Predictions of Alaskan Summer Ice Conditions form May 2010

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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 2010. These 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 which provides us with retrospective estimates of the current ice and ocean conditions. The model is the PIOMAS model developed and operated by Dr. Jinlun Zhang (http://psc.apl.washington.edu/zhang/IDAO/seasonal_outlook.html). The model uses the observed air temperature, wind, clouds, and precipitation 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 Dr. Sheldon Drobot (Drobot et al, 2006). This relationship is then used with the current month model output to predict the ice parameters listed below. The method may be used 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/equal to five-tenths ice concentration.
9. Number of days between initial opening date and 1 Oct
10. Barnett Ice Severity Index, high numbers indicate large expanses of open water.
11. Rank of the BIS index

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, the percent of the variance explained and the most effective predictor variable using model output through the end of each month, May to August. 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 prediction.

Table 2 gives the prediction for each Alaskan ice parameter using May data. Parameters for which the method predicts a 50% or greater chance of a new record value are printed in bold and the standard deviation of the regression error gives an indication of the uncertainty of the prediction. The prediction for the amount of open water as seen in the BIS index is 1145, very close to the previous maximum of 1136 seen in 2007 or the 1103 seen last year.

A set of four panels is shown for each Alaskan ice parameter. The first is shows the observed value for the last 22 years, 1988–2009, the values of the regression fit (blue) and the predicted value for 2010 (orange) with the one-standard-deviation error bar. The trend line and the trend prediction is also shown (black). The three maps show the correlation between the ice parameter and the best predictor (right), the anomaly of the best predictor for May 2010 (center), and the product of the correlation and the anomaly (left). It is the integral of the last map that makes the single predictor variable used in the regression equation.

Table 1. Percent variance explained and best predictor for each parameter using model data from the end of each month, May to August.

Ice Parameter	Apr	May	Jun	Jul	Aug	
ice_dist_10Aug	0.71	0.72	0.77	0.77	0.70	R^2
	G1.0m	IC	IC	IC	IC	Predictor
ice_dist_15Sep	0.83	0.81	0.82	0.83	0.86	
	G1.0m	G1.0m	IC	IC	IC	
ice_05_10Aug	0.82	0.79	0.75	0.72	0.72	
	G1.0m	G0.4m	G0.4m	G0.4m	G0.4m	
ice_05_15Sep	0.76	0.72	0.80	0.81	0.85	
	G1.0m	G1.0m	IC	IC	IC	
date_start	0.62	0.64	0.68	0.58	0.54	
	G1.0m	IC	IC	IC	G1.0m	
date_end	0.40	0.34	0.62	0.50	0.40	
	G1.0m	G1.0m	IC	IC	IC	
Ndays_ice_free	0.50	0.60	0.70	0.57	0.53	
	G1.0m	IC	IC	IC	G1.9m	
Ndays_ice_05	0.49	0.58	0.75	0.59	0.47	
	G1.0m	IC	IC	IC	G1.9m	
Ndays_start_1oct	0.62	0.63	0.67	0.58	0.53	
	G1.0m	IC	IC	IC	G1.0m	
BSI_Index	0.81	0.78	0.84	0.86	0.89	
	G1.0m	G1.0m	IC	IC	IC	
Rank	0.70	0.69	0.69	0.70	0.70	
	G1.9m	G1.9m	G1.9m	G1.9m	G1.0m	

Table 2. Predictions using data from the end of May

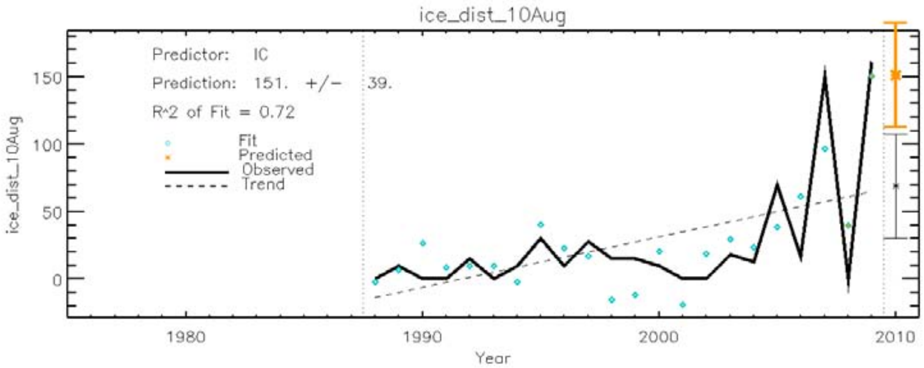
Ice Parameter	Prediction	Error	
ice_dist_10Aug	151.4	23.0	
ice_dist_15Sep	**419.8**	52.6	
ice_05_10Aug	**215.2**	26.7	
ice_05_15Sep	480.0	69.2	
date_start	**184.0**	7.4	(3 July)
date_end	307.8	6.7	(4 November)
Ndays_ice_free	93.6	13.9	
Ndays_ice_05	**114.1**	15.1	
Ndays_start_1oct	**89.8**	7.5	(3 July)
BIS_Index	**1145.0**	131.8	
Rank	-1.0	8.5	

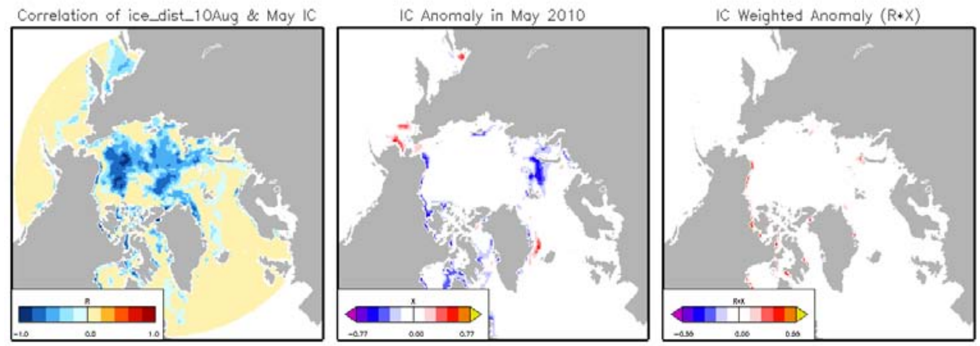
References

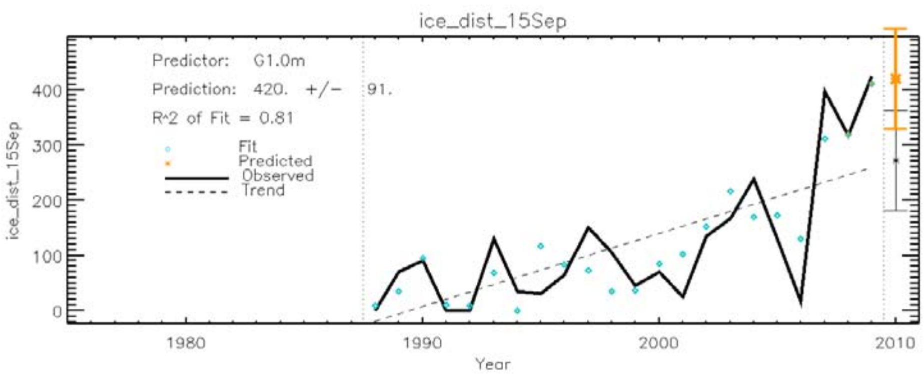
Drobot, S. D., J. A. Maslanik, and C. F. Fowler (2006), A long-range forecast of Arctic summer sea-ice minimum extent, Geophys. Res. Lett., 33, L10501, doi:10.1029/2006GL026216

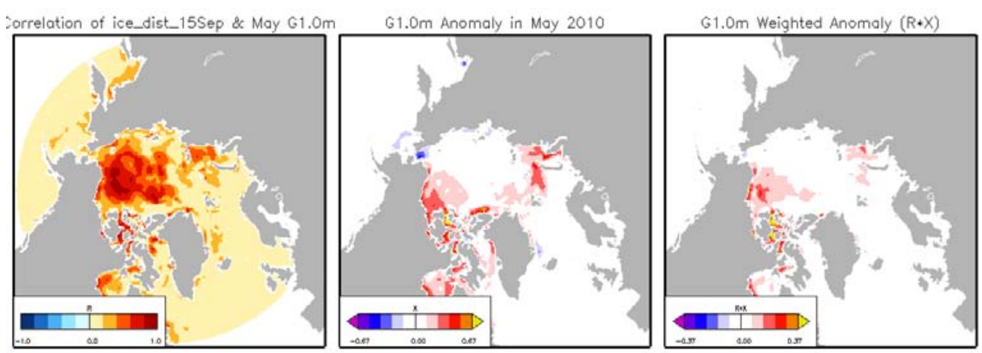
Lindsay, R. W., J. Zhang, A. J. Schweiger, and M. A. Steele, 2008a: Seasonal predictions of ice extent in the Arctic Ocean, J. Geophys. Res., 113, C02023, doi:10.1029/2007JC004259.

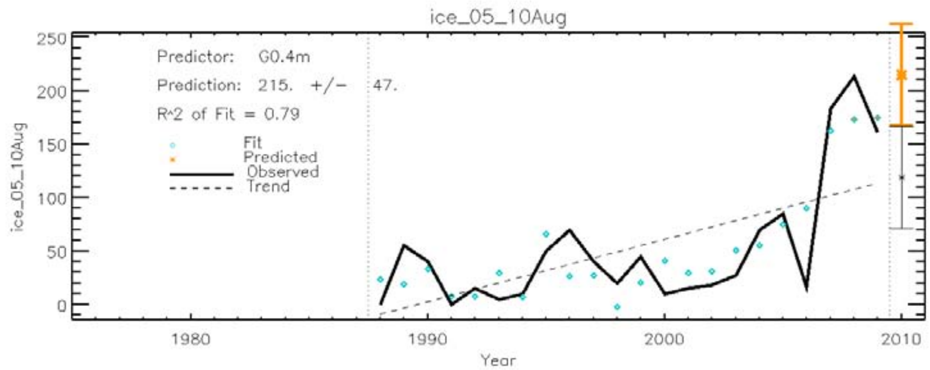
Figures

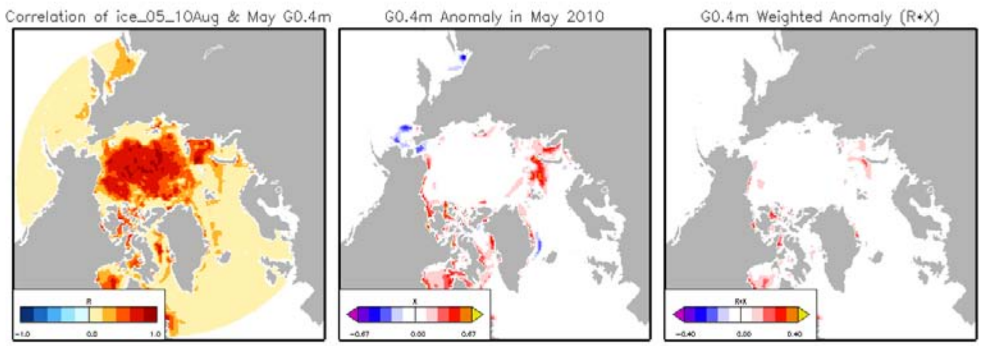

ice_dist_10Aug
Predictor: IC
Prediction: 151. +/- 39.
R^2 of Fit = 0.72
Fit
Predicted
Observed
Trend
ice_dist_10Aug
0
50
100
150
1980
1990
2000
2010
Year

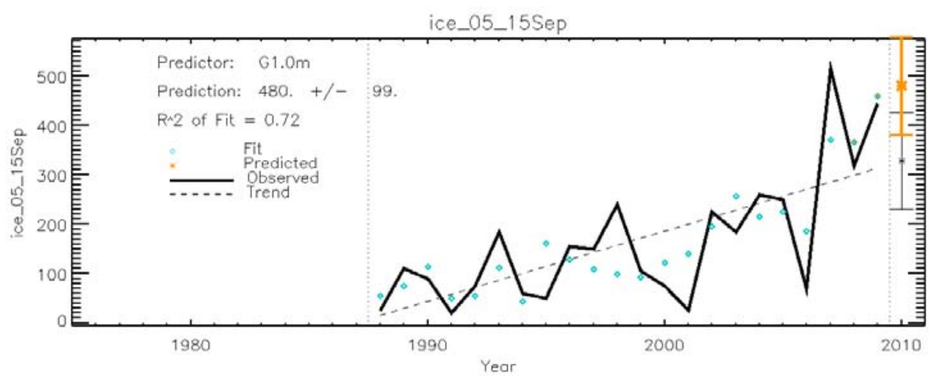

Correlation of ice_dist_10Aug & May IC
IC Anomaly in May 2010
IC Weighted Anomaly (R*X)

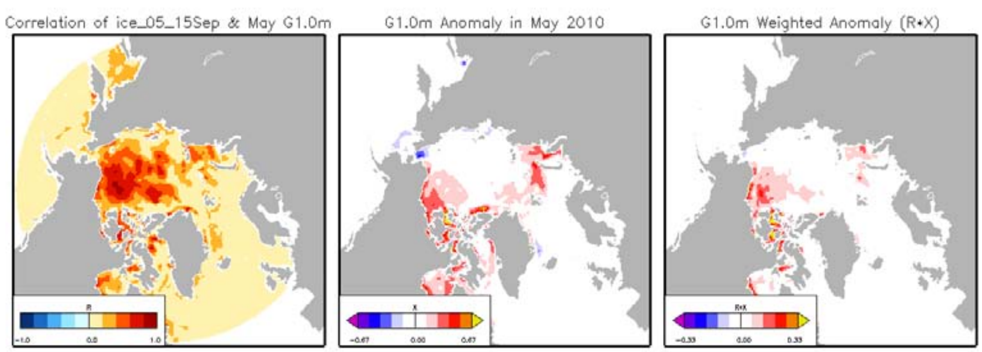

ice_dist_15Sep
Predictor: G1.0m
Prediction: 420. +/- 91.
R^2 of Fit = 0.81
Fit
Predicted
Observed
Trend
ice_dist_15Sep
0
100
200
300
400
1980
1990
2000
2010
Year

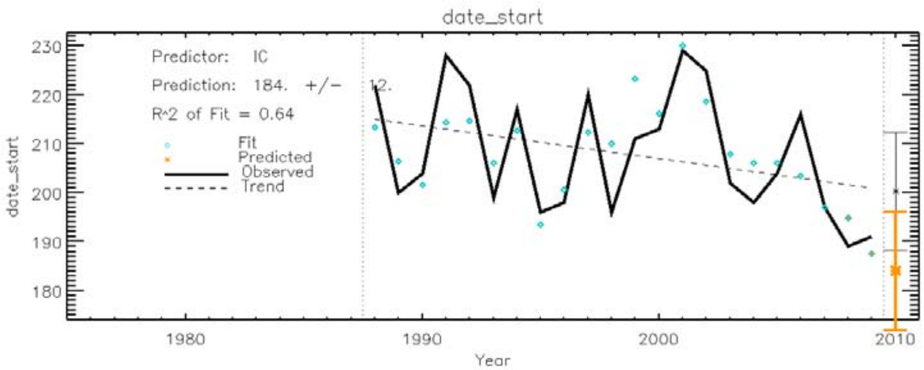

Correlation of ice_dist_15Sep & May G1.0m
G1.0m Anomaly in May 2010
G1.0m Weighted Anomaly (R*X)

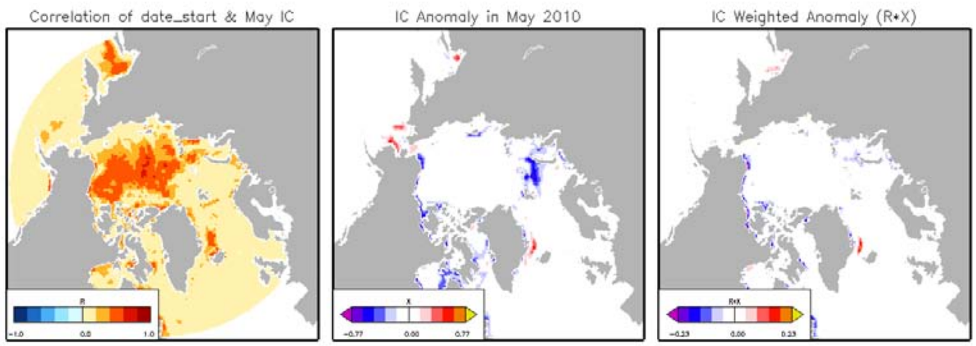

ice_05_10Aug
Predictor: G0.4m
Prediction: 215. +/- 47.
R^2 of Fit = 0.79
Fit
Predicted
Observed
Trend
ice_05_10Aug
Year

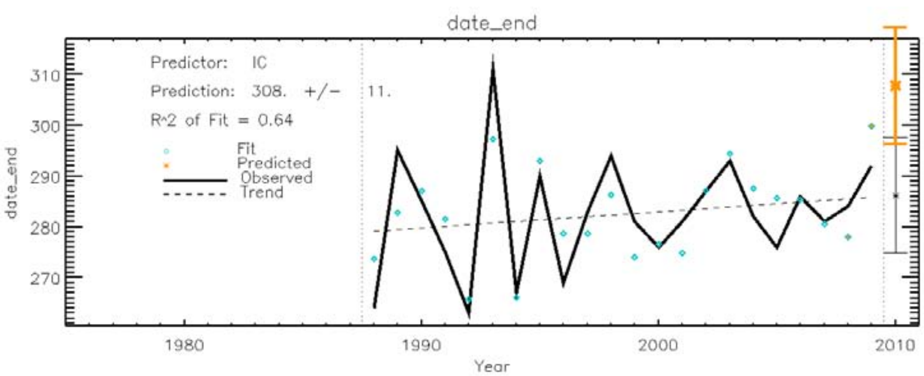

Correlation of ice_05_10Aug & May G0.4m
G0.4m Anomaly in May 2010
G0.4m Weighted Anomaly (R*X)

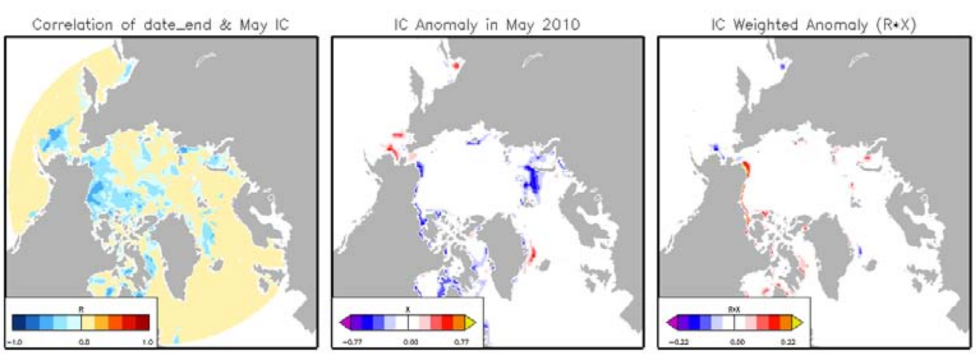

ice_05_15Sep
Predictor: G1.0m
Prediction: 480. +/- 99.
R^2 of Fit = 0.72
Fit
Predicted
Observed
Trend
ice_05_15Sep
Year

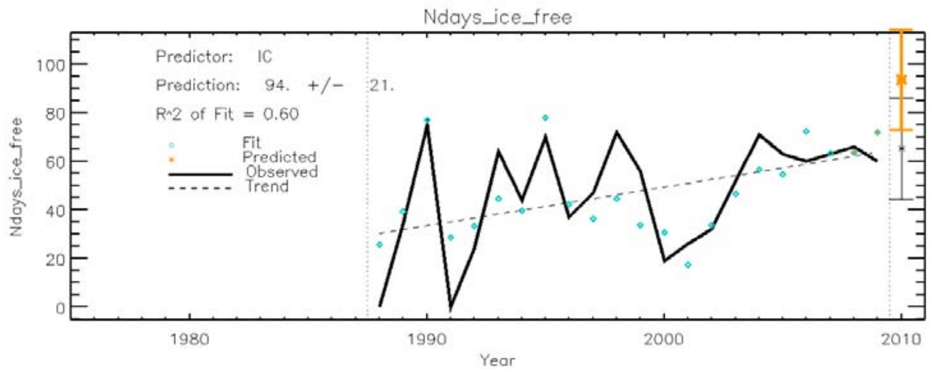

Correlation of ice_05_15Sep & May G1.0m
G1.0m Anomaly in May 2010
G1.0m Weighted Anomaly (R*X)

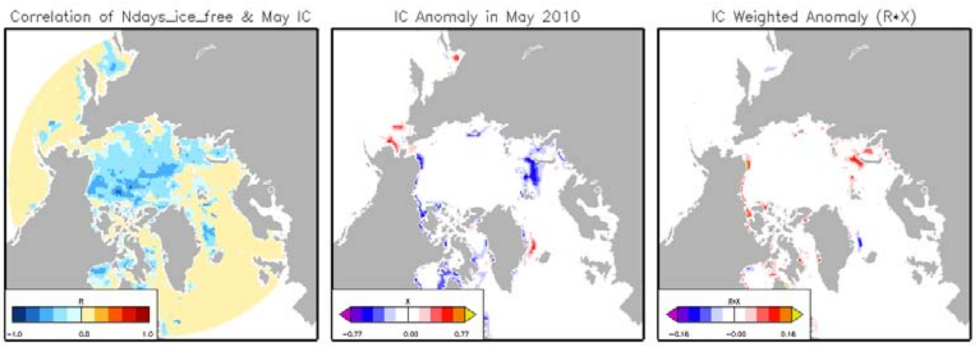

date_start
Predictor: IC
Prediction: 184. +/- 12.
R^2 of Fit = 0.64
Fit
Predicted
Observed
Trend
date_start
Year

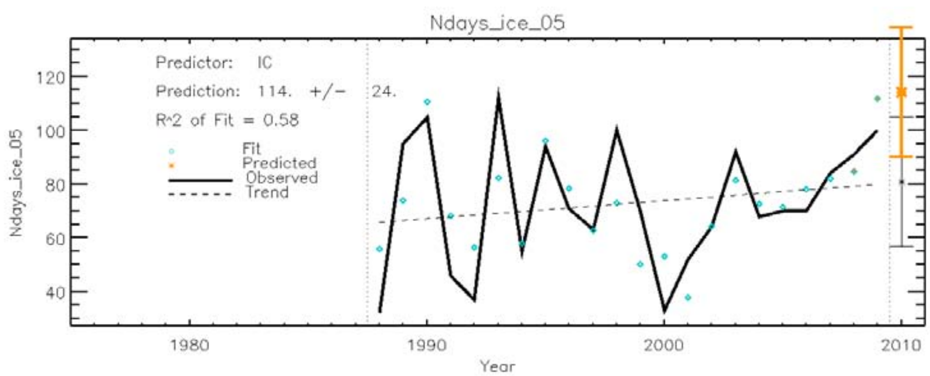

Correlation of date_start & May IC
IC Anomaly in May 2010
IC Weighted Anomaly (R*X)

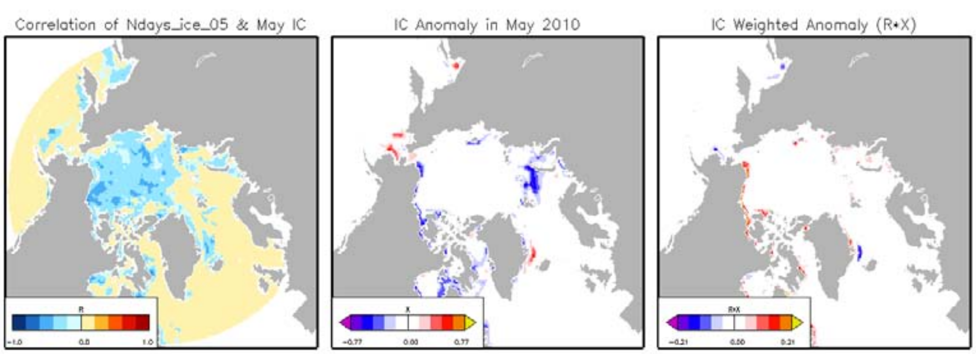

date_end
Predictor: IC
Prediction: 308. +/- 11.
R^2 of Fit = 0.64
Fit
Predicted
Observed
Trend
date_end
Year

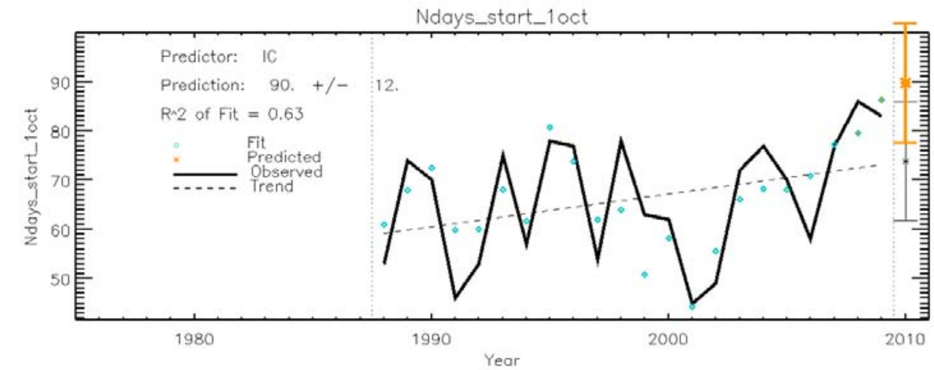

Correlation of date_end & May IC
IC Anomaly in May 2010
IC Weighted Anomaly (R*X)

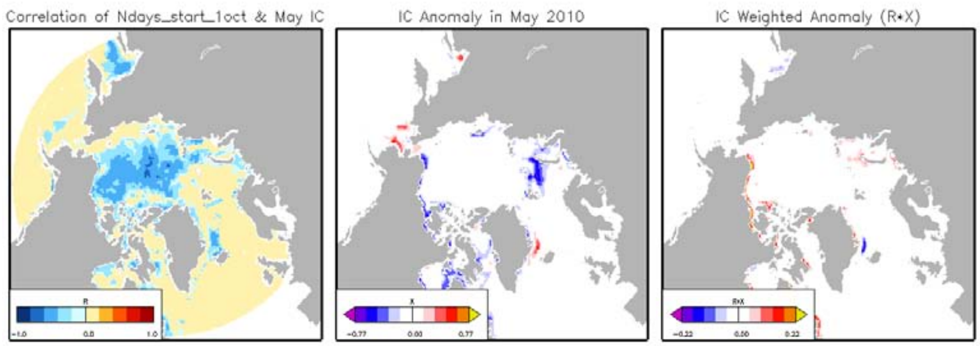

Ndays_ice_free
Predictor: IC
Prediction: 94. +/- 21.
R^2 of Fit = 0.60
Fit
Predicted
Observed
Trend
Ndays_ice_free
100
80
60
40
20
0
1980
1990
2000
2010
Year

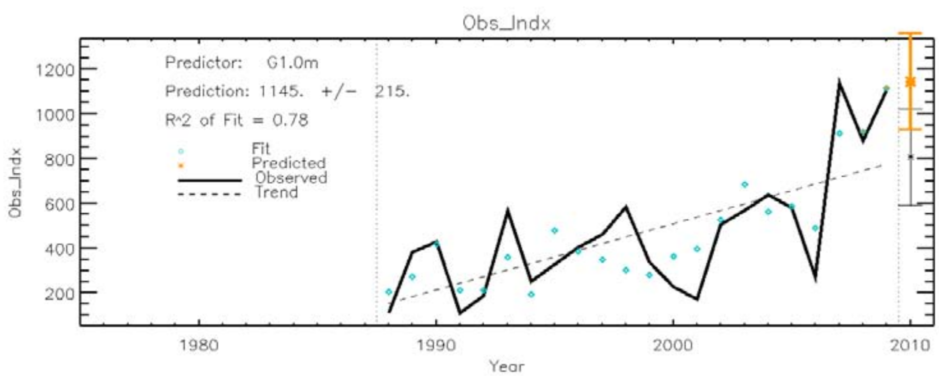

Correlation of Ndays_ice_free & May IC
IC Anomaly in May 2010
IC Weighted Anomaly (R*X)

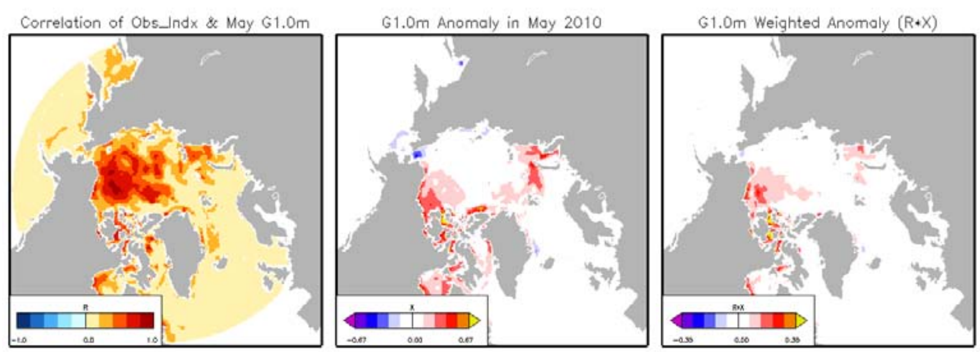

Ndays_ice_05
Predictor: IC
Prediction: 114. +/- 24.
R^2 of Fit = 0.58
Fit
Predicted
Observed
Trend
Ndays_ice_05
120
100
80
60
40
1980
1990
2000
2010
Year

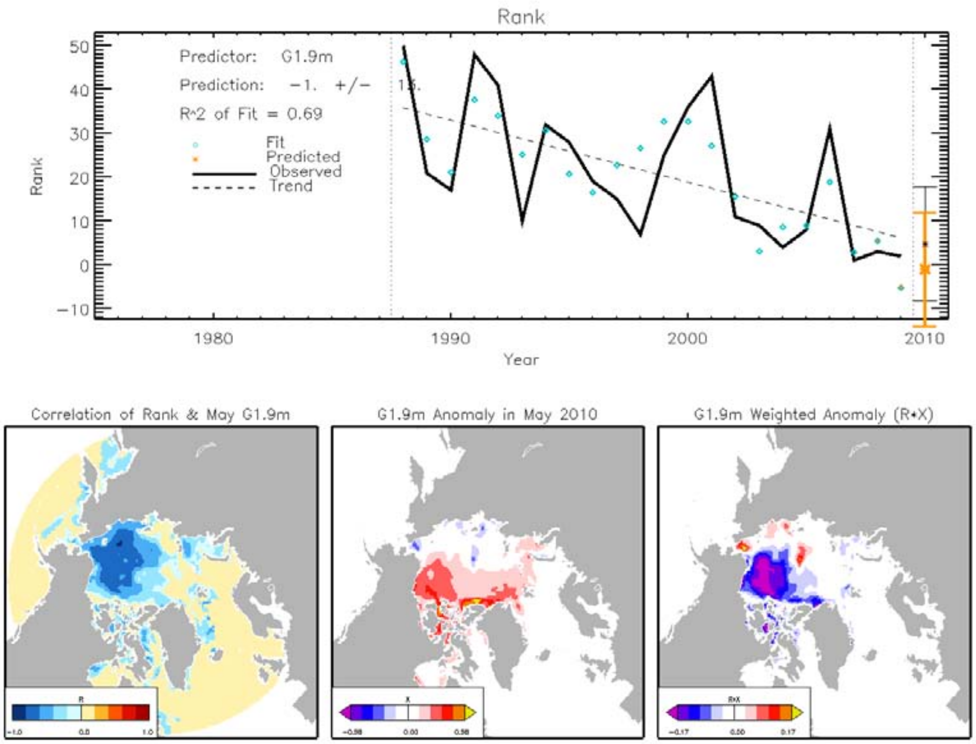

Correlation of Ndays_ice_05 & May IC
IC Anomaly in May 2010
IC Weighted Anomaly (R*X)


Ndays_start_1oct
Predictor: IC
Prediction: 90. +/- 12.
R^2 of Fit = 0.63
Fit
Predicted
Observed
Trend
Ndays_start_1oct
Year
1980
1990
2000
2010
50
60
70
80
90


Correlation of Ndays_start_1oct & May IC
IC Anomaly in May 2010
IC Weighted Anomaly (R*X)


Obs_Indx
Predictor: G1.0m
Prediction: 1145. +/- 215.
R^2 of Fit = 0.78
Fit
Predicted
Observed
Trend
Obs_Indx
Year
1980
1990
2000
2010
200
400
600
800
1000
1200


Correlation of Obs_Indx & May G1.0m
G1.0m Anomaly in May 2010
G1.0m Weighted Anomaly (R*X)


Rank
Predictor: G1.9m
Prediction: −1. +/−
R^2 of Fit = 0.69
Fit
Predicted
Observed
Trend
Rank
50
40
30
20
10
0
−10
1980
1990
2000
2010
Year
Correlation of Rank & May G1.9m
G1.9m Anomaly in May 2010
G1.9m Weighted Anomaly (R*X)
-1.0
0.0
1.0
-0.98
0.00
0.98
-0.17
0.00
0.17