Forecast for 2021 Ice Season off Newfoundland, Canada

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- The WERR control systems model predicts a medium ice year, of 675±123 icebergs past 48°N by the end of July 2021.
- All three machine learning models predict a medium year.
- The machine learning tools also predict a low/medium rate of change and a single peak in iceberg numbers.
- **The combined 2021 iceberg forecast is therefore for a medium ice year.**

We have now run the WERR control systems model and the machine learning aspect to estimate the 48N iceberg number (I48N) for the 2021 iceberg season. This uses the same procedure as set out in Bigg et al. (2019), but with updated forcing data into late 2020. The updated Greenland Surface Mass Balance forcing data is courtesy of Edward Hanna of the University of Lincoln.

Recap of recent forecasts

The systems model developed by Bigg et al. (2019) achieved an 80% skill level in predicting whether an ice season would be above or below the mean I48N value over the verification period of 1997-2016. Since then, the forecast for the 2017 season was 766±297, with an observed total of 1008, this being a **success**. In 2018 the forecast was 685±207, with an observed number of 208. While the forecast was lower than the 2017 number it was still too high, thus a **failure**. The 2019 forecast for August was for 516±150 icebergs. By the end of the season the total number had reached 1515. The 2019 forecast was therefore also a **failure**. The 2020 forecast (including the machine learning approach) was for low/medium ice year with 584±303 icebergs by the end of July. The observed number by this point was 221, therefore a low year, but approaching the threshold for medium which is set by the International Ice Patrol (IIP) at 230 icebergs. However the lower bound on the WERR forecast was 281, so was still slightly too high. Nevertheless, as the forecast was a combined WERR and machine learning approach, it was overall a **success**.

WERR Control Systems Model

As it was previously found that using recent years produces closer ensemble results to reality than those earlier in the trial period, the WERR model was extended by two years to 2018. The updated WERR forecast is therefore 675±123 icebergs, which is in keeping with a medium ice year. The monthly cumulative totals can be seen in Figure 1, along with the average iceberg numbers for the last 10 and 50 years. The plot shows a steady increase in iceberg numbers over the years, with greatest increase at the expected months. It also fits very closely to the 10 year average.

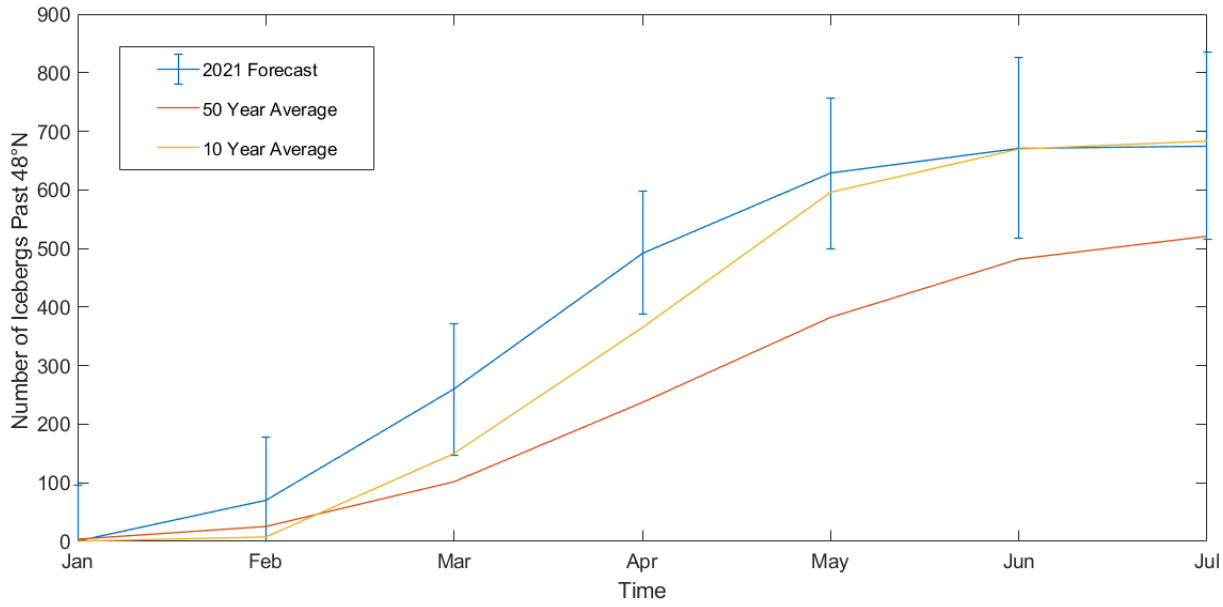

Figure 1. Plot of the 2021 iceberg forecast, including the average number of icebergs past 48°N by the end of July in the last 10 and 50 years.

Machine Learning Aspect

As with last year, we have a forecast for I48N and the rate of change (both are either low, medium or high), however this year we have also added an initial attempt to predict the number of peaks in an ice year (either one or multiple). To achieve this we used three machine learning tools: linear discriminant analysis, a linear Support Vector Machine algorithm (SVM) and a quadratic SVM algorithm. All models used knowledge of the annual means of the three environmental parameters forcing the control systems model, namely Labrador Sea Surface Temperature (LSST), the NAO and the Greenland Surface Mass Balance, as well as allowing a measure of auto-regression through having knowledge of previous years' value of the appropriate measure. For measures with three categories, a success level over 33.3% means the method has some skill, similarly when forecasting the number of peaks, we are interested in models with more than 50% accuracy.

Forecasting I48N

All three models predict a medium ice year, defined by the IIP as between 231 and 1036 icebergs.

	Accuracy (%)	RMSE
Linear Discriminant:	54.6512	0.7924
Linear SVM:	50.0	0.8627
Quadratic SVM:	50.0	0.9022

Predicting Rate of Change

Two models predict a low rate of change and one predicts a medium rate of change.

	Accuracy (%)	RMSE
Linear Discriminant:	41.8605	1.0000
Linear SVM:	37.2093	1.0230
Quadratic SVM:	41.8605	1.0173

Predicting the Number of Peaks

Forecasting the number of peaks in an ice year, either one or multiple.

All three models predict only one significant peak.

	Accuracy (%)	RMSE
Linear Discriminant:	55.8140	0.6647
Linear SVM:	56.9767	0.6559
Quadratic SVM:	60.4651	0.6288

Thoughts and Conclusions

After extensive trialling of various combinations of the input data for the machine learning models, the accuracy has increased from 43.2-52.3% for I48N last year to 50-54.7% this year. While this is not a dramatic improvement, it shows that last year's models were very successful, especially considering they were a first attempt. This was also shown in the success of the forecast. The updated LSST data has proved to be less reliable for prediction, hence the slight reduction in accuracy for the rate of change prediction (39.2-49.4% last year to 37.2-41.9% this year).

Overall, as all models predict a medium ice year we can have reasonable confidence in the forecast. While the rate of change prediction has more variation, a low/medium rate seems likely when combined with the WERR monthly forecast.

References

Bigg, G. R., Y. Zhao, E. Hanna, 2019, Forecasting the severity of the Newfoundland iceberg season using a control systems model, J. Operational Oceanogr., doi:10.1080/1755876X.2019.1632128.