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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Development of a global model of mineral dust aerosol microphysics" *by* Y. H. Lee et al.

Y. H. Lee et al.

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1. I would recommend the authors be very clear about what is new science in the paper; as far as I can tell, just the CCN numbers.

Response: We agree that the dust emission scheme is obtained from previous studies with some modifications for our existing global microphysics model and the major new content in this paper is the effect of dust particles on CCN concentration. We have added the following text to the Introduction: "In this work, we use previously existing dust source functions to simulate mineral dust in the TOMAS framework, thereby completing development of the GISS-TOMAS model and studying the impacts of mineral dust on the tropospheric CCN cycle"

2. The CCN numbers with and without dust is the important science in this paper, but I

find no discussion of how these things are defined, and what the uncertainty is in these numbers. Also, the mineral dust were there before the humans, so I would like to see the change in CCN from humans, and how that number changes since you included mineral dust.

Response: See more detailed responses to other reviewer comments. The CCN(0.2 %) concentration is used in this paper and the activation diameter at the maximum supersaturation of 0.2 % is about 100 nm. Because the CCN concentration active at a single supersaturation is a somewhat limited metric, we have also added a CCN spectrum to the paper that shows Figure 11. We also added more discussion and additional results for the CCN number changed by dust (See Section 3.6 and Figure 10 especially).

3. There are more data to compare against including the AERONET optical depths in the source regions; maybe use the datasets from Cakmur et al., 2006 and Mahowald et al., in press (iron paper).

Response: In the revised paper, we have added some of the additional observations suggested by this and the other reviewer (the PM 2.5 concentration at two IMPROVE sites and dust deposition flux data from DIRTMAP as well as the dust size distribution data measured near the Chinese deserts during the ACE-Asia). These additional comparisons can be found in Sections 3.2, 3.3, and 3.4 and Figures 4, 5, 8, and 9. We are currently preparing a separate manuscript for model AOD comparison against remote sensing data such as AOD and Angstrom Coefficient from MODIS, MISR, and AERONET. Because AOD, by definition, results from all aerosol components (e.g. the results show some biases in biomass burning areas) and the comparison is fairly involved, we choose to keep it in a separate paper. Here, we focus on dust-specific observations.

4. Please include the budgets for each of your size bins-this may help explain the issues with your dust lifetime.

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Response: Given 30 size bins, a fully bin-resolved budget would be cumbersome. We have changed Table 1 such that the budgets for fine and coarse modes are presented separately.

5. There is data on the size distribution in the source regions from AERONET, which could be used, with caveats, to compare to the model. There is also data at the IMPROVE sites (Virgin Islands and Hawaii) in the fine mode to compare your finer mode.

Response: As discussed above, we choose to reserve the AERONET comparison for a later paper. However the fine mode dust mass concentrations are compared with IMPROVE data in two IMPROVE sites (Virgin Islands and Hawaii). See Section 3.2 and Figure 4 and 5.

6. There is some data on wet deposition ratios; see Hand et al., 2004 for review of that data. That could also provide information on why the distance sources seem to have problems.

Response: We compared our model wet deposition ratios to those in Table 7 in Hand et al. (2004). See the table below for an overview of the comparison. Our model shows higher wet deposition ratio compared to observations in Burmuda, Cape Ferrat, New Zealand, and Amsterdam Island and lower compared to observation in Antarctica. This comparison suggests that our model may somewhat overestimate the ratio of wet to dry deposition, similar to the Hand et al model. However, given that the data are presented as a ratio, it is difficult to make conclusions about total deposition rates or dust lifetimes.

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Sites	Observations	Our model	Their model
Bermuda	17-70	80-90	75-95
Amsterdam Island	35-43	70-80	75-95
Cape Ferrat	35	80-90	50-75
Enewetak Atoll	83	80-90	75-95
Samoa	83	80-90	75-95
New Zealand	53	80-90	75-95
North Pacific	75-85	70-80	75-95
Summit Greenland	63	40-80	50-75
Antarctica	90	40-80	50-95

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