

The Cryosphere Discuss., referee comment RC1  
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## Comment on tc-2021-181

Anonymous Referee #1

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Referee comment on "Brief communication: Preliminary ICESat-2 (Ice, Cloud and land Elevation Satellite-2) measurements of outlet glaciers reveal heterogeneous patterns of seasonal dynamic thickness change" by Christian J. Taubenberger et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-181-RC1>, 2021

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### Summary:

The authors present a preliminary analysis of seasonal patterns in Greenland outlet glacier elevation change using 1-2 years of ICESat-2 ATL06 observations. The study focuses primarily on glaciers in the southeast, central west, and northwest. For each glacier, after detrending the data to eliminate the interannual elevation change signal, they classify the seasonal elevation change patterns. They do not find that seasonal patterns are spatially or temporally consistent, nor are they correlated with seasonality in speed. The authors suggest that future work should include critique of the summary flag used to automatically identify poor data and comparison with dense time series of terminus position change and environmental parameters. The article is easy to read overall and presents interesting new data from ICESat-2. I have several relatively minor comments below and one comment regarding reference elevations that may require considerable data reprocessing. Note that the authors may have addressed some of my comments in their response to the other reviewer comment, but I intentionally do not read comments by other reviewers so that I can provide an unbiased evaluation of the work.

### Major Points:

- My primary concern with the presented analysis is the use of the GIMP DEM as the reference surface. If I follow the methods correctly, the authors subtract the GIMP DEM from the ICESat-2 elevations so that the ICESat-2 elevations are effectively converted to anomalies and slope effects are removed. Why use the GIMP DEM which, as the authors state, represents the mean ice sheet surface from 2003-2009? The ice sheet

has evolved considerably since that time and the ArcticDEM should be more accurate and closer in time to the ICESat-2 observations. Thus, if the ArcticDEM is used as a reference, the vertical offsets due to imprecise repeats over a sloping surface should be more accurately removed from the analysis.

- I appreciate the transparency in the process by which the glaciers were selected, but I find it curious that the glaciers were selected in part based on their inclusion in the CALFIN detailed terminus position dataset yet these data were not included in the analysis. Why were the CALFIN data not included in the analysis? The authors state that the inclusion of terminus position time series in such an analysis would be beneficial and it seems as though those data are available, but simply not included here. I do not think a detailed inter-comparison is necessary but it would be helpful to know if seasonal patterns in terminus position and thickness are correlated. The preliminary analysis could focus on centerline terminus change and could aggregate the changes across all glaciers to determine if there is any hint of a relationship between the variables. A more detailed analysis could then be presented in another paper.

#### Minor Points:

- line 63: Are the units on discharge correct? Normally discharge refers to mass or volume per unit time, not a unit of length per unit time.
- line 84: Instead of "vertical component of surface elevation change", I recommend "vertical component of surface elevation differences" since the word change has the connotation of differences over time and the removal of slope effects is meant to isolate the vertical component of the full difference (both due to spatial offsets and temporal changes) in surface elevation observations.
- line 94: Add a space between numbers and units ("25 m").
- lines 118-122: No statistical seasonal change is the first in the long list of categories and is also listed in the following sentence.
- lines 160-171: I recommend renaming "medium-fast speed" and "medium-slow" to "moderately fast" and "moderately slow".
- lines 196-202: It is worth noting in this section that the variability can be driven by atmospheric forcing even if the variability is unlikely to be directly driven by variations in surface mass balance. The authors point out that the geometry of fjords may be incredibly important in regard to the access of warm waters to glacier termini, but the underlying topography of the glacier may also influence the dynamic response of the glacier to changes in meltwater fluxes and/or driving stresses driven by atmospheric change.