

reported; they were least numerous on the 14th, 24th to 27th, and most numerous on the 1st, 5th, 7th, 13th, 17th to 19th, and 31st; they were observed on from ten to sixteen dates in the following states and territories: Cal., Dak., Me., N. Y., Oregon, and Wash.

Only a few lunar halos were reported from the 1st to 15th and on the 28th and 29th, but during the remainder of the month they were generally observed throughout the country, being most frequent on the 17th, 18th, 21st to 23d, and 25th; none were observed on the 5th, 7th, 8th, 27th, and 30th; they were most frequently observed in California and Oregon.

The phases of the moon, Washington mean time, during April, as given in "The American Ephemeris and Nautical Almanac," are as follows: last quarter, 2d, 19h. 33m.; new moon, 10th, 15h. 59.5m.; first quarter, 18th, 18h. 44.2m.; full moon, 25th, 13h. 14m.; apogee, 12th, 5.7h.; perigee, 25th, 15.7h.

METEORS.

Webster, Day Co., Dak.: a fine meteor was observed in the western sky at 7.30 p. m. on the 6th; it was apparently as large as Venus, of yellowish color, and left a long trail.

Dudley, Worcester Co., Mass.: a meteor was observed at 12.10 a. m., 7th; it started in the west about 20° from the zenith and moved southward, leaving a train of brilliant sparks.

Meteors were also observed as follows: 1st, Savannah, Ga. 4th, Beverly, N. J. 5th, Pekin, Ill. 6th, Voluntown, Conn., and Columbia, S. C. 7th, New Market, Ala. 8th, Huron, Dak. 9th, Nashua, N. H. 10th, Wauseon, Ohio. 13th, Manhattan, Kans.; Moorhead, Minn. 15th, Orono, Me. 16th, Cedar Keys and Duke, Fla. 18th, Parkston and Webster, Dak.; Cedar Keys, Fla.; Beverly, N. J. 19th, Red Bluff, Cal.; Manatee, Fla.; Kalamazoo, Mich. 22d, Parkston, Dak.; Utica, N. Y. 23d, Red Bluff, Cal. 26th, East Norway, Kans.

27th, Red Bluff, Cal. 28th, Fort Meade, Fla.; Indianapolis, Ind. 29th, Elkin, Ky.; College Hill, Ohio. 30th, Cedar Keys, Fla.

MIRAGE.

Fort Assinaboine, Mont.: from 9 a. m. to 12.30 p. m. on the 4th the banks of Milk River, distant twelve miles, and ordinarily not visible, were seen from this station.

San Diego, Cal.: on the 12th a beautiful mirage appeared in the southwest, showing the Coronada Islands very distinctly, the two islands being apparently connected by a large suspension bridge.

Parkston, Hutchinson Co., Dak.: an unusually fine mirage was observed on the 18th before sunrise; in some parts of the horizon objects appeared grotesquely elongated and several times their natural size; the images of cattle, distant several miles, were seen having gigantic proportions; also large lakes, with their shores dotted with trees and houses. The display ended at noon, and shortly afterwards the sky clouded over and rain and snow began to fall.

Toledo, Ohio: on the afternoon of the 27th the ice houses on Gard's Island and the light house on Turtle Island were plainly seen from Maumee Bay; two images of the light house appeared, one being inverted. The phenomenon lasted from 6.30 to 7.30 p. m.

Mirages also occurred as follows: Traverse City, Mich., 8th; Yuma, Ariz., 9th; Webster, Dak., 10th, 11th, 18th to 21st, 23d, 30th; Marquette, Mich., 18th to 20th; Duluth, Minn., 24th.

SAND STORMS.

Sand storms were reported as follows: Yuma, Ariz., 3d, 24th, 25th, 30th; Willcox, Ariz., 5th, 25th; Rio Grande City, Tex., 8th; San Carlos, Ariz., 13th; Lava, N. Mex., 16th; Fresno, Cal., 25th.

VERIFICATIONS.

INDICATIONS FOR 33 HOURS IN ADVANCE.

The percentages of verifications of the tri-daily indications for April, 1888, as determined from comparison of succeeding telegraphic reports, are given in the table below.

The predictions for all districts east of the Rocky Mountains for April, 1888, were made by 1st Lieutenant Robert Craig, 4th Artillery, U. S. Army, Acting Signal Officer and Assistant, except those for Minnesota and Dakota, which were made at Saint Paul, Minn., by 1st Lieutenant Thomas M. Woodruff, 5th Infantry, U. S. Army, Acting Signal Officer; those for the Pacific coast districts were made at San Francisco, Cal., by 2d Lieutenant J. E. Maxfield, Signal Corps; the verifications for all districts were determined by Junior Professor C. F. Marvin.

Percentages of indications verified, April, 1888.

States.		States.	
Maine.....	84.33	Kentucky.....	84.27
New Hampshire.....	79.97	Ohio.....	80.63
Vermont.....	80.63	West Virginia.....	79.77
Massachusetts.....	78.80	Indiana.....	82.83
Rhode Island.....	78.00	Illinois.....	80.53
Connecticut.....	79.60	Lower Michigan.....	80.93
Eastern New York.....	80.47	Upper Michigan.....	69.07
Western New York.....	76.17	Wisconsin.....	78.57
Eastern Pennsylvania.....	85.80	Minnesota*.....	79.07
Western Pennsylvania.....	76.93	Iowa.....	78.37
New Jersey.....	81.77	Kansas.....	81.10
Delaware.....	83.63	Nebraska.....	79.27
Maryland.....	82.20	Missouri.....	77.60
District of Columbia.....	83.33	Colorado.....	78.57
Virginia.....	79.53	Eastern and Southwestern Dakota*	79.47
North Carolina.....	78.53	Southern California*	79.87
South Carolina.....	81.87	Northern California*	80.93
Georgia.....	80.70	Oregon*	74.95
Eastern Florida.....	82.07	Washington Territory*	70.65
Western Florida.....	82.33		
Alabama.....	83.53	By elements:	
Mississippi.....	81.00	Weather.....	83.43
Louisiana.....	80.80	Wind.....	77.36
Texas.....	80.83	Temperature.....	77.38
Arkansas.....	77.60		
Tennessee.....	83.50	General average.....	80.41

* In determining the general average percentage for the different elements, Minnesota, Dakota, and the Pacific coast states have not been included.

CAUTIONARY SIGNALS.

Of the total number of cautionary and storm signals ordered during April, 1888, it was practicable to determine the justification or failure of thirty-two; justified, sixteen, or 50.00 per cent. Of the above, twenty were ordered for cautionary signals; number justified, thirteen, or 65.00 per cent. Twelve storm signals were ordered; justified, three, or 25.00 per cent. Total number of direction signals ordered, forty-seven; justified, forty-four, or 93.62 per cent. Number of signals ordered for easterly winds, twenty-four; justified, twenty-one, or 87.50 per cent. Number of signals ordered for westerly winds, twenty-three; all, or 100 per cent., of which were justified. Number of storms without signals, twenty-five. Number of signals ordered late, *i. e.*, after the justifying velocity had begun, one, or 3.12 per cent.

COLD-WAVE SIGNALS.

Total number of cold-wave signals ordered from Office Chief Signal Officer, sixty-two; justified, forty-one, or 66.13 per cent. Twenty-nine cold-wave signals were ordered during the month by the Signal Service Officer at Saint Paul, Minn., of which, fourteen, or 48.28 per cent., were justified.

LOCAL VERIFICATIONS.

The following extracts from the published reports of the state weather services for April, 1888, show the percentages of verification of weather and temperature signals for the various states:

Michigan.—Weather and temperature signals are now displayed in one hundred and forty towns in the state, and upon the baggage-cars of twenty-six trains of eight of the principal railroads of the state.

The indications and cold-wave warnings are issued by the Chief Signal Officer and distributed to the different stations through the central office. The indications are issued at 1 a. m., daily, from the Chief Signal Office, Washington, and are for the twenty-four hours from 7 a. m. to 7 a. m.

The percentage of verification of these indications for April is as follows (the verification is taken from reports of displaymen furnished this office monthly): temperature, 82.8 per cent; weather, 77.8 per cent.; temperature and weather, 80.8 per cent.

The percentage of verification of weather predictions for April on the D., G. H., and M. R'y, is 83.0 for weather, and 75.0 for temperature; on the C. & G. T. R'y, weather, 84.7, temperature, 79.3; P. H. & N. W. R'y, weather, 76.7, temperature, 85.0; M. C. R'y, weather, 75.0, temperature, 79.7; G. R. & I. R'y, weather, 80.0, temperature, 83.0; C. & W. M. R'y, weather, 78.7, temperature, 83.3; P. O. & P. A. R'y, weather, 78.0, temperature, 76.8.

Cold-wave warnings were issued by the Chief Signal Officer on the 10th at 11.55 a. m., and were partially justified, a majority of the stations reporting a fall of 20° by 7 a. m. of the 11th. An order was issued at 7 a. m. of the 29th (Sunday) and the temperature fell from 35° to 42° during the afternoon

of the 29th. The temperature was high during the forenoon, reaching 75°, and by night had fallen to 38°.

Nebraska.—The percentages of correct predictions for the state are as follows: temperature, 89.6; weather, 93.1; mean, 91.4.

South Carolina.—The percentages of verifications of the weather and temperature predictions for the state was: weather, 91.3; temperature, 97.9.

Tennessee.—The percentages of verifications of weather and temperature predictions sent daily from the Signal Office at Washington to the various stations in the state were for the state: weather, 90.6 per cent.; temperature, 90.4 per cent.

STATE WEATHER SERVICES.

The following extracts are republished from reports for April, 1888, of the directors of the various state weather services:

The "Alabama Weather Service," P. H. Mell, jr., of the Agricultural and Mechanical College, Auburn, director:

With the exception of a few days that were cool, the month has been mild and pleasant. The average temperature was 3° above the normal, and there was a deficiency of 3.83 inches of rain. The 15th is about as late as the last killing frost occurs in this section, but in some portions of the state it came this month on the 26th. On the 21st the minimum thermometer registered 42°, and a light frost was formed. There were no decidedly cold days, yet the weather was cool enough to injure the tender plants to a slight degree and retard their growth. Farming operations have progressed rapidly, and planting has been pressed with much vigor. Oats, rye, and other grains are well advanced in fruitage and promise well. A great deal of cotton is up, and the warm days towards the last of the month caused the young plant to grow with increased vigor. The deficiency of rain has given cause for serious apprehensions in some sections, but no damage has yet resulted.

Summary.

Temperature (in degrees Fahr.).—Monthly mean, 66.6; highest monthly mean, 71.9, at Newton; lowest monthly mean, 59.9, at Gadsden; absolute maximum, 89, at Troy, on 16th; absolute minimum, 30, at Evergreen, on the 1st; range for state, 59; greatest local monthly range, 58, at Evergreen; least local monthly range, 33, at Newton.

Precipitation, including melted snow (in inches).—Average for the state, 2.46; greatest, 4.70, at Eufaula; least, 9.96, at Pineapple.

Wind.—Prevailing direction, southeast.

The "Arkansas Weather Service," Prof. John C. Branner, Little Rock, director:

Frosts were reported at Lead Hill, Portia, and Memphis, Tenn., on the 13th, and at Portia on the 30th; the one of the 13th was observed in the valleys only at Eureka Springs.

The rainfall was largely in excess throughout the western portions of the state, being at Fort Smith 2.40 inches greater than the average of five years; Washington, 1.16 inches above twenty years; Conway, 4.5 inches; Russellville, 2.70 inches; Eureka Springs, 1.02 inches, and at Alexander, 0.18 inch above the same month last year; while it was below the average of eight years at Little Rock, 4.28 inches; Lead Hill, 2.70 inches below seven years; Helena, 0.40 inch, and Osceola, 0.20 inch below April, 1887.

The "Monthly Review of the Illinois Weather Service," Col. Charles F. Mills, Springfield, director:

The rainfall in the state has been far below the average, so that the month just passed has been the driest April on record in the state. Only two general rains occurred during the month, on the 9th and 10th, and on the 29th and 30th. In fact less rain fell in this state during April than in any other state east of the Rocky Mountains, and as a consequence winter wheat has been considerably damaged, and farming operations have been generally retarded. The average rainfall for the month was only 1.83 inches, which was 1.94 inches below the average of the past ten years. The driest April previous to this was in 1879, when the average rainfall was 2.18 inches, which was over half an inch greater than the rainfall of the April just passed. The greatest deficiency, as compared with the average, was in the southern division, where the rainfall was below the average.

The "Indiana Weather Service," Prof. H. A. Huston, of Purdue University, Lafayette, director:

The rainfall during the month was deficient nearly everywhere, except at a few places in the central portion of the state, where the total amount was increased by heavy local rains during thunder-storms on the 5th and 10th. Snow fell at a few places in the northern portion, but the amount was small.

Summary.

Temperature (in degrees Fahr.).—Monthly mean, 53.1; highest monthly mean, 65.8, at Marengo; lowest monthly mean, 46.2, at La Grange; absolute maximum, 89.0, at Connersville, on the 29th; absolute minimum, 22.0, at La Grange, on the 3d; range for state, 67; greatest local monthly range, 63.0, at La Grange; least local monthly range, 44.0, at Dagonia Springs.

Precipitation, including melted snow (in inches).—Average for the state, 2.27; greatest, 4.13, at Marengo; least, 1.00, at Crawfordsville.

Wind.—Prevailing direction, north.

The "Kansas Weather Service," Prof. J. T. Lovewell, Topeka, director:

Temperature.—The mean temperature for the state is slightly above the April mean, except in the Verdigris Valley, where it is slightly below. In the counties bordering the Missouri River it is 3° above the average. At Topeka it is .6° above, while in the Arkansas Valley it is from 2° to 4° above. The average temperature for the eastern division is 58°, for the middle, 57°, and for the western division, 55°; average for the state, 57°. The frost of the 29th and 30th was general, and was severe, doing much damage to gardens and some to vineyards.

Precipitation.—The average precipitation for the state is 2.89; for the eastern division, 3.13; for the middle division, 1.17, and for the western division, 4.37. Of the total amount fallen in the state, the eastern division received 36 per cent., the middle division 14 per cent., and the western 50 per cent. In Johnson county the rainfall was about the April average. Proceeding south and southwest of Johnson there is an excess, which increases until the Verdigris Valley is reached, where it is from 2.70 to 3.10 inches in excess; it then diminishes slightly until the Ninescaw Valley is reached, but rapidly increases to the west again, being 2.50 above the normal in Ford county. There is a large deficiency in the counties bordering on the Missouri River, amounting to over an inch. In Douglas county a deficiency occurs, amounting to .61 at Lawrence. This deficiency rapidly increases westward, and at Topeka amounts to 1.31; it culminates in the contiguous portions of Mitchell, Osborne, Russell, and Lincoln counties, where less than two-tenths of an inch of rain fell during the entire month. The deficiency rapidly diminishes to the west again, there being an excess in the extreme western counties.

Summary.

Temperature (in degrees Fahr.).—Monthly mean for the state, 57; highest monthly mean, 61, at Sedan; lowest monthly mean, 53, at Eustice and Tribune; absolute maximum, 101, at Halstead, on the 22d; absolute minimum, 20, at Montero, on the 9th; range for state, 81; greatest local monthly range, 73, at Halstead; least local monthly range, 49, at Waterville; greatest daily range, 52, at Gibson and Tribune, on the 16th; least daily range, 0, at Rome on the 8th.

Precipitation, including melted snow (in inches).—Average for the state, 2.89; greatest, 10.20, at McAllister; least, .20, at Cawker City.

Wind.—Prevailing direction, south.

The "Louisiana State Weather Service," in charge of R. E. Kerker, Sergeant, Signal Corps, at New Orleans:

The marked meteorological features of April, 1888, were the high average monthly temperatures, the great deficiency in the average rainfall, the absence of high winds, and the comparatively few thunder-storms.

The average rainfall for the past month for the state was 1.78 inches, being a deficiency of 4.10 inches, compared with a normal covering the past twenty years. There were but two years during that period when the average was less than during the past month, viz., 1873, 1.72 inches, and 1887, 1.80 inches. The greatest April average is recorded in 1874, when 15.50 inches fell. In 1880 an average of 10.12 inches is recorded. The average for the northern section during the past month was 2.02 inches, against an April normal of 6.31 inches, being a deficiency of 4.29 inches for the month. In the southern section of the state the average for the past month was 1.55 inches, the normal April rainfall for that section being 5.32.

The "Michigan Weather Service," N. B. Conger, Sergeant, Signal Corps, Lansing, director:

Temperature (in degrees Fahr.).—The mean temperature for April, 41.6, is 2.9 below the normal of thirteen years. The temperature was below the normal in all sections during April. The greatest deviation, 3.4, was for the Upper Peninsula, and the least was 1.3 below the normal in the northern section. The mean daily temperature was below the normal on twenty days and above on nine days. The highest mean daily temperature, 67, occurred on the 27th, when the temperature was 18 above the normal, and the lowest, 32, occurred on the 2d, when the temperature was 2 below the normal. The highest mean daily temperature, 67, for the past thirteen years occurred on April 27, 1888, and the lowest, 21, occurred on April 1 and 5, 1888. The highest mean monthly temperature, 52.7, occurred in April, 1878, and the lowest, 40.6, occurred in April, 1881. The maximum temperature, 90,