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Responses to Reviewer's Comments and Suggestions
(The answers are shown in blue)

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Referee 1 comments

The authors of the manuscript have done a lot of work on mapping the thermal state of the permafrost in the Northern Hemisphere: the average annual soil temperature (MAGT) at a depth of zero annual amplitude (ZAA) and the thickness of the active layer (ALT), zoning of permafrost based on hydrothermal conditions with a resolution of 1 km per period 2000-2016 The results obtained undoubtedly enrich the previously obtained data of previous researchers and have been successfully mapped on a global scale (the entire northern hemisphere), they can also be mapped at the local (regional) level, as the most demanded in practice.

Technical Notes (Corrections):

- In fig. 2 contours of the "lake" are missing.? They are present in the following figures. This error should be eliminated;

Response: Thank you. The "lake" has been added in the revised manuscript.

- In Fig. 3, the MAGT (oC) color selection is unsuccessful (-15 - -14; -14 - -13 and -2 - -1; -1 - 0). They almost do not differ in color. Also, the color of the "lake" repeats the color "-10…-9; -9 - -8". You should choose a different color for the "lake";

Response: We have adjusted the colour scheme to improve its visibility.

- In fig. 4 remark is similar as in fig. 3. Choose a different shade for the color of the "lake".

Response: We have adjusted the colour of the "lake".

In my opinion, the gradations of average annual temperatures should be chosen according to generally accepted classifications of types of seasonal freezing and thawing of rocks: transitional (-1 - 0), semi-transitional (-2 - -1), long-term stable (-5 - -2), stable (-10 - 5), arctic (-15 - -10) and polar (-20 - -15). I do not insist on following my advice, leaving the choice to the authors of the manuscript.

Response: Thank you for your suggestion. This legend mainly shows the distribution of MAGT in detail, so a detailed classification interval is used here. We have optimized the colour configuration to improve its discrimination.

Referee 2 comments

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:

1. L185: provide the "SoilGrids250" website or data center.

Response: The website "SoilGrids250" has been provided in the revised manuscript.

2. L327: "….and aridity transects in the NH, as shown in Figure 7." Should be "….and aridity transects in the NH (Fig. 7).

Response: This has been revised as suggested.

3. 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.

Response: According to your helpful suggestion, a more detailed comparison including a spatial difference figure has been added to the revised manuscript, as shown in Figure 7.

4. 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 ℃ 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.

Response: Some discussion of the difference between the IPA map and our new map has been added in Section 3.2.

5. 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.

Response: This has been added in L320 in Section 3.2.

6. "Climate aridity" is a more reflecting the distance from oceans rather than longitudinal. The authors may just consider changes in words in the text.

Response: Thank you. This has been corrected.

7. I just wonder if the models used by the authors can output TTOP?

Response: The output of the models is dependent on training data. MAGT is used here, so TTOP cannot be output at present.

8. 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.

Response: This reference has been added.

9. 3: Be clear the figure shows the MAGT average over period of 2000-2016, i.e. "the average MAGT" or "mean MAGT".

Response: Thank you for this suggestion. We have clarified this.

10. 4: save as the above. "the average active layer thickness"

Response: This has been corrected.

11. 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.

Response: More details have been added to clarify this.

12. 6: The authors may need to distinguish their probability with the previous studies such as Gruber et al. (2012) and Cao (2018??).

Response: Yes, these are two different definitions. We have clarified this.

13. 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.

Response: More details have been added to the figure caption to clarify this.

14. 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.

Response: According to your very helpful comments, the conclusion has been expanded, and other text and figure captions have also been improved.

15. 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?

Response: Thank you. We have clarified this in L332.