

Interactive comment on “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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As a developer of GEOtop model I am very happy to review this paper, which applies the model for a permafrost site in the Qinghai-Tibet plateau and shows that the thermal conductivity of the thawed soil in a permafrost site can be in some conditions larger than the thermal conductivity of frozen soil. The topic is very interesting, the model really fits well with it, and the research questions are well posed. My attention was particularly drawn by the model settings and results:

1. The model settings are extremely important since they strongly affect the results. However, the paper does not fully describe them. For example, the paper should list the van Genuchten parameters, since the behaviour during freezing/thawing is based

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on them. It is not enough to refer to neural network routines.

2. The characteristics of the 3 soil architectures A1, A2, A3 are not completely clear to me. You should put a table or drawing that clarifies the soil layers with correspondent properties and parameters.

3. In the papers the parameters are assigned in a deterministic way. Apart considering 3 soil architectures, no or little sensitivity to parameters is performed. This is extremely important, since many parameters are actually idealised or strongly simplified. The van Genuchten parameters result from a strongly simplified model of soil retention, and, since the results are dependent on them, a sensitivity analysis is essential. Pedo-transfer functions and, probably, neural network routines have limitations and cannot be fully trusted. The sensitivity to other parameters should also be considered, for example, when no data are available, for bottom soil, snow precipitation, lateral flow, albedo, etc. In addition, you set the vegetation coverage to 0.3, referring to Gubler et al. (2013), but in this paper we did not consider vegetation.

4. The simulation settings also assume simplified conditions that are described only at the end of paragraph 3.5, namely to justify disagreements between observations and model results. The simplifications should be listed at the beginning, and their plausibility discussed in advance.

5. In par. 3.6 you write that the effect of stratified active layer is validated with modelling. Validate is a strong word. You are not validating, but you are using the model to understand physical processes.

6. The formula of Cosenza et al. (2003) is just one parameterisation of bulk thermal conductivity. GEOtop gives also the possibility to use other formulae (De Vries for example). Maybe it would be worth checking if there are significant differences in the results if other formulae are used.

7. In Fig. 6a you consider only unfrozen water content. However, bulk thermal conduc-

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tivity also depends on ice content. You should discuss this point.

8. I do not understand why in Fig. 5b the 0 C isotherm is not close to the curve of the unfrozen water content decrease.

9. In the paper you often use temperature/time as a proxy of permafrost warming. However, temperature only describes the effect of sensible heat, but not the latent heat. If permafrost has a temperature close to 0 C, more heat is needed to increase soil temperature, because some energy is needed for thawing. Therefore, I do not think that a temperature difference of 0.01 C to end spinup is good. Performing a good spinup is also essential to have good model results. This should be more completely described. For how many years the spinup simulation was run? You should also check that water and ice content differences are small to end spinup.

10. In 2014 I wrote a paper describing the model, in particular the version 2.00. Although you used a previous version, you should have a look and cite the paper. This is the link to the paper:

<http://www.geosci-model-dev.net/7/2831/2014/gmd-7-2831-2014.html>

11. I saw some errors in the English language. Please correct them.

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