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2008 Sea Ice Minimum Summary Report

Recap of Predictions of September 2008 Arctic Sea Ice Extent
Our method uses estimates of ice thickness from a coupled ice-ocean model as predictors for a statistical forecast of the minimum ice extent in September. Fields of ice thickness (H), ice concentration (IC), area with less than 0.66 m thick ice (G1), and area with less than 1.94 m thick ice (G2) are the predictors considered in this forecast. The method is described in Lindsay et al (2008a). The model fields are collapsed to scalar time series by weighting each field with its correlation to the September ice extent (Drobot, 2006). A statistical model is then fit for the years 1987–2007. The performance of each predictor at each lead time is shown in Figure 1.

In retrospect the mean thickness H was the best predictor from almost all months but the error standard deviation of the prediction equation using H in past years was larger than for the G1 or G2 predictors. Ice concentration was a poor predictor in every month except August. The predictions from both G1 and G2 were correct to nearly within the error bars every month and one of the two was the best predictor each month. As might be expected, the area with less than 0.66 m of ice, G1, was the best predictor at shorter intervals, 1 to 3 months, while the area with less than 1.94 m of ice, G2, was better for longer intervals.

The main reason the ice extent was quite low in 2008 was that there were large areas of thin ice. Figure 2 shows the time series of each of the four predictors in March and August, along with the trend lines. There are two reasons why 2008 didn't quite match the ice record low extent of 2008: 1) thin ice was more extensive in the spring of 2007 than in 2008 and 2) the unusually persistent winds from the Pacific side of the basin that blew much of the ice to the opposite side in 2007 were absent in 2008. Note that, relative to the trend line, the March H, IC, G1, and G2 values all fully recovered during the winter from the extreme 2007 values.

As discussed in Lindsay et al (2008b) the linear trend accounts for much more of the variance of the mean ice thickness than for the variance of either the mean ice concentration or ice extent. The mean ice thickness in 2008 was nearer the linear trend line (1987–2007) than in 2007. So while the thickness in 2008 was the thinnest in the record except for 2007, it was quite consistent with the downward trend in the mean ice thickness in the basin over the last 21 years. The fact that 2008 sea ice extent did not establish another record minimum is thus consistent with our understanding that the 2007 sea ice record anomaly was established by a combination of long-term thinning and unusual wind patterns (Maslanik et al., 2007; Lindsay et al., 2008b; Zhang et al, 2008)

To improve predictions using a statistical approach such as the one we used would require a longer and more accurate record of the seasonal changes in the ice thickness distribution. Unfortunately that is only obtainable through models. New observations can't help much except for driving improvements in the models because they can't give a consistent record of the past behavior of the system. Perhaps a more problematic issue is that the statistical relationships between elements of the system are changing rapidly. Until a new stable regime is established and we can get an adequate number of sample years of this new regime, statistical methods of prediction will be limited in their accuracy. With nonstationary statistics the standard error of the fit over past years is not a good measure of the uncertainty in the prediction. Here the trend is our friend. It allows us to obtain some skill relative to climatology. The harder part is to predict the increasingly large deviations about the trend and to know when the trends are changing.

As the September ice extent and ice thickness decrease, they will be more subject to variable and unpredictable wind patterns earlier in the season, making the total ice extent more difficult to predict. More importantly, the summer ice extent in particular regions (where individuals can actually use the predictions for planning purposes) will be even harder to predict beyond what the trends suggest.

The 2008 observations reinforce our contention (Lindsay et al., 2008b) that the record minimum of 2007 was less just the damage left by a perfect storm of unusual winds, but more the result of a gradual erosion of the mean sea ice thickness over the past 20 years and the increasing abundance of thin young ice at the beginning of the melt season.

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.

Lindsay, R. W., J. Zhang, A. J. Schweiger, and M. A. Steele, and H. Stern, 2008b: Arctic sea ice retreat in 2007 follows thinning trend. *J. Clim*., in press.

Maslanik, J., C. Fowler, J. Stroeve, S. Drobot, J. Zwally, D. Yi, and W. Emery, 2007: A younger, thinner Arctic ice cover: Increased potential for rapid, extensive sea-ice loss, *Geophys. Res. Lett.,* 34, L24501, doi:10.1029/2007GL032043.

Zhang, J., R. Lindsay, M. Steele, A. Schweiger, 2008: What Drove the Dramatic Retreat of Arctic Sea Ice During Summer 2007? *Geophys. Res. Lett*., 35, L11505, doi:10.1029/2008GL034005.

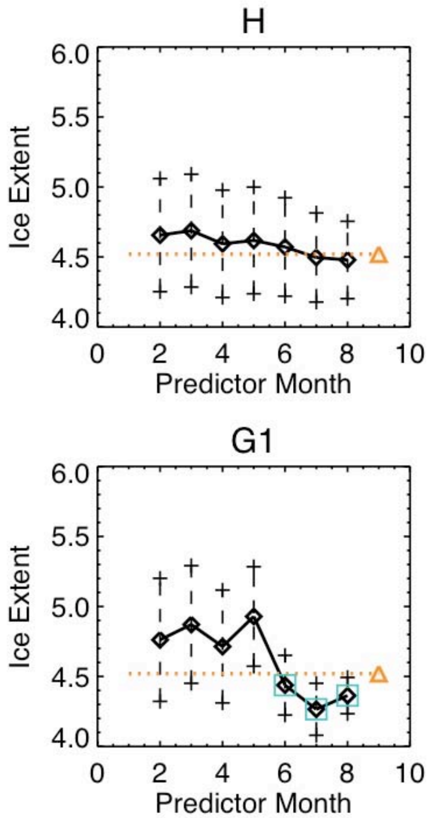

Figure 1. The performance of each predictor in 2008 in predicting the September minimum ice extent (in million sq km). The black lines show the prediction based on each of the four variables for each predictor month back to February. The dashed lines are the prediction uncertainties—the error standard deviations of the linear regression fit. The blue squares in the G1 and G2 plots show which variable of the four had the minimum prediction uncertainty in each month and hence the value chosen for the prediction at the end of each month. The orange triangle and dotted line is the observed minimum September ice extent (4.52 million sq km) from the NSIDC web site.

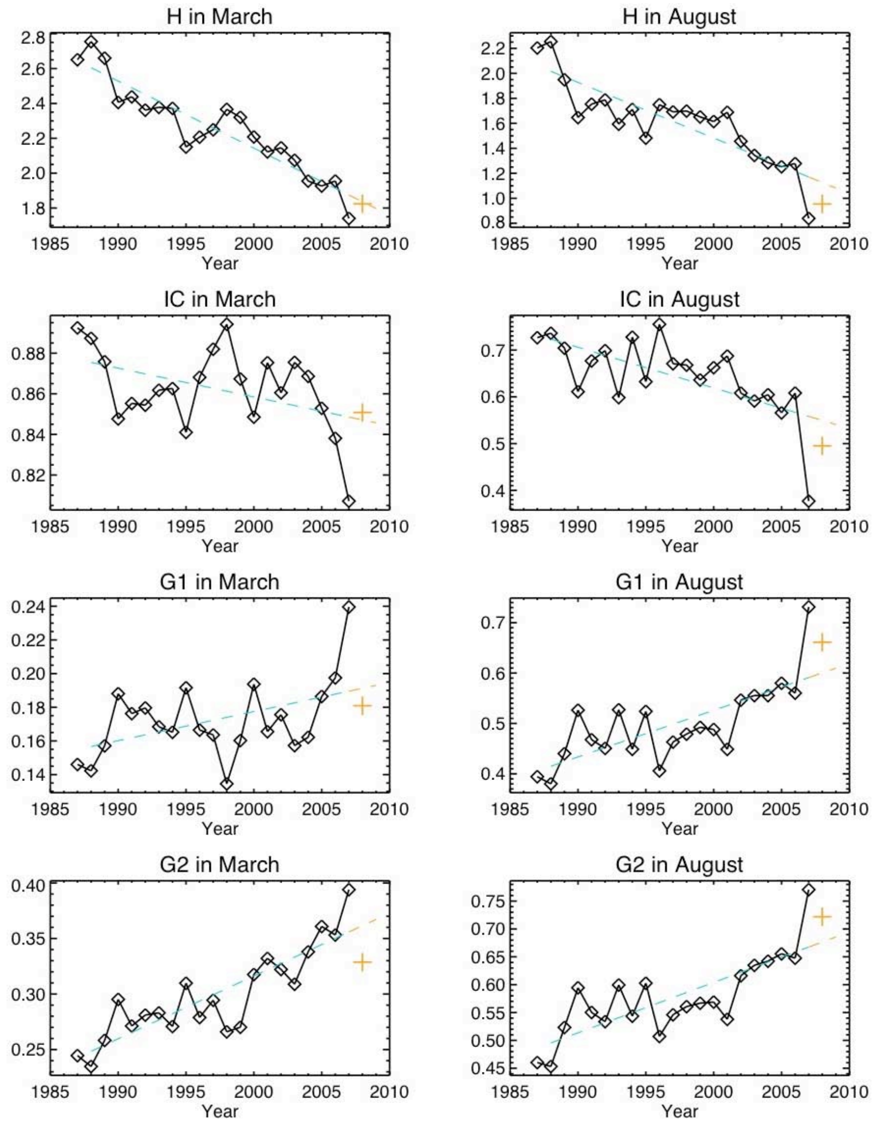

Figure 2. The simulated mean ice thickness H, ice concentration IC, area with less than 0.66 m thick ice, G1, and area with less than 1.94 m ice, G2, for the Arctic Ocean in March and August. The trend lines are computed for 1987–2007 and the extension of the trend is shown in orange along with the estimates for 2008 as an orange cross.