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Comment on hess-2022-215

Anonymous Referee #1

Referee comment on "Application of an improved distributed hydrological model based on the soil–gravel structure in the Niyang River basin, Qinghai–Tibet Plateau" by Pengxiang Wang et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-215-RC1, 2022

The paper is interesting to read, which presented the development of Water and Energy transfer Processes model in the Qinghai–Tibet Plateau (WEP-QTP) that modified based on the original Water and Energy transfer Processes model in Cold Regions (WEP-COR). In the presented model, the vadose zone processes considered three strategies under different conditions: (1) a dualistic soil-gravel structure using the Richards equation under non-heavy rain in the nonfreeze–thaw period; (2) a multi-layer Green-Ampt model in a heavy rain scenario in the nonfreeze–thaw period; and (3) a hydrothermal coupling model based on the continuum of the snow-soil-gravel layer during the freeze––thaw period. The modified model was then verified with measured river discharge in Niyang River Basin by comparing the simulated groundwater.

The study adopted a new conceptualization of the water and energy transfer in Qinghai–Tibet Plateau, which is considered as novel. However, significant improvement is needed before the consideration of publication to Hydrology and Earth System Sciences.

Major comments:

- Author stated in Line 52-62 that the existence of gravel in soil can significantly affect the soil water content and water transport. However, coupling of soil water and heat transport may be still not fully achieved in the modified version of WEP-QTP. When the dualistic soil-gravel structure was used in the nonfreeze–thaw period, the soil water transport may be decoupled with the thermal transport (see Line 296: "for soil and gravel layers, the average temperature was represented by the temperature of the middle layer"). It seems that the full coupling of water and heat transport can only be achieved for freeze––thaw period? Author should at least state whether the neglection of heat transport in nonfreeze–thaw period affect hydrological processes.

- During the nonfreeze–thaw period, the soil hydrology was simulated with either a dualistic soil-gravel model or a Green-Ampt equation, and the selection of the two options depend on whether the rainfall intensity exceeded 20 mm/day (Line 677). Why was such threshold selected? Would the dualistic model more suit to the high intensity rainfall?
- In the schematic figure shown in Fig. 3 (a), the author proposed a dualistic soil-gravel model, it is not clear whether the dualistic model is similar to the dual-porosity model proposed by Greke and van Genuchten (1993). Moreover, author should clearly state how to separate the water flow in such dualistic pore system.
- The soil water retention curve was described with van Genuchten model in Eq. B2 (Line 685), while the soil hydraulic conductivity function adopted a power functionï¼□B3ï¼□which is similar to that was used in Brooks-Corey model. Besides, the parameter n in Eq.B3 also adopted Mualem's constant (Line 692). Such combination may be acceptable only if more cautions were taken for the parameterizations. Author should clarify why chosen to combine the selected soil water retention curve and soil hydraulic function, and how these soil hydraulic parameters were specified for distributed hydrological modeling.
- In Page 20, Fig.8, why the simulated soil moisture differed between the two models in a freeze–thaw period (Line 414)? Modification in the proposed model may be solely focused on the nonfreeze–thaw period.
- All the figures have poor resolution. Please consider replacing all of them.

Reference: Gerke, H. H. and van Genuchten,M.: A dual-porositymodel for simulating the preferential movement of water and solutes in structured porous media, Water Resources Research, 1993, 29, 305–319

Minor comments:

Line 132: "Temperature" should be "temperature"

Line 154: The "0" may be redundant.

Line 164: The citation of MODIS data should be added.

Line 166: The citation China's second glacier inventory data set should be added.

Line 167: add the citation of Water and Energy transfer Processes in Cold Regions (WEP-COR) model.

Line 267: The unit of saturated hydraulic conductivity K_s and snow water equivalent S should be consistent.

Line 289: The unit of Eï¼□ρ_a, c_p, and r_a should be added.

Line 290: r_a is aerodynamic resistance?

Line 340: where can we found the calibrated parameters?

Line 454: Figure 10 In order to prove the conclusion in this paper that WEP-QTP can better simulate the measured runoff, it was suggested to plot the measured runoff data in the figure.

Figure11 Legend and the scale is too small to read; It is recommended to mark the location of the three stations. What the source of the plotted data, measured snow thickness or the model simulation? If it is a map of measured snow, it is recommended to put it in the appendix. If it is a map of modeled results, suggest making a comparison with the actual measurement.