The Cryosphere Discussions

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Comment on tc-2021-274

Anonymous Referee #2

Referee comment on "Derivation of bedrock topography measurement requirements for the reduction of uncertainty in ice-sheet model projections of Thwaites Glacier" by Blake A. Castleman et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-274-RC2, 2021

This study investigates the impact of bed topography error on uncertainty in ice sheet model projections in the Thwaites Glacier basin in West Antarctica. The authors tests a number of different aspects of bed error (e.g. horizontal and vertical resolution), and their impact on grounding line retreat and sea level contribution under an extreme ocean-driven melt rate forcing. This is achieved through a series of experiments using the ISSM ice sheet model and a key contribution of this paper is that these experiments help indicate data resolution requirements needed to keep the uncertainty in SLR projections (due to bed topography error) below a certain threshold (e.g. +/- 2 cm over 200 years).

I don’t have any major comments and I congratulate the authors on a rigorous, well-written study.

Minor comments/suggestions:

L80: plus potentially errors in the interpretation of radiograms -- e.g. misattribution of basal crevasses as bed returns

L115: Do you specify a minimum ice thickness? i.e. in some simulations do you see the ice shelf thins to a point where the ice shelf front has essentially retreats (but is held in position by the imposed minimum ice thickness)?

L153: Personally, I would include the leading zero before the decimal.

L151: Melt rates extrapolate inland, but later on your mention that there is no melt in partially grounded elements. So is this extrapolation inland for newly ungrounded ice only? Perhaps just clarify this.

Section 4.1: Would it be possible to include a conceptual diagram to explain how the wavelet decomposition works or at least what it ultimately means for adding noise to bed topography? Or perhaps some examples in the SI of the various bed realizations (or difference plots between the perturbed and control beds). This is so that readers who don't follow the details at least can understand what the bed perturbations looks like, aiding their intuitive understanding of the results.

Section 4.2: What is the assumption being made here about bed roughness under Thwaites? Is the minimum resolution of 2 km that you are proposing only required if high frequency variation in topography actually exists?

L341-2: Because you have already described Fig 3b, this sentence about exceeding 2cm around the 2 km mark seems repetitive. I'm not sure what you mean by 'eventually'…

L344-5: Similarly, this sentence is confusing – what does compensation mean in this context? Does "before 2 km" mean higher or lower resolution?

L246-349: This is an interesting finding. Can you reiterate the context, i.e. this 2 km is therefore the desired minimum horizontal resolution required for bedrock topography data in order to keep uncertainty in SLR projections due to bedrock data to less than 2 cm.

L387-8: Perhaps refer back to Experiment 1 here as it seems relevant.

L404-6: Could you add vertical/horizontal lines on Fig 4 to mark the +/- 2cm SLR and corresponding +/- 8 m vertical res?

L444: "repeat the bedrock sampling experiments, but this time with perturbation of only the ice shelf basal melting rates". I wasn't entirely sure what you meant by this – from the Fig 5 caption, I think you mean running the control topography (i.e. bedmachine with no errors) for 300 different melt rate perturbations. Could you make this clearer?

L475 and elsewhere: when you provide the range of the distribution, is this a range between certain percentiles, e.g. 5-95% range (given you are presenting PDFs)?

L496-7: "locations or strong topographical influence on the grounding line, or pinning points" – I would consider a depression which results in no stable GLs / rapid retreat to also be a strong topographical influence on the GL -- could you find an alternative way of phrasing these locations that are particularly conducive to stable grounding lines?

L628-9: Favier et al. 2017 (https://doi.org/10.5194/gmd-12-2255-2019) test a range of melt rate parameterisations and should probably be cited here.