Response to Reviewer #2 on "Weekly to monthly terminus variability of Greenland's marine-terminating outlet glaciers"

Comment received: 24 October 2022

Key:
Reviewer comment (blue)
Response (black)

Summary:
In the manuscript Black and Joughin present a monthly (to sub-monthly) dataset of terminus positions for >200 marine-terminating glaciers of the Greenland Ice sheet between 2015 and 2021. The authors use this data set to characterise and evaluate seasonal variability. Specifically, they find: 75 % of their studied glaciers show significant seasonal variability; seasonal retreat to begin in mid-May and advance in early October, on average; retreat events to peak in late summer and reach a minima in late winter; and a stronger correlation between seasonal magnitude and velocity as opposed to magnitude and glacier width.
Whilst several aspects of the work have been reported on before, the scale at which the analysis has been conducted is unique and provides new insights into ice-sheet-wide trends of seasonal terminus position variability and—for the six-day data—the frequency and seasonality of glacier retreat events.
Overall the manuscript is well written and structured, and the dataset will be a useful (and impressive) addition to the growing availability of ice-sheet-wide studies of glacier termini. I recommend the manuscript be accepted after some minor revisions outlined below.
We thank the reviewer for their comments, which have helped to clarify the writing and improve the analysis.

Main points:
1. As highlighted in the review of RC1 (07 Oct 2022), the data analysis and comparison with other data (e.g. Section 5.3 and 5.4) misses opportunity for more thorough investigation. For example, furthering their comment 2, there is no real investigation/discussion on how or if seasonality has changed over your study period, or longer, at glacier or sector scale. This is important as highlighted in the abstract and elsewhere (e.g. Felikson et al. [2022] doi:10.1029/2021JF006249) seasonal fluctuations can influence longer-term glacier dynamics. A more thorough analysis here would certainly strengthen the manuscript and further highlight the glaciological application of the dataset.

Given the short duration of our study period and the high interannual variability, we are not going to be able to detect significant trends in seasonality over our study period. However, it is valuable to characterize the interannual variability in the timing and magnitude of seasonality, and we have done so in a new Table 2 which outlines the duration and magnitude of the retreat period for each year during the study period. In time, with more data, this would be an excellent avenue of research. For longer-term data at annual (not seasonal) temporal resolution, we refer to our recent publication on glacier retreat and climatic drivers in northwestern Greenland (Black and Joughin, 2022; doi:10.5194/tc-16-807-2022).

2. One of the more novel findings of the work is the association between seasonal magnitude and velocity as opposed to glacier width, but some of this analysis is buried in the supporting material. It would be worth merging Figures S6 b and S7 and placing these in the main manuscript.

Great suggestion – we have merged Figures S6b and S7 to create a new Figure 6 in the main manuscript. We have removed Figure S6a entirely.

Specific points:

1. Lines 57 -60. You specify that a detailed investigation of the causes of seasonal variability is beyond the scope of the manuscript, but include some basic analysis and arguments in this regard in Section 5.2. Consider rewording to better highlight the comparisons. '…beyond the scope of the paper, rather we discuss the potential role these factors may have.'?

We have edited the last sentence as follows:
"…a more detailed investigation of the causes of seasonal variability is beyond the scope of this paper; rather, we discuss the potential role these factors may have."

2. Lines 80-81. Please provide an indication of how much data is missed (e.g. median % coverage of the glaciers).

We added the line:
"On average, over the seven-year study period, these missed acquisitions resulted in two missing data points for monthly glaciers, and 20 missing data points for six-day glaciers (accounting for the transition from 12-day to six-day acquisitions)."

3. Lines 107-113. This method feels more akin to the curvilinear box method. If so I'd also reference Lea et al. (2014) doi: 10.3189/2014JoG13J061.

We modified a sentence in this paragraph to read:
"…particularly if the glacier has retreated substantially; in this way it is comparable to the curvilinear box method (Lea et al., 2014)."
We do wish to note that the boxes we used are the original boxes of Moon and Joughin (2008), with modifications as needed if glaciers have retreated past the original boxes, so our citation of that method was quite literal. The Moon and Joughin boxes were never the narrow three-sided ones (which often don't capture much of the front) that are seen in some other studies; we are trying to correct this common misconception.

4. Line 130. How were the data detrended? Linear as per Section 3.2?

Yes, linearly; we restated as "linearly detrended".

5. Line 142. 'threshold value of 50 m' à 'threshold value of 50 m (i.e. 2σ)'

Changed as suggested.

6. Line 163. '...as described above' à '…as described in Section x.x'.

Changed as suggested (Section 3.3).

7. Line 240-242. Have you explored if there is any relationship between duration of retreat and magnitude of retreat? Could be worth exploring?

We added a new Table 2 which shows the annual ice-sheet-wide magnitude and duration of retreat. In section 4.2 we added that "The annual median magnitude of ice-sheet-wide terminus-position seasonality ranged from 200 to 275 m (Table 2)." We edited the lines noted in this comment (in section 5.2) to read:
"The duration of the retreat period varies from year to year (Figure 3). The annual magnitude of ice-sheet-wide terminus-position seasonality tends to increase with the duration of the annual retreat period (Table 2); although the sample size is small, linear regression indicates a strong fit (R^2=0.803, p=0.016) between magnitude and duration. The years 2019 and 2016 have the longest retreat periods…"

8. Line 266. Add references to Howat et al. (2010) doi: 10.3189/002214310793146232 and Bevan et al. (2019) doi: 10.5194/tc-13-2303-2019.

We have added the suggested references.

9. Line 315. More recent papers by Brough et al. (2019) doi: 10.3389/feart.2019.00123 and Bevan et al. (2019) doi: 10.5194/tc-13-2303-2019 highlight similar findings for Kangerlussuaq and cover more of your study period. Include these references here too.

We have added the suggested references.