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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global dust model intercomparison in AeroCom phase I" *by* N. Huneeus et al.

Anonymous Referee #2

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Comments:

The paper presents the results of a broad intercomparison of a total of 15 global aerosol models within the AEROCOM Project. The paper focuses on the validation of the dust component of the models with a variety of observations including AOD, AE, deposition, and surface concentrations.

The paper is valuable for the scientific community since: 1) it outlines the current limitations of global dust models to represent the global dust cycle, specifically focusing on metrics that influence the Earth's radiative balance and the supply of iron to the oceans, 2) it intends to analyze the causes for discrepancy whenever possible 3) it outlines the limitations of the available observations to understand the model discrepancies and proposes recommendations in that sense, and 4) it establishes an initial

benchmark for future dust model validation and developments with an unprecedented amount and variety of observations.

Therefore I recommend the paper for publication in ACP. However I have some comments and concerns that should be addressed before publication in ACP. Some of them are general and other more specific.

General comments:

The findings of the paper are summarized in the abstract. I will go through each of the findings including my comments and questions about the paper in general.

1. "In general, models perform better in simulating climatology of vertically averaged integrated parameters (AOD and AE) in dusty sites than they do with total deposition and surface concentration."

I understand the arguments of the authors in the paper to reach this conclusion but I feel that this point should be at least reformulated. AOD and AE values in this comparison span 1 order of magnitude while measurements of surface concentrations and deposition can span up to 3-4 orders of magnitude. Indeed AOD is used for stations with high influence of mineral dust, while deposition and surface concentration includes all types of stations. The statement above and the related discussion in the paper should be reformulated.

I also strongly recommend including additional statistics in the paper when comparing to deposition and surface concentration. RMS and Bias definitely overweight the regions with higher concentrations. Please include normalized statistics as well.

2. "Almost all models overestimate deposition fluxes over Europe, the Indian Ocean, the Atlantic Ocean and ice core data."

In the paper there is a full discussion on the observed data quality issues. I believe that the limitations of the data should be somehow outlined also in the abstract since, 1) some measurement periods vary according to the site, 2) a 3.5% iron content is

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assumed to infer dust deposition fluxes from iron deposition, 3) some stations from Tegen et al (2002) may only include 50 days of data (1/7 of the total days in a year).

In this sense, can you provide in the paper some estimates of the uncertainty of the different data used?

One additional comment here: it is difficult for me reconcile the deposition estimates from table 2 and the comparison in Figure 1. For example ECMWF model simulates almost 6000 Tg/yr of dust deposition, about a factor of five more than the AEROCOM median, while in Figure 1 ECMWF has the lowest positive bias. Is there any error or the implication is that the current network of dust deposition is not representative at all of the global dust deposition? The latter is highly improbable since most of the stations lie within the main dust transport pathways. Please clarify this point and address the implications accordingly.

3. "Differences among the models arise when simulating deposition at remote sites with low fluxes over the Pacific and the Southern Atlantic Ocean." 4. "This study also highlights important differences in models ability to reproduce the deposition flux over Antarctica. The cause of this discrepancy could not be identified but different dust regimes at each site and issues with data quality should be considered."

I don't understand the last statement. The cause of discrepancy among models is independent from the observed data quality. Please consider revising the sentence.

5. "Models generally simulate better surface concentration at stations downwind of the main sources than at remote ones."

Ok. I have just one comment concerning the surface observations. Is there any additional information provided by the comparison with cruise data (Figure 4)? I don't think it is a helpful approach to consider the cruise data as a yearly average.

6. "Likewise, they simulate better surface concentration at stations affected by Saharan dust than at stations affected by Asian dust."

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Dust modelers highly tune the emission scheme, and most of the community is biased towards tuning the model with Saharan dust observations. I strongly encourage that you include in the paper a discussion about this aspect and comment how the emission scheme was tuned in the different models (for example in table 1).

7. "Most models simulate the gradient in AOD and AE between the different dusty regions, however the seasonality and magnitude of both variables is better simulated at African stations than Middle East ones."

Don't you think this can partly be explained by the influence of anthropogenic aerosols in the Middle East?

Even if only months dominated by coarse dust aerosols or the mixture of coarse and fine aerosols are analyzed, shouldn't the anthropogenic contribution affect the AE? How can you then assure (page 23804 - line 16-18) that higher AE indicates smaller dust particles in the Middle East than in Africa? The fact that Ilorin and Djougou in Africa (highly affected by biomass burning but nevertheless are not filtered by your selection criteria) show higher AE contradicts your argument.

8. "The models also reproduce the dust transport across the Atlantic in terms of both AOD and AE; they simulate the offshore transport of West Africa throughout the year and limit the transport across the Atlantic to the summer months, yet overestimating the AOD and transporting too fine particles. However, most of the models do not reproduce the southward displacement of the dust cloud during the winter responsible of the transport of dust into South America."

Ok. Is there any clue if this is due to emissions or transport/deposition? Can't this be checked with the results from the different models? I understand that for this exercise, the models were nudged towards (or run with) an Atmospheric Reanalysis. Since the southward displacement in winter is not reproduced by most of the models, can this be due to problems in the reanalysis? Have you checked whether if the models that reproduce the displacement use different atmospheric reanalysis?

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9. "Based on the dependency of AOD on aerosol burden and size distribution we use model data bias with respect to AOD and AE and infer on the over/under estimation of the dust emissions. According to this we suggest the emissions in the Sahara be between 792 and 2271 Tg/yr and the one in the Middle East between 212 and 329 Tg/yr."

This is a very original and interesting aspect of the paper. However, taking into account the different characteristics and representation of the size distribution in the models I would be cautious on the emitted mass estimates or at least this should be clearly highlighted in the paper and the abstract.

Other comments:

- Page 23784 L23-24. There is some speculation about the role of dust on meningitis epidemics in the Sahel. However, meningitis (bacterial) is not a vector-borne disease, it is spread person to person. Please reformulate.

- I suggest including an additional figure that shows the global distribution of wet and dry deposition, surface concentration and AOD for AEROCOM median. I would include the same maps for each model in the supplement. I think this could be useful for the reader and would complement table 3.

- Table 1: I understand that most of the information about the models is available in Textor et al 2006. However I would recommend including the specific information on the dust module in this table apart from the references. I am referring to whether the emissions are interactive or not, and how the model was tuned. Additionally it would be good for the reader to know which of the models are CTM's and GCM. . .. How were they run (offline, nudged??) and what data (climatology,analysis, reanalysis, NCEP, ECMWF?)

- Table 3: Please revise. There are some inconsistencies. For example ECMWF model 514 Tg/year of emission and 5999 Tg/year of deposition.

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- Table 4: Please note the different size distribution characteristics of the models..

- Figures 1 and 5: Please include additional normalized scores as commented above.

- Figure 4: As commented above, is this figure providing additional information? Can the cruise data be taken as a yearly average?

- Figure 7: Please remake the left plot so one can see the upper part.

- Page 23798- L4: Here it should be noted that many models do not include the Kalahari desert as a source. I believe that the different modeler co-authors could comment on that.

- Page 23800-L14: Hawaii station is #14

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 23781, 2010.