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Cloud processing of mineral dust: direct comparison of cloud residual and clear sky particles during AMMA aircraft campaign in summer 2006

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Abstract. In order to gain insights into the characteristics of the mineral dust particles incorporated in the actual cloud droplets and the related cloud processing, the French ATR-42 research aircraft equipped both with a counterflow virtual impactor (CVI) and community aerosol inlet was deployed in Niamey, Niger (13°30' N, 02°05' E) in August 2006 within the framework of the African Monsoon Multidisciplinary Analysis (AMMA) project.

Cloud residual and clear-sky particles were collected separately and analyzed individually using a transmission electron microscope (TEM) and a scanning electron microscope coupled with an energy dispersive X-ray spectroscopy (SEM-EDX). The analysis revealed interesting characteristics on the coarse dust particles (Dp>1μm), particularly those which likely had acted as CCN.

Traces of heterogeneously formed secondary sulfate, chloride and nitrate were found on many dust particles (though fraction of sulfate may be present in the form of gypsum as primary dust component). These secondary species were particularly enhanced in clouds (i.e. cloud processing). The study illustrates that calcium-rich particles assumed to be carbonates (Calcite, Dolomite) contained the secondary species in significantly larger frequency and amount than the silicates (Quartz, Feldspar, Mica, Clay), suggesting that they represent the most reactive fraction of the mineral dust. A surprisingly large fraction of the Ca-rich particles were already found in deliquesced form even in clear-sky conditions, most probably reflecting their extreme hygroscopicity, resulting from their reaction with HNO_3 gas.

Both silicate and Ca-rich particles were found dominant among the supermicron cloud residues, and they were supposed to be those previously activated as CCN. It is highly probable that the observed formation of soluble materials enhanced their cloud nucleating abilities.

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