

Summary:

In this study, the authors modeled Ryder Glacier in northern Greenland under different climate scenarios to assess the risk and consequences of ice tongue loss. The model results suggested that ice discharge is the primary contributor to mass loss until 2100 under both low and high emission scenarios assumed in the study. After 2100, the results show that surface mass balance becomes the dominant factor driving mass loss under the high emission scenario until 2300, while ice discharge remains the largest contributor under the low emission scenario. The authors compared their results with observations and other modeling studies for neighboring glaciers, Petermann and C.H. Ostenfeld, and highlighted the importance of topographical controls on heterogeneous behaviour in neighbouring glaciers.

Overall, this study raises several interesting discussion points and provides valuable insights for Ryder glacier, which, as noted in the manuscript, has not been studied as extensively as other glaciers in northern Greenland. These findings could also provide valuable insights for other glaciers in northern Greenland and highlight the importance of high-resolution modeling of individual glaciers to better assess the future change in individual glaciers. However, the manuscript needs revisions, including improvements to the modeling framework part and the overall structure of the writing. Below are the major and minor comments that I believe should be addressed before publication.

Major comments:

1. Model relaxation.

The model relaxation part (L146-156) is somewhat confusing as it lacks details about the calving parameterization which is only introduced later in section 3.2.2. In addition, I would appreciate more results and clarity regarding this model relaxation. For example, is the purpose of the relaxation to match current observations? How closely does the modeled melt rate match to published present-day melt rate (L149-151)? Is it spatial pattern or the maximum melt rate that you try to compare? How does the mass loss change during this relaxation period compared to the observation? How do the changes in ice front positions compare to observations during the relaxation period? Providing these details would improve the modeling part.

2. Manuscript structure

Consider revising the structure of 1. Introduction and 2. Petermann, Ryder, and C.H. Ostenfeld Glaciers section. It seems that the primary research questions the authors aim to address in this study are outlined in Section 2 (L107-L109), rather than at the end of the introduction (L44-47). These different questions may confuse readers about the main objectives of the study. Additionally, the comparison between three neighboring glaciers is too detailed in section 2, which may mislead/confuse the readers on the focus of this study.

Consider summarizing this comparison part and rephrasing it to emphasize Ryder glacier's unique characteristics and the study's goals.

In addition, I think section 3.1. is unnecessary and could be merged with other modeling descriptions. Consider rewriting the modeling part as well, particularly the model relaxation part and related forcings.

Specific comments:

L18: ... are already higher than at any time during ... -> ... are already higher than at any time during...

L27: ...that this this sector contains... -> that this sector contains...

L33: "*Observational records from recent decades have shown a large degree of spatial...surrounding the future behaviour of glaciers*". Add references to support this statement.

L53-55: The mean SMB per area is compared between the three glaciers, but what about the spatial pattern of SMB? For instance, are there more negative SMB values near the front of Ryder Glacier compared to the other glaciers? Highlighting such patterns could strengthen the argument.

L61-62: This sentence is unclear. Are you comparing the highest melt rates at Ryder Glacier to the overall melt rates at Petermann Glacier? Clarify the comparison.

L64: "higher grounding line melt rates than what?" Clarify the reference point for comparison.

L85: "*The lack of lateral friction at C. H. Ostenfeld's ice tongue...survived to the present day*" Add references.

L120: Is the model domain the same as the green basin shown in Fig.1? If so, clarify this in the text.

L125: "*performing considerably better*" Does this mean more accurate? Better in terms of what specific metric or criteria?

L128: "*...satisfy the Courant-Friedrichs-Lewy condition*". Add references.

L174: "*...increase by around 1°C by 2100 and around 2°C by 2200*". What climate scenario are these values based on? Why not using the same future climate scenarios (SSPs) as the SMB forcing? This needs to be justified.

L191: Add some transition sentences before explaining calving parametrization to improve the flow.

L196: “...best match observations of front position...”: Specify the year or period of the observations you are referring to.

L199: “Finally, the stress threshold for grounded ice...during the relaxation”: consider rewriting this sentence. Isn't the calving front floating during the relaxation? Please clarify it.

L205: reducing the value linearly in time?

L228: “In all simulations, the melt rate applied across the ... below the floating tongue” : Was this frontal melt rate also applied during the relaxation simulation?

L287: “In a high emission scenario...” Do you mean all high emission scenarios? or is this the mean value from multiple high emission scenarios?

L360: “show acceleration occurring” -> “show acceleration of retreat?”