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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Efficiency of cloud condensation nuclei formation from ultrafine particles" *by* J. R. Pierce and P. J. Adams

Anonymous Referee #3

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This paper describes a model that calculates the efficiency to form CCN from size distributed ultrafine particle numbers, with no reference to particle content. The paper is an important input to the understanding of the effect from ultrafine particles onto the climate system, as the efficiency of CCN formation from ultrafine particle varies a lot. It uses particle size and is based onto standard particle dynamics, i.e. coagulation, condensation and deposition, but also onto availability of condensable gases, affecting the condensation rate; background particle size distribution, affecting the coagulation process; and content of the particle, affecting particle hygroscopic growth etc. The model assumes the same content of all particles, i.e. ammonium bisulphate, and only includes one of the condensable gases, i.e. sulphuric acid. The influence onto the result by not including effect from other condensable gases, and from size distribution

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change during the process is not totally transparent.

The model is compared to another model, developed by the same researchers, and then used to decide the CCN formation efficiencies in different regions of the Earth. The resulting efficiency for a particle to become a CCN often lies between 5 and 40%. Different regions of the atmosphere have different probabilities. The reason for this is a bit vaguely described, even if the regions dealt with are described, the parameters included into the model to differentiate between the regions are not totally clear.

The paper addresses relevant scientific questions within the scope of ACP. It also presents a novel tool to describe and calculate the CCN formation efficiency. In some parts the description of input variables to the model should be more specific. The results from the particle dynamics seem OK to me. This paper describes a comparison between models. What about comparisons to real life or lab data?

The paper is in principal clear and well written.

Abstract: Would prefer to have the input variables specified already in this context, as this implies an important description of the of the model, e.g. that the variable hygroscopic growth factor is not taken into account, only size.

p. 11001 r. 6: “the CCN deposition lifetime, which typically will be nearly equal to the aerosol mass lifetime computed by global models.” Please show or give reference.

Section 4.1 and 4.4 The compared models: The choice of the model to compare PUG with is probably due to practical reasons, as the model has the same developers as the PUG model. The possibility to use another model should be further discussed, as the compared models have very different approaches that affect the implementation of the size distributions between the models. The PUG model bases the calculated coagulation rates etc. onto the initial size distribution. How much does this differ from the obtained size distribution, if that would be calculated? The size distributions in each of the models, i.e. PUG’s initial size distribution as well as the end point one calculated

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from the processes taken part in the simulation, and for the other model both the initial size distribution and the equilibrium size distribution should be shown in Figures for the reader to decide if the differences are big or small. Please add figure, e.g. size distributions!

p. 11003 r. 12– The reasons for the choices in the case used for comparison is not clear to me, e.g. why was all particle content ammonium bisulphate? There are available papers that recommend that the content of particles is of minor importance to CCN formation efficiency compared to size that could be included as reference (e.g. Dusak et al, 2006).

p. 11004 r.10 Why remove aerosol microphysics when choosing the emission rate?

p. 11004 r.2 “The 90 nm cut-off was used because it corresponded to one of the mass doubling sizes in the model” What would happen if you used e.g. 120 nm? Would it be possible to use something close to 90, i.e. not a specific size bin? How would that affect the result?

p 11006 r.4: “does not change much” What is much, please put number!

p. 11006 r. 14: Boundary layers values; please use a more specific word than “values”, e.g. “time-scales”.

The PUG model seem to be a first step towards a model that can be used to describe the CCN efficiency, based on more variables than present in the model today, and thus more realistic.

p. 11008 r. 23: The traffic emitted aerosol normally has even larger variation between sizes, according to my knowledge: I’d probably test 10-60 nm. Would that make a big difference? Here a possibility to understand the effect from content onto the CCN formation efficiency is large, as the smaller particles ($<$20 nm) mostly consist of oil droplets and the 60 nm particles are soot, so why assume ammonium nitrate? Why assume anything if the content is unimportant? Traffic emitted particles also comprise

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a large part of the anthropogenic emissions present, and thus the CCN formation of the traffic exhaust would be of large interest.

Figure 6: I'd suggest to put also the "urban aerosol" into the figure, on another y-axis naturally.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 10991, 2006.