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1918

REPORT OF THE CHIEF OF THE WEATHER BUREAU

UNITED STATES DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU,
Washington, September 28, 1918.

Sir: I have the honor to submit herewith a report of the operations of the Weather Bureau during the fiscal year ended June 30, 1918.

Respectfully,

C. F. MARVIN,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

WAR CONDITIONS.

War conditions have imposed various difficulties in the conduct of the work of the bureau and have caused numerous changes in its personnel during the fiscal year just closed. The call to military service has been accorded a prompt and general response by Weather Bureau men. Many who were not within the selective draft have eagerly sought opportunity to render useful service and have been released in numerous cases to make their qualifications and training as forecasters and meteorologists of military value. A large proportion of those within the draft are now in active service, and some of these, as yet fortunately only a few, have been called to make the supreme sacrifice of life itself.

At this date 145 commissioned employees are carried on indefinite furlough on account of military service, representing a depletion of fully 25 per cent of the trained force of the bureau. A further loss of 200 occurred during the year on account of resignations, almost without exception on account of inadequate pay and the numerous opportunities in commercial and industrial life for larger salaries and better prospects of advancement.

These consequences are inherent to the fixity of statutory employment rolls and the limitations upon expenditures for salaries characteristic of the appropriations for the Weather Bureau. Many able and efficient employees have left the service because of these conditions, and the filling of vacancies has been necessarily restricted to those willing to accept employment upon the relatively unfavorable terms we must offer. It is hoped that recommendations to be made in the estimates may serve to partially improve these conditions.

While all the important features of the full daily program of Weather Bureau work have been maintained as fully as possible, curtailments have been made in a number of minor ways, and as the consequences of war conditions come to be more fully felt more important limitations of our regular service must doubtless be imposed.

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

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SUMMER TIME LEGISLATION.

The daylight saving law, which makes the hours of business an hour earlier between specified dates in April and October, has imposed a distinct extension of the hours of duty of Weather Bureau men, and otherwise has increased the work at stations. This outcome of the legislation resulted inevitably, because on the one hand it was most undesirable for this year at least to make a double break and discontinuity in the standard series of our regular meteorological observations, which for the last 30 years have uninterruptedly been made at the hours of 8 a. m. and 8 p. m., mean seventy-fifth meridian time. On the other hand, it was equally undesirable and more impracticable to issue our daily bulletins, forecasts, maps, warnings, and crop weather information an hour later in the day than the public had been accustomed to receive the same.

The only escape from one or the other of these consequences lay in preserving the continuity of the old records by continuing to make observations for the record at the same absolute hours as in the past, and making and telegraphing another observation at the same hour as usual by the clock but one hour earlier by actual mean time of the seventy-fifth meridian. This course was ordered and compelled the men to be on duty one hour later in the evening than otherwise, simply to secure the night observation and at least for this year to round out the meteorological record, much of the value of which for all scientific work depends upon its uninterrupted continuity under identical conditions for the longest possible period of time.

The daylight saving scheme has doubtless come to stay, and meteorological services must soon adjust their program of observations and public service in a way that will harmonize the conflicting consequences of the present wide adoption of the so-called daylight-saving plan. The suggestion to this end already considered in England and France, that the time of observation be advanced one hour throughout the year, encounters more serious difficulties in the United States than in western Europe, because of the great range of longitude covered by the system of stations now making simultaneous observations.

WAR ACTIVITIES.

The extensions of the work and cooperation of the bureau with direct reference to military service, inaugurated a year ago and mentioned in the last annual report, have been developed, strengthened, and further extended. The bureau has contributed of its personnel and otherwise aided the Chief Signal Officer through the Science and Research Division in the formation of a meteorological unit which now comprises a considerable number of officers and men on active duty in Europe. Skilled forecasters, in cooperation with French and English meteorologists, receive nightly telegrams containing representative weather reports from the eastern districts of the United States, Canada, and the Atlantic coast. These reports supplement local observations over western Europe and the British Isles. Men of the aerological corps make further local observations with pilot balloons and other special equipment. These agencies, largely directed and operated by Weather Bureau men now in mili-

tary service, supply commanders with every species of meteorological information needed for the most effective work with infantry, airplanes, poison gas, etc.

In the United States the cooperation with the Signal Corps has been intimate and continuous, comprising the special training of meteorologists, first at numerous Weather Bureau stations, and later the detailing of two Weather Bureau men for the purpose of giving full courses in meteorology to a large body of soldiers gathered for this and other purposes at a suitable camp at College Station, Tex.

The activities of the Weather Bureau in connection with the war are briefly summarized as follows:

Furnishes forecasts and warnings—

a. To army cantonments and camps and naval bases.

b. To railroads in connection with handling and transportation of food and other supplies.

Furnishes War and Navy Departments with meteorological instruments.

Supplies meteorological data to the Surgeon General's Office for use in connection with studies of dietetics, camp sanitation, hygiene, and the like.

Makes aerological investigations to secure free-air data for aviation and artillery uses.

Conducts special work with kites to test searchlights at night and as an aid to artillerists in detecting moving objects in the air.

Cooperates with the Signal Corps in training balloonists and enlisted men in meteorological work.

Reports vessels entering and leaving Atlantic, Gulf, and Pacific coast ports.

Transmits naval and military business over its telegraph and cable lines.

Assisted in the organization of gas and flame regiment.

Transferred to War Department, for service in France, meteorological experts and forecasters.

More detailed mention of other important features of this work will be found in the topical presentations which follow.

FORECASTS AND WARNINGS.

FORECAST DISTRIBUTION.

The fixed policy of the bureau to purge, from time to time, its lists of those receiving maps, bulletins, forecast cards, etc., by mail has effected a considerable reduction in the number of telegrams sent and cards delivered, but without, it is thought, materially impairing the value of the service. The vital interests centered in food conservation and production, and the growing appreciation by farmers and agriculturists of the value of the forecasts and warnings of the Weather Bureau have necessitated increased effort to extend the free distribution of such information by telephone, through the cooperation of the rural telephone lines, with considerable success. In one State the forecasts were made available by telephone to one fifth as many subscribers as there were inhabitants in the State, and five-sixths of the post offices received the forecast cards by mail on the day of issue.

TRANSPORTATION OF PERISHABLES.

Because war conditions and the congestion of transportation entailed conservation in every direction, special effort was directed to the effective distribution of shippers' forecasts and the warnings of injurious weather conditions, such as cold waves, frosts, etc. Information received from several sources clearly shows the great value of these warnings and the saving they make possible.

The month of October was notable for the unusually early occurrence of frosts and freezing weather throughout the sugar and truck regions of Louisiana and Texas. It is estimated that advance warnings of these conditions issued from the District Forecast Center at New Orleans during that month saved from destruction nearly one-half of the sugar crop, worth millions of dollars; one-half of the white and sweet potato crops, and large quantities of the small matured vegetable crops in those regions.

Several hundred thousand dollars' worth of truck was saved in southern Florida as a result of cold wave warnings issued in the early part of December, 1917.

Livestock warnings for the benefit of the cattle and sheep interests were reported as of great value, particularly during the lambing and shearing seasons. One of the warnings of this kind issued in April, 1918, from the San Francisco forecast district center resulted in the protection of over 100,000 new born lambs and in the postponement of the shearing of great numbers of sheep.

The system for the preparation and distribution of warnings of weather conditions favorable to the inception and spread of forest fires has been considerably improved and extended to include warnings of fire hazard conditions likely to result in damage or loss in connection with crops, stock, other foodstuffs, and all kinds of inflammable war material; and a number of these warnings was issued during the year with beneficial results. A special station has been established at Hampton, Oreg., for the carrying on of investigations in connection with this service.

The exceptionally severe weather of December, 1917, and January and February, 1918, resulted in the issue of an unusually large number of storm warnings and probably a larger number of cold wave warnings than during any other three months in the history of the bureau. A total of 540 of the former and 1,339 of the latter were issued during this period. Special attention was given to the distribution of these warnings in the interest of conservation of food and fuel.

A new application of special weather forecasts was made during the year in connection with the forecasting of weather conditions favorable to the spraying of fruit trees. This project was carried out in the fruit regions of western New York with considerable success.

TROPICAL STORMS.

Only one tropical storm severe enough to justify the display of hurricane warnings occurred during the year, namely, that of September 22-30, 1917. This moved from the central Caribbean Sea in a general west-northwest direction to a position off the mouth of the Mississippi River, whence it recurved sharply to the northeast and entered the United States near Pensacola, Fla. The center of the track crossed Jamaica and caused great destruction to the banana industry on that island, and also caused great destruction on the Isle of Pines and in western Cuba. Hurricane warnings in advance of the storm were issued to points on the central Gulf coast from New Orleans to Apalachicola and resulted in a great saving in life and property. A barometer reading of 28.51, with a wind velocity of 125 miles per hour, was recorded at Pensacola.

WEST INDIAN AND CARIBBEAN SEA STATIONS.

In the completion of the project for the improvement of the weather service in the West Indies additional stations were established at Castries, St. Lucia, and Puerto Plata; and arrangements made for the securing of reports, when threatening conditions were observed, from St. Croix, Antigua, and Grenada. In cooperation with the Cuban Meteorological Service, special stations, supplied with instrumental equipment by the Weather Bureau, were established at Guane and Santa Cruz del Sur, and arranged for at Nueva Gerona, Isle of Pines. Arrangements were also made for daily reports from the Observatory de Montserrat at Cienfuegos.

VESSEL WEATHER STATIONS AND LIGHTSHIPS.

At the close of the year 40 vessels engaged in coastwise traffic were enlisted as stations to report meteorological conditions at sea by wireless. On account of war conditions, however, very few reports were received. The stations previously established on the lightships at Nantucket Shoals, Fryingpan Shoals, Diamond Shoals, and Heald Bank were discontinued, as it was found too difficult to secure accurate observations, which, moreover, were not of great value owing to the relatively close proximity of the lightships to shore stations.

SUBSTITUTION OF BULLETINS FOR MAPS.

In the interest of conservation of material, card bulletins containing the forecasts, weather summary, and a table of data derived from the daily observations were substituted for the graphic maps with satisfactory results at about 50 stations.

STATIONS AND OBSERVATIONS.

The act making appropriations for the Department of Agriculture made provision for a newly equipped Weather Bureau station at Greenville, S. C. This was duly established and observations were begun.

New Federal buildings were occupied during the year for offices at Charlotte, N. C.; Elkins, W. Va.; Grand Junction, Colo.; and Kalispell, Mont., and the Weather Bureau stations at these points were moved to quarters provided therein from rented offices.

As it was necessary to increase the force at Tatoosh Island and North Head, Wash., to cooperate better with the Naval Coast Patrol, temporary residence buildings were provided at these stations for the use of assistant observers.

It having been found practicable to utilize a frame office building formerly occupied at the discontinued Port Crescent, Wash., station, this building was taken down, removed to Port Angeles, and re-erected on a lot owned by the Weather Bureau, of which legal possession had finally been secured after several years of litigation. This enabled the bureau to move out of rented quarters previously occupied at Port Angeles and effect a considerable saving in rental.

Permanent title having been secured to the reservation occupied by the Weather Bureau station at Bismarck, N. Dak., since June 1, 1894, action was taken during the year to move the residence build-

ing thereon to face on Main Street, and effect greatly needed permanent improvement in the equipment at that station.

An acceptable bid was finally secured for the construction of a new telegraph office and observatory building at Cape Henry, Va., authorized by Congress in 1917. This building will be completed within the appropriation therefor and be ready for occupancy in September, 1918.

The status of the Independence, Cal., station was changed from that of a special meteorological to a fully equipped station, occupying rented quarters.

AEROLOGICAL INVESTIGATIONS.

During the year considerable enlargement in the aerological work of the Weather Bureau was effected, under the provisions of an item in the Army bill, which reads as follows:

For the establishment and maintenance by the Weather Bureau of additional aerological stations for observing, measuring, and investigating atmospheric phenomena in aid of aeronautics, including salaries, travel, and other expenses in the city of Washington and elsewhere, \$100,000, to be expended under the direction of the Secretary of Agriculture.

In accordance with this act, sites for aerological stations in addition to the one already established at Drexel, near Washington, Nebr., have been selected at Broken Arrow, Okla., Ellendale, N. Dak., Groesbeck, Tex., Leesburg, Ga., and Royal Center, Ind. This distribution is as favorable as possible with the limited number of stations to secure observations of free air conditions over a large portion of the country. Installation of equipment has been completed at the Ellendale station, and free air observations were begun in December, 1917. The other four stations are being equipped as rapidly as the difficulties of obtaining suitable apparatus permit. Surface meteorological observations are already being made at each of the stations.

Free air observations, by means of kites, were continued at the Drexel Aerological Station during the entire year, and have been obtained at the Ellendale Aerological Station since December 17, 1917. The data thus obtained include observations of atmospheric pressure, temperature, humidity, wind direction and velocity, cloud altitude and movement, and, at Drexel, electric potential. Daily telegraphic reports of conditions at one or more selected levels were sent to the forecast center of the Bureau at Washington, D. C., on all days when flights were made. At Drexel, in addition to the daily flights, series of observations covering a period of about 30 hours were made whenever conditions were favorable. The data thus obtained enable the bureau to follow in considerable detail the diurnal changes at different altitudes. In all, 478 observations were made from July 1, 1917, to June 30, 1918. Of these, 134 were made in 18 different series, the remaining 344 being made as daily observations. The average altitude reached in all flights was about 3,000 meters. At Ellendale 163 flights were made from December 17, 1917, to June 30, 1918, the mean altitude being about 2,400 meters.

The free air data obtained at Drexel from April to December, 1916, inclusive, were published in Supplements 7 and 8 (Aerology Nos. 3 and 4) of the Monthly Weather Review; those obtained dur-

ing 1917 have been sent to the printer; those during the first half of 1918 have been reduced and will shortly be ready for publication. In addition, considerable work has been done in the preparation of a summary based on all free air data thus far obtained at Drexel.

In its purpose to render the greatest possible assistance in the vigorous and successful prosecution of the war, the bureau has cooperated with various branches of the United States Army in the following ways:

1. Papers on "Meteorology and Aeronautics," "Mean Values of Free Air Barometric and Vapor Pressures, Temperatures and Densities over the United States," and "The Turning of Winds with Altitude" were prepared and published and copies have been furnished for the information and use of the Aviation and Artillery Services.

2. Information relative to free air conditions at certain specified times in this country and in different parts of Europe has been furnished whenever requested.

3. Instrumental equipment, including kite meteorographs, has been supplied for the use of the American Expeditionary Forces and the training camps in this country.

4. In connection with special experimental tests, temporary field stations have been established and kite flights made at Ellington Field, Tex., Potomac Park, Washington, D. C., and Aberdeen Proving Grounds, Md.

WORK IN CLIMATOLOGY.

The regular climatological work of the Bureau was carried forward during the year by the large corps of cooperative observers as usual. Many changes occurred during the year in the observing force, arising largely from the necessities attending the war. Some of the younger observers have responded to the call for military service, and others have voluntarily assumed lines of war work which have either required their absence from home or taken up their time to such an extent as to interfere with the observations. Despite the added duties arising out of the war it is gratifying to note a constant improvement in the character of the observations furnished. The promptness of the observers in forwarding their monthly reports is deserving of the highest commendation.

No material effort has been made during the year to increase the number of stations, but rather to effect a more satisfactory distribution, improve their equipment, and secure better reports.

Cordial cooperation continues between the Weather Bureau and other branches of the Government, and reporting stations, under the supervision of employees of these bureaus, have been established in regions where it would be impossible to secure other observers. This is particularly true as regards the Forest, Indian, and Reclamation Services, whose employees have given valuable reports from otherwise inaccessible regions, mostly in the high mountains of the West.

The policy of more frequent inspection of cooperative stations inaugurated recently has continued, and the beneficial results became at once apparent. This has been especially noticeable in the Alaska section, which has only lately been reorganized and put upon a basis

similar to that existing in the States. Practically all the stations in the Territory were visited during the year, and reports are now being received with much more regularity and in greater number than previously.

OCEAN METEOROLOGY.

In general the work of the Marine Section has progressed along the usual lines. The war has still further reduced the number of vessel weather reports received from the north Atlantic Ocean, but the number of reports from the north Pacific continues to increase, though slowly. A considerable number of reports, largely from the north Atlantic Ocean, are being withheld by the naval and military authorities until after the war. The work of charting reports from the north Pacific Ocean, begun last year, is proceeding.

The extensive ship-building program on which the United States has embarked creates an increased need for more complete knowledge of weather conditions over the seas, and when peace again prevails ocean meteorology will claim far greater attention on the part of the Weather Bureau than ever before. Evidence of this is indicated by the increasing number of requests for information respecting weather conditions at sea received by the Bureau during the year.

The publication in the Weather Review of the monthly summaries of weather conditions over the north Atlantic Ocean, together with charts showing the averages of pressure and temperature, the prevailing direction of the winds, and the paths of the more important storms, has continued.

DATA AND INFORMATION SUPPLIED.

Many extra demands for data, resulting from the war, have come from the several Government departments, particularly from the Aviation and Medical sections of the War Department, which have required extensive computations of climatic data for consideration in determining the location of flying fields, sites for hospitals, etc.

TELEGRAPH SERVICE.

Notwithstanding the serious strain imposed upon the telegraph and telephone systems by war conditions, transmission of Weather Bureau circuit reports, forecasts, and miscellaneous telegrams has been accomplished, as a rule, without detriment to the public service. Approximately 170 station reports, including their reciprocal distribution over 21 circuits, represent the transmission of 4,500 reports twice daily, totaling over 3,000,000 code words annually. The operation of this system in conjunction with the dispatch of a limited number of special messages daily places in the hands of the public in every section of the country full knowledge of the weather conditions over practically the entire United States and adjoining territory at comparatively small cost.

By arrangement with the Western Union Telegraph Co. the preparation of the monthly bills of that company has been materially expedited by the use of telegraph division forms for that purpose. Examination of all telegraph and telephone accounts presented by

about 70 different companies, involving an expense of approximately \$250,000 per annum, is made by the employees of this division. Settlement has followed closely upon their presentation.

The division pamphlet, Instructions to Operators on the Weather Bureau Telegraph and Telephone Lines, has been completely revised during the year, the last previous revision having been made in the year 1906.

WEATHER BUREAU TELEGRAPH AND TELEPHONE LINES.

Detailed statements and descriptions of the several telephone and telegraph lines maintained by this bureau were submitted in the report for last year and need not be repeated here as no changes of material consequence claim attention.

RIVER AND FLOOD SERVICE.

The flood warning service has been maintained without appreciable change, although for obvious reasons retrenchments have been made whenever practicable. Fortunately no serious floods occurred in any part of the country, yet one of the most serious ice gorges of which there is a record formed in the early part of the winter in the Ohio River below Cincinnati and held continuously for 58 days. This gorge so reduced the cross section of the stream that when the ice in the upper tributaries broke up and the flood waters came down a lake or pool formed, extending about 100 miles upstream. At one time the surface of this pool was higher than the river below the gorge by about 25 feet, thus creating a situation of the utmost gravity along the lower river. When the gorge finally broke, river craft moored for the winter in sheltered places suffered great losses, aggregating approximately \$3,000,000. Coming at a time when replacement is extremely difficult, such a loss must seriously retard the growth of river transportation for several years.

INSPECTIONS.

The absence of serious floods gave the field officials of the bureau a much needed opportunity of inspecting gaging stations and of making the necessary repairs to the equipment. During the year 93 stations were inspected and repairs were made or were in progress at the close of the year.

SNOW MEASUREMENTS.

Measurements of snow depth at high level stations in the West were made at 147 stations, being a decrease of 18 as compared with the previous year. Intensive snow surveys were necessarily abandoned except on the high levels of the watershed that supplies the Roosevelt Reservoir of Arizona.

PRECIPITATION IN MOUNTAINS OF LOS ANGELES AND SAN BERNARDINO COUNTIES OF CALIFORNIA.

The project of determining the amount of precipitation in the mountains of Los Angeles and San Bernardino Counties, Cal., has been carried on at 51 stations, an increase of 32 during the year, in cooperation with the United States Forest Service of the department, the United States Geological Survey and the counties above named, and without cost to the bureau except for apparatus.

The Wagon Wheel Gap Experiment Station has also been continued. This station is maintained in cooperation with the Forest Service of the department as in former years. Since the first phase of the experiment is drawing to a close, arrangements have been made looking to a discussion of the meteorological data that have been accumulated in the last seven years.

PRINTING AND PUBLICATIONS.

The utmost economy was practiced throughout the year in the issue of publications and in the purchase of the necessary supplies of paper, ink, and other printing materials. Nevertheless, the usual series of periodical and nonperiodical publications have been adjusted to war conditions and issued much as usual, including some new publications which have more or less definite relations to war work.

A careful revision of mailing lists justified dropping the names of a number of recipients of periodical publications whose interest in the same ceased to be active for one reason or another.

Large and frequent demands were made for such Weather Bureau pamphlets, reprints, etc., as are of value in military instruction and practice, especially in aviation, and these were promptly and liberally filled to the extent of our resources. The requests were made not only officially by bureau chiefs, commanding officers, and instructors; but also in large numbers by individual officers and enlisted men stationed at the various camps throughout the country.

Since the beginning of the war the distribution of publications to foreign addresses by mail and international exchange has gradually been reduced to a comparatively small number of copies. At present the service is discontinued to all the central powers and their allies, and to countries wholly or in part occupied by them. A limited reserve of the more important publications is maintained in our stock for supplying authorized foreign demands after the cessation of the war.

All the material for the Monthly Weather Review was prepared and submitted on schedule time, and the data for the Annual Report of the Chief of Bureau, 1916-17, were collected, compiled, and the volume issued at the time prescribed by law. Considerable data regarding the occurrence of tornadoes and hail storms were collected, and the text, indicating some of the details of these storms, together with appropriate charts showing their distribution throughout the country, form valuable additions to the report.

The monthly and annual summaries of the State climatological services were prepared along the usual lines, and with a few exceptions were issued on schedule time. The printing of a climatic summary for Alaska, similar to those for the States, began with January, 1917, and most of the issues for that year have been printed. It is probable this work will soon be brought up to date.

No material changes were made in the snow and ice bulletins issued last winter at the central office, or for the mountain States of the West, except that a few additional reports have been provided for in some of the higher mountains where observers have not heretofore been available.

A short report on the climate of France and Belgium was prepared during the year, and by publication in the *Weather Review* and the monthly summaries of the State climatological services received an unusually wide distribution.

The preparation of data for the atlas of American agriculture was carried forward to near completion. The text sections on temperature and miscellaneous data were completed, as well as the major part of the necessary drafting work, and some of the folios have been printed and will soon be available for distribution.

In response to the needs of aviators and other students of the atmosphere, an effort has been made to bring together as much as practicable of the important knowledge of the physics of the air. The publication of this without cost to the Government was begun as a serial in the *Journal of the Franklin Institute*, August, 1917, and continued through the year.

In cooperation with the Smithsonian Institution, the Smithsonian meteorological tables have been extensively revised by officials of the Weather Bureau and republished by the Smithsonian Institution.

Considerable progress has been made on a paper discussing the more important weather features attending the severe cold of last winter. It was expected that this would be completed before the end of the fiscal year, but it has been delayed by press of routine work and failure so far to receive reports from some far northern districts.

LIBRARY.

During the year, 827 books and pamphlets were added to the library, the same number as last year. The total strength of the collection is now about 37,100. The library has been utilized extensively by men undergoing training for the meteorological work of the Army and the Navy and has lent a considerable number of books for use at the front. A brief bibliography was prepared on the subject of military meteorology.

The number of promotion examination papers rated during the year was 32, of which 28, or 87 per cent, received passing grades. The promotion examinations, which, with some variations in form and scope, have been in operation since 1899, were discontinued May 4, 1918. This course does not imply any lowering of the standards of qualifications for entrance or eligibility for advancement, but rather the reverse, because a new entrance grade has been established, examinations for which are held as frequently as necessary by the Civil Service Commission.

SEISMOLOGICAL INVESTIGATIONS.

The systematic work of collecting and publishing earthquake data, begun December 1, 1914, was continued during the year. These data are of two kinds—noninstrumental reports of earthquakes felt and instrumental records, often of quakes wholly imperceptible to the senses. The noninstrumental reports are rendered by all the regular stations of the bureau, nearly 200 in number, and also by nearly all the bureau's 4,500 cooperative observers. The instrumental records published by the bureau have been obtained in part by instruments

owned and operated by the bureau itself, one at Washington, D. C., the other at Northfield, Vt. The remainder are furnished through cooperation with various agencies at 18 additional stations distributed from Panama to Alaska and from the Hawaiian Islands to Porto Rico.

During the calendar year 1917, 112 earthquakes were felt within the borders of the United States proper. The great majority of these produced no damage whatever, and none any material damage.

SOLAR RADIATION INVESTIGATIONS.

Continuous records of the total amount of radiation received on a horizontal surface from the sun and sky were obtained throughout the year at Washington, D. C., Madison, Wis., and Lincoln, Nebr. Measurements of the intensity of direct solar radiation have been made at the above stations, and also at Santa Fe, N. Mex., whenever atmospheric conditions have been suitable, and at Washington and Madison the percentage of polarization of sky light has been measured. A monthly summary of the results has been published in the *Monthly Weather Review*.

Experience has shown the superiority of the silver-block type of Marvin pyrhelimeter over the spiral-ribbon type. Two new instruments of the former type have therefore been constructed and standardized during the year to replace instruments of the spiral-ribbon type in use at Lincoln and Madison. A similar change in the instrumental equipment has also been made at Santa Fe, so that all four pyrhelimetric stations are now equipped with the new and improved form of Marvin pyrhelimeter.

Persistent requests have been received from various sources for the cooperation of the Weather Bureau in a project having for its object the determination of sky brightness, or the intensity of natural lightning, in various sections of the United States, at different seasons of the year and hours of the day, and under various atmospheric conditions. Some preliminary work has been done along this line.

A program for meteorological observations was planned for about 55 Weather Bureau stations in or near the path of total obscuration of the sun during the eclipse of June 8, 1918. In addition, a special station for measuring both incoming and outgoing radiation during the eclipse was established at Goldendale, Wash., at the center of the path of totality. The complete program was carried out as planned, although weather conditions at some points were unfavorable.

The Office of Solar Radiation Investigations at Camp American University has cooperated with the experiment station of the Bureau of Mines (now the Chemical Warfare Service, National Army) in determining the prevailing meteorological conditions during experiments in the open air.

AGRICULTURAL METEOROLOGY.

With the growth and extension of the service rendered by the Weather Bureau and represented by its great weather and crop service, the establishment of the Division of Agricultural Meteorology to handle all such work under capable direction was the natural outcome. This organization became effective February 21, 1916, and has

been described in previous reports. Its activities have been continued, improved, extended, and given specially direct application as far as possible to all agricultural activities of the Nation now so directly concerned in food production and conservation.

In addition to its function of supervising and directing the weather and crop service, this division is also responsible for conducting studies of many different kinds. Without attempting to describe the various special investigations comprised within the operations of this division, the following brief outline will indicate the extent and character of its activities:

CORN AND WHEAT REGION SERVICE.—Covers 16 principal grain States, with the region center at Chicago, Ill., and 188 special reporting stations.

COTTON REGION SERVICE.—Covers 11 principal cotton States, with the region center at New Orleans, La., and 165 special reporting stations.

SUGAR AND RICE REGION SERVICE.—Covers the rice and sugar cane growing sections of the South, with 6 special-reporting stations.

CATTLE-REGION SERVICE.—Covers all or parts of eight grazing States, with 67 special-reporting stations. This service was changed in the spring of 1918 from a daily service during the summer months to a weekly service throughout the year. This change is proving to be of decided advantage.

SPECIAL FORECAST AND WARNING SERVICES.—Special stations are maintained in the principal tobacco, potato, alfalfa seed, cranberry, citrus, and deciduous fruit-growing regions, to aid in special forecasts and minimum temperature warnings, and have proven to be of marked value in this connection.

COOPERATION.—The Weather Bureau is cooperating with other bureaus and departments in maintaining special stations for the benefit of science and agriculture. Such stations are maintained in 14 different States.

PROTECTION OF ORCHARD AND TRUCK CROPS FROM FROST.—Considerable time has been devoted to the making of temperature and air-drainage surveys in citrus and deciduous orchards in the West, and in studying orchard-heating problems. Officials of the bureau have been placed in the principal districts where orchard heating is extensively practiced to aid in making and distributing minimum temperature forecasts.

FROST STUDIES IN NORTH CAROLINA.—For several years the bureau has been conducting frost and temperature studies in North Carolina. During the year the final report of the discussion of nearly five years' accumulated data was submitted and is undergoing careful examination and consideration with the view to ultimate publication.

THE EFFECT OF THE WEATHER UPON CROPS.—The Division of Agricultural Meteorology has continued its study of the relation between weather and climate, and crops. Data have been collected and tabulated and results obtained which are proving of marked advantage to agriculture.

THE NATIONAL WEATHER AND CROP BULLETIN.—The preparation and issue of this bulletin continue to take the greater part of the time of the force of this division during the crop season. It is published weekly from April to September, inclusive, and monthly during the winter season. A new feature during the past season has been the inclusion of data regarding the planting and harvesting of the principal crops, at the request of the Office of Farm Management, as an aid in determining the labor requirements. The results of the correlation of weather and crops have been published in this bulletin from time to time.

PACIFIC COAST WEATHER AND CROP SERVICE.—A special weather and crop service covering the States of Arizona, Utah, Nevada, Idaho, Washington, Oregon, and California, was inaugurated at the beginning of the 1918 crop-growing season, with San Francisco as the district center. A bulletin somewhat similar to the National Weather and Crop Bulletin was issued at the district center each Wednesday from April to September, inclusive, and will be continued monthly during the winter season.

INSTRUMENTATION, TESTS, AND REPAIRS.

The closing of European markets for scientific apparatus, accompanied by the great congestion of manufacturing work in this country, has presented serious difficulties to the Weather Bureau in procuring the necessary high-grade instruments for its work and has imposed upon what was formerly known as the instrument division of the bureau many additional duties, since it became necessary in certain respects at least to undertake to construct here instruments which could not possibly be procured elsewhere. In fact, we have with limited facilities endeavored to extend aid to the Army and Navy in constructing meteorological instruments to meet special needs. Under these conditions it became necessary to reorganize this part of the work of the bureau and to divide the original instrument division into two parts, one devoted to general administrative affairs connected with the receipt and issue of instruments and their exposure at stations, the other to be concerned with the testing of new instruments, the construction and repair of instruments, and their careful adjustment to meet station requirements. Even at best the difficulty of maintaining necessary supplies to meet all needs has been serious, and more or less delay has necessarily marked the progress of this part of our work. As time goes on and as American manufacturing interests become more able to meet requirements which in many cases formerly were supplied from European sources, a general improvement must result.