Sea Ice Outlook for September 2013
July Report - NASA Global Modeling and Assimilation Office

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Please note that these predictions are experimental and are produced for research purposes only. Use of these forecasts for purposes other than research is not recommended.

1. Extent projection

3.65 ± 0.50 million km^2

2. Methods/Techniques (ensemble of global coupled model simulations)

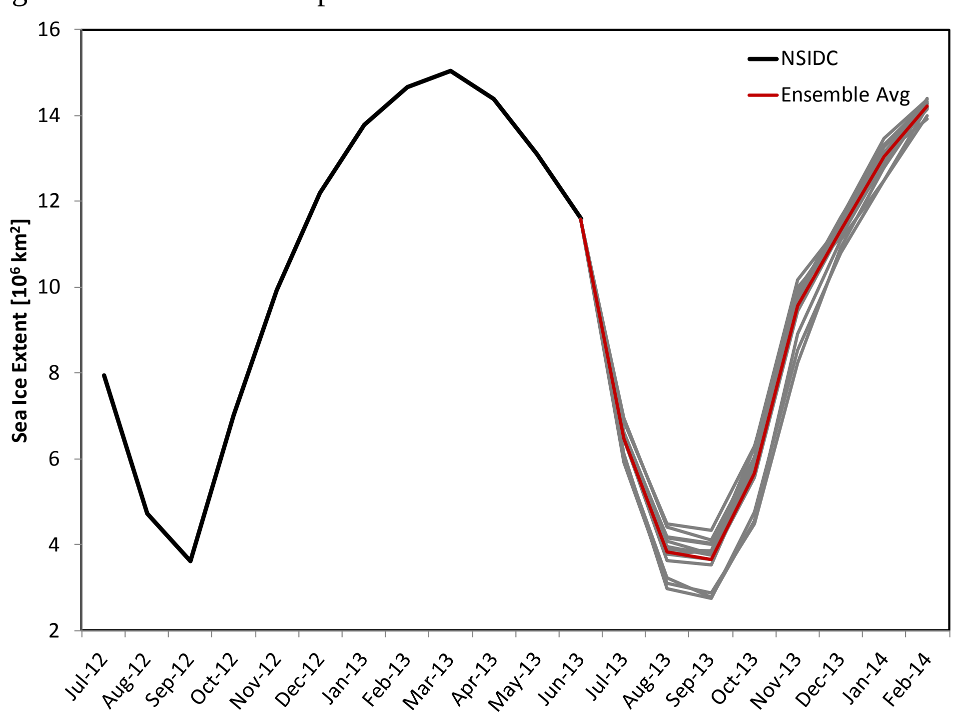
Seasonal coupled forecasts are conducted by the Global Modeling and Assimiliation Office (NASA GMAO) on an experimental basis in near real time with the GEOS-5 AOGCM. Seasonal forecasts are initialized with GEOS-iODAS, MERRA-Land, and MERRA atmospheric fields. Forecasts are initialized every 5 days, with 10 ensemble members initialized on the date closest to the beginning of the month. The ensemble members are generated by coupled model breeding and by independent perturbations in the ocean and atmosphere. Sea ice extent is defined by the area in which monthly-mean ice concentration exceeds 15 percent.

GEOS-5 is a system of models designed to simulate climate variability on a wide range of time scales, from the synoptic to multi-century climate change and integrated using the Earth System Modeling Framework (ESMF). For the AOGCM, the main components are the atmospheric model, the MOM4 ocean model, and CICE sea ice model. The GEOS-5 AGCM and its catchment-based hydrologic land surface model (Koster et al., 2004) were developed by the GMAO (GEOS-5 AGCM; Rienecker et al., 2008). The AGCM is configured with finite-volume dynamics (Lin, 2004) and includes moist physics with prognostic clouds (Bacmeister et al., 2006), a modified version of the relaxed Arakawa–Schubert convective scheme described by Moorthi and Suarez (1992), the shortwave radiation scheme of Chou and Suarez (1999), and the longwave radiation scheme of Chou et al. (2001). Two atmospheric boundary layer turbulent mixing schemes are used. The Louis et al. (1982) scheme is used in stable situations with no planetary boundary layer (PBL) clouds, while the Lock et al. (2000) scheme is used for unstable or cloud-topped PBLs. GEOS-5 incorporates both an orographic gravity wave drag scheme based on McFarlane (1987) and a scheme for nonorographic waves based on Garcia and Boville (1994). The Modular Ocean Model, version 4 (MOM4) is a finite-difference version of the ocean primitive equations under the Boussinesq and hydrostatic approximation, and was developed by Geophysical Fluid Dynamics Laboratory (Griffies et al., 2005). These AOGCM components exchange fluxes of momentum, heat, and freshwater through a “skin layer” interface. The skin layer includes a parameterization of the diurnal cycle and the sea ice model. The sea ice model is the Community Ice CodE (CICE) version 4.0, and was developed by Los Alamos National Laboratory (Hunke and Lipscomb, 2008). In the adaptation for GEOS-5, the 1D thermodynamics are separated from the dynamical sea ice component as part of the semi-implicit time stepping computation of the ocean skin temperature.

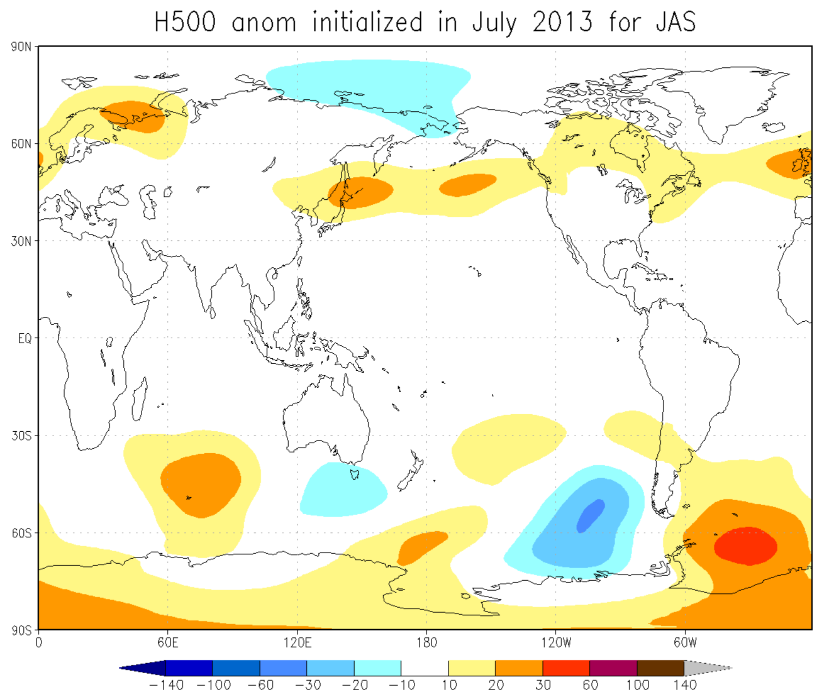
The Goddard Earth System integrated Ocean Data Assimilation System (GEOS iODAS; Keppenne et al., 2008; Vernieres et al., 2012) is a system for both ocean and sea-ice data assimilation. The iODAS uses ensemble optimal interpolation, where covariances are drawn from the 20 leading EOFs of an ensemble of forecast anomalies (calculated relative to the climatological forecast drift) obtained from GEOS AOGCM hindcasts. The iODAS assimilates a wide range of observations into the ocean and sea ice components: in-situ temperature and salinity profiles, sea level anomalies from satellite altimetry, analyzed SST, and sea-ice concentration. The climatological sea surface salinity is used to constrain the surface salinity prior to the Argo years. Climatological temperature and salinity gridded data sets from the 2009 version of the World Ocean Atlas (WOA09) are used to help constrain the analysis in data sparse areas. The ice component of the iODAS assimilates sea-ice concentration from the National Snow and Ice Data Center (NSIDC).

3. Rationale

The projection is comparable to the September 2012 record minimum, and is less than the previous month's contribution to the Sea Ice Outlook (4.42 million km^2). While the ensemble forecast indicates an absence of significant atmospheric circulation anomalies over the western Arctic, high pressure features over the Barents sea appear to be conducive to greater ice extent reductions along the Eurasian side. Observed ice extent rapidly decreased over the last week of June, and the ensemble forecast has bifurcated in response to evolving conditions with three ensemble members indicating record ice loss. For these members, greater ice cover loss is found throughout the Arctic as compared to the ensemble mean.



GEOS-5 AOGCM seasonal forecast of Northern Hemisphere sea ice extent for July 2013.



Ensemble-averaged 500 hPa anomalies for the period July-August-September 2013, in geopotential meters.

4. Executive Summary

A projection of 3.65 ± 0.50 million km^2 is made from forecasts initialized from 10 June until 30 June. This projection is made in order to understand the relative skill of the forecasting system and to determine the effects of future improvements to the system. The forecasting cycle is typically executed during the first week of the month, and thus the June forecast is not available at this time.

5. Estimate of Forecast Skill

The uncertainty denotes the ensemble standard deviation. This does not account for other sources of uncertainty inherent in the forecasting system. September forecasts initialized from this time of year for the period 1998-2012 explain 79 percent of the variance using this system, indicating reasonable skill. However, the detrended correlation is 0.59 (r^2 = 0.35). Forecasts for previous years indicate a large, temporally-evolving model bias, which is unaccounted for here. Preliminary analysis suggests the model may have difficulty initializing ice volume under conditions of low ice extent.

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