The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
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# Comment on tc-2021-164

Anonymous Referee #2

Referee comment on "Multi-decadal retreat of marine-terminating outlet glaciers in northwest and central-west Greenland" by Taryn E. Black and Ian Joughin, The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-164-RC2, 2021

Summary:

The authors analyzed a variety of environmental datasets in conjunction with annual records of terminus position changes from 1972-2021 for 87 marine-terminating glaciers in western Greenland. They find that there was a step change in terminus positions in ~1996 and that nearly all glaciers have retreated since the turn of the century. Changes in retreat coincide with a number of environmental parameters so the authors cannot conclusively point to one trigger for the observed retreat. There are a few places where the presentation of the methods and discussion can be modified to improve clarity, as outlined below, but there are no major methodological flaws or issues with interpretation. Overall the paper is easy to read and presents an interesting analysis that bridges the gap between the shorter-term but highly detailed analyses and long-term but broad analyses commonly found in the literature.

Major Points:

- There are some parts of the methods that need a bit more detail.
  - The first dataset that would benefit from more detail is the terminus position dataset. For example, when Landsat 7 SLC-off data are available, are those preferred to the Landsat 5 images despite the image gaps simply because they are higher resolution images? Also, for the optical images, what bands were used? I assume panchromatic for Landsat 7 and 8 but that band does not exist before Landsat 7. Figure 2 should also be referenced in this section since it conveys important information regarding the seasonality of the satellite images.
  - For the environmental data, I recommend you move much of the information in the

last paragraph of section 2.4 to the end of the first paragraph or immediately after it. It is helpful for the reader to know what metrics you extracted from each dataset before they read through the details for each dataset. It is also helpful to know more about the location from which the ice sheet variables were extracted. Is "near the front" a fixed location within a certain distance from the most retreated terminus position? Does the position move with the terminus? Did you consider extracting these data from the full catchment for each glacier? For the ocean data, why did you pick a depth of 250 m? Does the depth selected influence your interpretation?
    - For each climate variable, more justification for its use should be presented earlier in the manuscript. There is some discussion about the importance of each variable, but justification should be presented in the methods so that the reader understands why these data are used in the comparison.
- In the example in Figure 3, it looks like the glacier margin may expose land along its southern margin or at least a region of very stable ice. The inclusion of this essentially stagnant ice margin may considerably influence your terminus change rate calculations. Although you acknowledge that the boxes were drawn somewhat arbitrarily, it may be helpful to impose a velocity threshold to identify regions of stagnant ice that will artificially lower retreat rates if included in some terminus boxes and not others.
- For the break-point analysis, did you include data for all years? Did you include the linearly interpolated terminus position during observation gaps? In looking at the seasonal data coverage in Figure 2, it looks like 1993 and 1995 were years when most terminus observations are from summer imagery (although it is really difficult to distinguish the summer and autumn colors). Have you considered that the inclusion of these summer observations in relatively rapid succession may have an influence on the break point analysis?
- I thought the results were presented in a clear and logical order but the discussion is a little disorganized. Like the section describing the climate data, it would be helpful to have an overview of your data synthesis at the beginning of the discussion instead of buried in lines 292-299. Then you can dedicate a paragraph to observed relationships between retreat and each variable and the reader will be able to follow why those variables should be related.

Minor Comments:

- line 24: Rearrange this sentence slightly from "in northwest and central-west Greenland over half of the mass loss is currently due to ice discharge" to "over half of the mass loss in northwest and central-west Greenland is currently due to ice discharge"
- lines 36-38: The phrase "Because of the interaction of terminus position with glacier geometry" is somewhat awkward. I recommend dropping that portion of the sentence and slightly rephrasing the remainder of the sentence so it can be merged with the previous sentence.
- lines 83-84: Are these size thresholds based on previous analyses? How were they determined?
- In section 2.2, you mention that errors are from the imagery and digitization but then present the sources of error in the opposite order.
- Why is Figure 2 missing data for all years for 2-3 glaciers (77?-78)?
- line 147: Change "singular important" with the "single-most important"

- Figure 5: Change the initial description from "Timing of change" to something more descriptive.
- I really like the MAR panels in Figure 6.
- lines 278-281: Does the same population of glaciers decrease from 2000-2010 and 2010-2020?
- line 296 and elsewhere: I find the expression "step-change acceleration in glacier retreat" to be misleading. My interpretation of your data is that there was a sudden onset of terminus retreat for most glaciers in 1996. I would describe this as a "step-change in terminus retreat rate" or "acceleration in terminus retreat rate" if the termini were generally retreating before 1996 but at a slower rate.
- line 327: You don't define ice mélange until this line but refer to it far earlier in the text.
- lines 338-346 and appendix: The description of the effect of sea ice of terminus positions is really difficult to follow in just the main text. I'm left wondering why this analysis is mostly confined to the appendix and not woven into the rest of the manuscript.