Comment on gmd-2021-17
Anonymous Referee #2

Referee comment on "Analysis of the MODIS above-cloud aerosol retrieval algorithm using MCARS" by Galina Wind et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-17-RC2, 2021

Review comments on 'Analysis of the MODIS Above-Cloud Aerosol Retrieval Algorithm Using MCARS' by Wind et al.

This manuscript uses Multi-sensor Cloud and Aerosol Retrieval Simulator (MCARS) and GEOS5 Nature Run (G5NR) model output to simulate the MODIS radiance, run above cloud aerosol retrieval using generated radiance, and evaluate the MODIS above cloud aerosol retrieval product (MOD06ACAERO), focusing on the absorbing aerosol above low-level water cloud scene from Southeast Atlantic Ocean. The community need for such an aerosol product is urgent since it fills the aerosol data gap in regular MODIS products, which can only retrieve aerosol in the clear sky and on a larger scale (i.e., 3X3 or 10X10 km). Such a 'truth in truth out' study can validate the instrument performance, improve retrieval algorithm, and investigate the potential uncertainties in the retrieval product. This method is beneficial, especially in future satellite missions. Overall, this is a well-written paper with a clear description of the data and methods, and the results are presented and discussed in an appropriate and concise manner. This paper should be accepted essentially with one major comment and few minor revisions discussed below.

Major comment:

One potential uncertainty in aerosol retrieval comes from the aerosol model, especially the single scattering albedo (SSA). The MOD06ACAERO algorithm uses the standard MODIS dark target aerosol model. However, this SSA is higher than the ORACLES campaign reported values (Pistone et al., 2019). In a recent GRL paper by Chang et al. 2021, they compared the MOD06ACAERO product with their own MODIS above cloud AOD retrieval and many other observations (e.g., HSRL2, 4STAR) from the ORACLES campaign. And they found that the difference in SSA is a major source of uncertainty in above cloud aerosol retrieval. What is the spectral SSA in the dark target aerosol model, and how it compares to G5NR SSA and real SSA measured from the filed campaign? The correlation between MOD06ACAERO and G5NR ACAOD can be high as long as both aerosol models are similar to each other, but this doesn't mean they are accurate or close to the observations. Therefore, the authors need to address this problem in the paper. And for any algorithm development study, a validation by real observations would be helpful.
Specific comments:

- Please add color bars to figures 4-10.
- Line 71: Reference is missing as authors marked in the text.
- Line 110: In MCARS simulation, is instrument measurement uncertainty also accounted?
- Line 118: Increase the number of streams will increase the accuracy of simulated radiance. Meanwhile, the computational time also increases, but how much more accuracy gain due to this change?
- Line 136: It will be great to compare with the field campaign data (e.g., NASA ORACLES).
- Line 270: 'from' is used twice, please delete one.

References:

