Mapping Superior's Winds

Identifying seasonal surface wind patterns on Lake Superior

University of Minnesota
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Introduction

1.

What do the winds look like on Lake Superior? How strong are they? How do they change with the seasons? These are important questions that affect the people living along its shores, the ships traveling on its waters, and even potential offshore wind turbine sites. As recently as 1986, wind on the lake was modeled using ship logs, or shore based observations. Today, several studies have modeled lake winds from large networks of inland weather stations, but lack in situ observations.

This is what make this project unique. Where other models opt for larger, cleaner datasets from further inland, this project took 10 years worth of data from 17 different locations. These locations included buoys, lighthouses, shore-based sites, and two inland weather stations.

2.

1. Stannard Rock, Michigan-STDM4 nicknamed "The Loneliest Place on Earth" is 24 miles offshore.

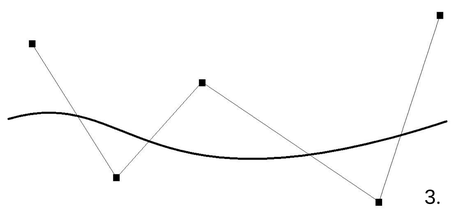
2. Station 45004 pictured here is a research buoy maintained by the National Buoy Data Center (NBDC)

Methodology

In order to identify seasonal patterns, isotach maps needed to be created depicting seasonal averages, but what is an isotach map? An isotach map shows contours lines of consistent wind speed; similar to how a topographic map depicts contours of consistent elevation. In order to accomplish this, control points and corresponding values first need to be established. The control points themselves were the latitude and longitude of the each station, but determining the seasonal values required a more through process.

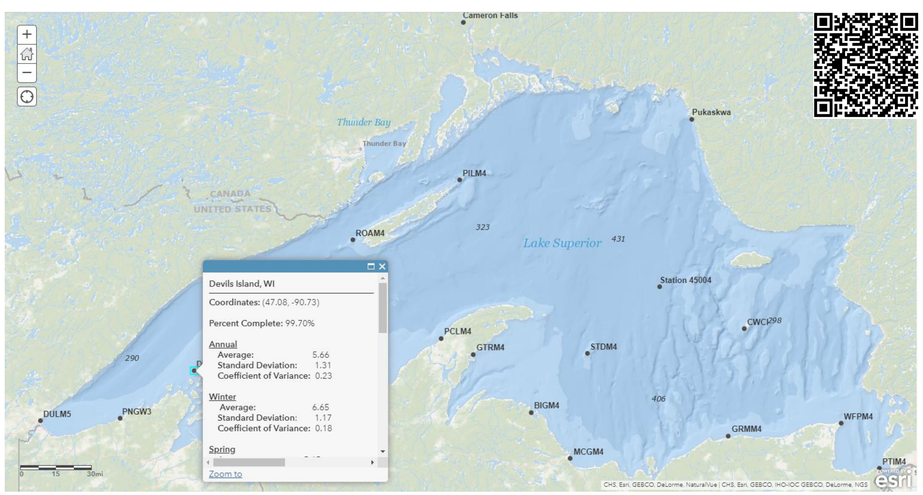
For each station, all available data from 2008 to 2017 were collected. The hourly observations for each day with sufficient data were then averaged to produce daily means. Next, these daily means were averaged for each date in a non-leap year to produce a 10-year daily averages. With the 10-year daily averages 4 seasonal means could then be derived. These seasonal means were used as the control point values.

With control points and seasonal values set, the next step was to interpolate a raster surface or determine the values of the space in between points. There are several different methods of doing this, but the spline methodology was determined to be the best fit due to the gradient behavior wind and wind speed. Once the raster surfaces were finished, the contour lines could be drawn.



3.

3. An example of Spline interpolation

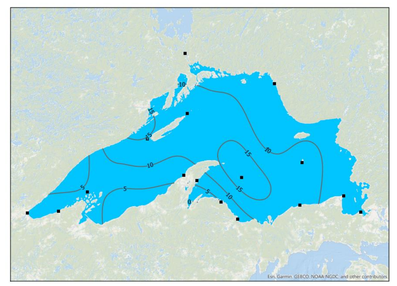


Results

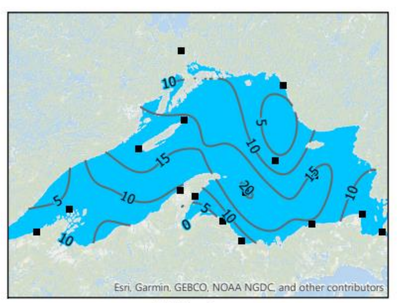
The analysis produced the maps below. One can see that the most intense wind speeds occur over Lake Superior during winter and its weakest winds speed during the summer. Both of these findings align with known wind behaviors and the spatial distribution of wind speeds aligns with previous models.

These maps show us where on the lake one could expect to observe, on average, high winds speeds and their seasonality on Lake Superior. With these areas identified, we can begin to ask questions such as, what is the safest route for ships or where could we successfully site offshore wind farms.

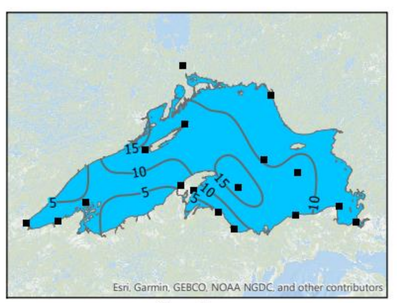
Annual Mean



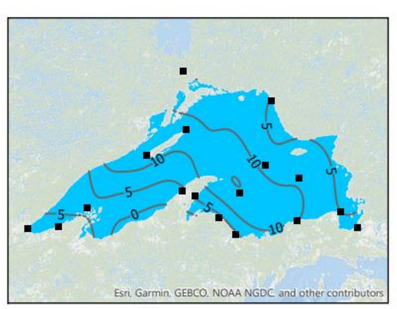
Seasonality



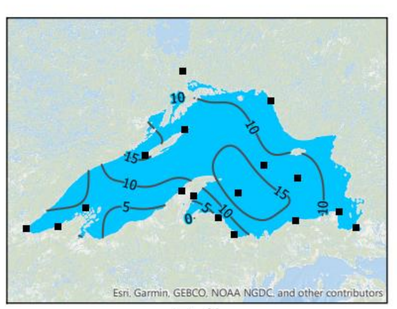
Winter



Spring



Summer



Fall