

Interactive comment on “A three-dimensional full Stokes model of the grounding line dynamics: effect of a pinning point beneath the ice shelf” by L. Favier et al.

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The paper presents a state-of-the-art 3D full Stokes model of the grounding line dynamics and shows the stabilizing effect of pinning points through two numerical experiments. The complexity introduced by the full Stokes system in an area where a mesh refinement of tens of meters is needed, presents a very challenging problem that it is crucial to solve in order to understand the dynamics of the area. This paper analyse the main difficulties of the problem and show the evolution of the grounding line in two controlled scenarios. I believe this papers shows a step in the right direction and I recommend its publication in The Cryosphere.

C1098

I don't have any major criticism of the paper as the authors point out the main model limitations, i.e., the mesh-dependent results and the fixed grid that only allows the use of the model in controlled experiments. I have written bellow some comments and suggestions, mainly to include a sensitivity study of the mesh dependence in the verification section, eliminate Table 2, Figures 2, 4 and 6, and rewrite Section 2.5 and the Conclusions.

English is not my first language but the paper seems to be well written. I have to admit I find it wordy and, as I have written above, repetitive in some sections.

General comments

It is my understanding that the word “validation” is used to determine the ability of the physical model to describe reality, and “verification” determine that a computational model accurately represents the underlying mathematical model. In this context I would suggest to use the word verification instead of validation in Section 3.

My main concern about the results presented in this paper is the mesh dependency. The rational is that the sensitivity of the results to the mesh should be insignificant when compared with the typical scale of the problem. But in the model verification Section the authors show a mesh dependent offset of the grounding line 1km when the results show a divide migration of 3-5km. I believe that the paper would benefit from a discussion about this mesh dependency and I would find interesting a Figure showing grid sensitivity, in particular convergence of the solution with mesh refinement.

Most of the Section Conclusions is just a repetition of Sections 3 and 4. Most of the rest should be better placed on Sections 3 and 4 in a Results and Discussion Section or in another new Discussion Section. I really think that this Section needs to be rewritten and Conclusions should be a concise Section highlighting the paper main findings.

Specific comments

Abstract

C1099

1996 L2-L6 Excessive repetition of i.e. in the abstract.

1996 L7 I would say the word “mathematical” is unnecessary.

1996 L14 The word “demonstrate” has a very strong meaning in science, why not use the word “show”.

1996 L14 is it me or “multiple grounding lines” sounds confusing? What about “a curved grounding line and the effect of pinning points under the ice self”

1 Introduction

1997 L7-L16 I find this few sentences awkward to read. What about talking first about the source of instability and explain at the end that recent studies point out to potential instabilities in East Antarctica as well?

1999 L13 I would use advection equation instead of local transport as it is more concrete and descriptive.

2 Detailed description of the model

2000 L2 I would add that you are using a full Stokes solver.

2000 L8 I wouldn't talk about the linear mesh in this Section. In my opinion is better to separate mathematical model and numerics.

2001 L9 Again I would suggest using “advection” instead of “local transport”

2.5 Model algorithm

2005 L10-20 I find this Section too long and in particular this paragraph is mostly unnecessary.

2006 L7-11 I may be missing something but I fail to see the interest of how the authors label the nodes and I can't see the significance of Figure 4.

3 Validation of the 3-D full Stokes model

C1100

2007 L3-6. I don't understand what plane of longitudinal symmetry the authors are referring and how only half the domain is taking in to account. Do they mean the xz-plane at y=50km?

2008 L4 I don't see Figure 6 bringing anything interesting to the paper.

2008 L11 Figure 7b is not showing velocity, parenthesis should refer the reader to Figure 8

2008 L13 there is a reference to Figure 9 but I can not see the volume change for the verification experiment in Figure 9.

2010 L8-11 I find a bit weird justifying this oscillations with Schoof theory when the final state of the grounding line presented in Figure 13 is precisely in the up-slope side of the bedrock bump. I would write something as “this oscillations could be related with”.

Table 2 Is this table really necessary?

Figure 2 This highly detailed table together with the description in Section 2.5 is very repetitive and unnecessary. A sort paragraph describing the algorithm and how to solve the contact problem would be in my opinion more effective.

Figure 12 dashed black line?

Figure 13. It could be me being particularly slow but I find that Figure very difficult to understand.

Interactive comment on The Cryosphere Discuss., 5, 1995, 2011.

C1101