

Supporting Information

Atmospheric fine particulate matter (PM_{2.5}) in Bloemfontein, South Africa

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Figure S1 Stevenson meteorological instrument shelter, outside (*left*) and inside (*right*).

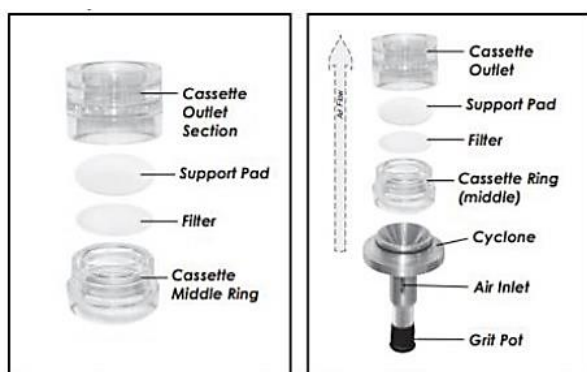


Figure S2 Cyclone Air Sampling assembly

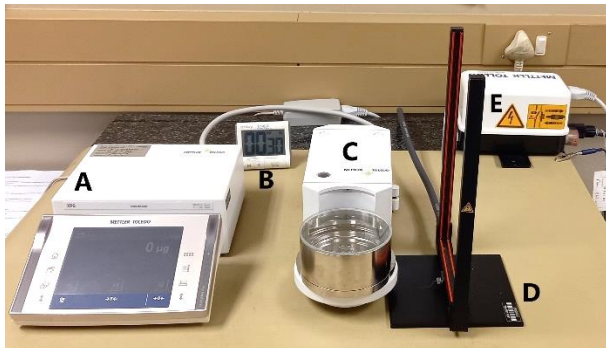


Figure S3 Mettler-Toledo XP6 Ultra-microbalance, where **A** is the control unit, **B** timer, **C** weighing chamber, **D** ionizer and **E** the AC adapter.



Figure S4 Diffusion System Ltd EEL model 43D Smoke Stain Reflectometer, where **A** is the control unit and **B** measuring head.

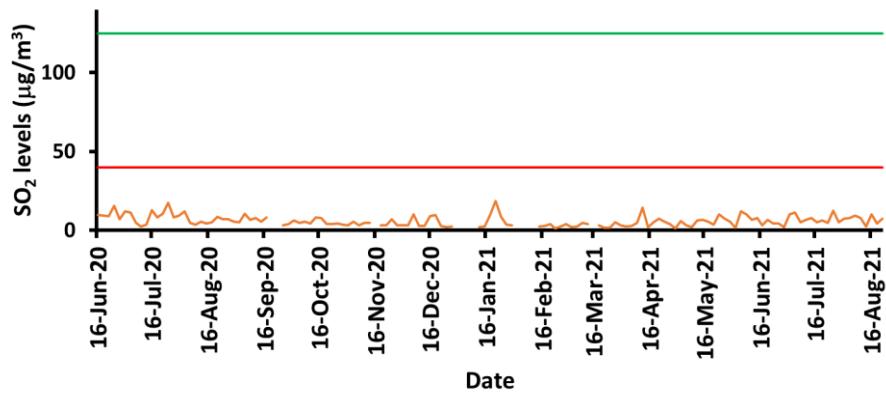


Figure S5 SO₂ concentration collected at Pelenomi hospital, Bloemfontein, SO₂ (orange), WHO daily guideline (red) and SA standard (green).ref

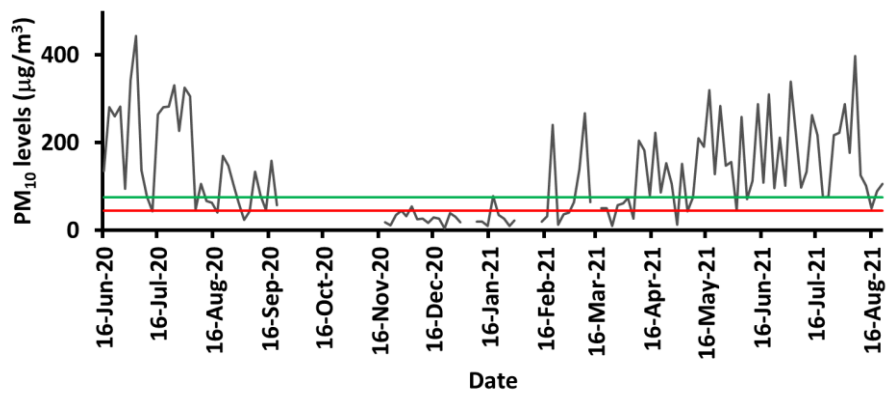


Figure S6 PM₁₀ concentration collected at Pelenomi hospital, Bloemfontein, PM₁₀ (blue), WHO daily guideline (red) and SA standard (green).ref

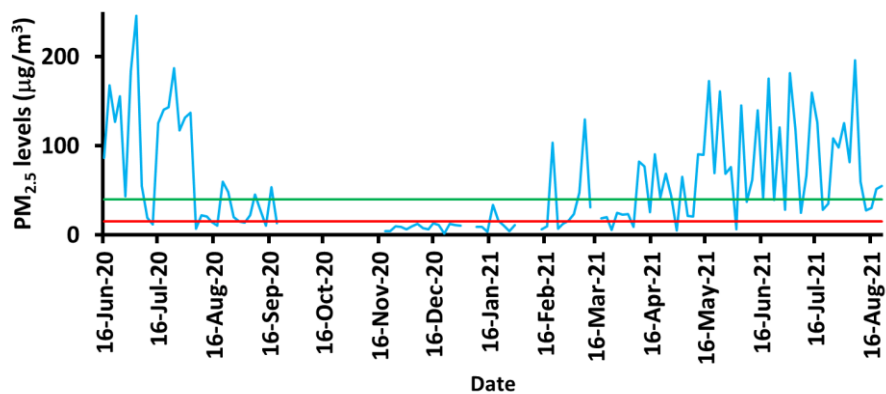


Figure S7 PM_{2.5} concentration collected at Pelenomi hospital, Bloemfontein, PM_{2.5} (blue), WHO daily guideline (red) and SA standard (green).ref

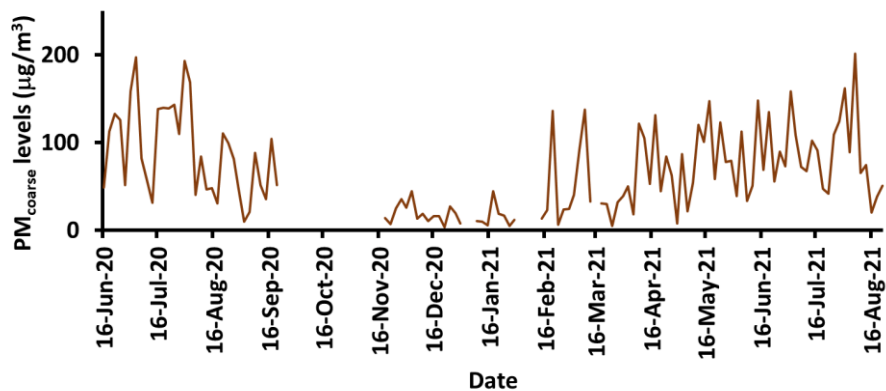


Figure S8 PM_{Coarse} concentration collected at Pelenomi hospital, Bloemfontein.ref

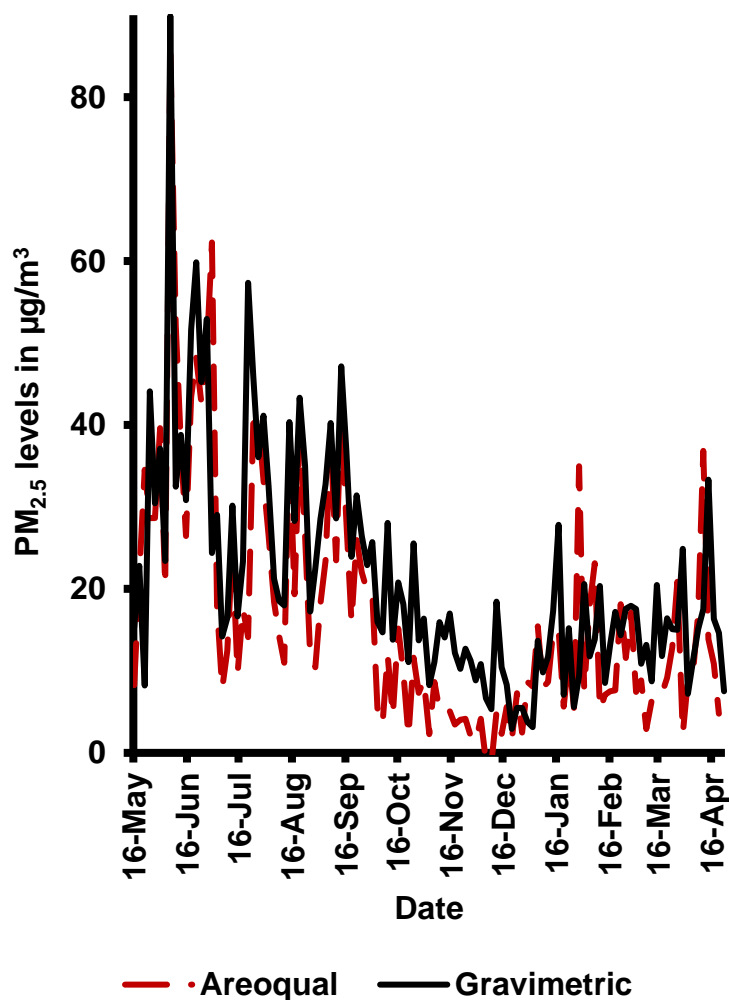


Figure S9 Comparison between PM_{2.5} levels obtained with gravimetric analysis against the real-time continuous Aeroqual instrument, measured at the School of Health Systems and Public Health, University of Pretoria from 19 April 2018 to 23 April in 2019.

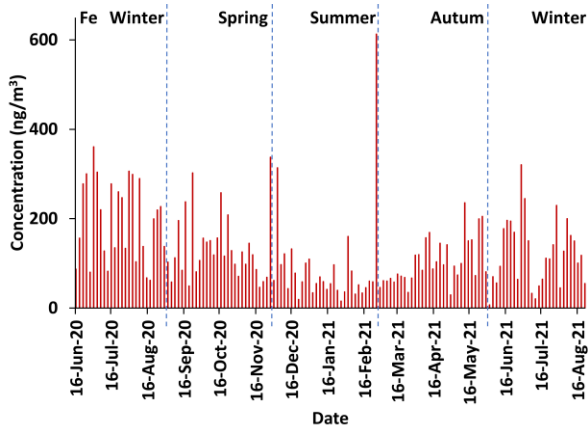


Figure S10 Time series XRF Fe results including the outlier.

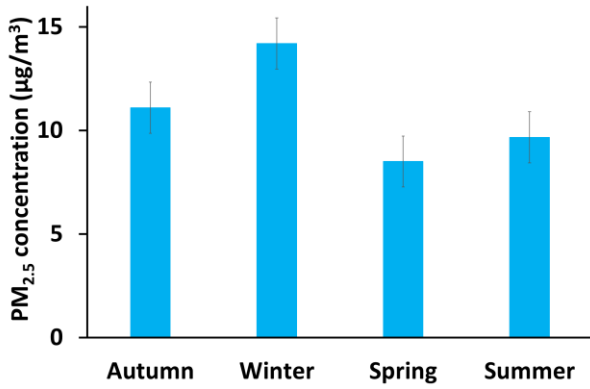


Figure S11 PM_{2.5} concentration with Kruskal-Wallis p test values (grey lines).

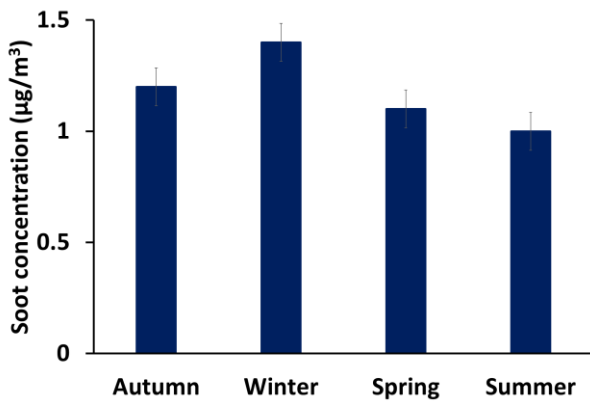


Figure S12 Soot concentration with Kruskal-Wallis p test values (grey lines).

Table S1 Weather variables for comparison with PM_{2.5} Concentration

Date	Temperature (°C)	Humidity (%)	Wind Speed (km/h)	Wind Direction	Pressure (mbar)	Pressure (kPa)
16-Jun-20	14	45	16	NNE	1033	103.3
19-Jun-20	16	40	7	N	1030	103.0
22-Jun-20	18	25	9	N	1026	102.6
25-Jun-20	19	25	9	N	1024	102.4
28-Jun-20	13	54	13	WSW	1023	102.3
01-Jul-20	19	37	10	NNW	1029	102.9
04-Jul-20	20	16	10	W	1028	102.8
07-Jul-20	21	18	10	S	1025	102.5
10-Jul-20	21	33	32	NNW	1013	101.3
13-Jul-20	19	18	21	NW	1018	101.8
16-Jul-20	18	15	4	N	1037	103.7
19-Jul-20	23	9	4	N	1029	102.9
22-Jul-20	20	12	7	N	1027	102.7
25-Jul-20	17	32	12	N	1028	102.8
28-Jul-20	18	31	16	WNW	1024	102.4
31-Jul-20	22	11	8	N	1031	103.1
03-Aug-20	23	18	14	NW	1028	102.8
06-Aug-20	16	15	16	W	1022	102.2
09-Aug-20	18	30	26	W	1019	101.9
12-Aug-20	19	14	12	WNW	1021	102.1
15-Aug-20	22	14	21	W	1013	101.3
18-Aug-20	9	31	24	SW	1020	102.0
21-Aug-20	19	13	8	N	1026	102.6
24-Aug-20	24	23	16	NNW	1018	101.8
27-Aug-20	25	21	27	W	1013	101.3
30-Aug-20	13	21	11	SSW	1023	102.3
02-Sep-20	16	70	34	NNE	1023	102.3
05-Sep-20	29	30	14	NNW	1023	102.3
08-Sep-20	26	32	9	NW	1022	102.2
11-Sep-20	28	16	14	NNW	1024	102.4
14-Sep-20	25	18	21	NW	1017	101.7
17-Sep-20	25	8	8	N	1021	102.1
20-Sep-20	30	8	18	W	1015	101.5
23-Sep-20	26	23	6	N	1024	102.4
26-Sep-20	19	15	21	WSW	1015	101.5
29-Sep-20	20	11	11	S	1022	102.2
02-Oct-20	21	63	35	NNE	1014	101.4
05-Oct-20	26	21	10	NW	1020	102.0
08-Oct-20	27	34	16	N	1017	101.7
11-Oct-20	21	23	11	N	1019	101.9
14-Oct-20	29	17	8	N	1024	102.4
17-Oct-20	35	9	21	W	1017	101.7
20-Oct-20	30	11	17	W	1017	101.7
23-Oct-20	34	19	17	W	1022	102.2

26-Oct-20	33	21	18	WNW	1017	101.7
29-Oct-20	28	33	24	WSW	1020	102.0
01-Nov-20	19	63	21	NE	1020	102.0
04-Nov-20	28	33	16	N	1012	101.2
07-Nov-20	30	23	26	WNW	1016	101.6
10-Nov-20	27	40	20	W	1019	101.9
13-Nov-20	30	32	14	NW	1021	102.1
16-Nov-20	32	31	20	NW	1016	101.6
19-Nov-20	28	24	19	W	1016	101.6
22-Nov-20	27	54	20	N	1015	101.5
25-Nov-20	25	22	12	W	1017	101.7
28-Nov-20	26	53	34	NNW	1018	101.8
01-Dec-20	28	17	21	W	1013	101.3
04-Dec-20	29	19	14	SW	1017	101.7
07-Dec-20	29	36	11	N	1020	102.0
10-Dec-20	30	42	23	NW	1013	101.3
13-Dec-20	29	42	23	NNW	1017	101.7
16-Dec-20	31	34	10	NNW	1018	101.8
19-Dec-20	31	36	18	NNE	1018	101.8
22-Dec-20	21	92	14	NE	1015	101.5
25-Dec-20	30	29	14	W	1016	101.6
28-Dec-20	34	33	24	N	1015	101.5
31-Dec-20	30	59	19	N	1016	101.6
03-Jan-21	21	79	11	SSE	1022	102.2
06-Jan-21	29	42	14	SSE	1015	101.5
09-Jan-21	28	62	15	WSW	1015	101.5
12-Jan-21	26	66	11	NNW	1019	101.9
15-Jan-21	23	92	12	NNW	1013	101.3
18-Jan-21	28	43	8	N	1016	101.6
21-Jan-21	32	44	9	N	1020	102.0
24-Jan-21	31	46	14	SSE	1014	101.4
27-Jan-21	22	91	17	S	1012	101.2
30-Jan-21	29	37	9	SW	1011	101.1
02-Feb-21	18	86	19	NE	1024	102.4
05-Feb-21	30	46	6	N	1019	101.9
08-Feb-21	29	49	14	N	1016	101.6
11-Feb-21	30	42	9	N	1018	101.8
14-Feb-21	31	44	9	N	1012	101.2
17-Feb-21	29	42	12	NW	1016	101.6
20-Feb-21	31	16	24	W	1015	101.5
23-Feb-21	22	90	15	NNW	1022	102.2
26-Feb-21	29	35	9	N	1016	101.6
01-Mar-21	26	43	10	N	1023	102.3
04-Mar-21	31	27	14	W	1016	101.6
07-Mar-21	30	18	24	WSW	1018	101.8
10-Mar-21	29	22	17	NW	1016	101.6
13-Mar-21	29	38	9	N	1022	102.2
16-Mar-21	28	42	17	NNW	1017	101.7

19-Mar-21	30	31	13	W	1019	101.9
22-Mar-21	27	28	12	SW	1020	102.0
25-Mar-21	19	87	14	N	1013	101.3
28-Mar-21	25	35	9	NE	1021	102.1
31-Mar-21	26	42	13	WNW	1020	102.0
03-Apr-21	27	29	11	SW	1022	102.2
06-Apr-21	28	38	15	N	1021	102.1
09-Apr-21	30	21	12	WSW	1022	102.2
12-Apr-21	30	26	10	NNE	1028	102.8
15-Apr-21	30	23	12	SW	1022	102.2
18-Apr-21	25	34	7	N	1026	102.6
21-Apr-21	25	31	12	WNW	1025	102.5
24-Apr-21	24	21	20	S	1019	101.9
27-Apr-21	26	26	19	WNW	1018	101.8
30-Apr-21	16	66	21	SSW	1019	101.9
03-May-21	22	32	8	N	1025	102.5
06-May-21	24	33	15	N	1022	102.2
09-May-21	20	38	14	SSW	1025	102.5
12-May-21	25	20	11	W	1024	102.4
15-May-21	25	22	20	WNW	1017	101.7
18-May-21	21	24	13	NNW	1025	102.5
21-May-21	13	41	11	WSW	1026	102.6
24-May-21	21	29	7	NW	1027	102.7
27-May-21	23	24	15	NW	1023	102.3
30-May-21	17	23	9	SSW	1022	102.2
02-Jun-21	18	46	29	S	1022	102.2
05-Jun-21	17	20	8	N	1031	103.1
08-Jun-21	16	43	17	NE	1027	102.7
11-Jun-21	21	37	15	NNW	1023	102.3
14-Jun-21	23	22	11	WSW	1024	102.4
17-Jun-21	21	26	15	W	1023	102.3
20-Jun-21	19	40	7	W	1031	103.1
23-Jun-21	20	29	15	NW	1021	102.1
26-Jun-21	15	26	16	WSW	1019	101.9
29-Jun-21	25	20	24	NNW	1018	101.8
02-Jul-21	16	39	7	SW	1025	102.5
05-Jul-21	18	12	7	SE	1028	102.8
08-Jul-21	20	23	26	NNW	1024	102.4
11-Jul-21	22	19	17	NW	1025	102.5
14-Jul-21	11	29	8	N	1030	103.0
17-Jul-21	18	25	9	SW	1030	103.0
20-Jul-21	18	17	17	NW	1023	102.3
23-Jul-21	12	16	14	SSE	1033	103.3
26-Jul-21	16	27	15	N	1030	103.0
29-Jul-21	19	14	12	WSW	1028	102.8
01-Aug-21	22	18	15	WSW	1029	102.9
04-Aug-21	23	22	9	N	1026	102.6
07-Aug-21	22	11	7	N	1025	102.5

10-Aug-21	18	27	11	NE	1027	102.7
13-Aug-21	17	40	25	NNE	1026	102.6
16-Aug-21	16	52	19	N	1025	102.5
19-Aug-21	16	31	16	WNW	1017	101.7
22-Aug-21	21	22	7	N	1022	102.2

Table S2 PM_{2.5} bound trace element summary of XRF results

Element	S/N	Present in number of filters	Concentration (ng/m³)	Uncertainty (ng/m³)
S	35	178	540	13
Si	15	179	440	24
K	20	178	160	6.4
Fe	16	180	130	7.0
Ca	14	178	100	6.0
Cl	7.1	172	30	3.2
Zn	3.7	169	7.6	1.7
Ba	3.2	149	36	8.6
Cu	2.7	150	8.1	2.8
Br	2.5	148	5.8	1.5
Ti	0.96	108	14	7.9
V	0.95	34	15	3.8
Mn	0.77	108	9.6	5.4
Cr	0.31	17	2.4	1.5
Ni	0.19	17	1.6	2.5
Sr	0.12	61	1.7	2.1
U	0.090	18	2.4	4.3
Ag	0.083	52	17	20
P	0.0	1	22	54

Table S3 Descriptive statistics of PM_{2.5} and its soot and trace element composition in Bloemfontein, South Africa during 26 June 2020 to 18 August 2021 (n=180 samples)

Variable	Mean	Std. Dev.	Median	Min	Max
PM _{2.5} (µg/m ³)	11	7.3	9.7	0.52	51
Soot (µg/m ³)	1.2	0.28	1.1	0.81	2.4
Ag (ng/m ³)	17	7.2	15	11	37
Ba (ng/m ³)	36	19	40	0.30	67
Br (ng/m ³)	5.8	6.8	3.4	0.40	47
Ca (ng/m ³)	100	71	79	0.40	400
Cu (ng/m ³)	8.1	3.7	7.6	2.9	17
Cl (ng/m ³)	30	39	17	0.80	260
Cr (ng/m ³)	2.4	6.5	0.50	0.50	46
Fe (ng/m ³)	130	89	100	7.3	610
K (ng/m ³)	160	170	94	6.6	830
Mn (ng/m ³)	9.6	8.3	9.2	0.20	40
Ni (ng/m ³)	1.6	2.8	0.90	0.20	25
P (ng/m ³)	22	8.2	21	0.30	51
S (ng/m ³)	540	570	360	5.0	3400
Si (ng/m ³)	440	330	360	15	1900
Ti (ng/m ³)	14	13	11	0.0	76
U (ng/m ³)	2.4	1.7	1.8	0.0	7.3
V (ng/m ³)	15	37	0.60	0.60	160
Zn (ng/m ³)	7.6	5.4	5.7	2.0	33

Table S4 Autumn descriptive statistical analysis. Number of filters observed for the season (Obs)

AUTUMN						
Variable	Obs	Mean	Std. Dev.	Median	Min	Max
PM _{2.5} (µg/m ³)	39	11	7.1	8.7	1.39	33
Soot (µg/m ³)	39	1.2	0.20	0.96	1.10	1.7
Ag (ng/m ³)	39	17	7.2	15	10.6	37
Ba (ng/m ³)	39	36	15	38	2.31	64
Br (ng/m ³)	39	4.4	4.3	2.4	0.43	20
Ca (ng/m ³)	39	82	47	73	15.1	230
Cu (ng/m ³)	39	7.3	3.6	5.7	2.95	15
Cl (ng/m ³)	39	17	6.7	15	2.76	34
Cr (ng/m ³)	39	0.95	0.93	0.53	0.53	3.7
Fe (ng/m ³)	39	100	55	95	29.5	240
K (ng/m ³)	39	90	94	54	22.1	550
Mn (ng/m ³)	39	9.7	6.6	8.5	0.46	24
Ni (ng/m ³)	39	1.1	0.90	0.86	0.84	5.8
P (ng/m ³)	39	22	8.2	22	3.98	44
S (ng/m ³)	39	450	450	350	30.1	1700
Si (ng/m ³)	39	300	170	270	91.7	790
Ti (ng/m ³)	39	9.0	7.2	7.0	0.03	34
U (ng/m ³)	39	2.4	2.0	1.6	0.21	6.9
V (ng/m ³)	39	6.7	19	0.64	0.64	81
Zn (ng/m ³)	39	6.5	3.1	5.8	2.00	16

Table S5 Spring descriptive statistical analysis. Number of filters observed for the season (Obs)

SPRING						
Variable	Obs	Mean	Std. Dev.	Median	Min	Max
PM _{2.5} (µg/m ³)	37	8.5	4.9	8.0	0.52	25
Soot (µg/m ³)	37	1.2	0.16	0.92	1.1	1.6
Ag (ng/m ³)	37	18	6.5	17	11	36
Ba (ng/m ³)	37	42	12	43	12	63
Br (ng/m ³)	37	4.6	3.8	3.2	0.43	14
Ca (ng/m ³)	37	94	54	73	15	240
Cu (ng/m ³)	37	9.3	3.6	8.6	4.2	17
Cl (ng/m ³)	37	24	23	17	4.9	120
Cr (ng/m ³)	37	2.9	7.3	0.53	0.53	35
Fe (ng/m ³)	37	130	73	120	23	340
K (ng/m ³)	37	140	110	96	6.6	520
Mn (ng/m ³)	37	12	7.9	11	0.74	40
Ni (ng/m ³)	37	0.85	0.01	0.85	0.83	0.88
P (ng/m ³)	37	22	7.4	22	0.33	36
S (ng/m ³)	37	510	590	320	9.6	2800
Si (ng/m ³)	37	500	340	400	46	1900
Ti (ng/m ³)	37	14	13	9.4	2.0	76
U (ng/m ³)	37	2.5	1.7	2.1	0.02	4.3
V (ng/m ³)	37	20	44	0.64	0.64	160
Zn (ng/m ³)	37	7.4	5.5	5.6	2.8	33

Table S6 Summer descriptive statistical analysis. Number of filters observed for the season (Obs)

SUMMER						
Variable	Obs	Mean	Std. Dev.	Median	Min	Max
PM _{2.5} (µg/m ³)	38	9.7	8.6	8.2	1.7	51
Soot (µg/m ³)	38	1.0	0.06	0.94	1.1	1.2
Ag (ng/m ³)	38	17	7.2	15	11	33
Ba (ng/m ³)	38	42	9.9	41	18	63
Br (ng/m ³)	38	1.9	1.2	2.0	0.43	4.4
Ca (ng/m ³)	38	52	31	51	0.40	130
Cu (ng/m ³)	38	8.4	3.5	7.9	3.0	15
Cl (ng/m ³)	38	28	48	14	1.0	220
Cr (ng/m ³)	38	5.8	11	0.53	0.53	46
Fe (ng/m ³)	38	84	100	60	16	610
K (ng/m ³)	38	55	42	42	8.2	180
Mn (ng/m ³)	38	15	9.8	13	0.74	37
Ni (ng/m ³)	38	1.5	3.8	0.85	0.83	25
P (ng/m ³)	38	21	4.2	20	13	30
S (ng/m ³)	38	660	560	490	5.0	1900
Si (ng/m ³)	38	280	280	200	15	1700
Ti (ng/m ³)	38	9.2	13	4.7	0.04	64
U (ng/m ³)	38	2.7	1.7	3.5	0.10	4.3
V (ng/m ³)	38	31	56	0.64	0.64	160
Zn (ng/m ³)	38	5.5	2.7	4.5	2.8	16

Table S7 Winter descriptive statistical analysis. Number of filters observed for the season (Obs)

WINTER						
Variable	Obs	Mean	Std. Dev.	Min	Median	Max
PM _{2.5} (µg/m ³)	66	14	6.9	1.8	13	34
Soot (µg/m ³)	66	1.4	0.35	1.3	0.81	2.4
Ag (ng/m ³)	66	16	7.7	11	11	37
Ba (ng/m ³)	66	28	25	0.31	18	67
Br (ng/m ³)	66	9.7	9.0	0.43	7.4	47
Ca (ng/m ³)	66	140	86	27	130	400
Cu (ng/m ³)	66	7.8	3.9	3.0	7.2	16
Cl (ng/m ³)	66	42	49	0.84	28	260
Cr (ng/m ³)	66	1.0	2.9	0.53	0.53	24
Fe (ng/m ³)	66	160	93	7.3	140	380
K (ng/m ³)	66	270	200	23	230	830
Mn (ng/m ³)	66	5.0	5.8	0.24	1.4	23
Ni (ng/m ³)	66	2.4	3.3	0.19	0.94	16
P (ng/m ³)	66	23	10	1.1	22	51
S (ng/m ³)	66	540	640	21	300	3400
Si (ng/m ³)	66	570	360	24	500	1700
Ti (ng/m ³)	66	20	13	2.3	20	58
U (ng/m ³)	66	2.3	1.6	0.15	1.7	7.3
V (ng/m ³)	66	8.9	21	0.64	0.64	110
Zn (ng/m ³)	66	9.7	6.9	2.0	7.3	30