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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluation of aerosol distributions in the GISS-TOMAS global aerosol microphysics model with remote sensing observations" *by* Y. H. Lee and P. J. Adams

Anonymous Referee #2

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The manuscript evaluated simulated AOD as well as Angstrom coefficient in the GISS-TOMAS global aerosol microphysics model, using satellite (MODIS and MISR) and ground-based (AERONET) data. An offline module is used to calculate AOD, using the monthly-averaged aerosol fields from the GISS-TOMAS model. Possible causes for the over- and underestimation compared with observations are discussed.

The manuscript is well organized, and the methodology is described in detail. This manuscript services as a good document about their model performance. A fair amount of efforts are put to understand the discrepancy between the model and observations. This kind of exercise is important for their model development, and can produce valuable information for their future model improvement. But unfortunately, the manuscript did not produce significant new sights that are useful to a more general audience.

Specific comments:

Satellite and ground-based aerosol optical property data have been used in many previous studies. The authors fail to distinguish this study with previous studies. A similar study by Liu et al (2006) is missed in the references. Liu et al. (2006) used more satellite data (MODIS, MISR, AVHRR, POLDER, and TOM) and did a better job to explain and to explore the difference between different satellite data. Liu et al. (2006) also evaluated more aerosol optical property parameters (AOD, single scattering albedo, and Angstrom coefficient). As pointed out by Reviewer 1, the aerosol microphysics model used in this study has some advanced features, but the authors did not go deep enough to evaluate these features, such as mixing state, and size distribution. Angstrom coefficient is meant to evaluate simulated aerosol sizes, but the authors only have one paragraph for the evaluation of the parameter. More discussion regarding this parameter will be helpful. It will be also desirable to compare simulated single scattering albedo with observations. This may provide insights about simulated mixing states.

The GISS global atmospheric circulation model runs at very coarse resolution (4x5 horizontal resolution, and with 9 vertical sigma layers), and only one year integration is used (I am not aware of any other global aerosol model studies that used a similar resolution in recent years). This coarse resolution may affect simulated winds, cloud and precipitation fields, which are critical to their simulated aerosol fields as the authors suggested in their manuscript. Please comment on the use of this old global atmospheric circulation model, and how the coarse resolution will affect the model results, and please also comment why the model does on run at finer resolutions (more vertical levels, and more horizontal grids).

p. 19476, section 2.2: Need more details about the module. How is your approach different with those used in Stier et al. (2005) and Ghan and Zaveri (2007)? Can your approach be computationally fast enough to be included online? It is still a challenge to calculate aerosol optical properties online in global climate models, using size-resolved aerosol composition from detailed aerosol microphysics models. Also, do the TOMAS's aerosols affect the radiation in GISS? If they do, how are their effects calculated, e.g., is this consistent with the offline calculation described here?

p. 19476, line 27, p. 19484, line 17-29: Why does the model not distinguish the clear-sky with the cloudy sky? The difference between clear-sky and cloudy-sky mainly comes from aerosol water. So how does the model calculate aerosol water in the clear-sky and cloudy-sky? Schmidt et al. (2006) suggested that clear sky value is the most appropriate comparison to the satellite observations. So why is the aerosol water in clear sky not used in this study? Your model should be able to track aerosol water in the clear-sky. A large part of the discussion in section 4 is related to this clear-sky vs. cloudy-sky issue.

p. 19486, line 17-29; p. 19487, line 1-6: I agree with Reviewer 1 that more is needed about wet deposition. In your aerosol microphysics model, are all aerosol species assumed to be internally mixed in each aerosol bin? How does the assumption about the mixing state in the aerosol model affect the wet removable rate of biomass burning aerosols?

p. 19496, Table 2: need references for refractive index (references for density are also missed). Please also comments about the large imaginary part used for dust and OM. 0.0055 is probably too large for dust. Myhre et al. (2003) suggested that 0.0014 is better.

A table of global aerosol optical depth will be helpful.

Technical corrections:

p. 19475, line 20: Pierce and Adams (2009a) is not in the references.

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p. 19476, line 6: Correct the sentence “Dry deposition is used the series resistance”;

p. 19477, line 20: miss “,” after “However”;

p. 19480, line 15: the model did not do a good job during SON too.

p. 19483, line 16: I do not think agreeing within a factor of 2 for AOD is a good agreement.

p. 19485, line 17: “party” → “partly”?? Also, you may want to add “caused” after “partly”;

p. 19487, line 8: The calculation of aerosol optical depth is an offline calculation. So it may not be accurate to say that the module “is implemented in the GISS-TOMAS global aerosol microphysics model”;

p. 19495, Table 1: Should the burden and the model column mass be the same thing? With the units used in Table 1, the amount of column mass is about 2 times of the burden. That is the case for dust, total EC, and total OM in your table. But why is that not the case for sulfate.

References:

Liu, L., A. A. Lacis, B. E. Carlson, M. I. Mishchenko, and B. Cairns (2006), Assessing Goddard Institute for Space Studies ModelE aerosol climatology using satellite and ground-based measurements: A comparison study, J. Geophys. Res., 111, D20212, doi:10.1029/2006JD007334.

Myhre, G., Grini, A., Haywood, J. M., Stordal, F., Chatenet, B., Tanre, D., Sundet, J. K., and Isaksen, I. S. A.: Modeling the radiative impact of mineral dust during the Saharan dust experiment (SHADE) campaign, Journal of Geophysical Research, 108, 8579, doi:10.1029/2002JD002566, 2003.

Ghan, S. J., and R. A. Zaveri (2007), Parameterization of optical properties for hydrated internally mixed aerosol, J. Geophys. Res., 112, D10201, doi:10.1029/2006JD007927.

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