Anonymous Referee #2

This manuscript investigated the impact of topography and vegetation on catchment hydrology in two cold mountainous basins of the Mongolian Plateau using stepwise top-down modelling approaches. It is very interesting and scientifically sound. Also, it is suitable for Hydrology and Earth System Sciences. However, some improvements are still required.

Reply: We sincerely appreciate the reviewer's positive and constructive comments. In response, we will carefully revise the manuscript to address all specific points and will provide detailed explanations and modifications where appropriate. Detailed responses to all comments are provided below.

Detailed comments

1. The annual precipitation is ~200mm and ~160mm in the two basins, which belongs to sub-arid region. Therefore, most quick runoff should generate from infiltration excess runoff. On the other hand, in the FLEX, runoff generation is described as saturation excess generation. The reliability of the conclusion and the rationality of the method should be further assessed. At least, more explanations and discussions are requested.

Reply: We thank the reviewer for this valuable comment.

Fig. 1 shows the daily precipitation in the two basins during the study period. Rainfall events exceeding 15 mm d^{-1} occur only 2-3 days per year, while most rainfall days receive less than 15 mm d^{-1}. Given these rainfall intensities, which generally remain below the infiltration capacity of grassland and forest soils, infiltration-excess (Hortonian) overland flow (HOF) is expected to be rare and largely restricted to bare or compacted surfaces (Blackburn, 1975; Beven and Germann, 2013).

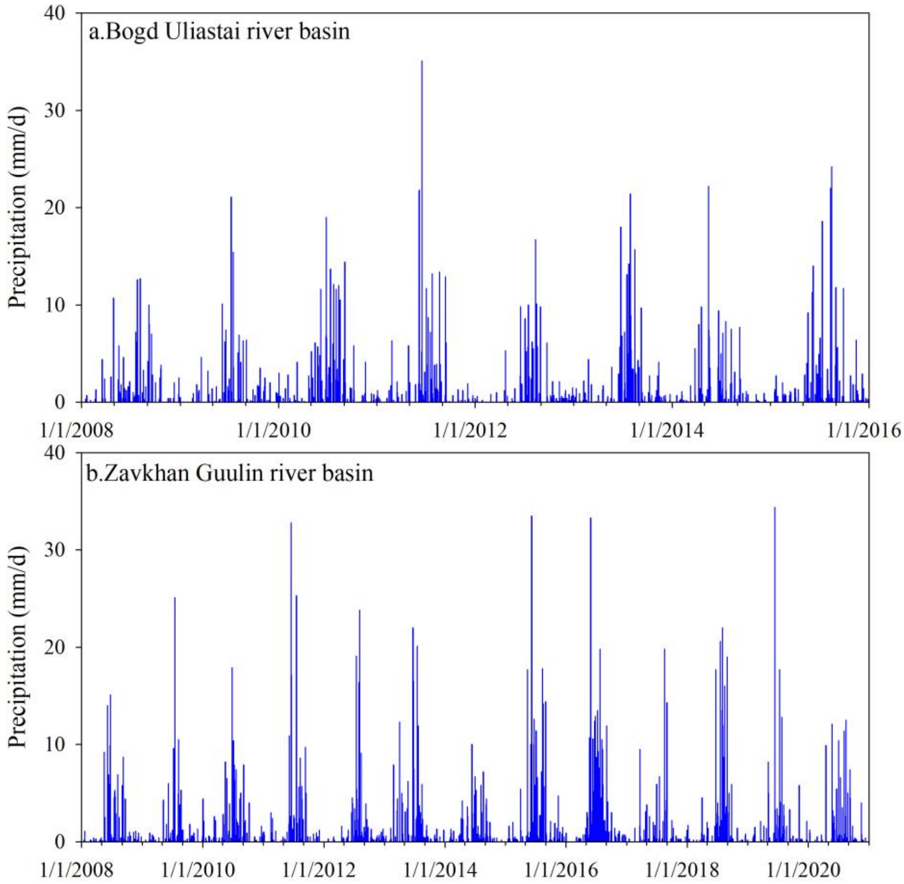

Fig.1 Daily precipitation in the two basins during the study period.

Runoff generation varies across the main landscape units, which exhibit distinct hydrological behaviors forming the basis of the FLEX^T model:

Bare soil/rock (~2% of the basin): Low infiltration capacity and sparse vegetation can produce localized HOF during high-intensity rainfall events. HOF is explicitly included in the model for these units to capture the full range of potential runoff processes.

Grazed grasslands and forests: High soil infiltration rates and well-developed macropore networks promote storage excess subsurface flow (SSF), particularly during snowmelt or prolonged rainfall (Beven and Germann, 2013; Lyford and Qashu, 1969). Hortonian runoff is negligible due to dense vegetation and high infiltration capacity.

Riparian wetlands: Shallow groundwater tables and limited soil storage capacity favor soil overland flow (SOF) as the dominant mechanism (Dunne and Black, 1970).

In the revised FLEX^T model, HOF will be explicitly represented in bare soil/rock units for potential infiltration-excess runoff, with saturation-excess generation remaining the primary mechanism elsewhere. This configuration is scientifically justified, physically consistent, and realistically reflects landscape-dependent runoff processes. In the revised manuscript, we will include these precipitation- and landscape-based explanations to clarify the modeling rationale.

2. This study selected two alpine Basins as the study basin. In the study basins, there is only one meteorological station for each basin. To represent the spatial variation of precipitation, the authors a precipitation increase rate of 4.2% from the Heihe River basin in China. Does the precipitation increase rate of 4.2% conform to the study basins? More explanations and discussions are requested.

Reply: It should be clarified that the precipitation increase rate used in this study is not solely derived from the Heihe River basin in China. The following steps describe how the precipitation increase rate was determined in this study.

Reanalysis data attempts and limitations: We have attempted to use multiple reanalysis datasets to quantify the spatial variation of precipitation within the study basins. However, the quality of these datasets in this region is relatively poor, making them unreliable for accurately estimating precipitation gradients.

Literature-based regional reference (most important): To obtain a more scientifically justified precipitation–elevation relationship, we consulted extensive literature on nearby catchments. In particular, the Tsagan-Turutuin-gol catchment, which also originates from the Khangaï Mountains and exhibits similar topographic and climatic characteristics to our study basins, shows an annual precipitation of approximately 230 mm, with a precipitation gradient between 2000 and 3350 m a.s.l. slightly below 10 mm/100 m (equivalent to about 4.3%/100 m) (Dauksza and Soja, 1977; Klimek and Starkel, 1980). Based on this reference, we selected 4.2%/100 m as the precipitation increase rate for our study basins, ensuring that the chosen value is both physically reasonable and consistent with regional observations.

We will provide a more detailed explanation and cite the appropriate references in the revised manuscript.

3.In the study basins, winter temperature falls below -30 degree. It’s better to discuss the impact of frozen soil.

Reply: In the revised manuscript, we will include a dedicated discussion on the potential impacts of frozen soils in winter and early spring. This will include a brief review of relevant literature on permafrost and seasonally frozen soils in alpine catchments, as well as implications for runoff generation in our study basins.

4.Lines 259-260, there is a mistake on the description of the method for actual evaporation, i.e. “Ep” should be “Ep - Ei” (potential evaporation minus interception evaporation).

Reply: We will clarify this point in the revised manuscript. We note that Equation 13 is correctly formulated and remains unchanged; the correction applies only to the textual description.

5. The authors conducted relevant researches in other alpines basins, such as Heihe River basin. In this study, it's more useful to discuss both the similarities and the differences in order to gain a clearer understanding.

Reply: In the revised manuscript, we will expand the discussion to highlight similarities and differences between our study basins and other alpine basins, such as the Heihe River basin. We will consider factors including snow accumulation and melt patterns, topography, and vegetation heterogeneity, all of which influence catchment hydrology. This comparison will clarify the generality and specificity of our findings and situate the results in a broader regional hydrological context.

References

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