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Interactive comment on "The influence of nitric acid on the cloud processing of aerosol particles" *by* S. Romakkaniemi et al.

Anonymous Referee #1

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Review of Romakkaniemi et al.: The influence of nitric acid on the cloud processing of aerosol particles.

The paper presents results of model simulations of cloud development that combine several aspects important for climate stusies, i.e., the effect of HNO3 on activation of particles, sulfur chemistry in the water phase, and removal of interstitial particles through coalescence with cloud droplets. Study of these processes is highly relevant in the light of understanding and quantifying climate change. The processes have been studied quite extensively in recent years (HNO3) and decades (sulfur chemistry).

- The subject of the paper is suitable for publication in ACP(D). The strong point of this

study is the combination of the processes.

- The paper does not present new concepts. The effect and characteristics of the processes have been studied and discussed quite extensively already in the past. The simulation results presented here therefore do not really hold surprises.

- The experiments are described clearly but it is not always clear which aerosol distributions are used.

- The title and introduction are adequate.

General conclusion: The present version of the manuscript, with description of the results of several simulations, is a little meager: what purpose do the simulations serve, what is the big picture, are there any recommendations for climate change studies? In my opinion the paper should be rewritten with a clear research question as a basis and a focussed discussion of the results, after which it is more suitable for publication.

Specific remarks:

Page 4:

“is between 20 and 30”: is this not fixed, where does it depend on? And is the resolution not too coarse given the “wiggles” in the drop size distribution (Fig 3)?

“This decreases numerical diffusion...” I do not understand this remark. Is there another way to use processed aerosol as input that produces more numerical diffusion?

Page 5, section 3.2:

Should be rewritten for clarity, some questions and apparent inconsistencies arise.

“...uptake of HNO3 enhances the coagulation scavenging”: How important is this when also the time period in-between clouds is considered? I can imagine that the fact that particles are NOT scavenged inside the cloud at 0 ppbv HNO3, is to some extent compensated by more efficient impaction after the cloud has evaporated. Since the

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model also accounts for coalescence between unactivated particles this issue could be investigated.

“the number of aerosol particles is appr. 50 cm-3 lower... ” But the total amount of particles (aerosol+ cloud drops) is much closer, so how much of the decrease is due to additional activation (HNO3 effect) and how much to coalescence?

“chosen to be short enough to prevent...” why do you not want to consider that?

“number of maximas... is smaller”: the maxima probably indicate a numerical problem (resolution?).

"This implies that rain formation can be delayed due to HNO3" But you wanted to prevent efficient droplet-droplet coalescence! Either leave it at that and do not discuss any consequences on rain formation in the paper, or simulate it fully.

Page 6, section 3.3.

The different pH dependence of the O3 oxidation vs. peroxide oxidation has been discussed already many times. Not much news here.

Section 3.3.1

“of HNO3 on aerosol size distributions.... “ which distributions?

“Due to 1 ppb of HNO3 98 cm-3 more cloud drops form”: in the previous section there is a smaller (50 cm-3) difference for a larger amount (4 ppb) of HNO3. Apparently I do not understand it correctly, please explain more clearly.

Section 3.3.2.

Is it possible to add a plot of the supersaturation needed to activate the particles vs. radius, after each cloud cycle? That would make the results for the different cloud cycle simulations more clear.

“On the third cycle CDNC is even higher...” please explain.

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Interactive Comment

Conclusions. What I miss is: what is the message of this study? What is the more general importance of these processes for cloud evolution and climate change? I would advise to formulate a clear research question as a basis for the study and a systematic approach to answer that question.

The second paragraph of the conclusions is not very clear. Please rewrite.

Figure captions.

It was unclear which distributions have been used in which simulations. This should also be mentioned in the captions. E.g., when I compare the distributions in Fig. 3 and Fig 4. I can see that the initial aerosol is different, but what is used exactly?

Figure 3 a-c:

Why is there such little difference in scavenging of interstitial particles between 0, 1 and 4 ppbv? Or is the figure simply too small? And why is there a larger difference between 0 and 1 ppbv in Figure 4? I assume that different aerosol distributions are used here, is the specific distribution a critical parameter for the magnitude of the effects?

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 10197, 2005.