Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-56-AC1, 2020

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Hydrological evaluation of open-access precipitation data using SWAT at multiple temporal and spatial scales" *by* Jianzhuang Pang et al.

Jianzhuang Pang et al.

zhanghl@bjfu.edu.cn

Received and published: 19 May 2020

Response to Comments:Reviewer#2

We sincerely appreciate your time and comments on our manuscript. We both thank the positive remarks and the specific concerns, which provide guidance to improve the manuscript. Please see the bellowing point-to-point responses to the main concerns and minor revisions.

General comments: This paper presents a hydrological evaluation of two open-access precipitation products (CHIRPS and CPC) compared with rain gauge dataset, at multiple temporal and spatial scales. The content of this research is of great interest to readers of watershed hydrology, remote sensing, and satellite meteorology, since it provided valuable suggestions for researchers in these fields, especially for hydrologic modelers. It is demonstrated by the authors that, even with obvious statistical differences, performances of the three selected precipitation datasets in simulating water yield are parallel. Comparably, inconsistency were found when OPPs and rain gauge data were used to simulate hydrological components, e.g. Surface runoff, lateral flow, and base flow. Inner mechanism was highlighted from both spatial and temporal scales. Overall, this manuscript is quite well written and presented. Minor revision comments below aim to improve the quality of the manuscript.

Authors' response: Thank you very much for your comment and encouragement. And we greatly appreciate your suggestions which provide great suggestions to improve the manuscript.

Specific comments:
1. The spatial resolutions of CHIRPS (0.05°) and CPC (0.5°) were higher than that of the geographic datasets, "some of the grid records are potentially missed, especially for the high - resolution CHIRPS products." Duan Z et al. (2019) proposed an area-weighted method to calculated precipitation for each subbasin, "Calculate the area-weighted average daily CHIRPS data (after disaggregated by 10 times (0.005°)) from all grids within the subbasin to represent the effective daily precipitation for each subbasin". This might be an alternative way to solve the data problem.

Authors' response: Greatly appreciate your suggestion. Following this advice, we recalculated the precipitation inputs for each sub-basin via "area-weighted" (AW) method, and compared the results with those derived by "Nearest Distance" (ND) adopted in this manuscript. Take the sub-basin No.411, which is located at Beibei hydrological station, as an example, the calculated precipitation inputs by the above two methods were depicted in Fig. 1. It's shown in Fig. 1 that no significant difference (P = 0.88) were detected by using these two methods. Compared with the ND method, the amount of rainfall obtained by AW method is slightly underestimated (*PBIAS* = -0.78%), especially when the rainfall intensity is between 50 mm and 100mm. Both methods slightly increase the uncertainty of precipitation inputs. Considering the effectiveness in producing peak discharges of streamflow in SWAT model, the ND method in the original manuscript is adopted. Actually, the "potentially missed" grid records mainly refers to CHIRPS products. More than 10000 grids within the JRW or nearby were adopted, which is much higher than that of the CPC (˜165 grids) and rain gauges (20 stations). Considering that the "missed" grids could be covered by other grids within the same sub-basin due to the high resolution of CHIRPS.

Figure 1. plot of the CHIRPS precipitation comparing between Nearest Distance method an

Therefore, to avoid misrepresentation of data accuracy, the manuscript will be revised as follows (**line 177 to line 178**):

L177-178 – "Using this method, some of the grid records are potentially missed, especially for the high-resolution CHIRPS products." Will be revised as "Using this method, the grid records of high-resolution CHIRPS products within the same sub-basin will be uniformly assigned the grid value closest to the centroid, which will offset the high resolution advantage of CHIRPS products."

2. Moriasi et al. (2007), cited by the author, used three indicators RSR (ratio of the root mean square error to the standard deviation of measured data), NSE, and PBIAS to establish a model to evaluate performance level, while the author used only two. Why not use all three metrics? Besides, since only the NSE index was graded into different evaluation levels, was the evaluation on model performance reliable without the evaluation grades from other two indicators?

Authors' response: Greatly appreciate the comment. After an extensive literature review on model evaluation system, we followed the suggestion and adopted all three indicators to evaluate the performance of the hydrologic models with different precipitation datasets. The *RSR* indicator incorporates the benefits of error index statistics and includes a scaling/normalization factor, so this statistic indicator can be applied to various scale and object.

RSR value: observations standard deviation ratio (*RSR*) is an error index statistic between the OPPs and Gauge datasets. Root mean square error (*RMSE*) divided by *STD* values would derive the *RSR* value. *RSR* has a ranges from 0 to ∞ with 0 as the optimal value. The calculation equation is expressed as follows:

$$RSR = \frac{RMSE}{STD} = \frac{\sqrt{\sum_{i=1}^{n}(S_i - Q_i)^2}}{\sqrt{\sum_{i=1}^{n}(S_i - \overline{S})^2}}, \quad (4)$$

The models' performances were classified using *RSR*, *NSE*, and percentage bias (*PBIAS*) values defined by Moriasi et al. (2007), which are shown in Table 2. And the evaluation results by using all three metrics at monthly and daily scales were depicted in Table S1 and Table S2, respectively.

Comparably, in the original manuscript, like most existing papers did (Zhu et al., 2015; Tuo et al., 2018; Duan et al., 2019), only *NSE*, *CC*, and *PBIAS* were adopted to evaluate the simulation performance of hydrologic models. But they did not give a classified evaluation of the simulation results. When we used only *NSE* to classify the simulation performance of the model, as presented in the original manuscript, the evaluation results are "Very good" for all three models at the monthly scale, but when we used three indicators to evaluate, CPC only reached the level of "Good" (Table S1.).

Table 2. General performance ratings statistics recommended by Moriasi et al. (2007).

Performance Rating	*RSR*	*NSE*	*PBIAS*
Very good	$0.00 < RSR \leq 0.50$	$0.75 < NSE \leq 1.00$	$PBIAS \leq \pm 10$
Good	$0.50 < RSR \leq 0.60$	$0.65 < NSE \leq 0.75$	$\pm 10 < PBIAS \leq \pm 15$
Satisfactory	$0.60 < RSR \leq 0.70$	$0.50 < NSE \leq 0.65$	$\pm 15 < PBIAS \leq \pm 25$
Unsatisfactory	$RSR > 0.70$	$NSE < 0.50$	$PBIAS > \pm 25$

Table S1. Evaluation results of monthly scale SWAT model

		Calibration			Validation	
	Gauge	CHIRPS	CPC	Gauge	CHIRPS	CPC
RSR	0.28	0.42	0.36	0.36	0.49	0.46
NSE	0.92	0.82	0.87	0.87	0.76	0.79
PBIAS (%)	7.9	2.3	10.8	1.2	-6.6	4.2
Evaluation	Very good	Very good	Good	Very good	Very good	Very good

Table S2. Evaluation results of daily scale SWAT model

		Calibration			Validation	
	Gauge	CHIRPS	CPC	Gauge	CHIRPS	CPC
RSR	0.52	0.67	0.67	0.53	0.69	0.63
NSE	0.73	0.55	0.55	0.72	0.53	0.6
PBIAS (%)	5.1	-1.7	19.9	0.2	-12.2	9.9
Evaluation	Good	Satisfactory	Satisfactory	Good	Satisfactory	Satisfactory

Duan, Z., Tuo, Y., Liu, J., Gao, H., Song, X., Zhang, Z., Yang, L., and Mekonnen, D. F.: Hydrological evaluation of open-access precipitation and air temperature datasets using SWAT in a poorly gauged basin in Ethiopia, J. Hydrol., 569, 612-626, https://doi.org/10.1016/j.jhydrol.2018.12.026, 2019.

Tuo, Y., Marcolini, G., Disse, M., and Chiogna, G.: A multi-objective approach to improve SWAT model calibration in alpine catchments, J. Hydrol., 559, 347-360, https://doi.org/10.1016/j.jhydrol.2018.02.055, 2018.

Zhu, H., Li, Y., Liu, Z., Shi, X., Fu, B., and Xing, Z.: Using SWAT to simulate streamflow in Huifa River basin with ground and Fengyun precipitation data, J. Hydroinform., 17, 834–844, https://doi.org/10.2166/hydro.2015.104, 2015.

3. Explain what "The correlation coefficients' spatial variation" is? The spatial correlation of the three precipitation datasets should be a value rather than a graph. Explain how Fig. 8 was calculated and obtained. Explain why distinguish average precipitation in daily and monthly scales?

Authors' Response: Thanks a lot for the question. Basically, the term "correlation coefficients" (CC_{sub}) refers to the correlation between two OPPs and Gauge at either daily or monthly scales for each sub-basin. "The correlation coefficients' spatial variation" is the variation of CC_{sub} in different sub-basins. The calculation steps of CC_{sub} are as follows. Firstly, the spatial distribution diagrams of Gauge records and the two OPPs are calculated. The correlation coefficient for each sub-basin between the Gauge series and OPPs series is calculated by using the correlation coefficient method. Coefficients for the all 414 sub-basins will form a spatial distribution plot of the correlation coefficients. Fig. 8 aims to distinguish the correlation of rainfall amounts in different sub-basins, and to preliminarily judge the performance of OPPs in different sub-basins, especially at different time scales. Distinguish average precipitation at daily and monthly scales are important, since the difference in precipitation amount statistics may highly resulted in different modelling performance and inner mechanics of hydrologic processes. Actually, the *CC* values between spatial-aggregated CPC and Gauge records are higher than that of CHIRPS and Gauge at both scales, yet the *CC* values at the monthly scale are much higher than that at daily scale. Similar variation regularity was found in spatial distribution, which was described in Fig. 8. However, *CC* values between CPC and Gauge are smaller than that of CHIRPS and Gauge at a portion of sub-basins, which was explained at **line313** to **line315** in manuscript:
"Spatially, the higher CC values between the Gauge and CPC at the monthly scale are mainly distributed in areas with comparably low or high rainfall amounts, such as Wudu and Wangyuan. Yet, the CC value was less relevant in areas with moderate rainfall (e.g., Suining), compared with to that of the Gauge and CHIRPS."

The manuscript will be accordingly revised as follows (**line313** to **line315**):

Original version:
L311-315 – "The correlation coefficients' spatial variation between the Gauge and OPPs at monthly and daily scales are illustrated in Fig. 8. Overall, the monthly scale *CC* values (with a rang of 0.7 1) are comparably larger than that of the daily scale values (with a rang of 0.5 0.7). Spatially, the higher *CC* values between the Gauge and CPC at the monthly scale are mainly distributed in areas with comparably low or high rainfall amounts, such as Wudu and Wangyuan. Yet, the *CC* value was less relevant in areas with moderate rainfall (e.g., Suining) relative to that of the Gauge and CHIRPS."

Revised version:
"The *CC*, STD_n, and *RSR* values of precipitation spatial distribution between CHIRPS and Gauge are 0.89, 0.96, and 0.55, respectively, and 0.82, 0.87, 0.62 between CPC and Gauge, respectively. These statistics indicate that both CHIRPS and CPC estimates can describe the spatial distribution of precipitation in JRW, among which CHIRPS depicts better performance. The correlation coefficients between the Gauge and OPPs at monthly or daily scales for every sub-basin are illustrated in Fig. 8. Overall, the *CC* values at monthly scale (with a rang of 0.7 1) are comparably larger than that of the daily scale (with a rang of 0.5 0.7). Spatially, the higher *CC* values between the Gauge and CPC at the monthly scale are mainly distributed in areas with comparably low or high rainfall amounts, such as Wudu and Wangyuan. Yet, the *CC* value was less relevant in areas with moderate rainfall (e.g., Suining), compared with to that of the Gauge and CHIRPS.

Minor revisions:

1. Double-check: L11- “Jiang River”. L114- “larges” should be “largest”. L299- “varations” should be “variations”.

Authors’ Response: Thanks a lot for pointing out the typos, and we will make revisions all through the revised manuscript.

L11 – “the **Jiang** River Watershed (JRW)” will be corrected as “the **Jialing River** Watershed (JRW)”

L114 – “the **larges** drainage area” will be corrected as “the **largest** drainage area”

L299 – “Spatial **varations**” will be corrected as “Spatial **variations**”

Other typos in the paper will be also revised, which are listed as below:

L214 – “**base flow**” will be revised as “**baseflow**”

L218 – “**by pass**” will be revised as “**bypass**”

2. Grammar errors. L98- The verb “have” should be “has”. L92- The article “an” here should be “a”. L310- "relative" should be "relatively".

Authors’ Response: Thank you very much for pointing out the grammar errors, and we will correct them as follows:

L98 – “**have** not been fully investigated.” will be corrected as “**has** not been fully investigated.”

L92 – “Bai & Liu (2018) used **an** HIMS model . . .” will be corrected as “Bai & Liu (2018) used **a** HIMS model. . .”

L310 – “the overall precipitation values estimated by the CHIRPS are **relative** higher” will be corrected as “the overall precipitation values estimated by the CHIRPS are **relatively** higher”

3. L342 & L360-361 unit of CC should be decimal rather than percentage.

Authors’ Response: Thank you so much for the suggestion.

L342 – “The spatial correlation between WYLD and precipitation for rainfall for the Gauge, CHIRPS, and CPC products reached **84.8 %, 84.3 %, and 90.84 %**, respectively.” will be corrected as “The spatial correlation between WYLD and precipitation for rainfall for the Gauge, CHIRPS, and CPC products reached **0.85, 0.84, and 0.91**, respectively.”

L360-361 – "The it CC values between the WYLD and precipitation for Gauge, CHIRPS, and CPC at the daily scale are **83.45 %, 84.41 % and 91.70 %**, respectively, . . ." will be corrected as "The *CC* values between the WYLD and precipitation for Gauge, CHIRPS, and CPC at the daily scale are **0.83, 0.84 and 0.92**, respectively, . . ."

4. L257-As IPCC reported, "Extreme rainfall" was defined as the 95th percentile of daily precipitation data. Therefore, Fig.3, shown as monthly rainfall box chart, failed to capture "extreme rainfall values"

Authors' Response: Thanks a lot for the comment and suggestion.

The term "extreme rainfall" here means that estimation of Gauge monthly rainfall in the rainy season (especially in July) is significantly higher than that of the other two OPPs. For better interpretation, the term will be revised as:

L257 – "Fig. 3 shows that **the extreme rainfall values** captured by Gauge are higher than those of CHIRPS and CPC." will be revised as"Fig. 3 shows that **the rainfall values in the rainy season (especially in July)** captured by Gauge are higher than those of CHIRPS and CPC."

5. L327-Usually we use "validation" instead of "verification".

Authors' Response: Thank you very much for your advice, and we will revise this term into validation all through the manuscript:

L327 – "Moriasi et al. (2007), all three models, each using a different precipitation product, achieved "very good" performance for both the calibration and **verification** periods, . . ." will be corrected as "Moriasi et al. (2007), all three models, each using a different precipitation product, achieved "very good" performance for both the calibration and **validation** periods, . . ."

L336 – "CPC showed significant overestimation in 2017 and 2018 during the **verification** period." will be corrected as "CPC showed significant overestimation in 2017 and 2018 during the **validation** period."

6. L451- "although they performed slightly better at the daily scale." the model should perform better at the monthly scale?

Authors' Response: We apologize for this error, and we will revise it as follows:

L451 – "although they performed **slightly better** at the daily scale." will be corrected as "although they performed **slightly worse** at the daily scale."

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-56, 2020.

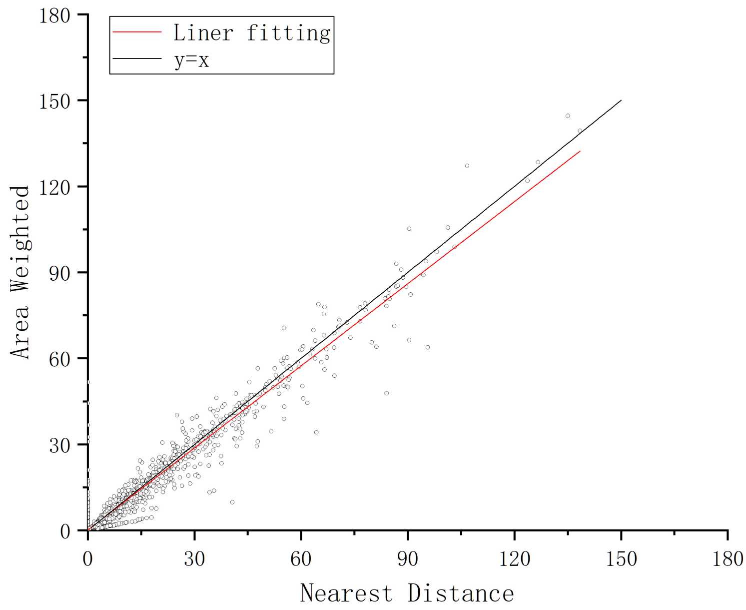

Fig. 1. Scatter plot of the CHIRPS precipitation comparing between Nearest Distance method and Area Weighted method.