

MONTHLY WEATHER REVIEW.

Editor: Prof. CLEVELAND ABBE.

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INTRODUCTION.

The MONTHLY WEATHER REVIEW for March, 1898, is based on 2,929 reports from stations occupied by regular and voluntary observers, classified as follows: 147 from Weather Bureau stations; numerous special river stations; 32 from post surgeons, received through the Surgeon General, United States Army; 2,583 from voluntary observers; 96 received through the Southern Pacific Railway Company; 13 from Life-Saving stations, received through the Superintendent United States Life-Saving Service; 31 from Canadian stations; 20 from Mexican stations; 7 from Jamaica, W. I. International simultaneous observations are received from a few stations and used, together with trustworthy newspaper extracts and special reports.

Special acknowledgment is made of the hearty cooperation of Prof. R. F. Stupart, Director of the Meteorological Service of the Dominion of Canada; Mr. Curtis J. Lyons, Meteorologist to the Government Survey, Honolulu; Dr. Mariano Bárcena, Director of the Central Meteorological Observatory of Mexico; Mr. Maxwell Hall, Government Meteorologist,

Kingston, Jamaica; Capt. S. I. Kimball, Superintendent of the United States Life-Saving Service; and Commander J. E. Craig, Hydrographer, United States Navy.

The REVIEW is prepared under the general editorial supervision of Prof. Cleveland Abbe.

Attention is called to the fact that the clocks and self-registers at regular Weather Bureau stations are all set to seventy-fifth meridian or eastern standard time, which is exactly five hours behind Greenwich time; as far as practicable, only this standard of time is used in the text of the REVIEW, since all Weather Bureau observations are required to be taken and recorded by it. The standards used by the public in the United States and Canada and by the voluntary observers are believed to generally conform to the modern international system of standard meridians, one hour apart, beginning with Greenwich. Records of miscellaneous phenomena that are reported occasionally in other standards of time by voluntary observers or newspaper correspondents are sometimes corrected to agree with the eastern standard; otherwise, the local meridian is mentioned.

STORM WARNINGS AND WEATHER FORECASTS.

By Lieut. Col. H. H. C. DUNWOODY, Supervising Forecast Official.

Under this head it is proposed to make note of all extreme and injurious weather conditions occurring during the month, and the warnings of the same issued by the Bureau, with instances, as far as reported by observers or the press, in which these warnings were of special public benefit. The signals displayed by the Weather Bureau will be referred to as "information," "storm," "hurricane," "cold-wave," and "norther," respectively.

The injurious weather conditions of note that occurred during the month were the storm of the 2d-5th, which moved from the east Gulf to the New England coast, the cold waves of the 20th-23d and 24-28th in the west and northwest, and the heavy rains in the central valleys which resulted in the floods during the latter part of the month in the Ohio and central Mississippi rivers. Injurious low temperatures occurred in the truck raising districts of Texas on the 4th, and frosts, which in some instances were quite destructive, occurred in the fruit regions of California on nearly every night from the 12th to the 27th, inclusive. A severe norther, with gales on the coast, prevailed in California on the 9th and 10th.

STORM OF MARCH 2-5.

In connection with this storm the following maximum velocities during the twelve hours preceding the hours named were recorded, viz: 3d, 8 p. m., Savannah, 52 northeast; Charleston, 36 north. 4th, 8 a. m., Charleston, 46 northeast; Cape Henry, 52 northeast. 4th, 8 p. m., Atlantic City, 40

north; Block Island, 48 northeast; Nantucket, 42 northeast. 5th, 8 a. m., Block Island, 64 northwest.

Information signals for this storm were ordered from Pensacola to Norfolk at 9:30 a. m. of the 3d. These were changed to storm northeast from Jacksonville to Cape Henry at 1:30 p. m. of the 3d. At 10 p. m. of the 3d information signals were extended as far north as Boston, and storm northeast to Cape May. At 9:30 a. m. of the 4th storm northeast signals were extended to Boston. All shipping was well warned and no serious losses were reported.

COLD WAVES OF 20-23 AND 24-28 IN THE WEST AND NORTHWEST.

Concerning these cold waves Prof. E. B. Garriott, in charge of the Chicago forecast district, reports:

About 650 points in Wyoming, Colorado, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Michigan, Illinois, and Indiana were forewarned by telegraph of the approach of the cold wave of the 20th-23d, together with all transportation interests in the States named, and thousands of persons and places were warned by prompt telephone and mail service. The advance of the cold wave was attended by light snow as far south as southern Kansas and southern Missouri. High winds were experienced over the western lake region during the day and night of the 22d. On the 21st, when the storm center occupied the middle Rocky Mountain region, the following message was telegraphed to the open lake ports: "Much colder, with snow flurries and high east to northeast winds by Tuesday morning;" and on the morning of the 22d, when the storm center had advanced to north-western Illinois, the following was telegraphed to the open ports: "Cold wave to-night, with snow flurries; wind will shift to high northwest this afternoon." The night of the 22d the wind reached a maximum

velocity of 48 miles per hour from the north, and a velocity of 40 miles or more per hour was maintained for some time during the evening of the 22d. A wind of this velocity from the northward makes a tremendous sea on the south end of the lakes, and under the advice of this office boats about to sail for points on the eastern shore of Lake Michigan remained in port.

The cold wave of the 24-28th swept the Western and Northwestern States and carried the line of freezing weather into northern Texas. Warning of the approach of this cold wave was telegraphed twelve to thirty-six hours in advance of its arrival to some 700 points, and widely distributed to railroad and other interests throughout the entire forecasting district. The afternoon of the 26th, when the storm was central over the middle Rocky Mountain region, lake ports were notified that the wind would shift to northerly that night and become strong, with snow flurries. On the morning of the 27th, when the storm center occupied Oklahoma, lake ports were wired that "cold wave, snow flurries, and wind shifting to strong northerly may be expected by night." The afternoon and evening of the 27th the wind increased to a gale and attained a velocity of 64 miles per hour at night. No damage was reported, as boats were advised to remain in port, and, so far as is known, they did so."

In relation to the warning of the 24th issued at Chicago for Montana, Mr. J. Warren Smith, section director at Helena, Mont., reports:

The warning was distributed by mail to 369 places, and by free telephone and telegraph to about 75 places. The warning was received from six to twelve hours in advance of the storm, and was of great benefit to all stock interests. On receipt of the warning action was immediately taken, wherever possible, to place sheep and cattle in safe localities, either in sheltered places or in sheds, and for which there was ample time.

The following extracts from reports to this office show the interest in and value of the warning:

Clarks Ranch: "All sheep were kept close to shelter and fed; the value of property protected was \$120,000; probably \$2,000 worth would have been lost if sheep had been caught out; the warning is of great service to stockmen."

Lewiston: "Stock was kept in feed lots and general care taken; value of sheep and cattle protected, \$58,000."

Great Falls: "Warning telephoned to all available places along the telephone lines; much appreciation expressed, and great credit given for timely warning."

Oka: "Sheep protected to the value of \$40,000."

White Sulphur Springs: "Two hundred thousand head of sheep and cattle protected."

Virginia City: "We wired large stock owners along the lines; stock protected was very valuable; nearly all sheep in this section were taken to the sheds and hay fed."

Martinsdale: "Sheep were brought in and fed; sheep protected to the value of \$300,000. There was very little snow in this valley, but too cold to graze stock."

The following extract from an article in the Greatfalls Tribune is given as of interest in this connection: "The severe blizzard which raged here on the 23d and 24th was certainly the worst ever experienced during the writer's life in Montana. * * * The temperature fell 42° in thirty-six minutes. * * * Great droves of cattle could be heard lowing and moaning above the roar of the tempest. * * * The drift was so furious that a few crevices no larger than a pencil in the side of a building were sufficient to fill the structure with snow from floor to ridge."

FLOODS IN THE OHIO AND CENTRAL MISSISSIPPI RIVERS.

Heavy rains in the central valleys, amounting to from 2 to 6 inches in excess of the normal for the month, caused a flood of considerable magnitude in the Ohio and central Mississippi rivers. Concerning the warnings issued for this flood and the benefits derived therefrom, the following reports from the officials in charge of the river forecast districts and newspaper extracts are given.

From Mr. Frank Ridgway, Local Forecast Official, Pittsburg, Pa.:

The river reached the danger line about 3 a. m., March 23, 1898, and continued at a flood stage until 5 p. m. of the 25th, the maximum height of 28.9 feet being reached at 1 a. m. of the 24th. Three flood warnings were issued, viz, at 2 p. m., 22d; 11.05 p. m., 22d; and 9 a. m., 23d, respectively. These warnings were thoroughly disseminated by telephone, telegraph, press, and through the Departments of Public Safety of both cities. No lives were lost, and it is estimated that property to the value of \$500,000 was saved by the timely promulgation of the warnings. Following is a copy of a letter received from A. H. Leslie, Superintendent of Police, Pittsburg:

"PITTSBURG, March 26, 1898.

"DEAR SIR: If there be any doubt in the mind of the public as to the value of the Weather Bureau, the recent floods ought to remove it and convince the most skeptical of its worth in forewarning the public of impending danger.

"Upon receipt of the notice from you of the expected high water of 25 feet with the request that we warn the public, we sent word over our lines directing the patrolmen on the beats to notify those residing and doing business along the river fronts and streets adjacent thereto to make preparation and remove their property. The warning was generally observed, and resulted in the saving of hundreds of thousands of dollars in value which otherwise would have been lost to the individuals.

"We assure you that we appreciate the service we were permitted to render the public in the saving of their property by your timely warning and advice."

From Mr. S. S. Bassler, Local Forecast Official, Cincinnati, Ohio:

On March 22 and 23, 1898, the Muskingham, Scioto, and the two Miamis were pouring volumes of water into the Ohio and a flood of critical proportions was assured.

A peculiarity of the recent flood was that the river rose rapidly and was for several days above the danger line at all points at the same time.

On the 22d a warning was issued that the river at Cincinnati would pass the danger line during the night. It passed the danger line at 11 a. m. of the 23d, and the period the river was above the danger line at Cincinnati was from 11 a. m. of March 23 to 9:30 a. m. of March 29. On the 22d a warning was sent to Point Pleasant, W. Va., that the river there would pass the danger line on the following day. It passed the danger line at Point Pleasant on the night of the 23d and remained above the danger line there from the night of March 23 to April 2, the highest reported stage being 51.2 feet on March 27. On the 23d a local warning was issued that the river would reach 50 feet by the following morning and continue rising. The stage passed the 50-foot mark at 11 a. m. of the 24th. On the 23d a warning was sent to Parkersburg that the river there would pass the danger line by morning. It passed the danger line at that point on the night of the 23d-24th and was above the danger line from the 24th to the 29th of March, inclusive.

On the 24th another warning was sent to Point Pleasant of a big and sudden rise at that point during the night. A rise of over 7 feet occurred there by the morning of the 25th. On the 25th a warning was sent to Portsmouth, Ohio, and Cattlettsburg, Ky., that the stage at both places would exceed 55 feet during the night. The stage passed 55 feet at Portsmouth during night of 26th, and at Cattlettsburg not until night of 27th. At Portsmouth the stage was above the danger line from March 25 to March 31.

On the 26th a local warning was issued that the stage would reach 60 feet by the 28th. Warned Cattlettsburg of continued high stage till the 27th. Heavy rains in this locality caused a prolonged and somewhat accelerated rise below Portsmouth, while the river above was falling. On the 28th the statement was issued that the flood limit could not possibly be more than a trifle over 61 feet by morning. All on the edge of the flooded district were confidently assured that it would not reach 61.5 feet and gave themselves no further trouble.

Every means was taken to keep informed as to the conduct of the river from day to day. Special observations were supplemented by frequent observations received by the Chesapeake and Ohio Railway Company from along the line of their road and courteously telephoned to this office. The distribution of the flood warnings was through the press, the telegraph, and the telephone, by extra maps and reports posted in the flooded district, and by several parties to whom the reports and forecasts were at once telephoned and who acted as so many distributing centers. It appeared as if all business interests in the city affected, or likely to be affected by the steadily rising water, were in direct personal telephonic communication with this office. It is very gratifying to be able to say that the work of the Weather Bureau during the recent flood was thoroughly appreciated. Each successive flood demonstrates more and more the reliance placed upon the information given, but also increases the responsibility thrust upon the official.

No lives were lost nor even in jeopardy. The value of property saved by reason of its removal out of the reach of water can not be ascertained.

Cincinnati, Ohio, Commercial Tribune, April 4, 1898.—The Local Forecast Official of the Weather Bureau has been the hardest worked Government official in the city during the past two weeks, and his efficient work has been worthy of the praise of everybody. His river forecasts were exceptionally accurate and were much appreciated by not only the rivermen but the public in general.

Cincinnati, Ohio, Commercial Tribune, April 5, 1898.—The recent flood and the excellent manner in which the local United States Weather Office kept the business community informed in advance of the developments of the river have given the public generally a new idea of the value and importance of the office in its relations to the community.

LOW TEMPERATURES IN TEXAS.

In relation to the injuriously low temperatures that occurred in Texas during the month, the following reports from Mr. I. M. Cline, Local Forecast Official, Galveston, Tex., and newspaper extracts are given:

Galveston, Tex., March 8, 1898.—The 8 a. m. weather map Thursday, March 3, 1898, indicated injurious frosts throughout the vegetable districts, and the following special warning was included with the regular a. m. local forecast:

"Continued cool to-night and probably frost near coast."

There was heavy frost in places to the coast line, and light frost on adjacent islands Friday morning, with temperatures in the vegetable districts as follows: Galveston, 44°; Columbia, 31°; Brenham, 34°; Houston, 36°; Missouri City, 31°.

It is shown from information at hand that vegetation was protected generally as far as was possible and serious damage to the vegetable crop averted.

The following are from acknowledgments received relative to use made of this frost warning and its value to the public:

"Hitchcock, J. F. Ware.—Warning received about twenty-four hours in advance of frost. Many people covered up their vegetables and strawberries. Value of strawberries and early vegetables saved, from \$500 to \$2,000. It is hard to tell the amount of stuff saved in value."

"Alvin, C. W. Benson.—Warning of frost timely. Extra protection was given vegetation in forcing work. Early vegetables to the value of \$1,500 were saved from injury by frost of night of 3d. No frost on night of 2d."

"Peppergrove, W. W. Gregory.—Warning was received twelve hours in advance of frost. All patrons of post office notified. All garden truck that could be was covered, which was considerable. Value of that saved, \$500. The service is greatly appreciated."

"Harrisburg, T. G. Bennett.—The warning was received on the afternoon of the 3d, the day before the frost. All tender plants above ground were covered up. As far as heard from, several hundred dollars worth was saved. I can form no estimate as to the value."

"Laporte, A. O. Blackwell.—Warning received about seventeen hours in advance of frost. It was bulletined and special attention called to it. Each farmer took such action as appeared necessary in protecting vegetables and fruits. The value saved was large, and amounted to hundreds and perhaps thousands of dollars. The patrons of this post office, and particularly the fruit growers and truck farmers, thoroughly appreciate these warnings. The warnings reach here at 5 p. m., and attention is at once called to the coming sudden changes. Most farmers are in town after that time and get the information."

"The value of the berry and vegetable crops at this time is very large, and the value of that susceptible to injury by frost is approximated at more than \$20,000, and reports indicate that the greater portion of this was saved from injury by frost through the frost warning of the 3d instant."

Galveston and Dallas, Tex., Galveston and Dallas Daily News, March 8, 1898.—But for the timely warnings of the approach of this frost given out by the United States Weather Service, it is indicated that the loss in early vegetables would have been heavy, for where not protected on certain classes of soil the crops have been seriously damaged. The weather warnings in this instance, not to mention previous warnings, have saved thousands of dollars to this section. So marked has become the accuracy of the weather warnings during recent years that whenever a frost or freeze is predicted preparation is made for its reception at once by protecting vegetation and cutting off and draining water pipes. Actual temperatures expected have been predicted with sufficient accuracy to demonstrate that the warnings prepared by the Weather Service are based on scientific deductions made by having a knowledge of changes which precede, accompany, or follow certain conditions which present themselves. From reports published showing savings as a result of Weather Service warnings, it is noticed that the value of property saved to this section in a year is more than sufficient to pay the running expenses of the Weather Bureau, to say nothing of the vast savings to other portions of the country.

Galveston, Tex., Galveston Daily News, March 13, 1898.—The successful production of early fruits and vegetables along the Texas Coast has been demonstrated beyond a doubt. The only drawback in past years has been an occasional frost, and damage from this source has been removed through the certainty with which every frost or freeze has been predicted by the Weather Service for this locality during the past few years. These warnings are so accurate and timely that the only thing remaining necessary to insure success is means for the better protection of more extensive areas than the covering with hay, earth, and other matters when the Weather Service announces the approach of injurious conditions.

DESTRUCTIVE FROSTS AND SEVERE NORTHERS IN CALIFORNIA.

Concerning these conditions Mr. W. H. Hammon, Forecast Official, San Francisco, Cal., reports:

The month was one quite remarkable for the many frosts destructive to deciduous, and in some instances somewhat injurious to blossoming citrus fruit, and also unusual for northwest gales which were injurious to shipping along the north Pacific Coast, and which resulted in dry northers throughout the interior of California that greatly injured grain and feed.

On Thursday morning, March 10, a warning was distributed throughout northern California for "Killing frost Friday night, and, if wind ceases, to-night." Severe frosts occurred on Friday and Saturday mornings in a few sections of northern California, the lowest temperature reported being 26° at Yolo, Cal. On Sunday morning, March 13, warning of "Severe frost to-night" was distributed throughout northern California, and on Monday morning throughout the southern portion of northern California and throughout southern California and at Phoenix, Ariz. On March 15 warning of "Severe frost" was distributed in northern California; for southern California the warning read "Danger of frost where clear to-night." On the 16th the warning read "Severe frost where clear" in northern California, and "Severe frost to-night if clear" in interior of southern California. Similar warnings were distributed on the 17th and 18th. On Monday, March 21, a warning of "Severe frost Tuesday morning if wind ceases" was distributed throughout California. On Tuesday morning a similar warning was distributed throughout California and also sent to Phoenix, Ariz. On Wednesday morning the warning for California read "Frost to-night but less severe than last night." On Saturday, March 26, a warning for "Killing frost to-night" was distributed in northern California, and for "Severe frost" in southern California; this latter was also sent to Phoenix, Ariz. On every night when severe or killing frost was forecast injury occurred throughout some portion of the region in which the warning was distributed and on several nights the frost was generally injurious. The lowest temperatures probably generally occurred on the 16th and 23d. From a large number of newspaper articles relative to the injury done it would appear that the almond and apricot crops were for the most part generally destroyed and considerable injury done to peaches and other fruits then in blossom. Many efforts at protection were made, but were not generally successful, owing to the extreme severity of the frosts. In some instances even grain was severely injured.

On March 9 northwest storm signals were ordered displayed along the coast north of San Francisco. The signal was continued at Eureka throughout the 10th. On March 10 information signals were hoisted along the coast south of San Francisco "For high north winds increasing in force northward." On the afternoon of March 12 northwest storm signals were again displayed at San Francisco, and at points to the northward, and information signals as far south as Ventura. On the afternoon of March 14 information signal was ordered displayed at Port Harford. On March 22 northwest storm signals were distributed from Eureka to Point Conception. On the night of March 9 the wind reached a velocity of 39 miles an hour at San Francisco from the north, which caused many vessels to drag their anchors where no special precautions were taken, and those tied to the wharves were in some cases badly injured. The steamer *Eureka*, which was undergoing repairs at the wharf, was sunk and several small schooners were injured or capsized. The Coast Survey steamer *Patterson* collided with the bark *Martha Davis* and considerable injury was done to both. A severe norther prevailed at this period throughout the entire State. On the nights of March 12 and 13 considerable damage was done, the greatest disaster being the wrecking of the ship *New York* on the evening of March 13 in Half Moon Bay. On Tuesday, March 22, the bark *Alma* which left this port Sunday morning, March 20, for Alaska was found capsized off Pillar Point; 40 lives are supposed to have been lost.

AREAS OF HIGH AND LOW PRESSURE.

By Prof. H. A. HAZEN.

During the month the tracks of 9 highs were sufficiently well defined to be traced on Chart I, and those of 10 lows on Chart II. The accompanying table shows the principal facts relating to the origin and disappearance, the length of track, and velocity of these highs and lows. In taking the sums and means high No. VI has been omitted because of the shortness of its duration and lack of motion. The following notes are added:

HIGHS.

The locality of the first appearance of highs was to the north of Montana, exactly as in February. Nos. III and IV, however, have been traced to the Pacific. No. VII began in the middle Plateau Region. The general direction of apparent motion was a little south of east, and nearly all disappeared off the north Atlantic Coast. The temperature falls accompanying these highs were remarkably moderate. A fall of 40° in twenty-four hours occurred at Bismarck, p.