

Reply on AC1

Anonymous Referee #1

Referee comment on "Characterizing basin-scale precipitation gradients in the Third Pole region using a high-resolution atmospheric simulation-based dataset" by Yaozhi Jiang et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-103-RC2>, 2022

Thank you for the quick response. The responses to all comments look great to me, except for the RPG problem. I don't think the explanation of systematic bias can solve the problem. Before I state my reasons, I will just give my suggestion: the authors can include both relative and absolute precipitation gradients and thoroughly discuss absolute VS relative gradients in the manuscript. The current manuscript only has five figures presenting the quantitative results (Figures 2 to 6). I believe as a research article, it has enough room to include more results which will make this paper more interesting and informative. The comparison between absolute and relative gradients can partly solve the concerns, considering gradients from ERA5_CNN contain large uncertainties in the third pole.

The authors' explanation is that the systematic bias can be expressed as the relative bias (i.e., a fraction of precipitation amount), which is relatively uniform in different regions of the TP. Therefore, it is appropriate to calculate RPG. However,

- The experiments in my previous comments are not answered. RPG from different datasets/regions/periods is not comparable. For example, for cases where RPG1 from ERA5_CNN and RPG2 from rain gauge data are the same, we cannot say RPG1 is perfect or not because ERA5_CNN and RPG2 could have different mean precipitation. On the other hand, if RPG1 and RPG2 are different, it is still possible that ERA5_CNN captures the correct gradient pattern. Besides, the signs of RPG under/over estimation could be different from under/over estimation of absolute precipitation gradients, making the results-based RPG less reliable. Due to this problem, evaluation of ERA5_CNN using rain gauge data and comparing gradients in different regions of the third pole in the manuscript could be meaningless using RPG.
- There is no evidence that the relative bias is uniformly distributed in space. Relative bias is affected by many factors particularly in the large scale, while precipitation amount is just one of those factors. Actually, if relative bias can be so easily estimated, bias correction should be an easy task such as in the third pole, but the reality is that researchers are struggling with bias correction in complex terrain. I believe the authors hope that the RPG calculated in this study can be applied in other situations, but if the RPG is built on assumptions with large uncertainties, the application of RPG will be risky.
- The definition of bias is unclear. In evaluation studies, the relative bias is calculated

against the reference dataset such as ground observations, but the calculation of RPG in this study is against the target dataset ERA5_CNN. I don't know how large the impact is, but this can weaken the reliability of RPG. For example, for a mountain slope, ERA5_CNN has low precipitation (P1) in low elevation and high precipitation (P2) in high elevation, I expect that P1 is more reliable than P2 because models are less reliable in high elevation. Using the method in this study, we can calculate RPG1 in low elevation and RPG2 in high elevation. Comparing the quality of RPG1 and RPG2 is cumbersome because we don't know the direction (over or underestimation) of P1 and P2. Of course, this problem also affects absolute gradients, but after normalizing using P1 and P2, this problem becomes too complex.

In summary, the concept of RPG has many limitations in theory. In the future, if you or other researchers have a better dataset than ERA5_CNN in the third pole, it is almost impossible to compare their RPGs considering their mean precipitation could be different.