

Hydrol. Earth Syst. Sci. Discuss., author comment AC2
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Reply on RC2

Hongkai Gao et al.

Author comment on "Diagnosing the impacts of permafrost on catchment hydrology: field measurements and model experiments in a mountainous catchment in western China" by Hongkai Gao et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-264-AC2>, 2021

Reviewer#2

Based on the measured data and model experiments, the authors analyzed the influence of different meteorological forcing and terrain distribution on the hydrological process in alpine mountainous areas, which is of great significance for the future development of frozen soil hydrological forecast. However, the story is not clear. Permafrost hydrology is a very complex process. This study only selects the data of one observation station to optimize the model, which I think is unreliable. Moreover, one of the results is that the permafrost impacts on streamflow response mostly at the beginning of the melting season, but I can't find any definite data and scientific insight in the manuscript. As another example, in the manuscript, the descriptions of the topography and landscape heterogeneity are dominant controls on catchment response, what we can learn. Therefore, it is not clear what scientific insight the manuscript provides.

Response: We thank Reviewer#2 for endorsing the importance of this study. We fully agree that permafrost hydrology is very complex. Among the complexities, we attempted to use the hydrological model as a tool to identify which processes play a more important role than others. We found that meteorological forcing and terrain distribution are important. Also landscape heterogeneity is essential to increase model performance. About what we have learned from this study, we summarized as five points: 1) the improvement associated to the model modifications suggest that topography and landscape heterogeneity are dominant controls on catchment response; 2) baseflow recession in permafrost regions is the result of a linear reservoir, and slower than non-permafrost regions; 3) parameter variation infers seasonally non-stationary precipitation-runoff relationships in permafrost catchment; 4) permafrost impacts on streamflow response mostly at the beginning of the melting season; 5) allowing the temporal variation of frozen soil related parameters, i.e. the unsaturated storage capacity and the splitter of fast and slow streamflow, improved model performance. For your detailed comments, we made point-by-point replies in below.

Other comments:

1. In introduction, the achievements and shortcomings of the present research should be

added, and the research significance of this paper should be explained.

Response: We will further improve the introduction section, to highlight the scientific question we are targeting to.

2. In the Study site and data section, the introduction to the use of data is somewhat simple, please add basic information.

Response: We will improve Study site and data section.

3. In the Study site and data section, how do you handle gaps in data? Please give a supplementary explanation.

Response: Runoff data has a gap period in 2013 due to flooding and equipment malfunction. The meteorological forcing data is continuous, without gaps. While running the hydrological model, the runoff data gap does not impact model functioning, it only influences model evaluation (in calibration and validation). While evaluating the model, we did not include the data gap period.

4. In the Modelling approach section, the authors recommend that the model be appropriately simplified by introducing too much space.

Response: We are not quite sure we fully understand this question. If our understanding is correct, we will further improve Modelling section, and simplify the narratives.

5. The author sets all parameters to dynamic in Ex9, and explains how this pattern reflects the difference from other patterns.

Response: We are not quite sure we fully understand this question. If our understanding is correct, we will further improve our discussion on Ex9.

6. It is suggested that the authors increase the applicability of stepwise modeling in alpine mountains in the discussion section. To verify the feasibility of this paper.

Response: We will improve the discussion on stepwise modeling.

7. In the discussion section, the authors can compare and discuss the relevant similar studies in alpine mountains at home and abroad, and analyze the similarities and differences.

Response: This is a good point. We will add the comparison and discussion of previous studies in other alpine regions.

8. What factors lead to the base flow recession in permafrost regions ?

Response: This is a very important and basic question. For catchment without permafrost, the baseflow recession is influenced by many factors, including topography, geology, and vegetation. In permafrost regions, the existence of underground ice and freeze-thaw process make the baseflow recession more complicated. Interestingly, we found a beautiful linear baseflow recession in this permafrost catchment, similar to other general regions. Since the baseflow recession is the result of groundwater discharge, and the volume of groundwater reservoir is much larger than the topsoil reservoir, even in permafrost catchments, the large amount of groundwater reservoir may not be significantly influenced by topsoil thaw-freeze processes, whereby it still performs as a linear reservoir.

9. The author introduces that the study area is located in the northeast of the Qinghai-Tibet Plateau. It is suggested that the study area should be added to Fig. 1 to increase the overall readability of the article.

Response: This is a good point. We will add a map to show the location of study area on the Qinghai-Tibet Plateau.

10. The conclusion of the manuscript is just a summary of the results. This section should include the main findings and outcomes of your work and describes how your research will impact the current state of science in the field.

Response: We will improve the conclusion section, to include the main findings and outcomes of this work, and highlight the new knowledge we obtained in this study.

11. References have some format errors, please modify them carefully.

Response: We will correct the reference format thoroughly.