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Interactive comment on "Long-term Surface Temperature (LoST) Database as a complement for GCM preindustrial simulations" *by* Francisco José Cuesta-Valero et al.

Francisco José Cuesta-Valero et al.

fcuestavaler@mun.ca

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We thank Dmitry Demezhko for his thoughtful and constructive feedback.

Reviewer comments are shown in plain text, while author responses are shown in bold text.

Dmitry Demezhko (Referee)

Review of "Long-term Surface Temperature (LoST) Database as a complement for GCM preindustrial simulations" By: Cuesta-Valero, et al. General comments: The development and improvement of climate models (GSM) is a leading scientific method for

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understanding the Earth's climate system and its forecast- ing. Despite considerable efforts in the development of these models, there remains a large uncertainty in GCM scenarios. Authors suggest a new Long-term Surface Temperature (LoST) Database as "a reference to narrow down the spread of surface temperature climatologies on GCM preindustrial control and past millennium simulations". Preindustrial (1300-1700) ground surface temperatures cover North America and obtained from borehole temperature profiles (BTP) analysis. A robust paleotemperature evaluation technique based on extrapolating the temperature profile from the interval 200-300 m to the Earth surface has been used. Unlike BTP inversion methods, this simple technique is not burdened by the uncertainties associated with the choice of the algorithm for the inverse problem solving, and provides comparable estimates of paleotemperatures. I suppose the paper describes a new and important result for the development of climatology and can be published in the CP.

Specific comments

1. The simplicity of the technique used does not obviate the need to justify it. Strictly speaking, the extrapolation of temperature profiles from the interval of 200-300 m provides a very approximate estimate of the mean ground surface temperature in 1300-1700. It is necessary to provide a justification or refer to the paper where it was done (for example, "First-order estimate of the GST history" technique by Pickler et al., 2016).

Although the original manuscript already cited the work of Pickler et al., we have added another reference to this paper in the description of the T0 estimates as suggested by the reviewer.

First-order estimate technique is based on the use of formula (2), but its description ". . .the recorded temperature at a depth z can be related to an estimate of time (t)" is incorrect. Correctly: t is the time after which the temperature anomaly dT appeared at the surface reach 0.16dT at a depth of z and 0.005 at a depth of 2z. Therefore, if we assume that 0.16 dT is a negligible part of the anomaly, we should replace the

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description on Figure 1

from: $z = 300m- > t \approx 1300, z = 200m- > t \approx 1700$

to: $z = 300m \rightarrow t > 700 years\, ago, z = 200m \rightarrow t > 300 years\, ago$

We have made the suggested changes in Figure 1 and we have modified the conflicting definition of t in the new version of the manuscript.

2. A large sample of BTP data was used. Obviously, many temperature profiles revealed evidences of non-climatic influences within the studied interval (hydrogeology, heterogeneity of thermal properties). Did the authors select (or correct) the initial data and by what criteria?

Yes, the BTP database was previously filtered to remove profiles containing non-climatic signals as described in Jaume-Santero et al. (2016).

We have acknowledged this in the description of the borehole data.

3. P2,L32-34: ". . .BTP measurements have been employed to estimate . . . surface flux histories over the last centuries (e.g., Beltrami, 2002; Beltrami et al., 2002, 2006)". Here the authors refer only to themselves. Meanwhile, the possibility of estimating the surface heat flux changes from ground surface temperature changes was formulated by Wang, and Bras (1999). With regard to borehole temperature data, this technique (besides the mentioned papers) was developed in (Huang, 2006; Demezhko and Gornostaeva.2015a,b).

We have expanded our references as indicated by the reviewer, excluding the Huang (2004) work which does not employ BTP measurements for his flux estimates.

In the last two papers an alternative measure of the Earth's climatic sensitivity has been proposed as the ratio between the ground surface flux changes and external fluxes changes. I believe that estimates of preindustrial surface heat flux changes can

also be useful for GCM simulations, as well as estimates of paleotemperatures. I would like the authors to raise this question in the “Discussion” section.

The reviewer rises an interesting idea here; the possible estimation of the climate sensitivity using reconstructions of past changes in surface heat fluxes from BTP measurements. Such method for estimating the climate sensitivity should be further investigated, but we think that such investigation is beyond of the scope of this work.

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