Pre-Season Forecast: Pan-Arctic and Regional September 2010 Sea Ice Area

Overview

May 2010

Below is a "pre-season" forecast for pan-arctic and regional September sea ice area, provided by Adrienne Tivy (mailto:ativy@iarc.uaf.edu) , a post-doctoral fellow at the International Arctic Research Center (IARC).

This outlook is a statistical forecast, which relies on empirical relationships between pre-season climate variables and the variable being predicted—in this case, September sea ice area. The 2010 forecast results are summarized in Table 1.

Pan-arctic ice area is expected to be greater than in 2009 but still remain below normal. Regionally, increases in ice area compared to 2009 are expected in the Beaufort/Chukchi Seas, the East Siberian/Laptev Seas, the Barents/Kara Seas, and the Central Arctic Ocean. Decreases in ice area compared to 2009 are expected in the Greenland Sea and the Canadian Arctic Archipelago.

Location/Region	September Ice Area (million square kilometers)	
	2009 actual	2010 forecast
Pan-Arctic	3.730 Below Normal	4.539 Below Normal
Beaufort/Chukchi Seas	0.530 Below Normal	0.803 Below Normal
East Siberian/Laptev Seas	0.226 Below Normal	0.380 Below Normal
Barents/Kara Seas	0.049 Below Normal	0.164 Near Normal
Greenland Sea	0.185 Near Normal	0.095 Below Normal
Canadian Arctic Archipelago	0.220 Below Normal	0.172 Below Normal
Central Arctic Ocean (> 85N)	2.504 Near Normal	2.59 Below Normal

(http://www.arcus.org/files/page/images/639/table1.gif)

Table 1. Categorical and deterministic forecasts of September ice area for 2010; the actual ice area for 2009 is shown for comparison.

Model Details

The pan-arctic (Figure 1, below) and regional forecasts (Figures 3 to 8, below) for September ice area were generated from simple linear regression models. This statistical approach follows work done by Drobot et al. (2006, 2003) for forecasting the Beaufort Severity Index and the September minimum ice extent.

The predictors were chosen using an automated selected scheme (Tivy et al., 2007) based in part on step-wise regression and where the maximum number of predictors is restricted to two. Predictors included in the original predictor pool are: Sea Ice (Northern Hemisphere ice concentration, Northern Hemisphere multi-year ice concentration); Ocean (Near-global sea surface temperature, ENSO, PDO); and Atmosphere (Northern Hemisphere z500, Pan-Arctic [north of 60N] SAT and SLP, teleconnection indices). Each predictor was tested at lags ranging from 5 to 18 months. The models are trained on the 27-year period from 1981–2006. Independent forecasts were generated for 2007–2010. The 2010 forecast is expressed both categorically and deterministically (Table 1).

Pan-Arctic Forecast

The predictor for pan-arctic (northern hemisphere) September ice area is the preceding summer (May-June-July) sea surface temperature in the North Atlantic and North Pacific close to the marginal ice zone (14-month lag), where warm sea surface temperature (SST) anomalies are associated with reduced ice area. The regression r^2 and cross-validated r^2 are 0.83 and 0.78 respectively; the categorical forecast skill over the training period is 81%. While the model over-estimated ice area for the three independent forecast years (2007–2009), the categorical forecasts of below normal ice area were correct for each year.

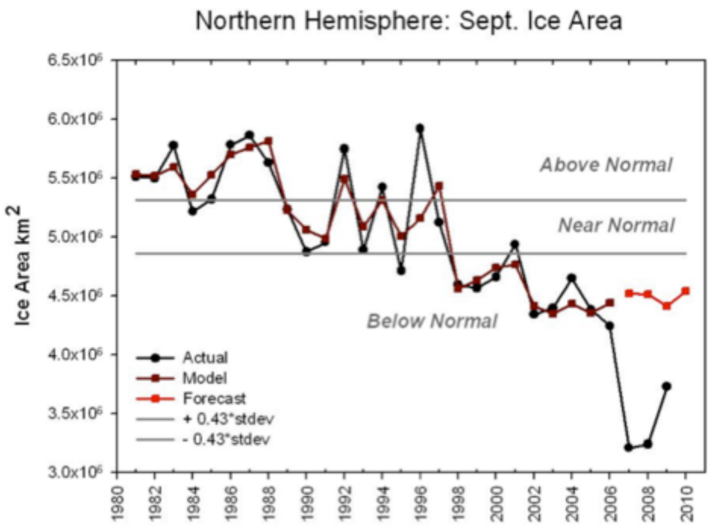

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Figure 1. Regression-based forecast for the 2010 pan-arctic September ice area. The model is trained on the 27-year period from 1981–2006 (dark red) and independent forecasts were generated for 2007–2010 (red); actual values are shown in black. The 2010 forecast is expressed both categorically, Below Normal, and deterministically, 4.539 million square kilometers.

Regional Forecasts

Six regional forecasts were completed for the following regions: Beaufort/Chukchi Seas, East Siberian/Laptev Seas, Barents/Kara Seas, Greenland Sea, Canadian Arctic Archipelago, and Central Arctic Ocean (> 85N).

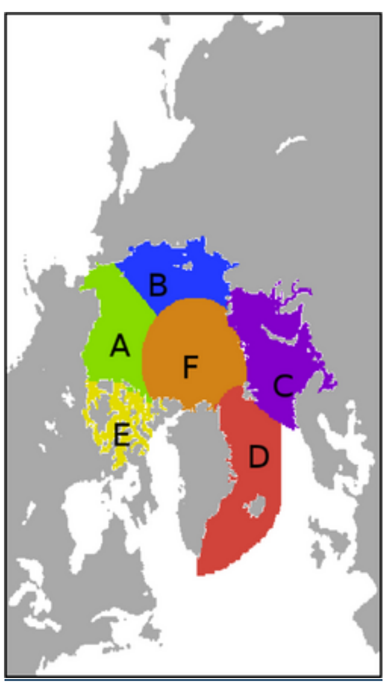

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Figure 2. Locator map of regional forecast areas; A – Beaufort/Chukchi Seas; B – East Siberian/Laptev Seas; C – Barents/Kara Seas; D – Greenland Sea; E – Canadian Arctic Archipelago; F – Central Arctic Ocean (>85N).

Beaufort/Chukchi Sea

The main predictor is winter (Dec-Jan-Feb) air temperature over the Beaufort Sea, Alaska and the Canadian High Arctic (7-month lag), where warm surface air temperature (SAT) anomalies are associated with reduced ice area. The regression r^2 and cross-validated r^2 are 0.79 and 0.69 respectively; the categorical forecast skill over the training period is 77%. The model over-estimated ice area for the three independent forecast years (2007–2009), the model incorrectly predicted near normal years for 2007 and 2008 but correctly predicted 2009 as below normal.

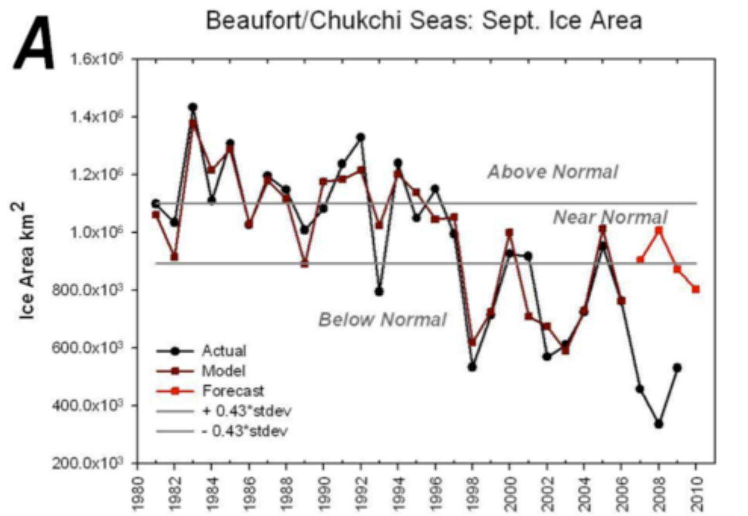

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Figure 3. Regression-based forecast for the 2010 Beaufort/Chukchi Seas September ice area. The model is trained on the 27-year period from 1981–2006 (dark red) and independent forecasts were generated for 2007–2010 (red); actual values are shown in black. The 2010 forecast is expressed both categorically, Below Normal, and deterministically, 0.803 million square kilometers.

East Siberian/Laptev Seas

The main predictor is summer (Aug-Sept-Oct) sea surface temperature in the North Atlantic (10-month lag), where warm SST anomalies are associated with reduced ice area. The regression r^2 and cross-validated r^2 are 0.62 and 0.56 respectively; the categorical forecast skill over the training period is 69%. While the model over-estimated ice area for the three independent forecast years (2007–2009), the categorical forecasts of below normal ice area were correct for two of the three years.

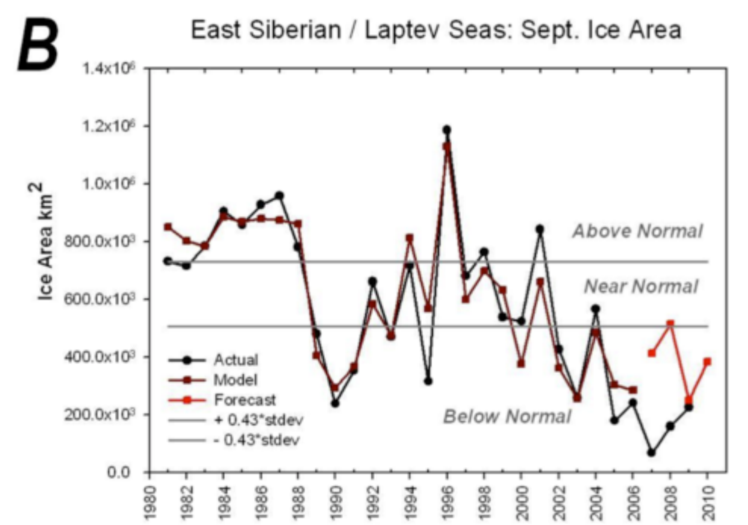

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Figure 4. Regression-based forecast for the 2010 East Siberian/Laptev Seas September ice area. The model is trained on the 27-year period from 1981–2006 (dark red) and independent forecasts were generated for 2007–2010 (red); actual values are shown in black. The 2010 forecast is expressed both categorically, Below Normal, and deterministically, 0.380 million square kilometers.

Barents/Kara Seas

The main predictor is winter (Jan-Feb-Mar) sea level pressure over the Kara and Laptev Seas (6-month lag), where high sea level pressure (SLP) anomalies are associated with increased ice area. The regression r^2 and cross-validated r^2 are 0.72 and 0.65 respectively; the categorical forecast skill over the training period is 69%. The model over-estimated ice area for the three independent forecast years (2007-2009), the model incorrectly predicted near normal ice area for 2007 and 2009 but correctly predicted 2008 as below normal.

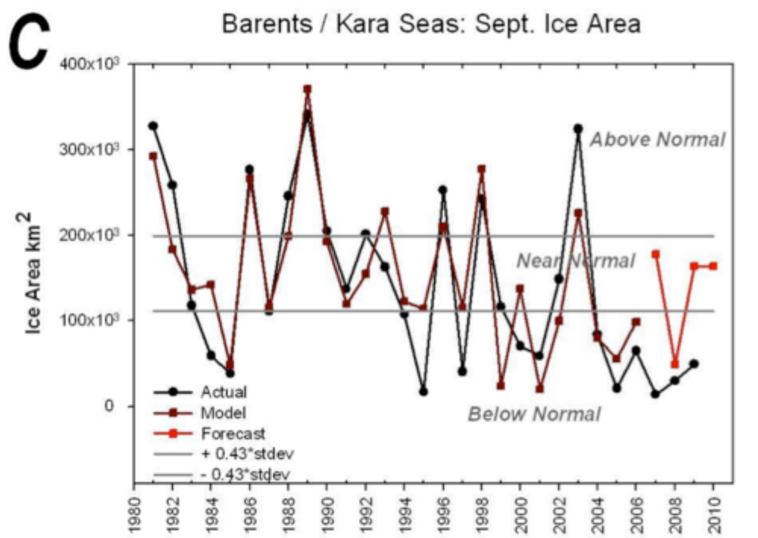

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Figure 5. Regression-based forecast for the 2010 Barents/Kara Seas September ice area. The model is trained on the 27-year period from 1981–2006 (dark red) and independent forecasts were generated for 2007–2010 (red); actual values are shown in black. The 2010 forecast is expressed both categorically, Near Normal, and deterministically, 0.164 million square kilometers.

Greenland Sea

The main predictor is fall (Sept-Oct-Nov) sea surface temperature in the North Atlantic (9-month lag), where warm SST anomalies are associated with reduced ice area. The regression r^2 and cross-validated r^2 are 0.62 and 0.44 respectively; the categorical forecast skill over the training period is 58%. The model under-estimated ice area for the three independent forecast years (2007-2009), the model incorrectly predicted below normal ice area for 2007 and 2009 but correctly predicted 2008 as below normal.

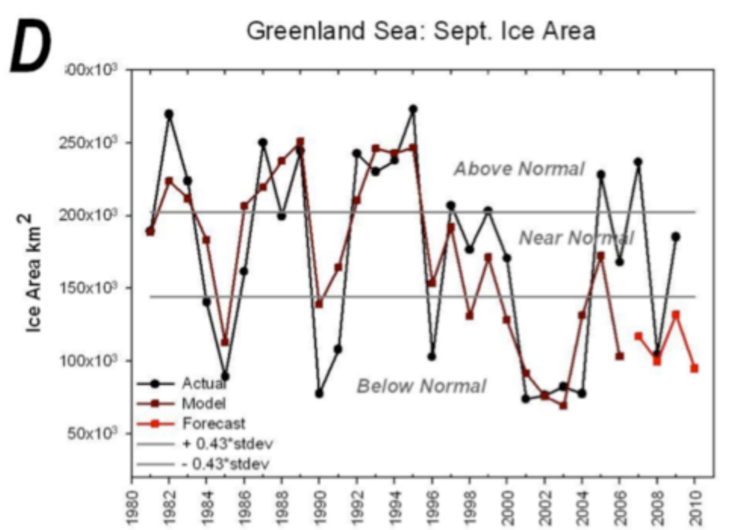

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Figure 6. Regression-based forecast for the 2010 Greenland Sea September ice area. The model is trained on the 27-year period from 1981–2006 (dark red) and independent forecasts were generated for 2007–2010 (red); actual values are shown in black. The 2010 forecast is expressed both categorically, Below Normal, and deterministically, 0.095 million square kilometers.

Canadian Arctic Archipelago

The main predictor is summer (May-June-July) multi-year ice (MYI) concentration in the Beaufort Sea (14-month lag), where increased MYI concentrations are associated with increased ice area. The regression r^2 and cross-validated r^2 are 0.6 and 0.56 respectively; the categorical forecast skill over the training period is 58%. The model incorrectly predicted near normal ice area for 2007 and below normal ice area for 2009 but correctly predicted 2008 as below normal.

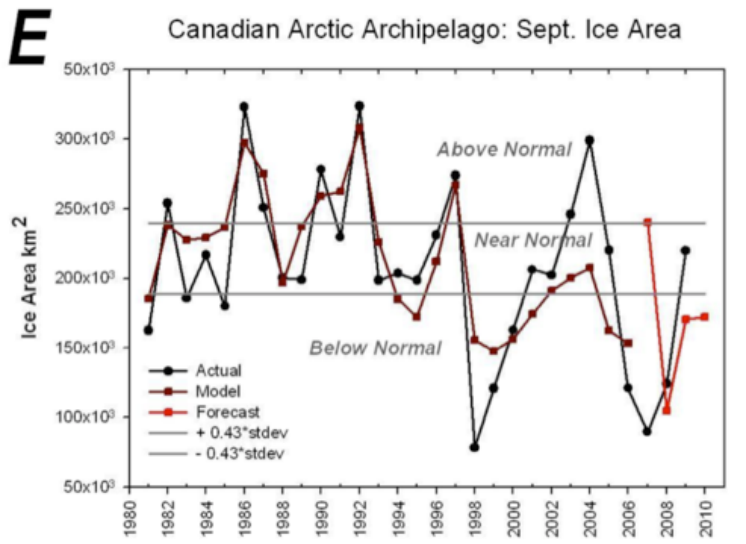

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Figure 7. Regression-based forecast for the 2010 Canadian Arctic Archipelago September ice area. The model is trained on the 27-year period from 1981–2006 (dark red) and independent forecasts were generated for 2007–2010 (red); actual values are shown in black. The 2010 forecast is expressed both categorically, Below Normal, and deterministically, 0.172 million square kilometers.

Central Arctic Ocean

The main predictor is preceding spring (March-April-May) multi-year ice (MYI) concentration in the Greenland Sea (17-month lag), where increased MYI concentrations are associated with increased ice area. The regression r^2 and cross-validated r^2 are 0.79 and 0.73 respectively; the categorical forecast skill over the training period is 65%. While the model over-estimated ice area for the 3 independent forecast years (2007–2009), the categorical forecasts of below normal ice area were correct for each year.

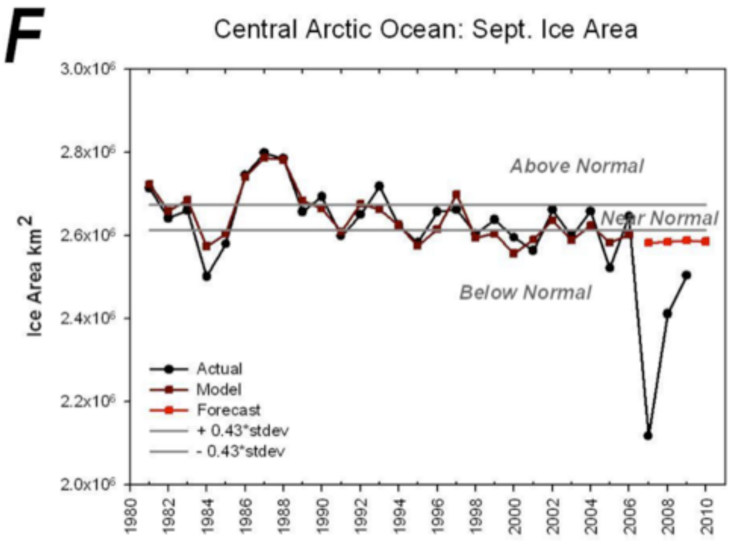

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Figure 8. Regression-based forecast for the 2010 Central Arctic Ocean September ice area. The model is trained on the 27-year period from 1981–2006 (dark red) and independent forecasts were generated for 2007–2010 (red); actual values are shown in black. The 2010 forecast is expressed both categorically, Below Normal, and deterministically, 2.59 million square kilometers.

References and Acknowledgements

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