

AMBIENT AEROSOL SAMPLING USING ONLINE MASS SPECTROMETRY: RESULTS FROM GROUND- AND AIRCRAFT BASED MEASUREMENTS

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INTRODUCTION

Mass spectrometry has proven to be a powerful tool for online, in-situ analysis of the chemical composition of aerosol particles. There are two basic principles that are widely used for ambient particle sampling: While the single particle laser ablation technique allows the qualitative analysis of single particles, the thermal vaporization technique with separate ionisation allows the quantitative analysis of bulk aerosol with high time resolution. In both techniques, the chemical composition is coupled with aerodynamic sizing of the particles, hereby giving chemically speciated size distributions.

Here we report on selected results obtained with a thermal vaporization mass spectrometer during two ground based measurement campaigns: MINOS (Mediterranean Intensive Oxidant Study), August 2001, Crete (Lelieveld et al., 2002), and HAZE (Hohenpeissenberg Aerosol Characterization Experiment), May 2002, Germany. The first aircraft measurements with this instrument in the tropopause region are scheduled for May 2003 within the project PAZI (Particles From Aircraft: Impact on Cirrus Clouds and Climate).

METHODS

The measurements have been carried out with the Aerosol Mass Spectrometer (AMS), developed by Aerodyne, Inc. The instrument has been described in detail by Jayne et al. (2000), Jimenez et al. (2002) and Allan et al. (2003). The particles (40 nm – 2 μm), which enter the vacuum chamber through an aerodynamic lens, are focused onto a narrow beam, evaporated on a hot surface ($\approx 600^\circ\text{C}$), ionised by electron impact (70 eV), and analysed with a 16-mm quadrupole mass spectrometer (Figure 1). The AMS can be operated in two modes: The bulk analysis mode, which is used for total chemical composition measurement, and the time-of-flight mode, in which the selective mass loading of the individual species can be measured.

Aerosol Mass Spectrometer (AMS)

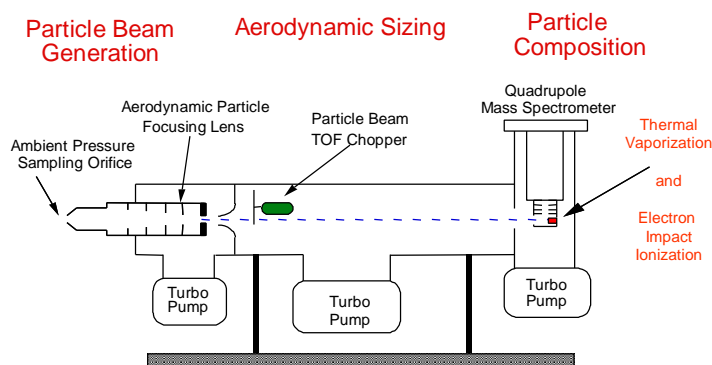


Figure 1. Schematic of the aerosol mass spectrometer (AMS) developed by Aerodyne Inc. (Jayne et al., 2000).

CONCLUSIONS

Figure 2 gives one typical mass distribution measured during August 2001 on Crete (MINOS campaign), and two mass distributions measured in southern Germany in May 2002 (HAZE campaign). While the chemical composition remained almost constant over the time of the MINOS measurements (17.8. - 23.8.2001), it varied considerably from day to day during the HAZE campaign. In Figure 2 an example of these variability is given: During 23.5.2002, the aerosol composition is dominated by sulfate between 00:00 and 08:00, while it was dominated by nitrate between 13:00 and 17:45. This finding can not be explained by the thermal instability of ammonium nitrate, since the temperature was higher in the afternoon (21°C) than during the night (13°C). The size distributions measured by the AMS represent the accumulation mode. This mode had its maximum in the mass distribution around 600 nm on Crete in August 2001, and around 400 nm during the HAZE campaign in May 2002.

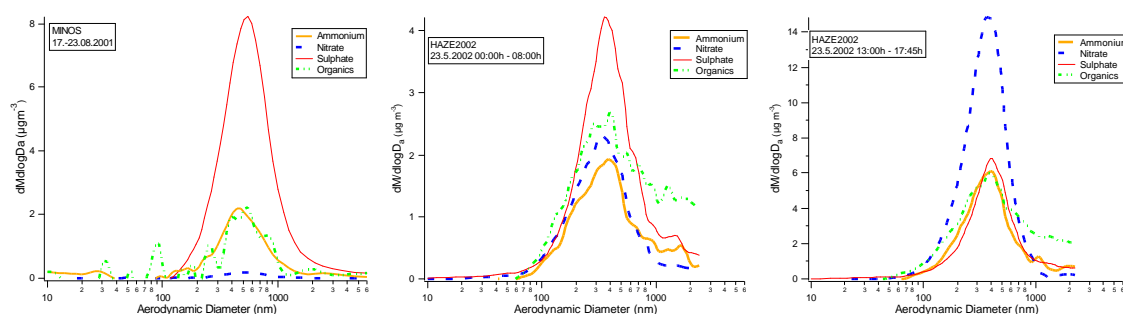


Figure 2. Size distributions for sulfate, organics, ammonium and nitrate from the MINOS campaign (left) and the Haze campaign (middle and right).

Vertical profiles of chemically resolved size distributions up the tropopause region will be measured during the PAZI campaign in May 2003, and further ground-based field studies are planned with the objective to better characterize the ambient aerosol composition and its dependency of meteorological parameters.

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