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2022-11-06

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Response to reviewer four, Prof. Jeremy Bassis

We are grateful for your comments on the manuscript, and have made many changes which we believe have led to considerable improvements. Please see below for responses to the general comments.

The main changes are:

- A new model limitations section

Additionally, we have run three additional simulations to allow exploration of the impact of a different sliding law, the impact of a more gradual undercut geometry, and the impact of having no tidal fluctuations in the model.

The original comments are shown in bold, with responses in normal typeface.

We hope you find the alterations satisfactory,

Yours Sincerely,

Felicity Holmes, on behalf of all authors

Technical and general comments

1. **My first recommendation is one that I always provide for all numerical studies. I humbly suggest that the authors consider a numerical convergence study with different element sizes and time step sizes. A few years ago, Brandon Berg and I ran into some subtle issues with the standard Elmer Ice implementation of no-penetration boundary conditions (Berg and Bassis, 2020). The effect was subtle and only manifested itself after re-meshing when we removed calved blocks of ice. However, the fix that we proposed was (I think?) incorporated into Elmer-Ice. Nonetheless, an important lesson for us based on that is to always do numerical convergence studies to make sure things behave as expected.**

Thank you for raising this issue. We have indeed run the same set-up with different time step sizes and element sizes, and not seen any noticable impacts on the solution suggesting that it has converged. However, many of these runs were conducted as part of a manuscript that is

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currently in preparation - also focusing on Kronebreen - and where we could address the convergence issue in slightly more detail. We also believe the fix to be implemented in Elmer/Ice, through reintroduction of the acceleration term in the force balance. This, too, could be a valuable addition to include in our forthcoming manuscript.

2. **The study we were trying to do when we discovered the numerical artifacts was to see if advection of crevasses was important in the process (Berg and Bassis, 2022). The Nye zero stress crevasse model assumes that glaciers have no fracture memory and that if a crevasse cannot form the detachment boundary of an iceberg, crevasses immediately close leaving no trace. When we look at glaciers, we clearly see crevasses have initiate upstream and propagated downstream. Where this is relevant is because, as other reviewers pointed out, the stress near the calving front depends on the shape of the imposed melt profile along the calving front, a small amount of crevasse advection from just upstream of the calving front could have a significant effect on the predictions any crevasse depth model. One of the conclusions from Berg and Bassis, 2022 was that advection *sometimes* mattered. The fact that advection *might* be important could be a worthwhile caveat because I wonder if you will end up with slightly different conclusions is you include advection and/or different melt profiles.**

Thank you for this comment; it is definitely interesting to consider how crevasse advection may impact the model results. As you stated, the calving model in Elmer/Ice assumes no fracture memory, but also ignores the yield strength required for fractures to initiate. We have added some discussion of this into the manuscript.