gradients were very wide apart during these high coast winds, and, as there was no visible storm center, it was not easy to account satisfactorily for the observed velocities. These are instances of the general fact that high areas are capable of producing high winds along their edges, though these are usually associated, if not exclusively so in the public mind, with a low barometer and storm center. There were no other high velocities of the wind in June, except the temporary gusts which accompany the development of thunderstorms.—*F. H. Bigelow, Professor.*

THUNDERSTORM FORECASTS.

The spring season of 1898 has been comparatively slow in warming up to summer temperatures; at the same time the eastward circulation of the upper atmosphere was apparently very stagnant. When the solar radiation became at last effective in warming the lower strata, this produced conditions favoring local convectional overturning of the lower strata, and the development of showers and thunderstorms in excess of the general amount belonging to June. The forecasts for June have as a rule, in the experience of the Weather Bureau, had a lower percentage of verification than any other month, and this is due to the turbulent convectional interchange between the surface and the lower cloud strata. On the 7th thunderstorms occurred in the Mississippi Valley and on the Rocky Mountain slope; on the 8th they covered the Ohio Valley, the Lake region, and the Southern Mountain slope; on the 9th they recurred in about the same districts; on the 10th they covered the Lake region, the Ohio and the Mississippi valleys; on the 11th they repeated in the same districts and extended somewhat toward New England; on the 12th they overspread New England and the Atlantic States, and occurred again in the Lake region, the Ohio, and lower Mississippi valleys; on the 13th they were reported in about the same districts; on the 14th they occurred in the Atlantic States, and began to appear once more on the Middle Mountain slope; on the 15th they were confined to the Gulf States and the Mountain slope; on the 16th, 17th, and 18th they were generally limited to the east Gulf States; on the 19th they visited the lower Lake region and the east Gulf States. After this date thunderstorms became somewhat less frequent. Their occurrence was generally well covered by the forecasts during the period just described. One noticeable fact may be mentioned, namely, that thunderstorms do not by any means limit themselves to localities included in the eastern quadrants of the low areas, but are found all around the periphery of the high areas, and also very frequently within a high area itself. This shows that it is the vertical convection, rather than the horizontal circulation, which is chiefly concerned in the production of this class of local storms. Sometimes the cumulus cloud stratum from the west may overflow a stagnant lower layer of air, and thus intensify these thunderstorm conditions. Insolation at the ground and overflowing of cool air at the height of a mile or two primarily produce these overturnings and local storms.—*F. H. Bigelow, Professor.*

FORECASTS AT CHICAGO, ILL.

The storm of June 24–25 was the only one during the month which was attended by high winds quite generally over the upper Lakes. The following message was issued on the 24th to Lakes Michigan and Huron and eastern and central Lake Superior:

Hoist storm southwest signals at 10:30 a. m. Partly cloudy weather and squalls indicated, with brisk to high southwest winds.

Maximum wind velocities were reported as follows: Chicago, 50; Marquette, 38; Alpena, 38; Green Bay, 30. The displayman at Mackinaw wrote, under date of June 25:

The most severe storm seen in this section for a long time began yesterday at 12:30 p. m., two hours after hoisting signals, the wind blowing a gale from southwest to west, accompanied by very heavy thunder squalls and very heavy rain. The storm caused considerable damage to electric wires; telegraphic communication to portions of northern Michigan was interrupted for twenty-four hours.

E. B. Garriott, Professor and Forecast Official.

FORECASTS AT SAN FRANCISCO, CAL.

No warnings of weather conditions were issued during the month of June. A serious and destructive norther occurred on June 29 and 30 throughout the region from San Francisco and Stockton northward, and mention of it was made in the daily forecasts. However, since there were no means of protecting the crops then exposed against its effects, a special warning was not deemed advisable.—*W. H. Hammon, Local Forecast Official.*

FORECASTS AT PORTLAND, OREG.

No wind-signal orders were issued during the month, there being no storms.

During June the prevailing barometric conditions were most peculiar. The "summer type" of weather conditions did not appear, and the result was that frequent showers occurred, with peculiar temperature changes. Under abnormal barometric conditions accurate forecasts are more difficult to make than when normal conditions prevail. From time to time during the month the office published information that the summer conditions had not yet arrived and that showers must be expected. This information was of great value to the farmers, for it enabled them to save their hay crop. Frequent personal and telephonic requests were made by fruit men, farmers, and hay dealers for special weather forecasts in connection with hay, strawberries, and cherries. Requests were made by farmers for logotype postal-card forecasts, and the requests were granted.

Inman, Poulson & Co., a large lumber firm in this city, constructed a raft containing 5,000,000 feet of rough lumber, to be taken to San Francisco by tugs. Success meant large profits and a new industry; failure meant the loss of many thousand dollars. They consulted this office and intended to start the raft when I said so; but, owing to prices, they started before I was satisfied that they were safe. I wanted a summer weather type. Fortunately they were fairly successful, losing only about 500,000 feet. They informed me that the next raft would go in August, on "Weather Bureau orders only."—*B. S. Pague, Local Forecast Official.*

AREAS OF HIGH AND LOW PRESSURE.

During the month the paths of eight highs and ten lows were sufficiently well defined to be traced, and they will be found on Charts I and II in this REVIEW. The accompanying table gives the principal facts regarding the first appearance of these conditions and the date and place of their disappearance, their duration, length of path, and velocity. The more interesting facts of the month relate to the occurrence of thunderstorms, and a note on their development will be found under the proper head.

Highs.—In projecting these highs on Chart I it should be noted that often they are extremely indefinite in their appearance and hence the positions are often only approximate. Also, as has been repeatedly stated before, in northwest Canada, the appearance of both highs and lows is quite deceptive, owing to the fact that the current temperature is used in making the reduction of pressure to sea level. In consequence of this a morning low temperature will produce a fictitious high, or very much exaggerate a weak one. This difficulty is avoided in the United States by using the mean temperature of the current and previous observation, thereby

diminishing the effect of the diurnal change in temperature. Of the highs three appeared off the Pacific coast, two to the north of Montana, and three in Manitoba or the Lake Superior region. Five of these were traced to the south Atlantic coast, two to Newfoundland, and one disappeared in Illinois.

Lows.—Of the lows, five were first seen near Montana, three in the central Plateau region, and two in the lower Missouri Valley. Six of the storms could be followed to Newfoundland, two were last noticed off the middle Atlantic coast, and one died out in the central Gulf States. As low No. I moved into the Atlantic Ocean a northeast wind of 52 miles an hour occurred at Block Island, p. m. of 4th. As low No. VIII reached the upper Lake region, evening of the 25th, a west wind of 48 miles an hour was caused at Cleveland. The same afternoon Parkersburg experienced a thunderstorm with west wind of 52 miles, and Pittsburg the same kind of wind of 48 miles from the northwest.—*H. A. Hazen, Professor.*

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long W.	Length.	Duration.	Daily.	Hourly.
High areas.		°	°		°	°	*Miles.*	*Days.*	*Miles.*	*Miles.*
I	*28, a. m.	37	124	1, p. m.	32	78	3,240	4.5	720	30.0
II	1, p. m.	52	96	3, p. m.	49	60	1,740	2.0	870	36.2
III	1, p. m.	37	123	11, a. m.	32	78	5,490	9.5	578	24.1
IV	5, a, m.	50	84	9, a. m.	34	76	1,500	4.0	375	15.6
V	12, p. m.	52	115	19, p. m.	48	54	3,780	7.0	546	22.5
VI	17, a. m.	50	107	20, a. m.	39	88	1,500	3.0	500	20.8
VII	20, a. m.	49	93	25, p. m.	27	79	2,370	5.5	431	18.0
VIII	23, a. m.	42	127	30, p. m.	33	75	4,300	7.5	560	23.3
Total							23,820	43.0	4,574	
Mean of 8 paths							2,977		572	23.8
Mean of 43 days									554	23.1
Low areas.										
I	*29, a. m.	54	116	3, a. m.	41	69	2,520	5.0	504	21.0
II	1, p. m.	42	112	5, p. m.	31	88	2,550	4.0	637	26.5
III	6, p. m.	54	113	10, a. m.	48	55	2,730	3.5	780	32.5
IV	8, p. m.	36	99	12, a. m.	48	78	1,470	3.5	420	17.5
V	10, a. m.	47	120	15, p. m.	47	55	3,060	5.5	556	23.2
VI	14, p. m.	51	118	21, a. m.	50	58	3,450	6.5	531	22.1
VII	21, p. m.	41	110	26, a. m.	49	56	2,640	4.5	587	24.5
VIII	24, p. m.	46	94	27, a. m.	46	55	1,830	2.5	732	30.5
IX	25, a. m.	41	104	29, p. m.	44	69	2,550	4.5	567	23.6
X	26, p. m.	53	118	†1, p. m.	48	58	2,640	5.0	528	22.0
Total							25,440	44.5	5,842	
Mean of 10 paths							2,544		584	24.3
Mean of 44.5 days									572	23.8

*May. †July.

RIVERS AND FLOODS.

During June the general tendency of all streams, except the extreme upper Mississippi and central Missouri, was to lower levels, and at intervals navigation on the rivers of South Carolina, Georgia, and Alabama, and on the Ohio and Cumberland rivers was seriously interrupted. Good navigable stages, however, were maintained on the Mississippi, Missouri, Arkansas, and Red rivers.

Heavy and in some instances excessive precipitation from the 2d to the 4th over the watersheds of the extreme upper Mississippi and the St. Croix rivers caused a rapid and decided rise of the rivers in that vicinity, and some apprehension was felt by squatters in the lowlands. There is no steamboating in that section; there is, however, considerable logging carried on, and the latter interest is reported as having sustained considerable damage. Sawmills were shut down and bottoms overflowed, the latter resulting in slight damage to crops. A moderate flood also occurred in the Kansas City river district, but no material damage was done.

The highest and lowest water, mean stage, and monthly range at 118 river stations are given in the accompanying table. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are: Keokuk, St. Louis, Cairo, Memphis, and Vicksburg, on the Mississippi; Cincinnati, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

For fuller details see Monthly Bulletin of the River and Flood Service for June, 1898.—*F. W. Krichelt.*

Heights of rivers referred to zeros of gauges, June, 1898.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Mississippi River.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
St. Paul, Minn	1,957	14	10.7	8,9	4.7	30	7.3	6.0
Reeds Landing, Minn	1,887	12	9.0	11	4.2	30	6.4	4.8
La Crosse, Wis	1,822	10	9.9	15	5.0	1	7.6	4.9
North McGregor, Iowa	1,762	18	10.0	19,20	4.6	1	6.8	5.4
Dubuque, Iowa	1,702	15	9.4	21-23	4.5	1-3	6.9	4.9
Leclaire, Iowa	1,612	10	6.0	24-27	3.1	2-5	4.5	2.9
Davenport, Iowa	1,596	15	7.4	24-26	4.0	1-6	5.5	3.4
Galland, Iowa	1,475	8	4.4	27	2.2	8	3.2	2.2
Keokuk, Iowa	1,466	14	7.9	27	3.3	9	5.6	4.6
Hannibal, Mo	1,405	17	9.3	28	4.9	8	7.0	4.4
Grafton, Ill	1,307	23	13.8	18	10.3	9,10	11.6	3.5
St. Louis, Mo	1,264	30	25.4	18	18.7	26	21.3	5.7
Chester, Ill	1,189	30	20.0	18,19	14.7	26	16.8	5.3
Cairo, Ill	1,073	40	30.9	1	21.8	26	25.0	9.1
Memphis, Tenn	843	33	24.9	1	15.6	15,29	18.7	9.3
Helena, Ark	767	44	36.0	1	23.2	30	28.0	12.8
Arkansas City, Ark	635	42	42.8	1	27.1	30	33.5	15.7
Greenville, Miss	595	40	36.8	1	22.6	30	28.3	14.2
Vicksburg, Miss	474	41	42.0	1-3	27.8	30	34.2	14.2
New Orleans, La	108	16	14.9	2,3	10.2	23	12.9	4.7
Arkansas River.								
Wichita, Kans	720	10	5.6	10	2.3	7	3.9	3.3
Fort Smith, Ark	345	22	13.8	16	6.7	3	9.3	7.1
Dardanelle, Ark	250	21	14.0	18	7.5	4	10.0	6.5
Little Rock, Ark	170	23	15.3	19	9.8	6	11.6	5.5
White River.								
Newport, Ark	150	26	14.5	1	6.1	28,29	7.9	8.4
Des Moines River.								
Des Moines, Iowa	150	19	8.6	11	3.7	30	4.7	4.9
Illinois River.								
Peoria, Ill	135	14	13.5	1	8.8	26	10.8	4.7
Missouri River.								
Bismarck, N. Dak	1,201	14	12.6	26	9.0	14,15	10.5	3.6
Pierre, S. Dak	1,006	14	11.2	28	8.2	1	9.4	3.0
Sioux City, Iowa	676	19	14.7	30	12.1	19,20	13.2	2.6
Omaha, Nebr	561	18	14.0	30	11.9	20,21	12.8	2.1
St. Joseph, Mo	373	10	10.1	10,11	7.6	1	8.8	2.5
Kansas City, Mo	280	21	21.5	12	16.6	24,25	18.7	4.9
Boonville, Mo	191	20	19.3	15	13.6	25	16.6	5.7
Hermann, Mo	95	24	18.8	17	13.4	25	15.9	5.4
Ohio River.								
Pittsburg, Pa	966	22	6.9	15	2.9	17	5.3	4.0
Davis Island Dam, Pa	950	25	6.7	15	3.2	12,29	4.5	3.5
Wheeling, W. Va	875	36	9.9	20	3.4	12	5.6	6.5
Parkersburg, W. Va	785	35	9.5	21	5.2	10	7.1	4.3
Point Pleasant, W. Va	703	36	9.3	1	3.4	12	5.9	5.9
Catlettsburg, Ky	651	50	13.0	1	4.4	13	8.2	8.6
Portsmouth, Ohio	612	50	14.5	1	6.0	14	9.4	8.5
Cincinnati, Ohio	499	45	18.8	1	8.1	15,16	11.7	10.7
Louisville, Ky	367	24	8.6	1	4.6	17	6.3	4.0
Evansville, Ind	184	30	18.6	1	6.4	18	10.1	12.2
Paducah, Ky	47	40	19.8	1	8.6	14	12.2	11.2
Allegheny River.								
Warren, Pa	177	7	5.0	28	0.9	{17-20, 26,27}	1.4	4.1
Oil City, Pa	123	13	3.8	30	1.2	9-12	1.8	2.6
Parkers Landing, Pa	73	20	4.5	29	1.0	8,9,12	1.8	3.5
Freeport, Pa	26	20	6.4	30	2.1	11,29	3.4	4.3
Conemaugh River.								
Johnstown, Pa	64	7	2.2	14	1.4	7-9	1.7	0.8
Red Bank Creek.								
Brookville, Pa	35	8	2.1	14	0.1	8-12	0.9	2.0
Beaver River.								
Ellwood Junction, Pa	10	14	5.0	19	—0.3	10-12	0.7	5.3
Cumberland River.								
Burnside, Ky	434	50	3.8	19	0.7	14	2.0	3.1
Carthage, Tenn	257	30	3.4	1,22	1.5	14	2.3	1.9
Nashville, Tenn	175	40	7.5	1	2.1	15	3.5	5.4
Great Kanawha River.								
Charleston, W. Va	61	30	7.6	20	4.4	2	6.5	3.2
New River.								
Hinton, W. Va	95	14	3.4	19,20	1.3	9-14,29,30	1.8	2.1
Licking River.								
Falmouth, Ky	30	25	4.5	29	1.0	18	1.9	3.5
Miami River.								
Dayton, Ohio	69	18	2.4	14	1.2	30	1.7	1.2
Monongahela River.								
Weston, W. Va	161	18	1.5	17	— 0.6	24-26	—0.4	2.1
Fairmont, W. Va	119	25	2.2	14	— 0.3	9,10	0.5	2.5
Greensboro, Pa	81	18	8.1	21	6.5	28	7.2	1.6
Lock No. 4, Pa	40	28	7.9	15	5.9	10,11	6.6	2.0
Cheat River.								
Rowlesburg, W. Va	36	14	3.5	21	1.8	8-13	2.2	1.7
Youghiogheny River.								
Confluence, Pa	59	10	3.9	14	1.0	10,11	1.8	2.9
West Newton, Pa	15	23	2.0	15	0.4	28-30	0.8	1.6
Muskingum River.								
Zanesville, Ohio	70	20	9.8	16	6.5	24-28	7.4	3.3