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Climate of the Past Discussions

Interactive comment on "Past climate changes and permafrost depth at the Lake El'gygytgyn site: implications from data and thermal modelling" *by* D. Mottaghy et al.

Anonymous Referee #2

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The manuscript "Past climate changes and permafrost depth at the Lake El'gygytgyn site: implications from data and thermal modelling" by Mottaghy et al. presents two-dimensional heat flow modeling of the temperature field under Lake El'gygytgyn. The paper is clearly written, and presents a wealth of important thermal parameters for the modeled domain, that are based on cores obtained from drilling campaigns. I have one major point of concern that the authors must clarify, plus a number of minor comments.

Major comment: The authors use a 2D-model to describe a 3D-situation. For this to be appropriate, the heat flux in the third dimension must be negligible on the considered timescales. This is fulfilled if the 2D-section with the prescribed thermal properties

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continues unchanged in the third dimension for a distance much larger than the extent of the modeling domain in the two other dimensions (in this case the lake would be an elongated trench or channel). However, the lake surface is more something like a circle, so that the required translational symmetry in the third dimension is clearly not given. Judging from the form of the lake surface, one should rather make use of the cylindrical symmetry of the problem and numerically solve the cylindrical form of the heat flow equation for a thin "cake slice". In such a work, the detailed stratigraphy of the different layers, as given in Fig. 2 can not be as easily incorporated as in the 2D-section presented in the manuscript, since it is clearly not cylindrically symmetric. But this could only be incorporated in a full 3D-simulation, which is computationally prohibitive. One could argue that the lake surface is not too far from a square, so that the translational symmetry assumed by the authors is not too much violated. This, however, will strongly depend on the bathymetry and the distribution of thermal parameters, and the authors would have to present evidence for this. I am not sure about how much the presented results would change if the cylindrical form is used, since this will depend on the exact domain and time period. In any case, the authors must present additional analysis to show that their results are valid under these geometrical considerations. For instance, simulations in both symmetries could be presented as two constraining cases for the problem.

Minor comments:

Abstract: The abbreviations GST, LIA, etc. should not be introduced in the Abstract

P. 2612, l. 21ff: The authors should explicitly state that the material was either fully frozen or fully thawed during the heated-needle-probe experiments. Partial thawing even at subzero temperatures directly around the needle would introduce large errors.

P. 2613, l. 17ff: Was the thermal conductivity also determined for the frozen state?

P. 2614, l. 23ff: What are the values for internal heat generation based upon?

CPD

8, C1763–C1765, 2012

P. 2615, l. 6: Use “lower bound” or “lower limit” instead of “lower boundary condition”

Table1 + 2: Define all abbreviations in the table header.

Fig. 4: T5 instead of Temp_5

Interactive comment on Clim. Past Discuss., 8, 2607, 2012.