Interactive comment on "Multi-sensor cloud and aerosol retrieval simulator and remote sensing from model parameters – Part 2: Aerosols" *by* G. Wind et al.

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Summary

This manuscript introduces MCARS software developed by NASA team. MCARS has unique capability to simulate synthetic MODIS-observable radiance and also conduct operational retrievals. By comparison model-generated geophysical parameters (AOD) and synthetic retrievals, scientists can study the impact of retrieval assumptions on operational algorithm. I really like the sensitivity studies to find out MOIDS operational retrieval biases through the case studies presented in this paper. There are quite many editorial suggestions to improve this manuscript for more high-impact paper. Please see the detailed comments below.

Major Comments

Section 3. Explanation of dark target is too long (3.5 pages out of total 19 pages). Please reduce into a half size or even shorter, just focusing on algorithm assumptions that lead the retrieval spreads/biases discovered in this study.

Page 13, Line 4-11: Principle of using synthetic data is to understand physically-based reasoning of satellite-retrieval biases and uncertainties elsewhere in the globe without field campaigns. Absence of AERONET won't be the major reasoning. In other words, even if AERONET data present on this location, it cannot directly tells what is the cause of satellite-based retrieval biases found in this study.

Section 4.1: This is software paper about MCARS. Please add more explanation of MCARS, especially, ICA for aerosols. Wind et al. (2013) described ICA for clouds, but aerosols. This is probably most important component of MCARS for treating aerosols from a global model. And, what is the resolution of GEOS-5 simulation in this case study? There is some description in Page 13 (Section 4.1), but not well describe how aerosol mass-microphysics are disaggregated through PDF. Are PDF of RH, clouds, and aerosols are independent or dependent each other? How are vertical profiles? Realistic? How is vertical overlapping of aerosols and clouds generated? ICA provides clouds and aerosols geolocation randomly? In other word, every single time, ICA provides different spatial locations in stochastic sense? Please explain (at least a few pages, again, this is the critical step of MCARS-GEOS-5 coupling, and again, you can reduce writing of MODIS DT algorithm.) Also, please add how long (wall-clock time) to generate synthetic MODIS radiance from GEOE-5.

Page 15 (line 15-17). "comparisons are to be contrasted to similar comparisons between MODIS aerosol retrievals" this is not true. These MODIS-AERONET comparisons and MODIS synthetic evaluation, conducted here is fundamentally different meaning and focus in evaluation.

Scatter plots. You have found albedo and column water vapor are major reasoning that

cause systematic biases in MODIS retrievals. But I still see systematic biases in low AOD, even after using homogeneous albedo and identical SSA. Do you know why?

Minor Comments

Figure 2, 5, 6, and 10. I suggest to add statistics (biases, RMSE, etc..) information over each scatter plot like Figure 3.

Figure 4. This is hard to see. I suggest remove surface BGR color, or add line contours for dust, sulfate, and carbon concentrations.

Figure 7: Is this bulk (all species, column-integrated) single scattering albedo? Or specific one species?

Figure 9: Please add wavelength for each vertical line.

Figure 11: Missing color-shade bar.

Followings are editorial corrections/suggestions. Page 2. Line 3: "model" → "meteorological model"? Line 4: "atmospheric column" → "atmosphere and land/ocean surface". Line 8: "36 available simulated layers" → "36 vertical layers" Line 17-18: "can be conducted in a controlled fashion." âĞŠ "can be controlled." Line 19: "GEOS-5" → "Global Earth Observing System (GEOS)–5" Line 20: "management methods" → "parameterization"

Page 3 Line 1: "actual sensor output" → "operational retrievals." Line 3: You may add "over Amazonia" after biomass burning. Line 3: "show" → "demonstrate"

Page 4 Line 13: "emission" → "infrared emission"

Page 5 Line 3: "do not scan" → "are limited at nadir" Line 7: "when such models are created" → "in dynamic core and physics parameterizations" Line 22: "used" → "applied" Line 23 :"any sensor" → "any similar type of visible-IR radiometeor".

Page 7 Line 13: "GOCART" → "The Goddard Chemistry Aerosol Radiation and Trans-

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port (GOCART)" model Line 13-15: These para will be shortened like"The GOCART bulk aerosol scheme is used in the GEOS-5 NRT aerosol forecasting system in this paper" Line 17: "radiatively coupled" → "affect atmospheric radiative heating and budget" Line 17: "chemistry of dust" I don't think GOCART handle any chemical process in dust species.

Page 8 Line 6: You are repeating same argument. I saw similar sentence in previous page. Line 7: "the aerosols and other tracers interact radiatively" again, you have already mentioned it in the previous page. Line 20: "Moderate Resolution Imaging Spectroradiometer (MODIS)" → "MODIS"

Page 13 Line 16: You already defined ICA before. Line 23: "radiative transfer" → "RT" already defined before.

Page 14 Line 14: "run" → "run-time" Line 24: Are molecular Rayleigh scattering is not included in this study? If so/not, please add it so (also in Figure 1).

Page 16 Line 7: Be careful. You cannot investigate 3D effect and/or surface BRDF effect in this package yet. You may add following after this sentence, "in great details, as long as the RT model and the aerosol model can handle."

Page 17 Line 23: It actually changes the spread, meaning of shape of scatter plots. So, I suggest re-write "the overall shape of scatter plot" → "the overall biase characteristics of scatter plots."

Page 18 Line 4: "AERONET is only able to provide direct" → "AERONET is only instrument that enable to estimate" Line 11: "good" → "reasonable" Line 13: "during" → "in" Line 19-20:" result lines up with "ground truth" GEOS . . ." → "result closely lines up with synthetic GEOS." Line 21: Improvement is limitted for high AOD regimes. Low AOD (<0.5) yet consistently have biases. Why? Line 17: "Dark target" → "DT" already defined before.

Page 20 Line 7: "is" → "are" Line 13: "aerosol optical depth" → "AOD" Line 14" "column

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relative humidity" → "realistic relative humidity" Line 15: Describe add impact of surface albedo, which greatly reduced the spread of scatter plots, while RH reduced biases of high AOD comparison. Line 17: ""ground truth"" → "synthetic" Line 23 − 25: I don't understand what this sentence really means.. Give some examples.

Page 21 Code release. NASA GSFC software release requires complete open-source process or partial release through the NASA paper work document. http://opensource.gsfc.nasa.gov/index.php

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