

Author response to reviewer's comments

On behalf of myself and the co-authors, I take the opportunity to thank the anonymous reviewers for his/her constructive comments, questions and editions. We have responded to all questions and comments, as discussed below. Most of the given comments and suggestions by the reviewer were relevant, and accordingly we have updated the manuscript significantly. We feel the quality and readability of the paper have been improved significantly.

Reviewer #1

Authors conducted a comprehensive evaluation of eight remote sensing rainfall products over T-A basin. It is an important step before applying remote sensing rainfall in hydrologic and/or agricultural application. However, the quality of this manuscript should be further improved to meet the criteria of HESS. My main concerns are listed as:

Response: The authors would like to thank the anonymous reviewer for his/her essential comments and suggestions. All given comments and suggestions helped us to improve the readability of the paper. Detailed responses to each specific issues and concerns of the reviewer are given as follows.

1. The independent of gauged rainfall to satellite rainfall. As we know, authors are also mentioned that satellite products like TRMM are calibrated by gauged rainfall at monthly scale. Therefore, authors are required to identify whether the 34 station were used by satellite rainfall products or not. If used, what kind of impact should be anticipated?

Response: We agree with the reviewer that the gauged rain fall from the ground stations used for evaluation should be independent of the gauged rainfall used for calibration of satellite rainfall. The result of the comparisons can be misrepresented if the same ground rainfall data is used in both calibration of the satellite product and performance evaluation. To avoid such problems, all rain gauge networks applied for the comparison are independent of the Global Precipitation Climatology Centre (GPCC) networks used for calibrations of the satellite products. The manuscript is then improved accordingly.

2. Some similar and new references are missed. Recently, several papers discussed the topography impacts on the satellite rainfall in mountainous regions, such as Tibet (Xu, 2017) and Mekong(He, 2017; Wang 2017), as:
–Xu R., F. Tian, L. Yang, H. Hu, H. Lu, and A. Hou (2017), Ground validation of GPM IMERG and TRMM 3B42V7 rainfall products over southern Tibetan Plateau based on a high-density rain gauge network, *J. Geophys. Res. Atmos.*, 122, doi:10.1002/2016JD025418.
–He, Zhihua, Long Yang, Fuqiang Tian, Guangheng Ni, Aizhong Hou, Hui Lu. Intercomparisons of Rainfall Estimates from TRMM and GPM Multisatellite Products over the Upper Mekong River Basin. *JOURNAL OF HYDROMETEOROLOGY*, 18:413-430.

–He, Zhihuiij NHongchang Hu, Fuqiang Tian, Guangheng Ni and Qingfang Hu. Correcting the TRMM rainfall product for hydrological modelling in sparsely-gauged mountainous basins. *Hydrological Sciences Journal*, 2017 VOL. 62, NO. 2, 306–318.

–Wang, Wei, Hui Lu, Tianjie Zhao, Lingmei Jiang, Jianchen Shi, Evaluation and Comparison of Latest GPM and TRMM Products over Mekong River Basin, *IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING*, 10(6), 2540–2549, DOI:10.1109/JSTARS.2017.2672786, 2017.

Response: The authors would like to thank the reviewer for his/her updating us on the recent and similar references. These papers were helpful to discuss and improve our manuscript. Such references are now included in the paper.

3. GPM is not used in this study, but it should be introduced in the introduction part, as it is the state-of-art satellite rainfall product.

Response: we agree with the reviewer that the Global Precipitation Measurement (GPM), which was developed based on the success of TRMM and released since 2014 could also a good option over the basin. However, selected satellite products in this study were based on availability of long-term data and their common application in Africa which the GPM lacks to be included in our study. Even though not included in the comparison, we have introduced it in the introduction as per the reviewer's suggestion.

4. Information of eight products. It is recommended to include more details information of these eight products, since it would help to explain the different performances of them.

Response: We agree with the reviewer that including more detailed information on each satellite product would help to understand their performance. To this effect, we have improved the descriptions and content of information for each product in the document. Moreover, several references are also included to refer readers for further detail explanations of these products.

5. In evaluation statistics: it is recommended to use relative RMSE, and please use RRMSE to evaluate the performance of the eight products. A Taylor diagram may be a good choice for comprehensive evaluation.

Response: We agree that the RRMSE is also one of the statistical indices for measuring of disagreement between predicted values against a given reference values which signifies a smaller discrepancy relative to the predicted values. The RMSE also indicates the discrepancy between observed and forecasted values. Smaller value of both RMSE and RRMSE indicates a better agreement between observed and forecasted. In the same way, both measurements are limited to assessing the errors between observed and predicted, but they cannot tell how accurate the products are. The RMSE and MAE are the two most commonly recommended measures for assessing the predicted accuracy (Chai and Draxler, 2014; Bayissa et al., 2017; Krause et al., 2005). The RMSE has an advantage of showing bigger deviations and helps to provide a complete picture of the errors distribution. Moreover, majority of recent published papers on satellite rainfall validation

(e.g. Gebremicael et al., 2014; Hu et al., 2014; Behringi et al., 2017; Worqlul et al., 2014; Guo et al., 2014, Dembele et al., 2016; Jiang et al., 2012) including papers suggested by the reviewer (He et al., 2017; Xu et al., 2017) have applied RMSE instead of RRMSE to measure the errors. Given its most commonly applied error measurement tool in satellite rainfall validation studies, we feel that replacing RMSE by RRMSE will not have a significant change in the result of the study.

6. P11, L12-14, if authors want to compare the performance in wet months with that in dry months, please show the PBIAS, RRMSE, R of different period. Then, we can quantitatively evaluate the performance.

Response: We agree with the reviewer that including quantitative explanation will help to elaborate the differences between dry and wet seasons. Quantitative values of these performance indicators are already summarized in Table 4. Moreover, Fig. 3 and Fig. 7 also explains how accurate these products are across all months of the year. However, to make it more clear for readers quantitative examples are now included in the discussion text document and the manuscript is improved accordingly.

7. More discussion about why chirps outperforms others is needed! Why CMAP and GPCP are worst? Related to resolution?

Response: Better performance of CHIRPS is due to its high spatial resolutions and the efforts made to consider topographic effects comparing to the remaining products. Another possible reason could be due to the fact that these products are linked to their embedded bias correction that relies on rain gauge data. Poor performance of CMAP and GPCP is due to the smaller spatial resolution which is at 2.5° compared to other products (less than 1° for all products). Various studies (e.g. Xie and Arkin, 1997; Feidas, 2010, Dinku et al., 2007) also showed that the CMAP and GPCP product suffers from inhomogeneity in addition to its coarse spatial and temporal resolutions. Such explanations are also included in the main document.

8. P6, L9-11, please confirm which version of TRMM is used. If it is 3B42V7, it is not necessary to introduce 3B43 here.

Response: Thank for your suggestion. We have used TRMM (3B42V7) and no need of to mention 3B43 here. This has also modified in the manuscript accordingly.

9. P6, L11-19, it is better to change the order of these two paragraphs

Response: Thank you for your suggestion and the paragraphs are now shifted each other.

10. P6, L17-18, please define the abbreviation of PM, IR, METEOSAT

Response: These abbreviations are now defined in the first sentences of the document.

11. P11, L31, similar findings from Xu et al (2017) in Tibet. –Xu R., F. Tian, L. Yang, H. Hu, H. Lu, and A. Hou (2017), Ground validation of GPM IMERG and TRMM 3B42V7 rainfall

products over southern Tibetan Plateau based on a high-density rain gauge network, *J. Geophys. Res. Atmos.*, 122, doi:10.1002/2016JD025418

Response: This reference is included in the mentioned sentences

12. P13,L24, remove “of the rain”

Response: removed

Reference:

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