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Source apportionment of the carbonaceous aerosol – Quantitative estimates based on 14C- and organic tracer analysis

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The World Health Organization (WHO) points towards combustion derived primary particles when ascribing the negative health effects that ambient particles have on human health. These particles consist mainly of carbonaceous material. Further, great uncertainties are associated with the contribution from natural sources to the ambient carbonaceous aerosol concentration.

Until recently there has been no way of separating such particles from particles from other sources in the ambient air. By the combined effort of thermal optical, 14C-, and organic tracer analysis this is now possible. When treating such data statistically using Latin Hypercube Sampling (LHS), we are able to apportion the ambient aerosol carbonaceous material to a total of seven different sources, i.e. Elemental carbon from combustion of biomass (ECbb) and fossil fuel (ECff), organic carbon from combustion of biomass (OCbb) and fossil fuel (OCff), primary biogenics (OCpb), and secondary organic aerosols from anthropogenic and (ASOA) and biogenic (BSOA) precursors. The current approach makes it possible to separate not only primary versus secondary aerosols, but also to separate between natural and anthropogenic sources, which is highly important in order to sort out abatement strategies for reducing man-made emissions of combustion derived primary particles.

The carbonaceous aerosol originating from the above mentioned seven sources has been examined with respect to size fraction (PM10 and PM1), time of the day and season for one rural background site (Hurdal) and one urban background site (Oslo) in Norway.

Briefly, the results show that combustion derived primary particles (ECbb, ECff, OCbb, OCff) accounted for 45% of the carbonaceous material in PM10 in Oslo in summer, whereas 46% of the carbonaceous material came from natural sources (OCpb, BSOA). For PM1, combustion derived primary particles accounted for 47% of the carbonaceous material, whereas 36% originated from natural sources. The major source of combustion derived primary particles in Oslo in summer was combustion of fossil fuel, constituting approximately 25-30% of the total carbonaceous content followed by combustion of biomass (16-21%). In winter, combustion derived primary particles constituted 81% of the carbonaceous material in the ambient aerosol at the urban background site in Oslo, of which 48% could be attributed to biomass burning and 33% to combustion of fossil fuel. Natural sources was the major contributor to the total carbonaceous material in PM10 (72%) and PM1 (66%) at the rural site in summer, whereas it was negligible in winter (< 8%).

One of the important conclusions from this study is that the population in Oslo could be subject to severe exposure with respect to combustion derived primary particles in winter. The finding that approximately 50% of the ambient aerosol carbonaceous material in Oslo in summer originates from natural sources is crucial knowledge when attempting to sort out abatement strategies for the urban PM level.