Black Carbon, PM10 Mass Concentration, Nitrogen Monoxide, Nitrogen Oxides and Particulate Number Concentration at the Woluwe Traffic Site

Period July 2009 – June 2010

PRELIMINARY REPORT

Brussels Environment
Brussels Institute for the Management of the Environment
Laboratory for Environmental Research
Gulledelle 100
B-1200 BRUSSELS

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1. Introduction

The Woluwe site is situated at the Brussels Institute for the Management of the Environment (IBGE-BIM), Gulledelle 100, B-1200 Brussels, directly at the Laboratory for Environmental Research (Fig. 1). It is a measuring site characteristic for traffic. The site is situated along a highway that leads the traffic coming from Leuven (Louvain) and Liège towards the centre of Brussels and vice versa. The air is sampled at about 40 m south of the highway exit, 60 m south of the highway itself and at about 25 m west from the 4-lane avenue that connects the municipalities of Evere and St.-Lambrechts-Woluwe (Woluwé-St-Lambert).

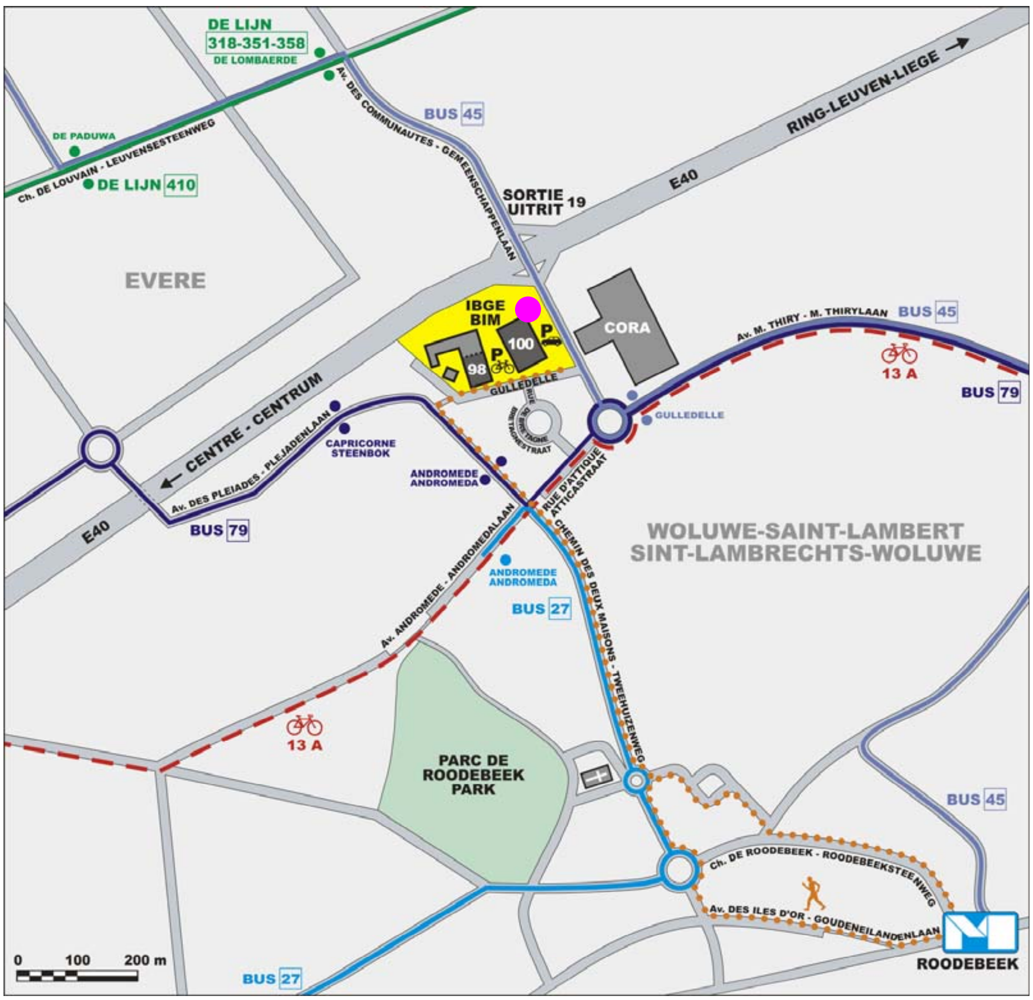

Fig. 1 : ● Location of the measuring site at the Brussels Environmental Institute

The Woluwe site belongs to the set of traffic oriented sites of the Brussels telemetric network for the monitoring of air quality. Operational since 1994, it has continuous analyzers for SO_2, NO and NO_2, O_3, CO, CO_2, the PM10 mass concentration and the Particulate Number concentration (31 classes between 0,25 and 32 µm).

The PM10 concentration is measured by means of a R&P TEOM 1400Ab continuous instrument, equipped with a FDMS 8500 module (*TEOM – Tapered Element Oscillating Microbalance ; FDMS – Filter Dynamics Measurement System).* The obtained PM10 mass concentration results are, in this way, more directly comparable to the results obtained by the gravimetric reference method.

Since July 2008, the particle number concentration is also measured. Results for 31 different particulate classes with equivalent diameters ranging from 0,25 to 32 µm, are obtained by the use of a Grimm laser nephelometer spectrometer model 365.

Since July 2009, the mass concentration of 'Black Carbon' is measured with an aethalometer, Magee Scientific model AE22-ER. The obtained results present an estimation of the elementary carbon concentration. Black Carbon is mainly emitted by combustion processes and traffic. Black Carbon particulates originating from traffic mainly consist in very small particulates of the submicron scale (10 nanometer up to 1 µm).

2. Black Carbon and PM10 at the Woluwe Site

2.1 Evolution Half Hourly Concentration Values

The monthly evolution of the half hourly concentrations for 'Black Carbon' and PM10 are represented, from July 2009 till June 2010, in the Figures 2 to 13. The results for June 2010 are given in Fig. 2 and those for July 2009 in Fig. 13. The Black Carbon results refer to the left scale of the graph (0 – 14 µg/m^3) and those for PM10 to the right scale of the graph (0 – 140 µg/m^3). One can observe that, on a average and for most of the time, the lines follow nearly the same pattern, meaning that there is roughly a factor 10 between the concentration levels of the two pollutants.

Regarding the different graphs more in detail one can observe that, although many peak values do coincide, there are several discrepancies during other peak periods: high peak values for Black Carbon and not for PM10 or also high peak values for PM10 and not for Black Carbon. A very clear example of the latter is illustrated by the situation between the 6th and the 9th February 2010 (left side in Fig. 6) and between the 25th and 27th January 2010 (Fig. 7). Some other examples, but to a lesser extent, are found during some of the other monthly periods and especially during January (Fig. 7) and April 2010 (Fig. 4).

The observation of peak values for PM10 not associated to peak values for Black Carbon, could be an indication of a pollution by particulates that are not from local origin or for which the local factor is not the predominant one as in the case of the importation of particulates of a distant origin or the formation of secondary aerosol. However, if no elevated PM2,5 mass concentration values are associated with the PM10 increase, then it is probably the result of the local (re)suspension of the coarser fraction of the particulates (particulates between 2.5 and 10 µm).

A clear illustration of the first hypothesis is given by the example of the 2009 Car Free Sunday. The graph in Figure 14 represents, for the period from Friday the 18th till Tuesday the 22th September 2009, the dynamic evolution of half hourly values for Black Carbon, PM10 and NO. The data for Black Carbon refer to the concentration scale at the left of the graph (0 – 21 µg/m^3) and those for PM10 and NO to the scale at the right of the graph (0 – 140 µg/m^3). The traffic ban hours during the Car Free Sunday 20 September 2009 are indicated by the short red horizontal line in the middle of the graph.

The PM10 concentration is peaking during the traffic ban hours, while the Black Carbon concentration continues to decrease. So the evolution of the Black Carbon concentration clearly does not follow that of PM10, but rather that of the traffic related NO, as can be seen from the results between Saturday 19 and the evening rush hours of Monday 21 September. The relation between Black Carbon and NO data is dealt in more detail later (see in section 3 on Black Carbon and NO at the Woluwe Site).

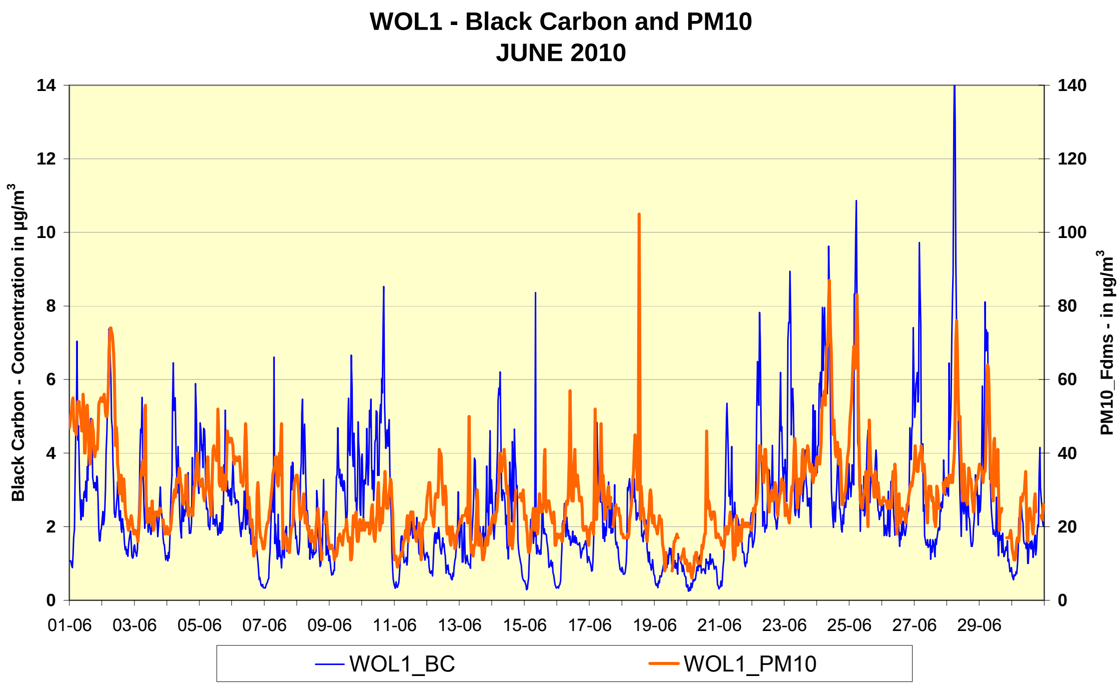

Fig. 2 : Woluwe – **Black Carbon** and **PM10** – Evolution Half Hourly Values – June 2010

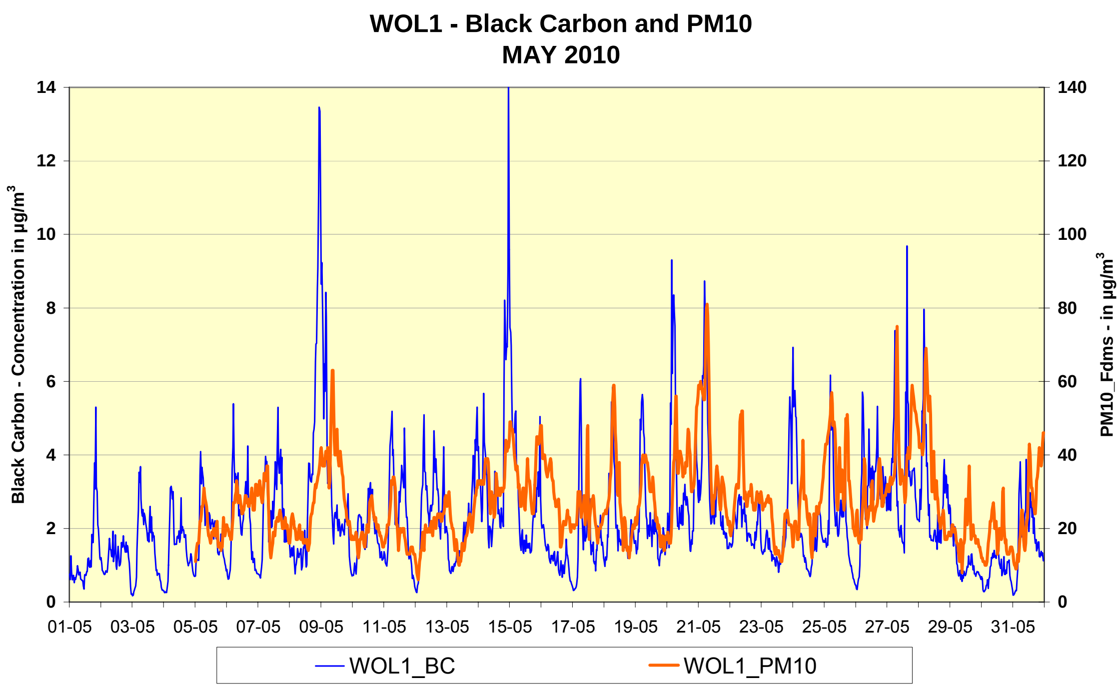

Fig. 3 : Woluwe – **Black Carbon** and **PM10** – Evolution Half Hourly Values – May 2010

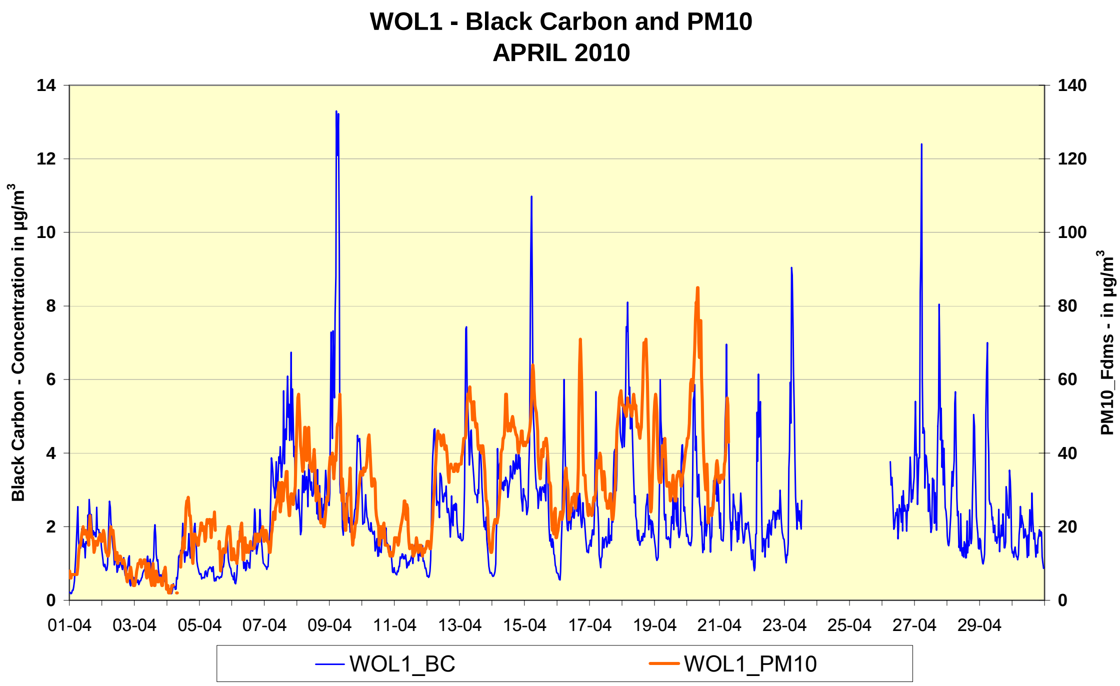

Fig. 4 : Woluwe – **Black Carbon** and **PM10** – Evolution Half Hourly Values – April 2010

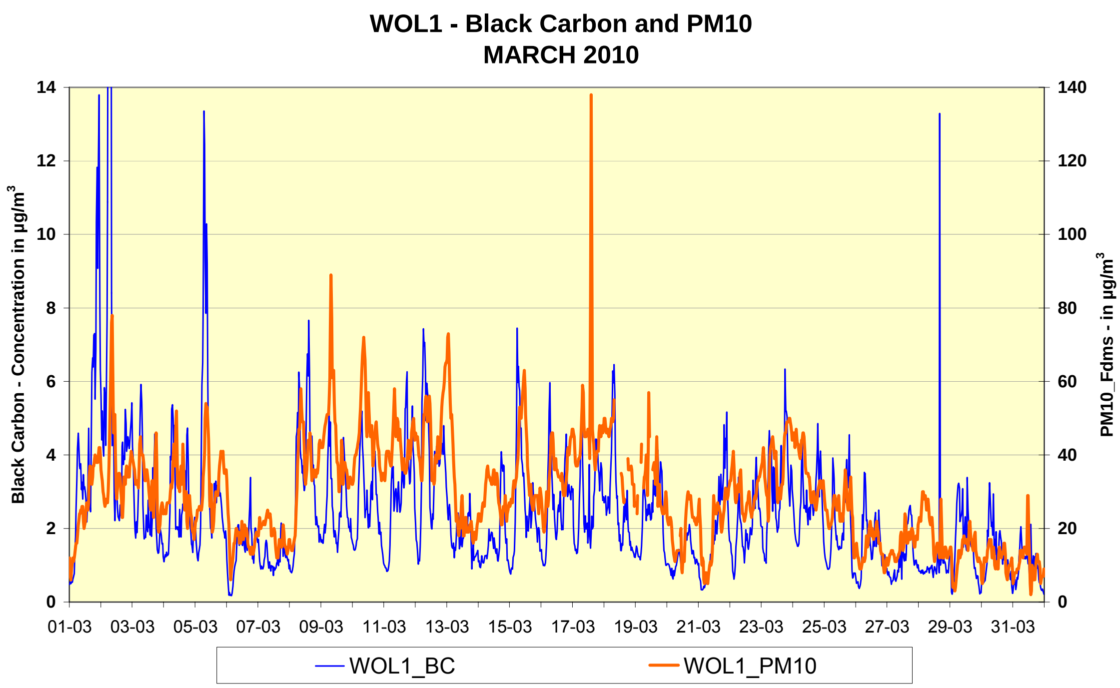

Fig. 5 : Woluwe – **Black Carbon** and **PM10** – Evolution Half Hourly Values – March 2010

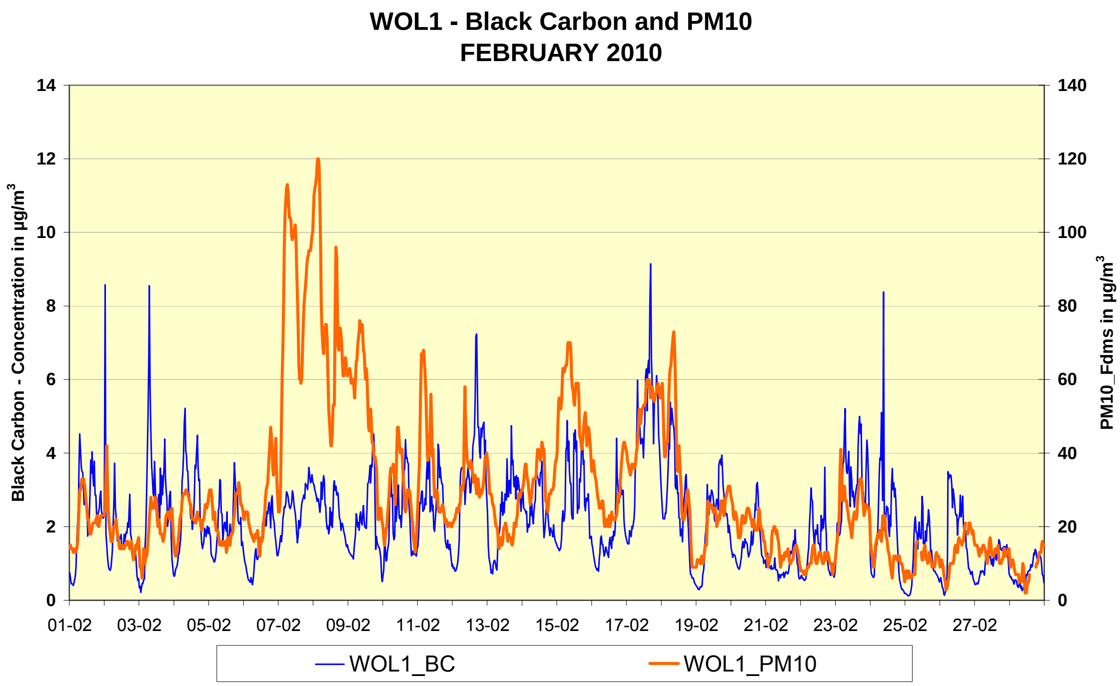

Fig. 6 : Woluwe – **Black Carbon** and **PM10** – Evolution Half Hourly Values – February 2010

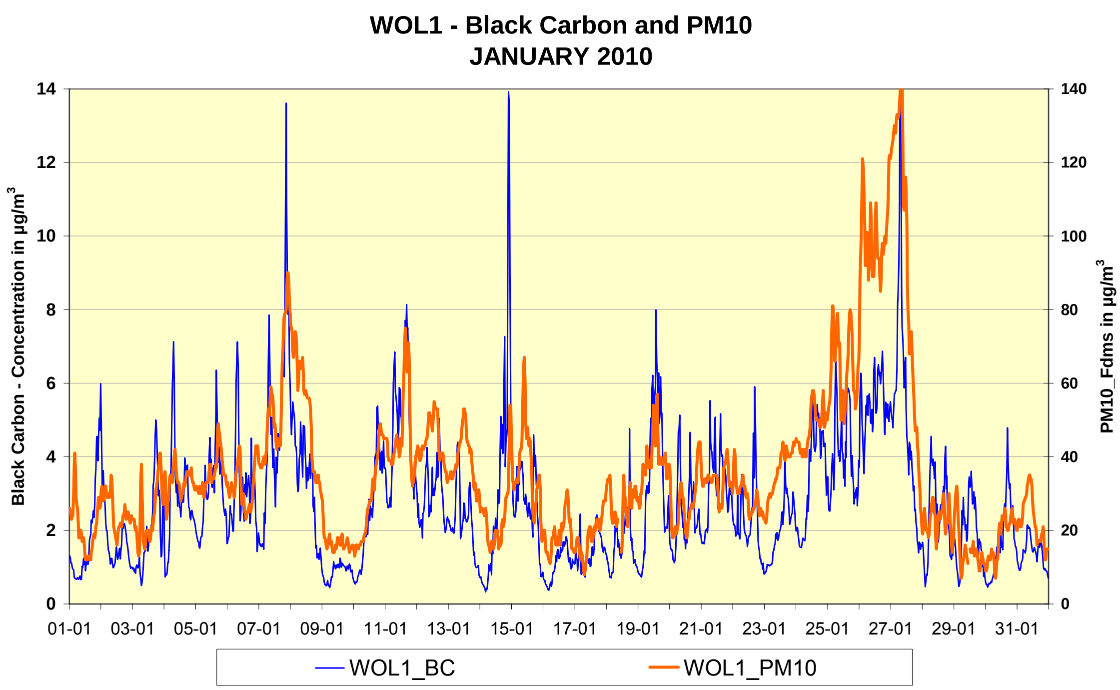

Fig. 7 : Woluwe – **Black Carbon** and **PM10** – Evolution Half Hourly Values – January 2010

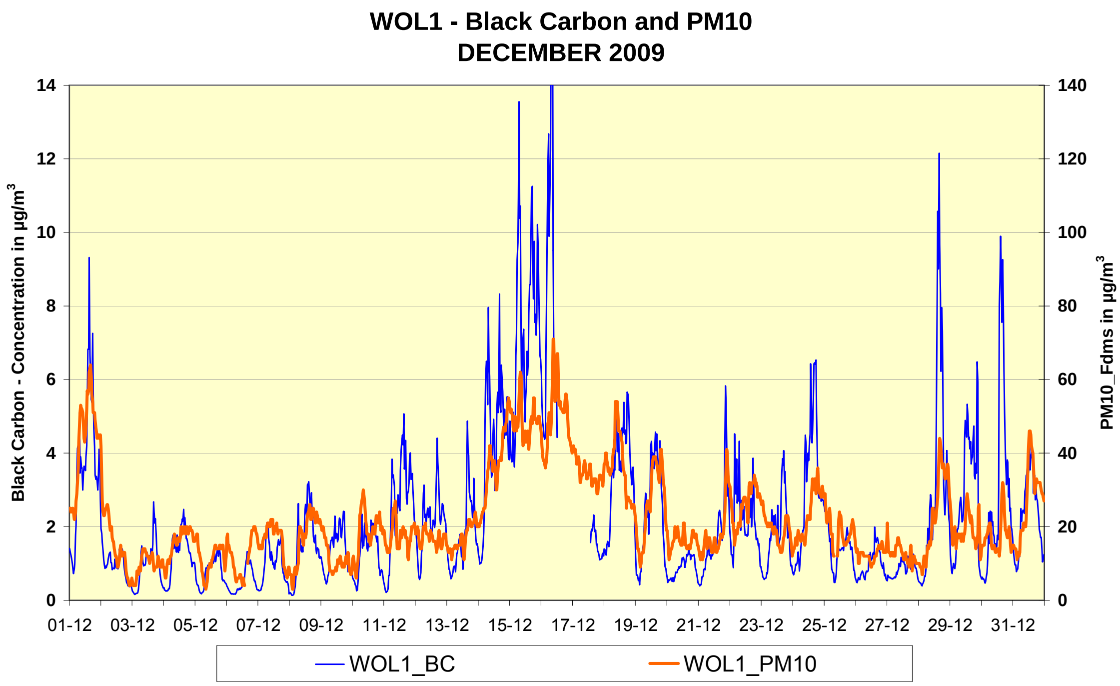

Fig. 8 : Woluwe – **Black Carbon** and **PM10** – Evolution Half Hourly Values – December 2009

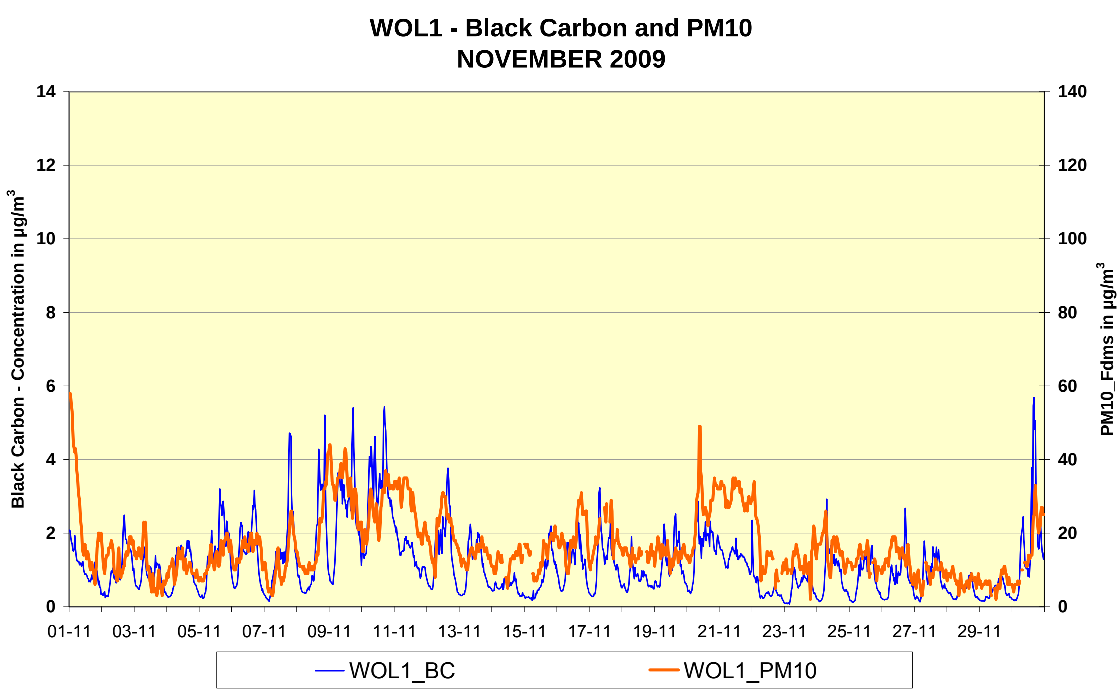

Fig. 9 : Woluwe – **Black Carbon** and **PM10** – Evolution Half Hourly Values – November 2009

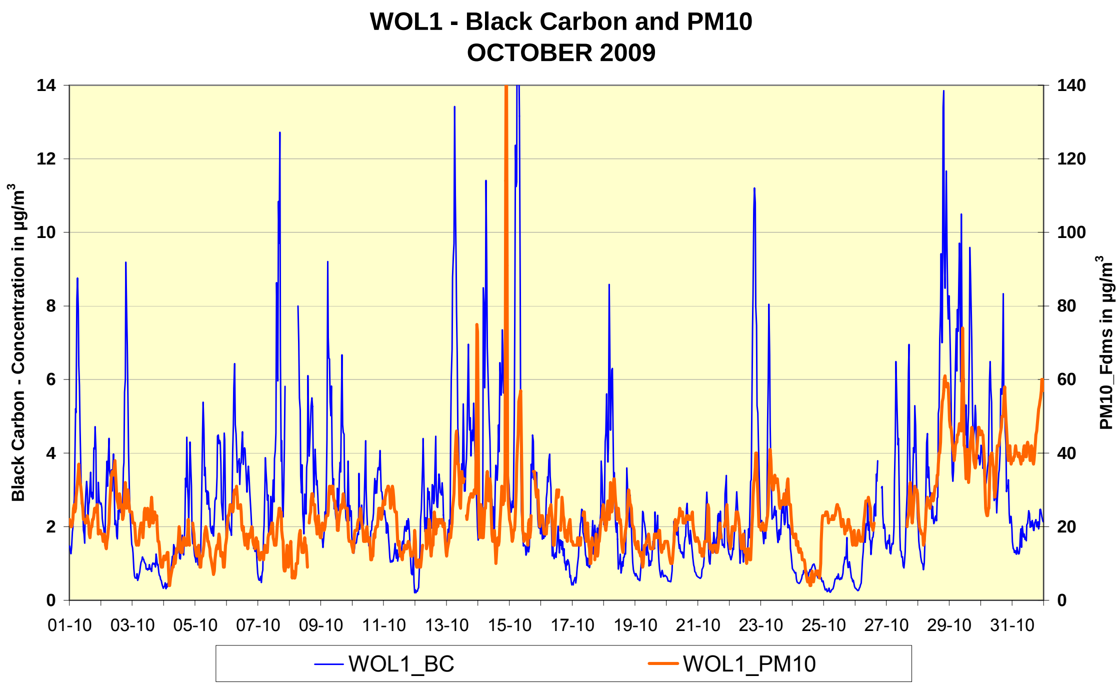

Fig. 10 : Woluwe – **Black Carbon** and **PM10** – Evolution Half Hourly Values – October 2009

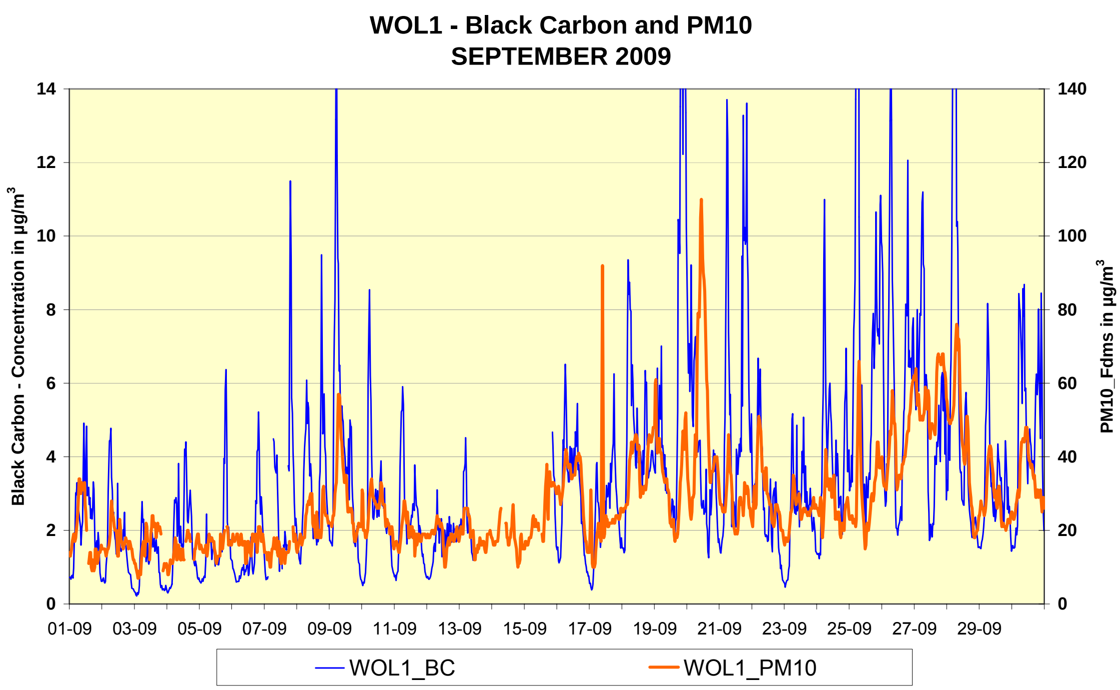

Fig. 11 : Woluwe – **Black Carbon** and **PM10** – Evolution Half Hourly Values – September 2009

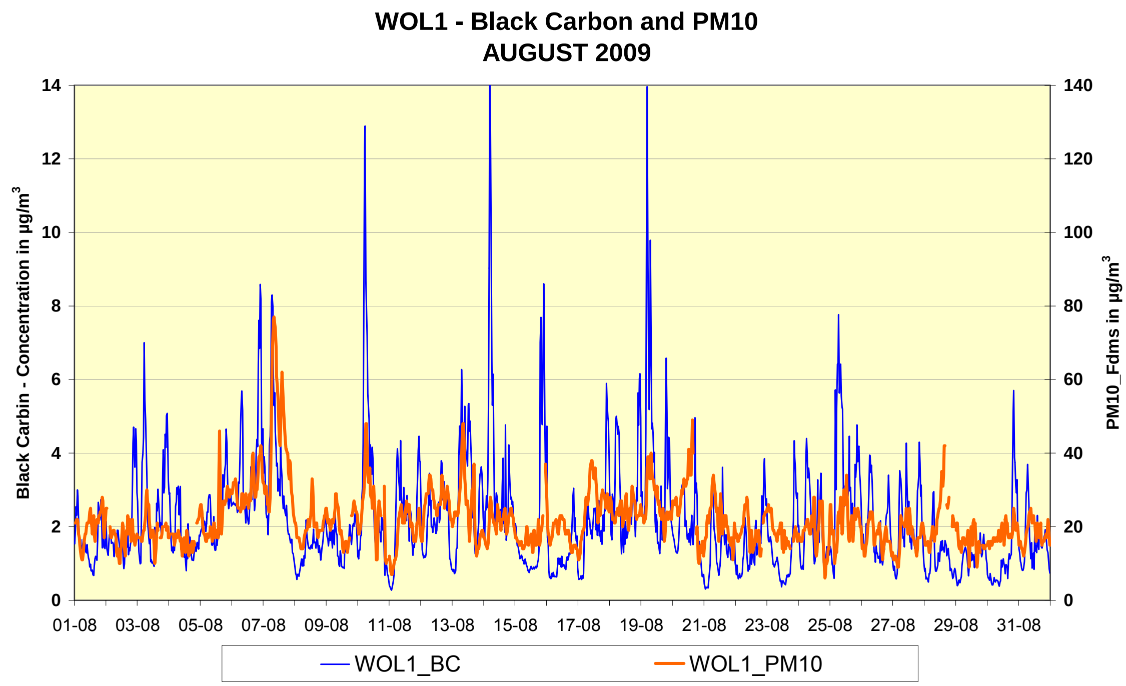

Fig. 12 : Woluwe – **Black Carbon** and **PM10** – Evolution Half Hourly Values – August 2009

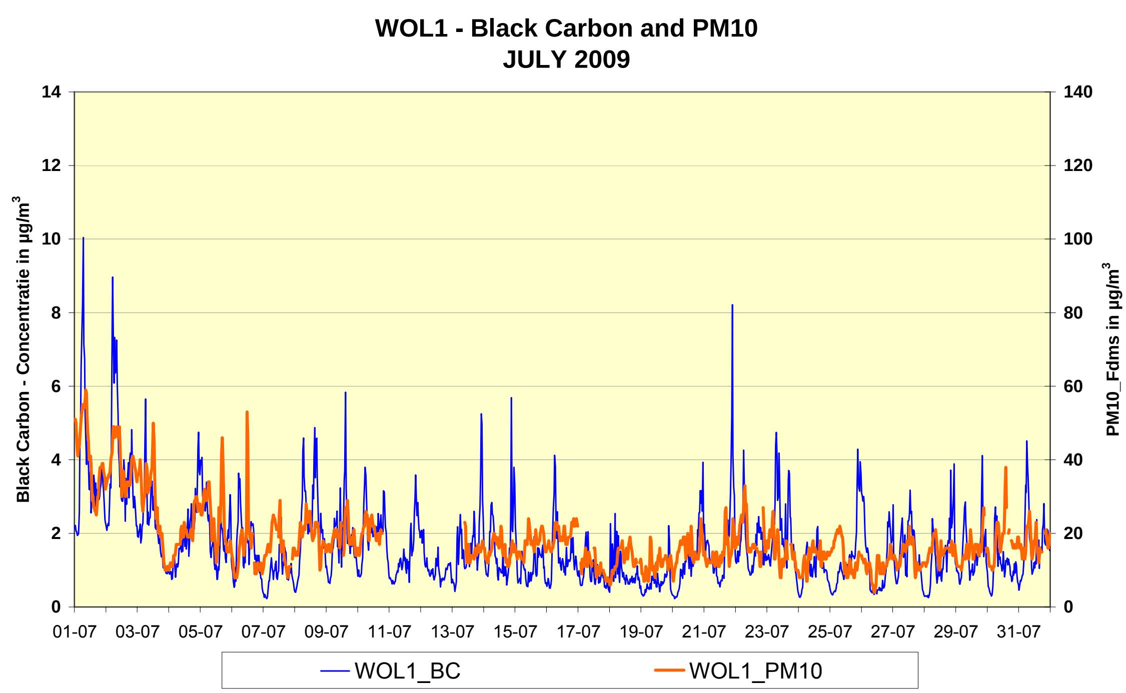

Fig. 13 : Woluwe – **Black Carbon** and **PM10** – Evolution Half Hourly Values – July 2009

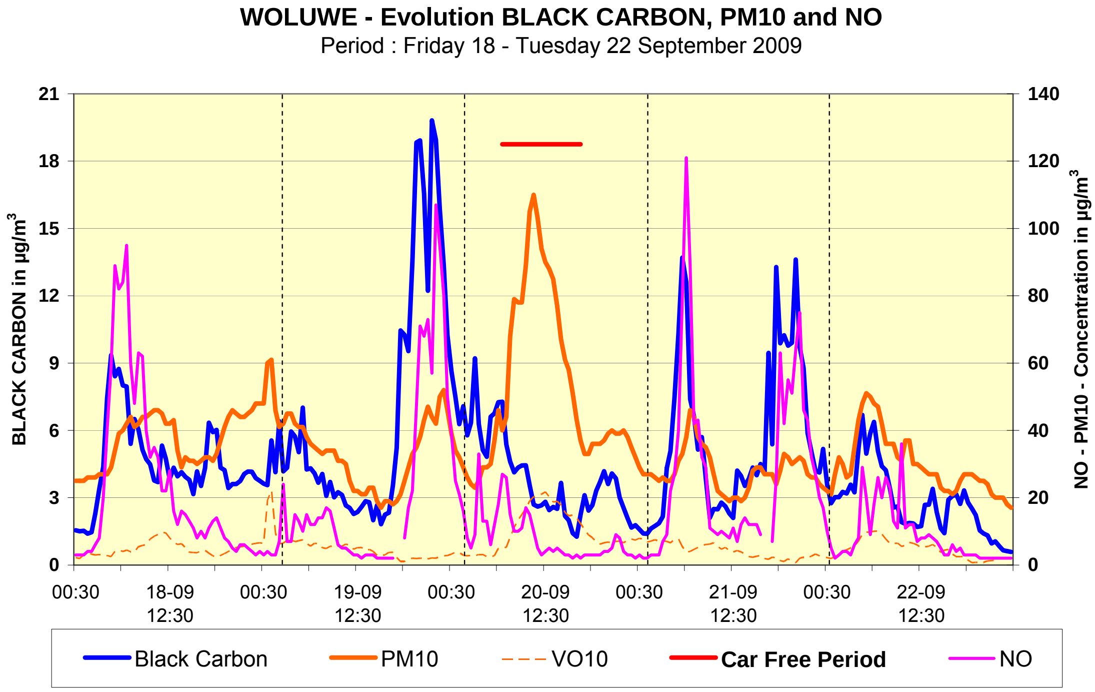

Fig. 14 : Woluwe – Concentration evolution for **Black Carbon**, **PM10** and **NO**
Period : Friday 18 till Tuesday 22 September 2009 with Car Free Sunday 20/09/2009

2.2 Cumulative Frequency Distribution – Ratio of Average Concentration Values

The evolution of the average concentrations for Black Carbon and PM10, computed for the half hourly values, and the ratio between both is given in table I, starting with the six month period 'July 2009 – December 2009' and ending with the one year period 'July 2009 – June 2010'. Similar results computed for the daily average values of the one year period are given in table II.

The cumulative frequency distributions for the one year period 'July 2009 – June 2010' are given in tables III and IV, computed respectively for the half hourly values and for the daily average values.

Table I – Half Hourly Values for Black Carbon and PM10
Average Concentrations and Ratio of the Averages

Period	Black Carbon Average Conc. [µg/m^3]	PM10 Average Conc. [µg/m^3]	Ratio BC/PM10
2009.07 – 2009.12	2.21	22	**0.1005**
2009.07 – 2010.01	2.29	24	**0.0954**
2009.07 – 2010.02	2.27	24	**0.0946**
2009.07 – 2010.03	2.29	25	**0.0916**
2009.07 – 2010.04	2.30	25	**0.0920**
2009.07 – 2010.05	2.29	25	**0.0916**
2009.07 – 2010.06	2.31	26	**0.0888**

Table II – Daily Average Values for Black Carbon and PM10
Average Concentrations and Ratio of the Averages

Period	Black Carbon Average Conc. [µg/m^3]	PM10 Average Conc. [µg/m^3]	Ratio BC/PM10
2009.07 – 2010.06	2.29	26	**0.0881**

Table III – Cumulative Frequency Distribution Black Carbon and PM10
Half Hourly Values – Period: July 2009 – June 2010

CUMULATIVE FREQUENCY DISTRIBUTION : Half Hourly Values

Period : 01 July 2009 - 30 June 2010

Selection Days : All Days

All Half Hourly Periods : yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy

Total Number of Periods = 17.520

Site Symb Unit	41WOL1 Black Carbon µg/m³	41WOL1 PM10_Fdms µg/m³
Min	0,07	2
P-10	0,65	12
P-20	0,96	15
P-30	1,25	17
P-40	1,53	19
P-50	1,84	22
P-60	2,19	25
P-70	2,65	29
P-80	3,29	35
P-90	4,37	44
P-95	5,63	53
P-98	7,67	66
P-99	9,30	79
P-99.5	11,20	98
P-99.9	18,82	126
Max	36,86	163
AM	2,31	26
ASD	1,90	15
GM	1,76	22
GSD	2,14	1,71
Nval	17192	16386
Nval%	98,1	93,5
Max-1	28,88	147
Max-2	28,10	145
Max-3	25,12	142
Max-7	22,64	133
Max-8	21,02	133
Max-17	18,82	125
Max-23	15,88	121

Table IV – Cumulative Frequency Distribution Black Carbon and PM10
Daily Average Values – Period: July 2009 – June 2010

CUMULATIVE FREQUENCY DISTRIBUTION : Daily Values

Period : 01 July 2009 - 30 June 2010

Selection Days : All Days

Total Number of Periods = 365

Site Symb Unit	41WOL1 Black Carbon µg/m³	41WOL1 PM10_Fdms µg/m³
Min	0,40	7
P-10	0,99	13
P-20	1,27	16
P-30	1,52	18
P-40	1,78	19
P-50	2,09	23
P-60	2,39	26
P-70	2,70	29
P-80	3,14	34
P-90	3,75	41
P-95	4,53	48
P-98	5,57	54
P-99	6,05	76
P-99.5	6,63	84
P-99.9	7,64	100
Max	7,64	100
AM	2,29	26
ASD	1,19	13
GM	2,01	23
GSD	1,69	1,56
Nval	356	345
Nval%	97,5	94,5
Max-1	7,39	92
Max-2	6,63	84
Max-3	6,35	76
Max-7	5,57	54
Max-8	5,41	54
Max-17	4,53	48
Max-23	4,27	45

2.3 Regression Line(s) “Black Carbon” versus “PM10”

Since both data sets (PM10 and Black Carbon) are subject to measurement errors, a weighted orthogonal regression is used corresponding to the regression technique applied for EU equivalence testing of SO_2-methods by the end of the ’80: *“Application of linear regressions to the comparison of analytical procedures for the determination of SO_2 in ambient air”, P. Vanderstraeten, S. Hallez, A. Derouane and G. Verduyn, The Science of the Total Environment, 71 (1988) 201-208.*

The data for PM10 are represented as the X-data set (abscissa) and those for Black Carbon as the Y-data set (ordinate). Results are computed for a regression line through the origin, as well as for a line with an intercept on the Y-axis. For the half hourly data, the results are computed for different periods, starting with a six month period, July till December 2009, and ending with a one year period ‘July 2009 – June 2010’. Results for the daily average values are computed for the one year period ‘July 2009 – June 2010’.

For each of the considered periods, the correlation coefficient is given with the results for the weighted orthogonal regression line through the origin (Table V and VI). The correlation factor between the half hourly data for Black Carbon and PM10 is rather weak and slightly variable over time (R = 0,51 up to 0,59). The correlation factor for the daily data is somewhat stronger (R = 0,66).

Table V – Half Hourly Values
Weighted orthogonal regression through the origin: **Y = b * X**

Period	**b**	s{b}	**Ndata**
2009.07 – 2009.12	**0.0898**	0.0006	8.273
2009.07 – 2010.01	**0.0830**	0.0005	9.755
2009.07 – 2010.02	**0.0806**	0.0005	11.085
2009.07 – 2010.03	**0.0789**	0.0005	12.545
2009.07 – 2010.04	**0.0780**	0.0004	13.507
2009.07 – 2010.05	**0.0776**	0.0004	14.803
2009.07 – 2010.06	**0.0776**	0.0004	16.203

R_{corr}
0.5881
0.5649
0.5227
0.5119
0.5143
0.5106
0.5098

Table VI – Daily Average Values
Weighted orthogonal regression through the origin: **Y = b * X**

Period	**b**	s{b}	**Ndata**
2009.07 – 2010.06	**0.0852**	0.0015	339

R_{corr}
0.6588

The graphs in Fig. 15 and 16 represent the results for the computed regression lines through the origin, corresponding to the data for the one year period, respectively for the half hourly data and the daily average data. Considering the daily data, the slope of the regression line (0.0852 – table VI), corresponds well to the ratio of the average daily values (0.0881 – table II).

Table VII – Half Hourly Values
Weighted orthogonal regression : **Y = a + b * X**

Period	a	s{a}	b	s{b}	Ndata
2009.07 – 2009.12	**-0.0974**	0.0407	**0.0941**	0.0020	8.273
2009.07 – 2010.01	**0.2392**	0.0350	**0.0735**	0.0016	9.755
2009.07 – 2010.02	**0.4029**	0.0332	**0.0649**	0.0014	11.085
2009.07 – 2010.03	**0.4309**	0.0317	**0.0627**	0.0013	12.545
2009.07 – 2010.04	**0.4388**	0.0298	**0.0619**	0.0012	13.507
2009.07 – 2010.05	**0.4504**	0.0291	**0.0612**	0.0012	14.803
2009.07 – 2010.06	**0.4467**	0.0284	**0.0614**	0.0012	16.203

Table VIII – Daily Average Values
Weighted orthogonal regression : **Y = a + b * X**

Period	a	s{a}	b	s{b}	Ndata
2009.07 – 2010.06	**0.3721**	0.1228	**0.0708**	0.0051	339

The Y,X-scatter plots represented in figures 15 and 16, respectively for the half hourly and daily data, seems to suggest that the data sets are composed by two interfering data populations or distributions. This observation is also reflected by the relative weaker correlation factors between the Black Carbon and the PM10 data: ~0,51 for half hourly values and ~0,66 for the daily values. The split of the data into different distributions may eventually be related to different physical phenomena at the origin of these particulates.

Weighted Orthogonal Regression : Y = b.X

$Y = 0.0776 * X$

$s(b) = 0.0004$

$Rcor = 0.5098$

Half Hourly Values

Period : 01/07/2009 - 30/06/2010

41WOL1-BC [μg/m³] vs. 41WOL1-FD10 [μg/m³]

Y-ordinate : BC : 41WOL1 (Woluwé-St-Lambert)
X-abscissa : FD10 : 41WOL1 (Woluwé-St-Lambert)

(16203 data sets)
(16191 data sets whitin the area)
ALLD - ALLD
ALL-HH : yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy

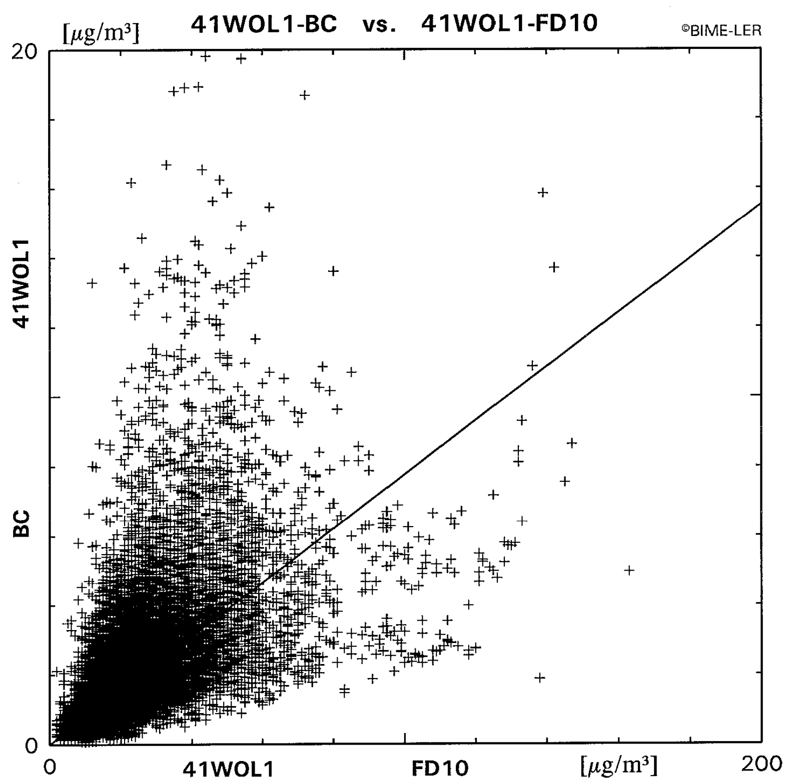

Fig. 15 : Woluwe – Black Carbon data versus PM10
Half Hourly Values – Weighted Orthogonal Regression: **Y = b.X**
One Year Period : July 2009 – June 2010

Weighted Orthogonal Regression : Y = b.X

Y = 0.0852 * X

s(b) = 0.0015

Rcor = 0.6588

Daily Values

Period : 01/07/2009 - 30/06/2010

41WOL1-BC [µg/m³] vs. 41WOL1-FD10 [µg/m³]

Y-ordinate : BC : 41WOL1 (Woluwé-St-Lambert)
X-abscissa : FD10 : 41WOL1 (Woluwé-St-Lambert)

(339 data sets)
(339 data sets whitin the area)
ALLD - ALLD
nhh > = 36 : nhh > = 36

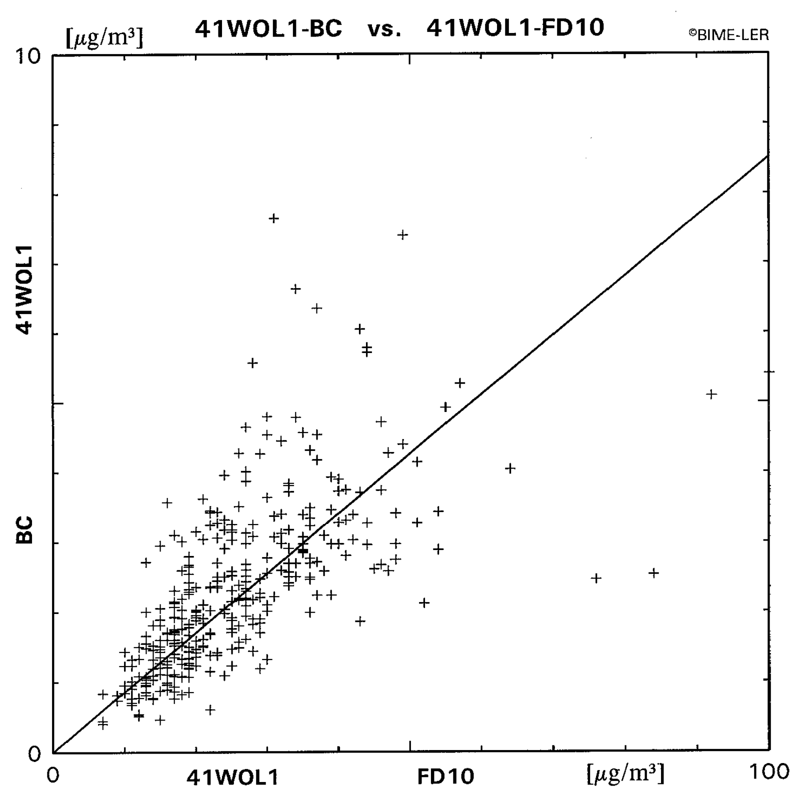

Fig. 16 : Woluwe – Black Carbon data versus PM10
Daily Average Values – Weighted Orthogonal Regression: **Y = b.X**
One Year Period : July 2009 – June 2010

3. Black Carbon and NO at the Woluwe Site

3.1 Evolution Half Hourly Concentration Values

The monthly evolution of the half hourly concentrations for 'Black Carbon' and NO are represented, from July 2009 till June 2010, in the Figures 17 to 28. The results for June 2010 are given in Figure 17 and those for July 2009 in Figure 28. The Black Carbon results refer to the left scale of the graph (0 – 14 µg/m^3) and those for NO to the right scale of the graph (0 – 140 µg/m^3). One can observe that, on a average and for most of the time, the peak values in the graphs follow the same pattern, meaning that there is roughly a factor 10 between the peak concentration levels of the two pollutants.

Many peak values of both pollutants do coincide but, regarding the different graphs more in detail, one can observe that the baseline for NO, compared to the height of the peak values, is generally lower than the baseline for Black Carbon. At several occasions the NO levels are falling down towards the detection limit. This is most obvious during the summer months July and August 2009, but the lower baseline for NO was also observed during all other months. Therefore the observed ratio between the average concentrations for Black Carbon and PM10 could significantly differ from a factor ~10 between the peak values.

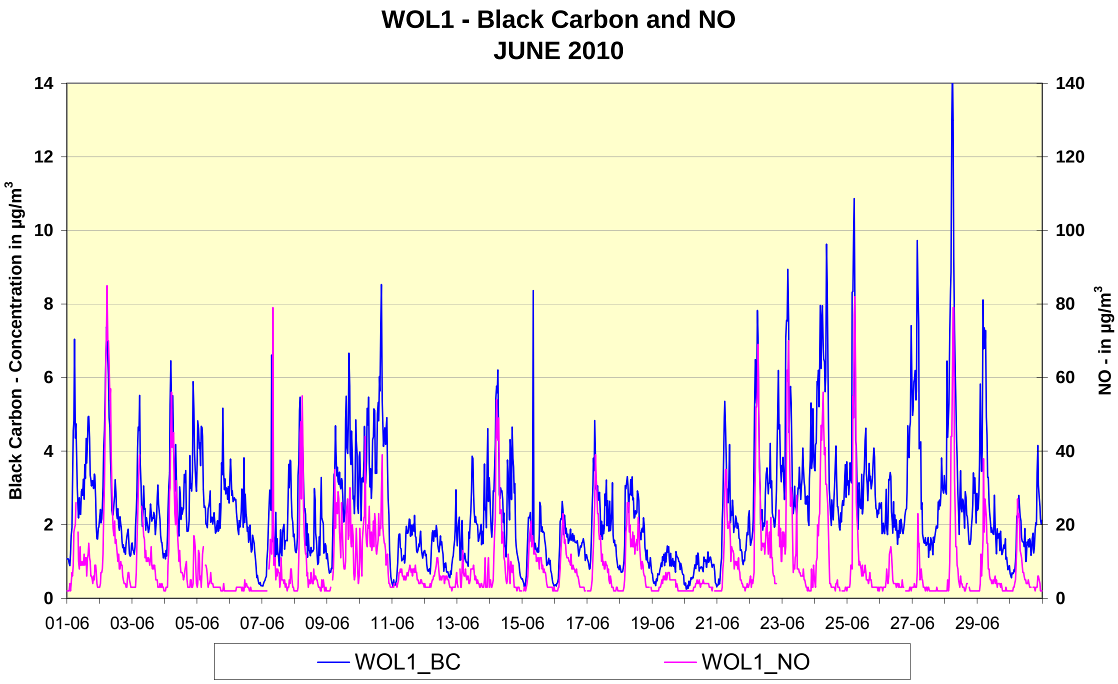

Fig. 17 : Woluwe – **Black Carbon** and **NO** – Evolution Half Hourly Values – June 2010

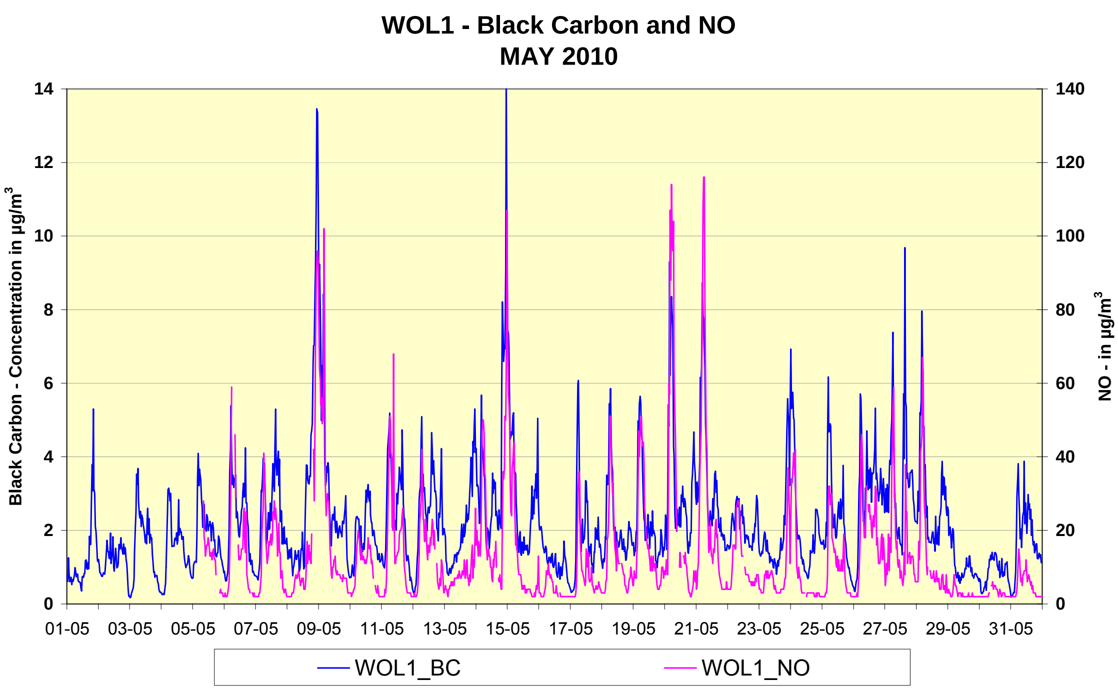

Fig. 18 : Woluwe – **Black Carbon** and **NO** – Evolution Half Hourly Values – May 2010

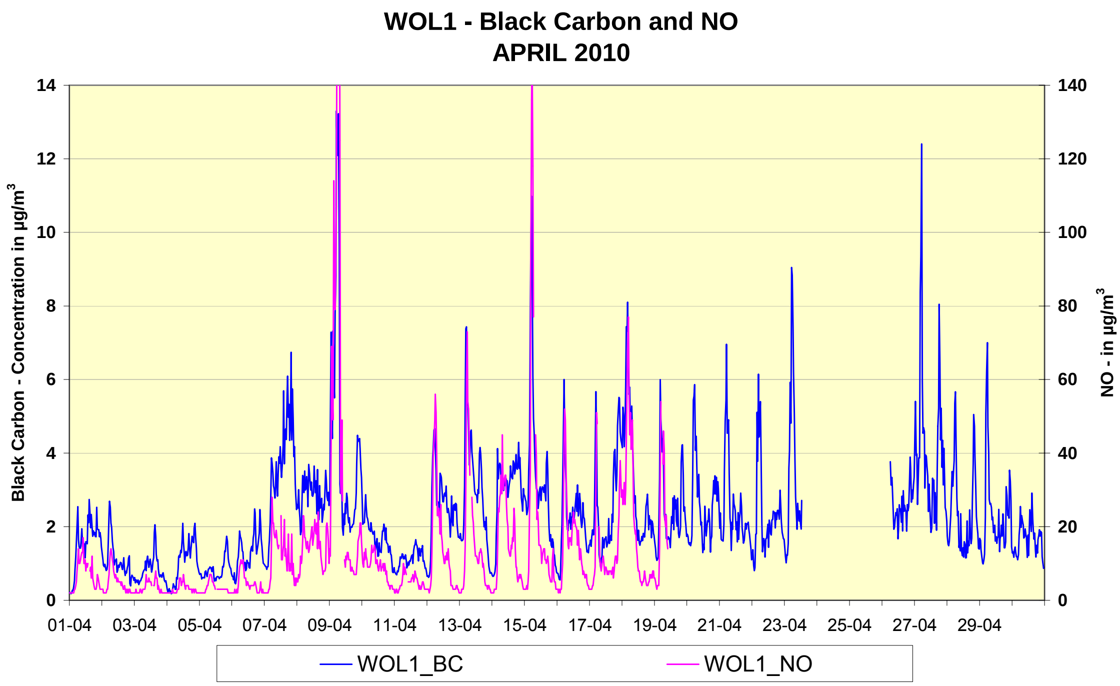

Fig.19 : Woluwe – **Black Carbon** and **NO** – Evolution Half Hourly Values – April 2010

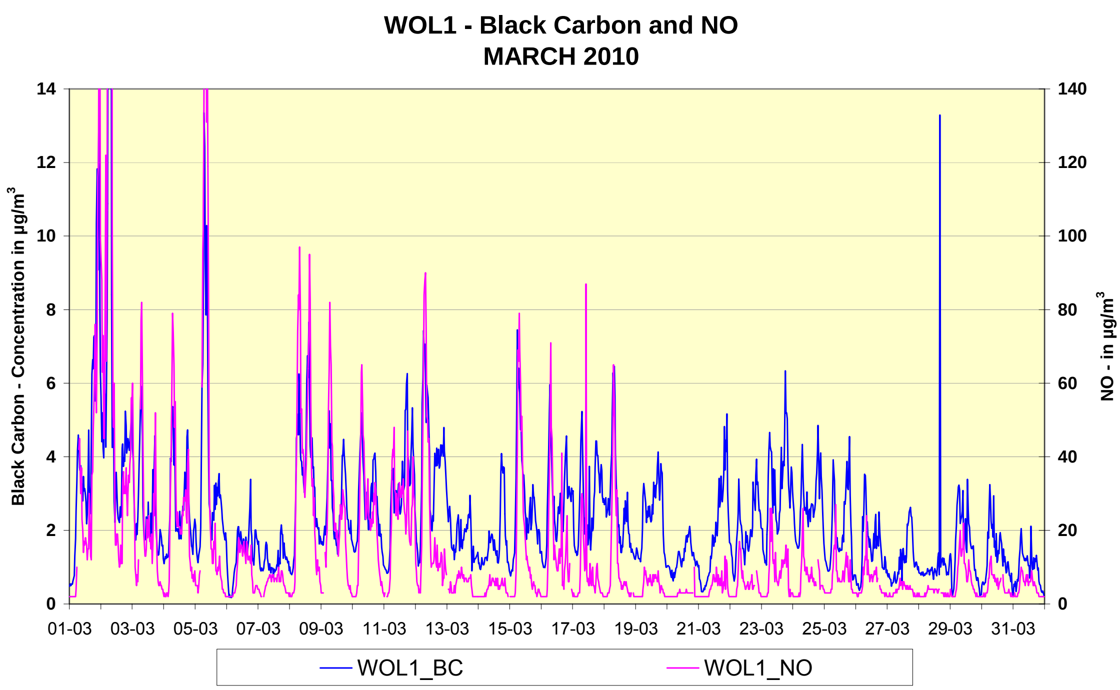

Fig. 20 : Woluwe – **Black Carbon** and **NO** – Evolution Half Hourly Values – March 2010

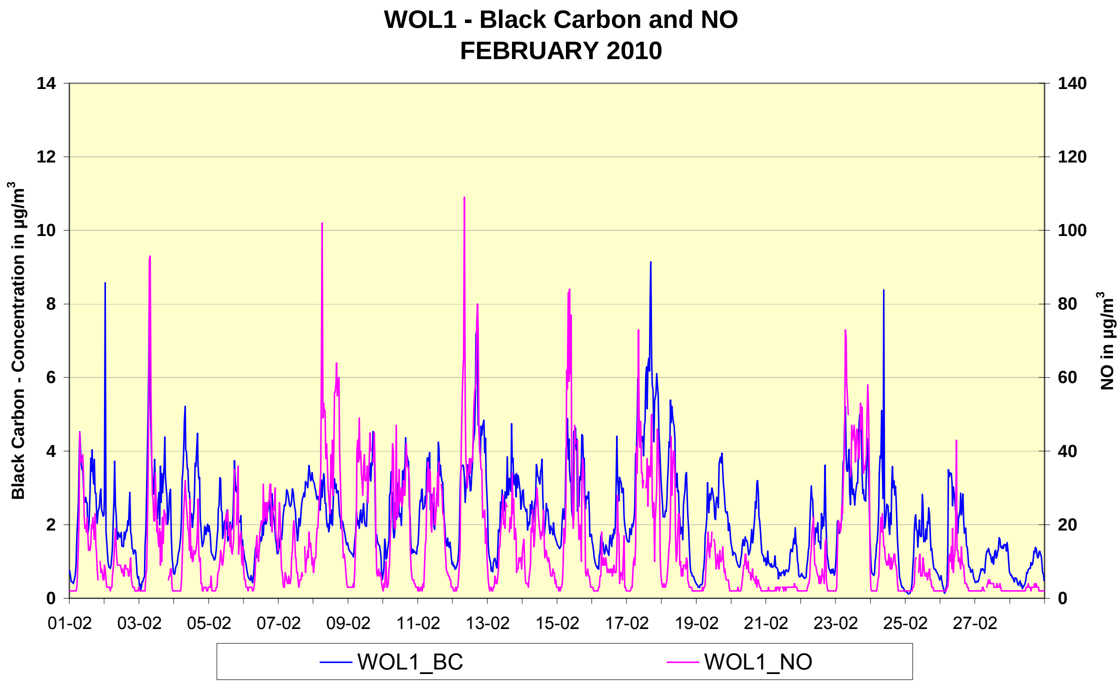

Fig. 21 : Woluwe – **Black Carbon** and **NO** – Evolution Half Hourly Values – February 2010

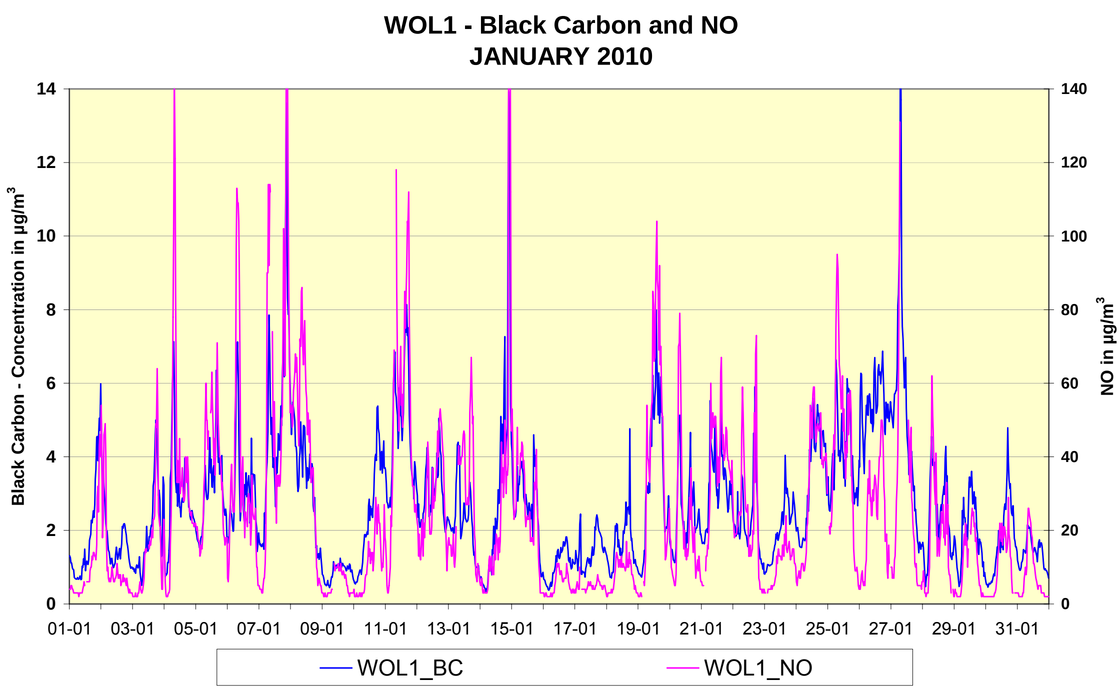

Fig. 22 : Woluwe – **Black Carbon** and **NO** – Evolution Half Hourly Values – January 2010

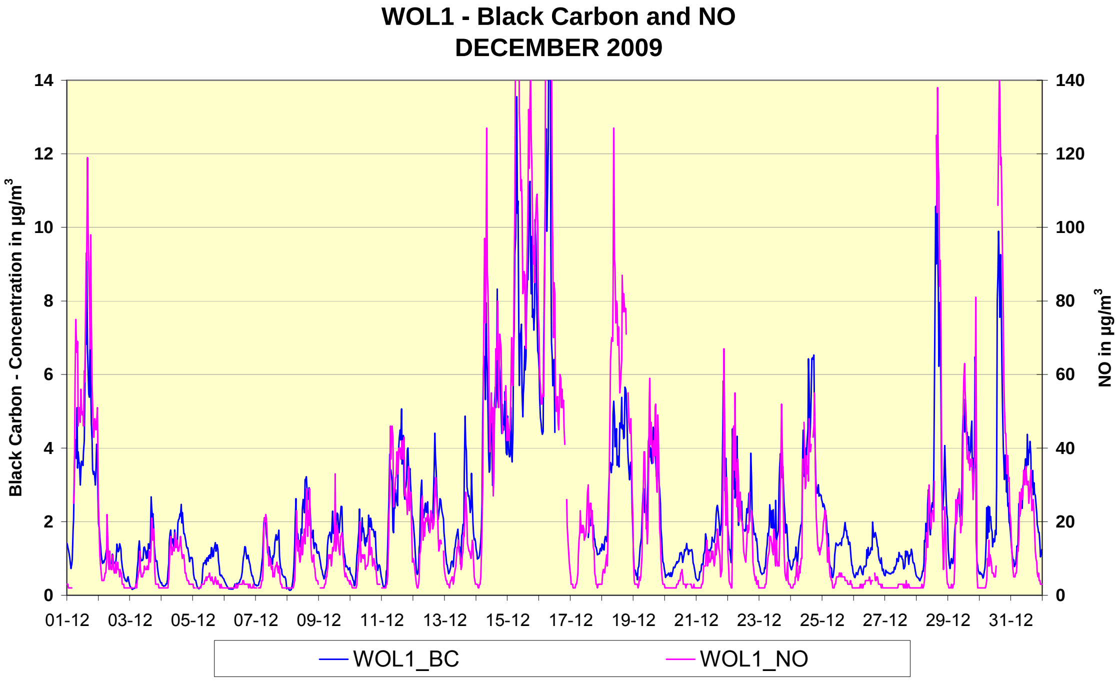

Fig. 23 : Woluwe – **Black Carbon** and **NO** – Evolution Half Hourly Values – December 2009

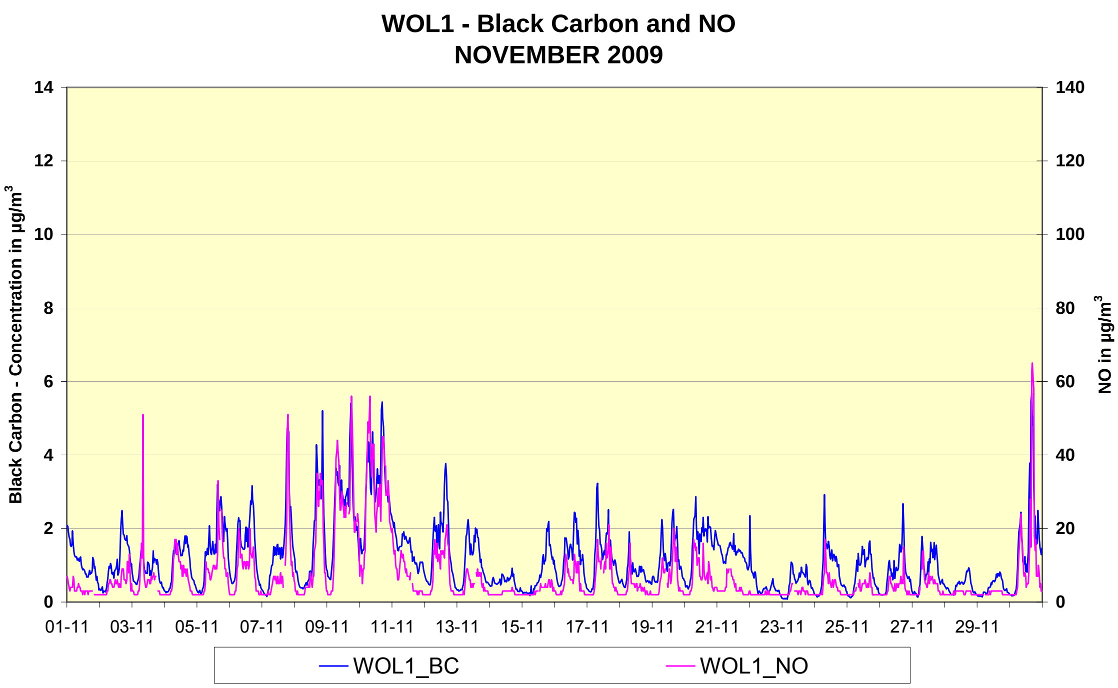

Fig.24 : Woluwe – **Black Carbon** and **NO** – Evolution Half Hourly Values – November 2009

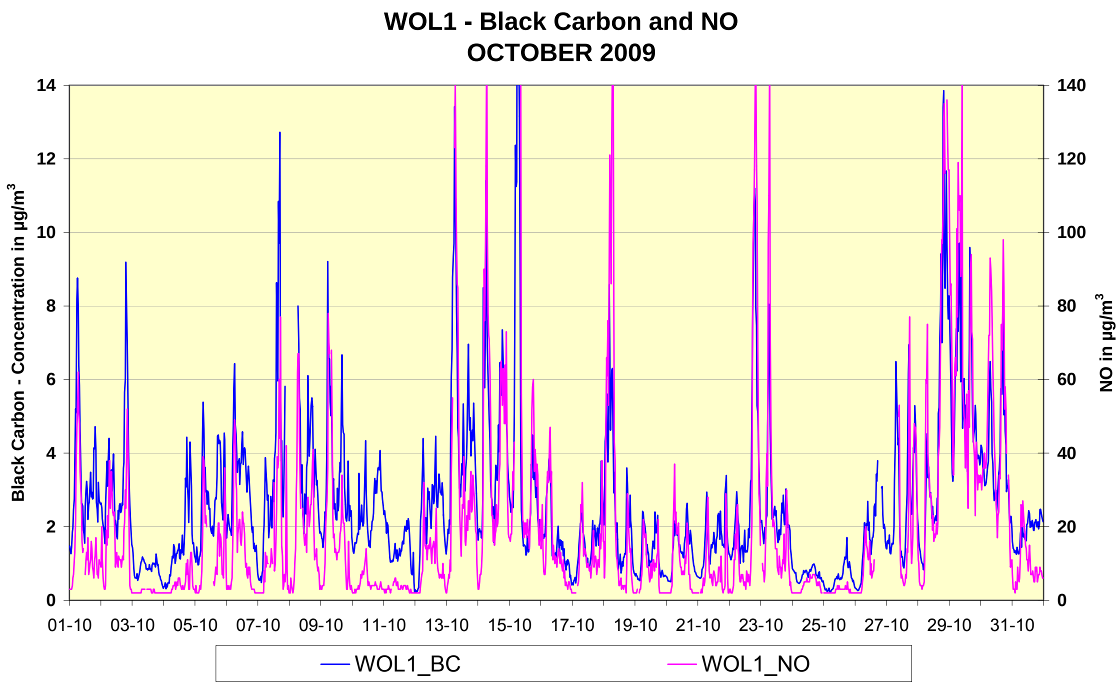

Fig. 25: Woluwe – **Black Carbon** and **NO** – Evolution Half Hourly Values – October 2009

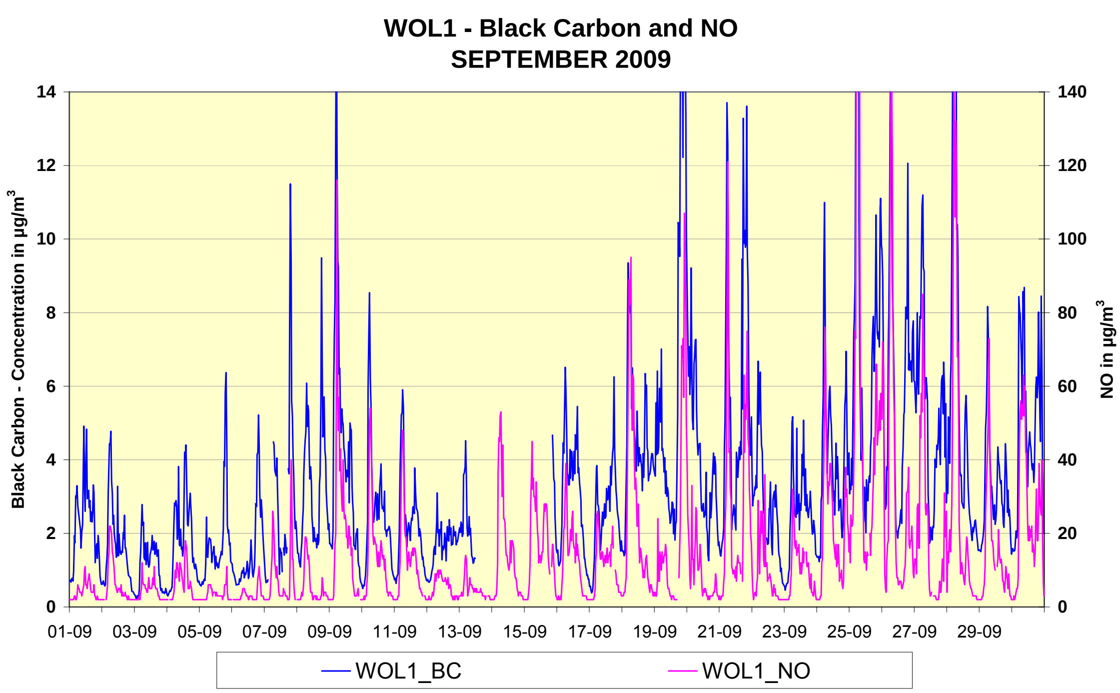

Fig. 26 : Woluwe – **Black Carbon** and **NO** – Evolution Half Hourly Values – September 2009

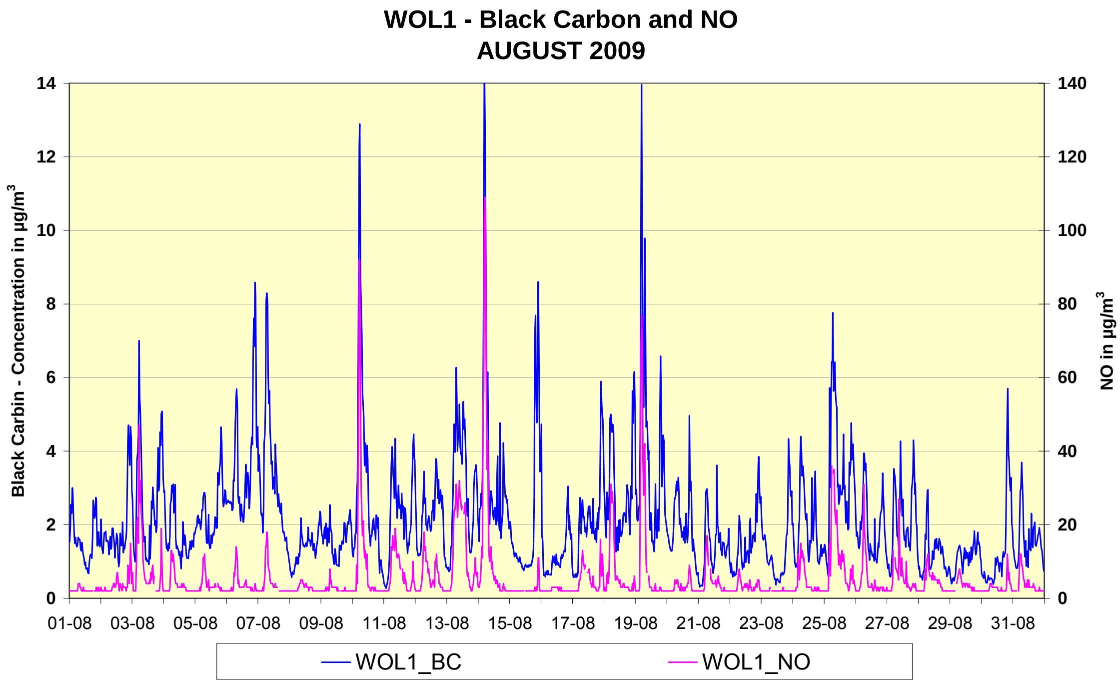

Fig. 27: Woluwe – **Black Carbon** and **NO** – Evolution Half Hourly Values – August 2009

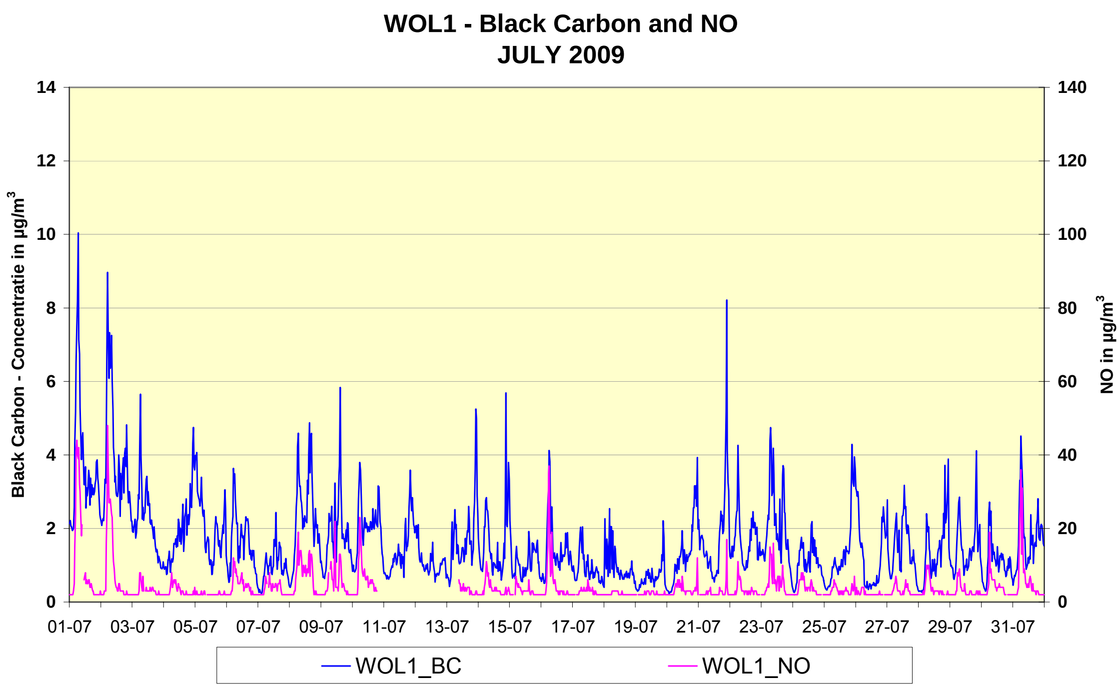

Fig. 28: Woluwe – **Black Carbon** and **NO** – Evolution Half Hourly Values – July 2009

3.2 Cumulative Frequency Distribution – Ratio of Average Concentration Values

The evolution of the average concentrations for Black Carbon and NO, computed for the half hourly values, and their ratio is given in table IX. It starts with a six month period 'July 2009 – December 2009' and ends with a one year period 'July 2009 – June 2010'. In table X similar results are given, but computed for the daily average values from the one year period 'July 2009 – June 2010'.

The cumulative frequency distributions for the one year period 'July 2009 – June 2010' are given in tables XI and XII, computed respectively for the half hourly values and for the daily average values.

Table IX – Half Hourly Values for Black Carbon and NO
Average Concentrations and Ratio of the Averages

Period	Black Carbon Average Conc. [µg/m^3]	NO Average Conc. [µg/m^3]	Ratio BC/NO
2009.07 – 2009.12	2.21	12	**0.1842**
2009.07 – 2010.01	2.29	14	**0.1636**
2009.07 – 2010.02	2.27	14	**0.1621**
2009.07 – 2010.03	2.29	14	**0.1636**
2009.07 – 2010.04	2.30	14	**0.1643**
2009.07 – 2010.05	2.29	14	**0.1636**
2009.07 – 2010.06	2.31	14	**0.1650**

Table X – Daily Average Values for Black Carbon and NO
Average Concentrations and Ratio of the Averages

Period	Black Carbon Average Conc. [µg/m^3]	NO Average Conc. [µg/m^3]	Ratio BC/NO
2009.07 – 2010.06	2.29	14	**0.1636**

Table XI – Cumulative Frequency Distribution Black Carbon and NO
Half Hourly Values – Period: July 2009 – June 2010

CUMULATIVE FREQUENCY DISTRIBUTION : Half Hourly Values

Period : 01 July 2009 - 30 June 2010

Selection Days : All Days

All Half Hourly Periods : yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy

Total Number of Periods = 17.520

Site Symb Unit	41WOL1 Black Carbon µg/m³	41WOL1 NO µg/m³
Min	0,07	2
P-10	0,65	2
P-20	0,96	2
P-30	1,25	3
P-40	1,53	4
P-50	1,84	6
P-60	2,19	8
P-70	2,65	12
P-80	3,29	19
P-90	4,37	34
P-95	5,63	51
P-98	7,67	78
P-99	9,30	104
P-99.5	11,20	127
P-99.9	18,82	221
Max	36,86	537
AM	2,31	14
ASD	1,90	22
GM	1,76	7
GSD	2,14	2,96
Nval	17192	16204
Nval%	98,1	92,4
Max-1	28,88	470
Max-2	28,10	452
Max-3	25,12	368
Max-7	22,64	304
Max-8	21,02	292
Max-17	18,82	221
Max-23	15,88	197

Table XII – Cumulative Frequency Distribution Black Carbon and NO
Daily Average Values – Period: July 2009 – June 2010

CUMULATIVE FREQUENCY DISTRIBUTION : Daily Values

Period : 01 July 2009 - 30 June 2010

Selection Days : All Days

Total Number of Periods = 365

Site Symb Unit	41WOL1 Black Carbon µg/m³	41WOL1 NO µg/m³
Min	0,40	2
P-10	0,99	3
P-20	1,27	4
P-30	1,52	5
P-40	1,78	7
P-50	2,09	9
P-60	2,39	11
P-70	2,70	15
P-80	3,14	21
P-90	3,75	29
P-95	4,53	41
P-98	5,57	52
P-99	6,05	63
P-99.5	6,63	88
P-99.9	7,64	103
Max	7,64	103
AM	2,29	14
ASD	1,19	14
GM	2,01	9
GSD	1,69	2,40
Nval	356	343
Nval%	97,5	93,9
Max-1	7,39	90
Max-2	6,63	88
Max-3	6,35	63
Max-7	5,57	52
Max-8	5,41	51
Max-17	4,53	41
Max-23	4,27	35

3.3 Regression Line(s) "Black Carbon" versus "NO"

The data for NO are represented as the X-data set (abscissa) and those for Black Carbon as the Y-data set (ordinate). Since both data sets are subject to measurement errors a weighted orthogonal regression is applied as mentioned in section 2.3.

Results are computed for a regression line through the origin, as well as for a line with an intercept on the Y-axis. For the half hourly data the results are computed starting with a six month during period, July till December 2009, and ending with the one year period 'July 2009 – June 2010'. Results for the daily average values are computed for the one year period 'July 2009 – June 2010'.

The correlation coefficient is given with the results for the weighted orthogonal regression line through the origin (table XIII and XIV). The results are indicating that there is a much better correlation between Black Carbon and NO (R = 0.75 – 0.77) than between Black Carbon and PM10 (R = 0.51 – 0,59 for half hourly data and 0.65 for daily data). The correlation factor between the data for Black Carbon and NO is more stable over time and is nearly identical for the detailed data (half hourly values) as for the integrated data (daily values).

Table XIII – Half Hourly Values
Weighted orthogonal regression through the origin: **Y = b * X**

Period	b	s{b}	Ndata
2009.07 – 2009.12	**0.1283**	0.0015	8.291
2009.07 – 2010.01	**0.1128**	0.0010	9.733
2009.07 – 2010.02	**0.1132**	0.0010	11.049
2009.07 – 2010.03	**0.1127**	0.0009	12.506
2009.07 – 2010.04	**0.1146**	0.0009	13.370
2009.07 – 2010.05	**0.1183**	0.0009	14.609
2009.07 – 2010.06	**0.1222**	0.0009	16.017

R_{corr}
0.7662
0.7683
0.7632
0.7688
0.7696
0.7703
0.7584

Table XIV – Daily Average Values
Weighted orthogonal regression through the origin: **Y = b * X**

Period	b	s{b}	Ndata
2009.07 – 2010.06	**0.1442**	0.0055	337

R_{corr}
0.7706

Considering the daily data, the slope of the regression line through the origin (0.1442 – table XIV), corresponds well to the ratio between the daily average values (0.1636 – table X).

The graphs in Fig. 29 and 30 represent the results for the computed regression lines (**Y = a + B.X**), corresponding to the data for the one year period, respectively for the half hourly data and the daily average data.

Table XV – Half Hourly Values
Weighted orthogonal regression : **Y = a + b * X**

Period	a	s{a}	b	s{b}	Ndata
2009.07 – 2009.12	**1.0860**	0.0132	**0.0734**	0.0010	8.291
2009.07 – 2010.01	**1.0956**	0.0120	**0.0688**	0.0008	9.733
2009.07 – 2010.02	**1.0996**	0.0112	**0.0683**	0.0007	11.049
2009.07 – 2010.03	**1.1298**	0.0105	**0.0673**	0.0007	12.506
2009.07 – 2010.04	**1.1281**	0.0102	**0.0680**	0.0007	13.370
2009.07 – 2010.05	**1.1329**	0.0097	**0.0692**	0.0006	14.609
2009.07 – 2010.06	**1.1604**	0.0096	**0.0698**	0.0006	16.017

Table XVI – Daily Average Values
Weighted orthogonal regression : **Y = a + b * X**

Period	a	s{a}	b	s{b}	Ndata
2009.07 – 2010.06	**1.2522**	0.0537	**0.0666**	0.0032	337

Weighted Orthogonal Regression : Y = a + b.X

Y = 1.1604 + 0.0698 * X

s(a) = 0.0096 s(b) = 0.0006

Rcor = 0.7584

Half Hourly Values

Period : 01/07/2009 - 30/06/2010

41WOL1-BC [µg/m³] vs. 41WOL1-NO [µg/m³]

Y-ordinate : BC : 41WOL1 (Woluwé-St-Lambert)
X-abscissa : NO : 41WOL1 (Woluwé-St-Lambert)

(16017 data sets)
(16004 data sets whitin the area)
ALLD - ALLD
ALL-HH : yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy

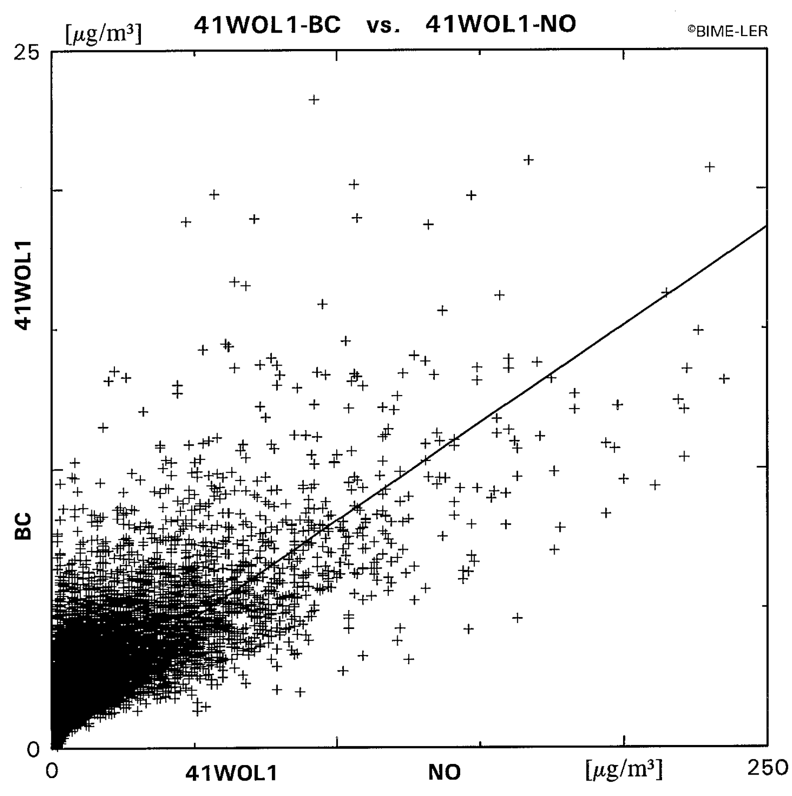

Fig. 29 : Woluwe – Black Carbon data versus NO data
Half Hourly Values – Weighted Orthogonal Regression: **Y = a + b.X**
One Year Period : July 2009 – June 2010

Weighted Orthogonal Regression : Y = a + b.X

$$Y = 1.2522 + 0.0666 * X$$

s(a) = 0.0537 s(b) = 0.0032

Rcor = 0.7706

Daily Values

Period : 01/07/2009 - 30/06/2010

41WOL1-BC [μg/m³] vs. 41WOL1-NO [μg/m³]

Y-ordinate : BC : 41WOL1 (Woluwé-St-Lambert)
X-abscissa : NO : 41WOL1 (Woluwé-St-Lambert)

(337 data sets)
(336 data sets whitin the area)
ALLD - ALLD
nhh > = 36 : nhh > = 36

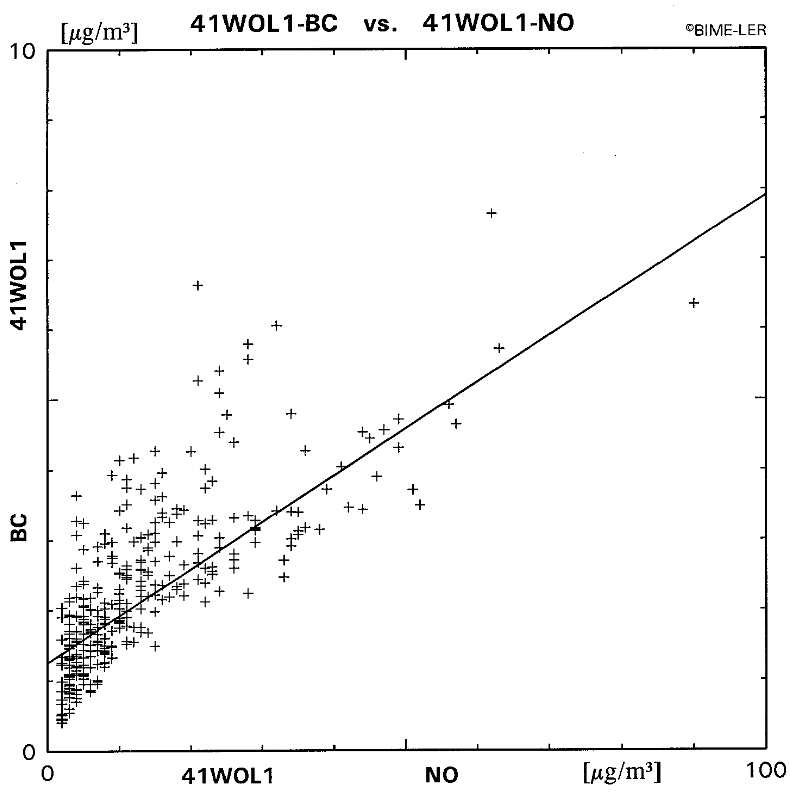

Fig. 30 : Woluwe – Black Carbon versus NO data
Daily Average Values – Weighted Orthogonal Regression: **Y= a + b.X**
One Year Period : July 2009 – June 2010

3.4 Correlations between "Black Carbon" and other Pollutants

For the period 'July 2009 – June 2010', the correlation coefficients between the results of Black Carbon and those of the other pollutants are computed on a monthly base. The results for NO, NO_2, NO_X, CO, CO_2, PM10, PM2,5 and the Particulate number concentration for the finer particulates [0,25–0,65 µm] and particulates above 0,65 µm are given in table XVII. The evolution of the correlation results for NO, NO_2, NO_X, PM10, PM2,5 and both particulate number concentrations [0,25–0,65 µm] and >0,65 µm are graphically represented in figure 31.

Table XVII – Monthly Correlation Coefficients to Black Carbon
Pollutants : NO – NO_2 – NO_X – CO – CO_2 – PM10 – PM2,5
Particulate Number concentration
PNbc>0,25 µm, PNbc>0,65 µm and 0,25<PNbc<0,65 µm
Period : July 2009 – June 2010

Correlation Coefficient to Black Carbon	WOL1 NO µg/m³	WOL1 NO2 µg/m³	WOL1 NOx µg/m³	WOL1 CO mg/m³	WOL1 CO2 ppm	WOL1 PM10 Fdms µg/m³	WOL1 Base10 µg/m³	WOL1 BC µg/m³	WOL1 UVPM µg/m³	BXLAVG PM2,5 Fdms µg/m³	BXLAVG Base2,5 µg/m³	WOL1 PNbc >0,25 µm KNb/l	WOL1 PNbc >0,65 µm KNb/l	WOL1 PNbc 0,25-0,65 µm KNb/l
2009_07	0,6739	0,9001	0,9178	0,6980	0,3894	0,6442	0,6408	1,0000	0,9892	0,6697	0,6839	0,6368	0,3064	0,6371
2009_08	0,7280	0,8359	0,9214	0,7327	0,5951	0,4571	0,5012	1,0000	0,9876	0,5037	0,5506	0,3298	0,0337	0,3301
2009_09	0,7948	0,7664	0,8650	0,8041	0,7941	0,4823	0,5305	1,0000	0,9949	0,4144	0,4574	0,4342	0,1230	0,4359
2009_10	0,8384	0,7384	0,8738	0,6557	0,6319	0,4855	0,5102	1,0000	0,9910	0,4305	0,4835	0,3545	0,0498	0,3575
2009_11	0,8546	0,8645	0,9140	0,7285	0,7160	0,5647	0,5830	1,0000	0,9853	0,5458	0,5930	0,5245	0,1786	0,5259
2009_12	0,9294	0,8171	0,9440	0,8200	0,8757	0,7244	0,7330	1,0000	0,9818	0,6856	0,7077	0,6102	0,3066	0,6091
2010_01	0,8076	0,6221	0,8368	0,7372	0,7413	0,6913	0,6979	1,0000	0,9743	0,6754	0,6814	0,6352	0,5035	0,6323
2010_02	0,6785	0,7970	0,7943	0,6151	0,6579	0,4138	0,4172	1,0000	0,9688	0,4004	0,3992	0,4311	0,2572	0,4324
2010_03	0,8453	0,7983	0,9032	0,7537	0,8213	0,4316	0,4766	1,0000	0,9858	0,4276	0,4893	0,2621	0,1955	0,2615
2010_04	0,7854	0,8429	0,8923	0,4899	0,6994	0,5833	0,6055	1,0000	0,9876	0,5239	0,5535	0,3091	0,3666	0,3076
2010_05	0,8043	0,7281	0,8485	0,5409	0,6544	0,4493	0,4677	1,0000	0,9914	0,4504	0,4980	0,4514	0,2548	0,4511
2010_06	0,6597	0,7694	0,8143	0,3973	0,6254	0,4905	0,5039	1,0000	0,9859	0,5481	0,5739	0,5332	0,2080	0,5346

The best correlation with Black Carbon is found for NO_X, with monthly correlation factors between 0,81 and 0,94, followed by the correlation with NO and NO_2. The better correlation between Black Carbon and NO_X (sum of NO and NO_2, expressed as equivalent to NO_2), rather than with NO, may probably be explained by the fact that, at traffic sites, the NO_2 concentration contains a non negligible contribution directly emitted by the local traffic and by the fact that, due to the rapid oxidation, part of the local emitted NO may already be converted into NO_2 at the receptor point.

Another important observation is the moderate correlation between Black Carbon and PM10 or PM2,5, with monthly correlation coefficients ranging from 0,4138 to 0,7244 for PM10 and from 0,4004 to 0,6856 for PM2,5. The highest correlation with PM10 and PM2,5 is observed for the months of December 2009 (0,7244 and 0,6856) and January 2010 (0,6913 and 0,6754), when increased concentrations are more often the result of meteorological situations that lead to a poor dispersion capacity of the lower atmosphere.

As a consequence of an accumulation effect, then the impact of the local emissions on the measured concentration becomes more important, resulting in a better correlation between PM10, a pollutant whose presence depends on many different phenomena and that is therefore more generally present, and Black Carbon, more directly linked with local emissions.

The correlation between the particulate number concentration of the finer particulates [0,25–0,65 µm] and Black Carbon is not better than between the PM particulate mass concentration and Black Carbon. With the restriction for some very exceptional situations the number of the finer particulates [0,25–0,65 µm] counts for 96 to 99% of the particulate number concentration of all particulates >0,25 µm.

With the exception for January 2010, a very poor correlation is observed between Black Carbon and the number of particulates with an equivalent diameter above 0,65 µm. The monthly computed correlation coefficients are ranging between 0,03 and 0,30. With increasing size range, the (re)suspension effect, under dry weather conditions, becomes more and more important and the particulates in that size range are not directly linked with Black Carbon, a pollutant mainly originated by combustion processes.

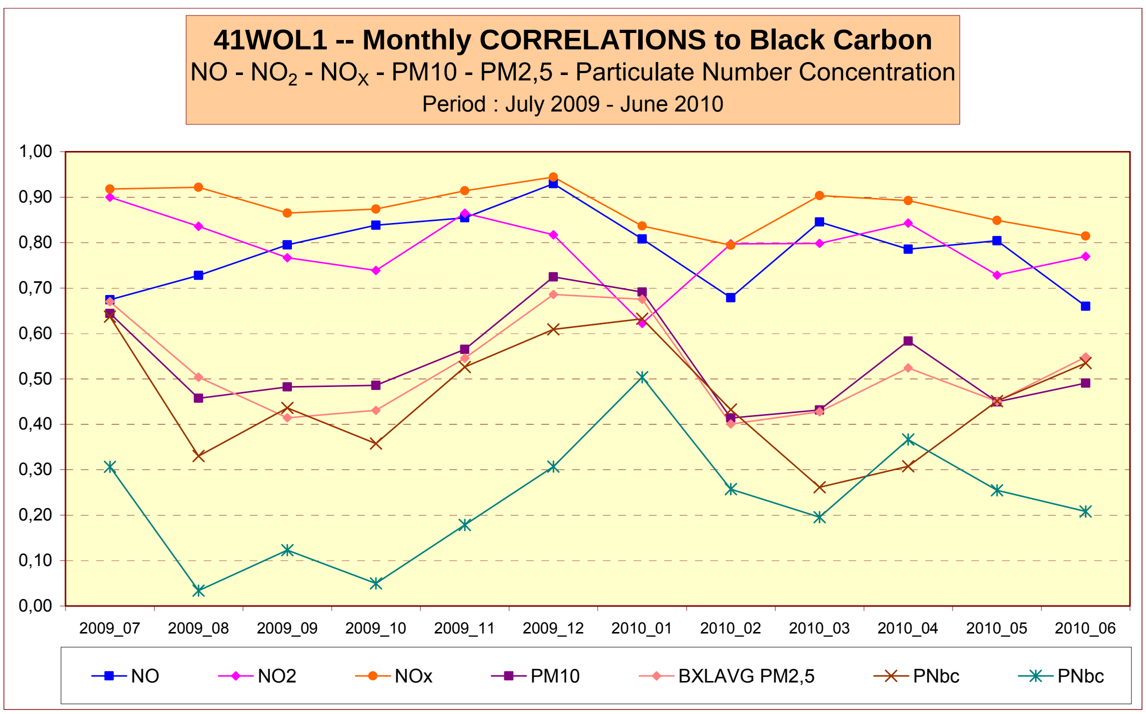

Fig. 31 : Woluwe – Monthly Correlation Coefficients to Black Carbon
Results for NO, NO_2, NO_X, PM10,PM2,5 and the Particulate number concentration for finer particulates [0,25–0,65 µm] and particulates>0,65 µm.

4. Particulate Number Concentration

4.1 Evolution Half Hourly Concentration Values

The monthly evolution of the logarithm of the half hourly concentrations for certain particulate size classes are represented, from July 2009 till June 2010, in the Figures 32 to 43. The results for June 2010 are given in Figure 32 and those for July 2009 in Figure 43.

The results are corresponding to the logarithmic scale (0-7) at the left of the graph: a value of 6 corresponds to 1.000.000 particulates per litre air, a value of 5 to 100.000 particulates per litre air, etc… .The results for the PM10 mass concentration are also represented and refer to the scale at the right of the graph (0 – 175 µg/m^3 PM10).

Result are given for 10 different size classes:

- particulates >0,25 µm
- particulates >0.30 µm
- particulates >0.40 µm
- particulates >0.50 µm
- particulates >0.65 µm

- particulates >1.00 µm
- particulates >2.50 µm
- particulates >5.00 µm
- particulates >7.50 µm
- particulates >10 µm

The total number of particulates (>0,25 µm) is generally ranging between 10.000 and 1.000.000 particulates per litre of air (logarithmic value between 4 to 6). For the given period, the maximum half hourly value measured up to now is about 1.900.000 particulates per litre air. This very high value was observed on Saturday 10 April 2010, at 5:00 h UT (Figure 34). The number of particulates with equivalent diameter between 0,25 and 0,28 µm ranged as high as 1.000.000 particulates per litre air. That Saturday morning, between 3:00 and 8:00 h UT, the total particulate number concentration (>0,25 µm) stayed above 1.000.000 particulates per litre air as a consequence of the formation of secondary aerosol.

The number of particulates >0.50 µm is ranging between 1.000 and 100.000 particulates per litre of air, corresponding to a logarithmic value between 3 and 5. The evolution of the number concentration of the smaller particulate sizes follows a similar pattern, probably reflecting their common physical origin. Different patterns can be found for particulate size ranges above 1 µm. The differences become more pronounced as the size ranges increases, as can be seen for instance by comparing the concentration evolution for the fractions above 2.5 µm and above 7.5 µm.

The number of particulates >2.5 µm is ranging between 10 (scale 1) and a few hundred (scale 2 to 3) particulates per litre air. The number of particulates >10 µm is ranging between 1 and 100 (scale 0 and 2).

Particulates with an equivalent diameter >2.5 µm and those of the taller size ranges (>7.5 µm) are mainly present under dry weather conditions (dry road surface), as a result of the (re)suspension of the coarser particulates caused by the turbulences created by the highway traffic. During winter time this phenomenon may be due to the preventive salting process of dry road surfaces, as can be seen from the results during the first half of February 2010 (Fig. 36). This was especially true during the night from Saturday 6 till Sunday 7 February and between Tuesday 9 and Friday 12 February, a period characterized by temperatures that stayed continuously below the freezing point. As the temperature rises and the road surfaces become wet, the (re)suspension of the coarser particulate fractions becomes negligible. During the wet and rainy month of November 2009 (Figure 39) there were almost no larger particulates (>10 µm) present.

The evolution of the PM10 mass concentration with time follows nearly the same pattern as the one of the total particulate number concentration. The highest PM10 mass concentrations are found when the number of particulates is approaching or exceeding 1.000.000 particulates per litre of air (scale value 6). Very clear illustrations are encountered on Sunday 7 and Monday 8 February (Fig. 36) and between Monday 25 and Wednesday 27 January 2010 (Fig. 37). High particulate number concentrations in the lower sizes (below 1 µm) are mainly observed during periods of poor dispersion (winter peaks) and periods with a considerable formation of secondary aerosol. At other occasions however, high PM mass concentrations might correlate well with high particulates number concentrations for the coarser fractions.

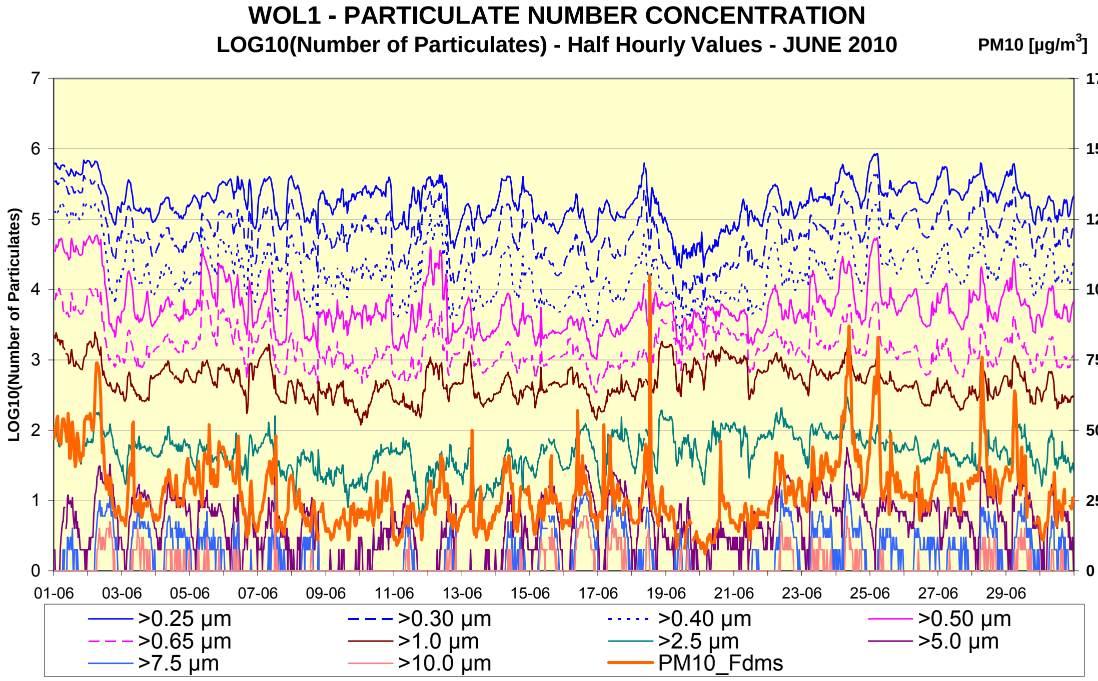

Fig. 32: Particulate Number concentration for different size classes (**>0,25 µm** till **>10 µm**) and **PM10 mass concentration** at the Woluwe site – June 2010

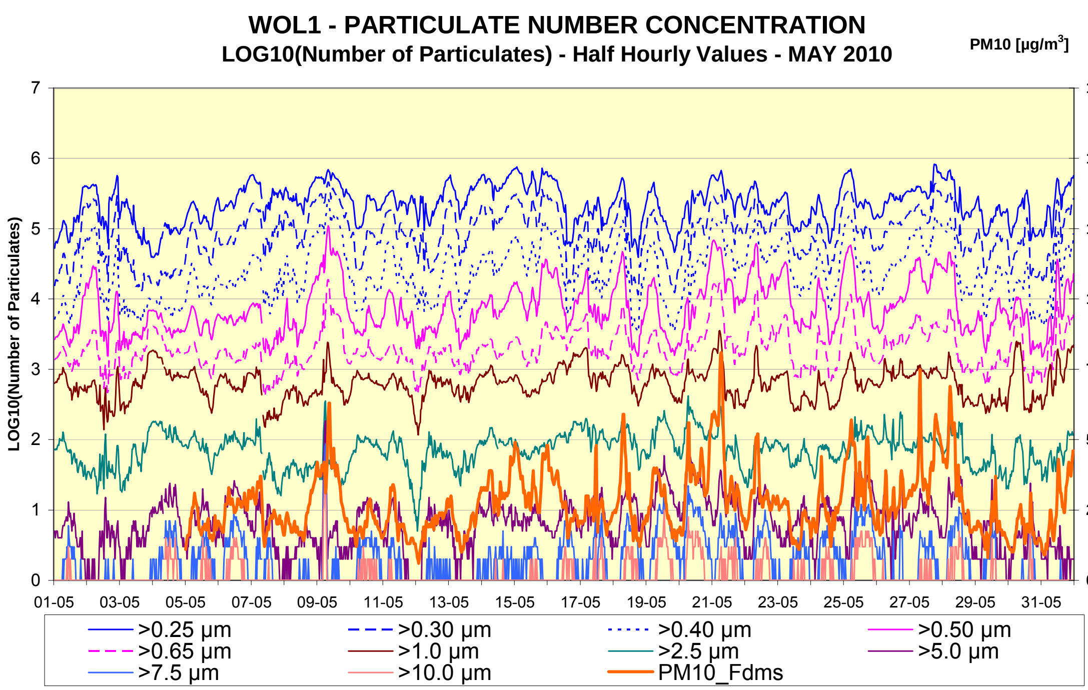

Fig. 33: Particulate Number concentration for different size classes (**>0,25 µm** till **>10 µm**) and **PM10 mass concentration** at the Woluwe site – May 2010

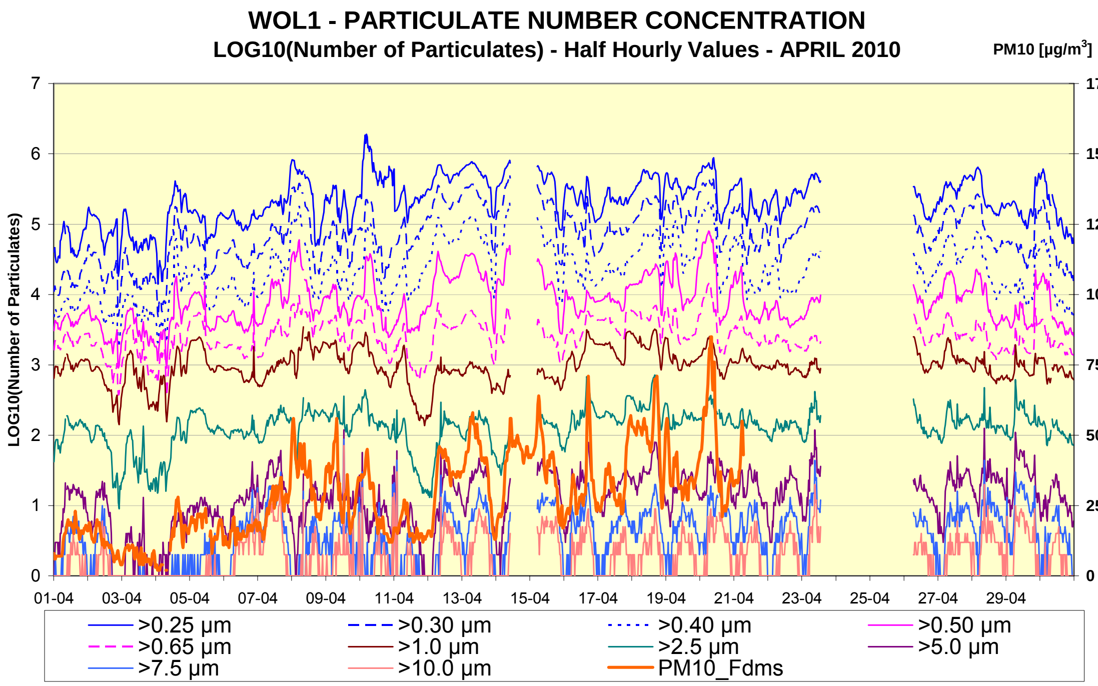

Fig. 34: Particulate Number concentration for different size classes **(>0,25 µm** till **>10 µm**) and **PM10 mass concentration** at the Woluwe site – April 2010

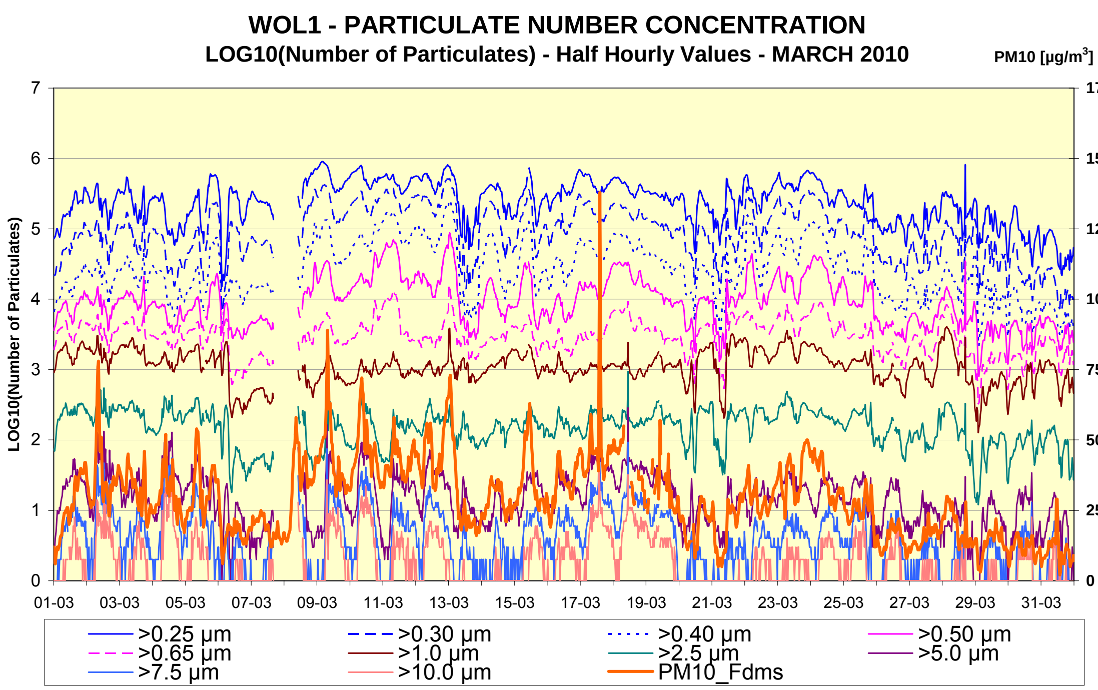

Fig. 35: Particulate Number concentration for different size classes **(>0,25 µm** till **>10 µm**) and **PM10 mass concentration** at the Woluwe site – March 2010

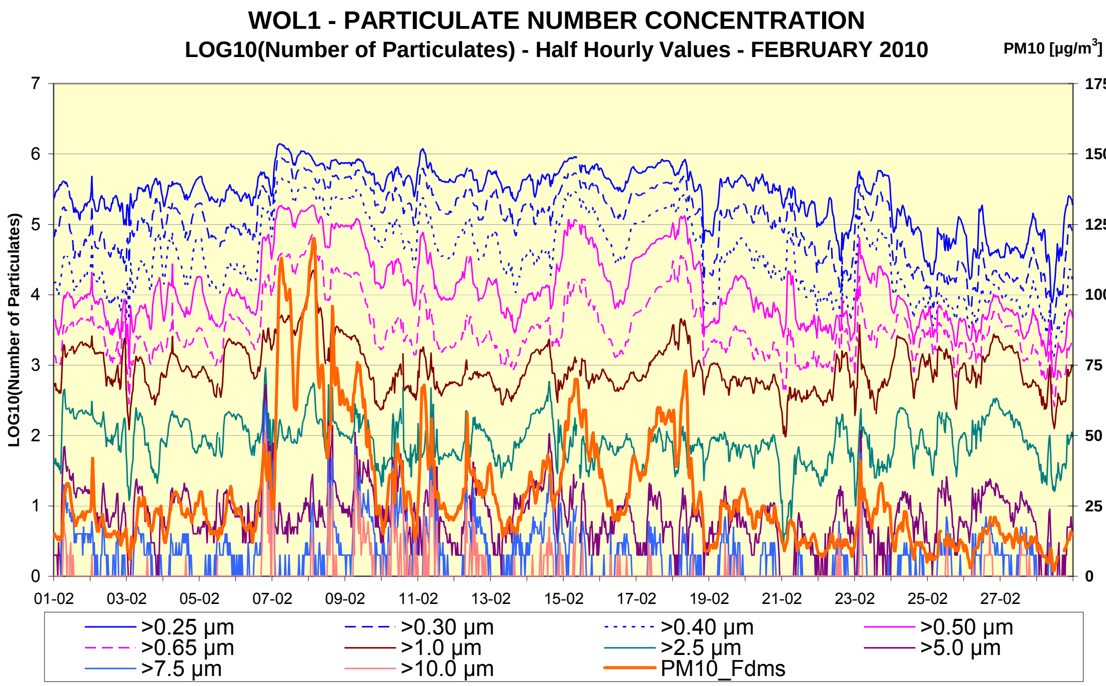

Fig. 36: Particulate Number concentration for different size classes (**>0,25 µm** till **>10 µm**) and **PM10 mass concentration** at the Woluwe site – February 2010

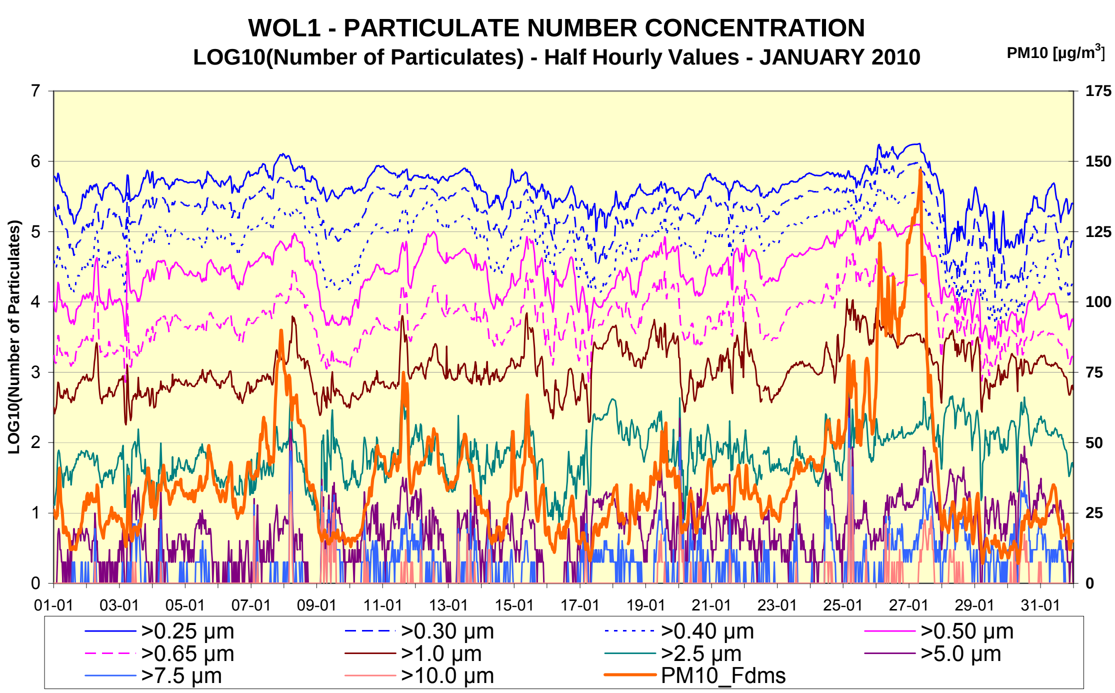

Fig. 37: Particulate Number concentration for different size classes (**>0,25 µm** till **>10 µm**) and **PM10 mass concentration** at the Woluwe site – January 2010

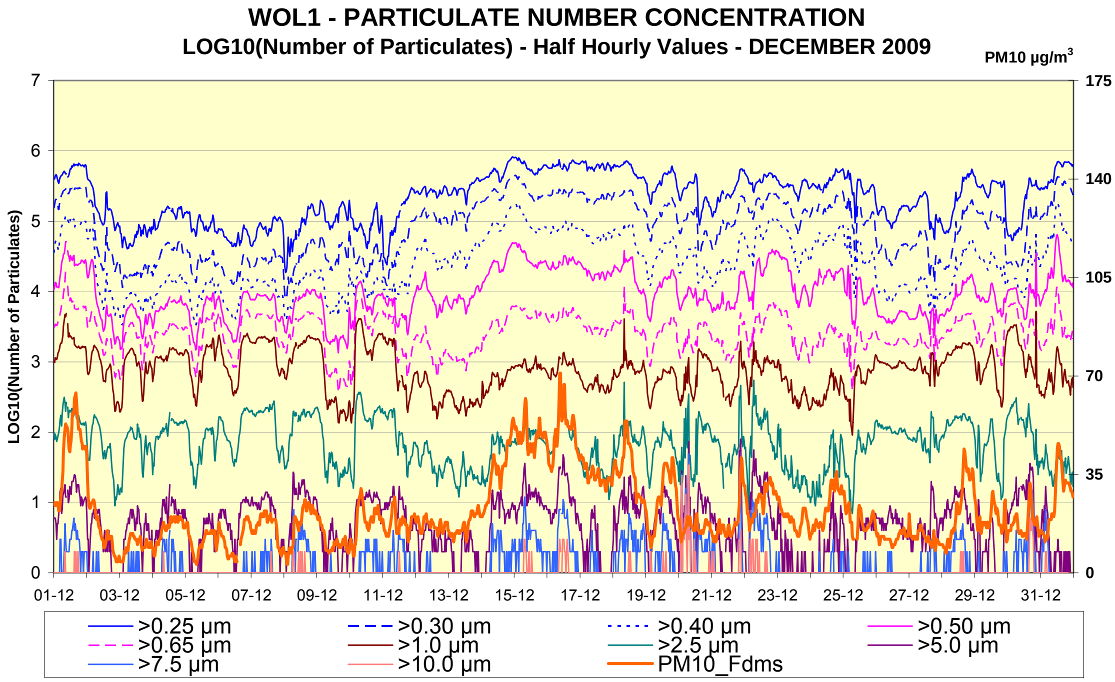

Fig. 38: Particulate Number concentration for different size classes (**>0,25 µm** till **>10 µm**) and **PM10 mass concentration** at the Woluwe site – December 2009

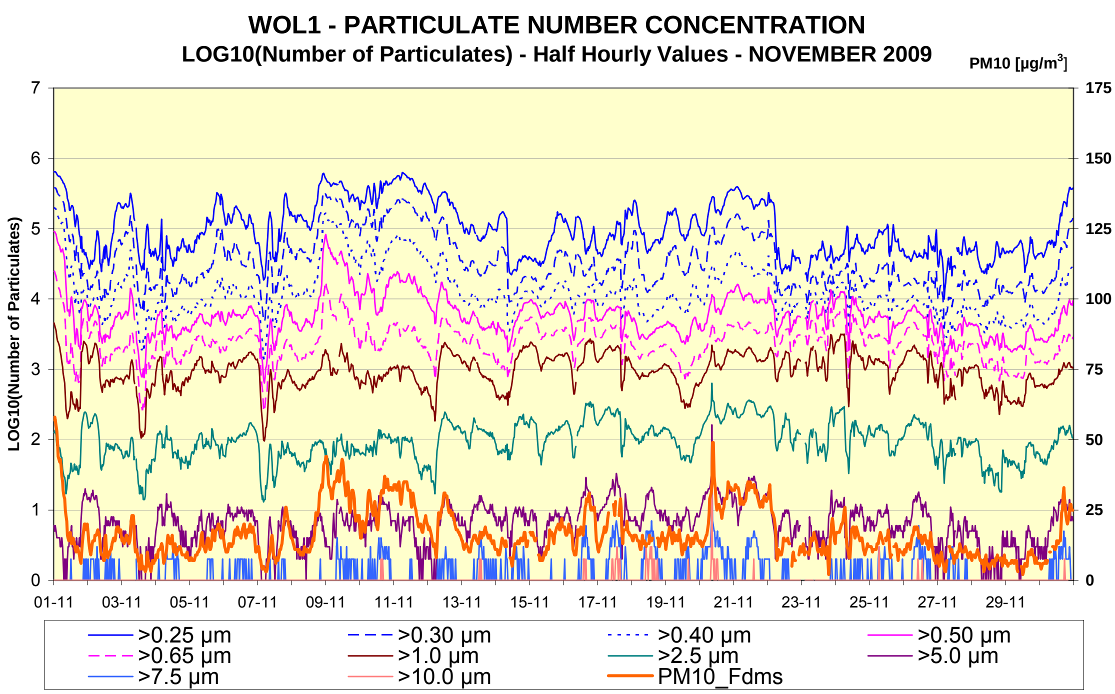

Fig. 39: Particulate Number concentration for different size classes (**>0,25 µm** till **>10 µm**) and **PM10 mass concentration** at the Woluwe site – November 2009

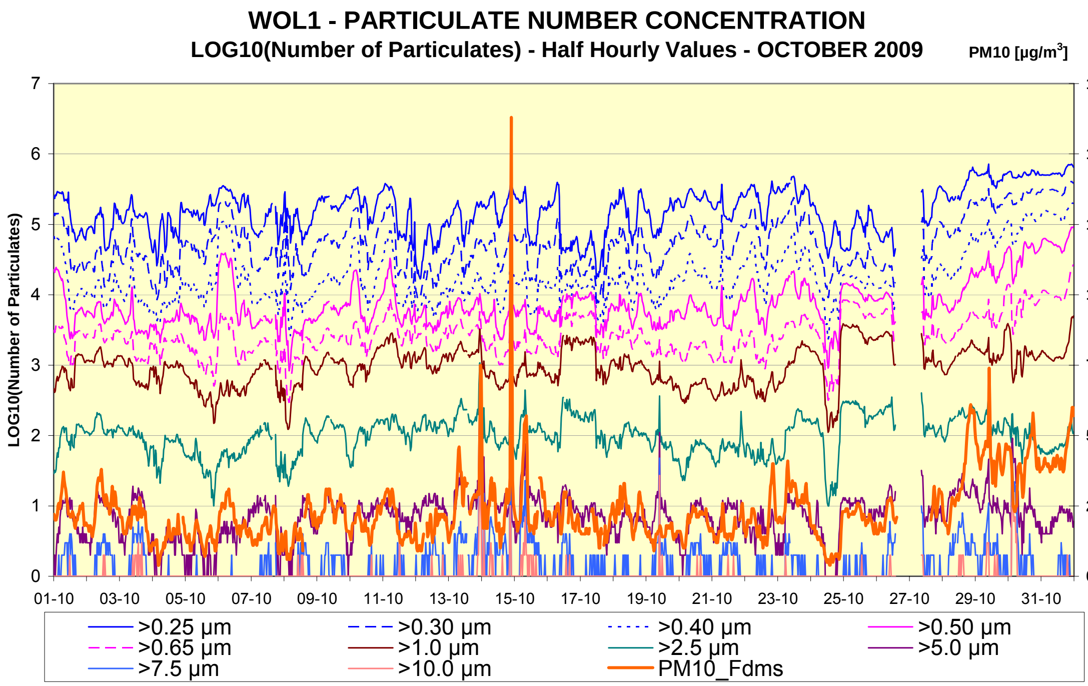

Fig. 40: Particulate Number concentration for different size classes **(>0,25 µm** till **>10 µm**) and **PM10 mass concentration** at the Woluwe site – October 2009

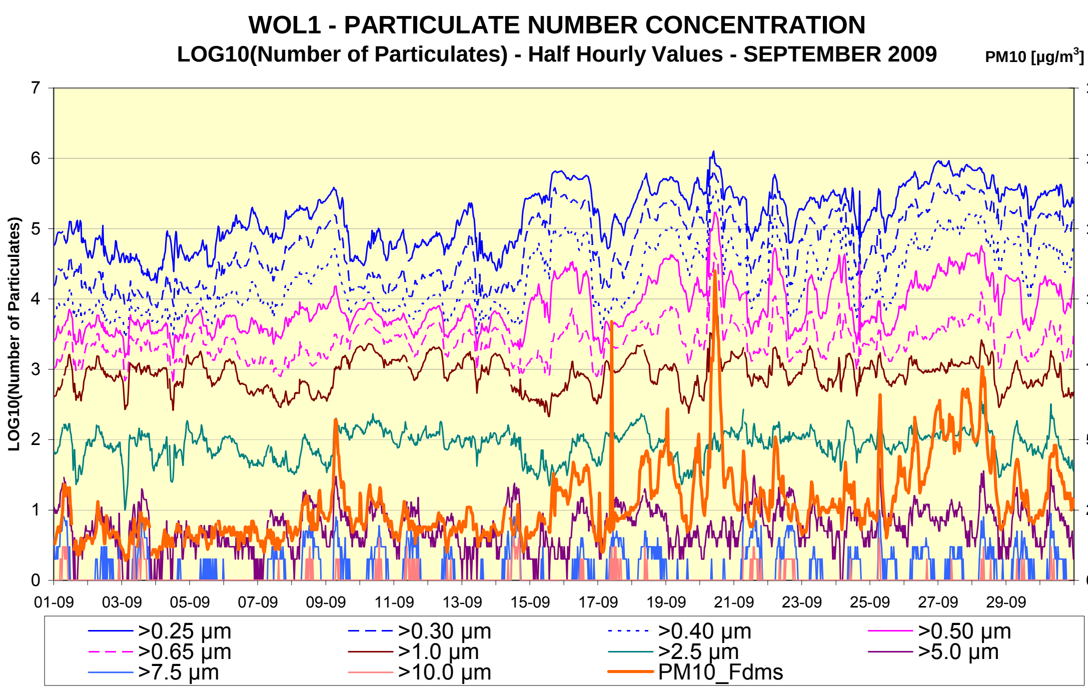

Fig. 41: Particulate Number concentration for different size classes **(>0,25 µm** till **>10 µm**) and **PM10 mass concentration** at the Woluwe site – September 2009

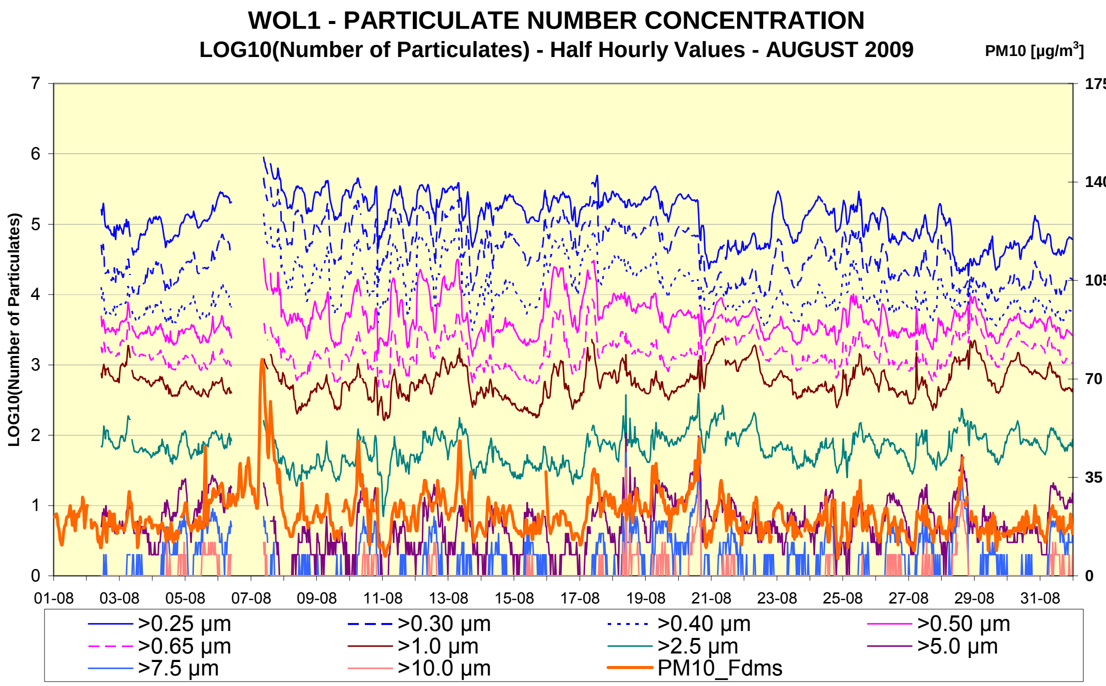

Fig. 42: Particulate Number concentration for different size classes (>0,25 µm till >10 µm) and PM10 mass concentration at the Woluwe site – August 2009

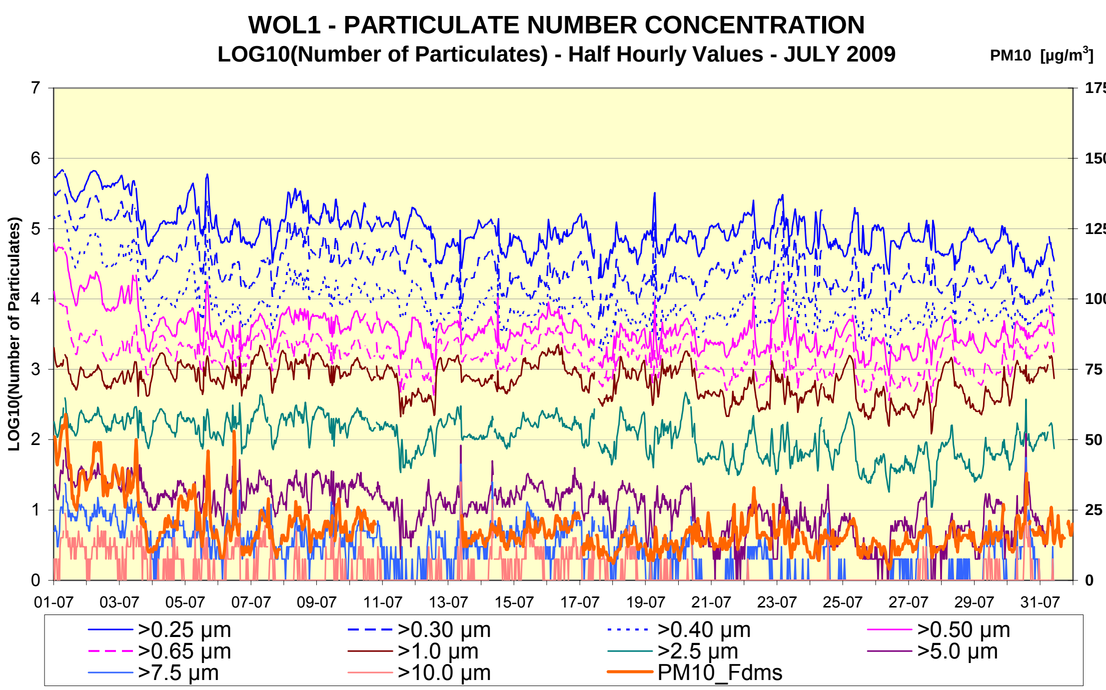

Fig. 43: Particulate Number concentration for different size classes (>0,25 µm till >10 µm) and PM10 mass concentration at the Woluwe site – July 2009

4.2 Cumulative Frequency Distribution – Particulate Number Concentration

For the one year period ‘July 2009 – June 2010’ the average number concentrations of the half hourly data for some particular size classes are given in the tables XVIII and XIX. The selected size classes respectively are:

For table XVIII – particulates greater than a specific diameter:

>0,25 µm	>0,28 µm	>0,30 µm	>0,35 µm
>0,40 µm	>0,45 µm	>0,50 µm	>0,65 µm
>1,00 µm	>1,60 µm		

For table XIX – particulates comprised between specific diameters:

0,25-0,28 µm	0,28-0,30 µm	0,30-0,35 µm	0,35-0,40 µm
0,40-0,45 µm	0,45-0,50 µm	0,50-0,65 µm	0,65-1,00 µm
1,00-1,60 µm	1,60-2,50		

The ratios between the average number concentration of the subsequent selected size ranges are computed and presented in the third column.

Table XVIII – Average Number Concentration for different size ranges and ratios between the values of subsequent classes

Half Hourly Values
Period: July 2009 – June 2010

Size Fraction	Number of Particulates per Litre Air	Ratio
>0,25 µm	257.700	
		1,5858
>0,28 µm	162.500	
		1,4976
>0,30 µm	108.510	
		1,6638
>0,35 µm	65.220	
		1,7383
>0,40 µm	37.520	
		1,7227
>0,45 µm	21.780	
		1,6651
>0,50 µm	13.080	
		3,9162
>0,65 µm	3.340	
		3,3300
>1,00 µm	1.003	
		2,3111
>1,60 µm	434	

Table XIX – Average Number Concentration for different size ranges
and ratios between the values of subsequent classes

Half Hourly Values
Period: July 2009 – June 2010

Size Fraction	Number of Particulates per Litre Air	Ratio
0,25 – 0,28 µm	95.110	
		1,7603
0,28 – 0,30 µm	54.030	
		2,2481
0,30 – 0,35 µm	43.290	
		1,5628
0,35 – 0,40 µm	27.700	
		1,7598
0,40 – 0,45 µm	15.740	
		1,8071
0,45 – 0,50 µm	8.710	
		0,8943
0,50 – 0,65 µm	9.740	
		4,1624
0,65 – 1,00 µm	2.340	
		4,1125
1,00 – 1,60 µm	569	
		1,7401
1,60 – 2,50 µm	327	

For the same year period, the cumulative frequency distributions for the half hourly values are given in tables XX and XXI and for the daily values in tables XXII and XXIII.

The tables XX and XXII represent the computed statistical data for the following size classes (*particulates greater than a specific diameter):*

>0,25 µm	>0,28 µm	>0,30 µm	>0,35 µm	>0,40 µm
>0,45 µm	>0,50 µm	>0,65 µm	>1,00 µm	>1,60 µm
>2,50 µm	>10 µm	0,25-1 µm	0,25-2,5 µm	0,25-10 µm

and tables XXI and XXIII for the size ranges (*particulates comprised between specific diameters*):

0,25-0,28 µm	0,28-0,30 µm	0,30-0,35 µm	0,35-0,40 µm
0,40-0,45 µm	0,45-0,50 µm	0,50-0,65 µm	0,65-1,00 µm
1,00-1,60 µm	1,60-2,50 µm	2,50-10 µm	

Table XX – Cumulative Frequency Distribution – Particulate Number Concentration
Half Hourly Values – Period: July 2009 – June 2010
Number of Particulates per Litre Air

>0,25 µm ; >0,28 µm ; >0,30 µm ; >0,35 µm ; >0,40 µm ; >0,45 µm ; >0,50 µm ; >0,65 µm
>1 µm ; >1,60 µm ; >2,50 µm ; >10 µm ; [0,25-1 µm] ; [0,25-2,5 µm] ; [0,25-10 µm]

CUMULATIVE FREQUENCY DISTRIBUTION - PARTICULATE NUMBER CONCENTRATION
Number Particulates per Liter Air
JULY 2009 - JUNE 2010 : : : ALL HALF HOURLY PERIODS : : : 17.520 Data

Site	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1
Symb	>0,25 µm	>0,28 µm	>0,30 µm	>0,35 µm	>0,40 µm	>0,45 µm	>0,50 µm	>0,65 µm	>1,00 µm	>1,60 µm	>2,50 µm	>10 µm	0,25-1 µm	0,25-2,5 µm	0,25-10 µm
Min	7.700	4.400	3.160	2.030	1.260	860	640	250	91	34	3	0	7.500	7.600	7.700
P-10	52.500	26.500	16.180	9.470	5.870	3.850	2.720	970	345	150	33	0	51.600	52.400	52.500
P-20	78.500	38.800	22.710	12.770	7.660	5.060	3.510	1.290	455	199	46	0	77.600	78.400	78.500
P-30	111.400	57.200	32.280	17.210	9.830	6.230	4.290	1.570	567	248	59	0	110.600	111.300	111.400
P-40	151.100	80.600	46.670	23.900	12.860	7.710	5.160	1.880	682	302	73	0	150.300	150.900	151.100
P-50	199.000	111.200	65.210	33.140	16.930	9.900	6.380	2.250	802	361	88	0	198.300	198.900	199.000
P-60	254.300	149.500	90.970	47.630	23.810	13.070	8.190	2.700	946	431	106	1	253.500	254.200	254.300
P-70	322.000	200.000	128.450	71.260	36.270	18.880	10.870	3.280	1.121	510	127	1	321.100	321.900	322.000
P-80	410.800	266.800	179.690	105.210	57.880	31.050	17.030	4.180	1.376	622	159	1	409.900	410.700	410.800
P-90	548.600	374.800	260.630	164.520	96.150	54.020	30.390	5.840	1.848	814	204	2	547.100	548.500	548.600
P-95	651.000	461.400	335.200	220.600	135.200	80.180	47.200	8.860	2.314	981	249	4	649.400	650.900	651.000
P-98	782.200	569.600	425.590	296.850	198.440	124.320	75.350	16.350	3.136	1.207	309	6	778.400	782.100	782.200
P-99	907.200	666.000	516.130	364.050	252.530	164.240	101.700	23.610	3.956	1.391	350	9	906.100	907.100	907.200
P-99.5	1.205.700	859.800	651.120	455.480	313.040	202.090	124.950	30.550	4.967	1.611	408	12	1.204.100	1.205.600	1.205.700
P-99.9	1.711.000	1.254.200	908.920	612.810	394.720	257.690	170.210	43.080	8.461	2.367	635	29	1.707.700	1.710.800	1.711.000
Max	1.900.200	1.340.900	999.990	701.850	456.440	296.100	186.880	73.210	22.437	6.429	1.590	115	1.897.500	1.899.800	1.900.200
AM	257.700	162.500	108.510	65.220	37.520	21.780	13.080	3.340	1.003	434	107	1	256.700	257.600	257.700
ASD	214.000	155.600	115.910	78.770	50.180	31.100	18.970	4.210	865	307	77	3	213.700	214.000	214.000
GM	182.200	104.300	65.020	36.600	20.480	12.110	7.690	2.380	801	353	85		180.800	182.100	182.200
GSD	2,41	2,69	2,84	2,94	2,89	2,75	2,56	2,12	1,92	1,91	2,04		2,43	2,41	2,41
Nval	17.030	17.030	17.030	17.030	17.030	17.030	17.030	17.030	17.030	17.030	17.030	17.030	17.030	17.030	17.030
Nval%	97,2	97,2	97,2	97,2	97,2	97,2	97,2	97,2	97,2	97,2	97,2	97,2	97,2	97,2	97,2

Table XXI – Cumulative Frequency Distribution – Particulate Number Concentration
Half Hourly Values – Period: July 2009 – June 2010
Number of Particulates per Litre Air

[0,25-0,28 µm] ; [0,28-0,30 µm] ; [0,30-0,35 µm] ; [0,35-0,40 µm] ; [0,40-0,45 µm]
[0,45-0,50 µm] ; [0,50-0,65 µm] ; [0,65-1 µm] ; [1-1,6 µm] ; [1,6-2,5 µm] ; [2,5-10 µm]

CUMULATIVE FREQUENCY DISTRIBUTION - PARTICULATE NUMBER CONCENTRATION
Number Particulates per Liter Air
JULY 2009 - JUNE 2010 : : : ALL HALF HOURLY PERIODS : : : 17.520 Data

Site	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1
Symb	0,25-0,28 µm	0,28-0,30 µm	0,30-0,35 µm	0,35-0,40 µm	0,40-0,45 µm	0,45-0,50 µm	0,50-0,65 µm	0,65-1,00 µm	1,00-1,60 µm	1,60-2,50 µm	2,50-10 µm
Min	3.140	1.300	1.000	610	360	190	380	130	44	29	3
P-10	26.350	10.000	6.140	3.170	1.660	950	1.500	580	182	112	33
P-20	39.160	16.280	9.950	4.760	2.330	1.260	1.950	760	244	148	46
P-30	52.540	24.390	15.630	7.400	3.370	1.730	2.410	920	301	182	59
P-40	67.750	33.310	22.620	11.360	5.060	2.410	3.000	1.110	362	223	73
P-50	83.400	44.460	31.310	16.390	7.490	3.500	3.890	1.330	431	266	88
P-60	99.860	56.040	42.380	23.660	11.200	5.200	5.230	1.630	507	317	105
P-70	118.280	69.350	55.790	33.990	17.470	8.300	7.950	2.060	603	383	126
P-80	142.660	87.190	73.060	47.470	26.510	13.820	13.680	2.720	753	471	157
P-90	176.960	111.470	97.700	68.660	41.570	23.480	24.940	4.420	1.039	621	203
P-95	204.920	130.830	116.820	86.480	55.970	33.360	38.250	7.400	1.325	757	247
P-98	250.080	155.970	140.470	108.780	74.420	48.440	59.760	13.690	2.086	930	306
P-99	292.070	179.600	166.610	123.510	90.340	61.570	79.960	19.950	2.868	1.093	345
P-99.5	371.240	218.350	207.330	162.600	107.190	74.940	97.310	26.330	3.858	1.270	403
P-99.9	491.040	343.600	319.350	234.700	148.700	96.510	128.110	34.420	6.550	2.008	602
Max	999.990	366.620	344.200	264.640	167.460	113.350	146.180	50.770	16.008	5.872	1.528
AM	95.110	54.030	43.290	27.700	15.740	8.710	9.740	2.340	569	327	106
ASD	66.760	42.700	39.540	29.940	19.750	12.500	15.150	3.530	609	247	76
GM	74.510	37.980	27.450	15.460	7.910	4.100	4.960	1.490	435	264	84
GSD	2,11	2,50	2,82	3,16	3,34	3,37	2,93	2,31	2,00	1,93	2,04
Nval	17.030	17.030	17.030	17.030	17.030	17.030	17.030	17.030	17.030	17.030	17.030
Nval%	97,2	97,2	97,2	97,2	97,2	97,2	97,2	97,2	97,2	97,2	97,2

Table XXII – Cumulative Frequency Distribution – Particulate Number Concentration
Daily Values – Period: July 2009 – June 2010
Number of Particulates per Litre Air

>0,25 µm ; >0,28 µm ; >0,30 µm ; >0,35 µm ; >0,40 µm ; >0,45 µm ; >0,50 µm ; >0,65 µm
>1 µm ; >1,60 µm ; >2,50 µm ; >10 µm ; [0,25-1 µm] ; [0,25-2,5 µm] ; [0,25-10 µm]

CUMULATIVE FREQUENCY DISTRIBUTION - PARTICULATE NUMBER CONCENTRATION
Number Particulates per Liter Air
JULY 2009 - JUNE 2010 : : : ALL DAILY VALUES : : : 365 Data

Site	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1
Symb	>0,25 µm	>0,28 µm	>0,30 µm	>0,35 µm	>0,40 µm	>0,45 µm	>0,50 µm	>0,65 µm	>1,00 µm	>1,60 µm	>2,50 µm	>10 µm	0,25-1 µm	0,25-2,5 µm	0,25-10 µm
Min	30.800	15.900	10.950	7.720	4.530	2.740	1.900	770	256	108	20	0	29.900	30.700	30.800
P-10	69.400	33.500	19.530	11.030	7.020	4.740	3.410	1.240	440	192	46	0	69.000	69.300	69.400
P-20	93.500	48.500	28.140	15.410	9.000	5.780	4.270	1.590	569	243	58	0	92.100	93.300	93.500
P-30	129.900	69.300	40.310	20.680	11.970	7.510	4.890	1.850	666	298	71	0	129.300	129.800	129.900
P-40	167.900	96.800	59.630	30.550	15.820	9.060	5.850	2.140	777	345	81	0	167.300	167.800	167.900
P-50	214.700	124.900	78.440	42.580	22.020	12.160	7.420	2.480	870	386	95	1	212.800	214.400	214.700
P-60	256.100	155.700	98.480	53.260	28.390	15.300	9.050	2.800	996	445	111	1	255.100	255.900	256.100
P-70	309.600	197.900	130.550	72.910	39.090	21.150	12.260	3.300	1.117	510	127	1	307.600	309.400	309.600
P-80	388.000	259.200	174.390	104.800	59.140	31.900	17.770	3.930	1.316	601	152	2	387.400	388.000	388.000
P-90	519.800	344.900	238.920	146.190	86.440	47.740	26.100	5.670	1.626	726	188	2	519.200	519.800	519.800
P-95	608.800	396.400	285.440	193.400	121.900	71.460	39.850	7.960	1.929	822	211	3	608.100	608.700	608.800
P-98	716.400	506.800	397.950	278.740	184.350	111.000	64.190	12.770	2.316	925	247	4	715.600	716.300	716.400
P-99	790.400	568.100	409.990	304.690	217.820	136.260	78.770	16.000	3.114	1.073	266	6	788.400	790.300	790.400
P-99.5	1.024.900	798.900	599.130	385.990	234.390	161.610	109.060	28.520	4.499	1.246	284	6	1.020.400	1.024.800	1.024.900
P-99.9	1.356.000	1.011.700	752.340	506.070	331.980	221.230	141.650	31.650	6.544	1.648	317	9	1.352.400	1.355.800	1.356.000
Max	1.356.000	1.011.700	752.340	506.070	331.980	221.230	141.650	31.650	6.544	1.648	317	9	1.352.400	1.355.800	1.356.000
AM	257.400	162.500	108.670	65.420	37.700	21.910	13.160	3.350	1.004	434	107	1	256.400	257.300	257.400
ASD	188.800	138.300	103.170	70.080	44.640	27.670	16.810	3.580	643	220	55	1	188.600	188.800	188.800
GM	198.100	115.400	72.760	41.430	23.290	13.730	8.640	2.620	874	384	94	0	196.800	198.000	198.100
GSD	2,12	2,37	2,52	2,62	2,60	2,47	2,30	1,87	1,67	1,64	1,70		2,13	2,12	2,12
Nval	351	351	351	351	351	351	351	351	351	351	351	351	351	351	351
Nval%	96,1	96,1	96,1	96,1	96,1	96,1	96,1	96,1	96,1	96,1	96,1	96,1	96,1	96,1	96,1

Table XXIII – Cumulative Frequency Distribution – Particulate Number Concentration
Daily Values – Period: July 2009 – June 2010
Number of Particulates per Litre Air

[0,25-0,28 µm] ; [0,28-0,30 µm] ; [0,30-0,35 µm] ; [0,35-0,40 µm] ; [0,40-0,45 µm]
[0,45-0,50 µm] ; [0,50-0,65 µm] ; [0,65-1 µm] ; [1-1,6 µm] ; [1,6-2,5 µm] ; [2,5-10 µm]

CUMULATIVE FREQUENCY DISTRIBUTION - PARTICULATE NUMBER CONCENTRATION
Number Particulates per Liter Air
JULY 2009 - JUNE 2010 : : : ALL DAILY VALUES : : : 365 Data

Site	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1	41WOL1
Symb	0,25-0,28 µm	0,28-0,30 µm	0,30-0,35 µm	0,35-0,40 µm	0,40-0,45 µm	0,45-0,50 µm	0,50-0,65 µm	0,65-1,00 µm	1,00-1,60 µm	1,60-2,50 µm	2,50-10 µm
Min	14.940	4.950	3.180	1.890	1.220	770	1.110	440	131	82	20
P-10	33.690	14.170	8.470	4.100	1.950	1.120	1.810	750	233	145	46
P-20	46.150	20.040	12.930	6.330	3.040	1.570	2.310	920	307	182	58
P-30	59.360	28.910	19.120	9.390	4.390	2.210	2.910	1.090	361	220	71
P-40	70.520	37.810	27.350	14.660	6.720	3.270	3.530	1.280	415	251	80
P-50	87.730	46.570	34.450	20.250	10.260	4.740	4.890	1.530	471	291	94
P-60	100.950	55.540	43.420	25.790	12.790	6.340	6.190	1.770	536	338	110
P-70	114.450	66.180	55.080	33.360	18.400	9.120	9.680	2.070	605	383	126
P-80	134.400	85.100	67.050	45.250	25.820	14.280	14.130	2.760	711	450	151
P-90	161.210	103.560	92.580	63.110	36.180	20.620	21.510	4.310	935	547	186
P-95	185.590	119.460	104.790	76.740	48.780	29.000	33.110	6.660	1.096	636	210
P-98	227.880	136.860	119.610	97.090	69.590	47.080	52.730	11.300	1.565	739	245
P-99	259.690	156.500	137.140	103.220	72.770	52.560	66.000	13.180	2.307	805	265
P-99.5	308.860	170.150	162.790	144.470	94.610	57.480	78.200	23.060	3.635	1.052	280
P-99.9	527.500	258.850	246.800	190.570	121.490	79.580	110.000	27.150	4.896	1.429	314
Max	527.500	258.850	246.800	190.570	121.490	79.580	110.000	27.150	4.896	1.429	314
AM	94.840	53.890	43.250	27.730	15.790	8.750	9.810	2.350	570	327	106
ASD	57.150	37.100	34.740	26.380	17.420	11.090	13.480	3.070	469	174	55
GM	79.880	41.740	30.720	17.700	9.210	4.810	5.690	1.660	478	288	93
GSD	1,83	2,14	2,43	2,74	2,93	2,99	2,65	2,06	1,73	1,66	1,70
Nval	351	351	351	351	351	351	351	351	351	351	351
Nval%	96,1	96,1	96,1	96,1	96,1	96,1	96,1	96,1	96,1	96,1	96,1

4.3 Regression Line(s) – Number concentration for Different Size Classes

Regression lines (through the origin) between the number concentration data sets of different size classes are computed for the one year period 'July 2009 – June 2010'. Results are computed for the half hourly values as well as for the daily average values.

The results for the size classes greater than a defined diameter are given in tables XXIV and XXV, respectively for the half hourly and the daily average data.

For the bigger size ranges (>0,65 µm) the data set seems to split up into two different populations, resulting in a somewhat lower correlation factor. This twofold distribution probably refers to different physical origins of the particulates within this size range. In these cases the weighing technique, proposed to minimize the contribution of the outliers, tends to a regression line in favor of the data belonging to the larger distribution and therefore the weighted orthogonal regression is replaced by a simple orthogonal regression. As an example for the smaller size ranges, the regression line between the size ranges [> 0,25 µm] and [>0,28 µm] is given in figure 44. The regression line between the bigger size ranges [> 1,00 µm] and [> 1,60 µm] is represented in figure 45.

Table XXIV – Half Hourly Values
Weighted orthogonal regression through the origin: **Y = b * X**
One year period 'July 2009 – June 2010'

Y-data set	X-data set	b	s{b}	Ndata	R_{corr}
> 0,25 µm	> 0,28 µm	**1.5501**	0.0018	17.030	0.9814
> 0,28 µm	> 0,30 µm	**1.4921**	0.0015	17.029	0.9930
> 0,30 µm	> 0,35 µm	**1.6657**	0.0022	17.029	0.9900
> 0,35 µm	> 0,40 µm	**1.7501**	0.0023	17.029	0.9900
> 0,40 µm	> 0,45 µm	**1.7534**	0.0021	17.029	0.9915
> 0,45 µm	> 0,50 µm	**1.7167**	0.0016	17.030	0.9924
> 0,50 µm	> 0,65 µm	**4.7657**	0.0146	17.030	0.9272

Orthogonal regression through the origin: **Y = b * X**

Y-data set	X-data set	b	s{b}	Ndata	R_{corr}
> 0,65 µm	> 1,00 µm	**4.4945**	0.0261	17.030	0.8225
> 1,00 µm	> 1,60 µm	**2.5781**	0.0090	17.030	0.8887
> 1,60 µm	> 2,50 µm	**4.2369**	0.0165	17.030	0.8348

Weighted Orthogonal Regression : Y = b.X

Y = 1.5501 * X

s(b) = 0.0018

Rcor = 0.9814

Half Hourly Values

Period : 01/07/2009 - 30/06/2010

41WOL1-C025 [KNb/l] vs. 41WOL1-C028 [KNb/l]

Y-ordinate : C025 : 41WOL1 (Woluwé-St-Lambert)
X-abscissa : C028 : 41WOL1 (Woluwé-St-Lambert)

(17030 data sets)
(16943 data sets whitin the area)
ALLD - ALLD
ALL-HH : yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy

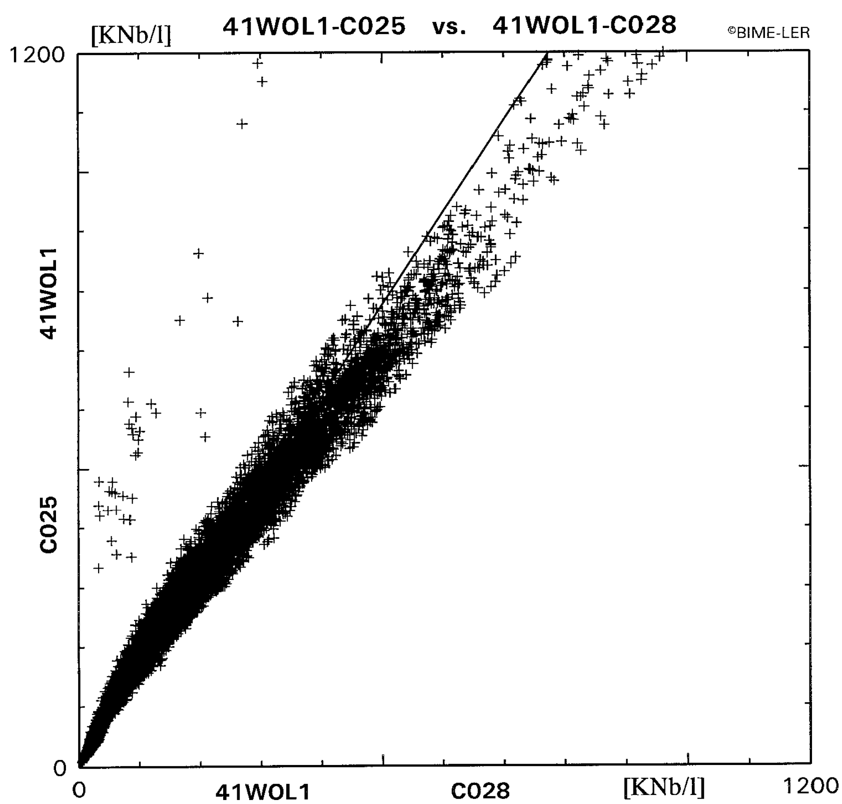

Fig. 44 : Particle size class [> 0,25 µm] versus Particle size class [> 0,28 µm]
Half Hourly Values – Weighted Orthogonal Regression: **Y= a + b.X**
One Year Period : July 2009 – June 2010

Orthogonal Regression : Y = b.X

Y = 2.5781 * X

s(b) = 0.0090

Rcor = 0.8887

Half Hourly Values

Period : 01/07/2009 - 30/06/2010

41WOL1-C100 [Nb/l] vs. 41WOL1-C160 [Nb/l]

Y-ordinate : C100 : 41WOL1 (Woluwé-St-Lambert)
X-abscissa : C160 : 41WOL1 (Woluwé-St-Lambert)

(17030 data sets)
(17015 data sets whitin the area)
ALLD - ALLD
ALL-HH : yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy

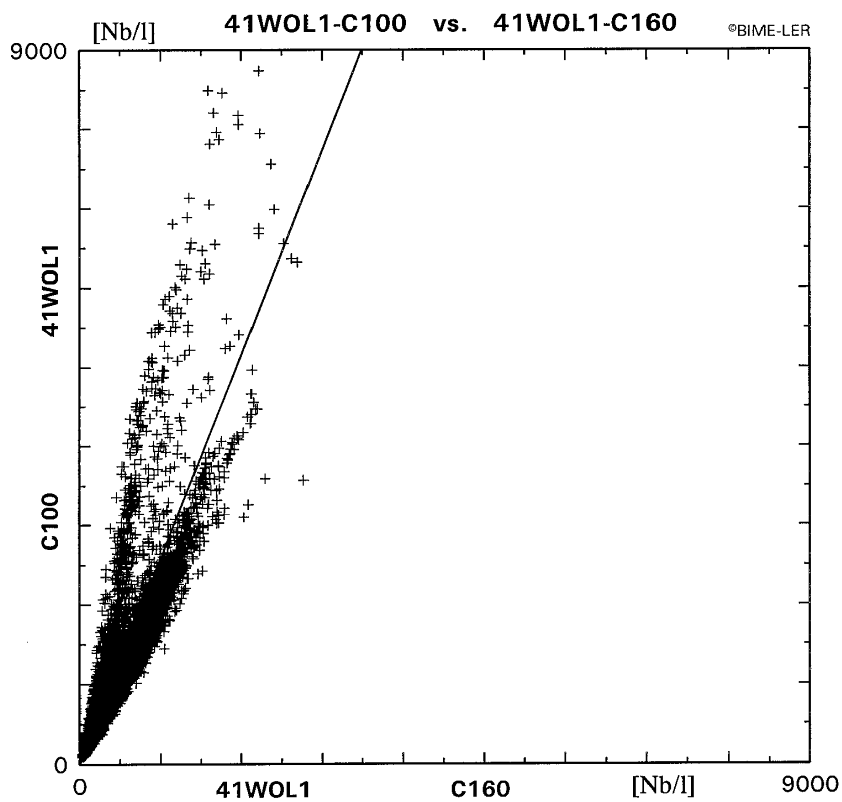

Fig. 45 : Particle size class [> 1,00 µm] versus Particle size class [> 1,60 µm]
Half Hourly Values – Orthogonal Regression: **Y= a + b.X**
One Year Period : July 2009 – June 2010

Table XXV – Daily Average Values
Weighted orthogonal regression through the origin: **Y = b * X**
One year period 'July 2009 – June 2010'

Y-data set	X-data set	b	s{b}	Ndata	R_{corr}
> 0,25 µm	> 0,28 µm	**1.5524**	0.0101	351	0.9848
> 0,28 µm	> 0,30 µm	**1.4943**	0.0083	351	0.9949
> 0,30 µm	> 0,35 µm	**1.6696**	0.0122	351	0.9923
> 0,35 µm	> 0,40 µm	**1.7586**	0.0138	351	0.9922
> 0,40 µm	> 0,45 µm	**1.7479**	0.0120	351	0.9936
> 0,45 µm	> 0,50 µm	**1.7091**	0.0091	351	0.9945
> 0,50 µm	> 0,65 µm	**4.5610**	0.0722	351	0.9452

Orthogonal regression through the origin: **Y = b * X**

Y-data set	X-data set	b	s{b}	Ndata	R_{corr}
> 0,65 µm	> 1,60 µm	**4.5141**	0.1717	351	0.8282
> 1,00 µm	> 1,60 µm	**2.5255**	0.0571	351	0.8537
> 1,60 µm	> 2,50 µm	**4.1350**	0.0758	351	0.8677

The results for the particle number concentration of specific size ranges comprised between two distinct diameters are given in tables XXVI and XXVII, respectively for the half hourly and the average daily values. The computed regression line for the particulates between 0,25 and 0,28 µm and those between 0,28 and 0,30 µm is represented in figure 46. The correlation line between the bigger size classes, [1,00 – 1,60 µm] and [1,60 – 2,50 µm], is given in figure 47.

Table XXVI – Half Hourly Values
Weighted orthogonal regression through the origin: **Y = b * X**
One year period 'July 2009 – June 2010'

Y-data set	**X-data set**	**b**	s{b}	**Ndata**	$\mathbf{R_{corr}}$
0,25 – 0,28 µm	0,28 – 0,30 µm	**1.6954**	0.0027	17.027	0.9008
0,28 – 0,30 µm	0,30 – 0,35 µm	**1.2375**	0.0016	17.029	0.9785
0,30 – 0,35 µm	0,35 – 0,40 µm	**1.5677**	0.0027	17.030	0.9756
0,35 – 0,40 µm	0,40 – 0,45 µm	**1.7626**	0.0032	17.029	0.9786
0,40 – 0,45 µm	0,45 – 0,50 µm	**1.8238**	0.0030	17.029	0.9848
0,45 – 0,50 µm	0,50 – 0,65 µm	**0.9177**	0.0016	17.030	0.9737
0,50 – 0,65 µm	0,65 – 1,00 µm	**4.9787**	0.0172	17.030	0.9257

Orthogonal regression through the origin: **Y = b * X**

Y-data set	**X-data set**	**b**	s{b}	**Ndata**	$\mathbf{R_{corr}}$
0,65 – 1,00 µm	1,00 – 1,60 µm	**5.6525**	0.0328	17.030	0.8459
1,00 –1,60 µm	1,60 – 2,50 µm	**2.1721**	0.0118	17.030	0.8088
1,60 – 2,50 µm	2,50 – 10 µm	**3.3982**	0.0179	17.030	0.7354

Table XXVII – Daily Average Values
Weighted orthogonal regression through the origin: **Y = b * X**
One year period 'July 2009 – June 2010'

Y-data set	X-data set	b	s{b}	Ndata	R_{corr}
0,25 – 0,28 µm	0,28 – 0,30 µm	**1.6911**	0.0155	351	0.9032
0,28 – 0,30 µm	0,30 – 0,35 µm	**1.2370**	0.0088	351	0.9863
0,30 – 0,35 µm	0,35 – 0,40 µm	**1.5674**	0.0142	351	0.9830
0,35 – 0,40 µm	0,40 – 0,45 µm	**1.7648**	0.0173	351	0.9840
0,40 – 0,45 µm	0,45 – 0,50 µm	**1.8285**	0.0173	351	0.9883
0,45 – 0,50 µm	0,50 – 0,65 µm	**0.9173**	0.0101	351	0.9815
0,50 – 0,65 µm	0,65 – 1,00 µm	**4.8301**	0.0960	351	0.9453

Orthogonal regression through the origin: **Y = b * X**

Y-data set	X-data set	b	s{b}	Ndata	R_{corr}
0,65 – 1,00 µm	1,00 – 1,60 µm	**5.7072**	0.2037	351	0.8760
1,00 –1,60 µm	1,60 – 2,50 µm	**2.1180**	0.0768	351	0.7552
1,60 – 2,50 µm	2,50 – 10 µm	**3.2227**	0.0789	351	0.7834

Weighted Orthogonal Regression : Y = b.X

Y = 1.6954 * X

s(b) = 0.0027

Rcor = 0.9008

Half Hourly Values

Period : 01/07/2009 - 30/06/2010

41WOL1-2528 [KNb/l] vs. 41WOL1-2830 [KNb/l]

Y-ordinate : 2528 : 41WOL1 (Woluwé-St-Lambert)
X-abscissa : 2830 : 41WOL1 (Woluwé-St-Lambert)

(17027 data sets)
(16959 data sets whitin the area)
ALLD - ALLD
ALL-HH : yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy

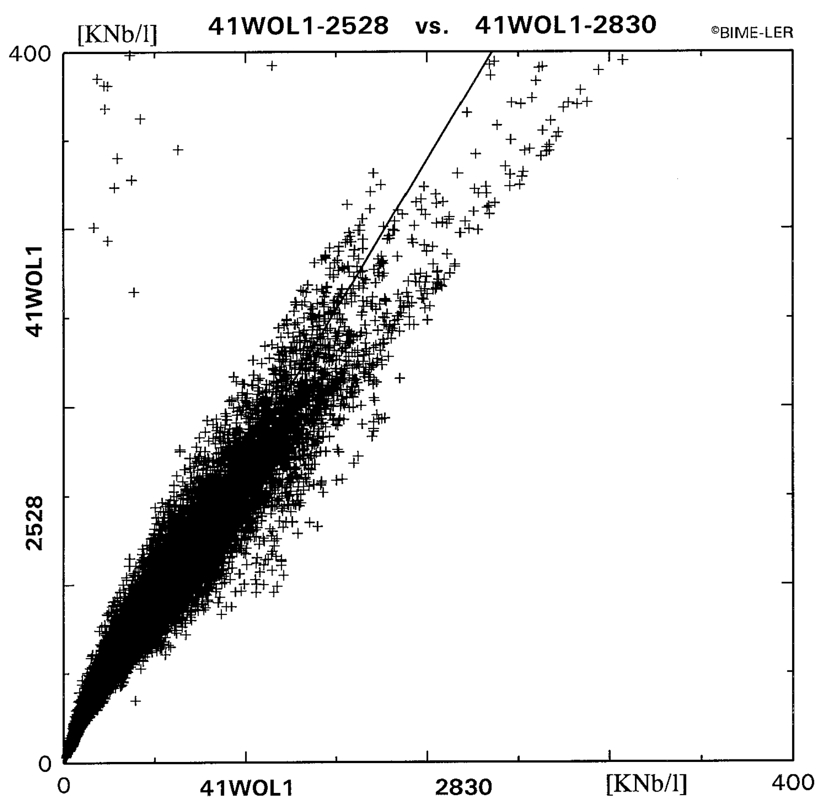

Fig. 46 : Particle size class [0,25-0,28 µm] versus Particle size class [0,28-0,30 µm]
Half Hourly Values – Orthogonal Regression: **Y= a + b.X**
One Year Period : July 2009 – June 2010

Orthogonal Regression : Y = b.X

Y = 2.1721 * X

s(b) = 0.0118

Rcor = 0.8088

Half Hourly Values

Period : 01/07/2009 - 30/06/2010

41WOL1-0116 [Nb/l] vs. 41WOL1-1625 [Nb/l]

Y-ordinate : 0116 : 41WOL1 (Woluwé-St-Lambert)
X-abscissa : 1625 : 41WOL1 (Woluwé-St-Lambert)

(17030 data sets)
(17006 data sets whitin the area)
ALLD - ALLD
ALL-HH : yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy yyyyyyyyyyyy

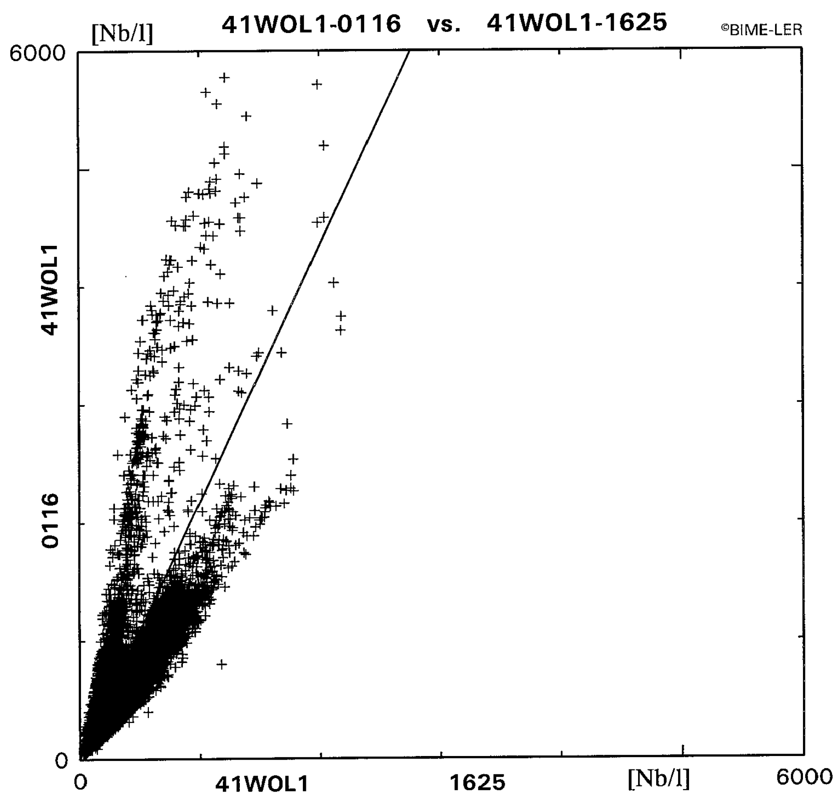

Fig. 47 : Particle size class [1,00-1,60 µm] versus Particle size class [1,60-2,50 µm]
Half Hourly Values – Orthogonal Regression: **Y= a + b.X**
One Year Period : July 2009 – June 2010

5. Particulate Number Concentration Indoor and Outdoor

During the period of ‘January – June 2010’ the particulate number concentration was also measured inside the room hosting the Calibration Bench of the Laboratory for Environmental Research. This room is equipped with an air conditioning system, regulating the temperature and the relative humidity at respectively 23°C ± 1°C and 50% RH ± 5% RH. There is no source inside the room that generates particulates.

Normally, the activity takes only place during working days and never on weekend or holidays. During one third of the working days, as primary calibration tests are running, generally 2 to 3 operators are present in the laboratory and they enter and leave the room several times per day. During another third of the working days, test sessions with transfer standards are performed and then 2 to 4 operators remain continuously in the room. During these test, eventually 2 more individuals could be entering and leaving the room several times a day. For the other working days, the human activity within the room hosting the calibration bench is reduced to a general surveillance of the systems with 2 operators entering and leaving about 4 to 6 times per day. Occasionally, some technical maintenance is also performed.

5.1 Evolution Half Hourly Concentration Values

The graph in Fig. 48 represents, for January 2010, the evolution of the half hourly values of the particulate number concentration outdoor as well as indoor. Data are given for 5 specific size ranges: [0,25-0,50 µm], [0,50-1,00 µm], [1,00-2,50 µm], [2,50-10 µm] and [>10 µm]. The data are represented on the same logarithmic scale as in figures 32 to 43. Thus a value of 6 corresponds to 1.000.000 particulates per litre air.

The figures 49 to 54 represent the evolution of the particulate number concentration for each month during the period ‘January – June 2010’. The upper graphs (Fig. 49.a – 54.a) refer to the data outside the lab and the lower graphs (Fig. 49.b – 54.b) refer to the data inside the laboratory. The data for January 2010 are represented in Fig. 49 and those for June 2010 in Fig. 54.

As can be seen from the graphs, there is a one order of magnitude difference in the particulate number concentration for the same particulate size group indoor and outdoor. This is especially visible for the size ranges [0,25-0,50 µm], [0,50-1 µm], [1-2,5 µm] and [2,5-10 µm]. Particulates of the taller size range [>10µm] are regularly present outdoor. The outdoor monitoring station is located close to the highway. When the road surface is dry, the taller size fraction is held in suspension by the air turbulences created by the traffic. Particulates of that size range are normally not present inside the lab, unless there is a source generating particulates inside, as it was the case on 10 and 24 February (Fig. 50.b) and 29 March 2010 (Fig. 51.b). At each of these occasions some new analyzers were installed in the laboratory. Some technical work was performed, like sawing wooden supports or drilling holes in metal frames and this activity was responsible for the generation of particles belonging to the coarser fraction.

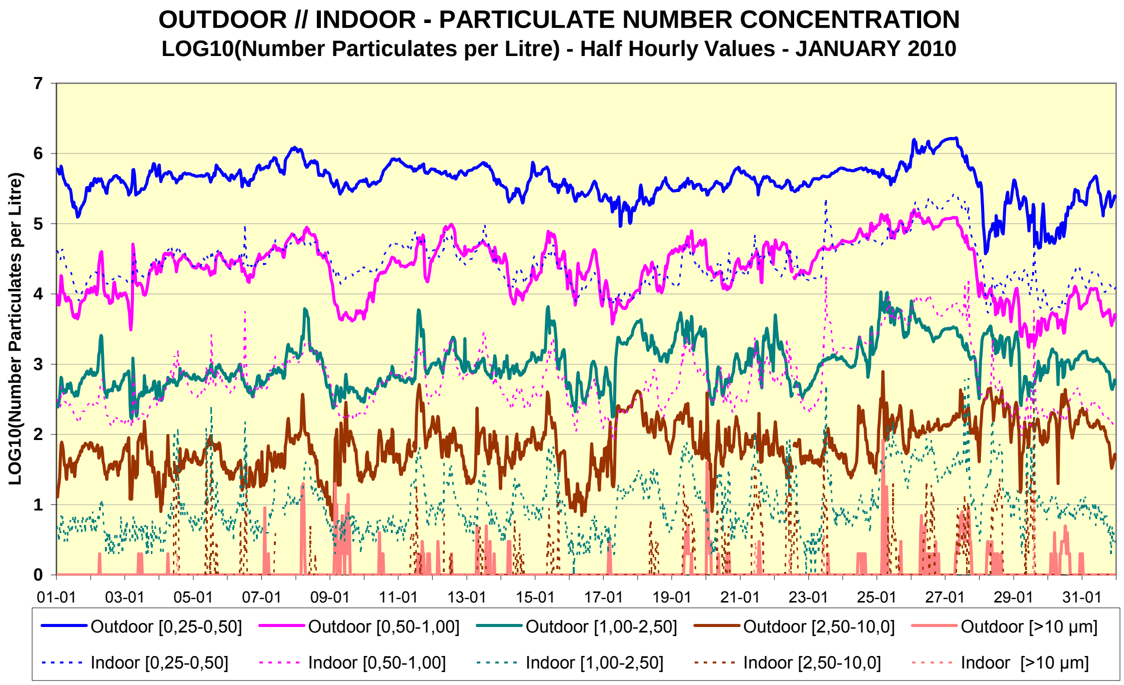

Fig. 48: Woluwe – Particulate Number Concentration Outdoor and Indoor – different size classes **[0,25-0,50 µm]** ; **[0,50-1,00 µm]** ; **[1,00-2,50 µm]** ; **[2,50-10 µm]** and **[>10 µm]** – January 2010

Special attention is to be given to the size fraction [2,5-10 µm]. Inside the laboratory particulates of that size range are only observed on working days and, besides one or two exceptions, never on weekend or holidays. The presence of operators inside the laboratory is apparently sufficient but also necessary to keep this size fraction into suspension. Since the air conditioning and ventilation system is running permanently, 24 hours per day all year long, weekend days as well as during the week, the ventilation system cannot be held responsible for the (re-)suspension of the coarser fraction of the particulates. Therefore the presence of personal inside the lab seems to be the main explanation for the observed difference.

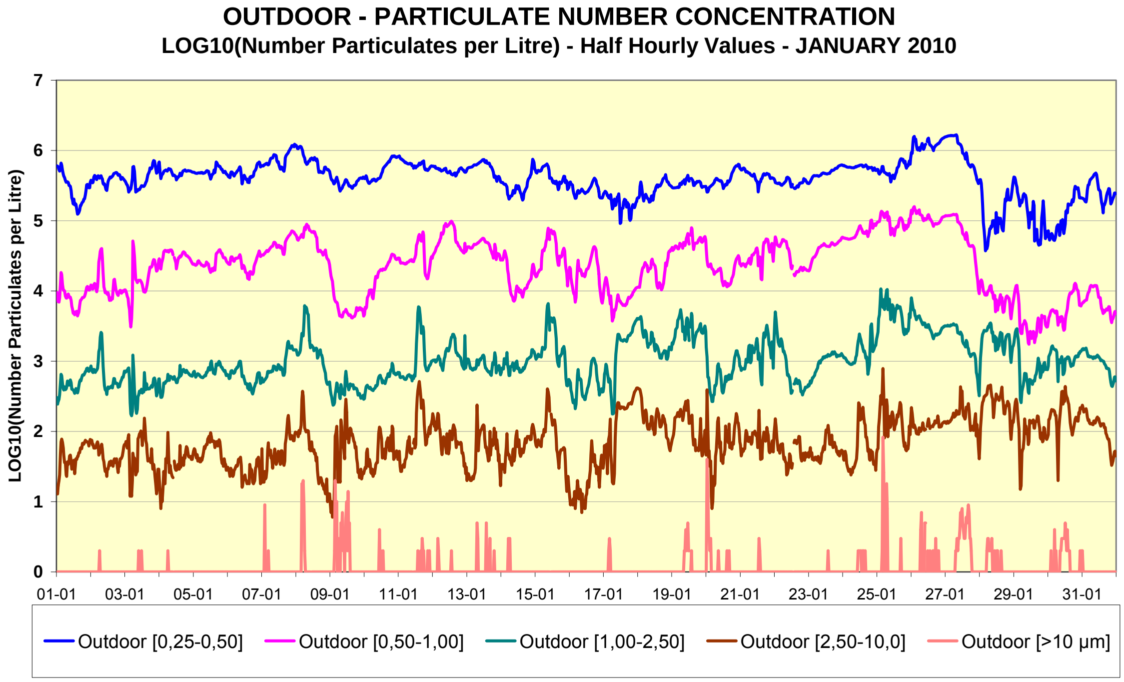

Fig. 49.a: Woluwe Outdoor – Particulate Number Concentration – different size classes **[0,25-0,50 µm]** ; **[0,50-1 µm]** ; **[1-2,5 µm]** ; **[2,5-10 µm]** and **[>10 µm] –** January 2010

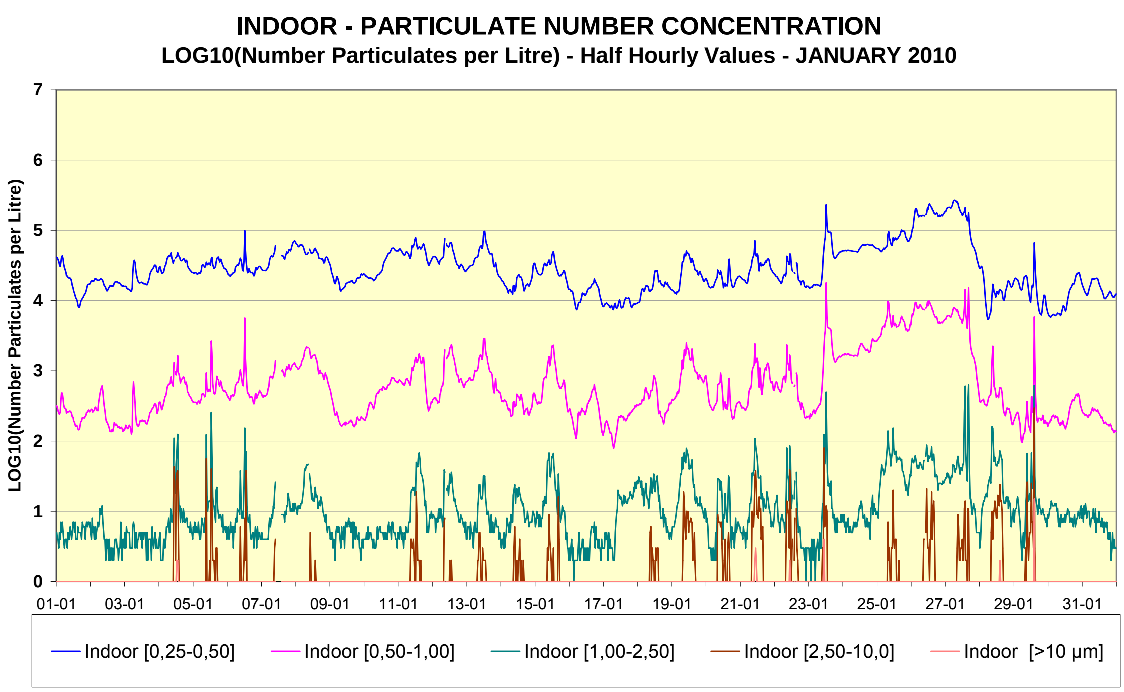

Fig. 49.b: Woluwe Indoor – Particulate Number Concentration – different size classes **[0,25-0,50 µm]** ; **[0,50-1 µm]** ; **[1-2,5 µm]** ; **[2,5-10 µm]** and **[>10 µm] –** January 2010

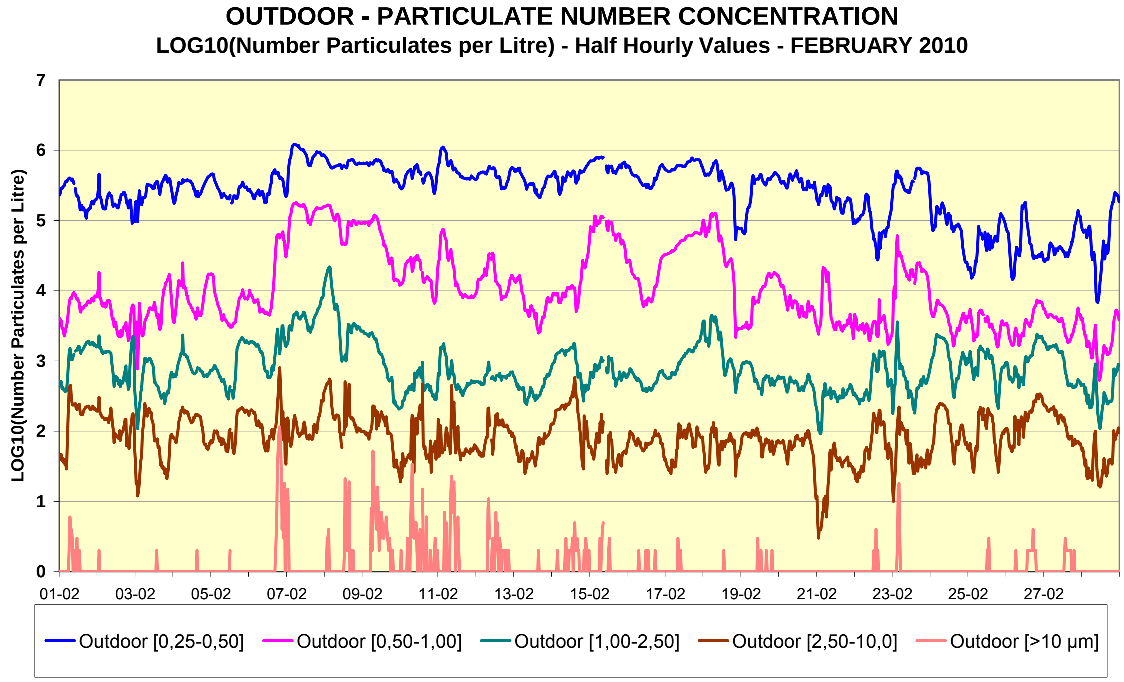

Fig. 50.a: Woluwe Outdoor – Particulate Number Concentration – different size classes **[0,25-0,50 µm]** ; **[0,50-1 µm]** ; **[1-2,5 µm]** ; **[2,5-10 µm]** and **[>10 µm] –** February 2010

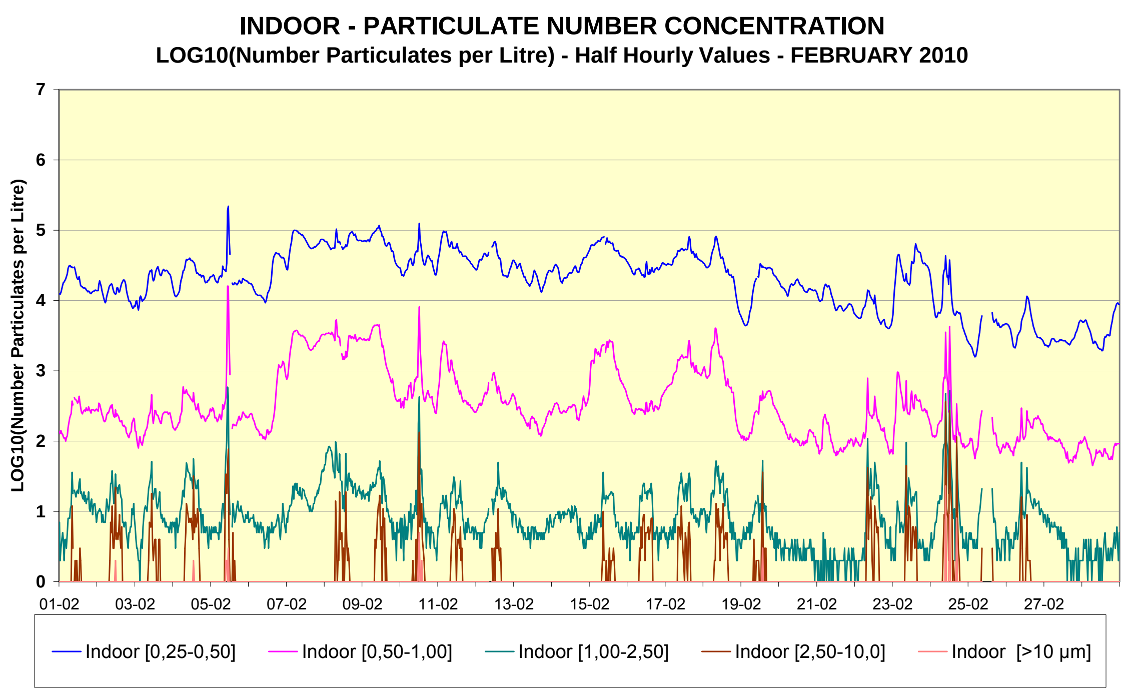

Fig. 50.b: Woluwe Indoor – Particulate Number Concentration – different size classes **[0,25-0,50 µm]** ; **[0,50-1 µm]** ; **[1-2,5 µm]** ; **[2,5-10 µm]** and **[>10 µm] –** February 2010

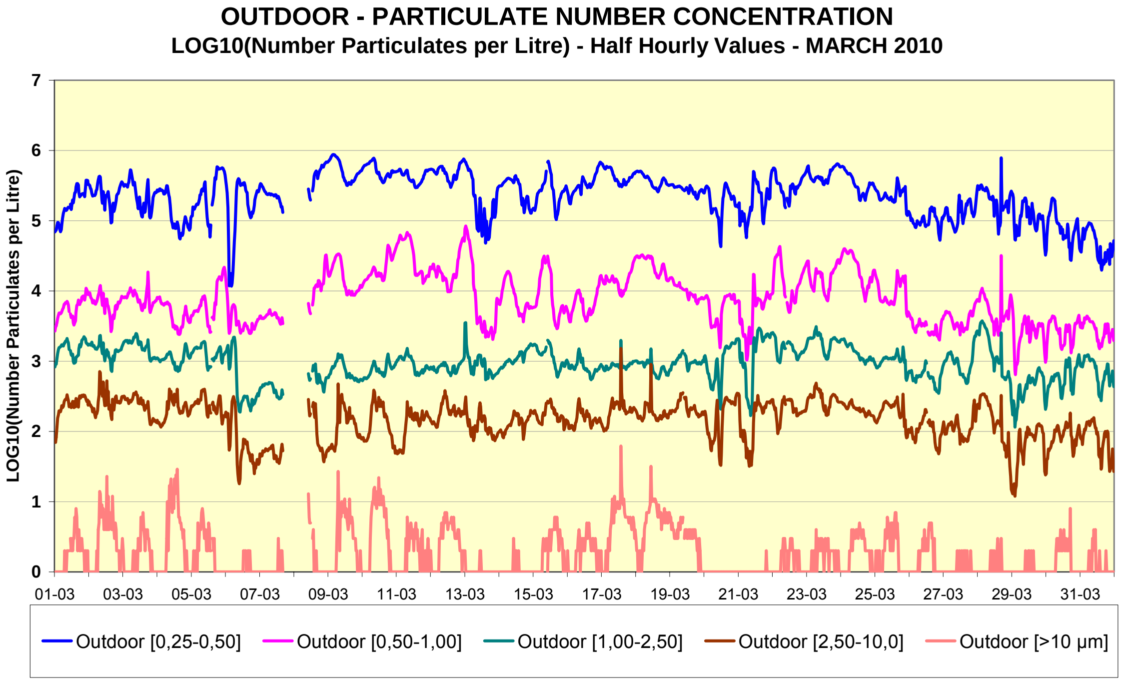

Fig. 51.a: Woluwe Outdoor – Particulate Number Concentration – different size classes
[0,25-0,50 µm] ; **[0,50-1 µm]** ; **[1-2,5 µm]** ; **[2,5-10 µm]** and **[>10 µm] –** March 2010

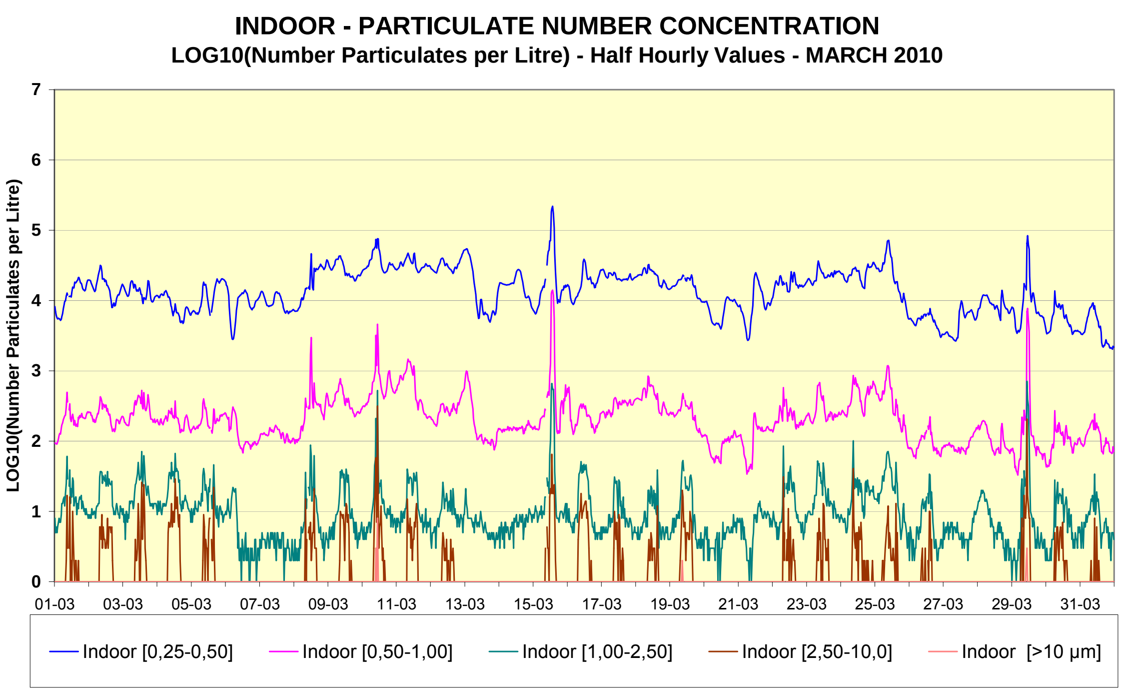

Fig. 51.b: Woluwe Indoor – Particulate Number Concentration – different size classes
[0,25-0,50 µm] ; **[0,50-1 µm]** ; **[1-2,5 µm]** ; **[2,5-10 µm]** and **[>10 µm] –** March 2010

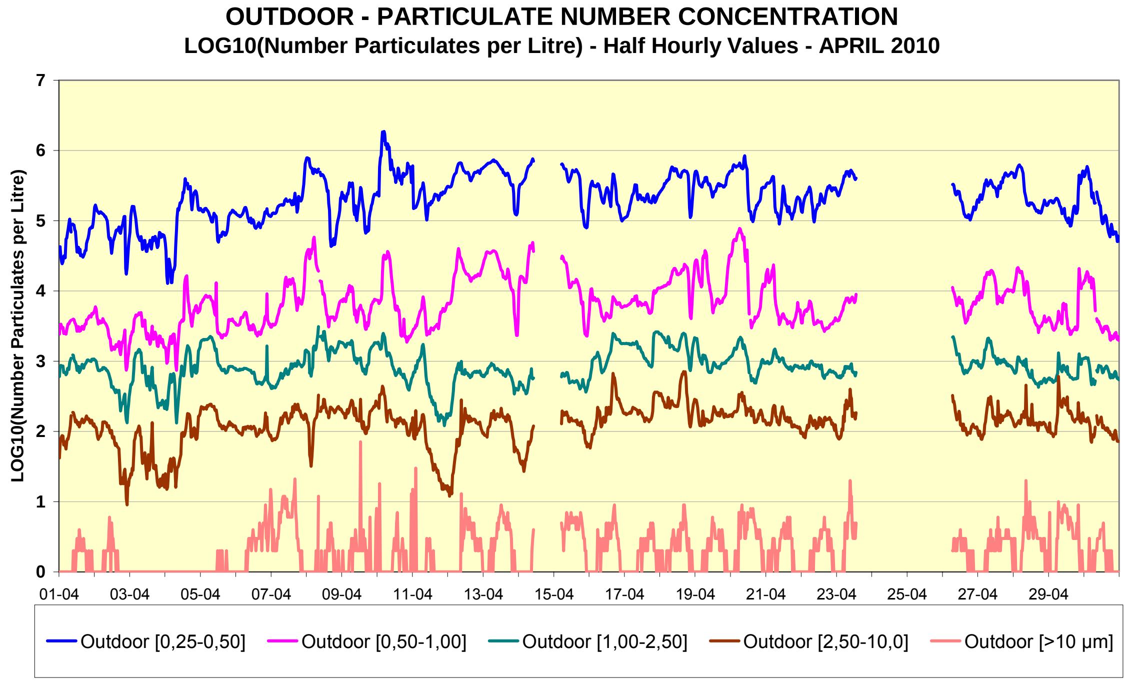

Fig. 52.a: Woluwe Outdoor – Particulate Number Concentration – different size classes
[0,25-0,50 µm] ; **[0,50-1 µm]** ; **[1-2,5 µm]** ; **[2,5-10 µm]** and **[>10 µm] –** April 2010

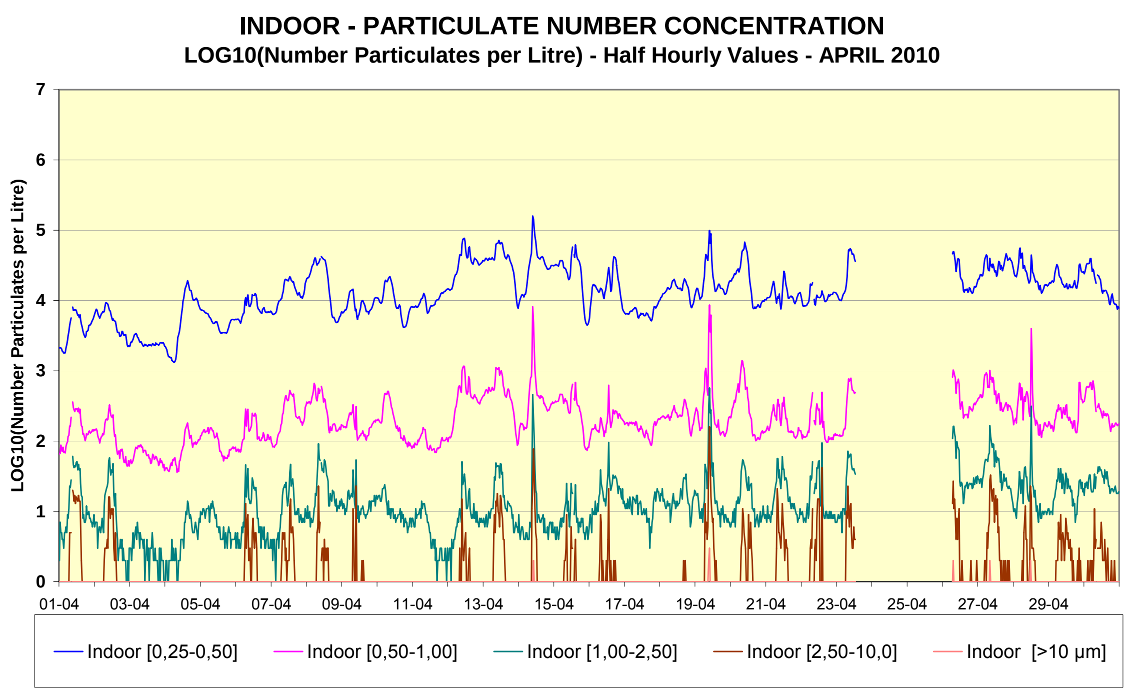

Fig. 52.b: Woluwe Indoor – Particulate Number Concentration – different size classes
[0,25-0,50 µm] ; **[0,50-1 µm]** ; **[1-2,5 µm]** ; **[2,5-10 µm]** and **[>10 µm] –** April 2010

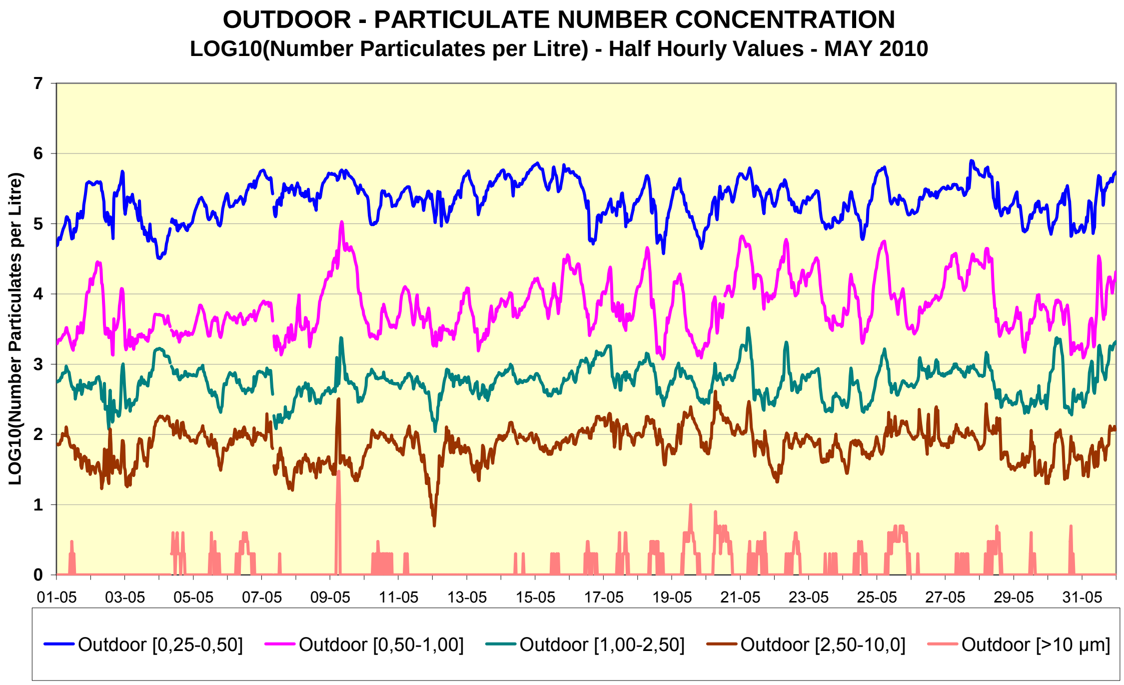

Fig. 53.a: Woluwe Outdoor – Particulate Number Concentration – different size classes
[0,25-0,50 µm] ; **[0,50-1 µm]** ; **[1-2,5 µm]** ; **[2,5-10 µm]** and **[>10 µm] –** May 2010

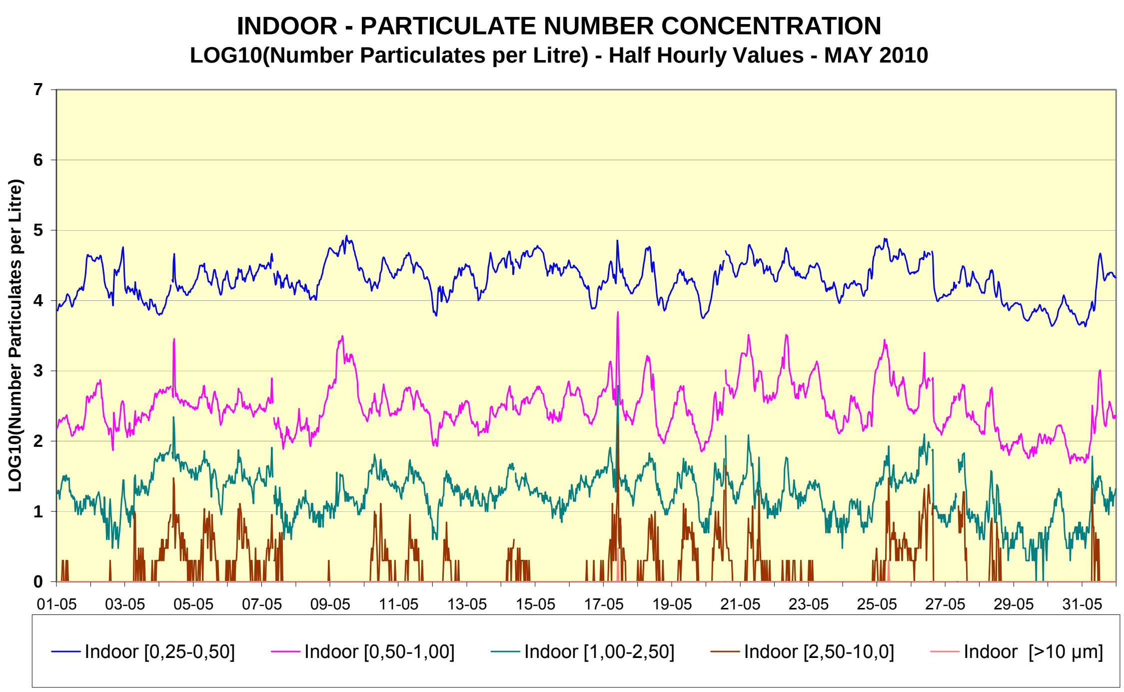

Fig. 53.b: Woluwe Indoor – Particulate Number Concentration – different size classes
[0,25-0,50 µm] ; **[0,50-1 µm]** ; **[1-2,5 µm]** ; **[2,5-10 µm]** and **[>10 µm] –** May 2010

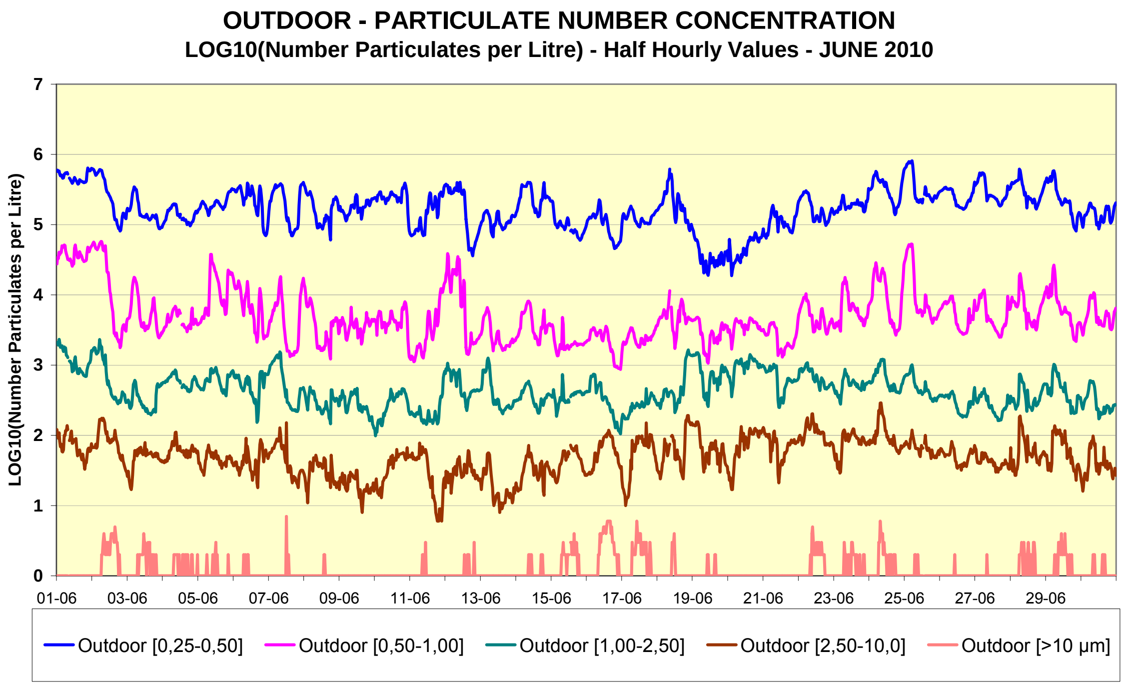

Fig. 54.a: Woluwe Outdoor – Particulate Number Concentration – different size classes
[0,25-0,50 µm] ; **[0,50-1 µm]** ; **[1-2,5 µm]** ; **[2,5-10 µm]** and **[>10 µm] –** June 2010

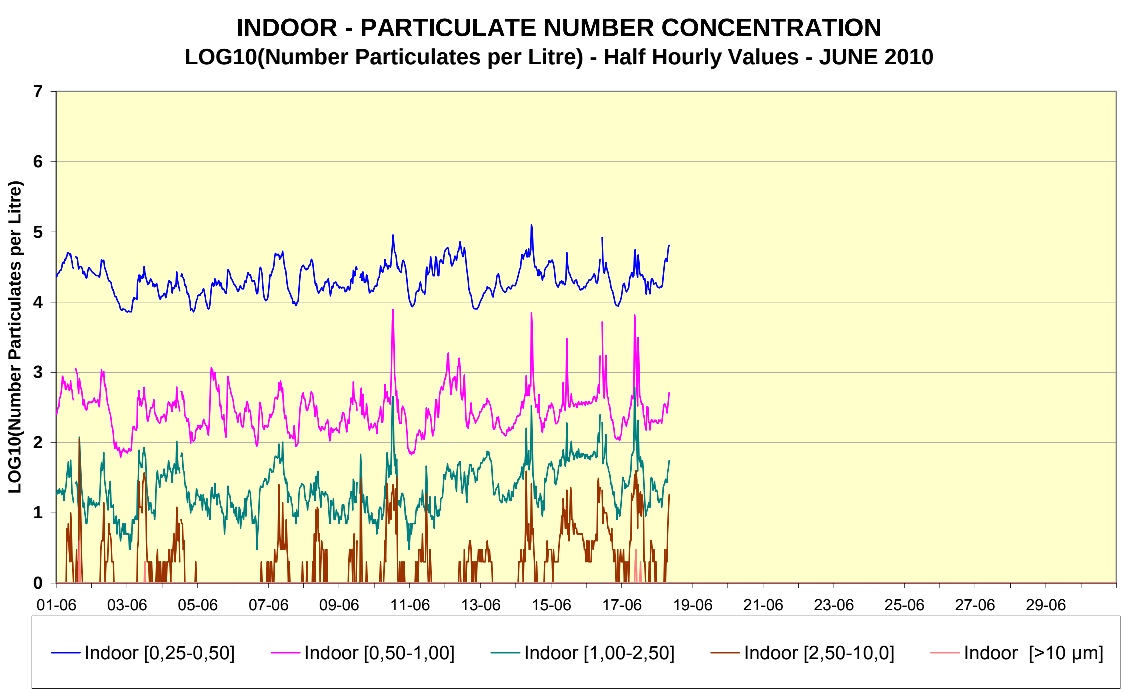

Fig. 54.b: Woluwe Indoor – Particulate Number Concentration – different size classes
[0,25-0,50 µm] ; **[0,50-1 µm]** ; **[1-2,5 µm]** ; **[2,5-10 µm]** and **[>10 µm] –** June 2010

5.2 Evolution for specific subclasses

As already mentioned the evolution of the particulate number concentration within the smaller size ranges [0,25 – 0,65 µm] is quite homogeneous in the different subclasses [0,25-0,28 µm], [0,30-0,35 µm], …., [0,50-0,65 µm]. Those particulates seem to originate from a common phenomenon. In the outdoor air, the ratio between these subclasses seems to be more or less constant over the different monthly periods. For these finer classes, the ratio of the number concentration indoor and outdoor also seems to be more or less stable over the different monthly periods.

Te relationship between the particle number concentration of subgroups comprised between 0,65 and 2,50 µm seems to indicate the existence of two data distributions, suggesting that the particulates may originate from different physical phenomena. The ratio of the number concentration indoor and outdoor seems also less stable over time.

Particulates belonging to the coarser fraction, with diameter above 2,5 µm, are locally kept in suspension by turbulent movements of the air, such as the air turbulences created by the traffic or by a people moving around in a room.

For one specific month, May 2010, the particulate number concentrations (in real data numbers) are presented for several size ranges in the figures 55-60. Each graph represents the evolution of half hourly data for a distinct size range indoor and outdoor. The outdoor data refer to the left scale of the graph and the indoor data to the right scale of the graph. Both scales were chosen in order to align patterns. Therefore the ratio between the two scales became a measure for the ratio between the indoor and outdoor particulate number concentration, for the selected particulate size range.

Data for the subgroups [0,25-0,30 µm] and [0,30-0,40 µm] are represented respectively in Fig. 55 and 56. For the subgroup [0,25-0,30 µm] the data are represented on a scale of 1.000.000 and 100.000 particulates per litre air, respectively for outdoor and indoor. For the subgroup [0,30-0,40 µm] the scaling ranges are respectively 800.000 and 80.000. Hence, a ratio of about 10 exists between the number concentration, indoor and outdoor, for both these size classes.

Data for the subgroups [0,40-0,50 µm], [0,50-1,00 µm] and [1-2,5 µm] are represented in the figures 57, 58 and 59. With a scaling range of respectively 300.000 and 15.000 particulates per litre for the subgroup [0,40-0,50 µm], 200.000 and 10.000 for the subgroup [0,50-1 µm] and 10.000 and 500 for the subgroup [1-2,5 µm] there is a 20 folds difference between the particulate number concentration, indoor and outdoor, for these classes.

For the coarser fraction [2,5-10 µm], represented in figure 60, the particulate number concentration is, amongst others, strongly depending on the local air turbulences and therefore no stable ratio between indoor and outdoor number concentration can be assessed.

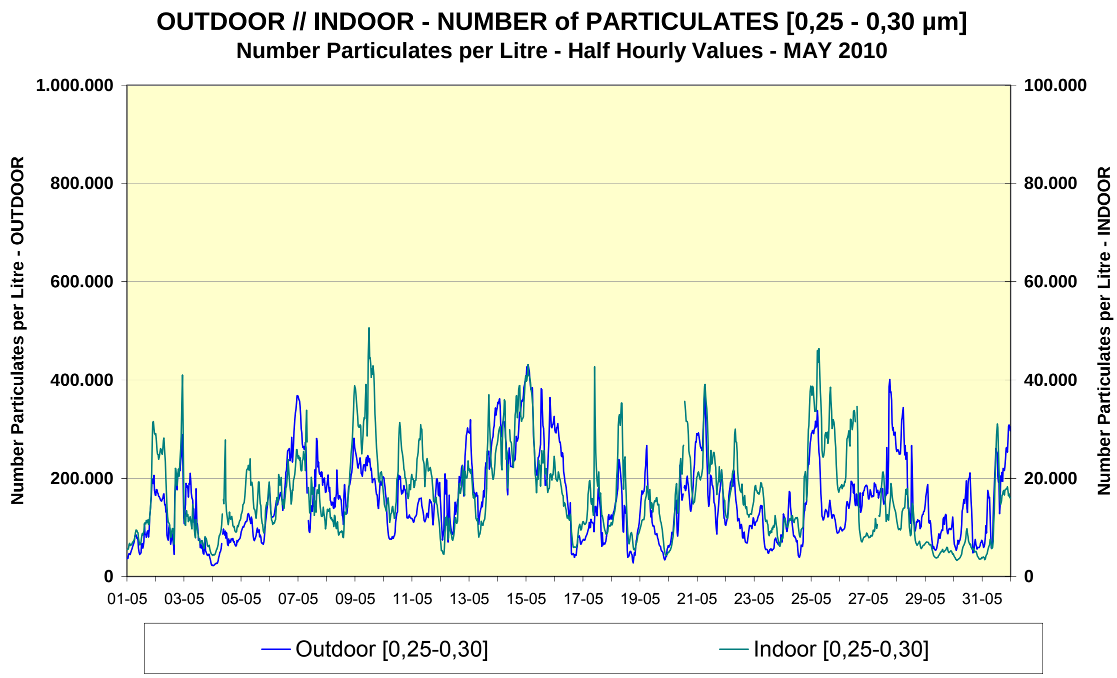

Fig. 55: Particulate Number Concentration **Outdoor** and **Indoor** – May 2010
Particulates between 0,25 and 0,30 µm

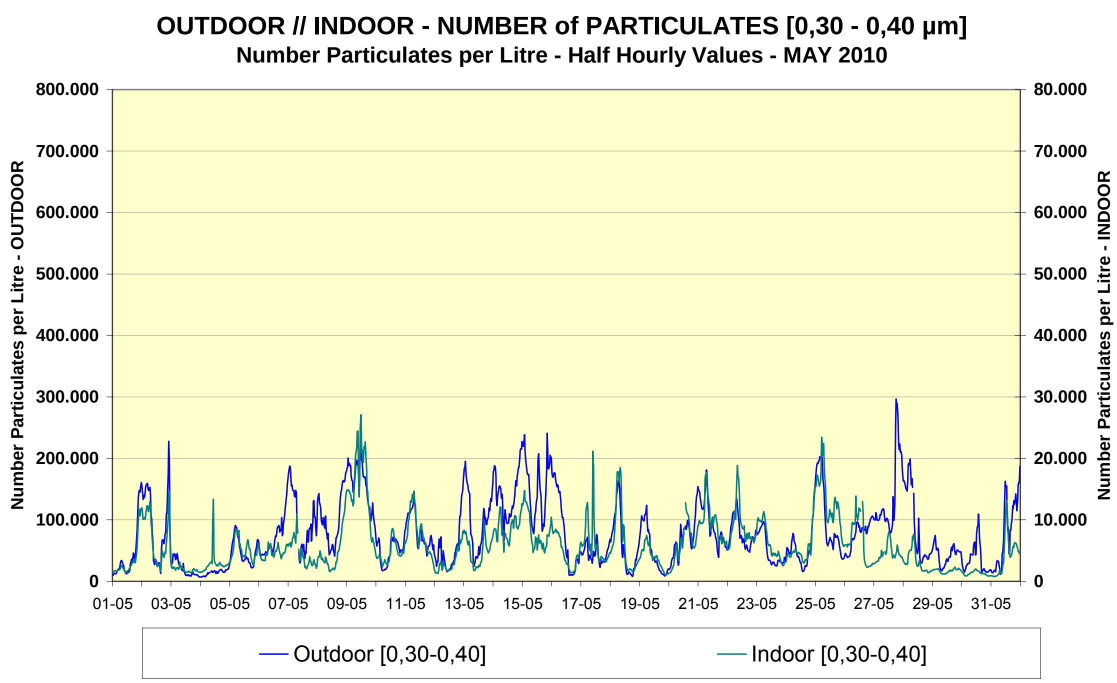

Fig. 56: Particulate Number Concentration **Outdoor** and **Indoor** – May 2010
Particulates between 0,30 and 0,40 µm

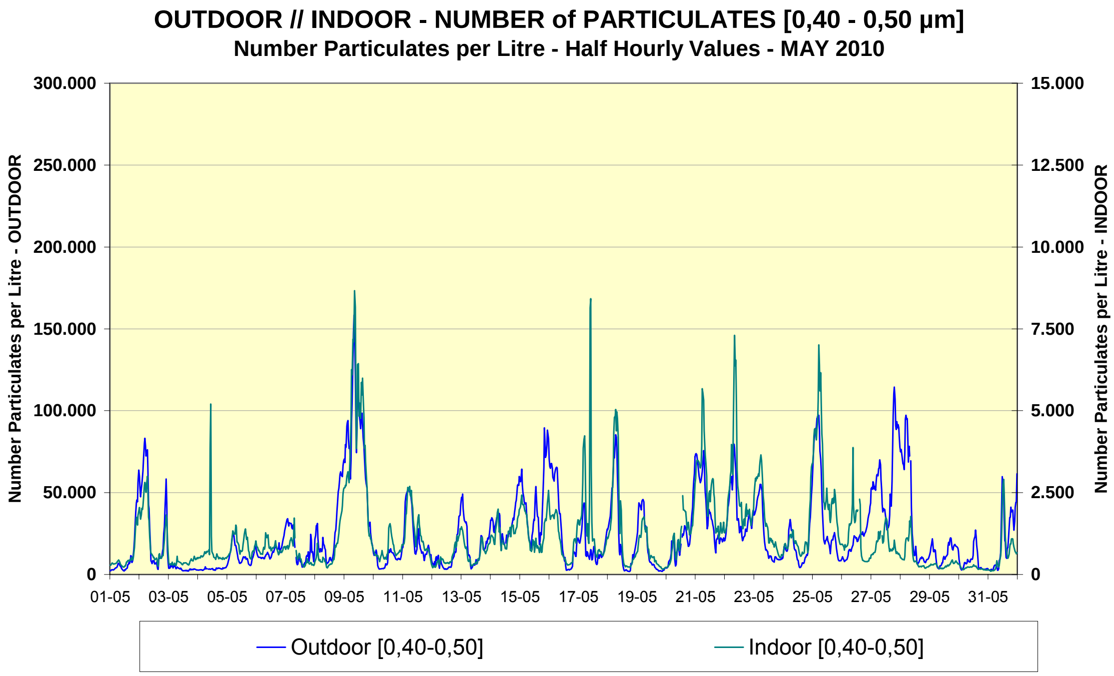

Fig. 57: Particulate Number Concentration **Outdoor** and **Indoor** – May 2010
Particulates between 0,40 and 0,50 µm

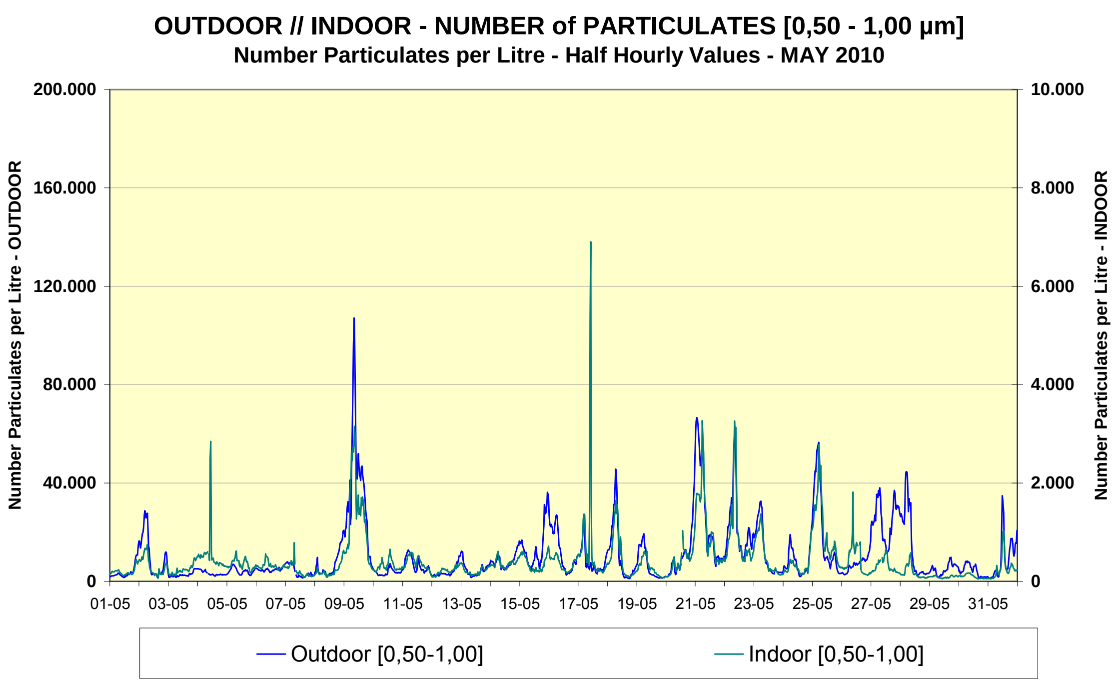

Fig. 58: Particulate Number Concentration **Outdoor** and **Indoor** – May 2010
Particulates between 0,50 and 1,00 µm

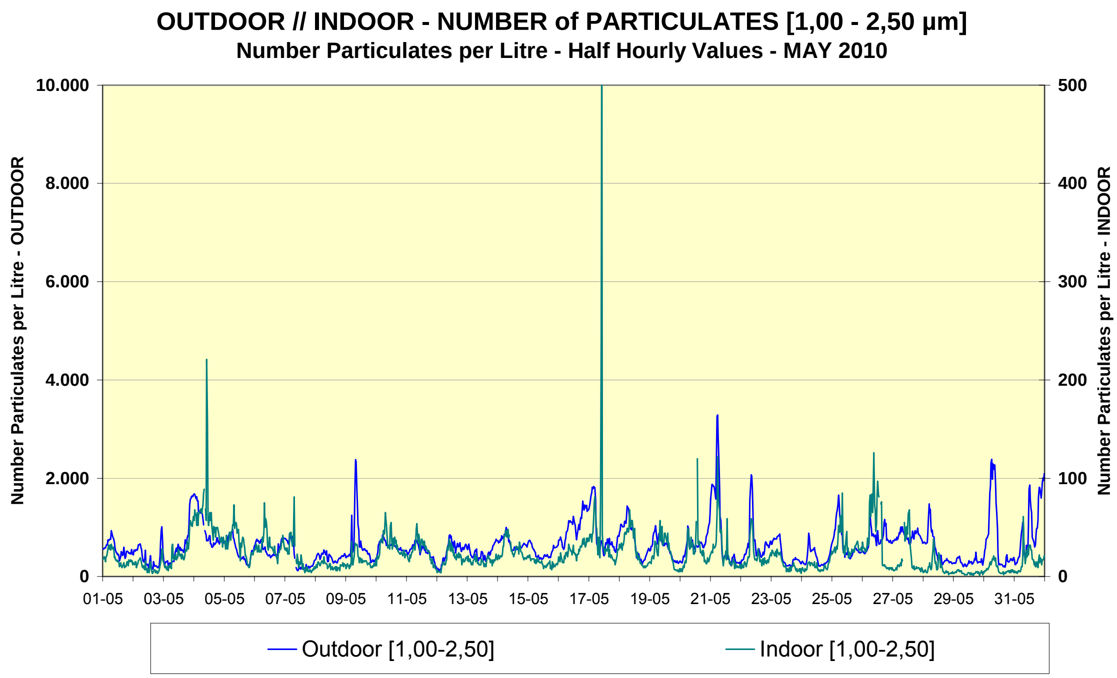

Fig. 59: Particulate Number Concentration **Outdoor** and **Indoor** – May 2010
Particulates between 1,00 and 2,50 µm

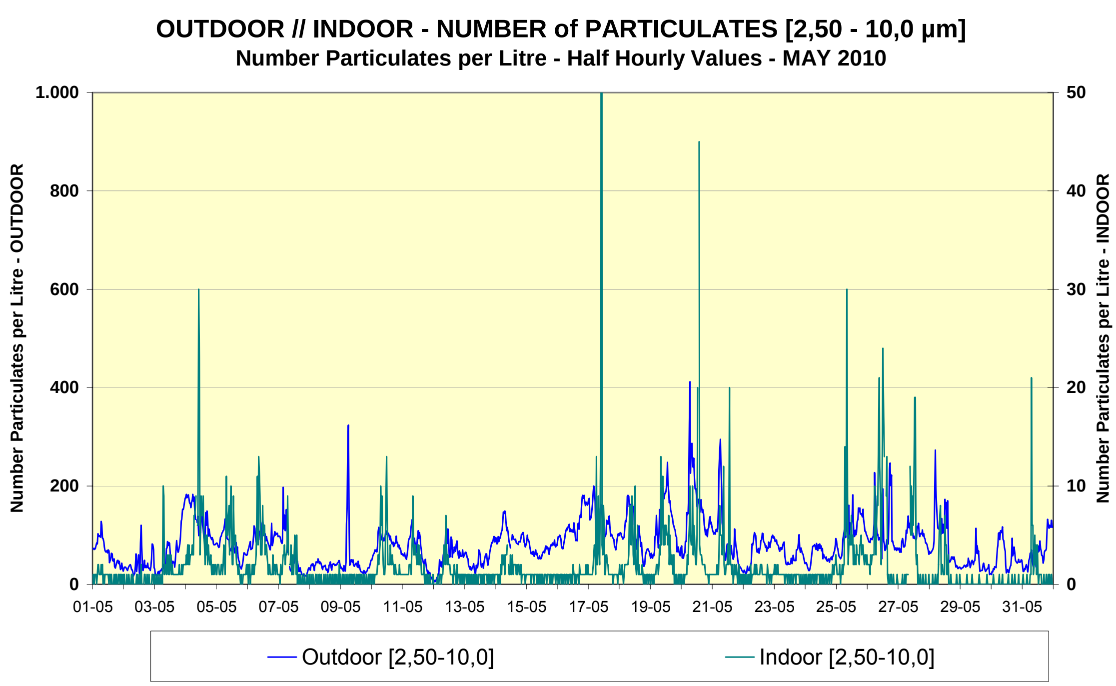

Fig. 60: Particulate Number Concentration **Outdoor** and **Indoor** – May 2010
Particulates between 2,50 and 10 µm

6. Black Carbon Indoor and Outdoor

During the month of January 2010 two Black Carbon analyzers were measuring the outside air at the Woluwe traffic station. A comparison of the results of both these analyzers is given in Figure 61. Absolute differences were limited to ± 0,2 µg/m^3. The correlation factor between the two data sets is as high as R_{corr} = 0.9838 (R^2 = 0.9678).

The particle number concentration for the finer size range is at least 10 times lower inside the laboratory than in the outside air.

During the period ‘February – June 2010’ Black Carbon was measured outside as well as inside the laboratory. For the different months, the data are represented in the figures 62 to 66. The results for February 2010 are presented in Fig. 62 and those of June 2010 in Fig. 66. The scaling in the graphs is set at 10 µg/m^3. From these graphs it is obvious that the Black Carbon concentration indoor is about 5 to 10 times lower than in the outside air.

An attempt to compare the PM10 mass concentration indoor and outdoor was made during the same period. Unfortunately serious technical problems occurred with two TEOM analyzers operational in the air pollution network. Therefore the spare TEOM analyzer had to be installed in the field to replace the faulty analyzers. So, over the considered period, the available information on PM10 indoor is too scarce and a comparison indoor/outdoor could not be performed.

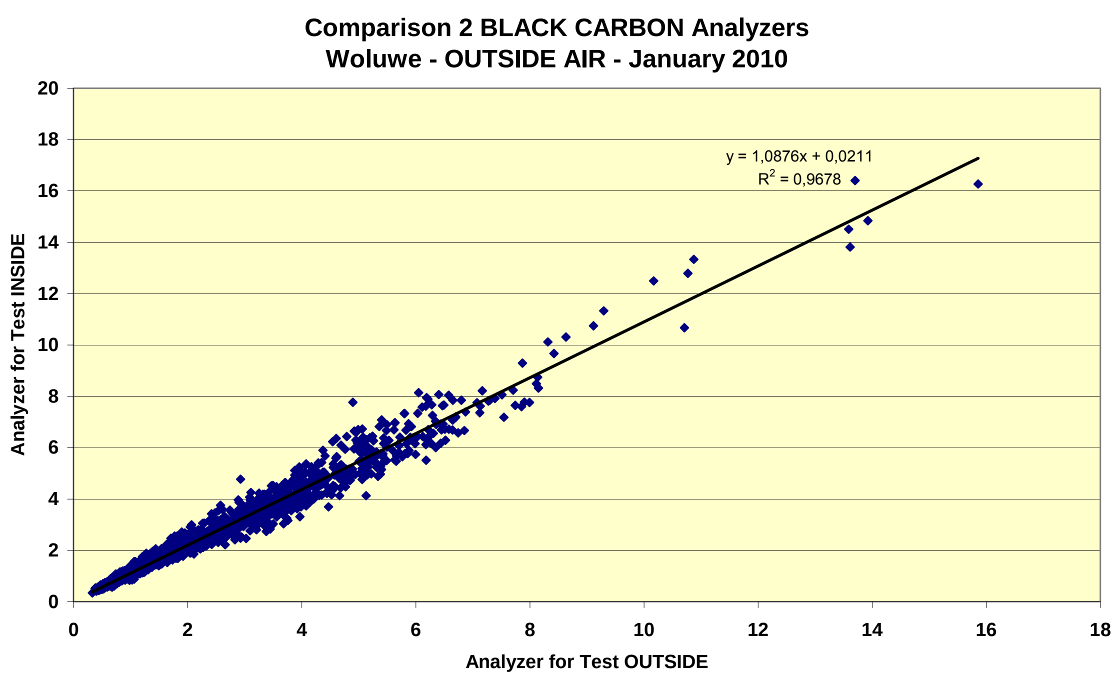

Fig. 61: Comparison results of 2 Black Carbon analyzers – Outside Air – January 2010

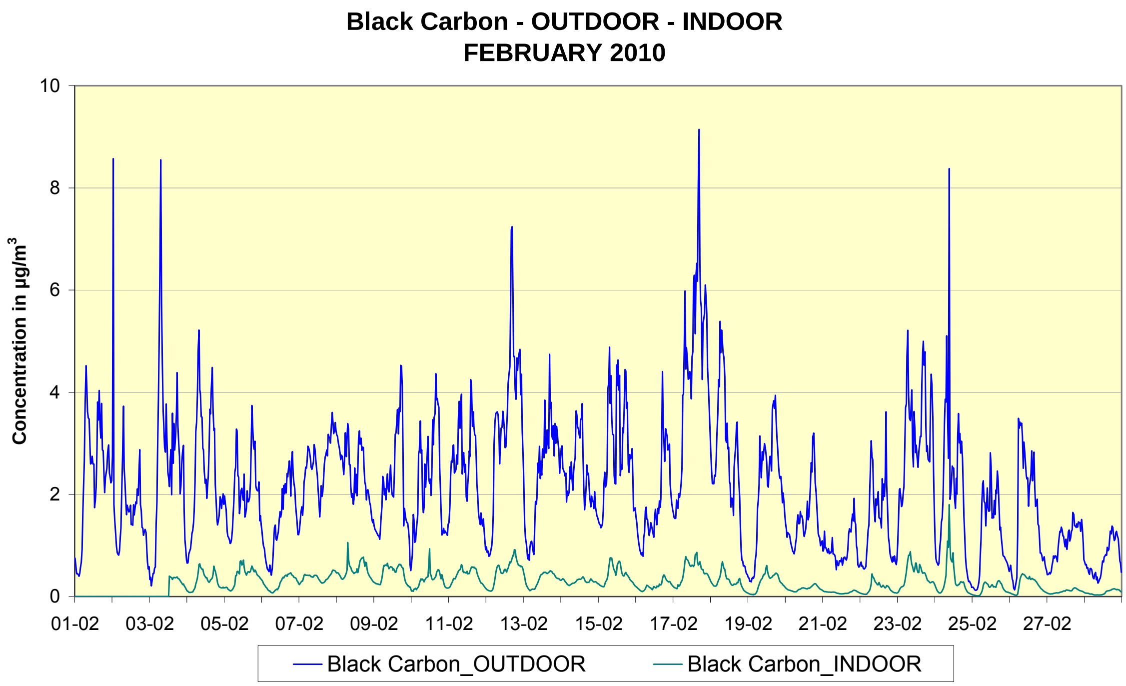

Fig. 62: Black Carbon Concentration **Outdoor** and **Indoor** – February 2010

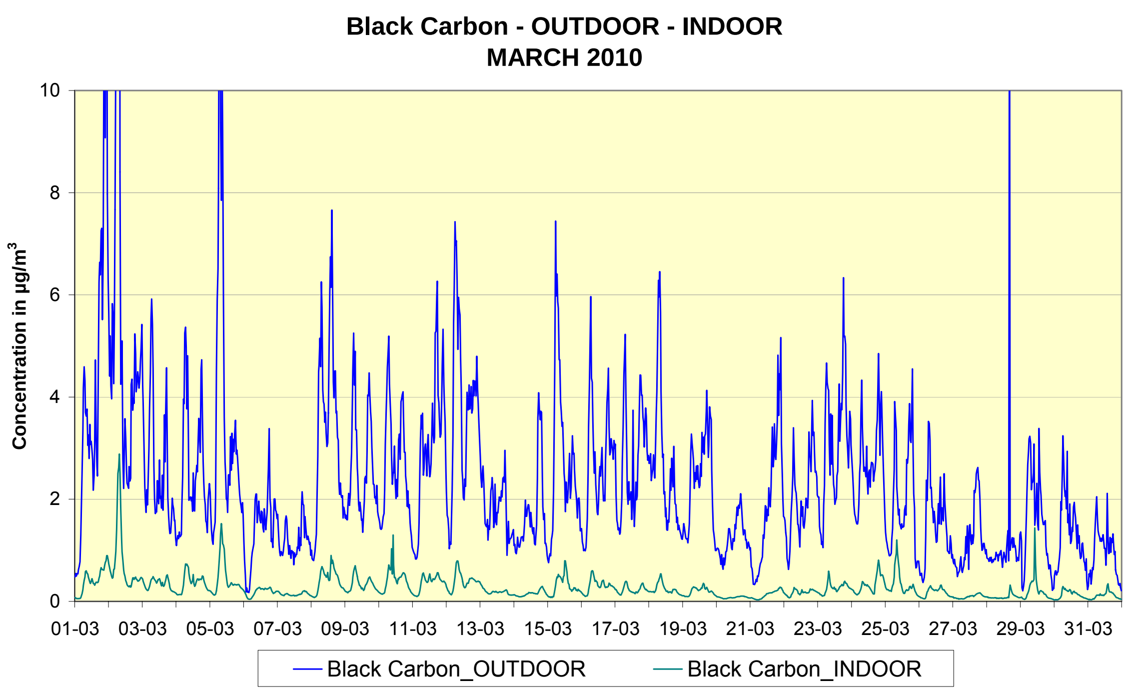

Fig. 63: Black Carbon Concentration **Outdoor** and **Indoor** – March 2010

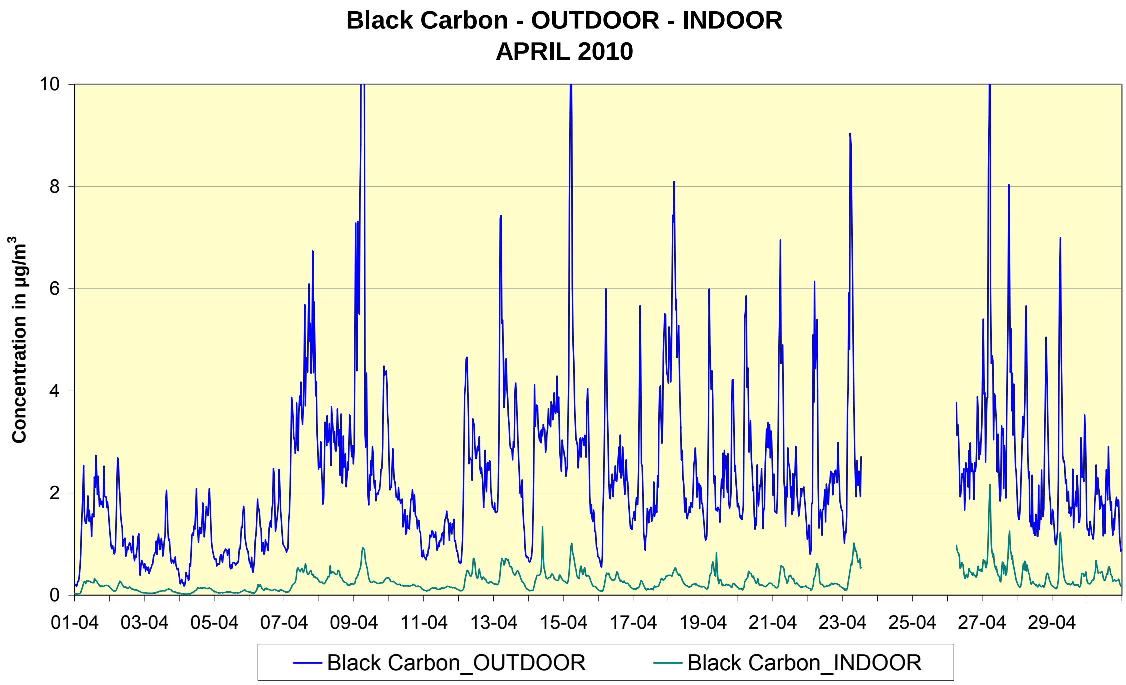

Fig. 64: Black Carbon Concentration **Outdoor** and **Indoor** – April 2010

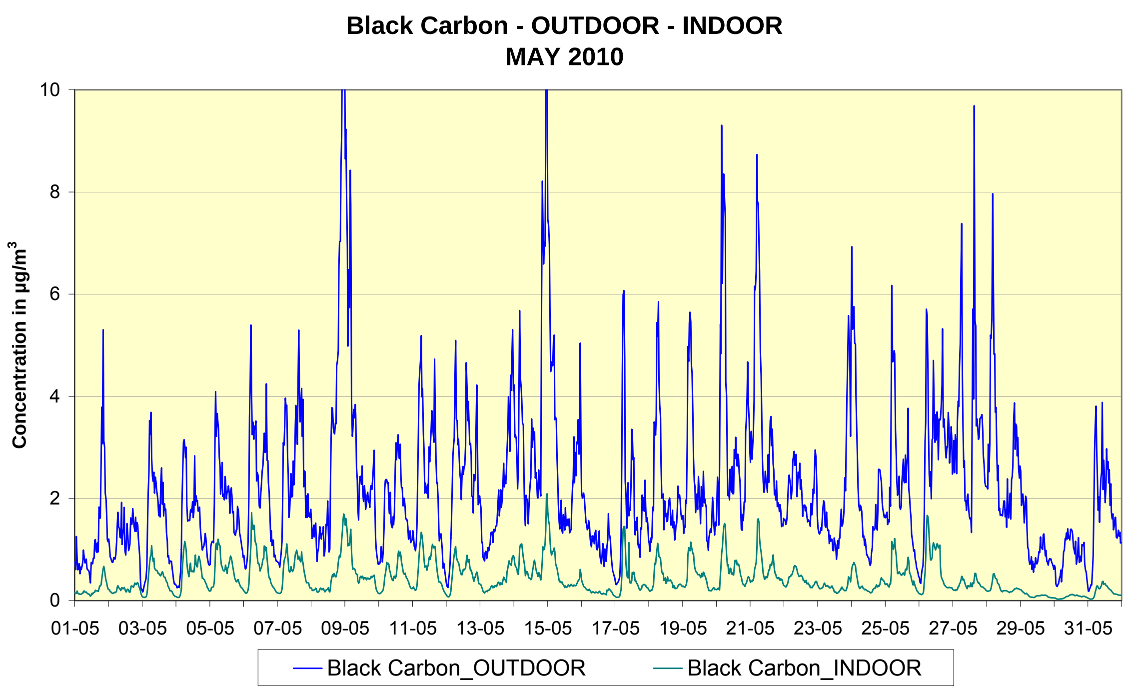

Fig. 65: Black Carbon Concentration **Outdoor** and **Indoor** – May 2010

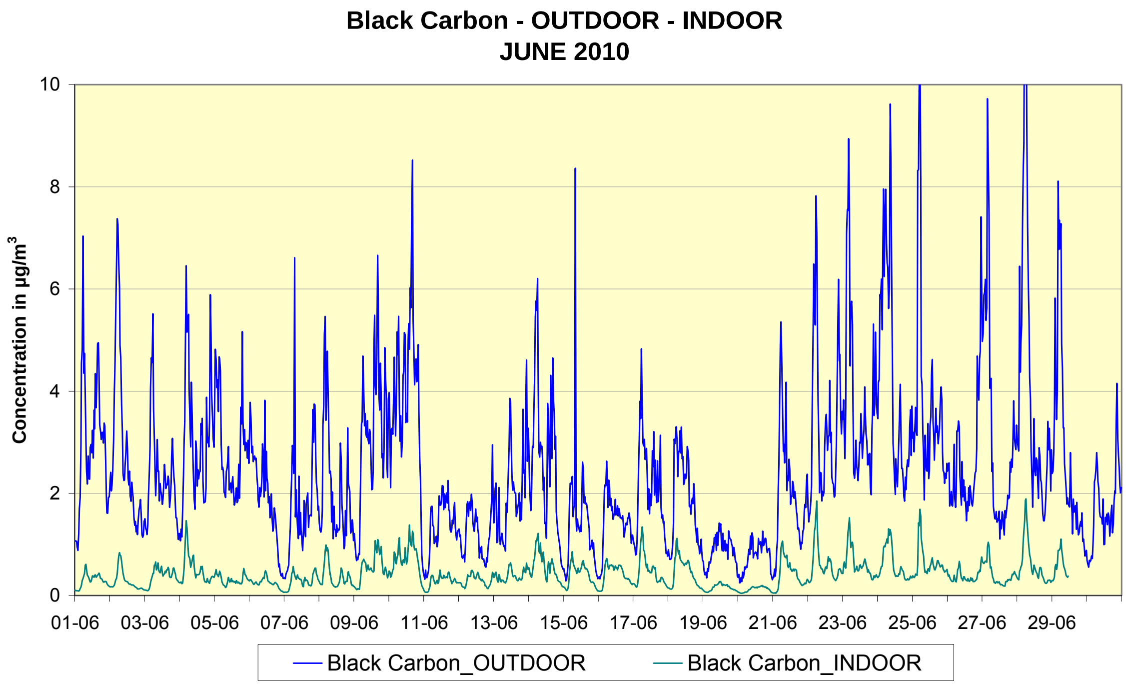

Fig. 66: Black Carbon Concentration **Outdoor** and **Indoor** – June 2010

7. Summary and Conclusions

Ambient air: The results of Black Carbon (BC), the PM10 mass concentration, nitrogen monoxide (NO) and the particulate number concentration at the Woluwe traffic station are analyzed in detail for the one year period 'July 2009 – June 2010'.

The results provide the following observations: There is a much better correlation between BC and NO data than between BC and the PM10 mass concentration. The correlation factor between BC and NO data yields about 0,78 for both half hourly data and integrated daily data. Between BC and the PM10 mass concentration the correlation factor reaches only 0,50 for the half hourly data and about 0,65 for the daily data. This concludes to a much better correlation between the short term peak values of BC and NO than between the peak values of BC and PM10. Since NO is still the best indicator for the vicinity of road traffic, it can be stated that BC is more directly linked with the local traffic than PM10.

At the Woluwe traffic site Black Carbon, on an average, represents only about 10% of the total PM10 mass concentration.

The Y,X scatter plot of BC and PM10 data suggests two interfering data distributions, probably indicating a different physical origin.

Analysis of correlation coefficients, month by month, between Black Carbon and different pollutants, showed that the best correlation was observed with NO_X, rather than with NO. This may be explained by the fact that, at traffic stations, part of the traffic emission is directly present as NO_2 and that part of the NO emitted is rapidly oxidized and therefore present as NO_2 at the receptor point.

The correlation between BC and PM10 is weaker than between BC and NO, but higher correlation coefficients were observed for the winter months December 2009 and January 2010, when meteorological conditions led more frequently to a poor dispersion capacity of the lower atmosphere. During these period and due to the accumulation effect, there is a better relationship between the overall pollutant PM10 and the local generated Black Carbon.

The variations in the time series of the particulate number concentration of the finer size ranges, 0,25 up to 0,65 µm, seems to be very homogeneous. They probably originate from the same physical processes. The scatter plot of the number concentration of different subclasses in the taller ranges, between 0,65 and 2,5 µm, suggests two different distributions, probably indicating a different physical origin of these particulates. Within these subclasses, some particulates are probably related to the finer ones, while others probably belong to the mechanical particulates that are mainly present in coarser size ranges.

Particulates of the coarser fraction (2,5-10 µm) and beyond are mainly kept in suspension by local air turbulences. These particulates are mostly present during dry weather conditions. The are observed and measured in the vicinity of roads with dense traffic. During winter time salting dry road surfaces may also influence their occurrence.

Indoor Air: the Black Carbon mass concentration and the particle number concentration of the finer size ranges (0,25 to 0,65 µm) inside the laboratory are at least 10 times lower than in the ambient air. The time series evolution of the particulate number concentration however follows the same pattern as in the outside air.

For the particulates between 0,65 and 2,5 µm the link between indoor and outdoor air is already somewhat less evident. The particulate number concentration is at least 10 to 20 times lower inside than outside.

For particulates above 2,5 µm there is no clear link between indoor and outdoor air. Inside the laboratory this fraction is only observed on working days and never on weekend days, meaning that the presence of a few persons moving around in the lab is sufficient but also necessary to hold this fraction into suspension. This fraction has never been observed during weekend or holidays while nobody was present is the room.

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