Impact of heat treatment and cloud cycling on the single particle chemical composition of soil dust

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Soil dust particles, ubiquitous in the atmosphere, are considered to be the second largest primary particle source globally (Silva et al., 2000). The major inorganic components, e.g. minerals, and organic species of soil dust particles may play a yet unclear but potentially crucial role in atmospheric ice nucleating (O'Sullivan et al., 2014; Tobo et al. 2014; Hill et al., 2016). Large knowledge gaps still exist related to the chemical composition of the organic and inorganic components, their mutual interaction, and the influence of the organic components on the propensity of soil dust particles to act as cloud nuclei.

We deployed a Laser Ablation Aerosol Particle Time-of-Flight Mass Spectrometer (LAAPTOF), at the Aerosol Interaction and Dynamics in the Atmosphere (AIDA) simulation chamber during the SOIL02 campaign, aiming to compare the chemical composition of the different soil dust particles with their ice nucleating behaviour. Four different soil dusts sampled at two sites from Germany (SDGe01 and SDPA01), Argentina (SDAr08), and Wyoming in USA (SDWY01) were studied with and without heat treatment (2 hours at 300°C in air), and before and after cloud expansion**.** The LAAPTOF, which is a new compact single particle mass spectrometer, commercially available for a short time, is capable of measuring the chemical composition and mixing state of individual aerosol particles on line (Gemayel et al., 2016; Marsden et al., 2016). Positive and negative ion mass spectra were recorded typically for several hundred individual particles of each soil dust type before and after cloud expansion experiments in the temperature range 228−260 K.

We found that: 1) the dominant mass spectral peak patterns are similar for all soil dust particle types studied. They are located at around m/z 27 ($Al^+/C_2H_3^+$), 39 ($K^+/C_3H_3^+$), and 56 ($Fe^+/CaO^+/Si_2^+/C_4H_8^+$) in positive spectra; 26 (CN^-), 42 (CNO^-), 60 (SiO_2^-), and 76 (SiO_3^-) in negative spectra. Less prominent but detected reproducibly are carboxylic groups (e.g., $COOH^-$) and elemental carbon signatures (EC, C_n^-). However, characteristic differences can be observed, especially between German and Argentinian soil dust particles (cf. Figure 1). 2) Compared with the untreated samples, the peaks related to nitrogen containing organic compounds and elemental carbon are much more pronounced for heat treated samples, while the peaks indicative of organic acids are significantly reduced. 3) Compared with the total soil dust particles before cloud expansion, the particles after expansion have much less intensive peaks at m/z 26, 38, 55, possibly contributed from hydrocarbons, in positive spectra.

This paper discusses the characteristic size dependent chemical composition of the differently treated soil dust particles before and after cloud expansion experiments.

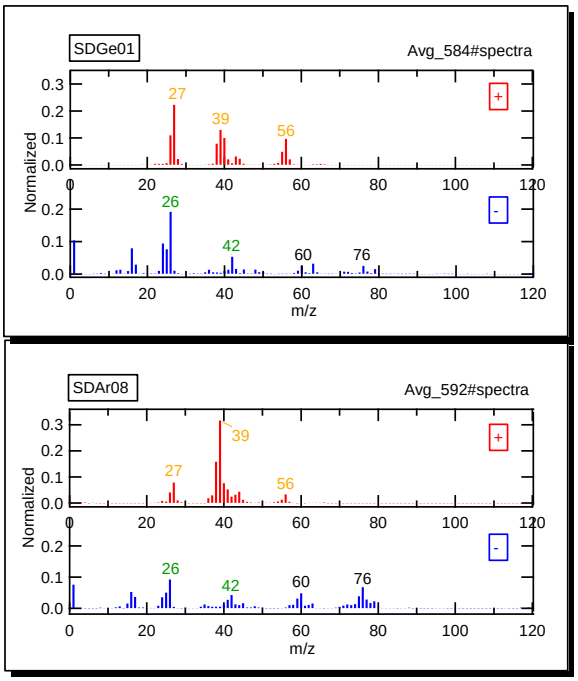

Figure 1. Average mass spectra for German (SDGe01) and Argentinian (SDAr08) soil dust particles. Black tags represent inorganic fragments; green tags represent organic fragments; orange tags represent fragments may contributed by inorganic and organic species

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