

The authors present an interesting combination of data to visualize the timeline of the Petermann glacier's retreating grounding line, which fits within the scope of TC. The novelty of the research is the long time series of grounding line mapping which has not yet been done on the Petermann glacier. However, the methods used in the study are not very novel and much of the reported findings are a temporal extension of other studies. Based on the findings the conclusion is that the grounding line is retreating following an increase in the ocean water temperature in the nearby Nares Strait. The authors could improve on the clarity of the conclusion by providing a clear timeline of events with an explanation of the causality that precedes them. Additionally, the conclusions would carry more weight when an error estimation is provided with each result. Therefore, with some minor revision the paper could be published.

General comment:

As stated earlier a more clear timeline (perhaps even with an actual timeline) would immediately get the message of the paper across. Additionally, considering the signal-to-noise was too low in earlier studies to visualize grounding line migration, a confidence interval has to be provided with the reported findings.

We would like to thank Reviewer #1 for his insightful comments on our manuscript.

We now provide error bars for the relative position of the grounding lines (see later response to comment), and we have extensively revised the discussion to provide a clearer timeline of the recent events affecting Petermann.

Specific comments:

Abstract:

L22: As a result of the warming or the grounding line retreat? Rückamp et al. (2019) suggest that the speed-up is due to calving. This in turn can be due to an increase of ocean water temperature, but is a bit more complicated (see Shroyer et al. "Seasonal control of Petermann Gletscher ice-shelf melt by the ocean's response to sea-ice cover in Nares Strait," 2017).

Authors: As a result of the grounding line retreat. We clarified the sentence accordingly.

L24: change "accentuate" to speed-up/enhance

Authors: Done

From L32-45 From the text it seems there is no reason at all to do this study, as everything appears to be stable. Therefore, the reason for this study should be stated more clearly: i.e. "earlier it was not possible to map the grounding line migration, due to a low signal-to-noise ratio. Considering the importance of grounding line migration to glacier stability we now show its evolution and provide additional data to explain its behaviour".

Authors: Grounding line mapping was possible in the past, and we can show it with the dense coverage of ERS-1/2 double difference interferograms in 1992 (Figure 2). These “historical” data are optimal for grounding line mapping, with 1-3 days repeat cycles, hence with a good signal to noise ratio. However, in the past, the grounding line migration of Petermann could not be distinguished from the signal due to tides (Hogg et al., 2016), as it did not exceed 500-600 m, hence the glacier was considered dynamically stable. What is new here, is that the grounding line position of Petermann significantly changed, exceeding its natural variations due to the tidal signal. In short, Petermann has clearly entered a phase of retreat similar to that observed for tidewater glaciers elsewhere in Greenland or Antarctica. We believe this is an important event that should be reported to the scientific community: a major Greenland glacier that was dynamically stable between 1992 and 2011 has entered a phase of retreat and acceleration since about 2015. We now specify this more clearly at L56.

L46-57: This is data/method description and therefore doesn’t fit in the introduction. Or if this is new data that now allows you to do this study then mention it shortly.

Authors : This is already stated clearly in the first sentence of the paragraph: “Since 2011, the launch of a constellation of two Sentinel-1 [...] satellites have increased the perspective to study glacier dynamics and grounding line migration” and later on at line 51 “This continuous observation record has made it possible to map the grounding line again since ERS-1, but on multiple occasions, several times a year, hence providing information about the zone of short-term migration or grounding zone.”. No change.

L59-60: Do you combine these data sources or do you use them separately for two different things?

Authors: We think that the reviewer is referring to the sentence about Cosmo-SkyMed dataset at L55 of the original manuscript. We modified the sentence to clarify that we combine both Sentinel-1 and Cosmo-SkyMed data to map the grounding line at L66-70.

L61: expand a bit on how you get to those conclusions. Just showing data is not enough, you also need to explain how they are related and what explanatory features they provide.

Authors: We revised the discussion extensively to better explain how data are related to each other, and what processes may explain those connections.

L109-117: Note that it is not strain, but stress that causes ice shelves to fracture. Strain is of course related to stress, but ice rheology is an important factor as well. Additionally note that movement of decoupled ice does not suggest high strain rates, but just shows relative movement.

Authors: Agreed. We clarified the sentence accordingly at L128.

L135: Can you include some form of confidence interval for the estimations of the grounding line retreat?

Authors: Mohajerani et al., 2021 quantified, at the scale of Antarctica, uncertainties on grounding line delineation, and calculated a MAD of 110 m and an IQR of 155 m. Error bars were added accordingly to Figure 3a. We also provide R^2 values and standard errors on the slopes for the linear fits that are used in Figure 3a.

L163-164: Do you have data or reference supporting this statement?

Authors: Agreed. The sentence was removed.

L187: You state that an increase in flow leads to enhanced thinning which causes the grounding line to retreat. Although there is some truth in that statement it would be better to rephrase it a bit, as grounding line retreat is also related to the fjord topography. When warm water can flow along a retrograde slope the grounding line will retreat much faster than when presented with a prograde slope. Additionally I can imagine a scenario where a reduction in buttressing increases the discharge of the glacier and causes an advancement of the grounding line. One not necessarily follows the other.

Authors: Agreed. The paragraph was rephrased accordingly at L215-254 of the tracked change file, and we move the last paragraph of the discussion, which was discussing specifically the retrograde bed slope at L254-264, to have a more coherent discussion.

L197: Can you explain a bit more about this model, so the reader does not have to read the paper of Rignot et al. (2016)?

Authors: Agreed. A sentence was added at L275 to describe the simple model used by Rignot et al. (2016).

L199: Is this q_m part of a formula? If so, please provide the whole formula.

Authors: We removed the mention of q_m as it was not necessary for the discussion.

L200-205: Considering you are an order of magnitude off the observed grounding line retreat, is this a really useful calculation to make? Indeed subglacial water discharge can influence the basal melt rate, but make sure to provide how much this effect can be. Same for pressurized seawater. If these effects can explain the discrepancy between observed and calculated than your argument for making the calculation is a lot stronger.

Authors: We revised extensively the discussion and specifically this paragraph to provide more clarity on this calculation and the related processes. See also response to reviewer #2.

L218: consider replacing “accentuate” with promote/increase/further

Authors: Agreed. We replaced “accentuate” with “promote”.

Conclusion:

The conclusion is basically repeating the abstract. Consider leaving it out as it does not add anything to the paper and allows for more space to explain the methods a bit further.

Authors: Manuscript guidelines from the cryosphere requires to have a “Conclusions” section. Furthermore, we have revised the conclusions so that it does not repeat itself in comparison with the abstract.

FIG1:

Where is cross section D-D' used? Pane 1c is quite difficult to interpret and doesn't make the situation more clear than 1b. Consider replacing it by an along fjord cross section. Here as well some notion of confidence interval with the visualized data would help.

Authors: We removed the Panel 1c accordingly. The confidence interval was added to the relative grounding line position plot, in Figure 3a, which is more appropriate.