Met Office
September 2014 Pan-Arctic Sea Ice Outlook
August Report (Using July Data)

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Group: Met Office

Projection Type: Model based estimate.

September Monthly Averaged Extent Projection: $(\mathbf{5.3 \pm 0.6}) \times \mathbf{10^6}$ $\mathbf{km^2}$

Model: HadGEM3

Ice Component: CICE [Hunke and Lipscomb, 2010], Global Sea Ice 3.0

Ocean Component: NEMO [Madec, 2008], Global Ocean 3.0

Atmospheric Component: Met Office Unified Model (UM) [Brown et al., 2012], Global Atmosphere 3.0

Land Component: JULES [Best et al., 2011], Global Land 3.0

Coupler: OASIS3 [Valcke, 2006]

Method: Ensemble coupled model seasonal forecast from the GloSea5 seasonal prediction system [MacLachlan et al., 2014], using the HadGEM3 coupled model [Hewitt et al., 2011]. Prediction compiled from forecasts centred around 1 August and initialized between 22 July and 11 August (2 per day) from an ocean and sea ice analysis (FOAM/NEMOVAR) [Blockley et al., 2014, Peterson et al., 2014] and an atmospheric analysis (Met Office NWP/4DVar) [Rawlins et al., 2007] using observations from the

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previous day. Special Sensor Microwave Imager (SSM/I) ice concentration observations from ESA OSI-SAF [OSI-SAF] were assimilated in the ocean and sea ice analysis, along with satellite and in-situ SST, subsurface temperature and salinity profiles, and sea level anomalies from altimeter data. Observational data from 21 July to 10 August were used in the initialization process. No assimilation of ice thickness was performed. The forecast has been bias corrected upward 1.8×10^6 km^2 due to a mean under-forecast of the ice extent relative to the observed NSIDC ice extent over the hindcast period 1996 to 2009 [Peterson et al., 2014].

Projection Uncertainty: $\pm 0.6 \times 10^6$ km^2 representing two standard deviations of the (42 member) ensemble spread around the ensemble mean.

Executive Summary: Using the Met Office GloSea5 seasonal forecast systems we have generated a model based mean September sea ice extent outlook of $(\mathbf{5.3 \pm 0.6}) \times \mathbf{10^6}$ km$^\mathbf{2}$. This has been generated using start dates between 22 July and 11 August to generate an ensemble of 42 members centred around 1 August.

Caveat: The ensemble mean forecast is one of many realizations of possible September sea ice extent produced by the seasonal forecast system. Whilst the system is devised to accurately account for the range of possible outcomes, as expressed by our ensemble spread and uncertainty estimate, there is still a possibility of the actual outcome falling outside this estimate.

Additional Information: Validation and calibration of the forecast was done using a 1996-2009 historical re-forecast (hindcast) using start dates of 25 July, 1 and 9 August (3 members each). Over the hindcast period, the correlation between the GloSea5 forecast and NSIDC sea ice extent observations was 0.94 which reduces to a correlation of 0.74 if the trend is removed from the time series. See the accompanying figure 1 showing the time series of September sea ice predictions in the hindcast, along with the forecast for 2014. Both correlation values are significantly different from 0 at the 95% confidence level with a correlation skill better then both persistence of July anomalies and a linear extrapolation of the September trend. The 1996-2009 ice extent climatology generated by the hindcast was 1.8×10^6 km^2 lower then the 1996-2009 observed climatology. Thus we have adjusted both the hindcast and forecast upward by this amount to account for the model bias. After bias correction, the hindcast has a root mean square error (rmse) of 0.3×10^6 km^2, which is less then the quoted uncertainty. While the correlation skill for this forecast is significantly better then the skill of our June contribution (June correlation skill was 0.86 and 0.33 when detrended), the bias correction required due to systematic model bias for low ice extent was much larger. Since it is difficult to account for the bias in terms of spatial maps of ice concentration, we do not include a spatial plot of the ice concentration and ice edge.

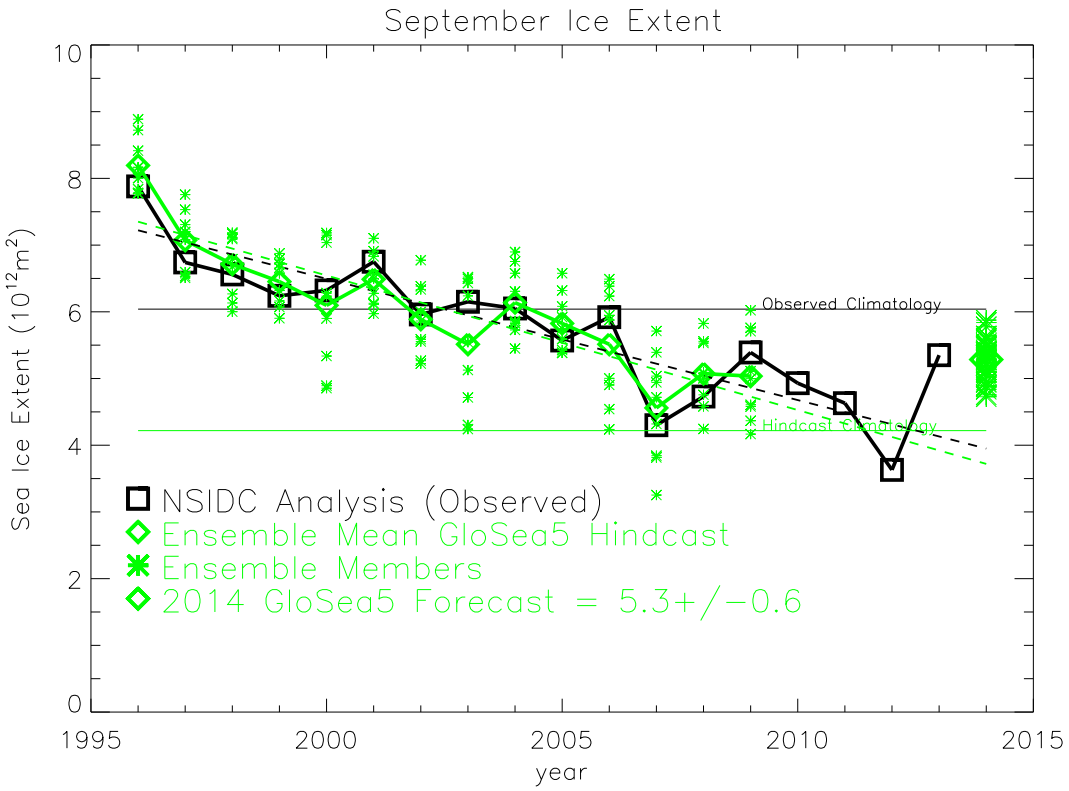

Figure 1: Time series of ensemble mean September sea ice extent from GloSea5 (green $\diamond$) and NSIDC observations (black $\square$). Individual ensemble member sea ice extents are denoted by $*$ (green). The green and black horizontal lines denote the hindcast and observed (1996-2009) climatological mean respectively. The forecast and hindcast values have all been adjusted upward by the amount between the two lines (1.8×10^{12}m^2). The green and black dashed lines are the forecast and observed trends in the timeseries over the period 1996-2009.

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