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LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

Chemical and microphysical characterization of black carbon containing urban, rural and laboratory aerosols

A.C. Eriksson*, J.H. Pagels, J. Martinsson, J. Rissler, E.Z. Nordin, E. Swietlicki

¹Division of Nuclear Physics, Lund University, Box 118, SE-22100, Lund, Sweden

²Division of Ergonomics and Aerosol Technology, Lund University, Box 118, SE-22100, Lund, Sweden

*Corresponding author: axel.eriksson@nuclear.lu.se

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Agglomerated, carbonaceous primary particles emitted from combustion processes are ubiquitous in the atmosphere. These are often referred to as black carbon (BC) due to their strong light absorption. BC is considered the second largest contribution to anthropogenic radiative forcing. This, in addition to the suspected detrimental effects on human health, more so than PM in general, motivates studies of BC containing particles. We report experimental findings from urban, rural and laboratory measurements with the Soot-Particle Aerosol Mass Spectrometer (SP-AMS) and complementary techniques. The instrument was deployed and operational for >1 month in each campaign.

The SP-AMS (Onasch et al 2012) is a recent modification of the High-Resolution Time-of-Flight AMS (AMS), an instrument which quantitatively measures the chemical composition of PM₁ in-situ, with high precision and sufficient mass resolution for elemental analysis. AMS utilizes 70 eV electron ionization applied to vapors resulting from impaction on a heated (600 C) W surface, coupled with Particle Time of Flight (PToF) measurements to provide data on ensemble chemical composition resolved in time and particle size. The technique separates particles based on their inertia and drag at low pressure, i.e. vacuum aerodynamic equivalent diameter (D_{va}). In D_{va} space (as opposed to mobility diameter) agglomerated particles are small owing to their high surface/mass ratio, which enables unambiguous separation of fresh and processed restructured (compacted) agglomerates. The AMS mode of vaporization limits the technique to species which evaporate sufficiently fast after impaction, which is not the case for BC. Hence another mode of vaporization was added to the design, a 1064 nm intracavity laser, which heats absorbing particles (such as BC containing particles) until they vaporize. Other instrumentation employed in these campaigns includes the Differential Mobility Analyzer-Aerosol Particle Mass Analyzer (DMA-APM) which measures mobility resolved particle mass in-situ, and 7 wave-length Aethalometer which measures light attenuation via filter deposition.

The data plotted in Figure 1 and 2 were collected during 24 hours, sampling wintertime roadside urban aerosol in Copenhagen. Figure 1 illustrates the

diurnal variation of BC during the campaign, which strongly implies traffic as main source.

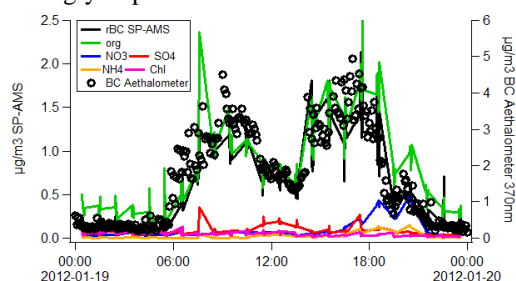


Figure 1. 24 hours of SP-AMS data from roadside in Copenhagen (left). Aethalometer data on BC concentration (right)

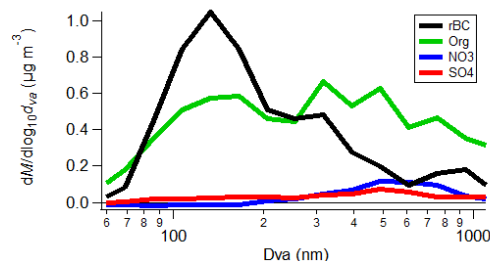


Figure 2. Size resolved SP-AMS data from the period plotted in figure 1.

The values for rBC (refractory Black Carbon as measured with the SP-AMS) concentration are preliminary as generic calibration factors were applied, pending full analysis of the on-site calibrations. The good agreement on temporal variability confirms the connection between light absorption and carbon cluster ions, interpreted as rBC. Figure 2 shows the size resolved average composition. Notably the smaller diameter bins (<200 nm) are dominated by rBC and OA, while the larger particles also contain NO₃ and SO₄. Internal mixing of the latter with BC was inferred by comparison with (non-SP) AMS data. The smaller particles are similar to those observed in fresh diesel (Euro II vehicle) exhaust laboratory measurements, while the larger mode resembles the PM sampled at the rural site.

References

Onasch, T.B et al. (2012). *J. Aerosol Sci.*, **46**, 804-817.