

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

Anonymous Referee #1

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This paper addresses an interesting question about the past behaviour of the NEGIS system in Greenland. Its is relevant to the readership of TC and is a useful investigation of paleo-retreat controls in this area. The conclusions reached are reasonable based on the relatively simple experimental design (although see problem below). The work is linked to the appropriate existing literature in the region, and is mostly well written. In a few places the language used needs rephrased (see below) for clarity.

The main problematic issue I found with this paper is that it is very unclear whether the advance condition fits well with the geological evidence for LGM extent and therefore it is further unclear whether the retreat is to any degree preconditioned by this lack of fit. Thus the magnitudes and rates of retreat are harder to trust when we don't see the fit between the model and the data in a clear way. This could be solved by

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a more rigorous discussion of fit, and with figures enabling the fit to be visualised and quantified. That said, most of the sensitivity tests show advance to a fairly similar distance from the GL and therefore the comparative nature of the sensitivity tests is useful. In addition, the fact that sustained melt could have driven the retreat seems like a conclusion that wouldn't change if there were a different fit with the model extents and geological data.

Overall, with this issue addressed above, and the general comments addressed below, then this should be a useful contribution to the understanding of the NEGIS system.

General Comments:

Page 1:

L5 'important conundrum' – please indicate more clearly what the conundrum actually is. I.e. you outline that the ice stream is losing mass and retreating over the last decades and that it retreated further inland at MIS3. Why is this a conundrum?

L6: 'a modelling approach is pending' – you mean a modelling approach has never been used to test the hypotheses?

L14: I would like to see a good location map with the detail of the glaciers (and names) picked out and the overall setting shown clearly.

L16: 'almost lost' – can this actually be quantitatively described because otherwise this is quite a vague statement.

L17: 'due to its bed configuration' – please describe the differences in bed configuration – add detail and explain what you mean.

L18: 'lost mass' – can the mode of mass loss be described? E.g. thinning? Retreat?
Both?

Page 2:

L5: delete 'even'.

L10: delete 'further back in time'. Also, what is meant by 'largely'? E.g. the fluctuations were large in magnitude? Or most of the ice margin fluctuated?

L11: delete 'even'.

L10-12: You don't mention that there must have been readvance since MIS3. Perhaps indicate what is known about this too?

L12-13: 'The Holocene retreat... Etc.' – this sentence conflates the past and the future. It would be good to separate out the past bit and then say why it is important to look at this - e.g. because conditions may have been similar to what is expected in the future. In other words, this is the justification for why the paper is a useful piece of work.

L13-14: delete 'On the other hand' as it is superfluous text.

L15: 'was undertaken yet' should be 'has yet been undertaken'.

L30-31: The friction law is mentioned, but not quantitatively described. Can it be described more quantitatively?

Page 3:

L1: Can a comment be made about whether the flotation criterion and calving model has implications for any particular behavioural characteristics of the model. E.g. will this still produce good overall responses in terms of space? Will the rates of retreat (or readvance) be expected to be robust (or too fast or too slow?). Does it deal with retreat vs. readvance hysteresis well? Perhaps a general paragraph on what we know this model is good at in general would therefore be useful.

L14: I was surprised to see that there was no sensitivity testing of the climatic controls on the model experiments. Can you comment somewhere in the text as to whether you think the results would be significantly different if the climate control was altered within

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a certain range of uncertainty?

Page 4:

L18: Can you justify why basal melt rate is not parameterised in a depth-dependent manner? Or in other words, why is a 10% Bm on all floating grid cells an appropriate decision to make?

L25 or thereabouts: Do you make any assessment of whether the pre MIS3 state is realistic? I.e. how good is the spinup, can it be assessed, and how does it fit to the geological/field data from the region. In addition, can you confirm you are allowing the grounding line to evolve through time? And does the ice shelf characteristics evolve through time during spinup?

L30: I think a map of the fit between the pre MIS-3 state and the geological evidence would be an important figure to show. This will allow better discussion of whether the system is appropriately setup for the retreat experiments. I.e. if the extent or thickness is not correct, then how can we trust the degree or rates of retreat?

L32: delete 'already'.

Page 5:

L1: What is meant by 'substantially steady' – describe the margin stability pattern in clearer detail.

L21: 'stationing' isn't a good word to use. Do you mean 'stopping', or 'retreating to'?

L27: you mention that there is no melt imposed at the LGM. You could discuss somewhere later about whether you think this is a realistic condition.

Page 6:

L1 'saturates for high values' – can the high values be stated quantitatively?

L14-19: As mentioned before – I would like to see a better exploration, and a figure,

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showing the fit of the LGM expansion and the field data. I think the weakness of this paper lies in both a lack of description of this, but also the fact that the fit is not as good as it could be. We really need to see how good the fit is so we can better judge the results. In addition, were there no modifications, for example to the climate, or the the Bm during the advance phase, that would help enable a better fit to the data? Some more sensitivity tests on this would have been good to see.

L17: 'insufficient basal drag' . Please tell us why the imperfect drag imposition would alter the result in this way?

Page 7:

L1: can you describe the pattern of saturation in more quantitative detail?

L9: 'it is unlikely that this could have happened for a long period of time and in such a persistent way.' Can you justify why this is the case? Explain in more detail – link to any knowledge in ocean circulation change etc.

Page 8:

L4: 'helps to constrain' – so you mean 'helps to limit'? Constrain could be interpreted in a number of ways – e.g. to limit or to provide evidence to help understand.

L7: It would be useful to know whether the 'prolonged presence of submarine melt' is something that is a realistic prospect based on any other evidence.

Figures:

Fig1: I would separate the inset map to a separate new figure 1 which should be a location map showing the NEGIS area in much more detail, including the key outlets, the location of the profiles, the offshore bathymetry, the onshore ice cover etc. In addition, either on that map or on an additional new figure, all the evidence for past ice extent should be shown so that we can then use it to judge how well the model fits with the geological dataset.

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In addition, in this figure the growth and retreat steps are rapid. Can you say much about whether these are purely a function of the forcing provided, or whether the bed topography or fjord width is having any particular control on the 'stepped' nature of advance or retreat?

Given that you mention that there was a retreat to a position inland of the present day grounding line position, can you also show a horizontal dotted line to represent the knowledge of where this inland retreat reached?

Fig3: These figures are a little hard to follow because of their size. Can they be made bigger? The arrows pointing to the PG grounding line positions aren't terribly useful – surely a line on the map would be more appropriate. Finally, you mention these are snapshots at different times along MIS3 and the LGM. Please state which times these actually represent.

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