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Interactive comment on "Modeling the response of Lambert Glacier–Amery Ice Shelf system, East Antarctic, to uncertain climate forcing over the 21st and 22nd centuries" *by* Y. Gong et al.

Anonymous Referee #1

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This paper addresses the impact of increased ice-shelf melting on grounded ice volume (VAF) of the Lambert Glacier/Amery Ice shelf system. Model simulations until the year 2220 use data sets from two ocean circulation models and two atmospheric models yielding basal melt rates and surface mass balances as perturbation under several climate scenarios.

The main outcome of the manuscript is the apparent stability of the Amery catchment area, even in case of complete removal of the Amery Ice shelf within a few time steps. Moreover, increased surface accumulations from atmospheric projections will compensate accelerated outflow from the ice sheet due to a thinning ice shelf.

The applied ice model uses adaptive mesh refinement (AMR) which in principal is a sophisticated method to handle the flow across grounding lines. In contrast, the model setup falls short. Unlike the SMB projections, which were directly adopted from two atmospheric models, the chosen perturbations at the ice-shelf base are rather questionable. This holds for all experiments except the "FESOM" simulations and is one of my main concerns. Nothing is said about basal melting at new ice-shelf nodes after the grounding line would have retreated. I wonder if neglected melting would exclude a more drastic retreat of tributary glaciers, particularly if they flow over an inland deepening bed.

The structure of the paper is okay, but the quality of the presentation is far from being acceptable. Text and figures need to be thoroughly revised.

I can't recommend the current paper for publication. Instead, I would reduce the experiments to the FESOM and the S0 cases. The latter stands for an instantaneous disintegration of the ice shelf and causes the highest impact so far. If, using an extra parametrization for melting at new ice-shelf nodes wouldn't change previous results, the conclusion about the stability of the catchment area would become much more confident.

General remarks

A main caveat concerning the model setup is the performed use of basal melting data. I do not understand why the authors decided to use averaged values of available basal melting. By looking into Timmermann & Hellmer (2012), basal melt volumes from BRIOS and FESOM are strongly time dependent. The used method will bring forward the strong FESOM signal from the 22nd century.

Unlike FESOM, BRIOS data cover just the northern part of the Amery Ice Shelf. But according to Walker et al. (2012) the distribution of melting is essential for the stability of grounding lines. Thus, neglecting melting in the deep places inevitably will lead to an advance as can be seen in Table 3. I think, BRIOS data cannot be used at all to

investigate a grounded-ice volume loss.

Further, nothing is said about melting under new ice-shelf areas evolving from a retreat of the grounding line, though the freezing point of a deep-drafting base would favor high melting and possibly a more vigorous retreat.

I'm missing a plot of the bedrock elevations to get an idea about how far the Lambert Glacier is from floatation. An inland deepening bedrock could favor grounding-line instabilities in particular because the used ice model is able to represent high velocities of a narrow Lambert Glacier.

The classification of WC, BC, N1 and N2 is confusing. I had to read the text and tables several times before I understood the meaning.

Generally, the figure captions have to be revised. A better description of important features is essential.

Specific comments

There are several typos in the text which I don't point to.

p 5688, from 6: This chapter describes model initialization and a relaxation towards a steady state. I understand that Ms-0 is not derived for the ice shelf. If so, Mb-0 covers both, surface accumulation and basal melting or freezing. Why and how are you decomposing Mb-0 – or is the distribution just a result of the continuity equation? Anyhow - you must present a plot of Mb-0!

p 5688, 19: 'adding' should be 'replacing' if the perturbations are not changes with respect to Ms-0 and Mb-0. You have to reveal that just deviations from Ms-0 and Mb-0 had been added in your experiments. If not, the VAF is overestimated by mistake due to wrong accumulation rates. Also, the ice shelf's thickness and velocity field would be affected. P 5689,14 and 24 seem answer to this comment.

p 5690, 4: You are certainly aware that a melt rate of 1000 m/yr is physical impossible.

The reader should know that this number is virtual and just a synonym for 'instant ice-shelf disintegration'. Presumably, 839 m/yr would lead to the same results.

p 5690, 12: This sentence undermines the profit of AMR methods. Where in the text could I check the given imbalance (percentage)? Do we learn something about the smallest resolution necessary?

p 5691, 4: A – Aitof should read A-A'. You should introduce this as an intended along-flow profile. (comment at fig. 5). It seems that the profile touches grounded areas in two places.

p 5691, 23: Suddenly, this statement appears and there is no reference to a place in the manuscript, where it could be checked. Figure 4 which was mentioned in the line above, doesn't help though.

p 5694, 8: There is absolutely no reference for Tamean explaining its relevance for the conclusion drawn in this sentence.

Figures

Fig. 1: The figure is to dark, the mesh unclear and the grounding line not visible. The finest resolution is 625m.

Fig. 2: o.k.

Fig. 3: Figures are too small and grounding lines are not visible.

Fig. 4: o.k.

Fig. 5: What means 'left 2 columns'? Figure annotation numbers differ from those given in the caption. S0 case should give zero velocity numbers on the ice shelf. Does the profile perhaps cross the grounding-line? Was is the reason for the difference in maximum S0-velocity (2500 m/yr vs. 1600 m/yr)?

Fig. 6: Changes in grounding-line position are hardly visible. S0 velocities should be

zero for the entire ice shelf.

Fig. 7: A legend should be included.

Tables

Tab. 1: The caption needs to provide more information. Why is Tamean not given for RACMO? Use extra column for temperature. Explain trend parameters.

Tab. 2: Caption has to be revised.

Tab. 3: Why are data for S1 to S5 missing?

References

Agosta et al. (2013) is just an abstract.

Beckmann et al. (1999): Hellmer et al. (2012) is the appropriate reference for basal melt rates used in this manuscript.

Colella et al. (2000): Perhaps there is a citable application of this method available?

References cited by the reviewer

Hellmer, H. H. , Kauker, F. , Timmermann, R. , Determann, J. and Rae, J. (2012): TwentyâĂŚfirstâĂŚcentury warming of a large Antarctic iceâĂŚshelf cavity by a redirected coastal current , Nature, 485 (7397), pp. 225 âĂŚ 228, (2012)

Walker, R. T., Dupont, T.K., Parizek, B. R. and R. B. Alley. Effects of basal-melting distribution on the retreat of ice-shelf grounding lines, Geophys. Res. Lett., 35, (2008)

Interactive comment on The Cryosphere Discuss., 7, 5683, 2013.