Mass Concentration and Size-Distribution of Atmospheric Particulate Matter in an Urban Environment

Sabrina Rovelli[1], Andrea Cattaneo[1], Francesca Borghi[1], Andrea Spinazzè[1], Davide Campagnolo[2], Andreas Limbeck[3], Domenico M. Cavallo[1]

[1] Department of Science and High Technology, University of Insubria, via Valleggio 11, 22100 Como, Italy
[2] Department of Biomedical and Clinical Sciences-Hospital "L. Sacco", University of Milan, via G.B. Grassi 74, 20157 Milano, Italy
[3] Institute of Chemical Technologies and Analytics, TU Wien, Getreidemarkt 9/164-IAC, A-1060 Vienna, Austria

Supplementary Material

Analytical Procedures and Quality Control for PM Mass Determination

The particle mass collected on membrane filters was determined gravimetrically following a standard operating procedure (UNI EN 14907; UNI EN 12341). Briefly, each filter was conditioned before weighing at 50% ± 5% relative humidity and 20°C ± 1°C for a minimum of 24 hours in a controlled environment (Bio Activa VE Climatic Cabinet, Aquaria, Lacchiarella, Milan, Italy). The filters were weighed three times (every 20") by a micro-balance with a readability of 1 µg (Gibertini 1000, Novate, Milan, Italy), ensuring a standard deviation ≤ 3 µg. An electrical C-shaped ionizer (HAUG GmbH & CO. KG, Germany) was used to eliminate electrostatic charges from the filter surfaces. This procedure was repeated before and after each sampling, and the particulate masses were determined by differential weighing. Laboratory blanks - two for each type of filter used - were always weighed under the same conditions to verify possible anomalies in the weighing room conditioning (e.g., temperature and humidity variations). The average blank filter masses were then used to correct the filter mass results for each test. Prior to the analysis, the micro-balance was auto-calibrated, and a calibration check was performed using certified standard weights of 1, 100 and 1000 mg, allowing deviations from the true value ≤ 3, 5 and 10 µg, respectively.

The quality of the weighing procedure was assessed using the ASTM D 6552 method (ASTM, 2000). The weighing procedure was repeated on three greased PC and three PTFE filters at least three times on the same day for twelve different days to obtain a representative number of repeated weighing (> 30) for each type of collection substrate.

Mass limits of detection (LODs) of 0.9 µg and 6.2 µg ($\alpha = 0.05$) were calculated for 25-mm PC filters (DLPI) and 37-mm PTFE membranes (HI), respectively. When referenced to an α-value of 1.1% ($\alpha = 0.011$), LODs increased up to 1.2 µg and 8.7 µg, respectively.

The mean LOD (α-value of 1.1%) for the PM concentrations determined on each DLPI collection plate was 0.0072 μg m^{-3} for an average sampling time of 96-h and a nominal flow rate of 30 L min^{-1}. The mean LOD for the $PM_{2.5}$ collected by HI was 0.2 μg m^{-3} for the same sampling time and a nominal flow rate of 10 L min^{-1}.

Mass limits of quantification (LOQs) of 10.7 μg and 75.2 μg were determined for PC and PTFE filters, respectively.

Table S1. Sampling information and weekly weather conditions at the URB site in Como, from May 2015 to March 2016.

Sample No.	Sampling period (mm/dd/yy–mm/dd/yy)	T (°C) Mean (Min.–Max.)[a]	RH (%) Mean (Min.–Max.)[a]	WS (m s^{-1}) Mean (Min.–Max.)[a]	Prevalent WD[b]	AtP (hPa) Mean (Min.–Max.)[a]	PBL (m) Mean (Min.–Max.)[a]	Cumulative rainfall (mm)[c]
Non-heating season								
1	05/25/15–05/29/15	18.9 (11.6–26.1)*	66.1 (26.8–99.4)*	n.a.	n.a.	n.a.	608 (87–2088)	0.4
2	05/29/15–06/02/15	20.7 (14.3–30.1)*	79.5 (38.7–99.4)*	n.a.	n.a.	n.a.	434 (87–1782)	5.8
3	06/08/15–06/12/15	22.7 (17.0–30.9)*	73.2 (44.9–99.4)*	n.a.	n.a.	n.a.	589 (87–2241)	9.0
4	06/15/15–06/19/15	20.9 (15.6–28.6)*	84.9 (49.5–99.4)*	n.a.	n.a.	n.a.	451 (87–1310)	16.0
5	06/22/15–06/26/15	22.1 (14.6–28.7)*	65.2 (26.9–99.4)*	n.a.	n.a.	n.a.	686 (87–2500)	0.0
6	07/27/15–07/31/15	24.8 (18.6–31.0)*	75.8 (47.6–99.4)*	n.a.	n.a.	n.a.	676 (87–1694)	14.2
7	08/03/15–08/07/15	27.4 (21.4–37.2)	58.4 (26.6–82.1)	0.50 (0.20–1.03)	S/ESE	1005.2 (1003.5–1006.8)	708 (87–2098)	0.0
8	08/10/15–08/14/15	26.7 (18.4–36.6)	53.5 (21.4–86.3)	0.59 (0.19–1.34)	SE/SW	1004.2 (1005.0–1007.5)	754 (87–2500)	0.0
9	08/17/15–08/21/15	21.7 (14.5–30.4)	66.3 (30.5–94.0)	0.54 (0.05–1.23)	S	1003.6 (996.4–1011.3)	587 (87–2201)	11.2
10	08/24/15–08/28/15	21.7 (16.3–31.7)	74.6 (34.2–95.2)	0.49 (0.03–1.39)	S/SSE	1005.8 (1001.3–1009.5)	427 (87–1680)	33.6
11	08/31/15–09/04/15	22.5 (14.5–34.5)	66.6 (27.5–93.4)	0.52 (0.12–1.25)	SE/SW	1002.1 (999.3–1007.7)	553 (87–2280)	9.4
12	09/07/15–09/11/15	18.5 (11.1–26.1)	60.3 (28.1–89.5)	0.44 (0.02–1.26)	S/SSE	1007.7 (1004.4–1011.8)	572 (87–1498)	0.6
13	09/14/15–09/18/15	19.0 (16.1–26.0)	84.1 (41.2–95.2)	0.37 (0.01–1.91)	SE	999.4 (995.6–1003.7)	192 (87–1055)	11.4
14	09/21/15–09/25/15	15.3 (6.6–26.5)	73.0 (29.7–96.4)	0.65 (0.02–4.73)	SSE	1000.3 (991.6–1006.1)	357 (87–1245)	63.2
15	09/28/15–10/02/15	14.8 (8.8–21.1)	62.1 (35.3–85.8)	0.43 (0.01–1.29)	SE/SSW	1015.4 (1013.1–1017.4)	480 (87–1564)	0.0
16	10/05/15–10/09/15	17.1 (12.4–26.0)	81.2 (46.7–96.5)	0.28 (0.01–1.03)	S/SSE	n.a.	220 (87–724)	5.4
17	10/12/15–10/16/15	13.3 (6.6–23.3)	87.7 (46.0–97.2)	0.34 (0.01–0.94)	SE	999.3 (995.0–1004.4)	246 (87–909)	67.8

n.a.: data not available
*: data from the Regional Agency for Prevention and Environment of Lombardy
[a]: average, minimum and maximum values of hourly data for each 5-d monitoring session
[b]: prevalent WD during each 5-d monitoring session
[c]: cumulative rainfall during each 5-d monitoring session

Table S1 (continues). Sampling information and weekly weather conditions at the URB site in Como, from May 2015 to March 2016.

Sample No.	Sampling period (mm/dd/yy–mm/dd/yy)	T (°C) Mean (Min.–Max.)[a]	RH (%) Mean (Min.–Max.)[a]	WS (m s^{-1}) Mean (Min.–Max.)[a]	Prevalent WD[b]	AtP (hPa) Mean (Min.–Max.)[a]	PBL (m) Mean (Min.–Max.)[a]	Cumulative rainfall (mm)[c]
				Heating season				
18	10/19/15–10/23/15	10.7 (4.5–20.8)	79.6 (39.5–97.7)	0.27 (0.02–1.05)	S	1005.5 (1001.1–1011.0)	299 (87–1010)	0.2
19	10/26/15–10/30/15	12.2 (5.8–22.7)	85.7 (32.9–97.7)	0.20 (0.00–0.84)	SE	1008.1 (1001.9–1013.9)	179 (87–672)	31.0
20	11/02/15–11/06/15	11.5 (4.1–21.6)	80.9 (40.8–98.1)	0.17 (0.00–0.74)	SSE	1014.3 (1008.9–1021.7)	140 (87–372)	0.0
21	11/09/15–11/13/15	11.7 (5.6–24.1)	82.9 (37.6–98.0)	0.17 (0.00–0.88)	S	1014.2 (1011.3–1017.4)	116 (87–222)	0.0
22	11/16/15–11/20/15	9.1 (5.0–16.8)	88.4 (59.2–97.8)	0.38 (0.05–1.23)	SSE	1010.0 (1006.1–1013.1)	134 (87–508)	0.0
23	11/23/15–11/27/15	4.2 (–2.1–15.1)	67.1 (14.4–97.1)	0.51 (0.00–2.81)	SSE	1003.7 (994.4–1014.3)	239 (87–621)	0.0
24	11/30/15–12/04/15	4.7 (–0.7–15.3)	83.5 (33.6–98.2)	0.18 (0.02–0.76)	SE	1017.3 (1011.8–1022.6)	109 (87–238)	0.0
25	12/09/15–12/11/15	4.6 (0.9–10.8)*	93.7 (52.7–99.5)*	n.a.	n.a.	n.a.	154 (87–340)	0.0
26	12/14/15–12/18/15	4.8 (0.1–15.0)	85.1 (48.0–98.3)	0.14 (0.01–0.52)	SSE	1017.6 (1013.4–1020.8)	90 (87–148)	0.0
27	12/21/15–12/23/15	7.2 (4.2–12.6)	83.7 (56.2–96.7)	0.19 (0.02–0.58)	SE	1022.3 (1019.4–1025.0)	96 (87–157)	0.0
28	01/11/16–01/15/16	4.2 (–2.2–14.2)	78.6 (22.6–98.9)	0.42 (0.05–1.61)	SSE/SW	997.6 (983.0–1006.8)	207 (87–679)	5.8
29	01/18/16–01/22/16	–0.9 (–5.6–8.4)	60.3 (18.5–94.0)	0.25 (0.02–1.29)	SSE	1010.1 (1004.5–1022.2)	169 (87–915)	0.0
30	01/25/16–01/29/16	7.0 (2.2–13.2)*	93.3 (62.8–99.5)*	n.a.	n.a.	n.a.	127 (87–538)	0.0
31	02/01/16–02/05/16	8.4 (0.6–16.8)	66.2 (12.2–95.2)	n.a.	SSE	1011.1 (1000.6–1016.3)	215 (87–964)	16.2
32	02/08/16–02/12/16	6.4 (3.6–10.9)*	72.1 (28.8–99.5)*	n.a.	n.a.	n.a.	248 (87–890)	23.8
33	02/15/16–02/19/16	6.5 (3.1–11.0)*	98.3 (70.3–99.5)*	n.a.	n.a.	n.a.	234 (87–884)	10.2
34	02/29/16–03/04/16	9.8 (2.1–19.6)	50.0 (14.0–96.7)	0.83 (0.02–2.35)	S	994.8 (985.2–1002.7)	327 (87–1384)	15.6
35	03/07/16–03/11/16	6.6 (–1.3–17.5)	64.4 (15.6–94.8)	0.44 (0.02–1.50)	SSE	998.4 (989.5–1006.3)	376 (87–1260)	0.0
36	03/14/16–03/18/16	7.8 (1.2–16.6)	66.6 (30.6–93.2)	0.53 (0.02–1.98)	SE	1010.4 (1000.4–1016.8)	349 (87–1402)	13.4
37	03/21/16–03/25/16	11.9 (1.8–20.7)	54.6 (15.4–91.3)	0.63 (0.01–2.23)	SW	996.4 (986.7–1006.0)	438 (87–2127)	0.0
38	03/29/16–04/01/16	14.1 (11.4–20.4)	73.9 (37.9–92.1)	0.37 (0.02–1.31)	SSE	1005.5 (1002.4–1008.4)	235 (87–1126)	1.8

n.a.: data not available

*: data from the Regional Agency for Prevention and Environment of Lombardy

[a]: average, minimum and maximum values of hourly data for each 5-d monitoring session

[b]: prevalent WD during each 5-d monitoring session

[c]: cumulative rainfall during each 5-d monitoring session

Table S2. Correlation analysis between PM fractions. Pearson correlation coefficients (r) and levels of significance (*p*) are shown.

DLPI Stage (µm)		***1 (0.0283–0.0559)***	***2 (0.0559–0.0944)***	***3 (0.0944–0.157)***	***4 (0.157–0.262)***	***5 (0.262–0.383)***	***6 (0.383–0.614)***	***7 (0.614–0.950)***	***8 (0.950–1.60)***	***9 (1.60–2.40)***	***10 (2.40–4.00)***	***11 (4.00–6.60)***
2 (0.0559–0.0944)	r	.386*										
	p	.018										
3 (0.0944–0.157)	r	.323	.925**									
	p	.051	.000									
4 (0.157–0.262)	r	.199	.874**	.956**								
	p	.239	.000	.000								
5 (0.262–0.383)	r	.283	.831**	.930**	.966**							
	p	.089	.000	.000	.000							
6 (0.383–0.614)	r	.268	.748**	.839**	.885**	.942**						
	p	.109	.000	.000	.000	.000						
7 (0.614–0.950)	r	.208	.647**	.731**	.785**	.847**	.959**					
	p	.216	.000	.000	.000	.000	.000					
8 (0.950–1.60)	r	.179	.602**	.677**	.736**	.785**	.906**	.979**				
	p	.288	.000	.000	.000	.000	.000	.000				
9 (1.60–2.40)	r	.140	.533**	.572**	.644**	.691**	.787**	.839**	.887**			
	p	.407	.001	.000	.000	.000	.000	.000	.000			
10 (2.40–4.00)	r	.179	.504**	.463**	.472**	.529**	.591**	.594**	.626**	.843**		
	p	.290	.001	.003	.003	.001	.000	.000	.000	.000		
11 (4.00–6.60)	r	.283	.459**	.408*	.403*	.476**	.504**	.485**	.508**	.724**	.905**	
	p	.089	.004	.011	.012	.002	.001	.002	.001	.000	.000	
12 (6.60–9.97)	r	.392*	.469**	.494**	.501**	.588**	.586**	.533**	.527**	.663**	.682**	.810**
	p	.016	.003	.002	.001	.000	.000	.001	.001	.000	.000	.000

*: correlation is significant at the 0.05 level

**: correlation is significant at the 0.01 level

Table S3. Correlation analysis between PM fractions and meteorological parameters monitored at the URB site. Pearson correlation coefficients (r) and levels of significance (*p*) are shown.

DLPI stage (μm) or PM fraction		***Rainfall***	***PBL***	***T***	***RH***	***WS***	***AtP***
1 (0.0283–0.0559)	r	–.360*	.090	–.091	–.116	–.120	.226
	p	.029	.598	.626	.534	.552	.257
2 (0.0559–0.0944)	r	–.443**	–.710**	–.452**	.414*	–.709**	.679**
	p	.005	.000	.009	.018	.000	.000
3 (0.0944–0.157)	r	–.551**	–.730**	–.535**	.362*	–.680**	.685**
	p	.000	.000	.002	.042	.000	.000
4 (0.157–0.262)	r	–.538**	–.798**	–.548**	.426*	–.675**	.664**
	p	.000	.000	.001	.015	.000	.000
5 (0.262–0.383)	r	–.575**	–.742**	–.565**	.362*	–.628**	.636**
	p	.000	.000	.001	.042	.000	.000
6 (0.383–0.614)	r	–.514**	–.727**	–.519**	.367*	–.593**	.547**
	p	.001	.000	.002	.039	.001	.003
7 (0.614–0.950)	r	–.444**	–.773**	–.482**	.419*	–.588**	.498**
	p	.005	.000	.005	.017	.001	.008
8 (0.950–1.60)	r	–.411*	–.761**	–.391*	.433*	–.621**	.559**
	P	.010	.000	.027	.013	.001	.002
9 (1.60–2.40)	r	–.401*	–.649**	–.228	.363*	–.523**	.543**
	p	.013	.000	.210	.041	.005	.003
10 (2.40–4.00)	r	–.313	–.524**	–.136	.379*	–.629**	.535**
	p	.055	.001	.456	.032	.000	.004
11 (4.00–6.60)	r	–.431**	–.327*	–.112	.198	–.587**	.461*
	p	.007	.045	.541	.277	.001	.016
12 (6.60–9.97)	r	–.634**	–.238	–.312	-.074	–.253	.457*
	p	.000	.149	.082	.687	.203	.017
$PM_{0.03–0.1}$	r	–.460**	–.546**	–.379*	.358*	–.617**	.631**
	p	.004	.000	.032	.044	.001	.000
$PM_{0.1–1}$	r	–.530**	–.760**	–.532**	.384*	–.621**	.581**
	p	.001	.000	.002	.030	.001	.001
PM_1	r	–.534**	–.761**	–.533**	.384*	–.623**	.587**
	p	.001	.000	.002	.030	.001	.001
$PM_{1–2.5}$	r	–.415**	–.742**	–.348	.422*	–.613**	.568**
	p	.010	.000	.051	.016	.001	.002
$PM_{2.5}$	r	–.525**	–.773**	–.520**	.399*	–.636**	.593**
	p	.001	.000	.002	.024	.000	.001
$PM_{2.5–10}$	r	–.478**	–.403*	–.178	.199	–.554**	.526**
	p	.002	.012	.331	.276	.003	.005
PM_{10}	r	–.547**	–.768**	–.502**	.400*	–.656**	.614**
	p	.000	.000	.003	.023	.000	.001

*: correlation is significant at the 0.05 level (2-tailed)
**: correlation is significant at the 0.01 level (2-tailed)

Table S4. Summary of the regression model results, segregated for each DLPI size range. Results show the standardized coefficients for the independent variables that were found to be statistically significant in each model, with the standardized Beta, 95% confident interval - upper and lower bounds - (95% C.I.) and *p* value. The last two rows provide an overview of the linear regression model for each dependent variable, presenting the R squared value (r^2), the standard error (Std. error) and the *p* value. Only the regression model with statistically significant independent variables are shown.

Dependent variable (n = 25)	Stage 3 (0.0944–0.157 µm)				Stage 4 (0.157–0.262 µm)				Stage 5 (0.262–0.383 µm)				Stage 6 (0.383–0.614 µm)			
Independent variables	Beta	95% C.I. Lower	Upper	*p*	Beta	95% C.I. Lower	Upper	*p*	Beta	95% C.I. Lower		*p*	Beta	95% C.I. Lower	Upper	*p*
PBL	–0.584	–0.412	–0.004	0.046	–0.702	–0.893	–0.150	0.009	–0.586	–0.997	–0.667	0.032	–0.667	–1.473	0.019	0.040
Rainfall					–0.314	–0.177	–0.022	0.014	–0.382	–0.245		0.006				
T									–0.355	–0.346		0.019				
Regression model statistics	r^2	Std. error		*p*	r^2	Std. error		*p*	r^2	Std. error		*p*	r^2	Std. error		*p*
	0.795	0.051		0.000	0.845	0.093		0.000	0.827	0.118		0.000	0.709	0.187		0.001

Dependent variable (n = 25)	Stage 7 (0.614–0.950 µm)				Stage 9 (1.60–2.40 µm)				Stage 12 (6.60–9.97 µm)			
Independent variables	Beta	95% C.I. Lower	Upper	*p*	Beta	95% C.I. Lower	Upper	*p*	Beta	95% C.I. Lower	Upper	*p*
PBL	–0.772	–1.489	–0.102	0.027	–0.623	–0.445	–0.040	0.021				
Rainfall	–0.316	–0.284	0.005	0.058					–0.533	–0.099	–0.021	0.004
Regression model statistics	r^2	Std. error		*p*	r^2	Std. error		*p*	r^2	Std. error		*p*
	0.718	0.174		0.001	0.559	0.078		0.004	0.451	0.054		0.001

Table S5. PM mass concentrations for research studies citied in the paragraph: *Comparison of Ambient PM Concentrations with Literature Data.*

Reference	*Location*	*Sampling period*	*Sampling site*	*Concentration (µg m^{-3}) – [Mean ± SD^{a}] or [Min–Max]*			
				PM$_{10}$	*PM$_{2.5}$*	*PM$_{1}$*	*UFPs or QUFPs^{b}*
This study	Como (Italy)	Non-heating Heating Total data	Urban background	15.5 ± 3.7 37.5 ± 17.0 27.7 ± 16.9	10.6 ± 3.4 31.9 ± 15.7 22.4 ± 15.9	8.8 ± 3.2 27.8 ± 13.6 19.3 ± 14.0	0.6 ± 0.1 ($PM_{0.03–0.1}$) 0.8 ± 0.4 ($PM_{0.03–0.1}$) 0.7 ± 0.3 ($PM_{0.03–0.1}$)
Chen *et al.* (2013)	East Asia	Summer-fall	Rural background	5.5 ± 2.7	4.1 ± 2.1		0.1 ± 0.1 ($PM_{0.1}$)
Duarte *et al.* (2008)	Portugal	Summer	Urban Coastal-rural	46.0 ± 19.4 24.7 ± 3.8			
Gnauk *et al.* (2008)	China	Fall	Rural/coastal background	89.3			
Gugamsetty *et al.* (2012)	New Taipei City (Taiwan)	Summer-fall	Urban	39.5 ± 11.6	21.8 ± 7.5		1.4 ± 0.6 ($PM_{0.1}$)
Hughes *et al.* (1998)	Pasadena (CA-USA)	Winter	Urban		20.2 ± 5.4 ($PM_{1.8}$)		0.80–1.58 ($PM_{0.017–0.1}$)
Lin *et al.* (2005)	Taiwan	Winter-spring	Traffic	191.0 ± 53.0	140.0 ± 41.0		31.0 ± 19.0 ($PM_{0.1}$)
Liu *et al.* (2015)	Changsha (China)	Spring	Urban-traffic	184.4 ± 76.9 (PM_{9})	136.5 ± 46.7 ($PM_{3.3}$)	57.7 ± 29.1	7.7 ± 12.1 ($PM_{0.4}$)
Mbengue *et al.* (2014)	Dunkirk region (France)	Winter	Industrial sector Urban-traffic sector	23.6 ± 6.0 29.8 ± 4.1		10.1 ± 4.1 16.6 ± 3.9	0.8 ($PM_{0.1}$) 2.4 ± 1.1 ($PM_{0.29}$) 0.5 ($PM_{0.1}$) 5.8 ± 2.1 ($PM_{0.29}$)
Ntziachristos *et al.* (2007)	Los Angeles (CA -USA)	Winter-spring	Traffic Urban	21.0 ± 3.5 13.8 ± 2.5	10.9 ± 0.9 7.5 ± 1.6		2.6 ± 0.5 ($PM_{0.18}$) 1.7 ± 0.7 ($PM_{0.18}$)
Pakkanen *et al.* (2001)	Helsinki (Finland)	1-y (~ 1 sample per month)	Urban Rural				0.49 ($PM_{0.1}$) 0.52 ($PM_{0.1}$)
Ramgolam *et al.* (2008)	Paris (France)	Winter-spring	Urban background	12–42	10–36		

[a]: standard deviation
[b]: quasi-ultrafine particles

Table S5 (continues). PM mass concentrations for research studies citied in the paragraph: *Comparison of Ambient PM Concentrations with Literature Data.*

Reference	*Location*	*Sampling*	*Sampling site*	*Concentration (µg m^{-3}) – [Mean ± SD^{a}] or [Min–Max]*

		period		PM_{10}	$PM_{2.5}$	PM_1	UFPs or QUFPs[b]
Salma *et al.* (2005)	Budapest (Hungary)	Spring (non-heating season)	Kerbside	50*	20* ($PM_{2.0}$)		
Sardar *et al.* (2005)	Los Angeles (CA-USA)	Fall	Urban mix of industrial and traffic sources				3.5 ± 0.1 ($PM_{0.18}$)
			Traffic				3.1 ± 0.1 ($PM_{0.18}$)
			Residential area				2.9 ± 0.1 ($PM_{0.18}$)
			Residential area				2.9 ± 0.07 ($PM_{0.18}$)
		Winter	Urban mix of industrial and traffic sources				1.5 ± 0.06 ($PM_{0.18}$)
			Traffic				1.2 ± 0.05 ($PM_{0.18}$)
			Residential area				1.3 ± 0.09 ($PM_{0.18}$)
			Residential area				1.4 ± 0.06 ($PM_{0.18}$)
		Summer	Urban mix of industrial and traffic sources				2.1 ± 0.08 ($PM_{0.18}$)
			Traffic				0.9 ± 0.1 ($PM_{0.18}$)
			Residential area				1.5 ± 0.06 ($PM_{0.18}$)
			Residential area				1.4 ± 0.05 ($PM_{0.18}$)
Spinazzè *et al.* (2015)	Como (Italy)	Winter	Urban traffic routes				12.7 ± 4.8 ($PM_{0.25}$)
		Spring					14.1 ± 1.6 ($PM_{0.25}$)
		Summer					9.5 ± 2.6 ($PM_{0.25}$)
		Fall					13.8 ± 3.6 ($PM_{0.25}$)

[a]: standard deviation
[b]: quasi-ultrafine particles
*: median value

Figure S1. Wind intensity and direction data for the non-heating (left) and the heating (right) season.

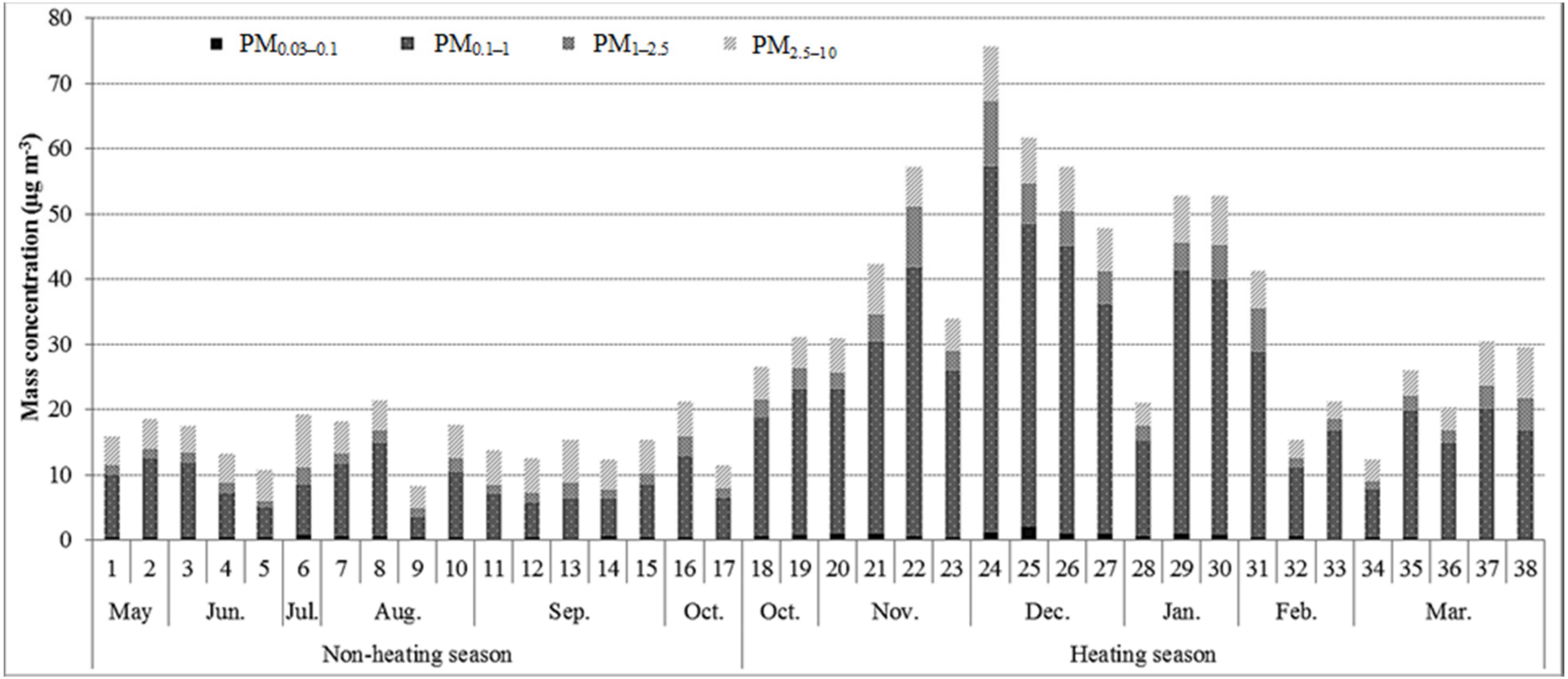

Figure S2. Mean contribution of the principal PM fractions to the total PM_{10} during each 5-d sampling session. The sample number is displayed on the x-axis.

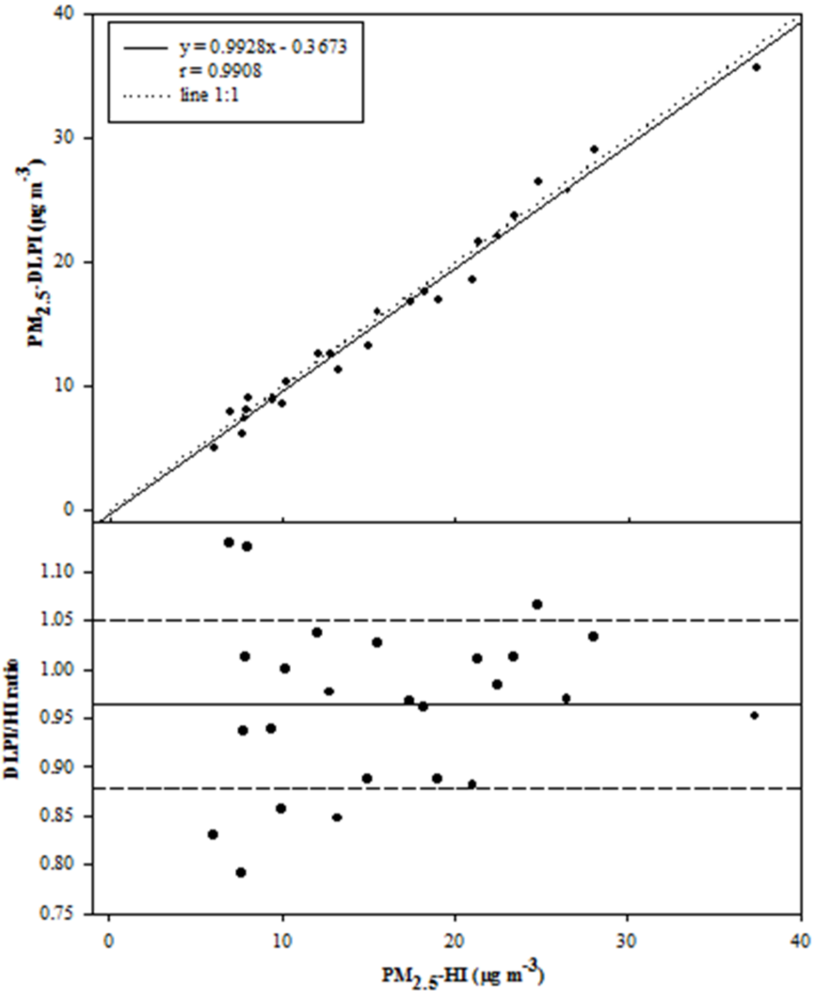

Figure S3. Linear regression between $PM_{2.5}$ concentrations (n = 25) determined via HI and DLPI. Only $PM_{2.5}$ data responding to the DLPI recommended operating conditions are reported in the graph. In the bottom panel, the DLPI/HI ratios as a function of $PM_{2.5}$-HI concentrations are reported. The mean ratio and its standard deviation (0.96 ± 0.09) are indicated by the solid and dashed lines, respectively.

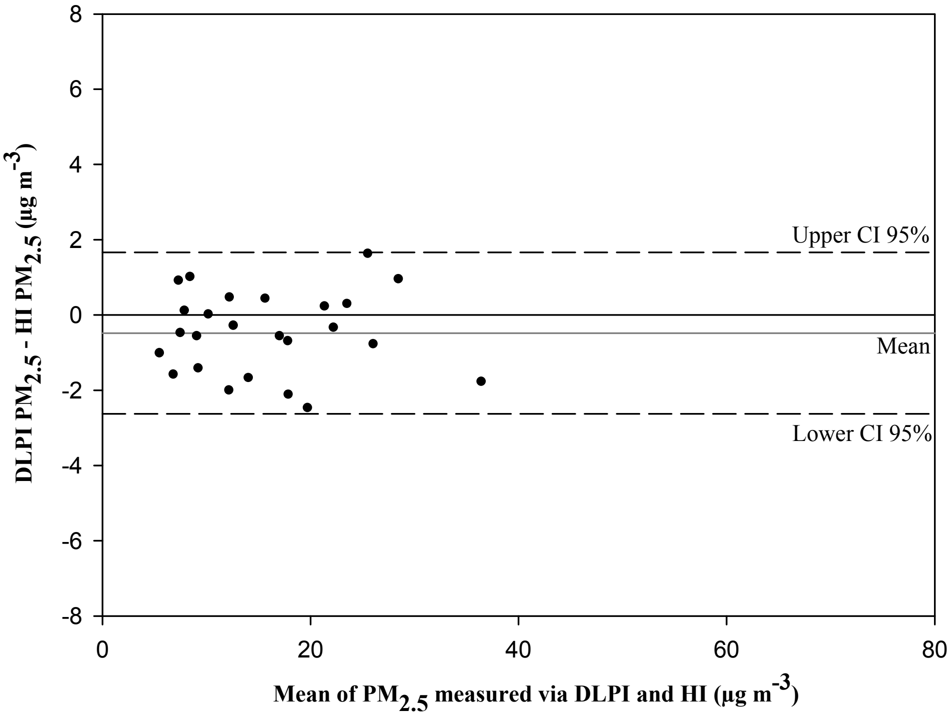

Figure S4. Comparison of $PM_{2.5}$ sampled with DLPI and HI using the Bland-Altman plot. Only $PM_{2.5}$ data responding to the DLPI recommended operating conditions are reported in the graph. The solid black line represents the perfect agreement between the two methods, the solid grey line represents the observed average, whereas broken lines correspond to the upper and lower 95% limits of agreement.