

unobstructed Southern hemisphere there may be such a true, circumpolar whirl.⁵ The low pressures of Davis Strait and Baffins Bay appear to extend all over the American Arctic Archipelago. The problem of the north polar circulation is still left open, though there is a fair hope of its solution during Amundsen's expedition, in conjunction with which aerological observations are being conducted in the polar regions. There should be a permanent meteorological station in northeast Greenland, which is apparently the north polar, high-pressure center of action.

Occasional captive balloon and kite flights were made at Holstensborg and Godhavn. The weather of May 22-24 was fairly typical of spring conditions at Holstensborg; clear weather began with slowly falling barometer and continued so long as the barometer fell. The wind, at least in the free air, was SE. to S. With rising pressure come W. and NW. winds, with the sky covered with low clouds, stratus and nimbus, and with precipitation. This northwest streaming seems usually to be very thin. There appears to be a direct connection between the inflowing cold, heavy air from the northwest (Davis Strait) and rising barometer. With a layer 1,000 m. thick the rise was 4 mm. but with lesser thicknesses 2 or 3 mm. The wind aloft was föhnlíke, from the SE.

The captive balloon was used in midwinter and later, when it was certain there would be enough hydrogen for the pilot balloons. On February 24, a warm winter day, there was an inversion of 4° C., with the maximum temperature at 250 to 400 m. At the time of minimum temperature that day the inversion must have been 8° or 9° C. On the coldest day, March 10, with the minimum -24.7° C., there was no inversion at noon, and practically no wind.

On the 28th to 29th of May eight ascents were made to get the diurnal sequence of temperature. The greatest inversion occurred at 23 h., and thereafter the ground temperature rose, while that aloft sank; the altitude of the maximum temperature usually varied from 150 to 260 m., but at 4 a. m. it was at 400 m. With a sea fog at 6 a. m. the fall in temperature began first at 100 to 300 m. and later at the ground. This made a strong, vertical temperature gradient.

The general results of 83 pilot balloon ascents in Iceland by Thorkelsson were not so great as those in Greenland, for the weather was generally adverse and only when low clouds would not interfere was it practicable to attempt flights. Lack of balloon materials prevented the making of any flights in January before the 29th. South was the most frequent direction of the wind, then W., and NW. NE. and E. winds were absent, partly

⁵ Cf. W. H. Hobbs, loc. cit.

because flights could not be attempted when such winds occurred, the clouds being too low. It was found that the wind in the lowest 100 m. was governed by the direction of the deep fiord in which the station lay. Winds aloft often did not show any connection immediately with the surface pressure distribution. This may be accounted for by the fact that under some conditions the temperatures make the pressure distribution at even moderate heights differ markedly from those at the surface.

The most pronounced facts from these 83 flights are: On the E. or NE. side of a depression the turn of the wind outwards 50 to 70° was striking. It began to occur at only 2 to 3 km. In a saddle the wind aloft was prevailing west. On the back side of an eastern depression the NW. wind goes to great heights. With the distant approach of a low on the SW., however, the wind may go suddenly to S., or a SE. wind may come in at a different level. The center of a depression leans N. or NW. In many cases, particularly in winter, when there is high pressure to the north the wind aloft is SW. to W., indicating that the cold air which makes the high pressure under such conditions can not be in a very thick layer. Only in October (once) and several times in March and April did the characteristic easterly winds aloft occur with high pressure to the north. This is explained as a result of the anticyclones of winter in this region being a relatively thin layer of cold air, while by spring the overflow from warmer latitudes has so built up the air column that the anticyclone is dynamic. Even in west Greenland there are indications of a more pronounced development of the E. and SE. winds aloft in spring than in winter (partly in fall).

The results of the Spitzbergen flights by K. Wegener and H. Robitsch show characteristic S. to SE. winds with depressions in the SW. and NW. winds with depressions in the SE. No depressions seem to have passed on the north. There are, however, a number of instances, more numerous than the case with E. to NE. winds to heights of 6 km. or more, in which westerly winds prevail aloft (in fall and spring). Especially interesting are the westerly winds above high pressure areas lying north of lows. It seems as if there were here the edge of a true circumpolar whirl, north of the high pressure belt between 70° and 80°N. which bounds the subpolar low-pressure belt.⁶ Yet this high pressure "belt" may be merely a wind divide between the Atlantic low and one on the other side of the pole. Whether or not it is such must be determined from more extended observations, such as those Amundsen is making.⁷

⁶ V. Bjerknes seems to have used these observations as the basis for a new detail in his general circulation of the atmosphere. See Fig. 31 in *Geofysiske Publ.* No. 5, Kristiania, 1922.

⁷ A general review of the work of the Swiss Greenland expedition is published in the *Geogr. Rev.*, July, 1923.

SNOWSTORM OF MAY 8-9, 1923, IN MICHIGAN.

By B. B. WHITTIER, Meteorologist.

[Weather Bureau Office, Lansing, Mich., June 20, 1923.]

The months of March and April and the first half of May, 1923, were marked by unusually capricious weather in Michigan, with frequent cold waves, which in many localities broke all previous records for low temperature in the months in question. Killing frosts on the 10th and 13th of May were unusually late in the season, but as the cold spring had held vegetation back, and fruit buds were snow covered, the frost caused but little loss. The most unusual feature of the late spring was the snowstorm of May 8-9, which was the heaviest on record

for the month of May in the State by a full inch, averaging 3.3 inches for the State, against 2.3 inches for May, 1917, the previous record. What threatened to be a very damaging frost to fruit, much of which was in full bloom, on the morning of the 10th, was minimized by the melting snow on the branches.

The weather map on the morning of May 8 showed a low-pressure area over the Great Lakes, with the main center over northern Lake Huron, and a secondary center over northern Lake Michigan, with high pressure and

colder weather to the north and west. This secondary center of the LOW gave considerable precipitation in the form of snow over the western upper peninsula of Michigan on this date, amounting to about 11 inches in portions of Ontonagon and Gogebic Counties (fig. 1), a very unusual fall for so late in the season even in that section of the State. Comparison may be made with the monthly

snowfall records for May were broken on the night of the 8th and on the 9th in the "palm" and "thumb" districts, with 14 inches in eastern Montcalm County, and from 8 to 12 inches from Kent County eastward (fig. 1). Comparison may be made with the total snowfall for May, 1907, the greatest previous snowfall in southern counties, and the second greatest previous record for the entire State. In that month the heaviest fall in the southern portion of the State was 8 inches in southern Lapeer County, a fall of 10 inches near the northern end of the lower peninsula helping to raise the average for the State.

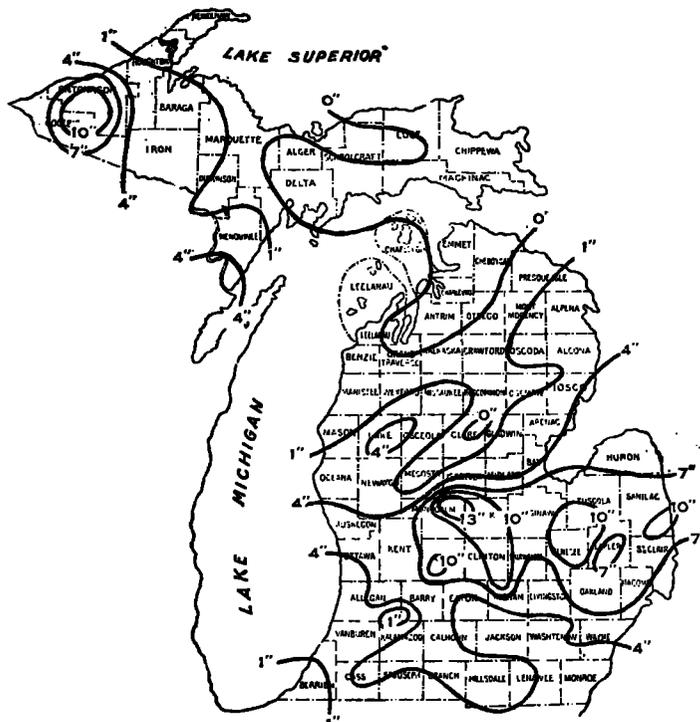


FIG. 1.—Snowstorm of May 8-10, 1923, in Michigan.

snowfall for May, 1917, the previous heaviest record for the upper peninsula, when 14 inches was reported in Alger County, and 17 inches on Mackinac Island.

On the morning of the 9th the low-pressure area showed a united center over Lake Erie, the low temperature having overspread the State with west and northwest winds on the surface, forcing the warm, moist air aloft, and heavy snow falling in the southern counties. All previous

The regular Weather Bureau offices at Grand Haven, Grand Rapids, Lansing, Saginaw, Port Huron, and Detroit, being in the line of heavy snow, all reported falls exceeding previous records by from 2 to 7 inches. (See Table 1 for depths.) The snow was moist and heavy, though soft, and in some sections some damage was caused by breaking limbs, wires, etc., though fortunately the economic damage was surprisingly small. Melting occurred rapidly, especially as the ground was still warm, causing the snow to melt at the bottom and settle. Traffic was considerably demoralized, especially in the eastern counties, where the snow was still falling on the morning of the 9th, but being soft many automobiles ventured forth and soon plowed lanes on the main-traveled highways. By the morning of the 10th most of the snow had disappeared, and by the evening of the 10th this record storm was but a memory.

TABLE 1.—Stations in the lower peninsula of Michigan reporting 5 inches or more of snow on May 8 and 9.

	Inches.		Inches.
Edmore.....	14.0	Port Huron.....	6.5
Alma.....	12.0	Battle Creek.....	6.0
Flint.....	12.0	Durand.....	6.0
Millington.....	12.0	Harbor Beach.....	6.0
Lansing.....	11.5	Lapeer.....	6.0
Saranac.....	11.0	Lowell.....	6.0
Croswell.....	10.0	Plymouth.....	6.0
Pontiac.....	9.0	Grand Rapids.....	5.5
Saginaw.....	9.0	Grand Ledge.....	5.0
Sandusky.....	9.0	Hillsdale.....	5.0
Bay City.....	8.0	Howell.....	5.0
Greenville.....	8.0	Muskegon.....	5.0
Owosso.....	8.0	Port Austin.....	5.0
Webber Dam.....	8.0	Grand Haven.....	4.8
Detroit.....	6.7		

SNOWSTORM OF MAY 9, 1923, IN THE SAGINAW VALLEY, MICH.

By F. H. COLEMAN, Meteorologist.

[Weather Bureau Office, Saginaw, Mich., May 28, 1923.]

On May 8-9, 1923, there was a very unusual snowfall in the Saginaw Valley, and in fact all of southern Michigan, unusual in view of the fact that snow of any amount rarely falls so late in the season. The ground within the valley limits was covered to a depth ranging from 4 to 14 inches.

At Saginaw, where the depth was 9 inches, records have been kept since 1897, and the greatest previous snowfall in any May was 0.8 of an inch on the 4th in 1907 and the same amount on the 2d in 1909. In no other May was more than a trace recorded.

This investigation covers only the watershed of the Saginaw River, and was undertaken not only because of the unusual nature of the phenomena, but also because of the great destruction wrought by its peculiar character in certain localities.

The snow depth was least over the western portion of the watershed, attained an average depth of 8 to 10 inches

in the middle portion, and increased to 12 inches or more over the eastern portion.

As it fell, the snow was very wet, and in the eastern portion of the watershed over an oval-shaped area about 70 miles long and 15 miles wide at the greatest width, it adhered firmly to such objects as branches of trees and telephone and telegraph wires.

In Saginaw, which lay well within this area, it was no unusual sight to see telephone poles bearing the burden of many wires each of which presented the appearance of a cable of snow 2 inches or more in diameter. The weight of these masses of wet, heavy snow not only snapped many wires, but dragged down the cross pieces to which they were attached and even pulled over or broke down many poles. Out of approximately 11,000 telephones in the Saginaw district, nearly 4,000 were put out of commission in this manner.