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Interactive comment on "Modelling the impact of submarine frontal melting and ice mélange on glacier dynamics" *by* J. Krug et al.

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This is an interesting modeling study looking the effects of ice melange and submarine melting on tidewater glacier behavior. The model used is an advanced flow line model that incorporates damage mechanics to simulate the propagation of crevasses and ultimately calving. This paper should be published. I do have a few questions and comments that I hope will be addressed:

1) The geometry chosen is one with a positive bed slope, when it is well known that many of the interesting phenomena on tidewater glaciers occur on negatively sloped beds. What motivates this choice? Will the model simply lead to too many instabilities?

2) I think floating tongues are not properly treated here. On temperate glaciers they

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are rarely observed. The reason, I believe, is hinted at in the paper: under floating tongues the melt rates are so high that it would quickly become unstable and fall apart. If near-glacier fjord circulation is driven by subglacial freshwater discharge, as seems reasonable, then the near grounding line melt rates would have to be very large. I therefore question the choice of a floating-tongue glacier as the control run; it is likely not a good representation of reality.

3) The basal boundary condition should be explicitly stated, rather than just via reference to Krug et al. (2014) (The flip side is that it made me go look at that paper, which is impressive work!). Again, a lot of interesting tidewater glacier behavior is tied to sliding laws that are effective pressure dependent and thus lead to acceleration upon thinning (e.g. Pfeffer, 2007, JGR). Perhaps it is not so relevant in the positive bed slope, but it is important enough to clearly state in the paper.

4) Is it important that the upstream flux is fixed? I am wondering whether the glacier can be 'supply starved', i.e. higher terminus fluxes would occur if the glacier could supply them? This is perhaps outside the scope of this paper, but is an important question for ice sheet evolution.

Below is a list of detailed comments in order of occurrence:

p.184, l.16: heaviest -> strongest

p.184, l.21: delete the second 'pathways'

p.185, l.13: what do you mean by 'unavoidable mechanism'?

p.185, l.15: there is no force imbalance, is there? Forces are always balanced. What are feedbacks between ice discharge and ice flow, isn't that the same thing?

p.189, l.16: Can you specify exactly how calving happens? If a crevasse penetrates to full depth, that ice becomes part of the melange and the glacier boundary jumps back, correct? This might be nice to clarify in light of the discussion 5.1 where a comparison with Amundson et al's results are made. Those authors calculated a force balance on

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an ice berg that is fully separated from the glacier, but prevented to rotate by the ice melange.

p.190, l.7: It might be worth mentioning shortly what LHS is or give a reference.

p.190, l.19: This sentence is hard to understand. Are you simply stating that the upstream boundary is that of a constant flux?

p.192, l.6: Motyka et al. (2013, GRL) is also a good reference for showing the dependence of melting on subglacial discharge

p.194, eqn (5): The onset of freezing on Jan. 1 seems rather late, no?

p.197, l.10: 'do not' -> 'does not'

p.199, l.8: I don't understand that sentence ('when the glacier undergoes the melange layer')

Fig. 6 and 8: What is the daily normalization you refer to?

Fig. 10: why the strange upside down order? What does 'undergoing an ice melange' mean?

Fig. 11: the caption could be clarified a bit. Currently it only becomes understandable together with the text. What is a 'ratio between summer and winter events' or 'the mean length of the front retreat ratios'?

Martin Truffer

Interactive comment on The Cryosphere Discuss., 9, 183, 2015.