Response to Reviewer #1 comments

We thank the reviewers for their time in reviewing the manuscript. Those comments are valuable and helpful to improve the manuscript. We have considered the comments very carefully and made revisions to the manuscript. We hope our revision could satisfy your requirements and meet your approval. Our point-by-point replies to the comments and suggestions are described as below.

Comment 1

p1l11: "proposed" better present tense?

Response:

Thank you for your useful advice. We have revised it. Please see line 11 in page 1 (red color).

Comment 2

p2l2: which challenges and problems?

Response:

Thank you for your very valuable and careful advice. These problems mean advantages of gauge data and RADAR. We think the description “These problems can be effectively resolved by using satellite remote sensing techniques” may not make logical sense. Thus, we removed this sentence, which will not result in inconsistency of the context.

The main problem is no dense and high-quality gauge network to evaluate RADAR data. Because RADAR has high resolution, there is always no gauge located within the pixel. It is difficult to get the answer how good are RADAR estimates and its full structure of the error distribution.

Comment 3

fig1: c is unclear what can be seen there

Response:

Thank you for your useful advice. We have revised it. Please see figure 2.

Comment 4

p3l19ff: the matching is not decribed, what means matching how is it done? Formula?Is that Quantile mapping?

Response:

Thank you for your very valuable advice. It is very significant to improve our paper. CDF matching belongs to quantile mapping. CDF matching relates one variable (Tb in our study) to reference (precipitation in our study) using same cumulative frequency. We used figure and formula to explain the CDF matching.

Specifically, the matching process is shown as figure 2 (Reference represents precipitation rate; variable represents Tb). The matching process is implemented by a one-to-one mapping CDF of variable onto that of the reference (Equation 5). We have added the description of the CDF matching in the manuscript and equation 5, and revised figure 2. Please see line 5~6 in page 5 (red color) and figure 2.

The matching process of Tb and CMORPH is decripted in line 11~15 in page 6 (red color).

Thanks again for your valuable advice.

Comment 5

p4l11: ..behind [the] downscaling.

Response:

Thank you for your useful advice. It has been revised. Please see line 25 in page 5 (red color).

Comment 6

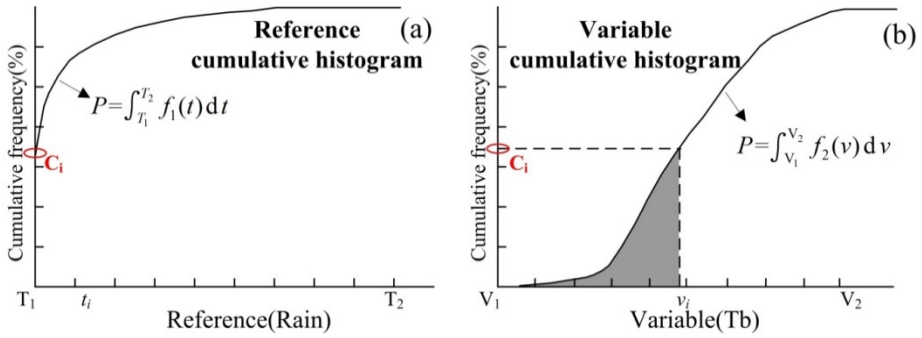
p4l28ff: sentence is unclear, what is a non-raining frequency?

Response:

Thank you for your very valuable advice. It is very significant to improve our paper. “a non-raining frequency” is an unclear expression. Here, it means the frequency of critical value of rain rate when rain rate is less than the value, it would not rain. As shown in figure below, the rain–no-rain threshold is set at about v_i where the cumulative frequency equals C_i.

Specially, all precipitation rate (Tb) are sorted in ascending (descending) order. Then cumulative probability distributions are both obtained. The cumulative probability is defined as critical probability when precipitation rate equals zero. The rain-no-rain threshold is the Tb with cumulative probability same as the critical probability. As shown in Fig. 2c and 2d (T means precipitation rate; V represents Tb), the rain–no-rain threshold is set at about v_i where the cumulative probability equals C_i (critical probability).Please see line 11~15 in page 6 (red color).

Thanks again for your valuable advice.



Comment 7

p5l20 and p6l2: A variogram

Response:

Thank you for your useful advice. We have revised them. Please see line 8 and line 9 in page 7 (red color).

Comment 8

p5l21: (Matheron,..)

Response:

Thank you for your useful advice. We have revised it. Please see line 9 in page 7 (red color).

Comment 9

Chapter 2.3 and 2.4 also fig 3, tab.1 are well known scores and techniques maybe you skip them.

Response:

Thank you for your useful advice. We have removed chapter 2.3, also fig 3 (Schematic of the variogram curve), tab.1 (Contingency table for the definition of the categorical metrics).

Comment 10

Fig4: please exclude the islands with climate situations 8 and 9 from the map. The status of these territories are unclear.

Response:

We used the distribution of average annual precipitation during 1960~2010 as base map because it is an most important factor for selecting evaluation regions. Please see figure 1.

Comment 11

Fig5: is again a processing scheme, maybe it is better to make one out of fig2 and fig5, if you change the order of chapter 2 and 3 you can combine chapters 3.3 and 2.2

Response:

Thank you for your so careful and valuable advice. We agreed with you. New figure 3 was made combing fig2 and fig5. We have changed the order of chapter 2 and 3. We first introduced study areas and datasets (chapter 2), and then the methodology (chapter 3). We have combined chapter 3.3 and 2.2 into 3.2.

Comment 12

p7: I found to0 much information in chapter 3.2.2 maybe you short it and only refer to the 2 or 3 most important references.

Response:

Thank you for your useful advice. We agreed with you. We have removed some redundant description. We think these description are better in discussions. Please see line 3~9 in page 10 (red color).

Comment 13

p8l15: [the] image ....definitely needs language editing

Response:

Thank you for your so careful and useful advice. We have revised the description. Please see line 4~6 in page 7 (red color).

Comment 14

fig7: inscribe, which picture is cmorph data and which dcdf, and which picture belongs to which region, maybe confusing or unclear for the reader.

Response:

Thank you for your useful advice. We have revise figure5. Please see fig.5.

Comment 15

p9l7ff: please write sill, range when necessary instead of d and c+c0

Response:

Thank you for your useful advice. We have revised them. Please see line 7, 8 an 15 in page 8 (red color).

Comment 16

p9-10l32ff: Fig 10, according to the shown events the conclusion is not significant, the better fit of dcdf at gauge scale may be pure luck.

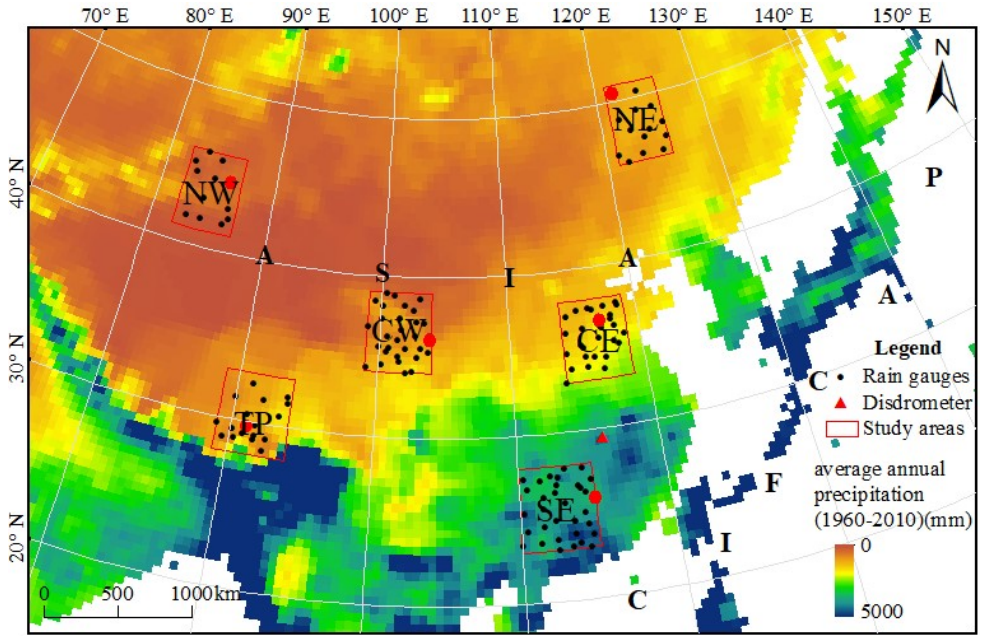
Response:

Thank you for your very valuable advice. It is very significant to improve our paper. It is difficult to validate the representativeness of the selected gauge (point) (red dots in figure below) in every region. We just selected these six gauges because their annual precipitation almost equal to average precipitation over area in respective region.

We have compared the DCDF, CMORPH and gauge for all gauges. You are right that not all the fit of DCDF at gauge scale is better than CMORPH. The result showed that the better fit between DCDF and gauge than that between CMORPH and gauge is 10%. The nearly equivalent fit is 69%. The poorer fit is 21%, and mainly happened in region NW, CW and TP.

We have revised the description in our results (Please see line 32 in page 8 and line 1~5 in page 9) (red color), and conclusions (Please see line 23~24 in page 11) (red color).

Thanks again for your valuable advice.



Comment 17

p10l11ff: the bad performance of the approach in winter was something i except reading your methods. How are the correlations between tb and rain in teh winter months?

Response:

The table below gives R^2 in four seasons. The most average of R^2 are higher than 0.90 for six regions in four seasons. The maximum CC is higher than 0.98. Most of the minimum R^2 is higher than 0.80 in summer and autumn. Minimum R^2 ranges from 0.60 to 0.89 in spring, and from 0.51 to 0.71 in winter. It showed that Tb had relatively poor correlation with precipitation rate in winter. This result may inferred that the bad performance of the approach in winter is mainly caused by low accuracy of CMORPH, which may be also applicable for dry regions and mountainous or hilly areas.

Time		SE	CE	NE	CW	NW	TP
SP	Mean	0.91	0.97	0.96	0.98	0.97	0.98
	Max	0.99	0.99	0.99	0.99	0.99	0.99
	Min	**0.64**	0.89	**0.60**	0.83	**0.73**	**0.78**
	Std	0.05	0.02	0.04	0.01	0.02	0.02
SU	Mean	0.92	0.96	0.96	0.97	0.99	0.97
	Max	0.98	0.99	0.99	0.99	0.99	0.99
	Min	0.84	**0.77**	0.85	0.86	0.97	0.86
	Std	0.03	0.03	0.02	0.03	0.00	0.03
FA	Mean	0.97	0.97	0.97	0.97	0.88	0.98
	Max	0.99	0.99	0.99	0.99	0.99	0.99
	Min	0.82	0.89	0.87	0.86	**0.64**	0.94
	Std	0.04	0.03	0.03	0.02	0.11	0.01
WI	Mean	0.92	0.92	0.89	0.95	0.92	0.97
	Max	0.99	0.99	0.99	0.99	0.99	0.99
	Min	**0.65**	**0.51**	**0.60**	**0.71**	**0.58**	**0.69**
	Std	0.07	0.07	0.09	0.04	0.07	0.03

Comment 18

p10l13: rain-no-rain threshold, where is this threshold defined? how large is threshold?

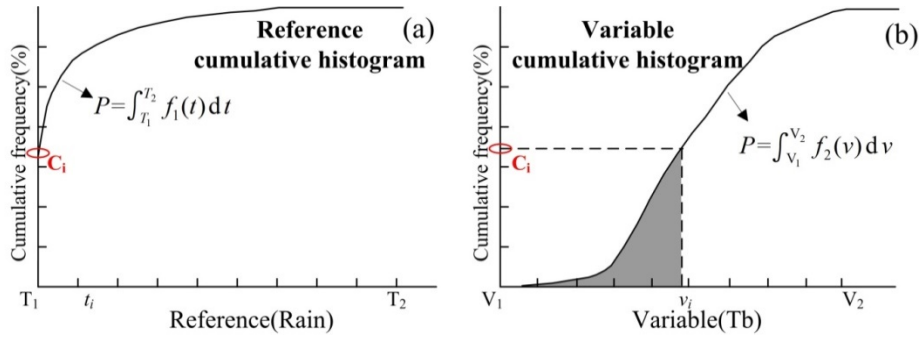
Response:

Thank you for your very valuable advice. I am sorry I didn't explain it clearly. All precipitation rate (Tb) are sorted in ascending (descending) order. Then cumulative probability distributions are both obtained. The cumulative probability is defined as critical probability when precipitation rate equals zero. The rain-no-rain threshold is the Tb with cumulative probability same as the critical probability. As shown in figure below, the rain–no-rain threshold is set at about vi where the cumulative frequency equals Ci. Please see line 11~15 in page 6 (red color).

The threshold generally ranges from 190K to 270K, and most thresholds fall between 200K and 250K. As examples in fig5, the probability of precipitation rate was the largest for a given Tb in region SE, followed by region CE and then region NE. The

rain-no-rain thresholds for regions CW and NW were approximately 230 K, while 254K for region TP. The probability of precipitation rate was the largest for a given Tb in region TP.

Thanks again for your valuable advice.



Comment 19

p10l15: what is meant by complex rain systems?

Response:

Thank you for your very helpful advice. I am sorry I didn't describe it exactly. It means orographic rain systems over mountainous or hilly areas. We have revised this sentence. Please see line 16 in page 9 (red color).

Comment 20

p12l3f: I don't agree with that. the method has problems with, heavy rain (cold, tall clouds), with complex rain systems? and in winter.

Response:

Thank you for your very valuable advice. This description is not accurate. We have revised it. The DCDF reflected more detailed moving and changing processes of rainfall under the condition that DCDF perform better than or nearly equivalent to CMORPH. Please see line 17~18 in page 11 (red color).