

Hydrol. Earth Syst. Sci. Discuss., referee comment RC1
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Comment on hess-2022-355

Anonymous Referee #1

Referee comment on "Hydrological response to climate change and human activities in the Three-River Source Region" by Ting Su et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-355-RC1>, 2022

It's my pleasure to review this manuscript. The TRSR region is important for water resource security and of interest to researchers because of its complex hydrological processes. This study conducts a systematic modeling work on this region, and analyze the contribution of runoff components and the hydrological response to climate change and human activities. The results are helpful for understanding the hydrological processes in this important region, which make this manuscript worth publishing. Overall, the manuscript is written well and easy to follow. However, I have some concern about the results, especially for the snow and glacier simulations. I recommend to accept the manuscript after moderate revisions to address following issues.

1. The description of model:

A module representing glacier processes was integrated into the model, and the authors described them in detail. The snowmelt contributes more than glacier runoff in most of the basins, but the simulation of snow processes was not introduced in the Method section. I think this might be due to that the snow module has been included in the VIC model, and the authors only introduced the extension module. Nonetheless, since the simulation of snow processes is equally important as glacier, I suggest the authors to add some description on the snow simulation.

2. Definition of the runoff component:

The authors estimated the contribution of runoff components in each basin, which is an important result. However, the result would be confusing if the definition of runoff component was not clarified. Is the runoff component defined based on the contribution of each water source in the total water input, or the proportion of each component in the streamflow? The amount of river water should be smaller than the sum of each water

source due to evaporation loss. How does the model consider this? I suggest the authors to clearly clarify the definition of runoff components. The authors can refer to a recent review on this issue ("A meta-analysis based review of quantifying the contributions of runoff components to streamflow in glacierized basins").

3. Validation of snow/glacier simulation:

It is good to involve snow and glacier simulation into the hydrological model, but the results could be unreasonable if the snow and glacier simulation are not validated by any measurement dataset. In my opinion, the contribution of glacier runoff in source Yangtze River (Zhimenda station) was significantly overestimated, and my approximate estimation is as follows: The mean annual runoff at Zhimenda station was about 160mm/a, so the glacier runoff should be 13.92mm/a (if the authors define the runoff component by the proportion in the streamflow). Considering the glacier area is 0.81%, the runoff generation in glacier area is $13.92/0.81\%=1700\text{mm/a}$. Excluding the precipitation (about 400mm/a), the glacier meltwater would be more than 1.3m/a, which is significantly higher than the estimation from existed glacier studies (0.5m/a). Besides, if the runoff component was defined by the water source definition, the glacier mass meltwater estimated in similar way would even be larger than 4m/a.

Nonetheless, I agree with the authors that the meltwater has little influence on the streamflow due to the small glacier area. But I just think that if snow and glacier simulations are not verified, the benefit of using a glacier hydrological model would be reduced.

4. Designation of climate change scenarios:

The authors set four scenarios to analyze the hydrological response to the climate change. In my understanding, the scenarios designation seems more likely a sensitivity analysis between runoff and T and P, but the attribution analysis has shown the result that the precipitation is the most important factor. So we can expect the sensitivity analysis would give similar conclusion. If the aim of setting scenarios is to predict the runoff change in the future, why not directly use the projection climate data such as CMIP6?