New York.—The mean temperature was 65°, or about 2.7° above the normal. The highest temperature was 99° at Poughkeepsie on the 23d and West Point on the 24th; the lowest, 22°, at Bloomville on the 15th. The average precipitation was 2.31, or about 1.07 below the normal amount. The largest rainfall was 6.42, and was recorded at Number Four, and the smallest, 0.72 at Warwick.

North Carolina.—The month was the most abnormal on record. The characteristic features were the unprecedented hot wave during the second and third decades, and the severe drought during the same period. The mean temperature was 74.2°, or 4° above the normal. The highest temperature was 104° at Tarboro on the 22d and 23d; the lowest, 32°, at Blowing Rock and Highlands on the 30th. The average rainfall was 1.25, the lowest on record for September, and 3.40 less than the usual amount. Frost occurred on the 28th, 29th, and 30th.

North Dakota.—The mean temperature, 56.6°, was also the normal. The highest temperature, 100°, occurred at Fort Berthold and Washburn on the 2d; the lowest, 12°, at Forman on the 30th. The rainfall was moderately heavy in the eastern and southeastern sections and very light and poorly distributed in other portions; the average amount was considerably less than normal. Frosts were recorded on the 6th, 7th, 17th, 22d, 23d, 26th, 27th, 28th, 29th, and 30th.

Ohio.—The mean temperature was 69°, or 5.1° above normal. The highest temperature was 105° at Hillsboro on the 20th, and the lowest, 25°, at New Waterford on the 15th and 28th. It was excessively hot from the 9th to the 12th and the 17th to the 22d; the latter period was the most oppressive and severe. The warmth was very unusual for September, and previous records were broken. The month closed with freezing temperatures in many localities. Much less than the usual amount of precipitation fell. The average amount was 1.66, or 1.49 below the normal. The heaviest rainfall occurred in the northeastern, and the lightest in the western, counties. Frosts occurred on the 1st, 2d, 3d, 4th, 14th, 15th, 23d, 24th, 25th, 27th, 28th, 29th, and 30th. Traces of snow occurred at isolated places on the 29th and 30th.

Oklahoma.—The mean temperature was 77.3°, or 5.7° above the normal. The highest temperature was 108° at Anadarko on the 4th; the lowest, 30°, at Clifton on the 30th. The average precipitation was 1.10, or 1.79 less than normal. The greatest amount, 6.00, was recorded at Vinta, and the least, 0.00, at Sac and Fox Agency.

Oregon.—The mean temperature was 55.4°, being 3.0° below the normal. This was one of the coldest Septembers Oregon has experienced. The cold weather was not confined to any particular section of the State. The average total precipitation was 2.90, or 0.92 less than the usual amount. The greatest amount, 10.28, was recorded at Bandon, and the least, 0.19, at New Bridge. Frosts occurred on the 5th, 6th, 7th, 8th, 9th, 10th, 14th, 15th, 17th, 18th, 19th, 20th, 21st, 22d, 23d, and 27th.

Pennsylvania.—The mean temperature was 57.8°, or 5.1° above the average. The highest temperature was 100°, recorded on the 21st and 22d at Carlisle, Coatesville, and Hamburg; the lowest, 24°, at Shinglehouse on the 15th. The average precipitation was 1.71, or 2.38 less than the usual amount. Injurious drought prevailed throughout the month. Streams and springs were unusually low. The largest total amount was 5.41, at Saegerstown, and the smallest, 0.37, at Reading. Snow occurred on the 29th and 30th, and frost on the 2d, 14th, 15th, 25th, 28th, 29th, and 30th.

Rhode Island.—(See *New England.*)

South Carolina.—The mean temperature was 76.9°, or 2.8° above normal. It was the warmest September in the interior of which there is any record. The highest was 106°, at Spartanburg, on the 25th; the lowest, 35°, at Holland, on the 30th. The average precipitation, 1.29, or 3.65 less than the normal. The largest amount recorded was 6.94, at Charleston, and the smallest, 0.00, at Central, Longshore, and Shaws Forks. The only territory having an excess of rainfall was a narrow strip extending from Beaufort to Charleston. Frost was recorded at Oconee, on the 30th.

South Dakota.—Unusually high temperatures prevailed at times during the first and second decades, with scattered showers, mostly light, and followed by cooler weather in the third decade, with quite general heavy rains. The mean temperature was 63.2°, or about 4.3° above normal. The maximum temperature was 112°, at Forestburg, on the 17th, and the minimum, 12°, at Watertown, on the 30th. The average precipitation was 1.65, or 0.21 in excess of the normal amount. The greatest total amount, 4.40, was recorded at Tyndall, and the least, 0.15, at Farmingdale. Frost occurred on the 4th, 5th, 6th, 7th, 8th, 14th, 15th, 21st, 22d, 23d, 24th, 27th, 28th, 29th, and 30th.

Tennessee.—The high temperatures and small amount of rain which prevailed almost during the entire month caused a severe drought. The mean temperature was 74.2°, or 6.5° above the average, and is the highest September average for the past thirteen years. The highest temperature was 100°, recorded at Covington on the 16th; the lowest, 27° at Bristol, on the 30th. The average rainfall was 2.12, or 1.40 less than the usual amount. Most of the rain fell during the first seventeen days, after which date little or none was reported. The greatest amount was 7.48, at Lynnville, and the least, 0.05, at Bristol. Frost was recorded on the 28th, 29th, and 30th.

Texas.—The mean temperature was 2.8° above the normal; the highest daily being 106° at Roby on the 5th, and the lowest, 30°, at Happy on the 23d. The rainfall was very unevenly distributed. There was comparatively none during the first and second decades, but some good local rains occurred during the third which, to some extent, reduced the deficiency. The average total amount was 1.72 less than usual. The largest amount, 6.79, was recorded at Fort Stockton, and there was no rain at four stations. Frosts occurred on the 21st, 22d, 23d, and 24th.

Utah.—The mean temperature was 60.8°; the maximum daily, 103°, at St. George on the 8th, and the minimum, 9°, at Fillmore on the 22d. The average precipitation was 0.60; the greatest recorded was 2.26 at Millville, and the least, "trace," at Orton. The precipitation was principally in the form of snow, which fell on the 20th and 21st. Frosts were recorded on the 5th, 7th, 20th, 21st, 22d, 23d, 24th, 25th, 26th, 27th, 28th, 29th, and 30th.

Virginia.—The mean temperature was 72.7°; the highest daily, 107°, occurred at Bon Air on the 19th; the lowest, 25°, was reported at Big Stone Gap on the 30th. The average precipitation was 0.76, considerably less than the usual amount; the greatest, 2.24, was recorded at Callaville, and the least, 0.00, at Cape Henry. Frost on the 2d, 28th, 29th, and 30th.

Vermont.—(See *New England.*)

Washington.—The principal characteristics of the weather were unusual dryness in the western section; rainfall double the average in the eastern section, and a temperature decidedly below the normal in both. It was the coldest September for several years. The mean temperature was 53.9°, or 3.4 below the normal. The maximum temperature was 96° at Fort Spokane on the 1st, and the minimum, 22°, at Hunters on the 21st. The average precipitation was 2.07, or 0.11 below normal. The greatest amount, 11.45, occurred at Monte Cristo, and the least, 0.51, at Hoxie.

West Virginia.—The mean temperature was 70.3°, or about 4° above the normal. The highest temperature recorded was 107°, at Nuttallburg, on the 20th, and the lowest, 20°, at the same station on the 30th. The rainfall was greatly below the normal, and drought prevailed in all sections. The average amount was 1.70. Frost occurred on the 28th, 29th, and 30th.

Wisconsin.—The mean temperature was 64.7°, or 4° above the average. The highest temperature recorded was 100°, at Prairie du Chien on the 11th, and the lowest, 23°, at Barron and at Belleville on the 23d and 30th, respectively. Continued high midday temperatures and moderately cool nights prevailed until the 22d, when it became much cooler. The average rainfall was 2.99, or 0.10 above the normal. The greatest amount recorded was 10.21 at Butternut, and the least, 0.67, at Janesville. The rainfall was very poorly distributed, and occurred in the form of heavy local thunderstorms, which only slightly relieved the droughty conditions generally prevailing. Frost occurred on the 24th, 26th, 27th, 28th, 29th, and 30th.

Wyoming.—The mean temperature, 53°, was very near the normal. The highest temperature recorded was 101°, at Fort Laramie on the 14th, and the lowest, 0°, at Fort Yellowstone on the 22d. It is probable that such extremes were never known during any previous September. The average total amount of precipitation was 0.83, or about normal. The greatest amount recorded was 2.20, at Lander, and the least, 0.16, at Fort Laramie. The average depth of snowfall was 7.50 during the storm of the 20th to 22d.

STUDIES BY FORECAST OFFICIALS.

COLD WAVES ON THE MIDDLE GULF COAST.

By Prof. E. B. GARRIOTT (dated December 16, 1895).

Practically, all of the important cold waves of the United States first appear over British America and advance thence over districts in the United States which are covered by the sweep of northerly winds in the west quadrants of areas of low barometric pressure. The cold waves of the middle coast of the Gulf of Mexico follow in the wake of areas of low pressure which reach the lower Mississippi Valley.

As cold waves are a product of the cyclonic circulation of winds about areas of low pressure, a consideration of the habits and characteristics of the low areas of the colder months, and more especially of those which have been attended by cold waves, is necessary to a determination of the

several types of cold waves and of the conditions which contribute to their development and movement.

A well-defined low area presents a warm and a cold side. In the east or warm side southerly winds are attended by the higher temperature of lower latitudes; in the west, or cold side of the low area west to north winds carry southward the cold of higher latitudes. At any given point in the east quadrants of the low area warm, southerly winds will prevail. As the center of disturbance passes to the eastward the cold, northerly winds of the west quadrants are experienced. When, therefore, abnormally high temperature obtains in the front, and abnormally low temperature in the rear, of a low area, a decided fall in temperature will be experienced within the area of active cyclonic disturbance following the passage to the eastward of the storm center, and in cases where a decided and specified fall to the freezing or frost temperature occurs, a cold wave is noted.

The cold waves of the middle Gulf Coast belong to two fairly well-defined types. They either follow the passage of a low area from the northwestern States to the lower Mississippi Valley, or follow a low area which develops or appears in the extreme southwest. The southwest low area may develop in the southern part of a trough of low pressure which extends southward between the Rocky Mountains and Mississippi River, or it may appear near the west Gulf Coast and move thence over the middle Gulf States. A necessary condition to the southward sweep of the cold waves, whether they depend upon the northwest or the southwest low areas, is an unbroken area of high barometer extending over the Rocky Mountain and Plateau regions. It is also necessary to the verification of a cold-wave signal on the middle Gulf Coast, in cases where a fall of 16° to 42° is required, that a 24-hour fall in temperature of 20°, or more, shall have occurred in the middle-western States, and that a gradient of at least 25° shall appear between the Gulf Coast and the thirty-fifth parallel. When, therefore, the weather maps show a well-defined low area over the lower Mississippi Valley, with temperature 60°, or below, at New Orleans, and an area of high pressure of great magnitude covering the Rocky Mountain and Plateau regions, with a 24-hour fall in temperature of 20°, or more, in States lying between the lower Missouri River and the middle Rocky Mountains, and a temperature gradient of 25°, or more, between New Orleans and Oklahoma, a fall in temperature of at least 16° may be expected along the middle Gulf Coast within twenty-four hours.

SPECIAL CONTRIBUTIONS.

METEOROLOGY AND MAGNETISM.

By Prof. FRANK H. BIGELOW (dated December 15, 1895).

General remarks on the observations for the year, October 1, 1894, *to September* 30, 1895.

The leading facts regarding the existence at the earth of two systems of deflecting magnetic forces, depending upon solar action as their cause, are now so far developed as to show that there is an intimate connection between them and certain meteorological phenomena. It is evident that the further development of the subject should proceed along two lines, leading (1), to the elucidation of the physical laws involved, and (2), to a practical application to current meteorological conditions, particularly the art of forecasting. Unfortunately neither of these are easy to prosecute satisfactorily, in consequence of the very complex nature of the interrelated phenomena prevailing in the earth's atmosphere, and the obscurity of our information regarding the nature of the ether and the transference of its energy to ponderable matter. Only a slow growth in such knowledge can be looked for, though eventually much may be accomplished, and since close attention is being paid to these topics by physicists, a steady advance will doubtless take place.

For the year October 1, 1894–September 30, 1895, inclusive, certain data regarding the horizontal magnetic force, the pressures and temperatures have been published in the MONTHLY WEATHER REVIEW. The primary object of this publication has been, not so much to establish a connection between meteorology and magnetism, as to exhibit the condition of the practical problem in the simplest possible form, and to gather data from which to judge regarding the proper system of operations to be pursued in connection with forecasting. It is not possible to approach the problem directly, because no magnetic and meteorological observations have ever been taken simultaneously at the seat of the principal transference of energy on the American continent, namely, just east of the Rocky Mountain range in the British Possessions, where the belt of maximum auroral frequency crosses that district; that is to say, at about 115° west longitude and 55° north latitude. A limited knowledge of the operations of the polar magnetic field that emanates from the sun, shows that, as it enters the earth, it is subject to great local variations in direction and in strength at different stations. This differentiation of a field, which is uniform just outside the earth's atmosphere, into local fields of varying vectors will, no doubt, in time, become one of the best means of studying the meteorological conditions of the upper atmosphere, considered as an absorber and transformer of ether energy, but at present it complicates the question under immediate consideration.

The successful establishment and maintenance of first class magnetic observatories requires money and skill, and this need, unfortunately, limits their number to such an extent as to prevent adding one to each of the principal stations of the Weather Bureau. Possibly, however, a few stations can be fully equipped with magnetic instruments, and others may supplement these by using secondary apparatus for relative variations, entirely apart from absolute measurements. During the past two years some attention has been devoted to a consideration of the best form of secondary apparatus for the purpose of recording the relative changes in the impressed solar field from day to day. The features most desired are moderate expense for the instrument, and ease of observation, so that it can be as readily handled as a barometer or thermometer by the observers of the Bureau. My efforts have taken two directions: (1), the construction of a time-integrator by means of a rapidly vibrating magnet; (2), the use of the ordinary bifilar indications unreduced for temperature and instrumental errors. Regarding the former a report may be expected after further observations are secured. Concerning the latter, the data for the present remarks have been presented in this REVIEW.

It is known that the field with which the frequent changes in the meteorological elements of the Northwest are apparently associated, enters the atmosphere of the earth in directions nearly parallel to the magnetic meridians, more definitely in lines normal to the ovals of the distribution of auroral frequency. We may properly call them *auroral meridians*. The concentration of energy in ovals surrounding the magnetic and the geographical poles must be due to such a distribution of the permeable material of the earth as shall make an exflected field in the arctic zone, and an inflected field