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Dear Editor,

Following your request for minor revision, my co-author and I resubmit with this letter a manuscript (*EGUSPHERE-2022-236* entitled *'Geothermal heat flux is the dominant source of uncertainty in englacial-temperature-based dating of ice-rise formation')* for consideration by *The Cryosphere*.

In this final version of the manuscript, we have addressed the remaining comments provided by the Reviewer. The new version of the manuscript has now a more focussed Results section and also discusses more uncertainties related to thermal conductivity and its dependence on temperature of ice.

Here, we outline how these comments have been addressed in the revised manuscript. The detailed summary can be found below in this cover letter. It contains description of the changes made in response to the Reviewer's comments, which have been highlighted in green and *italised*. Along with the new version of the manuscript, we also attach a change-tracked version of the manuscript in our resubmission to facilitate the revision evaluation process.

We look forward to seeing our work published in *The Cryosphere*. We shall look forward to hearing from you in due course.

Sincerely,

Aleksandr Montelli

Co-author: Jonathan Kingslake

REVIEWER

Second review of Montelli and Kingslake: "Geothermal heat flux is the dominant source of uncertainty in
englacial-temperature-based dating of ice-rise formation

The revised paper is a significant improvement and will be a useful contribution to the field. The method and application to Crary Ice Rise is thoughtful and compelling.
We thank the Reviewer for their time and useful comments throughout the revised manuscript, addressed below.

There are three aspects which deserve a little last attention.
1) The supplemental figure should have some text accompanying it and explaining the important results.
Caption of the supplemental figure has been extended to highlight the results of inversion that uses a range of thermal diffusivity parameters.

2) The supplemental figure addresses uncertainty in bulk values for the thermal conductivity for rock and ice. However, the thermal conductivity for ice is temperature dependent. The modeling uses a fixed value and simply shifting what that value is does not encompass the full uncertainty of allowing it to vary with temperature. The conclusion of a paper by one of our grad students was fundamentally changed by including the temperature dependent thermal conductivity. The modeling does not need to be redone with a temperature dependent thermal conductivity, but the limitation and appropriateness of including in future models does need a paragraph (or at least multiple sentences). The primary way the temperature-dependent conductivity has the potential to change the result is that it changes the slope of the englacial temperatures in a way that is different than if the value is different but still constant.
We ran additional forward model to see how a range of values for warm (~-5ºC) and cold (~-30ºC) ice would impact the resultant temperature profiles; these were mentioned in Section 3.2. We also did add a few sentences in the Discussion section to highlight this limitation of our model and the potential of temperature-dependant conductivity to contribute (though probably not significantly) to the overall ice-rise dating uncertainties.

3) Section 3.2 "Englacial temperature profile sensitivity" lacks a clear message. I think this section would be improved if it was framed around identifying which parameters are most important for ice-rise dating. A new intro paragraph should explain this, and then a new conclusion paragraph should summarize what was learned. For instance, the vertical velocity profile is relatively unimportant for shallow ice rises, which is an interesting result because the onset of divide flow is then unlikely to change the answer significantly. I also think that the main value of the 2000m thick results is showing the difference for what is important for borehole thermometry compared to that for ice rise dating - a poitn that should be made in the new introductory paragraph.

The Section 3.2 has been restructured – new separate introduction is now more focused, and conclusive paragraph summarises some key findings.

A few other minor comments:
- What is the unit 'm/ky' or 'm k.y.-1'. I found this very confusing. I think this is mostly used (inaccurately) as the accumulation rate (m/yr) but in some instances it may be a change in accumulation rate per time for the accumulation history? This needs to be made clear.
We believe this is a standard notation: ka corresponds to thousands of year ago, whereas k.y. corresponds to thousands of years. However, three typos where accumulation rates were using m/ky rather than m/y were corrected accordingly. Thank you for noticing this.

- I also suggest an additional figure, like a new figure 1, which is a large image of Antarctica with locations mentioned in the text. The location of Crary Ice Rise is pretty subtle in Fig. 1a. And then I have no idea where the Lazarev and Riiser-Larsen seas are. It would be great to have a figure which shows where this method can be best applied.
Thank you for this very useful suggestion. A new figure (Fig. 8) has been produced, where potentially useful ice rises are mapped with relation to heat flux, accumulation and ice thickness.