

Anonymous referee #1:

The authors have generally addressed my previous comments. It can be accepted for publication in HESS.

Reply: We thank Referee #1's endorsement for the acceptance for publication in HESS.

Anonymous referee #2:

The author has answered all of my questions, and some revisions are adequate. However, I still has concerns about to develop a robust model. My comments are shown bellow:

Reply: We are glad that Referee #2' satisfied with our revision. Please find our answers for your detailed questions.

1. The author mentioned that the perceptual model comes from the observations from not only the observations and expert knowledges at the Hulu catchment itself, but also widely considered the impact of frozen-soil on hydrological processes in other catchments, including the Zhamashike and Qilian (two nested sub-catchments of the upper Heihe). Therefore, I think the model can be easy to apply at the nested Zhamashike and Qilian catchment and also the whole upper Heihe basin. To validate the model performance in the Zhamashike and Qilian catchment or the whole basin is necessary to prove the model's accuracy. This is because spatial scale problems for hydrology usually exist although there is spatial variations of landscape in the small Hulu catchment. As scale increasing, the response of hydrology processes to atmosphere forcings may be different.

Reply: We also believe that transferring the frozen-soil hydrological model from Hulu catchment to larger upper Heihe basin and its sub-basins is a stronger model realism test. We will conduct this study in the near future. Since the length of current manuscript is already over 13.8k words, and doing model transferability test needs more detailed landscape analysis and meteorological forcing distribution, which are out the scope of this paper. We believe current multi-source, multi-scale and multi-catchment measurements are strong enough to support the realism of our model, including not only the hydrography measurements in multi-catchments with different permafrost coverage, but also multi-source and multi-scale observations, particularly the freezing and thawing front in the soil, the lower limit of permafrost, and the trends in groundwater level variation. We thank Referee #2's valuable inputs which are valuable to guide our future studies. This paper is definitely not the end of our exploration in frozen-soil hydrology.

2. The author mentioned that the model empirical parameters, most of them are related to the freeze- thaw processes related to Stefan equation. I think it need more explanation for the relationship between the Stefan equation and all the parameters in table 2.

Reply: This is a good question. Stefan equation described the soil freeze/thaw processes, which are mostly the vertical processes. The parameters in Table 2 are all about catchment hydrological processes, which involved both vertical and lateral processes. All this paper is to link soil freeze/thaw processes with catchment hydrology in a process-based way. The detailed methodology for linking soil freeze/thaw processes (calculated by Stefan equation) and hydrological parameters can be found mostly in Section 4.2.2.