Measurements of black carbon using the Transmissometer

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Quartz and teflon coated glass fibre filters were exposed in London as part of a PM_{10} mass measurement monitoring programme prior to the commencement of routine EC/OC measurements and prior to the implementation of the Low Emission Zone (LEZ). Analysis of these filters is designed to allow an assessment of tailpipe EC/BC emissions reductions brought about by the LEZ. The Transmissometer (Magee, 2007) offers a very cost effective method of measuring black carbon (BC) concentration on filter samples using a similar technique to that used in the Aethalometer (Magee, 2005). Various methods are available to correct aethalometer measurements for filter loading effects, (Virkkula et al., 2007; Park et al., 2010) but these methods do not directly apply to the transmissometer. Instead an empirical method was tested to correct for filter loading effects using the relationship between transmissometer BC and elemental carbon (EC) concentrations measured using a Sunset Labs Instrument.

Filters were exposed daily at the North Kensington (NK) urban background site, Marylebone Road (MY) traffic site and Earls Court Road (ECR) traffic site. After mass analysis, these filters were analysed using the Transmissometer. A subset of quartz filters, from NK and MY, were analysed for BC using the transmissometer before thermal analysis for EC by Sunset. These EC measurements were used to calculate the corrected transmissometer BC measurements with the generalised least squares method using XGenline (NPL, 2010). Various fitting methods of the calibration curve were tested. Subsequently time series of corrected BC measurements with a known uncertainty were produced to assess changes in the concentration due to the LEZ.

Two short time periods in 2006, during which thermal EC/OC measurements were available at KC and MY, were used to evaluate the transmissometer BC concentrations. Transmissometer BC from $PM_{2.5}$ filters and PM_{10} agreed well as most of the BC can be found in the smaller size fraction.

Comparing the transmissometer BC concentrations from the PM_{10} filters with the EC concentrations recorded by thermal analysis at MY, it is noticeable that the corrected BC is significantly lower than the thermal EC at higher concentrations (Fig. 1). This is not the case for NK, were concentrations are generally much lower (Fig. 2).

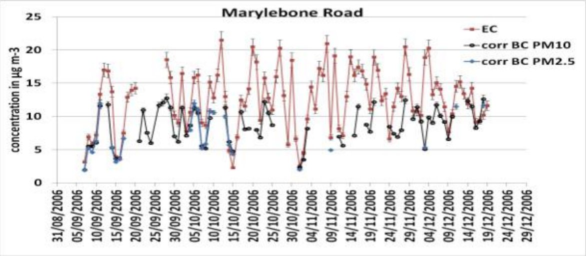

Figure 1: Conc. of thermal EC and corrected BC in PM_{10} and $PM_{2.5}$ filters at MY (all in µg m^{-3})

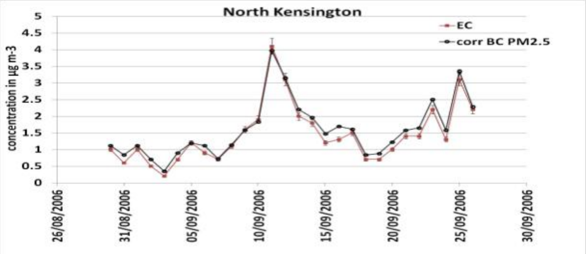

Figure 2: Conc. of thermal EC and corrected BC in PM_{10} and $PM_{2.5}$ filters at KC (all in µg m^{-3})

Overall the corrected transmissometer BC offers an opportunity to extend time series at sites with low EC concentrations – see Fig.3.

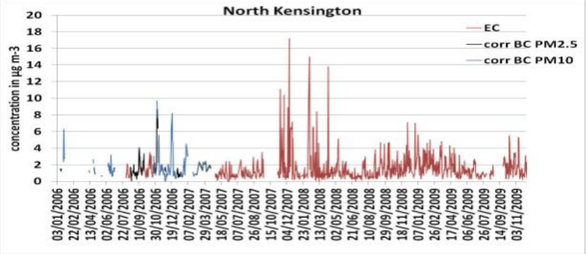

Figure 3: EC and corrected BC in PM_{10} and $PM_{2.5}$ filters at KC between 2006 and 2009 (all in µg m^{-3})

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Magee Scientific 2005. The Aethalometer ™ - Manual

Magee Scientific 2007. Dual-Wavelength Optical Transmissometer Data Acquisition System – Manual

NPL, 2010. http://www.npl.co.uk/mathematics-scientific-computing/mathematics-and-modelling-for-metrology/xgenline-8.1

Park, S.S et al 2010. ATMOS ENVIRON 44, 1449–1455.

Virkkula, et al. 2007. J AIR WASTE MA (1995), 57. 1214–1222