Hydrology and Earth System Sciences Discussions

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Comment on hess-2020-657

Anonymous Referee #1

Referee comment on "Interaction of soil water and groundwater during the freezing–thawing cycle: field observations and numerical modeling" by Hong-Yu Xie et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-657-RC1, 2021

It's my pleasure to review hess-2020-657 "Interaction of soil water and groundwater during the freezing-thawing cycle: field observations and numerical modeling" by Xie et al. The authors quantified the impact of freezing-induced groundwater migration and lateral groundwater inflow on soil moisture profile and groundwater level dynamics at site scale using the SHAW model. This is a very specific study at a single site, and the broad implication of this study to the relevant research community is unknown and needs to be justified. In addition, additional numerical experiments should be included to better quantify the impact of freezing-induced groundwater migration and lateral groundwater inflow, and additional descriptions of the measurements and methods are also necessary. According to these, a major revision is recommended. My comments are as follows.

Major Comments:

- This paper describes a specific case of observing and simulating the impact of freezing-induced groundwater migration and lateral groundwater inflow on soil moisture profile and groundwater level dynamics at a single site with very shallow water level ranging from 90-143cm. I think this is a very special case for the frozen areas that the water level is generally much deeper. As such, the broad implication of this study to the relevant research community should be justified. In addition, the authors are suggested to include additional numerical simulations to investigate the impact of different water level depths.
- Related to comment #1, I think detailed descriptions of the study site and all the available measurements are necessary as these given in Jiang et al. 2017,2018 cited in this paper. I found that there are at least two experimental wells and several other kinds of wells shown in Jiang et al. 2017,2018. Why only one experimental well is investigated in this study? What's the typical depth of groundwater level found across the whole Wudu lake catchment? How far is the Otak meteorological station from the monitoring site? What's the accuracy of precipitation and soil moisture measurements? Did the authors perform site-specific calibration for the 5TM sensor? And how accurate

can the 5TM sensor measure the liquid water contend under frozen condition? What's the typical vegetation and soil types? The measurements of soil texture and soil temperature are also suggested to include in the supplement.

- The authors indicated that "we find snowfall did not infiltrate into the soil column due to the low permeability of frozen soil", which I think is questionable. If the permeability of frozen soil is so low that the snowmelt cannot infiltrate into the soil, how can the freezing-induced groundwater migration enter the soil column? What's the mechanism behind this? I am curious how the authors simulate the snow process? What's the accuracy of snowfall measurements and snowmelt simulations?
- Detailed descriptions of how the authors determine the hydraulic parameters are necessary. Did the authors measure the soil texture and other relevant hydraulic parameters such as porosity, bulk density and saturated hydraulic conductivity? Why the saturated hydraulic conductivity estimated for the second layer (0.7-1.0 m) is so different from other two layers? How the authors determine the permeability of aquifer?
- Detailed descriptions of the SHAW model and its implementation are necessary. For instance, how the model compute the snow process and permeability of frozen soil? How the authors include the lateral groundwater inflow into the SHAW model? How the authors determine the temperature at the lower boundary? What are the state variables need to be determined before the simulations? What's the time step of simulations? How the authors consider the impact of vegetation processes?
- Four numerical experiments are conducted to investigate the impact of soil heterogeneity and lateral groundwater on the simulations. I do not found the necessary to quantify the impact of soil heterogeneity. Instead, I think the authors can consider following additional experiments such as simulations without impact of groundwater, simulations with deeper water level depth, and simulations with changing rates of lateral groundwater inflow. It's not clear why the authors fix the rate of lateral groundwater inflow.

Minor Comments:

- The authors are suggested to merge Figures 4 and 5, and the info of precipitation is suggested to include in the figure. The scale for the temperature can be set at 10~-20.
- Why there is not increase found for the simulation of total water content at 10 cm as shown in Figure 5?
- It's suggested to plot the measured frost depth and WTD in all the subplots of Figure 6. In addition, how the authors determine the frost depth?
- For all the simulations, it's suggested to show how they affect both soil liquid water content and temperature simulations, as well as to list the corresponding error statistics.
- For the description of soil evaporation in Section 3.3, can the authors provide validation data? If not, I don't find the necessary to include this subsection. Instead, the impact of different numerical experiments on both soil liquid water content and temperature simulations can be shown in detail.
- For the Table S1, it's suggested to remove 110cm and 150cm since there are not measurements recorded for these two depths. Besides, it's suggested to add the measured soil temperature and lateral groundwater inflow in the supplement.