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Interactive comment on "The ERA5-Land Soil-Temperature Bias in Permafrost Regions" *by* Bin Cao et al.

Anonymous Referee #2

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General comments

This paper presented a good assessment of the soil temperature at a large scale using in-situ observations and previous products/maps. Understanding current soil temperature bias in reanalysis could improve further Earth-system model design by accounting more essential permafrost processes and hence benefit the permafrost community. This paper is generally well written. I have some comments for further revisions.

Major comment

- As Reviewer#1 stated, some important points became clear a little bit late. To casual readers, this may be not easy to follow.

- The authors MUST recheck this statement in L70-71. From the ERA5L website, they said: "Temperature of the soil in layer 1 (0 - 7 cm) of the ECMWF Integrated Forecasting System. The surface is at 0 cm. Soil temperature is set at the middle of each layer, and heat transfer is calculated at the interfaces between them." This is very important because these depths were used to interpolate soil temperature profiles and to determine ALT, if my guess is correct. If incorrect depths were used, the comparisons were already artificially altered.

- The authors should describe the estimate of ALT by using ERA5L.

- Did the authors consider the uncertainties from vegetation?

- In section 2.3, I miss a description of air temperature observation, while it is used for analyses of ERA5L soil temperature bias (i.e. in Table 1 and the linear model). Authors have to add a brief description here, and even show them in a proper way. This could be easily done, for example, by changing the shape of the station with both air and soil temperatures in Figure A1.

Specific comments:

P2, L27: The RMSE of reanalyses soil temperature? Please clarify.

P2, L40: ... and example numerical or process-based simulation...

P2, L57: Note that ERA5L is now available from 1981.

P4, L86: The soil temperature from the TTOP and CP maps are used as comparisons, please as mention here.

P4, L89: ...(denoted as PZI map)",".., should it be ";"? Similar in L91.

P4, L97: The MAGT of TTOP and CP maps are additionally used as reference in your Table 1 and Figure 3. Please clarify here.

P5, L104: ...in the same ERA5L grid cell...

P5, L107: ...of ERA5L soil temperature....

P5, L126: there is a repeat of the "the".

P5, L134: ...and (2) an increase of 1 m wSDmax

P7, L149: Is the ALT also overestimated in high latitudes and underestimated in high altitudes?

P10, L164: Also mention the high spatial (and maybe temporal) resolution here, this is one of the most significant features of ERA5 compared to the others.

P13, L215: ...for c_ξ in Eq. B5...

P13, L216: It should be 150 kg m^{-3} based on Eq. B5, please double check.

P14, L236: Underestimate permafrost...(what)? Permafrost area? Please clarify.

P14, L252–253: The bracket is incomplete

P14, L255: Brackets are needed here for the url.

P15, L270: Add space between m and s^{-2}

P16, L278: ρ_ξ is not included in Eq. (B5).

P16, L280: Considering move $\Delta\beta_s = 0$ to the upper so that Eq B6 would be aliened with the state of Eq. B8 and B10

C3

P16, L297: ...ice density of 920...

Tables and figures:

- Table 1: This is only for the observations in permafrost regions. Please clarify in the caption otherwise including the observations in non-permafrost regions.

- Figure 3: In the caption, it should be "...(observation-ERA5L)..."

- Figure 6: Considering add unit to the permafrost area changing rate.