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Interactive comment on "Ground surface temperature reconstruction for the last 500 years obtained from permafrost temperatures observed in the Stelvio Share borehole, Italian Alps" *by* Mauro Guglielmin et al.

Anonymous Referee #1

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In summary, the manuscript by M. Guglielmin et al. gives results of reconstructing the ground surface temperature (GST) history by inversion of data from a borehole in the Italian Alps. Generally, the data presented is very interesting and valuable and a study about GST history using this data contributes to the knowledge about the interaction of climate changes and permafrost.

However, I do have some concerns regarding the procedure and method presented here – particular regarding uncertainty: the manuscript provides a too "straightforward" GST history reconstruction, neglecting any uncertainty ranges in the parameters in-

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Discussion paper

volved. What about different regularization parameters? Could synthetic temperature profiles and the corresponding reconstruction of GST history give more insight into the method? Some additional (sensitivity) studies and a corresponding critical discussion is necessary, in my opinion. Data is available only at a few depth levels (Figure 5). How about the minimum value at 60 m particular? What would be the influence on the result if possible variations of the data beneath and above this depths occur? Regarding the result in Figure 6, it is not possible to assess any uncertainties or to distinguish between effects arising from the "smoothed" data and the presented inversion.

As a consequence, I consider numerical methods for reconstructing GST history in this case (mountain area, unfrozen water content, uncertainties. . .) superior to analytical methods. If the latter ones are applied, a thorough justification and critical discussion must be given. Regarding this, presenting only one GST history result in Figure 6 and using this for the interpretation does not comply with the demands/conclusions of the manuscript.

Other comments:

- Abstract: a significant part of the manuscript deals with the method used for GST reconstruction. Therefore, the method etc. should be mentioned in the abstract. Also, some important information one the borehole, such as depth, temperature ranges etc.

- Line 18: . . .roughly double the MAAT. . .is not clear, doubling of the increase of MAAT?

- Line 22: linearly only, if there is additionally no heat production.

- Lines 27/28: the propagation of signals is a diffusive process, therefore it is interesting where a maximum of a signal occurs.

- Line 13: no groundwater flow only within continuous permafrost, more explanation needed.

- Line 41: the authors should justify this statement by some calculation (". . .for much of the last millenium"), due to the diffusive nature, the signal of the last millennium is

not only visible in the upper 230 m, so a “truncation” of this signal may lead to a bias. - Line 74: heat flow in mountainous areas may differ stron gly from the typical literature values, so an estimation of permafrost thickness only using this value is questionable - Line 87, laboratory data: there is no information about porosity, this parameter is important with respect to the latent heat effect. It is only mentioned that there is no evidence of ice encountered, although ice has been encountered in a very close borehole only a few meters apart. The temperature range (-2-0 °C) is within the very range where a coexistence of both phases in soil/rock occurs (see references below).

- Line 93: if the accuracy of the measurements of thermal properties is around 5%, it is then necessary to state values in table 2 accordingly (three decimal places are certainly not applicable). The same applies to Table 1 regarding the temperature gradients.

- Please check generally, if “°C” is used for absolute temperatures and “K” for temperature differences, this makes the distinction easier.

- Line 126: the linear trend in the “deepest par” (below 60 m) can be still disturbed by a transient signal from the surface, so I does not really represent a background signal. This should be discussed.

- Line 139: 0.2 is choses, why? What would be the effect different values? - Line 147: it enhances the robustness: can this be justified?

- Line 167: How is the optimal parameter alpha determined? What is the influence on the results for different values of alpha? The regularization has been applied in earlier works (see references below).

- Line 208: what are the 13 depths listed in section 3.1? A figure would be helpful.

- Figure 1 A and Figure 2: Scale is missing.

- Figure 3: labels are missing (time/temperature).

- Figure 6: vertical axis is Delta T, referring to what?

- Figure 7: What is 0.02? Is the linear regression really justified? How about correlation coefficients?

References: Mottaghy, D. & Rath, V. (2006), Latent heat effects in subsurface heat transport modelling and their impact on palaeotemperature reconstructions, Geophysical Jounal International 164, 236-245.

Romanovsky, V. E. and Osterkamp, T. E. (2000), Effects of unfrozen water on heat and mass transport processes in the active layer and permafrost. Permafrost Periglac. Process., 11: 219–239.

Rath, V. & Mottaghy, D. (2007), Smooth inversion for ground surface temperature histories: estimating the optimum regularization parameter by generalised cross-validation, Geophysical Journal International 171 (3), 1440-1448.

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