

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.

Response to Anonymous Referee #1

Dear Referee #1

We would like to acknowledge the anonymous referee 1 for providing comments on our paper. We have used your comments to greatly improve the quality of our manuscript. In the following pages we have responded to each of your comments. [Changes in the original manuscript are highlighted in yellow for visibility. Changed text is also copied to the responses.](#)

Scientific questions

Can the type/origin of rainfall for Ethiopia be highlighted in the beginning of the document – i.e. what the source/cause for rainfall is in which months? A general discussion on the (rainfall) climatology of the area would be beneficial. Some mention of this is made on page 8022 line 18: : : Can this be expanded?

RESPONSE: We have accepted your valuable comments and added the requested discussion in the text:

In general, three seasons exist in Ethiopia. The main rainfall season from June to September called "Kremt" season accounts a large proportion of the annual rainfall approximately 86%, the dry season extends from October to January called "Bega" followed by a small rainy season called "Belg". The most important weather systems that cause rain over the country includes Intertropical Convergence Zone (ITCZ), Red Sea Convergence Zone (RSCZ), Tropical Easterly Jet (TEJ) and Somalia Jet (NMSA, 1996; Seleshi and Zanke, 2004). The main rainy season were found to be significantly correlated to the El Niño-Southern Oscillation (ENSO) (Camberlin, 1997) and most of the drought seasons in Ethiopia are more likely to occur during warm ENSO events (Seleshi and Demaree, 1995).

I would recommend that the descriptions of the three QPEs are included in the main text and not as appendices.

RESPONSE: We have accepted your valuable comment and included the description of the three QPEs in the main text.

Would it be possible to show maps of the three QPEs and rain gauge rainfall totals for some of the months? This would help to get a “feel” for the products - to see more than just the statistical number crunching.

RESPONSE: We have accepted your valuable comment and the annual rainfall map is included.

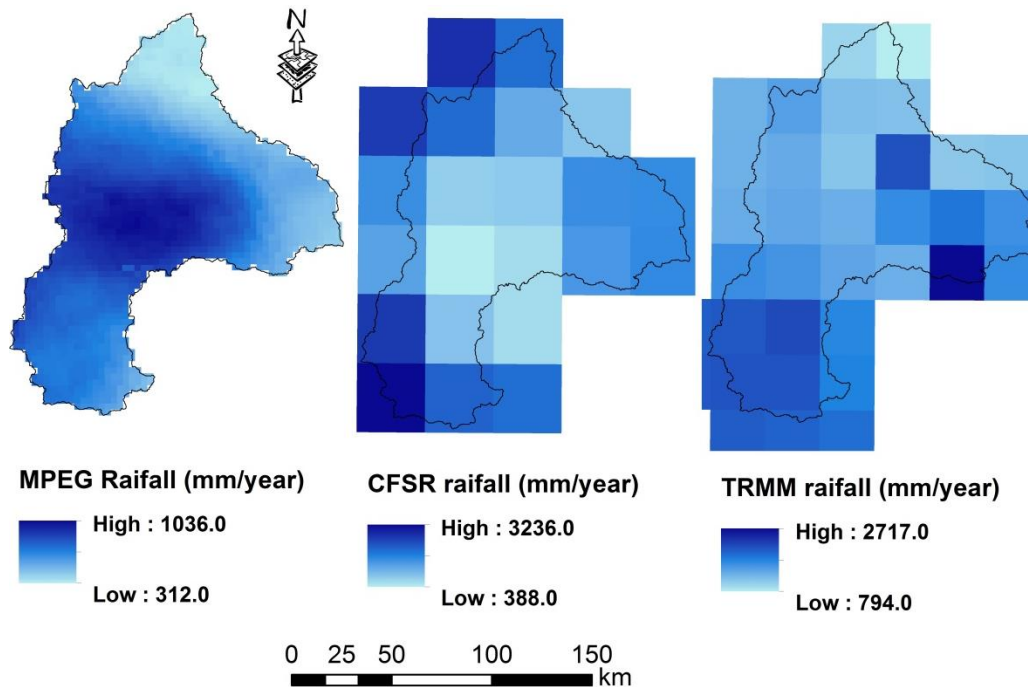


Figure 5: Spatial distribution of annual rainfall estimate for year 2010 from MPEG, CFSR and TRMM data.

Which of the two satellite QPE can be available in near real time for operational purposes? Do forecasters see any of these satellite QPEs displayed graphically in real time? Is the CFSR available to forecasters every day in the Ethiopian Nat Met Agency?

RESPONSE: The Multi-Sensor Precipitation Estimate (MPE) from Meteorological Product Extraction Facility (MPEF) is available near real time (at 15 minutes temporal resolution) at Ethiopian National Metrological Agency, Addis Ababa and also Bahir Dar University, Bahir Dar, Ethiopia. Yes, the forecasters see the MPE raster file at near real-time. CFSR data is not available at the National Meteorological Agency of Ethiopia.

How can the knowledge that CFSR and MPE are better than TRMM affect processes in the Ethiopian Nat Met Agency?

RESPONSE: The Ethiopian highland is under gauged as far as ground-based rainfall observation stations are concerned. Thus present measurements do not adequately represent the spatial and temporal distribution. Traditional manual gauges dominate in the rainfall measurement stations and are located in populated areas so that personnel can easily access the stations. The data scarcity is severe in remote part of the country. It is in these data scare regions that of the validated CFSR and MPE products will kick in to understand rainfall spatial and temporal variability. This has a very high relevance for many water resources, agriculture and climate applications and in the reconstructions of recent environmental change.

Technical Corrections Figure 3: Caption is not describing the two separate images: : : more description is needed.

RESPONSE: We have accepted your comments and improved the description (please see Fig. 3 below and it is incorporated in the revised manuscript)

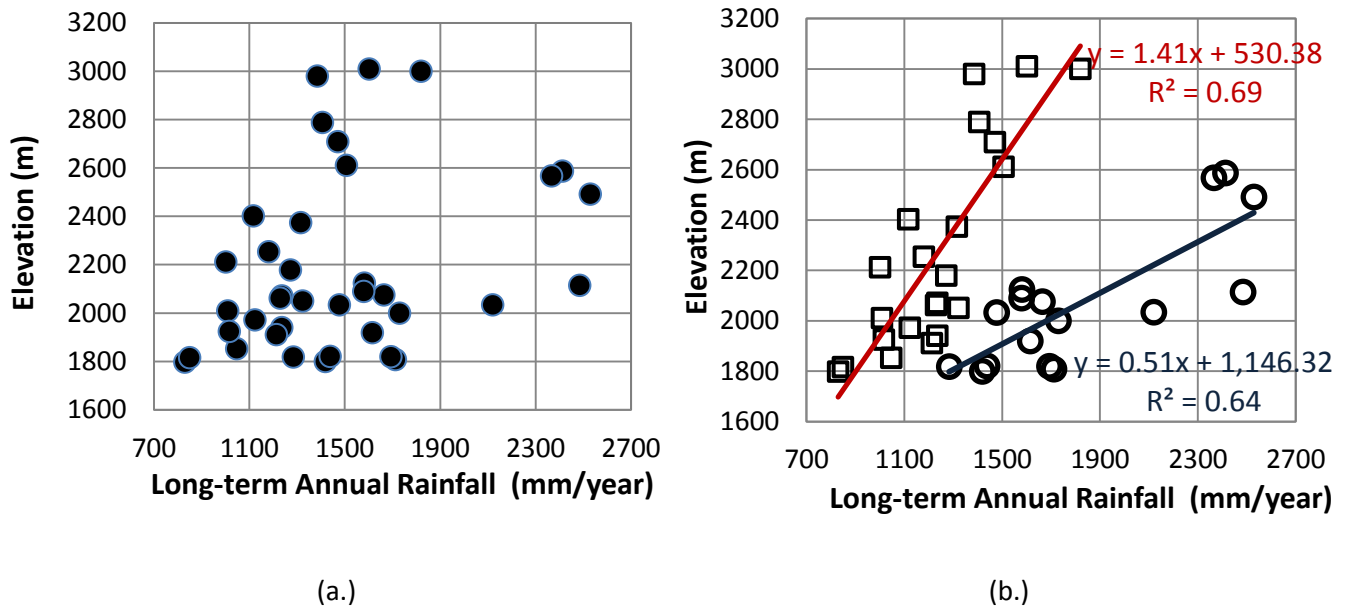


Figure 1: (a.) Elevation versus long-term annual average rainfall relations in the Lake Tana Basin (38 stations from 1984 to 2008) and (b.) Two clear trends: first one shows a 50 mm of rainfall increase for every 100 m elevation increase and the second trend observed was a 125 mm rainfall increase for every 100 m elevation increase.

Abstract:

Page 8014 Line 3: network of weather stations
 measuring Line 9: : : where 28 weather stations were available in 2010: : : Line
 10: Daily gridded: : : Line 11: observed ground rainfall and (2) areal: : : Line 12: omit
 comma after that Line 13: On average, : : : (omit the and add comma) Line 14: : : data,
 respectively, : : : Line 17: : : CFSR also have a lower: : : Line 18: omit comma after that
 and omit “the” before MPEG/TRMM/CRSR Line 19: : : for some months? Cases?

RESPONSE: We have accepted your comments and made the necessary corrections.

Introduction:

Line 22: omit comma after cycle

RESPONSE: We have accepted your comment and removed the comma.

Precipitation is a major component of the water cycle, and is responsible for depositing approximately 505,000 km³ (or on the average 990 mm) of the fresh water on the planet.

Line 24: water balance components

RESPONSE: We have accepted your comment and corrected the expression.

It is one of the major water balance components of the global water budget.

Page 8015

Lines 1-2 don't make sense: : : perhaps the word "though" in the beginning is the misfit?

RESPONSE: We have accepted your valuable comment and corrected the expression.

Ground based rainfall observation station networks are often unevenly and sparsely distributed in developing countries (Kaba et al., 2014).

Lines 3-4: Sentence not properly constructed, rephrase

RESPONSE: We have accepted your comment and rephrased our sentence.

For example Rahad, Dindir and Welaka Sub-basins in the Blue Nile Basins, Ethiopia had each only one rainfall station despite catchment area greater than 5,000 km². This situation is not likely to improve in the near future.

Line 7: rain gauges: : :

RESPONSE: We have accepted your comment and corrected our expression.

The poor coverage of rain gauges hinders drought forecasting for food deficits, and is of great hindrance of accurately predicting discharge (both low flows and floods), sediment discharge and nutrient fluxes.

Line 7: hinders flood forecasting for flood deficits – meaning not clear?

RESPONSE: We have accepted your valuable comment and corrected our expression.

The poor coverage introduces large uncertainties in rainfall distribution estimation and will evidently undermine the dependability of hydrologic models used in simulating flow (both low flows and floods), sediment load and nutrient fluxes (Kaba et al., 2014).

Line 10: omit comma after hydrologists and put "as noted by Baveye (2013)" between brackets

RESPONSE: We have accepted your comment and re-write the whole expression.

Unavailability of good quality rainfall data render hydrologists reluctant to confidently deal with pressing and unprecedented societal questions vis-à-vis food deficits, global warming, climate change, water scarcity and water shortage issues (Baveye, 2013).

Lines 10-11: meaning not clear

RESPONSE: We have accepted your comment and add clarity to our expression.

Unavailability of good quality rainfall data render hydrologists reluctant to confidently deal with pressing and unprecedented societal questions vis-à-vis food deficits, global warming, climate change, water scarcity and water shortage issues (Baveye, 2013).

Line 13: : : . data, particularly: : :

RESPONSE: We have accepted your comment and added a comma.

The growing availability of high-resolution (and near real time) satellite rainfall products can help hydrologists to obtain more accurate precipitation data, particularly in developing countries and remote locations where weather radars are absent and conventional rain gauges are sparse (Bitew et al., 2012).

Lines 17-18: “the availability of earth observation data for environmental or societal purposes is increasingly available: : :” rephrase

RESPONSE: We have accepted your comment and rephrased our expression.

Recently earth observation data for environmental or societal purposes has become readily available through earth observation (EO) satellites and data distribution systems.

Line 25: omit comma before and

RESPONSE: We accepted your comment removed the comma.

....Precipitation Estimation from Remotely Sensed Information using Artificial Neural Network (PERSIANN), the Naval Research Laboratory’s blended product (NRLB) and more.

Page 8016

Line 1: : : :that tends to be associated with..

RESPONSE: We have accepted your comment and rephrased our sentence.

The assumption in the TIR is that relatively cold clouds are associated with thick and high clouds that tend to be associated with producing high rainfall rates (Haile et al., 2010)..

Line 2: .. one of the limitations with a TIR sensor: : :

RESPONSE: We have accepted your comment and corrected our sentence.

One of the limitations with a TIR sensor is that it only uses the top cloud temperature...

Line 5: Microwave sensors utilizes a more direct way: : :

RESPONSE: We have accepted your comment and corrected our sentence.

Microwave sensors utilizes a more direct way of retrieving precipitation from satellite; they gather information about the rain rather than the cloud (Dinku et al., 2010).

Line 9:omit coma after that

RESPONSE: We have accepted your comment and removed the comma.

The disadvantage of PM sensors is **that** they are not available on geostationary satellites, which make them to have a longer re-visit time (Heinemann et al., 2002).

Line 10: which gives them a longer latency: : :

RESPONSE: We have accepted your comment and corrected our sentence.

The disadvantage of PM sensors is that they are not available on geostationary satellites, which **make** them **to have a longer latency** (Heinemann et al., 2002)

Line 12: add comma after systems

RESPONSE: We have accepted your comment and added a comma.

A combination of both, microwave (MW) data from polar orbiting satellites and IR data from geostationary **systems**, is an obvious approach to ...

Line 14:... a combination of MW and IR data from? TRMM, MPEG and: : :

RESPONSE: We have accepted your comment and corrected our sentence.

In this study a validation of satellite rainfall estimation using a combination of MW and IR data **from** TRMM, MPEG and CFSR ...

Line 15: Tana Basin in Ethiopia.

RESPONSE: We have accepted your comment and edited our sentence.

... TRMM, MPEG and CFSR will be done by comparing with the ground observation rainfall data for the Lake Tana Basin in **Ethiopia**.

Line 17-19: perform in this region.

RESPONSE: We have accepted your comment and edited our sentence.

Validation of satellite rainfall products in the Ethiopian highlands will give an insight into how the different products perform **in this region**.

A number of studies have been done to validate TRMM in the Ethiopian highlands (: : :). These studies have focused on comparison: : : Lines21-24 – meaning not clear.

RESPONSE: We have accepted your comment and rephrased our sentence.

A number of studies have been done to validate TRMM in the Ethiopian highlands (Dinku et al., 2010;Tsidu, 2012). **These** studies have focused on....

Rephrase Line 27:

RESPONSE: We have accepted your comment and rephrased our sentence.

These rainfall products are selected for comparison given the fact that the state of the art algorithms are used to generate them. They are also freely available for use in Africa.

omit comma after because Line 28:

RESPONSE: We have accepted your comment and removed the comma.

These rainfall products are selected for comparison given the fact that the state of the art algorithms are used to generate them. They are also freely available for use in Africa.

omit Ethiopia Line 29:

RESPONSE: We have accepted your comment and omitted the word.

For example, Bahir Dar University in collaboration with Tana Sub-Basin Office ...

omit Faculty ITC

RESPONSE: We have accepted your comment and omitted the word.

... and University of Twente the Netherlands have established a GEONETCast ...

Page 8017:

Line 2: omit of after all

RESPONSE: We have accepted your comment and omitted the word

In addition, all three rainfall estimates (TRMM, CFSR and MPEG) have a ...

Line 5: Omit Consequently

RESPONSE: We have accepted your comment and omitted the word.

The general objective of the study is to examine which of the three freely available satellite products give the best estimates....

Lines 7-13 – repetition, can be omitted I suggest serious language revision for the entire paper. I have not pointed out any language/punctuation errors further that paragraph 1 on the top of page 8017.

RESPONSE: We have revised the manuscript for the English revision by a native speaker.

We would like to express our great appreciation to you for comments on our paper. Looking forward to hearing from you. Thank you and best regards. Yours sincerely,

Abeyou W.

References

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