C31D-1552: Evaluating the impact of satellite-derived ice thickness initialization in predicting the September Arctic minimum sea ice extent

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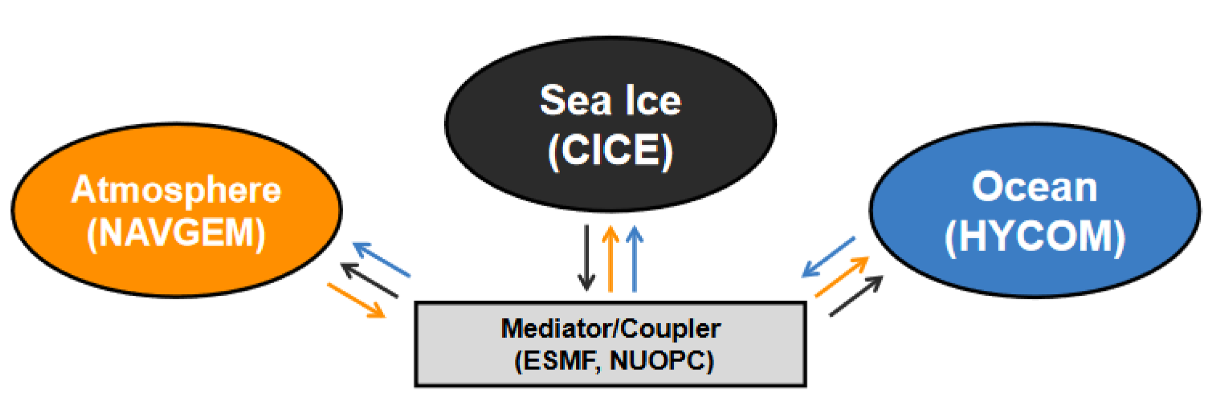
INTRODUCTION

A series of twin experiments are performed to predict the September 2018 minimum ice extent using the fully coupled Navy Earth System Model (NESM), which consists of the NAVy Global Environmental Model (NAVGEM), the HYbrid Coordinate Ocean Model, and the Community Ice CodE (CICE).

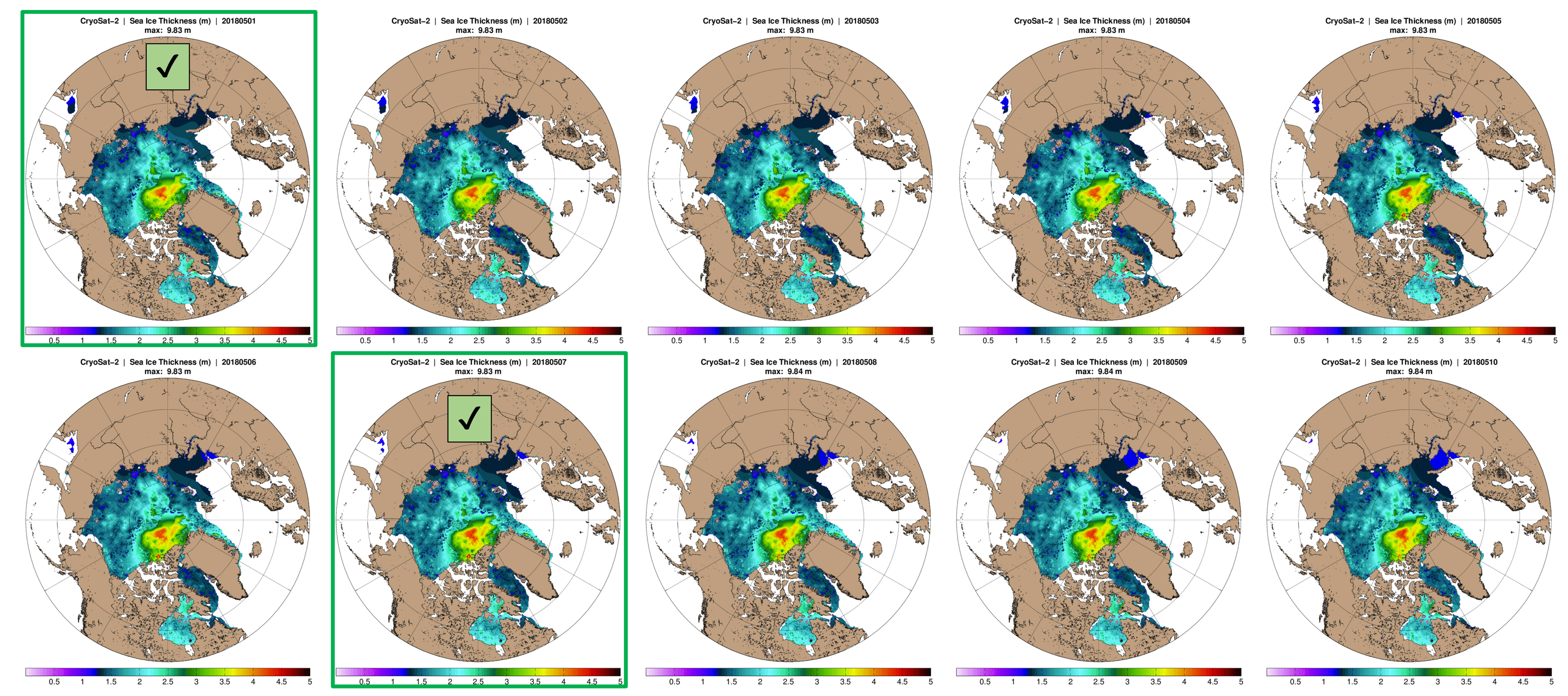
In the control run, ensemble forecasts are initialized from the operational US Navy Global Ocean Forecasting System (GOFS) 3.1 (Metzger et al., 2014) for the ocean and sea ice using the Navy Coupled Ocean Data Assimilation (NCODA, Cummings and Smedstad, 2013) system that assimilated SSMIS and AMSR2 sea ice concentration products. Atmospheric initial conditions are from operational NAVGEM (Hogan et al. 2014) using the Naval Research Laboratory Atmospheric Variational Data Assimilation System (NAVDAS) (Baker et al., 2007).

Another set of experiments are initialized with ice thickness derived from CryoSat-2 (Kurtz and Harbeck, 2017) for the 10-day period beginning 1 May 2018. We use the technique to reinitialize the GOFS 3.1 ice thickness field from CryoSat-2 (CS2) as described by Allard et al. (2018). For areas outside the Central Arctic (e.g., Barents Sea), the mean snow depth of first-year ice from climatology (see Tilling et al, 2015) is used in the CS2 retrievals. Both sets of experiments are performed with 10 time-lagged ensemble members for the period of May 1-10, 2018 run through September 30, 2018. We present results for the predicted versus observed September sea ice minimum extent to examine the impact of satellite-derived ice thickness initialization versus the set of experiments which did not utilize this data. **At this time, only 2 of the 10 CS2 hindcasts have completed due to long waits in computational queues.**

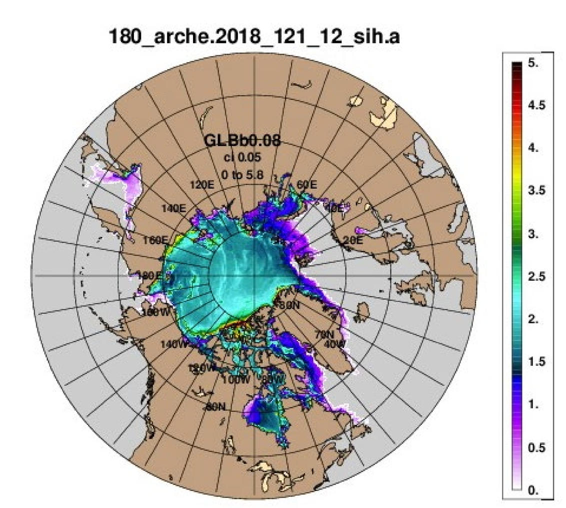
NAVY'S EARTH SYSTEM MODEL (NESM):



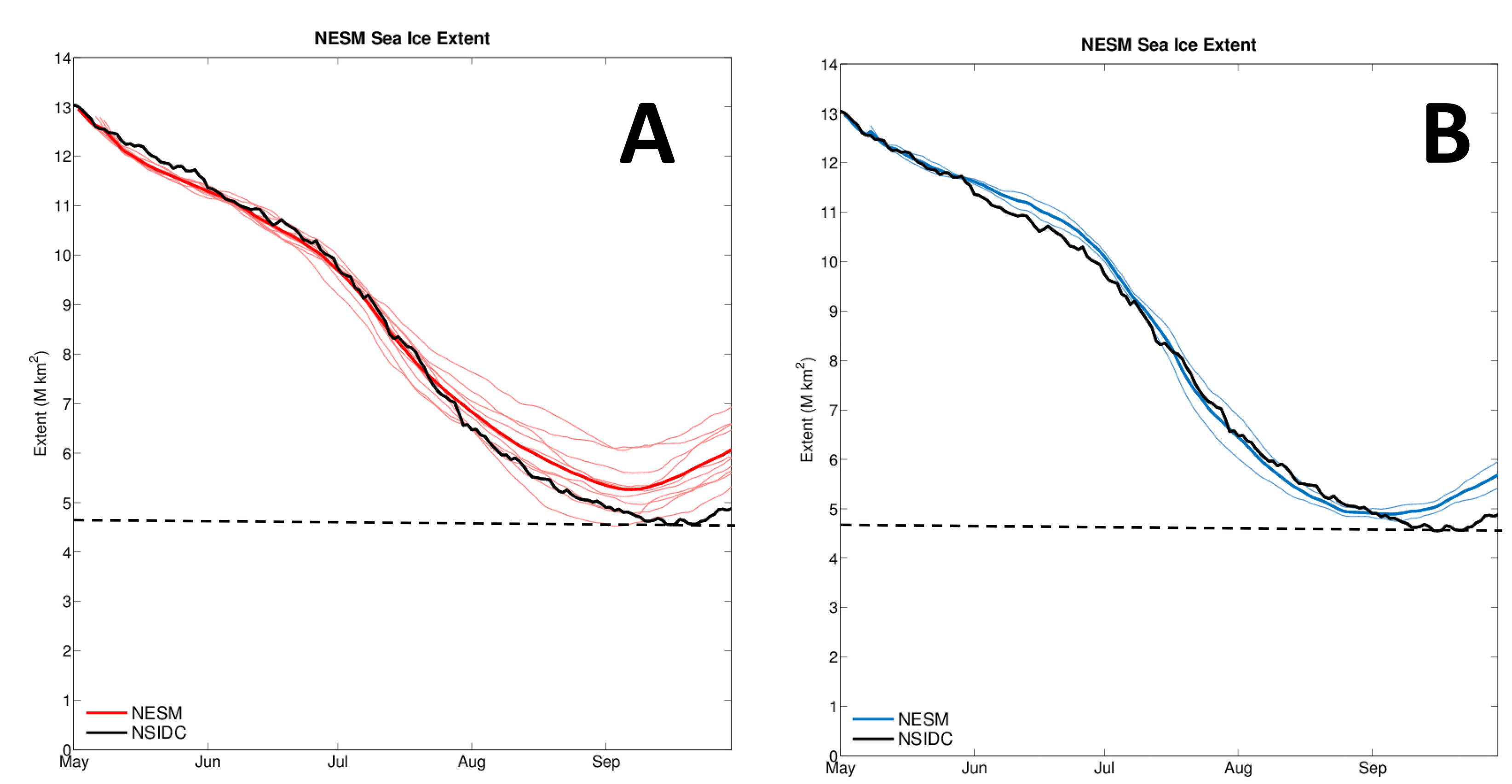
The fully coupled NESM model components



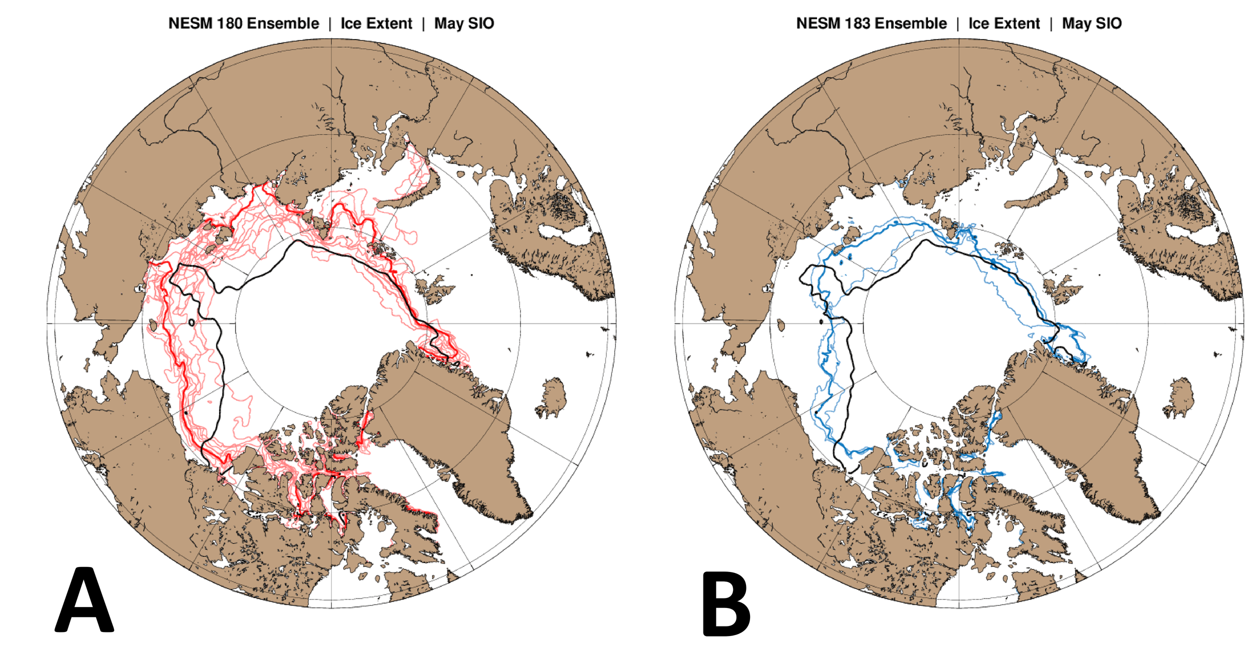
CS2 ice thickness fields for May 1-10, 2018. Little difference is evident on a daily basis, except for areas in the Barents Sea and Sea of Okhotsk. Plots with **green** check boxes indicate completed forecasts.



Note the difference in the GOFS 3.1 ice thickness field for May 1, 2018 versus CS2 (above).



A) NESM sea ice extent for the period of May 1 – September 30, 2018 for all 10 ensemble members (red lines) versus the observed sea ice extent (black line) from the National Snow and Ice Data Center. Plot on the right depicts results using CS2 data for **2 of the 10** ensemble forecasts (**blue lines**) completed at this time. Dashed black line represents observed September minimum extent of 4.59 M km^2.



A) September ice extent for all 10 ensemble members (red lines) versus observed (black line). The bold red line represents the ensemble mean. B) Same as A except that this is for CS2-initialization experiments (**only 2 of 10 experiments completed**). Note more accurate pan-Arctic ice edge with experiments shown on right.

CONCLUSION

The NESM ensemble mean September 2018 minimum sea ice extent initialized with GOFS 3.1 ice thickness was over-predicted by 1.0 M km^2 (5.59 M km^2 observed) versus the ensemble set (**only 2 of 10 completed at this time**) of runs initialized with CS2 ice thickness which had an error of 0.28 M km^2, a 72% reduction in error. The NSIDC minima were reached on September 19 and 23, while our NESM runs minima was reached on September 5. This research suggests that ice thickness initialization improves the predictive skill in seasonal ice forecasts. Future efforts will investigate the utilization of a combined CS2/SMOS thickness product.

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