Detailed air quality monitoring methodology

Measurement of PM concentration

The basic principle of operation of both the Tapered Element Oscillating Microbalance TEOM and TEOM-FDMS are identical. The ambient sample stream is firstly drawn through a size fractioning inlet that selects particles of the required aerodynamic cross sectional diameter: PM_{10} and $PM_{2.5}$. This air stream, containing only the selected particles, then passes through a Teflon filter which is attached to an oscillating tapered element. The PM is collected on the filter and the mass gained decreases the frequency of the oscillating tapered element. By knowing the spring constant of the tapered element and by measuring this change of resonant frequency, the mass gained by the filter can be calculated. This calculation is carried out automatically by the TEOM or TEOM-FDMS control unit. Heating of the tapered element to avoid interference from the thermal expansion of the tapered element and relative humidity leads the TEOM to have poor sensitivity to semi-volatile particles. The TEOM-FDMS makes a separate measurement of the semi-volatile particulate to correct for these losses by determining the rate of sample mass loss when dry, particle-free air is passed through the filer sample at 30∘C. Alternatively, the loss of the semi-volatile PM can be corrected using the volatile correction model (VCM). Both TEOM-FDMS and TEOM-VCM data have been found to be equivalent to the European Union's reference method for monitoring PM_{10} (Green et al. 2009). All instruments in the SAQD and AURN undergo extensive 6-monthly QAQC audits and the data are subjected to detailed post-measurement quality assurance and quality control processes.

Calculation of non-primary PM

The non-primary PM was calculated as:

$$NonPrimary = PM - f(NO_X) \tag{1}$$

where PM is the total hourly concentration of PM for a given fraction expressed in $\mu g\ m^{-3}$; NO_X is the hourly concentration of nitrogen dioxides expressed in $\mu g\ m^{-3}$; and f is the emission ratio of primary PM to NO_X. The emissions factor (f) was calculated using regression analysis of the difference between concentrations of both NO_X and PM at a busy road in London and a nearby urban background monitoring site for 2010/11 using the method of the (Airborne Particles Expert Group (APEG) 1999). The emissions ratios, f, were 5.8×10^{-2} for $PM_{10}:NO_X$ and 4.2×10^{-2} for $PM_{2.5}:NO_X$. The uncertainty associated with the non-primary fraction of PM [U(NonPrimary)] was calculated by the GUM uncertainty method (International Organisation for Standardisation (ISO) 1995)as:

$$U(NonPrimary) = 2\sqrt{[U \cdot (PM)]^2 + [f \cdot U(NO_x)]^2 + [U(f) \cdot (NO_x)]^2} \tag{2}$$

where $U(PM)$ was the uncertainty of the total PM concentration accounted as:

$$U(PM) = 0.045 \times PM \tag{3}$$

as estimated by Harrison et al. (2008) from daily mean PM measurements by TEOM-FDMS. $U(NO_X)$ was the uncertainty of the NO_X measurements, calculated as:

$$U(NO_X) = 0.09 \times NO_X \tag{4}$$

estimated from over 6,000 hours of equipment performance trials held in a range of locations in London. U(f) was the uncertainty in the emission ratio and its value is $5.73 \times 10^{-3}\ \mu g\ m^{-3}$ PM_{10} for $\mu g\ m^{-3}$ NO_X from standardised major axis regression; and $2.86 \times 10^{-3}\ \mu g\ m^{-3}$ $PM_{2.5}$ for $\mu g\ m^{-3}$ NO_X. A multiplier of 2 is used to approximate to a 95% confidence limit. Whenever the non-primary uncertainty was greater than the non-primary PM concentration, the hourly concentration was discarded from the analysis.