Highly time- and size-resolved measurements of trace elements in London during ClearfLo

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The identification and quantification of particle sources has long proven challenging due to the complex composition of ambient aerosol. Measurements of trace elements provide uniquely source-specific information; e.g. barium and copper are emitted by traffic sources, while vanadium and nickel are linked to heavy oil combustion. The power of source apportionment by trace elemental analysis is greatly enhanced by simultaneous measurements of complementary aerosol species. Optimization of trace elemental data requires measurements with sufficient temporal resolution to distinguish sources with different characteristic diurnal patterns such as traffic and sea salt, while size-resolved measurements can help resolve different source classes with similar composition, e.g. iron from resuspension appears in $PM_{10-2.5}$ while brake wear processes appear in PM_1. Here we present highly time- and size-resolved measurements of trace elements as part of the ClearfLo (Clean Air for London) 2012 field campaign, a multinational collaborative effort to investigate boundary layer pollution in and around London, UK.

Sampling was performed at several sites in and around London during two Intensive Observation Periods (IOPs) in 2012. During the winter IOP (11 Jan. to 8 Feb.) particulate matter was sampled at a site with heavy traffic (Marylebone Road, MR) and an urban background site (North Kensington, NK) in London, and at a rural site in Detling, southeast of London. Summer sampling took place at the two London sites from 18 July till 22 August, a period which included the Olympic Games. Rotating drum impactors (RDIs) collected particles in three size bins ($PM_{10-2.5}$, $PM_{2.5-1.0}$ and $PM_{1.0-0.1}$) with a high time resolution of 2 h, instead of more common 24 h sampling times (Bukowiecki et al., 2005). The elemental composition of the samples was analysed by synchrotron radiation induced X-ray fluorescence spectrometry (SR-XRF) at the Swiss Light Source (SLS, Paul Scherrer Institute, CH) and at HASYLAB (Deutsches Elektronen-Synchrotron, DE). The RDI SR-XRF setup provides quantification of elements with atomic number 11 (sodium) to 82 (lead) with a detection limit on the order of a few pg (Richard et al., 2010).

Figure 1 shows the median diurnal variations of selected elements in $PM_{10-2.5}$ (ng m^{-3}) during the winter IOP. The rush hour peaks for iron (Fe) and barium (Ba) (top panel) are commonly observed in a street canyon with stop-and-go traffic. Ba is typically related to brake wear (e.g. Furusjö et al., 2007) and elevated concentrations are thus likely at such a site (Ba at NK was below detection limit). Elevated concentrations during daytime for mineral dust elements like aluminium (Al) and calcium (Ca) (centre panel) occur from continuous resuspension at MR. NK shows lower levels due to dilution of air during transport from the traffic to the urban background site. Rather constant values were observed for e.g. sodium (Na) and magnesium (Mg) (bottom panel). These sea salt elements are likely advected throughout the day, but the elevated values at MR indicate local emissions as well. Correlations with e.g. black carbon, nitrogen oxides and meteorological conditions will enhance the source separation of the trace elements.

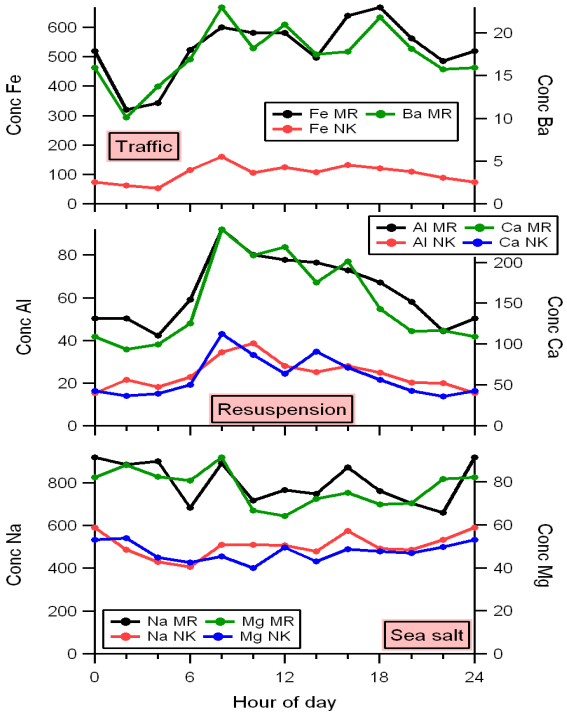

Figure 1. Median diurnal variations of $PM_{10-2.5}$ trace elements (ng m^{-3}) separated into three suggested source categories for a heavy traffic (MR) and an urban background (NK) site during ClearfLo 2012, winter IOP.

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Bukowiecki, N. et al. (2005) *Environ. Sci. Technol.* **39**, 5754-5762
Furusjö, E. et al. (2007) *Sci. Total Environ.* **387**, 206-219
Richard, A. et al. (2010) *Atmos. Meas. Tech.* **3**, 1473-1485