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Interactive comment

Interactive comment on "Bias correction in assimilation of AOD observations with WRF-Chem" *by* Anton Kliewer et al.

Anonymous Referee #2

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General comment: The primary objective of this study is to improve 3D aerosol structure over littoral zones. To improve the 3D aerosol structure, the authors assimilated MODIS AOD from Aqua and Terra Satellites using a coupled modeling system, consisting of a MLKF (Maximum Likelihood Ensemble Filter) analysis system and WRF-Chem. A case study that occurred over the Arabian Peninsula was used as a demonstration. The authors argued that systematic differences between observations and model guess (i.e. short-term forecast) exist, defined as biases. Thus the authors proposed to use two different bias correction methods, one "moving average (MA)" and the other "bootstrap", to correct AOD observations before assimilation. Three experiments were conducted: one without AOD bias correction and the other two with each of the bias correction methods. Metrics of diagnosed parameters were used to evaluate the

analyses among these three experiments. They concluded that the result with the assimilation of MA bias corrected AOD data was slightly better than that without any bias correction and that the result from the assimilation of bootstrap bias corrected data was the worst. The study is interesting and important. However, there are some major concerns that need to be addressed before this article can be accepted for publication in ACPD.

Major comments: 1. The introduction did not provide enough review on AOD data assimilation. It needs to be significantly improved. 2. The difference between observed AOD and model guess could be due to model bias too. While it sounds like a good idea to apply the bias correction to AOD observations before they are assimilated, it is possible that model biases can be aliased into observation biases, in particular when the bias is defined as the difference between observation and model guess (short-term forecast). The use of another independent observation to verify the analysis is important to this study. In addition, as the purpose of developing the coupled system is to reduce forecast uncertainty, it makes sense to extend the work to include some forecast results, which is another way to evaluate the use of the AOD data with and without bias correction. 3. Are there meteorological observations, either conventional or remotely sensed data, assimilated in these numerical experiments? To more accurately evaluate the impact of AOD assimilation on analysis, other meteorological observations have to be assimilated in order to do a fair comparison. In addition, were the aerosol-cloud-radiation interactions included in the model forecast (i.e. model guess)? The neglect of these physical processes can cause some model aerosol biases, which can then be aliased into observation biases. 4. When evaluating DA analysis, were observations used in evaluation also bias corrected for those experiments using bias corrected data? This will have a great impact on the evaluation results, but it is not clearly stated in the manuscript. If the answer is yes, then the use of another independent observation for verification is important in this study.

Minor comments: Page 2, line 29" "the controls variables are . . . " Page 3: what are the

radiation and boundary layer schemes that were used in model simulations? Page 4, line 1: "The control variables includes . . ." Page 5, line 5: Shouldn't Terra satellite pass at about 10:30 am local time, instead of 11:30 am? Page 5, line 11: Does GOCART take care of aerosol aging processes? If not, use "internally mixed" instead of "externally mixed". Page 7, line 21, what is the "control estimates" here? Is it the ensemble mean? Clarify it. Page 8. Line 21: the "maximization" of the cost function. Fig. 3 looks more like a table, instead of a figure. Fig. 4. Why was there no AOD data over eastern side of North Africa? Is there any quality issue of AOD data over there? Thirty-two ensemble members are used in the study. What is the localization value used in data assimilation? Is it the same for both domains?

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-1156, 2018.