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The Cryosphere Discussions

Interactive comment on "Geothermal flux beneath the Antarctic Ice Sheet derived from measured temperature profiles in deep boreholes" *by* Pavel Talalay et al.

Anonymous Referee #2

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Manuscript by Talalay et al.

In this study the authors provide new estimates of geothermal heat flow (GHF) at six locations in Antarctica: Byrd, WAIS Divide, Dome C, Kohnen, Dome F, and Vostok. The thermal conditions at the base of the ice sheet in the drilling locations as well as the local GHF values are derived through thermodynamic modeling. The GHF is inferred solving the 1D heat-transfer equation in steady state conditions. The results indicate that higher GHF values, with respect to previous studies, are found for two of the locations, Kohnen and WAIS Divide.

The study is within the scope of the Journal and of high interest to the scientific com-

munity. However, there are crucial aspects that are unclear from the text such as, why the results are important, what is the new gained knowledge, how these results compared with other local GHF values obtained through modeling in the same drill sites by other authors? The manuscript lacks of a proper discussion section. In addition, key components of the methods are not adequately described or are missing. In particular, uncertainties are not adequately addressed which makes it difficult to evaluate the results and conclusions of this study.

Below are my comments, suggestions and concerns that I hope will be useful for the authors to improve the manuscript:

- I suggest to change the title as it is not accurately representing the content of the manuscript.

- Regarding the discrepancy between the high values obtained in Kohnen and WAIS Divide in comparison with Antarctic-wide maps:

One thing to consider is that the Antarctic-wide geothermal heat flow maps are representing the heat flow of a region, while a heat flow value derived using borehole measurements is representing a specific local value. Therefore, probably these higher than predicted heat flow values obtained for Kohnen and WAIS Divide are only representing local values, not necessarily hot spots. The higher values could be consequence of, for example, a higher concentration of a particular radiogenic material in that spot, or a consequence of some particularity of the subglacial topography or the parameters and assumptions that are involved in the solutions of the model to obtain the local value. For these reasons, understanding the uncertainty sources and quantifying them is extremely important and it is necessary.

- L69: The manuscript should demonstrate the temperature measurement precision in a robust and scientific way

- L78-80: Where is this shown? Quantify the good agreement. This is important for the

uncertainties of the estimated local geothermal heat flow

- Figure 1: The drill sites as well as other local values are plotted in this figure together with a geological map for the Antarctic continent. However, the geology is not mentioned in the text, there is no discussion about results and the subglacial geology. What is the purpose of the geological map if it is not used in the manuscript? I recommend to either include some discussion about it or select another background data to plot the drill sites and discuss the results in that context.

- Regarding uncertainties I have two main comments/concerns:

1. How uncertainties are calculated is not adequately explained and more information and details are needed to evaluate the GHF estimates.

2. A substantial discussion about which parameters are contributing to the uncertainty is necessary. In addition, there are assumptions made in the thermodynamic model and also parameters that are assumed to be constant. These assumptions also carry uncertainties and they need to be properly quantified and included in the final uncertainty budget. For example, one important aspect to quantify would be the contribution to the uncertainty budget of considering steady-state condition.

- The manuscript should separate results from discussion and conclusions. Additionally, a more detailed discussion is necessary.

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