dates frost occurred, especially on the 15th, extending as far south as Wilmington and Southport. The rise in temperature during the last few days was very rapid, the highest, 99°, was recorded at several places in the central portion of the State on the 31st. The effect of these conditions on crops was bad. Plowing and planting was much hindered, and growth of all staple crops retarded, until at the end of May, the season was from two to four weeks late everywhere.

North Dakota.—The month of May has been characterized by a deficiency in temperature and sunshine and an excess of precipitation. While frosts have been more frequent than usual, they have not, on the whole, been destructive to vegetation. The mean temperature for the month, 54.4°, is 1.3° below the normal; and the precipitation, 2.48 inches, 0.23 of an inch above. The highest temperature during the month was 101°, at Larimore, on the 8th, and the lowest, 15°, at White Earth, on the 20th.

Ohio.—The mean temperature for the State for May, 61.1°, is 1.3° above the average, and the precipitation, 1.80 inch, is 4.43 inches below. The rainfall is the smallest on record for May since the opening of the service. The maximum temperature for the month was 102° on the 30th, at Milligan, and on the 31st, at Warsaw, and is the highest maximum on record; the minimum temperature was 19°, at Norwalk, on the 21st, which is the lowest minimum on record. Killing frosts, with ice and light snow during the cold period, caused great damage to the corn crop, wheat, oats, barley, rye, young clover on lowlands, cherries, grapes, and garden vegetables. The corn and grapes were nearly all destroyed, and replanting of corn was in general progress at the close of the month. The hot dry periods at the opening and close of the month caused too rapid maturing of the cereals and grass, causing them to head out unusually short and close to the ground. The droughty conditions were general over the State, and all crops suffered. The grass fields looked brown and bare as if in August.

Oklahoma.—The mean temperature for the month was 69.9°, which is 1.3° above the normal, and the precipitation, 2.91 inches, is 2.39 inches below. Light frosts occurred on the lowlands on the 11th and 12th, and over the Territories as far south as Healdton, Chickasaw Nation, doing no damage. The month closed with the long drought unbroken over the greater part of old Oklahoma, and the prospects for corn lessening daily.

Oregon.—This month's weather conditions were very favorable to all crops grown in this State. The mean temperature, 54.0°, is 1.8° below the average, and the precipitation, 4.80 inches, 2.62 inches above. In the coast and Willamette Valley districts the excess of precipitation was very great, being over 7 inches in the former and over 3 inches in the latter. At the close of the month the outlook for cereal crops was much better everywhere, but more particularly in eastern Oregon. While frosts, both light and killing, were frequent during the month, yet in the western half of the State there was no damage to vegetation worth mentioning, and in the eastern half the crops were not sufficiently advanced, except in a few isolated places, to be damaged by the frosts. The weather has been all that could be desired by the farmers and agriculturists generally.

Pennsylvania.—High temperatures prevailed until the 11th, causing rapid growth to vegetation. On the night of the 12-13th a severe frost occurred, which killed the greater portion of the grape crop and badly injured other fruits. This was followed on the 17th by another damaging frost and freeze, which added additional injury to fruit, corn, and early vegetables. The average temperature for the month, 60.6°, is 1.4° above the normal. The highest temperature recorded during the month was 110°, reported at Hollidaysburg, on the 30th, and the lowest, 22°, at Smethport, on the 17th. The average amount of precipitation for the State for the month was 2.68 inches, being 2.90 inches less than the average.

Rhode Island.—(See *New England.*)

South Carolina.—The mean temperature was 69°, which is 1.6° below the normal, and the precipitation, 4.36 inches, is 0.84 of an inch above. The month exhibited almost the extreme variations in temperature ever recorded during May. The period from the 13th to 28th was cool and continuously below the normal, with light frosts over the greater portion of the State on the mornings of the 13th and 15th and at a few places on the morning of the 23d. These frosts did no material injury, except to check crop growth and development. The month was not generally favorable for agricultural interests, chiefly on account of the cool weather.

South Dakota.—The monthly mean temperature, 57.2°, was about 1.8° above the normal, and the precipitation, 2.36 inches, was 1.12 inch less than the usual amount. A remarkable feature of the month was the late and severe frost. Frosts were frequent, and killing frosts occurred over the eastern portion of the State as far south as Huron as late as the 26th. Corn, potatoes, flax, and garden vegetables were cut to the ground in many localities and over much of the State; fruit was almost entirely destroyed where unprotected; small grain crops did not suffer permanent injury, and most of the corn and potatoes recovered.

Tennessee.—The month of May showed but few abnormal features, the low temperature during the second decade being the most pronounced. This period culminated in frosts and in some localities freezing temperature, which seriously injured and retarded the growth of vegetation. The closing days showed quite a high temperature in many parts of the State. The average temperature for the month was 64.9°, being less than 1° below the normal; the precipitation for the month, 3.10 inches, was less than the usual amount for May by nearly an inch.

Texas.—The average temperature for May, for the State, was 2.0° below the normal and the rainfall 2.78 inches in excess of the normal. A severe norther for this season of the year prevailed from the 11th to the 13th, and the temperature fell 10° to 16° and ranged from 5° to 10° below the normal. The minimum temperature for the month at nearly all stations was recorded on these dates. On the night of the 21st and on the 22d high winds, with rain and hail, did much damage to crops in some localities. The wind at Salado, Bell Co., was very severe, and large corn was badly blown down and much of it broken off. Oats were also blown down. At Rockport, on the 22d, over 25 residences were reported blown from their foundations.

Utah.—The temperature for May, 1895, averaged about 1° below the normal, and the precipitation, 1.16 inch, about 0.76 of an inch below. The highest temperature recorded during the month was 99°, at St. George, on the 7th, 8th, and 25th, and the lowest, 19°, at Filmore on the 10th. The principal portion of the precipitation fell during the first and last weeks of the month. Killing frost was reported as late as the 31st.

Vermont.—(See *New England.*)

Virginia.—The mean temperature for the State averaged a little below the normal for May and the precipitation above. The highest temperature, 102°, was reported from Bon Air and occurred on the 31st, and the lowest, 26°, at Big Stone Gap on the 14th and 15th. Killing frosts were reported on the 13th, 14th, 15th, 16th, 22d, and 23d, doing considerable damage in the western sections.

Washington.—The mean temperature for May, 1895, was 53.4°, which is 1.6° below the normal, while the precipitation, 3.94 inches, is 1.46 inch above. The month averaged eleven clear, ten partly cloudy, and ten cloudy days. Thunderstorms were recorded on the 4th, 26th, 27th, and 30th.

Wisconsin.—The weather during May was unusual in many respects, but the most notable feature was the extremes in temperature, which were the greatest on record, the mean temperature, 57.6°, being 4.0° above, and the average amount of precipitation, 3.83 inches, or 0.15 of an inch below the normal. The highest temperature recorded during the month was 100°, at Crandon, on the 31st, and the lowest, 17°, at Florence on the 14th. During the first week the temperature was considerably above the normal, and vegetation was advancing rapidly when, about the 10th, a sudden change occurred. The temperature fell rapidly, and frosts occurred in some portions of the State every night from the 10th to the 22d, killing all vegetation in some sections, and in all sections tender plants were cut down. Added to this a heavy snowstorm occurred, amounting in the northern part of the State to from 4 to 6 inches. Thunderstorms were frequent from the 1st to the 19th and were reported on five subsequent dates.

Wyoming.—The mean temperature for the month was 51°, which is very near the May normal, while the precipitation, 2.55 inches, is almost an inch in excess of the average amount for that month. The highest temperature for the month was 90°, at Wheatland, on the 8th, and the lowest, 6°, at Wise, on the 10th. Frosts, more or less severe, were reported as late as the 31st.

STUDIES BY FORECAST OFFICIALS.

TROPICAL STORMS OF THE GULF OF MEXICO AND THE ATLANTIC OCEAN IN SEPTEMBER.

By E. B. GARRIOTT: dated August 18, 1893.

The first indications of the approach of a cyclone in the West Indies are abnormally high barometric pressure and unusually cool, clear weather. These conditions may continue several days. The nearer approach of a cyclone is indicated by slowly falling barometer and the appearance in the upper atmosphere of thin, hazy, cirrus clouds. The cirrus clouds thicken, change to cirro-stratus, and, at sunrise and sunset, present dark red and violet tints. The air becomes moist and heavy and the heat oppressive. Following these conditions the cloud bank of the cyclone appears, the barom-

eter falls rapidly, and squalls of wind and rain occur, increasing in intensity as the storm center approaches. Before the recurve the diameter of West India cyclones is 500 to 1,000 miles and their average velocity is 15 to 18 miles per hour. After the recurve they assume larger dimensions and the velocity increases. About 80 per cent of the cyclones traced in the last fifteen years appeared during the months of August, September, and October.

It is the purpose of this paper to deal with West India cyclones that have appeared in September during the last fifteen years, and to state the conditions that have preceded their occurrence in the Gulf of Mexico and on the southern coasts of the United States. As a first step in the direction of discussing the storms of this class the tracks of September cyclones for the fifteen years, 1878 to 1892, inclusive, have been plotted [see Chart IV], and some of the more prominent features shown by the plotted tracks are given in the following table:

Table showing cyclones occurring in September from 1878 *to* 1892, *inclusive.*

Year.	Appeared.	Recurved.	Disappeared.
	° °	° °	
1878	N. 11, W. 60. East of Windward Islands.....	N. 24, W. 81. Florida	South of Iceland.
1878	N. 15, W. 71. Caribbean Sea.....	N. 19, W. 73. North of Haiti.....	Northeast of Bahamas.
1878	N. 14, W. 49. East of Windward Islands.....	N. 25, W. 60. West of Windward Islands.....	North Sea.
1879	N. 15, W. 68. Caribbean Sea.....	N. 23, W. 87. Gulf of Mexico	Mid ocean.
1881	N. 25, W. 70. North of Haiti.....	N. 33, W. 76. North Carolina coast.....	New England coast.
1882	N. 21, W. 72. North of Haiti.....	N. 25, W. 88. Gulf of Mexico	Near Iceland.
1883	N. 15, W. 66. Caribbean Sea.....	N. 30, W. 79. South Atlantic coast.....	South of lower lakes.
1884	N. 14, W. 77. East of Windward Islands.....	N. 20, W. 58. Northeast of Windward Islands.	Northeast of Windward Islands.
1885	N. 27, W. 56. Northeast of Windward Islands.	No recurve	South of Nova Scotia.
1885	N. 24, W. 89. North of Yucatan.....	N. 25, W. 93. Gulf of Mexico	Mid ocean.
1885	N. 23, W. 97. West Gulf.....	N. 23, W. 97. West Gulf.....	Northwest of British Isles.
1886	N. 22, W. 66. North of Puerto Rico	No recurve	West of Bermuda.
1886	N. 14, W. 62. Windward Islands	N. 22, W. 97. Gulf of Mexico	Middle Missouri Valley.
1887	N. 13, W. 57. East of Windward Islands.....	No recurve	Northern Mexico.
1888	N. 20, W. 67. North of Puerto Rico.....	No recurve	Southern Mexico.
1888	N. 26, W. 80. South of Florida	N. 28, W. 83. East Gulf	Mid ocean.
1888	N. 21, W. 79. Southeast of Florida	.....	West Gulf of St. Lawrence.
1889	N. 20, W. 55. East of Windward Islands.....	N. 25, W. 56. Northeast of Windward Islands.	Near Azores.
1889	N. 14, W. 56. East of Windward Islands.....	No recurve	Virginia coast.
1889	N. 14, W. 69. Caribbean Sea.....	N. 25, W. 92. Central Gulf.....	East Canada.
1891	N. 24, W. 57. Northeast of Windward Islands.	N. 34, W. 64. Near Bermuda	Near Grand Banks.
1891 *...	.....	.....	
1892	N. 27, W. 91. Gulf of Mexico	.....	Northeast Labrador.
Mean...	N. 19, W. 69.	N. 25, W. 79.	N. 44°, W. 54°.

*Two storms of slight energy appeared over the central Gulf, and two storms advanced east of north from the subtropical region north of the West Indies in 1891.

The chart and table show that 22 cyclones were traced for September during the last fifteen years, an average of about 1.5 per month. This average is somewhat less than the average for August and October. Of this number 5, or about 23 per cent of the cyclones traced, recurved east of the sixty-fifth meridian, and were not felt on the coasts of the United States. A second class embraced those cyclones that recurved between the sixty-fifth and ninetieth meridians. This class may be considered as having followed a normal course, and included 45 per cent of the cyclones traced. A third class, to which 32 per cent of the cyclones belonged, comprises those cyclones that passed west of the ninetieth meridian or reached the United States coasts without a recurve.

In connection with the storms of the first class, i. e., those that recurved east of the sixty-fifth meridian, it will be observed by referring to the chart that they first appeared either east of the fiftieth meridian or north of the twentieth parallel. But two of the storms traced in that region, those of September 12–18, 1878, and September 3–11, 1884, appeared far enough south to render their advance over or near the West Indies a probability. As storms liable to influence the weather conditions of the United States coasts, these two storms only of the first class will be considered. The cyclone of September 12–18, 1878, appeared while a West India storm of great energy occupied the south Atlantic coast. From the 12th to the 15th the cyclone east of the Windward Islands moved westward. During that period the south Atlantic coast storm moved northward, and was replaced by an area of high pressure which covered the Southern States and the Gulf of Mexico. The pressure continued high over the Southern and Southeastern States from the 15th to the 18th. This area of high pressure extended eastward off the southern coast of the United States, and *apparently obstructed* the westward advance of the cyclone referred to, and *forced* a recurve to the northward. The cyclone of September 3–11, 1884, moved westward from the 3d to the 5th. During that period the pressure continued high and 0.10 to 0.15 inch above the normal over the southeastern districts of the United States. During the 6th the high area over the southeastern part of the United States moved eastward, and the cyclone began to recurve to the northward. During the succeeding three days the pressure continued high off the southern coasts of the United States. *In each instance the westward movement of the cyclones which recurved east of the sixty-fifth meridian was apparently prevented by anticyclonic areas which moved eastward over the southern coasts of the United States.*

The second class of storms, i. e., those that recurved between the sixty-fifth and ninetieth meridians, will be considered in connection with the distribution of atmospheric pressure. Forty-five per cent., or 10 of the 22 cyclones traced, belonged to this class. Of this number 5 appeared over the Caribbean Sea, 4 east of the Bahamas, and 1 near the southern extremity of the Florida Peninsula. A study of the charts of the last fifteen years shows that when these storms appeared over the eastern Caribbean Sea or the eastern West India Islands the pressure was above the normal over the western West Indies and the Florida Peninsula. *This high pressure does not appear to have been translated from over the American Continent, but was the result of a slow and steady increase of pressure due possibly to the overflow of air, or the upper currents, from the advancing cyclone.* When the cyclones reached the longitude of eastern Cuba the pressure began to decrease over western Cuba and the southern part of the Florida Peninsula, and, in cases where the storms recurved east of the ninetieth meridian, the pressure increased over the western part of the Gulf of Mexico and over the Southwestern States. Until the cyclones reached the American coast the attendant rain area was small. After the United States coast was reached the rain area extended rapidly, and in some instances the storm center occupied the south Atlantic coast and the rain area covered the Atlantic coast States. When storms of this class reached the longitude of western Cuba the pressure began to give way and rain be-

gan to fall over the Florida Peninsula and the eastern Gulf. Over the western Gulf the pressure continued to rise. *The recurve of these cyclones was apparently due to the obstruction offered to a westward course by anticyclonic areas which had advanced or had been drawn from the continent over the west Gulf and the Southwestern States.*

Thirty-two per cent of the cyclones traced did not recurve to the northward, and had no easterly movement. A large proportion of the cyclones of this class advanced from the eastern West Indies. Upon their arrival in about longitude W. 80°, the average longitude in which September cyclones recurve, the pressure over the west Gulf began to *decrease*, and rain set in, and the interior-eastern districts of the United States were occupied by an extensive anticyclonic area. As storms prefer to follow the path of least resistance, the centers moved toward the region of decreasing pressure and avoided the high and increasing pressure to the northward. When the pressure continued high over the eastern districts of the United States the storms were unable to recurve and were penned in over Mexico or the Southwestern States. In such cases the cyclones usually developed great violence before dissipating. Similarly cyclones of this class that advanced northwestward toward the middle or south Atlantic coasts of the United States were apparently prevented from recurving by high pressure over the ocean to northward and northeastward. Description of storms of this class will be found in the MONTHLY WEATHER REVIEW for September, 1888, and September, 1889. The storm of September, 1888, raged with fearful violence over Cuba and passed thence to southern Mexico. The storm of September, 1889, was exceptionally severe, and dissipated off the middle Atlantic coast.

It may be assumed that with a nearly normal distribution and movement of atmospheric pressure September cyclones will recurve near longitude W. 80° and between latitudes N. 25° and 28°. When a cyclone is central east of Cuba and an area of high pressure is advancing eastward over the Gulf and south Atlantic States, the cyclone will probably recurve east of the Bahamas. When the cyclone reaches central Cuba or longitude W. 80°, and an area of high pressure is advancing over the west Gulf and Southwestern States, the cyclone will probably recurve over Florida or the east Gulf. When the cyclone reaches the seventy-fifth meridian and an area of high pressure is overspreading the interior and eastern districts of the United States, with stationary or falling barometer over the west Gulf and the Southwestern States, the cyclone will probably advance westward over the Gulf of Mexico. When cyclones are moving northwestward toward the south or middle Atlantic coasts of the United States, and the pressure is abnormally high over the Northeastern States and the Canadian Maritime Provinces, the chances are that the storm will not recurve but will be crowded in upon the coast and develop destructive energy.

SPECIAL CONTRIBUTIONS.

CLOUD PHOTOGRAPHY.

By ALFRED J. HENRY, U. S. Weather Bureau. Written August, 1895.

A considerable mass of information concerning the condition of the air at the surface of the earth has been accumulated, but we know very little of what is going on at some distance above us. The regions of the higher atmosphere have been studied to some little extent through the scant data afforded by balloon ascensions, mountain meteorological observatories, and the movements of upper clouds. While the latter method is not so promising in direct results as others that might be mentioned, its simplicity and adaptability commend it to all lovers of science.

The question of cloud photography is of especial interest at the present time in view of the following resolutions passed by the International Meteorological Committee at its meeting in Upsala, August 20–24, 1894:

Since experience shows that the altitude of clouds can be easily determined with sufficient accuracy, the introduction of these investigations into all countries is recommended, preferably by the use of the photographic process. Observations of direction and relative velocity should be made at as many stations as possible, and measures of height at a limited number of suitably distributed stations.

The value of these investigations would be greatly increased if made at the same epoch; therefore, it is proposed that they be commenced May 1, 1896, and continue for one year.

Cloud photography has received more attention during the last ten years than at any time since the introduction of dry plates, and it is now possible, as a result of the combined efforts of amateur photographers and meteorologists to obtain fairly good negatives with comparatively little difficulty. The employment of the camera to permanently fix the appearance of the sky and the changes in form of clouds can not be too strongly recommended. One of the most practical results likely to flow from a close watch of the sky is the ability to associate various cloud forms with coming weather changes. After an experience of four years in this regard I am confirmed in the belief that for the purpose of forecasting the weather from the standpoint of the solitary observer the clouds afford the most valuable data at his command.

With a view of increasing activity in cloud work during the coming year of special observation and to encourage all who may be inclined to take an active interest in cloud photography, the following suggestions are offered:

Apparatus.—No particular form of camera is required. Hand cameras have the advantage of being ready for use at a moment's notice, and when a cloud mass is changing rapidly it is possible to make a series of exposures at a very few seconds' interval. For the best results, however, a tripod camera should be used (unless one adopts the expensive photogrammetric apparatus). A lens of the rectilinear type, having a focal length equal to the diagonal of the plate used, is best suited for cloud work, and one should always be careful to adjust the camera so that the sensitive plate shall be exactly perpendicular to the optical axis of the lens.

Plates.—It is perhaps unnecessary to state that when any color is looked at with the naked eye the sensation experienced is the joint effect of the various elementary colors of which it is composed. When we examine the colors of the spectrum as regards their action on the ordinary photographic plate, we find that those of the greatest visual intensity—yellow and orange—have the least actinic effect, while the blue and violet rays are especially active. When we attempt to photograph the spectrum with the ordinary commercial dry plate, we find that the blue and violet rays are rendered almost white and the remainder of the colors of a uniform blackness.

To reproduce these colors in their correct chromatic value we must use plates that are specially sensitive to the most luminous rays and restrain those rays that are most active, and this is what dry-plate makers aim to accomplish with the so-called isochromatic or orthochromatic plate.

There are various brands of orthochromatic plates on the market, such as Cramer's, Carbutt's, Wuestner's, and others, and, since they tend to maintain the natural relations of light and shade, they are to be recommended for cloud work, although there are conditions when an ordinary slow plate may be used to good advantage. Before determining upon the special plate to use, it is advisable to make a comparative