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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Radiative effects of desert dust on weather and regional climate" *by* C. Spyrou et al.

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Dear Authors!

This is a nice paper which presents radiative effects of Saharan mineral dust over land and ocean surfaces. I recommend it for publication, however, I would like to comment the following points that should be discussed before:

1) p 1329, l 20-21: Do the cited papers discuss optical properties as a function of the particle shape?

2) Section 3: Please give a brief overview of the settings of the model, particularly of the radiative transfer solver applied, e.g., how many streams are used or how the scattering phase function of the particles is considered or what spectral surface albedo

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is applied for the mean land and ocean surfaces.

3) p 1334, l 18-23: The choice of a single scattering albedo (SSA) at 550 nm of 0.95 seems to be too large as it turned out during the last years (e.g. Otto et al., 2007, 2009, 2011; McConnell et al., 2008, 2010; Ryder et al., 2013). Close to source regions dust populations contain a big fraction of large particles (of diameters greater than about 3 microns) which decrease significantly the SSA of the dust in the solar spectral range.

The paper of Kahn et al. (2009) suggests indeed a SSA value close to 1 for a scenario during the SAMUM campaign. However, these remote sensing results are in contrast to optical property calculations based on in-situ measurements for the same situation (Otto et al., 2009). That remote sensing techniques may lead to discrepancies and, e.g., to too high SSA values is discussed by other independent studies (Müller et al., 2010a,b, 2012).

Since the radiative forcing of dust is a complex function of, e.g., its size distribution (fraction of fine and coarse mode), spectral complex refractive index (chemical composition), the dust load, spectral surface albedo, surface temperature, it would help the reader to interpret the results, if the authors would present lower and upper bounds as well as means of these quantities as applied in the model simulations, graphically or tabulated. It would also be nice, if the spectral optical properties (SSA, asymmetry parameter, optical depth) would be displayed, for both the solar and thermal spectral range. For example, the optical properties both in the solar range and at the thermal window region (8-15 microns wavelength) are extremely influenced by the maximum particle size (Otto et al., 2011). In combination with surface albedo and temperature variabilities, different forcings can be obtained which makes unique interpretations impossible. So I suggest to additionally consider certain scaled spectral optical properties leading to a SSA value of 0.8 at 550 nm and to compare these results with those considering the lowly absorbing dust represented by 0.95.

4) p 1334-1335, l26-l2: Actually, the non-sphericity of the particles cannot be neglected.

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Size equivalence and particle shape have non-negligible optical impacts. However, to deal with non-spherical particles is too time-consuming to be considered here.

5) p 1335, l22: What is meant here by heating/cooling rates? Does "heating rate" mean the solar and "cooling rate" the thermal spectral range or the sum of both?

6) p 1337, l16-27: It would be interesting to see the impact on these findings, if a lower SSA would be chosen as suggested above (see 3)).

7) p 1340, l11: This value of 25 W m-2 over Morocco is quite similar to the values of about 22 W m-2 (spherical particles) and 24 W m-2 (spheroidal p.) as calculated for a dust scenario based on in-situ data measured in May 2006 in Morocco (Otto et al., 2011).

8) p 1340-1341, l24-l2: As defined by the authors, negative values of F are obtained, if F_TOA_up for the dusty atmosphere (WDE) is larger the F_TOA_up in the case of a clear-sky atmosphere (NDE). This would mean that more radiation leaves the Earth to space, that is, we have a cooling by the dust compared to the clear-sky case. This seems to be the opposite to the statement that "negative values [...] denote an increase in the atmospheric absorption", if it is meant here that an increased amount of radiation stays in the atmosphere.

9) p 1341, l3-l15: In principle, I would expect a cooling over ocean and a warming over land, that is, negative and positive values of F as defined in the paper. A cooling over land can also occur, if the fraction of fine and coarse mode particles is very high and hence SSA in the solar spectral range is close to 1 (Otto et al., 2011, Fig. 14 top) as assumed in the present paper. In this case, the variabilities in the solar and thermal forcings at the top of the atmosphere might be of the same order of magnitude such that the variabilities in the thermal forcing due to surface temperature changes might be larger than the solar forcing. However, a change in the thermal forcing of about 25 m-2 over two different ocean surfaces, which changes also the sign of the forcing from cooling to warming, seems to be more than interesting. On the other hand, as

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said above, the forcing is a complex function of a lot of parameters and ambiguous. That's why, as stated in 3), it would be nice to get quantitative information about the optical properties (graphically or tabulated) that were the basis for these results of the radiative transfer simulations, especially for the situations marked by circles in Fig. 11.

Regards,

Sebastian Otto

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 1327, 2013.

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