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# *Interactive comment on* "The role of history and strength of the oceanic forcing in sea-level projections from Antarctica with the Parallel Ice Sheet Model" *by* Ronja Reese et al.

**Anonymous Referee #1**

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———- General comments:

This paper describes the sensitivity of ice-sheet projections to the initialization method (simulating the 1850-2014 historical period vs starting in 2015, after the same long spin-up in both cases). It also describes the sensitivity to ocean warming, and compares the effect of parameterised melting (through PICO in ISMIP6 simulations) to melt perturbations imposed in LARMIP2. These sensitivities are expressed as Antarctic contributions to sea level rise.

The paper is well written, although a few clarifications are required in the Methods section. While I find the results useful for the ice-sheet/climate community, I have a few



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major comments that should probably be addressed before publishing this paper:

1- An important conclusion of this paper appears to be that ice-sheet models should simulate the entire historical period to make meaningful projections. However, this would not be true is the initial state was selected in a way to get present-day thinning rates (e.g. including an observational ice thinning rate in the score used to pick the initial state in the long-term ensemble). I don't expect the authors to change this in their methodology, but this should be discussed.

2- A strong ad hoc temperature correction is applied to the Amundsen Sea, with deep-ocean temperatures set to -1.25°C, i.e. relatively cold conditions. Then, it is claimed that the PICO tuning parameters cannot be changed because they were tuned to match observational ice-shelf averaged melt rates (in Reese et al. 2018 with other ocean forcing dataset). These aspects need to be investigated in this paper. Melting (and ideally the ice-sheet response) without temperature correction should be described, and other tuning parameters should be considered. Further, it could be argued that the important observational target in terms of ice-shelf buttressing is not the ice-shelf average but the average in PICO's first box (near grounding line).

3- Melt rates obtained through the ISMIP6 framework are compared to the melt rates imposed in LARMIP2 (based on previous plume-model studies). It would be interesting to describe how these two types of melt rates compared to other observational or modelling studies (see specific comment below).

———- Specific comments:

- L. 43-45: These are global feedbacks related to freshwater injection into the ocean. There are also important local thickness-melting feedbacks described by Timmermann and Goeller (2017) and Donat-Magnin et al. (2017).

- L. 51: "haven" -> "have".

- Section 2.1: I don't necessarily ask the authors to do it, but it would be interesting to





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see the score of the historical simulation in 2015 compared to the ensemble of initial states and in particular the one that was selected against present-day observations of ice geometry and speed.

- L. 81: About “scoring against present-day observations of ice geometry”: including the ice thinning rate in the score would have helped get an initial state similar to observations and maybe to the historic state at 2015.

- L. 89-90: What constant value is used for 1850-1949?

- L. 90-91: This sentence is unclear.

- Section 2.2: Specify here what is done for SMB in LARMIP-2.

- L. 96-97: “C=106” would be better than programming notation. And both C and $\gamma$T should have units. The $\gamma$T value does not seem to be exactly the same as Reese et al. (2018), why has it been modified despite a careful tuning in that paper?

- L. 98-99: How was the data compilation based on World Ocean Atlas (WOA) 2018 and Schmidtko’s dataset built? Was the latest update of WOA 2018 used? If not it is worth being mentioned because there were important updates near Antarctica. See https://www.nodc.noaa.gov/OC5/woa18/woa18data.html

- L. 99-100: Changing the Amundsen Sea temperatures to -1.25°C is quite an issue. Does it mean that PICO produces overly high melt rates in the Amundsen Sea, or that PISM cannot handle melt rates close to observational estimates? In Levermann et al. (2020), a similar correction is done to -0.37°C with a claim that this possibly represents pre-industrial conditions. This needs to be discussed, and what’s happening for uncorrected temperatures needs to be shown in this paper. It is a crucial point because (1) the Amundsen Sea is our best present-day test for future warm conditions, and (2) the small sensitivity reported in this paper with the ISMIP6 framework could be due to this artificial cooling in the Amundsen Sea.

- L. 103: Is NorESM1-M used from1850 onward? I don’t understand what is the “new

climatology" and how it is used.

- L. 104: Not clear, what "ISMIP6 ocean forcing" refers to? It has just been explained that PICO is used, "initialized with an ocean data compilation from Locarnini et al. (2018) and Schmidtko et al. (2014)", with additional CMIP5 anomalies. Is there anything else to add?

- Arriving at section 3, it is surprising to see several CMIP5 models while only NorESM1-M was mentioned in section 2. The use of several models (all starting from NorESM1-M's 1850-2014 period) should be described in section 2. The methods should be understandable without knowing the full ISMIP6 framework.

- L. 124: "basal mass balance increased" or basal mass balance DEcreased? Same in Tab. 1, should SMB and BMB have the same sign for ice-sheet mass loss? Maybe just a matter of taste. . .

- Section 3.1: it might be clearer to define the "ctrl" experiment in section 2, and to explain how it is designed: which part of the historical forcing is kept constant until 2100?

- Tab. 1 and section 3.2: please briefly define "asmb" and "abmb" so that it can be understood without having to read Seroussi et al. (2019).

- Throughout section 3: In view of the drifts in ctrl vs ctrl*, it is expected to see different mass loss for the two initialisations. All the plots and mass loss estimates could be calculated with respect to ctrl or ctrl*. . .

- L. 146: you could cite Edwards et al. (2019) here as it revisits several previous estimates.

- L.147: it is difficult to visualise the 50%. You could consider redo Fig. 2 with ctrl and ctrl* subtracted.

- Section 3.4: The differences between the initial state used for PISM-PIK in Levermann

et al. (2020) and the one used for LARMIP-2 PISM simulations should be summarised somewhere in this manuscript. Without this it is difficult to understand what to expect from this section.

- Section 4.1: here only NorESM1-M results are shown because it "shows highest mass losses of all ISMIP6 experiments". This is true for the total Antarctic mass loss, but the results considering individual sectors (as in Fig. 4) may be higher in other models. Furthermore, LARMIP-2 is based on a CMIP5 19-model mean, so it seems more appropriate to use the ISMIP6 multi-model mean here rather than just NorESM1-M.

- L.224-225: It is true that tuning C and $\gamma$T would "affect the comparison of sub-shelf melt rates to present-day observations". But (1) the input temperatures have been modified compared to the initial tuning of PICO, and (2) it could also be argued that the important observational target is not the ice-shelf average but the average in PICO's box 1 (near grounding line). In view of Reese et al. (2018b), this is what matters the most for buttressing, isn't it?

- Section 4.2: The sensitivity used in LARMIP (7 to 16 m/yr/K) was estimated from plume models (Jenkins 1991 and Payne et al. 2007). It is discussed in the manuscript as if these were well-established values. These numbers may be acceptable, but there have been a few observational and more complex modelling studies since then, which have estimated sensitivities to ocean warming. It would be useful to mention whether these numbers can still be considered as plausible (Naughten et al. 2018; Séroussi et al. 2017; Jenkins et al. 2018). Besides, it is possible that the ocean sensitivity depends on the ice shelf under consideration (for example because ocean heat entering a very large ice-shelf cavity will be entirely consumed, while only a part of the available heat is consumed in smaller cavities, which may be captured by PICO?). Please also discuss these aspects.

- L.225-227: a similar correction has actually been applied to the Amundsen Sea in





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