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Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Performance of GPM-IMERG precipitation products under diverse topographical features and multiple-intensity rainfall in an arid region" *by* Safa A. Mohammed et al.

**Husain Najafi (Referee)**

husain.najafi@ufz.de

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Three different products of Global Precipitation Measurement - Integrated Multi-satellitE Retrievals from Global Precipitation Measurement (GPM-IMERG) are compared to a reference rainfall dataset in the Kingdom of Saudi Arabia. Complex topography, and rainfall intensity events are introduced as two challenges of satellite precipitation products addressed in the paper. GPM-IMERG is evaluated over the period between March 2014 to June 2018 for five topographical classes, ten hydrological regions and five rainfall intensity classes. Six metrics based on the contingency table



and continuous evaluation were calculated and reported for four seasons (fall, spring, summer and winter).

General Comments

Data and methodological approach of any research study must lead to robust scientific findings. Otherwise, the results will be doubtful for scientific community. Research findings based on reliable data and robust methods will support further improvement of available satellite precipitation products. The scientific methods provided in the current study are valid; however, some specific aspects have not been outlined clearly. The novelty cannot be considered as substantial. Scientific significance is limited in provision of new concepts, tools, and data. The performance of GPM-IMERG products was evaluated in different parts of Arabian Peninsula recently in two research studies listed in references (Mahmoud et al., 2018; 2019) using similar performance measures. Therefore, the novelty of submitted manuscript required justification.

Specific comments

(1) Research questions are not clearly mentioned in the introduction.

(2) In the first section of the paper, some aspects of advances and challenges of evaluating satellite precipitation products is discussed. Extensive introduction is provided on precipitation measurements with specific focus on remote sensing of precipitation. However, literature on the result of other studies which evaluate satellite-based products in arid regions is not sufficiently elaborated. Findings from other research studies which assessed the performance of GPM-IMERG products in regional scale in general, and the area under study in specific, is not provided.

(3) Seasonal and annual rainfall based on Ministry of Environment, Water, and Agriculture (MEWA) rain gauges are not provided in section 2. This information can provide a basis for comparison between reference data and GPM-IMERG.

(4) Since the research is based on local rainfall data, access protocol to the reference

data is not provided. It is mentioned in line 194 that the data was downloaded from MEWA website; however, the corresponding link is not provided. Relevant aspects of reproducibility of scientific result is not addressed.

(5) The overall quality of selected reference data (MEWA stations) is not mentioned in section 3.1. Quality control procedure applied to MEWA data is not explained. Previous studies which have used this dataset are not cited. Convincible reasons is required on why MEWA is selected as the reference data of the research besides the reason mentioned in lines 172-174. It was helpful if mentioned which authorities are responsible for recording rainfall within the study area, and to provide some arguments on reliability of MEWA compared to other rainfall sources. The type of MEWA rain gauges is not mentioned.

(6) Domain selection requires careful attentions for evaluating a satellite precipitation product in the absence of a dense rain gauge network. Although two important aspects (topographical effect and evaluating satellite products in hydrological regions) have been studied to investigate the performance of GPM-IMERG, the results are likely to be sensitive and dependent to some unknown extent on the spatial evaluation described in section 4.3.3. The low density and spatially non-uniform rainfall network selected as reference in this research will influence spatial evaluation of GPM-IMERG in at least some regions reported in section 5.3. There is not any rain gauge station located between 16 °-24 °N and 48 °-55 °E. Given the low density of MEWA stations in regions I, II, III, IV, VII, VIIII, and their corresponding topographical classes, robustness of the results provided in section 5.3.1 and 5.3.2 is under question and not straightforward. It is explicitly declared in the conclusion section of the manuscript (lines 466-469) that the issue (low density of rain gauge stations) prevents a proper evaluation of the rainfall satellite product. Results provided in table 6 for hydrologic regions number II, III and VII also provide evidence that the highest percentage of relative bias (RBIAS) are calculated in those areas incorporating small number of gauge stations (see Figure 4). This argument is critical and requires careful considerations as it could highly effect the



result.

(7) In lines 136-138, it is stated that a comprehensive evaluation is presented in the current study. However, often-used metrics namely statistical distribution and metrics on extended contingency table have not been considered.

(8) It is not apparent how the methodology described in line 206 as “point to point analysis” is used for spatial evaluation (explained in section 4.3.3). The research method used in generating figures 5 and 6 is not clear. How metrics provided in Table 1 are calculated for spatial evaluation? How Probability of Detection (POD) is calculated over the five topographical classes, and ten hydrological regions? Relevant formulation on pointwise analysis and areal-average evaluation is not provided for metrics in Table 1.

(9) Figure 3 and Figure 4 provide the spatial coverage of MEWA rain gauges within correspondent topographical and hydrological regions. However, the percentage of areas correspond to each class and corresponding percentage of MEWA stations is not provided. The number of rainfall events for each intensity class is not provided.

(10) Evaluation methods for comparing satellite rainfall to gauge-based products have limitations which are not addressed.

(11) In section 4.1, it is mentioned that rainfall events are determined during March 2014 to June 2018 based on ground observations. However, missing rate is not provided. The way missing data is treated to detect rainfall events is not mentioned in the research methodology.

(12) The sentence “The main superiority of satellite data over rain gauge data is that it provides uniform spatial coverage at high temporal resolution” stated in lines 53 and 54 is subject to argument.

(13) Lines 97-102: It is argued that availability of rain gauges in mountains areas is not common. The statement is general, and might not hold valid for some regions.

(14) Same as above, Lines 167-168: The sentence “Many researchers used the GPCC

(http://www.dwd.de/) gauge data for evaluation purposes; this data is not of sufficient density nor distribution for obtaining ground observation data at fine spatial resolution (Wang et al., 2017)" is a general statement and is subjected to arguments.

(15) Lines 243-247: How seasonal evaluation of GPM-IMERG products during March 2014-June 2018 could help to bring a better understanding of the climate of Saudi Arabia and monitoring climate change in the region?

Technical comments

(16) Sentence in line 128 requires revision.

(17) Geographical coordination of area under study provided in lines 142 and 143 requires revision.

(18) Figure 1 does not have a legend. Both MEWA stations and major cities within the study area are represented in black dots.

References:

(I) Mahmoud, M T., Al-Zahrani, M A. and Sharif, H O. 2018. Assessment of global precipitation measurement satellite products over Saudi Arabia, J. Hydrol., 559: 1–12. doi:10.1016/j.jhydrol.2018.02.015.

(II) Mahmoud, M T., Hamouda, M A. and Mohamed, M M. 2019. Spatiotemporal evaluation of the GPM satellite precipitation products over the United Arab Emirates, Atmos. Res., 219: 200–212. doi:10.1016/j.atmosres.2018.12.029.

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