

## ***Interactive comment on “ISMIP6 Antarctica: a multi-model ensemble of the Antarctic ice sheet evolution over the 21<sup>st</sup> century” by Helene Seroussi et al.***

### **Anonymous Referee #2**

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I commend all authors and contributors for their efforts and time investment into this MIP (one of many) and highly recommend this community effort for publication in TC. I have no significant points of concern; my only main comment is about the discussion and conclusions. Despite the tricky task of analyzing outputs from such a diverse range of forcings and model designs, I would have liked to see a stronger emphasis on the ‘lessons learnt’ from this exercise, and suggestions for possible ways forward. In my opinion, one of the key messages that should prevail from this MIP is that, despite the large spread in projections, significant advances have been made in the recent decade to reduce the uncertainties. Although this is mentioned in the text, I think this success should be stressed more and perhaps even quantified (e.g. L501 and following, L538-

539). Moreover, as this is very much 'work in progress' whilst the modelling community continues its efforts to improve models, these MIPs are a great way to guide such improvements. Individual groups will have used ISMIP6 and related MIPs to test and upgrade their models, and other developers/users might benefit from adopting these improvements in their own models. Perhaps there is scope for a paragraph or two in the discussion on i) recent key challenges (numerics, physics,...) that have been considered/overcome by individual contributors and how this has influenced their results, ii) an expert judgement on key improvements that need to be prioritized in the near future? In light of future publications, such as additional results based on CMIP6, the community might also want to think about more concrete 'measures of progress'.

Below is a list of more specific comments and points for further clarification.

L1 It might be worth introducing an abbreviation for Antarctic Ice Sheet, as I counted 10 instances on the first 3 pages alone.

L3 'estimated' → estimates of?

L3 You say 'primarily because of differences in the representation of physical processes and the forcings employed' but my understanding is that the initial state of the ice sheet and numerical design of the models are equally important sources of uncertainty?

L4 13 groups?

L7 '...between -7.8 and 30.0cm...': is this for a fixed forcing scenario, or does it include uncertainties from variability in models and the full range of forcings?

L15 define AOGCM

L15 'overall' → additional

L27 'paradigm shift' is rather vague. Perhaps you can be more precise, e.g. by saying that models have been verified against analytical solutions of ice flow, grounding line flow etc.

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L30 Do you mean that model validation against observations of past changes is critical to improve projections, or are you alluding to a more general understanding of how climate change affects sea level?

L33-35 Perhaps the ice sheet initial state (and results from initMIP) should be included here as an additional source of uncertainty.

L41 'mitigate the gaps' seems like an unfortunate choice of words. My understanding is that MIPs aim to quantify the spread in model projections, rather than to eliminate the spread?

L44-48 I was expecting to read about the impact of the initial ice sheet state here, but instead the focus is on SMB. Can you provide a 1-line summary of the initMIP results?

L135 Perhaps you can point out that this result was obtained in the context of the idealized MISOMIP experiment, but has not been tested for realistic geometries.

L140-145 Although Jourdain et al. (under review) will provide further details, it would be nice to have a little bit more information here. E.g. it is not clear what is meant by 'random samplings of Antarctic melt rate and ocean temperature'. Are these melt rates from Rignot et al., and is the ocean temperature taken from observations/reanalysis?

L185-186 I'm unclear about the difference between ctrl and ctrl\_proj. Are they identical except for the duration, i.e. ctrl runs from the initialization time until 2100, whereas ctrl\_proj runs from 2015 until 2100?

Table1, first row. Is 'Ocean coefficient' the  $\gamma_0$  parameter in Eq(1) and what is meant by 'Low', 'Medium' and 'High'?

L201 It would be good to have some further info about the 'open experiments' here. Does it mean that some ocean conditions (T,S,...) are prescribed but the melt parameterization is left free?

L217 include abbreviations FE and FV to help the reader interpret the second column

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of Table 3.

L278 what is meant by 'consistent' here? Perhaps this can be quantified.

L278 'ice shelves that extend slightly farther': again, perhaps this can be quantified. Could this be a resolution issue, i.e. the offset is on the order of the resolution of the analysis mesh?

L283-285 this information seems to be repeated from lines 268 and 270.

L300 'trends cannot be considered as a physical response of the AIS...': despite the constant climate conditions applied, could internal ice dynamics not give rise to a trend?

L309 The reference to figure 1 is appropriate here, but I'm finding it hard to distinguish the individual model results due to the choice of colour scheme. It is therefore difficult to verify this point.

L310 please check this sentence as I'm not sure what is meant here.

L312 At this point it is unclear why NorESM1-M was singled out for these experiments. Can you comment?

L325 'slit'?

L332-333, L337-338 The Siple Coast ice streams seem to produce an equally large response, yet they are not mentioned here?

L351 4 out of 6?

L352 You say that 'uncertainties for the WAIS are larger than for the EAIS' but I can't see any significant difference between the length of the error bars in Figure 8. . .

L376 Both here and later on, it would be useful to reference back to Table 3 with the experiment names, e.g. '...experiments were simulated with both open (exp01-04) and standard (exp05-08)...'

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L391 Again, a reference to the experiment names in Table 3 would be helpful, i.e. exp05.

L413 superscript st in 21st

L479 Are ocean processes even reliably included in the Greenland studies?

L499-500 As discussed earlier, it would be nice to see a more quantitative statement here, and further documentation on what is meant by 'significant improvement'.

L538 In my opinion this sentence is somewhat misleading. I assume that the 'main sources of uncertainties' refer to the uncertainties that were addressed as part of this study? Other sources of uncertainty such as the initial state of the ice shelf were not addressed here, and could be equally important.

Table A1. title: FL instead of FX?

Table B1. title: add (2015) to better specify 'beginning of the experiments'?

Figure 2. Something gone wrong with the colorbar in panel a? Also, black lines are very hard to see with the dark blue background, so consider adjusting the colors for more contrast.

Figure 3. Yellow text is hard to read. I'm not sure what the log plot in panel c contributes to the analysis. Spatial maps of ice thickness and velocity std between models might be a useful metric to identify areas where models disagree the most and highlight geographical regions where efforts for improvement should be focused.

Figure 12 and 13. Experiment names in the legend would be a handy cross-reference to Table3 here.

Figure 13b Why is the sea level contribution larger (more negative) without ice shelf collapse?

Figure 15. It is very hard to distinguish individual basins here, whereas this is crucial

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to understand the figure. Perhaps consider splitting into subfigures with equal axis to show results for different basins or groups of basins? Also consider adding basin names to help readers understand the main text (L473-475).

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