ANNUAL REPORT

OF THE

CHIEF SIGNAL OFFICER

TO

THE SECRETARY OF WAR

FOR

THE FISCAL YEAR ENDED JUNE 30, 1871.

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Annual Report of the Chief Signal Officer, U.S. Army Signal Corps

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REPORT

OF

THE CHIEF SIGNAL OFFICER, U. S. A.

WAR DEPARTMENT,
OFFICE OF THE CHIEF SIGNAL OFFICER,
Washington, D. C., November 1, 1871.

SIR: The signal school of instruction at Fort Whipple, Virginia, has been maintained during the past year, and, as in previous years, instruction has been given to officers of both the Army and Navy.

The course of study pursued by the naval officers has been similar to that described in the report of last year, consisting of the theory and practice of military and naval signaling and telegraphy, using as text-books the "Manual of Signals," "Cully's Hand-book of Practical Telegraphy," and "Pope's Modern Practice of the Electric Telegraph."

The officers of the Army were instructed, in addition to the above-named branches, in the outlines of meteorology, including a practical knowledge of the different meteorological instruments in ordinary use. In this branch of study the text-books have been Professor Loomis's Treatise on, and Buchan's Hand-book of, Meteorology. Special instructions were also given in the use of the especial system of weather-reports adopted by this office, and in the care and management of stations of observation.

The number of naval officers fully instructed during the year has been twelve, and of officers of the Army, three; three officers of the Army are still under instruction. In addition to this number, two officers were instructed in meteorology alone, they having previously, in 1869, completed the other part of the course. One officer received a leave of absence immediately after his detail, with permission to leave the country, and has not yet returned.

Reference is made to Tables I and II, hereto annexed, in which is a list of all the officers instructed, with the date of report for duty, of announcement as competent as acting signal officers, and the actual amount of out-of-door or field practice had by each. The instruction of naval officers was temporarily suspended on the 10th of July, 1871, the Chief Signal Officer of the Navy representing that the weather during the summer months was, in his view, unsuited for field-work on the part of naval officers. Arrangements are now in process for the detail of another class of naval officers for instruction.

The instruction of the observer-sergeants required for duty in the division of telegrams and reports for the benefit of commerce has been an important feature of the school during the past year. These soldiers have been instructed in the theory, and in, as far as was practicable in the limited time alotted to the course, the practical uses of signaling and telegraphy; they have been schooled in the manual of arms and the duties of the soldier, but principal and prominent attention has been given, in the tuition marked out for them, to the subject of meteorology, in which the course has been as thorough as the nature of the

circumstances would permit. Especial care has been given to that portion of the study relating to the uses of the various instruments with which each station of observation is supplied, and in the preparation of the ciphers and of the different forms employed in making, recording, and publishing the weather-reports, and in the general management of stations; the text-books used have been the "Manual of Signals," "Pope's Modern Practice of the Electric Telegraph," "Loomis's Treatise on Meteorology," with the "Smithsonian Instructions to Meteorological Observers," and the "Instructions to Observer-sergeants" issued by this office.

During the year, seventy-three sergeants have been under instruction. Of this number, twelve have not yet completed the course; two have been assigned to duty in the office of the Chief Signal Officer before completing the course; three were discharged before final examination; twelve failed to pass the examination as to their competency for the management of stations; ten of these latter have been discharged, and two are returned to the signal detachment from which they had been selected for promotion. The remaining sergeants, forty-four in number, have passed the required (observer's) examination and been assigned to duty at stations. Table III, herewith, gives in detail the names of the sergeants, date of report and examination, the result in each case, and the stations at which the observers are now on duty.

Second Lieutenant Allyn Capron, First United States Artillery, who was in immediate charge of instruction at the school as acting instructor at the date of last annual report, continued to act in that capacity until May 18, of this year, when he was relieved from duty, under the direction of this office, at his own request, and returned to his regiment. He was a faithful and energetic instructor, taking a strong personal interest in the work, and under his charge a corresponding degree of interest in their studies was manifested by the classes.

Lieutenant Capron was succeeded by First Lieutenant Robert Craig, Fourth United States Artillery, acting signal officer, who took temporary charge as acting instructor until another officer could be fitted for the position.

First Lieutenant O. M. Mitchell, Fourth United States Artillery, acting signal officer, was assigned to duty as acting instructor June 2, 1871, but resigned his commission in the service June 16; he was succeeded by First Lieutenant G. S. Grimes, Second United States Artillery, acting signal officer, who performed the duties of acting instructor, in addition to his especial duty as post quartermaster, until relieved July 3, 1868. Second Lieutenant C. C. Wolcott, of the Third United States Artillery, having completed his course of study, was announced as acting signal officer and acting instructor July 7, 1871, and remains in immediate charge of instruction at this date. The numerous changes here referred to caused many and vexatious delays, and had an injurious effect upon the school. This effect has been gradually removed since the assignment of Lieutenant Wolcott as instructor. The tuition is now progressing in a satisfactory manner; the services rendered during the past year by the officers and men who have undergone the course is a sufficient commentary upon its value.

The instruction in military signaling and telegraphy, from the Military Academy at West Point, has been meager and unsatisfactory, and does not afford sufficient data for a detailed report here. It is understood, however, that a course has been pursued, and that the cadets of the first and second classes have received a partial instruction in the theory and practice of signaling and telegraphy.

It is in every way desirable that the course at the Military Academy be made as complete as it can be, in view of the brief time which can be devoted to it at that institution, and that it be conducted by an officer himself thoroughly instructed, and in such manner and in such complete communication with this office as is contemplated by the law providing for the discharge of the duties of the signal service.

The recommendation of this office, that the duty be made an especial branch of instruction, and that a merit value be given, affecting the standing of the cadets, as mentioned in the last annual report of the chief signal officer, is renewed.

The instruction in military signaling in the Departments of the South, of the Platte, and of Texas has been, during a portion of the last year, in the charge of acting signal officers regularly instructed under the direction of this office.

The instruction in the Department of the Missouri has been under similar charge during the whole year. The results are exhibited in Table IV, herewith.

In the remaining geographical military departments, viz, those of New Mexico, Arizona, California, and the East, instruction has been attempted at isolated points, but not under the immediate direction of this office. This attempted instruction has been conducted under the provisions of General Order No. 19, Adjutant General's Office, March 18, 1869.

This order makes no provision for the instruction of the instructors, and officers acting under it have found themselves called upon to give instructions in a branch of the service than which none requires more thorough practical knowledge, and wholly in want of practice themselves. It was wise, however, perhaps, that the experiment should be made. It has not been fruitless, for the attention it has caused to be given to the signal service throughout the Army has led to a knowledge of its duties, such as would enable most officers to avail themselves to some extent of expert and instructed signalists in time of war, and it has proven the necessity of the permanent retention of a corps of officers and enlisted men thoroughly instructed and drilled in military signaling and telegraphy. Upon officers and men so instructed in these especial duties only can there be reliance for the proper instruction of other officers and men where these instructions are needed, or for such discharge of the duties in the Army as the country has the right to expect in time of emergency or of war.

The wisdom of those acts of the Secretary of War and of the General of the Army which have established and maintained the signal-service post of Fort Whipple, and the corps of officers and men there serving, needs no other confirmation than the results of the irregular instruction elsewhere attempted throughout the Army.

It is recommended that the instruction in geographical departments, whenever attempted hereafter, should be under the guidance or direction of some thoroughly instructed officer at department headquarters, through whom the necessary reports shall be made to this office, and who shall, in addition, have general charge of the property pertaining to the service throughout that department.

Table IV, herewith, exhibits the signal equipments and signal stores issued during the year to the several military departments.

It has been possible to give but little attention to the practice in field telegraphy and the drills with the field telegraphic train. These specialties of military practice at Fort Whipple are of an importance to the service hardly to be overestimated. The very extensive and important

duties suddenly imposed upon the office of the Chief Signal Officer and the signal service have, of necessity, taxed its abilities to the utmost, and the necessary withdrawal from the detachment of officers and men for duties in connection with the stations throughout the country so reduced its force that thorough drills have been impossible. A minor difficulty has been that the animals necessary for the movements of the trains could not be immediately procured.

Recent enlistments and additions to the detachment have increased its strength, and it is in contemplation to enter upon the drills of the train with the least practicable delay. The preliminary drills are already commenced.

During the past year experimental improvements have been made upon the vehicles of the train. It is desirable that every facility should be had for practice with and improvements of the service and of the drill. It is not necessary to comment on the value to the Army of a well-organized and properly equipped telegraphic service.

The duty discharged at Fort Whipple, Virginia, has been, during the past year, of paramount importance to all divisions of the signal service. It has been embarrassed to some extent by the frequent changes of officers, incident to the fact that the details for the service have been temporary, and by that discouragement of officers and men which always attends such changes.

The buildings at the fort are not well suited to the purposes to which the post is now devoted. It is recommended that permanent and better quarters and stables be provided and facilities given to place the post and the school maintained at it in the best condition. A principal point will have been gained when an assignment of an officer of suitable rank can be made to the command, and both officers and men there serving shall be encouraged to attempt perfection in their especial duties by a reasonable certainty that their duties will be permanent.

The number of non-commissioned officers and privates on duty at Fort Whipple is eighty-one.

DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

At the date of the last annual report of this office the organization, form of duty, and plan of supply and of service of the office division of telegrams and reports for the benefit of commerce had been in part provided, but had had no test of actual practice.

On November 1, 1870, at 7.35 a. m., the first systematized synchronous meteoric reports ever taken in the United States were read from the instruments by the observer-sergeants of the signal service at twenty-four stations, and placed upon the telegraphic wires for transmission.

With the delivery of these reports at Washington, and at the other cities and ports to which it had been arranged they should be sent, which delivery was made by 9 a. m., commenced the practical working of this division of the signal service in this country.

The pleasant feeling with which the service was everywhere recognized, and the aid everywhere tendered and rendered the office, are known to the Secretary of War.

On the first day of report the tabular bulletin reports were bulletined and furnished at twenty-four cities. The organization and instructions seem to have been sufficiently minute to guard against accident or error, and the form and plan commenced with the first morning report has

continued without need of alteration, as that under which the labor of the office for the past year has been conducted.

Paper 1 exhibits the bulletin as this day published at Washington, and summarizes the reports distributed to the different stations. As soon as the working of the organization thus tested had proved a success, and the correct and prompt receipt of the reports was no longer doubtful, it became a duty to provide in some way for giving notice of the approach of storms which the reports often heralded. The need for this duty was especially urgent upon the lakes. The first storm-warning was telegraphed and bulletined along the lakes on November 8, 1870.

In November, 1871, Professor I. A. Lapham, of Milwaukee, a meteorologist well known throughout the lake region, was employed as assistant to the Chief Signal Officer, and stationed at Chicago, with special reference to the supervision of the signal service on the lakes. His immediate supervision of this portion of duty ceased with the close of navigation.

The reports of Assistant I. A. Lapham, herewith (Papers 2 and 3) exhibit the character of his labors, their extent, and, to some degree, the results had from them. In addition to his duties in connection with the preannouncement of storms, this gentleman has prepared a series of valuable tables for this office. Clear + Reduction to Sea Level of Barometer

In the early winter of 1870–'71 the efforts of the office were directed to the extension of the system of stations as rapidly as it was possible to supply them with observers and instruments.

On January 15, 1871, the stations on the east Atlantic coast were added to the list of those reporting.

The section from Chicago to San Francisco, including the station at Corinne, commenced reporting February 2, 1871.

The stations on the coast of the Gulf of Mexico, and in the valleys of of the Ohio and Mississippi Rivers, have been established during the past summer.

The issue of the tabulated reports at the different cities was followed, with as little delay as practicable as the service extended, by an exhibition at the rooms of the boards of trade and chambers of commerce, or in other prominent places in the different cities, of weather-maps, on which the meteoric conditions at the stations throughout the country were exhibited by symbols. In the "instructions to observer-sergeants," a copy of which is herewith, (Paper 4,) a full description of these symbols and their uses is given. Maps of this description are now displayed daily at forty-five of the principal stations.

Maps similar in style are exhibited in the office of the Chief Signal Officer, and, during the sessions of Congress, in the hall of the House of Representatives. The preparation of graphic weather-charts became next incidental to the receipt and consideration of reports from stations so widely extended. Charts of this kind were drawn to embrace the reports of the earliest dates.

The meteoric conditions were exhibited on these charts by printed symbols and figures for the readings of the instruments placed at each station. The graphic chart herewith (Paper 5) illustrates the character of these papers. It was desirable that copies of these charts should be furnished the different scientific institutions in the city of Washington and elsewhere throughout the country. The mode in which these charts are prepared is described at length hereafter.

The successful issue of these charts at Washington has led to the publication, under the direction of this office, of similar charts at New York,

Philadelphia, Cincinnati, Chicago, and New Orleans. It is contemplated to extend the publication to other principal cities.

The organization of the telegraphic circuits, over which the reports are received at this office, and which permits the telegraphic meteoric information received at Washington to be at the same time communicated in the different cities, renders the publication of charts elsewhere easily practicable.

The popular attention was early attracted by these publications. It soon became evident that the popular will, as well as the views of eminent scientific men, required the publication of deductions of some kind had from the material received at this office.

The services of Professor Cleveland Abbe, A. M., assistant to the Chief Signal Officer, as meteorologist, were secured on the 3d of January, 1871, since which date he has been on duty in this office.

Professor Thompson B. Maury, A. M., entered upon service as assistant in the office June 18, 1871.

The issue of synopses and probabilities, as they are styled, was commenced by the office on February 19, 1871, and has been made thrice daily since that date.

The synopses consist of a synoptic view of the meteoric condition of the United States, as had from the data received at each regular report.

The probabilities are the deductions made by the office, from the data in its possession at the time of each report, as to the meteoric conditions probably to be for the eight hours then next ensuing.

Copies of these synopses and probabilities are furnished at the moment of their issue to the different press associations in the United States. They are also printed upon the graphic weather-charts issued by the office.

By the display of weather maps and bulletins, the issue of the graphic charts, the tabulated meteoric reports, and the synopses and probabilities, provision seemed to have been made for that publication of meteorological information at the different ports and cities of the United States with which the office had been charged. A popular attention to the subject of meteorology had been excited, and a popular instruction in some of the uses of the science was progressing rapidly.

It was deemed advisable to furnish, for general distribution, suggestions as to the practical use of the information so widely diffused, and to embody in a compact form some of the rules and generalizations bearing upon that use.

On August 2, 1871, the brochure herewith (Paper 6) was issued from this office. It was the object of this publication to put it in the power of the largest number to make use of, and to profit by, the labors of this office, and to afford the means by which at once to supplement, judge of, and aid the work of the Department. The paper has been widely distributed, and copies have been furnished the press, the boards of trade, and chambers of commerce, agricultural societies, and other associations whenever it has been thought the information it contains could be used to advantage.

Early in October, 1871, an examination of the experiments had daily for some months in the office, in the preparation of detailed synopses, on which had been indicated the times and places at which signals of caution or of safety ought to be shown, indicated that the office would be warranted in assuming to display cautionary signals at twenty ports on the Atlantic coast, the Gulf coast, and on the northern lakes. The period from October 1 to October 23 was devoted to giving proper notification of the points at which the signals would be displayed, their

character, and their exact meaning, and to the necessary preparations at the different signal-stations.

The display of cautionary signals was ordered to be at the designated stations of the observer-sergeants on and after Wednesday, October 23, 1871, whenever such display should, in view of the meteoric information had at this office, be deemed necessary. Each signal is required to be ordered by telegraph from this office, and remains displayed until it is ordered down by the same authority.

The cautionary signal—a red flag, with black square in the center by day, and a red light by night—displayed at the office of the observer, and other prominent places throughout any city, signifies—

1. That, from the information had at the central office in Washington, a probability of stormy or dangerous weather has been deduced for the port or place at which the cautionary signal is displayed, or in that vicinity.

2. That the danger appears to be so great as to demand precaution on the part of navigators and others interested, such as an examination of vessels or other structures to be endangered by a storm, the inspection of crews, rigging, &c., and general preparation for rough weather.

3. It calls for frequent examination of local barometers, and other instruments, and the study of local signs of the weather, or clouds, &c. By this means those who are expert may often be confirmed as to the need of the precaution to which the cautionary signal calls attention, or may determine that the danger is overestimated or past.

The fact that no cautionary signal is displayed, or that it is ordered down at any station, indicates that there is no information in the possession of the office which would call for especial precaution at that station. The pamphlet herewith (Paper 7) gives at length the meaning and the uses of the signal. It is designed to furnish copies of this paper to every vessel of both the merchant and military marine of the United States.

The cautionary signal was ordered to be shown when necessary at the following posts, viz:

Baltimore.	Mobile.
Boston.	New London.
Buffalo.	New Orleans.
Cape May.	New York.
Charleston.	Norfolk.
Chicago.	Oswego.
Cleveland.	Portland, Maine.
Detroit.	San Francisco.
Galveston.	Savannah.
Grand Haven.	Toledo.
Key West.	Wilmington, North Carolina.
Milwaukee.	Jacksonville, Florida.

In addition to the exhibition of the signal at the ports named, the statement of synopses and probabilities furnished the press tri-daily has added to it the names of the ports at which the cautionary signal is at any time ordered to be displayed, and also the names of those at which, being displayed, it has been ordered down.

The display of the cautionary storm-signal had practical effect for the first time in the United States on the night of Tuesday, October 26, 1871, when the signal was ordered at 7 p. m. to displayed at the port of

Oswego, New York. The signal so displayed was ordered down at 1 a. m. on Friday morning, October 27.

The service of the cautionary signals has imposed additional labor upon the force at the different stations, by the fact that the station must be ready to receive the telegraphic orders at night as well as in the day. The details for the duty must be so arranged that the signal so ordered will be promptly and well displayed, and care had that it so remains while the need for caution is supposed to exist. The frequent calls for information which the exhibition of the signal always brings to the office of the observer, to which those interested are by public notice referred for such intelligence, must also be answered.

The character of the meteoric observations at the different stations, and the cipher in which the readings are transmitted, have remained as described in the last annual report of the office.

The organization of working-forms of telegraphic circuits, explained at some length in the same report, has proven capable of indefinite extension. Experience has confirmed the opinion last year expressed, and has shown that, with working-forms of telegraphic circuits properly arranged, meteoric observations taken synchronously around the globe could be as readily made available for scientific purposes as those of a continent have been. The working forms of circuit herewith exhibit those under which telegraphic service of the past year has been rendered.

The organization of circuits reported in the last annual report, and extending to those of the Western Union and International Ocean Telegraph Companies, continued in effect until March 4, 1871, when it was terminated on the part of the Western Union Telegraph Company in consequence of misunderstanding as to the powers of the United States in relation to the telegraphic lines. These powers, as expressed in the act of 1866, secure to the United States precedence for the transmission of Government dispatches over lines which have availed themselves of its conditions. The act also imposes upon the Postmaster General the duty of fixing annually the rates at which such messages shall be transmitted. The sudden cessation of reports extending in their consequences to so many interests might have proved disastrous. The War Department, charged with the duty of collecting them, was placed in an unfortunate position. In this emergency the Franklin, the Atlantic and Pacific, and the Pacific and Atlantic Telegraphic Companies tendered their services promptly, and assumed the transmission of reports from all points to which their lines extended, with such effect that these companies receiving notification of the requirements of the service only at 10 a. m. on March 5, a sufficient number of the regular reports were received over their lines the same day to permit the usual press-report to issue from this office that evening. The International Ocean Cable Telegraph Company continued its service for the Department without interruption, and with a spirit of accommodation.

The subject of the relation of the United States to the telegraph companies being brought, by the Secretary of War, to the attention of the Attorney General of the United States, was by him placed in immediate charge of the Hon. William Whiting, assistant to the Attorney General of the United States. There could be, in the view of this officer, little question as to the rights or powers contemplated by the law. Several conferences, in which officers of this office took part, were held with the representatives of different telegraph companies, the conferences being in New York and at Washington. These meetings resulted in a satisfactory adjustment of all questions between the United States and the telegraph companies, both as relating to the special duties of

the signal service and the general telegraphic business of the United States. The conclusions are exhibited in the paper, (Paper 35,) and in the order of the Postmaster General, (Paper 36,) who has paid this office the compliment of accepting as just the rates recommended by it.

The relations had at this time with the telegraph companies of the United States are satisfactory. Embarrassments, however, arise, which, in the main, cannot be remedied until the United States secures, by some arrangement, the absolute control of the lines extending over its territory.

The working-forms of circuits herewith are made for the Western Union Telegraph Company, the Northwestern Telegraph Company, the Montreal Telegraph Company, and the International Ocean Telegraph Company; the former being the only companies possessing facilities for uniting so many parts of the continent with an organization of working so minute, and the latter controlling the cables to Key West, and holding by its wires and privileges the United States termini of the West Indian cables. The wires of these companies enter the telegraphic rooms at this office, and afford, if necessary, communication over almost any line within the United States; the failure of one line being thus to be made good by the employment of another. By such connections, telegraphic communication can be extended wherever telegraphic lines are in operation throughout the world. Of the service of the lines upon this continent, the Secretary of War has had illustration in his inspections of this office. As a single example, reports were called for on these occasions, and replies were received in a total time of eight minutes for the transmission of the message to and from San Francisco, California the working being over a single circuit of three thousand four hundred and seventy-six miles in length.

It is a fact illustrating the rapid extension of telegraphs throughout the world, that from this office can be had to-day communication by lines of telegraph reaching by their connections the coast of the Pacific on the west, and extending eastward to the eastern coasts of China and Japan.

The one link of the Pacific cable is wanting to girdle the world. Northward the lines reach those of the Canadas and British Possessions; southward they connect the West Indies and stretch toward South America. The advantages yet to result from a proper connection of the telegraphic system everywhere with systems of meteoric report can be contemplated in imagination only.

The telegraphic service of this office has been under the immediate supervision of George C. Maynard, esq., electrician, by whom it has been skillfully conducted.

The subject of a cipher, by which to further condense the telegraphic reports, has continued to receive attention. It is contemplated to commence, so soon as careful experiment shall have proved it practicable, the use of one prepared in this office, by which it is hoped the character of the reports will be improved without increasing the expense of transmission.

During the past year applications have been made by boards of trade of cities in the river valleys to have added to the telegraphed bulletined reports of the signal service a telegraphed report of the rise or fall of the greater rivers. An examination of this subject, showing that, by the addition of two words per day to a single one of the cipher reports already had from the river stations, the requisite reports might be given, and that the expense of the necessary apparatus will be trivial, it is proposed to embody this information with the reports, as having a direct connection with the meteoric information they already contain.

During the eleven months ending September 30, 1871, the aggregate number of words of regular weather-reports received at the office of the Chief Signal Officer in Washington was five hundred and sixty-one thousand nine hundred and twenty-nine, and the total number of words that was transmitted during the same period over the several circuits amounted to one million seven hundred and fifty-nine thousand nine hundred and fifty-two. These numbers do not include the service-messages and other telegraphic business of the office, which would swell the gross amount to about two million words. Tables 6, 7, 8, 9, and 10, herewith, give the service in detail.

The subject of the study and consolidation of the reports daily received at this office, and the preparation of deductions to be had from them, has been under the immediate and able supervision of Professor Cleveland Abbe, A. M., assistant. This officer has devoted himself to these duties and to others of the most onerous description with rare fidelity.

The favor with which the Synopses and Probabilities issued by the office have been received, and the commendatory expressions of scientific meteorists, sufficiently evidence the skill with which he has discussed the mass of material laid before him. This officer has rendered very valuable assistance in the preparation of the publications of this office—the circulars in relation to the practical use of meteorological reports and weather-maps issuing from it. It is believed that some of the rules and generalizations contributed by him to these papers are now for the first time announced. (Papers 6 and 7.)

The services of Professor Thompson B. Maury, A. M., have also been employed as an assistant in this Department. A series of meteorologic charts, synopses, and probabilities has been prepared for file in this office by assistant Maury.

First Lieutenant Robert Craig and Second Lieutenant A. W. Greely, acting signal officers, United States Army, have been employed upon the studies and in the preparation of the charts and papers necessary to fit them for duties in connection with this service.

The system of synchronous reports, and their regularity, has afforded unusual facilities for the study of the atmospheric conditions of the continent, and the changes incident to the different conditions.

During the year the reports received at the office of the Chief Signal Officer tri-daily, commencing with those of November 1, 1870, have been charted, three charts, one for each report, being draughted for each day.

The meteoric condition at each station, and the isobars for the United States, are exhibited on these charts. Accompanying each has been a synopsis of atmospheric changes and of the atmospheric conditions for the twenty-four hours preceding the hour at which the chart is timed, and a deduction then had as to the changes probably to follow.

A practice for the duties which the office contemplated as necessarily to be discharged, by the display of signals, has been had by the draughting, in tabular form, thrice daily, a detailed synopsis, which relates to designated sections of the country, and enumerates the points at which a cautionary signal might be properly exhibited. It has been only after the comparison of these sheets with the results had from the reports collected at this office has seemed to justify the display of cautionary signals, that the responsibility of ordering such display has been assumed.

There have thus been drawn and filed in the office of the Chief Signal Officer one thousand and ninety-five charts. The studies of each are drawn upon the face of the chart in such manner that the photographic copies of the charts alone, bound into volumes, will give a meteoric re-

cord for the United States perhaps not paralleled in kind by any before made. The securing of such a record, the establishing by practical example how meteorological reports may be taken over regions, no matter how extensive, and how telegraphs may be organized to transmit such reports, would, of themselves, have made fair return, had there been no other for the appropriation expended. In the preparation of the charts referred to, the course of more than three hundred areas of high barometer, and of about the same number of areas of low barometer, have been traced with the attending changes of weather.

From January 19, 1871, to November 1, 1871, eight hundred and forty-six detailed sheets of synopses have been tabulated to accompany sheets exhibiting the changes of weather deemed probable for the succeeding day. Papers 38 and 39 exhibit the plan of this work.

Press reports of the general synopses and probabilities, as they are styled, have been furnished the press, as heretofore mentioned in this report. The wide diffusion given these reports by the relations the office has established with the press is evidenced by the fact that it is estimated, computing the number of copies published at each edition of each newspaper in which reports or bulletins have appeared, the aggregate number of copies of the reports furnished from this office, which have been laid before the public, has reached a total of sixteen million. This extensive publication has been without cost to the United States. It is computed that in the morning editions of the New York newspapers alone, two hundred thousand copies are thus distributed daily. In addition to these press-reports, special reports are occasionally requested by ship-owners and others, and have been furnished. The Memphis Board of Trade recently applied for special reports during the meeting of the Agricultural Fair in that city.

As instances of particular storms described in their course from day to day in the general reports from this office, may be cited those of November 22, 1870; February 5, March 9, May 9, August 16 and 22, September 27, and October 12, 1871.

The comparison of the forecasts of the weather, or "probabilities," as they have been styled, deduced from the study of the relations of each regular report to those which have preceeded it, together with the meteoric conditions reported as actually existing over those sections of territory to which the "probabilities" have referred, has shown that of the predictions 69 per cent. may be held to have been fulfilled. A higher percentage of verifications results, if allowance is made for the meteoric changes that may have occurred within an hour of the times stated in the predictions. The percentage of such partial verifications is considered to be one of about 21 per cent.; the total of verifications and partial verifications being thus in the proportion of ninety to each one hundred of the predictions announced. It is not deemed advisable that the partial verifications be considered for any practical purposes. It is proper, therefore, to limit the official claim of the office to the fact that 69 per cent. of the forecasts made of record, and published by it, have been verified. It will be the aim of the office, with improved organization, larger experience, and established facilities, to increase this proportion.

It must be remembered, in apology for the failures, that the duties of the signal service require very rapid action. The reports are no sooner received at this office at the time of each reporting than they must, to meet the demands of the press for speedy publication, be discussed, the deductions made (written out in form) and telegraphed to the different cities in a period of time limited by minutes. Thus the

midnight report is made from observations taken at 11.35 p. m., (Washington time,) at stations on the Pacific, in the interior of the continent, in the Mississippi valley, throughout the States east of the Mississippi, upon the Atlantic and Gulf coasts, and upon the shores of the northern lakes. These reports must be concentrated at Washington, consolidated, the deductions made and reported at 1 a. m., at which exact hour the press-report is telegraphed from this office. The average time from the moment at which the observations are made at the stations, near and distant, to that at which the results are reported and telegraphed to the press, after they have been received and discussed at this office, has been eighty-five minutes.

An advantage is had in the fact that the reports to be issued follow each other so rapidly—the greatest interval being nine hours—each may be regarded rather as a supplement of the one that preceded it than a solitary report to be made complete from a single series of data.

Especial attention has been given by the office to the subject of the accurate reductions of the barometric readings (observations) made at the different stations to the hypothetical readings at sea-level.

A series of tables for this purpose has been prepared by Professor I. A. Lapham, assistant. A second series, to be made by methods original with Professor Abbe, assistant, is in course of preparation. The tables will be prepared for all the stations.

In this connection it is proper to refer to a difficulty encountered, which extends in its effects beyond its mere relation to the correctness of the meteoric observations.

The altitude of the different stations above the sea-level ought, of course, to be accurately known. In some cases the exact and satisfactory determination of the elevations are not to be obtained. The altitudes of the different signal stations of observation, once properly determined, the barometrical observation had at them becomes a reliable base to which to refer hypsometrical observations had in reconnaissances, surveys, or exploring expeditions. In view of the importance of this subject to all interests of internal improvement, of railroads, canals, &c., the institution of a system of accurate levelings to those stations to which they are needed seems warranted.

A station of observation has been maintained since December 15, 1870, on the summit of Mount Washington, at an elevation of 6,290 feet above the sea. The occupation of this summit for meteoric observation in winter was urged by Professor C. H. Hitchcock, State geologist of New Hampshire, and for a portion of the time during the past winter it was occupied, in common with a party there stationed under his directions by an observer-sergeant of the signal service making the observations for this office. Since June the station has been occupied by the observers of the signal service alone.

The observations made in the higher aerial currents are of especial value in relation to some of the duties of practical meteorology. It is desirable that other mountain stations should be established, and similarly provided, along the Apalachian Chain, as at the Black Mountain, South Carolina, White Top, Virginia, and others to be selected, and that these, together with certain special stations on the western plains, should be provided with self-registering meteoric apparatus.

It has been the aim of the office to extend its system of synchronous reports, collecting the material for future studies by observations made at the same hour, wherever there has been the opportunity to reach by exploring parties or expeditions distant points, or those of the meteorology of which little is known. With this view, at the request of

Captain C. F. Hall, commanding the Polaris and North Polar expedition, and with the approval of the Secretaries of War and of the Navy, an observer-sergeant, equipped with carefully selected instruments, was detailed to accompany the expedition. One series of observations to be made by this observer, will be, so far as practicable, synchronous with those on that day making at the different stations in the United States.

It is deemed desirable to secure reports of observations from some points, as Pembina, Sitka, the Sandwich Islands, which as yet can be reached only by mail.

It is proposed to give a still wider extent to the synchronal system of observations upon the ocean, by seeking the assistance of intelligent ship-captains and others making voyages at sea who will be willing to make the observations at the designated times. A form of "log," or record, (Paper 37,) has been prepared for such use. Though these observations may lack the certainty of those officially made, their value, as supplementary to the regular reports on land, will be readily appreciated by meteorists. The observers will receive copies of the publications of this office.

With the rapid extension of telegraph cables, and the results of a years' experience in the concentration of telegraphic reports, the idea of national systems of isochronal observations, to be internationally interchanged, referred to in the last annual report of this office, seems easy of realization. It is already certain that, to complete the system of the United States, stations of observations should be had in the West Indies, on the Windward Islands, and at tropical stations in South America.

The international co-operation of Spain, England, France, and Denmark is needed for this purpose. So far as the service of the United States is concerned, the co-operation to be thus desired need extend only to the assent to the establishment of the stations and the transmission of the cipher report. An ample return for this much of courtesy can be proffered in the furnishing to the governments named copies of the observations made for the service of the United States, to each of which they are of value.

The benefit to accrue to all commercial interests when, at the principal ports of any coast, the meteoric conditions can be found announced for all that coast, (as now in the United States,) or even for the trans-oceanic coast, need not be commented upon.

In anticipation of such uses for meteoric knowledge, it seems proper to invite attention to the aid to be had in making them practicable by the services of the officers of the Army and Navy, and to express the hope that, in the courses of the military and naval schools, at West Point and Annapolis, some study of meteorology may have place.

It has not been possible to carry into effect the plan of a model observatory, at which the different varieties of self-registering and other meteorological instruments might be compared and tested. The contracted building in which the office has been located, has not been suited in any part of it for the purpose. The project has not been abandoned. Standard and ingeniously devised instruments have been procured from Europe and from meteorologists in the United States. Arrangements have been made by which an instrument-room, to answer sufficiently well a temporary purpose, will be had. It is contemplated to mount all the instruments which have been proved, together with such as may be invented and come to the attention of this office, in this room, for the study of their peculiarities and to test them.

The opinion last year expressed as to the great value to the United

States of the records to be made by self-registering instruments properly placed, as, for instance, at the capitol city of each State, remains unchanged. It is eminently proper that facilities for the best study and use of instruments be had.

A properly devised and constructed observatory building, and one so located as to be free from local disturbances, as at some point in the public grounds, will, it is probable, be ultimately needed for such purposes. The expense of such a structure would be trivial in comparison to the advantages to be derived from its use.

The great fires in the Northwest, at Chicago, and in the northern parts of Wisconsin and Michigan, have afforded an opportunity for inquiry, whether any theories of meteoric effects were to be established by them. It is probable that burnings upon a similar scale will not again occur in this country.

Professor I. A. Lapham, assistant, has been requested to examine and report minutely upon the subject, visiting, if necessary, the scenes of the conflagrations.

A valuable paper has been already prepared by him upon the relation of such fires to the formation of prairies. Subjects of this nature having an important bearing upon agricultural interests are, by the necessary duties of the office, frequently brought under consideration.

The very general expectation of agriculturists that, in some way, the duties of the office in reference to the approach and force of storms would be made to contribute to their interests, has found frequent expression in letters and communications from societies and associations. It has been the desire of the office to comply with the wishes of a class so eminently entitled to consideration as the mass of the intelligent farmers of the country, in so far as was practicable without any diversion of the duties of the office. For this purpose the circular papers 40 and 41 were prepared and have been issued. Copies of all meteorological bulletins and the weather-charts of the office are furnished the Bureau of Agriculture. The reports necessarily collated in the publications of the office, such as the bulletins at the stations and the press reports—and these latter reach points as well in the interior as upon the coasts—are sufficient of themselves to enable farmers, as well as other classes, to better judge of the probable weather than they have been able to do at any time previous to the issue of such reports.

This incident benefit was not contemplated at the commencement of the service, and the reports were not drawn to produce it. It seems probable that if the means were available for increasing the number of interior stations, a corresponding increase of advantages would accrue to the inland interests, while a greater certainty of protection would be had for the coasts with every addition of stations. The number of stations ought to be largely increased.

The following is the record, given alphabetically, of the stations of observation under the direction of this office:

AUGUSTA, GEORGIA, (No. 23.)

The office is located on McIntosh street, one block from the telegraph-office and the board of trade rooms, and about the same distance from the principal business houses of the city. The roof of the building occupied is flat, and being several feet higher than any of the surrounding buildings, gives a full exposure to the wind-vane, anemometer, and rain-gauge. The instrument-shelter is a modification of the Smithsonian

plan, having louver-boarded sides, tight roof, and open bottom, and projecting from a window of the observer's office.

Sergeant James R. Allen, who was assigned to duty at this station, commenced making telegraphic reports on the morning of November 2, 1870, and has continued them regularly to date. Since June 12, 1871, he has been assisted by Private Frank Mangels, as the increased duties of the station rendered assistance necessary. Full reports are received here from all other stations, and it is also the point of transfer to and from the New Orleans circuit. Nine bulletins are issued twice daily, and displayed in the principal public places of the city. Two daily newspapers publish the synopsis and probabilities regularly, but do not print the tabular report.

Latitude of station	33° 28′
Longitude of station	81° 53′
Elevation of barometer above sea-level	173 feet.

The instruments in use are Green's standard barometer and thermometer, one hygrometer of the Glaisher model, one Robinson's anemometer, one copper rain-gauge, and one large wind-vane; all of which are in good condition.

BALTIMORE, MARYLAND, (No. 18.)

At this station the office is located at the corner of South and Water streets, and has remained unchanged since the occupation of the station. It is only one square from the telegraph-office, and about the same distance from the principal newspaper offices, the post-office, board of trade rooms, and exchange reading-room, and within half a square of ten shipping-houses and four marine insurance companies. The exposure of the vane, anemometer, and rain-gauge is good, as there are no high buildings to obstruct the free circulation of air for several squares, and then only isolated ones that are higher than the office. The instrument-shelter is a modification of the Smithsonian plan, and the arrangement good, being louver-boarded on sides and front, with tight roof and open bottom, and is built out from a window facing the north.

The station was occupied and the office selected by Sergeant Faherty, in the latter part of December, 1870, but reports were not made until the morning of January 1, 1871, at which time Sergeant J. E. Cowan was in charge, and continued so until March 27, when he was relieved on account of alleged misconduct, and was succeeded by Private Singleton, who had been previously acting as assistant observer, and who managed the station alone and in a satisfactory manner until called in for promotion, when the present observer, Sergeant H. J. Penrod, was placed in charge May 11. An assistant was sent to this station on the 26th of May, as the work was found too laborious for one man to perform well. Full reports from all other stations are received at the station. Six bulletins with the synopsis and probabilities, and five of the manifold maps, are issued in the morning, and five bulletins in the afternoon, and posted in the most prominent public places.

Five daily papers are supplied with the midnight report, and two of them, the Sun and American, publish the full tabular report; two of them, the Correspondent and the Wecker, publish an abstract, and all give a synopsis. The board of trade of this city has appointed a committee, to whom all meteorological matters connected with the signal office are referred.

Latitude of station	39° 18′
Longitude of station	76° 36′
Elevation of barometer above sea-level	45 feet.

Instruments at station are: one barometer, one thermometer, one hygrometer, one anemometer, one rain-gauge, and one wind-vane; all standard and in good condition.

A large weather map, furnished by this office, is hung in the Exchange reading-room, and is changed each morning by the observer.

BOSTON, MASSACHUSETTS, (No. 13.)

The office of the observer at this station is located at 103 Court street, in the business center of the city. The distance to the telegraph-office is four squares; to the newspaper offices from four to six squares; and to the Merchants' Exchange, three squares. The vane, anemometer, and rain-guage are well exposed upon the top of a cupola on the office-building, and the instrument shelter, built after the Smithsonian model, projects from a window of the cupola. The station was occupied and office selected in the old State House in October, 1870, by Sergeant Lloyd, but he was relieved by Sergeant Daboll before the reports commenced, on the morning of November 1, 1870. The change of office was made in January, 1871, on the recommendation of the meteorological committee. Sergeant Daball being relieved May 31, on account of ill health, was succeeded by Sergeant H. E. Cole, who now remains in charge. An assistant was sent to this station January 10, 1871.

Full reports are received here from all other stations. Five morning bulletins with synopsis and six manifold maps are issued and properly posted, and two each of afternoon and midnight bulletins. Three evening papers, the Transcript, Traveler, and Journal, and four morning ones, the Herald, Journal, Post, and Advertiser, are supplied with press reports, and also print the current synopsis and probabilities. A large weather-map is hung in the Merchants' Exchange, and the symbols changed each morning.

Latitude of station	40° 20′
Longitude of station	71° 03′
Elevation of barometer above sea-level	82 feet.

The instruments used are: one barometer, one thermometer, one hygrometer, one anemometer, one rain-gauge and one wind-vane; all of the standard patterns, and in good order.

A meteorological committee has been appointed by the board of trade at this station, and its members have rendered valuable assistance to the observers during the year.

Office-rent, $18 per month.

BURLINGTON, VERMONT, (No. 45.)

The observer's office is located on the third floor of the building known as the City Hotel, on one side of the public square, around which are located the court-house, city-hall, principal hotels, telegraph and express offices, and many of the principal business houses.

Upon the roof of the building, which is flat, a raised platform has been built of sufficient height to clear the top of the parapet, with which a portion of the roof is surrounded, and on this platform the wind-vane, anemometer, and wind-gauge are placed. The exposure is good and the circulation of air unobstructed.

The instrument-shelter projects from a north window in the office, and is built after the Smithsonian plan, the instruments being so placed that they can be read through the window without opening it.

The station was opened and office selected by Sergeant R. R. Martin,

in the latter part of May, 1871, and reports have been regularly made since the morning of May 24, 1871. Sergeant Martin was relieved on the 17th of August by Sergeant George H. Ellery, who still remains in charge. There is no assistant, as the number of reports received is so small that the work can be safely performed by one man.

Reports are received here from five other stations, and two bulletins of the morning and afternoon reports are issued. Local observations only are published by the press.

Latitude of station	44° 29′
Longitude of station	73° 11′
Elevation of barometer above sea-level	401 feet.

Manifold maps are not issued at this station, the number of reports received being too small to make them of value. The instruments now in use are: one barometer, one thermometer, one hygrometer, one anemometer, one rain-gauge, and one wind-vane; all of which are in good condition.

A meteorological committee has been appointed by the board of trade, and its members have materially assisted the observer in establishing the station.

Rent of office is $10 per month.

BUFFALO, NEW YORK, (No. 33.)

At this station the observer's office is located in Weed's Block, on Main street, on the fourth floor. The situation is a good one, and in the immediate vicinity of the post-office, custom-house, and different telegraph-offices. The office was originally located in the same building as the Western Union Telegraph Office, at 223 Main street, but was soon removed by orders from this office. The office selected by the observer was at the corner of Main and Seneca streets, and was pronounced unsuitable by the inspecting officer, who visited the station August 24, and who removed it to its present location.

The roof of the building is flat, and offers a good exposure for the vane, anemometer, and rain-gauge. The instrument-shelter is built after the Smithsonian plan, but with louver-boarded sides. It projects from a window on the east side of the observation-office, and the facilities for reading the instruments through the window are good.

The station was established by Sergeant W. F. Slater, and reports have been regularly made since the morning of November 1, 1870. Sergeant Slater still remains in charge, and has had an assistant since January 25, 1871.

Full reports from all other stations are received, and five morning, three afternoon, and two midnight bulletins issued. The newspapers are regularly supplied with the press report at the midnight and morning observations. All papers here print the synopsis and probabilities. Three manifold maps are issued each morning.

This station is provided with a large weather-map, which is hung up in the board of trade room, and the symbols changed each morning.

Latitude of station	42° 53′
Longitude of station	78° 55′
Elevation of barometer above sea-level	624½ feet.

The instruments now at the station are: one barometer, one thermometer, one hygrometer, one anemometer, one rain-gauge, and one wind-vane; all of the standard patterns and in good condition.

The board of trade has appointed a meteorological committee, which

has rendered valuable service to the observer. I regret to report that the observer has not performed his local duties with the proper amount of energy during the year, but all reports to the office have been made regularly and properly. It is proposed to remove him to a less important station, and fill his place with a more energetic man.

The office consists of two rooms, for which $15 per month are paid.

CAPE MAY, NEW JERSEY, (No. 54.)

The observation-office is located within three squares of most of the principal hotels, two squares from the newspaper offices, one square from the telegraph-office, and in full view of Cape May light-house. The location is a good one for the proper exposure of instruments, and easily accessible to visitors. The building has a sloping roof, and it was necessary to put up a platform above the ridge to place the vane and anemometer upon. The rain-gauge is placed upon the ground and well exposed. The instrument-shelter is of the Smithsonian pattern, with sides and front louver-boarded and the bottom left open. It projects from a north window of the office, and the instruments are read through the glass as at the other stations.

Sergeant Theodore F. Townsend is in charge of station, and commenced transmitting reports on the morning of May 24, 1871. He has no assistant, as no reports are received at present from other stations, although it was intended to receive all sent over the coast circuit. The synopsis, however, is received regularly and posted properly in the principal public places. Full reports were received for a few days in July, but were stopped by the telegraph company until an additional wire could be built. There seems to be no necessity for sending anything to the station but the synopsis, except during the summer months, when the hotels are filled with visitors from different stations of the country, and who are naturally curious to know the state of weather at their respective homes.

Latitude of station	39° 00′
Longitude of station	
Elevation of barometer above sea-level	19½ feet

The station is supplied with a full set of standard instruments, and all of them are in good condition. The large wind-vane is protected by a lightning-rod, put up by the office at the request of the proprietor.

The observer reports a gratifying interest manifested by citizens and visitors in the labors of this office.

The amount of rent paid is $18 per month.

CAIRO, ILLINOIS, (No. 53.)

The office is located in the City National Bank building, on Ohio levee, and in the immediate vicinity of the telegraph and other public offices. The instrument-shelter is built upon the plan adopted by the central office in Washington, having double walls of lattice-work, double floor and triple roof to prevent the instrument from being affected by either the direct or the reflected heat of the sun. This shelter, or more properly speaking, observatory, was built by Mr. Holliday, a public-spirited citizen, who takes a lively interest in the development of the system of weather reports, and rented at a moderate rate to the department. The rain-gauge, vane, and anemometer are well exposed on the roof of the observatory.

The station was established by Sergeant Henry Fenton, and reports

commenced on the morning of June 1, 1871. Sergeant Fenton fitted up the station comfortably and well, but getting into a personal difficulty with the manager of the telegraph office, it was thought advisable to transfer him to another station, and he was accordingly relieved September 10, by Sergeant T. L. Watson. Owing to the unhealthiness of the station, an assistant was sent there in August.

Reports are received from fifteen other stations. Three bulletins are posted regularly in the most public places, and both daily papers furnished with the reports and manifold maps issued each morning. The large weather-map is hung in the City National Bank, and changed each morning after the reception of reports.

Latitude of station ..... 37° 00′
Longitude of station ..... 89° 00′
Elevation of barometer above sea-level ..... 400 feet.

The observer is provided with a full set of standard instruments, all of which are reported in good condition. There is an extra barometer at this station, the first one sent having been injured by the observer in moving his office from its original location on Commercial avenue. It has been repaired, and is now in good condition.

Amount of rent paid for office and observatory is $25 per month.

CHARLESTON, SOUTH CAROLINA, (No. 21.)

The office is located at the corner of East Bay and Broad streets, in easy reach of the telegraph and newspaper offices, and principal business houses. The wind-vane, anemometer, and rain-gauge, are well exposed, and the instrument-shelter is of the usual model and well constructed.

The station was established by Sergeant J. E. Evans, and reports commenced on the morning of January 5, 1871, and have been continued regularly since that time, with the exception of the midnight reports from March 4 to May 24, during which time the telegraph office closed at 10 p. m., and the reports were necessarily held over until next morning. Full reports are received from all other stations, and six daily bulletins are issued and posted in prominent places. The daily papers publish a portion of the afternoon and midnight reports, and the probabilities regularly. A large weather-map is hung in the rooms of the Chamber of Commerce, and the symbols changed each morning.

Latitude of station ..... 32° 45′
Longitude of station 79 57
Elevation of barometer above sea-level ..... 64 feet.

The station is supplied with a complete set of standard instruments, and all are reported to be in good condition. An assistant was sent from this office June 12, 1871, as the work was too great for one man to perform satisfactorily. Reports have been made regularly and properly, and the conduct of the observer has received the commendation of the meteorological committee of the chamber of commerce. Both observer and assistant have been attacked with yellow fever, and were unable for a few days to perform their duties, but they are now so far recovered as to dispense with the services of the citizen who made the reports during their illness.

This station has not been visited by an inspecting officer, owing to the prevalence of fever, and the only information had is derived from the reports of the observer and of the chairman of the meteorological committee.

The rent paid for office is $10 per month.

CHEYENNE, WYOMING TERRITORY, (NO. 68.)

The office at this station is located in the center of the business portion of the town, and in the immediate vicinity of the telegraph offices. The roof of the buiding occupied is flat, and affords a good exposure for the vane, anemometer, and rain-gauge. The instrument-shelter is of the authorized pattern, with louver-boarded sides and front, and projects from a window of the office.

The station was established by Sergeant A. C. Dobbins, and reports commenced on the morning of November 1, 1870. Sergeant Dobbins still remains in charge and performs his duties alone, as only the reports of four other stations are received and one bulletin issued in the morning and afternoon of each day. The newspaper declines to publish anything but the local observations, and these very irregularly.

Latitude of station	41° 12′
Longitude of station	104 42
Elevation of barometer above sea-level	6,057 feet.

The observer is supplied with a full set of standard instruments, and reports them in good condition. All reports from this station have been correctly and promptly made, and the management of the station has been satisfactory.

The rent of office is $15 per month.

CHICAGO, ILLINOIS, (NO. 37.)

The observation office is located in the fourth story of a building on Washington street, one square from the city-hall, and on the same block as the chamber of commerce building, and consequently in the heart of the business portion of the city. It is convenient in size and location for the display of instruments and performance of official work. The roof of the building is flat and surrounded by a parapet, to clear which it was necessary to elevate the anemometer upon a framed support 18 feet in height. The wind-vane, being of the new model, was fairly exposed, and was made to indicate the direction in the office of the observer.

The instrument-shelter is of the standard pattern, and projects from one of the office windows facing due north. The station was established by Sergeant James Mackintosh, and reports commenced November 1, 1870, since which date there has been no serious interruption. Reports are received here from fifty-three other stations and are bulletined and furnished regularly to the press. Nine morning bulletins are issued and seven afternoon ones. The midnight report is furnished to the Times and Tribune, and is published regularly by them with the synopses and probabilities. The morning report is published in the Evening Post and Evening Journal. Seven manifold maps are issued at present, but a printing-press is now at the station, and when set up it is proposed to issue a much greater number. The large weather-map is hung up in the hall of the Chamber of Commerce, and its symbols are changed regularly.

This being the grand western center of the circuits over which weather reports are transmitted, the duty of making the necessary transfers from the several circuits has been an important one, and has been well performed through the assistance of the telegraph officials, who, from the general superintendent down, appear to have taken a lively personal interest in having the work well done.

The observer in charge has not been changed since the station was opened, but several changes of assistants have been made from various

causes. Sergeant A. B. Williams was first sent out as assistant in November, and remained until December 31, when he was transferred to the charge of the Du Luth station, and his place taken by the observer from that place. On the 1st of March this latter man was discharged for conduct that unfitted him for the performance of his duties, and Private Mason, of the signal detachment, took his place and remained until June 15, when he was removed, and the present assistant, Sergeant W. S. Kauffman, sent there, since which time there has been no difficulty. The reports have been regularly and promptly made during the whole year and the general management of the station satisfactory.

Latitude of station	41° 52′
Longitude of station	87° 35′
Elevation of barometer above sea-level	645 feet.

The observer is provided with a full set of standard instruments and reports them all in good condition. A meteorological committee has been appointed here by the board of trade.

The rent of office is $18 per month.

NOTE.—Since writing the above, the building in which the office was located has been destroyed by fire, together with all the instruments and records of the station. A fresh supply of instruments and a new outfit throughout has been forwarded, and reports are again being received from the new office, which is temporarily located at No. 10 West Randolph street.

CINCINNATI, OHIO, (No. 65.)

The observer's office is located in Pike's Opera House building, and in close proximity to the telegraph and newspaper offices, &c. The high parapet by which the flat roof of the building is surrounded has rendered the construction of a platform necessary in order to get the proper exposure for the vane, anemometer, and rain-gauge. The agent of the building has declined to allow the large wind-vane to be erected without consulting the owners, so that at present the small one only is used. The instrument-shelter is of the standard pattern.

The station was established by Sergeant F. H. Fletcher, and reports commenced on the morning of November 1, 1870. Sergeant Fletcher remained in charge until June 22, when he was relieved by Sergeant F. B. Lloyd, who had been acting as his assistant since January 4, 1870. Sergeant James H. Garrard was sent out as assistant, and remained in that capacity until transferred to the charge of Nashville station, being succeeded in Cincinnati by a private from the school of instruction at Fort Whipple, Virginia.

Cincinnati receives the reports of fifty-three other stations, being on what is known as the Lake circuit. Seven bulletins are issued, the four leading dailies furnished with tabular report, and the several public libraries and reading-rooms, with the chamber of commerce and board of trade, are supplied daily with maps. A printing-press has been recently sent to this station, and the issue of maps commenced on a more extensive scale, but no detailed report has yet been made of the precise number. The daily newspapers all publish the latest synopsis received, and several of them give the full tabular report. The observer here prepared a monthly abstract of the local observations, which is printed in the leading papers, and gives much valuable meteorological information in concise shape.

Latitude of station	39° 06′
Longitude of station	84° 30′
Elevation of barometer above sea-level	656 feet.

The observer is supplied with a full set of standard instruments, all of which are reported to be in good condition. The chamber of commerce and the board of trade have each appointed a meteorological committee.

The rent of office is $12 per month.

CLEVELAND, OHIO, (No. 34.)

The observer's office is located in the Atwater building, at the foot of Superior street, and is convenient to the telegraph-office and other public places. The vane, anemometer, and rain gauge are placed on the roof of the building and properly exposed. The instrument-shelter is of the standard pattern.

The station was established by Sergeant Theodore Mosher, who still remains in charge, and reports were commenced on the morning of November 1, 1870. There has been an assistant at the station since February 6, 1871, and the management of the station has been satisfactory.

Reports are received from fifty-three other stations, and four morning and one evening bulletin issued. The daily papers were supplied for some time with the tabular report and published it, but have now discontinued it, and print only the synopsis and probabilities. Four manifold maps are issued daily, and the large weather-map is changed regularly.

Latitude of station	41° 30′
Longitude of station	81° 36′
Elevation of the barometer above sea-level	671 feet.

The observer is provided with a complete set of standard instruments, all of which he reports in good condition. A meteorological committee has been appointed by the board of trade.

The rent of office is $12 per month.

CORINNE, UTAH, (No. 70.)

The observer's office is located on Montana street, and is convenient to the telegraph-offices of both the Western Union and Atlantic and Pacific companies. The rain-gauge, anemometer, and wind-vane are exposed on the roof of the building—the latter instrument being the old or small pattern first adopted. It will be replaced soon by a large one. The instrument-shelter is of the standard pattern.

The station was established by Sergeant William McElroy, and reports commenced February 2, 1871. No change has been made at this station either in the observer or location of office. The reports from four other stations are received, and one bulletin of each report properly made out and posted at the observer's office.

The local observations were given in the newspaper published at the station until the printing-office was removed. All official reports have been promptly made by the observer, and his duties performed in a satisfactory manner so far as can be judged without a personal inspection. There is no assistant at this station.

Latitude of station	41° 30′
Longitude of station	112° 18′
Elevation of barometer above sea-level	4,308 feet.

The observer is supplied with a complete set of standard instruments, all of which are reported to be in good condition.

Rent of office is $18 per month.

DAVENPORT, IOWA, (No. 51.)

The observer's office is located on the corner of Main and Second streets, in the First National Bank building, and in the immediate vicinity of the telegraph and newspaper offices. The roof affords a good exposure for the wind-vane, anemometer, and rain-gauge. The instrument-shelter is of the standard pattern.

The station was established by Sergeant George H. Richmond, and reports commenced May 24, 1871, since which time they have been regularly made. Being on the long circuit from Chicago to San Francisco, the reports passing over that circuit were, at first, all that were received at this station, but on the application of the leading citizens, the number has been increased to twenty-three. This increased the work of the observer to such an extent that it was found necessary to furnish him with an assistant, which was done July 24, 1871.

Eight daily bulletins are posted in public places and the large weather-map regularly changed. Manifold maps are not issued.

Latitude of station	41° 30′
Longitude of station	90° 36′
Elevation of barometer above sea-level	645 feet.

The observer is provided with a full set of standard instruments, and he reports them all in good condition.

The board of trade has reported a meteorological committee.

The rent paid for the office is ——— per month.

DETROIT, MICHIGAN, (No. 36.)

The observer's office is located in the third story of the Bank Block, corner of Griswold and Congress streets, and in close proximity to the telegraph and post offices and the offices of the daily newspapers, and the location is pronounced by the inspecting officers as good a one as could have been selected. The instrument-shelter consists of an observatory, built after the plan of the one used at the central office in Washington, and on the roof of this the rain-gauge and anemometer are placed. The wind-vane, large model, is attached to the roof of the main building and is well exposed.

The station was established by Sergeant Allen Buell, and reports commenced on the morning of November 1, 1871, and have been made continuously since that date. Reports are received from fifty-three other stations; twenty-two bulletins are made out and posted of each morning report, fifteen of the afternoon report, and three of the midnight report. Four daily papers, three morning and one afternoon, are supplied with and publish the tabular report and synopsis. In addition to this, the observer issues a manifold map with each bulletin, and changes daily the large weather-map which is hung in the board of trade building.

The enterprise and energy of the observer at this station has won for him the commendation of the meteorological committee, and deserves especial mention here. There has been an assistant at the station since February 6, 1871. Private Graham, of the signal detachment at Fort Whipple, was first sent out, and remained until August 14, when he was put in arrest for disorderly conduct, and is now awaiting, at Fort Wayne, Michigan, the action of a court-martial. Private McGovern was sent out to replace him, and is giving satisfaction.

Latitude of station	42° 18′
Longitude of station	83° 0′
Elevation of barometer above sea-level	656 feet.

The observer is supplied with a full set of standard instruments, all of which he reports in good condition.

There is a meteorological committee, appointed by the board of trade, at this station.

Rent of office per month, $18.

DU LUTH, MINNESOTA, (No. 40.)

The observer's office is located in the upper story of Edmunds's Block, on Superior street, near the business center of the town, and in the immediate vicinity of the telegraph-office, post-office, and board of trade building. The wind-vane, anemometer, and rain-gauge are placed on the roof of the building, and the former indicates in the office the direction of the wind. The exposure on the southern and eastern sides is good, but a range of hills shuts off the wind from the north and west. The instrument-shelter is of the standard pattern, and projects from a window of the office.

The station was established by Sergeant A. W. Cox, and reports commenced on the morning of November 1, 1870. Sergeant Cox was relieved January 1 by Sergeant A. B. Williams, who continues in charge. The reports of ten stations are received here, and four morning and three afternoon bulletins issued and properly posted. The three newspapers are furnished with the reports, and two of them publish a weekly statement of the observations. The daily paper does not give the tabular reports, but is making arrangements to do so soon. The large weather-map is hung in the board of trade room and properly changed. The reports are not received with regularity, owing to want of proper telegraphic facilities, and this difficulty cannot be overcome until the increase in population and business justifies the putting up of additional wires.

Latitude of station	46° 48′
Longitude of station	92° 06′
Elevation of barometer above sea-level	660 feet.

The station is supplied with a full set of standard instruments, all of which are in good condition.

A meteorological committee of the board of trade has been appointed at the station.

The rent of office is $20 per month.

ESCANABA, MICHIGAN, (No. 49.)

The observer's office is located on the second floor of a three-story building in Tilden street, and is near the business center of the town, and has been selected with good judgment. The wind-vane and anemometer are on the roof of the building, and the rain-gauge on the ground, with its top one foot above the surface of the earth. The instrument-shelter is of the standard pattern, and projects from a window of the office.

The station was established by Sergeant John N. Martin, and reports commenced on the morning of May 24, 1871. There has been much irregularity in the transmission of the reports to and from this station, owing to the imperfect working of the telegraph line. The observer has been regular in making his observations, and in filing them at the proper hours.

The reports from eleven other stations are received here, and four morning and the same number of afternoon bulletins issued and posted

in public places. The only paper published in Escanaba is a weekly one, and it gives a summary of the most important points in the week's reports. There is no large weather-map at this station, and no manifold maps are issued. There is no assistant here, as the labor can be easily performed by one man when in good health.

Latitude of station	46° 36′
Longitude of station	87° 06′
Elevation of barometer above sea-level	603 feet.

The observer is supplied with a full set of standard instruments, all of which are reported to be in good condition. The station has been visited by an inspecting officer, and its general management pronounced satisfactory. There is no board of trade at this station, and its principal importance to this office is the meteorological value of its reports in connection with the weather on the lakes.

A monthly rental of $14 is paid for the office.

GALVESTON, TEXAS, (No. 55.)

The observer's office is at No. 67 Strand, and is well located for the convenience of the business portion of the community and for ready access to the telegraph-office. The vane, anemometer, and rain-gauge are located on the roof of the building, and well exposed. The instrument-shelter is of the standard pattern, and is built out from a window of the office.

The station was established by Sergeant William Von Hake, and reports commenced on the morning of April 19, 1871. There being but a single wire between New Orleans and Galveston, telegraphic communication has been frequently interrupted, and the reports delayed in consequence. The station receives the reports of eighteen other stations, and the work was so exhaustive in that hot climate that an assistant was sent out there on the 18th of August, arriving in time to prevent a break in the reports, as the health of Sergeant Von Hake had been gradually failing; and although he kept at work as long as he was able to get about, he was finally forced to stop. Up to the present time he has been unable to resume work, and the assistant, a thoroughly competent man, has performed all the station duties.

Six bulletins a day are posted, and two papers furnished with the reports.

Much interest is manifested in the reports by the citizens, and if the telegraph were in good working order, so that their reception could be relied upon, they would prove of much service to the shipping at this point.

Latitude of station	29° 19′
Longitude of station	94° 46′
Elevation of barometer above sea-level	50 feet.

The observer is supplied with a complete set of standard instruments, and reports them as being all in good condition. Some doubt was expressed at one time as to the accuracy of his thermometric reports, but a careful series of comparative readings established their correctness.

A meteorological committee has been appointed by the board of trade, and its members have manifested a lively interest in the success and accuracy of the reports. There are no manifold-maps issued here, but a large weather-map is hung up, and changed properly and regularly.

The rent paid for office is $25 per month; is higher than the amount paid in much larger places at the North, but as low as a suitable one

could be obtained, even with the assistance of the meteorological committee.

GRAND HAVEN, MICHIGAN, (No. 48.)

The observer's office is located at the corner of Second and Washington streets, in the business center of the town. The post-office and custom-house are in the same block, and the telegraph office only one square distant. A line of hills on the west and southwest cut off the important winds in that direction, and this fact will require a change of location to a better exposed one as soon as the necessary facilities can be had. The vane, anemometer, and rain-gauge are all on the roof of the building in which the office is situated, and are as well exposed as the location will permit. No instrument-shelter was used at the station until the inspecting officer ordered one made of the standard pattern when there in the early part of September, 1871.

The station was established by Sergeant F. F. Wood, and reports commenced May 24, 1871, and have been regularly made since that time. The reports of nine of the principal lake-stations are received here, and four morning and three afternoon bulletins issued. Three weekly papers are furnished with and publish an abstract of the local reports and the most important features of the others. No manifold-maps are issued, and there is no large weather-map at the station.

Latitude of station	43° 05′
Longitude of station	86° 13′
Elevation of barometer above sea-level	599 feet.

The station is provided with a full set of standard instruments, all of which are reported to be in good condition.

There is no board of trade here, and no assistant.

Eight dollars per month is paid for rent of office.

INDIANAPOLIS, INDIANA, (No. 43.)

The office is located at the corner of Meridian and Washington streets, and convenient to the telegraph and principal newspaper offices. The instruments are well exposed, and the observations accurately made and reported regularly by Sergeant C. F. R. Wappenhaus, who established the station, and commenced sending telegraphic reports February 10, 1871, since which time there has been no interruption nor any change in location of office.

Indianapolis receives the reports of thirty other stations. Four bulletins are posted in conspicuous places, and all the daily papers furnished with the press-report, but they do not publish it regularly. An assistant was sent to the station August 22. Manifold-maps are not issued.

Latitude of station	39° 42′
Longitude of station	86° 06′
Elevation of barometer above sea-level	748 feet.

The station is supplied with a complete set of standard instruments, all of which are reported to be in good condition.

The board of trade has appointed a meteorological committee, and its members have displayed much interest in the development of the system.

Rent paid for office is $7 per month.

JACKSONVILLE, FLORIDA, (No. 73.)

The observer's office is located in the Freedmen's Bank building, at the corner of Forsyth and Pine streets, and is in the center of the busi-

ness part of the city, and within a short distance of the telegraph-office. The office room is on the second floor, but the vane, anemometer, and rain-gauge are on the roof of the building, and have a good exposure. The instrument shelter is of the standard pattern, and projects from a window of the office in the usual manner.

The station was established by Sergeant D. A. Daboll, and reports were commenced on September 11, 1871, the arrival of the observer having been delayed somewhat by the quarantine regulations established to protect the city from being affected by the yellow fever, then prevalent at Charleston and other seaport towns.

Nine stations send their reports to Jacksonville, and these reports are bulletined and given to the press, but no report has yet been made to the office of the precise number of bulletins issued, and their location.

Latitude of station	30° 15′
Longitude of station	82° 00′
Elevation of barometer above sea-level	50 feet.

The station is provided with the regular outfit of standard instruments, and all of them are reported in good condition.

The office has no knowledge of the appointment of a meteorological committee by the board of trade, nor of the existence of such a body as a board of trade. The reports are made regularly and properly.

Rent paid for the office is $18 per month.

The station has not yet been visited by an inspecting officer.

KEOKUK, IOWA, (No. 47.)

The office at this station is located at the corner of Main and Second streets, and in the immediate vicinity of the principal business houses. The wind-vane, anemometer, and rain-gauge are exposed upon the roof of the building, and secured to a platform built for the purpose. The instrument-shelter is of the standard pattern, and projects from a window of the office.

Reports are received from twenty-six other stations, and are bulletined in the most important public places. No inspection has yet been made of the station, and the details for a satisfactory report are wanting. The daily papers are supplied with the press-report, and the observer is a competent and reliable man, and has a good assistant, who has been with him since August 4, 1871.

The station was established by Sergeant A. C. Barclay, and reports commenced on the morning of July 15, 1871, and have been continued, with very few interruptions, since that date.

Latitude of station	40° 18′
Longitude of station	91° 30′
Elevation of barometer above sea-level	580 feet.

The station is supplied with a full set of standard instruments, and all of them are reported to be in good condition. Manifold-maps are not issued here, but the large weather-map is displayed, and its symbols changed regularly.

The amount of rent paid per month for office is $6.

KEY WEST, FLORIDA, (No. 25.)

This station was established by Sergeant John R. Allen, and reports commenced November 1, 1870. Until September 10, 1871, there was no regular transmission of reports to Key West, but since that time those

of nine other stations have been sent and regularly bulletined in four public places. The reports from this station have been frequently interrupted by telegraphic irregularities, but the work of the observer has been faithfully and well done, and his mail reports regularly and properly rendered.

Latitude of station	24° 36′
Longitude of station	81° 48′
Elevation of barometer above sea-level	20 feet.

The station is supplied with the regular outfit of standard instruments, and they are all reported to be in good condition.

The amount of rent paid for office, $15 per month.

(Since writing the above, news has been received of the death of Sergeant Allen, on the 12th of October, of yellow fever. This leaves the station without a regular observer, but a civilian, who had been instructed by Sergeant Allen, is making reports, and has not lost a single one to date.)

KNOXVILLE, TENNESSEE, (No. 42.)

The observer's office at this station is located in the university building, and is at a distance from the business part of the city, but as this is merely a reporting station, there appears to be no good reason for changing the locality. The instruments are well exposed, and the large vane is made to indicate the direction of the wind on the ceiling of the office.

The station was established by Sergeant John K. Payne, professor of mathematics in the university, and reports commenced January 20, 1871, since which date they have been made without interruption. The only reports received here are those from Lynchburgh, Virginia, and consequently there are no bulletins posted nor maps issued. The daily papers are furnished with all the local observations, and insert them regularly.

Latitude of station	35° 56
Longitude of station	83° 58′
Elevation of barometer above sea-level	1,007 fee.

The station is supplied with a full set of standard instruments, all of which are reported to be in good condition. The first barometer for this station was sent by express carefully packed, but was broken in transit, and another was sent in charge of the postal route-agent, through the kindness of the Post Office Department, and this was received in good order. The management of the station has been quite satisfactory, and all reports made properly and promptly.

Office rent is $15 per month.

LAKE CITY, FLORIDA, (No. 24.)

The office is located on the corner of Main and Franklin streets, about one-fourth of a mile from the telegraph office, railroad depot, and post-office. The building is the best in town for the purpose, being isolated from others and from high trees. It has a sloping roof, and the wind-vane, anemometer, and rain-gauge are erected upon a platform 8 feet square, built upon the ridges of the roof. The vane registers in the office. The instrument-shelter is of the standard pattern, and projects from a window in the usual manner.

The station was established by Sergeant A. C. Barclay, and reports commenced November 1, 1870. Sergeant Barclay was transferred on

the 23d of June to another station, and was succeeded by Sergeant J. E. Magruder, and on the 25th of September an assistant was sent to the station.

The reports of ten other stations are received here, and are transferred to the Key West and Jacksonville circuits. Full reports were received until July of this year, when they were discontinued, as being useless to the citizens and causing extra and unnecessary work to the observer. No bulletins are posted at present, and the inspecting officer reports that they would be of no use. The station was established more to facilitate and ensure the transfer of the reports to and from Key West and other stations from one telegraph line to the other, the Western Union and Inter-Ocean lines connecting here, but occupying offices some distance apart.

Latitude of station	30° 06′
Longitude of station	82° 42′
Elevation of barometer above sea-level	190 feet.

The station is supplied with a full set of standard instruments, all of which are in good condition.

The rent paid for office is $10 per month.

The following extract from the report of the inspecting officer shows that a portion, at least, of the inhabitants fail to appreciate properly the labors of the observer:

> Indignation meetings have been held, and resolutions passed, to drive him (the observer) from the town, because it was believed that his instruments caused the unexampled bad weather and large amount of rain which has fallen here lately.

As the work of transferring reports at this point can and should be performed by the telegraph companies, there is no necessity for maintaining the station, and its removal to some other point is recommended.

LEAVENWORTH, KANSAS, (No. 52.)

The office of the observer at this station is located on Delaware street, and within easy reach of the several public offices. It is in the upper story of the building, and the roof is used for the exposure of the wind-vane, anemometer, and rain-gauge. The shelter projects from the window of the office and is built after the standard model.

The station was established by Sergeant George H. Bochmer and reports commenced on the 24th of May, 1871. Telegraphic communication with this station has been regular, and reports have been uninterrupted. The reports of fourteen other stations are received here, and seven bulletins are issued and properly posted, and all the daily papers are supplied with and publish full tabular reports.

Latitude of station	39° 21′
Longitude of station	94° 44′
Elevation of barometer above sea-level	929 feet.

The observer is supplied with a complete set of standard instruments, all of which he reports to be in good condition. Manifold-maps are not issued. The station has been conducted in a satisfactory manner, and the reports have been properly and promptly made.

Rent paid for office is $14 per month.

LOUISVILLE, KENTUCKY, (No. 64.)

The observer's office is temporarily located in the custom-house, and it is hoped that arrangements will be made to retain it here permanently.

The vane, anemometer, and rain-gauge are exposed on the roof of the building, and the other instruments in the office, no shelter having yet been built.

The station was established by Sergeant Thomas J. Brown, and reports commenced September 11, 1871. Thirty reports are received, and bulletins are issued daily. The daily newspapers are all supplied with and print the tabular reports as well as the synopsis and probabilities. No maps are issued.

Latitude of station	38° 00′
Longitude of station	85° 25′
Elevation of barometer above sea-level	493½ feet.

The station is provided with a full set of standard instruments, all of which are reported to be in good condition. The reports are made properly and promptly, and the management of the station is satisfactory so far as known. It has not been visited by an inspecting officer.

No rent is paid at present for office.

LYNCHBURGH, VIRGINIA, (No. 44.)

The office of the observer is located at the corner of Eighth and Court streets, and the exposure of the wind-vane, anemometer, and rain-gauge on the roof is a good one. The shelter is of the standard pattern, and projects from a north window of the office.

The station was established by Sergeant James B. Murray, and reports commenced May 24, 1871. The schedule reports received are those of Knoxville only, but, through the courtesy of the Western Union Telegraph Company, twenty additional reports are sent each morning, and bulletined properly. There is no assistant at this station, and no manifold-maps are issued.

Latitude of station	37° 18′
Longitude of station	85° 54′
Elevation of barometer above sea-level	650 feet.

The station is supplied with a full set of standard instruments, and all of them are reported to be in good condition. The reports have been made with regularity and promptness, and the general management of the station satisfactory. It has not yet been visited by an inspecting officer.

Rent paid for office is $11 per month.

MARQUETTE, MICHIGAN, (No. 50.)

The office at this station is located at the corner of Spring and Front streets, in the upper story of the building, and in the immediate vicinity of the post-office and telegraph office and the custom-house, and is favorably situated for the convenience of the business portion of the town. A low range of hills extends along the lake shore, and partly cuts off the wind from the west and south, but this cannot be remedied without sacrificing the advantages to be derived from close proximity to the telegraph-office. The anemometer and vane are on a platform built upon the roof for the purpose of giving them the necessary exposure. The rain-gauge is on the roof of the building and well placed. The instrument-shelter is of the standard pattern, and projects from an office window.

The station was established by Sergeant Thomas P. Stout, and reports commenced on the 11th of May, 1871. The same difficulty is experienced

here that was referred to in the report upon the Esconawba station, in reference to the reception and transmission of reports, owing to the frequent interruption of telegraphic communication with Milwaukee. The reports of eleven other stations, principally along the lakes, are received here, but so irregularly as to be of little actual value. Fourteen morning bulletins are issued, and nine of the afternoon reports. One paper only, and that a weekly, is published here, and it prints a synopsis of all received since last issue.

Latitude of station	46° 33′
Longitude of station	87° 23′
Elevation of barometer above sea-level	668 feet.

The station is supplied with a full set of standard instruments, all of which are reported in good condition.

The rent of office is $12 50 per month.

The reports from this station are properly made, and the sergeant proved himself a hard-working man, but his personal conduct was found to be such that the inspecting officer, when he visited the station in the latter part of September, recommended his relief, and he was accordingly replaced by Sergeant Clendenon.

MILWAUKEE, WISCONSIN, (No. 38.)

The office at this station is located in the third story of the Northwestern Insurance building, on Broadway, in the heart of the business part of the city. The vane, anemometer, and rain-gauge are on the roof of the building, and the instrument-shelter is also on the roof, built from the cover of a hatchway. It is a modification of the standard pattern, and answers the purpose well.

The station was established by Sergeant A. Brimer, and reports commenced November 1, 1870, since which time there has been no serious interruption. The station receives fifty-three reports, and four bulletins of both the afternoon and morning reports are issued. Three morning reports are supplied with the midnight report, and one evening paper with the morning. Seven manifold-maps are issued daily, and the large weather-map, which is hung in the hall of the chamber of commerce, is changed regularly. An assistant, Private Gilligan, of the signal detachment, was sent to this station on the 17th of July, 1871, and remained until September 9, 1871, when he was relieved for misconduct, and succeeded by another man equally as bad, who, after a few days' trial, was called in, and still another one sent. This latter man is doing well.

Latitude of station	43° 03′
Longitude of station	87° 57′
Elevation of barometer above sea-level	641 feet.

A full set of standard instruments is in use at this station, and all of them are reported to be in good condition.

There has been a meteorological committee appointed by the chamber of commerce.

The management of the station has been satisfactory, and reports have been regularly made, and, it is believed, in a reliable form. It was inspected in September, and found in good order. This is the transfer-point for all reports going to and from the Northwestern States, and this fact increases the amount of labor required of the observer.

The office rent is $20 per month.

MOBILE, ALABAMA, (No. 27.)

The office of the observer is located on St. Michael street, and convenient to the telegraph-office. The instrument-shelter is made after the standard pattern.

The station was established by Sergeant A. R. Thornett, and reports commenced November 7, 1870, since which time there has been no serious interruption. Eleven reports are received here, and four bulletins issued daily. In addition to this, three daily papers are supplied with the reports, and publish the afternoon ones, not caring to take the midnight reports on account of the lateness of the hour at which they arrive. An assistant, Private William Line, was sent to the station May 18, 1871, and has shown himself to be a steady, reliable man.

Latitude of station	30° 42′
Longitude of station	87° 59′
Elevation of barometer above sea-level	50 feet.

A full set of standard instruments has been sent to this station, and they are all reported to be in good condition.

A meteorological committee has been appointed by the board of trade, and the management of the station has been satisfactory.

The office rent paid is $12 per month.

MONTREAL, CANADA, (No. 56.)

The observations at this station are made by Dr. Charles Smallwood, of the Montreal Observatory, who exchanges with this office, sending his own reports regularly except on Sundays, and receiving in return as many reports as he chooses to select from the number received at Portland. The instruments used are those belonging to the observatory. Reports are made weekly to this office, by Dr. Smallwood, on the regular forms, and those sent by telegraph are made out in precisely the same manner as those at all other reporting stations.

MEMPHIS, TENNESSEE, (No. 62.)

The office at this station was originally located in an unsuitable portion of the city, as the observer could not procure a room in the business quarter without paying higher rent than his instructions authorized. On the 1st of September a room was obtained, and the office moved to Second street. The exposure of instruments on the roof is reported to be good, and the shelter of the standard pattern.

The station was established by Sergeant Thomas J. Brown, and reports commenced February 28, 1871, since which time they have been regularly made. On the 28th of August, 1871, Sergeant Brown was transferred to another station, and was succeeded by Sergeant S. W. Rhode, who remains in charge, and is assisted by Private Hugh Coyle. Thirty reports are received here, and seven bulletins issued daily; and, in addition to this, the daily papers are furnished with the full local report, which is the only one they will publish. All the papers publish the latest synopsis received up to the time of going to press. Manifold-maps are not issued.

Latitude of station	35° 08′
Longitude of station	88° 00′
Elevation of barometer above sea-level	286 feet.

The station is supplied with a full set of standard instruments, all of which are reported to be in good condition.

The chamber of commerce has appointed a meteorological committee, and the observer reports that its members have manifested considerable interest in his labors. Both sergeants who have been in charge of the station have given satisfaction, and made all reports regularly and promptly.

The office rent was $15 per month to September 1, since which time it has been $16 50.

MONTGOMERY, ALABAMA, (No. 26.)

The office was well located, and the instruments properly exposed by Sergeant J. E. Evans, who commenced reporting November 1, 1870. When it was decided to occupy the coast stations, Montgomery was abandoned, and the observer transferred to Charleston, South Carolina. Reports were discontinued December 18, 1870.

MT. WASHINGTON, NEW HAMPSHIRE, (No. 46.)

The observer's office is located in the depot building of the Mount Washington Railroad, through the kind permission of the officers of the company. The instruments used are of the standard patterns, and are duplicated to prevent any interruption of reports through the accidental breakage of any of them. Spirit-thermometers, prepared especially for the station, are supplied to the observer, the experience of last winter having shown the necessity of getting instruments that were graduated for unusual low temperatures.

In the fall of 1870 an expedition was organized by Professor Hitchcock, of Dartmouth College, for the occupation, during the winter, of the mountain as a meteorological station, and efforts were made by him to raise sufficient means to defray the expenses from private sources, but being unsuccessful, he applied to this office for a telegraph cable and the necessary instruments to work it. Reports from such an elevated position were considered important, and three miles of Kerite covered wire and a complete set of telegraph instruments and an operator were sent to assist the professor in carrying out his enterprise. The operator was also an instructed observer, and some delay was experienced in getting him ready, and the cable was laid before his arrival, by Professors Hitchcock and Huntington, upon the trestle-work of the railway, and fastened by eyelets to prevent its being swayed by the wind and the insulation destroyed.

Sergeant Theodore Smith, the observer sent to take charge of the station, reached the mountain in December, and his first duty was to insure telegraphic communication with Littleton, the nearest station, by a personal inspection of the main line. He found this line in a bad condition, it being broken in several places, and blown off the poles on many exposed points along the road. The winter had set in, and a continuous snow-storm for several days and an almost impassable road made the labor of repairing a severe one, and it was not until the 12th of December that communication was had over the main wire from the base of the mountain with Littleton. The line to the summit was still imperfect, as the several pieces of cable, although securely laid, were not spliced together at the ends, this labor having been left for more experienced hands than those which laid the wire. The difficulty of the task can be imagined when it is considered that the depth of snow along the line varied from 10 to 20 feet, and the precise localities where the

splices were to be made were unknown, as the boards originally put up as guides were quite covered up by the snow. In spite of these obstacles, the work was performed in less than two days, and a ground connection having been secured by running the suspended wire of the main line into the Ammonoosuc River, at the base of the mountain, communication was complete with the office in Washington, and on the morning of December 15 regular weather-reports were commenced, and transmitted, after that date, as regularly as circumstances would permit. Violent storms of wind frequently broke the cable, and the difficulty of repairing these breaks when the temperature was below zero from 10° to 40° can be better imagined than described. As the trestle-work is in some places 30 feet high, the work was not without danger, and Sergeant Smith at one time met with a serious accident, from the effects of which he still suffers. The Kerite wire proved itself a good and reliable conductor, and the greater portion of that used last winter has been relaid for use again the present season. One mile of Bishop's covered wire has been added to the Kerite, above the line of vegetation. Sergeant Smith was relieved May 22, on account of ill health, and was succeeded by Sergeant Martin L. Hearne, who will remain during the present winter, assisted by Private Stevens, of the signal detachment, and the work will be wholly under the control of this office.

The faithfulness and devotion to duty manifested by Sergeant Smith, during the time he was in charge of the station, entitle him to the commendation of his superior officer, as they have won for him the respect of all students of meteoric science in the country.

As the office has profited by past experience, and supplied the station with the best attainable instruments, it is hoped that more reliable data will be collected during the ensuing winter than was possible last winter under the circumstances. The cost of maintaining the station greatly exceeds that of stations at more accessible points. Efforts have been made by the office to obtain permission to erect a building for permanent use as an observatory, but so far they have been unsuccessful, owing to the ownership of the summit being the subject of litigation, and the consequent difficulty of getting a title.

NASHVILLE, TENNESSEE, (No. 63.)

The office was at first located on Cherry street, but was soon afterward removed to College street, where it now remains. The vane, anemometer, and rain-gauge are well exposed on the roof of the building, and the instrument-shelter, of the standard pattern, projects from a window in the usual manner.

The station was established by Sergeant George H. Witmer, and reports commenced on the morning of November —, since which time they have been sent regularly. Sergeant Witmer was relieved, on account of drunkenness, January 31, 1871, and was succeeded by Sergeant W. Moore, who was relieved, for the same cause, February 10, 1871, by Sergeant Thomas L. Watson, who remained in charge of the station until August 4, 1871, when he was relieved for failing to transmit his mail reports promptly. Sergeant J. H. Garrard is now in charge, and gives satisfaction. He is assisted by Private William Henderson, who was sent to the station July 6, 1871. Thirty reports are received here, and five bulletins issued daily. The newspapers publish nothing but the local reports and the probabilities. Manifold-maps are not issued.

Latitude of station	36° 10′
Longitude of station	86° 49′
Elevation of barometer above sea-level	532 feet.

The station is supplied with a full set of standard instruments, all of which are reported to be in good condition. The board of trade has appointed a meteorological committee to confer with the Chief Signal Officer whenever necessary.

Rent paid for office is at the rate of $200 per annum.

Since the station has been in charge of the present observer, all reports have been regularly and properly made.

NEW LONDON, CONNECTICUT, (No. 14.)

The office is located on the second floor of a four-story building on Water street, within one square of the business center of the city, and within half that distance of the Western Union telegraph-office. Although not in the highest part of the city, the location is pronounced a good one by the inspecting officer. The wind-vane, anemometer, and rain-gauge are exposed on the roof of the building upon a cross-armed support about 6 feet in height. The instrument-shelter is of the standard pattern, and projects from a window on the fourth or upper story of the building. The station was established by Sergeant C. E. Bunsmade, and reports commenced January 15, 1871, since which time they have been received without serious interruption. Full reports from all other stations are received here, and six bulletins issued and posted daily, and two papers supplied with the press-report, one of the papers being published in Norwich, and the copy sent each night by train. Manifold-maps are not issued. The large weather-map is hung in the post-office, and corrected daily.

Latitude of station	41° 22′
Longitude of station	72° 9′
Elevation of barometer above sea-level	21 feet.

The station is supplied with a complete set of standard instruments, all of which are reported to be in good condition. The board of trade have appointed a meteorological committee, the members of which, and the citizens generally, display a lively interest in the reports.

The rent paid for office is $12 per month. All reports have been made promptly, and the management of the station has been satisfactory. Private John Healy was sent here as assistant June 15, 1871.

NEW ORLEANS, LOUISIANA, (No. 28.)

The office is situated on the third floor of building, No. 222 Custom-house street, at a considerable distance from the telegraph and newspaper offices. Arrangements have been made to remove it to the custom-house as soon as a suitable room can be prepared, and then the location will be the best in the city. The office was moved, soon after the station was opened, from Carondelet street to its present location.

The wind-vane, anemometer, and rain-gauge have been exposed on the roof of the building, and the other instruments in the usual manner. The station was established by Sergeant D. S. Pullen, and reports were commenced November 1, 1870. Private J. C. McCoy was sent here as assistant May 18, 1871, and both men have performed their duties in a satisfactory manner. The reports of thirty other stations are received, and bulletined in the most prominent places in the city, and all the daily papers are furnished with the press-report, but only print selections from it, and that irregularly. The synopsis is received and published regularly.

A printing-press has recently been sent to this station, and the issue

of printed weather-maps has commenced, but no report has yet been made of the number distributed daily.

Latitude of station	29° 57′
Longitude of station	90° 00′
Elevation of barometer above sea-level	47 feet.

The station is supplied with a full set of standard instruments, all of which are reported in a good condition.

Ten dollars per month has been paid for rent of office.

This being a transfer-station for reports passing between Augusta, Galveston, and Shreveport, the observer is required to attend closely to his work. There have been some irregularities in the telegraphic work of the station, but these are being corrected, and it is believed that there will be no serious ground for complaint in the future.

NEW YORK, NEW YORK, (No. 15.)

The office was located on Wall street until removed to the Equitable Insurance building, on Broadway, July 25, 1871. The location of the building is a good one, and the advantage to be derived from the use of its elevated roof superior perhaps to any that can be had in the city, but the office occupied by the observers, and in which their duties are necessarily performed, is entirely unsuitable for the purpose, owing to the want of room.

The following extract from the report of the inspecting office shows the result of the want of space:

> The observer's duties cannot be properly performed in this office, and they have not been, for, on account of a lack of sufficient space for two persons to write at the same time, the records have not been kept up.

This is the more to be regretted because the station is one of the most important in the country, and its shipping interests the greatest. The instrument-shelter is an iron copy of the observatory on the central office in Washington, and is sufficiently elevated from the roof to guard against the effects of radiation from the flat roof of the building.

The wind-vane, anemometer, and rain-gauge are fixed upon the roof of the observatory, and the two first-named instruments are made to register inside, the former by a shaft running into the building, and the latter by means of electricity. Two large flag-staffs, for the display of signals, have been erected upon the roof of the main building, and are in full view of a greater part of the harbor. If the office-room was suitable, the station would reflect credit upon the city, but as it now stands, few people ever visit it, and those seldom make a second visit.

The station was established by Sergeant C. R. Estabrook, and reports commenced on the morning of November 1, 1870, since which date there has been no interruption. Reports from the east, west, and south are here transferred and interchanged, and the routine work is exacting and laborious. Sergeant C. R. Daw was ordered here, as assistant, November 15, 1870, and remained until transferred to the charge of Philadelphia station, April 19, 1871, when he was succeeded by Sergeant A. W. Eastlake, who still remains. Full reports from all stations are received, fourteen bulletins of the and morning, and six of the evening reports are issued and distributed. Five papers are supplied with the morning report, and seven with the midnight one, although it is not published regularly by all of them. Nearly all the dailies in the city publish the synopsis.

The station is supplied with a printing-press for maps. Eighteen of these are issued per day, and properly distributed. This number has

temporarily increased, during the last ten days of September, to three hundred per day, but it is not proposed to continue such a large issue, unless to supply the popular demand. The large weather-map is hung in the Merchants' Exchange, and properly corrected.

Latitude of station	40° 42′
Longitude of station	74° 01′
Elevation of barometer above sea-level	128 feet.

The station is supplied with a full set of instruments, and all of them are reported to be in good condition. The chamber of commerce and board of underwriters have both appointed meteorological committees, which have rendered material aid to the office and to the observer.

No rent has been paid for the office since its establishment.

The sergeant in charge has made his reports regularly to this office, but until a larger office-room is obtained the station cannot be worked satisfactorily. The size of the city renders it impossible for the present force to distribute a sufficient number of bulletins in time to make them of value, and it is recommended that if the present system of publication is continued, one or two boys be employed to give a wider circulation to the morning reports.

NORFOLK, VIRGINIA, (No. 30.)

The office at this station is located on the fourth floor of a building on the corner of Main and Gray streets, two blocks from the wharves, custom-house and board of trade rooms, and the offices of the telegraph companies, and one block from the newspaper offices and the business part of the city. The location is pronounced a good one by the inspecting officer. The anemometer, vane, and rain-gauge are exposed on the roof of the building. The instrument-shelter is of the standard pattern, and projects from an office window in the usual manner.

The station was established by Sergeant W. E. Smith, and reports commenced January 1, 1871, and there has been no serious interruption since that date. An assistant was ordered to the station June 5, 1871, as the work was too laborious for one man. Full reports are received here, and four bulletins issued daily, besides eight manifold maps. Three papers are regularly furnished with the press-report.

Latitude of station	36° 51′
Longitude of station	76° 19′
Elevation of barometer above sea-level	54 feet.

The station is supplied with a full set of instruments, and all of them are reported in good condition. One barometer was broken by the observer in attempting to clean it, but another was immediately sent him, and very few barometric observations were lost.

Up to the 1st of September, 1871, the office was located in the custom-house, and no rent was paid; but, the location being considered undesirable, it was removed on that date, and rent is now paid at the rate of $200 per year.

Reports have been regularly made by the observer, and his management of the station has been satisfactory, while his personal conduct is commended by the members of the board of trade and by the inspecting officers.

OMAHA, NEBRASKA, (No. 67.)

The office at this station is located in the upper story of a bank building on Farnam street, within easy reach of the telegraph, newspaper, and post offices. The vane, anemometer, and rain-gauge are

fixed on the roof of the building, which is flat, and well adapted to the purpose, and the exposure is as good as can be had at any available point in the city. A low range of hills partially cuts off the wind from the west, but does not offer material obstruction.

The shelter here is a modification of the standard pattern, and is built out from a window, as at other stations.

Sergeant W. W. Craig established the station, and commenced sending reports November 1, 1870, but was relieved November 9, on account of gross irregularities in his reports, by Sergeant W. B. Webster, who still remains in charge, and who has given satisfaction by the promptness and accuracy of his reports.

The reports of only four other stations are received here, and the number of bulletins issued consequently small. One is posted at the office, and two press-reports are furnished the daily newspapers. No manifold-maps are issued.

Latitue of station	41° 16′
Longitude of station	96° 00′
Elevation of barometer above sea-level	1000 ft.

The station is furnished with the usual standard instruments, all of which are in good condition. The barometer carried by Sergeant Craig when sent to establish the station was broken in passage, and another one was sent direct from Mr. Green's shop in New York. This is the only barometer in use on station that has not been compared with the standard in the Washington office.

A meteorological committee has been appointed by the board of trade, and efforts have been made to get more reports for the information of the citizens.

Rent of office is $22 per month.

OSWEGO, NEW YORK, (No. 31.)

The office at this station is located in a front room on the third floor of a building at the corner of Bridge and Front streets, and in the business center of the city. It is one square from the post-office and custom-house, and immediately opposite the Western Union telegraph office. The board of trade rooms are half a square distant, and all the newspaper offices are within three squares.

The wind-vane, anemometer, and rain-gauge are fixed upon a rough platform on the roof of the building; and the exposure is good since the visit of the inspecting officer, under whose direction several changes were made in the location of instruments. The instrument-shelter is built after the standard pattern, and projects from an office window.

The station was established by Sergeant B. F. Hough, who commenced making reports November 1, 1870, and has continued them uninterruptedly since that date. Full reports are received here from all other stations. Seven bulletins are issued daily, and four manifold-maps and three daily papers are furnished with the press-report.

The large weather-map is hung in the observer's office, having been removed there from the board of trade room by order of the inspector, on account of the shortness of time the latter was accessible to the public each day. Private D. C. Murphy has been on duty here as assistant since February 27, 1871.

Latitude of station	43° 28′
Longitude of station	76° 35′
Elevation of barometer above sea-level	261 feet.

The usual standard instruments are used at this station, and are all reported in good condition.

A meteorological committee has been appointed by the board of trade, and much interest is manifested in the reports by the members of the committee and by the citizens generally.

The rent paid for office is at the rate of $175 per annum.

All the reports have been promptly and properly made, and the general management of the station has been satisfactory.

PHILADELPHIA, PENNSYLVANIA, (No. 17.)

The office is located in the chamber of commerce building, and has been fitted up with great care and at considerable expense for this special purpose. Until September 1, 1871, it was at 505 Chestnut street, where access to the roof of the building for exposure of instruments could not be had. At present the anemometer and range-gauge are well exposed, and the arrangement of the cupola of the building occupied is similar to the form of observatory in use at the Washington office.

The station was established by Sergeant A. W. Eastlake, and reports commenced January 1, 1871. An assistant was sent from the detachment at Fort Whipple, January 16, and remained until April 10, when he was succeeded by Sergeant Sullivan, who being soon afterward transferred to the charge of the Pittsburgh station, was succeeded by Private Bell from the detachment. Sergeant Eastlake was transferred to New York April 19, exchanging with Sergeant Daw, who has been in charge since that date.

Full reports are received here and seven bulletins and fourteen manifold maps issued daily, and nine papers furnished with the press report. A printing-press for the manifold-map has been sent to this station, and when it gets in operation the number of maps issued will be largely increased.

Latitude of station	39° 57′
Longitude	75° 12′
Elevation of barometer above sea-level	80 feet.

A full set of standard instruments has been furnished the station, and all of them are reported in good condition. A meteorological committee has been appointed by the board of trade.

Office rent is $25 per month.

The observer in charge is competent to perform his duties, but has not been as prompt with his mail reports as he should have been, nor has he displayed the amount of energy required to work a station as important as this one; and measures will be taken to supply his place with a man of geater working capacity, and to transfer him to a less important station.

PITTSBURGH, PENNSYLVANIA, (No. 41.)

The office at this station has been a movable one, owing to lack of judgment on the part of the observers who at different times have been in charge, but it is hoped that a permanent location has been secured at last, in the upper story of the First National Bank building, at the corner of Fifth Avenue and Wood street. The first location was at No. 24 Fifth Avenue; then it was moved to Grant street, from there to the St. Clair Hotel, and finally to its present location. It is now on the same floor with the Western Union telegraph-office, within one

square of the post-office, and within the same distance of all the principal newspaper offices.

The wind-vane, anemometer, and rain-gauge are fixed on the roof of the building, and the exposure is as good as can be had in the business part of the city. The instrument-shelter is of the standard pattern, having been remodeled under the direction of the inspecting officer.

The station was established by Sergeant James West, and reports were commenced November 1, 1870, since which time there has been no serious interruption. Sergeant West was sick for several weeks, and the station was worked by Sergeant Eastlake, who was sent there for that purpose, and remained until his transfer to Philadelphia. Sergeant West's conduct was so bad that he was relieved January 31, 1871, by Sergeant H. D. Schmidt, who also failed to perform his duty, and was ordered in May 23, 1871, and succeeded by Sergeant George N. Sullivan, who remained until August 21, when his health became so poor that he was unable to work the station, and was relieved by Sergeant L. M. Crist. An assistant was sent to the station August 23, and its present management is giving satisfaction to the citizens and to this office.

Fifteen reports are received here, four bulletins are issued and posted, and three papers are supplied with the press-report. Manifold-maps are not issued. The large weather-map is hung in the observer's office, and is corrected daily.

Latitude of station	40° 32′
Longitude of station	80° 02′
Elevation of barometer above sea-level	955 feet.

The station is supplied with a full set of standard instruments, all of which are reported to be in good condition.

The rent paid for office is $25 per month.

Reports are now made from the station promptly and properly, and the service is gradually becoming of interest to the business and scientific citizens, who were disposed to attribute the misconduct of the two first observers to the system itself, and therefore looked upon it with disfavor.

PORTLAND, MAINE, (No. 12.)

The office at this station is located in the upper story of No. 4 Exchange Place, a building in the center of the business portion of the city. The roof of the building is sloping, and the instruments are fixed upon a rough platform built on the highest part of it. The vane, anemometer, and rain-gauge are well exposed. The instrument-shelter is a small copy of the observatory on the central office, and is also upon the roof, and well adapted to the purpose, but difficult of access.

The station was established by Sergeant William Lewin, and reports commenced January 15, 1871. Sergeant Lewin was relieved for drunkenness on duty April 5, and succeeded by Sergeant R. E. McGrady, who still remains in charge and performs his duties in a satisfactory manner. Private William Ramsey was sent to this station as an assistant June 5, 1871. Full reports are received from all other stations, and seven bulletins are issued daily and three papers supplied with the press-reports.

Latitude of station	43° 40′
Longitude of station	70° 14′
Elevation of barometer above sea-level	69½ feet.

The station is supplied with a complete set of standard instruments, all of which are reported in good condition.

Rent paid for office is $18 per month.

PUNTA RASSA, FLORIDA, (No. 59.)

There is only one building at this station, so there was little difficulty experienced in selecting a location for the office. The building referred to is the property of the telegraph company sending the reports, and permission to occupy a portion of it was at once granted by the manager of the office.

The wind-vane, anemometer, and rain-gauge are fixed upon an elevated staging or platform 20 feet high, built for the purpose, and the other instruments are in the office, no regular shelter having as yet been constructed.

The station was established by Sergeant C. E. Ingram, and reports were commenced August 15. No reports are received here and no bulletins are issued.

This being the shore-end of the cable to Key West, all reports for that place necessarily pass through the station and might be taken off if any use could be made of them.

Latitude of station	27° 00′
Longitude of station	82° 18′
Elevation of barometer above sea-level	20 feet.

The station is supplied with a full set of standard instruments, and all of them are reported to be in good condition.

An allowance of $18 a month is made for use of office-room.

As all supplies have to come from Key West, considerable difficulty has been experienced in getting furniture and other materials necessary to fit up the station properly.

ROCHESTER, NEW YORK, (No. 32.)

The office at this station was located on the fourth floor of Reynold's Arcade until September 1, when it was removed by order of the inspecting officer to Power's Block, where a better exposure for the instruments is had. The present location is a desirable one, being within easy reach of the post and telegraph offices and in the business center of the city. The office is heated and lighted without expense to the Government.

The wind-vane, anemometer, and rain-gauge are well exposed on the roof of the building. The instrument shelter is built on the roof also, and is a modified copy of the observatory at the central office in Washington.

The station was established by Sergeant F. M. M. Beall, and reports were commenced November 1, 1870. Private M. F. Tighe was sent to station as assistant February 20, 1871. Full reports are received and nine bulletins are issued daily and three papers supplied with the press-report, which is published in full. Two manifold-maps only are issued. The large weather-map is hung up in the court-house and corrected regularly.

Latitude of station	43° 8′
Longitude of station	77° 51′
Elevation of barometer above sea-level	556 feet.

The station is supplied with a full set of standard instruments, and all of them are reported in good condition.

All reports have been made promptly and regularly, and the general management of the station satisfactory.

Rent paid for office is $18 per month.

San Francisco, California, (No. 29.)

The office at this station is located in the Merchants' Exchange building, and in the immediate vicinity of the telegraph office and other prominent business places.

The wind-vane and rain-gauge are exposed on the roof of the building. The anemometer is out of repair at present, but a new one will be furnished the station without delay. The cost of skilled labor is so high in this city that the expense of repairing instruments of this nature is greater than the cost of new ones.

The station was established by Sergeant W. P. Faherty, and reports were commenced February 2, 1871. Sergeant S. P. Carusi took charge of the station March 11, 1871, relieving Sergeant Faherty. Four reports only are received here, and bulletins are therefore not posted, but the local observations are furnished to the daily papers and regularly published.

Latitude of station	37° 48′
Longitude of station	122° 26′
Elevation of barometer above sea-level	60 feet.

The station is supplied with a complete set of standard instruments, all of which are in good order except the anemometer, as stated above.

Rent of office is $28 25 per month, including light and janitor's fee.

Savannah, Georgia, (No. 22.)

The office at this station is on the third floor of the building at the corner of Buell and Bay streets. It is within half a square of the telegraph office and within a square of the newspaper offices, exchange and custom-house buildings, board of trade rooms, and the principal hotels.

The wind-vane, anemometer, and rain-gauge are erected on a platform about 8 feet square, which is built upon the highest part of the roof, and the exposure is good. The instrument shelter is of the standard pattern, and projects in the usual manner from a window, through the glass of which the instruments can be read.

The station was established by Sergeant C. W. Held, and reports were commenced January 1, 1871. Private Purdum was sent here as assistant June 12, 1871. No changes have since been made, as the duties have been performed satisfactorily. Full reports are received, and seven bulletins are posted daily and three papers furnished with the press-report. No manifold-maps have been issued, but upon the recommendation of the inspecting officer a supply has been sent to the station, and their issue will be commenced without delay.

Latitude of station	32° 5′
Longitude of station	81° 8′
Elevation of barometer above sea-level	74 feet.

The station is supplied with a complete set of standard instruments, all of which are reported in good condition.

Rent of office is $15 per month.

The morning papers publish the afternoon reports only.

Shreveport, Louisiana, (No. 72.)

The office is in a hotel on Milan street, and near the principal business houses of the town. The instruments are fairly exposed, but no

detailed description has yet been received of their location and exposure, as the station has not been inspected.

The observer who was sent to open the station was a man of experience and supposed to be trustworthy, but he has failed to do his duty here, and will be relieved at once. Reports were commenced September 2, 1871, and have been made irregularly since that date, owing in part to breaks in the telegraph line and partly to neglect of the observer.

Latitude of station	32° 30′
Longitude of station	93° 45′
Elevation of barbmeter above sea-level	223 feet.

The station is supplied with a full set of standard instruments, and all of them are reported to be in good condition. The barometer sent out by the observer was broken in transit by a railroad accident, and a second one was sent through the Post-Office Department, and reached the station in safety.

The rent paid for office is $18 per month.

The observer would have been relieved at an earlier date but for the remoteness of the station and the expense of transportation to and from it, and for the hope that the irregularities were occasioned by illness, as he was injured on the way to the station and detained for several weeks in Vicksburgh before he was sufficiently recovered to proceed.

St. Louis, Missouri, (No. 66.)

The office at this station is located on Olive street, and in the immediate vicinity of the post and telegraph offices, and near the principal newspaper offices.

The wind-vane, anemometer, and rain-gauge are well exposed on the roof of the building, and the other instruments in a shelter of the standard pattern.

The station was established by Sergeant Frederick Meyer, and reports commenced November 1, 1870. Sergeant Meyer was selected to accompany the North Polar expedition under Captain Hall, and was succeeded by Sergeant E. H. Singleton, May 23, 1871. An assistant, Private Conrad Schmitt, was sent to station July 12, 1871. Both observers and the assistant have given full satisfaction to the citizens and the office, in the discharge of their duties, all reports being made regularly and promptly, and the personal conduct of the men unexceptionable.

Fifteen reports are received here and bulletined in the most important business places, besides being furnished to all the daily papers, in which they have been printed with great regularity. Manifold-maps are not issued here.

Latitude of station	38° 37′
Longitude of station	90° 16′
Elevation of barometer above sea-level	474½ feet.

The station is supplied with a complete set of standard instruments, and all of them are in good condition.

Office rent is $25 per month.

Since May 24, 1871, reports to and from Leavenworth have been transferred here, and the work has been well done by the telegraph manager.

ST. PAUL, MINNESOTA, (No. 39.)

The office is located in the upper story of a building on the corner of Third and Wabashaw streets, near the business center of the city, and convenient to the telegraph-office.

The vane, anemometer, and rain-gauge are well exposed on the roof of the building, and the other instruments in a shelter of the standard pattern, projecting from a window in the usual manner.

The station was established by Sergeant I. V. Munger, and reports commenced November 1, 1870. There has been some irregularity in the telegraphic transmission of the reports from this station, owing to the peculiar arrangement of the lines leading to it, but it has been sufficiently regular to make its reports serviceable.

Ten reports are received here, and are bulletined and furnished to the press in the usual manner. All reports have been made properly and promptly, and the general management of the station satisfactory.

Latitude of station ..... 44° 53′
Longitude of station ..... 93° 05′
Elevation of barometer above sea-level ..... 831 feet.

The station is supplied with a full set of standard instruments, all of which are reported to be in good condition. The thermometer is graduated 45° below zero to register the extreme cold.

The amount of rent paid for office is $8 per month.

The station has not been inspected, therefore the details are not so fully known as desired to make a complete report.

TOLEDO, OHIO, (No. 35.)

The office at this station is on the third floor of the chamber of commerce building on Summit street. The post-office and custom-house are one square distant, and the union and freight depots within three squares.

The vane, anemometer, and rain-gauge are on the roof of building, and well exposed. The shelter for the other instruments is also on the roof, and has louver-boarded sides, and was arranged under the direction of the inspecting officer.

The station was established by Sergeant Henry Fenton, who commenced sending separate reports November 1, 1870. He was transferred to another station, May 3, 1871, and was succeeded by Sergeant A. C. Ford, who still remains in charge, assisted by Private I. Davis. Private Chambers was sent to the station as assistant, February 6, but was relieved on the report of the sergeant, March 18, 1871.

Full reports are received here from all reporting stations. Twelve bulletins are issued daily, and posted in the usual manner. One paper, the Toledo Blade, is furnished with and publishes the full tabular reports, and all the dailies publish the synopsis and probabilities. Manifold-maps are issued and properly distributed. The large weather-map is hung in the room of the board of trade, and is corrected properly.

Latitude of station ..... 40° 39′
Longitude of station ..... 83° 32′
Elevation of barometer above sea-level ..... 644 feet.

The station is supplied with a full set of standard instruments, and all of them are reported to be in good condition.

The rent paid for office is $20 per month.

All reports are promptly and neatly made from this station, and the general management satisfactory.

VICKSBURG, MISSISSIPPI, (No. 61.)

The office is located in the business center of the town, and near the post and telegraph-offices.

The vane, anemometer, and rain-gauge are well exposed on the roof of the building, and the shelter for the other instruments is of the standard pattern.

The station was established by Sergeant R. R. Martin, who commenced sending reports September 10, 1871. He is assisted by Private Max Marix, who reported to him for duty September 15, 1871. Thirty reports are received here and bulletined in the usual manner. The daily newspapers do not publish anything but the local observations and the synopsis.

Latitude of station	32° 24′
Longitude of station	91° 00′
Elevation of barometer above sea-level	257 feet.

The station is provided with a full set of standard instruments, and all of them are in good condition.

The rent paid for office is $25 per month, and considerable difficulty was met with in securing one at any price.

Both the observer and his assistant have been attacked by fever, but have recovered and are again on duty. The reports are made regularly and in good form. The station has not been inspected.

WILMINGTON, NORTH CAROLINA, (No. 20.)

The observer's office is situated at the corner of Market and South Water streets, within one square of the telegraph-office, custom-house, commercial exchange, post-office, and the principal hotels, and the location is as good as can be found in the business part of the city.

The vane, anemometer, and rain-gauge are well exposed on the roof of the building, and the shelter for the other instruments is of the standard pattern, and projects from a window in the usual manner. The building is several feet higher than any of the surrounding ones.

The station was established by Sergeant Robert Seyboth, who commenced sending reports January 1, 1871. He is assisted by Private Henry Bessant, of the signal detachment. Both men have given satisfaction, and all reports have been made regularly and promptly.

Full reports are received here from all stations. Five bulletins are issued, and four of the manifold-maps, and all are posted. The newspapers are furnished with the press-report, and one, the Daily Journal, now publishes the greater part of it.

Latitude of station	34° 11′
Longitude of station	78° 10′
Elevation of barometer above sea-level	31 feet.

The station is supplied with a full set of standard instruments, and all of them are reported to be in good condition.

The office rent is at the rate of $100 per annum.

WASHINGTON, D. C., (No. 19.)

The observer's office is in the upper story of the building occupied by the Chief Signal Officer, on G street, near the War Department. Upon the flat roof of the building is erected a wooden observatory, designed with great care for the purpose of comparing thermometers and other

instruments in an equal temperature. The walls are of double lattice-work, and are one foot apart. The floor is double, one thickness being fastened to opposite sides of joists one foot in depth, and the boards slightly separated to permit free circulation of air. The roof is of three thicknesses, to guard against the direct effect of the sun's rays. Careful experiments have shown that the temperature does not vary over one half a degree in different parts of the inclosed space, except in winter, when the heat from the chimney near the western side raises the temperature on that side one and a half degrees. The structure is 7 feet square inside, in width and length, and 9 feet in height. On its roof are fixed one wind-vane, two anemometers, and one rain-gauge, all self-registering, and one rain-gauge of the standard pattern.

On the roof of the main building are placed one self-registering rain-gauge and four of the standard pattern, and one large wind-vane, which is made to indicate the direction of the wind by means of a long rod passing through the roof into the office of the observer. It is also made to indicate the direction by means of electricty and an apparatus, to be described in another part of the report.

The work of this office has been laborious, as all instruments were here compared carefully with official standards before issue to stations, all plans proposed for adoption and all changes required at other stations were thoroughly tested before being acted upon decisively, and all instruments offered by manufacturers and others examined and compared. It has also been the base of supplies for all established stations, and the daily shipment of stationery and other necessary supplies requires the constant services of one man.

All reports made by the observers are sent here and compared, and when errors are found the responsible party is called to account. Books of record when filled at a station are sent here for preservation, and the records of all self-registering instruments are filed away for future reference.

Observer D. J. Gibbon has been in charge of the station since its establishment, and has been assisted in the branches named by the following observers, each of whom has had special charge of his own work: examination and comparison of instruments, Sergeant George C. Schaeffer; photographic work, Sergeant C. A. Shaw; printing department, Sergeant Jno. T. Downes; in charge of correspondence and clerical work, Sergeant James B. Newlin.

In addition to their special work each of the observers named has been required to make observations and assist in the issue of maps and bulletins and such other labor connected with the working of the stations as may be necessary. Sergeant Schaeffer has also packed for shipment most of the instruments sent out during the year, and has done this with so much care that few accidents have happened to them, and these have oftener been the result of careless handling than of improper packing. Thermometers have been sent by mail and by express with the result much more favorable to the latter means of transportation. Barometers have been carried by the Post Office Department, however, with greater safety than by the express companies. Of the barometers sent by hand but two have been injured, and both of these by railroad accidents.

The number of bulletins and maps issued daily at this office varies, but will average not far from thirty-five of the former and sixty of the latter. The maps contain all the matter of the bulletins and also the synopses and probabilities prepared by Professor Abbe. The Associated Press agents and the daily papers are furnished with the three synopses

issued daily. The Sunday weekly papers are also supplied. Bulletins are posted in the signal office, at the post-office, and at the main office of the Western Union Telegraph Company, and maps in all of the principal hotels; three large weather-maps are hung in the signal office, on which the weather at the different stations throughout the country, as given at the three daily reports, is indicated by proper symbols. These are changed regularly, and a glance at the maps shows the state and changes of weather for twenty-four hours. The office is kept open continuously, and the men divided into day and night reliefs. Elevation of barometer above sea-level 90½ feet.

In addition to the standard instruments used at all stations, and which are compared here, several varieties of self-registering instruments are being tested and will be described in another part of this report. The manner of printing the map issued daily is quite novel in many of its features and deserves a detailed description.

Previous to May 1 maps of the observations were printed by the "manifold process;" since that time a press has been used which has been found to be far superior to the "manifold." An ordinary "proof-press" is used, with a bed plate, in which square holes are made, coinciding with the stations on the map, in which are placed the symbol type to designate the weather and direction of the wind. The arrows for showing the direction of the wind are diagonal on some of the type, and cross-wise on the rest, making them available for pointing in eight different directions, and fitting so closely in the holes as to prevent their pulling out by the ink-roller; close to each of these holes is cut a slot, in which is set the figure types showing in regular order, first, the height of thermometer, next, the barometer, and, lastly, the velocity of the wind. These are printed in red ink on the black base chart of the United States, the contrast in color rendering them clearly perceptible; at the same time is set up and printed, in the southwest corner of the map, a table showing opposite the name of each station the change of barometer in the last eight hours, change of thermometer in the last twenty-four hours, relative humidity of the atmosphere, and the amount of rain-fall in the last twenty-four hours. Adjoining this table is also printed at the same time the "synopsis for past twenty-four hours," and the "probabilities," making a complete meteorological record for the day.

Provision has been made against the interruption of the reports, in case of the destruction of this office by fire, by the provision of a duplicate office, to which, in the contingency of such disaster, the telegraphic connections may be at once made, and from which the usual issues of the office in maps, the general press-reports &c., could be had without delay.

The charge of stations and of reports has been under the immediate direction of Brevet Captain H. W. Howgate, United States Army, acting signal officer, and assistant, by whom the diverse duties of such a charge have been ably conducted. To the rare fidelity and energy of this officer the successful management of the past year is largely due.

The total number of observer sergeants on duty at stations is 83, and of privates acting as assistants is 40.

In connection with the equipment of these stations the thanks of the Department are due to the Post-Office Department, which has taken upon itself, under the especial order of the Postmaster General, whenever requested, the duty of transporting in care of its mail agents the barometers needed to supply the places of those rendered useless by accident. This service, an unusual one for the Post-Office Department, and requiring great care, has been rendered with invariable success.

The care of the correspondence, papers, and publications of the office necessary for the management of the various duties at Fort Whipple and the stations of observation so widely extended, together with communications with the press, with scientific and other associations, and with individuals scattered throughout the country, is one of magnitude. Table 11, herewith, affords the data of description and of the extent of the labor. The total of papers sent and received by mail has reached an aggregate of 90,514.

Captain Garrick Mallery, first United States Infantry, brevet lieutenant colonel, United States Army, acting signal officer and assistant, has had charge of the general correspondence and records of the office, and has rendered especial and very valuable service.

The duties of the observers at the stations have been already reported to the Secretary of War. The forms appended to this report, and which, in order to systematize labor, are those required to be used and filled by them, sufficiently illustrate the details of the service.

The fact that each observer reports thrice daily by telegraph, at hours fixed to the minute to this office, by the reports he renders, which he is required to present in person at the instrument in the telegraph-office at his station, and on the accuracy of which the neighboring reports are a check, would suffice to secure good conduct, if the character of the men was less high than it is.

There is an additional guard against laxity in the fact that both operator and sergeant are called to an account and at once by telegraph for any missing report, and both are called to correct any manifest error. Neither is willing to be blamed for the carelessness of the other, and each is prompt to fix the fault where it belongs. Each regular general report is in effect a telegraphic roll-call of the stations spread over a continent from the Atlantic to the Pacific and from the northern lakes to the Gulf and the Caribbean Sea. This roll is called in the morning, in the afternoon, and at midnight, at fixed times, and each call must be answered.

In the year of duty now reported, the failures have been of the fewest. There are none which the records of this office fail to give, either the circumstances which excused them, or the censure or punishment of the observers.

The promptitude, regularity, and steadiness with which the stations have been served, have evidenced the wisdom of the act of Congress which placed the service under military control. A rigor less than that of military discipline could not have secured that strict obedience to orders which has been necessary.

The system, as arranged, is capable of indefinite extension. It would be as easy (telegraphic facilities given) to call the roll of stations around the world as of those from New York to San Francisco. In addition to this daily supervision, the condition of the station is assured by regular inspections made personally from time to time by officers instructed for the purpose. The form of inspection (paper 42) exhibits the subjects which come under attention. Two inspecting officers are at this time making a tour of the stations. Since June 15, 1871, twenty-eight stations have been inspected.

In the review of the duties of the past year the Chief Signal Officer finds reason to commend the officers, non-commissioned officers, and men of the signal service for a faithful discharge of duty. Their services have been rendered with a zeal and pride, of which the results are given in the statements above submitted. They are subjected to hardships which it is proper to mention. No branch of the service requires better men, more careful especial instruction, or greater fidelity to duty. There is none involving greater responsibilities. The details for the ser-

vice are, however, wholly temporary. It is just that the position of the observer-sergeants should be fully recognized, and the hope of promotion to be had by faithful discharge of duty be given the deserving. Until this is effected by law, it is recommended that an appointment to a commission be given each year to that sergeant who shall in that year be reported as most distinguished for fidelity and ability.

The need of permanent appointments in the office of the Chief Signal Officer for the now very extensive duties of the Bureau, is pressingly felt. In no branch of duty is more careful selection needed, and in none does long experience render better results. There is no branch of the service of equal importance but for whose duties the officers are permanently commissioned, and can therefore attempt improvement in view of a study and practice which may be life-long.

The care of the Secretary of War has provided for the past year that permanence for these duties to which the success of the office has been largely due. The appointments ought to be lasting.

A year ago the duties of this division could be reported only as a statement of intentions rather than of facts. In the period which has since elapsed a mass of facts have accumulated, and results have been attained, of which there is herewith a rehearsal in outline. It has been a service which has no holidays and can know no rest; the labors of which continue equally throughout every night as well as every day, and to the vigilance of which has been intrusted responsibility extending not only to property but possibly to the life of any citizen of the United States. The appendixes to this report will illustrate the character and the details of the plans adopted; the descriptions of stations, and of the telegraphic arrangements by which the work at each is made available; the aggregate of reports, papers, &c., stated in numbers, indicate the extent of the service. Sufficient data of the times employed for especial portions, of each day's duty, exhibit the effectiveness of theorganization provided. Some of the generalizations to be had for scientific purposes from the information collected are given in the circulars annexed. The publications contemplated to be made hereafter from time to time will submit, for the study of scientific men, the facts on which the office has been compelled to act from day to day. It has fallen to this Bureau to take the responsibility of originating, and to hazard erroneous action rather than not to act at all. The results, have been fully as favorable as were anticipated. At the end of the first year the service can be reported with a working organization practically tested, and discharging, with some success, all the duties contemplated for it by Congress. It has been everywhere welcomed with the recognition of the utility of its purposes. The scientists of foreign countries and the scientific institutions throughout the United States have proffered expressions of good will, and have rendered assistance. The chambers of commerce, boards of trade, agricultural societies, commercial associations, and the public press, to all of which so much was due at the outset, have continued to give the aid of their support, and have suggested improvements when these seemed to them practicable. It has been owing to such encouragement and assistance, to the interest the Secretary of War has manifested in this branch of his duties, and that faithful labor of the assistants in this office which has made the care of the Chief Signal Officer supervisory only, that he is enabled to report this progress.

I am, sir, very respectfully, your obedient servant,

ALBERT J. MYER,

Brigadier General, and Chief Signal Officer of the Army.

Hon. W. W. BELKNAP,

Secretary of War, Washington, D. C.

APPENDIX.

RECORD OF SIGNAL CAMP OF INSTRUCTION, FORT WHIPPLE, VIRGINIA.

TABLE I.—*Officers instructed during the year ending October*, 1871.

Names.	Rank and corps.	Reported for instruction.	Relieved from instruction.	Remarks.
James Franklin	Ensign U. S. Navy	Nov. 10, 1870	Mar. 8, 1871	Completed full course in signaling and telegraphy.
N. J. R. Patch	do	Nov. 10, 1870	Feb. 9, 1871	Do. do.
John A. Norris	do	Nov. 10, 1870	Feb. 23, 1871	Do. do.
Charles A. Bradbury	do	Nov. 10, 1870	Feb. 23, 1871	Do. do.
Nelson T. Houston	do	Nov. 12, 1870	Mar. 8, 1871	Do. do.
Edward B. Barry	do	Nov. 12, 1870	Feb. 9, 1871	Do. do.
O. M. Mitchel	1st Lieutenant, 4th U. S. Artillery.	Feb. 7, 1871	June 1, 1871	Do. do.
Robert Craig	do	Feb. 13, 1871	June 1, 1871	Instruction in meteorology only. Acting instructor from May 18 to June 2. Previously instructed in other branches.
C. C. Wolcott	2d Lieutenant, 3d U. S. Artillery.	Mar. 3, 1871	July 1, 1871	Completed full course.
Andrew Dunlap	Master U. S. Navy	April 3, 1871	July 10, 1871	Completed full course in signaling and telegraphy.
Willie Swift	do	April 3, 1871	June 28, 1871	Do. do.
Alfred Foreé	do	April 3, 1871	July 8, 1871	Do. do.
Frederick Singer	do	April 3, 1871	June 29, 1871	Do. do.
Edward H. Gheen	do	April 3, 1871	June 29, 1871	Do. do.
William H. Reeder	do	April 3, 1871	June 28, 1871	Do. do.
Thomas R. Adams	1st Lieutenant, 5th U. S. Artillery.	May 27, 1871	Aug. 22, 1871	Completed full course.
H. H. C. Dunwoody	1st Lieutenant, 4th U. S. Artillery.	July 10, 1871	.....	On leave of absence.
Charles S. Smith	do	July 15, 1871		
H. H. Humphreys	1st Lieutenant, 15th U. S. Infantry.	Aug. 18, 1871	.....	Still under instruction.
Henry Jackson	1st Lieutenant, 7th U. S. Cavalry.	Aug. 30, 1871	Sept. 25, 1871	Instructed in meteorology only. Previously instructed in other branches.
Charles E. Kilbourne	1st Lieutenant, 2d U. S. Artillery.	Sept. 19, 1871	.....	Still under instruction.

TABLE II.—*Amount of field practice had by each officer.*

Names.	Rank and corps.	No. of days flag practice was had.	No. of nights torch practice was had.	Remarks.
James Franklin	Ensign U. S. Navy	21	5	
N. J. R. Patch	do	16	3	
John A. Norris	do	15	3	
Charles A. Bradbury	do	15	3	
Nelson T. Houston	do	22	5	
Edward B. Barry	do	16	3	
O. M. Mitchel	1st Lieutenant, 4th U. S. Artillery.	17	5	
C. C. Wolcott	2d Lieutenant, 3d U. S. Artillery.	25	3	
Andrew Dunlap	Master U. S. Navy	27	4	
Willie Swift	do	27	5	
Alfred Foreé	do	28	4	
Frederick Singer	do	25	4	
Edward H. Gheen	do	27	4	
William H. Reeder	do	27	5	
Thomas R. Adams	1st Lieutenant, 5th U. S. Artillery.	15	4	
Charles S. Smith	1st Lieutenant, 4th U. S. Artillery.	15	3	
H. H. Humphreys	1st Lieutenant, 15th U. S. Infantry.	.....	.....	Still under instruction.
Charles E. Kilbourne	1st Lieutenant, 2d U. S. Artillery.	.....	.....	Do. do.

TABLE III.—*Number of observer-sergeants instructed.*

Name.	Instruction commenced.	Date of examination.	Remarks.
Charles W. Held	Oct. 19, 1870	Nov. 29, 1870	In charge of station at Savannah, Ga.
Valentine Hamman	Oct. 19, 1870	Nov. 21, 1870	Failed to pass examination; discharged
Lewis C. Fosnot	Oct. 19, 1870	Nov. 29, 1870	Do. do.
Allen L. Bowie	Oct. 21, 1870	Nov. 21 1870	Do. do.
Robert Seyboth	Oct. 21, 1870	Nov. 30, 1870	In charge of station at Wilmington, N. C.
William E. Smith	Oct. 21, 1870	Nov. 30, 1870	In charge of station at Norfolk.
H. A. Fernald	Nov. 23, 1870	Jan. 28, 1871	Failed to pass examination; discharged.
William Lewin	Nov. 28, 1870	Jan. 4. 1871	Sent to Portland, Me., in charge of station; discharged for neglect of duty.
Weston Moore	Nov. 28, 1870	Jan. 28, 1871	Sent to Nashville in charge of station; reduced to ranks for drunkenness on duty.
John T. Downes	Dec. 13, 1870	Jan. 28, 1871	On duty in office of the Chief Signal Officer.
H. D. Schmidt	Dec. 20, 1870	Jan. 28, 1871	Sent to Pittsburgh in charge of station; recalled and reduced to ranks for misconduct and neglect of duty.
D. S. Townsend	Jan. 6, 1871	.....	Ordered to duty in office of the Chief Signal Officer before completion of course; discharged on his own application.
William McElroy	Jan. 7, 1871	Jan. 23, 1871	In charge of station at Corinne, Utah.
James F. Keegan	Jan. 10, 1871	.....	Discharged before completion of course, on his own application.
C. F. R. Wappenhans	Jan. 10, 1871	Jan. 28, 1871	In charge of station at Indianapolis, Ind.
Thomas L. Watson	Jan. 10, 1871	Feb. 9, 1871	In charge of station at Cairo, Ill.
S. P. Carusi	Jan. 10, 1871	Feb. 9, 1871	In charge of station at San Francisco, Cal.
P. H. McCabe	Jan. 15, 1871	.....	Ordered to duty in office of the Chief Signal Officer before completion of course.
Thomas J. Brown	Jan. 20, 1871	Feb. 18, 1871	In charge of station at Louisville, Ky.
F. F. Wood	Feb. 6, 1871	Mar. 11, 1871	In charge of station at Grand Haven, Mich.
George N. Sullivan	Feb. 6, 1871	Mar. 11, 1871	On duty in office of the Chief Signal Officer.
F. B. Pilling	Feb. 7, 1871	Mar. 11, 1871	Do. do.
Rudolph Johnson	Feb. 16, 1871	Apr. 3, 1871	Failed to pass examination; discharged.
William Von Hake	Feb. 16, 1871	Apr. 3, 1871	In charge of station at Galveston, Texas.
Z. P. Falls	Feb. 20, 1871	Apr. 4, 1871	Failed to pass examination; discharged.
A. C. Ford	Feb. 22, 1871	Apr. 3, 1871	In charge of station at Toledo, Ohio.
Thomas P. Stout	Feb. 25, 1871	Apr. 4, 1871	In charge of station at Marquette, Mich.
R. E. McGrady	Feb. 25, 1871	Apr. 4, 1871	In charge of station at Portland, Me.
Theodore F. Townsend	Mar. 1, 1871	Apr. 18, 1871	In charge of station at Cape May, N. J.
M. L. Hearne	Mar. 4, 1871	Apr. 18, 1871	In charge of station at Mt. Washington, N. H
H. J. Penrod	Mar. 6, 1871	Apr. 18, 1871	In charge of station at Baltimore, Md.
C. J. White	Mar. 6, 1871	Apr. 18, 1871	Failed to pass examination; discharged.
George H. Boehmer	Mar. 14, 1871	May 12, 1871	In charge of station at Leavenworth City, Kans.
James B. Murray	Mar. 15, 1871	May 12, 1871	In charge of station at Lynchburgh, Va.
Hugh Coyle	Mar. 20, 1871	May 12, 1871	Failed to pass examination; now on duty as assistant.
L. C. Haven	Mar. 27, 1871	May 13, 1871	Failed to pass examination; discharged.
J. N. Martin	Apr. 3, 1871	May 13, 1871	In charge of station at Escanaba, Mich.
Robert Courtney	Apr. 8, 1871	May 13, 1871	Failed to pass examination; returned to detachment, at Fort Whipple, Va., from which he had been temporarily detached.
R. R. Martin	Apr. 10, 1871	May 13, 1871	In charge of station at Vicksburgh, Miss.
George H. Richmond	Apr. 10, 1871	May 12, 1871	In charge of station at Davenport, Iowa.
James B. Newlin	Apr. 15, 1871	May 15, 1871	On duty in office of the Chief Signal Officer.
H. E. Cole	Apr. 15, 1871	May 15, 1871	In charge of station at Boston, Mass.
Robert E. Cane	May 1, 1871	June 20, 1871	Failed to pass examination; discharged.
J. E. Magruder	May 1, 1871	June 9, 1871	In charge of station at Lake City, Fla.
J. H. Garrard	May 7, 1871	June 9, 1871	In charge of station at Nashville, Tenn.
Gustave A. Dandelet	May 9, 1871	.....	Reduced to ranks for disobedience of orders.
W. S. Kaufman	May 13, 1871	June 9, 1871	On duty at Chicago, Ill.
E. H. Singleton	.....	May 23, 1871	Instructed on station; now in charge of station at St. Louis, Mo.
E. O. C. McInerney	June 1, 1871	July 11, 1871	Reduced to ranks for misconduct; now on duty as assistant.
George H. Ellery	June 6, 1871	July 14, 1871	In charge of station at Burlington, Vt.
John Pearson	June 9, 1871	July 14, 1871	On duty in office of the Chief Signal Officer.
L. M. Crist	June 13, 1871	July 21, 1871	In charge of station at Pittsburgh, Penn.
S. D. Clark	June 15, 1871	.....	Ordered on duty in office of the Chief Signal Officer before completion of course.
C. E. Ingram	June 17, 1871	July 21, 1871	In charge of station at Punta Rassa, Fla.
S. W. Rhode	June 30, 1871	Aug. 4, 1871	In charge of station at Memphis, Tenn.
William Kesley	July 8, 1871	Sept. 22, 1871	Failed to pass examination; discharged.
F. M. Clark	July 24, 1871	Aug. 11, 1871	On duty in office of the Chief Signal Officer.
W. H. Clendenon	Aug. 1, 1871	Sept. 22, 1871	Awaiting orders.
George S. Rowley	Aug. 5, 1871	Sept. 22, 1871	Do.
E. Garland	Aug. 5, 1871	Sept. 22, 1871	Do.
R. L. P. Roifsriedor	Aug. 10, 1871	.....	Discharged before completing course.
N. D. Lane	Aug. 12, 1871	.....	Still under instruction.
T. Mansfield	Aug. 18, 1871	.....	Do.
J. B. Wells	Aug. 18, 1871	.....	Do.
George McDonald	Aug. 18, 1871	.....	Do.
A. J. Tilley	Aug. 19, 1871	.....	Do.

TABLE III.—*Number of observer-sergeants instructed*—Continued.

Name.	Instruction commenced.	Date of examination.	Remarks.
T. Mann	Aug. 24, 1871		Still under instruction.
Charles E. Wheeler	Aug. 25, 1871		Do.
M. J. Shanefelter	Sept. 8, 1871		Do.
A. B. Knight	Sept. 8, 1871		Do.
D. O'Donoghue	Sept. 13, 1871		Do.
F. P. Bayes	Sept. 14, 1871		Do.
John P. Clum	Sept. 18, 1871		Do.

TABLE IV.—*Instruction and supply of the Army, year ending October* 1, 1871.

	District of New Mexico.*	DEPARTMENT— Of Arizona.*	Of Columbia.*	Of California.	Of Dakota.	Of the East.*	Of the Missouri.	Of the Platte.	Of the South.	Of Texas.	United States Military Academy.†	Total for past year.	Aggregate to date.
Officers instructed							21					21	211
Officers partially instructed					3		74	18	16	87		198	361
Enlisted men instructed				9			83			31		123	444
Enlisted men partially instructed				8	45		279	46	178	207		762	1,113
Sets of signal equipments issued to departments and posts.			4		22				7	30			
Telescopes		4	2		14		3		10	4			
Marine glasses					6				2				

* No systematic instruction given. † All cadets partially instructed.

TABLE V.—*Stations from which weather-reports have been sent during the year ending October* 1, 1871.

Name of station.	Reports commenced.	Name of observer.	Name of assistant.	Remarks.
Augusta, Ga	Nov. 2, 1870	James R. Allen	F. Mangels	Assistant ordered there June 12, 1871.
Baltimore, Md	Jan. 1, 1871	H. J. Penrod	A. M. Wagg	Station opened by Sergeant Faherty, who was relieved December 21 by Sergeant Cowan. Sergeant Cowan relieved March 27 by Private Singleton, who remained in charge until relieved by the present observer, May 11, 1871. Assistant ordered May 26, 1871.
Boston, Mass	Nov. 1, 1870	H. E. Cole	P. J. Huneke	Station occupied by Sergeant D. A. Daboll until May 31, when he was relieved on account of ill health. Assistant ordered January 10, 1871.
Buffalo, N. Y	Nov. 1, 1870	W. F. Slater	John Clark	Private McInerney ordered as assistant January 25, 1871, and relieved May 18 by Private Clark.
Burlington, Vt	May 24, 1871	George H. Ellery		Station opened by Sergeant R. R. Martin, who was relieved August 17, 1871.
Cleveland, Ohio	Nov. 1, 1870	Theodore Mosher	W. W. Craig	Private Murphy ordered as assistant February 6, 1871. Relieved February 27, 1871.
Chicago, Ill	Nov. 1, 1870	James McIntosh	W. S. Kaufman	Assistant Williams ordered to station November 7, 1870. Relieved December 31 by Sergeant A. W. Cox, who was relieved in turn by Private Mason February 10, 1871. Private Mason relieved June 15 by Sergeant Kaufman.
Cheyenne, W. T.	Nov. 1, 1870	A. C. Dobbins		

TABLE V.—*Stations from which weather-reports have been sent, &c.*—Continued.

Name of station.	Reports commenced.	Name of observer.	Name of assistant.	Remarks.
Cincinnati, Ohio	Nov. 1, 1870	F. B. Lloyd	E. F. Maynard	Station opened by Sergeant F. H. Fletcher. Sergeant Lloyd ordered as assistant January 4, 1871. Took charge of station, in relief of Sergeant Fletcher, June 22, 1871. Sergeant Garrard ordered as assistant June 22. Relieved August 4 by Private Maynard.
Charleston, S. C	Jan. 5, 1871	J. E. Evans	J. O'Dowd	Assistant ordered June 12, 1871.
Corinne, Utah	Feb. 2, 1871	William McElroy		
Cape May City, N. J.	May 24, 1871	T. F. Townsend		
Cairo, Ill	June 1, 1871	T. L. Watson	J. M. Watson	Station opened by Sergeant H. Fenton, who was relieved September 18, 1871. Assistant ordered August 22, 1871.
Du Luth, Minn	Nov. 1, 1870	A. B. Williams		Station opened by Sergeant A. W. Cox, who was relieved December 31, 1870.
Detroit, Mich	Nov. 1, 1870	Allen Buell	E. McGovern	Private J. A. Graham ordered to station as assistant February 6, 1871, and relieved August 14, 1871.
Davenport, Iowa	May 24, 1871	G. H. Richmond	Edward Lloyd	Assistant ordered to station July 24, 1871.
Escanaba, Mich	May 24, 1871	J. N. Martin		
Galveston, Texas	April 19, 1871	William Von Hake.	E. O'C. McInerney.	Assistant ordered to station August 18, 1871.
Grand Haven, Mich.	May 24, 1871	F. F. Wood		
Indianapolis, Ind	Feb. 10, 1871	C. F. R. Wappenhans.	M. A. Rath	Assistant ordered to station August 22, 1871.
Jacksonville, Fla	Sept. 11, 1871	D. A. Daboll		
Key West, Fla	Nov. 1, 1870	John R. Allen		
Knoxville, Tenn	Jan. 20, 1871	J. K. Payne		
Keokuk, Iowa	July 15, 1871	A. C. Barclay	W. W. Warren	Assistant ordered August 4, 1871.
Lake City, Fla	Nov. 1, 1870	J. E. Magruder	S. W. Beall	Station opened by Sergeant A. C. Barclay, who was transferred to Keokuk June 23. Assistant ordered September 25, 1871.
Leavenworth, Kans	May 24, 1871	George H. Boehmer.		
Louisville, Ky	Sept. 11, 1871	T. J. Brown	—— Lawler	Assistant ordered to station ——, 1871.
Lynchburgh, Va	May 24, 1871	James B. Murray		
Milwaukee, Wis	Nov. 1, 1870	Alfred Brimer	R. Williams	Private Gilligan ordered to station January 17, 1871; relieved September 9 by private Gorselin, who was relieved September 14, 1871, by Private Williams.
Montgomery, Ala	Nov. 4, 1870	J. E. Evans	None	Abandoned, and observer transferred to Charleston, S. C., December 13, 1870.
Mobile, Ala	Nov. 7, 1870	A. R. Thornett	William Line	Assistant ordered May 18, 1871.
Mount Washington, N. H.	Dec. 15, 1870	M. L. Hearne	William Stevens.	Station opened by Sergeant Theodore Smith, who was relieved on account of ill health May 22, 1871. Assistant ordered to station September 7, 1871.
Memphis, Tenn	Feb. 28, 1871	S. W. Rhode	Hugh Coyle	Station opened by Sergeant Thomas J. Brown, who was transferred to Louisville August 28, 1871. Assistant ordered to station June 17, 1871.
Marquette, Mich	May 11, 1871	T. P. Stout	None	
Nashville, Tenn	Nov. 1, 1870	J. H. Garrard	W. Henderson	Station opened by Sergeant G. H. Witmer, who was relieved January 31 by Sergeant W. Moore, who was relieved by Sergeant T. L. Watson February 10, 1871. Sergeant Watson relieved August 4, 1871. Assistant ordered to station July 6, 1871.
New Orleans, La	Nov. 1, 1870	D. S. Pullen	J. McCoy	Assistant ordered to station May 18, 1871.

TABLE V.—*Stations from which weather-reports have been sent, &c.*—Continued.

Name of station.	Reports commenced.	Name of observer.	Name of assistant.	Remarks.
New York City	Nov. 1, 1870	C. R. Estabrook	A. W. Eastlake	Sergeant C. R. Daw ordered as assistant to this station November 15. Transferred to charge of Philadelphia station April 19, 1871, and succeeded by Sergeant Eastlake.
Norfolk, Va	Jan. 1, 1871	W. E. Smith	M. Foley	Assistant ordered to station June 5, 1871.
New London, Conn	Jan. 15, 1871	C. E. Brinsmade	John Healey	Assistant ordered to station June 15, 1871.
North Polar Expedition.		F. Meyer	None	On steamer Polaris, with Captain Hall.
Omaha, Neb	Nov. 1, 1870	W. B. Webster	None	Station opened by Sergeant W. W. Craig, who was relieved November 9, 1871.
Oswego, N. Y	Nov. 1, 1870	B. F. Hough	D. C. Murphy	Assistant ordered to station February 27, 1871.
Pittsburgh, Pa	Nov. 1, 1870	L. M. Crist	H. Barton	Station opened by Sergeant James West, who was relieved January 31 by Sergeant H. D. Schmidt. Sergeant Schmidt was relieved May 23 by Sergeant George N. Sullivan, who was transferred to Washington station August 21, 1871.
Portland, Me	Jan. 15, 1871	R. E. McGrady	William Ramsay	Station opened by Sergeant William Lewin, who was relieved April 5, 1871. Assistant ordered to station June 5, 1871.
Philadelphia, Pa	Jan. 1, 1871	Charles R. Daw	R. J. Bell	Station opened by Sergeant A. W. Eastlake, who was transferred to New York station April 19, 1871. Sergeant George N. Sullivan was sent to station as assistant April 10, and was transferred to Pittsburgh May 23. Private McCoy sent as assistant January 16, 1871, and relieved April 15, 1871.
Punta Rassa, Fla	Aug. 15, 1871	C. E. Ingram	None	
Rochester, N. Y	Nov. 1, 1870	F. M. M. Beall	M. F. Tighe	Assistant ordered to station February 25, 1871.
St. Louis, Mo	Nov. 1, 1870	E. H. Singleton	Conrad Schmitt	Station opened by Sergeant F. Meyer, who was transferred to North Polar Expedition May 23, 1871. Assistant ordered to station July 12, 1871.
St. Paul, Minn	Nov. 1, 1870	I. V. Munger	None	
Savannah, Ga	Jan. 1, 1871	C. W. Held	J. K. P. Purdum	Assistant ordered to station June 12, 1871.
San Francisco, Cal.	Feb. 2, 1871	S. P. Carusi	None	Station opened by Sergeant W. P. Faherty, who was relieved March 11, 1871.
Shreveport, La	Sept. 2, 1871	F. H. Fletcher	None	
Toledo, Ohio	Nov. 1, 1870	A. C. Ford	John Davis	Station opened by Sergeant Henry Fenton, who was relieved May 3, 1871. Private Chambers ordered to station as assistant February 6, and relieved March 18, 1871.
Vicksburgh, Miss	Sept. 10, 1871	R. R. Martin	Max Marix	Assistant ordered to station September 11, 1871.
Washington, D. C	Nov. 1, 1870	D. J. Gibbon	Geo. C. Schaeffer, C. A. Shaw	
Wilmington, N. C	Jan. 1, 1871	Robert Seyboth	Henry Bessant	Assistant ordered to station June 5, 1871.

TABLE VI.—*Showing telegraphic circuits used for weather-reports.*

No.	Circuit.	Length in miles.	Names of stations on each circuit.
1	Washington and New York*	229	
2	Washington and New Orleans*	1,250	
3	Washington and Chicago*	842	
4	New York and Portland	337	New York, New London, Boston, Portland.
5	Mount Washington and Boston	163	Mount Washington, Boston.
6	Burlington and Boston	237	Burlington, Boston.
7	Washington and Knoxville	562	Washington, Lynchburgh, Knoxville.
8	New York and Lake City	1,138	New York, Philadelphia, Cape May, Baltimore, Washington, Norfolk, Wilmington, Charleston, Augusta, Savannah, Lake City.
9	Lake City and Key West	350	Lake City, Punta Rassa, Key West.
a9	Lake City and Jacksonville	100	Lake City, Jacksonville.
10	Augusta and New Orleans	775	Augusta, Mobile, New Orleans.
12	New York and Milwaukee	1,019	New York, Oswego, Rochester, Buffalo, Cleveland, Cincinnati, Toledo, Detroit, Chicago, Milwaukee.
14	Detroit and Grand Haven	189	Detroit, Grand Haven.
15	Milwaukee and Marquette	317	Milwaukee, Escanaba, Marquette.
16	Milwaukee and Du Luth	541	Milwaukee, St. Paul, Du Luth.
17	Chicago and Pittsburgh	537	Chicago, Pittsburgh.
18	Chicago and New Orleans	1,050	Chicago, Indianapolis, Louisville, Nashville, Memphis, Vicksburgh, New Orleans.
19	Chicago and Cairo	425	Chicago, St. Louis, Cairo.
20	St. Louis and Leavenworth	313	St. Louis, Leavenworth.
22	New Orleans and Galveston	387	New Orleans, Galveston.
23	Chicago and San Francisco	2,337	Chicago, Davenport, Omaha, Cheyenne, Corinne, San Francisco.
24	Chicago and Keokuk	245	Chicago, Keokuk.
25	New Orleans and Shreveport	450	New Orleans, Shreveport.
26	San Francisco and Portland	688	San Francisco, Portland.
27	San Francisco and San Diego	562	San Francisco, San Diego.

* Special through circuit.

TABLE VII.—*Location of observation offices, with elevation, and number of reports received at each.*

Station.	Street and number.	Elevation of barometer above sea-level.	Number of stations from which reports are received three times each day.	Number of bulletins issued daily.	Number of maps issued.	Number of papers supplied with reports.
		Feet.				
Augusta	17 McIntosh street	173	55	12	0	2
Baltimore	Corner South and Water streets	45	55	11	5	5
Boston	103 Court street	82	54	9	7	7
Buffalo	22 Weed's Block	624.6	53	6	2	4
Burlington	City Hotel	401	5	0	0	1
Cairo	65 Ohio levee	400	15	3	3	2
a Cape May	8 North street	14	0	12	0	1
Charleston	Corner Bay and Broad streets	64	55	8	0	2
Cheyenne	Sixteenth, between Furguson and Hill streets.	6,057	4	2	0	0
b Chicago	10 West Randolph street	645	53	17	8	4
Cincinnati	Pike's Opera House	656	53	13	11	5
Cleveland	Atwater Building	671	53	3	4	3
Corinne	Montana, between Fourth and Fifth streets	4,308	4	1	0	1
c Davenport	First National Bank building, corner Main and Second streets.	645	23	8	0	.....
Detroit	Corner Griswold and Congress streets	656	53	40	22	4
Du Luth	Edmond's Block, Superior street	660	10	9	0	3
Escanaba	Tilden street	603	11	9	0	1
Galveston	67 Strand	50	18	6	0	2
Grand Haven	Akley's Building	599	9	7	0	3
Indianapolis	Corner Meridian and Washington streets	748	30	8	0	5
d Jacksonville	Freedman's Bank, corner Pine and Forsyth streets,	23	9	.....	0	2
Keokuk	Corner of Main and Second streets	580	26	2	0	2
Key West	Office of C. Tift & Co	20	9	4	0	1
Knoxville	University	1,007	1	3	0	2
Lake City	Marion and Franklin streets	190	10	0	0	0
Leavenworth	71 Delaware street	929	14	9	0	3
e Louisville	Custom-house	493.6	30	.....	0	4
Lynchburgh	Corner of Eighth and Court streets	650	21	2	0	0
Marquette	Corner of Spring and Front streets	668.45	11	23	0	1
Memphis	257 Second street	285.11	30	7	0	3
Mount Washington	Railroad depot	6,292	0	0	0	0
Milwaukee	Chamber of Commerce building	641	53	9	8	4
Mobile	48 Saint Michael street	50	11	4	0	2
f Montreal	Observatory	182	.....	.....	.....	.....
Nashville	30 College street	532	30	5	0	2
g New London	1 Water street	21	54	6	0	2
h New Orleans	222 Custom-house street	47	30	5	.....	3
New York	120 Broadway, Equitable Insurance building	128	55	22	15	12
Norfolk	Corner Main and Gray streets	54	55	8	7	3
Omaha	195 Farnam street	1,000	4	3	0	2
Oswego	Grant Block	261	53	7	4	3
Philadelphia	Chamber of Commerce building	80	55	8	13	9
Pittsburgh	First National Bank building	955	15	4	0	3
Portland	4 Exchange Place	69.6	54	7	0	3
i Punta Rassa	Telegraph office	20	9	0	0	0
Rochester	Powers Block	556	53	9	2	3
j San Francisco	Merchants' Exchange building	60	4	.....	0	2
k Savannah	Buell and Bay streets	74	55	8	0	3
l Shreveport	84 Milan street	223	0	0	0	0
Saint Louis	210 Olive street	474.6	15	5	0	3
Saint Paul	Third and Wabashaw streets	831	10	2	0	3
Toledo	Finley's Block	644	53	12	2	1
m Vicksburgh	139 Washington street	257	30	.....	0	.....
Washington	Chief Signal Office	90.6	55	35	60	9
Wilmington	South Water and Market streets	31	55	5	5	2

a When reports are received, which is during the summer.
b Before the fire. No report since.
c Number of papers unknown.
d No report made of bulletins.
e Number of bulletins not reported.
f Voluntary reports made. No figures given.
g One of the papers published in Norwich.
h Maps not reported.
i No paper at station.
j No report of bulletins made.
k Maps will be issued soon.
l No reports received at this station.
m No report made.

TABLE VIII.—*Statement showing number of words of weather-reports transmitted over signal circuits, monthly, from November 1, 1870, to March 4, 1871.*

Circuit.	November 1 to 30.	December 1 to 31.	January 1 to 31.	February 1 to 28.	March 1 to 4.	Total for each circuit.
New York and Boston	13, 200	13, 640	8, 008	.....	.....	34, 848
New York and Portland	.....	.....	11, 748	19, 712	2, 816	34, 276
New York and Washington	26, 136	26, 664	26, 400	29, 128	4, 400	112, 728
New York and Lake City	6, 600	6, 820	.....	.....	.....	13, 420
New York and Augusta	.....	.....	17, 732	16, 016	2, 288	36, 036
Augusta and Lake City	.....	.....	10, 912	9, 856	1, 408	22, 176
Lake City and Key West	1, 320	1, 364	8, 184	7, 392	1, 056	19, 316
Augusta and New Orleans	5, 880	4, 840	9, 548	8, 674	1, 232	30, 174
New York and Knoxville	.....	.....	528	1, 232	176	1, 936
New York and Chicago	32, 736	33, 484	.....	.....	.....	66, 220
New York and Milwaukee	.....	.....	44, 132	45, 144	6, 688	95, 964
Chicago and Pittsburgh	1, 320	1, 364	1, 364	1, 232	176	5, 456
Chicago and New Orleans	7, 920	8, 184	9, 548	9, 504	1, 584	36, 740
Chicago and St. Louis	1, 320	1, 364	1, 364	1, 232	176	5, 456
Chicago and Du Luth	5, 280	5, 456	.....	.....	.....	10, 736
Milwaukee and Du Luth	.....	.....	4, 092	3, 696	528	8, 316
Chicago and Omaha	2, 640	2, 728	2, 728	88	.....	8, 184
Omaha and Cheyenne	1, 340	1, 364	1, 364	44	.....	4, 112
Chicago and San Francisco	.....	.....	.....	4, 752	704	5, 456
Total for each month	105, 692	107, 272	157, 652	157, 702	23, 232	551, 550

TABLE IX.—*Statement showing number of words of weather-reports transmitted over signal circuits, monthly, from May 24 to September 30, 1871.*

Circuit.	May.	June.	July.	August.	September.	Total.
New York and Portland	16, 544	63, 360	66, 968	67, 616	70, 048	284, 536
Boston and Mount Washington	352	1, 320	1, 364	1, 364	1, 320	5, 720
Boston and Burlington	2, 112	7, 920	8, 184	8, 184	7, 920	34, 320
Knoxville and Washington	704	2, 640	2, 728	2, 728	2, 640	11, 440
New York and Lake City	16, 544	63, 360	66, 968	68, 948	69, 368	285, 188
Augusta and New Orleans	3, 168	11, 880	12, 276	18, 024	15, 300	55, 648
Lake City and Key West	352	1, 320	1, 268	1, 496	4, 752	9, 188
New York and Milwaukee	15, 840	60, 720	64, 240	65, 052	68, 728	274, 580
Detroit and Grand Haven	3, 520	13, 200	13, 640	13, 640	13, 200	57, 200
Chicago and Pittsburgh	4, 224	17, 160	17, 732	17, 732	20, 284	77, 132
Chicago and New Orleans	8, 800	34, 320	35, 464	35, 044	38, 764	152, 392
Chicago and Cairo	4, 576	17, 160	17, 732	17, 732	20, 284	77, 484
St. Louis and Leavenworth	352	1, 320	17, 732	17, 732	19, 008	56, 144
Galveston and New Orleans	5, 632	21, 120	21, 824	21, 404	24, 640	94, 620
Chicago and San Francisco	1, 760	11, 528	16, 368	21, 120	30, 844	81, 620
Chicago and Keokuk	.....	.....	17, 952	32, 152	34, 804	84, 908
Milwaukee and Marquette	4, 224	15, 840	16, 368	16, 368	15, 840	68, 640
Milwaukee and Du Luth	3, 872	14, 520	15, 004	15, 004	14, 520	47, 916
New Orleans and Shreveport	.....	.....	.....	.....	1, 276	1, 276
Total	.....	.....	.....	.....	.....	1, 759, 952

TABLE X.—*Number of words of weather-reports received at the office of the Chief Signal Officer, in Washington, D. C., from November 1, 1870, to September 30, 1871.*

Name of month.	Year.	Number of words.
November	1870	31, 416
December	1870	32, 104
January	1871	39, 340
February	1871	42, 774
March	1871	47, 366
April	1871	50, 268
May	1871	56, 024
June	1871	60, 697
July	1871	64, 798
August	1871	67, 798
September	1871	69, 284
Total	.....	561, 929

TABLE XI.—*Table exhibiting the communications sent from and received at the office of the Chief Signal Officer, (exclusive of all telegrams,) from October 20, 1870, to October 31, 1871.*

SENT.

Division of telegrams and reports for the benefit of commerce.

To heads of departments and bureaus	105
To observer-sergeants in reference to their duties	4,480
In reply to applications for stations, and others similar	115
To telegraphic companies in reference to transmission of weather-report	624
To boards of trade, chambers of commerce, and agricultural societies	983
To foreign correspondents relating to this division	18
Answers to applications for appointments as observer-sergeants	516
To surgeon, asking for physical examination of observer-sergeants, &c	91
To officer in charge of Fort Whipple, Virginia, prior to order announcing observer-sergeants	89
General and special orders with reference to this division	1,679
Suggestions as to practical use of meteorological reports and weather-maps sent specially	929
Letters with circulars regarding cautionary signals sent specially	948
Miscellaneous	652
Total	11,229

Signal division.

To heads of departments and bureaus	81
Relating to enlisted men	202
Concerning instruction in signaling	134
Miscellaneous	101
Total	518

Property division.

To heads of departments and bureaus	535
To manufacturers and others in reference to equipments, instruments, &c	423
To observer-sergeants and men in the field, in reference to property and money accounts	7,550
Concerning quarterly returns of officers	310
Miscellaneous	662
Total	9,480
Papers comprising subjects in more than one of the divisions named	1,779
Aggregate	23,006

RECEIVED.

Division of telegrams and reports for the benefit of commerce.

From heads of departments and bureaus	83
Applications for stations, &c	114
From telegraph companies, in reference to transmission of weather-map	307
From observer-sergeants, in reference to their duties, &c	2,406
From boards of trade, chambers of commerce, and agricultural societies	231
From foreign correspondents relative to this division	29
Special applications for "Suggestions for Practical use of Weather-maps, &c."	336
Reports for instruction for observer-sergeants	392
Applications for appointment as observer-sergeants	516
Reports of preliminary examinations of observer-sergeants, &c	163
Answers from surgeon, with report of physical examinations of observer-sergeants, &c	91
Reports of final examinations of observer-sergeants	102
Mailed reports of observer-sergeants on station	50,940
Miscellaneous	578
Total	56,288

Signal division.

From heads of departments and bureaus	98
Relative to instruction in signaling	718
Relative to enlisted men	192
Miscellaneous	867
Total	1,875

Property division.

From heads of departments and bureaus	95
Relative to free entry of books, instruments, &c	26
From manufacturers and others, relating to instruments, &c	415
From officers, concerning property, quarterly returns, &c	533
From observer-sergeants and men on stations, relating to property returns and money-accounts	5,070
From observer-sergeants and men on stations, regarding commutation of rations, extra-duty pay, and commutation of fuel and quarters audited and paid from this office	1,422
Regarding property transferred to stations	1,223
Miscellaneous	561
Total	9,345
Aggregate	67,508
Aggregate sent	23,006
Aggregate received	67,508
Total	90,514

TABLE XII.—*Enlistments for signal service, United States Army, from October* 20, 1870, *to October* 31, 1871.

Number enlisted after passing examination for observer-sergeants, and promoted at once to that position	71
Enlisted as privates signal service detachment	62
	133
Selected recruits forwarded from general recruiting depot, at Fort Columbus, New York Harbor, by order of the Secretary of War	38
Total	171

PAPER 42½.

[Circular.]

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE,
Washington, D. C., July 1, 1871.

The following circular is published for the information of those desiring to enlist for appointment as non-commissioned officers in the Army, for the duties of the "observation and report of storms by telegraph and signal for the benefit of commerce," under the joint resolution of Congress, approved February 9, 1870, and the authorization of the Secretary of War, and for such other duties as may be required in connection therewith.

Every candidate will be subjected to an examination, prior to enlistment, before a board appointed by the Chief Signal Officer, which meets at this office every Thursday at noon, and before which he must appear at his own expense. Testimonials as to good character and capacity, signed by persons known at this office, must be presented, together with an application in the handwriting of the candidate, (addressed to the Chief Signal Officer of the Army,) stating his age, past and present avocation and residence. The examination will be chiefly directed to accurate spelling, legible handwriting, proficiency in arithmetic, with special attention to decimal fractions, and the geography of the United States.

Persons enlisting for this service will be disciplined in the duties of non-commissioned officers, but will not be transferred to other duties than those pertaining to the signal service.

The United States is entitled to the whole time of the person enlisted; but the duties required are of such a nature that, with care and diligence, some time between the hours of reports, when no active duty is pressing, will be at the disposal of the observer, which may be devoted to reading or study. Most of those already enlisted have had such purposes in view. No employment of this nature can, however, be permitted to interfere in any way with that prompt and constant attention to duty which will be insisted upon.

Candidates, after successfully passing the educational examination above referred to, and also a physical examination by the surgeon, will be enlisted in the general service of the United States, and will then receive the appointment and pay of sergeant from the date of enlistment. If, however, after having been for a reasonable time under the course of instruction provided to fit them for the discharge of the duties of observer, they fail to pass another examination, directed with reference to that instruction, they will be immediately discharged, as unfitted for the service. The length of the course of instruction varies according to the ability and industry of the several sergeants, averaging about five weeks.

All the duties will be performed strictly under the discipline of military law, all persons in the military service being subject to trial and punishment for improper conduct or neglect of duty, under the Rules and Articles of War. Those whose services are no longer required, while their conduct has been good, or who may be discharged at their own request for satisfactory reasons, will receive honorable discharges. The term of service is five years, unless sooner discharged. The Secretary of War has power to grant discharges, which this office is authorized to promise when applied for on proper grounds, and at times when no special injury to the service would result therefrom.

The penalties for neglect of duty, bad conduct, &c., are dishonorable discharge, or such other punishment as a court-martial may direct, or as may be provided for by the customs of the service. The pay and allowances are as follows: A sergeant on this duty serving with troops (as stationed at a military post where other troops are serving, or whose quarters, fuel, &c., are furnished in kind) receive as follows:

Pay per month	$27 50
Pay per year	331 75

with rations, and the money value of clothing not drawn in kind.

A sergeant on this duty stationed in a city, or at a point where there are no other troops serving, receives, approximately, as follows:

	Per month of 30 days.	Per year.
Pay	$17 00	$204 00
Subsistence	22 50	273 75
Clothing, (varying each year,) average about	2 96	35 45
Quarters	10 00	120 00
Fuel	8 00	96 00
Extra-duty pay, 35 cents per day	10 50	127 75
	70 96	856 95

It is not designed that any observer-sergeant, after passing the second examination, shall, for any length of time, be stationed with troops; and none are now so stationed.

The duties will be chiefly those pertaining to the observations, record, and proper publication and report, at such times as may be required, of the state of the barometer, thermometer, hygrometer, and rain-gauge, or other instruments, (instructions in the use of which instruments will be given by this office,) and the report by telegraph or signal, at such times as indicated, and to such places as may be designated by the Chief Signal Officer, of the observations as made, or such other information as may be required; the telegraphic reports to be forwarded by the regular telegraphic operators, or in such manner as may be directed. The utmost precision will be required in observations and reports. The specification of these particular duties is not to exclude others connected therewith which may be necessary.

The object of this plan is to insure the correctness and regularity of reports, by having them made under military control. It being desired to make this body of men especially select, rigid examinations will be insisted upon.

Married men are not enlisted, and only persons between the ages of twenty-one and forty years.

NOTE.—When this circular is sent in answer to any inquiry, it may be understood that vacancies still exist in the number of observer-sergeants authorized, and that candidates may continue to apply as above directed.

P. S.—SEPTEMBER 16, 1871.—The above circular is furnished in answer to inquiries, as exhibiting the pay and duties of the position described. The mode of obtaining it is from this date changed as follows:

Application for examination by the board above-mentioned will not be entertained except when made by men enlisted in the signal service detachment, United States Army, who shall have satisfactorily performed, for six months, the duty of assistant to an observer on station, or similar duty at this office. The compensation when on such duty is about fourteen dollars per month less than that of an observer-sergeant, and the character of the duty is substantially the same as that of the observer, for which position it is a preparation.

Persons desiring to enlist in the signal service detachment with the view of subsequent promotion to the grade of observer-sergeant must possess the general qualifications and present the same testimonials as are required for those sergeants, according to the terms of the foregoing circular. They must report themselves in person to this office, at their own expense, and satisfy the officer charged with the duty of enlistment that they are fitted for the service, after which they will be examined by the surgeon, and, if physically competent, will be enlisted, and ordered, in the first instance, to Fort Whipple, Virginia, near this city, where the signal service detachment and school of instruction is stationed. Before being placed on duty as assistant (the length of which delay can only be determined by the requirements of the service and the conduct of the individual) his pay, quarters, allowances, and duties will be those of a private soldier. No promise will be given by this office which can alter or affect the usual terms of enlistment, but it is expected and desired to make service in the detachment probationary for, and preparatory to, the grade of observer-sergeant, and to place competent men who enlist with a view to that position on duty as assistants, where instruction can be obtained and opportunities for study afforded.

By order of the Chief Signal Officer of the Army:

GARRICK MALLERY,

Capt. and Brt. Lieut. Col., U. S. A., Acting Signal Officer and Assistant.

PAPER 1.—FORM 3.

DAILY BULLETIN.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY

Division of telegrams and reports for the benefit of commerce.

Meteorological record, November 1, 1870, 7.35 a. m.

Observations at all the stations taken at the same moment of time.

Place of observation.	Height of barometer.	Change since last report.	Thermometer.	Change in last 24 hours.	Relative humidity. (Per cent.)	Direction of wind.	Velocity of wind. (Miles per hour.)	Pressure of wind. (Lbs. per square foot.)	Force of wind reduced to Beaufort scale. (Approximately.)	Amount of cloud.	Rain-fall since last report. (Inches and hundredths.)	State of weather.
Albany, N. Y												
Augusta, Ga												
Baltimore, Md												Fair.
Boston, Mass	29.65		44			W.	3	.04	Gentle			Clear.
Buffalo, N. Y	29.38		40			W.	7	.24	Light			
Charleston, S. C												Clear.
Cheyenne, W. T	27.12		45			W.	13	.83	Brisk			Clear.
Chicago, Ill	30.03		40			S. W.	14	.75	Brisk			Clear.
Cincinnati, Ohio	29.52		40			S. E.	5	.12	Light	1-4		Clear.
Cleveland, Ohio	30.09		35			S. E.	12	.83	Brisk			
Corinne, Utah												Clear.
Detroit, Mich	29.84		37			S.	5	.12	Light			
Du Luth, Minn	28.99		37			S. W.	4	.07	Light			
Fortress Monroe, Va												
Fort Benton, M. T												
Indianapolis, Ind												
Jackson, Miss												Cloudy.
Key West, Fla	29.98		75			E.	4	.07	Gentle	4-4		
Knoxville, Tenn												Clear.
Lake City, Fla	30.05		62			0	0	0	Calm	1-4		
Louisville, Ky												
Memphis, Tenn												Clear.
Milwaukee, Wis	30.07		42			W.	12	.83	Brisk			
Mobile, Ala												
Montgomery, Ala												Fair.
Nashville, Tenn	30.08		51			N.	2	.02	Gentle	1-2		
New Haven, Conn												Fair.
New Orleans, La	30.08		64			N. E.	3	.04	Gentle	1-4		Clear.
New York, N. Y	30.12		45			0	0	0	Calm			Clear.
Omaha, Nebr	29.32		36			S.	4	.07	Gentle			Fair.
Oswego, N. Y	29.94		44			W.	20	1.96	Very brisk			
Philadelphia, Pa												Fair.
Pittsburgh, Pa	29.32		38			S.	3	.04	Gentle	1-4		
Portland, Me												
Portland, Oregon												Fair.
Rochester, N. Y	30.03		40			W.	7	.24	Light	3-4		
San Diego, Cal												
San Francisco, Cal												
Santa Fé, N. M												
Savannah, Ga												Clear.
St. Louis, Mo	29.91		45			S. E.	7	.24	Light			Clear.
St. Paul, Minn	29.50		38			E.	1	.01	Very light			Clear.
Toledo, Ohio	30.00		38			S.	2	.02	Gentle			Fair.
Washington, D. C	30.03		45			W.	1	.01	Light	1-4		
Wilmington, N. C												

[Published by order of the Secretary of War.]

NOTE.—Barometer corrected for temperature and elevation. Reports are received over circuits arranged at the War Department with the Western Union, Northwestern, and International Ocean Telegraph Companies.

PAPER 2.

ATMOSPHERIC ELECTRICITY.

That electricity has much to do with the condition of the weather, and with its numerous, constantly-recurring changes, is known to every one. There is just now a disposition among meteorologists to give this mysterious force much of the credit heretofore awarded to heat, for the general circulation of the atmosphere, the permanent, ever-flowing winds. It therefore becomes important to have a series of observations, made several times a day, and continued through many years, showing the quantity and kind of electricity in the atmosphere. It is fair to suppose that such observations might be made of great utility in our endeavor to anticipate the approach of storms upon our lake-shores and sea-coasts, for the benefit of commerce.

So far as I know, Dr. Wislizenus, of St. Louis, Missouri, is the only person in this country who has applied himself to the elucidation of this important problem of atmospheric electricity. He has devoted to this subject an amount of patient and persevering labor which entitles him to the thanks of all meteorologists. To make six regular daily observations, each requiring careful manipulation, and to continue them, from month to month, for ten consecutive years, with no other hope of reward than the consciousness of adding to the sum of human knowledge, is a task few would voluntarily undertake.

The electrometer used by him is one contrived expressly for the purpose by Professor F. Dellman, of Germany, being a torsion-balance, and is fully described by Dr. Wislizenus as follows:

"A very fine glass thread, about 18 inches long, running vertically through a glass tube, has on its lower end, fastened by shellac, a very thin and light beam or needle of brass, in a horizontal position. This beam, when moved by any force, will be driven around in a circle over a metalic disc, with a graduated scale divided into four times ninety degrees. Directly below the movable beam, but not connected with it, is another similar thin piece of brass, which is fixed, perfectly isolated from the metallic disc, and ends below in a metalic wire, also isolated, to which the electrical charge is applied from without. The upper beam with the glass thread can, by a micrometer screw, be lowered or elevated, so as either to touch the lower beam or hang suspended above it. Now, if an electrical charge is applied to the outside wire and to the lower beam, and if the upper beam, by screwing it down, is for a moment brought into slight contact with the lower one, the upper beam will be charged with the same electricity, and the movable upper beam will be driven off a certain number of degrees, according to the intensity of the charge."

The electricity is collected by a hollow ball of copper, with a metallic stem, the latter resting in a metallic tube, from which it is perfectly isolated by shellac. This collecting apparatus is fixed to a long pole, which is drawn up to the roof of the house, where the air circulates freely.*

The following is a sample of the record of the electrical and meteorological observations made by Dr. A. Wislizenus:

Day.	Hour.	Atmospheric electricity.	WIND. Direction.	WIND. Force.	Cloudiness.	Wet-bulb.	Dry-bulb.	Relative humidity.	Remarks.
1861.									
Mar. 28 ..	9.00	+ 3	S. E.	1	5	58.5	50.5	53	
29 ..	6.00	—45	S. E.	3	9	58	53.5	73	Distant thunder almost constantly.
		—75	.....	....	....	.....	.....	.....	
		—25	.....	....	....	.....	.....	.....	
		—85	.....	....	....	.....	.....	.....	
	7.00	—75	S.	3	10	61	57	77	A few drops of rain,
		—45	.....	....	....	.....	.....	.....	Louder thunder; rain.
	7.15	—50	.....	....	....	.....	.....	.....	Rain, thunder, and lightning.
	7.30	—25	.....	....	....	.....	.....	.....	Rain, strong thunder, and lightning.
		—90	.....	....	....	.....	.....	.....	Do. do.
	8.00	—45	S.	2	10	61	58	83	Strong rain for half an hour.
	9.00	—20	S. E.	2	9	64	60	77	Clearing up a little.
	12.00	—30	W.	4	10	54	54	100	Strong rain, with thunder and lightning for several hours.
	3.00	—35	W.	4	10	50	49.5	96	Fine rain for short time.
	6.00	+ 5	W.	4	10	45.5	43	80	
	9.30	+ 8	W.	3	10	44	41	76	

* Transactions of the Academy of Science, St. Louis, vol. 2, p. 4—1863.

The two following tables exhibit the general mean results, and the data from which the curves are constructed:

I.—*Hourly means of positive atmospheric electricity at St. Louis, Missouri, in* 1861–1870, *based on daily observations at* 6, 9, 12, 3, 6 *and* 9 *o'clock, from morning till night, by A. Wislizenus, M. D.*

Year.	6 a. m.	9 a. m.	12 m.	3 p. m.	6 p. m.	9 p. m.
1861	8.5	9.9	9.0	7.7	8.5	6.8
1862	8.9	10.0	9.1	7.3	8.1	6.8
1863	10.5	10.6	10.0	7.5	9.1	7.4
1864	7.9	8.8	7.4	5.4	5.9	5.5
1865	6.4	7.1	6.0	5.3	5.4	3.8
1866	5.5	6.2	5.2	4.5	5.2	4.4
1867	5.2	5.6	4.9	4.2	4.3	3.8
1868	2.7	3.0	2.7	2.2	2.5	1.9
1869	3.3	3.5	2.8	2.4	3.2	2.7
1870	4.7	5.3	4.3	3.6	5.0	3.9
Mean	6.4	7.0	6.1	5.0	5.7	4.7

II.—*Monthly and yearly means.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.
1861	16.5	12.1	9.8	8.8	7.8	4.0	3.7	3.4	3.0	7.1	10.0	14.3	8.4
1862	12.1	16.0	9.4	10.6	7.5	3.0	2.2	2.3	3.0	7.7	12.6	13.9	8.4
1863	16.9	15.9	13.6	8.8	4.7	2.0	2.8	4.4	4.8	12.5	12.1	11.5	9.2
1864	15.8	11.3	11.0	8.5	5.1	4.0	2.3	0.9	1.8	5.4	6.6	9.0	6.8
1865	12.2	9.5	5.9	3.3	2.4	3.4	2.6	5.9	1.2	5.3	10.1	6.4	5.7
1866	5.9	8.1	5.7	2.1	3.3	2.1	2.4	5.1	3.2	7.0	10.2	7.0	5.2
1867	9.2	8.2	6.5	3.3	2.9	2.8	2.7	5.2	3.5	3.0	4.2	4.2	4.6
1868	4.1	5.0	2.5	1.7	1.1	0.4	0.5	0.4	1.4	2.6	4.3	6.3	2.5
1869	8.7	2.5	4.6	1.6	0.7	0.9	1.1	0.3	1.3	7.8	4.7	1.6	3.0
1870	8.6	10.2	5.5	6.9	5.0	1.3	0.8	0.4	0.1	0.1	5.9	8.7	4.5
Mean	11.0	9.9	7.4	5.6	4.0	2.4	2.1	2.8	2.3	5.8	8.0	8.3	5.8

Among the general results from these extended observations, Dr. Wislizenus deduces the following:

1. That our atmosphere is almost always charged with electricity; of 2,200 observations made in 1861, only 59 indicated zero, or a non-electric condition.

2. This electricity is almost always positive; of 2,124 observations, only 78 were negative.

3. This negative electricity appears generally in greater intensity than the positive, and is usually attended by (1) thunder-storms; (2) common rains, without thunder; or (3) high winds, without rains or thunder.

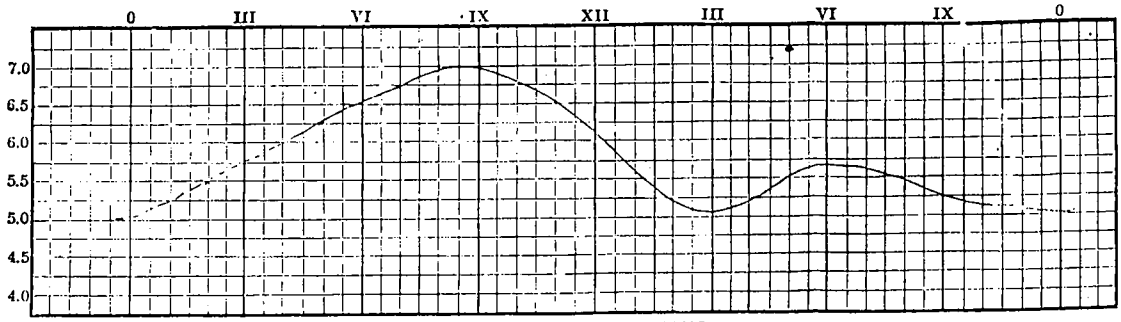
4. There is regular daily periodicity, with two maxima and two minima; the former at 9 a. m. and 6 p. m.; the latter at 3 p. m., and (probably) about midnight. (See curve of hourly means.)

5. The quantity of positive electricity is greatest in winter and least in summer, corresponding inversely, in this hemisphere, with the curve of temperature. (See curve of monthly means.)

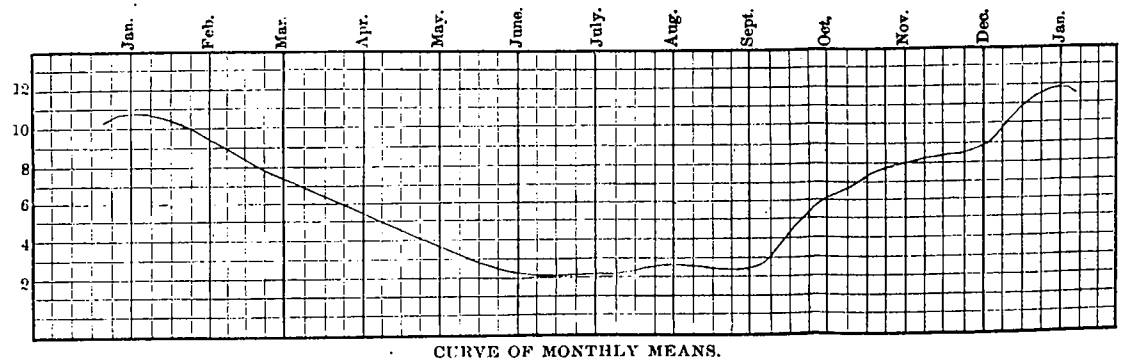
6. It seems probable that there is also an annual periodicity, analogous to the periodicity of the sun-spots, the magnetic elements, and the aurora; this will be decided when the observations have been continued a few more years. (See curve of yearly means.)

With reference to the possibility of predicting the approach of storms from these electrical observations, Dr. Wislizenus writes that "he had, many times, occasion to observe how easily the equilibrium in the quantity of the usual atmospheric electricity is disturbed. Quite distant rain-falls and thunder-storms often made the electricity here disappear at once; still more so snow-falls. In the winter, when strong positive electricity, with fair and cold weather, suddenly declines, or disappears entirely, without any appreciable local cause, I have often predicted a contemporaneous considerable snow-fall at great distances, and the telegraph generally confirmed my supposition

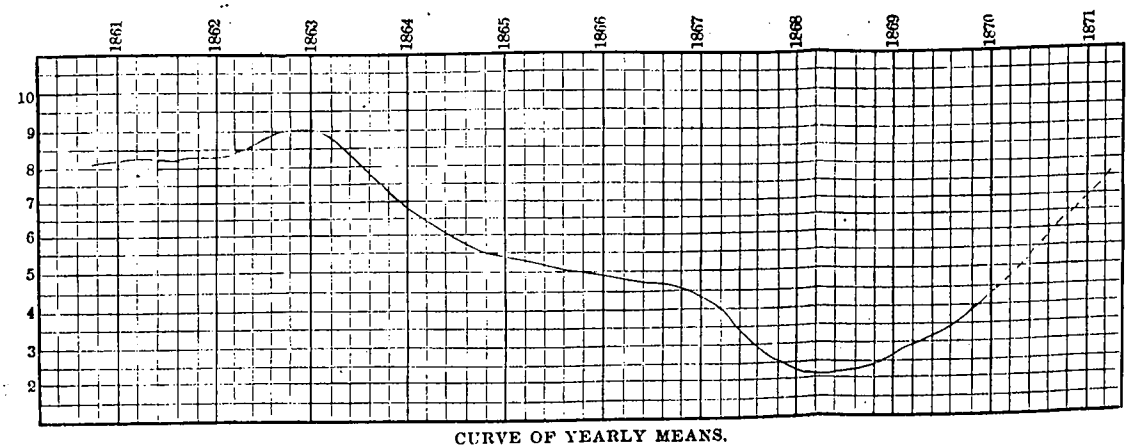
ATMOSPHERIC ELECTRICITY.



CURVE OF HOURLY MEANS.



CURVE OF MONTHLY MEANS.



CURVE OF YEARLY MEANS.

from such localities as Cairo, Cincinnati, Chicago, Buffalo, and even New York. The accumulation of positive electricity there, as is usual with snow-falls, seemed to have produced a vacuum here. The sensibility of the electrometer in such changes is far greater than that of the barometer. Dry storms, too, of no great violence and of more local extent, affect often the electrometer, while the barometer scarcely shows any fluctuation. But in strong gales, that are invariably accompanied by sudden depression of the barometer, the electrometer confirms and corroborates the barometer by a sudden change into most intense negative electricity, lasting during the gale.. The electrometer becomes thus a most valuable aid to the practical purposes of the barometer."*

These very valuable and highly interesting results induced me to consult with Dr. Wislizenus as to the propriety and practicability of adding similar observations to those made by the sergeants of the Signal Corps; and it was found that though they might be of great service, yet the delicate nature of the instrument at present used and the difficulties of making the observations were such that they could not become general. If our electricians could devise some more simple and easily managed electrometer adapted for this purpose—especially one that would be self-registering—the object could be accomplished, and an additional certainty given to the daily conjectures of the "probabilities" of the occurrence of storms.

I. A. LAPHAM,
Assistant to the Chief Signal Officer.

MILWAUKEE, WISCONSIN, *May*, 1871.

PAPER 3.

List of disasters on the lakes during the months of November and December, 1870.

NOVEMBER.

1*st*.—James Burns, fireman on the tug J. H. Martin, lost overboard and drowned in the St. Clair River.

2*d*.—Bark Mary Amanda, ashore at Grand Haven, on Lake Michigan; got off without damage.

2*d*, (*at night*.)—Schooner Ben Flint, struck by a sudden gale, was capsized, and lost on Big Point Sable; a complete wreck; the captain, Thomas Roberts, and a passenger, McCune, lost.

2*d*, (*at night*.)—Schooner Mary M. Scott, ashore and lost, at Grand Island, Lake Superior.

2*d*, (*at night*.)—Schooner Athenian, ashore at Grand Island, Lake Superior; pulled off, slightly injured.

2*d*.—Brig Starlight, with building-stone, encountered a gale, and slightly damaged.

3*d*.—Schooner Fleetwing, with iron ore, ashore at Cleveland; hull severely injured.

3*d*, (*at night*.)—Brig Lucy J. Clark, considerably injured by collision with the bark Sweetheart.

Brig City of Tawas, with lumber, ran upon Colchester Reef, Lake Huron, and filled with water; got off.

Schooner Star of the North, with lumber, sprang a leak, and was towed to Grand Haven.

3*d*, (*at night*.)—Schooner Jesse McDonald, ashore near Picton, Lake Ontario, and pounded upon rocks; 1,800 bushels wheat damaged.

Schooner W. O. Brown, much damaged by collision with a propeller near Point au Barques, Lake Huron.

Brig Monitor, sustained damage in a gale on Lake Huron.

4*th*.—Tug Davidson, injured by striking an obstruction at Milwaukee.

4*th*.—Schooner Hero, ashore at Bailey's Harbor, Lake Michigan; filled with water; got off.

4*th*.—Scow William Kelly, lost on Lake Erie; seven lives lost.

4*th*.—Bark J. G. Marten, lost jib-boom at Chicago.

Schooner Oak Leaf, lost topsail on Lake Michigan.

Bark Jessie Hoyt, lost fore and main staysails on Lake Michigan.

Scow Windsor, struck a pile and sunk at Benton Harbor, on Lake Michigan.

Steamer Northwest, broke crank-pin, near Pointe Pelée; towed to Detroit.

Scow Ellen, drifted ashore at Port Clinton, Lake Erie; little damage.

4*th*, (8 *p. m.*)—Bark S. B. Pomroy, lost two seamen, William Mosher and Thomas Little, on Lake Superior.

Propeller Old Concord, damaged by striking the piers at Cleveland.

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* Transactions of the Academy of Science, St. Louis, vol. 2, p. 295—1866.

Scow H. B. Rathbone, lost between 15,000 and 20,000 feet of lumber overboard on Lake Ontario.

Propeller H. G. Trusdell, burst cylinder off Sister Bay; towed to Green Bay.

Schooner Frank Perew, lost some canvas on Lake Michigan.

Schooner Atlanta and bark Naiad collided off Thunder Bay; damage $3,000.

Brig Charles Napier, ashore at East Sister Island.

Schooner W. F. Allen, lost anchor, chains, &c., on Lake Michigan.

Scow Quickstep, ashore at Big Bay, got off without damage.

Propeller Schickluna, burned in the harbor at Port Colborne, Lake Erie.

Schooner Hornet, ashore and abandoned at Good Harbor, Lake Michigan.

Schooner William Young, on a reef at St. Helena; jettisoned 100 tons of coal.

A schooner ashore at North Manitou Island, Lake Michigan.

Schooner S. Robinson, waterlogged; towed to Beaver Harbor.

Schooner Frank D. Barker, lost main-boom.

Schooner Jefferson, ashore between Pentwater and Manistee, on Lake Michigan.

Schooner George Y. Foster, ashore between Pentwater and Manistee; buried in sand.

Scow White Oak, ashore between Pentwater and Manistee; got off without assistance.

Propeller Bruno, ashore on Chantry Island, Lake Huron.

Scow G. D. Wright, injured by collision with the bark Unadilla, near Point Sable, Lake Michigan.

5th.—Propeller St. Paul, struck a rock off Bar Point, Lake Erie; returned to Detroit for repairs.

6th.—Schooner J. C. Maxwell, leaking badly.

Schooner W. J. Preston, arrived at Milwaukee with center-board and main-gaff broken.

Schooner Bahama, leaking; jettisoned 100 tons coal; ashore near North Bay; got off.

Bark Red, White and Blue, lost spars on Lake Michigan.

Brig Waucoma, lost spars on Lake Michigan.

Bark John F. Warner, with cargo of iron, sunk near Mackinac.

Schooner Amaranth, lost small boat.

7th.—Tug Allen, lost upper works by fire at Toledo.

8th.—Schooner Quinlan, ashore at Toronto.

Forty-five vessels arrived at Chicago, all more or less damaged.

Schooner Melvina, injured by collision near the straits.

Schooner B. Eveleigh, supposed to be lost in this gale.

Schooner J. H. Hartzell, reached Oswego in a damaged condition; cargo wheat.

Two men lost from a fishing smack, on Lake Ontario, in a gale.

9th, (morning.)—Scow John Lillie, struck the piers at Grand Haven, and was dashed to pieces.

9th.—Schooner Christe, damaged at Milwaukee.

Schooner Oswegatchie, jettisoned deck freight, mostly apples and salt, on Lake Ontario.

Bark Two Fannies, ashore at North Manitou Island; lost deck-load of lumber.

Schooner American Union, disabled at Beaver Harbor.

Steam barge Josephine, ashore at Kettle Point, Lake Huron.

Schooner Gem, ashore, and filled with water, at Clough's Pier, near Black River, Lake Erie.

Schooner Ellen Williams, struck a rock, causing a leak, in Sault Canal.

Scow R. D. Owen, lost jib at Sheboygan.

Bark Mary Jane, sprung a leak on Lake Michigan; cargo of corn damaged.

10th.—A trading schooner capsized off Little Point Sauble, Lake Michigan.

Schooners Ketchum and Albatross, damaged by collision with the barge Detroit.

11th.—The heavy sea delayed propellers crossing Lake Michigan from Milwaukee.

Schooner R. J. Sanburn, waterlogged at Kenosha.

Tug Admiral Porter, broke machinery off Two Rivers, Lake Michigan.

Bark Constitution, lost her bowsprit.

Bark Sunbury, run into the steam barge Empire off Charity Island, Lake Huron.

13th, (night.)—Schooner Ariel, completely wrecked, on a shoal at Collingwood, in a gale.

Tug S. R. Kirby, broke her machinery near Port Austin, Lake Huron.

13th.—Propeller Annie L. Craig lost her top-mast on Lake Michigan.

Schooner Brooklyn, at Chicago, leaking badly.

Schooner Aunt Ruth, ashore near Dunkirk, Lake Erie; got off slightly damaged.

Brig Baltic, at Port Colborne with broken center-board.

13th, (night.)—Many vessels found shelter, and were delayed in Milwaukee from blustering rain-storm.

Bark Sweetheart, disabled by collision and towed to Chicago.

Schooner Mary Ann Rankin, wrecked near Port Colborne.

14th.—Four vessels—steamer Alpena, schooners Florence, Ebenezer, and Guide—injured by collision at Chicago.

Schooner J. R. Bentley ashore at St. Helena Reef, near Mackinac; lost 1,200 bushels wheat.

Tug Union destroyed by fire at Saginaw Bay.

Propeller Roanoke, steam-barge Empire, and a schooner, grounded on the St. Clair Flats, obstructing the channel.

15th.—Brig Fanny Gardner, at Chicago, in a leaky condition.

Tug Babcock damaged her engine at Chicago.

Tug Harrison broke her crank-pin at Chicago.

Steamer Algoma, at Copper Harbor, Lake Superior, with broken wheel.

Schooner Lillian lost one of her crew near Galloe light, Lake Ontario.

Bark H. C. Winslow lost her second mate on Lake Huron.

A fishing-boat capsized and three men lost at Au Sable, Lake Huron, in a squall that lasted but a few minutes.

15th, (at 11 p. m.)—Bark Badger State, with wood, wrecked on Sleeping Bear Point, Lake Michigan; total loss.

16th.—Steam-barge Empire ashore and lost, off Port Huron, Lake Huron.

Propeller Wade's upper works damaged by collision at Chicago.

Scow Tuttle damaged by collision on the Detroit River.

S. W. Mason was drowned by upsetting of a sail-boat on Lake Ontario.

17th.—Propeller left Milwaukee for Grand Haven, but returned on account of heavy sea.

Schooner G. D. Dousman at Chicago in a leaky condition; docked for repairs.

Schooner Lillie Parsons injured by collision in the Welland Canal.

17th, (at night.)—Propeller Chicago sprung a leak, in a heavy northwest gale near Point Aux Bees Scies, Lake Michigan; wheat and flour damaged.

17th, (7½ p. m.) Schooner Elbe, with wood, struck a rock near Centerville, filled with water and capsized; towed to Manitowoc.

18th.—Schooner Walhalla, ran back to Milwaukee in a damaged condition.

Schooner Golden Rule broke center-board near Sheboygan, and returned to Milwaukee.

A bark loading with iron ore at Bear Creek, for Charlotte, broke loose and was driven ashore.

19th.—Schooner Reindeer ashore near Pinepog River; high and dry.

19th, (night.)—Schooner Yankee Trader ashore at Manitowoc; little damage.

19th, (evening.)—Schooner Norway ashore at Muskegon, Lake Michigan.

Schooner Hanna, with lumber, capsized off Milwaukee; was towed in.

Scow Southside ashore at Whitehall, Lake Michigan; abandoned for the winter.

19th.—Propeller Prairie State on a reef near Pointe Pelée; jettisoned 25 tons cargo.

Schooner Rob Roy waterlogged near Holland, on Lake Michigan.

Schooner George L. Wen struck an obstruction while entering the Welland Canal; 3,000 bushels grain wet.

Schooner Alpha grounded on a bar at Presque Isle.

Schooner Floretta damaged by a squall, twenty-two miles from Marquette, Lake Superior.

20th.—Propeller Detroit aground in the Detroit River; pulled off.

Schooner Prince Edward ashore at Isle Cove; not off.

Steamer Dolphin aground on the St. Clair Flats; pulled off.

Schooner Mary Morton ashore on Long Point, Lake Erie; total loss; cargo, coal.

21st.—Schooner Morning Star sprung a leak on Lake Ontario; 3,000 bushels barley damaged.

Schooner John Jewett sunk by collision with the barge E. L. Coyne, on the flats.

Propeller Georgiana pounded on a shoal near Kingston; little damage.

Tugs Armstrong and Tiger destroyed by fire in the river below Bay City.

Barge B. F. Sears, totally wrecked at Port Rowan.

Schooners Winnie Wing and Maine slightly damaged by collision.

Schooner Arcturus lost anchor on Lake Huron.

Steamer Metropolis had a hole stove in her upper works; damage slight.

Bark C. J. Wells arrived at Detroit damaged; docked for repairs.

Propeller Cleveland returned to Manitowoc slightly damaged.

22d.—Schooner Tidy Adly disabled near Sleeping Bear Point, Lake Michigan.

22d, (night.)—Brig Mohegan driven ashore in a snow-storm at Point au Barques.

Schooner Margaret Drayton struck the piles at Racine; damage slight.

Steamer Alpena grounded on the bar at Grand Haven, and narrowly escaped going ashore.

Propeller Galena on a bar at Sandusky; got off.

Schooner Lucy, with grain, at St. Catharine's in a leaky condition.

24th.—Schooner David Hull damaged on Lake Michigan.

Schooner Ida lost her center-board on Lake Michigan.

Schooner Sunnyside ashore at Whitehall.
Schooner Julia Willard ashore at Toronto Point, Lake Ontario; damage slight.
25*th*, (*night.*)—Schooner R. H. Becker ashore at Muskegon, Lake Michigan; got off.
Schooner Dolphin ashore at Muskegon, Lake Michigan.
Scow Southside ashore, high and dry, at Whitehall.
Schooner Montpelier ran ashore in a blinding snow-storm near Port Edwards, Lake Huron.
Scow Fairy Queen ashore at South Haven, Lake Michigan; could not be got off.
Schooner Dauntless, with iron ore, ashore at St. Martin's Island, Lake Michigan; stripped and abandoned.
25*th*.—Bark James Bell, schooner Sigel, and scow Trio damaged by collision at Chicago.
Schooner Gazelle, with wheat and barley, delayed and damaged by gale.
Schooner Geo. W. Hoyt lost her jib-boom on Lake Superior.
Schooner Sweepstakes ashore at Port Nelson, Lake Michigan; off without damage.
28*th*.—Bark Lafrinier and schooner Millard Fillmore ashore at Grand Traverse Bay, Lake Michigan.
A Canadian schooner, with grain, ashore, east coast of Lake Huron; probably total loss.
Tug Mayflower aground in the Detroit River.
Schooner Governor damaged by collision with schooner Frank D. Baker, below Cape Vincent.
Bark Henry Bissell ashore at Pointe au Pelée, Lake Erie; filled with water; 8,000 bushels wheat wet; got off much damaged.
28*th*, 29*th*.—Bark Chicago Board of Trade ashore at Milwaukee; got off materially damaged.
Schooner Seneca Chief injured the schooner Julia Palmer and the scow Home by collision at Milwaukee.
Schooner Alnwick ashore at Racine; got off.
Propeller Susquehanna upon a reef at North Bay, Lake Michigan; 500 barrels flour lost; got off, much damaged.
Schooner Libbia Nau, with iron ore, aground at Green Bay.
29*th*.—Schooner Annie Vought aground at Chicago; pulled off.
Schooners Tempest, Dolphin, Jamaica, Collingwood, Hattie Earl, and Reciprocity, the tug Preston Beasly, and the propeller Sun, suffered damage by collision during the storm at Chicago.
Propeller Galena hard aground on the St. Clair Flats.
Schooner Wanderer damaged by collision at mouth of the Detroit River.
Brig Mohega ashore at Pointe au Barques, and completely broken up.
Schooner W. A. Chisholm ashore at Northeast Point, Pennsylvania.
Schooner S. Robinson, with lumber, struck a rock and filled with water at Perry's Sound, Georgian Bay, Lake Huron.
Schooner Pierrepont, with groceries, &c., supposed lost on Lake Superior.
Schooner Hattie Johnson lost her center-board on Lake Erie.
30*th*.—Schooner Tartar ashore, a total wreck, at Pointe au Pelée, Lake Erie.
Schooner D. McInnes, with coal, supposed to be lost.
Schooner Rainbow sprung a leak off the Ducks, Lake Ontario; 200 bushels barley damaged.
Schooner Cornelia, at Chicago, in a leaky condition.
Two fishermen drowned at the entrance of Green Bay.
Propeller Salina aground on the St. Clair Flats.

DECEMBER.

1*st*.—A sailor washed overboard and drowned, at Port Colborne.
Brig Frankie Wilcox, leaking and in distress, near Long Point, Lake Erie.
5*th*.—Bark City of Buffalo injured by collision with the schooner C. P. Marsh at Cleveland, during a sudden squall.
Scow Christie lost her jib-boom.
Scow Mendota lost her rudder on Lake Michigan.
A schooner off Port Ontario went down in a storm; entire crew lost.
16*th*.—Schooner Napoleon ashore at Manistee; got off with little damage.
28*th*.—Propeller Ironsides disabled by loosening a wheel on Lake Michigan.
Two scows broke loose from their moorings and floated into the lake at Charlevoix, Michigan.

Recapitulation, and comparison with the same months in 1869.

	1869.	1870.
Wrecked and lost	39	18
Destroyed by fire	4	3
Sunk	6	2
Capsized	3	3
Leaking	23	17
Damaged by collision	42	32
Ashore, grounded, &c.	111	59
Damaged	138	99
Total	366	233
Men lost	97	23

Cf. Circular #2 Feb. 21, 1871.

PAPER 4.

INSTRUCTIONS TO OBSERVER-SERGEANTS, SIGNAL SERVICE, UNITED STATES ARMY, ON DUTY AT STATIONS.

1. Each observer, upon arriving at his station, will immediately proceed to secure a room suitable for office purposes, and the storage of instruments and other United States property in his charge. This room must be in the immediate vicinity of the telegraph office charged with the transmission and receipt of the weather reports, and should be in the upper story of a building, and contain at least *one* window facing the north. In all cases he will endeavor to get permission to occupy the roof of the (or a) building for the necessary exposure of his instruments, and the erection of an instrument-room, in accordance with the plans furnished by this office. When such permission cannot be obtained, or a suitable roof found, an instrument shelter will be constructed, similar to the one described on page 2 of the Smithsonian Directions for taking Meteorological Observations, a copy of which is furnished each observer, when ordered to a station.

The building selected should be detached from other buildings, and, where this cannot be had, should be higher than those surrounding it.

Too much attention cannot be given to the proper setting up of the instruments and their protection from local influences.

2. An observer, upon arriving at his station, will, as soon as practicable, put himself in communication with the meteorological committee of the board of trade, chamber of commerce, or board of underwriters, and such other committees as may desire to co-operate with this office, and also with all colleges, scientific associations, and other institutions of learning. He must bear constantly in mind that it is expected he will use every effort in his power to render his office of the greatest public utility.

3. The office furniture will be of the plainest kind, and consist of such articles only as are absolutely necessary for the proper transaction of business. The room, furniture, and instruments must be kept neat and clean at all times, and prepared for inspection.

4. The regular reports from station No. — will commence with the morning report of ——— ———, and from and after that date three observations will be made daily, for transmission, by telegraph, to ——— ———, and three observations, at different hours, for transmission by mail, weekly, to this office.

5. The observations for telegraphic transmission will be entered in Forms 1 and 5, supplied by this office, and made at — a. m., — p. m., and — m., daily. The instruments will be read in the following order:

1. Barometer.	2. Thermometer.	3. Hygrometer.
4. Anemometer.	5. Anemoscope.	6. Rain-gauge.

These observations will also be entered in the daily record of observations and in the record of bulletins, and a weekly record of them, on Form 4, will be sent to this office.

6. The reports will be handed in person to the operator charged with their transmission, in the order and at the times named below, viz: Report No. 1, (on Form 1, 20 words,) at ——— a. m.; report No. 2, (on Form 5, 10 words,) at ——— p. m.; report No. 3, (on Form 5, 10 words,) at — m.

7. Observers will be at the telegraph office, with the reports carefully and plainly written out *in duplicate*, ten minutes before the hours named, in order that the operator may be notified in time to prepare for their transmission, and will obtain the signature of the operator to *both* copies *of each report*. They will also furnish the manager of the office with a plainly written list of the stations (with their proper telegraphic numbers) from which reports are to be received, and also of those to be sent from his office, with the names of the stations to which they are to be sent. If reports are to be transferred, or selected for transfer at any station, the observer at that station must personally attend to such transfer or selec

tion, unless prevented by sickness or other extraordinary cause. To provide against such an event, he will so arrange with and instruct the manager that the regular transmission of reports will not be interrupted by his absence.

8. The following is a list of stations, with their proper telegraphic numbers. Those to be received at station No. — are underlined in red ink, and any failure to receive these will be promptly reported to this office, with a statement of the probable cause of failure.

Station.	*No.*	*Station.*	*No.*
Plaister Cove, Nova Scotia	10	.....	56
St. John's, New Brunswick	11	.....	57
Portland, Maine	12	.....	58
Boston, Massachusetts	13	.....	59
New London, Connecticut	14	.....	60
New York City, New York	15	Jackson, Mississippi	61
Albany, New York	16	Memphis, Tennessee	62
Philadelphia, Pennsylvania	17	Nashville, Tennessee	63
Baltimore, Maryland	18	Louisville, Kentucky	64
Washington, District of Columbia	19	Cincinnati, Ohio	65
Wilmington, North Carolina	20	St. Louis, Missouri	66
Charleston, South Carolina	21	Omaha, Nebraska	67
Savannah, Georgia	22	Cheyenne, Wyoming Territory	68
Augusta, Georgia	23	Santa Fé, New Mexico	69
Lake City, Florida	24	Corinne, Utah	70
Key West, Florida	25	Fort Benton, Montana Territory	71
Montgomery, Alabama	26	.....	72
Mobile, Alabama	27	.....	73
New Orleans, Louisiana	28	.....	74
San Francisco, California	29	.....	75
Norfolk, Virginia	30	.....	76
Oswego, New York	31	.....	77
Rochester, New York	32	.....	78
Buffalo, New York	33	.....	79
Cleveland, Ohio	34	.....	80
Toledo, Ohio	35	.....	81
Detroit, Michigan	36	.....	82
Chicago, Illinois	37	.....	83
Milwaukee, Wisconsin	38	.....	84
St. Paul, Minnesota	39	.....	85
Du Luth, Minnesota	40	.....	86
Pittsburgh, Pennsylvania	41	.....	87
Knoxville, Tennessee	42	.....	88
Indianapolis, Indiana	43	.....	89
.....	44	.....	90
.....	45	.....	91
.....	46	.....	92
.....	47	.....	93
.....	48	.....	94
.....	49	.....	95
.....	50	.....	96
.....	51	.....	97
.....	52	.....	98
.....	53	.....	99
.....	54	.....	100
.....	55		

9. In addition to the observations made for telegraphic transmission, three others will be taken daily, at 7 a. m., 2 p. m., and 9 p. m., (local time,) respectively. These will be recorded upon Form 4, in the same manner as the telegraphic observations, but on a separate sheet, and a copy of them will be forwarded weekly, by mail, to the office of the Chief Signal Officer.

10. After delivering his own reports to the operator, each observer will remain in the telegraph office until they are sent to their proper destination, and until the reports from other stations, intended for use at his station, are received, or until assured that their receipt has been prevented by some cause beyond the control of the operator. The reports for station No. —— should be received by —— a. m., —— p. m., and —— m., respectively; and when they are delayed beyond these hours, the facts should, in all cases, be promptly reported to this office by mail, with a statement of the cause of delay, when known.

11. The telegraph offices at which the reports are received will be kept constantly supplied by the observers with Form 2, and, in all cases, the receiving operator will be required to fill in the *date* and time of receipt. Observers will, in like manner, fill up Forms 1 and 5 before delivery.

12. Reports will be made on Sundays at the regular hours, and the same punctuality in delivering them at the telegraph offices will be required.

13. Immediately upon the receipt of the morning reports at any station, the observer will take them to his office, and translate them into ordinary language He will then write out plainly, on manifold paper, when necessary, a copy for each evening newspaper published at his station, the editor of which desires it for publication, and will furnish it promptly and regularly to such newspapers. He will also fill up properly the bulletin sheet, (Form No. 3,) using the manifold issue, and post this regularly in the rooms of the board of trade, chamber of commerce, and such other conspicuous places as may have been officially designated. The local observations will invariably be entered in all bulletins, press-reports, and maps. At stations supplied with the manifold-maps, these will follow the bulletins, and be printed as rapidly as practicable, and furnished to such parties as may be designated by this office. The "War Department Weather-Map" will then be changed in accordance with the following key:

The index consists of an arrow, disk, and card, which show the direction and velocity of the wind, state of the weather, height of the barometer, and height of the thermometer at the place on which they are affixed. The index will be changed once daily, at 10 a. m., or as near that hour as is practicable. The arrow flies with the wind.

A red disk indicates clear weather

A blue disk indicates sky covered with clouds.

A $\frac{1}{4}$ blue disk indicates sky $\frac{1}{4}$ covered with clouds.

A $\frac{1}{2}$ blue disk indicates sky $\frac{1}{2}$ covered with clouds.

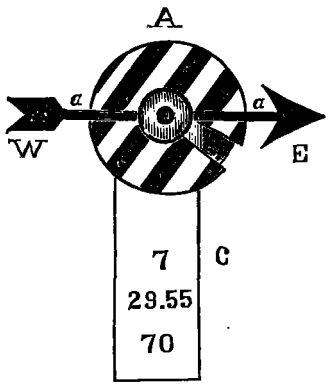
A $\frac{3}{4}$ blue disk indicates sky $\frac{3}{4}$ covered with clouds.

A black disk indicates rain.

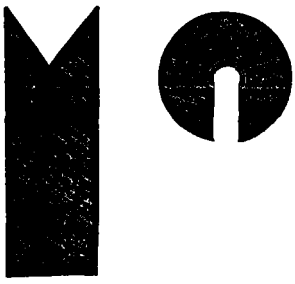
A white and black barred disk indicates snow.

A yellow card projecting below the disk, and held in position by the same screw that fastens the arrow and disk, shows the velocity of the wind in miles per hour, the height of the barometer in inches and hundredths, and the height of the thermometer in degrees Fahrenheit.

EXAMPLE.



The barred disk A indicates snow, and the position of the arrow *a a* that the wind is blowing from the west. The upper figure on the card, *c*, shows that the velocity with which the wind is blowing is seven miles per hour. The height of the barometer, shown by the middle figures, is twenty-nine inches and fifty-five hundredths, while the height of the thermometer, indicated by the lower figures, is seventy degrees above zero. When the temperature is below zero the minus sign should always be prefixed. To facilitate changing the disks and cards they are cut so as to slip on and off without removing the clamp, as shown in the following figures:



14. The afternoon reports will be received and translated in the same manner, but will be bulletined only, and at such places as will insure the greatest publicity.

15. The night reports, after translation, will be carefully and promptly written out on manifold-paper, and furnished to each morning paper printed at the station, in time for publication. Observers will endeavor to arrange with the publishers to have the reports taken from the observer's office; but where this arrangement cannot be effected, the observer will deliver them in person at the different newspaper offices.

16. At stations where the publishers of newspapers desire to have all the reports of the previous day, they will be supplied by the observers on the manifold-form issued by this office for that purpose. In such cases, observers will write up the morning and afternoon reports during the day and evening, so that there will be no delay in getting out the full report at midnight. In filling out the heading of the daily bulletin, for publication, the *time* of the reports will be the exact local time of the place of publication and will be so stated at all stations. In carrying out that part of their duty which relates to the publication and distribution of reports, observers will be required to act promptly and intelligently, as the usefulness of the reports depends wholly upon the speed and accuracy with which they are laid before the public.

INSTRUMENTS.

17. Each station will be supplied with one of Green's standard barometers, one thermometer, one hygrometer, one wind-vane, one rain-gauge, one Robinson anemometer, and one clock.

BAROMETER.

18. The barometers will in all cases be carefully compared with the standard at this office before issue, and the amount of instrumental error will be sent with each.

The barometer should be placed in a room of a temperature as uniform as possible, not heated nor too much exposed to the sun. It should be suspended at the height of the eye near a window, in such a manner as to be lighted perfectly without exposure either to the direct rays of the sun or to the currents of air which are always found at the window-casings and doors. To protect the instrument from external injuries, from dust, and from the direct radiation of warm bodies or the currents of air from the window, observers will fasten the wooden case in which it is carried firmly against the wall in a vertical position near the window, in such a manner that the cover will open in a direction parallel to the panes. An opening large enough to admit the tube of the barometer will be cut in the upper end of the box: and directly above this, at the distance of one inch, a strong hook will be driven into the wall. This hook should extend two or three inches beyond the box, and upon it the instrument will be suspended. When not in use the cover will be closed; but when an observation is to be taken it will be opened, and the instrument drawn out on the hook, clear of the box, and in the full light of the window. After the observation is made the barometer will be slipped back into the box.

19. All readings of the barometer taken for telegraphic transmission will be corrected by the observer making the observation, for *temperature*, for *elevation*, and for *instrumental* error, before they are sent from his station. In correcting for temperature, the reading of the *attached* thermometer will be used, while in correcting for elevation, the temperature used will be that of the exposed or open-air thermometer.

In correcting for elevation, the height of the surface of the mercury in the cistern of the barometer above the ground must be added, in all cases, to the height of the station above sea-level, as in the following example, viz: Suppose height of station above sea-level to be 670 feet; height of mercury (surface) in cistern to be 17 feet; then the elevation to be corrected for would be 687 feet.

In correcting for temperature, Table XVII, pages 66 to 71, paper C, of Guyot's tables, will be used; and for elevation, Table XIX, page 92, paper D, of the same book, when special tables, prepared at this office, are not furnished.

20. In transporting a barometer, even across a room, it should be screwed up, and carried with its cistern uppermost; for traveling, it is provided with a wooden case. On steamboats or railroads it should be hung up by a hook in the state-room or car, and the lower end firmly strapped to the side of the room or car to prevent jarring; in wheeled vehicles, it should be carried by hand, supported by a strap over the shoulder, or held upright between the legs, but it should *not* be allowed to rest on the floor of the carriage, for a sudden jolt might break the tube. If carried on horseback, it should be strapped over the shoulders of the rider, where it is not likely to be injured, unless the animal is subject to a sudden change of gait. When about to be used, it should be taken from its case, and, while screwed up, gently inverted and hung up, when it can be unscrewed. While it has its cistern uppermost, the tube is full, is one solid mass of metal and glass, and not easily injured; but when hung up, a sudden jolt might send a bubble of air into the vacuum at the upper end of the tube, and the instrument would be useless until repaired.

If the cistern should become dirty, it can be cleaned with safety, and without changing, in the slightest degree, the zero of the instrument. Everything used in the operation must be clean and dry; avoid blowing upon any of the parts, as the moisture from the breath is injurious.

The instrument being placed upright, the cistern uppermost, unscrew and take off the brass casing which incloses the wooden and leathern part of the cistern. This wooden part (which has the grain crosswise, and therefore is not air-tight) is made in two pieces, fastened together by four screws and four brass pieces, each in the form of a half of a circular ring. It will be necessary to take out two of these screws, and loosen the other two, when the brass pieces can be taken off; the upper wooden piece, to which the bag is attached, can then be lifted off, and the mercury will be exposed; by then inclining the instrument a little, a portion of the mercury in the cistern may be poured out into a clean vessel at hand to receive it, when the end of the tube will be uncovered. This is to be closed by the *gloved hand*, when the instrument can be inverted, the cistern emptied, and the tube brought again to its upright position; great care must be taken not to permit any mercury to pass out of the tube. The long screws which fasten the glass portion of the cistern to the other parts can then be taken off, the various parts wiped with a clean cloth or handkerchief, and restored to their former positions. The mercury which had been taken out of the cistern must now be cleaned, or it must be replaced by other that is clean and pure; if the old mercury is merely dusty, or dimmed by a film of oxide, the cleaning may be effected by straining it through a chamois leather, or through a funnel with a capillary hole at the end, of a size to admit of the passage of but a small thread of the metal; such a funnel is conveniently made of letter-paper. The dust will adhere to the skin or paper, and the filtered mercury will present a clean and bright appearance; if chemically impure, it should be rejected, and fresh, clean mercury used. With such clean mercury, the cistern should be filled as nearly full as possible; the wooden portions put together, and securely fastened by the screws and clamps; the brass casing screwed on, and the screw at its end screwed up; the instrument can then be hung up and readjusted. The tube and its contents having been undisturbed, the instrument should read the same as before. If a little mercury has been lost during the operation, and there is none at hand to replace it, no serious harm has been done; but if much is lost, the open end of the tube may become exposed in inverting the instrument, in which case air may enter.

THERMOMETER.

21. The thermometer should be hung in the open air facing the north in such a manner that it will always be in the shade, and at least one foot from the wall of the building to which the shelter is attached, where the Smithsonian form of shelter is used. It must be protected against the light reflected from surrounding objects, and from rain, snow, and hail. The instrument must be placed exactly perpendicular, the middle of the scale being at the height of the eye in order to prevent error in reading. The readings should be made at all times, and, especially in the winter, *through the panes*, without opening the window, when the shelter is built out from a window. When the shelter is built upon a roof, great care must be exercised in making the readings in order to prevent the instrument from being affected by the heat of the body or of the lantern at night. The observation must be made as rapidly as is consistent with accuracy.

HYGROMETER.

22. The hygrometer will be placed in the same shelter as the thermometer, and at a distance of one foot from it. The cistern will be kept supplied with pure water at all times when the temperature of the air is above the freezing-point, and the muslin cover of the wet-bulb will be changed every two months, and the bulb carefully cleaned. The muslin may be washed as often as necessary, without removal, by means of a jet of clean water from a small syringe.

When the temperature of the air is below the freezing-point, the water will be emptied from the cistern, and the wet-bulb will be moistened with cold water by means of a camel's-hair brush fifteen minutes before the observation is made, or long enough to permit the ice to form and *dry* on the bulb. The coating of ice allowed to form should be very thin, otherwise the reading will be inaccurate. Alcohol must not be used to prevent the water from freezing. The reading must be made rapidly, and without opening the window. The relative humidity of the air will be obtained from Table VII, page 46, paper B, of Guyot's tables.

ANEMOMETER.

23. The anemometer will be fixed in a vertical position upon a post of sufficient height to bring the dial on a level with the eye of the observer, and will be in an exposed situation, so as to receive the full force of the wind. When possible, this post should be framed into the roof, to steady it and prevent the instrument from vibrating; but when this cannot be done, it should be framed at the bottom into two pieces of scantling, not less than three feet in length, which cross each other at right angles, and which can be nailed fast to the roof or platform upon which the instrument is placed. Short braces can be added when necessary to insure steadiness. The outer dial of the instrument is graduated in miles and tenths of miles—the figures 1, 2, 3, &c., indicating miles, and the subdivisions tenths. One complete

revolution of this dial is equivalent to ten miles of wind, and carries the inner dial forward one subdivision. This inner dial registers up to one thousand miles, and moving so slowly, will not be used in making ordinary observations, but will be noted by observers daily when making the 7 a. m. observation. To make an observation, two readings of the outer dial must be taken, with an interval of five minutes between them, and the *difference* between these readings will be the distance in tenths of miles traveled by the wind in that interval. This, multiplied by twelve and divided by ten, will give the proximate velocity in miles per hour. Example: Suppose the index of the outer dial to be at 3 when the first reading is taken, and at 3.6 five minutes after, the difference, 6, is the distance traveled in that time; and this, multiplied by twelve and divided by ten, gives a velocity of seven and two-tenths miles per hour. Whole numbers only will be used in expressing the velocity. When the decimal is greater than five-tenths, the unit's figure will be increased by one; when five or less, it will be thrown out. The whole distance traveled by the wind in any twenty-four hours, provided it does not exceed one thousand miles, will be obtained from the inner dial by a double observation as above, making the interval twenty-four hours instead of five minutes, and will be entered on the copy of Form 4 used for the local observations.

WIND-VANE.

24. The wind-vane should be set in a place as free and open as possible, in order that the wind may act freely upon it, and must never be sheltered by surrounding buildings or other objects. Observers will mark, with the aid of a compass, at the base of the upright which supports the vane, the true meridian of their respective stations. The magnetic variation at station No. — is —— degrees.

The observation of the vane requires more care than is usually given. In winds of considerable strength the vane is never at rest, or fixed in the same direction; it oscillates incessantly, and its oscillations increase in extent with certain winds and with the violence of the wind. In such cases observers must *note the mean* direction between the extremes. When the wind is too light to move the vane, and when it is calm, no direction will be given in the report, but the space will be filled with the word "Naught." The attention of observers is called to this matter in order to prevent them from recording direction of wind when it is calm. The direction of the wind will be designated by the eight principal points of the compass, beginning with the north and moving around by the eastward, and numbered from one to eight respectively.

RAIN-GAUGE.

25. The rain-gauge will be placed, whenever practicable, with the top of the funnel-shaped collector twelve inches above the surface of the ground, firmly fixed in a vertical position, and protected from the interference of unauthorized persons. It will be examined daily, at the time of making the morning observation; the amount of water it contains carefully measured by means of the graduated rod sent with each gauge, and then emptied and returned to its proper position. When a position at the level of the ground cannot be found with a sufficiently clear exposure the gauge will be placed on the top of the instrument-room, or roof of the building occupied by the observer, who will measure the height above the ground and report it to this office. The measuring rod is graduated in inches and tenths of inches, and the proportion between the cylinder and funnel is as ten to one, so that ten inches upon the rod correspond with one inch of actual rain-fall, one inch on the rod to one tenth of rain, and one-tenth on the rod to one-hundredth of rain. Snow will be melted and then measured and reported in the same manner as rain, but the fact of its being melted snow must be noted under the head of remarks, in the weekly reports, on Form 4.

TOOL-BOX.

26. For repairing and putting in order a barometer, the following implements are furnished, neatly packed in a small box:

A couple of screw-drivers, one fitting the screws about the cistern, the other those about the scale; a small glass funnel; two porcelain cups, from two to four inches in diameter; kid-skin; shoemaker's thread; white wax; chamois leather; a pair of small forceps; a small three-cornered file, and a blow-pipe.

CLOCK.

27. The clock will be hung upon the interior wall of the room occupied as an office, and at each station will be adjusted to the local time.

Immediately after placing his instruments in position, each observer will make out and forward to the Chief Signal Officer at Washington a full report in writing, stating the kind, size, and position of room selected; the street, and number of the building in which the room is situated; the position of each instrument, and height of each above the ground. In giving height of the barometer the measurement will be made from the surface of the mercury in the cistern.

In addition to this information, such other facts will be stated as will enable the Chief Signal Officer to judge of the manner in which this part of the observer's duty has been performed.

FORMS.

28. The following-named forms will be furnished to each station:
Form 1. Morning report.
Form 2. Receiving sheet.
Form 3. Bulletin.
Form 4. Weekly report.
Form 5. Afternoon and night reports.
Form 6. Receipt for property.
Form 7. Press report.
Form 8. Manifold map.

29. Form 1 will be used for the morning report of twenty (20) words, and will be filed up as follows:

In the first line the first three figures will show the height of the barometer, and the last two the number of the station. The barometer will be read to hundredths; and in filling up this form the first figure of the height in inches will be omitted.

In the second line the first two figures will show the reading of the exposed thermometer —; the next two, the relative humidity, and the last one the direction of the wind, indicated by a series of numbers from one to eight, beginning at the north and moving around by the eastward. A *calm* will be indicated by the word *Naught*.

In the third line the first two figures will show the velocity of the wind in miles per hour, the next two the date of the report, and the last figure the state of the weather, indicated by a series of numbers from naught to nine, inclusive, as follows:

Naught will indicate clear weather.
One will indicate fair weather.
Two will indicate cloudy weather.
Three will indicate clearing up after storm.
Four will indicate threatening to storm soon.
Five will indicate light rain.
Six will indicate heavy rain.
Seven will indicate light snow.
Eight will indicate heavy snow.
Nine will indicate hail or sleet.

From the first to the ninth day, inclusive, of each month, the first of the two spaces assigned to the date will also be filled with the word "Naught"

The first space in the fourth line will be used to indicate the amount and kind of the *upper* clouds, by the following scale:

Naught will indicate a clear sky.
One will indicate atmosphere hazy.
Two will indicate sky 1-4 to 2 4 covered with cirrus clouds
Three will indicate sky 3-4 to 4-4 covered with cirrus clouds.
Four will indicate sky 1-4 to 2-4 covered with cumulus clouds.
Five will indicate sky 3-4 to 4-4 covered with cumulus clouds.
The word "Blank" will indicate that the upper clouds are hidden.

The second space in the fourth line will be used to indicate the amount and kind of *lower* clouds, by the following scale:

Naught will indicate absence of lower clouds.
One will indicate fog.
Two will indicate sky 1-4 to 2-4 covered with stratus clouds.
Three will indicate sky 3-4 to 4-4 covered with stratus clouds.
Four will indicate sky 1-4 to 2-4 covered with nimbus clouds.
Five will indicate sky 3-4 to 4-4 covered with nimbus clouds.
The word "Blank" will indicate that the lower clouds are hidden.

The three last figures will show the amount of rain-fall, or of melted snow, in the past twenty-four hours, in inches and hundredths of an inch. When there is no rain-fall to report, the spaces will be filled with the word "Naught." This form must be filled in duplicate, as previously directed, and the printed instructions upon it must be strictly followed, and observers must assure themselves that they are clearly understood by the operators charged with their transmission. Whenever the margin at the right is too narrow to permit the figures to be duplicated in the customary manner, these figures may be written *across* the end of the paper, but should never be omitted.

30. Form 5 will be used for the afternoon and night reports of ten words and two supplementary letters each, and will be filled up as follows: The first line will show height of barometer and number of station, as in Form 1, followed by the letter "D" in the afternoon report, and the letter "N" in the night report The first figure of the second line will show

the direction of the wind by the same series of numbers used in Form 1. The second figure will show the velocity of the wind in miles per hour as follows:

	Pressure—pounds per square foot.		Pressure—pounds per square foot.
A velocity of 1 mile by One	0.00	A velocity of 31 miles by Fail	4.80
A velocity of 2 miles by Two	.02	A velocity of 32 miles by Feed	5.12
A velocity of 3 miles by Three	.04	A velocity of 33 miles by Flea	5.44
A velocity of 4 miles by Four	.08	A velocity of 34 miles by Foam	5.78
A velocity of 5 miles by Five	.12	A velocity of 35 miles by Fray	6.12
A velocity of 6 miles by Six	.18	A velocity of 36 miles by Hark	6.48
A velocity of 7 miles by Seven	.24	A velocity of 37 miles by High	6.84
A velocity of 8 miles by Eight	.32	A velocity of 38 miles by Hope	7.22
A velocity of 9 miles by Nine	.40	A velocity of 39 miles by Huge	7.60
A velocity of 10 miles by Ten	.50	A velocity of 40 miles by Hyde	8.00
A velocity of 11 miles by Ace	.60	A velocity of 41 miles by Maid	8.40
A velocity of 12 miles by Age	.72	A velocity of 42 miles by Mean	8.82
A velocity of 13 miles by Alas	.84	A velocity of 43 miles by Mile	9.24
A velocity of 14 miles by Amen	.98	A velocity of 44 miles by Mode	9.68
A velocity of 15 miles by Bay	1.12	A velocity of 45 miles by Muck	10.12
A velocity of 16 miles by Aunt	1.28	A velocity of 46 miles by Nag	10.58
A velocity of 17 miles by Bang	1.44	A velocity of 47 miles by Nero	11.04
A velocity of 18 miles by Beam	1.62	A velocity of 48 miles by New	11.52
A velocity of 19 miles by Bird	1.80	A velocity of 49 miles by Note	12.00
A velocity of 20 miles by Blue	2.00	A velocity of 50 miles by Nude	12.50
A velocity of 21 miles by Cane	2.20	A velocity of 51 miles by Raid	13.00
A velocity of 22 miles by Card	2.42	A velocity of 52 miles by Rate	13.52
A velocity of 23 miles by Cole	2.64	A velocity of 53 miles by Read	14.04
A velocity of 24 miles by Crab	2.88	A velocity of 54 miles by Ride	14.58
A velocity of 25 miles by Cube	3.12	A velocity of 55 miles by Ring	15.12
A velocity of 26 miles by Dam	3.38	A velocity of 56 miles by Sad	15.68
A velocity of 27 miles by Dear	3.64	A velocity of 57 miles by Shun	16.24
A velocity of 28 miles by Dime	3.92	A velocity of 58 miles by Skin	16.82
A velocity of 29 miles by Drug	4.20	A velocity of 59 miles by Steam	17.40
A velocity of 30 miles by Duke	4.50	A velocity of 60 miles by War	18.00

The third figure will show the state of the weather by the same numbers used for this purpose in Form 1, and the two last figures will show the height of the exposed thermometer. The *date* will be shown by a letter at the end of this line corresponding by the number of its place in the alphabet *to* the date, thus: *a* for the first, *b* for the second, and so on; the 27″, 28″, 29″, 30″, and 31″ will be shown by *a b*, *a c*, *a d*, *a e*, and *a f*, respectively.

31. In filling up Forms 1 and 5, when the reading of the thermometer is below zero, the word *minus* will be sent in the first of the two spaces assigned to the thermometer, and the whole number of degrees below zero in the other. In the marginal check-figures the minus *sign* may be used, but never in the body of the report. When the reading is one hundred degrees, or above, the first figure will be omitted in filling up these two forms, in order to keep the matter within two spaces. In translating, the figure can be readily supplied, as is done in the case of the first figure of the barometric reading.

Form 2 will be used by the operators in receiving the reports from other stations, and the spaces will be filled up in regular order, commencing at the upper left-hand space, and filling each space to the right in succession, on the first line, and then commencing at the left-hand space of the second line, and so on until each space is filled. Observers will require the receiving operators to sign and date each sheet, and also note the time of receipt, before receiving it from them. The sheets will be preserved, and at the end of each week will be made up into a neat package and mailed to the Chief Signal Officer, Washington, D. C., with a written memorandum showing the number of reports missed during the week, with names of stations.

32. Form 3 is the daily bulletin for public information, and will be filled out in manifold promptly, on the receipt of the morning and afternoon reports. It is divided into thirteen columns, filled as follows:

No. 1. Names of stations from which reports are received.

No. 2. Height of the barometer at each station, corrected for temperature, elevation, and instrumental error.

No. 3. Change in the barometer since the time of last report, using the plus sign before the figures when it has risen, and the minus sign when it has fallen.

No. 4. Height of exposed or open-air thermometer.

No. 5. Change of thermometer in the last twenty-four hours and *not* since last report. A rise or fall will be indicated by the plus or minus sign, as in the barometric column.

No. 6. Relative humidity will be entered in the *morning* bulletin only.

No. 7. Direction of the wind in the initial letters of the points of compass.

No. 8 Velocity of wind in miles per hour.

No. 9. Pressure per square foot in pounds.
No. 10. Character of wind.

A wind blowing from 1 mile to 2 miles per hour will be designated	Light.
From 3 miles to 5 miles	Gentle.
From 6 miles to 14 miles	Fresh.
From 15 miles to 29 miles	Brisk.
From 30 miles to 39 miles	High.
From 40 miles to 49 miles	Gale.
From 50 miles to 60 miles	Storm.
Absence of wind	Calm.

No. 11. Amount of cloud.
No. 12. Amount of rain-fall—in morning bulletin only.
No. 13. State of the weather.

33. Form 4 is a weekly report of all observations, and is filled up and transmitted weekly by mail to the Chief Signal Officer. It is divided horizontally into seven parts, in each of which will be entered the three observations of a single day under the proper headings. As two series of observations are taken at all stations, one for telegraphic transmission and one at different hours for transmission weekly by mail, two copies of this form will be used weekly, one for each series of observations, and both will be mailed in the same envelope.

34. Form 6 is a memorandum receipt for property, and will be filled up with the number and kind of articles received; signed, dated, and transmitted promptly to the property officer of the Signal Office in Washington, D. C.

35. Form 7 is the "press-report," and will be filled up in manifold properly, under the printed headings, as soon as practicable after the receipt of the morning reports, and copies furnished to the different afternoon papers. This form will also be used for the midnight report, and must be filled up rapidly at that hour, or as soon afterward as the reports are received, in order that it may be supplied to the different morning newspapers in time for publication.

36. Form 8 is the weather-map, to be made out in manifold, and to show the direction of the wind, kind of weather, height of barometer, height of thermometer, and velocity of wind at each station. The arrow is always to fly *with* the wind, and *not toward* the wind, like a vane. In printing these maps, great care must be exercised to make the figures and different signs correctly and distinctly. Observers must never allow imperfect or illegible maps to leave their offices. To insure accuracy, the printed maps must be carefully compared with the reports received before being issued; and if errors are found they will be corrected, if the correction can be made without disfiguring the map and without rendering it illegible. If they cannot be so corrected, the whole edition will be destroyed, as it is better not to issue any map than one which is imperfect.

BOOKS OF REFERENCE AND RECORD.

37. The following books of reference and record will be furnished by this office to each station:

For reference.—Guyot's Meteorological Tables, Buchan's Handy-book of Meteorology, Loomis's Treatise on Meteorology, Manual of Signals, Smithsonian Directions for Meteorological Observations.

For records.—Journal, Daily Records of Observations, Record of Bulletins, Record of Letters Sent, Record of Letters Received, Weather Map of the United States.

38. In the journal will be entered daily all matters of interest not provided for in the various forms, such as meteoric and auroral displays, earthquakes, and unusual atmospheric appearances and disturbances, giving in all cases, when possible, the time of beginning and duration of each. Especially will the observer enter a detailed account of the characteristic phenomena of every serious storm that passes over or near his station. In this book will also be noted the condition of the instruments, and when they are damaged in any way the cause will be stated. A monthly abstract of the entries in this journal will be forwarded to the Chief Signal Officer within five days after the expiration of each month.

39. The daily record of observations will be an exact copy of Form 4, and filled up in the same manner. Both series of observations can be entered in the same book, care being taken to date and time them properly.

40. The record of bulletins will be filled up regularly from the daily bulletins, of which it is a copy.

41. In the books of letters sent, and letters received, will be entered all letters sent and received relating to the official business of the station.

42. The map of the United States will be hung up in the principal room of the board of trade or chamber of commerce, or both, and the state of the weather throughout the United States will be shown upon it in the manner already described, as soon after the receipt of the morning report as is practicable.

GENERAL INSTRUCTIONS.

43. Each observer in charge of a station will, as soon as practicable after arriving at his station, make arrangments with some competent person to perform his duties in case of sick-

ness or disability, The person so selected must be carefully instructed in the use and care of the several instruments, in the manner of taking the observations, of making out and forwarding the weather-reports sent from the station, and the proper disposition of those received from other stations. His name and regular post-office address will be reported to this office as soon as this selection is made. The employment of this assistant will be temporary only, and he will be paid at the end of each month in which the services were rendered, at the rate of compensation fixed by the Chief Signal Officer, on forwarding the proper vouchers to this office, with a certificate from the observer-sergeant, stating the number of days employed, with the dates in each case.

44. In case of sickness or disability rendering an observer incapable of performing his duties, he will report the fact by telegraph to the Chief Signal Officer, and will forward by mail the certificate of his attending physician.

45. Observers will call for treatment in case of sickness upon the medical officers on duty at their respective stations.

46. At stations where there is no regular medical officer, a resident practitioner will be employed, whose account, made out in duplicate on the form given below, will be transmitted for payment to the Surgeon General of the Army, through the office of the Chief Signal Officer, Washington, D. C.:

THE UNITED STATES,

To ——— ———, M. D., DR.

For medical attendance furnished to ——— ———, at ———, from ——— to ———, 187–, —— visits:

$ ——

I certify that the above account is correct and just, and that the charges do not exceed those customary at this place.

——— ———, *M. D.*

Subscribed and sworn before me this —— day of ———, 187–.

——— ———.

I certify that the above account is correct and just; that the services were rendered as stated; that I was on duty at ———, and could not secure attendance from a medical officer of the Army.

——— ———,

Observer-Sergeant, Signal Service, U. S. A.

Sworn to and subscribed before me this —— day of ———, 187–.

——— ———.

Approved:

——— ———,

Chief Signal Officer, U. S. A.

47. The publication of the Government weather-reports by newspapers must be done without expense to the United States, as the information given is of general interest.

48. Observers will select such places for posting the daily weather-bulletins and maps as will insure their widest publicity at all hours of the day or night, and will report the names and locations of the places thus selected to the Chief Signal Officer. At the same time they will report the location of their own offices, giving the name of the street and number. This information will also be furnished to the manager of the telegraph office charged with the transmission and receipt of the reports.

49. Observers must not make use of the telegraph in communicating with the central office in Washington, except in cases of the utmost importance. Where the use of the telegraph is considered unnecessary by the Chief Signal Officer, the cost of the telegram will be charged against the observer sending it.

50. Communications to this office on official business will be written on the official size of letter-paper, inclosed in an official envelope, and directed to "The Chief Signal Officer of the Army, Washington, D. C." The words "Official Business" will be written on the right-hand upper corner of the envelope. Letters thus addressed and indorsed are free of postage.

51. Observer-sergeants will comply with the Regulations of the Army, and wear their uniform coat buttoned up while on duty. They are required to be especially neat and careful in their dress; and any negligence in this particular coming to the knowledge of the Chief Signal Officer will be considered sufficient cause for the reduction of the offender to the rank of a private soldier.

52. Each observer on station will forward weekly, by mail, to this office, a written illustration of the manner in which he makes the necessary barometrical corrections, and also of the manner in which he obtains the relative humidity of the air. A *single* observation weekly, properly and *fully* worked out, will be sufficient.

53. Observer-sergeants will not comprise in the same communication, matters relating to their meteorological observations and general details of duty, with those relating to property or money, in any form.

Letters of transmittal, application, or explanation, under these two general heads, must be written on separate sheets of paper, but may be sent in the same envelope, as a matter of economy.

54. Observers will give close attention to the observation and record of all local premonitory signs of storms or changes of weather, and report them promptly to this office. The following points should be particularly noted: direction and force of the wind; kind, direction, motion, and appearance of clouds; action of the barometer and thermometer before, during, and after a storm or change of weather, and such other purely local causes as appear to influence the results.

55. The attention of observer-sergeants is directed to the fact that they are required to make their reports absolutely correct, and that any shortcoming in this respect renders them liable to punishment. Aside from this, it should be kept constantly in mind that a single incorrect report may cause the loss of life and property to an unknown amount, and all reports must be made with this responsibility clearly in view. Whenever an observer is unable, from any cause, to get in his report, properly corrected, at the regular hours of report, he will *not* send the uncorrected portion, but will write the word "blank" in each of the spaces that would otherwise have been occupied by this portion of the report. Observers will *never* send any report or part of report which they have reason to believe is incorrect, and will bear in mind that it is safer and more in accordance with instructions to omit a report than to make a false one.

56. In the event of one or more instruments at a station becoming disabled and unfit for use, observers will fill up the space or spaces in the different forms intended for the readings of such instruments with the word "blank," until they are repaired or replaced. If the instruments cannot be properly repaired at the station, the observer will at once notify this office.

57. Observers are expected and required to improve themselves in the duties of their position, and are liable at any time after one year's service to be called before a board for their second regular examination.

58. Any carpenter, or other work found necessary in fitting up or repairing a station, the observer may forthwith have done, unless it involves considerable expense, when a detailed description of the work needed, with its cost, must first be transmitted to this office, and authority obtained before ordering it. The bills for the same will be sent to this office for settlement, always accompanied by a full description of the amount and kind of work performed.

59. One room, for the performance of his duties, will be rented by the month, at each station, by the sergeant in charge, but no more than eighteen dollars per month will be paid therefor without special authority from this office. He is also authorized to purchase, if necessary, the following office-furniture and supplies, viz: one desk, (price not to exceed $20;) one table, with drawers, (stained pine, and not to exceed $6;) two chairs, (not to exceed $2 25 each;) one stove, with pipe, (not to exceed $15;) one coal-scuttle, one fire-shovel, one water bucket, one cup or dipper, one goblet, one basin, one large lamp, one oil-can, one dust-pan and brush, one broom, two common spittoons, one lantern. The above-named articles must be of a cheap, plain, and substantial kind. Memorandum bills (unreceipted) for rent, labor, and purchases will be sent to this office as soon as presented, and will be settled at the earliest opportunity.

60. The necessary fuel will also be purchased at each station, until arrangements can be made to have it supplied by the Quartermaster's Department.

61. Observer-sergeants, in charge of stations, will be made responsible for the Government property issued to them or purchased by them, and they will be required to account for the same to this office, quarterly, on the prescribed forms. Property lost or damaged through the carelessness of the sergeants will be charged against them, and the value deducted from their pay.

62. The pay and allowances of the observer are to be obtained monthly from three different sources. His pay proper, $20 per month, and his commutation of clothing, $4 42 per month, (when no clothing in kind has been drawn,) may be procured by sending his descriptive list (about the 22d of each month) to the nearest Army paymaster, with a letter requesting payment. The paymaster will return vouchers to be signed by the sergeant, and when these are received back, the former will remit a check for the amount of pay.

Extra-duty pay is allowed by special authority from the War Department to the observer-sergeants, and together with commutation for fuel, $3 per month, and quarters, $10 per month, (allowed when sergeant is not serving with troops,) will be drawn from the Quartermaster's Department by the property and disbursing officer at this office. Each observer will make out his account, in duplicate, on Form 22, (blanks furnished from here,) in the following manner, placing the amount only in the receipt, and signing the latter. He will then transmit them to this office for settlement, not later than the 20th day of each month.

[Form 22.]

THE UNITED STATES,
To J. W. ROBINSON, *observer-sergeant, Signal Service, U. S. A.*, *Dr.*

To extra-duty pay from the 1st of February, 1871, to the 28th day of February, 1871, inclusive, 28 days, at 35 cents per day	$9 80
To commutation of fuel from February 1, 1871, to February 28, 1871, inclusive, one month	8 00
To commutation of quarters from February 1, 1871, to February 28, 1871, inclusive, one month	10 00
	27 80

I certify that the above account is correct and just; that the services were rendered as stated; and that they were necessary for the public service.

———, ———,
First Lieut. and Bvt. Major, U. S. A., and A. A. Q. M., Signal Service.

Received at ———, the —— of ———, 187–, ——— ———, quartermaster, United States Army, the sum of $27 80, in full of the above account.

J. W. ROBINSON,
(Duplicate.) *Observer-Sergeant, Signal Service, U. S. A.*

Commutation of rations, 75 cents per day, (when the non-commissioned officer is not serving with troops,) will be obtained of the Commissary Department, through the property and disbursing officer at this office. The sergeant will make out his account, in duplicate, on Form Y, (blanks supplied from here,) in the following manner, signing the receipt, but omitting therefrom everything but the amount of money due The accounts will then be forwarded here each month for settlement, along with those for extra-duty pay, commutation of fuel and quarters.

[Form Y.]

THE UNITED STATES,
To J. W. ROBINSON, *observer-sergeant, Signal Service, U. S. A.*, *Dr.*

For commutation of rations while on extra duty as observer at Smithville, Tennessee, from February 1 to February 28, 1871, inclusive, 28 days, at 75 cents per day	$21 00
	21 00

I certify that the above account is correct and just; that the commutation was made by order of the Secretary of War, and was necessary for the public service, there being no opportunity for messing.

———, ———,
First Lieut. and Bvt. Major, U. S. A., Acting Signal Officer and Assistant.

Received at ———, this —— day of ———, 187–, from ——— ———, commissary of subsistence, United States Army, the sum of $21, in full of the above account.

J. W. ROBINSON,
(Signed in duplicate.) *Observer-Sergeant, Signal Service, U. S. A.*

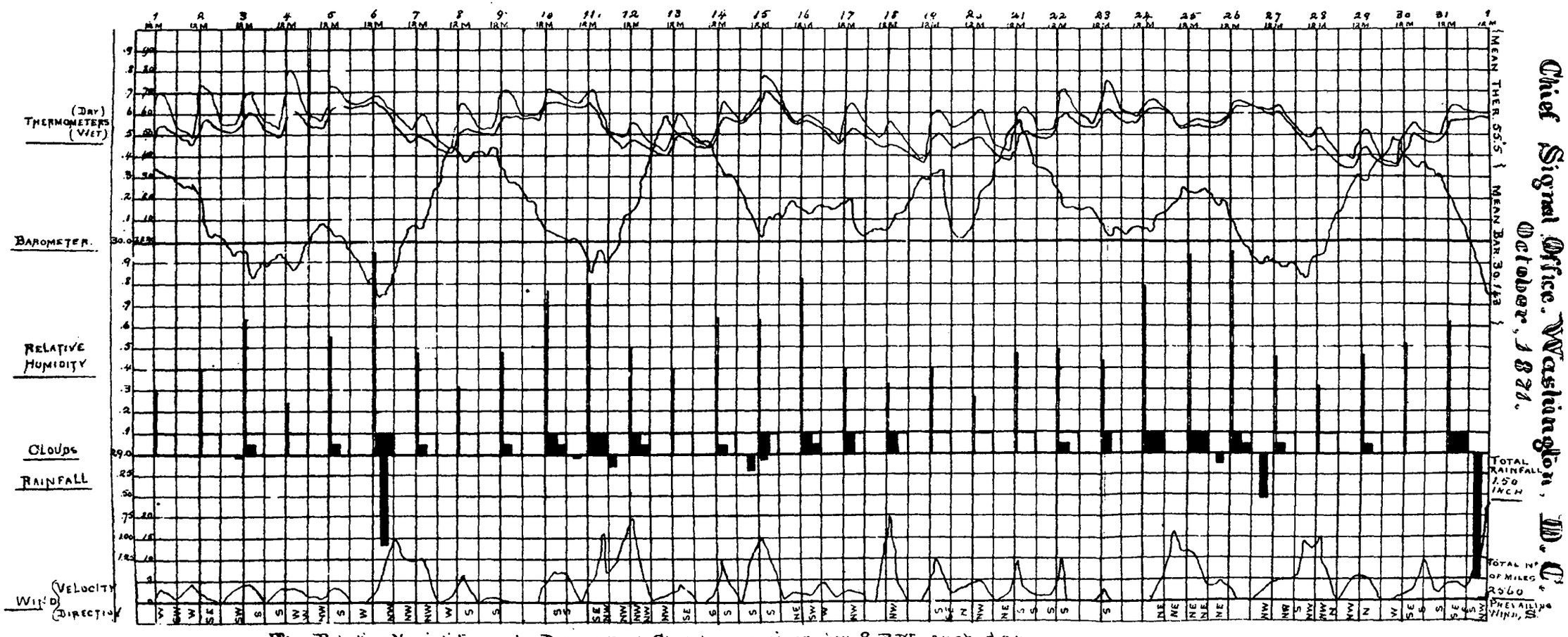
Privates of the signal-service detachment, on duty as assistants to observer-sergeants, will draw their regular pay, $16 per month, and their commutation of clothing, $4 36 per month, (when no clothing in kind has been drawn,) in the same manner and from the same paymaster as the sergeants with whom they may be serving, the sergeant obtaining pay for the private at the same time that he does his own. Privates, as assistants, will also be allowed commutation of rations, fuel, and quarters, (when not serving with troops,) at the same rates, and to be drawn in the same manner, upon the same forms, as is that of the sergeants, the latter forwarding the assistants' accounts with their own. Privates will not be allowed the extra-duty pay.

PAPER 5.

War Department Weather-map.

Chief Signal Office, Washington, D. C.

October, 1871.



The Relative Humidity and Amount of Cloud are given for 2 P.M. each day.

REPORT OF THE CHIEF SIGNAL OFFICER.

PAPER 6. 1873-109

THE PRACTICAL USE OF METEOROLOGICAL REPORTS AND WEATHER-MAPS.

[Circular.]

WAR DEPARTMENT, OFFICE OF CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE,
Washington, D. C., ——— —, 1871.

The following paper is published by the direction of the Secretary of War:

It is the object of the publication to put it in the power of the largest number to make use of, and to profit by, the labors of this office; to enable them to test, and to avail themselves of some of the laws and generalizations by which meteorologists are guided; and to afford the means by which at once to supplement, judge of, and aid the work of the Department.

ALBERT J. MYER,
Brig. General and Chief Signal Officer, U. S. A.

3d ed. author tatione. C.A. rev. by C.A. only.

THE PRACTICAL USE OF METEOROLOGICAL REPORTS AND WEATHER-MAPS.

In pursuance of the duty imposed upon the Secretary of War by the law providing for the announcement by telegraph and signal of the approach and force of storms, and under his direction, the office of the Chief Signal Officer of the Army, at the War Department, causes meteorological observations and reports to be made daily and nightly at 55 stations.

The office division of telegrams and reports for the benefit of commerce is organized for the preparation, receipt, and use of these reports.

At every station three observations are taken daily at the same moment of actual (not local) time for all stations, by the observer-sergeants of the signal service. The reports are immediately telegraphed to the office of the Chief Signal Officer at Washington.

By a carefully arranged system of telegraphic operation, copies of the full reports of all stations thus transmitted to Washington, or of portions of them, are sent at the same time to many of the signal-service stations in principal cities and towns.

At each station so receiving a tabular report, one or more bulletins are published. The observations are made synchronously at the different stations at the exact hours, 7.35 a. m., 4.35 p. m., and 11.35 p. m., Washington time.

The full reports from all stations are telegraphed to, and received at, Washington, translated from cipher and published in the form of bulletins of reports by the hours of 9 a. m., 6 p. m., and 1 a. m., respectively, (Washington time.) The bulletins of reports are designated as follows: That published at 9 a. m., the Morning Report; that published at 6 p. m., the Afternoon Report, and that published at 1 a. m., the Midnight Report. The bulletins, wherever published, at Washington, or elsewhere, exhibit the following particulars, viz: height of barometer; change since last report; thermometer; change in last twenty-four hours; relative humidity, in per cent.; direction of wind; velocity of wind, in miles, per hour; pressure of wind, in pounds, per square foot; force of wind; amount of cloud; rain-fall since last report, in inches and hundredths, and state of weather.

The following places, now occupied as stations of this division, were selected as of most immediate importance for meteorological purposes, and possessing telegraphic facilities. Those which are gradually to be added during this year are already designated by the Secretary of War, for similar reasons, with a design to perfect the net-work of the system so far as the appropriations allow.

* Portland, Maine.
* Boston, Massachusetts.
* New London, Connecticut.
* New York City, New York.
* Philadelphia, Pennsylvania.
* Baltimore, Maryland.
* Washington, District of Columbia.
* Wilmington, North Carolina.
* Charleston, South Carolina.
* Savannah, Georgia.
* Augusta, Georgia.
Lake City, Florida.
Key West, Florida.
* Mobile, Alabama.
* New Orleans, Louisiana.
San Francisco, California.
* Du Luth, Minnesota.
* Pittsburgh, Pennsylvaina.
Knoxville, Tennessee.
* Indianapolis, Indiana.
Lynchburgh, Virginia.
Burlington, Vermont.
* Keokuk, Iowa.
* Grand Haven, Michigan.
* Vicksburgh, Mississippi.
Escanaba, Michigan.
Marquette, Michigan.
* Davenport, Iowa.
* Leavenworth, Kansas.
* Cairo, Illinois.
* Cape May, New Jersey.
* Galveston, Texas.

* Norfolk, Virginia.
Mt. Washington, New Hampshire.
Jacksonville, Florida.
* Oswego, New York.
* Rochester, New York.
* Buffalo, New York.
* Cleveland, Ohio.
* Toledo, Ohio.
* Detroit, Michigan.
* Chicago, Illinois.
* Milwaukee, Wisconsin.
* St. Paul, Minnesota.
* Montreal, Canada.
Punta Rassa, Florida.
* Memphis, Tennessee.
* Nashville, Tennessee.
* Cincinnati, Ohio.
* St. Louis, Missouri.
Omaha, Nebraska.
Cheyenne, Wyoming Territory.
Corinne, Utah.
Shreveport, Louisiana.
* Louisville, Kentucky.

At those places marked with a star, the number of reports received and published in the bulletin is sufficiently large to permit them to be used in the manner pointed out in this paper. The remaining stations, either on account of special reasons connected with their locality, or of those relating to the telegraphic system, are now chiefly used as reporting stations.

The morning and afternoon reports (bulletins) are posted at each of the local signal-service offices, and at a number of other public places in the cities and towns to which they are transmitted.

They are always open for examination. At the more prominent stations, and those in principal cities, large weather-maps are also posted every morning, exhibiting, by means of changeable symbols, the reports of the morning observations at the different stations. The midnight report (bulletin) is gratuitously furnished to every morning newspaper published in the city, at which a station of observation may be, which will insert it in its columns. The morning report is also delivered to afternoon papers in time for publication.

The observers at each station are instructed to afford every facility to the press and to the public for the earliest receipt and most extended use of the reports and information at their respective offices.

In addition to the bulletins, a statement of synopses and probabilities is prepared at the office of the Chief Signal Officer, and thence issued thrice daily. It is immediately furnished to the Associated Press, by which it is telegraphed to all its agencies throughout the country.

The synopses and probabilities, with which the public is familiar, through the columns of the different newspapers, are issued from the office of the Chief Signal Officer, at 1 a. m., 10 a. m., and 7 p. m., daily.

In the study of local probabilities, the student should make sure that he has before him (as in the columns of the local newspaper) the latest synopses and probabilities issued at Washington. To be sure of such facts he must notice the hours at which they are dated from the office in Washington. *The midnight reports dated at 1 a. m. of each day ought to be found in the morning newspapers of that day; the morning report dated at 10.30 a. m., of each day, is furnished in time for the afternoon and evening papers.*

At places where stations are established, the use of the bulletined reports in the mode suggested in this paper would often, perhaps, enable the student to make forecasts of the weather with greater local particularity than can be expressed in the "synopses and probabilities" telegraphed to the press, as the latter must, in a limited number of words, give generalizations embracing the whole country. And it is believed that, in many places distant from any station, but on or near the lines of railways or steamers, or with other modes of rapid communication, the bulletins can be utilized in a corresponding manner. *If, at the station nearest to persons interested, as, for instance, the board of trade, or chamber of commerce, or the meteorological committee of an agricultural society, or individuals interesting themselves in the study of practical meteorology, no newspaper prints the bulletins furnished gratuitously by this office for that purpose, there is a strong probability that, upon proper application made to the editors or proprietors, they would be printed as of interest to the subscribers and readers.* In cases where delay would thereby be avoided, arrangements can often be made with the publisher to have copies of the newspaper containing bulletins sent in advance of its delivery by mail. By such means, and others which will suggest themselves, a record of meteorological conditions elsewhere can be obtained in many places within so few hours after the observations are taken at the different stations, as to enable a student to make for himself many important deductions. The accuracy of these would be greatly assisted by local observations made at the same time as those of the observers of this division, with similar instruments, and by frequent local observations made during any time at which there is especial interest or anxiety as to the probable weather.

The navigator, the agriculturist, or the student, can supplement in this way, by the readings of his own instruments and his local knowledge, the reports and information furnished by the United States, and is fitted to arrive at intelligent conclusions as to the data before him.

There s yet no provision for furnishing instruments, on the part of the United States, to any other than the observer-sergeants, although it is possible that some such authority may hereafter be given. Full information as to the instruments and their use will, however, be furnished to all persons who may provide them for themselves.

In addition to the weather bulletins, and the "synopses and probabilities," a graphic weather chart or map is issued thrice daily from the office of the Chief Signal Officer of the Army, at the War Department. To those who know how to use them, all of these reports offer valuable help in estimating the probable character of the weather at any station or over any district during the following day, and often for a still longer period The bulletins and graphic charts, properly filled, convey the same information, with this difference, while the former merely tabulates the reports alphabetically, the latter reveals to a single glance of the eye a synoptic view, at once, of the meteoric conditions at the different stations, and of the deductions thence to be made as to the conditions of the atmosphere then extending over the continent.

The graphic charts are of additional value, from the fact that it is often possible to trace upon them, in lines, the progress of storms, or the change of meteoric condition, (as the movement of an area, of high or low barometer,) from report to report, and thus by considering the past, and by applying laws and generalizations reasonably well established, to estimate more easily the "probability" of the future.

Those who receive the bulletin through the newspapers, or otherwise, can, if they deshe, so easily transfer its information to the blank charts, that the reader is supposed to be in possession of, or familiar with, a series of such weather-maps.

As the anticipation of dangerous winds is at present the most important subject for examination, the following remarks are made with the view of directing the attention to those matters that are considered to have a direct bearing upon the subject of storms and gales in the United States. The study of the science of meteorology and of the theories that have been formed to explain the complicated phenomena that are daily presented in our atmosphere will be but lightly touched upon, since persons of education are already in possession of sufficient inductive generalizations to give a fair insight into the actual nature of the changes that are taking place at every hour of the day.*

ABBREVIATIONS USED IN THE PRESS-REPORTS.

It may be well to state here that, in the weather synopses and probabilities emanating from the Signal Office, different parts of the country are thus designated:

Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island are alluded to as the *New England States*, or *the Northeast*, or simply as the *Eastern* States.

New York, New Jersey, Pennsylvania, Maryland, District of Columbia, and Virginia, as the *Middle States*, or sometimes as the *Middle Atlantic States*.

North Carolina, South Carolina, Georgia, and Northern and Eastern Florida, as the *South Atlantic States*.

Western Florida, Alabama, Mississippi, Louisiana, and Texas, as the *Gulf States*.

Sometimes the Gulf States, the South Atlantic, Virginia, Tennessee, Kentucky, and Arkansas are grouped together as the *Southern States*.

The Lower Lakes, when used, means Lakes Erie and Ontario.

The Upper Lakes are Lake Superior, Huron, and Michigan.

The Northwest, popularly, means the country lying between the Mississippi and the Missouri Rivers.

The Southwest means Texas, Indian Territory, and New Mexico.

Pacific Coast, or *Pacific States*, includes California, Oregon, and Washington Territory.

The *Ohio Valley* includes the belt of country about two hundred miles broad from Pittsburgh to Cairo.

The *Mississippi Valley* includes a belt of about the same width, from Vicksburgh to Davenport.

The extensions from Missouri to Ohio, &c., refer to areas reaching to and including the central portions of the States named. Thus, a report "Westerly winds extending from Iowa to Pennsylvania," would convey that those winds would be felt in the interior of those States as well as over the territory lying between them of the respective States.

In *the coasts*, &c., is included the land between the coasts and the parallel range of coast hills or mountains. In Texas, Louisiana, and Northern Florida, a belt of land extending a hundred miles inward would be included.

Winds are said to blow from northeast when they are generally included within the quadrant from north to east, &c., and similarly for other directions.

THE GRAPHIC WEATHER-MAP.

A weather-map should be made out as often as a bulletin is received; and it is a very great advantage to be able to do this thrice daily; one map every day is the least that can be usefully studied. It is found best to preserve the maps in books of a hundred or so, they being very exactly superposed upon each other.

Owing to the translucency of the paper on which they are printed, it is generally possible

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* Blank charts on which to enter observations can be obtained from the office of the Chief Signal Officer, at Washington, D. C., at actual cost, ($2 75 per hundred,) and will be sent by mail, free of other expense, to applicants.

to see through several of the sheets, and thus more easily compare the successive phases of the weather

The record for each station should be entered in its appropriate place; the wind and weather may be easily indicated by arrows and black or white circles.

All the entries being made with a black-lead pencil, the whole operation will barely consume fifteen minutes.

Auxiliary charts of the same size should be at hand, on which are entered the isobarometric* and isothermal lines for the month, and such other data as need to be continually borne in mind.

Especially important is it that the eye should be familiar with the ordinary charts of physical geography, on which are pictorially given the belts of trade-winds and the anti-trade winds, the mountainous and alluvial regions, the plateaus, &c., and it should be borne in mind that the climatic belt continually moves up and down on the earth's surface with the sun's apparent annual motion. Relief-maps, or orographic charts, showing, pictorially, the face of the country whose meteorology is studied, will add the liveliest interest and clearness to the investigation.

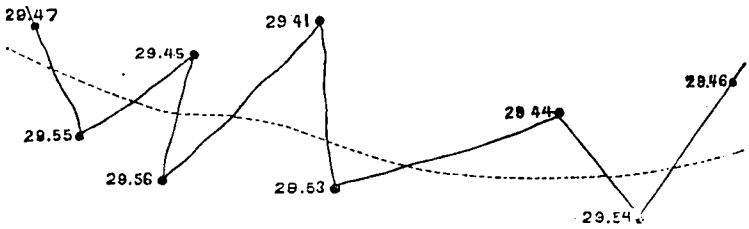
It is probable that elementary charts, showing the principal topographical and meteorological features of North America, and on precisely the same scale as the weather-map, will be eventually published by the office of the Chief Signal Officer; but for the present the desired information may be obtained from such works as Keith Johnston's Physical Atlas, Guyot's, Cornell's, or Maury's Physical Atlas and Geography, Buchan's Meteorology and his essay on the Distribution of Atmospheric Pressure; Blodgett's Climatology of the United States, Coffin's Winds of the Northern Hemisphere.

The manner of tracing isobarometric lines on *weather-map* is this:

1. Record with a lead-pencil in small plain figures at each station the height of barometer as given in the report.

2. Find the location of *lowest* barometer—say 29.45. Draw a line with red pencil through those stations where the barometer stands between 29.45 and 29.55; mark this line at each end, or in two or three places, 29.50. Then take the height at 29.55 to 29.65; trace a line in the same way as before, marking it 29.60; continue this until the highest barometer is reached.

By tracing the line of the map of the previous observation, showing through the translucent current one with *blue*, (or dotted red over,) the difference in location of the area of lowest pressure, and the changes since last report, also the direction in which the storm (if there be one) is moving, and the rate at which it is progressing, are readily shown. The following is an illustration: The dotted line showing the isobaric line of 29.50, located by the readings supposed to have been found upon the map on either side of that line.



The specimen of a War Department weather-map accompanying this paper will enable this subject to be fully understood.

THE ATMOSPHERIC PRESSURE.

The pressure of the atmosphere at a given place is not expressed by the weight of the mercury sustained in the tube of the barometer by that pressure, but by the perpendicular height of the mercurial column.

In comparing barometric observations at different stations, it is necessary to take into account their respective elevations above the sea-level; for, as there is an ascent above the sea, the heavier strata of the atmosphere are left behind, and the pressure being thereby reduced, the height of the mercury is proportionally reduced.

A slight acquaintance with the weather-map will, however, bring to notice the fact that the barometric heights, as reported from Mount Washington, Cheyenne, and other very elevated stations, even after all allowances are made for the altitudes, are very different from those at neighboring stations which are more nearly on the sea-level. Attention is therefore, for the present, confined to the barometeric readings at those stations that are less than 2,000 feet above the sea, which includes nearly all those from which reports are at present received.

* Isobarometric (sometimes abbreviated to isobaric lines, (or isobars,) means lines along which the mercurial column indicates equal pressure.

Paper #5

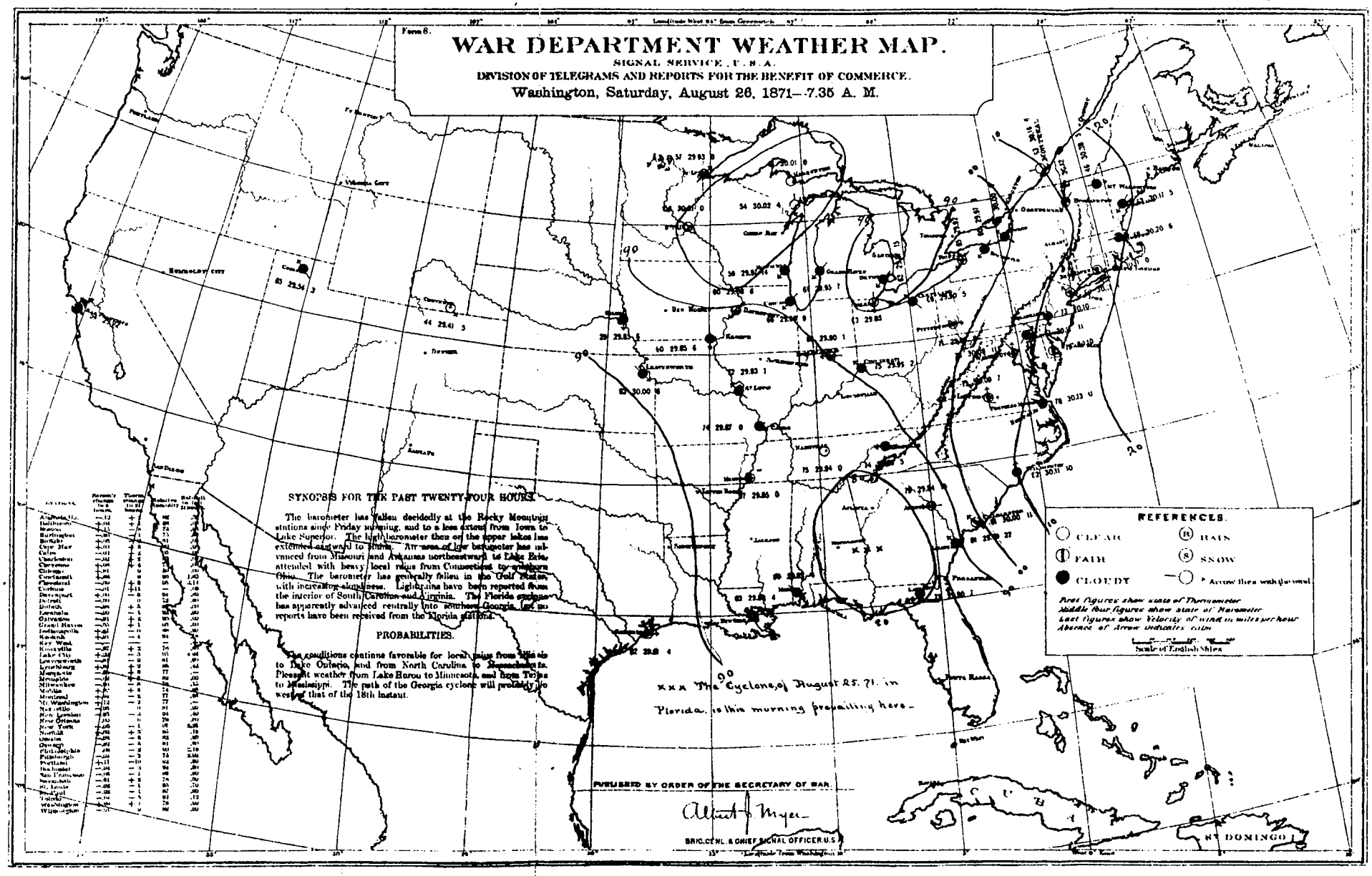
Form 8.

WAR DEPARTMENT WEATHER MAP.

SIGNAL SERVICE, U. S. A.

DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

Washington, Saturday, August 26, 1871—7.35 A. M.



SYNOPSIS FOR THE PAST TWENTY-FOUR HOURS.

The barometer has fallen decidedly at the Rocky Mountain stations since Friday morning, and to a less extent from Iowa to Lake Superior. The high barometer then on the upper lakes has extended eastward to Maine. An area of low barometer has advanced from Missouri and Arkansas northeastward to Lake Erie, attended with heavy local rains from Connecticut to southern Ohio. The barometer has generally fallen in the Gulf States, with increasing cloudiness. Lightnings have been reported from the interior of South Carolina and Virginia. The Florida cyclone has apparently advanced centrally into southern Georgia, but no reports have been received from the Florida stations.

PROBABILITIES.

The conditions continue favorable for local rains from Illinois to Lake Ontario, and from North Carolina to Massachusetts. Pleasant weather from Lake Huron to Minnesota, and from Texas to Mississippi. The path of the Georgia cyclone will probably be west of that of the 18th instant.

A few trials will convince one that it is almost always possible to draw a continuous line through those points where the barometer stands at 30.00 inches. If, furthermore, from two neighboring points there are reported, respectively, 29.95 and 30.05, then half way between them, it may, in the majority of cases, be assumed that the barometer stands at 30.00. By connecting with red lead pencil lines all the points thus determined, that narrow band over which the barometric pressure is uniform is made visible at a glance.

It is generally well understood that the height of the mercury in the barometer-tube is a simple and direct measure of the intensity with which the atmosphere is at that moment pressing down upon the basin of the barometer, and upon the neighboring region of the earth; and not only is the pressure downward, but equally so is it exerted upward and horizontally in all directions.

The pressure varies in intensity at any station with the varying temperature, moisture, depth, and motion of the atmosphere. There is also a slight regular rise culminating between 9 and 10 a. m., and a fall culminating between 3 and 5 p. m., called the diurnal change.

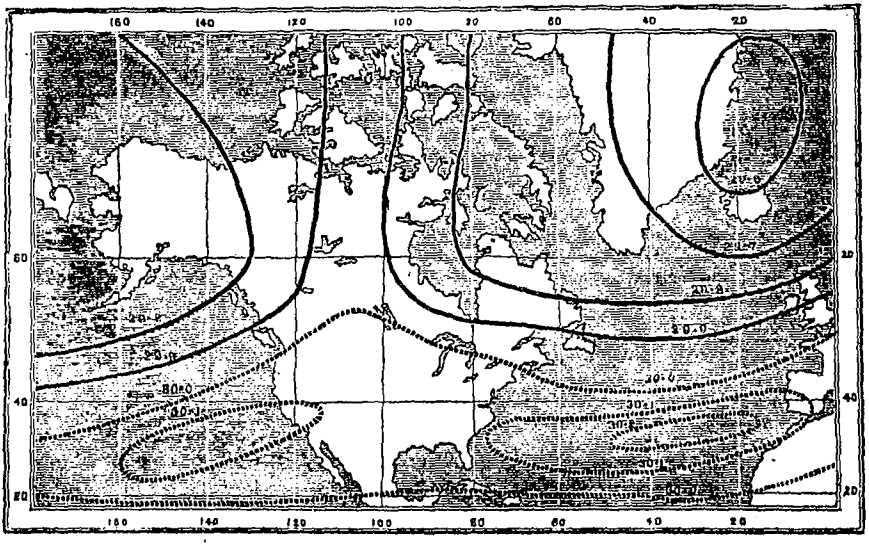
The average height of the barometer at the level of the sea, on the Atlantic coast of the United States, does not vary much from 30.00; on the western plains it rises to 30.2 in the winter. It diminishes as we approach the Arctic regions.

Now draw other red lines showing where the pressure is lower than its average value, (30.00,) or where the barometer stands at 29.90, 29.80, &c., inches. These lines will almost invariably be found to be upon one and the same side of the line of 30.00, and to be approximately parallel to each other. Oftentimes they gradually inclose with their bounds a central area of small extent, and over which the pressure is decidedly lower than anywhere else on the map. If this central area be not too near the limiting line of the signal-stations, it will be found to be completely inclosed by the encircling lines of equal pressure, or isobarometric lines, as they are called, words which, for convenience, are now generally contracted into the simple noun *isobarics* or *isobars*.

Similarly, if, on passing the other side of the line of 30.00 inches of pressure, a system of isobarics connecting the points where the barometer stands at 30.10, 30,20, &c., be drawn, there will be noticed an area of the highest pressure, though very frequently the stations are not widely enough extended to give the precise limits of this area. In general the areas of average and high pressure are more extensive than those of low pressure.

Could reports be received from the whole of the north temperate regions of the earth, from the oceans as well as the continents, it would undoubtedly be found that each area of lowest pressure is completely separated, by areas of average and high pressure, from its neighboring low-pressure areas. For the limited region from which the daily reports are received this is found to be approximately true; so that, for instance, a low barometer over the extreme western plains will be bounded by areas of high barometer on the Pacific coast and the Mississippi Valley, while another area of low pressure prevails in the New England States. On the borders of the great areas of high barometer, and within the areas of low barometer, occur the smaller areas of low pressure with which cyclones, tornadoes, and thunder-storms are associated. It is the study of these areas, of high and low barometer, that is now of particular interest.

ISOBAROMETRIC LINES, SHOWING, IN INCHES, MEAN ANNUAL ATMOSPHERIC PRESSURE FOR UNITED STATES.



The dimensions of these smaller areas vary from that of a few square miles, as in tornadoes, to that of five hundred miles square, as in extensive cyclones. The largest areas of high barometer of interest to this country are those of the Tropic of Cancer and the South Atlantic and Pacific Oceans, and (in the winter) that which exists in the interior of the North American Continent.

While carefully studying the every-day variations of the barometer, the meteorologist will not forget each day diligently to compare the day's isobars with the mean monthly isobars on his isobarometric chart.

THE WINDS AND THEIR LAW.

Whether considered as the indices, or as the causes of coming changes of weather, no phenomenon is more important than that of the winds. Upon the direction and force of the winds, some meteorologists lay very great stress in every attempt at storm forecasting; and, in order to determine these, it is necessary to draw the isobars on the weather-chart.

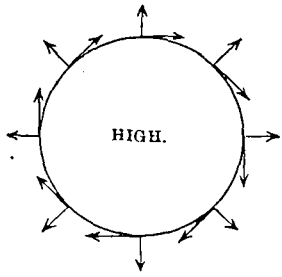
Assuming the lines of equal barometric pressure to be drawn on the weather-chart, it is at once perceived that, in well-understood accordance with the laws of mechanics, the atmosphere must be pushing from the regions of higher to those of lower pressure. The resulting movement of the air, modified by the forces of inertia and friction, and by the rotation of the earth and local obstructions, is converted into the *local* winds, whose directions are indicated by the arrows upon the maps, and whose velocities are given in miles per hour. These winds may be called local winds, as distinguished from the general winds in any section, and from the great currents of air to be hereafter spoken of. The general winds appear to be primarily dependent upon the existence and position of the areas of low and high pressure. The great currents, spreading, as they do, over whole continents and encircling the earth, are largely influenced by, if not dependent upon, the earth's axial rotation.

If the earth were not in rotation on its axis, the winds would uniformly blow in straight lines outward from the center of every area of high barometer toward the surrounding localities of lower barometer, just as naturally as the water-wave tends to spread itself out in radial lines.

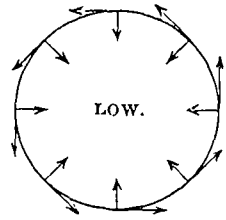
Observation, however, has long since clearly shown that, in this hemisphere, within any area of high pressure, the winds will be found to be not only blowing away from the center, (outwards,) but also to be deflected towards the right hand as they move forward. Observation has also shown, with equal clearness, that, in this hemisphere, within any area of low pressure, the winds will blow toward the center (inwards,) and will also be deflected toward the right hand as they move forward. This deflection to the right has been demonstrated by Mr. William Ferrel, of Cambridge, Massachusetts, to be a mathematical necessity arising from the influence of the earth's diurnal rotation, which causes everything moving on its surface to deflect slightly to the right in the northern hemisphere, and to the left in the southern hemisphere. This force, by which, to give a popular illustration, a railroad train is made to bear more heavily on the right-hand rail of the track along which it advances, is the key to the explanation of any phenomena in connection with atmospheric and other currents. This interference drawn from it, taken in connection with concurrent observations, enables one to construct the following table, which shows which winds will generally prevail on each side of areas of high and low pressure:

The observer being—	THE PREVAILING WINDS WILL BE—	
	Low pressure.	High pressure.
On the N. side	N. and E	S. and W.
On the N. W. side	N. W. and N. E	S. E. and S. W.
On the W. side	W. and N	E. and S.
On the S. W. side	S. W. and N. W	N. E. and S. E.
On the S. side	S. and W	N. and E.
On the S. E. side	S. E. and S. W	N. W. and N. E.
On the E. side	E. and S	W. and N.
On the N. E. side	N. E. and S. E	S. W. and N. W.

The same regular distribution of the winds is shown by the arrows in the accompanying diagrams:



AREAS OF HIGH PRESSURE.



AREAS OF LOW PRESSURE.

The deflection from the radial line (*i. e., to the right*) is not always nor usually 90°, as represented in the diagrams, but the angle is generally between 30° and 60°, amounting to 60° or 80° only in case of severe storms, cyclones, &c. In using the above table or diagrams, if, for illustration, it be assumed that the observer is placed within an area of unusually low pressure, then, on the northwest side of its center he should find the wind blowing *from some point in the horizon between northwest and northeast. If he is within an area* of high pressure, and on the northwest side of its center, he should find the wind blowing from some point in the quadrant between southeast and southwest.

When no well-marked central areas are actually within the limits of the map, the winds still unite with the lines of equal pressure in indicating such areas as existing near by. Thus, during the summer, for instance, the southwest and the southeast winds of the western plains indicate the low pressure that exists at that season in the Missouri Valley and northward. When the pressure over a considerable area is very uniform, then minor local influences (such as cannot generally be exactly located by the limited number of reports *that are at present received) affect the gentle winds that then exist. On such occasions local* differences of temperature and moisture, affecting, as they do, the local pressures, give rise to light winds extending over only a few square miles, but which still tend to obey the general laws given in the above table.

Vertical, as well as horizontal systems of winds, depending upon the disturbances of equilibrum continually taking place in the region of the clouds, always exist in connection with the ordinary horizontal gales. These are, in fact, a most prominent feature of tornadoes and water-spouts.

The system of winds above given is not only that which all observations show to exist, but also *that which follows from the mathematical theory of the motions of fluids on the* earth's surface, as developed by Ferrel and others, which, as has been already stated, proves that all bodies, whatever be their direction of motion on the earth's surface, in the Northern hemisphere are deflected, or trend towards the right hand in their onward progress. This deflection towards the right, small as it is originally, increases with the diameter of the storm, and seems by its cumulative force to determine the general direction of the rotation of the West India cyclones, as well as that of the much weaker storms that pass over our continent; in all which it is evident that the air actually has a sinuous spiral motion inward toward the central area of lowest pressure, and at the center upward from the earth's surface, on *the outer edge of the tornado and cyclones a downward current is evident. This same,* principle (Ferrell's law) also decides the deflection northward of the afternoon sea breezes and southward of the evening land breezes, as experienced along our Atlantic coast from North Carolina to Florida, which deflection is, however, greatly increased by the general trend of the coast, and the greater friction of air passing over land than over water.

The rule called "Buys Ballott's Law," is not to be confounded with that which, for brevity, is called "Ferrel's Law." The former is expressed as follows:

"If any morning there be a difference between the barometrical readings at any two stations, a wind will blow on that day in the neighborhood of the line joining those stations, *which will be inclined to that line at an angle of 90° or thereabouts, and will have the station* where the reading is lowest on its left hand side."

This rule is a generalization first specially announced for Holland and the neighboring country, and has been found applicable to the weather in Great Britain in cases where strong winds occur.

The law was first published by Buys Ballot in 1860;* it had also been deduced by Dr. Lloyd in 1854, and had been recognized under a different form by the students of tropical cyclones and hurricanes.

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*Einige Regelen voor aanstaande Weersveranderingen in Nederland, voornamelijk id Verband met de dagelijksche telegraphische Seinen. Utrecht, 1860.

This rule will evidently hold good in general, best when the two stations considered are in a line with the centre of the neighboring area of high or low pressure. It is, if possible, always best to seek the boundaries of these areas by means of the isobaric lines, and having located these, to make use of the laws of mechanics that are applicable to the whole earth's surface. Buys Ballot's rule was originally intended to be applied to regions from which but few isolated reports were received.

Since, however, the centers of disturbance are in continual motion, it is evident that "we must not interpret the rule too strictly." In investigations upon the applicability of this rule to the British weather-reports, an allowance of about one hundred miles was made for the movement of the center of disturbance, and thus it was deduced that "94 per cent. of the gradients recorded were succeeded by winds in the direction indicated by the law," and in 62 per cent. both the force and direction were correctly indicated.*

The force of a local wind at any point, and at any moment, certainly depends primarily upon the relative barometric pressure at points in the vicinity, and upon the rapidity with which the pressure has been or at that moment is changing; but the force and direction of the wind at any station are also very materially influenced by the character of the ground in the immediate and distant neighborhood. The wind which on the ocean would blow with a certain velocity will have but one-half or one-third of that velocity when blowing over hilly country This is due to the lesser friction on the ocean, and this frictional resistance in two different ways disturbs the direction of the wind:

1. If, for example, there is a north wind blowing, very generally over a lake of elliptical shape, such as Lake Michigan, and over the neighboring country, then on the central line of the lake a strong north wind will be experienced, and a feebler one at the points on land far removed from the shore; but at points on the northwest and southeast shores of the lake a northwest wind will be experienced, while a northeast wind will be observed on the northeast and southwest shores. Similarly, if a south wind blows steadily over the Southern States and coast, it will, to observers on the coast, appear as a southwest wind, and a north wind will be changed into a northeast wind, and this, too, independently of the additional influence exerted by the earth's rotation, which should, in this present example, increase the extent of those changes, in accordance with the law above given, as first deduced in all its generality by Ferrel.

2. The friction of the earth's surface has a greater influence upon strong than upon feeble winds, and thus does more to retard the tangential than the centripetal motion of the air in the neighborhood of an area of low pressure. Consequently, in severe storms on land, the wind is found to be directed more nearly toward the central area of the disturbance than in oceanic storms. Thus in tornadoes the inward and upward motions predominate over the tangential.

Precisely as the velocity over water is greater than over land, so is the velocity far above the earth's surface greater than lower down. Balloon voyages show occasional velocities of one hundred miles per hour. The severest gales on the earth's surface rarely exceed eighty-five miles, though doubtless this has been exceeded in certain tornadoes and momentary gusts, &c. The currents only a few hundred feet above the earth have frequently twice the velocity of those observed on the surface, as shown by observations of the velocity of passing cloud shadows.

The friction of air moving over land or water gives rise to ascending currents, extending over large areas of land, and of which the westerly winds of the Pacific Coast and the easterly winds of the Atlantic Coast are important examples.

Heavy gales (*i. e.*, those having velocities of forty miles and upward) immediately attend the areas within which the isobarics are very near to each other, and die away so soon as these lines are seen to separate. In the case of violent but *very* local storms, the stations will generally fail to give more than a general indication of the disturbance.

The existence of several local winds a short distance above the earth's surface, and on the tops of mountains, and in the regions traversed by balloons, and especially over the edges of lakes, the ocean, and arid, dry plains, is very frequently observed, when, at the same time, neither the barometer nor the wind is affected at the lower stations near by.

This phenomenon is probably in most cases due to the fact that very rapid barometric changes may exist above us, while below there is perfect equilibrium.

Thus, suppose that at two neighboring stations the barometers read the same, and the winds are light or calm, but the temperatures are, respectively, ninety and seventy five degrees, and these differences occur in summer time at points less than a hundred miles apart. It follows that, at an elevation of a mile above those points, the barometric pressure may be at least a tenth of an inch different, and this would suffice to set a strong wind in motion.

By considering the influence of moisture in diminishing the density of the air in which it is present, it is shown that the decided differences of pressure that exist at neighboring stations may easily be completely reversed in the strata from one to two miles above the earth.

The destructive power of a wind, or its power to overthrow or move any body, is the dif-

*See R. H. Scott, An Inquiry into the Connection between Strong Winds and Barometrical Differences. London, 1869.

ference in the pressure on opposite sides of a body. In steady winds this difference depends not only upon the velocity of the wind, but equally on the shape of the resisting body. Those bodies offer least resistance in which (as in fishes, the hulls of ships, bridge-piers, &c.) the hinder portion receives the backward pressure of the fluid that presses up against it, thus permitting as little approach to a vacuum as possible. In the case of sudden gusts, the resisting body receives the whole force of the impulse precisely as a blow. The atmosphere, though so light, is not devoid of mass and inertia. Air in motion at the rate of one hundred miles per hour strikes obstacles with a force equal to that which moves the same volume of water, would exert if moving at the rate of 3½ miles per hour.

In descending from higher to lower land, the wind's velocity is affected by the force of gravitation in a measure quite independent of the differences of pressure shown by the horizontal isobaric lines. Although the primary effect of gravitation is in the vertical direction, yet a portion of this is transferred to the horizontal, and the descending currents acquire increased velocity. Such descending winds are found not only in mountainous countries, but also on the western plains.

Winds of this class are sometimes to be considered as the pushing effect of a heavy descending gas; while ordinary winds are considered as the effects of the drawing action of areas of low pressure. Both cases, however, more properly should be regarded as simple cases of the transfer of air, in the continual struggle going on to maintain that equilibrium of pressure, for which the atmosphere is ceaselessly struggling, but which it is not possible for it to realize except for brief intervals of time.

THE TEMPERATURE.

The thermometric conditions of all parts of the earth's surface are mainly dependent upon the apparent annual and daily motions of the sun.

As fluids and gases are both bad conductors of heat, the distribution of heat in the atmosphere is effected most largely by the winds or by convection, just as in the ocean it is effected by means of the grand aqueous currents.

Although the average temperature is higher at the southern stations than at the northern ones, and higher in the day than at night time, yet the weather-map will disclose innumerable departures from this law, and especially so if any great differences in the pressure, or any extended cloudiness exist.

Aqueous vapor visibly suspended in the air as haze or cloud, serves as an effectual and double shield against the radiation of heat from the earth, and also against the sun's rays themselves. Even the invisible particles of vapor floating in the atmosphere, however rare, present an obstruction to the free passage of heat of low intensity much in the same way as haze and smoke obstruct the light, or as stones in the bed of a water-course retard the flow of that fluid. On the most Alpine situations, where, on account of their loftiness, much less aqueous vapor is interposed between them and the cold stellar regions, radiation is least disputed, and, consequently, when exposed to the direct rays of a serene mid-day sun the heat is intolerable, while at night the unimpeded radiation produces a corresponding extreme of cold. The temperature observed is the difference between the heat given out and that received in a definite interval of time.

The temperature of the lower air depends primarily, indeed, upon the amount of heat poured down upon the earth by the sun, and the amount absorbed by the air, as the earth radiates its heat back into space; but, in addition to this, the heat held latent in the vapor diffused through the air is at times liberated by the condensation of the vapor into fog, rain, and snow, and then it becomes sensible to the thermometer. During the day a moist atmosphere will become warmer than one that is dry, and during the night the radiation of heat through a moist atmosphere will be less than that through a dry one. During cloudy or hazy weather the radiation is almost wholly cut off, so that a very uniform temperature prevails between the earth and the bottom of a layer of clouds. On the other hand, sufficient heat is absorbed (*i. e.*, becomes latent) in the process of evaporation to materially reduce the temperature of the air; thus it is that "drying winds" are also "cooling." An increase of barometric pressure, by increasing the capacity of the air for moisture, serves to stimulate evaporation, and temporarily reduce the temperature. A diminution of pressure, and consequent expansion of confined air, produces a lower temperature and diminished capacity for moisture, until the condensing vapor gives out its latent heat.

Again, the lower strata of air receive heat from the upper strata, and radiate back to them, so that the temperature on the earth's surface is in part the result of this interchange. In the normal condition of a clear sky, the temperature above should be less than that prevailing below. The abnormal condition is generally the consequence of the elevation of moist air into the regions high above the earth, and the condensation of its moisture consequent upon the expansion of the air. The undue heat thus generated in the upper strata is radiated down to the earth as well as out into space.

Examination of the weather-charts will show that the temperature varies much less over cloudy than over clear districts; that it varies less in low than in elevated regions; that it is warmer on one side of an area of low or high pressure than the other, and generally *warmer in advance of any storm center and colder in the rear.*

The meteorologist, in search of the confines of the storm-area, and the path of its advance will carefully compare the reported temperatures of contiguous stations, (lying in this path,) both with each other and with the isothermal lines for the season.

By careful attention to the position of the areas of rising and falling temperature, he receives an early intimation of approaching storms, as will be mentioned in a subsequent section.

The relation of the temperature (even for vast regions of country) to the barometric pressure at distant points, is full of importance and instruction. For instance, severe frosts and cold have frequently been experienced in Great Britain and Western Europe, traceable directly to an abnormally high pressure of the atmosphere over Iceland, precipitating a powerful polar current of air toward the southeast continuously for periods of two or three weeks.

It is probable that, at some future time, weather-telegrams from the West Indian and Sandwich Islands, the North Pacific Ocean, and Alaska, by furnishing barometric readings, may give indications of the weather in the United States.

THE MOISTURE, (RELATIVE HUMIDITY.)

In all localities on the globe, and at all times, moisture, in greater or smaller quantities, exists in the atmosphere, which is, consequently, never absolutely dry. Intervals or interstices occur between the particles of the dry air, which are partially filled with this ever-present aqueous vapor. The more numerous such intervals are, the greater is the *capacity* of the air for moisture; and when these intervals are so full of vapor that the air is incapable of containing or holding any more, it is said to be *saturated*.

An increase of heat increases the capacity of the air for moisture; while, on the contrary, a fall of temperature is the occasion of a corresponding diminution of the capacity for vaporous matter.

The important element of moisture is given in the Signal Service bulletins, not in the absolute quantity in which it is found at any given place, but as a percentage of full saturation, or what, in the language of meteorologists, is expressed by the term *relative humidity*. This must not be confounded with absolute humidity, which is a very different thing. For, supposing the temperature of the air at a given place to be 40,° and fully saturated with aqueous vapor, and then to be suddenly raised to 50°, without any addition being made to its store of vapor, its absolute humidity would in each case be exactly the same; but in the former case the weather would, in popular language, be very damp, and in the latter case very dry. In the former case the relative humidity (or *humidity*, as it is often simply called) would be very high; in the latter, very low.

Watery vapor dissolves in air very much as salt dissolves in water; and as the salt is deposited in crystals whenever the water becomes fully saturated, so, whenever the air becomes folly saturated with vapor, the latter is deposited on the earth in the form of mist, dew, and rain, if the temperature be high, or as frost, hail, or snow crystals, if the temperature be low.

One cubic foot of air, having a temperature of 56°, and under a uniform barometric pressure of 30.00 inches, and *fully saturated*, will hold 4.28 grains of water, according to Glashier's tables. If, under these conditions, the temperature or the pressure of the air is lowered, there will result a deposition of a portion of the water, and that either in the form of fog, dew, rain, frost, or snow and hail. On the other hand, if there is an increase in the temperature or the pressure, the air becomes capable of holding a larger quantity of vapor, and ceases to be fully saturated. Relative humidity expresses the proportion of vapor actually contained in the air compared with what the air could contain.

By denoting full saturation by 100 per cent., and absolute dryness by zero, the relative moisture of the air at the different stations can be indicated on the map by the proper percentage. [This relative humidity is obtained from the Tables of Relative Humidity, (pp. 59, 60,) where the practical process is fully explained.] This table is directly applicable to such stations as are less than 1,000 feet above the sea. A correction of considerable amount is needed for mountain stations.

The absolute quantity of moisture in the normal condition of the atmosphere decreases with ascent above the earth's surface, but the law of decrease in cloudy and falling weather is, of course, different from that in clear weather. The degree of saturation of the atmosphere increases up to the lower-cloud stratum, and rapidly decreases above the top of the highest clouds. Indeed there is reason to believe that very little moisture enters the higher strata of air, except as it is carried up by the ascending currents; and that rain-falls are mostly derived from low clouds that have derived their moisture from the earth near by.

Fog and dew attend the supersaturation of the lower strata of air. Rain and snow are merely the moisture deposited from supersaturated strata above. The weather-chart will show an increase of moisture near bodies of warm water, fields of snow, extensive forests and meadows, &c., as compared with dry plains and rocky mountains. The humidity will be found large in advance of storm-centers, and small in their rear. It will be greater over warm, cloudy districts, than where cold and clear weather prevails.

Certain winds will be found to be moister than others. The west and northwest are

1. Cirrus.
2. Cirro-cumulus.
3. Cirro-stratus.
4. Cumulo-stratus.
5. Cumulus.
6. Nimbus.
7. Stratus.

generally the driest in the Mississippi Valley. Dry air almost always predominates on the leeward side of mountain-chains, and is the characteristic of the plains and plateaus west of the Mississippi Valley. Dryness will be found attending clearing-up weather. Dampness, or a large increase of relative humidity, accompanies threatening weather as an almost invariable premonition. Ascending currents of air also increase in dampness; descending currents grow drier.

THE CLOUDS AND THEIR INDICATIONS.

By entering graphically on the map the general features of the weather and sky, we complete the detailed representation of the atmospheric condition. The clouds, by their kinds and changes, are indices to the relative temperature, moisture, and pressure existing at high altitudes: by their motions they indicate the nature of the prevailing current of air, showing whether it is from the tropics, and hence likely to be warm, or from the polar regions, and cool.

The ascent of expanding warm air gives rise to the cumulus clouds, whose flat bases are all on a pretty uniform level. These subside and dissolve when they cease to be fed by rising currents of moist air. The cirrus clouds are probably formed independently by the radiation of heat outward into the highest regions of the atmosphere, in which case they are composed of snow-flakes, or of spiculæ of ice; and they are also formed of the remnants of the storm clouds, in which case they are generally composed of warmer vapor. The strong winds that attend areas of low barometer give rise, through the influence of friction, &c., as before stated, to ascending strata of moist air, in which, by expansion or cooling, as the case may be, are produced the scud and rain-cloud, of which there is a fine example in the easterly rains of the Atlantic Coast. This scud-cloud, which is at first like a cumulus of irregular shape, subsequently spreads into broad sheets of stratus and nimbus.

Two or more layers of clouds almost invariably coexist wherever extended rain-storms prevail, the upper layer stretching far in advance of the lower, but, descending and merging into the lower over the area on which rain is falling, frost abundantly. In the rear of this area cumulus clouds are abundant. A general survey of the map will show that cumuli or the cirri first mentioned in the preceding sentence are not inconsistent with fair and clear weather, as these terms are popularly used. An increased accumulation of large cumulus clouds may become cloudy weather, but does not generally presage the extended storms of winter. The cirrus of the second class, sometimes called cirro-stratus, almost always precedes at some distance any extensive storm, whether of winter or of summer. The stratus will generally be found to be reported in connection with threatening weather at the different stations.

The classification of clouds into cumulus, cirrus, &c., as originally given by Howard, is indicated on the accompanying plate.

GENERAL ATMOSPHERIC CURRENTS.

Without undertaking in this small volume to discuss the general circulation or system of the atmosphere, it is necessary to bear in mind a few general facts. The trade-winds on the surface of the earth, as is well known, steadily blow from the northeast and southeast in the respective hemispheres toward the meteorological torrid zone, which is a narrow belt where calms and clouds prevail at all seasons, and the uniformity of these winds is only disturbed, as in the Indian Ocean, by the unequal distribution of land and water in the two hemispheres. After reaching the equatorial regions as surface winds, the air must ascend to a great elevation, and thence move toward the polar regions in high upper currents, which descend to the earth in the region of the polar calms. It is probable that in this way are produced the northerly polar currents on the surface of the earth in high latitudes, but in the middle latitudes, in obedience to mechanical law, westerly winds prevail, which are known as the anti-trades.

In the temperate zone of the northern hemisphere the most frequent winds for eight or nine months are from the west or southwest, and allowing for the strength of the respective winds, the atmosphere is during the whole year carried to the eastward. The great currents that circulate around continental areas of high or low barometer, interfere with and even reverse this eastward motion in the temperate and westward motion in the tropical zone, but in the United States, north of the Gulf, any westward motion of the lower winds (and especially in the autumn, winter, and spring months) is to be considered as the result of a local disturbance, which may originate on the immediate surface of the ground, but frequently originates in the lower stratum of clouds. It is this disturbance that induces the surface winds from the northeast and southeast which blow nearly toward the storm center, while west winds prevail far above, and also on the western side. On the east side of a winter storm, and not far from its center, these easterly surface winds may extend for two miles upward above the earth, but at a considerable distance in advance of the central region they become weaker and more and more superficial. In the rear of a storm area the westerly winds which blow may be regarded as the upper current of air extending down to the earth's surface, and weakened by the retarding effect of friction, but accelerated by the flow of air in toward the area of low pressure.

In the trade-wind regions the easterly surface winds are the permanent and normal condi-

tion of the atmosphere, and equally so are the southwest winds that prevail above. The line that divides the north tropical from the north temperate climate (the meteorological Tropic of Cancer) moves northward during the summer months, so that, for instance, the ocean in the latitude of New Orleans, during the summer, is generally covered by easterly winds, while high above the southwest wind prevails. This normal movement, north in summer and south in winter, of the system of winds is, however, so greatly mollified by the effect of continental heat upon the distribution of the atmosphere, and consequently upon the winds, that it would be not improper to say that in winter the winds tend to circulate around the center of continents in the direction of the motion of the hands of a watch; in the summer, in the contrary direction. The disturbing effect of the unsymmetrical distribution of continents and oceans, water thus transforms into mingled vertical and horizontal currents, the system of three simple vertical currents that Ferrel has shown would exist in the temperate zones if the earth's surface was all land or all water, of uniform absorbing and radiating power.

THE DIRECTION AND PROGRESS OF STORMS.

The previous considerations have been confined to the study of a few isolated charts of the weather. But in comparing the indications of a series of these, constructed as are those of this office, thrice daily, the student is at once struck with the regularity with which the areas of stormy and clear weather move over the surface. The lines of high and low pressure, the areas of high and low temperature, &c., are in continual motion generally to be eastward, except for the regions south of 30° of latitude, where the movement is westward in summer; they may change in their details, but their features are always identifiable in each successive chart until they have passed the limits of the map, and other phenomena have succeeded. The rapidity of the easterly movement may occasionally amount to fifty miles per hour, but probably averages less that thirty miles.

In this connection it may be well to notice an important generalization recently published by the London Meteorological Office, as deduced from the logs and special observation of the Cunard steamships plying between New York and Liverpool, *i. e.*, that a vessel bound to the westward meets advancing areas of low pressure, and the observer finds that his barometer falls and rises again more rapidly than it would were he on shore, while an observer on board of a ship bound to the eastward has just the reverse experience. Instances occur in which steamers bound from New York to Liverpool overtake severe cyclones, and sometimes outstrip the eastward moving area of low pressure—a fact which, taken with what has been now advanced, clearly indicates that a number of successive barometrical depressions, each with its own cyclonic wind system, are moving across the Atlantic, somewhat after the manner in which eddies pursue each other down the current of the river. The movement of these areas of low pressure, for both hemispheres, has been observed, on the ocean, to be eastward between the latitudes of 35° and 50°.

The controlling influences which determine the course that a given storm-center, or, in fact, any area, whether of clear or warm or stormy weather, may be considered as follows:

1. There is a decided tendency of areas of low pressure to move northward more rapidly than southward, and the reverse for areas of high barometer. These tendencies are, respectively, strongest in the latitude of 45°. This principle, which is a deduction from the mathematical theory of the atmospheric currents, is confirmed by observation.

2. Storms of considerable extent disturb the atmosphere to a sufficient height to have their course determined by that of the upper currents of air; *i. e.*, the southwest current in the North Temperate Zone.

3. Storms of less extent—for instance, the local summer thunder-storms—are carried along by the general winds of the lower strata of air. These, however, are determined by the existence of the continental and oceanic areas of high and low pressure, whose changes from month to month may be seen in the charts of monthly isobarometric lines. Thus it is that, with but very few exceptions, the storms that have been traced to any distance from April to October are found to move about the tropical areas of high barometer, in the Atlantic and Pacific Oceans, in the direction corresponding to the movement of the hands of a watch; and in the contrary direction, about the area of low barometer in the interior of North America, those traced during the winter months move about the area of high barometer, in the interior of the continent, in the direction of the movement of the watch-hands.

These great areas of high pressure are, however, ever varying in outline and position, thus giving rise to changes in the storm-paths.

4. The central low pressure produces a fall in the barometer in all directions about it; wherever that fall is accompanied with a deposition of vapor, a further fall will be thereby induced—consequently, the storm-center will be drawn in that direction.

On becoming familiar with the extent of the changes that may be produced by the heat of day and the cold of night, it is learned that from September to May such daily changes rarely or never interrupt the progress of storms when they have once set in; they exert but a subordinate influence, compared to that exerted over the atmosphere by the central area of low pressure, which appears to maintain the storm, so long as it is supplied with moist air.

Storms may increase and decrease in severity as they move along through moist or dry

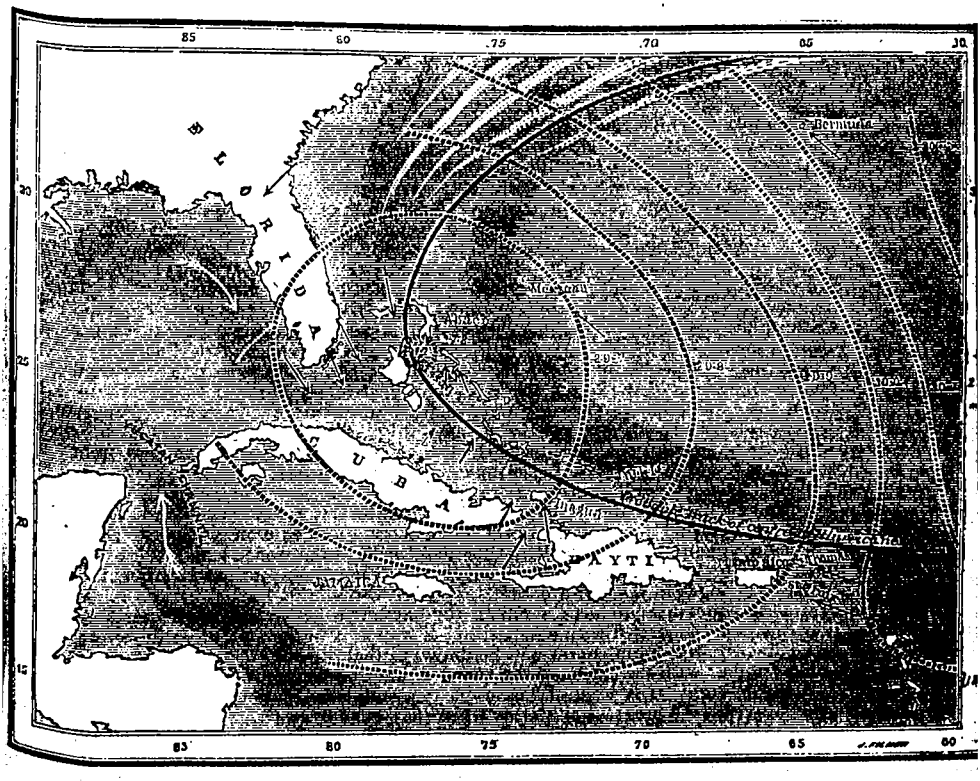
regions of air, respectively; and the change is accompanied by a corresponding fall or rise in the barometer at the central area, and an expansion or contraction of the storm-area.

It is especially necessary, in determining the storm-path, to bear in mind the motion of the upper stratum of air. Over the country north of the Gulf of Mexico, there generally prevail, (as upper currents,) in the higher regions of the atmosphere, southwest, west, northwest, or north, and rarely northeast winds, according to the season, and the distribution of atmospheric pressure, and these are those that principally determine the general movement of storms, &c. The thin-surface stratum of air is comparatively quiescent, or is at different points moving simultaneously in opposite directions, while overhead the whole body of air is moving onward with a far more uniform direction and velocity.

In this connection, the reports of winds from the top of Mount Washington are of interest for New England, although that station can hardly be considered as always in the upper current. The phenomena of storms in the United States may be well comprehended if we consider the office of the lower strata (within two miles) to be to carry vapor hither and thither; that of the upper strata, on the other hand, by successive aerial waves and tides, to subject the lower strata to alternate compression and dilatation, thus giving rise, respectively, to clear and cloudy weather, which latter becomes at times rainy, and is then the center of a local low barometer, and its system of circulating winds.

STORMS AND CYCLONES.

Whether of snow, rain, or wind, whether of greater or less violence, storms and cyclones have much similarity in their general features and behavior; strong contrasts of temperature, and of pressure in contiguous currents of warm and cold air, mark the progress, and also the origin, of a storm. The Gulf Stream, and the adjacent areas of colder water; the land bordering on oceans or lakes, whether frozen or open; mountains and plains, and river valleys, are examples of regions over which moist and dry, or warm and cold strata, come in contact; but even more important, though imperfectly understood, are the sudden changes that take place overhead, which are apparently due to the elevation of moisture into the higher regions of the atmosphere. The storms that visit the United States may be described as of four types, as follows:



1st. The West India cyclones, originating in the southern regions of the zone of easterly trade-winds, and generally east of the Windward Islands, possibly even in the Meteorological Torrid Zone or equatorial belt of calms and rains. A low pressure and large humidity mark their central region; toward this the winds blow from all points, and, deflecting to the right, pursue their spiral course inward and upward; at least this is the only satisfactory explanation that has yet been offered for the various phenomena. The moisture brought by this wind condenses as the pressure is reduced, and clouds are formed, with heavy rain.

At the center of a cyclone an upward current is supposed to exist, and high above are formed the cirrus clouds, which stream far away in advance on the upper currents of air. These storms are carried to the north and west, until they pass into the meteorological temperate zone, where the prevailing south and west winds control their motions. This generally happens on or opposite the South Atlantic coast, and as the storms then pursue a course nearly parallel with the Gulf Stream, with its attendant band of warm moist air, they produce heavy easterly gales on our East Atlantic coast, and finally are lost in the Northern Atlantic, but occasionally, doubtless, reach Iceland and the coast of Great Britain.

Instances are not wanting in which these heavy storms have passed across the Gulf to Texas, thence northward to the lakes, and northeast to Maine, widening the area of disturbances, and gradually changing into extended rains with moderate winds; thus differing from the Atlantic storms only in that their path is farther westward and that southwest gales are produced in the Eastern States.

2d. The autumn, winter, and spring rains, which generally first announce themselves on the southwest or western plains of this country, may be regarded as disturbances originating on the northern confines of the tropical zone and on the Pacific slope (as distinct from those of the preceding class that originate in the West Indies.)

From the area of high pressure on the Pacific coast of central and North America, a volume of moist air is forced up over the Sierra Nevadas and Rocky Mountains; its moisture is deposited, and a wave of rarified but probably dry air is started on its northeast or eastern course. No sooner does this arrive as a wave of low barometer over the comparatively moist air of the Mississippi Valley, than, by relieving the surface stratum of its pressure, there at once begins the condensation of its moisture, which process, if the air is not too dry, goes on rapidly increasing.

Local currents arising in this surface stratum of air feed the central area of condensation, which soon becomes hazy, and then cloudy until rain begins. While the general progress of the storm-center will be northeastward, yet it is evident that wherever the moistest air exists, there the condensation will take place the most rapidly; there the barometer will also fall the most rapidly; and thither the storm will be strongest drawn. Such storms naturally, therefore, move very rapidly up toward the lakes, and hang tenaciously over them, and move slowly away from them. In winter their course is eastward, in the early autumn northeastward.

The temperature of the upper regions must decide whether rain or snow will attend these storms. Their advance is almost invariably heralded by an increase of temperature, due apparently to latent heat evolved by the condensation going on in the circumjacent and superior air and radiated downward to the earth, and to the increased facility with which the saturated air on the surface absorbs the heat radiated by the earth.

Following the increase of temperature the cirrus clouds are observed, which geographically precede the stratus and the rain. The lowest pressure is felt on the earth after the rain has begun to fall. Although often these storms pass over without rain, until they near the lake district or Eastern States, yet their first cause may be traced back to the changes going on in the southern and western limits of the United States; at least two such have been actually followed during the four or six days occupied in passing from the California coast to Nova Scotia, and many instances are recorded of those that have passed from Texas over Lakes Superior and Huron.

3d. Well-defined, though generally weak disturbances, have been observed to pass from the north to the south, or the northwest to the southeast, but these are probably rare in the United States and probably occur only in midwinter, when the northeast winds and high pressure in British America are exceptionally strong. Continuous snow succeeded by cold, dry weather characterize these storms, and such a one, on one occasion during the past winter, after striking the coast of Alabama and turning eastward ascended the Gulf Stream to the northeastward, thus coursing around the area of high pressure that had then pushed itself southward over the lake region.

4th. The storms which are generally confined within the United States are the northers, tornadoes, and thunder-storms. The latter are generally spread over a very narrow space, so that they may at times pass between the stations from which our reports are received. These storms evidently originate in the lower-cloud stratum in local but intense differences of temperature, moisture, and pressure, and are believed in general to prevail only on the western side or in the rear of areas of high pressure. The gyratory movements of these small storms depend upon local currents and resistances rather than on the earth's rotation; they *may*, therefore, gyrate either toward the right or the left. In these storms the cumulus clouds are particularly remarkable for their height, and the cirrus clouds for their small

extent. The presence of a surface area of dry air is oftentimes sufficient to dissipate these storms, or to cause them to retire into the cloud regions. Similar storms form over mountain-tops, and are experienced by balloon voyagers when the air is quite undisturbed below. Several such smaller storms frequently simultaneously coexist, pursuing parallel paths, circulating with the general winds about the continental areas of low barometer, and the area of local storms thus corresponds very nearly to what would be an area of general rain were the temperature lower over the region. The lightning which accompanies these storms is the effect of the concentration upon large drops of water of the electricity previously distributed throughout the invisible vapor.

5. It has been noticed that there is a tendency in the spring and summer toward an accumulation of barometric pressure over the Middle and Eastern Atlantic States. When this area of high barometer moves eastward the easterly winds on its south side driving on to the coast from Maryland to Massachusetts produce clouds and occasionally severe storms of small extent, which are driven north and westward until broken up among the Appalachian Mountains.

THE PREDICTION OF STORMS.

The wind is that element which most affects the commercial interest of the country, and, in forecasting the approach of a storm, a student at present naturally gives his principal attention to this element; the prevalence of fog, rain, or snow, and the temperature of the air, may, however, be estimated in a general way. In making use of the weather bulletin and chart for the purposes of prediction for any region of the country different from that in which the student is at the moment residing, he is, of course, cut off from the use of many local rules which would influence his judgment were he at the time there present, and able to know by personal observation all the minutiæ of the atmospheric condition. If deprived of these important helps, and forced to rely exclusively upon the bare numerical data offered by the bulletin, he must call to his aid all such knowledge as is offered by the preceding brief statement of the prominent meteorological principles, such local laws as he may know to hold good for the districts in question, and such more general laws as have been deduced by the study of eminent meteorologists. A number of these latter will be found in the appendix.

The local laws referred to are now being collected at the office of the Chief Signal Officer, and will eventually be published in such a manner as to make them practically available. At present such general laws are prescribed as seem most applicable to this continent

The general direction of the wind over any region is given by the table on page 89, supposing it to be known where the continental and oceanic areas of high and low pressure exist. The local wind may be deduced from the general wind by due consideration of local friction and other resistances, as well as of the existence of secondary and smaller areas of low or high pressure. The force of the wind at any locality depends primarily upon the rapidity with which the pressure is changing at that point, as indicated to some extent by the crowding of the isobaric lines, but is greatly modified by the local topography, as before explained on page 90. The effect of lakes and hills in altering the winds will, at some future time, be published in detail, the present data being scarcely sufficient for most of the stations.

The prediction of an extended storm for any portion of the country, therefore, is reduced to the *determination of the path pursued by the central area of low pressure*, and the rapidity with which this will extend its influence in any given direction.

It frequently happens that two or more areas of low pressure may be defined; when such is the case the areas seem to influence each other as to their extent, outline, and course of progression.

The rapidity of movement is a physical question that cannot yet be solved numerically; but, in general, it is known that for the same temperature, the moister the air, or the greater its relative humidity, the greater will be the effect of a general diminution of pressure or temperature, in inducing condensation and a further fall of the barometer.

As regards the path pursued, it has already been stated that large areas of high pressure are known to exist in the northern hemisphere, and the small areas of low barometer that constitute the nuclei of storms have been observed to move around the borders of these greater areas; which latter, however, are by no means stationary.

Fortunately, however, the general reader may be spared the trouble of the numerical estimate of the resultant of a number of mechanical forces, for the clouds themselves indicate several hours in advance the probable direction of progress of these storms, since the clouds actually form first in those regions in which the falling pressure or temperature has the greatest influence in condensing the moisture.

The general distribution of the principal masses of cirrus and cirro-stratus clouds, combined with the distribution of the areas over which the temperature and pressure have risen or fallen with abnormal rapidity, will safely indicate, at least for the winter months, the immediate region into which the storm will pass, and occasionally even give a premonition of its breaking up into two portions, each drawn in different directions.

The more violent winds generally follow in the rear, and on the south side of the advancing area of lowest pressure; those that precede the progress of that area may often be more

dangerous, however, because of the accompanying rain, fog, &c. The latter winds are preceded by the cirrus and threatening storm-clouds; the rain that accompanies or follows these generally abates, and thus gives warning of the strong clearing-up winds.

The rapidity of progression of the area of cloud and rain varies from fifteen to sixty miles in an hour, the actual velocity varying with the influence of moisture, as explained in a previous section.

The average velocity of the currents, which determine the general direction of the progress of the nucleus of the storm, varies from twenty to forty miles hourly, and rarely reaches the higher limit.

Allusion has been made, in the earlier pages, to the fact that the barometric observations at very high stations cannot be combined with those taken simultaneously at lower stations in drawing our isobaric lines. This is the result, partly, of ignorance of the laws of diminution of moisture and temperature actually prevailing at the station, which laws vary with the hour of the day, the seasons, and the state of the weather, and still more is it the result of the extraordinary changes that are continually taking place in those upper regions, and which are but very sluggishly followed by the lower strata.

The barometric and thermometric changes that are reported from Mount Washington, for instance, sometimes afford sure premonitions of a change in the general character of the weather, and with great frequency foreshadow the storms that pass directly over New England.

It is by increasing the mountain stations, and by adding such balloon observations as can be made, and specially by the study of the forms, changes, motions, height, and velocity of the clouds, and of the optical phenomena of the atmosphere, that meteorologists hope eventually to arrive at a full knowledge of the regions of the air where the severe storms are propagated.

The following appendix contains a number of important generalizations and laws given in the language of the original sources from which they are extracted.

Tables are added for the calculation of the relative humidity of the atmosphere.

PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Eleventh meeting, held at Montreal, C. E., August, 1857.

LEADING PRINCIPLES OF REDFIELD'S THEORY OF STORMS AS DEVELOPED BY HIM FROM 1831 TO 1857.

That all violent gales or hurricanes are great whirlwinds in which the wind blows in circuits around an axis either vertical or inclined; that the winds do not move in horizontal circles, as the usual form of his diagrams would seem to indicate, but rather in spirals toward the axis, a descending spiral movement externally and ascending internally.

That the *direction of revolution* is always uniform, being from right to left, or against the sun, on the north side of the equator, and from left to right, or with the sun, on the south side.

That the *velocity of rotation* increases from the margin toward the center of the storm.

That the whole body of air subjected to this spiral rotation is at the same time *moving forward* in a path at a variable rate, but always with a velocity much less than its velocity of rotation; being at the minimum hitherto observed as low as four miles, and at the maximum forty-three miles, but more commonly about thirty miles per hour, while the motion of rotation may be not less than from one hundred to three hundred miles per hour.

That in storms of a particular region, as the gales of the Atlantic or the typhoons of the China Seas, *great uniformity exists in regard to the path* pursued: those of the Atlantic for example, usually issuing from the equatorial regions eastward of the West India Islands, pursuing at first a course toward the northwest as far as the latitude of 30 degrees, and then gradually wheeling to the northeast, and following a path nearly parallel to the American coast, to the east of Newfoundland, until they are lost in mid-ocean; the entire path when delineated resembling a parabolic curve whose apex is near the latitude of 30 degrees.

That their *dimensions* are sometimes very great; being not less than one thousand miles in diameter, while their path over the ocean can sometimes be traced for three thousand miles,

That the *barometer* at any given place falls with increasing rapidity, as the center of the whirlwind approaches, but rises at a corresponding rate after the center has passed; and finally,

That the phenomena are more uniform in large than in small storms, and more uniform on the ocean than on the land.

Tenth meeting, held in Albany, N. Y., August, 1859.

V.—METEOROLOGY.

I.—ON THE SPIRALITY OF MOTION IN WHIRLWINDS AND TORNADOES, BY W. C. REDFIELD, OF NEW YORK.

I. An aggregated spiral movement, around a smaller axial space, constitutes the essential portion of whirlwinds and tornadoes.

II. The course of spiral rotation, whether to the right or left, is one and the same in this respect throughout the entire whirling body, so long as its integrity is preserved. But the oblique inclination which the spiral movement also has to the plane of the horizon is in the opposite directions as regards the exterior and interior portions of the revolving mass. Thus in the more outward portion of the whirlwind the tendency of this movement is obliquely downward, where the axis is vertical; but in the interior portion, the inclination or tendency of the spiral movement is upward. This fact explains the ascensive effects which are observed in tornadoes and in more diminutive whirlwinds.

III. Owing to the increased pressure of the circumjacent air in approaching the earth's surface, the normal course of the gradually descending movement in a symmetric whirlwind is that of an involuted or closing spiral; while the course of the interior *ascending* movement of rotation is that of an evolved or opening spiral. Hence the horizontal areas of the higher portion of the whirl exceed greatly those of its lower portions.

IV. The area of the ascending spiral movement in the vortex, as it leaves the earth's surface, is by far the smallest portion of the whirling body for the reason that the rotation here is proportionally more active and intense, being impelled by the aggregated pressure and movement of the more outward portion of the whirlwind as it converges from its larger areas, on all sides, by increasingly rapid motion, into the smaller areas of ascending rotation.*

That this interior portion of the whirl resembles an inverted hollow cone, or column, with quiescent and more rarefied air at its absolute center, may be inferred from the observations which have been made in the axial portions of the great cyclones. Into this axial area of the tornado, the bodies forced upward by the vortex cannot fall, but are discharged outwardly from the ascending whirl. The columnar profile of this axial area sometimes becomes visible, as in the water-spouts, so called.

V. Accessions caused by circumjacent contact and pressure are constantly accruing to the whirling body so long as its rotative energy is maintained. A correlative diffusion from its ascending portion must necessarily take place toward its upper horizon; and this is often manifested by the great extent or accumulation of cloud, which results in this manner from the action of the tornado. In other words, there is a constant discharge from the whirling body in the direction of least resistance.

VI. The spirality of the rotation and its inclination to the horizon, in the great portion of the whirl, which is exterior to its ascending area, are not ordinarily subject to direct observation; nor is the outline or body of the more outward portion of the whirlwind at all visible otherwise than in its effects.

VII. In aqueous vortices the axial spiralities of the exterior and interior portions of the whirl are in reverse direction to those in the atmosphere, the descending spiral being nearest to the axis of the vortex. Hence lighter bodies and even bubbles of air are often forced downward in the water, in the manner in which heavier bodies are forced upward in the atmosphere.

FOURTH METEOROLOGICAL REPORT, BY PROFESSOR J. P. ESPY, WASHINGTON, JULY, 1854.

8. GENERALIZATIONS.

1. The rain and snow storms, and even the moderate rains and snows, travel from the west toward the east in the United States, during the months of November, December, January, February, and March, which are the only months to which these generalizations apply.

2. The storms are accompanied with a depression of the barometer near the central line of the storm, and a rise of the barometer in the front and rear.

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* The law of increment in the velocity of the whirlwind as it gradually converges into lesser areas, by its spiral involution, is that which pertains to all bodies when revolving around inferior foci toward which they are being gradually drawn or pressed nearer and nearer in their involute course; the line of focal or centripetal pressure thus sweeping *equal areas in equal times*, at whatever diminution of distance from the center, except as the velocity may be affected in degree by the resistance of other bodies. Such resistance is of little effect in a tornado, because its revolving mass is mainly above all ordinary obstacles, such as orchards and forests, into which the spiral *descending* and accelerated blast, near the contracted extremity of the inverted and truncated cone of the whirl, penetrates with constant freshness and intensity of force already acquired in the higher and unobstructed region.

3. This central line of minimum pressure is generally of great length from north to south and moves side foremost toward the east.

4. This line is sometimes nearly straight, but generally curved, and most frequently with its convex side toward the east.

5. The velocity of this line is such that it travels from the Mississippi to the Connecticut River in about twenty-four hours, and from the Connecticut to St. John, Newfoundland, in nearly the same time, or about thirty-six miles an hour.

6. When the barometer falls suddenly in the western part of New England, it rises at the same time in the valley of the Mississippi, and also at St. John, Newfoundland.

7. In great storms the wind for several hundred miles on both sides of the line of minimum pressure blows toward that line directly or obliquely.

8. The force of the wind is in proportion to the suddenness and greatness of the depression of the barometer.

9. In all great and sudden depressions of the barometer there is much rain or snow; and in all sudden great rains or snows there is a great depression of the barometer near the center of the storm, and rise beyond its borders.

10. Many storms are of great and unknown length from north to south, reaching beyond our observers on the Gulf of Mexico and on the northern lakes, while their east and west diameter is comparatively small. The storms therefore move side foremost.

11. Most storms commence in the "far west," beyond our most western observers, but some commence in the United States.

12. When a storm commences in the United States the line of minimum pressure does not come from the "far west," but commences with the storm, and travels with it toward the eastward.

13. There is generally a lull of wind at the line of minimum pressure, and sometimes a calm.

14. When this line of minimum pressure passes an observer toward the east, the wind generally soon changes to the west, and the barometer begins to rise.

15. There is generally but little wind near the line of maximum pressure, and on each side of that line the winds are irregular, but tend outward from that line.

16. The fluctuations of the barometer are generally greater in the northern than in the southern parts of the United States.

17. The fluctuations of the barometer are generally greater in the eastern than in the western part of the United States.

18. In the northern parts of the United States the wind generally in great storms sets in from the north of east and terminates from the north of west.

19. In the southern parts of the United States the wind generally sets in from the south of east and terminates from the south of west.

20. During the passage of storms the wind generally changes from the eastward to the westward by the south, especially in the southern parts of the United States.

21. The northern part of the storm generally travels more rapidly toward the east than the southern part.

22. During the high barometer on the day preceding the storm it is generally clear and mild in temperature, especially if very cold weather preceded.

23. The temperature generally falls suddenly on the passage of the center of great storms, so that sometimes, when a storm is in the middle of the United States, the lowest temperature of the month will be in the west on the same day that the highest temperature is in the east.

Some of the storms, it is true, are contained entirely for a time within the bounds of my observers, and in that case the minimum barometer does not exhibit itself in a line of great length, extending from north to south, but it is confined to a region near the center of the storm, and travels with that center toward the eastward.

From these experiments it may safely be inferred, contrary to the general belief of scientific men, that *vapor permeates the air from a high to a low dew-point with extreme slowness*, if indeed it *permeates it at all;* and in meteorology, it will hereafter be known that *vapor rises into the regions where clouds are formed only by being carried up by ascending currents of air containing it.*

Extract from letter of S. C. Walker, March, 1837.

Dr. Franklin first ascertained that all storms travel toward the northeast.

Mr. Espy's researches led him to believe that this constancy of direction is confined to our winter storms and summer tornadoes. He has also found, from observations furnished by Professor Hamilton, that in the winter season the rise of barometer, as well as the presence of the center of the storm, takes place at Nashville, Tennessee, about twenty-four hours earlier than at Philadelphia. And here I would remark that Dr. Emerson is the first observer, so far as my knowledge extends, who noticed that a great rise of the barometer is a prelude to a northeasterly storm, a conclusion to which Mr. Espy has arrived *a priori* from his theory of storms.

This conclusion is in direct opposition to popular opinion, and, indeed, to that of most philosophers, who have marked set fair on the barometer at one inch above the mean.

The valuable mathematical essay of Professor William Ferrell, published in 1856, (and a second edition in 1860,) "On the Motions of Fluids and Solids on the Surface of the Earth," specifies the following general laws as applicable to our atmosphere:

GENERAL MOVEMENT OF THE ATMOSPHERE.

Assuming that there is absolutely no friction between the atmosphere and the face of the earth, and regarding the latter as a sphere rather than an oblate spheroid, we have for the general condition of the atmosphere the following conclusions:

The atmosphere, however deep it may be at the equator, cannot exist at the poles.

The exterior surface of the atmosphere would be slightly depressed at the equator, and have its maximum height about the parallel of 35°, and meet the surface of the earth near the poles.

At the latitude of maximum height, the atmosphere would have no motion east or west.

Between the parallel of 35° and the poles the motion is eastward, but between those parallels and the equator it is toward the west.

LOCAL MOVEMENTS.

Under the same assumption of no friction, we have for a small circular portion of air rotating horizontally on the earth's surface:

The air, however deep it may be at the extreme boundary, cannot exist at the center.

The upper surface of the revolving portion of air will be very slightly convex, and meet the surface of the earth near the central axis of revolution.

There will be no gyratory motion at the region of maximum height of the air.

The inner part of the fluid will gyrate from right to left, (*i. e.*, opposed to the motion of the hands of a watch,) but the external part from left to right.

If the fluid gyrate from right to left, the whole mass has a tendency to move toward the north, but if from left to right, toward the south.

In whatever direction a body moves on the surface of the earth, there is a force arising from the earth's rotation which deflects it to the right in the northern hemisphere, but to the left in the southern.

GENERAL MOVEMENT, TAKING ACCOUNT OF FRICTION AND VARYING DENSITY.

Although the preceding results, when applied to the atmosphere, are very much modified by the resistances of the earth's surface, yet they will be of great advantage in explaining its general motions; for as there can be no resistance until there is motion, the atmosphere must have a tendency to assume in some measure the same motions and figures as in the case of no resistances. Hence, toward the poles the general motions of the atmosphere must be toward the east, and in the torrid zone toward the west; there must also be a comparatively small depression at the poles and at the equator.

There must be a region of calms about the poles, and a belt of calms at the equator, (the latter belt lying a short distance north of the exact equator.)

The belt of calms, which, in the case of no friction, it was previously shown, must exist at the parallels of 35°, will be moved toward the equator nearly to the parallels of 30°, (and nearer the equator in the northern than in the southern hemisphere.)

The lesser friction of air moving over air than over the earth causes an additional accumulation of atmosphere at the tropical belts, the overflow of which, combined with the westerly and easterly motions of the atmosphere, gives rise to the fresh northeast trade-winds of the northern hemisphere, and to the southwest surface-currents of the temperate zone.

The cold air of the polar regions gives rise to the very superficial, weak, northeasterly winds of the arctic zone.

A belt of calms must exist within the polar circles. The system of belts of calms and winds on the earth's surface must be distorted from absolute symmetry by the influence of continents and oceans, and ocean-currents; and the respective belts must change their positions somewhat during the year, as the sun varies his declination; moving southward in the fall, and northward during our spring. The upper currents of air are from the southwest over the entire northern hemisphere; but a middle current (or perhaps a local superficial current) from the northeast may exist in the temperate zone.

LOCAL MOVEMENTS—CYCLONES.

Whenever, by reason of local rarefaction or other cause, an upward current is established at any place, fed by moist surface-currents, the surrounding atmosphere assumes a gyratory motion, but the resistances cause a calm at the exact central area, the most rapid motion being on the immediate outer limit of this area. The contrary gyrations above indicated, as existing on the outer rim of the cyclone, where no frictional resistance is present, are in this case generally destroyed by such resistance. The gyrations will be from right to left in the northern hemisphere. At the equator there will be no gyratory motion, and consequently no

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cyclones. The effect of the earth's rotation in determining the direction of rotation of a cyclone is very small where the disturbance extends over a small area, hence tornadoes, properly so called, depend for their gyrations more upon the initial state of the atmosphere, and may rotate in either direction; hence tornadoes, but not cyclones, may be experienced at the equator.

The force that maintains the gyrations of a cyclone being one in constant action, these perpetuate themselves from hour to hour, and for many days; while in tornadoes the resistances of the earth and air soon overcome the initial gyratory tendency.

The great depression of the barometer in tornadoes and cyclones is caused, not so much by the rarefaction of the air by expanding moisture, though this ordinarily gives the first start to the whirlwind, but principally by the centrifugal (not the tangential) force due to the rapid motion of the particles of air near the center.

As there is less resistance in the upper strata, the rapid gyratory motion commences there first.

The interior portions of cyclones always gyrating, as they do, from right to left in the northern hemisphere, must always move toward the north pole; while between the equator and the tropical calm-belt they are carried westward by the general motion of the atmosphere, but after passing this belt the general asmospheric movement carries them eastward.

Near the equator they must move slowly toward the poles, but after passing the tropical calm-belt the motion of progression must be accelerated.

The progression of small tornadoes is dependent almost entirely upon that current of air in which they exist, and the general tendency of all small disturbances is to run into the largest belts of low pressure.

The following generalizations are deduced by Professor J. H. Coffin, in his exhaustive memoir "On the Winds of the Northern Hemisphere:"

In the arctic regions of North America, lying within the polar circle, the mean direction of the wind is about north-northwest, and well defined.

Between the parallels of 60° and 66° there appears to be a belt of easterly or northeasterly winds, whose pole is at about latitude 84° and longitude 28° west of Washington.

Passing south of this circle, we find a belt of westerly winds, about 23½° in breadth, entirely encircling the globe, and the poles of whose southern and northern limits very nearly coincide with that of the preceding belt.

Near the limits which divide this zone from its neighbors the progressive motion of the wind is very small; the progression is less in Europe than in America.

Passing south of this (the temperate) zone we find that contiguous to it the winds are on the whole easterly, yet quite irregular, and having a very small progressive motion.

Farther south we fall in with the well-known northeasterly trade winds, showing more decided prevalence between latitude 10° and 25° than nearer the equator.

On each side of the Atlantic ocean there is a systematic change in the winds prevailing during the different seasons of the year similar to the monsoons of Asia.

On the Atlantic coast of North America the monsoon character is more marked than on the European coast, and more marked on the coast than in the interior; but again becomes well marked as we near the elevated plains west of the Mississippi.

BLODGET'S CLIMATOLOGY OF THE UNITED STATES.

Dr. Gibbons has noticed with great care at San Francisco the course of the higher strata of clouds—the cirrus and the very high stratus—when they were visible, and has found them to come uniformly from some westerly point, as he had also observed for many years at Philadelphia. The writer has long observed the same facts in Western New York, where an average of not more than one instance annually occurs of clouds in the higher strata moving from any other than a westerly point. During three years of very careful registry directed to this particular point, but three instances of a contrary direction were observed; and these were during the prevalence of extensive and disastrous storms on the Atlantic coast. The lower clouds are from various points, and the wind is quite variable during the greater storms, two strata of different movement often lying beneath that from the west, yet the stratum from a westerly point usually deposits the rain, and when it ceases the rain-fall ceases, though the lower strata may continue to run on the wind twenty-four hours or more longer.

The invaluable charts of Mr. Buchan, showing the average barometric pressure and winds for each month of the year, together with the many detailed generalizations, can only be referred to here. The following, however, seem to sum up his results:*

"An examination of the isobaric and wind charts for the months shows, as has been already pointed out, that where there is a mean low pressure, such as occurs in the north of

*Transactions of The Royal Society of Edinburgh, vol. xxv, Mr. Alexander Buchan on the mean pressure of the atmosphere, &c.

the Atlantic in the winter months, and in the center of Asia in the summer months, thitherward the winds tend in all directions in an inmoving spiral course; and where there occurs a mean high pressure, as in the center of Asia in winter and in the Atlantic, between Africa and the United States, in summer, out of this space the winds flow in all directions, or they appear to be thrown out from the space of high pressure in a manner exactly the reverse from that by which they are drawn inward upon a space of low pressure."

Pliny Earle Chase, in the proceedings of the American Philosophical Society, 1871, March 3, among other results gives the following:

"The wind, especially in the Southern States, often blows directly in the line of the greatest barometric gradient. But even in such cases, after a few hours' continuance, it tends toward the azimuth indicated by Buys Ballot's law.

"The isobaric lines are therefore often of less relative importance than the gradients in forming forecasts.

"Currents with an anti-cyclonic tendency, controlled by areas of high barometer, are notably common.

"Our recent storms have been anti-cyclonic, and there seems some reason for supposing that anti-cyclones are the usual weather-breeders, even of such of our land storms as become more or less cyclonic after they are fully developed.

"The precipitation of vapor of course gives rise to local cyclones, which, however, may be easily and speedily overborne by the grand anti-cyclonic whirls of a half million miles or more in area."

Extracts from "Barometer Manual," compiled by Robert H. Scott, for the meteorological office, London, 1871.

RULES TO EXPLAIN THE INDICATIONS OF THE INSTRUMENTS.

It should always be remembered that changes in weather generally give signs of their coming, for the instruments are affected before the wind actually begins to blow or the rain to fall; thus they may be said to enable us to feel the pulse of the atmosphere. It must not be forgotten that the length of time which passes between the first appearance of a change of weather and its actual setting in are not the same. It is much greater when a southwest wind is going to succeed a northeast wind than when the opposite change is about to take place. We shall see, a little further on, why this is the case, and also how the appearance of the sky will aid us in forming an opinion as to probable weather.

The general principles on which the following rules are founded have been laid down by Professor Dové, of Berlin, on the basis of a long series of observations, which were made at several stations situated in the north temperate zone, between the parallels 49° and 65°, to which regions they specially refer. The rules themselves may be shortly stated thus:

The average height of the mercury in the barometer, at sea-level, in the British Islands, is about 29.9 inches. If the barometer rises steadily above its mean height while the weather gets colder and the air becomes drier, northwesterly, northerly, northeasterly winds, or less wind, less rain, or snow, may generally be expected. On the contrary, if the barometer falls while the weather gets warmer, and the air becomes damper, wind and rain may be looked for from the southeast, south, or southwest.

The deviations from these general principles which are noticed correspond to the various changes of weather.

If the weather gets warmer while the barometer is high and the wind northeasterly, we may look for a shift of wind to the south. On the other hand, the weather sometimes becomes colder while the wind is southwesterly and the barometer low, and then we may look for a sudden squall, or perhaps a storm, from the northwest, with a fall of snow if it be winter time.

No absolute laws for weather can, however, be laid down; the most striking exceptions to the rules are those noticed by Admiral Fitz Roy. They occur with northeast winds, which sometimes bring rain, or sleet, or snow, especially during gales, although the barometer may be high and rising. On the other hand, when the wind is northeasterly and light, and the barometer begins to fall, rain may set in before the wind changes to east or east-southeast.

Besides these rules for the instruments, there is a rule about the way in which the wind changes, which is very important. It is well known to every sailor, and is contained in the following couplet:

When the wind shifts against the sun,
Trust it not, for back it will run.

The wind usually shifts *with the sun*, *i. e.*, from left to right* in the northern hemisphere. A change in this direction is called *veering*.

Thus an east wind shifts to west through southeast, south, and southwest, and a west wind shifts to east through northwest, north, and northeast. If the wind shifts the opposite way, viz, from west to southwest, south, and southeast, the change is called backing, and it seldom occurs, unless when the weather is unsettled. However, slight changes of wind

*In the southern hemisphere motion *with the sun* is, of course, from right to left.

do not follow this rule exactly; for instance, the wind often shifts from southwest to south and back again.

In most parts of the world it has been observed that there are two prevailing wind-currents, which vary with the circumstances of the place, but are, on the whole, nearly opposite each other.

In these islands these directions are about northeast and southwest, and the latter of these winds blows for about ten times as many days in the year as the other does.

What is it that causes these winds to blow and makes them so different from each other as we know them to be? The simplest account of them is that the air is always flowing toward the equator from the poles, and back again. It then forms two great currents; one is called the polar current, as it flows from the direction of the pole, and is felt here as a northeast wind; the other is called the equatorial current, as it flows from the direction of the equator, and is felt here as a southwest wind.

The air of the polar current has been chilled, and is heavy, cold, and dry; while it is blowing the barometer is high and the weather usually dry.

The air of the equatorial current has been heated, and is light, warm, and moist; while it is blowing the barometer is low and the weather usually wet.

If we keep the idea of these two great wind-currents clearly in our heads, we shall easily understand most of the signs of the weather which are noticed.

The air of the equatorial current is lighter than that of the polar, and so southerly winds will begin to blow aloft before they are felt on the ground, while northerly winds will begin to blow close to the ground. Accordingly southwest winds give much more warning of their coming than northeasterly ones.

The southwest wind will often show itself first by long streaks of cirrus clouds at a great height, called "mare's tails;" or, when a gale is very near, by driving scud.

Signs of weather, such as those just noticed, are important to any one watching for changes, as they will enable him to confirm or modify the opinions formed from the behavior of his instruments. As to the instruments themselves, we have already seen that when the barometer rises, owing to a change of wind, the weather usually becomes colder; while when the barometer falls, owing to a change of wind, the weather usually becomes warmer.

If the barometer be high, (above 30.5,) and *remain steady* for some days, it is because there is, so to speak, a surplus of air at the place. The wind will be light, and the weather will probably be dry. A gale can set in only when the air flows away, and it will not at first be severe at the place. If the barometer be low (below 29.0 inches) and remain steady, there is a deficiency of air at the place. The wind will be light, also, but the weather will probably be cloudy and wet. However, there may be fine weather for a short time, what is called a "pet day," but there is great danger of a serious storm, because the air will try to force its way into the district where the readings are low, and increase the pressure there so as to restore the atmospherical equilibrum.

If the barometer rises slowly from a low level, the weather may become drier, and the wind lighter, or perhaps die away. There may also be local fogs.

If the barometer falls gradually from a high level, the weather may become wetter and more unpleasant, and there will never be a certainty of having a fine day, though there need not be much wind.

In general, whenever the level of the mercury continues steady, we may expect settled weather, but when it is unsteady we must look for a change, and perhaps a serious gale. A sudden rise of the barometer is very nearly as bad a sign as a sudden fall, because it shows that atmospherical equilibrium is unsteady. In an ordinary gale the wind often blows hardest when the barometer is just beginning to rise, directly after having been very low.

It must never be forgotten that it is impossible for any one to interpret the meaning of all the changes in his barometer, at first, or perhaps for a day or two, inasmuch as he requires to learn what is going on at stations in his neighborhood, for without this information he cannot know whether these changes are due to mere local causes, or are the first symptoms of the approach of a more serious disturbance. A storm may be raging at a comparatively short distance from him, but his barometer, *taken by himself*, will not necessarily enable him to detect its existence.

However, in many cases, a good guess at what is likely to happen may be formed by an experienced observer who watches his instrument closely, records its indications on such a form as shown at Plate IV, and interprets them by the rules provided in this manual. He will, however, require to call to his aid not only observations of the temperature and dampness of the air, but all his experience as to the influence of the several seasons, the ordinary character of the water at the place, and the local signs of its change.

The daily weather reports issued by the meteorological office are calculated to render important service to any one who wishes to study weather; they contain observations made daily at 8 a. m., at twenty British and about as many foreign stations. Great care has been taken to insure the accuracy of these reports, and the result is that a great mass of information of very great value is published every day.

The table shows the readings of the barometer and dry and wet bulb thermometers, the direction and force of the wind, &c., and from it a very good idea may be gathered of the weather which is actually prevailing on or near our coast.

As regards the use which may be made of these reports, a most important principle has been discovered of late years.

Professor Buys Ballot, of Utrecht, and others have shown that we can tell with considerable certainty what wind may be expected to blow at any place if we know the readings of the barometer, taken a short time previously, at a number of stations situated within a distance of, say, one hundred or two hundred miles from that place.

The rule is: Stand with your left hand toward the place where the barometrical reading is lowest, and your right hand toward that where it is highest, and you will have your back to the direction of the wind which will blow during the day.

Thus the wind may be expected to be easterly when the pressure is highest in the north, lowest in the south.

Southerly, pressure highest in east, lowest in west.

Westerly, pressure highest in south, lowest in north.

Northerly, pressure highest in west, lowest in east.

The force of the wind on each day bears some proportion to the amount of difference in barometrical readings noticed between any two stations situated near the place where the wind was felt. Thus we find that it has been shown that a westerly gale hardly ever blows in the British Isles, unless, at least a few hours before, the pressure in the north of Scotland is half an inch less in amount than it is on the south coast of England.

We shall return to this subject when dealing with weather telegraphy. At present it is sufficient for us to say, with reference to the principles above laid down for the behavior of the instrument, that whenever a storm is blowing, the level of the barometer will be very different at stations near each other, so that as the storm travels across the country the barometer at any station will show signs of its coming and going by the mercury sinking or rising in the tube. This shows us why it is when the barometer is steady there is no great likelihood of a sudden change of weather, while when it is changing quickly, there is great danger of the wind freshening to a gale.

WEATHER TELEGRAPHY.

The facilities afforded us, by means of telegraphy, for comparing observations taken simultaneously at several stations, have revealed to us great differences, even between adjacent stations, as regards the instrumental readings, and the actual phenomena observed under various conditions of weather. In seeking to assign causes for these differences, we have been greatly assisted by applying the principle, to which allusion has already been made, under the name of Buys Ballot's law.

The immediate result of the law is to show that whenever barometrical readings are lower over any area than over those adjacent to it, the air will sweep round that area as a center, and the direction of its motion will be opposite to that of the hands of a watch; conversely, the air will sweep round an area of relatively high barometrical readings in the direction in which the hands of a watch move; the former of these motions is said to be *cyclonic*, the latter, *anti-cyclonic*. These words are derived from the word "cyclone," the general name for hurricanes and typhoons, in all which storms the motion of the air takes place around an area of diminished barometrical pressure.

We see, therefore, that the existence of a deficiency of atmospherical pressure, or what is termed a barometrical depression, over any district, is accompanied by cyclonical movement in the air in the neighboring districts.

The actual movement of the air has no reference, either in direction or velocity, to the absolute readings of the barometer at the point where it is lowest, or to the distance of the particles of air which are in motion from that point, but is related almost entirely to the distribution of pressure, in accordance with Buys Ballot's law. The law gives the direction of motion, and its truth for these islands, and the adjacent parts of the earth's surface, is incontestable; it appears, moreover, to hold good generally.

The velocity of the air depends, at least in a great measure, though not absolutely, on the difference of barometrical readings over a given distance, or on what is termed the barometrical "gradient."

The gradients adopted by the meteorological office are expressed in hundredths of an inch of mercury per fifty geographical miles.

To apply the same principles to the weather of the British Islands generally, it may safely be asserted that no storm of any serious extent is ever felt over the United Kingdom, unless there be an absolute difference in barometrical readings exceeding half an inch of mercury between two of our stations.*

The difference in readings between Rochefort and Aberdeen, on the 1st of February, 1868, when a tremendous westerly gale was blowing, was as much as 1.76 inches, the reading at Rochefort being 30.16, and that at Aberdeen 28.40. These figures give a gradient of 13.5 over the entire distance of six hundred and seventy-three miles, and we find that gales were reported from sixteen stations that morning. If these simultaneous barometrical readings for any considerable tract of country, such as that represented in the daily weather-reports,

* Local storms, which occasionally do great damage, may be felt when the barometrical disturbance is itself only local, and when the actual amount of difference between the extreme readings is less than half an inch although the gradients for a short distance may be high.

which embraces these islands and the adjacent coasts of the continent, be entered on a chart, a simple inspection of that chart is sufficient to show the direction and probable force of the winds felt over the entire district. Each of these elements will, however, be modified to a certain extent by the irregularities of the surface, for we can only feel the currents of the lowest stratum of the atmosphere, which are liable to be checked and deflected by mountains, and, in their passage over plains, to be seriously retarded even by the woods with which those plains are covered. * * * * * * *

All the storms which we feel are accompanied by a considerable relative deduction of pressure, and these barometrical depressions travel over the country, carrying their own wind system with them. If, therefore, we could determine beforehand the direction of advance, and the rate of motion of each successive area of depression, as well as its shape, its gradients in each direction, and the rate of their increase or decrease in intensity, we should have made a considerable advance toward forecasting weather; of these several conditions, our knowledge is very incomplete. The attempts which have hitherto been made to lay down laws for any of these undetermined quantities, have met with a very limited amount of success. The *shape* of the area of depression is far from uniform, and is liable to modification—first, according to the character of the ground over which it passes; and, secondly, according to the conditions of pressure in the neighborhood.

The *direction of advance* takes place most usually from some point between southwest and northwest, but not unfrequently lies in a different direction, and it is stated that occasionally a motion even from the eastward has been recognized. The velocity of motion varies from five or six miles an hour, to as much as sixty or seventy; this latter rate of motion having been reached by the storm of December 16, 1869. * * * * *

Owing to the extreme sensitiveness of the thermometer to changes of weather, it has been frequently proposed to consider its indications as fully equal in importance as those of the barometer; but great caution is necessary in acting on this idea. The accuracy of thermometrical observations depends on a great many conditions, such as aspect, exposure to the air, elevation above sea-level and above the surface of the ground, all of which are immaterial or can be allowed for in dealing with the barometer.

THE "POLAR-BANDS" AS STORM INDICATORS, BY DR. M. A. F. PRESTEL.

A. Von Humboldt is the first to have directed attention to the delicate uniformly broken groups of clouds (cirro-cumulus) and cloud striæ, (cirro-stratus,) and to describe them under the name of polar-bands (bandes polair) because their perspective points of convergence (vanishing points) very frequently lie in the magnetic poles, so that the parallel series of little clouds and bands follow the magnetic meridian.

The rays of the auroræ polaris show similar vanishing points, and not unfrequently one subsequently finds on the extinction of the polar lights the cirrus bands in the direction of these rays; this indication has called out most varied associations of ideas as well as words, since polarity, pole, pole of the winds, pole of the cold, &c., do not fail by many persons to excite the lively activity of the imagination.

The peculiarity of this enigmatical phenomenon, as A. Von Humboldt very appropriately specifies, is the variability, or at other times the regular change of the vanishing points. Ordinarily the bands are perfectly formed only in one direction, and as they move one sees them directed first from south to north, then gradually from east to west. They arise at times of great clearness of the sky. According to Humboldt, they are much more frequent under the tropics than in the temperate and cold zones. The observation that the original direction of the polar-bands from south to north gradually changes to that from east to west, applies also to the southern hemisphere.

Over Northwest Germany polar-bands extend from south to north or also from south-southeast to north-northwest, then change slowly into the position from south-southwest to north-northeast, and not unfrequently the vanishing points move still further to the east and west points. To the author of the Cosmos no relation seemed likely between the polar-bands and the upper currents of air. He says: "One cannot ascribe the progress (of these vanishing points) to the change in the current in the highest regions of the atmosphere."

When such polar-bands appear over Europe the telegraphic weather reports at present make it possible to compare the simultaneous condition of the atmosphere over the whole of Europe by this comparison, and have found that an area of storm, even if still far distant, is simultaneously present in all cases where decided polar-bands and their vanishing points in the horizon are shown. The polar-bands are present, then, on the extreme limits of the storm area and have a tangential direction to its limiting line. While the weather is still quiet and beautiful in the lower regions of the atmospheric ocean, the polar-bands already indicate the currents of air in the higher strata. The gradual change to eastward of the vanishing points of the bands pointing north and south, is the consequence of the progress of the center of the storm. When the latter moves from the west over the Atlantic ocean (toward Holland) the polar-bands have the direction from south to north at the first approach of the storm area; if the center of the storm and the bands themselves advance toward the northeast, then also the apparent direction of the latter alters in a corresponding manner, and since they are at right angles to a line drawn toward the storm center, they show to the observer the direction in which such a storm area lies, though in many cases five hundred to a thousand miles distant,

as well as that in which it progresses. If the storm area does not pass to one side of the observer, but the center approaches him more or less directly, then always twenty-four to thirty-six hours elapse before the arrival of the storm. The storms thus announce themselves telegraphically by means of the polar-bands. The remaining uncertainty with respect to their paths which may still prevail is removed in the customary manner by the barometric observations with the fine cirrus filaments when these appear isolated The polar-bands form on the celestial hemisphere a configuration similar to that of the marks and stripes on the surface of a melon, and they always converge toward two opposite points in the horizon.—*From "Der Sturmwarner," Emden*, 1870.

TABLES.

The explanation of the accompanying tables is as follows:

Tables No. I and No. II are used for finding the moisture or relative humidity of the atmosphere at any station, when simply the indications of the hygrometer are to be had.

The hygrometer in use by the signal office is the wet and dry bulb thermometer.* Having noticed the height of the mercury in each of these two thermometers, the observer enters the table with the difference of the two readings (on the horizontal line at the top) and with the temperature of the wet-bulb thermometer, (denoted by t'.) Let him, then, seek first the column at the head of which stands the difference of the thermometers; then go down as far as the horizontal line, at the beginning of which stands the temperature of the wet-bulb thermometer; and the figures he finds on that line will express the relative humidity, for which he is searching.

When the temperature in both thermometers is the same and the difference 0°, evaporation from the moist muslin on the wet-bulb has entirely ceased, the quicksilver in its tube has ceased to fall, and, of course, the relative humidity is that of full saturation or 100, as is shown by the second vertical column in table No. I.

* The best form of hygrometer consists of two mercurial thermometers, which, placed side by side, indicate the same temperature. When fixed together on a frame they are called the *wet and dry bulb thermometers*. The dry-bulb is a common thermometer, intended to show the temperature of the air. The wet-bulb is also a common thermometer, having its bulb covered with a piece of muslin, from which pass a few threads of darning cotton into a small vessel containing rain-water. The water rises by capillary att action, thus keeping the muslin constantly wet. When the air is dry, evaporation goes on rapidly from the muslin, and on account of the heat lost by evaporation, the wet-bulb indicates a lower temperature than the dry-bulb. But when the air is damp, evaporation is slower, and the difference between the two thermometers becomes smaller. When the air is completely *saturated* with moisture, evaporation ceases entirely, and the two thermometers show the same temperature. The instrument is shown in the following cut:

THE WET AND DRY BULB THERMOMETER.

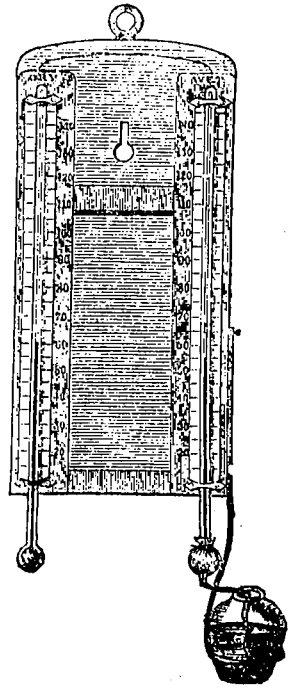

Table No. I is used but seldom, because it is adapted for extreme temperatures below the freezing point of fresh water, (32° Fahrenheit.) It gives the relative humidity in the vertical columns for differences of half degree between the two thermometers and when the wet-bulb falls as low down as 0°. Whenever the wet-bulb stands at any figure between 0° and 9° above 0° (inclusive) use lower part of table No. I. In other cases, table No. II.

These tables are compiled from "Guyot's Meteorological and Physical Tables, prepared for the Smithsonian Institution."

No. 1.—BELOW FREEZING-POINT; BULB COVERED WITH A FILM OF ICE.

Temperature Fahrenheit.—Relative humidity in hundredths.

Wet-bulb thermometer t' Fahrenheit.	0°.0	0°.5	1°.0	1°.5	2°.0	2°.5
	Relative humidity.	Relative humidity.	Relative humidity.	Relative humidity.	Relative humidity.	Relative humidity.
—31°	100	36.0				
—30	100	39.6				
—29	100	42.9				
—28	100	46.1				
—27	100	49.0				
—26	100	51.8				
—25	100	54 4				
—24	100	56.8				
—23	100	59.0				
—22	100	61.0				
—21	100	62.6	26.9			
—20	100	64.2	30.3			
—19	100	65.9	33.5			
—18	100	67.5	36.6			
—17	100	69.0	39.5			
—16	100	70.4	42.3			
—15	100	71.8	44.9	19.4		
—14	100	73.0	47.4	23.0		
—13	100	74.3	49.8	26.4		
—12	100	75.4	51.9	29.5		
—11	100	76.5	53.9	32.5		
—10	100	77.5	55.7	35.3	15.6	
— 9	100	78.5	55.7	38.3	19.1	
— 8	100	79.4	59.4	40.6	22.5	
— 7	100	80.3	61.1	43.0	25.7	
— 6	100	81.1	62.7	45.4	28.4	12.9
— 5	100	81.8	64.5	47.6	31.7	16.4
— 4	100	82.5	65.8	49.8	34.5	19.8
— 3	100	83.2	67.1	51.7	36.9	22.8
— 2	100	83.9	68.3	53.5	39.3	25.8
— 1	100	84.5	69.5	55.3	41.6	28.6
— 0	100	85.0	71.0	57.0	43.8	31.3
0	100	85.0	70.7	57.0	43.8	31.3
1	100	85.6	71.8	58.6	46.0	33.9
2	100	86.2	73.0	60.2	48.0	36.4
3	100	86.7	74.0	61.8	50.0	38.8
4	100	87.2	75.0	63.3	52.0	41.2
5	100	87.7	76.0	64.7	53.8	43.4
6	100	88.2	76.9	66.0	55.3	45.2
7	100	88.6	77.7	67.1	56.8	47 0
8	100	89.0	78.4	68.2	58.2	48.8
9	100	89.4	79.1	69.2	59.6	50.5

No. 2.—RELATIVE HUMIDITY.

Difference between wet and dry-bulb thermometers.

WET-BULB THERMOMETER.	1°	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
10°	79	61	44	28	13																				
15	83	67	52	39	27	15	5																		
20	85	72	60	48	38	28	19	11																	
25	88	77	67	59	48	41	32	26	18	10															
30	89	79	69	61	52	45	37	30	26	18	11	6													
35	90	80	71	63	56	48	42	35	30	24	19	14	10	6											
40	91	83	75	67	60	54	48	42	37	32	27	23	19	14	12										
45	92	85	77	71	64	59	53	48	43	38	34	30	26	23	19	16	13	10							
50	93	86	79	73	68	62	57	53	48	44	40	36	33	29	26	23	20	18	15	13	11				
55	93	87	81	76	70	66	61	57	52	48	45	41	38	35	32	29	26	24	20	19	17	15	13	11	9
60	94	88	83	78	73	68	64	60	56	52	49	45	42	39	36	34	31	29	26	24	22	20	18	17	15
65	94	90	84	79	75	71	67	63	59	56	52	49	46	43	40	38	35	33	31	29	27	25	23	21	20
70	95	90	85	81	76	72	69	65	61	58	55	52	49	46	44	41	40	37	35	32	31	29	27	26	24
75	95	90	86	82	78	74	70	67	64	61	58	55	52	49	47	45	42	40	38	36	34	32	30	29	27
80	95	91	87	83	79	75	72	69	66	63	60	57	54	52	49	47	45	43	41	39	37	35	34	32	30
85	96	91	88	84	80	76	73	70	67	64	62	59	56	54	52	50	47	45	43	41	40	38	36	35	33
90	96	92	88	85	81	78	75	72	69	66	63	61	58	56	54	52	49	47	46	44	42	40	39	37	36
95	96	92	89	85	82	79	76	73	70	68	65	62	60	58	56	53	51	49	48	46	44	42	41	39	38
100	96	93	89	86	83	80	77	74	71	69	66	64	62	59	57	55	53	51	50	48	46	44	43	41	40

PAPER 7.

THE CAUTIONARY SIGNAL.

[Circular.]

WAR DEPARTMENT, OFFICE OF CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE,
Washington, D. C., October 25, 1871.

The cautionary signal of the signal service, United States Army—a red flag with black square in the center by day, and a red light by night—displayed at the office of the observer, and other prominent places throughout any city, signifies:

1. That, from the information had at the central office in Washington, a probability of stormy or dangerous weather has been deduced for the port or place at which the cautionary signal is displayed, or in that vicinity.

2. That the danger appears to be so great as to demand precaution on the part of navigators and others interested—such as an examination of vessels or other structures to be endangered by a storm—the inspection of crews, rigging, &c., and general preparation for rough weather.

3. It calls for frequent examination of local barometers, and other instruments, by ship-captains, or others interested, and the study of local signs of the weather, as clouds, &c. By these means those who are expert may often be confirmed as to the need of the precaution to which the cautionary signal calls attention, or may determine that the danger is overestimated or past.

ALBERT J. MYER,
Brigadier General and Chief Signal Officer, U. S. A.

THE CAUTIONARY SIGNAL.

This red flag or red light (the cautionary signal) is displayed when the informaton in possession of the office leads to the belief that dangerous winds are approaching.

The term dangerous winds has ordinarily a somewhat different meaning, according to the location of the station. Thus the severe gales of the Atlantic (where the hourly velocity of the wind ranges from forty to seventy miles) are comparatively very rare on the lakes, where the limited sea-room causes winds that on the neighboring shores are registered only as brisk (*i. e.*, fifteen to twenty-five miles) to become dangerous. Again, the direction in which the wind is blowing is a most important consideration, and as general experience

shows that most danger is apprehended from wind blowing on to a lee shore, the cautionary signal may very properly be expected to be hoisted only in case such winds are apprehended for the port in question.

For inland and well-sheltered points, however, as Baltimore and Philadelphia, this distinction cannot be easily made, and in order to avoid the confusion that might very possibly arise from the display of different signals at adjacent ports, such as Milwaukee and Grand Haven, Detroit and Toledo, &c., it has been decided for the present, at least, not to put into practice the above suggestion. The cautionary signal will therefore be hoisted whenever the winds are expected to be as strong as twenty-five miles an hour, and to continue so for several hours within a radius of one hundred miles of the station. It will thus be left to the public individually to decide whether that wind will be dangerous to any special occupation. It is hoped that eventually it will be practicable to add a second signal giving warning of severe gales. Each signal holds good for the space of about eight hours from the time at which it is hoisted. When no signal is displayed it indicates that the office has no knowledge of any approaching danger, and as this is not only the case when there is really no danger, but also in many cases may be the consequence of the failure of the telegraphic connection of the central office at Washington with neighboring stations, it should not lead the mariner to be less watchful of the weather, nor to neglect to obtain such weather intelligence as he can from the telegraphic reports at the observer's office. If the mariner desires more exact information as to the nature of the threatening danger, he should obtain the latest "weather-bulletin," or "weather-map," published by the office, as well as the general "synopses and probabilities," or the so-called "press-reports." These can generally be had at the office of the observer.

If he finds that high winds are prevailing within two hundred miles of the port at which he is, he should consider what the disturbing cause is that produces these winds. This may in general be stated to be an excess of barometric pressure over some district and a deficiency over some neighboring region.

If the region of low barometer be very small, the area of violent winds will be correspondingly contracted, as in tornadoes on land. Even if no fall in the barometer be noticed, brisk winds may be experienced, owing to the fact that the air in rapid motion overhead may drag along with it that on the surface of the ground, but in general it may be stated that ninety per cent. of the winds that are dangerous to navigators are accompanied by areas of notably high and low barometer. Now, when the barometer falls over any region the inertia of the surrounding air causes some time to elapse before it is set in motion, and similarly a large mass of air moving with rapidity preserves its motion after the exciting cause is removed. Thus it may happen that strong winds exist in regions at which no barometric disturbance exists at the moment, but has existed a short time previously

Again, the space inclosing the partial vacuum, into which the wind tends to rush, itself moves slowly over the earth, and thus the wind at any point appears still longer to delay to follow the barometric disturbance. This delay will, of course, vary with the motion of the central area of low pressure, or that of the neighboring high pressure.

The general consequences of the preceding considerations are that the area covered by the weather-chart presents to our view one, two, or three regions of low pressure, and one or two of high, and that between these, but much nearer to the low than the high barometer, we find the strongest winds. As regards the direction of the winds, they may be described as not tending directly to the center of the area of low pressure, but as circulating around and in upon it in a sinuous spiral, in a direction contrary to the movements of the hands of a watch, (when it is laid down with its face upward;) thus there are found northerly winds on the west side of the region, westerly ones on the south side, and so around. Of these winds those from the northwest and southwest are more violent, on the average, than those from the southeast and northeast, but the latter may be more dangerous, and, when they pass over smoother ground, may be even stronger at the immediate surface of the earth.

The general tri-daily press report (to be had at observers' offices) contains always a statement of the positions and movements of the larger areas of high and low barometer, of cold and warm weather, or of stormy, cloudy, and clear weather. In the absence of a weather-map, therefore, one can determine in a general way whether these are approaching to or departing from his neighborhood; and this knowledge leads to the following conclusions:

1. If the barometer is very low at the center, very severe gales may be expected over a large area, say within a circle of two hundred miles radius, from October to April, but within a smaller circle, less than one hundred miles, from May to September.

2. Areas of low barometer, when first perceived in Minnesota, may be expected to move eastward in the summer months, with westerly winds on Lake Superior, and to move to the southeast and east-southeast in the fall, with east and northeast winds on Superior and Michigan.

3. When perceived in Nebraska or Indian Territory, they may be expected to move northeast to Lake Ontario, with northeast winds on Superior, Michigan, and Huron.

4. When perceived in Texas, or anywhere on the Gulf coast, they may be expected to move northward to the latitude of 35° or 40°, and there begin to move northeastward, with northeast, north, and northwest winds on the lakes, and subsequently southerly winds on the Middle and East Atlantic coasts.

5. When perceived on the coast of Florida, or off the South Atlantic, they, in the fall, winter, and spring, may be expected to move slowly up the coast, preceded by northeasterly winds and rain.

6. While the preceding sentences mark out the most general average phenomena attending the movement of the disturbing areas of low pressure, it must be borne in mind that but very rarely will the ever-varying atmospherical condition allow any storm to pursue a uniform average course over the earth.

7. The most important condition disturbing the regular movement of a storm is the presence of moist air; that is to say, air nearly saturated with aqueous vapor. Such air is found over extensive forests and marshes, over bodies of warm water, and especially over a field of snow or ice which is being melted by the sun. Toward these regions the areas of low barometer may be expected to be drawn more or less strongly, or at least to spread out over them.

8. When the low barometer on the west of the Appalachian chain of mountains causes easterly winds on the Atlantic coast, these force a mass of air up the western slopes of these hills, and this, as it rises, becomes more and more nearly saturated, so that the low pressure west of the mountains may be expected to be rapidly spread over the range and even transferred, as it were, to the Atlantic coast.

9. Waves of low pressure on the Pacific coast are also transferred across the Rocky Mountains and the elevated plateaus, and may be expected, when they arrive at the Mississippi Valley, to produce cloud and probably storm centers.

10. Besides the disturbing attractions of moist area, we have to consider the contrary influences exerted by areas of dry air; such as are found on the eastern slope of the Rocky Mountains. Where a storm-center is driven into such a region, clouds and weaker winds may be expected, and the storm will gradually die out, unless moist air lies beyond.

11. Besides the forces attracting the areas of low pressure, we have also to consider the pressure of an area of high barometer; this, by causing a system of decidedly strong wind to circulate around in it the anti-cyclonic direction, may drive the storm-center (whether it be a small tornado, or an extensive cyclone) before it, so as to undergo quite a change in its path.

12. The general path pursued day after day by a storm-center is indeed the resultant of a system of pressures, some of which arise from the pressures of areas of high and low barometer, some from areas of moist or heated air, some from winds, and others from the rotation of the earth on its axis; these are the important controlling influences; such others as may arise from lunar tides in the air, &c., &c., are considered at present as of inferior prominence.

13. Whether the observer determines the probable movement of a given storm-center, by means of these general considerations, or not, he cannot safely neglect the indications of his own barometer. The experience of the past fifty years has borne uniform testimony to the pre-eminent value of the indications of this instrument, taken in conjunction, of course, with the wind and weather.

14. If it be known that a center of low pressure is in the neighborhood of the observer, and he stand facing it, he will find the wind blowing from some point on his left, toward some point on his right; and vice versa, if he stand with his left hand toward the direction from which the wind comes, he will face the region of lowest pressure. It is better to use, not the direction of the local wind, but that from which the *low* clouds are moving; the *very high* clouds should not be used.

15. If while facing the low pressure he finds the wind steady and his barometer falling, then the central area is advancing directly toward him, and so long as this continues, he may expect the wind to increase until the barometer reaches its lowest; then a lull will take place followed by strong winds from the opposite quarter, which will continue while the barometer is rapidly rising, but subside as it rises more slowly. The strength of the wind may be expected to be in general proportioned to the rapidity of the fall or rise of the barometer.

16. The storm-center has been spoken of as being in front of the observer. It will, however, in general be somewhat more to his right as he stands with his left to the wind.

17. If the wind *veer*, (that is to say, gradually change its direction, for instance, from southeast to southwest, or in that order around the compass,) the storm-center is passing by on the north side of the observer; if it *backs*, (changing, for instance, from southwest to southeast,) the center of lowest pressure is passing by on the south side, and the distance at which it is may be roughly estimated by the rapidity of the fall in barometer.

18. The severest winds are those, as before stated, on the south and west side of the center, those on the east side are more frequently squally.

19. In the foregoing the observer has been supposed to be stationary; should he be in motion, however, this will affect especially his observation of the barometer, since he may easily run into or away from an area of low pressure, and he himself must mentally allow for the influence of his motion.

20. In comparing the readings of his own barometer with those published on the bulletin and map of this office, the mariner will find that the latter have all been reduced to a uniform sea-level and to a uniform temperature. He, therefore, will find it most convenient to bear in mind the amount of these corrections and to mentally apply them to his own barometer.

Should he preserve his records and transmit them to this office, however, the original uncorrected observations only are desired. The following tables show the general amount of these corrections.

21. An allowance for the temperature of the barometer is made by noting the thermometer attached to that instrument.

For a temperature of 20° Fahrenheit add	0.02 inch.
For a temperature of 30° Fahrenheit add	0.00 inch.
For a temperature of 40° Fahrenheit subtract	0.03 inch.
For a temperature of 50° Fahrenheit subtract	0.06 inch.
For a temperature of 60° Fahrenheit subtract	0.08 inch.
For a temperature of 70° Fahrenheit subtract	0.11 inch.
For a temperature of 80° Fahrenheit subtract	0.13 inch.
For a temperature of 90° Fahrenheit subtract	0.16 inch.
For a temperature of 100° Fahrenheit subtract	0.18 inch.

These numbers are applicable to barometers having brass scales, which are the most reliable ones; aneroid barometers ought not to require any temperature correction.

The correction for altitude above the sea will vary with the annual temperature, but may be approximately made as follows:

	Altitude of water.	Altitude of barometer.	Add to barometer.
	Feet.	*Feet.*	*Inch.*
For the ocean	0	25	0.02
For Lake Champlain	95	120	0.14
For Lake Ontario	235	260	0.29
For Lake Erie	564	590	0.66
For Lake St. Clair	570	595	0.66
For Lake Huron	574	600	0.66
For Lake Michigan	584	600	0.66
For Lake Superior	600	625	0.69
For the Ohio at Pittsburgh	725	750	0.80
For the Ohio at Cincinnati	450	475	0.50
For the Ohio at Louisville	400	425	0.47
For the Ohio at Cairo	300	325	0.34
For the Missouri at Omaha	950	975	1.05
For the Mississippi at St. Paul	650	675	0.74
For the Mississippi at St. Louis	425	450	0.48
For the Mississippi at Vicksburgh	130	155	0.17
For the Mississippi at New Orleans	20	50	0.05

PLACING AND READING OF THE INSTRUMENTS.

NOTE.—The following instructions apply to Green's, Fortin's, and other barometers constructed on the Fortin principle, and Robinson's anemometer, (Green's model.)

BAROMETER.

The barometer must be kept in a room of as uniform temperature as practicable; and to protect the instrument from such external influences as would produce irregularities it should be kept in a box. The box will be firmly attached against the wall in a vertical position, in such a way that the cover when open will be in a direction parallel to a window.

An opening, large enough to admit the tube of the instrument, will be cut in the upper end of the box, and directly above this a strong hook, of such length as to extend two or three inches beyond the box, will be driven into the wall.

The instrument will be suspended on the hook, and when not in use will be kept in the closed box.

When an observation is to be made, the barometer will be slipped out on the hook into the full light of the window.

It is always well to follow a system in every mechanical operation, and particularly in taking observations, as it insures an accuracy that cannot otherwise be obtained. The following rules are therefore presented:

1st. Tap the instrument a little above the cistern, to destroy the adhesion of the metal to the glass.

2d. Read the attached thermometer, which is very sensitive.

3d. By means of the adjusting-screw bring the surface of the mercury in the cistern in contact with the ivory point which denotes its constant level. If correctly done neither a line of light can be seen between the point and the surface of the mercury, nor will there appear on the surface of the mercury a dimple caused by capillary action.

4th. Again tap the instrument just above the cistern.

5th. Take hold of the instrument above the thermometer, with the left hand, and by means of the vernier-screw bring the back and front lines of the vernier into the same horizontal plane with the top of the mercury in the tube, just touching it and no more. Remove the hand, and as soon as the barometer is vertical, note whether any line of light appears between the summit and the edge of the ring. When correctly adjusted a small portion is obscured, while the light is seen on both sides.

6th. Read the barometer at leisure.

On the barometer-tube is a fixed scale, divided into inches and tenths of inches. There is also a vernier, or sliding scale, which reads to hundredths of an inch.

First read the point marked on the fixed scale, by the bottom of the vernier, which will give the inches and tenths of inches; set this down and then refer to the vernier for the hundredths.

The vernier is divided into ten equal parts, numbered from 1 to 10. Commencing at the bottom, examine the lines until one is found exactly coinciding with *any* line on the fixed scale; the number of such line on the vernier gives you the hundredths; *i. e.*, if the eighth line on the vernier coincides exactly with any line of the fixed scale, the reading is 0.8 inch. In case no line of the vernier exactly coincides with a line on the fixed scale, two lines of the vernier must somewhere be embraced in the space indicated by two successive lines on the fixed scale, and observing where this occurs, read for hundredths the vernier line which most nearly coincides with one of them. In case the coinciding line is 10, which only happens when the zero also coincides, there are no hundredths, and zero must be placed for the hundredths.

The barometrical readings must be reduced for temperature and elevation.

Tables for such corrections can be found in Williamson "On the use of the barometer," and in "Guyot's Tables," Tables XVII and XIX.

This information may also be obtained by application to the observer-sergeant in charge of the station nearest to the applicant.

THE THERMOMETER.

Place the thermometer in the open air, so situated that it will be always in the shade, and have a free circulation of air around it.

The thermometer should be at least from nine to twelve inches from any neighboring object, and should be protected against its own radiation to the sky and earth, and from the heat reflected by neighboring objects.

These conditions can be fulfilled by the construction of an instrument-shelter, which should be constructed outside of a window of a room not heated, and which, corresponding in size to the window, should project about two feet from the panes. Two lattice-blinds should form the exterior of the shelter, one of which should always be closed, as a shelter to the instruments, and the other, except in violent storms, should be open, in order to admit air and light.

A foot from the panes, and at the height of the observer's eye when in the room, two parallel transverse wooden bars, about an inch wide, should be fastened; the thermometer should be fastened exactly perpendicularly to the bars, so that its top is secured by a screw to the upper bar, while its bulb projects a few inches below the lower bar, to which the instrument is secured by a clasp or screw.

The bulb should be so placed that it will not rest against a wooden or metal back, but be free from both scale and back.

READING.

In reading, it is very important that the observer's eye should be exactly at the same height as the top of the column of mercury, otherwise an erroneous reading will be made.

The reading should always be made through the panes, to avoid the influence of the temperature of the chamber on the thermometer, and a second one should be made shortly after, to verify the first. When the bulb becomes moistened by rain or fog, or is covered by ice or snow, it should be carefully wiped, and the reading should not be made until the instrument has acquired the temperature of air.

VERIFICATION.

The zero point should be verified at the beginning and end of winter. To do this, immerse the bulb in a vessel filled with snow or pounded ice, and press slightly a layer of several inches around it, so that the stem, which should be exactly perpendicular, is covered

with snow as high as the freezing point on the scale. Do this in a room the temperature of which is above freezing point, as that point indicates the temperature of *melting* snow.

After about half an hour, read it, taking the utmost care to have the eye exactly at the same height as the top of the mercury.

In case the summit of the mercury and the freezing point of the scale do not agree, note the difference. Some instruments are so constructed as to admit of loosening the screws, and sliding the glass tube containing the mercury up or down a distance equivalent to the error; but it is not advisable to make frequent mechanical changes of this kind. The correction should be applied to each reading.

SELF-REGISTERING THERMOMETERS.

The two thermometers—maximum and minimum—are to be placed beside the common thermometer, with their bulbs opposite and free, attached horizontally to two perpendicular wooden bars, uniting the parallel bars running across the shelter.

In reading them, the same care must be used as with the common thermometer, the eye being in a perpendicular line with the extremity of the index; after verifying the first reading by a second, bring the index of each to the summit of its column by the use of a magnet, in order to set them for the next day's record.

VERIFICATION.

Compare the two thermometers frequently with the common thermometer, and verify the zero several times each year, in the same manner as stated for the common thermometer and enter the error in the register, to be applied at each reading.

HYGROMETER.

These thermometers, one with a dry and one with a wet bulb, must be placed on the same parallel bars as the common thermometer, and several inches apart. The bulbs should be free, and at a distance from the bars. In case of a violent wind, the instrument may be protected by the closing of the movable blind, which may also be used as a fan, to cause evaporation when the air is too still.

The cloth covering the bulb must be linen, and of medium texture, and must be changed every month, and the bulb cleaned. It can be washed without removing, by means of a syringe. It may be kept continually wet, or be moistened a short time before taking the observation, and experience has shown that the average result is the same in both cases. Filtered rain-water must be used.

VERIFICATION.

The two thermometers must be frequently compared, and if they are not adjusted so as to correct any difference which may exist, the error must be registered and taken into account after making an observation.

THE ANEMOMETER.

The anemometer should be carefully fixed, in a vertical position, upon a post of sufficient height to bring the dial on a level with the eye of the observer, and in an exposed condition, so as to receive the full force of the wind. The post must be firmly enough planted to prevent the instrument from vibrating.

To obtain the velocity of the wind at any time, two observations, at an interval of five minutes, must be made on the *outer dial only*, and the difference between the readings, which will be obtained in miles and tenths of miles, multiplied by 12, gives the velocity per hour. Example: Suppose the outer index to be at 3 the first reading, and at 3.6 the second; the difference is 0.6, which, multiplied by 12, gives 7.2 miles as the velocity per hour. Great care should be exercised to make these observations exactly five minutes apart.

Reading: Each line on the inner dial indicates 10 miles, and the dial reads by tens from ten to one thousand. Each line on the outer dial indicates a tenth of a mile, and the dial reads, by tenths and by miles, from one-tenth of a mile to ten miles. The zero line of the outer dial is the point at which the inner dial must be read. Read on the inner dial the line exactly coinciding with the *zero line of the outer dial*, or if no line exactly coincides, then read the line next less than it.

No line of the inner dial can exactly coincide with the zero of the outer dial, unless the zero exactly coincides with the steel index at the top of the dials, except when the instrument is improperly adjusted.

When such coincidence does not take place, the outer dial must be read at the point exactly coinciding with the steel index, and the distance there indicated, which is noted on the outer dial in miles and tenths of miles, must be added to the result obtained from the inner dial.

RAIN-GAUGE.

The rain-gauge should be placed with the top of the collector twelve inches above the surface of the ground, and be firmly fixed in a vertical position. It should be examined each morning at the usual time of observation, and its contents carefully measured by a graduated rod, which is furnished with the gauge. Snow should be melted, and measured as rain. The gauge should be emptied for each observation.

PAPER 8.

[Working forms of circuit.]

CIRCUIT No. 1.—WASHINGTON AND NEW YORK.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

SPECIAL CIRCUIT.

To be made up daily at { 7.45 a. m. / 4.45 p. m. / 11.45 p. m. } Washington time.

NOTES.

1. Each station will take down the reports sent by the others, in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 9.

[Working forms of circuit.]

CIRCUIT No. 2.—WASHINGTON AND NEW ORLEANS.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

SPECIAL CIRCUIT.

To be made up daily at { 7.45 a. m. / 4.45 p. m. / 11.45 p. m. } Washington time.

NOTES.

1. Each station will take down the reports sent by the others, in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 10.

[Working forms of circuit.]

CIRCUIT No. 3.—WASHINGTON AND CHICAGO.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

SPECIAL CIRCUIT.

To be made up daily at { 7.45 a. m. / 4.45 p. m. / 11.45 p. m. } Washington time.

NOTES.

1. Each station will take down the reports sent by the others, in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 11.

[Working forms of circuit.]

CIRCUIT No. 4.—PORTLAND, MAINE, AND NEW YORK.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

PORTLAND TO NEW YORK.				NEW YORK TO PORTLAND.
At 8.31 a. m., 5.31 p. m., and 12.31 a. m., Portland will send reports from—	At 8.25 a. m., 5.25 p. m., and 12.25 a. m., Boston will send reports from—	At 8.19 a. m., 5.19 p. m., and 12.19 a. m., New London will send—		At 8.17 a. m., 5.17 p. m., and 12.17 a. m., New York will send reports from—
Portland, Montreal, *Through—* Boston, New London, *To—* New York.	Boston, Burlington, Mount Washington, *Through—* New London, *To—* New York.	*To—* New York.		All other stations, except Punta Rassa, *To—* Portland.

NOTES.

1. Each station will take down the reports sent by the others, in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 12.

[Working forms of circuit.]

CIRCUIT No. 5.—BOSTON AND MOUNT WASHINGTON.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

MT. WASHINGTON TO BOSTON.	BOSTON TO MT. WASHINGTON.
At 8.22 a. m., 5.22 p. m., and 12.22 a. m., Mt. Washington will send to—	
Boston.	

NOTES.

1. Each station will take down the reports sent by the others, in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 13.

[Working forms of circuit.]

CIRCUIT No. 6.—BOSTON AND BURLINGTON.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

BURLINGTON TO BOSTON.	BOSTON TO BURLINGTON.
At 8.15 a. m., 5.15 p. m., and 12.15 a. m., Burlington will send to—	At 8.34 a. m., 5.34 p. m., and 12.34 a. m., Boston will send reports from—
Boston.	Boston, New York, Portland, Me., Buffalo, Oswego, *To*— Burlington.

NOTES.

1. Each station will take down the reports sent by the others, in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 14.

[Working forms of circuit.]

CIRCUIT NO. 7.—WASHINGTON AND KNOXVILLE.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

KNOXVILLE TO WASHINGTON.		WASHINGTON TO KNOXVILLE.
At 7.32 a. m., 4.32 p. m., and 11.32 p. m., Knoxville will send, through—	At 7.35 a. m., 4.53 p. m., and 11.53 p. m., Lynchburgh will send—	
Lynchburgh, *To*— Washington.	*To*— Washington.	

NOTES.

1. Each station will take down the reports sent by the others, in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 15.

[Working forms of circuit.]

CIRCUIT No. 8—NEW YORK AND LAKE CITY.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

LAKE CITY TO NEW YORK.										NEW YORK TO LAKE CITY.
At 7.29 a. m., 4.29 p. m., and 11.29 p. m., Lake City will send reports from—	At 7.39 a. m., 4.39 p. m., and 11.39 p. m., Savannah will send reports—	At 7.36 a. m., 4.36 p. m., and 11.36 p. m., Augusta will send reports—	At 7.47 a.m., 4.47 p.m., and 11.47 p. m., Charleston will send reports—	At 7.56 a. m., 4.56 p. m., and 11.56 p. m., Wilmington will send reports—	At 8.04 a. m., 5.04 p. m., and 12.04 a. m., Norfolk will send reports—	At 8.02 a. m., 5.02 p. m., and 12.02 a. m., Washington will send reports from—	At 8.08 a.m., 5.08 p.m., and 12.08 a. m., Baltimore will send reports—	At 8.14 a. m., 5.14 p. m., and 12.14 a. m., Philadelphia will send reports—	At 8.16 a. m., 5.16 p. m., and 12.16 a. m., Cape May will send reports—	At 8.22 a. m., 5.22 p. m., and 12.22 a. m., New York will send reports from—
Lake City, Key West, Punta Rassa, Jacksonville, *Through*— Savannah, Augusta, Charleston, Wilmington, Norfolk, Washington, Baltimore, Philadelphia, Cape May, *To*— New York.	*Through*— Augusta, Charleston, Wilmington, Norfolk, Washington, Baltimore, Philadelphia, Cape May, *To*— New York.	*Through*— Charleston, Wilmington, Norfolk, Washington, Baltimore, Philadelphia, Cape May, *To*— New York.	*Through*— Wilmington, Norfolk, Washington, Baltimore, Philadelphia, Cape May, *To*— New York.	*Through*— Norfolk, Washington, Baltimore, Philadelphia, Cape May, *To*— New York.	*Through*— Washington, Baltimore, Philadelphia, Cape May, *To*— New York.	Washington, Knoxville, Lynchburgh, *Through*— Baltimore, Philadelphia, Cape May, *To*— New York.	*Through*— Philadelphia, Cape May, *To*— New York.	*Through*— Cape May, *To*— New York.	*To*— New York.	All other stations *To*— Lake City.

NOTES.

1. Each station will take down the reports sent by the others, in regular succession, so that, when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words; the afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 16.

CIRCUIT NO. 9—LAKE CITY AND KEY WEST.

[Working forms of circuit.]

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

KEY WEST TO LAKE CITY.			LAKE CITY TO KEY WEST.	
At 7.31 a.m., 4.31 p.m., and 11.31 p. m., Key West will send—	At 7.31 a. m., 4.31 p. m., and 11.31 p. m., Punta Rassa will send—		At 7.37 a. m., 4.37 p. m., and 11.37 p. m., Lake City will send reports from—	
To— Lake City.	*To*— Lake City.		Savannah, Charleston, Wilmington, Norfolk, Mobile, New Orleans, New York, Jacksonville, *To* Key West.	

NOTES.

1. Each station will take down the reports sent by the others, in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words; the afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 17.

[Working forms of circuit.]

CIRCUIT NO. 9 A.—LAKE CITY AND JACKSONVILLE.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

JACKSONVILLE TO LAKE CITY.			LAKE CITY TO JACKSONVILLE.	
At 7.32 a. m., 4.32 p. m., 11.32 p. m., Jacksonville will send—			At 7.37 a. m., 4.37 p. m., 11.37 p. m., Lake City will send reports from—	
To— Lake City.			Lake City, Key West, Punta Rassa, Savannah, Charleston, Wilmington, Norfolk, Mobile, New Orleans, *To*— Jacksonville.	

NOTES.

1. Each station will take down the reports sent by the others, in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 18.

[Working form of circuit.]

CIRCUIT No. 10.—AUGUSTA AND NEW ORLEANS.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

AUGUSTA TO NEW ORLEANS.			NEW ORLEANS TO AUGUSTA.	
At 7.40 a. m., 4.40 p. m., 11.40 p. m., Augusta will send reports from—	At 7.22 a. m., 4.22 p. m., 11.22 p. m., Mobile will send—		At 7.15 a. m., 4.15 p. m., 11.15 p. m., New Orleans will send reports from—	
Key West, Savannah, Augusta, Charleston, Wilmington, Norfolk, Punta Rassa, Jacksonville, *Through*— Mobile, *To*— New Orleans.	*To*— New Orleans.		New Orleans, Galveston, Shreveport, *To*— Augusta.	

NOTES.

1. Each station will take down the reports sent by the others, in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 19.

[Working forms of circuit.]

CIRCUIT No. 12.—NEW YORK AND MILWAUKEE.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

MILWAUKEE TO NEW YORK.									NEW YORK TO MILWAUKEE.
At 7.25 a. m., 4.25 p. m., and 11.25 p. m., Milwaukee will send reports from—	At 7.33 a. m., 4.33 p. m., and 11.33 p. m., Chicago will send reports from—	At 7.43 a. m., 4.43 p. m., and 11.43 p. m., Detroit will send reports from—	At 7.40 a. m., 4.40 p. m., and 11.40 p. m., Toledo will send—	At 7.34 a. m., 4.34 p. m., and 11.34 p. m., Cincinnati will send—	At 7.45 a. m., 4.45 p. m., and 11.45 p. m., Cleveland will send—	At 7.54 a. m., 4.54 p. m., and 11.54 p. m., Buffalo will send—	At 7.59 a. m., 4.57 p. m., and 11.57 p. m., Rochester will send—	At 8.02 a. m., 5.02 p. m., and 12.02 a. m., Oswego will send—	At 8.52 a. m., 5.52 p. m., and 12.52 a. m., New York will send reports from—
Milwaukee, St. Paul, Du Luth, Escanaba, Marquette, *Through—* Chicago, Detroit, Toledo, Cincinnati, Cleveland, Buffalo, Rochester, Oswego, *To—* New York.	Chicago, Davenport, Omaha, Cheyenne, Corinne, San Francisco, St. Louis. Leavenworth, Cairo, Indianapolis, Memphis, Jacksonville, Vicksburg, Louisville, Nashville, New Orleans, Galveston. Mobile, Augusta, Key West, Savannah, Charleston, Wilmington, Norfolk, Pittsburgh, Shreveport, Punta Rassa, Keokuk, *Through—* Milwaukee, Detroit, Toledo, Cincinnati, Cleveland, Buffalo, Rochester, Oswego, *To—* New York.	Detroit. Grand Haven, *Through—* Toledo, Cincinnati, Cleveland, Buffalo, Rochester, Oswego, *To—* New York.	*Through—* Cincinnati, Cleveland, Buffalo, Rochester, Oswego, *To—* New York.	*Through—* Cleveland, Buffalo, Rochester, Oswego, *To—* New York.	*Through—* Buffalo, Rochester, Oswego, *To—* New York.	*Through—* Rochester, Oswego, *To—* New York.	*Through—* Oswego, *To—* New York.		New York, Portland, Mount Washington, Boston, New London, Cape May, Philadelphia, Baltimore, Washington, Lynchburgh, Knoxville, Montreal, *To—* Milwaukee.

NOTES.

1. Each station will take down the reports sent by the others, in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 20.

[Working forms of circuit.]

CIRCUIT No. 14.—GRAND HAVEN AND DETROIT.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

GRAND HAVEN TO DETROIT.			DETROIT TO GRAND HAVEN.	
At 7.23 a. m., 4.23 p. m., and 11.23 p. m., Grand Haven will send—			At 7.51 a. m., 4.51 p. m., and 11.51 p. m., Detroit will send reports from—	
To— Detroit.			Detroit, Chicago, Milwaukee, Escanaba, Marquette, Buffalo, Cleveland, Toledo, Oswego, *To*— Grand Haven.	

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 21.

[Working forms of circuit.]

CIRCUIT No. 15.—MILWAUKEE AND MARQUETTE.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

MARQUETTE TO MILWAUKEE.			MILWAUKEE TO MARQUETTE.	
At 7.19 a. m., 4.19 p. m., and 11.19 p. m., Marquette will send—	At 7.21 a. m., 4.21 p. m., and 11.21 p. m., Escanaba will send—		At 7.36 a. m., 4.36 p. m., and 11.36 p. m., Milwaukee will send reports from—	
Through— Escanaba, *To*— Milwaukee.	*To*— Milwaukee.		Milwaukee, Oswego, Buffalo, Cleveland, Toledo, Detroit, Grand Haven, Chicago, Du Luth, St. Paul, *To*— Marquette.	

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 22.

[Working forms of circuit.]

CIRCUIT No. 16.—MILWAUKEE AND DU LUTH.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

DU LUTH TO MILWAUKEE.		MILWAUKEE TO DU LUTH.	
At 7 a. m., 4 p. m., and 11 p.m. Duluth will send through—	At 6.57 a. m., 3.57 p. m., and 10.57 p. m., St. Paul will send—	At 7.36 a. m., 4.36 p. m., and 11.36 p. m., Milwaukee will send reports from—	
St. Paul, *To*— Milwaukee.	*To*— Milwaukee.	Milwaukee, Chicago, Omaha, Marquette, Detroit, Escanaba, Grand Haven, Cleveland, Buffalo, *To*— Duluth.	

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 23.

[Working forms of circuit.]

CIRCUIT No. 17.—CHICAGO AND PITTSBURGH.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

PITTSBURGH TO CHICAGO.			CHICAGO TO PITTSBURGH.	
At 7.48 a. m., 4.48 p. m., and 11.48 p. m., Pittsburgh will send—			At 7.33 a. m., 4.33 p. m., and 11.33 p. m., Chicago will send reports from—	
To— Chicago.			Chicago, New Orleans, Memphis, Nashville, Cincinnati, Cairo, St. Louis, St. Paul, Davenport, Cleveland, Buffalo, Detroit, Shreveport, Louisville, Vicksburgh, *To*— Pittsburgh.	

NOTES.

1. Each station will take down the report sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 24.

[Working forms of circuit.]

CIRCUIT NO. 18.—CHICAGO AND NEW ORLEANS.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

NEW ORLEANS TO CHICAGO.						CHICAGO TO NEW ORLEANS.	
At 7.13 a. m., 4.13 p. m., and 11.13 p. m., New Orleans will send reports from—	At 7.08 a. m., 4.08 p. m., and 11.08 p. m., Vicksburgh will send—	At 7.11 a. m., 4.11 p. m., and 11.11 p. m., Memphis will send—	At 7.23 a. m., 4.23 p. m., and 11.23 p. m., Nashville will send—	At 7.26 a. m., 4.26 p. m., and 11.26 p. m., Louisville will send—	At 7.24 a. m., 4.24 p. m., and 11.24 p. m., Indianapolis will send—	At 7.37 a. m., 4.37 p. m., and 11.37 p. m., Chicago will send reports from—	
New Orleans, Galveston, Mobile, Augusta, Wilmington, Charleston, Savannah, Key West, Punta Rassa, Jacksonville, Norfolk, Shreveport,						Chicago, St. Paul, Davenport, Omaha, Leavenworth St. Louis, Cairo, Cincinnati, Pittsburgh, Buffalo, New York, Boston, Portland, Baltimore,	
To— Chicago.	*To*— Chicago.	*To*— Chicago.	*To*— Chicago.	*To*— Chicago.	*To*— Chicago.	*To*— New Orleans.	

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 25.

[Working forms of circuit.]

CIRCUIT No. 19.—CHICAGO AND CAIRO.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

CAIRO TO CHICAGO.		CHICAGO TO CAIRO.
At 7.11 a. m., 4.11 p. m., and 11.11 p. m., Cairo will send through—	At 7.08 a. m., 4.08 p. m., and 11.08 p. m., St. Louis will send reports from—	At 7.28 a. m., 4.28 p. m., and 11.28 p. m., Chicago will send reports from—
St. Louis, *To*— Chicago.	St. Louis, Leavenworth, *To*— Chicago.	Chicago, Pittsburgh, Cincinnati, Nashville, Memphis, New Orleans, Davenport, St. Paul, Omaha, Galveston, Vicksburgh, Louisville, Shreveport, *To*— Cairo.

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 26.

[Working forms of circuit.]

CIRCUIT No. 20.—ST. LOUIS AND LEAVENWORTH.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

LEAVENWORTH TO ST. LOUIS.	ST. LOUIS TO LEAVENWORTH.	
At 6.48 a. m., 3.48 p. m., and 10.48 p. m., Leavenworth will send to—	At 7.08 a. m., 4.08 a. m., 11.08 p. m., St. Louis will send reports from—	
St. Louis.	New Orleans, Chicago, St. Paul, Pittsburgh, Davenport, Cairo, Galveston, Vicksburgh, Memphis, Nashville, Louisville, Cincinnati, St. Louis, Omaha, *To*— Leavenworth.	

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 27.

[Working forms of circuit.]

CIRCUIT No. 22.—NEW ORLEANS AND GALVESTON.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

GALVESTON TO NEW ORLEANS.	NEW ORLEANS TO GALVESTON.	
At 6.49 a. m., 3.49 p. m., and 10.49 p. m., Galveston will send to—	At 7.09 a. m., 4.09 p. m., and 11.09 p. m., New Orleans will send reports from—	
New Orleans.	New Orleans, Key West, Mobile, Savannah, Charleston, Wilmington, Norfolk, Baltimore, Punta Rassa, Jacksonville, Shreveport, New York, Boston, Portland, Me., Memphis, Cairo, St. Louis, Cincinnati, *To—* Galveston.	

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 28.

[Working forms of circuit.]

CIRCUIT No. 23.—CHICAGO AND SAN FRANCISCO.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

SAN FRANCISCO TO CHICAGO.					CHICAGO TO SAN FRANCISCO.	
At 5.07 a. m., 2.07 p. m., and 9.07 p. m., San Francisco will send reports from—	At 5.44 a. m., 2.44 p. m., and 9.44 p. m., Corinne will send reports from—	At 6.12 a. m., 3.12 p. m., and 10.12 p. m., Cheyenne will send reports from—	At 6.46 a. m., 3.46 p. m., and 10.46 p. m., Omaha will send—	At 7.06 a. m., 4.06 p. m., and 11.06 p. m., Davenport will send—	At 7.31 a. m., 4.31 p. m., and 11.31 p. m., Chicago will send to—	
San Francisco, San Diego, Portland, Oregon, *Through*— Corinne, Cheyenne, Omaha, Davenport,	Corinne, Fort Benton, Virginia City, *Through*— Cheyenne, Omaha, Davenport,	Cheyenne, Santa Fé, Denver, *Through*— Omaha, Davenport,	*Through*— Davenport.		Davenport, Boston, New York, Charleston, Key West, New Orleans, Buffalo, Cleveland, Chicago, St. Paul, Du Luth, Knoxville, Mt. Washington, Leavenworth, Galveston, Vicksburgh, Memphis, Louisville, St. Louis, Shreveport.	
To— Chicago.	*To*— Chicago.	*To*— Chicago.	*To*— Chicago.	*To*— Chicago.		

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of 20 words. The afternoon and night reports will consist of 10 words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 29.

[Working forms of circuit.]

CIRCUIT No. 24.—CHICAGO AND KEOKUK.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

KEOKUK TO CHICAGO.		CHICAGO TO KEOKUK.		
At 7.02 a. m., 4.02 p. m., and 11.02 p. m., Keokuk will send—		At 7.19 a. m., 4.19 p. m., and 11.19 p. m., Chicago will send reports from—		
To— Chicago.		Chicago, Pittsburgh, Buffalo, Cincinnati, San Francisco, Corinne, Cheyenne, Omaha, Davenport, Milwaukee, St. Paul, Cairo, St. Louis, *To*— Keokuk.	Leavenworth, Indianapolis, Nashville, New Orleans, Key West, Savannah, New York, Washington, Knoxville, Philadelphia, Shreveport, Vicksburgh, Louisville, *To*— Keokuk.	

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of 20 words. The afternoon and night reports will consist of 10 words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 30.

[Working forms of circuit.]

CIRCUIT No. 25.—NEW ORLEANS AND SHREVEPORT.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

SHREVEPORT TO NEW ORLEANS.		NEW ORLEANS TO SHREVEPORT.
At 6.53 a. m., 3.53 p. m., and 10.53 p. m., Shreveport will send—		
To— New Orleans.		

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of 20 words. The afternoon and night reports will consist of 10 words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 31.

[Working forms of circuit.]

CIRCUIT No. 26.—SAN FRANCISCO AND PORTLAND.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

PORTLAND TO SAN FRANCISCO.	SAN FRANCISCO TO PORTLAND.
At 4.57 a. m., 1.57 p. m., and 8.57 p. m., Portland will send to—	At 4.59 a. m., 1.59 p. m., and 8.59 p. m., San Francisco will send reports from—
San Francisco.	San Francisco, San Diego, *To*— Portland.

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 32.

[Working forms of circuit.]

CIRCUIT NO. 27.—SAN FRANCISCO AND SAN DIEGO.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

SAN DIEGO TO SAN FRANCISCO.	SAN FRANCISCO TO SAN DIEGO.
At 5.19 a. m., 2.19 p. m., and 9.19 p. m., San Diego will send to—	At 4.59 a. m., 1.59 p. m., and 8.59 p. m., San Francisco will send reports from—
San Francisco.	San Francisco, Portland, *To*— San Diego.

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 33.

[Working forms of circuit.]

CIRCUIT NO. 28.—CHEYENNE AND SANTA FÉ.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

SANTA FÉ TO CHEYENNE.		CHEYENNE TO SANTA FÉ.		
At 5.59 a. m., 2.59 p. m., and 9.59 p. m., Santa Fé will send—	At 6.04 a. m., 3.04 p. m., and 10.04 p. m., Denver will send—			
Through— Denver. *To*— Cheyenne.	*To*— Cheyenne.			

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 34.

[Working forms of circuit.]

CIRCUIT NO. 29.—CORINNE AND FORT BENTON.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

FORT BENTON TO CORINNE.			CORINNE TO FORT BENTON.	
At 5.41 a. m., 2.41 p. m., and 9.41 p. m., Fort Benton will send—	At 5.36 a. m., 2.36 p. m., and 9.36 p. m., Virginia City will send—			
Through— Virginia City. *To*— Corinne.	*To*— Corinne.			

NOTES.

1. Each station will take down the reports sent by the others in regular succession, so that when the last one finishes, all of them will have the full reports from the others.
2. Each intermediate station will take down the above reports as they pass over the line. Copies of these reports will be bulletined in the rooms of the different boards of trade, and furnished to the local papers for publication.
3. The morning report will consist of twenty words. The afternoon and night reports will consist of ten words each.
4. The time given for sending reports is the local time of that particular station.

PAPER 35.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
Washington, D. C., July 18, 1871.

SIR: According to your request, the following report is furnished, regarding the rates for telegraphic service submitted on June 26, 1871, for your consideration, by Hon. William Whiting, special assistant to the Attorney General, and specified in your subsequent order dated June 29, 1871.

In March last it was considered by this office important to obtain, by personal interviews between its officers and the representatives of the most important telegraph companies of the United States, a full understanding, and, if possible, an adjustment of the subjects both of compensation and also of special facilities required, in regard to which difficulties had arisen.

Brevet Lieutenant Colonel Garrick Mallery and Brevet Captain H. W. Howgate, both of United States Army, and acting signal officers, on duty at this office, were, on March 20, 1871, designated by the War Department to represent it in conference with officers of the several companies, and took part in all the meetings held.

On April 4, 1871, Hon. William Whiting was commissioned as special assistant to the Attorney General of the United States, in relation to matters in controversy between the Government and the telegraph companies of the United States, and was instructed to act in co-operation with the Chief Signal Officer of the Army, who met him, and participated in the various subsequent meetings and discussions.

The above-named officers met, at different times and places in reference to the above-named duty, the president, vice-president, and electrician of the Western Union Telegraph Company, (who also represented the Northwestern Telegraph Company;) the president, general superintendent, and secretary of the Pacific and Atlantic Telegraph Company; the general superintendent of the Atlantic and Pacific Telegraph Company; the president and superintendent of the Franklin Telegraph Company; and the president and treasurer of the International Ocean Telegraph Company.

In these meetings were obtained a mass of reports, estimates, and other statistics, verified in many cases by reference to the books of the companies, which were made fully accessible.

The purpose of the representatives of the Government, persistently adhered to, was to ascertain the actual cost to the telegraph companies for the service required for the weather-reports, Signal Service, fairly estimated, with proper allowance for the difference in cost between that particular service and ordinary commercial, or press business. It was also proposed, after ascertaining that cost, to allow a fair profit upon it; the profit of 30 per cent. being the one used in the general calculations.

The result of many and prolonged consultations was that part of the above-mentioned order relating to the weather-reports, Signal Service, which is in the following language:

"The rate for all telegraphic communications known as the 'Signal Service messages and reports,' shall be two cents for each word of said reports and messages for each circuit over which it may pass, in accordance with the schedule of circuits and plans of the Chief Signal Officer of the Army, which are now adopted, or may hereafter be adopted by him, for transmitting these dispatches, or such part thereof as he may designate, in such words or ciphers as may, from time to time, be directed by him. The amount thus estimated is to be taken in full payment for said dispatches, no additional allowance to be made for drops, office messages, or other services or special facilities required by the Chief Signal Officer for the correct and prompt transmission of said Signal Service messages and reports."

This rate was voluntarily and in advance of your order assented to by the Western Union Telegraph Company, and the following table exhibits the comparative cost of transmitting the weather-reports for the forty-eight stations, being eighteen circuits actually in operation on July 1, 1871, according to the provisions of your order, as contrasted with the commercial rates previously charged and paid.

Circuits.	WEATHER REPORTS.		Commercial rates for the same number of words.
	Number of words.	Cost by Postmaster General's order.	
Galveston and New Orleans	704	$14 08	$29 32
New York and Milwaukee	2,024	40 48	74 26
Burlington and Boston	264	5 28	4 84
Lake City and New York	2,112	42 24	176 00
Augusta and New Orleans	396	7 92	26 38
Cairo and Chicago	572	11 44	20 97
New Orleans and Chicago	1,144	22 88	95 33
San Francisco and Chicago	220	4 40	29 33
Pittsburgh and Chicago	572	11 44	14 30
Portland and New York	2,112	42 24	35 20
Grand Haven and Detroit	440	8 80	12 46
Mt. Washington and Boston	44	88	88
Knoxville and Washington	88	1 76	8 80
Chicago and Davenport	308	6 16	7 70
Leavenworth and St. Louis	572	11 44	20 97
Milwaukee and Marquette	528	10 56	36 96
Milwaukee and Duluth	484	9 68	38 72
Lake City and Key West	396	7 92	52 80
One day	12,980	259 60	685 22
Three months, 30, 31, 31=92 days	1,194,160	23,883 20	63,040 24

This statement shows a saving to the United States for a service of three months of $39,157 04, being at the rate of over 62 per cent.

The additions to and changes in this service, to be made from time to time, will not probably reduce this rate of saving.

It will be understood that the weather-reports of the Signal Service are necessarily sent over defined and established circuits, and circuits of great length under different circumstances from messages of any other character, and therefore required special provision, an essential part of the plan being that the reports of observations should be furnished by what is technically called "drops," at many points intermediate between those of transmission and address. This increased the amount of service rendered, and occasioned the recommendation of a rate which would compensate in fact for the "drops," while it was not practicable to consider them directly as the basis of calculation.

Under the general instructions to Mr. Whiting, it was also proper and necessary to examine and report upon the rates considered to be fair for the transmission of telegraphic communications between the several Departments of the Government of the United States and their officers and agents, other than the Signal Service messages, and observing the same principle before alluded to, the result was reported to you in the following language: "One cent per word for each circuit through which it shall be transmitted, said rates to be computed subject to the following conditions, viz: A distance of two hundred and fifty miles, as computed by the tables of the Post-Office Department, shall be deemed a circuit. If, on computing circuits, there shall be found one or more circuit, and a fraction of a circuit, such fraction shall be deemed a circuit."

If a communication shall be sent a distance less than two hundred and fifty miles, that distance shall be deemed a circuit.

All words of the communication transmitted are to be counted, excepting the date and place at which such communicationis filed. No communication to be at a rate less than 25 cents.

The unit of a distance, two hundred and fifty miles, mentioned in this part of the report as above submitted to you, was found to be the average length of circuit over which messages in the United States were transmitted.

This rate was substantially acceded to, in advance of your order, by the Western Union and the Franklin Telegraph Companies.

The following table exhibits the rates of late actually charged to the Departments of the United States by the several telegraph companies, and the cost to the United States for the same messages and distances, according to the rate established by you, sixty-five of the most important telegraphic stations in the United States being taken for example, with Washington as the point of transmission.

	Com'l.	Gov't.	Com'l.	Gov't.		Com'l.	Gov't.	Com'l.	Gov't.
	13 body words.	30 total words.	100 body words.	100 total words.		13 body words.	30 total words.	100 body words.	100 total words.
Albany, N. Y	$0 95	$0 60	$5 30	$2 00	Lewes, Del	$0 77	$0 30	$4 25	$1 00
Poughkeepsie, N. Y.	85	60	5 20	2 00	New Castle, Del	67	30	4 15	1 00
Augusta, Ga	1 98	90	11 55	3 00	Memphis, Tenn	1 49	1 20	8 45	4 00
Baltimore, Md	26	30	2 00	1 00	Milwaukee, Wis	1 31	1 20	7 40	4 00
Annapolis, Md	36	30	2 10	1 00	Green Bay, Wis	2 18	1 20	11 75	4 00
Elkton, Md	54	30	3 15	1 00	Mobile, Ala	3 01	1 50	17 80	5 00
Bangor, Me	1 08	90	6 48	3 00	Montgomery, Ala	2 88	1 20	16 80	4 00
Boston, Mass	67	60	4 15	2 00	Nashville, Tenn	1 21	90	7 30	3 00
Buffalo, N. Y	1 08	60	6 30	2 00	New London, Conn	72	60	4 20	2 00
Burlington, Vt	1 57	90	9 40	3 00	Palmer, Mass	67	60	4 15	2 00
Cairo, Ill	2 16	1 20	12 60	4 00	New Orleans, La	3 01	1 50	17 80	5 00
Charleston, S. C	1 98	90	11 55	3 00	New York, N. Y	49	30	3 10	1 00
Cheyenne, Wy. Ter	5 17	2 40	30 40	8 00	Norfolk, Va	49	30	3 10	1 00
Chicago, Ill	1 21	1 20	7 30	4 00	Omaha, Nebr	3 06	1 80	17 80	6 00
Cincinnati, Ohio	59	90	3 20	3 00	Oswego, N. Y	1 08	60	6 30	2 00
Cleveland, Ohio	1 31	90	7 40	3 00	Philadelphia, Pa	41	30	2 15	1 00
Davenport, Iowa	1 80	1 50	10 50	5 00	West Chester, Pa	77	30	4 25	1 00
Des Moines, Iowa	2 75	1 50	15 80	5 00	Pittsburgh, Pa	31	60	2 05	2 00
Denver, Col	4 90	2 40	31 00	8 00	Portland, Me	90	90	5 25	3 00
Detroit, Mich	1 57	90	9 40	3 00	Rochester, N. Y	1 08	60	6 30	2 00
Monroe, Mich	1 57	90	9 40	3 00	Canandaigua, N. Y	1 21	60	7 30	2 00
Jackson, Mich	1 80	90	10 50	3 00	Savannah, Ga	2 34	90	13 65	2 00
Ft. Benton, Mont	9 05	3 90	52 55	13 00	St. Louis, Mo	2 11	1 20	12 55	4 00
Ft. Smith, Ark	3 78	1 80	22 05	6 00	Alton, Ill	2 29	1 20	13 60	4 00
Galveston, Tex	4 81	2 10	28 30	7 00	San Diego, Cal	8 51	4 50	49 40	15 00
Grand Haven, Mich	2 03	1 20	11 60	4 00	San Francisco, Cal	5 99	3 90	34 70	13 00
Indianapolis, Ind	59	90	3 20	3 00	Santa Fé, N. M	6 72	2 70	53 60	9 00
Penn Yan, N. Y	1 62	60	9 45	2 00	Springfield, Ill	2 29	1 20	13 60	4 00
Terre Haute, Ind	2 03	1 20	11 60	4 00	Toledo, Ohio	1 57	90	9 40	3 00
Jackson, Miss	3 42	1 20	19 95	4 00	Oberlin, Ohio	1 31	90	7 40	3 00
Louisville, Ky	90	90	5 25	3 00	Wilmington, N. C	1 44	60	8 40	2 00
New Albany, Ind	1 62	90	9 45	3 00					
Leavenworth, Kans	3 06	1 50	17 85	5 00	Average difference	2 29	1 25	13 98	4 14
Topeka, Kans	3 24	1 80	18 90	6 00					

In explanation of this table, it may be stated that experience shows messages of 13 "body words" (the address and signature being omitted) to be properly considered equivalent to those of 30 "total words," under the terms of your order.

Calculations made from the above table show an average saving to the United States beyond what had been paid previous to the date of your order, in the case of the shorter messages classified as above, of 45 per cent., and in the longer messages of 70 per cent., which rate increases in favor of the United States when the number of words exceeds one hundred.

It was further insisted upon by the representatives of the United States that the proper construction of the act of Congress approved July 24, 1866, entitled "An act to aid in the construction of telegraph lines, and to secure to the Government the use of the same for postal, military, and other purposes," was that all telegraphic communications in relation to the affairs or business of the United States by its civil or military officers, agents, or employés, in their transmission over the lines of the companies which had accepted the provisions of that act, should be entitled to priority over all other business, and also that the said companies are not entitled to receive prepayment therefor, but are bound to receive compensation therefor, at rates to be annually fixed by the Postmaster General. No objection is made on the part of the several companies conferred with to the above construction.

Attached hereto are copies of several papers considered of importance as connected with the above report.

I am, sir, very respectfully, your obedient servant,

ALBERT J. MYER,
Brigadier General and Chief Signal Officer of the Army.

The Hon. the POSTMASTER GENERAL.

SUB-PAPER 1.

Proposed rates for Signal-Service messages and reports, as assented to by the Western Union Telegraph Company.

"The rate for all Government dispatches known as the Signal-Service messages and reports are and shall be fixed for the year commencing May 24, 1871, as follows, viz: two cents for each word of said reports and messages for each circuit over which it may pass, in accordance with the schedule of circuits and plans of the Chief Signal Officer of the Army which are now adopted, or may hereafter be adopted by him, for transmitting these dispatches, or such part thereof as he may designate, in such words or ciphers as may, from time to time, be directed by him. The amount thus estimated to be taken in full payment for such dispatches, no additional allowances to be made for drops, office messages, or other services or special facilities required by the Chief Signal Officer for the correct and prompt transmission of said Signal-Service messages and reports."

The above is satisfactory, and the service may commence at once.

WILLIAM ORTON,
President Western Union Telegraph Company.

NEW YORK, *May* 8, 1871.

SUB-PAPER 2.

Letter of Wm. Orton, president of the Western Union Telegraph Company, proposing terms for departmental telegraphy other than that of the weather-reports.

WASHINGTON, D. C., *June* 24, 1871.

SIR: The Western Union Telegraph Company will consent to the fixing, by the Postmaster General, of the following rates for telegraphic service for the several Departments of the Government, for the fiscal year 1871–'72, (excepting the weather-reports,) viz: One cent per word for each circuit of two hundred and fifty miles, or fractional part thereof, all words to be counted except the date and the place at which a message is filed. Provided, however, that no message shall be counted as less than 25 words. Distances to be computed by the tables of the War Department.

I have the honor to be, very respectfully, &c.,

WILLIAM ORTON,
President.

Hon. WM. WHITING,
Assistant Attorney General of the United States.

SUB-PAPER 3.

Letter of the president of the Pacific and Atlantic Telegraph Company to Mr. Whiting, proposing terms for the Department telegraphing other than that of the weather-reports.

WASHINGTON, D. C., *June* 24, 1871.

SIR: Our company are of the opinion that, for the service for which proposals are asked in the foregoing letter, the following would be a just rate of compensation: A message shall be held to be 30 words or less, all words or figures to be counted. A unit of distance shall be held to be two hundred and fifty miles. The rate of compensation to be one cent per word for each unit of distance, all portions of the unit to be deemed as a unit. No message to be less than 30 cents.

Very respectfully,

GEO. H. THURSTON,
President of the Pacific and Atlantic Telegraph Company.

Hon. WM. WHITING,
Assistant Attorney General of the United States.

SUB-PAPER 4.

Proposal of the Franklin Telegraph Company for Signal Service.

NEW YORK, *May* 12, 1871.

SIR: In reply to your letter of the 11th, I conclude, without consultation with any other lines, to make our offer at once, on the lowest basis we can afford, two cents per word, counting address and signature, for our entire line through Baltimore, New York, Philadelphia, or Boston, and everything intermediate.

Yours respectfully,

GEORGE H. ELLERY,
President.

Captain H. W. HOWGATE,
Acting Signal Officer and Assistant.

SUB-PAPER 5.

Memorandum of Hon. W. Whiting, filed with Chief Signal Officer, after interview with the General Superintendent of Franklin Telegraph Company.

The Franklin Telegraph Company, represented by J. G. Smith, general superintendent, agree to the rates for the general business of the Department, as proposed by us.

W. WHITING.

JUNE 26, 1871.

SUB-PAPER 6.

Rights of the Government against the telegraph companies in relation to priority of service and the mode of payment therefor, as stated by Mr. Whiting, and assented to by the Western Union Telegraph Company.

Whereas questions have heretofore arisen between the Departments of the Government and certain telegraph companies, in respect to the obligations imposed by law upon such companies as have filed their written acceptance with the Postmaster General of the restrictions and obligation of the act of Congress approved July 24, 1866, entitled "An act to aid in the construction of telegraph-lines, and to secure to the Government the use of the same for postal, military and other purposes;" in order to prevent future misunderstandings, it is claimed by Mr. Whiting, acting on behalf of the United States, as assistant to the Attorney General of the United States, that, by the true interpretation of the aforesaid statute, all telegraphic communications in relation to the affairs or business of the United States, by its civil or military officers, agents, or employés, are entitled, in their transmission over the telegraphic lines of said companies, to priority over all other business; also, that said companies are not entitled to receive prepayment therefor, but are bound to receive compensasation therefor, at rates to be annually fixed by the Postmaster General.

The Western Union Telegraph Company will make no objection to this construction of the said statute.

THE WESTERN UNION TELEGRAPH COMPANY,
By WILLIAM ORTON, *President.*
WILLIAM WHITING, *Assistant to the Attorney General, &c.*

WASHINGTON, *June* 24, 1871.

PAPER 36.

Rates of pay for communications by telegraph, 1871–'72.

POST-OFFICE DEPARTMENT, *June* 29, 1871.

Whereas, by the act of Congress approved July twenty-fourth, A. D. eighteen hundred and sixty-six, entitled "An act to aid in the construction of telegraph-lines, and to secure to the Government the use of the same for postal, military, and other purposes," in section second it is enacted that telegraphic communications between the several Departments of the Government of the United States and their officers and agents shall, in their transmission over the lines of said companies, have priority over all other business, and shall be sent at rates to be annually fixed by the Postmaster General:

Now, therefore, in pursuance and by virtue of the authority on me by said act conferred,

I, J. A. J. Creswell, Postmaster General of the United States, do hereby fix the rates at which the telegraphic communications aforesaid shall be sent, for the year commencing on the first day of July, A. D. eighteen hundred and seventy-one, as follows, namely:

The rate for all telegraphic communications known as the Signal-Service messages and reports shall be two cents for each word of said reports and messages for each circuit over which it may pass, in accordance with the schedule of circuits and plans of the Chief Signal Officer of the Army, which are now adopted or may hereafter be adopted by him for transmitting these dispatches, or such part thereof as he may designate, in such words or ciphers as may, from time to time, be directed by him. The amount thus estimated is to be taken in full payment for said dispatches, no additional allowance to be made for drops, office-messages, or other services or special facilities required by the Chief Signal Officer for the correct and prompt transmission of said Signal-Service messages and reports.

The rate for all telegraphic communications aforesaid, other than the said Signal-Service messages and reports, shall be as follows, viz: One cent per word for each circuit * through which it shall be transmitted, said rate to be computed subject to the following conditions, viz:

A distance of two hundred and fifty miles, as computed by the tables of the Post-Office Department, shall be deemed a circuit.

If, on computing circuits, there shall be found one or more circuits and a fraction of a circuit, such fraction shall be deemed a circuit.

If a communication shall be sent a distance less than two hundred and fifty miles, that distance shall be deemed a circuit.

All words of the communication transmitted are to be counted, excepting the date and place at which such communication is filed; no communication to be at a rate less than twenty-five cents.

JNO. A. J. CRESWELL,
Postmaster General.

POST-OFFICE DEPARTMENT,
Washington, D. C., July 29, 1871.

As a question has been raised in regard to the meaning of the last sentence of the concluding paragraph of the order issued by me, under date of June 29, 1871, concerning the rate to be charged for telegraphic communications between the officers and agents of the several Departments of the Government of the United States, which sentence is as follows, to wit: "no communication to be at a rate less than twenty-five cents," *it is hereby further ordered* that the same shall be construed as follows to wit:

All messages of less than twenty-five words, address and signature included, will be rated as if containing twenty-five words; but all messages exceeding twenty-five words will be rated by the exact number of words they contain, address and signature included.

JNO. A. J. CRESWELL,
Postmaster General.

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* The word "circuit," as here used, means, not a telegraphic circuit, but *a unit of distance of two hundred and fifty miles.*

PAPER 37.

FORM 18.—*Marine weather-record and log kept on board the steamer* ——, —— ——, *Captain, for the Chief Signal Officer of the Army.*

Year 1871. Day of the—		Mean time.		Position.		Ship's course and rate.	Wind.		Weather.	Temperature of—		Barometer.		State of the ocean.	Kind of clouds and direction of their motion.	Remarks.
Week.	Month.	Washington.	Greenwich.	Longitude.	Latitude.		True direction, not magnetic.	Force.		Air.	Wet bulb.	Attached thermometer.	Height of mercury.			

The Chief Signal Officer desires, by means of these reports, to extend over the ocean that system of synchronous observations which has already been established over the United States. It is for this reason that he is obliged to ask especially for observations made, as nearly as possible, exactly at the same moments as are those made by the stationary observers, *i. e.*, at 7.35 a. m., 4.35 p. m., and 11.35 p. m., Washington mean time, or at 12.43 p. m., 9.43 p. m., and 4.43 a. m., Greenwich mean time. Particular care is invited to this point, and to the correctness of the above record as to the day of the week and month.

Observations at intermediate hours are very desirable, but the above only are insisted upon. It is very important to compare the instruments with the standards used by the observers on land; and that, too, several times each year.

Further information may be found in the publications of the Signal Office, the Smithsonian Institution, the British Admiralty, and Meteorological Office.

The following terms are employed in describing the Winds, Weather, Ocean, Clouds, &c.

WIND.—BEAUFORT SCALE.

0—Calm.
1—Light Air.
2—Light Breeze.
3—Gentle Breeze.
4—Moderate Breeze.
5—Fresh Breeze.
6—Stormy Breeze.
7—Moderate Gale.
8—Fresh Gale.
9—Stormy Gale.
10—Whole Gale.
11—Storm.
12—Hurricane.

WEATHER.

Blue Sky. Overcast.
Detached Clouds. Squally.
Drizzling Rain. Snow or Rain.
Fog and Mist. Moist and Damp.
Haze and Smoke. Threatening.
Hail. Clearing.
Thunder and Lightning.

OCEAN.

Tranquil.
Smooth.
Rough.
Heavy Sea.
Short Sea.
Long Swells.

CLOUDS.

Fog.
Haze.
Stratus.
Cumulus.
Cirrus.
Scud.

PHENOMENA TO BE ESPECIALLY NOTED.

The veering and backing of the winds.
The lowest and highest readings of the barometer and thermometer. [day.
The maximum wind during a gale, or during the
The diurnal changes in the winds.
The existence of several currents of clouds.
The weather attending auroras.
The prognostics of weather-changes.

DIRECTIONS.

This sheet of observations is to be sent as soon as practicable, by mail, to the Army Signal Office. It will pass free of postage within the U. S. if marked "Official."

PAPER 38.

Detailed synopsis and probabilities for Tuesday, October 31.

	Tuesday, October 31, 7.35 a. m.					
	Barometer.	Thermometer.	Winds.	Weather.	Humidity, per ct.	Rain.
San Francisco	30.19 S	53 S	N. Bk	Clear	0.73 Fn	0.00.
Rocky Mountains	30.38 S and 29.97 Fn	22 Fn and 17 S	N. 3 and NW. 2	Fair and clear	Bk and 0.67 S	0.00.
Central Valley	29.80 Fn-30.10 Fn	64 S-58 Rn and 35 S	SE. 7-NE. 1-10 and N. 19	Rain and T	0.89 Rn-0.80 Rn	D. and E.(?)0-0.20, and N. 1.00.
Gulf, western	30.08 Rn and 29.92 S	51 Fn and 68 S	NW. 16 and SE. 3	Clearing and cloudy	0.71 Fn-0.91 Rn	E. 0.03, and D. and E. 3.04.
Gulf, eastern	29.98 Fn-30.05 S	70 S-75 S and Rn	E. 6-0 and NE. 12	Cloudy	0.95 Rn	E. and N. 1.40-N. 0.01.
Key West	30.00 Rn	79 S	SE. 8	Hazy	0.75 Fn	0.00.
South Atlantic	30.15 Fn-30.31 Fn	70 S and 58 Rn	0-NE. 1	Cloudy and fair	0.95 Rn-0.90 Rn	0 and N.(?) 0.07.
Middle Atlantic	30.36 Fn-30.31 S	54 S-48 S	0 and SW. 2-11	Fair	0.95 Rn-0.85 Rn	0.60.
East Atlantic	30.31 S-30.20 S and Fn	52 Rn-42 S	SW. 11-0	Fair, cloudy, and smoky	0.85 Rn-0.70 Rn	0.00.
Ontario	30.20 S-30.23 S	47 S and 46 S	NW. and N. 4	Fair and cloudy	0.60 Fn & 0.77 Rn	0.00.
Erie	30.21 S-30.17 Fn	56 Rn-45 S	NE. 7-12	Rainy, cloudy, and smoky	0.90 Rn-0.80 Rn	0.00.
Huron	30.15 S-30.25 Fn and S					
Michigan	30.13 Fn-30.30 Fn	44 Rn-36 Rn	NE. 22-N. 5	Light rain and cloudy	0.93 Rn-0.90 Rn	N. 0.21-0.
Superior	30.26 Fn-30.36 Fn	36 Rn-28 S	0 and light	Cloudy	0.80 Rn	0.00.
Northwest	30.37 Fn-30.20 Fn	27 S-22 Fn	N. 5 and 12	Cloudy	0.88 S-0.77 Fn	0.00.

	Tuesday, October 31, 4.35 p. m.				Signals.	Note of reference.
	Barometer.	Thermometer.	Winds.	Weather.		
San Francisco						S, stationary; Fg, falling; Fn, fallen; Rg, rising; Rn, risen; D denotes that rains fell during the day; E denotes that rains fell during the evening; N denotes that rains fell during the night; I, safety; II, warning; T, threatening.
Rocky Mountains						
Central Valley	Fg and Rg	Rg and Fg	SE.-SW. and NW	Rain-clearing	II.	
Gulf, western	Rg	Fg	NW	Cloudy and clearing	II and I.	
Gulf, eastern	S and Fg	Rg	NE.-SE	Cloudy and rain	I.	
Key West						
South Atlantic	Fg	S and Rg	E	Rain and cloudy	I.	
Middle Atlantic	Fg	Rg	SE.-SW	Cloudy	I.	
East Atlantic	Fg	S	SW	Cloudy	I.	
Ontario	Fg	Rg	NE	Cloudy	I.	
Erie	Fg	Rg	NE.-SE	Rain and T	I and II.	
Huron	Fg				II and I.	
Michigan	Fg	Rg	NE	Rain and cloudy	II.	
Superior	Fg and S	Rg and S	NE. light and fresh	Cloudy and T	I.	
Northwest	Fg	S and Rg	NE.-NW	Cloudy	I.	

The highest pressure extends from North Carolina to New Jersey, and a similar area exists in the extreme northwest. The lowest barometer has advanced northwestward into Missouri, with brisk winds from Kansas to Michigan. Rising barometer with brisk northwest winds in Texas. The area of low barometer and rain will probably by this evening extend over Lakes Michigan and Ontario, and from the South Atlantic coast to the Ohio Valley.

PAPER 39—FORM 15.

This official report is furnished the press with the explicit understanding that it shall not be altered or garbled, and that any paper using it at all will follow the precise wording given below the line. There is danger that incorrect or altered reports may greatly mislead the public and bring discredit upon the service. Editors are requested to insist upon the accurate following of the copy.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
Washington, D. C., ——— —, 1871.

SYNOPSIS FOR THE PAST TWENTY-FOUR HOURS.

PROBABILITIES.

WARNING SIGNALS ORDERED.

PAPER 40.

[Circular.]

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE,
Washington, D. C., ——— —, 1871.

SIR: Under a joint resolution of Congress approved February 9, 1870, a copy of which is hereto annexed, the duty was imposed upon the Secretary of War of causing meteorological observations to be taken, and of giving notice by telegraph and signal of the approach and force of storms. By order of the Secretary of War, the Chief Signal Officer of the Army is specially charged with the execution of this duty.

It will be observed that the language and original intent of the resolution contemplated directly the benefit of the commerce of the United States. Indirect advantage would naturally accrue to other industries, but it is certain that the reports of this division may be made directly useful to agriculture, since, after sufficient notice, the operations of the farm might frequently be so ordered as to avoid the serious losses occasioned by storms. It is also true that the observations taken and made public, which involve particulars regarding heat, moisture, wind, rain, cloud, and electricity, from which statistics valuable for particular localities are compiled, and general laws relating to climate can be deduced, must be of importance to every scientific or intelligent agriculturist.

The Secretary of War has directed the Chief Signal Officer to render the work of this division available for the benefit of agriculture, to the full extent of the power so far granted by law and of the facilities attained or attainable by this office, the latter being limited by the appropriations made or to be made by Congress.

The following-named stations are now established, viz.:

Portland, Maine.
Boston, Massachusetts.
New London, Connecticut.
New York City, New York.
Philadelphia, Pennsylvania.
Baltimore, Maryland.
Washington, District of Columbia.
Wilmington, North Carolina.
Charleston, South Carolina.
Norfolk, Virginia.
Oswego, New York.
Rochester, New York.
Buffalo, New York.
Cleveland, Ohio.
Toledo, Ohio.
Detroit, Michigan.
Chicago, Illinois.
Milwaukee, Wisconsin.
Grand Haven, Michigan.
Escanaba, Michigan.
Marquette, Michigan.
Davenport, Iowa.
Leavenworth, Kansas.
Cairo, Illinois.
Cape May, New Jersey.
Galveston, Texas.
Memphis, Tennessee.
Savannah, Georgia.
Augusta, Georgia.
Lake City, Florida.
Key West, Florida.
Mobile, Alabama.
New Orleans, Louisiana.
San Francisco, California.
Jacksonville, Florida.
San Diego, California.
Santa Fé, New Mexico.
St. Paul, Minnesota.
Du Luth, Minnesota.
Pittsburgh, Pennsylvania.
Knoxville, Tennessee.
Indianapolis, Indiana.
Lynchburgh, Virginia.
Burlington, Vermont.
Vicksburgh, Mississippi.
Portland, Oregon.
Denver, Colorado.
Nashville, Tennessee.
Cincinnati, Ohio.
St. Louis, Missouri.
Omaha, Nebraska.
Cheyenne, Wyoming Territory.
Corinne, Utah.
Mt. Washington, New Hampshire.
Louisville, Kentucky.
Fort Benton, Montana Territory.
Virginia City, Montana Territory.

It is intended to increase this number gradually, as the requisite telegraphic connections can be obtained, and competent observers can be enlisted and instructed.

At every station three synchronous observations are taken daily and telegraphed immediately to the central office; being also published in whole or in part at other stations. At all stations bulletins are issued within an hour after each of the three daily reports are received, and, besides being posted in public places, are furnished gratuitously to the press—the morning bulletin for the afternoon, and that of midnight for the morning papers. At the more important stations, a weather-map is also issued each morning. A copy of the weather-map and bulletin of this date is inclosed herewith.

A paper showing the synopsis and probabilities of the weather is also prepared at this office immediately after the reception of each of the three above-mentioned reports, and is furnished the Associated Press for distribution throughout the United States.

In addition to the above-mentioned observations, three others are taken at intermediate

hours, the reports of which are not telegraphed, but mailed and recorded, and, embracing further particulars, are specially designed for use in obtaining local statistics and establishing meteorological laws.

That part of the duty required by law "to give notice on the northern lakes and the seaboard, by magnetic telegraph and marine signals, of the approach and force of storms," will, on the display of signals on the shores mentioned, (for which arrangements are now in progress,) be in regular performance. It is, however, the desire and intention of this office to perform its duties, under the instructions received, in such manner as will be most useful also to the agricultural interests, and the intelligent views of gentlemen interested in the latter, as to such modifications of, or additions to, the present work as can consistently be adopted, with the above-mentioned object, are invited and will be attentively considered.

It is believed that the co-operation of agricultural and horticultural societies with this office will best conduce to success in the object to be attained, and it is suggested that practical form be given to such co-operation by the appointment, on the part of your society, of a permanent committee to confer from time to time with the Chief Signal Officer of the Army, and to take, in conjunction with him, such steps, or to recommend for the consideration of the society such action, as may be deemed desirable. Committees of a similar character have been appointed by many of the boards of trade and chambers of commerce throughout the country, with great benefit to this service as specially relating to commerce, and it is hoped that a corresponding advantage will be obtained from the selected intelligence of gentlemen interested in agriculture.

I am, sir, very respectfully, your obedient servant,

ALBERT J. MYER,
Brig. Gen., and Chief Signal Officer of the Army.

Mr. H. T. HENNING,
Secretary of the Carver County Agricultural Society, Carver, Minn.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION to authorize the Secretary of War to provide for taking meteorological observations at the military stations and other points in the interior of the continent, and for giving notice on the northern lakes and seaboard of the approach and force of storms.

Be it resolved by the Senate and House of Representatives of the United States of America in Congress assembled. That the Secretary of War be, and he hereby is, authorized and required to provide for taking meteorological observations at the military stations in the interior of the continent, and at other points in the States and Territories of the United States, and for giving notice on the northern lakes and on the sea coast, by magnetic telegraph and marine signals, of approach and force of storms.

Approved February 9, 1870.

PAPER 41.

[Circular.]

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE,
Washington, D. C., ———, 1871.

SIR: By direction of the Chief Signal Officer of the Army, I have the honor to acknowledge and answer your communication to him of September 3, 1871, and to express his gratification at the action of the Pike County Agricultural Society in appointing your permanent committee to confer with this office, on the subjects mentioned in his circular addressed to its secretary.

The places now occupied as stations of this division were selected as of most immediate importance for meteorological purposes, combined with telegraphic facilities, and those which are gradually to be added during this year are already designated by the Secretary of War, for similar reasons, with a design to perfect the net-work of the system so far as the appropriation allows. There is, as yet, no provision for furnishing instruments to any other than the observer-sergeants, although it is probable that some such authority may hereafter be given.

Reports of observations would not be of use for the immediate purposes of this division, except as made and telegraphed according to the plans adopted, (which cannot be understood and executed without special instruction,) to do which requires the whole time of an industrious man—indeed, at most stations two instructed men are necessary. All records of meteorological observations carefully made will, however, be thankfully received, and examined with reference to the study of the science, verification of the theories entertained, and use in the publications contemplated.

It is obvious that this office is not now able to establish meteorological stations at all the points where, with increased facilities, observations could be made, and the reports of others directly received, with advantage both to the interest of agriculture and commerce. The present system is, however, so far complete—the bulletins being published at already fifty stations throughout the country, and furnished gratuitously to the local press—that at most places a newspaper can be obtained which contains a bulletin issued by this office, of that day's observations, from which, and the inclosed circular upon the practical uses of meteorological reports and weather-maps, the more important deductions can be made. If at the station nearest to you a newspaper does not print the bulletins furnished to it, there is a strong probability that, upon proper application and effort of the society you represent, it would do so. It is also supposed that in cases where delay could thereby be avoided, persons interested could make arrangements with the publisher to have copies of the newspaper containing bulletins sent in advance of its delivery by mail.

By taking advantage of these publications, gentlemen in your position can make forecasts for themselves, and furnish information to localities which cannot be reached by the "synopsis and probabilities" from this office without such delay as would defeat the object, and a local station of the society itself, which undoubtedly would be useful for its purposes, would thus be established by its committee.

Independently of plans for the future not immediately practicable, but proper to be considered with reference to enlarged facilities hoped for, this office would be gratified to receive any suggestions from your committee as to further utilizing those now existing.

I am, sir, respectfully yours,

GARRICK MALLERY,

Capt. 1st Inf., Brt. Lt. Col. U. S. A., Acting Signal Officer and Assistant.

Mr. J. S. POPE, *Chairman Meteorological Committee,*
Pike County Agricultural Society, Zebulon, Ga.

NOTE.—The following are the places now occupied by stations of this division. At all of them bulletins are issued, giving the following particulars, viz: Height of barometer; change since last report; thermometer; change in last 24 hours; relative humidity, in per cent.; direction of wind; velocity of wind, in miles per hour; pressure of wind, in pounds per square foot; force of wind, reduced to Beaufort scale; amount of cloud; rain-fall since last report, in inches and hundredths, and state of weather.

At those places marked with a star, the number of reports received and published in the bulletin is sufficiently large to be used in the manner pointed out in the "suggestions."

* Portland, Maine.
* Boston, Massachusetts.
* New London, Connecticut.
* New York City, New York.
* Philadelphia, Pennsylvania.
* Baltimore, Maryland.
* Washington, District of Columbia.
* Wilmington, North Carolina.
* Charleston, South Carolina.
* Savannah, Georgia.
* Augusta, Georgia.
Lake City, Florida.
Key West, Florida.
* Mobile, Alabama.
* New Orleans, Louisiana.
San Francisco, California.
* Norfolk, Virginia.
Mt. Washington.
Jacksonville, Florida.
San Diego, California.
Santa Fé, New Mexico.
* Oswego, New York.
* Rochester, New York.
* Buffalo, New York.
* Cleveland, Ohio.
* Toledo, Ohio.
* Detroit, Michigan.
* Chicago, Illinois.
* Milwaukee, Wisconsin.
* St. Paul, Minnesota.
* Du Luth, Minnesota.
* Pittsburgh, Pennsylvania.
Knoxville, Tennessee.
* Indianapolis, Indiana.
Lynchburgh, Virginia.
Burlington, Vermont.
* Keokuk, Iowa.
* Grand Haven, Michigan.
* Vicksburgh, Mississippi.
Portland, Oregon.
Denver, Colorado.
Escanaba, Michigan.
Marquette, Michigan.
* Davenport, Iowa.
* Leavenworth, Kansas.
* Cairo, Illinois.
* Cape May, New Jersey.
* Galveston, Texas.
* Montreal, Canada.
Punta Rassa, Florida.
* Memphis, Tennessee.
* Nashville, Tennessee.
* Cincinnati, Ohio.
* St. Louis, Missouri.
Omaha, Nebraska.
Cheyenne, Wyoming Territory.
Corinne, Utah.
Shreveport, Louisiana.
* Louisville, Kentucky.
Fort Benton, Montana.
Virginia City, Montana.

PAPER 42.—FORM 14.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

INSPECTION REPORT.

Diagrams of office, giving dimensions, number, and location of doors and windows. Position of instruments to be marked.	Name and number of street on which office is situated.	Price paid for rent of office, (per month.)	Name and address of person or persons from whom office is rented.
		Elevation of station above mean tide level.	Authority.

REMARKS UPON THE LOCATION OF OFFICE.

INSTRUMENTS.

Name.	Barometer.	Thermometer.	Hygrometer.	Anemometer.	Wind-vane.	Rain-gauge.	Kind of shelter, size and location, with position of instruments.
Number.....							
Elevation above the ground.....							
Condition.....							

REMARKS.

OFFICE FURNITURE.

Name.	Desks.	Tables.	Chairs.	Stoves.	Pails.	Brooms.	Bulletin-boards.	Clock.									
Number.....																	
Condition.....																	

REMARKS.

NOTE.—State how fuel and lights are obtained.

BOOKS OF REFERENCE AND RECORD, AND FORMS

Name.	Daily journal.	Bulletin-books.		Letters sent.	Letters received.	Buchan.	Loomis.	Guyot.	Myer.	Smithsonian.	Form 1.	Form 2.	Form 3.	Form 4.	Form 5.	Form 6.	Form 7.	Form 7b.	Form 8.	Form 9.
Number																				
Condition																				

REMARKS.

BULLETINS.

Number issued of a. m. reports.	Where posted.	Number issued of p. m. reports.	Where posted.	Number issued of night reports.	Where posted.

REMARKS.

NOTE.—The style, size, and general appropriateness of the bulletin-boards should be stated,

PRESS REPORTS.

Number of papers supplied with 7.35 a. m. reports.	Names of papers.	Number supplied with 4.35 p. m. reports.	Names of papers.	Number supplied with 11.35 p. m. reports.	Names of papers.

REMARKS.

MANIFOLD MAPS.

Number issued.	Where posted.	Condition.

REMARKS.

GENERAL REMARKS AND SUGGESTIONS.

DATE _____

STATION _____

_____
U. S. A., A. S. O. and Inspector.

PAPER 43.—FORM 1.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

Report of observations taken at ——————, *on* ————— *at* ————— *M.*

1						
2						
3						
4						

Received from observer at ————— M ——. ——————, *Observer.*

——————, *Operator.*

NOTE.—Operators will send the numeral *words* and not the figures, which are written as a *check* on the words. The numbers must always consist of five figures each. They will send only the matter inside the heavy lines, without address or signature.

PAPER 44.—FORM 2.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

Telegraphic report of observations received at _____.

DATE: _____ TIME: _____

Received from operator at _____ M. _____.

_____

PAPER 45.—FORM 3.—DAILY BULLETIN.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

Meteorological record, ————, 187 , —— *M.*

(Observations taken at the same moment of time at all stations.)

Place of observation.	Height of barometer.	Change since last report.	Thermometer.	Change in last 24 hours.	Relative humidity. Per cent.	Direction of wind.	Velocity of wind. Miles per hour.	Pressure of wind. Pounds per square foot.	Force of wind reduced to Beaufort scale. (Approximately.)	Amount of cloud.	Rain-fall since last report. Inches and hundredths.	State of weather.
Albany, N. Y.												
Augusta, Ga.												
Baltimore, Md												
Boston, Mass.												
Burlington, Vt.												
Buffalo, N. Y												
Cape May, N. J.												
Cairo, Ill.												
Charleston, S. C.												
Cheyenne, Wyo.												
Chicago, Ill.												
Cincinnati, Ohio												
Cleveland, Ohio												
Corinne, Utah												
Davenport, Iowa												
Denver, Col.												
Detroit, Mich.												
Des Moines, Iowa												
Du Luth, Minn												
Escanaba, Mich.												
Fort Benton, M. T.												
Galveston, Tex												
Grand Haven, Mich.												
Indianapolis, Ind.												
Jackson, Miss												
Keokuk, Iowa												
Key West, Fla.												
Knoxville, Tenn												
Lake City, Fla.												
Leavenworth, Kans.												
Louisville, Ky.												
Lynchburgh, Va.												
Marquette, Mich.												
Memphis, Tenn.												
Milwaukee, Wis												
Mobile, Ala.												
Montgomery, Ala.												
Mt. Washington, N. H												
Nashville, Tenn.												
New London, Conn.												
New Orleans, La.												
New York, N. Y.												
Norfolk, Va.												
Omaha, Nebr												
Oswego, N. Y.												
Philadelphia, Pa.												
Pittsburgh, Pa.												
Portland, Me												
Portland, Oreg.												
Punta Rassa, Fla												
Rochester, N. Y												

PUBLISHED BY ORDER OF THE SECRETARY OF WAR.

NOTE.—Barometer corrected for temperature and elevation. Reports are received over circuits arranged at the War Department with the Western Union, Northwestern, and International Ocean Telegraph Companies, and are furnished gratuitously to such newspapers as desire to publish them for the benefit of their readers.

PAPER 46.—FORM 4.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

Meteorological record for the —— ending ——, ——.

Date of observation.	Time of observation.	Height of barometer.	Height of attached thermometer.	Height of exposed thermometer.	Reduced barometer.	Hygrometer. (Open air.)		Relative humidity.	Direction of wind.	Velocity of wind in miles per hour.	Daily velocity of wind.	Pressure of wind. Lbs. per sq. foot.	Amount of cloud.	Direction in which upper clouds move.	Rain (or snow) commenced. (Time.)	Rain (or snow) ended. (Time.)	Amount of rain or melted snow.	Remarks.
						Dry-bulb.	Wet-bulb.											

PAPER 47.—FORM 5.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

Report of observations taken at ————, *on* ————, *at* ————.

1						
2						

Received from observer ———— M ————.

———————— *Operator.*

———————— *Observer.*

NOTE.—Operators will send the numeral *words* and not the figures, which are written as a *check* on the words. The numbers must always consist of five figures each. They will send only the matter inside the heavy lines, without address or signature.

PAPER 48.—FORM 6.

Received at ———, this ——— day of ———, 187—, of ——— ———, the following articles of Government property pertaining to the Signal Service, U. S. A., Division of Telegrams and Reports for the Benefit of Commerce, viz:

No.	Articles.	Style.	Condition.
....	Barometers		
....	Thermometers		
....	Hygrometers		
....	Anemometers		
....	Rain-gauges		
....	Measuring-sticks		
....	Sections battery		
....			
....			
....			
....			
....			
....	Copies Loomis's Meteorology		
....	Copies Manual of Signals		
....			
....			
....	Journal		
....	Daily record observations		
....	Record of telegrams sent		
....	Record of bulletins		
....	Record of letters sent		
....	Record of letters received		
....			
....	Form No. 1		
....	Form No. 1		
....	Form No. 2		
....	Form No. 3		
....	Form No. 4		
....	Form No. 5		
....	Form No. 5		
....	Form No. 6		
....			
....			
....			
....			
....			
....			
....			

——— ———,
United States Army.

PAPER 49.—FORM 7.

WEATHER-REPORT.

_____, 187 , _____ M.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

Place of observation.	Height of barometer.	Change in last 7 hours.	Thermometer, degrees.	Change in last 24 hours.	Direction of wind.	Force of wind.	Relative humidity, per cent.	State of weather.
Albany, N. Y								
Augusta, Ga								
Baltimore, Md								
Boston, Mass								
Burlington, Vt								
Buffalo, N. Y								
Cape May, N. J								
Cairo, Ill								
Charleston, S. C								
Cheyenne, Wyo								
Chicago, Ill								
Cincinnati, Ohio								
Cleveland, Ohio								
Corinne, Utah								
Davenport, Iowa								
Denver, Col								
Detroit, Mich								
Des Moines, Iowa								
Du Luth, Minn								
Escanaba, Mich								
Fort Benton, Mont								
Galveston, Tex								
Grand Haven, Mich								
Indianapolis, Ind								
Jackson, Miss								
Keokuk, Iowa								
Key West, Fla								
Knoxville, Tenn								
Lake City, Fla								
Leavenworth, Kans								
Louisville, Ky								
Lynchburgh, Va								
Marquette, Mich								
Memphis, Tenn								
Milwaukee, Wis								
Mobile, Ala								
Montgomery, Ala								
Mt. Washington, N. H								
Nashville, Tenn								
New London, Conn								
New Orleans, La								
New York, N. Y								
Norfolk, Va								
Omaha, Nebr								
Oswego, N. Y								
Philadelphia, Pa								
Pittsburgh, Pa								
Portland, Me								
Portland, Oreg								
Punta Rassa, Fla								
Rochester, N. Y								
San Diego, Cal								
San Francisco, Cal								
Santa Fé, N. Mex								
Savannah, Ga								
Shreveport, La								
St. Louis, Mo								
St. Paul, Minn								
Toledo, Ohio								
Washington, D. C								
Wilmington, N. C								

NOTE.—Barometer corrected for temperature and elevation.

FORM 7*b*.

WEATHER-REPORT.

———————, 187 , ——— *M.*

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

[Observations taken at the same moment of time at all stations. Snow and hail are reduced to rain.]

The following is the official meteorological record for the twenty-four (24) hours ending ——— m, ——— time. The table shows the height of the barometer and thermometer at the hours named, and also the amount of rain-fall for the twenty-four (24) hours ending at ——— a. m.

Place of observation.	BAROMETER.			THERMOMETER.			RAIN.
	a. m.	p. m.	m.	a. m.	p. m.	m.	Inches.
Albany, N. Y							
Augusta, Ga							
Baltimore, Md							
Boston, Mass							
Burlington, Vt							
Buffalo, N. Y							
Cape May, N. J							
Cairo, Ill							
Charleston, S. C							
Cheyenne, Wyo							
Chicago, Ill							
Cincinnati, Ohio							
Cleveland, Ohio							
Corinne, Utah							
Davenport, Iowa							
Denver, Col							
Detroit, Mich							
Des Moines, Iowa							
Du Luth, Minn							
Escanaba, Mich							
Fort Benton, Mont							
Galveston, Tex							
Grand Haven, Mich							
Indianapolis, Ind							
Jackson, Miss							
Keokuk, Iowa							
Key West, Fla							
Knoxville, Tenn							
Lake City, Fla							
Leavenworth, Kans							
Louisville, Ky							
Lynchburgh, Va							
Marquette, Mich							
Memphis, Tenn							
Milwaukee, Wis							
Mobile, Ala							
Montgomery, Ala							
Mt. Washington, N. H							
Nashville, Tenn							
New London, Conn							
New Orleans, La							
New York, N. Y							
Norfolk, Va							
Omaha, Nebr							
Oswego, N. Y							
Philadelphia, Pa							
Pittsburgh, Pa							
Portland, Me							
Portland, Oreg							
Punta Rassa, Fla							
Rochester, N. Y							
San Diego, Cal							
San Francisco, Cal							
Santa Fé, N. Mex							
Savannah, Ga							
Shreveport, La							
St. Louis, Mo							
St. Paul, Minn							
Toledo, Ohio							
Washington, D. C							
Wilmington, N. C							

FORM 7*b*.

The following shows the state of the Wind and Weather at the same stations. The letters on the left-hand side of each column show the direction of the Wind; the following figure or figures, the velocity of the Wind in miles per hour; and the last letter the state of the Weather; c stands for clear, f for fair, d for dark (cloudy,) D for very cloudy, r for light rain, R for heavy rain, s for snow, h for hail, G for gale, and GG for great gale:

Place.	A. M.	P. M.	M.
Albany, N. Y.			
Augusta, Ga			
Baltimore, Md			
Boston, Mass.			
Burlington, Vt.			
Buffalo, N. Y.			
Cape May, N. J			
Cairo, Ill			
Charleston, S. C			
Cheyenne, Wyo			
Chicago, Ill			
Cincinnati, Ohio			
Cleveland, Ohio			
Corinne, Utah			
Davenport, Iowa			
Denver, Col			
Detroit, Mich			
Des Moines, Iowa			
Du Luth, Minn			
Escanaba, Mich			
Fort Benton, Mont			
Galveston, Tex			
Grand Haven, Mich			
Indianapolis, Ind			
Jackson, Miss			
Keokuk, Iowa			
Key West, Fla			
Knoxville, Tenn			
Lake City, Fla			
Leavenworth, Kans			
Louisville, Ky			
Lynchburgh, Va			
Marquette, Mich			
Memphis, Tenn			
Milwaukee, Wis			
Mobile, Ala			
Montgomery, Ala			
Mt. Washington, N. H			
Nashville, Tenn			
New London, Conn			
New Orleans, La.			
New York, N. Y			
Norfolk, Va			
Omaha, Nebr			
Oswego, N. Y			
Philadelphia, Pa			
Pittsburgh, Pa			
Portland, Me			
Portland, Oreg			
Punta Rassa, Fla			
Rochester, N. Y			
San Diego, Cal			
San Francisco, Cal			
Santa Fé, N. Mex			
Savannah, Ga			
Shreveport, La			

FORM 7*b*.—Continued

Place.	A. M.	P. M.	M.
St. Louis, Mo			
St. Paul, Minn			
Toledp, Ohio			
Washington, D. C			
Wilmington, N. C			

NOTE.—Barometer corrected for temperature and elevation. Reports are received over circuits arranged at the War Department with the Western Union, International Ocean, and Northwestern Telegraph Companies, and are furnished gratuitously to such newspapers as desire to publish them for the benefit of their readers.

PAPER 50.—FORM 8.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS.

Telegraphic Record, ———— 187—, ————M.

Report from station.	Office received from.	Time received.	Sending operator.	Receiving operator.	No. words regular report.	No. words late reports.	Time occupied.	Explanations.
25								
24								
23								
13								
15								
40								
39								
38								
68								
67								
66								
37								
36								
35								
34								
41								
33								
32								
31								
28								
27								
26								
63								
65								
19 sent to								

PAPER 51.—FORM 9.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

Operator's wire report, ————, 187–, ——*m*.

PAPER 52.—FORM 10.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

Telegram.] *Washington, D. C.*, ————, 187–, ——*m*.

To —— ——:

PAPER 53.—FORM 11.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE,

Telegram.] *Washington, D. C.*, ————, 187–, ——*m*.

From ————.

To —— ——:

PAPER 54.—FORM 12.

DIVISION OF TELEGRAMS AND REPORTS.

Telegrapic record, ——— ———, 187–, ———*m*.

Report from station.	Office received from.	Time received.	Sending operator.	Receiving operator.	Number words regular report.	Number words late report.	Time occupied.	Explanations.
25								
24								
22								
23								
21								
20								
30								
42								
44								
18								
17								
54								
12								
13								
14								
15								
27								
28								
29								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
43								
45								
46								
48								
49								
50								
51								
52								
53								
55								
62								
63								
65								
66								
67								
68								
70								
19 sent to								

PAPER 55.—FORM 13.

WAR DEPARTMENT, SIGNAL SERVICE UNITED STATES ARMY.

DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

Meteorological record of observations taken at ——, *from* —— *to* ——, 187–.

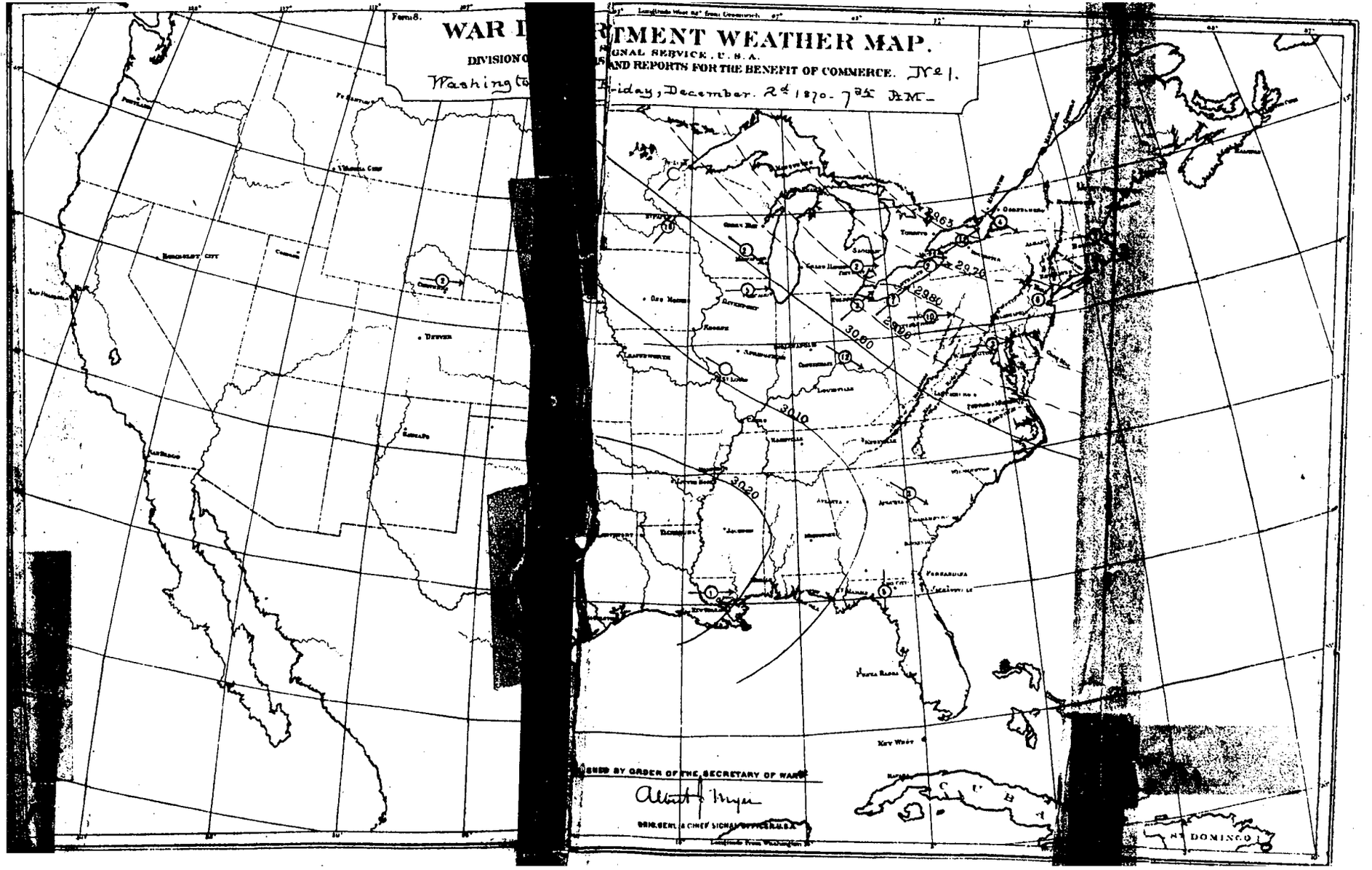
(Three observations taken daily, at ——, and ——, time being 7.35 a. m., 4.35 p. m., and 11.35 p. m., by Washington time.)

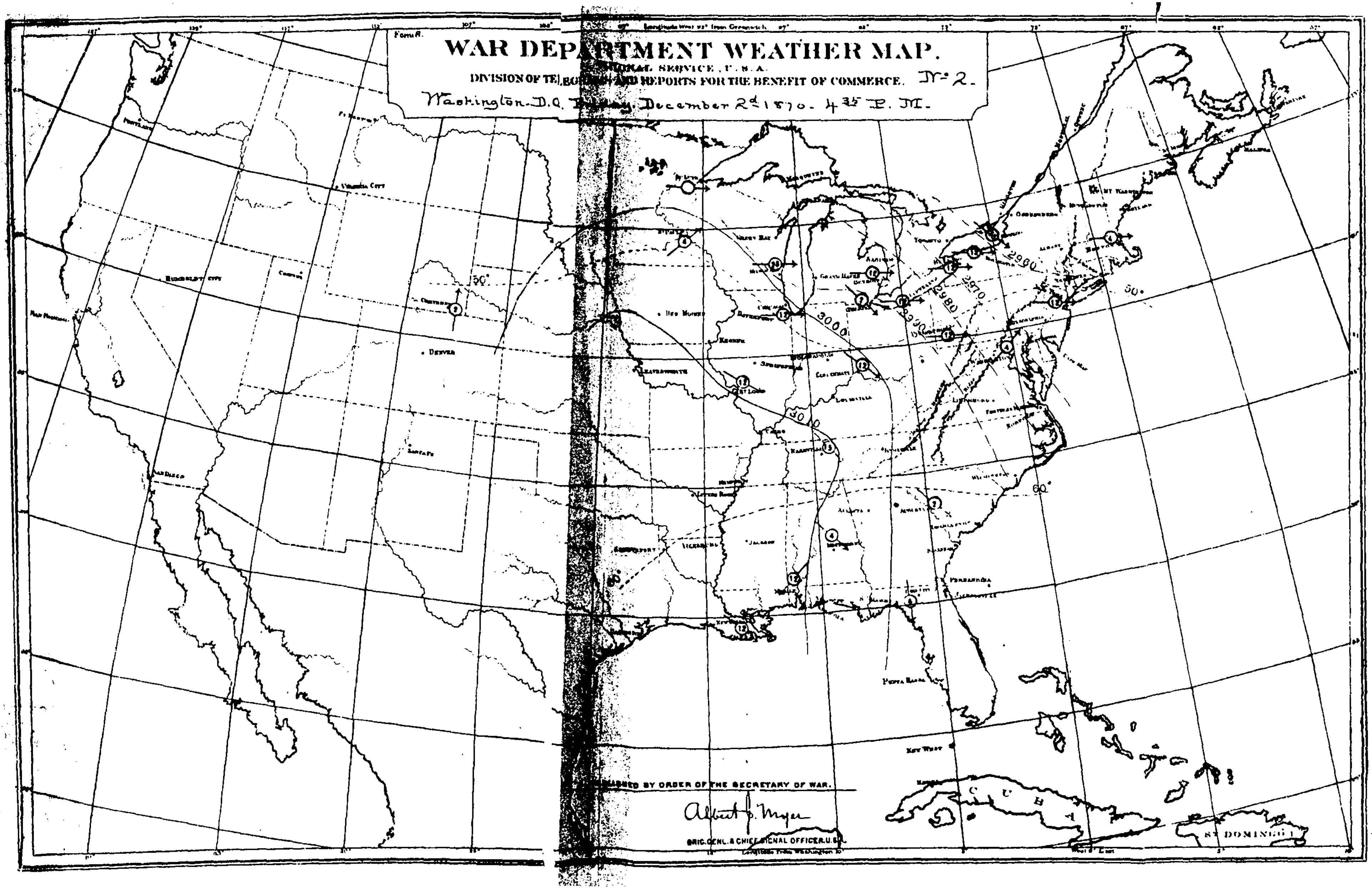
DATE.	Time.	Observed height of barometer.	Height of attached thermometer.	Barometer corrected for temperature and elevation.	Thermometer, (open-air.)	HYGROMETER.		Relative humidity, (per cent.)	Direction of wind.	Velocity of wind, (miles per hour.)	Pressure of wind, in pounds, (per square foot.)	Amount of sky covered with cloud.	Direction in which upper clouds move.	Rain (or snow) commenced.	Rain (or snow) ended.	Amount of rain or melted snow, (inches.)	Remarks.
						Dry.	Wet.										

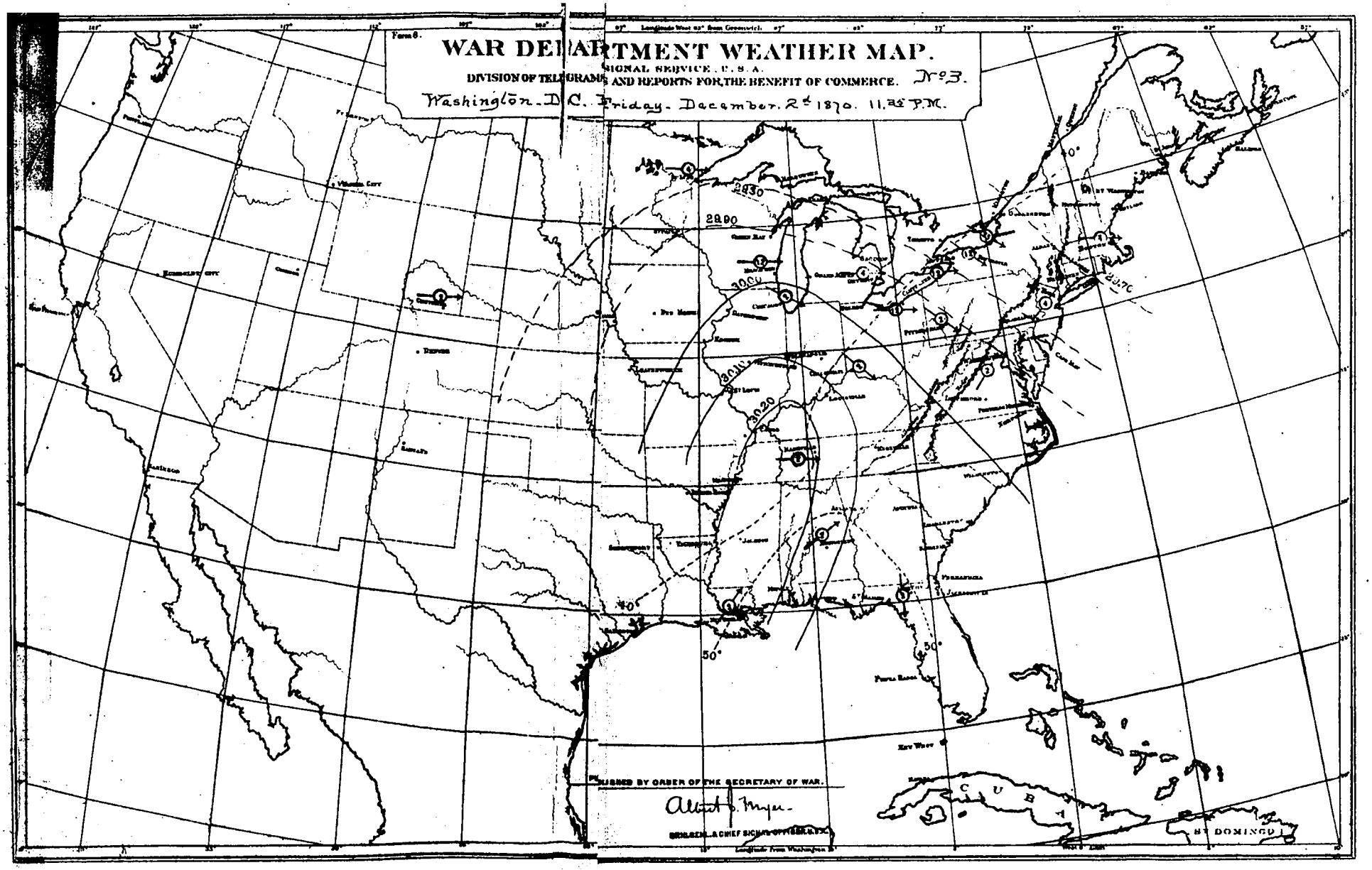
Elevation of station above sea-level _____

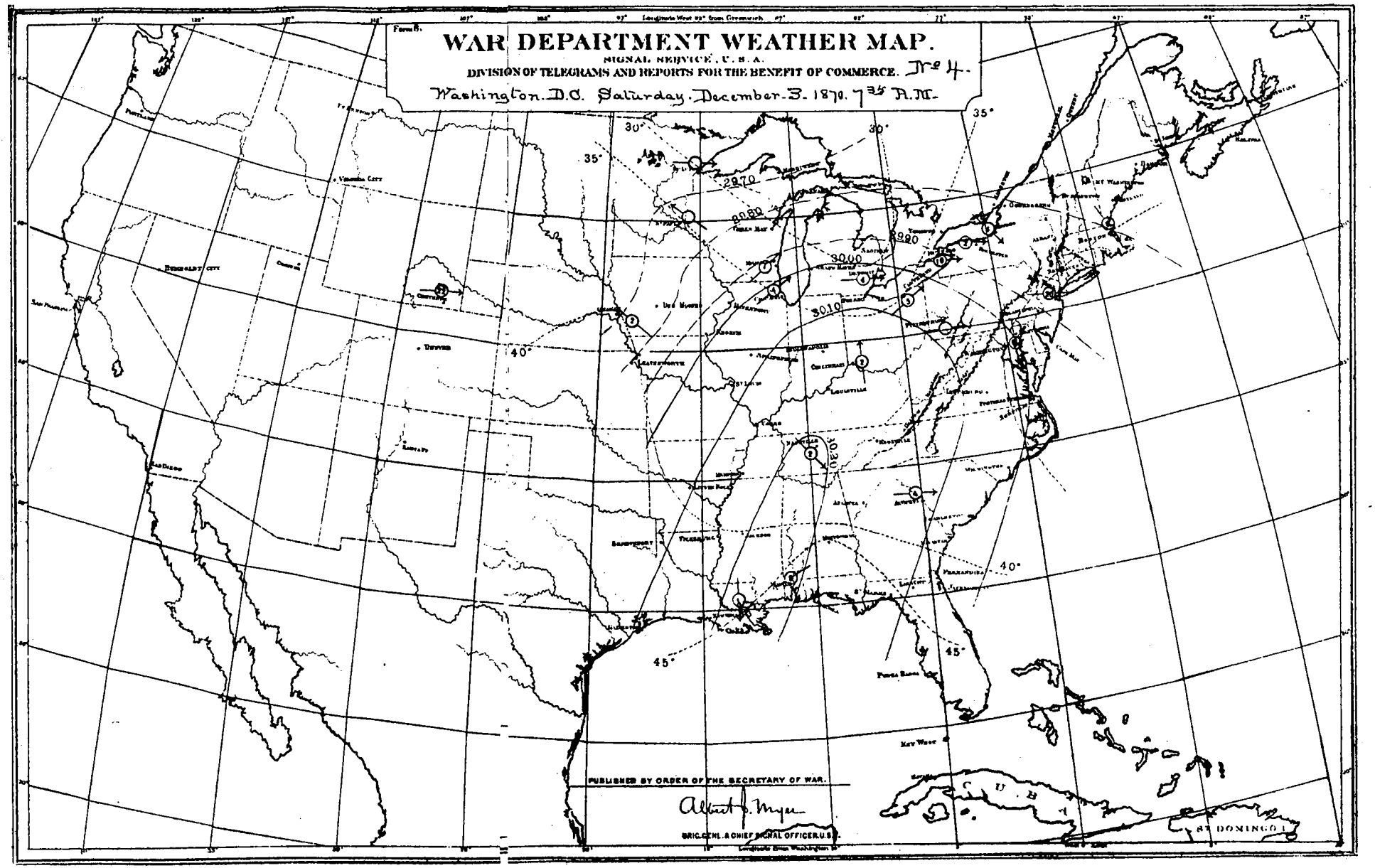
Elevation of instrument above ground _____

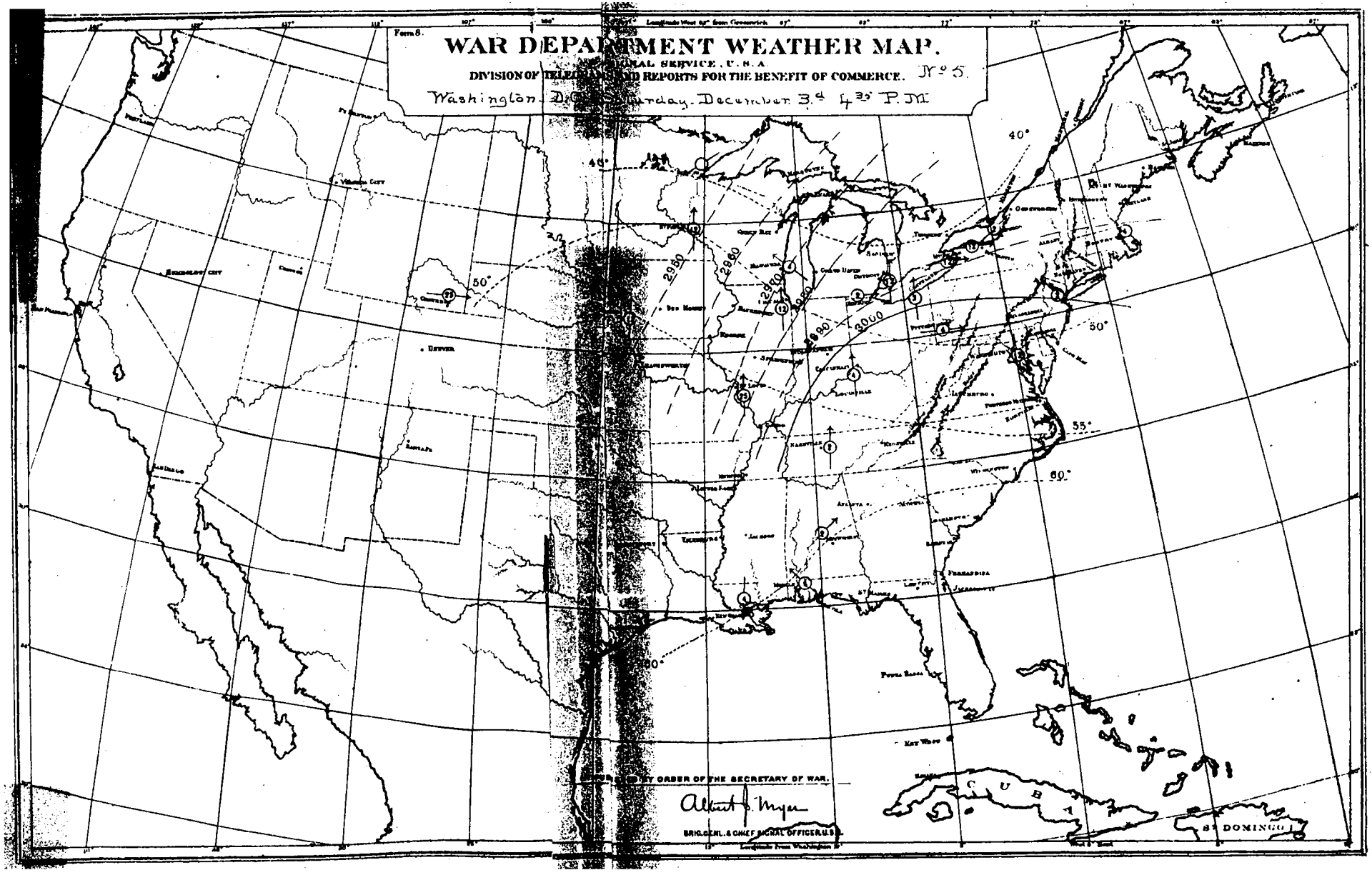
Letters
nos
Dec 1870 167

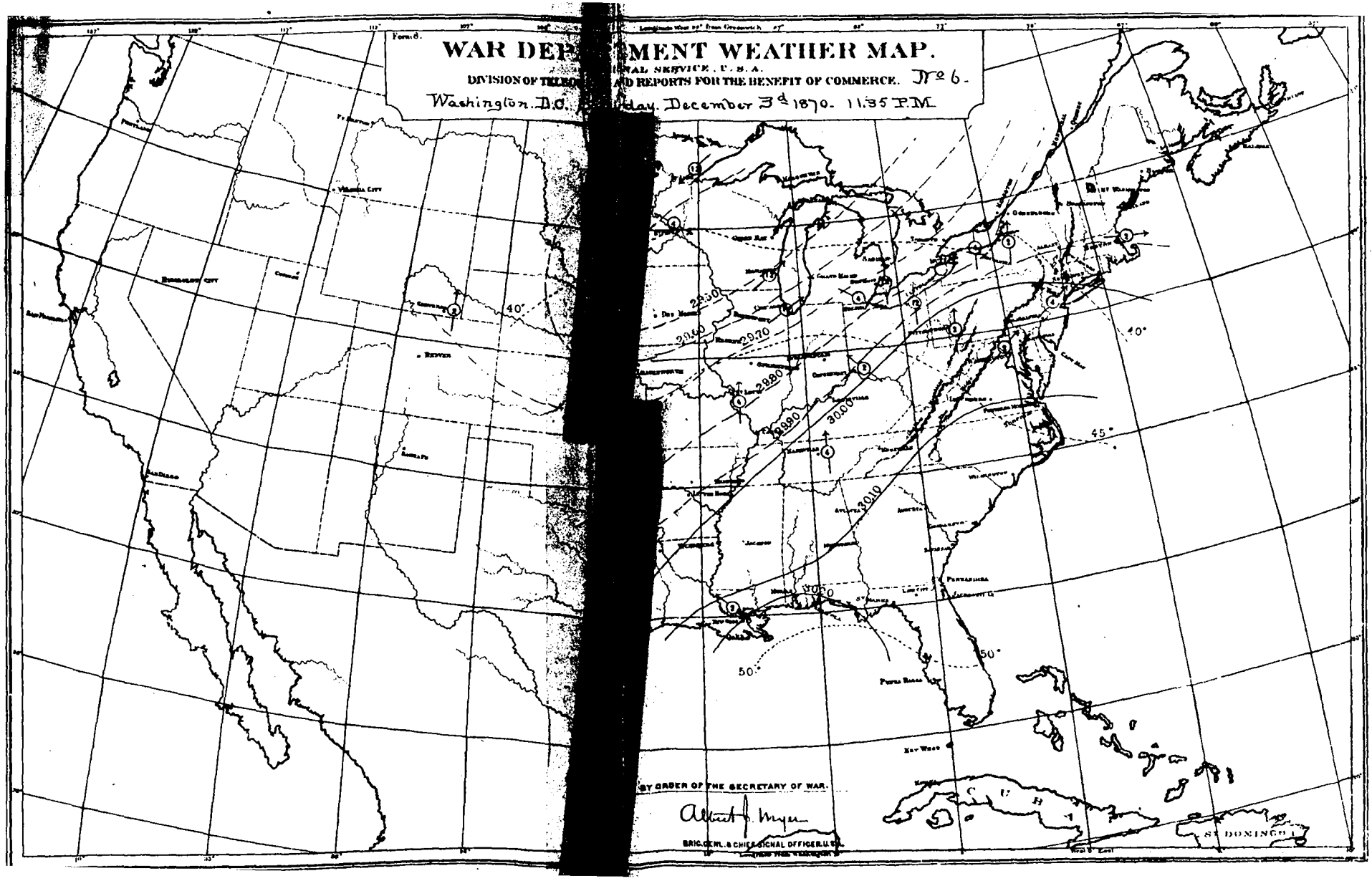


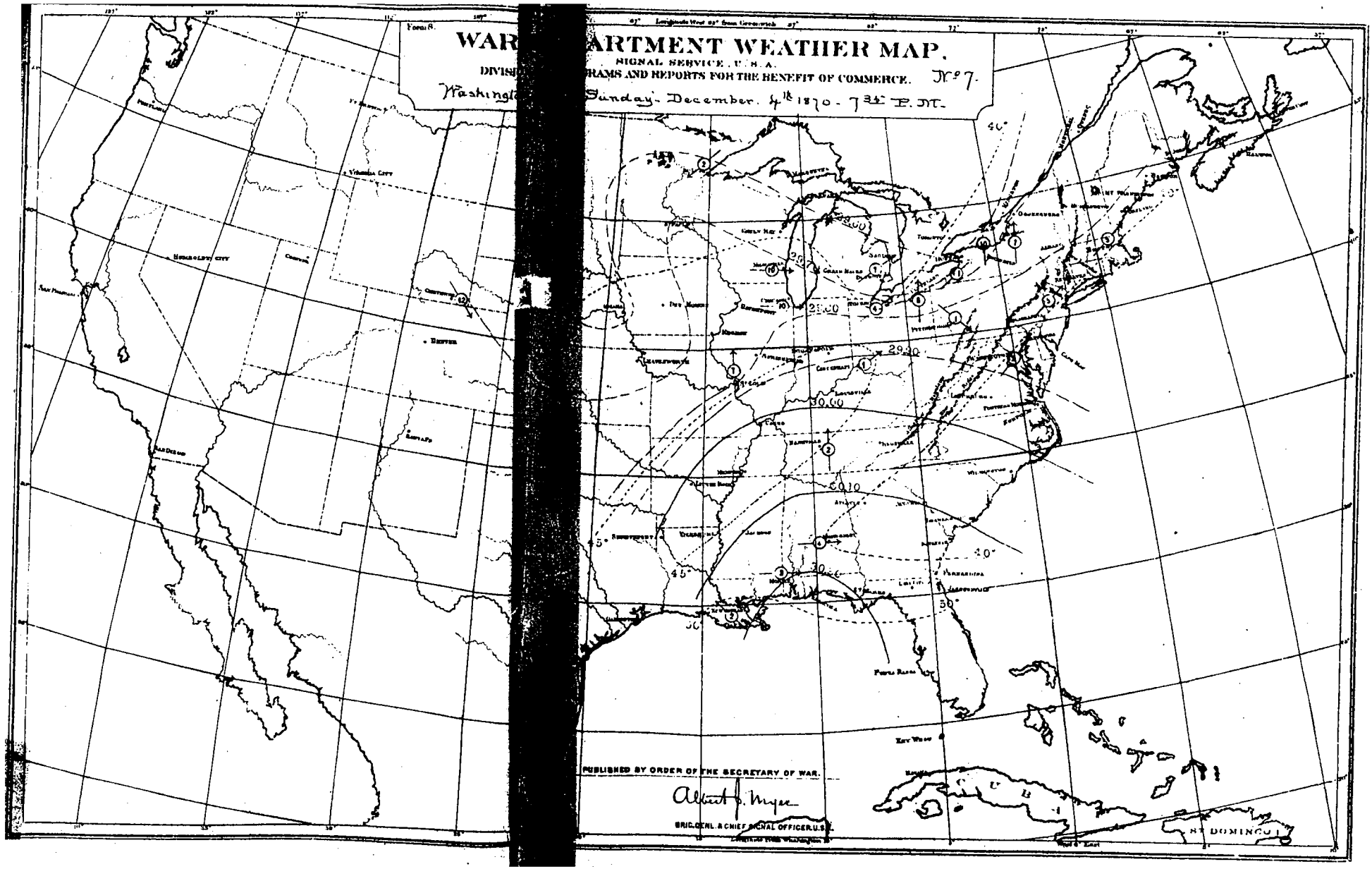

WAR DEPARTMENT WEATHER MAP.
DIVISION OF TEL REPORTS FOR THE BENEFIT OF COMMERCE.
No 2.
Washington D.C. December 2d 1870. 4 35 P.M.
BY ORDER OF THE SECRETARY OF WAR.
BRIG. GENL. & CHIEF SIGNAL OFFICER U.S.A.
CUBA
ST DOMINGO

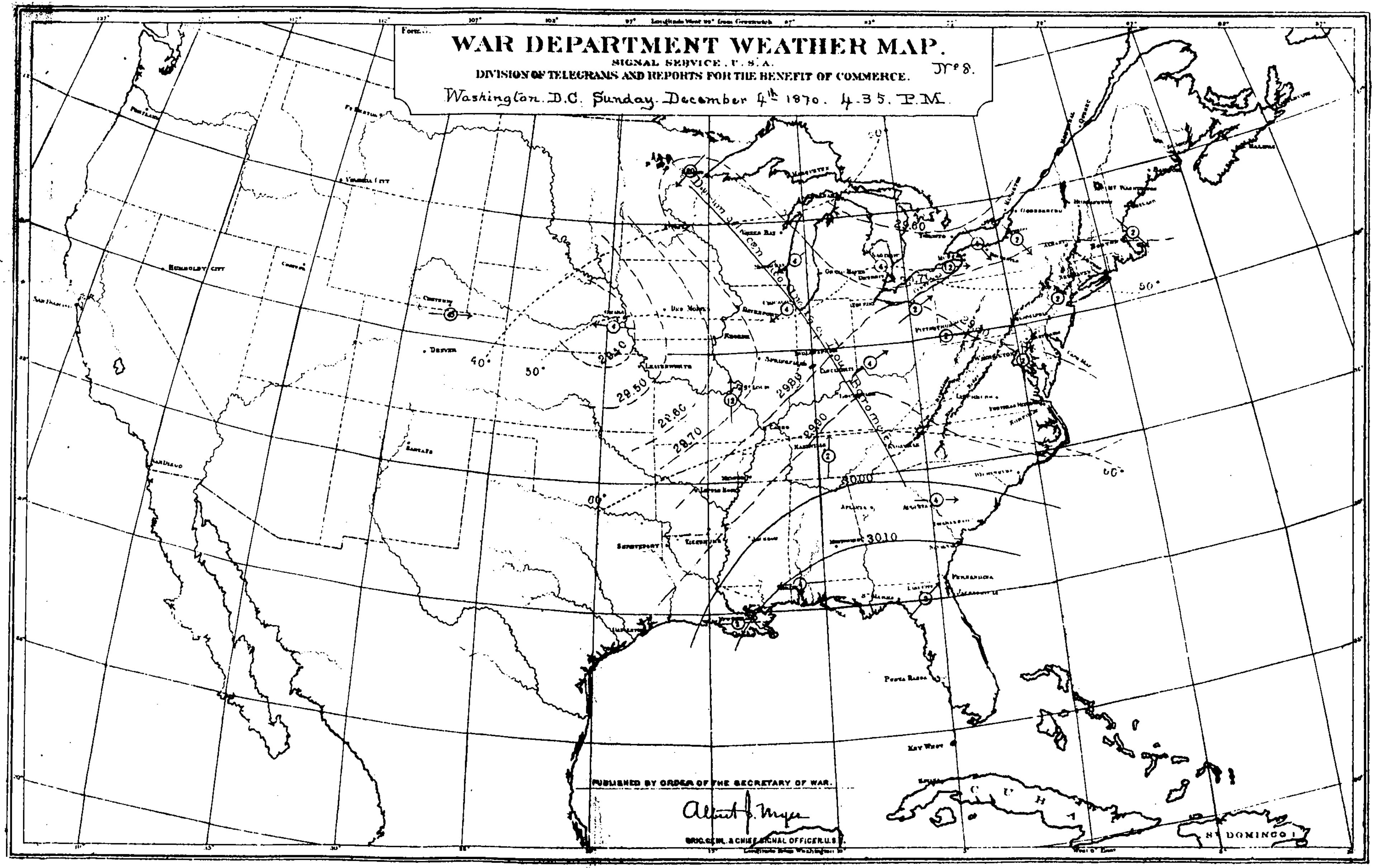

Form 8.
WAR DEPARTMENT WEATHER MAP.
SIGNAL SERVICE, U. S. A.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.
No 3.
Washington. D.C. Friday. December. 2d 1870. 11.35 P.M.
29.30
29.90
30.00
30.10
30.20
29.70
40°
50°
CUBA
ST DOMINGO
PUBLISHED BY ORDER OF THE SECRETARY OF WAR.
Albert J. Myer
BRIG. GEN. & CHIEF SIGNAL OFFICER, U.S.A.

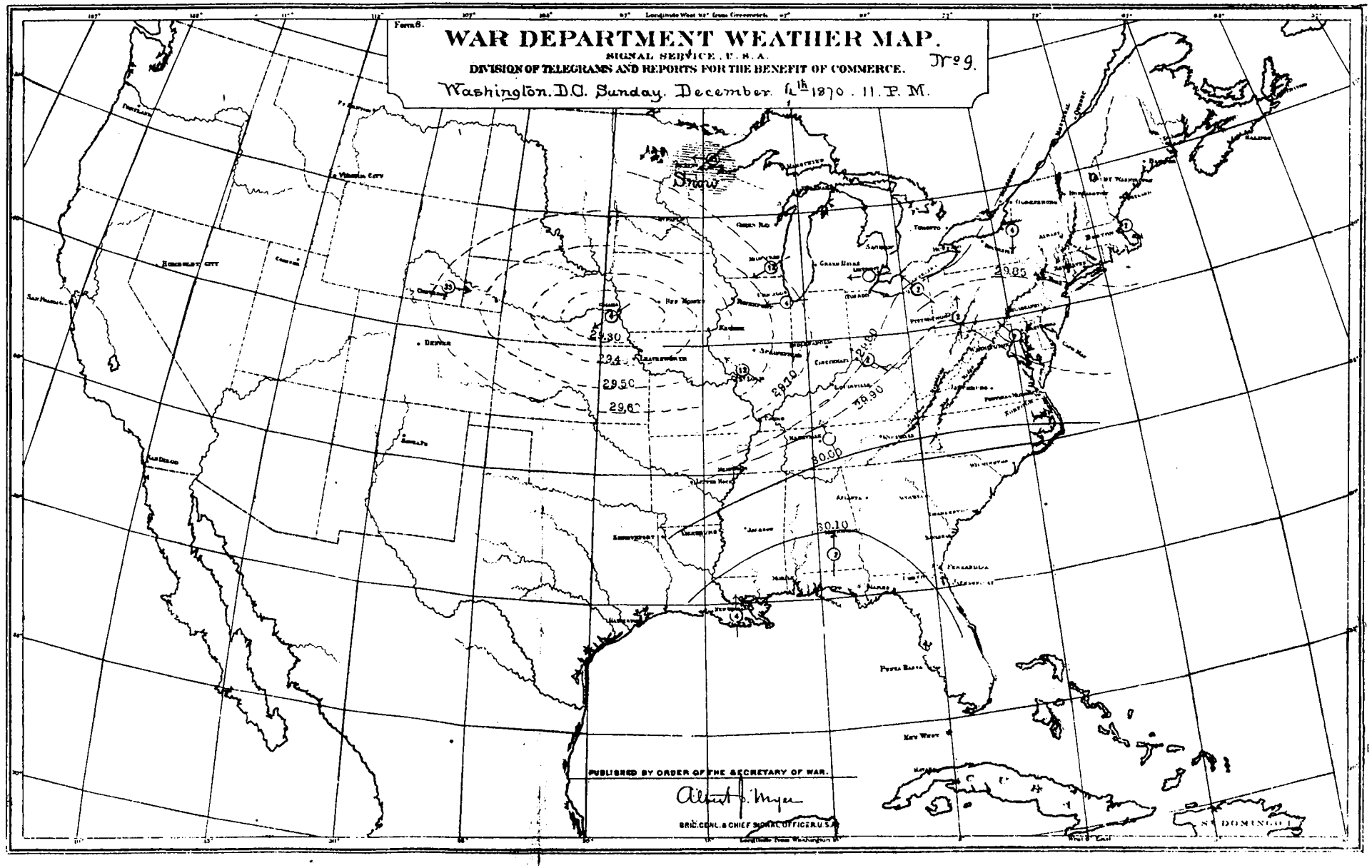

WAR DEPARTMENT WEATHER MAP.
SIGNAL SERVICE, U. S. A.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE. No 4.
Washington. D.C. Saturday. December 3. 1870. 7 35 A.M.
PUBLISHED BY ORDER OF THE SECRETARY OF WAR.
Albert J. Myer
BRIG. GENL. & CHIEF SIGNAL OFFICER U.S.A.
Longitude West 92° from Greenwich
Longitude from Washington
30°
35°
40°
45°
29.70
29.80
29.90
30.00
30.10
30.20
C U B A
ST DOMINGO I.

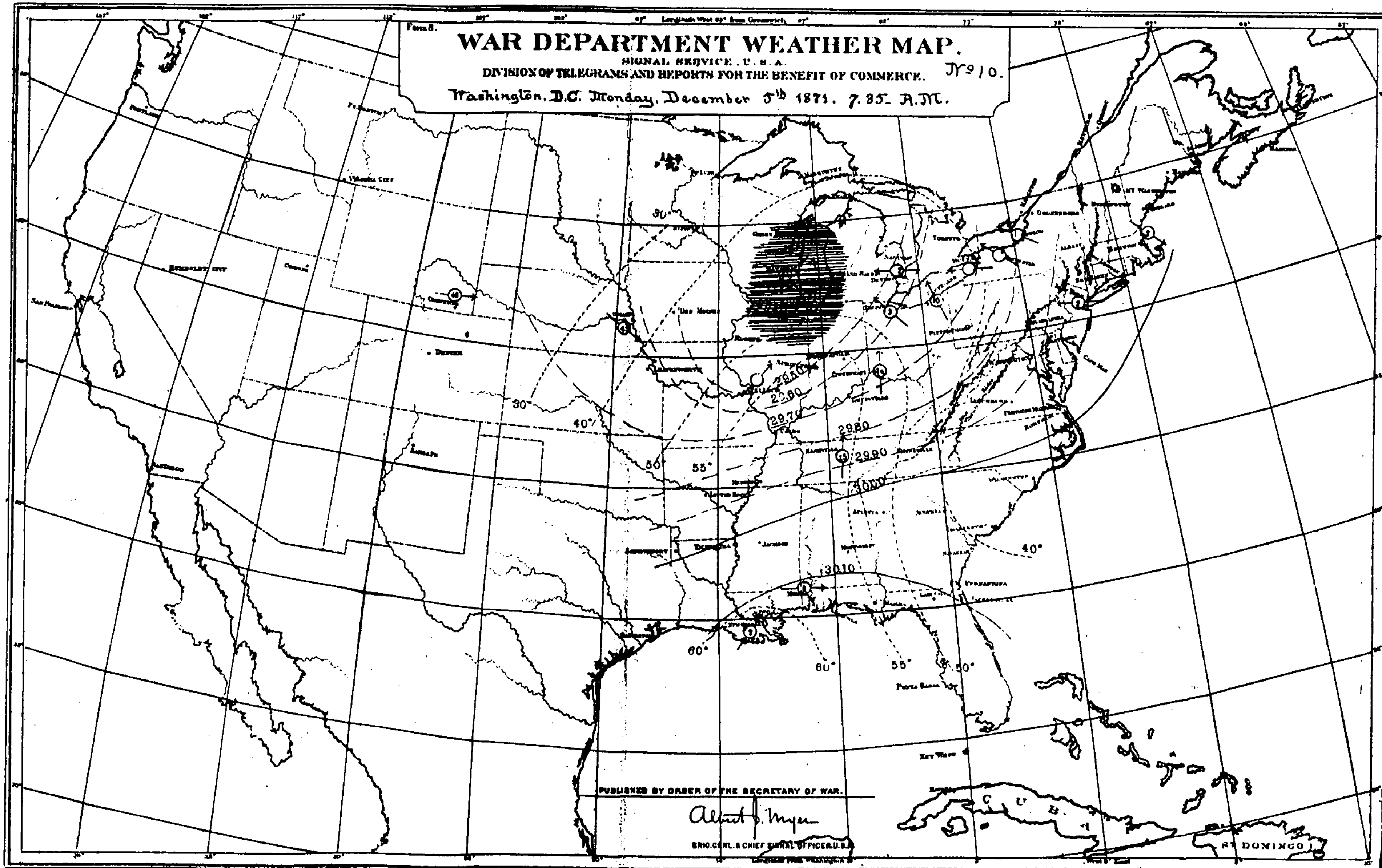

Form 8.
WAR DEPARTMENT WEATHER MAP.
SIGNAL SERVICE, U.S.A.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.
No 5.
Washington, D.C. Saturday, December 3d 4 35 P.M.
40°
50°
55°
60°
2950
2960
2970
2980
2990
3000
CUBA
ST DOMINGO
BY ORDER OF THE SECRETARY OF WAR.
Albert J. Myer
BRIG. GENL. & CHIEF SIGNAL OFFICER, U.S.A.

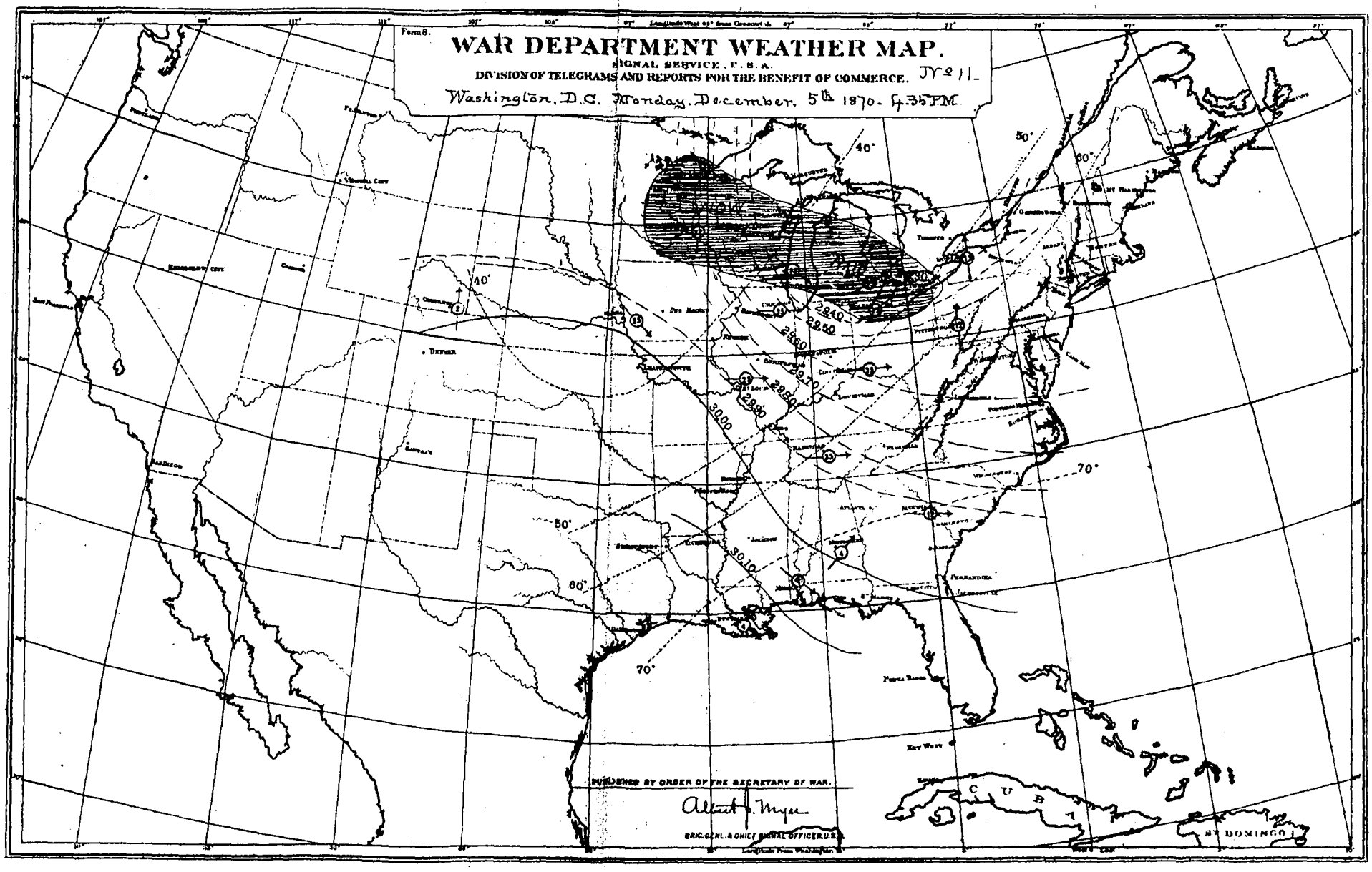

Form 8.
WAR DEP MENT WEATHER MAP.
NAL SERVICE, U. S. A.
DIVISION OF TELEG AND REPORTS FOR THE BENEFIT OF COMMERCE.
No 6.
Washington, D.C. day, December 3d 1870. 11.35 P.M.
2950
2940
2970
2980
2990
3000
3010
3020
40°
45°
50°
BY ORDER OF THE SECRETARY OF WAR.
BRIG. GENL. & CHIEF SIGNAL OFFICER U.S.A.
ST DOMINGO


Form 8.
WAR ARTMENT WEATHER MAP.
SIGNAL SERVICE, U. S. A.
DIVIS RAMS AND REPORTS FOR THE BENEFIT OF COMMERCE. No 7.
Washingt Sunday. December. 4th 1870. 7 35 P. M.
PUBLISHED BY ORDER OF THE SECRETARY OF WAR.
Albert J. Myer
BRIG. GENL. & CHIEF SIGNAL OFFICER U.S.A.
CUBA
ST DOMINGO
Longitude West 82° from Greenwich
Longitude from Washington
29.00
29.30
30.00
30.10
40°
45°
50°

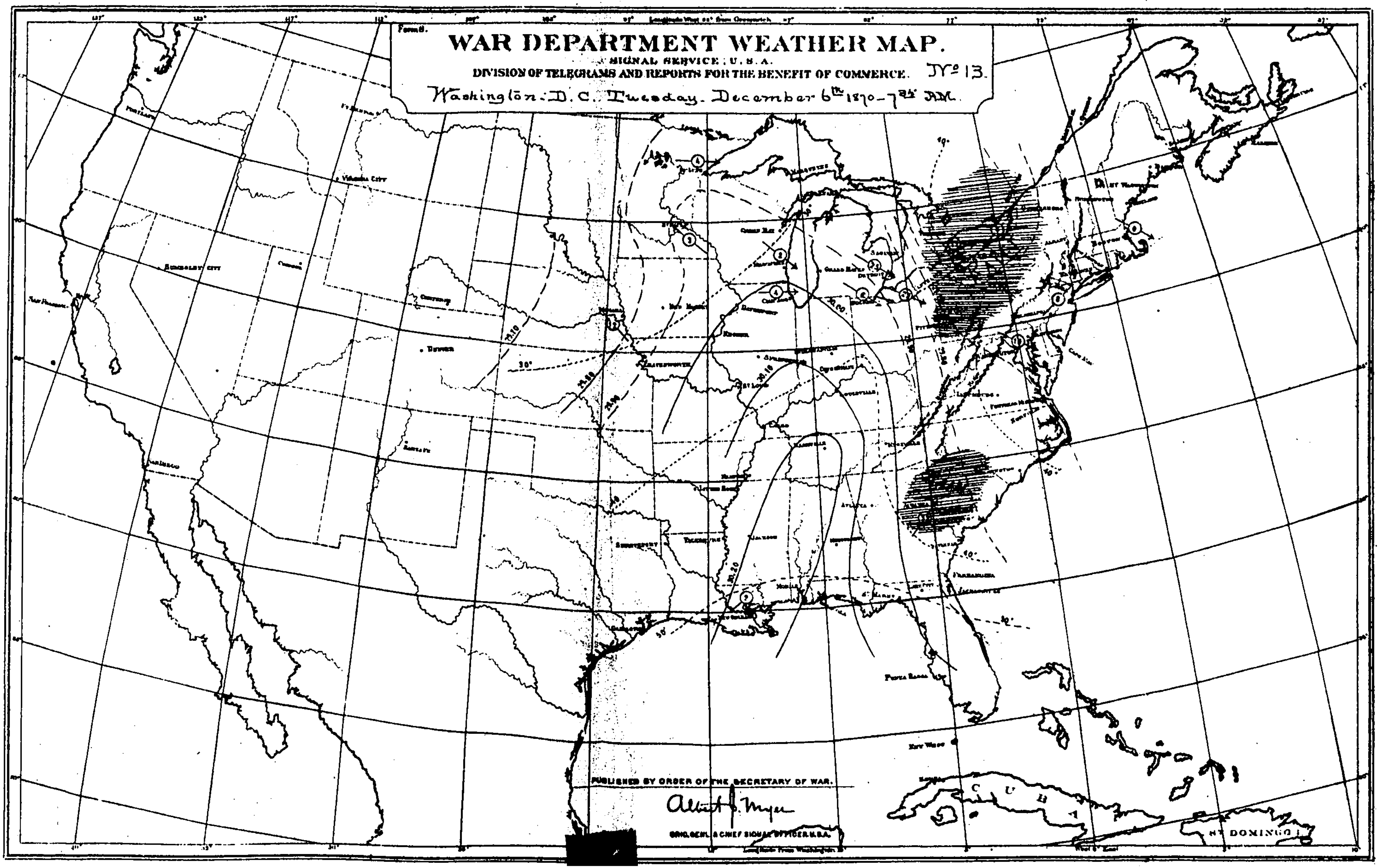

WAR DEPARTMENT WEATHER MAP.
SIGNAL SERVICE, U. S. A.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.
Nº 8.
Washington. D.C. Sunday. December 4th 1870. 4.35. P.M.
29.60
29.80
29.50
29.60
29.70
29.80
29.90
30.00
30.10
40°
50°
60°
PUBLISHED BY ORDER OF THE SECRETARY OF WAR.
BRIG. GEN'L. & CHIEF SIGNAL OFFICER U.S.A.
C U B A
ST DOMINGO I.
Key West


Form 8.
WAR DEPARTMENT WEATHER MAP.
SIGNAL SERVICE, U. S. A.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.
No 9.
Washington. D.C. Sunday. December 4th 1870. 11. P. M.
Snow
29.30
29.50
29.85
30.00
30.10
PUBLISHED BY ORDER OF THE SECRETARY OF WAR.
BRIG. GENL. & CHIEF SIGNAL OFFICER U.S.A.

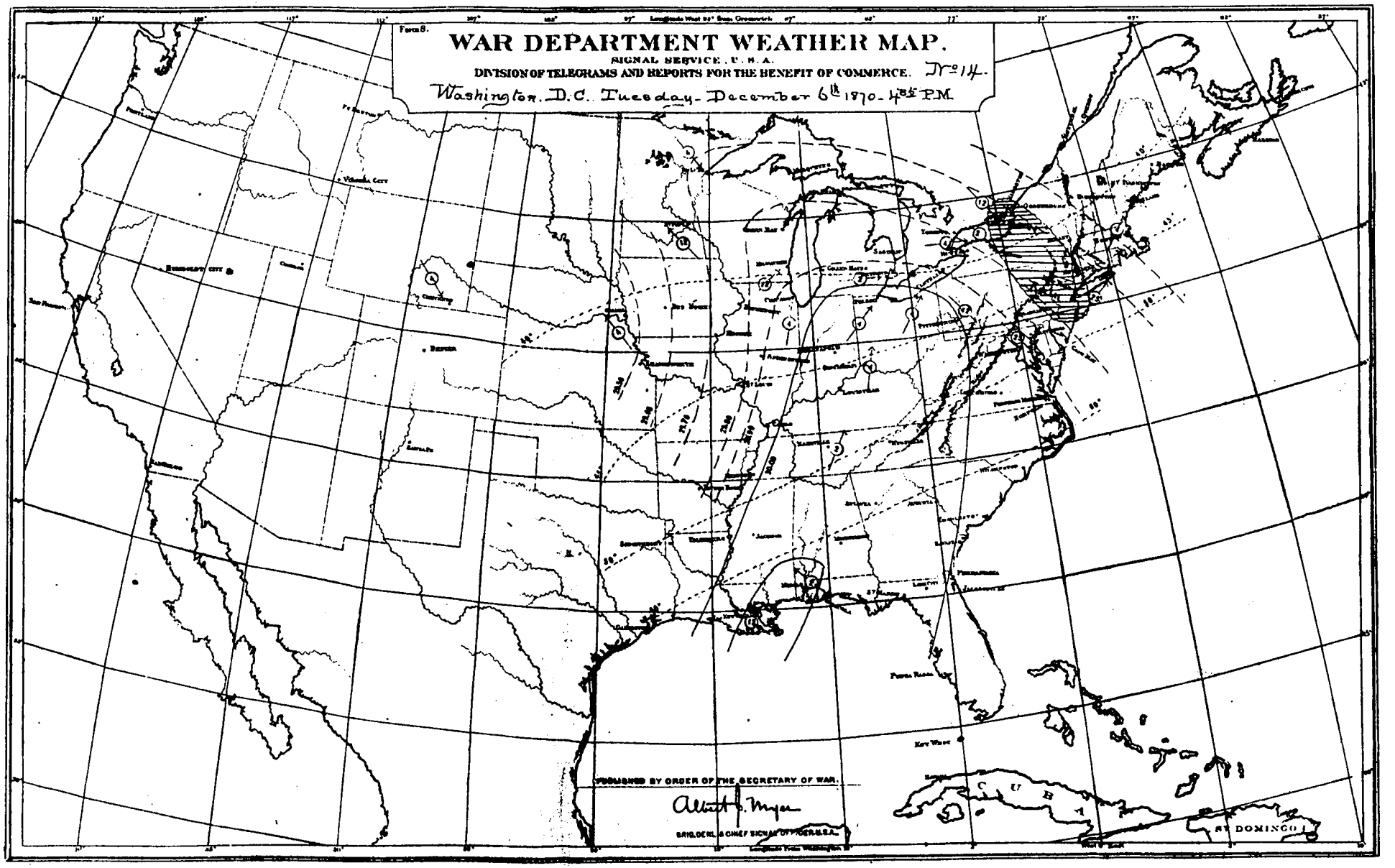

WAR DEPARTMENT WEATHER MAP.
SIGNAL SERVICE, U. S. A.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.
No 10.
Washington, D.C. Monday, December 5th 1871. 7.35 A.M.
30°
30°
40°
50°
55°
60°
60°
55°
50°
40°
29.50
29.60
29.70
29.80
29.90
30.00
30.10
PUBLISHED BY ORDER OF THE SECRETARY OF WAR.
Albert J. Myer
BRIG. GENL. & CHIEF SIGNAL OFFICER U.S.A.
CUBA
ST DOMINGO

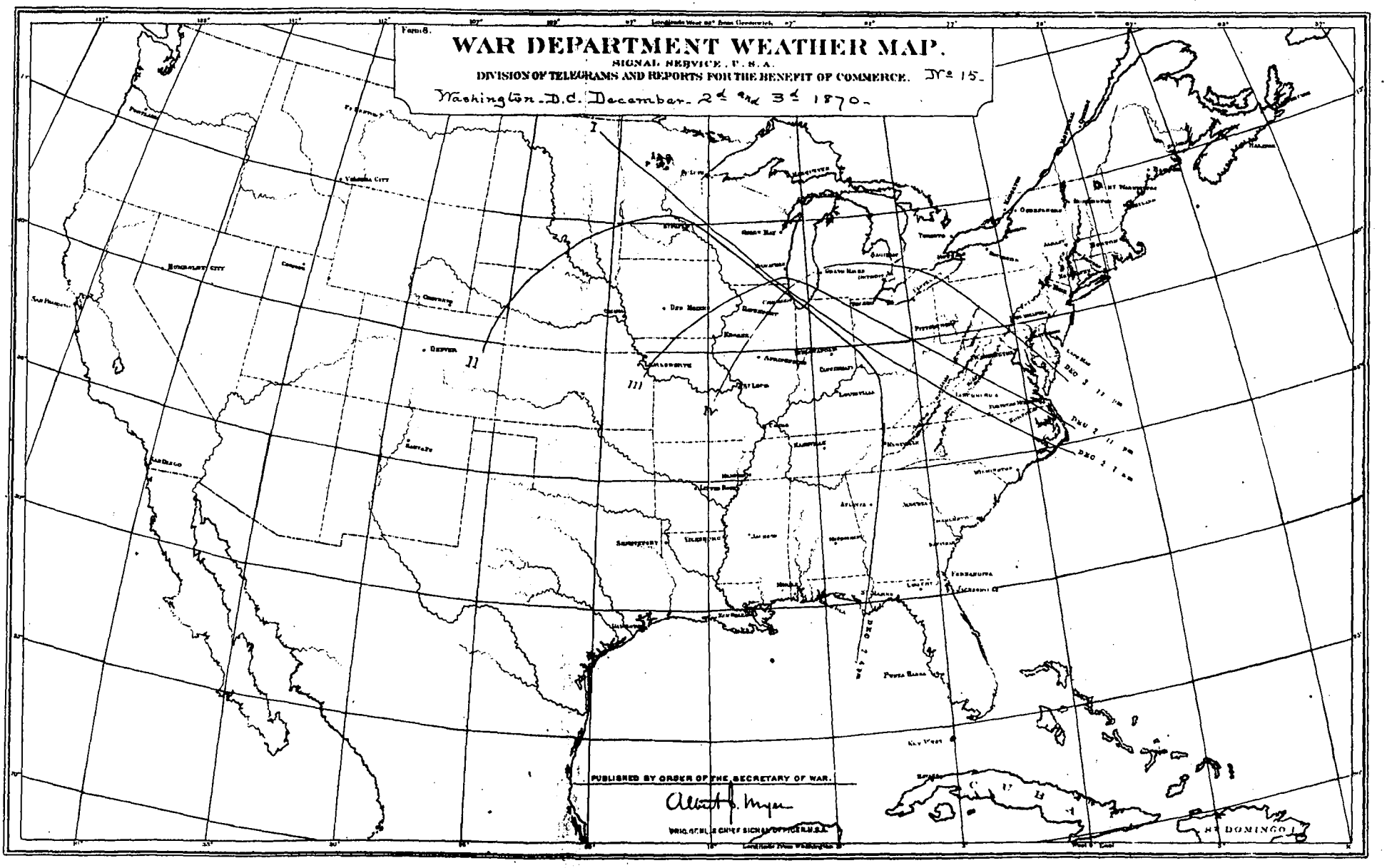

Form 8.
WAR DEPARTMENT WEATHER MAP.
SIGNAL SERVICE, U. S. A.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE. No 11
Washington, D.C. Monday, December, 5th 1870 - 4.35 PM
40°
50°
60°
70°
2940
2950
2960
2970
2980
2990
3000
3010
PUBLISHED BY ORDER OF THE SECRETARY OF WAR.
Albert J. Myer
BRIG. GENL. & CHIEF SIGNAL OFFICER U.S.A.
CUBA
ST DOMINGO

Form 8.
WAR DEPARTMENT WEATHER MAP.
SIGNAL SERVICE, U. S. A.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.
No 12.
Washington-D.C. Monday. December 5th 1870. 11 25 P.M.
PUBLISHED BY ORDER OF THE SECRETARY OF WAR.
BRIG. GENL & CHIEF SIGNAL OFFICER U.S.A.
CUBA
ST DOMINGO



WAR DEPARTMENT WEATHER MAP.
SIGNAL SERVICE, U. S. A.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.
No 13.
Washington. D. C. Tuesday. December 6th 1870 – 7 35 P.M.
VIRGINIA CITY
HUMBOLDT CITY
DENVER
SANTA FE
SAN DIEGO
C U B A
ST DOMINGO
PUBLISHED BY ORDER OF THE SECRETARY OF WAR.
BRIG. GENL. & CHIEF SIGNAL OFFICER U.S.A.


Form 8.
WAR DEPARTMENT WEATHER MAP.
SIGNAL SERVICE, U. S. A.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.
Nº 114.
Washington, D.C. Tuesday - December 6th 1870 - 4½ P.M.
PUBLISHED BY ORDER OF THE SECRETARY OF WAR.
BRIG. GEN. & CHIEF SIGNAL OFFICER U.S.A.
CUBA
ST DOMINGO


Form 8.
WAR DEPARTMENT WEATHER MAP.
SIGNAL SERVICE, U. S. A.
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.
No 15.
Washington D.C. December 2d and 3d 1870.
I
II
III
IV
PUBLISHED BY ORDER OF THE SECRETARY OF WAR.
BRIG. GEN. & CHIEF SIGNAL OFFICER U.S.A.

PAPER 56.—FORM 16.

PAPER 57.—FORM 17.

Detailed synopsis and probabilities.

For—					
Barometer.	Thermometer.	Winds.	Weather.	Humidity, per cent.	Rain.

For—				Signals.	
Barometer.	Thermometer.	Winds.	Weather.		
					S—stationery. Fg—falling. Fn—fallen. Rg—rising. Rn—risen. D—denotes that rains fell during the day. E—denotes that rains fell during the evening. N—denotes that rains fell during the night. I—safety. II—warning.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY.

DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

Station No.——

Error Sheet for week ending ——, 187 .

Date.	Time.	Reports missing at closing of circuits.	REPORTS RECEIVED AFTER THE SCHEDULE TIME.				Remarks.	No. words received.
			A. M. reports.	P. M. reports.	M. reports.	Time received.		
Sunday	A. M.							
	P. M.							
	M.							
Monday	A. M.							
	P. M.							
	M.							
Tuesday	A. M.							
	P. M.							
	M.							
Wednesday	A. M.							
	P. M.							
	M.							
Thursday	A. M.							
	P. M.							
	M.							
Friday	A. M.							
	P. M.							
	M.							
Saturday	A. M.							
	P. M.							
	M.							

NOTE.—Stations will be designated by their official numbers. Morning reports will be counted 20 words each; P. M. and M. reports 12 words each. Duplicates and corrections not to be counted.

Total number of words, ——

——, *Observer.*

PAPER 59.—FORM 20.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.
Station ————, *week ending* ————, 187—.

Original reading of barometer.	Reading of attached thermometer.	Correction for temperature.	Elevation of barometer above sea level.	Reading of exposed thermometer.	Correction for elevation.	Instrumental error.	Corrected barometer.	RELATIVE HUMIDITY.			
								Dry bulb thermometer.	Wet bulb thermometer.	Difference.	Humidity.

Observer, Signal Service, United States Army.

PAPER 60.—FORM 21.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

List of stations, with their telegraphic numbers.

Station.	No.	Station.	No.	Station.	No.
Plaister Cove.....N. S.	10	Pittsburgh .....Pa.	41	Shreveport .....La.	72
Saint Johns.....N. B.	11	Knoxville .....Tenn.	42	Jacksonville.....Fla.	73
Portland .....Me.	12	Indianapolis .....Ind.	43	Portland .....Oreg.	74
Boston .....Mass.	13	Lynchburgh .....Va.	44	San Diego .....Cal.	75
New London .....Conn.	14	Burlington .....Vt.	45	.....	76
New York City.....N. Y.	15	Mount Washington .N. H.	46	.....	77
Albany .....N. Y.	16	Keokuk.....Iowa.	47	.....	78
Philadelphia.....Pa.	17	Grand Haven.....Mich.	48	.....	79
Baltimore .....Md.	18	Escanaba .....Mich.	49	.....	80
Washington .....D. C.	19	Marquette.....Mich.	50	.....	81
Wilmington.....N. C.	20	Davenport.....Iowa	51	.....	82
Charleston.....S. C.	21	Leavenworth.....Kans.	52	.....	83
Savannah.....Ga.	22	Cairo .....Ill.	53	.....	84
Augusta.....Ga.	23	Cape May .....N. J.	54	.....	85
Lake City.....Fla	24	Galveston.....Tex.	55	.....	86
Key West.....Fla.	25	Montreal ..... Canada.	56	.....	87
Montgomery..... Ala.	26	.....	57	.....	88
Mobile.....Ala.	27	.....	58	.....	89
New Orleans.....La.	28	Punta Rassa.....Fla	59	.....	90
San Francisco.....Cal.	29	.....	60	.....	91
Norfolk .....Va.	30	Vicksburgh .....Miss.	61	.....	92
Oswego..... ....N. Y.	31	Memphis .....Tenn.	62	.....	93
Rochester .....N. Y.	32	Nashville.....Tenn.	63	.....	94
Buffalo .....N. Y.	33	Louisville .....Ky.	64	.....	95
Cleveland .....Ohio.	34	Cincinnati .....Ohio.	65	.....	96
Toledo.....Ohio.	35	Saint Louis.....Mo.	66	.....	97
Detroit.....Mich.	36	Omaha .....Nebr.	67	.....	98
Chicago .....Ill.	37	Cheyenne .....Wyo.	68	.....	99
Milwaukee.....Wis.	38	Santa Fé .....N. M.	69	.....	100
Saint Paul .....Minn.	39	Corinne.....Utah.	70	.....	
Du Luth .....Minn.	40	Fort Benton .....Mont.	71	.....	

PAPER 61.—FORM 22.

WAR DEPARTMENT, SIGNAL SERVICE, UNITED STATES ARMY,
DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE,
——————————, 187–.

Table showing daily and monthly mean of barometer and thermometer, monthly velocity of wind and amount of rain-fall, with the prevailing direction of wind for the month of ——————, 187–.

Date.	Mean daily barometer.	Mean daily thermometer.	Rain-fall.	Remarks.
Monthly mean.....				
Total rain-fall				

Prevailing wind.....

Total number of miles traveled .....

——————————————,

Observer, Signal Service, U. S. A.

PAPER 62.—FORM 23.

Signals.

STATION,

Date.	Order to hoist signal received.		Signal hoisted.		Signal lowered.		Gale commenced.		Gale at its height.		Gale ended.		Signal justified.		Remarks, as to any known benefits or injury to commercial or other interests resulting from display of signals.
	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	Yes.	No.	

PAPER 63.—FORM 24.

Record of bulletins, maps, and press-reports issued during the week ending ——, 187–, at ——.

Day.	NUMBER OF BULLETINS.			NUMBER OF MAPS.	NUMBER OF PRESS-REPORTS.			Remarks.
	Morning.	Afternoon.	Midnight.		Morning.	Afternoon.	Midnight.	
Sunday								
Monday....								
Tuesday ...								
Wednesday								
Thursday..								
Friday.....								
Saturday ..								
Total...								

——————————, *Observer.*

PAPER 1½.

CHICAGO, *January* 16, 1871.

SIR: Having been appointed an assistant to the Chief Signal Officer of the Army of the United States, in the department of telegrams and reports for the benefit of commerce, for the purpose of considering the tri-daily reports of the condition of the weather, received at Chicago, and reporting the results, with such information as would be likely to lead to a knowledge of the approach of storms, especially upon the great northern lakes, it becomes proper that I should make report of what has been done up to this time.

All papers, reports, and instruments were placed subject to my inspection, and all facilities were directed to be afforded me in the discharge of these duties. My instructions were to furnish daily to the Chief Signal Officer for his consideration and action, as quickly as possible after receiving the morning reports, a brief analysis of the reports received for the twenty-four hours preceding, (or for a longer period,) as to facts bearing upon the probable weather, with a statement of the probable character of the weather for the next twenty-four hours; and in case of imminent danger, the dispatches were to be immediately published along the lakes by the several observers without awaiting orders from the Chief Signal Officer. In addition, it was required that a weekly report be made to the Chief Signal Officer.

In the prosecution of this work I have had occasion to suggest certain changes and improvements in the methods of doing the important work in hand, some of which have been adopted, and have resulted in saving the time of the observers and of securing greater accuracy of results.

Twenty-five stations were occupied on the 1st day of November, 1870, to wit:

Western and northern stations.—Cheyenne, Wyoming Territory; Omaha, Nebraska; St. Paul, Minnesota; Du Luth, Minnesota; St. Louis, Missouri; Milwaukee, Wisconsin; Chicago, Illinois; Cincinnati, Ohio; Toledo, Ohio; Detroit, Michigan; Cleveland, Ohio; Pittsburgh, Pennsylvania; Buffalo, New York; Rochester, New York; and Oswego, New York.

Southern and eastern stations.—New Orleans, Louisiana; Mobile, Alabama; Montgomery, Alabama; Nashville, Tennessee; Key West, Florida; Lake City, Florida; Augusta, Georgia; Washington, District of Columbia; New York, New York; and Boston, Massachusetts.

Such was the perfection of the arrangements made that twenty reports were received on the first morning, and this number was gradually increased until the 24th, when reports were received from all the stations. A break in the sub-marine cable to Key West prevented reports from that station until the 20th. The average number of reports received at Chicago during the month of November was twenty-three out of twenty-five, or an average failure of only two. In December the number received varied from eighteen on the 5th, and twenty-one on the 29th, up to the full number required, the average being twenty-three and a half. One station (Montgomery) was abandoned on the 18th. There was, therefore, an average failure of only one. In January, 1871, six new stations were occupied by observers, to wit:

Savannah, Georgia; Charleston, South Carolina; Wilmington, North Carolina; Norfolk, Virginia; Baltimore, Maryland; and Philadelphia, Pennsylvania; making thirty in all, of which the average number failing to report during the first half of the month was but one.

The daily reports received included the following items:

The height of the barometer in inches, corrected for instrumental variation from the standard at Washington, if any, for temperature and for elevation above the sea;

The height of the thermometer (Fahrenheit's) showing the temperature of the open air;

The difference between the wet and dry bulb, or, after January 1, the relative humidity;

The direction of the wind and its velocity in miles per hour;

The cloudiness of the sky on a scale of one to four;

Whether light or heavy rain or snow was falling at the time of making the observations; and

The amount of rain-fall (including melted snow) during the twenty-four hours preceding the morning observations.

The observations were taken at the same moment of absolute time at all the stations.

The reports were received in cipher, for the purpose of saving time and expense in their transmission, and were immediately translated into ordinary language and figures by the very competent and efficient observer, (Sergeant James Mackintosh;) a service which was usually performed, and the reports made ready for the assistant, by half-pas 9 or 10 o'clock.

Bulletins showing the reports in detail were immediately posted in the rooms of the

board of trade; and the same information is represented on a large map of the United States by means of small arrows and cards, attached at the several stations from which reports were received.

The members of the board of trade and others manifest their interest in these weather reports by thronging around this map when corrected each morning.

In compliance with the instructions above recited, I proceeded each morning, with as little delay as possible, to construct a skeleton-chart of the weather on a large sheet of paper, upon which the relative position of the several stations had been marked, showing the height of the barometer above or below the mean, (assumed to be thirty inches;) the state of weather; the temperature; the direction and velocity of the wind, &c, at the several stations from which reports were received. These items were so connected by lines (in different colors) as to show the districts where the barometer and the temperature were high or low, where rain or snow was falling, &c.; thus representing to the eye in a comprehensive manner the condition of the weather over the whole country, from the Atlantic to the Rocky Mountains, and from the Gulf of Mexico to the great northern lakes.

With the aid of this meteorological chart and of the column showing the amount of change since the last preceding report, and with a general knowledge of the character and movement of storms over the interior of our continent, one can readily determine what predictions to send forward. Comparing one of these with the next preceding, the progress of weather-changes, as they move over the country, can at once be seen, and their direction and velocity ascertained.

The general results thus found have usually been telegraphed before 11 o'clock to the Chief Signal Officer, pointing out those facts that are deemed most indicative of meteorological changes.

The first dispatch of the signal service sent from Chicago was dated at noon on the 8th November, and was directed to be bulletined at once by the observers on the lakes. It was as follows:

"High winds all day yesterday at Cheyenne and Omaha. A very high wind reported this morning at Omaha. Barometers falling, with high wind at Chicago and Milwaukee to-day. Barometer falling and thermometer rising at Chicago, Detroit, Toledo, Cleveland, Buffalo, and Rochester. High winds probable along the lakes."

The high winds thus presumed to be about to fall upon the lakes were shown by the reports of the next morning, as follows: At Milwaukee, twenty-five miles an hour; at Detroit, thirty-two; at Toledo, thirty-eight; at Buffalo, twenty-five; and at Oswego, twenty-five miles an hour. Very brisk winds were also blowing at the same time as follows: At Du Luth thirteen miles, at Chicago seventeen miles, and at Cleveland twenty miles an hour.

The second bulletin was directed to be posted on the lakes, and at New York and Boston, dated November 9, at 11 a. m., as follows:

"Low barometer, moving eastward. High winds along the lakes, and probable along the New York and Eastern coast."

At 4 p. m., high winds appear in the reports from the lake stations, and at 11 p. m., in the lower lakes and at Washington.

[The telegrams above referred to were ordered by the Chief Signal Officer of the Army, when in person at Chicago.]

On the 19th November, at 10½ o'clock a. m., bulletins were directed to be posted at Milwaukee, Chicago, and Detroit, stating that the barometer was falling rapidly at Du Luth, St. Paul, and Omaha, and that high winds were probable upon the lakes. Later in the day bulletins were directed to be posted at the other lake ports. This storm appears to have passed to the northward of the lakes, touching them only at Du Luth and Detroit, so far as is shown in our reports.

The first considerable storm that swept over the lake region, after the commencement of these reports, was that of December 3 and 6, 1870, and it seems proper to report the facts in regard to it somewhat in detail.

I. On the morning of the 2d of December the barometer was high at the west and south, no indications of any disturbance coming from any direction; the line of medium barometer, reduced to a uniform temperature and level, was nearly straight across the country, as shown by the accompanying map No. 1, passing a little east of St. Paul, Chicago, and Cincinnati, and in the same general direction to the Atlantic coast. Southward of this line the barometer was high, being more than thirty inches; and northward of it, the barometer was below the mean height, the lowest (29.62) being at the extreme eastern station, Boston. The thermometer indicated a nearly uniform temperature over the whole country, being only 3° warmer at New Orleans, in latitude 29° north, than at Milwaukee, in latitude 43°; and above the freezing-point of water at all points eastward of Du Luth, St. Paul, and Omaha. The winds were moderate, the sky was cloudy at only three of the twenty-five stations, and there was no rain.

II. On the same day, December 2, at 4 p. m., the barometer had fallen 0.31 inch at Cheyenne, the most westerly station situated upon the Rocky Mountains, (elevation over 6,000 feet,) and the northerly extremity of the line of medium atmospheric

pressure was thus thrown far to the south, as shown on map No. 2. The barometer fell considerably also at eastern and southern stations, but remained nearly stationary at Cincinnati, Chicago, St. Louis, &c. This considerable change in nine hours at Cheyenne may be deemed the first indication of the great disturbance that subsequently passed thence eastward over the region of the lakes.

III. The reports received at 11 p. m. (December 2) show that this southern deflection of the line of medium barometer had moved eastward to beyond Omaha, a distance of about three hundred and fifty miles, (see map No. 3,) showing a rate of progress of about fifty miles an hour. The weather remained mostly clear and the winds moderate.

IV. On the 3d, at 7 a. m., (see map No. 4,) the line of medium barometer had nearly reached St. Louis, passing over a space of about two hundred miles in eight hours, or at the rate of twenty miles an hour. The winds, nowhere high, were blowing from northerly or westerly quarters at nearly all the stations; the temperature was still low and nearly uniform, being below the freezing-point only at Du Luth, Toledo, and Detroit; while at New Orleans and Mobile it was but thirteen degrees above. The weather was cloudy at all stations west of Lake Michigan.

It now became apparent that there was a storm of considerable magnitude approaching the region of the great lakes, and accordingly the following telegram was sent by the assistant in charge at Chicago to the Chief Signal Officer at Washington, and to the observers on the lakes, who were directed to bulletin it:

"Barometer falling rapidly at Omaha, St. Paul, and Du Luth. Heavy weather probable on the lakes."

This dispatch, which was sent at 11 a. m. December 3, was received at Du Luth, at the western extremity of Lake Superior, on the day of its date, and within one hour afterward the storm set in with great violence, the wind from the northeast and the lake very rough.

It will be noticed that the several lines of medium barometric pressure on the first four maps (for December 2, at 7, 4, and 11, and December 3, at 7) all cross each other or pass between Milwaukee and Chicago, as shown on map No. 15, thus constituting what may be called a *storm node*, about which the lines revolve. While the barometer is changing considerably all around this node, it remains nearly stationary here. The average amount of barometric change in twenty-four hours, at six stations in and near the meridian of Chicago, is 0.15, while at an equal number, both at the eastward and westward of this meridian, the amount of change in the same time is 0.36, being more than double the former. This fact may be deemed one of considerable importance in the determination of the position of future observing points; for it is obvious that those places where the greatest fluctuations occur are in the regions from which it is most desirable to receive reports.

V. On the 3d, at 4 p. m., the line of mean barometer had passed eastward, as shown on map No. 5, to more than half way between St. Louis and Nashville in Tennessee, about two hundred miles, at the rate of twenty-two miles an hour. The line on the map representing 29.70 inches height of barometer (or 0.30 below the mean) progressed during the same time from Omaha to St. Louis, and from St. Paul to Milwaukee, over three hundred miles in eight hours, or at the rate of about forty miles an hour. The depression of the barometer was now greatest at St. Paul, more than half an inch below the mean. The winds were high only at St. Louis and Cheyenne.

VI. December 3, at 11 p. m., (see map No. 6,) it was now found by the reports that the disturbance had moved much more slowly, scarcely fifty miles in the seven hours intervening since the last observations were made; the medium and low barometer moving at about the same rate of speed. The greatest depression was now at St. Paul and Milwaukee. The temperature remained remarkably uniform, showing (if there is no mistake in the reports) the same degree (42°) at New Orleans and at Milwaukee. The sky was mostly clear; no high winds.

VII. On the 4th, at 7 a. m., (see map No. 7,) the line of medium barometer was still between St. Louis and Nashville, having fallen back slightly from its position at the time of the last observations. The more northerly portion of the line had, during the night, passed southward along the Atlantic coast about two hundred and fifty miles, or at the rate of thirty miles an hour. The barometer stood below the mean in all the Northern and Western States, being lowest at Omaha and Buffalo, thus showing a decided tendency to divide and the storm become double. The temperature, still quite uniform, was increasing at the south. Up to this time there had been no rain or snow in any part of the United States since November 30, except sprinkles at Montgomery and Lake City. Clouds covered most of the western stations; no high winds.

VIII. On the same day, at 4 p. m., it was found that the medium line had moved southward about two hundred and fifty miles, or twenty-eight miles an hour, having approached very nearly to Montgomery, in Alabama, and Augusta, in Georgia, as represented on map No. 8. Low barometer prevailed over nearly the whole country, the lowest being still at Omaha, on the west, and Buffalo, on the east. Cloudiness pre-

vailed at the northern stations, and a very high wind had sprung up from the west at Cheyenne.

IX. December 4, at 11 p. m., the medium line remained very nearly in its last position, and the center of the region of low barometer was still at Omaha, the mercury having fallen to 29.20, or 0.80 below the mean. (See map No. 9.) High wind continued to blow from the west at Cheyenne, and from the east, accompanied by snow, at Du Luth.

X. December 5, 1870, at the time of making the morning observations great changes had taken place: the eastern division of the storm had disappeared; the line of medium barometer had returned toward the north and northwest; and the low barometer had shifted its position from Omaha to the shore of Lake Michigan, four hundred and fifty miles, or fifty-six miles an hour. Rain was falling at Milwaukee and Chicago. A mass of warm air was penetrating the immediate valley of the Mississippi from the south, the temperature of 50° reaching almost to Chicago and Toledo. At New Orleans, where the barometer was highest, the thermometer stood at 60°. High winds continued at Cheyenne, and had commenced at Omaha and at St. Louis. Cloudiness prevailed at nearly all the stations. The failure of reports from St. Paul and Du Luth added to the probability of bad weather, which had doubtless injured the telegraph lines.

These indications were deemed sufficient to authorize the telegram, "Very low barometer with rain at Milwaukee and Chicago, progressing eastward," to be sent to the chief signal officer, and also to all the observers of the lakes below the two ports named, at 10 o'clock a. m.

This dispatch was published in the Evening News at Cleveland, Ohio; and at 3.20, according to the Cleveland Ledger of the next morning, "the storm arrived, falling at once upon the city in the utmost fury, drenching the streets with floods of water, wrenching off signs, knocking down several chimneys, and causing the wildest consternation among pedestrians, who were caught without a moment's warning in a terrific gale." The manner in which this storm was followed in its course was deemed, by the editor, to have established beyond dispute the utility of the signal office.

It will be remembered that the line of mean barometer remained in nearly the same position on maps No. 8, 9 and 10, while the low barometer was moving with considerable rapidity eastward; and a more careful inspection of these maps will show that the anterior portion of the storm moved with much the greatest velocity, by which means the area of low barometer was hourly becoming more and more elongated in the direction of its motion.

XI. On the same day, at 4 p. m., the position of the medium line, which in the morning ran in a northeasterly direction, from a little south of Nashville to the eastward of Washington, New York, and Boston, had now assumed a position nearly at right angles to this course, or from near Omaha southeasterly to Montgomery, as shown on map No. 11. The position of the lowest barometer had passed from Milwaukee to Detroit, at the rate of about tweny-eight miles an hour. Snow was falling at St. Paul and Du Luth; rain at Milwaukee, Toledo, Detroit, and Cleveland. Very brisk or high winds were blowing at Omaha, Du Luth, St. Louis, Chicago, Nashville, Cincinnati, Toledo, and Detroit. From Rochester, Oswego, Washington, New York, and Boston, no reports were received.

XII. December 5, at 11 p. m., (see map No. 12,) the line of mean barometer retained its general direction, as at 4 p. m., but had moved considerably to the northward, now passing from Omaha to points near St. Louis, Nashville, and Augusta; lowest on Lake Erie. The rain had progressed eastward, and was now at Chicago, Cincinnati, Detroit, Pittsburgh, Buffalo, and Oswego; the front moving most rapidly, so as to embrace a much larger area. The gale had reached Pittsburgh and Buffalo, and high or very brisk winds were blowing at Milwaukee, Chicago, Nashville, Cincinnati, and Detroit.

The barometer was now lower at Washington and New York than at Boston, indicating that the direction of the movement of the disturbance had changed from eastward to southeast.

XIII. On the 6th, at 7 a. m., (see map No. 13,) the very low barometer still lingered on Lake Ontario, where rain continued to fall, which extended south to Pittsburgh. Perhaps this retardation of the progress of the storm may have been occasioned by the high lands of the Adirondacks and of the eastern States; it being known that the topographical features of a country often do modify the condition of approaching storms.

It will be noticed by reference to this map (No. 13) that while the great atmospheric disturbance now being traced in detail was passing off at the east, another of equal magnitude had already shown itself at the west.

XIV. On the 6th, at 4 p. m., (see map No. 14,) snow was falling at Oswego, but the rain had shifted its southern limits from Pittsburgh to New York City. After this time it entirely disappeared from the region covered by our stations. High wind continued at Rochester, Washington, and New York.

The map of the next morning shows this storm passing off from the eastern coast, and that the succeeding one had nearly reached the same region of country.

A glance at the skeleton-charts daily prepared to show the meteorological phenomena more readily to the eye, shows the magnificent extent of the atmospheric disturbances that thus follow each other with such rapidity over the country. The several lines of equal barometric pressure seldom inclose a space within the region covered by our stations, a region extending from Boston, on the east, to Cheyenne, on the Rocky Mountains; and from Du Luth, on Lake Superior, to Key West, at the most southerly extremity of Florida. These lines are mostly in the form of curves of very great radius; it is, therefore, to be remembered that we are dealing with but a small portion—only the border—of these disturbances. Such far-spreading phenomena can surely not be produced by any local changes of temperature, as has been supposed. We must look for some more general cause, perhaps exterior to our earth; for nothing less than cosmical causes would induce a simultaneous change of the barometers, either rising or falling together, over nearly the whole of this vast region of country.

On the 7th day of December, at 10 o'clock a. m., the following was directed by telegraph to be bulletined by the observers at Toledo, Cleveland, Buffalo, Rochester, and Oswego:

"The storm indicated yesterday is at Chicago and Milwaukee this morning; probable on Lakes Erie and Ontario to-day."

This storm is shown by the 4 o'clock reports of that day to have been on Lake Erie at Cleveland, in the form of light rain, and on Lake Ontario as high wind at Rochester and Oswego; and by the 11 o'clock reports it was shown in the form of rain at Buffalo and Rochester, and snow at Oswego, with high winds at Detroit, Cleveland and Buffalo.

December 11, at 11 a. m., bulletins were directed to be posted by the observers at Toledo, Detroit, and all points below, as follows:

"Low barometer, with heavy rain, at St. Louis; will probably extend over the lakes."

The reports received at 4 p. m. show that this rain had reached Milwaukee, Cincinnati, Toledo, Detroit, and Cleveland; and those received at 11 o'clock show that it had then reached New York and Boston.

Since this date, navigation on the lakes having been suspended for the winter, no further bulletins were directed from Chicago; but weather changes were on several occasions indicated in advance in my daily telegrams to the Chief Signal Officer at Washington.

As a general result, it will be seen that these observations and reports abundantly show the correctness of the most important general deductions first reported by Espy; especially in regard to the western origin and eastward progress of storms in the interior of the United States. Our work also leads to the suggestion of some new theories, but it would be premature to refer to them, until further observations shall show whether they are correct.

I deem it quite important for the interest of the service that an observing station should be occupied in Iowa, about half way between Omaha and Chicago, and another at Marquette, on Lake Superior, a port at which there is a very considerable amount of shipping.

Another means of increasing the usefulness of these observations would be their prompt publication in full detail as often as once a month. The distribution of such a publication, if free from typographical or other errors, to scientific institutions and individuals, could not but lead to important results.

Very respectfully submitted.

I. A. LAPHAM,
Assistant to the Chief Signal Officer.

General A. J. MYER,
Chief Signal Officer.

Statement of the number of stations from which telegraphic reports of the weather were received at Chicago, Illinois, at or about 8 o'clock a. m. each day, from November 1, 1870, to January 15, 1871.

Date.	No. of stations.	Date.	No. of stations.	Date.	No. of stations.
1870.		1870.		1870.	
November 1	20	November 27	23	December 23	23
November 2	20	November 28	25	December 24	24
November 3	20	November 29	24	December 25	23
November 4	20	November 30	25	December 26	23
November 5	21	December 1	25	December 27	23
November 6	22	December 2	25	December 28	23
November 7	20	December 3	25	December 29	21
November 8	23	December 4	25	December 30	24
November 9	23	December 5	18	December 31	24
November 10	23	December 6	23		
November 11	23	December 7	23	1871.	
November 12	23	December 8	23	January 1	25
November 13	23	December 9	23	January 2	24
November 14	24	December 10	23	January 3	28
November 15	24	December 11	22	January 4	28
November 16	24	December 12	23	January 5	29
November 17	24	December 13	24	January 6	29
November 18	24	December 14	24	January 7	29
November 19	24	December 15	24	January 8	30
November 20	23	December 16	23	January 9	30
November 21	24	December 17	24	January 10	30
November 22	24	December 18	24	January 11	29
November 23	22	December 19	24	January 12	29
November 24	25	December 20	24	January 13	.....
November 25	25	December 21	23	January 14	.....
November 26	25	December 22	24	January 15	.....