Author response to reviewer's comments

On behalf of myself and the co-authors, I take the opportunity to thank the anonymous reviewers for their constructive comments, questions and suggestions. We have responded to all questions and comments, as discussed below. Most of the given comments and suggestions were relevant, and we have updated the manuscript accordingly. We think the quality and readability of the paper have improved significantly compared to the previous version.

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:

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, to give sensible results of evaluation, the rainfall data from the ground stations should be independent of the ground data used for calibration of satellite products. In fact, all rain gauge networks data used in this study for the comparison are independent of the Global Precipitation Climatology Centre (GPCC) networks used for calibrations of the satellite products. We have amended the text accordingly in Section 2.2.1. "It is to be mentioned that, the selected rain gauge networks are independent of the Global Precipitation Climatology Centre (GPCC) networks used for calibration of satellite products."

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, Zhihuaïij 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 valuable suggestions of recent literature on the subject. We have incorporated these references at the respective places within the Manuscript: Xu, 2017; He et al., 2017 and Xu et al., 2017 in Section 1

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 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. However, we have introduced it in the introduction part paragraph 2.

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 have improved the descriptions and content of information for each product in the manuscript, as given in Section 2.2.2. Moreover, several references are also included to refer for further readings about 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 disagreement between datasets. But we think that RMSE is more commonly used in satellite rainfall data validation studies, than RRMSE. Furthermore, replacing RMSE with RRMSE will not have a significant change in the result of this study.

   The RMSE and MAE are the two most commonly used 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 the bigger deviations and provides a complete picture of the errors distribution. Similar relevant studies used RMSE to validate satellite datasets, including, but not limited to: 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; He et al., 2017; Xu et al., 2017.

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: Quantitative values of these performance indicators for wet and dry seasons are already summarized in Table 4. Moreover, Fig, 3 and Fig.7 also explain how accurate these products are across the months of the year. However, to make seasonal comparison more clear, we have added quantitative examples in the discussion, given in Section 4.1 of the manuscript. We have added “For example, CHIRPS and TRMM products perform better in dry season with PBIAS of 10 and 27 compared to -17 and 8 during the wet season.

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

Response: We think the better performance of CHIRPS is due to its high spatial resolution and consideration of topographic effects. Another possible reason could be due to the fact that this product is linked to its embedded bias correction that relies on rain gauge data. Poor performance of CMAP and GPCP is due to the coarse spatial resolution (2.5^o) compared to the other products (less than 1^o for all products).

Some studies, e.g., Xie and Arkin (1997), Feidas (2010), Dinku et al. (2007) also showed that CMAP and GPCP products suffer from inhomogeneity in addition to their coarse spatial and temporal resolution. We have added the explanations in the manuscript at Section 4.2.

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: We have used TRMM (3B42V7). We have modified the text in the manuscript accordingly, Section 2.2.2 and Table 1.

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

Response: We have changed the order of paragraphs as suggested, Section 2.2.2.

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

Response: Abbreviations are now defined in the first sentences of the document, as Passive Microwave (PM), Infrared (IR)

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: Thanks for the suggestion, this reference is included in the manuscript, in Section 1.

12. P13,L24, remove “of the rain”

Response: removed

Reference:

Bayissa, Y., Tadesse, T., Demisse, G., & Shiferaw, A.: Evaluation of Satellite-Based Rainfall Estimates and Application to Monitor Meteorological Drought for the Upper Blue Nile Basin, Ethiopia. *Remote Sens*., 9(7), 669, 2017.

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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, 2017.

Worqlul, A, Maathuis, B., Adem, A. A., Demissie, S. S., Langan, S., & Steenhuis, T. S.: Comparison of rainfall estimations by TRMM 3B42, MPEG and CFSR with ground-observed data for the Lake Tana basin in Ethiopia. *Hydrol. Earth Syst. Sci., 18*(12), 4871-4881, 2014.

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