

*Lake Superior.*—Navigation closed at Marquette, Mich., on the 3d, and at Duluth, Minn., on the 4th.

Otsego Lake closed at Cooperstown, N. Y., on the 25th, the earliest date since 1878. Lake Champlain was frozen at Plattsburgh Barracks, N. Y., on the 31st.

The Androscoggin River closed at Livermore Falls, Me., and the Penobscot River at Bangor, Me., on the 1st.

*Connecticut River.*—Reports indicated that navigation closed on the 16th.

*Hudson River.*—Navigation practically closed on the upper Hudson on the 3d. On the 30th the Hudson and East Rivers were filled with floating ice at New York City, although the ice was not heavy enough to seriously interfere with navigation. Five miles up the Hudson it had been almost entirely suspended. A report from Catskill, N. Y., dated the 8th, stated that "navigation on the Hudson closed this year earlier than it has since the year 1880, and that the dates for the closing of the river at that point are as follows: 1889, January 8; 1888, December 19; 1887, December 22; 1886, December 4; 1885, December 8; 1884, December 19; 1883, December 18; 1882, December 7; 1881, January 2; 1880, December 1. In 1888 the river, though closed on December 19, was subsequently opened, and tow-boats ran until January 20, and the same conditions were possible last year."

*Susquehanna River.*—Navigation closed at Wilkes Barre, Pa., on the 1st. The river was filled with large cakes of floating ice on the 8th; clear of ice on the 18th; floating ice on the 19th and 20th; closed on the 21st; open on the 24th; and closed on the 28th.

*Delaware and Schuylkill Rivers.*—On the 3d light ice formed in the Delaware River at Philadelphia, Pa., and the Schuylkill River was frozen over at that point.

*Monongahela River.*—Navigation was closed at Morgantown, W. Va., on the 28th, and at Greensborough, Pa., on the 29th.

*Ohio River.*—Floating ice was reported at Marietta, Ohio, on the 11th, 15th, 17th, 19th to 22d, 25th to 27th, and 29th to 31st.

*Sandusky River.*—The river was frozen at Tiffin, Ohio, on the 3d.

*Maumee River.*—The river was frozen at Toledo, Ohio, on the 7th, and navigation closed on the 11th.

*Detroit River.*—Ice was running in the river and navigation was generally closed at Detroit, Mich., on the 3d. Floating ice in the river 6th, 7th, 11th, 15th, 18th, 20th, 25th, and 28th to 30th. The last vessels of the season passed Detroit on the 12th.

*Black River.*—The river was completely frozen over at Port Huron, Mich., for the first time this season on the 2d.

*Saint Mary's River.*—The last boat of the season passed down on the 3d, closing navigation.

*Mississippi River.*—At Saint Paul, Minn., the river was frozen over on the 2d. There was considerable floating ice at La Crosse, Wis., on the 2d. At Red Wing, Minn., the river was frozen over on the 2d. Lake Pepin was frozen during the night of the 2-3d. At Dubuque, Iowa, the river was frozen on the 4th. At Davenport, Iowa, ice was running in the river

on the 3d to 14th, 27th, and 30th. The Rock River was frozen over at Rockford, Ill., on the 4th.

*Missouri River.*—Ice was running at Fort Buford, N. Dak., on the 2d, and the river closed at that point the night of the 3d-4th. The river was closed at Fort Yates, N. Dak., on the 6th. Ice was running at Fort Sully, S. Dak., from the 1st to 4th, and the river closed at that point on the 6th. On the 8th and 9th a large quantity of ice was running at Leavenworth, Kans.; 10th, river free from ice; 13th, heavy floating ice; 14th, river free from ice; 18th, considerable floating ice; 19th, river free from ice; 25th to 30th, river filled with floating ice. At Kansas City, Mo., floating ice was reported on the 7th, 8th, and 9th. At Saint Joseph, Mo., running ice in the river 5th to 10th and 24th to 30th. On the 31st the river was clear.

*Yellowstone River.*—Ice was reported in the river at Glendive, Mont., on the 7th.

*Erie Canal.*—On the 2d water was drawn off west of Little Falls, N. Y. Over fifty boats were reported frozen in, forty-between Schenectady and Amsterdam, and about twelve at Crescent.

*Morris Canal.*—The canal closed for the season on the 18th; several boats were frozen in.

STAGE OF WATER IN RIVERS AND HARBORS.

The following table shows the danger-point at the several stations; the highest and lowest water during December, 1890, with the dates of occurrence and the monthly ranges:

Heights of rivers above low-water mark, December, 1890 (in feet and tenths).

Stations.	Danger-point on gauge.	Highest water.		Lowest water.		Monthly range.
		Date.	Height.	Date.	Height.	
<i>Red River.</i>						
Shreveport, La.....	29.9	10	17.7	29	7.7	10.0
<i>Arkansas River.</i>						
Fort Smith, Ark.....	22.0	27	12.3	24	3.0	9.3
Little Rock, Ark.....	23.0	30	15.1	24	5.8	9.3
<i>Missouri River.</i>						
Fort Buford, N. Dak.*.....						
Kansas City, Mo.....	21.0	5	5.5	11, 13, 14	3.1	2.4
<i>Mississippi River.</i>						
Saint Paul, Minn.*.....	14.5					
La Crosse, Wis.*.....	13.0					
Dubuque, Iowa*.....	16.0					
Davenport, Iowa.....	15.0	1	2.4	12	0.2	2.2
Keokuk, Iowa.....	14.0	1, 2, 3	2.1	13	0.6	2.7
Saint Louis, Mo.....	32.0	1	6.8	30, 31	2.8	4.0
Cairo, Ill.....	40.0	31	19.6	25	8.7	10.9
Memphis, Tenn.....	34.6	1	16.3	26, 27	7.2	9.1
Vicksburg, Miss.....	41.0	1	26.5	30	10.7	15.8
New Orleans, La.....	13.0	4, 5	8.3	31	4.3	4.0
<i>Ohio River.</i>						
Pittsburgh, Pa.....	22.0	24	10.8	16, 17	3.0	7.8
Parkersburg, W. Va.....	38.0	25	16.2	3, 19	6.2	10.0
Cincinnati, Ohio.....	50.0	29	31.5	5, 6, 7	12.3	19.2
Louisville, Ky.....	25.0	30	12.8	6, 7	6.4	6.4
<i>Cumberland River.</i>						
Nashville, Tenn.....	40.0	31	24.4	5	3.2	21.2
<i>Tennessee River.</i>						
Chattanooga, Tenn.....	33.0	29	12.9	3, 4, 5	2.3	10.6
Knoxville, Tenn.....		28	6.4	3	0.4	6.0
<i>Monongahela River.</i>						
Pittsburgh, Pa.....	29.0	24	10.8	16, 17	3.0	7.8
<i>Savannah River.</i>						
Augusta, Ga.....	32.0	9	15.4	3	6.7	8.7
<i>Willamette River.</i>						
Portland, Oregon.....	15.0	16, 17	3.1	8	2.2	5.3

\*Frozen.

ATMOSPHERIC ELECTRICITY.

AUROSAS.

Auroras were reported as follows: 3d, Saint Vincent, Minn. 4th, Carson, Iowa. 11th, Vevay, Ind. 14th, Webster, S. Dak. 29th, Appleton City, Mo. 30th, Seymour, Ind.

On the 3d, at Saint Vincent, Minn., a distinct auroral arch, about 8° in altitude and extending from 165° to 215° of azimuth, was observed from 8.40 to 11.50 p. m.; 75th meridian time. The arch was about 1° in width and of a whitish color.

THUNDER-STORMS.

Thunder-storms were reported as follows: east of the Rocky Mountains thunder-storms were reported in the greatest number of states, 8, on the 3d; in 7 on the 6th and 31st; in 6 on the 7th; in 5 on the 5th; in 2 on the 8th, 24th, and 25th; and in 1 on the 4th, 18th, and 26th. On dates other than those named no thunder-storms were reported.

East of the Rocky Mountains thunder-storms were reported on the greatest number of dates, 5, in La. and Miss.; on 4 in N. C., Tenn., and Tex.; on 3 in Ala., Fla., Ga., and S. C.; on

2 in Ark.; and on 1 in Ill., Iowa, Kans., Ky., Mo., and N. H. West of the Rocky Mountains thunder-storms were reported as follows: Ariz., 5th, 30th, and 31st; Cal., 3d; Nev., 29th

and 30th; Oregon, 14th and 19th; Utah, 30th; Wash., 13th and 18th. In states and territories other than those named no thunder-storms were reported.

MISCELLANEOUS PHENOMENA.

DROUGHT.

Drought prevailed in parts of Illinois, Iowa, Missouri, Louisiana, Texas, and Montana. At Philo, Ill., only 0.13 inch of rain had fallen from November 16th to December 31st, and water was very scarce. At Fort Madison, Iowa, the month was very dry. At Cedar Rapids, Iowa, the monthly precipitation was the smallest for December during the last 5 years; the river was quite low, and streams and wells were becoming dry. At Oregon, Mo., water was failing in streams and springs. At Haunibal, Mo., it was the driest month of the year, and the river was reported lower than at any time in 50 years. At Shelbina, Mo., no precipitation fell from November 16th until December 31st, and wells and stock ponds were unusually low. The drought that prevailed in north Louisiana from November 16th was broken on the 5th, and in south Louisiana on the 3d. Near San Antonio, Tex., scarcity of water on the ranges caused large loss of live stock; the drought was broken on the 23d. Near Fort Custer, Mont., many streams were dried up, and stock was suffering for water.

MIRAGE.

On the 14th, at Saint Vincent, Minn., the Pembina Mountains, 50 miles distant, and Hamilton, N. Dak., 22 miles distant, were in full view at 8 a. m., 75th meridian time. At this time a remarkably fine mirage was observed. Objects, large and small, were plainly brought to view. Smoke from chimneys many miles away could be distinctly seen, and cattle in a farm-yard, 8 miles distant, were plainly visible. The phenomenon lasted from daybreak until 9.45 a. m. On the 20th a mirage was observed at Ship Island Light-house, Miss., between 3 and 4 p. m., Biloxi, Miss., and vessels and bathing-houses being clearly seen.

SUN SPOTS.

Mr. D. E. Hadden, Alta, Iowa: 3d, 1 group, 1 spot; large spot on nw. limb, disappearing by solar rotation. 7th, small faculae on nw. limb; faint groups faculae near e. and sw. limbs. 12th, small faculae near e. limb. 14th, 2 groups, 10 spots; larger groups s. latitude on meridian; other group e. one-fourth across disc; small faculae near se. limb. 15th, 3 groups, 14 spots, definition poor. 16th, 2 groups, definition poor. 17th, 1 group, definition poor. 18th, 2 groups, 8 spots; large group of 5 spots near sw. limb, surrounded by faculae; the other group 1 day east of meridian. 19th, 2 groups, 10 spots; new spots in group on meridian. 20th, 3 groups, 5 spots; 1 group on w. limb, disappearing by solar rotation, had brilliant faculae, but spots could not be seen; new group on e. limb with large areas of faculae. 21st, group which was near meridian n. latitude 20th had disappeared, and the group visible

on e. limb 20th could not be seen; small faculae e. 23d, faculae w. and sw. 26th, 1 group, 2 spots; new group n. latitude 1 day e. of meridian. 27th, 1 group, 1 spot; spot on meridian vanishing. 28th, small faculae by rotation on e. limb. 29th, 1 group, 1 spot; new group in faculae near e. limb; faculae nw. Cloudy 1st, 2d, 4th, 5th, 13th, 24th, and 31st.

Mr. C. E. Buzzell, Leaf River, Ill.: 1st, the large disturbance of November 21st was passing w. limb. 2d to 7th, cloudy. 8th, marked faculae and small spots near w. limb. 9th to 12th, poor definition. 13th, poor definition; 1 group, 2 days in, in n. latitude; 1 group, 5 days in, in s. latitude; both unchanged on 14th. 15th and 16th, cloudy. 18th, 1 new group near meridian; 1 group near w. limb, which faded out on 19th. Group of 18th subsided on 20th, with apparent clear disc on 21st. 25th, 2 small groups in n. latitude near meridian; faded out on 28th. 29th, new group, 3 days in, in n. latitude; faded out on 30th. 31st, cloudy.

Mr. John W. James, Riley, Ill.: the large spot on the sun's meridian November 28th disappeared by solar rotation 4th, but failed to reappear when due on e. edge. 4th to 13th, none seen. 14th, a group of 12 small spots on sun's meridian in very low s. latitude; still seen 18th. 21st, faculae near e. limb. 21st to 28th, no spots seen. 29th, 1 small spot, surrounded by faculae, 2 days from e. edge; spot gone on 30th.

Mr. H. D. Govey, North Lewisburgh, Ohio: sun spots were observed on the 2d, 14th, 15th, 18th, and 19th.

Haverford College Observatory, Pa. (observed by Prof. F. P. Leavenworth):

Date.	Number of new		Disappeared by solar rotation.		Reappeared by solar rotation.		Total number visible.		Faculae.	Remarks.
	Groups.	Spots.	Groups.	Spots.	Groups.	Spots.	Groups.	Spots.		
Dec., 1890.										
1, 10 a. m.	1	1	0	0	0	0	3	13	2	Definition fair; 2 large spots.
2, 11 a. m.	0	0	0	0	0	0	2	8	1	Definition good; 1 large spot.
4, 11 a. m.	0	0	1	3	0	0	0	0	2	Definition fair.
9, 2 p. m.	1	4	0	0	0	0	1	4	1	Definition good.
10, 10 a. m.	1	3	1	4	0	0	1	3	1	Definition good; spots small.
11, 11 a. m.	0	0	0	0	0	0	1	2	1	Definition good; spots small.
12, 11 a. m.	0	0	0	0	0	0	0	0	0	Definition poor.
13, 11 a. m.	2	15	0	0	0	0	2	15	2	Definition fair.
14, 12 m.	0	17	0	0	0	0	2	32	1	Definition fair.
15, 9 a. m.	0	0	0	0	0	0	2	32	2	Definition fair.
18, 3 p. m.	0	0	0	0	0	0	2	21	0	Definition bad.
19, 10 a. m.	1	1	0	0	1	17	3	24	2	Definition poor; 1 large spot.
20, 1 p. m.	0	19	0	0	0	0	3	31	2	Definition good.
22, 10 a. m.	0	0	1	4	0	0	0	0	1	Definition fair.
23, 10 a. m.	1	2	0	0	0	0	1	2	2	Definition poor.
24, 10 a. m.	0	4	0	0	0	0	1	6	2	Definition poor.

VERIFICATIONS.

[Verifications made by Assistant Professor C. F. Marvin, assisted by Mr. H. E. Williams, chief clerk of the Forecast Division.]

FORECASTS FOR 48 AND 72 HOURS IN ADVANCE.

Appreciating the great importance that long time predictions possess for the general public the Chief Signal Officer has authorized forecasts for 48 and 72 hours, covering the 2d and 3d days in advance. These are optional with the forecast official, and are only made when clearly in the public interest, and cover, in all cases, considerable areas of country, and are not confined to localities.

Percentages of verifications of forecasts made for second day in advance. Number of predictions made: weather, 243; temperature, 158. Percentages of verifications: weather, 84.1; temperature, 94.4; weather and temperature combined, 87.5.

Percentages of verifications of forecasts made for third day in advance. Number of predictions made: weather, 25. Percentage of verifications: weather, 96.

FORECASTS FOR 24 HOURS IN ADVANCE.

The forecasts for districts east of the Rocky Mountains for December, 1890, were made by Captain James Allen, 3d Cav-