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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Models transport Saharan dust too low in the atmosphere compared to observations" *by* Debbie O'Sullivan et al.

Anonymous Referee #2

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The paper "Models transport Saharan dust too low in the atmosphere compared to observations" presents and discusses the performance of two dust forecasts from MetUM and CAMS atmospheric models in comparison with in-situ measurements of dust size-distribution, airborne lidar derived optical properties and satellite based MODIS-Aqua and CATS-ISS observations obtained during August 2015 over the Eastern Atlantic Ocean, in the Saharan dust outflow vicinity, in the framework of the AER-D/ICE-D campaigns. The study, offering insight on dust transport, falls within the scope of ACP. The manuscript is well-written and well-structured, the presentation clear, the language fluent and the quality of the figures high. The authors have done a thorough job and the results support the conclusions. I recommend publication in ACP, however I recommend the following minor revisions before publication.

Comments:

1) As stated by the authors, MODIS AOD is assimilated in both MetUM and CAMS models. In MetUM MODIS C5 AOD is assimilated. Is this the same collection that is assimilated in CAMS? If not, how are the conclusions affected by the different assimilated collections? Furthermore, the comparison of the models is performed against MODIS C6.1. How do the different satellite datasets, the assimilation of different collections, and the non model-sattelite independence qualitative/quantitative affect the conclusions?

2) Regarding CATS, only two sentences are provided, in the "Satellite Data" Section. However, CATS is extensively used in the manuscript. The authors should extend the section with a proper description of the dataset, including information on the Version that is used (if not the latest version it is suggested to use V3.1), including in addition information on the Quality Assurance procedures that are followed prior to the comparison with the models and the FAAM airborne dataset.

3) Regarding the discussion of the comparisons made between MetUM, CAMS, FAAM lidar, CATS, and MODIS, the authors frequently remain to qualitative presentation of the results, without providing any quantitative values. For instance, the authors frequently use phrases like "very little wavelength dependence was noted", "there is virtually no difference", "agrees well", "are in agreement", "is broadly in agreement with", "underpredict the intensity", "is less than half", "the magnitude of the predicted extinction is similar, although with differences in the dust layering", without providing values. The entire manuscript should be revised accordingly.

4) In Table 1, statistical metrics are provided for the different AER-D flights, for MetUM, CAMS and FAAM lidar. It would be beneficial for the manuscript to include a flowchart showing the methodology of the comparison followed by the authors. The entire process can be summarized there along with the followed comparison methodology and requirements e.g. the spatial - temporal constraints, screening requirements, Quality

Assurance approach, etc. The information exists in the manuscript but I feel like it is scattered among the sections. Furthermore, I suggest the authors to provide the collocation criteria (both spatial and temporal), wavelengths, etc, since the datasets are very different. Finally, Table 1 should include more statistical metrics than the minimum, maximum and standard deviation.

5) Regarding references, the authors give proper credit to related work, especially in the introduction and the methodology sections. However, regarding the basic concept of the performance of dust models in dust transport and the main findings, I would suggest the authors to expand the discussion and the list of references in order to strengthen the manuscript and at the same in order to give credit to related studies, and additionally to discuss how the findings of the studies compare.

6) During August 2015, CATS operating on board the ISS was one of the two satellite-based operational lidar systems. Regarding ICE-D and the performed B920 ISS underflight, near the Cape Verde islands, the high collocated airborne and CATS lidar observations is a clear reason for the implementation of CATS. However, due to the broader study domain and the performed extended analysis in Section 4.3 “Comparison with the CATS spaceborne lidar”, I am a bit surprised that the authors do not attempt to use a similar CALIOP-CALIPSO lidar approach. Dust retrieval is probably one of the best products from CALIPSO, even if CALIPSO reports only at 01:30 and 13:30 hrs local time, it should be useful to compare the MetUM and CAMS at those local times.

7) “The Cloud-Aerosol Transport System (CATS) onboard the International Space Station was a polarization sensitive backscatter lidar with higher detection sensitivity than CALIOP and superior ability to differentiate different aerosol types (Yorks et al., 2016)”. The authors are kindly asked to check this statement. According to Table 1 of Yorks et al., 2016, although the MDB of CATS M7.2 1064nm is lower than CALIOP 1064nm during nighttime, this does not hold during daytime. Furthermore, this case study corresponds to a case study of cirrus clouds at 15km.

8) The quality of the Figures is high. Regarding the visualization of the extinction coefficient cross-section from CATS, it is suggested the authors to use a similar approach as done in the airborne lidar cross-sections, regarding missing calues (e.g. totally attenuated due to clouds, quality filtering, etc). In the way that the cross sections are provided in the present version of the manuscript, instead of missing values, values “zero” are assigned, leading to misinterpretations to the reader.

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