

Ensemble Predictions of September 2009 Arctic Sea Ice Conditions (Summary)

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Ensemble predictions were conducted as a part of community-wide Arctic Sea Ice Outlook for September 2009. The September 2009 mean sea ice extent is predicted to be 4.5 or 5.3 million square km when the ensemble prediction starts on the first day of July or September. The NSIDC reported that the September 2009 mean ice extent is 5.4 million square km, based on satellite observations. To illustrate the results, the September 2008 sea ice conditions predicted on 7/1 and 9/1 are presented, followed by a summary.

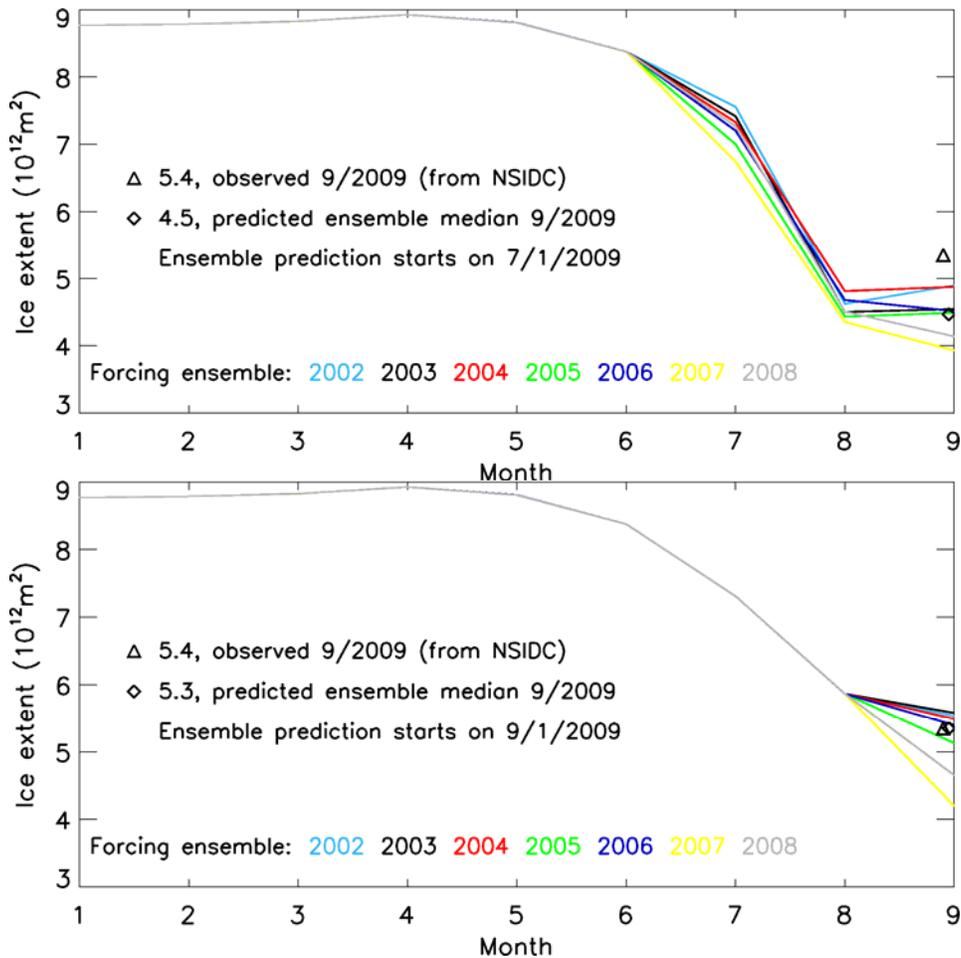


Figure 1. Monthly ice extent over January–September 2009 from seven ensemble members and their ensemble median for September 2009, with the starting date of prediction being 7/1 (upper) and 9/1 (lower). The ensemble median is considered to have a 50% probability of occurrence and the ensemble median ice extent for September 2009 is 4.5 million square kilometers when the prediction starts on 7/1 and 5.3 million square kilometers when the prediction starts on 9/1.

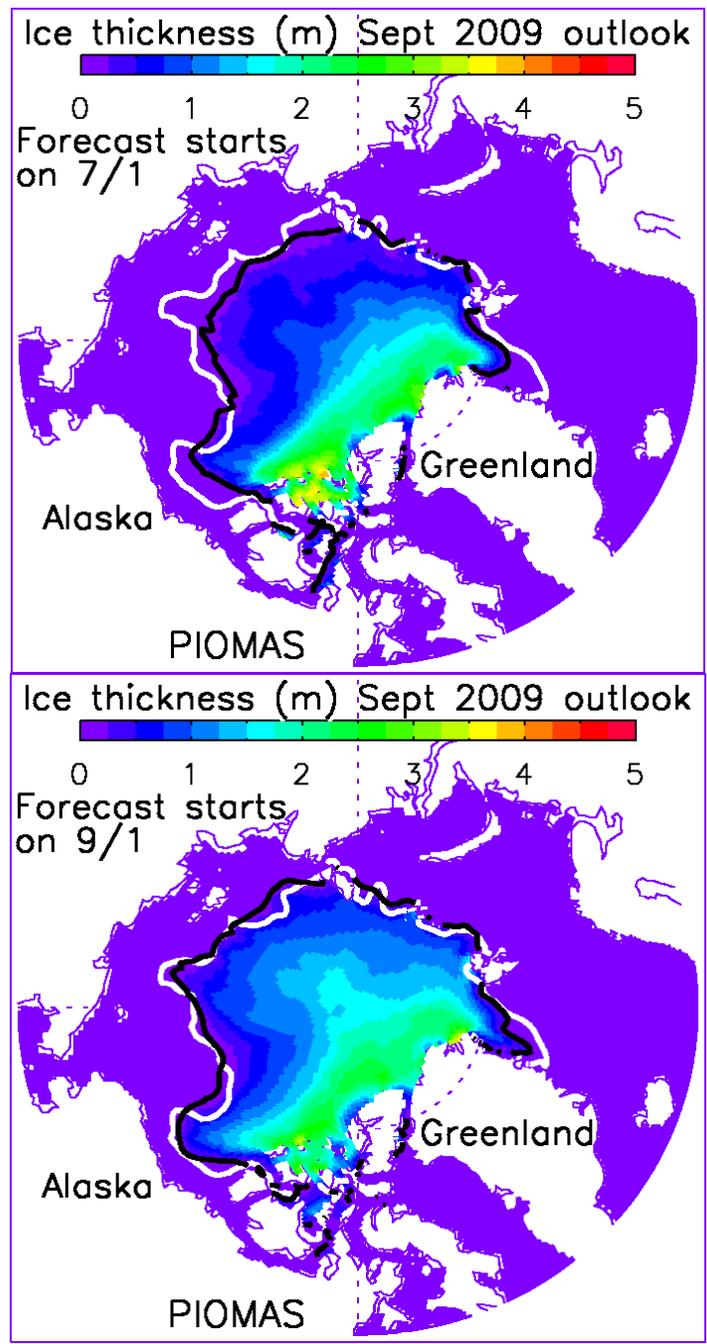


Figure 2. Ensemble predicted September 2009 sea ice thickness fields with two different starting dates of prediction. The white line represents satellite observed ice edge defined as of 0.15 ice concentration, while the black line model predicted ice edge.

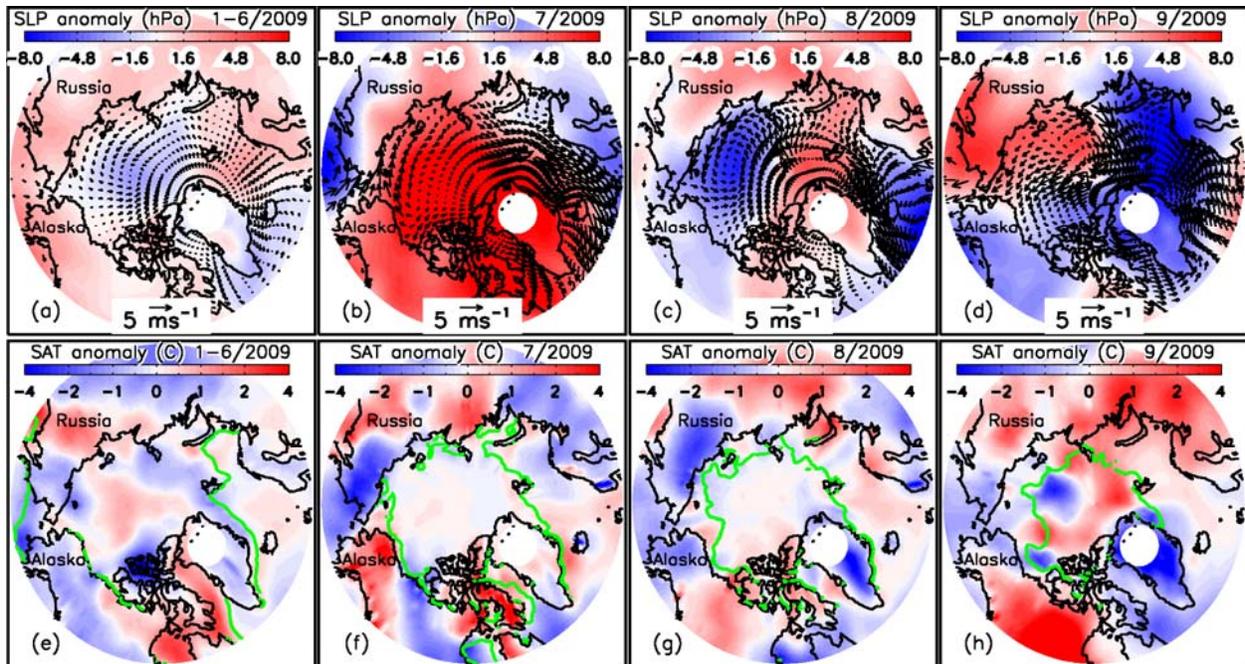


Figure 3. Anomalies of the NCEP/NCAR reanalysis sea level pressure (SLP) and surface wind (a–d) and surface air temperature (SAT) (e–h). An anomaly is defined as the difference between the 2009 value and the 2002–2008 average. The green line in (e–h) represents corresponding satellite observed ice edge.

Summary

- (1) With the starting date of prediction being 7/1, the area of the predicted ice extent is smaller than that of the observed (Figures 1 upper), but the shape of the predicted ice extent is close to that of the observed and in various areas the predicted ice edge is close to observed ice edge (Figure 2 upper). Thus the prediction is perhaps within the error tolerance in many areas, but not in other areas. The model has the tendency to under-predict September ice extent because the SAT over a large area in the Arctic Ocean is higher than the recent (2002–2008) climate during January through June (Figure 3e). This may explain why many of the participating groups also under-estimate the September ice extent when the ice conditions during January through June were taken into account heavily.
- (2) With the starting date of prediction being 9/1, the area of the predicted ice extent is very close to that of the observed (Figure 1 lower), and the predicted ice edge is mostly aligned closely with the observed ice edge (Figure 2 lower). This indicates that as the prediction range becomes shorter, realistic initial prediction conditions become important in capturing the size of the observed ice extent and the location of observed ice edge.
- (3) The scattering of the predicted ice extent values among the 7 ensemble members is not reduced as the starting date of prediction moves from 7/1 to 9/1 (Figure 1). This indicates that atmospheric and oceanic forcing affects the prediction outcome regardless of prediction range. Thus when the ice conditions in spring are used as an indicator of what

may happen several months later in September, there is a need to significantly raise the error bar considering the significant variability of weather/climate.

- (4) The under-prediction of September ice extent by the model with starting prediction date of 7/1 may be also attributed to the changes in the atmospheric circulation in August. In August, SLP is relatively low in the Pacific sector of the Arctic Ocean and relatively high in the European sector in comparison with the recent (2002–2008) climate, leading to a pattern of wind anomaly that tends to drive ice toward the East Siberian Sea (or to resist ice retreating from the East Siberian Sea) (Figure 3c). Because of the wind circulation pattern that tends to retain ice in part of the East Siberian Sea in August, the SAT there is slightly lower than the 2002–2008 mean (Figure 3g), which also tends to decelerate ice retreat in that area. In addition, the September wind and SAT pattern may also help resist ice retreat.

Information about ensemble predictions:

The ensemble predictions are based on a synthesis of a model, NCEP/NCAR reanalysis data, and satellite ice concentration data. The model is the Pan-arctic Ice-Ocean Modeling and Assimilation System (PIOMAS), which is forced by NCEP/NCAR reanalysis data. It is able to assimilate satellite ice concentration data. The ensemble consists of seven members each of which uses a unique set of NCEP/NCAR atmospheric forcing fields from recent years, representing recent climate, such that ensemble member 1 uses 2002 NCEP/NCAR forcing, member 2 uses 2003 forcing, ..., and member 7 uses 2008 forcing. Each ensemble prediction starts with the same initial ice–ocean conditions on the first day of a particular month in 2009. The initial ice-ocean conditions are obtained by a retrospective simulation that assimilates satellite ice concentration data. Of course, no data assimilation is performed during the predictions. More details about the prediction procedure can be found in Zhang et al. (2008).

Reference

Zhang, J., M. Steele, R.W. Lindsay, A. Schweiger, and J. Morison, Ensemble one-year predictions of arctic sea ice for the spring and summer of 2008. *Geophys. Res. Lett.*, 35, L08502, doi:10.1029/2008GL033244, 2008.
(http://psc.apl.washington.edu/zhang/Pubs/Zhang_etal2008GL033244.pdf)