

withstanding the heavy snowfall, there was practically no snow on the ground over the greater portion of the winter-wheat region. The following notes have been extracted from the monthly reports of the State Weather Services, and refer to the relation between precipitation and agriculture:

Alabama.—The weather for the month was generally unsettled; rainy periods were quite close together; on the 24th, hail and sleet; 25th, rain, sleet, hail, and snow; these conditions retarded plowing preparatory to early planting.

Arizona.—The amount of snow ranged from 24 inches at Flagstaff to a trace at Peoria; the total was unusually great, and has not been equaled in many years.

Iowa.—The precipitation on the 11th and 12th south of the Ohio and Missouri valleys was rain, and north of this snow, all of which will prove beneficial rather than injurious to agricultural interests.

Louisiana.—Precipitation was rather below the average in the northern half of the State, but with more than the usual number of rainy days, and farmers are considerably behind with their work. Abbeville: on the 20th to 22d rain came in floods; every bridge was washed away; the water was higher than for sixteen years; the month was very unfavorable for farm work.

Mississippi.—A general storm of snow and sleet on the 24th and 25th, and snow fell in all portions of the State; trees were covered with ice for two or three days in the northern and central districts; ice on the trees did considerable damage in breaking off limbs.

New England.—In northern New Hampshire an observer reports that wells and springs were never before known to be so low at this time of the year.

Ohio.—Between the 12th and 27th heavy snow fell over the State, affording good protection to the cereals in the ground. At the close of the month the wheat was generally in fair condition. The snowfall of the 12th and 13th was especially heavy over the middle and northern sections; that of the 25th was heaviest over the southern and southern portions of the middle sections. During the progress of these two storms all commercial business nearly ceased.

South Carolina.—Precipitation was well distributed over the entire State, with an average of ten rainy days; the principal precipitation occurred as rain on the 14th and 15th, and as rain, sleet, or snow on the 24th to 26th; the ground was not frozen when the snow and sleet began, nor did it freeze, and so was in the best possible condition to receive the utmost benefit from the gradual thawing and the subsequent absorption of the greater part of the snow and sleet.

Utah.—The deficiency of rainfall in the northern part of the State was not enough to spoil the prospect of an abundant water supply for the coming summer.

Wisconsin.—In the lumber districts of the north, on the 28th, the snow lay from 10 to 30 inches deep in the woods. At the close of the month the southern half of the State, containing nearly all the area of winter grains, was entirely bare of snow and the frost rapidly coming from the ground; conditions very unfavorable for crops, as considerable freezing weather must ensue before spring can permanently open.

WIND.

PREVAILING WINDS.

The prevailing winds for February, 1894, viz., those that were recorded most frequently at Weather Bureau stations, are shown in Table I, but are not given on Chart II, as has hitherto been the custom. The summary of State Weather Service reports gives the prevailing winds as recorded at voluntary stations in the respective States; these may be summarized as follows:

North.—Alabama, Arkansas, Kansas, Louisiana, Mississippi, Oklahoma, Tennessee, Texas, and Virginia.

Northeast.—None.

East.—None.

Southeast.—None.

South.—Washington.

Southwest.—Illinois, Michigan, Nevada, North Carolina, Ohio, South Carolina, and Wisconsin.

West.—California, Colorado, Idaho, West Virginia, and Wyoming.

Northwest.—Illinois, Indiana, Iowa, Kentucky, Maryland, Minnesota, Missouri, Nebraska, New England, New Jersey, New York, North Dakota, Pennsylvania, South Dakota, and Utah.

RESULTANT WINDS.

The resultants for the current month, as deduced from the hourly records of winds, by self-registers at 67 regular Weather Bureau stations, are given in Table VIII. Other resultants deduced from the personal observations made at 8 a. m. and 8 p. m. at all stations that appear on the morning and evening maps of the Weather Bureau are given in Table IX. These latter resultants are also shown graphically on Chart II, in connection with the isobars based on the same system of simultaneous observation; the small figure attached to each arrow shows the number of hours that this resultant prevailed, assuming each of the morning and evening observations to represent one hour's duration of a wind of average velocity; these figures (or the ratio between them and the total number of observations in this month) will indicate the extent to which winds from different directions counterbalanced each other. The actual north, south, east, and west components, on which these resultants are based, are given in detail in Table IX for convenience in making further studies.

During February the movement from the northwest has prevailed along the Atlantic coast, except southwest in Florida

and southern Georgia. The movement from the southwest has prevailed in the Lake region, and the movement from the southeast has prevailed over the northern plateau and north Pacific coast.

HIGH WINDS.

Wind velocities of 50 miles, or more, per hour were reported at regular stations of the Weather Bureau as follows. Maximum velocities are averages for 5 minutes; extreme velocities are gusts of shorter duration:

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
		<i>Miles.</i>				<i>Miles.</i>	
Amarillo, Tex.	8	60	w.	Fort Canby, Wash.	26	54	s.
Do	11	52	n.	Do	27	53	s.
Do	17	56	nw.	Keeler, Cal.	21	53	nw.
Block Island, R. I.	12	72	e.	Lexington, Ky.	12	80	ne.
Do	13	73	e.	Nantucket, Mass.	13	53	se.
Do	26	65	e.	Pikes Peak, Colo.	16	92	w.
Do	27	56	ne.	Do	17	91	nw.
Buffalo, N. Y.	10	58	w.	Saint Louis, Mo.	9	53	sw.
Cheyenne, Wyo.	17	50	nw.	Tatoosh Island, Wash.	4	50	sw.
Chicago, Ill.	12	50	sw.	Do	7	62	sw.
Do	16	84	sw.	Do	14	52	s.
Do	17	50	sw.	Do	15	60	e.
Colorado Springs, Colo.	8	55	nw.	Do	19	72	sw.
Do	16	59	w.	Toledo, Ohio.	12	60	ne.
Do	20	64	w.	Tucson, Ariz.	10	60	sw.
Detroit, Mich.	10	57	sw.	Winnemucca, Nev.	11	55	s.
Eastport, Me.	15	50	se.	Do	17	58	sw.
Fort Canby, Wash.	4	60	s.	Do	18	72	sw.
Do	6	60	se.	Do	19	74	sw.
Do	7	58	se.	Woods Holl, Mass.	16	50	nw.
Do	11	52	e.	Do	23	58	nw.
Do	14	80	s.	Yuma, Ariz.	10	52	nw.

LOCAL STORMS.

3d.—Destructive local storms occurred in Georgia, Alabama, and Mississippi. At Atlanta, Ga., a gale of short duration began at 10.10 a. m., and reached a maximum velocity of 48 miles per hour at 10.35 a. m., accompanied by a heavy shower of rain for ten minutes; damage was done to fences and electric wires. In Alabama the windstorm was the most severe that has occurred in a number of years. At Irondale, Ala., showers, with gusts of wind, occurred from 6 to 7 p. m. At East Birmingham, about 4 miles west of Irondale, the storm moved due east, with a zigzag motion, in a path about 2 miles wide; a church was blown down and other damage done. At Gate City, a suburb of Birmingham, the railroad station and a church were blown down and sev-

eral smaller buildings demolished; there were 30 persons in the church at the time, 4 of whom were killed and the remainder more or less injured. A violent storm of short duration, and moving southeast, struck Columbus, Miss., at 5.30 p. m.; a funnel-shaped cloud was observed; several persons were injured and the damage to property was estimated at \$2,500. At Winona, Miss., the railroad depot was moved from its foundation and a large storehouse destroyed. A severe storm moving south, in a path several miles wide, passed over Artesia, Miss., at 5.15 p. m.; 5 funnel-shaped clouds were observed; great destruction was done to property. About 4 p. m., a storm moving east, with heavy rain after, caused \$3,000 damage at McCarley, Miss.

4th.—A northwest gale occurred at Pensacola, Fla., in the afternoon. At Santa Rosa Sound, 10 miles from Pensacola, a sail boat was capsized, and 5 men were drowned.

7th.—Four miles southeast of Palestine, Tex., a windstorm blew down outhouses and fences. At Rockdale, Tex., a storm, with heavy rain, moved southeast at 11.10 p. m.; a church was damaged to the extent of \$1,600. A heavy thunder and rain storm occurred at Kountze, Tex., about midnight; a few miles north and south some small buildings were unroofed.

8th.—Severe gales and heavy rain passed over southern Louisiana in the morning. The storm was exceptionally severe in the vicinity of Port Hudson, in East Baton Rouge Parish, where it occurred between 7 and 8 a. m. Buildings were moved from their foundations and large trees uprooted. On plantations 2 miles north of Port Hudson a number of persons were injured and a child was killed; stock was also killed and the damage to property considerable. At New Orleans, La., a gale, beginning in the morning, attained a maximum velocity of 42 miles per hour from the south at 12.25 p. m. A building in course of erection was blown down and other damage done. At Greenville, Miss., a wind and rain storm, moving southeast, began at 10.30 a. m.; one person was killed and damage done to property. At Huntington, Miss., a storm moving northeast, with heavy rain and light hail before, occurred about 11 a. m.; minor damage was done. On the 8th, at 10 a. m., special warnings were sent from Washington to Tennessee, Illinois, Arkansas, and Missouri, i. e., "conditions are favorable for severe local storms this afternoon or evening."

9th.—Severe local storms occurred in Arkansas, the Ohio Valley, Tennessee, and the Lake region. At Hicksville, Ohio, a heavy thunderstorm moved northeast, with heavy rain followed by hail; damage to buildings, \$500. At Toledo, Ohio, the storm was of short duration, attended by thunder and lightning and high wind; hail fell for two minutes. The wind reached a maximum velocity of 47 miles per hour from the northwest and an extreme velocity of 55 miles. A house was struck by lightning and a woman and child were injured; a house in course of erection was blown down and other damage done. At Fremont, Ohio, small buildings were overturned. High wind did considerable damage throughout Indiana. At Michigan City, Ind., the storm occurred between 3 and 4 p. m.; light thunder was heard; 5 freight cars were demolished and other damage done. At Madison, Ind., considerable damage of a minor character was sustained. At Huntingburg, Ind., a severe gale unroofed barns and blew down trees. At Peru, Ind., a storm moving southeast caused damage to the amount of \$1,000. High wind caused minor damage at Decatur, Ill. The southern part of Michigan was swept by a heavy storm in the afternoon. At Dundee, Mich., the storm was attended by thunder, lightning, and heavy hail; it moved from the southwest with great speed, doing considerable damage. At Royal Oak, Mich., 2 persons were slightly injured, and damage was caused of a minor character. An unusually heavy gale struck St. Louis, Mo., at 10.30 a. m., the wind reaching a

maximum velocity of 58 miles per hour. Considerable damage was done to property and a number of persons were injured by flying débris. On the 9th, at 10 a. m., special warnings were sent from Washington to Iowa, Missouri, Illinois, Indiana, Wisconsin, Ohio, Kentucky, Michigan, and West Virginia, i. e., "conditions are favorable for the occurrence of severe local storms this afternoon or evening."

10th.—At Toledo, Ohio, high winds in the early morning reached a maximum velocity of 37 miles per hour, and an extreme velocity of 60 miles. A boy was injured. During a windstorm at Mount Huachuca, Ariz., outhouses were unroofed. A gale from the northwest prevailed at Fresno, Cal.; the Pine Ridge flume was blown down.

11th.—High wind blew down fences at Adairsville, Ga. A thunderstorm, with high wind and heavy rain, occurred at Vicksburg, Miss., about 9.20 p. m.; damage was done by flood. A heavy thunder and rain storm moved northwest over Beauregard, Miss., at 11 p. m.; 5 persons were injured and buildings were damaged to the extent of \$3,000. Unusually high winds, accompanied by sleet and snow, and in some localities the coldest weather of the winter, prevailed over Texas, Kansas, Oklahoma, and Indian Territory, delaying traffic and causing much suffering to cattle. Special warnings of a severe norther were telegraphed from the Weather Bureau at Washington on the morning of this date to railroads and Weather Bureau observers in Texas. At San Antonio, Tex., a gale began in the afternoon and reached a maximum velocity of 45 miles per hour; considerable damage of a minor character was done. At Shiner, Tex., a storm moved east in a narrow path at 3.30 p. m.; it had a whirling motion and a funnel-shaped cloud was observed. A church was damaged and houses were moved from their foundations. A heavy drifting snowstorm set in over Topeka, Kans., at 8.30 a. m., delaying railroad and street-car traffic. At Dodge City, Kans., the most severe norther, accompanied by the heaviest snow that has visited that section in years, began in the early morning. No trains on the Santa Fe railroad arrived until 6 p. m. of the 12th; cattle were lost and stock on the plains suffered badly.

12th.—High winds and heavy snowstorms extended from New England to the Mississippi Valley, delaying traffic and causing damage to property, and several local storms occurred in Alabama and North Carolina. Wrecks occurred along the New England and New Jersey coasts, and in some cases were attended by loss of life. At Buffalo, N. Y., the storm was the most severe in the history of that station. It began on the 12th, at 7.35 a. m., and continued until the morning of the 13th. The snow, which was light and feathery, was drifted by the high wind in some sections to a depth of 4 to 5 feet. About 6 p. m., a tornado appeared about 4 miles north of Chapel Hill, in Orange County, N. C. It traveled in a northeast path about 100 yards wide; a funnel-shaped cloud was observed, which alternately raised and lowered. Large trees and everything in its path were gathered up and whirled around like pieces of paper. The tornado passed about 15 miles northeast to Durham, and disappeared near Cozart, in Granville County. No lives were lost, but great damage was done to property.

On the 11th, at 11 p. m., special warnings, i. e., "conditions favorable for severe local storms," to occur on the 12th, were sent to the Weather Bureau observers in Alabama. At Dunham, Ala., several houses were blown down, trees uprooted, and fences blown away; several persons were injured. At Snow Hill, Ala., the path of the storm was about half a mile wide; a church and school-houses and many cabins were demolished. At Camden, Ala., several houses were unroofed, trees uprooted, and a barn blown down. Damage was also done at Troy and Eufaula, Ala. At Pleasant Hill, Ky., a heavy rain and wind storm damaged property to the extent of \$1,500. At Toledo,

Ohio, snow began at 7.05 a. m., with a gale reaching a maximum velocity of 60 miles per hour from the northeast, and an extreme of 88 miles; the storm was the heaviest ever experienced; the Weather Bureau observer at that place reports that snowdrifts in some places reached 8 feet high; considerable damage was done by high wind, and traffic was suspended; the gale caused the water in the river to rise rapidly, flooding docks and cellars. The heaviest storm in the history of Chicago began in the early morning; snow began at 5.30 a. m., and continued during the day; the wind averaged nearly 70 miles an hour from the northeast for more than ten hours and reached a maximum velocity of 84 miles at 11 a. m.; damage was done to the amount of \$250,000. At Detroit, Mich., snow began at 9.20 a. m., and continued during the day, accompanied by high wind; trains were delayed throughout the State, and business in general suffered. At Port Huron, Mich., snow began at 9.51 a. m., with high winds, reaching a maximum velocity of 48 miles per hour; the wind did not go below 40 miles an hour during the afternoon, drifting the snow in some places to a depth of 6 feet. At Milwaukee, Wis., snow began during the early morning, accompanied by a gale of 42 miles per hour, drifting the snow badly. The storm was general throughout Iowa, Kansas, and Missouri, and traffic was greatly delayed.

15th.—At Key West, Fla., high winds attained a maximum velocity of 42 miles per hour; 23 miles west of Key West a bark went ashore. A thunderstorm, with high wind

and heavy rain, moved northeast over Alexandria, La., about 1 a. m., damaging property to the extent of \$10,000.

17th.—During a thunderstorm on the Arkansas River, near Little Rock, Ark., a man was killed by lightning.

19th.—A thunderstorm at Hightstown, N. J., caused minor damage. Damage was caused by heavy rain and high wind in California, north of San Francisco. Damage was done by a windstorm which began in Nevada on the 17th and continued during the 19th.

22d.—A report from Los Angeles, Cal., states that a severe norther prevailed in that section. Great damage was done to oranges and other fruits.

24-26th.—Unusually severe snow and sleet storms prevailed from Massachusetts over the south Atlantic States, and extended over the Ohio Valley and Tennessee to Texas, attended by heavy gales from the New England to the North Carolina coasts.

Special warnings of heavy snow were sent out to the observers of the Weather Bureau at Washington, Baltimore, Philadelphia, New York, Pittsburg, and Buffalo, and to railroads in Maryland, District of Columbia, and Pennsylvania. A tabulated statement giving the beginning and ending and the total depth of snow in the Southern States during this storm is given on pp. 61-62. At Charleston, S. C., and other points in the South early vegetables were considerably injured.

28th.—During a thunderstorm at Rush Point, La., a man was killed by lightning.

ATMOSPHERIC ELECTRICITY.

THUNDERSTORMS AND AURORAS.

The table on page 69 shows in detail for February, 1894, the number of stations from which meteorological reports were received, and the number of such stations reporting thunderstorms (T) and auroras (A) in each State and on each day of the month.

THUNDERSTORMS.

A mention of the more severe thunderstorms reported during the month is given under "Local storms." The dates on which reports of thunderstorms were most numerous are the 9th, 11th, and 19th. The dates on which reports were least numerous are the 4th, 5th, 6th, 13th, 14th, 15th, 16th, 22d, 23d, 24th. The States from which the most numerous reports were received were: Arkansas, 46; Florida, 40; Louisiana, 73; New Jersey, 28; Texas, 32.

AURORAS.

The evenings on which bright moonlight must have interfered with observations of faint auroras were the 15th to 23d, inclusive. On the remaining twenty days of the month 232 reports were received, or an average of 11 per day. The dates on which the reported number especially exceeded this average were the 21st, 22d, 23d, 24th, 25th, and 28th. The period of maximum thunderstorm frequency, viz, the 17th to 21st preceded the great auroral display by several days, but there may have been no very close connection.

The aurora of the 22d and 23d was one of the most remarkable of recent years; reports of its visibility have been received from over 600 stations representing every State, except Indian Territory, Texas, Arkansas, Louisiana, Mississippi, Alabama, Georgia, Florida, and South Carolina, and this mass of data is worthy of a more thorough analysis than can be given to it in the present REVIEW. The 19th, 20th, and 21st had been marked by an unusual number of thunderstorms in Louisiana and New Jersey and the weather maps of those days show that the low pressures and rain or snow areas in the

Southwest, Gulf, and Atlantic States were finally pushed south and east by the great high area, No. VII, which apparently moved from Siberia into Alaska and southeastward until, on the 22d, 8 p. m., it was central in Wyoming, but on the 23d, 8 p. m., extended as a ridge over Idaho, Wyoming, Minnesota, and Ontario. There was a similar area of high pressure January 12-14, 1893, in Siberia and North America, but I do not know that a special auroral display attended it.

The reports of the aurora of February 22 and 23 show many interesting chronological and geographical correlations, among which I note the following:

1. The reported time of beginning of visibility of the aurora, as expressed in uniform seventy-fifth meridian time, or, if it is preferred, uniform Greenwich time, or any other preferred uniform system, seems to have been earlier on the 23d than on the 22d (16 regular Weather Bureau stations report earlier, 5 later, and 4 the same time). This would be an important point were it not that one must naturally fear lest the occurrence of the aurora on the 22d had made the observers more alert on the 23d.

2. As expressed in seventy-fifth meridian time the aurora began on the 22d between 8 and 9 p. m. in New England, Lake Superior, Minnesota, and North Dakota; between 9 and 10 p. m. in the States south and west of this region, and between 10 and 10.30 p. m. in the extreme southern border and in California, Washington, and Oregon. This correlation with absolute time might be supposed to furnish some suggestions as to the position of the earth in its orbit and of the relation of the aurora to the sun, but the records show that, expressed in the same absolute time, the visibility on the 23d began between 6 and 8 p. m. in New England and New Jersey; between 8 and 9 p. m. in the upper Lake region and Minnesota; between 9 and 10 p. m. at stations south and west of these. The records of the two nights do not seem to show any uniform relation, indicating that the aurora depended upon emanations from the sun; it would certainly be incredible that these, if they occurred, should have hap-