

The Cryosphere Discuss., referee comment RC1
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Comment on tc-2022-50

Anonymous Referee #1

Referee comment on "Sensitivity of the Ross Ice Shelf to environmental and glaciological controls" by Francesca Baldacchino et al., The Cryosphere Discuss.,
<https://doi.org/10.5194/tc-2022-50-RC1>, 2022

The region of Ross Ice Shelf (Antarctica) is presently stable but basal melt rates might increase more and more in the future, leading to potential important mass loss of the ice shelf, and subsequent acceleration of its tributary glaciers. In this paper, the authors propose to map the regions of high sensitivity of the RIS basin to potential changes in ice rigidity and basal friction (glaciological controls), as well as surface mass balance and basal melting (environmental controls). For that, they use an Automatic Differentiation (AD) method, coupled to a 20-year simulation of RIS evolution under current forcings, using the Shallow-Shelf Approximation of the Ice-sheet and Sea-level System Model (ISSM). The AD allows to compute the gradient of the Volume of ice Above Floatation (VAF) with respect to the four parameters, and therefore the effect of a small perturbation in a parameter on the VAF (which is a good proxy to quantify the final effect of ice mass change on sea level rise). They conclude that the sensitivity to friction and ice rigidity is the higher at the grounding line and at glacier and ice stream shear margins (with geographical variations). They also find, similarly to other studies (using different methods), that the sensitivity to basal melt changes is maximal at the grounding line.

The paper is relatively similar to Morlighem et al. (2021): Mapping the Sensitivity of the Amundsen Sea Embayment to Changes in External Forcings Using Automatic Differentiation, 2021). The authors used the same methods (2 co-authors are also on the 2021 paper) but on another region. As expected, the conclusions of the study are relatively similar: the sensitivity to basal friction and ice rigidity is the stronger over the shear margins and upstream the grounding line. In this regard, little new insights are brought. However, in my opinion, the AD used by the authors is a powerful method that is still underused in the ice sheet community. Overall, this is an interesting work which can help in deciding what physical mechanism we should work on for better projections of the evolution of the region. It could also help in targeting regions to monitor when collecting observations.

Reading the results, I was wondering how different the sensitivity maps would be if (1)

the forcings were different, (2) if the time period was longer (100 years for example), and (3) if the inverted friction/ice rigidity were different. If the results are sensitive to the simulation parameters and time, then, it should be discussed (see my specific comments below). If not, I think it would be worth mentioning. This could also be a great additional value with respect to Morlighem et al. (2021). Even without looking at longer simulations, I think that there was not enough results and discussion on the inversion and the 20-year simulation. Adding some details about it (as a supplementary material or as an Appendix) would be very valuable.

I found the comparison of the results with other papers (using totally other methods or based on observations) really interesting. I however want to point out that the discussion would benefit from being reorganized and a better writing. In general, I was slightly disappointed by the grammar and punctuation. Some sentences are poorly written and tend to decrease the readability of the paper (even in the abstract, see my technical comments).

Regardless of my concerns, and even though the method and the conclusions of the paper are very similar to Morlighem et al. (2021), I think that the relative novelty of the method and the appropriate comparison/discussion of the results with respect to other studies make the paper interesting and worthy of publication (after revision) and will be useful to the community.

A supplement with more details is attached to my review.

Please also note the supplement to this comment:

<https://tc.copernicus.org/preprints/tc-2022-50/tc-2022-50-RC1-supplement.pdf>