

Response to comments on “The terrestrial ice margin morphology in Kalaallit Nunaat (Greenland)” (essd-2025-2424) by Steiner et al.

Response to CC1 (Jonathan Ryan):

We are grateful for this community comment and your careful checking of the data and respond to all points below.

I just wanted to alert the authors that Ryan et al. (2024) mapped lengths of marine- and lake-terminating (and land-terminating by subtraction) margins for the Greenland Ice Sheet (see citation below). Some of the text in your manuscript therefore slightly overstates its significance (e.g. L4 and L358: “for the first time...” and “first comprehensive quantification...”). I think the statements at L4 and L358 should be revised to acknowledge this.

We regret having missed including the findings you have already made in Ryan et al. (2024). While we have included this publication in our discussion of the results, we have indeed missed its acknowledgement in our discussion of margin lengths. In response to reviewer suggestions, our framing of the results with respect to these numbers has also changed (moving somewhat away from the emphasis on lengths, which was indeed not the study focus), hence the text in these sections has changed overall, but we naturally now also compare to the findings from your study.

I was not able to reproduce the total values in Table 1 for the GrIS. I found that the total length of *Regional_Lake_Margin_GrIS.gpkg* is 6,446 km which would be 8.5% of the total perimeter. Likewise, *Regional_Marine_Margin_GrIS.gpkg* has a total length of 12,138 km which would be 16.0% of the perimeter. Maybe I did something wrong – I’ve included my code in the attached PDF.

We apologize for the error in compiling the data when pulling it into gpkgs, where segments were duplicated. After the complete revision following the suggested changes from the review we will provide an updated dataset in the repository that naturally needs to match the data presented in the manuscript.

The length of GrIS margin is longer than Ryan et al. (2024) (76,154 vs. 29,269 km). I think the main reason for the differences is the treatment of nunataks which you include (but we exclude). It looks like you are able to provide statistics with and without nunataks. It would be great if you could provide two numbers (i.e. with nunataks included and excluded) throughout the manuscript so that we can more directly compare our findings.

The treatment of nunataks was indeed a source of concern – while we think they are probably less interesting in terms of understanding any kind of flux processes and to some degree even melt runoff, in the end they still constitute margin and may cease to be nunataks in future as the ice retreats. Hence, their inclusion also seems warranted. However, we agree that it’s crucial to

have clarity on where they are included and where not. We have now throughout (specifically in tables) stated numbers for the analysis with and without nunataks.

The length of the GrIS ice-ocean boundary looks like it is overestimated (12,138 km for GrIS). It looks like the dataset incorrectly identifies some nunataks as ice-ocean boundaries. There are also many cases where the sides of tidewater glaciers are identified as ice-ocean boundaries. See attached PDF for a couple of examples. Note that Ryan et al. (2024) found the GrIS ice-ocean boundary to be 1,598 km in 1990-95 and 1,439 km in 2003-07. The large differences between the two numbers should at least be mentioned in the Discussion.

The big difference comes from a rather stringent definition we took here based on elevation from the Bedmachine product, which we did not manually verify except for completely erroneous regions due to glitches in the DEM. As a result, like you note, the sides of tidewater glaciers that do not have a water interface but with respect to the DEM are in a location where the sea level is higher or nearly the same, are considered as marine termini as well, even though there would be no flux, or no interaction between water and ice. To avoid this problem, we initially considered manually mapping all parts of the margin located at locations below sea level but not actual a marine termini, but realized that this wasn't trivial in many locations and would add a lot of subjectivity on an issue that wasn't the focus in this study. To however further emphasize this issue, we have now mapped this for a subset of tidewater glaciers where the distinction is clearly possible, calculate the fraction of clear termini and non-termini shear margins and other lateral sides that are marked marine-terminating by our approach. This allows for an estimate for a general fraction of these different sections across Greenland. We have now also more clearly emphasized that our marine termini should not be misconstrued termini with flux gates, in both Methods and Results.

There is also a large difference between the length of the GrIS ice-lake boundaries between this study and Ryan et al. (2024) (6,445 km vs. ~550 km). I understand that the ice-lake boundaries are more challenging to identify but, again, it would be useful to mention whether these differences are caused by decisions to include vs. exclude nunataks in the Discussion given the similar goal of both datasets.

For lakes we are faced with a more complex issue of other studies actually having identified even larger margins (>3000 km (Carrivick et al., 2022)) over our length of >2500 km (see Table 1), visualizing the large differences for different methods. We now also add your estimate in the Discussion and provide a clearer discussion on how these differences can be explained (nunataks in the comparison to your data being one case, the fact that we mapped additional lakes to the dataset by (How et al., 2021) where they were missing for the 2000 time step). We try to quantify as much as possible where these differences come from based on these considerations. For this we compare some of the termini regions from both studies and provide the comparison in the Supplementary Material.

Thanks and good luck with the rest of the review process.

References

Ryan, J., Ross, T., Cooley, S., Fahrner, D., Abib, N., Benson, V., & Sutherland, D. (2024). Retreat of the Greenland Ice Sheet leads to divergent patterns of reconfiguration at its freshwater and tidewater margins. *Journal of Glaciology*, e65. <https://doi.org/10.1017/jog.2024.61>

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