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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Characterising energy budget variability at a Sahelian site: a test of NWP model behaviour" *by* Anna Mackie et al.

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Thank you for the useful comments, which we respond to here, as well listing the ways in which we have amended the manuscript.

Major comments 1. Evaluating the performance of a global model at a single station is not a common method for extracting robust results and limiting the study in Niamey limits also the significance of this work. You should present and discuss also the comparison with other measuring sites preferably at areas with different climate properties.

This work focuses on the particular challenges of modelling radiative processes in the Sahel region, using the unique combination of measurements from the AMF and GERB/SEVIRI to allow the radiation budget at the surface and TOA to be coupled and,

critically, interpreted, via the use of ancillary measurements, at high temporal resolution. Regarding the robustness of the results, it is worth noting that the Niamey site was specifically chosen by the ARM programme as being representative of the wider Sahelian behavior (Miller and Slingo, 2007) and that observations from this single location have been used to evaluate global climate model performance in the past (e.g. Miller et al., 2012).

More practically, databases such as the one exploited here are exceptionally rare: to the best of our knowledge there are only four other locations globally where the opportunity to combine AMF and GERB/SEVIRI data currently exists. As evidenced by the careful analysis here, adding just these sites would constitute a significant amount of extra work and lead to an unwieldy final manuscript. Performing a similar analysis over different locations that experience very different climate conditions would be a natural and interesting extension of this work. However this is not the goal of this paper.

A paragraph has been added to clarify our goals and choice of site in the Introduction: "The combination of data available from the AMF and GERB/SEVIRI provide a valuable insight into radiative processes in a region where surface measurements are scarce. In particular, the high temporal frequency of the data allows us to look in detail at the relationships and dependencies between key variables. It is worth noting that although this study is necessarily limited to the one measurement site at Niamey, this location was chosen carefully in order to sample the range of climatic conditions typically experienced across the wider Sahelian region (Miller and Slingo, 2007)."

2. The considerations about the constant positive bias in modeled albedo are in my opinion some of the most important findings of this work. Following my previous consideration, it is possible that such albedo bias is also present in different areas worldwide. Improving the surface / soil model in the model (possibly incorporating NDVI observations) could probably improve the overall model performance since a more physically based representation of surface fluxes will also affect cloud formation (hopefully towards the correct direction). As a first step I would encourage that you perform a test

run with the modified albedo in 43r1 (as you present in section 4.2.2) and see how this will affect the model results.

We agree with the reviewer that the surface albedo bias is an interesting result. It is obviously also possible that similar biases exist elsewhere although arid and semi-arid regions are known to present a particular challenge for regional and global models (see for example Milton et al., 2008, Greuell et al., 2011). We also completely agree regarding the potential implications. However, simply inserting a modified albedo for one grid location into the ECMWF operational model is not viable either from a scientific or practical perspective. Assessing the impact of a more realistic representation of albedo (including its impact on dynamics) could be part of a longer term initiative working collaboratively with the relevant experts at ECMWF: indeed we hope this work would serve to motivate improvements in this area.

Minor Comments -How do you explain the great variability in daily measurements compared to the model results in Figures 2, 3?

We have added a sentence at the end of section 4.1.1 addressing this: “All radiative variables show more variability in the observations than the model, reflecting the larger range of competing influences in comparison to the idealised and less chaotic model.”

-P4, L17 “ERA-I has also been evaluated by other studies in West Africa (Marsham et al., 2015).” Please state briefly what are the results of these evaluations for ERA-I.

This has been added: “, who find that TCWV is well captured by the model and that its role in controlling TOA net flux is more important than that of dust.”

-P6, L28: “However, the the majority” Please correct

Done

-P7, L3-4 and elsewhere “Wet season average bias in DLR and ULR is small at 0 and 1 Wm-2, respectively” Averaging over a long period of negative and positive biases can result in almost zero average bias but this is probably misleading. Using absolute bias

could provide more insight on the model performance.

The sentence has been amended from “Wet season average bias in DLR and ULR is small at 0 and 1 Wm-2, respectively” by adding “, though this is due to cancellation of the model underestimation of DLR and ULR in the first part of the wet season (days 126- 200) with the overestimation in the second part of the wet season (days 200–300).”

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