Review of Geothermal heat flux is the dominant source of uncertainty in englacial-temperature-based dating of ice-rise formation

Authors present an analysis of contributions of multiple parameters when inferring the timing of the grounding of ice rises using temperature-depth profile measurements as data. The method is applied to synthetic data, and to borehole measurements from the Crary Ice Rise. Furthermore, they perform a detailed sensitivity analysis of their forward model, showing how the changes in different forcings (accumulation rates, heat flux, thinning rate...) influence modelled englacial temperatures. Authors identify the heat flux as the main source of uncertainties as their key result, making this paper important for any future studies focusing on ice rise grounding.

The manuscript is clear in its purpose, well written and requires only minor updates.

Major comments

State the boundary conditions applied in the Methods section. I understand they can be found in the Dahl-Jensen et al. (1999), but it would make it easier for the reader to follow as they are important part of the presented setup.

Try to separate the forward Monte-Carlo and the inverse MCMC simulations more clearly, mainly in the Results and Discussion sections. Maybe refer to forward Monte-Carlo simulations as sensitivity experiments to avoid confusing the two.

In most Figures you write A. B. C. instead of (a), (b), (c) – please recheck with the rules and adjust accordingly.

Figures 3 and 4 – These two figures are very hard to follow. Either break each into at least two figures or simply put some plots in the Appendix and show us just the ones you discuss in detail. Colorbar is placed a bit strangely. Also, Figures 3 and 4 have different figure captions but show the same type of plots, and some plots are not described in the figure captions. In general, try to make all of your figures and figure captions as clear as possible.

In Section 3.2 you mention the accumulation change, case of 2 km ice thickness, yields large effect on resultant temperature when accumulation is low. Could you in the same place report what would that change be for a 500 m thick ice?

Expand the discussion on the effect of uncertainties in accumulation rates, surface temperatures and other parameters on your results with respect to currently available data over Antarctica.

Concerning the sensitivity study (forward Monte Carlo), it would be useful to discuss how well the range of values chosen (accumulation, thickness...) represents what we see in reality. For example, are more ice rises in the range of 500-1000 m ice thickness or thicker

than 2000 m. Are accumulation rates over most ice rises in the lower range (0.05 m/yr) of tested values or higher (0.25m/yr)?

Minor comments

Methods

2.1.1. Model equations – First sentence is a bit off, compared to the rest of the text. I would reword it.

Equations (3) and (4) – w_s is not defined

Section 2.1.3 Do you need the word prior in the title?

Table 1. This table should either be expanded with numerical values of your forward and inverse modelling runs, or another table should be added with those values as well.

Results

Section 3.1 Inverse modelling has Subsections 3.2.1 Synthetic data and 3.2.2 Crary Ice Rise borehole measurements. It should be Sections 3.1.1 and 3.1.2.

Line 265 – use proper signs for less than or equal to instead of <=

Line 280 – There is no Section 3.3, should it be Section 3.2?

Results 3.2 Englacial temperature profile sensitivity – maybe separate steady state and transient runs into two subsections to avoid reader confusion

Figure 5 The figure caption can be shortened here, no need to repeat the same words for each plot. Word timing after E., and geothermal after F. should be capital. Why did you choose the max accumulation example to be 0.25 m/yr and not more? Or is 0.25 m/yr the highest accumulation reported over an ice rise?

Discussion

Figure 7A - the w should be capital in x label (Heat flux, mW/m^2).

Line 350 typo, there's an extra d following "corresponds to ice grounding"

GitHub link is not active but that is understandable as the paper is still in review.

References

Please make sure that all of the references are in the same format. Sometime year is in brackets, sometimes not. Add DOI to more references if possible. Also recheck them for typos, i.e., Millero (1978) and Neuhaus et al. (2020) have typos in the title.