Volatility of urban background ultrafine atmospheric aerosol particles in Athens, Greece

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More than half of world's population lives in urban areas, which are greatly affected by air pollution. Among the air pollutants, particulate matter poses one of the greatest risks to human health. The ultrafine fraction of particulate matter (UFP) represents most of particle number, and has been associated with adverse health effects (Pope and Dockery, 2006). Furthermore, UFP may affect the climate of the Earth directly by absorbing and scattering radiation, or indirectly by acting as cloud condensation nuclei (Lohmann and Feichter, 2004). Probing the properties of UFP in the atmosphere can be challenging due to their typical low mass concentration in ambient aerosol. For this reason, Tandem Differential Mobility Analysers (TDMAs) have been used to infer UFP properties like volatility, hygroscopicity and organic content. Volatility is increasingly considered one important property to assess, since it can provide valuable real-time information on particle mixing state, chemical composition and morphology.

The present study aims to analyze the size distribution and volatility of urban atmospheric aerosol particles observed in the city of Athens. A Scanning Mobility Particle Sizer (SMPS, TSI Inc.) and a Volatility TDMA (Mendes et al., 2016) were used. Measurements were carried out during three weeks at the DEM GAW urban background station, located at the N.C.S.R. "Demokritos". The average particle size distribution is shown in Figure 1.

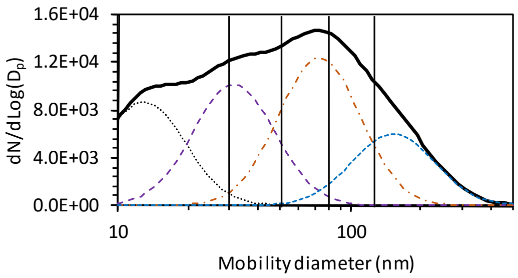

Figure 1. Average particle size distribution (solid black line) and calculated modes (dashed lines). The sizes analyzed by the VTDMA are indicated by solid vertical lines.

Upon heating, particles may be sorted in 3 classes: volatile, semi-volatile, and non-volatile, depending on whether they disappear, shrink, or stay unaffected. The VTDMA was used to evaluate the volatility of particles with diameters of 30, 50, 80 and 120 nm, and temperatures of 25, 110, 200 and 300 °C. The mean number and volume fractions remaining after heating are shown in Figure 2. Despite losing most of their volume, particle number remains mostly unchanged, indicating the existence of a solid core coated with volatile and semi-volatile material, or fully refractory particles. Particle shrinking to sizes lower than the detection limit may explain the particle loss for 30- and 50-nm particles. Larger particles have consistently larger refractory fractions. Aerosol volatilization rate was higher between 110 and 200 °C, which is expected since the major urban particles components volatilize within this temperature.

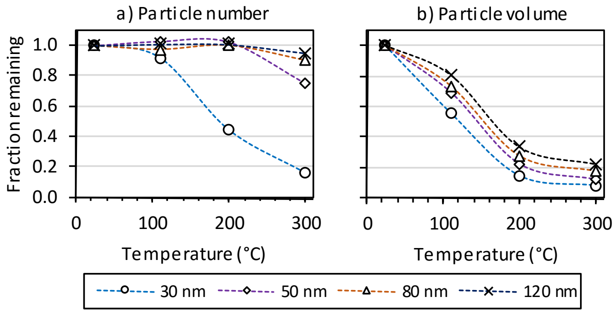

Figure 2. Particle number (a) and volume (b) fractions remaining upon heating.

Further measurements will be carried out and daily trends associated with meteorology and anthropogenic factors will be explored.

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