WIND VELOCITY AND RAIN FREQUENCY ON THE SOUTH TEXAS COAST.

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SYNOPSIS.

The frequency of rainfall over southern Texas and particularly Corpus Christi is discussed with reference to the strength of the prevailing southeasterly wind. This section of the coast experiences daily in summer a fresh Gulf breeze having the characteristics of a monsoon. Its rainfall, however, is much less in summer than that of the upper Texas coast. It is shown that the increase in velocity of this prevailing wind in the forenoon is coincident with the interruption of the convectional process which indicates that the wind prevents local inequalities of temperature and, by mixing, interrupts convection already begun. It is further shown that this region bordering the Texas coast is dependent upon convection for its precipitation in summer and hence the strength of this monsoon is the important *factor in rainfall forecasts for south Texas.*

Over the lower coast section of Texas, rainfall in the months of June, July, and August averages much less than over the upper coast section. The prevailing winds in those months are onshore throughout the entire length of the coast line. Over the lower coast the daytime southeast breezes are persistent and there is an abundance of moisture in the air. Yet, precipitation here is small compared to that which occurs along sections of the Gulf coast to the north and east.

Rainfall in Texas decreases from the coast toward the interior, or, roughly, from east to west. This is easily understood as the Gulf is the chief source of moisture. It is not so readily understood why the rainfall decreases southward along the Texas coast, even though the lower portion lies farther to the west. Certainly the source of supply is as near at hand and the moist winds blow with even greater regularity. In fact, as is the rule in subtropical regions, the rainfall should increase toward the equator.

The normal rainfall for the months of June, July, and August, totals 18.24 inches at New Orleans, 13.74 inches at Galveston, and 6.68 inches for Corpus Christi. The relative dryness of the extreme southern portion of Texas is remarkable in view of the regularity and average velocity of the moisture laden winds that daily sweep over that entire section in summer.

During the 10 years, 1912 to 1921, inclusive, at Corpus Christi, the average hourly movement of the prevailing southeast wind in June, July, and August, has reached 19 miles at the hour of maximum movement and the five-minute maximum velocity frequently exceeds 30 miles per hour. This southeast monsoon increases in strength about sunrise and steadily continues to increase until about sunset and then slowly subsides during the night. This occurs day after day with monotonous regularity.

This southeasterly wind penetrates far into the interior and is felt as a hot, dry wind in southwestern and south-central counties. Its apparent dryness is due to increase of temperature in passing inland.

Practically all rains in the coast section of Texas in the months named are due to convection. Local inequalities of temperature cause vertical currents which build convection columns to altitudes sufficient for precipitation. Farther in the interior the convection columns must build upward to greater heights for condensation and precipitation on account of the lower relative humidity. There is insufficient slope for condensation by forced ascent; there is very little cyclonic influence; rarely is there an interruption of the prevailing wind or any mixing of winds of different temperatures; therefore, were it not for convection, the territory lying westward from the lower Texas coast would receive little or no rainfall.

There have been many periods of prolonged drouth, when crops suffered in this section even though the Gulf winds blew with great regularity.

In the April, 1921, number of this REVIEW,[1] is discussed the relation between wind velocity and convective rains at Houston, Tex. It was there shown that on days with strong wind movement, convection is interrupted. In an effort to determine whether this southeast monsoon in the vicinity of Corpus Christi is of sufficient strength to prevent convection, the records of wind velocity and rain frequency have been compared. In Table 1 (not reproduced), the average hourly wind movement for each of the 24 hours, for the months of June, July, and August, covering the years, 1912 to 1921, inclusive, are shown, together with the hourly frequency of rain for each of the 24 hours for the same months during the same period.

Frequency of rain is taken as the total number of occurrences of precipitation of 0.01 inch or more in each hour for the months of June, July, and August during the period named.

An examination of this table shows clearly that the rainfall does not show the usual increase in frequency toward the hours after midday.[2] With the light winds of early morning rainfall becomes rapidly more frequent until there has been a considerable increase in wind velocity, when the frequency of rainfall remains stationary and then decreases rapidly. The minimum frequency of rainfall is coincident with the maximum wind, at an hour when convection, begun during the heat of the day, should continue with much activity.

Figure 1 shows this fact graphically. One sees at a glance that the fresh winds after midday have mixed the lower layer of the atmosphere thoroughly, smoothed out all inequalities of heating over the surface, and thus interrupted the convectional processes.

There is noticeable a certain lag in rain frequency as compared with wind velocity, which is to be expected. After the morning lull it takes a certain interval of time for the convectional columns to become established, and, once established, there is a strong tendency to continue despite the increase in wind velocity.

It is thus seen that, though the moisture is present over this region in great quantities, the only process which usually causes its precipitation is at times interrupted by increased movement of the wind. Turning again to the average rainfall values for the Gulf Coast during the summer months, we have New Orleans with 18.24 inches and an average hourly wind movement of 6 miles; Galveston with 13.74 inches and an average hourly wind movement of 9 miles; and Corpus Christi with 6.68 inches and an average hourly wind movement of 12 miles.

Rainfall records for southern Texas show a marked increase during the month of September, whereas the

[1] I. R. Tannehill. Correlation of wind velocity and convective rains at Houston, Tex. MO. WEATHER REV., April, 1921, 49: 204-205.

[2] E. D. Coberly. The hourly frequency of precipitation at New Orleans, La. MO. WEATHER REV., September, 1914, 42: 537-538. Here is shown graphically the increase in frequency of rainfall to be expected toward midday, with maximum shortly after noon. By referring to fig. 1, showing the frequency at Corpus Christi, it will be seen that, were it not for interruption of convection by wind movement, the frequency would continue to increase and the total summer rainfall at Corpus Christi would greatly exceed that received with such interruption.

wind movement is considerably less, though the southeasterly wind in September is yet strong. An examination of the records indicates that this unusual rainfall is due to cyclonic activity. For illustration: During the months of September in the last 10 years, 1911 to 1921, a total of 38.23 inches has been recorded at Corpus Christi. Of that amount 21.11 inches fell in five 24-hour periods, and during all of those periods the prevailing wind was from some point from east to north, indicating a deflection of the prevailing wind due to some tropical or other disturbance.

and evaporated. Hence wind movement is the important factor in the production of rainfall over this region. Therefore a further study into the causes of the monsoon in summer over the Texas coast, a determination of inequalities of temperature over extended land and water surfaces, and a study perhaps of upper air circulation and the relation between the strength of this current and the general pressure distribution may all yield important results in connection with forecasts of precipitation, and may make possible seasonal rain forecasts for the region bordering the Texas coast.

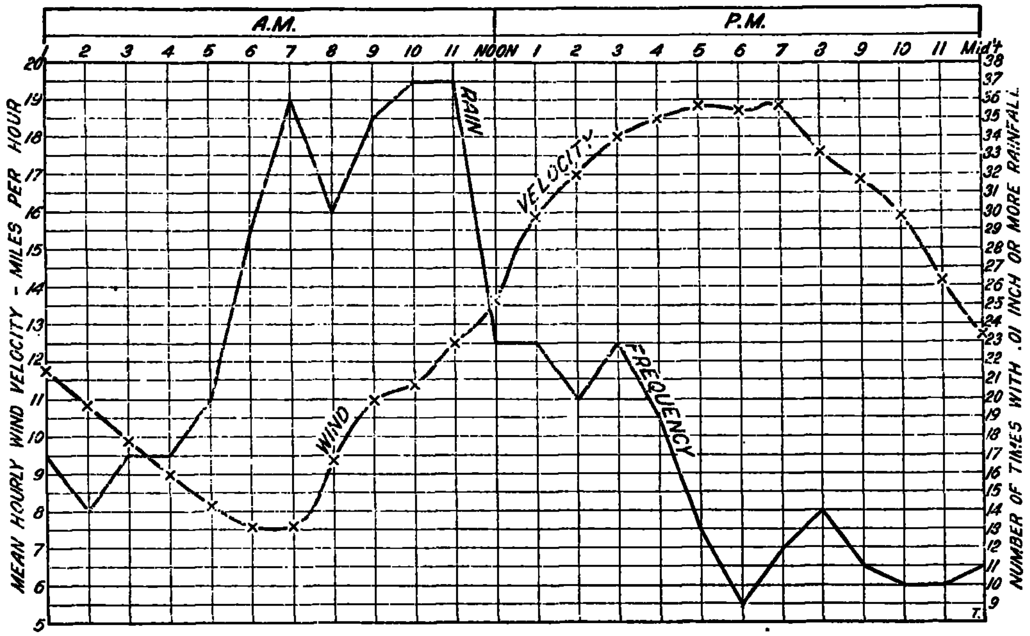

FIG. 1.—Relation between rain frequency and wind velocity on the South Texas Coast.

The southeasterly wind is so strong during the daytime that it obscures in the averages any temporary lull that aids convection and any delay of the increase of wind in in the morning, hence no very clear relationship can be established between daily wind movements and frequency of rainy days. Yet this relationship over extended periods is consistent and noticeable. For example, in the very dry year, 1917, at Corpus Christi, with only 5.38 inches of rainfall, the total wind movement was 118,106 miles, whereas, in the wet year, 1919, with 34.31 inches, the total wind movement was 101,813. During the dry year, 1917, there was only 0.26 inch of rainfall in June with 12,685 miles of wind, while in the wet year, 1919, there were 6.24 inches of rain in July with a wind movement of 7,775. These departures from normal rainfall were not local. The drougth of 1917 was marked over the entire State and all southern Texas received an excess of rainfall in 1919. It is therefore evident that changes in the velocity of wind in the summer monsoon affect not only the local rainfall but that of the coast section and much of the interior.

CONCLUSION.

Much of the coast section and interior adjoining the coast section of Texas is dependent upon convection for precipitation from its prevailing moisture bearing winds. When the southeasterly wind is strong, local inequalities of temperature at the surface are prevented and cloud masses, after formation, are mixed with surrounding air

THE MASS-GROUPING OF RAINDROPS.

By W. J. HUMPHREYS.

[Weather Bureau, Washington, D. C., Sept. 19, 1921.]

A number of years ago, Defant[1] made an extensive study of the masses of raindrops. Measurements of more than 10,000 drops, representing several different storms, showed that in each case the drops grouped themselves chiefly about the mass ratios 1 : 2 : 4 : 8 : . . .

Recently Prof. T. Okada, of Japan, told me that he had repeated Defant's observations and that he had found the same results. Apparently, therefore, the observational evidence is quite sufficient to justify the tentative assumption that the phenomenon reported is practically universal, and to call for an effort to explain it.

It may be assumed (the justifying evidence need not be here repeated) that rain seldom occurs except in rising air. If this be true it follows that only those drops can fall from the cloud that are heavy enough to overcome the lift of the upward current, and that close to the under surface of the cloud the greatest number of drops actually descending are those that have substantially the minimum falling size. Let the mass of this minimum drop (minimum under the existing conditions) be m.

Now, drops of the same size, and under like conditions, fall with the same velocity, and, if once close together, continue close together for some time; whereas drops of

[1] *Sitzungsberichte der K. Akad. der Wiss.*, Wien, p. 114: 585, 1905.