

## ***Interactive comment on “Repeated temperature logs from the sites of the Czech, Slovenian and Portuguese borehole climate stations” by J. Šafanda et al.***

### **Anonymous Referee #3**

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#### General comment

The paper presents results of a joint project (Czech Rep., Slovenia and Portugal) aimed to monitoring the temperature variations in three, specifically designed geothermal boreholes, one for each country, together with data from further four boreholes from Slovenia. The objective is to show the ability of repeated temperature logs to analyze the SAT-GST coupling and to infer local effects which cause disagreement between calculated and observed changes in the temperature depth profile. The adopted methods for the analysis sound appropriate as well as the data quality. However, the applications are not always clearly described; the text is not properly organized at some parts

and seems a patchwork. Also the aim of the three-nations joint project is not well explained. To this regard, one would expect also a joint discussion of the results. One of the most interesting aspects of the paper (the comparison of the differences between the older and the more recent thermal logs with T-z profiles synthetically obtained by using SATs as a forcing function) is not clearly presented and only specialist readers can fully understand what authors did. Recent warming results both from inversion of T-z logs and from SAT series in the “vicinity” of the boreholes, but with different magnitude. Thus, the proposed method should be very promising to unravel the SAT-GST coupling, but the discussion of results and the conclusions appears a bit too simplistic and should be widened a little bit. I understand that authors present preliminary results and probably they are more concerned with methodology. However this is not clearly explained in the present version, partly due to grammar and editing. In summary, even though the paper presents interesting methods and data, I suggest a careful revision before its final publication.

Specific points and technical corrections

Abstract

In principle a reader should be able to understand the paper from the abstract alone. I am afraid that the abstract is not fully informative of the paper content. It contains, instead, some unclear sentences. I suggest a deep revision. How “two borehole climate stations in Slovenia and Portugal” can complete “the older Czech station”? This is clear only after reading Sections 1 and 2.

r. 8-9 - modify as "...0.2-0.6 °C below 20 m depth.”

r. 10 - “...surface temperature (GST) history of the last 150-200 years. GSTs were compared with...”

r. 13 - “...the recent warming inferred from the meteorological data, 1-1.5 °C above the ...”

r. 13-14 - Explain better that there are five boreholes from Slovenia. There is something that does not work in the abstract. It is not clear that there are five boreholes, four too shallow for inversion and another one 5 km far from the Slovenian reference station. (Malence). “The depth (100 m) of the (?) Slovenian boreholes was too shallow for inversion, but climatic reconstruction was carried out for a deeper borehole”

r.16 - “...from Ljubiana operating since 1851. The compatibility...” The analysis of repeated logs does not seem an alternative to FSI, but simply a test on the compatibility of the GST and SAT changes.

r. 19-21 - “...differences of the repeated temperature logs with the synthetic ones, calculated by using the Sat series as a forcing function.” Last sentence of the abstract is generic and unclear. “unaccounted” does not seem properly used.

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r. 25-27 - modify as “Reconstructing the ground surface temperature (GST) histories from present-day measurements of temperature-depth profiles in boreholes has been established as one of the independent and well physically justified ways to obtain information...”

r. 4-5 - Remove “...obtained by the method...”

r. 7-8 - “...scales. To testify the validity of this assumption, empirical studies at site-specific locations are necessary with the aim of monitoring air, round...”

r. 12-13 - The definition proposed by Putnam and Chapman (1996) seems more appropriate than that suggested by the authors.

r. 14- modify as “In the Czech Republic, a borehole has been...”

r. 14-22 - The description of the three observatories is partly a replica of that in section 2. I suggest shortening.

r. 23 - modify as “The paper focuses on the ground-air...” Why “alternative”? To inver-

sion? It is not clear at this point of the text.

r. 25-26 - Here again there is something that does not work with the borehole number  
Page 634

The title of the subsection 2.1 is too long. Simply, “Borehole climate stations” or “Geothermal climate change observatories” seems better.

r. 4 - modify as “...is located in a park within the campus...”

r. 12 - “...is used for monitoring the temperature continuously.”

r. 13 - What do they mean with “stable”. Tectonically?

r. 16 - “layer” rather than “bedding”

r. 18 - “depth” rather than “depths”

r. 26 - some commas are needed.

Page 635

r. 1-2 - “The basin is encompassed by...” What does it mean? The basin is part of the Internal Dinarides?

r. 8-9 - Was thermal conductivity measured on samples taken at two different depths? Please clarify.

r. 14 - modify as “...was installed from 1 to 40 m depth.”

r. 16 - “A string of platinum has been monitoring temperature in the uppermost 40 m of the 200 m ...”

r. 24 - remove “small”

r. 28-29 - modify as “The logs were repeated from 2000 to 2005.”

Pages 636-637

The text on p. 636 and the first three rows of p. 637 deals with Slovenian boreholes, which are not reference geothermal climatic change observatories, but supply additional data. I suggest adding a subsection for example “2.2 Further underground temperature data”

r. 4-5 - modify as “...is situated in a slightly hilly area at the south-western border of the Pannonian Basin, about 55 km...”

r. 10-23 - No description of topography in this section. Are all the boreholes located in a flat region?

r. 26 - modify as “It penetrated 14 m of ...”

r. 26-27 - the stratigraphic description of this borehole is unclear. Compare also with p. 637, r. 21.

Page 637

r. 1 - Fig. 4 is presented before Fig. 1.

r. 7 - modify as “...logs were done with the logging...”

r. 7-8 - “the resolution is several mK” Does it mean that the resolution is a few mK?

r. 9 - “with” instead of “by”

r. 11 - “When comparing” instead of “In comparing”

r. 16-17 - The title of section 3.1 is again too verbose. I suggest simply “GST history”

r. 18 - “from” instead of “by”

r. 20-21 - compare with p. 636, r. 24-26

r. 22 - The sentence “As mentioned above, this Slovenian borehole lies only 5 km from the Malence station in the same geological setting.” is unnecessary.

r. 23 - modify as “The other temperature profiles from Slovenia are only...”

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r. 6-8 - Reformulate as “The GST histories reconstructed from individual inversions of the oldest and the youngest profiles differ considerably, whereas the effect of different diffusivity values assumed for the reconstructed GST history is small.”

r. 16 - “The distance” instead of “A distance”

r. 17 - “...Portugal. Each of the meteorological stations...”

## Page 639

Most of this section should be incorporated in section “Temperature logs” (from r. 3 to 19). This implies also a new order for figures.

r. 5 - “...borehole, starting from the depth of 15 m.”

r. 22-23 - “...which were calculated for each borehole site by solving the heat conduction equation, using the SAT...”

r. 25 - “...equation was solved with the finite difference...”

r. 26-27 - “...and Cermak, 2000) for a one dimensional case. No heat flow was assumed through the lower boundary set at a depth of 500 m. The simulation spans since...”

## Page 640

r. 1-3 - The definition of POM is well known for people working of climatic change from geothermal boreholes. However, in view of the aim of the special issue of CP, I would give more details and or references to this regard.

r. 8 - “°C” instead of “degree C”

r. 17 - “Northern hemisphere, was ...”

r. 21 - remove “of the SAT”

r. 22 - remove “ beside the annual”

r. 26 - “°C” instead of “degree C”

r. 27 - “we tested also the concept of Ě”

r. 28 - “et al., 2005), i.e. surficial...”

r. 29 - “We considered a 0.52 m thick layer,...” “below” instead of “bellow”

Page 641

r. 2 - “...negligible. This is in agreement...”

r. 4 - “...logs from multi-year variations...”

r. 6-7 - “Figures 6-8 show a comparison between the observed and simulated differences. In the Portuguese...”

r. 9 - remove “but amounts to only half of it at 20 m”

r. 23 - remove “of the GST”

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r. 9 - “...is 50% of that in Prague...”

r. 17 - “...GST history obtained by inversion of the temperature...”

r. 19 - “...Krka river. As the long-term temperature...”

r. 24 - put a comma after “Brdo”

Page 643

r. 8-9 - The sentence “which were used as a surface forcing function in solving the transient heat conduction equation in geothermal models of the borehole sites.” is a useless repetition. To be removed.

r. 19-22 - Last sentence is very trivial. All papers might conclude with a sentence like that. I suggest removing it.

Figure 2. Line fit is given for data in Fig1 and 3, but not here. Why? The data presentation should be homogenized. The same applies to Fig. 4.

Fig. 5, caption - the last sentence does not sound clear. Probably authors wanted to show three different hypothesis of thermal diffusivity assumed in their modeling rather than the “uncertainty given by a loosely constrained diffusivity”

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