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Interactive comment on "Intensification characteristics of hydroclimatic extremes in the Asia monsoon region under 1.5 and 2.0 °C of global warming" *by* Jeong-Bae Kim and Deg-Hyo Bae

Anonymous Referee #2

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Overview

The manuscript presents an analysis of likely changes in future temperature, precipitation, and runoff extremes over different climatic regions of Asia. Climate projections are obtained from a suite of climate models and a hydrologic model is used to translate climate to runoff. While the manuscript addresses a topic of relevance to the journal, it has several major shortcomings that prohibit readers from interpreting the results and gauging their reliability. These are listed below:

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Discussion paper

1. Novelty: There are several studies that discuss the consequences of 1.5°C and 2.0°C global warming on hydrology of river basins across the globe. A number of such analyses are cited in the paper but some significant research is not discussed. For example Betts et al. (2018) discuss the difference between the two global warming levels in terms of hydrologic extremes as well as food security. Similarly, Doll et al. (2018) employ two hydrologic models and an ensemble of bias corrected climate models to understand how freshwater related hazards are likely to change across the globe under the two warming levels. A number of similar studies can be found. The authors need to justify how their analysis adds value to this literature. A statistical analysis of expected changes is useful but these numbers need to be eventually translated into variables that have direct impact on society (such as food availability, flood hazard, etc.). Perhaps the authors can provide some policy relevant insights to the readers, for example, by suggesting how the adaptive measures will vary across different climate regions.

2. Methodology: There are a number of issues here:

a. Climate data: the analysis involves a number of steps and the text is a little hard to follow in this regard. For example, to select the five GCMs, a comparison with a multi-model mean is carried out (Page 3, line 117). But why are GCMs selected on the basis of their performance w.r.t the ensemble mean? Why not directly compare the individual GCM performance with the observed data and select those that best represent the observed climate in the Asia region? It is later revealed that a bias-correction is also carried out on the climate data. Was this bias correction carried out before or after the shortlisting of the five GCMs? Overall, the sequence of methods is unclear and many methodological choices are not defended well in the text. Maybe a flowchart to guide the readers through the main steps will help.

b. Hydrologic model and runoff projections: the variable infiltration capacity model is a commonly used model to obtain continental to global scale runoff projections. However, many studies limit their analysis to understanding patterns in mean annual runoff. In this study, however, the focus is on runoff extremes, which are inherently harder to

capture than a long-term mean value. However, the calibration and validation of the model are not included in the main manuscript. A regionalization approach is used to transfer parameters from gauged to ungauged sites, but how successful was this? It is important to show that the model with the regionalization scheme can capture the observed hydrologic extremes in the past. Only then, we can have some confidence regarding the reliability of the projections in the future.

c. Choice of extreme indices: The choice of indices for precipitation and runoff seem counter-intuitive. The precipitation indices focus on only high precipitation events while the runoff indices focus on both high and low events. Why not include precipitation extremes that involve minimum or very low precipitation?

d. Selection of time periods: A time sampling method is used to identify the time period of analysis for various GCMs. The authors arrive at single time period for each GCM-warming level. This suggests that a spatially aggregated value of climate indices was used to identify the time periods. However, the analysis focuses on different climate regions and it is possible that each climate region reaches a global warming level in different time periods. Why was this spatial heterogeneity ignored? The same applies on the bias correction methodology, which could have been applied on each homogeneous climate region one by one. On a similar note, the climate zone classification results are presented in Line 206 onwards. Is this classification carried out using observed data or GCM data? How sensitive is the classification to the choice of climate data?

e. Choice of scenarios: it is not clear why RCP4.5 was chosen for the analysis when RCP6.0 and RCP8.5 are equally relevant.

3. Presentation: Overall, the manuscript can gain from improvement in language. In addition, the figure clarity can be improved. The figure captions are not very descriptive and it is hard to follow what is on the figures without carefully reading the main text. Please explain all symbols and abbreviations used in the figures in the caption itself.

References Betts, Richard A., Lorenzo Alfieri, Catherine Bradshaw, John Caesar, Luc Feyen, Pierre Friedlingstein, Laila Gohar et al. "Changes in climate extremes, fresh water availability and vulnerability to food insecurity projected at 1.5 C and 2 C global warming with a higher-resolution global climate model." Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 376, no. 2119 (2018): 20160452. Döll, Petra, Tim Trautmann, Dieter Gerten, Hannes Müller Schmied, Sebastian Ostberg, Fahad Saaed, and Carl-Friedrich Schleussner. "Risks for the global freshwater system at 1.5 C and 2 C global warming." Environmental Research Letters 13, no. 4 (2018): 044038.

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