Atmos. Chem. Phys. Discuss., 12, C6411–C6415, 2012
www.atmos-chem-phys-discuss.net/12/C6411/2012/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "The effects of mineral dust particles, aerosol regeneration and ice nucleation parameterizations on clouds and precipitation" *by* A. Teller et al.

A. Teller et al.

amit.teller@gmail.com

Received and published: 30 August 2012

We would like to thank referee #2 for his review of our study and for giving us the opportunity to improve our paper. The comments that were raised in the review are answered in this document and most of them were also clarified in the final revised version. Below please find our response to the specific comments and questions that were addressed by the reviewer.

In reference to the reviewer statement: "...however, the lack of comparison of model output with observational data does not allow the extraction of general conclusions regarding the above interactions and limits the scope of the manuscript to a model

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

intercomparison study."

Indeed, the study focuses mainly on the sensitivity of cloud microphysical processes and precipitation formation to different aerosol properties by using the detailed bin microphysics scheme, however a comparison between Fig. 1 that shows the remote sensing observations and both Fig. 3 and 4 that show the spatial distribution of precipitation in the model, implies that the model results follow (with some variations) the observed cloud and precipitation fields. As for the initial conditions, the aerosol data from the flight measurements was used for initializing the simulation. We added a sentence in the second paragraph of p. 8235 – "These measurements represent the aerosol size distribution properties at the edges of the dust storm of 28 January 2003 and therefore can be used as a realistic initialization conditions."

Major comments

1. p. 8229 – We changed the sentence "in this research we utilized the WRF bin microphysics scheme in a real mode three dimensional set up." to "in this research we utilized the WRF bin microphysics scheme in a three dimensional set up that uses coarse resolution reanalysis meteorological data for the initialization." Apparently, the inner most domain simulation is not driven by a single sounding.

2. The 1-way nesting approach was utilized in this research only in order to initialize the inner domain with reasonable thermodynamic conditions. An important feature of the bin microphysics scheme, which was implemented in the inner domain, is the presence of aerosols while the coarse domains, where Lin scheme is used, eliminate the aerosols. We found that the optional 2 way configuration caused instabilities in the coarse domains due to the presence of aerosol in the inner domain. The same computational difficulties were also found when other schemes (Thompson, Morrison) were applied for the coarse domains.

3. We added a sentence in the second paragraph of p. 8235 (line 14) – "These measurements represent the aerosol size distribution properties at the edges of the

ACPD

12, C6411–C6415, 2012

Interactive Comment

dust storm of 28 January 2003 and therefore can be used as a realistic initialization conditions."

4. We added the following clarifying sentence in line 25 on p. 8235 – ". It should be noted that the coarse domain with a resolution of 9 km includes only $9\times20=180$ grid points from the NCEP FNL database. This means that the model initialization is based on meteorological data that was taken from only 180 locations with distances of approximately 100 km one from the other. Thus, the resolution of the meteorological data that is used for initialization of the simulations is rather low and comparison of the simulation results with ground measurements at specific locations can be interpreted incorrectly. In addition, NCEP reanalysis data is by no means the REAL atmospheric condition and obviously the simulations driven by such data will not reproduce the observations in all aspects."

5. The aerosol properties were kept constant for the entire run of the inner domain (6 hours). The only available aerosol data for this dust storm came from the airborne measurements (Levin et al., 2005) and the MODIS retrievals. These observations were carried out for relatively short time compared to the duration of the dust storm, thus we are lacking of information about the time variation of the aerosol characteristics. A comment was added at the end of p. 8235 (line 28) - "No data was available about the time evolution of the aerosol physical characteristics, therefore the aerosol characteristics at the boundaries were not modified during the simulation run."

6. We find significant difference between the precipitation spatial distributions even when a comparison between two bulk schemes (Thompson and Lin) for the 3 km resolution external domain was made. We added a clarifying sentence in p. 8238, line 25 – "Apparently, even a comparison between two bulk schemes that are commonly used in WRF (Thompson and Lin) for the 3 km external domain showed major differences in the spatial distribution of precipitation (not shown here)." While it is highly important to validate the bin scheme with other, widely used schemes, it was certainly not a major objective of our study that mainly challenged questions about dust-cloud interactions.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

7. We changed the term normalized variability to the more common statistical term of "Coefficient of Variation" following a suggestion made by a qualified statistician. In addition, number rounding in the raw representing the Coefficient of Variation in Table 2 was modified as well as in the text (last paragraph of p. 8239).

8. The beginning of the last paragraph on p. 8244 was changed – "Fig. 9 shows the domain average production rate (number-s-1-L-1) of ice crystals as function of the temperature for the entire simulation time. It should be noted that the temperatures are not constant with the height"

9. The answer to this question is not straightforward because the number of eliminated "cloudy" grid points changes with height. At high altitude (above 8 km) most of the grid points lack condensate matter (water or ice) while at altitudes near cloud base (about 2 km ASL) many of the points (above 50%) contain water. Another factor that affect the categorization of a grid point as "cloudy" or "non-cloudy is the threshold value for the total condensate mixing ratio – the difference between choosing threshold mixing ratio value of 0.001 g/kg and 0.01 g/kg is above 15%. In general, the calculated average aerosol concentration difference between simulations with and without the regeneration scheme represents more than 40% of the entire grid points.

10 Two of the authors (ZL and AT) were taking significant part in the MEIDEX campaign (Levin et al., 2005). The airborne measurements and the aerosol sampling during MEIDEX were mainly aimed at the characterization of the physical and chemical properties of dust aerosols. Unfortunately, due to this rather narrow objective, no other measuring platforms such as ships, radiosonde etc. were utilized. With this in mind, the uniqueness and importance of these measurements were still recognized at later stages and few modeling studies were already published in recent years (WRF-Chem - Smoydzin et al., ACPD, 2012; RAMS - Solomos et al., ACP, 2010). An intercomparison study between the above mentioned simulations tools will serve as a natural follow up to our study. We believe that such comparisons definitely exceed the scope of the current research. It should also be noted that the study does not intent to reproduce the details of

the real event or to improve the forecast skill of the model. The study distinguishes itself from most previous research in that it investigates detailed processes of aerosol-cloud-precipitation interactions in a 3D real environment. The results indicate that the aerosol effects on cloud and precipitation are different from those of more idealized numerical studies when the fully coupled surface-atmosphere-radiation system is considered.

Minor comments 1. Some minor corrections were applied to the text.

2. Corrected

3. Corrected

4. Corrected

5. Corrected

6. Corrected

7. Corrected. Adding a zoomed figure of the rectangular area could cause deviation from the desired length of the manuscript. However, we believe that the differences between the cases are well depicted in the figure.

8. The additional "Fig. 12" was removed. The figure has been corrected.

9. The figure was modified. The maximum difference of the aerosol concentration was never found to be above 350 cm-3.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 8225, 2012.

ACPD

12, C6411–C6415, 2012