General response: We sincerely thank the reviewer for the comments, which are helpful for us to improve the quality of this manuscript. The main concern of the reviewer is why the relative precipitation gradient (RPG) rather than the absolute precipitation gradient was presented. In the manuscript, the systematic bias of precipitation in ERA5_CNN is not well described, which may have misled the reviewer. **Actually, this "systematic bias" is the bias relative to the precipitation amount (in other words, its unit is percentage but not mm).** The justification is detailed below, which will be added to the coming revised manuscript. Brief responses to other comments are also listed below and further revisions will be given in the revised manuscript. We hope these responses have addressed all your concerns.

1. RPG problems

The definition of relative precipitation gradient (RPG) in Equation (2) is problematic from my perspective. There is no obvious linkage between precipitation intensity and precipitation gradient because precipitation gradient is just a spatial pattern no matter how large the mean value is (e.g.,1 0 or 1000). The authors state that RPG is used because ERA5_CNN has systematic bias in the TP. The most common systematic bias is overestimation or underestimation. If we assume the spatial distribution of overestimation or underestimation is even (cases with uneven distributions are more complex), the precipitation gradient has nothing to with the magnitude of precipitation, which means the normalization operation in Equation (2) is meaningless. Actually, the normalization could be harmful. For example, Let's assume a is 0.2 mm/m and P is 2 mm/day according to ERA5_CNN. Then, RPG=a/P=0.2/2 = 0.1. If we have another dataset which could have similar spatial distribution with ERA5_CNN but an overestimation bias. Let's say its P=4 mm/day. According to results from this study, the gradient for this new dataset will be 0.1 X 4 =0.4, which is incorrect. I can imagine that this simple example could be quite common in applications motivated by this work. The RPG problem could also result in wrong comparison between different products. For example, when comparing ERA5_CNN and gauge data in a basin, RPG cannot provide useful information. Even the RPG values of the two products are the same, their absolute precipitation gradients are often different because their mean precipitation is different. Similarly, even the RPG of a product is biased, its absolute precipitation gradient could be correct. Therefore, the use of RPG does not make sense.

Besides, I recommend the authors also present absolute precipitation gradient. RPG maps cannot show the impact of atmosphere vapor. For example, large RPG may

happen in dry basins, but its significance could be weaker compared to relatively smaller RPG in wet basins where precipitation amounts and bias are larger.

Response: Thanks for your comments! **The reviewer assumes that the systematic biases in precipitation dataset have the same absolute value in different altitudes or regions. In reality, we have assumed that the relative bias in precipitation is systematic.** We are sorry that the description about this assumption is not well clarified in the manuscript. In general, locations with large precipitation amounts tend to have large absolute values of bias and vice versa. For example, Gao et al. (2015, Evaluation of WRF mesoscale climate simulations over the Tibetan Plateau during 1979-2011. J. Clim. 28, 2823–2841) showed that the absolute values of bias are large in wet regions and small in dry regions of the Tibetan Plateau. This is also demonstrated in our evaluation results (Figure R1b). Accordingly, the relative bias is relatively uniform in different regions of the TP (Figure R1c). We will give more introduction about the systematic bias in ERA5_CNN in the revised manuscript.

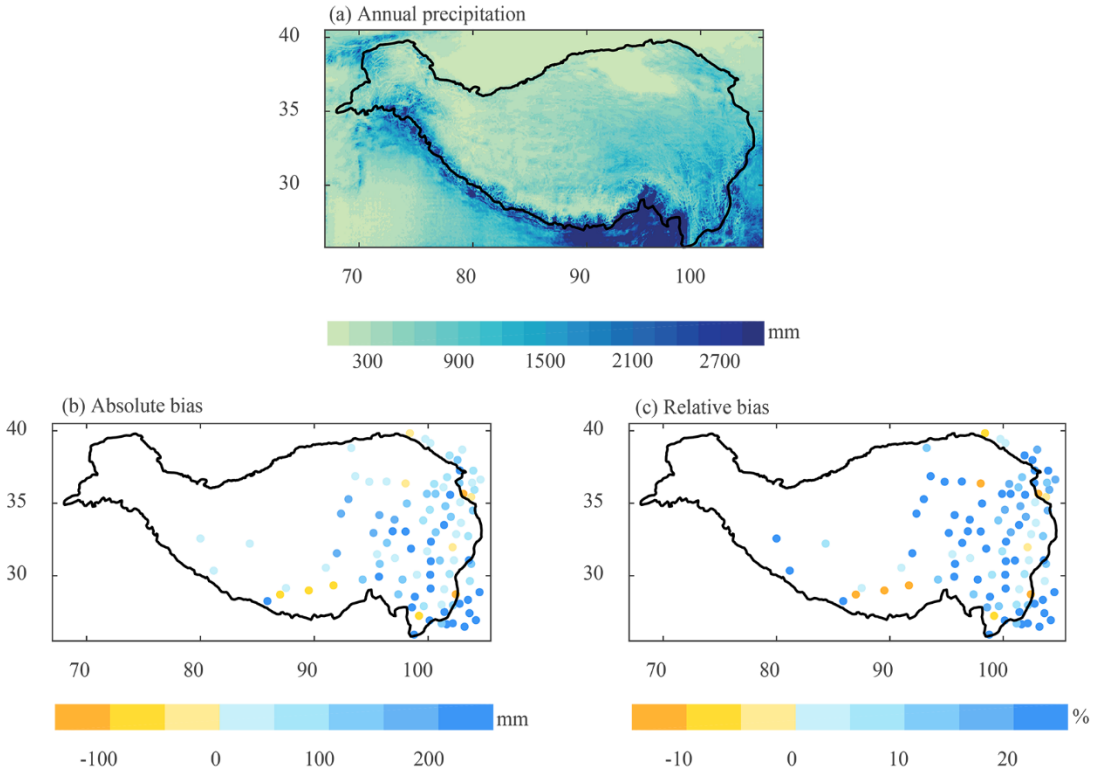

Figure R1 Distribution of (a) averaged annual precipitation (mm), (b) absolute bias (mm) and (c) relative bias (%) in ERA5_CNN during the period from 1980 to 2018.

Given that the relative biases are relatively uniform, it is appropriate to calculate the relative precipitation gradients (RPG). For example, there are two points, A (with actual precipitation amount of P_1 and altitude of H_1) and B (with actual precipitation amount of P_2 and altitude of H_2). Given that ERA5_CNN has the same relative bias of 10% at the two points, the precipitation amount in ERA5_CNN at A and B are $P_1 \times (1 + 10\%)$ and $P_2 \times (1 + 10\%)$, respectively.

The RPG derived from ERA5_CNN is

$$RPG = \frac{[P_2\times(1+10\%)-P_1\times(1+10\%)]/(H_2-H_1)}{[P_2\times(1+10\%)+P_1\times(1+10\%)]/2} = \frac{(P_2-P_1)/(H_2-H_1)}{(P_2+P_1)/2},$$

which is the **same** as that calculated from the actual precipitation.

Therefore, we presented the relative precipitation gradients in the manuscript.

2. Atmospheric model still has large bias in complex terrain including the study area which is also acknowledged in this study. This problem needs more discussion.

Response: Thanks for the comment! We will include more discussions about the uncertainties in atmospheric models in the revised manuscript.

3. The discussion between the relationship between precipitation and wind speed can be further improved. They are both aspects of air mass movement which is affected by both atmosphere and topography. If you try to investigate the causality (e.g., some sentences in abstract and discussion parts), you should go further. High or low wind speed is also the result of various environmental factors.

Response: This is a very good suggestion! We absolutely agree that orography has impacts on the spatial variability of both precipitation and wind speed. In the revised manuscript, we will discuss the relations between precipitation gradients and wind speed/relative humidity within different sub-regions of the TP that may have diverse orography.

4. Section 2.1: what's the time period of the 1/30-degree WRF simulations? Since ERA5_CNN is taken from Jiang et al. (2021), it is recommended to introduce more method and evaluation details in the manuscript.

Response: The 1/30-degree WRF simulations cover the whole years of 2013 and 2018. We will add more details about the production and evaluation of ERA5_CNN in the revised manuscript.

5. Section 2.2 introduces IMERG and HAR V2 which should be in “Section 2.1 Precipitation Datasets”.

Response: Thanks for the suggestion. We will move them to Section 2.1.

6. Equation (1): units of P and H are needed.

Response: The units of P and H are “mm” and “100 m”, respectively. We will add them in Equation (1).

7. Line 145-149: This description has a logical problem. It is stated that “the precipitation gradient is estimated only when the following three principles are met” and the third principle is “(3) the p-value of the Student’s t-test for the regression equation should be less than 0.05”. But you cannot know p-value without estimating precipitation gradient. Please revise this sentence.

Response: Thanks for pointing out this unclear description. Actually, we first fit the regression equation at each sub-basin, then, the Student’s t-test for the regression equation is conducted. If the p-value of the Student’s t-test is less than 0.05, the slope of the fitted line is treated as the precipitation gradient, otherwise, the precipitation of the sub-basin is filled with a missing value. We will revise this sentence as “The value of precipitation gradient for a sub-basin is given only when the following three principles are met: 1) the number of grids within the sub-basin should not be less than 10; 2) the standard deviation of altitude within the sub-basin should not be less than 50 m; 3) the p-value of the Student’s t-test for the regression equation should be less than 0.05.”

8. Figure 2: I suggest adding rain gauge number of different elevation bands.

Response: We will add the number of rain gauges in each elevation band in Figure 2.

9. Is Tibetan Plateau a more suitable word compared to “Third Pole”? Tibetan Plateau is clearer as a geographical concept.

Response: Our study region covers a wide region, including Pamir and Hindukush. This region is now called Third Pole.

10. The writing and presentation of the manuscript can be further improved.

Response: Thanks for the suggestion！ We will thoroughly revise and edit the language

of the manuscript.