# P1.29 CLIMATE PERSPECTIVE OF THE 1997-98 LAURENTIAN GREAT LAKES ICE COVER

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## 1. INTRODUCTION

Great Lakes ice cover affects the lake aquatic system, lake levels, regional and local climate (lake-effect snowfall), and shipping (Fig. 1). Ice can also cause flooding, shore property damage and damage to hydro-electric-generating plants. These are just a few examples of how the annual ice cover affects the regional economy and ecology. The mild 1997-98 ENSO winter is noteworthy because it likely produced one of the least extensive ice covers on the Laurentian Great Lakes this century.

## 2. WINTER SEVERITY

The 1997-98 ENSO winter ranked as one of the warmest winters of the century (Fig. 2). In the Great Lakes region departures from average temperatures (Dec. 1997 - Feb. 1998) ranged from 12°F above average in the northwest to 8°F above average in the southeast (portions of the region).

## 3. ENSO AND GREAT LAKES ICE

The 1997 ENSO event is similar to the record 1982 ENSO (Fig. 3). The 1982-83 winter following the 1982 event had much-above-average temperatures and much-below-average ice cover (*Assel et al.*, 1985). Comparing Great Lakes winter (temperature) severity and annual maximum ice cover for the six strongest warm ENSO events relative to other winters since 1950 (Assel, 1998) it was found that a regional winter temperature severity index averaged 1.2°C higher and modeled annual maximum ice cover averaged 15% lower for the winters following the onset year of a strong warm ENSO event relative to the average of other winters in the 1950-1994 base period.

## 4. HISTORICAL PERSPECTIVE OF THE 1997-98 GREAT LAKES ICE COVER

Here we make a preliminary comparison of the lakes' averaged seasonal progression (Fig. 4) and spatial pattern of seasonal maximum extent (Fig. 5, Fig. 6, & Fig. 7) of the Great Lakes ice cover for winter 1997-98, winter 1982-83, and a 20-year (1960-1979) normal given in Assel et al. (1983).

## 5. NORMAL WINTER ICE COVER

Ice is usually limited to the shallow areas of the Great Lakes in early winter (Dec.-Jan.) when it covers less than 30% of the surface. Ice formation in the deeper bays and open midlake areas starts in the second half of January and continues until March. The ice cover typically reaches its maximum extent in February or early March when it covers approximately 60% of the Great Lakes (Fig. 5). The ice cover loss period starts in March and by mid April the bulk of the ice cover has dissipated from the Great Lakes.

## 6. 1997-98 WINTER ICE COVER

Ice was limited to the shallow areas of the Great Lakes and was much-below-normal all winter (Fig. 4). And even in the larger bays where the ice is usually stable ice covers were more transitory this winter. A decline in ice cover Jan. 1-10 was followed by the largest increase in ice extent for the entire winter during the next ten days [Jan. 11-20]. By Jan. 20 about 12% of the Great Lakes was ice cover. After that only small changes in extent occurred through mid-February. Maximum ice extent was estimated to occur Feb. 10 when ice covered 14% of the Great Lakes (Fig. 6). It is remarkable that Lakes Erie, which normally has a maximum ice cover of 90% was virtually ice free on that date. The ice cover dissipated over the next two months and the Great Lakes were virtually ice free by the end of the third week of April.

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## 7. 1982-83 WINTER ICE COVER

The daily progression of ice cover extent on the Great Lakes during winter 1982-83 was remarkably similar to the 1997-98 ice cover (Fig. 4). The primary difference was in winter 1983 ice cover extent was approximately 5% to 10% higher [Jan. 20 to Mar. 10] then it was in winter 1998. Maximum ice extent during the mild 1983 winter occurred near Feb. 8 (Fig. 7) when ice was estimated to cover about 23% of the surface area of the Great Lakes.

## 8. CONCLUDING REMARKS

The Great Lakes ice cover of winter 1997-98 is the least extensive since systematic observations of Great Lakes ice cover started in 1960, a distinction formerly held by the 1982-83 ENSO winter. We are in the process of making a more detailed analysis of the 1997-98 winter ice cover and ancillary data for the Great Lakes.

## 9. ACKNOWLEDGMENTS

This is Great Lakes Environmental Research Laboratory contribution number 1114.

## 10. REFERENCES

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Assel, R.A., Snider, C.R., and Lawrence, R., 1985. Comparison of 1983 Great Lakes winter weather and ice conditions with previous years. *Monthly Weather Review* 113:291-303.

Assel, R.A., F.H. Quinn, G.A. Leshkevich, and S.J. Bolsenga, 1983. Great Lakes ice atlas. *NOAA Atlas No. 4.* Great Lakes Environmental Research Lab., Ann Arbor, MI.


Figure 1. USCG assisting a ship. The USCG typically spends between 1000 and 2000 hours a year keeping Great Lakes shipping channels open.

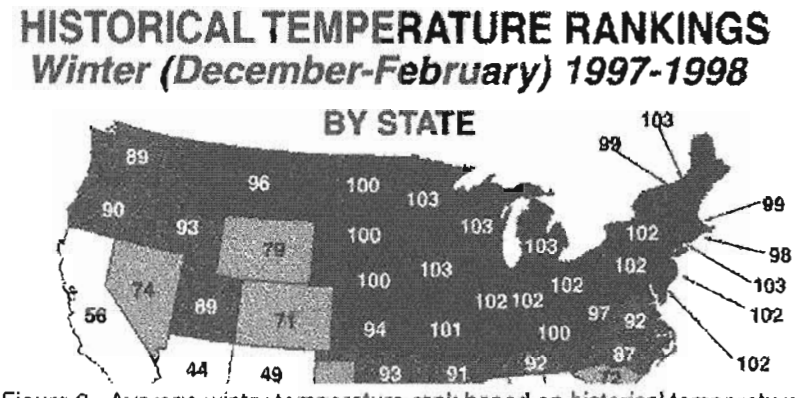


Figure 2. Average winter temperature rank based on historical temperature generated by NCDC and preliminary data generated by CPC (1 = coldest, 103 = Warmest).

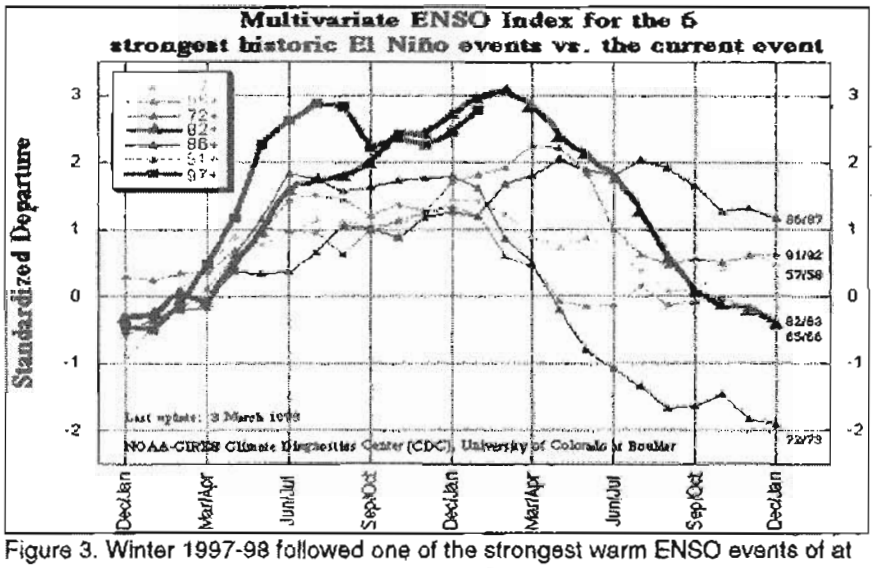


Figure 3. Winter 1997-98 followed one of the strongest warm ENSO events of at least the past 50 years. Only the warm 1982 ENSO was stronger (from NOAA-CIRES Climate Diagnostics Center, University of Colorado at Boulder)

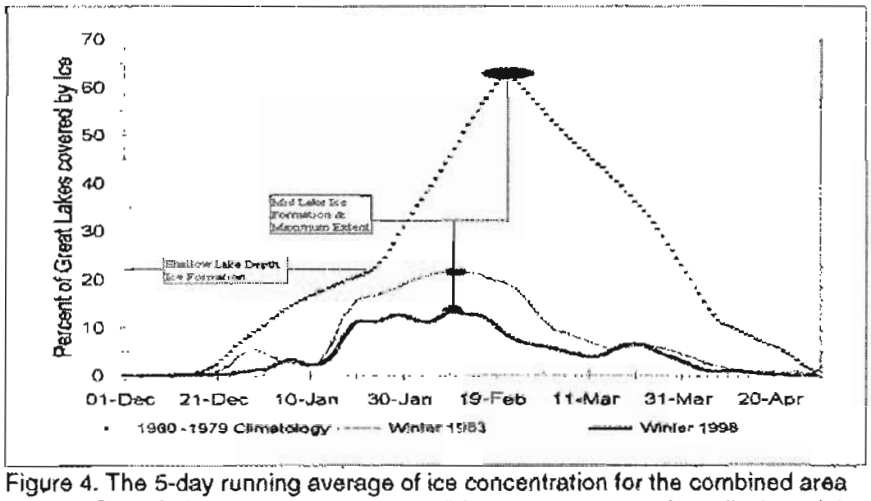


Figure 4. The 5-day running average of ice concentration for the combined area of the 5 Great Lakes for winters 1997-98 (black line), 1982-83 (gray line), and the normal for the base period 1960-1979 (dotted line).

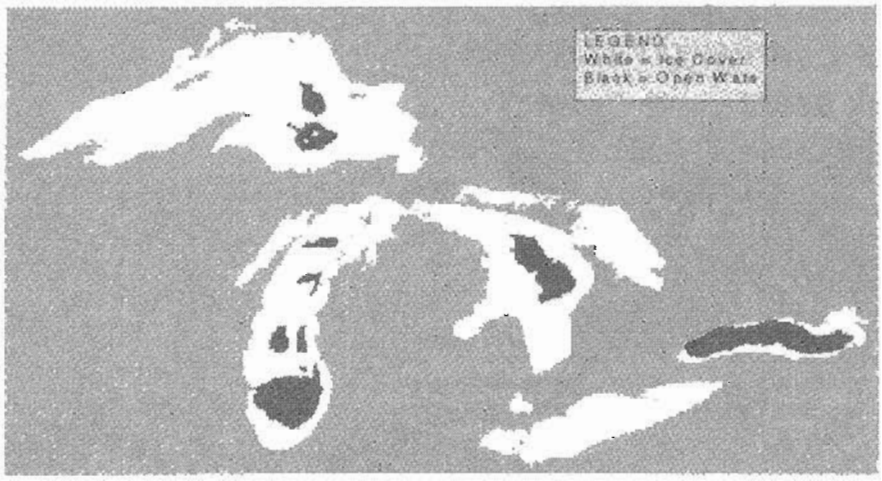

Figure 5. Normal Ice Cover February 15-28, 1960-1979 (Assel et al., 1983).

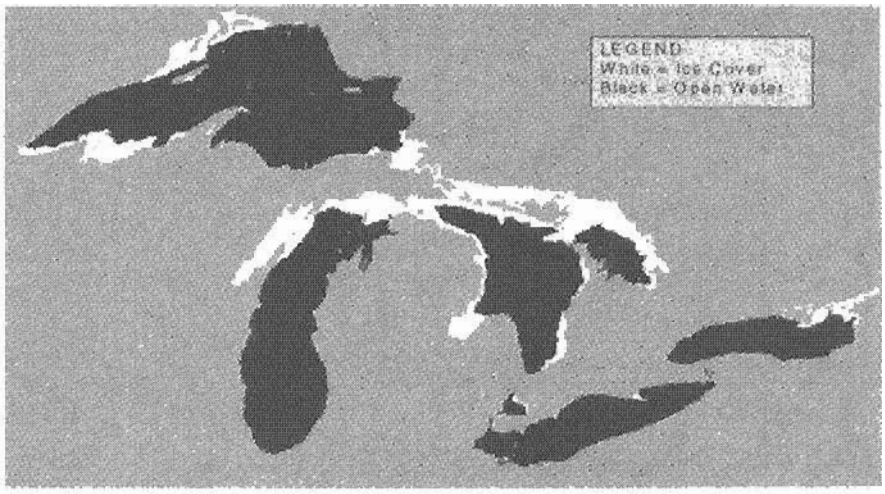

Figure 6. Ice extent for February 10, 1998, near the time of maximum ice extent for winter 1997-98.

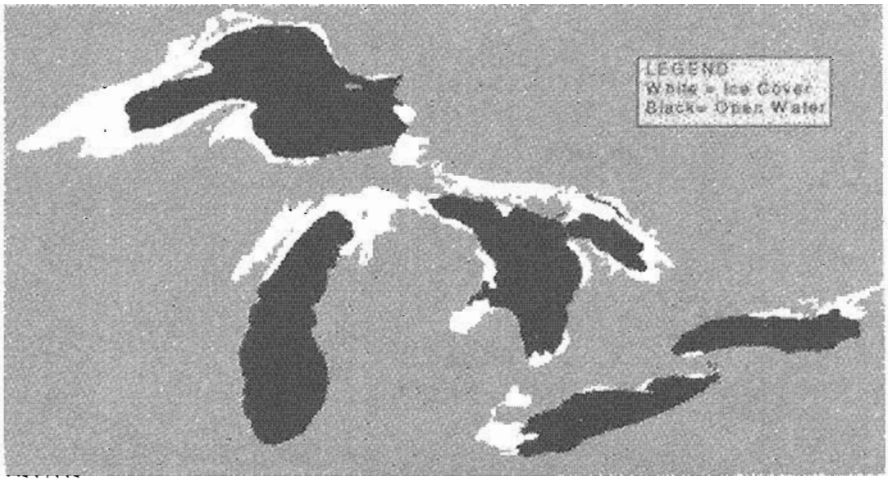

Figure 7. Ice extent for February 8, 1983, near the time of maximum ice extent for winter 1982-83.