

Modelling GNSS-observed seasonal velocity changes of the Ross Ice Shelf, Antarctica, using the Ice-sheet and Sea-level System Model (ISSM)

– Response to Reviewer –

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Firstly, we would like to thank the reviewer for their final supportive and constructive suggestions. We have responded to the reviewer’s specific comments below.

1 Reviewer Suggestions

Line 3: the comma placement seems a bit unusual; please consider revising.

Done. We have changed the sentence to: ‘However, the drivers of this variability remain poorly understood’.

Line 11: Suggested wording “Here, we investigate the potential role of basal melt variability on ice flow speed and use the Ross Ice Shelf a testbed”

Done.

Line 20-21: consider rephrasing to “... on ice flow speed, the amplitude of the perturbation required to ...”

Done.

Line 61: replace “;” with “and”

Done.

Line 209: be sure to comment on the unrealistic refreezing that is applied in the sine function.

Done. We comment on this in the Discussion section titled: ‘Magnitude of Variability’.

Line 410: consider specifying what you mean by “... as has been done previously”. For example, in Reese et al. (2018) they also look at a local perturbation.

Done. We have added in the reference *Klein et al.* [2020].

Line 420-425: I suggest to better link the two with something like: “This can be explained by the loss of buttressing force triggered by the ice shelf thinning.”

Done. Added this sentence ‘This can be explained by the loss of buttressing force triggered by ice shelf thinning near the Ross Island pinning point.’

The explanation of the impact of thinning on pinning points could be more detailed. Depending on the way you apply the melting, you may not lose any grounded area over Ross Island in your experiments. The loss of buttressing would therefore be due to a reduced thickness close to the pinning point and a decreased transmission of stresses from the pinning point to the rest of the ice shelf. This might not be clear in the text right now, as

the reader might think that melting leads to a reduction of grounded area (which might be the case though). If there is some unpinning, I think that it will only occur in ISSM if you apply melting at the first grounded node or if the thinning over the ice floating area leads to an increased advection of ice from a grounded area to a floating area (which, again, might be the case). This might be good to check in the outputs and to emphasize in the discussion.

Done. We have added this sentence into the discussion section titled 'Local Perturbations': 'This loss of buttressing force is due to reduced ice thickness near the Ross Island pinning point, and a decreased transmission of stresses from the pinning point to the rest of the ice shelf.'

Line 510: This sentence nicely recaps the limitation of the experiments but is a bit long. Here is a suggestion to improve readability: "However, we highlight that if melt alone were responsible, and it occurred only in sensitive regions of the ice shelf, then a variability in basal melting with peaks of 20-80 m/a in April and October would be needed to match the GNSS observations at sites 1, 2 and 4."

Done. We have included the suggested rephrased sentence.

Line 580: As in line 420-425, it might be good to specify the effect of ice shelf melting on pinning points.

Done. We have clarified this in the discussion section titled: 'Local Perturbations'.

Line 588: "Therefore" is repeated from line 585. Consider rephrasing to avoid redundancy.

Done. 'Therefore' was removed, and no longer repeated.

Line 591: Remove the period at the beginning.

Done.

However, I believe combining Figures A8 and A9 or aligning their time axes would be highly beneficial to readers, as it would allow for straightforward comparison of MITgcm with the sinusoidal forcing. This seems logical to me and is little extra-work but I leave this decision to the authors.

We have decided not to include this figure, as it would be significant work to do so.

Also, in your response, you mention that each color on the plot represents basal melt at different nodes of the mesh. Could you please include this information in the figure label for clarity?.

Done.

References

Klein, E., C. Mosbeux, P. D. Bromirski, L. Padman, Y. Bock, S. R. Springer, and H. A. Fricker, Annual cycle in flow of Ross Ice Shelf, Antarctica: Contribution of variable basal melting, *Journal of Glaciology*, 66(259), 861–875, doi:10.1017/jog.2020.61, 2020.