Arctic Cap Nowcast Forecast System (ACNFS) end of summer 2013 Ice Extent Projection – August Report

Naval Research Laboratory, Stennis Space Center, MS

The NRL Ice Team consists of:

Pamela Posey[1], E. Joseph Metzger[1], Richard Allard[1], Ruth Preller[1], David Hebert[1], Alan Wallcraft[1], Michael Phelps[2] and Ole Martin Smedstad[3]

[1] Naval Research Laboratory, Stennis Space Center, MS
[2]Jacobs Technology Inc, Stennis Space Center, MS
[3]QinetiQ North America, Stennis Space Center, MS

Executive Summary

The ACNFS outlook for September ice extent is 4.14 Mkm^2 +/- 0.5 Mkm^2.

The skill of the Arctic Cap model run in forward mode for a season is not yet quantified.

Rationale

The Arctic Cap Nowcast Forecast System (ACNFS) was run in forward model mode, without assimilation, initialized with a July 1, 2013 analysis, for eight simulations using archived Navy atmospheric forcing fields from 2005-2012. The mean ice extent in September, averaged across all ensemble members, corrected for forward model bias is our projected ice extent. The standard deviation across the ensemble mean ice extents is an estimate of the uncertainty of our projection given we do not know the atmospheric conditions that will occur this summer. Please note, this is a developmental model that has not been fully validated in non-assimilative mode, but the assimilative system has been validated to provide an accurate ice forecast [Posey et al. 2010].

Introduction

The ACNFS, developed by the Oceanography Division of the Naval Research Laboratory (NRL), is a ~3.5 km coupled ice-ocean model, with assimilation of passive microwave ice concentration, which has been developed to produce 7 day forecasts of the Arctic sea ice state. Currently this system is being transitioned to operational use at the Naval Oceanographic Office. The system is configured, and validated, for it's capability in producing an accurate 7 day sea ice forecast.

The results presented in this report come with a 'health warning' that they are preliminary and additional work is required in validating the capability of this model for seasonal projections.

The Arctic Cap Nowcast-Forecast System

The ACNFS ocean component is the HYbrid Coordinate Ocean Model (HYCOM) [Metzger et al. 2010], and is coupled to the Los Alamos National Laboratory Community Ice CodE (CICE) [Hunke and Lipscomb 2008] via the Earth System Modeling Framework (ESMF). The ocean and ice models are run in an assimilative cycle with the Navy Coupled Ocean Data Assimilation (NCODA) system [Cumming 2005]. The system is run once per day, assimilating SSMI ice concentration into CICE to provide an initial condition for a 7 day forward model run (the forecast). Atmospheric forcing is provided by the Navy Operational Global Atmospheric Prediction System (NOGAPS) [Hogan et al. 1991]. Additional information on the system and its performance can be found in Posey et al. [2010].

Ensemble Model Runs for End of Summer Projection

The seasonal projection was made using an ensemble of forward model simulations. Eight model runs were made, using NOGAPS forcing from 2005 through 2012. Each model run was initialized with the same assimilative analysis field from July 1, 2013 (Fig. 1), and run forward for 3 months from July 1 for each specific year. This ensemble of eight members gives an indication of how sea ice can respond to variable atmospheric conditions during summer. Figure 2 shows examples of ice concentration for two ensemble members.

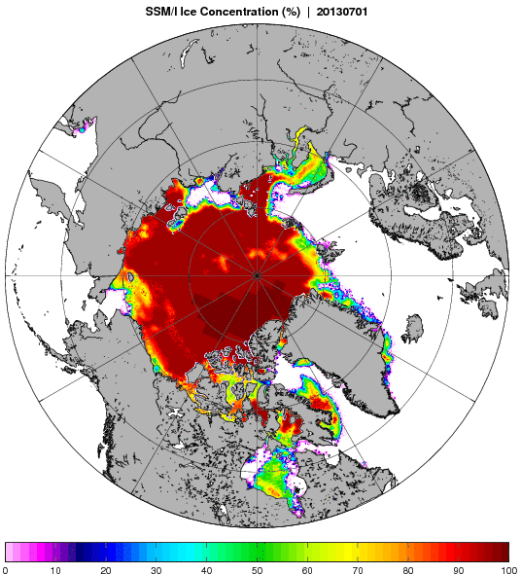

Figure 1: Ice concentration field (%), from SSMI/S valid July 1, 2013. This is the initial condition for each ensemble member

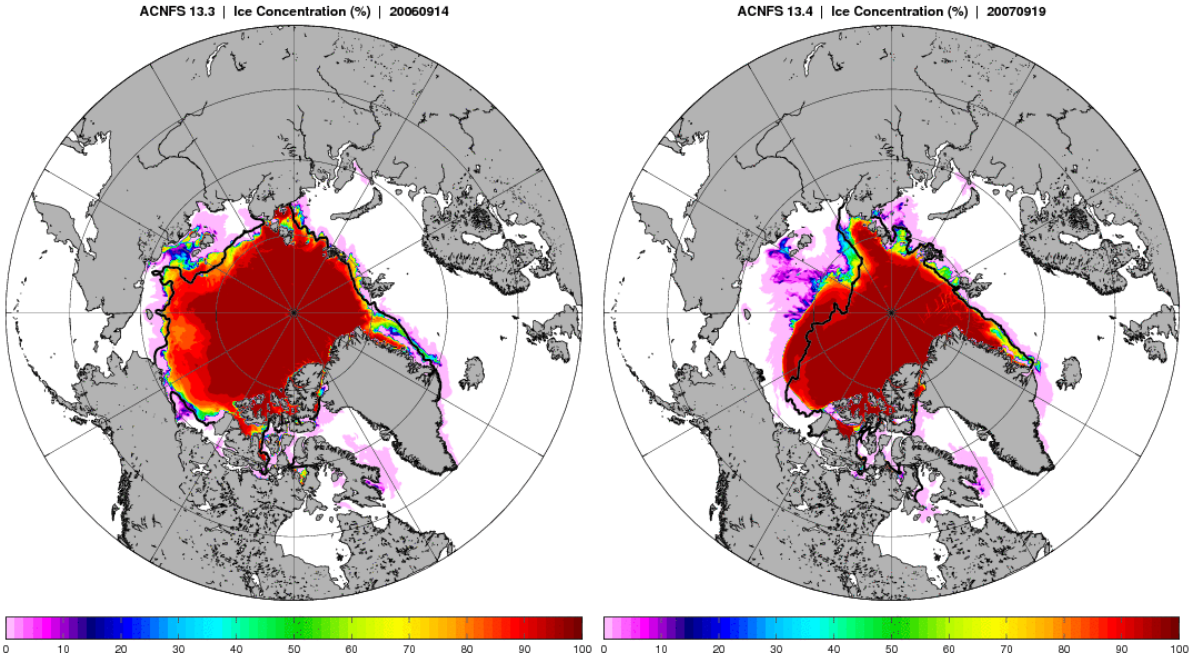

Figure 2: ACNFS ensemble ice concentration (%) on September 14, 2006 (left) and September 19, 2007 (right). The black line on the figures represents the ice edge provided in real time, i.e. in 2006 and 2007, by the National Ice Center for these actual days. These two simulations have the maximum and minimum projected ice extents out of the eight ensemble members, respectively.

Ice extent was calculated using all grid cells with at least 15% ice concentration and then averaged over each day in September. Ice extent averaged across all ensemble members during September is 6.04 Mkm^2, with a standard deviation of 0.5 Mkm^2. The ensemble appears to be doing a reasonable job of reproducing variability due to uncertainty in atmospheric forcing. The extent estimate, however, is high. We have applied a bias correction to our outlook to account for this bias. As ACNFS has been run in assimilative mode since Fall 2007, the analysis fields from the assimilative run are used to identify forward model biases in mean September ice extent. The ACNFS has demonstrated good skill at predicting ice extent, hence it is reasonable to use the assimilative run analysis fields as 'truth' for our bias correction estimate. A set of control runs for 2008 through 2012 were performed using the July 1 analysis for initial conditions. Comparing the control runs mean September ice extent to ACNFS analysis mean September 2008/2012 ice extent, an estimate of the forward model bias is -1.90 Mkm^2. As seen in Fig. 3, there is a spread in September ice extents between ensemble members. The mean of these values, 4.14 +/- 0.5 Mkm^2, represents the projected ice extent for September 2013.

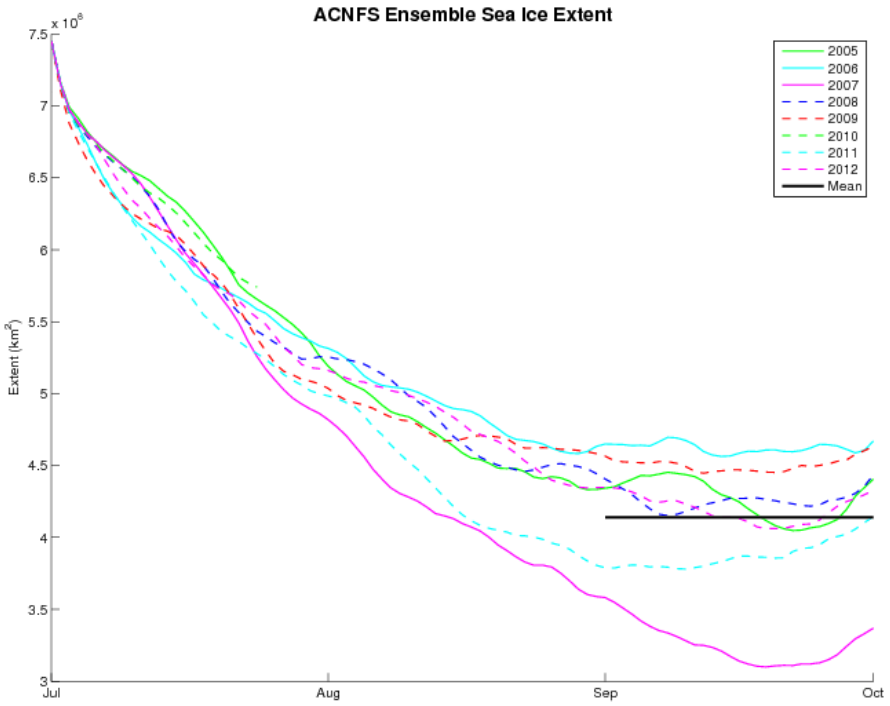

Figure 3: Time series of ice extent for each ensemble member. Black line represents the predicted September minimum ice extent of 4.14 Mkm^2.

Based on recent observations, the summer of 2013 is on track to represent a period more typical of the average minimum ice extent observed for the period 2000-2012. If the current trend continues, and the 2012 bias (using only 2008-2011) is removed, the September 2013 mean ice extent estimate would increase to 4.42 +/- 0.5 Mkm^2.

References

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