Review ´Disentangling the drivers behind the post-2000 retreat of Sermeq Kujalleq, Greenland (Jakobshavn Isbrae)´

This study examines the retreat of the Sermeq Kujalleq glacier from 1985 to 2018, utilizing ensemble modeling to assess the role of frontal and submarine melt, as well as calving. Unlike previous studies, this research adapts the calving law to incorporate the backstress effect of ice mélange. To predict the glacier's future evolution, understanding the relative importance of these drivers is crucial. While the study cannot fully answer all open questions, it offers a thoughtful discussion of potential scenarios. Some assumptions and simplifications in the model could be better justified to enhance the interpretation of the results. With a few minor revisions to the text and figures, the manuscript would provide a valuable contribution to understanding the dynamics of Sermeq Kujalleq.

Thank you for your thoughtful comments. We have addressed the issues raised below.

Comments

As you are looking only at oceanic drivers, I would clearly state this in the title.

Changed

Abstract

Highlighting more what your study is adding to the model compared to former studies and which results are new would help to show the importance of your study. For example L10-13 is already known and could be shortened but then an explanation why you conclude that ´more sophisticated models of iceberg mélange and calving evolution´ are needed would be useful.

This would be a lot of explanation for the abstract. We have opted to keep it as is to ensure readability.

Introduction

L18: Sermeq Kujalleq is not the only Sermeq Kujalleq in Greenland. For clarification add Sermeq Kujalleq in Kangia here.

Corrected to Sermeq Kujalleq in Kangia

L30-31: I can understand your reasoning of comparability, but it seems to rather belong to the method section. Here you can just say that the collapse of the ice tongue is widely believed to have initiated the retreat although the study of Gladish et al. suggested that the warmer water did not reach SK.

The late 1990s saw warmer subsurface waters arrive in Disko Bay and the Illulisat Icefjord, leading to the collapse of the floating ice tongue, which is widely believed to have initiated SK's retreat and acceleration over the next 20 years, although \citet{Gladish2015} suggest that warmer waters may not have reached SK's front due to the downstream sill.

L32: In the sentence before you write that the warmer water did not reach SK and now it is generally agreed that warm subsurface water triggered the retreat. Rephrase to make these two sentences not contradicting each other.

Corrected the contradictory statement, by including that Gladish (2015) provides a reason for intrusion into fjord by overcoming the sill. This occurred due to the rising Irminger

Water layer as a byproduct of cyclonic circulation in Disko Bay.

L34-38: Formulated like this, it doesn’t fit into this section of the introduction. You can move this part to the last part of the introduction, where you explain what you are doing in your study. Here I would just explain what the different physical processes are and potentially link to recent studies.

Reformatted to address

L39-40: A delay or another mechanism responsible for the increase in flow speed?

Corrected in text

L63: For SK not just in winter, also in summer it is not possible to collect ocean measurements in proximity of the glacier terminus. But other close-range observations are possible and available (seismic, terrestrial radar, drones; e.g. Xie et al. 2016). However, they are often restricted to shorter time periods. Additionally, satellite observations can help to understand for example ice mélange density (e.g. Wehrlé et al., 2023). Observations are still rare but increasingly available (e.g. Kim et al., 2024, Wehrlé et al. 2023; Xie et al. 2016, 2018).

Added additional references

Methods:

L156: Do you have any evidence (e.g. observations) supporting this linear sensitivity?

Robel, 2017 argues that buttressing strength is linearly dependent on mélange thickness. We do not have observations relating mélange strength to temperature, however we use temperature as a proxy for mélange robustness to assume a linear stress-temperature calving threshold relation.

L185-187: What if subglacial meltwater discharge would increase a lot? Several recent studies show increased calving activity in the proximity of convective plumes. I understand that you are not considering convective plumes due to complexity, but I am wondering if this assumption holds true with increased melt.

It could, but this consideration is beyond the scope of this study.

L191: I do not understand your justification here. Any evidence?

We match the nearest point in time modeled calving front to our observed calving front

Figure 1: It is hard to see which dashed line corresponds to which solid line. Please change the colors.

Corrected in text

L212: I miss the source of your calving front location catalogue.

Corrected in text

Discussion:

L395-397: This sentence is a bit confusing ('insufficiently strong ocean melt is unable..'), please rephrase.

Corrected in text

L396: stong -> strong

Corrected in text

L397: Within these simulations -> Simulations with insufficient ocean melt?

Corrected in text

L405: Could there be other reasons than the simplified parametrization of ice mélange?

Yes there could be, but we highlight that mélange presence is the dominant control on calving activity at SK.

L408-410: Could you shortly mention which simplifications limit the applicability? Or is this related to the next sentences?

It is related to the next sentences

L431: However -> However

Fixed in text

Conclusion:

How robust does the ice mélange has to be to suppress calving activity and is this realistic?

Since we do not physically model a buttressing stress we cannot sufficiently answer this question. However, SK's mélange has been shown to have a direct control on the stability of SK's calving front. Amundson, 2010 argues that a mélange buttressing stress on the order of 100-200kPA can prevent or decelerate an overturning iceberg during calving.

Supplemental material:

There are grounding line positions for summer 2016 available (Kim et al., 2024). Do they agree with your modelled grounding line positions?

Yes, similarly to (Kim et al., 2024), our simulated SK's grounding line arrests at a pinning point the southern trunk. We note in text that grounding lines which recede past this point of arrest continue to experience unabated retreat.