

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

Anonymous Referee #2

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Summary

In this paper, Kittel and co-authors present a series of experiments in which they use the regional climate model MAR to simulate climate over Antarctica over the coming century with boundary conditions provided by four different earth system models (drawn from CMIP5 and CMIP6). They find a substantial difference in the surface mass balance of grounded versus floating ice in all cases, with the former acting as a net sink for sea level, and the latter acting as either a contributor or neutral, depending on the forcing. The authors also find that the integrated differences between MAR response to different ESMs is largely explained by differences in the timing and intensity of projected global warming. This allows the authors to develop simple polynomial

C1

functions relating near-surface temperature anomaly in the Antarctic region to SMB, snowfall, rainfall, and runoff anomalies. They then apply these relationships to the remainder of the CMIP5 and CMIP6 ensemble members to produce an approximation of model uncertainty in SMB anomaly for each CMIP scenario.

I find this paper to be a well-written and useful contribution to the community's understanding of variability in climate model predictions. It does a good job of laying out critical assumptions and also is careful to couch their results as model predictions (rather than a factual future). Besides a few requests for changes to the structure of the paper, and a few technical corrections, I suggest that the paper be published with little further review.

Major Points

I believe that Supplement S2 should be included in the main text, more or less in its entirety. The results section's primary points are devoted to summarizing its content and referencing its figures, so why not just include it in the manuscript?

I also believe that it would be appropriate to cross-validate the quadratic fits with an independent dataset. For example, if one fits this polynomial to 3 of the 4 experiments, how well is the fourth predicted? Showing that it does a good job would go a long way towards ensuring that this surrogate model (which is what it is) is likely to be skillful at predicting the anomalies for other models.

Minor Points

L13 Specify what a 'lower surface mass balance' means. More negative?

C2

Fig. 1 Would it be possible to include observed temperature anomaly in some form? maybe ERA5?

L128 It's okay to leave the details to the references, but it would be helpful to at least qualitatively describe the methodology for comparing ESMs to ERA5 that are used here.

L170 SIC: 'Suplement'

L227 SIC: 'questionning', SIC: 'in pace'

Sec 4.1 When reporting the bounds on SLE in this section, is the error in the surrogate model accounted for? The fit to the simulations isn't perfect, so there should be some extra variance injected to account for potential mismatch between Eq. 2/3 and the true model predictions, rather than just the spread in the predictions themselves.