MONTHLY WEATHER REVIEW.

JULY, 1894.

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INTRODUCTION.

The REVIEW for July, 1894, is based on reports from 3,299 stations occupied by regular and voluntary observers. These reports are classified as follows: 148 reports from Weather Bureau stations; 41 reports from U. S. Army post surgeons; 2,248 monthly reports from State weather service and voluntary observers; 34 reports from Canadian stations; 223 reports through the Southern Pacific Railway Company; 509 marine reports through the co-operation of the Hydrographic Office, Navy Department, and "New York Herald Weather Service;" monthly reports from 33 U. S. Life-Saving stations; 63 reports from navigators on the Great Lakes; monthly reports from local services established in all States and Territories; and international simultaneous observations. Trustworthy newspaper extracts and special reports have also been used.

The WEATHER REVIEW for this month has been prepared under the general editorial supervision of Prof. Cleveland Abbe. The statistical tables are furnished by the Division of Records and Meteorological Data, in charge of Mr. A. J. Henry, acting chief of that division.

CHARACTERISTICS OF THE WEATHER FOR JULY, 1894.

The most prominent meteorological features of the month of July were the absence of well-developed cyclonic storms in the United States and the general prevalence of high barometric pressure with variable winds and clear, hot weather over the interior of the country; the special hot winds of the 25–28th from Kansas to Minnesota and Wisconsin; the general deficiency of rain throughout the northern half of the United States, constituting the first part of a memorable drought and attended by numerous forest and prairie fires in July and the succeeding months; the general absence of tornadoes; the severe thunderstorms; the remarkably high maximum temperatures; the heavy rains of the south Atlantic and east Gulf States and the very low percentage of sunshine for those regions; the low water in the upper Ohio and Mississippi rivers.

ATMOSPHERIC PRESSURE.

[*In inches and hundredths.*]

The distribution of mean atmospheric pressure reduced to sea level, as shown by mercurial barometers not reduced to standard gravity and as determined from observations taken daily at 8 a. m. and 8 p. m. (seventy-fifth meridian time), during July, 1894, is shown by isobars on Chart II. That portion of the reduction to standard gravity that depends on latitude is shown by the numbers printed on the right-hand border. This Chart also gives the so-called resultant wind directions for this month, based on the data given in Table IX of this REVIEW.

During the current month of July the mean pressures at sea level have been high, 30.10, off the coast of the south Atlantic States and highest off the north Pacific coast, 30.13, at Tatoosh Island. The regions of lowest pressure were in southern Arizona, 29.82, at Yuma, and nearly as low in Manitoba and Saskatchewan.

The normal distribution of atmospheric pressure and normal resultant wind direction for the month of July were approximately shown on Chart V of the REVIEW for July, 1893, as computed by Prof. H. A. Hazen, and are not now reproduced. As compared with the normal for July, the mean pressure for the current month was above the normal throughout the United States, except a deficit of 0.01 at Pensacola and 0.03 at Roseburg. The principal excesses were: 0.05 or 0.06 in Nova Scotia, on the New Jersey and Carolina coasts, Key West, Nashville, Cairo, Lake Ontario, and from Missouri northwestward to Nevada, Idaho, and Oregon; this latter region constituted a decided ridge of high pressure, in which excesses of from 0.06 to 0.13 occurred, and divided the low pressure of the Gulf of California from that of British America.

As compared with the preceding month of June the pressures reduced to sea level show no appreciable change throughout the Atlantic States, Nova Scotia, and New Brunswick. There was a decided rise in the region of the ridge above mentioned, viz, from Kansas and New Mexico to Oregon, British Columbia, Saskatchewan, and Manitoba, over all of which region the rise was over 0.05, amounting in the maximum to 0.15 in Colorado, 0.13 in Wyoming, and 0.12 in Assiniboia.

DIURNAL VARIATIONS.

The systematic periodic diurnal variations of pressure are shown by the hourly means given in Table VI.

AREAS OF HIGH AND LOW PRESSURE.

The following sections give some details as to the phe-

nomena attending the individual areas of high and low pressure. The storm warnings officially issued either by the Weather Bureau through the general forecast official at Washington, or by the respective local forecast officials, are enumerated in connection with the respective areas of disturbance.

MOVEMENTS OF CENTERS.

The following table shows the date and location of the center at the beginning and ending of each area of high or low pressure that has appeared on the U. S. Weather Maps during the month, together with the average daily and hourly velocities. The monthly averages will differ according as we consider each path as a distinct unit, or give equal weight to each day of observation; in the first case the monthly average is taken by paths, in the latter case by days.

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	1, a. m.	43	114	14, a. m.	31	80	3,700	13.0	285	11.9
II	10, a. m.	47	124	15, a. m.	38	94	1,800	5.0	360	15.0
III	16, a. m.	44	75	18, a. m.	41	70	450	2.0	225	9.4
IV	17, a. m.	46	125	24, a. m.	46	57	4,100	7.0	586	24.4
V	25, a. m.	46	124	29, a. m.	38	101	1,700	4.0	425	17.7
Sums							11,750	31.0	1,881	
Mean of 5 paths									376	15.7
Mean of 31 days									377	15.7
Low areas.										
I										
II	1, a. m.	39	121	1, p. m.	42	123	200	0.5		
III	1, p. m.	28	88	2, p. m.	32	89	200	1.0	200	8.3
IV	2, p. m.	50	88	6, a. m.	50	57	1,400	3.5	400	16.7
V	3, a. m.	37	103	4, a. m.	37	97	300	1.0	300	12.5
VI	6, a. m.	53	116	12, a. m.	46	88	2,300	6.0	383	16.0
VII	5, p. m.	46	91	7, a. m.	48	67	1,200	1.5	800	33.3
VIII	8, a. m.	31	96	10, p. m.	31	80	1,000	2.5	400	16.7
IX	12, a. m.	51	69	14, a. m.	49	55	700	2.0	350	14.6
X	14, p. m.	52	115	23, a. m.	35	74	3,500	8.5	412	17.2
XI	19, p. m.	52	117	25, p. m.	52	60	2,900	6.0	483	20.1
XII	23, p. m.	53	120	27, a. m.	43	96	1,600	3.5	457	19.0
XIII	28, p. m.	51	111	31, p. m.	46	94	900	3.0	300	12.5
Sums							16,200	39.0	4,485	
Mean of 11 paths									408	17.0
Mean of 38.5 days									416	17.3

HIGH AREAS.

During July the so-called tropical areas of high pressure reach their extreme northern positions, and the general circulation of the atmosphere in the Northern Hemisphere is so much affected by the solar heat that the descending currents of the upper atmosphere, in so far as they flow toward the North Pole, reach the earth's surface far to the north. The circulation over the area covered by the Daily Weather Map of the United States is now vertical rather than horizontal, and this does not cause the great barometric variations from the areas of high to the areas of low pressure that occur in winter time, when the sun is far to the south. In accordance with general experience the current month has shown many areas of slight barometric elevations and depressions, but none of unusual intensity. So far as can be judged by the limited region covered by our daily maps, both high and low areas have an eastward movement from the Pacific to the Atlantic. The first portion of their path is toward the southeast, the latter portion toward the northeast, as though they were at first controlled by an anticyclonic movement around the high area of the Pacific Ocean and afterwards by the anticyclonic movement around the high area of the Atlantic Ocean, or as if they were wholly controlled by a cyclonic movement about a general depression central over British America. The low areas frequently appear on our maps almost simultaneously in British Columbia and Arizona. The northern area moves eastward more rapidly than the southern, and a high area then appears moving southeastward over the Pacific States and Rocky Mountain plateau, until finally its northerly winds push south toward Texas; as these winds lift up the air of the warmer southerly winds that they encounter, there are produced local rains and sometimes local thunderstorms and tornadoes in long belts, representing a series of individual disturbances caused by the uplifted moisture. Again, after the northern area of low pressure has moved eastward to the St. Lawrence Valley, an area of high pressure is apt to move southward apparently from the region of Hudson Bay, bringing cold weather to the Middle States and New England.

Finally, in a few cases a low pressure has developed in the Gulf States apparently in sympathy with, if not an offshoot from, the low pressure of the Gulf of California; as this moves eastward an area of high pressure is apt to encroach upon the Middle States and New England from the Atlantic Ocean, bringing cool northeast winds to some portion of the Atlantic coast, and out of this condition severe storms may develop in later months of the year, but are not so likely to occur in July. Although the areas of high and low pressure, when they first appear on our Pacific coast, oftentimes appear to have the character of simple waves of pressure due to pressure changes in the upper atmosphere, yet their subsequent motions show that they have a mixed character, combining the wave of pressure with the actual movement of translation of masses of air on a large scale, and that the vertical component of motion is quite as important as the horizontal movement.

I.—On the 1st, a. m., an area of high pressure extended from British Columbia southeast to Texas, its center being apparently in western Montana; the northern portion moved more rapidly eastward, with rising barometer and falling temperature; on the 3d, a. m., no center of highest pressure can be located, but the barometer continued above the normal for several days on the north Pacific coast, Rocky Mountain plateau, in Assiniboia, and Manitoba. By the 5th, a. m., pressure had fallen, leaving the central highest in Kansas, and by the 6th, a. m., an inflow from the north over Manitoba had occurred. On the 7th, a. m., pressure was highest in Iowa, and by the 8th, a. m., in the Ohio Valley; 9th, a. m., in Ohio; 10th, a. m.. in Pennsylvania; 11th, a. m., in northern Georgia; 12th and 13th, a. m., in South Carolina; after which this area merged into the permanent high off the south Atlantic coast.

II.—On the 6th, a. m., pressure rose on the coasts of Oregon and Washington and continued high until the 8th, a. m., while low No. VI moved southeastward into Alberta. By the 10th, a. m., this low area having passed entirely east of the Rocky Mountains the high pressure, with cool northerly winds, prevailed in Washington and Oregon, and by the 12th, a. m., the highest pressure had passed over the Rocky Mountains into Alberta. At this time high area No. I was central in the south Atlantic States and a low pressure, No. IX, was retreating northeastward over Lake Superior, leaving a slight depression extending from that region southwest to Colorado. This depression was rapidly filled up by the inflow of air from the northwest, and the center of high No. II moved southeastward, reaching South Dakota by the 13th, a. m., while the center of high No. I remained nearly stationary. Thus, a ridge of high pressure was formed from British Columbia to Florida, which, on the 14th, a. m., was central in Nebraska and which divided the low pressure in Ontario and Quebec from that on the Pacific coast. The differences of pressure were but one or two tenths of an inch and the gradients exceedingly slight; such areas of high pressure are apparently due to the general circulation of the atmosphere, and especially to the vertical component of the descending

air which is so slight as to allow of the formation of very low temperatures in the atmosphere at a comparatively small distance above the earth's surface.

On the 6th and 7th of the current month, a similar area of high pressure over Europe was explored by the ascent of the small balloon named the "Cirrus," from Berlin, and temperatures of —50° to —55° C. (—58° to —67° F.) were observed at an altitude of 14,000 to 17,000 meters (45,932 to 55,774 feet). These temperatures show that the air was colder at great altitudes than is required by the laws of hydrostatic equilibrium and that, therefore, a condition of unstable equilibrium existed, such that during the nighttime and early morning hours the descending air continually retained its tendency to descend, since the dynamic warming due to compression was counterbalanced by the cooling due to radiation and mixture. The irregularity of the horizontal movement of the air above the central portion of the region of high pressure and the simultaneous presence of layers moving in several directions are shown not only by the movements of the balloon just referred to, but by the changes in the shapes of the contours of the isobars in the region of the central high pressure. In the case of our present high area No. II, on the morning of July 14, the isobar of 30.20 extended from central Missouri and Iowa westward to northern Colorado, but by July 15th, a. m., it was restricted to the former States, the central highest pressure being in Missouri. By the 16th, a. m., this area of high pressure had united with high No. I, while areas of low pressure had developed in Arizona and in Alberta.

III.—The pressure increased on the Atlantic coast from the 15th to the 16th, and on the latter date a small elevation was central in northern New York, having apparently moved southwestward over Labrador and Newfoundland in the rear of low No. IX. By the 17th, a. m., the highest pressure was off Cape Cod, but this was due to the westward movement of isobars from the Atlantic. Pressure continued high off the middle Atlantic coast during the 18th, with northeasterly winds as far south as South Carolina, and by the 19th, a. m., pressure was highest in the south Atlantic and Gulf States and so continued until the 20th.

IV.—On the 16th, a. m., pressure was high on the coast of Oregon, and by the 18th, a. m., an area of high pressure had extended east and south over the Rocky Mountain plateau region, being central in northern Idaho. By the 19th, a. m., this ridge had extended southward to New Mexico and northward to Saskatchewan and beyond, the highest pressures being apparently in Assiniboia and Wyoming, respectively. On the 20th, a. m., this ridge extended from Colorado to Minnesota, and on the 21st, a. m., from New Mexico to Lake Superior and beyond, probably into northern Labrador, the center being apparently in Wisconsin. By the 22d, a. m., there had occurred a slight fall in pressure in the central portion of this ridge, which was now over Lake Michigan; but the general dimensions of the region covered by the isobar of 30.00 had correspondingly increased, so that the Weather Map presents, on the 21st and 22d, two troughs of low pressure, No. X on the Atlantic and No. XI in Manitoba, separated by this great ridge of high pressure. This configuration illustrates the general principle that the prime mover in the formation of high and low areas is the presence of the high, whose descending air flows outward to supply the low areas; in this outward flow the air that moves southerly is dense relatively to that which it meets, and both by mixing it and by uplifting it brings about the formation of cloud and rain, and at first local storms, but afterwards a general cyclonic circulation; the air that flows northward is generally warmer than that which it meets and rises above it, but eventually cools and feeds other low areas. In such cases the so-called storm center with cyclonic winds is a development from a trough or other area of low pressure between ridges of high pressure; a special flow of cold, dry air into some part of this trough, usually the western end, starts the conversion of the trough with its opposing winds into the oval depression with its circulating winds. By the 23d, a. m., pressure had generally fallen over the United States, and the area of highest pressure was confined to the lower St. Lawrence. By the 24th, a. m., it had merged into the high pressure that had descended over Labrador and Newfoundland, so that pressure was highest at Cape Breton and St. Johns.

V.—From the 23d to the 26th pressure rose off the coast of Oregon and Washington apparently in consequence of the southeasterly movement of an area of high pressure banking up against the Rocky Mountains from Idaho to Alaska; during these days pressure was falling at Yuma as also, apparently, in Alberta and Stikine, forming low pressure area No. XII. By the 27th, a. m., pressure was apparently highest in western Washington, after which it rapidly fell and, by the 28th, a. m., was highest in Wyoming. During the 24th to the 27th pressure also rose on the Atlantic coast evidently because of the westward movement of the Atlantic area of high pressure in response to the development of the extensive low pressure No. XII. By the morning of the 28th this low pressure had begun to disappear; it had, in fact, formed a trough trending northeast and southwest between these two areas of high pressure and the inflow descending into it had been sufficiently rapid to bring the highest temperatures of the month to a number of stations on the 25th, 26th and 27th in Colorado, Kansas, Missouri, Illinois, Indiana, and northward to Lake Superior; these high temperatures, with clear, dry weather, showed that conditions were not favorable to the perpetuation of a low area, and by the 29th, a. m., the high area No. V had overspread the region where the trough of low pressure had existed the day before, and both the high and low areas had lost their characteristic pressures.

VI.—On the 30th pressure was again rising in Oregon and Washington while low No. XIII was passing over Alberta and Assiniboia. Pressure was highest off the coast of Washington on the 31st, a. m., but the further history of this area belongs to the month of August.

VII.—On the 30th, a. m., pressure was rising in the Lake region in the rear of an area of low pressure that was over Labrador and Newfoundland, but which was too far beyond the limits of our stations to be included in the previous list of low pressures. By the 31st, a. m., an area of high pressure was apparently central between Lake Superior and James Bay, but it rapidly spread out and disappeared over the Middle States.

LOW AREAS.

The month of July has been marked by the appearance of a number of ill-defined and minor areas of low pressure in addition to a few that developed into important storms. It is believed that all depressions that are marked "Low" on the Daily Weather Map have been included in the following list:

I.—This number is given to the low area of Arizona and the Gulf of California, which has, as usual for July, been the prominent feature of this month. The pressure at Yuma fell slowly from the 1st to the 2d, and remained low during the 5th, 6th, and 7th, while the corresponding low, No. VI, in British Columbia developed and started eastward. After this pressure rose at Yuma, but was again falling on the 11th, reaching a minimum on the 13th, at which time low No. X was developing in British Columbia. The minimum occurred on the 16th, p. m., when the low area stretched over Arizona and Idaho into northern California, while low No. X was central in Manitoba and Assiniboia. On the 20th pressure was again falling at Yuma, reaching a minimum on the 21st, p. m., while low No. XI passed over British Columbia on the 19th into Saskatchewan on the 21st. On the 25th pressure was falling in Yuma, while low No. XII was central in Saskatch-

ewan. The lowest pressure of the month at Yuma occurred on the 26th, p. m., at which time an extensive depression extended thence northeastward into British America, with three centers respectively in Arizona, South Dakota, and Manitoba. On the 30th pressure was again falling in Yuma, while low No. XIII was central in Assiniboia. The minimum occurred on the 31st, p. m., at which time low No. XIII was central in Minnesota.

A general review of the month shows that the low area of Arizona and the Gulf of California develops in connection with a low area to the northward. The latter in a few days moves eastward, while the former rarely sends off an independent low area, but, so far as can be seen by our daily maps, subsides by filling up or withdrawing to the southward and only occasionally has some influence in developing a low on the border of Texas; even in this latter case its influence is usually indirect, since the first step is the flow of air over northern Texas and New Mexico from the north and east toward the Gulf of California. The origin of the trough of low pressure whose northern end so often stretches up over Arizona seems to consist in the fact that when the area of high pressure over the Pacific Ocean retires westward, and that over the Atlantic retires eastward, the intervening low pressure extends north and south between Alaska and the Pacific coast of Mexico, where it joins the equatorial belt of low pressure.

II.—This appeared on the 1st, a. m., in northern California, and by the 1st, p. m., stretched as a long oval into northern Oregon, after which it disappeared.

III.—Appeared on the 1st, p. m., apparently central near the southeast point of Louisiana and moved slowly northward, with high winds and heavy rains, disappearing on the 2d, p. m., in central Mississippi.

IV.—This was developing on the 1st, a. m., north of Manitoba and was probably central on the 1st, p. m., in the eastern portion of that State. It moved southeastward, and on the 2d, p. m., was near Lake Superior, and on the 3d, p. m., near the mouth of the St. Lawrence. It disappeared on the 5th, p. m., over the Straits of Belle Isle.

V.—Appeared on the 3d, a. m., in southeastern Colorado, and moving eastward disappeared on the 4th, a. m., in southeastern Kansas. Heavy rains attended this slight depression, evidently due to the inflow of cooler air from the high area immediately north of it.

VI.—On the 5th, p. m., an area of low pressure appeared in Alberta which, by the 6th, p. m., had moved southeastward until it was central in northwest Assiniboia. This depression continued developing in this region, extending its influence to the southward, but by the 8th, p. m., it had begun to fill up without much eastward motion. During the 9th and 10th the depression spread over a large area and then again gave rise to a trough of low pressure, but on the 11th, p. m., it extended northeast and southwest on the borders of Minnesota and the Dakotas, with corresponding high winds and severe local storms. The depression now began to die away; it was central on the 12th, a. m., in upper Michigan, after which it disappeared by moving northeastward beyond our stations, while low No. IX developed in Labrador.

In connection with low area No. VI the following signals were ordered: 11th, 10 p. m., storm southwest for Lake Michigan, Duluth, and Marquette; 12th, noon, storm southwest, Sault Ste. Marie and Lake Huron; 12th, 9.53 p. m., storm northwest, lakes Michigan, Superior, and Huron.

VII.—On the 4th pressure fell rather rapidly in Alberta and Saskatchewan, but as the Canadian methods of reducing the barometer to sea level differ from those of the United States, it is probable that a portion of this fall in the reduced pressures is only apparent and due to the rise of local temperature at the earth's surface. In general, the temperature of the mass of atmosphere above us has but a very slight diurnal period as compared with that of the air at the surface of the ground, and this law was recognized by Prof. Ferrel in his Meteorological Researches No. III in 1881, and in the tables of reduction to sea level that he subsequently prepared for the use of the Signal Service. In these tables the average temperature of the air is supposed to change from day to day as the irregular or non-periodic changes of temperature pass over the country, but the regular periodic changes at the surface of the earth are partially eliminated. If we compare the map of the 4th, p. m., with that of the 5th, p. m., it would seem that, while low No. VI remained in Alberta and low No. IV was at the mouth of the St. Lawrence, a third depression started near Lake Superior on the 5th; during that day strong northerly winds extended over Manitoba and southward, meeting warm southerly winds in Minnesota. In this manner low area No. VII developed, which was central in Wisconsin on the 5th, p. m., and moved eastward through Upper Michigan into Ontario and the St. Lawrence Valley, where it disappeared on the 7th.

VIII.—During the 8th a slight depression, with rain, developed over the eastern Gulf and south Atlantic States, while high area No. I extended southward, with northeasterly winds, into this region. This low pressure may be considered as having been maintained by the latent heat of condensation and the action of the sun on the clouds. The area of cloud and rain moved slowly eastward during the 9th and 10th; the barometric depression at the center of the trough did not exceed one-tenth of an inch; the rainfall increased slightly as the disturbance passed eastward, varying from 2 or 3 inches in Arkansas and Louisiana to 3, 4, and 5 inches in Georgia and South Carolina. By the 10th, p. m., the disturbance was off the south Atlantic coast, and northeast winds, with fair weather, had generally succeeded it. No general cyclonic whirl was developed out of this disturbance, but local storms were numerous.

IX.—This appeared on the 12th, a. m., at the mouth of the St. Lawrence, and was evidently within the general depression, of which low No. VI represented the southwest extremity. Between the 11th, p. m., and 12th, a. m., pressure fell both over Lake Superior and the St. Lawrence Valley and became lowest north of the St. Lawrence. An area of low pressure seems to have moved eastward over southern Labrador and northern Newfoundland, passing eastward from the latter on the 14th, a. m.

X.—This depression developed in British Columbia and Alberta on the 14th. By the 15th, p. m., it may be located in southwestern Saskatchewan and by the 16th, p. m., in southern Assiniboia. Its exact location is, as before explained, rendered difficult by the uncertainties of reduction of high stations to sea level. By the 17th, a. m., this depression had extended southward into Colorado, while the center was in southern Manitoba, and this position was maintained until the 18th, p. m., by which time high area No. IV had moved southeastward into the central Rocky Mountain plateau region and the area of low pressure became converted into a trough of opposing northerly and southerly winds, with rain, extending over Colorado, Nebraska, South Dakota, and Minnesota. In this manner the southern portion of this depression was filled up and disappeared, and the northern portion moved slowly eastward through Canada. On the 20th this portion extended southward over New England, followed by rapidly rising pressure on its western side, and a belt of northerly winds prevailed from the Lake region southward to Louisiana in advance of the ridge of high pressure No. IV. Low area No. X moved southward during the 21st and 22d along the middle Atlantic coast and disappeared on the 23d, a. m., off Cape Hatteras.

In connection with low area No. X the following signals

were ordered: 22d, 9.50 a. m., storm northeast from Breakwater to Woods Holl section.

XI.—On the 18th pressure fell in Washington and British Columbia in connection with the trough stretching southward to the Gulf of California; this was followed by a rise on the 19th, while the lowest pressure developed in Alberta. By the 20th, p. m., low pressure extended from Alberta north to Athabasca, south to Montana, and east over Assiniboia, and by the 21st, p. m., was central in Manitoba. During the 22d, while this depression was extending eastward, the barometer again fell in British Columbia and the map of the 23d, p. m., shows two depressions, Nos. XI and XII, central, respectively, in Manitoba and Alberta. Low No. XI kept far to the north of our stations and disappeared on the 25th, p. m., in Labrador.

XII.—On the 23d, a. m., pressure was falling in British Columbia and the map of the 23d, p. m., shows that a depression must have existed in that region which, on the 24th, p. m., was central in Alberta. During the 25th, this depression stretched rapidly southward along the entire eastern Rocky Mountain slope and the Missouri Valley, and on the 25th, p. m., was central in Saskatchewan, while high pressure (30.20), No. V, was off the coast of Oregon and a similar high pressure was off the Carolina coast. By the 26th, a. m., this general depression had divided into three cyclonic regions, respectively, in Manitoba, South Dakota, and Arizona, of which the latter was the least perfectly developed and has already been mentioned under low No. I. The principal depression in South Dakota was attended with high winds which were remarkably hot from Texas to Illinois, Wisconsin, and Minnesota, as also in Arizona; these hot winds continued during the 27th, but diminished somewhat on the 28th and 29th; the sky was generally clear and the air dry, only a few local rains being reported; the high temperature must be attributed principally to the dynamic heating of the air that flowed down and into the central depression from the high area over the Atlantic States and ocean to the eastward. From the 26th, a. m., to the 28th, a. m., the central low pressure gradually filled up and, after stretching as a trough from New Mexico to Lake Superior on the 27th, it had disappeared by the 28th, leaving areas of low pressure in Arizona, Assiniboia, and at the mouth of the St. Lawrence as remnants of the general depression that had previously existed.

In connection with low area No. XII the following signals were ordered: 25th, 10 p. m., storm southeast, lakes Superior and Michigan; 26th, 10 a. m., storm southeast, Sault Ste. Marie and Lake Huron; 26th, 10 p. m., storm southeast, continue on lakes Superior and Michigan.

XIII.—This number is given to the depression in Assiniboia just referred to as a remnant of low No. XII. By the 29th, p. m., pressure had generally fallen in Alberta and Assiniboia, and the depression continued to develop during the 30th and 31st moving, at the same time, slowly southeastward while the barometer also fell at Yuma, so that on the 31st, p. m., depressions were central in Minnesota and Arizona, but without well-marked cyclonic winds.

NORTH ATLANTIC METEOROLOGY.

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

NORMAL CONDITIONS.

The normal barometric pressure for July over the North Atlantic Ocean, as deduced from international simultaneous meteorological observations taken at Greenwich noon and not reduced to standard gravity, is highest, 30.25 (769), over an oval extending between N. 28° and N. 40° and W. 21° and W. 34°. A similar area of high pressure prevails on the Pacific Ocean between N. 40° and N. 20° and west of W. 135°; from this Pacific area a narrow prolongation extends northeastward to Vancouver Island, giving high pressures to the coast of Oregon and British Columbia. The area of low pressure characteristic of the North Atlantic during the winter months moves northward or northeastward during May and June, while the corresponding low area characteristic of Bering Sea moves northwestward during those months, so that the normal average for July shows these to have combined in one region of low pressure covering the Arctic Ocean and closely adjoining the Asiatic and Himalayan low pressures.

As compared with June, the normal pressures for July are higher throughout the United States, but lower throughout the British provinces, Greenland, Alaska, and the Arctic regions and nearly all of Asia; the pressures are higher in the Aleutian Islands, the United States, Mexico, and the northern central portion of Siberia. During this month the diminution of pressure that has been going on in the Arctic regions ceases and soon becomes converted into a rise, indicating a change from summer to winter conditions.

The normal zone of maximum frequency of tracks of centers of low pressure during the month of July passes from the southern part of the China Sea, near Borneo, northeastward along the coast of China and Corea over the Japan Sea, the Island of Jesso, south of Kamchatka into Bering Sea, thence east and southeast into British Columbia and eastward over Lake Superior and Newfoundland, thence east-northeast to northern Norway and Sweden and southeast into the interior of Russia. These storm tracks thus circulate along the isobars of 29.80 to 29.90 that surround the low pressure of Asia and the Arctic regions; they represent the paths pursued by cyclonic eddies of air overflowing from the so-called areas of high pressure into the greatly distorted polar depression of the Northern Hemisphere. The number of such cyclonic whirls is probably not much smaller in July than in December, but the severity of the surface winds is very generally less, and therefore, the number of recorded storms is less. The greatest so-called storm frequency for the United States occurs in the winter months, but the chart showing the actual number of storm tracks passing over each square degree annually shows that a region of maximum frequency of from 40 to 50 storm centers per 5° square per ten years always exists, and that local variations in storm frequency depend upon comparatively slight changes in the location of the maximum region. Therefore, in so far as the existence and movement of cyclonic centers are an index to the general circulation of the atmosphere we should conclude that this is nearly uniform from month to month.

The normal rate of progress of storm centers during July is 25 miles per hour in the United States; 19 in the North Atlantic Ocean; 17 in Europe; 20 in the China and Japan seas; 23 in Bering Sea; the average for storms moving easterly is 21 miles per hour; the average of storms near the tropics moving westerly is given as 22 miles per hour.

NORTH ATLANTIC STORMS.

The following paragraphs give some account of the areas of low pressure and strong winds on the North Atlantic Ocean during July, 1894. Daily charts are compiled at the Weather Bureau showing the atmospheric conditions over the United States, Europe, and the Atlantic Ocean, as nearly as practicable at Greenwich noon, and afford a basis for approximating