# Chemical composition and source apportionment of PM$_{2.5}$ at kerbside, London, UK

D.C. Green[1], A.H. Tremper[1], M. Priestman[1], S.H. Hamad[2], F.Canonaco[3]

[1]MRC HPA Centre for Environment and Health, King's College London, London, SE1 9NH, UK
[2]University of Wisconsin-Madison, 660 N. Park St. WI53706, Madison, Wisconsin/USA
[3]Laboratory of Atmospheric Chemistry, Paul Scherrer Institute, Villigen PSI, 5232, Switzerland
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Presenting author email: david.c.green@kcl.ac.uk

Measurements of the chemical composition of PM$_{2.5}$ were made at the Marylebone Road kerbside station in central London during Oct and Nov 14. This included the first use of an automated high time resolution XRF instrument. PMF and ME2 source apportionment was used to illustrate the influence of different sources on PM$_{2.5}$ concentrations at this location which included a period of local firework and bonfire activity on 5$^{th}$ Nov.

**Chemical Composition Measurements**

The XACT 625 sampled ambient air through a PM$_{2.5}$ inlet and a filter tape. The resulting PM deposit was then automatically advanced and analysed by XRF for selected elements (As, Ba, Ca, Cd, Ce, Cr, Cu, Fe, K, Mn, Mo, Ni, Pb, Pd, Pt, S, Sb, Se, Si, Sr, Ti, V, and Zn) and provided a measurement for each element every hour. The Aerodyne Aerosol Chemical Speciation Monitor (ACSM) measured NO$_3$, SO$_4$, NH$_4$ and organic mass in non-refractory PM$_1$ at a 30 min resolution using aerosol mass spectrometry. The Aethalometer AE21 measured black carbon in PM$_{2.5}$ at a 5 min resolution. PM$_{2.5}$ mass concentrations were provided by an FDMS.

**Figure 1** shows the measurements of the most abundant chemical components. This demonstrates that measurements of the black carbon, non-refractory and elemental PM can provide an excellent agreement (slope 0.91, r$^2$ 0.88) with co-located PM$_{2.5}$ mass measurements.
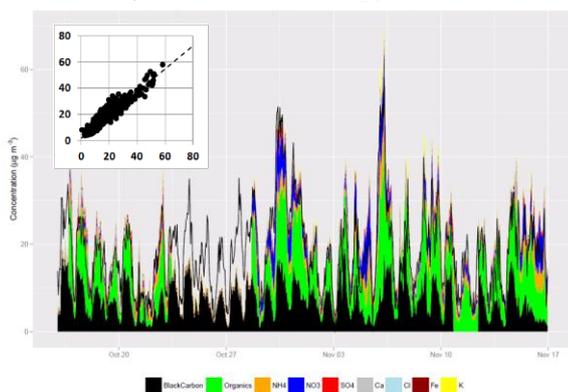


Figure 1: PM$_{2.5}$ chemical composition and mass

**Source Apportionment**

Representative and physically meaningful solutions were derived with PMF and ME2 using the SoFi source finder tool (Canonaco et al., 2013). This was achieved by undertaking the source apportionment in a number of steps to provide an independent time series of sources (esp. the fireworks/bonfire or biomass burning organic aerosol source) against which later source time series could be verified. Firstly, SoFi was used to apportion the ACSM organic aerosol into a number of sources, these consisted of those commonly attributed (hydrocarbon-like (HOA), cooking (COA), low-volatility (LVOA) and biomass burning (BBOA)) plus a novel source which had a temporal correlation with the fireworks/bonfire activity; these results are shown in Figure 2. These common attributed sources were verified using external time series (e.g. NO$_X$ for traffic), locally derived referenced mass spectra (Young et al., 2014) and knowledge of the diurnal evolution of specific emission sources (e.g. cooking (Allan et al., 2010)). Secondly, the XRF measurements were apportioned; resulting in a number of sources, including those identified as non-exhaust, mineral, marine and fireworks/ bonfire activity. A supplementary source apportionment, including the black carbon measurements alongside the XRF, was undertaken to better attribute the vehicular sources. These XRF source apportionment results were verified using external time series (e.g. NO$_X$ for traffic, Cl and Na from ion chromatography for marine) and the previously derived ACSM fireworks/bonfire source.
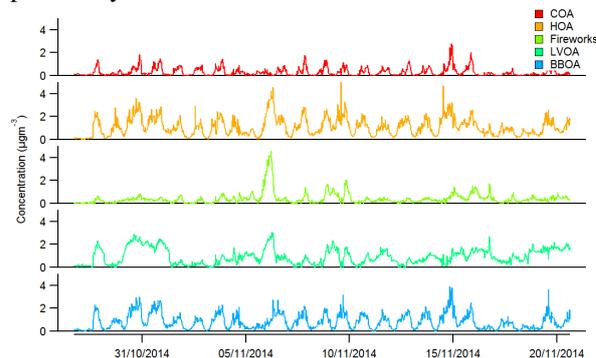


Figure 2: PMF output from ACSM organic signal

**Conclusions**

The use of high time resolution XRF data has allowed the characterisation and source apportionment of vehicle non-exhaust sources, mineral sources, firework and bonfire activity; this was primarily due to the availability of well conserved tracers for these sources (Ba, Ti and Sr respectively). This novel measurement technique has been combined with the more established source apportionment of the ACSM organic mass and the direct measurement of chemical composition to provide a unique perspective on the wide range of PM$_{2.5}$ sources influencing this location.

1. Canonaco et al, (2013) AMT **6,** 3649-2013
2. Young et al (2014) ACPD **14,** 18739-2014
3. Allan et al (2010) ACP **10,** 647-2010