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Composition and formation of organic aerosol particles in the Amazon

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We applied scanning transmission X-ray microscopy with near edge X-ray absorption fine structure (STXM-NEXAFS) analysis to investigate the morphology and chemical composition of aerosol samples from a pristine tropical environment, the Amazon Basin. The samples were collected in the Amazonian rainforest during the rainy season and can be regarded as a natural background aerosol. The samples were found to be dominated by secondary organic aerosol (SOA) particles in the fine and primary biological aerosol particles (PBAP) in the coarse mode. Lab-generated SOA-samples from isoprene and terpene oxidation as well as pure organic compounds from spray-drying of aqueous solution were measured as reference samples. The aim of this study was to investigate the microphysical and chemical properties of a tropical background aerosol in the submicron size range and its internal mixing state.

The lab-generated SOA and pure organic compounds occurred as spherical and mostly homogenous droplet-like particles, whereas the Amazonian SOA particles comprised a mixture of homogeneous droplets and droplets having internal structures due to atmospheric aging. In spite of the similar morphological appearance, the Amazon samples showed considerable differences in elemental and functional group composition. According to their NEXAFS spectra, three chemically distinct types of organic material were found and could be assigned to the following three categories: (1) particles with a pronounced carboxylic acid (COOH) peak similar to those of laboratory-generated SOA particles from terpene oxidation; (2) particles with a strong hydroxy (COH) signal similar to pure carbohydrate particles; and (3) particles with spectra resembling a mixture of the first two classes.

In addition to the dominant organic component, the NEXAFS spectra revealed clearly resolved potassium (K) signals for all analyzed particles. During the rainy season and in the absence of anthropogenic influence, active biota is regarded to be the major potassium source. In addition a strong size dependence of the K mass fraction in the SOA particles has been found, with highest K content in small particles. We suggest that K-rich biogenic salts act as a template for condensational growth by low-volatility organic compounds from atmospheric isoprene and terpene oxidation. The presence of K-rich salts in SOA particles has been confirmed by scanning electron microscopy (SEM) and secondary ion mass spectrometry (nanoSIMS) techniques. Seeding of SOA particles by biogenic salts may explain the absence of new particle formation events in pristine boundary layer air over the Amazonian rainforest.