Author's response: Review of the manuscript "The stability of present-day Antarctic grounding lines — Part A: No indication of marine ice sheet instability in the current geometry" by Urruty et al.

Dear Alexander Robinson,
Thank you for reviewing our manuscript. Your comments are helpful and we are glad to respond to them. Please find our responses to your comments below and we will address all comments in a revised version of the manuscript. In order to facilitate the reading of this document, our responses are given in blue and italic compared to your comments which are given in black without italic font.

This study presents a comprehensive evaluation of the possibility for large-scale, internally driven retreat of present-day Antarctic grounding lines. Two different ice sheet models were spun-up to approximate a steady-state with the present-day geometry of Antarctica, while a third model was spun-up to approximate the ice sheet after transient historical forcing since 1850. Perturbation analysis was then used to determine whether a temporal increase in basal melting over 20 years could cause the ice sheet to undergo strong grounding-line retreat that would continue after the forcing was removed. In all experiments, the present-day geometry was found to be a stable configuration, in the sense that all major grounding lines essentially returned to their original position.
This study is very interesting, timely and well done. The experiments are designed to test a specific hypothesis, and the results are convincing. Furthermore, overall the authors do a good job of discussing the various caveats to their methods and using the complementary strengths of the different models and experimental setups to confirm their findings. Particularly, I think the value of the study comes across quite well in the discussion section.
In contrast to the first reviewer, I find no major impediments to publication. I do agree that some of the framing in the Introduction and Methods could be more precise, with a few comments noted below. But I would recommend publication after only minor revisions.

Thank you for your positive words on our work and we are glad you understood the main objectives of the study. Following the suggestions of reviewer 1 we have made improvements to the introduction and methods. In particular we have clarified the need for a steady-state configuration of the ice sheet for our numerical model experiments. We have also modified the introduction to make sure there is no confusion relating to bed slope as the only criterion for grounding line stability. We have additionally added some extra justification for our mass balance correction in Section 2.2.1 in the methods.

Specific comments:

L46: Delete "In the future," as it doesn't seem to fit. Maybe instead add an "also" to become "have also shown potential"

Done.

L51: larger event => larger one

Done.

L52: marine basins => marine basins,

Done.

L57: "The aim of this paper is to determine if stable grounding-line positions exist in the current geometry of the ice sheet." <= Rephrase here. The current geometry has been stable for several thousand years now.

We have rephrased the aim to: "The aim of this paper is to determine if the current positions of the grounding line are undergoing self-sustained retreat."

L63: "control parameter that satisfies the steady state condition" <= It should be a control variable that satisfies the steady-state condition, right? The perturbation is applied to a parameter and the control variable (e.g., grounding-line position) is allowed to evolve. Please revise.

Agreed, this sentence is confusing as it is currently written. We have rephrased to: "We can apply a small-amplitude perturbation to a control variable that satisfies the steady state condition, in this case the position of the grounding line. We perturb the grounding line position indirectly, by increasing the sub-shelf melt rates."

L71-73: "The existence of such stable steady states is also strong indication that the currently observed retreat of Antarctic grounding lines is purely driven by changes in the external drivers such as oceanic forcing." <= It could also be an indication that the ice-sheet continues to evolve due to past climatic forcing, since as mentioned, in reality it is not in steady state. Consider adding some nuance here, which would flow better into the next paragraph which treats this point.

We have now added that this could also be in response to past climate forcing.

L74: ice sheet state => ice-sheet state

Done.

L100: set-ups => setups

Done.

L205: What is the motivation for this formula for error in grounding-line position? Add a sentence or two, as there could be many ways to define this error.

Integrated grounded area is easy to obtain for all models rather than calculating the movement of individual grounding line segments. Grounded area is also an appropriate proxy for grounding line position change, but we wanted to convert this to a length (rather than area), and so normalised this by the grounding line length. This is also the same metric we use in our results, for grounding line position change (grounded area normalised by grounding line length). We have adjusted the text to: "We calculate the error in the grounded ice area (a proxy for grounding line change), by differencing the simulated and observed grounded ice areas. To obtain a relative displacement of the grounding line itself, we normalise this area change by the simulated length of the grounding line."

L287: 500 years => 480 years [right?]

Done.

L415: "The spin-up procedure..." <= Fragment, please revise.

Changed to "Due to the spin-up procedure…"

L440: firstly => first

Done.

L536: committing => producing

Done.