

# Interactive comment on “Bias Correction of Satellite-Based Rainfall Estimates for Modeling Flash Floods in Semi-Arid regions: Application to Karpuz River, Turkey” by Mohamed Saber and Koray K. Yilmaz

Dear Editor,

Please find below our detailed responses to the reviews made by Reviewer #1. We found the Reviewer comments very helpful and believe that the revisions detailed below will represent a significant improvement over the original submission. In our responses below, we have clearly noted each comment and our specific response to those comments so that you can make a well-informed judgment. We would like to thank Reviewer #1 for his/her detailed comments on the paper.

Sincerely,

Mohamed Saber and Koray K. Yilmaz

## GENERAL COMMENTS:

**Overview Comment:** This study investigates the utility of gauge-corrected satellite-based rainfall estimates in simulating flash floods at Karpuz River - a semi-arid basin in Turkey. Global Satellite Mapping of Precipitation (GSMaP) product was evaluated with the rain gauge network at monthly and daily time-scales considering various time periods and rainfall rate thresholds. Literature lacks of studies using satellite rainfall estimates for flash flood modelling therefore the paper is relevant and of interest for the readers of the journal.

**Response:** We thank Reviewer # 1 for his/her positive comments and support for our work.

**Comment 2:** Despite this, I think the paper contains serious shortcomings and its presentation is very poor. The main drawback is the analysis of the rainfall which is carried out on a monthly basis while flash flood occurrence time scale is often sub-daily and even sub-hourly (in this respect the authors claim in the abstract that the analysis has been carried out at daily time steps but no daily results can be found in the paper). An analysis at hourly and daily rainfall would be more appropriate for the study. The interpolation of rain gauges on the GSMaP grid seems wrong (I see many artefacts in Figures 15 and 22). An adequate discussion of the potential error of the interpolation (5 stations for obtaining rainfall at  $0.1 \times 0.1$  degree on  $2 \times 1.5$  degree area) should be present in the manuscript.

**Response 2:** We thank Reviewer # 1 for these valuable comments. We will make sure to address the shortcomings and improve the presentation during the revision process. We concur with the statement that flash floods should be considered at sub-daily and hourly time scales in addition to monthly. We actually have already conducted the rainfall analysis at both daily and monthly time scales, but discussed only the monthly analysis in the manuscript to avoid excessive length of the manuscript. Thus, we will include the results and discussion of daily rainfall analysis during the revision process. Hourly analysis could not be performed due to lack of hourly rain-gauge observations; which is a common limitation for most of the semi-arid basins around the world. The interpolation methodology used is the Thiessen polygon method, and we believe that the most challenges in arid and semi-arid regions are the scarcity of the rain gauge network. Thus with this

study we are attempting to improve and correct the satellite rainfall data based on the (limited) available rain gauges to be used in flash floods simulation at the hourly time scale. We will double-check the interpolation procedure we have utilized. We will also make sure that the visualization of rainfall distribution maps are correctly processed in GIS.

**Comment 3:** The presentation of the paper lacks of an appropriate organization:

1. Intro section rationale should be:

A. Flash flood problems.

B. Use of gauge rainfall network problematic because there are too little number of Stations.

C. Possible alternative use of satellite data, problem with bias with satellite data,

D. Bias correction improves the hydrological model.

**Response 3:** We thank Reviewer # 1 for these valuable comments that would improve the flow of text and readability of the manuscript. We will surely take these comments into consideration during the revision process.

**Comment 4:** In the way it is presented it is difficult to follow.

**Comment 4.1:** Datasets description is totally missing (GSMaP is not described at all) and study area is described twice in section 2 and in section 4.1. after the result section. In section 4.1. no further information is given about the catchment characteristics neither about the discharge time series, event selection and so on. Here, only additional info about the flash flood problem are given (material that fits more for the introduction section).

**Response 4.1.** We thank Reviewer # 1 for these comments that will improve the organization of the manuscript. We will include the description of GSMaP in Section 2 (Study area and datasets). We will also introduce the study area in one section in more detail using a combined map.

**Comment 4.2:** The number of figures is enormous and redundant. Tables often contain the same information of the figures. 4. Performance scores are inadequate. NSE is used in rainfall assessment and not in flood assessment. I think it would be interesting to use categorical performance scores (Probability of detection and False alarm ratio) for rainfall assessment and RMSE and use NSE in the flood part. Based on that, I suggest the paper to be not acceptable and suggest to resubmit after being improved.

**Response 4.2.** Agreed. We will carefully revise the figures and the tables to remove any redundancy. We will also include categorical performance measures in the revised manuscript to improve the precipitation analysis.

**Comment 5:** I also have other comments that I will list below in order of appearance in the manuscript indicating also their relevance. The authors could take them into account for improving the manuscript. MODERATE: Pag. 3 lines 17-22 – Pag. 4 lines 1-8. This part should be moved at the beginning of the manuscript.

**Response 5:** Agreed. We will move indicated section to the beginning of the manuscript.

**Comment 6:** MODERATE: Pag. 2 lines 19-20. It seems the sentence is not a consequence of what is written before. Consider moving after describing potential problems of bias in satellite rainfall estimates.

**Response 6:** Agreed. We will re-write this section.

**Comment 7:** MINOR: Figure 1. Merge this figure with Figure 16.

**Response 7:** Agreed. We will merge these figures.

**Comment 8:** MAJOR: Pag. 4 lines 21-22. Why do you assess rainfall at monthly time scale then?

**Response 8:** As we discussed earlier and in the manuscript, raingauge networks are generally sparse and hourly observations are generally not available in semi-arid basins. Thus, we would like to make use of GSMaP product which is spatially continuous and available at hourly time scale for flash floods simulation. We have no other option but to asses GSMaP product at time scales for which rain gauge observations are available; daily and monthly. We aim to devise a correction procedure for GSMaP at these timescales and further apply this procedure at hourly timescale to investigate whether flood-simulations with a hydrological model improve pre- and post- bias correction procedure. Improvement in bias-corrected GSMaP driven hydrological model simulation as compared to flow observations provides an independent check on the performance of the devised bias correction procedure. We will make sure that the above message is clearly outlined in the revised manuscript. We have already conducted the monthly time scale based on daily data, therefore, it will be easy to include the daily analysis in the revised manuscript.

**Comment 9:** MAJOR. Pag 6 line 1- GMap. Is not described in the text. Its description is relevant for the paper.

**Response 9:** Agreed. We will describe the GSMaP product in the relevant section.

**Comment 10:** MODERATE: Section 3. Explain better the difference between the PBIAS and BIAS and what information they should give one with respect to the other.

**Response 10:** Agreed. We will clarify the difference between these measures in the revised manuscript.

**Comment 11:** MODERATE: Pag. 8 lines 17-20. Not clear.

**Response 11:** Agreed. We will re-write and clarify this statement about the rainfall threshold selection during the revision process.

**Comment 12:** MINOR: figure 10 contains the same information of table 3. Consider removing.

**Response 12:** Agreed. We will avoid this redundancy by removing Figure 10.

**Comment 13:** MAJOR. Section 3.1. Point vs. grid comparison. Is not described in the methodology. What is the objective of this analysis?

**Response 13:** In this section, we aim to investigate the agreement between direct rain gauge observations (point-scale) with the overlying GSMaP grids. We will include a description of this procedure in the methodology section.

**Comment 14:** MODERATE. Pag 16 line 1-10. Please try to describe better this part. It seems very important for the paper.

**Response 14:** We will make every effort to improve and clarify the discussion provided in this section.