Sensitivity of the Ross Ice Shelf to environmental and glaciological controls

by Baldacchino et al.

-Second revision-

I want to thank the authors for having addressed most of my comments during their revisions. I found their answers to my questions very informative and detailed. I also appreciate the extra work, pushing the time of simulation to 40 years as well as the use of a second (non-linear?) friction law as suggested by the other reviewer. The restructuration of the discussion, e.g., less back and forth between "basal friction" and "ice rigidity", as well as the addition of subsections really makes the discussion more reader-friendly.

I have very few additional comments to make (see after), mostly asking for a few precisions that might help the reader. The most obvious, which has nothing to do with the quality of the scientific work, is the number of typos and mispunctuations that, I think, need to be corrected before publication. I have pointed out some of these in my technical comments but I am sure I missed others.

In conclusion, I believe that this work, corroborating the main results of Morlighem et al. (2021) but on a different region, will be useful to the community. It is therefore well suited for publication in The Cryosphere, after very minor revisions.

Specific comments:

- You ran additional simulations with a Weertman Friction law ($\tau_b = C|\boldsymbol{u}_b|^{m-1}\boldsymbol{u}_b$) but you did not mention what exponent (m) you used in the law, I suppose that $m \neq 1$, since the goal was to introduce a non-linear relationship between the velocity and the basal drag. If the exponent is $m = 1$ (which I doubt), then I think that the extra results might not be that useful to the manuscript and that a non-linear friction law should be used instead. Could you mention the exponent you use and maybe add the equation in the Appendix? A proper reference to Weertman is also missing, probably "*Weertman, On the Sliding of Glaciers, JoG, 1957*".
- I am sorry if I mention this idea only now but I think that some numbering such as "Figure Xa,b,c,…" and associated references in the text would really help navigating between the text and the figures. Keeping the name is fine but additional "lettering" would nice. For example, line 218 could write: "*Our results show that Bindschadler Ice Stream has the highest sensitivity to changes in ice rigidity at the margins (Fig. 4e), while MacAyeal Ice Stream has a higher sensitivity in the main ice trunk (Fig. 4f).*"
- **Line 198:** the basal friction within the main trunk is more important than what? More important than in the shear margins? I think this statement is really clear for Binschadler Ice Stream but not that much for MacAyeal Ice Stream. At least this is what I see when comparing Figure 4b and 4c.
- **line 220:** I think I did not catch this one during my first review. "*Meyer and Minchew (2018) show that Bindschadler Stream has temperate zones of ice within its shear margins and*

thus changes in ice rigidity here would influence the ice stream discharge as shown by our results." Could you explain why a change in temperate zones is any different to a change in a cold zone? I think that what matters is the intensity of the change in rigidity, not the absolute value of the rigidity.

- **4.4 Limitations**: Can you add a unit for the basal drag coefficient (and maybe specify that this coefficient is the one for Budd law you used during the inversion)?
- You use alternatively "yr" (e.g., fig A1) and 'a' for years (e.g., Fig 2 or Fig A3). Could you use one or the other only? You give the units for sensitivity maps (Fig 2 and 5) but not for the grounding-line and along-flow profiles (Fig 3 and 4). Could you add those?

Technical comments and typos:

- **Line 50:** Thank you for the edition of this sentence. Please, just add some punctuations to the sentence, e.g., *"(Dinniman et al., 2018), which will highly likely increase ice-shelf basal melting and, subsequently, the future stability of the RIS (Stewart et al., 2019)."*
- **Line 62:** I am not sure I understand the correction, i.e., keeping only *"[…] which changes in external forcings and internal material properties of the ice effect the overall mass balance […]"*. Do you mean "affect" instead of "effect"?
- **Line 79:** I'd suggest to rewrite *"(i.e. Sub-element Parameterization 1 in Seroussi et al., 2014)"* .
- **Line 149:** I still think that passive ice should be introduced in the text and not only in Figure 5.
- **Line 188:** leading to *"leading to a~~n~~ thickening"*
- **Line 193:** delete the last part, since basal friction is always at the bed, i.e., *"by the basal friction conditions ~~at the bed~~."*
- **Line 205:** *"Our results show that Whillans Ice Stream is highly sensitive to changes in basal friction at its shear margins, suggesting that changes in lubrication conditions here influence~~s~~ the flow and discharge rates of the ice stream."*
- **Line 212:** To me, this sentence is almost a repetition of the previous paragraph, I don't understand why you introduce a new paragraph here.
- **Line 240**: *"[…] and this makes it highly sensitive to changes in ice rigidity, which is also shown by our results*."
- **Line 324:** I'd change "but the sensitivity patterns remain ~~quantitatively~~ qualitatively similar" since the "quantity" doubles when you double the simulation period.
- **Figure A3:** "Top row ~~if~~ of the figure"