RAINFALL STATIONS ESTABLISHED—Continued.

Station.	District.
Shoemaker, N. Mex.	Denver, Colo.
Springer, N. Mex.	Denver, Colo.
Stonewall, Colo.	Denver, Colo.
Summit, Cal.	San Francisco, Cal.
Tercio, Colo.	Denver, Colo.
Thornton, N. Mex.	Denver, Colo.
Tucumcari, N. Mex.	Denver, Colo.
Wahpeton, N. Dak.	Moorhead, Minn.
Westcliffe, Colo.	Denver, Colo.

RAINFALL STATIONS DISCONTINUED.

Station.	District.
Covington, Va.	Richmond, Va.
Kineo, Me.	Portland, Me.
Moncure, N. C.	Raleigh, N. C.
Oriskany, Va.	Richmond, Va.
Ottawa, Ill.	St. Louis, Mo.
Verbena, Ala.	Montgomery, Ala.

The highest and lowest stages for the year, together with the annual ranges at 249 selected stations, are shown in Table V.—*H. C. Frankenfield, Professor of Meteorology.*

REPORT OF THE CHIEF OF THE WEATHER BUREAU FOR THE FISCAL YEAR ENDING JUNE 30, 1905.

[Dated July 28. Extract from the report of the Secretary of Agriculture, October, 1905.]

I have the honor to submit a report of the operations of the Weather Bureau during the fiscal year that ended June 30, 1905.

REVIEW OF TEN YEARS' WORK.

The present Chief of the Weather Bureau completed ten years of service as such on July 4, 1905, having served previous to his appointment as Chief of the service nineteen years in the various subordinate grades. It may, therefore, not be inappropriate at the end of this decade to make a brief survey of the development of the weather service during his administration.

It is probable that there is no part of the Government service in which rigid discipline is more necessary to its well-being than in the United States Weather Bureau. It has to do with the saving of life and property. While its observations are made with scientific precision, yet its warnings of danger from floods, from gales, or from frigid air, are the results of empirical reasoning, and, therefore, even with favoritism eliminated from its personnel, and with the maintenance of the highest form of the merit system of appointment, promotion, and preferment, there will still be a small percentage of error in its warnings. The public is entitled to know, however, that it is only by the maintenance of a high standard of official integrity that the percentage of error is reduced to and kept at a low figure.

The following statement of appropriations, disbursements, and unexpended balances, from July 1, 1895, to June 30, 1905, ten years, shows that the average per annum increase in the appropriations for the support of the Weather Bureau has only been 4.41 per cent; that during three years of this period there was an actual decrease in the appropriations and that during no year was there a deficit, but that each year a considerable sum of money—in one case amounting to over $71,000, in another to $13,000, in another to over $9,000, and in still another to over $8,000—was returned to the Treasury as unexpended balance.

Appropriations, disbursements, and unexpended balances from July 1, 1895, to July 1, 1905.

Fiscal year.	Amount appropriated.	Amount disbursed.	Amount unexpended.	Per cent of increase in appropriations.
1896	$885,610.00	$814,584.17	$71,145.30	0.82
1897	883,772.00	870,581.46	13,190.54	†0.21
1898	883,702.00	877,388.35	5,863.65	†0.01
1899	1,015,502.00	1,007,962.92	9,539.08	14.91
1900	1,022,482.00	1,014,238.80	8,243.20	0.68
1901	1,058,320.00	1,052,626.99	5,693.01	3.51
1902	1,148,320.00	1,146,769.16	1,550.84	8.50
1903	1,263,760.00	1,256,752.90	7,007.10	10.05
1904	1,248,520.00	1,245,653.81	2,866.19	†1.21
1905	1,337,740.00	*1,336,198.58	*1,541.42	7.14

*Estimated. †Decrease.

Again referring to the fact that the average per annum increase in the cost of the weather service during the past ten years is only 4.41 per cent, it is significant, as showing the benefit to the weather service of a determination to apply the spirit as well as the letter of the civil service law, that the daily distribution of forecasts and warnings, or of printed charts containing the daily meteorological data of the United States, has increased from 22,582 to 622,880 copies, of which 158,000 represent printed reports.

The frequently expressed opinions of persons who represent the important interests that the Weather Bureau was created to serve, show that it has made such progress in its internal discipline and in the results accomplished for the benefit of the farmer, the mariner, the shipper, the manufacturer, and the seeker after health or pleasure, that there is no weather service anywhere in the world comparable with it. It has received the commendation of citizens of this country as well as the encomiums of scientists both at home and abroad, many of whom come here to study its organization. In recent years its stations have been equipped with standard instruments, apparatus, and furnishings of the latest design; daily maps are printed at nearly 100 of its local stations; large glass maps, containing the current weather reports, are exhibited each morning before important commercial associations; maps, either neatly printed or milleographed, are distributed within three hours from the time that the observations are made. Climatic statistics for the various States are collected from nearly 4,000 voluntary observers using standard instruments, and printed in the form of monthly section reports, so that the climate of one region can be readily compared with that of another. The Bureau has extended its network of stations around the Caribbean Sea and the Gulf of Mexico, so that no destructive tropical storm may come without warning. It has established stations in Bermuda and in the Bahamas, and arranged for cable cooperation in the Azores and along the western coast of Europe, which enables it to make forecasts for two or three days in advance for steamers leaving this country, and to warn steamers leaving Europe for America of severe storms which they may encounter on their westward voyage. With kites and mountain stations it has explored the upper air and gained useful knowledge. It has conducted experiments in wireless, or space, telegraphy, and developed one of the best wireless systems now in use. It has extended its system of telegraphic and climatic observations so that now, except in some portions of the Rocky Mountain States, the temperature and rainfall conditions of nearly every county can be ascertained; these observations are of great benefit in the development of the arid and subarid regions, especially in the organization of the extensive irrigation works recently authorized by Congress.

The Weather Bureau has developed and put into effect a fair, yet rigid, discipline for the control of its personnel—a system of merit in which each person works out his own status to such an extent that it is practically impossible for an incompetent or undeserving person, or a person lacking in good character, to reach any important post of duty. With this discipline there is associated a system of study and examination which develops the intellectuality of those who receive advancement. With

such a discipline it has, with rare exceptions, given timely warning of the coming of injurious changes in temperature, and allowed no important storms or floods to come unannounced.

It has encouraged the study of meteorology in educational institutions by allowing its employees, outside of their official duties, to deliver courses of lectures to students, so that there are now twenty institutions of learning in which meteorology forms a part of the curriculum, thereby giving preliminary training to the young men who, in after years, will succeed to the duties now performed by the meteorologists of the Government.

Finally, three years ago the Bureau began the development, at Mount Weather, Va., of an institution devoted purely to meteorological research.

The present appropriation for the support of the Bureau is $1,392,990. This is the amount to be expended during the current fiscal year in applying our limited knowledge of meteorology to the commerce and the industries of the United States, and to the saving of human life. A knowledge of the coming weather enters so intimately into every contemplated human action that the question is often asked: "What are the prospects for further improvement in the accuracy of weather forecasts, and can the seasons ever be foretold?" The answer is that the Government has a corps of forecasters, the members of which are the survivals of the fittest in a thorough system of elimination by competition. Since they are now applying all of the knowledge of the atmosphere that has been attained, little hope for material improvement in their work can be held out until a substantial addition is made to the pure science of the problem. This can only come through experimentation, study, and research. With 200 stations engaged in applying the science, it is a wise economy to devote at least one of them to the work of adding to the knowledge that we are annually spending nearly a million and a half of dollars to apply. Accordingly we have endeavored to lay out a plan of study and research leading to an increase in our knowledge of the laws governing the atmosphere such as should eventually enable our successors, if not ourselves, to add to the accuracy of weather forecasts and to make them for a longer period in advance.

The progress of every branch of science is necessarily slow. Four hundred years of unremitting observation and study were necessary in order to bring astronomy up to its present high standard of accuracy and it must be expected that the complex problems of meteorology will require time for their elucidation.

The last thirty years has witnessed such remarkable progress in new branches of science that fields of research formerly closed to the meteorologist are now open to him and justly can not be neglected. The discovery of the remarkable properties of radium has opened up a field of research relative to the ionization of gases, and this has led to a complete revolution in our ideas relative to atmospheric electricity. The studies of Professor Langley with the bolometer have led to the perfecting of similar instruments by various European and American students, so that now the analysis and measurement of sunshine and the determination of the nature and influence of the radiations that come from the sun form a fundamental field of study for the meteorologist. Recent observations by the Bureau have shown the plausibility of a large variation of the amount of heat that is received from the sun or an equivalent possible variation in the transparency of the highest portions of the earth's atmosphere, a discovery confirmed by corresponding observations in Switzerland. A year of special cloud observations all over the world has led to the modification of earlier views as to the general circulation of the atmosphere, while mathematical methods have been perfected that give promise of being directly applicable to the rigorous discussion of these complex motions.

In all these studies the Weather Bureau has hitherto taken a subordinate part, whereas in matters of so-called practical meteorology it has always occupied the leading position.

In order that this country may do its share toward the advancement of meteorology along the lines that specially relate to conditions in America, it is imperative that the Weather Bureau should establish an observatory for its own special research work. It would seem a severe criticism to say that the United States Weather Bureau has 200 stations for routine observations and spends such a large amount of money annually for routine work without doing anything for the permanent improvement of the science upon whose development its efficiency depends. It was long since stated that the highest efficiency in any art implies a perfect knowledge of the higher science behind it.

We have therefore secured a piece of land and inaugurated work at an establishment that is intended to respond to the present and prospective needs of meteorology. We have called this the Mount Weather Research Observatory, and have organized it on a broad and elastic basis so that it may from year to year expand with the growing knowledge of our needs. The other weather bureaus of the world have been inclined to make research more prominent than practical routine. Their appointments, their promotions, and internal organization, and their whole animus, are in harmony with the principle that in the present state of meteorology research is more important than forecasts; that to establish a new law is better than to forecast rains, frosts, or storms; that, in general, our knowledge of the atmosphere and its mechanics needs to be increased so that we may venture upon forecasts that will establish a new standard of accuracy.

In order to prosecute the researches contemplated at Mount Weather, we have established there a plant especially adapted to atmospheric research. By means of balloons and kites, the temperature, moisture, and movements of the air at great heights will be ascertained. The absorption of solar heat by the atmosphere will be measured by means of the pyrheliometer and actinometer. The special analysis of the sunbeam will be carried out by means of the bolometer and spectrometer. The electric condition will be determined by means of the electrometer, and the radioactivity, or ionization of the air, by means of the dissipation apparatus of Ebert. To all this we have added apparatus for studying the relations to the atmosphere of the magnetism of the earth, the temperature of the soil, and even the motions of the earth as shown by the seismographs. All these phenomena have been shown to have a more or less intimate connection with meteorology.

In so far as aerial research may require it, sounding balloons will be liberated from many of the weather stations in distant parts of the country in cooperation with those at Mount Weather, since it is considered very important to know the condition of the atmosphere above the land every day of the year up to the greatest attainable height, especially during the passage of storms and cold waves. These so-called sounding balloons may attain altitudes of twenty miles; through them a record will be obtained of the winds and temperatures at that height as well as throughout the whole intermediate strata. Therefore Mount Weather may be expected to do as much for the science of meteorology and the future improvement of the service as the service has already done during the past 35 years for the material interests of the United States. As this country led the world in the practical application of meteorology, it is desired henceforth to lead in the development of the science itself.

In addition to the observational side of the above-mentioned studies it is absolutely necessary to provide conveniences for experimental work, that is to say, a physical laboratory in which to investigate all questions that yield to treatment by experiment as distinct from pure observation. There is also needed a power house and an electrical installation for the

manufacture, by the electrolytic process, of the hydrogen gas for the use of balloons; this process has been demonstrated to be by far the most convenient and economical method of obtaining large quantities of pure hydrogen. It has even been necessary to stimulate the manufacturers of india rubber in order to secure a material that will retain its elasticity at the very low temperatures to which the balloons are exposed at great altitudes.

As meteorology is essentially a study of the physics of the atmosphere, the physical laboratory will become the central life of the institution. A capable physicist has therefore been selected as the supervising director of the whole institution, and men of the highest talent for each line of coordinated research.

Similar institutions designed to carry on one or more of these lines of study have been established at Potsdam near Berlin, Pavlovsk near St. Petersburg, Montsouris and Parc St. Maur near Paris, and Kew Observatory near London, but we have combined in the Research Observatory at Mount Weather the principal duties that devolve upon all those observatories, with the additional kite work and balloon work carried on by the famous observatory for dynamic meteorology established at Trappes near Paris, by Teisserenc de Bort, the private observatory of Mr. A. L. Rotch, at Blue Hill near Boston, and the new institution established by the Government of Prussia, at Lindenburg, about 40 miles southeast of Berlin, where aerial research will be prosecuted under Assmann.

As in the case of all these establishments, so also with the institution at Mount Weather, the employees must necessarily live close by their apparatus, and provision must be made for all the ordinary needs of domestic life precisely as is done in all large astronomical observatories, and in military establishments. This has been accomplished economically and in accordance with established usage.

As it may happen that others, not employees of the Bureau, may be engaged in research that is of importance to the Weather Bureau, it is contemplated to extend to such every facility for the prosecution of their studies at this institution, in the belief that the Bureau will receive great advantage from such association with distinguished scholars and experts.

WORK OF THE YEAR, WITH RECOMMENDATIONS.

THE MOUNT WEATHER RESEARCH OBSERVATORY—BUILDINGS COMPLETED AND PROJECTED.

During the past year work on both buildings and grounds has been pushed as vigorously as circumstances would permit. The administration building and weather station was completed and equipped last fall and observations begun, which have since been used daily by the forecasters at Washington. Two magnetic observatory buildings have been completed during the year, one for absolute and one for differential determinations of the elements of the earth's magnetism. The instruments for both magnetic observatories are now being installed. The power house which was completed during the last fiscal year has been fitted with engines, generators, etc., for use in aerial work. All of the large machines were in place by the end of March, 1905, and work was then resumed on the revolving kite shelter, which was completed before the end of the fiscal year. Work was begun on the building for the physical laboratory in July. There are still some difficult questions regarding the best plans for the solar physics work, but as a final decision is not required at present, more time will be employed in consultation.

In planning the power house and kite shelter and in the installation of machinery in the first named, valuable aid has been rendered by Prof. Charles F. Marvin.

The schedule of apparatus for the solar physics observatory has been submitted to prominent instrument makers for estimates as to cost of construction.

The subject of solar radiation appears to be so important that early in the year the climatologist, Mr. H. H. Kimball, was instructed to prepare himself to take up this line of research at the Mount Weather Observatory. Through the courtesy of Secretary S. P. Langley of the Smithsonian Institution, arrangements were made for the detail of Mr. Kimball to the Astrophysical Observatory for instructions and actual work in connection with the spectro-bolometric apparatus devised and used at that observatory. This detail commenced on May 1, 1905, and will probably continue until October of the same year. The practical experience thus gained by Mr. Kimball should be of great value to the Bureau when the study of solar radiation is taken up in earnest.

Observations with the Ångström pyrheliometer and the Pickering polarimeter have been continued at Washington throughout the year. A discussion of the results will be found in the Monthly Weather Review for March, 1905. The Ångström instrument has been carefully compared with the actinometers used by the Smithsonian Institution. It is hoped that this will enable us to connect European actinometer work with Professor Langley's spectro-bolometric work, and to thus perhaps obtain some knowledge of variations in solar radiation over a considerable period of time.

METEOROLOGICAL OBSERVATIONS AT MOUNT WEATHER.

Regular observations of the several meteorological elements at 8 a. m. and 8 p. m. were begun at Mount Weather, Va., in November, 1904, and have been continued uninterruptedly since that time.

PERSONNEL OF MOUNT WEATHER RESEARCH OBSERVATORY.

The research staff has been strengthened by the appointment of William J. Humphreys, Ph. D., Johns Hopkins University, and late professor of physics in the University of Virginia, to be supervising director at Mount Weather, to take effect July 1, 1905, and by the recall of Mr. Louis G. Schultz from temporary detail in Argentina in connection with the equipment of magnetic observatories in that country.

Mr. Herbert L. Solyom, recently of the U. S. Patent Office, has been appointed as a special aid to Professor Humphreys in studies of radiation, ionization, and solar physics.

The organization of the Mount Weather Observatory as at present constituted is as follows:

AT WASHINGTON.

Director.—The Chief.

Board of advisers.—Prof. Cleveland Abbe, Prof. Charles F. Marvin, Prof. Frank H. Bigelow, Chairman; Prof. Edward B. Garriott, Prof. Henry J. Cox, Prof. Alfred J. Henry, Prof. Alexander G. McAdie, Prof. Harry C. Frankenfield, and Prof. William J. Humphreys.

AT MOUNT WEATHER.

Supervising director.—Prof. William J. Humphreys, who shall have supervision in detail of all work in the physical laboratory and solar physics observatory and general, rather than detailed supervision of other researches. He will aid the research directors in matters wherein his knowledge may be of assistance, and will be an advisor rather than a director of their research; although in all matters of cooperation between research directors he will have the controlling voice. He will have charge of the discipline of the institution, referring to the Chief such matters as can not be settled at the station.

Mr. Herbert H. Kimball, who, through the courtesy of Prof. S. P. Langley, is receiving special training in the use of the bolometer in the Smithsonian Institution, will be Professor Humphreys's principal aid in solar physics, and Mr. Herbert L. Solyom, who, by the kindness of Prof. E. B. Frost, is doing special work at the Yerkes Observatory, will be an additional assistant.

Director of magnetic and electric research.—Mr. Louis G. Schultz, who shall have charge of the magnetic observatories

and observations in atmospheric electricity and special electric and magnetic research.

Director of upper air research.—Dr. Oliver L. Fassig, who shall have charge of balloon and kite observations and the discussion thereof. Messrs. Schultz and Fassig will arrange for cooperation in the taking of electrical observations from kites.

Observer in charge of property.—Mr. Charles S. Wood, who, under the general control of the supervising director, shall have charge of the premises, repairs, improvements, heating and lighting, power plants, horses and vehicles, meteorological observations and forms, and the mess and forage funds. He may correspond direct with the Central Office in regard to the details of the work with which he is charged.

Each official will discuss his own observations and, so far as possible, correlate the events shown by his reports with those indicated by the observations of others. There will be a cheerful willingness to cooperate for the general good of the institution and the advancement of the science of meteorology.

There will be no publication in the bulletins of the Bureau of mere argument over abstract theories in science. The place for such is the scientific publications, which are open to all. No more data will be published in the announcement of results than are necessary to make clear the subject matter, except when the data are new.

The prime object of the institution, viz, the taking of observations and the gathering of data with which to make experimentation and prosecute research, will be kept in mind. Unpublished data will be open to the use of all recognized investigators, and cooperation with other scientific workers will be encouraged. Questions that may directly or indirectly be of value to the science of meteorology will be proper subjects for investigation. The field of inquiry will, therefore, be a broad one.

PROBLEMS IN INSTRUMENTAL EQUIPMENT AWAITING SOLUTION.

For a number of years Prof. Charles F. Marvin, the official in charge of the Instrument Division, has endeavored to give a portion of his time and efforts to the study of problems which are directly related to the development of new apparatus and the perfection of the equipment now in use. Such efforts seemed to be indispensible, in order to keep pace with the demands for better instrumental devices. Thus far, however, while the value of such work has been conceded, it has had no recognized place or funds in the yearly schedule, and much of the little that has been done was accomplished only by effort during extra hours when the official in charge of the Instrument Division could be free from the constant interruption incident to the daily routine. During the last ten years the extension of the service with respect to the instrumental equipment of stations has been very great. In 1895 only about 361 automatic instruments of all kinds were in operation at stations. The number at the present time is 1,195.

Instrumental apparatus has been greatly improved and perfected; many new designs have been brought out and other scientific work accomplished, such, for example, as the partial determination of the constants of the anemometer equation, and the relation of wind velocities and pressures; the determination of vapor pressures at low temperatures; studies upon the mechanics and equilibrium of kites, etc.

At no time in its past history has the Bureau assumed such an attitude toward the solution of the scientific problems of meteorology as at the present time. Extensive preparations are being made for a comprehensive study of difficult matters that may require years for their solution. At the same time many of the simpler but equally important problems are pressing for attention which it is hoped may be given in the near future.

Some of the investigations that can be taken up when the laboratories at Mount Weather are finished, are as follows:

(1) Studies in the development of practical apparatus for the measurement and registration of evaporation, both in the interest of plant physiologists and irrigation engineers.

(2) Apparatus for the better observation and the automatic registration of humidity, especially at low temperatures.

(3) Apparatus for the indication at local offices of river stages. Some work was done on this problem last year, but thus far opportunity has not offered to bring the matter to a satisfactory status.

(4) Apparatus for measurement and registration of solar radiation. This embraces not only the present type of station sunshine recorders, in which improvement is needed, but also the class of instruments known as pyrheliometers, actinometers, etc., such as have been employed for some years by Mr. H. H. Kimball in his special observations.

(5) Stations need apparatus for the more exact registration of the beginning and ending of precipitation. A device for this purpose has been partly worked out by Dr. Oliver L. Fassig, but important structural and mechanical improvements are required to render this device actually available for station use.

(6) Improvements are required in tele-thermographs. These instruments are needed at many stations.

(7) Rain gages are needed suitable for exposure on mountain ridges, remote from the habitation of the observer, and in the water-sheds of great rivers, so that the precipitation, snow or rain for a whole season, can be collected and measured even though regular daily observations be not made.

(8) Apparatus intended for the recording of lightning has already received some attention, but we should be in a position to discuss the structural details of these devices and their merits and demerits on a basis of real experience.

(9) The improvements in seismometry have revealed how widely sensitive the seemingly rigid earth really is to vibrations in its crust, and that all great earthquakes can be recorded over the entire globe by sufficiently sensitive instruments. At about 6 a. m. April 4, 1905, a great earthquake occurred in northwestern India, killing and injuring a great many people and causing the total destruction of towns and villages. The entire crust of the earth was set into elastic vibrations which were recorded at the Weather Bureau and all over the world wherever delicate seismographs were maintained. Dr. F. Omori, secretary of the earthquake investigation committee of Japan, reports concerning the Indian earthquake that the large seismograph at Tokyo recorded first the waves proceeding from India to Tokyo direct, via Siberia, and later on, those which crossing Europe and America, reached Japan by way of the Pacific Ocean. Still more remarkable than this, the seismogram at the Osaka Meteorological Observatory showed the waves which, having reached Japan from India direct, passed on across the Pacific Ocean, America, and Europe, and finally, as it seems, returned to Japan after having made literally a complete circuit of the earth. The time required was 2 hours, 3 minutes, and 35 seconds. Certain seismic records appear to show that the crust of the earth is appreciably sensitive to great meteorological changes, and these the Weather Bureau is preparing to study with the aid of the instruments at Washington and those it is about to install elsewhere. The great delicacy of these instruments requires corresponding skill and attention in their maintenance.

(10) The Weather Bureau is almost daily in receipt of requests for information relative to high wind velocities and the relation of pressure to velocity. This is a subject in great need of further experimental investigation.

(11) Similar to the foregoing is the question of atmospheric humidity at temperatures above 100° F. The present humidity tables end at 140° F. Many inquiries are received for values at higher temperatures, such as are encountered in methods for artificial drying, etc. The Bureau can render a distinct service

to many interests by an accurate extension of the tables into the upper ranges of temperature.

There is a demand upon the Bureau for authoritative results in each of the several lines of inquiry cited above, but progress on such original work has heretofore been impossible; now, however, with the completion of the physical laboratory, at Mount Weather which it is expected will be under roof before cold weather, and the installation of apparatus in this and other buildings at that place, these important problems may soon be attacked with hope of success in their solution.

FORECASTS AND WARNINGS.

There were but two severe atmospheric disturbances during the year, both of which were confined to Atlantic coast districts. The first assumed marked intensity on September 14–15, in the subtropical region north of the West Indies, and moved thence with considerable speed to the New England coast and the Canadian Maritime Provinces. It was attended along the Atlantic seaboard by excessively heavy rain and strong gales that attained hurricane force at points along the middle and south Atlantic coasts. The maximum wind velocity reported in connection with this storm was 100 miles an hour from the northwest at Delaware Breakwater at 2 a. m. of the 15th, and the rainfall exceeded five inches at points in the Middle Atlantic States. Although the approach of this storm was announced by timely advices and warnings that prompted precautionary measures, a number of lives were lost, much damage was caused to seaside property, and many casualties to shipping occurred along the Atlantic coast of the United States.

From November 11 to 14, 1904, a storm of exceptional severity advanced from the Isle of Pines to Nova Scotia with barometer readings of 29.08 inches at Hatteras, 28.74 inches at New York, and 28.60 inches over Nova Scotia. Attending this storm, heavy gales occurred along the coast from Eastport to Jacksonville, heavy snow fell from the Lake region over the North Atlantic States and snow was reported as far south as North Carolina. The life-saving station at New Inlet, N. C., was swept away by the heavy seas and four of the men stationed there were drowned, and several vessels were wrecked along the coast. Communication by telegraph and telephone was interrupted in New England and the Middle Atlantic States, and coast towns suffered considerable damage. Storm warnings were issued well in advance of the storm as it moved up the coast and hurricane warnings were displayed for the New England coast where it attained its maximum intensity; undoubtedly much property and many lives were saved by the attention paid to these warnings.

The Boston Transcript remarks as follows regarding the warnings issued for the New England coast in connection with this storm:

> Ample warning was given by the Weather Bureau Saturday on the approach of the storm at a time when the skies were fair and northeasterly winds little expected; and to the warnings is doubtless due the small number of wrecks and disasters.

A number of severe storms occurred on the north Pacific coast and the high winds and gales accompanying them did considerable damage to shipping. The following is from the Oregonian of Portland, Oreg., under date of November 10, regarding warnings issued in connection with these storms:

> The accuracy of the forecasts of the Weather Bureau on last week's storms was remarkable and shipping masters who heeded the forecasts and remained in port saved money for the underwriters and much unpleasantness for themselves. Considering the violence of the gales which raged for the greater part of the week, the Weather Bureau was quite fortunate in maintaining communication with the North Head station. The service from that point is of great value to the shipping community, and Mr. Beals has been untiring in his efforts to make it as prompt and accurate as possible and is to be congratulated on his success.

NOTABLE COLD WAVES.

A cold wave of unusual intensity crossed the United States from December 24 to 29, 1904. This cold wave extended from the Dakotas to the Texas coast and from the Ohio Valley to the Gulf. During its passage, the greatest 24-hour fall in temperature, 54°, occurred at Springfield, Mo.; a minimum of 36° below zero was noted at Williston, N. Dak., and the line of zero temperature extended to southern Colorado and southern Kansas. The following are among the press comments made in connection with this cold wave:

From the Springfield, Ill., News, of December 28, 1904.

> One of the worst blizzards in many years has swept this country, causing distress and damage. Life and property must be sacrificed to these storm monsters that no human ingenuity can control. The best that we can do is to send warnings ahead and forewarn others of its approach. This is the work the Government has undertaken in its Weather Bureau. How much life and property has been saved by the Government's system of forewarning can not be computed. There is no branch of public service that is of such immense value to the people. This is attested by the widespread credit given it and the unanimity with which shipping, mercantile, railroad, manufacturing, and farming interests watch the weather forecasts. A twenty-four hour or even twelve hour warning of the approach of such a storm as that which swept upon us yesterday is often more than ample to protect life and property that are exposed.

From the New Orleans Picayune of December 29, 1904.

> While the temperature has been below freezing in the sugar and trucking region around New Orleans several times this season, the freezing mark at New Orleans was registered for the first time yesterday morning. Timely warnings were scattered broadcast by the Weather Bureau, stating that planters and the public should prepare for temperatures of 24° to 28° in the sugar region and 30° at New Orleans. The prediction was fully verified. The Weather Bureau issued warnings for every severe change in the weather, and the few failures were when certain conditions which were expected did not materialize. Farming interests consider the warnings of incalculable value, and they do not complain if a prediction sometimes falls short. One freeze without warning means the loss of many thousands of dollars, and perhaps of millions of dollars, while the expense of occasional protection when a predicted freeze does not come is a very small matter. So accurate and definite have the warnings become, that no planting interest in the State has suffered from weather conditions when the warnings were believed and action taken to prevent loss and damage.

A severe cold wave appeared over the Dakotas, Minnesota, Nebraska, and Iowa on January 24, 1905, and on the 25th it covered the central and upper Mississippi valleys and extended over the northern portions of the east Gulf States, the line of zero temperature reaching into northern Tennessee. On the 26th, the cold wave covered Florida, and temperatures below freezing were reported as far south as Tampa and Jupiter. At the latter place, the minimum temperature, 24°, equalled the lowest ever recorded since the establishment of the Weather Bureau station at that point, the lowest previous minimum having occurred December 29, 1894. Considerable damage was done to orange trees where groves could not be fired or protected. Ample warnings had been given of the expected low temperatures, and the Morning Tribune of Tampa in an editorial of January 26, estimated that—

> But for the prompt and ample warnings given by the Weather Bureau office, and the precautions immediately taken upon receipt of these warnings by farmers and growers, the damage would have been about ten times what it really was.

The work of the Weather Bureau is not confined to the issuance of warnings of notable storms and severe cold waves. A service that well represents the value of the Bureau, especially in commercial and marine circles, is the giving out daily, by telephone and otherwise, of information respecting the current weather conditions in different parts of the country.

In the distribution of forecasts and warnings, little change has been made in the methods formerly employed. The distribution by telephone is increasing quite rapidly; next to the daily newspaper, this method must eventually become the most effective within reach.

The following statement shows the distribution by States

and Territories, and the changes, as compared with the work of the previous year:

Distribution of daily forecasts and special and emergency warnings.

State or Territory.	At Government expense.			Without expense to United States by—				
	Forecasts and special warnings.	Special warnings only.	Emergency warning.	Mail.	Rural free delivery.	Telephone.	Railroad telegraph.	Railroad train service.
Alabama	21	3	139	1,206	425	109	100	12
Arizona	3	1	0	0	0	20	0	0
Arkansas	28	5	102	581	621	84	6	0
California	139	12	0	2,541	5,071	49	0	0
Colorado	15	69	39	1,035	645	2*	0	7
Connecticut	16	3	49	1,220	155	0	0	151
Delaware	9	0	0	72	472	0	34	0
District of Columbia	0	0	0	1,191	0	0	0	0
Florida	27	153	61	906	0	82	57	0
Georgia	39	40	241	1,593	1,558	24	217	41
Idaho	9	1	0	366	0	874	0	17
Illinois	149	21	468	3,376	9,538	113,618	93	459
Indiana	102	11	208	1,893	2,792	48,937	72	287
Indian Territory	6	1	4	170	0	4,016	114	0
Iowa	186	25	400	1,948	9,920	66,845	13	0
Kansas	81	6	186	886	5,485	3,875	15	15
Kentucky	37	37	96	2,186	75	27,094	14	0
Louisiana	33	46	61	896	115	441	6	0
Maine	21	5	40	1,116	995	7	0	77
Maryland	31	5	42	1,992	1,540	20	91	0
Massachusetts	26	18	63	3,041	310	15	0	331
Michigan	128	17	379	5,328	2,269	43,837	264	457
Minnesota	76	13	196	2,003	5,573	9,483	19	0
Mississippi	30	7	118	763	416	767	6	0
Missouri	70	7	240	5,125	2,269	17,000	25	0
Montana	13	19	18	413	0	227	0	0
Nebraska	68	8	221	1,131	1,085	1,850	0	0
Nevada	3	0	0	106	0	0	0	0
New Hampshire	22	1	34	1,207	1,398	145	0	31
New Jersey	20	23	45	1,223	305	587	176	0
New Mexico	4	2	0	60	0	0	0	0
New York	108	47	365	7,947	2,230	12,049	243	168
North Carolina	54	17	189	1,144	1,909	93	1	16
North Dakota	13	14	99	154	640	70	0	0
Ohio	103	94	437	6,568	3,060	61,490	37	17
Oklahoma	11	2	13	317	622	5,894	72	0
Oregon	18	2	0	693	675	0	0	104
Pennsylvania	61	21	367	3,871	1,553	7,375	532	0
Rhode Island	5	0	12	105	0	0	0	28
South Carolina	28	9	109	1,185	1,156	17	40	23
South Dakota	41	27	77	718	891	1,411	0	0
Tennessee	40	10	291	1,506	1,715	868	2	2
Texas	52	67	240	1,707	3,336	636	65	0
Utah	16	58	0	410	1,202	17,377	0	0
Vermont	13	1	46	586	260	38	8	13
Virginia	39	10	96	1,562	433	425	61	96
Washington	20	4	0	795	901	8	0	29
West Virginia	17	12	55	758	225	1,666	60	26
Wisconsin	100	15	298	2,036	1,722	15,178	0	16
Wyoming	7	4	8	138	40	135	0	0
Total June 30, 1905	2,158	973	6,152	77,774	75,602	464,738	2,443	2,423
Total June 30, 1904	2,076	983	6,152	77,605	83,639	152,302	2,655	2,423
Changes	+82	−10	0	+69	−8,037	+312,436	−212	0

*Practically every telephone station in the State receives the forecasts through the cooperation of the Colorado Telephone Company.

WIRELESS DISTRIBUTION OF STORM WARNINGS TO VESSELS AT SEA.

Pursuant to recommendations in the report of the Interdepartmental Board on Wireless Telegraphy, dated July 12, 1904, and approved by the President July 29, 1904, the control of meteorological work on the oceans has been transferred from the Hydrographic Office, Navy Department, to the Department of Agriculture, and all meteorological work, heretofore done by the Navy Department for the purpose of publication or for the making of forecasts of storm warnings, has been assigned to the Weather Bureau of the Department of Agriculture.

In further compliance with the recommendations of the Board, the Navy Department has instructed its wireless stations to receive and promptly transmit to the ocean, or to islands, or to other places where the information can be made useful, the storm warnings of the Weather Bureau, and has requested vessels having the use of its wireless stations for the receipt of messages to take daily meteorological observations of the weather when within communicating distance, and to transmit such observations to the Weather Bureau through wireless stations at least once daily, and to transmit observations oftener when there is a marked change in the barometer. The recommendations further provide that there shall be no charge against the Department of Agriculture for these observations or for the transmission thereof by wireless telegraphy.

In the development of the plan of transmitting storm warnings by wireless telegraphy, the cooperation of the Light-House Board of the Department of Commerce and Labor has been secured and instructions have been issued by that Department for the display and dissemination of storm warnings and advices at light-houses and light-ships that are in communication with the Naval wireless stations.

At the close of the fiscal year, the scope of the wireless work provided for the transmission of storm warnings from Naval stations to offshore points as follows:

Portsmouth, N. H., Navy Yard to Cape Ann, Thatcher's Island, Mass.
Torpedo Station, Newport R. I., to Nantucket Shoals, Mass., Light-ship.
Brooklyn Navy Yard to Highlands of Navesink, N. J.
Norfolk Navy Yard to Diamond Shoals Light-ship off Hatteras, N. C.
Charleston, S. C., Navy Yard to Charleston Light-vessel.
Mare Island Navy Yard, Cal., to Yerba Buena, Cal.
San Juan, Porto Rico, Naval Station to Culebra, Porto Rico. (In partial operation.)

Arrangements will be perfected at the earliest possible date for similar wireless service as follows: Portland, Me., to Cape Elizabeth, Me.; Boston Navy Yard to Highland Light, Cape Cod, Mass.; Key West, Fla., Naval Station to Dry Tortugas, Fla.; and from the Pensacola, Fla., Navy Yard to vessels within communicating distance.

Negotiations are also in progress with the Marconi Wireless Telegraph Company for the receipt at the station of this company at Siasconset, Nantucket Island, Mass., of wireless messages containing meteorological observations from vessels that are equipped with the Marconi apparatus, and for the transmission of storm warnings to vessels that may be in communication with the station. The inauguration of a system of interchange between shore stations and vessels at sea of messages containing storm advices and meteorological observations promises an enlargement of Weather Bureau work that will be coextensive with the development and scope of wireless telegraphy. The extension over the ocean of the area of meteorological reports by wireless telegraphy may, in time, permit a service to transatlantic steamers about to leave American and European ports that will advise them regarding the character of the weather they will experience at sea. Furthermore, it is likely that reports that will be available with an extension of wireless telegraphy, will result in a communication of storm advices to vessels in mid-ocean, and render possible a storm warning service for the western coasts of Europe.

RIVER AND FLOOD SERVICE.

The year 1904–5, like its immediate predecessor, was not productive of serious floods in the larger rivers, although several damaging floods occurred in the smaller rivers, notably in the upper Sacramento in January, 1905; in the Purgatory and upper Arkansas rivers of Colorado; the Rio Grande, Pecos, and upper Canadian rivers during the latter part of September and the early part of October, 1904, and in the Grand River of Michigan in June, 1905. The floods in the rivers of the southwest in September and October, 1904, were peculiar, in that they occurred in the semiarid region and at a time of the year when heavy rainfall is not anticipated. Their coming was not announced, since no flood service had yet been organized in that part of the country. The damage done by the floods in Colorado, New Mexico, Oklahoma and Indian Territories, and Texas amounted to at least $4,000,000, of which the greatest share fell upon the railroads. The loss

among the inhabitants was not less than $1,000,000. These very destructive floods brought to the attention of the Weather Bureau the need of a flood service in the States above mentioned. Such a service was organized during the winter of 1904–5, and it began operation with fifteen river and ten rainfall stations, the headquarters of the district being at Denver. Although the service is not completed, it has done much good in giving warning of the floods in the Rio Grande during May and June, 1905.

The flood of June, 1905, in the Grand River of Michigan, while not as great as that of 1904, was nevertheless a disastrous one, and that it was not even more so was without question due to the forecast and warning service given by the Weather Bureau.

Extensions during the year.—During the year, several new districts were established and a large number of river and rainfall stations were opened. The new districts are as follows: 1) For the rivers of Ohio, with headquarters at Columbus; (2) for the the rivers of Iowa, with headquarters at Des Moines; (3) for the rivers of lower Michigan, with headquarters at Grand Rapids, and (4) for the smaller streams of Mississippi, with headquarters at Meridian. These districts, while quite limited in area, were established in order that warnings might be given of the severe floods that visit them, usually during the spring months. There were also established during the year 109 special river stations and 38 special rainfall stations, distributed as advantageously as possible among the various districts. Five special river and nine special rainfall stations were discontinued during the year, and at its close there were in active operation 329 special river and 96 special rainfall stations. About two-thirds of these are regular reporting stations, the observers receiving compensation averaging $84 and $36 a year, respectively. In addition, daily river observations are also taken at 54 regular Weather Bureau stations, making a grand total of 383 river and 96 rainfall stations.

WEATHER-CROP BULLETINS.

The Weather Bureau issues both national and sectional Weather-crop bulletins. Mr. James Berry continues to edit, with skill and intelligence, the National Weather-crop Bulletin. The sectional bulletins are edited by Weather Bureau officials in charge of the various section centers. In addition to the bulletins above mentioned, the Bureau issues a cotton region bulletin from New Orleans, La. These publications aim to give the most accurate and impartial information concerning the weather and crop conditions that it is possible to obtain through its corps of telegraphic and mail crop correspondents.

Outside of Washington, D. C., there are 44 sections centers for the collection and dissemination of weather statistics in connection with crop conditions. The following table shows, for each section of the climate and crop service, the number of cooperating observers and crop correspondents, and the editions of the weekly bulletins and the monthly climatological reports:

SNOW AND ICE BULLETINS.

The snow and ice bulletins have been issued regularly from the beginning of December to the close of March, as heretofore. These bulletins show graphically the depth of snow over the country, and give in tabular form the actual depths reported, together with the thickness of ice in the rivers and harbors.

COTTON REGION SERVICE.

The information upon which the reports of weather conditions in the cotton region are based is collected mainly from 146 stations distributed throughout the cotton growing States, and reported daily by telegraph to certain district centers.

CORN AND WHEAT REGION SERVICE.

The Weather Bureau maintains a similar service in the interests of the corn and wheat growing States. One hundred and thirty-four stations report the weather conditions by telegraph, daily, during the growing season, from April 1 to September 30 of each year.

For the benefit of the rice interests of Louisiana, nine subordinate stations are maintained in that State. These stations likewise report the weather conditions daily by telegraph.

Number of cooperative observers, correspondents, etc.

Section.	Number cooperative observers.	Crop correspondents.	Publications issued.	
			Weekly bulletins.	Monthly climate and crop reports.
Alaska	24	.....	0	0
Alabama	38	401	800	500
Arizona	77	140	420	360
Arkansas	71	310	750	750
California	375	225	500	750
Colorado	82	125	1,000	1,000
Florida	59	300	900	500
Georgia	40	650	1,000	600
Hawaii	138	61	280	250
Idaho	62	200	500	300
Illinois	92	400	1,500	400
Indiana	59	379	700	725
Iowa	135	400	2,900	2,600
Kansas	99	439	1,500	1,250
Kentucky	47	300	750	515
Louisiana	46	266	650	1,000
Maryland and Delaware	52	168	720	720
Michigan	120	564	1,300	1,100
Minnesota	62	400	1,200	450
Mississippi	62	225	750	625
Missouri	86	468	1,500	452
Montana	79	190	900	800
Nebraska	144	450	1,080	535
Nevada	39	65	300	300
New England*	142	400	1,000	700
New Jersey	51	101	1,000	500
New Mexico	83	87	1,000	1,000
New York	126	466	1,000	800
North Carolina	55	402	1,000	1,000
North Dakota	68	306	600	500
Ohio	99	590	1,400	560
Oklahoma and Indian Territories	65	1,030	2,500	1,400
Oregon	81	223	850	750
Pennsylvania	61	168	780	600
Porto Rico	41	44	400	375
South Carolina	34	175	540	390
South Dakota	57	398	950	500
Tennessee	55	145	850	425
Texas	145	750	1,500	1,200
Utah	81	155	550	500
Virginia	53	320	525	900
Washington	79	130	800	900
West Virginia	57	250	1,200	500
Wisconsin	65	513	950	1,200
Wyoming	64	65	375	350
Yellowstone Park	6	.....	.....	.....
Total	3,656	13,834	41,670	31,532

*Six New England States.

BAROMETRY.

Prof. Frank H. Bigelow continues to have charge of the Barometry Section, and has rendered valuable aid in the organization of the Mount Weather Research Observatory.

Professor Bigelow has continued his studies on the diurnal periods in the lower strata of the atmosphere, and has published the following papers thereon in the MONTHLY WEATHER REVIEW:

I. The diurnal periods of the temperature.

II. The diurnal periods of the pressure.

III. The diurnal periods of vapor tension, the electric potential, and the coefficient of dissipation.

IV. The diurnal periods of the magnetic field and the periodic disturbances.

In addition to his studies on the above-named subjects, Professor Bigelow has delivered three courses of university lectures intended to introduce the theory of cosmical meteorology.

MONTHLY WEATHER REVIEW AND WORK OF THE EDITOR.

In addition to his work as editor of the MONTHLY WEATHER REVIEW, Prof. Cleveland Abbe has had general supervision of the

educational work in meteorology as carried on by the officials of the service and has also given attention to educational work along these lines by schools and colleges in general. In the course of this work he has begun the preparation of a handbook for the use of those who are pursuing courses of education leading up to research in meteorology. He has also prepared for publication an abbreviated copy of his voluminous report of 1891, on "Climates and Crops," the publication of which has been ordered, as it has been frequently requested by those who have had occasion to examine the manuscript.

The articles contributed to the Monthly Weather Review by special students, and the notes by the editor, or assistant editor, have continued to occupy about two-fifths of each number and have been of exceptional interest. The increasing interest in meteorology on the part of scientists throughout the country encourages the hope that the progress of our knowledge of the atmosphere will be especially furthered by American research.

Among the noteworthy articles published in the Review for the months of June, 1904, to May, 1905, inclusive, are the following:

June, 1904.—W. N. Shaw, Chief of the London Meteorological Office, "On the general circulation of the atmosphere in middle and higher latitudes." Prof. F. H. Bigelow, "The average monthly vectors of the general circulation of the atmosphere."

July, 1904.—John T. Quinn, "The movement of high clouds in the West Indies." C. C. Hutchins and J. C. Pearson, "Air radiation."

August, 1904.—Stanislav Hanzlik, Ph. D., "The annual and geographical distribution of cyclones of high velocity in the United States."

October, 1904.—Wilson A. Bentley, "Studies of raindrops and raindrop phenomena." Joseph Bily, jr., "Thunderstorms at Tampa, Fla." Rev. F. L. Odenbach, S. J., "An index of meteorological items in the Jesuit Relations."

November, 1904.—Rev. D. Hammer, "Airy's theory of the rainbow."

December, 1904.—H. H. Kimball, "Evaporation observations in the United States."

January, 1905.—Johnstone Stoney, "Escape of gases from the atmosphere."

February, 1905.—S. Tetsu Tamura, Ph. D., "Mathematical theory of ice formation. Prof. A. J. Henry, "High water in the Great Lakes." E. D. Emigh, "Unusual weather at Dodge, Kans."

March, 1905.—H. H. Kimball, "The variation in atmospheric transparency during 1902, 1903, and 1904."

April, 1905.—S. Tetsu Tamura, Ph. D., "Mathematical theory of the nocturnal cooling of the atmosphere." J. L. Bartlett, "Influence of small lakes on local temperature conditions." Prof. C. F. Marvin, "The great Indian earthquake of April 4, 1905." D. A. Seeley, "A heavy deposit of hoarfrost and its effect in retarding the nocturnal cooling of the air."

May, 1905.—Robert E. Horton, "Snowfall, freshets, and winter flow of streams in the State of New York." F. S. Shields, "Rainfall of the drainage area of New Orleans, La."

METEOROLOGY IN SCHOOLS.

At every station of importance occupied by the Weather Bureau it is the custom for the official in charge to deliver such lectures as are desired by the public schools in his immediate neighborhood, and to instruct such classes as visit the offices of the Weather Bureau. In this way a general knowledge of the work of the Bureau is being disseminated throughout the community. During the past year several hundred such lectures have been given most of which are specifically recorded in the MONTHLY WEATHER REVIEW.

CONVENTION OF WEATHER BUREAU OFFICIALS.

The third triennial convention of Weather Bureau officials was held at Peoria, Ill., September 20–22, 1904. Conventions of Weather Bureau officials are regarded as being of great importance, since they afford opportunity for the exchange of views and the discussion of methods for advancing Weather Bureau work. The convention was helpful not only to those who participated in it, but to all other employees of the Bureau.

A report of the proceedings, constituting a volume of nearly 300 pages, has been published.

NEW WEATHER BUREAU STATIONS.

During the year the following new stations were established and fully equipped with automatic instruments:

Madison, Wis.	Charles City, Iowa.
Brooklyn, N. Y.	Roswell, N. Mex.
Hartford, Conn.	La Salle, Ill.
Providence, R. I.	Durango, Colo.
Mount Weather, Va.	Peoria, Ill.
Devils Lake, N. Dak.	Honolulu, Hawaii.

STORM-WARNING STATIONS.

Preparations were made just before the beginning of the fiscal year that ended June 30, 1905, to equip about ten stations with the storm-warning equipment, and contracts were closed for the necessary steel towers, lanterns, etc. It was subsequently found impossible, however, to provide sufficient funds for the whole undertaking, and the work of installation at stations could only be taken up little at a time as small sums of money could be spared for the purpose. Seven new stations only were equipped during the year, but towers are now at six additional stations and will be erected at an early date.

One hundred and fifty-six display stations are now equipped with steel towers. Eighty-one have high power electric lanterns; seventy-two have high power oil lanterns, and day signals only are displayed from three towers. In a few cases towers are not, or can not, be employed, but other provisions are made for the improved storm warning displays. Thus, eleven stations, not included above, are yet equipped with high power lanterns.

TELEGRAPH SERVICE.

The following new cables and land lines were completed and put into operation during the year:

A 2-conductor cable from Nags Head, N. C., to Roanoke Island, N. C., and the necessary land lines connecting the cable with the Hatteras-Norfolk line on one side, and with the Weather Bureau station at Manteo, N. C., on the other. The station at Kittyhawk, N. C., was moved to Manteo on November 10, 1904.

A 1-conductor cable and necessary land lines to extend the existing telephonic connection between Glen Haven and South Manitou Island, Mich., to North Manitou Island, Mich. The new line was put into operation during October, 1904.

A 1-conductor cable at the mouth of the Columbia River, between Fort Stevens, Oreg., and Fort Canby, Wash., and a land line from the latter point to the Weather Bureau station at North Head, Wash. By connecting this cable with the Western Union system at Fort Stevens, direct communication was established between North Head and Portland, Oreg.

Extensive general repairs were made to the Hatteras line, including the erection of 76 miles of new copper wire and about 2,000 new poles. A large amount of work and new materials were also put into the Tatoosh Island section, with gratifying results.

The Government receipts from private telegrams transmitted over Weather Bureau lines amounted to $2,130.77.

LIBRARY.

During the year 820 books were added to the library, 150 of which were by purchase and 670 by gift or by exchange.

New books are now catalogued under both authors and subjects, but a great many old books are still catalogued under authors only. Much work on the subject catalogue, especially in indexing climatological data, still remains to be done before the library can be brought up to its maximum efficiency.

All library shelving is now practically full. Space was found for books acquired during the year only after sending to the Superintendent of Documents a large number of volumes of Government publications. While many of these contained valuable data, they can easily be consulted in the libraries of the bureaus or departments publishing them. Enough volumes of a similar character can be disposed of to make room for the accessions of another year.

EXAMINATIONS FOR PROMOTION.

In October, 1904, the plan of conducting examinations in one or more subjects at a time was inaugurated, instead of not less than three subjects, as heretofore, when this could be done without expense to the Weather Bureau. There had been a general complaint that it was a hardship for busy employees to prepare for so many examinations at once. The change has resulted in a gratifying increase in the number of applicants for examinations, as the following table shows:

Requests for examinations.

Subjects.	1904, June.	1904, Sept.	1904, Dec.	1905, March.	Total.	Passed.	Failed.
English Grammar	1	7	11	3	22	22	0
Arithmetic	2	6	11	5	24	24	0
Meteorology (Elementary)	1	7	12	6	26	23	3
Algebra	4	4	14	13	35	33	2
Physics	4	4	6	8	22	20	2
Trigonometry	4	4	2	6	16	14	2
Astronomy	3	3	3	4	13	13	0
Botany	4	3	4	3	14	14	0
Meteorology (Advanced)	4	3	3	2	12	12	0
Total	27	41	66	50	184	175	9

A change has been made in the character of the examinations in advanced meteorology, so that now it is intended to test an employee's general knowledge of meteorology, especially with respect to the meteorological literature published by the Weather Bureau.

MISCELLANEOUS METEOROLOGICAL INFORMATION SUPPLIED TO THE PUBLIC.

The care of the meteorological records of the service and their tabulation for the various needs have been, as heretofore, under the charge of Mr. William B. Stockman, Chief of the Division of Meteorological Records. This division continues to tabulate the meteorological data of the various stations for publication in the Monthly Weather Review and the annual climatological volumes. The division also supplies information of a varied character to different Federal Departments and Bureaus, State, county, and city officials, civil engineers, and others.

PERSONNEL OF THE BUREAU.

CLASSIFIED SERVICE.

Appointments.—One hundred and six appointments were made during the fiscal year; by certification, 94, at salaries ranging from $360 to $1,250 per annum; by transfer from other bureaus, 2, at $630 and $1,000 per annum, respectively; by transfer from unclassified positions, 5, at salaries ranging from $600 to $720 per annum; by reinstatement, 5, at salaries ranging from $480 to $840 per annum.

Temporary appointments.—There were 46 temporary appointments for periods of less than 90 days and at salaries ranging from $360 to $1,250 per annum, the greater number being station messenger boys at $360, whose appointments were made pending the obtaining of eligibles for permanent appointment; 27 emergency appointments for five to thirty day periods at salaries ranging from $450 to $1,250 per annum. All temporary and emergency appointments were made under the authority of the Civil Service Commission.

The total number of appointments of all kinds made during the year was 179.

Promotions.—One hundred and fifty-five promotions were made, in every instance by advancement to the next higher grade.

Reductions.—Necessitated by the public needs or due to change of station assignment requested by the employee, 11; because of decreased efficiency, 9 (of which 7 involved a change of station assignment); for excessive absence from duty, 3; for reprehensible conduct in connection with the improper use of Government time and property, 3; for neglect of duty, 6; for insubordination, 1; for inability to perform duties to which the employee was assigned at his own request, 1; total reductions for the year, 34.

Resignations.—Fifty-two voluntary separations occurred, of which 11 were made to enable the employees to accept positions in other bureaus. Eleven resignations were required; 2 for physical disabilities, 7 for inefficiency, 1 for false representations relative to absence from duty, 1 for conduct closely approaching insubordination. Total separations by resignation during the year, 63.

Dropped from rolls at termination of probationary period.—Two probationers were refused absolute appointment because of unsatisfactory services.

Removals.—For intoxication, 1; for neglect of duty, 1; for insubordination and discreditable personal conduct, 1; for absence without authority, 2; for unsatisfactory services, 1; total, 6.

Deaths.—Total, 4.

UNCLASSIFIED SERVICE.

Appointments.—Appointments to the unclassified service numbered 10, the salaries ranging from $300 to $600 per annum, as follows: For duty at Washington, D. C., 3 (2 through the Board of Labor Employment and 1 for an emergency period of less than one month); for duty outside the District of Columbia, 7 (2 station agents, 4 student assistants, 1 laborer).

Promotions.—Five unclassified employees were promoted during the year, each promotion being made to the next higher grade, the salaries ranging from $480 to $720 per annum.

Resignations.—One resignation was required on account of intemperance.

Reductions.—One unclassified employee was reduced on account of insubordination.

Discharges.—One employee (a station agent) was discharged on account of unsatisfactory services.

Deaths.—One death occurred in the unclassified service.

ABSENCES DURING THE CALENDAR YEAR 1904.

Station.—The average absence of station employees, with pay, during the calendar year 1904, was 0.8 of a day on account of sickness and 10.1 days on account of annual leave. Ninety-nine per cent of the station employees being males, the matter of sex has been disregarded in figuring the station averages.

Washington, D. C.—The average absence, with pay, of employees at Washington, D. C., (officials, clerks, mechanics, messengers, and laborers), during the same period was: males, 4.7 days on account of sickness and 25.7 days on account of annual leave; females, 9.4 days on account of sickness and 26.9 days on account of annual leave.

The general average of the entire service, station and Washington combined, was 2.0 days on account of sickness and 14.5 days on account of annual leave.

STATISTICS OF THE SERVICE.

The following tables show the numerical strength of the Bureau and the highest and lowest salaries paid in the classified and unclassified grades:

Numerical strength of the Weather Bureau, June 30, 1905.

At Washington, D. C.:		
Classified	172	
Unclassified	11	
		183
Outside of Washington, D. C.:		
Classified	483	
Unclassified	14	
		497
Total commissioned employees		680
Additional employees outside of Washington, D. C.:		
Storm warning displaymen *	159	
River observers	344	
Cotton region observers	146	
Corn and wheat region observers	134	
Rainfall observers	106	
Fruit and wheat region observers	16	
Sugar and rice region observers	9	
Total noncommissioned employees		914
Total paid employees †		1,594
Persons serving without compensation (except through the distribution of Government publications):		
Cooperative observers		3,665
Cooperative storm warning displaymen §		85
Crop correspondents		13,834
Total numerical strength		19,178

Distribution of the Commissioned Force.

In Washington, D. C.:			
Accounts Division	13	Library	4
Barometry and research work	2	Division of Meteorological Records	15
Climate and Crop Division	7	Miscellaneous mechanical work	4
Editor, Monthly Weather Review	2	Publication Division	43
Executive branch †	18	Supplies Division ‡	9
Forecast Division (including River and Flood Service and Section of Ocean Meteorology) †	20	Telegraph Division ‡	11
Instrument Division	10	Captain of the Watch (under direction of the Chief Clerk)	25
		Total	183

Outside of Washington, D. C.:

62 stations with	1 employee =	62 employees.
53 stations with	2 employees =	106 employees.
28 stations with	3 employees =	84 employees.
19 stations with	4 employees =	76 employees.
15 stations with	5 employees =	75 employees.
4 stations with	6 employees =	24 employees.
3 stations with	7 employees =	21 employees.
1 station with	8 employees =	8 employees.
4 stations with	9 employees =	36 employees.
1 station with	10 employees =	10 employees.
190 stations.		¶502 employees.

In addition to the above, there are seven one-man stations in the West Indies, in charge of noncommissioned employees, (agents of cable companies).

The following table of salaries does not include employees on duty at substations (storm-warning displaymen, river observers, etc.), whose compensation ranges from $5 to $20 per month, and whose tour of service would average less than one hour a day, and seven station agents in the West Indies at $25 a month.

Salaries paid in the classified and unclassified grades.

Grades.	June 30, 1905. Station.	June 30, 1905. Washington, D. C.
CLASSIFIED GRADES.		
Highest salary	$3,000	$5,000
Lowest salary	360	450
Average salary	991	1,193
UNCLASSIFIED GRADES.		
Highest salary	720	720
Lowest salary	300	240
Average salary	399	475

Average salary for all (station and Washington, including the Chief of Bureau), $1,021.

OBSERVATORY BUILDINGS.

Buildings owned by the Weather Bureau.

Location.	Value of lot.	Value of buildings.	Total value.
Amarillo, Tex.	$1,255.00	$6,503.00	$7,758.00
Atlantic City, N. J.	(a)	6,000.00	6,000.00
Bismarck, N. Dak.	(a)	10,000.00	10,000.00
Block Island, R. I.	1,100.00	7,700.00	8,800.00
Cape Henry, Va.	(a)	9,104.25	9,104.25
Columbia, S. C.	3,799.00	9,170.00	12,969.00
Devils Lake, N. Dak.	2,300.00	8,000.00	10,300.00
Duluth, Minn.	2,100.00	7,900.00	10,000.00
Hatteras, N. C.	125.00	4,875.00	5,000.00
Havre, Mont.	1,850.00	5,700.00	7,550.00
Jupiter, Fla.	(a)	6,094.95	6,094.95
Key West, Fla.	2,020.00	7,994.75	10,014.75
Kittyhawk, N. C.	(a)	1,616.00	1,616.00
Modena, Utah.	(a)	4,346.00	4,346.00
Mount Weather, Va.:			
Observatory building	2,000.00	18,000.00	20,000.00
Power house and balloon building	650.00	8,000.00	8,650.00
Absolute building	(a)	6,500.00	6,500.00
Variation building	(a)	8,000.00	8,000.00
Kite building	(a)	3,000.00	3,000.00
Stable		2,000.00	2,000.00
Mount Washington, N. H.	(b)	300.00	300.00
Nantucket, Mass.	1,236.50	3,968.00	5,204.50
Narragansett Pier, R. I.	4,100.00	8,000.00	12,100.00
North Head, Wash.	(a)	4,000.00	4,000.00
Peoria, Ill.	54.00	7,915.00	7,969.00
Point Reyes Light, Cal.	(a)	3,000.00	3,000.00
Port Crescent, Wash.	82.00	1,000.00	1,082.00
Sand Key, Fla.	(a)	5,593.00	5,593.00
Sault Ste. Marie, Mich.	(a)	3,000.00	3,000.00
Southeast Farallon, Cal.	(a)	5,211.22	5,211.22
Tatoosh Island, Wash.	(a)	5,000.00	5,000.00
Washington, D. C.	25,000.00	150,000.00	175,000.00
Yellowstone Park, Wyo.	(a)	11,500.00	11,500.00
Yuma, Ariz.	(a)	1,500.00	1,500.00
Total	47,671.50	350,491.17	398,162.67

a Government reservation. *b* Leased.

The Weather Bureau completed the erection, during the fiscal year, of six buildings, and also has in course of construction six additional buildings. The preceding lists give the number of buildings owned by the Weather Bureau, the number in course of construction, the number of rented buildings occupied wholly for office and living purposes, and the stations at which living quarters are furnished by the Government separate from offices:

Weather Bureau buildings in course of construction, and approximate cost of each.

Location.	Cost of lot.	Cost of buildings.	Total cost.
Bentonville, Ark.	$500.00	$5,500.00	$6,000.00
Burlington, Vt.	(c)	10,000.00	10,000.00
Mount Weather, Va., physical laboratory building	(a)	(d) 13,000.00	(d) 13,000.00
North Platte, Nebr.	1,000.00	3,000.00	4,000.00
Oklahoma, Okla.	(b)	10,000.00	10,000.00
Springfield, Ill.	(a)	10,000.00	10,000.00
Total	1,500.00	51,500.00	53,000.00

a Government reservation.
b Donated by Epworth University.
c Donated by University of Vermont.
d One-half cost as building will take two years to complete.

* The number of displaymen (236) given in the report for 1904, included cooperative displaymen, serving without compensation.

† This total embraces all paid employees in the Bureau on June 30, 1905, including the Chief of Bureau, but excluding employees on furlough for three months or more.

§ Thirty-six of these cooperative displaymen are employed in other branches of the Government service.

† One man devotes half his time elsewhere.

‡ Plus one half the time of one man.

¶ This number represents the *normal* regular station force. On June 30, 1905, there were actually on duty but 497 employees.

Rented buildings occupied wholly by the Weather Bureau.

Station.	Annual rent.	Other items included.
Alpena, Mich	$650.00	Heat, light, water.
Anniston, Ala	475.00	
Charles City, Iowa	420.00	Heat, light, water.
Durango, Colo	440.00	Heat, cleaner, water
East Clallam, Wash	120.00	
Flagstaff, Ariz	300.00	
Helena, Mont	504.00	Heat, water.
Independence, Cal	430.00	Heat, light, water.
Iola, Kans	468.00	Heat, light, water.
Kalispell, Mont	360.00	
Lewiston, Idaho	540.00	
Manteo, N. C	96.90	
Moorhead, Minn	600.00	Heat, light, water.
Mount Tamalpais, Cal	420.00	Heat, light, water.
Roseburg, Oreg	550.00	Heat, light, water.
Roswell, N. Mex	720.00	Heat, cleaner, light.
Santa Fe, N. Mex	360.00	
Santo Domingo, W. I	480.00	
Thomasville, Ga	420.00	
Twin, Wash	100.00	
Williston, N. Dak	450.00	Heat, cleaner, light, water.
Winnemucca, Nev	360.00	Heat, light, water.
Yankton, S. Dak	500.00	Heat, light, water.

Stations at which observers' quarters are furnished by the Government separate from offices.

Station.	Annual rent.	
	Office.	Residence.
Havana, Cuba	(a)	$300.00
Honolulu, Hawaii	$480.00	540.00

a Public.

RECOMMENDATIONS CONCERNING APPROPRIATIONS FOR 1906.

STATUTORY SALARIES.

Weather Bureau.—One clerk at $1,200, one clerk at $1,000, and one clerk at $900 are submitted. This increase is made necessary by the natural growth and normal development of the work of the Bureau, and especially by the proposed increase of eight stations.

LUMP SUM APPROPRIATIONS.

Weather Bureau.—An increase of $20,000 is submitted under "Salaries, station employees," and is to cover the services of officials and employes required to establish and maintain eight new stations.

An increase of $131,000 is submitted under "General expenses, Weather Bureau," as follows: $96,000 for the purchase of ground and the erection of eight observatory buildings for the establishment of eight new stations; $20,000 for the purchase of supplies and instruments for equipping eight new stations, and $15,000 to cover the increased cost of supplies and telegraphing for old stations.

An increase of $7,000 is submitted under "Buildings, Weather Bureau," to cover the increased cost of these buildings, due to the increased cost of building materials.

As it will not be necessary to construct any "Cable and land lines" the appropriation of $35,000 for that purpose has been omitted.

GENERAL CLIMATIC CONDITIONS.

By Mr. W. B. STOCKMAN, Chief, Division of Meteorological Records.

PRESSURE.

The contour of isobars of mean pressure for the year departs considerably from the normal, the greatest variation appearing over the middle and northern slope regions and southwestern North Dakota.

The mean pressure for the year was below the normal in Maine, Vermont, northern New Hampshire, extreme eastern Massachusetts, the Peninsula of Florida, the western portions of the southern and middle Plateau and southwestern portion of the northern Plateau regions, and the south and middle Pacific and southern portion of the north Pacific districts; elsewhere it was above the normal.

In the middle and northern slope regions and southwestern North Dakota the mean pressure generally ranged from +.05 to +.07 inch above the normal; smaller variations from the normal obtained in the remainder of the area of positive departures. The negative departures were small; the greatest, —.05 inch, occurred over north-central California.

TEMPERATURE OF THE AIR.

The isotherm of 70° of mean temperature crosses the northern portion of the Peninsula of Florida, and takes in the extreme southwestern portion of Arizona. The isotherm of 60° of mean temperature trends westward from the Atlantic coast near the parallel of 35° until it reaches the meridian of 95°, where it bends to the southward until it reaches meridian 105°; thence it trends to the northwestward until the interior of central California is reached, where it turns to the southward. A small portion of north-central California also is inclosed by the isotherm of 60°. The isotherm of 50° follows closely parallel 41° from the Atlantic Ocean to meridian 100°, where it bends to the southward, with a decided dip along the 105° meridian into central New Mexico and a marked northward turn along the western boundary to southwestern Wyoming, thence westward to western Utah, thence southward to about the northern boundary of Arizona and westward to meridian 120°, where it turns sharply to the northward as far as the Canadian border, thence to the southwestward, passing off about the mouth of the Columbia River. Over north-central Arizona there was a small area with mean temperature below 50°, while the greater portion of western Idaho was slightly above it. The isotherm of 40° passes north of the eastern portion of the United States until Upper Michigan is reached, where it passes westward to the western boundary of central North Dakota, where it turns northward into Canada. A small portion of northwestern Wyoming had a mean temperature of less than 40°.

The mean temperature for the year was above the normal generally over the Peninsula of Florida, over northeastern North Carolina, the extreme portions of southeastern Pennsylvania, southwestern New York, and northeastern Massachusetts, extreme northern New England, the central portion of northwestern New York, northern Lower Michigan, Upper Michigan, northern Wisconsin, Minnesota, Iowa, except the extreme northeastern portion, northwestern Missouri, northeastern Kansas, eastern Nebraska, South Dakota, except the extreme southwestern portion, North Dakota, Montana, Idaho, western Utah, northwestern Arizona, and the Pacific States, except the interior of central California; elsewhere the mean temperature was below the normal. The departures in but few instances exceeded 1°, the greatest +2.5°, occurred over the Red River of the North Valley.

By geographical districts the mean temperature was above the normal in the Florida Peninsula, upper Lake region, North Dakota, Missouri Valley, and the northern slope, northern Plateau, and Pacific regions; elsewhere it was below the normal. The greatest positive departure, +1.1°, occurred in North Dakota, and the greatest negative, —1.1°, in the southern slope region.

PRECIPITATION.

Over the country east of the Mississippi River the distribution of precipitation was not well marked as to geographic districts, as excesses and deficiencies of considerable amount occurred in the same district. To the westward of the Mississippi River the lines of demarcation between the excesses and deficiencies were much better defined as to geographical districts. Considering the geographic districts as a whole the