

Interactive comment on “Improvements in one-dimensional grounding-line parameterizations in an ice-sheet model with lateral variations” by David Pollard and Robert DeConto

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This paper described a modification to the 'PSU3D' ice sheet model, which has been used to carry out a wide variety of Antarctic simulations and has been used to produce some of the highest profile results in that field. The model is perhaps the best known of a number that determine an ice flow velocity across the grounding line from an analytic expression derived by Schoof (2007) that applies to 1D flows without buttressing, adapted in some way to higher dimensional flows with buttressing. The signal characteristic of these models is that they perform far better than conventional models (that do not make use of the analytic expression) at low resolution (~ 10 km). Conventional

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models must be run at far finer resolutions (1 km) to produce plausible results. There are still discrepancies between these groups of models when the conventional models are run at fine resolution, and the modification in this paper addresses the difference that was evident in the MISMIP+ model comparison.

I think this is a good paper that describes its methods well and shows clearly the impact of the modification. I recommend publication, but ask the authors to consider two points (see general comments)

1 General Comments

The modifications described have an impact on the MISMIP+ results (a narrow channel with strongly curved grounding line) but little impact on the (probably more interesting) Antarctic experiments. One interpretation (and the interpretation given here) is that the unmodified model was already computing the relevant quantities well enough. That could be the case. But there is another source of information on this point: the ABUMIP comparison, which is set in Antarctica. This is in review, but the authors of this paper are co-authors of that paper, so are aware of its results. It seems that PSU3D is 'in the envelope' there, as well (at least from the figures I have seen), which seems to be further evidence in support of the author's position. Perhaps it is simply premature to cite a paper that has yet to be published and is not in 'open review', but it seems a shame to miss out on that extra evidence (I see that Frank Pattyn has also reviewed this paper and of course knows the ABUMIP results much better than I, so he may have more to say on that, but I have not looked for the sake of an independent review)

There is quite a lot of material on brittle failure / cliff collapse (section 5). I don't disagree that ice sheet modellers should be taking these things seriously, but it seems also a bit tangential to the topic of the paper. I don't think it detracts from the paper in any serious sense.

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2 Specific Comments

Abstract, L10 "...presumably because dynamics in the wider major Antarctic basins are "adequately represented by the model's previous simpler one-dimensional formulation". see general comments - ABUMIP seems to support the case too.

L27 "Here we implement a more rigorous," Rigorous (as in mathematical rigour) does not seem like the right word, lacking a formal analysis of error. Complete?

L177 (MISMIP+ experiments). What is the value of A ? In MISMIP+, PSU3d used a quite different value from other models to place its initial grounding line. Is that still the case?

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