

High-time-resolution chemistry measurements of fine particles at an urban site in Helsinki, Finland

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High-time-resolution chemical measurements of fine particles has been conducted at an urban site in Helsinki, Finland to complete the previous studies focusing mainly on organic carbon, and made using 24 h filter sampling (Saarikoski et al., 2008). Using fast on-line methods the origin and source of individual short events can be more easily specified with the help of ancillary information like backward air-mass trajectories, wind direction or model simulations. The objectives of this study were to specify the chemical composition during different events, to assess the particle source and origin, and finally to identify the atmospheric processes that particles have experienced during the transport.

The measurements were started on December 2008 in Helsinki, Finland at an urban background station (SMEARIII, 60°12'N, 24°58'E, 26 m above sea level). The site is located 5 km northeast from the centre of Helsinki. The most important local source of fine particulate matter is traffic since a densely trafficked major road (60 000 vehicles/day) is situated at a distance of 200 m to the east. However, the contribution of regional residential wood combustion may be substantial during winter.

The chemical composition of aerosol particles in the submicron size range was measured with an aerosol mass spectrometer (HR-ToF-AMS, Aerodyne Research Inc.; Jayne *et al.*, 2000), a semi-continuous organic and elemental carbon analyzer (OC/EC; Bae *et al.*, 2004), and two Particle-Into-Liquid -Samplers (PILS, Orsini *et al.*, 2003) one coupled with two ion chromatographs (IC) (for cation and anion analysis) and the other coupled with a total organic carbon analyzer (TOC analyzer, Shimadzu, Model TOC-V_{CPH})

The AMS measured organics, sulfate, nitrate, ammonium, and non-refractory chloride of which sulfate, nitrate, ammonium and chloride were also analyzed by the PILS-IC. In addition, the PILS-IC was able to measure also oxalate, sodium and potassium. Water-soluble organic carbon was determined by a PILS coupled to the TOC analyzer. Gaseous components, SO₂, NO, NO_x, CO and O₃, were also measured at the station. The time-resolution of aerosol and gas measurements varied from 1 min to 2 h.

As an example of the collected data, two cases are shown in Figure 1 where sulphate concentrations are quite high during a few hours, while the other components such as organics, ammonium and nitrate

were not elevated. Sulphate was only partly neutralized and seemed to be mainly in the form of sulphuric acid. According to the backward air mass trajectories the first events were originated most probably from oil shale fuelled power plants in Narva, Estonia. The other high sulphate event seemed to be transported from Saint Petersburg area. Local short-time events dominated by traffic related or biomass burning particles affected mainly the concentrations of organics, nitrate and chloride. These events were often related to the low atmospheric mixing due to the temperature inversion.

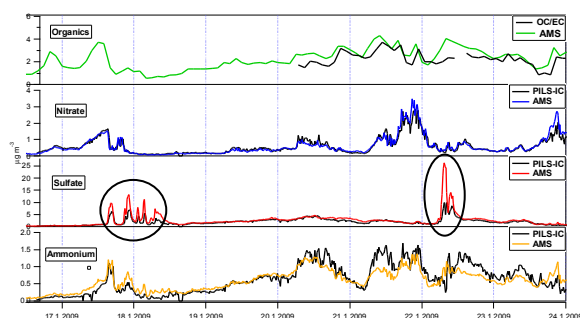


Figure 1. Time-series of organics, nitrate, sulphate, and ammonium measured by AMS or PILS-IC or OC/EC-analyzer in January 16-23, 2009 in Helsinki, Finland. The units are in $\mu\text{g m}^{-3}$. In the AMS data constant 50% collection efficiency is assumed causing an obvious overestimation for the cases where sulphate is acidic.

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