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Interactive comment on “Simulating the Antarctic ice sheet in the Late-Pliocene warm period: PLISMIP-ANT, an ice-sheet model intercomparison project” *by* B. De Boer et al.

Anonymous Referee #2

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Review article : Simulating the Antarctic ice sheet in the Late-Pliocene warm period: PLISMIP-ANT, an ice-sheet model intercomparison project By De Boer et al.

This paper presents an intercomparison of ice sheet models simulating the Antarctic ice sheet during a warm interval in the Late-Pliocene (PRISM interval $\sim$ 3 million years ago). This period is interesting because it could be considered as an analogue of the projected future climate and it is crucial to assess to which extent ice sheet models are able to reproduce sea-level rise at that time as deduced from paleo sea-level reconstructions. This article is the output of the Antarctic part (PLISMIP-ANT) of the international Pliocene Ice Sheet Modeling Intercomparison Project.

Six existing numerical ice sheet models have been used, all of them able to deal with both grounded and floating ice. The comparison is based on four sensitivity experiments for both present time (control) and Pliocene, all consisting in “steady state” experiments, ie. long enough simulations to obtain an ice sheet in equilibrium with the given climate. Considering the other uncertainties, this steady state approach is appropriate. The models are forced with HadCM3 atmosphere–ocean climate model runs for the pre-industrial and for the Pliocene. In this last case, a substantially reduced Antarctic configuration (PRISM3) was used as a boundary condition for the atmosphere-ocean model, so the climate itself is based on a reduced Antarctic ice sheet. On the ice sheet modeling side two experiments were performed, one starting from the present day configuration, on starting with the PRISM3 reduced ice sheet. This allow to assess the impact of the initial ice sheet. The paper also points out the influence of the bedrock map used, bemap2 giving significantly larger contribution than bedmap1 in East Antarctica (Wilkes and Aurora basin). The experimental design is clearly described.

This article presents a real interest both for paleo studies and to asses the mechanisms and amplitude of sea level rise in response to global warming. However, if we want this intercomparison to be useful to improve ice sheet models and projections over the next centuries, it is crucial to understand why the models behave differently.

The major reproach is that the grounding line migration is almost not dealt which in the paper while many studies have demonstrated that it is a key isssue. Solving shallow equations for both grounded ice and ice shelves is not sufficient to simulate grounding line migration. We know from the various MISMIP experiments that only a specific parameterization prescribing ice flux at the grounding line allow for a proper grounding line treatment at the time scales considered here. Some other crucial processes such as calving or basal drag are not detailed enough. I understand that this comparison was done with existing models and that no specific development were done, but at least the new version of the paper should:

Be careful that the models descriptions are more homogeneous and all include how are modeled the following processes: -Grounding line. This is the most important. How is it done (flux or other specific parameterization, subgrid, or no special care), what is the resolution at the grounding line (if a subgrid is used). - How is implemented basal melting right at the grounding line. It seems a technical aspect but it is a well know trick to make a grounding line retreat for the wrong reasons. It seems especially important to know for SICOPOLIS (see p. 5553) that has a specific value at the grounding line (high) and no treatment of the GL migration. - calving, both in the case of retreat and advance (many calving schemes prevent ice shelves to grow). - basal drag (or distribution of sliding coefficient). If it has been calibrated to give a steady state for present conditions, with which atmospheric fields ? - are all the models on a 40x40 km grid ? (as are the projected forcing fields)

This could be done quite easily in table 3 with eventually details in the text (preferably more explicit than for instance the following description in AISM-VUB "coupled across a one grid-box wide transition zone").

In the results analysis, try as much as possible to make the distinction between surface mass balance effects and dynamical effects (likely driven by oceanic forcing). For instance, systematically discuss the extent versus the volume. How much does the extent explain differences between volume, can you explain the spread of the models as a function of grounding line retreat in figure 8 (and 7)

A major finding in this intercomparison is that, for Pliocene climate, the initial ice sheet geometry plays an important role on the final (at steady state) ice sheet with always a larger ice sheet when starting from the present day (larger than PRISM3) geometry. Both Pliocene simulations were done with the same forcing fields (except for surface temperature that is corrected with a lapse rate). This raises questions that have to be discussed. Are there two branches depending on the initial condition and if so, are these branches numerical (due to grounding line modelling or is it an ill-posed problem) or are they physical (due to various feedbacks, and then which ones)? Is it a general

behaviour for antarctic models if they were applied to other time slices / climate ? This could be tested by an additional experiment with present day climate and initial PRISM3 ice sheet.

detailled comments in the supplement file

Please also note the supplement to this comment:
http://www.the-cryosphere-discuss.net/8/C2835/2015/tcd-8-C2835-2015-supplement.pdf

Interactive comment on The Cryosphere Discuss., 8, 5539, 2014.