

Appendix E Colocation: Lighthouse vs FDMS

Figure E1 below shows the orthogonal regression between hourly mean PM_{2.5} concentrations measured at the fixed monitoring sites detailed in Section 3.2 (FDMS) versus PM_{2.5} concentrations as measured by both the LOW and HIGH Lighthouse samplers (note that LOW and HIGH are only used as labels for the samplers in this case – both samplers were measuring PM_{2.5} at the same height as the FDMS analyser). The results of this regression are detailed in Table E1. A total of 18 data pairs were recorded by both LOW and HIGH samplers with calculated between-sampler uncertainties of 4.67 µg m⁻³ and 4.66 µg m⁻³, and strong r² of 0.847 and 0.839, respectively. No outliers were identified in the data sets. The calculated slopes of the regression lines for the LOW and HIGH samplers are 1.329 and 1.293 with intercepts of -11.905 µg m⁻³ and -11.229 µg m⁻³, respectively, all of which are determined as significant. All PM_{2.5} data recorded by both Lighthouse samplers were therefore corrected for both slope and intercept using the following equations:

$$C_{L-Adj} = \frac{C_L + 11.905}{1.329} \quad (E1)$$

$$C_{H-Adj} = \frac{C_H + 11.229}{1.293} \quad (E2)$$

Where:

C_{L-Adj} is the corrected PM_{2.5} concentrations as measured by the LOW Lighthouse sampler.

C_{H-Adj} is the corrected PM_{2.5} concentrations as measured by the HIGH Lighthouse sampler.

The low number of data pairs included in this analysis is due to analyser faults with the FDMS analysers at both Kerbside and Townhead resulting in rejection of data and colocation data only available from Glasgow Kerbside on 25/04/2014, 19/06/2014 and 27/08/2014.

Figure E1 FDMS vs Lighthouse Regression – PM_{2.5}

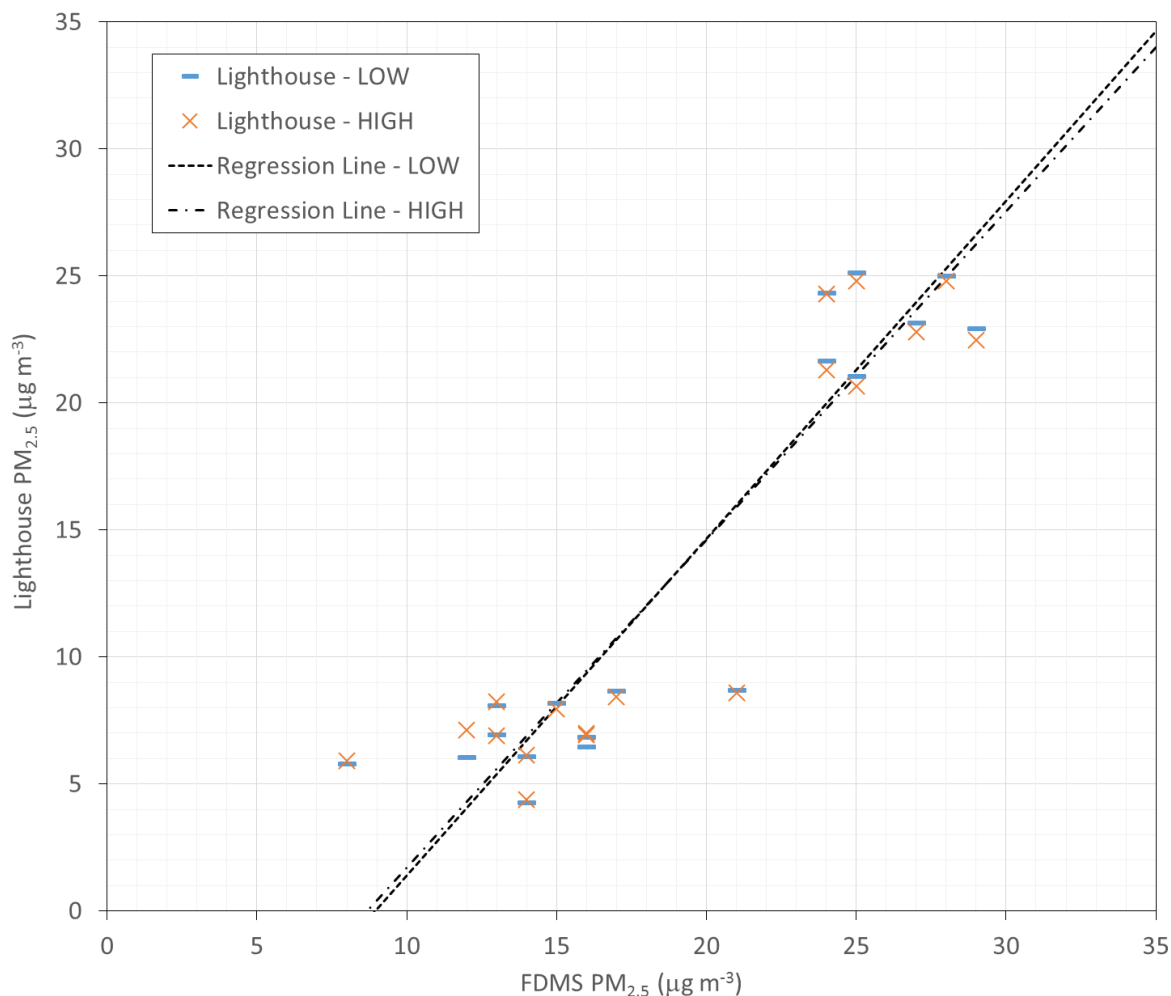


Table E1 FDMS vs Lighthouse Regression Results – PM_{2.5}

Lighthouse PM _{2.5}	1 hour		Orthogonal Regression		
	<i>n_{bs}</i>	<i>u_{bs}</i>	<i>r</i> ²	Slope (<i>b</i>) ± <i>u_b</i>	Intercept (<i>a</i>) ± <i>u_a</i>
LOW	18	4.67	0.847	1.329 ± 0.127	-11.905 ± 2.534
HIGH	18	4.66	0.839	1.293 ± 0.127	-11.229 ± 2.533

The corrected collocation data and associated regression results are shown in Figure E2 and Table E2. The calculated between-sampler uncertainties of the corrected LOW and HIGH sampler data are 1.74 µg m⁻³ and 1.79 µg m⁻³, respectively. The calculated slopes of the regression lines for the LOW and HIGH samplers are 0.976 and 0.977 with intercepts of 0.450 µg m⁻³ and 0.433 µg m⁻³, respectively.

The associated relative expanded uncertainty versus PM_{2.5} concentration using the orthogonal regression corrected data is shown in Figure E3. This corresponds to a relative expanded uncertainty of 65% and 66% at an hourly mean concentration of 12 µg m⁻³ (annual mean objective concentration) and 29% at an hourly mean of 50 µg m⁻³ as measured by the LOW and HIGH AQMesh samplers, respectively.

For completeness, a time series plot of hourly mean PM_{2.5} concentrations at Glasgow Townhead, Glasgow Kerbside and corrected PM_{2.5} concentrations measured by the Lighthouse samplers is shown in Figure E4. In general, the Lighthouse data follow the trends in PM_{2.5} at Glasgow Kerbside very well.

Figure E2 FDMS vs Corrected Lighthouse Regression – PM_{2.5}

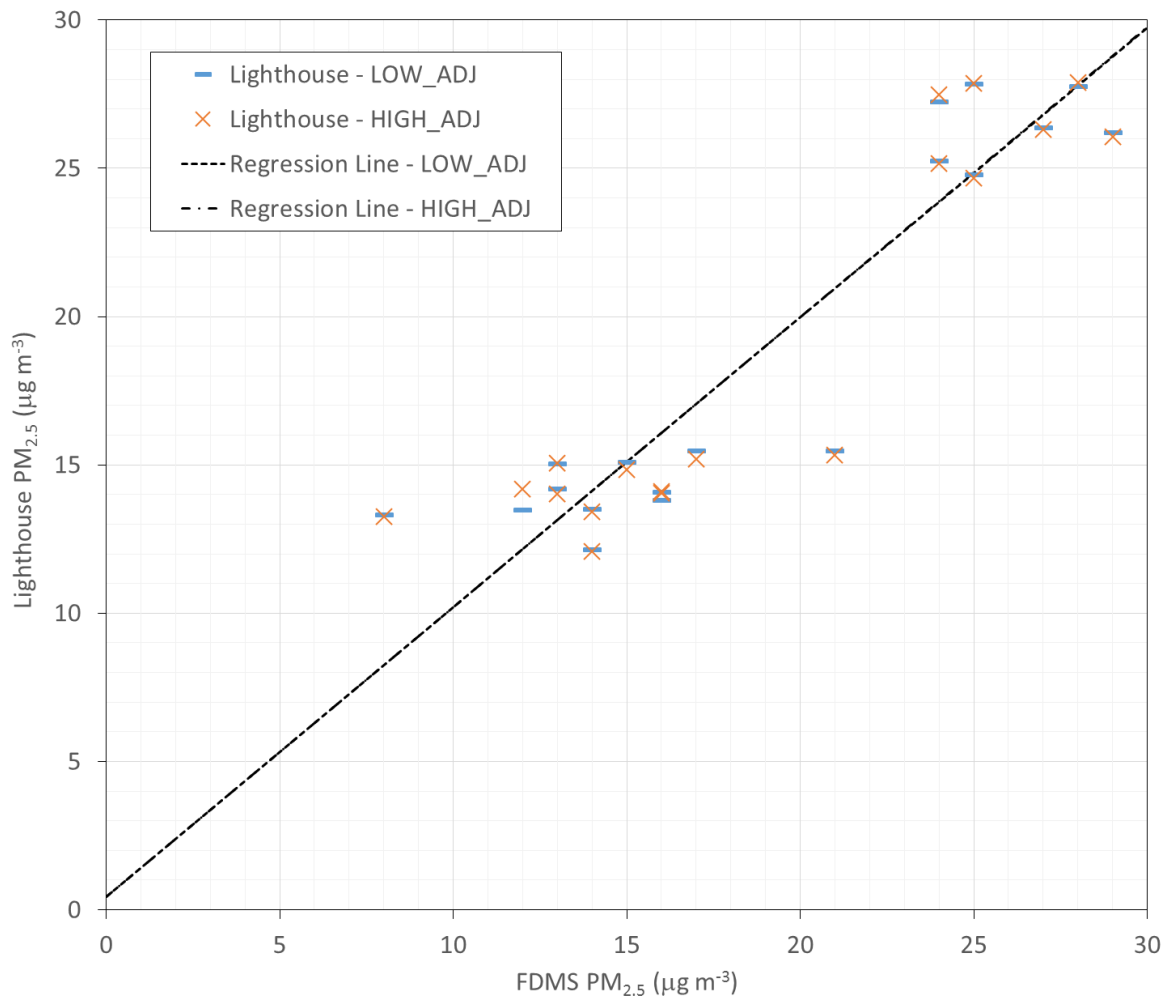


Table E2 FDMS vs Corrected Lighthouse Regression Results – PM_{2.5}

Lighthouse PM _{2.5}	1 hour		Orthogonal Regression				
	<i>n</i> _{bs}	<i>u</i> _{bs}	<i>r</i> ²	Slope (<i>d</i>) ± <i>u</i> _{<i>d</i>}		Intercept (<i>c</i>) ± <i>u</i> _{<i>c</i>}	
LOW_ADJ	18	1.74	0.847	0.976 ± 0.096		0.450 ± 1.906	
HIGH_ADJ	18	1.79	0.839	0.977 ± 0.098		0.433 ± 1.959	

Figure E3 Expanded Relative Uncertainty – PM_{2.5}

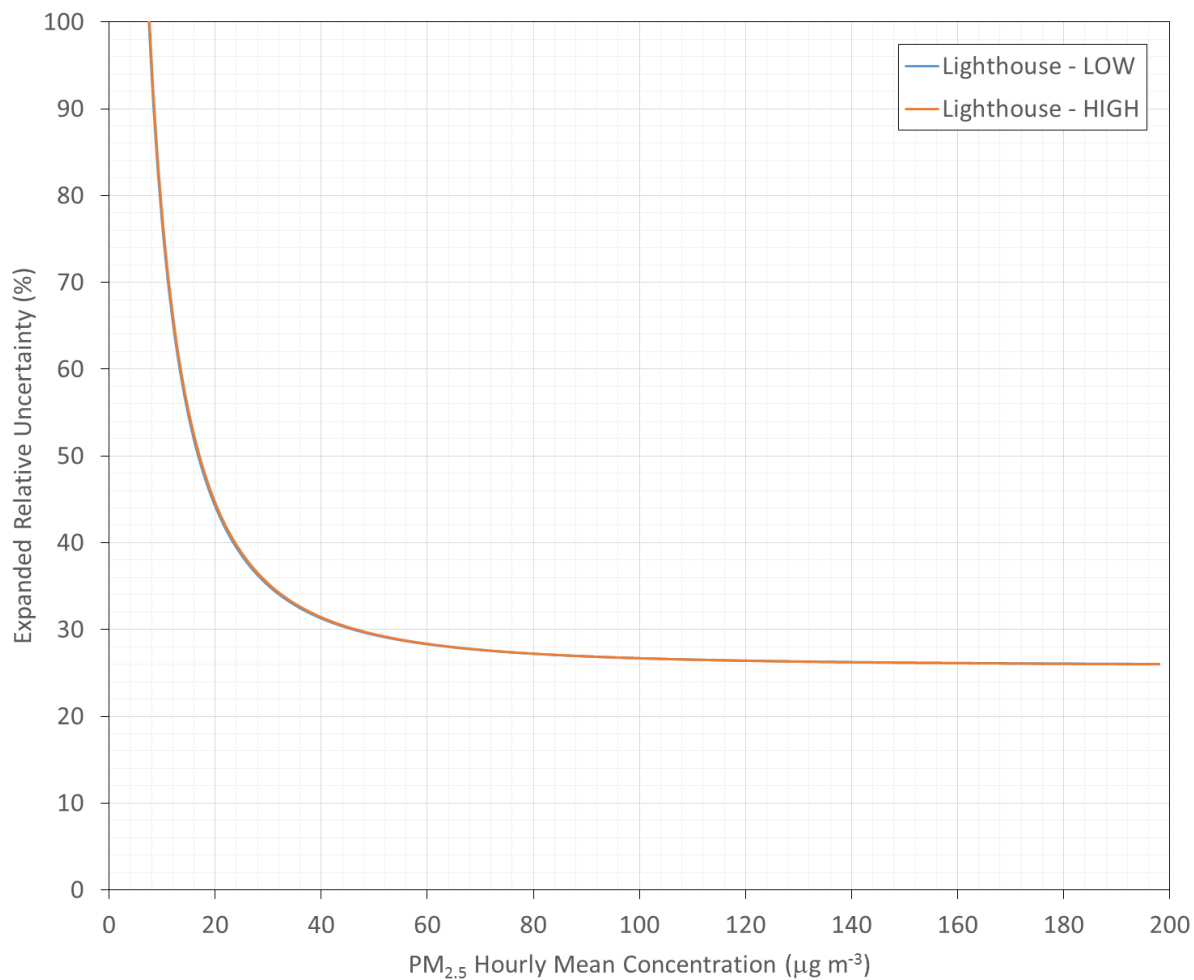


Figure E4 FDMS vs Corrected Lighthouse Time-series

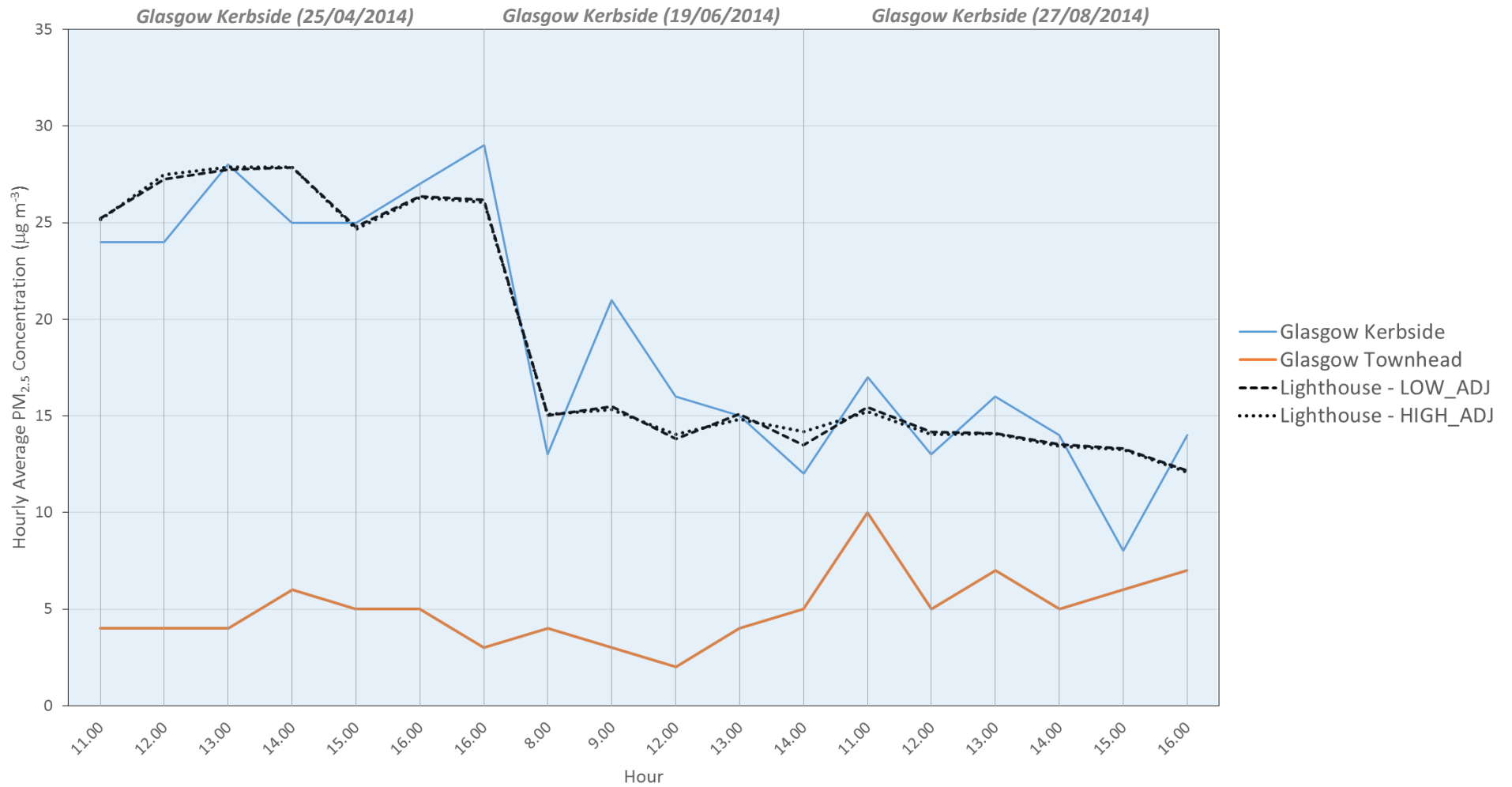


Figure E5 below shows the orthogonal regression between hourly mean PM₁₀ concentrations measured at the fixed monitoring sites detailed in Section 3.2 (FDMS) versus PM₁₀ concentrations as measured by both the LOW and HIGH Lighthouse samplers. The results of this regression are detailed in

Table E3. A total of 34 and 75 data pairs were recorded by both LOW and HIGH samplers with calculated between-sampler uncertainties of 15.47 µg m⁻³ and 10.50 µg m⁻³, and r² of 0.320 and 0.645, respectively. One outlier was identified in each data set. The calculated slopes of the regression lines for the LOW and HIGH samplers are 3.205 and 0.731 with intercepts of -15.420 µg m⁻³ and -14.622 µg m⁻³, respectively, all of which are determined as significant.

Due to the number of data pairs, mild r² and significantly different slope of the LOW regression compare to the HIGH Lighthouse results, an alternative correction was carried out. The relationship derived from the intra-sampler collocation regression results detailed in **Error! Reference source not found.**, Appendix F were used to correct HIGH Lighthouse data in order to estimate the response of the LOW sampler over a similar concentration range. The following equation was used to carry out the correction:

$$C_{H-A} = \frac{C_H - 1.101}{0.851} \quad (\text{E3})$$

Where C_{H-A} is the corrected PM₁₀ concentration as measured by the HIGH sampler; and C_L is the concentration measured by the HIGH sampler. This corrected concentration is then an estimate of what the LOW sampler would have been measuring. The calculated results from the orthogonal regression of these corrected data are shown as HIGH_A. The calculated slope of the regression line is 0.892 with an intercept of 14.944 µg m⁻³.

All PM_{2.5} data recorded by the Lighthouse samplers were therefore corrected for both slope and intercept using the following equations:

$$C_{L-Adj} = \frac{C_L - 14.944}{0.892} \quad (\text{E4})$$

$$C_{H-Adj} = \frac{C_H - 14.622}{0.731} \quad (\text{E5})$$

Where:

C_{L-Adj} is the corrected PM₁₀ concentrations as measured by the LOW Lighthouse sampler.

C_{H-Adj} is the corrected PM₁₀ concentrations as measured by the HIGH Lighthouse sampler.

The corrected collocation data and associated regression results are shown in Figure E6 and Table E4. The calculated between-sampler uncertainties of the corrected LOW, HIGH and HIGH x2 sampler data are 3.17 µg m⁻³, 10.10 µg m⁻³ and 9.66 µg m⁻³, respectively. The calculated slopes of the regression lines for the LOW, HIGH and HIGH x2 data are 0.496, 1.078 and 0.892 with intercepts of 8.038 µg m⁻³, 2.219 µg m⁻³ and 0 µg m⁻³, respectively.

The associated relative expanded uncertainty versus PM_{2.5} concentration using the orthogonal regression corrected data is shown in Figure E7. This corresponds to a relative expanded uncertainty of 92%, 168% and 144% at an hourly mean concentration of 18 µg m⁻³ (annual mean objective concentration) and 95%, 62% and 56% at an hourly mean

of $50 \mu\text{g m}^{-3}$ (daily mean objective concentration) as measured by the LOW, HIGH and HIGH x2 Lighthouse samplers, respectively.

Figure E5 FDMS vs Lighthouse Regression – PM_{10}

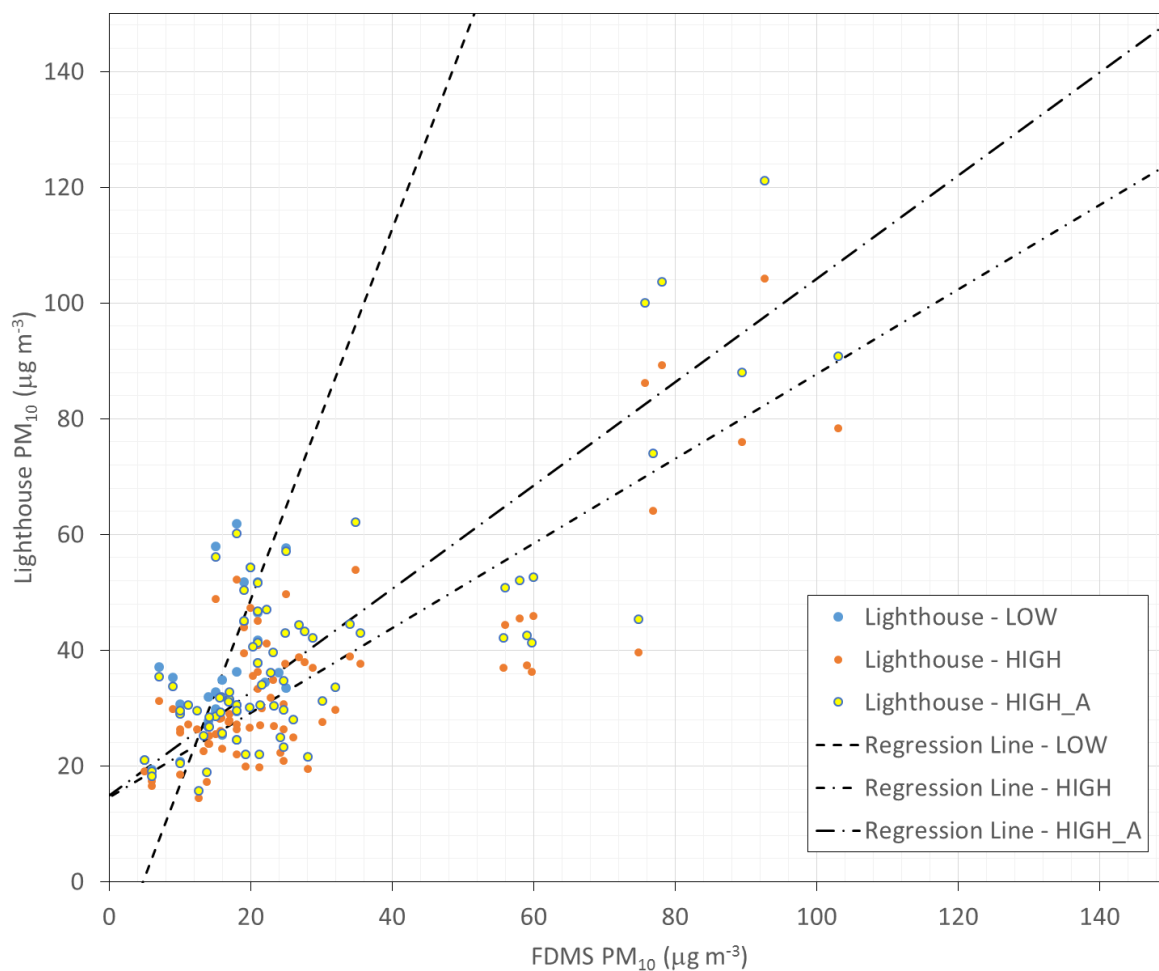


Table E3 FDMS vs Lighthouse Regression Results – PM_{10}

Lighthouse PM_{10}	1 hour		Orthogonal Regression			No of Data Pairs Rejected
	n_{bs}	u_{bs}	r^2	Slope (b) \pm u_b	Intercept (a) \pm u_a	
LOW	34	15.47	0.320	3.205 \pm 0.308	-15.420 \pm 5.177	1 (2.9%)
HIGH	75	10.50	0.645	0.731 \pm 0.054	14.622 \pm 1.947	1 (1.3%)
HIGH_A	75	12.61	0.645	0.892 \pm 0.064	14.944 \pm 2.288	1 (1.3%)

Figure E6 FDMS vs Corrected Lighthouse Regression – PM₁₀

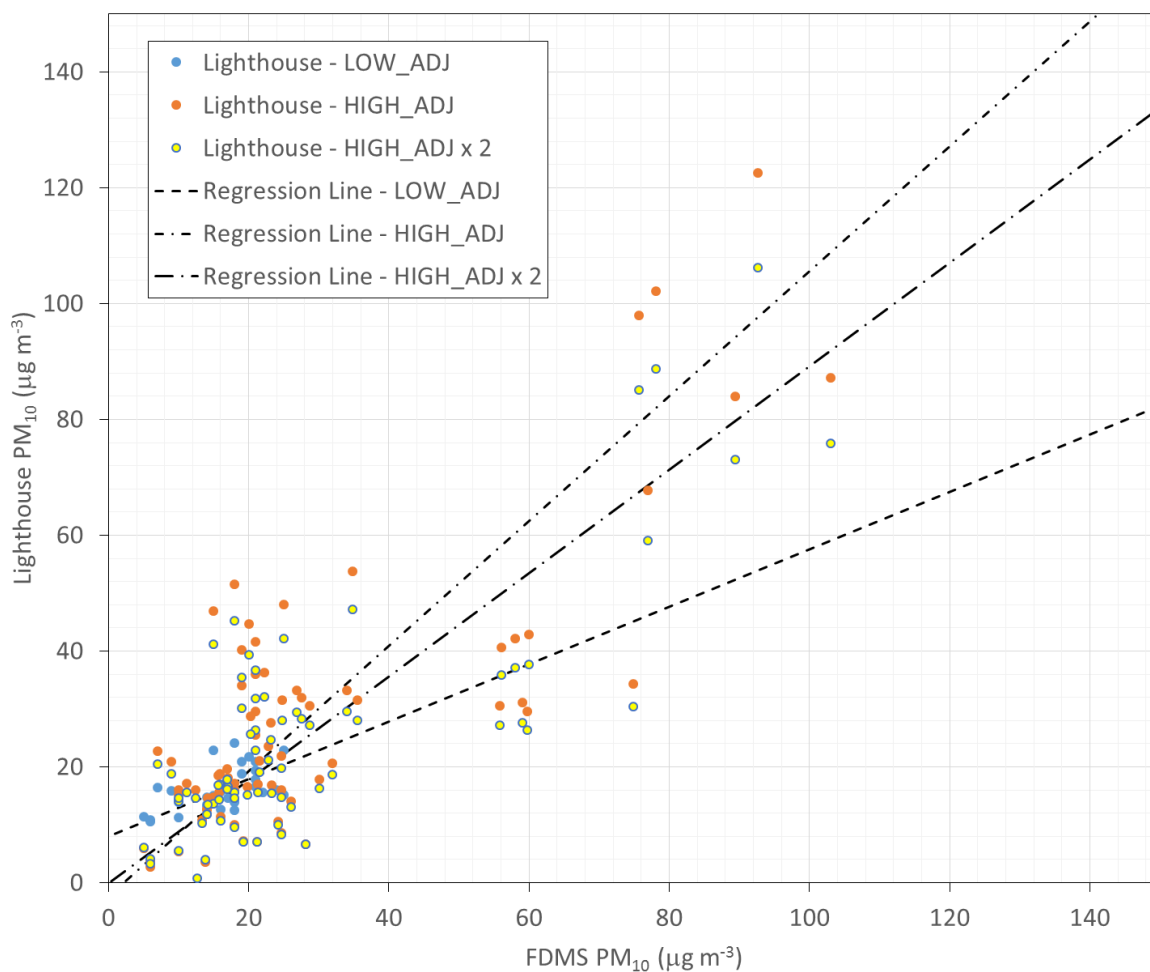


Table E4 FDMS vs Corrected Lighthouse Regression Results – PM₁₀

Lighthouse PM ₁₀	1 hour		Orthogonal Regression		
	n_{bs}	u_{bs}	r^2	Slope (d) $\pm u_d$	Intercept (c) $\pm u_d$
LOW_ADJ	34	3.17	0.320	0.496 \pm 0.096	8.038 \pm 1.616
HIGH_ADJ	75	10.10	0.645	1.078 \pm 0.074	-2.219 \pm 2.664
HIGH_ADJ x 2	75	9.66	0.645	0.892 \pm 0.064	0.000 \pm 2.288

Figure E7 Relative Expanded Uncertainty – PM₁₀

