

Interactive comment on “Diverging future surface mass balance between the Antarctic ice shelves and grounded ice sheet” by Christoph Kittel et al.

Anonymous Referee #1

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This paper fills an important gap left in the current research literature on future changes to the Antarctic Ice Sheet. My understanding of the current state of affairs is as follows. At present, centurial-scale predictions of future Antarctic ice volume use the outputs of global-scale earth system models to provide fields such as surface mass balance and runoff to ice flow models. These ESMs are necessarily run at a spatial resolution too coarse to resolve features like the Transantarctic Mountains. These topographic features would affect the local mass balance through feedbacks between elevation and precipitation and thus may be important for the purposes of ice flow modeling. Downscaling using a regional climate model such as MAR can provide the necessary resolution. Nowicki et al. 2020, due to time constraints and the computational cost of running RCMs, had little choice but to use ESM output directly to force ice sheet

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models in their work. The present paper fills the gap by downscaling the outputs from several ESMs using MAR for Antarctica over this forcing period.

I'm an ice flow modeler, so I found the methodology convincing but would not be in a great position to critique it in the first place. The big takeaway that I got from this paper was the necessity of doing the right thing and using downscaled RCM output to force future ice flow projections rather than the less expensive approach of using ESM output directly. Figure 10 was particularly striking in illustrating the difference, especially for CNRM-CM6-1 in the vicinity of the Amundsen Sea Embayment and over the Siple Coast Ice Streams.

A few numbers are stated without additional context that might be helpful. For example, the authors state that the amount of precipitation falling as rain over the ice shelves will increase, but give only anomalies. Here it might be nice to say roughly what the total amount of rainfall is so that readers can get a feel for what the relative change is, or state that quantity directly.

Although it isn't strictly necessary, it would help to say something about what the oceans will do. It would be enough to add a single sentence stating that, while higher atmospheric temperatures and thus SMB over Antarctica may offset some sea level rise, increases in ocean heat content delivered to the ice shelves are likely to be a strong influence as well. You could cite Holland et al. 2019, West Antarctic ice loss influenced by internal climate variability and anthropogenic forcing. The authors do mention the possibility of other internal feedback mechanisms leading to ice shelf retreat, but I found the omission of any mention of ocean forcing to be quite glaring.

Overall I recommend for publication with a few minor corrections.

Technical corrections:

14: predict -> predicted

22: resultant -> result, or maybe sum

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28: retaining -> restraining

59: the abbreviation ESM is used before the term "Earth System Model"

79: abundantly -> frequently or predominantly

114: Why not REMA or BedMachine? Was this for consistency with work from before those products were available?

195: contrasted -> contrasting

332: cumulated -> summed or aggregated

343: "Although RCMs have been believed..." -> Some studies have argued that RCMs..."

355: "that simulates..." -> "which simulates"

360: cumulated -> aggregated

396: carrefuly -> carefully

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2020-291>, 2020.