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Aerosol-cirrus interactions: a number based phenomenon at all?

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Abstract. In situ measurements of the partitioning of aerosol particles within cirrus clouds were used to investigate aerosol-cloud interactions in ice clouds. The number density of interstitial aerosol particles (non-activated particles in between the cirrus crystals) was compared to the number density of cirrus crystal residuals. The data was obtained during the two INCA (Interhemispheric Differences in Cirrus Properties from Anthropogenic Emissions) campaigns, performed in the Southern Hemisphere (SH) and Northern Hemisphere (NH) midlatitudes. Different aerosol-cirrus interactions can be linked to the different stages of the cirrus lifecycle. Cloud formation is linked to positive correlations between the number density of interstitial aerosol (Nint) and crystal residuals (Ncvi), whereas the correlations are smaller or even negative in a dissolving cloud. Unlike warm clouds, where the number density of cloud droplets is positively related to the aerosol number density, we observed a rather complex relationship when expressing Ncvi as a function of Nint for forming clouds. The data sets are similar in that they both show local maxima in the Nint range 100 to 200cm $^{-3}$, where the SH- maximum is shifted towards the higher value. For lower number densities Nint and Ncvi are positively related. The slopes emerging from the data suggest that a tenfold increase in the aerosol number density corresponds to a 3 to 4 times increase in the crystal number density. As Nint increases beyond the ca. 100 to 200cm $^{-3}$, the mean crystal number density decreases at about the same rate for both data sets. For much higher aerosol number densities, only present in the NH data set, the mean Ncvi remains low. The situation for dissolving clouds allows us to offer two possible, but at this point only speculative, alternative interactions between aerosols and cirrus: evaporating clouds might be associated with a source of aerosol particles, or air pollution (high aerosol number density) might retard ice particle evaporation rates.

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