Firstly, we would like to thank all reviewers for their constructive and detailed comments.

Main comments

We understand the main concerns that were raised regarding the conclusions being too 'strong'. We have addressed this issue throughout our revised manuscript as follows:

- We have removed or toned down some of the conclusions and claims. In particular we have focused on editing these statements in the abstract, discussion and conclusion.
- We have restructured our aims to clarify that we use the RIS as a *testbed* to see if local changes in basal melt can affect flow speed, and what magnitude of variability is needed to match the GNSS observed velocity changes.
- We have restructured the Discussion to include more details on our methodology limitations and caveats, the type of perturbations used and comparison with observations. Additionally, we have removed our strong statements regarding MITgcm ocean model and the SSH results.
- We have highlighted throughout that our basal melt perturbations are likely not realistic for the RIS because of (1) the high magnitudes and (2) the sinusoidal pattern, and we suggest that other mechanisms are also at play to drive the observed velocity changes.
- We focus on discussing the sensitivity maps and how these results show that localized changes in melt can have a strong impact on flow speed in general.

We highlight again that our study brings novel contributions, which include:

- We present new GNSS time series from the Ross Ice Shelf that have not previously been published. These include sites near the calving front, near a significant pinning point, and in the deep interior of the ice shelf near the grounding line.
- We show that these measurements consistently show 2 peaks in ice shelf velocity every year (for Sites 1, 2 and 4, the newly collected datasets), contrary to previous measurements presented in *Klein et al.* [2020] and *Mosbeux et al.* [2023].
- We use the RIS as a *testbed* to see if local changes in basal melt can affect flow speed, and what magnitude of variability is needed to match the GNSS observed velocity changes.
- We use a novel approach of combining Automatic Differentiation and weekly MITgcm basal melt rates ([*Klein et al.*, 2020] used monthly basal melt rates).
- Our final sensitivity maps allow us to understand that localized changes in melt can have a strong impact on ice flow on the RIS.

We have responded to the reviewer's specific comments below.

Reviewer 1: Specific comments

However, to me, Figure 3 does not look good enough. I do not understand why the grounding line is randomly cut off on the left and the top of the panels (same for Figures A5, A6 and A7). Figure 5, suffers the same issue and I personally think the melt on the grounded ice and open ocean should not be displayed as null value, but just left blank

Thank you for pointing this out. Figures 3, A5, A6 and A7 have been edited to make sure the grounding line is not cut off. We decided to remove Figure 5.

Figure A3: the y axis for the direction has a strange unit system.

Figure A3 has been edited so that the y-axis has a user friendly unit system.

Figure A9: Why is the time going from 2040 to 2042? It would be interesting to align A8 and A9 to compare MITgcm melt rates in sensitive regions. Also, what is the meaning of the different colours and lines?

We chose 2040-2042 arbitrarily. This figure provides an example of the sinusoidal pattern, which is repeated throughout the years. We have decided not to include this figure, as we think A8 and A9 highlight the differences in phase well without needing to spend significant time combining the figures. Each coloured line represents basal melt at a different sensitive region (i.e., each node on the model mesh).

Line 669: 'exploring' instead of 'exploration of' to stay consistent with (1) and (2)?

Done.

Reviewer 2: Specific comments

The comment from the previous review has not been addressed: 'It is not inconceivable that small, solar annual or semi-annual tides could drive the remaining 1 percent semi-annual variations in velocity shown in Figure 3 and it needs to be explained why they can be ignored.

This has been addressed in Discussion section titled: Potential drivers of intra-annual velocity variation.

Now that you have added a figure on MITgcm model baseline melt rates, I find it strange that while there is one very dominant seasonal peak in Jan, there appears to be no velocity variation in your unperturbed run. If seasonal melt rates lead to velocity change, surely this should exist in the unperturbed state due to the January peak?

The MITgcm baseline melt rates drive very very small velocity variations ranging from -0.05 to 0.05 m/a at the GNSS sites. Therefore, we perturbed (in both phase and amplitude) the MITgcm basal melt rates significantly to match the GNSS observations.

It also is not mentioned in the text that your perturbation involves a very high negative melt rate (Figure A9). This is perhaps even more unrealistic than the positive melt rates.

Thank you for highlighting this. This has been clarified in the Methodology and Discussion sections.

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.

Mosbeux, C., L. Padman, E. Klein, P. Bromirski, and H. Fricker, Seasonal variability in antarctic ice shelf velocities forced by sea surface height variations, *The Cryosphere*, *17*(7), 2585–2606, 2023.