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Interactive comment on "Long-Term Global Ground Heat Flux and Continental Heat Storage from Geothermal Data" *by* Francisco José Cuesta-Valero et al.

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Response to Reviewers Document for "Long-Term Global Ground Heat Flux and Continental Heat Storage from Geothermal Data" by Francisco José Cuesta-Valero, Almudena García-García, Hugo Beltrami, Fidel González-Rouco and Elena García-Bustamante.

We thank the Reviewers for their thoughtful and constructive feedback.

This Response to Reviewers file provides a complete documentation of the changes made in response to each individual Reviewer's comment. Reviewers'

Printer-friendly version

Discussion paper

comments are shown in plain text. Author responses are shown in bold blue text. Corrections within the revised manuscript are shown in blue text. All line numbers in this file refer to locations in the revised manuscript with changes marked unless indicated otherwise.

Reviewer 2

Review of Cuerta-Valero et al Long-Term Global Ground Heat Flux and Continental Heat Storage from Geothermal Data.

This paper represents a useful update and expansion of a large body of work that uses borehole temperature measurements to estimate surface temperature changes and accumulation of heat in the upper few hundred metres of the Earth's crust, both associated with recent climate change. Advances in the paper include (a) the addition of additional borehole temperature data, and (b) a new approach to the inversion of the borehole data that produces better estimates of the uncertainties.

The introduction section is a particularly useful, comprehensive summary of work in this area with an extensive reference list. Figure 3a, the updated ground temperature history from 1580 CE to present with uncertainty estimates is very important. It is shown in comparison to previous ground temperature histories and the meteorological record back to 1900 and should be widely used as a constraint in climate reconstructions. The authors perhaps should make a stronger point that Fig3a (and the analysis that results in Fig 3a) shows about 0.4K of warming from pre-industrial times to the start of the observational meteorological record around 1880.

The reviewers suggest an interesting result. We have included a comment on the Results section as indicated by the reviewer (lines 326-331).

And the total land surface warming to present time (Fig 3a) is close to 1.4K. In view of that number I don't understand the sentence in the conclusions that reads "The magnitude of the retrieved changes in ground surface temperature in this analysis supports

the claim that the Earth's surface has warmed by 0.7 K since preindustrial times." Nor the sentence in the abstract that includes "land temperature changes of 1K... during the last part of the 20th century relative to preindustrial times." These statements should be consistent with each other and with Fig. 3a.

Regarding the estimate of global temperature change since preindustrial times, that value is obtained as explained in the Discussion section (lines 357-372 of the original manuscript, lines 386-402 of the new version of the manuscript). The estimate is based on averages of land temperature reconstructions using the three inversion methods discussed in this analysis and a factor to convert land temperature changes into global temperature changes. That is, we use the averaged results for each inversion model as indicated in Tables 1, S1 and S2 to estimate the change in land temperature relative to preindustrial conditions –in this case, the mean temperature between 1300 CE and 1700 CE (lines 360-363 of the original manuscript, lines 389-391 of the new version of the manuscript). Then, we calculate global (land and ocean) temperature change by scaling the change in land temperatures to account for the probable change in ocean temperatures, resulting in an increase in global temperature of around 0.7 K since preindustrial times (lines 365-372 of the original manuscript, lines 397-399 of the new version of the manuscript).

We have added some changes in the Discussion to improve the clarity of the text (lines 386-402).

Attention to the following details would improve the manuscript. 1. In Eqn 1, R is nota thermal depth which would have dimensions of length. It is in fact the thermal resistance with units mËĘ2 K /W.

The reviewer is right, we have changed this on the new version of the text (line 94).

2. In section 3.1, the criteria for accepting a borehole temperature log of 1 measure-

ment in the 15-100m depth range and at least 3 measurements in the 250-310 m depth range seems pretty loose. It would be good to know why such a fairly lax criteria was chosen and how many sites creep into the data set as a result.

Indeed, we included three criteria to select suitable borehole logs for our analysis: at least one temperature measurements between 15 m and 100 m to ensure the borehole profile recorded climate information near the logging year, at least one temperature measurement between 250 m and 310 m to ensure all temperature anomaly profiles include information about seven centuries before the logging date, and at least three temperature measurements between 200m and 300 m in order to perform a linear regression analysis.

We have changed the text in order to clearly explain why these criteria are applied and the number of logs excluded due to this filtering (lines 171 and 178-185).

3. It is a personal style, but I would prefer fewer acronyms. Are the following all necessary: GHC, BTP, GSTH, GHFH, PPI, RMSE, PPIT?

Indeed we used several acronyms to obtain a better flow in the original text. Furthermore, we have included additional acronyms in the new version of the manuscript to facilitate the interpretation of figures, responding the petition of the first reviewer. We have kept the acronyms that are more important to maintain the flow of the text, those necessary to understand the results, and those that are typical in scientific works, removing those that were superfluous. A new appendix (page 17) includes the remaining acronyms and their definition in order to improve the interpretation of results and the readability of the manuscript.

Overall this paper is a very useful contribution to the climate change literature.

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