We thank the Editor and the Referees for their time and their positive and constructive feedback of the manuscript. In response to these reviews, we have edited the text to clarify our arguments and the results of the study. In particular, we have added text to the introduction that contextualizes the motivation of our study for a broader audience. Further, we have addressed all minor revisions suggested by the Referees. We believe that the revised manuscript is improved relative to the original.

In the following, we address each of the comments raised in the reviews and provide a detailed listing of the associated revisions to the text. We intersperse the reviewers' comments (black font) with our responses (blue font).

Referee #3
I apologise for the late posting of this review.

This manuscript presents a series of idealised grounding line stability simulations for the Ross Sea Embayment, both with contemporary and palaeo bathymetry reconstructions. The authors show that isostatic depression at the LGM restricts the potential areas of grounding line stability, and that the areas allowing stability increase at the present day due to local relative sea level fall since the LGM. Later results demonstrate the importance of horizontal resolution to this problem; coarser (20 km) resolution underestimates the frequency of potential areas of grounding line stability.

Arguably, each individual element of the results is not surprising. But the work is comprehensive in its exploration of the topic. The exploration of the resolution dependency, for example, is robust and detailed. Simplifications in the grounding line flux simulations are well justified, and the experimental design allows for clear comparisons to be drawn. These technical choices are clearly described in the text.

We thank the Referee for these positive comments.

The introduction might benefit from a more detailed introduction to GIA, and there are some sections where added clarify would be useful (highlighted below). As such, I recommend publication after minor revisions.

Main points

As someone whose knowledge of GIA comes through ice sheet modelling (rather than my first-order research focus), it might be beneficial to provide some more detail and background in the introduction on GIA and Antarctica, including a brief review of the recent advances in coupled modelling (at the moment this is limited to a sentence around line 51). The introduction is currently brief enough for you to safely add more background without bloating the section, and it might increase the potential audience of the manuscript and/or increase the usefulness of the manuscript to an audience like me.
In response to this comment and a similar comment by Referee #2, we have added text to the introduction that contextualizes our research study (L 58-70):

> "Although coupled GIA-ice sheet models provide valuable insight into ice sheet-solid Earth interactions across Antarctica, they are computationally

expensive. As a result, ensemble runs of ice sheet or coupled GIA-ice sheet models that can encompass uncertainties in climate and glaciologic conditions are run at relatively coarse resolution (16-40 km; Albrecht et al., 2020, 2024; van Calcar et al., 2023; Gomez et al., 2018; Pollard et al., 2017), and are unable to resolve smaller scale bathymetric features, such as pinning points (≤5 km; e.g., McKenzie et al., 2023), which control grounding line evolution. Recent coupled GIA-ice sheet modeling showed that increasing bathymetric resolution (from 2 km to 1 km) slowed predicted grounding line retreat by up to ~20% in the Amundsen Sea; however such high-resolution modeling is more appropriate for smaller regions (the Ross Sea Embayment is ~4x their model domain size) and for timescales of centuries rather than millennia (Houriez et al., 2025). Exploring the impact of high-resolution bathymetry on grounding evolution since the LGM across a larger area, such as the Ross Sea Embayment, is still a computational challenge."

Specific points

58: "large- and small-scale bathymetric features", what do you mean by this?
We no longer reference "large-scale" and specify "small-scale" (L 436):

> "…small-scale (≤5 km) bathymetric pinning points"

74: Just BedMachine minus GIA signal? Are there any complications from mismatched grids?
The Referee is correct that we subtract the GIA signal from BedMachine (L 84-87):

> "To reconstruct Ross Sea Embayment 20 ka paleobathymetry we modify present-day BedMachine v1.38 bathymetry (500 m horizontal resolution; Morlighem et al., 2020) for the spatiotemporal patterns of GIA caused by the deformational, gravitational, and rotational effects associated with changes in ice load (i.e. $\text{topography}_{20\text{ ka}} = \text{topography}_{\text{pres}} - \text{relative sea level}_{20\text{ ka}}$)."

There are no complications from mismatched grids because the GIA output varies over long wavelengths (~100 km scale) so it can be interpolated to higher resolution without introducing artifacts (L 98-99).

> "The resulting GIA output varies smoothly across spatial scales much broader than the spatial scales of Ross Sea Embayment bathymetric changes."

102: Can you provide some more detail of the Gom18 reconstruction here? An ensemble again? If so, how did you select which members to use/average?
The Gom18 ice sheet model is the result of a single run of the coupled GIA-ice sheet model. We have added additional text about each ice history adopted in our study, including Gom18 (L 113-117):

> "The third ice history Gomez et al. (2018; henceforth Gom18) has a deglacial Antarctic Ice Sheet volume change of ~6 m GMSLE. The Gom18 model is a single model run of a coupled, gravitationally consistent GIA-dynamic ice sheet model that incorporates 3-D earth structure and was forced by climate via benthic $\delta^{18}O$ records. The ice sheet model was run with 20 km resolution and 200 year timesteps."

119: Some more information about how these flowlines are produced would be useful.

We have added text in response to this comment and a similar comment made by Referee #2 (L 136-139):

> "From the ice divide to the present-day grounding line, ice flowlines are based on observed ice surface velocities (Rignot et al., 2011), and from the present-day grounding line to the edge of the continental shelf, ice flowlines follows reconstructions of paleo-ice flow reconstructed of Anderson et al., (2014)."

123: Is the flow reorganization during the deglaciation significant? The justification of keeping the flowlines consistent to aid comparison seems sound, but it would be useful to consider what magnitude of reorganization we're dealing with.
The changes in flow associated with the reorganization was limited to near the present-day outlets of the Transantarctic Mountains (near Drygalski Trough). The evidence shows slight changes in flow direction (Lee et al., 2017), and a general readvance (Greenwood et al., 2018; Lee et al., 2017). These changes are of second order compared to changes in grounding line position associated with the deglaciation, and therefore we would expect would have minimal impact on our findings given their relatively small magnitude. The flow reorganization during the deglaciation would be potentially interesting to explore in future research.

138: How do you statistically sample over the parameter space?
We now specify the sample size used for each parameter in Table 1 and include text describing how we sample the parameter space (L 155-159):

> "We consider different combinations of accumulation, basal friction, and ice-shelf buttressing parameters (Table 1) by uniformly sampling the range of basal friction and ice-shelf buttressing and sampling the range of accumulation rates with a non-linear spacing, since they range over an order of magnitude…"

150: "Nye-Glenn law" > "Nye-Grenn flow law"?
Corrected

339: "T-test" > "t-test"?
Corrected

174-183: I'm not sure how the zones along the flowline were defined?
Zones are defined as a 50 km reach along a flowline representing in ice stream transect (Figure 2), or 20 km x 20 km grid cell within the Ross Sea Embayment (Figure 3). We have added text to make this definition clearer in response to this comment and a similar comment made by Referee 2. We have added the following text (L 270-273):

> "Zones along the transect with higher counts of potential stable grounding line locations are stable across a wider range of input parameter combinations and therefore have a relatively higher likelihood of being stable regardless of parameter uncertainty and are referred to as "zones of potential persistence"

255: "Changes in the density of potential zones of ground line stability" took some time for me to fully understand as a concept. Room to explain it in more detail elsewhere?
In response to this comment, we have rephrased our wording to focus on counts of potential grounding line locations, rather than density. We hope this wording makes the concept more intuitive for the reader.

We have edited the text to clarify (L 262-277):

> "For example, Figure 2b shows the count of potential stable steady-state grounding lines associated with the reconstructed bathymetric transect for the paleo-Whillans ice stream (Fig. 2a) corrected for GIA (Gom18–orange, W12–purple, Gol14–red; Figure 2b), compared to the present-day bathymetry (black; Figure 2b). Present-day bathymetry contains a higher count of potential stable steady states upstream of the flowline, close to the present-day grounding line (black; Figure 2B), compared to any of the 20 ka bathymetries corrected for GIA (orange, purple, and red; Figure 2b), which contain higher counts of potential stable steady states near the edge of the continental shelf.
>
> Zones with higher counts of potential stable steady-state grounding line locations are stable across a wider range of input parameter combinations and therefore have a higher likelihood of being stable regardless of parameter uncertainty. Henceforth, we refer to these locations as "zones of potential persistence" (ZPP). Each zone contains the count of potential stable grounding lines within a 50 km reach along a given ice stream flowline (Figure 2b). The present-day bathymetry has zones of potential persistence near the present-day grounding line (~750 km downstream; black; Figure 2b), whereas each 20-ka bathymetry has zones of potential persistence near the continental shelf break (~1600 km downstream; orange, purple, and red; Figure 2b)."

And we also change the Figure 2 caption wording for clarity (L 286):

> "Zones of potential persistence (ZPP) along individual flowlines".

268: "less" > "fewer"?
Corrected

292: "Our analysis shows…" onwards; this sentence is hard to follow.
We rephrase to (L 324-330):

> During the LGM the grounding line was located near the edge of the continental shelf, and at present-day the grounding line is located within the Ross Sea Embayment interior. Our analysis shows that GIA promotes grounding line stability near the edge of the continental shelf during the LGM and promotes grounding line stability within the Ross Sea Embayment interior at present-day. The co-occurrence of inferred locations of the grounding line for present-day and LGM suggests GIA stabilizes the grounding line at both glacial maximum and interglacial climate states.

Figure 3: Struggling a little bit with the telling apart the "stable for present-day only" and the lighter blues. Could you make it more obviously different?
We have changed the color to purple to make this more obvious visually.

355: 20-40 km (40 is quite common for palaeo), but your later analysis (figure 6, for example) caps out at 20 km?
We now include 40 km resolution in our analysis in Figure 6b.

377: In this section also mention the resolution dependency of simulating GL dynamics, as in MISMIP experiments?

We instead choose to highlight a recent study that show resolution dependency for a coupled GIA-ice sheet model (Houriez et al., 2025) 9L 64-66):

> "Recent coupled GIA-ice sheet modeling showed that increasing bathymetric resolution (from 2 km to 1 km) slowed predictions of grounding line retreat by up to ~20% in the Amundsen Sea (Houriez et al., 2025)…"

Houriez, Luc, Eric Larour, Lambert Caron, Nicole-Jeanne Schlegel, Surendra Adhikari, Erik Ivins, Tyler Pelle, Hélène Seroussi, Eric Darve, and Martin Fischer. "Capturing Solid Earth and Ice Sheet Interactions: Insights from Reinforced Ridges in Thwaites Glacier," January 24, 2025. https://doi.org/10.5194/egusphere-2024-4136.