Predictions of Alaskan Summer Ice Conditions from May 2011 For June Outlook

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Here we attempt to predict the ice conditions near Barrow Alaska as listed in Table 4 of the *Seasonal Outlook For North American Arctic Waters Summer 2010* prepared by the North American Ice Service in a collaboration with the Canadian Ice Service, 02 June 2011 (http://www.natice.noaa.gov/products/nais_forecasts.html). The parameters in this table (listed below) are various measures of the amount or duration of open water near Barrow.

The predictions are based on the output of a coupled ice-ocean model that provides us with retrospective estimates of the ice and ocean conditions in the Arctic. The model is the PIOMAS model developed and operated by Dr. Zhang (http://psc.apl.washington.edu/zhang/IDAO/seasonal_outlook.html). It uses the air temperature, winds, clouds, and precipitation from the NCEP Reanalysis to estimate maps of the ice motion, ice thickness distribution, and ocean temperatures and currents for past years, up to and including the most recent month. The observed ice concentration is assimilated so that the model ice extent is close to the observed ice extent. Statistical relationships between the model parameters in May (or any other month) and the various measures of the ice conditions are found from past years using a method developed by Drobot et al (2006). This relationship is then used with the current month model output to predict either the pan-Arctic ice extent or any other scalar quantity such as those listed in the Ice Service outlook. Updates are posted at http://psc.apl.washington.edu/lindsay/prediction.html

The Alaskan ice parameters predicted here are

1. Distance from Point Barrow northward to ice edge on 10 Aug (nautical miles).
2. Distance from Point Barrow northward to ice edge 15 Sept (nautical miles).
3. Distance from Point Barrow northward to boundary of five-tenths ice concentration on 10 Aug (nautical miles).
4. Distance from Point Barrow northward to boundary of five-tenths ice concentration on 15 Sept (nautical miles).
5. Initial date entire sea route to Prudhoe Bay less than/equal to five tenths ice concentration (year day).
6. Date that combined ice concentration and thickness dictate end of prudent navigation (year day).
7. Number of days entire sea route to Prudhoe Bay ice free.
8. Number of days entire sea route to Prudhoe Bay less than or equal to five-tenths ice concentration.
9. Number of days between initial opening date and 1 Oct

10. Barnett Ice Severity Index (BIS Index), high numbers indicate large expanses of open water.
11. Rank of the BIS index from 1953 to 2010 (1 is the highest BIS Index, 57 the lowest)

We have determined the single most effective predictor for each of these variables for each predictor month and the amount of the variance explained by the predictor. The candidate predictors include fields of the ice thickness (H), the ice concentration (IC), the ice extent (IX, 0 or 1 for each grid cell), the fraction of the area with open water or ice less than 0.4m (G0.4m), less than 1.0 m (G1.0m), or less than 1.9 m (G1.9m). Table 1 lists each of the Alaskan ice parameters and for each month the most effective predictor and the percent of the variance explained. The method uses monthly averaged model output, so for predictions using the month of May, the model is run through the end of May and the fields of the average values for each predictor variable are used to make the predictions.

Table 2 gives the prediction for each Alaskan ice parameter using May 2011 data. The standard deviation of the regression error gives an indication of the uncertainty of the prediction. Figure 1 shows the data and the prediction for the BIS index.

The prediction this year for the amount of open water as seen in the BIS index is 1048 +/- 167, close to the previous maximum of 1136 seen in 2007.

Table 1. Percent variance explained and best predictor variable for each parameter using model data from the end of each month, April to August, using data from 1988 to 2010 to determine the correlations. Skills greater than 50% are in bold.

Ice Parameter	Apr	May	Jun	Jul	Aug	
Ice_Dist_10Aug:	**0.52**	0.47	0.49	**0.56**	**0.68**	R^2
variable:	G0.4m	G1.0m	IC	IC	IX	Predictor
Ice_Dist_15Sep:	**0.67**	**0.65**	**0.65**	**0.66**	**0.79**	
variable:	H	H	H	H	IC	
Ice_05_10Aug:	**0.78**	**0.73**	**0.69**	**0.69**	**0.78**	
variable:	G0.4m	G1.0m	H	IX	IX	
Ice_05_15Sep:	**0.62**	**0.60**	**0.61**	**0.63**	**0.77**	
variable:	G1.9m	G1.9m	G1.9m	IC	IC	
Date_Start:	**0.50**	0.47	0.44	0.41	0.39	
variable:	G1.0m	IC	IC	G1.9m	IC	
Date_End:	0.26	0.19	0.29	0.31	0.27	
variable:	G1.0m	G1.9m	IC	IC	IC	
Ndays_Ice_Free:	0.39	0.43	0.46	0.42	0.42	
variable:	G1.0m	IC	IC	IC	IC	
Ndays_Ice_05:	0.44	0.46	**0.52**	0.44	0.37	
variable:	G1.0m	IC	IC	IC	IC	
Ndays_Start_to_:	0.50	0.46	0.43	0.40	0.38	
variable:	G1.0m	IC	IC	G1.9m	IC	
BIS_Index:	**0.65**	**0.63**	**0.65**	**0.67**	**0.81**	
variable:	H	G1.9m	H	IC	IC	
Rank:	**0.63**	**0.61**	**0.63**	**0.61**	**0.65**	
variable:	G1.9m	G1.9m	G1.9m	G1.9m	IX	

Table 2. Predictions using data from the end of May 2011

Ice Parameter	predictor	R^2	Prediction	Error	
Ice_Dist_10Aug	G1.0m	0.48	93	30	
Ice_Dist_15Sep	H	0.65	352	70	
Ice_05_10Aug	G1.0m	0.73	156	33	
Ice_05_15Sep	G1.9m	0.63	422	80	
Date_Start	IC	0.48	198	8	(17 July)
Date_End	G1.9m	0.48	277	10	(4 October)
Ndays_Ice_Free	IC	0.43	67	16	
Ndays_Ice_05	IC	0.46	85	16	
Ndays_Start_to_1	IC	0.48	75	8	
BIS_Index	G1.9m	0.63	1048	167	
Rank	G1.9m	0.64	-11	9	

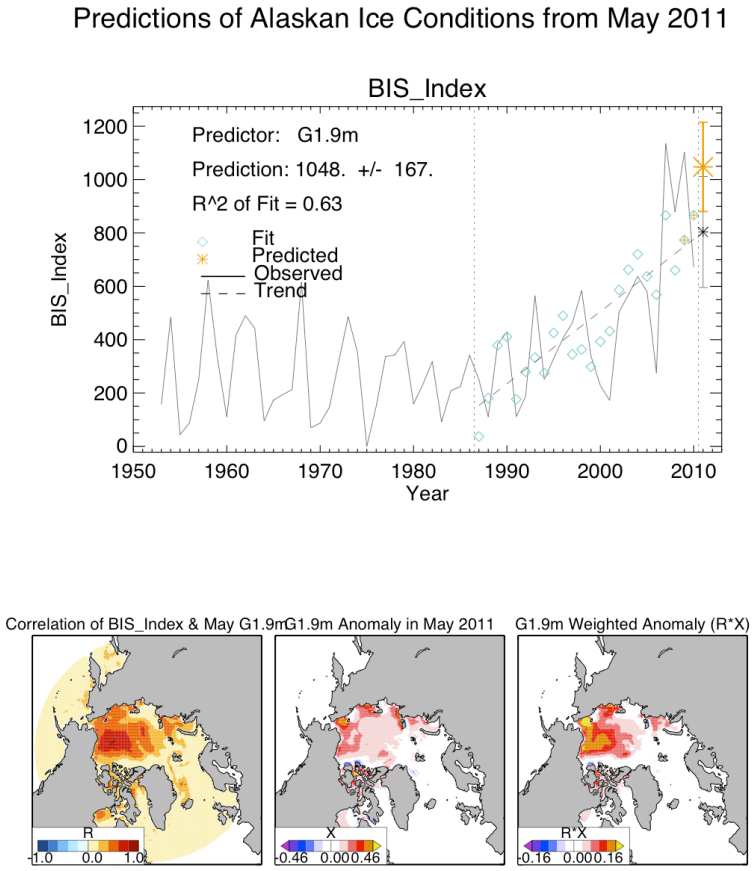

Figure 1. The top panel shows the time series for the BIS index since 1953. The blue dots are the fit of the statistical model using only data since 1987. The orange star is the prediction for 2011 with the error bar shown as well. The black dashed line and the black star are the linear trend line and the trend prediction. The lower maps show the correlation of the BIS Index with the G1.9m parameter, the anomaly of G1.9m in May 2011, and the product of the two which shows where anomalies in G1.9m are influential in determining the prediction. It is the integral of the last map that makes the single predictor variable used in the regression equation created with the historical data.

References

Drobot, S. D., J. A. Maslanik, and C. F. Fowler (2006), A long-range forecast of Arctic summer sea-ice minimum extent, Geophys. Res. Lett., 33, L10501, doi:10.1029/2006GL026216

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