Atmos. Chem. Phys. Discuss., 5, S3375–S3378, 2005
www.atmos-chem-phys.org/acpd/5/S3375/
European Geosciences Union

Atmospheric Chemistry and Physics Discussions

Interactive comment on "A global off-line model of size-resolved aerosol microphysics: II. Identification of key uncertainties" *by* D. V. Spracklen et al.

D. V. Spracklen et al.

Received and published: 20 October 2005

We appreciate the helpful comments of the referee. The issues raised are well taken and we have responded to every comment made by the referee.

General comments

1. The referee suggests additional clarification should be made regarding the sensitivity studies that we have carried out. We include a section 'Limitations of this study' which outlines some problems that result from not including all aerosol constituents.

2. The referee suggests that this paper would be more appropriate after additional model description and validation and suggests we change the order of the papers. However, additional model validation and comparison with observations has now been included in the first paper as suggested during the open discussion phase of that paper. We now believe that there is sufficient model validation in the first paper to allow the conclusions drawn in this paper to be evaluated.

Specific comments

1. The referee asks for comment on whether our conclusions would change if the model sensitivity runs were for a different period or time of year. We have shown that the uncertainty in sulfate and sea salt CN and CCN due to uncertainties in aerosol processes is large. Running the model sensitivity studies in a different period is likely to produce different absolute sensitivities but we believe that our results will be indicative of the uncertainty throughout the year. We have repeated selected sensitivity scenarios for July 1996. The changes in global mean CN and CCN are similar in magnitude to those observed in the NH winter and presented in this paper.

2. We have replaced the sentence 'Comparisons with measurements would look poor even if the model captured the shape and magnitude of the CN maximum correctly but simulated a 1-2 km error in the altitude of the maximum.' (p3447, l18) with 'Due to the strong vertical gradients of particle number concentrations in the UT, model error in the altitude of the CN maxima will cause large errors in the predicted CN concentrations at any altitude.'

3. Figure captions for Figure 5 (a) - (d) have been added.

   (a) and (c) Tropical Pacific (10°N-10°S, 210°-270°E)

   (b) and (d) Northern Europe (45°-60°N, 5°-25°E)

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4. The Kulmala et al. (1998) nucleation scheme calculates the nucleation rate but does not provide information on the critical cluster size. We therefore carry out sensitivity tests to these two variables separately. Later nucleation schemes (e.g., Vehkamaki et al. (2002)) give information on the nucleation cluster size. However, it is difficult to know the accuracy of these values, given that present instrumentation cannot observe nucleating clusters.

5. The referee asks for comment on accuracy of modelling coagulation rates for small clusters. We have added the sentence (p3450, l8): 'Conclusions regarding the growth rates and survival of nucleating clusters will be dependent on the accuracy of model coagulation rates.' Given that it is not possible to observe the growth of nucleating clusters smaller than 3 nm it is difficult to verify the accuracy of theses rates from observations.

6. Page 3450, l12. 'low warm-phase cloud' added for clarity.

7. The sensitivity runs with different cloud processing activation diameters effectively simulate different supersaturations in the cloud. We have added the following sentence before 'Effectively we are simulating ...' (p3450, l22). 'In any model sensitivity run the activation diameter and hence cloud supersaturation is fixed.' The CCN number is then calculated off-line from the predicted aerosol distribution and for a range of supersaturations.

8. The referee asks for a comment on the shortcoming of choosing a constant scavenging diameter and a description of how the baseline value is chosen. We have added the following text to the paper (p3452, l20):

   'An effective scavenging diameter of 0.206 μm is chosen above which nucleation scavenging may occur in the model. This value is intermediate between the values used by Adams and Seinfeld (2003) (0.03 μm and 0.082μm for convective and stratiform clouds respectively) and that used by Capaldo et al. (1999)

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(0.250 μm). The assumption of one globally uniform scavenging diameter limits the extent to which the model can capture the effect of different cloud types, however this is difficult to rectify without the inclusion of a detailed cloud microphyics model. Scavenging is scaled to the rate of conversion of condensate to rain drops, this value is typically close to 100%.'

9. The referee asks why we change sulfur gas emission rates by 25% but sea-salt emissions by a factor of 10. The sensitivity runs are intended to represent realistic uncertainties in emission rates of sulfur gases and sea-salt. A 25% change in sulfur gas emission rates is reasonable considering the estimated uncertainty in DMS and SO_2 emissions. This is discussed in the paper (page 3457). We have added the following sentence to justify altering sea-salt emissions by a factor of 10.

   'Estimates of the sea-salt flux at any particle diameter vary by over an order of magnitude (Hoppel et al., 2002).'

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 3437, 2005.