

No such connection appears in the annual means for Mount Weather, but in winter the coefficient between P_0 and T_0 is -0.41 . These figures confirm the conclusions already given, viz., that in the United States, particularly in the interior portions, wind direction exerts a greater influence on the air temperatures than does the sea level pressure.

THE ORIGIN OF ANTICYCLONES AND DEPRESSIONS.

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[Abstracted from Proceedings Royal Society, Edinburgh, 1918, vol. 39, pp. 56-77.]

The essential feature of this theory is "that the chief cause of depressions and anticyclones is to be sought

¹ cf. abstract, Sci. Abs., Aug. 31, 1919, p. 361.

GENERAL MOVEMENTS OF THE ATMOSPHERE.

(Discussion.)

In a recent paper¹ H. H. Hildebrandsson has presented the results of an exhaustive study of all available information on the subject of free air wind conditions. This information is based on observations of cloud and volcanic dust movement and on those with kites, pilot and sounding balloons. From the study are drawn certain conclusions, sweeping in character, which appear to be well founded, providing we can accept the data on which they are based as representative of all conditions. They are not representative, however, and the conclusions, at any rate some of them, are therefore not final. Particularly is this true of the conclusion No. 7, which reads: "* * * a direct upper current from the Equator to the poles does not exist, nor a lower current in the opposite direction from the poles to the Equator."

Most unfortunately neither upper clouds nor free balloons can be observed as a rule during conditions in which a southerly component in the upper winds is to be expected because of the existence of low clouds and generally stormy weather. That is to say, when a cyclone is approaching or is passing to the north of a station, upper winds are strong and have a decided southerly component. This condition is found when observations can be made with a cyclone in that position, as is well shown, for example, in figures 41 and 43 of Cave's "The Structure of the Atmosphere in Clear Weather." But in most cases such observations can not be made in the eastern half of a cyclone because of low clouds. The same thing is true of northeasterly and easterly surface winds under the influence of a cyclone approaching from the southwest with an anticyclone to the north or northwest, as shown in figure 47 and discussed on pages 6 and 78 of Cave's work. See also, in this connection, "Rules" 1, 2, and 4 in "The turning of the winds with altitude," MONTHLY WEATHER REVIEW, January, 1918, p. 21. Under such conditions kites can not be flown owing to the existence of a calm stratum between the surface easterly and the upper southwesterly wind, nor can balloons or upper clouds be observed, because of rainy weather or at least dense cloudiness in the lower layers. It follows, then, that undue weight is given to the observations made in the western half of cyclones where a northerly component in the upper winds is to be expected and is usually observed. Yet we find that even when the greater weight is given to observations in the western half of cyclones, still the resultant wind is almost exactly

in the phenomenon of *radiation*; * * * that cyclones are caused by *cooling*, and anticyclones by *heating* of the air."

That temperature changes lead in turn to pressure changes is, of course, well known; hence, much of the argument in this paper is new only in form. It is also known that clouds modify the effects of insolation in the manner claimed.

The paper is well worth reading for it deals, in the language of thermodynamics, with a contributing factor (and in our opinion only a factor) in the production of cyclones and anticyclones; a problem full of difficulties, and whose solution is urgently needed.—W. J. H.

westerly. What would happen if representative observations could be obtained in all parts of cyclones and anticyclones? Most certainly we should find a resultant westerly wind with a small southerly component, probably so small that it would be shown only by the mean of a very large number of observations—observations which unfortunately can not be made, at least with present methods, for the reasons already given.

Practically no free air observations have been made at sea in middle latitudes, the one region where the planetary circulation should find greatest opportunity for unrestricted development. Conditions here can be judged only from the movements of cyclones. These as a rule travel eastnortheastward, and it is generally recognized that on the average they follow the direction of the upper winds. Unless we consider conditions in all parts of the temperate zones, we can draw no final conclusions.

From theoretical considerations it is certainly to be supposed that the prevailing westerlies have in the mean a slight southerly component. As is well known the latitudinal pressure variation at intermediate altitudes, i. e., 5 to 15 kilometers consists of a decrease from the tropics toward the polar regions. The corresponding temperature change is very small, with the result that the air density also decreases poleward. Under ideal conditions the resulting wind would be exactly parallel with the isobars, i. e., west to east. But conditions are never ideal in any part of the atmosphere. At the surface, where friction and other retarding effects are most in evidence, the departure from a gradient wind is exceedingly large. At the higher levels these effects, which include friction, turbulence and viscosity, disappear to a considerable extent, but most assuredly not altogether. If they are still present (and it must be admitted that they are) then the winds must necessarily make a small angle with the isobars, i. e., the prevailing westerlies at those levels have a slight southerly component.

How does this air return equatorward? In all probability practically all of it does so in the lower 5 kilometers. Here we find a latitudinal variation in pressure and temperature such that the air density decreases from north to south, a condition that favors a slight northerly component on the average in the winds at these levels. The actual transfer is accomplished for the most part in the movements of anticyclones from north to south, especially over the continents. In a relatively short time as much air can be carried southward in this way as is carried northward at higher altitudes in a much longer time, owing to the greater density in the former than in the

¹ Results of some empiric researches as to the general movements of the atmosphere. Translation by W. W. Reed. MONTHLY WEATHER REVIEW, June, 1919, 47, pp. 374-389.