Atmos. Chem. Phys. Discuss., 8, S9025–S9029, 2008
www.atmos-chem-phys-discuss.net/8/S9025/2008/

Atmospheric Chemistry and Physics Discussions

ACPD

8, S9025–S9029, 2008

Interactive Comment

Interactive comment on "Saharan dust transport and deposition towards the Tropical Northern Atlantic" *by* K. Schepanski et al.

K. Schepanski et al.

Received and published: 12 November 2008

The response to reviewers comments are indicated by italics.

The need for a good aerosol transport models for climate studies is great. In particulars dust transport models that can reproduce realistic dust fluxes and depositions and help to estimate the true atmospheric dust loading. In this paper the authors describe a study of Saharan dust transport toward the Atlantic Ocean during the spring and summer of 2006 and the winter of 2006-2007.

In this paper two types of information are provided:
1) The model results and the possible explanation for the patterns in the different seasons, and

2) The validations and comparison to remote sensing measurements (from space and surface).

The results presented here can be of interest providing that the authors will discuss the limitation of the model in depth. The validation and comparison to measurements part is weak. The authors do not provide sufficient explanations to the nature of remote sensing, to the physical advantages and disadvantages of the measurements from the surface and space, and some of the statements and explanations are wrong (listed below).
In most cases when there was disagreement between the measurements and the model the authors explain why the measurements are limited or wrong. I would suggest considering more the likelihood for problems in the model. A key point that is missed in the paper: Dust models rely heavily on the accuracy of the winds and in particular the surface winds for source activation (threshold wind). After the source is activated and dust is emitted, the whole fate of the dust (transport, flux pattern and deposition) depends on the wind direction, speed and derivatives. The authors do not discuss the accuracy and the limitations of the wind properties in the model. Given the fact that the Sahara is not dense with ground measurements and meteorological stations that can provide profiles of the upper atmosphere regularly, the author should explain why they expect to have an accurate dust fluxes on a daily basis. Can this be part of the disagreement with the measurements?

The reviewer is correct that the quality of the model results depends on a large extent on the realism of the modelled surface wind fields. Several studies in the recent literature investigate the reliability of LM-MUSCAT's wind fields. Heinold et al. 2007, Laurent et al. 2008 and Reinfried et al. (2008, submitted to JGR) validate the model with wind observations from meteorological stations. Furthermore, Schepanski et al (2008, submitted to JGR) discuss the ability of LM-MUSCAT to reproduce dust emission linked to the break-down of the nocturnal LLJ, which is identified to be the

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most important meteorological feature for dust Saharan dust emission.
Nevertheless, simulated fields of AOT are the result of emission, transport and deposition processes, which have to be reproduced accurately. Differences in e.g. wind fields can increase by several mistreatments along a trajectory and thereby lead to a differing modelling results.
The authors add more comparisons to different satellite products and sun-photometer measurements to discuss the reliability of the model results.

More specific points:
1) Why Cape Verde in the winter? In the summer this station is located in the heart of the average dust plume, however the winter flux pattern is shifted southward and Cape Verde seats on the Northern Border of the plumes. The noise and sensitivity to small changes and to the model accuracy would be much greater then.

In the revised version, comparison of model results and AOT sun-photometer measurements are shown for several stations located in the Saharan and Sahelian sector to draw a more comprehensive image of the model's ability to reproduce Saharan dust plumes and its transport path.

2) The measured AOD in the summers is mostly dust with contribution of marine aerosol and in the winter contains significant contribution of smoke. The authors should consider that when comparing the results.

The contribution of smoke to AOT measurements is considered.

3) Dust is not spherical - Why calculating the AOD as spherical (and not spheroids like in the AERONET retrieval). Currently MODIS can not consider non-spherical aerosol (due to limitation of the inversion) and therefore assumes spherical particles and retrieve the optical properties (AOD and fine-fraction). This is not symmetric to

the model calculations. Having the dust loading and estimating the AOD of spherical particles can introduce significant differences to the measurements.

Dust is not spheroidal, either! Please note that our simplification of using a spherical particle shape only affects the calculation of the extinction efficiency, which is much less sensitive to particle shape than for instance the scattering phase function, which in turn is required for the AERONET retrieval. Furthermore, the model does not give an information on particle shape, so that the mentioned asymmetry in the comparison between model data and AERONET data can not be solved.
However, as we said, the effect should be rather small. Here, we disagree with the Reviewer's statement that " Having the dust loading and estimating the AOD of spherical particles can introduce significant differences to the measurements." The situation may be different in the thermal infrared spectrum, where the size parameter of dust particles can be near the resonance region and where the choice of the particle shape can have a significant effect on the extinction efficiency and thus on the calculation of AOD from a given size distribution.
We have added the following sentences to the manuscript: 8220;In the calculation of AOD from the model size distribution and refractive index information we use Mie-theory, i.e. a spherical shape of the dust particle is assumed, whereas the AERONET retrieval takes spheroidal dust particle shapes into account. However, our simplification only affects the calculation of the extinction efficiency, which not very sensitive to particle shape at the dust size parameters in the solar spectral range.

4) Linking AOD to mass: there are several insitu measurements showing numbers similar to the ones in Kaufman8217;s paper. Based on the comments above the authors should re-estimate their constant and explain why it is so different form the insitu measurements.

The difference arise from different particle sizes from the model results compared to

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those used in the literature. For individual cases the particle sizes might differ considerably. Here, we include a comparison of the modelled size distribution with AERONET results, showing good agreement in most cases. Also, Heinold et al (in press) shows that the modelled size distribution agree well with different measurements near the source regions in Morocco for a separate case study using this model. The model thus appears to provide realistic size distributions compared to observations. The use of a single value for the M/AOD ratio may not be appropriate for this type of computations.

7) The authors should use the CALIPSO retrievals of the dust vertical profiles for model validations.

Visual comparison of vertical profiles of dust concentrations and CALIPSO sounding profiles indicating the presence of aerosol shows promising agreements. A discussion in detail would be beyond the scope of the manuscript and should be the subject of an additional publication. Here, the authors concentrate more on the comparison to measured AOTs which implicitly includes information on the reliability of the modelling results.

8) Emissions and patterns of the Bodele are especially sensitive to the accuracy of the surface winds and to the model translation of the wind to dust fluxes. How accurate the model winds there? Isn8217;t the Bodele too far from any meteorological station? Can the model be trusted on a daily resolution (in figure 8).

There are already studies on the accuracy of the model winds compared to station observations. This references are added in Section 3.2 (former Section 3.1). For the Bodele, there are two meteorological stations, Faya-Largeau and Chicha. These stations are used for LM-MUSCAT validation (Laurent et al. 2008).

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 16061, 2008.