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# *Interactive comment on* "Comparing ice discharge through West Antarctic Gateways: Weddell vs. Amundsen Sea warming" *by* M. A. Martin et al.

**M. A. Martin et al.**

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1. General Comments

My review is in the line of the first reviewer. While I also appreciate the conciseness of the paper, clarifications and additional discussions are required. In a journal like The Cryosphere, we can anticipate that most of the readership of this paper will have at least some knowledge on ice flow modelling and will be also interested by the technical aspects of the paper. Thus, I think that the technical parts presented in the Appendix should be included in the main text and expended.

Author Answer: We would like to thank the reviewer for taking the time to read and evaluate this manuscript. We have now included the technical parts from the Appendix into



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the main text and expanded it, in particular with regard to the requests for clarifications.

My main concern is that, looking at Figure 7, the projected SLR seems to decrease with the mesh resolution. SLR and Rate of SLR is halved when the grid size is decreased from 5km to 2.5km for the Amundsen sector. Looking at Durand and Pattyn (2015) in open discussion, this result could be the sign that the grounding line retreat is forced by the melt prescribed at the grounding line and not by internal ice dynamics. As the results for the Weddell-Sea are not shown for the grid resolution of 2.5km (which is still a coarse grid resolution to capture grounding line dynamics according to the MISMIP intercomparison results), I am not totally convinced that the difference between the two sectors is really physical and will persist if the grid size is further reduced.

Author Answer: The question of the resolution is indeed crucial. While it was computationally feasible for us to perform the simulations on the 2.5 km resolution for the Amundsen Sector, this was unfortunately not possible for the Weddell Sea Sector. We have nevertheless opted to perform those 2.5 km resolution simulations, even if we cannot compare the results between the basins. The reason for that is that we could thereby test one important thing: Would the “shape of the curve”, which distinguishes Amundsen and Weddell results so clearly, persist if the grid resolution was further reduced, at least for the Amundsen sector? It does, although the results are of course not necessarily reliable quantitatively. We cannot be sure, however, that even the qualitative difference remains the same upon further grid resolution, since we cannot reach the domain of quantitative convergence. We have now discussed this caveat more clearly in the text. The reviewer also raises the question of melt-forced retreat. We agree that the retreat is indeed melt-forced. The step-function type forcing is continued during the entire 500-year experiment and the observed retreat is not of self-sustained nature. Self-sustained retreat would become manifest much later after the forcing, as in (Mengel, Levermann 2014). But self-sustained ice loss was not the process we aimed to explore in this work. We here raise the question how the two ice basins, with their different ice- and bed topography, basal conditions and flow regimes respond to forcing



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caused by the same temperature increase in ocean water. This aspect is covered in the first sentences of the Discussion Section.

2. Specific comments

As mentioned above the Appendix should be moved to the main text to clarify the experimental design. In the main text we only learn that 22 parameter combinations are tested, but we don't know what are the parameters. It's only in the Appendix that we learn that there is 3 parameters (Fw, m and Essa). I think that it could be useful here to give the equations where these parameters appear and discussed with more detailed their role in the model.

Author Answer: We have moved these sections to the main text and given the equations.

The choice of the parameters range is not really discussed and it is really not clear how many combinations are tested for each grid resolution. It is never clear in the Figures if the results are the results for one combination of the 3 parameters (and which one), the ensemble mean, or the "representative ensemble members" mean?

Author Answer: Please excuse the confusion. We hope that we have now described the parameter choices more clearly. There is never a "mean of representative ensemble members". This specific ensemble member represents always one specific parameter combination of the 3 parameters. The figures almost exclusively show 5km results, which use one single parmeter combination as indicated in Fig. 5a by the letters W and A.

We understand that the 22 parameters are those that give the best match to observed grounding-line position, but the procedure to evaluate this "best match" is not described.

Author Answer: We have now done so. It is a "by eye" evaluation, which is possible because there is a clear border in the parameter space which separates states where



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a) either the entire basin is lost in equilibrium OR most of the shelf area becomes grounded and b) where this is not the case.

The computation of the basal melt rates is only very briefly described but as this is the external forcing studied in the paper, this is a key point. However we read in Appendix A2 that it "roughly adapt" to changing shelf depth and that it's "not particulary realistic". More attention should be devoted to the description of this implementation and to the discussion of the assumptions and their potential effect.

Author Answer: This is of course true, thank you for putting your finger on this. We have now discussed this in more depth.

P1709, l1 to l14; discussion on the mesh resolution and uncertainty associated with model parameters: I agree that there is a large uncertainty associated with the model parameter choice and that most of the paper discuss this point. However, even if the results should not be understood as projections, they are used to conclude that the Weddel-Sea sector is more sensitive to ocean warming than the Amundsen-Sea sector. As mentioned in my general comments I'm not totally convinced that this result is really robust as I would expect some kind of convergence of the results when the mesh size is decreased; which is not the case here when the grid size is decreased from 5km to 2.5km.

Author Answer: Yes, this is true. We cannot be entirely sure (due to limitations in reaching finer grid resolutions), which prevents us from reaching the domain of convergence. We do believe, however, that our experiments, covering a wide range of grid resolutions and parameters, provide a strong indication that the results are indeed robust. We have now clarified this caveat more clearly in the manuscript (Sect. 2.4)

3. Technical comments

p1706, l8: "At the same time, regional ocean projections show much stronger warm-water intrusion into ice-shelf cavities in the Weddell Sea compared to the observed



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Amundsen warming"; Is that projections for next century? What is the status for present day? I think this is what confused the 1rst reviewer, the Amundsen-Sea sector is actually changing because warming as started while warming is "projected" for Weddel sea sector? This needs to be clarified.

Author Answer: Done

P1708, l14, "22 parameter combinations": As mentioned above describe the parameters, the sampling etc.. in the text and not in an Appendix.

Author Answer: Done

P1708, l24, "representative ensemble members": In don't clearly understand from the appendix how many members are chosen as representative and the values of the parameters (The value for one representative member are given, is there more representative members?) P1710, l15, "representative ensemble members": Idem, are the results a mean of the members or is there only 1 representative member?

Author Answer: We have clarified this. There is always only one representative ensemble member presented, but they differ for the two basins at 5 km resolution.

P1714, l7-8:give more details on the climatic input, i.e. representative of present day?

Author Answer: It is representative for present day (1980-2004, see Berg et al, 2006). We detailed this in the text now.

Fig. 1: Is the ratio H/Hf from model results or data? Grey lines are hardly visible.

Author Answer: The ratio is simulated in equilibrium. (Mentioned in the caption now) The choice of the color grey is an attempt to make the lines visible both against the white and the dark blue color. We have tested several colors, but this seems to be the best choice.

Fig. 9 : The discussion on the choice of the representative members should be moved to the text and detailled.



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Author Answer: Done

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Interactive comment on The Cryosphere Discuss., 9, 1705, 2015.