PM_{10} chemical composition in at street canyon and urban locations in London, UK

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Introduction

Concentrations of a number of elements have been used as tracers for non-combustion sources of PM in London[1]. By 2020 non-combustion sources are predicted to rise to 80-90% of vehicle emissions[2], are highly uncertain and despite being predominantly found in the coarse fraction, have been associated with health end points[3]. Previous studies have been campaign based, however this study quantifies the concentrations of these elements at a background and a street canyon location over a 12 month period.

Methods

PM_{10} samples were collected every 24 hours onto mixed cellulose esters filters using Partisol samplers. This was undertaken at urban background (North Kensington) and street canyon (Marylebone Road) locations between Jan 11 and Jan 12. The samples were digested using hydrofluoric acid and analysed using ICP-MS for a range of elements (Al, Ba, Ca, Cr, Cu, Fe, Mg, Mn, Mo, Na, Ni, Pb, Sb, Sr, Ti, V and Zn). A traffic increment was calculated as the difference between the contemporaneous daily measurement from North Kensington and Marylebone Road.

Results and discussion

Mean concentrations ranged over three orders of mangnitude; Fe was the most abundant element measured, 430 ngm^{-3} at the background site and a traffic increment of 1720 ngm^{-3} while Ni was the least abundant 1.3 ngm^{-3} at the background site and a traffic increment of 1.7 ngm^{-3}. The relative abundance of each element is shown in Figure 1. Elements can be grouped into broad source categories based on the concentrations measured at the two sites and what is known about their origins.

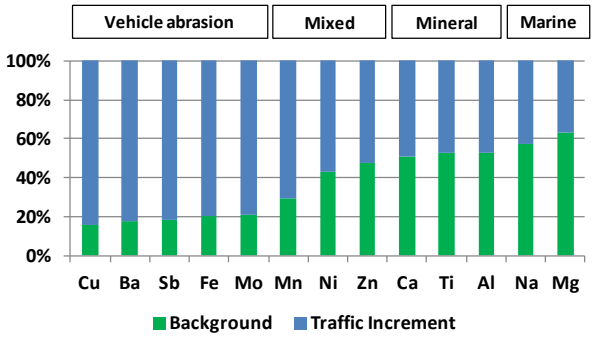

Figure 1: Relative abundance of selected elements in background and traffic increment

The correlations between NO_X and the elements associated with vehicle abrasion emissions (Ba, Cu, Fe, Sb, Mo) is shown in Table 1 for both the background site and in the traffic increment; this demonstrates the traffic related source of these elements.

Table 1: Correlation of vehicle abrasion elements with NO_X ; background in green, traffic increment in blue

	NO_X	Ba	Cu	Fe	Sb	Mo
NO_X		0.81	0.81	0.80	0.81	0.80
Ba	0.75		0.96	0.92	0.97	0.94
Cu	0.82	0.88		0.92	0.96	0.93
Fe	0.87	0.81	0.84		0.91	0.89
Sb	0.78	0.88	0.83	0.80		0.94
Mo	0.91	0.81	0.85	0.95	0.82	

Many of the elements, such as those which are predominantly mineral in origin (Al, Ca, Ti) have regional, as well as local sources. The local sources are highly dependent on wind speed and direction. The bivariate polar plot in Figure 2 demonstrates the wind direction and wind speed dependence of the Al and Ca traffic increment concentrations

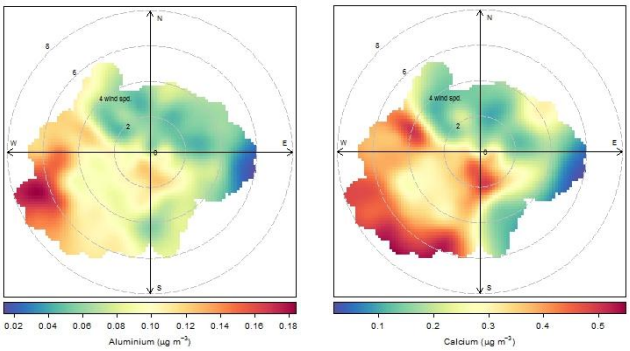

Figure 2: Bivariate polar plot of Al traffic increment concentration.

Together with the additional chemical characterization measurements made at these sites, this dataset will allow a detailed examination of the sources and processes governing the non-exhaust PM concentrations measured at these sites.

References

1. Harrison, R.M. et al (2012) Estimation of the Contributions of Brake Dust, Tire Wear, and Resuspension to Non-exhaust Traffic Particles Derived from Atmospheric Measurements. ES&T. DOI: 10.1021/es300894r

2. Rexeis M. et al. Trend of vehicle emission levels until 2020 – Prognosis based on current vehicle measurements and future emission legislation. Atmos. Env. 2009, 43, 4689-4698.

3. Malig, B.J.et al. Coarse particles and mortality: evidence from a multi-city study in California. OEM 2009;66:832-839.