Canadian Ice Service Contribution

to the

September 2010 Sea Ice Outlook

The Canadian Ice Service (CIS) is predicting the minimum Arctic sea ice extent to be less than 5 million square kilometres in September, 2010. A value equal to or slightly greater than the average extent observed in September, 2008, is expected. This value ($4.7 \leq x < 5.0$ million square kilometres) will make the Arctic sea ice extent in September, 2010, the third lowest in the 1979-2010 record. This value lies well below the average September extent for 1979-2009 of 6.63 million square kilometres based on the NSIDC sea ice index.

The above CIS value was derived empirically, based on the following: Although the extent of the Arctic Ocean multi-year ice pack at the beginning of May, 2010, was greater than the extents witnessed at the beginning of May in 2007, 2008 and 2009 (the result of new areas of second and third year ice), multi-year ice floe concentrations within the pack in 2010 were less than those of previous years (the result of extensive fracturing and the repeated formation of large open water leads within the multi-year ice pack during the winter months of 2010). The extensive fracturing that occurred within the Arctic Ocean multi-year ice pack in the winter of 2010 was the result of: 1) a delayed freeze-up and warmer than normal winter temperatures (which averaged 2-5°C warmer than normal during January to March over the area); and 2) persistent periods of east-northeasterly winds associated with generally higher than normal sea level pressures near the North Pole and a generally negative January-March Arctic Oscillation Index (which led to large ice flow divergences within the MY ice pack along the northwest coasts of the Canadian Arctic Islands). Taking the above into consideration, the operational staff at CIS are predicting a 2010 summer sea ice minimum extent similar to but slightly greater than that of 2008.

CIS is also currently testing two models for long-range sea ice prediction. A Multiple Linear Regression (MLR) prediction system, that tests ocean, atmosphere and sea ice predictors, predicts a September, 2010, Arctic sea ice extent of 5.7 million square kilometres. An Optimal Filtering based model (OFBM) applied to the ice extent time-series predicts 4.9 million square kilometres. The average of these model predictions, 5.3 million square kilometres, represents an extreme upper limit of the empirically determined range of values 4.7 to 5.0 million square kilometres. CIS will be continuing its verification studies of the predictions produced by these models in the coming years. In 2009, the OFBM model under-predicted the sea ice extent at 4.2 million square kilometres, while the MLR model over-estimated it at between 5.5 and 6 million square kilometres. However, the average of the two models corresponded well with the empirically determined forecast of 5.0 million square kilometres, both of which did better than all the other predictions submitted to SEARCH in June 2009.

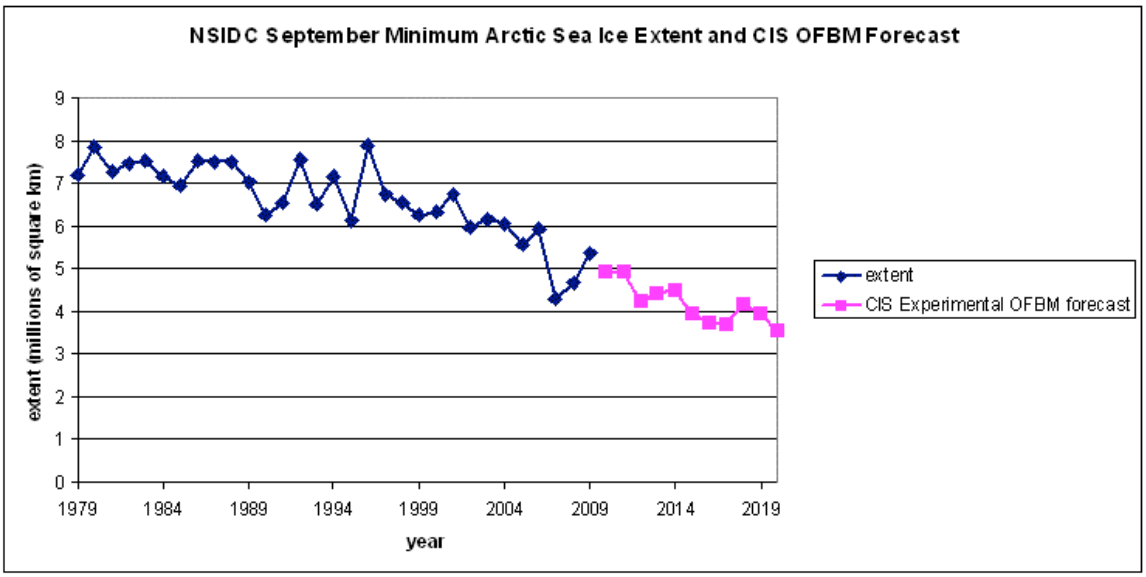

Figure 1. The Optimal Filtering Based model (OFBM) forecast for 2010-2020. The **2010 forecast** is **$4.9*10^6$ km^2**.

Model Details

Details of the OFBM used here, as well as the model code, can be found in Chapter 13, section 6, of Numerical Recipes in Fortran 77, 2nd Ed. (1992).

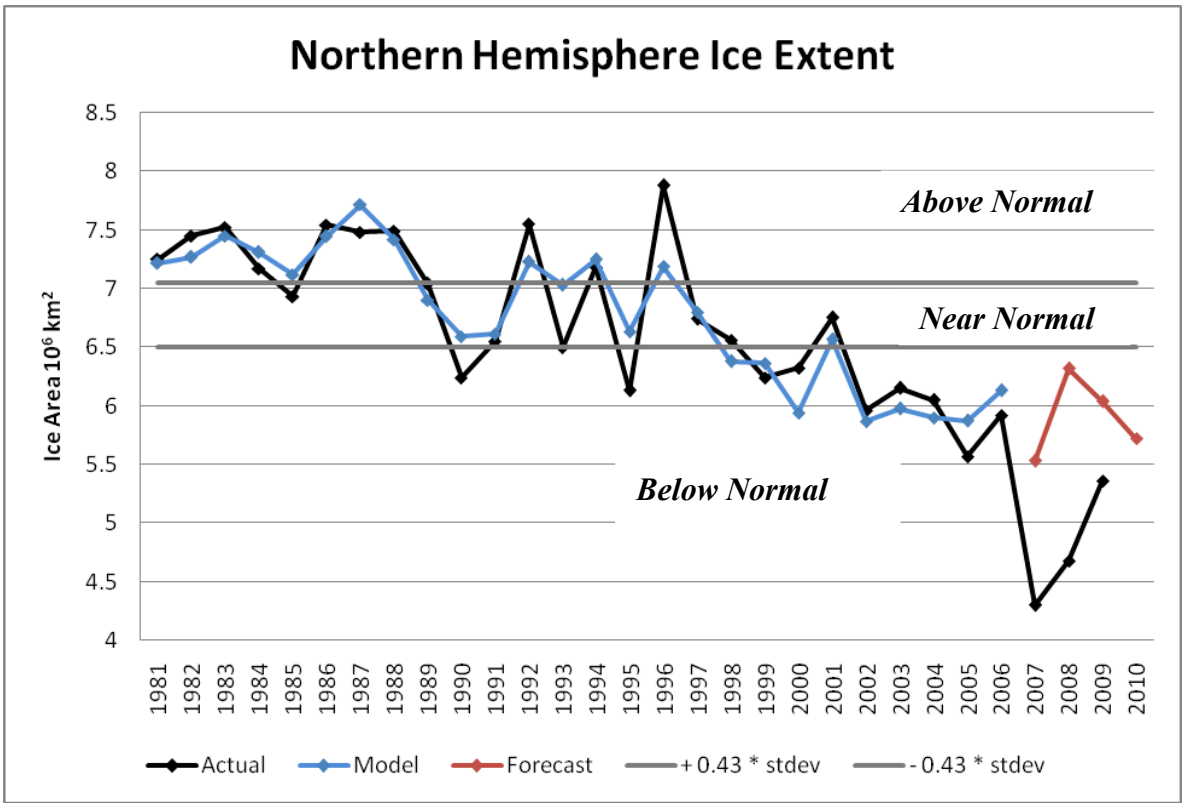

Figure 2. Regression based forecast for the 2010 September Ice Extent. The model is trained on the 27-year period from 1981-2006. Independent forecasts were generated for 2007–2010. The **2010 forecast** is expressed both categorically, **Below Normal**, and deterministically, **$5.7*10^6$ km^2**.

Model Details

The regression model is generated using an automated selection scheme (Tivy et al., 2007) based in part on step-wise regression and where the maximum number of predictors is restricted to two. The predictor for northern hemisphere September ice extent is the preceding summer (May-June-July) sea surface temperature in the North Atlantic and North Pacific close to the marginal ice zone, which represents a 14-month lag. The regression r^2 and cross-validated r^2 are 0.82 and 0.78 respectively; the categorical forecast skill over the training period is 80%. While the model over-estimated ice extent for the 3 independent forecast years (2007-2009), the categorical forecasts of below normal ice extent were correct for each year and 2007 is an extreme minimum in the model time-series. Predictors in the original predictor pool included: 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.

Tivy, A., B. Alt, S.E.L. Howell, K. Wilson, and J.J Yackel. (2007). Long-range prediction of the shipping season in Hudson Bay: A statistical approach. Weather and Forecasting, 22, 1063–1075, doi:10.1175/WAF1038. WAF10