Atmos. Chem. Phys. Discuss., 7, S112–S115, 2007
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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ice nucleation of ammonia gas exposed montmorillonite mineral dust particles" *by* A. Salam et al.

Anonymous Referee #1

Received and published: 31 January 2007

General comments: The paper shows experimental evidence that montmorillonite aerosols exposed to ammonia gas can activate ice particles at lower relative humidity than without gas exposure. The experiments have been made with a continuous flow chamber and appear to be well performed. The paper deals with an important topic in atmospheric research, since cloud formation processes are not fully understood, but clouds are important in the climate change discussion. The paper is generally well written, but I had some problems within the Results and Discussion part. I was several times lost with the numbers given in the text (see also specific comments). To my opinion, a table with the relevant numbers would help. Nevertheless, after the authors have addressed to the following points, I recommend the paper to be published in ACP.

Specific comments: Page 384 lines 7-10: Enhanced to what? I guess to the unexpo-

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sured case, as written the next sentence.

Page 384 lines 9-10: 90% and 100% RHw mean xx% and yy% RHi, respectively? Give these numbers in brackets.

Page 385 lines 8-10: Can you assign which mode belongs to the which experiment?

Page 389 line 23: What about a lower limit of the nucleation rate?

Page 392 lines 5-7: Do the authors rule out the condensation mode for the particles exposed with 25 ppm at 100% RHw, because the values 90% RHw reaches almost the same magnitude than that for 100% RHw? (Figure 4, bottom). The authors claimed that for pure ammonia exposure, the condensation mode is possible. Can I therefore conclude that the increase in the ammonia concentration could lead to a different nucleation mode?

Page 392 lines 7-9: How large will this underestimation be maximal? This could be crucial for the atmospheric adaptation of the experiments.

Page 392 lines 17-20: It is not obvious to me how the authors have obtained these numbers. Why 3 to 8 times or 5 to 8 times? Two possible explanations may be reasonable to my view: 1) If one just compares the pairs of data points given in figure 5 (e.g., solid diamonds at -15°C and -35°C), one would end up in 1 number. For the case mentioned in the brackets, I would guess an increase in the activated fraction of about 4. Have you compared the minimal and maximal values of all series with each other, and thus a minimal and maximal increase are given? 2) Is just a "when compared to the unexposed particles" missing? If the authors do ever refer to other numbers than shown in one of the figures, a table with the relevant numbers would be extremely helpful.

Page 393 line 3: Where in Figure 5 are the points for the experiments with 25 ppm performed at -30°C and -35°C?

Page 393 lines 10-13: See comment Page 392 line 17/20

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Page 393 lines 15-20: I don not understand the explanation to overcome the discrepancy with the previous studies. Birstein investigated silver iodide. Which IN did Georgh 1963 use in his experiments? You compare different IN, and thus one can conclude that the gas concentration is the determining factor, ant not the nature of the IN?

Page 393 lines 23-26: The authors wrote The activation temperature of 25 ppm ammonia exposed montmorillonite mineral dust aerosols was -8°C at 100% RHw (108% RHi) (Fig. 5); whereas the activation temperature of unexposed montmorillonite was -15°C at 109%. Why -8°C? Figure 5 shows no data point at -8°C. This number obviously determines the difference of 7°C. Where does this number come from?

Page 395 lines 8-10: See comment Page 392 line 17/20;

Page 395 lines 12-13: How did the authors obtain the two numbers 10°C and 12°C?

Page 395 line 19: The authors make the following statement: "This is the first experimental evidence for an enhancement of ice nucleation by mineral dust aerosols exposed to ammonia gas. Although the ammonia concentrations used are higher than those found in the polluted atmosphere the effect has been demonstrated and future experiments will be performed using lower concentrations." The atmospheric NH3 concentrations are 3 orders of magnitude smaller than in this study. Is it possible that the ice nucleation enhancement is negligible small under atmospheric concentration? Is it likely that a threshold concentration must be exceeding before any enhancement takes place? I would like to see a more detailled discussion, because the NH3 concentration seems to be crucial for the observed enhancement. Can the authors be certain that the low ammonia concentration in the atmosphere do still result in a distinct ice nucleation enhancement?

Page 403 Figure 5 shows that particles exposed to 100% ammonia gas at 100% RHw may activate about 2.5% of the total particle at temperature larger thab -10°C. What about the experimental uncertainty in detecting the percentage of activated particles? The included standard deviation for some data sets just indicates the reproducibility of

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the measurements? The reproducibility for the two filled squares at -5 and -10°C is less than the size of the symbol?

Technical corrections:

Page 385 line 2: Does the Knopf and Koop 2006 paper deal with radioactive properties of clouds?

Page 385 line 8: "...above -20°C". A citation would here be desirable.

Page 385 line 20: Does the study of Möhler et al with montmorillonite? I thought they investigated Sahara, Asian and Arizona Test Dust.

Page 386 line 11: Put "45 cm ... 20cm" into brackets

Page 392 line 25: -27°C? I can not see any data point in Fig 5 at this temperature.

Figures: Use equally steps for the numbers on the x-axis in Figures 2 and 3. Minor ticks on the y-axis of figures 2, 4 and 5 would be helpful.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 383, 2007.