Atmos. Chem. Phys. Discuss., 9, C6897–C6900, 2009
www.atmos-chem-phys-discuss.net/9/C6897/2009/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Using aircraft measurements to determine the refractive index of Saharan dust during the DODO experiments" *by* C. L. McConnell et al.

Anonymous Referee #1

Received and published: 9 November 2009

This a nice paper which dicusses the optical properties of Saharan mineral dust based on detailed in-situ measurements. Since dust is one of the most important aerosols of the Earth's atmosphere and its radiative effects are in discussion recently, this article can be considered as a valuable contribution to the literature. Therefore, I recommend publication in ACP under consideration of the following minor remarks:

1) In Section 2.3 the observed chemical composition is discussed. On page 23512 (line 21) it is stated that "we use the simplified aerosol composition [...] (Lafon et al., 2006)" Does this mean that measurements from DODO were not used?

The dust particles were treated to consist of quartz, calcite and iron-clay aggregates.

These three mineral classes were externally mixed, while for the iron-clay material four types are defined (HI, HK, GI, GK internally mixed). Why not mixing internally all individual components according their measured volume fraction?

It would be interesting to the reader to get an information about characteristic volume fractions of all the individual components and to consider this as a fifth case of mixture applying a simple volume mixing rule for all components.

2) In Section 2.5 the Two-stream approximation is applied in the radiative transfer simulations. In comprehensive and more complex dynamic models this simplification is needed to minimise computational effort. However, for the closure study here I would suggest to use a four-stream solver at least, since the two-stream assumption may lead to significant errors, especially if the optical depths of the scattering and absorbing dust are relatively large (approximately 1.7 as presented in Table 4).

The surface albedo is also very important in radiative transfer simulations. The Authors used a value of 0.44 which was calculated from the radiation measurements. Does it mean that the spectral variation of the albedo is neglected? If yes, for which wavelength is the value of 0.44 representative? Moreover, typical spectral variations of the albedo for desert surfaces are available from ASTER database. These data could be used to generate a more realistic albedo by scaling with the factor of 0.44. The spectral variation is very important for the upwelling radiation. If spectrally integrated irradiances (in W m-2) are considered, as in Section 4.4 to find the best type of chemical mixture, a spectrally constant surface albedo is expected to lead to relatively large errors in the modelled upwelling radiation. Since a certain fraction of the ground-reflected radiation is scattered downwards, errors may also be occur in the modelled downwelling radiation.

3) Section 3.1, pages 23515/16, lines 24-26/1-10: Table 1 presents a quantitative comparison with AERONET. I have the impression that AERONET can only reproduce the accumulation mode of the dust aerosol. This should be stated in the text and explicitly

in the Abstract as well as in the Conclusions.

Pages 23516/17, lines 28-29/1-4: It would very interesting to the reader to learn something about the size resolved composition. How does the composition vary quantitatively as a function of particle size during DODO? What changes in the refractive indices may be expected? This could explain why the imaginary parts derived from filter samples are larger than the Mie-derived ones in most cases.

4) Page 23520, lines 25-27: Indeed, the coarse mode particles have a big influence on the optical properties as the single scattering albedo as well as on the radiative transfer (Section 4.4). Therefore it is very important to measure these particles as exactly as possible. The question is, with regard to the statements on page 23522 (lines 2-9), how precise the measurements of the coarse mode were performed, since Table 2 presents a coarse mode diameter of 3.8 micrometer which is up to factor of 2 smaller than recently observed during Saharan mineral dust events (Weinzierl et al., 2009).

5) Section 4.4: As stated in 2) I expect that the use of the two-stream approximation is not accurate enough. To maximise accuracy I suggest to use a four-stream solver at least.

Page 23525, lines 12-14 and pages 23525/26, lines 28-29/1-2: With regard to 3) it is important to verify the statements, that there is little change in chemical composition and refractive index with particle size, with DODO measurements which were not presented in this manuscript.

6) Page 23526, lines 5-20: How are the radiative effects defined? Case with dust minus Case without? What do the signs "+" and "-" mean (cooling/warming)? This should be specified more detailed.

7) Conclusions, page 23527, lines 12-13: This statement can explicitly be verified if representative DODO measurements of the chemical composition as a function of particle size are considered (see 3)).

References:

Weinzierl et. al, Airborne measurements of dust layer properties, particle size distribution and mixing state of Saharan dust during SAMUM 2006, Tellus B, 61, 96-117, 2009.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 23505, 2009.