	.....	.....	.....	−.4281	.....	.....
Approx. $B'-e'$	.....	.....	637	620	.....	.....	.....	.....	.....	617	.....	.....
$\frac{e'}{B'-e'}$	.....	.....	.0072	.0074	.....	.....	.....	.....	.....	.0074	.....	.....
III'	.....	.....	.0099	.0101	.....	.....	.....	.....	.....	.0101	.....	.....
II'	.....	.....	−.4407	−.4387	.....	.....	.....	.....	.....	−.4382	.....	.....
$B'-e'$	.....	.....	637	620	.....	.....	.....	.....	.....	617	.....	.....
B'	.....	.....	641.6	624.6	.....	.....	.....	.....	.....	621.6	.....	.....
Log B'	.....	.....	2.80726	2.79560	.....	.....	.....	.....	.....	2.79351	.....	.....
Log B_1	.....	.....	2.81048	2.81187	.....	.....	.....	.....	.....	2.82508	.....	.....
$+m_1$	.....	.....	322	1627	.....	.....	.....	.....	.....	3157	.....	.....
$+\beta m+\gamma m$	.....	.....	+4	+5	.....	.....	.....	.....	.....	+10	.....	.....
m	.....	.....	326	1632	.....	.....	.....	.....	.....	3167	.....	.....
θ_1	.....	.....	0.2	0.9	.....	.....	.....	.....	.....	1.7	.....	.....
$h'-h_1=\Delta h_1$	.....	.....	60	301	.....	.....	.....	.....	.....	587	.....	.....
h'	.....	.....	1368	1641	.....	.....	.....	.....	.....	1697	.....	.....
B_1	.....	.....	646.4	648.4	.....	.....	.....	.....	.....	668.5	.....	.....
t_1	.....	.....	0.4	1.7	.....	.....	.....	.....	.....	3.4	.....	.....
e_1	.....	.....	4.71	5.18	.....	.....	.....	.....	.....	5.82	.....	.....
$G.B_1$	.....	.....	−8.2	−8.2	.....	.....	.....	.....	.....	−8.0	.....	.....
$G.t_1$	.....	.....	−.69	−.61	.....	.....	.....	.....	.....	−.58	.....	.....
$G.e_1$	.....	.....	−.238	−.211	.....	.....	.....	.....	.....	−.213	.....	.....

TABLE 140.—*Cumulus clouds, 12 to 2 p. m.*—Continued.

γ STAGE.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
γ const. $II'+III'$	.....	.....	−.4308	−.4286	.....	.....	.....	.....	.....	−.4281	.....	.....
Approx. B^0	.....	.....	642	625	.....	.....	.....	.....	.....	622	.....	.....
B^0-e^0	.....	.....	637	620	.....	.....	.....	.....	.....	617	.....	.....
$\frac{e^0}{B^0-e^0}$	.....	.....	.0072	.0074	.....	.....	.....	.....	.....	.0075	.....	.....
III^0	.....	.....	+.0112	+.0115	.....	.....	.....	.....	.....	+.0116	.....	.....
IV^0	.....	.....	−.0013	−.0015	.....	.....	.....	.....	.....	−.0015	.....	.....
II^0	.....	.....	−.4407	−.4386	.....	.....	.....	.....	.....	−.4382	.....	.....
B^0-e^0	.....	.....	637	620	.....	.....	.....	.....	.....	617	.....	.....
B^0	.....	.....	641.6	624.6	.....	.....	.....	.....	.....	621.6	.....	.....
Log B^0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
B_0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
$+m_1$	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
$+\beta m_1+\gamma m_1$	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
m	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
$\theta_0=0$	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
$h^0-h_0=\Delta h_0$	.....	.....	0	0	.....	.....	.....	.....	.....	0	.....	.....
h''	.....	.....	1368	1641	.....	.....	.....	.....	.....	1697	.....	.....
$G.B_0$	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

δ STAGE.

t''	−11.8	−5.9	0	0	.....	.....	.....	.....	.....	0	.....	−3.8
$\frac{e_1}{B_1}$	.0025	.0042	.0073	.0080	.....	.....	.....	.....	.....	.0087	.....	.0050
$B_{11}-e_{11}$	664.3	659.8	637.0	620.0	.....	.....	.....	.....	.....	617.0	.....	663.2
$\frac{e_{11}}{B_{11}-e_{11}}$	.0025	.0042	.0072	.0074	.....	.....	.....	.....	.....	.0075	.....	.0050
I_{11}	1.3279	1.3377	1.3512	1.3531	.....	.....	.....	.....	.....	1.3549	.....	1.3417
II_{11}	−.4448	−.4440	−.4408	−.4387	.....	.....	.....	.....	.....	−.4383	.....	−.4441
III_{11}	+.0039	+.0065	+.0112	+.0115	.....	.....	.....	.....	.....	+.0116	.....	+.0079
δ const.	.8870	.9002	.9216	.9259	.....	.....	.....	.....	.....	.9282	.....	.9055
Obs'vd h''	1580	1590	1880	1840	.....	.....	.....	.....	.....	1770	.....	1650
$h''-h_{11}$	480	450	512	199	.....	.....	.....	.....	.....	73	.....	540
θ_{11}	−13.5	−7.5	−1.8	−0.9	.....	.....	.....	.....	.....	−0.5	.....	−5.7
$-m$	−2734	−2510	−2796	−1084	.....	.....	.....	.....	.....	−397	.....	−2992
$\beta m+\gamma m$	+3	+5	+6	+3	.....	.....	.....	.....	.....	+1	.....	+6
Log B_{11}	2.82347	2.82125	2.80726	2.79560	.....	.....	.....	.....	.....	2.79351	.....	2.82380
Log B''	2.79616	2.79620	2.77936	2.78479	.....	.....	.....	.....	.....	2.78955	.....	2.79394
B''	625.4	625.5	601.7	609.2	.....	.....	.....	.....	.....	616.0	.....	622.2
Approx. t''	−15.3	−9.0	−3.0	−1.2	.....	.....	.....	.....	.....	−0.3	.....	−7.6
Approx. e''	1.21	2.14	3.56	4.13	.....	.....	.....	.....	.....	4.44	.....	2.40
$B''-e''$	624.2	623.4	598.3	605.1	.....	.....	.....	.....	.....	611.6	.....	619.8
$\frac{e''}{B''-e''}$	.0019	.0034	.0060	.0068	.....	.....	.....	.....	.....	.0073	.....	.0039
II''	−.4406	−.4402	−.4365	−.4371	.....	.....	.....	.....	.....	−.4377	.....	−.4395
III''	+31	+55	+94	+106	.....	.....	.....	.....	.....	+113	.....	+62
I''	1.3245	1.3349	1.3487	1.3524	.....	.....	.....	.....	.....	1.3546	.....	1.3388
t''	−15.5	−9.0	−2.7	−0.8	.....	.....	.....	.....	.....	−0.2	.....	−7.1
e''	1.20	2.14	3.65	4.26	.....	.....	.....	.....	.....	4.48	.....	2.51
$G.B_{11}$	−8.5	−8.3	−7.8	−7.7	.....	.....	.....	.....	.....	−7.7	.....	−8.2
$G.t_{11}$	−0.78	−0.69	−0.53	−0.40	.....	.....	.....	.....	.....	−0.28	.....	−0.62
$G.e_{11}$	−.096	−.143	−.181	−.155	.....	.....	.....	.....	.....	−.124	.....	−.151

COMPUTATIONS OF THE $B.t.e.$ FOR THE $\alpha.\beta.\gamma.\delta.$ STAGES IN CUMULUS AND CUMULONIMBUS CLOUDS—Continued.

TABLE 141.—*Cumulus clouds, 4 to 6 p. m.*

α STAGE.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
5 p. m. B	765.8	764.8	760.0	762.2	762.3	761.7	763.8	763.9	762.4	764.2	767.4	765.3
t	−1.5	4.3	10.0	15.3	20.5	24.1	26.9	28.5	21.8	14.6	12.7	5.8
e	2.20	3.74	5.70	6.64	10.44	13.88	17.66	15.87	12.76	7.38	7.77	4.06
d	−8.7	−2.4	3.1	5.3	12.0	16.4	20.3	18.6	15.1	6.8	7.6	−1.5
$\frac{e}{B}$	.0029	.0049	.0075	.0087	.0137	.0182	.0231	.0208	.0167	.0097	.0101	.0053
Table I	1.3330	1.3399	1.3467	1.3521	1.3608	1.3675	1.3741	1.3734	1.3645	1.3524	1.3513	1.3416
II	−.4559	−.4561	−.4562	−.4566	−.4574	−.4582	−.4592	−.4587	−.4579	−.4569	−.4572	−.4563
α const.	.8771	.8838	.8905	.8955	.9034	.9093	.9149	.9147	.9066	.8955	.8941	.8853
t_s	−9.7	−3.8	1.6	3.2	10.1	14.7	18.7	16.3	13.6	5.2	6.3	−2.7
I	1.3256	1.3327	1.3395	1.3419	1.3522	1.3600	1.3676	1.3636	1.3580	1.3446	1.3460	1.3339
α const.−I=II	−.4485	−.4489	−.4490	−.4464	−.4488	−.4507	−.4427	−.4489	−.4514	−.4491	−.4519	−4486
B_s	687	688	684	657	672	683	695	662	693	681	710	686
e_s	2.01	3.34	5.13	5.74	9.20	12.44	16.03	13.78	11.58	6.60	7.18	3.65
$\frac{e_s}{B_s}$	.0029	.0049	.0075	.0087	.0137	.0182	.0231	.0208	.0167	.0097	.0101	.0053
h_1	1030	1070	1220	1270	1210	1160	1020	1080	1040	1040	1040	1020
From d t_1	−11.8	−5.6	−0.5	1.5	8.4	12.9	17.2	15.4	12.0	3.7	4.5	−4.6
From t_s t_1	−11.8	−5.8	−0.8	0.7	8.0	12.7	16.8	14.5	11.8	3.3	4.4	−4.7
θ	−6.7	−0.7	4.8	8.4	14.5	18.5	22.1	22.0	16.9	9.2	8.6	0.6
$-m$	−5728	−5820	−6505	−6683	−6235	−5894	−5123	−5423	−5313	−5458	−5469	−5521
$+\beta m+\gamma m$	+9	+12	+20	+22	+32	+39	+43	+38	+39	+22	+22	+13
Log B	2.88412	2.88355	2.88081	2.88207	2.88213	2.88178	2.88298	2.88304	2.88218	2.88321	2.88502	2.88383
Log B_1	2.82693	2.82547	2.81596	2.81546	2.82010	2.82323	2.83218	2.82919	2.82944	2.82885	2.83055	2.82875
B_1	671.3	669.1	654.6	653.8	660.8	665.6	679.5	674.8	675.2	674.3	676.9	674.1
From $\frac{e_1}{B_1}$ t_1	−12.1	−5.8	−0.5	1.3	8.4	13.0	17.2	15.3	11.9	3.7	4.2	−4.4
e_1	1.61	2.81	4.38	5.03	8.20	11.12	14.60	12.96	10.39	5.93	6.16	3.17
$\frac{e_1}{B_1}$	.0024	.0042	.0067	.0077	.0124	.0167	.0215	.0192	.0154	.0088	.0091	.0047
I	1.3231	1.3304	1.3372	1.3395	1.3496	1.3575	1.3650	1.3613	1.3554	1.3424	1.3432	1.3320
II	−.4469	−.4468	−.4456	−.4458	−.4474	−.4486	−.4508	−.4501	−.4495	−.4483	−4484	−.4475
α const.	.8762	.8836	.8916	.8937	.9022	.9089	.9142	.9112	.9059	.8941	.8948	.8845
$G.B$	−9.2	−9.0	−8.6	−8.5	−8.5	−8.5	−8.3	−8.3	−8.4	−8.7	−8.8	−9.0
$G.t$	−1.03	−0.95	−0.86	−1.11	−1.00	−0.96	−0.96	−1.23	−0.96	−1.05	−0.82	−1.00
$G.e$	−.058	−.087	−.109	−.127	−.184	−.238	−.300	−.270	−.228	−.140	−.155	−.088
$G.\alpha$	−0.9	−0.2	+0.9	−1.4	−1.1	−0.4	−0.7	−3.3	−0.7	−1.4	+0.7	−0.8

TABLE 141.—*Cumulus clouds, 4 to 6 p. m.*—Continued.

β STAGE I.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
B_1-e_1	.....	.....	.....	648.8	652.6	654.5	664.9	661.8	664.8	668.4	670.7	.....
$\frac{e_1}{B_1-e_1}$	.....	.....	.....	.0078	.0126	.0170	.0220	.0196	.0157	.0089	.0092	.....
h'	.....	.....	.....	.....	1920	1930	1920	1900	1880	.....	.....	.....
$h'-h_1$	.....	.....	.....	.....	710	770	900	820	840	.....	.....	.....
θ_1	.....	.....	.....	.....	6.2	10.7	14.6	12.9	9.5	.....	.....	.....
$-m$	.....	.....	.....	.....	−3766	−4021	−4636	−4248	−4402	.....	.....	.....
$+\beta m+\gamma m$	.....	.....	.....	.....	+18	+26	+36	+31	+25	.....	.....	.....
Log B'	.....	.....	.....	.....	2.78262	2.78228	2.78818	2.78702	2.78567	.....	.....	.....
B'	.....	.....	.....	.....	606.2	605.7	614.0	612.4	610.5	.....	.....	.....
I_1	.....	.....	.....	1.3534	1.3723	1.3878	1.4044	1.3965	1.3833	1.3586	1.3598	.....
II_1	.....	.....	.....	−.4418	−.4410	−.4400	−.4398	−.4401	−.4413	−.4434	−.4438	.....
III_1	.....	.....	.....	.0105	.0166	.0219	.0277	.0249	.0203	.0120	.0123	.....
β const.	.....	.....	.....	.9221	.9479	.9697	.9923	.9813	.9623	.9272	.9283	.....
Approx. t'	.....	.....	.....	.....	4.6	9.3	13.4	11.5	7.9	.....	.....	.....
Approx. e'	.....	.....	.....	.....	6.33	8.72	11.43	10.09	7.94	.....	.....	.....
$B'-e'$	.....	.....	.....	.....	599.9	597.0	602.6	602.3	602.3	.....	.....	.....
$\frac{e'}{B'-e'}$	.....	.....	.....	.....	.0106	.0146	.0190	.0168	.0132	.....	.....	.....
II'	.....	.....	.....	.....	−.4353	−.4339	−.4332	−.4337	−.4347	.....	.....	.....
III'	.....	.....	.....	.....	.0143	.0192	.0244	.0217	.0175	.....	.....	.....
I'	.....	.....	.....	.....	1.3689	1.3844	1.4011	1.3933	1.3795	.....	.....	.....
t'	.....	.....	.....	.....	4.5	9.1	13.5	11.6	7.5	.....	.....	.....
e'	.....	.....	.....	.....	6.28	8.61	11.50	10.16	7.72	.....	.....	.....
$G.B_1$	.....	.....	.....	.....	−7.7	−7.8	−7.2	−7.6	−7.8	.....	.....	.....
$G.t_1$	.....	.....	.....	.....	−0.55	−0.51	−0.41	−0.46	−0.53	.....	.....	.....
$G.e_1$	.....	.....	.....	.....	−0.271	−0.327	−0.341	−0.342	−0.319	.....	.....	.....

β STAGE II.

$\frac{e_1}{B_1}$	.....	.....	.....	.0077	.....	.....	.....	.....	.....	.0088	.0091	.....
t_1	.....	.....	.....	0	.....	.....	.....	.....	.....	0	0	.....
β const.	.....	.....	.....	.9221	.....	.....	.....	.....	.....	.9272	.9283	.....
I'	.....	.....	.....	1.3522	.....	.....	.....	.....	.....	1.3552	1.3560	.....
$II'+III'$	.....	.....	.....	−.4301	.....	.....	.....	.....	.....	−.4280	−.4277	.....
Approx. $B'-e'$	.....	.....	.....	632	.....	.....	.....	.....	.....	615	614	.....
$\frac{e'}{B'-e'}$	.....	.....	.....	.0072	.....	.....	.....	.....	.....	.0074	.0074	.....
III'	.....	.....	.....	.0099	.....	.....	.....	.....	.....	.0101	.0101	.....
II'	.....	.....	.....	−.4400	.....	.....	.....	.....	.....	.4381	.4378	.....
$B'-e'$	.....	.....	.....	632	.....	.....	.....	.....	.....	616	614	.....
B'	.....	.....	.....	636.6	.....	.....	.....	.....	.....	620.6	618.6	.....
Log B'	.....	.....	.....	2.80387	.....	.....	.....	.....	.....	2.79281	2.79141	.....
Log B_1	.....	.....	.....	2.81546	.....	.....	.....	.....	.....	2.82885	2.83055	.....
$+m_1$	.....	.....	.....	1159	.....	.....	.....	.....	.....	3604	3914	.....
$+\beta m+\gamma m$	.....	.....	.....	+4	.....	.....	.....	.....	.....	+9	+10	.....
m	.....	.....	.....	1163	.....	.....	.....	.....	.....	3613	3924	.....
θ_1	.....	.....	.....	0.7	.....	.....	.....	.....	.....	1.9	2.1	.....
$h'-h_1=\Delta h'$	.....	.....	.....	215	.....	.....	.....	.....	.....	671	729	.....
h'	.....	.....	.....	1485	.....	.....	.....	.....	.....	1711	1769	.....
B_1	.....	.....	.....	653.8	.....	.....	.....	.....	.....	674.3	676.9	.....
t_1	.....	.....	.....	1.3	.....	.....	.....	.....	.....	3.7	4.2	.....
e_1	.....	.....	.....	5.03	.....	.....	.....	.....	.....	5.93	6.16	.....
$G.B_1$	.....	.....	.....	−8.1	.....	.....	.....	.....	.....	−8.0	−8.0	.....
$G.t_1$	.....	.....	.....	−.61	.....	.....	.....	.....	.....	−.55	−.57	.....
$G.e_1$	.....	.....	.....	−.214	.....	.....	.....	.....	.....	−.203	−.218	.....

TABLE 141.—*Cumulus clouds, 4 to 6 p. m.*—Continued.

γ STAGE.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
γ const. II′+III′				−.4301						−.4280	−.4277	
Approx. B^o				637						620	619	
B^o-e^o				632						616	614	
$\frac{e^o}{B^o-e^o}$				.0072						.0074	0075	
III°				+.0112						+.0115	+.0117	
IV°				−.0014						−.0014	−.0016	
II°				−.4399						−.4381	−.4378	
B^o-e^o				632						616	614	
B^o				636.6						620.6	618.6	
Log B^o												
Log B_o												
$+m_1$												
$+\beta m_1+\gamma m_1$												
m												
$\theta_o=0$												
$h^o-h_o=\Delta h_o$				0						0	0	
h^o				1485						1711	1769	
$G\,.\,B_o$												

δ STAGE.

t_{II}	−12.1	−5.8	−0.5	0						0	0	−4.4
$\frac{e_I}{B_I}$	.0024	.0042	.0067	.0077						.0088	.0091	.0047
$B_{II}-e_{II}$	669.7	666.3	650.2	632.0						616.0	614.0	670.9
$\frac{e_{II}}{B_{II}-e_{II}}$	.0024	.0042	.0067	.0072						.0074	.0075	.0047
I_{II}	1.3274	1.3379	1.3491	1.3523						1.3552	1.3560	1.3404
II_{II}	−.4455	−.4445	−.4423	−.4400						−.4379	−.4378	−.4451
III_{II}	+.0037	+0065	+0104	+.0112						+0115	+.0117	+.0074
δ const.	.8856	.8999	.9172	.9235						.9288	.9299	.9027
Obs'v'd h''	1940	1870	2010	1970						1810	1820	1920
$h''-h_{II}$	910	800	790	485						99	51	900
θ_{II}	−15.0	−8.4	−3.0	−1.5						−0.2	0	−7.0
$-m$	−5223	−4478	−4332	−2644						−538	−276	−5011
$+\beta m+\gamma m$	+8	+11	+10	+8						+2	0	+10
Log B_{II}	2.82692	2.82549	2.81598	2.80387						2.79281	2.79141	2.82872
Log B''	2.77477	2.78082	2.77276	2.77751						2.78745	2.78865	2.77871
B''	595.3	603.7	592.6	599.1						613.0	614.7	600.8
Approx. t''	−19.5	−11.5	−5.0	−2.5						−0.5	−0.2	−10.5
Approx. e''	0.83	1.71	3.01	3.71						4.38	4.48	1.87
$B''-e''$	594.5	602.0	589.6	595.4						608.6	610.2	598.9
$\frac{e''}{B''-e''}$	.0014	.0029	.0051	.0062						.0072	.0073	.0031
II''	−.4374	−.4378	−.4358	−.4361						−.4371	−.4373	−.4373
III''	+24	+47	+81	+97						+112	+113	+51
I''	1.3206	1.3330	1.3449	1.3499						1.3547	1.3559	1.3349
t''	−19.3	−11.0	−4.6	−2.7						−0.3	−0.1	−10.6
e''	0.84	1.79	3.11	3.65						4.45	4.53	1.86
$G\,.\,B_{II}$	−8.4	−8.2	−7.9	−7.7						−7.9	−7.8	−8.2
$G\,.\,t_{II}$	−0.80	−0.65	−0.52	−0.56						−0.31	−0.21	−0.69
$G\,.\,e_{II}$	−.085	−.125	−.161	−.188						−.122	−.079	−.146

COMPUTATIONS OF THE $B.t.e.$ FOR THE $\alpha.\beta.\gamma.\delta.$ STAGES IN CUMULUS AND CUMULO-NIMBUS CLOUDS—continued.

TABLE 142.—*Cumulus clouds—Domes.*

α STAGE.

Time	March, 2 p. m.	March, 5 p. m.	April, 2 p. m.	April, 5 p. m.	May, 10 a. m.	May, 2 p. m.	May, 5 p. m.	June, 10 a. m.	June, 2 p. m.	July, 2 p. m.	August, 2 p. m.	October, 2 p. m.
Number	4	3	2	2	1	3	2	1	3	2	8	1
B	753.4	758.2	762.8	759.5	763.3	763.0	763.0	763.6	761.3	763.2	763.9	766.3
t	14.2	11.2	25.4	22.3	20.2	21.5	20.8	24.6	28.3	30.6	29.3	11.7
e	7.46	5.72	10.84	9.43	13.36	8.82	11.58	16.78	14.09	14.78	14.89	6.42
d	7.0	3.2	12.6	10.5	15.8	9.5	13.6	19.5	16.7	17.4	17.5	4.8
$\frac{e}{B}$	.0099	.0075	.0142	.0124	.0175	.0116	.0152	.0220	.0185	.0194	.0195	.0084
Table I	1.3523	1.3478	1.3651	1.3610	1.3638	1.3597	1.3622	1.3712	1.3712	1.3739	1.3729	1.3489
II	−.4560	−.4560	−.4576	−.4570	−.4582	−.4572	−.4577	−.4590	−.4581	−.4585	−.4584	−.4569
α const.	.8963	.8918	.9075	.9040	.9056	.9025	.9045	.9122	.9131	.9154	.9145	.8920
t_s	5.4	1.3	9.8	8.0	14.9	7.1	12.0	18.3	14.0	14.7	14.8	3.2
I	1.3450	1.3393	1.3524	1.3494	1.3596	1.3480	1.3553	1.3663	1.3597	1.3611	1.3613	1.3417
α const.−I=II	.4487	.4475	.4449	.4454	.4540	.4537	.4508	.4541	.4466	.4457	.4468	.4497
B_s	677	669	635	642	718	645	689	712	644	641	644	690
e_s	6.69	5.02	9.02	7.99	12.59	7.51	10.45	15.63	11.88	12.43	12.51	5.74
$\frac{e_s}{B_s}$	.0099	.0075	.0142	.0124	.0175	.0116	.0152	.0220	.0185	.0194	.0195	.0084
h_1	1150	1150	1300	1227	800	1200	1100	830	1200	1300	1130	1020
From d t_1	3.5	−0.3	8.7	6.9	13.4	5.9	10.3	17.1	12.8	13.5	14.1	1.7
From t_s t_1	3.3	−0.8	7.4	5.8	13.8	5.0	10.0	17.2	11.7	12.7	13.2	1.5
θ	8.9	5.5	17.1	14.6	16.8	13.7	15.6	20.9	20.6	22.1	21.7	6.7
$-m$	−6042	−6116	−6638	−6319	−4092	−6200	−5646	−4183	−6053	−6525	−5674	−5402
$+\beta m+\gamma m$	+23	+18	+37	+31	+29	+28	+31	+34	+43	+45	+40	+20
Log B	2.87703	2.87978	2.88241	2.88053	2.88270	2.88252	2.88252	2.88287	2.88156	2.88264	2.88304	2.88440
Log B_1	2.81684	2.81880	2.81640	2.81765	2.84207	2.82080	2.82637	2.84138	2.82146	2.81784	2.82670	2.83058
B_1	655.9	658.9	655.2	657.1	695.1	661.9	670.5	694.0	662.9	657.4	671.0	677.0
From $\frac{e_1}{B_1}$ t_1	3.4	−0.6	8.6	6.8	13.4	6.0	10.3	17.0	13.1	13.6	14.2	1.6
e_1	5.83	4.34	8.31	7.35	11.46	6.95	9.32	14.36	11.20	11.56	12.01	5.14
$\frac{e_1}{B_1}$	.0089	.0066	.0127	.0112	.0165	.0105	.0139	.0207	.0169	.0176	.0179	.0076
I	1.3423	1.3369	1.3501	1.3473	1.3576	1.3450	1.3526	1.3640	1.3577	1.3587	1.3594	1.3396
II	−.4463	−.4462	−.4469	−.4467	−.4516	−.4471	−.4487	−.4524	−4485	−4479	−.4493	−.4482
α const.	.8960	.8907	.9032	.9006	.9060	.8979	.9039	.9116	.9092	.9108	.9101	.8914
$G.B$	−8.6	−8.6	−8.3	−8.3	−8.5	−8.4	−8.5	−8.4	−8.2	−8.1	−8.4	−8.8
$G.t$	−0.94	−1.03	−1.29	−1.26	−.085	−1.34	−0.96	−0.92	−1.27	−1.31	−1.34	−1.00
$G.e$	−.133	−.121	−.193	−.169	−.238	−.159	−.211	−.292	−.240	−.246	−.255	−.126
$G.\alpha$	−0.3	−1.0	−3.3	−2.8	+0.5	−3.8	−0.6	−0.8	−3.3	−3.6	−3.9	−0.6

TABLE 142.—*Cumulus clouds—Domes*—Continued.

β STAGE I.

Time	March, 2 p. m.	March, 5 p. m.	April, 2 p. m.	April, 5 p. m.	May, 10 a. m.	May, 2 p. m.	May, 5 p. m.	June, 10 a. m.	June, 2 p. m.	July, 2 p. m.	August, 2 p. m.	October, 2 p. m.
Number	4	3	2	2	1	3	2	1	3	2	8	1
B_1-e_1	650.1	.....	646.9	649.7	683.6	654.9	661.2	679.6	651.7	645.8	659.0	671.9
$\frac{e_1}{B_1-e_1}$	.0090	.....	.0129	.0113	.0168	.0106	.0141	.0212	.0172	.0179	.0183	.0077
h'	.....	.....	.....	.....	2980	.....	.....	3040	3010	2910	2850	.....
$h'-h_1$	.....	.....	.....	.....	2180	.....	.....	2240	1710	1610	1720	.....
θ_1	.....	.....	.....	.....	7.4	.....	.....	11.0	8.2	9.5	9.6	.....
$-m$	.....	.....	.....	.....	−11513	.....	.....	−11679	−9006	−8440	−9013	.....
$+\beta m+\gamma m$	.....	.....	.....	.....	+56	.....	.....	+75	+52	+47	+53	.....
Log B'	.....	.....	.....	.....	2.72750	.....	.....	2.72534	2.73192	2.73391	2.73710	.....
B'	.....	.....	.....	.....	534.0	.....	.....	531.3	539.4	541.9	545.9	.....
I_1	1.3586	.....	1.3742	1.3676	1.3877	1.3650	1.3779	1.4020	1.3884	1.3907	1.3921	1.3534
II_1	−.4418	.....	−.4403	−.4410	−.4431	−.4417	−.4415	−.4418	−.4396	−.4388	−.4400	.4443
III_1	.0122	.....	.0170	.0151	.0216	.0139	.0184	.0267	.0221	.0229	.0237	.0105
β const.	.9290	.....	.9509	.9417	.9662	.9372	.9548	.9869	.9709	.9748	.9758	.9196
Approx. t'	.....	.....	.....	.....	2.2	.....	.....	6.3	4.7	5.7	6.0	.....
Approx. e'	.....	.....	.....	.....	5.35	.....	.....	7.12	6.37	6.83	6.97	.....
$B'-e'$	.....	.....	.....	.....	528.6	.....	.....	524.2	533.0	535.1	538.9	.....
$\frac{e'}{B'-e'}$	.....	.....	.....	.....	.0101	.....	.....	.0136	.0120	.0128	.0129	.....
II′	.....	.....	.....	.....	−.4254	.....	.....	−.4239	−.4261	−.4259	−.4265	.....
III′	.....	.....	.....	.....	.0137	.....	.....	.0181	.0162	.0171	.0174	.....
I′	.....	.....	.....	.....	1.3779	.....	.....	1.3927	1.3808	1.3836	1.3849	.....
t'	.....	.....	.....	.....	2.3	.....	.....	6.3	4.4	5.5	6.0	.....
e'	.....	.....	.....	.....	5.39	.....	.....	7.12	6.24	6.74	6.97	.....
$G.\ B_1$	.....	.....	.....	.....	−7.4	.....	.....	−7.3	−7.2	−7.2	−7.3	.....
$G.\ t_1$	.....	.....	.....	.....	−0.51	.....	.....	−0.48	−0.51	−0.50	−0.49	.....
$G.\ e_1$	.....	.....	.....	.....	−0.279	.....	.....	−0.323	−0.291	−0.298	−0.294	.....

β STAGE II.

Time	March, 2 p. m.	March, 5 p. m.	April, 2 p. m.	April, 5 p. m.	May, 10 a. m.	May, 2 p. m.	May, 5 p. m.	June, 10 a. m.	June, 2 p. m.	July, 2 p. m.	August, 2 p. m.	October, 2 p. m.
Number	4	3	2	2		3	2					1
$\frac{e_1}{B_1}$	.0089	.....	.0127	.0112	.....	.0105	.0139	.....	.....	.....	.....	.0076
t'	0	.....	0	0	.....	0	0	.....	.....	.....	.....	0
β const.	.9290	.....	.9509	.9417	.....	.9372	.9548	.....	.....	.....	.....	.9196
I′	1.3555	.....	1.3656	1.3616	.....	1.3597	1.3689	.....	.....	.....	.....	1.3520
II′+III′	−.4265	.....	−.4147	−.4199	.....	−.4225	−.4141	.....	.....	.....	.....	−.4324
Approx. $B'-e'$	605	.....	529	561	.....	578	527	.....	.....	.....	.....	650
$\frac{e'}{B'-e'}$	.0075	.....	.0086	.0081	.....	.0079	.0087	.....	.....	.....	.....	.0070
III′	.0103	.....	.0118	.0111	.....	.0108	.0120	.....	.....	.....	.....	.0096
II′	−.4368	.....	−.4265	−.4310	.....	−.4333	−.4261	.....	.....	.....	.....	−.4420
$B'-e'$	604	.....	529	561	.....	578	527	.....	.....	.....	.....	650
B'	608.6	.....	533.6	565.6	.....	582.6	531.6	.....	.....	.....	.....	654.6
Log B'	2.78390	.....	2.72722	2.75251	.....	2.76537	2.72558	.....	.....	.....	.....	2.81598
Log B_1	2.81684	.....	2.81640	2.81765	.....	2.82080	2.82637	.....	.....	.....	.....	2.83058
$+m_1$	3294	.....	8918	6514	.....	5543	10079	.....	.....	.....	.....	1460
$+\beta m+\gamma m$	+9	.....	+21	+18	.....	+15	+25	.....	.....	.....	.....	+7
m	3303	.....	8939	6532	.....	5558	10104	.....	.....	.....	.....	1467
θ_1	1.7	.....	4.3	3.4	.....	3.0	5.2	.....	.....	.....	.....	0.8
$h'-h_1=\Delta h'$	612	.....	1674	1219	.....	1036	1898	.....	.....	.....	.....	270
h'	1762	.....	2974	2446	.....	2236	2998	.....	.....	.....	.....	1270
B_1	655.9	.....	655.2	657.1	.....	661.9	670.5	.....	.....	.....	.....	677.0
t_1	3.4	.....	8.6	6.8	.....	6.0	10.3	.....	.....	.....	.....	1.6
e_1	5.83	.....	8.31	7.35	.....	6.95	9.32	.....	.....	.....	.....	5.14
$G.\ B_1$	−7.7	.....	−7.4	−7.6	.....	−7.6	−7.4	.....	.....	.....	.....	−8.3
$G.\ t_1$	−.56	.....	−.52	−.56	.....	−.58	−.55	.....	.....	.....	.....	−.59
$G.\ e_1$	−.206	.....	−.224	−.229	.....	−.229	−.250	.....	.....	.....	.....	−.212

TABLE 142.—*Cumulus clouds—Domes*—Continued.

γ STAGE.

Time	March, 2 p. m.	March, 5 p. m.	April, 2 p. m.	April, 5 p. m.	May, 10 a. m.	May, 2 p. m.	May, 5 p. m.	June, 10 a. m.	June, 2 p. m.	July, 2 p. m.	August, 2 p. m.	October, 2 p. m.
Number	4	3	2	2		3	2					1
γ const. II′+III′	−.4265	.....	−.4147	−.4199	.....	−.4225	−.4141	.....	.....	.....	.....	−.4324
Approx. B^o	609	.....	530	562	.....	579	524	.....	.....	.....	.....	655
B_o-e_o	604	.....	525	557	.....	574	519	.....	.....	.....	.....	650
$\frac{e^o}{B^o-e^o}$	.0076	.....	.0087	.0082	.....	.0080	.0088	.....	.....	.....	.....	.0071
III°	+.0118	.....	+.0135	+.0127	.....	+.0123	+.0136	.....	.....	.....	.....	+0110
IV°	−.0016	.....	−.0021	−.0020	.....	−.0019	−.0026	.....	.....	.....	.....	−0014
II°	−.4367	.....	−.4261	4306	.....	−.4329	−.4251	.....	.....	.....	.....	−.4420
B^o-e^o	604	.....	525	557	.....	574	519	.....	.....	.....	.....	650
B^o	608.6	.....	529.6	561.6	.....	578.6	523.6	.....	.....	.....	.....	654.6
Log B^o	.....	.....	2.72395	2.74943	.....	2.76238	2.71900	.....	.....	.....	.....	.....
Log R_o	.....	.....	2.72722	2.75251	.....	2.76537	2.72558	.....	.....	.....	.....	.....
$+m_1$	.....	.....	327	308	.....	299	658	.....	.....	.....	.....	.....
$+\beta m_1+\gamma m_1$	.....	.....	+2	+1	.....	+1	+1	.....	.....	.....	.....	.....
m	.....	.....	329	309	.....	300	659	.....	.....	.....	.....	.....
$\theta_o=0$	.....	.....	0	0	.....	0	0	.....	.....	.....	.....	.....
$h^o-h_o=\Delta h_o$	0	.....	60	57	.....	55	122	.....	.....	.....	.....	0
h_o	1762	.....	3034	2503	.....	2291	3120	.....	.....	.....	.....	1270
$G\,.\,\beta_o$	.....	.....	−6.8	−7.1	.....	−7.3	−6.6	.....	.....	.....	.....	.....

δ STAGE.

Time	March, 2 p. m.	March, 5 p. m.	April, 2 p. m.	April, 5 p. m.	May, 10 a. m.	May, 2 p. m.	May, 5 p. m.	June, 10 a. m.	June, 2 p. m.	July, 2 p. m.	August, 2 p. m.	October, 2 p. m.
t_{11}	0	−0.6	0	0	.....	0	0	.....	.....	.....	.....	0
$\frac{e_1}{B_1}$	.0089	.0066	.0127	.0112	.....	.0105	.0139	.....	.....	.....	.....	.0076
$B_{11}-e_{11}$	604	654.6	525	557	.....	574	519	.....	.....	.....	.....	650
$\frac{e_{11}}{B_{11}-e_{11}}$	.0076	.0066	.0087	.0082	.....	.0080	.0088	.....	.....	.....	.....	.0071
I_{11}	1.3555	1.3488	1.3656	1.3616	.....	1.3597	1.3689	.....	.....	.....	.....	1.3520
II_{11}	−.4367	−.4424	−.4262	−.4306	.....	−.4329	−.4251	.....	.....	.....	.....	−.4420
III_{11}	+.0118	+.0102	+.0135	+.0127	.....	+.0124	+.0136	.....	.....	.....	.....	+.0110
δ const.	.9306	.9166	.9529	.9437	.....	.9392	.9574	.....	.....	.....	.....	.9210
Obs'vd h''	2900	2913	3223	2997	.....	2900	3144	.....	.....	.....	.....	2900
$h''-h_{11}$	1138	1763	189	494	.....	609	24	.....	.....	.....	.....	1630
θ_{11}	−3.2	−5.5	−0.5	−0.5	.....	−2.8	0	.....	.....	.....	.....	−6.5
$-m$	−6246	−9760	−1028	−2683	.....	−3338	−130	.....	.....	.....	.....	−9058
$+\beta m+\gamma m$	+16	+21	+3	+5	.....	+9	+1	.....	.....	.....	.....	+20
Log B_{11}	2.78433	2.81882	2.72395	2.74943	.....	2.76238	2.71900	.....	.....	.....	.....	2.81598
Log B''	2.72203	2.72143	2.71370	2.72265	.....	2.72909	2.71771	.....	.....	.....	.....	2.72560
B''	527.3	526.5	517.2	528.0	.....	535.9	522.0	.....	.....	.....	.....	531.6
Approx. t''	−6.4	−11.2	−1.0	−2.7	.....	−3.3	−0.5	.....	.....	.....	.....	−9.6
Approx. e''	2.67	1.76	4.21	3.65	.....	3.47	4.38	.....	.....	.....	.....	2.03
$B''-e''$	524.6	524.7	513.0	524.3	.....	532.4	517.6	.....	.....	.....	.....	529.6
$\frac{e''}{B''-e''}$	.0051	.0034	.0082	.0070	.....	.0065	.0084	.....	.....	.....	.....	.0038
II''	−.4272	−.4278	−.4246	−.4264	.....	−.4276	−.4242	.....	.....	.....	.....	−.4282
III''	+80	+53	+127	+109	.....	+101	+132	.....	.....	.....	.....	+59
I''	1.3498	1.3391	1.3648	1.3592	.....	1.3567	1.3684	.....	.....	.....	.....	1.3433
t''	−6.3	−11.4	−0.9	−2.8	.....	−3.3	−0.4	.....	.....	.....	.....	−9.7
e''	2.68	1.73	4.24	3.63	.....	3.94	4.42	.....	.....	.....	.....	2.01
$G\,.\,B_{11}$	−7.1	−7.5	−7.6	−6.9	.....	−7.2	−8.0	.....	.....	.....	.....	−7.6
$G\,.\,t_{11}$	−0.56	−0.61	−0.48	−0.58	.....	−0.55	−0.20	.....	.....	.....	.....	−0.60
$G\,.\,e_{11}$	−.166	−.149	.175	−.192	.....	−.104	−.075	.....	.....	.....	.....	−.157

COMPUTATIONS OF THE $B.t.e.$ FOR THE $\alpha.\beta.\gamma.\delta.$ STAGES IN CUMULUS AND CUMULO-NIMBUS CLOUDS.

TABLE 143.—*Cumulo nimbus.*

α STAGE.

Time	1897					1896				1897		
	March 3, 5 p. m.	March 20, 6 p. m.	April 14, 2 p. m.	May 4, 2 p. m.	May 21, 2 p. m.	May 12, 6 p. m.	May 22, 2 p. m.	June 10, 2 p. m.	June 26, 4 p. m.	June 4, 1 p. m.	June 19, 7 p. m.	June 24, 2 p. m.
B	759.7	752.3	761.8	760.0	754.9	761.2	763.5	753.1	764.3	758.0	762.0	759.0
t	14.4	15.8	24.0	15.6	23.9	24.1	24.4	24.7	26.4	27.9	24.2	28.9
e	9.48	11.61	7.84	8.26	12.82	13.31	16.90	13.32	19.39	17.51	13.24	22.70
d	10.5	13.6	7.7	8.5	15.2	15.8	19.6	15.8	21.8	20.1	15.7	24.4
$\frac{e}{B}$	.0125	.0154	.0103	.0109	.0170	.0175	.0221	.0177	.0254	.0231	.0174	.0299
Table I	1.3547	1.3583	1.3606	1.3542	1.3664	1.3670	1.3712	1.3677	1.3756	1.3749	1.3669	1.3815
II	−.4570	−.4568	−.4572	−.4568	−.4574	−.4580	−.4590	−.4573	−.4596	−.4587	−.4581	−.4600
α const.	.8977	.9015	.9034	.8974	.9090	.9090	.9122	.9104	.9160	.9162	.9088	.9215
t_s	9.7	13.2	4.5	7.1	13.3	13.9	18.4	13.9	20.7	18.3	13.9	23.4
I	1.3508	1.3566	1.3446	1.3473	1.3579	1.3588	1.3664	1.3590	1.3711	1.3672	1.3588	1.3772
α const.−I=II	.4531	.4551	.4412	.4499	.4489	.4498	.4542	.4486	.4551	.4510	.4500	.4557
B_s	718	733	607	687	668	675	713	669	716	678	677	714
e_s	8.96	11.29	6.28	7.52	11.36	11.81	15.73	11.81	18.14	15.63	11.79	21.38
$\frac{e_s}{B_s}$	.0125	.0154	.0103	.0109	.0170	.0175	.0221	.0177	.0254	.0231	.0174	.0299
h_1	1027	1000	1500	1100	1062	1100	1000	1000	950	1200	1000	1018
From d t_1	7.4	10.6	3.2	5.2	12.0	12.5	16.6	12.8	19.0	16.5	12.7	21.3
From t_s t_1	6.9	11.5	1.5	5.1	11.2	12.0	16.6	12.1	19.2	16.3	12.1	21.3
θ	10.9	13.2	13.6	10.4	18.0	18.3	20.5	18.8	22.7	22.2	18.5	25.1
$-m$	−5353	−5176	−7758	−5749	−5404	−5593	−5047	−5076	−4760	−6020	−5081	−5058
$+\beta m+\gamma m$	+27	+30	+30	+23	+35	+38	+45	+36	+46	+50	+35	+53
Log B	2.88064	2.87639	2.88184	2.88081	2.87789	2.88150	2.88281	2.87685	2.88326	2.87967	2.88195	2.88024
Log B_1	2.82738	2.82493	2.80456	2.82355	2.82420	2.82595	2.83279	2.82645	2.83612	2.81997	2.83149	2.83019
B_1	672.0	668.2	637.6	666.1	667.1	669.8	680.4	670.6	685.7	660.7	678.4	677.9
From $\frac{e_1}{B_1}$ t^1	7.5	10.7	3.2	5.2	12.1	12.5	16.6	12.9	19.0	16.6	12.8	21.4
e_1	7.72	9.55	5.74	6.59	10.47	10.78	14.00	11.07	16.32	14.01	10.98	18.90
$\frac{e_1}{B_1}$	.0115	.0143	.0090	.0099	.0157	.0161	.0206	.0165	.0238	.0212	.0162	.0279
I	1.3481	1.3533	1.3422	1.3450	1.3558	1.3565	1.3637	1.3572	1.3684	1.3642	1.3569	1.3737
II	−.4485	−.4484	−.4442	−.4475	−.4486	−.4489	−.4508	−.4491	−.4519	−.4489	−.4499	−.4518
α const.	.8996	.9049	.8980	.8975	.9072	.9076	.9129	.9081	.9165	.9153	.9070	.9219
$G.B$	−8.6	−8.4	−8.4	−8.5	−8.7	−8.5	−8.3	−8.3	−8.4	−8.1	−8.4	−8.0
$G.t$	−0.67	−0.51	−1.40	−0.96	−1.12	−1.06	−0.78	−1.18	−0.78	−0.94	−1.14	−0.74
$G.e$	−.171	−.206	−.141	−.154	−.222	−.233	−.290	−.225	−.324	−.292	−.226	−.373
$G.\alpha$	+1.9	+3.4	−3.7	+0.1	−1.7	−1.2	+0.7	−2.3	+0.6	−0.8	−1.8	+0.4

TABLE 143.—*Cumulo nimbus.*—Continued.

β STAGE I.

Time	1897					1896				1897		
	March 3, 5 p. m.	March 20, 6 p. m.	April 14, 2 p. m.	May 4, 2 p. m.	May 21, 2 p. m.	May 12, 6 p. m.	May 22, 2 p. m.	June 10, 2 p. m.	June 26, 4 p. m.	June 4, 1 p. m.	June 19, 7 p. m.	June 24, 2 p. m.
B_1-e_1	664.3	658.6	631.9	659.5	656.6	659.0	666.4	659.5	669.4	646.7	667.4	659.0
$\frac{e_1}{B_1-e_1}$	.0116	.0145	.0091	.0100	.0159	.0164	.0210	.0168	.0244	.0217	.0165	.0287
Obs'd top. h'	.....	.....	.....	.....	2520	.....	.....	.....	3484	4320	.....	5360
$h'-h_1$	.....	.....	.....	.....	1458	.....	.....	.....	2534	3120	.....	4342
θ_1	.....	.....	.....	.....	8.0	.....	.....	.....	13.0	9.0	.....	11.0
$-m$	.....	.....	.....	.....	−7685	.....	.....	.....	−13122	−16380	.....	−22630
$+\beta m+\gamma m$	.....	.....	.....	.....	+33	.....	.....	.....	+93	+104	.....	+153
Log B'	.....	.....	.....	.....	2.74768	.....	.....	.....	2.70583	2.65721	.....	2.60542
B'	.....	.....	.....	.....	559.3	.....	.....	.....	508.0	454.2	.....	403.1
I_1	1.3690	1.3794	1.3586	1.3629	1.3843	1.3858	1.4014	1.3872	1.4124	1.4231	1.3862	1.4254
II_1	−.4424	−.4410	−.4397	−.4424	−.4406	−.4405	−.4401	−.4406	−.4396	−.4380	−.4415	−.4374
III_1	.0155	.0188	.0123	.0135	.0205	.0212	.0265	.0216	.0304	.0274	.0212	.0353
β const.	.9421	.9572	.9312	.9340	.9642	.9665	.9878	.9682	1.0032	.9925	.9659	1.0233
Approx. t'	.....	.....	.....	.....	4.5	.....	.....	.....	7.7	1.8	.....	2.2
Approx. e'	.....	.....	.....	.....	6.28	.....	.....	.....	7.83	5.20	.....	5.35
$B'-e'$	.....	.....	.....	.....	553.0	.....	.....	.....	500.2	449.0	.....	397.7
$\frac{e'}{B'-e'}$	.....	.....	.....	.....	.0114	.....	.....	.....	.0157	.0116	.....	.0135
II'	.....	.....	.....	.....	−.4288	.....	.....	.....	−.4200	−.4133	.....	−.4037
III'	.....	.....	.....	.....	.0153	.....	.....	.....	.0207	.0157	.....	.0183
I'	.....	.....	.....	.....	1.3777	.....	.....	.....	1.4025	1.3901	.....	1.4087
t'	.....	.....	.....	.....	4.5	.....	.....	.....	7.9	1.8	.....	2.5
e'	.....	.....	.....	.....	6.28	.....	.....	.....	7.94	5.20	.....	5.46
$G.B_1$	.....	.....	.....	.....	−7.6	.....	.....	.....	−7.0	−6.6	.....	−6.3
$G.t_1$	.....	.....	.....	.....	−0.54	.....	.....	.....	−0.44	−0.48	.....	−0.44
$G.e_1$	.....	.....	.....	.....	−0.296	.....	.....	.....	−0.331	−0.282	.....	−0.310

β STAGE II.

$\frac{e_1}{B_1}$	.0115	.0143	.0090	.0099	.....	.0161	.0206	.0165	.....	.....	.0162	.....
t'	0	0	0	0	.....	0	0	0	.....	.....	0	.....
β const.	.9421	.9572	.9312	.9340	.....	.9665	.9878	.9682	.....	.....	.9659	.....
I'	1.3624	1.3700	1.3557	1.3581	.....	1.3748	1.3868	1.3757	.....	.....	1.3750	.....
$II'+III'$	−.4203	−.4128	−.4245	−.4239	.....	−.4083	−.3990	−.4075	.....	.....	−.4091	.....
Approx. $B'-e'$	565	518	589	585	.....	492	446	489	.....	.....	499	.....
$\frac{e'}{B'-e'}$	.0081	.0088	.0078	.0079	.....	.0093	.0102	.0094	.....	.....	.0092	.....
III'	.0111	.0120	.0106	.0107	.....	.0126	.0140	.0128	.....	.....	.0126	.....
II'	−.4314	−.4248	−.4351	−.4346	.....	−.4209	−.4130	−.4203	.....	.....	−.4217	.....
$B'-e'$	565	518	589	585	.....	492	447	488	.....	.....	499	.....
B'	569.6	522.6	593.6	589.6	.....	496.6	451.6	492.6	.....	.....	503.6	.....
Log B'	2.75557	2.71817	2.77349	2.77056	.....	2.69601	2.65475	2.69249	.....	.....	2.70209	.....
Log B_1	2.82738	2.82493	2.80456	2.82355	.....	2.82595	2.83279	2.82645	.....	.....	2.83149	.....
$+m_1$	7181	10676	3107	5299	.....	12894	17804	13396	.....	.....	12940	.....
$+\beta m+\gamma m$	+16	+19	+7	+11	.....	+21	+24	+21	.....	.....	+21	.....
m	7197	10695	3114	5310	.....	12915	17828	13417	.....	.....	12961	.....
θ_1	3.8	5.3	1.6	2.6	.....	6.7	8.8	6.5	.....	.....	6.4	.....
$h'=h_1=\Delta h_1$	1345	2001	577	988	.....	2450	3393	2533	.....	.....	2447	.....
h'	2372	3001	2077	2088	.....	3550	4393	3533	.....	.....	3447	.....
B_1	672.0	668.2	637.6	666.1	.....	669.8	680.4	670.6	.....	.....	678.4	.....
t_1	7.5	10.7	3.2	5.2	.....	12.5	16.6	12.9	.....	.....	12.8	.....
e_1	7.72	9.55	5.74	6.59	.....	10.78	14.00	11.07	.....	.....	10.98	.....
$G.B_1$	−7.6	−7.4	−7.6	−7.7	.....	−7.1	−6.8	−7.1	.....	.....	−7.2	.....
$G.t_1$	−.56	−.54	−.55	−.53	.....	−.51	−.49	−.51	.....	.....	−.53	.....
$G.e_1$	−.233	−.246	−.203	−.204	.....	−.254	−.249	−.257	.....	.....	−.262	.....

TABLE 143.—*Cumulo nimbus*—Continued.

γ STAGE.

Time	1897					1896				1897		
	March 3, 5 p. m.	March 20, 6 p. m.	April 14, 2 p. m.	May 4, 2 p. m.	May 21, 2 p. m.	May 12, 6 p. m.	May 22, 2 p. m.	June 10, 2 p. m.	June 26, 4 p. m.	June 4, 1 p. m.	June 19, 7 p. m.	June 24, 2 p. m.
γ const. II′+III′	−.4203	−.4128	−.4245	−.4239	.....	−.4083	−.3990	−.4075	.....	.....	−.4091	.....
Approx. B^0	563	518	594	588	.....	491	438	486	.....	.....	496	.....
B^0-e^0	558	513	589	583	.....	486	433	481	.....	.....	491	.....
$\frac{e^0}{B^0-e^0}$	.0082	.0089	.0078	.0078	.....	.0094	.0105	.0095	.....	.....	.0093	.....
III^0	+.0127	+.0138	+.0121	+.0121	.....	+.0145	+.0156	+.0147	.....	.....	+.0144	.....
IV^0	−.0021	−.0025	−.0016	−.0018	.....	−.0029	−.0037	−.0030	.....	.....	−.0029	.....
II^0	−.4309	−.4241	−.4350	−.4342	.....	−.4200	−.4109	−.4192	.....	.....	−.4206	.....
B^0-e^0	558	513	589	583	.....	486	433	481	.....	.....	491	.....
B^0	562.6	517.6	593.6	587.6	.....	490.6	437.6	485.6	.....	.....	495.6	.....
Log B^0	2.75020	2.71399	.....	2.76908	.....	2.69073	2.64108	2.68628	.....	.....	2.69513	.....
Log B_0	2.75557	2.71817	.....	2.77056	.....	2.69601	2.65475	2.69249	.....	.....	2.70209	.....
$+m_1$	537	418	.....	148	.....	528	1367	621	.....	.....	696	.....
$+\beta m_1+\gamma m_1$	+1	+1	.....	0	.....	+1	+2	+1	.....	.....	+1	.....
m	538	419	.....	148	.....	529	1369	622	.....	.....	697	.....
$\theta_0=0$	0	0	.....	0	.....	0	0	0	.....	.....	0	.....
$h^0-h_0=\Delta h_0$	99	77	0	27	.....	98	253	115	.....	.....	129	.....
h_0	2471	3078	2077	2114	.....	3648	4646	3648	.....	.....	3576	.....
$G\,.\,B_0$	−7.1	−6.6	.....	−7.5	.....	−6.2	−5.6	−6.1	.....	.....	−6.2	.....

δ STAGE.

t''	0	0	0	0	.....	0	0	0	.....	.....	0	.....
$\frac{e_1}{B_1}$	.0115	.0143	.0090	.0099	.....	.0161	.0206	.0165	.....	.....	.0162	.....
$B_{11}-e_{11}$	558	513	589	583	.....	486	433	481	.....	.....	491	.....
$\frac{e_{11}}{B_{11}-e_{11}}$	.0082	.0089	.0078	.0078	.....	.0094	.0105	.0095	.....	.....	.0093	.....
I″	1.3624	1.3699	1.3557	1.3581	.....	1.3747	1.3868	1.3757	.....	.....	1.3750	.....
II″	−.4306	−.4242	−.4351	−.4341	.....	−.4192	−.4110	−.4192	.....	.....	−.4206	.....
III″	+.0127	+.0138	+.0121	+.0121	.....	+.0146	+.0163	+.0148	.....	.....	+.0144	.....
δ const.	.9445	.9595	.9327	.9361	.....	.9701	.9921	.9713	.....	.....	.9688	.....
Obsv′d h''	4450	4243	3520	5437	.....	7373	4795	3907	.....	.....	5492	.....
$h''-h_{11}$	1979	1165	1443	3323	.....	3725	149	259	.....	.....	1916	.....
θ_{11}	−5.5	−3.2	−4.1	−9.3	.....	−9.3	−0.3	−0.5	.....	.....	−5.0	.....
$-m$	−10954	−6382	−7947	−18659	.....	−20914	−809	−1408	.....	.....	−10587	.....
$+\beta m+\gamma m$	+25	+24	+31	+37	.....	+59	+3	+4	.....	.....	+29	.....
Log B_{11}	2.75020	2.71399	2.77349	2.76908	.....	2.69073	2.64108	2.68628	.....	.....	2.69513	.....
Log E''	2.64091	2.65041	2.69433	2.58286	.....	2.48218	2.63302	2.67224	.....	.....	2.58955	.....
B''	437.4	447.1	494.7	382.7	.....	303.5	429.6	470.2	.....	.....	388.6	.....
Approx. t''	−11.5	−6.3	−8.3	−21.3	.....	−21.0	−0.7	−1.2	.....	.....	−10.5	.....
Approx. e''	1.71	2.68	2.26	0.68	.....	0.71	4.30	4.13	.....	.....	1.87	.....
$B''-e''$	435.7	444.4	492.4	382.0	.....	302.8	425.3	466.1	.....	.....	386.7	.....
$\frac{e''}{B''-e''}$	.0039	.0061	.0046	.0018	.....	.0024	.0101	.0089	.....	.....	.0049	.....
II″	−.4136	−.4143	−.4228	−.4052	.....	−.3887	−.4096	−.4171	.....	.....	−.4044	.....
III″	+61	+95	+72	+28	.....	+37	+157	+138	.....	.....	+76	.....
I″	1.3520	1.3643	1.3483	1.3385	.....	1.3551	1.3860	1.3746	.....	.....	1.3656	.....
t''	−11.7	−6.4	−8.3	−21.3	.....	−21.0	−0.8	−1.2	.....	.....	−10.5	.....
e''	1.68	2.67	2.27	0.68	.....	0.71	4.28	4.13	.....	.....	1.87	.....
$G\,.\,B_{11}$	−6.3	−6.0	−6.9	−6.2	.....	−5.1	−5.3	−5.9	.....	.....	−5.6	.....
$G\,.\,t_{11}$	−0.59	−0.55	−0.58	−0.64	.....	−0.56	−0.54	−0.47	.....	.....	−0.55	.....
$G\,.\,e_{11}$	−.146	−.163	−.161	−.117	.....	−.104	−.194	−.171	.....	.....	−.141	.....

COMPUTATIONS OF THE $B.t.e.$ FOR THE $\alpha.\beta.\gamma.\delta.$ STAGES IN CUMULUS AND CUMULO-NIMBUS CLOUDS—continued.

TABLE 144.—*Cumulo nimbus.*

α STAGE.

Time	1896											
	July 3, 3 p. m.	July 7, 4 p. m.	July 15, 7 p. m.	July 22, 7 p. m.	July 28, 6 p. m.	July 29, 7 p. m.	July 30, 6 p. m.	Aug. 31, 6 p. m.	Sept. 3, 2 p. m.	Sept. 18, 6 p. m.	Sept. 28, 2 p. m.	Nov. 18, 9 p. m.
B	764.3	760.8	759.5	758.9	763.0	762.5	759.2	759.4	754.4	761.2	764.5	768.1
t	29.1	26.5	29.0	26.3	28.6	26.4	28.3	23.7	32.8	24.8	24.4	13.6
e	15.45	17.21	24.22	20.64	21.21	21.05	16.48	11.35	16.00	16.72	16.09	7.38
d	18.1	19.9	25.5	22.8	23.3	23.2	19.2	13.3	18.1	19.4	18.8	6.8
$\frac{e}{B}$	.0202	.0226	.0319	.0272	.0278	.0276	.0217	.0149	.0212	.0221	.0211	.0096
Table I	1.3734	1.3733	1.3834	1.3771	1.3795	1.3775	1.3740	1.3643	1.3772	1.3715	1.3703	1.3515
II	−.4587	−.4588	−.4605	−.4595	−.4600	−.4599	−.4585	−.4574	−.4580	−.4588	−.4589	−.4574
α const.	.9147	.9145	.9229	.9176	.9195	.9176	.9155	.9069	.9192	.9127	.9114	.8941
t_s	15.6	18.3	24.6	22.0	22.0	22.4	17.0	11.1	15.5	18.3	17.5	5.4
I	1.3625	1.3667	1.3797	1.3737	1.3741	1.3743	1.3649	1.3542	1.3633	1.3664	1.3648	1.3446
α const.—I=II	.4478	.4522	.4568	.4561	.4546	.4567	.4494	.4473	.4441	.4537	.4534	.4505
B_s	652	691	721	722	706	728	665	656	618	707	705	695
e_s	13.17	15.63	22.99	19.63	19.63	20.12	14.40	9.84	13.09	15.63	14.87	6.69
$\frac{e_s}{B_s}$	.0202	.0226	.0319	.0272	.0278	.0276	.0217	.0149	.0212	.0221	.0211	.0096
h_1	1377	1100	852	900	800	765	1200	1100	1200	700	800	1100
From d t_1	14.0	16.6	23.0	20.1	20.9	20.9	15.6	10.0	14.5	17.3	16.4	3.5
From t_s t_1	12.9	16.1	23.1	20.5	20.8	21.4	15.0	9.1	13.5	17.3	16.4	3.4
θ	21.6	21.6	26.0	23.2	24.8	23.7	22.0	16.9	23.7	21.1	20.4	8.6
$-m$	−6923	−5531	−4220	−4501	−3979	−3820	−6025	−5620	−5989	−3526	−4038	−5785
$+\beta m+\gamma m$	+51	+45	+50	+46	+42	+41	+47	+32	+43	+30	+32	+21
Log B	2.88326	2.88127	2.88053	2.88018	2.88252	2.88224	2.88036	2.88047	2.87760	2.88150	2.88338	2.88542
Log B_1	2.81454	2.82641	2.83883	2.83563	2.84315	2.84445	2.82058	2.82259	2.81814	2.84654	2.84332	2.82778
B_1	652.4	670.5	690.0	684.9	696.9	698.9	661.6	664.6	657.9	702.3	697.1	672.6
From $\frac{e_1}{B_1}$ t_1	14.1	16.6	22.9	20.1	20.9	20.7	15.6	9.8	15.1	17.4	16.4	3.5
e_1	11.93	14.02	20.70	17.46	18.33	18.17	13.17	9.04	12.76	14.81	13.87	5.85
$\frac{e_1}{B_1}$	.0183	.0209	.0300	.0255	.0263	.0260	.0199	.0136	.0194	.0211	.0199	.0087
I	1.3596	1.3638	1.3767	1.3708	1.3720	1.3717	1.3621	1.3518	1.3614	1.3647	1.3629	1.3423
II	−.4476	−.4498	−.4534	−.4521	−.4535	−.4535	−.4487	−.4480	−.4481	−.4532	−.4524	−.4481
α const.	.9120	.9140	.9233	.9187	.9185	.9182	.9134	.9038	.9133	.9115	.9105	.8942
$G.B$	−8.2	−8.3	−8.3	−8.4	−8.2	−8.4	−8.1	−8.6	−8.1	−8.4	−8.4	−8.7
$G.t$	−1.10	−0.91	−0.72	0.69	−0.96	−0.75	−1.05	−1.26	−1.51	−1.06	−1.00	−0.92
$G.e$	−.257	−.293	−.415	−.350	−.356	−.375	−.274	−.209	−.268	−.272	−.278	−.137
$G.\alpha$	−2.0	−0.5	+0.3	+1.3	−1.3	+0.8	−1.8	−2.8	−4.9	−1.7	−1.1	+1.0

TABLE 144.—*Cumulo nimbus*—Continued.

β STAGE I.

Time	1896											
	July 3, 3 p. m.	July 7, 4 p. m.	July 15, 7 p. m.	July 22, 7 p. m.	July 28, 6 p. m.	July 29, 7 p. m.	July 30, 6 p. m.	Aug. 31, 6 p. m.	Sept. 3, 2 p. m.	Sept. 18, 6 p. m.	Sept. 28, 2 p. m.	Nov. 18, 9 p. m.
B_1-e_1	640.5	656.5	669.3	667.4	678.6	680.7	648.4	655.6	645.1	687.5	683.2	666.7
$\frac{e_1}{B_1-e_1}$	.0186	.0214	.0309	.0262	.0270	0267	.0203	.0138	.0198	.0216	.0203	.0088
Obs'vd top h'	.....	.....	.....	.....	.....	.....	3660	.....	.....	.....	3459	.....
$h'-h_1$	.....	.....	.....	.....	.....	.....	2450	.....	.....	.....	2659	.....
θ_1	.....	.....	.....	.....	.....	.....	10.0	.....	.....	.....	10.0	.....
$-m$	.....	.....	.....	.....	.....	.....	−12871	.....	.....	.....	−13912	.....
$+\beta m+\gamma m$	.....	.....	.....	.....	.....	.....	+71	.....	.....	.....	+84	.....
Log B_1	.....	.....	.....	.....	.....	.....	2.69258	.....	.....	.....	2.70348	.....
B_1	.....	.....	.....	.....	.....	.....	492.7	.....	.....	.....	505.2	.....
I_1	1.3931	1.4023	1.4325	1.4179	1.4207	1.4197	1.3987	1.3769	1.3970	1.4035	1.3993	1.3580
II_1	−.4381	−.4390	−.4380	−.4390	−.4398	−.4401	−.4384	−.4411	−.4383	−.4422	−.4420	−.4435
III_1	.0237	.0269	.0376	.0324	.0332	.0327	.0258	.0180	.0251	.0272	.0257	.0119
β const.	.9787	.9902	1.0321	1.0113	1.0141	1.0123	.9861	.9538	.9838	.9885	.9830	.9264
Approx. t'	.....	.....	.....	.....	.....	.....	3.8	.....	.....	.....	3.6	.....
Approx. e'	.....	.....	.....	.....	.....	.....	5.99	.....	.....	.....	5.99	.....
$B'-e'$	.....	.....	.....	.....	.....	.....	486.7	.....	.....	.....	499.3	.....
$\frac{e'}{B'-e'}$	.....	.....	.....	.....	.....	.....	.0123	.....	.....	.....	.0118	.....
II′	.....	.....	.....	.....	.....	.....	−.4189	.....	.....	.....	−.4209	.....
III′	.....	.....	.....	.....	.....	.....	.0167	.....	.....	.....	.0159	.....
I′	.....	.....	.....	.....	.....	.....	1.3883	.....	.....	.....	1.3880	.....
t'	.....	.....	.....	.....	.....	.....	3.9	.....	.....	.....	3.5	.....
e'	.....	.....	.....	.....	.....	.....	6.03	.....	.....	.....	5.86	.....
$G.B_1$	.....	.....	.....	.....	.....	.....	−6.9	.....	.....	.....	−7.2	.....
$G.t_1$	.....	.....	.....	.....	.....	.....	−0.48	.....	.....	.....	−0.49	.....
$G.e_1$	.....	.....	.....	.....	.....	.....	−0.292	.....	.....	.....	−0.301	.....

β STAGE II.

$\frac{e_1}{B_1}$	.0183	.0209	.0300	.0255	.0263	.0260	.....	.0136	.0194	.0211	.....	.0087
t'	0	0	0	0	0	0	.....	0	0	0	.....	0
β const.	.9787	.9902	1.0321	1.0113	1.0141	1.0123	.....	.9538	.9838	.9885	.....	.9264
I′	1.3806	1.3875	1.4122	1.4001	1.4022	1.4014	.....	1.3680	1.3837	1.3882	.....	1.3550
II′+III′	−.4019	−.3973	−.3801	−.3888	−.3881	−.3891	.....	−.4142	−.3999	−.3997	.....	−.4286
Approx. $B'-e'$	459	437	366	401	397	402	.....	527	449	450	.....	621
$\frac{e'}{B'-e'}$	.0100	.0104	.0125	.0114	.0115	.0113	.....	.0087	.0102	.0101	.....	.0074
III′	.0137	.0142	.0171	.0157	.0158	.0155	.....	.0120	.0140	.0138	.....	.0100
II′	−.4156	−.4115	−.3972	−.4045	−.4039	−.4046	.....	−.4262	−.4139	−.4135	.....	−.4386
$B'-e'$	459	437	366	401	397	402	.....	528	449	450	.....	622
B'	463.6	441.6	370.6	405.6	401.6	406.6	.....	532.6	453.6	454.6	.....	626.6
Log B'	2.66614	2.64503	2.56891	2.60810	2.60379	2.60917	.....	2.72640	2.65667	2.65763	.....	2.79699
Log B_1	2.81454	2.82641	2.83883	2.83563	2.84315	2.84445	.....	2.82259	2.81814	2.84654	.....	2.82778
$+m_1$	14840	18138	26992	22753	23936	23528	.....	9619	16147	18891	.....	3079
$+\beta m+\gamma m$	+21	+26	+30	+28	+28	+28	.....	+16	+14	+27	.....	+8
m	14861	18164	27022	22781	23964	23556	.....	9635	16161	18918	.....	3087
θ_1	7.1	8.3	11.5	10.1	10.5	10.4	.....	4.9	7.6	8.7	.....	1.8
$h'-h_1=\Delta h_1$	2811	3451	5194	4357	4589	4510	.....	1807	3063	3600	.....	572
h'	4188	4551	6046	5257	5389	5275	.....	2907	4263	4300	.....	1672
B_1	652.4	670.5	690.0	684.9	696.9	698.9	.....	664.6	657.9	702.3	.....	672.6
t_1	14.1	16.6	22.9	20.1	20.9	20.7	.....	9.8	15.1	17.4	.....	3.5
e_1	11.93	14.02	20.70	17.41	18.33	18.17	.....	9.04	12.76	14.81	.....	5.85
$G.B_1$	−6.7	−6.7	−6.2	−6.3	−6.4	−6.5	.....	−7.3	−6.7	−6.9	.....	−8.0
$G.t_1$	−.50	−.48	−.44	−.45	−.46	−.46	.....	−.55	−.50	−.48	.....	−.61
$G.e_1$	−.262	−.274	−.311	−.284	−.300	−.302	.....	−.248	−.268	−.284	.....	−.224

TABLE 144.—*Cumulo nimbus*—Continued.

γ STAGE.

Time	1896											
	July 3, 3 p. m.	July 7, 4 p. m.	July 15, 7 p. m.	July 22, 7 p. m.	July 28, 6 p. m.	July 29, 7 p. m.	July 30, 6 p. m.	Aug. 31, 6 p. m.	Sept. 3, 2 p. m.	Sept. 18, 6 p. m.	Sept. 28, 2 p. m.	Nov. 18, 9 p. m.
γ const. II′+III′	−.4019	−.3973	−.3801	−.3888	−.3881	−.3891	.....	−.4142	−.3999	−.3997	.....	−.4286
Approx. B^0	456	432	357	391	389	394	.....	527	445	441	.....	627
B^0-e^0	451	427	352	386	384	389	.....	522	440	436	.....	622
$\frac{e^0}{B^0-e^0}$	.0102	.0107	.0130	.0119	.0119	.0117	.....	.0088	.0104	.0105	.....	.0074
III^0	+.0158	+.0165	+.0200	+.0183	+.0183	+.0181	.....	+.0137	+.0161	+.0163	.....	+.0115
IV^0	−.0034	−.0039	−.0055	−0047	−.0049	−.0048	.....	−0025	−0036	−.0039	.....	−.0015
II^0	−.4143	−.4099	−.3946	−.4024	−.4015	−.4024	.....	−.4254	−.4124	−.4113	.....	−.4386
B^0-e^0	451	427	352	386	384	389	.....	522	440	436	.....	622
B^0	455.6	431.6	356.6	390.6	388.6	393.6	.....	526.6	444.6	440.6	.....	626.6
Log B^0	2.65858	2.63508	2.55218	2.59173	2.58950	2.59506	.....	2.72148	2.64797	2.64404	.....	.....
Log B_0	2.66614	2.64503	2.56891	2.60810	2.60379	2.60917	.....	2.72640	2.65667	2.65763	.....	.....
$+m_1$	756	995	1673	1637	1429	1411	.....	492	870	1359	.....	.....
$+\beta m_1+\gamma m_1$	+2	+6	+25	+12	+12	+19	.....	+1	+1	+5	.....	.....
m	758	1001	1698	1649	1441	1430	.....	493	871	1364	.....	.....
$\theta_0=0$	0	0	0	0	0	0	.....	0	0	0	.....	0
$h^0-h_0=\Delta h_0$	140	185	313	304	266	264	.....	91	161	252	.....	0
h^0	4228	4736	6359	5561	5655	5539	.....	2998	4424	4552	.....	1672
$G.\ B^0$	−5.8	−5.5	−4.5	−5.0	−4.9	−5.0	.....	−6.6	−5.6	−5.6	.....	.....

δ STAGE.

t_{11}	0	0	0	0	0	0	.....	0	0	0	.....	0
$\frac{e_1}{B_1}$	.0183	.0209	.0300	.0255	.0263	.0260	.....	.0136	.0194	.0211	.....	.0087
$B_{11}-e_{11}$	451	427	352	386	384	389	.....	522	440	436	.....	622
$\frac{e_{11}}{B_{11}-e_{11}}$	.0102	.0107	.0130	.0119	.0119	.0117	.....	.0088	.0104	.0105	.....	.0074
I_{11}	1.3806	1.3876	1.4122	1.4001	1.4022	1.4014	.....	1.3680	1.3836	1.3882	.....	1.3549
II_{11}	−.4143	−.4101	−.3946	−.4020	−.4014	−.4023	.....	−.4254	−.4124	−.4113	.....	−.4387
III_{11}	+.0158	+.0164	+.0199	+.0183	+.0183	+.0180	.....	+.0137	+.0161	+.0163	.....	+.0115
δ const.	.9821	.9939	1.0375	1.0183	1.0191	1.0171	.....	.9363	.9873	.9932	.....	.9277
Obs'd h''	5544	5607	10160	11075	8134	14153	.....	5414	11815	6146	.....	3377
$h''-h_{11}$	1316	871	3801	5514	2479	8614	.....	2416	7391	1594	.....	1705
θ_{11}	−3.8	−2.3	−8.5	−15.6	−5.6	−24.3	.....	−5.5	−25.5	−3.8	.....	−5.0
$-m$	−7239	−4764	−21277	−31708	−13728	−51244	.....	−13376	−24187	−8750	.....	−9422
$+\beta m+\gamma m$	+33	+18	+75	+78	+47	+95	.....	+44	+86	+39	.....	+24
Log B_{11}	2.65858	2.63508	2.55218	2.59173	2.58950	2.59506	.....	2.72148	2.64797	2.64404	.....	2.79699
Log B''	2.58652	2.58762	2.34016	2.27543	2.46269	2.08357	.....	2.58816	2.20696	2.55693	.....	2.70501
B''	385.9	386.9	218.9	188.5	290.2	121.2	.....	376.4	161.0	360.5	.....	507.0
Approx. t''	−6.5	−4.2	−19.2	−31.4	−11.2	−59.2	.....	−14.7	−51.5	−7.8	.....	−10.0
e''	2.65	3.22	0.84	0.24	1.76	0.02	.....	1.27	0.03	2.33	.....	1.96
$B''-e''$	383.2	383.7	218.1	188.3	288.4	121.2	.....	377.1	161.0	358.1	.....	505.0
$\frac{e''}{B''-e''}$	.0069	.0084	.0039	.0013	.0061	.0002	.....	.0034	.0002	.0066	.....	.0039
II''	−.4032	−.4030	−.3624	−.3534	−.3821	−.3237	.....	−.4035	−.3442	−.3980	.....	−.4246
III''	+107	+130	+61	+21	+95	+3	.....	+53	+3	+103	.....	+61
I''	1.3736	1.3839	1.3938	1.3696	1.3917	1.3405	.....	1.3545	1.3312	1.3809	.....	1.3462
t''	−6.5	−4.1	−19.3	−31.4	−11.3	−59.2	.....	−14.8	−51.5	−8.0	.....	−10.2
e''	2.65	3.24	0.84	0.24	1.75	0.02	.....	1.26	0.03	2.33	.....	1.92
$G.\ B_{11}$	−5.3	−5.1	−3.6	−3.7	−3.6	−3.2	.....	−6.1	−3.8	−5.0	.....	−7.0
$G.\ t_{11}$	−0.49	−0.48	−0.51	−0.57	−0.46	−0.69	.....	−0.61	−0.60	−0.50	.....	−0.60
$G.\ e_{11}$	−.146	−.153	−.098	−.083	−.114	−.053	.....	−.137	−.062	−.141	.....	−.155

α Stage.

The preceding investigation was merely preliminary to the compution of $B.t.e.$ at the beginning and end of the $\alpha.\beta.\gamma.\delta.$ stages, respectively, in cumulus clouds, and was necessary in consequence of the fact that even in cases of vigorous vertical convection the lower layers of the atmosphere do not conform strictly to an adiabatic equilibrium in the α stage. It was essential that the ratio $\frac{e_1}{B_1}$ on entering the β stage be found for the actual conditions, because this is used as an argument throughout the $\beta.\gamma.\delta.$ stages, and we could not adopt the ratio $\frac{e}{B}$ measured at the surface. It is the characteristic of the α stage, before saturation begins, that in adiabatic equilibrium $\frac{e}{B}$ is constant from the bottom to the top. Unfortunately this changes in the actual atmosphere, and hence the correction $\frac{e}{B}-\frac{e_1}{B_1}$ was required in order to give the data needed to enter the β stage. The following computation is here presented in full, to serve as a model for such reductions. It is the result of no little experimentation, in order to secure a working notation and arrangement which shall be as clear and concise as possible. One is gratified to find on actual trial that the tables give rigorous results up to the limits of accuracy needed in meteorology—that is, 0.1 mm. for B, 0.1 C° for t, and 0.05 to 0.10 mm. for e, according to the temperature. The important outcome is that of finding the gradients of $B.t.e.$ and the constants under all possible conditions, so that with given surface elements it will be easy to select gradients which shall be very approximately correct throughout the space occupied by a cloud. It is shown that we shall also be able to employ the lofty cumulo-nimbus clouds as deep gauges for measuring temperatures at great altitudes, and thus supplement, at least in summer, the data obtained occasionally by balloons with these more frequent and even systematic explorations of the status of the air at great elevations. Only a brief explanation of the computation is needed in addition to that already given by the examples of Chapter 10.

The surface data entering the computation is that already described, and collected for the cumulus clouds on Table 131. The cumulus has four divisions: For the 10 a. m. hour, the 2 p. m. hour, and the 5 p. m. hour, which are interpolated from the table data to these hours; also the domes where the required data is extracted from the self-register records of the Washington, D. C., station at the given hours. The cumulo nimbus data is also extracted from the records at the hour indicated. At the head of each column in the α stage, Table 139, is found the date, the number of observations for the domes, and the surface conditions $B.t.e.d.$ From this is found $\frac{e}{B}$ the surface ratio which is to be modified. A companion problem is to find how the α constant itself changes in the actual atmosphere up to the cumulus cloud base. From Tables I_α and II_α, 94 and 96, the α constant is computed. If we could use this confidently up to a given height the solution for the cloud base would be very simple. We proceed as follows: By a set of trial temperatures t_s find the term I_α; subtract this from the α constant, which gives II_α, and consequently B_s; e_s is taken from *S. I.* Table 43 for the temperature t_s; if the ratio $\frac{e_s}{B_s}=\frac{e}{B}$ the trial t_s is correct. Now at the observed height h_1, found by means of the theodolite altitude observations, using the d method, we compute the corresponding t_1; also from t_s by the t method we find t_1. A comparison of these two temperatures shows a fairly close agreement, and this is valuable at least as a check. Proceeding with t_1 by the d method the mean air column temperature $\theta=\frac{t+t_1}{2}$ is found. With $(h_1.\theta.)$ as arguments, take $-m$ from the m table, and also the correction $+\beta m+\gamma m$. Add $(-m+\beta m+\gamma m)$ to log B, to obtain log B_1 and hence B_1 at the base of the cloud. From t_1 we find e_1 and hence $\frac{e_1}{B_1}$. By a recomputation of t_1 through the $\frac{e_1}{B_1}$ method, using the B_1 just found, which must be sufficiently accurate for the purpose, we find t_1 again for the third time. These three values of t_1 by the d method, the t_s method, and $\frac{e'}{B_1}$ method are each given, and the

result shows that we have, by our investigation, reached a close approximation to the true temperature at the cloud base, generally within a few tenths of a degree centigrade. From these data $B_1 . t_1 . e_1 .$ the α constant is recomputed, and, by comparison with the surface α constant, it shows a tendency to become smaller. When we consider that this variation in the α constant has a physical significance, which can be interpreted by means of the original thermodynamic formulæ, it is inferred that we have an efficient method for discussing the problem of insolation and radiation, in consequence of which the atmosphere departs from that distribution of the elements having an ideal or adiabatic equilibrium. Subtracting the values $(B-B_1)$, $(t-t_1)$, $(e-e_1)$, $(\alpha-\alpha_1)$, and dividing by the height in multiples of 100 meters, the gradients per hundred meters are found, $G . B$, $G . t$, $G . e$, $G . \alpha$.

β Stage.

The treatment of the β stage must be divided into two portions: I, that in which the top of the observed cloud does not enter the γ stage, since the temperature does not sink to 0° C; and II, that in which the cloud does enter the γ stage, and where the top is at or below 0° C. For the former case we compute the pressure, temperature, vapor tension at the top $B' . t' . e' .$ from $B_1 . t_1 . e_1 .$, and $\frac{e_1}{B_1}$ at the base by means of the β constant. In the latter case we assume the temperature $t'=0$ at the top, and compute the corresponding B', while $e'=4.57$ mm.

First section of the β Stage I.

I. The important features of this computation are two in number, (1) the determination of the change in the ratio $\frac{e_1}{B_1-e_1}$ at the base and $\frac{e'}{B'-e'}$ at the top, since in this stage the ratio is constantly variable with the e_1; (2) the finding the temperature of the cloud at the top t' by a series of trials. These two processes interlock in such a way as not only to check the result, but make it comparatively easy to find t' by two or three trials. We will describe the operation in detail. From B_1 of the α stage at the base of the cloud subtract e_1 for B_1-e_1; form the ratio $\frac{e_1}{B_1-e_1}$ in which there can be no ambiguity. From the observed height of the top of the cloud h' subtract h_1, the height of the base as observed, for $h'-h_1$. At this point it is necessary to separate the two portions of the β stage, and it can be done approximately by a knowledge of the gradient system in the β stage, which is given in Table 147 following. The gradient in temperature per 100 meters for the height $h'-h_1$ gives a temperature fall to be subtracted from t_1, already found at the top of the α stage, which does or does not reach 0° C. If this reduced temperature does not fall to 0° C. the computation is in the first portion, Table 139, I, but if it does reach 0° C. the work goes on under the second portion, Table 139, II. Sometimes the temperature at the height h' is so close to 0° C. that one must actually compute the temperature t' before assigning the observation to its proper place in Sections I, II. It was more difficult to do this in the first development of the process, before the table of β gradients was constructed. It will be shown that these gradients are free from complications and exact in the β stage, and that little inconvenience need arise at this point in future discussions.

Proceeding with the β stage I, some approximate value of $\theta_1=\frac{t_1-t'}{2}$ must be taken, by means of the first value of t' just assumed at the height h', where θ_1 corresponds to the height $h_1+\frac{h'-h_1}{2}$. With the arguments $h'-h_1$ and θ_1 in the m Table take out $(-m+\beta m+\gamma m)$ and add to log B_1, already found in the α stage to make log B', from which B' is taken. If $h'-h_1$ is accurately known and θ_1 within 1 or 2 degrees, B_1 will be correct to 0.1 mm. Enter Table 97, $I_\beta=I_1$ with the arguments $\left(t_1 . \frac{e_1}{B_1}\right)$. It should be carefully observed that the argument of the table being $\left(t . \frac{e}{B}\right)$; that is, the adiabatic surface conditions, it is nevertheless available for other conditions provided the arguments are specifically distinguished. Thus we have computed $\left(t_1 . \frac{e_1}{B_1}\right)$ for the cloud base, and we may suppose that within the cloud an adiabatic equilibrium actually exists, and to this the

theory is strictly applicable. Next enter Table 98, $II_\beta = II_1$ with the arguments $\left(B_1 - e_1 \text{ and } \frac{e_1}{B_1}\right)$ for the term II_1. Finally enter Table 99, $III_\beta = III_1$ with $\left(t_1 \text{ and } \frac{e_1}{B_1 - e_1}\right)$ for the term III_1. The sums $I_1 + II_1 + III_1 = \beta$ const. Now assume an approximate t', temperature at the top of the cloud, and take the corresponding e', from which $\frac{e'}{B' - e'}$ is formed. With the new arguments $\left(B' - e' \text{ and } \frac{e_1}{B_1}\right)$ take II' from II_β; and with the arguments $\left(t' \text{ and } \frac{e'}{B' - e'}\right)$ take III' from III_β. Subtract the sum $(II' + III')$ from the β const., which gives I', and by interpolation from Table I_β with the argument $\frac{e_1}{B_1}$ find t'. If this value of t' agrees with the approximate t' assumed for the trial, the work is complete. If they are not alike, for a second trial assume a value of t', which is the mean of the previously assumed and computed values. This will be nearly correct. The formulæ are very sensitive to these variations in the trial temperatures, and can be readily made to yield a value which is accurate to one-tenth of a degree. From the final t' extract e' from the tables. Having thus found $B_1 . t_1 . e_1 .$ at the base of the cloud, and $B' . t' . e' .$ at the summit, the gradients per 100 meters $G . B_1$, $G . t_1$, $G . e_1$, in the β stage are computed.

We may observe that the number of observations in the two sections of the β stage taken together is not equal in number to the observations with which the α stage commenced. This is due to certain conditions which passed through the 0° C. temperature within the α stage itself, and thus entered the δ stage directly. Such cases occur whenever the final temperature t_1 of the α stage is below 0° C. The other cases which pass through the β stage and through the γ stage finally enter the δ stage. In such clouds as embrace the β, γ, and δ stages, the upper portion is composed of fine snow; the γ stratum of snow turning to water with a mixture of ice, thus forming hail; and the lower portion contains water and vapor. By these computations we can easily draw surfaces through a given cloud at the proper heights to mark off these stages from one another.

Second section of the β stage II.

II. The second portion of the β stage contains such clouds as actually enter the freezing temperature, and we are now to compute the height and the pressure at which this condition begins. The temperature at the top of the β stage is $t' = 0°$. We enter the values of $\frac{e_1}{B_1}$, $t' = 0$, and the β constant from the preceding data. With the arguments $\left(t' = 0 \text{ and } \frac{e_1}{B_1}\right)$ take I' from Table I_β, and subtract it from the β constant. The remainder is equal to the sum $(II' + III')$, from which the corresponding B', the pressure at the end of the β stage, is to be computed. Utilizing the temperature gradients of the β stage, Table 147, it can be estimated how many 100 meters it is required to ascend in order to reduce the base temperature t_1 to 0° C, and from this difference in height, also using the pressure gradient table, an approximate value of B' is assumed. Since e' is always 4.57 mm. at this point, the value of $B' - e'$ is found, and the ratio $\frac{e'}{B' - e'}$. With the arguments $\left(t' = 0 \text{ and } \frac{e'}{B' - e'}\right)$ take III' from III_β table and subtract from the preceding sum $(II' + III')$, the remainder being II'. Enter Table II_β with this value and the argument $\frac{e'}{B_1}$ and take the corresponding $B' - e'$. B' is derived by adding e'. If the assumed and the computed values of $B' - e'$ agree, the work is correct. Having now $B_1 . t_1 . e_1 .$ at the bottom and $B' . t' . e' .$ at the top of the column in the β stage, it is easy to compute the height separating them. Take $\log B_1 - \log B' = m_1$; add the correction $+\beta m + \gamma m$ to obtain m; $\theta = \frac{t_1 + t'}{2}$; with the arguments $m . \theta_1 .$ in the m Table find $\Delta h_1 = h' - h_1$; then $h = h_1 + \Delta h_1$, the height of the base of the freezing stratum. Finally, the gradients per 100 meters are found from $G . B_1 = \frac{B' - B_1}{h' - h_1}$, $G . t_1 = \frac{t' - t_1}{h' - h_1}$, $G . e_1 = \frac{e' - e_1}{h' - h_1}$.

γ Stage.

From the theory of the γ stage the γ constant is equal to the sum (II′+III′) brought forward from the β stage. The quantities at the top of the β stage $B' . t' . e'$. are identical with the quantities $B_o . t_o . e_o$., the notation being changed simply to distinguish clearly the different stages. The depth of the freezing stage depends upon the difference between the two ratios $\frac{e_1}{B_1}$ and $\frac{e'}{B'-e'}$. If these are close together the γ stage is shallow; if they are wide apart the stage may have a depth of more than 300 meters. Whenever the ratio $\frac{e_1}{B_1}$ is less than 0.0088 the β stage practically passes directly over into the δ stage. Now, assume an approximate B^o at the top of the γ stage; form B^o-e^o, where $e^o=4.57$ mm. and also $\frac{e^o}{B^o-e^o}$. From Table 100, III_γ with the arguments $\left(t^o=0 \text{ and } \frac{e^o}{B^o-e^o}\right)$ take III°; and from Table 100, IV_o with the arguments $\left(t^o=0 \text{ and } \frac{e_1}{B_1}\right)$ take IV°. The sum (III°+IV°) subtracted from the γ constant gives II°; and by entering Table 98, II_β with the arguments $\left(\text{II}^o \text{ and } \frac{e_1}{B_1}\right)$ we find the corresponding B^o-e^o at the top of the γ stage. If this agrees with the assumed B^o-e^o the work is correct. Having found $B_o . t_o . e_o$. at the bottom and $B^o . t^o . e^o$. at the top of the γ stage, it is easy to compute the difference of height between them, $h^o-h_o=\Delta h_o$. Take log B_o−log $B^o=m_1$; also $m=m_1+\beta m+\gamma m$ and $\theta_o=0$; from the m Table with the arguments ($m . \theta_o$.) take $\Delta h_o=h^o-h_o$, and hence find h^o, the height at which the γ stage ends and the δ stage begins. Since the $t_o=0$ and $e_o=4.57$ mm. throughout the γ stage it is necessary to find only the gradient for the pressure per 100 meters, where $G . B_o=\frac{B^o-B_o}{h^o-h_o}$, h^o-h_o being expressed in units per 100 meters.

δ Stage.

In the δ stage, wherein all the temperatures are lower than 0° C., the limiting quantity by which all the rest are controlled is the observed height of the summit of the cloud. It is, therefore, required to compute the pressure, temperature, and vapor tension $B'' . t'' . e''$. at the top of the cloud. The temperatures at the beginning of the δ stage are 0° or less than 0° C. The computation proceeds as follows: The notation makes $B^o . t^o . e^o$. at the end of the γ stage identical, respectively, with $B_{11} . t_{11} . e_{11}$. the beginning of the δ stage. $\frac{e_1}{B_1}$ retains the same value as in the β and γ stages, and is the argument written $\frac{e}{B}$ in the $\beta . \gamma . \delta$. Tables. Bring forward the quantities t_{11}, $\frac{e_1}{B_1}$, $B_{11}-e_{11}$, and $\frac{e_{11}}{B_{11}-e_{11}}$ from the preceding stages, part from the α stage and part from the γ stage, according as the zero temperature is reached directly from the α stage, or through the γ stage. With the arguments $\left(t_{11} \text{ and } \frac{e_1}{B_1}\right)$ in Table 101, I_δ form I_{11}; with the arguments $\left(B_{11}-e_{11} \text{ and } \frac{e_1}{B_1}\right)$ in Table 98, II_δ form II_{11}; and with the arguments $\left(t_{11} \text{ and } \frac{e_{11}}{B_{11}-e_{11}}\right)$ in Table 102, III_δ form III_{11}. The sum $\text{I}_{11}+\text{II}_{11}+\text{III}_{11}$ is the δ constant, which is assumed to hold good throughout the cloud mass, implying that a state of adiabatic equilibrium exists therein.

The observed height of the top of the cloud h'' is entered, and from the computed height h_{11} of the beginning of the δ stage the depth of the δ stage $h''-h_{11}$ is found. From an approximate knowledge of the temperature gradients in the δ stage, given in Table 147, which follows, the temperature θ_{11} at the half height within the δ stage is obtained, $\theta_{11}=t_{11}+\frac{h''-h_{11}}{2} . G . t_{11}$. With the arguments ($h''-h_{11}$ and θ_{11}) in the m Table the sum of terms ($-m+\beta m+\gamma m=m_1$) is found. Subtract m_1 from log B_{11} and we have log B'', and thence B'', the pressure at the top of the cloud. To

compute the corresponding t'', temperature at the summit, assume an approximate t'', by the help of the table of gradients; take the e'' from the tables, form $B''-e''$ and $\frac{e''}{B''-e''}$. The value of e'' at very low temperatures is perhaps a quantity which is not very exactly known, but at present I have, as already stated, used the Marvin determination. Furthermore, since much dependence can be placed upon the resulting pressure and temperature gradients, the present computation gives us a new and very delicate method for measuring the vapor tension at low temperatures, freed from all the difficulties of laboratory experiments. *We should, therefore, continue our measurements of the high summer clouds for the purpose of perfecting this sort of low-temperature data.* With the arguments $\left(t'' \text{ and } \frac{e_1}{B_1}\right)$ in II_δ find II''; and with the arguments $\left(t'' \text{ and } \frac{e''}{B''-e''}\right)$ in III_δ take out III''. Subtract the sum $(\mathrm{II}''+\mathrm{III}'')$ from the δ constant to obtain I''. With the arguments $\left(\mathrm{I}'' \text{ and } \frac{e_1}{B_1}\right)$ in I_δ take the corresponding t'', and thence e'' at the top of the cloud. Since e'' is the numerator of the ratio $\frac{e''}{B''-e''}$ this changes rapidly with e'', and as it is the argument for the table, the check for the final and assumed values of t'' is such as to afford a complete determination of these related quantities. Finally, from $B_{11} \,.\, t_{11} \,.\, e_{11}$. at the base of the δ stage, and $B'' \,.\, t'' \,.\, e''$. at the top, we find the gradients $G \,.\, B_{11}=\frac{B''-B_{11}}{h_{11}-h_{11}}$, $G \,.\, t_{11}=\frac{t''-t_{11}}{h''-h_{11}}$, $G \,.\, e_{11}=\frac{e''-e_{11}}{h''-h_{11}}$, where $h''-h_{11}$ is expressed in units of 100 meters in vertical height.

Looking back upon the theory involved in these reductions, it is seen to depend upon two steps: (1) The first consists in determining the law of the departure of the surface ratio $\frac{e}{B}$ from the adiabatic rate, so that at the cloud base height h_1 the ratio $\frac{e}{B}$ has become $\frac{e_1}{B_1}$; (2) in making the assumption that within the cloud itself, from the bottom to the top, the adiabatic equilibrium is maintained in the ratio $\frac{e_1}{B_1}$ is constant. The former determination depends largely upon the Weather Bureau kite observations with the thermograph, and the second may be tested eventually by a series of accurate direct temperature observations within the cloud, if such can be secured by means of kite or balloon ascensions.

DEPTH OF THE α . β . γ . δ . STAGES.

TABLE 145.—*Depth of the several stages on the average.*

I.—DEPTH OF THE α STAGE.

N	$\frac{e}{B}$	H	N	$\frac{e}{B}$	H	N	$\frac{e}{B}$	H	N	$\frac{e}{B}$	H	N	$\frac{e}{B}$	H	N	$\frac{e}{B}$	H
5	38	1050	17	80	1108	13	122	1156	16	173	1069	15	216	1039	5	276	887	1	319	852

Adjusted mean depth for $\frac{e}{B}$.

$\frac{e}{B}$	H	$\frac{e}{B}$	H	$\frac{e}{B}$	H	$\frac{e}{B}$	H
0	970	100	1136	200	1047	300	876
10	984	110	1144	210	1032	310	856
20	1006	120	1150	220	1017	320	838
30	1030	130	1146	230	1000	330	820
40	1050	140	1138	240	982		
50	1070	150	1126	250	964		
60	1088	160	1112	260	946		
70	1100	170	1097	270	928		
80	1112	180	1082	280	912		
90	1124	190	1065	290	894		

The units of $\frac{e}{B}$ are in the fourth decimal.

II.—DEPTH OF THE β STAGE.

N	$\frac{e}{B}$	H_1	N	$\frac{e}{B}$	H_1	N	$\frac{e}{B}$	H_1	N	$\frac{e}{B}$	H_1	N	$\frac{e}{B}$	H_1	N	$\frac{e}{B}$	H_1
10	91	398	13	122	951	16	174	1363	15	217	2070	5	276	4234	1	319	4357

Adjusted mean depth for $\frac{e}{B}$.

$\frac{e}{B}$	H_1	$\frac{e}{B}$	H_1	$\frac{e}{B}$	H_1	$\frac{e}{B}$	H_1
		100	490	200	1850	300	4050
		110	600	210	2020	310	4360
		120	710	220	2200	320	4680
		130	830	230	2380	330	5000
		140	960	240	2580		
50	0	150	1090	250	2790		
60	60	160	1240	260	3010		
70	160	170	1390	270	3240		
80	270	180	1530	280	3490		
90	380	190	1680	290	3760		

TABLE 145.—*Depth of the several stages on the average*—Continued.

III.—DEPTH OF γ STAGE.

N	$\frac{e}{B}$	H_0	N	$\frac{e}{B}$	H_0	N	$\frac{e}{B}$	H_0	N	$\frac{e}{B}$	H_0	N	$\frac{e}{B}$	H_0	N	$\frac{e}{B}$	H_0
10	90	0	7	124	56	5	170	108	5	216	198	3	275	278	1	319	313

Adjusted mean depth for $\frac{e}{B}$.

$\frac{e}{B}$	H_0	$\frac{e}{B}$	H_0	$\frac{e}{B}$	H_0	$\frac{e}{B}$	H_0
		100	16	200	162	300	313
		110	31	210	177	310	328
		120	46	220	192	320	344
		130	60	230	207	330	360
		140	75	240	222		
		150	89	250	237		
		160	104	260	252		
		170	118	270	267		
		180	133	280	283		
90	0	190	148	290	298		

IV.—DEPTH OF δ STAGE.

N	$\frac{e}{B}$	H_{11}	N	$\frac{e}{B}$	H_{11}	N	$\frac{e}{B}$	H_{11}	N	$\frac{e}{B}$	H_{11}	N	$\frac{e}{B}$	H_{11}	N	$\frac{e}{B}$	H_{11}	N	$\frac{e}{B}$	H_{11}
5	38	1696	16	79	2094	8	121	3720	2	153	3694	3	175	5591	5	216	6781	4	286	10881

Adjusted mean depth for $\frac{e}{B}$.

$\frac{e}{B}$	H_{11}	$\frac{e}{B}$	H_{11}	$\frac{e}{B}$	H_{11}	$\frac{e}{B}$	H_{11}
0	0	100	1078	200	3111	300	5751
10	106	110	1225	210	3361	310	6016
20	219	120	1384	220	3611	320	6288
30	320	130	1564	230	3873	330	6570
40	440	140	1747	240	4136		
50	570	150	1945	250	4399		
60	662	160	2144	260	4672		
70	740	170	2365	270	4955		
80	838	180	2615	280	5225		
90	956	190	2867	290	5488		

It is evident from the theory that the vertical thickness or depth of the several stages depends upon the surface conditions which are summed up briefly in the ratio $\frac{e}{B}$. The great practical advantage of reducing meteorological analyses, as far as possible, to this ratio, as has been done in this discussion, consists in the fact that we are thereby, to a large extent, emancipated from the complex and cumbersome classification which is involved in referring to the various subareas surrounding the centers of high and low barometric pressures. Since $\frac{e}{B}$ is rather closely a function of the temperature and pressure, it in general distinguishes the high and low pressure areas by its magnitude, just as it separates the winter and summer seasons, and also the cold and warm portions of the day. It will be a real improvement in working meteorology to deal with this ratio as the medium of operations. Especially is this true in view of the fact that the three arguments $B \cdot t \cdot e$. involving three coordinate axes, are thereby reduced to two arguments, $t \cdot \frac{e}{B}$, and to two coordinates, so that most of our discussions can be illustrated graphically on a single plane. It has in this way been shown that the depth of the several stages is a simple function of the surface conditions, as determined by $\frac{e}{B}$, and this is especially true in view of the physical process by which the cumulus clouds are produced, namely, convection in a vertical direction.

α Stage.

From the data given in the computations for the α stage, we first collect together the relative quantities $\frac{e}{B}$ and h, the height of the observed cloud base, in such groups that the values of $\frac{e}{B}$ from 0 to .0049 are in the first, all from .0050 to .0099 are in the second, and so on. Table 145 (I) contains in the first line the result of this compilation, where N is the number of observations in the group, $\frac{e}{B}$ the mean of the N values of $\frac{e}{B}$, and H the corresponding mean height. The mean quantities $\frac{e}{B}$ and H were then plotted on a diagram, and an average line was drawn through the system of points as carefully as possible. This is called the adjusted mean depth, and the H is scaled off for equal interval of $\frac{e}{B}$, the result appearing in the Table 145 (I) and on chart 74. It shows a distinct maximum at about $\frac{e}{B}$=.0120, with a drop for the smaller and also for the larger values of $\frac{e}{B}$. This agrees with the common observation that the base of the cloud rises from the cool part of the day, when $\frac{e}{B}$ is small, till the warmest hours, but falls again in the afternoon when the evening radiation begins, while the vapor contents are yet retained aloft, thus running up the value of the ratio $\frac{e}{B}$ while the cloud base descends. In the same way the very high cumulo-nimbus clouds have comparatively low bases because they form in the latter part of the afternoon, when the atmosphere is cooling as a whole by general radiation along those meridians which have already passed by the maximum of direct and accumulated insolation. It will not be necessary to discuss this table further at this place, because the determination of the vertical gradients in the following section will really include all that can be properly remarked about it. While the α stage exists for all values of $\frac{e}{B}$ which occur in the lower atmosphere, it is limited on the one side practically by $\frac{e}{B}$=0.0030, and on the other by $\frac{e}{B}$=0.0330, the former occurring with low and the latter with high temperatures. The vapor contents may sometimes nearly disappear at Washington, D. C., but other localities are even drier in winter; in the summer it may reach a very large number of grams per kilogram, as is seen from Table 103.

β Stage.

The table of heights, 145 (II), in the β stage was prepared in exactly the same manner as in the α stage, where the first line contains the means of the values collected in groups and the lower part of the table the adjusted values obtained from a diagram. The line connecting the coordinates H_1 and $\frac{e}{B}$ is a curve which touches the top of the α stage at $=0.0050$, and is then gently concave upward till it reaches the altitude 5,000 meters with the largest ratio $\frac{e}{B}=0.0330$, as given

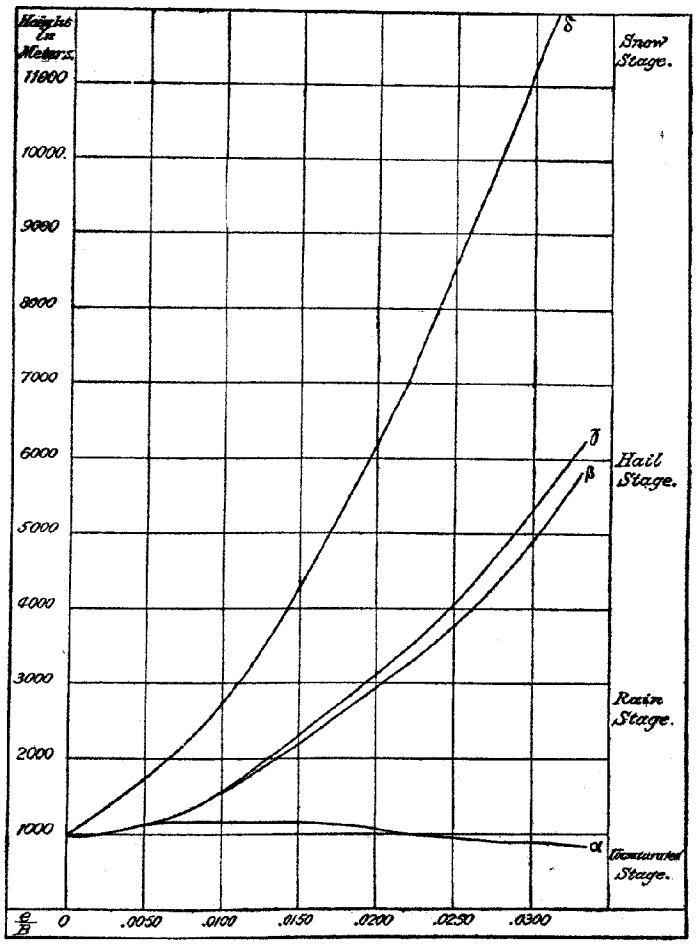

CHART 74.—Mean height of the top of the four stages.

on Chart 74. This shows that cloudy condensation takes place only a little under $\frac{e}{B}=0.0050$, and that with the increase in $\frac{e}{B}$ the depth of this stage increases up to fully 3 miles in altitude, when $\frac{e}{B}=.0330$. The H_1 here discussed is equal to $h'-h_1$; hence the total height of the top of this stage equals h'. This may be either the observed top of a cumulus cloud, if the temperature at that point is greater than zero degrees, or it may be the height of the isotherm of 0° within the cloud itself. The great depth of the β stratum for large values of $\frac{e}{B}$ shows why the summer months

usually have copious showers, with brief and yet heavy downpours of rain, since the saturated stage is two or three miles deep in the cumulo-nimbus clouds, because any dynamical uplift or sudden contact with adjacent cooler strata may cause condensation through the entire length of this column.

γ Stage.

The results for the γ stage, Table 145 (III), are found in the same way, and they show that this stage sets in at $\frac{e}{B}=0.0090$ and extends as a thin wedge-shaped figure along the top of the β stage, being about 360 meters or one-fourth of a mile at the largest values of $\frac{e}{B}$; that is, in warm and very moist summer weather. Compare Chart 74. This is well known to be the condition necessary for the formation of hail. The mode of the production of hailstones is probably as follows: The snow which fills the top of a high cumulus cloud down to the γ stage, on falling by gravity through it turns to ice and water in this stage, so that the mixture is favorable for the adhesion of large masses of snow and ice by the action of the water surfaces which thinly coat the snow masses. This can happen only when the γ stage has considerable thickness, as in hot summer days. These ice and snow masses pass through a long column in the β stage in contact with the water held there in suspension, which adds a more or less clear layer of ice to the mass that has dropped from the γ stage. If there be two or more layers of the γ stage in the cloud, as might happen when the air is very definitely stratified with currents, some at the freezing temperature and some below it, superposed in alternate succession, then the falling mass would receive a series of alternate layers of snow and ice from the core outward in passing through such a series of stages as has been often found in hailstones which have fallen to the ground. We have stated elsewhere that the maximum upward vertical current which occurs in the tube of powerful tornadoes is about 15 meters per second, and it is highly improbable that any vertical velocities approaching this ever occur in the air which is not under similar vortex motions, and is therefore restricted to very small areas. As these never develop in an atmosphere which is other than relatively quiescent in horizontal directions in the lowest levels, it would be assuming too much to suppose that such tubes occur at the high altitudes of the hail stage where the horizontal motion is more likely to be rapid in consequence of the eastward drift. Furthermore, hail falls over quite large areas, such as are incompatible with the gyrations accompanying large vertical velocities. Hence we conclude that the dynamic theory assumed by Professor FERREL to account for the stratification observed in hailstones, namely, an uplifting by strong vertical currents and falling outside them, several times repeated in a sort of orbit, can hardly be defended. It seems much more natural to suppose that several of these thin γ stages are formed in successive stratified layers, with snow or saturated vapor and water between them, and that a snowball from the highest snow stage falls through them and receives more than one coating of ice and snow before entering that portion of the β stage, where the final layer of ice is deposited. Even large masses of snow may thus be turned into ice in the descent, at first slow by reason of the large surface which snow presents to the air, so that the size of a hailstone depends largely upon the original mass of snow which adheres together in the original γ stage, and then receives additions as it passes through successive strata at and above the freezing temperature, respectively.

δ Stage.

To obtain the depth of the δ stage, the heights of the tops of the clouds observed, especially the cumulo-nimbus, the domes, and the mean top of the thin cumulus, were collected in groups by the argument $\frac{e}{B}$, and the result is shown in the last section of the table 145 (IV). By plotting these points a mean curve of average height of the tops of the clouds was found, which appears on the chart 74. Scaling the intermediate values the table of heights in the column for the δ stage was obtained. Finally, upon subtracting the tops of the α. β. γ stages from the top of the δ stage, the depth of the δ stage was determined. There should properly be a small correction to all the stages for variations of t, with the above values of the ratio, but it would complicate our

results too much, if introduced. From the Chart 74 one may readily learn the meaning of the great height of the cumulo-nimbus clouds of the hot afternoons of summer when the air is very moist, since it is a direct function of the ratio $\frac{e}{B}$ which is always large at such times.

MEAN HEIGHT OF THE TOP OF THE STAGES.

TABLE 146.—*Mean height of the top of the stages.*

$\frac{e}{B}$	α stage	β stage	γ stage	δ stage	$\frac{e}{B}$	α stage	β stage	γ stage	δ stage
0	970			970	170	1097	2487	2605	4970
10	984			1090	180	1082	2612	2745	5360
20	1001			1220	190	1065	2745	2893	5760
30	1030			1350	200	1047	2897	3059	6170
40	1050			1490	210	1032	3052	3229	6590
50	1070	1070		1640	220	1017	3217	3409	7020
60	1088	1148		1810	230	1000	3380	3587	7460
70	1100	1260		2000	240	982	3562	3784	7920
80	1112	1382		2220	250	964	3754	3991	8390
90	1124	1504		2460	260	946	3956	4208	8880
100	1136	1626	1642	2720	270	928	4168	4435	8390
110	1144	1744	1775	3000	280	912	4402	4685	9910
120	1150	1860	1906	3290	290	894	4654	4952	10440
130	1146	1976	2036	3600	300	876	4926	5239	10990
140	1138	2098	2173	3920	310	856	5216	5544	11560
150	1126	2216	2305	4250	320	838	5518	5862	12150
160	1112	2352	2456	4600	330	820	5820	6180	12750

If the depth of the successive stages be added to each other the height of the top of each stage above the ground will be found. Table 146 and Chart 74 exhibit this result. The table gives the height for each 0.0010 difference in the ratio $\frac{e}{B}$, for each of the four stages; the chart gives the locus of the lines which bound the successive stages, and as a whole shows the area occupied by these several conditions of the atmosphere. Hence by finding the ratio $\frac{e}{B}$ at any hour at the ground, one may readily conclude the approximate state of the condensation in a vertical column above that place. *We may infer that an auxiliary map constructed to show the lines of the equal ratios $\frac{e}{B}$ over the United States is very likely to be of much value as an aid to forecasting the weather conditions.* A map of this kind has never been utilized, and the argument in favor of trying it is evidently of considerable strength.

GRADIENTS IN THE FOUR STAGES.

By means of the computations, pages 695–712, the gradients of pressure, temperature, and vapor tension, per 100 meters in vertical distance, have been obtained for the four stages. It is now necessary to reduce them to such a tabular form as shall make them available for practical reductions.

TABLE 147.—*Metric—Mean pressure, temperature, and vapor tension gradients in the four stages.*

I.—$\left(t \cdot \frac{e}{B}\right)$ α STAGE—PRESSURE.

t	$\frac{e}{B}$ 0	25	50	75	100	125	150	175	200	225	250	275	300	325	350
35	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	7.9	7.9	8.0	8.0	8.1	8.1	8.2
30	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	8.0	8.0	8.1	8.1	8.2	8.2	8.2	8.2	
25	. . . . .	. . . . .	. . . . .	. . . . .	8.1	8.1	8.2	8.3	8.3	8.4	8.4	8.5	8.5		
20	. . . . .	. . . . .	. . . . .	8.2	8.3	8.4	8.4	8.5	8.6	8.6	8.7				
15	. . . . .	. . . . .	. . . . .	8.5	8.5	8.6	8.7	8.8	8.8	8.9					
10	. . . . .	. . . . .	8.7	8.7	8.8	8.9	9.0	9.0							
5	. . . . .	8.8	8.9	8.9	9.0	9.1	9.2								
0	. . . . .	8.9	9.0	9.1	9.2	9.3	9.4		Multiply by 0.012 to reduce to						
— 5	. 9.1	9.1	9.2	9.3	9.4	9.5			the English gradients.						
—10	. 9.3	9.4	9.4	9.5	9.6										

III.—$\left(\frac{e}{B}\right)$ α STAGE—VAPOR TENSION.

$\frac{e}{B}$	$G \cdot e$	$\frac{e}{B}$	$G \cdot e$	$\frac{e}{B}$	$G \cdot e$	$\frac{e}{B}$	$G \cdot e$
		.0100	.140	.0200	.260	.0300	.380
.0010	.048	110	.152	210	.272	310	.392
20	.054	120	.164	220	.284	320	.404
30	.062	130	.176	230	.296	330	.416
40	.070	140	.188	240	.308	340	.428
50	.080	150	.200	250	.320	350	.440
60	.092	160	.212	260	.332		
70	.104	170	.224	270	.344		
80	.116	180	.236	280	.356		
90	.128	190	.248	290	.368		

TABLE 147.—*Metric—Mean pressure, temperature, and vapor tension gradients in the four stages.*

IV.—$\left(\frac{e_I}{B_I}\right)$ β STAGE.				V.—γ STAGE.		VI.—δ STAGE.		
$\frac{e_I}{B_I}$	$G \cdot B_I$	$G \cdot t_I$	$G \cdot e_I$	$\frac{e_I}{B_I}$	$G \cdot B_o$	$\frac{e_I}{B_I}$	$G \cdot B_{II}$	$G \cdot t_{II}$
50	8.3	.62	.176	50	7.7	0	9.2	0.80
60	8.2	.61	.188	60	7.6	10	9.0	.78
70	8.1	.60	.199	70	7.5	20	8.8	.75
80	8.1	.59	.209	80	7.4	30	8.6	.73
90	8.0	.58	.220	90	7.2	40	8.4	.71
100	7.9	.57	.230	100	7.1	50	8.1	.68
110	7.8	.56	.240	110	6.9	60	7.9	.66
120	7.7	.55	.250	120	6.8	70	7.7	.64
130	7.6	.54	.260	130	6.7	80	7.5	.62
140	7.6	.53	.268	140	6.6	90	7.3	.60
150	7.5	.52	.276	150	6.4	100	7.1	.59
160	7.4	.51	.284	160	6.3	110	6.9	.57
170	7.3	.50	.290	170	6.2	120	6.7	.56
180	7.2	.50	.297	180	6.0	130	6.5	.55
190	7.1	.49	.304	190	5.9	140	6.3	.54
200	7.1	.48	.311	200	5.8	150	6.0	.53
210	7.0	.48	.317	210	5.6	160	5.8	.52
220	6.9	.47	.322	220	5.5	170	5.6	.52
230	6.8	.46	.326	230	5.4	180	5.4	.51
240	6.7	.46	.329	240	5.3	190	5.2	.51
250	6.6	.46	.331	250	5.1	200	5.0	.50
260	6.5	.45	.333	260	5.0	210	4.8	.50
270	6.5	.45	.335	270	4.9	220	4.6	.50
280	6.4	.44	.337	280	4.7	230	4.4	.50
290	6.3	.44	.338	290	4.6	240	4.2	.49
300	6.2	.44	.338	300	4.5	250	4.0	.49
310	6.1	.44	.339	310	4.3	260	3.7	.49
320	6.0	.44	.339	320	4.2	270	3.5	.49
330	6.0	.43	.340	330	4.1	280	3.3	.48
340	5.9	.43	.340	340	4.0	290	3.1	.48
						300	2.9	.48
						310	2.7	.48
						320	2.5	0.48

TABLE 147.—*Metric—Mean pressure, temperature, and vapor tension gradients in the four stages.*

II.—THE TEMPERATURE GRADIENT PER 100 METERS FOR THE ARGUMENTS $\left(t \text{ AND } \frac{e}{B}\right)$ AT THE SURFACE.

$\frac{e}{B}$	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
t=34																	
33																	
32																	
31																	
30																	16
29	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15	1.51
28	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14	1.51	1.44
27	.	.	.	.	.	.	.	.	.	.	.	.	.	13	1.51	1.44	1.36
26	.	.	.	.	.	.	.	.	.	.	.	.	12	1.51	1.43	1.36	1.28
25	.	.	.	.	.	.	.	.	.	.	.	11	1.51	1.43	1.36	1.28	1.20
24	.	.	.	.	.	.	.	.	.	.	10	1.51	1.43	1.36	1.28	1.20	1.12
23	.	.	.	.	.	.	.	.	.	.	1.52	1.45	1.38	1.30	1.21	1.13	1.05
22	.	.	.	.	.	.	.	.	.	9	1.45	1.38	1.30	1.22	1.14	1.06	.98
21	.	.	.	.	.	.	.	.	8	1.49	1.40	1.32	1.23	1.14	1.06	.98	.91
20	.	.	.	.	.	.	.	.	1.52	1.43	1.34	1.25	1.16	1.08	.99	.91	.84
19	.	.	.	.	.	.	.	7	1.46	1.37	1.28	1.19	1.10	1.01	.92	.84	.80
18	.	.	.	.	.	.	.	1.49	1.40	1.31	1.22	1.12	1.03	.94	.85	.78	.73
17	.	.	.	.	.	.	.	1.43	1.35	1.25	1.15	1.06	.97	.88	.80	.72	.66
16	.	.	.	.	.	.	6	1.40	1.30	1.20	1.10	1.00	.90	.81	.74	.67	.62
15	.	.	.	.	.	.	1.42	1.33	1.23	1.13	1.03	.93	.84	.76	.69	.63	.58
14	.	.	.	.	.	5	1.38	1.29	1.18	1.07	.96	.85	.77	.70	.64	.60	.56
13	.	.	.	.	.	1.41	1.32	1.22	1.11	1.00	.89	.79	.72	.65	.58	.56	.54
12	.	.	.	.	.	1.37	1.27	1.16	1.05	.93	.83	.75	.68	.60	.54	.52	.50
11	.	.	.	.	.	1.32	1.21	1.10	.99	.88	.79	.69	.63	.57	.52		
10	.	.	.	.	4	1.27	1.15	1.04	.93	.84	.75	.66	.60	.55			
9	.	.	.	.	1.34	1.22	1.10	.98	.87	.79	.72	.64	.58				
8	.	.	.	3	1.28	1.16	1.04	.92	.82	.74	.68	.63	.57				
7	.	.	.	1.34	1.22	1.10	.98	.87	.78	.70	.64	.59					
6	.	.	.	1.32	1.18	1.05	.93	.82	.72	.64	.58						
5	.	.	.	1.28	1.14	1.00	.88	.77	.67	.59	.53						
4	.	.	2	1.23	1.08	.95	.83	.72	.62	.53							
3	.	.	1.33	1.18	1.03	.89	.76	.66	.57								
2	.	.	1.28	1.13	.98	.84	.71	.61									
1	.	1	1.24	1.08	.94	.80	.66										
0	.	1.35	1.19	1.03	.89	.76											
−1	.	1.31	1.15	.98	.84	.71											
−2	.	1.28	1.10	.93	.77												
−3	.	1.24	1.05	.86	.69												

Multiply by 0.549 to reduce to the English gradients.

TABLE 147.—*Metric—Mean pressure, temperature, and vapor tension gradients in the four stages.*

II.—THE TEMPERATURE GRADIENT PER 100 METERS FOR THE ARGUMENTS $\left(t \text{ AND } \frac{e}{B}\right)$ AT THE SURFACE—Continued.

$\frac{e}{B}$	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340
t=34					21	1.52	1.45	1.39	1.33	1.27	1.21	1.15	1.10	1.05	1.00	.95	.90	.86
33			19	20	1.50	1.43	1.37	1.31	1.25	1.20	1.15	1.10	1.05	1.01	.97	.93	.89	.85
32		18	1.54	1.48	1.41	1.34	1.28	1.22	1.17	1.12	1.08	1.04	1.00	.96	.92	.88	.84	.80
31	17	1.52	1.46	1.40	1.33	1.26	1.20	1.15	1.12	1.06	1.02	.98	.94	.90	.86	.82	.78	.74
30	1.51	1.44	1.38	1.32	1.26	1.19	1.13	1.08	1.04	.99	.95	.91	.87	.83	.79	.75	.71	.68
29	1.44	1.37	1.30	1.23	1.17	1.11	1.06	1.01	.96	.91	.87	.83	.79	.75	.71	.68	.66	
28	1.37	1.30	1.23	1.15	1.09	1.04	.99	.94	.89	.87	.81	.77	.73	.69	.66	.64		
27	1.28	1.22	1.15	1.08	1.02	.97	.92	.87	.82	.79	.75	.71	.67	.64	.62	.60		
26	1.20	1.13	1.06	1.00	.94	.89	.84	.79	.74	.70	.67	.65	.62	.60				
25	1.12	1.05	.99	.93	.87	.82	.77	.72	.68	.65	.63	.60	.58					
24	1.05	.98	.92	.86	.80	.75	.70	.66	.63	.61	.58	.56						
23	.98	.92	.85	.80	.75	.70	.65	.62	.60	.58	.56							
22	.91	.85	.80	.75	.70	.65	.62	.59	.57	.56	.54							
21	.85	.80	.75	.70	.65	.62	.59	.57	.55	.54								
20	.80	.75	.70	.65	.61	.58	.56	.54	.52									
19	.75	.70	.65	.60	.57	.54	.52											
18	.68	.63	.60	.56	.54	.52												
17	.62	.58	.56	.54	.52													
16	.59	.56	.54	.52														
15	.56	.54	.52	.50														
14	.54	.53	.52															
13	.52																	

II, A.

SURFACE SUPERHEATING.
Corrections to $G \cdot t$ for height.

H.		H.	
0	....	1600	—0.19
100	+0.80	1700	—0.22
200	+0.63	1800	—0.24
300	+0.47	1900	—0.26
400	+0.33	2000	—0.27
500	+0.22	2100	—0.28
600	+0.15	2200	—0.29
700	+0.10	2300	—0.30
800	+0.06	2400	—0.31
900	+0.03	2500	—0.32
1000	+0.00	2600	—0.33
1100	—0.02	2700	—0.34
1200	—0.05	2800	—0.35
1300	—0.08	2900	—0.36
1400	—0.12	3000	—0.37
1500	—0.16	3100	—0.38

Change the signs for surface subheating.

TABLE 147.—*Metric—Mean pressure, temperature, and vapor tension gradients in the four stages.*

VII.—$\left(\frac{e_1}{B_1}\right)$. δ STAGE—GRADIENT OF THE VAPOR TENSION $G \cdot e$.

Height	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320
0	.100	.140	.180	.210													
1000	.070	.110	.150	.180	.210												
2000	.040	.080	.120	.150	.180	.200											
3000	. .	.050	.090	.120	.150	.170	.190	.210									
4000	. .	.020	.060	.090	.120	.140	.160	.180	.190	.200							
5000	. . . .	.	.030	.060	.090	.110	.130	.150	.160	.170	.180	.190	.195	.200			
6000	. . . . .	.	.030	.060	.085	.105	.125	.135	.145	.155	.165	.170	.175	.180	.185	.190	
7000	. . . . .	.	.	.030	.060	.080	.100	.110	.120	.130	.140	.150	.160	.170	.175	.180	
8000	. . . . .	.	.	.	.040	.060	.080	.090	.100	.110	.120	.130	.140	.150	.155	.160	
9000	. . . . .	.	.	.	.	.040	.060	.070	.085	.095	.105	.115	.125	.135	.140	.145	
10000	. . . . .	.	.	.	.	.	.040	.060	.070	.080	.090	.100	.110	.120	.125	.130	
11000	. . . . .	.	.	.	.	.	.	.050	.060	.070	.080	.085	.095	.100	.110	.115	
12000	. . . . .	.	.	.	.	.	.	.	.050	.060	.070	.075	.080	.085	.090	.095	
13000	. . . . .	.	.	.	.	.	.	.	.	.050	.060	.065	.070	.075	.080	.085	
14000	. . . . .	.	.	.	.	.	.	.	.	.	.050	.060	.065	.070	.075	.080	
15000	. . . . .	.	.	.	.	.	.	.	.	.	.	.055	.060	.065	.070	.075	

α Stage.

It has been discovered that in the α stage the pressure gradient depends (1) upon two arguments $\left(t \cdot \frac{e}{B}\right)$; the temperature gradient upon three arguments $\left(t \cdot \frac{e}{B} \cdot h\right)$; and the vapor tension gradient upon one argument $\frac{e}{B}$. In all the other stages but one argument is required, and we have taken $\frac{e_1}{B_1}$. This is easily found from $\frac{e}{B}$ at the surface by subtracting the correction due to the height, as given in Table 136 (III). By means of these gradients and the heights heretofore given, we may determine the temperature and pressure and vapor tension at the boundary of the several stages.

147, I. The pressure gradient is found as follows: With the ratio $\frac{e}{B}$ for the axis of abscissas and the temperature at the surface as that of the ordinates, transfer to a diagram the gradients given in the several computations, Tables 139–144. By inspection it is easy to draw a series of lines which have the same gradient values, and they form a system of parallel lines at equal distances apart, sloping upward from the axis of abscissas. With the arrangements $\left(t \text{ and } \frac{e}{B}\right)$ given in section I of Table 147, the corresponding values have been taken from the auxiliary diagram, not here reproduced. They show a diminution of the pressure gradient with the increase of temperature, but an increase with the increase in the ratio $\frac{e}{B}$, ranging from 9.3 mm. per 100 meters at (−10°, .0025) to 8.2 mm. at (35°, .0350).

147, II. The temperature gradient was much more difficult to determine under all the combinations which occur, but the result is satisfactory. With the arguments $\left(t \text{ and } \frac{e}{B}\right)$ as ordinate and abscissa axes, respectively, enter on a diagram the gradients as computed, the gradient number being copied in the proper places. Through the diagram draw curves of equal gradients which com-

pose a system, the lines being slightly concave to the axis $\frac{e}{B}$. These values were then transcribed for equal intervals, and they are found in section II of the Table 147 of gradients. The use is very simple. As an example for $\left(t=20^\circ \text{ and } \frac{e}{B}=.0200\right)$ the temperature gradient per 100 meters is 0.65° C. An inspection of this table shows how complex the function for the gradients of temperature is, and how inadequate previous discussions of the subject have generally been in their details. The arguments here used make the table at once applicable for all seasons of the year and for all kinds of weather, as characterized by cyclonic and anticyclonic areas. The ratio $\frac{e}{B}$ is calculated to embrace these distinctions, and the temperature argument gives the variations depending upon the thermal conditions of the atmosphere.

SPECIAL TEST OF THE TEMPERATURE GRADIENT $G \cdot t$ IN THE α STAGE.

We have two sets of observations by means of which these gradients can be accurately tested as to their efficiency in practice, namely, the kite observations and the cloud observations previously computed. Applying the Table 147 (II), we find for the given observations, starting with t and $\frac{e}{B}$, the gradient $G \cdot t$, which multiplied by the height of the cloud base, to which all these observations refer, gives the product $h \cdot G \cdot t$, and this is a correction which, subtracted from the surface temperature, gives the temperature at the cloud base t_1. This quantity has already been found by the kite thermograph, as t_k; also by the dew-point method, by the adiabatic saturation method, and by the ratio method for the kite and the cloud observations. Taking the last as a representative of the system, we compare the t_1, computed by direct gradients with it, and find that for low altitudes the temperature t_1 from $G \cdot t$ runs *larger* than the t_1 from $\frac{e}{B}$; for the altitudes near 1,000 meters they *agree* closely, and for the higher altitudes up to 1,500 meters they are too *small*. This indicates that for the low altitudes the total correction to the surface temperature was not large enough and that the gradient should be increased, and for the high altitudes the correction was too large and the gradients should be decreased; that is to say, the gradient Table 147 (II) must have a correction depending upon the height. The reason of this, it is easy to see, lies in the fact that in the lowest layers there is a strong tendency to superheating during the times when cumulus clouds develop up to the height of 500 or 600 meters (compare Charts 78, 79 from balloon ascensions, page 756); and that above 1,000 meters the temperature curves fall off much more slowly. The lower strata in the atmosphere, about 1,500 meters deep, are so strongly influenced by insolation at the ground, which is a better absorber of heat and is active during the summer afternoons, that certainly in the daytime the lowest layers are overheated relatively to the normal vertical gradients. The adiabatic gradient runs through the center of the table, but it extends in one direction to the gradients pertaining to the β stage, being about 0.50, and in the other direction to about 1.50 per 100 meters.

In order to determine this correction to the temperature gradient $G \cdot t$ with the height, the residuals (t_1) by $G \cdot t$, minus (t_1) by $\frac{e}{B}$, are collected in groups of H for every 250 meters, and also each group is subdivided into three parts for $\frac{e}{B}$. The latter step is necessary in order to determine whether the correction to $G \cdot t$ with the height depends upon $\frac{e}{B}$, or whether the same correction is to be added to the entire table as it stands. The following is a summary of this correction:

TABLE 148.—*Temperature residuals from the gradients uncorrected for height.*

N	H	$\frac{e}{B}$ 0—100	$(t)-t$	N	H	$\frac{e}{B}$ 100—200	$(t)-t$	N	H	$\frac{e}{B}$ 200—300	$(t)-t$
4	405	68	+1.0	7	386	162	+0.7	4	393	262	+1.2
5	590	56	+0.1	9	586	149	+1.0	13	560	252	+1.3
12	885	73	−0.1	11	888	152	+0.2	22	863	255	+0.7
23	1105	70	−0.4	26	1100	157	0.0	10	1114	236	−0.3
11	1362	70	−1.9	8	1385	153	−1.5	9	1483	259	−1.7

The table of temperature residuals from the gradients uncorrected for the height, collected in groups shows no decided tendency to vary with the argument; only the second and third strata have any such run, and these are distinctly contradicted by the first, fourth, and fifth. This table has been consolidated so far as $\frac{e}{B}$ is concerned, by weights, and the variation is made to depend exclusively upon the height. Plotting these final residuals by height and correction, as the arguments, and running a smooth curve through the five given points, the subtable 147 (II, A) of correction to the gradients for the height which appears at the side of the gradient table was obtained. The final method for determining the gradient to use is as follows:

As an example, for $h=500^m$, $t=20°$, $\frac{e}{B}=.0200$, $G\,.\,t=0°.87$

for $h=1500^m$, $t=20°$, $\frac{e}{B}=.0200$, $G\,.\,t=0°.49$.

It will be necessary to use some judgment in applying this subtable, because the variations of sub and superheating from the normal are not constant, and the corrections in Table 147, II, A, must be evidently taken proportional to the existing departures.

COMPARISON WITH THE TEMPERATURES FROM KITES.

The reduction of the temperature at the surface to that at the height h_1, by the gradient table, was then repeated for the kite and the cloud observations, and the residuals $(t_1)-t_1$ taken, namely the temperature obtained by the gradients minus that found by the $\frac{e}{B}$ method. The probable error of a single observation is now computed and it is $r=\pm 0°.527$, about half a degree; the average error is 0°.63, and the mean departure is 0°.05, showing that our system is well balanced. These residuals depend upon the kite and the cloud observations without discrimination, and an inspection of the residuals shows that it is not possible to distinguish one set of observations from the other in a systematic way, so that we must conclude that this entire set of reductions is blended together harmoniously.

In order to exhibit the outcome of this discussion of the temperatures, by the five methods described, the following Table 149 recapitulates the results, and these can be readily compared:

TABLE 149.—*Recapitulation of the temperatures at the height h_1 by five methods.*

FROM KITE OBSERVATIONS.

h_1	t_k From—	t_1 d	t_1 t_s	t_1 $\frac{e}{B}$	t_1 G	h_1	t_k From—	t_1 d	t_1 t_s	t_1 $\frac{e}{B}$	t_1 G
253	15.1	14.9	15.1	14.9	14.4	828	−4.3	−1.5	−1.1	−1.7	−3.0
256	19.0	18.3	18.3	18.3	18.4	862	1.7	3.0	3.0	3.0	3.0
267	18.9	16.5	16.5	16.5	16.6	866	−7.2	−4.7	−4.5	−4.6	−5.5
301	−5.0	0.2	0.0	0.0	−0.2	869	20.0	20.6	20.5	20.5	21.7
360	10.4	9.6	9.9	9.7	8.5	878	10.7	11.7	12.2	11.8	11.8
360	14.7	14.6	14.8	14.6	13.5	890	13.3	18.3	18.5	18.3	17.8
376	1.1	0.9	0.6	0.8	0.9	896	3.3	0.2	0.2	0.2	0.0
384	1.0	0.9	0.8	0.8	0.4	918	1.5	3.7	4.3	3.6	2.4
397	21.1	21.9	21.8	21.8	21.8	924	19.4	19.0	19.0	19.1	19.8
408	20.7	17.6	17.8	17.6	16.5	929	21.1	22.1	22.0	22.1	22.4
423	10.6	9.3	9.5	9.4	8.8	938	16.3	17.1	17.1	17.2	18.0
424	−1.1	−0.2	0.0	−0.2	−1.1	950	13.3	9.4	10.1	9.4	8.4
436	11.3	11.7	11.7	11.8	12.2	951	20.0	21.6	21.5	21.6	22.0
454	21.7	22.6	22.3	22.6	23.3	952	13.9	9.4	9.4	9.5	8.3
483	10.7	9.5	9.6	9.4	8.7	962	12.2	14.3	14.5	14.4	14.9
490	−7.2	−7.7	−7.7	−7.6	−8.8	969	19.4	20.7	20.3	20.7	21.5
490	2.5	2.5	2.7	2.3	1.7	1012	−7.8	−8.4	−8.4	−8.7	−8.4
499	14.4	14.4	14.4	14.5	15.2	1019	0.3	−1.4	−1.5	−1.4	−2.5
499	−2.1	−1.4	−1.4	−1.3	−2.0	1029	13.9	12.9	12.9	12.9	14.3
523	15.6	14.7	15.1	14.9	14.6	1067	7.1	3.9	4.5	4.0	3.1
531	7.2	5.9	6.0	6.0	6.0	1068	14.1	12.8	12.8	12.9	14.0
545	23.3	22.7	22.3	22.6	24.0	1086	0.7	2.5	2.7	2.3	1.4
547	18.2	19.1	19.6	18.9	18.3	1107	15.0	12.6	12.5	12.6	13.8
571	13.9	16.2	16.4	16.2	16.6	1109	17.5	13.0	13.9	13.0	12.2
565	10.4	10.5	10.5	10.5	11.0	1136	17.2	12.7	13.6	12.7	11.4
591	22.2	20.4	20.6	20.4	19.6	1144	−1.2	−3.2	−3.9	−3.5	−2.9
596	15.3	16.2	16.2	16.3	16.7	1141	0.0	−1.3	−1.4	−1.3	−2.1
599	5.6	6.2	6.7	6.4	6.8	1160	1.4	−0.7	−0.6	−0.7	−1.6
604	18.0	17.9	17.8	17.9	19.5	1220	18.3	20.4	20.4	20.3	20.1
612	18.9	17.1	17.0	17.1	18.3	1223	0.0	−1.0	−0.9	−0.9	−2.1
630	8.3	9.1	9.4	9.0	8.2	1227	0.1	2.6	2.8	2.6	1.7
632	22.2	22.8	22.6	22.7	23.7	1274	18.3	18.8	19.0	18.8	18.9
632	11.7	11.8	12.1	11.9	12.3	1275	16.9	15.9	15.8	15.9	16.5
646	15.6	18.0	18.0	18.7	17.9	1281	−7.8	−5.6	−5.9	−5.8	−6.4
650	17.8	20.7	20.7	20.7	20.4	1309	0.6	−1.1	−1.0	−1.3	−2.1
654	7.9	6.9	6.9	6.9	7.4	1329	−0.6	1.6	1.6	1.5	0.8
678	15.6	16.0	16.6	16.0	15.6	1345	−7.9	−5.8	−6.0	−5.8	−6.8
693	17.9	18.0	18.4	18.0	18.0	1352	17.5	16.3	16.2	16.5	16.6
693	−7.2	−6.6	−6.4	−6.7	−7.7	1385	5.3	7.6	7.5	7.6	7.6
702	25.0	22.2	22.7	22.2	21.8	1411	4.4	0.9	0.5	0.7	−0.3
707	−4.4	−4.4	−5.2	−4.4	−5.0	1412	13.3	15.7	16.4	15.8	16.6
726	20.0	21.9	22.3	21.9	21.2	1413	−3.3	−8.2	−9.2	−8.5	−7.5
749	16.1	10.4	10.4	10.3	11.0	1426	12.5	10.7	10.3	10.7	11.6
751	17.4	17.0	17.2	17.0	17.9	1434	−7.9	−6.1	−6.3	−6.2	−7.0
754	21.7	22.0	22.1	22.0	22.3	1532	−8.3	−6.7	−6.8	−6.9	−7.1
792	15.6	14.7	15.5	14.7	13.4	1582	17.1	18.2	18.4	18.2	19.3
798	15.9	16.1	16.5	16.1	16.3	1612	4.4	7.4	7.8	7.4	8.5
800	7.8	3.9	4.1	3.9	4.0	1612	16.9	18.4	18.8	18.5	19.1
812	4.2	3.1	3.9	3.3	1.8	1688	16.3	18.2	18.3	18.3	20.6
814	5.0	3.7	4.1	3.9	3.5	1712	16.4	18.2	18.5	18.4	20.7
818	14.9	15.3	15.9	15.3	15.4	1744	6.9	6.0	6.0	5.9	7.5
827	−3.3	−2.8	−2.3	−2.7	−3.4	2033	16.2	16.7	17.3	17.5	18.7

TABLE 149.—*Recapitulation of the temperatures at the height h_1 by five methods.*

FROM CLOUD OBSERVATIONS.

h_1	t_k	t_1	t_1	t_1	t_1	h_1	t_k	t_1	t_1	t_1	t_1
	From—	d	t_s	$\frac{e}{B}$	G		From—	d	t_s	$\frac{e}{B}$	G
700		17.3	17.3	17.4	18.6	1080		15.4	14.5	15.3	16.2
765		20.9	21.4	20.7	20.7	1090		1.4	1.0	1.5	1.2
800		20.9	20.8	20.9	21.6	1100		10.3	10.0	10.3	9.7
800		16.4	16.4	16.4	17.4	1100		16.6	16.1	16.6	16.9
800		13.4	13.8	13.4	13.8	1000		10.0	9.1	9.8	10.8
830		17.1	17.2	17.0	17.6	1100		3.5	3.4	3.5	3.2
852		23.0	23.1	22.9	22.9	1100		5.2	5.1	5.2	5.0
900		20.1	20.5	20.1	20.1	1100		−11.3	−11.3	−11.8	−11.2
910		13.8	14.2	13.7	14.2	1100		3.6	2.8	3.4	4.0
910		−9.9	−10.8	−11.2	−12.6	1100		4.6	4.5	4.4	4.0
930		16.9	17.3	16.9	17.4	1120		10.8	10.2	10.9	11.5
930		11.6	11.8	11.6	12.0	1130		14.1	13.2	14.2	15.3
940		4.3	3.7	4.2	4.4	1140		−5.9	−6.0	−5.9	−4.3
940		4.8	5.0	4.7	2.9	1150		−0.3	−0.8	−0.6	−0.5
940		−4.0	−4.4	−4.1	−3.4	1150		3.5	3.3	3.4	3.3
950		−4.4	−4.4	−4.3	−4.9	1170		14.5	13.1	14.4	15.0
950		19.0	19.2	19.0	19.1	1160		12.9	12.7	13.0	13.0
970		15.8	15.5	15.6	16.5	1200		15.6	15.0	15.6	15.8
980		9.7	9.6	9.6	10.1	1200		14.5	13.5	15.1	15.6
1000		10.6	11.5	10.7	9.2	1200		5.9	5.0	6.0	6.4
1000		16.6	16.6	16.6	16.6	1200		16.5	16.3	16.6	16.6
1000		12.8	12.1	12.9	14.1	1200		12.8	11.7	13.1	13.4
1000		12.7	12.1	12.8	13.8	1210		8.4	8.0	8.4	8.2
1018		21.3	21.6	21.4	22.5	1220		−0.5	−0.8	−0.5	−1.3
1020		−4.6	−4.7	−4.4	−4.5	1227		6.9	5.8	6.8	6.9
1020		17.2	16.8	17.2	17.7	1250		12.6	12.3	12.5	12.5
1020		1.7	1.5	1.6	1.6	1270		1.5	0.7	1.3	1.2
1027		7.4	6.9	7.5	6.8	1300		8.3	7.8	8.3	8.1
1030		−11.8	−11.8	−12.1	−11.4	1300		8.7	7.4	8.6	8.6
1040		4.5	4.4	4.2	3.8	1300		13.5	12.7	13.6	13.6
1040		3.7	3.3	3.7	3.9	1320		0.5	0.4	0.4	−0.1
1040		12.0	11.8	11.9	12.3	1340		1.8	0.8	1.7	1.2
1060		−0.4	0.0	−0.4	−1.8	1377		14.0	12.9	14.1	13.5
1062		12.0	11.2	12.1	13.0	1500		3.2	1.5	3.2	3.0
1070		−5.6	−5.8	−5.8	−5.9						

The kite and the cloud observations are exhibited separately. At a given height h_1 the temperature has been found by several distinct methods of procedure—by direct thermograph observations by the dew-point, the adiabatic saturation, the ratio, and the gradient methods. It has already been explained that a few rather wide differences between t_k and the other values of t_1 must be due to real local stratifications caused by separate currents, and of course these can not be reckoned with at the ground; nor can they be systematically measured by any means at our disposal. With this exception it is seen that there is sufficient exactness among the four other methods to permit any one of them to be used, and that they all have ample accuracy for map construction at considerable elevations. Since the gradient method is the most simply executed in practice, and is available for all elevations up to 2,000 meters, and is quite accurate at the 1,100-meter level—that is, 3,500 feet—it is clear that the pressure, temperature, and vapor tension can be found for that or any other moderate elevation, and by the most simple numerical operations, using only the surface conditions. It has been the object of this investigation to accomplish this. A continuation of similar observations and computations will undoubtedly enable us to increase the accuracy of these tables, and may even bring to light some other interesting and valuable related facts in the physics of the atmosphere. This discussion of the variation of the mean temperature gradients varying with the height has been conducted for the times of the cumulus cloud formation—that is to say, during periods of unusual heating of the lower layers and when the phenomenon of exversion takes place. On the other hand, in the cold dry portions of the year when true inversion occurs by radiation, the corrections to the gradient depending on the heights must be exactly reversed.

Exversion applies to the overheating of the surface and inversion to overcooling it. This variation, of course, greatly complicates the practical dealing with the entire subject, but it is the province of the meteorologist to consider these changes. Fortunately the variations at the 1,000-meter plane are very small, so that it is only for low elevations that a special correction with the height is required.

THE VAPOR TENSION GRADIENT.

147, III. In the case of the gradient of the vapor tension the result is expressed simply as a function of the ratio $\frac{e}{B}$. Having formed a chart with the arguments $\left(t \text{ and } \frac{e}{B}\right)$, the gradients are plotted in their proper places. An inspection shows that the values of the gradient of the vapor tension do not vary with t in any systematic way independently of $\frac{e}{B}$, and that argument may therefore be abandoned. Hence, collecting in groups by the argument $\frac{e}{B}$ and determining the mean gradients, the result appears as Section III in the Table 147 of the gradients. It runs from 0.048 mm. per 100 meters fall for $\frac{e}{B}=.0010$ to 0.440 for $\frac{e}{B}=.0350$ by a very regular gradation.

By means of these three gradients within the α stage we shall be able to follow all the average conditions of change in the lower atmosphere up to the level of the clouds. It may be remarked that this scheme belongs properly to those days when cumulus clouds form. It is possible that the α stage works somewhat differently on other occasions.

GRADIENTS IN THE β STAGE.

147, IV. A preliminary plotting of the gradients of the β stage for the arguments $\left(t_1 \text{ and } \frac{e_1}{B_1}\right)$ appropriate to this stage shows that they fall on a single curve, such that either argument alone suffices to determine the gradient. The ratio $\frac{e_1}{B_1}$ at the cloud base has been chosen to carry all the gradients through the β . γ . δ . stages wherein adiabatic processes are assumed to hold generally—that is, under the supposition that in the cloud actually formed as much heat radiates as is received by insolation, and that the cloud is in adiabatic equilibrium. In the α stage the argument was the ratio $\frac{e}{B}$; in the other stages it is $\frac{e_1}{B_1}$, which can be obtained from $\frac{e}{B}$ by Table 136, Section III,

when the height of the cloud base has been found by observations. The gradients are now collected in groups, as in the α stage, with the result shown in the Table 150, where N is the number of observations in a group, $\frac{e_1}{B_1}$ the mean ratio, $G \cdot B$, $G \cdot t$, $G \cdot e$ the mean gradients of pressure, temperature, and vapor tension.

TABLE 150.—*Gradients collected in groups.*

β STAGE.

N	$\frac{e_1}{B_1}$	$G \cdot B_1$	$G \cdot t_1$	$G \cdot e_1$
14	.0087	8.0	0.58	0.213
12	.0129	7.5	0.54	0.258
19	.0175	7.3	0.50	0.301
9	.0213	7.1	0.47	0.318
4	.0264	6.4	0.45	0.299
1	.0300	6.2	0.44	0.311

These values are now plotted on a diagram and an average line drawn through the points, that for the pressure being a straight line and for the temperature and the vapor tension curves gently convex to the axis $\frac{e_1}{B_1}$. While the individual values of the gradients differ slightly from these average values, the utility of the gradients is great in practical operations. An extensive series of observations conducted for the purpose of improving these results in their minor details is very desirable for the perfection of this branch of meteorology. Finally, the values given in Section IV of Table 147 were scaled off the diagram for equal steps in the argument.

GRADIENTS IN THE γ STAGE.

147, V. The treatment of the gradients in the γ stage is the same, but is confined to the pressure, since the temperature and the vapor tension are constant throughout the stage. The collection in groups results as follows:

TABLE 151.—*Gradient in γ stage.*

N	$\frac{e_1}{B_1}$	$G \cdot B_0$
1	.0099	7.5
7	.0125	6.9
5	.0173	6.0
3	.0209	5.6
3	.0259	5.0
1	.0300	4.5

This is transferred to a diagram, and it evidently should be interpreted as a straight line, the table, Section V, being transcribed from it at equal intervals of $\frac{e_1}{B_1}$.

GRADIENTS IN THE δ STAGE.

147, VI, VII. Collecting all the gradients in groups for the δ stage, the result is shown in Table 152.

TABLE 152.—*Gradients collected in groups.*

δ STAGE.

N	$\frac{e_1}{B_1}$	$G \cdot B_{11}$	$G \cdot t_{11}$	$G \cdot e_{11}$	Height.
8	.0038	8.3	0.73	0.129	1690
16	.0085	7.6	0.57	0.159	2461
6	.0125	6.8	0.58	0.148	3858
5	.0173	5.1	0.53	0.125	6826
3	.0209	5.1	0.51	0.163	5516
4	.0270	3.5	0.51	0.087	11130

When these values are plotted on $\frac{e_1}{B_1}$ as the horizontal argument, it is seen that the pressure gradients fall close to a straight line, which is transferred to Table 147, Section VI. The temperature gradients apparently construct a curve convex to the axis $\frac{e_1}{B_1}$, and this is also transferred to the same table. Although the δ stage, as well as the β stage, range through great heights, the argument $\frac{e_1}{B_1}$ in general includes the variation of the gradient with the elevation, because large values of $\frac{e_1}{B_1}$ occur only when the height of top of the cloud is also great. These gradients are average values of the gradients which occur through the extent of a cloud region. If the pressure and temperature gradients have second differences within the cloud, greater toward the bottom and smaller toward the top, as must be the case, a fact which is shown by the m Table of the reduction pressures, and also by the charts of temperatures derived from the balloon observations, yet from our method of construction—that is, by computing the top and bottom temperatures of each stage, we have obtained the *mean gradients applicable as a homogeneous quantity in reduction from base to summit of the stage.* Since the value of the ratio itself implies the depth of the stage, it is the sufficient argument for identifying the gradient to be used. This principle is true for all the gradients in all the stages except the pressure and the temperature in the α stage and the vapor tension in the δ stage. The two former have been already explained; the latter will be further considered.

It is probable that the vapor tension must undergo great changes in ranging through altitudes up to 14,000 or 15,000 meters, at which heights the summer cumulo-nimbus clouds are occasionally observed. Some trials show that this element must be constructed under the two arguments $\left(h \text{ and } \frac{e_1}{B_1}\right)$. Transcribing the gradients on a diagram plotted to these axes and drawing curves of equal gradients, we find a system of curves spreading fan shaped, and concave to the axis $\frac{e_1}{B_1}$ the intervals gradually widening from the top to the bottom. Section VII of Table 147 is constructed by reading off the values for the coordinate points indicated in the arguments. The range of the table for given values of $\frac{e_1}{B_1}$ shows that the argument height could not properly be neglected.

We have now found a complete system of gradients, covering all possible conditions of cloud formation, by which one may compute the pressure, temperature, and vapor tension, also the depth and height of the stages, and they will be found practically useful. The corresponding English system of gradients will be given in Chapter 13.

CHAPTER 13.

REDUCTION OF THE PRESSURE AND TEMPERATURE FOR MAPS AT SEA LEVEL, AT THE 3,500-FOOT LEVEL, AND AT THE 10,000-FOOT LEVEL.

GENERAL REMARKS.

The problem of forming an accurate map of the barometric pressures reduced to the sea level is for the Weather Bureau the most important practical question yet waiting solution, on account of its immediate bearing upon the daily forecasts of the storm conditions. Unfortunately it is one of the most difficult to solve satisfactorily, on account of the very variable elevations of the stations where the observations are made, which are caused by the great Rocky Mountain plateau covering the western portions of the United States. The surface rises rapidly from the Pacific coast to the mountain divide, and it then slopes gradually to the Mississippi River, while the elevations are all moderate in the eastern districts. The specific difficulty is the determination of the temperature argument, which shall represent the mean temperature of the air column in the plateau region. If this were known with certainty, then an air column could be at once substituted for the plateau, and any of the standard barometric reduction tables to the sea level would be suitable for use. But it is not easy to decide what relation the temperature observed at a station situated on the plateau has to this reduction temperature. The elevation of the station at the top of the reduction column, being located on the ground instead of in the free air, is thus subjected to the exaggerations of temperature variations which are caused by great absorption of heat from insolation during the day and excessive radiation during the night. The diurnal swing of the temperature at the ground, no matter what its elevation may be, is much greater than in the free-air column at the same height, and therefore during the passage of warm or cold waves over the plateau these surface temperatures undergo greater fluctuations than can be assigned to the corresponding air column, on the supposition that the station be treated as if transferred to the true sea level.

PROGRESS ALREADY MADE IN DISCUSSING PLATEAU BAROMETRY.

It is not our purpose to discuss this problem at any length in this chapter; indeed, the subject is so large that it will be reserved for a special report on barometry, which is now in preparation under my charge. It may, perhaps, be proper to mention the steps that have been already taken and are completed as preliminary to a study of this temperature argument. (1) There have been numberless changes in the elevation of the stations of the Weather Bureau since the beginning of the observations in 1871 to the present day, due to the abandonment of old and the opening of new stations, or to the removal of the apparatus from one building to another at the same place, caused by the occupation of various offices. The reports on these elevations have all been collected together; they have been carefully studied and revised, as was necessary in consequence of the improvement of the data as the surveys of the United States have been gradually perfected; they are now tabulated and referred to Gannett's altitudes (edition of 1899, recently issued) and mean sea level, so that the dates of removal, the amount of the change in elevation, and the correction of elevation to the height actually occupied at the epoch January 1, 1900, are known. This will enable us to reduce all observations for the interval of time 1873–1899 inclusive, to a homogeneous system of elevations referred to the end of the nineteenth century. The observations of 1871

and 1872 are excluded from the compilation. (2) Tables are prepared for correcting the air column at each station to standard gravity for latitude and altitude; also for reducing all the actual barometric pressures which were made at selected hours, as 7 a. m., 3 p. m., and 11 p. m.; or 8 a. m. and 8 p. m., to the true mean of 24 hourly observations. (3) The English reduction tables, corresponding to the Metric Tables 91, 92, 93, for temperatures −40° F. to 100° F., and from 0 to 10,000 feet elevation, are finished and ready for use. (4) A long series of computations has been executed for stations situated on the plateau, in connection with those out on the Pacific coast and in the Mississippi Valley, with reductions to the 3,500-foot level, from which the temperature argument was determined by an inverse process, so that the result indicates the general law by which the surface temperatures may be turned into the proper temperature argument. This work is preliminary and will need further consideration. It is proposed to make the report on barometry include: (1) a deduction of the formulæ and the general reduction tables to any elevation under 10,000 feet; (2) a thorough discussion of the temperature arguments for the plateau and their connection with the surface temperatures; (3) a reduction of all the actual monthly mean barometric pressures at each station, from its opening to the present time, to a homogeneous system of normals, based upon the quarter century of work by this office and made standard for the given epoch; (4) also, the variations for each year or month on this normal, which will test the connections with the solar periods; (5) the separated special station tables for reducing the barometer readings to sea level, the 3,500-foot level, and the 10,000-foot level. It is probable that other questions of importance may be necessarily involved in this discussion which can not now be anticipated.

THE ENGLISH GRADIENTS OF B . t . e.

It is very desirable to approach the problem of the temperature argument from every side, so that all possible light may be thrown upon the subject, and I have accordingly at this time prepared the English gradient tables in the α . β . γ . δ stages, corresponding to the metric gradient tables 147, with the purpose of reducing a specimen set of maps at the three levels specified, in order to bring out the advantage of preparing such maps for use in the daily forecasting work of the office, Table 153. These gradients were constructed, it will be remembered, so as to pass from the observed surface conditions at any time up to the elevation of 1,600 meters with accuracy, and even to 3,000 meters approximately. This method of attacking the problem of barometric and temperature reductions, by starting with one complete set of surface observation of the meteorological elements, is certainly most likely to give us an advantage in studying the plateau problem. In the eastern portions of the United States it is at once sufficiently comprehensive to construct a satisfactory working map, since we begin the reductions there from low elevations, and in the plateau districts it will probably show us how to change the surface temperatures in order to reach a correct mean temperature argument.

TABLE 153.—*English—Mean pressure, temperature, and vapor tension, gradients in four stages.*

I.—$\left(t \cdot \frac{e}{B}\right)$ α STAGE—PRESSURE.

t F	$\frac{e}{B}$ 0	25	50	75	100	125	150	175	200	225	250	275	300	325	350
95	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	.095	.095	.096	.096	.097	.097	.098
90	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	.095	.095	.096	.096	.097	.097	.098	.098	.099
85	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	125	.096	.096	.097	.097	.098	.098	.099	.100	
80	. . . . .	. . . . .	. . . . .	. . . . .	100	.096	.096	.097	.097	.098	.099	.100	.101	.102	
75	. . . . .	. . . . .	. . . . .	75	.096	.097	.098	.098	.099	.100	.101	.102	.103	.103	
70	. . . . .	. . . . .	. . . . .	.096	.098	.099	.100	.100	.102	.102	.103	.104	.104		
65	. . . . .	. . . . .	. . . . .	.098	.100	.101	.102	.103	.104	.104	.106	.106			
60	. . . . .	. . . . .	. . . . .	.101	.102	.103	.104	.105	.106	.107	.108				
55	. . . . .	. . . . .	50	.103	.103	.104	.106	.107	.108	.109					
50	. . . . .	. . . . .	.104	.104	.105	.106	.107	.108	.109						
45	. . . . .	. . . . .	.105	.105	.106	.107	.108	.109							
40	. . . . .	25	.106	.106	.107	.108	.109	.110							
35	. . . . .	.106	.106	.107	.108	.109	.110								
30	. . . . .	.107	.107	.108	.109	.110	.111								
25	.108	.108	.109	.110	.111	.112									
20	.109	.110	.111	.112	.113	.114									
15	.111	.112	.113	.114	.115	.116									
10	.113	.114	.115	.116	.117	.118									
5	.115	.116	.117	.118	.119										
0	.116	.117	.118	.119	.120										
— 5	.117	.118	.119	.120											
—10	.118	.119	.120	.121											
—15	.119	.120	.121	.122											

III.—α STAGE—VAPOR TENSION.

$\frac{e}{B}$	$G \cdot e$	$\frac{e}{B}$	$G \cdot e$
.0010	.0006	.0190	.0030
20	6	200	31
30	7	210	33
40	8	220	34
50	10	230	36
60	11	240	37
70	12	250	38
80	14	260	40
90	15	270	41
100	17	280	43
110	18	290	44
120	20	300	45
130	21	310	47
140	23	320	48
150	24	330	49
160	25	340	51
170	27	.0350	.0053
.0180	.0028		

TABLE 153.—*English—Mean pressure, temperature, and vapor tension, gradients in four stages*—Continued.

IV.—$\left(\frac{e_I}{B_I}\right)$ β STAGE.				V.—γ STAGE.		VI.—δ STAGE.		
$\frac{e_I}{B_I}$	$G \cdot B_I$	$G \cdot t_I$	$G \cdot e_I$	$\frac{e_I}{B_I}$	$G \cdot B_0$	$\frac{e_I}{B_I}$	$G \cdot B_{II}$	$G \cdot t_{II}$
.0050	.100	.340	.0021	.0050	.092	0	.110	.442
60	.098	.335	23	60	91	.0010	.108	.428
70	97	.329	24	70	90	20	.106	.414
80	97	.324	25	80	88	30	.103	.401
90	96	.318	26	90	86	40	.101	.389
.0100	95	.313	27	.0100	85	50	.098	.376
110	94	.307	29	110	83	60	95	.363
120	92	.302	30	120	82	70	92	.351
130	91	.296	31	130	80	80	90	.340
140	91	.291	32	140	79	90	88	.329
150	90	.285	33	150	78	.0100	85	.320
160	89	.280	34	160	76	110	83	.313
170	88	.276	35	170	74	120	80	.308
180	86	.272	36	180	72	130	78	.302
190	85	.269	36	190	71	140	75	.296
.0200	85	.265	37	.0200	70	150	72	.291
210	84	.261	38	210	68	160	70	.288
220	83	.258	39	220	66	170	67	.285
230	82	.254	39	230	65	180	65	.282
240	80	.251	39	240	63	190	62	.280
250	79	.249	40	250	61	.0200	60	.278
260	78	.246	40	260	60	210	58	.276
270	78	.244	40	270	58	220	55	.274
280	77	.243	40	280	56	230	53	.272
290	76	.242	41	290	55	240	50	.270
.0300	74	.240	41	.0300	54	250	48	.269
310	73	.239	41	310	52	260	45	.267
320	72	.238	41	320	50	270	42	.266
330	72	.236	41	330	49	280	40	.265
.0340	.071	.235	.0041	.0340	.048	290	37	.264
						.0300	35	.264
						310	32	.264
						320	30	.264
						330	28	.264
						.0340	.026	.0264

TABLE 153.—*English—Mean pressure, temperature, and vapor tension, gradients in four stages*—Continued.

II.—THE TEMPERATURE GRADIENT PER 100 FEET, FOR THE ARGUMENTS $\left(t \text{ AND } \frac{e}{B}\right)$ AT THE SURFACE—α STAGE.

t F	$\frac{e}{B}$ .0010	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
94																
92																
90																
88																
86																160
84															150	.82
82														140	.82	.78
80													130	.82	.78	.74
78												120	.81	.76	.73	.69
76											110	.81	.76	.72	.68	.63
74										100	.81	.76	.72	.68	.63	.59
72										.80	.76	.72	.67	.63	.59	.54
70								80	90	.79	.73	.68	.63	.59	.54	.51
68								.83	.79	.74	.69	.64	.59	.54	.50	.46
66							70	.80	.75	.70	.65	.60	.55	.50	.46	.43
64							.81	.76	.71	.66	.61	.56	.51	.46	.42	.40
62							.78	.73	.68	.62	.57	.52	.47	.43	.39	.36
60						60	.75	.70	.64	.59	.53	.48	.43	.40	.36	.33
58						.77	.72	.66	.60	.54	.48	.44	.40	.36	.33	.31
56					50	.74	.68	.62	.56	.50	.44	.40	.36	.33	.31	.30
54					.76	.70	.64	.58	.52	.46	.42	.38	.33	.30	.29	.28
52					.73	.67	.61	.55	.48	.43	.39	.35	.31	.29		
50				40	.70	.63	.57	.51	.46	.41	.37	.33	.30			
48				.73	.66	.60	.53	.47	.43	.40	.35	.32				
46			30	.70	.63	.57	.50	.44	.40	.37	.34	.31				
44			.73	.66	.59	.53	.47	.42	.37	.34						
42			.71	.64	.57	.50	.44	.38	.34	.31						
40			.69	.60	.53	.47	.41	.35	.30							
38		20	.65	.57	.50	.43	.37	.32								
36		.71	.63	.54	.47	.40	.34									
34	10	.69	.60	.52	.44	.36	.31									
32	.74	.65	.57	.49	.42	.34										
30	.72	.63	.53	.46	.38	.32										
28	.70	.60	.51	.42	.35											
26	.68	.57	.47	.37	.32											
24	.65	.54	.43	.33	.30											
22	.63	.51	.40	.30	.27											
20	.61	.48	.37	.27	.24											
18	.59	.45	.34	.23												
16	.57	.42	.31	.20												
14	.54	.39	.27	.16												
12	.52	.36	.24	.12												
10	.50	.33	.21	.08												

t F	.0010	20	30
8	.48	.30	.18
6	.46	.27	.15
4	.43	.24	.12
2	.41	.21	.09
0	.39	.18	.05
—2	.37	.15	.02
—4	.35	.12	—.01
—6	.32	.09	—.04
—8	.30	.06	—.07
—10	.28	.03	—.11
—12	.26	.00	—.14
—14	.23	—.03	—.17
—16	.21	—.06	—.21
—18	.19	—.09	—.24
—20	.17	—.12	—.27

TABLE 153.—*English—Mean pressure, temperature, and vapor tension, gradients in four stages.*—Continued.

II.—THE TEMPERATURE GRADIENT PER 100 FEET, FOR THE ARGUMENTS $\left(t \text{ AND } \frac{e}{B}\right)$ AT THE SURFACE—α STAGE—Continued.

t F	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340
94						.86	.82	.79	.75	.72	.68	.64	.61	.58	.55	.53	.50	.48
92			190	200	.84	.80	.76	.74	.70	.67	.64	.61	.58	.56	.54	.52	.49	.47
90		180	.86	.82	.79	.74	.71	.68	.65	.62	.60	.58	.55	.53	.51	.49	.47	.44
88	170	.84	.81	.77	.74	.70	.66	.64	.62	.59	.57	.54	.52	.50	.48	.46	.43	.41
86	.83	.79	.76	.72	.69	.65	.62	.59	.57	.54	.52	.50	.48	.46	.43	.41	.39	.37
84	.79	.75	.71	.68	.64	.60	.58	.55	.52	.49	.47	.45	.43	.41	.38	.37	.36	
82	.74	.70	.66	.63	.59	.57	.54	.51	.48	.47	.43	.42	.40	.37	.36	.34		
80	.69	.65	.61	.58	.55	.52	.50	.47	.44	.42	.40	.38	.36	.34	.33	.32		
78	.64	.60	.57	.53	.50	.47	.44	.42	.39	.37	.36	.35	.33					
76	.59	.55	.52	.49	.46	.43	.40	.37	.36	.35	.33	.32	.31					
74	.55	.52	.48	.45	.42	.39	.37	.35	.33	.32	.31	.30						
72	.51	.47	.44	.42	.39	.36	.34	.33	.32	.31	.30							
70	.47	.43	.41	.38	.36	.34	.32	.31	.30	.29								
68	.44	.41	.38	.36	.33	.32	.31	.30	.29									
66	.41	.38	.35	.32	.30	.29	.28											
64	.37	.34	.32	.31	.29	.29												
62	.33	.31	.30	.29														
60	.32	.30	.29	.28														
58	.30	.29	.29															
56	.29																	
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12																		
10																		

CORRECTIONS TO $G \cdot t$ FOR SURFACE SUPERHEATING.

H.		H.		H.	
0		3400	.00	6800	—.15
200	+.48	3600	—.01	7000	.16
400	.42	3800	.02	7200	.16
600	.36	4000	.03	7400	.17
800	.30	4200	.04	7600	.17
1000	.25	4400	.05	7800	.17
1200	.20	4600	.07	8000	.18
1400	.15	4800	.08	8200	.18
1600	.12	5000	.09	8400	.18
1800	.10	5200	.10	8600	.18
2000	.08	5400	.11	8800	.19
2200	.05	5600	.12	9000	.19
2400	.04	5800	.12	9200	.19
2600	.03	6000	.13	9400	.19
2800	.02	6200	.14	9600	.20
3000	.02	6400	.14	9800	.20
3200	+.01	6600	—.15	10000	—.21

Change the signs for surface subheating.

TABLE 153.—*English—Mean pressure, temperature, and vapor tension gradients in four stages*—Continued.

VII. $-\left(\frac{c_1}{B_1}\right)$. δ STAGE—GRADIENT OF THE VAPOR TENSION G . e.

Height	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320
Feet. 0	.00120	.00168	.00216	.00252													
2000	.00098	146	194	230	**80**												
4000	.00077	125	172	209	.00245	**100**											
6000	.00055	103	151	187	223	.00247											
8000	. . . .	80	129	164	200	224	**120**	**140**									
10000	. . . .	57	106	142	178	202	.00226	.00250									
12000	. . . .	36	84	120	156	180	204	228	**160**	**180**							
14000	. . . .	.00014	62	98	134	158	182	206	.00218	.00230	**200**	**220**	**240**				
16000	. . . . .	. . . .	.00041	77	113	137	161	185	197	209	.00221	.00232	.00239				
18000	. . . . .	. . . .	. . . .	55	91	118	142	166	178	190	202	213	224	**260**			
20000	. . . . .	. . . .	. . . .	.00032	68	98	122	146	158	170	182	194	200	.00216	**280**		
22000	. . . . .	. . . .	. . . .	. . . .	48	80	104	128	140	152	164	176	186	198	.00204	**300**	**320**
24000	. . . . .	. . . .	. . . .	. . . .	.00024	61	85	109	121	133	145	157	169	181	193	.00199	.00205
26000	. . . . .	. . . .	. . . .	. . . .	. . . .	.00048	72	96	108	120	132	144	156	168	180	186	192
28000	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	58	82	94	109	121	133	145	157	169	175	181
30000	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	44	68	80	98	110	122	134	146	158	164	170
32000	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	.00030	54	66	88	100	112	124	136	148	154	160
34000	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	.00040	54	77	89	101	113	125	137	143	150
36000	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	.00052	70	82	94	102	114	122	132	138
38000	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	62	74	86	96	102	108	120	126
40000	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	.00055	67	79	89	95	101	107	113
42000	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	61	73	83	88	94	100	106
44000	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	.00055	67	77	82	88	94	100
46000	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	60	72	78	84	90	96
48000	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	57	68	74	80	86	92
50000	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	.00053	.00064	.00070	.00076	.00082	.00088

TABLE 154.—*Reduction of the pressure and temperature to sea level, 3,500-foot level, and 10,000-foot level.*

MARCH 30, 8 A. M., 1899.

Station	Vertical distance			Mar. 30, 1899, 8 a. m.		Mean		Gradients		Corrections			Reduced pressure			Corrections			Reduced temperature		
	To the sea level	To the 3500	To the 10000	B	t	(t)	$\left(\frac{e}{B}\right)$	$G.B$	$G.t$	ΔB_1	ΔB_2	ΔB_3	B_1	B_2	B_3	Δt_1	Δt_2	Δt_3	t_1	t_2	t_3
Hatteras	11	3489	9989	30.10	51.0	49.9	.0073	.104	.55	+.01	−3.62	−10.39	30.11	26.48	19.71	0	−19.2	−54.9	51.0	31.8	− 3.9
Nantucket	14	3486	9986	29.77	36.0	35.5	.0048	.106	.48	.01	3.70	10.59	29.78	26.07	19.18	0	16.8	48.0	36.0	19.2	−12.0
Corpus Christi	18	3482	9982	29.58	68.0	67.0	.0189	.102	.37	.02	3.55	10.18	29.60	26.03	19.40	0	12.9	36.9	68.0	55.1	+31.1
Father Point	20	3480	9980	28.99	29.4	30.8	.0057	.107	.35	.02	3.69	10.68	29.01	25.30	18.31	0	12.2	34.9	29.4	17.2	− 5.5
Chatham	21	3479	9979	29.09	30.0	32.2	.0051	.106	.41	.02	3.72	10.58	29.11	25.37	18.51	0	14.3	40.9	30.0	15.7	−10.9
Key West	22	3478	9978	29.95	76.5	74.5	.0239	.102	.35	.02	3.55	10.18	29.97	26.40	19.77	0	12.2	34.9	76.5	64.3	+41.6
Jupiter	28	3472	9972	29.95	73.2	69.2	.0203	.102	.36	.03	3.54	10.17	29.98	26.41	19.78	0	12.5	35.9	73.2	60.7	+37.3
Tampa	34	3466	9966	29.95	58.0	61.5	.0087	.102	.69	.03	3.54	10.17	29.98	26.41	19.78	0	23.9	68.8	58.0	34.1	−10.8
Sidney	35	3465	9965	29.33	34.2	34.0	.0059	.106	.37	.04	3.68	10.57	29.37	25.65	18.76	0	12.8	36.9	34.0	21.2	− 2.9
Jacksonville	43	3457	9957	29.97	57.5	55.0	.0106	.103	.44	.04	3.56	10.26	30.01	26.41	19.71	0	15.2	43.8	57.5	42.3	+13.7
Charleston	48	3452	9952	30.06	50.0	51.6	.0061	.104	.66	.05	3.59	10.35	30.11	26.47	19.71	0	22.7	65.7	50.0	27.3	−15.7
Atlantic City	50	3450	9950	29.88	44.0	40.5	.0066	.106	.43	.05	3.66	10.55	29.93	26.22	19.33	0	14.8	42.7	44.0	29.2	+ 1.3
New Orleans	51	3449	9949	29.78	59.4	55.7	.0109	.103	.45	.05	3.55	10.25	29.83	26.23	19.53	0	15.1	43.8	59.4	44.3	+15.6
Galveston	54	3446	9946	29.62	66.0	63.5	.0166	.104	.38	.06	3.58	10.34	29.68	26.04	19.28	0	13.1	37.8	66.0	52.9	+28.2
Mobile	57	3443	9943	29.83	61.0	56.0	.0105	.102	.47	.06	3.51	10.14	29.89	26.32	19.69	0	16.1	46.8	61.0	44.9	+14.2
Havana	57	3443	9943	29.89	73.0	74.0	.0235	.102	.36	.06	3.51	10.14	29.95	26.38	19.75	0	12.3	35.8	73.0	60.7	+37.2
Eureka	62	3438	9938	30.03	47.0	48.8	.0094	.104	.44	.06	3.58	10.34	30.09	26.45	19.69	0	15.1	43.7	47.0	31.9	+ 3.3
Eastport	76	3424	9924	29.30	29.0	30.5	.0046	.107	.42	.08	3.66	10.61	29.38	25.74	18.69	0	14.3	41.7	29.0	14.7	−12.7
Wilmington	78	3422	9922	30.03	45.8	46.9	.0058	.104	.60	.08	3.56	10.32	30.11	26.47	19.71	0	20.5	59.5	45.8	25.3	−13.7
Savannah	78	3422	9922	29.99	51.4	52.0	.0077	.104	.57	.08	3.56	10.32	30.07	26.43	19.67	0	19.4	56.5	51.4	32.0	− 5.1
San Diego	87	3413	9913	29.80	48.0	51.7	.0089	.104	.49	.09	3.55	10.31	29.89	26.25	19.49	0	16.4	47.6	48.0	31.6	+ 0.4
Norfolk	91	3409	9909	29.96	41.0	43.2	.0056	.106	.54	.10	3.61	10.50	30.06	26.35	19.46	0	18.4	53.5	41.0	22.6	−12.5
Albany	97	3403	9903	29.72	29.0	36.8	.0044	.106	.53	.10	3.60	10.49	29.82	26.12	19.23	0	18.0	52.4	29.0	11.0	−23.4
Halifax	97	3403	9903	29.32	32.7	33.8	.0049	.106	.45	.10	3.60	10.49	29.42	25.72	18.83	0	15.3	44.5	32.7	17.4	−11.8
Portland, Me	103	3397	9897	29.45	29.8	32.0	.0030	.107	.57	.11	3.62	10.59	29.56	25.83	18.86	0	19.3	56.5	29.8	10.5	−26.7
Washington	112	3388	9887	29.86	39.0	38.9	.0041	.106	.58	.12	3.59	10.48	29.98	26.27	19.38	0	19.7	57.4	39.0	19.3	−18.4
Philadelphia	117	3383	9883	29.81	37.9	37.4	.0042	.106	.54	.12	3.58	10.47	29.93	26.23	19.34	0	18.3	53.4	37.9	19.6	−16.5
Baltimore	123	3377	9877	29.79	39.0	38.6	.0037	.106	.61	.13	3.58	10.47	29.92	26.21	19.32	0	20.6	60.3	39.0	18.4	−21.3
St. Johns	125	3375	9875	29.48	33.0	29.0	.0044	.107	.41	.13	3.62	10.57	29.61	25.86	18.91	0	13.8	40.6	33.0	19.2	− 7.6
Boston	125	3375	9875	29.61	31.0	32.0	.0030	.107	.57	.13	3.62	10.57	29.74	25.99	19.04	0	19.3	56.3	31.0	11.7	−25.3
Yuma	144	3356	9856	29.66	44.0	54.0	.0050	.103	.76	.15	3.46	10.16	29.81	26.20	19.50	0	25.5	74.9	44.0	18.5	−30.9
San Francisco	153	3347	9847	29.85	47.3	49.8	.0109	.105	.37	.16	3.52	10.34	30.01	26.33	19.51	0	12.4	36.4	47.3	34.9	+10.9
Portland, Oreg.	154	3346	9846	29.90	41.6	46.7	.0083	.105	.44	.16	3.52	10.34	30.06	26.38	19.56	0	14.7	43.3	41.6	26.9	− 1.7
Augusta	180	3320	9820	29.86	40.3	45.0	.0059	.105	.56	.19	3.49	10.31	30.05	26.37	19.55	0	18.6	55.0	40.3	21.7	−14.7
Montreal	187	3313	9813	29.33	23.7	24.0	.0035	.109	.38	.20	3.61	10.69	29.55	25.72	18.64	0	12.6	37.3	23.7	11.1	−13.6
Montgomery	221	3279	9779	29.70	43.8	47.4	.0070	.105	.51	.23	3.44	10.27	29.93	26.26	19.43	0	16.7	49.9	43.8	27.1	− 6.1

TABLE 154.—*Reduction of the pressure and temperature to sea level, 3,500-foot level, and 10,000-foot level*—Continued.

MARCH 30, 8 A. M., 1899—Continued.

Station	Vertical distance			Mar. 30, 1899, 8 a. m.		Mean		Gradients		Corrections			Reduced pressure			Corrections			Reduced temperature		
	To the sea level	To the 3500	To the 10000	B	t	(t)	$\left(\frac{e}{B}\right)$	$G.B$	$G.t$	ΔB_1	ΔB_2	ΔB_3	B_1	B_2	B_3	Δt_1	Δt_2	Δt_3	t_1	t_2	t_3
Vicksburg	247	3253	9753	29.50	51.1	53.8	.0107	.103	.43	.25	3.35	10.04	29.75	26.15	19.46	0	14.0	41.9	51.1	37.1	+ 9.2
Shreveport	249	3251	9751	29.42	53.3	56.8	.0077	.103	.66	.26	3.35	10.04	29.68	26.07	19.38	0	21.5	64.4	53.3	31.8	−11.1
Little Rock	257	3243	9743	29.28	49.0	51.8	.0071	.104	.60	.27	3.37	10.13	29.55	25.91	19.15	0	21.5	58.4	49.0	27.5	− 9.4
Quebec	296	3204	9704	28.98	24.5	27.0	.0046	.110	.40	.33	3.52	10.67	29.31	25.46	18.31	0	12.8	38.8	24.5	11.7	−14.3
New York	311	3189	9689	29.55	39.0	36.8	.0044	.106	.53	.33	3.38	10.27	29.88	26.17	19.28	0	16.9	51.4	39.0	22.1	−32.4
Los Angeles	335	3165	9665	29.56	46.0	51.5	.0097	.105	.44	.35	3.33	10.15	29.91	26.23	19.47	0	13.9	42.5	46.0	32.1	+ 3.5
Oswego	335	3165	9665	29.44	27.0	27.5	.0032	.109	.49	.37	3.46	10.54	29.81	25.98	18.90	0	15.2	46.4	27.0	12.8	−19.4
Cairo	356	3144	9644	29.36	44.2	46.5	.0061	.105	.58	.37	3.30	10.12	29.73	26.06	19.24	0	18.2	55.9	44.2	26.0	−11.7
Raleigh	375	3125	9625	29.68	38.0	41.1	.0073	.106	.41	.40	3.32	10.21	30.08	26.36	19.47	0	12.8	39.5	38.0	25.2	− 1.5
Memphis	397	3103	9603	29.36	45.0	48.1	.0055	.105	.63	.42	3.25	10.08	29.78	26.11	19.28	0	19.5	60.4	45.0	25.5	−15.4
Fort Smith	451	3049	9549	29.00	57.2	57.9	.0075	.102	.75	.46	3.14	9.84	29.46	25.86	19.16	0	22.9	71.6	57.2	34.3	−14.4
Palestine	515	2985	9485	29.08	62.4	63.5	.0166	.103	.38	.53	3.08	9.77	29.61	26.00	19.31	0	11.3	36.1	62.4	51.1	+26.3
Roseburg	518	2982	9482	29.47	42.0	48.2	.0081	.105	.46	.54	3.14	9.96	30.01	26.33	19.51	0	13.7	43.6	42.0	28.3	− 1.6
Rochester	523	2977	9477	29.26	24.2	25.0	.0030	.108	.45	.57	3.22	10.24	29.83	26.04	19.02	0	13.4	42.7	24.2	10.8	−18.5
Louisville	525	2975	9475	29.28	42.0	44.0	.0054	.105	.57	.55	3.13	9.95	29.83	26.15	19.33	0	17.0	54.0	42.0	25.0	−12.0
Nashville	546	2954	9454	29.32	39.5	44.2	.0056	.105	.55	.57	3.10	9.92	29.89	26.22	19.40	0	16.2	52.0	39.5	23.3	−12.5
St. Louis	567	2933	9433	29.07	41.0	37.4	.0065	.106	.38	.60	3.11	10.00	29.67	25.96	19.07	0	11.1	35.8	41.0	29.9	+ 5.2
Davenport	606	2894	9394	29.17	24.0	28.0	.0030	.107	.51	.67	3.09	10.05	29.84	26.08	19.12	0	14.7	47.9	24.0	9.3	−23.9
Alpena	609	2891	9391	29.11	19.0	20.5	.0029	.110	.37	.68	3.18	10.33	29.79	25.93	18.78	0	10.7	34.7	19.0	8.3	−15.7
Keokuk	614	2886	9386	29.11	23.0	28.2	.0043	.107	.40	.67	3.09	10.05	29.78	26.02	19.06	0	11.5	37.5	23.0	11.5	−14.5
Green Bay	617	2883	9383	29.20	10.0	16.0	.0020	.111	.42	.70	3.20	10.41	29.90	26.00	18.79	0	12.1	39.4	10.0	− 2.1	−29.4
Sault Ste. Marie	624	2876	9376	29.01	15.6	17.2	.0025	.111	.37	.71	3.20	10.41	29.72	25.82	18.60	0	10.7	34.7	15.6	4.9	−19.1
Cincinnati	628	2872	9372	29.19	40.4	41.4	.0053	.106	.53	.67	3.04	9.93	29.86	26.15	19.35	0	15.2	49.7	40.4	25.2	− 9.3
Toledo	628	2872	9372	29.23	26.0	27.2	.0037	.107	.42	.68	3.07	10.03	29.91	26.16	19.20	0	12.0	39.3	26.0	14.0	−13.3
Grand Haven	632	2868	9368	29.17	24.0	24.8	.0032	.108	.43	.69	3.10	10.12	29.86	26.07	19.05	0	12.3	40.3	24.0	11.7	−16.3
Parry Sound	635	2865	9365	29.01	22.0	22.5	.0029	.108	.41	.70	3.10	10.12	29.71	25.91	18.89	0	11.7	38.4	22.0	10.3	−16.4
Parkersburg	638	2862	9362	29.25	41.0	40.0	.0054	.106	.51	.68	3.03	9.92	29.93	26.22	19.33	0	14.5	47.8	41.0	26.5	− 6.8
Springfield, Ill	644	2856	9356	29.07	32.0	36.6	.0054	.106	.47	.68	3.03	9.92	29.75	26.04	19.15	0	13.4	44.0	32.0	18.6	−12.0
Port Arthur	644	2856	9356	28.93	15.0	19.5	.0030	.111	.37	.71	3.17	10.39	29.63	25.76	18.54	0	10.6	34.6	15.0	4.4	−21.6
Saugeen	656	2844	9344	29.07	21.5	22.5	.0036	.110	.34	.72	3.12	10.27	29.79	25.95	18.80	0	9.7	31.8	21.5	11.8	−10.3
Lynchburg	680	2820	9320	29.24	42.0	42.6	.0044	.106	.62	.72	2.99	9.88	29.96	26.25	19.36	0	17.4	57.9	42.0	25.6	−15.9
Milwaukee	681	2819	9319	29.17	16.8	20.7	.0022	.110	.48	.76	3.09	10.26	29.93	26.07	18.91	0	13.5	44.8	16.8	3.3	−28.0
Dubuque	698	2802	9302	29.14	19.2	22.0	.0027	.109	.43	.77	3.05	10.14	29.91	26.09	19.00	0	12.0	40.0	19.2	7.2	−20.8
Duluth	702	2798	9298	29.09	11.1	16.3	.0020	.111	.42	+.80	−3.10	−10.32	29.89	25.99	18.77	0	−11.7	−39.0	11.1	−0.6	−27.9

TABLE 154.—*Reduction of the pressure and temperature to sea level, 3,500-foot level, and 10,000-foot level*—Continued.

MARCH 30, 8 A. M., 1899—Continued.

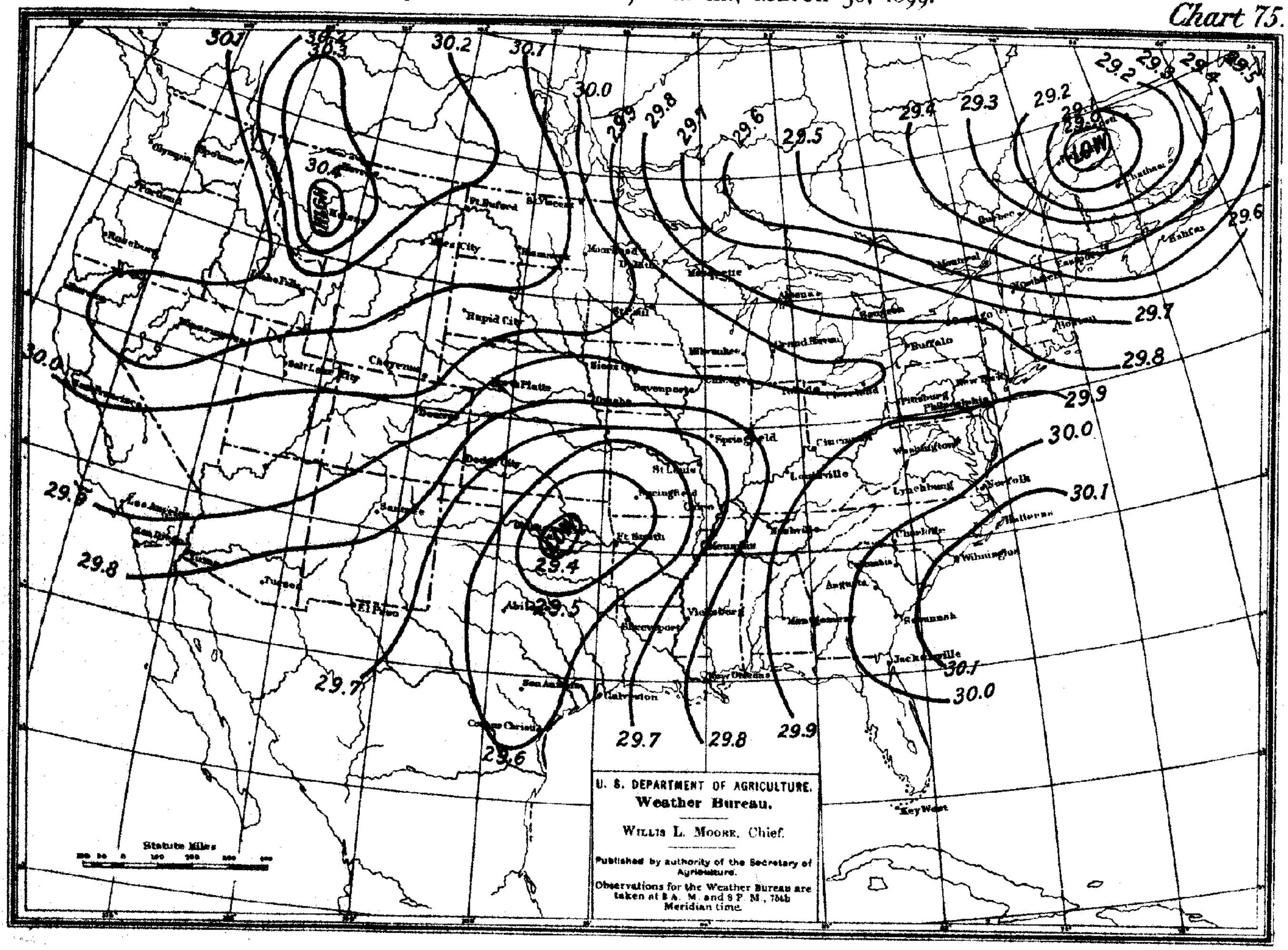
Station	Vertical distance			Mar. 30, 1899, 8 a. m.		Mean		Gradients		Corrections			Reduced pressure			Corrections			Reduced temperature		
	To the sea level	To the 3500	To the 10000	B	t	(t)	$\left(\frac{e}{B}\right)$	$G.B$	$G.t$	ΔB_1	ΔB_2	ΔB_3	B_1	B_2	B_3	Δt_1	Δt_2	Δt_3	t_1	t_2	t_3
San Antonio	704	2796	9296	28.87	63.8	66.2	.0092	.099	.74	+ .70	−2.77	− 9.21	29.57	26.10	19.66	0	−20.7	−68.8	63.8	40.1	− 5.0
Erie	713	2787	9287	29.14	24.0	26.0	.0042	.108	.36	.77	3.01	10.03	29.92	26.13	18.92	0	10.0	33.4	24.0	14.0	− 9.4
Detroit	730	2770	9270	29.10	24.0	24.8	.0031	.108	.48	.79	2.99	10.01	29.89	26.11	19.09	0	18.1	44.5	24.0	5.9	−20.5
Marquette	734	2766	9266	28.92	15.0	18.0	.0024	.111	.40	.82	3.07	10.29	29.74	25.85	18.63	0	11.0	37.0	15.0	4.0	−22.0
Chattanooga	762	2738	9238	29.17	40.0	44.2	.0052	.105	.58	.80	2.88	9.70	29.97	26.29	19.47	0	15.9	53.6	40.0	24.1	−13.6
Cleveland	762	2738	9238	29.09	25.0	27.1	.0035	.107	.44	.81	2.93	9.88	29.90	26.16	19.21	0	12.1	40.7	25.0	12.9	−15.7
Buffalo	767	2733	9233	29.02	23.5	24.1	.0035	.108	.38	.83	2.95	9.97	29.85	26.07	19.05	0	10.4	35.1	23.5	13.1	−21.6
Charlotte	773	2727	9227	29.21	39.0	41.8	.0050	.106	.55	.82	2.89	9.78	30.03	26.32	19.43	0	15.0	50.8	39.0	24.0	−11.8
Indianapolis	822	2678	9178	28.94	35.3	38.7	.0059	.106	.46	.87	2.84	9.72	29.81	26.10	19.21	0	12.3	42.2	35.3	23.0	−16.9
Chicago	823	2677	9177	29.00	23.0	27.2	.0037	.108	.43	.89	2.89	9.91	29.89	26.11	19.09	0	11.5	39.5	23.0	17.5	−16.5
Columbus	824	2676	9176	29.00	36.5	37.6	.0061	.106	.42	.87	2.84	9.73	29.87	26.16	19.27	0	11.2	38.6	36.5	25.3	−12.1
St. Paul	837	2663	9163	29.02	8.1	15.6	.0019	.111	.44	.93	2.95	10.17	29.95	26.07	18.85	0	11.7	40.3	8.1	− 3.6	−32.2
Pittsburg	841	2659	9159	29.00	32.0	33.2	.0057	.106	.37	.89	2.82	9.71	29.89	26.18	19.29	0	9.8	33.9	32.0	22.2	− 1.9
Des Moines	861	2639	9139	28.91	22.2	26.1	.0033	.107	.44	.92	2.82	9.78	29.83	26.09	19.13	0	11.6	40.2	22.2	10.6	−18.0
Northfield	876	2624	9124	28.66	25.0	24.7	.0038	.108	.37	.95	2.83	9.85	29.61	25.83	18.81	0	9.7	33.7	25.0	15.3	− 8.7
Moorhead	935	2565	9065	29.00	− 4.0	6.0	.0016	.115	.34	1.08	2.96	10.43	30.08	26.04	18.57	0	8.7	30.8	− 4.0	−12.7	−34.8
Kansas City	963	2537	9037	28.53	29.4	36.5	.0056	.106	.42	1.02	2.69	9.58	29.55	25.84	18.95	0	10.7	38.0	29.4	18.7	− 8.6
Knoxville	1004	2496	8996	28.91	37.1	40.0	.0056	.106	.49	1.06	2.65	9.54	29.97	26.26	19.37	0	12.2	44.1	37.1	24.9	−20.0
Walla Walla	1018	2482	8982	28.96	38.0	47.8	.0088	.104	.44	1.06	2.58	9.34	30.02	26.38	19.62	0	10.9	39.5	38.0	27.1	− 1.5
Omaha	1103	2397	8897	28.63	20.0	22.8	.0036	.109	.36	1.20	2.62	9.70	29.83	26.01	18.93	0	8.6	32.0	20.0	11.4	−12.0
Phenix	1109	2391	8891	28.66	46.9	55.7	.0051	.103	.71	1.14	2.46	9.16	29.80	26.20	19.50	0	17.0	63.1	26.9	9.9	−36.2
Atlanta	1114	2386	8886	28.80	39.5	43.4	.0044	.105	.62	1.17	2.51	9.33	29.97	26.29	19.47	0	14.8	55.1	39.5	24.7	−15.6
Kamloops	1193	2307	8807	28.81	26.9	34.4	.0055	.106	.40	1.26	2.45	9.34	30.07	26.36	19.47	0	9.2	35.2	26.9	17.7	− 8.2
Oklahoma	1214	2286	8786	28.16	44.5	54.4	.0070	.103	.64	1.25	2.36	9.05	29.41	25.80	19.11	0	14.7	56.3	44.5	29.8	−11.8
White River	1252	2248	8748	28.18	16.2	19.6	.0035	.110	.32	1.37	2.47	9.62	29.55	25.71	18.56	0	7.2	28.0	16.2	9.0	−11.8
Huron	1306	2194	8694	28.57	3.2	11.0	.0020	.113	.35	1.48	2.47	9.82	30.05	26.10	18.75	0	7.7	30.4	3.2	− 4.5	−26.2
Springfield, Mo.	1324	2176	8676	28.09	44.2	47.4	.0079	.105	.46	1.39	2.29	9.11	29.48	25.80	18.98	0	10.1	39.9	44.2	34.1	+ 4.3
Wichita	1351	2149	8649	28.07	34.0	45.5	.0051	.105	.62	1.42	2.26	9.08	29.49	25.81	18.99	0	7.1	53.6	34.0	26.9	−19.6
Concordia	1398	2102	8602	28.20	21.0	29.0	.0046	.107	.41	1.50	2.25	9.20	29.70	25.95	19.00	0	9.0	35.2	21.0	12.0	−14.2
Prince Albert	1432	2068	8568	28.54	−13.0	2.6	.0013	.116	.39	1.66	2.40	9.94	30.20	26.14	18.60	0	8.1	33.4	−13.0	−21.1	−46.4
Battleford	1620	1880	8380	28.40	2.0	10.5	.0023	.114	.49	1.85	2.14	9.55	30.25	26.26	18.85	0	9.2	41.1	2.0	− 7.2	−39.1
Bismarck	1674	1826	8326	28.27	1.0	8.0	.0015	.114	.39	1.90	2.09	9.50	30.16	26.18	18.77	0	7.1	32.5	1.0	− 6.1	−31.5
Minnedosa	1690	1810	8310	28.20	1.7	9.0	.0017	.114	.36	1.93	2.06	9.47	30.13	26.14	25.73	0	6.5	29.9	1.7	− 4.8	−28.2
Abilene	1738	1762	8262	27.81	53.0	63.0	.0118	.102	.55	1.77	1.80	9.45	29.58	26.01	18.36	0	9.7	45.4	53.0	43.3	+ 7.6
Williston	1875	1625	8125	28.08	3.0	8.0	.0017	.114	.35	2.14	1.86	9.27	30.22	26.22	18.81	0	5.7	28.5	3.0	− 2.7	−25.5
Spokane	1943	1557	8057	27.98	29.5	40.0	.0030	.105	.69	2.04	1.64	8.46	30.02	26.34	19.52	0	10.8	55.8	29.5	18.7	−26.3

TABLE 154.—*Reduction of the pressure and temperature to sea level, 3,500-foot level, and 10,000-foot level*—Continued.

MARCH 30, 8 A. M., 1899—Continued.

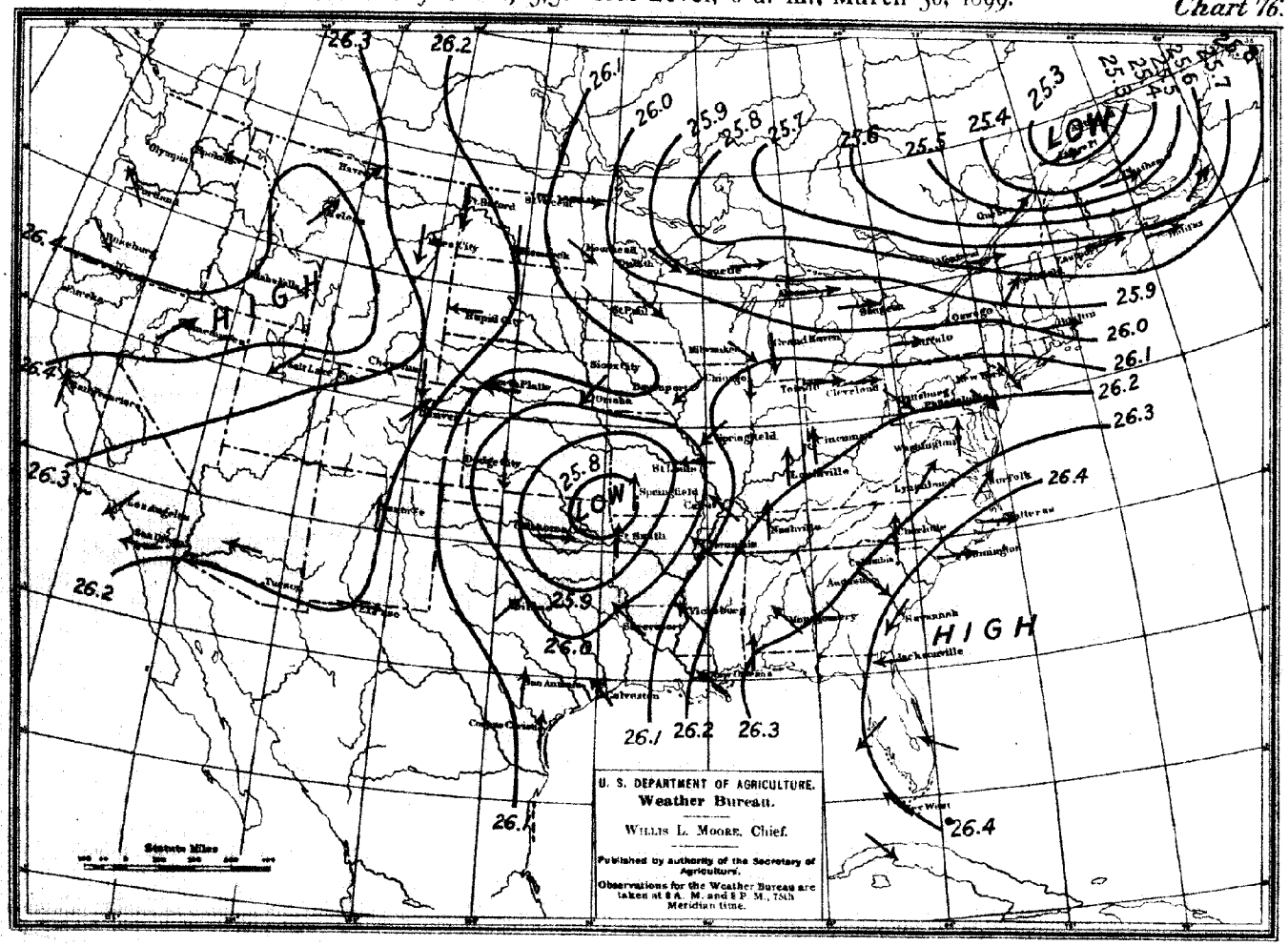
Station	Vertical distance			Mar. 30, 1899, 8 a. m.		Mean		Gradients		Corrections			Reduced pressure			Corrections			Reduced temperature		
	To the sea level	To the 3500	To the 10000	B	t	(t)	$\left(\frac{e}{B}\right)$	$G.B$	$G.t$	ΔB_1	ΔB_2	ΔB_3	B_1	B_2	B_3	Δt_1	Δt_2	Δt_3	t_1	t_2	t_3
Qu'Appelle	2115	1385	7885	27.77	− 3.9	4.0	.0017	.116	.30	2.46	1.61	9.15	30.23	26.16	18.62	0	4.1	23.6	− 3.9	− 8.0	−27.5
Edmonton	2158	1342	7842	27.80	6.0	13.5	.0025	.113	.33	2.44	1.51	8.86	30.24	26.29	18.94	0	4.4	29.2	6.0	1.6	−23.2
Medicine Hat	2168	1332	7832	27.81	4.7	10.5	.0021	.113	.32	2.45	1.50	8.85	30.26	26.31	18.96	0	4.3	25.1	4.7	0.4	−20.4
Mt. Tamalpais	2371	1129	7629	27.51	44.5	43.5	.0077	.105	.43	2.49	1.19	8.01	30.00	26.32	19.50	0	4.9	32.8	44.5	39.6	+11.7
Miles City	2372	1128	7628	27.52	10.1	18.6	.0032	.111	.32	2.63	1.25	8.47	30.15	26.27	19.05	0	3.6	24.4	10.1	6.5	−14.3
Swift Current	2440	1060	7560	27.48	3.3	8.2	.0013	.114	.43	2.78	1.21	8.62	30.26	26.27	18.86	0	4.6	32.5	3.3	− 1.3	−29.2
Havre	2505	995	7495	27.46	6.8	10.6	.0024	.113	.29	2.84	1.12	8.47	30.30	26.34	18.99	0	2.9	21.7	6.8	3.9	−14.9
Dodge City	2511	989	7489	27.00	25.0	37.5	.0055	.106	.46	2.66	1.05	7.94	29.66	25.95	19.06	0	4.5	34.4	25.0	20.5	− 9.4
Boise City	2739	761	7261	27.08	33.8	40.9	.0057	.106	.51	2.90	0.81	7.70	29.98	26.27	19.38	0	3.9	37.0	33.8	29.9	− 3.2
North Platte	2821	679	7179	26.81	18.0	24.0	.0038	.108	.35	3.05	.73	7.75	29.86	26.08	19.06	0	2.4	25.1	18.0	15.6	− 7.1
Rapid City	3234	266	6766	26.44	9.0	16.4	.0028	.111	.33	3.59	.30	7.51	30.03	26.14	18.93	0	0.9	22.3	9.0	8.1	−13.3
Calgary	3389	111	6611	26.48	− 4.7	5.8	.0012	.115	.32	3.90	.12	7.60	30.38	26.36	18.88	0	0.4	21.2	− 4.7	− 5.1	−25.9
Baker City	3471	29	6529	26.35	33.2	39.2	.0057	.106	.47	3.68	−.03	6.92	30.03	26.32	19.43	0	−0.1	30.7	33.2	33.1	+ 2.5
Amarillo	3676	− 176	6324	25.85	30.0	49.0	.0039	.104	.75	3.83	+ .18	6.57	29.68	26.03	19.28	0	0	47.4	30.0	30.0	−17.4
Elpaso	3762	− 262	6238	25.92	42.0	56.9	.0037	.102	.87	3.84	.27	6.36	29.76	26.19	19.56	0	0	54.3	42.0	42.0	−12.3
Independence	3910	− 410	6090	25.86	41.0	45.1	.0035	.105	.71	4.11	.43	6.39	29.97	26.29	19.47	0	0	43.2	41.0	41.0	− 2.2
Helena	4120	− 620	5880	25.88	5.0	7.1	.0018	.114	.46	4.70	.71	6.70	30.58	26.59	19.18	0	0	27.0	5.0	5.0	−22.0
Winnemucca	4341	− 841	5659	25.56	28.9	35.2	.0062	.106	.37	4.60	.89	6.00	30.16	26.45	19.56	0	0	26.9	28.9	28.9	+ 8.0
Salt Lake City	4366	− 866	5634	25.42	35.3	38.4	.0069	.106	.38	4.63	.92	5.97	30.05	26.34	19.45	0	0	21.4	35.3	35.3	+13.9
Grand Junction	4608	−1108	5392	25.08	33.8	38.4	.0068	.106	.39	4.89	1.18	5.71	29.97	26.26	19.37	0	0	21.0	33.8	33.8	+12.8
Pueblo	4682	−1182	5318	24.89	31.3	36.4	.0069	.106	.35	4.96	1.25	5.64	29.85	26.14	19.25	0	0	18.6	31.3	31.3	+12.7
Idaho Falls	4741	−1241	5259	25.16	28.5	36.2	.0066	.106	.36	5.02	1.31	5.58	30.18	26.47	19.58	0	0	18.9	28.5	28.5	+ 9.6
Denver	5290	−1790	4710	24.31	23.5	27.0	.0045	.107	.37	5.66	1.92	5.04	29.97	26.23	19.27	0	0	17.4	23.5	23.5	+ 6.1
Lander	5372	−1872	4628	24.41	14.8	27.9	.0039	.107	.43	5.75	2.00	4.95	30.16	26.41	19.46	0	0	19.9	14.8	14.8	− 5.1
Cheyenne	6088	−2588	3912	23.59	22.0	24.8	.0048	.109	.33	6.64	2.82	4.26	30.23	26.41	19.33	0	0	12.9	22.0	22.0	+13.5
Flagstaff	6907	−3407	3093	23.04	12.0	21.0	.0043	.110	.27	7.60	3.75	3.40	30.64	26.79	19.64	0	0	8.3	12.0	12.0	+ 3.7
Santa Fe	7013	−3513	2987	22.89	28.7	35.2	.0045	.106	.49	+7.43	+3.72	−3.17	30.32	26.61	19.72	0	0	−14.7	28.7	28.7	+14.0

Auxiliary Chart, Sea Level, 8 a. m., March 30, 1899. *Chart 75.*



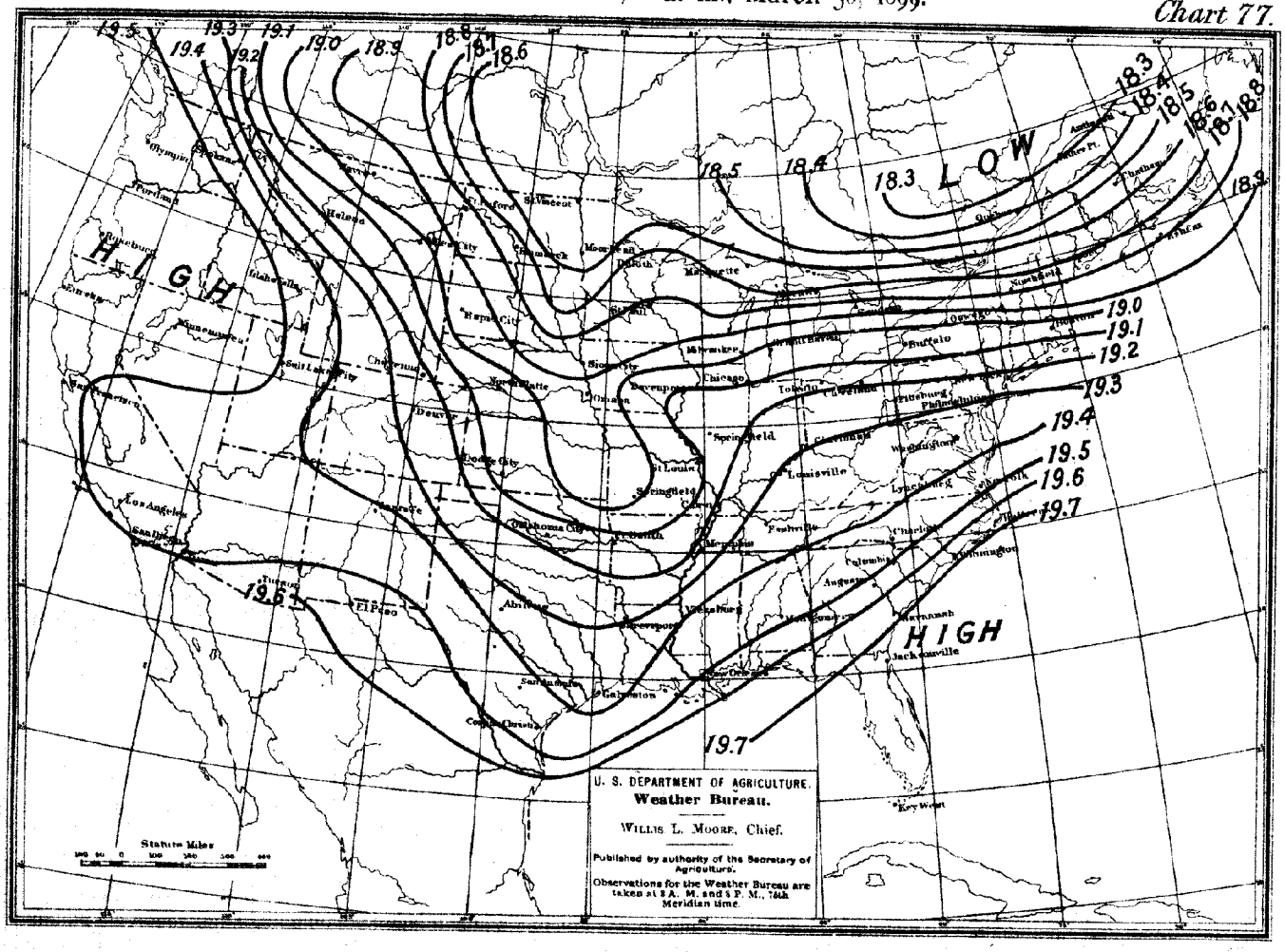
Auxiliary Chart, 3,500-foot Level, 8 a. m., March 30, 1899.

Chart 76.



Auxiliary Chart, 10,000-foot Level, 8 a. m., March 30, 1899.

Chart 77.



The distortion of the map on the 3,500-foot level will be a minimum on the plateau, and since the reductions from the surface to that level in the eastern districts is very safe by the use of this gradient system and it follows that the 3,500-foot level map should represent the actual air conditions quite accurately in all the districts. Without further preliminary considerations the three maps thus computed for March 30, 8 a. m., 1899, will be presented.

The factors of transformation for the pressure gradients which express the change in the millimeters per 100 meters in the metric system to that in inches per 100 feet are obtained as follows: 1 meter=3.2808 feet, 1 millimeter=.03937 inch; hence $\frac{.03937}{3.2808}=.012$. Multiplying each $G \cdot B$ and $G \cdot e$ of Table 147 by .012, the result gives the corresponding parts of the English gradient, Table 153. The factor for transforming the metric temperature gradients to the English value is found as follows: $\frac{dt}{dh}$ (English)=.0054146; $\frac{dt}{dh}$ (metric)=.009869; $\frac{.0054146}{.009869}=0.5486$. By the use of these factors the temperature gradients of Table 147 are transformed at once into those of Table 153 for the English gradients.

THE REDUCTION TO SEA LEVEL, TO 3,500-FOOT LEVEL, AND 10,000-FOOT LEVEL.

In reducing for auxiliary daily weather maps only $G \cdot B$, $G \cdot t$, $G \cdot e$ gradients in Sections I, II, III for the α stage will be needed, and in the charts herewith shown the temperature and the vapor tension is omitted. The example is taken from March 30, 8 a. m., 1899, which shows a cyclonic formation in the central valleys, one anticyclonic area over the South Atlantic States, and another on the northern Rocky Mountain plateau. Table 154 presents the data for the construction of the charts 75, 76, and 77, at the sea level, at 3,500-foot level, and at 10,000-foot level, respectively. The first column contains the station name, the section "Vertical distances," the difference in elevation between the station and the three planes respectively; the section, "March 30, 1899, 8 a. m.," the barometric pressure and temperature of the observation; the section mean (t) $\left(\frac{e}{B}\right)$ the mean temperature of the 8 p. m., March 29, and 8 a. m., March 30, observations, and $\left(\frac{e}{B}\right)$ the mean of the $\frac{e}{B}$ ratios for the same two epochs; $G \cdot B$ and $G \cdot t$ the pressure and temperature gradients from Table 153, Sections I, II; the corrections found by multiplying these gradients into the vertical heights given in the first section; B_1, B_2, B_3, and t_1, t_2, t_3 the reduced pressures and temperatures on the three planes. These pressure values are then transferred to Charts 75, 76, and 77, and lines are drawn for the isobars.

REMARKS ON THE THREE CHARTS.

It may be said that these isobars indicate that the barometric reduction derived from the gradients is satisfactory and harmonious, except for a few mountain stations—Helena, Boise, Cheyenne, Flagstaff, and Santa Fe. In all these cases the reductions need to have a somewhat smaller gradient than the direct arguments in entering the tables produce, and this implies a higher temperature. But such a discrepancy is by no means surprising, in view of the mode employed in constructing the gradients for pressure in the α stage, and for what they were intended. They were computed at the low-level station, Washington, D. C., and were meant to reduce upward into the free air, starting with the surface elements $B \cdot t \cdot e$. The plateau reduction presents a much more complicated problem, however, and it is quite remarkable that these gradients applied to that reduction should be as serviceable as is shown to be the case on these three charts. On the plateau the surface temperatures under the action of insolation and radiation in that relatively dry region undergo wide oscillations, and they do not agree with such temperatures as exist in the free air at the same elevations over the eastern districts. For the few mountain stations mentioned which show a discrepancy in the reduction the results indicates that a higher temperature by several degrees would be proper, and in fact it is always in connection with low temperatures that this divergence occurs on that date. The functional relations between the surface temperature and the true temperature will be discussed fully in the report on

barometry now in preparation, as already stated, and we shall then hope to reach a solution of this problem. As our purpose in this connection is simply to show the utility of the gradients of Table 153 for making auxiliary maps at 3,500-foot level and 10,000-foot level, we lay no special stress upon the imperfections occurring at individual stations on the plateau, because such exceptions can be remedied by further experience.

An inspection of the three Charts 75, 76, 77, for March 30, 1899, 8 a. m., is not only interesting but instructive. On the sea level, Chart 75, which conforms closely to the one published by the Weather Bureau for that date, we see that a cyclonic area occupies the Gulf of St. Lawrence and extends westward to the Lake region; a second cyclone is central in the West Gulf States and on the southern Rocky Mountain slope; an area of high pressure covers the South Atlantic States; a second area of high pressure is central over the northern Rocky Mountain plateau. The reduction to the 3,500-foot level, Chart 76, where the distortion in the Rocky Mountain region is at a minimum, is similar to the sea-level chart, except on the Rocky Mountain plateau, where the high-pressure center which was over the northern districts in Chart 75 is destroyed and transferred to the central districts and the Pacific States. The information given on the sea-level chart is that the action of the high operates from the west Canadian Provinces, but on the 3,500-level chart that it is coming in from the Pacific Ocean. Turning to the 10,000 level, Chart 77, we see that a very different configuration is developed, consisting of a decided low-pressure belt along the Lake region and the St. Lawrence Valley, with an increasing pressure to the southward throughout the entire region. The cyclone of the southern slope has disappeared, so far as circular isobars are concerned, and there remains merely a looping of the isobars southward over that region, while the high areas as centers of action have been transformed into a high-pressure belt. If we suppose that at this elevation the air currents are generally parallel to the isobars, then there must be a stream from the northwest over the eastern mountain districts, recurving in the lower Missouri and Mississippi valleys and continuing its movement toward the northeastward. The cyclone is developed just at the bend in this continental circulation and it is formed in the lowest strata as a whirl, but in the upper strata as a loop in the general circulation. This is in harmony with the theory advanced in the preceding chapters, which shows that cyclones are only by-products of the general circulation in the lower strata, and that they practically disappear as separate gyrations within 2 miles of the ground. At any rate, enough has been shown to indicate the desirability of furnishing the forecaster with auxiliary charts at the 3,500-foot level and the 10,000-foot level, as well as at sea level, and that was the only purpose of this chapter. Such charts are constructed by simply multiplying the gradient into the vertical distance for the reduction; the gradient is found on entering Table 153 with the arguments $(t)\left(\frac{e}{B}\right)$, where (t) is the mean surface temperature for the current and preceding 8 o'clock observation, and $\left(\frac{e}{B}\right)$ the mean of the ratios for the same times. These quantities are at once obtained for the several stations in the course of the regular observations, the reduction computation is very short and it can be readily arranged for the different observers to telegraph the additional barometer temperature words to the central office at least once daily. Special station tables will also be prepared which will make the complete reduction to the three selected levels simple and accurate, and they will be included in the report on barometry.

THE TEMPERATURE REDUCTIONS.

The temperature reductions are less satisfactory, and nothing more will be done with them in this connection. There is no difficulty in reducing the temperatures to the three planes for the low-level eastern districts, but the problem is especially unsatisfactory on the plateau. The practice of the Weather Bureau has been to make no reduction of the temperatures to the sea level, but to adopt the surface readings, no matter what may have been the elevation of the stations, as if they had been observed at the sea level. Now, if these surface temperatures should be reduced by a gradient corresponding to the elevation, as through a free-air column, they would be excessively large at sea level for the high stations. If they are transported as observed to the sea level and then diminished for the elevation, as in the eastern districts, they become much less

than were actually observed at the stations themselves. If they are assumed as identical for the actual station level and for the sea level we have a large air column between them with no gradient, which may or may not be true. In Table 154 this latter supposition was adopted by making the correction zero throughout all the vertical land-area dimensions—that is, by assuming that the plateau has the surface temperature from the sea level to its upper contour. The result shown in the final values of $t_1 . t_2 . t_3 .$ is not very good, and this question must also be retained for future study. The probability is that the plateau problem must be solved in an empirical manner, at least to some extent, but it is believed that such a method can be made much more scientific and satisfactory than in the rough empiricism heretofore employed.

CHAPTER 14.

THE AMOUNT OF HEAT THAT WOULD CONVERT AN ADIABATIC ATMOSPHERE INTO THE CONDITIONS ACTUALLY EXISTING.

GENERAL REMARKS.

A complete discussion of the physical conditions under which clouds form in the free air can be made only after the pressure, temperature, and vapor gradients have been determined. The heights at which the several cloud forms occur having been worked out, it now becomes necessary to discuss the physical conditions prevailing at these altitudes in order to state definitely what significance the occurrence of a given cloud form should suggest beyond its mere shape and motion relative to the surface of the earth. That these cloud forms are the resultants of delicately adjusted forces producing cloudy condensations is to be assumed, and hence they contain much information in themselves which has not been accessible to meteorologists for the lack of clear information regarding these physical features. The difficulties attending the solution of such problems are very considerable, arising chiefly from the infrequent observations which it has been possible to secure at the actual altitudes of the clouds themselves. In recent years, however, there has been a slow accumulation of such observations by means of meteorological apparatus carried up in balloons or kites, so that it is already possible to make some beginning in this class of investigations. It is one of the purposes of this chapter to show how these direct observations can be efficiently supplemented by computations based upon the observations of the height of clouds by theodolites, and also the value of the thermodynamic equations when adapted to such discussions. At present it is expected that only a beginning can be made in this direction, but even so, it will be desirable to establish a method which can be further employed for these purposes.

The observations on pressure, temperature, vapor tension, and height made by kites must generally be confined to the lower strata of the atmosphere 1 or 2 miles high; that is, up to the region of the cumulus clouds. In the lowest mile stratum these observations can be made sufficiently numerous to determine the character of the gradients in all possible conditions with great accuracy; in the second mile stratum the kite observations will no doubt add some data to the sources of computation. Above this level meteorology must depend entirely upon balloon ascensions, and since it has been shown to be practicable to send up unmanned balloons to the height of 10 miles, it is evident that only the expense of the undertaking and some uncertainties attaching to self-recording instruments, when placed at such extreme conditions of pressure, temperature, and humidity as prevail at that elevation, postpone the complete survey of the vertical gradient variations. The permanent mountain observations also are contributing important data for discussion, and yet their attachment to the surface conditions on the mountain peaks gives a less perfect kind of data than do the observations taken in the free air. The gradual improvement which is to be noted in instrumental efficiency is very likely to increase the number of reliable readings to be obtained from both balloons and solitary mountain peaks where it is not possible for an observer to watch the working of the instruments. Hence, as time goes on, meteorologists of another generation will be able to solve accurately the very questions which we can hardly do more than suggest in our day.

THE BALLOON OBSERVATIONS.

We begin by collecting together the available data from balloon ascensions already made in Europe and the United States. These ascensions have been conducted by GLAISHER in England, under the auspices of the British Association for the Advancement of Science, by the Continental æronautical societies, and by a few private individuals in America. A list of such ascensions as were used in compiling the material for discussion is given in Table 155, and it contains the refer-

TABLE 155—*References to the balloon ascensions contributing to the data used in the discussion of vertical temperature gradients.*

Month	Date	Hours	Place	Pressure	Reference
January	1891. Jan. 30	A. M.	Berlin	High	Zeit. f. Luft. 1891. 16
	1894. Jan. 12	A. M.	Berlin	Low	Zeit. f. Luft. 1894. 16
	1864. Jan. 12	P. M.	Woolwich	Low	Rep. B. A. A. S. 1864. 220
	1885. Jan. 19	P. M.	Philadelphia	High	Am. Met. Journ. VII. 525
	1888. Jan. 21	P. M.	Berlin	Low	Zeit. f. Luft. 1888. 67
February	1891. Feb. 24	A. M.	Berlin	High	Zeit. f. Luft. 1891. 88
	1894. Feb. 17	A. M.	Berlin	High	Zeit. f. Luft. 1894. 97
	1894. Feb. 28	A. M.	Berlin	High	Zeit. f. Luft. 1894. 279
	1895. Feb. 15	A. M.	Berlin	High	Zeit. f. Luft. 1895. 90
March	1891. Mar. 13	A. M.	Berlin	High	Zeit. f. Luft. 1895. 90
	1893. Mar. 1	A. M.	Berlin	High	Zeit. f. Luft. 1894. 315
	1893. Mar. 14	A. M.	Berlin	High	Zeit. f. Luft. 1895. 194
	1893. Mar. 28	A. M.	Berlin	High	Zeit. f. Luft. 1894. 26
	1894. Mar. 16	A. M.	Berlin	Low	Zeit. f. Luft. 1894. 214
	1896. Mar. 22	A. M.	Paris	Low	Zeit. f. Luft. 1896. 157
	1863. Mar. 31	P. M.	Crystal Palace	High	Rep. B. A. A. S. 1863. 434
	1885. Mar. 13	P. M.	Philadelphia	Low	Am. Met. Journ. VII. 525
	1885. Mar. 27	P. M.	Philadelphia	High	Am. Met. Journ. VII. 525
	1892. Mar. 8	P. M.	Berlin	Low	Zeit. f. Luft. 1892. 139
	1893. Mar. 21	P. M.	Paris	High	Zeit. f. Luft. 1894. 108
April	1893. Apr. 7	A. M.	Berlin	High	Zeit. f. Luft. 1894. 26
	1893. Apr. 19	A. M.	Berlin	High	Zeit. f. Luft. 1894. 26
	1893. Apr. 26	A. M.	Berlin	High	Zeit. f. Luft. 1894. 26
	1894. Apr. 26	A. M.	Berlin	High	Zeit. f. Luft. 1894. 247
	1863. Apr. 18	P. M.	Crystal Palace	Low	Rep. B. A. A. S. 1863. 440
	1864. Apr. 6	P. M.	Woolwich	Low	Rep. B. A. A. S. 1864. 228
	1885. Apr. 16	P. M.	Philadelphia	High	Am. Met. Journ. VII. 525
	1894. Apr. 11	P. M.	Berlin	High	Zeit. f. Luft. 1894. 247
May	1894. May 11	A. M.	Berlin	High	Zeit. f. Luft. 1894. 199
	1894. May 18	A. M.	Berlin	Low	Zeit. f. Luft. 1894. 247
June	1886. June 25	A. M.	Providence	Low	Am. Met. Journ. 1891. 292
	1887. June 29	A. M.	Berlin	Low	Zeit. f. Luft. 1887. 228
	1889. June 19	A. M.	Berlin	Low	Zeit. f. Luft. 1889. 258
	1894. June 9	A. M.	Berlin	Low	Zeit. f. Luft. 1895. 90
	1894. June 30	A. M.	Berlin	Low	Zeit. f. Luft. 1894. 270
	1836. June 26	P. M.	Wolverton	Low	Rep. B. A. A. S. 1863. 444
	1864. June 13	P. M.	Crystal Palace	High	Rep. B. A. A. S. 1864. 232
	1864. June 20	P. M.	Derby	Low	Rep. B. A. A. S. 1864. 236
	1864. June 27	P. M.	Crystal Palace	High	Rep. B. A. A. S. 1864. 242
	1887. June 17	P. M.	St. Louis	Low	Am. Met. Journ. 1891. 295
July	1862. July 17	A. M.	Wolverhampton	Low	Rep. B. A. A. S. 1862. 388
	1889. July 10	A. M.	Munich	Low	Zeit. f. Luft. 1891. 21
	1892. July 11	A. M.	Munich	Low	Zeit. f. Luft. 1893. 253
	1893. July 2	A. M.	Munich	High	Zeit. f. Luft. 1893. 193
	1893. July 15	A. M.	Berlin	Low	Zeit. f. Luft. 1894. 29
	1893. July 25	A. M.	Berlin	Low	Zeit. f. Luft. 1894. 29
	1894. July 7	A. M.	Berlin	High	Zeit. f. Luft. 1894. 171
	1894. July 6	A. M.	Berlin	High	Zeit. f. Luft. 1895. 90
	1863. July 11	P. M.	Crystal Palace	Low	Rep. B. A. A. S. 1863. 452
	1863. July 21	P. M.	Crystal Palace	Low	Rep. B. A. A. S. 1863. 466
	1889. July 14	P. M.	Paris	Low	Zeit. f. Luft. 1889. 216

TABLE 155—*References to the balloon ascensions contributing to the data used in the discussion of vertical temperature gradients*—Continued.

Month	Date	Hours	Place	Pressure	Reference
July	1862. July 30	P. M.	Crystal Palace	High	Rep. B. A. A. S. 1862. 390
	1893. July 2	P. M.	Munich	High	Zeit. f. Luft. 1894. 135
	1893. July 15	P. M.	Stockholm	Low	Zeit. f. Luft. 1895. 29
August	1862. Aug. 21	A. M.	Hendon	Low	Rep. B. A. A. S. 1862. 408
	1887. Aug. 13	A. M.	Paris	Low	Zeit. f. Luft. 1887. 273
	1891. Aug. 3	A. M.	Berlin	High	Zeit. f. Luft. 1891. 220
	1893. Aug. 9	A. M.	Stockholm	High	Zeit. f. Luft. 1895. 109
	1893. Aug. 18	A. M.	Berlin	High	Zeit. f. Luft. 1894. 29
	1894. Aug. 4	A. M.	Berlin	Low	Zeit. f. Luft. 1895. 90
	1894. Aug. 9	A. M.	Berlin	Low	Zeit. f. Luft. 1895. 90
	1862. Aug. 18	P. M.	Wolverhampton	High	Rep. B. A. A. S. 1862. 394
	1862. Aug. 20	P. M.	Crystal Palace	Low	Rep. B. A. A. S. 1862. 402
	1863. Aug. 31	P. M.	Newcastle	Low	Rep. B. A. A. S. 1864. 200
	1864. Aug. 29	P. M.	Crystal Palace	High	Rep. B. A. A. S. 1864. 250
	1887. Aug. 13	P. M.	Philadelphia	High	Am. Met. Journ. 1891. 298
	1894. Aug. 4	P. M.	St. Petersburg	Low	Zeit. f. Luft. 1895. 21
	1894. Aug. 9	P. M.	St. Petersburg	Low	Zeit. f. Luft. 1895. 21
September	1863. Sept. 29	A. M.	Wolverhampton	Low	Rep. B. A. A. S. 1864. 204
	1890. Sept. 18	A. M.	St. Petersburg	High	Zeit. f. Luft. 1891. 85
	1892. Sept. 15	A. M.	Vienna	High	Zeit. f. Luft. 1892. 288
	1893. Sept. 1	A. M.	Berlin	High	Zeit. f. Luft. 1894. 29
	1893. Sept. 29	A. M.	Berlin	High	Zeit. f. Luft. 1894. 29
	1894. Sept. 6	A. M.	Berlin	Low	Zeit. f. Luft. 1895. 90
	1894. Sept. 6	A. M.	Berlin	High	Zeit. f. Luft. 1895. 90
	1894. Sept. 6	A. M.	Berlin	High	Zeit. f. Luft. 1895. 90.
	1862. Sept. 1	P. M.	Crystal Palace	Low	Rep. B. A. A. S. 1862. 414
	1862. Sept. 5	P. M.	Wolverhampton	Low	Rep. B. A. A. S. 1862. 418
	1862. Sept. 8	P. M.	Crystal Palace	Low	Rep. B. A. A. S. 1862. 424
October	1891. Oct. 24	A. M.	Berlin	High	Zeit. f. Luft. 1895. 90.
	1893. Oct. 19	A. M.	Berlin	High	Zeit. f. Luft. 1894. 29
	1894. Oct. 5	A. M.	Berlin	Low	Zeit. f. Luft. 1895. 129
	1894. Oct. 12	A. M.	Berlin	High	Zeit. f. Luft. 1895. 90
	1894. Oct. 19	A. M.	Berlin	Low	Zeit. f. Luft. 1895. 90
	1863. Oct. 9	P. M.	Crystal Palace	High	Rep. B. A. A. S. 1864. 214
	1894. Oct. 1	P. M.	St. Petersburg	High	Zeit. f. Luft. 1895. 21
November	1891. Nov. 27	A. M.	Berlin	High	Zeit. f. Luft. 1895. 90
	1893. Nov. 10	A. M.	Berlin	High	Zeit. f. Luft. 1895. 90
	1896. Nov. 14	A. M.	Paris	High	Zeit. f. Luft. 1897. 44
	1896. Nov. 14	A. M.	Strassburg	High	Zeit. f. Luft. 1897. 44
	1896. Nov. 14	A. M.	Berlin	High	Zeit. f. Luft. 1897. 44
	1896. Nov. 14	A. M.	St. Petersburg	High	Zeit. f. Luft. 1897. 44
	1896. Nov. 14	A. M.	Berlin	High	Zeit. f. Luft. 1897. 46
	1896. Nov. 14	A. M.	St. Petersburg	High	Zeit. f. Luft. 1897. 46
	1896. Nov. 14	A. M.	Warsaw	High	Zeit. f. Luft. 1897. 46
	1896. Nov. 14	A. M.	Munich	High	Zeit. f. Luft. 1897. 46
December	1890. Dec. 11	A. M.	Munich	High	Zeit. f. Luft. 1892. 159
	1893. Dec. 15	A. M.	Berlin	Low	Zeit. f. Luft. 1895. 90
	1894. Dec. 4	A. M.	Berlin	High	Zeit. f. Luft. 1894. 311
	1894. Dec. 4	A. M.	Berlin	Low	Zeit. f. Luft. 1895. 90
	1893. Dec. 2	P. M.	Berlin	High	Zeit. f. Luft. 1895. 90
	1893. Dec. 7	P. M.	Vienna	High	Zeit. f. Luft. 1894. 128

ences by which the data used can be identified. In some cases several references might have been made to the same ascension, as the results are alluded to in different publications. After giving the month and the date, in the third column it is stated that the ascension took place during the morning hours, that is between midnight and noon, or during the afternoon hours, from noon to midnight; in the fifth column it is indicated that the ascension occurred during the prevalence of a high or low pressure area at the surface of the ground, under high areas being included generally clear weather, and under low areas the cloudy weather. Hence, high pressure and clear weather, for the afternoon, and also for the afternoon hours, respectively, make up material for one system of charts, while low pressure and cloudy weather for the same hours, respectively, make up the second type of charts. In some cases it was difficult to classify an ascension, but the table gives the decision reached regarding each ascent.

The data was worked up as follows: In extracting the results from the several reports the temperatures were always interpolated for assigned heights, as ground, 200, 400, 600, 800, 1,000, 1,500, 2,000, 2,500, 3,000 meters, and at each succeeding 1,000-meter level up to 16,000 meters. Where the reported temperatures at given heights other than those assigned could be thus reduced to certain elevations, it was done for the sake of carrying forward the discussion in compact form. The time of beginning of the ascent and that of the maximum flight was noted; also the time of landing, the temperature data being extracted for both the upward and the downward directions. I have not attempted to separate the two vertical directions with attendant effects upon lag in temperature readings, but merely suppose that the mean gives more closely the average state of the atmosphere than one directional movement alone would have been able to do. Nor has any effort been made to correct the diurnal variations for the several hours as influencing the vertical gradients. Such refinements were not possible with the data in hand, nor was it very important for the object immediately in view, which is really to discover the aspect of the mean vertical gradients and their variations throughout the year at the higher elevations.

Having interpolated the readings of the thermometer and separated them into the groups A. M. (high and low) and P. M. (high and low), the differences were taken between the readings at the ground and the readings at the several prescribed elevations, giving the actual temperature fall for a certain number of meters. These operations are performed in groups for each month in the year. Then the mean values for each of the four groups in every month were obtained, and these give the values used in constructing the diagrams. Table 156 presents these final means for each of the four divisions of the material. There are many serious gaps in these tables, which it is very desirable to fill up by means of more balloon ascensions, but it is evident that we have enough for treatment by the graphic method to procure very valuable results. In Tables 156 (I, II) it is stated that the change of temperature from the ground to the given elevation is so many degrees. Thus in high areas and the forenoon hours for January the rise was 0°.6 C for 200 meters, 1.2 for 400 meters. Here is a case of inversion of temperature where the strata of the air at moderate heights are warmer than at the surface. It is also evident that it would be possible to discuss the values in the vertical columns by the theory of least squares, but such a computation is too laborious, and the resulting curve could hardly be brought to an analytic expression. Accordingly, only a graphic network of "balanced lines" has been executed. At the upper limits of the observations—about 16,000 meters—the number of readings of temperature is very limited, yet it is quite certain that a temperature fall of approximately 70° C occurs, and accordingly this has been adopted. It seems to harmonize well with the trend of all the gradients which are determined in the strata below 10,000 meters.

TABLE 156 I.—*Total fall of temperature from the surface to the given elevation in high areas and clear weather.*

[Mean monthly values compiled from the ascensions mentioned in Table 155.]

Height in meters		200	400	600	800	1000	1500	2000	2500	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Month	Hour	For the forenoon hours																						
Jan.	10.0 a. m.	+0.6	+1.2	+1.6	+1.2	−0.1	− 2.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Feb.	9.6 a. m.	+2.5	+6.5	+6.5	+6.5	+4.0	+ 2.2	− 4.0	− 6.0	− 9.0	−17.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mar.	10.4 a. m.	−0.6	−1.4	−1.9	−2.7	−3.6	− 5.6	− 7.8	−11.3	−13.9	−19.5	−28.7	−36.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Apr.	9.9 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	−24.5	−33.2	−34.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
May	7.4 a. m.	.....	.....	−5.5	−7.5	−9.5	−11.5	−12.5	.....	.....	−25.5	−33.5	−40.0	−46.0	−50.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
June	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
July	7.3 a. m.	+2.3	+4.3	+2.5	+0.5	−0.5	.....	.....	−16.6	−11.0	−21.8	−20.0	−28.0	−34.0	−38.0	−42.0	−47.0	−54.0	−59.0	−61.0	−63.0	−66.0	−69.0	.....
Aug.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sept.	9.5 a. m.	+1.0	+2.0	+3.3	+1.3	+0.8	+ 0.9	.....	.....	.....	−22.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	−72.0	−77.0
Oct.	9.9 a. m.	.....	.....	.....	.....	.....	.....	− 9.0	−11.0	−13.0	−17.0	.....	−30.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nov.	5.5 a. m.	.....	.....	.....	.....	−2.0	− 2.7	− 3.8	− 3.7	− 5.3	− 9.9	−14.5	−21.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Dec.	10.8 a. m.	.....	.....	.....	+1.5	+2.0	.....	.....	.....	− 5.0	− 7.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
		For the afternoon hours																						
Jan.	5.6 p. m.	.....	.....	.....	−6.5	−6.3	− 5.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Feb.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mar.	3.4 p. m.	−1.7	−3.0	−4.1	−5.4	−6.7	− 8.6	−10.5	−13.4	−16.1	−20.1	−23.8	−27.9	−32.6	.....	−56.0	−57.0	−51.5	−68.0	.....	−65.0	.....	−66.0	.....
Apr.	4.0 p. m.	−2.3	−4.7	−6.8	−8.5	−9.3	−12.0	−15.0	−19.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
May	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June	7.8 p. m.	−1.1	−1.4	−2.2	−3.7	−4.7	− 6.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
July	4.1 p. m.	−0.6	−1.3	−2.9	−4.9	−5.9	− 8.7	−12.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aug.	4.5 p. m.	−0.7	−2.8	−4.5	−5.6	−6.7	− 9.0	−10.0	−11.3	−13.7	−18.5	−19.0	−20.7	−23.4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sept.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Oct.	4.1 p. m.	−1.1	−3.1	−4.8	−6.4	−7.2	−10.1	−12.3	−13.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nov.	3.4 p. m.	−0.8	−1.8	−1.3	−2.2	−1.8	.....	.....	.....	.....	.....	.....	.....	.....	−29.5	.....	.....	.....	.....	.....	.....	.....	.....	.....
Dec.	0.8 p. m.	0.0	−0.3	−0.5	−1.0	−3.0	− 5.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE 156 II.—*Total fall of temperature from the surface to the given elevation in low areas and cloudy weather.*

[Mean monthly values compiled from the ascensions mentioned in Table 155.]

Height in meters		200	400	600	800	1000	1500	2000	2500	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Month	Hour	For the forenoon hours																						
Jan.	9.3 a. m.	+1.0	+2.0	+3.0	+4.0	+2.0	0	−2.0	−6.0	−10.5	−15.0	−21.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Feb.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mar.	9.6 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	−24.9	−28.9	.....	.....	.....	.....	.....	.....	.....	−73.0	.....	.....	.....	.....
Apr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
May	7.6 a. m.	.....	+1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June	8.2 a. m.	−1.5	−2.0	−2.8	−2.7	−4.5	−6.7	−8.9	−10.3	−13.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
July	8.5 a. m.	−0.8	−1.8	−2.9	−3.8	−4.1	−6.9	−10.6	−12.4	−14.8	−16.3	−17.2	−18.1	−21.3	−23.8	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aug.	7.0 a. m.	−1.3	−3.2	−4.7	−6.0	−7.3	−10.7	−12.1	−11.2	−16.8	−20.7	−18.8	−19.8	−21.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sept.	9.0 a. m.	−0.6	−2.0	−3.2	−5.0	−5.8	−10.0	−12.1	−13.7	−17.6	−21.7	−26.9	−36.0	−39.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Oct.	5.3 a. m.	.....	.....	.....	.....	.....	−9.0	−11.0	−13.6	.....	.....	−21.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nov.	2.9 a. m.	−1.5	−1.5	−2.8	−2.8	−2.7	−3.0	−3.2	−3.8	−5.9	−10.8	−21.1	−27.6	−32.3	−29.0	−35.0	−45.0	−52.5	−57.0	−59.0	−61.0	.....	.....	.....
Dec.	9.6 a. m.	.....	.....	.....	+1.0	+1.3	.....	.....	.....	−16.1	.....	−23.0	−30.5	−36.0	−44.0	−54.0	.....	.....	.....	.....	.....	.....	.....	.....
		For the afternoon hours																						
Jan.	1.7 p. m.	−0.7	−1.3	−1.5	−0.5	+0.4	−4.6	−7.9	−9.5	−13.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Feb.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mar.	2.8 p. m.	−1.4	−2.5	−3.2	−2.5	−3.3	−8.0	−11.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Apr.	3.4 p. m.	−1.1	−2.6	−3.3	−4.6	−5.4	−5.6	−6.6	−6.4	−9.9	−22.0	−23.7	−25.7	−27.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
May	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June	4.6 p. m.	−0.5	−1.9	−3.6	−6.1	−7.3	−10.7	−14.2	−16.6	−19.4	−22.4	−21.6	−24.8	−27.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
July	5.4 p. m.	−1.5	−2.8	−3.5	−4.7	−5.2	−8.8	−10.9	−8.7	−12.5	−12.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aug.	4.9 p. m.	−1.5	−3.2	−4.7	−6.4	−8.1	−9.2	−10.6	−12.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sept.	3.3 p. m.	−0.6	−2.3	−3.5	−4.8	−6.4	−8.4	−10.6	−12.2	−14.8	−18.3	−22.5	−23.5	−31.9	−33.7	−35.9	.....	.....	.....	.....	.....	.....	.....	.....
Oct.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nov.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Dec.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

CONSTRUCTION OF CHARTS OF VERTICAL TEMPERATURES.

Charts 78 and 79 are constructed as follows, and they contain the essence of the method employed to fill up the gaps which exist in the observations: First, the 0° temperature for each month, January, February, March, etc., was located at the foot of every second vertical line, and then the point of the mean temperature adopted for each month was plotted on this base. Thus

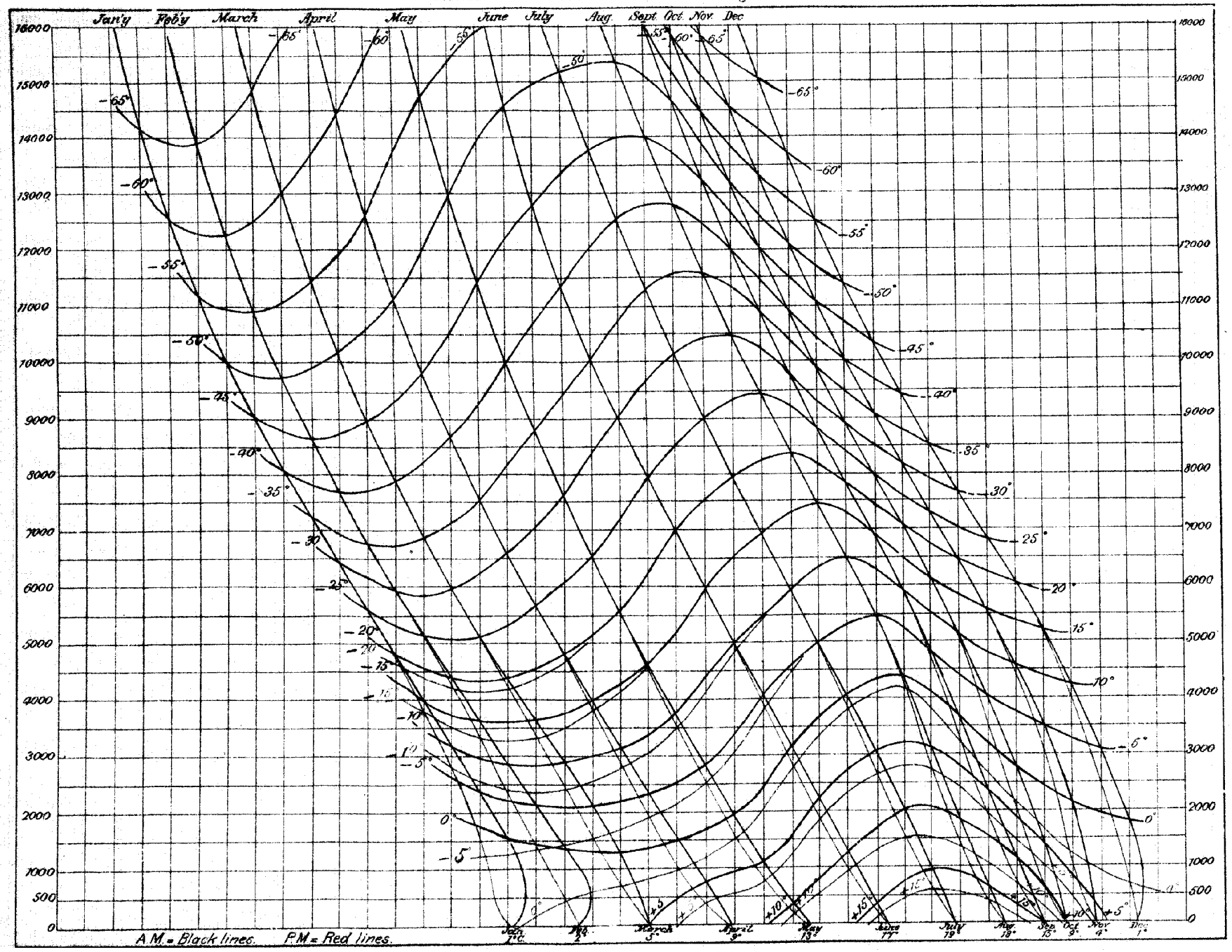
Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1°	2°	5°	9°	13°	17°	19°	18°	15°	9°	4°	1°

is the set of adopted mean monthly temperatures for middle Europe, as given by the stations, Greenwich, Paris, Vienna, Munich, Berlin, from BUCHAN'S data in the Challenger Report. It makes little difference what the actual values of the surface temperatures are if the scale of the normal annual temperatures are preserved. The horizontal scale is 5° for each space, and the vertical scale 500 meters for each space; hence the initial points for each month are plotted as shown on the lowest line. Then from these points the corresponding temperature falls are plotted in at the respective heights, those for January, February, and December showing an inversion, and hence a curve ascending to the right for the morning hours in both the high and the low areas. All the other curves ascend to the left of the initial point. Next, a series of average lines is drawn through these vertical gradients as accurately as possible, but from this rough data much doubt might exist at many places unless another system of lines could be simultaneously constructed. To accomplish this we observe that the vertical curves cross the adopted 0° ordinates at certain points, and by connecting these the 0 isothermal can be drawn from left to right, descending slowly in January, February, and March, then rising till August, after which it falls again till January. In the same way the 5° isothermal can be drawn. Now, continuing the isothermals at 5° intervals from the bottom to the top of the diagram, it is found that they run quite harmoniously by steps, and that in order to construct a balanced system where the lines are distributed in simple gradation it is necessary to move the vertical temperature curves to the right or left at certain places. Hence, by doing this, namely, moving the verticals to the right or the left and the isotherms upward or downward, we constructed, after some labor, the diagrams here presented. It is believed that such a balanced network of lines, which pass gradually from one to another, must be in reality a very close picture of the mean temperature condition of the atmosphere up to 16,000 meters for each month in the year. The original observations by balloons give the scale and trend of the lines in the drawing, while the average gradients and the balance of the two interlocking systems of lines drawn in detail cover the gaps with interpolated lines which are worthy of confidence. In order to test the result, these vertical gradient curves were transferred to a larger scale, and the temperatures from each individual balloon ascension were plotted in their proper places. It can be stated that while there are some discrepancies between the original and the resultant curves there is every evidence that the mean system is a good one. The irregularities are in most cases due to the special atmospheric conditions prevailing at the ascension, which may well be assumed to differ from the means representing the average by the months. The overflow of warm on cold currents, or of cold on warm currents, is so peculiarly characteristic of the atmosphere that we may well expect seldom to have any ascension conform exactly to the mean or normal conditions. It may be mentioned in passing that the cloud heights for the international year 1896–97 in the upper strata show the peculiar drops here exhibited from January till March and the rise in temperature till August. While not pretending to claim too much accuracy for this construction, which will be modified somewhat in parts by future experience, it may be presumed to give us the vertical temperatures with enough accuracy to warrant the prosecution of the studies alluded to in the beginning of this chapter, and they will accordingly be employed for that purpose.

In order to increase the usefulness of this compilation, the following tables have been constructed from the diagrams. Table 157 gives the total fall of the temperature from the surface to the height expressed at the head of each column. In the second column is found the adopted mean temperatures of middle Europe, for which the chart was drawn. However, any other observed mean monthly temperatures may be substituted for these, such, for example, as those prevailing at Washington, D. C., and then the numerical addition of the surface temperature and the temperature fall with the altitude will give the temperature at that elevation. Hence, by

Seasonal Isotherms at Different Elevations. High Areas.

Chart 78.



Seasonal Isotherms at Different Elevations. Low Areas.

Chart 79

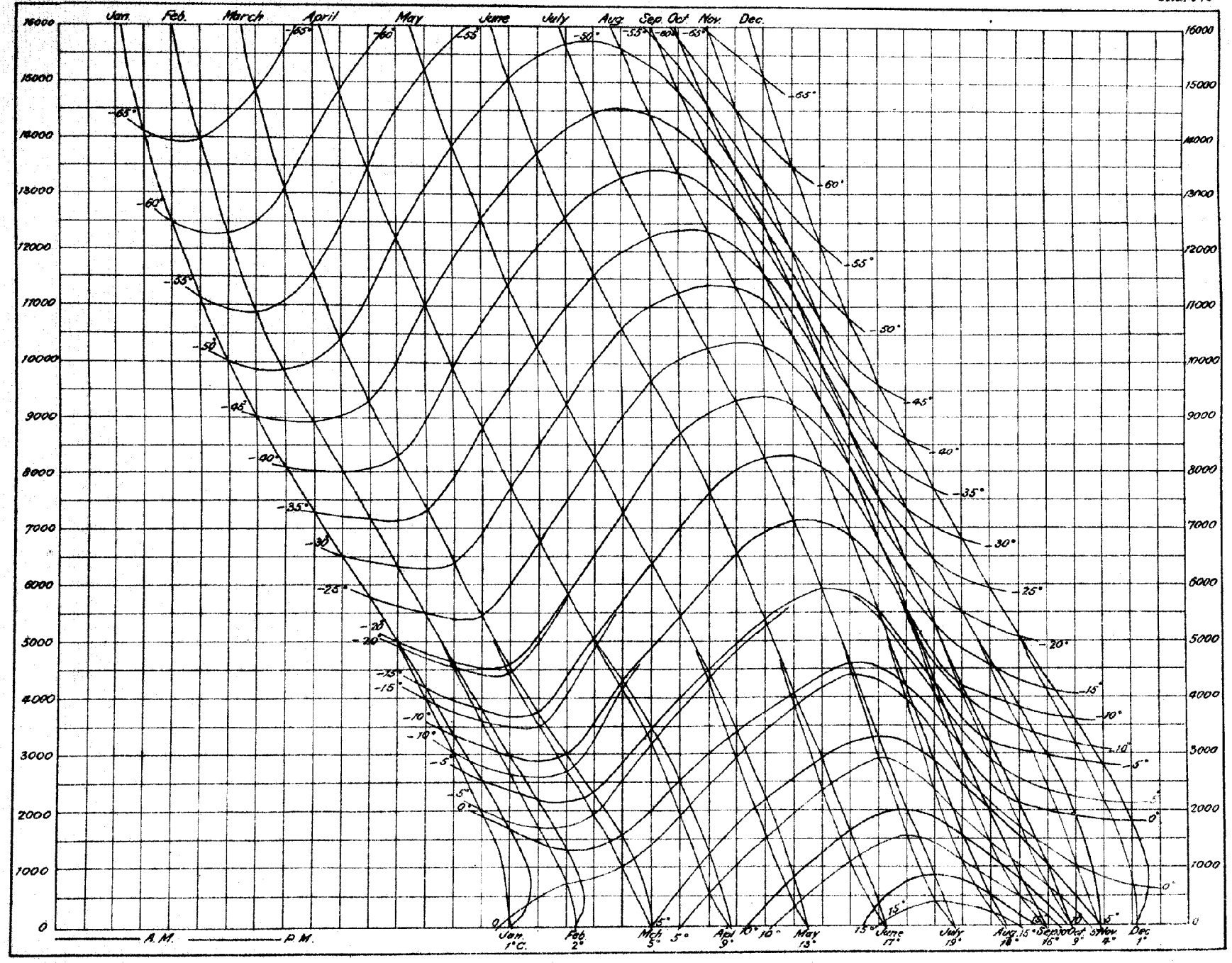


TABLE 157 I.—*Total fall of temperature from the surface to the given elevation in high areas and clear weather.* Δt.

[Values taken from the charts 78, 79.]

Height in meters		200	400	600	800	1000	1500	2000	2500	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Month	Surface t.	For the forenoon hours																					
January	1° C.	+1.1	+1.3	+1.6	+1.4	+1.1	−1.0	−4.1	−7.2	−10.2	−16.3	−22.8	−28.8	−34.9	−40.5	−46.1	−50.6	−55.0	−58.8	−62.6	65.9	−68.3	−70.0
February	2	+1.6	+2.2	+2.2	+1.6	+0.6	−1.0	−6.7	−10.0	−13.2	−20.0	−26.6	−32.6	−38.2	−44.0	−49.1	−53.7	−57.9	−61.8	−64.8	−68.0	−70.6	−72.3
March	5	−0.4	−1.0	−1.7	−2.6	−3.5	−6.2	−9.1	−12.5	−15.9	−22.7	−29.1	−35.3	−40.6	−45.6	−50.2	−54.5	−58.6	−62.4	−65.2	−67.9	−70.5	−72.5
April	9	−1.1	−2.3	−3.6	−5.0	−6.1	−9.4	−12.7	−15.6	−18.7	−24.6	−30.7	−36.7	−42.3	−47.1	−51.5	−56.0	−59.8	−63.2	−66.3	−69.2	−71.6	−73.6
May	13	−1.5	−3.0	−4.6	−6.1	−7.3	−10.6	−13.6	−16.2	−19.2	−24.9	−30.6	−36.0	−41.0	−45.8	−50.0	−54.1	−57.6	−60.9	−64.1	−67.2	−69.6	−72.0
June	17	−0.7	−1.6	−2.6	−3.7	−4.7	−7.3	−10.2	−12.8	−15.5	−21.0	−26.6	−31.8	−37.1	−42.8	−47.2	−51.9	−55.8	−59.7	−63.0	−66.1	−68.7	−70.5
July	19	−0.6	−1.3	−2.1	−3.1	−3.9	−6.6	−9.0	−11.5	−13.9	−19.0	−24.1	−29.6	−34.4	−39.2	−44.1	−49.0	−53.2	−57.8	−62.1	−65.9	−69.7	−72.6
August	18	−0.6	−1.3	−2.1	−3.1	−4.0	−6.2	−8.4	−10.3	−12.2	−16.2	−20.9	−25.8	−30.9	−36.0	−41.0	−46.1	−50.5	−55.2	−59.6	−63.8	−67.6	−70.8
September	15	−0.6	−1.3	−2.1	−3.0	−3.7	−6.0	−8.1	−10.1	−12.1	−16.1	−20.6	−25.2	−30.4	−35.6	−40.8	−45.8	−50.7	−54.8	−59.1	−63.2	−67.0	−70.7
October	9	−0.2	−0.6	−1.0	−1.4	−2.0	−3.7	−5.6	−7.4	−9.3	−13.8	−18.5	−23.4	−28.3	−33.6	−39.0	−44.4	−49.2	−54.0	−58.7	−63.0	−66.6	−70.4
November	4	+0.2	+0.2	0.0	−0.2	−0.6	−1.8	−3.2	−5.1	−7.0	−11.3	−16.2	−21.5	−27.2	−33.2	−38.6	−44.0	−49.0	−53.9	−58.2	−62.6	−66.2	−70.2
December	1	+0.7	+1.2	+1.3	+1.3	+1.1	0.0	−1.5	−3.4	−5.6	−10.3	−15.4	−20.8	−27.0	−33.2	−39.2	−44.8	−49.8	−54.3	−58.7	−63.0	−66.7	−70.1
		For the afternoon hours																					
January	1° C.	−2.1	−3.2	−4.0	−4.4	−4.8	−5.7	−7.6	−9.8	−12.2	−16.4	−22.8	−28.8	−34.9	−40.5	−46.1	−50.6	−55.0	−58.8	−62.6	−65.9	−68.3	−70.0
February	2	−0.9	−1.8	−2.9	−3.9	−4.8	−7.6	−10.2	−12.9	−15.6	−21.0	−26.6	−32.6	−38.2	−44.0	−49.1	−53.7	−57.9	−61.8	−64.8	−68.0	−70.6	−72.3
March	5	−1.6	−3.0	−4.2	−5.6	−6.8	−9.7	−12.4	−15.1	−17.9	−23.5	−29.1	−35.3	−40.6	−45.6	−50.2	−54.5	−58.6	−62.4	−65.2	−67.9	−70.5	−72.5
April	9	−2.1	−4.2	−6.1	−7.8	−9.2	−12.7	−15.4	−18.1	−20.5	−25.6	−30.7	−36.7	−42.3	−47.1	−51.5	−56.0	−59.8	−63.2	−66.3	−69.2	−71.6	−73.6
May	13	−2.7	−5.1	−7.0	−8.6	−10.0	−13.1	−16.1	−18.6	−21.1	−26.0	−30.6	−36.0	−41.0	−45.8	−50.0	−54.1	−57.6	−60.9	−64.1	−67.2	−69.6	−72.0
June	17	−1.6	−3.0	−4.3	−5.7	−6.9	−9.8	−12.6	−15.1	−17.5	−21.9	−26.6	−31.8	−37.1	−42.8	−47.2	−51.9	−55.8	−59.7	−63.0	−66.1	−68.7	−70.5
July	19	−1.5	−2.8	−4.0	−5.4	−6.4	−8.9	−11.2	−13.4	−15.6	−20.0	−24.1	−29.6	−34.4	−39.2	−44.1	−49.0	−53.2	−57.8	−62.1	−65.9	−69.7	−72.6
August	18	−1.4	−2.6	−3.8	−5.1	−6.0	−8.2	−10.2	−11.9	−13.7	−17.1	−20.9	−25.8	−30.9	−36.0	−41.0	−46.1	−50.5	−55.2	−59.6	−63.8	−67.6	−70.8
September	15	−1.4	−2.7	−3.9	−5.1	−6.1	−8.3	−10.6	−12.3	−14.0	−17.3	−20.6	−25.2	−30.4	−35.6	−40.8	−45.8	−50.7	−54.8	−59.1	−63.2	−67.0	−70.7
October	9	−1.1	−1.9	−3.0	−3.9	−4.9	−7.1	−9.0	−10.5	−11.9	−15.0	−18.5	−23.4	−28.3	−33.6	−39.0	−44.4	−49.2	54.0	−58.7	−63.0	−66.6	−70.4
November	4	−1.0	−1.9	−2.7	−3.4	−4.1	−5.4	−6.5	−7.9	−9.3	−12.6	−16.2	−21.5	−27.2	−33.2	−38.6	−44.0	−49.0	−53.9	−58.2	−62.6	−66.2	−70.2
Deeember	1	−0.4	−0.9	−1.2	−1.7	−2.0	−3.1	−4.6	−6.1	−7.8	−11.5	−15.4	−20.8	−27.0	−33.2	−39.2	−44.8	−49.8	−54.3	−58.7	−63.0	−66.7	−70.1

TABLE 157 II.—*Total fall of temperature from the surface to the given elevation in low areas and cloudy weather.* Δt.

[Values taken from the charts 78, 79.]

Height in meters		200	400	600	800	1000	1500	2000	2500	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Month	Surface t.	For the forenoon hours																					
January	1° C.	+1.6	+2.6	+3.2	+3.1	+2.8	+0.5	−2.3	−5.5	−8.2	−14.2	−20.5	−27.2	−33.3	−40.0	−45.6	−50.5	−55.1	−59.0	−62.8	−65.2	−67.7	−70.0
February	2	+1.2	+1.5	+1.3	+0.9	0.0	−2.6	−5.7	−8.8	−11.9	−18.0	−24.0	−30.2	−35.7	−41.1	−46.9	−52.1	−57.0	−61.0	−64.0	−67.1	−69.2	−71.3
March	5	−0.1	−0.3	−0.8	−1.4	−2.1	−4.7	−8.0	−11.6	−15.2	−21.7	−28.0	−33.6	−38.6	−44.9	−48.8	−53.4	−57.9	−62.0	−65.2	−68.0	−70.6	−73.0
April	9	−0.5	−1.1	−1.7	−2.1	−2.8	−4.6	−6.9	−9.1	−12.0	−17.8	−24.2	−30.4	−35.4	−40.3	−45.1	−49.3	−54.1	−58.4	−62.8	−66.2	−69.8	−73.0
May	13	−0.4	−1.0	−1.6	−2.1	−3.0	−4.9	−6.9	−8.8	−10.9	−15.3	−20.2	−26.0	−31.8	−36.9	−42.1	−46.9	−51.4	−56.0	−60.2	−63.8	−67.3	−70.6
June	17	−0.5	−1.1	−1.8	−2.6	−3.2	−5.2	−7.2	−9.2	−11.5	−15.5	−19.3	−23.5	−28.8	−33.3	−38.3	−43.4	−49.0	−54.1	−59.0	−63.0	−67.0	−70.4
July	19	−0.6	−1.3	−2.2	−3.1	−3.9	−6.1	−8.2	−10.3	−12.2	−16.1	−19.9	−23.9	−28.0	−32.6	−37.1	−42.2	−47.6	−52.8	−57.7	−62.2	−66.5	−70.4
August	18	−0.9	−1.9	−2.9	−3.9	−4.8	−7.1	−9.2	−11.2	−13.2	−16.9	−20.4	−24.3	−28.1	−32.2	−36.6	−41.3	−46.0	−51.0	−56.2	−61.0	−65.9	−70.3
September	15	−1.0	−2.1	−3.1	−4.1	−5.2	−7.5	−9.7	−11.9	−14.0	−18.1	−22.2	−26.3	−30.1	−34.0	−38.2	−42.6	−47.0	−51.4	−56.5	−61.2	−65.7	−70.2
October	9	−0.7	−1.6	−2.3	−3.1	−4.0	−6.1	−8.3	−10.7	−12.9	−17.8	−23.1	−27.7	−31.9	−36.0	−40.2	−44.0	−48.2	−52.6	−57.2	−62.3	−66.5	−70.8
November	4	0.0	−0.1	−0.3	−0.8	−1.3	−2.8	−4.4	−6.7	−9.2	−15.4	−21.7	−27.2	−32.6	−37.6	−42.2	−46.3	−50.8	−54.9	−58.8	−63.0	−66.8	−70.2
December	1	+0.9	+1.6	+1.9	+2.1	+1.9	+0.7	−1.3	−3.8	−6.7	−13.1	−20.1	−26.3	−32.1	−37.8	−42.9	−47.7	−52.0	−55.8	−59.2	−63.0	−66.0	−69.0
		For the afternoon hours																					
January	1° C.	−0.7	−1.1	−1.1	−1.2	−1.5	−3.0	−5.3	−7.7	−10.2	−15.5	−20.5	−27.2	−33.3	−40.0	−45.6	−50.5	−55.1	−59.0	−62.8	−65.2	−67.7	−70.0
February	2	−0.1	−0.5	−1.1	−1.8	−2.7	−5.5	−8.1	−10.8	−13.4	−19.0	−24.0	−30.2	−35.7	−41.1	−46.9	−52.1	−57.0	−61.0	−64.0	−67.1	−69.2	−71.3
March	5	−1.0	−1.9	−3.0	−3.8	−4.8	−7.6	−10.5	−13.7	−16.9	−22.6	−28.0	−33.6	−38.6	−44.9	−48.8	−53.4	−57.9	−62.0	−65.2	−68.0	−70.6	−73.0
April	9	−1.2	−2.3	−3.4	−4.4	−5.4	−7.3	−9.1	−11.0	−13.1	−18.6	−24.2	−30.4	−35.4	−40.3	−45.1	−49.3	−54.1	−58.4	−62.8	−66.2	−69.8	−73.0
May	13	−1.3	−2.6	−3.6	−4.4	−5.3	−7.1	−8.9	−10.6	−12.5	−16.0	−20.2	−26.0	−31.8	−36.9	−42.1	−46.9	−51.4	−56.0	−60.2	−63.8	−67.3	−70.6
June	17	−1.3	−2.6	−3.7	−4.8	−5.5	−7.7	−9.6	−11.2	−12.9	−16.1	−19.3	−23.5	−28.8	−33.3	−38.3	−43.4	−49.0	−54.1	−59.0	−63.0	−67.0	−70.4
July	19	−1.6	−2.8	−4.1	−5.2	−6.2	−8.3	−10.3	−12.0	−13.8	−16.9	−19.9	−23.9	−28.0	−32.6	−37.1	−42.2	−47.6	−52.8	−57.7	−62.2	−66.5	−70.4
August	18	−1.6	−3.2	−4.6	−5.9	−6.9	−9.1	−11.1	−13.1	−14.7	−17.6	−20.4	−24.3	−28.1	−32.2	−36.6	−41.3	−46.0	−51.0	−56.2	−61.0	−65.9	−70.3
September	15	−1.7	−3.3	−4.8	−6.1	−7.1	−9.2	−11.6	−13.7	−15.5	−19.0	−22.2	−26.3	−30.1	−34.0	−38.2	−42.6	−47.0	−51.4	−56.5	−61.2	−65.7	−70.2
October	9	−1.4	−2.8	−4.0	−5.1	−6.1	−8.2	−10.4	−12.4	−14.6	−18.9	−23.1	−27.7	−31.9	−36.0	−40.2	−44.0	−48.2	−52.6	−57.2	−62.3	−66.5	−70.8
November	4	−1.0	−1.9	−2.8	−3.3	−4.1	−5.9	−7.6	−9.6	−11.9	−16.9	−21.7	−27.2	−32.6	−37.6	−42.2	−46.3	−50.8	−54.9	−58.8	−63.0	−66.8	−70.2
December	1	−0.1	−0.2	−0.6	−0.8	−1.3	−2.6	−4.4	−6.8	−9.1	−14.8	−20.1	−26.3	−32.1	−37.8	−42.9	−47.7	−52.0	−55.8	−59.2	−63.0	−66.0	−69.0

adding successively the temperature falls along any line we have the variations for a given month with the height; or by adding the temperature falls in a given column to the successive surface temperatures in the several months we have the annual variation at that level. Since similar variations are computed for the forenoon and the afternoon hours in both the high and the low areas, there is presented the data for very varied interpretations of all observations which may be made, so far as the European data is generally transferable to other regions. The probability is that the American districts will show the same laws or aspects as the European, but under more exaggerated values, especially in the lowest stratum of the atmosphere. The reality of this supposition, and the amount of the variation from the European scale, if it exists, can only be tested by a suitable series of American observations. The kite records will probably serve for the lower levels, but resort must evidently be had to balloon ascensions for direct measurement in the strata above two miles, or 3,000 meters. If such ascensions are projected above that elevation, these records in the free air will be a valuable addition to the temperature records obtained with the kite meteorograph in the 2 miles nearest the ground, and that, too, with standard meteorological instruments because the weight of meteorographs is necessarily reduced to a minimum for kite flights.

THE MEAN TEMPERATURE FALL TO A GIVEN ELEVATION.

Table 158 contains the results of a computation of great practical importance, namely, the mean temperature fall which occurs from the surface up to a given elevation. This is the temperature argument which is used in entering the primary table for barometric reductions from a given height to sea level. It was obtained by an integration of the numbers found in the preceding table (157). Thus the total fall up to 200 meters is divided by 2 $\left(\frac{1.1}{2}=0.6\right)$; the sum of those at 200 and 400 meters is divided by 3 $\left(\frac{1.1+1.3}{3}=0.8\right)$, and so on for the January forenoon high area. This integration by 200-meter steps was continued up to 1,000 meters. From that point the step changes to 500 meters, as $\frac{1.5+1.1-1.0}{4}=+0.4$ for 1,500 meters and $\frac{1.5+1.1-1.0-4.1}{5}=-0.5$ for 2,000 meters. It should be noted that in making the transition from the 200 step to the 500 step there was danger of omitting some important part in the sum, and hence by continuing the 200 step to 1,500 meters a correction of +0.2 was found necessary, and it was accordingly added. From 3,000 to 16,000 meters the formation of the sums was by 1,000-meter steps. In making these integral sums the surface value (0) must not be omitted, or else the sum must be divided by one more $(n+1)$ than the number (n) of the elements which entered into it.

A study of these tables will not fail to disclose the complex character of the problems that meteorologists have before them in determining the nature of the temperature gradients in the atmosphere, the direction of their variation with the height, with the season, the diurnal change, and the anticyclonic and cyclonic circulation prevailing at any station. The assignment of any one gradient as a normal for the atmosphere, such as the adiabatic rate, is seen to be wholly inadequate, in view of the very changeable character of this quality, especially in the lowest stratum. If the adiabatic rate is a fall of 9°.849 C. for 1,000 meters, then the *actual fall is not more than half as much* on the average, being about 4°.5 per 1,000 meters up to 16,000 meters. It is greater or less than this according to the location on the chart, and the gradient per 100 meters can always be found from Table 157 by dividing the actual temperature fall (Δt) between two points by the difference in height (Δh); $G \cdot t=\frac{\Delta t}{\Delta h}$.

It will be observed on Charts 78, 79 that the vertical lines drawn for the forenoon and the afternoon hours, respectively, approach gradually, and are merged in the same ascending gradient at the level of about 5,000 meters. It should be remembered distinctly that it was at this elevation (3 miles) that the observations on the direction and velocity of motion of the clouds indicated that there the complex circulation of the anticyclones and cyclones gave way to the permanent eastward drift over the United States, which above that elevation exhibits only comparatively small deflections or disturbances of the eastward direction. The inference there made would seem to be

TABLE 158 I.—*Mean temperature fall of the air column from the surface to the given height.* $\Delta\theta$.

HIGH AREAS AND CLEAR WEATHER.

Height in meters		200	400	600	800	1000	1500	2000	2500	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Precept	Month	For the forenoon hours																					
Add these values to the surface temperature to find mean temperature of the air column.	Jan.	+0.6	+0.8	+1.0	+1.1	+1.1	+0.6	−0.5	−1.6	−2.9	−5.9	−8.7	−11.6	−14.5	−17.4	−20.3	−23.0	−25.7	−28.2	−30.7	−33.0	−35.2	−37.3
	Feb.	+0.8	+1.3	+1.5	+1.5	+1.4	+0.7	−1.0	−2.5	−4.0	−8.0	−11.0	−14.1	−17.1	−20.1	−23.0	−25.8	−28.4	−31.0	−33.4	−35.7	−37.9	−39.9
	Mar.	−0.2	−0.5	−0.8	−1.1	−1.5	−3.0	−4.0	−5.5	−6.9	−10.2	−13.4	−16.5	−19.5	−22.4	−25.2	−27.9	−30.4	−32.8	−35.2	−37.4	−39.4	−41.4
	Apr.	−0.6	−1.1	−1.5	−2.4	−3.0	−4.8	−6.2	−7.8	−9.3	−12.4	−15.5	−18.5	−21.5	−24.3	−27.0	−29.7	−32.2	−34.6	−36.8	−39.0	−41.1	−42.9
	May	−0.8	−1.5	−1.8	−3.0	−3.8	−5.6	−7.1	−8.6	−10.1	−13.0	−15.9	−18.8	−21.6	−24.3	−26.8	−29.3	−31.7	−33.9	−36.1	−38.2	−40.1	−42.0
	June	−0.4	−0.8	−1.2	−1.7	−2.2	−3.7	−4.9	−6.2	−7.5	−10.3	−13.0	−15.7	−18.4	−21.1	−23.7	−26.2	−28.7	−31.1	−33.4	−35.6	−37.6	−39.6
	July	−0.3	−0.6	−1.0	−1.4	−1.8	−3.2	−4.2	−5.4	−6.7	−9.2	−11.7	−14.2	−16.7	−19.2	−21.7	−24.2	−26.6	−29.0	−31.4	−33.7	−35.9	−38.1
	Aug.	−0.3	−0.6	−1.0	−1.4	−1.9	−3.2	−4.1	−5.1	−6.1	−8.2	−10.4	−12.6	−14.9	−17.2	−19.6	−22.0	−24.4	−26.7	−29.1	−31.4	−33.7	−35.8
	Sept.	−0.3	−0.6	−1.0	−1.4	−1.8	−3.1	−3.9	−5.0	−6.0	−8.0	−10.1	−12.3	−14.5	−16.9	−19.3	−21.7	−24.1	−26.4	−28.8	−31.1	−33.3	−35.5
	Oct.	−0.1	−0.3	−0.5	−0.6	−0.9	−1.8	−2.4	−3.3	−4.1	−6.1	−8.2	−10.4	−12.6	−14.9	−17.4	−19.8	−22.3	−24.7	−27.1	−29.5	−31.8	−34.1
	Nov.	+0.1	+0.1	+0.1	0.0	−0.1	−0.8	−1.1	−1.8	−2.5	−4.4	−6.4	−8.5	−10.9	−13.4	−15.9	−18.4	−21.0	−23.5	−26.0	−28.4	−30.8	−33.1
	Dec.	+0.4	+0.6	+0.8	+0.9	+0.9	0.0	−0.1	−0.7	−1.4	−3.3	−5.3	−7.5	−9.9	−12.5	−15.2	−17.9	−20.5	−23.1	−25.7	−28.2	−30.6	−32.9
		For the afternoon hours																					
	Jan.	−1.1	−1.7	−2.3	−2.7	−3.1	−3.7	−4.3	−5.3	−6.2	−8.2	−10.6	−13.2	−15.9	−18.7	−21.4	−24.1	−26.6	−29.1	−31.5	−33.8	−35.9	−38.0
	Feb.	−0.5	−0.9	−1.4	−1.9	−2.4	−3.9	−5.0	−6.3	−7.6	−10.3	−13.0	−15.8	−18.6	−21.4	−24.2	−26.9	−29.5	−31.9	−34.3	−36.6	−38.7	−40.7
	Mar.	−0.8	−1.5	−2.2	−2.9	−3.5	−5.2	−6.5	−7.9	−9.4	−12.1	−14.9	−17.9	−20.7	−23.5	−26.1	−28.7	−31.2	−33.6	−35.9	−38.0	−40.0	−41.9
	Apr.	−1.1	−2.1	−3.1	−4.0	−4.9	−7.0	−8.5	−10.1	−10.6	−14.1	−16.9	−19.7	−22.5	−25.3	−27.9	−30.5	−32.9	−35.2	−37.4	−39.6	−41.6	−43.5
	May	−1.4	−2.6	−3.7	−4.7	−5.6	−7.5	−9.1	−10.7	−12.1	−14.6	−17.3	−20.0	−22.6	−25.2	−27.7	−30.1	−32.4	−34.6	−36.7	−38.7	−40.6	−42.5
	June	−0.8	−1.5	−2.2	−2.9	−3.6	−5.3	−6.6	−8.0	−9.4	−11.8	−14.3	−16.8	−19.3	−21.9	−24.4	−26.9	−29.3	−31.7	−33.9	−36.1	−38.1	−40.0
	July	−0.8	−1.4	−2.1	−2.7	−3.4	−4.9	−6.0	−7.2	−8.4	−10.6	−12.9	−15.3	−17.7	−21.0	−22.5	−24.9	−27.2	−29.6	−31.9	−34.2	−36.4	−38.5
	Aug.	−0.7	−1.3	−2.0	−2.6	−3.2	−4.6	−5.5	−6.6	−7.6	−9.4	−11.3	−13.4	−15.6	−17.8	−20.2	−22.5	−24.8	−27.2	−29.5	−31.8	−34.0	−36.2
	Sept.	−0.7	−1.4	−2.0	−2.6	−3.2	−4.6	−5.7	−6.8	−7.8	−9.6	−11.4	−13.4	−15.5	−17.8	−20.1	−22.4	−24.8	−27.1	−29.4	−31.6	−33.9	−36.0
	Oct.	−0.6	−1.0	−1.5	−2.0	−2.5	−3.8	−4.7	−5.7	−6.6	−8.2	−9.9	−11.8	−13.9	−16.1	−18.4	−20.7	−23.1	−25.5	−27.9	−30.2	−32.5	−34.7
	Nov.	−0.5	−1.0	−1.4	−1.8	−2.2	−3.2	−3.7	−4.4	−5.1	−6.5	−8.1	−10.0	−12.2	−14.5	−16.9	−19.4	−21.8	−24.3	−26.7	−29.1	−31.4	−33.7
	Dec.	−0.2	−0.4	−0.6	−0.8	−1.0	−1.8	−2.2	−2.8	−3.5	−5.2	−6.9	−8.9	−11.1	−13.6	−16.2	−18.8	−21.3	−23.9	−26.4	−28.8	−31.2	−33.5

TABLE 158 II.—*Mean temperature of the air column from the surface to the given height.* $\Delta\theta$.

LOW AREAS AND CLOUDY WEATHER.

Height in meters		200	400	600	800	1000	1500	2000	2500	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Precept	Month	For the forenoon hours																					
Add these values to the surface temperature to find mean temperature of the air column.	Jan.	+0.8	+1.4	+1.9	+2.1	+2.2	+1.8	+0.8	−0.3	−1.4	−4.4	−7.1	−9.9	−12.9	−15.9	−18.9	−21.7	−24.5	−27.2	−29.7	−32.1	−34.3	−36.4
	Feb.	+0.6	+0.9	+1.0	+1.0	+0.8	+0.2	−1.1	−2.4	−3.8	−7.1	−9.9	−12.8	−15.7	−18.5	−21.4	−24.1	−26.9	−29.5	−32.0	−34.3	−36.5	−38.5
	Mar.	−0.1	−0.1	−0.3	−0.5	−0.8	−1.7	−3.1	−4.5	−6.0	−9.4	−12.5	−15.5	−18.4	−21.3	−24.1	−26.8	−29.3	−31.9	−34.2	−36.5	−38.6	−40.6
	Apr.	−0.3	−0.5	−0.8	−1.1	−1.0	−2.2	−3.1	−4.1	−5.3	−7.9	−10.6	−13.4	−16.2	−18.9	−21.5	−24.0	−26.5	−28.7	−31.4	−33.7	−36.0	−38.1
	May	−0.2	−0.5	−0.8	−1.0	−1.0	−2.3	−3.2	−4.2	−5.1	−7.2	−9.4	−11.8	−14.3	−16.8	−19.3	−21.8	−24.3	−26.7	−29.1	−31.4	−33.7	−35.8
	June	−0.3	−0.5	−0.9	−1.2	−1.2	−2.5	−3.4	−4.4	−5.4	−7.5	−9.5	−11.4	−13.6	−15.8	−18.1	−20.4	−22.8	−25.2	−27.6	−29.9	−32.3	−34.5
	July	−0.3	−0.6	−1.0	−1.4	−1.4	−3.0	−4.0	−5.1	−6.1	−8.1	−10.1	−12.0	−14.0	−16.1	−18.2	−20.4	−22.6	−24.9	−27.3	−29.6	−31.9	−34.2
	Aug.	−0.5	−0.9	−1.4	−1.9	−1.8	−3.6	−4.7	−5.8	−6.8	−8.8	−10.7	−12.7	−14.6	−16.6	−18.6	−20.6	−22.8	−24.9	−27.2	−29.4	−31.7	−34.0
	Sept.	−0.5	−1.0	−1.6	−2.1	−1.9	−3.8	−5.0	−6.2	−7.3	−9.4	−11.5	−13.6	−15.7	−17.7	−19.8	−21.9	−23.9	−26.1	−28.2	−30.4	−32.6	−34.8
	Oct.	−0.4	−0.8	−1.2	−1.5	−1.5	−3.0	−4.1	−5.2	−6.3	−8.6	−11.0	−13.4	−15.7	−18.0	−20.2	−22.4	−24.5	−26.7	−28.9	−31.1	−33.3	−35.5
	Nov.	0.0	0.0	−0.1	−0.2	−0.3	−1.1	−1.7	−2.6	−3.5	−6.1	−8.7	−11.3	−14.0	−16.6	−19.2	−21.6	−24.1	−26.4	−28.7	−31.0	−33.3	−35.4
	Dec.	+0.5	+0.8	+1.1	+1.3	+1.1	+1.1	+0.6	−0.1	−1.1	−3.8	−6.6	−9.4	−12.2	−15.1	−17.8	−20.6	−23.2	−25.7	−28.1	−30.4	−32.6	−34.8
		For the afternoon hours																					
	Jan.	−0.4	−0.6	−0.7	−0.8	−0.9	−1.4	−2.2	−3.1	−4.1	−6.5	−8.8	−11.5	−14.2	−17.1	−19.9	−22.7	−25.4	−28.0	−30.5	−32.8	−35.0	−37.0
	Feb.	−0.1	−0.2	−0.4	−0.7	−1.0	−2.3	−3.4	−4.7	−5.9	−8.6	−11.2	−13.9	−16.5	−19.3	−22.1	−24.8	−27.5	−30.1	−32.5	−34.8	−36.9	−39.0
	Mar.	−0.5	−1.0	−1.5	−1.9	−2.4	−3.7	−5.1	−6.5	−8.0	−11.0	−13.8	−16.6	−19.4	−22.2	−24.9	−27.5	−30.0	−32.5	−34.8	−37.0	−39.1	−41.1
	Apr.	−0.4	−1.2	−1.7	−2.3	−2.8	−3.9	−4.9	−6.0	−7.0	−9.2	−11.7	−14.4	−17.0	−19.6	−22.2	−24.6	−27.1	−29.5	−31.9	−34.2	−36.4	−38.5
	May	−0.4	−1.3	−1.9	−2.4	−2.9	−3.9	−4.9	−5.8	−6.8	−8.5	−10.5	−12.7	−15.1	−17.5	−20.0	−22.4	−24.8	−27.2	−29.6	−31.9	−34.1	−36.2
	June	−0.4	−1.3	−1.9	−2.5	−3.0	−4.1	−5.2	−6.2	−7.2	−8.8	−10.6	−12.4	−14.5	−16.6	−18.7	−21.0	−23.3	−25.7	−28.1	−30.4	−32.7	−34.9
	July	−0.8	−1.5	−2.1	−2.7	−3.3	−4.5	−5.7	−6.7	−7.7	−9.4	−11.2	−13.0	−14.9	−16.8	−18.9	−21.0	−23.2	−25.5	−27.8	−30.1	−32.4	−34.6
	Aug.	−0.8	−1.6	−2.4	−3.1	−3.7	−5.0	−6.2	−7.4	−8.4	−10.1	−11.8	−13.6	−15.4	−17.3	−19.2	−21.2	−23.3	−25.4	−27.6	−29.8	−32.1	−34.3
	Sept.	−0.9	−1.7	−2.5	−3.2	−3.8	−5.1	−6.4	−7.6	−8.7	−10.6	−12.6	−14.5	−16.5	−18.4	−20.4	−22.4	−24.5	−26.5	−28.7	−30.8	−33.1	−35.2
	Oct.	−0.7	−1.4	−2.1	−2.7	−3.2	−4.4	−5.6	−6.8	−7.9	−10.0	−12.2	−14.4	−16.6	−18.7	−20.9	−23.0	−25.1	−27.2	−28.6	−31.5	−33.7	−35.9
	Nov.	−0.5	−1.0	−1.4	−1.8	−2.2	−3.1	−4.0	−4.9	−5.9	−8.1	−10.4	−12.8	−15.3	−17.7	−20.2	−22.6	−24.9	−27.2	−29.5	−31.7	−33.9	−36.0
	Dec.	−0.1	−0.1	−0.2	−0.3	−0.5	−1.1	−1.7	−2.6	−3.5	−5.9	−8.3	−10.9	−13.5	−16.2	−18.9	−21.5	−24.1	−26.5	−28.8	−31.1	−33.3	−35.4

hereby confirmed, that it is only the three lower miles of the atmosphere wherein the complex cyclonic and anticyclonic circulation of the air takes place, which is principally due to the interaction of convection currents whose mission it is to restore the average temperature equilibrium that has been disturbed and that seeks to prevail. If the solar radiation on the equatorial belt is responsible for the general distribution of heat and cold in the atmosphere which causes the primary circulation, then the excesses or defects such as the differential radiation on ocean and land areas produces, or such as the accumulation of heat in the Tropics and of cold in the polar regions causes, are naturally readjusted by means of the long horizontal currents flowing within the lower 5,000 meters of the atmosphere. These currents produce vortex motions when they come in contact more or less perfectly, called cyclones and anticylones. It is also inferred that the assumed overflow from the equatorial regions to the poles in the highest strata, which has played a leading rôle in theoretical discussions of the general circulation of the atmosphere, has found almost no verification in this research; hence much of the popular meteorology resting upon this idea is really imaginary. The active interchange between equator and pole is apparently in the lowest strata, and these currents, tending to restore equilibrium, in fact *underrun* the great upper current of air that flows steadily eastward, and which is only a little influenced by the operations going on beneath it. In other words, the principal distributions of temperature over the earth are not much disturbed above 5,000 meters by the effects of solar radiation in the lower strata. But at the same time it should be remembered that since greater densities prevail in the lower strata the mass of air affected by this circulation is about half of the total atmosphere.

The kite observations of the Blue Hill Observatory (Ann. H. C. Obsy., 1897) exhibit similar types of vertical gradients to those disclosed by the balloon ascensions. The chief feature of divergence is in their statement that the diurnal gradients are not generally perceived above 2,000 meters (p. 103). The second difference is in the fact that the local variations on individual dates due to anticyclones and cyclones would require a wider range of values in the lowest strata than is found in Europe. In fact the weather conditions are much more severe in New England than in Europe, as is well known to be the case. Especially would this be so when cold waves, or semi cold waves, sweep over the United States in the rear of a cyclone. Also the unstable gradients of temperature are produced by the flowing above one another of cold and warm currents in an inverted succession of vertical conditions. However, it is certainly instructive to possess the general picture of the changes which so incessantly disturb the normal vertical temperature gradients of the atmosphere.

EXTENSION OF THE COMPUTATION OF THE α CONSTANT TO ALL THE OTHER TYPES OF CLOUDS.

The special purpose for constructing the temperature lines in a vertical direction, and the seasonal isothermal surfaces at different elevations, was the preparation of the data needed for computing the α constant corresponding to all the other types of clouds besides the cumulus and cumulo-nimbus, which have been already fully discussed. It is certainly important to extend this investigation as far as is practicable to all altitudes in the atmosphere, and it has been stated that the method involves the possibility of studying the problems of isolation and radiation from a new point of view. Evidently in the present state of this subject we can not go beyond the conditions of the α stage; but, on the other hand, we are justified in considering the state of the atmosphere as very approximately approaching the end of the α stage when other than cumulus clouds are forming. Whatever may be the special physical conditions which cause the other types of clouds to form, it is clear that they indicate by their presence that the moisture in the air is just brought to the point of saturation, and is on the verge of passing out of the α stage. The action of the vapor in the β . γ . δ . stages is to be neglected in this portion of our inquiry. The question before us is some comprehensive information regarding the amount of the divergence between the adiabatic and the actual conditions of the atmosphere. Since in the α stage such divergence may be attributed to four terms, as given by the formula,

$$\int \frac{dQ}{T} = (\lambda c_p + \mu c'_p) \log \frac{T}{T_o} - A(\lambda R + \mu R_1) \log \frac{p}{p_o},$$

wherein dQ is not to be neglected—that is to say, to the heat contents (1) of the *dry* air, (2) of the *aqueous vapor;* and to the heat required to do work against external pressure (3) by the *dry* air and (4) by the *aqueous vapor.* The value of μ, the number of grams of aqueous vapor contained in each kilogram of the mixture, diminishes to small quantities at high altitudes, and while it is this term which produces cloudy condensation, the divergence from the adiabatic law is largely confined to the first and the third terms. Of these it will be shown that the third term conforms closely to the adiabatic variation, and, therefore, it is the first term which is chiefly responsible for the divergence under consideration.

In our preceding discussion we kept in mind the conception of a "pilot," or "exploring kilogram," which, starting at the surface, is raised to different heights, and compared with specimen kilograms poised in equilibrium at the respective levels. It was shown that the ratio $\frac{e}{B}$ falls off to the ratio $\frac{e_1}{B_1}$, the amount of change being a function of the height (Table 136, III) even in the formation of cumulus clouds. In the case of the drier air, which prevails when the other types are produced, this falling off must be even greater. Now, the only practical value of the ratio $\frac{e}{B}$ has been to define in the most convenient form what the vapor contents of the air is at a given point, since from it the value of μ may be computed by the formula, $\mu=622\frac{e}{B}+235\left(\frac{e}{B}\right)^2$. Whenever the cloud forms in the sky, there occurs a case of saturation in which e is a direct function of t, and its value is taken at once from Table 103. Hence, by computing the temperatures for each month at all elevations, or at least the average temperature changes from the surface to the given height by means of the observations derived from the balloon ascensions, we have the data for computing $\frac{e}{B}$, and hence μ, under specific average conditions. In Table 131 we have already given the mean surface conditions for each month at which each of the cloud types formed, the data being extracted from the Washington observations, Table 129. Hence the quantities are in a homogeneous state, and the two classes of data can be put together so that the result of the computation which follows will be the average or normal divergence of the actual from the adiabatic atmosphere, accurate up to the reliability of the observations of the two kinds which have been employed.

While the attempt was made to classify the balloon temperature observations by forenoon and afternoon hours, and by high and low areas of pressure, thus giving us four tables (157 I, II), it is thought desirable to take the mean of these four cases, and construct a table which represents simply the mean state of the atmosphere under all the observed surface conditions. The result of this condensation is shown in Table 159, I, II, the first section of which gives the mean temperature fall Δt from the surface to the assigned elevation, limited to the height at which clouds commonly occur; the second section of the same table giving the mean temperature of the air column $\Delta\theta$ from the surface. Both Δt and $\Delta\theta$ are differences, and they are to be applied to the actual surface temperature. If Δt is subtracted from the surface temperature, it gives the corresponding temperature t_1 at the height h_1, at that place where the cloud condenses; if $\Delta\theta$ is subtracted from the surface temperature, it gives the mean temperature θ_1 of the air column, and thence by means of the tables of barometer reductions 91–93, the pressure B_1 at the height h_1 is computed; since e_1 is taken directly from t in the Smithsonian Tables 43, or from Table 103, as the argument, we have $B_1 \,.\, t_1 \,.\, e_1$. at the height h_1. From these values can be computed the α_1 constant at the height h_1, which in adiabatic conditions will agree with the α constant at the surface, but which diverges strongly from it in the actual atmosphere.

TABLE 159, I.—*Means of the total fall of temperature from the surface in high and low areas taken together.* Δt.

	200	400	600	800	1000	1500	2000	2500	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	13000
Jan.	0.0	−0.1	−0.1	−0.3	−0.6	−2.3	−4.8	−7.5	−10.2	−15.6	−21.6	−28.0	−34.1	−40.2	−45.8	−50.6	−55.1		
Feb.	+0.4	+0.4	−0.1	−0.8	−1.7	−4.2	−7.7	−10.6	−13.5	−19.5	−25.3	−31.4	−36.9	−42.6	−48.0	−52.9	−57.5		
Mar.	−0.8	−1.6	−2.4	−3.4	−4.3	−7.1	−10.0	−13.2	−16.5	−22.6	−28.6	−34.5	−39.6	−45.2	−49.5	−54.0	−58.2		
Apr.	−1.2	−2.5	−3.7	−4.8	−5.9	−8.5	−11.0	−13.5	−16.1	−21.7	−27.7	−33.6	−38.9	−43.7	−48.3	−52.4	−57.0		
May	−1.5	−2.9	−4.2	−5.3	−6.4	−8.9	−11.4	−13.6	−15.8	−20.6	−27.9	−31.1	−36.4	−41.4	−46.1	−50.5	−54.5		
June	−1.0	−2.1	−3.1	−4.2	−5.1	−7.5	−9.9	−12.1	−14.4	−18.6	−23.0	−27.6	−33.0	−38.0	−42.8	−47.7	−52.4		
July	−1.1	−2.1	−3.1	−4.2	−5.1	−7.5	−9.7	−11.8	−13.9	−18.0	−22.0	−26.8	−31.2	−35.9	−40.6	−45.6	−50.4	−55.3	−59.9
Aug.	−1.1	−2.3	−3.4	−4.5	−5.4	−7.7	−9.7	−11.6	−13.5	−16.9	−20.3	−22.5	−29.5	−34.1	−38.8	−43.7	−48.3	−53.1	−57.9
Sept.	−1.2	−2.4	−3.5	−4.6	−5.5	−7.8	−10.0	−12.0	−13.9	−17.6	−21.4	−25.8	−30.3	−34.9	−39.5	−44.2	−48.9		
Oct.	−0.9	−1.7	−2.6	−3.4	−4.3	−6.3	−8.3	−10.3	−12.2	−13.9	−20.4	−25.6	−30.1	−34.8	−39.6	−44.2	−48.7		
Nov.	−0.5	−0.9	−1.5	−1.9	−2.5	−4.0	−5.4	−7.3	−9.4	−14.1	−19.0	−24.4	−29.9	−35.4	−40.4	−45.2	−49.9		
Dec.	+0.3	+0.4	+0.4	+0.2	−0.1	−1.3	−3.0	−5.0	−7.6	−12.4	−17.8	−23.6	−29.6	−35.5	−41.1	−46.4	−51.4		

TABLE 159, II.—*Mean temperature of the air column from the surface in high and low areas taken together.* $\Delta\theta$.

	200	400	600	800	1000	1500	2000	2500	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	13000
Jan.	0.0	0.0	0.0	−0.1	−0.2	−0.7	−1.6	−2.6	−3.6	−6.3	−8.8	−11.6	−14.4	−17.3	−20.2	−22.9	−25.3		
Feb.	+0.2	+0.3	+0.2	0.0	−0.3	−1.3	−2.7	−4.0	−5.2	−8.5	−11.3	−14.3	−17.5	−19.8	−22.7	−25.6	−28.1		
Mar.	−0.4	−0.8	−1.2	−1.6	−2.0	−3.4	−4.7	−6.1	−7.6	−10.7	−13.7	−16.7	−19.5	−22.4	−25.1	−28.0	−30.3		
Apr.	−0.6	−1.2	−1.8	−2.5	−2.9	−4.5	−5.7	−7.0	−8.0	−10.9	−13.7	−16.5	−19.3	−22.0	−24.7	−27.2	−29.7		
May	−0.7	−1.5	−2.1	−2.8	−3.4	−4.8	−6.1	−7.4	−8.5	−10.9	−13.3	−15.8	−18.4	−20.9	−23.5	−25.9	−28.3		
June	−0.5	−1.0	−1.6	−2.1	−2.5	−3.9	−5.0	−6.2	−7.4	−9.6	−11.9	−14.1	−16.5	−18.9	−21.2	−23.6	−26.0		
July	−0.6	−1.0	−1.6	−2.1	−2.5	−3.9	−5.0	−6.1	−7.2	−9.4	−11.5	−13.6	−15.8	−18.3	−20.4	−21.6	−24.9	−27.2	−29.6
Aug.	−0.6	−1.1	−1.7	−2.3	−2.7	−4.1	−5.1	−6.5	−7.2	−9.2	−11.0	−13.1	−15.2	−17.2	−19.4	−21.6	−23.8	−26.0	−28.4
Sept.	−0.6	−1.2	−1.8	−2.4	−2.7	−4.2	−5.2	−6.4	−7.4	−9.4	−11.4	−13.4	−15.6	−17.7	−19.8	−22.1	−24.4		
Oct.	−0.5	−0.9	−1.3	−1.7	−2.0	−3.2	−4.2	−5.5	−6.2	−8.2	−10.3	−12.5	−14.7	−16.9	−19.2	−21.5	−23.8		
Nov.	−0.2	−0.5	−0.7	−1.0	−1.2	−2.1	−2.6	−3.4	−4.3	−6.3	−8.4	−10.6	−13.1	−15.5	−18.0	−20.5	−22.9		
Dec.	+0.2	+0.2	+0.3	+0.3	+0.1	−0.5	−0.9	−1.6	−2.4	−4.6	−6.8	−9.2	−11.7	−14.4	−17.0	−19.7	−22.3		

Table 160 gives the details of this computation of the α_1 constant at the height h_1 for all clouds, except the cumulus and the cumulo-nimbus already computed in Tables 139–141, and which will be united with these results for discussion. The surface data, Table 131, comes from Table 129, as stated. Thence is computed the α constant at the surface for these conditions. From Table 23 is taken the heights h at which *on the average* these clouds form during each month of the year. For these heights by interpolation from Table 159, I, we obtain Δt, which added to t at the surface gives t_1 at the height h_1. For the same height by Table 159, II, we find $\Delta\theta$, which added to t gives the mean temperature of the air column θ_1. Thence by the usual computation, having already found e_1 from t_1, B_1 is computed. This gives $B_1 . t_1 . e_1 .$ at the cloud height h_1. Finally the α_1 constant is computed at the cloud, and it is seen that it differs from the α constant at the surface, and that it is always larger.

TABLE 160.—*Computation of the α_1 constant at the height h_1.*

STRATUS.

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Surface B	769.4	772.2	760.8	762.4	758.3	763.8	764.6	765.2	760.2	762.8	763.1	768.0
Surface t	−1.5	−1.6	10.2	12.5	16.0	19.8	23.4	25.6	17.8	12.2	15.0	3.3
Surface e	3.65	3.52	7.96	7.90	11.90	14.46	17.72	18.38	12.84	8.52	10.60	4.56
Surface d	−2.7	−3.2	7.9	7.8	14.0	17.1	19.7	20.9	15.2	9.0	12.2	0.0
$\frac{e}{B}$	.0047	.0046	.0104	.0104	.0157	.0189	.0232	.0240	.0169	.0112	.0139	.0059
Table I	1.3346	1.3344	1.3493	1.3514	1.3590	1.3647	1.3715	1.3740	1.3615	1.3519	1.3566	1.3398
II	−.4565	−.4568	−.4567	−.4569	−.4574	−.4585	−.4592	−.4595	−.4578	−.4571	−.4575	−.4566
α const.	.8781	.8776	.8926	.8945	.9016	.9062	.9123	.9145	.9037	.8948	.8991	.8832
Δt	−4.8	−0.8	−2.5	−3.8	−5.3	−3.1	−6.1	−7.6	−7.0	−4.3	−2.8	−2.3
$\Delta\theta$	−1.6	0.0	−1.2	−1.8	−2.5	−1.6	−3.1	−4.0	−3.4	−2.0	−1.2	−0.7
θ_1	−3.1	−1.6	9.0	10.7	13.2	18.2	20.3	21.6	14.4	10.2	13.8	2.6
h_1	2011	779	666	672	844	640	1243	1445	1250	1021	1102	1852
$-m$	−.11034	−.04257	−.03498	−.03510	−.04369	−.03255	−.06277	−.07264	−.06443	−05339	−.05691	−09952
$+\beta m+\gamma m$	+21	+9	+15	+15	+26	+24	+54	+60	+40	+24	+30	+24
Log B	2.88615	2.88773	2.88127	2.88218	2.87984	2.88298	2.88343	2.88377	2.88093	2.88241	2.88258	2.88536
Log B_1	2.77602	2.84531	2.84644	2.84723	2.83641	2.85067	2.82120	2.81173	2.81690	2.82926	2.82597	2.78608
Const. at cloud B_1	597.0	700.3	702.2	703.4	686.1	709.0	662.5	648.2	656.0	674.9	669.8	611.1
Const. at cloud t_1	−6.3	−2.4	7.7	8.7	10.7	16.7	17.3	18.0	10.8	7.9	12.2	1.0
Const. at cloud e_1	2.690	3.747	7.83	8.38	9.58	14.12	14.67	15.33	9.64	7.94	10.57	4.91
$\frac{e_1}{B_1}$	.0045	.0054	.0112	.0119	.0140	.0199	.0221	.0237	.0147	.0118	.0158	.0080
Table I	1.3301	1.3344	1.3480	1.3495	1.3530	1.3631	1.3655	1.3675	1.3538	1.3489	1.3560	1.3394
II	−.4391	−.4502	−.4514	−.4516	−.4503	−.4535	−.4492	−.4479	−.4473	−.4488	−.4490	−.4413
α_1 const.	.8910	.8842	.8966	.8979	.9027	.9096	−.9163	−.9196	.9068	.9001	.9070	.8981
	Adiabatic data from sheet omitted.											
Mean B	764.4	765.3	765.3	763.0	760.5	761.9	763.6	763.7	762.3	762.2	768.0	766.2
t	−1.0	1.3	9.1	12.0	19.1	20.5	25.1	23.7	19.3	13.4	10.0	2.1
Adiab. t_1	−19.5	-5.4	2.5	5.4	10.6	15.4	13.0	10.2	6.9	3.7	−0.8	−15.1
Adiab. θ_1	−10.3	-2.1	5.8	8.7	14.9	18.0	19.1	17.0	13.1	8.6	4.6	−6.5
h_1	2011	779	666	672	844	640	1243	1445	1250	1021	1102	1852
$-m$	−.11336	−.04259	−.03540	−.03534	−.04342	−.03257	−.06303	−.07380	−.06472	−.05368	−.05879	−.10291
$+\beta m+\gamma m$	+21	+9	+15	+15	+26	+24	+54	+60	+40	+24	+30	+24
Log B	2.88332	2.88383	2.88383	2.88252	2.88110	2.88190	2.88287	2.88292	2.88213	2.88207	2.88536	2.88434
Log B_1	2.77017	2.84133	2.84858	2.84733	2.83794	2.84957	2.82038	2.80972	2.81781	2.82863	2.82687	2.78167
Adiab. B_1	589.1	694.0	705.6	703.6	688.6	707.3	661.3	645.2	657.4	674.0	671.2	604.9

CUMULUS.

[The data for the observations is the mean value of the three computations, 8 to 10 a. m., 12 to 2 p. m., and 4 to 6 p. m., on Table 139–141.]

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean B	764.4	765.3	765.3	763.0	760.5	761.9	763.6	763.7	762.3	762.2	768.0	766.2
t	−1.0	1.3	9.1	12.0	19.1	20.5	25.1	23.7	19.3	13.4	10.0	2.1
Adiab. t_1	−9.5	−8.8	−2.8	0.2	8.0	10.8	15.3	12.7	9.5	3.7	0.1	−8.1
Adiab. θ_1	−5.3	−3.8	3.2	6.1	13.6	15.7	20.2	18.2	14.4	8.6	5.1	−3.0
h_1	1013	1053	1200	1233	1163	1107	1017	1073	1030	1030	1030	1023
$-m$	−.05604	−.05793	−.06434	−.06543	−.06011	−.05680	−.05138	−.05457	−.05309	−.05416	−.05485	−.05611
$+\beta m+\gamma m$	+9	+12	+20	+22	+32	+39	+43	+38	+39	+22	+22	+13
Log B	2.88332	2.88383	2.88383	2.88252	2.88110	2.88190	2.88287	2.88292	2.88213	2.88207	2.88536	2.88434
Log B_1	2.82737	2.82602	2.81969	2.81731	2.82131	2.82549	2.83192	2.82873	2.82943	2.82813	2.83073	2.82836
Adiab. B_1	672.0	669.9	660.2	656.6	662.7	669.1	679.1	674.1	675.2	673.2	677.2	673.5

TABLE 160.—*Computation of the α_1 constant at the height h_1*—Continued.

NIMBUS.

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Surface B	.....	.....	.....	759.7	757.0	762.0	764.5	762.8	760.6	757.6	766.3	760.4
Surface t	.....	.....	.....	10.3	18.6	19.8	24.8	21.4	21.0	12.6	13.0	1.1
Surface e	.....	.....	.....	7.34	10.91	14.69	19.39	12.67	17.80	8.94	8.88	4.02
Surface d	.....	.....	.....	6.8	12.7	17.3	21.8	15.0	20.4	9.7	9.6	−1.6
$\frac{e}{B}$	.....	.....	.....	.0097	.0144	.0193	.0254	.0166	.0234	.0118	.0116	.0053
Table I	.....	.....	.....	1.3488	1.3599	1.3650	1.3746	1.3641	1.3697	1.3528	1.3529	1.3373
II	.....	.....	.....	−.4565	−.4561	−.4584	−.4597	−.4580	−.4590	−.4567	−.4574	−.4558
α Const.	.....	.....	.....	.8923	.9038	.9066	.9149	.9061	.9107	.8961	.8955	.8815
Δt	.....	.....	.....	−7.0	−14.6	−4.2	−11.4	−11.2	−15.4	−4.3	−5.0	+0.3
$\Delta\theta$	.....	.....	.....	−3.6	−8.0	−2.1	−5.9	−6.1	−8.2	−2.0	−2.3	+0.3
θ_1	.....	.....	.....	6.7	10.6	17.7	18.9	15.3	12.8	10.6	10.7	1.4
h_1	.....	.....	.....	1237	2871	831	2402	2370	3395	1050	1831	699
$-m$	.....	.....	.....	−.06552	−.14812	−.04233	−.12185	−.12173	−.17584	−.05484	−.09557	−.03775
$+\beta m+\gamma m$	.....	.....	.....	+25	+66	+29	+81	+64	+116	+25	+39	+9
Log B	.....	.....	.....	2.88064	2.87910	2.88195	2.88338	2.88241	2.88116	2.87944	2.88440	2.88104
Log B_1	.....	.....	.....	2.81537	2.73164	2.83991	2.76234	2.76132	2.70648	2.82485	2.78922	2.84338
Const. at cloud B_1	.....	.....	.....	653.7	539.1	691.7	578.6	577.2	508.7	668.1	615.5	697.2
Const. at cloud t_1	.....	.....	.....	3.3	4.0	15.6	13.4	10.2	5.6	8.3	8.0	1.4
Const. at cloud e_1	.....	.....	.....	5.78	6.07	13.17	11.43	9.26	6.78	8.15	7.99	5.05
$\frac{e_1}{B_1}$	.....	.....	.....	.0088	.0113	.0190	.0198	.0160	.0133	.0122	.0130	.0072
Table I	.....	.....	.....	1.3421	1.3450	1.3614	1.3603	1.3544	1.3482	1.3494	1.3499	1.3391
II	.....	.....	.....	−.4461	−.4332	−.4517	−.4395	−.4387	−.4295	−.4482	−.4426	−.4502
α_1 Const.	.....	.....	.....	.8960	.9118	.9097	.9208	.9157	.9187	.9012	.9073	.8889
Mean B	.....	.....	.....	763.0	760.5	761.9	763.6	763.7	762.3	762.2	768.0	766.2
t	.....	.....	.....	12.0	19.1	20.5	25.1	23.7	19.3	13.4	10.0	2.1
Adiab. t_1	.....	.....	.....	−0.2	−8.3	13.4	2.5	0.8	−12.5	2.9	−6.7	−5.2
Adiab. θ_1	.....	.....	.....	5.9	5.4	17.0	13.8	12.3	3.4	5.3	1.7	−1.6
h_1	.....	.....	.....	1237	2871	831	2402	2370	3395	1050	1831	699
$-m$	.....	.....	.....	−.06568	−.15269	−.04244	−.12404	−.12302	−.18192	−.05588	−.09871	−.03816
$+\beta m+\gamma m$	.....	.....	.....	+25	+66	+29	+81	+64	+116	+25	+39	+9
Log B	.....	.....	.....	2.88252	2.88110	2.88190	2.88287	2.88292	2.88213	2.88207	2.88536	2.88434
Log B_1	.....	.....	.....	2.81709	2.72907	2.83975	2.75964	2.76054	2.70137	2.82644	2.78704	2.84627
Adiab. B_1	.....	.....	.....	656.3	535.9	691.4	575.0	576.2	502.8	670.6	612.4	701.9

TABLE 160.—*Computation of the α_1 constant at the height h_1*—Continued.

STRATO-CUMULUS.

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Surface B	761.0	764.4	761.9	761.6	760.9	762.0	761.8	763.8	762.1	765.4	769.2	765.0
Surface t	1.6	2.6	8.6	11.8	18.3	21.5	24.8	21.3	19.1	16.0	9.4	3.4
Surface e	3.30	4.36	6.93	6.80	11.40	13.72	18.83	13.42	12.78	10.85	7.56	4.32
Surface d	−3.9	−0.6	5.9	5.7	13.4	16.2	21.3	15.9	15.1	12.6	7.2	−0.7
$\frac{e}{B}$	.0043	.0057	.0091	.0089	.0151	.0181	.0247	.0176	.0168	.0142	.0098	.0057
Table I	1.3370	1.3390	1.3469	1.3494	1.3603	1.3654	1.3740	1.3648	1.3624	1.3577	1.3481	1.3397
II	−.4557	−.4563	−.4566	−.4566	−.4575	−.4581	−.4593	−.4582	−.4579	−.4578	−.4574	−.4563
α const.	.8813	.8827	.8903	.8928	.9028	.9073	.9147	.9066	.9045	.8999	.8907	.8834
Δt	−3.8	−10.3	−13.8	−11.6	−14.7	−16.1	−15.0	−11.8	−10.8	−9.9	−9.3	−4.7
$\Delta\theta$	−1.3	−3.8	−6.3	−6.5	−8.0	−8.3	−7.7	−6.6	−5.9	−5.3	−4.2	−1.4
θ_1	0.3	−1.2	2.3	5.3	10.3	13.2	17.1	14.7	13.2	10.7	5.2	2.0
h_1	1817	2439	2574	2322	2801	3411	3278	2570	2377	2412	2971	2383
$-m$	−.09845	−.13289	−.13846	−.12355	−.14639	−.17646	−.16729	−.13228	−.12300	−.12599	−.15812	−.12831
$+\beta m+\gamma m$	+19	+29	+42	+37	+69	+95	+119	+80	+66	+57	+53	+27
Log B	2.88138	2.88332	2.88190	2.88173	2.88133	2.88195	2.88184	2.88298	2.88201	2.88389	2.88604	2.88366
Log B_1	2.78312	2.75072	2.74386	2.75855	2.73563	2.70644	2.71574	2.75150	2.75967	2.75847	2.72845	2.75562
Const. at cloud. B_1	606.9	563.3	554.4	573.5	544.0	508.7	519.7	564.3	575.0	573.4	535.1	569.7
Const. at cloud. t_1	−2.2	−7.7	−5.2	0.2	3.6	5.4	9.8	9.5	8.3	6.1	0.1	−1.3
Const. at cloud. e_1	3.810	2.386	2.959	4.64	5.90	6.69	9.02	8.84	8.15	7.02	4.60	4.04
$\frac{e_1}{B_1}$	.0063	.0042	.0053	.0081	.0108	.0112	.0174	.0157	.0142	.0122	.0086	.0071
Table I	1.3353	1.3286	1.3318	1.3368	1.3442	1.3461	1.3552	1.3535	1.3512	1.3477	1.3391	1.3367
II	−.4405	−.4351	−.4341	−.4369	−.4337	−.4292	−.4316	−.4371	−.4381	−.4376	−.4323	−.4363
α_1 const.	.8948	.8935	.8977	.9019	.9105	.9169	.9236	.9164	.9131	.9101	.9068	.9004
Mean B	764.4	765.3	765.3	763.0	760.5	761.9	763.6	763.7	762.3	762.2	768.0	766.2
t	−1.0	1.3	9.1	12.0	19.1	20.5	25.1	23.7	19.3	13.4	10.0	2.1
Adiab. t_1	−18.3	−21.7	−15.6	−10.4	−7.7	−10.6	−5.0	−0.2	−3.3	−9.0	−17.9	−20.1
Adiab. θ_1	−9.7	−10.2	−3.3	0.8	5.7	5.0	10.1	11.8	8.0	2.2	−4.0	−9.0
h_1	1817	2439	2574	2322	2801	3411	3278	2570	2377	2412	2971	2383
$-m$	−.10219	−.13743	−.14133	−.12558	−.14953	−.18113	−.17155	−.13363	−.12526	−.12979	−.16354	−.13367
$+\beta m+\gamma m$	+19	+29	+42	+37	+69	+95	+119	+80	+66	+57	+53	+27
Log B	2.88332	2.88383	2.88383	2.88252	2.88110	2.88190	2.88287	2.88292	2.88213	2.88207	2.88536	2.88434
Log B_1	2.78132	2.74669	2.74292	2.75731	2.73226	2.70172	2.71251	2.75009	2.75753	2.75285	2.72235	2.75094
Adiab. B_1	604.4	558.1	553.3	571.9	539.8	503.2	515.8	562.5	572.2	566.0	527.7	563.6

TABLE 160.—*Computation of the α_1 constant at the height h_1*—Continued.

ALTO-CUMULUS.

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Surface B	762.3	766.8	762.4	763.2	761.8	761.8	763.4	763.0	762.8	762.4	770.1	766.8
Surface t	−4.3	1.8	10.1	12.4	19.3	21.4	24.6	23.6	19.2	12.7	8.8	1.6
Surface e	2.54	4.02	6.84	6.68	13.38	14.48	18.16	15.82	13.56	8.20	6.20	3.86
Surface d	−7.0	−1.6	5.7	5.4	15.8	17.1	20.6	18.5	15.1	8.4	4.3	−2.1
$\frac{e}{B}$	.0033	.0052	.0090	.0088	.0176	.0190	.0238	.0208	.0178	.0108	.0080	.0050
Table I	1.3309	1.3379	1.3480	1.3499	1.3632	1.3662	1.3730	1.3694	1.3633	1.3519	1.3461	1.3375
II	−.4557	−.4564	−.4566	−.4567	−.4581	−.4583	−.4593	−.4587	−.4582	−.4570	−.4572	−.4564
α const.	.8752	.8815	.8914	.8932	.9051	.9079	.9137	.9107	.9051	.8949	.8889	.8811
Δt	−9.1	−24.4	−23.1	−23.2	−28.5	−22.9	−26.5	−15.0	−18.8	−10.7	−15.6	−15.9
$\Delta\theta$	−2.9	−10.9	−11.0	−11.6	−13.8	−11.8	−13.4	−8.7	−10.1	−5.7	−6.9	−6.0
θ_1	−7.2	−9.1	−0.9	0.8	5.5	9.6	11.2	14.9	9.1	7.0	1.9	−4.4
h_1	2803	4872	4086	4265	5180	4949	5931	3772	4344	2620	4292	4664
$-m$	−.15616	−.27319	−.22237	−.23027	−.27520	−.25921	−.30886	−.19397	−.22795	−.13855	−.23112	−.25701
$\gamma+\beta m+\gamma m$	+22	+47	+63	+61	+122	+136	+168	+109	+152	+51	+57	+45
Log B	2.88213	2.88468	2.88218	2.88264	2.88184	2.88184	2.88275	2.88252	2.88241	2.88218	2.88653	2.88468
Log B_1	2.72619	2.61196	2.66044	2.65298	2.60786	2.62399	2.57557	2.68964	2.65598	2.74414	2.65600	2.62812
Const. at cloud. B_1	532.3	409.2	457.6	449.8	405.4	420.7	376.3	489.4	452.9	554.8	452.9	424.7
Const. at cloud. t_1	−13.4	−22.6	−13.0	−10.8	−9.2	−1.5	−1.9	8.6	0.4	2.0	−6.8	−14.3
Const. at cloud. e_1	1.439	0.602	1.492	1.826	2.100	4.036	3.906	8.32	4.70	5.27	2.577	1.326
$\frac{e_1}{B_1}$	.0027	.0015	.0033	.0041	.0052	.0096	.0104	.0170	.0104	.0095	.0057	.0031
Table I	1.3221	1.3173	1.3230	1.3258	1.3281	1.3385	1.3388	1.3539	1.3409	1.3416	1.3303	1.3216
II	−.4309	−.4129	−.4207	−.4196	−.4126	−.4159	−.4083	−.4274	−.4211	−.4349	−.4203	−.4155
α_1 const.	.8912	.9044	.9023	.9062	.9155	.9226	.9305	.9265	.9198	.9067	.9100	.9061
Mean B	764.4	765.3	765.3	763.0	760.5	761.9	763.6	763.7	762.3	762.2	768.0	766.2
t	−1.0	1.3	9.1	12.0	19.1	20.5	25.1	23.7	19.3	13.4	10.0	2.1
Adiab. t_1	−27.7	−43.8	−29.5	−28.0	−28.9	−15.4	−29.9	−11.6	−21.0	−10.5	−29.8	−40.8
Adiab. θ_1	−14.4	−21.3	−10.2	−8.0	−4.9	+2.6	−2.4	+6.1	−0.9	+1.5	−9.9	−19.4
h_1	2803	4872	4086	4265	5180	4949	5931	3772	4344	2620	4292	4664
$-m$	−.16051	−.28653	−.23017	−.23827	−.28599	−.26580	−.32439	−.20008	−.23633	−.14134	−.24149	−.27225
$+\beta m+\gamma m$	+22	+47	+63	+61	+122	+136	+168	+109	+152	+51	+57	+45
Log B	2.88332	2.88383	2.88383	2.88252	2.88110	2.88190	2.88287	2.88292	2.88213	2.88207	2.88536	2.88434
Log B_1	2.72303	2.59777	2.65429	2.64486	2.59633	2.61746	2.56016	2.68393	2.64732	2.74124	2.64444	2.61254
Adiab. B_1	528.5	396.1	451.1	441.4	394.8	414.4	363.2	483.0	443.9	551.1	441.0	409.8

TABLE 160.—*Computation of the α_1 constant at the height h_1*—Continued.

ALTO-STRATUS.

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Surface B	.....	768.5	765.7	763.7	761.8	760.4	763.2	762.7	764.8	760.0	768.6	767.6
Surface t	.....	−1.1	8.8	13.0	20.1	21.9	25.1	23.4	19.4	15.6	3.2	−0.1
Surface e	.....	3.54	6.33	4.65	12.26	14.41	18.56	15.24	12.22	10.68	3.98	3.34
Surface d	.....	−3.1	4.6	0.2	14.5	17.0	21.1	17.9	14.4	12.4	−1.7	−3.8
$\frac{e}{B}$	.....	.0046	.0083	.0061	.0161	.0190	.0243	.0200	.0160	.0141	.0052	.0044
Table I	.....	1.3349	1.3462	1.3482	1.3627	1.3666	1.3739	1.3686	1.3620	1.3573	1.3392	1.3355
II	.....	−.4564	−.4567	−.4565	−.4578	−.4582	−.4594	−.4585	−.4581	−.4573	−.4566	−.4563
α const.	.....	.8785	.8895	.8917	.9049	.9084	.9145	.9101	.9039	.9000	.8826	.8792
Δt	.....	−13.3	−14.1	−20.7	−28.7	−24.6	−34.6	−25.6	−23.9	−20.5	−20.8	−18.3
$\Delta\theta$	.....	−4.9	−6.5	−10.7	−13.9	−12.7	−17.6	−14.7	−12.5	−10.4	−9.1	−7.0
θ_1	.....	−6.0	2.3	2.3	6.2	9.2	7.5	8.7	6.9	5.2	−5.9	−7.1
h_1	.....	2958	2646	3829	5270	5356	7732	6793	5569	5023	5340	5088
$-m$	.....	−.16404	−.14231	−.20591	−.27937	−.28090	−.40785	−.35684	−.29447	−.26724	−.29591	−.28322
$+Bm+\gamma m$	.....	+29	+42	+42	+129	+133	+197	+156	+116	+101	+52	+44
Log B	.....	2.88564	2.88406	2.88292	2.88184	2.88104	2.88264	2.88235	2.88355	2.88081	2.88570	2.88513
Log B_1	.....	2.72189	2.74217	2.67743	2.60376	2.60147	2.47676	2.52707	2.59024	2.61458	2.59031	2.60235
Const. at cloud B_1	.....	527.1	552.3	475.8	401.6	399.5	299.8	336.6	389.3	411.7	411.4	400.3
Const. at cloud t_1	.....	−14.4	−5.3	−7.7	−8.6	−2.7	−9.5	−2.2	−4.5	−4.9	−17.6	−18.2
Const. at cloud e_1	.....	1.314	2.933	2.386	2.212	3.655	2.048	3.810	3.140	3.034	0.988	0.934
$\frac{e_1}{B_1}$	.....	.0025	.0053	.0050	.0055	.0091	.0068	.0113	.0081	.0074	.0024	.0023
Table I	.....	1.3210	1.3317	1.3293	1.3297	1.3371	1.3291	1.3394	1.3346	1.3337	1.3178	1.3172
II	.....	−.4302	−.4338	−.4236	−.4120	−.4122	−.3921	−.4007	−.4103	−.4140	−.4132	−.4113
α_1 const.	.....	.8908	.8979	.9057	.9177	.9249	.9370	.9387	.9243	.9197	.9046	.9059
Mean B	.....	765.3	765.3	763.0	760.5	761.9	763.6	763.7	762.3	762.2	768.0	766.2
t	.....	1.3	9.1	12.0	19.1	20.5	25.1	23.7	19.3	13.4	10.0	2.1
Adiab. t_1	.....	−26.6	−15.9	−24.1	−29.6	−39.2	−54.8	−38.4	−31.9	−27.0	−36.3	−44.7
Adiab. θ_1	.....	−12.7	−3.4	−6.0	−5.3	−9.4	−14.9	−7.4	−6.3	−6.8	−13.2	−21.3
h_1	.....	2958	2646	3829	5270	5356	7732	6793	5569	5023	5340	5088
$-m$	.....	−.16829	−.14533	−.21233	−.29138	−.30075	−.44326	−.37859	−.30905	−.27932	−.30423	−.29919
$+\beta m+\gamma m$	.....	+29	+42	+42	+129	+133	+197	+156	+116	+101	+52	+44
Log B	.....	2.88383	2.88383	2.88252	2.88110	2.88190	2.88267	2.88292	2.88213	2.88207	2.88536	2.88434
Log B_1	.....	2.71583	2.73892	2.67061	2.59101	2.58248	2.44158	2.50589	2.57424	2.60376	2.58165	2.58559
Adiab. B_1	.....	519.8	548.2	468.4	390.0	382.4	276.4	320.5	375.2	401.6	381.6	385.1

TABLE 160.—*Computation of the α_1 constant at the height h_1*—Continued.

CIRRO-CUMULUS.

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Surface B	764.8	765.0	767.8	763.6	761.2	762.0	763.8	763.0	760.0	763.0	769.0	766.3
Surface t	0.0	2.4	8.9	11.0	21.0	21.6	24.9	23.3	19.6	11.4	6.6	2.2
Surface e	3.20	3.76	5.68	5.64	14.45	13.97	17.66	14.96	14.86	6.88	5.21	3.34
Surface d	−4.3	−2.3	3.0	2.9	17.1	16.5	20.3	17.6	17.5	6.8	1.8	−4.1
$\frac{e}{B}$	.0042	.0049	.0074	.0074	.0190	.0183	.0233	.0196	.0195	.0090	.0068	.0044
Table I	1.3355	1.3382	1.3457	1.3475	1.3658	1.3656	1.3728	1.3682	1.3650	1.3492	1.3434	1.3376
II	−.4561	−.4562	−.4568	−.4565	−.4582	−.4582	−.4592	−.4585	−.4582	−.4567	−.4569	−.4562
α const.	.8794	.8820	.8889	.8910	.9076	.9074	.9136	.9097	.9068	.8925	.8865	.8814
Δt	−24.4	−40.4	−37.7	−40.9	−41.3	−42.7	−42.5	−34.7	−37.4	−32.3	−41.5	−36.3
$\Delta \theta$	−9.9	−19.2	−18.4	−20.5	−20.8	−21.1	−20.8	−17.4	−18.9	−15.7	−18.6	−14.7
θ_1	−9.9	−16.8	−9.5	−9.5	0.2	0.5	4.1	5.9	0.7	−4.3	−12.0	−12.5
h_1	5448	7747	6635	7439	7981	8979	9379	8129	8560	7482	9234	8142
$-m$	−.30648	−.44740	−.37262	−.41773	−.43220	−.48562	−.50064	−.43122	−.46265	−.41202	−.52333	−.46239
$+\beta m+\gamma m$	+45	+64	+72	+80	+161	+172	+207	+169	+172	+88	+86	+62
Log B	2.88355	2.88366	2.88525	2.88287	2.88150	2.88195	2.88298	2.88252	2.88081	2.88252	2.88593	2.88440
Log B_1	2.57752	2.43690	2.51335	2.46594	2.45091	2.39805	2.38441	2.45299	2.41988	2.47138	2.36346	2.42263
Const. at cloud B_1	378.0	273.5	326.1	292.4	282.4	250.1	242.3	283.8	263.0	296.1	230.9	264.6
Const. at cloud t_1	−24.4	−38.0	−28.8	−29.9	−20.3	−21.1	−17.6	−11.4	−17.8	−20.9	−34.9	−34.1
Const. at cloud e_1	0.503	0.120	0.321	0.287	0.758	0.699	0.988	1.729	0.970	0.713	0.167	0.183
$\frac{e_1}{B_1}$	.0013	.0004	.0010	.0010	.0027	.0028	.0041	.0061	.0037	.0024	.0007	.0007
Table I	1.3106	1.2964	1.3061	1.3050	1.3156	1.3149	1.3193	1.3269	1.3187	1.3148	1.2998	1.3006
II	−.4072	−.3848	−.3970	−.3895	−.3874	−.3791	−.3771	−.3882	−.3826	−.3906	−.3734	−.3826
α_1 const.	.9034	.9116	.9091	.9155	.9282	.9358	.9422	.9387	.9361	.9242	.9264	.9180
Mean B	764.4	765.3	765.3	763.0	760.5	761.9	763.6	763.7	762.3	762.2	768.0	766.2
t	−1.0	1.3	9.1	12.0	19.1	20.5	25.1	23.7	19.3	13.4	10.0	2.1
Adiab. t_1	−50.8	−69.0	−52.5	−56.7	−53.2	−58.9	−58.4	−50.0	−57.7	−54.2	−72.7	−70.4
Adiab. θ_1	−25.9	−33.9	−21.7	−22.4	−17.1	−19.2	−16.7	−13.2	−19.2	−20.4	−31.4	−34.2
h_1	5448	7747	6635	7439	7981	8979	9379	8129	8560	7482	9234	8142
$-m$	−.32634	−.47939	−.39073	−.43923	−.46145	−.52333	−.54130	−.46294	−.49896	−.43835	−.56513	−.50443
$+\beta m+\gamma m$	+45	+64	+72	+80	+161	+172	+207	+169	+172	+88	+86	+62
Log B	2.88332	2.88383	2.88383	2.88852	2.88110	2.88190	2.88287	2.88292	2.88213	2.88207	2.88535	2.88434
Log B_1	2.55743	2.40508	2.49382	2.44409	2.42126	2.36019	2.34364	2.42167	2.38489	2.44460	2.32109	2.38053
Adiab. B_1	360.9	254.1	311.8	278.0	263.8	229.2	220.6	264.0	242.6	278.4	209.5	240.2

TABLE 160.—*Computation of the α_1 constant at the height h_1*—Continued.

CIRRUS.

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Surface B	770.6	765.6	766.6	764.1	761.5	761.7	763.4	763.8	765.4	762.0	768.2	767.8
Surface t	−5.2	1.7	6.3	11.2	19.0	21.8	25.0	24.6	17.6	13.6	10.1	0.4
Surface e	2.52	3.34	4.66	5.74	10.66	13.70	17.68	15.96	11.33	8.70	6.66	3.08
Surface d	−7.1	−3.8	0.3	3.2	13.7	16.2	20.3	18.6	13.3	9.3	5.3	−4.7
$\frac{e}{B}$	.0033	.0044	.0061	.0075	.0140	.0180	.0232	.0209	.0148	.0114	.0087	.0040
Table I	1.3301	1.3371	1.3426	1.3478	1.3599	1.3655	1.3728	1.3704	1.3595	1.3532	1.3478	1.3357
II	−.4564	−.4562	−.4565	−.4565	−.4574	−.4581	−.4594	−.4588	−.4579	−.4570	−.4571	−.4563
α const.	.8737	.8809	.8861	.8913	.9025	.9074	.9134	.9116	.9016	.8962	.8907	.8794
Δt	−43.6	−45.3	−50.9	−49.5	−49.6	−48.2	−48.8	−44.5	−48.6	−43.3	−46.6	−40.6
$\Delta\theta$	−19.2	−21.2	−26.0	−26.6	−25.4	−23.9	−23.1	−21.9	−24.2	−21.0	−21.2	−16.7
θ_1	−24.4	−19.5	−19.7	−14.4	−6.4	−2.1	1.9	2.7	−6.6	−7.4	−11.1	−16.3
h_1	8659	8494	9302	9744	9818	10139	10672	10149	10936	9815	10320	8898
$-m$	−.51527	−.49602	−.54319	−.55732	−.54468	−.55415	−.57411	−.54441	−.60870	−.54658	−.58276	−.51278
$+Bm+\gamma m$	+59	+63	+78	+91	+143	+179	+223	+197	+157	+117	+108	+61
Log B	2.88683	2.88400	2.88457	2.88315	2.88167	2.88178	2.88275	2.88298	2.88389	2.88195	2.88547	2.88525
Log B_1	2.37215	2.38861	2.34216	2.32674	2.33842	2.32942	2.31087	2.34054	2.27676	2.33654	2.30379	2.37308
Const. at cloud B_1	235.6	244.7	219.4	212.2	218.0	213.5	204.6	219.0	189.1	217.0	201.3	236.1
Const. at cloud t_1	−48.8	−43.6	−43.6	−38.3	−30.6	−26.4	−23.8	−19.9	−31.0	−29.7	−36.5	−40.2
Const. at cloud e_1	0.035	0.068	0.068	0.117	0.267	0.414	0.539	0.789	0.256	0.293	0.140	0.097
$\frac{e_1}{B_1}$	.0001	.0003	.0003	.0006	.0012	.0019	.0026	.0036	.0014	.0014	.0007	.0004
Table I	1.2851	1.2906	1.2906	1.2963	1.3045	1.3092	1.3122	1.3167	1.3043	1.3055	1.2982	1.2942
II	−.3746	−.3773	−.3698	−.3675	−.3694	−.3681	−.3653	−.3701	−.3596	−.3691	−.3639	−.3748
α_1 const.	.9105	.9133	.9208	.9288	.9351	.9411	.9469	.9466	.9447	.9364	.9343	.9194
Mean B	764.4	765.3	765.3	763.0	760.5	761.9	763.6	763.7	762.3	762.2	768.0	766.2
t	−1.0	1.3	9.1	12.0	19.1	20.5	25.1	23.7	19.3	13.4	10.0	2.1
Adiab. t_1	−79.1	−75.7	−75.9	−65.3	−68.8	−68.4	−68.4	−65.0	−77.0	−73.4	−80.4	−77.0
Adiab. θ_1	−40.1	−37.2	−33.4	−26.7	−24.9	−24.0	−21.7	−20.7	−28.9	−30.0	−35.2	−37.5
h_1	8659	8494	9302	9744	9818	10139	10672	10149	10936	9815	10320	8898
$-m$	−.54996	−.53289	−.57425	−.58514	−.58529	−.60220	−.62800	−.59490	−.66246	−.59737	−.64178	−.55891
$+\beta m+\gamma m$	+59	+63	+78	+91	+143	+179	+223	+197	+157	+117	+108	+61
Log B	2.88332	2.88383	2.88383	2.88252	2.88110	2.88190	2.88287	2.88292	2.88213	2.88207	2.88536	2.88434
Log B_1	2.33395	2.35157	2.31036	2.29829	2.29724	2.28149	2.25710	2.28999	2.22124	2.28587	2.24466	2.32604
Adiab. B_1	215.8	224.7	204.3	198.7	198.3	191.2	180.8	195.0	166.4	193.1	175.7	211.9

TABLE 160.—*Computation of the α_1 constant at the height h_1*—Continued.

CIRRO-STRATUS.

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Surface B	757.7	766.0	763.3	766.4	760.2	761.5	763.6	764.8	762.0	763.0	770.0	769.2
Surface t	3.8	0.2	10.6	11.3	18.7	22.7	26.4	21.6	18.4	11.7	11.4	0.2
Surface e	3.90	3.10	7.06	5.15	12.02	15.44	18.23	13.10	12.54	6.62	6.84	3.32
Surface d	−1.9	−4.7	6.2	1.7	14.2	18.1	20.8	15.5	14.8	5.2	5.7	−3.8
$\frac{e}{B}$	.0054	.0041	.0093	.0067	.0158	.0203	.0239	.0171	.0165	.0087	.0089	.0043
Table I	1.3398	1.3356	1.3487	1.3472	1.3613	1.3683	1.3745	1.3647	1.3616	1.3492	1.3491	1.3357
II	−.4556	−.4561	−.4568	−.4566	−.4576	−.4585	−.4593	−.4582	−.4579	−.4566	−.4573	−.4565
α const.	.8842	.8795	.8919	.8906	.9037	.9098	.9152	.9065	.9037	.8926	.8918	.8792
Δt	−39.0	−55.2	−53.5	−46.0	−48.3	−46.0	−58.6	−48.5	−45.8	−41.5	−46.6	−40.4
$\Delta\theta$	−19.6	−26.8	−27.7	−23.3	−24.7	−22.7	29.0	−24.0	−22.8	−20.2	−21.6	−16.7
θ_1	−15.8	−26.6	−17.1	−12.0	−6.0	0.0	−2.6	−2.4	−4.4	−8.5	−10.2	−16.5
h_1	7812	10496	9905	8480	9512	9671	12729	11105	10346	9426	10294	8884
$-m$	−.44940	−.62992	−.57248	−.48066	−.52694	−.52394	−.69589	−.60672	−.56965	−.52713	−.57925	−.51237
$+\beta m+\gamma m$	+64	+72	+111	+84	+160	+185	+247	+179	+173	+97	+106	+64
Log B	2.87950	2.88423	2.88270	2.88446	2.88093	2.88167	2.88287	2.88355	2.88195	2.88252	2.88649	2.88604
Log B_1	2.43074	2.25503	2.31133	2.40464	2.35559	2.35958	2.18945	2.27862	2.31403	2.35636	2.30830	2.37431
Const. at cloud. B_1	269.6	179.9	204.8	253.9	226.8	228.9	154.7	189.9	206.1	227.2	203.4	236.8
Const. at cloud. t_1	−35.2	−55.0	−42.9	−34.7	−29.6	−23.3	−32.2	−26.9	−27.4	−29.8	−35.2	−40.2
Const. at cloud. e_1	0.162	0.018	0.073	0.170	0.296	0.566	0.225	0.393	0.373	0.290	0.161	0.097
$\frac{e_1}{B_1}$	.0006	.0001	.0004	.0007	.0013	.0024	.0015	.0021	.0018	.0013	.0008	.0004
Table I	1.2994	1.2784	1.2914	1.3000	1.3051	1.3135	1.3032	1.3088	1.3081	1.3054	1.2996	1.2942
II	−.3839	−.3561	−.3650	−.3798	−.3722	−.3730	−.3459	−.3601	−.3657	−.3723	−.3646	−.3751
α_1 const.	.9155	.9223	.9264	.9202	.9329	.9405	.9573	.9487	.9424	.9331	.9350	.9191
Mean B	764.4	765.3	765.3	763.0	760.5	761.9	763.6	763.7	762.3	762.2	768.0	766.2
t	−1.0	1.3	9.1	12.0	19.1	20.5	25.1	23.7	19.3	13.4	10.0	2.1
Adiab. t_1	−71.5	−83.1	−80.0	−75.9	−66.5	−64.2	−85.0	−74.0	−72.2	−70.5	−80.0	−76.8
Adiab. θ_1	−35.3	−40.9	−35.5	−32.0	−23.7	−41.9	−30.0	−25.2	−26.5	−28.6	−35.0	−37.4
h_1	7812	10496	9905	8480	9512	9671	12729	11105	10346	9426	10294	8884
$-m$	−.48625	−.66871	−.61681	−.52054	−.56435	−.61893	−.77431	−.66264	−.62060	−.57047	−.63963	−.55780
$+\beta m+\gamma m$	+64	+72	+111	+84	+160	+185	+247	+179	+173	+97	+106	+64
Log B	2.88332	2.88383	2.88383	2.88252	2.88110	2.88190	2.88287	2.88292	2.88213	2.88207	2.88536	2.88434
Log B_1	2.39771	2.21584	2.26813	2.36282	2.31835	2.26482	2.11103	2.22207	2.26326	2.31257	2.24679	2.32718
Adiab. B_1	249.9	164.4	185.4	230.6	208.1	184.0	129.1	166.7	183.3	205.4	176.5	212.4

HEAT DIVERGENCE BETWEEN THE OBSERVED AND ADIABATIC CONDITIONS.

TABLE 161.—*Divergence between the observed and the adiabatic states of the atmosphere.*

JANUARY.

Cloud	h_1	B_1	t_1	$\frac{e_1}{B_1}$	ΔI	I	Dry	Vapor	ΔII	II	Dry	Vapor
	Observations											
Ci. S.	7812	269.6	−35.2	.0006	−.0404	1.2941	1.2989	−.0048	+.0717	−.3843	−.3839	−.0004
Ci.	8659	235.6	−48.8	.0001	−.0450	1.2895	1.2848	+.0047	+.0818	−.3742	−.3746	+.0004
Ci. Cu.	5448	378.0	−24.4	.0013	−.0249	1.3096	1.3094	+.0002	+.0489	−.4071	−.4070	−.0001
A. S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
A. Cu.	2803	532.3	−13.4	.0027	−.0088	1.3257	1.3196	+.0061	+.0248	−.4312	−.4305	−.0007
S. Cu.	1817	606.9	− 2.2	.0063	−.0017	1.3328	1.3298	+.0030	+.0152	−.4408	−.4395	−.0013
Cu.	1013	672.0	−11.7	.0025	−.0091	1.3254	1.3213	+.0041	+.0089	−.4471	−.4465	−.0006
N.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
S.	2011	597.0	− 6.3	.0045	−.0045	1.3300	1.3261	+.0039	+.0174	−.4386	−.4384	−.0002
Surface	0	764.4	− 1.0	.0040	0	1.3345	1.3309	+.0036	0	−.4560	−.4453	−.0007
	Adiabatic conditions											
Ci. S.	7812	249.9	−75.7	$\frac{e_1}{B_1}=.0040$	.....	1.2578	1.2546	+.0032	.....	−.3793	−.3787	−.0006
Ci.	8659	215.8	−84.1		.....	1.2477	1.2445	+.0032	.....	−.3692	−.3685	−.0007
Ci. Cu.	5448	360.9	−53.5		.....	1.2830	1.2798	+.0032	.....	−.4045	−.4039	−.0006
A. S.	.....	.....	.....		.....	.....	.....	.....	.....	.....	.....	.....
A. Cu.	2803	528.5	−28.1		.....	1.3091	1.3058	+.0033	.....	−.4306	−.4300	−.0006
S. Cu.	1817	604.4	−18.3		.....	1.3184	1.3151	+.0033	.....	−.4399	−.4392	−.0007
Cu.	1013	672.0	−21.3		.....	1.3157	1.3124	+.0033	.....	−.4372	−.4465	−.0007
N.	.....	.....	.....		.....	.....	.....	.....	.....	.....	.....	.....
S.	2011	589.1	−20.3		.....	1.3166	1.3133	+.0033	.....	−.4381	−.4374	−.0007
Surface	0	764.4	− 1.0		.....	1.3345	1.3309	+.0036	.....	−.4560	−.4553	−.0007
Adiabatic constant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.8785		

	h_1	B_1	T_1	I Dry	I Vapor	II Dry	II Vapor	I Dry	I Vap.	II Dry	II Vap.	Q
	Observations—adiabatic											
Ci. S.	7812		217.5	+.0443	−.0080	−.0052	+.0002	**+9.66**	**−1.74**	**−1.13**	**+0.04**	**+6.83**
Ci.	8659		206.5	+.0403	+.0015	−.0061	+.0011	**+8.34**	**+0.31**	**−1.26**	**+0.23**	**+7.62**
Ci. Cu.	5448		234.0	+.0296	− 0030	−.0031	+.0005	**+6.93**	**−0.70**	**−0.73**	**+0.12**	**+5.62**
A. S.	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
A. Cu.	2803		252.7	+.0138	+.0028	−.0005	−.0001	**+3.48**	**+0.71**	**−0.12**	**−0.02**	**+4.04**
S. Cu.	1817		262.7	+.0147	−.0003	− 0003	−.0006	**+3.87**	**−0.08**	**−0.08**	**−0.16**	**+3.55**
Cu.	1013		256.5	+.0089	+.0008	.0000	+.0001	**+2.28**	**+0.20**	**0.00**	**+0.03**	**+2.51**
N.	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
S.	2011		259.7	+.0128	+.0006	−.0010	+.0005	**+3.32**	**+0.16**	**−0.26**	**+0.13**	**+3.35**
Surface	0		272.0	.0000	.0000	.0000	.0000	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

TABLE 161.—*Divergence between the observed and the adiabatic states of the atmosphere*—Continued.

FEBRUARY.

Cloud	h_1	B_1	t_1	$\frac{e_1}{B_1}$	ΔI	I	Dry	Vapor	ΔII	II	Dry	Vapor
	Observations											
Ci. S.	10496	179.9	−55.0	.0001	−.0572	1.2799	1.2783	+.0016	+.1000	−.3563	−.3561	−.0002
Ci.	8494	244.7	−43.6	.0003	−.0465	1.2906	1.2904	+.0002	+.0789	−.3774	−.3772	−.0002
Ci. Cu.	7747	273.5	−38.0	.0004	−.0418	1.2953	1.2961	−.0008	+.0714	−.3849	−.3848	−.0001
A. S.	2958	527.1	−14.4	.0025	−.0139	1.3232	1.3187	+.0045	+.0262	−.4301	−.4298	−.0003
A. Cu.	4872	409.2	−22.6	.0015	−.0206	1.3165	1.3111	+.0054	+.0435	−.4128	−.4125	−.0003
S. Cu.	2439	563.2	− 7.7	.0042	−.0104	1.3267	1.3249	+.0018	+.0212	−.4351	−.4344	−.0007
Cu.	1053	669.8	− 5.3	.0044	−.0091	1.3281	1.3270	+.0011	+.0092	−.4471	−.4463	−.0008
N.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
S.	779	700.3	− 2.4	.0054	.0000	1.3371	1.3296	+.0075	+.0066	−.4497	−.4493	−.0004
Surface	0	765.3	1.3	.0048	0	1.3371	1.3329	+.0042	0	−.4563	−.4554	−.0009
	Adiabatic conditions											
Ci. S.	10496	164.4	−96.0	$\frac{e_1}{B_1}=.0048$	.....	1.2313	1.2276	+.0037	.....	−.3505	−.3499	−.0006
Ci.	8494	224.7	−80.2		.....	1.2529	1.2491	+.0038	.....	−.3721	−.3714	−.0007
Ci. Cu.	7747	254.1	−73.4		.....	1.2613	1.2575	+.0038	.....	−.3805	−.3798	−.0007
A. S.	2958	519.8	−27.5		.....	1.3105	1.3065	+.0040	.....	−.4297	−.4289	−.0008
A. Cu.	4872	396.1	−46.1		.....	1.2917	1.2878	+.0039	.....	−.4109	−.4102	−.0007
S. Cu.	2439	558.1	−22.3		.....	1.3154	1.3114	+.0040	.....	−.4346	−.4338	−.0008
Cu.	1053	669.9	− 9.0		.....	1.3279	1.3237	+.0042	.....	−.4471	−.4463	−.0008
N.	.....	.....	.....		.....	.....	.....	.....	.....	.....	.....	.....
S.	779	694.0	− 6.3		.....	1.3303	1.3261	+.0042	.....	−.4495	−.4487	−.0008
Surface	0	765.3	1.3		.....	1.3371	1.3329	+.0042	.....	−.4563	−.4554	−.0009
Adiabatic constant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.8808		

	h_1	B_1	T_1	I Dry	I Vapor	II Dry	II Vapor	**I Dry**	**I Vap.**	**II Dry**	**II Vap.**	**Q**
	Observations—adiabatic											
Ci. S.	10496		197.5	+.0507	−.0021	−.0062	+.0004	**+10.03**	**−0.42**	**−1.23**	**+0.08**	**+8.46**
Ci.	8494		211.1	+.0413	−.0036	−.0058	+.0005	**+ 8.71**	**−0.76**	**−1.22**	**+0.11**	**+6.84**
Ci. Cu.	7747		217.3	+.0386	−.0046	−.0050	+.0006	**+ 8.37**	**−1.00**	**−1.08**	**+0.13**	**+6.42**
A. S.	2958		251.0	+.0122	+.0005	−.0009	+.0005	**+ 3.06**	**+0.13**	**−0.23**	**+0.13**	**+3.09**
A. Cu.	4872		238.6	+.0233	+.0015	−.0023	+.0004	**+ 5.57**	**+0.36**	**−0.55**	**+0.10**	**+5.48**
S. Cu.	2439		258.0	+.0135	−.0022	−.0006	+.0001	**+ 3.48**	**−0.57**	**−0.15**	**+0.03**	**+2.79**
Cu.	1053		265.8	+.0033	−.0031	.0000	.0000	**+ 0.88**	**−0.82**	**0.00**	**0.00**	**+0.06**
N.	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
S.	779		268.6	+.0035	+.0033	−.0006	+.0004	**+ 0.94**	**+0.89**	**−0.16**	**+0.11**	**+1.78**
Surface	0		274.3	.0000	.0000	.0000	.0000	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

TABLE 161.—*Divergence between the observed and the adiabatic states of the atmosphere*—Continued.

MARCH.

Cloud	h_1	B_1	t_1	$\frac{e_1}{B_1}$	ΔI	I	Dry	Vapor	ΔII	II	Dry	Vapor
	Observations											
Ci. S.	9905	204.8	−42.9	.0004	−.0573	1.2894	1.2911	−.0017	+.0918	−.3648	−.3650	+.0002
Ci.	9302	219.4	−43.6	.0003	−.0520	1.2947	1.2904	+.0043	+.0867	−.3699	−.3697	−.0002
Ci. Cu.	6635	326.1	−28.8	.0010	−.0396	1.3071	1.3053	+.0018	+.0598	−.3968	−.3969	+.0001
A. S.	2646	552.3	− 5.3	.0053	−.0145	1.3322	1.3270	+.0052	+.0229	−.4337	−.4330	−.0007
A. Cu.	4086	457.6	−13.0	.0033	−.0250	1.3217	1.3200	+.0017	+.0359	−.4207	−.4201	−.0006
S. Cu.	2574	554.4	− 5.2	.0053	−.0151	1.3316	1.3271	+.0045	+.0225	−.4341	−.4333	−.0008
Cu.	1200	655.8	− 0.2	.0069	−.0090	1.3377	1.3315	+.0062	+.0104	−.4462	−.4448	−.0014
N.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
S.	666	702.2	7.7	.0112	−.0013	1.3454	1.3385	+.0069	+.0053	−.4513	−.4495	−.0018
Surface	0	765.3	9.1	.0084	0	1.3467	1.3396	+.0071	0	−.4566	−.4554	−.0012
	Adiabatic conditions											
Ci. S.	9905	185.4	−85.3	$\frac{e_1}{B_1}=.0084$	.....	1.2494	1.2428	+.0066	.....	−.3593	−.3581	−.0012
Ci.	9302	204.3	−80.0		.....	1.2561	1.2490	+.0071	.....	−.3660	−.3648	−.0012
Ci. Cu.	6635	311.8	−55.0		.....	1.2852	1.2783	+.0069	.....	−.3951	−.3938	−.0013
A. S.	2646	548.2	−16.6		.....	1.3239	1.3168	+.0071	.....	−.4338	−.4325	−.0013
A. Cu.	4086	451.1	−29.5		.....	1.3104	1.3046	+.0062	.....	−.4204	−.4191	−.0013
S. Cu.	2574	553.3	−15.9		.....	1.3245	1.3174	+.0071	.....	−.4344	−.4331	−.0013
Cu.	1200	660.2	− 2.4		.....	1.3367	1.3296	+.0071	.....	−.4466	−.4452	−.0014
N.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
S.	666	705.6	2.8	.....	.....	1.3413	1.3342	+.0071	.....	−.4512	−.4498	−.0014
Surface	0	765.3	9.1	.....	.....	1.3469	1.3396	+.0071	.....	−.4566	−.4554	−.0012
Adiabatic constant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.8901		

	h_1	B_1	T_1	I Dry	I Vapor	II Dry	II Vapor	I Dry	I Vap.	II Dry	II Vap.	Q
	Observations—adiabatic											
Ci. S.	9905		208.9	+.0483	−.0083	−.0069	+.0014	**+10.09**	**−1.73**	**−1.44**	**+0.29**	**+7.21**
Ci.	9302		211.2	+.0414	−.0028	−.0049	+.0010	**+ 8.74**	**−0.59**	**−1.03**	**+0.21**	**+7.33**
Ci. Cu.	6635		231.1	+.0270	−.0051	−.0031	+.0014	**+ 6.24**	**−1.18**	**−0.72**	**+0.32**	**+4.66**
A. S.	2646		262.0	+.0102	−.0019	−.0005	+.0006	**+ 2.67**	**−0.50**	**−0.13**	**+0.16**	**+2.20**
A. Cu.	4086		255.6	+.0156	−.0045	−.0010	+.0007	**+ 3.97**	**−1.15**	**−0.26**	**+0.18**	**+2.74**
S. Cu.	2574		262.4	+.0097	−.0026	−.0002	+.0005	**+ 2.54**	**−0.68**	**−0.05**	**+0.13**	**+1.94**
Cu.	1200		271.7	+.0019	−.0009	+.0004	.0000	**+ 0.52**	**−0.24**	**+0.11**	**0.00**	**+0.39**
N.	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
S.	666		278.2	+.0043	−.0002	+.0003	−.0004	**+ 1.20**	**−0.06**	**+0.08**	**−0.11**	**+1.11**
Surface	0		282.1	.0000	.0000	.0000	.0000	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

TABLE 161.—*Divergence between the observed and the adiabatic states of the atmosphere*—Continued.

APRIL.

Cloud	h_1	B_1	t_1	$\frac{e_1}{B_1}$	ΔI	I	Dry	Vapor	ΔII	II	Dry	Vapor
	Observations											
Ci. S.	8480	253.9	−34.7	.0007	−.0472	1.3019	1.2993	+.0026	+.0768	−.3798	−.3797	−.0001
Ci.	9744	212.2	−38.3	.0006	−.0515	1.2976	1.2959	+.0017	+.0890	−.3676	−.3674	−.0002
Ci. Cu.	7439	292.4	−29.9	.0010	−.0425	1.3066	1.3042	+.0024	+.0670	−.3896	−.3894	−.0002
A. S.	3829	475.8	− 7.7	.0050	−.0189	1.3302	1.3249	+.0053	+.0329	−.4237	−.4228	−.0009
A. Cu.	4265	449.8	−10.8	.0041	−.0241	1.3250	1.3221	+.0029	+.0371	−.4195	−.4190	−.0005
S. Cu.	2322	573.5	0.2	.0081	−.0106	1.3385	1.3319	+.0066	+.0197	−.4369	−.4356	−.0013
Cu.	1233	656.8	1.5	.0078	−.0117	1.3374	1.3330	+.0044	+.0105	−.4461	−.4449	−.0012
N.	1237	653.7	3.3	.0088	−.0067	1.3424	1.3347	+.0077	+.0104	−.4462	−.4446	−.0016
S.	672	703.4	8.7	.0119	−.0019	1.3472	1.3393	+.0079	+.0053	−.4513	−.4496	−.0017
Surface	0	763.0	12.0	.0082	0	1.3491	1.3421	+.0070	0	−.4566	−.4552	−.0014
	Adiabatic conditions											
Ci. S.	8480	230.6	−71.0	$\frac{e_1}{B_1}=.0082$	.....	1.2668	1.2602	+.0066	.....	−.3743	−.3732	−.0011
Ci.	9744	198.7	−79.5		.....	1.2565	1.2500	+.0065	.....	−.3640	−.3629	−.0011
Ci. Cu.	7439	278.2	−59.7		.....	1.2797	1.2731	+.0066	.....	−.3872	−.3860	−.0012
A. S.	3829	468.4	−25.2		.....	1.3156	1.3087	+.0069	.....	−.4231	−.4218	−.0013
A. Cu.	4265	441.4	−29.5		.....	1.3114	1.3046	+.0068	.....	−.4189	−.4176	−.0013
S. Cu.	2322	571.9	−10.7		.....	1.3292	1.3222	+.0070	.....	−.4367	−.4354	−.0013
Cu.	1233	656.6	0.1		.....	1.3388	1.3318	+.0070	.....	−.4463	−.4449	−.0014
N.	1237	656.3	0.0		.....	1.3387	1.3317	+.0070	.....	−.4462	−.4448	−.0014
S.	672	703.6	5.3		.....	1.3435	1.3365	+.0070	.....	−.4510	−.4496	−.0014
Surface	0	763.0	12.0		.....	1.3491	1.3421	+.0070	.....	−.4566	−.4552	−.0014
Adiabatic constant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.8925		

	h_1	B_1	T_1	I Dry	I Vapor	II Dry	II Vapor	I Dry	I Vap.	II Dry	II Vap.	Q
	Observations−adiabatic											
Ci. S.	8480		220.2	+.0391	−.0040	−.0065	+.0010	**+8.60**	**+0.88**	**−1.43**	**+0.22**	**+6.51**
Ci.	9744		214.1	+.0459	−.0046	−.0045	+.0009	**+9.82**	**−0.98**	**−0.96**	**+0.19**	**+8.07**
Ci. Cu.	7439		228.2	+.0311	−.0042	−.0034	+.0010	**+7.09**	**−0.96**	**−0.78**	**+0.23**	**+5.58**
A. S.	3829		256.6	+.0162	−.0016	−.0010	+.0004	**+4.16**	**−0.41**	**−0.26**	**+0.10**	**+3.59**
A. Cu.	4265		252.8	+.0175	−.0039	−.0014	+.0008	**+4.43**	**−0.99**	**−0.35**	**+0.20**	**+3.29**
S. Cu.	2322		267.8	+.0097	−.0004	−.0002	.0000	**+2.60**	**−0.10**	**−0.05**	**0.00**	**+2.45**
Cu.	1233		273.8	+.0012	−.0026	.0000	+.0002	**+0.33**	**−0.71**	**+0.00**	**+0.05**	**−0.33**
N.	1237		274.6	+.0030	+.0007	+.0002	−.0002	**+0.83**	**+0.09**	**+0.05**	**−0.05**	**+1.02**
S.	672		280.0	+.0028	+.0009	.0000	−.0003	**+0.78**	**+0.25**	**0.00**	**−0.08**	**+0.95**
Surface	0		285.0	.0000	.0000	.0000	.0000	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

TABLE 161.—*Divergence between the observed and the adiabatic states of the atmosphere*—**Continued.**

MAY.

Cloud	h_1	B_1	t_1	$\frac{e_1}{B_1}$	ΔI	I	Dry	Vapor	ΔII	II	Dry	Vapor
	Observations											
Ci. S.	9512	226.8	−29.6	.0013	−.0562	1.3052	1.3045	+.0007	+.0854	−.3721	−.3720	−.0001
Ci.	9818	218.0	−30.6	.0012	−.0554	1.3060	1.3035	+.0025	+.0880	−.3695	−.3693	−.0002
Ci. Cu.	7981	282.4	−20.3	.0027	−.0502	1.3112	1.3133	−.0021	+.0708	−.3867	−.3870	+.0003
A. S.	5270	401.6	− 8.6	.0055	−.0330	1.3284	1.3241	+.0043	+.0458	−.4117	−.4110	−.0007
A. Cu.	5180	405.4	− 9.2	.0052	−.0351	1.3263	1.3235	+.0028	+.0455	−.4120	−.4113	−.0007
S. Cu.	2801	544.0	3.6	.0108	−.0161	1.3453	1.3349	+.0106	+.0238	−.4237	−.4320	−.0017
Cu.	1163	664.6	8.8	.0127	−.0107	1.3507	1.3393	+.0114	+.0097	−.4478	−.4457	−.0021
N.	2871	539.1	4.0	.0113	−.0149	1.3465	1.3353	+.0112	+.0229	−.4346	−.4314	−.0032
S.	844	686.1	10.7	.0140	−.0060	1.3554	1.3409	+.0145	+.0071	−.4504	−.4479	−.0025
Surface	0	760.5	19.1	.0157	0	1.3614	1.3478	+.0136	0	−.4575	−.4549	−.0026
	Adiabatic conditions											
Ci. S.	9512	208.1	−71.1	$\frac{e_1}{B_1}=.0157$	.....	1.2721	1.2601	+.0120	.....	−.3682	−.3660	−.0022
Ci.	9818	198.3	−74.3		.....	1.2689	1.2563	+.0126	.....	−.3650	−.3627	−.0023
Ci. Cu.	7981	263.8	−57.3		.....	1.2885	1.2757	+.0128	.....	−.3846	−.3823	−.0023
A. S.	5270	390.0	−31.6		.....	1.3155	1.3025	+.0130	.....	−.4116	−.4092	−.0024
A. Cu.	5180	394.8	−30.9		.....	1.3162	1.3032	+.0130	.....	−.4123	−.4100	−.0023
S. Cu.	2801	539.8	− 8.3		.....	1.3379	1.3243	+.0136	.....	−.4340	−.4315	−.0025
Cu.	1163	662.7	+ 8.1		.....	1.3522	1.3388	+.0134	.....	−.4483	−.4455	−.0028
N.	2871	535.9	− 8.8		.....	1.3374	1.3239	+.0135	.....	−.4335	−.4310	−.0025
S.	844	688.6	+10.9		.....	1.3547	1.3411	+.0136	.....	−.4508	−.4482	−.0026
Surface	0	760.5	+19.1		.....	1.3614	1.3478	+.0136	.....	−.4575	−.4549	−.0026
Adiabatic constant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.9039		

	h_1	B_1	T_1	I Dry	I Vapor	II Dry	II Vapor	I Dry	I Vapor	II Dry	II Vapor	Q
	Observations—adiabatic											
Ci. S.	9512		222.6	+.0444	−.0113	−.0060	+.0021	**+ 9.90**	**−2.51**	**−1.34**	**+0.47**	**+6.52**
Ci.	9818		220.5	+.0472	−.0101	−.0066	+.0021	**+10.43**	**−2.23**	**−1.46**	**+0.46**	**+7.20**
Ci. Cu.	7981		234.2	+.0376	−.0149	−.0047	+.0026	**+ 8.80**	**−3.49**	**−1.10**	**+0.61**	**+4.82**
A. S.	5270		253.2	+.0216	−.0087	−.0018	+.0017	**+ 5.46**	**−2.20**	**−0.46**	**+0.43**	**+3.23**
A. Cu.	5180		252.9	+.0203	−.0102	−.0013	+.0016	**+ 5.14**	**−2.58**	**−0.32**	**+0.41**	**+2.65**
S. Cu.	2801		270.6	+.0106	−.0030	−.0005	+.0008	**+ 2.87**	**−0.81**	**−0.13**	**+0.22**	**+2.15**
Cu.	1163		281.5	+.0005	−.0020	−.0001	+.0007	**+ 0.14**	**−0.56**	**−0.03**	**+0.19**	**−0.26**
N.	2871		270.6	+.0114	−.0023	−.0004	−.0007	**+ 3.00**	**−0.62**	**−0.11**	**−0.19**	**+2.17**
S.	844		283.8	−.0002	+.0009	+.0003	+.0001	**− 0.06**	**+0.26**	**+0.08**	**+0.03**	**+0.31**
Surface	0		292.1	.0000	.0000	.0000	.0000	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

TABLE 161.—*Divergence between the observed and the adiabatic states of the atmosphere*—Continued.

JUNE.

Cloud	h_1	B_1	t_1	$\frac{e_1}{B_1}$	ΔI	I	Dry	Vapor	ΔII	II	Dry	Vapor
	Observations											
Ci. S.	9671	228.9	−23.3	.0024	−.0548	1.3113	1.3105	+.0008	+.0855	−.3728	−.3727	−.0001
Ci.	10139	213.5	−26.4	.0019	−.0563	1.3098	1.3076	+.0022	+.0900	−.3683	−.3678	−.0005
Ci. Cu.	8979	250.1	−21.1	.0028	−.0507	1.3154	1.3126	+.0028	+.0791	−.3792	−.3787	−.0005
A. S.	5356	399.5	− 2.7	.0091	−.0281	1.3380	1.3294	+.0086	+.0462	−.4122	−.4109	−.0013
A. Cu.	4949	420.7	− 1.5	.0096	−.0277	1.3384	1.3304	+.0080	+.0424	−.4159	−.4144	−.0015
S. Cu.	3411	508.7	5.4	.0112	−.0193	1.3468	1.3366	+.0102	+.0289	−.4294	−.4274	−.0020
Cu.	1107	669.5	13.1	.0167	−.0096	1.3565	1.3430	+.0135	+.0092	−.4491	−.4462	−.0029
N.	831	691.7	15.6	.0190	−.0036	1.3625	1.2450	+.0175	+.0067	−.4516	−.4485	−.0031
S.	640	709.0	16.7	.0199	−.0016	1.3645	1.3459	+.0186	+.0050	−.4533	−.4503	−.0030
Surface	0	961.9	20.5	.0188	0	1.3661	1.3489	+.0172	0	−.4583	−.4551	−.0032
	Adiabatic conditions											
Ci. S.	9671	184.0	−77.1	$\frac{e_1}{B_1}=.0188$	.....	1.2679	1.2529	+.0150	.....	−.3601	−.3577	−.0024
Ci.	10139	191.2	−74.8		.....	1.2706	1.2556	+.0150	.....	−.3628	−.3602	−.0026
Ci. Cu.	8979	229.2	−64.2		.....	1.2832	1.2681	+.0151	.....	−.3754	−.3728	−.0026
A. S.	5356	382.4	−31.2		.....	1.3183	1.3029	+.0154	.....	−.4105	−.4078	−.0027
A. Cu.	4949	414.4	−25.5		.....	1.3241	1.3084	+.0157	.....	−.4163	−.4133	−.0030
S. Cu.	3411	503.2	−11.3		.....	1.3375	1.3216	+.0159	.....	−.4297	−.4266	−.0031
Cu.	1107	669.1	10.9		.....	1.3572	1.3411	+.0161	.....	−.4494	−.4462	−.0032
N.	831	691.4	13.3		.....	1.3594	1.3430	+.0164	.....	−.4516	−.4484	−.0032
S.	640	707.3	15.3		.....	1.3610	1.3446	+.0164	.....	−.4532	−.4500	−.0032
Surface	0	761.9	20.5		.....	1.3661	1.3489	+.0172	.....	−.4583	−.4551	−.0032
Adiabatic constant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.9078		

	h_1	B_1	T_1	I Dry	I Vapor	II Dry	II Vapor	I Dry	I Vapor	II Dry	II Vapor	Q
	Observations—adiabatic											
Ci. S.	9671		222.8	+.0576	−.0142	−.0150	+.0023	**+12.84**	**−3.17**	**−3.35**	**+0.51**	**+6.83**
Ci.	10139		222.4	+.0520	−.0128	−.0076	+.0021	**+11.54**	**−2.84**	**−1.68**	**+0.47**	**+7.49**
Ci. Cu.	8979		230.4	+.0445	−.0123	−.0059	+.0021	**+10.24**	**−2.82**	**−1.36**	**+0.48**	**+6.53**
A. S.	5356		256.0	+.0265	−.0068	−.0031	+.0014	**+ 6.78**	**−1.74**	**−0.79**	**+0.36**	**+4.61**
A. Cu.	4949		259.5	+.0220	−.0077	−.0011	+.0015	**+ 5.72**	**−2.00**	**−0.29**	**+0.39**	**+3.82**
S. Cu.	3411		270.0	+.0150	−.0057	−.0008	+.0011	**+ 4.05**	**−1.54**	**−0.22**	**+0.30**	**+2.59**
Cu.	1107		285.0	+.0019	−.0026	−.0000	+.0003	**+ 0.54**	**−0.74**	**0.00**	**+0.07**	**−0.17**
N.	831		287.4	+.0020	+.0011	−.0001	+.0001	**+ 0.58**	**+0.32**	**−0.03**	**+0.03**	**+0.90**
S.	640		289.0	+.0013	+.0022	−.0003	+.0002	**+ 0.38**	**+0.64**	**−0.08**	**−0.06**	**+0.88**
Surface	0		293.5	.0000	.0000	.0000	.0000	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

TABLE 161.—*Divergence between the observed and the adiabatic states of the atmosphere*—Continued.

JULY.

Cloud	h_1	B_1	t_1	$\frac{e_1}{B_1}$	ΔI	I	Dry	Vapor	ΔII	II	Dry	Vapor
	Observations.											
Ci. S.	12729	154.7	−32.2	.0015	−.0713	1.3021	1.3019	+.0002	+.1134	−.3459	−.3457	−.0002
Ci.	10672	204.6	−23.8	.0026	−.0606	1.3128	1.3100	+.0028	+.0941	−.3652	−.3649	−.0003
Ci. Cu.	9379	242.3	−17.6	.0041	−.0535	1.3199	1.3158	+.0041	+.0821	−.3772	−.3765	−.0007
A. S.	7732	299.8	− 9.5	.0068	−.0448	1.3286	1.3233	+.0053	+.0673	−.3920	−.3912	−.0008
A. Cu.	5931	376.3	− 1.9	.0104	−.0342	1.3392	1.3300	+.0092	+.0510	−.4083	−.4067	−.0016
S. Cu.	3278	519.7	9.8	.0174	−.0188	1.3546	1.3401	+.0045	+.0277	−.4316	−.4289	−.0027
Cu.	1017	680.1	16.8	.0210	−.0093	1.3641	1.3459	+.0182	+.0082	−.4511	−.4473	−.0038
N.	2402	578.6	13.4	.0198	−.0143	1.3591	1.3431	+.0160	+.0202	−.4391	−.4362	−.0029
S.	1243	662.5	17.3	.0221	−.0060	1.3674	1.3463	+.0211	+.0100	−.4493	−.4455	−.0038
Surface	0	763.6	25.1	.0238	0	1.3734	1.3526	+.0208	0	−.4593	−.4552	−.0041
	Adiabatic conditions											
Ci. S.	12729	129.1	−93.4	$\frac{e_1}{B_1}=.0238$	.....	1.2505	1.2322	+.0183	.....	−.3364	−.3333	−.0031
Ci.	10672	180.8	−75.4		.....	1.2737	1.2550	+.0187	.....	−.3596	−.3564	−.0032
Ci. Cu.	9379	220.6	−63.8		.....	1.2875	1.2685	+.0190	.....	−.3734	−.3701	−.0033
A. S.	7732	276.4	−50.0		.....	1.3031	1.2837	+.0194	.....	−.3890	−.3855	−.0035
A. Cu.	5931	363.2	−31.9		.....	1.3220	1.3022	+.0198	.....	−.4079	−.4041	−.0038
S. Cu.	3278	515.8	− 6.4		.....	1.3462	1.3260	+.0202	.....	−.4321	−.4283	−.0038
Cu.	1017	679.1	15.5		.....	1.3654	1.3448	+.0206	.....	−.4513	−.4472	−.0041
N.	2402	575.0	2.0		.....	1.3538	1.3334	+.0204	.....	−.4397	−.4358	−.0039
S.	1243	661.3	13.3		.....	1.3635	1.3431	+.0204	.....	−.4494	−.4453	−.0041
Surface	0	763.6	25.1		.....	1.3734	1.3526	+.0208	.....	−.4593	−.4552	−.0041
Adiabatic constant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.9141		

	h_1	B_1	T_1	I Dry	I Vapor	II Dry	II Vapor	I Dry	I Vap.	II Dry	II Vap.	Q
	Observations—adiabatic											
Ci. S.	12729		210.2	+.0697	−.0181	−.0124	+.0029	**+14.64**	**−3.80**	**−2.60**	**+0.61**	**+8.85**
Ci.	10672		223.4	+.0550	−.0159	−.0085	+.0029	**+12.27**	**−3.55**	**−1.90**	**+0.65**	**+6.47**
Ci. Cu.	9379		232.3	+.0473	−.0149	−.0064	+.0026	**+10.97**	**−3.46**	**−1.48**	**+0.60**	**+6.63**
A. S.	7732		243.3	+.0396	−.0141	−.0057	+.0027	**+ 9.62**	**−3.43**	**−1.39**	**+0.66**	**+5.46**
A. Cu.	5931		256.1	+.0278	−.0106	−.0026	+.0022	**+ 7.12**	**−2.71**	**−0.67**	**+0.56**	**+4.30**
S. Cu.	3278		274.7	+.0141	−.0157	−.0006	+.0011	**+ 3.88**	**−4.32**	**−0.17**	**+0.30**	**−0.81**
Cu.	1017		289.2	+.0011	−.0024	−.0001	+.0003	**+ 0.32**	**−0.69**	**−0.03**	**+0.09**	**−0.33**
N.	2402		280.3	+.0097	−.0044	−.0004	+.0010	**+ 2.72**	**−1.23**	**−0.11**	**+0.28**	**+1.66**
S.	1243		298.3	+.0032	+.0007	−.0002	+.0003	**+ 0.95**	**−0.21**	**−0.06**	**+0.09**	**+0.77**
Surface	0			.0000	.0000	.0000	.0000	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

TABLE 161.—*Divergence between the observed and the adiabatic states of the atmosphere*—**Continued.**

AUGUST.

Cloud	h_1	B_1	t_1	$\frac{e_1}{B_1}$	ΔI	I	Dry	Vapor	ΔII	II	Dry	Vapor
	Observations											
Ci. S.	11105	189.9	−26.9	.0021	−.0559	1.3127	1.3070	+.0057	+.0981	−.3605	−.3598	−.0007
Ci.	10149	219.0	−19.9	.0036	−.0537	1.3149	1.3137	+.0012	+.0887	−.3699	−.3696	−.0003
Ci. Cu.	8129	283.8	−11.4	.0061	−.0413	1.3273	1.3215	+.0058	+.0703	−.3883	−.3873	−.0010
A. S.	6793	336.6	− 2.2	.0113	−.0292	1.3394	1.3298	+.0096	+.0578	−.4008	− 3990	−.0018
A. Cu.	3772	489.4	8.6	.0170	−.0155	1.3531	1.3388	+.0143	+.0313	−.4273	−.4247	−.0026
S. Cu.	2570	564.3	9.5	.0157	−.0113	1.3573	1.3399	+.0174	+.0211	−.4375	−.4345	−.0030
Cu.	1073	675.7	15.1	.0189	−.0120	1.3566	1.3445	+.0121	+.0086	−.4500	−.4469	−.0031
N.	2370	577.2	10.2	.0160	−.0097	1.3589	1.3405	+.0184	+.0193	−.4393	−.4361	−.0032
S.	1445	648.2	18.0	.0237	−.0065	1.3621	1.3469	+.0152	+.0116	−.4470	−.4440	−.0030
Surface	0	763.7	23.7	.0197	0	1.3686	1.3515	+.0171	0	−.4586	−.4552	− 0034
	Adiabatic conditions											
Ci. S.	11105	166.7	−82.2	$\frac{e_1}{B_1}=.0197$	.....	1.2622	1.2467	+.0155	.....	−.3533	−.3508	−.0025
Ci.	10149	195.0	−72.3		.....	1.2743	1.2587	+.0156	.....	−.3643	−.3616	−.0027
Ci. Cu.	8129	264.0	−54.1		.....	1.2952	1.2792	+.0160	.....	−.3852	−.3823	−.0029
A. S.	6793	320.5	−41.6		.....	1.3087	1.2924	+.0163	.....	−.3987	−.3957	−.0030
A. Cu.	3772	483.0	−13.2		.....	1.3365	1.3200	+.0165	.....	−.4270	−.4238	−.0032
S. Cu.	2570	562.5	− 1.1		.....	1.3475	1.3307	+.0168	.....	−.4375	−.4343	−.0032
Cu.	1073	674.1	13.4		.....	1.3601	1.3431	+.0170	.....	−.4501	−.4467	−.0034
N.	2370	576.2	0.7		.....	1.3491	1.3323	+.0167	.....	−.4391	−.4359	−.0032
S.	1445	645.2	9.8		.....	1.3570	1.3401	+.0169	.....	−.4470	−.4437	−.0033
Surface	0	763.7	23.7		.....	1.3686	1.3515	+.0171	.....	−.4586	−.4552	−.0034
Adiabatic constant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.9100		

	h_1	B_1	T_1	I Dry	I Vapor	II Dry	II Vapor	I Dry	I Vap.	II Dry	II Vap.	Q
	Observations—adiabatic											
Ci. S.	11105		218.5	+.0603	−.0098	−.0090	+.0018	**+13.21**	**−2.15**	**−1.97**	**+0.39**	**+9.48**
Ci.	10149		226.9	+.0550	−.0144	−.0088	+.0024	**+12.49**	**−3.27**	**−2.00**	**+0.54**	**+7.76**
Ci. Cu.	8129		240.3	+.0423	−.0102	−.0050	+.0019	**+10.15**	**−2.45**	**−1.20**	**+0.46**	**+6.96**
A. S.	6793		251.1	+.0374	−.0067	−.0033	+.0012	**+ 9.39**	**−1.68**	**−0.83**	**+0.30**	**+7.18**
A. Cu.	3772		275.3	+.0188	−.0022	−.0009	+.0006	**+ 5.17**	**−0.61**	**−0.25**	**+0.17**	**+4.48**
S. Cu.	2570		277.2	+.0092	+.0006	−.0002	+.0002	**+ 2.55**	**+0.17**	**−0.06**	**+0.06**	**+2.72**
Cu.	1073		287.2	+.0014	+.0049	−.0002	+.0003	**+ 0.40**	**+1.41**	**−0.06**	**+0.09**	**+1.84**
N.	2370		278.4	+.0082	+.0017	−.0002	+.0000	**+ 2.28**	**+0.47**	**−0.06**	**0.00**	**+2.69**
S.	1445		286.9	+.0068	−.0017	−.0003	+.0003	**+ 1.95**	**−0.49**	**−0.09**	**+0.09**	**+1.46**
Surface	0		296.8	.0000	.0000	.0000	.0000	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

TABLE 161.—*Divergence between the observed and the adiabatic states of the atmosphere*—Continued.

SEPTEMBER.

Cloud	h_1	B_1	t_1	$\frac{e_1}{B_1}$	ΔI	I	Dry	Vapor	ΔII	II	Dry	Vapor
	Observations											
Ci. S.	10346	206.1	−27.4	.0018	−.0535	1.3097	1.3066	+.0031	+.0922	−.3659	−.3635	−.0024
Ci.	10936	189.1	−31.0	.0014	−.0552	1.3080	1.3031	+.0049	+.0983	−.3598	−.3595	−.0003
Ci. Cu.	8560	263.0	−17.8	.0037	−.0463	1.3169	1.3156	+.0013	+.0756	−.3825	−.3821	−.0004
A. S.	5569	389.3	−4.5	.0081	−.0274	1.3358	1.3277	+.0081	+.0478	−.4103	−.4091	−.0012
A. Cu.	4344	452.9	0.4	.0104	−.0224	1.3408	1.3320	+.0088	+.0371	−.4210	−.4194	−.0016
S. Cu.	2377	575.0	8.3	.0142	−.0112	1.3520	1.3388	+.0132	+.0198	−.4383	−.4358	−.0025
Cu.	1030	675.9	11.5	.0149	−.0095	1.3537	1.3415	+.0122	+.0085	−.4496	−.4469	−.0027
N.	3395	508.7	5.6	.0133	−.0215	1.3417	1.3365	+.0052	+.0295	−.4296	−.4274	−.0022
S.	1250	656.0	10.8	.0147	−.0077	1.3555	1.3469	+.0086	+.0105	−.4476	−.4448	−.0028
Surface	0	762.0	19.3	.0175	0	1.3632	1.3479	+.0153	0	−.4581	−.4551	−.0030
	Adiabatic conditions											
Ci. S.	10346	183.3	−81.5	$\frac{e_1}{B_1}=.0175$	.....	1.2648	1.2475	+.0173	.....	−.3597	−.3573	−.0024
Ci.	10936	166.4	−86.8		.....	1.2580	1.2408	+.0172	.....	−.3530	−.3507	−.0023
Ci. Cu.	8560	242.6	−62.3		.....	1.2842	1.2702	+.0140	.....	−.3790	−.3766	−.0024
A. S.	5569	375.2	−34.2		.....	1.3143	1.2999	+.0144	.....	−.4091	−.4065	−.0026
A. Cu.	4344	443.9	−22.4		.....	1.3259	1.3113	+.0146	.....	−.4208	−.4180	−.0028
S. Cu.	2377	572.2	−3.6		.....	1.3434	1.3285	+.0149	.....	−.4383	−.4355	−.0028
Cu.	1030	675.2	9.5		.....	1.3549	1.3399	+.0150	.....	−.4498	−.4468	−.0030
N.	3395	502.8	−13.4		.....	1.3345	1.3197	+.0148	.....	−.4294	−.4266	−.0028
S.	1250	657.4	7.4		.....	1.3530	1.3380	+.0150	.....	−.4479	−.4449	−.0030
Surface	0	762.0	19.3		.....	1.3632	1.3479	+.0153	.....	−.4581	−.4551	−.0030
Adiabatic constant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.9051		

	h_1	B_1	T_1	I Dry	I Vapor	II Dry	II Vapor	I Dry	I Vap.	II Dry	II Vap.	Q
	Observations—adiabatic											
Ci. S.	10346		218.6	+.0591	−.0142	−.0062	.0000	**+12.94**	**−3.11**	**−1.36**	**0.00**	**+8.47**
Ci.	10936		214.1	+.0623	−.0123	−.0088	+.0020	**+13.33**	**−2.63**	**−1.88**	**+0.43**	**+9.25**
Ci. Cu.	8560		233.0	+.0454	−.0127	−.0055	+.0020	**+10.58**	**−2.96**	**−1.28**	**+0.47**	**+6.81**
A. S.	5569		253.6	+.0278	−.0063	−.0026	+.0014	**+7.06**	**−1.60**	**−0.66**	**+0.36**	**+5.16**
A. Cu.	4344		262.0	+.0207	−.0058	−.0014	+.0012	**+5.42**	**−1.52**	**−0.37**	**+0.31**	**+3.84**
S. Cu.	2377		275.4	+.0103	−.0017	−.0003	+.0003	**+2.83**	**−0.47**	**−0.08**	**+0.08**	**+2.36**
Cu.	1030		283.5	+.0016	−.0028	−.0001	+.0003	**+.45**	**−0.80**	**−0.03**	**+0.09**	**−0.29**
N.	3395		269.1	+.0168	−.0096	−.0008	+.0006	**+4.52**	**−2.58**	**−0.22**	**+0.16**	**+1.88**
S.	1250		282.1	+.0089	−.0064	+.0001	+.0002	**+2.51**	**−1.80**	**+0.03**	**+0.06**	**+0.80**
Surface	0		289.0	.0000	.0000	.0000	.0000	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

TABLE 161.—*Divergence between the observed and the adiabatic states of the atmosphere*—Continued.

OCTOBER.

Cloud	h_1	B_1	t_1	$\frac{e_1}{B_1}$	ΔI	I	Dry	Vapor	ΔII	II	Dry	Vapor
	Observations											
Ci. S.	9426	227.2	−29.8	.0013	−.0438	1.3091	1.3043	+.0048	+.0843	−.3727	−.3721	−.0006
Ci.	9815	217.0	−29.7	.0014	−.0477	1.3052	1.3042	+.0010	+.0879	−.3691	−.3689	−.0002
Ci. Cu.	7482	296.1	−20.9	.0024	−.0344	1.3185	1.3128	+.0057	+.0661	−.3909	−.3903	−.0006
A. S.	5023	411.7	− 4.9	.0074	−.0236	1.3293	1.3273	+.0020	+.0433	−.4137	−.4129	−.0008
A. Cu.	2620	554.8	2.0	.0095	−.0103	1.3426	1.3334	+.0092	+.0221	−.4349	−.4333	−.0016
S. Cu.	2412	573.4	6.1	.0122	−.0100	1.3429	1.3369	+.0060	+.0202	−.4368	−.4356	−.0012
Cu.	1030	675.0	3.8	.0088	−.0101	1.3428	1.3349	+.0079	+.0086	−.4484	−.4468	−.0016
N.	1050	668.1	8.3	.0122	−.0034	1.3495	1.3387	+.0108	+.0085	−.4485	−.4461	−.0024
S.	1021	674.9	7.9	.0118	−.0030	1.3499	1.3385	+.0114	+.0083	−.4487	−.4468	−.0019
Surface	0	762.2	13.4	.0112	0	1.3529	1.3434	+.0095	0	−.4570	−.4551	−.0019
	Adiabatic conditions											
Ci. S.	9426	295.4	−76.5	$\frac{e_1}{B_1}=.0112$	.....	1.2625	1.2536	+.0089	.....	−.3668	−.3652	−.0016
Ci.	9815	193.1	−79.8		.....	1.2584	1.2496	+.0088	.....	−.3625	−.3609	−.0016
Ci. Cu.	7482	278.4	−58.5		.....	1.2836	1.2744	+.0092	.....	−.3877	−.3860	−.0017
A. S.	5023	401.6	−34.6		.....	1.3088	1.2995	+.0093	.....	−.4129	−.4112	−.0017
A. Cu.	2620	551.1	−11.8		.....	1.3305	1.3211	+.0094	.....	−.4346	−.4328	−.0018
S. Cu.	2412	566.0	− 9.8		.....	1.3324	1.3230	+.0094	.....	−.4365	−.4347	−.0018
Cu.	1030	673.2	3.8		.....	1.3444	1.3349	+.0095	.....	−.4485	−.4466	−.0019
N.	1050	670.6	3.5		.....	1.3442	1.3347	+.0095	.....	−.4483	−.4464	−.0019
S.	1621	674.0	3.9		.....	1.3445	1.3350	+.0095	.....	−.4486	−.4467	−.0019
Surface	0	762.2	2.0		.....	1.3529	1.3434	+.0095	.....	−.4570	−.4551	−.0019
Adiabatic constant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.8959		

	h_1	B_1	T_1	I Dry	I Vapor	II Dry	II Vapor	I Dry	I Vap.	II Dry	II Vap.	Q
	Observations—adiabatic											
Ci. S.	9426		219.8	+.0507	−.0041	−.0079	+.0010	**+11.15**	**−0.90**	**−1.74**	**+0.22**	**+8.73**
Ci.	9815		218.2	+.0546	−.0078	−.0080	+.0014	**+11.90**	**−1.70**	**−1.74**	**+0.31**	**+8.77**
Ci. Cu.	7482		233.3	+.0384	−.0035	−.0043	+.0011	**+ 8.95**	**−0.82**	**−1.02**	**+0.26**	**+7.37**
A. S.	5023		253.2	+.0278	−.0073	−.0017	+.0009	**+ 7.08**	**−1.85**	**−0.43**	**+0.23**	**+4.98**
A. Cu.	2620		268.1	+.0123	−.0002	−.0005	+.0002	**+ 3.30**	**−0.05**	**−0.13**	**+0.05**	**+3.17**
S. Cu.	2412		271.1	+.0139	−.0034	−.0009	+.0006	**+ 3.77**	**−0.92**	**−0.24**	**+0.11**	**+2.72**
Cu.	1030		276.8	.0000	−.0016	−.0002	+.0003	**0.00**	**−0.44**	**−0.06**	**+0.08**	**−0.42**
N.	1050		278.9	+.0040	+.0013	−.0003	−.0005	**+ 1.11**	**+0.36**	**−0.08**	**+0.14**	**+1.53**
S.	1021		278.9	+.0035	+.0019	+.0001	.0000	**+ 0.98**	**+0.53**	**+0.03**	**0.00**	**+1.54**
Surface	0		280.7	.0000	.0000	.0000	.0000	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

TABLE 161.—*Divergence between the observed and the adiabatic states of the atmosphere*—Continued.

NOVEMBER.

Cloud	h_1	B_1	t_1	$\frac{c_1}{B_1}$	ΔI	I	Dry	Vapor	ΔII	II	Dry	Vapor
	Observations											
Ci. S.	10294	203.4	−35.2	.0008	−.0495	1.2987	1.3093	−.0106	+.0927	−.3645	−.3645	.0000
Ci.	10320	201.3	−36.5	.0007	−.0496	1.2996	1.3106	−.0110	+.0932	−.3640	−.3638	−.0002
Ci. Cu.	9234	230.9	−34.9	.0007	−.0436	1.3046	1.3090	−.0044	+.0835	−.3737	−.3733	−.0004
A. S.	5340	411.4	−17.6	.0024	−.0214	1.3268	1.3298	−.0030	+.0434	−.4138	−.4128	−.0010
A. Cu.	4292	452.9	− 6.8	.0057	−.0158	1.3324	1.3378	−.0054	+.0369	−.4203	−.4194	−.0009
S. Cu.	2971	535.1	0.1	.0086	−.0090	1.3392	1.3404	−.0012	+.0251	−.4321	−.4309	−.0012
Cu.	1030	677.7	4.4	.0092	−.0074	1.3408	1.3355	+.0053	+.0087	−.4485	−.4471	−.0014
N.	1831	615.5	8.0	.0130	−.0030	1.3452	1.3386	+.0066	+.0148	−.4424	−.4404	−.0020
S.	1102	669.8	12.2	.0158	−.0006	1.3476	1.3421	+.0055	+.0085	−.4487	−.4463	−.0024
Surface	0	768.0	10.0	.0092	0	1.3482	1.3403	+.0079	0	−.4572	−.4556	−.0016
	Adiabatic conditions											
Ci. S.	10294	176.5	−87.6	$\frac{c_1}{B_1}=.0092$	.....	1.2469	1.2397	+.0072	.....	−.3559	−.3547	−.0012
Ci.	10320	175.7	−87.9		.....	1.2466	1.2392	+.0072	.....	−.3556	−.3544	−.0012
Ci. Cu.	9234	209.5	−78.3		.....	1.2589	1.2517	+.0072	.....	−.3678	−.3665	−.0013
A. S.	5340	381.6	−41.4		.....	1.3001	1.2926	+.0075	.....	−.4091	−.4077	−.0014
A. Cu.	4292	441.0	−31.7		.....	1.3100	1.3024	+.0076	.....	−.4190	−.4176	−.0014
S. Cu.	2971	527.7	−17.7		.....	1.3224	1.3147	+.0077	.....	−.4314	−.4299	−.0015
Cu.	1030	677.2	0.0		.....	1.3396	1.3318	+.0078	.....	−.4486	−.4470	−.0016
N.	1831	612.4	− 7.6		.....	1.3326	1.3249	+.0077	.....	−.4406	−.4390	−.0016
S.	1102	671.2	− 0.6		.....	1.3390	1.3312	+.0078	.....	−.4480	−.4464	−.0016
Surface	0	768.0	10.0		.....	1.3482	1.3403	+.0079	.....	−.4572	−.4556	−.0016
Adiabatic constant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.8910		

	h_1	B_1	T_1	I Dry	I Vapor	II Dry	II Vapor	I Dry	I Vap.	II Dry	II Vap.	Q
	Observations – adiabatic											
Ci. S.	10294		211.6	+.0696	−.0178	−.0098	+.0012	**+14.76**	**−3.77**	**−2.08**	**+0.25**	**+9.16**
Ci.	10320		210.8	+.0714	−.0182	−.0094	+.0010	**+15.07**	**−3.84**	**−1.98**	**+0.21**	**+9.46**
Ci. Cu.	9234		216.4	+.0573	−.0116	−.0068	+.0009	**+12.43**	**−2.52**	**−1.48**	**+0.19**	**+8.72**
A. S.	5340		243.5	+.0372	−.0105	−.0051	+.0004	**+ 9.08**	**−2.56**	**−1.24**	**+0.10**	**+5.38**
A. Cu.	4292		253.8	+.0354	−.0130	−.0018	+.0005	**+ 8.99**	**−3.29**	**−0.46**	**+0.13**	**+5.37**
S. Cu.	2971		264.2	+.0257	−.0089	−.0010	+.0003	**+ 6.78**	**−2.35**	**−0.26**	**+0.08**	**+4.25**
Cu.	1030		275.2	+.0037	−.0025	−.0001	+.0002	**+ 1.02**	**−0.69**	**−0.03**	**+0.05**	**+0.35**
N.	1831		273.2	+.0137	−.0011	−.0014	−.0004	**+ 3.74**	**−0.30**	**−0.38**	**0.11**	**+3.17**
S.	1102		278.8	+.0109	−.0023	+.0001	−.0008	**+ 3.04**	**−0.64**	**−0.03**	**−0.22**	**+2.15**
Surface	0		283.0	.0000	.0000	.0000	.0000	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

TABLE 161.—*Divergence between the observed and the adiabatic states of the atmosphere*—Continued.

DECEMBER.

Cloud	h_1	B_1	t_1	$\frac{e_1}{B_1}$	ΔI	I	Dry	Vapor	ΔII	II	Dry	Vapor
	Observations											
Ci. S.	8884	236.8	−40.2	.0004	−.0415	1.2964	1.2939	+.0025	+.0814	−.3749	−.3750	−.0001
Ci.	8898	236.1	−40.2	.0004	−.0415	1.2964	1.2939	+.0025	+.0815	−.3748	−.3748	.0000
Ci. Cu.	8142	264.6	−34.1	.0007	−.0370	1.3009	1.3000	+.0009	+.0736	−.3827	−.3825	−.0002
A. S.	5088	400.3	−18.2	.0023	−.0183	1.3196	1.3153	+.0043	+.0450	−.4113	−.4109	−.0004
A. Cu.	4664	424.7	−14.3	.0031	−.0159	1.3220	1.3188	+.0032	+.0409	−.4154	−.4150	−.0004
S. Cu.	2383	569.7	− 1.3	.0071	−.0030	1.3349	1.3305	+.0044	+.0200	−.4363	−.4352	−.0011
Cu.	1023	673.3	− 4.1	.0048	−.0097	1.3282	1.3281	+.0001	+.0088	−.4475	−.4466	−.0009
N.	699	697.2	1.4	.0072	+.0018	1.3361	1.3329	+.0032	+.0056	−.4507	−.4490	−.0017
S.	1852	611.1	1.0	.0080	−.0004	1.3375	1.3326	+.0049	+.0153	−.4410	−.4399	−.0011
Surface	0	766.2	2.1	.0049	0	1.3379	1.3337	+.0042	0	−.4563	−.4555	−.0008
	Adiabatic conditions											
Ci. S.	8884	212.4	−85.3	$\frac{e_1}{B_1}=.0049$	.....	1.2465	1.2426	+.0039	.....	−.3682	−.3675	−.0007
Ci.	8898	211.9	−85.5		.....	1.2463	1.2424	+.0039	.....	−.3680	−.3673	−.0007
Ci. Cu.	8142	240.2	−75.8		.....	1.2583	1.2544	+.0039	.....	−.3767	−.3760	−.0007
A. S.	5088	385.1	−47.0		.....	1.2907	1.2869	+.0040	.....	−.4090	−.4083	−.0007
A. Cu.	4664	409.8	−43.1		.....	1.2949	1.2909	+.0040	.....	−.4133	−.4126	−.0007
S. Cu.	2383	563.6	−21.0		.....	1.3168	1.3127	+.0041	.....	−.4352	−.4344	−.0008
Cu.	1023	673.5	− 7.5		.....	1.3291	1.3250	+.0041	.....	−.4475	−.4467	−.0008
N.	699	701.9	− 4.5		.....	1.3319	1.3277	+.0042	.....	−.4503	−.4595	−.0008
S.	1852	604.9	−15.7		.....	1.3217	1.3176	+.0041	.....	−.4400	−.4392	−.0008
Surface	0	766.2	2.1		.....	1.3379	1.3337	+.0042	.....	−.4563	−.4555	−.0008
Adiabatic constant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.8816		

	h_1	B_1	T_1	I Dry	I Vapor	II Dry	II Vapor	I Dry	I Vap.	II Dry	II Vap.	Q
	Observations – adiabatic											
Ci. S.	8884		210.2	+.0513	−.0014	−.0085	+.0006	**+10.77**	**−0.29**	**−1.79**	**+0.12**	**+8.81**
Ci.	8898		210.2	+.0515	−.0014	−.0075	+.0007	**+10.82**	**−0.29**	**−1.58**	**+0.14**	**+9.09**
Ci. Cu.	8142		218.0	+.0456	−.0030	−.0065	+.0005	**+ 9.94**	**−0.65**	**−1.42**	**+0.11**	**+7.98**
A. S.	5088		240.4	+.0284	+.0003	−.0026	+.0003	**+ 6.82**	**+0.07**	**−0.62**	**+0.07**	**+6.34**
A. Cu.	4664		244.3	+.0279	−.0008	−.0034	+.0003	**+ 6.81**	**−0.20**	**−0.83**	**+0.07**	**+5.84**
S. Cu.	2383		261.8	+.0178	+.0003	−.0008	−.0003	**+ 4.66**	**+0.09**	**−0.21**	**−0.08**	**+4.46**
Cu.	1023		267.2	+.0031	−.0040	+.0001	−.0001	**+ 0.83**	**−1.07**	**+0.03**	**−0.03**	**+0.24**
N.	699		271.4	+.0052	−.0010	+.0005	−.0009	**+ 1.41**	**−0.27**	**+0.14**	**−0.24**	**+1.04**
S.	1852		265.6	+.0150	+.0008	−.0007	−.0003	**+ 3.99**	**+0.21**	**−0.19**	**−0.08**	**+3.99**
Surface	0		275.2	.0000	.0000	.0000	.0000	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

These data are transferred to Table 161, "Divergence between the observed and adiabatic states of the atmosphere" under the columns $h_1 . B_1 . t_1 . \frac{e_1}{B_1}$ against each type of clouds, under the section headed observations, for each month in the year. The following computation contains so much interesting information that it is given in full. Since the surface conditions differ but little among themselves, it facilitates the discussion to substitute the mean surface condition $B . t . e . \frac{e}{B} . \mathrm{I}\alpha . \mathrm{II}\alpha . \alpha$ constant for that actually occurring when the several cloud types were observed, and these appear on the line marked surface. In constructing the values of Iα and IIα at the several cloud heights, we form the columns ΔI, ΔII, which are the differences between the α constant at the surface and the α constant at the cloud. Thus for January, stratus, Iα constant at the surface is 1.3346, and Iα constant at the stratus level is 1.3301; hence $\Delta\mathrm{I}\alpha = -.0045$. (See Table 160, stratus, Jan.) Also, IIα constant at the surface is −.4565; and IIα constant at the stratus is −.4391; hence $\Delta\mathrm{II}\alpha = +.0174$. (See same table.) The other differences in these columns are obtained in the same way. Now, by adding these to the mean Iα constant 1.3345 and the IIα constant at the surface −.4560, we obtain I and II made homogeneous with the surface conditions, by this differential method.

The next process is to separate the dry-air function from the aqueous vapor, and it is done in this simple manner. With the arguments $\left(T=273^\circ+t_1 \text{ and } \frac{e_1}{B_1}\right)$ in Table 94, entering the first or 0.00 column we take out that part of the Iα constant which pertains to the dry air, because the other columns of that table differ from the first only by the operation of the aqueous vapor, as is seen by inspecting the formula. In the same way, with the arguments $\left(B_1 \text{ and } \frac{e_1}{B_1}\right)$ in Table 96, first column, we find the dry-air function IIα constant. These are placed in the columns headed "Dry." By subtracting the columns "Dry" from I and from II, respectively, the residual is the part of the function due to the action of the aqueous vapor. This completes the data to be found from the direct observations.

It is necessary now to compute the corresponding adiabatic conditions, and this involves two approximations, the first being omitted from the publication. Starting with the surface conditions identical with the preceding section, that is the mean surface data, instead of letting $\frac{e}{B}$ vary with the altitude, we assume that the surface value of this ratio is maintained throughout the cloud region, as if the surface kilogram were carried upwards without loss of its contents, but only with the changes in temperature and volume due to the environment. First with the arguments (B_1 at the cloud height and $\frac{e}{B}$ that of the surface) in Table 96 take the successive values of IIα. Then add these to the surface α constant, 1.3345 for stratus, January. This gives us the several values of Iα at the different cloud heights. Then by means of the ratio $\frac{e}{B}$ and Table 94, take out the corresponding value of t_1, the adiabatic temperature at the cloud height. These temperatures differ so widely from those observed at the respective heights, being much lower at great elevations, that they affect the computation of pressure under adiabatic conditions at that height. Hence, the pressures must be recomputed, and they are found in the middle portions of Table 160.

Returning with them to Table 161 these pressures are entered under B_1 of the adiabatic section. With the arguments (B_1 at the cloud height and $\frac{e}{B}$ constant) in Table 96 take out the values IIα. The value Iα—IIα at the surface for January is 0.8785. From this the value IIα at the cloud level is to be subtracted and the Iα is found. With the argument $\frac{e}{B}$ in Table 94 we obtain the corresponding value of the temperature which is entered under t_1. Comparing $B_1 \,.\, t_1$. in the observed and the adiabatic sections, it is seen that they differ widely in the upper strata. Finally, to separate the dry from the vapor function, proceed as before; entering the 0.00 columns in Tables 94 and 96, respectively, we take out the terms placed under "Dry," which subtracted from the Iα and IIα terms gives the vapor function by itself.

The third section, "observations—adiabatic," of Table 161 is next formed by subtracting the second section from the first, in the four parts of dry and vapor, for each of the cloud levels. The resulting sum is equal to $\int\frac{dQ}{T}$ in each level; that is to say, since the observed and adiabatic data pertain to the same cloud level the general formula is,

$$\int\frac{dQ}{T}=(\lambda c_p+\mu c'_p)\log\frac{T}{T_o}-A\,(\lambda R+\mu R_1)\log\frac{p}{p_o}, \text{ or in the other form,}$$

$$\int dQ=Q=T\text{ const.}\begin{cases}\left(.2374+.1512\,\frac{e}{B}+.0232\,\frac{e^2}{B^2}\right)\log T-\left(.06858+.02592\,\frac{e}{B}\right)\log B\text{ (obsd.)}\\ -\left(.2374+.1512\,\frac{e}{B}+.0232\,\frac{e^2}{B^2}\right)\log T_o+\left(.06858+.02592\,\frac{e}{B}\right)\log B_o\text{ (adiab.).}\end{cases}$$

In integrating $\int\frac{dQ}{T}$, which is rigorous for a given constant temperature T, and changes with T, I have decided to take a mean value of $T=\frac{273+t_1+273+t_1\text{ (adiab.)}}{2}$, the mean absolute tempera-

ture at the cloud level for the observed and the adiabatic conditions. The error will not be large, even in the higher strata, and it is probably far less than the original data from the balloon ascensions with which we were obliged to begin this study. Practically, the mean $\frac{t_1 \text{ (obs.)} + t_1 \text{ (adiab.)}}{2}$ added to 273 is given in the temperature column T_1. This is now multiplied, term by term, into the four columns I Dry, I Vapor, II Dry, II Vapor. The sum is the value Q which it was sought to obtain. Q is the number of calories per kilogram of the mixture of dry air and aqueous vapor, which it would be necessary to add to the adiabatic state to produce the actual observed state, if we assume that these two stages are *identical at the surface* as was done in the computation. It is, perhaps, hardly proper to thus conceive the adiabatic state as normal at the surface and suppose that all this heat is added to the upper atmosphere, and yet I can at present think of no more correct way to describe the case. Of course the two states of the atmosphere might be assumed to be equal at some altitude H, and then the divergence would occur in the lower strata by adding the proper values of Q, in something like the inverse order to those given with the argument "height" in Table 162. Aside from certain irregularities which result from the data employed and the way of treating it, referring especially to the process of using mean surface values and mean differences, ΔI and ΔII, which, of course, produces a few obvious discrepancies, it is seen that the vapor contents do not play a very important part in this function. It is known that the air is greatly heated above a state which would result from pure diathermancy, by the absorption of radiant energy, and these results must represent this additional heat to at least a fair approximation.

VALUES OF Q FOR EACH 1,000-METER LEVEL.

The quantity Q, the number of calories per kilogram required to transform the adiabatic state into the actual state of the atmosphere, at a given cloud elevation, as computed for each month in the year, was transcribed to a diagram, with the arguments, height, and months of the year. Then, curves were drawn as nearly as possible through equal values of Q, numbered from 1 near the surface to 10 in the alto-cirrus region. They form a family of curves boldly concave toward the axis of the months, being 2,000 or 3,000 meters higher in summer than in winter. Next, by dropping the cloud names, and reading off from this diagram the values of Q at each 1,000-meter level, the Table 162 is formed. It shows for each month and for each 1,000-meter level the

TABLE 162.—*The number of calories per kilogram Q required to convert an adiabatic atmosphere into the actual atmosphere as observed.*

Height	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
13000	10.7	10.2	9.7	9.5	9.5	9.5	9.6	9.8	10.0	10.4	10.8	11.4
12000	10.0	9.5	9.1	8.8	8.7	8.7	8.8	9.1	9.4	9.7	10.1	10.7
11000	9.3	8.8	8.4	8.1	7.9	7.9	8.0	8.4	8.8	9.0	9.5	10.1
10000	8.6	8.1	7.7	7.4	7.1	7.1	7.2	7.7	8.1	8.4	8.9	9.5
9000	7.9	7.4	6.9	6.7	6.4	6.3	6.4	7.0	7.4	7.8	8.3	8.9
8000	7.2	6.8	6.2	6.0	5.7	5.6	5.7	6.3	6.7	7.1	7.6	8.2
7000	6.6	6.2	5.5	5.3	5.0	4.9	5.0	5.5	5.9	6.4	6.9	7.5
6000	6.0	6.6	4.9	4.6	4.4	4.2	4.3	4.7	5.1	5.7	6.2	6.8
5000	5.4	4.9	4.2	3.9	3.8	3.6	3.7	3.9	4.3	5.0	5.5	6.0
4000	4.7	4.2	3.6	3.2	3.1	2.9	3.0	3.1	3.6	4.0	4.7	5.2
3000	4.0	3.5	3.0	2.5	2.4	2.2	2.3	2.3	2.7	3.0	3.8	4.0
2000	3.2	2.8	2.3	1.8	1.7	1.5	1.5	1.5	1.8	2.0	2.8	3.0
1000	2.4	2.1	1.6	1.1	1.0	0.8	0.8	0.7	0.9	1.1	1.8	2.0

number of calories required to convert 1 kilogram of air from the adiabatic into the actual state of the atmosphere. By taking differences between any two months at the same level, or between any two levels for the same month, the adiabatic state used for the general reduction is eliminated, and the differential conditions of the actual atmosphere are obtained. This table is very instructive, and it suggests an entire series of further investigations. Up to the point where the research now leaves it, the meaning is perfectly evident, but its bearing upon other physical questions regarding the state of the atmosphere would require longer consideration than it is possible to give without unduly retarding the publication of this report. The subject is, therefore, retained for discussion in another paper.