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Climatology and Weather Services of the St. Lawrence Seaway and Great Lakes

Prepared by
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INTRODUCTION

Completion of the St. Lawrence Seaway opens the Great Lakes to deep-draft, oceangoing vessels for the first time. This publication is intended to familiarize masters, mates, and steamship company officials of vessels now plying the waterway and those who will, in the future, come to use the expanded facilities, with weather conditions and available weather services in the area. The elements described are primarily those affecting ship operations.

The area covered includes the St. Lawrence River from Quebec to Lake Ontario and all the Great Lakes. Climatology of the sea approaches to the St. Lawrence River and from the mouth of the river to Quebec can be found in U. S. Navy Hydrographic Office Publications No. 73 "Sailing Directions for Newfoundland" and No. 100 "Sailing Directions for the Gulf and River St. Lawrence".

Climatological tables for major ports and a list of warning display stations appear in the appendix. A station location chart is shown in figure 1.

ACKNOWLEDGMENTS

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GENERAL DESCRIPTION

The St. Lawrence River system, composed of an estuary and a chain of five major interconnected lakes, forms a natural transportation route from the sea almost 2000 mi. into the middle of the North American continent. The entire system has a water surface area of over 95,000 sq. mi., more than 8300 mi. of shoreline, and a drainage area of some 325,000 sq. mi. The region bordering this great inland waterway is notable for its industrial development and for the magnitude of its natural and agricultural resources.

The estuary of the St. Lawrence begins at the western end of Anticosti Island, near 64°30'W. The river here is some 70 mi. wide, narrowing to 24 mi. at Point des Monts, to 8 mi. at the foot of Orleans Island, and to 1/4 mi. near Quebec. The lower portion of the river, below Quebec, is bounded on both sides by mountain ranges. From Quebec to Montreal the river averages 2 1/3 mi. wide, reaching a maximum of 7 1/4 mi. in Lake St. Peter. This lake is shallow but by dredging here and in other shoal sections a 35-ft. channel is maintained from Montreal to the sea. The shores in this area are comparatively low [2].

From Montreal to Lake Ontario the natural river consists of a series of relatively shallow lakes connected by rapids and shallows. The St. Lawrence Seaway

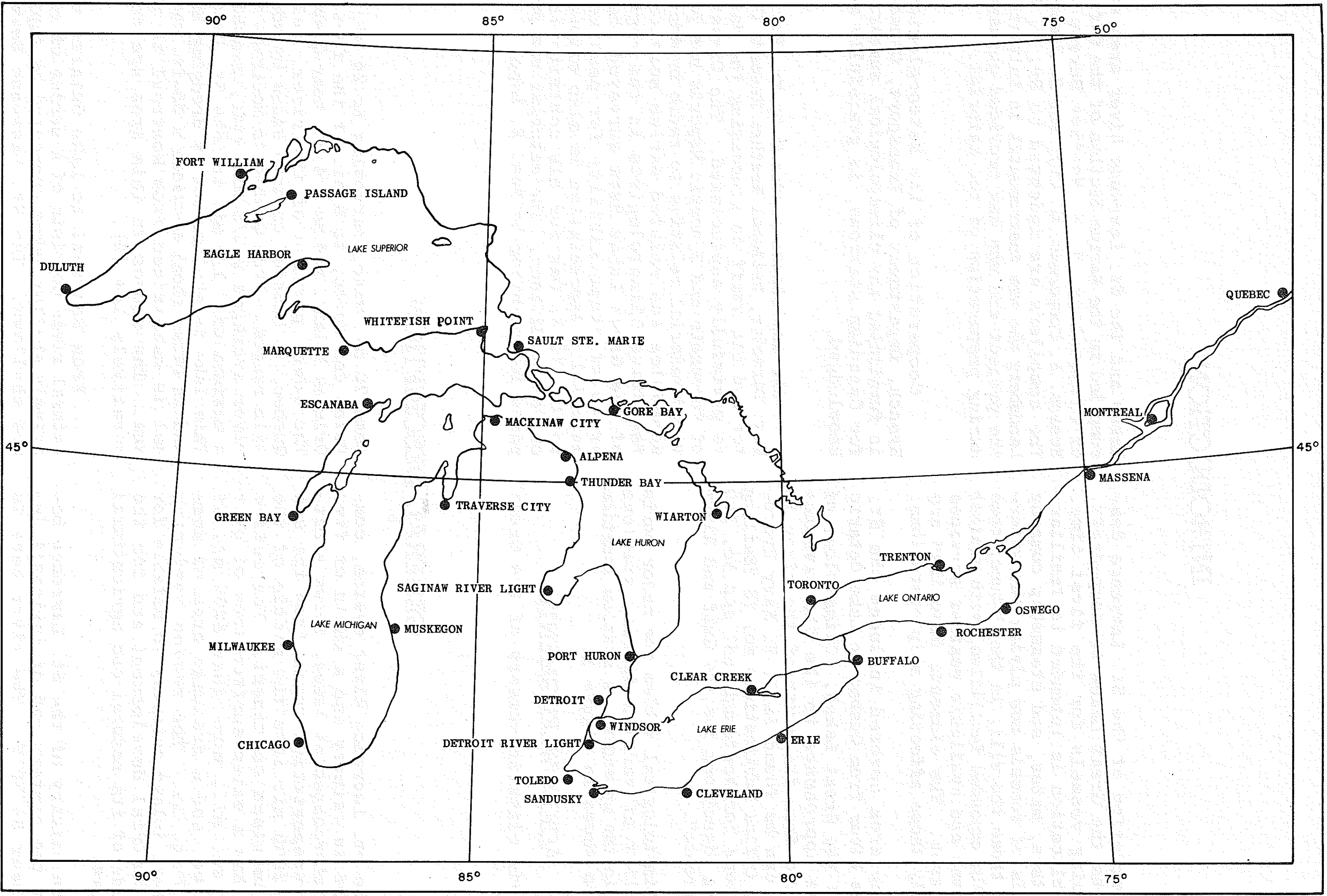

Figure 1. Station location chart of the St. Lawrence Seaway and Great Lakes.

Project, undertaken jointly by the governments of the United States and Canada has provided a navigation control channel at least 450 ft. wide and 27 ft. deep, with a series of 7 locks 800 ft. x 80 ft. x 30 ft., giving a total lift of 225 ft. through this section into the Great Lakes. The major works constructed to provide this access depth, which will make possible operation of some 80 percent of the cargo ships of the world in the Seaway are: 1) Lachine Canal and Locks; 2) Beauharnois Canal and Locks; 3) Wiley-Dondero Ship Channel and Locks, Long Sault Dam and St. Lawrence Power Dam; 4) Iroquois Dam and Lock.

Lakes St. Louis and St. Francis have also been dredged and some shoal areas in the river cleared [14].

The upper St. Lawrence, west of Iroquois, provides a natural channel of deep water through which navigation is unrestricted to Lake Ontario. This easternmost lake of the Great Lakes chain is also the smallest, with a water surface area of 7520 sq. mi. and a drainage basin of 34,800 sq. mi. [11].

The Welland Canal provides the navigation connection between Lakes Ontario and Erie across the Niagara Peninsula. This canal is 27.6 mi. long with 7 locks 800 ft. x 80 ft. x 30 ft. totaling 327 ft. of lift. As a part of the St. Lawrence Seaway project the Canadian government has dredged the canal to the 27-ft. standard depth [14].

Lake Erie is the second smallest of the Great Lakes, with a water surface area of 9930 sq. mi. and a drainage basin of 32,490 sq. mi. In contrast to the other Lakes, which have depths of at least 750 ft., Lake Erie is shallow, reaching a maximum depth of only 210 ft., and over half the area is less than 100 ft. in depth.

The connection between Lakes Erie and Huron is through the Detroit River, Lake St. Clair, and the St. Clair River. The lower Detroit River is broad, with many islands and shallow expanses, while the upper portion is generally deep. Lake St. Clair is an extensive (490 sq. mi.) shallow basin having a maximum depth of about 21 ft. The St. Clair River is generally shallow with several shoal and rapid areas [11].

Extensive rock excavation and dredging have been completed and more work is proceeding under the direction of the U. S. Army Corps of Engineers to provide a 27-ft. channel throughout this entire area between Lakes Erie and Huron [14].

Lakes Huron and Michigan are, in effect, only one lake. The connection through the Straits of Mackinac is so broad and deep that no flow is perceptible between the two lakes and their surfaces stand at the same level [12]. Lake Huron with a surface area of 23,010 sq. mi. and drainage area of 72,620 sq. mi. is the connecting link in the chain of the Great Lakes. It receives the waters of Lake Superior through the St. Marys River and those of Lake Michigan through the Straits of Mackinac. Lake Michigan has a surface area of 22,400 sq. mi. and a drainage area 67,860 sq. mi. and is the only one of the lakes completely within the United States.

The St. Marys River provides the connection between Lakes Huron and Superior. There are five locks, known as the Soo (or St. Marys Falls Ship Canal) Locks in the river. Extensive dredging and construction are being done in this region to provide a 27-ft. channel.

Lake Superior, with a surface area of 31,820 sq. mi. and a drainage area of 80,000 sq. mi. is the largest and deepest (1302 ft.) of the Great Lakes, and, in fact, is one of the largest expanses of fresh water in the world [11].

The edges of the present Great Lakes embrace almost every type of shoreline feature. Lake Superior is characterized by high and rocky shores along a large portion of its coast. The shorelines of the other lakes are, in general, bordered by flat plains which were portions of their bottoms during the time when the great continental glaciers formed their northern or northeastern shores. Sands of glacial origin, later modified by wave action, have been redeposited by the winds in large sand dunes, especially on the eastern and southern shores of Lake Michigan.

In various areas waves have undercut steep cliffs, worn terraces in the rock or glacial drift, and built terraces of loose material on the beaches. In other sections undertow and shoreline currents have deposited and redeposited sands in the shape of sandbars, spits, hooks, and barrier beaches [1].

CLIMATOLOGY

CYCLONES

The location of the Great Lakes in the interior of the North American continent between the source regions of contrasting polar and tropical air masses gives the region more rapidly changing and complex weather patterns than those of more maritime locations. The interaction of the air masses along the polar front produces LOWS or cyclonic storms which usually move toward the Great Lakes under the influence of the general westerly circulation. Over the oceans, areas of cyclogenesis or storm formation remain in relatively fixed locations. Larger seasonal changes in the heat and moisture characteristics of the land surface, and consequently greater modification of air mass properties as compared with the oceans, produce more variable areas of cyclogenesis over land. In addition, the complex relationships of, and sharper contrasts between, southward moving polar air and northward moving tropical air over the continent can produce extremely rapid deepening of LOWS over the Middle West. The development of a storm of major proportions sometimes occurs within less than 24 hr. Such rapid developments have resulted in extreme alertness on the part of the forecaster to provide adequate warning for shipping in the Great Lakes. Severe weather is made more serious on the Great Lakes by a lack of maneuvering room for vessels.

The Great Lakes area is at the junction of the paths of LOWS from several areas of cyclogenesis in the western portion of the continent. Figures 2 to 7 depict the tracks of a selected group of severe storms designed to illustrate the various paths followed by the more intense LOWS during the navigation season. The complete frequency of LOWS in the Great Lakes area is not portrayed.

November is usually the month of the most frequent severe weather during the season. The energy required for the development of large intense storms is released as sharper contrasts between the polar and tropical air over the continent develop. A secondary factor in the intensity of November storms is the heat energy supplied by the relatively warm open waters of the Great Lakes.

The usual sequence of weather conditions associated with the passage of a LOW depends greatly upon the location of the observer with respect to the path of the center. For vessels located south of the path the approach of the LOW is indicated by a falling barometer, a wind shift to south or southeast, a gradually lowering cloud level, and drizzle, rain, or snow. The wind veers at the warm front and precipitation diminishes as the temperature rises. During passage of the warm sector, temperatures and pressure remain about the same. The skies are clear to partly cloudy and the warm air is moist, with haze or fog often present.

The passage of the cold front is generally marked by the approach from the west of a bank of convective clouds, a rapid veering of the wind to west or northwest, sometimes sudden squalls and heavy showers often accompanied by thunder and lightning. After the passage of the cold front the pressure rises quite rapidly, visibility improves, and the clouds usually diminish.

North of the center the rapid changes in the weather sequence found south of the center do not occur. The winds in front of the LOW back from easterly through north to northwest but changes in direction are not sudden. The weather conditions vary gradually from those found ahead of the warm front to those behind the cold front.

The more destructive storms on the Great Lakes usually come from a southwesterly direction. These LOWS originally form in three areas: 1) Texas and New Mexico (figure 2); 2) the Central Rocky Mountains and Great Plains (figure 3); and 3) the Pacific Southwest (figure 4). The movement of storms from all three regions is similar, from the Middle West to the Great Lakes. The season for storms from these regions is generally from October through May.

East and northeast winds usually begin from 12 to 24 hr. prior to the approach of a storm center moving from the southwest. As the storm moves into the middle Mississippi Valley, the barometer falls rapidly, and winds over the lakes increase gradually to gale force. With the closer approach of the LOW, winds continue to increase in speed, backing to the left and veering to the right of the storm track. With the passage of the LOW center and cold front, winds shift suddenly to the northwest and

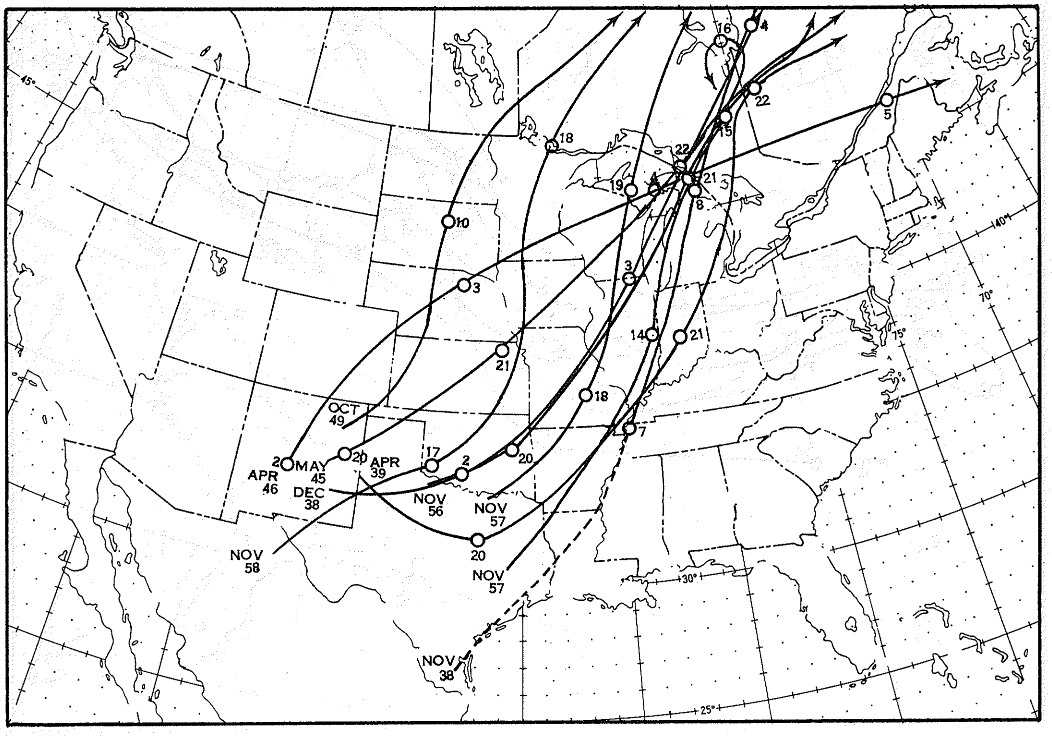

Figure 2. Great Lakes storms originating in the Texas-New Mexico region. Circles give location of storm center at 7:00 a.m. EST of date shown.

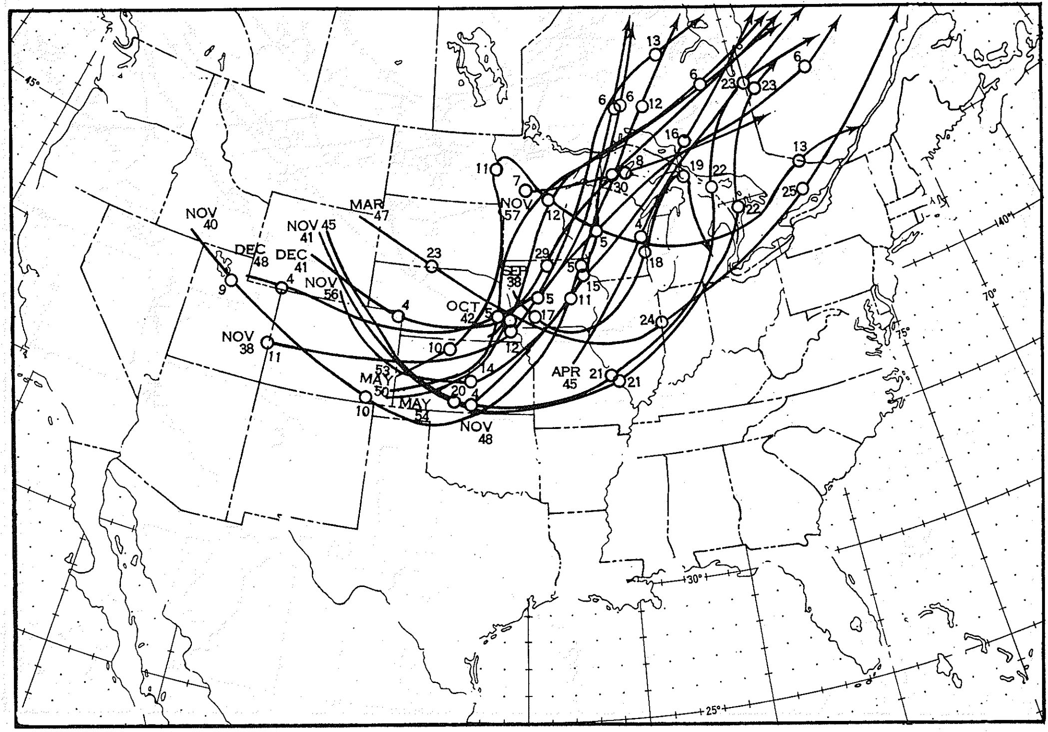

Figure 3. Great Lakes storms originating in the Central Rocky Mountains and Great Plains region. Circles give location of storm center at 7:00 a.m. EST of date shown.

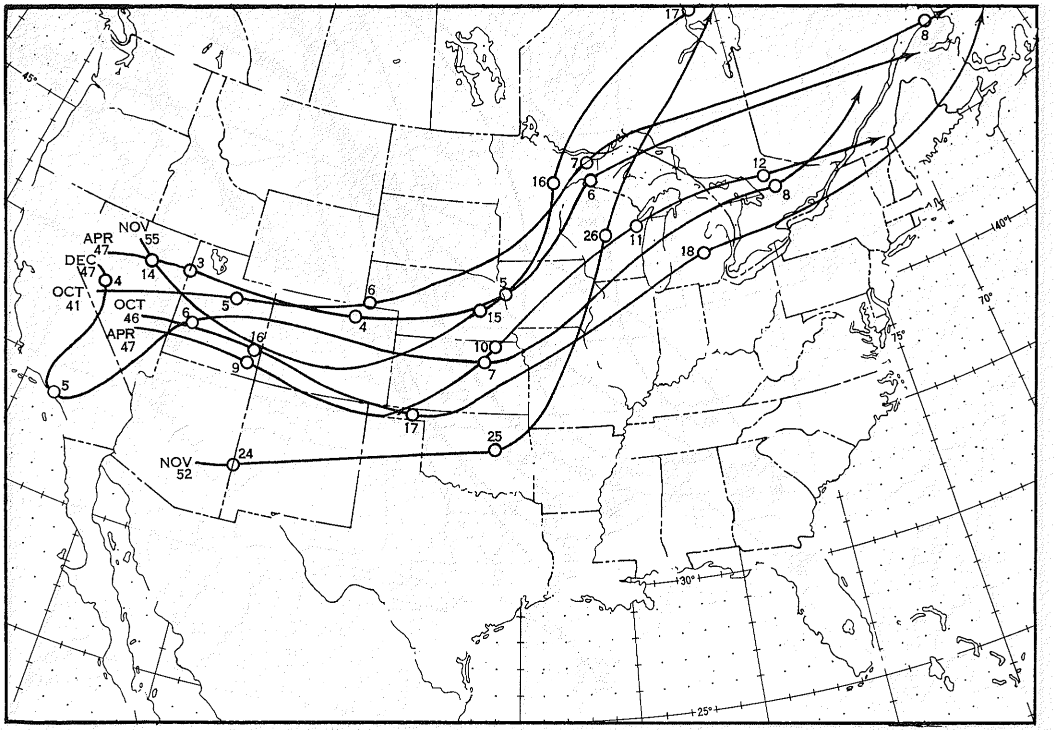

Figure 4. Great Lakes storms originating in the Pacific Southwest region. Circles give location of storm center at 7:00 a.m. EST of date shown.

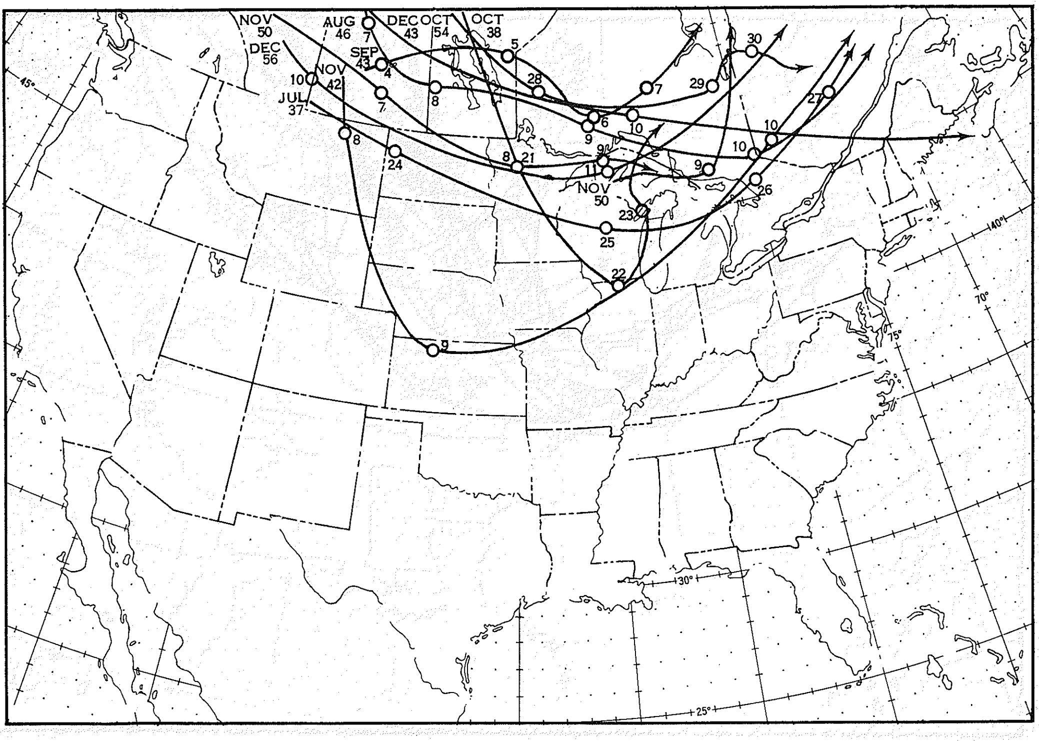

Figure 5. Great Lakes storms originating in the Western Canada region. Circles give location of storm center at 7:00 a.m. EST of date shown.

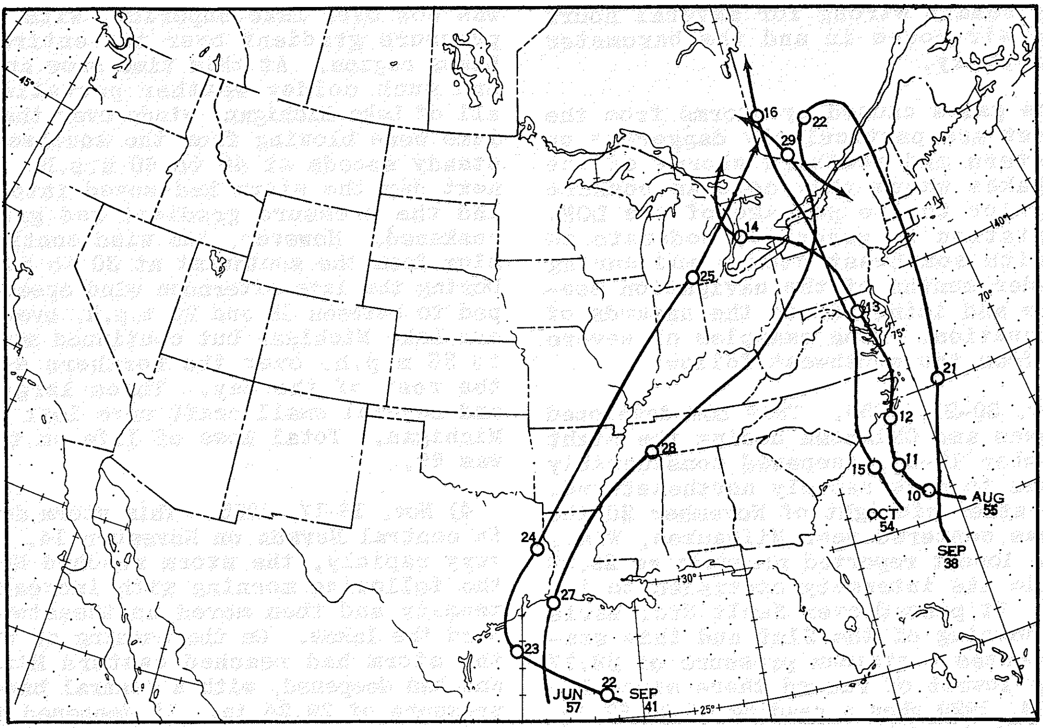

Figure 6. Great Lakes storms of tropical origin. Circles give location of storm center at 7:00 a.m. EST of date shown.

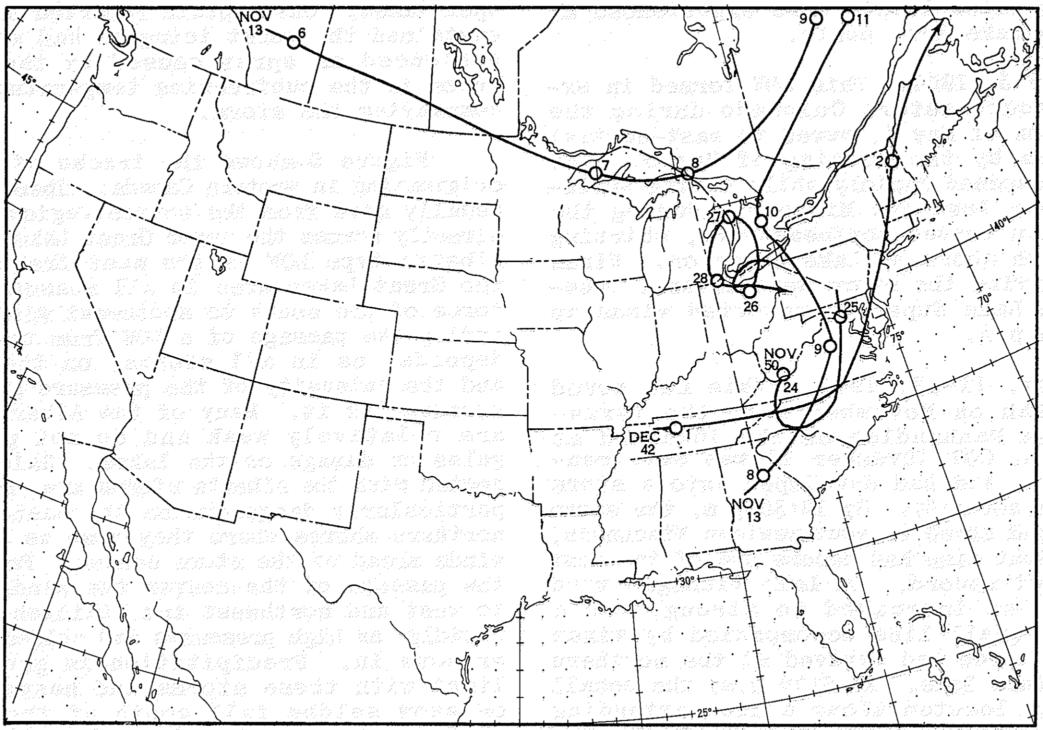

Figure 7. Great Lakes storms originating in the Eastern United States. Circles give location of storm center at 7:00 a.m. EST of date shown.

usually remain strong for several hours as cold air moves in and the barometer rises rapidly.

The gales caused by storms from the southwest are particularly dangerous on the western and southern shores of the Great Lakes where they come as onshore winds prior to the passage of the LOW. Precipitation is generally moderate to heavy with southwest storms and during the colder months of the navigation season snow and icing add to the hazards of ship operation. Some examples of severe storms from the southwest follow:

1) Nov. 20-21, 1956. This LOW developed over Texas and Oklahoma during the night of November 19-20, deepened considerably and began to move rapidly northeastward. Shortly after midnight of November 20 the storm was centered near Milwaukee, Wis., with the lowest reported pressure as 29.29 in. while its intensity continued to increase. It passed over Sault Ste. Marie on the morning of the 21st and this station reported a minimum pressure of 28.77 in., the lowest of record there since December 14, 1920 when a reading of 28.67 in. was recorded. Winds varying from 50 to 60 m.p.h. were reported by many vessels underway on the lakes. High waves resulting from the strong winds made navigation difficult on eastern Lake Superior and low water levels were experienced at western Lake Erie ports.

2) May 5, 1950. This LOW formed in extreme southeastern Colorado during the afternoon of May 4, moved to east-central Nebraska by the morning of May 5. The storm deepened rapidly while moving northward over Iowa and Minnesota during the 5th, then turned northeastward, skirting the north shore of Lake Superior. Winds accompanying the storm were severe. Vessels in Lake Superior reported winds up to 62 m.p.h.

3) Nov. 11-12, 1940. This LOW moved from Utah on November 9 to the Texas-Oklahoma Panhandles on the 10th and at 6:30 a.m. CST November 11 was over central Iowa and had developed into a storm of great severity. By 12:30 p.m. the storm center had moved to southwestern Wisconsin, and at that time had become one of the most severe of record. On Lake Michigan wind speeds had increased to strong, and a severe squall line accompanied by winds of gale force had arrived at the southern end of this lake. At 6:30 p.m. the squall line was located along a line extending from Sault Ste. Marie to near Erie, Pa. It had moved 350 mi. in 6 hr., being rotated around the severe storm center that was now over Lake Superior, with a steep pressure gradient over the entire Great Lakes region. At this time snow and sleet and much colder weather prevailed over all of Lake Michigan; winds over the entire lake were blowing from the southwest with steady speeds of 40 to 60 m.p.h. By the next day the storm had moved into Canada and the pressure gradient had gradually weakened. However, the wind continued to blow from the southwest at 30 to 50 m.p.h. During the late afternoon wind speeds dropped to between 18 and 25 m.p.h. over southern Lake Michigan but continued mostly 25 to 35 m.p.h. over the northern sections the rest of the day. Three large ships and several small craft were lost on Lake Michigan. Total loss of life on the lake was 69.

4) Nov. 16-17, 1955. This storm developed in central Nevada on November 14. Moving very rapidly, the storm reached Nebraska the following morning with increased intensity and then moved northeastward toward the lakes. On the morning of the 16th the storm had reached eastern Minnesota and had deepened, with a central barometric pressure of 29.24 in. It deepened further and then moved northward toward Hudson Bay on the night of the 16th-17th with a central pressure reported as 28.89 in. During the night of the 16th-17th winds varying from 50 to 70 m.p.h. were reported from the open lakes. One Captain reported his ship sustained the worst icing he had ever experienced as spray caused by the winds froze in the subfreezing temperatures accompanying the storm.

Figure 5 shows the tracks of storms originating in western Canada. These storms usually move from the source region almost directly across the upper Great Lakes. This Alberta type LOW is the most frequent in the Great Lakes area in all seasons. The force of the south to southwest winds preceding the passage of a LOW from this area depends, as in all storms, on the depth and the intensity of the pressure gradient surrounding it. Many of the Alberta LOWS are relatively weak and do not produce gales or damage on the lakes. Gales connected with the Alberta storms are, however, particularly dangerous on the eastern and northern shores where they come as onshore winds ahead of the storm center. Following the passage of the center the winds shift to west and northwest and diminish rather rapidly, as high pressures and colder weather move in. Precipitation is generally light with these storms and heavy rains or snow seldom fall south of the storm center. An example of a severe Alberta storm is that of October 28-29, 1954. The LOW was centered over northern Manitoba

TABLE 1

STORM DATES	WINDS AND REMARKS
TEXAS AND NEW MEXICO (FIGURE 2)	
November 17-18, 1958	CARL D. BRADLEY lost in storm, 33 lives lost. 60 m.p.h. over Lakes Michigan and Superior - gusts to 75 m.p.h.
November 14-15, 1957	40 to 45 m.p.h. over Lake Superior, 55 to 60 m.p.h. over Lake Erie.
November 18-19, 1957	45 to 55 m.p.h. over Lake Michigan, over 40 m.p.h. over Lake Ontario.
November 20-21, 1956	50 to 60 m.p.h. over all lakes. Pressure 28.77 in. at Sault Ste. Marie - lowest since 1920. Low water in western Lake Erie.
October 9-10, 1949	60 to 70 m.p.h. general over Lakes Superior and Michigan. Reported 102 m.p.h. and 12-ft. waves at Superior, Wis.
April 4, 1946	50 m.p.h. on Lake Michigan and 40 to 50 m.p.h. on Lake Erie.
May 21-22, 1945	In excess of 50 m.p.h. reported by vessels in the upper lakes.
April 1, 1939	40 to 55 m.p.h. over Lake Erie.
November 7-8, 1938	40 to 50 m.p.h. over Lakes Michigan and Huron.
December 2-3, 1938	40 to 50 m.p.h. over Lakes Huron, Erie, and Ontario.
CENTRAL ROCKY MOUNTAINS AND GREAT PLAINS (FIGURE 3)	
November 8, 1957	Above 60 m.p.h. at Duluth and Buffalo, 40 to 50 m.p.h. on all the lakes.
November 15-16, 1956	40 to 50 m.p.h. on all the lakes.
May 10-11, 1953	HARRY STEINBRENNER sank with 17 lives lost. 45 to 60 m.p.h. over Lake Superior.
May 5, 1950	Dock facilities destroyed at Superior, Wis. Winds at Superior were 62 m.p.h., gusts to 92 m.p.h., at Milwaukee 72 m.p.h., at Green Bay 109 m.p.h.
November 4-6, 1948	40 to 50 m.p.h. over the upper lakes.
December 4-6, 1948	45 to 50 m.p.h. over lower lakes, 60 m.p.h. over upper lakes.
March 25, 1947	Up to 55 m.p.h., above gale force for 20 hr. on Lake Erie.
April 4, 1945	Above 60 m.p.h. over central lakes.
November 22, 1945	45 to 50 m.p.h. over Lake Superior, 35 to 40 m.p.h. over the lower lakes.
October 29-30, 1942	45 to 50 m.p.h. over Lake Michigan, 30 to 35 m.p.h. over the lower lakes.
November 21-22, 1941	35 to 40 m.p.h. over Lakes Erie and Huron.

TABLE 1 (cont.)

STORM DATES	WINDS AND REMARKS
CENTRAL ROCKY MOUNTAINS AND GREAT PLAINS (FIGURE 3) (cont.)	
December 5, 1941	40 to 50 m.p.h. over the upper lakes, 50 to 60 m.p.h. over the lower lakes.
November 11-12, 1940	One of most severe storms. Winds 60 m.p.h. over a large area, up to 80 m.p.h. over Lakes Michigan and Huron. Severe snow and cold wave. Three large ships and several small craft lost on Lake Michigan, 69 lives lost.
September 18-19, 1938	35 to 40 m.p.h. over the upper lakes.
November 12-13, 1938	35 to 45 m.p.h. over Lake Michigan, 40 to 55 m.p.h. over Lake Erie.
PACIFIC SOUTHWEST (FIGURE 4)	
November 16-17, 1955	Above 60 m.p.h. over Lakes Michigan, Huron, and Erie. Severe icing.
November 26, 1952	Up to 60 m.p.h. over Lakes Michigan, Huron, and Erie.
April 5-6, 1947	Up to 60 m.p.h. over Lake Michigan, 50 m.p.h. over Lake Erie.
April 11, 1947	35 to 40 m.p.h. over the eastern lakes.
December 7-8, 1947	35 to 45 m.p.h. over all the lakes.
October 18, 1946	35 to 40 m.p.h. over Lake Erie.
October 7, 1941	35 to 50 m.p.h. over all the lakes.
ALBERTA (FIGURE 5)	
December 11, 1956	40 to 50 m.p.h. reported by many ships on all lakes.
October 28-29, 1954	45 to 60 m.p.h. on Lake Superior, over 50 m.p.h. on Lake Michigan.
November 8-9, 1950	40 to 50 m.p.h. over Lake Superior.
August 9-10, 1946	35 to 45 m.p.h. over the lower lakes.
September 6-7, 1943	50 to 55 m.p.h. over the upper lakes.
December 10-11, 1943	55 to 60 m.p.h. over the upper lakes.
November 9-10, 1942	40 to 50 m.p.h. over Lakes Erie and Ontario.
October 22, 1938	35 to 40 m.p.h. over Lakes Michigan and Superior.
July 25-26, 1937	One of the most severe summer storms. Up to 65 m.p.h. over Lakes Michigan, Huron, and Erie.
TROPICAL CYCLONES (FIGURE 6)	
June 28-29, 1957	50 to 60 m.p.h. over Lakes Erie and Ontario.
August 13-14, 1955	45 to 60 m.p.h. over Lakes Erie and Ontario. 40 m.p.h. on Lake Huron.

TABLE 1 (cont.)

STORM DATES	WINDS AND REMARKS
TROPICAL CYCLONES (FIGURE 6) (cont.)	
October 15-16, 1954	50 to 65 m.p.h. over Lakes Erie and Ontario. 35 to 50 m.p.h. on Lake Huron.
September 25, 1941	40 to 70 m.p.h. over the lower lakes, 35 to 45 m.p.h. over Lakes Michigan and Huron.
September 21-22, 1938	Small boats driven ashore, large vessels unable to leave port. 50 to 60 m.p.h. over Lakes Erie and Ontario.
EASTERN UNITED STATES (FIGURE 7)	
November 25-26, 1950	50 to 60 m.p.h. with gusts to 90 m.p.h. over Lakes Erie and Ontario.
December 1-2, 1942	40 to 60 m.p.h. over Lakes Erie and Ontario.
November 7-10, 1913	One of the most severe lake storms. 50 to 60 m.p.h. western lakes and above 80 m.p.h. over Lakes Erie and Ontario. Over 200 seamen and at least 8 large ships lost.

on the evening of October 27. It then deepened with a central pressure of 29.20 in. and moved southeastward to approximately 100 mi. north of Lake Superior on the 28th and then moved slowly northeastward. Southwesterly winds of 35 to 40 m.p.h. were reported on the upper Great Lakes on October 28, later shifting to northwesterly 45 to 60 m.p.h. over Lake Superior and 50 m.p.h. over Lake Michigan. Winds of 50 m.p.h. were also reported over Lake Michigan on October 29.

Some severe Great Lakes storms, especially over Lakes Ontario and Erie, have been of tropical origin (figure 6). These storms have, however, been very rare, and nearly all had lost their tropical characteristics by the time they reached the lakes. The increased friction between the land surface and the moving storm, and the reduction of the energy supplied by the warm ocean cause a diminution of intensity. The tropical storms which have been most severe in the Great Lakes were those modified and reintensified by the energy processes which form the cyclonic storms of the middle latitudes. One of the more severe tropical storms in the Great Lakes was "Hazel" on October 15-16, 1954. As the storm moved over the eastern United States on the 15th a cold front from the west moved into the circulation and the added energy from this interaction of the warm and cold air kept the storm intense and fast moving on a path from North Carolina to Canada. As "Hazel" crossed Lake Ontario, winds over the Great Lakes increased to southwesterly gales and speeds of 45 to 60 m.p.h. were reported over Lakes Erie and Ontario and 32 to 50 m.p.h. over the other lakes.

LOWS developing in the eastern States usually do not seriously affect weather over the Great Lakes. The normal movements of storms from the states east of the Appalachians is eastward or northeastward over the Atlantic. However, on rare occasions the general circulation is favorable for the movement of intense LOWS developed in the coastal region into the eastern Great Lakes. Precipitation is usually quite heavy and widespread because of the inflow of very moist air off the Atlantic.

The outstanding example of this storm type (figure 7) is the storm of November 7-10, 1913. An Alberta LOW moved into the Lake Superior region on November 7 and 8, causing gale winds over the upper lakes. A secondary circulation developed in central Georgia on the morning of November 8 and moved to central Virginia within 24 hr. as it deepened very rapidly, forming a very tight pressure gradient. The original Alberta LOW in the meantime drifted northeastward and the new storm moved north-northwestward and was centered between Lakes Huron and Erie on the morning of the 10th. High winds and heavy snow covered the entire lakes region. Over the eastern lakes winds were above 60 m.p.h. for 16 hr. At least eleven steamers were lost and several others driven ashore with a loss of life estimated at more than 250.

Table 1 gives information on the area of formation, region affected, highest winds, and damages for the storms shown in figures 2 to 7.

WINDS

The numerous shifts in wind and changes in weather encountered along the waterway are due to the many moving cyclones and anticyclones which traverse the area. Although winds from the westerly quadrants generally prevail, winds from any direction are likely to be encountered, shifting in relation to the vessel's position from the center of the moving LOW or HIGH. If a LOW is predicted to pass north of the vessel the winds can be expected to veer and if to the south, to back.

During the spring and fall months of the navigation season strong winds are most likely to be encountered in rapidly deepening and fast moving LOWS or in steep gradient HIGHS. In the summer months strong winds are rare but may be encountered in thunderstorms or squall lines.

In general winds experienced by vessels operating on the lakes are stronger than those recorded at shore stations bordering the lakes. This is due primarily to differences in surface friction between land and water. Recent work [4] on Lake Erie indicates that to convert land winds to over water winds the multiplication factor varies from 0.76 to 2.35 depending on the air mass (determined by air-water temperature differences) and the station location. Nearly all of the factors, however, are over 1.0.

Lake breezes are experienced on all the Great Lakes during the warmer months on clear days with weak pressure gradients. These breezes are similar in origin to the sea breeze experienced on oceanic coasts but they rarely extend more than 1 or 2 miles inland.

Table 2 gives the highest 1-minute winds reported from anemometer-equipped vessels on Lakes Erie, Huron, Michigan, and Superior for each year since 1941. Observations on Lake Ontario have been too limited in number to establish a reasonable maximum velocity. The highest velocity listed is 93 m.p.h. from the northwest, recorded on Lake Superior in a squall line on June 25, 1950. The velocities given in the table were recorded only at 6-hour intervals (1 and 7 a.m. and p.m. EST) during the navigation season. Higher values may and probably have occurred during the winter months and at times other than those given.

For the U. S. stations listed in the climatological tables appearing in the appendix Green Bay recorded the highest wind velocity with a fastest mile of 109 from the southwest in May of 1950. For the Canadian stations listed Quebec (Ancienne Lorette Airport) had the highest recorded maximum hourly mileage with 60 from the southwest in February of 1956.

TABLE 2

HIGHEST 1-MINUTE WIND (M.P.H.) REPORTED AT 1 & 7 a.m. and p.m. (EST)

Year	Lake Erie	Lake Huron	Lake Michigan	Lake Superior
1941	W 48	WSW 57	NW 50	NNW 62
1942	WSW 60	WSW 64	WNW 55	S 71
1943	WSW 65	WNW 50	SSW 58	WSW 60
1944	NE 44	NW 43	WSW 55	NNE 48
1945	WNW 60	SSW 62	WNW 56	NW 60
1946	SW 58	W 53	S 51	NW 54
1947	NW 59	SSE 50	ESE 45	WSW 50
1948	WSW 46	NNW 59	NW 52	WSW 55
1949	W 60	NNE 57	NNW 49	N 60
1950	SW 80	NW 55	NW 56	NW 93
1951	WSW 42	WSW 58	SW 56	WSW 62
1952	SW 53	SW 65	SSW 51	WSW 52
1953	WSW 56	NW 52	NNW 53	ENE 57
1954	W 52	NW 52	E 55	N 50
1955	W 60	SW 66	WSW 67	NW 55
1956	WSW 53	W 50	SSW 53	N 57
1957	WSW 83	SW 62	WSW 56	W 54
Highest	WSW 83 (1957)	SW 66 (1955)	WSW 67 (1955)	NW 93 (1950)

The description of the wind regimes for the St. Lawrence Seaway and Great Lakes will be general as detailed monthly information on percentage frequencies of direction and Beaufort force are contained in figures 8 through 19 for representative stations along the waterway. The wind roses for Quebec, Montreal, and Toronto were tabulated from airport data. The following description is based on data from land stations surrounding the lakes. Actual wind conditions on the lakes may vary from those described.

The winds encountered along the St. Lawrence River between Quebec and Lake Ontario tend to parallel the northeast-southwest axis of the river. Except for the spring months at Quebec when the winds are predominantly from the northeast, the prevailing winds at Quebec and Montreal are from the southwest with high percentages of northerlies and northeasterlies. At Massena the regime is slightly different with southwesterly winds predominating during most of the navigation season. During the winter and early spring months northeasterly winds are frequently encountered at Massena and may at times prevail over the southwesterlies. The mean wind speed on this section of the river averages between 7 and 11 kt. with the higher speeds occurring in the colder months. The mean number of days per year with winds of 28 kt. or over is 30 and 17 for Quebec and Montreal, respectively. During the navigation season strong winds are not likely to be encountered except in the early spring and late fall. Table 3 gives the mean number of days winds of 28 kt. or greater were encountered at Quebec and Montreal and of 34 kt. or greater at Massena.

A characteristic common to all the Great Lakes is that the effects of high winds are generally most serious when the winds blow parallel to the long axis of the lake for any considerable length of time. These winds have a long fetch and can build up a considerable sea.

On Lake Ontario the prevailing winds during the navigation season are generally from the southwest, almost paralleling the long axis of the lake. At the east end of the lake a funneling effect has been noted with west and west-southwest winds. These winds, on encountering the land on either side of the lake in the vicinity of the Thousand Islands, are accelerated, and what would be a strong blow in midlake often becomes a disastrous gale in this restricted area. Mexico Bay, north of Oswego in the extreme eastern part of the lake, used to be called "the graveyard of Lake Ontario" because ships foundered there in strong northwest, north, and northeast winds. The average wind speed on the lake varies from 6 to 9 kt. in the summer and from 9 to 11 kt. in the winter. Rochester recorded a fastest mile of 73 from the west in January 1950 and a maximum hourly mileage of 56 from the southwest was recorded in Toronto in March 1942. The maximum hourly mileage is the total wind flow for one hour and does not represent gusts which were probably much higher.

Lake Erie, which is comparatively shallow, is oriented in a northeast-southwest direction and strong winds from these directions raise a dangerous sea. Prevailing winds, in the sense of being more frequent than other directions, are from the southwest. Due to the orientation of the lake the strongest winds come most frequently from the westerly quadrants with a secondary maximum from the northeast. In the western end of Lake Erie and in the lower Detroit River where lack of water may restrict navigation, high easterly or westerly winds may raise or lower the water level. Changes as great as 6 ft. have occurred within 8 hr. The average monthly wind speed varies from about 7 kt. to 16 kt. with the higher averages occurring during the winter months in the eastern part of the lake. Of the shore stations reporting on Lake Erie, Buffalo, which has a 3 to 4 kt. greater average wind speed than the other stations due to a funneling effect at the eastern

TABLE 3

MEAN NUMBER OF DAYS WITH WINDS OF 28 KT. OR GREATER

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	No. of Years
Quebec	5	3	5	4	3	1	0.4	0.4	0.7	1	3	4	30	10
Montreal	4	2	2	2	1	+	0	+	1	1	2	2	17	10
Massena*	1	1	1	1	1	2	0.4	0.4	0.4	1	1	2	12	5

+ Amount less than 1
* 34 kt. or greater

extremity of the lake, recorded a fastest mile of 91 from the southwest in January 1950. Clear Creek, Ont. recorded a high maximum hourly mileage of 58 from the southwest in March 1955.

Due to the configuration of Lake Huron strong winds from any direction may build up a considerable sea. The long fetch, for high northeast and east winds over the waters from Georgian Bay to the Michigan shore, develops high seas which run athwart the normal traffic pattern on the lake. In the northern part of the lake where the shores converge winds from the south may be dangerous becuase of the funneling effect. Similarly, winds from the north may be dangerous in the pointed southern end of the lake, especially near the mouth of the St. Clair River [11]. On Lake Huron the winds vary considerably in direction, however, in general the prevailing winds are from the western quadrants usually between southwest and northwest. The range of the mean wind speed does not have as large a variation as the mean wind speeds on Lake Erie. It generally varies from about 8 kt. in the summer months to 11 kt. in the winter months. For the stations reporting on Lake Huron, Alpena recorded a fastest mile of 61 from the southwest in November 1940 and Gore Bay had a high maximum hourly mileage of 49 from the southwest in February 1953.

On Lake Michigan, dangerous seas are generally experienced with strong northerly and southerly winds due to the long fetch these winds have over the north-south oriented lake. Thus, in the southern part of the lake northerly winds are the most dangerous, while in the northern part of the lake southerly winds are most likely to hinder navigation. These winds may also create strong currents which make conditions hazardous at harbor entrances. The stronger winds of the early spring, fall, and winter are usually from the western quadrants, making entrance to the restricted harbor channels on the east shore especially difficult. Although the predominant wind directions are generally from the western quadrants, there is a considerable variation in direction, some stations during the warmer months reporting prevailing winds from the easterly quadrants. The mean wind speed on Lake Michigan varies from about 8 kt. in the summer to about 13 kt. in the winter and spring. On this lake Green Bay recorded a fastest mile of 109 from the southwest in May 1950, which is the highest velocity recorded on all the lakes. The high wind was the result of an extratropical LOW which was unusually intense for that time of the year.

Lake Superior is large enough so that strong winds from any direction have sufficient fetch to build up a sea. Although the long axis of the lake is east-west its southern shore is nearly divided in two by the Keweenaw Peninsula. This tends to diminish the seas created by strong easterly or westerly winds for those vessels navigating in the southern part of the lake. On the western half of the lake the winds are predominantly from the west and the northwest during the fall, winter, and early spring, and during the warmer months from the east and northeast. On the eastern half of the lake, as represented by Sault Ste. Marie, there is a complete reversal with easterly winds in the colder months and westerly winds in the summer months. This effect is due, in part, to lake breezes. Duluth, located on the western end of the lake, experiences easterlies during the warmer months and Sault Ste. Marie on the eastern extremity of the lake experiences westerlies during these months. The mean wind speed on Lake Superior varies between 7 kt. and 13 kt. with the higher speeds occurring in the winter and spring. Marquette which is well protected has the lowest average wind speeds ranging from about 7 to 9 kt. On Lake Superior, a maximum fastest mile of 91 from the south, was recorded at Marquette in May 1934. It occurred during a severe local thunderstorm. For the Canadian stations Caribou Island recorded a high maximum hourly mileage of 71.

The predominant winds in figures 8 through 19 may differ slightly from the prevailing directions contained in the climatological tables in the appendix because different periods of record were used.

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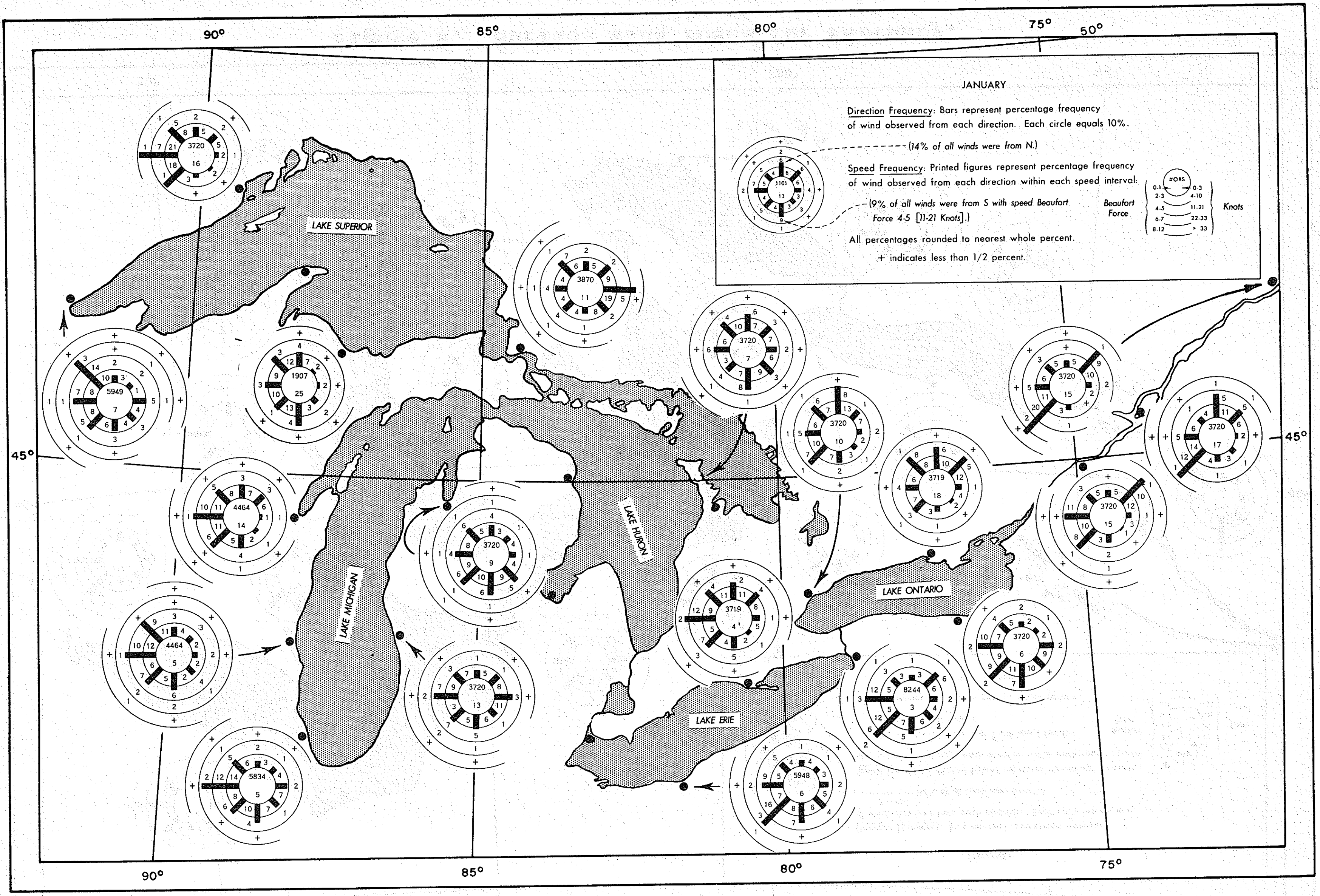


JANUARY

Direction Frequency: Bars represent percentage frequency of wind observed from each direction. Each circle equals 10%.

(14% of all winds were from N.)

Speed Frequency: Printed figures represent percentage frequency of wind observed from each direction within each speed interval:

(9% of all winds were from S with speed Beaufort Force 4-5 [11-21 Knots].)

All percentages rounded to nearest whole percent.

+ indicates less than 1/2 percent.

Figure 8. Surface wind roses for January.

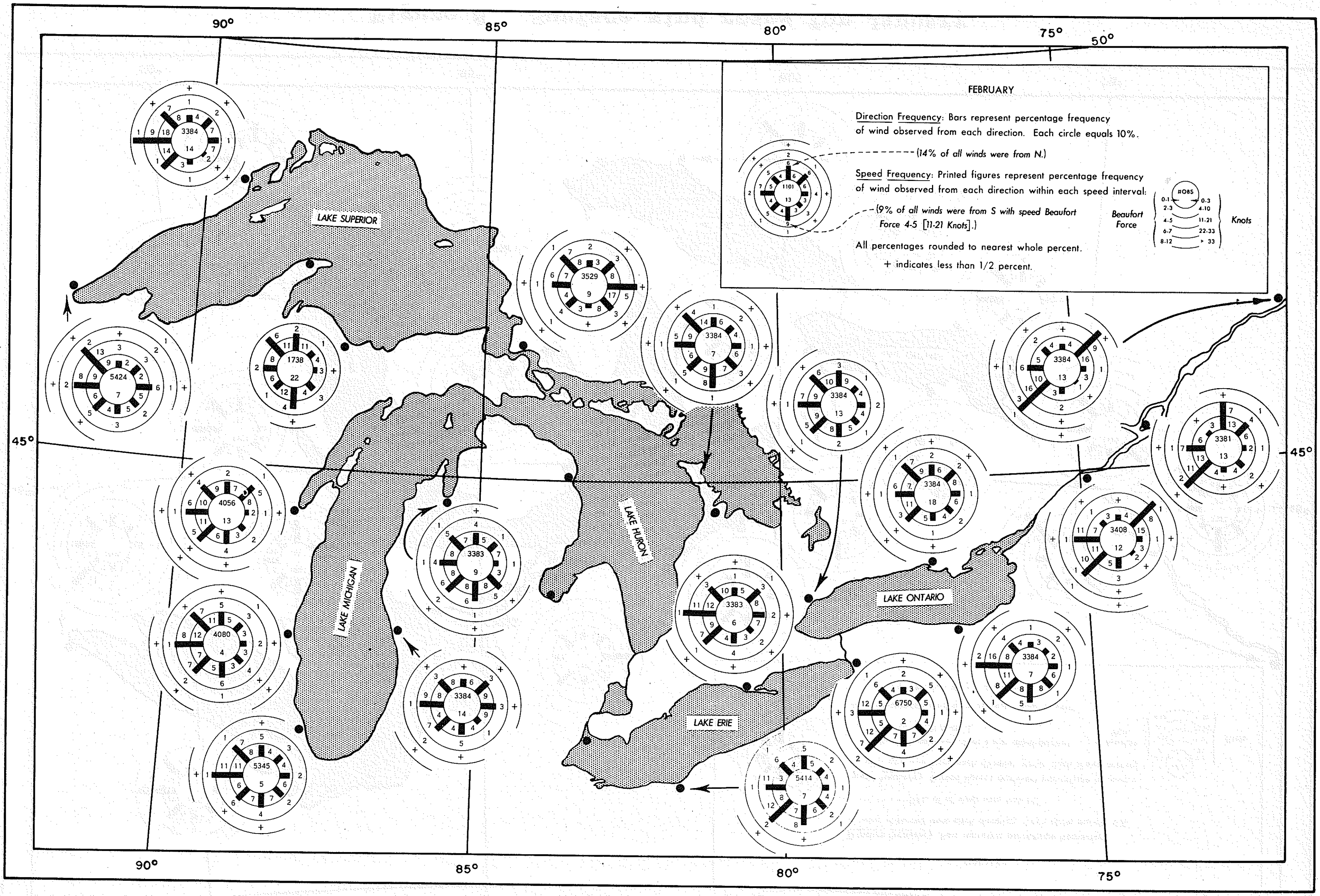


Figure 9. Surface wind roses for February.

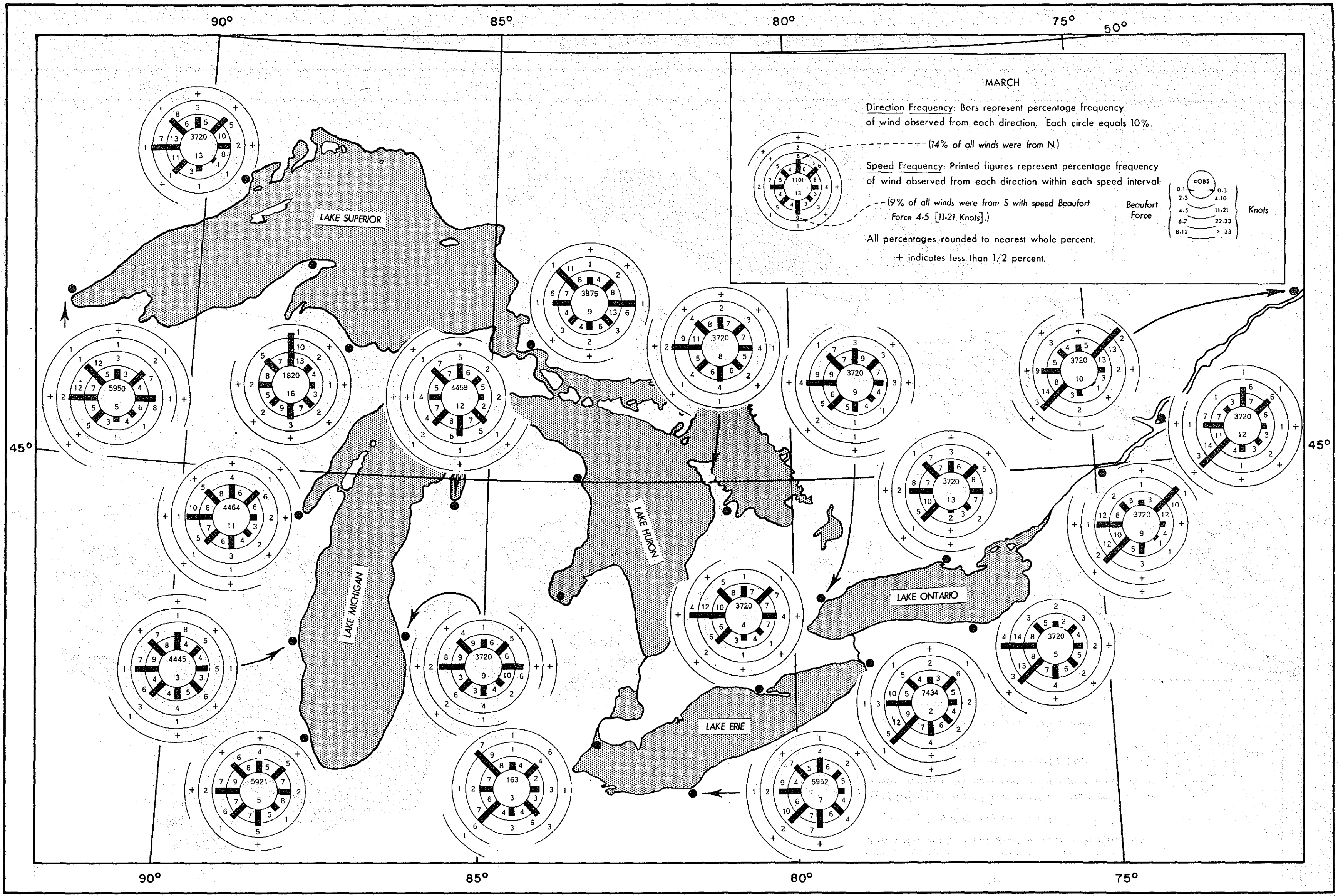
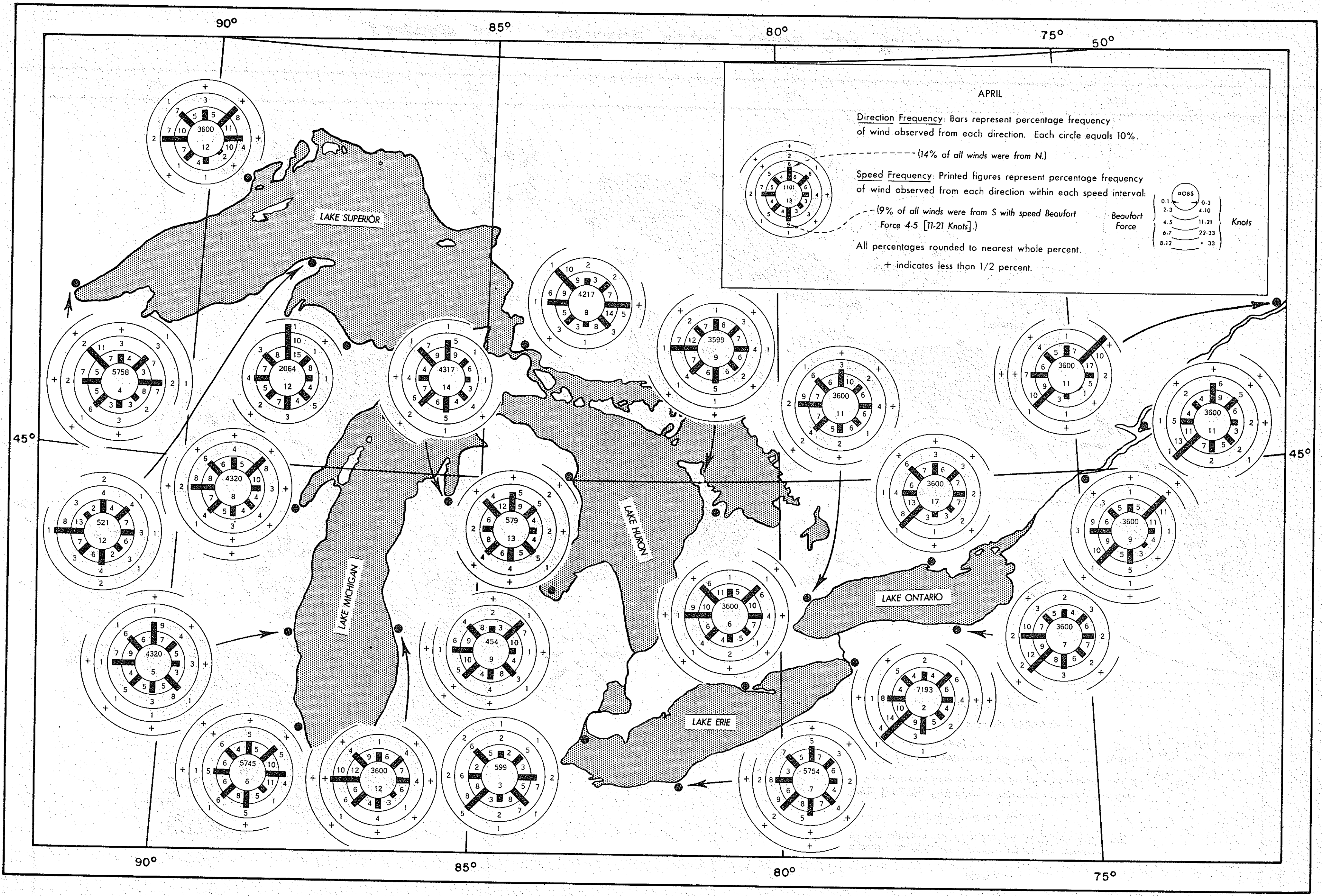


Figure 10. Surface wind roses for March.



APRIL

Direction Frequency: Bars represent percentage frequency of wind observed from each direction. Each circle equals 10%.

(14% of all winds were from N.)

Speed Frequency: Printed figures represent percentage frequency of wind observed from each direction within each speed interval:

(9% of all winds were from S with speed Beaufort Force 4-5 [11-21 Knots].)

All percentages rounded to nearest whole percent.

+ indicates less than 1/2 percent.

Figure 11. Surface wind roses for April.

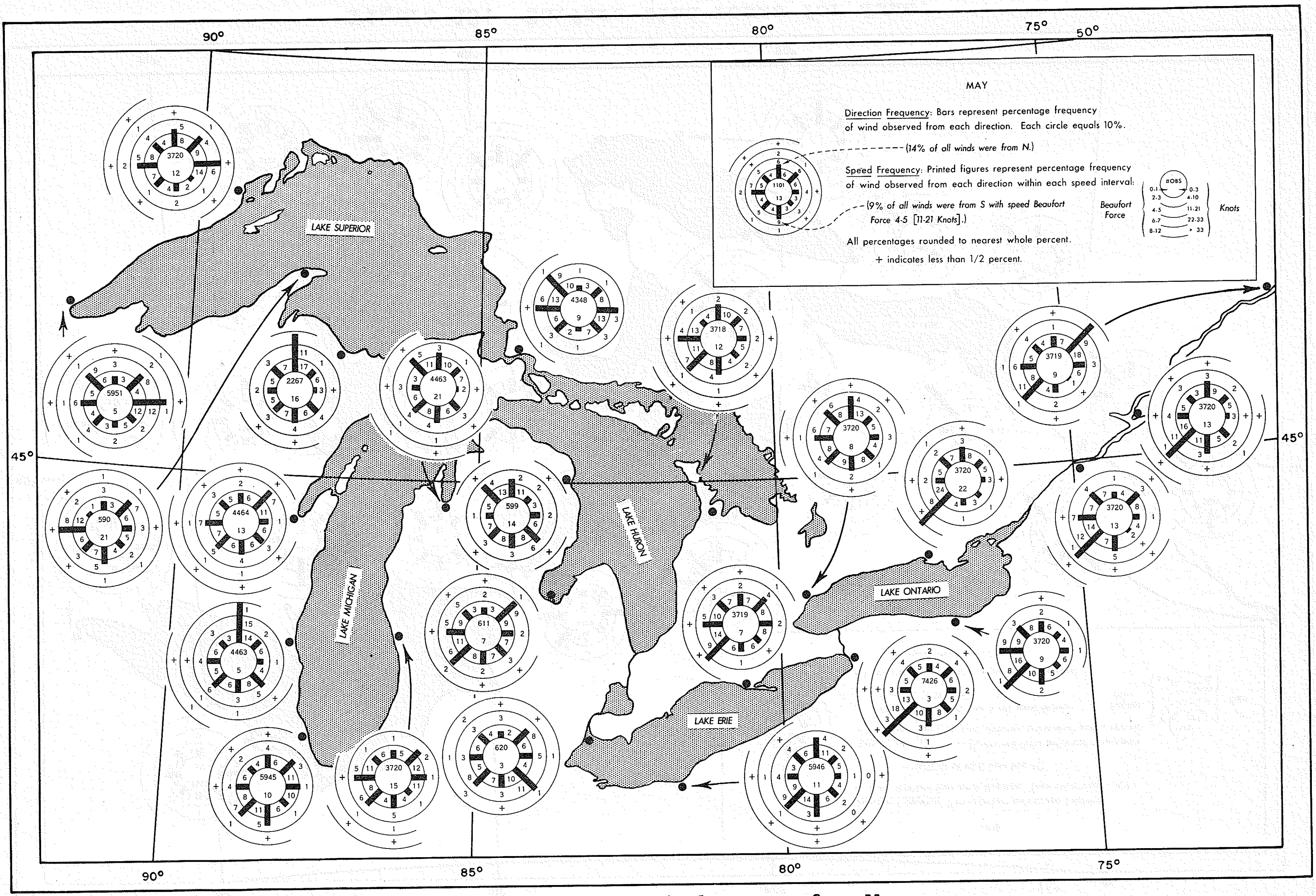


Figure 12. Surface wind roses for May.

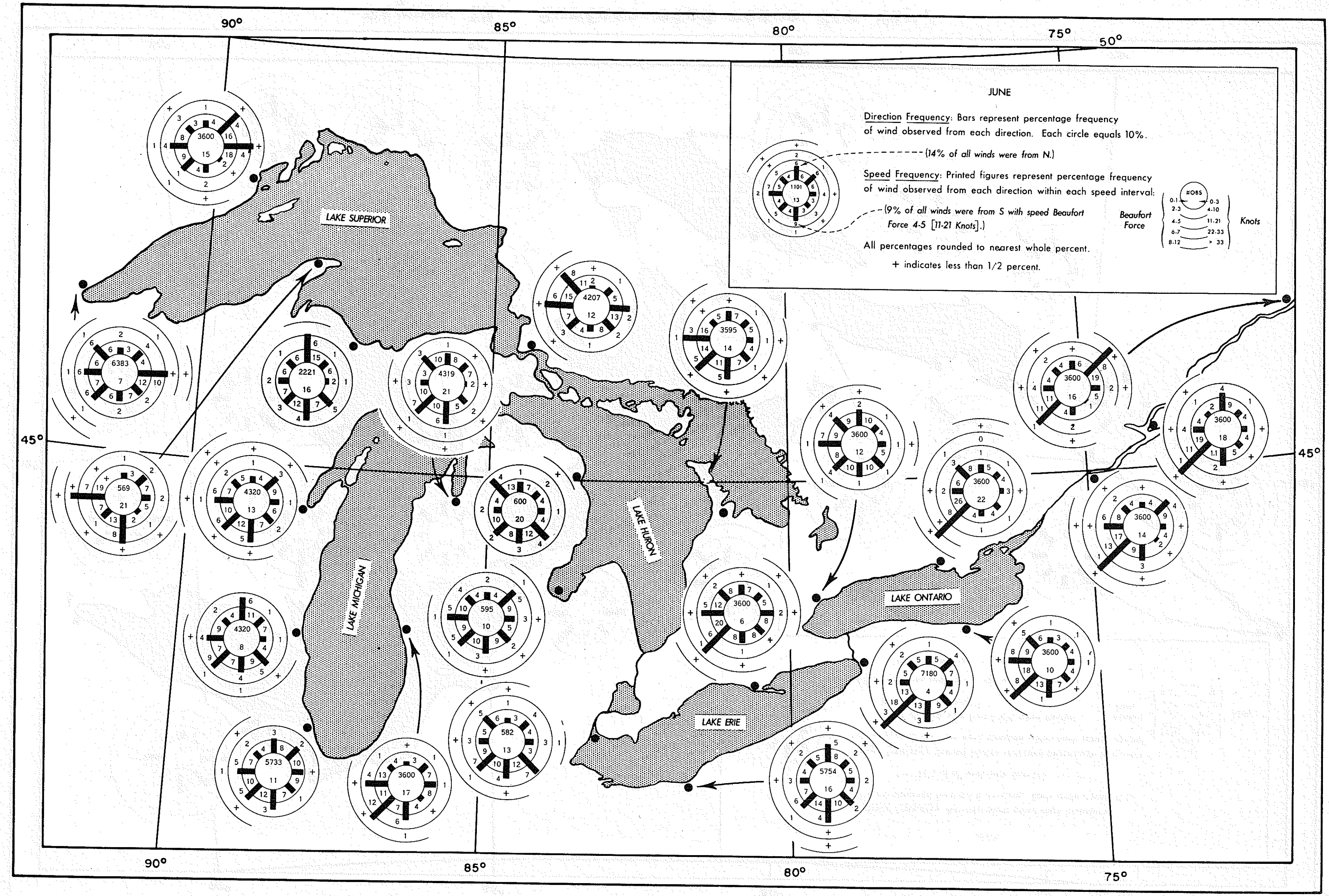
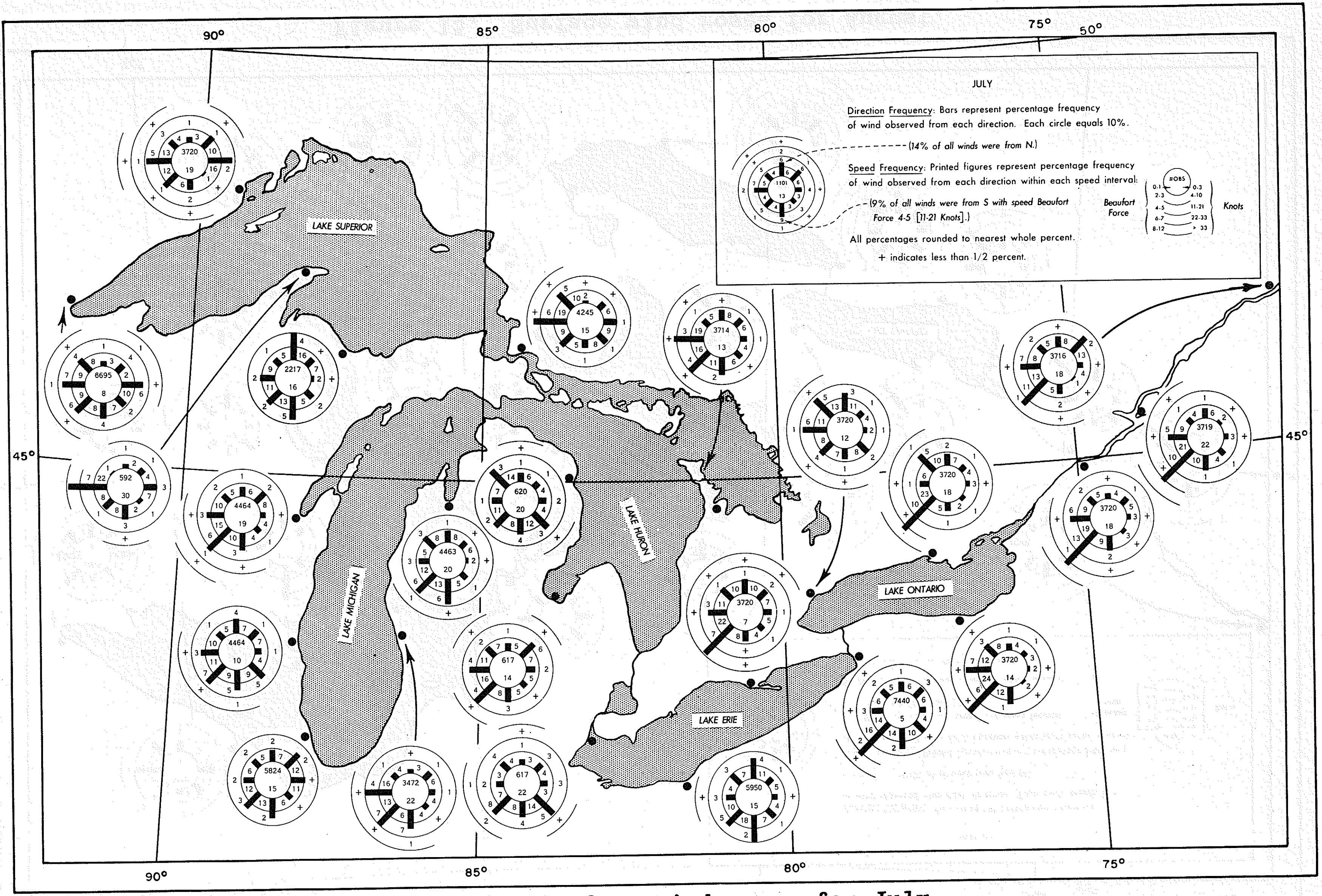


Figure 13. Surface wind roses for June.



JULY

Direction Frequency: Bars represent percentage frequency of wind observed from each direction. Each circle equals 10%.

(14% of all winds were from N.)

Speed Frequency: Printed figures represent percentage frequency of wind observed from each direction within each speed interval:

(9% of all winds were from S with speed Beaufort Force 4-5 [11-21 Knots].)

All percentages rounded to nearest whole percent.

+ indicates less than 1/2 percent.

Figure 14. Surface wind roses for July.

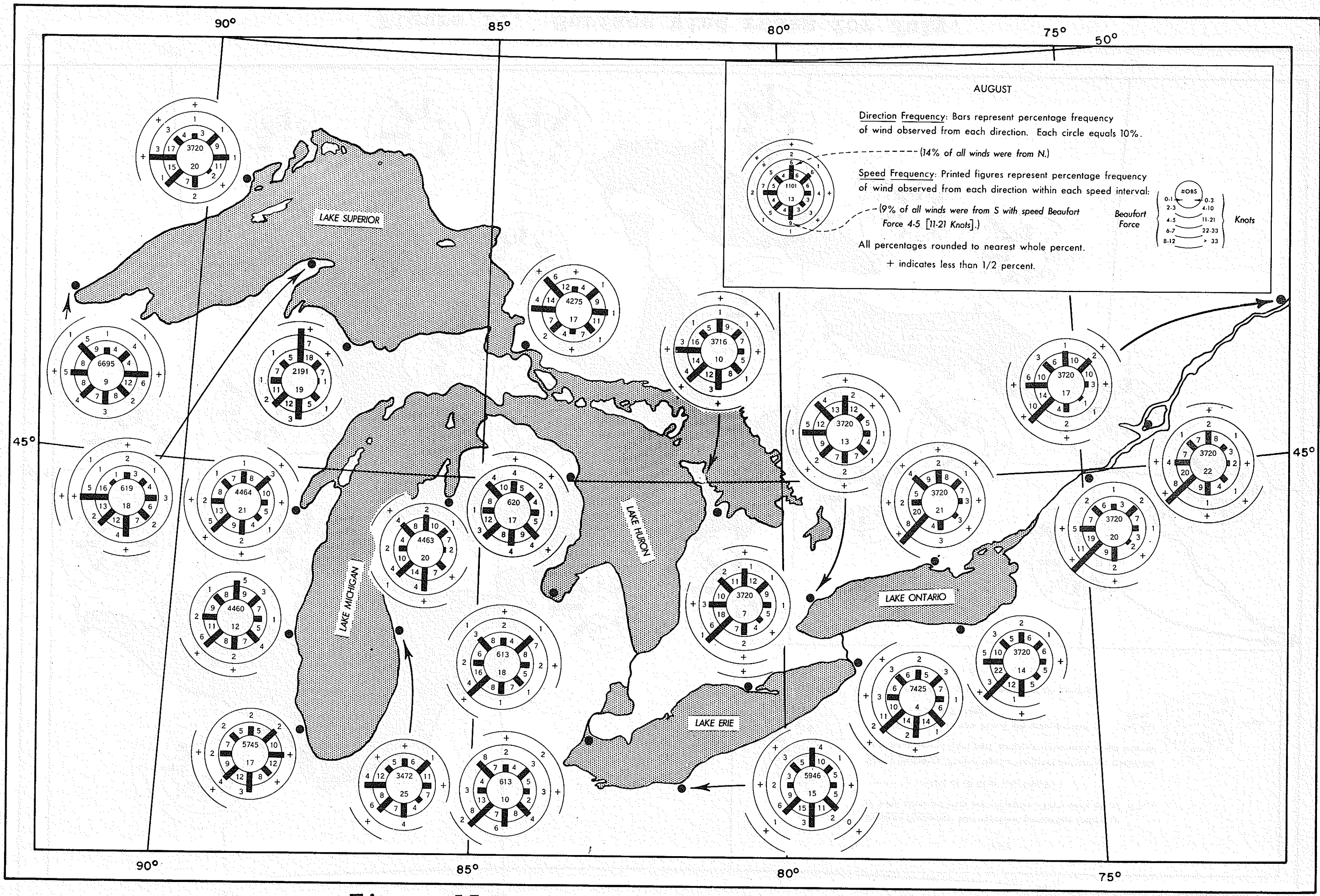


Figure 15. Surface wind roses for August.

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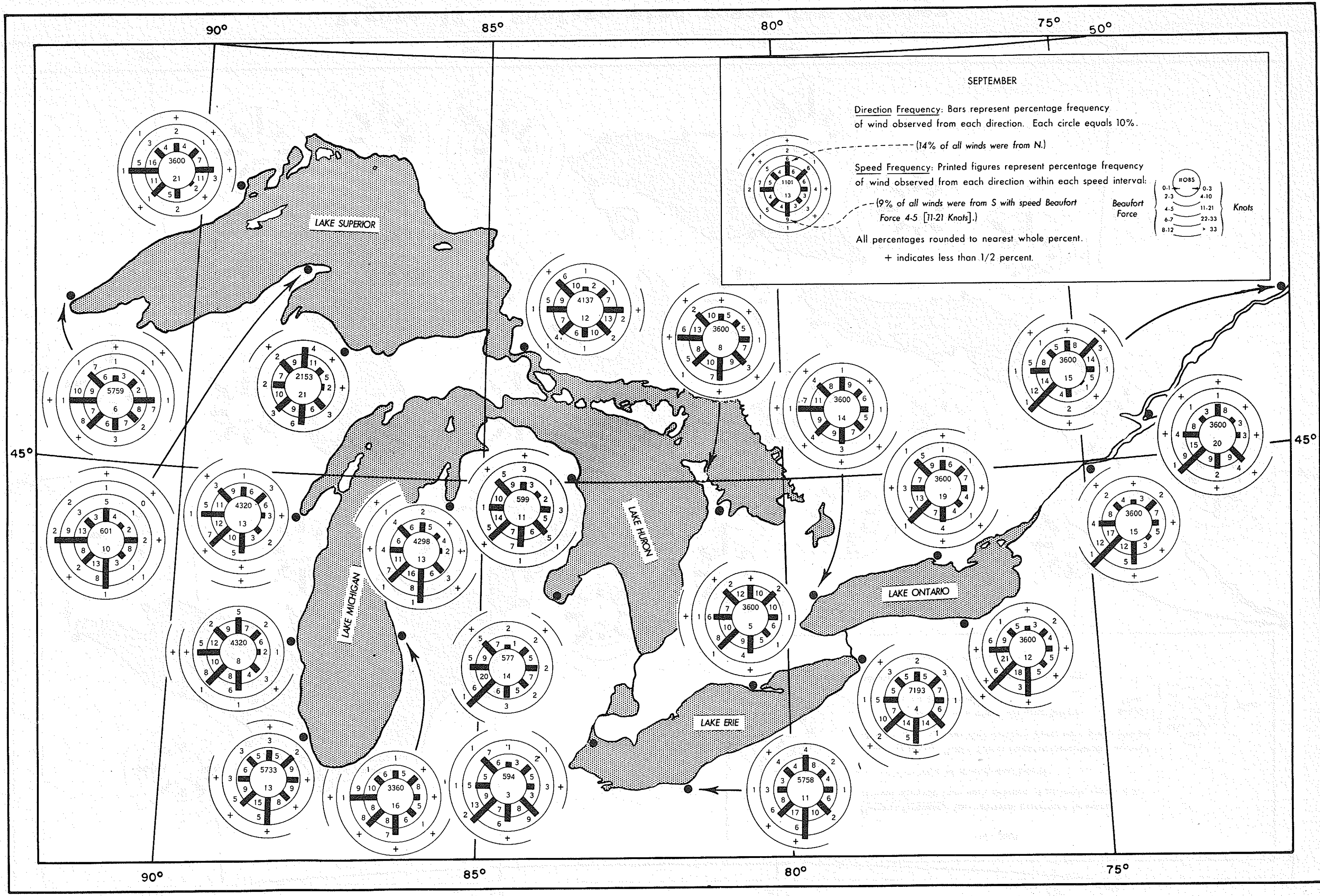
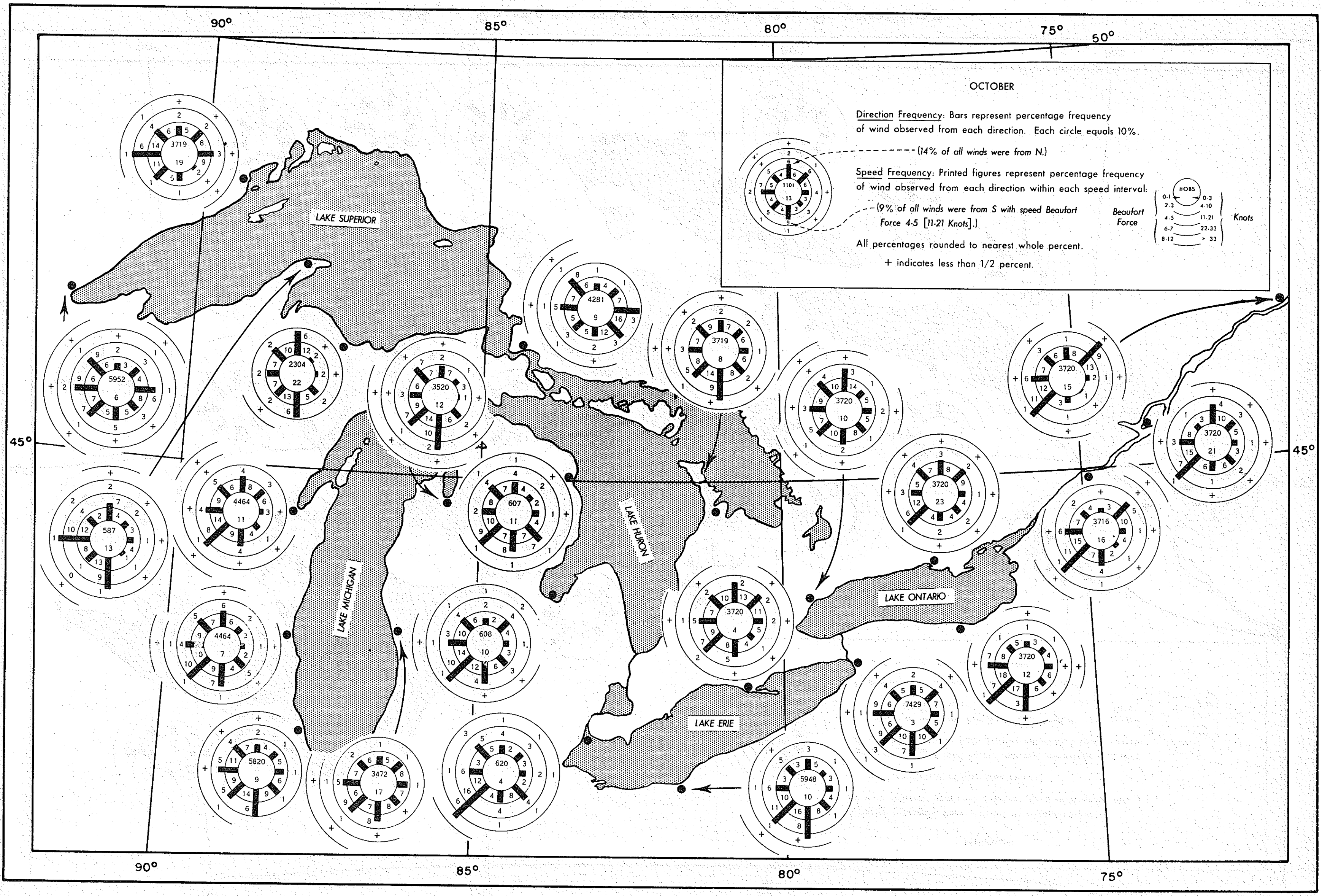


Figure 16. Surface wind roses for September.



OCTOBER

Direction Frequency: Bars represent percentage frequency of wind observed from each direction. Each circle equals 10%.

(14% of all winds were from N.)

Speed Frequency: Printed figures represent percentage frequency of wind observed from each direction within each speed interval:

(9% of all winds were from S with speed Beaufort Force 4-5 [11-21 Knots].)

All percentages rounded to nearest whole percent.

+ indicates less than 1/2 percent.

Figure 17. Surface wind roses for October.

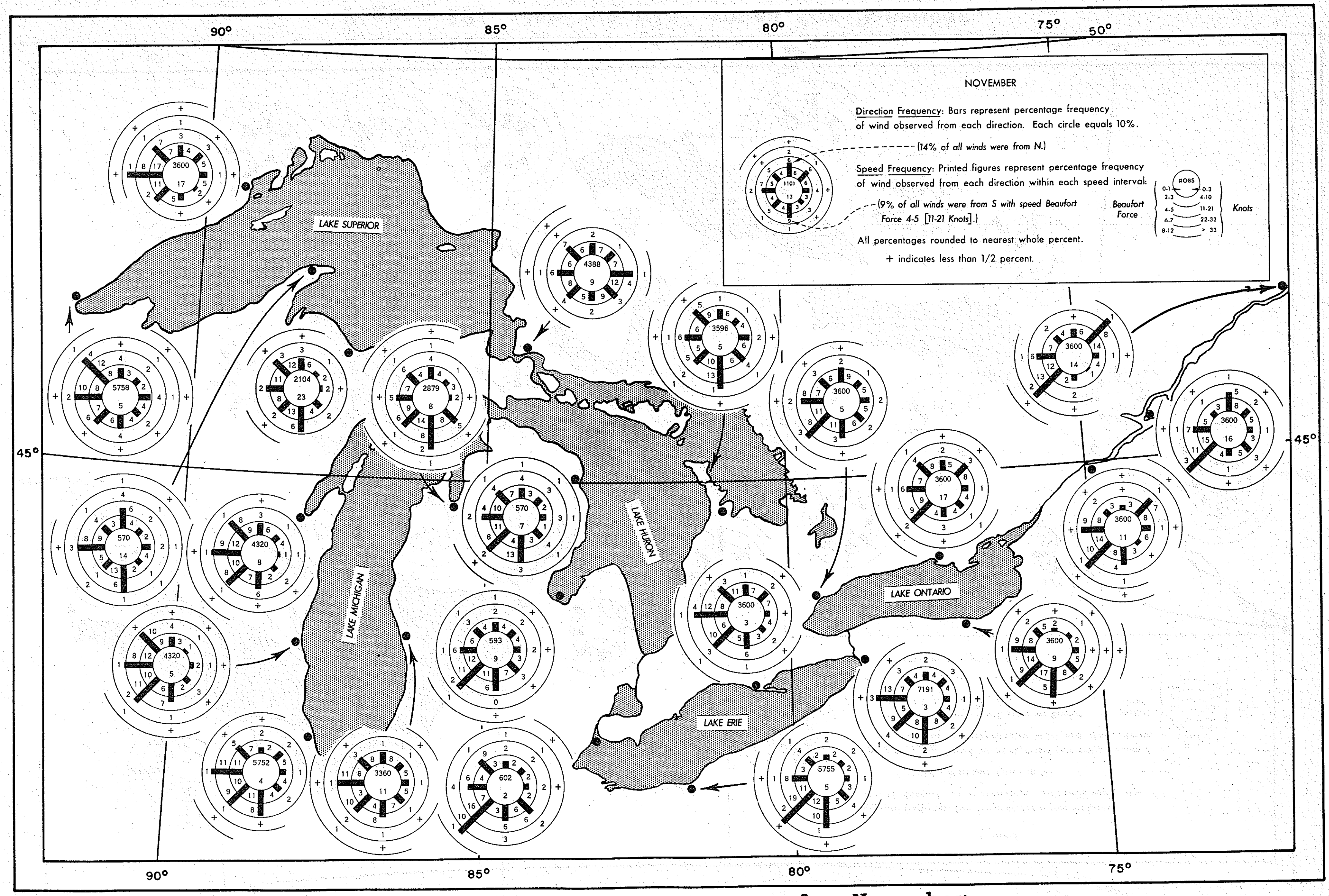
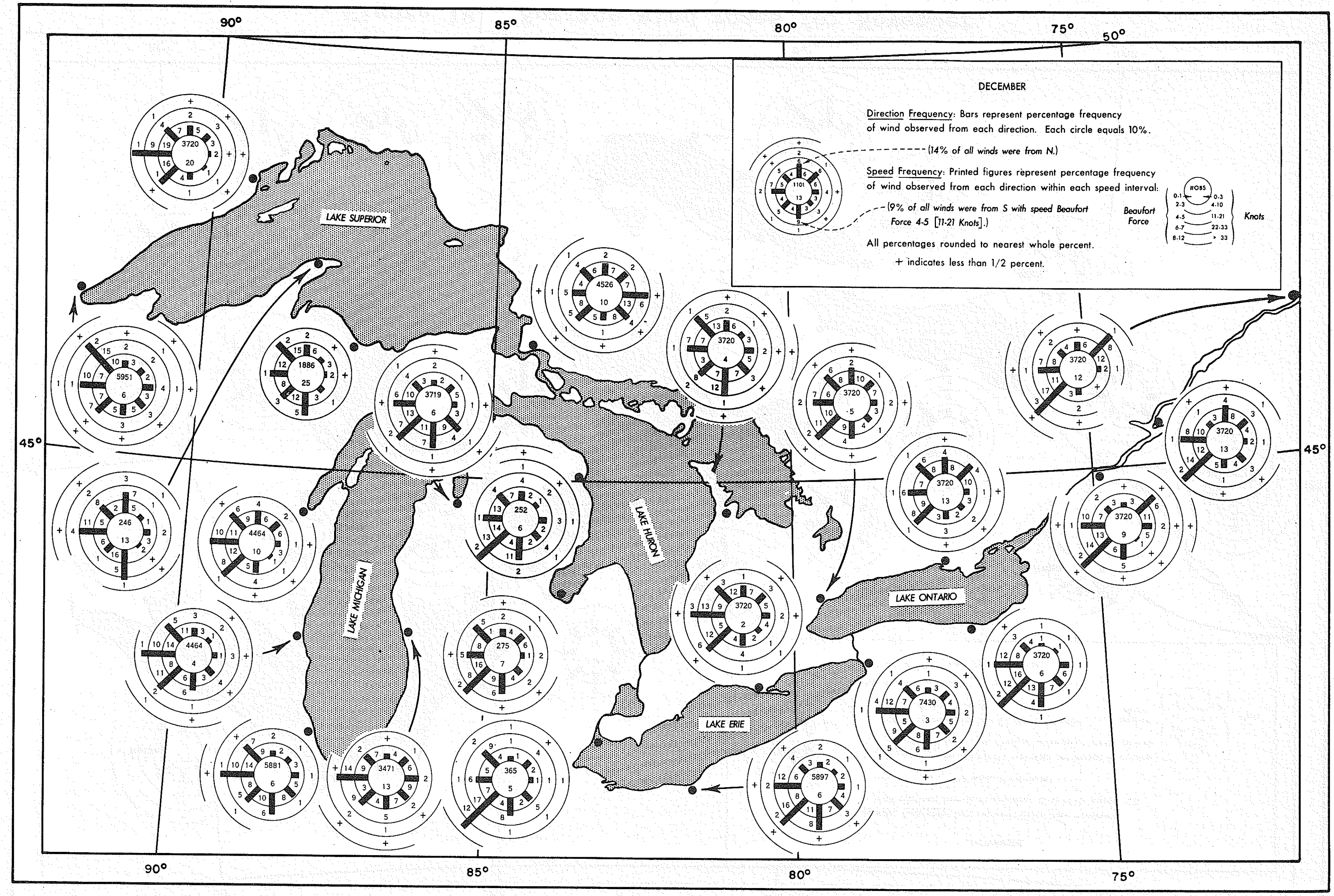


Figure 18. Surface wind roses for November.



DECEMBER

Direction Frequency: Bars represent percentage frequency of wind observed from each direction. Each circle equals 10%.

(14% of all winds were from N.)

Speed Frequency: Printed figures represent percentage frequency of wind observed from each direction within each speed interval:

(9% of all winds were from S with speed Beaufort Force 4-5 [11-21 Knots].)

All percentages rounded to nearest whole percent.

+ indicates less than 1/2 percent.

Figure 19. Surface wind roses for December.

FOG

From the entrance of the Gulf of St. Lawrence to Quebec the frequency of fog decreases rapidly from 103 days and a summer maximum at Belle Isle to 24 days and a winter maximum at Quebec. At Quebec, Montreal (Dorval) (figure 20) and Massena (table 5) the highest frequency of fog occurs during the winter months. The principal cause of this winter maximum along the St. Lawrence River above Quebec is the cooling of maritime air by the cold ground [8].

Radiation fog also occurs along the seaway and is most likely to be encountered on clear nights in the spring and fall. These fogs are of a local nature, their frequency depending greatly on the topography. They generally occur in the early morning hours dissipating with the heat of the day. During the dry season in September, and the first half of October, prolonged spells of thick weather are caused by the smoke of brush fires [2].

On the lakes the principal cause of fog is the temperature difference between the lakes and the surrounding atmosphere. A pronounced temperature lag occurs in the spring and early summer when the lakes are slow to lose their winter chill and the surrounding land is rapidly becoming warmer. From the spring to early fall the water is, on the average, colder than the air and therefore conditions are favorable for advection fog [10] which occurs when warm land breezes are cooled by the comparatively cold lake surfaces. In the fall steam fog also occurs when the first cold air outbreaks come down from the north and the lakes still retain the warmth of the summer.

Figure 20 shows by month the mean number of days with heavy fog (visibility 1/4 mi. or less) for the major ports.[1] The trend of a maximum in spring or early summer is not readily noticeable on this figure because many of the statistics were compiled for airports some distance from the lakes. At Duluth and Marquette, however, where city office figures were used, distinct maxima of 7 and 4 days of heavy fog, respectively, occur in June.

Table 4 is more representative of the conditions encountered on the lakes. It contains a 5-yr. monthly summary of the mean number of days visibility was less than 2 nautical miles at key stations (mostly Coast Guard) along the waterway. These figures generally indicate a maximum in the spring and early summer and an increase again in late fall. Observations at these lake stations are taken only during the navigation season.

The mean number of days visibility was reduced to less than 2 1/2 mi. at Canadian stations is given in table 5. These figures were generally recorded at airports some distance from the lakes and are not truly representative of lake conditions. Most of them show the maximum in the winter which was probably caused by a combination of smoke and stable meteorological conditions.

In general the three western lakes are foggier than the two eastern ones. Lake Superior is the foggiest and of the stations reporting Sault. Ste. Marie has the highest number of days per year with heavy fog (46 days) with a maximum of 7

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[1] In the figures that follow data for Quebec and Toronto were taken from the city offices; for Montreal from the airport.

TABLE 4

MEAN NUMBER OF DAYS WITH VISIBILITY LESS THAN 2 NAUTICAL MILES

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Massena	9	9	8	5	2	2	1	2	3	6	7	9
Oswego				4	3	1	1	1	0	2	1	2
Detroit River Light			1	1	2	1	0	1	1	0.4	2	4
Port Huron				3	1	2	0.4	0.2	1	0.4	2	2
Saginaw River Light				2	1	1	3	2	2	3	3	2
Thunder Bay				4	5	6	3	2	1	3	4	1
Mackinaw City				8	5	6	4	3	1	4	5	4
Whitefish Point				5	4	10	6	3	2	2	3	5
Eagle Harbor				3	4	8	5	4	1	0.4	3	2
Passage I. (4 yrs.)					1	9	7	3	1	2	4	3

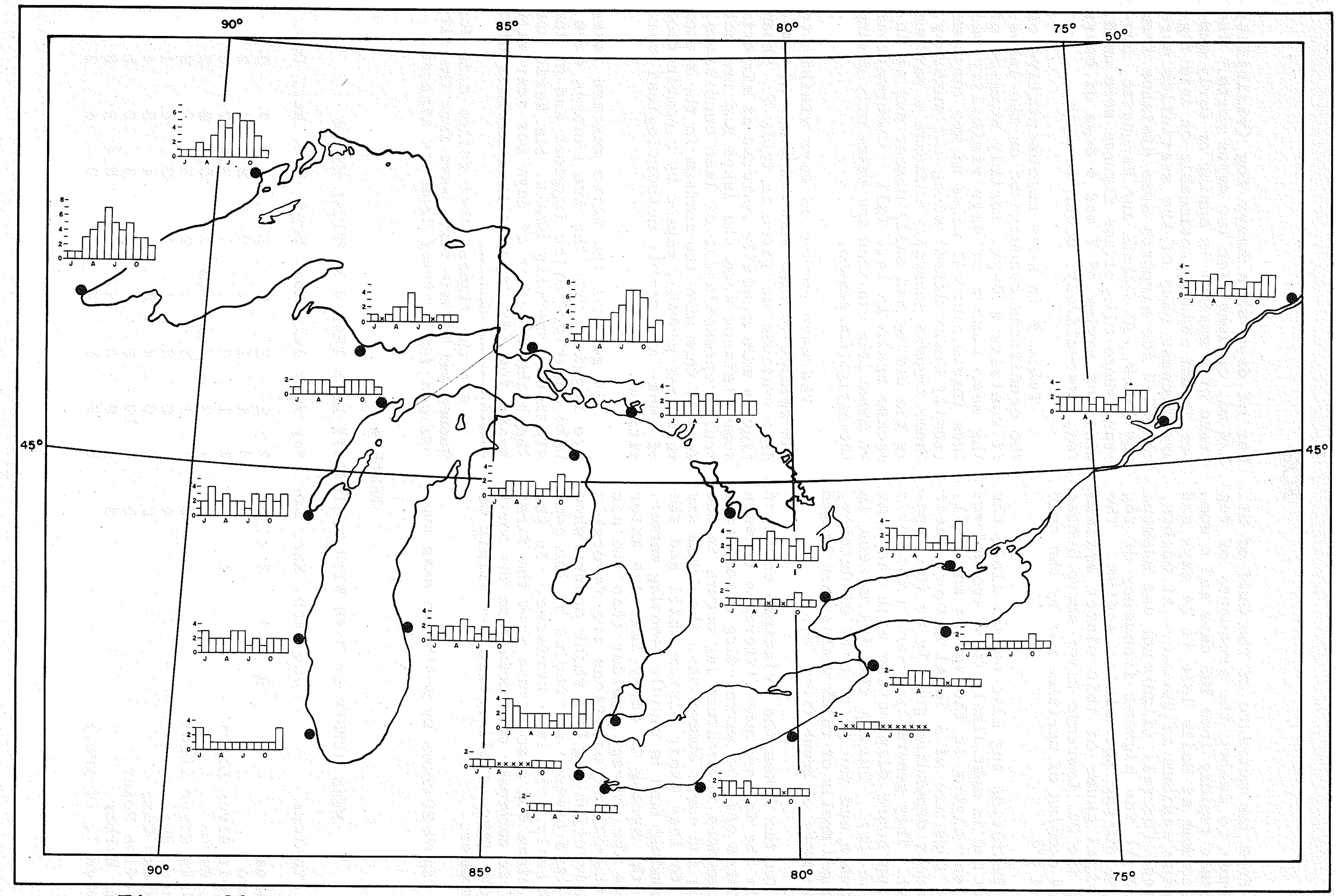


Figure 20. Mean monthly number of days with heavy fog. X indicates average frequency less than 1/2 day.

days per month in August and September. Duluth is close behind with a total of 43 days a year.

In areas where upwelling is present (usually along northwestern shores of the lakes) the cold water is likely to increase the possibility of advection fog in the spring and summer. Chances of this type of fog are not as great along the southeastern shores of the lakes where sinking occurs and the water temperatures are higher. These areas are most likely to experience steam fogs in the late fall and winter months.

On Lake Ontario prolonged periods of rain and foggy weather are quite common when frontal systems moving into New York become stationary. Of the stations reporting heavy fog on this lake, Trenton, Ont. with 25 days has the highest frequency.

Fog is more prevalent along the northern shore of Lake Erie than along the southern shore. Over the western part of Lake Erie fogs are rare though they do occur in the early fall and late spring. The average annual number of dense fogs is 5 per year while approximately 15 days are classified as "partly foggy" [16]. Steam fogs occur in the late fall and winter while advection fogs are confined to spring months. Visibility is sometimes reduced by haze during the late summer.

On the southern shores of Lake Michigan, in the Chicago-Gary area, shipping may be affected by extensive smoke. With a light offshore wind, visibility over the lake is reduced considerably. This is especially true when the water temperature is lower than the air temperature. Along the Indiana shoreline of Lake Michigan it is estimated that about five fogs occur during the colder months which are severe enough to slow down lake traffic.

Fog on Lake Superior usually occurs during the months of July, August, and September. Yearly occurrences average about 30 with more in the Duluth area due to industrial smoke. The area of greatest fog frequency on Lake Superior is east of Keweenaw Point and northward of Au Sable Point. Less fog is reported on the coast from Au Sable Point to Marquette and Portage Entry [11].

TABLE 5

MEAN NUMBER OF DAYS WITH VISIBILITY REDUCED TO LESS THAN 2 1/2 MILES DURING AT LEAST ONE OF THE FOUR SYNOPTIC HOURS

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	No. of Years
Quebec (Ancienne Lorette Airport)	12	9	9	7	3	3	4	3	6	6	9	12	83	15
Montreal (Dorval Airport)	14	13	12	6	4	4	4	6	7	9	9	13	101	17
Trenton (Airport)	12	10	10	7	7	5	4	6	6	10	11	11	99	15
Toronto (Malton Airport)	13	10	10	8	7	5	5	6	8	10	10	11	103	17
Clear Creek	14	15	15	7	6	4	5	6	6	7	8	11	104	16
Windsor (Airport)	15	16	15	11	8	8	8	12	10	15	13	15	146	17
Wiarton (Airport)	17	12	12	8	5	7	4	6	4	7	11	14	107	11
Gore Bay (Airport)	12	9	9	6	3	5	4	3	4	5	8	11	79	11
Fort William (Airport)	9	7	8	6	5	7	6	8	8	7	7	8	86	17

AIR TEMPERATURE

Mariners accustomed to operating over oceans under maritime climatic conditions will note that there is a wide difference between those conditions and those prevailing over a mid-continent body of water. These differences are noticeable in air temperatures which, over the waterway, change much more quickly from day to day and hour to hour, and reach greater extremes, than they do over stretches of open ocean. Extremes of temperature are greatest in areas near land and under conditions of offshore winds.

While the area bounding the Great Lakes is considered to have a continental climate the lake waters have a stabilizing effect and bring to the area influences of a marine climate that are apparent in such elements as temperature and humidity, and in the usual effects of land and lake breezes.

During cold periods stations along the shores of the Great Lakes benefit from the heat surplus of the lake waters and as a result temperatures are somewhat warmer than those in the surrounding area. These are the conditions under which steam fogs develop. Beginning in the spring when air temperatures at land stations rise above the still frozen surfaces of the lakes, locations along the shore may, for a period of a few weeks, remain colder than areas not strongly affected by the ice covered lakes. Such conditions end when the ice melts and the lake waters have had time to warm [6].

For stations having a pronounced prevailing wind direction, those with offshore winds have a more continental type climate than those with onshore winds. Winds coming in off the water bring greater cloudiness and humidity, heavier precipitation, and are stronger than those prevailing on the opposite shore. During the colder part of the year, with waters remaining open, the temperatures are higher on those shores with breezes off the lake.

Subject to some variation, the normal ranges of air temperature at stations along the Great Lakes are somewhat greater during the summer months than in the winter. In most cases the mean daily maximum temperatures for the various months and for the year are about 20 degrees higher than the daily minumum temperatures. Duluth, one of the colder stations, has an annual normal daily maximum of 47.9° and a daily minimum of 30.4°, and at Chicago (Midway Airport), one of the warmer locations, the annual normal daily maximum is 59.3° and the daily minimum 40.8°.

Lake Erie, the shallowest and most southerly lake, has the highest and earliest maximum air temperatures and Lake Superior, the deepest and most northerly, has the lowest and latest maxima. The lowest minimum temperatures are recorded along the north and west shores of Lake Superior. The extremes occur under the winter regime of prevailing westerly and northwesterly winds when the area receives the least heating effect from the lake waters. Duluth with an extreme minimum of -38° and Fort William with -42°, both in January, are representative of the area. Such temperatures are not experienced during the navigation season but do indicate why ships cannot operate on the Great Lakes throughout the year.

Intense cold spells in the area of the Great Lakes and the St. Lawrence River result from the spreading southward of Arctic air masses. With the arrival of these cold air masses, temperatures may drop as much as 50° to 60° over a period of 24 hr.

The modifying effect of lake waters is particularly noticeable when severe cold waves sweep down from Canada. Under such conditions the temperatures along the northern shores of Lake Ontario have been as much as 20 degrees colder than those on the southern shores [5].

The winter freeze-up, ending the season of navigation, does not ordinarily take place until December, when temperatures are considerably below those that prevail in spring when ports are first opened to navigation, in most instances in March or April. During spring break-up maximum temperatures considerably above freezing must prevail for a number of days before any notable deterioration of the ice takes place. Honeycombing of the ice does take place with high daytime temperatures even though mean temperatures for the day are near freezing and minimum temperatures at night considerably below freezing. Such deterioration leaves the ice in a porous state so that it may be easily broken and moved about by winds and currents. Slush ice of this type, drifting to the eastern end of Lake Erie, jams the approaches to Buffalo harbor and often delays the opening of that port until after the opening date at Duluth where temperatures, during that period of the year, average about 5 degrees colder than those at Buffalo.

The following paragraphs summarize air temperatures along the St. Lawrence River and the shores of the Great Lakes beginning at Montreal and moving westward to Duluth. Figures 21a and b graphically represent the temperature distribution along the waterway.

Average monthly temperatures along the St. Lawrence River, as represented by Montreal (McGill), range between a maximum of 70° in July and a minimum of 15° in January. The average daily maximum and minimum reach a high of 79° and 62°, respectively, in July and fall to 23° and 8°, respectively, in January. At Montreal an extreme high of 97° occurred in July and the extreme low of -29° was recorded in both February and December. Spring is late and cold along the St. Lawrence, being delayed till the snow and ice melt, after which temperatures often rise quickly and occasionally reach into the eighties. Changes in temperature can be large and sudden. Warm air masses in the front of depressions bring in abnormally warm tropical air and this can quickly be displaced by cold polar air moving in behind the cold front.

Temperatures at Buffalo may be considered representative of locations on Lakes Erie and Ontario. Here the average monthly range is between a high of 71° in July and a low of 25° in February. The average daily maximum and minimum reach highs of 81° and 60° in July and fall to 32° and 17° in February. The extremes for an 84-yr. period of record are a high of 99° in August and a low of -21° in February.

The long axes of Lakes Michigan and Huron are oriented north and south with the result that there is considerable temperature variation for locations at different latitudes. This difference is apparent when data for Chicago are compared with data for Escanaba, where temperatures average some 8° to 10° lower. At Chicago (Midway Airport) the average monthly temperatures range between a high of 75° in July and a low of 25° in January. Average daily maxima and minima range between 85° and 64° in July and 33° and 17° in January. Extreme values are 104° in June and -15° in both January and February.

For Lake Superior, Duluth may be considered representative. Here the range in average monthly temperatures is between a high of 66° in July and a low of 10° in January. Average daily maxima and minima are high at 76° and 56° in July and low at 19° and 2° in January. The extreme maximum recorded was 106° in July and the extreme minimum -38° in January.

Climatological tables covering temperature normals, means, and extremes for most stations, included in the station location chart, are given in the appendix.

HUMIDITY

The marine influence exerted by the lakes results in higher and more stable humidity values over the Great Lakes area than might be expected at mid-continent locations. Prevailing winds, which often vary with the season, and the strength of shore and lake breezes are important in raising or lowering humidity values. Overall values are highest at ports along the shores of Lakes Superior, Huron, and northern Michigan where the marine influences of the lakes are most clearly marked, and are, in general, lowest at more southerly locations along Lakes Erie and Ontario and the St. Lawrence River.

At most locations average relative humidity values during the early morning hours are uniform, ranging between about 75 and 80 percent. During the winter the afternoon readings are generally 5 to 10 percent lower than the morning readings and during the summer about 15 to 20 percent lower. During afternoon hours, there is more variation throughout the year, with highest values during the winter season and lower humidities in the summer months. During July and August early afternoon values, at the 1:00 p.m. observation, may be 20 to 25 percent lower than corresponding values for the winter months. At Cleveland (Hopkins Airport) this difference in the average monthly relative humidity at 1:00 p.m. ranges from a high of 73 percent in January to a low of 52 percent in July. At nearly all stations there is a rise of 5 to 10 percent in average monthly relative humidity between the 1:00 p.m. and 7:00 p.m. readings.

CARGO CARE - Relatively high humidity values and extremes of temperature encountered on the Great Lakes make protection of cargoes from sweat an important consideration. Critical conditions are most likely to develop when cargoes

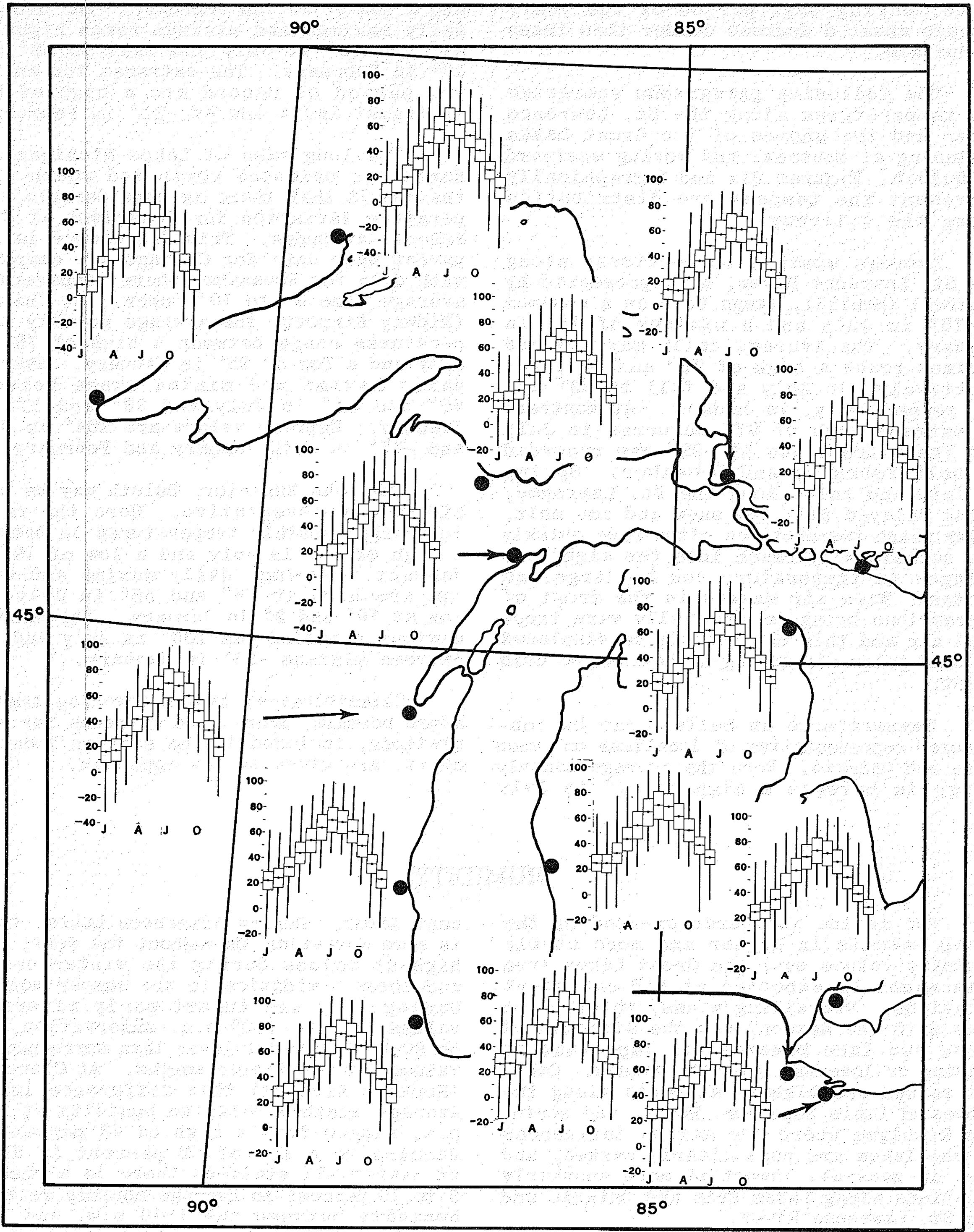


Figure 21 a. Monthly normals and extremes of air temperature - Western Great Lakes.

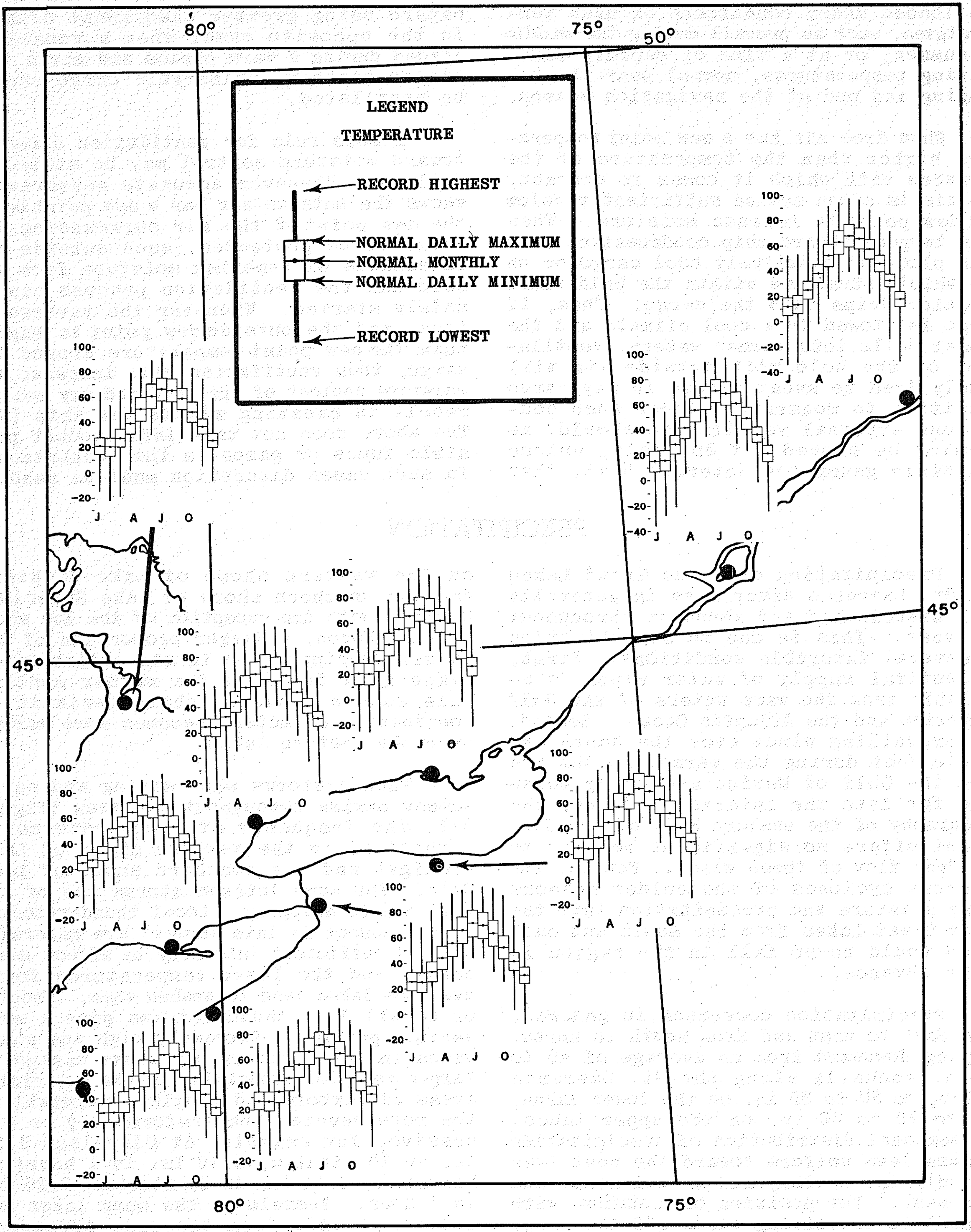


Figure 21 b. Monthly normals and extremes of air temperature - Eastern Great Lakes and St. Lawrence River.

are loaded under conditions of high temperatures, such as prevail during the middle of summer, or at a time of rapidly fluctuating temperatures, normal near the beginning and end of the navigation season.

When free air has a dew point temperature higher than the temperature of the surfaces with which it comes in contact, the air is often cooled sufficiently below its dew point to release moisture. When this happens aboard ship condensation will take place on relatively cool cargo or on the ship's structure within the hold where it later drips onto the cargo. Thus, if cargo is stowed in a cool climate and the vessel sails into warmer waters, ventilation of the hold with outside air will likely lead to sweat damage in any cargo sensitive to moisture. Under such conditions external ventilation should, as a rule, be closed off entirely, unless the cargo generates internal heat, that hazard being greater than sweat damage. In the opposite case, when a vessel is loaded during a warm period and moves into cooler weather, vulnerable cargo should be ventilated.

A safe rule for ventilation directed toward moisture control may be stated as follows: Whenever accurate measurement shows the outside air has a dew point below the dew point of the air surrounding the cargo to be protected, such outside air is capable of removing moisture from the hold and the ventilation process can be safely started. Whenever the reverse is true, and the outside dew point is higher than the dew point temperature around the cargo, then ventilation will increase the moisture content of the hold and may readily result in sweating within the ship [7]. The above does not take into account possible fumes or gases in the compartment. In such cases discretion must be used.

PRECIPITATION

Precipitation over the Great Lakes and St. Lawrence River area is generally well distributed and abundant throughout the year. This is due to a combination of several favorable conditions. First, a plentiful supply of water vapor is available from the warm waters of the Gulf of Mexico and the Atlantic Ocean. Second, the prevailing winds over the South and Middle West during the warmer months are from the Gulf of Mexico and bring moisture far into the interior. Third, the topography of the eastern half of the Continent offers no significant barrier to the free flow of these winds. Fourth, the numerous cyclones of the colder seasons bring moisture and precipitation into the lower Great Lakes from the south and east which would never fall in the region in their absence.

Precipitation decreases, in general, from east to west and from south to north, varying downward from an average of 40 to 45 in. annually along the St. Lawrence Valley, to 30 to 35 in. on the lower lakes, and to 25 to 30 in. on the upper lakes. The seasonal distribution of precipitation becomes less uniform toward the west (see appendix for monthly and annual means and extremes). The position of a station with respect to prevailing winds off the large water areas of the lakes appears to affect its total precipitation and the seasonal distribution. On the Canadian side of Lake Huron there are increases in the mean annual precipitation, winter maxima in the amount of precipitation, and the number of rainy days. Over the other lakes winter maxima of rainy days also occur except on the western shore of Lake Michigan and the northern shore of Lake Superior. However, with the exception of the lee shore of Lake Huron, a larger proportion of the annual precipitation in the entire Great Lakes area falls in the warmer months. This summer maximum, characteristic of continental climates, becomes more marked over the western lakes.

Thunderstorms show spring and early summer maxima throughout the area (figure 22). The frequency of thunderstorms is highest along the western shore of Lake Michigan and the southern shore of Lake Erie. The more intense storms are of importance to shipping. Local thunderstorms, more frequent in late summer, are generally only of sufficient intensity to affect small craft, and the lower temperatures found over the lakes tend to weaken them. Frontal or squall line thunderstorms pose a more serious problem. Extremely high and gusty winds in these storms may cause damage to larger vessels, especially in the restricted areas of harbors and canals. Rainfall in the more severe thunderstorms may be excessive, for example: at Cleveland 1.20 in. in 10 minutes, 2.09 in. in 1 hour; at Milwaukee, 1.11 in. in 10 minutes, 2.25 in. in 1 hour. Vessels in the open lakes are generally safe from the rare tornadoes observed in the region. These intense local storms tend to dissipate and to develop waterspout characteristics over the open lakes. Early and late season navigation may be severely hampered for limited times by freezing precipitation and by spray icing conditions.

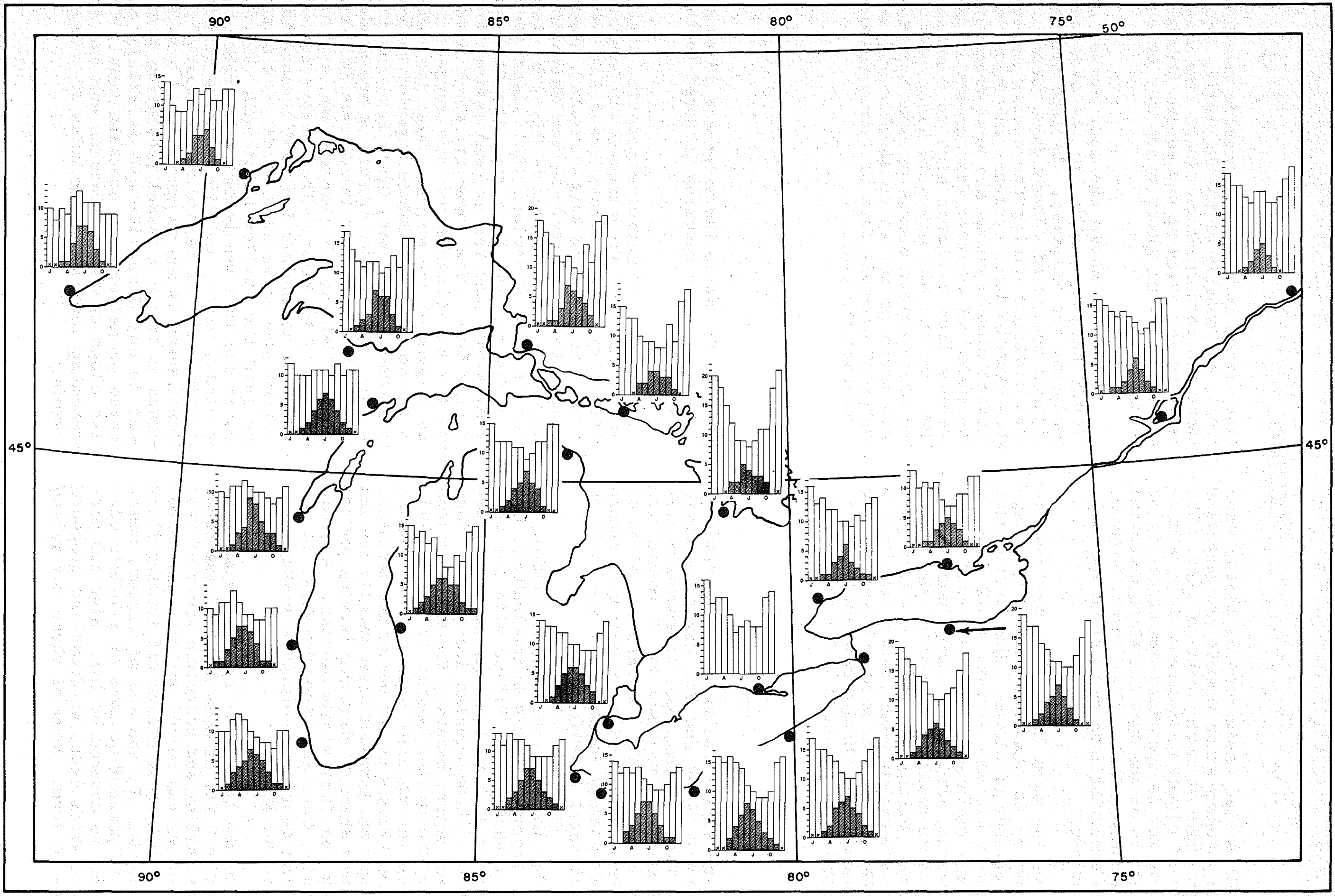


Figure 22. Mean monthly number of days with measurable precipitation (open bars) and thunderstorms (shaded). X indicates average frequency less than 1/2 day.

CLOUDS

Celestial navigation is rarely used on the waterway since vessels are generally within sight or radar range of land. The number of cloudy or overcast days, therefore, is not as important operationally as it would be on the open sea where celestial sights are required. Cloud forms, however, can be important indicators of an approaching cyclone.

As the warm front of a cyclone approaches it is usually heralded by a regular sequence of clouds. The first clouds to appear are the cirrus, which in turn give way successively to cirrostratus, altostratus, altocumulus, and nimbostratus. Steady rain usually accompanies the nimbostratus. During the early and late part of the navigation season this precipitation may fall as sleet or snow and severe icing may occur. The cloud forms which are associated with the cold front and squall line, which at times may precede the cold front, are usually of the convective type. Along the cold front or squall line cumulonimbus may build up and severe thunderstorms and high gusty winds may be encountered.

Figure 23 shows the mean number of cloudy days by month for the stations bordering the waterway. As expected the highest number of cloudy days occurs at most stations during the cooler months when extratropical cyclones and their attendant cloud systems are most frequent. The number of overcast days gradually decreases from a winter high to a summer low. On the St. Lawrence River and on the northwestern shores of Lake Superior this trend is not as noticeable and the number of overcast days is fairly uniform throughout the year.

ICE

Ice limits the navigation season on the Great Lakes and St. Lawrence River above Three Rivers, Que. to approximately eight months. The lakes do not freeze from shore to shore with the rare exception of Lake Erie. Ice begins to form in northern waters by early November and may still be present until mid-May.

The St. Lawrence River seldom, if ever, freezes across below Quebec, but it is almost always filled with ice that fluctuates with wind and current from shore to shore. Above Quebec ice bridges form and jams occur; however, for short periods during the winter months it is possible to keep the channel open between Quebec and Three Rivers by the use of ice breakers. The upper St. Lawrence River usually freezes over from shore to shore for varying periods during the late winter months. Between Prescott, Ont. and Ogdensburg, N. Y. ice breaking ferries maintain a passage the year round [2].

In the lakes, ice ranging from a few inches to 3 ft. or more in thickness forms in the shallow and protected areas of bays and harbors and builds out from the shoreline. Much of it breaks off forming floes and fields. By the end of winter, sometimes 60 percent or more of a lake's surface may be covered by ice. High and persistent winds cause windrows and pressure ridges to form. Some of these may extend 10 to 20 ft. above the water and 30 to 35 ft. below, often becoming anchored to the lake bottom.

From a navigation standpoint there are certain areas which present the greatest difficulty from windrows resulting from prevailing winds and lake currents. These areas, shown in figure 24, are Whitefish Bay, the upper St. Marys River at the foot of Lake Superior, the island area of northern Lake Michigan, the Straits of Mackinac, and the extreme eastern end of Lake Erie. The lower St. Marys River and the St. Clair River are subject to the dangers of ice gorges. Thick ice forms in Thunder Bay, the Duluth-Superior harbor area, Chequamegon Bay, Green Bay, and the De Nocs. Ice breaker operations are almost invariably required in these areas and also in Whitefish Bay, St. Marys River, and the Straits of Mackinac. The eastern end of Lake Erie is another bad spot because the current and prevailing winds pack slush ice into the shallow bottleneck. Slush ice is ice that has become well broken up by winds, waves, and the crushing effect of pressure. It is one of the most difficult forms of ice to combat as it quickly closes in around a vessel preventing movement in any direction and is likely to damage propellers and steering gear. It also clogs condenser intakes and exerts tremendous pressure on the hulls of trapped vessels.

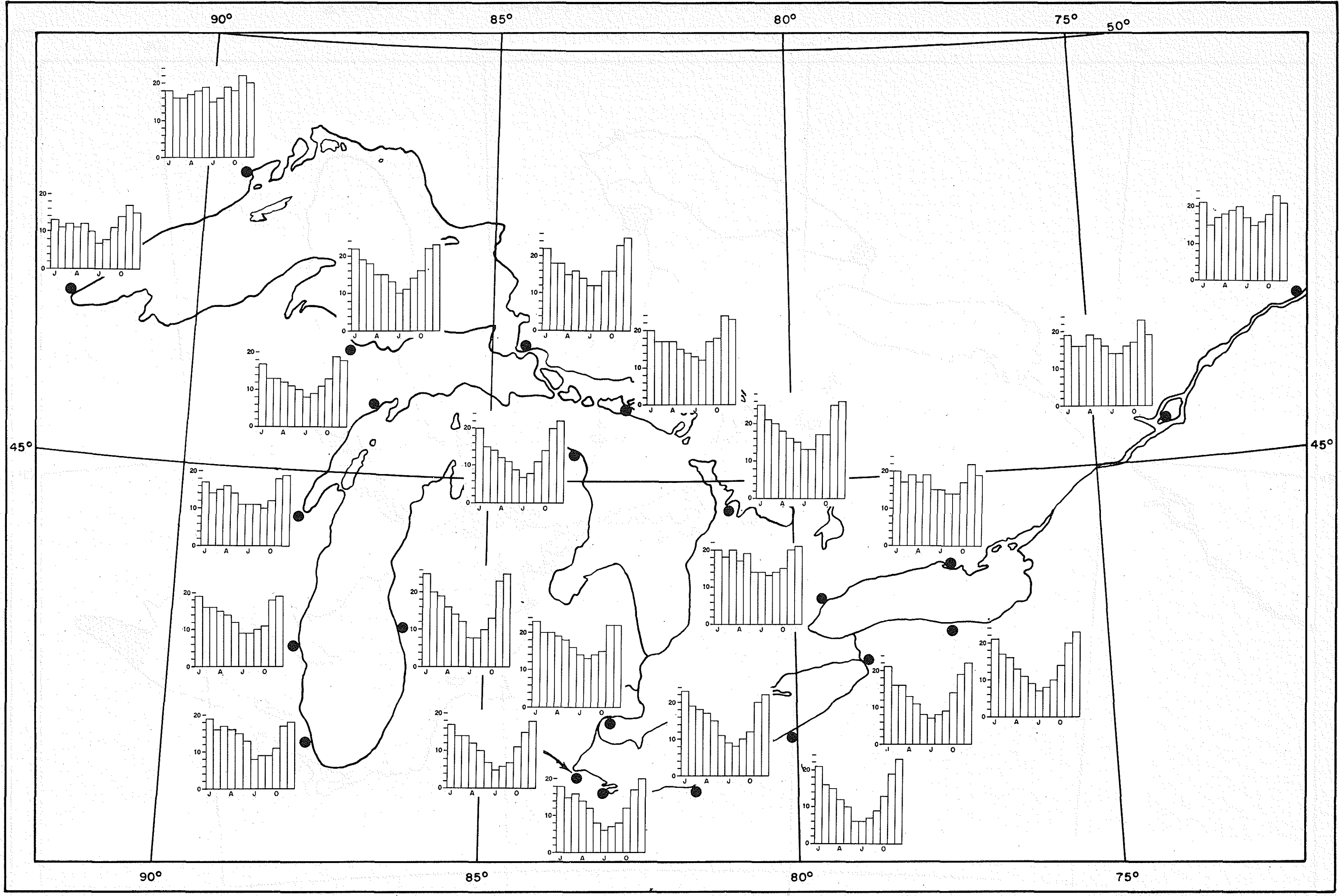


Figure 23. Mean monthly number of cloudy days (8 to 10 tenths clouds).

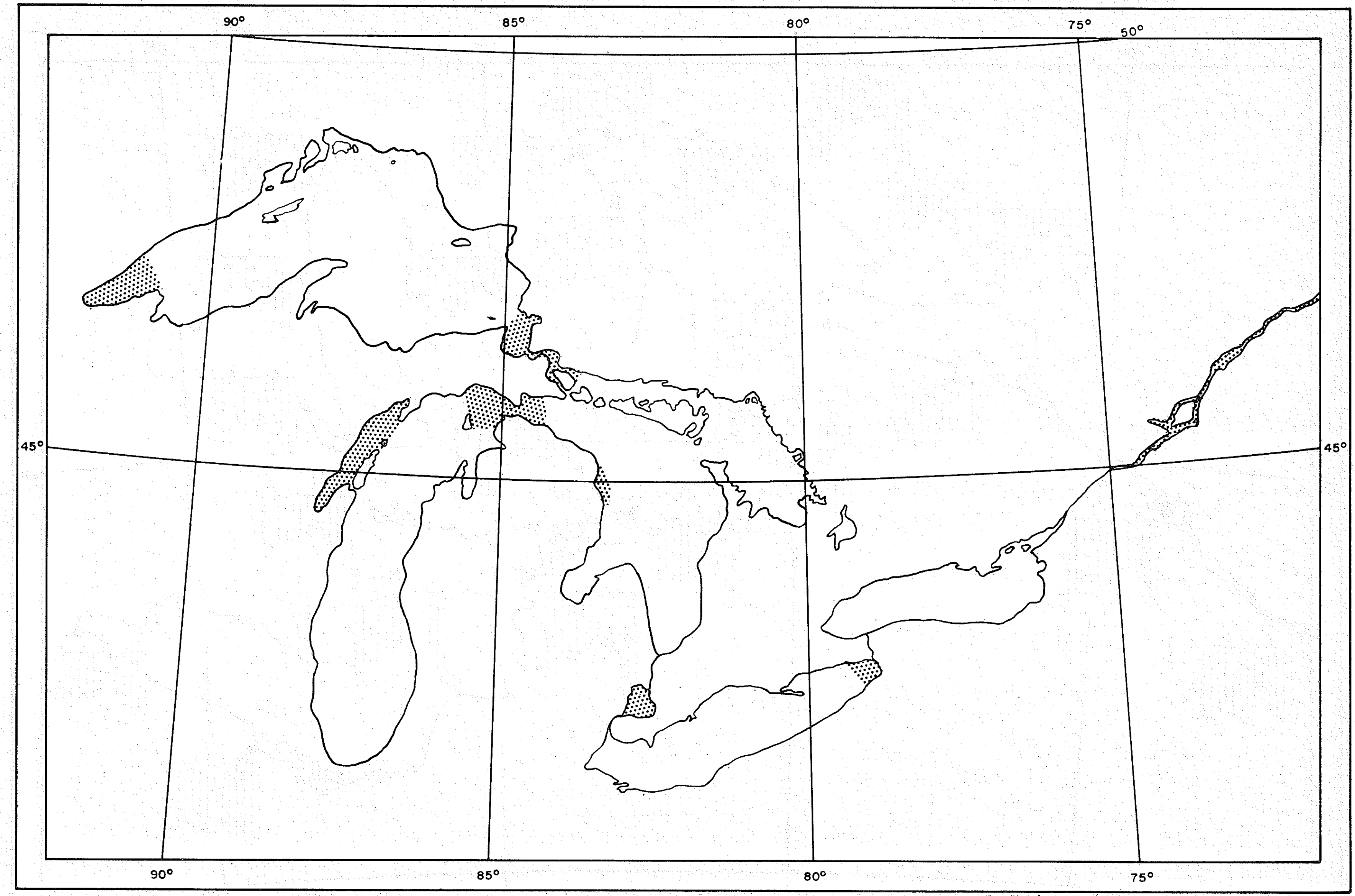


Figure 24. Critical early and late season ice areas.

TABLE 6

OPENING AND CLOSING DATES OF NAVIGATION SEASON

Location	No. of Years	OPENING Earliest	OPENING Latest	OPENING Average	CLOSING Earliest	CLOSING Latest	CLOSING Average
Montreal, Que.	65	Apr. 7	May 24	Apr. 24	Nov. 21	Dec.19	Dec. 4
Lachine Canal	5	Apr. 6	Apr.19	Apr. 15	Dec. 5	Dec.13	Dec. 9
Soulanges Canal	5	Apr. 6	Apr.19	Apr. 15	Dec. 5	Dec.12	Dec. 9
Cornwall Canal	5	Apr. 6	Apr.19	Apr. 15	Dec. 5	Dec.11	Dec. 9
Williamsburg Canal	5	Apr. 6	Apr.19	Apr. 15	Dec. 5	Dec.12	Dec. 9
Prescott, Ont.	5	Apr. 4	Apr.16	Apr. 12	Dec. 4	Dec.14	Dec. 9
Kingston, Ont.		Mar. 2			Dec. 15		
Cape Vincent, N. Y.				Apr. 4			Dec. 25
Oswego, N. Y.		Apr. 2	Apr.28	Apr. 16	Dec. 1	Dec.26	Dec. 15
Toronto, Ont.				Mar. 21			Dec. 19
Welland Canal				Apr. 15			Dec. 10
Buffalo, N. Y.		Mar. 12	May 11	Apr. 11	Dec. 16	Dec.31	Dec. 23
Erie, Pa.		Mar. 19	May 5	Apr. 14	Dec. 7	Jan.5	Dec. 26
Cleveland, Ohio		Mar. 2	Apr.15	Mar. 31	Nov. 28	Dec.31	Dec. 13
Sandusky, Ohio		Mar. 15	Apr.1	Mar. 28	Dec. 1	Dec.31	Dec. 8
Toledo, Ohio		Jan. 6	Mar.18	Feb. 21	Dec. 3	Dec.31	Dec. 20
Detroit (Rouge River), Mich.	10	Jan. 8	Mar.27	Mar. 3	Dec. 6	Dec.31	Dec. 19
Lower Detroit River	10	Feb. 3	Mar.18	Feb. 28	Dec. 1	Dec.31	Dec. 15
Lake St. Clair Ship Channel	10	Apr. 4	Apr.7	Apr. 5	Nov. 27	Dec.14	Dec. 5
St. Clair River (Port Huron), Mich.	10	Jan. 25	Mar.29	Mar. 19	Nov. 25	Dec.29	Dec. 15
South End, Lake Huron	10	Mar. 29	Apr. 7	Apr. 3	Nov. 25	Dec.29	Dec. 15
Saginaw River, Mich.	10	Jan. 20	Apr.11	Mar. 28	Nov. 28	Dec.19	Dec. 5
Alpena, Mich.	10	Mar. 13	Apr.13	Apr. 2	Nov. 1	Dec.31	Dec. 6
Cheboygan, Mich.	10	Mar. 30	May 1	Apr. 12	Nov. 16	Dec.29	Dec. 17
Straits of Mackinac				Apr. 12			Dec. 15
St. Marys Falls Canals	20	Mar. 21	Apr.26	Apr. 5	Dec. 15	Jan.14	Dec. 17
Marquette, Mich.	36	Mar. 26	May 26	Apr. 23	Nov. 9	Dec.25	Nov. 27
Duluth-Superior, Minn., Wis.*	85	Mar. 26	May 15	Apr. 22	Nov. 15	Jan.13	Dec. 10
Duluth-Superior, Minn., Wis.+	85	Mar. 1	May 12	Apr. 10	Nov. 24	Feb.28	Jan. 4

*Interlake
+Local

Ice strong enough to halt navigation is generally encountered in the key channels about December 15. Navigation resumes about April 15 when the channels are sufficiently clear of ice to allow operations. These dates vary considerably from place to place and from season to season. Table 6 shows the earliest, latest, and mean dates of navigation for some of the key ports, canals, and locks [11]. Forecasts of opening days for major lake ports are made by the U. S. Weather Bureau and are explained on page 53 under Weather Services.

Ice is also a major hazard in the locks during the spring and fall season. Ice not thick enough to obstruct navigation may be carried into the lock by the motion of a vessel. It collects behind the lock gates and prevents full opening or closing until the accumulation is removed [14].

LAKE LEVELS

During periods of low water levels on the Great Lakes, millions of tons of pay load annually may be dependent on each inch of navigable water under the hulls of vessels operating on the waterway. In a single bulk carrier the tons of cargo per inch of immersion varies from 38 tons in the older and smaller vessels to 100 tons in the newer additions to the fleet [12].

The depths of the lakes proper are, with the exception of Lake St. Clair and western Lake Erie, beyond the needs of navigation. The critical points appear in the numerous reaches of the dredged channels in the harbors and in the connecting rivers.

A systematic measurement of lake and river stages in the Great Lakes system began in 1860 and continues to the present day. These data indicate that lake levels fluctuate from year to year and also from month to month depending upon the volume of water in the lakes. In addition, the stages at specific locations vary from day to day and even from hour to hour because of unbalance or tilting of the lake surfaces resulting primarily from strong sustained winds and fluctuating barometric pressures.

The annual and seasonal variations in the measured levels may amount to a number of feet and the short term hourly or daily variations may range from a few inches to several feet depending on the particular location on the lake. Variations in lake levels are of major importance to navigation interests but also seriously increase shore erosion, destroy property, and disrupt or slow down the output of power installations. Developments along the shoreline that fail to take into account the wide natural range in surface elevations indicated by the record are subject to periodically increased losses and occasional heavy damage.

RANGES IN LAKE LEVELS
Long Period Fluctuations

Table 7 shows the long range variation of levels of the Great Lakes as indicated by the highest and the lowest monthly average levels for the 98 years of record. The maximum fluctuation in the monthly average levels ranges from 4 ft. on Lake Superior to over 6 ft. on Lakes Michigan, Huron, and Ontario.

Seasonal Fluctuations

In the usual pattern of seasonal varia-

TABLE 7

COMPARISON OF LAKE LEVELS*

Lake	Average level for period of Record 1860-1957	Highest one-month average		Lowest one-month average		Range between high and low one-month average (feet)
		Level	Month and Year	Level	Month and Year	
ONTARIO	246.05	249.20	June 1952	242.68	November 1934	6.52
ERIE	572.36	574.70	May 1952	569.43	February 1936	5.27
ST. CLAIR**	574.89	577.52	July 1952	571.68	January 1936	5.84
MICHIGAN-HURON	580.58	583.68	June 1886	577.35	February 1926	6.33
SUPERIOR	602.21	604.05	August 1876	599.98	April 1926	4.07

* All levels are in feet above mean tide at New York, 1935 Datum.
** Period of record for Lake St. Clair is 1898-1957.

tions of levels of the Great Lakes the high levels occur in summer or early fall and the low levels in late winter. Lakes Ontario and Erie usually reach their highest level in June, Lakes Michigan and Huron in July and Lake Superior in September. The lowest level is usually reached on Lake Ontario in January, on Lakes Erie, Michigan, and Huron in February, and on Lake Superior in March. The average seasonal range in level between the low monthly average and the high monthly average is 1.8 ft. for Lake Ontario, 1.6 ft. for Lake Erie, 1.1 ft. for Lakes Michigan and Huron, and 1.2 ft. for Lake Superior. There have been years in which the highest and lowest levels have occurred in months at a considerable variance from the established pattern.

Short Period Fluctuations

As indicated previously, short period fluctuations or seiches may occur daily or even hourly and are caused by unbalance or tilting of the lake surfaces. These variations are caused by winds, varying barometric pressures, and tides. Small scale differences in pressures and tides are usually unimportant but high winds, particularly of storm force, and sharp gradients in barometric pressure cause large changes in lake levels. Any short period fluctuations are superimposed on the general levels prevailing and may cause excessive highs in periods of generally high levels and excessive lows during periods of generally low levels. Fluctuations in level are, in general, more significant in shallow areas such as Green Bay, Saginaw Bay, and the western reaches of Lake Erie. Short period fluctuations as great as 10 ft., and existing as long as 12 hr., have occurred on Lake Erie where the maximum fluctuations are most frequently felt. A difference in water level as high as 13.5 ft. has been recorded between the extremities of Lake Erie along its long axis, Buffalo and Toledo [4]. These fluctuations affect the depths in the channel of the lower Detroit River where changes of as much as 6 ft. in 8 hr. have occurred.

During recent years extreme fluctuations up to 7 ft. above the monthly mean have occurred on Lake Erie on an average of once in every seven or eight years. Variations in level of several feet lasting for periods of several hours are common on all of the lakes.

RANGES IN STAGES ON THE ST. LAWRENCE RIVER

The mean level of the river falls gradually from a high stage in the spring to a low stage in the autumn. The fall from May to September ranges downward from an average of 5 ft. at Three Rivers through 1 3/4 ft. at Newville, and below St. Augustin Bar it is negligible. At Quebec and above, the range of the tide is reduced by the high stage of the river. The range increases during the season that the river is gradually falling so that the available depth at high water is not decreased as much as the fall in the stage of the river would indicate [2].

CURRENTS

On the St. Lawrence River below Quebec the currents are caused primarily by the rise and fall of the tide which has a mean range of 13.7 ft. at Quebec [13]. Between Montreal and Lake Ontario flow-through is the principal cause of currents while on the Great Lakes wind is the major factor governing the current regime.

At Quebec the ebb current which reaches a speed of 4 1/2 kt. is strongest along the southeastern shore, and the flood current which attains a speed of 3 1/2 kt. along the northwestern shore. At Batiscan, about 55 mi. above Quebec, there is no reversal and the current sets continuously downstream at a speed of about 2 1/2 kt. [15]. Between Batiscan and Lake St. Peter the speed of the downstream or flow-through current is either increased or decreased depending on the stage of the tide. At Montreal the current is constantly downstream with speeds in the main channel ranging from 1.7 to 6.3 kt. Generally the current follows the reaches of the channel, but at turns or bends in the river, in most instances it sweeps obliquely across the channel and must be guarded against. St. Mary's Current is the name of the current found in the 1,300-ft. passage between Ronde and Montreal through which the bulk of the St. Lawrence River water passes on its way to sea. The average speed of the current in this section of the river is about 4 1/2 kt.

The St. Lawrence Seaway is designed in such a manner that the average current speed will not exceed 2.4 kt. [14].

Currents in the Great Lakes are principally wind driven. In addition to the wind, other factors such as the rotation of the earth, density differences, shape

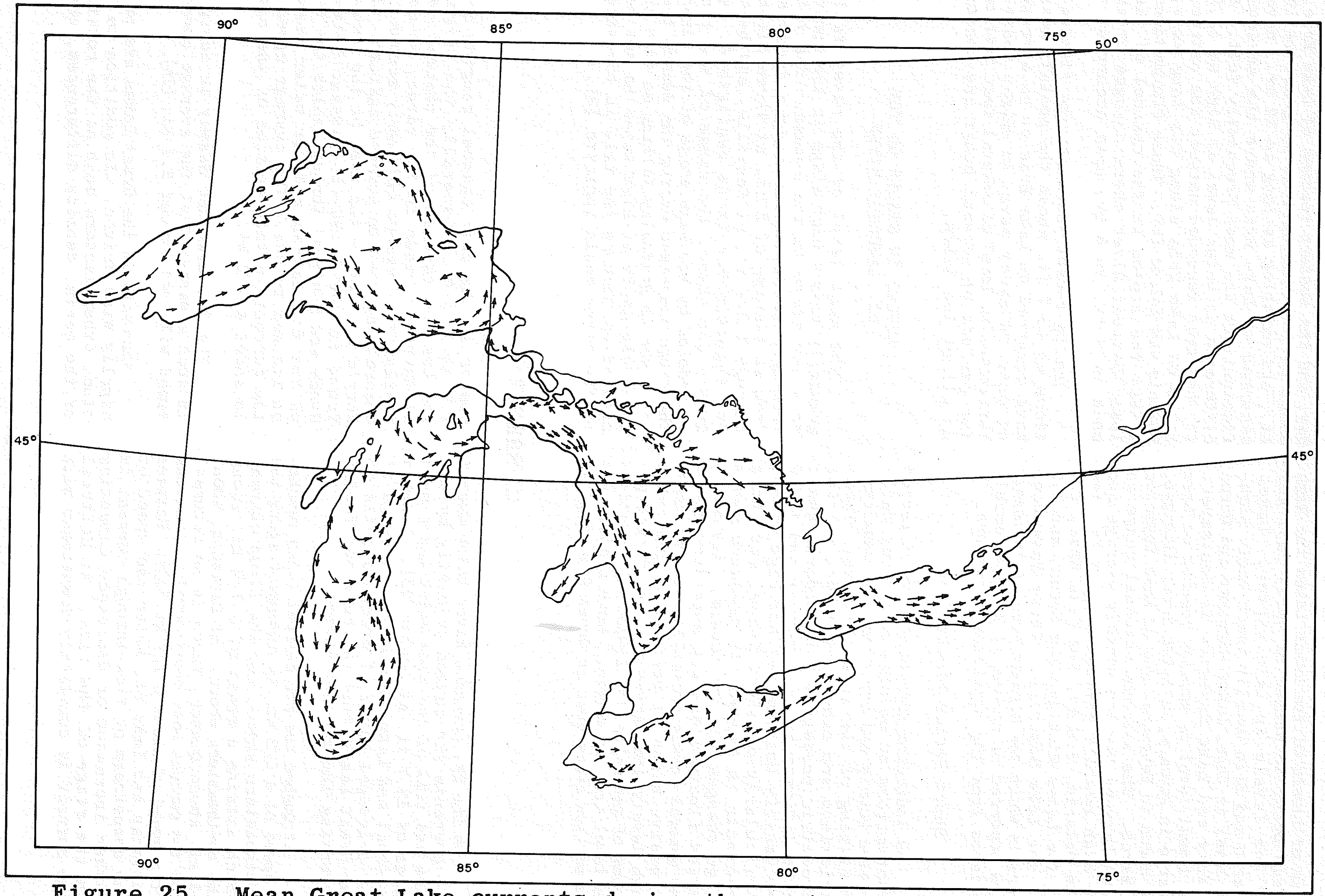


Figure 25. Mean Great Lake currents during the navigation season (after Millar).

of the basin, depths of water, and flow-through all have secondary effects on the horizontal currents of the lakes.

Figure 25 depicts the general current regime on the lakes as found by Harrington [3] and drawn by Millar [9]. The configuration was found by Harrington by means of drift bottles which were released during the navigation season. The figure, therefore, represents the mean pattern during the warmer months. However, there is nothing in the original data suggesting different patterns in the spring or fall months.

On the lakes, especially the large and deep basins, the currents tend to circulate in a cyclonic or anticlockwise direction with upwelling in the west and northwest and sinking in the east or southeast. The general pattern of the primary currents seems to persist with little change. Temporary changes do occur in connection with seiches and, in the case of secondary or weaker currents, with wind direction. Even the well marked currents are modified when strong winds blow for an extended period from a direction other than the prevailing one.

In general the currents on the lakes vary in speed from .2 to .4 kt. Over short distances, however, much higher speeds may be encountered. The most clearly marked currents have speeds of about 1 kt.

On Lakes Ontario and Erie the eastward drift due to the prevailing winds is predominant and extends from the middle of the lakes to their southern shores. There are small cyclonic whirls in the western sections of both lakes and the currents along their northern shores appear to be weak.

In the Welland Canal the current has an average velocity of about .9 kt. between Lock 8 and the Power Commission intake north of Bridge 11. A cross current towards the west exists 500 ft. south of Bridge 11 and also at the entrance to the Third Welland Canal Channel north of Bridge 11. Masters are warned to guard against being drawn over to the west at these locations [11].

The Detroit River which connects Lake Erie to Lake St. Clair has an average current speed of about 1.7 kt. with a maximum speed of 3.5 kt. at Limekiln Crossing. The St. Clair River, which connects Lake Huron with Lake St. Clair has a current speed near its upper end of about 4.3 kt. through the rapids section extending from about 1,000 ft. above to 200 to 300 ft. below the Blue Water Bridge at Port Huron, and a speed of about 1.7 kt. through the canal entering Lake St. Clair. At intermediate points the speed varies irregularly between these limits. During periods of sustained high north-northeast winds on Lake Huron, speeds in the upper St. Clair River are increased [11].

In Lake Huron the currents are divided into two cyclonic cells. One is located near the center of the lake close to the eastern shore and the other in the northern part of the lake. A comparatively strong southward to southeastward current parallels the entire length of the west coast. Weak northward and westward return currents flow along the east and north shores, respectively.

The currents in Lake Michigan are also divided into two cyclonic cells. A well-developed cell is located in the southern part of the lake with a marked southward drift on its western side and a northward drift on its eastern side. The northern cell is not as intense and the currents along the northwestern shores of the lake are weak. A well-defined northward current parallels the entire east shore of the lake.

In the Strait of Mackinac during intense storms with strong easterly winds the normal current from Lake Michigan to Lake Huron has occasionally been reversed.

The St. Marys River forms the outlet for Lake Superior, connecting it with Lake Huron. The swiftest currents in the navigable channels of the St. Marys River are found at the Middle Neebish dike, the West Neebish rock cut, and the Little Rapids cut. The strength of the current depends largely upon the discharge of the river and the elevation of the water surface at the mouth of the river. The speed of the current averages between 1.3 and 2.2 kt. and varies between a probable low of 0.9 kt. and a probable high of 3 kt. [11].

The currents in Lake Superior generally parallel the shoreline with an eastward drift along the southern shore and a westward drift along the northern shore.

LAKE TEMPERATURES

Aside from the geographical factor of latitude and its obvious effect on temperature distribution, there are additional considerations that are important to an understanding of the variations of water temperatures over the Great Lakes area. These factors include depth of lake and drift of surface water as a result of currents.

The influence of water depths in the lakes on surface temperatures is so strong that the depth contours resemble a blurred image of the water isotherms [9]. Outstanding instances of these resemblances are evident over the shallow reaches of Lake Erie and the unusual depths of Lake Superior.

The distribution of water temperatures in the Great Lakes is also related to currents. Observations show that the surface water over the southeastern portions of the lakes is relatively warm in summer due to the drift of warm surface water to these areas under the influence of prevailing westerly winds. As a result convergence and sinking occurs in these areas, and a compensating upwelling must result elsewhere and is evident in the western and northern portions of several of the lakes. In an area of upwelling the surface water is relatively cold during the warming season and during the early cooling stage until the mass of floating surface water has been cooled to the temperature of the bottom water.

On Lake Ontario there is a cyclonic circulation due to upwelling at the western end. Along the northern shore from Hamilton to east of Cobourg, during the period mid-June through August, the rather narrow band of cold waters resulting from upwelling is well known to ships' engineers, as it affects the operation of condensers. Similar patterns are apparent at the northern ends of Lakes Michigan and Huron while on Lake Superior the south-southwest set of the current along the northwestern shore is reinforced by upwelling. Cyclonic circulation is less marked on Lake Erie, probably because of the shallow nature of the lake with bottom friction acting as a brake.

Figures 26 through 30, prepared by Millar [9], indicate bimonthly (April through December) surface water temperatures of the Great Lakes. As would be expected Lake Superior, the deepest and most northerly lake, has throughout the year the lowest water temperatures, and Lake Erie, the shallowest and most southerly, has the highest temperatures. Temperature

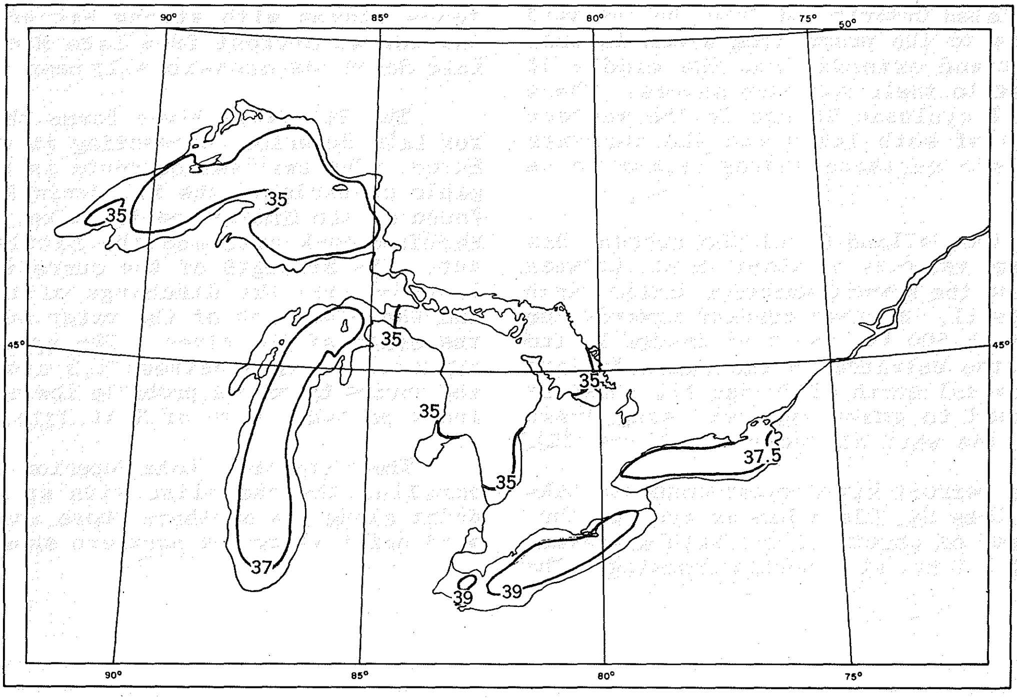


Figure 26. Mean Great Lakes water temperatures, April (after Millar).

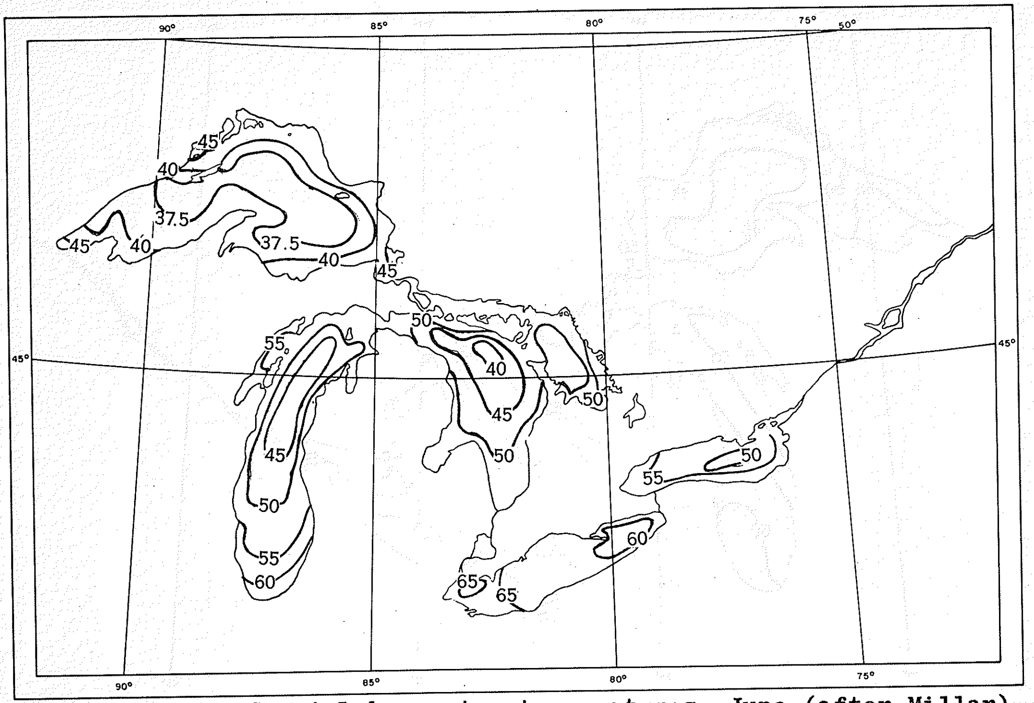


Figure 27. Mean Great Lakes water temperatures, June (after Millar).

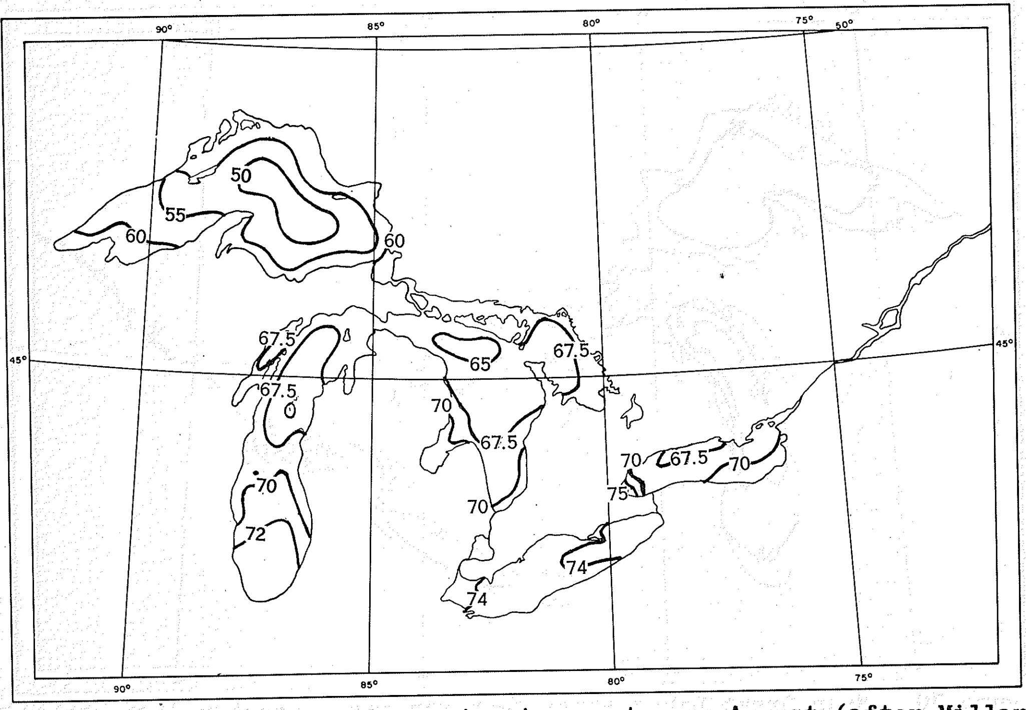


Figure 28. Mean Great Lakes water temperatures, August (after Millar).

variations over a single lake and between lakes are much greater during the warm season, as indicated by the chart for June, than they are during the colder months, as represented by the chart for December.

During the spring and early summer periods of maximum thunderstorm activity, the temperature of the water in the lakes is low, so that convective storms tend to weaken over the lakes. During autumn when

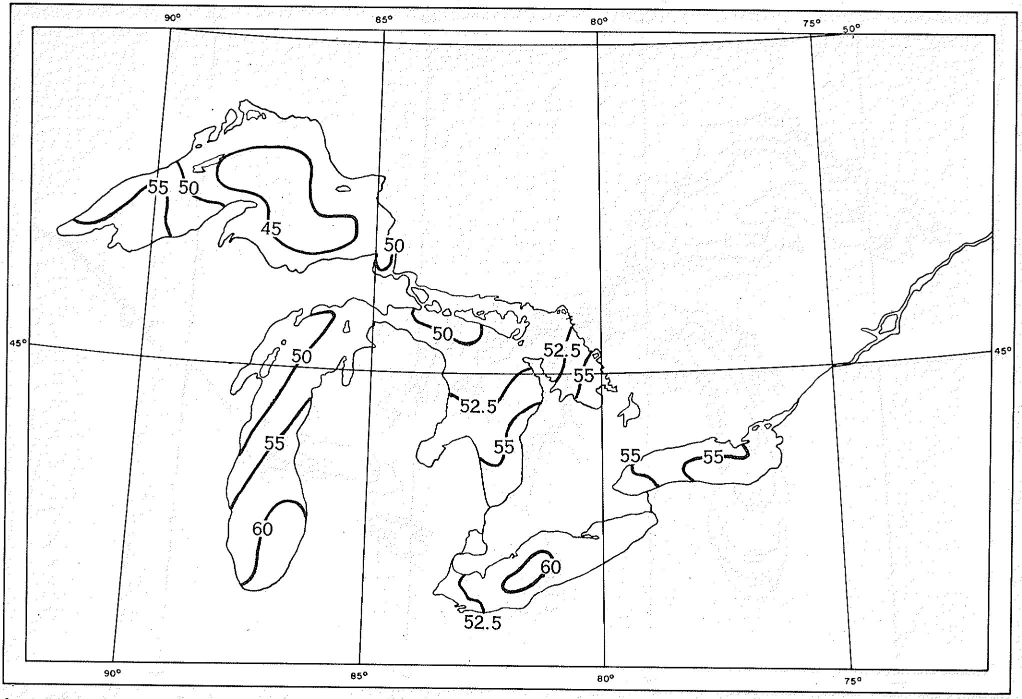


Figure 29. Mean Great Lakes water temperatures, October (after Millar).

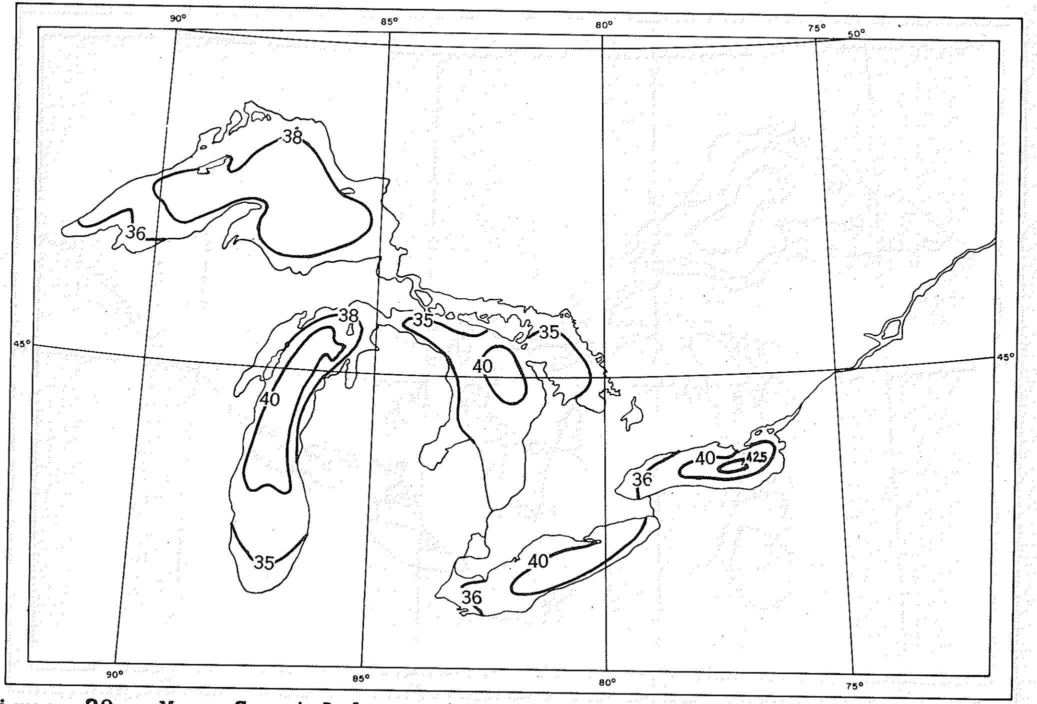


Figure 30. Mean Great Lakes water temperatures, December (after Millar).

the lakes become a heat source there is a tendency for cyclone centers and active cold fronts to intensify over the water. The conservative nature of water temperature causes a lag in reaching the temperature of the air above. This difference in air-water temperatures results in fog, discussed on page 27.

WEATHER SERVICES

The Great Lakes and St. Lawrence River form the world's most important and longest inland waterway for the movement of heavy cargoes. Ships engaged in this trade are vulnerable to the weather, mostly because the location of the waterway on the North American continent places it in the path of some of the most vicious of inland storms. Many of these storms, especially in the winter half of the year, develop quickly and move with alarming rapidity toward the Great Lakes and St. Lawrence River. The warning service must be alert, resourceful, and swift in its decisions and in the issuance of warnings.

For nearly two decades, waterborne cargoes on the Great Lakes alone have been not only of such hugh proportions as to surpass all previous records, but also of vital character, with weight and bulk such that no other means of transporation would have been capable of giving much assistance. Iron ore, limestone, and coal for the steelmaking industry, as well as grain and oil and many other commodities, are hauled cheaply and steadily over a water route, which, due to climatic conditions, is open only 8 1/2 months each year. During the other 3 1/2 months, ice on the lakes and in the connecting waterways makes navigation very difficult, and at times impossible.

Demands for extraordinary cargo movements in the past have resulted in forcing the opening of navigation on this waterway to the earliest possible date in the spring and delaying the closing of navigation until the latest possible date in early winter. Consequently, shipping is exposed to some of the worst storms which occur over this waterway. Thus the information services including weather contribute to the successful handling of an enormous amount of marine traffic on the waterway with a minimum of casualties due to storms and violent weather.

FORECASTING AND WARNING SERVICES

As a rule, navigation on this waterway from Montreal inland to the lakes, commences around the middle of April and continues until the middle of December each year. In some years these dates may be as much as two weeks or more earlier and extend past the end of December when demands for continuous movement of cargoes is essential to meet the needs of nations on the North American as well as on other continents.

To provide shipping on the Great Lakes with daily weather services, the U. S. Weather Bureau, through the Weather Bureau District Forecast Center at Chicago, Ill., issues forecasts, and warnings when necessary, for broadcast every 6 hr. during the navigation season by several U. S. Coast Guard and commercial marine radiotelephone stations along the lakes. Broadcasts by a limited number of U. S. radio stations are continued throughout the winter months. Similarly, the Canadian Meteorological Service, through the Dominion Public Weather Office at Toronto, issues forecasts and warnings for the Great Lakes and St. Lawrence River for broadcast to ships by the Canadian radio stations. Details of the U. S. and Canadian broadcasts to ships are shown in tables 8 and 9, respectively. Warnings whenever issued, are broadcast to ships on separate schedules as shown in the tables.

Forecasts for each lake (LAFOT) prepared for broadcast by U. S. and Canadian radio stations listed in the tables employ a simple number code, supplemented by plain language. An explanation of the LAFOT forecast code is given underneath tables 8 and 9.

In addition, a bulletin containing weather reports from vessels and stations located in harbors and other points in the Great Lakes Region (LAWEB) is also broadcast at 6-hourly intervals during the navigation season. The broadcast schedules for the LAWEB Bulletin are shown in table 10, together with a list of station reports included therein. Weather data for each station in the bulletin are given in plain language.

TABLE 8

U. S. LAFOT RADIOTELEPHONE BROADCASTS-MARINE WAVELENGTHS

Great Lakes coded weather forecasts (LAFOTS) issued by the U. S. Weather Bureau District Forecast Center, Chicago, Illinois, and broadcast by U. S. radiotelephone stations every six hours during the navigation season. Schedules, frequencies, call signs and LAFOTS included in broadcasts by each radio station are as follows:

City	Station	Kc.	Forecasts†	Broadcast times, E.S.T.
Lorain, Ohio	WMI	2514 4420.7 8797.3*	SMHEO	12:02 & 6:02 a.m. & p.m.
Chicago, Ill. (Lake Bluff)	WAY	2514 4420.7 8797.3#	SMHEO	12:09 & 6:09 a.m. & p.m.
Rogers City, Mich.	WLC	2514 4420.7 8797.3+	SMHEO	12:16 & 6:16 a.m. & p.m.
Buffalo, N. Y. (Martinsville)	WBL	2514ø 4420.7	HEO	12:23 & 6:23 a.m. & p.m.
Duluth, Minn.	WAS	2514@ 4420.7°	SMH	12:27 a.m. & 6:27 a.m. & p.m.;
Port Washington, Wis.	WAD	2514	SMH	12:23, 6:23 a.m., 12:27 p.m.

NOTE: LAFOTS for Lakes Superior and Michigan are broadcast on 2514 kc., and 4420.7 kc., during the winter months by Radio WAY at 12:02 and 6:02 a.m. & p.m., and Radio WAD at 12:06 and 6:06 a.m. and p.m. Broadcasts continue until regular LAFOT schedules are resumed in the spring.

† Forecast abbreviations: S-Lake Superior: M-Lake Michigan: H-Lake Huron: E-Lake Erie: O-Lake Ontario
* Not used at 12:02 a.m.
# Not used at 12:09 a.m.
+ Not used at 12:16 & 6:16 a.m.
ø Not used at 12:23 & 6:23 a.m.
@ At 12:23 p.m.
° At 12:27 p.m.

U. S. RADIOTELEPHONE BROADCASTS OF WARNING MESSAGES

(All broadcasts on 2182 kc.)

Gale and Whole Gale warnings are broadcast on receipt of the message by U. S. radiotelephone station, on the first warning schedule and at 2-hour intervals thereafter until 5 hours from the "Hoist" time given in the message, unless superseded or cancelled. Cancellation of a warning is broadcast once only on the next warning schedule following receipt of the message at the station. Schedules given in the table are in minutes past EVEN or ODD hours, E.S.T.

City	Station	Lakes	Broadcast times-E.S.T.
Buffalo, N. Y.	WBL	EO	On receipt & odd HH+55
Chicago, Ill.	WAY	SM	On receipt & odd HH+45
Duluth, Minn.	WAS	S	On receipt & odd HH+55
E. Tawas, Mich.	NMD-24	H	On receipt & odd HH+55
Erie, Pa.	NMD-11*	E	On receipt & even HH+55
Lorain, Ohio	WMI	SMHEO	On receipt & odd HH+35
Marquette, Mich.	NOG-5*	S	On receipt & even HH+55
Plum Island, Wis.	NMP-15	M	On receipt & even HH+35
Portage, Mich.	NOG-17	S	On receipt & even HH+35
Port Huron, Mich.	NMD-22	H	On receipt & even HH+35
Port Washington, Wis.	WAD	M	On receipt & odd HH+55
Rogers City, Mich.	WLC	SMH	On receipt & even HH+45
Sault Ste. Marie, Mich.	NOG*	SH	On receipt & odd HH+45

NOTE: Radiotelegraph Stations, WLC and WBL also make broadcasts of warnings on receipt. Broadcasts are made on 482 kc. after initial call on 500 kc.

* Daylight hours only

TABLE 9

CANADIAN LAFOT RADIOTELEPHONE BROADCASTS
(All broadcasts on 2514 kc.)

LAFOTS for Lakes Superior, Huron, Erie and Ontario and Georgian Bay are issued by the Dominion Public Weather Office, Toronto, Canada.

City	Station	Broadcast times-E.S.T.
Kingston, Ont.	VBH	4:40 & 10:40 a.m. & p.m.
Midland, Ont.	VBC	4 & 10 a.m. & p.m.
Port Arthur, Ont.	VBA	4:30 & 10:30 a.m. & p.m.
Port Burwell, Ont.	VBF	3:50 & 9:50 a.m. & p.m., includes South East Shoal Island reports; Long Point 9:50 only.
Sarnia, Ont.	VBE	4:10 & 10:10 a.m. & p.m.
Sault Ste. Marie, Ont.	VBB	4:20 & 10:20 a.m. & p.m.
Toronto, Ont.	VBG	3:40 & 9:40 a.m. & p.m.

Station VBH broadcasts local weather reports from Main Duck Island at 9:10 a.m., 2 and 8 p.m.; VBA reports from Caribou and Slate Islands at 9:10 a.m., 1:40 and 7:40 p.m.; VBB reports from Caribou and Slate Islands at 9:20 a.m., 1:50 and 7:50 p.m.; VBC reports from Cove Island at 10 a.m., 4 and 10 p.m. All broadcasts being made on 2514 kc.

Urgent reports of dangers to navigation and revisions to current weather forecasts are transmitted immediately on receipt by each station shown in the table above. These reports are repeated on 2514 kc. during the following schedules: 7-7:30; 8-8:30; 9-9:30; 10-10:30; 11-11:30 a.m., 1-2; 3-3:30; 4-4:30; 5:30-6; 7-9; 9:30-10 p.m. E.S.T.

CANADIAN RADIOTELEGRAPH (A_1) AND RADIOTELEPHONE BROADCASTS

St. Lawrence River forecasts and warnings are issued by the Dominion Public Weather Office, Toronto, Canada, and broadcast in plain language by the following radio stations:

Station	Call Sign	Frequency	Broadcast times, E.S.T.
*Father Point, P.Q.	VCF	2582	7:20 a.m. & p.m.; 12:30 & 11:30 p.m.
		$446(A_1)$	7:30 a.m. & p.m.; 12:40 & 11:40 p.m.
*Fox River, P.Q.	VCG	2582	7:30 a.m. & p.m.; 12:40 & 11:20 p.m.
		$434(A_1)$	7:40 a.m. & p.m.; 12:50 & 11:30 p.m.
#Montreal, P.Q.	VCA	2582	7 a.m. & p.m., 12 noon
		$420(A_1)$	7:10 a.m. & p.m.; 12:10 p.m.
*Quebec, P.Q.	VCC	2582	7:10 a.m. & p.m.; 12:10 p.m.
		$434(A_1)$	7:20 a.m. & p.m.; 12:20 p.m.
øThree Rivers, P.Q.	VBK	2582	7:20 a.m. & p.m.; 12:20 p.m.

* All year
\# Winter 7 a.m. to 7 p.m. E.S.T.
ø Navigation season only

EXPLANATION OF GREAT LAKES WEATHER FORECAST (LAFOT) CODE

Great Lakes weather forecasts (LAFOTS) are issued in code and broadcast by U. S. and Canadian radiotelephone stations (marine wavelengths) on schedules as published above.

The LAFOT code consists of groups of five figures represented by the letter symbols "DDffW", supplemented by plain language words. The first two digits, "DD", indicate the wind direction according to Table A. When the two figures for "DD" are the same, this means that the wind is expected to hold steady from that direction during the forecast period indicated in the LAFOT. If the figures for "DD" are different, this means that the winds will vary between the two directions indicated.

Figures for the third and fourth digits, "ff", give the wind speed expected in actual miles per hour. Variations from the forecast wind speed may be anticipated. For winds below 16 m.p.h., variations from the forecast speed will usually run as high as 40 percent and occasionally 70 percent; for speeds 16 m.p.h. and above, variations will run as high as 20 percent and occasionally 30 percent. The figure for the last digit "W", gives the average weather expected according to Table B.

Table A
Symbol D - Wind Direction

Code Figure	Direction
0	Calm
1	Northeast
2	East
3	Southeast
4	South
5	Southwest
6	West
7	Northwest
8	North
9	Variable

Table B
Symbol W - Weather

Code Figure	Weather
0	Fine (mostly clear)
1	Cloudy (or overcast)
2	Thundersqualls
3	Showers
4	Rain
5	Fog (visibility 1/2 mile or less)
6	Lake steam (visibility 1/2 mile or less)
7	Light to moderate snow
8	Freezing rain
9	Heavy snow (visibility 1/2 mile or less)

LAFOTS cover 24 hours divided into two 12-hour periods; the periods in LAFOTS being identified by the words "FIRST" and "SECOND". In LAFOTS transmitted by U. S. Radiotelephone stations commencing shortly after midnight, the "FIRST" period begins at 1 a.m., and the "SECOND" 12 hours later at 1 p.m., E.S.T. For LAFOTS broadcast a few minutes after 6 a.m., 12 noon and 6 p.m.,E.S.T., the "FIRST" period starts at 7 a.m., 1 p.m., and 7 p.m., E.S.T., respectively. In LAFOTS issued by the Dominion Public Weather Office, at Toronto for broadcast by Canadian radiotelephone stations, the "FIRST" period commences at the time of broadcast and the "SECOND" 12 hours later.

> Examples of U. S. LAFOTS issued for broadcast shortly after midnight E.S.T.: Superior: First 18347 west half 11189 east half. Second 87240 west half 88277 east half. Much colder with temperature falling to 15 by late evening. Michigan: First 99113 becoming 11193 middle period and 18301 end period Second 87310.
>
> Examples of above LAFOTS as translated: Lake forecasts for two 12-hour periods, the first commencing at 1 a.m. and the second starting at 12 hours later or at 1 p.m., E.S.T. Lake Superior: First period, northeast to north winds, 34 m.p.h. with light to moderate snow west half of Lake and northeast 18 m.p.h. with heavy snow east half of Lake. Second period, north to northwest winds 24 m.p.h., fine weather west half and north 27 m.p.h. with light to moderate snow east half of Lake. Much colder with temperature falling to 15 degrees by late evening. Lake Michigan: First period, variable winds, 11 m.p.h. with showers becoming northeast 19 m.p.h. with showers middle of period and northeast to north winds, 30 m.p.h. and cloudy end of period. Second period, north to northwest winds, 31 m.p.h. with fine weather. Synopsis: Each LAFOT Bulletin also contains a brief weather summary giving positions of Lows, Highs, Fronts, and other features on the weather map within a radius of 600 miles of the Lake Region. NOTE: When Small Craft, Gale, or Whole Gale Warnings have been issued for any Lake, the appropriate U. S. LAFOTS will also contain a statement indicating the type of display and the area along the Lakes where warning displays are in effect.

TABLE 10

U. S. LAWEB BROADCASTS

Great Lakes Weather Bulletins(LAWEB) are issued for radiotelephone broadcast by the U. S. Weather Bureau every six hours during the navigation season. Schedules of LAWEB broadcasts are as follows:

City	Station	Kc.	Broadcast times-E.S.T.
Lorain, Ohio	WMI	2514	2:30 & 8:30 a.m. & p.m.
		4420.7	* not used at 2:30
		8797.3*	a.m. after October 1

EXPLANATION OF GREAT LAKES WEATHER BULLETIN (LAWEB)

LAWEB Bulletins are issued in two parts. Part I contains plain language reports of wind direction and speed and/or barometer reading data from land stations in the Lake Region as follows:

Oswego Harbor, N. Y. (Wind only)
Rochester Harbor, N. Y. (Wind only)
Fort Niagara, N. Y. (Wind only)
Buffalo Harbor, N. Y.
Erie Harbor, Pa. (Wind only)
Ashtabula Harbor, Ohio (Wind only)
Cleveland Lighthouse, Ohio
Marblehead, Ohio (Wind only)
Toledo Lighthouse, Ohio
Port Huron Lighthouse, Mich. (Wind only)
Bay City, Mich. (Wind only)
Tawas Point, Mich. (Wind only)
Alpena, Mich. (Barom. only)
Thunder Bay Island, Mich. (Wind only)
Point Betsie, Mich. (Wind only)
Muskegon Harbor, Mich.
St. Joseph, Mich. (Wind only)
Chicago, Ill. (Barom. only)
Dunne Crib, Ill. (Wind only)
Milwaukee Lighthouse, Wis. (Wind only)
Green Bay, Wis.
Escanaba, Mich. (Wind only)
Lansing Shoals, Mich. (Wind only)
Mackinaw City, Mich. (Wind only)
Sault Ste. Marie, Mich.
Whitefish Point, Mich. (Wind only)
Grand Marais, Mich. (Wind only)
Stannard Rock, Mich. (Wind only)
Marquette, Mich. (Wind only)
Passage Island, Mich. (Wind only)
Manitou Island, Mich. (Wind only)
Eagle Harbor, Mich. (Wind only)
Keeweenaw, Upper Entrance, Mich. (Wind only)
Houghton, Mich. (Barom. only)
Superior Harbor, Wis. (Temperature when below 32°F.)
Fargo, N. Dak. (Barom. only)
Lakehead, Ont.
Gore Bay, Ont. (Wind only)
Wiarton, Ont.
Clear Creek, Ont. (Wind only)
Toronto, Ont. (Wind only)
Trenton, Ont.
Montreal, Que. (Barom. only)

Part II comprises reports from ships underway on the Lakes when more than 4 miles off shore. Positions of ships are given in distance in miles and direction from well-known landmarks; wind direction to 16 points of the compass and speeds in miles per hour. Ice data, in season, are added when reported by ships.

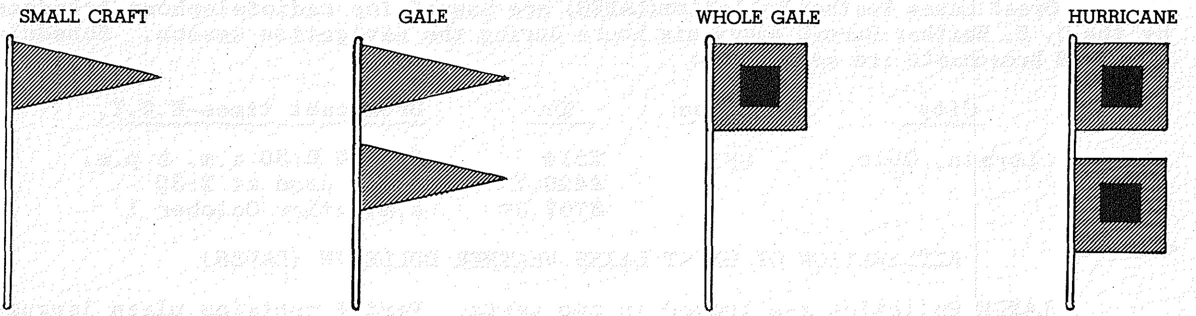
Visibility and weather are included in both land and ship station reports when visibility is less than 5/8 of a mile. Observations are taken one hour and 30 minutes prior to the time of each broadcast.

SMALL CRAFT, GALE, AND WHOLE GALE WARNING DISPLAYS

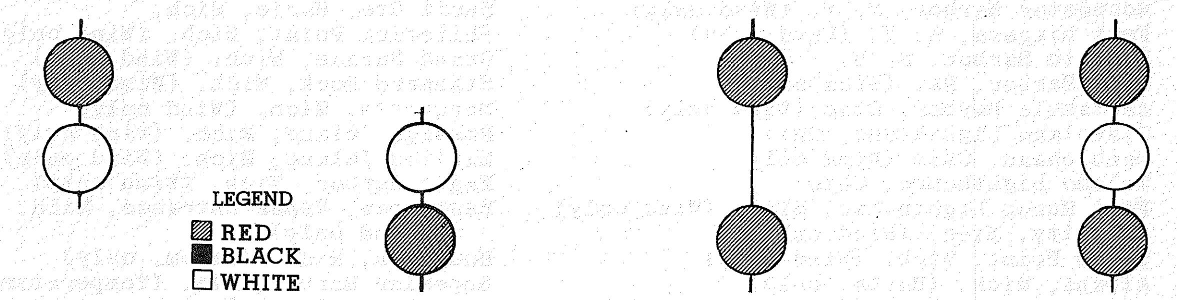
In addition to issuing warnings for broadcast, the U. S. Weather Bureau also makes visual displays of Small Craft, Gale, and Whole Gale Warnings by means of flags and pennants by day, and lights at night, at approximately 100 stations at U. S. points along the lakes. An illustration, together with an explanation, of each of these warning signals is given in figure 31. A list of the locations of these stations is contained in the appendix.

SMALL CRAFT, GALE, WHOLE GALE AND HURRICANE WARNINGS

DAYTIME SIGNALS



NIGHT (LIGHT) SIGNALS



EXPLANATION OF WARNING DISPLAYS

SMALL CRAFT WARNING: One RED pennant displayed by day and a RED light OVER a WHITE light at night to indicate winds and seas, or sea conditions alone, considered dangerous to small craft operations are forecast. Winds may range as high as 38 mph (33 kt.).

GALE WARNING: Two RED pennants displayed by day and a WHITE light ABOVE a RED light at night to indicate winds within the range 39 to 54 mph (34 to 47 kt.) are forecast for the area.

WHOLE GALE WARNING: A single square RED flag with a BLACK center displayed during daytime and two RED lights at night to indicate winds within the range 55 to 73 mph (48 to 63 kt.) are forecast for the area.

HURRICANE WARNING: Two square RED flags with BLACK centers displayed by day and a WHITE light between two RED lights at night to indicate that winds 74 mph (64 kt.) and above are forecast for the area. As a rule, hurricane warning signals may be ordered displayed at points along U. S. shores of the Great Lakes only on very rare occasions. For example, in the event a hurricane moves inland over the U. S. Gulf or Atlantic coast states and continues with marked intensity as it approaches or passes near the Lake Region, hurricane warnings may be ordered displayed along the lakes to be affected. Hurricane warning signals may also be ordered displayed on occasions during fall, winter, or early spring months when severe storms other than those of tropical origin are expected to affect the lakes. In such cases, warning messages issued for press and radio broadcast distribution will specify that the storm is not a hurricane, but winds of 74 mph (64 kt.) and above are expected.

NOTE: The above warning display signals are supplementary to, and can not replace the Small Craft, Gale, Whole Gale and Hurricane Warning messages issued for broadcast. Important details as to time, intensity, duration, direction of movement of the storm needed for navigation purposes are included in warning messages and lake forecasts broadcast by radio stations.

Figure 31.

WEATHER REPORTS FROM GREAT LAKES VESSELS

To supplement surface and upper air data received from stations throughout North America, which form the basis for issuing Great Lakes and other forecasts, the U. S. Weather Bureau has equipped a number of vessels with anemometers to furnish wind and weather reports by radio every six hours while the ships are underway on the lakes. The Canadian Meteorological Service has made similar arrangements with vessels registered under the flag of that country relative to furnishing reports for forecasting and warning purposes. A typical wind equipment installation aboard a vessel is shown in figure 32.

Figure 32. A Great Lakes freighter in port. U. S. Weather Bureau wind instruments circled. (Courtesy AP.)

PREDICTING OPENING OF NAVIGATION

Before the opening of navigation each year, the U. S. Weather Bureau at Detroit, Mich., provides an ice reporting and forecasting bulletin service to marine interests along the Great Lakes. Beginning during the middle or latter part of February, bulletins are issued weekly and contain reports of ice conditions from U. S. and Canadian weather reporting stations along the Great Lakes and the St. Lawrence River as far as Prescott, Ont. Reports of ice conditions on lakes furnished by airline pilots and U. S. Coast Guard aircraft are also included. The bulletin, issued during the last week of February or early in March, also contains a forecast of the dates when a number of major Great Lakes ports are expected to be free of ice and navigation can commence. As a rule, this service continues until the middle of April or when ice conditions are no longer a menace to navigation.

A knowledge of the dates when the major ports will be open to navigation is vital to marine interests. To fit out the U. S. Great Lakes fleet of carriers prematurely would entail an unnecessary operating expense ranging perhaps as much as $400,000 to $500,000 a day. On the other hand, it has been estimated that a million tons of iron ore alone can be gained per week, if the lake ore vessels can commence operation as soon as navigation is feasible.

The techniques employed for predicting a month or more in advance the dates when ports are expected to be free of ice have been evolved from an attempt to correlate winter months' temperatures with opening dates of the ports to navigation. A significant correlation was obtained from a study of December, January, and February mean temperature summations but better results were obtained from February temperatures alone. From these data, curves and standard errors were developed for eight major lake ports. Examples of the curves developed are shown in figure 33. Thus on March 1, if the February mean temperature for Duluth was 16.5°F., the probable opening date indicated by the graph is 98 days after January 1, or April 8, with a tolerance of plus or minus 13 days.

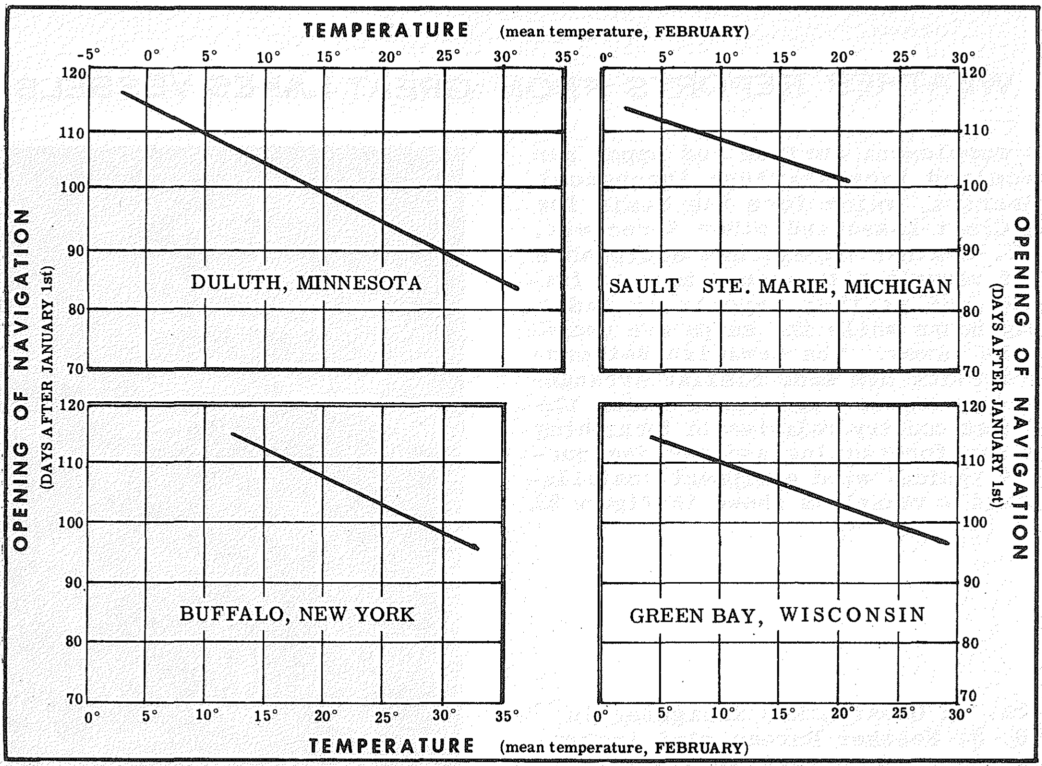


Figure 33. Curves used in prediction of opening date of navigation at four Great Lakes ports.

It should be noted that predictions from the graph are approximate dates and not exact. However, on several occasions the opening dates as forecast by the U. S. Weather Bureau coincided with or were very near to the actual port opening dates. Of course, economic conditions, as well as ice conditions, are important factors in determining when early season navigation on the Great Lakes is to commence.

All of these weather services now provided to shipping on this waterway have been arranged in cooperation with the U.S. Lake Carriers , the International Shipmasters,and the Dominion Marine Associations. These organizations hold their annual meetings, usually in January of each year, with representatives of the U. S. Weather Bureau and the Canadian Meteorological Service participating. At these meetings, the weather services provided to shipping are reviewed for the purpose of making improvements in line with suggestions offered by shipmasters and others interested in marine transport.

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APPENDIX

CLIMATOLOGICAL TABLES

NORMALS, MEANS, AND EXTREMES

LATITUDE	46° 48' N
LONGITUDE	71° 13' W
ELEVATION (ground)	296'

QUEBEC (CITY) P.Q.

Month	Temperature							Normal degree days
	Normal			Extremes				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	
(a)	30	30	30	91		91		30
J	19.1	4.8	12.0	52	1950+	-34	1890	1640
F	20.8	6.1	13.4	53	1953	-32	1888	1460
M	31.8	17.9	24.8	64	1945+	-23	1886	1250
A	45.1	30.7	37.9	80	1945+	-2	1882	810
M	61.1	42.8	52.0	91	1911+	18	1880	400
J	71.7	53.1	62.4	94	1947+	31	1881	100
J	76.6	58.7	67.6	97	1953	39	1957+	20
A	73.7	56.9	65.3	96	1876	37	1909+	70
S	64.7	49.0	56.8	88	1895	22	1875	250
O	52.0	38.8	45.4	82	1949	14	1887	610
N	37.2	26.9	32.0	71	1938	-14	1875	990
D	23.5	11.5	17.5	59	1951	-32	1933+	1470
YEAR	48.1	33.1	40.6	97	JULY 1953	-34	JAN 1890	9070

Month	Precipitation											
								Snow				
	Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year
(a)	30	85		85		23		30	85		17	
J	3.63	7.10	1873	1.10	1896	2.64	1945	28.9	71.0	1873	13.8	1941
F	2.80	8.77	1939	0.93	1941	1.69	1955	25.7	82.4	1939	16.9	1955
M	2.95	6.17	1877	0.42	1915	1.30	1943	20.4	51.7	1877	13.0	1943
A	3.29	6.49	1920	0.70	1883	1.81	1947	11.0	33.6	1874	8.0	1945
M	3.55	7.64	1947	0.27	1887	1.36	1937	0.3	6.0	1943	6.0	1943+
J	4.50	9.31	1957	0.80	1955	4.11	1942	T	T	1930	0	
J	4.40	10.11	1935	0.53	1877	2.95	1935	0	0		0	
A	4.41	11.87	1938	0.99	1953	5.17	1937	0	0		0	
S	4.21	9.43	1918	0.84	1922	2.86	1946	0	T	1888	0	
O	3.72	7.54	1937	0.84	1947	1.76	1942	1.2	9.8	1952	8.0	1952
N	4.00	8.95	1927	0.90	1876	2.07	1950	13.0	40.0	1875	8.1	1941
D	3.30	8.12	1954	1.13	1892	1.76	1954	23.2	80.8	1954	17.6	1954
YEAR	44.76	10.11	JULY 1955	0.27	MAY 1887	5.17	AUG 1937	123.7	82.4	FEB 1939	17.6	DEC 1954

Month	Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days											
							Maximum Hourly Mileage					At 1330E							Temperatures				
																			Max.		Min.		
	0130 E.S.T.	0730 E.S.T.	1330 E.S.T.	1930 E.S.T.	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 0.1 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)		10		10	18	18	18								20	20	10	10	30	17	10	30
J		80		76	10.0	W	52	NE	1938						17	16	0	2	0	27	31	11
F		79		73	10.3	W	49	NE	1939						15	14	0	2	0	24	28	8
M		79		69	10.8	NE	52	NE	1947						15	12	*	2	0	14	28	2
A		74		65	10.0	NE	41	NE	1947+						13	6	1	3	0	1	18	0
M		73		62	10.3	NE	42	NE	1944						12	*	2	1	0	0	2	0
J		78		68	8.3	SW	41	NE	1948						14	0	4	2	*	0	0	0
J		80		68	7.2	SW	34	NE	1937						14	0	5	1	*	0	0	0
A		81		71	7.1	SW	40	NE	1954						12	0	3	1	*	0	0	0
S		84		75	7.5	W	42	E	1938						12	*	1	2	0	0	*	0
O		82		73	8.3	W	41	E	1953						13	1	*	2	0	*	4	0
N		82		78	9.7	W	54	NE	1950						16	9	0	3	0	7	20	*
D		79		76	9.6	W	50	NE	1948						18	15	0	3	0	24	31	6
YEAR		78		71	9.1	W	54	NE	NOV 1950						171	73	16	24	*	97	162	27

The Quebec Observatory was in Battlefield Park overlooking the St. Lawrence River.

(a) Length of Record, years.
(b) Normal values are based on the period 1921-1950, and are means adjusted to represent observations taken at the present standard location.
(c) No wind data available.
(d) No observations taken at 1330 E.S.T.
(e) Insufficient data available.
(f) Means and extremes are from the existing location. Extremes listed may have been exceeded at prior locations.

* Less than one-half

T Trace, an amount too small to measure

\- No record

\+ Also on earlier dates, months, or years

\# Also on earlier dates, months, or years

NOTES: Unless otherwise indicated, dimensional units used are: temperature in degrees F; precipitation and snowfall in inches; wind movement in miles per hour; and relative humidity in percent.

Sky cover is expressed in a range of 0 for no clouds or obscuring phenomena to 10 for complete sky cover. The number of clear days is based on cloudiness 0-3 tenths; partly cloudy days on 4-7 tenths; and cloudy days on 8-10 tenths. For United States stations the number is based on average conditions from sunrise to sunset; for Canadian stations on average cloudiness at 1330 E.S.T.

Monthly degree day totals are the sums of the negative departures of average daily temperatures from 65°F.

Heavy fog also includes data referred to at various times in the past as "dense" or "thick". The upper visibility limit for heavy fog is 1/4 mile.

Below zero temperatures are preceeded by a minus sign.

NORMALS, MEANS, AND EXTREMES

LATITUDE 46° 48' N
LONGITUDE 71° 23' W
ELEVATION (ground) 245'

QUEBEC (ANCIENNE LORETTE AIRPORT) P.Q.

Month	Temperature							Normal degree days	Precipitation						
	Normal			Extremes											
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year
(a)	(b)	(b)	(b)	15		15		(b)	10	15		15		15	
J	18.6	1.9	10.3	50	1950	-31	1946	1690	3.21	5.36	1945	1.10	1956	1.27	1945
F	20.1	3.0	11.6	53	1953	-28	1951+	1510	2.63	4.39	1947	1.42	1957	1.30	1951
M	30.6	14.3	22.5	59	1945	-22	1950	1300	2.79	6.80	1955	0.89	1957	1.34	1945
A	45.6	27.8	36.7	80	1945	-2	1954	850	3.31	4.75	1947	1.27	1944	2.18	1947
M	61.8	40.4	51.1	89	1950	18	1947	430	3.31	6.87	1947	1.51	1944	1.47	1947
J	72.4	50.5	61.5	93	1947	31	1948	130	3.86	7.57	1957	0.72	1955	3.01	1952
J	77.4	55.8	66.6	96	1953	40	1946	40	4.15	6.01	1945	1.39	1946	1.80	1950
A	74.7	53.6	64.2	93	1947	37	1946	90	3.58	6.14	1943	0.61	1953	1.81	1950
S	65.4	45.4	55.4	93	1947	26	1947	290	3.47	8.13	1945	0.68	1948	2.09	1945
O	52.0	34.9	43.5	83	1949	17	1949	650	3.25	5.65	1943	0.65	1947	1.74	1955
N	36.8	24.8	30.8	68	1956	-4	1949	1030	3.74	5.30	1950	1.74	1955	1.80	1950
D	24.6	10.8	17.7	57	1951	-25	1943	1530	3.61	6.37	1957	1.30	1947	1.40	1946
YEAR	48.3	30.3	39.3	96	JULY 1953	-31	JAN 1946	9540	40.91	8.13	SEPT 1945	0.61	AUG 1953	3.01	JUNE 1952

Month	Precipitation					Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Snow											Maximum Hourly Mileage					At 1330E							Temperatures			
																								Max.		Min.	
	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	0130 E.S.T.	0730 E.S.T.	1330 E.S.T.	1930 E.S.T.	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 0.1 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	10	15		15		8	8	8	8	3	3	3	3				8	8	8	15	15	15	15	15	15	15	15
J	26.0	47.3	1946	10.8	1945	86	89	81	84	11.5	SW	32	WSW	1956			6	4	21	16	14	0	3	0	26	31	13
F	24.6	43.9	1947	11.5	1955	90	88	77	83	11.4	WSW	60	SW	1956			8	5	15	13	12	0	1	0	24	28	10
M	14.2	64.1	1955	13.0	1955	83	85	67	77	12.3	SW	42	SW	1955			9	5	17	13	10	1	3	0	15	29	3
A	9.0	18.9	1946	8.0	1947	81	80	66	73	10.8	ENE	35	SW	1957			7	5	18	12	4	*	3	0	1	19	*
M	0.3	2.8	1943	2.8	1943	81	75	55	67	11.4	SW	35	SW	1957+			6	6	19	12	*	1	2	0	0	4	0
J	.0	.0		.0		84	78	56	68	10.0	SW	35	SSW	1957			3	7	20	12	0	3	2	1	0	*	0
J	.0	.0		.0		87	81	60	69	8.7	SW	28	SW	1957			4	10	17	13	0	4	2	1	0	0	0
A	.0	.0		.0		87	81	57	72	8.5	SW	25	WSW	1957			7	9	15	10	0	3	2	1	0	0	0
S	T	T	1957	T	1957	86	85	60	77	9.1	SW	35	WNW	1957+			7	7	16	12	T	1	3	*	0	1	0
O	1.4	7.5	1952	4.5	1950	83	85	63	76	9.9	SW	35	WSW	1957+			7	6	18	11	*	*	3	0	0	9	0
N	12.3	29.0	1949	12.0	1946	87	86	76	84	11.2	SW	40	SW	1955			3	4	23	13	6	*	4	0	7	22	*
D	26.0	51.9	1946	14.0	1946	87	89	82	87	12.0	WSW	45	WSW	1957			5	5	21	16	14	0	3	0	24	30	8
YEAR	113.8	64.1	MAR 1955	14.0	DEC 1946	85	84	67	76	10.6	SW	60	SW	FEB 1956			72	73	220	153	60	13	31	3	97	173	34

Ancienne Lorette Airport is 8 miles W of Quebec in the St. Lawrence River valley, 4 miles N of the river.

LATITUDE 45° 30' N
LONGITUDE 73° 34' W
ELEVATION (ground) 187'

MONTREAL (McGILL) P.Q.

Month	Temperature							Normal degree days	Precipitation						
	Normal			Extremes											
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year
(a)	30	30	30	89		89		30	30	96		96		24	
J	22.7	8.2	15.4	55	1950	-27	1914	1540	3.54	6.84	1898	1.13	1955	1.75	1947
F	23.6	9.3	16.4	51	1880	-29	1943	1370	2.72	7.38	1869	0.49	1877	1.20	1944
M	34.6	21.3	28.0	77	1945	-20	1872	1150	3.26	7.32	1901	0.81	1915	1.67	1955
A	49.5	33.8	41.6	86	1941	2	1923	700	3.37	6.10	1924	0.35	1870	1.62	1954
M	64.3	46.9	55.6	94	1871	23	1880	300	3.30	7.38	1945	0.11	1903	2.04	1945
J	74.2	56.9	65.6	94	1925	34	1945	50	3.76	8.62	1922	0.49	1868	2.68	1957
J	78.7	62.1	70.4	97	1931	46	1891	10	3.97	7.72	1899	0.96	1914	2.71	1940
A	76.3	60.1	68.2	96	1917	43	1903	40	3.48	8.68	1869	0.08	1957	2.98	1933
S	67.1	52.0	59.6	91	1871	32	1914	180	3.72	8.44	1866	0.79	1948	1.94	1946
O	54.9	41.2	48.0	84	1949	19	1933	530	3.40	7.77	1885	0.42	1924	3.39	1932
N	40.6	29.7	35.2	72	1950	-18	1875	890	3.92	12.04	1927	1.44	1904	2.08	1950+
D	26.7	14.7	20.7	59	1951	-29	1933	1370	3.36	8.72	1885	1.12	1896	1.96	1952
YEAR	51.1	36.3	43.7	97	JULY 1931	-29	DEC 1943	8130	41.80	12.04	NOV 1927	0.08	AUG 1957	3.39	OCT 1932

Month	Precipitation					Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Snow											Maximum Hourly Mileage					At 1330E							Temperatures			
																								Max.		Min.	
	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	0130 E.S.T.	0730 E.S.T.	1330 E.S.T.	1930 E.S.T.	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 0.1 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	30	96		17			10		10	(c)		(c)					(d)			20	20	17	17	30	17	10	30
J	23.8	62.7	1898	10.0	1944		80		74											13	14	*	1	0	23	30	8
F	21.5	73.8	1869	12.0	1944		77		69											15	14	0	1	0	20	28	5
M	18.0	46.4	1900	11.7	1955		76		68											15	11	*	2	0	11	25	1
A	6.5	29.8	1885	9.2	1947		74		65											13	4	1	1	0	*	10	0
M	T	3.1	1869	T	1957+		74		64											13	*	2	1	*	0	1	0
J	0	0		0			76		67											13	0	5	1	*	0	0	0
J	0	0		0			77		68											13	0	6	*	1	0	0	0
A	0	0		0			80		70											10	0	3	1	*	0	0	0
S	T	1.0	1946	1.0	1946		83		74											12	*	2	1	0	0	0	0
O	0.7	22.1	1892	1.1	1945		83		73											12	1	1	1	0	0	3	0
N	9.2	36.1	1886	12.0	1944		81		77											15	6	*	1	0	5	17	0
D	21.1	53.2	1908	12.0	1951+		80		75											16	13	*	2	0	19	29	4
YEAR	100.8	73.8	FEB 1869	12.0	DEC 1951+		78		70											160	63	20	13	1	78	143	18

The Montreal City Observatory is located at McGill University on the SE slope of Mount Royal in downtown Montreal slightly more than a mile from the St. Lawrence River.

NORMALS, MEANS, AND EXTREMES

LATITUDE 45° 28' N
LONGITUDE 73° 45' W
ELEVATION (ground) 98'

MONTREAL (DORVAL AIRPORT) P.Q.

Month	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow											Maximum Hourly Mileage					At 1330E							Temperatures			
																																							Max.		Min.	
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	0130 E.S.T.	0730 E.S.T.	1330 E.S.T.	1930 E.S.T.	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 0.1 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	16		16		(b)	10	16		16		16		10	16		16		9	9	9	9	13	13	16	16				10	10	10	10	10	16	16	16	16	10	10
J	23.4	6.8	15.1	57	1950	-36	1957	1590	3.31	4.98	1947	1.35	1955	1.16	1945	23.7	37.0	1954	10.2	1954	80	80	74	76	12.6	SW	49	SW	1950			9	3	19	16	14	*	2	0	24	30	11
F	23.7	7.3	15.5	54	1953	-28	1943	1430	2.83	5.66	1954	1.57	1953	1.55	1954	22.8	46.8	1954	15.5	1954	78	80	66	71	12.7	W	45	SW	1956+			7	5	16	15	13	0	2	0	21	28	8
M	35.6	20.6	28.1	78	1945	-21	1950	1180	3.21	6.50	1955	1.24	1957	1.48	1955	14.1	42.8	1955	12.0	1955	77	79	60	68	12.5	SW	44	NE	1942			10	5	16	14	10	1	2	0	12	26	2
A	49.5	32.8	41.2	81	1945+	5	1954	730	3.04	4.48	1954	1.18	1955	1.18	1954	4.6	9.7	1943	6.8	1947	78	75	64	64	12.3	SW	39	NE	1956			6	5	19	13	3	1	2	0	*	14	0
M	64.4	45.7	55.1	87	1953+	26	1956+	270	2.98	6.90	1945	1.57	1944	1.48	1945	T	0.1	1945	0.1	1945	78	74	52	60	11.2	SW	41	SW	1947			6	7	18	14	*	2	1	0	0	1	0
J	74.0	55.3	64.7	93	1953	34	1945	60	3.18	8.49	1943	1.72	1942	2.13	1943	0	0		0		80	75	54	62	9.9	SW	42	SW	1957			5	9	16	13	0	4	2	1	0	0	0
J	79.3	60.9	70.1	96	1955+	45	1946	10	3.56	5.80	1945	1.55	1942	2.18	1951	0	0		0		80	77	53	62	9.3	SW	32	NE	1948			6	11	14	12	0	6	1	1	0	0	0
A	77.2	58.4	67.8	96	1944	38	1957	40	2.77	5.20	1952	0.02	1957	2.71	1952	0	0		0		80	78	53	64	9.1	SW	35	N	1954			8	9	14	10	0	4	1	2	0	0	0
S	69.0	50.3	59.7	91	1953	28	1951	190	3.23	5.61	1945	0.44	1948	2.05	1946	0.2	2.4	1946	2.4	1946	83	83	56	71	9.7	SW	41	SW	1949			7	7	16	11	*	2	2	*	0	1	0
O	56.2	39.1	47.7	82	1949	22	1950+	550	2.99	4.98	1941	1.01	1947	1.77	1942	0.3	1.5	1945	1.4	1945	82	85	59	72	10.5	SW	36	WSW	1951+			7	7	17	12	*	1	3	0	0	6	0
N	40.7	28.6	34.7	71	1948	-3	1949	910	3.76	5.53	1951	1.65	1956	2.17	1950	9.7	21.5	1944	12.0	1944	81	83	69	79	11.5	SW	44	NE	1950			3	4	23	16	6	*	3	0	5	19	*
D	26.2	12.7	19.4	62	1951	-26	1942	1390	3.55	5.76	1942	1.15	1955	2.00	1942	21.3	41.0	1942	12.5	1942	81	82	74	79	11.9	W	49	NE	1944			7	5	19	16	13	*	3	0	20	30	5
YEAR	51.6	34.9	43.3	96	AUG 1955	-36	JAN 1957	8350	38.41	8.49	JUN 1943	0.02	AUG 1957	2.71	AUG 1952	96.7	46.8	FEB 1954	15.5	FEB 1954	80	79	61	69	11.1	SW	49	SW NE	DEC 1950+			81	77	207	162	59	21	24	4	82	155	26

Dorval Airport is located 7 miles WSW of the center of Montreal in flat open country. The St. Lawrence river is 1 mile south.

LATITUDE 44° 07 N
LONGITUDE 77° 32' W
ELEVATION (ground) 266'

TRENTON (AIRPORT) ONT.

Month	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow											Maximum Hourly Mileage					At 1330E							Temperatures			
																																							Max.		Min.	
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	0130 E.S.T.	0730 E.S.T.	1330 E.S.T.	1930 E.S.T.	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 0.1 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	20		20		(b)	14	20		20		17		14	17		17		10	10	10	10	9	9	12	12				10	10	10	20	13	17	17	17	17	10	17
J	28.8	11.8	20.3	56	1950	-25	1945	1400	2.82	5.06	1950	1.29	1944	1.47	1957	16.1	38.2	1954	10.0	1954	86	87	84	85	10.8	NE	43	W	1947			7	4	20	13	10	*	3	0	19	29	7
F	28.3	11.7	20.0	56	1954	-26	1943	1280	2.34	3.71	1939	1.08	1935	1.35	1942	14.2	28.5	1947	12.0	1947	88	88	80	83	10.5	W	45	W	1956			6	5	17	10	8	*	2	0	15	27	4
M	38.5	22.0	30.3	73	1946	-20	1938	1080	2.68	4.83	1955	0.45	1935	2.11	1953	9.6	26.8	1955	14.0	1947	82	81	71	80	11.2	W	45	W	1956			7	5	19	11	5	1	2	0	8	25	1
A	51.5	34.1	42.8	78	1941	12	1943	670	2.21	5.49	1956	0.42	1941	1.51	1956	2.8	8.4	1944	4.5	1942	81	81	63	73	10.4	SW	35	WSW	1957			7	6	17	10	1	1	2	0	*	12	0
M	63.7	45.3	54.5	83	1944	26	1936	330	3.31	6.58	1943	0.60	1936	2.80	1943	T	T	1956+	T	1956+	82	78	63	71	9.3	SW	39	SW	1950			5	7	19	11	0	3	3	0	0	1	0
J	74.5	55.4	65.0	94	1956	33	1945	70	2.39	5.36	1947	0.61	1936	2.22	1947	0	0		0		83	79	63	70	8.9	SW	45	WSW	1957			7	8	15	8	0	4	1	*	0	0	0
J	79.6	60.4	70.0	102	1936	42	1940+	20	2.50	7.00	1951	0.56	1936	2.78	1951	0	0		0		84	79	62	67	8.9	SW	39	SW	1947			5	11	15	7	0	5	1	1	0	0	0
A	78.3	59.1	68.7	97	1948	38	1940+	30	2.13	4.69	1955	0.64	1935	2.81	1941	0	0		0		85	83	61	70	8.1	SW	35	NE	1955			6	11	14	7	0	4	2	1	0	0	0
S	70.2	51.4	60.8	95	1953	29	1935	160	2.50	4.85	1957	1.13	1950	1.95	1956	0	T	1956	T	1956	86	86	62	75	8.7	SW	43	SW	1941			8	8	14	9	0	3	1	*	0	1	0
O	58.6	40.8	49.7	78	1955+	19	1940	470	2.67	10.61	1955	0.32	1953	2.54	1955	0	T	1957+	T	1957+	88	90	68	80	8.5	SW	41	SW	1951			9	5	17	9	0	1	4	0	0	5	0
N	44.6	30.6	37.6	72	1956	-3	1949	840	3.08	5.75	1951	1.42	1955+	1.59	1951	6.1	25.2	1940	12.7	1956	86	88	74	83	10.3	SW	45	WSW	1956			4	4	22	12	3	*	2	0	2	18	*
D	31.8	17.1	24.5	57	1957+	-23	1942	1280	3.11	6.23	1941	0.78	1943	3.82	1941	11.3	36.6	1951	8.0	1948	85	87	77	84	11.2	W,SW	41	SW	1941			7	5	19	12	7	*	2	0	14	28	3
YEAR	54.0	36.6	45.3	102	JULY 1936	-26	FEB 1943	7630	31.74	10.61	OCT 1955	0.32	OCT 1953	3.82	DEC 1941	60.1	38.2	JAN 1954	14.0	MAR 1947	85	84	69	77	9.7	SW	45	W WSW	NOV 1957			78	79	208	119	34	22	25	2	58	146	15

Trenton Airport is 2 miles east of town on the north shore of the Bay of Quinte. The immediate country is flat and open.

NORMALS, MEANS, AND EXTREMES

LATITUDE 43° 07' N
LONGITUDE 77° 40' W
ELEVATION (ground) 543 feet

ROCHESTER (AIRPORT) N.Y.

Month	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes					Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Sleet					1:00 a.m., EST	7:00 a.m., EST	1:00 p.m., EST	7:00 p.m., EST	Mean hourly speed	Prevailing direction	Fastest mile					Sunrise to sunset			Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures			
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year									Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year							Speed	Direction	Year			Clear	Partly cloudy	Cloudy					Max.		Min.	
																																							90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	86		86		(b)	(b)	129		129		87		73	87		86		17	17	17	17	86	10	47	47		64	18	87	87	87	87	74	73	17	86	86	86	86
J	32.7	16.7	24.7	74	1950	-16	1957	1249	2.36	8.05	1878	0.11	1834	2.11	1878	18.0	50.2	1884	17.1	1879	81	81	73	79	11.0	WSW	73	W	1950	32	8.1	2	8	21	19	6	*	1	0	16	29	2
F	32.5	15.5	24.0	70	1932	-22	1934	1148	2.42	5.40	1876	0.21	1841	2.43	1950	18.1	42.7	1910	16.5	1910	80	81	69	78	11.1	WSW	66	W	1956+	41	7.8	3	8	17	17	5	*	1	0	14	26	2
M	41.8	24.1	33.0	86	1905	- 7	1885+	992	2.96	7.02	1873	0.55	1936	2.98	1900	13.5	54.0	1900	29.8	1900	80	81	64	75	10.9	WSW	65	W	1956	47	7.2	6	9	16	17	4	1	1	0	9	23	*
A	54.7	34.2	44.5	90	1885	7	1923	615	2.64	6.13	1857	0.50	1837	1.99	1943	3.5	25.1	1874	10.0	1885	79	79	57	66	10.1	WSW	59	W	1946	53	6.7	8	9	13	14	1	2	2	*	1	10	0
M	67.8	45.0	56.4	93	1895	27	1911	289	2.64	6.87	1894	0.52	1934	2.95	1916	0.2	3.3	1909	3.0	1909	81	77	54	63	8.9	SW	63	SW	1950	60	6.7	9	11	11	13	*	4	1	*	0	1	0
J	78.2	54.9	66.6	100	1953	35	1949+	54	2.85	8.35	1830	0.76	1929	2.86	1950	0.0	0.0		0.0		84	77	52	61	8.0	SW	61	SW	1949	67	5.9	10	11	9	11	0	5	1	2	0	0	0
J	82.7	59.7	71.2	102	1936	44	1945	9	3.09	9.70	1947	0.25	1854	3.57	1897	0.0	0.0		0.0		84	80	50	60	7.5	SW	56	W	1956	70	5.5	11	13	7	11	0	7	1	3	0	0	0
A	80.3	57.5	68.9	99	1948	43	1957+	34	2.48	7.26	1886	0.36	1876	4.19	1893	0.0	0.0		0.0		86	83	52	65	7.0	SW	59	NE	1955	66	5.6	11	12	8	10	0	5	1	2	0	0	0
S	73.0	50.9	62.0	98	1881	28	1947	133	2.66	7.41	1868	0.46	1897	2.47	1925	T	T	1956+	T	1956+	87	86	55	73	7.6	SW	59	SW	1949	60	5.6	10	10	10	10	0	3	1	1	0	*	0
O	61.1	40.4	50.8	91	1951	19	1879	440	2.50	8.67	1873	0.08	1924	3.77	1873	0.3	6.1	1880	5.8	1880	84	86	57	75	8.4	SW	55	SW	1937	50	6.1	8	9	14	12	*	1	2	*	*	3	0
N	47.4	32.0	39.7	81	1950	1	1875	759	2.74	7.12	1927	0.33	1904	3.13	1945	6.4	22.2	1886	12.8	1886	81	83	66	78	9.9	WSW	59	E	1950	32	8.0	3	7	20	15	2	*	1	0	3	15	0
D	35.4	21.0	28.2	70	1875	-16	1942	1141	2.40	6.17	1878	0.46	1835	2.20	1901	15.2	41.8	1944	17.8	1944	81	81	70	79	10.4	WSW	57	W	1932	26	8.1	2	6	23	18	5	*	1	0	12	25	1
Year	57.3	37.7	47.5	102	July 1936	-22	Feb. 1934	6863	31.74	9.70	July 1947	0.08	Oct. 1924	4.19	Aug. 1893	75.2	54.0	Mar. 1900	29.8	Mar. 1900	82	81	60	71	9.2	WSW	73	W	Jan. 1950	50	6.8	83	113	169	167	23	28	14	8	55	132	5

The Rochester Airport is located some 11 miles south of the shore of Lake Ontario in level to gently rolling terrain with a slight inclination toward the Lake.

LATITUDE 42° 56' N
LONGITUDE 78° 44' W
ELEVATION (ground) 693 Feet

BUFFALO (AIRPORT) N. Y.

Month	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes					Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Sleet					1:00 a.m. EST	7:00 a.m. EST	1:00 p.m. EST	7:00 p.m. EST	Mean hourly speed	Prevailing direction	Fastest mile					Sunrise to sunset			Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures			
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year									Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year							Speed	Direction	Year			Clear	Partly cloudy	Cloudy					Max.		Min.	
																																							90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	84		84		(b)	(b)	87		87		87		73	73		65		18	18	18	18	62	8	46			47	60	87	87	87	87	73	67	52	84	84	84	84
J	32.4	18.5	25.5	72	1950	-14	1884	1225	2.78	6.41	1910	0.89	1921	2.40	1957	19.1	50.6	1945	17.4	1902	78	79	72	78	17.4	WSW	91	SW	1950+	32	8.1	2	8	21	19	6	*	1	0	16	27	1
F	32.2	17.1	24.7	68	1932	-21	1934	1128	2.59	5.74	1910	0.46	1877	2.31	1954	16.6	43.7	1910	16.1	1910	79	80	69	76	16.4	SW	73	SW	1936	41	7.5	3	9	16	17	5	*	1	0	15	26	2
M	40.9	25.1	33.0	81	1945	- 4	1885	992	2.72	7.03	1936	0.68	1910	2.62	1936	10.6	38.5	1936	19.0	1936	78	79	65	74	15.9	SW	84	SW	1943	49	7.0	5	10	16	16	3	1	2	0	9	24	*
A	53.1	34.4	43.8	87	1957	5	1923	636	2.55	5.02	1929	0.59	1915	1.94	1903	3.1	15.7	1885	8.9	1894	78	77	58	68	14.8	SW	73	SW	1929	52	6.5	7	10	13	14	1	2	2	0	1	11	0
M	65.8	44.9	55.4	94	1911	25	1926	315	2.47	7.35	1892	0.53	1877	2.15	1894	0.2	5.2	1909	5.2	1909	80	77	56	67	13.2	SW	63	SW	1950	60	6.1	8	12	11	13	*	4	2	*	*	1	0
J	76.0	55.0	65.5	97	1933	35	1945	72	2.70	9.67	1928	0.11	1955	3.28	1885	0.0	0.0		0.0		82	77	56	65	12.5	SW	73	W	1924	68	5.6	8	14	8	11	0	5	1	*	0	0	0
J	81.1	60.0	70.6	96	1936	43	1945	16	2.43	8.29	1897	0.15	1933	3.56	1896	0.0	0.0		0.0		82	78	53	63	12.1	SW	62	SW	1927+	70	5.3	10	14	7	10	0	6	1	1	0	0	0
A	79.3	58.5	68.9	99	1948	43	1946	30	2.54	10.63	1885	0.05	1876	4.28	1893	0.0	0.0		0.0		83	82	54	66	11.7	SW	60	W	1923	65	5.4	9	14	8	10	0	5	*	1	0	0	0
S	72.6	52.2	62.4	98	1953	32	1957+	122	3.01	7.44	1878	0.31	1897	2.36	1875	T	T	1956+	T	1956+	82	82	56	72	12.8	S	68	SW	1941	60	5.6	9	12	9	11	0	3	1	*	0	*	0
O	60.4	42.0	51.2	92	1927	24	1936+	433	2.49	9.13	1954	0.08	1924	3.49	1945	0.4	6.0	1909	6.0	1909	80	82	58	74	14.1	S	71	W	1919	51	6.2	7	10	14	12	*	2	1	*	*	2	0
N	47.0	32.7	39.9	76	1950	2	1875	753	3.09	6.71	1927	0.51	1904	2.82	1920	7.8	28.6	1949	19.9	1955	77	80	66	75	16.4	S	76	SW	1914	32	7.7	3	8	19	15	2	1	1	0	2	13	0
D	35.3	22.6	29.0	70	1941	- 9	1880	1116	2.92	8.55	1878	0.69	1943	2.53	1878	17.6	51.1	1945	24.3	1945	78	79	71	77	17.0	WSW	85	SW	1921	26	8.2	1	8	22	18	5	*	1	0	11	24	*
Year	56.3	38.6	47.5	99	Aug. 1948	-21	Feb. 1934	6838	32.29	10.63	Aug. 1885	0.05	Aug. 1876	4.28	Aug. 1893	75.4	51.1	Dec. 1945	24.3	Dec. 1945	80	79	61	71	14.5	SW	91	SW	Jan. 1950+	53	6.6	72	129	164	166	22	30	13	2	53	127	4

The Buffalo Airport is located about nine miles northeast of the eastern end of Lake Erie and 25 miles south of Lake Ontario. The surrounding country is low and level to the west, gently rolling to the east and south, rising to pronounced hills within 12 to 18 miles.

NORMALS, MEANS, AND EXTREMES

LATITUDE 43° 40' N
LONGITUDE 79° 24' W
ELEVATION (ground) 379'

TORONTO (CITY) ONT.

Month	Temperature							Normal degree days	Precipitation											Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow											Maximum Hourly Mileage					At 1330E							Temperatures			
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	0130 E.S.T.	0730 E.S.T.	1330 E.S.T.	1930 E.S.T.	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 0.1 inch or more	Thunderstorms	Heavy fog	Max. 90° and above	32° and below	Min. 32° and below	0° and below
(a)	30	30	30	114		114		30	30	116		116		116		30	116		116		10	10	10	10	18	18	18	18				18	18	18	50	50	25	18	30	17	10	30
J	31.1	17.9	24.5	60	1950	-26	1859	1249	2.72	6.84	1932	0.61	1871	2.50	1843	14.1	43.6	1871	15.3	1873	80	81	69	74	14.7	W	48	SWW	1943+			6	5	20	16	12	*	1	0	17	27	2
F	30.8	17.2	24.0	57	1954	-25	1855	1147	2.31	5.21	1900	0.29	1877	1.70	1855	13.6	46.1	1846	16.0	1863	78	80	67	72	14.4	W	49	SW	1946			5	5	18	13	11	*	1	0	14	26	1
M	39.1	25.4	32.2	80	1946	-16	1868	1018	2.58	7.00	1870	0.51	1905	1.72	1881	9.4	62.4	1870	16.2	1876	69	72	57	63	13.9	NW	56	SW	1942			6	5	20	14	8	1	1	0	7	22	*
A	52.0	35.6	43.8	90	1842	5	1923	646	2.55	6.21	1929	0.10	1881	2.35	1850	3.1	12.9	1857	8.3	1901	67	68	50	56	13.0	NW	44	W	1940			7	6	17	12	3	1	1	0	*	9	0
M	64.5	45.7	55.1	93	1895	25	1854	316	2.65	9.36	1894	0.39	1920	2.70	1894	0.1	3.1	1875	3.0	1875	70	70	53	58	10.4	NE	40	W	1945			6	6	19	12	*	3	1	*	0	*	0
J	75.4	55.6	65.5	97	1901	28	1843	73	2.70	8.09	1870	0.06	1949	2.50	1957	.0	T	1859	T	1945*	70	73	53	57	9.1	SW	33	S	1943			8	8	14	10	0	4	*	1	0	0	0
J	80.6	60.9	70.8	105	1936	39	1843	8	3.23	8.15	1841	0.32	1954	3.88	1897	.0	.0		.0		79	77	53	59	8.3	SW	37	NW	1940			7	10	14	10	0	6	1	2	0	0	0
A	78.4	59.5	69.0	102	1918	40	1855	29	2.39	8.14	1915	T	1876	3.68	1908	.0	.0		.0		80	79	53	62	8.4	SW	32	W	1951			8	10	13	9	0	3	*	1	0	0	0
S	70.5	52.7	61.6	100	1953	28	1844+	154	2.67	9.76	1843	0.40	1897	3.46	1843	T	T	1956+	T	1956+	80	83	56	70	9.6	E,NW	47	SW	1941			8	8	14	11	0	2	1	*	0	0	0
O	58.2	42.3	50.2	85	1916+	16	1844	465	2.29	6.10	1954	0.52	1944	3.79	1954	0.2	12.0	1845	3.3	1875	77	84	58	72	10.0	SW	38	W	1941			10	6	15	10	*	1	2	0	0	2	0
N	45.1	33.2	39.2	75	1950	-5	1875	777	2.55	5.84	1846	0.11	1904	3.13	1861	4.3	22.5	1950	12.0	1950	76	80	64	73	13.0	SW	46	E	1940			4	6	20	13	4	1	1	0	2	13	0
D	34.2	22.5	28.4	61	1875	-22	1932	1126	2.29	6.60	1841	0.47	1845	2.05	1944	9.8	38.0	1872	20.5	1944	76	76	70	72	14.4	SW	50	SW	1938			4	6	21	14	9	*	1	0	11	24	1
YEAR	55.0	39.0	47.0	105	JULY 1936	-26	JAN 1859	7008	30.93	9.76	SEPT 1843	T	AUG 1876	3.88	JULY 1897	54.6	62.4	MAR 1870	20.5	DEC 1944	75	77	59	66	11.6	SW	56	SW	MAR 1942			79	81	205	144	47	22	11	4	51	123	4

Toronto (City) observations are taken at the Headquarters of the Meteorological Branch in downtown Toronto, 2 1/4 miles from Lake Ontario.

LATITUDE 43° 41' N
LONGITUDE 79° 38' W
ELEVATION (ground) 578'

TORONTO (MALTON AIRPORT) ONT.

Month	Temperature							Normal degree days	Precipitation											Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow											Maximum Hourly Mileage					At 1330E							Temperatures			
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	0130 E.S.T.	0730 E.S.T.	1330 E.S.T.	1930 E.S.T.	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 0.1 inch or more	Thunderstorms	Heavy fog	Max. 90° and above	32° and below	Min. 32° and below	0° and below
(a)	(b)	(b)	(b)	20		20		(b)	20	20		20		20		20	20		20		10	10	10	10	16	16	16					18	18	18	20	20	17	17	10	17	10	10
J	29.5	13.9	21.7	62	1950	-21	1939	1360	2.35	3.87	1947	0.76	1944	2.31	1946	14.2	26.8	1943	11.0	1943	86	86	77	83	11.9	W	49	SW	1949			6	5	20	17	13	*	4	0	12	30	5
F	28.6	12.6	20.6	54	1954	-24	1943	1260	2.21	3.47	1939	1.07	1947	1.04	1943	13.2	22.8	1939	9.8	1950	82	85	74	81	12.3	W	52	SW	1946			5	5	18	12	10	*	3	0	16	28	4
M	38.2	21.7	30.0	78	1946	-20	1950	1090	2.62	4.61	1942	1.10	1957	1.64	1943	9.0	21.4	1939	11.2	1949	81	81	66	74	12.1	W	54	SW	1942			6	6	19	13	8	*	3	0	8	26	2
A	52.1	33.1	42.6	85	1938	10	1954	700	2.19	3.60	1954	0.67	1946	1.64	1951	3.8	12.8	1939	4.2	1950	79	79	57	67	12.0	SW	46	SW	1947			6	6	18	11	2	2	3	0	1	15	0
M	65.1	43.7	54.4	91	1949	25	1947	370	3.47	5.71	1945	0.37	1949	3.65	1944	T	T	1958+	T	1958+	82	79	58	66	9.9	N	45	SW	1945			5	7	19	12		3	3	0	0	3	0
J	75.8	53.4	64.6	98	1952	33	1949	100	2.50	4.61	1947	0.16	1949	1.73	1957	T	T	1945	T	1945	84	78	55	66	9.1	N,W	36	NW	1944			5	10	15	9		4	3	1	0	0	0
J	80.8	57.7	69.3	97	1938	41	1945	30	3.20	4.65	1945	0.45	1957	1.83	1956	.0	.0		.0		84	79	55	65	8.5	N,W	39	S	1940			6	10	15	10		5	2	2	0	0	0
A	78.9	56.3	67.6	101	1948	37	1942	40	2.30	5.27	1949	1.13	1942	2.31	1955	.0	.0		.0		83	82	53	65	8.5	N	31	SW	1942			5	12	14	9		4	2	2	0	0	0
S	70.6	49.8	60.2	98	1953	28	1947	180	3.07	6.08	1948	0.87	1950	4.25	1948	.0	T	1956	T	1956	87	87	59	76	9.3	N,W	48	WSW	1941			7	10	13	10		3	4	*	0	1	0
O	58.6	38.7	48.7	87	1951	21	1944	540	2.18	8.42	1954	0.28	1938	4.78	1954	T	0.3	1952	0.3	1952	86	89	61	79	9.5	N,W	54	W	1954			9	6	16	9		1	5	0	0	5	0
N	44.4	30.0	37.2	77	1950	-1	1949	840	2.32	4.50	1940	1.08	1956	2.20	1943	7.0	24.0	1940	12.0	1950	86	88	73	82	11.6	W	48	S,SW	1947+			4	5	21	12	4	1	4	0	3	18	0
D	33.2	19.2	26.2	66	1946	-24	1942	1220	2.11	4.33	1942	0.60	1943	1.51	1942	8.9	34.1	1951	11.1	1944	84	85	74	84	11.8	SW	44	W,SW	1946+			5	5	21	15	10	*	4	0	14	28	2
YEAR	54.7	35.8	45.3	101	AUG 1948	-24	DEC 1942	7730	30.52	8.42	OCT 1954	0.16	JUNE 1949	4.78	OCT 1954	56.1	34.1	DEC 1951	12.0	NOV 1950	84	82	64	74	10.5	W	54	SW	MAR 1942			69	87	209	139	47	23	40	5	54	154	13

Malton Airport is located 15 miles NW of the center of Toronto, about 10 miles N of Lake Ontario. The surrounding country is flat.

NORMALS, MEANS, AND EXTREMES

LATITUDE 42° 05'
LONGITUDE 80° 12'
ELEVATION (ground) 732 Feet

ERIE (PORT ERIE AIRPORT) PA.

Month	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow, Sleet											Fastest mile					Sunrise to sunset							Temperatures			
																																							Max.		Min.	
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Normal degree days	Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	1:30 a.m., EST	7:30 a.m., EST	1:30 p.m., EST	7:30 p.m., EST	Mean hourly speed	Prevailing direction	Speed	Direction	Year	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	84		84		(b)	(b)	84		84		82		73	73		73		12	12	12	12	5	5	42			56	11	82	82	82	84	63	74	74	84	84	84	84
J	34.2	20.1	27.2	73	1876	-15	1875	1172	2.34	6.25	1950	0.85	1944	1.92	1914	12.6	38.3	1945	12.8	1910	84	84	79	73	12.4	SSW	56	SE	1918	22	8.4	2	8	21	17	3	*	*	0	13	27	1
F	34.1	18.9	26.5	72	1932	-16	1875	1078	2.07	8.50	1887	0.33	1877	3.35	1883	10.3	36.9	1947	10.7	1951	84	85	76	83	11.4	WSW	57	W	1923	35	7.9	4	8	16	15	3	*	*	0	13	25	1
M	42.6	25.6	34.1	82	1910	- 5	1916	958	2.79	7.36	1913	0.53	1910	3.06	1913	8.2	20.9	1896	16.1	1936	81	81	71	79	11.7	SSE	60	SW	1917	44	7.0	6	10	15	15	2	1	1	0	7	23	*
A	53.9	34.6	44.3	86	1883	7	1923	621	3.50	8.88	1947	0.74	1915	3.16	1947	2.8	19.3	1901	15.4	1901	79	78	65	71	10.2	WSW	56	W	1922	51	6.6	8	10	12	14	1	2	1	0	1	8	0
M	65.5	44.7	55.1	91	1879	30	1926	324	3.19	8.05	1892	0.55	1934	4.71	1893	0.1	1.7	1923	1.2	1923	82	78	66	71	7.9	S	51	SW	1925	58	6.2	10	11	10	13	*	5	1	*	0	*	0
J	75.9	55.0	65.5	97	1934	40	1894	78	2.87	7.74	1957	0.99	1925	3.64	1887	0.0	0.0		0.0		85	80	66	70	7.9	S	47	SW	1916	63	5.4	12	12	6	11	0	6	*	1	0	0	0
J	80.6	60.1	70.4	98	1936	47	1891	7	3.19	13.27	1947	0.39	1916	10.42	1947	0.0	0.0		0.0		84	79	64	70	7.6	S	51	W	1916	66	5.0	12	13	6	10	0	7	*	2	0	0	0
A	79.0	58.9	69.0	96	1918	42	1957	33	2.48	9.28	1915	0.07	1899	5.77	1915	0.0	0.0		0.0		85	82	63	74	7.5	S	58	SE	1926	63	4.9	11	13	7	10	0	5	*	1	0	0	0
S	72.9	53.5	63.2	99	1953	33	1957	105	3.39	8.45	1876	0.54	1897	3.40	1882	T	T	1954+	T	1954+	82	82	63	79	8.6	S	56	SW	1921	55	5.3	10	11	9	11	0	4	*	*	0	0	0
O	61.2	43.4	52.3	89	1951	23	1895	399	3.01	9.87	1954	0.02	1924	3.24	1912	1.2	14.7	1925	8.5	1913	80	82	65	78	9.0	S	51	SE	1916	44	5.5	9	9	13	13	*	2	*	0	0	1	0
N	48.2	33.7	41.0	82	1950	6	1929	720	3.26	8.93	1950	0.40	1904	2.86	1956	7.5	46.9	1950	23.0	1956	78	80	70	77	11.4	SSW	60	SE	1915	24	8.0	4	7	19	15	2	1	*	0	2	10	0
D	36.9	24.4	30.7	70	1941	-11	1880	1063	2.39	6.44	1881	0.66	1928	2.36	1944	12.2	53.6	1944	26.5	1944	80	82	75	80	12.6	SSW	53	SW	1927	16	8.4	2	6	23	17	4	*	*	0	9	23	*
Year	57.1	39.4	48.3	99	Sept. 1953	-16	Feb. 1875	6558	34.48	13.27	July 1947	0.02	Oct. 1924	10.42	July 1947	54.9	53.6	1944	26.5	1944	82	81	69	75	9.9	S	60	SW	Mar. 1917+	45	6.6	90	118	157	161	15	33	3	4	45	117	2

The Port Erie Airport is located six miles southwest of the center of the City and about one mile from the lake shore. The terrain rises gradually in a series of ridges, parallel to the shore to 500 feet above lake level 3 to 4 miles inland.

LATITUDE 42° 35' N
LONGITUDE 80° 34' W
ELEVATION (ground) 624'

CLEAR CREEK, ONT.

Month	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow											Maximum Hourly Mileage					At 1330E							Temperatures			
																																							Max.		Min.	
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Normal degree days	Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	0130 E.S.T.	0730 E.S.T.	1330 E.S.T.	1930 E.S.T.	Mean hourly speed	Prevailing direction	Speed	Direction	Year	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 0.1 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
	8	8	8	8		8		(e)	8	8		8		8		8	8		8		(e)				3	3	3	3	3			(e)	(e)	(e)	8	8	(e)	(e)	8	8	8	8
J	30.9	18.9	24.9	47	1953	-7	1957		3.41	4.83	1957	1.65	1956	2.32	1957	14.8	23.2	1957+	10.9	1955					12.4	W	36	WSW	1957+						16	12			0	16	29	1
F	33.1	21.0	27.1	50	1954	-15	1955		3.02	4.32	1954	1.81	1957	1.63	1954	8.6	12.8	1951	7.0	1951					10.4	W	35	WNW	1956						12	7			0	12	26	1
M	37.9	26.2	32.1	59	1952	5	1954+		3.56	6.85	1954	1.12	1957	1.80	1954	7.2	24.4	1954	18.0	1954					13.0	W	58	SW	1955						13	6			0	8	26	0
A	51.4	36.5	44.0	76	1957	7	1954		3.61	5.86	1954	1.84	1953	1.55	1957	2.1	7.7	1957	4.0	1956					11.5	W	48	SW	1957						13	2			0	*	9	0
M	60.4	44.5	52.4	78	1955	28	1957		3.06	5.59	1956	0.28	1954	1.83	1956	*	0.1	1956	0.1	1956					10.3	SW	30	W	1956						10	*			0	0	2	0
J	71.5	56.0	63.8	85	1957+	35	1956		2.10	4.43	1954	0.50	1952	2.00	1957	0	0		0						9.0	W	42	WSW	1957						7	0			0	0	0	0
J	77.4	60.6	69.0	89	1952	42	1954		2.34	4.75	1957	1.00	1952	2.25	1951	0	0		0						9.2	WSW	30	W	1957+						8	0			0	0	0	0
A	75.8	58.8	67.3	88	1955+	38	1950		2.77	4.90	1956	1.13	1951	1.74	1956	0	0		0						9.4	WSW	40	S	1956						9	0			0	0	0	0
S	69.2	51.2	60.2	93	1953	30	1951		2.80	5.50	1957	1.65	1953	1.90	1955	0	0		0						10.2	WSW	35	WSW	1957						8	0			*	0	*	0
O	59.8	42.8	51.3	78	1951	21	1952		2.78	7.27	1954	0.27	1953	2.83	1954	0.4	3.0	1952	3.0	1952					11.3	WSW	40	W	1955						8	*			0	0	4	0
N	45.8	32.6	39.2	69	1956	6	1950		3.52	4.93	1951	1.85	1952	2.39	1951	12.1	50.1	1950	13.0	1950					15.2	WNW	56	WSW	1957						13	5			0	3	15	0
D	36.5	24.9	30.7	56	1953	-1	1951		3.11	4.38	1957	1.82	1953	1.43	1952	7.3	25.7	1951	5.5	1951					13.8	W	42	WSW	1955						14	6			0	9	25	*
YEAR	54.1	39.5	46.8	93	SEPT 1953	-15	FEB 1955		36.09	7.27	OCT 1954	0.27	OCT 1953	2.83	OCT 1954	52.5	50.1	NOV 1950	18.0	MAR 1954					11.3	W	58	SW	MAR 1955						131	38			*	48	136	2

The Clear Creek telecommunications station is located near the base of the Long Point peninsula less than a mile from Lake Erie.

NORMALS, MEANS, AND EXTREMES

CLEVELAND (CLEVELAND HOPKINS AIRPORT) OHIO

LATITUDE	41° 24' N
LONGITUDE	81° 51' W
ELEVATION (ground)	787 feet

Month	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow, Sleet											Fastest mile					Sunrise to sunset							Temperatures Max.		Temperatures Min.	
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	1:00 a.m., EST	7:00 a.m., EST	1:00 p.m., EST	7:00 p.m., EST	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	17		17		(b)	(b)	16		16		16		16	16		16		16	16	16	16	16	8	16	16		16	16	16	16	16	16	16	16	16	16	16	16	16
J	36.0	20.9	28.5	73	1950	- 9	1942	1132	2.38	7.01	1950	0.79	1946	1.74	1952	10.6	18.7	1945	9.3	1952	80	82	73	79	12.5	S	59	SW	1950	27	8.1	3	5	23	16	4	*	2	0	12	27	2
F	36.4	20.8	28.6	69	1957	- 8	1951+	1019	2.12	4.64	1950	0.75	1947	1.77	1950	9.7	20.7	1942	7.5	1944	79	81	69	76	12.5	S	65	W	1956+	34	7.7	3	6	19	15	4	*	2	0	9	24	1
M	45.2	28.3	36.8	83	1945	- 5	1948	874	2.89	6.07	1954	1.50	1957	2.76	1948	10.9	26.3	1954	14.9	1954	77	80	62	72	13.0	WNW	74	W	1948	45	7.1	6	7	18	16	4	2	1	0	5	21	*
A	57.1	37.5	47.3	88	1942	19	1954	531	2.73	5.90	1950	1.18	1946	1.92	1950	3.1	14.3	1943	7.6	1957	77	78	56	65	12.0	S	65	W	1951	50	6.9	5	8	17	15	1	4	2	0	*	8	0
M	69.9	48.2	59.1	92	1944	29	1947	223	2.73	6.04	1947	1.04	1954	3.73	1955	0.0	T	1957+	T	1957+	79	76	55	66	10.5	S	68	SW	1957	57	6.6	5	11	15	14	0	6	1	*	0	*	0
J	80.4	58.3	69.4	101	1944	38	1945	46	3.05	6.07	1947	1.38	1954	2.79	1946	0.0	0.0		0.0		82	78	54	61	9.5	S	56	S	1953+	64	6.0	6	13	11	11	0	8	1	5	0	0	0
J	84.7	62.6	73.7	103	1941	46	1946+	0	3.04	5.37	1943	1.23	1952	2.73	1950	0.0	0.0		0.0		81	79	52	58	8.9	S	65	W	1956	69	5.3	10	12	9	10	0	7	1	7	0	0	0
A	82.7	61.1	71.9	102	1948	44	1952	10	2.64	5.19	1947	1.61	1945	3.07	1947	0.0	0.0		0.0		83	82	53	63	8.5	S	61	W	1956	67	5.2	10	13	8	9	0	5	1	6	0	0	0
S	75.8	55.1	65.5	101	1953	32	1942	75	3.13	6.37	1945	1.57	1953	1.85	1945	0.0	0.0		0.0		81	83	53	67	9.5	S	45	S	1953+	63	5.3	10	10	10	9	0	3	*	2	0	*	0
O	64.3	44.5	54.4	90	1946	25	1942	340	2.42	9.50	1954	0.61	1952	3.44	1954	0.6	6.4	1954	6.1	1954	78	82	55	70	10.2	S	43	W	1946	56	5.6	11	8	12	10	*	2	1	*	0	1	0
N	49.2	34.2	41.7	82	1950	7	1950	699	2.66	6.44	1950	1.14	1956	1.94	1950	6.5	22.3	1950	15.0	1950	77	80	64	73	12.8	S	59	W	1948	33	7.7	3	7	20	15	2	1	1	0	2	13	0
D	37.5	24.3	30.9	69	1941	- 9	1951	1057	2.29	5.60	1951	0.96	1955	1.26	1957	11.1	28.9	1944	8.7	1944	78	80	70	77	12.9	S	49	W	1949	28	8.0	3	6	22	16	5	*	1	0	10	25	1
Year	59.9	41.3	50.6	103	July 1941	- 9	Dec. 1951+	6006	32.08	9.50	Oct. 1954	0.61	Oct. 1952	3.73	May 1955	52.5	28.9	Dec. 1944	15.0	Nov. 1950	79	80	60	69	11.1	S	74	W	Mar. 1948	49	6.6	75	106	184	156	20	38	14	20	38	119	4

The Cleveland Hopkins Airport is located about 10 miles southwest of the downtown area and about 5 miles south of Lake Erie. The surrounding terrain is generally level except for a ridge to the southeast which rises some 500 feet above the shore terrain.

SANDUSKY (CITY) OHIO

LATITUDE	41° 27' N
LONGITUDE	82° 43' W
ELEVATION (ground)	603 feet

Month	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow, Sleet											Fastest mile					Sunrise to sunset							Temperatures Max.		Temperatures Min.	
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year		7:00 a.m., EST	1:00 p.m., EST	7:00 p.m., EST	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	80		80		(b)	(b)	81		81		81		73	73		73			53	25	20	80	80	80	80		47	69	80	80	80	81	66	74	74	80	80	80	80
J	35.7	21.8	28.8	73	1950	-16	1879	1122	2.29	6.58	1937	0.60	1902	1.71	1937	8.2	29.8	1893	11.8	1910		81	68	78	10.8	SW	56	SW	1952	35	7.4	5	8	18	14	4	0	1	0	13	26	2
F	36.4	22.4	29.4	72	1944	-15	1899	997	1.92	8.53	1887	0.27	1920	2.98	1887	6.5	22.1	1893	10.1	1900		81	70	76	10.9	SW	64	NE	1881	41	7.0	5	8	15	12	3	0	1	0	11	24	1
M	45.2	29.8	37.5	85	1910	- 3	1885	853	2.89	8.69	1913	0.28	1910	2.96	1913	4.5	16.1	1916	8.7	1955		79	64	74	11.3	SW	56	NW	1918	49	6.7	6	9	16	13	2	2	1	0	5	21	0
A	56.3	39.4	47.9	90	1942	14	1923	513	2.96	6.24	1910	0.35	1915	2.21	1929	1.2	12.0	1957	9.0	1886		73	61	68	10.6	SW	58	SW	1919	52	6.3	7	9	14	12	0	3	0	0	0	5	0
M	68.3	50.2	59.3	93	1941+	32	1923+	217	3.32	9.04	1943	0.64	1934	3.83	1938	0.0	0.0		0.0			72	59	67	9.0	SW	48	SW	1917	62	5.8	8	11	12	13	0	5	0	0	0	0	0
J	79.0	60.7	69.9	104	1934	40	1894	41	3.73	12.51	1937	0.91	1919	5.95	1937	0.0	0.0		0.0			73	58	68	8.1	SW	77	NW	1924	69	5.3	9	13	8	11	0	7	0	3	0	0	0
J	83.7	65.5	74.6	105	1936	50	1918	0	3.45	9.71	1943	0.26	1916	3.87	1935	0.0	0.0		0.0			72	56	65	7.6	SW	69	N	1879	71	4.7	11	14	6	10	0	7	0	5	0	0	0
A	81.7	63.9	72.8	105	1918	45	1946	0	2.81	8.02	1882	0.23	1894	4.20	1906	0.0	0.0		0.0			74	57	67	7.6	SW	63	NE	1885	68	4.8	11	13	7	9	0	5	0	3	0	0	0
S	75.4	57.5	66.5	99	1953+	34	1956+	66	3.26	7.72	1950	0.73	1928	4.28	1950	0.0	0.0		0.0			74	58	68	8.4	SW	52	NW	1897	63	5.0	11	11	8	9	0	3	0	2	0	0	0
O	63.5	46.5	55.0	93	1953	22	1925	327	2.10	6.22	1917	0.43	1897	2.76	1920	T	1.6	1917	1.5	1917		77	59	70	9.3	SW	54	N	1885	55	5.5	10	9	12	10	0	1	1	0	0	1	0
N	49.2	35.2	42.2	82	1950	0	1880	684	2.27	6.43	1927	0.09	1904	2.26	1927	1.9	12.3	1950	12.3	1950		79	66	73	10.9	SW	68	SW	1919	37	7.1	5	8	17	12	1	1	1	0	2	11	0
D	37.6	25.3	31.5	70	1899	-13	1880	1039	2.16	6.27	1881	0.63	1934	1.74	1927	6.1	20.2	1951	9.0	1886		81	71	75	10.6	SW	56	NW	1895	29	7.7	3	8	20	13	3	0	1	0	10	23	0
Year	59.3	43.2	51.3	105	July 1936+	-16	Jan. 1879	5859	33.16	12.51	June 1937	0.09	Nov. 1904	5.95	June 1937	28.2	29.8	Jan. 1893	12.3	Nov. 1950		76	62	71	9.6	SW	77	NW	June 1924	53	6.1	91	121	153	138	13	34	6	13	41	111	3

Sandusky is located at the open end of Sandusky Bay on the South Shore of Lake Erie. Terrain is level here and for a considerable distance inland from the lake shore.

NORMALS, MEANS, AND EXTREMES

LATITUDE 41° 36' N
LONGITUDE 83° 48' W
ELEVATION (ground) 676 Feet

TOLEDO (TOLEDO EXPRESS AIRPORT) OHIO

Month	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes					Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Sleet					1:00 a.m.,EST	7:00 a.m.,EST	1:00 p.m.,EST	7:00 p.m.,EST	Mean hourly speed	Prevailing direction	Fastest mile					Sunrise to sunset			Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures			
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year									Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year							Speed	Direction	Year			Clear	Partly cloudy	Cloudy					Max.		Min.	
																																							90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	87		87		(b)	(b)	87		87		87		73	73		73		17	69	27	69	77	9	46			58	87	87	87	87	87	67	87	86	84	84	84	84
J	34.7	18.0	26.4	71	1950+	-16	1897	1197	2.25	6.63	1913	0.51	1945	1.56	1948	8.0	26.2	1918	9.8	1885	80	80	72	76	12.6	WSW	66	SW	1949	33	7.0	6	8	17	13	3	*	1	0	14	27	2
F	36.0	18.6	27.3	71	1944	-16	1885	1056	1.86	6.84	1887	0.08	1877	2.26	1883	6.9	25.1	1900	19.0	1900	80	78	68	73	12.5	SW	69	SW	1919	40	6.5	6	8	14	11	2	*	1	0	12	25	2
M	45.6	26.0	35.8	83	1910	-10	1948	905	2.86	7.99	1913	0.05	1910	2.69	1913	5.1	17.1	1916	8.4	1888	79	78	62	70	13.0	SW	87	SW	1948	47	6.2	8	9	14	13	2	2	1	0	5	22	*
A	58.0	35.0	46.5	89	1942+	12	1875	555	3.25	7.13	1929	0.55	1876	2.93	1929	1.3	12.0	1957	9.8	1957	79	76	56	64	12.8	WSW	72	SW	1956	50	5.7	9	9	12	12	*	3	*	0	*	7	0
M	70.4	46.0	58.2	95	1911	28	1945	245	2.95	8.04	1943	0.45	1881	3.57	1913	0.1	4.0	1923	4.0	1923	81	75	55	63	11.0	ENE	58	SW	1917	59	5.2	10	11	10	12	*	5	*	*	0	*	0
J	80.7	56.5	68.6	101	1934	38	1945+	60	3.55	7.86	1911	0.12	1952	3.44	1944	0.0	0.0		0.0		83	76	54	63	9.8	SW	56	W	1930	65	4.8	11	12	7	11	0	7	*	3	0	0	0
J	85.3	60.9	73.1	105	1936	44	1945	0	2.65	6.65	1896	0.35	1916	2.47	1929	0.0	0.0		0.0		83	76	52	59	9.1	SW	76	SW	1922	71	4.1	14	12	5	9	0	7	*	5	0	0	0
A	83.0	58.9	71.0	103	1918	41	1946	12	2.69	7.64	1926	0.60	1894	4.58	1920	0.0	0.0		0.0		85	80	54	63	8.8	SW	76	W	1924	67	4.2	14	11	6	9	0	5	*	4	0	0	0
S	75.9	52.5	64.2	100	1953+	29	1942	102	3.02	8.07	1926	0.37	1946	5.98	1918	0.0	0.0		0.0		84	82	55	67	9.7	SW	62	S	1919	62	4.4	13	10	7	9	0	3	1	1	0	0	0
O	63.9	41.5	52.7	92	1951	21	1952+	387	2.32	8.49	1881	0.32	1892	3.10	1881	T	1.2	1925	1.1	1925	83	82	56	68	10.5	SW	57	SW	1916	55	5.1	12	8	11	9	*	2	1	*	0	2	0
N	48.9	30.7	39.8	80	1950	2	1947+	756	2.15	5.58	1927	0.04	1904	2.68	1871	2.0	12.0	1932	11.5	1932	81	81	66	73	12.4	SW	76	SW	1919	36	6.6	7	8	15	11	1	1	1	0	2	14	0
D	36.9	20.9	28.9	70	1889	-15	1872	1119	2.29	5.74	1923	[illegible].33	1919	2.04	1885	7.0	25.5	1951	10.8	1909	81	82	72	76	12.3	SW	69	SW	1920	30	7.1	5	8	18	12	2	*	1	0	10	24	1
Year	59.9	38.8	49.4	105	July 1936	-16	Jan. 1897+	6394	31.84	8.49	Oct. 1881	0.04	Nov. 1904	5.98	Sept. 1918	30.4	26.2	Jan. 1918	19.0	Feb. 1900	82	79	60	68	11.2	SW	87	SW	Mar. 1948	53	5.6	115	114	136	131	10	35	7	13	43	121	5

The Airport Office is located at Toledo Express Airport. The terrain is generally level with only a slight slope toward the Maumee River and Lake Erie.

LATITUDE 42° 17' N
LONGITUDE 82° 58' W
ELEVATION (ground) 637'

WINDSOR (AIRPORT) ONT.

Month	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes					Normal total	Maximum m nthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow									Mean hourly speed	Prevailing direction	Maximum Hourly Mileage					At 1330E			Precipitation .01 inch or more	Snow, Sleet inch or more	Thunderstorms	Heavy fog	Temperatures			
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year									Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Yea							Speed	Direction	Year			Clear	Partly cloudy	Cloudy					Max.		Min.	
																																							90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	18		18		(b)	10	18		18		18		10	18		18		10	10	10	10	14		14					18	18	18	18	18	18	18	18	18	18	18
J	30.8	18.2	24.5	64	1950	-9	1943	1220	2.12	5.28	1950	0.80	1958	0.94	1957	8.6	20.8	1943	9.4	1957	85	88	76	81	12.1	SW	44	SW	1942			4	4	23	14	11	0	4	0	16	28	1
F	32.2	19.4	25.8	65	1954	-8	1951	1100	2.17	4.18	1954	0.80	1958	1.34	1949	9.8	20.2	1944	8.0	1944	86	88	72	80	12.7	SW,W	39	SW	1943			4	4	20	13	9	*	3	0	13	27	1
M	42.3	26.7	34.5	79	1943	-3	1943	950	2.90	5.66	1954	0.34	1958	1.56	1954	4.4	20.5	1954	7.1	1954	80	84	66	74	13.2	SW,W	41	W	1942			6	5	20	13	6	1	2	0	6	22	*
A	55.2	36.2	45.7	87	1942	15	1954	580	3.03	6.78	1947	0.58	1946	1.65	1947	1.6	5.4	1957	2.7	1947	79	82	56	66	12.1	NE,SW	43	NE	1944			7	4	19	12	2	3	2	0	*	10	0
M	67.2	47.8	57.5	92	1942	29	1954	270	4.43	7.67	1943	1.11	1954	2.16	1953	T	0.2	1954	0.2	1954	82	81	58	67	9.5	NE	39	NW,S	1943+			6	7	18	12	0	5	2	*	0	1	0
J	77.9	58.3	68.1	99	1952	37	1945	70	2.98	4.90	1946	0.49	1952	1.94	1946	.0	.0		.0		86	83	58	66	7.8	SW	34	W	1944			5	9	16	10	0	6	2	3	0	0	0
J	83.1	62.9	73.0	101	1941	46	1954+	10	2.61	9.09	1957	1.01	1944	2.70	1957	.0	.0		.0		84	82	54	61	7.2	SW	29	N	1941			7	10	14	10	0	6	1	5	0	0	0
A	80.6	61.0	70.8	98	1944	44	1950	10	3.31	6.22	1940	1.42	1948	1.80	1953	.0	.0		.0		86	86	55	66	6.6	SW	29	NE	1944			8	10	13	9	0	5	2	3	0	0	0
S	73.7	54.5	64.1	99	1954+	30	1942	120	2.44	6.00	1945	0.80	1956	1.82	1950	T	T	1949	T	1949	86	91	59	73	8.0	SW	41	W	1941			8	8	14	9	0	3	2	1	0	*	0
O	61.1	42.9	52.0	87	1951	25	1952	410	2.70	6.42	1954	0.23	1945	2.82	1949	T	0.4	1952	0.4	1952	85	89	60	75	8.8	SW	34	W	1941			10	6	15	9	*	2	4	0	0	3	0
N	45.5	32.9	39.2	79	1950	7	1955+	780	2.43	4.96	1950	0.97	1953	2.01	1951	4.2	11.4	1950	6.1	1951	85	87	70	80	11.0	SW	38	SW	1952			4	4	22	12	5	*	2	0	3	14	0
D	34.5	22.7	28.6	62	1956+	-5	1951+	1130	2.31	3.94	1951	0.55	1943	0.98	1945	7.2	25.0	1951	7.7	1951	84	87	73	80	11.4	SW	39	SW	1943			5	4	22	14	8	*	4	0	11	27	1
YEAR	57.0	40.3	48.7	101	JULY 1941	-9	JAN 1943	6650	33.43	9.09	JULY 1957	0.23	OCT 1945	2.82	OCT 1949	35.8	25.0	DEC 1951	9.4	JAN 1957	84	86	63	72	10.0	SW	44	SW	JAN 1942			74	75	216	137	41	31	30	12	49	132	3

The airport is located 5 miles SE of the city center and the Detroit River, 5 miles SW of Lake St. Clair and 17 miles N of Lake Erie. The surrounding country is quite flat.

NORMALS, MEANS, AND EXTREMES

LATITUDE 42° 24' N
LONGITUDE 83° 00' W
ELEVATION (ground) 619 FEET

DETROIT (DETROIT CITY AIRPORT) MICH.

Month	Temperature: Normal: Daily maximum	Temperature: Normal: Daily minimum	Temperature: Normal: Monthly	Temperature: Extremes: Record highest	Year	Record lowest	Year	Normal degree days	Precipitation: Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Sleet: Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	Relative humidity: 1:30 A.M. EST	7:30 A.M. EST	1:30 P.M. EST	7:30 P.M. EST	Wind: Mean hourly speed	Prevailing direction	Fastest mile: Speed	Direction	Year	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days: Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures: Max.: 90° and above	Max.: 32° and below	Min.: 32° and below	Min.: 0° and below
(a)	(b)	(b)	(b)	23		23		(b)	(b)	23		23		23		23	23		23		19	23	19	23	23	7	23			23	23	23	23	23	23	23	23	23	23	23	23	23
J	33.1	19.3	26.2	67	1950	-9	1940	1203	2.08	4.38	1950	.45	1945	1.21	1935	7.8	21.1	1939	7.6	1939	78	82	71	77	11.3	N	57	SW	1949	31	8.0	3	6	22	13	3	*	2	0	15	28	1
F	33.8	19.6	26.7	68	1944	-16	1934	1072	2.02	4.95	1938	.38	1947	2.43	1950	7.6	14.7	1936	5.6	1950#	78	82	68	74	11.2	NW	49	W	1953#	43	7.3	4	7	17	12	3	1	1	0	13	26	1
M	43.1	27.0	35.1	82	1945	-1	1943	927	2.53	4.40	1938	.59	1937	1.85	1949	5.3	15.5	1954	9.8	1934	77	80	63	69	11.4	NW	68	SW	1943	51	6.9	6	8	17	13	1	2	1	0	5	22	*
A	55.9	36.8	46.4	87	1942#	14	1954	558	2.91	6.89	1947	.74	1946	2.94	1947	1.3	6.8	1943	4.2	1942	73	76	53	61	11.0	W	56	N	1949	53	6.8	6	8	16	12	*	2	1	0	*	8	0
M	68.1	47.5	57.8	93	1942	30	1943	251	3.61	8.05	1943	.58	1934	2.53	1948	T	.1	1954	.1	1954	75	72	53	59	9.5	S	61	NW	1942	59	6.4	7	10	14	12	0	5	1	*	0	*	0
J	78.3	57.8	68.1	104	1934	38	1945	60	2.90	4.70	1939	1.06	1952	2.65	1939	.0	.0		.0		77	75	54	59	8.9	S	56	SW	1951	65	6.1	6	13	11	11	0	6	*	3	0	0	0
J	83.5	62.6	73.1	105	1934	48	1954#	0	2.91	7.03	1937	.81	1936	2.51	1937	.0	.0		.0		77	74	50	56	8.1	S	57	N	1955	71	5.2	10	13	8	9	0	7	*	6	0	0	0
A	81.4	61.2	71.3	101	1936	43	1934	8	2.62	7.51	1940	1.07	1936	3.65	1956	.0	.0		.0		80	80	52	60	7.8	N	50	NW	1945	67	5.2	10	12	9	8	0	5	1	5	0	0	0
S	74.0	54.5	64.3	100	1953#	32	1942	96	2.78	5.90	1936	.58	1956	1.81	1945	.0	.0		.0		80	83	53	65	8.9	S	52	SW	1941	61	5.3	10	10	10	9	0	3	1	2	0	*	0
O	62.2	43.6	52.9	89	1953#	25	1936	381	2.29	7.80	1954	.61	1956	3.72	1954	.1	1.0	1943	1.0	1943	79	83	55	67	9.3	S	56	S	1942	56	5.6	11	8	12	9	0	1	1	0	0	2	0
N	47.1	33.1	40.1	81	1950	7	1950	747	2.18	4.14	1948	.57	1939	2.18	1951	1.9	9.2	1950	5.6	1951	78	81	65	72	11.2	SW	66	W	1942	34	7.5	4	7	19	12	1	1	1	0	3	14	0
D	35.7	23.2	29.5	64	1941	-3	1951	1101	2.20	3.51	1949	.43	1943	1.52	1950	4.7	24.0	1951	6.8	1951	78	81	71	76	11.1	SW	59	NW	1943	31	7.8	4	6	21	13	2	*	2	0	11	25	*
Year	58.0	40.5	49.3	105	JULY 1934	-16	FEB 1934	6404	31.03	8.05	MAY 1943	.38	FEB 1947	3.72	OCT 1954	28.7	24.0	DEC 1951	9.8	MAR 1934	78	79	59	66	10.0	S	68	SW	MAR 1943	54	6.5	81	108	176	133	10	34	12	16	48	126	2

(f) The Detroit City Airport is located about 5 miles north of the Detroit River and 6 miles from Lake St. Clair, which lies to the east and northeast. The terrain is generally level with rising ground toward the northwest.

LATITUDE 44° 45' N
LONGITUDE 81° 06' W
ELEVATION (ground) 720'

WIARTON (AIRPORT) ONT.

Month	Temperature: Normal: Daily maximum	Temperature: Normal: Daily minimum	Temperature: Normal: Monthly	Temperature: Extremes: Record highest	Year	Record lowest	Year	Normal degree days	Precipitation: Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow: Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	Relative humidity				Wind: Mean hourly speed	Prevailing direction	Maximum Hourly Mileage: Speed	Direction	Year	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days: At 1330E: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet inch or more	Thunderstorms	Heavy fog	Temperatures: Max.: 90° and above	Max.: 32° and below	Min.: 32° and below	Min.: 0° and below
(a)	(b)	(b)	(b)	11		11		(e)	30	11		11		11		10	11		11		4	4	4	4	(c)		(c)					11	11	11	11	11	11	11	11	11	11	11
J	27.8	14.2	21.0	64	1950	-15	1948		4.45	6.70	1955	1.80	1956	1.53	1955	29.5	62.1	1955	15.3	1955	88	92	87	88								3	3	25	20	18	0	3	0	21	30	4
F	27.5	13.1	20.3	53	1954	-22	1948		3.42	4.17	1949	2.11	1955	1.16	1951	23.8	32.9	1949	11.6	1951	93	92	82	87								3	4	21	18	16	0	2	0	18	27	4
M	34.3	20.2	27.3	65	1957	-19	1948		3.48	4.71	1948	1.05	1958	1.42	1948	17.6	29.2	1951	7.6	1951	87	88	76	82								6	5	20	15	12	*	2	0	14	29	2
A	47.0	30.7	38.9	79	1957	2	1954		2.74	6.12	1951	1.37	1958	1.54	1951	3.5	7.5	1951	2.9	1950	85	85	68	76								8	4	18	12	4	2	3	0	1	15	0
M	59.9	40.6	50.3	83	1951+	26	1957		2.50	3.33	1955	0.48	1951	0.96	1955	0.1	1.3	1954	T	1958+	84	81	67	71								9	6	16	9	*	2	3	0	0	4	0
J	70.2	50.8	60.5	89	1957	30	1949		2.92	4.40	1950	1.45	1955	2.67	1950	.0	.0		.0		88	83	67	73								9	6	15	9	0	5	4	0	0	0	0
J	75.0	57.1	66.1	91	1952	40	1954		2.44	4.26	1947	0.80	1950	2.95	1955	.0	.0		.0		88	83	65	74								10	8	13	8	0	4	3	*	0	0	0
A	74.2	56.2	65.2	95	1947	40	1957+		1.63	5.63	1956	1.27	1947	1.81	1953	.0	.0		.0		88	86	65	76								10	8	13	9	0	3	3	1	0	0	0
S	66.7	50.0	58.4	96	1953	27	1947		2.74	7.53	1957	0.54	1955	1.54	1953	T	T	1958+	T	1958+	88	89	71	83								7	6	17	11	0	3	2	*	0	*	0
O	56.0	39.8	47.9	83	1947	25	1957+		2.81	7.32	1954	0.62	1952	2.73	1954	1.3	7.7	1957	5.6	1957	89	91	71	83								9	5	17	11	1	2	3	0	0	4	0
N	42.2	30.6	36.4	74	1950	5	1949		4.01	4.93	1947	2.14	1953	1.12	1955	17.5	35.3	1947	11.2	1955	89	91	83	88								2	3	25	18	10	0	1	0	4	18	0
D	31.2	19.9	25.6	59	1951	-7	1954		4.35	7.36	1949	2.05	1948	0.98	1949	25.5	49.8	1951	8.4	1957	88	90	86	88								2	3	26	21	17	*	2	0	15	27	1
YEAR	51.0	35.3	43.2	96	SEPT 1953	-22	FEB 1948		37.49	7.53	SEPT 1957	0.48	MAY 1951	2.95	JULY 1955	118.8	62.1	JAN 1955	15.3	JAN 1955	88	88	74	81								78	61	226	161	78	21	31	1	73	154	11

Wiarton Airport is located NE of the town beside, but 200 ft. above, Colpoy's Bay on Georgian Bay.

NORMALS, MEANS, AND EXTREMES

GORE BAY (AIRPORT) ONT.

LATITUDE 45° 53' N
LONGITUDE 82° 34' W
ELEVATION (ground) 624'

Month	Temperature Normal Daily maximum	Temperature Normal Daily minimum	Temperature Normal Monthly	Temperature Extremes Record highest	Year	Record lowest	Year	Normal degree days	Precipitation Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow Mean total	Snow Maximum monthly	Year	Snow Maximum in 24 hrs.	Year	Relative humidity 0130 E.S.T.	1730 E.S.T.	1330 E.S.T.	1930 E.S.T.	Wind Mean hourly speed	Prevailing direction	Maximum Hourly Mileage Speed	Direction	Year	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days At 1330E Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 0.1 inch or more	Thunderstorms	Heavy fog	Temperatures Max. 90° and above	Max. 32° and below	Min. 32° and below	Min. 0° and below
(a)	(b)	(b)	(b)	11		11		(e)	11	11		11		11		10	11		11		(e)				7	7	7					11	11	11	11	11	11	11	11	11	11	11
J	26.4	6.6	16.5	46	1949	-28	1952		3.08	4.48	1950	0.97	1956	1.29	1957	25.8	41.1	1953	12.9	1957					11.5	NE	44	SW	1950			7	4	20	15	15	0	2	0	24	31	9
F	27.3	5.3	16.3	47	1954	-24	1951		2.41	4.04	1953	0.36	1958	1.82	1953	17.7	27.3	1949	7.8	1950					10.8	NW	49	SW	1953			8	3	17	13	11	0	2	0	21	28	7
M	34.4	14.6	24.5	53	1955+	-20	1950		2.58	3.68	1948	0.36	1958	1.41	1948	13.4	25.4	1951	6.2	1951					11.8	NW	44	W	1954			8	6	17	13	10	*	2	0	14	30	3
A	48.4	28.0	38.2	76	1952	3	1950		2.91	6.09	1954	1.08	1958	1.63	1954	4.0	14.6	1952	9.0	1952					10.9	NW,W	35	NE	1949			9	4	17	10	3	2	3	0	1	18	0
M	59.8	39.0	49.4	79	1953	24	1958		2.26	3.77	1949	0.80	1958	1.20	1956	0.2	2.4	1948	2.4	1948					9.9	W	35	NW	1954			10	6	15	9	*	2	2	0	0	4	0
J	72.3	49.3	60.8	88	1956	36	1958+		2.27	4.53	1949	0.29	1955	1.55	1949	.0	.0		.0						9.5	S	33	SW	1951			9	7	14	9	0	4	3	0	0	0	0
J	79.2	56.2	67.7	94	1955	44	1957		2.37	4.16	1952	1.39	1948	1.80	1953	.0	.0		.0						9.3	NW	30	S	1951			11	7	13	8	0	4	2	*	0	0	0
A	77.1	55.3	66.2	94	1955	41	1950		1.98	4.34	1950	1.01	1948	1.92	1950	.0	.0		.0						8.6	NW	27	W,NE	1951			11	8	12	8	0	3	2	1	0	0	0
S	65.4	48.4	56.9	92	1953	31	1956+		3.02	7.43	1954	0.83	1948	2.42	1954	.0	T	1947	T	1947					10.5	NW	36	SW	1951			6	7	17	12	0	3	2	*	0	*	0
O	56.0	38.6	47.3	74	1947	25	1957		2.23	5.28	1951	0.07	1952	1.67	1954	0.5	3.1	1949	2.0	1949					10.9	NW	42	SW	1951			8	5	18	9	*	1	3	0	*	4	0
N	41.6	28.1	34.9	65	1950	- 1	1947		3.56	4.98	1955	2.30	1953	1.18	1957	11.2	18.6	1955	8.0	1956+					11.9	SW	38	W	1948			2	4	24	16	8	*	2	0	6	18	*
D	31.1	15.3	23.2	54	1952	-15	1951		2.76	4.44	1949	1.46	1954	1.09	1950	20.6	32.5	1956	10.7	1956					11.6	NW	34	SW	1953			4	4	23	18	15	0	2	0	18	28	2
YEAR	51.6	32.1	41.8	94	AUG 1955	-28	JAN 1952		31.43	7.43	SEPT 1954	0.07	OCT 1952	2.42	SEPT 1954	93.4	41.1	JAN 1953	12.9	JAN 1953					10.6	NW	49	SW	FEB 1953			93	65	207	140	62	19	27	1	84	161	21

Gore Bay Airport is located 5 miles SW of town on the N side of Manitoulin Island. It is about 2 miles from open water in the north channel of Lake Huron.

ALPENA (CITY) MICH.

LATITUDE 45° 04' N
LONGITUDE 83° 26' W
ELEVATION (ground) 587 Feet

Month	Temperature Normal Daily maximum	Temperature Normal Daily minimum	Temperature Normal Monthly	Temperature Extremes Record highest	Year	Record lowest	Year	Normal degree days	Precipitation Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Sleet Mean total	Snow, Sleet Maximum monthly	Year	Snow, Sleet Maximum in 24 hrs.	Year	Relative humidity 1:00 A.M. EST	7:00 A.M. EST	1:00 P.M. EST	7:00 P.M. EST	Wind Mean hourly speed	Prevailing direction	Fastest mile Speed	Direction	Year	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days Sunrise to sunset Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures Max. 90° and above	Max. 32° and below	Min. 32° and below	Min. 0° and below
(a)	(b)	(b)	(b)	44		44		(b)	(b)	44		44		44		44	44		44		18	44	40	44	44	44	44			44	44	44	44	44	44	14	44	44	44	44	44	44
J	28.1	14.2	21.2	62	1944	-19	1920	1358	1.66	3.41	1914	.59	1944	1.23	1940	16.1	41.8	1943	14.3	1947	79	80	71	76	11.8	NW	56	E	1947	29	7.7	3	8	20	15	5	*	1	0	20	30	4
F	27.8	12.0	19.9	58	1921	-28	1934	1263	1.45	3.09	1922	.63	1957	1.67	1922	12.6	27.2	1936	11.1	1922	78	79	67	74	11.6	NW	50	NW	1918	43	6.9	5	8	15	12	5	*	1	0	19	28	4
M	35.3	20.1	27.7	79	1938	-16	1943	1156	2.04	4.28	1921	.24	1937	1.82	1916	11.7	33.8	1926	16.7	1947	78	80	66	72	12.4	NW	56	E	1944	52	6.4	7	10	14	12	3	1	2	0	12	28	1
A	47.7	31.4	39.6	88	1915	- 2	1923	762	2.15	4.73	1954	.63	1935	1.70	1952	3.7	13.7	1943	10.4	1949	77	77	61	68	12.1	NW	52	W	1946	56	6.0	8	10	12	12	1	2	2	0	1	16	*
M	59.9	41.9	50.9	93	1937	25	1947#	437	2.63	4.99	1927	.44	1925	2.25	1954	.6	9.7	1929	9.4	1929	78	74	61	67	10.9	SE	47	NW	1921	59	5.8	9	11	11	11	*	4	2	*	0	2	0
J	70.8	52.1	61.5	100	1933	34	1949#	135	2.55	6.05	1930	.76	1955	2.42	1915	.0	.0		.0		82	76	63	69	9.9	SE	50	NW	1931	64	5.5	9	12	9	11	0	5	2	1	0	0	0
J	76.8	57.9	67.4	104	1936	41	1926	50	2.45	4.92	1951	.20	1955	2.28	1951	.0	.0		.0		82	77	61	68	9.2	NW	44	S	1921	70	4.8	11	13	7	9	0	7	1	2	0	0	0
A	75.0	56.6	65.8	100	1948	37	1915	85	2.59	5.23	1938	.50	1927	3.09	1941	.0	.0		.0		83	82	62	71	9.3	NW	52	S	1952	64	5.1	10	13	8	10	0	5	1	1	0	0	0
S	66.9	49.8	58.4	99	1953#	29	1916	215	3.20	7.43	1937	.16	1955	4.40	1937	T	T	1956#	T	1956#	84	85	65	77	10.3	NW	49	SE	1932	52	5.8	8	11	11	12	0	4	2	*	0	*	0
O	55.7	40.0	47.9	87	1928	16	1925	530	1.98	5.31	1932	.26	1952	2.72	1929	.5	5.3	1930	5.0	1930	82	85	65	76	10.8	NW	50	NW	1954#	44	6.3	7	10	14	12	*	1	3	0	*	5	0
N	42.2	30.1+	36.2	77	1950	- 2	1929	864	2.18	5.44	1926	.54	1939	1.75	1924	6.1	19.4	1952#	8.0	1955#	82	84	71	78	11.9	NW	61	SW	1940	24	7.9	3	7	20	15	2	*	2	0	4	18	*
D	31.3	20.0	25.7	59	1946	-14	1933	1218	1.75	3.77	1920	.79	1919	2.51	1946	13.5	28.2	1933	15.0	1946	80	82	73	78	11.6	NW	49	NW	1939	22	8.1	2	7	22	15	4	*	2	0	17	28	1
Year	51.5	35.5	43.5	104	JULY 1936	-28	FEB 1934	8073	26.63	7.43	SEPT 1937	.16	SEPT 1955	4.40	SEPT 1937	64.8	41.8	JAN 1943	16.7	MAR 1947	80	80	66	73	11.0	NW	61	SW	NOV 1940	51	6.4	82	120	163	146	20	29	21	4	73	155	10

(f) Alpena is located at the head of Thunder Bay on the western shore of Lake Huron. The terrain is level to gently rolling.

NORMALS, MEANS, AND EXTREMES

LATITUDE 46° 28' N
LONGITUDE 84° 22' W
ELEVATION (ground) 721 Feet

SAULT STE. MARIE (AIRPORT) MICH.

Month	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow, Sleet											Fastest mile					Sunrise to sunset							Temperatures Max.		Min.	
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	1:00 A.M. EST	7:00 A.M. EST	1:00 P.M. EST	7:00 P.M. EST	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	16		16		(b)	(b)	16		16		16		16	16		16		16	16	16	16	16	5	16			16	16	16	16	16	16	16	16	16	16	16	16	16
J	21.9	5.7	13.8	43	1949#	-24	1948	1587	2.16	4.37	1950	.85	1951	1.37	1950	21.2	39.1	1950	11.4	1949	84	84	77	83	10.3	E	43	W	1952	33	8.0	3	6	22	18	7	*	1	0	26	31	10
F	22.7	4.3	13.5	45	1954	-25	1943	1442	1.52	2.67	1951	.59	1952	.95	1953	16.3	29.9	1949	10.9	1951	84	85	75	82	10.4	E	47	NW	1948	42	7.5	4	6	18	16	6	*	2	0	22	28	7
M	31.7	14.2	23.0	75	1946	-24	1943	1302	1.85	3.22	1943	1.13	1957	1.21	1943	15.8	32.2	1955	11.3	1943	82	85	69	77	11.1	WNW	50	NW	1942	50	7.0	7	6	18	14	5	1	3	0	15	29	3
A	45.7	27.8	36.8	82	1942	1	1950	846	1.95	5.16	1954	.60	1949	2.67	1954	5.3	14.7	1950	8.3	1943	81	80	61	69	11.3	WNW	52	SW	1945	53	6.5	7	8	15	12	2	1	3	0	2	22	0
M	59.7	38.1	48.9	85	1953	23	1954#	499	2.55	5.27	1945	1.23	1951#	2.46	1945	.6	4.6	1947	4.6	1947	82	79	57	64	10.5	WNW	47	SW	1942	53	6.6	6	9	16	11	*	3	3	0	0	7	0
J	69.7	46.5	58.1	92	1944	31	1949	224	3.02	6.66	1949	1.26	1955	2.63	1949	T	T	1951#	T	1951#	89	85	64	70	9.1	WNW	48	W	1943	54	6.0	6	10	14	12	0	7	4	*	0	*	0
J	75.4	52.4	63.9	92	1955#	36	1950	109	2.49	6.04	1956	.95	1954	2.36	1952	.0			.0		91	87	61	69	8.5	WNW	41	NW	1948	62	5.7	9	10	12	10	0	6	5	1	0	0	0
A	73.5	52.3	62.9	98	1947	32	1950	126	2.62	4.72	1944	.50	1947	2.20	1944	.0			.0		92	91	62	73	8.3	WNW	50	SW	1944	58	5.9	9	10	12	9	0	5	7	1	0	*	0
S	64.4	45.9	55.2	93	1953	25	1947	298	3.49	5.62	1942	.86	1943	1.59	1957	.2	2.7	1956	2.7	1956	91	92	67	81	9.2	WNW	48	SW	1943	43	6.9	5	9	16	14	*	4	7	*	0	1	0
O	52.4	36.4	44.4	80	1950	20	1949	639	2.98	4.39	1951	.25	1947	1.59	1951	2.4	12.5	1943	10.1	1943	88	89	65	80	9.8	E	47	W	1951#	46	6.6	7	8	16	11	1	2	6	0	*	8	0
N	37.9	25.1	31.5	66	1953	- 5	1956#	1005	3.26	5.62	1948	1.55	1954	1.50	1957	14.8	27.7	1943	14.3	1943	86	87	77	83	10.6	SE	55	W	1948	21	8.6	2	5	23	18	5	*	2	0	7	22	*
D	26.7	13.0	19.9	51	1946	-20	1946	1398	2.30	3.54	1957	.73	1954	.86	1957	25.5	36.4	1944	9.3	1932	85	86	79	84	10.6	E	58	NW	1943	24	8.4	2	4	25	19	8	0	3	0	22	30	5
Year	48.5	30.1	39.3	98	AUG 1947	-25	FEB 1943	9475	30.19	6.66	JUNE 1949	.25	OCT 1947	2.67	APR 1957	102.1	39.1	JAN 1950	14.3	NOV 1943	86	86	68	76	10.0	WNW	58	NW	DEC 1943	45	7.0	67	91	207	164	34	29	46	2	94	178	25

(f) Sault Ste. Marie Airport is located about 3 miles east-northeast of the City on a plateau overlooking Whitefish Bay.

LATITUDE 43° 10' N
LONGITUDE 86° 14' W
ELEVATION (ground) 627 Feet

MUSKEGON (AIRPORT) MICH.

Month	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow, Sleet											Fastest mile					Sunrise to sunset							Temperatures Max.		Min.	
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	1:00 A.M. EST	7:00 A.M. EST	1:00 P.M. EST	7:00 P.M. EST	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	16		16		(b)	(b)	16		16		16		16	16		16		9	14	14	14							15	15	15	15	16	16	16	14	16	16	16	16
J	31.4	18.3	24.9	63	1950	-13	1948	1243	1.95	3.88	1950	.45	1956	1.47	1947	20.0	33.9	1954	12.5	1947	83	82	76	78							8.7	2	4	25	15	7	*	2	0	16	29	1
F	31.8	17.1	24.5	57	1954	-11	1948	1134	1.64	2.74	1957	.94	1952	1.39	1957	12.5	23.8	1947	7.3	1946	80	81	74	78							8.1	3	5	20	13	4	1	1	0	13	27	1
M	40.3	24.4	32.4	77	1945	-10	1943	1011	2.18	5.10	1948	1.48	1945	1.98	1948	9.8	17.9	1956#	7.7	1954	78	81	66	72							7.2	5	7	19	14	3	2	2	0	7	25	*
A	53.1	34.1	43.6	84	1942	15	1954	642	2.34	7.12	1947	.86	1942	2.23	1947	1.6	6.0	1956	5.4	1956	77	80	59	64							6.7	7	7	16	12	1	3	2	0	*	12	0
M	64.8	43.7	54.3	86	1950#	22	1947	350	2.82	5.26	1945	1.43	1951	2.16	1955	T	.4	1954	.4	1954	80	78	57	62							6.4	7	10	14	13	0	5	3	0	0	2	0
J	74.8	53.9	64.4	97	1953	34	1949#	116	2.87	4.83	1954	1.13	1956	2.56	1949	.0	.0		.0		83	81	61	64							5.9	8	10	12	10	0	6	2	1	0	0	0
J	80.5	59.2	69.9	95	1955#	40	1945	26	2.12	6.63	1952	.47	1951	2.49	1952	.0	.0		.0		85	83	57	61							4.8	11	12	8	8	0	6	1	2	0	0	0
A	78.7	58.1	68.4	97	1947#	40	1942	48	2.66	4.22	1945	.96	1948	2.00	1945	.0	.0		.0		87	87	59	65							4.9	11	12	8	8	0	5	2	2	0	0	0
S	71.1	51.5	61.3	95	1954#	28	1950#	152	3.34	5.85	1947	.97	1956	3.51	1947	T	T	1949#	T	1949#	84	87	59	72							5.2	10	10	10	10	0	5	1	1	0	1	0
O	59.3	41.3	50.3	83	1953#	22	1952	462	2.52	6.36	1954	.33	1944	3.21	1954	.1	2.0	1952	1.0	1952	82	86	60	74							5.5	11	7	13	9	*	2	3	0	0	5	0
N	45.2	31.7	38.5	73	1950	-14	1950	795	2.64	4.43	1955	1.34	1953	1.91	1952	8.4	21.5	1951	7.6	1955	79	81	70	76							8.3	3	4	23	14	3	1	2	0	3	17	*
D	34.9	23.4	29.2	63	1951	- 4	1951	1110	1.93	5.42	1949	1.13	1943	1.70	1942	15.9	30.5	1951	9.1	1950	82	82	76	79							8.7	2	4	25	15	6	1	2	0	12	28	*
Year	55.5	38.1	46.8	97	JUNE 1953#	-14	NOV 1950	7089	29.01	7.12	APR 1947	.33	OCT 1944	3.51	SEPT 1947	68.3	33.9	JAN 1954	12.5	JAN 1947	82	82	65	70							6.7	80	92	193	41	24	37	23	6	51	146	2

(f) The Muskegon Airport is located about seven miles southeast of the City and Lake Michigan. The terrain is generally level, with several sand dunes along the shore line.

NORMALS, MEANS, AND EXTREMES

LATITUDE 41° 47' N
LONGITUDE 87° 45' W
ELEVATION (ground) 610 Feet

CHICAGO (MIDWAY AIRPORT) ILL.

	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow, Sleet											Fastest mile					Sunrise to sunset							Temperatures			
																																							Max.		Min.	
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	Midnight CST	6:00 A.M. CST	Noon CST	6:00 P.M. CST	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	15		15		(b)	(b)	15		15		15		15	15		15		15	15	15	15	15	13	15			15	15	15	15	15	15	15	15	15	15	15	15	15
J	32.7	17.1	24.9	67	1950	-15	1951	1243	1.84	3.77	1950	.38	1956	1.38	1950	6.9	20.8	1943	6.6	1957	78	80	70	75	10.9	W	50	W	1950	43	7.2	6	6	19	10	2	*	3	0	14	29	3
F	35.0	19.8	27.4	69	1954	-15	1951	1053	1.41	3.35	1950	.38	1947	1.25	1949	7.0	16.6	1950	8.3	1956	77	80	67	73	11.1	W	45	W	1951#	48	6.9	6	6	16	10	2	1	2	0	9	24	2
M	45.0	29.0	37.0	82	1945	- 7	1943	868	2.85	5.00	1954	1.10	1956	2.50	1948	6.4	19.9	1954	11.8	1954	74	78	60	66	11.6	W	54	NW	1955	53	6.7	6	8	17	12	2	3	1	0	5	20	*
A	57.6	38.6	48.1	84	1952#	19	1954	507	2.82	8.33	1947	1.28	1946	4.08	1947	.5	2.4	1951	2.4	1951	72	76	54	60	11.3	S	50	NW	1951	52	6.8	6	8	16	13	*	4	1	0	*	6	0
M	69.7	48.7	59.2	94	1949	30	1947#	229	3.66	7.59	1945	.78	1950	2.93	1951	T	.2	1954	.2	1954	74	75	54	59	9.9	NNE	54	S	1950	58	6.4	7	9	15	12	0	5	1	1	0	*	0
J	80.0	58.8	69.4	104	1953	35	1945	58	4.15	5.94	1957	.78	1956	2.73	1949	.0	.0		.0		77	77	54	58	8.8	SSW	50	W	1953	67	6.2	7	10	13	10	0	7	1	7	0	0	0
J	85.3	63.9	74.6	103	1956	49	1947	0	2.73	8.98	1957	1.33	1945	6.24	1957	.0	.0		.0		77	78	51	55	7.6	SSW	43	NW	1953	72	5.1	11	12	8	9	0	6	1	9	0	0	0
A	83.0	62.3	72.7	101	1947	46	1950	0	3.19	5.91	1954	1.00	1953	3.11	1955	.0	.0		.0		79	82	52	59	7.3	SSW	54	NW	1949	70	5.2	11	11	9	8	0	5	1	8	0	0	0
S	75.9	55.2	65.6	101	1953	36	1943	90	3.23	6.01	1945	.46	1956	2.55	1951	.0	.0		.0		76	81	50	61	8.3	S	47	N	1947	68	4.9	11	10	9	8	0	3	1	3	0	0	0
O	64.3	43.9	54.1	91	1954	20	1948	350	2.56	12.06	1954	.30	1956	5.63	1954	.3	3.0	1952	3.0	1952	73	80	51	63	9.0	S	45	S	1949	64	5.1	12	8	11	7	*	1	1	*	0	2	0
N	47.6	31.3	39.5	81	1950	- 2	1950	765	2.33	3.74	1951	.89	1949	1.79	1946	3.5	14.3	1951	8.0	1951	75	79	62	69	11.1	W	60	SW	1952	43	7.1	6	7	17	10	1	1	1	0	3	16	*
D	35.3	20.6	28.0	65	1951	-12	1951	1147	1.95	6.67	1949	.34	1943	2.38	1949	10.0	33.3	1951	10.0	1951	78	80	68	74	10.7	W	50	SW	1948	43	7.0	6	7	18	10	3	*	3	0	11	26	2
Year	59.3	40.8	50.1	104	JUNE 1953	-15	FEB 1951#	6310	32.72	12.06	OCT 1954	.30	OCT 1956	6.24	JULY 1957	34.6	33.3	DEC 1951	11.8	MAR 1954	76	79	58	64	9.8	SSW	60	SW	NOV 1952	59	6.2	95	102	168	119	10	36	17	28	42	123	7

(f) The Midway Airport is located 10 miles southwest of Chicago's "Loop" area. The Lake Michigan shoreline lies in a northwest-southeast line 8 miles to the east and approximately 20 miles to the north of the airport. The terrain is generally level. A series of low hills parallels the lake shore some 15 to 20 miles inland.

LATITUDE 42° 57' N
LONGITUDE 87° 54' W
ELEVATION (ground) 672 Feet

MILWAUKEE (GENERAL MITCHELL FIELD) WIS.

	Temperature							Normal degree days	Precipitation												Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow, Sleet											Fastest mile					Sunrise to sunset							Temperatures			
																																							Max.		Min.	
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	12:30 A.M. CST	6:30 A.M. CST	12:30 P.M. CST	6:30 P.M. CST	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	16		16		(b)	(b)	16		16		16		16	16		16		16	16	16	16	16	8	16			16	16	16	16	16	16	16	16	16	16	16	16	16
J	29.2	14.5	21.9	62	1944	-24	1951	1336	1.58	2.59	1949	.31	1945	1.13	1947	11.5	28.4	1943	12.3	1947	76	76	70	73	13.3	WNW	62	W	1950	38	7.1	6	6	19	10	3	*	3	0	17	30	5
F	31.8	16.6	24.2	60	1954	-19	1951	1142	1.27	1.87	1951	.29	1947	1.32	1948	6.5	9.9	1956	5.8	1956	74	76	68	72	13.2	W	50	S	1946	42	6.8	6	6	16	9	2	1	2	0	13	26	3
M	40.8	25.7	33.3	81	1945	- 7	1941	983	2.19	3.67	1952	1.05	1955	1.63	1943	8.0	19.8	1952	7.9	1950	76	78	65	71	14.1	WNW	73	SW	1954	48	6.8	6	9	16	11	3	1	2	0	7	23	1
A	52.8	35.8	44.3	82	1952#	13	1953	621	2.39	4.91	1951	.81	1942	2.11	1956	.6	5.1	1950	3.4	1950	75	77	58	64	13.8	NNE	66	SW	1947	53	6.5	7	8	15	11	*	3	2	0	*	9	0
M	63.9	44.7	54.3	90	1956#	28	1947	351	2.98	5.27	1945	1.72	1949	2.06	1948	T	T	1954#	T	1954#	77	77	60	64	12.5	NNE	72	SW	1950	56	6.5	6	11	14	13	0	5	3	*	0	1	0
J	75.1	54.7	64.9	99	1953#	33	1945	109	3.22	8.28	1954	2.33	1943	3.13	1950	.0	.0		.0		81	80	61	65	10.9	SE	57	S	1953	61	6.1	7	11	12	11	0	7	3	2	0	0	0
J	81.2	61.4	71.3	101	1955	45	1945	20	2.43	6.69	1952	.95	1946	3.30	1950	.0	.0		.0		82	81	58	64	9.9	NNE	59	W	1952	70	5.2	10	12	9	9	0	7	1	4	0	0	0
A	79.2	60.5	69.9	100	1955#	44	1950	32	2.62	4.34	1953	.46	1948	4.05	1953	.0	.0		.0		83	84	59	68	9.9	SW	50	W	1949	66	5.2	11	11	9	9	0	6	2	4	0	0	0
S	71.8	53.3	62.6	98	1953	28	1942	134	3.33	9.87	1941	.30	1956	5.28	1941	T	T	1942	T	1942	80	83	58	69	11.4	SW	62	S	1941	60	5.3	10	10	10	8	0	4	1	1	0	*	0
O	60.3	42.4	51.4	86	1947	21	1948#	428	1.97	4.42	1951	.15	1956	1.39	1954	T	T	1955#	T	1955#	77	82	57	70	12.1	SW	60	S	1949	59	5.2	12	8	11	8	0	1	2	0	0	3	0
N	44.7	29.9	37.3	77	1950#	- 5	1950	831	2.11	3.36	1952	.62	1949	2.18	1943	3.2	9.6	1951	6.3	1954	77	80	65	73	13.8	SW	72	W	1955	41	7.1	6	6	18	10	1	1	2	0	4	17	*
D	32.7	18.7	25.7	63	1946	-12	1950#	1218	1.48	2.64	1954	.99	1943	1.93	1942	9.6	26.5	1951	8.2	1954	76	77	70	74	13.2	WNW	62	SW	1948	37	7.1	6	6	19	10	3	*	2	0	14	28	2
Year	55.3	38.2	46.8	101	JULY 1955	-24	JAN 1951	7205	27.57	9.87	SEPT 1941	.15	OCT 1956	5.28	SEPT 1941	39.4	28.4	JAN 1943	12.3	JAN 1947	78	79	62	69	12.3	SW	73	SW	MAR 1954	54	6.2	93	104	168	119	12	36	25	11	55	137	11

(f) General Mitchell Field is located six miles south of the City and about three miles west of the Lake Michigan shore. The field is located in the NNE sector of a very shallow circular depression about four miles in diameter.

NORMALS, MEANS, AND EXTREMES

LATITUDE 44° 29' N
LONGITUDE 88° 08' W
ELEVATION (ground) 689 Feet

GREEN BAY (AUSTIN STRAUBEL AIRPORT) WIS.

	Temperature								Precipitation						
	Normal			Extremes											
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Normal degree days	Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year
(a)	(b)	(b)	(b)	8		8		(b)	(b)	8		8		8	
J	24.5	7.7	16.1	44	1953	-31	1951	1516	1.29	2.64	1950	.35	1957	1.05	1950
F	26.0	8.6	17.3	50	1954	-24	1951	1336	1.36	3.56	1953	.43	1957	1.51	1953
M	36.7	20.2	28.5	63	1954	-10	1950	1132	1.76	2.66	1951	.46	1957	.96	1950
A	51.7	31.9	41.8	84	1952	7	1954	696	2.51	5.52	1953	1.45	1956	1.75	1953
M	65.2	43.6	54.4	90	1952	25	1950	347	2.53	5.28	1957	.89	1951	2.73	1956
J	75.2	54.1	64.7	93	1956#	33	1956	107	3.57	4.38	1954	1.90	1953	1.56	1954
J	81.1	58.7	69.9	98	1955	44	1952#	32	2.59	6.50	1950	2.94	1954	2.32	1956
A	78.5	57.1	67.8	99	1955	38	1950	58	3.03	5.50	1951	.90	1955	2.62	1951
S	69.9	50.4	60.2	95	1955#	27	1956	183	2.87	5.78	1954	.76	1955	1.60	1954
O	57.5	39.3	48.4	83	1953	16	1952	515	1.80	5.00	1954	T	1952	3.68	1954
N	40.6	26.4	33.5	72	1953	- 7	1950	945	1.94	3.52	1957	.39	1953	1.25	1957
D	27.1	13.0	20.1	53	1951	-18	1950	1392	1.26	1.84	1950	.42	1954	.86	1950
Year	52.8	34.3	43.6	99	AUG 1955	-31	JAN 1951	8259	26.51	6.50	JULY 1950	T	OCT 1952	3.68	OCT 1954

	Precipitation					Relative humidity				Wind							Mean number of days												
	Snow, Sleet											Fastest mile					Sunrise to sunset							Temperatures			
																								Max.		Min.	
Month	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	Midnight CST	6:00 A.M. CST	Noon CST	6:00 P.M. CST	Mean hourly speed	Prevailing direction	Speed	Direction	Year	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	8	8		8		8	8	8	8	8	8	8			8	8	8	8	8	8	8	8	8	8	8	8	8
J	8.2	15.5	1952	5.2	1952	75	75	68	73	10.6	SW	61	W	1950	47	6.7	7	7	17	10	3	*	2	0	23	31	11
F	9.2	18.4	1953	8.2	1950	77	79	69	74	10.1	SW	66	W	1951	51	6.5	7	7	14	9	3	*	4	0	18	28	7
M	8.3	19.0	1956	9.3	1956	76	78	63	70	11.6	NE	68	W	1951	56	6.3	9	7	15	11	2	1	2	0	11	29	1
A	2.5	6.9	1957	3.5	1956	77	78	57	62	11.8	NE	57	NE	1952	51	6.7	7	7	16	11	1	3	3	0	*	16	0
M	.1	1.1	1954	.8	1954	79	78	54	59	11.0	NE	109	SW	1950	58	6.4	7	10	14	12	0	4	2	*	0	3	0
J	.0	.0		.0		85	83	59	65	9.7	SW	73	SW	1953#	64	6.0	7	12	11	11	0	9	2	1	0	0	0
J	.0	.0		.0		87	86	59	64	8.2	SW	70	NE	1957	64	5.6	10	10	11	10	0	8	1	2	0	0	0
A	.0	.0		.0		89	89	59	68	7.5	SW	50	SW	1950	62	5.6	9	11	11	10	0	5	3	2	0	0	0
S	.0	.0		.0		86	89	57	70	9.4	SW	66	W	1951	60	5.4	10	10	10	9	0	3	2	2	0	2	0
O	T	T	1957#	T	1957#	81	85	56	71	9.9	SW	65	SW	1951	57	5.6	9	10	12	8	0	3	3	0	0	7	0
N	4.2	8.9	1951	3.8	1951#	77	80	65	73	12.0	SW	67	W	1955	40	7.2	6	6	18	9	1	1	2	0	7	23	1
D	7.8	14.1	1950	5.3	1950	79	79	72	77	11.0	SW	52	W	1957#	37	7.3	6	6	19	11	3	*	3	0	18	30	5
Year	40.3	19.0	MAR 1956	9.3	MAR 1956	81	82	62	69	10.2	SW	109	SW	MAY 1950	55	6.3	94	103	168	121	13	37	29	7	77	169	25

(f) The Green Bay Airport is about eight miles west of the City which is located at the mouth of the Fox River. The terrain is slightly higher to the north, south, and westward.

LATITUDE 45° 45' N
LONGITUDE 87° 03' W
ELEVATION (ground) 594 Feet

ESCANABA (CITY) MICH.

	Temperature								Precipitation						
	Normal			Extremes											
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Normal degree days	Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year
(a)	(b)	(b)	(b)	48		48		(b)	(b)	48		48		48	
J	25.0	10.0	17.5	53	1942	-23	1915	1473	1.53	2.98	1915	.42	1942	1.25	1933
F	26.1	9.1	17.6	52	1943	-31	1934	1327	1.37	3.88	1937	.35	1952	2.30	1937
M	34.0	18.4	26.2	79	1946	-20	1917	1203	1.78	3.83	1950	.11	1937	2.24	1950
A	45.8	30.6	38.2	82	1957	- 1	1923	804	2.10	5.23	1954	.39	1946	2.10	1932
M	57.8	41.8	49.8	91	1925#	22	1911	471	2.60	5.77	1918	.76	1925#	2.14	1949
J	69.0	52.3	60.7	95	1931	32	1927	166	2.80	7.91	1953	1.06	1910	4.83	1953
J	75.3	58.4	66.9	100	1916	41	1912	62	3.22	9.93	1951	.38	1939	3.50	1951
A	73.2	56.6	64.9	100	1955	35	1915	95	2.89	7.46	1912	.69	1930	3.87	1921
S	65.2	49.5	57.4	96	1953	26	1926	247	3.12	7.58	1937	1.03	1948	5.05	1937
O	54.2	39.9	47.1	86	1922	10	1925	555	2.04	4.70	1919	.07	1952#	1.98	1911
N	39.9	27.9	33.9	69	1953#	- 7	1950	933	2.20	5.69	1948	.42	1930	2.00	1945
D	28.8	16.0	22.4	56	1931#	-20	1927	1321	1.43	3.17	1927	.18	1943	1.27	1911
Year	49.5	34.2	41.9	100	AUG 1955#	-31	FEB 1934	8657	27.08	9.93	JULY 1951	.07	OCT 1952#	5.05	SEPT 1937

	Precipitation					Relative humidity				Wind							Mean number of days												
	Snow, Sleet											Fastest mile					Sunrise to sunset							Temperatures			
																								Max.		Min.	
Month	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	1:00 A.M. EST	7:00 A.M. EST	1:00 P.M. EST	7:00 P.M. EST	Mean hourly speed	Prevailing direction	Speed	Direction	Year	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	48	48		48		19	48	40	48	26		26			48	48	48	48	48	48	48	48	48	48	48	48	48
J	14.0	31.6	1929	14.5	1915	77	78	70	75	10.2		47	N	1942	42	6.6	7	7	17	12	5	*	1	0	24	31	8
F	12.3	26.6	1953	11.1	1938	76	79	68	73	10.5		43	N	1941	50	6.2	8	7	13	10	4	*	2	0	20	28	7
M	10.8	32.4	1916	14.0	1916	77	79	66	73	11.1		68	N	1948	55	5.9	9	9	13	10	3	1	2	0	10	28	2
A	3.5	21.2	1923	11.4	1910	77	79	63	69	11.1		47	N	1949	56	5.7	10	8	12	10	1	2	2	0	1	17	*
M	.2	4.0	1954	3.8	1954	78	77	64	66	10.8		57	NW	1957	58	5.6	10	10	11	11	*	4	2	*	0	3	0
J	.0			.0		82	79	67	69	9.6		50	SE	1946	61	5.4	9	11	10	11	0	6	1	*	0	*	0
J	.0			.0		83	80	65	69	9.1		49	N	1949	66	4.8	11	12	8	11	0	7	1	*	0	0	0
A	.0			.0		84	84	67	72	9.3		43	NW	1945	62	5.1	11	11	9	10	0	6	2	*	0	0	0
S	T	.3	1942	.3	1942	85	86	68	76	10.0		47	NW	1939	54	5.6	9	10	11	12	0	4	2	*	0	1	0
O	.2	2.2	1933	1.5	1933	81	83	67	75	10.7		49	N	1947	49	6.0	9	9	13	10	*	2	2	0	*	6	0
N	5.3	18.1	1911	14.0	1911	80	81	70	76	11.2		56	N	1950	34	7.3	5	6	19	11	2	1	2	0	6	20	*
D	10.4	27.4	1927	10.5	1932#	78	79	71	75	10.6		47	NW	1939	35	7.1	6	7	18	11	4	*	1	0	19	29	3
Year	56.7	32.4	MAR 1916	14.5	JAN 1915	80	80	67	72	10.4		68	N	MAR 1948	54	5.9	104	107	154	129	19	33	20	*	80	163	20

Escanaba is located along the west shore of Little Bay De Noquet, an arm of Green Bay. The terrain is flat to slightly rolling.

NORMALS, MEANS, AND EXTREMES

LATITUDE 46° 34' N
LONGITUDE 87° 24' W
ELEVATION (ground) 677 Feet

MARQUETTE (CITY) MICH.

Month	Temperature							Normal degree days	Precipitation											Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow, Sleet										Fastest mile					Sunrise to sunset							Temperatures			
																																						Max.		Min.	
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	1:00 A.M. EST	7:00 A.M. EST	1:00 P.M. EST	7:00 P.M. EST	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	20		20		(b)	(b)	20		20		20		20	20		20		11	20	20	20	20	20	20			20	20	20	20	20	20	20	20	20	20	20	20	20
J	25.2	12.1	18.7	57	1944	-17	1951	1435	2.17	3.93	1938	.51	1956	1.39	1938	18.7	43.7	1950	11.5	1938	74	75	69	73	8.9	W	52	-	1938	29	8.1	3	6	22	17	6	0	1	0	24	31	5
F	26.0	11.8	18.9	54	1943	-12	1938	1291	1.72	3.29	1947	.31	1956	1.18	1951	16.6	39.1	1947	16.1	1947	73	76	67	72	8.8	NW	42	SW	1939	38	7.8	3	6	19	14	5	*	*	0	20	28	2
M	33.7	20.0	26.9	76	1946	-13	1943	1181	2.05	3.16	1955	.30	1941	1.56	1939	14.1	29.6	1955	16.0	1939	73	75	66	72	8.6	NW	57	SW	1938	48	7.2	5	8	18	12	4	1	1	0	15	27	1
A	46.2	31.2	38.7	86	1938	4	1954	789	2.51	5.28	1947	.64	1949	2.43	1947	9.9	32.8	1950	11.7	1951	70	73	62	66	8.6	N	42	S	1948	53	6.6	6	9	15	11	2	2	2	0	3	17	0
M	58.3	40.8	49.6	93	1941	22	1954	477	2.64	4.37	1940	.56	1948	2.22	1955	1.0	8.7	1954	7.8	1954	72	73	63	63	8.0	NW	50	S	1943	54	6.6	6	10	15	12	*	3	2	*	*	3	0
J	69.0	50.2	59.6	99	1956	34	1945	189	3.46	8.86	1939	1.37	1957	4.65	1939	T	T	1945#	T	1945#	78	76	66	68	7.4	N	56	S	1946	57	6.5	6	11	13	12	0	7	4	1	0	0	0
J	75.1	57.1	66.1	99	1941	44	1956#	69	3.13	10.20	1949	.75	1957	3.94	1949	.0	.0		.0		77	76	64	66	7.1	W	36	SE	1949	65	5.7	8	13	10	10	0	6	2	2	0	0	0
A	73.6	56.9	65.3	102	1947	41	1950#	87	2.71	5.40	1951	1.69	1940	2.34	1951	.0	.0		.0		79	79	64	70	7.4	W	38	S	1943	59	5.9	8	12	11	11	0	6	1	2	0	0	0
S	65.7	49.9	57.8	98	1939	31	1942	236	3.43	5.73	1942	1.21	1948	1.90	1949	.1	2.0	1942	1.5	1942	80	81	64	75	8.4	W	45	S	1943	50	6.6	6	10	14	13	*	3	*	1	0	*	0
O	54.8	40.2	47.5	86	1950	21	1942	543	2.26	4.15	1941	.21	1956	2.41	1938	2.2	9.1	1939	6.0	1939#	76	77	62	71	8.8	S	47	NW	1951#	47	6.6	7	8	16	11	1	1	1	0	*	4	0
N	39.3	28.4	33.9	73	1944	0	1955	933	3.12	5.08	1948	.79	1939	2.29	1943	15.7	35.2	1949	11.8	1948	79	80	71	77	9.0	W	49	S	1942	24	8.3	2	6	22	16	5	*	1	0	7	20	*
D	28.8	17.4	23.1	57	1939	-9	1938	1299	2.04	3.58	1942	.69	1943	1.23	1940	20.1	39.2	1950	11.8	1952	74	77	70	74	9.2	W	45	SW	1941	24	8.3	2	6	23	16	6	0	1	0	19	29	1
Year	49.6	34.7	42.2	102	AUG 1947	-17	JAN 1951	8529	31.24	10.20	JULY 1949	.21	OCT 1956	4.65	JUNE 1939	98.4	43.7	JAN 1950	16.1	FEB 1947	75	77	66	71	8.4	W	57	SW	MAR 1938	48	7.0	62	105	198	155	29	29	16	6	88	159	9

(f) Marquette is located on the south shore of Lake Superior. The terrain is generally level.

LATITUDE 48° 22' N
LONGITUDE 89° 19' W
ELEVATION (ground) 644'

FORT WILLIAM/PORT ARTHUR (LAKEHEAD AIRPORT) ONT.

Month	Temperature							Normal degree days	Precipitation											Relative humidity				Wind					Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes												Snow										Maximum Hourly Mileage					At 1330E							Temperatures			
																																						Max.		Min.	
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	0130 E.S.T.	0730 E.S.T.	1330 E.S.T.	1930 E.S.T.	Mean hourly speed	Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 0.1 inch or more	Thunderstorms	Heavy fog	90° and above	32° and below	32° and below.	0° and below
(a)	(b)	(b)	(b)	55		55		(b)	30	78		78		17		30	78		17		9	9	9	9	13	13	13					17	17	17	20	20	17	17	30	17	10	30
J	15.2	-3.5	5.9	48	1908	-42	1951	1830	1.67	6.66	1937	0.17	1944	2.03	1956	16.0	66.6	1937	20.3	1956	88	93	80	85	9.5	W	40	N	1946			9	4	18	14	13	0	1	0	27	31	16
F	17.5	-2.7	7.4	50	1935	-40	1951	1580	1.18	4.36	1937	0.04	1894	1.32	1951	11.4	32.9	1938	13.2	1951	88	92	73	81	9.3	W	34	NW	1949			8	4	16	10	10	0	1	0	24	28	14
M	29.5	10.2	19.8	73	1946	-34	1943	1380	1.37	3.52	1955	0.05	1915	1.65	1957	10.8	34.5	1955	14.9	1956	87	88	68	74	10.0	W	37	NE	1950			9	6	16	9	8	*	2	0	16	30	6
A	44.1	25.7	34.9	83	1942	-10	1936	890	1.81	4.31	1938	0.07	1898	2.73	1954	6.6	31.2	1950	9.5	1956	83	84	60	64	10.4	W	41	NW	1946			8	5	17	9	5	1	1	0	2	24	*
M	57.7	36.9	47.3	91	1953	16	1958+	540	2.37	4.82	1944	0.28	1924	2.13	1953	0.9	13.7	1954	8.5	1954	87	85	55	60	9.7	sv'l	39	NW	1947			6	7	18	11	1	2	3	0	0	13	0
J	67.8	46.7	57.2	96	1956	27	1949	230	3.29	7.12	1944	0.50	1889	1.94	1947	.0	.0		.0		92	89	62	66	8.9	E	39	W	1953			4	7	19	13	0	5	5	*	0	2	0
J	74.5	52.6	63.6	104	1936	35	1942	90	3.26	9.21	1887	0.74	1953	1.28	1944	.0	.0		.0		94	93	63	69	8.3	W	38	W	1948			5	11	15	12	0	5	4	*	0	0	0
A	71.9	50.9	61.4	96	1949	31	1950+	140	3.18	6.77	1900	0.35	1921	2.75	1958	.0	.0		.0		94	95	63	72	7.8	W	34	NW	1950			5	10	16	13	0	6	6	*	0	*	0
S	62.5	43.5	53.0	89	1921	17	1942	370	3.34	8.34	1941	0.77	1940	2.13	1941	T	0.3	1942	T	1956+	92	94	66	79	8.6	W	38	W	1943			4	7	19	11	*	3	5	0	*	7	0
O	50.1	33.1	41.6	83	1943	4	1936	740	2.52	7.80	1931	0.21	1947	1.84	1950	1.0	18.5	1880	6.4	1954	89	91	64	79	9.2	W	42	W	1945			7	6	18	11	1	1	5	0	1	16	0
N	33.2	19.2	26.2	69	1903	-22	1940	1170	2.17	5.65	1940	0.13	1916	2.07	1948	9.6	43.2	1940	13.5	1950	86	88	73	81	9.6	W	45	NW	1946			3	5	22	13	8	*	3	0	12	26	2
D	20.4	4.0	12.2	52	1941	-35	1940	1680	1.46	4.17	1948	0.02	1888	1.68	1948	12.5	37.6	1956	12.2	1947	89	91	78	84	9.5	W	42	NW	1943			7	4	20	13	12	0	1	0	24	31	11
YEAR	45.4	26.4	35.9	104	JULY 1936	-42	JAN 1951	10640	27.62	9.21	JULY 1887	0.02	DEC 1888	2.75	AUG 1958	68.8	66.6	JAN 1937	20.3	JAN 1956	89	90	67	75	9.2	W	45	NW	NOV 1946			75	76	214	139	58	23	37	1	106	208	49

The airport is located just west of Fort William and 5 miles west of Lake Superior in locally flat country. Prior to 1942 the observing station was located near the waterfront in Port Arthur.

NORMALS, MEANS, AND EXTREMES

Latitude 46° 47' N
Longitude 92° 06' W
Elevation (ground) 1162 Feet

DULUTH (CITY) MINN.

Month	Temperature							Normal degree days	Precipitation											Relative humidity 2/			Wind					Pct. of possible sunshine 4/	3/ Mean sky cover sunrise to sunset	Mean number of days										
	Normal			Extremes 1/												Snow, Sleet 1/									Fastest mile 5/					Sunrise to sunset 3/							Temperatures			
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Normal total	1/ Maximum monthly	Year	1/ Minimum monthly	Year	1/ Maximum in 24 hrs.	Year	Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	6:30 A.M. CST	12:30 P.M. CST	6:30 P.M. CST	3/ Mean hourly speed	3/ Prevailing direction	Speed	Direction	Year			Clear	Partly cloudy	Cloudy	1/ Precipitation .01 inch or more	6/ Snow, Sleet 1.0 inch or more	3/ Thunderstorms	3/ Heavy fog	Max. 4/ 90° and above	32° and below	Min. 4/ 32° and below	0° and below
(a)	(b)	(b)	(b)	54		54		(b)	(b)	54		54		54		54	54		54		37	25	37	46	46	31			39	46	46	46	46	54	53	46	46	54	54	54	54
J	18.7	1.9	10.3	55	1942	-38	1935	1696	1.01	3.48	1916	.18	1921	0.98	1916	11.2	36.6	1916	10.5	1935	90	79	84	13.4	NW	65	NW	1928	46	6.0	10	8	13	10	3	*	1	0	27	31	16
F	22.2	4.3	13.3	56	1931	-33	1936#	1448	1.02	4.24	1922	.27	1912	1.08	1922	10.2	34.4	1922	10.9	1922	89	76	80	13.5	NW	63	W	1948	55	5.5	10	7	11	8	3	*	1	0	23	28	12
M	32.7	16.4	24.6	81	1946	-25	1913	1252	1.54	4.97	1917	.30	1930	2.04	1917	11.4	48.2	1917	21.0	1917	85	69	73	13.8	NE	75	NW	1941	60	5.6	10	9	12	10	3	1	3	0	15	29	4
A	46.8	29.7	38.3	88	1952	- 5	1954	801	2.21	4.57	1948	.48	1926	2.41	1954	5.2	19.1	1950	9.1	1933	77	62	65	13.6	NE	60	NW	1912	59	5.5	10	9	11	9	2	1	4	0	2	19	*
M	59.0	39.5	49.3	95	1939	16	1907	487	2.95	7.12	1944	.64	1948	2.56	1944	0.6	6.2	1954	5.0	1924	75	59	63	13.0	NE	59	W	1916	58	5.7	9	10	12	12	*	4	5	0	*	4	0
J	68.8	48.5	58.7	97	1910	31	1946#	200	3.72	8.75	1905	.11	1910	2.78	1951	T	T	1945	T	1945	81	65	70	11.2	NE	59	NW	1949	59	5.6	9	11	10	13	0	7	7	*	0	*	0
J	75.8	55.8	65.8	106	1936	41	1953	66	3.31	10.83	1909	.63	1936	5.35	1909	.0	.0		.0		82	64	69	10.2	NE	54	NW	1949	68	4.8	12	12	7	11	0	7	5	1	0	0	0
A	74.1	55.5	64.8	97	1930	38	1941#	91	3.19	9.04	1953	.29	1930	3.38	1939	.0	.0		.0		84	63	71	10.5	NE	68	N	1934	63	5.0	11	12	8	11	0	6	4	1	0	0	0
S	64.9	47.3	56.1	92	1931	25	1926	277	3.05	7.72	1905	.27	1948	4.10	1955	T	1.5	1908	1.5	1908	87	67	76	11.6	NE	60	NW	1924	54	5.4	10	9	11	11	*	3	5	*	0	1	0
O	53.5	36.8	45.2	85	1953#	8	1951#	614	1.96	5.40	1946	.23	1953	2.33	1950#	1.5	14.0	1933	11.5	1933	85	66	75	12.6	NE	59	W	1918	46	5.9	9	8	14	9	*	1	3	0	1	10	0
N	35.4	21.7	28.6	70	1904	-18	1919	1092	1.67	3.89	1931	.09	1917#	1.93	1932	6.3	28.7	1919	9.5	1949	87	73	79	13.4	NW	63	NW	1940	36	6.8	6	7	17	9	2	*	3	0	11	25	1
D	22.7	7.3	15.0	56	1939	-35	1917	1550	1.00	3.02	1950	.07	1905	1.80	1950	9.8	36.0	1950	23.0	1950	90	80	85	13.4	NW	72	NW	1946	41	6.0	9	7	15	9	3	0	2	0	24	30	9
Year	47.9	30.4	39.2	106	JULY 1936	-38	JAN 1935	9574	26.63	10.83	JULY 1909	.07	DEC 1905	5.35	JULY 1909	56.2	48.2	MAR 1917	23.0	DEC 1950	84	69	74	12.5	NE	75	NW	MAR 1941	54	5.6	115	109	141	122	16	30	43	2	103	177	42

(a) Length of Record, years.
(b) Normal values are based on the period 1921-1950, and are means adjusted to represent observations taken at the present standard location.
(c) No wind data available.
(d) No observations taken at 1330 E.S.T.
(e) Insufficient data available.
(f) Means and extremes are from the existing location. Extremes listed may have been exceeded at prior locations.

* Less than one-half
T Trace, an amount too small to measure
\- No record
\+ Also on earlier dates, months, or years
\# And also in earlier months or years.

NOTES: Unless otherwise indicated, dimensional units used are: temperature in degrees F; precipitation and snowfall in inches; wind movement in miles per hour; and relative humidity in percent.

Sky cover is expressed in a range of 0 for no clouds or obscuring phenomena to 10 for complete sky cover. The number of clear days is based on cloudiness 0-3 tenths; partly cloudy days on 4-7 tenths; and cloudy days on 8-10 tenths. For United States stations the number is based on average conditions from sunrise to sunset; for Canadian stations on average cloudiness at 1330 E.S.T.

Monthly degree day totals are the sums of the negative departures of average daily temperatures from 65°F.

Heavy fog also includes data referred to at various times in the past as "dense" or "thick". The upper visibility limit for heavy fog is 1/4 mile.

Below zero temperatures are preceeded by a minus sign.

1/ Data covers period 1904-1957 incl.
2/ Relative Humidity observations to airport in June 1941
6:30 a.m. and 6:30 p.m. data cover period 1904-1940.
12:30 p.m. data covers period 1916-1940. No 12:30 a.m. observations ever taken at City Office.
3/ Data covers period 1904-1949.
4/ Data covers period 1910-1949.
5/ Data covers period through 1949.
6/ Data covers period 1905-1949.

GREAT LAKES SMALL CRAFT, GALE, AND WHOLE GALE WARNING DISPLAY STATIONS

Station	Latitude	Longitude	Type Display*
BUFFALO, N. Y. - Supervising Office			
Oswego (Fort Ontario), N. Y.	43°27.9'	76°30.6'	D&N
Clayton, N. Y.	44 14.3	76 05.3	D
Sodus Point, N. Y.	43 16.0	76 59.6	D&N
Sodus Bay (Leroy Island), N. Y.	43 15.7	76 56.6	D
Rochester LBSTA, N. Y. (CG)	43 15.4	77 36.2	D&N
Niagara LBSTA, N. Y. (CG)	43 15.8	79 03.9	D&N
Buffalo LBSTA, N. Y. (CG)	42 52.6	78 53.2	D&N
Lackawanna, N. Y.	42 49.9	78 51.7	D&N
Dunkirk, N. Y.	42 29.0	79 20.5	D&N
ERIE, PENN. - Supervising Office			
Erie Public Dock, Penn.	42 08.3	80 05.5	D&N
CLEVELAND, OHIO - Supervising Office			
Conneaut, Ohio	41 58.1	80 33.2	D
Ashtabula LBSTA, Ohio (CG)	41 54.1	80 48.1	D
Fairport LBSTA, Ohio (CG)	41 45.6	81 16.9	D
Mentor Harbor Yachting Club, Ohio	41 43.6	81 21.2	D
Willoughby (Chagrin Lagoons Yacht Club), Ohio	41 40.6	81 26.3	D
Cleveland (Northeast Yacht Club), Ohio	41 34.4	81 35.1	D
Cleveland (Lakeside Yacht Club), Ohio	41 31.6	81 39.9	D
Cleveland LBSTA, Ohio (CG)	41 30.2	81 42.7	D&N
Rocky River (Cleveland Yacht Club), Ohio	41 29.2	81 50.1	D
Lorain LBSTA, Ohio (CG)	41 28.3	82 10.7	D&N
SANDUSKY, OHIO - Supervising Office			
Vermilion, Ohio	41 25.6	82 21.5	D
Huron, Ohio	41 24.1	83 32.9	D&N
Sandusky (WB City), Ohio	41 27.4	82 42.9	D&N
Sandusky Boat Works, Ohio	41 27.4	82 41.9	D
Sandusky (Meigs Street), Ohio	41 27.6	82 42.1	D
Marblehead LBSTA, Ohio (CG)	41 32.2	82 42.7	D&N
Kelleys Island, Ohio	41 35.6	82 42.7	D
Put-in-Bay, Ohio	41 39.3	82 49.1	D
Catawba Cliffs Beach, Ohio	41 35.3	82 50.5	D
Port Clinton, Ohio	41 31.2	82 56.2	D
TOLEDO, OHIO - Supervising Office			
Toledo Coast Guard Depot, Ohio (CG)	41 41.6	83 28.3	D
Toledo (Ottawa River), Ohio	41 43.7	83 28.0	D
DETROIT, MICH. - Supervising Office			
Monroe, Mich.	41 52.3	83 23.0	D
Rockwood, Mich.	42 02.2	83 12.0	D
Gibralter, Mich.	42 05.3	83 11.4	D
Detroit Boat Club, Mich.	42 20.5	82 59.7	D
Belle Isle LBSTA, Mich. (CG)	42 20.4	82 57.7	D&N
Grosse Pointe (Crescent Sail Yacht Club), Mich.	42 24.1	82 53.1	D
Grosse Pointe Farms Municipal Pier, Mich.	42 24.4	82 53.2	D
Jefferson Beach Marina, Mich.	42 26.0	82 52.5	D
New Baltimore, Mich.	42 38.5	82 46.7	D
Mount Clemens (Romicks Boatyard), Mich.	42 36.2	82 47.3	D
Mount Clemens, Mich.	42 36.1	82 46.8	D
Selfridge Air Force Base, Mich.	42 36.6	82 48.7	D
Port Huron LBSTA, Mich. (CG)	43 00.4	82 25.4	D
Port Sanilac, Mich.	43 25.9	82 32.4	D
Harbor Beach LBSTA, Mich. (CG)	43 51.0	82 38.6	D
Bay City, Mich.	43 38.5	83 50.8	D
Saginaw, Mich.	43 26.0	83 56.5	D

GREAT LAKES SMALL CRAFT, GALE AND WHOLE GALE WARNING DISPLAY STATIONS

Station	Latitude	Longitude	Type Display*
ALPENA, MICH. - Supervising Office			
Oscoda, Mich.	44°25.0'	83°19.0'	D
Tawas LBSTA, Mich. (CG)	44 15.0	83 26.2	D&N
East Tawas, Mich.	44 16.7	83 29.4	D
Thunder Bay Island LTSTA, Mich. (CG)	45 02.2	83 11.7	D
Alpena (WB City), Mich.	45 03.8	83 25.8	D
SAULT STE. MARIE - Supervising Office			
Detour, Mich.	45 59.4	83 54.0	D&N
St. Ignace, Mich.	45 52.0	84 43.0	D
Mackinac Island LBSTA, Mich. (CG)	45 51.1	84 37.1	D&N
Mackinaw City, Mich.	45 47.1	84 43.4	D&N
Beaver Island LBSTA, Mich. (CG)	45 44.6	85 30.2	D
Harbor Springs, Mich.	45 25.7	84 59.3	D
Charlevoix LBSTA, Mich. (CG)	45 19.1	85 15.7	D
Whitefish Point LTSTA, Mich. (CG)	46 46.3	84 57.4	D&N
Grand Marais LBSTA, Mich. (CG)	46 40.6	85 58.0	D
MUSKEGON, MICH. - Supervising Office			
Northport, Mich.	45 07.8	85 36.7	D&N
Leland, Mich.	45 01.4	85 45.7	D
Frankfort LBSTA, Mich. (CG)	44 37.8	86 14.7	D&N
Manistee LBSTA, Mich. (CG)	44 15.0	86 20.4	D
Ludington LBSTA, Mich. (CG)	43 57.2	86 27.7	D
Pentwater Moorings, Mich. (CG)	43 46.9	86 26.5	D&N
Muskegon LBSTA, Mich. (CG)	43 13.7	86 20.4	D&N
Grand Haven LBSTA, Mich. (CG)	43 03.6	86 14.9	D&N
CHICAGO, ILL. - Supervising Office			
Holland CG Moorings, Mich. (CG)	42 46.4	86 12.5	D
Saugatuck, Mich.	42 39.0	86 12.0	D
South Haven LBSTA, Mich. (CG)	42 24.2	86 17.0	D
St. Joseph LBSTA, Mich. (CG)	42 06.8	86 29.1	D
New Buffalo, Mich.	41 48.1	86 44.9	D
Michigan City LBSTA, Ind. (CG)	41 43.4	86 54.1	D
Gary Marquette Park, Ind.	41 37.4	87 13.6	D
Gary (Miller), Ind.	41 37.2	87 15.9	D
Gary Steel Works, Ind.	41 37.4	87 19.6	D
Gary Buffington Harbor, Ind.	41 38.7	87 24.7	D
Chicago LBSTA, Ill. (CG)	41 53.3	87 36.6	D
South Chicago LBSTA, Ill. (CG)	41 43.1	87 31.5	D
Jackson Park LBSTA, Ill. (CG)	41 46.7	87 34.5	D
Chicago Yacht Club (Monroe Street), Ill.	41 52.9	87 36.9	D
Chicago Yacht Club (Belmont Harbor), Ill.	41 55.4	87 38.2	D
Wilmette Harbor LBSTA, Ill. (CG)	42 04.7	87 41.0	D
MILWAUKEE, WIS. - Supervising Office			
Waukegan, Ill.	42 21.7	87 49.3	D&N
Racine LBSTA, Wis. (CG)	42 44.1	87 46.2	D&N
Milwaukee, Wis.	43 01.5	87 54.1	D&N
Sheboygan LBSTA, Wis. (CG)	43 45.0	87 42.2	D&N
GREEN BAY, WIS. - Supervising Office			
Ephraim, Wis.	45 09.4	87 10.0	D&N
MARQUETTE, MICH. - Supervising Office			
Marquette LBSTA, Mich. (CG)	46 32.8	87 22.5	D
Ontonogan LTSTA, Mich. (CG)	46 52.5	89 19.3	D

GREAT LAKES SMALL CRAFT, GALE AND WHOLE GALE WARNING DISPLAY STATIONS

Station	Latitude	Longitude	Type Display*
DULUTH, MINN. - Supervising Office			
Black River Park, Mich.	46°40.0'	90°02.8'	D
Ashland, Wis.	46 35.5	90 53.1	D&N
Superior, Wis.	46 42.2	92 01.4	D&N
Duluth Yacht Basin, Minn.	46 46.5	92 05.5	D&N
Two Harbors, Minn.	47 00.8	91 40.5	D&N
North Superior LBSTA, Minn. (CG)	47 44.8	90 20.1	D&N

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* D Day Displays
D&N Day and Night Displays

Note:

Stations listed from east to west following the Great Lakes Coastline.

Displays are made during the Great Lakes Navigation Season.

(CG) Coast Guard

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