S33. THE 2014 HIGH RECORD OF ANTARCTIC SEA ICE EXTENT

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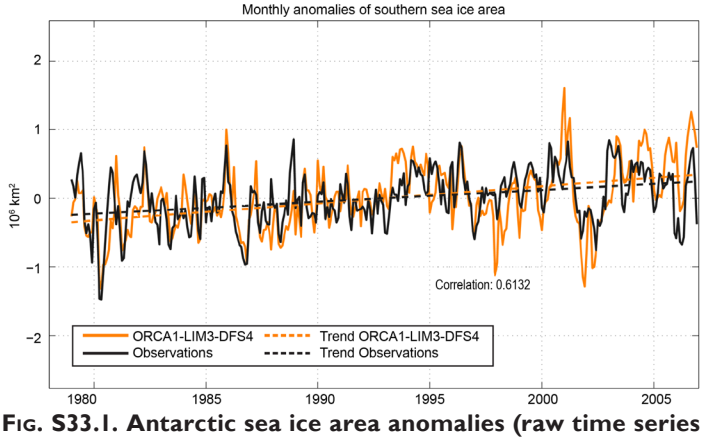

Fig. S33.1. Antarctic sea ice area anomalies (raw time series minus seasonal cycle) in observations (Comiso and Nishio 2008) and in the uninitialized ORCA1-LIM3 model, driven by the DFS4 (Brodeau et al. 2010) ERA-based atmospheric forcing.

Sea ice model and sea ice initial conditions

The Louvain-la-Neuve sea ice model (LIM3) is a dynamic–thermodynamic model widely used for climate studies. The model has been run in a one-category configuration. The sea ice reconstruction used for initializing the hindcasts was created following the methodology described and validated extensively in Guemas et al. (2013), that is, running the ocean–sea ice model with nudging of oceanic temperature and salinities towards the ORAS4 reanalyses, the whole system being forced by ERA-Interim reanalyses as described in the text.

Response of the model to atmospheric forcing

The present study covers the case of 2014, with validation of the seasonal runs over the past decade. A comprehensive study of the respective roles of initial conditions and atmospheric forcing on the skill of the model during the whole modern satellite era could be interesting to identify the sources of model performance, but this is the subject of a different study. Still, earlier results of the model forced by the Drakkar Forcing Set 4 (Brodeau et al. 2010) are displayed in Fig. S33.1. This forcing dataset is based on ERA40 and therefore shares similarities with the one used in our study. Sea ice extent variability is reproduced with a satisfactory degree of realism (positive trend and interannual variations). For comparison, the same model forced by the NCEP/NCAR reanalyses simulates variability that is more questionable in the Southern Ocean (Massonnet et al. 2011).

Treatment of uncertainty

Figure 33.2 of the main text displays error bars that represent two main sources of uncertainty in seasonal sea ice hindcasts: uncertainty related to initial conditions and uncertainty related to the atmospheric conditions. Uncertainty related to resolution and model physics/parameterizations was not investigated, since we aim in this study at examining the role of initial conditions and atmospheric forcing only on the 2014 maximum.

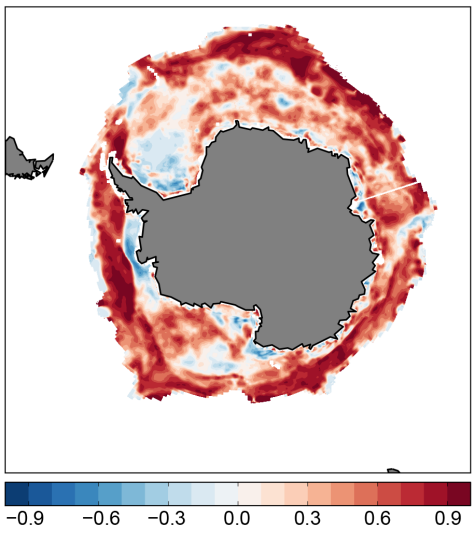

Fig. S33.2. Correlation of observed (Eastwood et al. 2014) and simulated (CTRL run, mean of five members) September sea ice concentration over 2005–14.

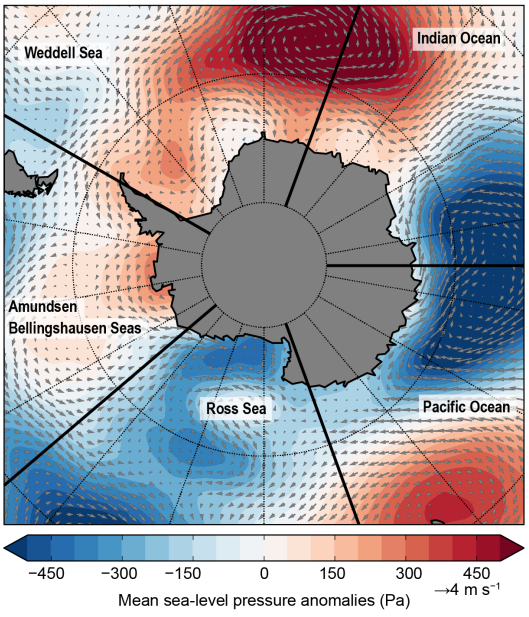

Fig. S33.3. Mean sea level pressure anomalies for winter (JAS) 2014 relative to 1979–2013, from the ERA-Interim reanalyses. Overlaid are the JAS 2014 10-m wind anomalies from ERA-Interim relative to 1979–2013.

a. Uncertainty in initial conditions

For each seasonal hindcast between 2005 and 2014, five members (labelled 1, 2, … 5 hereafter) are initialized from five distinct pairs of ocean and sea ice initial conditions. The oceanic initial conditions are those from the five members of the NEMOVAR-ORAS4 oceanic reanalysis while the sea ice initial conditions are those from the five members of the sea ice reconstruction described above.

b. Uncertainty in atmospheric forcing

Atmospheric reanalyses used to drive ocean–sea ice models can be subject to large errors or systematic biases in the polar regions. To account for possible errors in the atmospheric forcing that drives the ocean–sea ice model, we perturb the 10-m u- and v- components of the ERA-Interim wind as follows:

The wind forcing for month m of year y for member 1 is the ERA-Interim wind field itself:

$$\boldsymbol{u}_1(m,y) = \boldsymbol{u}_{ERA-Interim}(m,y) \quad (m = 3,\ldots 9; y = 2005,\ldots 2014)$$

The wind forcings for members 2 to 5 are obtained as the ERA-Interim wind plus a perturbation:

$$\boldsymbol{u}_i(m,y) = \boldsymbol{u}_{ERA\text{-}Interim}(m,y) + (\boldsymbol{u}_{\mathrm{DFS4}}(\tilde{m},\tilde{y}) - \boldsymbol{u}_{ERA-Interim}(\tilde{m},\tilde{y}))$$

where i = 2, …5; y =2005, …2014; $\tilde{m}$ is a random month between March and September, and $\tilde{y}$ is a random year between 1979 and 2006. The perturbation is constructed as the difference between another reanalysis product (Drakkar Forcing Set 4/DFS4; Brodeau et al. 2010) and ERA-Interim for a random year between 1979 and 2006.

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