This manuscript evaluates the performance of MODIS Above-Cloud AEROsol retrieval algorithm (MOD06ACAERO) in the Southeastern Atlantic for biomass burning aerosols using Multi-Sensor Cloud and Aerosol Retrieval simulator (MCARS). Lack of aerosol retrievals in cloudy conditions is a well-known problem in the aerosol community. This study helps address this issue using a closure study of MOD06ACAERO above-cloud Aerosol Optical Depth (AOD). The paper meticulously describes the observations and model and discusses the limitations and strengths of the retrieved AOD for different filtering conditions based on cloud cover, zenith angle, and pixel-level retrieval uncertainty. The results from this study are beneficial for model evaluation studies and design of future satellite missions.

Filtering conditions and related error metrics from this study provide an opportunity to test the model performance from assimilation of MOD06ACAERO AOD retrievals. Availability of code and data will make it easier to test this approach for other satellite instruments and aerosol types. The paper is well-written and easy to read. However, there are some major revisions that need to be addressed before the paper is published.

Major Revisions:

- Differences in the aerosol model between MOD06ACAERO retrievals and GEOS-5 need to be discussed in the analysis section. This can be included before describing the results from the sensitivity tests (before line 290).

A detailed study of those differences is presented in Wind et al (2016). Text has been amended to clarify.

- What are the uncertainties/biases in the retrieved AOT (using MCARS) from this study? What are the factors influencing the uncertainties over land and ocean for the retrieved AOT using MCARS synthetic radiances? It is not clear if the algorithm is useful for clear-sky conditions or can be used only in cloudy conditions.

MO06ACAERO algorithm is to be applied strictly over ocean. It does not execute over land. The algorithm is useful for both clear-sky and cloudy conditions and it was evaluated for both in this study. For detailed information about this algorithm one must consult Meyer et al (2013 and 2015). This paper gives only a brief overview of the algorithm details, as that is all that is needed here. Here the focus is on the closure and performance over synthetic data only.

- Figure 2. Shows real data example of MOD06ACAERO Aerosol Optical Depth (AOD) retrieval and MODIS Dark-Target (DT) aerosol retrieval. It is clear that

the data gaps are reduced in panel c). However, there are differences in AOD values between panel b) and c) even in areas where MODIS DT clear-sky retrievals are available. What are the reasons for these differences?

These differences are due primarily to aerosol radiative model differences and the different sensitivities of the retrieval approaches (clear sky retrievals are generally sensitive to aerosol scattering, while above-cloud retrievals are sensitive to absorption). While MOD06ACAERO uses the absorbing aerosol model from the MOD04 Dark Target over land retrievals, MOD04 uses a different retrieval approach over oceans that combines various course and fine mode aerosol models that are different from their land assumptions.

- How does the retrieved AOD compare against MODIS DT in clear-sky conditions?

This information can be found in Meyer et al (2013 and 2015), with additional comparisons against CALIPSO. The agreement was very good, considering that MOD06ACAERO and MOD04_DT use the same exact set of aerosol models. This particular study is a closure study where the algorithm is tested on a synthetic dataset with known "truth" for every pixel. Comparisons of MOD06ACAERO results with other sensors are outside the scope of this study.

- Figure 4-10 – it is not shown what do colors represent in the panels. Do they represent probability density values? Adding a colorbar and description of the colorbar in the caption is necessary.

Corrected. Thank you very much.

Minor Revisions:

- In general, it will be interesting to assess the performance of retrieved AOD in the Atlantic for dust transport from Africa above the clouds. For this paper, it will be helpful to include comments/references on the performance of MOD06ACAERO for other aerosol types.

MOD06ACAERO is a strictly regional algorithm developed for use in SEAO and similar areas around the globe. There are presently no plans to use it anywhere else. Any such studies would be in the domain of authors of MOD06ACAERO algorithm and are outside the scope of this paper. This study focuses on developing good practices for the modeling community for use of data that the authors of MOD06ACAERO might consider for public release.

- Although the goal of this paper is to evaluate MOD06ACAERO, comparison of the results against ORACLES data will strengthen the paper.

The goal of this paper is to develop a set of assimilation constraints for model developers interested in assimilating MODACAERO retrievals into their models. Comparisons of MODACAERO retrievals with in-situ field campaign data are planned by the authors of MODACAERO algorithm as a separate and unrelated study. Text has been amended to clarify that point.

- Line 71 add reference – reference is missing. "… daily mean cloud fraction greater than 50% in the MODIS Daily Level-3 gridded product (add reference)"

Corrected. Thank you very much. .

- Lines 277-280 : It is understandable that G5NR is a free running model and any resemblance to real data is a coincidence. Please elaborate (or rephrase) lines 277-280 to include comments on a similar comparison of cloud amount/distribution in MODIS granules and G5NR. Spatial distribution of clouds and cloud optical properties between G5NR and MODIS granules can affect the retrieved AOD. How is this addressed? (see Le Blanc et al., 2020).

Cloud amount and distribution are not important in this case as no intent of comparison with any real data is made at any point. That statement is made in text a number of times. What is important, that however clouds and aerosols are distributed and whatever their amount is, the content of atmospheric column for every pixel for which MOD06ACAERO retrieval is attempted is a known quantity at all times. We examine how well the MOD06ACAERO code is able to retrieve that "known quantity".

- Line 270 – "from from the simulation offers". Remove one.

Corrected. Thank you very much.

- Figure 4-10 - colorbar is missing. Since the data density between panels a and b change in these figures, it would be more meaningful to include normalized error metrics in these figures such as normalized mean bias or normalized RMSE, fractional gross error. Please add what colorbar represents in the figure captions (perhaps, probability densiity values) ?

Colorbars have been added. The color scale is normalized density. RMSE and fit equation are present on every panel of every histogram.