

Dear Sophie Goliber and co-authors,

Thank you for your replies to the reviewers and the corresponding changes you made to the manuscript. The addition of two results that illustrate the power of the dataset (seasonality and sinuosity, Figures 7 and 8) strengthen the manuscript.

I have a number of comments regarding the organization of the manuscript and the precision of the descriptions that need to be addressed before this can be published in The Cryosphere. First, a number of findings from the TermPicks dataset are currently presented in the Discussion section. These include results on terminus sinuosity and on the effects of lateral end points of termini on fjord-mean terminus position. These paragraphs should be moved to the Results section. Second, the clarity of some of the added text is less good than in the original manuscript. I copied one example below. I suggest that all changes (including to this and future versions) be reviewed again by the primary and supporting authors to ensure precision and smoothness.  
"We estimate seasonality for years in which there are terminus picks in at least three unique months to illustrate the density of the data set."

Thank you for your comments and helpful review of our new addition to the manuscript. We have reviewed and restructured the new sections (seasonality and sinuosity) in the methods, results, and discussion sections for clarity. The largest change is in the sinuosity figure (#10, previously #8). We have also proofread and edited for clarity in the overall text, including editing the figure order. Our responses to individual comments can be found below.

Specific items that need addressing:

Line 146: Center X and Y: In the dataset called TermPicks+CALFIN\_V2, X and Y are identical (both appear to be longitude).

Fixed and updated.

Line 151: Specify whether X=0 or 1 is automatically or manually created.

The prefix is assigned based on the method that the trace was created. All TermPicks data is from manually-digitized data, therefore it has a prefix of 0. Any machine-generated traces (i.e. CALFIN) have a qualify flag with a prefix of 1. In the future, if

machine-generated datasets would like to be used in conjunction with TermPicks, they would have a qualify flag with a prefix of 1. To clarify this, we added the following text:

“We assign a prefix 'X' for all data defining if the trace was created automatically or manually with X=0 for TermPicks data and X=1 for CALFIN data, or any machine-generated terminus traces that may be included in the future”

And edited table 3:

Flag Code	Issue
X = 0	Manually-digitized trace
X = 1	Machine-generated trace
X0	No issues
X1	Trace uncertainty due to environment or image issues (clouds, shadows, missing data, etc.)
X2	Supplemented trace
X3	Landsat 7 SLC off
X4	Incomplete/Box Method
X5	Automatically assigned scene ID

**Table 3.** Flags assigned to output terminus trace data created in conjunction with CALFIN Cheng et al. (2020). All data in the TermPicks dataset has the prefix of X = 0.

Line 244: Rephrase to remove the nested parentheses.

Removed. Rephrased to “As a metric of error between data sets, we calculated the Hausdorff distance (commonly used in pattern recognition), the greatest minimum distance between two lines (Huttenlocher et al., 1993).”

Paragraph beginning on line 284: This text should belong in Results rather than Discussion. It should also point to Figure 8, which illustrates these results.

We have restructured this paragraph and split the appropriate sections into the methods, results, and discussion.

Line 289: "high sinuosity" - This statement is subjective and needs to be more objective. Figure 8 shows that the sinuosity of Glacier #291 (~1.4) is pretty comparable to that of the only other sinuosity presented (Glacier #288, ~1.3-1.4). Perhaps the variance of sinuosity across glaciers is this low (~0.1); if so, that should be explained. It is simply too unclear from what is currently presented.

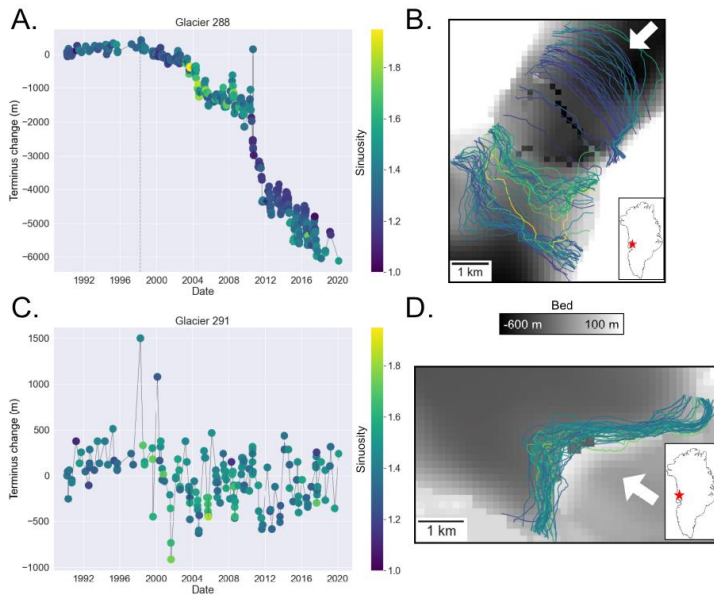
We were primarily focused on the change in sinuosity in time may reveal differences in processes effecting a single glacier through an example of a glacier that retreats (288) and one that remains stable (291). While the mean sinuosity over the record is comparable, the variability throughout the time series is notable. Sinuosity values generally range between 1 and 3 (Schumm, 1985), but we do not expect glacier termini to exceed a sinuosity of 2 (i.e. the terminus will be less than twice the length of the distance across the fjord), therefore we argue the range in sinuosity over time are notable. We believe the new figure shows this more clearly. As 288 begins retreating over a prograde slope, it becomes more sinuous. The sinuosity decreases as retreat rate increases (~2010) through an over-deepening in the bed. Conversely, glacier 291 does not show much change over the record.

As the sinuosity is a simple ratio of the length of the trace to the length between endpoints, it quantifies how much the terminus deviates from a straight line. Therefore, a curved terminus will also have a higher sinuosity compared to a crenulated one, so it is an imperfect metric. However, combined with other metrics such as curvature or skewness, it is useful for describing the shape of a terminus, but this analysis is out of scope for this paper and will be explored by the authors in future work.

Figure 8: This relates to the above comment. Oddly, the sinuosity for Glacier #291 in the 2020s (yellow) does not appear to be different from the rest of the record in the top plot, but in the bottom panel (map), the 2020s terminus looks more incised or protruded (and therefore more sinuous) than the rest of record shown in the top plot (1990-2020, roughly blue-green through yellow). Is this an error in analysis, an effect of the 4-year smoothing, or an artifact of the way the data are presented?

As we now present the unsmoothed data and do not have a large difference in the 2020s, we do not think this is a problem with smoothing. The terminus may appear to be more crenulated, however the overall shape of the terminus is also important. Because of how sinuosity is calculated, a smooth but very convex terminus may have a similar sinuosity to a relatively straight, but highly crenulated terminus. This has been clarified in the text.

New figure:



**Figure 10.** A: Terminus change between 1990-2020 colored by sinuosity for Glacier 288 (Sermeq Sitarleq). The dashed grey line is the start of progressive retreat as defined in Catania et al. (2018). B: Corresponding map-view terminus traces For Glacier 288 with every 5th trace colored by sinuosity. C: Terminus change between 1990-2020 colored by sinuosity for Glacier 291. D: Corresponding map-view terminus traces for Glacier 291 (Kangerdlugssup Sermerussua) with every 5th trace colored by sinuosity. The base map in B and D is the bed from BedMachine (Morigheim et al., 2017). The black pixels in B are errors, however they do not impact the overall interpretation of the bed. The bed scalebar applies to both B and D. The white arrows indicate glacier flow direction. The red star on the inset map is the location of the glacier on the Greenland Ice Sheet.

- Sinuosity data since 1973 appear on the map (it looks very sinuous, with a deeply incised or protruded centerline, in the 1970s) but not on the time series. Why not?

We only included sinuosity from 1990's onward because there are far more traces after the 1990s than earlier. This has been clarified in the text. Additionally, we were primarily focused on showcasing the change in sinuosity over time for glacier 288 as it retreats compared to the relatively consistent sinuosity for 291. We have edited the figure to show the unsmoothed retreat colorized by the unsmoothed sinuosity. The map-view figures show every 5<sup>th</sup> terminus trace. This shows the change in sinuosity in glacier 288 more clearly.

- It is not apparent from the map panels which directions these glaciers are flowing. It could be inferred for Glacier #288 (not #291), but an arrow label would go a long way here.

Added white arrows to indicate flow direction.

- Top panels are labeled "Retreat", with mostly negative numbers for the glacier that is in clear retreat (#288). This is inconsistent. Rename the label (recommended) or flip the scale.

Changed to "Terminus change (m)"

- The names of these glaciers appear in the text (Line 215-216), so they should also appear on the figures or at least in the caption.

Added the names to the caption.

- The overdeepened bed referred to on the text (line 292) is not discernible on the figure, as the terminus lines obscure any subtlety in the darkness of the DEM.

Change color scale to -600m-100m to increase contrast and plot every 5<sup>th</sup> terminus trace.

Line 291: The time series in Figure 8 for Glacier #288 doesn't really show an "after retreat" phase. It is basically retreating the whole time.

We added a grey dashed line indicating the time period where retreat begins. The glacier advances slightly, then begins retreating. The timing of progressive retreat onset is also calculated in Catania et al., 2018 as 1998.3, which we use as the marker in our plot.

Paragraph beginning on line 294: This text should belong in Results rather than Discussion.

Moved.

Line 377, 381: "TermPicks"?

Fixed.

Line 382-382:

- The TP+CALFIN\_v2 X,Y error needs correcting (see previous comment).
- Glacier 291.csv is sized 0 bytes (upload fail?).

Fixed and updated in Zenodo.

Figure 6 and caption: The panels show mostly 11-year periods with one 21-year period, but this is not what the caption says (20- and 30-year periods).

Added " 's " to each date to indicate that it is an average position over 10 years for each decade. For clarity, caption edited to "For each panel, the entire decade of traces were averaged to produce an average position for that decade. The 1940/1950s are an average over both decades as there are fewer traces available in the 1950s. Then the average position is differenced from the previous decade."

Figure 7 and caption:

- Please provide names for these three glaciers, and indicate in the caption that the top left panel shows the locations of these glaciers.

Fixed and updated.

- Glacier #116 has retreat in meters; this is likely an error / typo.

Fixed and updated.

Figure 8 and caption: See comments above.

Throughout text: Choose to use the # sign for glacier number either consistently or not at all. Currently, it is mostly omitted in the main text, then mostly used in the captions and supplement.

Fixed and updated.

Once these revisions have been completed, I will be happy to review the submission again for potential final publication in The Cryosphere.

Cheers,  
Kristin Poinar