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Interactive comment on "Diagnostic and model dependent uncertainty of simulated Tibetan permafrost area" *by* W. Wang et al.

Anonymous Referee #1

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The manuscript entitled by "Diagnostic and model dependent uncertainty of simulated Tibetan permafrost area by W. Wang et al." aimed to examine uncertainties in the estimated TP permafrost areas between 6 LSMs and 5 different methods. This paper is easy to follow to the final and seems to be reached to the objectives. TP locates at the southern boundary of permafrost regions, in which the permafrost is mainly classified to discontinuous and sporadic types. At regions of the southern permafrost boundary, the modeling ability that well captures the permafrost was a big challenge to the Arctic modeling community. Despite the models calculated vertical soil temperature profiles on the basis of the soil heat balance equation, TP permafrost areas presented the largest uncertainties between the models. The result that was obtained at TP regions of discontinuous, not continuous permafrost certainly provides important information to improve permafrost processes of models.

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Interactive Discussion
Discussion Paper

However, this paper has results inconsistent with knowledge that was generally known in the Arctic processes, which is a priority that should be solved for the publication. Methodologies this study used partially adopted empirical results that could probably further increase uncertainties for the analyzed permafrost area on TP. Therefore, it requires more analyses. The details are described below.

General comments

1. This study used Wang06 permafrost map as a reference. As compared with Wang06 map, there is a tendency that the indirect methods (MAAT, F, SFI) overestimated the permafrost area (Table 3). For the calculation, authors used thresholds of -2oC MAAT and frost number $\geq$0.5. It seems their selection was considerably subjective, based on empirical results of previous studies. The thresholds have considerable potentials that can change the results of this study. For example, when MAAT is set to 0oC, the permafrost area becomes probably larger than the areas indicated on Table 3. That is, the results of this study also include latent uncertainties in terms of the methodologies. A possible way to reduce the uncertainty is what examines the sensitivity of permafrost area against the changed threshold, calculating changes in the permafrost area to the ranges from -3 to 1oC of MAAT. The calculations have to be made for frost number. The results have to be summarized as a table and figure, including the discussions.

2. Snow cover has the insulation effect on soil temperature; deeper snow depth increases soil temperature and vice versa. However, figure 7 and 8 have results inconsistent with the facts, especially found in ground surface temperatures of UVic, ISBA, and JULES. In case of UVic, the ground surface temperature was warmer than the air despite of no snow cover. In contrast, the surface temperatures of ISBA and JULES were colder under thicker snow cover. They are not common. For the reasons, the authors mentioned problems of parameters the model used and the reliance of snow cover data derived from satellite observations. Of course, we can enough consider their influences. However, if there is problem in the snow cover data, how do you explain the results of the remaining three models that satisfy the common facts? The

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explanations authors mentioned are not enough to clear up the question. The ground surface temperature was extrapolated from the vertical soil temperature profiles. How did you extrapolate it, by liner or exponential way? Soil temperature doesn't generally have linear vertical profile. As the first step, you have to check the soundness for the extrapolated surface temperature; a way is to calculate the temperature offset using soil temperatures of 0.05 m. If there are no large differences, we could be doubtful about the snow cover data. If not so, you could have to recalculate the surface temperature that is implicated to SFI.

The authors mentioned influences of model parameters on the problem, but they didn't provide any scientific bases. For example, CLM4 (Lawrence et al., 2012, J. Clim.) and JULES (Dankers et al., 2011, Cryosphere) have characteristics of cold bias for soil temperatures. Likewise, you have to approach for the problem with scientific results and physical properties of individual models.

3. As the authors had already mentioned, the lowest soil boundary is a critical issue implicating to the permafrost uncertainty. Three models among the six models extended the soil to deeper depth, which makes it possible to do the discussion on this issue. The authors described a result of CLM4.5; when the soil was extended to 38 m, there was no significant change in the permafrost area (P1776 L3–5). From this description, the reviewer understands that there was a difference, though the difference was not so large numerically. If so, the authors have to provide the analyzed numbers on the manuscript, including results of other two models. The related description is summarized with one paragraph in the section of Conclusion, but which has to move to the Discussion section with additional discussion.

The monthly time resolution this study used could also increase the uncertainties for the estimated permafrost area, which has also to be mentioned in the Discussion section.

Specific comments

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P1771 L9, the word ‘best’ is not appropriate. Please remove it.

P1771 L15-7, it seems differences in vegetation types are implicated to.

P1772 L4, climate likely affects the permafrost distribution.

L10, does ‘the temperature’ mean air temperature?

L19, where are individual station locations?

P1774 L18-9, please add references.

P1778 L15, what means ‘SD’?

P1778 L26–P1779 L6, I don’t well understand why Miroc-ESM was used in this study. Figure 5 certainly includes data of Miroc-ESM, but the data are not closely related to this study. Your intent is to strengthen the high uncertainty in the permafrost processes between models, is it?

P1778 L10-2, you have to describe more specifically the way on how the ground surface temperature was extrapolated.

P1779 L17-24, it may be helpful if you describe the specific numbers about TP permafrost area reported by previous studies.

P1781 L20-1, The description about Figure 5 is too simple. You have to add more explanation about data displayed on the figure. From the figure, we can see differences in the simulated soil temperatures between models. The air temperature also shows differences between the models, especially in winter season, though the differences are smaller.

P1782 L10, does ‘observation’ mean Wang06 map?

L19-21, we can consider the impact of different forcing data, especially air temperature as identified in Figure 5. Therefore, it can’t conclude the difference with just different spatial resolution.

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P1786 L20-1, for ‘poor representation of soil hydrology’, I can’t find any scientific results from this paper to support the description.

P1788 L14-6, is the description able to apply to all models?

Table 3, it may be helpful if the uncertainties compared to Wang06 are included.

Figure 5, it may be helpful if the seasonal snow depth derived from the data of Figure 6 is added.

Interactive comment on The Cryosphere Discuss., 9, 1769, 2015.