The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC1
https://doi.org/10.5194/tc-2021-81-RC1, 2021

Comment on tc-2021-81

Anonymous Referee #1

Referee comment on "Geometric Controls of Tidewater Glacier Dynamics" by Thomas Frank et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-81-RC1, 2021

General comments
This manuscript addresses the impact of bed geometry to marine terminating glacier dynamics by simulating retreat on an artificial glacier comparing grounding line retreat on 21 fjord geometries (adapted from the MISMIP geometry). The manuscript is well written and structured, and the experiment set-up is well thought through and explained clearly. While other studies point out the impact of fjord geometry to glacier grounding line (GL) movements, this study presents a relation between GL retreat and glacier area below sea level across the fjord (or its change) and test their theory on a real-life example, Jakobshavn. There are some restrictions to this finding, like glacier has to be defined by fjord and no combinations of geometry perturbations have been tested but it is an interesting proposal that should be shared with the science community and tested further. I therefore suggest accepting this paper after some minor revisions are done.

My main comment is the discussion of bumps and no or slow retreat of the GL while the authors use SSA - plus no subglacial hydrology, and the Budd type friction law with a uniform friction coefficient. I understand the choices for the experiment setup but would wish for a more detailed discussion how a higher order or full stokes simulation would affect the results on bumps and overdeepenings (e.g. SSA critised for a similar setup in Favier et al., 2012). Furthermore, this concern is only raised in sub-section 4.2. Before (Lines 217ff, 263, 367ff, …), it is only mentioned that the reason for no retreat at bumps is the shallowness of the fjord.
The special section 4.2 “Study limitations” makes sense in this manuscript and addresses the issue (only briefly) but should not be disconnected from the results and discussion. I highly recommend referring to section 4.2 throughout the text and/or change the strong conclusions (like L.369 “Therefore, it must be the shallowness of the fjord at this point (indicated by low S) which governs the dynamics here.”) to more weaker expressions and elaborate a bit more on line 435ff.

I assume you don’t see any advance during your simulations since you set-up the experiment to grounding line retreat. However, I suggest including a comment (in section 4), how and if your finding could also capture/predict GL advance? If your relationship of GL retreat and wetted area (or velocity) is to be applied in real-life, those areas might also have seen GL advance.

Specific comments

- L.6 Re-phrase, it is a bit confusing for an abstract: "We find that retreat in an upstream widening or deepening fjord does not necessarily promote retreat, but conversely, […]"
- L.65 "larger suit of experiments" – why not mention you do 21 simulations?
- L.143-154: The table 2 is very clear, but the text is partly confusing. For example: "we test 20 fjord geometries […] Additionally, we test […]" Clarify this paragraph in term of total numbers and subsets.
- L.206 Define "very slowly" and "retreats quickly"
- L.226: Please re-phrase for clarity: "However, in fjords that have a smaller S at x_C than the reference fjord (bottlenecks and bumps), stable positions are also found where the fjord is narrow or shallow (small S). Therefore, S is also an important control on GL retreat."
- Fig. 8a: Maybe adjust present day glacier front line colour…
- Fig. A1e&f: include line for bed topography (like in Fig. 3 c,d)

Favier, L., Gagliardini, O., Durand, G., and Zwinger, T.: A three-dimensional full Stokes model of the grounding line dynamics: effect of a pinning point beneath the ice shelf, The Cryosphere, 6, 101–112, https://doi.org/10.5194/tc-6-101-2012, 2012.