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U. S. DEPARTMENT OF AGRICULTURE,

WEATHER BUREAU.

REPORT

[administrative]

OF THE

CHIEF OF THE WEATHER BUREAU

FOR

1900.

BY

WILLIS L. MOORE

[From the Report of the Secretary of Agriculture.]

WASHINGTON:
WEATHER BUREAU.
1900.

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., August 28, 1900.

SIR: I have the honor to submit a report of the operations of the Weather Bureau during the fiscal year that ended June 30, 1900.

Respectfully,

WILLIS L. MOORE,
Chief U. S. Weather Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

WORK OF THE YEAR.

FORECASTS.

The first and most important duty of the Weather Bureau, viz, the forecasting of severe storms, tropical hurricanes, cold waves, and frosts has received careful attention during the year. The extension of the system of observing stations over the West Indies and the Caribbean Sea in 1898 and by cooperation with Mexico over the latter country in 1899, very greatly increased the field of observation and enabled the Bureau to herald the approach of all dangerous tropical storms. The approach and movement of cold waves and the occurrence of killing frosts and heavy snow within the bounds of the United States were also accurately forecast.

No effort has been spared to improve and strengthen the forecast service wherever and whenever opportunity presented itself. Our latest effort has been directed toward a more speedy collection of telegraphic and cable reports from the Republic of Mexico and the West Indies. The outlook for obtaining telegraphic advices from these far-off regions within an hour and a half after the observations are made is promising.

An observing station was established at Turks Island, latitude 21° 21′ N., longitude 71° 7′ W., during the latter part of June, 1900, and regular meteorological observations were begun July 1, 1900. The station at Turks Island was needed to complete the chain of stations extending from the Lesser Antilles northwestward to Bermuda and the southeastern coast of the United States.

North Atlantic Forecasts.—The most important innovation by the Weather Bureau in the near future will be the beginning of special storm forecasts for the North Atlantic Ocean, a step made possible by the use of reports now received from the West Indies, the Bahamas, Bermuda, and those to be received from the Azores, Portugal, France, and Great Britain when the cable system connecting Lisbon, the Azores, and New York City shall be completed. The transoceanic and coastwise commerce of all nations will doubtless receive as much benefit from this important extension of the weather service as the commerce of the Caribbean Sea, the Gulf of Mexico, and our South Atlantic States has received as a result of the action of the United States in extending its meteorological reporting stations over all the important islands of the West Indies.

Whenever possible a forecast will be made of wind force and wind direction for the first three days of the route of all outgoing steamers, and for an equal period for such as place themselves in communication with the Bureau before leaving European ports. We view with much satisfaction the consummation of an object so long sought both by the meteorologist and the mariner.

This extension of the forecast service is an inevitable outcome of that study of the meteorology of the whole Northern Hemisphere which was inaugurated by the Weather Bureau in 1873.

The Bureau has arranged to send by the new cable daily messages containing observations from the eastern part of the United States to Capt. F. A. Chaves, director of the meteorological observatory at St. Michaels, Azores, thereby enabling him to issue storm warnings for his vicinity.

Eastward of the meridian of Bermuda the Bureau is especially interested in obtaining all possible knowledge of the conditions of the so-called North Atlantic area of high pressure, which extends from the Atlantic coast eastward to the coast of Africa and southern Europe. It is believed that the development of and the paths taken by West Indian hurricanes, the intensity and duration of hot waves, and to some extent the movement of cold waves, depend upon this great area of high pressure which covers a region larger than the United States.

Hurricanes.—In view of the importance of the forecast work of the Bureau, and as a matter of record, I append an extract from the report of the official in charge of the Forecast Division, which gives in some detail a history of each hurricane that occurred during the year, with copies of a few statements from persons not connected with the Bureau regarding the efficiency of the storm-warning service.

The most destructive storm of the year appeared east of the Island of Martinique on the morning of August 7, 1899, and moved thence north of west to Porto Rico by the morning of the 8th, devastating

the more southern of the Leeward Islands of the Lesser Antilles during the afternoon and night of the 7th, and causing the loss of hundreds of human lives and the destruction of millions of dollars' worth of property in Porto Rico on the 8th. Continuing a north of west course, the storm crossed the northern portion of Santo Domingo during the night of the 8th, caused a considerable loss of life and property in the Bahama Islands during the 11th and 12th, and from the 13th to the 17th skirted the south Atlantic coast of the United States, attended by gales of almost unprecedented severity on the North Carolina coast.

From the time this hurricane appeared within the region of observation until it disappeared off the Virginia coast, accurate advices regarding its character and course were telegraphed along the line of its advance, and preceded its arrival by periods which varied in length from a few hours in the Leeward Islands to thirty-six and forty-eight hours along the south Atlantic coast.

The following reports from points along the path of the storm contain data regarding its character and effects, and indicate the action taken by the Weather Bureau to disseminate warnings of its approach.

The following communications were received by Mr. W. H. Alexander, Observer, Weather Bureau, St. Kitts, W. I.:

ST. CHRISTOPHER, NEVIS, ADMINISTRATOR'S OFFICE,
St. Kitts, W. I., August 12, 1899.

I beg to tender on behalf of the government, and the public generally, sincere thanks for the information and timely warning afforded by you as to the approach of the late destructive hurricane, whereby this island was, no doubt, saved from more serious damage.

I have the honor to be, sir, your obedient servant,

(Signed) F. S. WIGLEY,
Acting Administrator.

CONSULAR SERVICE, UNITED STATES OF AMERICA,
St. Kitts, W. I., August 19, 1899.

I take this opportunity to express my sincere thanks to you for the service rendered by you on the 7th instant, and I have no hesitation in stating that the prompt and efficient manner in which you gave notice of the approaching cyclone was of the greatest benefit to this island, and was much appreciated by its inhabitants.

I am, dear sir, yours, truly,

(Signed) EMILE S. DELISLE,
United States Vice Com. Agent.

COLONIAL BANK,
St. Kitts, W. I., August 15, 1899.

The warnings and information given by you prior to and during the hurricane of the 7th instant, have proved very valuable and of the greatest use to the inhabitants of this island, and must have been of similar value to some of the islands northwest of us, and the usefulness of the Weather Bureau must be considered as fully established.

Yours, truly,

U. U. GEDDES,
Manager.

WEST LODGE,
St. Kitts, W. I., August 10, 1899.

Allow me to thank you for your courtesy on Monday the 7th instant, when I called at your office, and to express my appreciation of the timely warning you gave of the cyclone then approaching us, which was of great value to the people of this island, as they were able to make every possible preparation before the storm reached us.

I am, yours, respectfully,

F. W. DEATON.

The benefits derived in Porto Rico, the next island in the path of the hurricane which possessed facilities for receiving and distributing storm warnings, are indicated in the following extracts from a report made by R. M. Geddings, Observer, Weather Bureau, San Juan, Porto Rico:

Immediately upon the receipt of the hurricane warning on the 7th, hurricane warnings were ordered at Arecibo, Aguadilla, Mayaguez, Ponce, Arroya, Humacao, and Fajardo. The flags were displayed from the Weather Bureau office flagpole, and also from the signal staff on Fort Cristobal, the same pole from which all marine signals are displayed at this port. As soon as they were hoisted vessels began to move to a safe anchorage, and the warning was the means of saving many of them.

Reports from Ponce to date (August 16) show that nearly 500 bodies have been recovered, and it is thought that there are many yet to be found. In Humacao 60 persons were killed, and from every side come reports of tremendous loss of life and property.

The Bureau has been much complimented on its service here. The warnings were the means of saving much life and property. At Mayaguez the authorities and all masters of vessels in port were notified, and a number of vessels which were about to sail remained in port. The Weather Bureau displayman at Aguadilla reports that the timely advice was very valuable. At Ponce the hurricane warning order sent at 11 a. m., of the 7th, came to hand on Playa of Ponce at 5 p. m. It was immediately posted in the most public place, and numerous persons were advised thereof. The owners of boats, lighters, etc., availed themselves of the warning and placed their craft out of danger, and many persons placed their families out of harm's way. The warning flags were kept flying until flood and heavy breakers washed the pole down. Immediately upon the display of the warnings at Arroya all vessels were placed in supposed safety. Owing to the timely warnings no lives were lost among the shipping at Arroya. At Arecibo the authorities were notified and the warnings were spread as much as possible among the people. The flood of the three rivers which, by a common mouth, empty into the sea near Arecibo, was such an enormous one that old people have no recollection of anything equal to it, and the loss of life and property from the flood was enormous. At Fajardo the warnings prevented damage of importance, as word was immediately sent to plantations and shipping to prepare for an emergency. At Humacao the warning was well justified. A tidal wave destroyed almost all the houses in the port, and the loss of life was heavy. The display was of little benefit at Humacao, for the reason that during the last twenty-three years the inhabitants have been warned of many storms that never arrived, and believed that this would be the case in the present year.

A report made by Thomas J. McLain, United States Consul at Nassau, Bahamas, states:

The storm began at Nassau about 4 p. m., August 11, and ended late in the afternoon of the 12th. Warning of its approach had been given by cable by the Weather Bureau at Washington, so that the storm was expected and preparations were made for its arrival, which lessened the amount of damage done very materially. On the islands the loss of life and property was considerable, and many small vessels were torn from their moorings and wrecked. Mr. P. H. Burns, Superintendent of Bahamas Cable, Nassau, calculated that 50 small craft were lost, and placed the total loss of life at 150, probably 100 of which were lost at Red Bays.

The second severe West Indian hurricane of the season was felt only over the Leeward Islands of the Lesser Antilles on September 8, from which region it moved northwest, and recurved northeastward over the Bermuda Islands during the night of the 12–13th. On September 7 the Weather Bureau observers in the eastern West Indies were advised that conditions were threatening over the Lesser Antilles, and to be alert to take local action, if necessary. The morning of the 8th the approach of a severe storm from the eastward of St. Kitts was

indicated, and hurricane warnings were sent to that island, and advisory messages were telegraphed to other observers in the threatened district. It was calculated at that time that the hurricane would reach only the extreme northeast islands, and subsequent events showed that this was a correct calculation. At St. Kitts the wind reached and maintained a velocity of 62 miles an hour from 8:18 to 8:24 p. m. of the 8th, and a momentary or gust velocity of 120 miles was recorded at 5:51 p. m. The islands to the east and northeast of St. Kitts experienced correspondingly severe winds, and reports from vessels show that the violence of the hurricane did not lessen during its subsequent course over the ocean. The hurricane was slightly less intense and far less disastrous at St. Kitts than the storm of August 7, the latter fact being due to the circumstance that the August storm left only the stronger trees and buildings.

On the morning of the 9th the following message was sent to the central office of the Canadian Meteorological Service at Toronto, through which reports from Bermuda are transmitted to the Weather Bureau:

Hurricane central northeast of Porto Rico, moving northwest, and is likely to pass near Bermuda.

Similar messages were at the same time sent to the New York and Philadelphia Maritime Exchanges and to the Press Associations. The hurricane reached and passed Bermuda the night of the 12th. At Bermuda many houses were blown down and much property was destroyed.

The third and last destructive tropical storm of the year advanced from the west part of the Caribbean Sea along the Atlantic coast of the United States from October 28 to 31. For several days previous to the 28th, Atlantic coast shipping interests were advised of threatening weather conditions, and a careful watch was kept for a storm development which, at that season, these conditions favored. Reports of the 27th showed the looked-for development south of central Cuba, and, during the subsequent movements of the storm, warnings of dangerous gales were telegraphed to points along the Atlantic coast of the United States, twenty four to forty-eight hours before the beginning of the gales. The storm was exceptionally severe along the North Carolina and Virginia coasts, where an immense amount of damage was caused by heavy seas and high tides. On the New Jersey coast thousands of dollars' worth of fishing property was saved by fishermen who profited by the Weather Bureau warnings, and nets to the value of thousands of dollars were lost by fishermen who did not heed the warnings.

Cold waves, snows, etc.—The cold waves, frosts, and heavy falls of snow were forecast with great accuracy. In the Gulf districts alone, the warnings of frosts and freezing weather resulted in saving fruit and vegetables to the value of hundreds of thousands of dollars.

The cold waves of February, 1900, were particularly severe, and covered practically the entire United States. In New Mexico, warnings issued on the 6th prompted precautionary measures which saved a number of human lives and prevented the loss of live stock and

perishable produce. In the valleys of California special warnings of the heavy frost of February 7 were widely distributed. In the sugar and vegetable growing districts of the middle and west Gulf States thousands of dollars were saved by protective measures which were taken upon the receipt of warnings of freezing weather. Announcement was made on the 16th of the severe cold which reached Florida the night of the 17th, and on the morning of the 17th this announcement was supplemented by special forecasts and warnings of freezing weather as far south as Tampa. As a result of these warnings thousands of acres of orange groves were protected, either by the system of tents now in use, or by the use of dry heat. As a consequence nearly all bloom, representing many thousands of dollars to the growers, was saved. A large acreage of pineapples and vegetables was also protected and saved. Figures furnished by growers show that the value of orange and other citrus trees, pineapples, and vegetables saved in Florida aggregated over $500,000.

During February 28 and March 1, a heavy snowstorm extended from the lower Lake region over the interior of New York and central and northern New England. Timely warnings of this storm proved of great value to the public. A heavy and general snowstorm visited the Great Lakes March 4 and 5. This storm resulted in a partial blockade of railroads in Wisconsin and Michigan. All transportation interests had, however, been warned of its approach and prepared for the emergency.

On the 15th of March heavy snow fell in the Middle Atlantic and New England States and the upper Ohio Valley. All interests in the Middle Atlantic and New England States were notified the morning of the 15th that heavy snow and increasing northeast winds were indicated for the afternoon and night of that date from the upper Ohio Valley over the Middle Atlantic and south New England States and the lower Lake region.

Floods.—The month of April, 1900, was marked by destructive floods in the smaller streams of the Southern and Southwestern States. In districts where the river and flood service of the Weather Bureau had been organized, warnings were issued of the floods referred to. The extension of this service over Texas was begun last year and will be pushed as rapidly as available funds will permit. Notwithstanding the lack of data regarding the rivers of that section the floods of Texas were, in some degree, anticipated by the forecasts and warnings. On the 7th the interests along the Colorado River south of Austin were advised of a sudden and decided rise in the river. On the 27th all points along the Brazos and Colorado rivers were warned of a rise, and freshets in the smaller streams of Texas were forecast. In Alabama the damage by flood along the Tombigbee and Black Warrior rivers was placed at $1,500,000, and property to the esti-

mated value of $250,000 was saved by the Weather Bureau warnings of the 17th.

DISTRIBUTION OF DAILY FORECASTS AND SPECIAL WARNINGS.

The number of forecasts distributed daily during last year was greater than for any previous year. The methods of distribution have not been changed in any respect. It has been possible, however, to utilize the *rural free delivery* service in furnishing forecasts and warnings to the rural population in districts where such service has been organized.

The use of the rural free delivery service began during the closing months of the year. There is no class of people that will appreciate the forecasts more than those in agricultural communities, and I feel safe in saying that in reaching the farmer with this information by means of the rural free delivery, we have attained one of the great objects for which the Bureau was established.

At the close of the year 111 rural free delivery centers of distribution were in operation, supplying 11,625 families, or an average of over 100 families for each carrier. This work will be further extended during the coming year, and effort made to have as many routes served, as it may be possible, with the morning forecasts.

STEEL TOWERS FOR THE DISPLAY OF STORM WARNINGS.

In order to meet the increasing demands of commercial and shipping interests for storm warnings of the highest possible efficiency, it has been necessary to reorganize the equipment and provide tall masts or flagstaffs at a large number of stations at which either flags or lanterns are displayed. An important improvement in this connection has been made during the past year by the adoption of a specially constructed steel tower with a flagpole at the summit. After careful tests and improvements of a sample tower of this character, a standard pattern was devised and full drawings and specifications prepared. These towers are now under construction by contract, and steps have been taken to equip with them about fifty of the more important display stations.

Wherever it is possible to do so, electricity is used for the illumination of the lanterns used in the night warnings, and special efforts have been made to increase the efficiency and improve the quality, not only of the red and white lanterns illuminated by electric lights, but also the lanterns supplied to our ordinary stations where electricity is not available and where oil must be used.

All this work is in an advanced state and it is expected that fifty or more stations will be fully equipped before the occurrence of the severe storms of the fall and winter seasons.

WIRELESS TELEGRAPHY.

The Secretary of Agriculture, recognizing the advantages that would result to commerce and navigation by the establishment of electrical communication between vessels at sea and exposed points on our lake and sea coasts, and also between the islands along said coasts and the mainland, has authorized the Weather Bureau to systematically investigate the various methods of electrical communication without wires. The progress already made in this investigation is eminently satisfactory. The results thus far achieved will be communicated at another time.

BAROMETRIC REDUCTIONS.

A thorough reduction of the barometric observations taken by the service during the past thirty years to a homogeneous system has been undertaken. This study includes an investigation of the various elevations occupied by the barometers, the normals at each station and the variations from year to year and from month to month. A careful review of the several systems heretofore employed by the Bureau in making reductions to sea level has been completed, and a new set of gradients and reduction constants inside and outside the Rocky Mountain Plateau region has been constructed from many years' observations. A new set of pressure reduction tables is being prepared, which will include the results of this discussion. It is proposed to extend the system so that theoretical maps of the weather conditions may be readily constructed as often as desired at the 3,500-foot plane and the 10,000-foot plane, as well as at sea level. This work has been greatly needed by the service for many years, not only to correct some well known imperfections in the construction of the daily weather maps and the other sea level data used in general work, but to take advantage of the facts derived through the records of a long series of years. The work will require another year to complete.

ECLIPSE OBSERVATIONS.

Prof. F. H. Bigelow conducted a survey of the track traversed by the shadow of the total eclipse of May 28, 1900, for probable cloudiness, and a suitable report was prepared for the use of observers on that occasion. Suitable observations were also secured during the eclipse of the meteorological conditions, especially for a study of the shadow bands, and the absorption of the sun's heat in the atmosphere as affected by the shadow. The eclipse was observed by Professors Bigelow and Abbe, at Newberry, S. C., and a report is being prepared which promises to contain some new and desirable information regarding the effect of solar action upon the earth's atmosphere.

LAKE MARINE SERVICE.

Constant attention has been given to the very large interests cen-

tered about the lake marine. While the size and staunchness of the vessels that navigate the Great Lakes have greatly increased during recent years, a considerable number of vessels are wrecked or seriously damaged each year. During the season of navigation of 1899 thirty vessels, representing a money value of $328,900, were lost through causes directly connected with the weather, and damages to the amount of $284,850 were sustained by fifty-seven other vessels, due to the same cause.

Ninety-one persons lost their lives by shipwreck on the Great Lakes during 1899. It is not easy to determine what percentage of this number is properly chargeable to the weather, or to what extent bad seamanship and unseaworthy vessels contributed to the total number of persons lost.

The arrangements for distributing the forecasts and warnings of the Weather Bureau to vessels navigating the Great Lakes were never before so complete as at the present time. During the season of navigation each of the twenty thousand or more vessels that pass Detroit receives the latest information available with regard to the force and direction of the wind and the location and probable movement of storms. Similar information for the use of vessels bound northward from Chicago and other ports on Lake Michigan is distributed by the Weather Bureau officials in Chicago, while vessels entering or leaving Lake Superior receive the latest advices from the official in charge of the Weather Bureau office at Sault Ste. Marie.

IMPROVEMENT OF STATION EQUIPMENT.

A systematic plan for the improvement of the instrumental equipment and the office furnishings of Weather Bureau stations was put into operation a few years ago. The instrumental equipment of the different stations was fixed according to the varying needs of each locality. If the local station happened to be within the sphere of influence of large educational institutions, its instrumental equipment was enlarged and so displayed as to be easily accessible to visiting students and classes. A systematic plan for the betterment of the office furniture at outlying stations of the Bureau has also been in operation for several years past. Up to within recent years remnants of the original furniture procured thirty years ago were in use at many of the smaller stations. All of these have now been replaced by articles not only of modern manufacture, but also of uniform design and excellence throughout the service. By a judicious distribution of the supplies as they became available it has been possible, within about three years to thoroughly equip and refurnish the majority of the stations outside of Washington, D. C.

MONTHLY WEATHER REVIEW.

The Monthly Weather Review has been published regularly each

month under the able editorship of Prof. Cleveland Abbe. The Review contains text, charts and statistical tables illustrating the dominant weather conditions of each month; it also contains what may be called a popular summary of the forecasts, storms, floods, relation of climate to crops, and special contributions furnished by those devoted to the progress of meteorology, both within and without the service. The Review is especially helpful to employees of the Weather Bureau, since it offers a convenient medium for the prompt publication of abstracts or complete memoirs on many subjects directly connected with the practical work of the Bureau. During the past year the various methods of protection against frost were widely discussed and disseminated in the Review. The general results of the work done with kites and balloons in the study of the atmosphere, especially the data afforded by the work done at the Meteorological Observatory at Trappes, near Paris, under the directorship of Teisserenc de Bort, were published and discussed.

EXAMINATIONS FOR PROMOTION.

In selecting employees of the Weather Bureau for preference two conditions must be satisfied: First, the candidates must have a thorough knowledge of the practical work of the Bureau and be skilled in its performance; and second, they must possess certain scholastic requirements, including a knowledge of the fundamental principles underlying the science of meteorology. In order to obtain a list of employees eligible for promotion to the higher grades, examinations were held at a number of places during the first half of 1900. The general scope and character of the examinations are shown in the following extracts from orders:

Hereafter observers will be examined in the studies indicated below. Officials of or above the grade of local forecast official or section director will not be examined; but those who have not completed, at college or elsewhere, the course outlined herein, are requested to do so by general reading and study, as their duties may permit.

The course of study is not made obligatory, as it is not desired to work hardship upon those whose duties are already numerous and exacting, but it is intended that after January 1, 1900, only those observers who have been examined and found proficient in English grammar, arithmetic, and elementary meteorology will be recommended for advancement to the salary of $1,000; that for promotion to the grade of $1,200 or $1,300 observers will also be examined in algebra and physics; and, further, that an examination in the remaining studies will be required for advancement to the position of local forecast official or section director.

As soon as an observer reports that he considers himself proficient in one or more of the required subjects, effort will be made to have him examined therein as soon as possible. These examinations will be held, as a rule, by an inspector or an official in charge. Special arrangements will be made for examining persons serving alone at stations.

The following are the subjects:
English Grammar.
Arithmetic.
Elementary Meteorology.
Algebra, through quadratic equations.
Elementary Physics.
Trigonometry, plane, including use of logarithms.
Elementary Astronomy.
Elementary Plant Physiology.
Advanced meteorology.

For the information of messengers and others who aspire to appointment as observers in the Weather Bureau, it is stated that hereafter the Civil Service observer examination will be made to include the first four studies indicated in these Instructions.

In conducting the examinations required by Instructions No. 79, 1899, the supervising examiner in Washington will prepare all questions and forward the same to the official designated to hold the examination, which shall take place under such directions as to details as the supervising examiner may prescribe.

An observer must have passed in all studies prescribed for grades below and including his own before he can be examined for promotion to a higher grade. In case of failure to pass in any subject, he may be again examined in such subject after the lapse of three months.

Thus far seventy-five candidates have been examined, of which number fifty-eight have passed satisfactorily in three or more subjects.

The advancement of an employee from the lower to the higher grades does not depend wholly upon his ability to pass a creditable examination in the required subjects. In addition, he must show, in the performance of the duties to which he may be assigned, that he possesses the qualifications necessary to properly conduct a station, or perform work equivalent thereto, under all conditions that may arise.

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