

Review of 'Sensitivity of calving glaciers to ice-ocean interactions under climate change: New insights from a 3D full-Stokes model'

General comments

Using a 3D full-Stokes calving model, the authors explore the sensitivity of Store Glacier in western Greenland under changing magnitudes and durations of submarine melt and mélange buttressing. Scientific quality of the work is high. Calving is an important and active area of research at the moment, and this paper will be a welcome additional reference for further modelling and observational research. The paper is well-written, with appropriate figures, and provides an interesting addition to understanding how best to model calving processes, as well as further insight into processes at Store Glacier. Methods are well explained and the discussion flows nicely from the presented results. The work is also placed in context with other modeling studies, including specifically of Store Glacier. Some additional attention to clear and consistent use of specific language is needed, as well as additional (but brief) points of explanation. These are noted in the specific comments below.

Specific comments (by page/line number, including technical corrections)

Title. Since this study only examines a single glacier, the first half of the title is a bit of a reach. I'm OK with keeping it as is, but the editor may want to consider suggesting a change.

1/10. Not sure it's accurate that calving rates/processes is 'one of the largest uncertainties'. Perhaps just 'a substantial uncertainty'.

1/12. I would not normally consider that there is one calving mechanism. Suggest changing 'the calving mechanisms' to 'calving mechanisms'

1/16. Replace 'equivalently' with 'by 50%'

1/21. Specify if referring to surface or subglacial melt rate

1/25. Replace 'the most' with 'an'

1/32-33. Sustained acceleration does not always result from increased calving. Also, 'environmental forcings' is vague. Revise sentence to be more specific about forcings and note that sustained acceleration is not always a result of increased calving.

2/6. Recommend replacing 'routed along the bed' to 'discharged at the terminus-bed interface', because the discharge is playing the important role in this case, not the subglacial system.

2/14. This introductory sentence specifies that *internal* dynamics strongly modulate the effect of external forcing on calving, but subsequent sentences focus on external factors (topography, basal friction). The argument that internal dynamics modulate calving effect needs strengthening if that's the main point.

2/19. Change 'potentially' to 'potential'

3/8+. This section does not properly distinguish between distributed and plume-induced (contracted) melt. Begin to use the desired language right away and maintain clarity.

3/16. Any sense of how representative these temperature-salinity records are over multiple years? Expectations for future changes? (Could also go into discussion).

3/32. Change to 'third environmental forcing we consider is...'

3/34. Add citation of Amundson et al. 2010 (already in references)

3/38. Add a sentence summarizing the observations of 140 m thickness. Seems surprisingly thick and nice to have a quick explanation instead of sending the reader to another paper.

4/7-9. Please provide a bit more detail regarding the difficulty with scaling so that it's clearer why you applied a different method.

4/16. It's important to explain why the simulation broke down at the first mention of this problem. Move this information from the bottom of page 5.

5/17. Remove 'greatly'

5/30. Why did rapid change not start until year 2?

7/1-2. Change 'firstly' and 'secondly' to 'first' and 'second'

7/5+. Add another sentence or two on what was tested re: duration changes. 'Duration' can cover a wide variety of differences with one end member being the same as completely eliminating seasonal changes. Best to quickly sum up the experiments and results, while details remain in the supplementary text.

7/8-9 and 8/41-42. Reconsider the language used re: 'intermediate scenarios' and 'climate change becomes severe'/'severe warming'. These are much too vague. There is a fairly specific science community notion of what an intermediate scenario is (IPCC), while 'severe' has little to no quantitative meaning. If you want only to refer to specific 'scenarios' used in this paper, then you need to be very clear in consistently calling them 'scenarios' and can assign individual runs to 'intermediate', 'severe', etc. For example, do you want to define 'intermediate' at 50% more submarine melt and/or 50% less buttressing, as suggested in the abstract, or in some other way? Again, this must be laid out clearly and used throughout the paper/discussion.

7/13. Are there no other datasets that can help with speculation on continued retreat? For example, BedMachine v3. There's no reason that speculation must only be based on data within this study. Consider looking to other science resources.

7/19+. I was surprised that surface thinning is not discussed. Surface thinning certainly plays into the processes discussed in the paper, and should be at minimum briefly mentioned somewhere in the discussion.

7/36. Again, mention the magnitude of change in duration examined.

10/5+. Are these modeled or observed? Make sure to always be clear about this distinction. Also, do the comments regarding surface character from the model align with imagery?

10/35-37. 'can be used to predict the future behavior' may be too strong a statement. Additional comparisons between model and observed behavior are warranted before moving to stronger statements like this.

11/4+. Recommend commenting on how realistic any of these changes are. For example, the loss of mélange seems highly unlikely in cases where calving rates remain at current levels because mélange is strongly controlled by iceberg production.

11/25. Suggest noting need for continued improvement of bed topography data, especially near the terminus. There are still some substantial errors in BedMachine v3.

Figure 1. What does the velocity field look like for this region? Is there any lateral input from the south that is excluded from the model domain?

Figure 2. Does mélange buttressing really *close* crevasses, or simply suppresses calving? Consider change. Correct last sentence to read 'system discharges cold and fresh glacial meltwater, which feeds the'. Consider further exaggerating the difference in basal crevasses on the stoss/less sides in the graphic.

Figure 3. Remove number labels at top left of each plot and add MD1/2, MM1/2 labels. Can you add a background image of the glacier to help the reader visualize the scale of change (Landsat image would work well)?

Figure 4. Clarify the direction of advance v. retreat. Clarify if the tick mark of each year is meant to be January. Mention in caption why the lines in a) and d) are cutoff (stimulation breakdown). While I understand that you may not want to make all y-axis scales the same, matching as many as possible is helpful – a) and d) already the same, consider making b) and c) the same.

Figure 6. What terminus front position is shown?

Supplementary text (by page)

Table S1. Best to use full words in the column labels as much as possible. Using 'mean' instead of 'average' can help with space, while 'distributed' and 'concentrated' are more difficult (give it a moment of creative thought in case you can make it work).

Page 2. At the top, you say that combining magnitude and duration perturbations significantly changes terminus behavior. After reading the main text, in which you state that duration experiments didn't change glacier behavior much, I was not expecting to find 'significant changes' resulting from anything contained within the supplementary text. Reconsider the content of the main and supplementary text to avoid this surprise.

Page 2. First sentence of last paragraph – Clarify whether DM2 is the 'most aggressive' perturbation of all experiments or just the ones discussed in the supplementary text.

Figure S2. Make y-axis for b) and d) 4000-6000.