

***Interactive comment on “Water balance modelling  
in a semi-arid environment with limited in-situ  
data: remote sensing coupled with satellite  
gravimetry, Lake Manyara, East African Rift,  
Tanzania” by D. Deus et al.***

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Received and published: 15 December 2011

General reply to Reviewer 1-C4854-2011

We want to thank Reviewer 1 for his thoughtful contribution and comments on our manuscript. We have largely implemented the suggestions and tried to modify the paper in order to answer the critics. We have inserted a clear list of input data. We have also understood that the use of LST is not clearly explained in the text. We have

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specifically edited the text in that respect. This point raised by the reviewer and the ulterior text changes improved the lecture and the understanding of the manuscript.

Reviewer comment 1:

In the rainfall data description section, authors describe the quality of TRMM and GPCP datasets compared to in-situ information. However, it is not clear whether GPCP is also used as model input or only for validation purpose? The authors should make it clear that in-situ (and GPCP) data is used for validation only in this study and are not model input, if this is the case.

Answer:

We used GPCP datasets for validation only. We have amended the text to make the specific input data clearer.

Reviewer comment 2:

As it is explained in the paper, MODIS LST product is used as model input. This means that evapotranspiration is also calculated using LST data. However, the Penman-Montheith method for ET estimation uses air temperature as an input. This is why the authors should clarify how LST was integrated into the model. Was it directly used constituting air temperature information, which is actually not correct?

Answer:

We agree that Penman\_Montheith method for ET estimation use air temperature as input. Nonetheless we showed that LST and air temperature are correlated and therefore we can estimate air temperature from LST. In order to check the effect of using LST we used both air temperature and MODIS LST to force two separate models. The results produced using MODIS LST and in-situ air temperature are very similar and we conclude that air temperature estimated from LST is a valid temperature input (Fig. 1a,b). We have edited the text to make these points clearer.

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Reviewer comment 3:

In the structure of paper I would suggest to combine sections 4 and 5 (approaches and model setup) and name them as Methodology section. Model setup is also a methodology used in this study.

Answer:

We have merged sections 4 and 5, approaches and model setup to constitute a Methodology section.

Reviewer comment 4:

Presentation of modeling results is not clear enough (especially fig. 12). In my opinion, the authors should give more attention for clear representation of modelling results with better visualization options.

Answer:

The reviewer raises a valid point and we largely shortened and modified the model description. We decided to remove Fig. 12 in our result presentation and leave figures that could be visualized clearly.

Reviewer specific comments:

1. Page 8743, line 3-4: From my past readings I have always read that TRMM shows reduced quality in mountain areas. Would it be possible to check TRMM quality using individual stations (four rain gauges) at different elevations?

Answer:

Firstly we do not think that the region of interest is largely affected by orographic processes. Nonetheless, based on Andermann et al., 2011, the quality of TRMM data is suitable even for mountainous areas. secondly, we checked the quality of TRMM data in the area of interest and found out that they show a good correlation with in-situ data.

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2. Page 8744 lines 9-15: You need to state whether you used in-situ air temperature or in-situ LST for comparison with MODIS LST. State also from which station LS / air temperature data was used for comparison.

Answer:

We used in-situ air temperature for comparison with MODIS LST. We have stated that in the modified text. We also determined the ground stations used to determinate the correlations.

3. Page 8744 lines 9-15: Clarify how the comparison was done. Was the monthly mean MODIS LST compared against monthly mean in-situ LST / air temperature?

Answer:

Yes, we compared the monthly mean MODIS LST against monthly mean in-situ air temperature. This also has been clarified in the text.

4. Page 8744 lines 9-10: What is the combination of V4 and V4.1 product? Authors state earlier that V4 is from 2000 to 2006 and V4.1 is from 2006 to 2010. This is why clarification for combining these two datasets is necessary which were explained to have different time series.

Answer:

MODIS V4 and V4.1 products are produced using same algorithm. They have similar spatial resolution and projection. In our study we extracted the data from the two consecutive time series and merge to get a full time series of interest. We have amended the text to make it clear.

5. Page 8744 lines 9-15: You used Pearson's correlation for rainfall evaluation and used coefficient of determination for MODIS LST evaluation. It is better to use the same measure everywhere, unless you explain why you use other measure than previous one.

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Answer: Good point. In the modified text we have used same measure of evaluation for rainfall and MODIS LST.

6. Page 8744 lines 25-28: Is it important to mention all land use classes?

Answer:

We wanted to point out land use class types available in the study area however it is not really necessary, we have modified this in the text.

7. Page 8745 lines 6-7: Reformulate sentence.

Answer:

We modified the sentence on Page 8745 lines 6-7

8. Page 8745 lines 4-9: Useless information. Only mentioning SRTM in data section would be enough.

Answer:

We removed the information and mention about topography on the data section.

9. Page 8746 lines 5-6: There are four rain gauges shown in the map but authors say about five rain gauges. Remove "about" since it must be clear weather you have 4 stations as shown in the map or 5 stations as stated in the text. Change one of them, four or five in both, text and map.

Answer:

We have 4 rain gauge stations within the catchment and 1 meteorological station. We have corrected and make it clear in text.

10. Page 8748 line 6: I would suggest to use Methodology instead of Approaches as section title

Answer:

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We have changed "Approaches" to "Methodology" when combining approaches and model setup sections as we have pointed out in our answers to the reviewer's comment 3.

11. Page 8751 line 16: What do you mean by "hydrological target"? 12. Answer:

We mean hydrological parameters. We have changed this in the modified text to make it clear.

12. Page 8752 lines 25-28: In my opinion there is no need to explain goodness of fit since it should be familiar to any who wants to understand this paper.

Answer:

We have removed the explanation for goodness of fit as suggested.

13. Page 8753 lines 1-3: I would remove eq. 9 since it is common and well known coefficient.

Answer:

Eq. 9 has been removed

14. Page 8753 lines 16-18: No need to explain what model validation is.

Answer:

We have removed explanations for model validation

15. Page 8761 line 1: Please use same decimal numbers for area description. The sentence about Lake Manyara basin covering 18763 km<sup>2</sup> and 465.96 km<sup>2</sup> is little confusing. It is better to say about 466 km<sup>2</sup> than 465.96 km<sup>2</sup>.

Answer:

We now use integers for area description.

16. Fig. 12: More explanation for this figure is necessary. Especially, actual ET figure

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shows questionable illustration of its spatial distribution. The authors should explain why it suddenly changes in some parts.

Answer:

We agree that Fig 12 is not clearly explained. We decided to remove Figure 12 and use other figures to clearly present the result.

17. Fig. 7 can also be explained in words and in my opinion there is no need to illustrate it as a figure since you do not show legends anyway.

Answer:

Fig. 7 has been explained in words.

18. In my opinion, description of Land cover and topography can be explained in the beginning of data section and should not be explained as an additional sub-section. Moreover, slope and aspect as named in sub-section title are not described at all.

Answer:

We have amended the text accordingly. We have explained Land cover and topography at the beginning of the data section. Slope and aspect are derived from a Digital Elevation Model (DEM) which present the topography.

19. I wonder whether it would make more sense to use other methodology for ET estimation in data scarce region. Penman-Monteith methodology requires more input data and there are other methods which require less input data (e.g. Hargreaves-Samani). Computing ET using Hargreaves method and comparing it against observed ET data and choosing better method would increase the quality of paper. Another reason for this is that there is only one meteorological station which is located outside the basin. Extrapolating all climatic parameters from this station into whole study area is less accurate than transferring only temperature data which can also be extrapolated using simple lapse rate methodology.

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Answer:

We agree that the study is in a data scarce region and Penman-Monteith requires more input data. But thanks to our remote sensing approach we have access to all the requested input data and feel that a downgrade of the methodological approach is not necessary. Our previous experience with other methods such as the Hargreaves-Samani is not conclusive.

Reviewer technical corrections:

1. Lines 11-13: Reformulate sentence or use “,” after comparable trends. 2. Page 8740, line 9: add “to” before “test” 3. Page 8740, line 6: You say remote sensing and GRACE data. Is GRACE data not remote sensing product? 4. Page 8740, line 20: do you mean area instead of depth? 5. Caption of Fig. 3: comma after median. 6. Page 8742, line 24: Give extensions for SSM/I and VIS/IR 7. Page 8743, line 11: I would suggest using another synonym for “amalgamate”. 8. Page 8744 lines 15-17: MODIS over / underestimates LST and not in-situ temperature values. 9. Page 8745 lines 12: its aerospace centre? Does DLR belong to NASA? 10. Page 8745 line 25: is instead of are 11. Fig. 12: Map legends are too small and not readable. Enlarging obligatory. 12. Page 8761 line 22: Remove one “the” 13. Page 8761 line 23: intense instead of intesnse. 14. Page 8762 line 5: remove “with”

Answer:

We have addressed all technical corrections as suggested. We agree that is also remote sensing data that is why we described it under remote sensing on the data section. On page 8740, line 20: we mean area instead of depth. Page 8745 lines 12: we removed ‘its’. German Aerospace Centre (DLR) does not belong to NASA.

Reference Andermann, C., Bonnet, S., and Gloaguen, R.: Evaluation of precipitation data sets along the Himalayan front, *Geochemical. Geophysics. Geosystems*, 12, Q07023, doi:07010.01029/02011GC003513, 2011.

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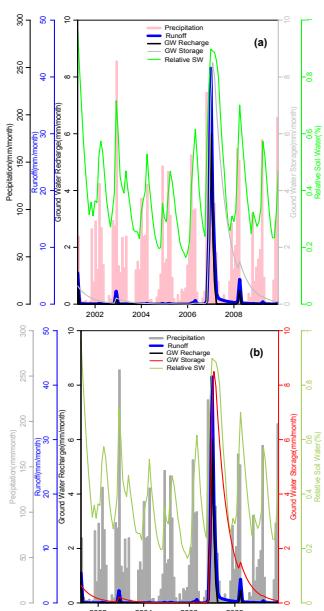


Figure 1: Model result based on (a) MODIS LST and (b) in-situ air temperature

**Fig. 1.**

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