

Comment on hess-2022-98

Anonymous Referee #1

Referee comment on "Frozen soil hydrological modeling for a mountainous catchment northeast of the Qinghai–Tibet Plateau" by Hongkai Gao et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-98-RC1>, 2022

The manuscript presents a process of new model development/improvement in frozen ground process. In general, it is clear and reasonable to me. However, the presentation needs proper revisions before it can be considered for publication in HESS. Please clarify the merits and limitations of the newly developed frozen ground model, since it is not clear that if this new empirical model can be applied to other cold regions or not.

Major comments:

- (1) It is not really clear that if this developed model can be applicable to other river basins. It seems to us that the model development is just from a very small cold river basin of northeast Tibetan Plateau, and the model contains quite a few empirical parameters that needs calibrations with in-situ observations. What is the evidence that this model can be suitable for other basins of Tibetan Plateau?
- (2) Figure 1: please clearly describe the time periods of these observations in the figure caption.
- (3) Figure 4: Why the runoff is so small in the Arctic watershed? Please also explain the difference between the disturbed and undisturbed.
- (4) Figure 5: The empirical parameters K_s changes at different periods from 80d to 60d. Is it difficult to apply/transfer the model to other regions, since you always needs calibrations at different periods?
- (5) Figure 6: Why are the simulated results only shown in one winter at 1974? How about the results in other years? You have never mentioned 1974 in the observations.
- (6) Figure 8: It is not clear here. please explain the FLEX-w, FLEX-h, FLEX-d, FLEX-g in the figure caption.
- (7) Figure 9, Figure 11 and Figure 10 can be merged. Particularly, Figure 9 and 11 should be put together for direct comparison. Similarly, a new result by FLEX-Topo-FS should be added to compare with Figure 10 that is the simulated result of freeze/thaw depth by FLEX-Topo. For the results in Figure 11, it seems that the new model simulates much more fluctuations than observed. What is the problem about the new model?
- (8) Figure 12: the comparison (only showing the periodical variation) is not meaningful, since the time periods for the two graphs are different.
- (9) Figure 13: Future projection on 2 degrees warmer is just too simple. Please use IPCC outputs or more scientific designs.
- (10) Reference: This reference list has missed a lot of recent literatures in frozen ground

modeling studies at Tibetan Plateau. Regarding this topic, there have been quite a few studies in past five years, at the headwaters of Yangtze, Yellow, Heihe, and other rivers.