

## SECTION III.—FORECASTS.

## FORECASTS AND WARNINGS FOR JULY, 1916.

By H. C. FRANKENFIELD, Supervising Forecaster.

[Dated: Weather Bureau, Washington, Aug. 1, 1916.]

## GENERAL PRESSURE DISTRIBUTION OVER THE UNITED STATES AND CANADA, INCLUDING THE HAWAIIAN AND ALEUTIAN ISLANDS, ALASKA, AND THE MIDDLE ATLANTIC OCEAN.

Over the Hawaiian Islands pressure was somewhat above normal during almost the entire month of July, 1916, with a principal crest from the 5th to the 10th, inclusive, during which time pressure was also somewhat above normal over the Aleutian Islands and northwestern Alaska. With this exception moderately low pressure prevailed over the Aleutians and Alaska during the first three weeks of the month, followed by a moderate rise thereafter. The lowest pressure occurred about the middle of the month over the Aleutians and northwestern Alaska, but the condition did not extend in material form either eastward or southward.

On the whole the general pressure conditions over the United States proper and Canada were much the same as prevailed over Alaska, with the lowest pressures over the northern districts, the usual summer condition. Exception should be noted, however, in the Atlantic States which were under the influence of the three tropical disturbances of the month, with the result that there was a quite uniform series of high and low pressure areas that also extended over northeastern Canada.

Over the Atlantic Ocean pressure was very nearly normal during the first week of the month, and this condition persisted throughout the month over the South Atlantic, except between the 13th and the 17th, when there was a considerable fall due to a tropical disturbance described below. To the northward, however, pressure was generally and substantially above the normal after the first week, except from the 21st to the 24th, inclusive, over the eastern ocean.

The persistence of the high pressure over the central western Atlantic Ocean, with the low pressure over Canada and the northern portion of the United States, resulted in a prolonged period of abnormally high temperature over the central and northern districts east of the Rocky Mountains that did not moderate until the last day of the month.

## WASHINGTON DISTRICT.

*The middle Gulf coast storm of July 1-10, 1916.*

The first definite indications of this disturbance were noted on the morning of July 1 at Swan Island (latitude  $17^{\circ}$  N., longitude  $84^{\circ}$  W.), when after a day or two of unsettled weather the barometer had fallen to 29.78 inches with a 24-hour fall since the morning of the 30th of 0.06 inch. The air was calm, but about  $1^{\circ}$  to the northward an east wind of about 24 miles an hour prevailed with the same pressure as at Swan Island. Belated evening radio reports from vessels in the vicinity of Swan Island confirmed the morning indications, and on the morning of the 2d it was clearly evident that the disturbance was well defined with a northward movement. At this time the barometer at Swan Island read 29.74

inches, with fresh southerly winds and rain. Advisory warnings were then telegraphed to Weather Bureau stations along the Atlantic and Gulf coasts and to other interested parties. On the morning of the 3d the storm center was estimated to be at about latitude  $20^{\circ}$  N., longitude  $85^{\circ}$  W., but the absence of radio reports prevented more precise location. The barometer at Swan Island had risen 0.02 inch to 29.76 inches, with fresh south winds still blowing. Pressure had also fallen materially over western Cuba; Pinar del Rio reported 29.82 inches, a fall of 0.08 in 24 hours, with moderate easterly winds and rain. Thus far the storm was apparently of not much intensity and notices to this effect were issued. No information was received during the remainder of July 3 until late at night when a single radio report at about latitude  $23^{\circ}$  N., longitude  $86^{\circ}$  W., showed a barometer of 29.50 inches with an east wind of 64 miles an hour.

On the morning of the 4th no radio reports were received except one from a point about 125 miles northwest of Habana. This gave a barometer reading of 29.72 inches, with a southeast wind of 40 miles an hour. A report from Key West received at 10:21 p. m., July 4 stated that the United States Coast Guard cutter *Itasca* had encountered a severe disturbance on the afternoon of July 3 about 25 miles south of Cape San Antonio with a whole gale from the east. It was afterwards learned that the U. S. S. *Monterey* also came within the storm field during the 3d. At noon of that day in latitude  $22^{\circ} 31'$  N., longitude  $86^{\circ} 52'$  W., the barometer read 29.66 inches with a fresh breeze from the northeast. At midnight in latitude  $22^{\circ} 43'$  N., longitude  $85^{\circ} 58'$  W., the barometer read 29.42 inches with a strong gale from the east-northeast. The lowest barometer, 29.40 inches, was recorded at 2 a. m. on July 4 when a whole gale was blowing from the southeast, indicating that the storm center had passed but a short distance to the westward. These reports show that the storm passed through the Yucatan Channel during the early night of the 3d and apparently had attained only moderate intensity until just before that channel was reached, after which there was a marked increase in its activity. The effects were felt as far east as Habana, as indicated by the following cablegram from the director of the Cuban Meteorological Service:

[HABANA, July 4, 1916.]

4:30 p. m. Tropical storm reaching moderate intensity passed Yucatan Canal this morning moving northwest to central Gulf. Highest gusts in Habana 56 miles (at) noon. (Signed) GANGOTTI.

At Key West, Fla., the highest wind velocity was 36 miles south. At 9:50 p. m. of the 4th advices were issued to the effect that the storm had passed through the Yucatan Channel and caution was advised for all vessels in the Gulf of Mexico. Apparently the advices of the previous day had been carefully heeded for not a single radio report was received from the Gulf of Mexico from the evening of July 3 until after the storm center had passed inland to southern Mississippi. At 2 p. m. of the 4th after the receipt of noon special observations the following warning was issued:

Noon: Disturbance in southeastern Gulf of Mexico, but no reports to indicate intensity or exact direction of movement. Probably moving northwest toward central Gulf, and Gulf shipping advised to remain in port until further advices this evening.

At 8 p. m., with falling pressure along the Gulf coast, northeast storm warnings were ordered along the Gulf coast from the Louisiana coast to Pensacola, Fla., and cautionary advices sent elsewhere. The warning stated that the storm was then probably near the middle Gulf, moving northwestward and, if so, northerly winds and gales were probable Wednesday (July 5). The caution of the afternoon to shipping to remain in port was repeated. On the morning of the 5th the barometer on the middle Gulf coast ranged from 29.56 to 29.60 inches, with northeast winds that at Pensacola had reached a velocity of 48 miles an hour, indicating that the storm center had moved across the Gulf with unusual rapidity and was near to and approaching the middle Gulf coast, and apparently somewhere between Mobile Bay and the mouth of the Mississippi River. Hurricane warnings were therefore ordered

ing of the 6th the storm hovered over Mississippi and Alabama for three days with steadily decreasing intensity, but with torrential rains that caused great floods in the rivers of the East Gulf States and enormous damage to growing crops. By the morning of the 10th the storm center in its vagaries had moved into Tennessee (Nashville, 29.70 inches) and by the evening of the 10th was over extreme eastern Tennessee (Chattanooga, 29.80 inches). The damage done by the storm was of the character incident to such occurrences. Unfortunately sev-

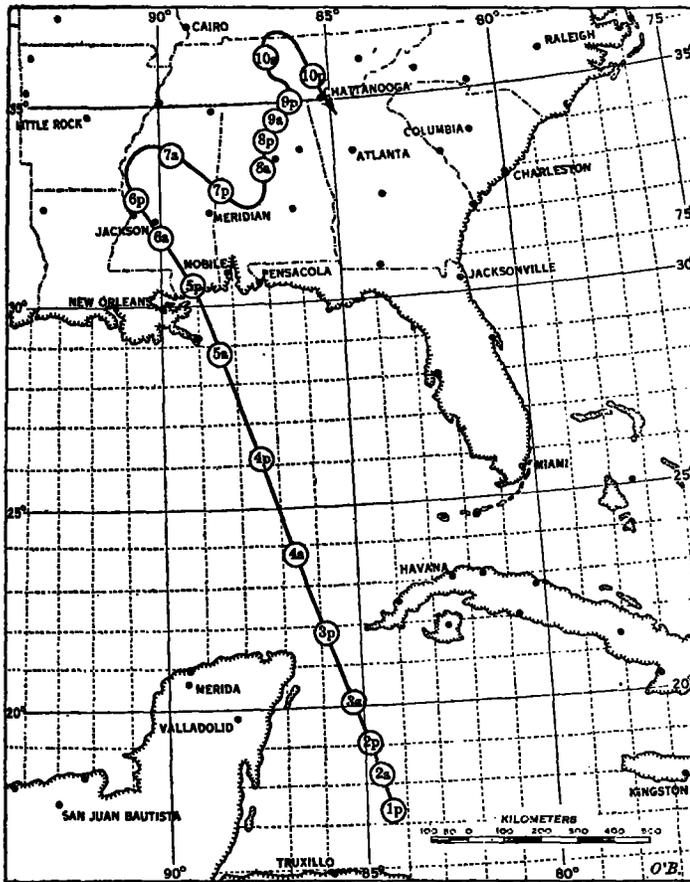


FIG. 1.—Track of the Middle Gulf storm of July 1-10, 1916.

at 9 a. m., from Mobile westward over the Louisiana coast and northeast storm warnings extended eastward to Carrabelle, Fla. Frequent special observations were obtained during the 5th but no changes in the warnings appeared to be necessary. The storm passed inland during the afternoon with a barometer reading of 28.92 inches at Mobile at 4:45 p. m. The maximum wind velocity was about 106 miles an hour, the highest velocity ever reported at that station. At Pensacola the lowest barometer reading was 29.31 inches at 2:30 p. m. and the maximum wind velocity was 104 miles an hour from the southeast at 2:22 p. m., also the highest velocity ever reported at that station. At 8 p. m. the barometer at Mobile read 29.05 inches. On the morning of the 6th the storm was central over southern Mississippi with a barometer reading at Meridian of 29.48 inches at 5 a. m. After the morn-

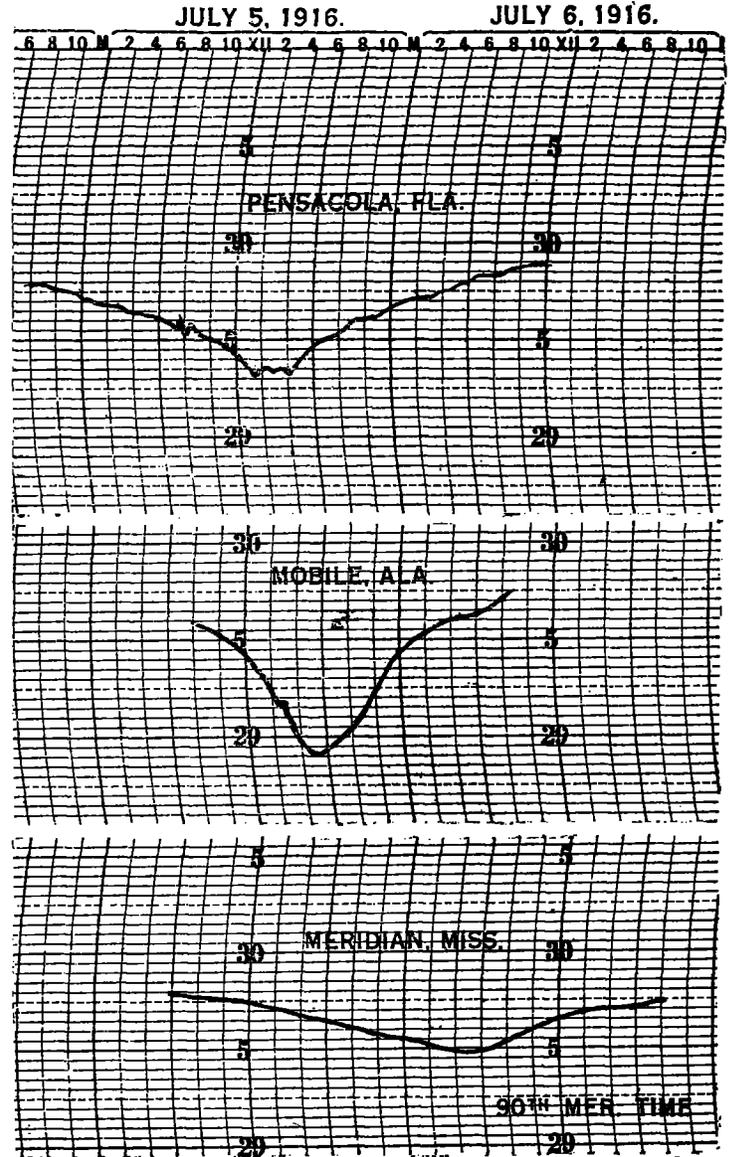


FIG. 2.—Barograms for a portion of the Middle Gulf storm of July 1-10, 1916, at Pensacola, Fla., Meridian, Miss., and Mobile, Ala. (sea-level records).

eral lives were lost along the middle Gulf coast, mainly persons in small boats. Marine casualties were of a minor character but the aggregate losses amounted to several millions of dollars, distributed principally between the cities of Pensacola and Mobile and the agricultural sections of southeastern Mississippi and southwestern Alabama. The high tides were responsible for the major portion of the coast damage. At Mobile the tide was somewhat more than 2 feet above the previous highest tide of 9.87 feet above mean tide in September, 1906, and the entire business district was inundated. At Pensacola

the tide was 5 feet above normal high tide, or 3½ feet lower than the highest reached during the storm of September, 1906. After the storm center passed inland torrential rains set in over the east Gulf States, and western Georgia and continued in the form of heavy showers for about a week. These rains of course caused enormous losses of staple crops and caused great floods in the rivers of eastern Mississippi, Alabama, and western Georgia.

Figure 1 shows the path of the hurricane and figure 2 copies of barograms recorded at Pensacola, Mobile, and Meridian:

On the morning of the 9th, when the hurricane storm was central over Alabama with some indications of redevelopment and northeastward movement, southwest storm warnings were ordered on the south Atlantic coast from Jacksonville, Fla., to Morehead City, N. C. The warning was hardly justified at the time, but, as it was Sunday, the receipt of special reports in time was doubtful and it was thought best to exercise due caution. The highest wind velocity reported during the display was a thunderstorm squall of 48 miles an hour at Jacksonville, while only fresh winds occurred to the northward.

*The south Atlantic coast storm of July 12-15.*

On July 12 a vessel radio report from about latitude 27° N., longitude 72° 30' W., gave the first notice of this disturbance. The wind was blowing 28 miles an hour from the west, and the barometer read 29.90 inches, an apparent fall. There was no other barometer reading below 30.00 inches in that locality. Pressure was high (30.30 inches) over Bermuda and moderately high (30.14 to 30.16 inches) on the Carolina coast. On the following morning another single radio report from about latitude 27° N., longitude 80° W., showed a barometer of 29.77 inches, with a strong westerly gale, indicating a storm of considerable intensity a short distance to the northeastward. Eleven a. m. special observations from coast stations showed little barometric change, but other conditions were threatening and at 12:30 p. m. northeast storm warnings were hoisted from Tybee Island, Ga., to Morehead City, N. C., and at 3:30 p. m. were extended northward to Coinjock, N. C. Northwest warnings were also displayed at Jacksonville. Late afternoon special reports indicated that the storm center was approaching the coast and at 7 p. m. hurricane warnings were ordered from Tybee Island, Ga., to Georgetown, S. C. By 8 p. m. the barometer at Charleston read 29.62 inches, and the highest wind had been 64 miles an hour from the northeast, with a very high tide. Savannah reported a maximum wind velocity of 38 miles an hour from the northeast, while at Frying Pan Shoals, N. C., 40 miles an hour from the east was reported. This storm center passed inland over or very near Charleston about 4 a. m. of the 14th, with a lowest barometer reading of 29.02 inches. At 8 a. m. the barometer read 29.40 inches and the wind had decreased to 42 miles from the southwest.

As pressure was falling to the north at 8 p. m. July 13, northeast storm warnings were ordered at 10 p. m. from Hatteras, N. C., to Fort Monroe, Va., but as the storm center kept on inland, nothing more than fresh winds occurred, and the warnings were lowered at 9 o'clock on the following morning. At 8 p. m. of the 14th the storm center was over central South Carolina, with a barometer reading of 29.58 inches and with a maximum wind velocity at Columbia of 36 miles an hour from the northeast. At the same observation, Charlotte, N. C., reported a maximum wind velocity of 52 miles from the

east, and another of 56 miles an hour from the east during the night. On the morning of the 15th the remnants of the storm were lost in the mountains of western North Carolina. Strong winds and moderate gales continued at Charleston, S. C., until the night of the 14th-15th.

This is the history of this disturbance so far as it is possible to give it from the Weather Bureau reports available at the time. On July 22 there were received by mail a series of observations from the U. S. S. *Hector*, which was wrecked by the storm, and some notes from the log of the U. S. S. *Terry*, which was also in the vicinity of the storm. It is greatly to be regretted that it was not possible to receive radio reports from these vessels on July 11 and 12, as only two reports were received from merchant vessels, one each on July 12 and 13, both south of latitude 28° N. The observational data from the *Hector* and the notes from the *Terry* follow.

TABLE 1.—*Meteorological observations taken on board U. S. S. Hector during July 12 to 14, 1916.*

Date.	Hour.	Ship's position.		Wind.		Barom-eter. <sup>1</sup>	Ther-mom-eter.	Weather. <sup>2</sup>
		Latitude N.	Longitude W.	Direction.	Force.			
July 12, 1916.	P. M.	° /	° /			Inches.	° F.	
12.....	4:00	32 38	79 42	n. by e.	4	30.02	84	bc
12.....	6:00	32 21	79 30	e. by n.	3	29.99	84	bc
12.....	8:00	32 07	79 21	e. by n.	5	29.99	84	bc
12.....	10:00	31 55	79 13	e.	5	29.96	84	bcq
12.....	12:00	31 46	79 07	e.	5	29.88	82	bcqg
13.....	A. M.							
13.....	2:00	31 37	79 02	ese.	7	29.80	80	ocr
13.....	4:00	31 35	79 01	ese.	8	29.70	82	ocr
13.....	6:00	31 34	79 00	ese.	8	29.61	80	ocr
13.....	8:00	31 34	79 00	e. by n.	10	29.48	79	ocrq
13.....	10:00	31 38	78 58	ne.	12	29.20	77	ocrq
13.....	Noon.	31 41	78 56	ne.	12	28.72	79	ocrq
13.....	P. M.							
13.....	2:00	31 43	78 55	ne.	12	28.60	78	ocrq
13.....	3:30	31 45	78 53	e. by n.	12	28.30	77	ocrq
13.....	4:00	31 46	78 53	e. by n.	12	28.40	77	ocrq
13.....	6:00	31 48	78 52	e.	12	28.50	77	ocrq
13.....	8:00	31 51	78 50	e.	12	28.60	78	ocrq
13.....	10:00	31 54	78 49	se.	12	28.75	78	ocrq
13.....	12:00	32 03	78 48	s.	12	29.02	78	ocrq
14.....	A. M.							
14.....	2:00	32 11	78 55	s.	10	29.10	79	ocrq
14.....	4:00	32 16	79 01	ssw.	10	29.30	79	ocrq
14.....	6:00	32 22	79 09	sw.	9	29.40	80	ocrq
14.....	8:00	32 31	79 08	sw.	9	29.66	80	ocrq
14.....	10:00	32 40	79 07	sw.	8	29.70	80	ocrq
14.....	Noon.	32 50	79 06	sw.	7	29.74	80	oo

<sup>1</sup> Aneroid barometer reads 0.07 inch too low.

<sup>2</sup> b, clear blue sky; c, cloudy weather; q, squally weather; o, overcast; r, rainy weather or continuous rain; g, gloomy or dark.

*Log of the Terry.*—The following data were taken from the log of the *Terry*; barometer readings were taken by an aneroid and are probably a little too high; error unknown.

July 11, 8 p. m.: Position, latitude 26° 06', longitude 79° 35'. Calm; long rolling sea from the eastward; barometer steady, 30.19.

July 12, noon: Position, latitude 29° 01', longitude 79° 33'. Commenced to breeze up in the afternoon, wind increasing to force 8. Barometer dropped from 30.12 at noon to 30.01 at midnight; wind northeast, wind waves making up; heavy cross sea from the eastward.

July 13, noon: Position, 50 miles south of Charleston Lightship. A. m., wind increased to force 10, north by east to north-northeast. Barometer dropped to 29.85.

P. m., wind north-northeast., increased to force 12.

7 p. m., wind north, force 12, barometer 29.66.

9 p. m., wind northwest, force 12, barometer 29.58.

Midnight wind, northwest, force 12, barometer 29.51.

July 14, 1 a. m.: wind west, force 10, barometer 29.50.

2 a. m., wind west, force 10, barometer 29.49. Position, 10 miles east of Hunting Island Light.

4 a. m., wind northwest, force 6, barometer 29.44.

6 a. m., wind southwest, force 10, barometer 29.45. Position, 6 miles south of Charleston Lightship.

July 14, 8 a. m., wind southwest, force 11, barometer 29.61.  
 10 a. m., wind south-southwest, force 10, barometer 29.64.  
 12 noon, wind south-southwest, force 9, barometer 29.85.  
 2 p. m., wind southwest, force 5, barometer 29.89.  
 4 p. m., wind south, force 5, barometer 29.88.  
 6 p. m., wind south by east, force 7, barometer 29.95.  
 8 p. m., wind south by east, force 7, barometer 29.99.  
 10 p. m., wind southeast, force 10, barometer 30.03.  
 12 midnight, wind south, force 8, barometer 30.07.  
 July 15, 2 a. m.: wind south-southeast, force 5, barometer 30.11.  
 4 a. m., wind south by east, force 5, barometer 30.12.  
 6 a. m., wind south, force 5, barometer 30.15.  
 8 a. m., wind south, force 5, barometer 30.17.

*The tropical storm of July 12-22, 1916.*

The first indication of this disturbance was a marked fall in pressure over the Windward Islands during the 24 hours ending at 8 a. m. of July 12. Light southeast winds were blowing from St. Kitts to Port of Spain, with an average pressure of 29.90 inches, while at San Juan, P. R., the barometer read 29.96 inches with a fresh northeast wind. During the five succeeding days this storm center moved slowly northwestward and apparently was of but moderate intensity; on the morning of the 17th it was central at approximately latitude 23° N., longitude 73° W., with a northward tendency. Advisory warnings regarding the storm were first issued on the morning of July 12 and one or more each day thereafter until the evening of the 18th, when the storm center was about at latitude 30° N., longitude 74° W., with a northward movement. Northeast storm warnings were then ordered from Wilmington, N. C., to Delaware Breakwater, and on the following morning were extended to Boston, the storm center being then at about latitude 33° N., longitude 74° W. Radio messages from vessels had shown strong gales, and during the 19th moderate gales occurred on the North Carolina coast and at the Virginia Capes. On the evening of the 19th the northeast storm warnings were continued from Hatteras, N. C., to Delaware Breakwater (except at Baltimore), and on the morning of the 20th northward to Boston, at which time the storm was apparently central at latitude 37° N., longitude 74° W., with a tendency toward a slight curve to the northeastward. No radio reports were received from that vicinity during the 20th, but strong northerly winds prevailed along the coast as far as New York. On the morning of the 21st the storm was central south of and very near the New England coast; the barometer reading this day of 29.38 inches at Block Island, R. I., was the lowest reported reading during the storm. Moderate easterly gales had extended as far north as Nantucket, Mass., and northeast warnings were ordered at all display points north of Boston. At the same time the warnings south of Boston were changed to northwest. The storm continued northeastward with diminishing intensity and without strong winds north of Massachusetts. By the morning of the 22d this storm had passed into Newfoundland.

Neither storm nor small-craft warnings were displayed during the month on the Great Lakes.

DISTRICT WARNINGS DURING JULY.

*Chicago District.*—No frost warnings were issued or required during the month. Fire-weather warnings were issued for South Dakota and Wyoming on the 3d.—*Chas. L. Mitchell, Assistant Forecaster.*

*Denver District.*—No special warnings were issued during the month.—*Frederick H. Brandenburg, District Forecaster.*

*New Orleans District.*—The hurricane of July 5, the western segment of which passed over southeastern Louisiana, was the only storm that occurred in this district during the month. Warnings of this hurricane were timely and the effective distribution of the same prevented the loss of property and probably loss of life. Small-craft warnings were ordered for the Texas coast on the 30th, on account of unsettled conditions in that region. All warnings were justified and no storm occurred without warnings.—*I. M. Cline, District Forecaster.*

*Portland, Oreg., District.*—In this district July is normally a pleasant month, but this year the portion of the North Pacific seasonal high-pressure area, touching and at times overlapping the North Pacific coast, was generally so far south that a southerly gradient obtained and local showers in western Oregon and particularly Washington were of frequent occurrence. The total monthly precipitation recorded at Portland exceeded the previous July record by 0.29 inch. Local showers fell east of the Cascade Mountains during the first week and near the middle of the month.

Only one special warning was issued during the month, giving information to alfalfa interests. This was sent out on the morning of the 11th and stated:

Favorable weather alfalfa harvest, indicated Wednesday, Thursday, and probably Friday.

This warning might well have been issued a day earlier, but the probable southeastward movement of the moderate disturbance that was central near Sitka on the afternoon of the 9th gave indication of coming unsettled weather conditions, and this was apparently confirmed by the decreasing pressure noted on the morning of the 10th along the North Pacific coast. The warning was, therefore issued at a time when the pressure was decreasing and an aneroid barometer in the hands of farmers might cause some apprehension as to probable coming weather conditions. Normal July weather in the alfalfa districts is favorable for harvesting operations, hence information of expected stormy periods, or of favorable weather when local signs seem to indicate a change, is of real value to the alfalfa grower. Although in this instance thundershowers occurred on the night of the 12th (Wednesday) in extreme eastern Washington and adjoining portions of Idaho, the amounts of precipitation falling in alfalfa sections were slight and no reported damage resulted. The warning was therefore a success.—*T. Francis Drake, Local Forecaster.*

*San Francisco District.*—No important warnings were issued in this district during the month.

The Forest Service was warned of warmer weather with drying northerly winds and conditions favorable for forest fires on the 10th, 11th, and from the 17th to the 23d. Subsequent conditions showed that the warnings were timely.—*G. H. Willson, District Forecaster.*

*A special chart, showing hurricane tracks for the season of 1916 will appear in the December issue of the Review.*