

# Reply to Reviewer, Anonymous referee 1, 21.10.2022

Impact of icebergs on the seasonal submarine melt of Sermeq Kujalleq  
Karita Kajanto et al. 2022

## Summary

I am impressed by the response to the previous (original) review and think that the manuscript is overall much clearer than before. I appreciate how much work it is to perform additional simulations, especially with computationally expensive packages like IceBerg, but I think that doing so has made the conclusions more robust in this case. My main comments have largely been addressed; however, my comment regarding the definition of GMW outflow has not been fully addressed and I suggest that some minor revisions to supplementary figure 7 and the manuscript are required to address that (details below).

In my original review, one of my major comments was "... no definition or means of identifying GMW and its fate is provided...". This comment has not been addressed in the revised manuscript. This is a major limitation because much of the discussion and many of the conclusions are dependent on this definition. The authors have performed some tracer experiments, to show the plume pathway, which I appreciated and I think have provided some support for the conclusions in the paper.

However, no means of identifying GMW is defined in the paper, so it is still difficult to for the reader to evaluate the conclusions that depend on this definition. I suggest that three minor modifications are necessary in this respect. Firstly, on or before line 229 (in the tracked changes) version, your definition of GMW should be defined clearly – streamlines seeded in the cell at which the plume reaches neutral buoyancy. The caption in Figures 3 and 4 does not provide a definition, so simply referring to those is inadequate. Secondly, the black arrows in Figures 3 and 4 should also be included in supplementary figure 7, so the reader can evaluate how well your streamline definition in the main text matches the simulated tracer distribution. Third, this comparison and its implications for your conclusions should be discussed briefly somewhere (perhaps section 5.3).

- Thank you so much for your time and effort and the thoughtful comments.
- We have now included the suggestions regarding the definition of the GMW outflow. We have explicitly included the definition on lines 174–176, added the outflow arrows to Fig. S7, and briefly discuss the comparison on lines 462–464.

## Minor comments

In addition, I have several other minor comments below (line numbers are taken from the document with tracked changes):

Line 11: "iceberg melt causes" could be more precisely written as something like "iceberg melt-induced changes to fjord stratification causes..."

- Thanks, text edited.

Line 18-21: "key mechanism linking the presence of an ice mélange with glacier calving" - I think it would be clearer if this sentence were merged with the previous one to make it clear that the mechanism being referred to is the undercutting of the glacier face.

- Thank you for the comment. The mechanism discovered in this paper is the suppression of the plume in the presence of icebergs. From this mechanism follows both the overall reduction of melt, and increased undercutting, although we do not directly show changes in undercutting. We have rephrased the sentence and removed calving since we do not directly show this, on line 14.

Line 39: Consider also citing Moyer et al (2019) along with Mortensen et al. (2020). Seasonal Variations in Iceberg Freshwater Flux in Sermilik Fjord, Southeast Greenland From Sentinel-2 Imagery - Moyer - 2019 - Geophysical Research Letters - Wiley Online Library

- Thank you for the suggestion, reference added.

Line 67: Suggest changing "introducing icebergs in models" to "including icebergs in fjord-scale ocean circulation models" or similar

- Thank you for the suggestion, text edited.

Line 132: "discharge outlet width – hereafter called plume width - ... determines the width of the plume" – I mentioned this in my original review and appreciated the authors' reasoning for keeping this terminology. However, now this sentence essentially says that the plume width determines the plume width, which is a bit odd. So I'll reiterate my suggestion to call it the outlet width.

- Thank you for the suggestion, we have reformulated the sentence on lines 97–98, but keep our choice of terminology.

Line 138: “Jackson... are a better match than a point-source plume” is imprecise. I suggest changing this to something like “However, an investigation in a small West Greenland fjord (Jackson et al., 2017) found that model-observation agreement was greatest when using a 200 meter-wide truncated line plume, rather than a point-source half-conical plume.”

- Thank you for the suggestion, text edited, lines 115–116.

Line 147: It’s not clear what the difference is between “a wider subglacial discharge outlet” and a “laterally distributed sheet discharge”. This needs to be clarified.

- Thank you for the comment, we have rephrased lines 122–124.

Line 147: “season” -> “melt season”?

- Thank you, text edited.

Line 148: The choice of a 1.2 km-wide outlet should be justified. Why 1.2 km specifically?

- Thank you for the comment, text edited, line 125.

Line 176: Add “to ensure conservation of mass” to the end of this sentence.

- Thank you for the comment, text edited, line 144.

Line 229: “outflow of GMW” – here you should make it clear how you define GMW (see major comment above).

- Thank you for the comment, as specified in the earlier reply, we have included the description on lines 174–176.

Line 261: “are not symmetrical” – is this despite identical subglacial discharge? If so, I think it would be worth mentioning.

- Thank you for the comment, text edited, line 214.

Line 280: It’s not clear whether you mean the plume equilibrates 80-120 m lower than it did without icebergs, or that it equilibrates at 80-120 m, which is lower than without icebergs. As currently written, you imply the former.

- Thank you for the comment, we have rephrased the sentence, line 230.

Line 366: suggest “greater refluxing” or similar, since some refluxing occurs in the absence of icebergs.

- Thank you for the comment, we have rephrased the sentence, line 290.

Line 367: “reduce the maximum submarine melt rate of the glacier front by up to 10% in the deep basin” is a bit confusing because the depth of the “deep basin” is not defined here and it’s a somewhat convoluted metric – why not just provide the change to the maximum melt rate of the entire ice front? And possibly the change to the overall freshwater flux from the ice front?

- Thank you for the comment, we have rephrased the sentence, lines 290–291.

Line 367: add “limit the vertical extent of the plume”

- Thank you for the comment, text edited, lines 290–291.

Line 371: here you use “plume/outlet widths”, so why not use outlet width everywhere? (see my comment above)

- Thank you for the comment, text edited, please see also the earlier reply.

Line 380: your definition of GMW outflow (as I understand it) does not provide any information about the concentration of the outflow (see major comment), so I’m not sure you can make this statement.

- Thank you for the comment, with this statement we refer to the smaller vertical distribution of the outflow, which can be seen from the streamlines in Fig. 9. We have now specified this, line 301.

Line 527: “vertical reach of the plume”?

- Thank you for the comment, text edited, line 423.

Line 552: use “reduce” instead of “moderate”, for clarity, and provide an explanation of why more undercutting would reduce calving for this glacier

- Thank you for the comment. We prefer to use moderate since the response to changes in undercutting is complex, and there are several factors to take into account if one would want to make a proper assessment. We choose not to elaborate on the literature regarding calving and undercutting here, but rather point this connection out for further study (line 448).

Line 584: it’s not clear what “rapid early season” means. It may be clearer to describe this in terms of runoff changes.

- Thank you for the comment, text edited, lines 471–472.

Line 640: use “reduce” instead of “moderate” here too

- Thank you for the comment, we refer to our earlier reply.

There are also a few typographical errors: Line 14: “glacially modified” should be hyphenated

- Thanks, we keep the terminology of Straneo and Cenedese (2015) with no hyphen.

Line 37: “measurements in”

- Thanks, text edited.

Line 160: “as is plausible in winter” should be “is plausible in winter” (or even just “occurs in winter”)

- Thanks, text edited.

Line 383: “of the plume”

- Thanks, text edited.

## References

Straneo, F. and Cenedese, C.: The Dynamics of Greenland's Glacial Fjords and Their Role in Climate, <http://dx.doi.org/10.1146/annurev-marine-010213-135133>, 7, 89–112, <https://doi.org/10.1146/ANNUREV-MARINE-010213-135133>, 2015.