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Review of Ice-shelf buttressing and the stability of marine ice sheets (G H Gudmundsson)

19 November 2012

This paper is essentially a companion paper to the paper "The stability of grounding lines on retrograde slopes" (also on TCD, and to which I will refer to as GH12), as it represents a more in-depth analysis of an aspect of the experiments in that study, namely the stress balance. Ice shelf buttressing is oft-talked about but rarely examined quantitatively, which is what is done here for the experiments in GH12. There is a somewhat lengthy discussion of the notion of buttressing and the balance of stresses at the grounding line, but I think this might be good for someone not as familiar with the literature. Some metrics used to examine buttressing are defined, and discussed in the context of previous experiments, and various parameterizations for grounding line flux.

I think this is a strong piece of work and deserves consideration, but not until some issues are addressed. I have some comments on the manuscript, and also I disagree with one of its main conclusions (below).

1. I looked both in this manuscript and in GH12, and I could not find the answer: aside from the calving front stress condition, what were the lateral boundary conditions on the "Ua" model? From GH12, Fig 2, it looks as though there might be no-slip sidewalls up to x=1500 km, and stress-free sidewalls downstream of that, but I am not sure.

2. It is stated on page 3940, and I think elsewhere as well, that "unconfined ice shelves do not cause any buttressing". This is not strictly true, and I am not talking about higher-order models. What is true is that the *contour integral* along the grounding

to take on faith that it will lead to reliable results, given that the conditions where we would expect it to be accurate are difficult to assess a priori, seems a bit risky to me. But also, the conclusion is based on the assumption that flux across the GL does not matter in those regions where agreement is poor, e.g. the margin. I don't think this is true. Even though velocities normal to the GL are much smaller than those transverse to it, situations could arise where the mass flux normal to the GL is an important factor in evolution of ice shelf thickness close to the margin. And the thickness of the ice shelf near the margin will strongly effect its ability to transfer stress, i.e. its buttressing capabilities.

Some minor typos I saw:

p3944, line 14: "shelves" not "shelf"

p3946, line 16: precise

p3948, line 19: "were", not "where" (also p3950, line 13)

p3951, line 22: "case", not "cases"

p3953, line 2: I understand this sentence, but it is *really* awkward

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