

## Response to Reviewer's Comments C867

Thanks for the careful review and comments on the paper.

We are happy to implement all the suggestions and corrections suggested by the reviewer and only comment on the following:

*Is there any reason for using units of meters per day when describing flow speeds rather than the more commonly used units of meters per year? Perhaps this is just personal preference, but I had a hard time putting the speeds in context, as I'm more used to thinking of Greenland outlet glaciers speeds in meters per year. Is the reason for using meters per day to distinguish velocity changes over shorter time periods than one year? If so, this should be made clear in the data and methods section.*

We used meters per day because feature-tracking observes displacements over time periods of days and measured velocities fluctuate on sub-annual timescales. We believe that authors are roughly equally divided between the two approaches. We can change if we have to but would prefer not to, and have made clear our preference in the text as requested.

*Throughout the paper, the word "stable" is used to describe calving front positions. It would be good to expand on the metric for this somewhere early on so that the reader knows exactly what this means. Is it a qualitative or quantitative measure? Does it imply a change outside of what is expected in terms of seasonal calving front position change? If so, how is the seasonal range known? A similar comment applies to the description of velocities (e.g. "none of the 5 outlets show . . . significant flow change other than that . . .", line 5, p.1648). Do you have the measurement resolution here to define the seasonal velocity range for all of the glaciers in the study?*

We have added the following to the end of the first paragraph in section 3.2, p.1646.

'In the following discussions we use the term stable to refer to ice-fronts or speeds that are within the range of expected values up to that date. The range of expected values is somewhat qualitative but is based on an inspection of the record and a consideration of the likely error in observations and published seasonal variability.'

*Throughout the discussion and conclusions, the descriptors "early period" and "later period" are used. Suggest being more precise, e.g. "1st two decades of the study period" and "last two decades of the study period".*

We have been more explicit which years are being referred to and only left in 'later' and 'early' where these are defined within the same paragraph.

*Abstract ————*

*The abstract provides an appropriate and adequate summary of the paper. It might be useful to provide an indication for the metric used to define "most significant" w.r.t. outlet glacier (e.g. fastest? greatest mass flux?). A few additional suggested wording changes to improve the clarity are suggested below under "technical corrections".*

Have changed 'most significant...' to 'fastest-flowing tidewater...'

*The introduction is a good and mostly complete summary of related work to date, which provides context for the clearly stated goals of the present work. In the literature review section, suggest adding some discussion on recently published paper by Bjork et al. (Nat. Geosc., 5, p.427). Does the Bjork et al. work complement or conflict with any of the conclusions from this work?*

## Introduction ————

We have amended the text by adding: 'Southeastern glaciers showed a similar retreat during an early period of warming in the 1930s (Bjork et al., 2012).'

*p.1641, lines 5-7: "The mechanisms underlying the correlation between . . . are likely to include . . . from over the ocean." This is awkwardly written. If the suggestion is that advection of warm air masses from the ocean onto the land surface is responsible for relatively more negative surface mass balance of the ice sheet, then I think it could be written more clearly and succinctly.*

After careful thought we have decided to remove this and the next sentence. We misinterpreted the conclusions of Hanna et al. (2009) who were in fact saying that the warm air advected over the ice sheet and affecting melt was more likely to have had a remote origin.

## Data and Methods ————

*The first paragraph on 1644 contains a wealth of technical information that is a bit unclear to me. E.g., are "multi-looked" and "geocoding" standard terminology? It sounds like all images are resampled to a final pixel resolution of 40 m? If this is true, I think it could be stated more clearly.*

These terms are standard and widely used in the literature in relation to SAR images. All images are not resampled to 40 m. We have changed

'A spatial sampling for tracking was selected such that velocity fields were produced at a pixel spacing of 40 m for all image types.'

to 'A spatial sampling for the feature-tracking of 40 m was selected such that velocity fields were produced at 40 m resolution for all image types.'

## Results ————

*1649, lines 13-17: "We see no evidence of a slowdown over this period . . ." In the figure, there does appear to be a small slowdown from \_1989-1992/93. Perhaps this points to the need for defining a threshold for velocity changes that are considered significant? "The 1985 measurement related to . . . of five SAR pairs." Clarify if/that this sentence applies to the discussion of the Joughin data?*

Agreed – have included some definition of stability (see above) and hence significant change. We have clarified that the sentence applies to the Joughin data.

## Discussion ————

*1652, Lines 11-14: "The exceptions observed here are . . . in the southeast." In this sentence you name what sounds like 6 of the 16 (nearly 1/2 ) glaciers in your study. This makes it sound like there is no obvious majority in terms of observed glacier behaviors. Is that really what you mean here?*

We have changed this to specify only Ikertivaq D in the southeast which shows no change, so only 2 instead of 6 glaciers.

*1653, lines: 10-15: Suggest giving some context for p-values reported here. E.g., remind the reader what a high vs. low p-value means. Also, the sentence ". . . and it should be noted that . . . between*

*glacier” seems awkwardly introduced here. It should go elsewhere or be made clear how/why it is relevant to the discussion in the first part of the sentence.*

We have changed the end of this paragraph to:

‘The p-values for the null hypothesis are listed in Table 1, a low p-value indicates a low probability that there is no change in variance; p-values less than or equal to 0.10 are in bold. For glaciers in the southeast and west the variance in speed increased significantly after 1995. ... It should be noted that temporal sampling is variable both in time and between glaciers and that this may influence the p-value, the statistic should be viewed in conjunction with the time series plots.’

*Figures/Tables ————*

*Figure 1: Unless the figure is made larger, it is difficult to see some of the “x’s” marking the location of speed measurements. Make them darker, or larger or both?*

They are already black, making them larger would obscure more speed details. We think the x’s are clear when the figure is zoomed in, as is necessary in order to read the scales.

*Figures 6 and 7: Kong Oscar is reported in the paper as belonging to the “western” group, but it is grouped with the “northern” glaciers in the plots. Suggest making consistent either in the text or figs?*

Kong Oscar was grouped with the northern glaciers in the Figure simply for figure size and layout, we can move it if necessary but the figure is not labelled as being only northern glaciers.

*1644, line 3: Is the “d” abbreviation for “day” (e.g. “16 or 32 d”) standard for TC publications?*

Not sure, TC editor should this be changed?

*Technical corrections ————*

*1640, line 24: “. . . although they have yet to ‘catch up’ . . .”. This is a bit awkward. Suggest omitting or being more specific about what you mean here.*

This was a quote from Box et al. (2009) so has been left in quotes.

*1646, lines 24-26: Conceptually, it would make more sense to discuss the acceleration and retreat of outlet glaciers along with the acceleration in mass loss, rather than after you note that mass loss rates are now decreasing.*

We have now changed this paragraph to read

‘This sector has experienced significant and accelerating mass loss over the last decade and many outlet glaciers have accelerated and retreated (Walsh et al., 2012)....

Rates of mass loss are now declining in the region (Schrama et al., 2011), and Kangerdlugssuaq and Helheim began to slow and re-advance in 2006 (Howat et al., 2007; Murray et al., 2010)....

Have left this as is – part of a general summary of recent processes in this region.

*1654, line 9: “. . . for all glaciers tested . . .” Remove “tested”, as this makes it sounds like not all of the glaciers in the study were tested (I assume they were?).*

Kong Oscar and Nioghalvfjærdsbrae were not tested because there were few or no ice-front positions, this is made clear in the text now.

All other technical corrections were made as suggested.