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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.

C. Spyrou et al.

kallos@mg.uoa.gr

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Response to Anonymous Referee #1

The paper presents an interesting evaluation of long term radiative effects of Sahara dust on weather and climate at regional scale. The target area of the study includes northern Africa, the Mediterranean basin and continental Europe. The paper is well written and addresses a relevant scientiïňĄc issue. It is worth publishing after minor corrections.

[REPLY]The authors would like to thank the reviewer for the very constructive comments he indicated. We discuss the comments step-by-step:

Comments and questions: Page 1336 The comparison of modeled solar radiation with

Crete measurements shows that SKIRON underestimates observed cloudiness even in WDE simulation. The ob- served radiation drops to very low values (about 100 W/m2 around midday). Can this behavior be explained with cirrus clouds underestimated by SKIRON or it should be attributed to concomitant smaller scale relevant cloudiness phenomena missed by the model? Can the underestimation of cloudiness be explained, at least partially, by the lack of the indirect effect in SKIRON simulation?

[REPLY]The underestimation of the cloudiness locally can be attributed to the model resolution used for the present simulations, 0.25x0.25 degrees, where the small scale phenomena cannot be captured. The lack of indirect effects could also contribute to the observed underestimation. We plan to address this in a future development of SKIRON model, where the radiative indirect effects will be described in detail.

Page 1340 lines: 8-10 The incoming radiation ïňĆux at the surface is said to be obtained by the superposition of dust nighttime LW emission and daytime incoming solar radiation. Does this mean that the daytime LW dust emission contribution is neglectable?

[REPLY]In general, the LW emission during the day is much less significant than the reduction in the SW. However it is included in our calculations, so we rephrase the sentence to clarify this: ". . ...daytime incoming shortwave and longwave radiation. . .."

Page 1340 line29, pag 1341 line 2 The sentence "negative values denote an increase in the atmospheric absorption..." is not easy to understand on the basis of eq. 2 and should be better clariïňĄed to avoid confusion between negative and positive effects.

[REPLY]Eq.2 shows that it corresponds to changes in atmospheric absorption between the two simulation sets. We have rewritten the paragraph in order to give a clearer presentation of our considerations and calculations.

Page 1342, line 22 The mentioned cooling over the Mediterranean area cannot be clearly observed from Figure 12 and 13 because colors do not completely separate

positive and negative values (the ïňĄrst negative class is still green like the positive ones).

[REPLY]We have redrawn Figures 12 and 13, so that the distinction between positive and negative values is clear (now the blue color represents the first negative class).

Moreover, Figure 11 shows a different column integrated forcing during spring and summer over the central Mediterranean area.

[REPLY]Please note that Figure 12 refers to the summer at 2deg West (Western Europe) and Figure 13 to spring at 18deg East (Central Europe). Also in Figure 11 the total integrated absorption is described, while in Figures 12 and 13 we examine how these changes are distributed into the atmosphere.

The overall cooling effect at surface should be better described.

[REPLY]In Figures 12 and 13 we focus on the vertical distribution of temperature changes. More details on the overall cooling are provided in the previous section (sec.7) and in Figures 7 and 8, where the effect is thoroughly discussed.

As mentioned in the introduction, the optical properties of dust particles depend on their size. The size distribution of dust is expected to change with distance from the source along its transport path. Is any of the modeled radiative effects inïňĆuenced by particle size, e.g. over continental Europe, or the dust mass concentration effect can be considered deïňĄnitely dominant?

[REPLY]The size of dust particles is considered to change rapidly close to the sources, where the larger particles are deposited. For our calculations, we apply the dust "transport mode" given in literature, which remains unchangeable at a distance far from sources and above the present area of interest. The optical parameters depend on particle size and this is taken into account in our simulations by using distinct values for the optical properties for each size interval of the particle distribution. Moreover, the mass concentration per size interval changes along the transport path and the

respective radiative effect is also considered in our calculations.

Minor technical corrections: The last sentence of Section 3 (from pag. 1333, line 25), concerning RRTM cloud treatment, is rather obscure in the present form. The mentioned model details are not used in the paper and could be removed or should be better explained.

[REPLY]The sentence has been removed

Pag 1342, lines 2-6 The cooling observed at 300 hPa is deïňĄned as "mid-tropospheric cooling", while the heating observed at 600 hPa is deïňĄned as "mid-tropospheric heating". The deïňĄnition of the cooling area can be better speciïňĄed to distinguish the different layers.

[REPLY]Both pressure layers can be defined as mid-tropospheric layers, so we provide the accurate height in hPa to distinguish between them. However, to avoid confusion we changed the "mid-tropospheric cooling" to "mid to upper tropospheric cooling".

Units of the different terms of equation 1 at pag. 1335 are missing.

[REPLY]The units have been added to the text

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