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Interactive Comment

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

J. Majorowicz (Referee)

majorowicz@shaw.ca

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In their recent CPD paper Demezhko and Golanowa (2007) investigate past ground surface temperature history from inversion of temperature-depth (T-z) profiles from 49 deep (>700m) boreholes located in the Urals. The wells are spreading through impressive distance from 51°N to 58°N. This is a unique and important data set and its analysis is worth publishing. Previous analysis (Golanova et al., 2001) of smaller data set from 30 wells located between 48°N to 56°N used inversion methods of POM-SAT model (where POM is pre-observational mean, SAT is surface air temperature time series) and functional space inversion (FSI) method. The FSI inverted GSTH was shown



for the last 5 centuries. In the present paper Demezhko and Golanova (2006) base their GSTH reconstruction on Demezhko and Shchapov (2001) inversion algorithm. Their GSTH reconstruction covers 12 centuries starting at 800 AD. The use of interval estimate method, accounting separately for the rock's thermal diffusivity variations and non-climatic noise, was used to obtain the average GSTH. Use of Ural's available meteorological data showed that ground surface temperature (GSTH) warming signatures closely follow the reduced averaged record of air surface mean annual in the time period 1830A.D. to 1990 A.D. This is encouraging result.

Reconstructed temperature changes since 800A.D. show peak in Middle Ages Optimum at 11 hundreds and low in the time of Little Ice Age (LIA) with minimum temperatures in early 17 hundreds. Large changes in amplitude of these changes are unlike the 'hockey stick' SATH (surface air temperature history) known from previous IPCC (2001) reconstructions and based on proxy data (not including well temperature reconstructions). The result of Demezhko and Golanova (2007) would therefore add ammunition to those who advocate larger importance of variability of the past surface temperature and larger importance of the Middle Ages Optimum and LIA from which recent warming recovers (Moberg et al. 2005). The GSTH shown from well temperatures is an obvious challenge to the so called 'hockey stick' proxy reconstructions for the Northern Hemisphere.

However, the question which we need to ask is: how accurate well temperature reconstructions are when it comes to depiction of the Middle Ages Optimum. Deep temperature signals are influenced by conductivity variations which are usually known with large noise (I assume that some 0.5W/mK) and temperature data noise which is relatively large in comparison with deep anomalies possibly related to climate. It is known that for more complicated surface temperature histories where inversion techniques are used, the GST value reconstructed for time t= τ before logging represents an average over the time interval, the width of which is proportional to. This is due to the diffusive character of the heat conduction. The rate at which the averaging interval increases

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with τ depends strongly on the level of noise inevitably present in each temperature log and on the density of the temperature sampling. For a typical log with depth step 5 – 10 m and level of noise of the order of hundredths of Kelvin (0.01K) GST is estimated as an average over about 0.5-0.7* τ . The borehole climate method is unique as it is based on the direct physical link between the measured temperature-depth profile and the reconstructed parameter of the past climate, the ground surface temperature. It has proved to be quite successful in reconstructing two robust signals, a) the amplitude of the last glacial/interglacial temperature difference, and b) the surface temperature trend of the last 100-150 years and eventually, when combined with the surface air temperature series, in estimating their pre-observational means. However, a reconstruction of less robust signals of the little ice age, medieval climatic optimum, Boreal, Atlantic and possibly some other climatic periods of the Holocene usually fails even in most cases of purely conductive subsurface thermal regime.

I present (Fig. 1) a test of the method acc. to Majorowicz et al., (2006). It is an example showing FSI inversions of a synthetic temperature –depth profile based on the ECHO-1 model (courtesy of Hans von Storch). The ECHO-1 model is picked as a test of ability of inversion of synthetic T-z in depicting Middle Ages Optimum and LIA which are of large amplitude in ECHO-1 model. Comparison of the FSI inversion of the synthetic T-z based on ECHO-1 surface temperature series with that time series shows that inverted GSTH averages LIA and Middle Ages Optimum and fails precise depicting of the Middle Ages Optimum and its amplitude.

I am therefore suspicious that the GSTH reconstruction by Demezhko and Golanowa, 2007, Fig. 4-upper panel) depicting large amplitude of changes (Middle Ages Optimum) and especially in times 800A.D. -1500 A.D. could be an artifact of the inversion procedure. My analysis of their Fig. 2 and especially of the right hand panel showing reduced anomalies, convince me that it is so. I do not see there large temperature changes pointing to high amplitude Middle Ages Optimum – LIA change except for a few temperature-depth anomalies in the left side of Fig. 2 – right panel.

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I would advise the authors:

1. to show a stack of their individual well inversions.

2. to reject some of the noisy data which they show in Fig. 2 (an example – the most right temperature depth anomaly in Fig. 2 – right panel). There are at least couple more of these which I can see at the scale provided by the figure .

3. to show error bars on the reconstruction shown in Fig. 4. - upper panel.

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Interactive comment on Clim. Past Discuss., 3, 1, 2007.



Figure 1: (description in the text above).

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