Weather Note

AN OCCURRENCE OF LAKE SNOW

ONE OF THE DIRECT EFFECTS OF LAKE MICHIGAN ON THE CLIMATE OF THE CHICAGO AREA*

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1. INTRODUCTION

A lake snow occurred near the southwestern shore of Lake Michigan between midnight and about 0900 cst January 19, 1963. While some snow fell over much of the Chicago area, there was a definite tendency toward concentration in a band 5 to 10 mi. wide and 40 to 50 mi. long where amounts were as great as 4 in. The band was centered about 7 mi. from the lake shore over the city and was inland as much as 15 mi. in the southern suburbs giving an orientation of north-northwest to south-southeast. Mesoscale weather conditions associated with the snowfall are examined and radar indications considered. The idea that the lake is a source of moisture for this snowfall is developed.

2. FACTORS ASSOCIATED WITH THE LAKE SNOW

A large Arctic high pressure system covered the north central United States. A careful analysis of 850-mb. data for 0600 cst showed the cold air to be around 5,000 ft. deep over the Chicago area and the southern end of Lake Michigan. In the cold air, above 2,000 ft., winds were northeasterly. The nearest radiosonde station is 150 mi. to the southwest. In a study of this type, where the local influence of Lake Michigan is important, only a radiosonde observation in the immediate vicinity of the lake could be expected to show pertinent detail of this local influence. Therefore, no sounding is presented.

Apparently because of the relatively shallow depth of the cold air as it crossed southern Lake Michigan, substantial warming and moistening of the entire depth occurred as it moved southwestward toward Chicago. Farther north, over the lake, the cold air was not modified so much.

Over water, stability of the air was decreasing due to warming and moistening from below. This allowed better vertical transfer of momentum from the gradient level to the surface. The latter fact plus the smaller frictional effect of the water surface (compared to land) resulted in surface winds very nearly paralleling the northeasterly winds at gradient level. (By 7 a.m. surface winds near the southwestern shore of the lake had become easterly.)

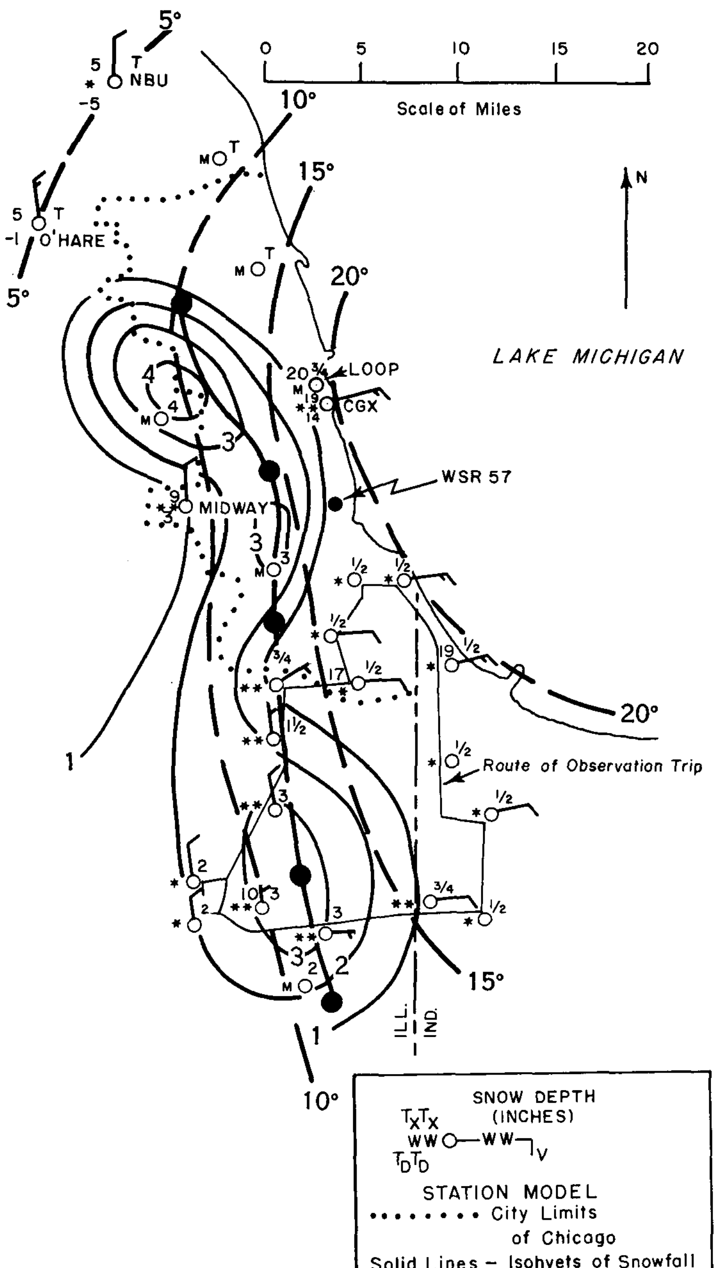

Figure 1.—Map showing snowfall, and temperature and wind situation, over Chicago and vicinity, January 19, 1963. Observations along the route shown were made between 7 and 9 a.m.

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To the west over northern Illinois, where the air was not affected by a lake trajectory, considerable frictional influence was noted in surface winds, which were north-northwesterly. Also, this unmodified air was 15° F. to 25° F. colder than the lake-modified air.

This led to the gradual formation of a convergence zone between the two "air masses" over the Chicago area and forced ascent of the lake-modified air. The temperature gradient in the convergence zone increased during the night, as follows: midnight Chicago Loop temperature 12° F., Midway Airport 8°; at 7 a.m., Loop 20°, Midway 9°. About midnight, fairly steady light snow began to fall in an area a few miles wide, just west of the sharp wind shift line (fig. 1).

Observations were made by the writer between about 7 a.m. and 9 a.m. along the path indicated on figure 1. Supplemental data were obtained from teletypewriter reports and from various people in other sections of the city. During the period of observation, where winds were definitely easterly and temperatures between 15° and 20° F., rate of snowfall was slight and flakes were fine. Close to and for a short distance west of the wind shift line, where temperatures were near 10° F., the rate of snowfall was much greater and the flakes comparatively large.

The wind shift line, oriented nearly parallel to the low-level winds in the cold air, apparently was providing the slope over which the lake-modified air was being forced to rise. In addition, it is possible that small convection cells were being produced in the convergence zone, adding to the precipitation. In general, snowfall intensity was greatest where observation showed new snow to be deepest, thus suggesting that the zone of convergence had remained nearly stationary since its formation around midnight.

Because the area of maximum precipitation was displaced inland from the lake shore, there is a similarity to a case discussed by Petterssen and Calabrese [1]. In that study, over a period of several days largest lake snowfall amounts occurred 10 to 25 mi. downwind from the lake shore. The study suggested that this landward displacement of the precipitation could be accounted for by frictional convergence and a change in lapse rate from over-water to over-land conditions. The detailed examination of surface weather in the present study may be measuring results of these effects. Cases of lake snow have been studied elsewhere. Near the lower Great Lakes convective cells elongated in the direction of the wind recently have been examined by Lansing [2]. An investigation of certain causes of lake snow was undertaken by George [3].

3. RADAR INDICATIONS

The Chicago WSR–57 radar was operational during test periods in December 1962. Figure 2 is a sketch, omitting ground clutter, of the radar scope during one of these test periods when intense lake snow was occurring.

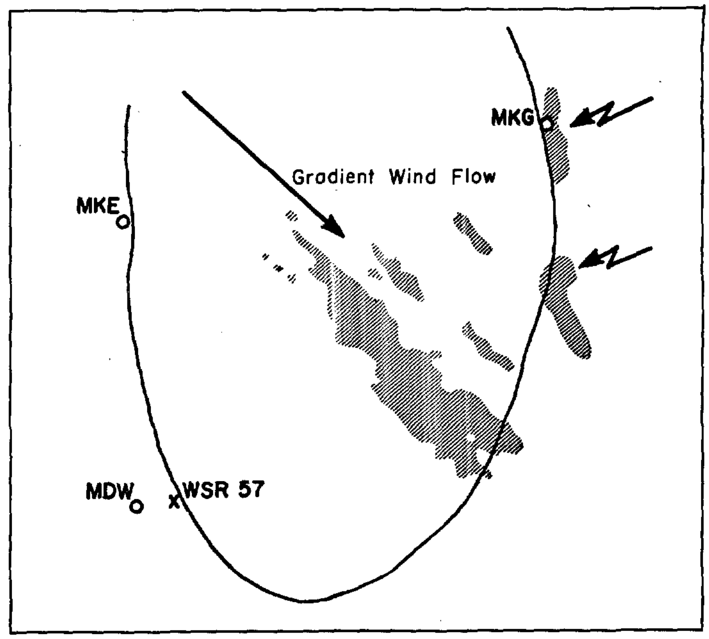

FIGURE 2.—Sketch of a photograph of the radar scope of the WSR–57 at Chicago on December 11, 1962, at 1102 CST, when echoes seem to suggest a situation similar to the case described here.

In this figure most of the precipitation echoes appear aligned with the gradient wind flow, especially those echoes over the lake itself. However, on the eastern shore, marked by arrows, are two spots where the precipitation areas take a different orientation. At these places the echo seems to be slightly inland, nearly paralleling the shore, and therefore, may be the result of a set of conditions similar to the ones producing the lake snow case examined in this paper. A second picture of the radar scope taken within 30 min. of this one showed the same types of precipitation echo patterns.

On January 19, 1963, radar observations by the WSR–57 at the Weather Bureau Forecast Center in Chicago showed echoes from areas of light snow mainly east of the city, during much of the period between midnight and 8 a.m. However, there was no apparent tendency for the echoes to concentrate over or near the area where largest snowfalls were observed. Since that area coincides with an area of heavy ground clutter on the scope, it is possible that radar indications of this snowfall were obscured.

4. CONCLUSIONS

The data indicated there was addition of considerable energy from Lake Michigan to the cold air as it crossed the lake. This energy, which was in the form of heat and moisture (latent heat of vaporization) added under the special meteorological conditions of the period led to the snowfall. Wind flow was such that the dividing line between the modified air produced over the lake and the unmodified Arctic air was located over northern Illinois several miles west of the lake shore. Mesoscale and synoptic scale conditions combined in such a way that organized vertical motion occurred within the modified air mainly near the wind shift line. This was quickly translated into snowfall due to the air's moisture content and still relatively low temperature. Since the synoptic pattern was quasi-stationary, the snow production zone moved little during the early morning hours and largest accumulations were localized.

This type of lake snow occurrence tends to produce snow areas paralleling the lake shore, since uplift is along a lake-induced convergence zone produced by differential heating and frictional effects of the lake on air passing over it.

A snowfall pattern slightly inland and tending to parallel the lake shore was observed on the WSR-57 at the Weather Bureau Forecast Center, Chicago, during another period of lake snow activity on Lake Michigan. This may be evidence that the mechanism producing lake snow studied here is a fairly common one to Lake Michigan and perhaps to other large lakes.

ACKNOWLEDGMENT

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REFERENCES

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3. J. J. George, "On the Distortion of Stream Fields by Small Heat Sources," *Monthly Weather Review*, vol. 68, No. 3, Mar. 1940, pp. 63-66.