Response to Review of O'Neill et al. 'ISMIP6-based Antarctic Projections to 2100: simulations with the BISICLES ice sheet model'

We thank Reviewer 3 for their further comments and suggested edits, please find below the point by point response to each of these. Reviewer comments are in bold font and responses are in standard font below.

Line 9: This sentence is very similar to the one on line 5 starting "We present simulations", I suggest combining them.

Changed line 9: 'We present BISICLES experiments showing…' to 'Our experiments show…'

Line 33: not clear what would "amplify uncertainty" here, do you mean potential for marine ice sheet instability introduces uncertainty in projections? Perhaps rephrase to improve clarity.

Have edited sentence to: 'Under anthropogenic warming, ice loss from marine basins could drive accelerating GMSL contribution in coming decades to centuries (Schlegel et al., 2018; Bulthuis et al., 2019; Lowry et al., 2021; Edwards et al., 2019; DeConto and Pollard, 2016; Golledge et al., 2015; Ritz et al., 2015; Seroussi et al., 2024), with uncertainty around unstable marine ice retreat contributing to uncertainty in future sea level projections (Robel et al., 2019).'

Line 100: When the ice is thinner than 1 metre is it fully removed from the model domain (rather than just being set to 1 metre and effectively ignored)? In the high-end simulations that are "collapse-off" how much of the ice shelves end up thinning to 1 m and then being calved off?

This is an error in the submitted manuscript which I have now corrected – floating ice thinner than 10 m thickness is calved. For high end collapse off simulations, maximum loss of floating area to thinning to <10m is ~4%. Have added the below sentence to results section line 198:
'In collapse off experiments, automatic calving of shelf ice thinner than 10 m can result in loss of up to ~4% of initial floating area.'

Line 170: Be consistent between "Ronne-Filchner" here and "Filchner-Ronne" elsewhere in the manuscript.

Have edited all occurrences to Filchner-Ronne

Line 176: Could you say why you see this slowdown at Pine Island? has the grounding line advanced and grounded on the ridge downstream of the current position?

The Pine Island grounding line remains stable on the ridge, remaining largely static throughout the simulation. Thinning there is fastest at the start of the control

simulation, and slows afterwards. Surface elevation gradient along the main Pine Island trunk gets shallower throughout the simulation period, which is not the case for Thwaites. Have edited from line 176 to:

'The most pronounced ice stream speed up in the control simulation occurs in the Thwaites glacier and its ice shelf (Fig. 3f), in response to grounding line retreat. By contrast, Pine Island glacier maintains its grounding line position and slows down between 2015 and 2100 in the control run (Fig. 3f). Pine Island slow down corresponds with shoaling of ice surface gradients over this period (not shown).'

Figure 3: suggest adding labels (initials) for Amery ice shelf and Totten Glacier to panels b and c. Also label Pine Island and Thwaites in panel f, as you refer to these several times in the main text.

Edited Figure and caption accordingly.

Line 202: Is that really the reason for the slow-down in the control simulation at Pine Island, or is it rather that the melt rates are not high enough close to the grounding line, or the sub-grid parameterisation, or the grounding line had grounded on the ridge and subsequently advanced?

Based on previous literature, buttressing may be a factor – additional detail added in edit from line 176 (see above) with regards to grounding line.

Figures 5 and 6: I did not notice this before, but why do all the simulations not start at the same grounded/floating area in 2015?

Our simulations start in 2010, at which point all areas are the same, however, we plot results for the ISMIP6 interval (2015-2100). We have clarified this in the caption by adding:
'Discrepancies in the initial area here and in Fig. 6 are due to our simulations beginning in 2010, whilst we show 2015 to 2100 results for consistency with ISMIP6.'

Line 219: "increase their VAF up to -21 mm sea level contribution" reads a bit awkwardly, if saying increases to -21 best to state what this is relative to. What was the VAF contribution in the control?

Edited to: 'In the Filchner-Ronne sector (Fig. 8-15), fourteen simulations increase their VAF relative to 2015, up to -21 mm sea level contribution, with -11 mm sea level contribution in the control.'

Line 222: Restate the range here.

Have added

Line 223: Remove "on the one hand" and "on the other".

Removed

Figure 8: Replace the numbers with letters.

Whilst it is more usual to use letters for subplots, we feel that since the numbers correspond to sectors, which are used for the basins across ISMIP6 studies, it is simpler for the sake of referencing within the text, and comparing with other publications, to keep numerical subplot labels.

Line 245: Suggest changing to "compare simulations using different GCM forcings but with the same ice shelf basal melt sensitivity and emission scenario".

Have edited accordingly.

Figure 9: Are these cumulative values for SMB integrated over the grounded part of the catchment? Add this detail to the caption.

Have edited the caption to:
'Total annual grounding line flux (mm SLC, positive values for mass loss) for the West Antarctic ice sheet (WAIS) (a) East Antarctic ice sheet (EAIS) (b) and the Antarctic Peninsula (AP) (e). Annual surface mass balance integrated over the grounded area of each region (mm SLC, so negative values indicate ice sheet mass gain) for WAIS (c), EAIS (d) and the AP (f). Region boundaries are also shown (g). Note that y-scales differ.'

Line 303-306: This sentence is too long. Split into two.

Edited to:
'CNRM-CM6-1 has an equilibrium climate sensitivity (ECS) of 4.8◦C (Meehl et al., 2020), similar to MIROC-ESM-CHEM (ECS = 4.7◦C): the highest ECS CMIP5 model sampled in ISMIP6 and discussed in Payne et al. (Payne et al. 2021). However, CNRM-CM6-1 ECS is higher than the remaining CMIP5 models, with CCSM4 and NorESM1-M both having an ECS of 2.9◦C (Flato et al., 2013)'

Line 327: Add "GCM" before model.

Changed model to GCM

Line 407: Is the reason the sea level contribution for basal melt sensitivities is similar because a large proportion of the total ice shelf area has been removed and therefore limited regions where basal melt is still applied?

Increase in sea level contribution with collapse on is similar for both basal melt sensitivities is the same, but baseline is higher under PIGL95. Have edited for clarity:
'As outlined in Section 3.7, the increase in sea level contribution with collapse on is almost identical for both basal melt sensitivities sampled (MeanAnt50 and PIGL95), though the 'no collapse' baseline is higher under PIGL95.'

Line 415: The start of the limitations section needs an introductory/topic sentence.

Added: ‘Our work complements the ISMIP6 ensemble, providing high resolution simulations of Antarctica with a physically comprehensive model, and exploring uncertainties beyond the original ISMIP6 protocol. However, limitations remain - these are outlined below.’

Line 446: Could also add something about the models ability to replicate the trend in present-day observations.

Added comparison end of first paragraph in section 3.1: ‘Average sea level contribution is 0.62 mm yr−1 over this period, compared with an implied rate of 0.41 mm yr−1 from 1992 to 2020 based on observations (Otosaka et al., 2023).’

Conclusions: I am grateful the authors made efforts to improve the conclusions in this version. I still think it could be shorter and more concise. I do not feel you need to go into detailed examples of results for individual climate model forcings.

Have edited paragraph beginning line 462 to remove example.

Supplement: supplementary figures should be referred to as “Supplementary Figure 1” or “Fig. S1” so that it is clear to the reader that you are not referring to figures in the main text.

Figure names and references in text edited accordingly.