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Evaluation of an online analysis method of nitrate aerosols using a particle trap laser desorption mass spectrometer

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Aerosols play important roles in global air quality and climate change. Ammonium nitrate, which is generated via photochemical reaction of NOx, often contributes to a major fraction of fine particles in urban air. The gas-to-particle equilibrium reaction of ammonium nitrate exhibits strong temperature dependency near ambient temperatures, which often yields evaporative loss of particles during sampling.

We have developed a particle trap-laser desorption mass spectrometer (PT-LDMS) for online measurements of aerosol chemical compositions (Takegawa et al., AST, 46, 428, 2012). Factors affecting the quantification of nitrate aerosols, including, have not been fully characterized. The purpose of this study is to evaluate the quantification of nitrate aerosols by the PT-LDMS in the current configuration and also to investigate an optimal condition for ambient sampling.

Laboratory experiments were performed by generating monodisperse ammonium nitrate particles using an atomizer and differential mobility analyzer. The dependence of the sensitivity (defined as ion signals per collected nitrate mass) on the particle trap temperature was measured by altering the temperature of the particle trap holder between 280 and 313 K. The dependence of the sensitivity on the time after particle collection until laser irradiation (exposure time) was also measured. In addition, effects of the mixing state of nitrate particles on the sensitivity were evaluated by atomizing a mixed solution of ammonium nitrate and sulfate.

Preliminary results show that the sensitivity tended to decrease with increasing the exposure time for each temperature condition, which is likely due to evaporative loss of nitrate particles in the vacuum. On the other hand, the sensitivity did not exhibit significant temperature dependency at least for the temperature conditions during the experiments.

Possible mechanisms affecting the loss of nitrate particles, along with the effects of the mixing state on the sensitivity, will be presented and discussed.

Keywords: nitrate aerosols, online analysis method, mass spectrometer