

Review of Muilwijk et al. (for EGUSphere)

Overall Assessment

This manuscript provides an insightful multi-model analysis of Southern Ocean regional responses to Antarctic Meltwater fluxes, including an estimate of the feedback on ice shelf basal melt. The key robust result is that Antarctic meltwater causes less-positive temperature anomalies along the continental shelf of the West Antarctic than for East Antarctica; since West Antarctica is currently experiencing large melt rates, they conclude that this meltwater feedback would tend to make melt rates more uniform. Beyond this headline result, the results are more mixed, because in some models “less positive” means a net cooling response, whereas in others it means “reduced warming”. A particularly perplexing result is how similar the GFDL models’ response to Antarctic meltwater is – in sign, magnitude, and pattern – to the SSP5-8.5 response.

The manuscript is long but I think worth it, as I anticipate the various discussions of model-specific behaviors (complemented by extensive referencing to relevant literature) will inspire future work to resolve the open questions about which model responses are correct. The authors have made a convincing case that the value of this controlled model intercomparison project outweighs the caveats about the unrealistic distribution of meltwater. (Additionally, they point out that several of the most important caveats will be addressed by later phases of this collaborative project.)

I recommend the manuscript be accepted for publication after addressing the following comments.

Main comments

Needs more precise language around West Antarctic cooling induced by meltwater.

In various places, but most importantly in the concluding paragraph (L. 783-786) and the abstract (L. 10-11), it is stated that the “cooling or reduced warming” on the West Antarctic continental shelf “suggest[s] a negative feedback” or “indicated a dampening feedback”. This is misleading, since more than half of the models in the ensemble still show net warming on the continental shelf, meaning a net positive/amplifying feedback. I believe you are trying to make one or both of the two subtler points:

- 1) The net feedback in West Antarctica is less positive than the circumpolar average, suggesting compensation by a negative feedback process.
- 2) The two models that you seem to have the most confidence in (GFDL ESM4 and CM4), because of their relatively small biases and higher resolution, exhibit a clear net negative feedback on West Antarctic temperatures in response to meltwater forcing (which, surprisingly, arises even under SSP5-8.5 forcings), suggesting that the feedback in the natural world is net negative.

Figure 3 - How is P-E + Runoff larger than the total in some models, e.g. HadGEM3, under SSP5-8.5 forcing? This implies the residual (sea ice melt/freeze and iceberg calving) is negative. But surely sea ice volume does not increase from 60°S-90°S under such high forcing... This either needs to be explained here or else there needs to be a concrete statement about how this is resolved in Pauling et al. (in prep), and this companion manuscript needs to be made accessible to the reviewers. This result makes me also wonder what is going on in the other models...

Minor comments

L. 114 - Remove “both” since you then have 3 references after

L. 172 - Missing citation

L. 757-759 - I don't understand the flow of this sentence. Misplaced commas?