Reviewer 1

Thank you for inviting me to re-review the paper: "Historical and Projected Future Runoff over the Mekong River Basin" by Wang et al.

I am impressed with the level of detail and responses to the last set of requests. I can also see that the replies to Reviewer 2 are thoughtful and comprehensive.

Response: We appreciate the reviewer's positive feedback and insightful suggestions, which are very helpful for us to improve the manuscript.

I think the paper is broadly ready to be published. However, the authors might like to consider improving (or expanding) just slightly more the important conclusions of the new paragraph (in Discussion) starting "This study systematically analyses the performance and uncertainty of runoff simulations from five GHMs driven by four GCMs….".

My interpretation of this paragraph is that it is slightly easier to constrain GHMs than GCMs, because GHMs can be forced offline with known climatological data and their performance analysed compared to river flow records. However, ESMs have substantial differences, both for the contemporary periods and indeed for their projections of future change. The authors might like to write a little more on how to, potentially, overcome inter-ESM uncertainty. The points to raise are:

(1) For the contemporary period, it is possible to weight ESMs by various statistics (such as the properties of rainfall projections at their gridboxes along the Mekong River). Once a weighting is made, this could also be used to weight future projections by different ESMs. However, the risk with this is that an ESM that performs poorly in the current climate might be very accurate at projecting key changes in near-surface meteorology.

(2) The other option always open to refining future projections is the Emergent Constraints (EC) method. To be useful in the context of Mekong River runoff, then their needs to be a quantity X across ESMs that links to a further quantity Y in the future (i.e., inter-ESM, there is a regression between X and Y). Then, if measurements are available of quantity X – which again might be a statistic of rainfall affecting runoff – then the regression can be used to refine important variable Y. There are many papers on ECs that might help – e.g., the review of Hall et al "Progressing emergent constraints on future climate change".

I am happy for the paper to now be accepted. However, the authors might like to include some of the above with a slightly expanded Discussion section. This will point readers to future analyses/research that may remove some of the uncertainty ranges identified in the current Wang et al manuscript.

Response: Thank you very much for your helpful suggestions. As you noted, the aim of this paragraph is to illustrate that uncertainty between GCMs could introduce uncertainty into future runoff projections. To address this, we have calculated the mean and standard deviation of several GCM-driven GHM simulation results, allowing us to reduce and assess the uncertainty. This is a common practice for reducing uncertainty among models, known as "model democracy" (Taylor et al., 2012; Collins et al., 2013). Your constructive suggestions are thoughtful and valuable, and the approaches you mention can hopefully further reduce uncertainty (Knutti et al., 2017; Brient, 2019; Hall et al., 2019; Schlund et al., 2020; Yang et al., 2017). Although comparing the effectiveness of different approaches in reducing uncertainty is beyond the scope of our current manuscript, additional elaboration on these approaches may be helpful in subsequent analysis/research to further reduce the uncertainty identified in our current work. Following your recommendations, we have supplemented this paragraph with additional information on promising practices for reducing uncertainty in GCMs. The detailed additions and revisions we have made to the manuscript are shown in red font below:

"*This study systematically analyses the performance and uncertainty of runoff simulations from five GHMs driven by four GCM ...... At the same time, the standard deviation of runoff results from the GHM driven by different GCMs can be used to quantify the uncertainty in future runoff projections. This approach gives equal weight to each GCM, often referred to as "model democracy", and has been widely used in climate impact assessments (Taylor et al., 2012; Collins et al., 2013). Another approach that can potentially reduce uncertainty is a weighting scheme that considers the performance of the GCMs (Knutti et al., 2017; Yang et al., 2017). The GCMs are weighted by different statistics in the past or present, and the weighting coefficients are applied to the future projections of the GCMs. However, there is a risk that a GCM that performs poorly in the current climate may perform better when environmental conditions are beyond the contemporary range of change (Yang et al., 2017). It is worth mentioning that a novel and promising approach to constrain uncertainties is the emergent constraints (ECs). The EC approach consists of statistical (emergent) relationships between an observable quantity (X) in the past or present climate and a quantity (Y) related to the future climate across GCMs (Brient, 2019; Hall et al., 2019; Schlund et al., 2020). Combining emergent relationships with observations can potentially reduce uncertainty in future projections, and several published ECs have shown us positive effects (Schlund et al., 2020; Shiogama et al., 2022). We encourage further experimentation with various approaches, including those described above, to overcome the uncertainty among GCMs in the MRB.*"

References

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