Permafrost Variability over the Northern Hemisphere Based on MERRA-2 Reanalysis
By Tao et al., 2019.

This study uses point measurement and airborn data in combination with the results of global model driven my MERRA-2 reanalysis modeling data to analyze present permafrost conditions and extent. Authors compare datasets from different scales to study the match between them. The main problem is how to compare in-situ data with averaged to 20x60 m^2 grid cell data and then averaged to 81 km^2 grid cell. Then authors touch on the problem on why global model unable to model permafrost in the Western Russia and Eastern Canada. Global model fail to model permafrost in those regional because those area represent ecosystem protected permafrost zones (Shur et al., 2007). This means that thick organic layer, most importantly including moss layer, protect permafrost below from warm air temperatures. To achieve this increasing the amount of the organic layer as was also done for example global models like CLM and SiBCASA (Nicolsky et al., 2007; Jafarov and Schaefer 2016) is simply not enough. It is important to drive those regions with cold initial temperatures with enough moss-organic insulation on top. In addition deep soil column should allow keeping permafrost in those regions. Overall, the paper indicates some important and interesting analysis, including the effect of soil moisture on the ground temperature and ALT. However, current version of the paper need some major clean ups to improve clarity. I suggest cutting the number of Figures, removing discussion from the conclusion and making results and discussion section, since results already have a lot of discussion. Keep the conclusion straight to the point, do not summarize your work in the conclusion. Instead suggest what improvement can be made to improve discrepancies in the ALT simulation in Mongolia, Russian etc. and how the permafrost extent can be better modeled on the global scale.

Abstract
L27 …some permafrost areas… Be specific, spell out those areas.

Introduction
P3. L26. I suggest acknowledging all the work done ALT measurement using GPR as a part of the pre-ABoVE campaign. Chen et al., (2016) documented extensive GPR ALT data collection near Toolik Lake, Alaska. Jafarov et al., (2018) documented extensive GPR ALT data collection near Barrow, Alaska. These datasets a unique because they represent spatial ALT collection in oppose to point measurements by CALM. Both dataset available for download from ABoVE website. These datasets can be extremely useful in this study because they give a better idea on spatial variability of the ALT on meter scale. The standard deviation from those works can be used to better constrain the uncertainty in measured ALT at a finer spatial scale.

In addition, I highly suggest checking the most recent and the most complete work on the near-surface permafrost data in Alaska (Wang et al., 2018). The data collected in that dataset provides a wider coverage for Alaska and can be extremely useful for this study.

P4. L 22-30. Do this freeze-thaw formulation allows multiple thaw zones? E.g. talik and seasonal frost above with the existing permafrost at a deeper depth.

P5.L12 Not sure why the model was spun up for 180 years? Typically spin up means total equilibrium.

Methods section needs some better organization. For example,
1. In-situ to AirMoss comparison
2. In-situ to CLSM comparison

P7-8. L30-12. The main point of those two paragraphs is the difference. I suggest plotting the difference between AirMoss and CLSM with 81 km^2 resolution, just one Figure instead of ABC. Then it will be clear when they do not match and then discussion can be more focused on the why they do not match.

P8. Paragraphs 3 and 4. Similarly don't need Figure 4 AB. In-situ data has smaller uncertainty and variability, when scaled up we average the variability into a one grid cell. The question is what is the uncertainty for CLSM should be, which was answered later in the manuscript by analyzing the effect of different factors (snow, organic layer, soil moisture). If you plot the CLSM uncertainty bars and they intercept with the solid lines then this makes the overall results much better.

P9. L16-30. It mainly depends on the pixel size (grid cell) of the modeled ALT. The authors should think how they can address the overall uncertainty in the global model, and how that uncertainty would change when they compare it with in-situ or AirMoss data.

P14. L6-20. Cite Shur et al., (2007) draw the discussion from that work. Refer to my main comment.

P14. L31. There are many CALM sites within a CLSM grid cell. The variation in CALM sites is a standard deviation (std). Again this deviation is from hand full of sites where the GPR measurement provides a wider range of the possible (std) in Barrow and Toolik Lake regions.

P15. L1-3. The soil characteristic in Mongolia might include rocky type environment. In mountain areas the ALT along the south face slopes might be quite deep. I wonder if that might explain the deep ALT in those regions.

P15. L30. Do you think if you drive the model with different reanalysis data (ERA-Interim or similar) it might give you better results?

P16. L19. I would drop unnecessary words phrases like at least to some extent from the text.

References

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