

afternoon and night. There were no higher wind velocities during the month and no storm warnings were issued.—*R. A. Dyke.*

Denver district.—The month was notably free from general or severe frosts. A warning of heavy frost for parts of eastern Colorado was issued on the 14th and warnings of light frost for parts of the district were issued on the 11th, 12th, 14th, 15th, 23d, 26th to 29th, inclusive.

On the morning of the 11th high pressure overlay Wyoming and the Great Basin, while low pressure prevailed in New Mexico and adjacent regions. Frost warnings were issued for Utah, northern Arizona, and northern and western Colorado. The front of the high-pressure area moved southeastward as expected, causing light frosts over the greater part of the area, with freezing temperatures in a few localities in the fruit districts of western Colorado. On the 12th warning of local frost in northern New Mexico was included in the regular forecast; it is probable that light frost occurred in the high districts. An area of high pressure overlay the northeastern Rocky Mountain slope on the morning of the 14th; its movement was southeastward, causing frosts in eastern Colorado and northeastern New Mexico, part of the area for which warnings had been issued. On the 23d frost was predicted for the high districts of Utah and was probably verified as the skies cleared. On the 26th a barometric trough extended from Arizona northeastward to Lake Superior, while high pressure overlay Oregon with the front of the high extending along the west side of the Continental Divide. Warnings of frost were issued for Utah, northern Arizona, western and northern Colorado, and northern New Mexico. Frosts occurred in parts of Utah, in northern Arizona, northwestern New Mexico, and locally in the fruit districts of western Colorado. In this case the warnings were somewhat premature, as the high did not continue southeastward but moved first north then east to Montana and thence southeastward on the east side of the Continental Divide. Warnings of frost were repeated on the 27th for Utah, Colorado, and northern New Mexico; they were fully verified in northeastern Colorado and locally in the rest of Colorado and Utah. Eastern Colorado, and northern and eastern New Mexico were still under the domination of the high on the morning of the 28th and warnings of frost were issued for these districts and were verified except in extreme southeastern New Mexico. The warning of the 29th for local frost in northern and eastern Colorado was verified only in a few localities, as the area came quickly under the influence of a northern low.—*F. H. Brandenburg.*

Portland district.—Normally quiet weather obtained during September over this district. The mean temperatures were above normal west of the Cascade Mountains and in northeastern Washington, and correspondingly below normal in the remainder of the district. Less than half of the usual rainfall occurred, and most of this fell during the first week. On this account there was a greater fire hazard than during August, and general fire weather warnings were issued on the 13th, 16th, and 20th, being disseminated by telegraph, telegram, and post card as usual. The forest fire patrols at the close of the month were still on duty in southern and eastern Oregon, eastern Washington, and Idaho.

No storm or small-craft warnings were issued, although they would have been justified on the 14th, when the verifying velocity was reached at Tatoosh Island, and again on the 26th, when similar conditions obtained at Tacoma. Winds of 26 to 36 miles from the northwest occurred on five days at the mouth of the Columbia River during afternoons following atmospheric conditions shown

on the morning maps that would hardly have justified the sending out of small-craft warnings. These high winds were largely local in character, and it is believed no damage resulted.

Frost warnings were issued on six dates, of which three were verified, two were partially verified, and one was a failure. There were three dates on which light frost formed in limited areas for which no warning had been issued.

On the 1st low pressure obtained over the Pacific slope, with high pressure east of the Rocky Mountains. On the 2d the northwestern "low" crossed the northern Rockies and was followed to the northern California coast by a high-pressure area, causing rains throughout most of this district. Similar conditions prevailed on the 7th, 8th, and 9th; on the last date a high-pressure area began to overspread the north Pacific slope, and generally fair weather followed until a strong high-pressure area on the 24th reached the Oregon-northern-California coast, while the pressure over British Columbia was low, resulting in southerly winds and rains on the following two days. This high subsequently moved northward and a portion moved inland, becoming the strong eastern high of the latter part of the month, while generally fair weather prevailed over the Northwest.—*T. F. Drake.*

San Francisco district.—Light showers fell on the extreme north coast on the 1st and 2d, extending south of San Francisco Bay on the 3d; with this exception the weather was fair and pleasant until the 21st, when a trough developed rapidly over the interior of California and the Plateau, giving light but general rains in northern California and Nevada that night. Warnings were issued to the fruit sections at 11 a. m. on the 21st, and the drying fruit and raisins were covered, and but little if any damage resulted.

A low area moving eastward over Saskatchewan on the morning of the 29th caused the rapid development of a secondary depression over northern California, and rain warnings were issued at noon covering California and Nevada. These warnings were continued during the remainder of the month. Rain fell generally in the district, beginning during the night of the 29th–30th, and continuing. Drying fruit and raisins were covered, and but little damage resulted where wooden trays were used, but raisins on paper trays, unpicked grapes, and beans that had been cut were damaged.—*G. H. Willson.*

HURRICANE TRACKS, 1912-1915.

By RICHARD HANSON WEIGHTMAN, Meteorologist.

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

Steps have been taken to extend the field of the Weather Bureau service in the West Indies and adjacent waters and at the same time to more completely equip the existing individual stations, as well as to secure two daily observations instead of the single daily report sent at present. This action was inaugurated primarily because the opening of the Panama Canal naturally resulted in an increased use of West Indian and contiguous waters as routes for trading vessels and, as a corollary, in the increased importance of meteorological observations and data pertaining to this area not only for climatological but for forecast purposes as well. The most important atmospheric phenomena with which commerce is concerned in these regions are the hurricanes or destructive storms which appear most frequently during the months of August, September, and October, about 90 per cent occurring in these months. In forecasting the move-

ment and intensity of a hurricane, two things are of foremost import: First, that there be available well-distributed observations daily, or twice daily, if possible, in order to enable the forecaster to locate accurately the center of the disturbance and, second, that there be at his disposal for ready references the previous history of all hurricanes, and more particularly accurate tracks of the same. It is only by an intensive study of the past behavior of such storms that a closer knowledge and better understanding of them may be gained, thereby better enabling the forecaster to anticipate their intensity and direction of movement. To this end it is the intention of the Bureau to bring up to date the charts given by Fassig in Weather Bureau Bulletin X, showing tracks of hurricanes for the period 1876 to 1911, inclusive.

Chart No. X (XLIV—121) shows the tracks of important hurricanes that have occurred in the West Indies and adjacent waters during the period 1912—1915, inclusive. The tracks for the present year will appear in the December, 1916, issue, and in subsequent years the tracks for the current year will appear in the December number of the REVIEW for that year. This will allow sufficient time to elapse between the occurrence of the storm and the publication of its track, so that all reports giving details of the hurricane may be received at the Central Office. It is believed that this scheme will result in the preservation of an accurate record of the tracks of these destructive storms of the Antilles that will be available to all persons and on which may be based any future study or discussion of the same.

To this end it is earnestly requested that any data bearing on the history of these disturbances be forwarded to the Central Office at Washington. Such information is particularly desired from vessels at sea.

FURTHER DATA ON THE TROPICAL STORM OF JULY 12-22, 1916.

By Prof. H. C. FRANKENFIELD.

[Dated: Weather Bureau, Washington, Oct. 13, 1916.]

The following report sheds some additional light on the behavior of the tropical storm of July 12-22, 1916, a brief account of which was published in the MONTHLY WEATHER REVIEW for that month. The report was prepared by Mr. T. Edelenborsch, second officer of the steamship *Ausable*, who made the observations, and is published in the MONTHLY WEATHER REVIEW in order that the record may be made as complete as possible.

The report has been edited slightly, and the metric barometer readings converted into inches:

SAN JUAN, P. R., July 23, 1916.

To the CHIEF, U. S. Weather Bureau,
Washington, D. C., U. S. A.

SIR: Sailed at 10:15 a. m., July 16, 1916, from Norfolk, Va., bound for Porto Rico to load bunker coal.

Met at first fresh southeasterly breezes with cloudy sky (the greater part cumulus). At 8 p. m. the wind became more southerly and during the watch from midnight till 4 a. m. it was calm with clear sky. In the forenoon of the 17th the wind became more southerly, with a force of 2 (Beaufort scale). It now became cloudy (cumulus and cumulo-nimbus). The barometer was observed continually, as we had read in the newspapers about a hurricane that had passed Porto Rico on July 12.

The average barometric pressure was 30.04 inches, and the temperatures were not out of the ordinary.

In the afternoon of the 17th the wind increased and shifted after 4 p. m. to east-southeast, increasing until a force of 6 was reached, while the sea became more turbulent. The barometer fell a little to 29.92 inches. The daily amplitude was normal. During the watch from midnight till 4 a. m. of the 18th the wind shifted to northeast, increasing to a force of 7, the barometer fell to 29.90 inches, the sea became more turbulent. A swell started from south-southeast with passing showers. After 4 a. m. it started to rain, while the wind increased after 8 a. m. to a force of 8 and 9. The barometer at 8 a. m. read 29.86 inches, and the wind shifted to north-northeast. The barometer fell to 29.76 inches at 11 a. m. and to 29.72 at noon, and the sea was very high with overcast sky. In the afternoon the wind shifted to east-northeast, increasing to a force of 10, with heavy rainfall, dirty sky, and a very high and turbulent sea. At 1 p. m. the barometer read 29.65 inches, at 2 p. m. 29.61 inches, and at 4 p. m. 29.53 inches. During the watch from 4 p. m. to 8 p. m. the wind became more easterly, and at 8 p. m. the barometer read 29.49 inches. After 8 p. m. the wind became more east-southeasterly with a force of 10; very high and turbulent sea, heavy rain squalls with hard sky. The barometer at midnight read 29.28 inches. After this the wind increased to a force of 11 and 12, while the barometer was falling rapidly. The wind continued east-southeasterly until the ship was in the center of the hurricane, when the barometer read 28.94 inches. Heavy rain squalls. Here the seas came from all directions. About 2 a. m. of the 19th the wind went down to force 5 and hauled to southwest through south, increasing from 3 a. m.; the rain stopped and the sky cleared a little. During the heaviest wind there was a high, regular sea from east-southeast; nearing the center it became irregular, but all the time, and throughout the entire storm field, we experienced a high swell from south-southeast. After 4 a. m. the wind became more southwesterly and decreased a little. Very heavy rain squalls with phenomenal sea and overcast sky. The barometer rose, and at 8 a. m. read 29.41 inches. During the whole day the wind blew principally from southwest with a force of 9. The barometer rose continually and at 11 a. m. read 29.57 inches, at noon 29.61 inches, at 4 p. m. 29.68 inches, at 8 p. m. 29.78 inches, and at midnight 29.82 inches. There was a very high and irregular sea with high swell, and further very heavy rain squalls with overcast sky. On the following day (20th) the barometer rose steadily, the wind decreased and became more westerly, and on the morning of the 21st shifted gradually to the east, after which the usual trade wind was met. During July 20 there were still heavy rain squalls with more or less covered sky and southwest and northeast swells. When the sky cleared in the afternoon of the 20th cirrus appeared with the radiation point bearing northwest, on the morning of the 21st north, and during the remainder of the day and also on the 22d north-northeast and northeast, the sky becoming free of cirrus during the afternoon of the 22d.

Barometer readings on July 20 were as follows: 4 a. m. 29.95 inches, 5 a. m. 29.96 inches, 8 a. m. 30.04 inches, noon 30.08 inches, 4 p. m. 30.08 inches, 8 p. m. 30.12 inches, midnight 30.16 inches.

Owing to the high sea and swell it was impossible to make any speed, and we met the hurricane at about 32° 30' north latitude and 73° west longitude.