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Comment on acp-2021-129

Anonymous Referee #3

Referee comment on "Investigating the Impact of Saharan Dust Aerosols on Analyses and Forecasts of African Easterly Waves by Constraining Aerosol Effects in Radiance Data Assimilation" by Dustin Francis Phillip Grogan et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-129-RC3>, 2021

General Comments:

Direct aerosol-affected radiance calculations are not practically adopted in current operational numerical weather prediction (NWP) and data assimilation (DA) systems. This is mainly due to computational cost issues. Also, uncertainties of land surface conditions in radiative transfer models contribute to the limitation. Thus, this paper are appropriate to the NWP development direction and requirement. The topics of the paper addresses the impact of aerosol-aware daiance calculation on the dynamical atmospheric structure on northern Africa. However, general recommendation is a major revision to the paper and additional experiments and evidences to draw a concrete conclusion and discussion. 2017 August time period was used in the experiment to investigate the dust impact on circulation patterns involving two Hurricanes cases, Gert and Harvey. The authors were able to identify that the aerosol-aware run reduces the errors of forecasting the African easterly waves. The improvement is positive especially for Hurricane Harvey case but neutral or no improvement for the Hurricane Gert case. Obviously additional experiment for different time period is needed for robust conclusion. General editorial comments about the current version of the paper: overall writing quality is not clear and additional literature survey is needed. Details are missing in figure and table captions and titles. At this stage, my opinion is to suggest major revisions and additional experiments for the paper. Detail editorial corrections and comments can be provided once a mature version is resubmitted. Nonetheless, a few early remarks and suggestions are given below.

Main Comments:

1. Title slightly misleads discussion points. Is the main point about the effect of Saharan Dust on AEW from AGCM dynamics point of view or impact from DA procedures? Detail dust structures and distributions are not provided in the paper. DA and analysis statistics are not fully provided.
2. Model experiments: Current operational version of the NCEP GFS system is based on the cubed sphere FV3 dynamical core and version number has already reached around version 16. GFS v14 used in the paper is considerably outdated. Prescribed monthly aerosol climatologies obtained from the OPAC package were applied in the experiments. It is very difficult to make any opinion about how useful the OPAC aerosol data sets are for direct applications in the NWP DA systems. Clearly, a trouble is to understand about the

experiment design and approach: monthly climatological aerosol data set for one month NWP forecast and DA experiments.

3. Figure 1 shows that NGAC data is used in the GDAS cycles. Again, DA analysis statistics of the aerosol-aware experiments are critically important for discussion.

4. In the paper, mean forecast field differences are extensively compared for the experiments with and without aerosol-aware data assimilation. Since the experiments are based on the whole month of August, distinguishing aerosol background structures are key factors and following impact on the brightness temperature calculation should be provided for all assimilated infrared observation data sets. Single IASI scatter plot figure (in figure 9) is not sufficient.

5. Forecast RMSE differences are compared in Table 1 to identify the improvement. Obviously, there is a statistical risk to draw any conclusion with limited forecast samples.