

### Author's response to comments of Referee #3

AC: We thank the anonymous referee for the review of our manuscript.

RC3: I read and totally agree with the comments from reviewers 1 & 2. The main issue is the mismatching between the title and content. From the title, as a reader, I would like to know how we can use active layer thickness to inverse palaeo-air temperature. However, the 'inversion' model seems not to be able to look backward for past years, decades, or centuries. Based on previous studies about this theme, the climate signal was stored in deep permafrost thermal condition (e.g., Clow (1992), Huang et al., (2000)) while the active layer is only several meters below the ground surface, which is strongly influenced by seasonal variation. The current study is only to calculate the present (rather than palaeo-) mean annual air temperature by using active layer thickness given fixed other parameters. Furthermore, assuming Aa maybe not acceptable for reconstructing palaeo-climate. P should be 365 (or 366) rather than ranges from 300+ to 400+ (in Table 2).

Thus, the current version is not able to be published but I would be willing to suggest this work for publication once the authors will show some palaeo-climate reconstructions results using active layer thickness.

#### References

Clow, G. D. (1992). The extent of temporal smearing in surface-temperature histories derived from borehole temperature measurements. *Global and Planetary Change*, 6(2- 4), 81-86.

Huang, S., Pollack, H. N., & Shen, P. Y. (2000). Temperature trends over the past five centuries reconstructed from borehole temperatures. *Nature*, 403(6771), 756-758.

AC: We agree with the referee and admit that there is a mismatch between the title and content of the original version of the manuscript. Our original intention was to show that the model performs well on present-day data, providing its best possible validation, which was to demonstrate that it could also reasonably derive past temperature conditions, but now we recognize that its real application on palaeo-periglacial features is necessary. Consequently, we intend to include in the revised version of the manuscript a palaeo-air temperature reconstruction using a palaeo-active-layer thickness and to compare its outputs with reconstructions based on other proxy records and/or model products. Still, a section containing present-day data will be retained in the revised version of the manuscript in order to provide model validation and perform sensitivity tests. Please note that the model is supposed to rely on relict permafrost features, which have formed within the active layer, and as such these features can indicate its former thickness (mostly through characteristic structures found in sedimentary profiles) at locations where permafrost occurred during Quaternary cold stages. It does not exploit temperatures measured in deep boreholes.