

Review of egosphere-2024-665

This paper aims to estimate the importance of tidally-driven fracture propagation in a supraglacial lake in the Amery grounding zone. Using an idealized flowline simulation of Amery Ice Shelf, the deviatoric tensile stress at different times during the tidal cycle is estimated in a Full-Stokes model with a visco-elastic rheology. Linear Elastic Fracture Mechanics are used to estimate the stress intensity factor, and a threshold condition is used to estimate when lake drainage could occur. I found this an interesting study, proposing a plausible process for the observed lake drainage events. However, I have a few comments about the model setup and presentation that should be addressed before publication.

1 Major comments

1. I found the information provided in section 3.2 about the LEFM model inadequate – I don't think sufficient information is provided to reproduce the stress intensity factors shown in the study.
2. Part of the stress field seen in figure 3 is a result of keeping the ice thickness fixed: In full-Stokes models, when you have flow across a slip/free slip boundary, the ice surface adjusts to have a very characteristic dip just downstream of the grounding line, which is a result of the speed up across this boundary (e.g., Barcilon and MacAyeal, 1993; Nowicki and Wingham, 2008). If the surface cannot adjust, residual stresses at the surface occur. Ideally, simulations would have been done with an evolving surface, but I understand that this is beyond the scope of this study. However, to account for this limitation, the difference of the deviatoric surface stress with tides and without (i.e., for a static grounding line) should be used (which I guess would be about 10 kPa less than the stresses shown, judging from the figures 3b and d).
3. The existence of a 10 m deep lake at the ice surface imposes a pressure of about 10 kPa at the ice surface, which is not necessarily negligible. How would that alter the stress considerations?

2 Minor comments

1. Page 4, 2nd line: "the the" → "the"
2. Page 4, 2nd paragraph: "The subglacial cavities downstream of the grounding zone are more than 20 m wide." I was confused by this, as BedMachine does not have 20 m resolution. What are you referring to here?
3. Figure 1b and caption: there is reference here to σ_1 and σ_2 but elsewhere in the text you refer to principle strain rates. Please make sure this is consistent.
4. Figure 6 and corresponding text: can you comment on the zero-tidal amplitude limit? Are the results what you would expect?

References

- V. Barcilon and D. R. MacAyeal. Steady flow of a viscous ice stream across a no-slip/free-slip transition at the bed. *Journal of Glaciology*, 39:167–185, 1993.
- S. M. J. Nowicki and D. J. Wingham. Conditions for a steady ice sheet–ice shelf junction. *Earth and Planetary Science Letters*, 265(1):246–255, 2008.