Atmos. Chem. Phys. Discuss., 5, S1798–S1803, 2005
www.atmos-chem-phys.org/acpd/5/S1798/
European Geosciences Union

Atmospheric Chemistry and Physics Discussions

Interactive comment on "CCN activation and cloud processing in simplified sectional aerosolmodels with low size resolution" *by* H. Korhonen et al.

Anonymous Referee #1

Received and published: 27 July 2005

General comments:

The paper discusses the quality of aerosol-cloud interaction simulations performed with a simplified sectional aerosol model in combination with a simplified cloud module. The special focus is the sensitivity of the simulated cloud properties, such as droplet number concentration, to the representation of the aerosol size distribution in low resolution sectional aerosol modules typically applied in large-scale models. Cloud-aerosol feedbacks are also discussed for different model approaches.

The effects of aerosols on climate are highly relevant research topics and aerosol-

cloud interactions play a key role in this context. Since simulations of aerosols, clouds, and aerosol-cloud interactions in large-scale models are still very uncertain, the paper addresses highly relevant scientific questions.

The methods applied appear to be sound. Most of the results are presented clearly. However, the presentation of the methods applied has to be improved. I would suggest publication of the manuscript after the following comments are considered by the authors:

Specific comments:

Major comments:

1) Following the title, the focus of the paper is the impact of simplified aerosol modules on cloud properties. In addition to simplifications in the representation of aerosols, the authors also apply a simplified cloud scheme they developed from a detailed scheme. This implies the following questions and comments:

i) Was the cloud scheme simplified due to high numerical expenses of the detailed scheme or in order to investigate the impact of simplifications of cloud schemes in large scale models? In the latter case, the choice of the input parameters remains unclear since the maximum supersaturation cannot be calculated in a large-scale model without detailed cloud microphysics. In large-scale models, typical input parameters for CCN activation parameterizations would be quantities like aerosol concentration and size distribution, vertical velocity, temperature and humidity. What is the link between such large-scale model parameters and the parameters employed by the authors? How are the cloud properties derived from the input parameters chosen by the authors? These aspects should be discussed in more detail.

ii) It should be explained how the cloud module was simplified. In many large-scale

ACPD

5, S1798–S1803, 2005

models cloud modules are based on simple thermodynamic approaches rather than considering detailed microphysics. Was the detailed dynamical cloud module reduced to simple thermodynamic considerations?

iii) The effects of the simplifications in the aerosol module frequently superpose the effects of the cloud module simplifications. Hence the analysis of cause and effect is complicated. In order to separate these different impacts, the authors should include an experiment performed with the simplified aerosol module in combination with the detailed cloud scheme or vice versa.

iv) Since the paper addresses not only the effects of simplified aerosol schemes, but also the effects of simplifications in the cloud scheme, the title of the paper should be changed accordingly.

2) In some large-scale models, especially general circulation models, log-normal size distributions rather than sectional approaches are applied to simulate aerosol size distributions. It would be worthwhile to perform calculations of the effects of lognormal approaches on cloud droplet activation, in addition to the calculations considering sectional approaches. If this is not possible with the model used by the authors, they should at least discuss potential effects of the lognormal approach.

3) The design of the reference simulations should be defined more clearly. The authors either mention the detailed cloud module or the detailed highly resolving aerosol module to be the reference scheme. It should be mentioned explicitly that the reference simulation was performed with a combination of both modules, if that is the case. It should also be mentioned explicitly that the sensitivity calculations (1-5) were realized with the simplified aerosol module in combination with the simplified cloud module. To enhance the clarity of the paper, I suggest the insertion of a table explaining all simulations performed (the reference simulation and the sensitivity studies). See also minor comments below.

ACPD

5, S1798–S1803, 2005

4) The simulated clouds should be characterized in more detail. Which cloud type is in focus? Are the simulated clouds representative? The sensitivity of the conclusions of this study to possible changes in cloud properties or cloud formation mechanisms should be discussed.

Minor comments:

1) Abstract:
The abstract mentions the low resolution of the simplified sectional aerosol module. It also mentions the simplified cloud scheme. In the following sentences, a 'simplified scheme' is discussed. It is unclear to the reader whether this refers to the aerosol scheme, the cloud scheme, or a combination of both. The authors should clarify in the abstract (and also in the main text) that a simplified activation model consisting of simplified aerosol and cloud modules is compared to a detailed model consisting of detailed aerosol and cloud schemes. This remains very unclear to the reader in the current version of the paper. (See major comment 3).

2) Abstract, last sentence:
The authors mention a "simplified cloud scheme with low size resolution" but probably mean the simplified aerosol module in combination with the simplified cloud module. (See major comment 3).

3) Abstract, last sentence; conclusions, last sentence:
The authors conclude that the simplified scheme is suitable for large-scale models since it performs well for clean or moderately polluted regions which cover most of the Earth's surface. Nevertheless, large areas of the globe are strongly polluted and this pollution drives most of the anthropogenic impacts on atmosphere and climate, which are the focus of many global modelling efforts. Hence the conclusion should be that the simplified cloud/aerosol schemes used in many global models show largest uncertainties in the case of polluted conditions.

ACPD
5, S1798–S1803, 2005

4) Introduction, paragraph 1:
It could also be mentioned that clouds and precipitation are very important for the atmospheric budgets of many reactive and/or climatically relevant trace gases.

5) Page 4873, line 19:
The purpose of “dynamically” is unclear.

6) Page 4874, line 2:
The purpose of “and for example” is unclear. It may be replaced by “Consequently,”?

7) Page 4874, line 10:
“their” may be replaced by “the”?

8) Page 4874, line 20:
“model size section” should be replaced by “aerosol size section”.

9) Page 4874, line 26:
It should be explained here, that simulations with the detailed model assuming constant updraft speed are taken as reference.

10) Page 4875, line 23:
The “standard simulations” were not defined before. The authors should mention, that they describe the details of the simplified aerosol scheme here.

11) Model description section, last paragraph:
It should be explained here that not only the detailed cloud scheme but also the high resolution aerosol model is applied for reference, if I understood that correctly. (See also major comment 3).

12) Section “Simulation design”, first sentence:
See major comment 3

13) Page 4877, line 5:
See major comment 3

ACPD

5, S1798–S1803, 2005

14) Page 4877, line 9:
The authors use the word “particles” as a synonym for aerosols. This potentially confuses the reader who may also think of cloud particles instead of aerosols. I would recommend to replace “particles” by “aerosol particles”

15) Page 4877, last paragraph:
The authors should provide references for the concentrations considered. The units of the OH concentration should be written as “molecules/cm^3”.

16) Page 4878, line 5:
See major comment 3

17) Page 4881, line 2:
The Hoppel minimum should be briefly explained or a reference should be provided.

18) Page 4883, line 11:
See major comment 3

19) Conclusions, last sentence:
See minor comment 3

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 4871, 2005.