U.S Weather bureau.

U. S. DEPARTMENT OF AGRICULTURE.

REPORT [administrative]

OF THE

CHIEF OF THE WEATHER BUREAU

FOR

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WILLIS L. MOORE.

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National Oceanic and Atmospheric Administration
Report of the Chief of the Weather Bureau

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REPORT OF THE CHIEF OF THE WEATHER BUREAU.

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU,
Washington, D. C., October 4, 1904.

SIR: I have the honor to submit a report of the operations of the Weather Bureau during the fiscal year that ended June 30, 1904.

Respectfully,

WILLIS L. MOORE,
Chief of Weather Bureau.

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR, WITH RECOMMENDATIONS.

PRACTICAL VALUE OF FORECASTS AND WARNINGS.

Weather forecasts for thirty-six and forty-eight hours in advance have been made daily throughout the year for each State and Territory, and special warnings of gales on the seacoasts, Gulf, and Great Lakes, and of cold waves, frost, heavy snows, floods, etc., have been issued when the advices were calculated to benefit commercial, agricultural, and business interests. The North Atlantic and West Indian storm-warning service was continued, and forecasts for the first three days out of steamers bound for European ports were issued daily at 8 a. m. and 8 p. m. In a number of instances European shipping interests were notified of the character and probable course of severe storms that were passing eastward from the American coast.

A WEST INDIAN HURRICANE.

The first important tropical storm of the year moved from the Windward Islands of the West Indies over the Caribbean Sea and the Gulf of Mexico from August 8 to 15, 1903. The vortex of this storm passed over or near the island of Martinique during the night of the 8th–9th, reached Jamaica on the morning of the 11th, crossed the Cayman Islands during the evening of the 11th, advanced over northern Yucatan on the 13th, and apparently dissipated on the Mexican coast of Tamaulipas during the 15th. Except during its passage over Jamaica the center of this hurricane did not come within the region of observation. Beginning with the first indications of its appearance near the Windward Islands, however, shipping interests and West Indian sta-

tions were advised daily regarding its character and probable course. At Kingston, Jamaica, the barometer fell to a minimum of 28.80 inches, and on the island the losses to owners of banana plantations were estimated at more than 500,000 pounds sterling, and the destruction to houses, property, and plantations was appalling. At Grand Cayman Island a minimum barometer reading of 28.30 inches was recorded in the harbor of Georgetown, and of 23 vessels in the harbor but one was saved. Every tree or plant on the island was either blown away or had its leaves and small branches stripped off, crops were entirely destroyed, and about 200 houses were blown down or unroofed. Reports from vessels that encountered the storm in the Gulf of Mexico show that it diminished rapidly in intensity after passing westward from the Caribbean Sea.

VESSELS SAVED FROM A BAHAMA STORM.

In September, 1903, two storms of marked intensity advanced from the subtropical region north of the West Indies to the Atlantic coast of the United States. The first of these storms appeared over the Bahamas on the morning of the 10th, advanced north of west over the southern point of Florida by the morning of the 12th, moved northwestward over the eastern part of the Gulf of Mexico during the 12th and 13th, after which it diminished in intensity and finally dissipated over the South Atlantic States. At Nassau, New Providence Island, Bahamas, the wind reached an estimated velocity of 90 miles an hour, and at Cat Bay, Bahamas, a minimum barometer reading of 28.30 inches was reported. During its progress over Florida and the Gulf, the storm destroyed property to the value of $100,000 from West Palm Beach to Miami, Fla., and 9 lives were lost by the stranding and breaking up of the British steamer *Inchulva* at Delray. The steamer and cargo were valued at $350,000. Other marine losses amounting to about $20,000 were reported on the eastern Florida coast. At Tampa, Fla., the barometer fell to 29.42 inches, the wind blew in squalls at a rate of 50 to 60 miles an hour, buildings were destroyed or damaged to the extent of about $200,000, and great havoc was wrought in the orange groves of the surrounding country.

The warnings and advices issued in connection with this storm permitted all possible precautions to save exposed property, and comparatively little damage was caused to vessels.

Mr. C. E. Garner, president of the Jacksonville Board of Trade, has written as follows regarding the warnings:

> I wish to express my appreciation of the timely warnings given by the Weather Bureau both at this point and at Tampa during the recent West Indian hurricane. They were especially valuable at Tampa, as I have steamers operating from that point to Manatee River and Terra Cela Bay points, and the notice we had from the Weather Bureau prevented our leaving port on Saturday, the 12th. The observer at Tampa kept us fully advised as to the situation there, and his warnings to vessels not to leave port, in my judgment, prevented serious disasters. I think it is very fortunate for the agricultural and shipping interests of this State that we have such an efficient service of the Weather Bureau, and that the service is in the hands of such capable and accommodating officials.

The Tampa Evening Herald of September 15 comments editorially regarding the storm, and says, in part:

> Too much credit for the saving effected can not be given to the Weather Bureau, and it is the intention of this article to direct public attention seriously toward one of the most valuable of the Government branches in this city.

The Weather Bureau observer at Jacksonville, Fla., reports that there is no doubt that a large amount of property and a number of lives were saved by the timely display of the storm warnings. During the displays ten vessels, the approximate value of which was one-quarter of a million dollars, remained in port at Jacksonville, and three vessels, valued at $135,000, at Fernandina. Sponge and fishing vessels, valued at nearly $200,000, and employing hundreds of men, remained in ports along the Florida coast, and the display of warnings undoubtedly saved many of these vessels and their crews. The observers at Tampa and Pensacola gave the widest possible distribution of the warnings, and state that they were, as usual, well heeded.

On September 16 a severe storm of small area advanced from the Atlantic Ocean and moved northward along the middle Atlantic coast, causing the loss of a number of lives and some destruction of crops and seaside property. Owing to the unusual character and course of this storm its indications did not result in a display of warnings until the morning of the 16th.

WARNING OF PACIFIC COAST GALES.

The severest storm of the year on the Pacific coast occurred on the night of March 9–10, 1904, when barometric pressure was below 29 inches on the Washington and Oregon coasts. The gales that attended this storm were severe from British Columbia to San Diego, Cal., and heavy rain fell in the coast districts and heavy snow in the mountain regions of the North Pacific States.

The Humboldt Standard, Eureka, Cal., of March 10, 1904, remarks as follows regarding the work of the Weather Bureau in connection with this storm:

One of the most violent storms that ever occurred on the coast of northern California was heralded yesterday morning by the display of southeast storm warnings at the local Weather Bureau station. The warnings were ordered up by District Forecaster McAdie twelve hours before the storm struck this city. All of the shipping in the bay having ample notice from the Weather Bureau there was no damage to vessels, all shipping being securely tied up, with no vessels at anchor.

SPECIAL FORECASTS OF SNOW.

The following are some of the special snow warnings that, in addition to the regular forecasts, were issued for the benefit of transportation interests:

January 2, 1904: Snow will be heavy in the interior of New York and New England this afternoon and to-night, with high northeast shifting to northerly winds.

January 26, 1904: Heavy snow indicated for the interior of New York and New England during next twenty-four hours, with high southerly shifting in New York to much colder northwest winds to-night.

April 15, 1904: Heavy snow and high easterly shifting to northerly winds indicated for the lower Lake region to-night.

SAVINGS BY COLD-WAVE AND FROST WARNINGS.

The following comments have been made regarding cold-wave and frost warnings:

[The Daily Picayune, New Orleans, La., November 19, 1903.]

Sugar planters have been warned by the Weather Bureau to prepare for temperatures as low as 25°, and reports received seem to indicate that they are acting in

accordance with the warnings, and protecting the cane crop. A temperature of 25° so early in the season would damage the cane crop to the extent of millions of dollars unless protection is accomplished. Since sugar cane grows richer in sugar content with every day that it is allowed to grow, many planters cut their cane only as fast as they can manufacture sugar. In some seasons grinding is completed without a freeze, and the cane harvested at the close of the season gives much greater production than that harvested at the opening. With a feeling of certainty that he will be warned by the Weather Bureau of an approaching freeze in time to enable him to protect his crop, the planter lets his cane grow until warned by the United States Weather Service to protect his crop. The Weather Bureau has in the past saved millions of dollars to the sugar planter, for there has not been a freeze in recent years but what the lowest temperature which occurred has been announced in warnings issued twenty-four to thirty-six hours in advance of its occurrence.

[The Savannah News of January 7.]

When the first intimation of the cold wave's approach was received at the Weather Bureau word was at once sent to florists and they were warned to have their fires up. These were immediately started, and when the wave reached here flowers were well protected.

[The San Francisco Call of January 20, 1904.]

Reports to-night from correspondents stationed throughout the orange districts of southern California are to the effect that the frost this morning did little damage to the citrus crop, which is now practically ready for market. Having received special warnings from the Weather Bureau, hundreds of ranchers resorted to smudging this morning and thereby removed all danger to their crops.

[The San Francisco Chronicle of March 20, 1904.]

The farmer shares equally with the merchant the advantages of Weather Bureau warnings, and every year this service increases in efficiency and value. Many millions of dollars have already been saved by the fruit growers of California by timely warnings sent out, enabling citrus growers to protect their crops against frost, and the raisin, prune, and apricot growers to stack their trays of drying fruit before overtaken by rain.

[The Daily States, New Orleans, La., March 4, 1904.]

The warnings of the United States Weather Bureau were, as usual, timely and accurate, and they enabled the protection of berry crops and truck gardens, and have thus saved thousands of dollars to the farming interests.

[The Advertiser, Montgomery, Ala., March 5, 1904.]

The Weather Bureau's warning saved many thousand young cabbages and tomatoes which were exposed in cold frames, almost ready to transplant, and which would have been killed had warnings not been received. This item of benefit from the Bureau's warnings means $50,000 or more to the truckers of this section. Had these young plants been killed, an entire new crop of early sets would have had to be started, which would make the vegetables too late to command lucrative prices in the Northern markets. The warning, verified to the degree, was far enough in advance to be of great benefit.

RIVER AND FLOOD SERVICE.

PROGRESS IN WORK AGAINST ICE PACKS AND FLOODS.

Happily the floods of the year did not nearly approach in character and importance the great overflows of the spring of the year immedi-

ately preceding, with their destruction of over 100 human lives and property valued approximately at over $40,000,000. There were, nevertheless, severe floods at various times, and in the management of the work occasioned by them the river and flood service continued to demonstrate its usefulness and growing efficiency as a valuable branch of the Weather Bureau. That there has been a constant increase in the accuracy of its work is evidenced by the more specific and detailed character of the forecasts and warnings in localities where such refined work had heretofore been considered practically impossible. The service performed during the prevalence of the great winter ice gorges in the Susquehanna, Allegheny, and Ohio rivers, with their attendant floods, was especially noteworthy. These gorges were the greatest in the history of the localities, and that their great dangers were minimized is due in no small degree to the timely advices and warnings of the Weather Bureau.

There were minor floods during nearly every month of the year, but each was amply covered by timely warnings. These floods were not in any sense alarming or dangerous, but they nevertheless attained sufficient importance to endanger a large amount of property, which without the benefit of the Weather Bureau advices and warnings would have been totally lost. As a matter of fact, considerable damage was done by these small floods, principally to growing crops which, of course, could not be protected, but the value of property saved by removal and otherwise was not far from $1,000,000.

ICE GORGES IN PENNSYLVANIA.

The great floods of the year were caused by the enormous ice gorges that formed in December in the Ohio and Susquehanna rivers, and continued during January in the Ohio and until late in March in the Susquehanna. The latter gorge was easily the greatest in our recorded history, the nearest approach to similar conditions having occurred in the same locality twenty-nine years before. From a short distance below Wilkesbarre, Pa., almost to the mouth of the river, a distance of 180 miles, there was practically a solid wall of ice, filling the river from bank to bank, and extending into the West Branch and Juniata rivers far up to their sources in the Alleghenies. In the North Branch of the Susquehanna, from Beach Haven to Sunbury, there was an unbroken mass of ice 40 miles in length and from 15 to 25 feet in height, much of it resting upon an entirely dry river bed. The floods caused by the gorges were very destructive. Towns, villages, farms, and railroad tracks were covered with masses of ice many feet in thickness, and bridges—some of them enormous steel structures—were moved from their piers. Below Harrisburg the destruction was even greater, although, owing to the wider channel, the ice was not piled so thick. Flood waters, carrying enormous masses of ice, were responsible for the major portion of the damage. At Middletown, Pa., the water reached a stage of 34.5 feet, the highest on record, and 5 feet higher than that of June 2, 1889, memorable as the period of the great Johnstown disaster. Some idea of the immensity of the gorges may be afforded by the statement that as late as May 20, 1904, ice in considerable quantities was seen in the Susquehanna River between Harrisburg and York Haven, Pa.

WARNINGS ON THE OHIO RIVER.

The Ohio River situation was equally unparalleled and almost equally grave, but very fortunately it was relieved without serious incident after a series of trying experiences and a prolonged period of apprehension. At Pittsburg the water reached a stage of 30 feet—8 feet above the danger line—and the official in charge of that station, with his corps of assistants, was compelled to remain on duty for forty-eight consecutive hours to receive reports from substations, issue warnings and advices, and furnish information to the public. Over 2,000 telephone calls were received and answered during that time. The Cincinnati situation was another that required the exercise of the best judgment as well as unremitting attention, the critical time coming when the ice gorges began to move. Elaborate preparations had been made for this event and its passage found no one unprepared.

It can readily be seen that these situations were such as to require the exercise of the best possible judgment, combined with the utmost vigilance and caution. The officials in charge of the districts were constantly on duty, day and night, during the critical periods. Every effort was made to keep the people over the districts thoroughly alive to the extreme danger and gravity of the situation, and to the success of these efforts may be attributed the extremely gratifying fact that there is no record of the loss of even a single human life during a period of such imminent danger. The property loss was very heavy, but there were no losses that could have been averted. The people had been thoroughly prepared and every possible precaution was taken.

LOWER MISSISSIPPI PROBLEMS.

The lower Mississippi flood of the spring of 1904 was not remarkable. The usual warnings were issued one to two weeks in advance, and there were no abnormally high stages of water except at Memphis, where a stage of 39 feet was recorded, but 1.1 feet below the great high-water mark of the previous year. Some damage and inconvenience resulted, but the flood caused no great losses, and in a technical sense it afforded some extremely valuable contributions to our knowledge of the local régime of the Mississippi River.

The much-debated question as to the influence of the railroad embankment on Hopefield Point, opposite Memphis, in the apparent ponding of the waters of the Mississippi, has evidently been decided. The experiences of the last flood and that of the preceding year would seem to indicate that this water was not ponded, but that it was overflow water that had come through Reelfoot Lake district and was reentering the river.

It is also worthy of note that for the first time the St. Francis levee successfully withstood a severe flood.

EXTENSIONS OF THE RIVER AND FLOOD SERVICE.

Some extensions of the river and flood service have been made during the year. The Texas service was the first to be improved, the new service having begun promptly on July 1, 1903, with the addition of eleven reporting stations on the Sabine, Neches, Trinity, and Colorado

rivers. Four days later the first flood warning was issued for the Trinity River. The North Pacific district has also been much improved, and the service will doubtless prove much more satisfactory in the future. Some lesser extensions have also been made, and the field of operations has been broadened during the year as much as the limited appropriations available would permit; but much yet remains to be done in order that the service may be made commensurate with the demands upon it. Very fortunately Congress, with a realization of the importance of the work, has appropriated a substantial increase for the river and flood service, and in a short time a considerable number of new stations will be in operation.

Arrangements have already been completed for the inauguration of a new service over the Kansas River watershed, the scene of the memorable floods of May, 1903.

LONG-RANGE FORECASTS.

It is hoped the time will come when it will be possible to forecast the weather for coming seasons—to specify in what respect the coming month or season will conform to or depart from the weather that is common to the month or season—but that time has not yet arrived, and the officials of the Weather Bureau have been informed that they will best serve the public interests when they teach the communities they serve the limitations of weather forecasting and warn them against imposition.

It is the opinion of the leading meteorologists of the world that the public interests are injured by the publication of so-called long-range weather forecasts, especially by such predictions as relate to severe storms, floods, droughts, and other atmospheric phenomena of a dangerous or damaging character. The publication of monthly forecasts has reached such proportions that it is deemed advisable to inform the public as to their harmful character. Some long-range forecasters may be honest, and may, in their ignorance, attach undue importance to storms that accidentally coincide in time of occurrence with certain relative positions of the planets, or with changes in the phases and positions of the moon, or with periods of increase or decrease in sun spots or apparent variations in solar intensity. They may believe that they have discovered a physical law or a meteorological principle that has not been revealed to astronomers, meteorologists, or any other class of scientific investigators; but the publication of predictions that, by reason of their inaccuracy, are injurious to agricultural, commercial, and other industrial interests, casts a serious doubt upon the honesty of their makers. Such publications bring the science of meteorology into disrepute, and can not, therefore, be made in response to a desire to advance that science along useful lines; and they retard the work of the honest investigator through whose efforts only can such gains be made in the fundamental knowledge of the causation of weather as will justify the making of forecasts for a month or season in advance.

VERIFICATION OF LONG-RANGE FORECASTS.

As the result of personal verification of the work of long-range weather forecasters, some of whom have so far gained the confidence of

the rural press as to receive liberal compensation for their predictions, I am led to the conclusion that these forecasters do positive injury to the public at large.

Professors Garriott and Henry have personally verified much of the work of several of the most popular long-range forecasters, and much of what follows on this subject is extracted from a report recently rendered by Professor Garriott.

The proof of a forecast is in its verification. Measured by this standard, long-range weather forecasts have an experimental value only, a value that does not justify their employment in the actual work of forecasting for specified dates and places.

Meteorologists who have conceived theories for long-range forecasting, or who have tested theories advanced by others, have applied to the theories the test of facts that are presented by meteorological records, and the results have been negative. Men who issue fake forecasts have adopted an opposite method—they have carefully ignored and concealed facts, and have depended upon advertisements of occasional successes that will inevitably occur in any system of chance.

The success of a long-range weather forecaster is usually measured by the extent to which he can impose upon the credulous and the ignorant. As a rule it is impossible to subject the rambling and indefinite statements of the long-range weather forecasters to a verification. In the summer of 1903, however, one of these forecasters was induced to submit to the Weather Bureau some forecasts for verification. The forecasts consisted of an enumeration of certain dates around which "storms would cluster and develop great intensity." The periods, or dates, of maximum storm force, as given by the forecaster, appear in italics at the beginning of the six paragraphs next following, and a statement of the actual weather that occurred follows each date.

August 11, 1903: On this date there were no storms in any part of the United States and no extraordinary weather conditions were manifested at any point within the region of observation, except that a tropical disturbance of small diameter was apparently moving westward south of Jamaica, West Indies. As the forecast did not specify in what part of the Northern Hemisphere the storms would reach their maximum intensity, it can not be considered that the occurrence of this storm in any way verified the forecast.

August 24, 1903: On this date no evidence could be discovered of an increase in storm force, the usual stagnant summer conditions prevailing in all parts of the United States.

September 7, 1903: On this date the weather conditions were not unusual; there were no storms of marked energy in any part of the country. A disturbance covered the northern Rocky Mountain region and the upper Missouri Valley, but it moved northeastward and did not in any way affect the region to the eastward. There was nothing unusual in the disturbance above mentioned. A storm of considerable energy developed, however, in the vicinity of the Bahamas on September 10 and persisted in the vicinity of the Gulf region until the 15th. No mention was made of this disturbance in the forecast.

September 21, 1903: On this date likewise the usual weather conditions prevailed in all parts of the region of observation.

October 6, 1903: On this date a depression of considerable magnitude covered the eastern slope of the Rocky Mountains. It moved eastward

and developed into a severe storm on the Atlantic coast on the 9th and 10th, three days after the date set by the forecaster.

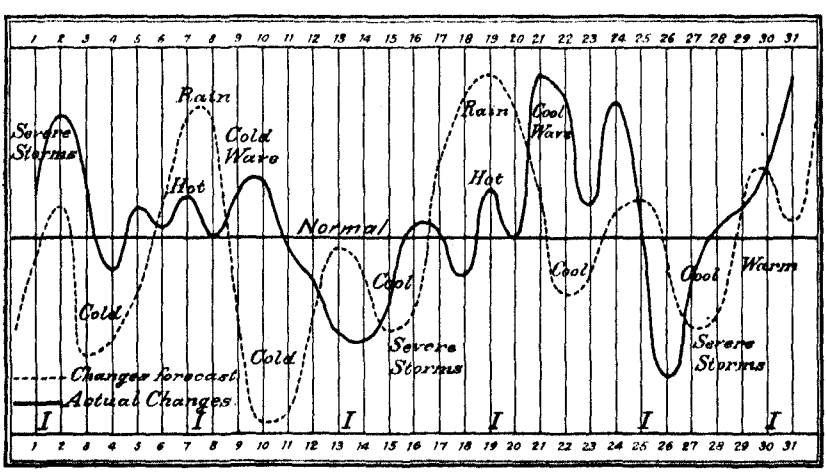
October 19, 1903: On this date the usual October weather prevailed in all parts of the United States. There was not the slightest evidence of increased storm energy on this date.

This is a plain statement of the weather conditions experienced on the dates when, according to the forecasts, the most severe storms of recent years were to occur. Let us quote one of the forecasts:

Clustering around September 7 and 21, October 5 and 20, will come some of the most severe storms of recent years. These will be so general all around the earth that I advise all to be on guard near the dates named. Storms miss 99 out of 100 places, but you will at least read of tornadoes, hurricanes, cloud-bursts, electrical storms, and seismic disturbances in nearly all sections where these sometimes occur.

Considerable time has already been devoted to an examination of forecasts of this character, and the results thus far show that the forecasters possess no knowledge that would justify them in the making of predictions.

The character of the work put forth by long-range forecasters is illustrated in the diagram below, which was made by one of those claiming the largest share of public attention. The central line is supposed to represent the normal temperature for March, 1904, and the dotted line indicates the changes forecast for that month. When the dotted line passes above the normal line warmer weather is indicated, and when it falls below the normal line colder weather is indicated. The original diagram from which the illustration reproduced below was taken does not show the amount of the expected temperature changes. In other words, it is conveniently left to the reader to determine the intensity of the hot wave or the cold wave scheduled for any given date. It is true that the crests of the warm waves and the cold waves are placed at different distances from the normal line, but the vital point, viz, the value of distance above and below the normal line, has been omitted.



MARCH, 1904, WEATHER CHART: The solid black wavy line, the word "normal," and the explanation in the lower left-hand corner were put upon the above chart by the Weather Bureau. All other matter, including the words "severe storms," "cold," "rain" "cold wave," "hot," "cool," etc., were copied from the original chart issued by this particular long-range forecaster. The dotted wavy line represents the temperatures predicted by him; the solid black wavy line the actual temperatures as recorded at St. Louis, Mo., a city on the ninetieth meridian.

The long-range forecaster says:

"In the above chart the letter I indicates the dates about which storm waves, "moving eastward, will reach meridian 90, which is about the same as the general "course of the Mississippi River. All weather events move eastward across the "continent and those marked on the chart are expected to reach meridian 90 about "the dates indicated. The straight, trebble,[a] horizontal line, running through middle "of chart, is the average temperature of March for many years past and the wave line "is temperature forecast for March 1904, showing where temperature is expected to "go above or below normal, indicating how warm or how cold it will be.

"*These weather charts are $1.50 a year; Weekly Bulletins $1.50 a year; 'What and "When to Plant and Sow,' $6.00 a year gives complete weather forecasts and advice; "Probable effects of weather on Chicago and New York market prices of grain and cotton "$3.00 a month.*"

I have superposed upon the original drawing a solid black line showing the actual daily departure of the temperature from the normal at St. Louis, Mo., longitude 90° 12′ west from Greenwich. The scale used in entering the temperature departures was 16 degrees to the inch, or 1 degree to each sixteenth of an inch. I have also reproduced verbatim the explanation that accompanied the so-called chart, except that I have had the closing paragraph printed in *italics*. It will be noticed that the relatively warm periods in the diagram are placed about five days apart, viz, on the 2d, 8th, 13th, 19th, 25th, and 29th, and the cold periods nearly a week apart thus, 3d, 10th, 15th, 22d, and 27th. The solid black line shows the temperature changes that actually occurred during the month.

Three "severe storm" periods are given, viz, on the 1st and 2d, 16th to 18th, and 28th to 30th. There were no severe storms during the month. The highest winds experienced were on the 10th, 42 miles, from the southwest; 22d, 42 miles, from the southwest, and 24th, 50 miles, from the west. The two last-named occurred in connection with thunderstorms and lasted but a short time. Not one of these high winds occurred on the dates assigned by the long-range forecaster.

To a long-range forecaster the occurrence of a thunderstorm or an electrical disturbance in some remote corner of the globe during one of his "storm periods" will fully justify his forecasts.

Forecasts of this character can be of no value to agricultural, commercial, or maritime interests. On the contrary, they are misleading, and, if given credence, are calculated to result in positive injury to property interests. As farmers, merchants, and mariners who keep pace with modern progress do not give credence to this class of forecasts the natural conclusion is that a long-range forecaster who receives remuneration from the press for forecasts submitted is simply catering to a class of readers who are deficient in a knowledge of the present status of popular science and who have no occasion to compare the forecasts with weather conditions that actually occur on the dates specified.

There is another long-range weather forecaster who draws his support from the American public who does not depart in any essential manner from the methods employed by the one above referred to. His statements are based upon a consideration of the moon's path with reference to the ecliptic and the equator, the phases of the moon, disturbing causes due to movements and positions of the planets—in fact a conglomerate gathering together of all imaginary and obsolete

[a] This has been reproduced as a single line. The use of three lines where but one is required appears to be simply another artifice of the long-range forecaster to avoid being specific.

notions regarding weather causes that are calculated to mystify credulous and uninformed people. He predicts the general character of a month with a consciousness that the forecast will be verified in at least some part of a great unspecified area. He then outlines "storm periods," with intervals of two to three days, which are covered by a margin that is claimed for verification purposes, and verifications are claimed if storms occur during the periods or in the intervals in any part of the United States and, at times, in the Northern Hemisphere. This system of forecasts and verifications admits of no failures. So much for his regular forecasts. Let us now examine some of his special, emphasized predictions.

In the early part of April, 1904, a tornado and severe storms were scheduled in various western papers, over the name of this forecaster, to appear "right after April 17." The storms failed to materialize in the United States during the period specified. Returns from remote parts of the Northern Hemisphere have not, however, been received, so it is possible that a justification of the forecast will be claimed. Aside from platitudes regarding average weather conditions that prevail in April, he announced that "one of the most decided, and perhaps violent, storm periods of the month extends from about the 25th to the 29th."

In the United States the period was a quiet one, and the disturbances that appeared (and one or more surely would appear within the area of the United States during the period specified) were not attended by "very general and violent storms, destructive hailstorms, and abnormal downpours of rain," which, according to the detailed forecast, should have been experienced.

His forecast statement for May, 1904, ends as follows: "The fifth storm period will be central on the 29th, and there will be violent disturbances. Watch the barometer, and if you have a trembling wife and children clinging to you for protection provide some place of safety in which to resort in case of danger."

Is it possible to soar to greater heights of nonsense? In what particular continent or country will the storm period be central on the 29th? The forecaster does not say. Is the entire population of the United States, or of the world, expected to dig cellars or caves of shelter in anticipation of a possible occurrence of a tornado whose path of destructive violence would not cover an area represented on a large map by a mark one-half inch in length made with a sharp pencil? Is it possible that a man who issues such totally unwarranted, sensational, and harmful forecasts is seriously considered by the intelligent portion of the American public? I regret to say that he and others of his kind have a considerable constituency.

CONCLUSIONS REGARDING LONG-RANGE FORECASTING.

A review of the foregoing remarks and opinions regarding the application of past and present astronomical and meteorological knowledge to the theory and practice of long-range weather forecasting leads to the following conclusions:

(1) That systems of long-range weather forecasting that depend upon planetary meteorology; moon phases, cycles, positions, or movements; stellar influences, or star divination; indications afforded by observations of animals, birds, and plants; and estimates based upon days, months, seasons, and years, have no legitimate bases.

(2) That meteorologists have made exhaustive examinations and comparisons for the purpose of associating the weather with the various phases and positions of the moon, in an earnest endeavor to make advances in the science along the line of practical forecasting, and have found that while the moon and, perhaps, the planets exert some influence upon atmospheric tides, the influence is too slight and obscure to justify a consideration of lunar and planetary effects in the actual work of weather forecasting.

(3) That the stars have no appreciable influence upon the weather.

(4) That animals, birds, and plants show by their condition the character of past weather, and by their actions the influence of present weather and the character of weather changes that may occur within a few hours.

(5) That the weather of days, months, seasons, and years affords no indication of future weather, further than showing present abnormal conditions that the future may adjust.

(6) That six and seven day weather periods are too ill-defined and irregular to be applicable to the actual work of forecasting.

(7) That advances in the period and accuracy of weather forecasts depend upon a more exact study and understanding of atmospheric pressure over great areas, and a determination of the influences, probably solar, that are responsible for normal and abnormal distributions of atmospheric pressure over the earth's surface.

(8) That meteorologists are not antagonistic to honest, well-directed efforts to solve the problem of long-range forecasting; that, on the contrary, they encourage all work in this field, and condemn only those who for notoriety or profit or through misdirected zeal and unwarranted assumptions bring the science of meteorology into disrepute.

(9) That meteorologists appreciate the importance to the world at large of advances in the period of forecasting, and are inclined to believe that the twentieth century will mark the beginning of another period in meteorological science.

OBSERVATORY BUILDINGS.

Carrying out the policy of the Department, the Weather Bureau has continued to cooperate with the leading universities throughout the country, and at the present time the relations existing are more cordial and the work done more important than at any time in the history of the service. Several universities and colleges have donated ground for the erection of buildings, notably the Bradley Polytechnic Institute of Peoria, Ill., and the Epworth University of Oklahoma City, Okla. Appreciation of the value of the work being done by the Weather Bureau has also been demonstrated by several other universities in placing at the disposal of the Bureau, without cost, office quarters in their buildings for recently established stations, among them being the Brown University of Providence, R. I., and the University of Wisconsin, at Madison, Wis.

The erection of buildings by the Weather Bureau not only saves the amount previously paid for rent of office quarters, but adds very much to the prestige of the service here and abroad. This prestige

will be further increased upon the completion of the group of observatory buildings at Mount Weather, Va., at which place it is intended to conduct extensive experimental and research work. The present appropriation provides for the erection of not less than five buildings, but this number has proven inadequate to the growing demands from all sections of the country, and it is hoped that Congress will soon increase the appropriation sufficiently to provide for the erection of not less than ten buildings annually.

Buildings owned by the Weather Bureau.

Location.	Value of lot.	Value of buildings.	Total value.
Amarillo, Tex	$1,255.00	$6,503.00	$7,758.00
Atlantic City, N. J	(a)	6,000.00	6,000.00
Bismarck, N. Dak	(a)	10,000.00	10,000.00
Block Island, R. I	1,100.00	7,700.00	8,800.00
Cape Henry, Va	(a)	9,104.25	9,104.25
Devils Lake, N. Dak	2,300.00	8,000.00	10,300.00
Duluth, Minn	2,100.00	7,900.00	10,000.00
Hatteras, N. C	125.00	4,875.00	5,000.00
Havre, Mont	1,850.00	5,700.00	7,550.00
Jupiter, Fla	(a)	6,094.95	6,094.95
Key West, Fla	2,020.00	7,994.75	10,014.75
Kittyhawk, N. C	(a)	1,616.00	1,616.00
Modena, Utah	(a)	4,346.00	4,346.00
Mount Weather, Va.:			
Observatory building	2,000.00	18,000.00	20,000.00
Power house and balloon building	650.00	8,000.00	8,650.00
Stable	.....	2,000.00	2,000.00
Mount Washington, N. H	(b)	300.00	300.00
Narragansett Pier, R. I	4,100.00	8,000.00	12,100.00
North Head, Wash	(a)	4,000.00	4,000.00
Point Reyes Light, Cal	(a)	3,000.00	3,000.00
Port Crescent, Wash	82.00	1,000.00	1,082.00
Sand Key, Fla	(a)	5,593.00	5,593.00
Sault Ste. Marie, Mich	(a)	3,000.00	3,000.00
Southeast Farallon, Cal	(a)	5,211.22	5,211.22
Tatoosh Island, Wash	(a)	5,000.00	5,000.00
Washington, D. C	25,000.00	150,000.00	175,000.00
Yellowstone Park, Wyo	(a)	11,500.00	11,500.00
Yuma, Ariz	(a)	1,500.00	1,500.00
Total	42,582.00	311,988.17	354,520.17

a Government reservation. b Leased.

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

Location.	Cost of lot.	Cost of buildings.	Total cost.
Columbia, S. C	$3,799.00	$9,170.00	$12,969.00
Peoria, Ill	54.00	7,915.00	7,969.00
Nantucket, Mass	1,236.50	3,968.00	5,204.50
Mount Weather, Va. (3 buildings):			
Absolute building	(a)	6,500.00	6,500.00
Variation building	(a)	8,000.00	8,000.00
Kite building	(a)	3,000.00	3,000.00
Total	5,089.50	38,553.00	43,642.50

a Government reservation.

Rented buildings occupied wholly by the Weather Bureau.

Station.	Annual rent.	Other items included.
Cape May, N. J	$650.00	Heat, cleaner, light.
Durango, Colo	440.00	Heat, cleaner, water.
Flagstaff, Ariz	300.00	
Lewiston, Idaho	540.00	
Williston, N. Dak	450.00	Heat, cleaner, light, water.
Winnemucca, Nev	360.00	Heat, light, water.
Helena, Mont	504.00	Heat, water.
Santa Fe, N. Mex	360.00	
Charles City, Iowa	420.00	Heat, light, water.
Roswell, N. Mex	720.00	Heat, cleaner, light.

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

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

a Public.

CLIMATE AND CROP DIVISION.

IMPROVEMENT OF ESTABLISHED LINES OF WORK.

The amount of funds allotted this division for its work during the year ending June 30, 1904, was the same as for the previous year. Therefore only those lines of work previously established have been pursued. The maintenance and improvement of established lines of work and the extension of the distribution of weather forecasts and special warnings as far as available means would permit have constituted the work of the year. The last-mentioned feature affords about the only item for especial remark in this report. Some of the older methods of distribution have in instances been abandoned for the quicker, more effective, and less expensive means of dissemination by telephone through rural telephone exchanges, the details of which are given elsewhere under the proper heading.

Action was taken during the latter part of the year to purchase a supply of thermometer supports of a new design, with a view of determining the advisability of their adoption for use at voluntary stations. These supports were not received in time to be given a test before the close of the fiscal year, but they are promised at an early date. It may be stated in this connection that there was a decided decrease in the breakage of thermometers at voluntary stations during the year, no doubt due in a great measure to a change in the method of mounting authorized in the previous year. From opinions expressed by some prominent section directors who have seen the new device, it is expected that the contemplated tests will lead to its adoption, and that a further decrease in the breakage of thermometers will result.

VOLUNTARY METEOROLOGICAL STATIONS.

Although nearly 300 voluntary stations were established during the year, the total number, 3,367, but slightly exceeds the number in operation at the close of the previous year, nearly as many stations as

were opened having been discontinued. No serious injury, however, has been sustained by the loss of a majority of the stations discontinued, as in but few instances were they located where it was important to have the records continued. Of the new stations opened a number have been located in the higher and less accessible places in the mountain districts in the semiarid States, with a view to meeting more fully the demands from irrigation engineers for rainfall data. Efforts have been continued to improve the instrumental equipment and the character of the exposure of instruments. More than 400 stations were inspected by section directors, and the inspection reports received show that, while most observers are efficient and painstaking in their work, there are but few stations that were not in some way benefited by the section director's visit.

Correspondence with the Chief Signal Officer of the Army resulted in securing the generous cooperation of that official in the opening of a number of voluntary stations in Alaska along the military telegraph lines. For this purpose twenty sets of instruments, constituting the voluntary observer's equipment, were sent to officers having charge of the telegraph lines, for the equipment of stations under charge of the Signal Corps telegraph operators. As a result of this action meteorological records are already being received from new Alaskan stations, and, with the establishment of the full number of stations for which equipments have been provided, the Bureau will receive meteorological data from a region concerning which available information is very meager.

In March, 1904, action was taken to establish a section of the Climate and Crop Service of the Bureau in the Hawaiian Islands. Twenty complete instrumental outfits were sent to Honolulu for this purpose and other arrangements, incident to the inauguration of a section of the Climate and Crop Service, had so far advanced by the close of the year as to justify the hope that the section would be in full operation and issuing the standard publications before the close of the succeeding year.

CLIMATE AND CROP BULLETINS.

No change has been made in the character of the National Climate and Crop Bulletin, nor in the method of collecting the reports used therein. This bulletin continues to be one of the most important publications of the Bureau, supplying, as it does, very complete information as to current weather conditions and their effects upon farm work and the growth and development of crops. The scope and purpose of this publication have been fully stated in previous reports.

MONTHLY REPORTS AND ANNUAL SUMMARIES OF CLIMATE AND CROP SECTIONS.

Each of the forty-three section centers has without interruption issued monthly reports and annual summaries containing the data afforded by the reports of the regular and voluntary stations. The demand for these publications is constantly increasing, rendering it necessary to secure the strictest economy in their distribution. They answer so fully and in such detail so many requests for information as to the climate of the different sections of the country that an application for information of this character can nearly always be satisfactorily met by supplying a monthly report or an annual summary.

SNOW AND ICE BULLETIN.

This publication, issued from the first week in December to the last week in March, shows the depth of snow on ground and the thickness of ice in rivers and other bodies of water. It meets an important need in supplying information as to protection afforded by snow to the winter wheat crop during the trying periods when the crop is exposed to injury from alternate thawing and freezing of the ground. It also continues to be of value to ice dealers and the manufacturers of rubber and other goods, the sale of which is largely governed by the presence or absence of snow or ice.

CORN, WHEAT, COTTON, SUGAR, RICE, AND FRUIT SERVICES.

These services have continued without change in the method of collection or publication of reports. Daily bulletins are issued from the several district centers, containing the full report from each substation, with the averages for all stations in each of the various districts.

SECTION SNOW BULLETINS.

The snow bulletins issued by the climate and crop sections in the Rocky Mountain and Plateau regions were more complete during the winter of 1903–4 than in any previous year, owing in a large measure to a plan of cooperation with the General Land Office, whereby was secured the aid of a large number of forest-reserve officers in reporting the depth of snow, more particularly at high altitudes. As these section snow bulletins show the amount of snow in the mountains, they afford a reliable basis of estimating the probable water supply and flow of streams for the succeeding spring and summer, and are therefore of much value to the important interests affected thereby.

DISTRIBUTION OF FORECASTS AND SPECIAL WARNINGS.

With no increase in the allotment for work in this direction, a repetition of the remarks in the annual report of last year would nearly cover the present situation. All that it was possible to do with available funds has been done, and every opportunity for extension where it could be done without exceeding the appropriation has been embraced.

There is a slight increase (61) in the number of places receiving daily forecasts by telegraph or telephone at Government expense; and as these points are, as a rule, selected on account of their eligibility as centers of distribution, the forecasts have been distributed in many sections not heretofore supplied with this information.

About 200 addresses were dropped from the emergency warning list, which has been revised and now provides for the distribution of special warnings of tropical hurricanes or storms and cold waves of unusual severity to postmasters at 6,152 points, who post the bulletins in their offices for the benefit of the public and in many instances telephone the warnings to adjacent points having special interests to be protected.

The railway telegraph and train services have continued in operation, supplying in the aggregate over 5,000 railroad stations with the daily forecasts, which are bulletined in the waiting rooms for the benefit of the employees and the traveling public.

Comparatively little change is shown in the number of card forecasts issued daily. This portion of the work has been so carefully examined into in previous years that nearly every post-office which could be reached in time to make the predictions of value is now being served. As mail schedules are changed the lists are modified, and as a rule the number added about equals that discontinued. Postmasters continue their cooperation in this, as well as in the Rural Free Delivery Service, and in a large number of instances have extensive lists to which the card forecasts are distributed daily. Action was taken to prevent the printing of names of individuals or firms on cards in connection with the forecasts. The Bureau is now free from this annoying advertising feature, and, so far as known, the cards as now issued contain nothing but the official forecasts, with occasionally a date and the name of the center from which the cards are distributed. The stand taken by the Bureau in this matter resulted in the loss of the cooperation of a few of the oldest distributors, who kept up the work on account of its advertising possibilities; but arrangements were quickly effected whereby others took up the work, or the substations were supplied from adjacent centers.

Through several causes the number of addresses on the rural free-delivery lists has been largely decreased as compared with that of the previous year, owing principally to the discontinuance of the afternoon forecast distribution from Columbus, Ohio, and the transfer of a large portion of this work in Iowa from the rural free delivery to the free telephone service. There are now available sufficient data to enable us to extend the rural free-delivery distribution, when practicable, to every route on which the carrier leaves the distributing office at an hour sufficiently late to receive the morning forecasts by telegraph from the district center.

The rural telephone lines are now the best and most economical means of distributing weather information. The forecasts are quickly disseminated, cover a large territory, and at little or no expense to the Government. Through arrangements made between the Weather Bureau officials at Cleveland and Columbus and two of the great trunk telephone lines, the daily morning forecasts are now available for the use of more than 100,000 subscribers in the State of Ohio, and the records at hand indicate that nearly one-half of that number are taking advantage of this opportunity to get the forecasts in their homes within a few minutes after their preparation at the district center. Officials of telephone companies operating lines in other States are rapidly signifying their desire to cooperate in this work, and it may be safely stated that the close of another fiscal year will show a gratuitous distribution of daily forecasts over the greater proportion of all independent telephone lines between the Atlantic seaboard and the western borders of Kansas, and as far south in the Middle West as the northern portion of Texas. The general manager of one of the largest independent lines in the State of Ohio stated in a circular letter to the managers of his exchanges that "intelligent handling of these reports will do much to make your service attractive, and whenever your service is attractive it is popular, and whenever popular it is a revenue producer." As these independent lines are merged with the long-distance companies the necessity for telegraphic forecasts to individual exchanges will cease to exist, making it possible to further extend the

distribution over rural free delivery lines into agricultural sections not now supplied with the forecasts.

The following statement shows the distribution by States and Territories and the changes, as compared with work of the previous year:

Distribution of daily forecasts and special and emergency warnings.

State or Territory.	At Government expense.			Without expense to United States by—				
	Forecasts and special warnings.	Special warnings only.	Emergency warnings.	Mail.	Rural free delivery.	Telephone.	Railroad telegraph.	Railroad train service.
Alabama	23	4	139	1,175	257	107	83	12
Arizona	3	1	0	0	0	1	0	0
Arkansas	19	8	102	541	249	97	5	0
California	128	10	0	2,549	2,218	35	0	0
Colorado	17	67	39	980	1,016	1,889	0	7
Connecticut	11	3	49	1,074	100	0	15	151
Delaware	9	0	0	36	520	0	41	0
District of Columbia	0	0	0	1,199	0	0	0	0
Florida	27	127	61	917	0	42	91	0
Georgia	39	39	241	1,527	1,582	30	222	41
Idaho	10	1	0	371	0	4	0	17
Illinois	109	24	468	3,082	6,783	7,962	115	459
Indiana	93	16	208	1,913	5,488	6,658	68	287
Indian Territory	7	0	4	194	0	630	0	0
Iowa	168	30	400	1,730	7,667	51,083	13	0
Kansas	69	9	186	889	4,187	1,164	15	15
Kentucky	41	34	96	2,095	75	3,606	18	0
Louisiana	26	45	61	921	0	28	0	0
Maine	21	4	40	1,107	920	4	0	77
Maryland	26	4	42	1,778	1,384	15	101	0
Massachusetts	24	20	63	3,040	10,025	12	1	331
Michigan	115	21	379	4,894	4,888	4,208	253	457
Minnesota	62	18	196	1,961	2,342	1,744	13	0
Mississippi	55	6	118	703	0	49	6	0
Missouri	84	10	240	5,254	6,581	1,505	25	0
Montana	15	20	18	499	0	5	0	0
Nebraska	63	9	221	1,110	1,227	1,133	0	0
Nevada	3	0	0	205	0	0	0	0
New Hampshire	18	1	34	1,184	1,205	0	0	81
New Jersey	23	25	45	1,219	255	3	189	0
New Mexico	3	3	0	15	0	84	7	0
New York	106	68	365	7,549	9,359	3,467	363	168
North Carolina	56	20	189	1,131	268	24	1	16
North Dakota	16	9	99	0	258	74	0	0
Ohio	136	89	437	7,951	6,693	46,328	37	17
Oklahoma	7	2	13	214	0	2,596	9	0
Oregon	16	2	0	689	600	0	0	104
Pennsylvania	59	18	367	4,299	485	1,525	660	0
Rhode Island	4	0	12	105	0	1	0	28
South Carolina	34	5	109	1,123	458	193	30	28
South Dakota	33	19	77	800	195	2,981	0	0
Tennessee	43	11	291	1,534	1,370	217	23	2
Texas	57	66	240	1,769	1,583	259	154	0
Utah	14	62	0	372	290	6	0	0
Vermont	10	1	46	547	100	0	8	18
Virginia	43	9	96	1,572	228	118	60	96
Washington	21	5	0	737	876	8	0	29
West Virginia	18	11	55	987	232	1,619	18	26
Wisconsin	85	24	298	1,952	1,687	10,787	0	16
Wyoming	7	3	8	112	40	1	11	0
Total June 30, 1904	2,076	983	6,152	77,605	83,639	152,302	2,655	2,428
Total June 30, 1903	2,015	926	7,096	78,164	97,648	28,251	3,087	2,428
Changes	+61	+57	−944	−559	−14,009	+124,051	−432	0

THE MOUNT WEATHER METEOROLOGICAL RESEARCH OBSERVATORY.

At Mount Weather, Va., it is proposed to make and send out the apparatus for the exploring of the atmosphere to altitudes of 3 to 10 miles. In this work it is probable that many balloons will be simultaneously liberated from different stations, so as to get records of storms and of

cold waves from their four quadrants. With the knowledge thus gained of vertical gradients of pressure and of temperature, it will doubtless be possible to gain a better understanding of the mechanics of storms. This exploration will be useful in determining how near right are those who believe that change in temperature other than seasonal is mainly a function of the mechanics of the lower atmosphere—that portion lying below the 10-mile level; that in the study of those aberrations of climate called "weather" investigators need concern themselves only with the atmosphere near the earth; and that variations in the condition and in the intensity of the many forms of solar radiation are inappreciable in their effect on the weather of the earth.

With observations from the magnetic, the electric, and the solar physics observatories which the Department is now building, and which will be equipped with the most approved appliances, opportunity will be given to those who believe that the cyclonic or anticyclonic whirls that constitute storms or cold waves are mainly the result of changes in the amount or intensity of some form of solar radiation. It is the opinion of the writer that the synchronism of changes in the activity of the chromosphere of the sun and the weather of the earth has not yet been established with sufficient definiteness to be of benefit to the forecaster, but a working hypothesis has been formulated which stimulates thought, study, and investigation. This fact must be credited to the patient work of Prof. Frank H. Bigelow. Even those who differ from him in their conclusions relative to the association between astrophysics and meteorology must admit that the fertility of his thought and his earnest seeking after the problems which, when solved, shall raise meteorology from empiricism to a closer approach to an exact science, have been highly beneficial. The study of storms has too long been made from a single view point. Daring minds are needed, even those that are willing to take a considerable hazard in the hypotheses which they are willing to lay down and attempt to demonstrate: for to doubt is to investigate. New truths are usually discovered by working inductively along conventional lines, but some of the greatest principles in nature have been made known to the world by deductive reasoning and by the assumption of a hypothesis that could not at the time be demonstrated. Due deference must be given to each other's opinions, and all must strive earnestly for the elucidation of the many difficult problems that now confront the meteorologist.

LINES OF PROPOSED INVESTIGATIONS.

It is proposed to make the research at Mount Weather catholic in its broadness; to look for the truth, and not to despise its source or the means of its conveyance; to discuss meteorological observations from the point of view of their relations to solar physics; to select meteorologic and magnetic elements and compare them with solar observations; to carry on research in the allied subjects of radiation, atmospheric electricity, ionization of gases, radioactivity, etc. Progress in knowledge of the effects of the sun's actions upon weather conditions depends upon introducing more refined processes than have generally been assigned to meteorology. It is hoped to determine the nature of the alliance between meteorology and solar physics. The atmosphere of the sun and of the earth, together with the connecting radiations, will be studied as one branch of science having common interests, which may be designated as cosmical meteorology.

In the seven buildings at Mount Weather the Weather Bureau will have the most approved apparatus for measuring atmospheric electricity and magnetism, for measuring the solar radiation in the spectrum, for registering the sun-spot areas, the prominence output, and the extent of the faculæ. These are all valuable as registers of the solar energy, which, falling upon the earth, may play a part in stirring up the atmosphere and producing our weather.

INTERPRETING THE LANGUAGE OF THE SUN.

The climate and crop conditions from year to year depend largely upon the invisible and subtle solar radiations, known to exist as waves, like those used in wireless telegraphy. The space between the sun and the earth—that is, the cosmical ether—is filled with wireless messages which science is laboriously learning to interpret. Its votaries do not understand the solar code very well, and the process of deciphering it is like that of learning to read the Babylonian inscriptions, namely, by putting this and that together, learning to read a bit here and there, by intercomparisons, trial, and failure, till at length the language of the sun shall be understood. The time may come when it may be possible to interpret the seasonal weather from year to year in advance. It has not yet arrived. The sun moves leisurely through its cycles and the terrestrial conditions seem to follow loosely. At present all available information concerning these matters comes in scattered form from observatories, in reports two or three years old. It is necessary, therefore, to have instruments, trained research observers and computers, and a discussion of results, subject to the direct control of the Weather Bureau.

BUILDINGS COMPLETED AND PROJECTED.

During the past year the main building of the Weather Bureau observatory has been completed, the power plant and the building from which balloon ascensions and kite flights are to be made have been erected, and the magnetic buildings started. It has been found that the rocks are entirely free from magnetism, and that the field is uniform, so that it is a suitable place on which to locate a magnetic observatory. A physical laboratory for electrical and radioactive effects is being planned, the erection of which will take place during another year. Finally, a comprehensive physical observatory for photographing the sun directly and through the spectrum, for measuring the radiation energy by actinometry and bolometry, with their allied equipment, will be required. This complex institution must grow up slowly; as plans can be matured along the best modern lines, our assistants must be trained to work in several lines on a harmonious general plan, and the results must be carefully studied as the science progresses.

CONVENTION OF WEATHER BUREAU OFFICIALS.

Under the authority of the Secretary of Agriculture, a convention of Weather Bureau officials was held at Peoria, Ill., in the audience room of the Bradley Institute of Technology, on September 20, 21, and 22, 1904. It is the custom to hold similar conventions once each three years. The character of the papers read and the discussions that followed were of an unusually high order. Particular effort was made to contribute to the science of meteorology, as well as to discuss methods

of utility. Several important results were obtained which will, without doubt, contribute to both the science of meteorology and the efficiency of the weather service.

Synopses of the papers read follow. A full report of the convention, including all of the papers in full and the discussions relative thereto, will be issued as soon as the work can be edited.

LABORATORY WORK IN METEOROLOGY, by Prof. A. G. McAdie: Laboratories essential in all courses of the applied sciences.—Meteorology to be the most important of the applied sciences.—Equipment of laboratory a measure of the standing of the university.—A laboratory containing only first-order station instruments does not meet the demand of the day.—Less routine work and more individual contributions.—Necessity of expressing clearly results obtained.—Teachers of science not familiar with meteorology.—Out-of-door work.—Movements of air on large scale and on small scale.—Arousing an interest in the students.—More important to understand the physical processes at work and to have clear conceptions of a few things than to maintain elaborate records or attempt long courses in reading.—Problems awaiting investigation.

THE MOUNT WEATHER RESEARCH OBSERVATORY, by Prof. F. H. Bigelow: Need of a modern research observatory for meteorology in the United States.—Recent advances in physics which concern meteorological problems.—Equipment of the proposed observatory at Mount Weather.—Problems and observations which can be undertaken.—Relation of the data to processes in forecasting the action of cyclones and anticyclones.—Problem of long range forecasts of the seasons and the synchronism between solar and terrestrial actions.

ERRORS OF METEOROLOGICAL INSTRUMENTS AND LINES ALONG WHICH IMPROVEMENT SHOULD BE SOUGHT, by Prof. C. F. Marvin: Three general classes of errors mentioned.—Accuracy of mercurial barometers and thermometers.—Clock errors in automatic instruments.—Discussion of effects of thermometer errors on the psychrometer at certain temperatures.—Construction of rain gages, errors of exposure, action of wind, etc., considered.—Difficult problems in snow measurements.—Errors of anemometers at high and unusual velocities.—Measurement of sunshine.—Lines of improvement discussed.

LONG RANGE FORECASTS, by Prof. E. B. Garriott: Refers to theories regarding weather periodicities dependent upon lunar or planetary influences, and pronounces them theories of faith and not of practice.—Summarizes results obtained by comparisons of maximum and minimum sunspot periods with the phenomena of the earth's atmosphere, and states that the next advance in meteorological science must result from extensive research in solar physics and terrestrial magnetism and comparison of solar and terrestrial phenomena.—Mentions means proposed to accomplish world-wide plan of observation permitting systematic study of the problem.

SEASONAL FORECASTS, by Prof. A. G. McAdie: Improvement of daily forecasts.—Experience at San Francisco; rain falling on typical fair weather maps; map classifications insufficient.—Seasonal types of pressure distribution.—The individual disturbance in its relation to the seasonal condition.—Permanent pressure areas and their relation to the season's character.—Typical wet winters on the Pacific coast.—Individual disturbances are by-products of the larger air movements; therefore the character of the individual high or low will vary more or less with the swinging of the larger pressure areas.—True normal conditions rare.—Ability to forecast the abnormal condition is the real test of the forecaster.

AMPLIFICATION OF FORECASTS FOR BENEFIT OF SHIPPERS OF PERISHABLE PRODUCTS, by Dr. W. M. Wilson: Importance of amplified forecast to large industrial and commercial enterprises.—Extent to which their needs are met at present, and practicability of specializing for their benefit.—Necessity of a definite view on the part of the forecaster regarding the interests to be thus served.—Terms proper to such forecasts.—Review of other special services now in operation.—Suggested methods of amplification.

AN AID IN FORECASTING, by Mr. F. H. Brandenburg: Disadvantages of a district forecaster under present methods through lack of convenient means of studying local weather signs at outlying stations.—Recommends compilations of prevailing wind directions, temperature changes, clouds, and pressure changes for twelve and twenty-four hour periods before and after precipitation.—Advantages of such compilation.

FORECASTING FOGS ON THE GULF COAST, by Mr. B. Bunnemeyer: Periods of and areas covered by dense formation.—Diurnal periods of maximum and minimum density.—Temperature, air pressure, and wind direction in connection with fogs.

A POPULAR ACCOUNT OF THE COUNTERCURRENT THEORY OF STORMS, by Prof. F. H. Bigelow: Leading meteorological theories and their defects.—Observations which have contributed to the new theory.—Cause of the counter currents in the general circulation of the atmosphere.—Local circulation in cyclones and anticyclones.—Equilibrium of temperature.—Interchange of inertia.—Relation of the theory to forecasts.

VARIATIONS IN INSOLATION AND IN THE POLARIZATION OF BLUE SKY LIGHT DURING 1903 AND 1904, by Mr. H. H. Kimball: Observations in Washington and their comparison with those in other cities.—Cause of diminution of solar insolation in 1903.—Effect of variation of solar energy on climatic conditions and plant life.—Value of solar investigations at Mount Weather.

A POSSIBLE METHOD FOR DETERMINING THE DIRECTIONS AND VELOCITY OF STORM MOVEMENT, by Mr. E. H. Bowie: Variations from the average direction and velocity of movement of cyclonic areas responsible for a large percentage of errors in forecasting.—General statement that storms follow lines of least resistance of small practical value without definite rules for determining such lines.—Brief summary of views of leading authorities as to the main laws of control of cyclonic movement.—Studies of erratic storm movement by the writer, disclosing the influence exerted by unequal pressure distribution surrounding the area of low pressure, and the presentation of a working basis for determining the value of such control upon the future movement of the storm.

TEMPERATURE FORECASTS AND IRON ORE SHIPMENTS, by Mr. H. W. Richardson: Temperature an important consideration in the shipment of iron ore.—When iron ore is frozen, it can not be economically transferred from cars to boats; thawing by steam expensive, also causes delays, which can be averted by advance information of freezing temperature.—Practical application at Duluth.

DISTRIBUTION OF FORECASTS BY TELEPHONE, by Dr. G. M. Chappel: List of telephone companies in Iowa.—Plan of cooperation.—Practical results.

PRACTICAL RULES FOR FORECASTING FLOOD-CREST STAGES FOR CAIRO, ILL., by Mr. P. H. Smyth: Difficulty of crest-stage forecasting.—Character of the data upon which forecasts are based.—Possibility of predicting the intensity of floods two or three months in advance of their occurrence.—Method of applying the tabulated data.—Brief history of the flood at Cairo in the spring of 1897.—Time of flood crests from Cincinnati, Chattanooga, Nashville, and St. Louis to Cairo.

THE COLUMBIA RIVER, by Mr. E. A. Beals: Its discovery and commercial importance.—Drainage basin, extent and character.—Precipitation over watershed.—River stages, including The Dalles Hydrograph.—Causes of floods, their frequency and duration.

SOME DIURNAL PERIODICITIES IN THE CLIMATIC FACTORS AT BALTIMORE, by Dr. O. L. Fassig: A diurnal period will be shown for temperature, pressure, humidity and vapor tension, rainfall (frequency and amount), wind velocity and direction, cloudiness and sunshine, and thunderstorms and atmospheric electricity.—Discussion based on series of ten years of hourly observations made at the Baltimore station.—Diurnal periods graphically shown by means of a system of "isopleths."

INSTRUCTION AND RESEARCH BY WEATHER BUREAU OFFICIALS, by Prof. Cleveland Abbe: In this address the author shows what has been done for meteorological education during the past thirty years by the Bureau or through its influence.—He examines the present condition of this subject in this country and considers its future prospects.—He shows that progress in forecasting means not only education in the physical sciences but research, and illustrates this by recent examples.—Finally he shows what research means, how it is to be fostered, and especially how it can be carried on at a well-equipped central meteorological observatory like that at Mount Weather.

PHENOLOGICAL OBSERVATIONS AT WAUSEON, OHIO, by Mr. J. Warren Smith: Temperature and precipitation at Wauseon, Ohio, since 1876, and their relation to the blossoming of fruit trees.—Average yield per acre of principal farm fruits and crops. (This paper will be accompanied by charts.)

A STUDY OF THE RAINFALL ON THE WEST FLORIDA COAST, by Mr. B. Bunnemeyer: Summary of rainfall data for twenty-four years, with charts.—Ratio of day rain storms to night rain storms.—Hours of greatest and of least frequency of showers.

CLIMATOLOGY OF PORTO RICO, by Mr. W. H. Alexander: Topography.—Temperature.—Rainfall.—Humidity.—Prevailing winds, etc.

MONTHLY STATEMENT OF AVERAGES FOR RURAL PRESS, by Mr. W. S. Belden: Form similar to 1079-Meteorological, based on data from all observation stations within

section, to be prepared at section centers.—Such data for ten years or more now available.—Data should be concise and plainly stated.—Extreme values for important agricultural districts to be stated.—Time of issue and use of by weekly newspapers and newspaper unions.—Result of experiments.

IRREGULARITIES IN FROST AND TEMPERATURE IN NEIGHBORING LOCALITIES, by Dr I. M. Cline: Marked variations of temperature in different localities in immediate neighborhoods.—Occurrence of "frost patches," or the irregular effect where small areas scattered over fields have suffered much greater damage than other parts of the same field.—Character and color of soils and their influence on insolation and radiation have much to do with the occurrence of frost and explain the "frost patches."

FORMER CONVENTIONS OF WEATHER BUREAU OFFICIALS, by Mr. James Berry: Brief mention of former conventions and of the benefits resulting therefrom.

WIRELESS TELEGRAPHY.

The Department of Agriculture, through the Weather Bureau, was one of the first of the Government Departments to take up, systematically, experimentation in problems concerned with the development of wireless telegraphy. By this action research into the physical problems concerned in transmitting messages through the medium of ether waves was greatly stimulated in this country. Probably one of the best, if not the best, instruments anywhere made for the receiving of wireless messages had its inception in the experimental work of the Weather Bureau.

Recently a Board, to consider the whole problem of wireless telegraphy and the relation of the Government thereto, was appointed by the President. Its conclusions and recommendations follow:

CONCLUSIONS.

The conclusions of the Board are—

That the science of wireless telegraphy has been advanced by the able and persistent work of the Signal Corps of the Army and the Weather Bureau of the Department of Agriculture, as well as by the experimental work of the Navy Department;

That wireless telegraphy is of paramount interest to the Government through the Navy Department, and that its use by the Signal Corps of the Army for communication between military posts of the Army and other necessary links will be necessary both in peace and war, and that such use shall be unrestricted. When interference seems probable between stations of the Navy and War Departments, the question involved shall be mutually settled by representatives of the two Departments;

That coastwise wireless telegraphy is not a necessity for the work of the Weather Bureau of the Department of Agriculture, provided that the necessary meteorological data for that Department can be collected by the stations of the Navy Department from ships at sea and by them sent to the Weather Bureau of the Department of Agriculture;

That the maintenance of a complete coastwise system of wireless telegraphy by the Navy Department is necessary for the efficient and economical management of the fleets of the United States in time of peace and their efficient maneuvering in time of war;

That the best results can be obtained from stations under the jurisdiction of one Department of the Government only, and that representatives of more than one Department should not be quartered at any station;

And finally the Board concludes that the Government must take the necessary steps to regulate the establishment of commercial wireless-telegraph stations among the States and between nations.

RECOMMENDATIONS.

In order that the above conclusions may be carried into effect, the Board recommends—

That the Signal Corps of the Army be authorized under its chief to establish from time to time such wireless stations as he may deem necessary, and that they do not interfere with the coastwise wireless-telegraph system of the Government under control of the Navy Department; and further, that the Chief Signal Officer be

requested to inform the Navy Department what stations of its system may be utilized to transmit messages for the Signal Corps or other bureaus of the War Department, and that representatives of the Signal Corps of the Army and the Bureau of Equipment of the Navy Department be at once requested to draw up such rules as will insure the efficient and harmonious carrying into effect of the above recommendations.

That the necessary steps be taken to have the Weather Bureau of the Department of Agriculture turn over to the Navy Department all coastwise wireless-telegraph apparatus now under its control, and such material as it may have in its possession which can be utilized by the Bureau of Equipment of the Navy Department, and that proper transfers of funds for this purpose be made;

That the Weather Bureau of the Department of Agriculture furnish to the Hydrographic Office of the Navy, and to the naval wireless-telegraph stations, or to other portions of the public service, such meteorological data as it or they may desire at no cost to them;

That the Department of Agriculture shall continue the work of its meteorological vessel-reporting and storm-warning stations, as now constituted and provided for by law, and continue the control of seacoast telegraph systems, except wireless systems;

That the necessary steps be taken that the Navy Department may equip and install a complete coastwise wireless-telegraph system covering the entire coasts of the United States, its insular possessions, and the Canal Zone in Panama;

That the Navy Department be directed to receive from the Signal Corps of the Army, at such points as may be requested by the Chief Signal Officer of the Army, all messages for army posts within their radii, and transmit them under such rules as may be agreed upon by the representatives of the Signal Corps and Bureau of Equipment, without cost to the Signal Corps of the Army;

That all meteorological reports from vessels of war or commerce or other sailing craft, now being forwarded direct to the Hydrographic Office of the Navy, shall be forwarded direct to the Weather Bureau, and the control of ocean meteorology be transferred to the Department of Agriculture, which already has ample law for doing this work;

That the estimates for the support of the Hydrographic Office of the Navy, or any other office of the Navy, for the next and succeeding fiscal years, do not contain any provision for the making of ocean forecasts, or for the publication of meteorological data, other than such as may be needed by the Hydrographer of the Navy for use on the pilot and other charts, which data shall be furnished by and credited to the Weather Bureau;

That it is the opinion of this Board that no meteorological work need or should be done by any portion of the Navy for the purpose of publication, or for the making of forecasts or storm warnings; that all such duties, being purely civil, should devolve upon the Weather Bureau of the Department of Agriculture in accordance with the organic act creating that Bureau;

That the wireless stations of the Navy Department shall, without charge to the Agricultural Department, receive and promptly transmit to the ocean or to islands, or to other places where the information can be made useful, the storm warnings of the Weather Bureau;

That the Navy Department shall request all vessels having the use of its wireless stations for the receipt of messages, to take daily meteorological observations of the weather when within communicating range and to transmit such observations to the Weather Bureau, through naval wireless stations, at least once daily, and transmit observations oftener when there is a marked change in the barometer; and that there shall be no charge against the Agricultural Department for these observations or for the transmission thereof;

That representatives of the Department of Agriculture and the Bureau of Equipment of the Navy Department be directed to prepare the necessary rules for the harmonious and efficient carrying on of the above recommendations.

We recommend that as fast as the naval wireless-telegraph stations are put in operation the Navy Department be directed to receive and transmit through these stations, free of charge, all wireless messages to or from ships at sea, provided such stations do not come in competition with commercial stations, until such time as Congress may enact the necessary legislation governing this subject.

In asking for legislation on this point, the Board desires to invite attention to the fact that where wireless stations are needed for the merchant marine, as a rule the Navy will also require them. The Board believes it to be in the interest not only of governmental but public economy and efficiency to permit the naval stations to handle the public service, for in the present state of the art but one station is desirable for the public interests in such places. As the needs of the Navy are paramount on account of the problem of national defence, private stations should not be

allowed to locate to the disadvantage of the former. Moreover, there is at present no public need for multiplication of stations at these points.

It is admitted, however, that there may be special cases where private stations can serve a useful purpose, and the Board believes that the Department of Commerce and Labor should have the duty of issuing licenses in such cases under such regulations as will prevent interference with stations necessary to the national defence. All private stations in the interior of the country should also be under supervision of the Department of Commerce and Labor.

This method of placing private stations under full Government supervision is desirable in order to regulate them for their mutual and the public welfare, as well as from considerations of national defence. Aside from the necessity of providing rules for the practical operation of such stations, it seems desirable that there should be some wholesome supervision of them to prevent the exploitation of speculative schemes based on a public misconception of the art.

It is believed that invention and private enterprise should be encouraged in every legitimate way, and it is the policy of the Navy Department to do this. It has the means of assisting inventors that no other Department has, and it believes that in order for it to lead the navies of the world in this matter, which is of great importance to the national defence, every reasonable facility should be given inventors, while at the same time it is working out the problems of the application of their inventions to its requirements in times of peace and war.

To prevent the control of wireless telegraphy by monopolies or trusts, the Board deems it essential that any legislation on this subject should place the supervision of it in the Department of Commerce and Labor.

Because international questions may arise, due to the fact that the use of wireless-telegraph stations in our own possessions may affect the use of similar stations in foreign countries, it is desirable for the Congress to enact legislation which will enable the Government properly to handle such cases; a failure to do so may seriously embarrass the Government at some future time.

It is thought that the legislation recommended in placing private stations under the supervision of the Department of Commerce and Labor will also cover this case.

In conclusion, the Board deems it essential that the Executive take such action as in his judgment seems wise to prevent the erection of private wireless-telegraph stations where they may interfere with the naval or military operations of the Government until legislation may be had by Congress on this subject.

Appended hereto are two extracts from the Revised Statutes, marked "W" and "X," which related to the operation of Government telegraph lines; also a decision of the Supreme Court, marked "Y," and the final protocol of the Preliminary Conference of Wireless Telegraph, held in Berlin in August, 1903, marked "Z." [a]

Very respectfully,

R. D. EVANS,
Rear-Admiral, U. S. Navy,
Representing the Department of Commerce and Labor.

H. N. MANNEY,
Rear-Admiral, U. S. Navy,
Representing the Navy Department.

A. W. GREELY,
Brigadier-General, U. S. Army,
Representing the War Department.

WILLIS L. MOORE,
Chief U. S. Weather Bureau,
Representing the Department of Agriculture.

JOSEPH L. JAYNE,
Lieutenant-Commander, U. S. Navy,
Representing the Navy Department.

MONTHLY WEATHER REVIEW AND WORK OF THE EDITOR.

Prof. Cleveland Abbe's time has been wholly occupied in collecting and preparing material for the Monthly Weather Review and in preparing and delivering a course of lectures on various problems in physical meteorology. The Monthly Weather Review has appeared as

[a] The papers referred to in this paragraph are omitted from this report.

promptly as practicable about six weeks after the close of the month whose name it bears. The salient features of the principal articles published in the Reviews for June, 1903, to June, 1904, are worthy of review in this report. From notes furnished by Professor Abbe the following comments are made:

W. N. Shaw: "La lune mange les nuages." A note on the thermal relations of floating clouds (June, 1903). In this the author, who is the chief of the Meteorological Office of London, shows graphically the effect of a slow descent of the air in evaporating the clouds, a phenomenon that occurs regularly every night.

Prof. C. F. Marvin: "The Weather Bureau seismograph" (June, 1903). This describes the apparatus now established at the Weather Bureau and the sources of error in its records. This apparatus was invented by Omori, of Japan, and manufactured by Bosch, of Strasburg. This article has been highly praised in Europe and reprinted by the manufacturer for general use. During the last year a number of earthquake waves have been recorded by it, and the records have been published in the Weather Review. Professor Marvin states that it needs to be supplemented by another smaller apparatus specially designed for the detection of short, minute waves. The present one is designed for the long, slow waves that frequently run several times entirely around the earth before their energy is spent. The Omori apparatus is said to be much more sensitive than the photographic horizontal pendulum of Milne, which is employed at Baltimore, Toronto, and Victoria, but it is apparently not so sensitive as the magnetic needle supported on a quartz fiber, as in the magnetic observatory at Cheltenham, England. The records of the Milne seismograph at certain stations are said to have demonstrated that the areas of high and low atmospheric pressure produce perceptible tiltings of the earth's surface, but the Omori instrument at Washington does not show this, possibly because its location in the basement of the main building does not isolate it sufficiently well from local changes due to temperature and the passage of wagons and individuals.

Harvey N. Davis: "Observations of solar radiation with the Angström pyrheliometer at Providence, R. I." (June, 1903).

H. H. Kimball: "Observations with the Angström pyrheliometer" (July, 1903). These reports were referred to in my previous annual report as having been presented and about to be published. Since that time they have been published in full, and have been followed by a general discussion of the whole subject of the sudden variation in the quantity of heat received at the earth's surface that occurred during 1902–3. Some have maintained that this change is due primarily to a change in the amount or quantity of heat that issues from the sun itself. Others, with more plausibility, maintain that it is due to a sudden accession of moisture, haze, or dust in our own atmosphere, and that the changes in the solar radiation or absorption are too small to have caused this change as measured at the earth. Mr. Kimball has continued his own series of observations during the past year at Washington, and if his work is maintained for several years it will doubtless give us additional information. It is very important that the bolograph records secured by Professor Langley should be duplicated by corresponding work at some very dry station having much clear sky, such as are found in our Rocky Mountain and Pacific coast regions.

W. N. Shaw: "On curves representing the paths of air in a special type of traveling storm" (July, 1903). The author deals with a special assumed case in which the speed of the air is assumed to be uniform over the whole area of the storm, although the direction varies from point to point. The isobars are assumed to be true circles, and the wind directions are tangential to them; the center describes a straight path with the same speed as the wind. Many of the conclusions drawn from these assumptions agree with the observations of actual storms. He postpones the consideration of the influence of ascending and descending currents to his next paper, "General circulation of the atmosphere." This has already been received and published in the Review for June, 1904.

D. T. MacDougal: "Soil temperatures and vegetation" (August, 1903). This is a study in the relation between climate and plant growth, and represents the results of several years of work. It would appear that the temperature of the soil is more important than the temperature of the air.

C. G. Knott: "Solar radiation and earth temperatures" (October, 1903). A novel feature of this paper consists in the computation of the accumulation of heat, or the total quantity of heat in the soil at any time of year, as obtained by integrating the expression for the quantity present in each successive layer of soil. The computation shows that at the beginning of September there is a maximum quantity of heat below the surface of the ground and at the beginning of March there is a minimum

quantity. At Edinburgh, Scotland, this difference amounts to over 1,200 units per square centimeter, or nearly 8,000 units to the square inch.

Prof. F. H. Bigelow: "Studies on the circulation of the atmospheres of the sun and of the earth." (1) The circulation of the sun's atmosphere (October, 1903); (2) The synchronism of the variations of the solar prominences with the terrestrial barometric pressures and temperatures (November, 1903); (3) The problem of the general circulation of the atmosphere of the earth (January, 1904); (4) Values of certain meteorological quantities for the sun (February, 1904); (5) Results of the nephoscope observations in the West Indies during the years 1899–1903 (April, 1904); (6) Circulation in cyclones and anticyclones (May, 1904); (7) Average monthly vectors of the general circulation in the United States (June, 1904).

This long series of papers by Professor Bigelow presents the results of several years of work. It is the opinion of Professor Abbe that the most important conclusion to the meteorologist is the presentation of the fact that in certain portions of the globe the oscillations of temperature are similar to those of the solar phenomena, such as sun spots and prominences, while in other parts of the globe they are opposite, and that about an equal number of regions show no decided agreement or opposition. He is of the opinion that terrestrial weather phenomena are the direct result of changes in the pressure and circulation of the earth's atmosphere, and it is not yet certain that these have any connection with the sun. Some are inclined to believe that changes in the sun are the direct or indirect cause of these terrestrial changes. Others believe that the latter would exist even if the sun's radiation were absolutely uniform, and that they represent hydrodynamic and thermodynamic phenomena confined to the atmosphere itself.

Another interesting result of Professor Bigelow's work is presented in his article on the nephoscope work in the West Indies, in which he shows the variation from month to month in the directions of motions of the winds and clouds. The season of hurricanes is distinguished by a special disturbance of the atmospheric circulation. The level of the maximum horizontal velocity changes systematically throughout the year. The mean altitude at which the westward drift reverses to the eastward drift is apparently above 6 miles in the summer months. The strata, from 4 to 6 miles high, are those chiefly concerned in causing the formation of hurricanes.

Alexander G. McAdie: "Mount Whitney as a site for a meteorological observatory" (November, 1903). This is a report of an expedition by Professor McAdie to the summit of Mount Whitney. The altitude of the mountain has been determined barometrically by a number of observers. Professor McAdie's result is 14,515 feet, but the levelings reported by Prof. Joseph N. LeConte since Professor McAdie's work give 14,434 feet.

Prof. Dr. J. M. Pernter: "Methods of forecasting the weather" (December, 1903); "Promotion of meteorology" (May, 1904). These two articles present an excellent summary of the arguments against the so-called long-range forecasts by means of planetary meteorology, and will do much to stem the tide of popular ignorance and superstition on this subject.

Oliver L. Fassig: "Kite flying in the Tropics" (December, 1903). This summarizes the results of meteorological work by Doctor Fassig on an expedition to the Bahamas under the auspices of the Geographical Society of Baltimore. A number of successful kite ascensions were made both from the land and the water, and the temperature, moisture, and wind were determined at various heights up to 4,000 feet.

G. C. Abbot: "Recent studies on the solar constant of radiation" (December, 1903). This is a most important publication in which for the first time meteorologists have been favored with quite reliable determinations of the absorbing power of the atmosphere for a number of specific wave lengths, ranging from the visible portion of the spectrum far down into the ultra red. A similar work by Professor Langley has been offered for publication, and a summary will appear in some future number of the Weather Review.

Prof. James Dewar: "Problems of the atmosphere" (January, 1904). The author computes the relative quantity of oxygen and nitrogen, carbonic-acid gas, and possible hydrogen up to the outer limit of the atmosphere, and gives important suggestions as to the origin of the aurora and its spectrum.

Gen. H. L. Abbot: "Disposition of rainfall in the basin of the Chagres River" (February, 1904); "Panama meteorology" (June, 1904). These form the conclusion of an important series of papers in which the meteorological data collected by the engineers of the New Panama Canal Company are subjected to discussion by one of the most prominent officers of the Engineer Corps of the United States Army. The great work of Humphreys and Abbot on the Mississippi River has been a standard for fifty years, and his work on the Chagres promises to hold an analogous position as regards that river.

Rev. Marc Dechevrens, S. J.: "Vertical component of the wind" (March, 1904). This article presents the results of observations for several years on the vertical movements of the atmosphere as recorded on the island of Jersey by the use of a special anemometer. The observations are very instructive, although it may be doubted whether they have anything but an extremely local application.

William B. Stockman: "The winter of 1903–1904." In this article Mr. Stockman gives a detailed record of departures from normal temperatures during the past winter. From New England westward to the Missouri Valley and southwest to the east Gulf States temperatures were generally below the normal. On the Rocky Mountain slope, the Plateau, and Middle Pacific districts temperatures were above normal.

Dr. Edgar Buckingham: "The amount of energy in a unit of light" (April, 1904). This is a very thoughtful paper revising our knowledge of radiant energy, and showing that to a certain extent we may calculate the temperature of a flame from its radiant energy, but the temperature of an ordinary body can scarcely be thus determined without involving undesirable assumptions.

E. L. Mosely: "The meteor of September 17, 1902" (April, 1904). The author collects the observations and calculates the path of this meteor. The sounds that emanated from it are, however, not explained by him.

R. Assmann: "The temperature of the air above Berlin" (April, 1904). The text and charts illustrate the results of the highest balloon and kite work, and give sections of the atmosphere showing the temperature day by day for fifteen months from October, 1902, to December 31, 1903. These are apparently the most accurate temperatures yet observed in the upper air, and show that at the height of 5,000 meters, or over 3 miles, the changes in temperature from day to day are surprisingly large, but very little less than at sea level. The so-called diurnal variation of temperature is of course very small, but the irregular oscillations, due to the passage of masses of warm air and cold air, are as large in summer as in winter. On the average there is a general inversion of the vertical temperature gradient; that is to say, the stratum between 500 and 2,000 meters has an average temperature a little higher than the strata above or below it. The level of freezing point varies between 3,000 meters and the ground. The international high balloon ascensions now being carried on in Europe on specified days promise to add more to our knowledge of the atmosphere than was obtainable by the use of high mountain stations; but both of these methods of investigation, as well as the kite work, have become of great importance. Each is specifically adapted to the investigation of some special problem.

S. A. Mitchell: "Pressure of light" (May, 1904). This is an exposition of the latest views accepted by experimental physicists as to the consequences of the well demonstrated fact that a beam of light, or any other form of radiant energy, exerts a pressure in the direction of the propagation. This pressure is inappreciable, when the body is large, in comparison with the attraction of gravitation, but becomes the most important item when the body is very small. By virtue of this pressure the finest dust of gaseous particles are repelled from the sun toward the earth and in all directions. When they impinge upon the outer boundary of the earth's atmosphere they may enter it temporarily and influence atmospheric and electric phenomena. These views have received their fullest development at the hands of J. J. Thomson, and at present the subject belongs to molecular and solar physics rather than to meteorology.

W. F. Tyler: "Sensation of discomfort" (May, 1904). The author has attempted to draw curves based upon personal observation showing under what conditions of temperature, wind, and moisture he experienced the greatest discomfort. His idea is quite analogous to that proposed by the editor some years since in which curves of perfect comfort were recommended. Either method seems to offer a convenient way of expressing something analogous to the so-called sensible temperature, and without involving the observer in any unsatisfactory theory.

The cooperation of so many physicists at home and abroad is gratefully acknowledged, and has contributed in an important degree in making the Monthly Weather Review of increased value to the service as well as to meteorology in general.

THE TEACHING OF METEOROLOGY BY WEATHER BUREAU OFFICIALS.

Meteorologists gratefully recognize the personal interest of the honorable Secretary of Agriculture in the general introduction of meteorology into the courses of study provided by the universities and higher technical institutions of the country. At his suggestion the mode of

teaching and the results obtained were made an important part of the work of the convention of Weather Bureau officials at Peoria, Ill., in September, 1904. At 14 educational institutions Weather Bureau officials, in addition to their regular duties and mainly outside of office hours, deliver courses of lectures on meteorology. The discussion at the convention brought to light the fact that a large amount of work is being done by Weather Bureau men in an educational way. The methods employed are determined by the different needs of the institutions receiving the cooperation of the Bureau, and range from impromptu talks to elaborately prepared lectures with suitable illustrations. The audiences included school classes, teachers' institutes, science associations, and business men's meetings. At many places regular and systematic courses are being given by Weather Bureau men, and at some of the leading universities a professor makes a specialty of the teaching of meteorology. We are anxious that it should be incorporated as a part of the science course in every university. I am of the opinion that some general study of meteorology should be required of persons who are fitting themselves to fill the position of civil engineer, mechanical engineer, geologist, or biologist, and that an elementary knowledge of meteorology and climatology is of prime importance in the study and cure of disease.

LECTURES BY PROFESSOR ABBE.

In addition to his work on the Monthly Weather Review, the editor, Professor Abbe, has delivered a course of lectures on meteorology to students who come to the Weather Bureau. These lectures should, perhaps, properly be considered as preliminary or introductory to those that may be given in future years at Mount Weather. One lecture of two hours' duration was given on consecutive Fridays from January to May, inclusive. The preparation of these lectures required much more time than was originally contemplated, and as the subjects were treated from a mathematical point of view it may be doubted whether they can properly be called popular. However, they presented the latest results of work done by some of the ablest meteorologists in the world. If they could be published they would perhaps be recognized as an extension of the knowledge collected by Hann in his Lehrbuch der Meteorologie. The publication of an English edition of this Lehrbuch is still greatly to be desired, but as the work is a herculean task it may perhaps be postponed until Professor Hann himself publishes a condensed edition of his volume.

ENCOURAGEMENT AND INCREASE OF EDUCATIONAL WORK.

The general subject of instruction in meteorology given by Weather Bureau men in the form of public lectures or college class work has been kept faithfully in mind. Every case worth mentioning has been noted in the Monthly Weather Review. Inspectors have been instructed to report fully as to the amount and character of the work and the possibility of increasing it. There is an increasing demand for class work in high schools and colleges. It is not likely that the Weather Bureau employees can fully respond to this demand, partly because of their want of training as teachers, but principally because of the absorption of their time in regular office work. It is to be hoped that our colleges and universities will establish proper positions for teachers of meteorology, and that some of our best men may fill

such places when retired from active service in the Weather Bureau. Meanwhile they are doing their best to respond to the demands made upon them.

LIBRARY.

The work of the library has been conducted on the same general lines as in recent years. On June 1, 1904, Dr. W. F. R. Phillips was succeeded by Mr. H. H. Kimball as librarian, climatologist, and supervising examiner.

The library is being used more and more as the work of the Bureau expands. Employees detailed to special lines of research need first of all to become familiar with the methods and results of others doing similar work. The library, therefore, becomes their starting point, and hence the necessity for having the books and pamphlets so arranged and indexed that all that relates to any given subject may be readily found.

As set forth in former reports, it has been the aim of the librarian to supplement the author index of books and pamphlets with a subject index, and this in turn with a bibliography of meteorological and allied topics made up from papers that appear in the periodicals of this and other countries. The bibliography is kept up to date, and most of the titles that are added to it are also published month by month in the Monthly Weather Review for the benefit of students. The subject index of books and pamphlets is still incomplete, however, and work upon it will be pushed during the coming year as fast as the resources of the library will permit.

The accessions during last year amount to 550 titles, of which 82 were by purchase and the remainder by exchange or gift. The total number of accessions now amounts to 24,680 books and 4,430 pamphlets, besides a number of miscellaneous works not catalogued.

Accessions are now limited to books and pamphlets bearing directly upon the science of meteorology. Many of these are the periodical publications of foreign governments and of scientific societies in all parts of the world; they contain so much that is of interest and value to meteorological students that it is plainly our duty to preserve them carefully.

A small collection of text-books, such as are required by observers in preparing for examinations for promotion, and also a few meteorological works of a more advanced character, is maintained at stations. Under the supervision of the library this collection of books is added to year by year as funds will permit. So many station officials are engaged in educational work in connection with high schools and colleges that a small library of this kind is necessary, although books are loaned to these officials from the central office library when practicable.

EXAMINATIONS FOR PROMOTION.

During the year 55 requests for examination were received by the supervising examiner and favorably acted upon. The subjects in which examinations are now given are arranged as follows:

1. For eligibility for promotion to the $1,000 grade: Arithmetic, English grammar, elementary meteorology.
2. For eligibility for promotion to the $1,200 grade: Algebra, elementary physics, plane trigonometry.

3. For eligibility for promotion to the $1,400 grade: Astronomy, plant physiology, advanced meteorology.

As a rule, all the subjects in a group are given at one examination. Of the 55 examinations held during the year 25 were on subjects in the first group, 21 in the second group, and 9 in the third group. Only five persons received less than the passing grade (70 per cent) on any subject.

Since one of the primary objects of these examinations is to elevate the educational standard among Weather Bureau employees, it is gratifying to note that the number of those who pass the examinations in the higher grades is increasing.

INSTRUMENTS AND EXHIBITIONS.

The Instrument Division is charged with the duties of providing, testing, adjusting, and supervising the installation of all meteorological instruments and storm-warning towers. During the past year the exhibits of the Weather Bureau at the Louisiana Purchase Exposition, St. Louis, were prepared and installed by the professor in charge of the division.

PRESENT STATUS OF STATION EQUIPMENTS.

The status of the instrumental equipment of stations at the close of business, June 30, 1904, was as follows:

One hundred and fifty-eight stations were completely equipped—that is, were supplied with instruments by means of which automatic records are made of the direction and the velocity of the wind, the duration of sunshine, the amount and the time of beginning and ending of rainfall, and, finally, the temperature and the pressure of the air. Of these stations the following were newly equipped with complete sets of apparatus, namely: Birmingham, Ala.; Modena, Utah (old station reequipped); Yellowstone Park, Wyo.; Maritime Exchange, New York; Brooklyn Eagle Building, Brooklyn, N. Y.; and Honolulu, Oahu, Hawaii. The number of completely equipped stations has been increased by twenty during the past year.

The following table shows the total number of the principal instruments in actual service:

Triple registers	166
Barographs	202
Thermographs	165
Tele-thermographs	8
Tipping-bucket rain gages	152
Electrical sunshine recorders	144
Photographic sunshine recorders	15

With one or two exceptions the stations that are not at present completely equipped are of slight importance, and, in general, have all the instruments necessary to the satisfactory performance of their work.

EQUIPMENT OF STORM-WARNING STATIONS.

The equipment of 26 selected stations with storm-warning towers and improved high-power lanterns was undertaken at the beginning of the year. The funds available for this were limited, and notwithstanding the fact that a considerable amount of other work was taken up, including the installation of an exceptionally high tower (115 feet)

at the Delaware Breakwater, Delaware, nearly all have been brought to a very satisfactory state of completion.

Almost a year is required in work of this kind, for the reasons that owing to the special nature of the towers, lanterns, etc., they are not carried in stock by contractors, but require to be manufactured after orders are placed, viz, after the beginning of the fiscal year. From sixty to ninety days are required for this purpose, and the shipment of towers to stations, the locations of which are often relatively inaccessible, consumes additional time. During this interim leases and other arrangements are made for title to the site of the towers, and bids for their erection and the installation of lights are obtained. Owing to the severity of the winters in the Lake regions it is necessary, in certain cases, to defer until springtime the erection and installation of towers and lanterns planned for during the winter.

At the close of business June 30, 149 steel towers, with improved auxiliary equipment, had been installed at as many stations distributed over the shores of the Great Lakes and the Atlantic and Pacific seacoasts.

High-power electric lanterns are installed at 77 stations, and improved oil lights at 68 stations. The towers at 3 stations are used for flag displays only.

The present plans contemplate the equipment of 10 additional stations, supplies for which have been ordered.

EXPOSITION WORK.

The preparation of the exhibit to be made by the Weather Bureau at St. Louis was actively taken up by the professor in charge of the instrument division, and practically all the apparatus and material required was boxed and ready for shipment February 1, 1904. Shipment was made a few days thereafter, and additional supplies, consisting of a special glass weather map, swinging chart frames (clusters), instrument cases, etc., were forwarded from Detroit, Mich. Nothing was injured or delayed in any way in transit. The work of installation began promptly on April 6 and was completed on April 29, the day before the opening, with the exception of the charging of the storage batteries and the installation of a special automatic card-printing press. The shipment of the latter had been unavoidably delayed, and the wiring of the building for electric current had not been completed. These deficiencies were supplied, however, in the course of a few weeks, and the exhibit was turned over to Mr. E. H. Bowie, in charge of the station at St. Louis, on May 21.

TELEGRAPH SERVICE.

TELEGRAPHIC REPORTS.

To meet as far as possible the pressing demands for a wider distribution of the daily telegraphic reports of observations, arrangements were perfected at the close of the year for a very generous increase in the number of such reports telegraphed over circuits or as special messages, to go into effect on July 1, 1904; including the establishment of a new circuit between Fort Worth, Tex., and St. Louis, Mo., with intermediate stations at Oklahoma, Okla., Wichita and Kansas City, Kans., and Hannibal, Mo. While for economic reasons it is impracticable to satisfy all demands in this respect, it is believed

that the present distribution of reports, resulting in a much more comprehensive display of weather conditions on the maps and bulletins issued at stations, will give general satisfaction, both to the public and to the officials charged with making district or local forecasts.

The services rendered by the principal telegraph companies in collecting and distributing the reports of observations and in telegraphing the daily forecast messages from the several district centers were, as a rule, prompt and efficient. Complaints of delays, errors, and other irregularities, when brought to the notice of the proper telegraph officials, received prompt attention and corrective action.

TELEGRAPH AND TELEPHONE LINES.

A new 3-conductor submarine telegraph cable was laid from the mainland to Block Island, R. I., a distance of 11 miles, on September 3, 1903. Preparations are now under way for laying submarine cables from near Nags Head to Manteo (Roanoke Island), N. C., from South Manitou to North Manitou Island, Lake Michigan, and from Flavel, Oreg., across the mouth of the Columbia River, to Fort Canby, Wash. All of these, it is expected, will be in operation within the next few months.

No old lines were abandoned or new ones built during the year.

The total receipts from commercial telegrams sent over Weather Bureau lines were $4,669.35, of which amount $2,337.33 was for United States tolls and was covered into the Treasury, and $2,332.02 was paid over to connecting commercial lines.

VESSEL REPORTS.

The reorganization, at the beginning of the year, of the vessel and wreck reporting service of the Weather Bureau, with additional stations at Sand Key, Fla., and Southeast Farallon, Cal., has largely added to the effectiveness of this popular feature of the Bureau, and has been much appreciated by maritime interests generally. Vessel and wreck reports are now furnished free of all charges, except for telegraph tolls over commercial lines, to all corporations and individuals who may apply for them. The average number of vessels reported per month from each designated station was as follows: Cape Henry, Va., 1,000; Jupiter, Fla., 57; Sand Key, Fla., 87; Point Reyes Light, Cal., 80; Southeast Farallon, Cal., 25; North Head, Wash., 112, and Tatoosh Island, Wash., 264.

Besides reporting passing vessels, these stations rendered important services in connection with wrecks and other maritime disasters. A brief account of the more striking cases follows:

On October 28, 1903, the schooner *Wempe Bros.* was wrecked on Bonilla Point, Vancouver Island. The Weather Bureau observer at Tatoosh Island telegraphed for assistance, which arrived in time to save the crew, but the vessel proved a total loss.

The U. S. torpedo boat *Moccasin* went ashore near Currituck Inlet, North Carolina, December 3, 1903. The Weather Bureau repairman at that point immediately opened a wreck station on the beach and put himself in direct telegraphic communication with the commandant's office at the Norfolk Navy-Yard, to convey all information and instructions to and from the scene of the wreck. Special acknowledgment was made by the Navy Department of the valuable services rendered in this connection.

On February 22, 1904, the schooner *Frank W. Howe* was observed by the North Head, Washington, station to be flying signals of distress. The observer promptly responded with an encouraging message by flag signals, and notified the life-saving crew, who succeeded in saving 7 of the vessel's crew out of 9. Vessel and cargo proved a total loss. Six days later distress signals were flown by the steam schooner *Grace Dollar*, when the same observer telegraphed for a tug, which was able to save both vessel and crew. The following is quoted from the Oregon Journal, of Portland, Oreg., in this connection:

Sailors plying up and down the coast have a true friend in Observer Kelliher, of the North Head weather station. During the past two weeks his "eternal vigilance" has been the means of saving a score or more of them from going down to watery graves. He was the first landsman to notice the helpless condition of the American schooner *Frank W. Howe*, and with admirable alacrity communicated the intelligence to the several life-saving stations, which immediately responded to the call. With the spirit of the true hero, at the risk of his own life and health, he joined in the work of rescue. Every man on board the doomed vessel was brought ashore in safety. A few days later the watchful observer discerned a small speck out upon the misty sea that did not look altogether right. With the aid of a telescope he discovered that it was a steamer in distress. He apprised the tugboat captains and they went to the rescue. Later they returned with the *Grace Dollar* in tow, and the alert Kelliher was again the direct means of saving life and property.

On June 6, 1904, the waterlogged schooner *Antelope* was sighted by the Southeast Farallon observer in great peril. Assistance from San Francisco was telegraphed for and arrived in the nick of time to save both vessel and crew.

PRINTING AND PUBLICATIONS.

The total number of copies, consisting of the regular publications of the Bureau, together with books, bulletins, and miscellaneous pamphlets and forms, printed and disseminated during the year amounted to 46,229,853, of which 21,919,853, an increase of 1,919,853 copies over the preceding year, were printed in the office of the Bureau, as follows:

Daily Weather maps, 569,680; Monthly Weather Reviews, 57,600; Climate and Crop Bulletins, 151,567; Snow and Ice Bulletins, 31,216; station maps, 3,093,400; and miscellaneous books, pamphlets, meteorological charts and forms, 18,016,390.

The remainder of the work, mostly station maps and forecast cards, was performed at the Government Printing Office.

There have been no additions to or improvements in the plant since last report.

PERSONNEL OF THE BUREAU.

CLASSIFIED SERVICE.

APPOINTMENTS.—During the fiscal year appointments were made as follows: By original certification at salaries ranging from $360 to $1,000 per annum, 48; by transfer at salaries from $1,000 to $1,250, 4, and by reinstatement at salaries from $360 to $1,000, 4; total, 56.

TEMPORARY APPOINTMENTS.—There were 14 temporary appointments for periods from ten days to three months and at salaries from $360 to $720; 25 emergency appointments for periods from a week to thirty days and at salaries from $450 to $1,250—all of which were made under the authority of the Civil Service Commission. Total appointments, all kinds, during the year, 95.

PROMOTIONS.—One hundred and thirty-one promotions were made, all but 3 being by advancement to the next higher grade. The exceptions were: One employee promoted from $1,600 to the position of librarian and climatologist at $2,000 because he was the only one between those grades qualified for the position. One was promoted from assistant observer at $1,000 to observer at $1,300 on account of his demonstrated fitness to fill the vacancy caused by the death of a section director, he being on duty as assistant at the station at which the vacancy occurred and for months during the illness of the deceased having performed the latter's duties. The third was in the case of a messenger certified by the Civil Service Commission to fill a temporary vacancy at $450 per annum. Coincidental with the termination of the $450 vacancy another occurred in the $600 grade, to which this employee was promoted and in which he served a few days only.

REDUCTIONS.—The exigencies of the service (change of station assignment requested by employees or necessitated by the public needs) required 8 reductions. In addition, 3 were made because of carelessness in the performance of important meteorological work, 4 because of physical disability, 1 because of frequent absences without authority and delaying payment of debts, 2 because of excessive use of intoxicants and neglect of duty, and 1 because of insubordination, making a total of 19 for all causes.

RESIGNATIONS.—There were 44 voluntary separations from the Bureau, of which number 9 were permitted for the purpose of enabling employees to accept appointments in other branches of the public service. Seven resignations were required, as follows: Three for inefficiency, 1 for excessive use of drugs, 1 for inefficiency and marked personal uncleanliness, 1 for nonpayment of debts, and 1 for delaying payment of debts and tardiness in reporting for duty. Total separations, 51.

REMOVALS.—Discharges were ordered in 9 cases, for the following causes: Unsatisfactory service, 4; intoxication and neglect of duty, 1; insubordination and unsatisfactory service, 2; intoxication and insubordination, 1; untruthful statement as to cause of absence and neglect of duty, 1.

DEATHS.—The total number of deaths was 5. During the preceding year but 2 were recorded.

UNCLASSIFIED SERVICE.

Appointments to the unclassified service numbered 9 (the salaries ranging from $1.50 per diem to $600 per annum), as follows: For duty at Washington, D. C., 4 (1 through the Board of Labor Employment and 3 for temporary periods of less than one month); for duty outside the District of Columbia, 5 (of which number 4 were appointed as temporary laborers at $1.50 per diem and employed in road building in connection with the new station at Mount Weather, Va.).

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

One unclassified employee was reduced, on account of change of station, at his own request. Eight voluntary resignations were accepted and 1, a station agent, was necessitated by a change of the status of

the station at which the agent was serving. But 2 unclassified employees were removed; one under strong suspicion of theft, and the other for obtaining leave of absence under false representation when his services were needed, and for absence without authority. No deaths occurred in the unclassified service.

ABSENCES DURING THE CALENDAR YEAR 1903.

STATION.—The average absence of station employees, with pay, during the calendar year 1903, was 1.1 days on account of sickness and 10.5 days on account of annual leave. Ninety-nine per cent of the station employees being males, the matter of sex has been disregarded in figuring the average.

WASHINGTON, D. C.—The average absence, with pay, of employees at Washington, D. C. (clerks, mechanics, messengers, and laborers), during the same period was, males, 4.7 days on account of sickness and 27.1 days on account of annual leave; females, 6.7 days on account of sickness and 28.8 days on account of annual leave.

The general average of the entire service, station and Washington combined, was 2.1 days on account of sickness and 14.9 days on account of annual leave.

STATISTICS OF THE SERVICE.

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

Numerical strength of the Weather Bureau, July 1, 1904.

At Washington, D. C.:		
Classified	169	
Unclassified	14	
		183
Outside of Washington, D. C.:		
Classified	476	
Unclassified	11	
		487
Total commissioned employees		670
Additional employees outside of Washington, D. C.:		
River observers	230	
Storm-warning display men	236	
Cotton-region observers	141	
Corn and wheat region observers	135	
Rainfall observers	71	
Fruit and wheat region observers	19	
Sugar and rice region observers	9	
Total noncommissioned employees		841
Total paid employees		[a] 1,511
Voluntary observers		3,367
Voluntary crop correspondents		13,406
Total numerical strength		18,284

[a] This total embraces all paid employees in the Bureau on July 1, 1904, including the Chief of Bureau, but excluding employees on furlough for three months or more.

Distribution of commissioned force.

In Washington, D. C.:

Accounts Division	13	Library	3
Barometry and research work	3	Meteorological Records Division	15
Climate and Crop Division	7	Miscellaneous mechanical work	4
Editor, Monthly Weather Review	2	Publications Division	45
Executive work	19	Supplies Division	9
Forecast Division	16	Telegraph Division	11
Instrument Division	10	Under captain of the watch	26

Outside of Washington, D. C.:

66 stations with 1 employee	=	66	employees.
47 stations with 2 employees	=	94	employees.
31 stations with 3 employees	=	93	employees.
17 stations with 5 employees	=	85	employees.
14 stations with 4 employees	=	56	employees.
4 stations with 6 employees	=	24	employees.
4 stations with 7 employees	=	28	employees.
4 stations with 8 employees	=	32	employees.
1 station with 9 employees	=	9	employees.
188		487	

Salaries paid in the classified and unclassified grades.

Grades.	July 1, 1904.	
	Station.	Washington, D. C.
CLASSIFIED GRADES.		
Highest salary	$3,000	$5,000
Lowest salary	360	450
Average salary	1,007	1,216
UNCLASSIFIED GRADES.		
Highest salary	720	720
Lowest salary	300	240
Average salary	541	534

Average salary for all (station and Washington, including the Chief of Bureau), $1,029.

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

METEOROLOGICAL RECORDS.

The routine work of recording the date of receipt of each meteorological form, examining and correcting same, tabulating the data contained therein for publication in the Monthly Weather Review, and Annual Report of the Chief of Weather Bureau; preparing error letters for the several forms; charting data from regular and selected voluntary stations for the several charts in Weather Review, and from which to prepare text; compiling data in compliance with requests from different Federal Departments and bureaus, including different divisions of the Weather Bureau; for State, county, and city officials; civil engineers, lawyers, physicians, health and pleasure seekers, numerous commercial concerns and purposes, and for certification under the seal of the Department has continued throughout the year.

INFORMATION SUPPLIED THE PUBLIC.

During the year 887 requests for data were answered, occupying in their preparation from a few minutes to days—sometimes as many as five to twelve. Besides this there were 90 calls for certified data, requiring 257 sheets, this not including a request from the sanitary district of Chicago, which required about one thousand hours to compile and verify the data, the work being performed by persons not connected with the Weather Bureau, and paid for by the sanitary commission.

Owing to the limited clerical force and the demands upon the time of clerks for more important duties, it was found necessary to adopt a new policy in connection with requests for certified data, viz: When there was a Weather Bureau office in the city in which applicant resided and the data were desired for that place the request was complied with, and in the letter of transmittal it was suggested to the applicant that he arrange to have future needs for such data filled by process of subpœna duces tecum served upon the official in charge of the station.

For requests for data which did not require certification from persons residing in a place where there is a Weather Bureau station, the applicants were referred to the local office and informed that they would be granted access to the records and allowed to extract the desired data. During the last few months applicants for information contained in climate and crop publications were referred to the local section directors.

IMPROVEMENTS IN SERVICE.

A scale for determining, without computation, wind velocities from the triple register sheets, devised and used by Mr. Arthur Thompson for several years past, was adopted as the standard gauge for station use and the necessary drawings made from which to have plates engraved for the purpose of printing the scales and issuing them to all stations.

All instructions for the preparation of meteorological forms, which heretofore have appeared on the backs and covers of the several forms, and in various other places, were revised and assembled in one publication under the caption, "Instructions for preparing meteorological forms, division of meteorological records circular, 1904." In this circular have been brought together all instructions for preparing meteorological forms, which will do away with the printing of instructions on the several forms, be a great convenience to observers, and render unnecessary the destruction of editions of forms which have become obsolete because of amendments to instructions relative thereto and the issue of new editions of the forms, thereby saving the expense of printing new editions. The circular will be issued each year, amended to date so far as practicable.

Under the supervision of the official in charge of the division, Mr. Eric Miller codified, and practically rewrote, the Instructions to Observers, in future to be known as "Station Regulations."

Negotiations are under way to obtain a large number of charts of the very best procurable types of clouds, with a view of having them mounted in a neat and attractive manner for issue to stations and for

sale to teachers of meteorology and physical geography and others. It is believed they will meet a popular want and their sale be large.

RECOMMENDATIONS CONCERNING APPROPRIATIONS FOR 1905.

It is recommended that the appropriations for the fiscal year beginning July 1, 1905, be the same as those for the current fiscal year, with the following exceptions:

An increase of $1,000 per annum, from $2,000 to $3,000 per annum, in the salary of the chief of the Climate and Crop Division, is urgently recommended. This official has charge of the climate and crop service of the Bureau. He writes the weekly National Crop Report, and supervises the reports issued by State section directors. For many years his work has been of such a high order, and has so commended itself to the agricultural and commercial industries of the country as to reflect credit upon the public service. In order that these reports, which frequently influence the price of the products of the farm, may command the confidence of the public, it is essential that there be assigned to the work an official whose integrity, as well as whose ability, is so high as to be above suspicion. The present incumbent has made no request for advancement, but I am firmly of the opinion that it would be a wise economy, as well as a just action, to recognize his many years of valuable and faithful public service by making the increase in salary herein recommended.

It is also recommended that the salary of the assistant chief of the Division of Accounts of the Department of Agriculture, who is appropriated for in another part of the bill making appropriations for the support of the Department of Agriculture, and who serves under the joint direction of the Disbursing Officer of the Department and the Chief of the Weather Bureau, as disbursing clerk of the Bureau, be increased from $2,000 to $2,500 per annum. For nearly ten years I have had the benefit of the valuable assistance of this official in handling the fiscal affairs of the Bureau. I have implicit confidence in his integrity, and know that his ability as an accountant is of the highest order. If the committee in Congress would look into the manner in which his many and important duties are performed, I believe that they would agree with me that his long and faithful service should be rewarded by the advancement in his salary that is now recommended. The Disbursing Officer of the Department joins me in this recommendation. There is no part of the work of the Weather Bureau that requires higher executive and business ability than that performed by this officer.

An increase of $20,000, as submitted under "Salaries outside of the city of Washington," is to cover the salaries of officials and employees required to establish eight new stations.

An increase of $2,000, as submitted under "Fuel, lights, and repairs," is for the purchase of new boilers for heat, light, and power.

An increase of $20,000, as submitted under "General expenses," is for supplies and maintenance of eight new stations.

An increase of $52,000 (from $48,000 to $100,000), as submitted under "Buildings, Weather Bureau," is for the purpose of erecting not less than ten Weather Bureau observatory buildings. The present

appropriation provides for the erection of not less than five buildings, which number has not met the growing demands for the construction of new observatories. The wisdom of the Department in erecting and owning its own observatories is more manifest each day. It not only saves the amount now paid for rent of office quarters, but provides structures with roof exposures suitable to meteorological purposes, and also adds dignity to the public service.

An increase of $8,000 (from $27,000 to $35,000), as submitted under "Cables and land lines," is for the purpose of constructing cables and land lines to connect Beaver Island with Charlevoix, Mich., or some point in the immediate vicinity.

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