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.

General response: We sincerely thank the reviewer for spending lots of time on helping us improve the work. The suggestion including both absolute and relative precipitation gradients is pretty good, which can make this manuscript more informative. Therefore, we will present absolute precipitation gradients in the revised manuscript. In addition, we will introduce more details about the evaluations and biases of ERA5_CNN and discuss the uncertainties in both absolute and relative precipitation gradients in the revised manuscript to amplify our work. Responses to specific comments are detailed below and we will include more details during our revision.

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,

1. 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.

Response: As we have not fully understood this comment, here we clarify why we present RPG in this study in another way, which will be added as the background in the revised version.

It is common to interpolate precipitation in complex terrain with station data at lower elevations. In this case, the interpolation may be conducted with either PG or RPG. If both PG and RPG are accurate, the interpolation results should be the same. So, the question is: can RPG be estimated more easily than absolute PG? If RPG can be estimated more stably, then RPG is favorable; if absolute PG can be estimated more stably, then absolute PG is favorable. The biases in the precipitation mean of the dataset will propagate to the interpolation results when using the absolute precipitation gradients because the absolute precipitation gradients contain the biases from both mean and spatial variability of precipitation. As shown in Figure R1, HAR V2 with high precipitation amount generally has large absolute precipitation gradients. However, if two datasets have similar spatial variability but different means of precipitation (as ERA5_CNN and HAR V2 in Figure R1), they will have similar RPGs. Thus, using RPGs can partly eliminate the influence of biases in precipitation mean on interpolation results and is favorable.

In the previous comment, the reviewer gave an example that the same RPG value will lead to different absolute gradients when datasets with different mean precipitation are used, accordingly, the reviewer said that RPG cannot provide useful information about the absolute precipitation variability. **In reality, the differences in absolute precipitation gradients were caused by the differences in precipitation mean, rather than RPG.**

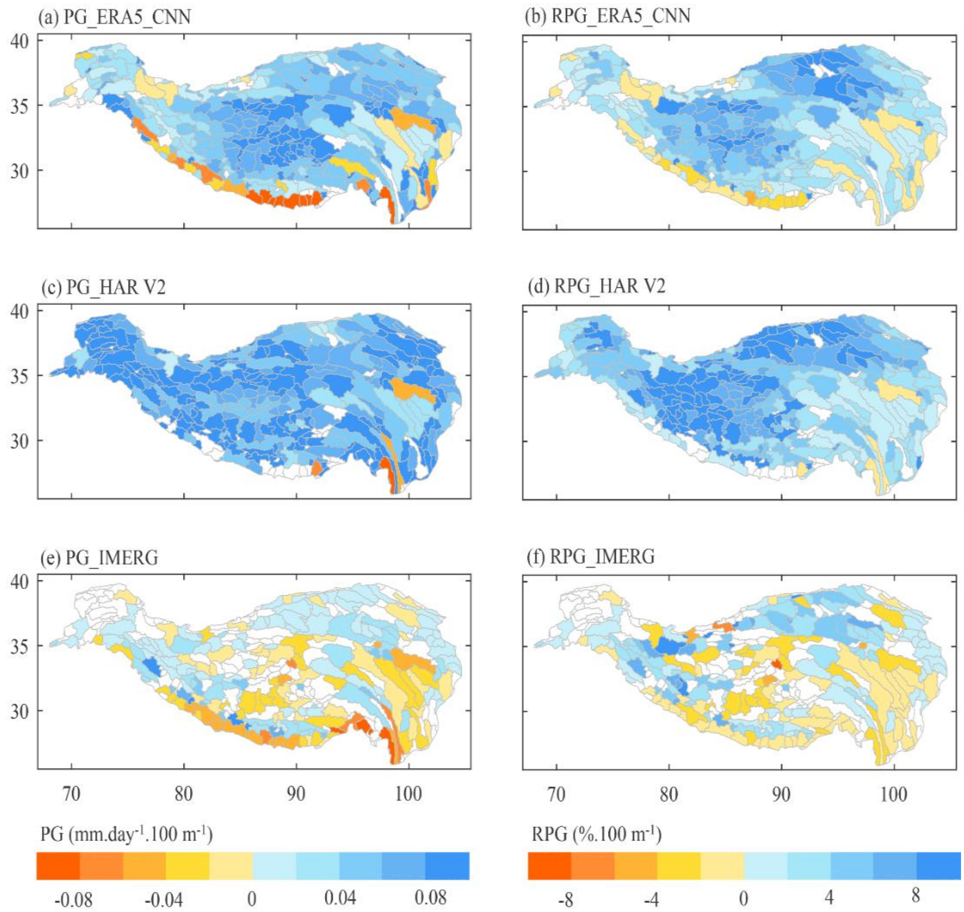

Figure R1 Spatial pattern of absolute precipitation gradients (PG; left panel) and relative precipitation gradients (RPGs; right panel) from ERA5_CNN, HAR V2 and IMERG. The precipitation gradients were calculated using average annual precipitation from 2008 to 2018.

2. 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.

Response: We don't intend to say the results presented in this manuscript is the accurate one but we believe it is a forward step toward understanding the precipitation distribution in this region with complex terrain. As demonstrated in Figure R2, the value of Coefficient of Variation (CV, defined as the ratio of the standard deviation to the mean of a set of samples, which is used to measure the degree of dispersion of a set of samples) for relative biases over the TP is 1.2, while it is 1.6 for absolute biases (a smaller CV value means less dispersion). Therefore, the relative biases are relatively uniform in space when compared with the absolute biases; in other words, using RPG can more reliably describe precipitation gradient. Nevertheless, we agree with you that the relative biases in ERA5_CNN vary in space and that biases in ERA5_CNN will result in uncertainties in RPG and will discuss the uncertainties in the revised manuscript.

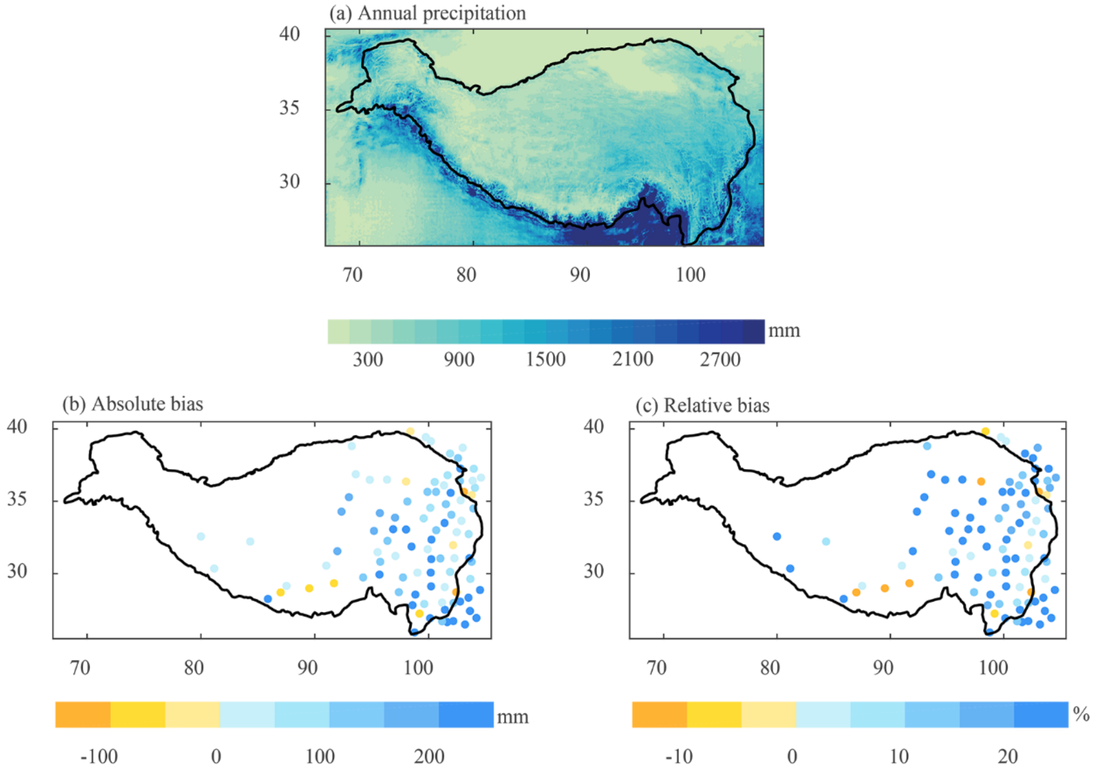

Figure R2 Distribution of (a) averaged annual precipitation (mm), (b) absolute bias (mm) and (c) relative bias (%) in ERA5_CNN during the period from 1980 to 2018.

3. 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 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.

Response: We need to clarify the wet bias of ERA5_CNN in the manuscript. It is expected that precipitation from interpolation of gauge observations or satellite-gauge merged products have small biases in low altitudes but large biases in high altitudes because rain gauges are usually located at low altitudes and have poor spatial representativeness. In our study, the ERA5_CNN is used, which is an atmospheric model-based dataset and is not corrected with rain gauge data. Constrained by the physical consistency of the atmospheric model, it is expected that ERA5_CNN generally shows consistent overestimation or underestimation at different altitudes in a basin. Aa shown in Figure R2, ERA5_CNN overestimates precipitation at most rain gauges over the TP, but

ERA5_CNN is skillful in representing the spatial variability of precipitation. As shown in Figure R3, ERA5_CNN presents more fine spatial structure of precipitation on the edge of the TP compared with IMERG. Moreover, the atmospheric model-based ERA5_CNN and HAR V2 can better represent precipitation distribution in the Karakorum of the western TP where high amount of solid precipitation is dominated, which was demonstrated in the work of Li et al. (2020, Characterizing precipitation in high altitudes of the western Tibetan plateau with a focus on major glacier areas. Int. J. Climatol. 1–14.). In general, although ERA5_CNN is biased, so far it is perhaps the best choice to characterize the precipitation gradients over the TP. In the revised manuscript, we will introduce more about the evaluation and biases in ERA5_CNN.

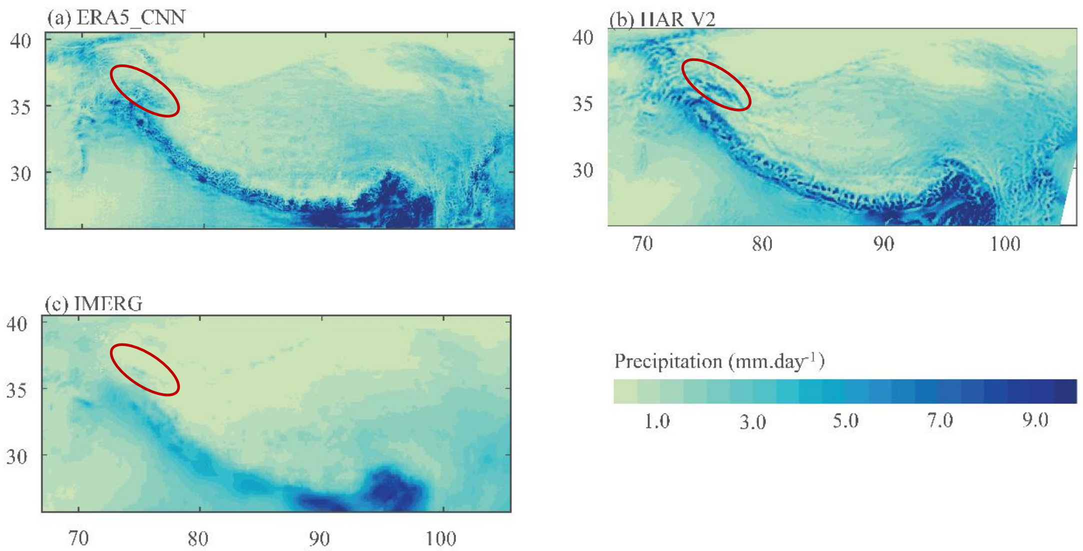

Figure R3 Spatial pattern of annual average precipitation from (a) ERA5_CNN, (b) HAR V2 and (c) IMERG during 2008-2018. The red ovals represent the western TP where solid precipitation is dominated. This Figure will be added to the revised manuscript.