Abstract

Knowledge of the chemical composition of individual aerosol particles is essential for our understanding of aerosol dynamics and chemistry in the atmosphere. Size resolved compositional data on the single particle level can provide detailed information on processes such as the formation, transformation and deposition of aerosols. This work has been focused on techniques to enable quantification of the alkali content in single aerosol particles. A newly developed aerosol mass spectrometer, AMS, based on surface ionization technique has provided the tool for on-line studies of submicron particles and the subsequent chemical analysis with respect to their alkali content. Special attention to instrumental design during the construction, calibration, and optimization phase of the project has resulted in an instrument applicable for field studies.

AMS combines standard vacuum and mass spectrometric (MS) techniques with an optimized inlet system. Aerosol particles are directed into the vacuum chamber where ionization occurs on a resistively heated surface. The low work function of platinum is favorable when monitoring the alkali content in particles since it excludes the ionization of most other elements. Calibrations with monodisperse aerosols prepared from Na and K salt solutions show a linear relation between ion emission signals and particle volume for particles in the size range 25 to 600 nm. This verifies that the alkali content can be accurately quantified and individual particles are efficiently surface ionized in the present setup.

AMS has proved useful during field measurements and data sampled from different aerosol sources has added detailed information on the alkali metal content in individual particles. Submicron combustion particles from large-scale biomass combustion were found to consist of almost pure K salt for particle diameters $\leq$ 100 nm. As larger biomass particles were sampled, the fraction of fly ash particles with a thin coating of alkali salt on the surface increased. The K content in particles from coal combustion was in general low, but Na was detected in higher concentrations in this fuel compared to the biomass fuel. Alkali concentrations in ambient air showed large variations in particle size and number distributions. Elevated Na number concentrations could be linked to air masses with a marine contribution to the aerosol. Correlations between calculated K/Na weight ratios and meteorological data indicate a potentially useful way to identify air masses of different origin.

The quadrupole MS in the AMS was recently replaced and an orthogonal acceleration time-of-flight MS was installed to allow simultaneous detection of multiple elements in single particles.

Key worlds: Aerosol mass spectrometry, surface ionization, alkali, ambient air, biomass combustion

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