

***Interactive comment on* “Spatial distribution of Pleistocene/Holocene warming amplitudes in Northern Eurasia inferred from geothermal data” by D. Yu. Demezhko et al.**

**Anonymous Referee #2**

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General comments:

The manuscript entitled “Spatial distribution of Pleistocene/Holocene warming amplitudes in Northern Eurasia inferred from geothermal data” presents an interesting application of geothermal data to examine the last glacial-interglacial transition (PHW). The spatial variation of the geothermal data (DELTA T values) is used to derive two main conclusions. The first is that the climate mechanism which influenced PHW warming was focused in the North Atlantic Ocean. This is based on the interpretation that DELTA T values show a pattern of warming centered in the North Atlantic Ocean. The second is that anomalies in the pattern of geothermal data in western Siberia and Yakutia and

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are a result of cover by ice sheets or ice-dammed lakes.

Although geothermal data may provide useful information about past climate changes, I believe that the conclusions drawn are not fully supported by data presented in the paper.

Specific comments:

Both conclusions are highly dependent on interpretations of the spatial distribution of the data. However, the data are not distributed evenly throughout the study area but instead generally occur in a few clusters. Two clusters are in western Siberia and Yakutia, where inferred DELTA T anomalies occur. The largest DELTA T value in the dataset is in Greenland and is substantiated by only one point. If the single point in Greenland is eliminated from the dataset, how does this change the interpolation of PHW anomaly contours? I believe the conclusions are skewed by a few data points or clusters of data. An effort should be made to include geothermal data in an even distribution across the study area. In order to support the first conclusion, geothermal data in Norway, Western Europe and in locations east of Greenland should be included.

I am not an expert in geothermal data interpretation and I have a general question about DELTA T values. Based on Dahl-Jensen (1998) as well as earlier borehole paleothermometry in the GISP2 ice core by Cuffey et al. (1995), it is known that the DELTAT value from the Greenland Ice Sheet records the change in mean annual air temperature over Greenland during late Pleistocene and Holocene time (see also Denton et al., 2005 for a detailed investigation of this DELTA T). However, what is recorded by DELTA T values from geothermal data in northern Eurasia? Some of these sites were covered by the Fennoscandian, Barents and Kara Ice Sheets while others were ice free during the last glacial period. Is it possible that the ice-covered sites were insulated from extremely cold air temperatures by thick ice sheets? What effect does cover by a thick ice sheet have on DELTA T values and is this taken into account prior to comparing all of the data equally? Is comparing DELTA T from the Greenland Ice Sheet and DELTA

T from a ground record (which may or may not have been covered by an ice sheet) comparing apples to apples?

I suggest that the authors include a more detailed discussion of the geothermal data and what DELTA T values from various sites represent. The citation of Balobaev (1991) is not helpful for me because it is in Russian. I also suggest for the authors to plot the locations of geothermal data sites on a map which also shows the margins of the former Fennoscandian, Barents and Kara Ice Sheets.

In addition, the basal conditions beneath the Fennoscandian, Barents and Kara Ice Sheets were variable throughout the last glacial period, ranging from a melting and sliding ice-sheet base to a cold, non-erosive base. I question whether the variations in geothermal data in western Siberia and Yakutia, which are interpreted to show a derivation from the regular pattern, in fact show differences between ice-sheet basal conditions between these locations and those covered by the Fennoscandian Ice Sheet (line 1-3, p. 614).

The first conclusion is consistent with the well-studied theory of thermohaline circulation in the North Atlantic Ocean affecting climate changes during the last glacial-interglacial transition. For example,  $^{231}\text{Pa}/^{230}\text{Th}$  ratios in ocean sediments suggest that resumption of Atlantic meridional overturning circulation at the end of the last glacial period was concurrent with strong regional warming (McManus et al., 2004). However, no reference is made to the vast numbers of studies on thermohaline circulation during the last glacial-interglacial transition. The first conclusion of the manuscript is not a new idea and thus previous studies should be discussed and cited.

In summary, I think that the authors have shown that geothermal data may be useful for interpretations of PHW patterns in Eurasia. However, I think more data are needed to obtain a better spatial distribution of data in the study area. In addition, the manuscript should include a detailed discussion of DELTA T values in order to investigate what values are recording.

Information from multiple and varied paleoclimate proxies is essential for understanding of the mechanisms which caused the PHW. However, this transition was characterized by numerous abrupt climate changes, some of which occurred in a matter of decades or less. In order to understand these rapid climate changes, paleoclimate records with high resolution are needed.

Cuffey et al., 1995. Large arctic temperature change at the Wisconsin-Holocene glacial transition. *Science* 270, 455-458.

Dahl-Jensen et al., 1998. Past temperatures directly from the Greenland Ice Sheet. *Science* 282, 268-271.

Denton et al., 2005. The role of seasonality in abrupt climate change. *Quaternary Science Reviews* 24, 1159-1182.

McManus et al., 2004. Collapse and rapid resumption of Atlantic meridional circulation linked to deglacial climate changes. *Nature* 428, 834-837.

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