Appendix C Correction of Black Carbon and UFP Data

C1.1 Correction for Filter Loading

The AE51 aethelometer measures back carbon by calculating the attenuation of light (λ = 880 nm) through a filter. AE51 data are known to require specialised processing as a result of high noise at high temporal resolution and interference from vibrations and mechanical shocks in the form of data spikes (Poppel et al, 2013; Hudda et al, 2013). A standalone software program for the processing of noisy data using the optimized noise-reduction averaging (ONA) algorithm has been developed by the United States Environmental Protection Agency (Hagler et al, 2011). It has also been identified that the relationship between the attenuation of light, filter loading and the calculated mass concentration is not linear, which can result in an underestimation of black carbon concentrations as the filter loading increases (Virrkula et al, 2007).

For the purposes of this study, 1-minute average data were recorded and it was found that this was sufficient to minimise noise and interference from vibrations and mechanical shocks. Therefore, the use of the ONA algorithm was not required. However, in order to investigate the possible effects of filter loading on measured black carbon concentrations, all data were corrected using the algorithm derived by Virrkula et al (2007):

$$BC_{corr} = (1 + k \cdot ATN)BC_0 \qquad \text{(C1)}$$

Where:

BC_{corr} = Corrected black carbon concentration.

BC_0 = Non-corrected black carbon concentration.

ATN = the attenuation.

$$k \approx \frac{1}{ATN(t_{i,last})}\left(\frac{BC_0(t_{i+1,first})}{BC_0(t_{i,last})}\right) \qquad \text{(C2)}$$

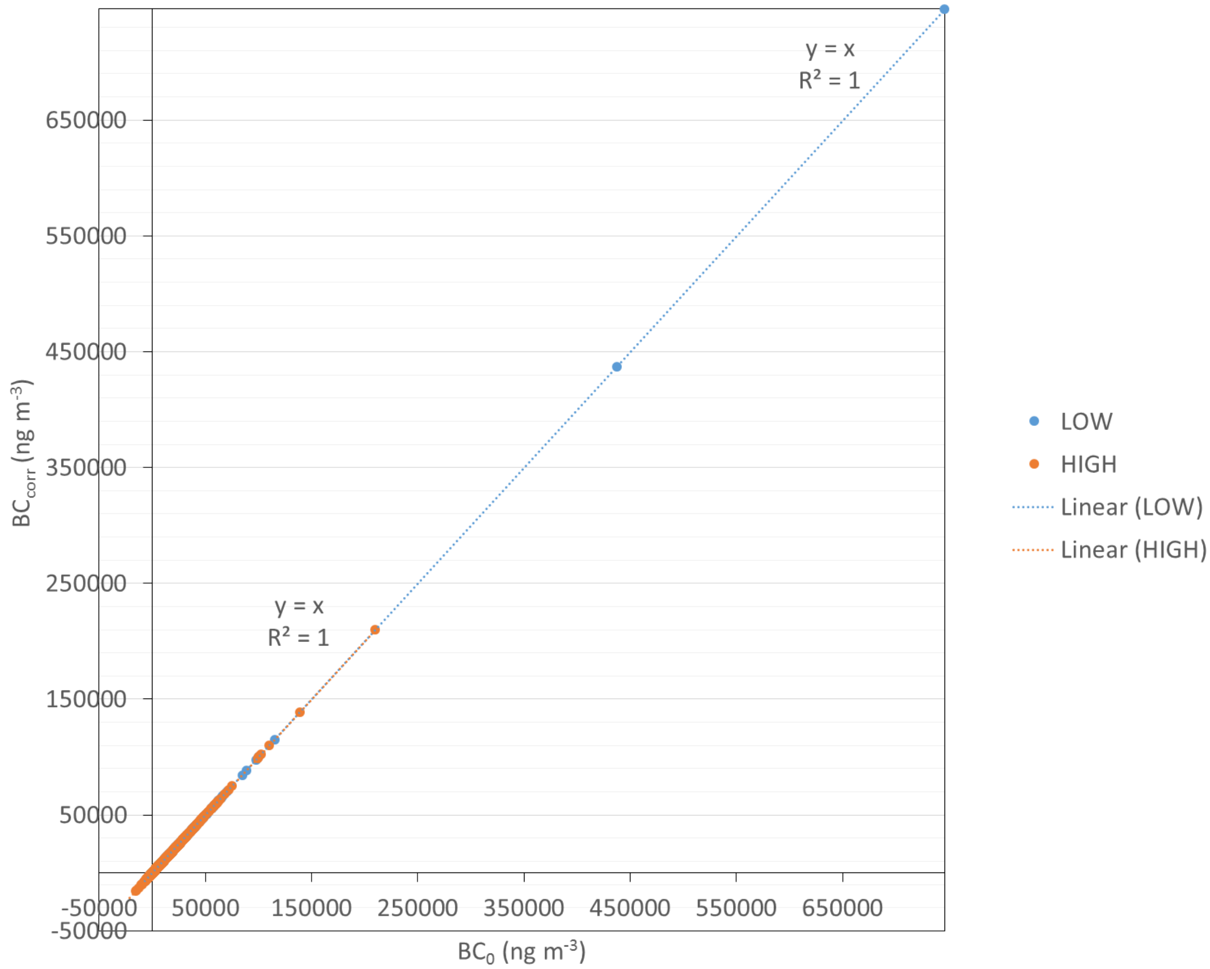
Where:

$t_{i,last}$ = the time of the last measurement data for filter spot i.

$t_{i+1,first}$ = the time of the first measurement data for the next filter spot.

Figure C1 shows the non-corrected versus corrected black carbon data for the LOW and HIGH AE51 samplers from all colocation and mobile monitoring exercises (11,373 measurements). Linear regression has been used to determine the relationship between the non-corrected and corrected concentrations. In this case, it was found that the filter loading had no effect on the measured black carbon concentrations with a relationship of 1:1 between no-corrected and corrected data. Therefore, no correction has been applied to BC data for the purposes of this study.

Figure C1 Non-Corrected versus Corrected Black Carbon Concentrations



C1.2 Limit of Detection – AE51

An assessment of the limit of detection (LoD) of the AE51 Micro-aethelometer (and Philips NanoTracer) was carried out by sampling low BC concentration air within an office environment. Figure C2 shows the LOW vs HIGH measurements recorded during this exercise. A total of 778 1-minute average concentrations were recorded.

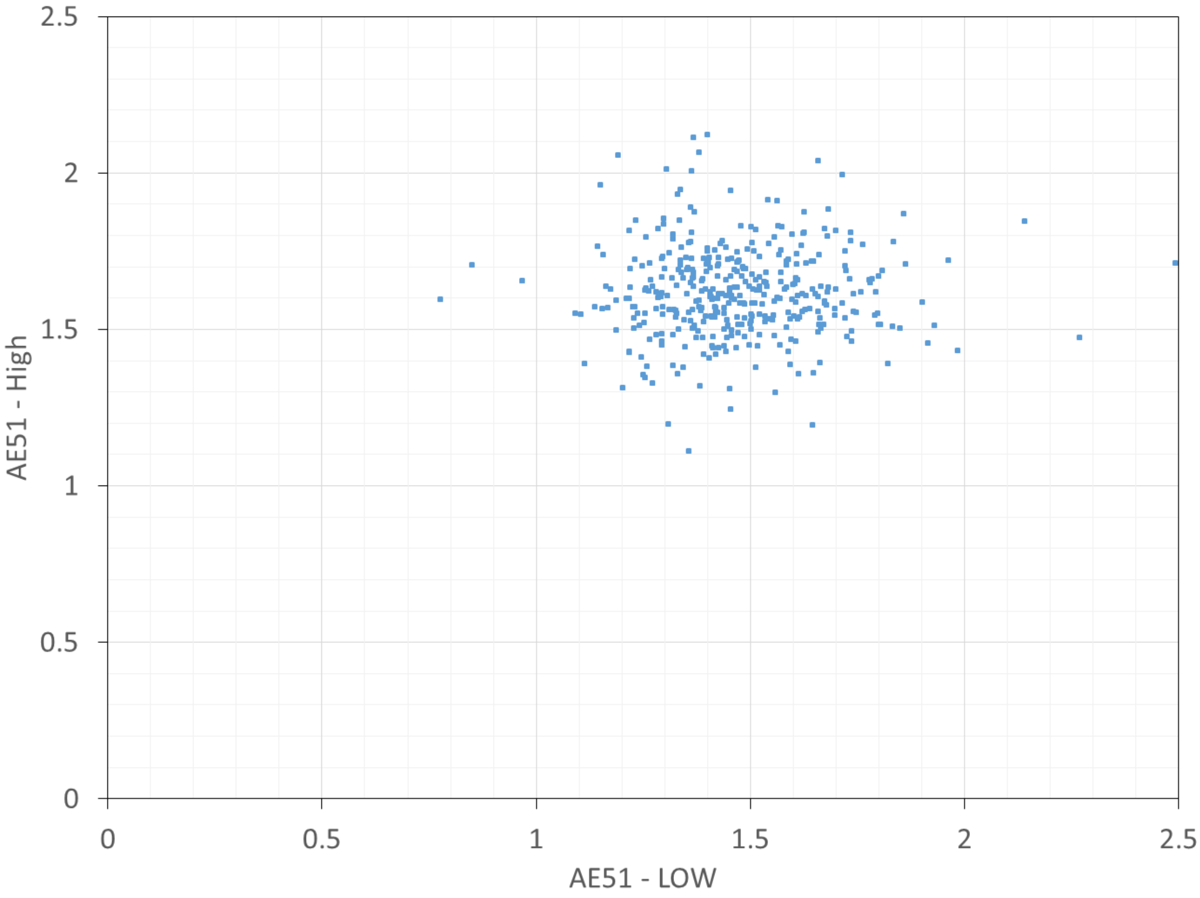
Equation C3 was used in order to calculate the LoD (MacDougall , Crummett, 1980):

$$LoD = 3.3 \times STDEV \quad \text{(C3)}$$

Where STDEV is the standard deviation.

Using equation C3, it was calculated that the LoD's for the AE51-LOW and AE51-HIGH are 0.635 μg m^{-3} and 0.549 μg m^{-3} respectively. Therefore, all data below the respective LoD's (multiplied by -1) have been rejected from the data analyses.

Figure C2 BC Intra-Sampler Colocation – Office ($\mu g\ m^{-3}$)



C1.2 Limit of Detection – NanoTracer

Figure C3 shows the LOW vs HIGH measurements recorded during this exercise. A total of 2724 1-minute average concentrations were recorded.

Using equation C3, it was calculated that the LoD's for the NanoTracer-LOW and NanoTracer -HIGH was 1928 N Particles cm^{-3} and 2047 N Particles cm^{-3} respectively. Therefore, all data below the respective LoD's (multiplied by -1) have been rejected from the data analyses.

Figure C3 UFP Intra-Sampler Colocation – Office (N Particles cm^{-3})