NOTES ON THE APPLICATION OF UPPER-AIR OBSERVATIONS TO WEATHER FORECASTING, JANUARY, 1912.

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The record of the daily kite flight frequently contains no suggestion that is helpful to the forecaster, but occasionally material is secured from upper-air observations which illumines the situation quite materially and at once removes the forecast from the domain of empirical reasoning and places it on a solid foundation.

It is hoped in these notes to point out as opportunity may present the cases wherein upper-air observations are believed to have an immediate and practical application to weather forecasting. The flight of January 8, 1912, is one in point. On that day a great anticyclone extended from the Gulf of St. Lawrence to the Carolinas; it was roughly ovalshaped with the narrowest end of the oval projecting over Virginia and the Carolinas. A shallow depression was centered over southwest Arkansas, and rain or snow was falling at a number of places in the Mississippi Valley and the Gulf States. Although the barometric gradients over the Middle Atlantic States were for strong southerly winds, the local winds, as often happens, were widely divergent therefrom, being mostly east to southeast.

Forecast.—But one forecast was possible. Nevertheless in the light of the upper-air observations that one was doubtless made with more confidence than would otherwise have been the case. The kite observations revealed the following facts: First, that the surface winds did not represent the true wind motion, for less than 200 meters (656 feet) above the mountain the direction had changed to south, thus conforming with the direction indicated by the isobars. The direction of the wind aloft, however, soon shifted to the southwest and continued in that direction to about a mile above sea level. The velocity increased to over 60 miles per hour (27 meters per second) at the mile level and then diminished slowly to 46 miles (21 meters per second) at the greatest altitude reached. The temperature, which was 5.2° F. on the surface (−14.9° C.), increased to 25° F. (−3.9° C.) at the mile level, and then decreased to 18.9° F. (−7.3° C.) at the highest point reached, 9,863 feet (3,007 meters). At that point, however, it was higher than at the surface of the mountain.

Summary.—On the surface we have a pressure distribution that warrants us in assuming, for the region about Mount Weather, strong southerly winds. Notwithstanding the exceedingly variable direction of the surface winds as spread on the weather map, in getting aloft the actual wind is found to be southwest, but the earth's rotation on its axis is probably sufficient to change a south wind into a southwest wind. Unexpectedly high temperatures are found aloft. Thus we have two factors which must strongly influence the course and development of the southwest cyclone, viz, a high tangential velocity on the west side of the anticyclone and relatively high temperatures in the lower strata wherein the seat of the energy of the storm probably resides. That the cyclone advanced rapidly and with an increasing barometric minimum goes without saying.

Three days later, viz, on January 11, a cyclone appeared in practically the same location in the southwest. The center of the anticyclone, however, was over the Dakotas, with a tongue-shaped projection of high pressure over the Middle Atlantic States. Although the surface winds at Mount Weather in this case were from the southeast, the barometric gradient was for west winds, and singularly the maximum velocity of 70 miles an hour (31 meters per second) was found at 5,118 feet (1,857 meters) above sea level, diminishing to 59 miles (26 meters per second) at 9,908 feet (3,022 meters). In this case the temperature of the air column was much stratified and departed widely from the conditions of stable equilibrium. The important point to the writer's mind lies in the wind direction and force aloft as influencing the probable course and development of the cyclone. In both cases high winds and relatively high temperatures have been found on the borders of anticyclones, separating them from a distant cyclone, whose subsequent course appears to have been strongly influenced by the conditions above described.

Although one does not expect to reach fundamentals in two cases, the strong southwest wind on the western border of an anticyclone has been observed so frequently that to us it has a definite application. Observations of the cloud motions in connection with the passage of a barometric depression which is characterized by very low pressures at its center invariably show the continuance of southwest winds toward the depression long after the wind at the surface and in the lower layers has shifted to a northerly quarter.

It is doubtful whether or not this last statement has any practical application in weather forecasting other than to roughly indicate that the general circulation of the air in the case of cyclones is disturbed to a much greater altitude than has been supposed in some quarters.