Simulating and forecasting seasonal ice cover

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Summary

- Past research has shown that teleconnection patterns (Fig. 3) are related to the ice cover in Great Lakes region.
- For the Apostle Islands (Fig. 2), we use two separate statistical models (e.g., beta model and Poisson model) to predict whether solid ice will happen and when it is the first date of solid ice in a given year.
- The results show that we can predict whether solid ice will happen quite well and a 10% confidence interval for the first date of solid ice indicates a safe time for the National Park Service to prepare to open the ice caves (Fig. 1) for visitors.

Data & Methods

Before building the model, we first check the correlation within and between teleconnections to prevent the multicollinearity problem. The results show that NINO 3.4, PDO and SOI all have significant temporal autocorrelation (Fig. 6).

We then use the fitted model to predict the 10-day average ice cover and check whether or not it is greater than 90%. If the 10-day average ice cover is greater than 90%, then there will be solid ice in that year.

Furthermore, we use the corresponding $\text{R}$ and $\text{P}$ to calculate the two shape parameters and fit it into the beta quantile function in R to get the probability. The comparison between the probability and whether or not solid ice occurred can help us decide a standard of the uncertainty of our prediction.

Result

In Fig. 7b, if the probability is small and no ice is observed, that means that our model does a good job of predicting no solid ice. Similarly, if the probability is large and ice is observed, the prediction of solid ice is also good. On the other hand, if the probability is small but ice is observed, (Type I error) which means we predict no solid ice but it occurs, National Park Service will lose money for these days. If the probability is large but no ice is observed, (Type II error) which means we predict solid ice but it doesn’t occur, someone might lose their lives. Notice that when probability is greater than 35%, only 1 year in history has Type II error, while if the probability less than 35%, 2 years have Type I error. Thus, we draw the constant probability line at 35% (red line) on the plot as the index of the uncertainty of the prediction. (Can be moved according to National Park Service). If the prediction probability is on the left side of the red line, then the solid ice has a low chance to occur. If the prediction probability is on the right side, solid ice has a high chance to occur.

Future Work

- Impact of date of forecast.
- Rolling forecast verification.
- Impact of Hazard model (instead of Poisson).

Table 2. Selected variables based on step-wise regression analysis.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adj. R^2</th>
<th>Significance</th>
<th>Beta model</th>
<th>Poisson model</th>
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<td>0.97</td>
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References