Characterisation of winter aerosols in the Helsinki region by TEM/EDX individual particle analysis

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The detailed monitoring of aerosol particle properties in urban and suburban areas is a challenging task, since particle concentration, size, composition and sources vary strongly in time and space. As a part of MMEA Programme (Measurement, Monitoring and Environmental Assessment, 2010-2014), we have conducted field campaigns in the poor air quality hot spot areas of the Helsinki region, i.e. city centre street canyons (Dec 2010 campaign; Pirjola et al. 2012), major roads (Oct-Nov 2012) and densely populated small house areas with local wood burning (Feb 2012). During the campaigns, stationary and mobile online measurements (laboratory van 'Sniffer') have been performed, focusing on particle composition, size distribution and volatility. Furthermore, particle samples have been collected for transmission electron microscopy coupled with energy-dispersive X-ray microanalysis (TEM/EDX). The combined application of several methods enables us to obtain a comprehensive view on aerosol properties and sources as well as to test new measurement methods.

We will present detailed TEM/EDX individual particle view, complemented with other methods, on typical winter aerosols in the Helsinki region. Four periods for TEM/EDX analysis were selected during the campaign in February 2012;

1. very clean period (CLEAN) at urban background site on seashore due to air flows from the Atlantic Ocean (Feb 21 morning),

2. strong long-range transported pollution episode (LRT-EPI) at urban background site on seashore due to air flows from eastern Europe (Feb 18 evening),

3. fresh smoke plumes from biomass burning (SMOKE) in suburban small house area mixed with LRT pollution (Feb 18 evening), and

4. fresh emissions from traffic (TRAFFIC) at kerbside of busy street in Helsinki city centre during morning rush hour (Feb 24 morning).

Description of aerosol properties

Aerosol properties were measured by Sniffer along the selected research routes. Online PM_1 chemical composition was monitored with a soot particle aerosol mass spectrometer (SP-AMS) and an aethalometer. Particle size distributions were measured with an electrical low pressure impactor (ELPI). During the 15 min samplings for TEM/EDX, the mobile laboratory was parked. The size-segregated particle samples (6 size fraction between 56 and 1 800 nm) for TEM/EDX were collected with a rotating MOUDI impactor.

The volume size distributions (Fig. 1) and PM_1 bulk chemical compositions (Fig. 2) of particles show the general view on aerosol properties for the four periods.

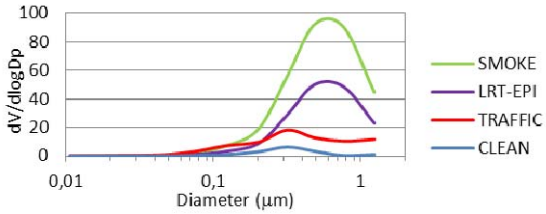

Figure 1. Particle volume size distributions (ELPI).

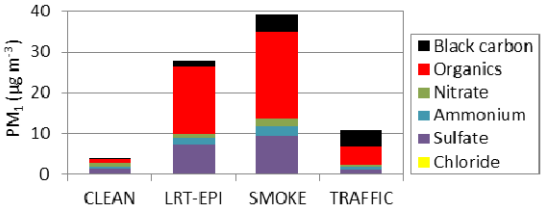

Figure 2. PM_1 bulk chemical compositions (SP-AMS).

The individual particles (# ~ 1100) analyzed with TEM/EDX were classified into several groups (particle types) based on their elemental composition, morphology, internal structure and susceptiblity to damage by an electron beam. The major particle groups were 1) tar balls, 2) K/C-rich, 3) soot, 4) soot mixed with secondary material, 5) S/C-rich secondary, 6) Ni-V-Fe with secondary, 7) Fe-rich, 8) Si-Al-rich, 9) sea salt, and 10) NaCl street-deicer rock salt. Figure 3 shows two TEM images, as an example for LRT-EPI and TRAFFIC periods. The detailed size-segrated particle classification and TEM-images will be shown in the EAC.

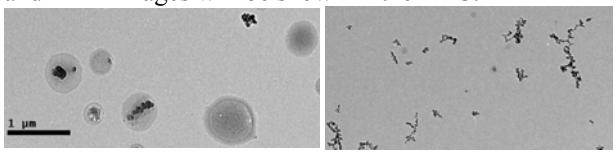

Figure 3. TEM images; LRT-EPI (left), STREET (right).

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