Storm tides and waves are the agents of greatest destruction in tropical storms and as this storm came in at low tide the damage along the coast was not so great as it would have been if the storm had moved inland in the forenoon.

Damage was confined mainly to railroad, telegraph, and telephone systems, the losses sustained by these interests being estimated at $750,000. The tides and waves washed out the Louisville & Nashville Railroad bridge at Chef Menteur and damaged the roadbed in other places to such an extent that it was about ten days before train service could be resumed. The telephone company reported 2,500 telephones out of commission in New Orleans and a little more than one third of the long distance system was put out of commission. The telegraph service west and north was badly crippled. The telephone and telegraph services were restored promptly. Damage to rice and sugar cane was confined mainly to Terrebonne, Lafourche, Plaquemine, and Jefferson Parishes. The total damage to crops is estimated at about $700,000. Only one death was reported and that as a result of an electric wire which had been broken down by the wind at New Orleans.

The fact that not a sea-going vessel was lost in the storm and only one life is reported lost shows the great value of the warnings and the effectiveness of their distribution.

NOTE.—Full reports of cloud observations, barometer readings, and remarks of cooperative observers can be seen on the original manuscript on file in the Central Office of the Weather Bureau, Washington, D. C.

TROPICAL STORM, SEPT. 29–30, 1920.

By ALEXANDER J. MITCHELL, Meteorologist.

[Weather Bureau, Jacksonville, Fla.]

The existence of the tropical storm of September 29–30, was first announced by the Central Office on September 27. (See pp. 544–545, below.) At the time reports from coast stations were rather indefinite, except that the wind direction may have been an affirmative factor.

Minus pressure changes became more significant on the 28th, and on the 29th they were conclusive as to the future direction of the disturbance. The rainfall increased on the lower coast of the section on the 28th, becoming heavy and general in the west-central portion of the peninsula on the 29th, on which date minus pressure changes were confined to South Atlantic districts and the immediate Gulf coast from Louisiana eastward. The western anticyclone, but feebly felt in the west Gulf States on the 28th, had, by the 29th, increased in magnitude and was rapidly pushing east and south, thus adding celerity to the northeast movement of the disturbance, as was indicated by the forecaster in his early advisory messages regarding the probable course of the storm.

The configuration of the isohyets and the 24-hour rainfall show the approximate path of the storm to have been from near Cedar Keys on the Gulf coast, which it approached during the night of the 29–30th, thence northeast to the Atlantic seaboard. The 24-hour rainfall along the path of the storm ranged from 5 inches at Cedar Keys, Levy County, to 8 inches at Lake City, Columbia County. Local observers reported "high winds," "storm," or "gales."

The storm was very severe when deep into the Gulf, as indicated by reports from masters of vessels, but it was probably losing energy as it approached the coast, as the minimum central pressure was not below 29.47 inches at any Florida station. Gales occurred, however, from Key West northward during the night of the 29th and early on the 30th. And considerable damage was done along the west coast from about Fort Myers northward to St. Marks. High tides, salt spray, and high winds inundated low lands on the immediate coast, and heavy rains flooded fields more inland, where truck and fruit suffered to a considerable extent. As the result of a prostrated wire one person was killed at St. Petersburg. A yacht was sunk at Fort Myers, and a number of vessels were wrecked or dismantled in the Gulf, among which was the American steamer *Speedwell*, en route British Honduras to New Orleans.

In view of the existence of the strong anticyclone which was rather exceptional for these low latitudes so early in the season, resulting in the breaking of minimum temperature records, is it altogether unorthodox to suspect an interdependence between the two phenomena? At least a relationship more than casual or incidental? Did the tropical storm, as reflected in the wide area over which a great displacement took place, accentuate the upbuilding of the "high"? Its counterpart, the cold wave, is not altogether the result of translation from high to low latitudes, but it arises, in a great measure, probably, as the result of outward radiation from the barren regions, of higher latitudes. Most of the great anticyclones, as they sweep south and east, incidentally develop LOWS which, as well developed entities, frequently play a vital part in the ultimate effects of cold waves.

TYPHOON IN PHILIPPINES.

By JOSÉ CORONAS, S. J.

[Weather Bureau, Manila, P. I., September, 1920.]

On the evening of August 31 a small typhoon struck Manila, the worst experienced in the city since September, 1905. It had formed almost unexpectedly in the China Sea, west of the southern part of Luzon, and moved ENE. across the Provinces of Bataan, Rizal, Bulacan and the narrow strip of the northern part of Tayabas, a track altogether abnormal and never before observed in the neighborhood of Manila. Considerable damage was done to the four provinces just mentioned as well as to Manila, particularly to the shipping, Corregidor and to the northern part of Cavite Province. The center passed between 7 and 8 p. m. a few miles north of the observatory where a gale blew for two to three hours backing very quickly from SE. to S., SW., and WNW.; relative calm was observed for about 15 minutes. The barographic record obtained on this occasion shows how small the typhoon was: it might be well called a miniature of a typhoon. In the early morning of September 1 the cyclonic center could still be noticed over the Pacific ENE. of Manila near Polillo Island; but it soon disappeared probably absorbed or swallowed up, we may say, by a big typhoon which was sweeping the Pacific from Guam to Formosa.

This big typhoon had passed near to the north of Guam on August 28, the barometric reading being at 2 p. m. as low as 742.9 mm. (29.248 inches), gravity correction applied, and a gale blowing for several hours from the north and west quadrants. The typhoon moved practically WNW. and struck Formosa on September 4. When the center was in Meiacoshima on September 3, it caused such

a considerable falling of the barometer, that the meteorological station of Ishigakishima reported at noon a barometric reading as low as 703 mm. (27.677 inches). All the telegraphic communications of Formosa were cut off, and it is believed that much damage was done by the typhoon throughout the island.

Another well-developed and severe typhoon swept the Pacific between the Ladrone Islands and the Loochoos from September 22 until the end of the month. Its center was clearly situated west of Guam on the afternoon of September 22, and passed north of the S. S. *Newport News* on her way from Manila to Guam, a gale being reported by her from the southwest to the southeast quadrants and a moderate falling of the barometer. The track of this typhoon is typical of those which recurve north and northeast far from the Philippines and move toward Japan, where the storm is supposed to be raging at the time these lines are being written (Sept. 30).

CLIMATOLOGICAL FACTORS GOVERNING THE SELECTION OF AIR ROUTES AND FLYING FIELDS.

By C. LE ROY MEISINGER.

[Weather Bureau, Washington, D. C., Oct. 4, 1920.]

SYNOPSIS.

Although the current values of weather conditions usually differ radically from the averages, they are important nevertheless in the selection of aerial routes and flying fields. For the preliminary selection of aerial routes, the normal values of the following elements are the most important:

1. Speed and direction of the wind.
2. Frequency of low clouds and fog.
3. Frequency and intensity of thunderstorms.
4. Vertical temperature distribution and its diurnal changes.

For the selection of flying fields there are needed, in addition to the above values, the normal values of precipitation.

INTRODUCTION.

There is, it seems, a vagueness in the opinions of many people regarding the value of meteorology in the selection of air routes. One reads of "pathfinding" and of "charting" flights by which it is implied that a single journey or, at most, several journeys over a proposed course will afford sufficient data to designate that route as satisfactory or unsatisfactory for continued use. Such reasoning is unsound. It is obvious that the aerial medium is possessed of such a host of variable attributes, that the conditions which one finds to-day may not occur again in precisely the same combination for months or even years. Of what profit shall it be to measure the temperature, humidity, and other elements, in a single flight, unless it be that these data are to be used in the discussion of the flight itself, relative to the performance of the motor or instrumental equipment, the physiological reaction of the travelers, or in one or more of the several other problems that may take the form of special tests? If such observations are to be made, they should be made over a wide area, by numerous craft, and as nearly simultaneously as possible. The ocean of air is far from being a fixed thing. Perhaps the likening of the atmosphere to the aqueous ocean is a figure of speech which has been somewhat overdone, and has resulted in the popular conception of aerial currents as fixed as the Gulf Stream or the Japan Current. It is also possible that the pioneer work of Rotch and Palmer, *Charts of the Atmosphere for Aeronauts and Aviators*, which appeared in 1911, did not lay sufficient emphasis upon the pitfalls of too great reliance in averages. Our atmosphere is not made up of great permanent streams and currents, and even our conception of prevailing westerly winds aloft is sometimes shocked by the spectacle of cirrus clouds moving from the north, east, or south. Therefore, efforts to lay down definite airways without reference to the fundamental conditions which really determine desirable routes can not prevent themselves being relegated to positions of slight importance. It would be unfair to assert that any carefully made scientific observation is of no value; but it is obvious that, in such matters as the selection of air routes, other factors than such observations must be considered before one can legitimately make generalizations upon so subtle a medium as the atmosphere.

THE SELECTION OF ROUTES.

It is self-evident that the point of departure and the destination must determine the general direction of flight. But it is by no means axiomatic that the air route shall follow a straight line between these two points. Irregularities of the terrain, its physical characteristics, and the weather along the route must, in the last analysis, determine the course of the aviator, if he is to cover the distance with the greatest economy of time and fuel. In brief, it is the geography and the climate of the region between two stations which must determine the approximate route, but the weather at the time of flight must determine the details of the aviator's course.[1]

While the fact is recognized that a single condition may not be representative of the weather over a given route, and also that mean conditions over the same route may differ greatly from the conditions of any particular day, it is believed, nevertheless, that the best basis for laying out a preliminary route between two points lies in the mean values of certain climatological and aerological factors.

Wind.—Perhaps the most important of all the weather elements to the aviator is the wind. It is necessary in commercial aviation to take advantage of any conditions which will aid in economy of time or fuel or will be conducive to greater safety. If, then, the "pathfinder" is to live up to his name, his first concern must be to determine the speed and direction of the prevailing winds over the proposed route. These winds should be determined, not at the surface alone, but to as great altitudes in the free-air as possible. Moreover, it is very likely that he will discover that certain elevations will, in the long run, be more favorable for flying in one direction, and that other levels will be more favorable for the return journey. Rouch and Gain [2] have shown how important such wind studies are in regard to flying in northern Africa. The journey from Oran to Tunis, they find, should be made at an altitude of about 2,000 meters, because at this elevation a strong westerly wind prevails. The return journey, in the long run, will be made most profitably at an altitude less than half as great, because the westerly wind at that elevation is greatly diminished in force. Such prevailing winds should be determined from as long records as are available and should be worked out for small time units; seasonal

[1] A later article will show how current conditions may modify an air route with a saving in time and fuel.

[2] Les cartes des vents à l'usage des aéronautes. *Revue générale des Sciences*, Mar. 30, 1919, pp. 168-171.