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Thermal stability analysis of particles incorporated in cirrus crystals and of non-activated particles in between the cirrus crystals: comparing clean and polluted air masses

M. Seifert[1,2], J. Ström[2], R. Krejci[2], A. Minikin[3], A. Petzold[3], J.-F. Gayet[4], H. Schlager[3], H. Ziereis[3], U. Schumann[3], and J. Ovarlez[5]

[1]Department of Meteorology, Stockholm University, Stockholm, Sweden
[2]Air Pollution Laboratory, Institute for Applied Environmental Research, Stockholm University, Stockholm, Sweden
[3]Deutsches Zentrum für Luft- und Raumfahrt, Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany
[4]Laboratoire de Météorologie Physique, Université Blaise Pascal, Clermont-Ferrand, France
[5]Laboratoire de Météorologie Dynamique, Ecole Polytechnique, Palaiseau, France

Abstract. A thermal volatility technique is used to provide indirect information about the chemical composition of the aerosol involved in cirrus cloud formation. The fraction of particles that disappears after being heated to 125°C is termed volatile and the fraction that disappears between 125 and 250°C is termed semi-volatile. Particles that still remain after being heated to 250°C make up the non-volatile fraction. The thermal composition of residual particles remaining from evaporated cirrus crystals is presented and compared to interstitial aerosol particles (non-activated particles in between the cirrus crystals) for two temperature regimes (cold: T< -38°C, warm: -38≤T< -23°C), based on in-situ observations. The observations were conducted in cirrus clouds in the Southern Hemisphere (SH) and Northern Hemisphere (NH) midlatitudes during the INCA project. In the cold temperature regime, the non-volatile fraction of the residual particles was typically in the range 10 to 30% in the NH and 30 to 40% in the SH. In the warm temperature regime, the non-volatile residual fraction was typically 10 to 30% (NH) and 20 to 40% (SH). At high crystal number densities the non-volatile fraction in both temperature regimes was even higher: in the range of 30 to 40% (NH) and 40 to 50% (SH). The semi-volatile fraction was typically less than 10% in both hemispheres, causing the volatile fraction to essentially be a complement to the non-volatile fraction. In terms of the fractioning into the three types of particles, the SH cold case is clearly different compared to the other three cases (the two warm cases and the cold NH case), which share many features. In the NH data the distribution of different particle types does not seem to be temperature dependent. In all the cases, the non-volatile fraction is enriched in the residual particles compared to the fractions observed for the interstitial particles. This enrichment corresponds to about 15 (NH) and 30 (SH) percent units in the two cold cases and to 15-25 (NH) and 25-35 (SH) percent units in the two warm cases. In the NH cold case, there is a clear relation between the fractions observed in the interstitial particles and what is observed in the residual particles. The observed large fractions

of non-volatile particles show that particles forming ice crystals are not entirely made up of water-soluble sulfate particles.

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