

definite number of water-spouts, some of them unusually large. There were eighteen in the immediate vicinity of the vessel, and two came so close that it was necessary to change the course in order to escape them. The spouts were shortly after swept away by a whirlwind.

Capt. R. B. Quick, of the s. s. "Eureka," reports having observed a large water-spout on the 22d, in N. 31° 32', W. 79° 10' (at noon).

VERIFICATIONS.

INDICATIONS.

The predictions for December, 1886, were made by 2d Lieutenant John C. Walshe, Signal Corps, U. S. Army, Assistant, and were verified by 2d Lieutenant Frank Greene, Signal Corps, U. S. Army, Assistant.

The detailed comparison of the tri-daily indications for December, 1886, with the telegraphic reports of the twenty-four hours for which the indications were prepared, shows the general average percentage of verifications to be 68.80. The percentages for the different elements are: Weather, 71.21; wind, 66.12; temperature, 66.47. By states, etc., the percentages are: For Maine, 67.07; New Hampshire, 69.49; Vermont, 60.60; Massachusetts, 67.53; Rhode Island, 67.98; Connecticut, 65.38; New York, 72.85; Pennsylvania, 69.84; New Jersey, 70.94; Delaware, 69.14; Maryland, 73.41; District of Columbia, 71.51; Virginia, 72.74; North Carolina, 74.30; South Carolina, 72.80; Georgia, 74.76; Florida, 70.00; Alabama, 66.69; Mississippi, 65.65; Louisiana, 65.91; Texas, 64.78; Arkansas, 63.78; Tennessee, 64.95; Kentucky, 67.04; Ohio, 74.35; West Virginia, 67.87; Indiana, 71.90; Illinois, 72.77; Michigan, 71.99; Wisconsin, 68.05; Minnesota, 68.55; Iowa, 68.71; Kansas, 64.84; Nebraska, 60.86; Missouri, 72.58; Colorado, 65.24; east Dakota, 57.82.

There were three omissions to predict, out of 9,951, or 0.03 per cent. Of the 9,948 predictions that have been made, 1,193, or 11.99 per cent., are considered to have entirely failed; eight hundred and thirty, or 8.34 per cent., were one-fourth verified; 1,892, or 19.02 per cent., were one-half verified; 1,715, or 17.24 per cent., were three-fourths verified; 4,318, or 43.41 per cent., were fully verified, so far as can be ascertained from the tri-daily reports.

Below are given for the Pacific coast the percentages of indications verified for November, 1886; this data was received too late for publication in the November REVIEW. The predictions were made by 2d Lieutenant W. A. Glassford, Signal Corps, U. S. Army, Assistant; they were verified by 2d Lieutenant Frank Greene, Signal Corps, U. S. Army, Assistant. The percentages for the different districts are: Washington Territory, 62.79; Oregon, 68.08; northern California, 78.37; southern California, 86.01.

CAUTIONARY SIGNALS.

Of the total number of signals ordered during December, 1886, it was practical to determine the verifications of one hundred and seventy-one; of these, eighty-eight, or 51.46 per cent., were fully verified both as to direction and velocity. Number of signals ordered for northeast winds, thirty-seven; verified both as to direction and velocity, seventeen, or 45.95 per cent. Number of signals ordered for southwest winds, twenty; verified both as to direction and velocity, one, or 5.00 per cent.; verified as to velocity only, one, or 5.00 per cent. Number of signals ordered for northwest winds, ninety; verified both as to direction and velocity, sixty-one, or 67.78 per cent.; verified as to velocity only, three, or 3.33 per cent. Number of signals ordered for winds without regard to direction, twenty-four; verified, nine, or 37.50 per cent. Number of signals ordered late, *i. e.*, after the verifying velocity had begun, four, or 2.34 per cent.

In thirty-nine instances winds were reported which would have justified the display of cautionary signals, but for which no signals were ordered, and in twelve instances winds which would have justified the display of on-shore signals, but for which no signals were ordered.

In addition to the above, four hundred and twenty-seven sig-

nals were ordered at display stations, the verifications of which it was impracticable to determine.

COLD-WAVE SIGNALS.

Total number of cold-wave signals ordered, the verifications of which were determined, was three hundred and fourteen; verified, two hundred and eight, or 66.24 per cent. Seventy-seven signals were ordered, the verifications of which it was impracticable to determine. In addition to the above, in four hundred and ninety instances, the signals ordered at the regular stations were repeated by the observers to towns in their vicinity. The verifications of these it was impracticable to determine.

RAILWAY WEATHER SIGNALS.

P. H. Mell, jr., director of the "Alabama Weather Service," in the report for December, 1886, states:

The verification of predictions for the whole area was 96 per cent. for temperature, and 87 per cent. for weather.

The following corporations comprise this system: South and North; Montgomery and Mobile; Mobile and Girard; Georgia Pacific; East Tennessee, Virginia and Georgia system in Alabama; Memphis and Charleston; Columbus and Western; Atlanta and West Point of Georgia; Northeastern of Georgia; Western and Atlantic; East Tennessee, Virginia and Georgia system in Georgia; Montgomery and Eufaula; Pensacola and Selma; Pensacola and Atlantic; the cities of Milledgeville, Georgia, and Talladega, Alabama.

The following is from the "Bulletin of the New England Meteorological Society" for December, 1886:

Verification of weather signals at New Haven was 68 per cent. for temperature, 84 for weather; at six stations reporting to the Signal Office in Boston, 85 for temperature, 74 for weather.

SUNSET PREDICTIONS.

The characteristics of the sky, as indicative of fair or foul weather for the succeeding twenty-four hours, have been observed at all Signal Service stations. Reports from one hundred and fifty-nine stations show 4,922 observations to have been made, of which six were reported doubtful; of the remainder, 4,916, there were 4,376, or 89.0 per cent., followed by the expected weather.

STATE WEATHER SERVICES.

The following is an extract from the December, 1886, report of the "Alabama Weather Service," P. H. Mell, jr., of the Agricultural and Mechanical College, Auburn, director:

The most remarkable feature of the month was the heavy precipitation of snow over all parts of the state on the 3d to 5th. Throughout north Alabama 17 to 20 inches of snow fell between the morning of the 3d and the evening of 5th. In middle Alabama 12 to 16 inches were reported during the same period; and in south Alabama as much as 12 inches were reported from several stations. This fall of snow is unusually heavy for this climate, and in some sections was the cause of marked comment, because such a sight had never been witnessed before, especially in the extreme southern part of the state.

The cold waves that were predicted by the Chief Signal Officer on the 1st, 17th, 24th, 26th, and 31st were verified with satisfactory accuracy. It is worthy of note that the frequency of these cold waves over the state during the month has reduced the average temperature 7° 2 below the normal, giving quite a cold winter month for Alabama.

There was a deficiency of precipitation amounting to 1.88 inches.

Summary.

Mean temperature, 43°; highest temperature, 76°, at Mount Willing, on the 12th; lowest temperature, 0°, at Valley Head, on the 7th; range of temperature, 76°; greatest monthly range of temperature, 62°, at Mount Willing; least monthly range of temperature, 39°, at Oswiechee; mean daily range, 18° 4; greatest daily range of temperature, 46°, at Eufaula, on the 22d; least daily range of temperature, 0°, at Livingston, on the 5th, Newton, on the 10th, and Tuscaloosa, on the 1st.

Mean depth of rainfall, 2.97 inches; mean daily rainfall, 0.096; greatest depth of monthly rainfall, 5.20 inches, at Newton; least depth of monthly rainfall, 0.27 inch, at Bernuda; greatest daily local rainfall, 2.20 inches, at Mount Willing, on the 5th.

Average number of days on which rain fell, 7; average number of cloudy days, 13; average number of fair days, 9; average number of clear days, 9.

Warmest days, 23d, 28th; coldest days, 7th, 16th.

Prevailing direction of wind, northwest.

Annual summary for 1886.

Mean temperature, 61° 5; highest temperature, 108°, August 18th, at Birmingham; lowest temperature, -7°, January 11th, at Gadsden; range of temperature, 110°; greatest daily range, 49°, February 23d, at Carrollton, and at Oswiechee on November 1st; least daily range, 0°, on various dates and at several stations.

Number of clear days, 127; number of fair days, 117; number of cloudy days, 121; number of days on which rain fell, 258.

Mean rainfall, 54.63 inches; mean monthly rainfall, 4.54 inches; mean daily rainfall, 0.15 inch; greatest local monthly rainfall, 18.25 inches, in March, at Newton; least local monthly rainfall, 0.00, in October, at Auburn, Bermuda, Eufaula, Mount Willing, and Osweechee; greatest daily rainfall, 9.75 inches, on March 29th, at Russellville.

The following is an extract from the December, 1886, report of the "Colorado Meteorological Association," Charles F. Wilson, president; central office at Colorado Springs:

The collection and publication of information on the weather of Colorado is of such manifest public utility that the Meteorological Association last spring resolved to trust to the public-spirited citizens of the state for that appreciation of the enterprise upon which alone it must depend for its support. The arguments which have induced the citizens of other states to maintain similar services apply with undiminished force to Colorado. In respect to the advantages elsewhere gained, the report of a committee of the Franklin Institute, charged with the establishment of a weather service for Pennsylvania, says, under date of December 15, 1886:

"The state services already established have proved of the greatest value to the citizens, and have afforded material aid to the [U. S.] Meteorological Bureau in its efforts to extend its usefulness. While the stations of the Signal Service may be numerous enough for storm and frost warnings and general weather predictions, they are not sufficient to determine the climatic conditions of our state sufficiently for the best scientific and practical results. They are mere outposts for general work, so far apart that numberless meteorological phenomena occur, that being unrecorded, are lost for comparison and study. The value of systematic and continuous records of atmospheric changes cannot be overestimated. There is not an industry in the country that could not be profited by them."

The following is an extract from the December, 1886, "Monthly Review of the Illinois Weather Service," Col. Charles F. Mills, of Springfield, director:

Temperature.—The mean temperature of the state for the month, 22°.0, was 5°.2 below the normal for the past twelve Decembers. The mean temperature of the northern counties was 18°.0; of the central counties, 21°.8; and of the southern counties, 26°.9.

The temperature was from 3° to 8° below the normal December temperature at all stations reporting, Decembers of 1876 and 1880, alone, were colder in past twelve years.

The cold wave of the 27th lowered the December record of minimum temperature by 5°. It was severe as far south as the thirty-ninth parallel.

The highest temperature during the month, 64°, was reported from Bloomington, McLean county, on the 11th; the lowest, -29°, from Elmira, Stark county, on the 27th.

Precipitation.—The average precipitation for the state for the month, 1.66 inches, was 1.08 inches below the normal December precipitation of the past eight years. The average for the northern counties, 1.19 inches, was 0.84 of an inch below; for the central counties, 1.44 inches, was 1.03 inches below; and for the southern counties, 2.38 inches, was 1.23 inches below. The precipitation was below the normal at all of the stations reporting, except Saint Louis, Missouri, where it was 0.19 of an inch above.

The departures below the normal ranged from 0.07 of an inch at White Hall, Greene county, to 2.46 inches at Golconda, Pope county.

The precipitation during December was less than any December since 1878, except, 1880, when it averaged only 0.08 of an inch less for the state.

The following is an extract from the December, 1886, report of the "Indiana Weather Service," Prof. H. A. Huston, of Purdue University, Lafayette, director:

Districts.	Temperature.			Average precipitation. Inches.
	Highest.	Lowest.	Monthly mean.	
Northern counties	60.0	-12.0	22.3	2.04
Central counties	60.0	-17.0	22.9	2.64
Southern counties	66.0	- 5.0	27.2	2.30
State	66.0	-17.0	24.1	2.33

The mean temperature of the state for December, 1886, was 5°.7 below the mean temperature of the last five years; 3°.9 below the mean of thirty-two years at Logansport; 8°.0 below the mean of sixteen years at Indianapolis; 10°.5 below the mean of twenty-one years at Vevay; 0°.7 below the mean of thirty-three years at Spiceland; 0°.9 below the mean of seven years at Mauzy; 8°.8 below the mean of nine years at Blue Lick; 6°.1 below the mean of five years at Worthington; 5°.2 below the mean of four years at Connersville; 2°.5 below the mean of seven years at Lafayette.

The temperature at the various stations was below the average, ranging from 0°.9 (at Worthington) to 6°.9 (at Indianapolis).

The mean precipitation of the state for December, 1886, was 1.16 inches below the mean of the past five years; 1.13 inches below the mean of thirty-two

years at Logansport; 1.04 inches below the mean of sixteen years at Indianapolis; 1.79 inches below the mean of twenty-one years at Vevay; 0.31 inch below the mean of twenty-six years at Spiceland; 1.61 inches below the mean of five years at Blue Lick; 1.39 inches below the mean of five years at Worthington; 1.43 inches below the mean of four years at Connersville; 1.22 inches below the mean of seven years at Lafayette.

The precipitation at various stations was below the average, ranging from 0.26 inch below (at Lafayette) to 1.63 inches below (at Worthington).

Every station but one reports the highest temperature of the month on the 11th, and, with a few exceptions, the lowest temperature is reported on the 3d.

Frosts are reported on every day except the 12th, 13th, 23d, 24th.

Fogs are reported on the 10th, 12th, 17th, 21st, 23d.

The following is from the advance bulletin for December, 1886, of the "Iowa Weather Service," Dr. Gustavus Hinrichs, director; central station at Iowa City:

December, 1886, was very cold, fair, and dry, with winds normal in direction and rather low in force.

The mean temperature of the air was over seven degrees below normal. During the past sixteen years it has but once been decidedly colder, namely, in 1876.

The middle decade of December, 1886, was normal in temperature, with rain and extended fog on the 11th and 12th, and cold with snow on the 15th and 16th. The first and last decades were very cold, averaging nearly eleven degrees below normal. The coldest days were the first and second, nearly thirty degrees below zero, and the thermometer remaining below throughout the state at noon. The next three days were also very cold, but only about twenty degrees below normal. The thermometer remained below zero at noon only in the northwest on the 3d and 4th, and reached above zero at noon on the 5th. The temperature of the 26th and 27th averaged fully twenty-five degrees below normal.

On these very cold days the run of the wind was comparatively light, so that the suffering produced was not extreme. At the central station, the run of the wind was not quite two hundred miles per day on the first and second, only one hundred and twenty miles per day on the 26th and 27th, and one hundred miles per day on the 3d to 5th.

The total number of very cold days, on which the temperature reaches to or falls below zero Fahrenheit, was eight, exceeding the average for December of the past ten years by two.

The warmest spell of the month comprises the four days from the 9th to the 12th, averaging fourteen degrees above normal in temperature, and marked by extended fogs or misty weather and very light rains. On the 11th the mean temperature was seventeen degrees above normal, while on the first it was thirty below normal, thus showing a difference of nearly fifty degrees in the mean temperature of these days.

The precipitation was light and mostly snow, falling on six to nine days in eastern Iowa, and on from three to five days in the western and central parts of the state.

The total amount of rain and melted snow averages less than half an inch for the interior parts of the state, and about an inch along the two great rivers.

Summary for the year 1886.

The year 1886 was extreme in temperature, very fair and dry, with but few severe storms, and a low aggregate run of the wind.

The mean temperature of the air for the entire year was nearly normal, exceeding this value by only a quarter of a degree. But the heat was very unequally distributed, the cold months being much colder, and the warm months of the year being much warmer than normal for each season. From the beginning of the year until April 10th, the temperature averaged nearly four degrees below normal; only one of these ten decades, namely middle March, was warmer than normal. From the eleventh of April until the tenth of November the temperature averaged three and one-third degrees above normal, and only three of the twenty-one decades comprised in this period were below normal. The balance of the year, from November 11th till the close of the year, was again quite cold, averaging five and a half degrees below normal, and every one of these five decades was separately below normal. Thus, the first ten and the last five decades of the year, comprising the winter months, were 4°.2 colder than normal, while the twenty-one decades, from the 11th of April until the 10th of November, and comprising the sowing and growing, the ripening and harvesting season, were 3°.4 warmer than normal.

The rainfall in Iowa was very low, less than two-thirds of the normal amount.

It is by far the least yet observed since the organization of the weather service has made more reliable comparisons possible. The total rainfall of the year was greatest along the Missouri River, where it averaged thirty inches. In a broad belt running from Osceola to Wayne counties, the total rainfall increased from fifteen inches in the north to twenty-five inches in the south. In the belt from Kossuth over Marshall and Tama to Wapello counties, the rainfall was nearly the same throughout, averaging twenty-five inches. From here eastward to the Mississippi, the total rainfall varies in nearly the normal manner, but amounts to about ten inches less than usual.

The following is an extract from the December, 1886, report of the "Minnesota Weather Service," Prof. Wm. W. Payne, Carleton College, Northfield, director:

The mean temperature of the state for December was 7°.3, which is 12°.2 below that of the corresponding month of 1885. At Saint Paul it was 11°

below the average; Moorhead, 9°.3; Duluth, 7°; Saint Vincent, 5°.7; La Crosse, 5°.6. The month at Saint Paul was the coldest since 1876, while other stations report it the coldest since 1879. The coldest periods during the month were from the 1st to 4th, 15th to 16th, and from the 18th to the close of the month in the northwestern portion of the state; and from the 24th to the close in the eastern portion. During these periods the minimum temperature was daily below zero. The lowest temperature was 38°.3 below zero on the 26th at Saint Vincent. Six stations reported the minimum temperature over 30° below zero, while but two stations, La Crosse and Mankato, reported it higher than 20° below zero. The mean temperature for the month was below zero at Saint Vincent, Moorhead, and Alexandria, while in the December of 1885 no station reported the mean lower than 12° above. The lowest daily mean temperature was 25°.8 below at Moorhead, on the 26th; the lowest of the maxima temperatures was 19°.0 below, at the same station, on the 2d. The warmest period of the month was generally from the 7th to the 12th; the maximum temperature reported was 48°.0, on the 8th and 9th, at Winona and La Crosse. The greatest monthly range of temperature was 77°.0, at Grand Forks, while Saint Vincent followed closely with a range of 74°.5; the least monthly range was 62°.6, at Mankato; the range for the state was 86°.3.

The precipitation was slightly below the average and mainly in the form of snow. The greatest fall (in inches) was 1.87 and 1.48, at Spring Valley and Saint Paul, respectively; while at Moorhead the fall amounted to .53; Grand Forks and La Crosse, .50; Saint Vincent and Morris, .27.

Summary for 1886.

The winter was very severe. The temperature was below the average, and the precipitation slight. The lowest temperature for the year was 41°.5 below zero, at Park Rapids, on January 23d.

Spring was characterized by late frosts—which did considerable damage to vegetation—and by a slight rainfall.

Summer proved one of the driest and warmest since the country's settlement. The highest temperature for the year was 107°.0, at Sherburne.

Autumn was marked by a deficient rainfall and a temperature below the average.

In May, one of the severest droughts ever known in the northwestern portion of the State was inaugurated and continued until September, when it was broken. The effects of the decrease in rainfall were augmented by the unusually high temperature which prevailed, proving exceedingly disastrous to growing crops. The water in rivers, lakes, and sloughs became very low, and, in fact, disappeared in many localities, thus causing great trouble in obtaining the necessary supply for cattle.

The following is an extract from the December, 1886, report of the "Missouri Weather Service," Prof. Francis E. Nipher, Washington University, Saint Louis, director:

December, 1886, has been a cold month though not unusual for very low temperatures. The mean of the month was 28°.2, which is 5°.2 below the normal for December at Saint Louis. The minimum temperature, 2°.7, has often been exceeded in former years, when it has fallen as low as 11° below zero as early as December 11th (in 1882). The highest temperature obtained was 57°.5, which was observed on the 10th. The lowest temperature was observed on the 27th. The temperature fell to or below the freezing point on twenty-four days and did not rise above freezing on fifteen days during the month. The low temperatures occurred in the first and third decades, which two were nearly of the same temperature, the latter being but two-tenths of a degree colder than the former. The middle decade, however, was comparatively warm, its mean temperature being 35°.3, which is ten degrees above that of the first and third decades.

The mean temperature for December has been below that of the past month eight times since 1837, the lowest of which occurred in the Decembers of 1872 and 1876, both showing a mean of 23°.3.

The rainfall (and melted snow) was 3.04 inches, most of which fell on the 23d and 24th, when 2.07 inches fell in about twelve hours. The normal for December at Saint Louis is 2.97 inches.

In the state the rainfall has been very light, except in the southeast parts along the Mississippi River, where it has been near the normal, while in the central and northern parts it was less than one inch. The least rainfall is reported from Kirksville, being only 0.22 inch, and Steelville, 0.23 inch.

The following is an extract from the December, 1886, report of the "Ohio Meteorological Bureau," Prof. B. F. Thomas, of the Ohio State University, Columbus, president:

Our records for the month just closed show a high mean barometric pressure, low mean temperature, more fair weather than usual, and a slightly deficient rainfall.

The mean temperature was 25°.5, the lowest mean we have recorded for December. The average for the last five years, including this year, was 29°.9. The normal for December is 32°.03. The next coldest December occurred in 1882, when a mean temperature of 29°.2 was recorded. The minimum was -5°.6, and the maximum 78°. Our lowest December minimum occurred in 1884, the record showing -32°.4.

Summary.

Mean relative humidity, 80.1 per cent.
Mean temperature, 25°.5; highest temperature, 78°.0, on the 11th, at Paulding; lowest temperature, 5°.6, on the 28th, at Paulding; range of

temperature, 83°.6; mean daily range of temperature, 17°.7; greatest daily range of temperature, 57°.0, on the 11th, at Paulding; least daily range of temperature, 2°.0, on the 25th, at Napoleon.

Average number of clear days, 8.8; average number of fair days, 8.4; average number of cloudy days, 13.9; average number of days on which rain fell, 12.4.

Greatest number of days on which rain fell, 18, at Cleveland; least number of days on which rain fell, 5, at New Bremen; mean rainfall, 2.72 inches; average daily rainfall, .088 inch; greatest rainfall, 4.00 inches, at Cleveland; least rainfall, 0.98 inch, at New Bremen.

Prevailing direction of wind, southwest.

The following extracts are from the December, 1886, report of the "New England Meteorological Society," Prof. Wm. H. Niles, of the Institute of Technology, Boston, Massachusetts, president:

Summary.

Reports for the month were received from one hundred and fifty-two observers.

The month was decidedly colder than the normal, probably in part owing to the prevalence of snow on the ground almost continuously after the storm of the 2d. The most remarkable feature of the temperature was the occurrence of the maximum of the month about midnight December 24-25th.

The last storm of November, whose central passage over New England caused thunder-storms about midnight of November 30-December 1, moved away slowly, leaving clouds and moderate temperature (maximum 36°-50°) behind it on December 1, and yielding a general snowfall on morning of December 2, which lasted into the night in Maine, clearing off with strong northwest winds. Fair, colder weather followed, as an anti-cyclonic area approached from the northwest, illustrating the gradual development of a cold wave, and on the morning of the 5th, with high pressure (30.7 inches) over northern New England, minimum temperatures of 10° or 5° were generally reached, while the cold in the northern valleys reached -24° at Newport, Vermont, -25° at Berlin Mills, New Hampshire, and -26° at West Milan, New Hampshire.

A cyclonic storm in the Gulf of Mexico foretold its coming by cirrus clouds in the afternoon and lunar halos noted at seventeen stations in southern New England in the evening of the 4th; while still lying off the south Atlantic coast it gave snow, with northeast wind, through the daytime of the 5th in central and southern New England, and from afternoon to night in southern Maine on the 6th, while the storm moved past Cape Hatteras, the winds were more northerly, the snow ceased, and the sky was fair or clear at interior stations; but on the 7th, as the storm-centre crossed the Gulf of Maine, northeast winds, with snow, came again, and extended to northern Vermont, lasting through the daytime in the south, and from noon into night in the north. This was followed by fair weather from the 8th to the 11th, with high pressure to the south, westerly and southerly winds, and rising temperature; on the evening of the 10th five observers report lunar halos, probably to be associated with an area of low pressure whose centre moved over northern Canada on that day.

On the 12th New England was under the influence of a cyclonic storm, moving from Missouri to the Lakes and down the Saint Lawrence Valley; the day was cloudy, and rain began in the afternoon, with northeast winds, at a number of our southern stations; the 13th was generally rainy in the south and snowy in the north, followed by a fine day on the 14th, with winds shifting from easterly to westerly. The 15th opened with a trough of low pressure reaching from Quebec, Canada, to Atlanta, Georgia, giving at first southerly winds, with rain and snow, followed in the afternoon and on the 16th by northerly winds and snow, and a rapid fall of temperature; the change was felt in northern New Hampshire at 14h. on the 15th, temperature 28°, falling 25° in twenty-four hours; and in eastern Massachusetts at 22h., temperature 40°, falling 27° in twenty-four hours; on the 16th the ordinary noontide increase of temperature was generally reversed to a decrease, and minima of -12° in the north and 15° in the south were reached on the night of the 16-17th, with fair weather on the day following.

The following is an extract from the "Tennessee State Board of Health Bulletin" for December, 1886, prepared under the direction of J. D. Plunkett, M. D., President of the State Board of Health. The weather report is prepared by H. C. Bate, Director of the State Meteorological Service:

The main features of the weather during December were the extraordinary fall of snow in the early part of the month, and the entire absence during the month of any electrical disturbances.

The mean temperature was 34°.6, several degrees below the December means of the past three years. The highest temperature was 73°, recorded on the 11th, and was one degree higher than the maximum for December of the two years previous, and five degrees lower than that of 1883. The lowest temperature was -8°, recorded on the 7th, and was seven degrees lower than the minimum recorded in December, 1884, which was thirteen degrees lower than the lowest of December, 1883 and 1885. It was probably the lowest December minimum for many years past. The daily ranges of temperature were generally wide, going as high as forty-six degrees on the 7th and 8th.

The mean precipitation for the month was 3.36 inches. Much of this, especially on the 3d, 4th, 5th, 6th, and 15th, was of snow. Of the amount, the east-

ern division received an average of about four inches, the middle division nearly three and a half inches, and the western division two and a half inches. The greatest precipitation for the month was 5.93 inches, reported at Hohenwald, and the least was 1.48 inches, reported at Nashville. The greatest local daily rainfall was 3.04 inches reported at Hohenwald on the 13th. The next greatest amounts were reported at Jonesborough and Greeneville on the 4-5th, and these were of melted snow. The day of the greatest rainfall was the 17th, the corresponding date of the greatest daily rainfall of the month previous. Most of the rains during the month were comparatively light and many of them were general. The 7th, 8th, 9th, 10th, 19th, 20th, were reported without precipitation.

The feature of the month, as above stated, was the great fall of snow which occurred on the 3d, 4th, and 5th. This was the greatest snowfall that, perhaps, occurred in December for many years, and was very heavy in the eastern division, reaching a depth of 36 inches in the extreme eastern portion. In many places the roofs of houses and barns were crushed by the weight of the snow, and travel was almost suspended. In the southern portion of the middle division the depth was much greater than in the northern portion. It was also great in some portions of the western division. Considerable snow also fell on the 15th throughout the state, and this was in many places attended with high winds which caused it to drift greatly. Some snow also fell on the latter days of the month.

Summary.

Mean temperature, 34°.6; highest temperature, 73°, on the 11th, at Beach Grove; lowest temperature, -8°, on the 7th, at Farmingdale; range of temperature, 81°; mean monthly range of temperature; 55°.8; greatest monthly range of temperature, 69°, at Beach Grove; least monthly range of temperature, 44°, at Dyersburg; mean daily range of temperature, 14°.7; greatest daily range of temperature, 46°, on the 7th, at Fostoria; least daily range of temperature, 2°, on the 27th, at Hurricane Switch, Waverly, Dickson, and Trenton, and on the 28th at Florence Station and Nashville; mean of maximum temperatures, 60°.7; mean of minimum temperatures, 4°.8.

Average number of clear days, 9.7; average number of fair days, 8; average number of cloudy days, 13.3; average number of days on which rain or snow fell, 9.8.

Mean depth of rainfall, 3.36 inches; mean daily rainfall, 0.108 inch; greatest rainfall, 5.93 inches, at Hohenwald; least rainfall, 1.48 inches, at Nashville; greatest local daily rainfall, 3.04 inches, on the 13th, at Hohenwald; days of greatest rainfall, 4th, 15th, 17th, 24th, 28th, 29th, 31st; day of greatest rainfall, 17th; days without rainfall, 2d, 7th, 8th, 9th, 10th, 19th, 20th; mean depth of snowfall, 13.1 inches.

Warmest days, 11th, 23d; coldest days, 7th, 16th.

Prevailing winds, north and northwest.

NOTES AND EXTRACTS.

The question of the temperature relations in the upper air strata during thunder-storms is of so great importance that the following translation of a discussion upon that question has been made by the thunder-storm division. A few notes are appended:

DIPPING OF THE FREEZING-POINT PLANE BEFORE THUNDER-STORMS, BY KARL PROHASKA IN GRAZ.

[Translated from "Das Wetter" of September, 1886.]

Among the lately published theories in relation to the origin of thunder-storm electricity that of Professor Sohneke demands special attention, as well by reason of the completeness of the treatment, as on account of his simple and consistent principle of explaining the cause of the appearances in question. Sohneke sees in the friction of water drops on the particles of ice floating in the atmosphere the cause of electric meteors. From the fact that during thunder-storms cirrus clouds are always to be seen, he makes the deduction that water and snow clouds are there present simultaneously—the first always below, the second generally above, the "freezing-point plane." By ascending currents or greater atmospheric whirls the water particles, when the cirrus clouds are low, can be carried into the region of the ice particles, and in the friction between the particles of the ice and water clouds we would have to seek, according to Sohneke, the origin of thunder-storm and atmospheric electricity.

An essential part of Sohneke's proof rests upon the assumption that the stratum of cirrus clouds at the time of thunder-storms is very low so that contact of the cumuli with the ice particles becomes possible. Sohneke refers to the observations of aeronauts to show that the "freezing-point plane" is especially low before the outbreak of a thunder-storm. The observations of aeronauts bearing on this question by no means reach a positive proof. Sohneke investigated, therefore, the temperature difference due to the difference in height (719 m.) of the stations Freiburg and Hühenschwand in Baden. His investigations confirmed his supposition that on thunder-storm days the temperature almost always decreases faster from below upward than at other times; for of seventeen cases considered, in which these stations furnished simultaneous thunder-storms, there were only three in which the difference of temperature was below the normal, while in all other cases it was above normal. Also Kaemtz established in his meteorology that a rapid alteration of temperature with height is an important condition in the formation of summer thunder-storms.

Dr. Assmann in his work on thunder-storms in Germany endorses Sohneke's hypothesis. He compared the temperature observations at the stations Sal-

zungen (253 m.), Eisenach (240 m.), and Erfurt (196 m.), with those at Inselberg (906 m.), and found that out of sixty-four days on which thunder-storms occurred simultaneously at the four stations, forty-six, or 72 per cent., had a difference above the normal, fixed by Dr. Hann at 0°.6 to 0°.7 C. for 100 meters in summer.

On the other hand, a comparison instituted by Assmann of the observations at the stations Schneekoppe and Eichberg, furnish negative results in a decision of this question. Professor Hann also expressed himself at the second meeting of the German Meteorological Society in 1885, to the effect that he considered the dipping of the "freezing-point plane" before the outbreak of a thunder-storm as improbable. In the annual report of the Royal Institution of Meteorology and Terrestrial Magnetism at Vienna have been published since 1881 the observations, in detail, at a large number of Austrian stations, among them the high stations Obirgipfel and Schafberg. In order to furnish a contribution, aiding in the decision of this question, I compared the temperature observations at the stations Schafberg (1,776 m.) with those at Salzburg (436 m.) and Kremsmünster (384 m.), and the observations at Obirgipfel (2,044 m.) with those at Klagenfurt (438 m.) and Laibach (287 m.). The data from Salzburg, Kremsmünster, and Laibach, I took likewise from the annual report. The detailed observations for Klagenfurt have been published regularly since 1867 in the annual report of the Natural History Land Museum of Kärnten. I used the material of the four years 1881-1884, and restricted myself to the four months May-August, because in the remaining months there were few simultaneous storms recorded at the low stations and their corresponding high stations.

In the first group above, only those cases, in general, were considered in which thunder-storms were recorded at the three stations, Schafberg, Salzburg, and Kremsmünster, at almost the same time of day, but in some months thunder-storm notes were wanting. I could then depend only on the data from Salzburg and Kremsmünster, and took each day into consideration on which these two stations furnished heavy thunder-storms, and Schafberg great precipitation.

In the second group above there were during the years 1881-1884 relatively few days on which simultaneous thunder-storms occurred at all three stations. I had, therefore, to consider the cases for both valley stations separately. The difference of temperature on thunder-storm days was now taken out for that one of the three daily observations (7 a. m., 2 p. m., 9 p. m.) which was nearest to the outbreak of the storm. In cases where it was difficult to decide this, I gave the preference to the observation hour preceding the storm, because I had to assume that the differences in temperature were largely influenced by the intensity and character of the rainfall, and by other attendant appearances (as a rapid increase in temperature), and did not belong so much to the condition during the formation of the storm.

In order now to decide whether in a special case the differences in temperature were above or below the normal, the mean monthly differences, reckoned from that observation which was nearest the beginning of the storm, were taken out as the normal. In determining whether the difference of temperature in the case of a storm in May, 4-6 p. m., was abnormal or not, the four year mean difference for May, 2 p. m., was taken as the normal, and the departure from that was reckoned. The differences of the mean temperature in the months May-August for the years 1881-1884, are shown in the following table, arranged according to the tri-daily observations:

Mean temperature (Centigrade) differences, 1881-1884.

Month.	(1) Salzburg and Schafberg.			(2) Kremsmünster and Schafberg.			(3) Klagenfurt and Obirgipfel.			(4) Laibach and Obirgipfel.		
	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.
May.....	6.5	10.7	8.3	6.7	10.4	8.4	10.1	13.8	11.4	10.3	14.0	11.3
June.....	7.7	10.7	8.7	7.5	10.2	8.4	10.9	13.4	11.2	10.1	13.7	11.1
July.....	7.1	10.5	8.4	6.9	10.3	8.6	9.4	12.3	10.2	8.9	13.1	10.7
August.....	6.5	10.3	7.6	6.2	9.4	7.7	8.1	11.4	9.7	7.9	11.8	9.7
Mean.....	7.0	10.5	8.2	6.8	10.1	8.3	9.6	12.7	10.6	9.3	13.1	10.7
Mean of all.....	8.6			8.4			11.0			11.0		

From this table it appears quite plainly that the normal difference in temperature beginning with May, or at least with June, continually decreases till August. This is specially evident in the differences of Laibach-Obirgipfel. In group three, the great difference in June, 7 a. m., is surprising, but may be traced to the fact that at the station Klagenfurt the thermometer during the morning hours was not wholly shielded at the time of the greatest yearly altitude of the sun from radiation influence, which was specially noticeable in the years 1875-1880.

To the yearly period of temperature difference there is a corresponding daily period, in which the maximum is sharply defined at 2 p. m. I thought therefore in the preceding case, that the numbers, which were calculated by Dr. Hann, for the separate months in reckoning the temperature difference with height, would not apply, although the computation would have been simpler, because I held that, on account of the great daily change, it was necessary to consider the time of the thunder-storm as nearly as was possible with the three daily observations. If we take Dr. Hann's value for the fall in temperature with height from May-August, and reckon the amount for the difference of 1,840 and 1,757 metres we shall find in the first case 8°.7, and in the second