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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The impact of dust storms on the Arabian Peninsula and the Red Sea" *by* P. Jish Prakash et al.

Anonymous Referee #1

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The authors present a case study of a dust storm over the Arabian Peninsula. Is is an application study, using the regional weather research forecast (WRF) model with a chemistry/aerosol module incorporated, to investigate the impact of a specific dust storm on the Arabian Peninsula and adjacent ocean regions, particularly the Arabian Sea and the Red Sea. The novelty of the study is limited to providing data on the effect of dust storms in this specific region, if the one case is taken as exemplary for dust storms generally. The paper is a solid work, though. It provides a systematic and thorough analysis of the dust storm event, which by itself is very interesting and a valuable contribution to science. The manuscript is well structured and well written. I have only a few minor comments and questions I would like to have taken into consideration before the study is published.

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Minor Comments

1. **Introduction:** The introduction of the manuscript provides a very general overview on the role of dust aerosols for Earth's weather and climate. It could be shortened quite a lot, and still give a sufficient introduction and motivation for the presented research. Remove the parts on the general role of dust on a global scale. Focus on dust storms, what research has been done so far on modeling the regional impact of dust storms, and why a study, like the one presented by the authors, on the effect of a dust storm on the Arabian Peninsula is needed.

2. **Page 19185, lines 12-14:** The authors write: "Sokolik and Toon (1999) and Claquin et al. (1999) showed that dust mineralogy is comprised of six main minerals: illite, montmorillonite, kaolinite, quartz, calcite and hematite."

   In my opinion, this is not a correct representation of the content of the two studies. *Claquin et al.* (1999) provide a Mean Mineralogical Table (MMT) on the average mineral composition of 25 arid soil types. Even though the eight minerals (not six, since fractions of feldspar and gypsum were provided as well) in the table are main minerals found in soils, the fact that there are only eight minerals in the MMT is rather caused by the lack of available measurement data on the mineral composition of soils, when the study was conducted. There are other important minerals in soils, which also can have relatively high fractions, at least regionally, like chlorite, palygorskite, or halite. In a recent study, a new data set with the fractions of 12 minerals in soil was provided (*Journet et al.*, 2014).

   Sokolik and Toon (1999) studied how the state of mixture of hematite with other minerals affects the absorptivity of soil dust particles, which is important for their radiative effect. They did not study the mineralogy of dust in general, though.

   Having said this, the paragraph in the Introduction with the statement on the two

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studies belongs to the part that could be removed altogether.

3. **Page 19189, line 27:** How were the values for the size mass fraction s_p of the accumulation and coarse mode derived? The original GOCART model by *Ginoux et al.* (2001) was based on a discreet bin scheme with an upper limit of $6\ \mu$m particle radius, and s_p for clay and silt were slightly different to the values chosen here. This should be explained more. The parameters for the log-normal size distributions of the modal aerosol scheme used in the present study should be provided explicitly as well, for reasons of reproducibility. These are important parameters, since they essentially determine the emitted size distribution of dust, and, in turn, fallout rates and how much dust mass is being transported to remote regions.

4. **Page 19194-19996 and Figure 3:** The description of evolution of the meteorological features in the regions in relation to the dust storm refers to the location of those conditions in the various countries of the region. Could the authors include the borders of the countries also in the maps shown in Figure 3, like it is done for Figure 1 and 2, if the plot program allows this? This will make it easier for the reader to follow the description in the text.

5. **Page 19199, lines 24-29:** The authors present an estimate about the numbers of dust storms, where the dust plume covered more than 20% of the Middle East area. It is not clear, though, how this number was exactly derived. The link to the Image of the Day published by the NASA Earth Observatory is not sufficient as description of the data source and of the methodology for someone who wanted to reproduce this result. The authors should provide a more detailed description of the analysis for this part (in the Methodology section of the paper).

6. **Page 19204, line 17-18, and Figure 13:** The authors write, "... aerosols exert a cooling or warming influence on the climate ..."

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This is not wrong, but the effect is not just on climate, but on the atmosphere and the surface in the context of weather. The study itself does not analyze climate. Instead it analyzes the effect of dust aerosols related to a weather event. Thus, I would write "... aerosols exert a cooling or warming influence on the atmosphere and at the surface ...

Equally, in the caption of Figure 13, replace "Positive values correspond to the heating of the climate system" with "Positive values correspond to heating" or with some other phrasing.

7. **Section 3.4:** It would make it easier for the reader, if the authors summarized the values for the domain averages of the radiative effect for shortwave, longwave, and net radiation at the top and bottom of the atmosphere in an additional table.

Typos

1. **Page 19194, line 2 and 3:** write: "ERA-Interim uses an improved atmospheric model ..."

References

Claquin, T., M. Schulz, and Y. J. Balkanski (1999), Modeling the mineralogy of atmospheric dust sources, *J. Geophys. Res.*, *104*(D18), 22,243–22,256, doi:10.1029/1999JD900416.

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