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Interactive comment on "Glacial cycles simulation of the Antarctic Ice Sheet with PISM – Part 2: Parameter ensemble analysis" *by* Torsten Albrecht et al.

Anonymous Referee #1

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1 Overall assessment

This study presents a large ensemble modelling of the Antarctic ice sheet over the last two glacial cycles with the PISM ice-sheet model. The ensemble reveals clusters of best fit parameters that are evaluated against a series of constraints related to the present-day ice sheet and glacio-geological evidence. Results of the best fit(s) reveal the deglaciation history of the Antarctic ice sheet (in line with previous results reported in Kingslake et al., 2018) and show the major ice loss after MWP-1A.

My first concern is the choice of the sensitivity parameters in the ensemble, which is

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limited to four factors: ice softness (ESIA), sliding plasticity (PPQ), precipation scaling (PREC) and mantle viscosity (VISC). Similar studies also explore the sensitivity of sub-shelf melting and how it relates to changes in far-field/continental shelf ocean and salinity in terms of oceanic forcing. Especially with respect to the explanation of MWP-1A, ocean forcing and its relation to sub-shelf melt may have played a crucial role (Golledge et al., 2014). Similar sensitivities have been explored in Pollard et al. (2016). Why are such parameters not taken into account, both sensitivity parameters within PICO, but also sensitivity to forcing, i.e. relation between atmospheric/ocean temperature forcing, for instance? As I understand from the paper, ocean temperature/salinity changes in the far field are not considered, neither through an offline ocean model, nor a parameterization that links atmospheric temperature change to oceanic temperature change. This is extremely important, as the conclusions with respect to the deglaciation do not take into account this sensitivity, hence show a large deglaciation pulse significantly later than the occurrence of MWP-1A. Many studies have shown the importance of the ocean in the dynamics of the Antarctic ice sheet, but neither the sensitivity (of PICO) or any ocean forcing has been investigated.

A related question is why choosing those four parameters (ESIA, PPQ, PREC and VISC) and not others? Have other studies or previous experience shown that these are the most sensitive/critical? Some explanation should be given.

A second concern is about the novelty of the study, that methodologically is heavily relying on Pollard et al. (2016) and is basically performing the same analysis. However, a clear rationale on the choice of the boundaries for the parameter changes is lacking. Moreover, as shown in Figure 4, clear clusterings in misfit show up and best fit results are generally found in a much smaller range of parameter values (basically the range of two values for each parameter. Therefore, it seems to me that a smaller range subsampling would lead to an improved fit, hence reduce the uncertainties of the whole ensemble.

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2 Specific remarks

Line 153: in -> to

Line 180 and following: All scores are aggregated into one score, thereby giving them an equal weight. However, some constraints are more reliable than others. Would different weighing lead to different results? Is there a certain bias towards one or several parameters; in other words, what is the result if scores would be calculated separately? Does this lead to the same clustering? Which scores are more representative?

Line 256: intermediate values of mantle viscosity give the best results. However, these are values for the whole Antarctic continent and several studies show that there is a distinct contrast in mantle viscosity between WAIS and EAIS. Would this not explain the best score (mean of both extremes)?

Line 278-79: why high basal friction? The power of the friction law only determines how sliding scales with τ_b.

Figure 4: see general remarks: clustering demonstrates that the sampling range is too large and can be refined.

Line 334: sub-surface melt: ambiguous, could point to melt occurring just below the surface. Using a term as sub-shelf melt is more appropriate.

Line 378: remove 'with' and add year of communication.

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