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Climate of the Past Discussions

Interactive comment on "Climatic changes in the Urals over the past millennium. An analysis of geothermal and meteorological data" *by* D. Yu. Demezhko and I. V. Golovanova

Anonymous Referee #1

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General comments

The paper addresses the relevant and for the CP journal topical problem of the ground surface temperature history (GSTH) reconstruction from borehole temperature - depth data in the Middle and South Urals (51-59 °N, 58 - 61 °E) and their comparison with the local meteorological surface air temperature series.

The GSTH reconstruction of the last millennium is based on an extended set of 49 borehole logs selected according the clear criterions (depth of the log at least 700 m; no evidence of the groundwater flow; no sharp contrast of the rock thermal properties; location within the same geological structure) from more than 200 temperature logs in

ore-prospecting boreholes.

The GSTH was reconstructed for each of the 49 selected logs by the borehole temperature inversion algorithm described earlier by Demezhko and Shchapov (2001). The method used in averaging and processing of the individual histories is the most novel and valuable part of the paper. Instead of a routine traditional procedure of simple averaging of the individual histories, which underestimates amplitude of the ground surface temperature variations, an alternative method of the interval estimates was applied (Demezhko, 2001). The interval estimate method substantiated by unrecognized and unaccounted thermal diffusivity variations among the individual boreholes leads to maximum amplitude estimate of the GST variations. To correct this opposite extreme of the individual histories joint interpretation, the optimum amplitude estimate is used as the final step of the processing. It consists in lowering the maximum estimate by taking into account overestimating effect of the other (excluding the thermal diffusivity variations) non-climatic random factors.

For me, the most important result seems to be a new estimate of the little ice age minimum in the first decades of the 18th century, 1.6 K below the 1900-1960 level, which suggests that the minimum was more than twice as deep as indicated by the previous estimate based on the borehole temperature data (Pollack et al., 2003).

The paper presents a novel approach to processing the individual GSTHs reconstructed from borehole profiles, which has yielded important regional climate characteristics. The paper meets the Climate of the Past quality requirements, but needs a language revision.

Specific comments

Dealing with the surface air temperature data, the authors do not refer to any paper, so my impression is that the data are published in the present form for the first time. The number of local meteorological stations used in compiling the 170 year time series varies large. The first 40 years is based on 1-2 stations only, but the authors claim that

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“the reliability of instrumentally measured data is beyond doubt”. The generally warming trend of the observed air temperatures agrees quite well with the trend indicated for the overlapping period by the GSTH. A reliability of the borehole reconstructions is supported also by their reproducing the increased air temperature warming rate in the period 1970-90.

In the discussion of the results the authors come with a conclusion that the temperature rise observed in the 20th century is the final stage of a global and natural warming connected with a termination of the little ice age. Referring to another finding presented in the paper, namely the warm spell culminating in the 12th century with temperature by 0.4 K above the 1900 - 1960 mean, they conclude that temperatures at the beginning of the 21st century are identical to those occurring thousand years ago.

Another interesting point is their finding that a rate of the warming indicated by the observed air temperatures for the period 1930 - 2001 decreases with the latitude, which contradicts the present knowledge.

The meteo data were also used to calculate a slope coefficient of linear regression in the running 11, 21 and 31 year intervals. The results depicted in Fig.5 show that the recent high warming rate of the period 1985 - 1995, 15.0 K/100 yrs is not the maximum one observed in the last 170 years. The warming rate within the period 1860 - 1870 was 15.2 K/100 yrs. For the 31 year running interval, however, the warming of the recent decades, 4.5 K/100 yrs for the 1968 - 1998 period, is by far the largest one.

Technical corrections

With respect to the standard deviations of the reconstructed minimum and maximum amplitudes of the little ice age and the medieval warm period, I suggest to give the optimal estimates not as 1.58 K and 0.38 K, but 1.6 K and 0.4 K.

On page 8, line 24, it should be instead of “1863 - 1983” a different date, probably “1963 - 1983”.

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I recommend a language correction of the manuscript. Some formulations are hard to understand.

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