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Interactive comment on "RAMS-MLEF Atmosphere-Aerosol Coupled Data Assimilation: A Case Study of A Dust Event over the Arabian Peninsula on 4 August 2016" *by* Ting-Chi Wu et al.

Anonymous Referee #1

Received and published: 6 February 2019

The paper presents a first-time application of the Regional Atmospheric Modelling System (RAMS) couple with the Maximum Likelihood Ensemble Kalman Filter with the aim at improving the aerosol model prediction by assimilating aerosol optical depth retrievals from from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument. The manuscript is divided into a technical description of the assimilation system and a part dedicated to the experimental design and results from a case study.

While the paper reads quite well and the topic is relevant and appropriate for ACP, I am left with some reservations in regards to its publication as I believe it still needs substantial work. My main comment is that unfortunately the case chosen for the study

does not do justice to the advanced assimilation system, due to the lack of observations both for assimilation and for independent verification of the results. The reader is left without sufficient information regarding the performance of the system. I would encourage the authors to choose a different case with more observations available. In particular, the authors mention the use of a Coastal Water retrieval but in their study no emphasis is given to how this novel data performs in the assimilation and whether it helps improve the aerosol forecasts. They also use mainly MODIS Dark Target data which are not available over the area of interest for their research, i.e. the desert of the Arabian peninsula. I am left wondering why MODIS Deep Blue data or MISR data were not used in this case. Also the author state that there were no ground-based data for the verification and use MERRA-2 as their verifying dataset. While it is fine to use independent reanalysis to verify model forecasts, again I am wondering if they could have picked a better case in which some (even limited) ground-based observations were available for independent verification. Satellite products other than MODIS could have also been chosen for verification, for example MISR data (if available for this case).

One final point is that the paper would also benefit from a more in-depth analysis of the meteorological analysis. The authors claim that there is an impact of assimilating aerosol data on the other control variables, for example horizontal winds, but they limit themselves to showing the analysis increments which in themselves do no prove whether this impact is real or an artefact of the coupled system. The information content analysis by itself is not very convincing.

For these reasons I would not recommend this paper for publication in this present stage, but I would encourage the authors to develop it further and resubmit it at a later stage with additional case studies and a more in-depth analysis of the results. Further comments and suggestions are made directly into the manuscript pdf (in attachment).

Please also note the supplement to this comment:

https://www.atmos-chem-phys-discuss.net/acp-2018-1249/acp-2018-1249-RC1-supplement.pdf

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