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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of mineral dust on cloud formation in a Saharan outflow region" *by* L. Smoydzin et al.

Anonymous Referee #2

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General Comments

The paper presents two case studies quantifying the impact of mineral dust on cloud formation over the Eastern Mediterranean. It was found that the total precipitation within the model domain did not change when mineral dust was included but locally a spatial and temporal shift of the precipitation pattern occurred. For the two case studies the dust-induced differences in the microphysical structure can contribute to a significant radiative forcing.

The paper is well within the scope of ACP and addresses a topic that currently raises high scientific interest. I have the impression that the work contains a lot of interesting material. However, major revisions of the paper are necessary before it might be published and I will explain my suggestions for such a revised version.

At the end of the introduction it would be nice to have a list of the questions that the paper wants to address and why. Why have you chosen these episodes? What is the main purpose of the work?

The paper suffers from a detailed description of the method that was applied to simulate the aerosol cloud interaction. Although several references are given that might describe the details the authors should address in the model description at least the following questions. Which kind of cloud scheme is used? Is it a bulk scheme? Is it a hybrid scheme? Are size distributions of the hydrometeors taken into account? Which processes (e.g. heterogeneous vs. homogeneous freezing) are taken into account? How is the radiative effect of the clouds that depends on cloud droplet and ice crystal numbers and sizes distributions treated? As this is a model study some equations my help to explain what is really used and in which way the interaction between the aerosol particles and the cloud quantities is accounted for. This is necessary, to understand the complexity of the model system and how it differs from other models used in previous and future studies. It is also not clear how the change in the soluble fraction is treated within the simulation. Please explain that in more detail; again maybe an equation would help to elucidate this.

The description and the interpretation of the model results is hard to follow I will give some specific points below.

The section 6 (Discussion and Conclusions) should be completely rewritten. It should really concentrate on the discussion and the conclusions based on the results that were achieved. I cannot see why the weakness of neglecting the GCCN is placed in this section. This should be moved to the model description. As the authors neglect the GCCN I cannot see the basis to speculate about their potential roles. This again should be moved to the section where a detailed model description including the advantages and disadvantages of the applied methods is given. The effect on temperature is discussed for the first time in the conclusion section which makes no sense.

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Specific comments

Page 32370 line 23: The statement about the quality of the agreement of the simulated and the observed precipitation is very optimistic and by no means documented. A simple scatter plot would show this. On the other hand, can we expect a good agreement?

Page 32371 line 5: What means in all cases where dust is allowed to act as CCN

line 6: The slightly northward extension of the cloudy area is not visible in Figures 2a-c. Please check.

line 7: Please explain the meaning of the total cloud droplet number in this region is 166391 cm-3 and the corresponding numbers for the other cases. Please check the units.

lines 23-25: Where can I see that the clouds are thin in scenario ïĄť48.

Section 4.1.2: This section contains numerous findings which are not documented in corresponding figure(s). At lease it is not clear which figure the authors are referring to. Please add figures that document your findings (if necessary in the supplement).

Section 4.1.3: From the material presented it is very difficult and almost impossible to follow the description of the results. Maybe it would help to indicate the areas where averages were taken and to add some tables. This procedure would also be very helpful for the following sections. Figure 5 is very confusing as long as the figure caption does not explain all the information that is depicted. Which scenario is presented in Figure 5?

Section 5.1: It is hard to follow a lot of the findings based on the figures that are presented.

Page 32375: line 8. How can you discuss the role of GCCN if you have neglected them in your model setup? To avoid confusion, the authors should use the term “GCCN“ in a consistent way throughout the text. Sometimes “GCCN” refers in general to CCN

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originating from dust [e.g. in the abstract or Line 8 page 32375] and sometimes it is used to refer to large particles that impact the colloidal stability of the cloud, which is the common definition.

Page 32376: line 1: how can you determine a time shift of 30 min from figures 4a,b.

line 15: You are talking about the coagulation of dust particles and sea salt. Is that process treated in your model? Do you have indication that this process is significant in reality? Which coagulation kernel did you use?

Figure 3: Which scenario is shown? What means mixing ratios of integrated total condensate in g k-1? Please explain.

Figure 5:

Which variables are shown in this figure? Which scenario?

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 32363, 2011.