SUMMARY

In this study the authors develop a simple parameterization of ice mélange in order to test the idea that there exists a negative feedback loop between iceberg production and buttressing forces from ice mélange. Although I think there is great value in developing simple parameterizations like this, both for understanding basic system behavior and for implementation in long time- and length-scale ice sheet models, I have several concerns about the proposed model. At a minimum, I think the model needs additional explanation and justification. Further model development may also be necessary to make the results more robust.

First, the model is based on an assumed relationship between ice mélange thickness and the "buttressed" calving rate (i.e., the reduction in calving that occurs when ice mélange is present). Although I have some concerns about the exact form of this relationship, it seems like a pretty reasonable starting point since the resistive stress depends on the ice mélange thickness (e.g., see Amundson and Burton, 2018).

Second, the authors use mass continuity to come up with an expression for the ice mélange thickness at the calving face. In doing so, they assume assume a linear thinning rate (if I understand correctly) along the length of the ice mélange, which is probably not a bad assumption but is a bit ad hoc. Note that thickness profiles have been plotted in at least two publications: Amundson and Burton (2018) and Xie et al. (2019). The authors also assume that the ice mélange volume is in steady-state, and then apply their model to non-steady-state situations. That seems dangerous, especially without further justification. I don't understand the consequences of that assumption, which the authors also don't address. In particular, the parameter a is treated as a constant, but it depends on the width of the calving face, the width of the end of the ice mélange, the length of the ice mélange, the velocity of icebergs at the end of the ice mélange, and some unknown flow parameterization b. Most or all of these could change with time as the glacier terminus advances/retreats through a fjord and the ice mélange geometry evolves.

As a result of these concerns, I'm not sure how much faith to put in the model results. Essentially, the authors started off with an assumption that there is a negative feedback loop between calving and ice mélange buttressing, and then demonstrated that their model produces a negative feedback loop. This also makes the title feel misleading. I think a more effective approach would be to ask "If ice mélange produces a negative feedback loop with calving, what properties must it have in order to appreciably affect tidewater glacier retreat?"

SPECIFIC COMMENTS

- P1, L22: Most studies also neglect the impact of iceberg meltwater on ocean heat transport.
- P3, L6: Amundson and Burton (2018) arrive at a similar result using a very different (continuum mechanics) approach to modeling ice mélange.
- P4, L25: This equation is ad hoc and, as written, not entirely consist with observations. Why does the ice mélange thickness have to equal the terminus thickness to prevent calving from occurring? In general, ice mélange thickness is considerably less than the terminus thickness. Note also that here d is used to refer to the effective ice mélange thickness, but later d_{cf} is used to refer to the thickness at the calving front and substituted into this equation, which is confusing.
- P6, L9-13: This is unnecessarily wordy. You could just write that conservation of mass dictates that $dV/dt = \ldots$, and then explain each of the three terms.

- P6, L11-12: The overall rate of mélange volume "change"?
- P6, L13: This equation shouldn't be set to 0, because its not until the next equation that you assume steady-state.
- P6, L18: How does b parameterize the flow? Are you just suggesting that this is something that could be taken from observations? Please elaborate.
- This is an upper limit, assuming steady-state geometry and flow...
- P7, L8-9: "as also suggested by previous studies."
- P13, L6-7: Please elaborate on what sort of observations could be made. How do you move forward from using steady-state assumptions?

REFERENCES

Amundson, J.M. and J.C. Burton, 2018. Quasi-static granular flow of ice mélange, J. Geophys. Res. Earth Surf., 123, 2243–2257, https://doi.org/10.1029/2018JF004685.

Xie, S., T.H. Dixon, D.M. Holland, D. Voytenko, and I. Vaňková, 2019. Rapid iceberg calving following removal of tightly packed pro-glacial mélange, Nature Comm., 10, 3250, https://doi.org/10.1038/s41467-019-10908-4.