This manuscript conducted a systematic projection on the runoff and cryospheric elements including glacier, snow and frozen soil in a typical mountainous catchment. Overall, the manuscript is well structured and written and easy to follow. It is suitable for publication in HESS, especially for this special issue. However, I would like to point out two major concerns regarding the uncertainty and reliability of the results

Reply: We thank Referee #1 for positive remarks about the manuscript's structure and suitability for publication in HESS. Regarding the concerns about uncertainty and reliability of the results, we will address these issues in the following ways and will detail them further in the revised manuscript.

The FLEX-Cryo model is an extension of the FLEX-Topo-FS model by coupling the Δh-parameterization method to estimates the evolution of glacier. Firstly, similar to the FLEX-Topo-FS model, we followed the same top-down approach to construct the model: data analysis → qualitative perceptual model → quantitative conceptual model → testing of model realism, which means the model structure is consistent. The parameters were carefully selected through the Generalized Likelihood Uncertainty Estimation (GLUE) method and have been robustly validated in the study by Gao et al (2022) study. No new parameters were introduced in the FLEX-Cryo model compared to the FLEX-Topo-FS model, maintaining the reliability previously established by Gao et al. (2022). Therefore, the results of the FLEX-Cryo are reliable.

The Global Climate Models (GCMs) were selected based on the previous validated studies. Despite inherent regional simulation uncertainties associated with each GCM, we have applied widely used statistical downscaling, bias calibration, and equal-weighted average methods to mitigate these uncertainties. By using well-validated GCMs and the widely used procedures for refining their outputs, we have enhanced the reliability of the FLEX-Cryo model results.

In conclusion, we are confident that the model's calculations are reliable, and that we have effectively managed the associated uncertainties. These verification details will be incorporated into the revised manuscript.

1. The model validation is poorly conducted. Although the authors claimed that the parameters are adopted from a previous study in this catchment, some results related to model performance should be presented to show the confidence of model. If I understand correctly, the model in this study is the combination of the model in Gao et al. (2022) and the Δh-parameterization. Isn't there new parameter brought by this module compared to the previous version? Could the -Cryo model simulate something that cannot be simulated by -FS model, and if so, how does the model perform on simulating this additional objective? It is rather easy to simulate the relative change of glacier thickness, but simulating the absolute thickness of glacier is difficult, which significantly influences the conclusions such as the time glacier will disappear. So, again, please present some results to show reliability of glacier simulation. Even though

all the simulations are the same with -FS model, some results need to be provided to show the confidence of model.

Reply: Thank you for your constructive feedback. We acknowledge the importance of thoroughly validating the FLEX-Cryo model and will include additional verification in the revised manuscript.

As clarified above, the FLEX-Cryo model integrates the robust FLEX-Topo-FS framework with the Δh-parameterization method, enabling it to simulate not only glacier melt and runoff from glacial regions but also the evolution of glacier characteristics, including changes in glacier area and thickness, and their hydrological impacts. The 11 parameters deployed in this study were selected using GLUE and validated by Gao et al. (2022), while the remaining parameters were determined based on prior research and empirical measurements. Importantly, this model does not introduce new parameters.

To address your specific concerns, we will present additional results, including Figure 5(b), which depicts the prediction of actual glacier thickness changes at the highest elevation band. This figure represents absolute glacier thickness changes, rather than relative changes, providing a clearer insight into the model's capability to simulate critical glaciological variables that influence projected timelines for glacier disappearance.

2. The uncertainty issue is addressed inadequately, although the authors mention it in the limitation section. I understand that this study aims to perform a systematic projection on the mountain cryosphere and hydrology, thus does not discuss much about the uncertainties of model parameter and GCM bias correction. However, I think the authors should at least report the uncertainties from different GCMs, given that eight GCMs are adopted for climate projection. The uncertainty range should be provided for the values in the main text (e.g., L304~314) and Figures (e.g., Figure 4).

Reply: This is a very good suggestion. Indeed, each GCM in CMIP6 demonstrates varying simulation capacities across different regions, resulting in a spectrum of uncertainties. We will quantify and report these uncertainties from the eight GCMs used for climate projection to provide a more comprehensive understanding of the potential variability in our results. In the revised manuscript, we will include an uncertainty range for the values discussed in the main text and depicted in figures (e.g., Figure 4).

Other specific issues:

1. Please adjust the paragraph format to justified.

Reply: We will do this in the revised manuscript.

2. Please provide a table to list the meaning of all the variables in Table 3 and Figure 3, to make them easier to find.

Reply: We will do this in the revised manuscript.

3. There are many GCMs in CMIP6. Why are these eight GCMs selected?

Reply: The eight GCMs are all models that have been well validated in the adjacent catchments by previous studies. We will add this reason for the selection of these eight GCMs in the revised manuscript.

I suggest the authors to reconstruct the Methodology section to make it more readable. It would be better to introduce the model first, and then introduce the spatial discretization of the catchment (the first paragraph of the current Methodology section), because the elevation band and HRU is the simulation unit of the model. Besides, more details of Δh-parameterization method need to be provided in the 3.1.1 section. The current description is too general, which is difficult to understand for a reader not familiar with this method.

Reply：This is a really good advice and we agree with you. The introduction of the model belongs to the construction of conceptual model and the spatial discretization is the part of procedural model. According to the construction principle of the hydrological model (Beven, 2012), the conceptual model building precedes procedural model. In our revised manuscript, we will adjust the structure of the Methodology section accordingly. The Δh-parameterization method is the key for the extension of the FLEX-Topo-FS model to FLEX-Cryo model and it is also the core module for calculating the glacier evolution. Detailed description of the Δh-parameterization method will be added in the revised manuscript.

4. Why a single value is provided for some parameters in Table 2, but a range is provided for others?

Reply： This is a very good question. The parameters for FLEX-Cryo model are the selected optimal results based on the study Gao et al (2022) using GLUE method. The parameters with range value are the parameter uncertainty range which is also list in Gao et al (2022). The single value is determined based on the previous study and measurement. The parameters presented with a single value were determined based on previous study by Gao et al. (2022) and field measurements, reflecting the most suitable values for these parameters within our specific catchment context. The parameters provided as a range represent the uncertainty bounds identified in the study by Gao et al. (2022). To avoid confusions, we will add a new table to list the optimal parameters and add more necessary explanations in the revised manuscript.

Reference:

Beven K., Rainfall-Runoff Modelling: The Primer, 1–23, https://doi.org/10.1002/9781119951001.ch1, 2012.

Gao, H., Han, C., Chen, R., Feng, Z., Wang, K., Fenicia, F., and Savenije, H.: Frozen soil hydrological modeling for a mountainous catchment northeast of the Qinghai–Tibet Plateau, Hydrol. Earth Syst. Sci., 26, 4187–4208, https://doi.org/10.5194/hess-26-4187-2022, 2022.