Pan-Arctic September 2013 Sea Ice Outlook

July report (based on June data)

Antoine Barthélemy, François Massonnet, Hugues Goosse, Thierry Fichefet

Georges Lemaître Centre for Earth and Climate Research (TECLIM), Earth and Life Institute (ELI), Université catholique de Louvain (UCL)

Louvain-la-Neuve, Belgium

1. Extent Projection

Our projection for the September monthly Arctic sea ice extent is 5.0 million square kilometers, with a range from 4.3 to 5.7 million square kilometers.

The total Arctic sea ice volume is projected to be 6.7 thousand cubic kilometers below the model September climatology over the period 1983-2012 (with a range from 7.6 to 6.1 thousand cubic kilometers below the climatology). For comparison, the PIOMAS reanalysis (Schweiger et al., 2011) gives a mean September ice volume of 11.4 thousand cubic kilometers over the same period.

2. Methods/Techniques

Sea ice-ocean model ensemble runs.

3. Rationale

Our estimate is based on results from ensemble runs with the global ocean-sea ice coupled model NEMO-LIM3. This model has been proven skillful in reproducing the monthly Arctic (and Antarctic) sea ice extent anomalies over the last 30 years, as well as the observed long-term downward trend (Fig. 1). The ensemble members are expected to sample the atmospheric variability that may prevail this summer. Our approach is closely related to the one used last year, with other models, by Zhang and Lindsay, Kauker et al. and the Naval Research Laboratory.

Version 3.5 beta of the NEMO ocean engine (Madec, 2012) is used, coupled with the state-of-the-art sea ice model LIM3 (Vancoppenolle et al., 2009). LIM3 includes, in particular, an ice thickness distribution, a multi-layer halo-thermodynamics and an EVP rheology. The model is run on a 1° global tripolar grid and is forced with NCEP/NCAR atmospheric reanalysis data (Kalnay et al., 1996) from 1948 to June 23, 2013. No data are assimilated during this simulation. Ten ensemble members are then started from the obtained model state, each using atmospheric forcing from one year between 2003 and 2012 (Fig. 2). This choice is a compromise between a sufficiently large ensemble and the rapidly changing Arctic atmospheric conditions in recent decades.

The estimate given above corresponds to the ensemble median monthly September extent, corrected by the mean bias between simulated and observed values reported in the NSIDC sea ice index. On average over the period 2003-2012, the model indeed

overestimates the September extent by 0.9 million square kilometers. The range around our projection is chosen as the range between minimum and maximum extents in the ensemble (see also below). Volume estimate and range are similarly obtained as median, minimum and maximum values in the ensemble.

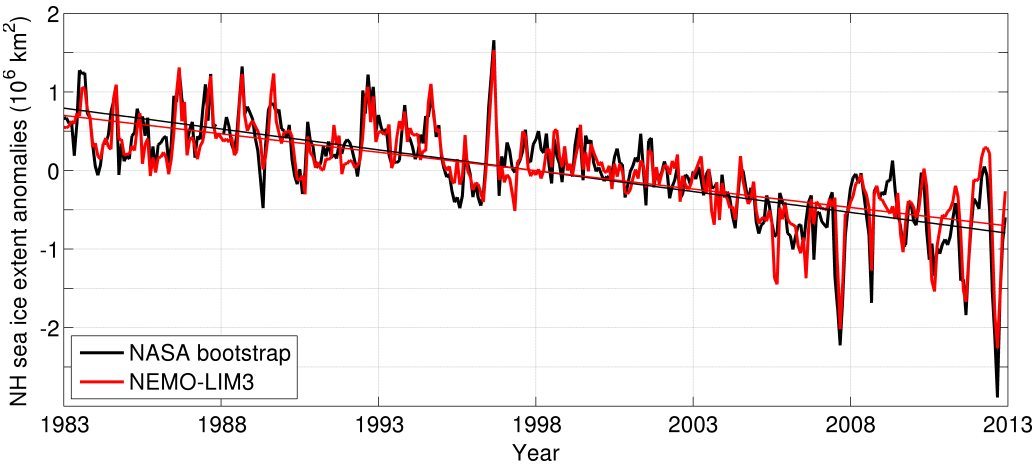

Figure 1: Monthly Arctic sea ice extent anomalies, observed (NASA bootstrap, black; Comiso and Nishio, 2008) and simulated by NEMO-LIM3 (red).

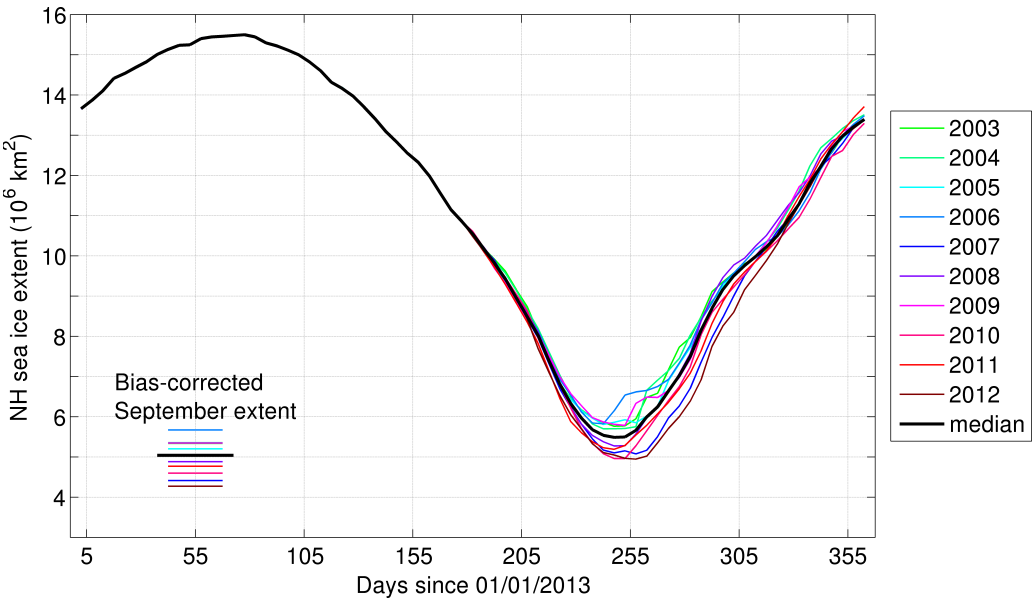

Figure 2: Ensemble members and median 2013 Arctic sea ice extents, plotted every 5 days. The bias-corrected September monthly mean extents for each members and their median (which is our final estimate) are also plotted as an inset.

4. Executive Summary

Our estimate is based on results from ensemble runs with the global ocean-sea ice coupled model NEMO-LIM3. Each member is initialized from a reference run on June 23, 2013, then forced with the NCEP/NCAR atmospheric reanalysis from one year between 2003 to 2012. Our estimate is the ensemble median, and the given range corresponds to the lowest and highest extents in the ensemble.

5. Estimate of Forecast Skill

Errors in our estimate may arise from erroneous initial state, model errors not accounted for through the mean bias correction and atmospheric variability. Although relatively wide, our uncertainty range is solely based on this last factor and on the hypothesis that the 2013 atmospheric summer conditions will be similar to the ones observed during the last decade.

6. References (by order of appearance in the text)

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