The Cryosphere Discuss.,
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The Cryosphere Discussions

Interactive comment on "Submarine melt as a potential trigger of the NEGIS margin retreat during MIS-3" *by* Ilaria Tabone et al.

Anonymous Referee #3

Received and published: 24 January 2019

The study of Tabone et al. focuses on the Northeast Greenland Ice Stream (NEGIS) and its response to changes in climate, and in particular submarine melt, during the last glacial period. By applying climate forcing mimicking conditions during the last glacial period, an ice sheet/ice shelf model is used to study the transient evolution of the Greenland ice sheet over the past 120ka years. The evolution of the NEGIS are discussed in light of existing reconstructions of its history.

The study is original in assessing the long term response of the NEGIS to changes in climate, and goes beyond state of the art by comparing the dynamical evolution of the ice stream to proxy records. The paper is well written and the figures are clear. However, there are a several concerns which should be considered before publication in the cryosphere.

GENERAL COMMENTS: The results of the study are clearly novel and of great potential in our understanding of the long term evolution of the NEGIS. However, there is a lack of detail in the description of the model results and the full potential of the study is untapped.

Given that the model simulates the entire Greenland Ice sheet these results should be included and discussed. In particular, how well does the model reproduce the present data ice sheet configuration as well as the ice stream. Similarly, how do the model results compare to published simulations and reconstructions of the LGM configuration of Greenland. This should also include an assessment of the transient evolution of the equivalent sea level contribution from Greenland.

For the NEGIS it is not clear how well the ice stream itself is reproduced by the model. To what extent does the model capture the observed geometry and velocities of the ice stream? And in particular, an assessment of the time evolution of the ice stream should be included. In what periods was the ice stream active, and did it change its position through time? If possible the model simulations should be compared with reconstructions from marine sediment archives. To make these comparisons relevant, as more data on the evolution of NEGIS become available, a time series showing the simulated ice flux at the margin of NEGIS should be included.

Another concern is the choice of oceanic forcing applied to the model ice sheet. For simplicity the submarine melt rate is assumed to be spatially uniform around Greenland. Given the lack of data this can be argued to be a fair assumption. However, the impact of this choice should be documented and discussed in light of existing data from sites along the margins of Greenland. A bigger concern is the inference that past oceanic temperatures below the ice evolve in phase with the atmospheric temperature (eq. 4). Several studies have shown that during glacial periods the subsurface temperatures off Greenland were relatively warm due to the stratification of the water column under an extensive sea ice cover and associated fresh surface layer (see e.g. Alvarez-Solas et al. 2011).

SPECIFIC COMMENTS:

Line 7, page 1: LGP is not a common acronym. Better to spell out last glacial period and if necessary use common acronyms such as the LGM to specify a specific period within the glacial period where appropriate.

Line 14, page 1: NG - a more common acronym for the 79N glacier in the literature is 79N.

Line 16, page 1: it is stated that 79N is more stable than ZI due to its bed configuration - please elaborate on this.

Line 5, page 2: the slow retreat of 79N suggested by Choi et al. is described as conservative. Why? Please elaborate.

Line 11, page 2: the ice is thought to have retreated 20-40km being its PD position during MIS3. How is this now? Please elaborate and include an assessment of the uncertainties.

Line 24, page 2: resolve "?"

Line 8, page 3: the climate forcing is composed of 3 different ice core reconstructions (Vinther, NGRIP, and NEEM). Substantiate why this is done, instead of using only one ice core record such as NEEM.

Line 9, page: why is the variability below orbital removed? What is the purpose of this? What is the model result given the full variability represented by the climate reconstructions? Is there a reason to believe the millennial scale variability should be neglected in forcing the ice sheet?

Line 11, page 3 and eq. 1: PD is referred to as interglacial. Please be more precise on definition of PD: interglacial, Holocene or present day?

Line 13, page 3: why use CLIMBER-3a and not PMIP for the LGM - interglacial climate? What is the impact of the choice of model?

Line 15, eq. 2, page 3: What is the rationale behind choosing the same approach for calculating precipitation as for temperature? Is this appropriate? What is the impact of this choice, please document. Note that P_LGM and P_PD are not described. How are these calculated?

Line 16, page 3: why use PDD and not scale SMB from MAR which is used for the temperature?

Line 17, page 3: it is claimed that using PDD does not "jeopardise" results as focus is no oceanic forcing. Note that this invalidates any comparison of the relative importance of atmospheric and oceanic forcing. Please elaborate on this point + check manuscript for consistency with the discussion of the importance of the oceanic forcing given that its relative role cannot be assessed.

Line 8, page 4: resolve "?"

Figure 3: what is shown here. Please specify time periods for each subplot.

Figure 4: Show A and B in relation to ice margin (e.g. in figure similar to 3). Specify where smb and Bmelt are taken from.

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