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Hydrology and Earth System Sciences Discussions

Interactive comment on "Rainfall retrievals over West Africa using SEVIRI: evaluation with TRMM-PR and monitoring of the daylight time monsoon progression" *by* E. L. A. Wolters et al.

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We are grateful to reviewer2 for the thorough evaluation of the manuscript and suggestions for improvements. The comments are included in our response for clarity. In our response, we have included modified text where appropriate, with the modifications to the original manuscript highlighted in bold face.

This paper deals with the application of a rainfall estimation technique, originally developed for Europe, to the West African monsoon region. The study further uses TRMM-PR data and a subset of rain gauges observations to evaluate the satellite derived rain rates. Finally a very crude analysis of the propagation of the rain features is proposed. The monsoon rainfall observations from satellite is a very active ïňĄeld since 40 years now (since GATE) and I think this paper does bring, if any, only very little pieces of interesting and new information. I encourage the authors to reconsider the objective of such a publication. In the present form I do not recommend accepting the manuscript.

Taking the suggestions of the reviewer into account, we have reconsidered the objective of our manuscript. This has led to a reformulation of the objective in the introduction section. We have put more focus on the evaluation of our algorithm with respect to other satellite-based rainfall estimates, which has resulted in the addition of the CMORPH product in the evaluation section. In addition, the included number of rain gauge stations that were part of the AMMA project has been increased from the initial 16 to 110.

Below is a listing of the major changes with respect to the initial submission:

- A new Figure 2 has been included to indicate the locations of the rain gauge stations and to also indicate the location of the three regions used to evaluate the daytime cycle of rainfall.

- Figure 4 (old Figure 3) has been modified; the separate lines are now plotted in color to improve readability.

- Figure 5 replaces the old Figure S1; it now presents a comparison of monthly accumulated daytime precipitation from CPP-PP and CMORPH.

- Figure 6 (old Figure 4) is now composed of 4 panels; CPP-PP and CMORPH for the years of 2005 and 2006.

HESSD

7, C4048–C4054, 2010

- Figure 7 is a new figure.

- Figure 8 is a continuation of Figure 6, but presents rain occurrence frequency instead of rain rate.

- Figure 9 (old Figure 5) includes now the CPP-PP and CMORPH daytime rainfall cycle.

- Figures S2, 6, and 7, which dealt with the travel speed of MCSs and the MCS precipitation ratio, have been removed.

Remote sensing aspects and justification

While the presentation of the algorithm is clear, its justification in the introduction is not. Opposing the ground network capabilities against the satellite perspective does not bring you anywhere. It is clearly possible to monitor the monsoon seasonal march with rain gauges over Sahel (Sultan and Janicot, 2003, JCLIM; Janicot et al., 2008, Annales G) so the satellite does not ïňĄt in a gap.

It complements the existing network and extends the capability of the ground network but not at all scales. Furthermore there are a large amount of products already doing this very well and I am not sure the present retrieval makes it any better than GPCP 1DD for instance.

Moreover there has been extensive work showing that the ultimate, best products for rainfall estimations is actually the merging of satellite and gauges products (see GPCP, TMPA, TAMSAT etc...) The recent intercomparison work of Jobard et al., 2010 IJRS clearly reveals that only the merged products are reaching a high quality level over the

HESSD

7, C4048–C4054, 2010

WAM. Finally I think there are many relevant previous papers that should be identiïňĄed in your manuscript that paved the way for satellite rainfall estimates over Africa that I could not see in the present version. Putting more work on a thorough bibliography effort might be needed. All the mentioned references and references there in might help to do so.

First, we did not have the intention to oppose the CPP-PP rainfall retrieval algorithm to the existing rain gauge network or to claim that our algorithm is superior to the wealth of rainfall retrieval products focusing on Africa currently available. However, to our opinion the CPP-PP algorithm does add to the current rainfall product suite in that rain rates are retrieved from cloud physical properties at a very high temporal and spatial resolution, while most of the rainfall products mentioned by the reviewer are only given at daily scales or larger. In addition, CPP-PP is a single instrument algorithm that provides precipitation retrievals over land and ocean without the necessity of using additional information. Because the CPP-PP retrievals are not corrected with other observations, the original precipitation statistics are conserved, which makes these retrievals very useful for monitoring climate trends. In order to demonstrate that our algorithm is of sufficient quality to report rain rates at sub-daily scale, we have included the MW/IR geo-based CMORPH 3-hourly 0.25 $\times$ 0.25 product in the evaluation section of the manuscript. A description of the CMORPH product is included in section 2.

Second, the authors acknowledge the limitations of a VIS/NIR rainfall retrieval algorithm with respect to the continuity of observations and therefore its inability to estimate accumulated rainfall and further application to e.g. drought monitoring, which is a clear objective of the TAMSAT algorithm. As a result, a comparison against for example GPCP-1DD would be of little added value, since no nighttime precipitation data are available. However, in order to meet the reviewers' criticism, we have performed a comparison of accumulated precipitation from CPP-PP to the 3-hr CMORPH product. This comparison is included as a new Figure 5.

Validation aspects

HESSD

7, C4048–C4054, 2010

There the validation is made for instantaneous rain rates (which is not used in the application section of the paper) and not much about the accumulated rain amount which is much important to the users in meteorology and hydrology (at various scales). Also while you focus on summer 2006 only a very small subset of the data from the AMMA project is used and these are strong limitations of the present evaluation/comparison. One product is used as a reference and there is no effort to further include other estimates in the evaluation. So it is unclear how the new product behaves compared to some other (for instance other geo based algorithms) which is one more strong limit of the present study. It does not allow to see what the new product brings in.

Roca et al 2010 JAMC, proposed a meteorological benchmark to evaluate the satellite products over the monsoon. It uses the errors on the estimates and a variety of ground based datasets and scales to assess the relevance of the satellite products for use by the meteorology community. They furthermore developed and applied the technique during summer 2006 and intercompared various products. I encourage the authors to actually get inspired by such a an approach to really evaluate what their new product is really bringing in to the topic.

As already stated in the reply to the previous comment, it is difficult to estimate accumulated precipitation over days/months if a substantial amount of the observations are lacking. However, one of the strengths of our algorithm, in combination with the unprecedented spatial and temporal resolution of SEVIRI, is the possibility to perform a detailed investigation on various physical processes, such as the daytime cycle of *precipitation throughout the West African Monsoon and the relation between initiation of convection and soil moisture.*

In order to obtain a better indication about the added value of our algorithm with regard to the general statistics of precipitation (i.e., the comparison of the frequency distributions) and the representation of the daytime cycle of rain, we have included the CMORPH 0.25×0.25 3-hourly product in the cumulative/relative distribution function comparison and the evaluation of the daytime cycle. In addition, to obtain a larger amount of statistics, we have also included results for the monsoon season of 2005.

Finally, we have included the amount of rain gauge data from the AMMA project from 16 to 110 stations, which for the largest part were collecting rainfall measurements during both 2005 and 2006.

Meteorology

I am very surprised of such a very crude analysis of the propagating features being presented here. The authors are spending quite some time to build their case of having a very accurate quantitative rainfall products and it is now used extremely qualitively (visual inspection of the hovmuller diagram). Carbone et al 2002 JCLIM provide a much more reïňĄned perspective on this topic that could be of interest to the authors. The conclusions are that Sahelian MCS travel around 50 km/h is known since the inception of tropical meteorology. Furhtermore the authors correctly note that in the literature there is a variety of deïňĄtion used for MCS yielding to hard to interpret differences in their contribution to rainfall but do not provide any effor ts to cope with

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It was not the intention to claim that the average MCS zonal travel speed we found is a new finding or that it is the most accurate estimate. We rather have the intention to highlight that owing to the high temporal and spatial resolution of the SEVIRI instrument combined with the CPP-PP algorithm separate MCSs can be well followed during

HESSD

7, C4048–C4054, 2010

Interactive Comment

daytime and that a good estimate of their travel speed can be made using a 'simple' visual inspection.

In order to keep the paper more constrained to the evaluation of the CPP-PP rainfall retrievals, we have decided to remove the part of the manuscript covering the travel speed and MCS precipitation ratio.

Finally, we thank reviewer2 for giving additional references to strengthen our insight in the interaction between AEWs and MCSs/squall lines. We have extended the discussion about the MCS dynamics with the references to Fink et al. (2003) and Diongue et al. (2002). In addition, we have included further references about the large-scale dynamics of the monsoon system and the sudden transition of the rain bands during the monsoon season. These topics are discussed in the introduction section.

References: Hagos, S.M., and K.H. Cook, Dynamics of the West African Monsoon Jump, *J. Clim.*, **20**, 5264-5284, doi: 10.1175/2007JCLI1533.1, 2007.

Cook, K.H., Generation of the African Easterly Jet and its role in determining West African precipitation, *J. Clim.*, **12**, 1165-1184, 1999.

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