GFDL contribution to September 2015 Sea Ice Outlook.
June report (based on May data)

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Note: This is an experimental projection and is not an official NOAA forecast.

1-Pan-Arctic sea ice extent predictions

We predict that September 2015 Arctic sea ice extent will be 5.17 million square kilometers. The model predicted value for September 2015 Arctic sea ice extent is therefore predicted to be 1.79 million square kilometers below the 1982 to 2011 observed average extent. The range of uncertainty, based on the different ensemble members, goes from 4.51 to 5.83 million square kilometers (Fig.1). The standard deviation among the ensemble members is 0.46 million square kilometers.

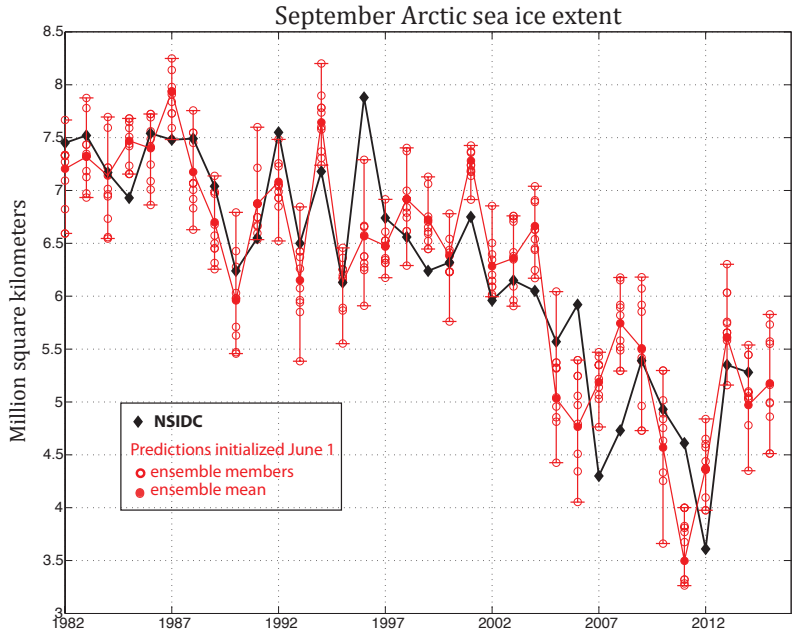

Figure 1: September Pan-Arctic sea ice extent in the GFDL CM2.1 predictions initialized June 1 (based on May data), compared to NSIDC observations. The ensemble means and the individual ensemble members are shown. The error bars indicate the lowest and highest extents in the 10-member ensemble. The model values have been bias-corrected.

2-Methods/Techniques

Our predictions are made using the GFDL CM2.1 forecast coupled model. They are initialized from the Ensemble Kalman Filter coupled data assimilation system, ECDA (Zhang et al. 2007). The initial conditions are constrained in the Arctic by surface

and subsurface oceanic data and atmospheric data. Sea ice concentration and thickness are not explicitly assimilated. Historical radiative forcing is used prior to 2005 and the RCP4.5 scenario for the predictions started after 2005. For the predictions initialized after 2004, the aerosols are fixed at the RCP4.5 scenario year of 2004. A 10-member ensemble is produced every year between 1982 and 2015, starting on the 1st of every month and run for one year. The ensemble members are expected to sample the atmospheric variability that may prevail each month. We focus here on the forecasts initialized 1-June, i.e. based on May data.

Over the period 1982-2014, the predictions initialized June 1 underestimate the September extent by 1.3 million square kilometers, a bias that increases with lead time. A bias correction is hence applied to account for differences with observations. The predictions given above correspond to the bias corrected ensemble mean.

3-Rationale

The GFDL CM2.1 forecast system shows good skill in retrospectively predicting the observed long-term downward trend of September Arctic sea ice extent anomalies as well as the year-to-year fluctuations (Msadek et al. 2014), as illustrated on Fig.1 and Fig.2 for full and detrended sea ice extent anomalies, respectively. Over the period 1982-2014, the correlation between the predicted September Pan-Arctic sea ice extent initialized June 1 and observations equals 0.86 The correlation is still statistically significant at 95% when data are detrended (r=0.56.) We note however a degradation of skill in predicting the year-to-year variability during the 2000s, which is coincident with the observed thinning of Arctic sea ice.

4-Executive Summary

Our prediction for the September-averaged Arctic sea ice extent is 5.17 million square kilometers, with an uncertainty range going between 4.51 and 5.83 million square kilometers. Our estimate is based on the GFDL CM2.1 ensemble forecast system in which both the ocean and atmosphere are initialized on June 1 using a coupled data assimilation system. Our prediction is the bias-corrected ensemble mean, and the given range corresponds to the lowest and highest extents in the 10-member ensemble. Our model predicts that September 2015 Arctic sea ice extent will be 1.79 million square kilometers below the 1982 to 2011 observed average extent, but will not reach values as low as those observed in 2007 or 2012.

5- Uncertainty of Forecast skill

The uncertainty range is estimated from the lowest and highest values in the ensemble forecast. Although relatively large, this uncertainty range only reflects variations in atmospheric summer conditions and does not account for other sources of uncertainty like errors in the initial conditions and model deficiencies that prevail despite the bias correction. The ensemble standard deviation is also given as a measure of error.

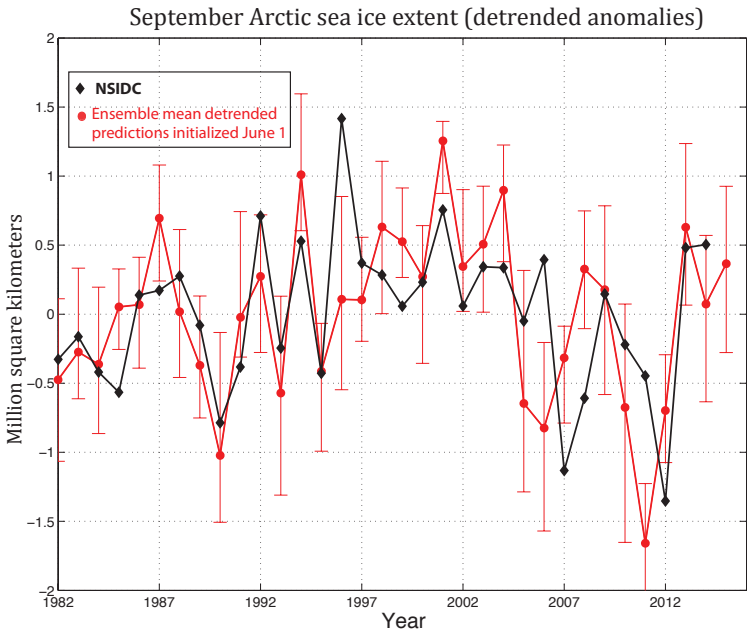

Figure 2: Comparison of detrended observations of September Arctic sea ice extent and detrended CM2.1 predictions initialized June 1. The error bars indicate the lowest and highest extents in the 10-member ensemble. The model values have been bias-corrected.

References

Msadek R., G. Vecchi, M. Winton, R. G. Gudgel, (2014): Importance of initial conditions in seasonal predictions of Arctic sea ice extent, Geophys. Res. Lett. 41, 5208–5215, doi:10.1002/2014GL060799.

Zhang, S., M. J. Harrison, A. Rosati, and A. T. Wittenberg, 2007: System design and evaluation of coupled ensemble data assimilation for global oceanic climate studies. Mon. Wea. Rev., 135 (10), doi:10.1175/MWR3466.1.