

In these descriptions where depths of rainfall are given they are for twelve hour periods:

I.—This area first appeared on the evening of the 1st in western Nebraska. It moved in a direction 14° north of east into the Province of Quebec. It then moved in a southeasterly direction and disappeared off the coast of Maine on the 5th. Its motion was more rapid in the middle part of its course through Wisconsin, Michigan, and Canada than at the beginning and end. It was accompanied by violent thunderstorms to the east of it, notably on the 1st at Saint Louis and at Louisville. The wind velocity at Saint Louis during the storm reached fifty-one miles an hour. The rainfall at both places was about 0.6 of an inch. A very remarkable display of lightning occurred at La Crosse during a thunderstorm from 2 a. m. to 4.30 a. m. of the 3d. The rainfall was 2.2 inches. Rains occurred on all sides of the area, and very strong winds, lasting, however, for only a short time. There was hail at Fort Maginnis in Montana to the north of it on the 2d. There were winds thirty-five miles an hour at Denver and Las Animas on the 1st to the southwest of it; forty miles an hour occurred at Chicago on the 2d to the east of it, and twenty-eight miles at La Crosse. On the 3d a velocity of sixty miles an hour occurred at Topeka and forty miles at Wichita, but these may have had some relation to an extensive low area with pressure of 29.8 to the southwest of Kansas which did not develop any proper motion.

II.—This area first appeared on the evening of the 12th in western Pennsylvania. It moved in a northeasterly direction across New York, Massachusetts, and Maine, and disappeared in the Gulf of Saint Lawrence on the 14th. The rainfall around it was mostly light. The heaviest occurred to the east of it. At Philadelphia the amount was 1.1 inches. Occasional strong winds occurred to the south of it. There was a rainfall of 2.0 inches at Oswego on 13th with wind velocity of forty-five miles an hour. Rain continued falling all around the low as it advanced and the winds increased in strength. A wind velocity of fifty miles an hour occurred at New York, forty miles at Eastport, thirty miles at Boston and Portland Me.

III.—This area first appeared in northern Dakota on the morning of the 13th and proceeded southward to western Texas, where it disappeared on the evening of the 16th. Rainfall occurred all around the centre, but over only a comparatively small area. There was a notably heavy wind at Moorhead, fifty-four miles an hour, but no rainfall. There was, however, a heavy hail-storm in its vicinity. The rain area continued small until the 14th when it spread out, there being rain from central Michigan to the Missouri River, and from southern Minnesota to southern Missouri. Winds of fifty miles an hour occurred at Fort Sully, Dak., and Valentine, Nebr., and thirty-five miles at Davenport, Iowa. On the 15th there was an extensive rain-area to the north of the low with rainfalls mostly light, except on its western edge, where there were falls of 1.8 inches at Fort McKinney and 2.5 inches at Rawlins.

IV.—This area was a typical cyclone, which described very nearly a parabolic path. Its apex was in southern Louisiana. One branch extended thence to the south of Florida and the other in a northeasterly direction across the United States and to the northeast of Nova Scotia. This area was first perceived off the southeast coast of Florida on the morning of the 16th. It moved in a direction 10° north of west for 950 miles before changing its course to the northeast. Its motion in this part of its path was only 11.3 miles per hour, much slower than in the other part of its path, where it was on the average 30.2 miles while moving in a northeasterly direction. Near the apex of parabola, where its direction of motion

changed, the centre described only 375 miles in two days. When started in a northeasterly direction its motion became gradually faster. From 8 a. m. of the 21st to 8 a. m. of the 22d it passed over 970 miles, or a little more than forty miles an hour. While the low was in the southern part of its path there was a high of 30.2 inches covering part of North Carolina, South Carolina, and Georgia, and extending into the ocean. Around this high area the low seemed to move. Throughout the whole course of the low area there were heavy rainfalls and high winds around the centre. The rainfall in southern part of Louisiana and Mississippi for the month was excessive, a great deal of it occurring in connection with this storm. On the 16th the wind reached sixty miles an hour at Point Jupiter on the Florida coast, and the rainfall was 2.02 inches. On the 18th the rain area extended up the Mississippi and Ohio River valleys. The winds were very strong on the Gulf coast on the 19th and 20th, reaching sixty miles an hour at Pensacola and fifty-five miles at Mobile on the southeast side of the low at a distance of 300 miles from the centre. At New Orleans the rainfall measured at 8 a. m. for previous twelve hours was 7.9 inches, and the wind was estimated to have blown at the rate of ninety miles an hour from 3.30 to 4 a. m. The anemometer connection with self-register was broken by the storm. Great damage was done by the storm in the city and vicinity. The further course of the storm was marked by heavy rainfalls over extensive areas, as for instance 2.0 inches from Louisville to Cincinnati and 3.25 inches at Norfolk. High winds also occurred at a greater number of stations as the storm advanced. There was a wind velocity of fifty miles an hour at Nashville and Knoxville, and forty miles at Norfolk and Block Island, and high winds all along the intermediate coast on the 21st. High northerly winds also prevailed in the Lake region on the 21st and 22d, reaching thirty-five miles an hour at Port Huron and Chicago and thirty miles at Oswego. These winds on the lakes were probably related also to the high area number iii. On the 22d there was a velocity of fifty miles an hour at Eastport and Block Island, and thirty-five miles an hour at New York. On the 21st, in connection with this low and to the east of it, there was a series of tornadoes in eastern Maryland, accompanied by intense thunder and lightning. A marked feature of the air in the surrounding country just before the occurrence of the tornadoes was the excessive humidity. At Baltimore it was 95 per cent. of saturation. The maximum temperature was not so very high. Late in the afternoon it was only $82^{\circ}.4$. There were no very marked twenty-hour falls in temperature in the country over which the cyclone passed.

V.—This area first appeared to the north of Montana on the 24th, and moving in a direction slightly south of east, disappeared in the Gulf of Saint Lawrence. Only a very slight rainfall in western New York occurred in connection with it. There followed in its wake, associated also with high area number iv on its eastern side, a very considerable twenty-four-hour fall in temperature, amounting to 30° on the 26th in northern Michigan and 20° later on farther to the east.

VI.—This area first appeared to the north of Montana on the morning of the 29th. It traveled southeast, and the centre was in northern Michigan at the evening observation of the 31st. There were light rains at two stations in Michigan on the 30th. On the 31st the area spread out into a very extensive one of low pressure, the 29.9 inch isobar including a stretch of country about two hundred miles wide extending from the Gulf of Saint Lawrence through the region of the Great Lakes and down the Mississippi Valley to the Gulf of Mexico. This area was not attended by any notable changes in temperature.

NORTH ATLANTIC STORMS FOR AUGUST, 1888.

[Pressure in inches and millimetres; wind-force by Beaufort scale.]

The paths of the depressions that appeared over the north Atlantic Ocean during August, 1888, have been determined from international simultaneous observations by captains of ocean steamships and sailing vessels, received through the co-

operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

Eight depressions have been traced, of which five advanced northeastward over Newfoundland; one moved eastward over the Grand Banks from Nova Scotia and from thence passed northward over Newfoundland, and two apparently developed over mid-ocean. One storm, traced as land low area number iv, is given a track from the straits of Florida to the north-central coast of the Gulf of Mexico. Three storms traversed the ocean from coast to coast. The depressions generally pursued normal east-northeast tracks, with a rather slow and irregular progressive movement over mid-ocean. The West Indian cyclone augmented in energy during its advance over the Gulf of Mexico, and on the 18th and 19th was attended by violent wind squalls and incessant rain. On the 27th a telegram was received from Havana, Cuba, stating that at 6 a. m. of that date a cyclonic storm of moderate energy was central southwest of that station, moving northwest. The severest disturbances of the month were reported over the ocean east of the fortieth meridian from the 21st to the 24th, inclusive, attending the advance of a depression which moved northeastward over Newfoundland during the 18th.

In August, 1887, nine depressions were traced, of which three originated in the tropics; five advanced eastward over Newfoundland; and one left the American coast in about N. 38°. Three storms traversed the ocean from coast to coast, of which two passed eastward from the Gulf of Saint Lawrence, and one moved from the West Indies along the course of the Gulf Stream to the sixtieth meridian, and thence advanced northeast to the northward of the fifty-fifth parallel. The depressions over mid-ocean were rather evenly distributed throughout the month, and were, as a rule, accompanied by disturbances of pronounced strength. Over the ocean east of the twentieth meridian the weather was generally fine, while during the first half of the month settled weather prevailed off the American coast south of the forty-fifth parallel. The tropical cyclones which advanced toward the Florida coast north of the West Indies, and subsequently moved northeast parallel with the American coast, were of the energetic and destructive type of storms peculiar to that region during the summer season.

In August, 1888, the general character of the weather over the north Atlantic was seasonable, and while the almost continued presence of cyclonic areas over the ocean north of the fiftieth parallel contributed to frequent barometric fluctuations and shifts of wind along the trans-Atlantic routes, the depressions seldom occasioned disturbances of marked energy.

In the following descriptions of the depressions traced, positions are given in degrees, latitude and longitude, except in cases where twenty-five to thirty-five minutes are cited, when they are shown in degrees and half degrees:

1.—This depression was a continuation of ocean storm number 8 traced for July, 1888, and on August 1st was apparently central over the northern extremity of Newfoundland. During the next three days the storm-centre remained nearly stationary north of Newfoundland, with fresh to strong gales to the fortieth parallel. Subsequent to the 4th the storm pursued a normal east-northeast course and disappeared north of the British Isles after the 7th.

2.—This depression advanced eastward from Nova Scotia during the 5th, and on the morning of the 6th was central in about N. 42°, W. 58°, from whence it moved east-northeast to the fifty-first meridian by the 7th. During this and the following two dates the centre of depression pursued an irregular course over and near the Banks of Newfoundland, and afterwards disappeared to the northward of Newfoundland, being unattended throughout by noteworthy features. The abnormal direction of movement of this depression subsequent to the 6th was evidently due to the presence over the ocean to the eastward of an area of high barometer whereby its eastward advance was impeded.

3.—This depression apparently developed over mid-ocean to

the northward of the Azores, and during the 10th, 11th, and 12th moved northeast and disappeared north of the British Isles after the 12th, attended by moderate to fresh gales and barometric pressure falling to about 29.50 (749.3) on the 11th.

4.—This depression is first located over mid-ocean in N. 53°, W. 33°, under date of the 13th; by the 14th the storm-centre had moved northeast to the fifty-eighth parallel, and thence recurved southeast to the fifty-fifth parallel by the 15th, after which it apparently moved westward under the influence of depression number 5 which had advanced northeastward from Newfoundland.

5.—This depression moved northeastward over Newfoundland during the 15th and on the 16th was central in N. 53°, W. 45°, with minimum pressure about 29.60 (751.8). Advancing slowly eastward the centre of depression is last located in N. 54°, W. 23°, under date of the 19th, after which it recurved to the northwestward and united with depression number 6, which had advanced from the American coast.

6.—This depression was central over the eastern portion of the Gulf of Saint Lawrence on the 18th, and from thence advanced to the thirtieth meridian in latitude N. 56° by the 20th, attended by moderate to fresh gales and barometric pressure falling to about 29.50 (749.3). By the 21st the storm-centre had recurved somewhat to the northwestward with an appreciable decrease in central pressure, and by the 22d had moved to N. 55°, W. 30°, where the minimum barometer fell below 29.00 (736.6). From this position the depression passed east-southeast to N. 51°, W. 14°, by the 23d, and from thence recurved to the northwestward by the 24th, after which date it disappeared north of the region of observation. The severest disturbances of the month in the trans-Atlantic routes were occasioned by this depression from the 21st to the 24th, inclusive, the gales, in instances, attaining hurricane force.

7.—This depression was a continuation of land area number iv, whose track is traced from the vicinity of the Bahama Islands west-northwest to the north-central coast of the Gulf of Mexico and thence to the middle Atlantic coast. On the 22d the centre was located off the western extremity of Nova Scotia where a minimum pressure of about 29.30 (744.2) was reported. On this date strong to whole gales attaining hurricane force prevailed west of the sixtieth meridian. Moving northeast over Nova Scotia and Newfoundland during the 22d and 23d the storm is thence given a normal track to the northward of the British Isles where it disappeared after the 27th, its course being attended throughout by low barometric pressure and fresh to strong gales.

8.—This storm passed northeastward over Labrador during the 30th, and on the 31st was apparently central about four degrees south of the southern extremity of Greenland.

OCEAN ICE.

On chart i the following positions of icebergs reported during the month are shown by ruled shading:

3d.—S. S. "Lake Winnipeg," off Belle Isle, two bergs.

4th.—S. S. "Parisian," in Straits of Belle Isle, several bergs.

5th.—S. S. "Sarnia," in Straits of Belle Isle, several large bergs; S. S. "Glendale," in Straits of Belle Isle to Greenlet Islands, bergs.

6th.—S. S. "Wandrahm," in Straits of Belle Isle, large bergs; S. S. "Hibernia," eight miles off Greenly Islands, a large berg; several large bergs in the Straits.

8th.—S. S. "Vancouver," detained twelve hours at Belle Isle by ice; numerous bergs were observed in the middle of the Straits.

10th.—S. S. "Sarmatian," from Belle Isle to six miles south from Greenly Island, eight large bergs; S. S. "Lake Huron," at Belle Isle, a few large bergs; S. S. "Lake Superior," off Point Amour, several bergs, and several off Belle Isle.

12th.—S. S. "Circassian," off Belle Isle, several bergs.

13th.—S. S. "Grecian," off Belle Isle, ten bergs.

16th.—S. S. "Glendale," near Groais Island, seven bergs.

18th.—S. S. "Pomeranian," in Straits of Belle Isle, some

small detached bergs; S. S. "Toronto," N. 51° 53', W. 55° 00', a large berg; several small ones in the Straits of Belle Isle.

19th.—S. S. "Concordia," near Belle Isle Light, a large berg, apparently aground.

22d.—S. S. "Colima," off Cape Norman, a small berg; S. S. "Wandrahm," south of Belle Isle, fractures of bergs and lumps; east of Belle Isle, a large berg.

24th.—S. S. "Siberian," Belle Isle Light, a large berg; S. S. "Sarnia," off Belle Isle, a medium berg.

25th.—S. S. "Lake Winnipeg," off Belle Isle Light, a large berg.

No icebergs were reported save in the Straits of Belle Isle and off the extreme northern coast of Newfoundland, where their presence was noted on fourteen days.

In July, 1888, several icebergs were observed off the south-east coast of Newfoundland, and numerous icebergs and large quantities of field ice were encountered in and to the eastward of the Straits of Belle Isle.

In August, 1887, the aggregate quantity of ice reported over the Banks of Newfoundland was largely in excess of the average for the month, while in the vicinity of Belle Isle it was deficient.

The August ice reports for the last six years show that the average southern limit of Arctic ice is in about N. 44° 45', and the average eastern limit in about W. 44° 10', and that during this month bergs are commonly observed in the Straits of Belle Isle. The entire absence of icebergs over the Banks of Newfoundland during August, 1888, was, therefore, an unusual feature.

The following table shows the southern and eastern limits of the region within which ice was reported for August during the last seven years:

Southern limit.			Eastern limit.		
Month.	Lat. N.	Long. W.	Month.	Lat. N.	Long. W.
August, 1882	46 50	46 00	August, 1882	46 50	46 00
August, 1883	43 26	51 41	August, 1883	48 00	44 00
August, 1884	43 24	48 44	August, 1884	47 50	43 50
August, 1885	43 48	52 04	August, 1885	48 03	42 45
August, 1886	48 35	48 46	August, 1886	50 00	48 00
August, 1887	42 21	49 51	August, 1887	48 06	40 00
August, 1888	Straits of Belle Isle		August, 1888	51 53	55 00

FOG.

Fog was reported at Saint John's, N. F., on the 10th, 15th, 18th, and 29th.

The limits of fog-belts to the westward of the fortieth meridian are shown on chart i by dotted shading. In the vicinity of Newfoundland fog was reported on twenty-six days, as compared with twenty-eight days for July, 1888, and eighteen days for August, 1887. To the westward of the sixtieth meri-

dian fog was reported for a total of nine days, as compared with thirteen days for the preceding month, and eleven days for August, 1887.

As compared with the charted fog-belts for July, 1888, the southern limit of the Newfoundland areas has contracted about one degree, while off the American coast fog was more frequently encountered along and to the southward of the fortieth parallel.

With the exception of the 12th and 13th, when variable winds and high barometric pressure prevailed over the Grand Banks, the development of fog to the eastward of the sixtieth meridian attended the circulation of winds in the southeast quadrant of areas of low barometric pressure which advanced eastward from the American continent north of the fortieth parallel. To the westward of the sixtieth meridian fog was generally reported following the passage of cyclonic areas to the eastward.

The following are the limits of fog-areas on the north Atlantic Ocean during August, 1888, as reported by shipmasters:

Date.	Vessel.	Entered.			Cleared.		
		Lat. N.	Lon. W.	Time.	Lat. N.	Lon. W.	Time.
1	S. S. Italy	40 40	66 30		40 40	66 45	
1-2	Bk. Valona	46 15	51 00		46 25	51 18	
5-6	S. S. City of Chester	40 33	71 30	1.30 a. m.	41 56	62 40	9 a. m.
5	Buffalo	42 30	64 54	8 a. m.	42 14	69 15	Midnight.
6	Sarnia	52 38	53 01		52 57	51 55	
7	Manhattan	Quarantine, New York.					
7	City of Chicago	43 53	57 33	3.15 a. m.	45 36	51 44	11 p. m.
8	Nova Scotian	46 17	53 40	10 a. m.	46 32	52 59	3.30 p. m.
8	Ailsa	36 17	74 51	2 a. m.	36 55	74 00	8 a. m.
8	Viola	42 12	51 26	1 a. m.	42 06	52 01	4 a. m.
9	Munitoban	44 36	51 01	midnight.	45 31	47 49	Midnight.
10	Lake Huron	Straits of Belle Isle.					
10	Ems	45 22	49 00	2.30 p. m.	44 49	51 00	8 p. m.
10	Helvetia	40 43	65 53	9 a. m.	40 41	68 06	2.40 p. m.
10-11	Lake Superior	Point Amour.					
10-11	Serapis	45 33	58 34	4.30 p. m.	46 27	60 00	6.30 a. m.
11	Westernland	43 08	50 55	4 p. m.	43 57	48 25	1 a. m.
12	Thingvalla	49 22	48 24	0.15 a. m.	48 43	49 18	8.17 a. m.
13	State of Nevada	43 48	56 38	8.10 a. m.	43 14	58 37	3.55 p. m.
13	Loerdam	46 47	45 05	7.30 a. m.	46 17	46 54	2 p. m.
14	City of Berlin	44 24	53 30	10.30 p. m.	44 06	54 28	1.30 a. m.
15	Egyptian Monarch	42 59	48 32		42 08	51 16	
16-17	Republic	43 23	58 50		41 51	64 41	
16-17	Main	45 05	47 50	11.49 p. m.	45 03	48 10	1.28 a. m.
17	Germanic	41 50	62 16	2 a. m.	43 21	56 43	7.30 p. m.
18	British King	41 14	66 30	0.30 p. m.	40 30	67 00	4.30 p. m.
18-19	Fulda	45 00	54 00	noon.	43 30	60 00	6 a. m.
19-20	Belgenland	46 17	49 17	9.20 a. m.	43 50	57 28	3.50 p. m.
20	Gallia	43 32	48 43	11 a. m.	42 51	50 55	8 p. m.
23	Phoenician	42 39	65 15		42 38	65 25	
23-24	Siberian	53 00	58 07		51 30	55 45	
24	Samaria	43 40	48 47		43 15	49 55	
25-26	Nevada	48 22	51 43	10.30 a. m.	44 49	57 02	Noon.
26	Amsterdam	47 26	43 45	7 a. m.	45 21	50 35	10 a. m.
26-27	Samaria	42 37	65 56		42 30	67 15	
27	Elbe	42 25	62 05	4 a. m.	42 15	62 45	5.30 p. m.
27	Celtic	48 10	43 12		47 59	44 23	
28	Island	45 04	52 02	1.30 a. m.	44 22	54 11	
29	City of Chicago	46 16	47 24	2.50 a. m.	45 44	49 13	8.50 a. m.
30	Donau	46 40	44 20	7 a. m.	46 19	46 14	3 p. m.
31	Venotian	47 03	42 56	7 p. m.	46 52	43 32	10 p. m.
31	Mareca	46 00	55 28	9 a. m.	45 42	56 40	2.30 p. m.

TEMPERATURE OF THE AIR (expressed in degrees, Fahrenheit).

The distribution of mean temperature over the United States and Canada for August, 1888, is exhibited on chart ii by the dotted isothermal lines. In the table of miscellaneous data are given the monthly mean temperatures, with the departures from the normal, for the various stations of the Signal Service. The figures opposite the names of the geographical districts in the columns for mean temperature, precipitation, and departures from the normal show, respectively, the averages for the several districts. The normal for any district may be found by adding the departure to the current mean when the departure is below the normal and subtracting when above.

August, 1888, was warmer than usual in the region to the northward of Montana, in the northern and middle plateau districts, and thence westward to the Pacific Ocean, and also

in the lower portions of the southern slope and southern plateau. Along the Atlantic coast from Connecticut to South Carolina the temperature was about normal, and in all other districts the month was colder than the average August, the region over which temperature was below the normal embracing the greater part of the country. The greatest excess of temperature occurred on the Pacific coast northward of the thirty-eighth parallel, and in British Northwest Territory northward of Montana, in which districts the mean temperatures generally ranged from 4° to 6° above the normal; the greatest deficiency occurred in the Missouri, upper Mississippi, and lower Ohio valleys, and in the Canadian Maritime Provinces, the departures generally ranging from 3° to 4°.

The following are some of the most marked departures from normal temperatures at Signal Service stations: