Forecast for 2020 Ice Season off Newfoundland

Grant R. Bigg & Jennifer B. Ross

Executive Summary

1. The control systems model is predicting a medium to low ice season for 2020, with the I48N forecast to July being 580±279.
2. Two new forecasts, based on experimental machine learning tools, have been introduced this year for measures of the ice season: a total season number and a rate of seasonal change.
3. The machine learning forecast is for a low ice season in 2020.
4. The machine learning forecast for the seasonal rate of change is for it to be rapid.
5. **The combined, three measure, forecast is therefore for a relatively low iceberg number in the 2020 ice season.**

Details

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

This year we have expanded the range of forecasts that we provide, in response to the discussion in Appendix B of the 2018 IIP Annual Report (IIP, 2019), which commented on the desirability of categorization of the 48N index, as well as understanding the rate of iceberg number through the season. In what should currently be regarded as experimental analysis, we have used a range of machine learning tools to produce forecasts of both annual I48N number and the rate of change of the seasonal increase. We explain these below but initial indications suggest some positive skill in the presented category forecasts.

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**. This time last year we issued a 2019 forecast for August of 516±150. By the end of the season the total number had reached 1515 (Mara Brown of the IIP). The 2019 forecast was therefore also **a failure**.

2020 forecast

The January-September forecast for 2020 is 744±271, which is consistent with 2020 having a relatively high ice season. The plot of the forecast monthly increment (Figure 1), however, shows, an extremely unusual late surge in forecast numbers in September; the forecast to July is 580±279, **suggesting a more medium to low ice season** in 2020 may be more likely.

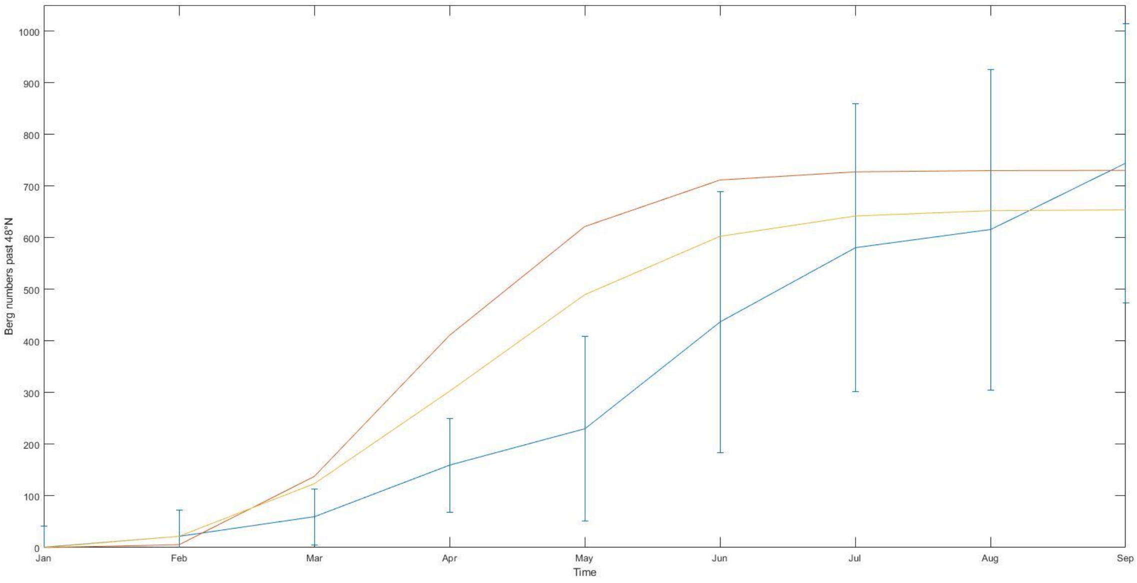

Figure 1: Forecast of the 2020 ice season I48N, with standard deviation error bars shown.

New forecast elements

In response to the analysis of IIP (2019) we decided to introduce two new forecast approaches this year. We have trialled forecasts of the total magnitude of the ice year and the relative rate of increase of iceberg numbers through the season. This rate of increase is calculated each year from the difference between the 85th percentile (of the year's I48N) and the 15th percentile, divided by the number of months between these events and then he result normalised relative to the year's total I48N. Therefore, a high rate implies a sudden increase in the number of icebergs past 48°N, whereas a low rate suggests a gradual increase over the ice year. In both cases we have used a three category predictand – for I48N total this is 0 (low, < 231), 1 (medium, 231-1036) and 2 (high, > 1036), while for rate of iceberg number increase it is 0 (low, <0.33), 1 (medium, 0.33-0.66) and 2 (fast, >0.66). For predicting both measures of I48N we used 3 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, 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. As both measures have three categories, a success level over 33.3% means the method has some skill. The forecasts for the 2020 ice season are given below in Table form; the time period over which the skill level was assessed was 1932-2018.

Table 1: Prediction of magnitude of ice year

All three models predicting **level 0** (low ice year) so less than 230 bergs past 48°N in total.

	Linear Discriminant	**Linear SVM**	**Quadratic SVM**
RMSE	0.885	0.917	0.826
% of time the prediction is true	48.9%	43.2%	52.3%
Correlation	0.234	0.154	0.285

Table 2: Prediction of rate of change

All three models predict **level 2** (high/fast) relative rate of change.

	Linear Discriminant	**Linear SVM**	**Quadratic SVM**
RMSE	0.88	0.87	0.97
% of time the prediction is correct	49.4%	39.2%	43.0%
Correlation	0.29	0.18	0.13

All models show some skill in predicting these two I48N measures, although at medium rather than high levels. Table 1 is predicting a low ice year, and Table 2 one with an early season peak in iceberg flux. Table 1's prediction is compatible with, if somewhat lower than, that for the July forecast from the systems model. Table 2's prediction suggests a faster peaking season than the control system model does, but the skill level for this measure is marginal for 2 out of 3 of the algorithms.

Reflections and cautions

We have pioneered a number of new approaches in this year's forecast. Two new measures of I48N have been introduced, with the different tool of machine learning algorithms being used to construct their forecasts. We have also trialled forecasting of the environmental parameters for the last couple of months of 2019 using a control systems approach to enable us to trial a full ice season forecast. Previously we only issued forecasts to August so as to only use actual forcing data. These new approaches are still in their trial phases and require further experimentation. In addition, we have not yet extended the control systems model ensemble beyond the period 1997-2016 used in Bigg et al. (2019); closer years had previously been found to produce closer ensemble results to reality than those earlier in the trial period. Nevertheless, there is a degree of consistency between the three forecast methods, especially if considering the former control systems approach of only forecasting up to July. The July forecast (580) lies below the long-term mean I48N up to that month (591) and so would have been scored as a Low year in the two category Bigg et al. (2019) categorization. Table 1 forecasts a low I48N total for 2020, which is consistent with a rapid rise in iceberg numbers earlier in the season, as suggested by Table 2. The overall indication of the three measures of I48N is therefore for a relatively low ice year in 2020.

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.

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