Earth Syst. Sci. Data Discuss., referee comment RC3
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Comment on essd-2021-83

Anonymous Referee #2

Referee comment on "New high-resolution estimates of the permafrost thermal state and hydrothermal conditions over the Northern Hemisphere" by Youhua Ran et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2021-83-RC3, 2021

Review comments on ESSD-2021-83

The authors probably compiled the most up-to-date dataset for permafrost and active layer thickness available worldwide. This first hand data and information would definitely make the mapping of permafrost and active layer thickness more accurate and reliable. The authors proposed new principal approach of permafrost mapping by using both mean annual ground temperature and aridity, this is new and very creative. The newly created permafrost map and dataset of active layer thickness would be an extremely valuable for cold regions and Arctic studies in variety of fields. I recommend the manuscript be accepted for publication in ESSD with some minor revisions:

- L185: provide the "SoilGrids250" website or data center.
- L327: "….and aridity transects in the NH, as shown in Figure 7." Should be "….and aridity transects in the NH (Fig. 7).
- As the authors mentioned several times, the IPA map was a milestone for NH permafrost mapping. I would suggest that the authors conduct a detailed comparison to see the spatial difference between two maps. It seems the IPA map is a little over estimate area of permafrost regions, where? The authors may conduct a spatial difference figure between the two maps.
- The authors may also explain why the two maps are different. First, the IPA map was a mechanical compilation of national maps, each nation had their own mapping standard, it therefore brings a lot of errors and uncertainties. Second, the new map used MAGT<=0°C as the boundary. In a real world, this is a very restrictive requirement. Due to the effect of thermal offset within the active layer, there may exist permafrost between the depth of ZAA and the depth of seasonal maximum thaw (ALT). There is may be other reasons, the authors do not need to do any new work but discuss potential issues in the text.
- The IPA map statistics may not exclude lakes in permafrost regions. However, there are numerous lakes in permafrost regions, the authors should provide information on what size of lakes were excluded from their new map although Fig. 6 has shown the excluded lakes.
- "Climate aridity" is a more reflecting the distance from oceans rather than longitudinal. The authors may just consider changes in words in the text.

- I just wonder if the models used by the authors can output TTOP?
- Bin Cao et al. also did the similar work over Qinghai-Tibetan Plateau. I recommend that the authors should include these work in their review.
- 3: Be clear the figure shows the MAGT average over period of 2000-2016, i.e. "the average MAGT" or "mean MAGT".
- 4: save as the above. "the average active layer thickness"
- 5: explain in details on what on the figure, such as what is black solid line? What is the dashed line? What is the shaded area and overlapped shaded area? Most readers may understand but it needs to be clear in caption.
- 6: The authors may need to distinguish their probability with the previous studies such as Gruber et al. (2012) and Cao (2018??).
- 7: The authors need to describe each line in the Figure in the Caption. Just from legend alone, it is hard to know what is what.
- All major results in the Abstract are not in Conclusions. These major results should be in more detailed than in the Abstract. Conclusions need to be expanded. Very often, potential readers read the title first, then the Abstract, then Conclusions, Figures with detailed captions, then the whole text depending on their interests.
- Again, the authors' permafrost map has its probability>0, this need to be clarified when comparing with the IPA map. The authors should also include statistics of areas with MAGT<0.0C, their probability map, and the IPA map. It will be interesting to their difference and why?