

Review of the Manuscript : Effects of Stratified Active Layers on the High-Altitude Permafrost Warming: A Case Study on the Qinghai-Tibet Plateau

by X. Pan et al.

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General Comments

The authors report about a specific phenomenon, namely a positive thermal offset monitored at a site in the Qinghai-Thibet Plateau. They explain the physical basis for this observation. Explanations are supported by modelling, observations, and are confronted to relevant scientific literature.

I congratulate the authors for the straightforwardness of their study, which reads well and leads to sharp conclusions. Plus, the topic is very accurate and the effect of stratified soils has been critically under-documented in the permafrost literature. Therefore the authors' findings are of major interest for this research community.

However, the other side of the straightforwardness is that the mentioned effect and its persistence over time should be supported by (more) relevant quantitative arguments (detailed exemples are given in the **Specific Comments** below). Also, the implications of the authors' findings at large scales or for other, possibly similar permafrost regions, and with respect to possibly changing precipitation patterns, could be more discussed. This would increase the paper's impact.

I therefore recommend the paper for publication, pending the revisions detailed below.

Specific Comments

- The formula for « thermal offset » and « surface offset » should be recall (in the introduction) for better clarity. In section 3.2, confusion is introduced about « thermal offset » : it was defined in the introduction as « $T_{TOP} - MAGST$ ». In section 3.2 it is approximated by « $T(-2.18 \text{ m below surface}) - MAGT$ » with MAGT quite different from MAGST. Please clarify.

- Section 2.2 is entitled : 2.2 Surface-subsurface monitoring scheme Subsection. « Scheme subsection » could be deleted from the title.

- The defined soil architectures in Section « 2.4.2 Simulation protocol » are not consistent with the caption of Fig 9 and the explanations of Section 3.6.1. Please make sure the Architecture definition is consistent in the whole document (maybe add a Table).

- P8 l 2, L31 : neither the model nor the effect are 'validated' in the current state of the paper. The comments below may give some sense to the validation of the effect through modelling.

- Concerning the local λ_t/λ_f ratio : Year 2008 is used as an illustration of typical annual conditions. Given that ground temperature and soil water content are being measured at this site since 2006, stepping back from Year 2008 and bringing an interannual perspective would strengthen the paper's conclusion. I at least recommend a Table with the maximum λ_t/λ_f value over the upper 2.18 m of the soil for each year with observations.

- Concerning the impact of the λ_t/λ_f ratio on permafrost warming :
 - Fig 6 could provide the vertical profiles for λ_t and λ_f with $\lambda_m=2.5$ W/m/K, in support of the assessment : *«In order to exceed the ratio of 1, the seasonal liquid water content has to fall below a certain threshold, which depends on soil thermal conductivity and water content in thawed state. For instance, the soils with high thermal conductivity of soil matrix will need larger liquid water content reduction than that of the soils with small thermal conductivity of soil matrix.»*
 - A high λ_t/λ_f ratio is advanced as an important argument for an enhanced permafrost warming rate at the observation site. However, Fig. 12 is the only illustration supporting this thesis (as modelling - Fig 8 - fails to reproduce the observed warming) ; it shows that permafrost warming rate is enhanced in the A3 configuration ; the authors explain that this is due to higher λ_t/λ_f ratio, but this ratio is unfortunately never explicitated. I highly recommend adding the mean interannual λ_t/λ_f for each of the 10-year periods preceding the selected years of Fig. 12, and for each soil architecture. This would make the paper's main argument less vague. This point is a **Major Comment**.
 - P 10 l 13 : the formulation could be improved (like : high -> higher)

- P5 l 30 and P8 l 24 : a crucial thing is to know whether the annual cycle of precipitation in the chosen downscaled projections, is still monsoon-like (as today) or shifts to different patterns in future climate. The authors mention that the projected rainfall may not be accurate. However, given the importance of the annual rainfall pattern on the site specific sub-surface thermal dynamics, more investigations on the projected precipitation pattern in the chosen downscaled climate product is needed, in support of the assessment of the impact of λ_t / λ_f on the warming. This point is a **Major Comment**.
- the implications of the authors' findings at large scales or for other, possibly similar permafrost regions, could be more discussed. Do the authors suspect that other sites could show similar characteristics ?

Technical Corrections

- Very frequently the authors confuse « whereas » with « while » or « in the opposite ». (p4 l 23 ; p5 l 14 ; p6 l 13 and l 24 ; p9 l 28 ; ...)
- P2 l 14 : basing -> based
- P3 l 15 : humility -> humidity
- P4 l 2 : incomplete sentence
- P5 line 13 to 16 : unclear, please reformulate
- P9 l 18 : till talik -> when talik