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Interactive comment on "Parameterization of the nitric acid effect on CCN activation" *by* S. Romakkaniemi et al.

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General comments:

Previous cloud model research indicated that the presence of soluble gases may significantly enhance the activation of aerosol particles by increasing their solubility. The extent of the effect depends on several parameters, e.g., the nitric acid concentration, characteristics of the aerosol, updraft speed, condensational growth rate of individual particles, etc. Considering such effects in large scale cloud models or climate models will hopefully lead to a better characterization of the aerosol-climate interaction, but it is a huge challenge considering the relative complexity of the cloud physics-chemistry system. The authors have developed a parameterization for this effect and that potentially can be applied in large-scale models. The paper presents the parameterization,

which can be applied to unimodal and bimodal distributions, and compares its performance with detailed cloud parcel model results. In general, I find the paper well written and the results and conclusions are presented clearly. However, I miss some information on how the parameterization is derived and I have a few questions on the applicability.

- The subject of the paper is suitable for publication in ACP(D). - The paper does not present new concepts, merely presents the parameterization and its accuracy - The experiments are described clearly and the results are sufficient for the conclusion - The paper is well and clearly written, with an adequate introduction and references - The title is adequate, abstract is clear

Specific comments and questions:

- The parameterization is relatively complex and not intuitively understandable, and I am curious how it was derived. The authors refer to a previous paper, Laaksonen et al., 1998. Note: this did not appear in J. Atmos. Sci. as stated in the references but in J. Aeros. Sci. instead! Unfortunately this is not available at my institute. I assume this applies to more readers as well. Therefore the authors should definitly elaborate on this.

- The parameterization contains a parameter Bc which depends on the composition and has values of 0, 1, and 2 for ammonium sulfate, ammonium bisulfate and sulfuric acid (Table 1). These values do not appear to be related to ion yield, molar weight or density. They could be related with the number of H+ released, but my guess is that this does not influence the dissolution of strong acids as HNO3 very much, while the fact that NH4+ releases additional H+ after dissociation is not considered. So, I am curious to see the meaning of Bc. Does this also mean the aerosol has to be externally mixed, i.e., no internal mixtures?

- The parameterization predicts the activated fraction of aerosol particles F. What is this exactly: the fraction of CCN (e.g. at 1%) or fraction of the total aerosol popu-

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lation represented in the parcel model? This is an important difference, but it is not explained. If the latter is the case then it seems that the parameterization reflects specific model characteristics. Example: suppose 200 aerosols from a population of 500 activate, then the fraction is 0.4, and it may be enhanced to 0.5 (250 drops) with a certain amount of HNO3. Fx-F0 is then 0.1. The total aerosol particle concentration in a cloud parcel model is mainly determined by the smallest aerosol size considered. Decreasing this lower limit means automatically that a larger number of aerosol particles is present, say 800. For simulation of the same cloud, the eventual drop concentration does not change because the smallest aerosol do not activate anyway, but the fraction of activated aerosols is now smaller, 200/800=0.25, and with HNO3: 250/800=0.31. Now, Fx-F0 is 0.06. So this would make the parameterization highly specific and not general applicable. Am I wrong in this interpretation?

- With our cloud parcel model we carried out a few experiments on the influence of HNO3 on activation. The results indicate that the magnitude of the enhancement also depends on the initial relative humidity of the parcel, with which the initial wet aerosol sizes are assumed to be in equilibrium. The relative growth of especially the large aerosols is not fast enough to maintain the equilibrium size during parcel ascent. So the initial RH influences the distribution of initial water over the aerosol and this affects the dissolution of HNO3 over the aerosol population. Again, do I see this wrong? How is the parcel model initialized and how important is this for the results?

- The aerosol matter is ammonium (bi) sulfate or sulfuric acid. In present day aerosol-climate models sometimes more aerosol species are considered (seasalt, organics, dust). Would the parameterization still be applicable here; would it be easy to adapt for such models?

Technical comments: I have no other technical comments than already mentioned above.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 7859, 2004.