Interactive comment on "Comparison of TRMM, MPEG and CFSR rainfall estimation with the ground observed data for the Lake Tana Basin, Ethiopia" by A. W. Worqlul et al.

Dear Dr. Leijnse,

We were delighted with the outcome of the review Thank you for the comments. Below we have responded to each of the comments by first repeating the comment with immediately below our response. In the following pages we have responded to each of your comments.

EDITOR: DR. HIDDE LEIJNSE:

COMMENTS TO THE AUTHOR

Two reviews have been submitted on this manuscript. Both of these reviewers have made several suggestions on how the paper could be improved, but none that could be classified as major. The first reviewer's main points were that a description both typical Ethiopian rainfall and the QPE methods should be included in the main text, and that it would be good to have an idea of how these data are used operationally. The second reviewer's main points were that appropriate references should be cited in the text, and that the conclusions about 3B42 were quite negative despite the fact that this estimator is generally unbiased.

COMMENT

The authors have written extensive replies to both reviews, in which they indicated that they agree with most comments and that the new version of the paper will be modified accordingly. However, I found that a small number of the replies raised some questions. For example, in reply to comment 9 of reviewer #2, the authors state that 1/0.51=1.25, which is simply not true. This difference is caused by the fact that performing linear regression of x on y may not yield a coefficient that is the reciprocal of that resulting from linear regression of y on x. When submitting a revised version of the manuscript, please make sure that these issues do not influence the manuscript.

RESPONSE:

This comment is correct. Apologies for our mistake. In the figures 1 and 2 below, we demonstrated that we were wrong: By changing the x and Y axis the slope explained on the manuscript is obtained and not the reciprocal.

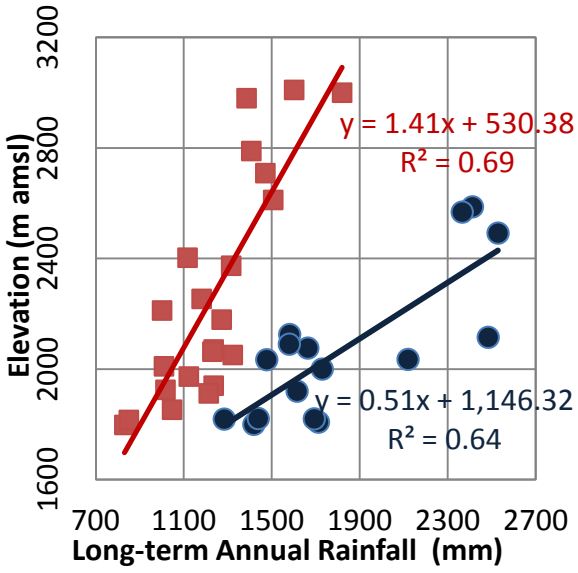


Figure 1

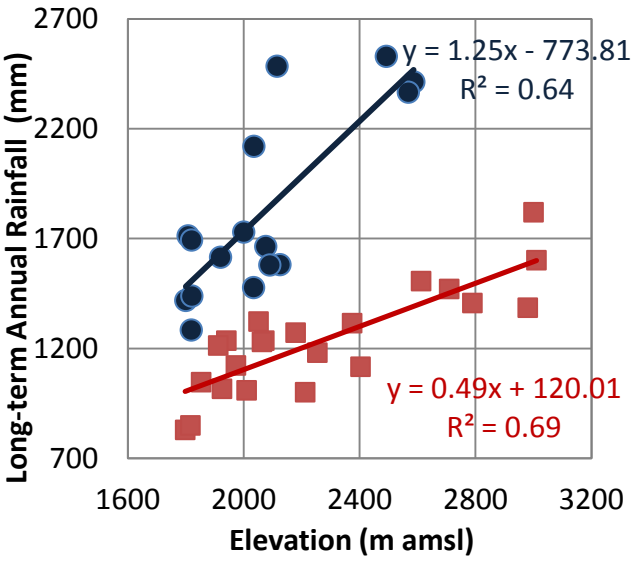


Figure 2

In the manuscript, Figure 1 is incorporated but the explanation was using Elevation as X-axis and long-term annual rainfall as Y-axis Figure 2.

I have some further minor suggestions for improving the manuscript:

- In Fig. 1, consider using a digital elevation model (DEM) as background rather than a Google Earth image.

RESPONSE:

We have modified Fig 1 by including the Digital Elevation Model as a background. See below:

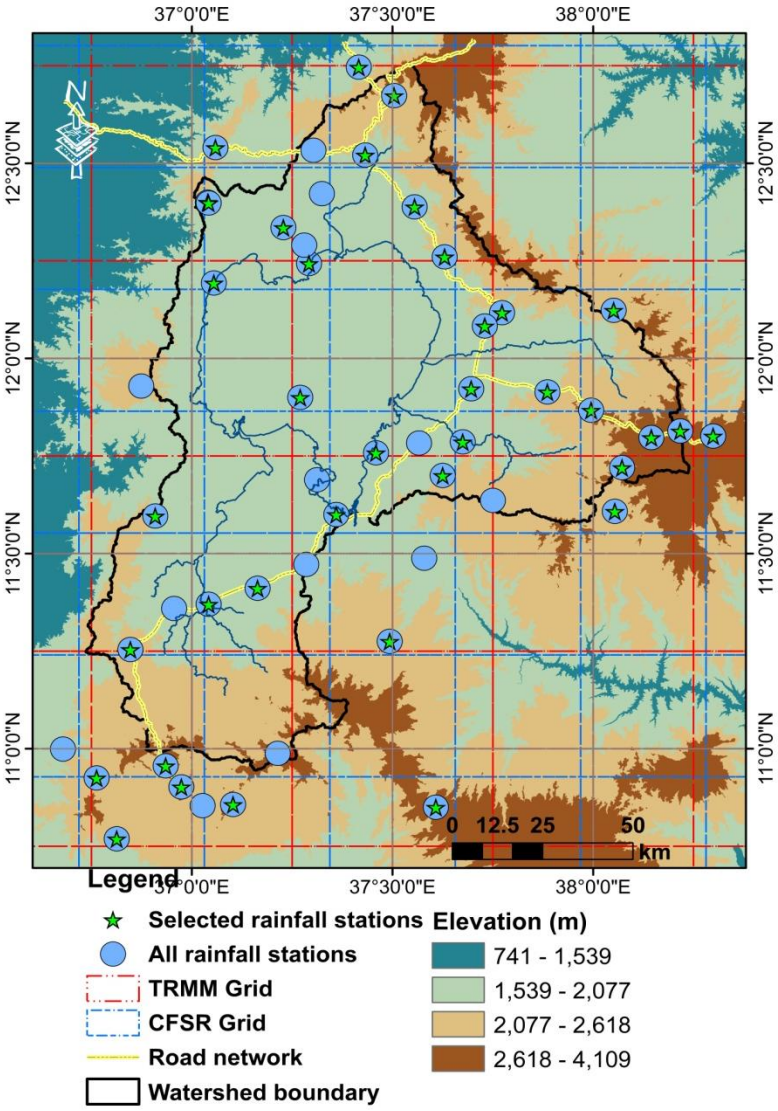


Figure 1: Lake Tana watershed, showing the TRMM and CFSR Grids and the location of the available and selected rainfall stations (90 meter Digital Elevation Model as background).

COMMENT:

- In Fig. 4, consider sorting the gauges according to elevation rather than alphabetically so that the order on the x-axis has a meaning (and as a consequence there is more information in the figure). Alternatively, the elevation of the gauge itself may be used on the x-axis, making the figure more like Fig. 3.

RESPONSE:

The stations are sorted according to elevation in increasing order (from left to right). The elevation information is also included on the secondary axis for R-square and RMSE figures.

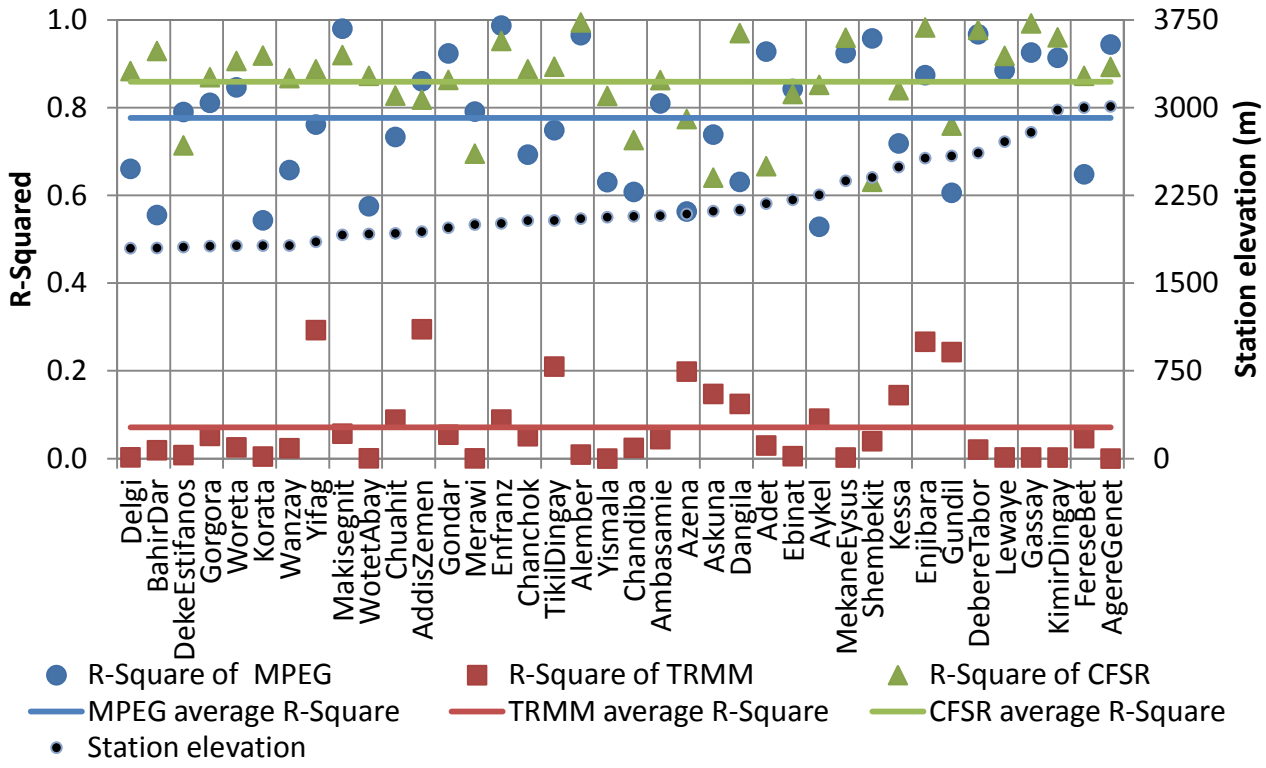


Figure 2a: R-Squared of MPEG, TRMM and CFSR compared with 38 Ground Rainfall Observation Stations (GROS) in the Lake Tana Basin sorted according to increasing stations elevation.

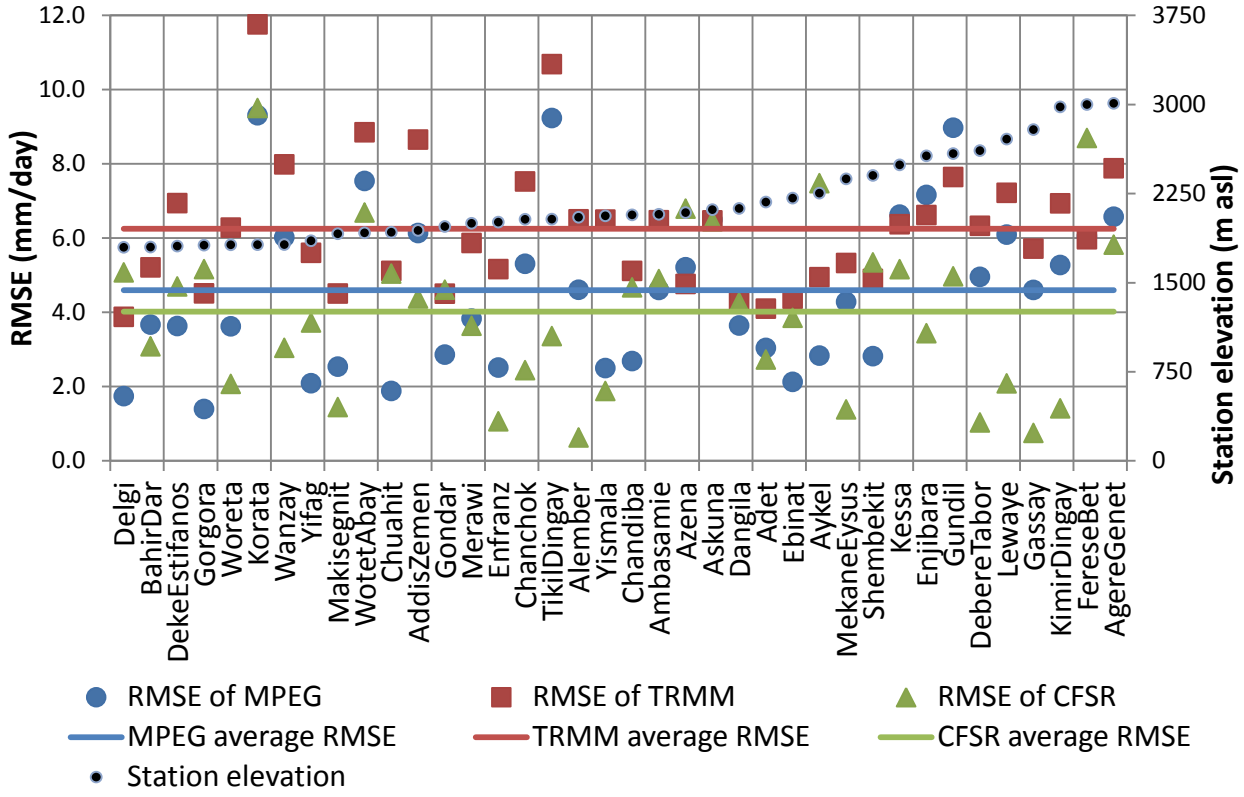


Figure 4b: RMSE of MPEG, TRMM and CFSR compared with the 38 Ground Rainfall Observation Stations (GROS) in the Lake Tana Basin sorted according to increasing stations elevation.

COMMENT

- In Fig. 4c, consider using a logarithmic axis for the bias, because a bias of e.g. 0.25 is as bad as a bias of 4.

RESPONSE:

Thanks, we agree that a bias of 0.25 is as bad as a bias of 4 is true, one is underestimating by 75% and the other one is overestimating by 75% respectively. If the Bias is less than 1 it is underestimating the observed rainfall and if it is above one it is overestimating the observed rainfall. If we take the logarithm of 0.25 and 4 they will give as the same value but with different sign.

$$\log(0.25) = -0.60206$$

$$\log(4.0) = 0.60206$$

We have included in the revised manuscript a plot with a logarithmic axis of bias.

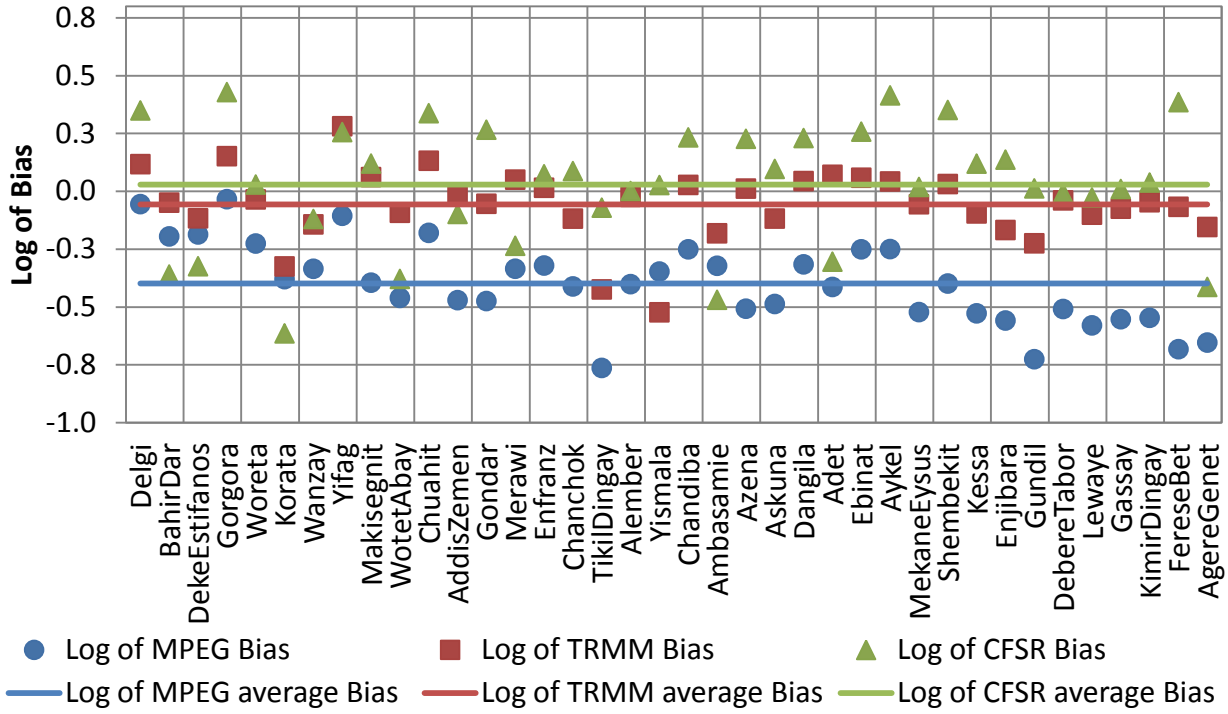


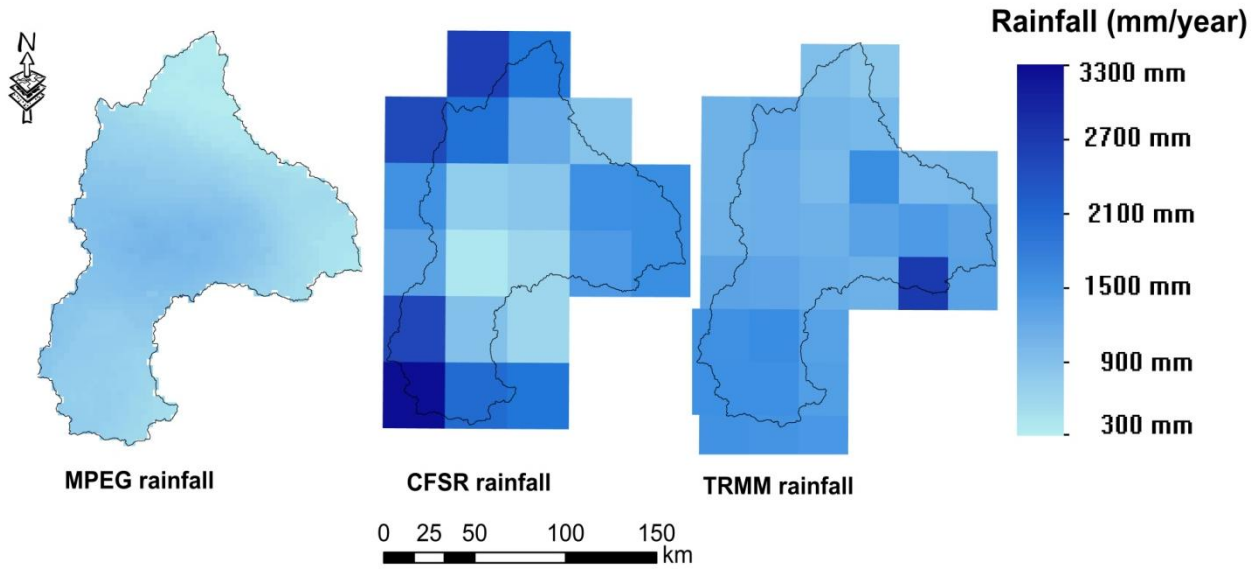
Figure 4c: Logarithm Bias of MPEG, TRMM and CFSR compared with 38 Ground Rainfall Observation Stations (GROS) in the Lake Tana Basin.

COMMENT:

- In the new Fig. 5, consider adding interpolated rain gauge data (the "ground truth"), and adjust the color scale of each panel so that they are equal (this makes it much easier to compare the different panels).

RESPONSE:

I have modified the Fig 5 for MPEG, CFSR and TRMM rainfall estimation.



COMMENT:

- In the Conclusions section, consider including a discussion of why TRMM 3B42 performs worse than the others in terms of RMSE and R2.

RESPONSE:

We have included a discussion on why TRMM 3B42 performs worst under the conclusion as follows:

The ground observation data indicated 86% of the annual rainfall to occur from June to September and the MPEG and CFSR indicated approximately the same percentage. The TRMM indicated only 30% of the annual rainfall to occur during the rainy season June to September. Although TRMM 3B42 bias is adjusted with a monthly gauged rainfall data and has performed well in many parts of the world (Ouma et al., 2012;Javanmard et al., 2010), such an adjustment was not made for the Ethiopian highlands because observed rainfall data was not made available (Haile et al., 2013).

REVIEWER 2

COMMENT:

-Reviewer #2 of your HESS manuscript has just sent me a message that there is a spelling mistake in one of the figures that you produced in your response to this reviewer's comments. Several labels of the new Fig.9 are misspelled (both in the legend (3 times) and in the y-axis label): it should be "Bias", but it now reads "Bais". Could you correct this when you submit the revised version of the manuscript?

RESPONSE:

Thanks, the spelling is corrected

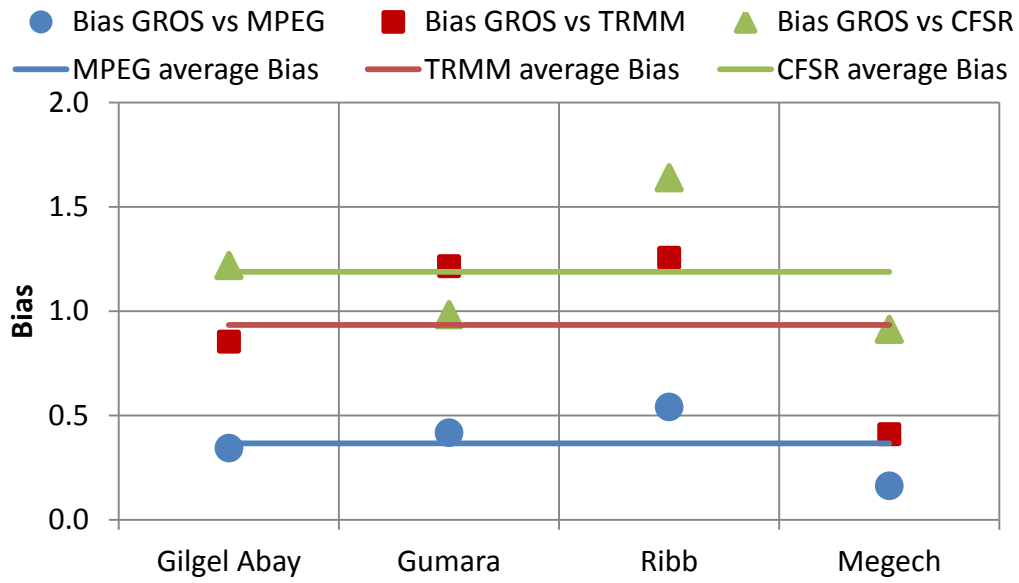


Figure 9: Bias of areal ground observed rainfall versus satellite rainfall estimate for the major river basins in the Lake Tana.

We would like to express our great appreciation for comments on our paper

Abeyou Worqlul and Tammo Steenhuis

Haile, A. T., Habib, E., Elsaadani, M., and Rientjes, T.: Inter-comparison of satellite rainfall products for representing rainfall diurnal cycle over the Nile basin, International journal of applied earth observation and geoinformation, 21, 230-240, 2013.

Javanmard, S., Yatagai, A., Nodzu, M., BodaghJamali, J., and Kawamoto, H.: Comparing high-resolution gridded precipitation data with satellite rainfall estimates of TRMM_3B42 over Iran, Advances in Geosciences, 25, 119-125, 2010.

Ouma, Y. O., Owiti, T., Kipkorir, E., Kibiiy, J., and Tateishi, R.: Multitemporal comparative analysis of TRMM-3B42 satellite-estimated rainfall with surface gauge data at basin scales: daily, decadal and monthly evaluations, International Journal of Remote Sensing, 33, 7662-7684, 2012.