

Met Office
September 2014 Pan-Arctic Sea Ice Outlook
June Report (Using May Data)

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Group: Met Office

Projection Type: Model based estimate.

September Monthly Averaged Extent Projection: $(4.1 \pm 1.0) \times 10^6$ km²

Model: HadGEM3

Ice Component: CICE [Hunke and Dukowicz, 2002, 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 [Walters et al., 2011]

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]. Forecast is compiled together from runs initialized between 30 March and 19 April (2 per day) from an ocean and sea ice analysis (FOAM/NEMOVAR) [Blockley et al., 2014, Peterson et al., 2014] and an atmospheric analysis (MO-NWP/4DVar) [Rawlins et al., 2007] using observations from the previous day. Special Sensor Microwave Imager (SSM/I) ice concentration observations from ESA OSI-SAF [OSI-SAF]

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was 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. No assimilation of ice thickness was performed. The forecast has been bias corrected downward $0.1 \times 10^6 \text{ km}^2$ due to a mean over-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: $\pm 1.0 \times 10^6 \text{ km}^2$ 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 $(4.1 \pm 1.0) \times 10^6 \text{ km}^2$. This has been generated using start dates between 30 March and 19 April to generate an ensemble of 42 members.

Caveat: The ensemble mean forecast is but 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 projection uncertainty, 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 1/9/17 April (3 members each). Over the hindcast period, the correlation between the GloSea5 forecast and NSIDC sea ice extent observations was 0.87, significantly different from zero at the 95% confidence level. This reduces to a correlation of 0.40 if the trend is removed from the time series. Indeed, the model-based forecast is not significantly better than one derived from a simple extrapolation of the observed trend.

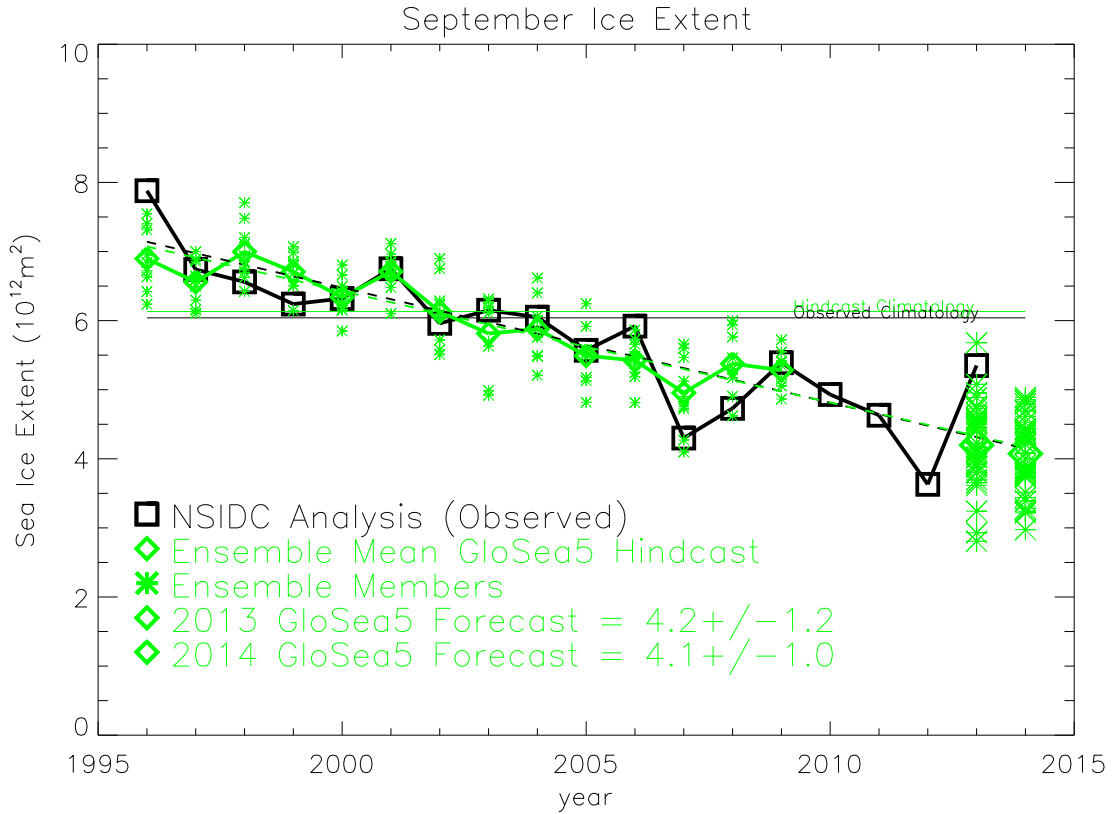


Figure 1: Time series of ensemble mean September sea ice extent from GloSea5 (green \diamond) and NSIDC observations (black \square). Individual ensemble member sea ice extents are denoted by * (green). The green and black horizontal lines denote the hindcast and observed (1996-2009) climatology respectively. The forecast and hindcast values have all been adjusted downward by the amount between the two lines ($0.1 \times 10^{12} \text{m}^2$). The green and black dashed lines — barely distinguishable on the plot — are the forecast and observed trends in the timeseries. Forecast trend is calculated using hindcast values, plus 2013 and 2014 forecast values. The observed trend is calculated using 1996-2013 observations. Note: The 2013 forecast value is the GloSea5 forecast value, obtained in an identical way to the 2014 forecast. This is **not** our contribution to the 2013 SEARCH outlook, which was derived from the previous operational system GloSea4 [Arribas et al., 2011].

The accompanying figure shows the time series of September sea ice predictions in the hindcast (1996-2009), along with forecasts for 2013 and 2014. The 1996-2009 climatology generated by the hindcast was $0.1 \times 10^6 \text{ km}^2$ higher than the 1996-2009 observed climatology. Thus we have adjusted both the hindcast and forecast downward by this amount to account for the model bias. After bias correction, the hindcast has a root mean square error (rmse) of $0.5 \times 10^6 \text{ km}^2$ comparable to the projected uncertainty.

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