STUDIES BY FORECAST OFFICIALS.

THE BAROMETRIC TROUGHS OF THE PLATEAU REGION.

[By Prof. H. A. HAZEN; dated October 14, 1893.]

A study of the barometric troughs covering the plateau region from the Colorado Valley northward to the British Possessions, to determine what influence such pressure conditions have in connection with the Mississippi Valley thirty-six hours after a well developed trough is observed. Also, to ascertain in what portion of the trough the depressions which move eastward are likely to form, and to determine the probability of the formation of low centers in the extreme southern portion of the trough, and the chance of such disturbances crossing eastward over low latitudes and affecting the weather in the Mississippi Valley.

In order to fully comprehend the general discussion to follow it is necessary to examine briefly the broader features of pressure distribution in the portion of country west of the Rocky Mountains during the autumn months. As is well known, in summer there is a rather permanent area of low pressure covering this whole region, from which there is almost no precipitation. During this same period there is an area of high pressure over the Pacific Ocean. The winds are mostly westerly and blowing toward the land. Even though they may be saturated, the relative humidity is quickly and greatly diminished by the high land temperature, and the possibility of precipitation is almost nothing.

On the other hand, in winter these conditions are exactly reversed. Now, the permanent high area is situated in the plateau region, and a permanent low pressure exists over the Pacific. It is easy to see that the autumn, being the time of transition from one state or condition to the other, would partake of both, and this commingling at first sight seems quite complex.

More particularly I find in each month the following facts:

SEPTEMBER.

On the whole a dry month in the region under discussion. Troughs in the plateau region advance rather slowly toward the Mississippi Valley. The indications are that summer influences are still potent during the month, and for this reason there is little rain either in the plateau region or to the eastward; that is, the depressed region travels eastward in a rather dry state, and I do not find that the air becomes much damper in the Mississippi Valley. I am also inclined to the opinion that the month is rather dry in the Mississippi Valley. Sometimes there is a slight concentration of energy or an increased barometric gradient around an oval area both in the extreme north at Dakota and in the south at Texas, after this trough has moved eastward; in these cases there is a tendency to a slightly increased rainfall in the upper Mississippi and in the west Gulf. This is the exception, however, and it is impossible to tell under what conditions this concentration takes place.

On the whole I would say that it is best not to place much dependence upon such a trough in the month of September, except that one may be reasonably certain that no trouble in the line of rain will come from it. As it moves eastward care should be taken to watch for a possible concentration in the extreme north or south, almost never in the center.

OCTOBER.

In this month there is a great deal more rain in this region under discussion and troughs increase in number and definiteness. The increase of rain in Arizona and New Mexico is especially noteworthy. These troughs have rather a peculiar tendency of moving on Arizona as a pivot, that is, the upper end moves to Manitoba and the trough extends across from Arizona to Manitoba. Under these conditions rain often occurs in Arizona, and generally in the rear of the trough in the extreme north. A little later the south end swings to Texas and then rain falls in the west Gulf. Generally the rain is confined to the north and south, but sometimes it extends over the whole Mississippi Valley. The motion is rather slow, seldom less than forty-eight hours to the west Gulf. As to forecasting I would say, such a trough is much more threatening than in September. However, care must be exercised, as in some Octobers the conditions are the same as in September, and I am inclined to think that this can be usually told by watching the maps. That is, there is a sort of persistency in these conditions and if the troughs begin the month with little rain they are likely to continue so. It is very difficult to determine beforehand under what conditions rain will form in these troughs as they move eastward, and one must watch as in September, forecasting very little rain until it begins to show itself. Rain is certainly the exception in these troughs.

NOVEMBER.

This month begins to show winter conditions, and is the easiest of the three to handle with respect to these troughs. Even if a trough forms in this region it will be found that generally it will be broken in two by the development of a high area in its center, or by a high extending out to southwest from the north. Rain from such troughs is very rarely experienced in the Mississippi Valley, and in fact the trough rarely moves to the Mississippi. It may be said that the trough in November is usually due to the permanent low area of the Pacific moving upon the land, and its life is almost wholly dependent upon this low area. Rains are quite frequent on the Pacific slope, but they seldom extend inland. The beginning of the permanent high area just west of the Rocky Mountains is well shown in this month. Sometimes there are concentrated lows which cross the central plateau region and give rain after reaching the middle Mississippi Valley. These lows have to be considered by themselves and are hardly a part of this trough phenomenon.

To review the whole, I would say, troughs as far west as the Colorado Valley and northward are dry and seldom increase in moisture. They move rather slowly; in October the north end moving faster than the south. Sometimes there is a concentration which will give rain in twenty-four hours. No safe forecast of rain can be made in any case till rain has begun, and even then west of the Mississippi it will be light. In a few cases there is a peculiar tendency to a fall of rain in the rear of the trough, and this takes place most frequently in the concentrated lows at the north. No rule can be laid down regarding this rain in the rear. The following lists comprise the troughs taken from the maps. In October and November, maps from 1877 to 1882, were not used, as the curves for this region were not drawn, and it was thought that enough cases could be obtained from the other years.

Troughs from Colorado Valley to the British Possessions and their movement (rainfall is given in inches). When the location of the trough is not specified, it is understood to be over the plateau region.

1877.

Sept. 3_1. Pressure 29.43 at Boise City.
6_2. 29.50 at Bismarck, no rain.
7_2. Rain at St. Vincent and Moorhead.
11_3. 29.56 at Salt Lake City.
13_1. Bismarck, 29.34; rain, 0.01.
14_1. Moorhead, rain.

Sept. 18_2. Boise City, 29.60.
19_2. St. Paul, no rain anywhere.
20_2. No rain, Mississippi Valley.
23_1. Rain at Marquette.
25_3. Boise City, pressure 29.43.
26_1. Rain at St. Paul far in front of trough.

1879.

Sept. 6_1. Sort of trough, but did not move east of Rockies.
8_3. Concentrated at Omaha.
10_1. No rain.
11_1. Light rain at La Crosse.

1882.

Sept. 15_1. 29.67, Winnemucca; 0.06 rain at Prescott only.
16_2. 29.56, Pioche.
17_3. Concentrated in North Dakota; no rain to speak of.
24_3. Rain at north end of trough.
26_1. Secondary formed at Deadwood with rain in its rear.
27_2. Trough from Texas to Dakota.
27_3. Rain in northern Texas, Yankton, Bismarck, and Fort Buford.
29_1. Disturbed region extends over whole country west of Mississippi, with very light rain.

1886.

Sept. 1_1. Salt Lake City, rain, 0.19.
2_2. From Texas to Dakota, little scattered rain.
13_3. Slight trough, no rain.
15_1. Trough moved and stretches from Texas to Manitoba, almost split in two; rain in lower Mississippi Valley and Minnesota.

1887.

Sept. 2_3. Disturbed region in plateau; rain north Pacific coast and North Dakota.
5_2. Disturbed region west of Mississippi; rain Minnesota and Wisconsin, none south.
6_3. Trough; rain at Boise City, 0.04, and in rear of trough on middle Pacific coast. This moved.
8_3. Trough from Arizona to Manitoba; rain, 0.06 at Cheyenne, and 0.70 at Deadwood.
9_2. Trough, but without motion at first; moved.
11_3. Stretches from Arizona to Manitoba; rain, 0.20 at Montrose, and 0.02 at Denver.
12_3. Stretches from western Texas to Manitoba; rain in Iowa, Minnesota, and North Dakota.
15_2. Trough; no rain.
16_3. Stretches from Arizona to Manitoba, with 0.04 rain at Fort Stanton.
17_1. Texas to Lake Superior; rain in middle and east Gulf only.
17_2. Trough; no rain.
19_2. Stretches from Texas to Manitoba; rain, at Concho 0.04, and trace at Minnedosa.

1888.

Sept. 2_2. Trough; rain, 0.02 at Montrose, and 0.08 at Fort Benton.
5_1. Stretches from Arizona to Manitoba; no rain.
8_2. Trough; no rain.
9_2. From New Mexico to Swift Current.
11_2. Trough, and rain, 0.02 at Santa Fe.
13_2. Stretches from Arizona to Manitoba; rain, 0.01 at Buford.
17_1. Trough, with 0.02 rain at Winnemucca and on Pacific.
19_1. Stretches from west Texas to Manitoba; no rain.

1883.

Oct. 5_3. Low pressure in Arizona and slight north of Montana; no trough.
7_1. Marked trough, Arizona to Manitoba; no rain.
8_1. Concentrated in Manitoba with rain in Wisconsin, Upper Michigan, and Manitoba.
16_2. Trough from Arizona to North Dakota; light rain at Santa Fe, Dodge City, and North Platte.
17_2. Slight changes, with rain in Missouri and upper Mississippi valleys.
25_2. Marked low, north Pacific coast; rain on Pacific coast only.
26_2. Concentrated in Colorado; rain on west Gulf and lower Mississippi.
27_1. Trough from New Mexico to north of Montana, not definite; rain in Missouri and Mississippi valleys.
28_1. Trough stationary, with rain in Ohio, Missouri, middle and upper Mississippi.

1884.

Oct. 1_1. Broad trough; rain in Texas and upper Mississippi only.
2_1. Trough stretches from Arizona to Manitoba; rain in west Gulf, Minnesota, and upper Lakes, none in central Mississippi Valley.
2_3. Concentrated in Minnesota; rain in west Gulf, Lake Superior, Manitoba, and North Dakota.
4_1. Trough, but pressure rather high in center; rain, at El Paso and Elliott.
5_1. Concentrated in Minnesota; rain there and North Dakota, none in the Gulf.
9_2. Trough; rain at Prescott only; pressure, 29.08 at Calgary.
10_2. Stretches from Arizona to Manitoba; rain at Grant only.
11_1. Concentrated over Lake Superior; no rain; a little in rear (next map).
18_3. Trough stretches Arizona to Manitoba; rain at Grant and Prescott.
19_2. Concentrated over Lake Superior; no rain.
24_2. Trough; rain in Texas.
25_2. Stretches from New Mexico to north of Montana; rain in Texas, none north.
26_1. Stretches from Texas to Manitoba; rain in Mississippi Valley and Gulf.
28_3. Trough from Arizona to Manitoba; rain in upper Mississippi.
29_2. Texas to Lake Superior; rain in Ohio Valley, not steady.
30_3. Trough, but no rain.
31_3. Stretches from New Mexico to North Dakota; light rain in North Dakota only.

1885.

Oct. 8_1. Trough; no rain.
10_1. Stretches from Arizona to Manitoba; no rain.
11_1. Texas to Manitoba; light rain in Missouri Valley rear, none in south.

1886.

Oct. 1_1. Trough; no rain.
2_2. Stretches from Arizona to Manitoba; no rain.
3_2. Arizona to Lake Superior; no rain.
3_3. Trough; light rain in New Mexico and east Arizona.
4_3. Stretches from Arizona to north Montana; rain in New Mexico and extreme west Texas only.
6_2. Stretches from west Texas to Manitoba; rain stopped.
7_2. Stationary; no rain anywhere.
7_3. Concentrated, north Texas; light rain there.
9_2. Still nearly stationary; no rain.
16_2. Trough, with rain north Pacific only.
16_3. Light rain at Montrose and West Las Animas.

Oct. 18_3. Moved to New Mexico and Manitoba; light rain in North Dakota.
19_2. Stretches from New Mexico to Minnesota; light rain in rear extreme north.
27_3. Trough; no rain.
30_1. Nearly stationary; no rain; great high in middle Minnesota.

1887.

Oct. 3_3. Trough; no rain.
4_3. Stretches from New Mexico to North Dakota; rain in North Dakota only.
5_2. New Mexico to Minnesota; no rain.
5_3. Trough; no rain.
7_1. Stretches from New Mexico to Manitoba; light rain in North Dakota only.
7_3. Stretches from New Mexico to Lake Superior; light rain in Minnesota and Dakota.
8_1. Northern Texas to Lake Superior; rain in Texas and middle and upper Mississippi valleys.
14_1. Trough, no rain.
15_2. West Texas to Manitoba; light rain in Dakota only.
16_2. Texas to Lake Superior; light rain in middle Gulf and upper lakes.

1888.

Oct. 2_1. Trough.
3_1. Stretches from New Mexico to Minnesota; light rain in Colorado.
17_1. Trough; rain in north Pacific.
17_2. Arizona to Montana; light rain in Montana.
18_1. Concentrated in Iowa; light rain in Missouri, middle and upper Mississippi valleys.
30_2. Trough.
31_2. Light rain in Montana only; trough not well formed.

1884.

Nov. 21_1. Trough.
21_2. Rain at Calgary and in Arizona, broken up by high to the north of Montana.

1885.

Nov. 4_2. Marked low, north Pacific, with rain there.
4_3. About stationary; rain in Utah, Wyoming, and western Colorado.
5_3. Stationary; rain, 0.42 at Salt Lake City; trough gradually filling up.
20_1. Trough, with rain in Arizona.
20_3. Filling up; rain at Salt Lake City, 0.12.
21_1. Concentrated, Colorado; no rain.
22_1. In middle Mississippi Valley; rain in rear.
24_3. Disturbed region, with rain on Pacific coast.
25_3. Not well defined; rain, 0.48 at Salt Lake City, and 0.19 at Prescott.
26_3. Stretches from Texas to Manitoba; rain in Texas, Colorado, and Nebraska.
27_1. Concentrated in Texas, with rain there and in lower Mississippi Valley.

1886.

Nov. 7_1. Trough.
7_2. Rain at Santa Fe and Elliott.
9_1. Concentrated in Minnesota; rain in Mississippi Valley.
20_2. Mostly in Idaho, with rain in rear.
21_2. Concentrated at Salt Lake City, with rain in Utah.
22_2. Concentrated in South Dakota; rain in Missouri, Ohio, middle and upper Mississippi valleys.

1888.

Nov. 17_1. Disturbance on Pacific coast, with rain there.
19_1. Still stationary on Pacific coast, with rain north; no motion east.
22_2. Disturbance on Pacific; rain on middle and north Pacific.
25_2. Still stationary, Pacific, with rain in Arizona and north Pacific.
26_2. Stretches from Arizona to Manitoba; rain in Texas; none north; disturbance disappearing.

SPECIAL CONTRIBUTIONS.

STATISTICS OF STATE WEATHER SERVICES.

[By OLIVER L. FASSIG, Librarian U. S. Weather Bureau.]

To those interested in the study of local climates in the United States it may be of interest to have, in convenient form for reference, some facts relating to the organization and published reports of the various State weather services. The entire domain of the United States, with the exception of Alaska, is now covered by organized State or Territorial services under the joint control of the National Weather Service and the respective States and Territories. The complete system at present includes about 3,000 observing stations, at which the ordinary elements of the weather are regularly recorded, and published from month to month.

Some of the monthly and annual reports have been printed regularly in pamphlet or book form from the establishment of the service. Others have variously appeared as separate publications or in connection with the crop reports or agricultural reports of the several States. Many have been published only in small numbers by means of some duplicating process, such as that of the milliograph.

The style of publication has varied greatly, not only in the different States, but also in the same State from time to time. It is to be regretted that some uniform size and style of printing has not yet been adopted for the publication of these valuable reports.

From replies to questions sent to the directors of the State Weather Services, and by means of the nearly complete file of the publications of these services in the library of the Weather Bureau, an attempt is here made to present in the order indicated: (1) The name of the State; (2) the location of the central office; (3) the name of the director on July 1, 1895; (4) the date of organization and by whom organized, and the local or State aid received; (5) the date of the first weather report and the first weather crop bulletin published; (6) the character of the first report, whether printed or milliographed; (7) the number of active stations on July 1, 1895; (8) the title of the report issued for June, 1895; (9) remarks.

It has been found difficult in all cases to get entirely accurate information relating to the early history of some of the State organizations, and some minor errors doubtless occur in these statistics. The writer will be pleased to have any such errors brought to his attention.

ALABAMA.—Central office, Montgomery. Director, F. P. Chaffee.† Organized February, 1884, by Prof. P. H. Mell. First report, March, 1884, printed at Auburn. Published by the State department of agriculture. First weather-crop bulletin, May 21, 1887. Number of stations, January 1, 1895, 60. Title of publication for June, 1895: The Alabama Weather Report. Contained in The Southern Agriculturist, volume 24, No. 14, July, 1895. Fol. Montgomery. Published continuously with the exception of July and August, 1887. Report milliographed from July, 1893 to January, 1894, inclusive.

ALASKA.—No organization as yet.

ARIZONA.—Central office, Tucson. Director, W. F. Burrows.* Organized October, 1891, by J. C. Hayden. First report, October, 1891, milliographed by U. S. Weather Bureau. First weather-crop bulletin,