

Interactive comment on “Delaying future sea-level rise by storing water on Antarctica” by K. Frieler et al.

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Please find the authors’ answer below in red.

Frieler et al. present an analysis of a scheme for delaying sea-level rise by pumping large amounts of seawater onto the Antarctic Ice Sheet, where it would freeze. The authors find that this scheme could produce a reduction in sea levels relative to a case in which nothing was done, that this benefit is only temporary in that much of the excess ice is advected to the ocean within a few hundred years, and that this scheme would be highly energy-intensive. The paper is generally well-written and discusses an interesting topic. In my opinion, this paper should be published after minor revisions involving reorganization of the text, additional discussion of selected points, and proofreading.

Answer:

We are happy to see this positive evaluation of our paper and thank the reviewer for the constructive comments we will address in the following.

Reorganization: – I would suggest that the authors move the part of the introduction having to do with the energy costs of pumping water onto the ice sheet to the discussion. – Similarly, the last three paragraphs of the Results section seem to belong in the Discussion.

Answer:

We have reorganized the paper. The paragraph of the introduction dedicated to the energy costs and the last paragraph of the results section have been moved to the discussion section. The detailed description of the sensitivity experiment accounting for the effects of latent heat release has been moved from the results section to section 2 dedicated to the specification of the simulation set-ups. The paragraph providing the results of the associated simulations has been left in the results section as it directly refers to the model simulations we have done.

Additional discussion of selected points: – The authors spin up their model by equilibrating it to the modern climate. This spinup procedure is fully adequate given the scope of the study; however, I would like for the authors to comment on how this spinup procedure might affect their results. How does the spun-up ice sheet compare to the real one, in terms of total ice volume and spatially-distributed ice thicknesses and ice velocities? In the case of Greenland,

I believe this type of spinup procedure generally results in an ice sheet that contains too much ice and where the ice velocities are generally smaller than on the real ice sheet. Does that result hold for Antarctica, too?

Answer:

We added three supplementary figures (Fig. S3-S5) that provide a comparison between observed and modeled grounding line, surface elevation and surface ice velocities. Total modeled ice volume ($27.0 \times 10^6 \text{ km}^3$) deviates less than 0.5% from the observed volume ($26.92 \times 10^6 \text{ km}^3$, Fretwell et al., 2013). Research on the transient nature of the Antarctic ice sheet and the influence of past climate change on its current state is still in its infancy. The Antarctic ice sheet is larger than Greenland and the costly shallow-shelf approximation is needed for reliable results. The related high computational cost makes it difficult to run ensembles of Holocene ice sheet evolution that would allow assessing the biases introduced by our spinup procedure. We are not aware of generally valid biases discussed in the literature.

The authors use Comiso (1999) as their surface boundary condition data set. I think RACMO2 output is considered the gold standard for forcing ice sheet models; why do the authors prefer Comiso (1999) over RACMO2 results?

Answer:

We missed the correct citation here. Surface temperatures are from Comiso (2000) and surface accumulation is from Arthern (2006). These datasets were made available in the ALBMAP dataset (Le Brocq 2010). We decided for the pure observational dataset as it is open access and free to download, therefore making our results easier to reproduce. The references have been added to the main text.

Proofreading: – The paper is missing many commas. The authors should review <https://owl.english.purdue.edu/owl/owlprint/607/> . – The manuscript needs to be read over carefully to catch missing words and other typographical errors.

Answer:

Thank you very much for the hint. A native speaker has carefully proofread the manuscript and corrected for errors.

Sincerely,
Katja Frieler, Matthias Mengel, and Anders Levermann