

TROPICAL DISTURBANCES DURING THE HURRICANE SEASON OF 1923.

By W. P. DAY.

The word "hurricane" comes from a Carib word meaning "a high wind." But meteorologically it is now associated with the small, intense cyclones which occur in this region and are responsible for the really destructive winds. Fortunately, a great many tropical disturbances do not develop these characteristics; but it is often difficult to decide from available reports whether any particular disturbance originating over warm waters carries with it the central core of low barometer, which writes a typical hurricane trace on the barograph.

The first disturbance showing characteristics of a hurricane was noted on the morning of September 5 near latitude 36° N. and longitude 61° W., the S. S. *Evergreen City* reporting a pressure of 29.32 inches with force 10 (Beaufort wind scale) from the northeast. The storm appeared to be of small diameter, forming a small part of a larger depression or trough of low pressure extending northeast from Bermuda. Previously a rather ill-defined depression had been traced as it recurved around Bermuda; but it was not until the 5th that either low barometer or high wind was detected. Meanwhile, a high-pressure area had obtruded itself into the path of the storm and its direction of motion was changed from northeast to north-northwest and greatly retarded. The center of the storm was again noted on the morning of the 9th as it crossed the steamer lanes near latitude 41° N and longitude $58^{\circ} 30'$ W, the S. S. *Emergency Aid* recording a pressure of 29.20 inches at 3 p. m. with a wind force of 10 from the south. The storm was now under the influence of a low moving along the northern border and, being caught in its attendant upper currents, was carried rapidly north-northeast, but with diminishing intensity over, the colder waters of the Labrador Current.

The next disturbance also developed north of the Tropics but well within the Gulf Stream, and was first noted to be of hurricane intensity when the S. S. *Emergency Aid*, which had encountered the previous storm farther northeast, recorded a pressure of 29.42 inches and winds as high as force 11, on the morning of September 12, near latitude 36° N. and longitude $64^{\circ} 30'$ W. This storm was carried northeast much more rapidly than the preceding one and by 4 p. m. was near latitude 42° N. and longitude 60° W., the S. S. *City of St. Joseph* recording a pressure of 29.11 inches and wind force 12 from the northwest. Like its predecessor, it showed a marked loss of intensity upon striking colder water and there was but little indication of it on the following morning.

During September 23 unsettled conditions were noted to the southeast of Turks Island, the barometer falling slowly and wind shifts indicating the presence of a disturbance, which was more definitely located on the morning of the 25th, when the S. S. *Tulsa* reported a wind force of 10 from the northeast, pressure 29.86 inches, in latitude $23^{\circ} 40'$ N and longitude 74° W. The storm was moving northwest at this time and passed just east of Nassau, Bahamas, on the 26th, the morning barometer reading 29.54 inches and wind 40 m. p. h. from the northwest. However, a large high-pressure area was now blocking its forward motion and the storm, though not diverted from its recurve to the northeast, showed very little movement during the next two or three days, but gradually increased its area of influence and its intensity with winds of gale force over a large area and wind force as high as 11 reported by vessels which approached its center. It was not until the morning of the 29th that the eastward movement of

the HIGH allowed a strengthening of the southwest drift aloft and a corresponding acceleration in the northeastward movement of the storm. The hurricane was now near latitude $31^{\circ} 30' N.$ and longitude 73° with lowest pressure somewhat below 29 inches. The following morning the S. S. *Collegian* recorded the passage of the center of the storm in latitude $33^{\circ} 20' N.$ and longitude $69^{\circ} W.$ with lowest barometer reading, 28.62 inches. The S. S. *Maraval* near by recorded a pressure of 28.98 inches with a shift of wind from east-southeast through north to northwest and a wind force of 12. At 2 a. m. the following morning (October 1) the S. S. *West Cobalt* reported passing through the storm near latitude $41^{\circ} 30' N.$ and longitude $59^{\circ} W.$ with lowest barometer 28.50 inches and wind force of 12. A little farther north the *Saxoleine* recorded a pressure of 28.59 inches at 10 a. m., the wind backing from south to east to north around to west-southwest. Turning northward to western Newfoundland, the hurricane lost intensity over colder water.

The next disturbance of this nature apparently originated in low latitudes off the Pacific coast of Guatemala and was central on the morning of the 13th of October southeast of the Mexican Pacific port of Salina Cruz on the Gulf of Tehuantepec. It moved rapidly northward across the Isthmus of Tehuantepec and the western Gulf of Mexico and was encountered by the steamships *Corning* and *El Siglo* during the evening of the 15th near latitude $27^{\circ} 30' N.$ and longitude $92^{\circ} W.$ By the following morning it had crossed the Louisiana coast and was central near Vicksburg, Miss., with a pressure of 29.26 inches; and during the night of the 16th dissipated over

Arkansas and southern Missouri. The contour of the isobars was considerably distorted from the ideal by a strong pressure gradient from northeast to southwest over the United States, which tended to squeeze the isobars together on the northeast quarter of the storm and throw them wide apart to the southwest. The closing up of the isobars was especially effective in the vicinity of Pensacola, Fla., which was about 250 miles from the path of the center but recorded the highest wind velocity (64 miles from the southeast) of any land station. The storm in general lacked the intensity near the center that we normally expect of a true hurricane.

Meanwhile, a disturbance became apparent just north of the Leeward Islands and began to move north-northeastward; but with the strengthening of a large high-pressure area to the north and northeast, the storm was slowed up and deflected to the northwest. It passed just northeast of Bermuda on the 17th and crossed the Atlantic coast near Nantucket, Mass., on the night of October 18th and was still in evidence near Boston the following morning. This storm lacked the intensity necessary to be classed as a hurricane, but the shape and distribution of the isobars showed a close resemblance to this type.

The severe storm of the 22d-25th of October, which developed north of the Bahamas and moved northward to Hatteras and thence north-northwestward to extreme northwest Pennsylvania, was formed and maintained by the usual processes attending extra-tropical storms and bore no resemblance to a hurricane. (See Chart XIII.)

STORMS AND WEATHER WARNINGS.

WASHINGTON FORECAST DISTRICT.

By EDWARD H. BOWIE, Supervising Forecaster.

At the beginning of the month the storm reported during the closing days of August as having formed to the eastward of the island of St. Martin, West Indies, was moving northwestward and on the 2d and 3d it produced strong winds and considerable rainfall in the vicinity of Bermuda. Its center apparently passed northward immediately west of Bermuda and thence its course was to the northeast, but being unable to continue to move northeast against the current flowing from an area of high barometric pressure to the northward it changed its course to the westward and finally again to the northward, so that on the 9th the center of the disturbance was south of Sable Island, from which position it moved northward to Newfoundland. Shipping was kept advised by means of radio as to the presence and movement of the disturbance.

During the 14th another disturbance but of extratropical origin formed off the coast between Cape Hatteras and Bermuda and moving northeastward increased greatly in intensity, passing beyond Newfoundland on the 19th. As in the former instance shipping was well advised by radio concerning the movement and intensity of this disturbance.

Following this disturbance the weather off our eastern and southern coasts remained relatively tranquil until the 25th, when reports by cable from the West Indies and radio reports from vessels at sea gave unmistakable indications of the forming of a disturbance northwest of Haiti. Based on the observations received at 8 p. m. of the 25th, the following advice was issued to ports and for broadcast by radio:

Disturbance apparently over Old Bahama Channel will move west-northwest and increase in intensity. Vessels in Bahaman waters and Florida Straits should exercise every precaution.

As forecast, this disturbance advanced west-northwestward and the morning of the 26th its center was near and southeast of Nassau, Bahamas, where the pressure was 29.54 inches, the wind northwest 40 miles, and the weather raining. Continuing to advance slowly, this disturbance moved northwestward during the next 24 hours

and then its course changed to north and northeastward and by 8 a. m. of the 28th its center was in approximately lat. 32° N. and long. 75° W. and moving northeast. During the following 24 hours this disturbance moved eastward and during the night of the 29th its course changed to northeast and on the morning of the 30th its center was near lat. 33° N. and long. 69° W. From this position its course was north-northeastward, and on October 2 its center passed over Newfoundland.

This disturbance was one of great intensity and very low level of the barometer. The lowest pressure reported was approximately 28.50 inches, while several vessels reported winds of hurricane force. Because of its having been detected in the process of formation and its path and intensity having been accurately described in special advices by radio to vessels at sea, minimum amount of damage was done to shipping. Moreover, since the center of the disturbance did not reach the coastal line, no extraordinary wind and weather conditions were recorded at land stations. Nevertheless, and to guard against vessels in port putting out to sea, storm warnings were displayed on the Atlantic coast in connection with this storm at all points at and south of the Virginia Capes, and on the afternoon of the 26th when the disturbance was moving northwestward and its center near Nassau, hurricane warnings were displayed along the coast at and between Savannah, Ga. and Jupiter Inlet, Fla.; but the following morning when observations showed that the disturbance would move northward, these hurricane warnings were lowered and northeast storm warnings substituted.

That the advices issued were greatly appreciated and of direct benefit to shipping off the Atlantic coast, the following extracts from letters received will attest. These letters were addressed to the New York office of the Weather Bureau. They follow.

From the general manager, marine department of the United Fruit Co. (dated October 9, 1923):

I wish to thank you, on behalf of the United Fruit Co., for the service which you rendered us during the recent hurricane. Your various reports and the information submitted by you were greatly appreciated by all concerned. (Signed) Asa F. Davison.

From the manager of the marine department, Standard Oil Co. of New Jersey (dated September 26, 1923):

I wish to thank you for your telephone advice of this noon that a hurricane is central this morning near Nassau, moving northwest, across

the track of ships to and from Gulf ports, which timely information is very much appreciated. (Signed) Robert L. Hague.

From the port captain (New York) of the Pan-American & Transport Co. (dated October 1, 1923):

I always feel when valuable service is rendered gratuitously that it is the least reward one can do is to show his appreciation. We certainly appreciate prompt reports from you giving us details of last week's hurricane; having ships in its track we were naturally anxious. We have since heard from them that by receiving weather reports enabled them to steer clear of the hurricane track. Thanking you for past performances and trusting for future assistance, etc. (Signed) H. A. Henshaw.

From the manager, Southern Pacific Co. (dated October 1, 1923):

While I have never had the pleasure of personally meeting you, I recall having received many communications from you with reference to weather conditions on the coast, which have been invaluable to our outgoing ships, as well as ships that were at sea and could be reached by wireless, in advising them of weather conditions they might expect to encounter. I consider the Weather Bureau and the service which it renders of inestimable value to shipping and want to thank you for keeping us informed of storm conditions on the coast, and hope you will continue to do so in the interest of coastwise shipping. (Signed) C. W. Jungen.

From the captain of the *Southern Cross*, a press report dated October 7, 1923, en route from Buenos Aires to New York:

"That we came through it [the hurricane] without serious trouble," the skipper said, "I attribute to the radio warnings sent from New York (?) by the Weather Bureau. The bureau let us know what to expect, and acting upon this advice, we skirted the rim of the biggest blow I have seen in all my experience. (St. Louis Post Dispatch.)

The track of this hurricane and reports from vessels encountering it will be found elsewhere in this number of the REVIEW.

On several days during the month frost warnings were required for the northern part of the Washington forecast district, and these were issued as occasion demanded.

STORMS AND WEATHER WARNINGS.

WASHINGTON FORECAST DISTRICT.

The weather conditions over the States east of the Mississippi River during the first two weeks of the month were dominated practically the entire time by an area of high pressure of great magnitude that moved very slowly southeastward from Manitoba to the Atlantic States. However, after the 9th pressure gradually decreased over the western Caribbean Sea, Mexico, and the southwestern Gulf of Mexico and there were torrential rains in portions of Mexico. At Acapulco, over 19 inches of rain fell within six days. By the 14th the barometer was falling slowly along the Texas coast, and on the morning of the 15th a disturbance of moderate intensity extended all the way from Vera Cruz and Frontera, Mexico, northward over the western Gulf of Mexico to the Texas and Louisiana coasts, with the center apparently some distance east of the mouth of the Rio Grande. This disturbance, in connection with the area of high pressure over the eastern States, produced a rather steep pressure gradient, so that small-craft warnings were ordered displayed along the Mississippi, Alabama, and northwestern Florida coasts at 10 a. m. At 12:30 p. m. the district forecaster at New Orleans ordered southeast storm warnings on the Louisiana coast and northeast warnings on the Texas coast.

The regular evening reports from the stations along the Gulf coast showed that the disturbance had increased considerably in intensity during the day and that it was moving northward toward the Louisiana coast. At 8:45 p. m. the display stations along the east Gulf coast from Bay St. Louis, Miss., to Cedar Keys, Fla., were ordered to hoist northeast storm warnings at 9:30 p. m. Shortly after this order was telegraphed to the stations concerned, radio reports were received from the S. S. *El Siglo* in lat. 28° 20' N., long. 92° W., and from the S. S. *Corning* in lat. 27° 20' N., long. 91° 30' W., indicating that the storm had developed hurricane intensity. The former reported a barometer reading of 29.22 inches and a wind velocity of 74 miles an hour from the east, and the latter a barometer reading of 29.18 inches and a wind velocity of 64 miles an hour from the east, with a two-hour pressure fall of 0.20 inch. As soon as these extremely important and timely vessel reports were charted and the storm center located at about lat. 27° N., long. 92° W., hurricane warnings were ordered displayed at 10 p. m. along the Louisiana, Mississippi, Alabama, and extreme northwestern Florida coasts. Ten p. m. and midnight special observations were called for from several of the stations along the Gulf coast, and an advisory

message was issued at 12:45 a. m. of the 16th informing the stations in the area affected that the storm center would likely reach the Louisiana coast not far from Morgan City between 4 and 6 a. m. The lowest pressure noted at Morgan City was 29.25 inches. The hurricane, which was of small diameter and not of great intensity, moved quite rapidly northward and its center was a short distance southwest of Vicksburg, Miss., at 8 a. m., this station reporting a barometer reading of 29.32 inches with a two-hour pressure fall of 0.20 inch and a wind velocity of 32 miles an hour from the southeast.

Extracts from press reports of the storm in the Times-Picayune, New Orleans, are as follows:

PENSACOLA, FLA., Oct. 16.—* * * Aside from the dragging of anchors by several tank ships anchored here, damage was confined in the harbor to the beaching of a number of loaded lumber and naval stores barges. Five hundred barrels of rosin were on one barge which went down. An even dozen barges were beached, more than half of them carrying lumber, and cargoes were scattered all along the beach and more or less damaged. * * *

GULFPORT, MISS., Oct. 16.—* * * Shipping in the Gulfport Harbor escaped damage, all the larger vessels remaining safely moored * * * but some of the trawl boats and other small craft which sought refuge in the basin were either sunk or driven on the beach. * * *

The highest wind velocities reported, all from the southeast, were as follows: New Orleans, La., 36 miles an hour; Burrwood, La., 48; Mobile, Ala., 60; and Pensacola, Fla., 64.

Pressure remained quite low over the Gulf of Mexico after the hurricane moved inland, and the barometer again fell over the western Caribbean Sea, and there was evidence that a disturbance was forming between the Island of Jamaica and the Isthmus of Panama. At 5:30 p. m. of the 17th southeast storm warnings were ordered displayed from Bay St. Louis, Miss., to Apalachicola, Fla., as another disturbance was approaching the middle Gulf coast. At 8 p. m. its center was between Mobile and New Orleans, and shortly thereafter a maximum wind velocity of 44 miles an hour from the southeast was registered at Mobile and 56 miles an hour from the southeast at Pensacola. This storm moved rapidly northward to the middle Mississippi Valley, then north-northeastward to the Hudson Bay region.

Over the western Caribbean Sea pressure continued low with some evidence of a slight disturbance central southwest of Jamaica. Following a slight rise in pressure over the western Caribbean Sea, Cuba, and the vicinity of the Bahama Islands on the 20th, the barometer again began to fall over Cuba and the Bahamas region during the 21st, and by the morning of the 22d a disturbance of slight intensity had developed with its center near Nassau, Bahama Islands. At this time there was an area of high pressure of great magnitude overlying all

sections from the Rocky Mountains eastward to the Atlantic coast and there was a steep barometric gradient along the coast from North Carolina northward. At 9:30 a. m. northeast storm warnings were displayed from Cape Hatteras to Boston, Mass. The disturbance increased gradually in intensity and moved almost due northward until it reached Cape Hatteras, after which it moved north-northwestward with slowly diminishing intensity to eastern Lake Erie where it was centered the evening of the 24th. It now recurved and moved northeastward down the St. Lawrence Valley. On the morning of the 23d the northeast warnings were extended northward to Eastport, Me., and southward to Wilmington, N. C. Severe gales prevailed during the 23d between Cape Hatteras and Cape Cod, several stations reporting maximum wind velocities of from 56 to 60 miles an hour, and at Atlantic City, N. J., 82 miles an hour from the northeast was registered.

A disturbance of slight intensity appeared north of St. Thomas, West Indies, on the morning of the 15th and it moved almost directly northward until it reached the vicinity of Bermuda, after which it moved northwestward to Massachusetts, its center passing almost directly over Boston on the morning of the 19th. During the day, this storm dissipated. Storm warnings were displayed from Delaware Breakwater to Eastport, Me., on the 18th when the storm was centered some distance southeast of Nantucket, Mass. The highest wind velocity reported was 48 miles an hour from the northeast at Nantucket.

The last storm warnings of the month were displayed the morning of the 30th in connection with a disturbance that developed suddenly during the preceding night and was central over Lake Erie at 8 a. m. This storm increased considerably in intensity and moved rapidly down the St. Lawrence Valley. The highest wind velocity reported was 44 miles an hour from the southwest at Block Islands, R. I.

Small-craft warnings were displayed on a number of dates, mostly along the south Atlantic and east Gulf coasts, and warnings of strong northerly winds were sent to the Chief Hydrographer, Panama Canal Zone, on the 21st and 25th.

Frost warnings were issued frequently during the month, but were mostly for the northerly sections until the 20th. On the 25th light frost was reported as far south as Mobile, Ala., and Jacksonville, Fla.—*Charles L. Mitchell.*

NEW ORLEANS FORECAST DISTRICT.

Weather conditions during this month were dominated to an unusual degree by anticyclonic areas having marked characteristics.

Three large sluggish areas of high pressure advancing southeastward over the eastern Rocky Mountain slope during October 1-4, 24-26, and 28-31 were attended by much rain in the northwestern portion of the district, the rainfall at Amarillo, Abilene, and Oklahoma City exceeding the previous highest of record for October, mainly because of the heavy rains occurring in connection with these areas of high pressure. In contrast to these remarkable anticyclonic conditions, another area of high pressure, following the movement of a sluggish trough of low pressure over the central districts, dominated conditions from the 18th to the 23d, with clear and frosty weather extending much farther south in the Mississippi Valley than is usual at the season, frost in Louisiana occurring southward to the west coast at times. In the eastern portion of the district the frosty weather was prolonged until the 26th by fresh accession of high pressure from the north while rainy weather prevailed in Oklahoma and northwestern Texas.

Another important feature was the storm that developed in the western portion of the Gulf on the 15th. Special observations were obtained from coast stations, and the Washington office supplied information based on ship reports. The indications favored a northward movement, with increasing winds, and storm warnings were issued accordingly at 12:30 p. m., southeast storm warnings for the Louisiana coast and northeast warnings for the Texas coast. On the Louisiana coast the storm warnings were replaced at 10 p. m. by hurricane warnings ordered from Washington and lowered the next morning after the storm passed inland.

The storm center reached the coast at about 1 a. m. on the 16th, near longitude $91^{\circ} 30'$ west, slightly west of Morgan City, La., and moved rapidly northward over Louisiana, without apparent change in lowest barometer until after reaching the vicinity of Vicksburg at 7 a. m. Reports of aneroid barometers, after comparison with standard instruments, show a lowest reading of 29.25 inches at Morgan City at 1:20 a. m. to 2:45 a. m. The wind reached a velocity of 49 miles an hour at Burrwood. The velocity of 40 miles an hour was observed at Morgan City on an anemometer without continuous record, but

equipped with a push-button indicator. Verifying velocity for storm warnings* occurred as far west as Galveston.

On the coast south of Morgan City, with tide about 3 feet above normal, wind and waves carried two empty barges to land, leaving them stranded as the water receded, causing loss of their use in transportation of shells until they could be refloated. Other damage on the Louisiana coast, aside from the blowing down of telegraph and telephone wires, was slight. Extensive distribution was given to all warnings.

Within a long trough of low pressure extending from Canada to the Caribbean Sea, a minor disturbance developed on the 17th, following a course just slightly east of the preceding storm. Northeast storm warnings were ordered for the Louisiana Coast at 1:30 p. m.; but the disturbance had only slight effect on the Louisiana coast, the higher winds being to the eastward. The storm warnings were ordered down at 9 p. m. but with caution for small vessels proceeding eastward.

Small-craft warnings were displayed on the Louisiana coast on the 8th and 9th because of strong barometric gradient on the southern side of an area of high pressure crested over the Ohio Valley. On the 9th the warning was changed to northeast storm warning. Small-craft warnings were displayed on the west coast of Texas on the afternoon of the 13th and on the entire Texas coast on the 18th.

Frost warnings were issued on the 13th, 14th, 17th, 18th, 19th, 20th, 21st, 22d, 23d, 24th, 25th, 26th, 29th, and 31st, for portions of the district. Owing to slow clearing frost did not occur as forecast on the first two dates but generally occurred as predicted thereafter. Cold-wave warnings were issued for the northwestern portion of the district at night on the 29th and were extended the following morning over the northeastern and central portions of the district. Temperatures of freezing, or slightly higher, occurred in the northern portion of the district.

Fire-weather warnings were sent to the State forester of Texas on the 13th and 30th, particularly for increase in the velocity of northerly winds. Conditions prevailed as predicted.

Special forecasts were issued for the State Fair at Shreveport, October 18 to 28, and weather occurred as forecast.—*R. A. Dyke.*