

## September 2013 sea ice outlook (from July 1): Pan-arctic and Northwest Passage region

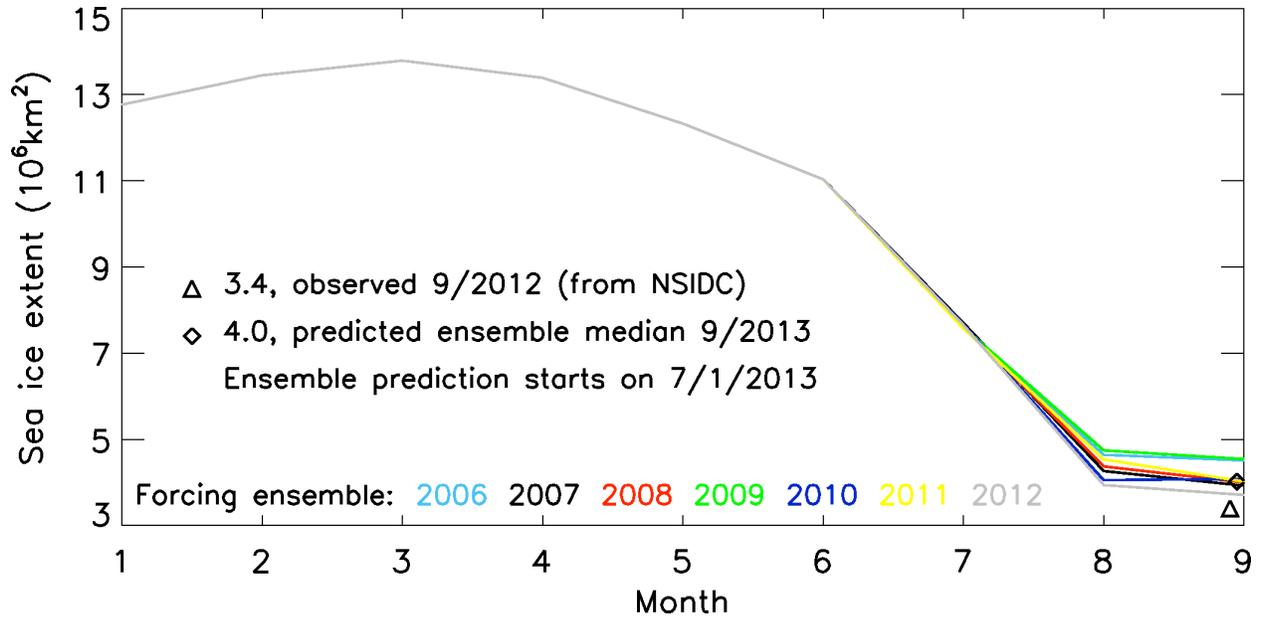
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**Pan-arctic outlook:** The September 2013 Arctic sea ice extent predicted from July 1, 2013 is **4.0 ± 0.5 million square kilometers** (Fig. 1). The predicted ice extent is greater in 2013 than in 2012 in both the western Arctic (mainly in the Beaufort Sea) and the eastern Arctic (Fig. 2).

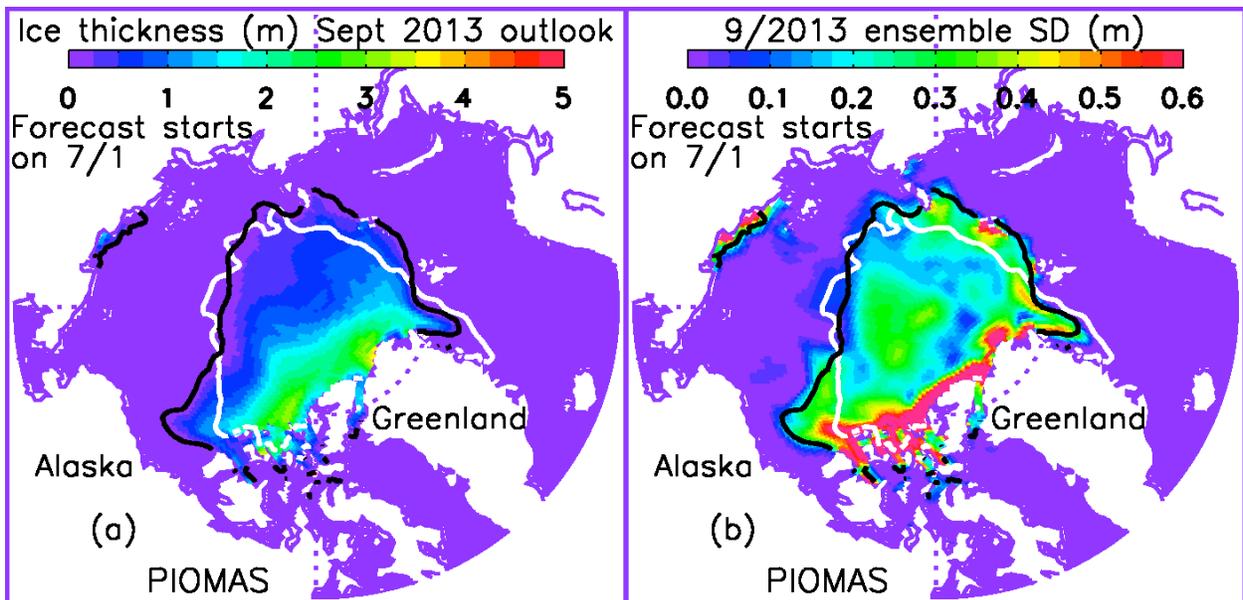
These results are obtained from a numerical ensemble seasonal forecasting system. The forecasting system is based on a synthesis of a model, the NCEP/NCAR reanalysis data, and satellite observations of ice concentration and sea surface temperature. The model is the **Pan-Arctic Ice-Ocean Modeling and Assimilation System (PIOMAS, Zhang and Rothrock, 2003)**. 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 2006 NCEP/NCAR forcing, member 2 uses 2007 forcing ..., and member 7 uses 2012 forcing. These seven ensembles of the reanalysis atmospheric forcing fields, which incorporate a range of observations, may capture the climate variability expected in 2013. Each ensemble prediction starts with the same initial ice-ocean conditions on 7/1/2013. To obtain the “best possible” initial ice-ocean conditions for the forecasts, we conducted a retrospective simulation using PIOMAS that assimilates satellite ice concentration and sea surface temperature data. More details about the ensemble prediction procedure can be found in Zhang et al. (2008).

In addition, sea ice thickness data from three different projects were used to correct the PIOMAS sea ice thickness distribution estimates for 1 April 2013. The data were collected between 21 March and 24 April. These projects were the NASA mission Operation IceBridge which collected sea ice freeboard and snow depth data across broad regions of the Beaufort and Chukchi seas and the Canadian Basin (data courtesy of Nathan Kurtz), the Beaufort Regional Environmental Assessment (BREA) which collected airborne electromagnetic measurements of the ice plus snow thickness near Banks Island (data courtesy of Christian Haas), and the Seasonal Ice Zone Observing Network (SIZONet) which collected airborne EM data near Barrow (data courtesy of Stephan Hendricks). The point data were clustered into 50-km averages and thickness distributions. The distributions were then merged with the PIOMAS estimates using optimal interpolation (Lindsay et al, 2012). With the model ice thickness distribution on 1 April being corrected by the observed ice thickness distribution, the model was integrated from 1 April to 1 July using the NCEP/NCAR reanalysis data from April through June of this year. Then the model was integrated from 1 July through 31 October 2013 using reanalysis data from the last seven summers to create an ensemble of seven predictions. The reported ice extent is the median of the seven estimates of the September mean extent.

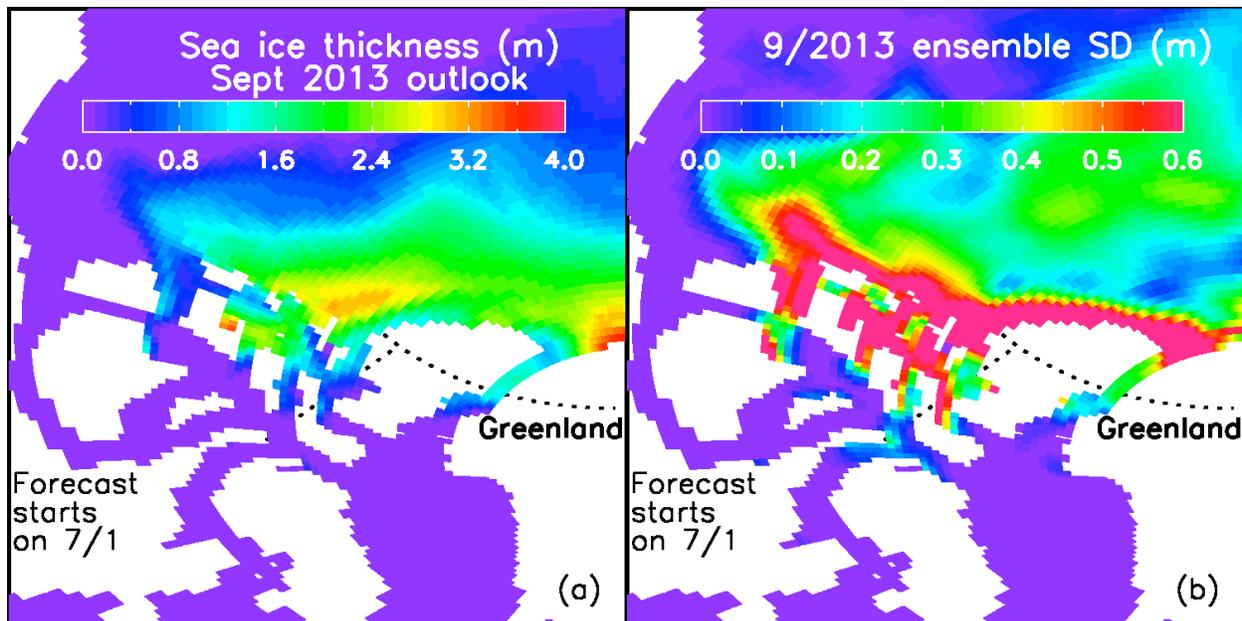
**Outlook for the Northwest Passage region:** The Northwest Passage (NWP) is predicted to be open fully in September 2013 (Fig. 3a). The prediction shows some thin ice in part of the Prince of Wales Strait, but with significant uncertainty there as reflected in the standard deviation field (Fig. 3b).



**Figure 1.** Monthly evolution of Arctic sea ice extent from the seven ensemble members. The ensemble median of 4.0 million square km is considered to be the predicted value of Arctic sea ice extent for September 2013.



**Figure 2.** (a) Ensemble median prediction of September 2013 mean sea ice thickness and edge location, and (b) ensemble standard deviation (SD) of ice thickness which shows the uncertainty of the prediction. The white line represents the satellite-observed mean September 2012 ice edge defined as the line of 0.15 ice concentration, while the black line is the model predicted September 2013 ice edge.



**Figure 3.** (a) Ensemble prediction of September 2013 sea ice thickness in the Northwest Passage region and (b) ensemble standard deviation (SD).

#### References:

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