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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Airborne measurements of the nitric acid partitioning in persistent contrails" *by* D. Schäuble et al.

Anonymous Referee #1

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This paper presents an interesting set of data that includes measurements of gas phase and ice phase, reactive nitrogen, ice water content, and ice crystal size distributions for both contrails and cirrus clouds. The findings are that the ice phase fraction of nitric acid (HNO3(ice) / HNO3(total)) is greatest for young contrails (aged < 1 hr), decreases as the contrails age and is approximately a factor of two smaller for cirrus clouds. Reports of nitric acid to water mole ratios and ice water content are also greater for contrails than cirrus. The differences in ice phase fraction of nitric acid and molar ratios of nitric acid to water for contrails and cirrus are attributed to large uptake of nitric acid in contrail formation followed by subsequent trapping of nitric acid by growing ice particles. Figure 4 demonstrates this nicely examining the molar ratios of nitric acid to water as a function of particle diameter (relating diameter to contrail age). These data have been fit nicely by models from Karcher and Voigt. The dif-

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ference in ice water content is small and is expected to diminish over time. Figure 2 shows temperature dependent differences between contrail and cirrus for ice phase fraction of nitric acid, molar ratios of nitric acid to water and ice water content (IWC). The molar ratios of nitric acid to water and IWC have been fit to a model by Karcher and measurements by Schiller et al., respectively, and apply specifically to the cirrus data. The authors state that the 'trapping model bounds the observed mean (molar ratios of nitric acid to water) in cirrus very well'. The model fit decreases with increasing temperature (reasoning explained well) although the data appear to increase with increasing temperature. The only exception is the average point near T = 217 K. I would agree, though, that for field measurements and the immense number of variables the data are somewhat bound by the model. However, at temperatures greater than 220 K, the model would greatly overpredict the measurements (the model is not extended to temperatures greater than 220 K). This difference is cited as due to 'the impact of sedimentation and more strongly varying ambient conditions throughout the probed cirrus cloud.' (More on this with respect to the IWC discussion.) Additionally, I'm unsure of what data the authors are referring to for how the molar ratio is affected by 'small ice crystals'. I understand this effect for Figure 4 but that refers to contrails. Does this also affect cirrus?

The IWC is compared to measurements by Schiller et al. The comparison of the Schiller data to the present work is excellent at T > 220 K. However, the Schiller measurements are greater than the present work at lower temperatures. The explanation for these differences include: 1) inclusion of thin ice clouds in the data set, 2) location of measurement in 'top region of frontal cirrus layers' where 'ice nucleation is supposed to take place and sedimentation of large ice particles . . . keeps the IWC small', and 3) entrainment of dry air. My concern comes from explanation 2 and its relationship to the explanation given above for the difference in molar ratios. How is it that sedimentation is occurring for T < 220 K for the IWC measurement but for T > 220 K for the molar ratio measurement? It appears to be somewhat contradictory. Further, with respect to point 1, if the thin ice clouds are removed from the analysis, does the IWC of the T < 220 K

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cirrus increase? Although I'm sure this analysis was performed, a statement could be added in the text.

A minor issue is with Figure 1. The figure is quite small and not completely addressed in the text as to other than showing a time series measurement. A smaller time window with relationship to one of the key points of the paper would be more beneficial.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 14165, 2009.