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The Cryosphere Discussions

Interactive comment on "Ice-shelf buttressing and the stability of marine ice sheets" *by* G. H. Gudmundsson

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General statement:

The study investigates the effect of ice-shelf buttressing on dynamics at the grounding line and its relation with the stability of marine ice sheet on retrograde bed slope. It is based on two horizontal dimensional experiments performed with an SSA ice-flow model (so-called 'Uà'), described in the companion paper 'The stability of grounding lines on retrograde slope'. The paper emphasizes the non-monotonic behaviour of the ice flux at the grounding line as a function of thickness due to ice-shelf buttressing effect. This paper is novel and strong in the sense that it quantitatively and physically demonstrates for the first time this 3D pattern, questioning the marine ice sheet instability commonly established for retrograde bed slope configuration. It particularly

gives some answers to questions asked in Schoof, 2007 (paragraph 4.2) concerning the limitations of the boundary layer theory to confirm stability and hysteresis for 3D problems. The paper is clear, with method and results progressively well described. I therefore recommend this paper to be published in The Cryosphere before addressing corrections suggested below.

Specific comments:

My main comment concerns the comparison between the computed flux from your model, considering the calculated normal buttressing ratio and the flux that would be obtained with the Schoof 's formula expressed through the Eq.(17). The absolute relative difference is represented in Figure 4 for the whole points of the grounding line and, if corresponding values are close to zero for the points where flux is the highest (high values for velocity and thickness), most of the grounding line is characterized by quite high values (zone where we don't fulfill validity conditions for boundary layer theory ?). So as to make the comparison with the Schoof's parameterization possible (non-monotonic behaviour), you have chosen to take the medial line to make all figures. However, in order to underline and illustrate your conclusions concerning the agreement of both fluxes (from Schoof's formula and from your model), it could be interesting to compute the whole flux, integrated over the horizontal distance (along the grounding line) and compare the value between both methods (your model and boundary layer theory).

Technical comments:

p3940, l.1: 'it it is now generally...': remove one it

p3944, l.10: 'hence, in 1HD, the stress...are identical': I suggest to already mention here that this is only the case for SSA approximations, and not for full-Stokes.

p3944, l.19:'In 1HD the ice-shelf buttressing numbers KN and KN' : KT instead of KN.

p3945,l.13-14: 'Provided some simplifying assumptions-similar to but somewhat

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stronger than those leading to....': I suggest to define more precisely the assumptions you mention.

p3946, l.22: 'Here that bed profile...': I would have rather used 'this' instead of 'that'.

p3948,l.11-14: 'The numerical model has been .... ': I would have put this paragraph in the beginning of part 4. Numerical model.

p3949, l.3: 'before moving the the...': 'to' instead of 'the'.

p3949, l.23-25: I would have specified again here that the normal buttressing number is equal to zero for SSA model (and not for full-Stokes).

p3950, l.16: 'model intercomparision': intercomparison instead.

p.3951, l.14-15: 'This result gives increased confidence...in large-scale flow models': I would have specified that this confidence arises for steady states only (conditions for the validity of the flux parameterisation).

p.3951, l.21-22: 'Fig.5 shows numerically...of a number of models as a function of ice thickness': I find the term 'models' inappropriate here and I would have rather used 'run types', or 'experiment', otherwise it seems to refer to a model type rather than to a the range of experiments, which I guess is suggested.

p.3952, l.6: 'For those models....': same remark as before.

p.3952, l.16: same remark as before.

p.3952, l.13: 'percent' instead of 'prectent'.

Fig.4: negative value for the colorbar are not visible.

Interactive comment on The Cryosphere Discuss., 6, 3937, 2012.