Dear Prof. Shu,

Thank you for your thorough and insightful review of our paper. We appreciate your positive feedback on our experimental design, credibility of arguments, clarity of charts, and readability of our writing. We also acknowledge your constructive comments and suggestions for improving our study. To distinguish your comments from our responses, we will present your comments in blue bold font and our responses in regular black font. Please find our detailed responses to your concerns below:

1. **The authors explored the relationship between slope and several hydrological processes. I did not see the process of slope calculation; therefore, I am uncertain if the slope here refers to the slope calculated from the DEM in different zones or the slope calculated based on the triangular mesh of the SHUD model. Since the resolution of the triangles is lower than that of the DEM, I believe that the slope based on triangles better reflects the impact of slope on hydrological processes. According to lines 187-189, the three zones are divided based on elevation differences, but the average slope attribute within the three zones is not displayed or discussed. Therefore, the article needs to clarify the slope calculation method.**

   We appreciate your observation regarding the slope calculation. In our study, the slope was indeed calculated based on the triangular mesh of the SHUD model rather than the three zones. Specifically, we used the DEM raster file with a spatial resolution of 30m x 30m to determine the slope of each raster grid. We then calculated the average slope for each triangular mesh by averaging the slopes of all raster grids within the mesh. All subsequent analyses were conducted using the slope values of each triangular mesh, as detailed in Appendix B. We agree that this method, with its higher resolution, more accurately reflects the impact of slope on hydrological processes compared to the three zones. We will include a detailed explanation of the slope calculation method in the revised manuscript. Additionally, we will discuss the average slope attributes within the three zones based on elevation differences.

2. **Based on the SHUD model, the authors analyzed the impact of slope on hydrological processes (subsurface). Local subsurface flow is usually affected by soil characteristics, especially hydraulic conductivity, and is also influenced by slope runoff (slope + accumulating area). Therefore, the groundwater level is higher in the flat areas around the river channel, leading to a larger subsurface flow.**

   We agree with your assessment that local subsurface flow is influenced by soil characteristics and slope runoff (slope + accumulating area). Consequently, groundwater levels are higher in flatter areas, leading to larger subsurface flow. Our results support this conclusion. The daily scale subsurface flow result (Fig. 5) shows a positive correlation between subsurface flow and slope in the flatter Zone 1, whereas this correlation is less pronounced in the steeper Zones 2 and 3. This indicates that in the flatter Zone 1, as the slope increases, the subsurface flow (outflow) also increases. Additionally, the annual scale subsurface flow results (Fig. 6) demonstrate that the positive correlation between subsurface flow and slope is more pronounced in the overall flatter BJRB compared with the steeper NTRB. We will add more detailed discussions on these findings in the revised paper and include additional figures if necessary to further illustrate the relationship between subsurface flow and slope.

3. **The SHUD model outputs subsurface flow, which may include the flow (Q1, Q2, Q3) in three directions of the triangle (positive outward) and the sum/net flow in the three directions (Qs = Q1 + Q2 + Q3, or eleqsub = eleqsub1 + eleqsub2 + eleqsub3). Then, the water balance of the saturated zone of this unit should be dS = Q1 + Q2 + Q3. In the long-term trend, dS should be close to zero. Here, dS is equivalent to Qs (eleqsub). Therefore, subsurface flow should be the sum of positive flows or the sum of negative flows. If the authors**

directly use new-flow (Qs/eleqsub) in the calculation, it no longer conforms to the meaning of subsurface flow. For example, the flow rates of the three sides of a triangle are eleqsub1 = 200, eleqsub2 = 100, and eleqsub3 = -310, then eleqsub = 200 + 100 + (-310) = -10. It indicates that the unit gains 10 units of water. In this case, the flow rate at this unit should be 300 (200 + 100) or -310, but definitely not -10. Similarly, the calculation of surface runoff may have the same concerns. I suggest that the authors clarify the reading and processing of variables in the appendix or supplementary materials.

Firstly, we would like to thank the reviewer for the very clear and detailed explanation. We acknowledge the importance of accurately representing subsurface flow calculations to ensure our results are clear and understandable for readers. We will include a detailed explanation of the subsurface flow calculation method in the supplementary materials.

We recognize the concern regarding the use of the net flow value (e.g., -10) instead of positive or negative direction flows (e.g., 300 or -310). In this research, we use the net flow (eleqsub) to represent the water balance within the control volume. While this approach simplifies the explanation of subsurface flow dynamics, it aligns with our study's objective to examine broader hydrological trends and patterns rather than the detailed hydraulic dynamics within each mesh. As mentioned in Appendix B, page 21, line 418 of the manuscript, we only calculated the triangular meshes with a positive net flow, indicating subsurface or surface net outflow. This ensures our analysis focuses on areas contributing to water movement out of the system, consistent with our objective to better understand outflow behavior.

To address your suggestion, we will provide a detailed explanation of the variable reading and processing methods in the appendix or supplementary materials. This will clarify the rationale behind using net flow and discuss its implications.

4. **Parameter calibration is a very challenging task for any ISSHMs. Although your study uses manual parameter calibration, I strongly recommend that you share more calibration details/experiences so that others can learn from your work. For example, how were sensitive parameters determined? How were parameters adjusted to gradually approach the observed results? How was it determined that the current parameter set reached "optimal" or "usable" levels?**

We appreciate the suggestion to provide more details about the parameter calibration process.

First, regarding the identification of sensitive parameters, we combined our previous experience with ISSHM model calibration and referenced relevant literature to select the seven parameters listed in Table 3. For example, Liu et al. (2020) considered the impact of climate variations, aquifer thickness, unsaturated zone parameters (such as soil saturated hydraulic conductivity and VG parameters), aquifer parameters (unconfined and confined aquifer hydraulic conductivity), and surface water runoff parameters (the length of the flow path for runoff contribution to the overland flow domain) on stream baseflow. Their findings indicated that the unsaturated zone parameters and aquifer parameters had the greatest influence on ET and baseflow. In this study, we selected parameters from the unsaturated zone and aquifer categories. Additionally, we observed the results of changing individual parameters within the unsaturated zone or aquifer (setting a series of variations) to assess their impact on streamflow and baseflow. We found that changes in certain parameters had minimal impact, leading us to exclude the remaining parameters in these two categories. Ultimately, we identified the seven most sensitive parameters for further calibration.

The iterative adjustment process to align the simulation results with the observed results can be roughly divided into three stages:

- Coarse adjustment of streamflow: During this stage, we primarily referenced the monitoring results of streamflow. The goal was to align the trend, peak timing, and peak values of the simulation results with the monitoring results, even if the baseflow simulation results were not yet consistent with the observations.
- Fine adjustment of streamflow: In this stage, we focused on adjusting parameters related to the aquifer to ensure that the simulated baseflow process closely matched the monitoring results.
- Adjustment of groundwater tables: In the final stage, we aim to minimize extensive modifications to previously determined parameters, instead focusing on adjusting soil and aquifer parameters near the monitoring points.

Throughout all stages of iterative parameter adjustment, we referred to the empirical ranges of the corresponding soil or aquifer values and their relative magnitudes to ensure the reasonableness of the parameter values.

Regarding the criteria for determining the "optimal" or "usable" parameter set, after completing the third stage of calibration, we calculated the NSE index for the simulated and observed streamflow results. If NSE > 0.5 and the simulated groundwater tables were also within an acceptable range (assessed using expert judgment), we considered this parameter set usable. Otherwise, we repeated the second and third stages. By consistently considering the reasonable ranges of parameters and the relative magnitudes between different soil and aquifer layers throughout the iterative adjustment process, we ensured that the parameters meeting our criteria were all usable.

In the revised manuscript, we will include a comprehensive description of our manual parameter calibration approach.

5. **Although the authors have clarified the data sources of this study, I strongly recommend that the authors share the research data of this article (including model input files, model source code used to implement this study, and calibrated parameters) in an open database (such as Zenodo). Of course, you can desensitize or not share meteorological and hydrological data that are restricted by copyright or confidentiality clauses. Sharing this data can help other researchers replicate your work and further expand the impact of your work. This is just a suggestion.**

Thank you for your thoughtful suggestion regarding data sharing. We are happy to share the model input files, source codes, and calibrated parameters in open databases such as Zenodo. We believe that sharing these resources will help other researchers replicate our work and further expand the impact of our study.

References

Liu, H., Dai, H., Niu, J., Hu, B. X., Gui, D., Qiu, H., Ye, M., Chen, X., Wu, C., Zhang, J., and Riley, W.: Hierarchical sensitivity analysis for a large-scale process-based hydrological model applied to an Amazonian watershed, Hydrol. Earth Syst. Sci.,24, 4971–4996, https://doi.org/10.5194/hess-24-4971-2020, 2020.