4.036 On-line measurement of aerosol volatility at a regional background site in China.

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Abstract:

The coupling of a Thermal Denuder (TD) with a High-Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS) was setup in Xianghe, which is a regional background site in North China, during June - July, 2013 to on-line measure the mass concentrations and semi-volatilities of atmospheric submicron particles, including organic matter (OM), SO_4^{2-} , NO_3^-, NH_4^+, and Cl^-. The total PM_1 mass concentration measured was averagely (47.9±47.3) mg/m^3 during the campaign, with OM accounting for 38.2% of the total PM_1 mass, followed by SO_4^{2-} (33.7%), NH_4^+ (13.8%), NO_3^- (12.3%), and Cl^- (2.0%). It was found that NO_3^- and Cl^- had the highest semi-volatility, with about 60% of them evaporating into the gas phase by increasing the temperature to 50 °C, while SO_4^{2-} showed the lowest semi-volatility, with almost 90% of its mass remaining in the particle phase at 50 °C. The semi-volatility of OM and NH_4^+ was at the middle level. The semi-volatility of NO_3^- was affected by the pollution level of the atmospheric submicron particles since it showed an increasing trend with the increasing of PM_1 at 50 °C. The oxygen-to-carbon ration of organic aerosol was 0.47 to 0.60 by increasing the temperature from 50 ℃ to 200 °C. In addition, the semi-volatility of the PM_1 species with vacuum aerodynamic diameters of 60-2000 nm was little size dependent. The calculation based on the high-resolution mass spectra of OM showed that CO_2^+-containing organic species had lower semi-volatility, while $C_4H_9^+$-containing organic species had higher semi-volatility. The semi-volatility of OM was found to be negatively related to its oxidation state. The quantitative result of atmospheric submicron particles' semi-volatility is essential to the research of the physicochemical properties and pollution mechanism of particles as well as the validation of the air quality models.