

The Cryosphere Discuss., referee comment RC4
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Comment on tc-2022-152

Jeremy Bassis (Referee)

Referee comment on "Impact of tides on calving patterns at Kronebreen, Svalbard – insights from three-dimensional ice dynamical modelling" by Felicity A. Holmes et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2022-152-RC4>, 2022

It looks like this manuscript already has three expert reviewers and I have little to add to the discussion already underway. I support publication of the manuscript and detailed reviews already provided. I will keep my comments brief to avoid torturing the review process.

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.

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 if you include advection and/or different melt profiles.

I leave these comments at the discretion of the authors to consider and I want to be clear that I am using the two cited studies as examples that illustrate my own experience working on slightly related problems and I am not requesting that the authors cite either of these manuscripts.

Berg, B. and Bassis, J.: Brief communication: Time step dependence (and fixes) in Stokes simulations of calving ice shelves, *The Cryosphere*, 14, 3209–3213, <https://doi.org/10.5194/tc-14-3209-2020>, 2020.

Berg, B., & Bassis, J. (2022). Crevasse advection increases glacier calving. *Journal of Glaciology*, 68(271), 977-986. doi:10.1017/jog.2022.10