

[From annual reports of the Department of Agriculture for 1913.]

REPORT OF THE CHIEF OF THE WEATHER BUREAU. 1915

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU,
OFFICE OF THE CHIEF,
Washington, D. C., August 29, 1913.

SIR: In submitting this annual report of the operations of the Weather Bureau during the fiscal year ended June 30, 1913, it seems proper to state that the undersigned entered upon his duties as Chief of the Weather Bureau August 4, 1913. Consequently such of the report as relates to work done during the past fiscal year deals with affairs accomplished under the administration of his predecessor.

Very respectfully,

C. F. MARVIN,
Chief of Bureau.

The SECRETARY OF AGRICULTURE.

STATIONS AND OBSERVATIONS.

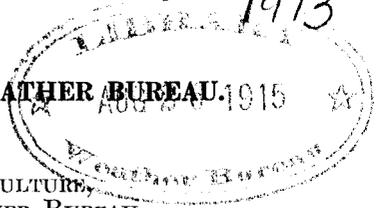
The station and observational work of the Weather Bureau has arrived at the present stage through a slow process of development. In the beginning stations were established primarily for the purpose of furnishing data for use in weather forecasting, being supplemented, nevertheless, by the numerous cooperative stations, the nucleus of which was taken over from the Smithsonian Institution. In later years the value of weather observations has greatly increased because of the increasing application of scientific methods to agriculture and to many lines of commercial activity. An insistent demand for stations has therefore sprung up from all large centers of trade and commerce—a demand that has been met by the maintenance of a large number of so-called corn and wheat, sugar and rice, and cotton region stations, and the like.

It is scarcely possible to estimate the great value of this service in the interests of agriculture and commerce, and in reality we are but just beginning to realize its possibilities.

ORCHARD INVESTIGATIONS.

This line of work was inaugurated in 1912, and more completely organized during the past year by the establishment of numerous stations in certain orchards in western North Carolina, Colorado, Utah, southern California, and Oregon, with the object of correlating certain climatic phenomena and topographic conditions in their bearing on the occurrence and distribution of frosts in the orchards under investigation. Valuable reports are now coming in from these projects for discussion by Prof. H. J. Cox, at Chicago.

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

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WATER RESOURCES BY SNOW SURVEYS.

A new line of work was inaugurated two years ago, and continued last year, by A. H. Thiessen, in charge at Salt Lake City, who advocated systematic measurements of the blanket of snow remaining on the ground at the close of winter over the entire watershed of streams that contribute to important irrigation projects. Such snow blankets constitute the chief storehouse of water supply for the irrigation service in question. Mr. Thiessen has shown that, in certain cases at least, definite measurements of the actual available water supply can be made early in the spring of each year, with the result that the irrigation service can be conducted throughout the following summer upon a basis of comparative facts rather than averages or estimates. The great value of water-resource measurements of this character is obvious, and the service is being extended.

OBSERVATORY BUILDINGS.

The Weather Bureau observatory building at Key West, Fla., which replaced the one that was so badly damaged by the hurricane of October 11, 1910, as to make a new structure necessary, was completed and occupied on January 23, 1913.

The construction of two new observatory buildings was authorized by Congress at its last session. These buildings will be located at Cincinnati, Ohio, and Sandy Hook, N. J. It is expected that they will be completed and occupied before July 1, 1914.

TELEGRAPH SERVICE.

The importance of the telegraph service is coequal with that of stations and observations, at least with respect to the forecast work and the immediate dissemination of important information.

One of the few telegraph lines owned and operated by the Weather Bureau runs along the south Atlantic coast from Cape Henry to Hatteras. Four hundred and seventy-five old and worn-out poles were replaced at points along this line during the past year, and a new submarine cable $1\frac{3}{4}$ miles long was purchased and will be laid in August of the present year across Oregon Inlet, N. C., to replace the old defective cable deeply buried in sand at that point. Further minor repairs will be effected on this line and better provisions made for the maintenance and repair of the line. Some slight improvements will also be effected on the Port Crescent-Tatoosh Island line. In fact, a small building is needed on this line at Neah Bay, Wash.

FORECASTS AND WARNINGS.

The nature of this service is such that but a small part of it can be regarded as essentially new work. The issue of the weekly forecasts, as well as of the daily forecasts, was continued during the year. The weekly forecast is prepared each Sunday morning and immediately distributed through the channels of the press associations and by mail. It is revised Monday and published in the National Weekly Weather Bulletin, issued each Tuesday during the crop-growing season.

A number of special stations have been established in the tobacco fields of Wisconsin, and frost warnings will hereafter be issued for the benefit of this industry.

Through cooperation with the naval radio service of the Navy Department, arrangements have been completed for a daily broadcast distribution of wind forecasts and warnings from two points—Radio, Va., and Key West, Fla.—beginning July 15, 1913. By this means it is hoped to place valuable information in the hands of each shipmaster approaching or navigating the coastal waters of the eastern United States and the West Indies.

The further study of meteorological data with the view of increasing the percentage of accuracy of the daily and weekly forecasts and, if possible, of extending the forecast period beyond one week will be continued as in the past, but particular attention will now be paid to the synoptic charts of the whole northern hemisphere that have become available for such studies only in the past few years.

The study of fog forecasting on the Great Lakes and the ocean coasts was conducted a number of years ago by one of the forecasters, and the results obtained justify a resumption of the study in so far as time permits.

RIVER AND FLOOD SERVICE.

No essentially new work was conducted during the year, although the flood conditions in the Ohio Valley during March, 1913, will form the subject of a special bulletin or monograph thereon. The flood waters later passed down the Ohio and into the lower Mississippi, causing a great flood in the latter, which, following so closely upon the destructive flood of 1912, has directed public attention anew to the menace of floods in the lower Mississippi. A careful survey of the money loss in the 1913 floods places the total at \$145,000,000.

METEOROLOGICAL RECORDS AND PUBLICATIONS.

The customary routine of checking, verifying, compiling summaries, and other disposition made of the large volume of climatological data annually collected by the bureau was continued during the year. The work is practically up to date, and the processes of binding, filing, and otherwise providing for the preservation of this valuable collection have received most careful attention.

The well-known serial and other regular publications of the bureau have been issued in due course.

The project of publishing marine meteorological charts of the oceans was continued until August, 1913, and near the close of the year the whole question of the issue of such charts was given careful study by a committee of Weather Bureau officials, acting in conferences with the Chief Hydrographer of the Navy Department. A unanimous conclusion was reached that an unnecessary duplication existed, and agreements have been formulated for the discontinuance of the issue of meteorological charts by the Weather Bureau and the apportionment of marine meteorological work along lines mutually satisfactory to all parties interested.

A contribution to the literature of floods in the rivers of the United States, entitled "Run-off and Streamflow, Piedmont Section of the Savannah River Watershed," was prepared.

An important monograph entitled "The Great Flood of 1913" is practically completed and will fully discuss the meteorology, hydrology, and other aspects of this unusual event.

A bulletin on the winds of the United States, in course of preparation last year, has been still further delayed pending the securing of additional data regarding variations in velocity with changes in elevation, which it is hoped to obtain from comparative observations of wind movement now being made.

LIBRARY.

About 33,000 volumes of books and pamphlets, including many old and rare works on meteorology, now constitute the meteorological library of the Weather Bureau, and a comprehensive catalogue and index serves to render the information stored in this splendid collection readily accessible to the student and worker generally. Early in January, 1913, the library moved to new and enlarged quarters and was thus enabled to undertake a complete rearrangement and reclassification of the books, which is now in progress.

The librarian has for a number of years acted as supervising examiner in connection with the promotion examinations heretofore conducted by the Weather Bureau in grammar, arithmetic, elementary meteorology, essay writing, algebra, and trigonometry. These examinations were conducted as usual during the past year, 302 employees taking the examinations, and of this number 288 passed, or 76 per cent.

TECHNICAL STUDIES AND RESEARCH.

Legitimate investigations and research are the processes by which the Weather Bureau as an institution grows and attains to greater things, better service, and a mastery over the conditions and phenomena of nature that may render them subservient and beneficent to mankind. The activity of the bureau in this field is, therefore, an index of its prospective growth.

The work outlined below, in so far as it relates to the past year, is of established value and justified by the attitude of meteorological services throughout the world.

The observatory at Mount Weather is headquarters for much of the systematic scientific work conducted by the bureau, and the results for the year may be summarized as follows:

AERIAL INVESTIGATIONS.

Prof. W. R. BLAIR in Charge.

THE DIURNAL CONVECTIVE SYSTEM.—One hundred and eighty-three free-air observations to an average height of 3 kilometers were made in 15 complete series lasting for a period of 24 hours or longer. Kites, occasionally supplemented by captive balloons, were used to carry the meteorograph. A series of observations was made in every 24-hour period throughout which kites could be used. The elements observed are air pressure, temperature, and humidity; wind velocity and direction, and the atmospheric electric potential. The purpose of these observations is to effect as complete a study as possible of the

diurnal convective system. This system is interesting in itself and is to a certain extent typical of the larger convective systems. Conclusions upon the diurnal variation of air pressure, wind velocity, and wind direction, as observed in these 15 series and in three similar series made the year before, can not well be stated until the data have been further reduced and studied. The temperature distribution up to about the 1.5-kilometer level shows the same type of diurnal variation as is observed at the earth's surface. In the region near the 1.5-kilometer level a second maximum of temperature appears after midnight, while the 3 p. m. to 4 p. m. maximum practically disappears. Above this region the 2 a. m. to 4 a. m. maximum is the principal one, the minimum for the day being found at 2 p. m. to 3 p. m., or earlier. There is some variation with the season in the times given for the above maxima and minima. Diurnal variation of the moisture content of the air is closely related to the diurnal temperature distribution. Current publication of the data on the diurnal variation of the different meteorological elements and some discussion of these data were begun in the Bulletin of the Mount Weather Observatory, Volume IV, page 344, and continued in succeeding volumes.

INTERNATIONAL COOPERATION.—Free-air observations on days selected by the international commission were made in cooperation with the commission.

THE FIVE-YEAR SUMMARY.—A complete summary of the data obtained in the five years ended June 30, 1912, has been nearly completed.

MOUNTS WILSON AND WHITNEY EXPEDITION.—Plans were begun in February, 1913, for an expedition to southern California in cooperation with the Smithsonian Institution. Measurements of solar radiation and nocturnal terrestrial radiation at different altitudes and measurements of the total moisture content of the atmosphere above Mount Wilson will be made by the Smithsonian Institution, while the Weather Bureau makes aerial soundings with captive and with free balloons. All preparations for this expedition were completed June 28, 1913.

SOLAR RADIATION INVESTIGATIONS.

Prof. H. H. KIMBALL in Charge.

APPARATUS.—To the equipment of the Mount Weather Observatory enumerated in the last annual report has been added a Sharp-Miller photometer, which, with the assistance of the Bureau of Standards, has been adapted to the measurement of daylight intensities. A Pickering polarimeter has been added to the equipment at Madison, Wis., and a Marvin pyrheliometer was installed at Santa Fe, N. Mex., in October, 1912.

THE DIMINISHED ATMOSPHERIC TRANSPARENCY OF 1912-1913.—The most interesting feature of the observational data for the year is the marked decrease in solar radiation intensities and in the polarization of skylight, which was first noted at Mount Weather in the observations of June 10, 1912. The intensity of direct solar radiation with the sun 60° from the zenith averaged only about 85 per cent

of its normal value during the second half of 1912, and but little more than this during the first half of 1913. The polarization of skylight averaged about 66 per cent of its normal value during the second half of 1912 and about 75 per cent of the normal during the first half of 1913. Similar depressions are apparent in solar radiation and skylight polarization data for the years 1884-1886, 1889-1892, and 1902-1904. Each of these periods followed volcanic eruptions of unusual violence. The low values of solar radiation and skylight polarization the past year are therefore attributed to the scattering of the solar rays by the volcanic dust that was thrown to great heights in the atmosphere by the eruption of Katmai Volcano, in Alaska, in June, 1912.

EFFECT OF DECREASED SOLAR RADIATION INTENSITIES UPON AIR TEMPERATURES.—The three periods of decreased solar radiation intensity, culminating in 1885, 1891, and 1903, were also periods of low temperatures in the United States, and, indeed, in the Northern Hemisphere. While the minus temperature departures were no greater than have occurred in other years, they persisted for a longer time—in the United States for four consecutive years, in the first instance, and for three consecutive years in each of the other two. Since this is a result that might logically be anticipated, Prof. Kimball, in charge of these investigations, made the prediction in a letter to the chief of bureau, dated November 30, 1912, that if the present hazy conditions continue, as is expected, the temperature in the United States will probably fall slightly below the normal in 1913, especially during the first half of the year. This forecast has already been verified, so far as the year has advanced; that is, the temperature in the United States has averaged slightly below the normal during the first half of 1913 and markedly so in February and March. Details of this important matter are discussed by Prof. Kimball in the pages of the Bulletin of the Mount Weather Observatory.

Prof. W. J. Humphreys also has devoted attention to the effects resulting from the ejection of great quantities of volcanic dust particles of minute size into the upper regions of the atmosphere, and has prepared a valuable contribution to the literature on this subject that is now in course of publication simultaneously in the *Journal of the Franklin Institute* and the *Bulletin of the Mount Weather Observatory*.

DIFFUSE SKY RADIATION.—Besides the standardization of Marvin pyrhemometers employed in measurements of direct solar radiation, considerable time has been devoted to the determination of the constants of a Callendar pyrhemometer, with a view to employing it in measuring the diffuse radiation received from the sky alone, as well as in measurements of the total radiation received from both sun and sky. The standardization has been effected by means of comparisons with a Marvin pyrhemometer when both were exposed to radiation intensities varying from the total of direct solar radiation to one-tenth that amount.

It has been found that at Mount Weather, on cloudless days, from 15 to 30 per cent of the total radiation received on a horizontal surface at noon is diffuse radiation from the sky. The clearer the sky the smaller is this percentage.

INSTRUMENTS AND THEIR IMPROVEMENT.

Work of this character bears on nearly all lines of investigation and observation undertaken by the bureau and justly deserves every possible encouragement. In several important cases—such, for example, as the measurement of solar radiation, intensity of daylight, evaporation, and even the seemingly simple element of atmospheric moisture—the insufficiency of any known instrumental apparatus appropriate to the work constitutes a distinct barrier to progress. The status of this work is indicated in what follows:

STANDARDIZATION OF ANEMOMETERS.—An investigation of the indications of the anemometer, with special reference to exceptionally high velocities, was undertaken just before July 1, 1912. A large motor-driven whirling machine having a horizontal arm 30 feet long, adapted to carry the anemometer to be tested at the end thereof, and capable of being driven at all velocities up to 75 to 100 miles per hour, measured at the anemometer, was employed for this purpose. The apparatus was installed in the open air at Mount Weather Observatory and tests made from October 9 to November 16, when outdoor weather conditions prevented further work. During the early spring months of the past year the tests were supplemented by comparisons made on the roof of the central office building at Washington of anemometers of different and peculiar construction, for the purpose of showing the effect of modifications on the indications of the instrument. Much valuable technical information has thus far been secured, but the investigation has been temporarily interrupted by the official in charge having become Chief of the Weather Bureau. Provision for the completing of the work will, however, soon be made.

REVISION OF PSYCHROMETRIC TABLES.—Revision of the psychrometric tables in current use is a matter that should receive early attention. Within the past five years there has been an entire revision of the fundamental measures of the saturation pressure of aqueous vapor. This work has been carried out at the *Physikalisch-Technischen Reichsanstalt*, at Charlottenburg, and represents, to a certain extent, practically final accuracy in all values of vapor pressures. While the new values at ordinary atmospheric temperatures differ by only small amounts from those heretofore used, yet the latter are not satisfactory, and the present state of applied physical science in this respect calls for a revision of the tabulation of the vapor pressure, and this has been in progress during the year as opportunity to do the work has offered. The revision and extension of the psychrometric formula itself is of still greater importance. At the present time standard psychrometric tables practically terminate at 120° or 13° on the Fahrenheit scale, whereas many demands exist for psychrometric data for temperatures up to and exceeding 200°, as, for instance, in connection with the artificial drying of lumber, the study of cooling towers, and in many manufacturing processes.

NEW RECORDING RAIN GAUGE.—The automatic rain gauge heretofore used by the Weather Bureau is well adapted to the needs of fully equipped stations, but a considerable demand has existed for a type of gauge that could be installed at country places and, to a certain

extent, left to itself for a period of at least several days, and, nevertheless, procure a complete record of precipitation for the interval. A superior gauge meeting these requirements, capable of giving a continuous record of reliable character for a period of eight days without attention, has been devised. A model of the gauge is now nearly completed, and it is confidently expected that the new apparatus will find a valuable use in the extension of automatic records into regions from which results could hardly have been obtained with any of the mechanisms heretofore available.