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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.

Anonymous Referee #3

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The paper constitutes an important contribution to the investigation of the role played by Saharan dust on dynamical processes and climate in the Mediterranean. The introduction of an accurate description of the radiation transfer processes into the SKIRON model, which already includes a detailed treatment of the dust mobilization, loading into the atmosphere, and transport, allows an improved investigation of the dust direct and indirect effects.

A couple of points need to be better discussed. One aspect is the way in which some dust optical properties are calculated. From the description in section 5 it seems that the dust optical properties are taken from OPAC, except at 550 nm, where a higher value of the single scattering albedo is adopted. I have the impression that by combining some properties derived from the Mie theory (i.e., by assuming a specific size

distribution and refractive index) with some independently assumed properties, especially if in specific wavelength ranges, may produce inconsistencies. For example, the aerosol scattering coefficient is fixed once the extinction coefficient and the single scattering albedo are defined. It is dubious what may be the effect of changing only one of these properties.

Another critical aspect is that the verification of the model results is given by comparison with Aeronet calculations of the surface irradiance. I believe that the caption of table 2 ("...between modeled and measured incoming solar flux...") is erroneous, since Aeronet is not giving direct measurements of downward irradiances. If I am not wrong, this is more an intercomparison among models (although the aerosol data from aeronet are direct observations); this should be stated clearly, and the significance of this exercise should be discussed. Regarding the correlation between SKIRON and aeronet, shown in table 2, we generally have a positive bias in all cases. The inclusion of the dust radiative effects appears to reduce a bit the bias, but not in all cases. Also the correlation does not seem to improve significantly. The correlation seems to be strongly site-dependent. Part of these results may be discussed in relation to the aerosol optical properties which have been adopted. For instance, what would be the impact of reducing the single scattering albedo with respect to what assumed? How the adopted values of the single scattering albedo compare with those measured by aeronet at the three sites?

The description of the April 2006 events may be improved. At least, figure 2 does not seem to be clear for the purpose of the presentation. Firstly, cloudy periods should be labeled or removed, in order to avoid confusion. I assume that the top graph of figure 2 displays the AOD derived from SKIRON, since also data during nighttime are displayed. May the authors clarify this aspect? How these data compare with aeronet data from Crete? The bottom part of figure 2 does not allow understanding clearly what the author are meant to display. The central part of the day for cloud-free periods may be selected for the purpose, or a different way to put in evidence the differences among

the different curves.

Minor points that may be clarified are listed below.

p. 1329, l. 23: what is meant by "optical intensity of dust"?

p. 1329, l. 28: "Several studies have focused on calculating the radiative feedback of dust on a global scale". I believe that the sentence refers to radiative effects (and not feedbacks)

p. 1330. l- 7-16: an intense dust event producing radiative perturbations of similar amplitude, both in the shortwave and longwave spactral ranges, has been reported also in the Mediterranean basin (di Sarra et al., 2011).

p. 1334, l.6: I would suggest "... scattering of light by a homogeneous spherical particle..."

p. 1334, l.11: the sentence "The real part n expresses attenuation due to scattering (non-absorbing)" does not seems totally correct; while the absorption depends only on the imaginary part of the refractive index, the scattering coefficient depends on both (real and imaginary parts).

p. 1334, l. 18-20: what is meant by: "For the 550nm spectral window, where the extinction of the incoming solar radiation is most intense..."?

p. 1335, l. 7: it may be useful to specify in which units the dust load is given (if I have derived it correctly, should be in ug/m2).

p. 1340, l. 25: expression 2 does not seem totally correct to me. The atmospheric absorption is generally given by the difference between the TOA and surface net irradiances; moreover, the definition of atmospheric absorption should apply only to the shortwave, and consequently should be positive (or zero for totally non absorbing particles). If only the TOA values are used, one gets an information on the behaviour of the whole armosphere+surface system (and in fact it is generally used to determine if

the addition of a specific component heats or cools the whole system). This may be the reason for some details of fig. 11 (e.g., the radiative effect changing sign over the ocean, depending on the season). This aspect should be considered in the discussions of figure 11.

p. 1341, l. 1-2: the authors attribute negative values of F in Fig. 11 to an increase in the atmospheric absorption due to dust feedback, and positive values to a decrease. I would expect that a reduction of the outgoing flux density at TOA (F > 0) is associated with an increase of the absorption, not the opposite.

p. 1341, l. 5-10: how is the sea surface temperature (SST) treated in the model? Changes of SST induced by dust are part of the indirect effect. Are they excluded from the NDE analysis? A 20 W/m2 perturbation due to trapping of emitted radiation from the sea surface by the aerosols appears large to me. How much of this may be due to surface effects (see the comment to the use of expression 2 above)?

References

di Sarra, A., C. Di Biagio, D. Meloni, F. Monteleone, G. Pace, S. Pugnaghi, and D. Sferlazzo (2011), Shortwave and longwave radiative effects of the intense Saharan dust event of 25-26 March 2010 at Lampedusa (Mediterranean Sea), J. Geophys. Res., 116, D23209, doi:10.1029/2011JD016238.

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