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REPORT OF THE CHIEF OF THE WEATHER BUREAU

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Report of the Chief of the Weather Bureau

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REPORT OF THE CHIEF OF THE WEATHER BUREAU.

UNITED STATES DEPARTMENT OF AGRICULTURE,
CENTRAL OFFICE OF THE WEATHER BUREAU,
Washington, D. C., August 31, 1912.

SIR: I have the honor to submit a report of the operations of the Weather Bureau during the fiscal year ended June 30, 1912.

WILLIS L. MOORE,
Chief of Weather Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

MOUNT WEATHER RESEARCH OBSERVATORY.

INVESTIGATION AND RESEARCH.

INVESTIGATION OF THE UPPER ATMOSPHERE.—Aerial investigations carried on at the Mount Weather Research Observatory have now resulted in the completion of a series of practically continuous atmospheric soundings extending over the last five years. The data thus afforded are in course of summarization and will be in suitable form for further study at an early date.

At the beginning of the kite work in the Weather Bureau, about 14 years ago, it was our expectation to be able to obtain data from which to construct a synoptic chart of the meteorological conditions prevailing in the free air some distance above the earth for a given date. This plan failed, through the impossibility of getting the kites into the air at all stations on the same dates.

In connection with the kite and captive balloon work at Mount Weather we have had in mind to explore as fully as might be done the layers of air next to the earth's surface, the data so procured to serve primarily to increase our knowledge of the processes that are continually going on in the free air, and, secondarily, as a probable aid in weather forecasting.

It seemed improbable at that time that the results of free-air observations from a single station could have a very wide application in making general forecasts. However, the experiment had never been tried, and the establishment of the Mount Weather Observatory made it feasible and desirable that the effort be made. The station was accordingly equipped with the best of modern appliances for kite flying, and a force of men was assembled which soon became quite skilled in the details of the work. This combination of personal skill and thorough equipment resulted in obtaining at Mount Weather the

highest kite flights ever made, and, what is more important, nearly continuous daily flights. Some of the flights were made under trying conditions. During the prevalence of fog, rain, snow, or high winds practically all of the flights were low, the meteorograph at such times being carried barely beyond the influence of the mountain top. Under adverse as well as favorable conditions the work was carried on, and it has been shown beyond doubt that at times the meteorological conditions disclosed by kite flights shed light upon the problem of weather forecasting. The work has thus been justified on the ground of its usefulness in forecasting, as well as on the broader ground of affording a substantial addition to the sum of our knowledge respecting the conditions that exist in the air some distance above the earth's surface.

Three series of continuous kite flights were made by day and by night during the year, with a view of obtaining further information regarding the diurnal variation of temperature in the free air with increase in altitude. More observations of this character are needed in order to fix with some definiteness the altitude in the free air to which the diurnal warming and cooling, respectively, extend.

In addition to the current work of daily kite flights, a report on the sounding-balloon ascensions made in western States in 1909, 1910, and 1911 has been completed and given publication as part 4, Volume IV, of the Mount Weather Bulletin for 1911. These ascensions were made, it may be remembered, for the purpose of exploring the air strata mostly between 3 and 15 miles above the earth's surface. Up to 3 miles above the surface of the earth independent explorations of the atmosphere have been extensively carried on by means of kites and captive balloons at Mount Weather, Va., and Blue Hill, Mass., in this country, and at many places in the British Isles and on the Continent of Europe. The conditions existing above the 3-mile level form an international problem in the solution of which the meteorological services of practically all civilized countries are engaged. The report already mentioned includes a discussion of the records of 138 sounding-balloon ascensions, 79 of which were made by the Mount Weather Observatory and the remaining 59 by the Blue Hill Observatory, thus uniting in one publication all of the high-level meteorological observations made in the United States. On the whole, this report forms the most important contribution to the meteorology of the higher atmosphere thus far made at Mount Weather. The atmospheric conditions at extremely high levels, as disclosed by these records, are not wholly in accord with the conditions found to exist at similar levels above the Continent of Europe, where the upper levels of the atmosphere have been more thoroughly explored. It is evident that in the United States only a good beginning has thus far been made in the exploration of the upper levels of the atmosphere, and that the phenomena observed and discussed in the report need further confirmation before we can consider them as being founded on sufficient observational data.

TEMPERATURES ON MOUNTAIN TOPS AND IN ADJACENT VALLEYS.—Studies of temperature conditions on mountain tops and in the adjacent valleys at Mount Weather and elsewhere have been continued and the results have appeared in the Mount Weather Bulletin. In general, these studies have tended to fix the relation be-

tween the prevailing weather conditions and the amount and quality of change of temperature to be expected in the valleys below. Indirectly, the data secured by these studies have an important bearing on the question of air drainage, and consequently on the protection of fruit in the valleys below.

SOLAR RADIATION INVESTIGATIONS.—The gradual extension of this work is continually demanding new and improved instruments, consequently considerable time is devoted to developing and testing apparatus. The Mount Weather Observatory now has the following equipment for the measurement of the intensity of solar radiation and the polarization of sky light:

One Callendar pyrheliometer, exposed horizontally above the roof of the physical laboratory.

Two Callendar pyrheliometers, one with the glass cover removed, and both mounted equatorially and clock driven, and shielded from diffuse sky radiation by means of diaphragmed tubes.

One Leeds & Northrup recording Wheatstone bridge.

Three Marvin pyrheliometers having different types of thermal elements, with auxiliary apparatus.

One Smithsonian silver disk pyrheliometer.

One Ångström pyrheliometer, reserved for comparative readings.

One Ångström pyrheliometer with absorption screen.

Two Pickering polarimeters.

Two Savart polariscopes.

Measurements of the polarization of sky light, of the positions of the neutral points of Arago and Babinet with the sun near the horizon, and of the intensity of solar radiation, have been made at Mount Weather throughout the year whenever atmospheric conditions permitted, except when the observer was absent from station on other duties. Polarization measurements were obtained on 63 days and radiation measurements on 73 days. These measurements are employed in studies of atmospheric transmissibility, which not only varies with the weather conditions from day to day, but also varies from year to year, on account of causes not yet well understood.

Since May 16, 1912, a continuous record has been maintained by means of the horizontally exposed Callendar pyrheliometer and one of the recording bridges, of the intensity of the radiation received from the sun and sky upon a horizontal surface. By means of the other recording bridge and one of the equatorially mounted Callendar pyrheliometers occasional records have been obtained of the intensity of direct solar radiation. At the same time the intensity of direct solar radiation has been measured either by a Marvin pyrheliometer or the Smithsonian silver disk pyrheliometer, or both. Comparisons of the records of the two automatic instruments give measurements of the intensity of the radiation received diffusely from the sky upon a horizontal surface. Comparisons of the records from the equatorially mounted Callendar pyrheliometer and the measurements by the Smithsonian silver disk pyrheliometer indicate a difference between the Smithsonian and the Callendar standards. However, the comparisons, at least, make it possible to express all the measurements in units of the same value.

Continuous records were obtained by means of a horizontally exposed Callendar pyrheliometer throughout the year at Madison, Wis.,

and until April 22, 1912, at Washington. The intensity of direct solar radiation was occasionally measured at Washington by means of an Ångström pyrheliometer, and at Madison, Wis., throughout the year whenever atmospheric conditions would permit, and after November 10, 1911, at Lincoln, Nebr., by means of a Marvin pyrheliometer. Preparations had been practically completed for the installation of a Marvin pyrheliometer on the Government reservation at Santa Fe, N. Mex., in April, 1912. The removal of the Weather Bureau office at Santa Fe from the Federal building necessitated delay and a change in plans, but the pyrheliometer will probably be installed at the present office in Santa Fe before the close of 1912.

The measurements of the intensity of direct solar radiation made at Madison, Wis., during the two years ending with June, 1912, have been prepared for publication in the Bulletin of the Mount Weather Observatory. The most interesting feature of these results is the high intensity measured each year during the months of February, March, and April. Some measurements of the intensity of radiation reflected from cloud surfaces, obtained at Madison and Mount Weather, have been prepared for publication in the Bulletin, and also some measurements of sky polarization and the intensity of both direct and diffuse radiation, made at Mount Weather during the dense haze that prevailed on June 10 and 11, 1912. Radiation measurements not only give definite information with regard to an important climatological element, but after we once learn to interpret them they must also serve as valuable integrating measurements of atmospheric conditions at all levels.

The effect of smoke upon the climate of cities constitutes a problem in atmospheric transparency that received attention by the Weather Bureau during the year. The results will be published by the University of Pittsburgh, in connection with the results of other studies of the smoke problem.

Plans for the coming year at Mount Weather.—So far as the aerial work at Mount Weather is concerned, it is proposed to modify the plan heretofore followed to the extent of not attempting to obtain a kite or balloon flight on each day regardless of the weather conditions, unless there is a type of weather over the station which it is desired to explore. The time so saved will be utilized in work on other problems of the atmosphere which relate less directly to the forecast work of the service. A beginning has been made on one of these problems, namely, the nucleation of the atmosphere at the low temperatures and pressures which prevail at the higher levels. It is hoped to continue kite flights throughout the 24 hours on selected dates, with a view of studying the diurnal temperature wave in the atmosphere, a beginning in which has already been made.

It is our purpose to utilize the equipment at Mount Weather in the study of such other problems in the practical work of the service as may be susceptible of laboratory treatment, and also to undertake photometric measurements of the intensity of sky light under different atmospheric conditions. Aside from the economic value of such measurements, they will be of meteorological interest because of their close relation to radiation intensity and atmospheric transparency.

MOUNT WEATHER BULLETIN.—The Bulletin of the Mount Weather Observatory has continued to publish the results of the important work done at that station. Its last volume, with index, completed on June 15, 1912, includes four regular quarterly parts and two extra parts, of which No. 4, the "balloon number," gives a complete summary of all work done during 1904–1911 in the United States with sounding balloons. This volume also includes a summary by Dr. Blair of all the daily kite flights during the three years July 1, 1907, to June 30, 1910. In addition to these extensive summaries of results by flights from kites and balloons the Bulletin has included several special memoirs by Profs. Henry, Humphreys, and Kimball. Prof. A. C. Crehore and Capt. G. O. Squier, of the Army Signal Office, have contributed a paper on the recording of minute changes of pressure by a special form of barograph. The bureau is indebted to the kindness of Mr. J. W. Sandstrom for the memoir published in the Bulletin, Volume III, part 6, "The relation between atmospheric pressure and wind," which has attracted wide attention. A second memoir, dealing specifically with the wind phenomena of mountains and seacoast, has been prepared by the same authority and will appear in full in the next volume of the Bulletin. The remarkable success attending Prof. Stoermer's study of the aurora borealis was fully explained in the third volume of the Bulletin. His complete report as now published shows that this subject must be taken up by his methods and by American observers if we would contribute to our knowledge of atmospheric electricity over the Western Hemisphere. Of the original contributions to the science and literature of meteorology made during the year by Prof. W. J. Humphreys, of the scientific staff of the Weather Bureau, several discuss the physical interpretation of certain luminous and other phenomena of the upper atmosphere. One paper, "Holes in the air," is of special interest to aviators, since it discusses in some detail a number of distinct atmospheric conditions that render flying dangerous, and also shows when and where they are most likely to occur and how best to avoid them. Another paper discusses at length one of the most difficult problems of meteorology—the phenomenon of the 12-hour periodic variation of the barometer. It is believed that the contributing causes of this phenomenon, of which there seem to be at least three, have been found and that this "meteorological mystery," as it has been termed, is at last substantially solved.

SCHOOL OF INSTRUCTION.

The duties of assistant observer at the 200 stations of the weather service outside of Washington are largely technical in character, and require on the part of the employee a knowledge of instruments and of methods of tabulating the results therefrom that can be obtained only by actual experience. It may be safely said that a new employee does not become really useful until he has had at least three months' experience under the guidance of a trained observer. If he is given immediate station assignment, the quality of the instruction that he will receive will depend largely on the kind of work performed at his station. Certain classes of work, such as the making of weather maps and the taking of observations, are common to all

parts of the country, but as a rule the general character of work is largely determined by the size and geographic position of the city in which the station is located. Thus, under local training alone, the instruction given a new employee is neither uniform nor complete unless he has made the round of all sorts of stations. It has therefore been decided to give new employees a systematic course of instruction in all branches of the work performed at any station, wherever it may be located. This is to be done at Mount Weather. Two rooms in the physical laboratory building have been set apart for the purpose, and all the paraphernalia of a fully equipped Weather Bureau station have been procured and properly installed. The aim will be to give the employee under instruction the actual practical experience necessary to fit him for the duties required of him later in his term of service. The observation station will be conducted in precisely the same manner and under the same general instructions as a regular station of the bureau. Meteorological observations will be made and prepared for transmission by telegraph. Copies of telegraphic reports received from the central office in Washington by mail will be translated and the results spread upon weather maps, and the new employees will be instructed in the several methods of map making and the preparation of the plates from which weather maps are printed. A course in the construction and upkeep of meteorological instruments will also be afforded, so that each new employee may be able not only to interpret the indications of meteorological instruments, but also to discover and remedy faults that may arise in them.

FORECASTS AND WARNINGS.

The forecasting of the weather and temperature conditions for the various States for 36 to 48 hours in advance, the dissemination of special warnings of heavy snows, cold waves, frosts, and other unusual atmospheric conditions for the continent, the display of warnings of the coming of destructive storms over the Great Lakes, along the Pacific, Atlantic, and Gulf coasts, and over West Indian waters for the benefit of shipping, the issue of daily forecasts of wind and weather conditions likely to be encountered by trans-Atlantic steamers in passing from the north Atlantic ports to the region of the Grand Banks, have been successfully carried on by the bureau as in former years.

In the forecast room at the central office is prepared each morning a synoptic chart of pressure and weather conditions over the Northern Hemisphere. This chart is based on reports received from foreign meteorological services and from Weather Bureau stations in the United States, Alaska, Hawaii, and the West Indies. The world-wide survey of atmospheric conditions presented by these charts is not only indispensable to the forecaster in his daily forecast work, but has also made possible accurate predictions of the general weather and temperature conditions over the United States for a week in advance. All pronounced changes from the prevailing types of weather conditions, whether from dry to wet, or wet to dry, and all reversals in temperature conditions have been successfully announced to the public through these weekly forecasts,

which are given widespread publicity by means of the various press associations.

During the year the field of observations over the Northern Hemisphere was materially extended. Reports are now being received from Dutch Harbor, in the Aleutian group of islands, by wireless, and daily reports from Nemuro in Japan and Shanghai in China come over the Manila cable. Additional daily observations by cable are also being received through the Russian meteorological service from Vardo, Astrakan, Tashkend, Nertchinsk, and Yakutsk.

PROPOSED WEATHER SERVICE FOR THE NORTH ATLANTIC OCEAN.

The Chief of the Weather Bureau visited England and took part, from June 4 to July 6, 1912, in the International Radiotelegraphic Conference. As a result of his intercessions, which were indorsed by all of the delegates of the United States, the conference agreed to an international regulation which shall give weather observations the right of way over all messages except distress calls. This is an important regulation and will make it possible in time to organize complete ocean weather services. With the cooperation of the various maritime nations, it is proposed to inaugurate in the near future a weather service for the north Atlantic Ocean. The ocean will be divided into two zones by the thirty-fifth meridian of longitude west of Greenwich. Observations taken over the western zone will be forwarded to Washington either directly or by relaying from one vessel to another, and observations taken within the eastern zone will be forwarded in like manner to Europe. Charts based on these reports will then be constructed and the dangerous storms located. While many of the observations will be repeated from ship to ship and thence to land stations on account of the comparatively limited radius of the transmitting stations on vessels, it is expected that information regarding the location and movement of dangerous storms will be transmitted to all vessels within the western zone at the same instant from some one of the high-power stations on our Atlantic seaboard. The value of such a service to life and property on the ocean can be faintly realized when it is considered that warnings to the shipping of the entire Atlantic, especially to tramp and other vessels that can not so well stand severe weather, will enable them by a slight change in their course to avoid the dangerous quadrants of the more severe storms.

An interesting and valuable extension already inaugurated in the weather service is the receipt daily, morning and evening, by aerial telegraphy of reports from vessels at sea off the middle and south Atlantic coast and in the Gulf of Mexico and Caribbean waters. With the further perfection of the wireless telegraph service, these reports will become of increased importance.

Among the more striking weather features that were successfully forecast during the year are the following: The cool weather following the prolonged hot wave in July, 1911; the hurricane of August along the Georgia-North Carolina coasts; the freezes in the west Gulf States in November; the severe freeze in California during December; the record-breaking cold wave of January; and the heavy snowfalls in the Middle West during the winter of 1911–12.

BREAKING UP OF THE HOT WAVE OF JULY, 1911.

During the early part of July and for some time previous the weather had been unusually warm over the eastern half of the country. The breaking up of this heated period was indicated in the following bulletin, issued July 12:

For a prolonged period the barometric pressure has been above normal over the Atlantic Ocean and low over the northwestern portion of the American continent. The international weather map of Wednesday showed a reversal of this pressure distribution—an extensive area of high barometric pressure appearing over Alaska, while the pressure over the middle latitudes of the Atlantic Ocean has fallen to below normal. This changed pressure distribution is strongly indicative of the dissipation of the warm weather over the Eastern States and the Middle West in the immediate future and the beginning of a period of moderate temperature in those districts lasting through the remainder of this and continuing into next week.

The cool weather announced in the bulletin overspread all parts of the country east of the Rocky Mountains on July 13 and 14, and on the night of the 16th light frosts formed in the cranberry marshes of Wisconsin. The following editorial comments on this forecast are extracted from the daily press:

Hannibal (Mo.) Courier-Post:

That the theory of meteorologists as to the immediate cause of the long-continued heat in this country is correct is demonstrated by results. They claimed that an extensive area of high barometric pressure had prevailed over the Atlantic since June 13 and that its effect was to interfere with the usual eastward movement of waves of temperature, damming up the heat, as it were. About July 8 this wall disappeared and the effects were soon manifested. The heat wave moved eastward and cool currents followed.

St. Louis (Mo.) Globe-Democrat:

It has been six days since the head of the Government Weather Bureau predicted the end of the long heat wave. His prediction has been so signally vindicated this time that it is worthy of special note, for great are the responsibilities and numerous the unavoidable embarrassments of the Weather Bureau, chiefly because human knowledge of the elements is still elementary compared to what we may expect it to be at the end of the next 100 years. On July 12 Chief Willis L. Moore said (quoting the forecast before given); "This," said the weather chief, "would bring a long-continued cool spell." The spell is here, and has been since Saturday last.

AUGUST, 1911, HURRICANE ALONG THE GEORGIA-NORTH CAROLINA COASTS.

A storm of small diameter and hurricane intensity passed inland from the south Atlantic Ocean slightly north of Savannah, Ga., about 8 a. m. August 28. On the morning of the 27th advices were sent to Savannah and Charleston as follows:

Advise caution locally until further advices. Indications of a disturbance approaching coast.

Storm warnings were ordered for the two stations mentioned at 10.55 a. m. of the 27th, and the following message was sent them at 3.30 p. m. of that date:

Hoist hurricane warnings 3.45 p. m. Storm still apparently off South Carolina and Georgia coasts; intensity unknown. May develop hurricane force. Advise all interests to take necessary precautions.

Shipping interests along the entire coast were fully advised. The storm was not so destructive at Savannah as at Charleston, although

it passed nearly over the former city. The following editorial regarding the warnings appeared in the Savannah (Ga.) News of August 30:

A word of appreciation and thanks is due to the Weather Bureau for its warnings of the coming of the storm. There was more than 12 hours' notice—all that might be expected. The warning bulletins were in positive language. There was no guesswork. It sometimes occurs that the Weather Bureau makes a mistake, but it always errs on the safe side. It gives property interests the benefit of the doubt.

NOVEMBER, 1911, FREEZES IN THE WEST GULF STATES.

The warnings issued in advance of the two severe freezes in the west Gulf States in November, 1911, enabled sugar, orange, and truck growers who were prepared to act on advices from the Weather Bureau to protect crops to the value of several millions of dollars, which would have otherwise been lost. Sugar planters protected their cane by windrowing. By smudging their orchards, orange growers not only protected the trees from damage, but saved the ripe fruit on the trees. Truck growers covered, smudged, or flooded their crops. The following editorial regarding the warnings and the benefits derived therefrom appeared in the New Orleans Times-Democrat of December 3, 1911:

It is impossible as yet to determine definitely and accurately the damage and loss to the Louisiana cane crop caused by the two recent freezes. It is unquestionably heavy, but how heavy we will not know until a careful examination has shown the condition of the cane. It is believed that it will be possible to determine this point in the next few days, and that we will then know within a few thousand dollars how much Louisiana has lost by the two unexpected and early freezes of last month.

Louisiana, and New Orleans in particular, has counted with great confidence on its sugar crop. The acreage was larger than usual; the cane, although a little backward, was in good condition and promised an exceptionally large tonnage to the acre; and finally, sugar is commanding a better price than for years past. A profit on the crop of between $7,000,000 and $10,000,000 over last year was looked for; and the circulation of that money promised activity in every line of business.

Suddenly and unexpectedly there descended on the sugar belt the freeze of November 13. It was one of the earliest freezes ever known in this section, and caught the planters unprepared, when they had only just begun their grinding. Fortunately the freeze continued only a few hours, so that the loss was not as heavy as it would otherwise have been. Two weeks afterwards, on November 27, came another freeze, more far-reaching, more severe, and far more damaging. It is the uncertainty as to the amount of the damage that renders it impossible to figure out the exact loss.

If we look back to the old records, before the Government established the Signal Service or Weather Bureau, we will find that the damage from premature freezes of this kind brought overwhelming ruin to the cane crop, and that in many years the crop was injured three-fourths and more. The planters had nothing to guide them as to the weather, no notice of the coming of a freeze until it was on them. To-day, because we know more of the weather, the loss is not likely to be over 15 per cent.

It is difficult to appreciate how much these weather forecasts mean to the cane growers, for perhaps no crop is in greater danger from sudden changes than sugar cane. Both of the recent freezes were sudden. The wind which carried the cold wave of November 13 to the sugar belt was blowing 40 to 50 miles an hour. It was impossible, therefore, to predict the freeze more than 40 hours in advance; but these 40 hours given the sugar planters to prepare were invaluable and saved Louisiana from millions of dollars of loss. The second freeze was predicted, or rather announced, two days in advance of its arrival and gave the planters ample time to get ready for their enemy. These warnings saved the greater part of the crop, and were valuable not only for

the present, but for future years, for they enabled the planters to save the seed cane. But for that we would have had to reduce our cane acreage next year.

The county correspondents of the Louisiana Planter furnish some valuable information on this point. Thus from Iberville we learn that a majority of the planters heeded the warning at once, began to windrow the moment the Weather Bureau informed them that a cold wave was on its way here, and they thus saved their crop.

In Assumption a number of planters did not believe the warning, and will lose heavily in consequence of their failure to windrow. But the strongest evidence comes from Lafayette, where the Planter's correspondent remarks:

"Fortunately the United States Weather Bureau gave timely warning of the coming freeze, and those planters who had standing cane were able to put it in windrows before the cold blast struck the county. A few, however, were caught, not fully appreciating the warning and trusting to luck that, after all, Uncle Sam's prediction as to destructive cold approaching might not come true. It is therefore quite certain that there will be some further loss, not only of standing cane, but of much exposed in heap rows."

Probably next time they will give better heeding to these warnings. The weather reports have vindicated themselves and proved their value; and with this protection and notice properly utilized by the planters, the cane crop will be better protected against sudden changes in weather conditions and the cane crops made more certain. The Weather Bureau in its predictions, especially as far as freezes go, has made great progress in the last few years, and we may hope for still further improvement as the science of meteorology progresses.

The following letters tell further of the use made of the warnings.

From W. W. and J. A. Ventress, Granada plantation, Sunshine, Iberville Parish, La.:

The warning issued on the 28th of November has been of very valuable service to us, as it enabled us to windrow our cane, thereby saving almost all of the crop. The cane now in windrow is as good as the day it was put down, and we are still finding good eyes in the cane, which we find may serve for seed cane. We hope that the Government will continue this service and that we will be able to get the warnings promptly as heretofore.

From R. S. Moore, Riverside orange grove, Naomi, Plaquemines Parish, La.:

This is the first time I have had the opportunity of writing you to thank you for the very valuable weather warnings of the freezes of November 30 and December 1.

I received your forecasts in plenty of time to prepare against any loss, and I am happy to say that I saved $4,000 worth of fruit. I have always considered the Weather Bureau as most important to farmers and fruit growers, and this last freeze, in which I was timely warned, proves its great value.

DECEMBER, 1911, FREEZE IN CALIFORNIA.

A very severe frost and freeze occurred in southern California during the early morning hours of December 26 and 27, 1911. The citrus crop, valued at $40,000,000, suffered damage to the amount of about $6,000,000, owing to inadequacy of facilities for general smudging. Wherever smudging was general, not only the fruit, but the trees and blooms as well, were saved. But for the frost warnings of the Weather Bureau and the cooperative efforts of the orange growers the loss would have approximated $20,000,000. Mr. A. F. Call, of Corona, Cal., writes in appreciation of the warning as follows:

The frost warning sent me about 4 p. m. December 25 enabled me to get ready in some orchards not then prepared and to save crops worth at least $10,000. Where smudging was done, it was a complete success.

COLD WAVE OF JANUARY, 1912.

The following weekly forecast was issued December 31, 1911:

There will be stormy weather the coming week over the North Atlantic steamer routes, the British Isles, and northwestern Europe.

In the United States wintry weather will be general during the greater part of the coming week. A marked change to colder weather will overspread the region east of the Mississippi River within the next 36 to 48 hours, with the line of freezing temperature extending southward to the Gulf and South Atlantic States and to northern Florida. Unseasonably cold weather will continue the next several days in the Middle West, the Southwest, and the Rocky Mountain region.

A storm that is now over the upper Lake region will move down the St. Lawrence Valley during Monday, attended by snow in the region of the Great Lakes, the upper Ohio Valley, the interior of New York, and New England; it will be followed by clearing weather elsewhere east of the Mississippi River during Monday. The next disturbance of importance to cross the United States will appear in the Far West Monday or Tuesday, cross the Middle West Wednesday or Thursday, and the Eastern States Friday; this disturbance will be preceded by a reaction to normal temperature, be attended by general snows in northern and rains in southern districts, and be followed by decidedly colder weather.

During the week following the issue of this forecast a general cold wave swept the country, and the lowest temperatures for several years were reported from the upper Mississippi Valley and the upper Lake region. Much suffering was caused by cold weather from the Plains States eastward to the Atlantic coast.

The following from Mr. A. Mitchell, jr., general agent of the Chesapeake & Ohio Railway Co., Lexington, Ky., dated January 13, 1912, refers to warnings of heavy snow issued by the Weather Bureau:

We wish to thank you very much for the forecasts we received from your department, especially for the information given us during the past 10 days. They have not only enabled us to protect and safely handle many shipments of perishable commodities, but your forecasts, both as to the severe weather and the snows, enabled us to protect in advance, especially at our shops and at our terminal yards, where we have a great many switches, to such an extent as to keep the invariable interference to the safe movement of transportation down to a minimum.

The following is an extract from an editorial that appeared in the Pittsburgh Gazette-Times of February 24, 1912, regarding the warnings issued in connection with the storm of February 21 and 22, 1912, which swept the Atlantic seaboard:

A striking illustration of the important part played by the Government Weather Bureau was furnished by the warnings issued in connection with the recent severe storm along the Atlantic coast. Shipping interests were advised in ample time that high winds of almost hurricane proportions were on the way. In many cases small vessels remained in port until after the danger was past. Ships at sea were warned by wireless and were able to prepare for the big blow. It is impossible to estimate the protection to life and property afforded by this up-to-date, efficient service. The instance mentioned was of a rather unusual and even spectacular nature, but every day in the year the Weather Bureau, from headquarters at Washington and through its employees throughout the country, is making careful observations, receiving and exchanging reports and issuing bulletins and warnings to shippers of perishable goods, railroad and marine interests, and others directly concerned with impending changes in meteorological conditions.

RIVER AND FLOOD DIVISION.

RIVER AND FLOOD SERVICE.

A new river district comprising the watershed of the San Joaquin River, formerly a portion of the Sacramento (Cal.) district, was created on March 1, 1912, with headquarters at Fresno, Cal. Greater promptness and efficiency of service, without any material increase in cost of operation, will result from this division. Owing to a change in the classification of the station at Moorhead, Minn., the river work of that district was transferred to the station at Devils Lake, N. Dak., on April 1, 1912. The change will not involve any increase in expense.

One cooperative and 28 paid river stations were established during the year and 10 paid stations were discontinued. Three paid rainfall stations were established and 4 discontinued. On June 30, 1912, river and rainfall observations were made at 483 regular Weather Bureau and special stations, of which 16 are cooperative stations. Rainfall observations were made at 93 special stations, of which 12 are cooperative stations.

No extensions of moment are contemplated during the coming year. A new district center will be opened on July 1, 1912, at Fort Wayne, Ind., with territory comprising the watershed of the Maumee River. As the new district is now a portion of the Columbus (Ohio) district, no additional expense will be involved beyond that necessary for two new special stations.

The river forecast schemes for the Ohio River and its tributaries were completed during the year and are now in use. Schemes for the interior rivers of the State of Ohio were also completed, and the scheme for the Savannah River is nearing completion. It is proposed to take up the study of the Mississippi soon, with a view to the preparation of similar schemes for that river.

Floods were frequent and widespread during the year, the rivers of the Pacific Coast States alone escaping on account of deficient precipitation. March was the month of greatest flood frequency. Nearly every stream east of the Rocky Mountains was in flood at some time during the month, except those along the immediate eastern slopes and in the northern and eastern Lake region. The floods were due to an excess of precipitation, ranging from 2 to 4 inches, falling upon saturated soil south of the Ohio River and upon frozen ground to the northward. Some floods were due to ice, but they were confined to the northernmost tier of States, and were not of great importance. The greater floods were caused by a remarkable series of storms that moved northeastward from the extreme Southwest over the Ohio Valley to the north Atlantic coast. Storms of this type are invariably accompanied by heavy rains, and when they are separated by intervals of a few days only floods are inevitable.

The flood in the lower Mississippi River was the greatest in its history. All high-water marks were exceeded from Cairo to the Passes, except in the vicinity of Vicksburg, Miss., where extreme conditions were moderated by crevasses in the levees above. The floods began in March, but did not reach their maximum at New Orleans until May 11; at the end of June flood waters were still flowing through the Hymelia Crevasse, 32 miles above New Orleans. Of the 30,000 square miles of territory subject to overflow, about 17,600, or

59 per cent, were flooded. The losses will exceed $75,000,000, and may possibly reach $100,000,000, of which much the greater portion represents the loss of the season's crops. In its forecasts of the flood stages and in its warnings of impending danger to the people of the threatened districts the Weather Bureau maintained the high plane of accuracy that has characterized its work during all the great floods of the Mississippi River since that of 1892. The forecasts and warnings were prompt, conservative, and accurate, and through them many lives were saved. As to the value of property saved through the warnings, it is difficult to arrive at a correct estimate, but from such reports as were obtainable it appears that $16,000,000 is a reasonable figure, and later reports may increase this amount. The first warning for the flood was issued on March 20, the last on June 8, and at the beginning of April it was announced that the floods would be the greatest in the history of the lower Mississippi Valley. The forecast for the river at New Orleans was issued nearly five weeks in advance of the occurrence of the crest stage, and its absolute accuracy was a triumph of forecasting skill. The press of the country has paid ample tribute to the work of the Weather Bureau in connection with the flood.

A report on the Mississippi flood, now in course of preparation, will be prepared jointly by the Department of Agriculture, the War Department, and the Interior Department. Each department concerned will deal only with such features as come within its particular province, and the combined report will be submitted to the President of the United States.

Although overshadowed by the lower Mississippi calamity, floods were of frequent occurrence elsewhere, except during November and December, and were forecast with the usual timeliness and accuracy. The river and flood service work in the Wisconsin Valley in October, in southern Michigan in April and May, and in the southern rivers generally during the spring months is deserving of special mention.

Persistent effort has been made to secure accurate data regarding the loss from floods. It is naturally impossible to obtain exact figures, and estimates are at times difficult to obtain. The total flood losses reported during the year were about $86,000,000, of which, however, only about $11,000,000 were incurred outside the lower Mississippi Valley. These figures are far from complete, and it is reasonably certain that if losses along small streams were reported and more detailed statements were obtained from the lower Mississippi Valley the total would be brought up to at least $100,000,000, as against a total of less than $8,000,000 for the year ended June 30, 1911. The total value of property saved through the Weather Bureau flood warnings was estimated at $19,000,000.

MOUNTAIN SNOWFALL WORK.

The measurement of the amount of snowfall in the mountain regions of the West was continued during the year. On June 30 there were 271 paid stations and 1 cooperative station in operation. During the year 1 cooperative and 7 paid stations were established and 17 paid stations were closed.

The measurement of mountain snowfall in winter is made for the purpose of determining the amount of water that is likely to be

available for agricultural and commercial purposes during the spring and summer seasons. The work is still in a formative state, but experiments with the special apparatus devised by Prof. Marvin have, in the main, proved satisfactory; and if funds can be provided for the purchase and installation of a supply of Marvin snow gauges and apparatus sufficient for all the stations, it is thought that the work can be placed on a permanent basis, and that acceptable forecasts of water supply can be made each spring over the various watersheds. Opinion regarding this subject is strengthened by an inspection of the results of the special snow surveys in the watershed of Maple Creek, Utah. The forecast based on the survey and measurements made in the spring of 1911 was of much value to the water users, and a second survey and measurements made in the spring of the present year promises equally valuable results.

FORESTS, CLIMATE, AND STREAM FLOW.

The work of the forest experiment station at Wagon Wheel Gap, in the Rio Grande National Forest, Colo., has made satisfactory progress. It will be remembered that this station is maintained jointly by the Weather Bureau and the Forest Service for the purpose of studying the effect of forests upon stream flow and climate. There had been some fears that the precipitation at such great elevations (9,200 to 11,000 feet above sea level) and in a supposedly semi-arid region would not be sufficiently heavy to afford a basis for legitimate comparison with data obtained from the more humid regions of the East; but now that complete data for nearly two years have been obtained, it appears that these fears were more or less unfounded. The total precipitation for 1911 at the principal station of observation was 23.80 inches; over watershed A, 26.88 inches; over watershed B, 27.33 inches; and at the summit or head of both watersheds, 28.56 inches. These data compare favorably with those from other portions of the country and indicate that the final results will permit of more general application than at first supposed.

The cooperative stations in the Coconino National Forest in Arizona and in the Fremont National Forest in Colorado were also continued during the year, and limited equipment was provided for additional stations in the Kaniksu National Forest in Idaho, the Manti National Forest in Utah, the Cloquet National Forest in Minnesota, and the Plumas National Forest in California. Data from these stations will be available for study in connection with the more elaborate and complete data from the station at Wagon Wheel Gap.

DIVISION OF OBSERVATIONS AND REPORTS.

This division supervises the observational work of the bureau and the preparation of maps for the forecaster. It has charge of the dissemination of forecasts and storm warnings both on the land and on the ocean, and of frost warnings for the farming, trucking, fruit, and cranberry interests. It has supervisory control of station and commercial maps and of the placing of glass maps, bulletin boards, and kiosks. It also has full charge of the marine meteorological work of the bureau and of the Hydrographic Office, comprising the collecting of all observational reports and the issuing of ocean meteorological charts based on those reports, the radiotelegraphic service used for transmitting observations, the dissemination of forecasts to and

charting of reports from vessel weather stations, and the vessel-reporting service on the Atlantic, Pacific, and Gulf coasts and the Great Lakes.

At the close of the year there were 197 regular observing and 3 repair stations in operation. Of the 197 stations, 167 take two observations a day, 22 take one observation in the morning, and 8 take one evening observation daily. These observations are telegraphed to Washington and over circuits to other stations, for use in making the daily weather and commercial maps and in preparing the forecasts and frost warnings issued to the public.

SPECIAL METEOROLOGICAL STATIONS.

In addition to the 197 regular observing stations there are 75 special meteorological stations, with paid observers in charge. Fifty-two of these are maintained as adjuncts to the work of the forecaster in making special frost predictions for the fruit and trucking interests of Oregon, Washington, Utah, Idaho, Colorado, North Carolina, California, and Florida, and precipitation predictions for the vineyard interests of California. Eight stations are in operation in the cranberry bogs of Wisconsin, Massachusetts, and New Jersey, these interests being looked after by the officials in charge of the stations at Chicago, Boston, and Atlantic City, respectively. Six special stations in Alaska telegraph evening observations daily to aid in the general forecast work of the service; these reports are of special value in making the weekly weather forecasts. One additional station in Alaska is used as a distributing center in connection with ocean meteorological work, while the reports from eight special stations in the West Indies, rendered from July 1 to November 15, are of great value to the forecaster in connection with the prediction of tropical storms during the hurricane season.

Of the 158,636 observations due from the 272 stations during the year, only one was missed, and that through an accident to the observer. Seven were taken from 15 to 30 minutes late, eight from 30 minutes to 1 hour late, and fourteen from 1 to 2 hours late. In most instances these delays were unavoidable. No better evidence than this could be advanced in illustration of the excellent discipline of the observers and of the spirit of promptitude and devotion to duty that animates the entire service.

In addition to the paid meteorological stations, there are 33 cooperative stations that render reports in connection with the special interests of their respective sections; of these, 2 are special meteorological stations, 22 are special fruit district stations, 1 is a special cranberry-marsh station, and 8 are West Indian stations.

No regular Weather Bureau stations of the first order were opened during the year. Four special meteorological and 22 fruit stations were established. This special fruit-district station service is being rapidly developed in connection with special investigations carried on under the direction of the officials at Chicago, Raleigh, Portland (Oreg.), San Francisco, Salt Lake City, Grand Junction, Jacksonville, and Columbus (Ohio).

In the mountain orchard districts of North Carolina study is being made of the thermal belts in the Blue Ridge Mountains. After a careful inspection by Weather Bureau officials from Chicago and Raleigh, accompanied by Mr. Hutt, State horticulturist of North

Carolina, the following places were selected for the establishment of stations:

Asheville, N. C., with 4 substations.
Blantyre, N. C., with 3 substations.
Blowing Rock, N. C., with 4 substations.
Globe, N. C., with 2 substations.
Gorge, N. C., with 3 substations.
Mount Airy, N. C., with 3 substations.
North Wilkesboro, N. C., with 3 substations.
Transon, N. C., with 2 substations.
Tryon, N. C., with 3 substations.
Waynesville, N. C., with 2 substations.

Each of these stations is equipped with an instrument shelter, a thermograph, and maximum and minimum thermometers. In addition, the home station has a rain gauge, a sling psychrometer, and an extra minimum thermometer exposed outside the shelter. The instruments at the home station are read once daily, while those at the substations are read weekly, the observations being continued throughout the year.

These stations are variously located along the slope of the mountains up to 4,000 feet above sea level, the range between the elevation of the home station and the highest substation being about 1,000 feet. A further extension of the service in North Carolina is planned for the coming year.

Under the Portland (Oreg.) center are grouped seven localized centers for fruit frost investigation and distribution of frost warnings:

1. In the Rogue River Valley around Medford, Oreg.
2. In the Umpqua Valley around Riddles, Oreg.
3. In the Stuck River Valley around Tacoma, Wash.
4. In the Yakima Valley around North Yakima, Wash.
5. In the Snake River Valley around Lewiston, Idaho.
6. In the Boise Valley around Boise, Idaho.
7. In the Hood River Valley around Hood River, Oreg.

Medford, in the Rogue River Valley, is the key station for that district, with the three cooperative stations at Ashland, Jacksonville, and Grants Pass, Oreg., taking observations during the frost period, or when specially called on. Observations are taken at Medford throughout the year. Riddles, Oreg., in the Umpqua Valley, is the distributing center for warnings for that section. The service in the remaining valleys has the same general system of reporting stations, working in conjunction with a central station, from which warnings are distributed to the surrounding fruit interests liable to be injured by expected frosts or low temperatures.

The supervision of five special fruit-district stations around Los Angeles was transferred to the San Francisco district during the past year. The San Francisco center now has charge of the fruit-district stations of the northern and central counties and the citrus fruit districts of the south. It is hoped soon to provide for a material extension of this service into the fruit districts of the San Gabriel, Santa Clara, San Joaquin, Sacramento, and Bay Valleys. Experiments with improved heaters are needed, so as to utilize the warnings to the fullest extent. Plans are being made for experiments with coverings as a plant protection.

The experiments in protecting fruit from frost by the use of canopies, begun at Provo, Utah, two years ago, have been continued by the Weather Bureau official at Salt Lake City, who has extended them so as to include the covering of trees with three different kinds of cloth, and taking the temperature observations both inside and

outside the coverings. He is planning to continue these experiments during the coming year, and to extend his studies to include the protection of vegetables and alfalfa from frost.

The frost-warning service has been continued in the Grand River Valley and extended to include the Gunnison Valley. Paid stations were established at Delta, Paonia, and Montrose, Colo., taking observations during May and June of this year only. Observations from these stations were telegraphed to Grand Junction and forecasts from Denver were amplified and distributed to the fruit interests. Special frost warnings were also sent to Hotchkiss.

Some frost-protection work was done in the vineyard districts of Ohio during the year by the official in charge at Columbus, in cooperation with the State agricultural experiment station. A further extension of the service is planned.

The frost-warning service for the protection of trucking and citrus fruit in Florida was continued without material change by the Weather Bureau official at Jacksonville.

Requests for the establishment of additional special meteorological stations in investigating frost protection were received during the year, but the lack of funds prevented further extensions. Dr. J. R. Guerrant desired a station at Callaway, Va., for conducting investigations in the Blue Ridge orchards. The Oregon Agricultural College requested assistance in frost investigations in the Umpqua Valley. The Appalachian Apple Orchards Co., of Atlanta, wanted a station at Tallulah Falls, Ga., and from Mosier, Oreg., Inman, S. C., Legerwood, N. C., and Grossnore, N. C., similar requests were received.

The special service for the protection of cranberries from frost in the bogs of the Cape Cod district is now well organized. Special stations report to Boston, from which point frost warnings are distributed to the cranberry interests. These bogs are the most extensive in this country, and the cranberry growers rely upon the warnings of the Weather Bureau in making preparations for the protection of their crops from frost.

Special cranberry stations are maintained in Wisconsin at Berlin, Mather, and Grand Rapids, under the supervision of the Chicago center. The Wisconsin State Cranberry Growers' Association has warmly expressed its appreciation of the work of the bureau in that State.

The station at New Lisbon, N. J., has been continued during the year for the protection of cranberries of that district.

At Seaview, Wash., a cooperative station was established under the Portland, Oreg., center for investigation into the frost conditions of the cranberry bogs.

Special stations conducted for the benefit of the cotton, corn, wheat, sugar, and rice interests will be described later.

FORECAST DISTRIBUTION.

Weather forecasts are issued daily from Washington, Chicago, New Orleans, Denver, San Francisco, and Portland (Oreg.). From these centers the forecasts are telegraphed to 2,059 regular Weather Bureau stations and forecast distributing centers, from which points the forecasts are made available by telegraph and telephone to 5,465,032 subscribers and others, and by rural free delivery and mail

to 120,050 places. In addition to this, special frost and emergency warnings are sent to 6,100 addresses. There was an increase of 89 in the number of places receiving the forecasts at Government expense, while the distribution by free telephone was increased nearly a million, and by mail forecast cards, 2,500.

Distribution of daily forecasts and special warnings.

State.	At Government expense.			Without expense to Government by—				
	Forecasts and special warnings.	Special warnings only.	Emergency warnings only.	Mail.	Rural delivery.	Telephone.	Railroad train service.	Railroad telegraph.
Alabama	24	7	136	1,450	337	43,907	0	10
Arizona	8	1	0	122	0	4,661	0	0
Arkansas	24	9	102	845	562	48,460	0	11
California	84	25	10	2,600	54	0	0	0
Colorado	9	63	41	1,124	1,080	84,300	0	1
Connecticut	5	0	72	2,116	50	75,000	140	0
Delaware	8	1	16	150	300	4,865	0	27
District of Columbia	0	0	0	1,285	0	20,000	0	0
Florida	34	107	52	1,367	225	22,201	0	240
Georgia	49	32	239	1,835	600	58,669	0	161
Idaho	12	0	0	285	200	18,782	0	0
Illinois	113	47	226	3,135	3,264	586,125	0	1
Indiana	93	2	74	2,659	510	239,890	0	0
Iowa	139	8	455	1,850	2,057	243,059	0	0
Kansas	92	2	175	1,721	785	136,383	0	0
Kentucky	69	32	99	1,772	100	54,400	0	0
Louisiana	76	22	48	637	0	32,136	0	18
Maine	11	1	58	1,190	180	24,000	0	0
Maryland	15	49	46	2,248	285	7,900	0	281
Massachusetts	13	13	78	3,158	110	150,000	80	0
Michigan	59	1	0	4,680	719	430,732	181	407
Minnesota	73	3	171	2,384	1,839	159,599	0	13
Mississippi	47	7	59	1,361	1,434	24,900	9	6
Missouri	27	2	236	5,539	0	391,050	0	1
Montana	12	19	13	428	0	19,500	0	5
Nebraska	71	9	205	2,188	420	210,702	0	0
Nevada	5	0	0	57	0	1,200	0	0
New Hampshire	15	0	44	693	775	14,980	15	0
New Jersey	20	17	105	1,484	265	39,004	0	179
New Mexico	8	2	0	135	0	10,500	0	17
New York	109	49	409	9,358	661	735,352	0	118
North Carolina	60	59	187	1,310	1,500	35,000	0	0
North Dakota	25	3	93	500	1,800	15,000	0	180
Ohio	70	147	237	7,291	323	450,000	0	0
Oklahoma	30	1	0	680	343	3,965	0	160
Oregon	10	7	0	492	218	13,000	0	0
Pennsylvania	76	42	315	6,475	1,393	491,700	0	452
Rhode Island	1	0	14	221	0	2,560	13	0
South Carolina	32	11	105	935	375	33,376	0	39
South Dakota	51	9	70	875	7	46,000	0	7
Tennessee	47	3	222	1,867	2,863	65,741	0	0
Texas	85	65	227	1,347	773	201,305	0	0
Utah	6	26	0	212	325	34,106	1	0
Vermont	12	0	54	906	425	22,475	12	0
Virginia	56	6	84	1,730	1,797	26,882	0	44
Washington	22	21	0	847	400	3,551	0	0
West Virginia	34	8	55	994	0	50,969	0	0
Wisconsin	106	6	309	2,653	1,184	67,330	0	0
Wyoming	12	2	13	320	0	6,935	0	0
Total	2,059	946	5,154	89,512	30,538	5,462,212	451	2,343

STORM-WARNING DISPLAY STATIONS.

Eighteen storm-warning display stations were established on the ocean and lake coasts during the past year and six stations of this class were discontinued.

Storm warnings were discontinued for the winter on the Great Lakes December 6, 1911, and resumed April 25, 1912.

The usual advance arrangements have been made for the dissemination of hurricane warnings on the Atlantic and Gulf coasts by the

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displaymen, by rockets, messages, and other suitable means. The following special instructions, issued on September 28, 1911, indicate the action authorized to be taken at the storm-warning centers in order to make these warnings of the greatest possible value in the protection of life and property:

When an order to hoist the hurricane warning is received at any station every effort will be made to give the warning the widest possible distribution, especially among vessels in the harbor and persons occupying isolated or dangerous points that can not be communicated with by telegraph or telephone. Vessel masters will be notified that it is dangerous to leave port. In the distribution of such warnings officials in charge of stations are hereby authorized to incur any reasonable expense, such as hire of boats, tugs, horses, automobiles, and special messengers, not to exceed $200 for any one occasion, without special telegraphic authority. A telegraphic report of such measures, with a statement of the expense incurred, will promptly be made to the central office.

The following statement gives the number of stations, arranged under district centers, receiving storm warnings:

District centers.	Paid stations.	Cooperative stations.	Weather Bureau stations.	Naval wireless stations.
Alpena, Mich	5	0	1	0
Atlantic City, N. J	0	4	1	1
Baltimore, Md	3	1	0	0
Block Island, R. I	1	0	1	0
Boston, Mass	25	11	2	5
Buffalo, N. Y	12	1	1	0
Cape May, N. J	1	0	1	0
Charleston, S. C	5	1	1	0
Chicago, Ill	25	3	1	1
Cleveland, Ohio	10	1	1	0
Corpus Christi, Tex	2	0	1	0
Detroit, Mich	0	1	1	0
Duluth, Minn	7	0	1	3
Eastport, Me	0	1	1	0
Erie, Pa	1	0	1	0
Escanaba, Mich	2	0	1	0
Eureka, Cal	0	1	1	1
Galveston, Tex	5	7	1	1
Grand Haven, Mich.[1]	0	0	1	0
Grand Rapids, Mich.[1]	0	0	1	0
Green Bay, Wis.[1]	0	0	1	0
Hartford, Conn.[1]	0	0	1	0
Houghton, Mich	3	3	1	0
Jacksonville, Fla	8	14	1	1
Key West, Fla	0	2	2	1
Los Angeles, Cal	1	3	1	0
Marquette, Mich	1	0	1	0
Milwaukee, Wis	9	0	1	0
Mobile, Ala	4	4	1	0
Nantucket, Mass.[1]	0	0	1	0
New Haven, Conn	3	0	1	0
New Orleans, La	3	2	1	0
New York, N. Y	4	6	1	2
Norfolk, Va	6	5	4	1
Oswego, N. Y.[1]	0	0	1	0
Pensacola, Fla	3	0	1	0
Philadelphia, Pa	3	1	1	0
Port Huron, Mich	3	1	1	0
Portland, Me	3	2	1	0
Portland, Oreg	10	4	5	1
Providence, R. I	1	0	1	0
Rochester, N. Y.[1]	0	0	1	0
San Diego, Cal	0	3	1	1
Sandusky, Ohio[1]	0	0	1	0
San Francisco, Cal	2	9	4	3
San Juan, P. R	0	2	1	2
Saulte Ste. Marie, Mich	5	0	1	0
Savannah, Ga	4	1	1	1
Tampa, Fla	2	6	1	0
Toledo, Ohio	0	1	1	0
Washington, D. C	2	0	1	0
Wilmington, N. C	3	3	1	0
Total	187	104	63	25

[1] Not centers.

SMALL-CRAFT WARNINGS.

A new warning for the protection of small craft, such as those engaged in fishing, towing, motor boating, and yachting, from danger from moderately strong wind was designed during the year, and nine small-craft cooperative stations were established. A red pennant, displayed during the day only, is flown to warn these interests.

STATION WEATHER MAPS.

The policy of publishing the commercial weather maps in the daily papers in order to give the reports and information furnished by the Weather Bureau wider distribution than obtainable by any other means has continued during the year. At its close there was a net increase of 20 papers publishing the map, as compared with the number for the previous year. The commercial map is now published at 106 cities and towns, in 147 papers having a total daily circulation of 2,904,704. This large distribution is entirely without expense to the Government except for the preparation of the original casts, and means the placing of weather information before the reading public at a great saving of funds that can be utilized in the extension of the bureau's work in other directions.

Daily weather maps are issued direct from 59 stations, with a total daily circulation of 20,550. Since the publication of the commercial map was begun, the station map has been discontinued at 51 stations.

Glass weather maps were installed during the year at Chicago, Evansville, New York, Tampa, Peoria, Fort Wayne, and San Antonio, and are now changed daily in 59 places at 45 stations. The usual points of display are cotton exchanges, fruit and produce exchanges, chambers of commerce, boards of trade, maritime exchanges, and customhouses. The high value attached by commercial organizations to this elaborate means of portraying general weather conditions is evidenced by the following extracts from letters received:

From the secretary of the Tampa (Fla.) Board of Trade:

I have not written you before to acknowledge the receipt of the large glass weather map, which has been installed on the first floor of the board of trade building, as I desired to wait a week and see what interest the public took in this excellent method of showing the weather of the United States daily. I expected in the winter time when we have 10,000 tourists in Tampa that the map would be surrounded all day long by our friends from the North, but I did not expect such an interest in it during the summer time. The map is so attractive that it commands attention, and it is located just back of a plate-glass window, and each day there are hundreds who stop to study the weather conditions as stenciled on the map.

I wish to assure you that the board of trade appreciates your efforts to have this map installed here; and I also know that the public appreciates it and it will go a long ways toward acquainting the public with the maps in the papers, as the weather map is done in colored chalk.

From the secretary of the Savannah (Ga.) Cotton Exchange:

Full information of the weather that prevails all over the cotton belt and the forecast of what may be expected to come is not only valuable information but is highly important to the trade; we are very anxious about the forecast, and the large glass weather map is now the most popular point of the exchange, and the map is surrounded by a crowd while it is is being made up.

From the secretary of the Evansville (Ind.) Business Association:

The large glass weather map is a great attraction, and it has proved so interesting to a great many of the business men that they come to the association rooms daily to observe the weather conditions throughout the country, and also to carefully study the map.

From the secretary of the Vicksburg (Miss.) Cotton Exchange:

You can not imagine how important a center our glass weather map is just now. Planters, Government engineers, and business men consult it many times a day, especially in regard to the weather and its effect on the present high water.

In other cities blackboard maps and bulletin boards are changed daily in 13 places at 11 stations. New bulletin boards were installed during the year at Evansville and Kansas City.

MARINE WORK.

OCEAN METEOROLOGICAL CHARTS.

The meteorological charts of the oceans, prepared by the Weather Bureau, are distributed to mariners, maritime exchanges, and meteorological institutions throughout the world, and their receipt is frequently acknowledged with assurances of their value to the interests served. The charts are also furnished by request to many schools, colleges, public libraries, and meteorological societies.

The meteorological charts for the north Atlantic, north Pacific, and Indian Oceans and for the Great Lakes are published monthly, while those for the south Pacific and south Atlantic Oceans are issued quarterly. The charts contain on the face a statement of all the meteorological elements of the oceans, together with the sailing routes of vessels, lines of magnetic variation, and the location of the radiotelegraphic stations of the world, and of the storm-warning stations of the United States and other countries. During the past year articles have appeared on the reverse side of the north Atlantic and north Pacific charts on water-surface temperature, air temperature, and ocean currents for each month. Similar data are in course of preparation for publication on the south Atlantic and south Pacific charts.

The meteorological data used in the preparation of these charts are collected from the vessels of all nations, and the land and island stations of all countries bordering on the ocean. The observers forward their reports through the local offices of the Weather Bureau or, when in foreign ports, through the American consular offices. The American consuls at all the principal ports are furnished with a full supply of meteorological forms, and act as agents for the Weather Bureau in their distribution. During the past year 2,291 vessels, representing 24 different nationalities, have cooperated with the Weather Bureau and furnished monthly reports of observations. Reports are also received from 261 land stations, making a total of 2,552 cooperative observers. This work is entirely gratuitous, the only return given being in the form of meteorological charts and other publications issued by the bureau. These cooperating vessels furnished 12,600 meteorological reports during the year, which have called for 3,259 letters of acknowledgment from the Washington office. Reports received through the marine centers are acknowledged by those centers, and often in person, as our agents visit the vessels upon their arrival in port. Three thousand barometer cards, containing comparative barometer readings, have been received and corrected, and tags giving the corrections of the barometers have been furnished each vessel.

The bureau maintains marine centers at 23 seaport towns on the ocean and Gulf coasts and 19 on the Great Lakes, at which points meteorological charts and supplies are distributed to the cooperating vessels. At New York, Boston, Philadelphia, Seattle, and New Orleans assistants are specially assigned to visit vessels, instruct the observers, make comparisons, and furnish general information. The official at Seattle has supervision over the meteorological work of all vessels entering Puget Sound.

The following are extracts from letters commendatory of the charts:

Mr. V. le Toumelin, of the French steamship *Cacique:*

I have been sending reports five years, and am too glad to receive your charts and rely on them.

Capt. W. A. Haughton, R. N. R., commander of the steamship *Persia:*

I can not express to you how valuable these charts are to a seaman, and beg to compliment you on the production of such valuable aids to safe navigation.

Acknowledgment is due to the meteorological services of other countries for furnishing reports on ocean meteorology and other special data. The bureau is also indebted to Mr. H. C. Thomson for valuable information relative to the fogs of Newfoundland and the higher latitudes of the north Atlantic Ocean. Mr. Thomson has made a study of the subject in connection with the contemplated establishment of a railway through Newfoundland and a northern steamship route to Europe.

VESSEL WEATHER SERVICE.

On April 1, 1912, the bureau inaugurated on the Atlantic and Gulf coasts a vessel weather service on 30 vessels sailing between New York and New Orleans and points in the West Indies and South American ports. This special service on 23 of the vessels was placed under the supervision of the official at New York and on 7 under that of the official at New Orleans. The vessels were equipped with aneroid barometers, and the observer on each takes two observations daily, one at 7 a. m. and the other at 7 p. m., seventy-fifth meridian time, when the vessel is 75 miles from the port of departure or port of entry, and radiographs them to the nearest wireless station on the coast, from which point they are sent over the land lines to Washington. For this service the observers are paid 50 cents for each observation. The transmission of the messages from the vessels and their transfer to the land line stations is done without cost to the bureau, through cooperation by the naval wireless, Marconi, the United Wireless, and the United Fruit radiotelegraph service, to which companies thanks are extended for the many courtesies shown. The steamers cooperating in this work are operated by the United Fruit Steamship Co., the New York & Cuba Mail Steamship Co., the Mallory Steamship Co., and the Panama Railroad Steamship Line.

Vessel weather service has also been started on the Pacific coast on vessels of the Nippon Yusen Kabushika Kaisha, plying between the Orient and points on the Pacific coast. The Japanese Government offered to take up the work free of cost, except for land tolls, and

has issued instructions to all its vessels to make reports to our officials at San Francisco and Portland.

At San Francisco the daily forecasts are distributed by the United Wireless at stated times each day to vessels at sea.

At San Francisco 321 vessel reports were received during the year, but the official states that most of the reports were of little value in connection with his forecast work. Reports from coastwise steamers were of interest to the public and were published in the papers. The maximum distance from which reports were received was 1,440 miles.

At Portland, Oreg., reports were received from 534 vessels, of which 176 were of benefit to the forecaster in connection with his work and 358 of only slight value. Forecasts made at Portland are sent over the Port Crescent Lines to Tatoosh Island, where they are delivered to the Naval Wireless station for distribution to vessels at sea and to points along the coast.

RADIOTELEGRAPH SERVICE.

The bureau is in close cooperation with the Naval Wireless, the United Wireless, the Marconi, and the United Fruit Telegraph services on the Atlantic, Gulf, and Pacific coasts. Instructions have been issued to the stations of these services to forward immediately to Washington all weather information received, and special hours have been set aside for the broadcast dissemination of forecast messages and storm warnings over the ocean. Even when information relating to a disturbed condition of the weather at sea is contained in a private message, the operator at the radio station has been instructed to request the master of the vessel to make a weather report. The proposed extension of wireless weather service to cover the entire north Atlantic Ocean, through international regulation and cooperation, has already been referred to.

VESSEL-REPORTING SERVICE.

In addition to their meteorological duties, the officials at the stations at Block Island, Cape Henry, Sand Key, Southeast Farallon, Point Reyes Light, North Head, Port Crescent, and Tatoosh Island are required to report all passing vessels, wrecks, and marine disasters, and to transmit communications between masters, owners, underwriters, and others interested in marine matters. All of these stations are prepared to transmit messages by telegraph, and all except Block Island and Port Crescent are equipped for day signaling by the international code. Cape Henry and Sand Key are also equipped for night communication by flash light, Morse code.

Cape Henry uses the telegraph and telephone in reporting all vessels to Norfolk and Newport News. The names of the vessels passing that station are also furnished to the Norfolk press and the New York Maritime Exchange. All naval vessels are reported to Norfolk, and in some cases a report is made to the Navy Department at Washington. Vessels bound for Baltimore are reported to the Maritime Exchange of that city. The Virginia and Maryland pilot associations cooperate with this station. Cape Henry has a list of 100 associations, firms, and individuals to receive notice of passing vessels.

A time flag is dropped at the station each day at noon for the benefit of the pilot boats and vessels in the offing. During the year 17 wrecks were reported to various ship companies, maritime exchanges, and individuals. The Cape Henry office receives information of wrecks from the 25 life-saving stations between Cape Henry and Hatteras Inlet and from the wireless station at Hatteras, and reports by telephone to the revenue cutters and to wrecking companies, so that they may render immediate assistance.

Block Island sends reports to 12 firms and associations. Four wrecks were reported by this station during the year.

Sand Key transmitted orders for 72 vessels and gave notice of three casualties during the year. Ten firms and associations receive reports from this station.

Tatoosh Island reports all passing vessels through the main station at Port Crescent to Seattle, Portland, and San Francisco stations and through the Naval Wireless station to Victoria Wireless station.

Port Crescent reports passing vessels, casualties, etc., to 10 firms and associations in Seattle, San Francisco, Port Angeles, Wash., and Victoria, British Columbia.

The following extracts from reports received during the year furnish instances of special service rendered by these stations to vessels in distress:

Sand Key, Fla., January 29, 1912.—British schooner *Sea Gull*, Bonacco to Key West, went ashore at Sand Key, Fla. Cargo of bananas and 16 passengers from Grand Cayman. Revenue cutter, notified by this office, went to assistance and towed schooner into this harbor.

Tatoosh Island, Wash., June 22, 1912.—At 4.30 a. m., while taking a. m. observation, sighted the American brigantine *William G. Irwin*, bound from Roche Harbor, Wash., to San Francisco, Cal., with lumber and lime. She was lying just off Mukkaw Bay, about 5 miles south of station, an unusual position for a sailing vessel. A very light wind, almost calm, prevailed, and the incoming tide was carrying her slowly into the bay. A close watch was kept on her, and about 9 a. m. she ran up her ensign, evidently for assistance. I immediately requested the wireless station to get into communication with the revenue cutter *Snohomish* at Neah Bay and notify her of the *Irwin's* position, which they did. *Snohomish* proceeded at once to Mukkaw Bay and towed the *Irwin* to a safe offing. No damage. Commander of *Snohomish* reports that *Irwin* was fast setting in toward rocks when he arrived.

September 14, 1911.—Small fishing launch capsized while leaving anchorage at this point. Notified life-saving crew at Neah Bay and assisted in holding boat on beach until they arrived. Small damage to boat and no injury to persons.

Port Crescent, Wash., March 1, 1912.—The launch *Pearl*, with scow load of machinery, dragged her anchors and went ashore in Crescent Bay. The life-saving tug was at once notified. The *Snohomish* pulled the launch off at 2.30 p. m. without damage. The scow was unloaded on the beach and floated by the *Snohomish* several days later without damage.

North Head, Wash., August 2, 1911.—The schooner *Americana*, with a crew of 18 men and a cargo of 1,000,000 feet of lumber, bound from Astoria, Oreg., to Australia, nearly drifted ashore inside Tillamook Rock during a calm. She was saved from almost certain destruction by the action of the observer, who discovered her plight and sent an urgent call for tugs, which arrived in time to render the necessary assistance.

January 13, 1912.—At 9 a. m. the four-masted schooner *The Admiral*, bound from Valparaiso, Chile, to Grays Harbor, Wash., in ballast, turned turtle and drifted ashore, a total wreck. This station notified the life-saving crew at Fort Canby and the bar tugs at Astoria, Oreg., who rescued the crew from the jetty and attempted to save the vessel. The observer also kept the Portland marine interests posted over the Seacoast Telegraph Line.

The following is the number of vessels reported by each vessel-reporting station during the year:

Block Island	5	Sand Key	1,813
Cape Henry	19,876	Southeast Farallon	31
North Head	1,619	Tatoosh Island	2,459
Point Reyes Light	1,206		
Port Crescent	622	Total	27,631

CLIMATOLOGICAL DIVISION.

METEOROLOGICAL AND CLIMATOLOGICAL REPORTS.

The Annual Report of the Chief of the Weather Bureau for 1910–11 was prepared and printed, as were also the regular issues of the Monthly Weather Review. The demand for the separates of the Review has continued to increase, the edition of the several parts now amounting to 14,729 each month.

The issue of the National Weather Bulletin weekly during the crop-growing season and monthly during the remainder of the year continued as in past years. The demand for this bulletin has likewise shown a healthy increase, the edition now exceeding 4,000 copies.

The snow and ice bulletins issued during the past winter were of uncommon interest on account of the severe cold and the unusual amount of ice reported on the lakes and rivers. In view of this condition it was found advisable to continue its issue until the first week in April. Likewise the special report issued at Detroit during the early spring as to the condition of the ice on the Great Lakes was continued until the latter part of April because of the unusually late date at which the ice broke up.

Snow bulletins for the Mountain States of the Far West were issued as in the past, additional effort being made to show the snow condition in more detail as a basis for forecasting the season's available water supply for irrigation and other purposes.

The monthly climatological reports and weekly bulletins for the Territories of Hawaii and Porto Rico, and for the State of Iowa in conjunction with the weather service of that State, were issued as usual. To meet the demands for prompt information as to the month's weather, especially the rainfall, several other section centers were authorized to print and distribute condensed monthly summaries for their States as early as possible. Annual summaries of the 44 sections were also published in full, and form a valuable addition to the series already issued.

Considerable work has been accomplished in the preparation of data for a bulletin on the winds of the United States, which it is hoped to complete before the end of the coming year.

During the year there has been a further increase in the number of requests for data, embracing all features of climate and coming from all portions of the United States as well as from many foreign countries. These requests were all promptly complied with as far as possible.

COOPERATIVE METEOROLOGICAL STATIONS.

Cooperative stations to the number of about 4,200 are now in successful operation, covering nearly every important locality in the United States and furnishing data by which to establish accurately

the essential features of the climate of the districts represented. Now that the country is fairly well covered with these stations, it has been the policy not to extend the cooperative work save in a few important newly settled districts. Requests are being constantly received, however, asking for new stations and claiming that the local interests demand their establishment.

SPECIAL SERVICES.

The corn and wheat, cotton, and sugar and rice region services were continued, with slight increase in the number of reporting stations. Reports from over 400 regular and special stations are now being used in these services. In the corn and wheat region 12 central points issue daily a total of more than 1,000 bulletins, while 26 stations in the cotton belt issue more than 1,500 bulletins. These services are rapidly becoming more popular, as evidenced by the increasing circulation of the bulletins and the many and persistent demands that have been made for the extension of the cotton and corn and wheat services westward into the more newly settled territory.

The policy of combining under a single observer the work done for the bureau at points where two observers had heretofore been employed has been continued. Thirty-four such combinations were accomplished during the year, resulting in some saving in pay to observers, a decrease in telegraph tolls, and less work in the preparation and auditing of accounts.

INSTRUMENT DIVISION.

The routine work of the Instrument Division, comprising the issue and maintenance of the standard instrumental equipment at all stations, has been maintained in a thorough manner throughout the year.

SPECIAL INSTRUMENTAL EQUIPMENTS.

Early in July, 1911, the officials of the city of New York requested the Weather Bureau to take over and operate the Central Park Meteorological Observatory, founded and for many years maintained by Dr. Daniel Draper. This was promptly done, and, in order to carry on proper comparisons between the Draper instruments and the standard types used by the Weather Bureau, a complete equipment of the latter was installed in August. Comparative records will be maintained for a year or more for the purpose of making as complete connection as possible between the old records and those that will be obtained in future.

Shielded rain and snow gauges were installed for comparative observations at stations in the Denver section, under Mr. Brandenburg; at Yellowstone Park, under Mr. Gittings; and in the Utah section, under Mr. Thiessen. These officials have reported generally satisfactory results, together with suggestions for structural modifications to overcome difficulties experienced. In all cases the records of snowfall from these gauges are 20 per cent to 25 per cent greater than obtained by the customary means. It seems advisable, therefore, to extend the installation of these gauges as means and opportunity permit, having due regard to the suitability of the location and exposure and the probable permanence of the station.

Upon the request of the Chief of the Bureau of Animal Industry, Prof. Marvin, of the Weather Bureau, was detailed to recommend and specify a complete equipment for the protection from lightning of the buildings and structures at the Morgan Horse Farm, Middlebury, Vt. The work of installation was carried out by the farm workmen, and an effective system of protection provided at a small part of the ordinary cost of such work.

In furtherance of the active cooperation of the Weather Bureau with other departments of the Government, instruments have been installed at Priest River, Idaho, and Cloquet, Minn., for the Forest Service, and equipments have also been sent to the forest experiment stations at Ephraim, Utah, and Quincy, Cal., where they will soon be installed. In cooperation with the Bureau of Mines, instruments have been supplied and provisions made for collecting humidity and temperature data over central Illinois, to be used in the study of causes and prevention of mine disasters.

In connection with the extensive arrangements made during the year to observe and study the conditions attending frosts in orchards, equipments were placed at 39 points of observation at 10 different orchard stations in North Carolina. Less extensive provisions were made for similar observations at Grand Junction, Colo., Provo, Utah, and a few stations in Oregon. Plans in hand for a general extension of studies in other important fruit sections will call for additional equipments.

Kiosks were purchased for 10 stations, and these are now in full operation, except at three stations where the work of erection is almost completed.

INSTRUMENTS FOR SPECIAL RESEARCH WORK.

The development of special apparatus for the measurement of solar radiation was extended during the year and equipments of the Marvin pyrheliometer were completed for use at Washington, Mount Weather, Madison, Lincoln, and Santa Fe, as earlier mentioned.

It has been known for a number of years that the velocities of the wind, as shown by the standard types of anemometers, are increasingly erroneous at velocities of 50 to 60 miles per hour and higher. As the exact evaluation of these indications can be determined only by comparatively elaborate investigations, Prof. Marvin was directed to take up this important problem. In accordance with his recommendations, two methods of investigation will be conducted. Preparations are already well advanced for making these tests by means of an anemometer whirling machine. This apparatus consists of a horizontal arm 30 feet in length, which revolves about a vertical axis and carries at its outer end the anemometer to be tested. Tests of a satisfactory nature can be obtained by this means at different velocities up to 70 or 80 miles per hour. The second method of testing will be carried out in a so-called wind tunnel. A large blower, or fan, will drive the air through a closed channel or duct producing conditions under which the velocity of the anemometers subjected to the current thus created can be measured accurately by well-known dynamic principles, as well as by the aid of special types of pressure gauges. General plans for the equipment required are now in the hands of blower companies, with a view to further development along lines of greatest efficiency and economy of power. With this apparatus the velocities will be carried beyond 100 miles per hour.

LIBRARY.

The additions to the library during the year numbered 1,204 books and separate pamphlets, bringing the total collection up to about 32,000. All additions were catalogued under author and subject. The cataloguing of the meteorological contents of scientific journals was carried on as usual.

The urgent need of more space for this branch of the office was met at the end of the fiscal year by the acquisition of two more rooms and the installation therein of modern steel shelving. There is thus provided a long-desired opportunity to relocate the books throughout the library; also to set aside space for a small reading room and a workroom. When the changes now in progress are complete, the Weather Bureau library will for the first time be installed in a manner corresponding to its importance as the principal collection of meteorological literature in this country.

Noteworthy books added during the year fall into two classes, viz, (1) old books, obtained chiefly in connection with sales of large private libraries abroad; and (2) important publications of the current fiscal year.

Under (1) should be mentioned the extremely rare first edition of Wells's "Essay on Dew" (1814); the first edition of Howard's "Climate of London" (2 vols., 1818–1820); the first and second editions of Daniell's "Meteorological Essays and Observations" (1823 and 1827); Bravais's "Mémoire sur les halos" (1847); Dove's "Verbreitung der Wärme" (1852); and Foucher's "Traité des hygromètres" (1686).

Under (2) the following may be noted, not only as important additions to the library, but as, on the whole, the most noteworthy publications in the field of meteorology that have appeared throughout the world in the course of the fiscal year:

"Meteorology," by W. I. Milham (New York, 1912), aims at comprehensive scope and adaptability to classroom purposes. A. Wegener's "Thermodynamik der Atmosphäre" (Leipzig, 1911) contains many novel features, reflecting especially the recent discoveries and hypotheses of aerology; it is planned as the first of a series of books in which the author proposes to cover the whole field of atmospheric physics. "Dynamic Meteorology and Hydrography," volume 2, by V. Bjerknes and others (Washington, 1911), deals with kinematics, applying the elaborate mathematical methods of the first volume. "The Sun," by C. G. Abbot, director of the Astrophysical Observatory of the Smithsonian Institution, devotes much attention to the solar relations of the earth's atmosphere, and may be regarded as a successor to Young's well-known work bearing the same title. "Forecasting Weather," by W. N. Shaw, director of the British meteorological office, summarizes the progress, during the past decade, of English meteorology in the subject treated; it is virtually a continuation and revision with much enlarged scope of the classical work by Abercromby on this subject. A second edition, in German, of the International Meteorological Codex was published by the Royal Prussian Meteorological Institute (Berlin, 1911).

Aerology and aeronautical meteorology are increasingly prominent in recent literature. A second and final volume of F. Linke's "Aeronautische Meteorologie" (Frankfurt a. M., 1911), has appeared, and a companion work by the same writer on aeronautical climatology

is promised. A. Zahm's "Aerial Navigation" (New York, 1911) devotes adequate attention to aeronautical meteorology. Other works in this field include J. S. Dines's "Second Report on Wind Structure," published by the British Advisory Committee on Aeronautics (London, 1911); P. Ludewig's "Die Messung vertikaler Luftströmungen" (Leipzig, 1911); and G. Jonas's "Methode und Tabellen für die Berechnung von Pilotballonaufstiegen" (Leipzig, 1911). However, the bulk of the recent literature on aerology, aeronautical meteorology, aerotechnics, and allied topics has appeared in the form of magazine articles, which can not be enumerated here.

The subject of agricultural meteorology is attracting much attention. The International Institute of Agriculture has issued an elaborate report on the organization of work in this field in various countries (Rome, 1911). A large series of publications have been issued by the meteorological bureau attached to the Russian Ministry of Agriculture. P. Klein's "Météorologie agricole" (Paris, 1911) is chiefly devoted to the general subject of meteorology, rather than its applications to agriculture. Phenology has made much more progress in Germany than elsewhere. A notable contribution to this subject was E. Ihne's "Phaenologische Karte des Frühlingseinzugs im Grossherzogtum Hessen," second edition (Darmstadt, 1911). In the United States the greatest share of attention has been given to the subject of frost and frost protection. This bureau published a bulletin on "Frost Data of the United States and Length of the Crop Season," by P. C. Day (Washington, 1911), and one on "Forecasting Frost in the North Pacific States," by E. A. Beals (Washington, 1912). Numerous bulletins on orchard heating were issued by the experiment stations, and this subject occupied a prominent place in the horticultural journals.

A work by C. Dorno, "Studie über Licht und Luft des Hochgebirges" (Braunschweig, 1911), is an example of elaborate modern methods of studying the radiation from the sun and sky and the normal electrical phenomena of the atmosphere as components of climate. In his "Characteristics of Existing Glaciers" (New York, 1911), W. H. Hobbs urges the importance of the polar continental ice caps as affecting the general circulation of the atmosphere. Hellmann and Elsner's "Meteorologische Untersuchungen über die Sommerhochwasser der Oder" (Berlin, 1911) is an exhaustive study on the relation of floods in the basin of the River Oder to barometric conditions. This bureau published a bulletin on "Stream Flow of the Ohio River at Cincinnati and Precipitation in the Watershed above Cincinnati," by J. W. Smith (Washington, 1912). Of more general application was D. W. Mead's memoir on "The Flow of Streams and the Factors that Modify It" (Madison, Wis., 1911).

Photographs of typical cloud forms appear in J. Loisel's "Atlas photographique des nuages" (Paris, 1911) and A. McAdie's "The Clouds and Fogs of San Francisco" (San Francisco, 1911).

The most remarkable addition to the literature of atmospheric optics was F. Busch & C. Jensen's "Tatsachen und Theorien der atmosphärischen Polarisation" (Hamburg, 1911), a monumental work on the subject treated. A useful and much-needed descriptive work on all the known forms of solar and lunar halos was published serially by L. Besson in "L'Astronomie" and subsequently

reprinted in separate form, viz, "Les différentes formes de halo et leur observation" (Paris, 1911).

The psychological effects of weather and climate are discussed at length in W. Hellpach's "Die geopsychischen Erscheinungen" (Leipzig, 1911).

That meteorology is being widely introduced into the curricula of German schools is indicated by the fact that a work on the teaching of this science, "Der wetterkundliche Unterricht," by F. Linke & J. Clöossner (Frankfurt a. M., 1912), went through three editions during the year.

The following climatological and climatographical publications may be noted: L. C. W. Bonacina, "Climatic Control" (London, 1911); F. Eredia, "Il clima di Roma" (Rome, 1911) and "Climatologia di Tripoli e Bengasi" (Rome, 1912); E. Grohmann, "Das Klima im Königreich Sachsen (Dresden, 1911); M. Hall, "The Rainfall of Jamaica" (Kingston, 1911); H. E. Hamberg, "Les pluies en Suède" (Upsala, 1911); A. Knox, "The Climate of the Continent of Africa" (London, 1911); and O. Rubel, "Das Klima von Baden-Baden" (Strassburg, 1911).

Arrangements were made during the year with the Library of Congress to take over "second copies" of copyright deposits in certain cases, in accordance with a general scheme recently inaugurated for the transfer of such material to Government libraries. However, very little of the available material has thus far been found to be of value to this bureau.

The policy noted last year of strengthening the libraries at Weather Bureau stations has been continued. A new undertaking in this connection was an arrangement made to supply the stations with the current files of important meteorological journals. A system of routes has been worked out, so that the Quarterly Journal of the Royal Meteorological Society is now seen regularly at all stations of the bureau and permanently deposited at the more important stations. Similarly, the Meteorologische Zeitschrift is now routed regularly to a number of stations where it can be used to advantage.

EXAMINATIONS FOR PROMOTION.

The total number of examination papers received and rated during the year was 352, as compared with 295 during the preceding year. Following is the record in detail:

Subject.	1911		1912		Total.	Passed.	Failed.
	August.	November.	February.	May.			
English grammar	11	16	13	18	58	39	19
Arithmetic	9	10	11	19	49	39	10
Elementary meteorology	7	16	10	16	49	42	7
Essay writing	11	11	9	14	45	30	15
Algebra	7	10	13	12	42	32	10
Physics	8	6	6	7	27	27	0
Trigonometry	9	6	6	11	32	29	3
Astronomy	3	3	3	6	15	14	1
Plant physiology	3	5	2	6	16	15	1
Advanced meteorology	1	5	5	8	19	17	2
Total	69	88	78	117	352	284	68

TELEGRAPH DIVISION.

Besides performing the routine daily telegraph work at the central office of the Weather Bureau, this division audits all accounts of the bureau for telegraph and telephone service, amounting to more than a quarter of a million dollars annually. The services performed by the various telegraph and telephone companies in collecting and distributing weather reports, forecasts, and warnings have been satisfactory throughout the year.

Except for temporary interruptions, the several sections of the Weather Bureau telegraph and telephone lines were in continuous operation during the year. The cable of the Block Island-Narragansett section, extending from Block Island to Narragansett Pier, was broken about 4 miles from shore by the anchor of a passing schooner during a 60-mile gale on December 29, 1911. Repair work was begun on January 18, 1912, and two days later communication was restored between Block Island and the mainland. The total cost of repairs was $1,302.35.

Communication was interrupted at intervals on the Norfolk-Hatteras lines, but only one special observation was missed on account of line trouble. Since the substitution of cross arms for brackets at various points along this line its working condition has been materially strengthened and less line trouble has been experienced than heretofore. A new two-conductor cable was laid across New Inlet, N. C., October 8, 1911, replacing the worn-out and defective cable. Splice work on the Manteo cable during the year cleared it of long-standing trouble.

The Life-Saving Service has rendered valuable assistance in making minor and temporary repairs to the Weather Bureau line during the year.

The public receives marked benefit from the Weather Bureau line in this section through the transmission of meteorological observations, storm warnings, and vessel reports, as well as commercial messages. During the aviation meet at Kill Devil Hill in October nearly 50,000 words of press matter were sent over the seacoast line from Manteo to the various newspapers of the country.

The submarine cable from Key West to Sand Key, Fla., has worked satisfactorily throughout the year.

The operations of the Alpena, Thunder Bay, and Middle Island, Mich., section have been satisfactory, and no general repairs have been made during the year. These lines are of inestimable value to maritime interests through the display of warnings that is secured on Middle and Thunder Bay Islands, the most important points for that purpose on Lake Huron, and the benefits given by the Weather Bureau through their maintenance are appreciated by the vessel interests.

The seacoast telephone line between Point Reyes and San Francisco is in need of considerable repair. Funds have been authorized for the most urgent repairs, and the line will be placed in good condition during the coming year.

The line of the Port Crescent-Tatoosh section continues to be of great benefit to the shipping and fishing interests on Puget Sound. Our shipping reports are watched closely in Seattle, Tacoma, Port Townsend, and San Francisco, to which points are furnished three daily reports of weather and shipping and special reports of inbound

shipping. Special reports of weather and of shipping bound for British Columbia ports are also furnished to Victoria, British Columbia. The opening of new salmon industries at Neah Bay, where about 2,000 fishermen, manning 350 or 400 fishing launches, make their headquarters during the salmon season, has largely increased the commercial business handled over this line.

The total line receipts collected during the year at stations on the seacoast telegraph lines were $2,998.49, which amount has been deposited in the Treasury of the United States.

PUBLICATIONS DIVISION.

This division has kept the stations fully supplied with the necessary blank forms, maps, and forecast cards, and continued the preparation and distribution of the Monthly Weather Review, the Bulletin of the Mount Weather Observatory, the National Weather Bulletin, the Snow and Ice Bulletin, the Washington edition of the daily weather map, and the Meteorological Charts of the Oceans.

There were published during the year 500 copies of Bulletin No. 39, "A Course in Meteorology and Physical Geography"; 2,500 copies of Bulletin No. 40, "The Relation Between the Precipitation Over the Watershed of the Ohio River Above and the Stream-Flow at Cincinnati"; and 2,500 copies of Bulletin No. 41, "Forecasting Frost in the North Pacific States." Also, there were reprinted 2,000 copies of Bulletin V, "Frost Data in the United States."

Binding was well advanced, including reviews and maps to date, and about 1,280 volumes nearly equally divided between the library and the Climatological Division, in both of which there had been large accumulations. The lithographic work was increased somewhat, chiefly by a larger issue of the Meteorological Charts of the Oceans and additional matter published therein.

DIVISION OF SUPPLIES.

In addition to its routine duties this division is charged with the purchase and inspection of all supplies for the central office and stations, including the preparation of specifications for articles not obtainable under the General Supply Committee's contracts.

Ten additional stations were equipped during the year with new stereotyping outfits for commercial map castings, making a total of 60 new outfits in actual use at the present time. This number does not include stations that were equipped with the old-style outfits prior to 1910 or stations where the commercial maps are produced by other processes.

With the assistance of the drafting room a new pattern for the outlines of the large glass maps was prepared in this division. This has added materially to their accuracy and general appearance. Detailed specifications for the construction and color scheme of these maps were also prepared, printed copies of which, together with blue prints of the new map pattern, have been supplied to such manufacturers as were invited to bid on furnishing and installing the maps. Through competition thus secured among art-glass manufacturers the average cost of glass maps has been reduced from about $350 to less than $200. Seven new glass maps were installed during the year—one each at Chicago, San Antonio, Seattle, New Orleans, Tampa, Evansville, and Fort Wayne.

OBSERVATORY BUILDINGS.

The new observatory building at Sand Key, Fla., which was completed early in December, 1911, is constructed of concrete, and has a foundation of concrete piles driven into the solid rock. It was designed and constructed to withstand the hurricanes that occasionally visit that region, the building that previously occupied the site having been destroyed by one of these storms.

The observatory building at Key West, Fla., which is to replace the one that was so badly damaged by the hurricane of October 11, 1910, as to make a new structure necessary, is well under way and will probably be ready for occupancy by December 1. This building has a massive concrete foundation and a superstructure of terra-cotta tiles and concrete and is designed to withstand the action of wind and waves that accompany the hurricanes of that region.

The following table shows where the buildings owned by the Weather Bureau are located, the fiscal year in which they were erected, and the cost of the building and ground in each case:

Buildings owned by the Weather Bureau.

Location.	Erected.	Cost of ground.	Cost of buildings.	Total cost.
Abilene, Tex	1909	$2,000.00	$12,841.81	$14,841.81
Amarillo, Tex	1903	1,255.00	6,503.00	7,758.00
Anniston, Ala	1907	1,799.75	12,920.69	14,720.44
Atlantic City, N. J	1902	(1)	5,991.00	5,991.00
Bentonville, Ark	1906	500.00	5,119.90	5,619.90
Birmingham, Ala	1907	[2] 61.50	15,630.36	15,691.86
Bismarck, N. Dak	[3] 1899	(1)	10,085.99	10,085.99
Block Island, R. I	1904	1,034.50	7,668.25	8,702.75
Burlington, Vt	1906	[2] 20.00	10,043.50	10,063.50
Canton, N. Y	1909	[2] 1.35	14,135.20	14,136.55
Cape Henry, Va	1902	(1)	9,222.45	9,222.45
Charles City, Iowa	1907	3,036.75	9,338.47	12,375.22
Columbia, S. C	1905	3,799.00	9,165.00	12,964.00
Devils Lake, N. Dak	1904	2,209.05	7,431.50	9,640.55
Dodge City, Kans	1909	2,050.00	10,837.62	12,887.62
Duluth, Minn	1904	2,041.70	7,430.68	9,472.38
East Lansing, Mich	1909	[2] 11.35	12,781.04	12,792.39
Hatteras, N. C	1902	[1] [4] 217.00	4,889.75	5,106.75
Havre, Mont	1904	1,795.00	5,087.08	6,882.08
Iola, Kans	1907	2,241.25	9,730.94	11,972.19
Jupiter, Fla	1902	(1)	6,346.90	6,346.90
Key West, Fla	1903	2,020.00	[5] 14,844.50	16,864.50
Kittyhawk, N. C	[3] 1902	(1)	1,616.00	1,616.00
La Crosse, Wis	1907	3,523.50	12,276.24	15,799.74
Modena, Utah	1903	(1)	4,346.00	4,346.00
Mount Weather, Va.:				
Administration building	1909	1,863.15	48,035.26	49,898.41
Machine shop and balloon shed	1904	650.00	8,167.00	8,817.00
Central heating and power plant	1909	(1)	11,964.74	11,964.74
Absolute building	[6] 1906	(1)	7,000.00	7,000.00
Variation building	[6] 1906	(1)	8,904.55	8,904.55
Stable	1903	(1)	1,900.00	1,900.00
Barn	1905	(1)	900.00	900.00
Cottage for workmen	[8] 1905	(1)	1,300.00	1,300.00
Physical laboratory	[7] 1909	(1)	37,521.51	37,521.51
Cottage and office	[8] 1909	(1)	11,246.34	11,246.34
Nantucket, Mass	1905	(9)	4,728.53	4,728.53
Narragansett Pier, R. I	1904	4,151.75	8,036.50	12,188.25

[1] Government reservation.
[2] Donated; figures represent cost of title transfer.
[3] Remodeled.
[4] Additional ground purchased.
[5] Estimated cost of new building now in course of construction.
[6] Begun in 1905.
[7] Begun in 1903.
[8] Begun in 1907.
[9] Building and ground purchased as a whole.

Buildings owned by the Weather Bureau—Continued.

Location.	Erected.	Cost of ground.	Cost of buildings.	Total cost.
Northfield, Vt.	1909	[1] $101.00	$12,795.64	$12,896.64
North Head, Wash.	1902	(2)	3,820.13	3,820.13
North Platte, Nebr.	1906	(3)	3,818.50	3,818.50
Oklahoma, Okla.	1906	[1] 38.90	10,520.25	10,559.15
Peoria, Ill.	1905	[1] 54.00	7,875.50	7,929.50
Point Reyes Light, Cal.	1902	(2)	2,875.00	2,875.00
Port Crescent, Wash.	1902	102.00	730.94	832.94
Richmond, Va.	1909	[1] 8.75	15,489.01	15,497.76
St. Joseph, Mo.	1909	5,040.95	16,882.80	21,923.75
Sand Key, Fla.	1903	(2)	14,991.39	14,991.39
Sault Ste. Marie, Mich.	1899	(2)	2,994.12	2,994.12
Sheridan, Wyo.	1907	2,021.75	12,089.30	14,111.05
Southeast Farallon, Cal.	1903	(2)	5,211.22	5,211.22
Springfield, Ill.	1906	(2)	10,236.50	10,236.50
Tatoosh Island, Wash.	1902	(2)	5,000.00	5,000.00
Washington, D. C.	.....	(3)	174,950.76	174,950.76
Yellowstone Park, Wyo.	1904	(2)	11,156.00	11,156.00
Yuma, Ariz.	[4] 1903	(2)	1,500.00	1,500.00
Total	.....	43,048.95	688,825.39	732,574.34

[1] Donated; figures represent cost of title transfer.
[2] Government reservation.
[3] Building and ground purchased as a whole.
[4] Remodeled.

Buildings rented by the Weather Bureau for living and observatory purposes.

Station.	Annual rent.	Other items included.
Alpena, Mich.	$650	Heat, light, water.
Cape May, N. J.	400	Water.
Clallam Bay, Wash.	120	Do.
Del Rio, Tex.	444	Heat, light, water.
Durango, Colo.	318	Water.
Honolulu, Hawaii.	1,020	Six rooms; heat, cleaner, light, janitor and porter service, electric current for fan, storage.
Independence, Cal.	456	Water for domestic and irrigation purposes, and the trimming and care of all trees on the premises.
Kalispell, Mont.	360	
Lewiston, Idaho.	540	
Manteo, N. C.	144	
Moorhead, Minn.	420	Seven rooms; heat, light, water.
Mount Tamalpais, Cal.	420	Heat, light, water, and the free transportation of Government employees and supplies.
Pysht, Wash.	144	Water.
Roseburg, Oreg.	550	Heat, light, water.
Roswell, N. Mex.	720	Heat, light, cleaner.
San Juan, P. R.	300	Five rooms.
Thomasville, Ga.	420	
Tonopah, Nev.	840	
Twin, Wash.	132	Water, and water-pipe system in building.
Winnemucca, Nev.	480	Heat, light, water.
Total	8,878	

PERSONNEL OF THE BUREAU.

The numerical strength of the Weather Bureau at the close of the year was 9,992, as compared with 9,483 at the end of the preceding twelve months. Of the total number, 7,830, or more than 78 per cent, are cooperative observers who serve without compensation other than that received through the free distribution of Government publications. There were 440 more of this class of employees than at the close of the preceding year, due to the extension of the service in various ways, the greatest increase being in the number of cooperative marine meteorological observers.

The total number of commissioned employees at the end of the year, 808, was 32 more than at the close of the preceding year. The central office force was increased by 11, much needed additional assistance having been provided for by an increase in the number of statutory positions in the appropriation bill for 1911–12. The field force was increased by 21 because of extensions of the service, mainly in the West and Southwest. The transfer of new assistant observers from the central office to Mount Weather, Va., for instruction nominally increased the force at the latter station. It was found possible to reduce the working force of five stations by one employee each, allowing a corresponding strengthening of the personnel at five other stations where the demands on the service had greatly increased.

The number of permanent appointments in the classified service, including transfers and reinstatements, was 122, or 46 more than during the preceding year. The temporary appointments numbered 58, or 31 more than in the previous year.

Mention was made in the last annual report of the difficulty experienced in retaining new assistant observers because of the low entrance salary ($720 per annum) and the temptation presented to young men possessing the requisite education and qualifications to engage in other employment giving more lucrative immediate returns. New assistant observers are now given promotion to $840 per annum after six months' satisfactory service. This has had the effect of materially reducing the number of resignations of that class of employees, and should enable the bureau to secure a better grade of men.

There were 276 promotions in the classified service during the year. All but one, which was a restoration to a position formerly held, were to the next higher grade or by civil service certification for advancement from subclerical positions. The considerable increase of the number of promotions as compared with the previous year was due partly to enlarged appropriations, which made possible the advancement of deserving employees, and partly to the transfer of many positions from the miscellaneous to the statutory roll on July 1, 1911, which required the immediate advancement of other employees following a vacancy in a higher grade.

In the classified service there were 59 voluntary resignations, 11 less than during the previous year. There were 5 forced resignations and 4 removals from the classified service, compared with 9 and 12, respectively, during the previous year.

Of the 114 probationary appointees, only 1 failed to complete successfully the six months' probationary period.

There were 9 reductions in the classified service: 7 for causes in no way reflecting upon the character or ability of the employees, and 2 because of physical disability.

In the unclassified service there were 2 permanent and 4 temporary appointments, 5 promotions, 1 reduction, and 1 resignation.

The absence record for the year shows that station employees took a little more sick leave than during the preceding year, while central office employees took a little less. With respect to annual leave, the amount taken by station employees was practically the same as last year; at the central office, the male employees had an average of 3.9 days more and the female employees an average of 0.7 of a day less. For the entire service, the amount of sick leave was the same as dur-

ing the previous year, and the average annual leave was 0.8 of a day more.

There were five deaths in the commissioned force during the year.

CHANGES IN THE FORCE OF THE BUREAU.

CLASSIFIED SERVICE.

Appointments:	
Probationary—	
Printer, at $1,000	1
Clerks, at $900	2
Copyists, at $840	2
Skilled artisans, at $840	4
Assistant observers, at $720	29
Copyists, at $720	3
Repairmen, at $720	3
Firemen, at $720	2
Messenger boy, at $480	1
Messenger boys, at $450	7
Skilled laborers, at $450	4
Messenger boys, at $360	56
	114
Permanent—	
Station agents, at $300	3
Student assistant, at $300	1
	4
By transfer—	
Clerk, at $1,200	1
Copyist, at $840	1
	2
By reinstatement—	
Messenger, at $600	1
Messenger boy, at $360	1
	2
Temporary—	
Compositors, at $1,250	2
Printers, at $1,000	2
Clerk, at $900	1
Repairmen, at $720	4
Messenger boy, at $480	1
Skilled laborer, at $450	1
Messenger boys, at $360	46
Student assistant, at $300	1
	58
Promotions (all promotions except 1 were to the next higher grade or by certification for advancement from subclerical positions)	276
Reductions:	
Causes—	
To grant assignment to preferred station	4
As an offset to the bureau for allowance of quarters, fuel, and lights	1
To conform to provisions of appropriation bill	2
Physical disability	2
	9

Resignations:	
Voluntary	59
Required because of—	
Unsatisfactory service	1
Unsuited for Weather Bureau service	2
Disobedience of instructions	1
Physical disability	1
	64
Transferred to other bureaus of the Department of Agriculture	4
Removals:	
Causes—	
Neglect of duty	1
Absence without authority	1
Falsification of records and harsh treatment of subordinates	1
Insubordination	1
	4
Services terminated (student assistants)	2
Dropped from the rolls at termination of probationary period because of unsatisfactory service	1
Deaths	4

UNCLASSIFIED SERVICE.

Appointments:	
Permanent—	
Unskilled laborer, at $720	1
Charwoman, at $240	1
	2
Temporary—	
Unskilled laborers, at $450	4
Promotions (all to the next higher grade)	5
Reduction:	
Cause—	
Not competent to perform duties of higher grade	1
Resignation (voluntary)	1
Death	1

ABSENCE.

Average number of days per employee during calendar year 1911.

	Sickness.	Annual leave.
Station (99 per cent males)	1.9	6.9
Washington, D. C.:		
Males	3.5	27.3
Females	9.2	26.6
Entire service	2.4	12.0

STATISTICS OF THE SERVICE.

The following tables show the numerical strength of the bureau, and the highest, lowest, and average salaries paid in the commissioned grades:

Numerical strength of the Weather Bureau, June 30, 1912.

At Washington, D. C.:		
Classified	184	
Unclassified	12	
		196

Outside of Washington, D. C.:		
Classified	607	
Unclassified	5	612
Total commissioned employees		808
Additional employees outside of Washington, D. C.:		
Storm-warning displaymen	186	
River observers	406	
Cotton region observers	104	
Corn and wheat region observers	124	
Rainfall observers	81	
Sugar and rice region observers	7	
Special meteorological observers	66	
Special cranberry-marsh observers	8	
Special snow and ice observers	4	
Mountain snowfall observers	271	
Marine meteorological observers	30	
Cotton region and river observers	27	
Corn and wheat region and river observers	9	
Sugar and rice region and river observers	2	
Cotton region and rainfall observers	19	
Corn and wheat region and rainfall observers	7	
Cotton region and special meteorological observer	1	
Special meteorological and river observer	1	
Corn and wheat region and mountain snowfall observer	1	
Total noncommissioned employees		1,354
Total paid employees		[1] 2,162
Persons serving without compensation (except through the distribution of Government publications):		
Cooperative observers and correspondents (omitting 388 paid observers enumerated elsewhere)	5,119	
Cooperative storm-warning displaymen	105	
Cooperative river observers	16	
Cooperative rainfall observers	12	
Cooperative mountain snowfall observer	1	
Cooperative special meteorological observers	24	
Cooperative special cranberry-marsh observer	1	
Cooperative marine meteorological observers	2,552	
Total cooperatives		7,830
Total numerical strength		9,992

Distribution of the commissioned force, June 30, 1912.

In Washington, D. C.:	
Accounts Division	[2] 15
Climatological Division	17
Executive branch	18
Forecasting	1
Instrument Division	11
Library	5
Division of Observations and Reports	27
Observatory	1
Publications Division	25
River and Flood Division	3
Supplies Division	[2] 11
Telegraph Division	12
Verification section	2

[1] This total embraces all paid persons connected with the bureau on June 30, 1912, except 13 commissioned employees absent on that date and who had been granted leaves of absence or furlough without pay for one month or more.

[2] One employee devotes a portion of his time at one of the map stations at the United States Capitol.

In Washington, D. C.—Continued.	
Drafting room (under direction of the chief clerk)	4
Heat, light, and power plant (under direction of the chief clerk)	7
Miscellaneous mechanical work (under direction of the chief clerk)	7
Watch force (under direction of the chief clerk)	5
General messenger and laborer service (under direction of the chief clerk)	25
Total	196
Outside of Washington, D. C.:	
53 stations with 1 commissioned employee	53
42 stations with 2 commissioned employees	84
52 stations with 3 commissioned employees	156
17 stations with 4 commissioned employees	68
17 stations with 5 commissioned employees	85
6 stations with 6 commissioned employees	36
4 stations with 7 commissioned employees	28
3 stations with 8 commissioned employees	24
1 station with 9 commissioned employees	9
3 stations with 10 commissioned employees	30
1 station with 14 commissioned employees	14
1 station with 25 commissioned employees	25
200 stations	[1] 612

In addition to the foregoing there are eight special observing (one man) stations in the West Indies, mainly in operation during the hurricane season, and a special repair station in Washington operated from October to April, inclusive.

The following salary table omits persons on duty at special observing and substations where the salaries are $25 a month or less, and where, as a rule, the tour of duty covers but a small fraction of the day and only certain seasons of the year:

Salaries paid in the commissioned grades.

	June 30, 1912.	
	Stations.	Washington, D. C.
Classified grades:		
Highest salary	$3,500	$6,000
Lowest salary	300	450
Average salary	1,047	1,193
Unclassified grades:		
Highest salary	720	720
Lowest salary	480	240
Average salary	552	540

Average salary of all (station and Washington) is $1,070.

[1] This represents the normal station force. On June 30, 1912, there were actually on duty 612 employees.