Supplementary Information

Assessing the sources of particles at an urban background site using both regulatory instruments and low-cost sensors – A comparative study

Dimitrios Bousiotis[1], Ajit Singh[1], Molly Haugen[3], David C.S. Beddows[1], Sebastián Diez[2], Pete M. Edwards[2], Adam Boies[3], Roy M. Harrison[1] and Francis D. Pope[1]

[1] Division of Environmental Health and Risk Management
School of Geography, Earth and Environmental Sciences
University of Birmingham, Edgbaston, Birmingham B15 2TT, United Kingdom

[2] Wolfson Atmospheric Chemistry Laboratories, Department of Chemistry, University of York, Heslington, York YO10 5DD, United Kingdom

[3] Department of Engineering, University of Cambridge, Trumpington Street, Cambridge, CB2 1PZ, United Kingdom

Table S1: Conditions for the simultaneous occurrence of the clusters from the OPC and SMPS datasets

NO_2 (ppb)	SMPS.1	SMPS.2	SMPS.3	SMPS.4	SMPS.5	SMPS.6	Avg. OPC
OPC.1	14.27	22.59	3.98	14.49	17.80	14.86	**18.56**
OPC.2	12.60	9.10	NA	10.14	NA	8.17	**9.64**
OPC.3	NA	NA	NA	13.10	NA	NA	**13.10**
OPC.4	13.64	14.42	4.30	11.44	2.50	10.25	**11.50**
OPC.5	23.40	17.24	5.32	21.17	30.99	17.58	**18.30**
OPC.6	8.68	10.84	3.03	8.80	NA	8.17	**8.58**
Avg. SMPS	**16.03**	**16.80**	**4.38**	**14.26**	**29.83**	**13.20**	

BC (ng m^{-3})	SMPS.1	SMPS.2	SMPS.3	SMPS.4	SMPS.5	SMPS.6	Avg. OPC
OPC.1	351.1	602.6	82.2	392.5	370.1	357.3	**554.6**
OPC.2	237.8	223.8	NA	261.0	NA	190.6	**232.9**
OPC.3	NA	NA	NA	278.0	NA	NA	**278.0**
OPC.4	295.4	278.5	85.7	329.5	29.4	261.6	**280.6**
OPC.5	1029.7	481.7	94.4	849.1	1448.5	510.3	**659.3**
OPC.6	194.8	189.5	83.2	240.9	NA	198.2	**197.5**
Avg. SMPS	**485.5**	**405.7**	**88.1**	**451.7**	**1389.1**	**340.1**	

O_3 (ppb)	SMPS.1	SMPS.2	SMPS.3	SMPS.4	SMPS.5	SMPS.6	Avg. OPC
OPC.1	32.5	28.7	42.1	33.8	26.6	35.0	**31.9**
OPC.2	38.4	39.3	NA	38.3	NA	38.7	**38.6**
OPC.3	NA	NA	NA	37.6	NA	NA	**37.6**
OPC.4	33.4	34.2	41.2	37.6	44.2	37.2	**36.5**
OPC.5	28.4	33.0	40.2	32.3	15.0	33.3	**31.5**
OPC.6	40.2	37.0	44.0	40.6	NA	40.4	**40.0**
Avg. SMPS	**32.2**	**32.9**	**41.6**	**35.6**	**16.1**	**36.0**	

PM_1 (µg m^{-3})	SMPS.1	SMPS.2	SMPS.3	SMPS.4	SMPS.5	SMPS.6	Avg. OPC
OPC.1	2.88	3.28	2.40	3.43	4.60	2.53	**4.32**
OPC.2	1.30	1.95	NA	3.10	NA	2.50	**2.56**
OPC.3	NA	NA	NA	2.95	NA	NA	**2.95**
OPC.4	2.42	1.97	2.42	3.20	0.30	2.33	**2.51**
OPC.5	5.63	3.16	2.78	5.38	18.72	3.14	**6.27**
OPC.6	2.25	2.31	2.73	3.23	NA	3.04	**2.85**
Avg. SMPS	**3.35**	**2.70**	**2.64**	**3.77**	**17.95**	**2.68**	

PM_{10} (µg m^{-3})	SMPS.1	SMPS.2	SMPS.3	SMPS.4	SMPS.5	SMPS.6	Avg. OPC
OPC.1	6.97	9.77	8.95	9.23	8.60	7.98	**9.97**
OPC.2	5.90	8.75	NA	11.46	NA	12.17	**10.65**
OPC.3	NA	NA	NA	9.70	NA	NA	**9.70**
OPC.4	7.32	6.54	7.97	11.11	0.90	7.66	**8.33**
OPC.5	17.26	10.48	10.18	13.98	26.11	10.81	**13.30**
OPC.6	8.32	8.84	8.66	11.16	NA	11.62	**10.31**
Avg. SMPS	**9.52**	**8.91**	**9.26**	**11.12**	**25.09**	**9.12**	

Organic (µg m^{-3})	SMPS.1	SMPS.2	SMPS.3	SMPS.4	SMPS.5	SMPS.6	Avg. OPC
OPC.1	0.201	0.219	0.061	0.293	0.603	0.230	**0.254**
OPC.2	0.012	0.183	NA	0.191	NA	0.076	**0.142**
OPC.3	NA	0.145	NA	0.088	0.738	0.116	**0.241**
OPC.4	0.127	0.074	0.051	0.168	0.747	0.121	**0.192**
OPC.5	0.373	0.115	0.041	0.396	1.425	0.170	**0.338**
OPC.6	0.118	0.094	0.110	0.102	0.739	0.081	**0.116**
Avg. SMPS	**0.215**	**0.132**	**0.062**	**0.249**	**1.066**	**0.164**	

NO_3^- (µg m^{-3})	SMPS.1	SMPS.2	SMPS.3	SMPS.4	SMPS.5	SMPS.6	Avg. OPC
OPC.1	0.055	0.037	0.057	0.084	0.323	0.065	**0.089**
OPC.2	0.003	0.019	NA	0.018	NA	0.016	**0.016**
OPC.3	NA	0.030	NA	0.008	0.350	0.032	**0.084**
OPC.4	0.026	0.013	0.015	0.092	0.642	0.026	**0.108**
OPC.5	0.097	0.029	0.008	0.119	0.641	0.028	**0.131**
OPC.6	0.016	0.020	0.011	0.018	0.639	0.013	**0.036**
Avg. SMPS	**0.055**	**0.026**	**0.021**	**0.081**	**0.574**	**0.039**	

SO_4^{2-} (µg m^{-3})	SMPS.1	SMPS.2	SMPS.3	SMPS.4	SMPS.5	SMPS.6	Avg. OPC
OPC.1	0.034	0.013	0.045	0.057	0.099	0.033	**0.041**
OPC.2	0.004	-0.013	NA	0.058	NA	0.020	**0.030**
OPC.3	NA	0.058	NA	-0.007	0.154	0.037	**0.067**
OPC.4	0.020	0.020	0.081	0.042	0.163	0.026	**0.045**
OPC.5	0.037	0.028	0.003	0.050	0.139	0.031	**0.041**
OPC.6	0.027	0.027	0.065	0.026	0.205	0.024	**0.035**
Avg. SMPS	**0.031**	**0.025**	**0.037**	**0.047**	**0.141**	**0.029**	

RH (%)	SMPS.1	SMPS.2	SMPS.3	SMPS.4	SMPS.5	SMPS.6	Avg. OPC
OPC.1	86.5	80.5	79.3	82.0	98.3	83.5	**83.9**
OPC.2	70.8	67.8	NA	68.3	NA	55.1	**65.1**
OPC.3	NA	92.4	NA	69.6	99.0	94.5	**91.8**
OPC.4	86.3	84.0	79.7	79.8	94.4	82.3	**83.4**
OPC.5	83.4	78.1	79.0	78.2	91.6	77.4	**82.6**
OPC.6	79.7	88.5	83.8	75.5	98.3	78.0	**80.8**
Avg. SMPS	**85.1**	**83.2**	**80.1**	**79.3**	**93.9**	**80.9**	

WS (m s^{-1})	SMPS.1	SMPS.2	SMPS.3	SMPS.4	SMPS.5	SMPS.6	Avg. OPC
OPC.1	4.24	3.55	6.38	4.81	2.36	4.97	**4.16**
OPC.2	6.30	6.90	NA	7.07	NA	7.62	**7.10**
OPC.3	NA	3.44	NA	5.90	2.09	4.07	**3.47**
OPC.4	4.01	3.68	6.98	4.28	3.97	5.13	**4.46**
OPC.5	3.33	4.16	7.13	4.55	2.06	4.04	**4.38**
OPC.6	5.78	3.27	8.38	5.41	2.76	4.76	**4.99**
Avg. SMPS	**4.10**	**3.74**	**7.19**	**4.77**	**2.60**	**4.83**	

T (°C)	SMPS.1	SMPS.2	SMPS.3	SMPS.4	SMPS.5	SMPS.6	Avg. OPC
OPC.1	5.17	4.15	5.48	5.99	5.28	5.76	**5.20**
OPC.2	5.44	6.64	NA	7.06	NA	8.42	**7.16**
OPC.3	NA	4.10	NA	7.47	5.50	3.73	**4.60**
OPC.4	5.42	4.24	6.19	7.24	6.84	6.55	**6.26**
OPC.5	5.73	6.76	8.10	7.56	3.72	6.20	**6.68**
OPC.6	7.72	3.16	9.11	8.18	5.80	5.79	**6.42**
Avg. SMPS	**5.53**	**4.64**	**7.43**	**6.97**	**4.90**	**6.10**	**NA**

Table S2: Weekly conditions for the time of the study (week number refers to weeks from the start of the year 2020)

Week	NO_2 (ppb)	BC (ng m^{-3})	PM_1 (mg m^{-3})	$PM_{2.5}$ (mg m^{-3})	PM_{10} (mg m^{-3})	O_3 (ppb)	NH_4^+ (µg m^{-3})	Org (µg m^{-3})	SO_4^{2-} (µg m^{-3})	NO_3^- (µg m^{-3})	RH (%)	WS (m s^{-1})	T (°C)
4	NA	NA	NA	NA	NA	NA	0.223	0.663	0.149	0.547	97.3	2.43	5.41
5	8.11	208	3.63	7.65	12.8	39.0	0.067	0.315	0.068	0.131	89.7	4.21	6.81
6	21.3	865	8.27	12.2	18.1	28.0	0.081	0.570	0.070	0.212	82.6	3.30	5.96
7	10.0	210	2.27	4.67	8.02	37.2	0.005	0.073	0.016	0.010	79.1	6.68	5.40
8	7.34	189	2.71	5.32	8.45	42.0	0.010	0.102	0.038	0.012	77.1	7.27	9.17
9	14.6	360	2.18	3.58	6.05	34.2	0.019	0.183	0.037	0.036	83.0	4.61	5.41
10	22.2	711	6.40	8.93	12.9	30.6	0.029	0.156	0.018	0.072	83.0	2.96	4.38
11	9.49	232	2.28	4.46	7.68	38.5	0.004	0.035	0.009	0.006	79.1	5.74	8.34

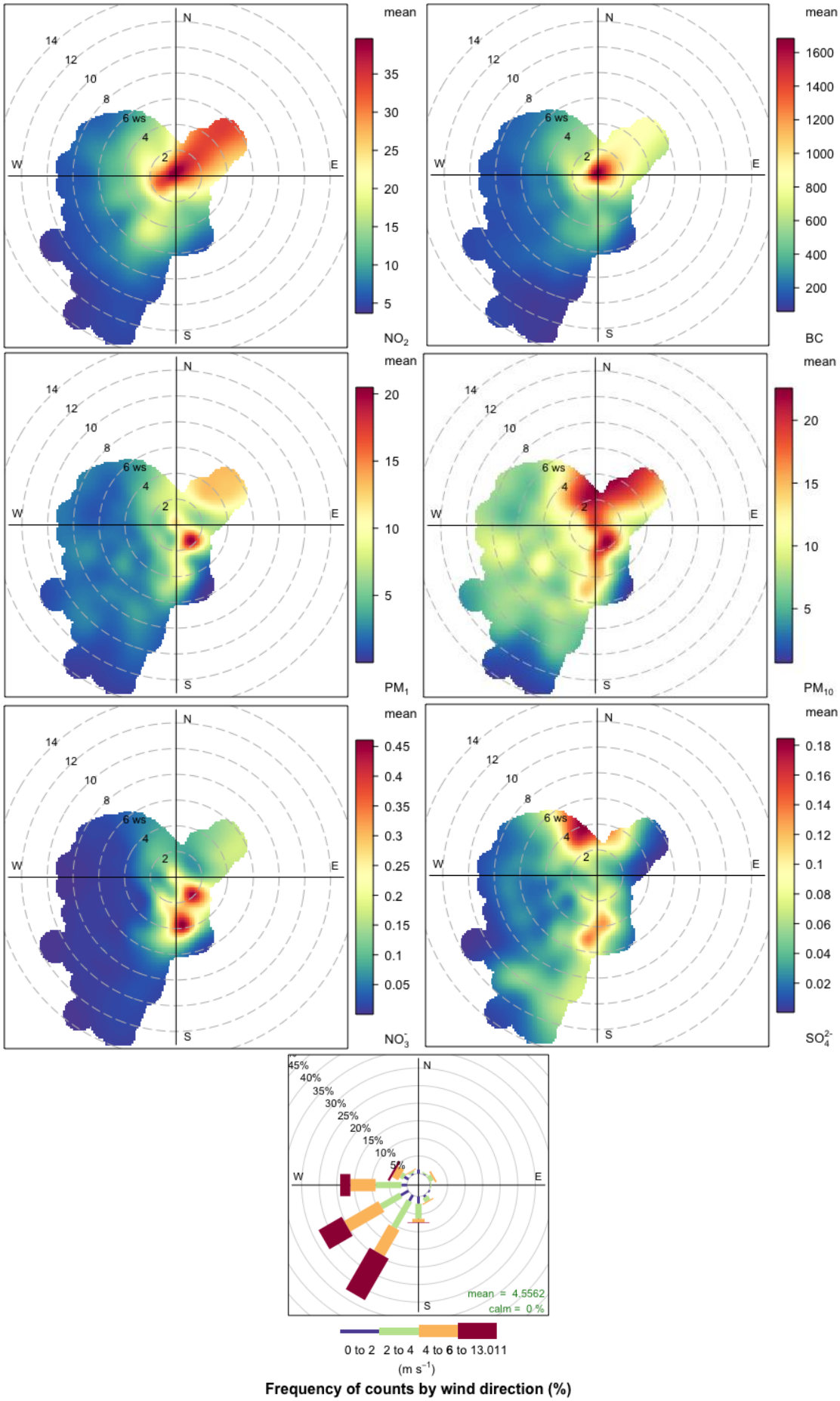


Figure S1: Polar plots of the average conditions and wind rose for the period studied

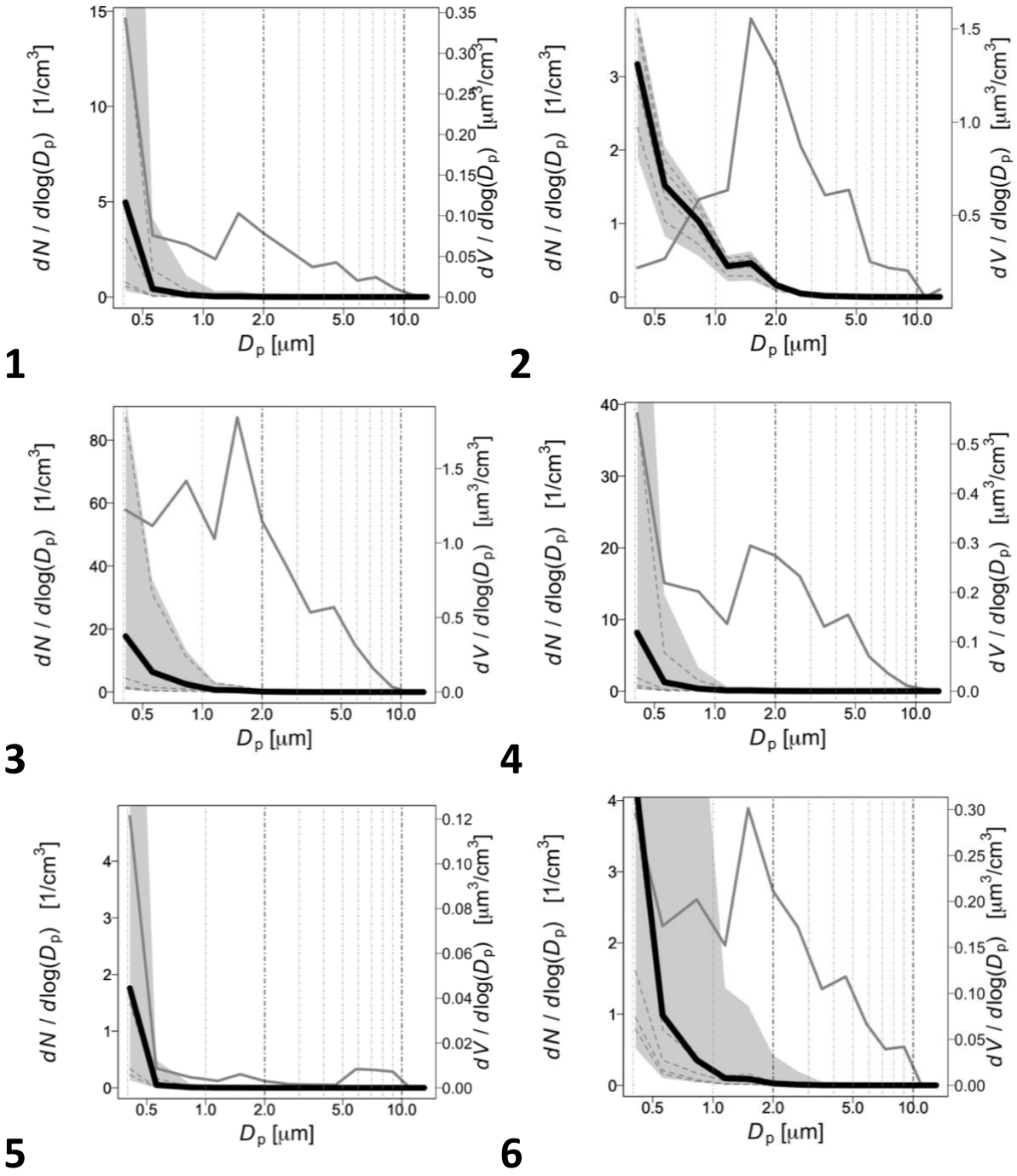
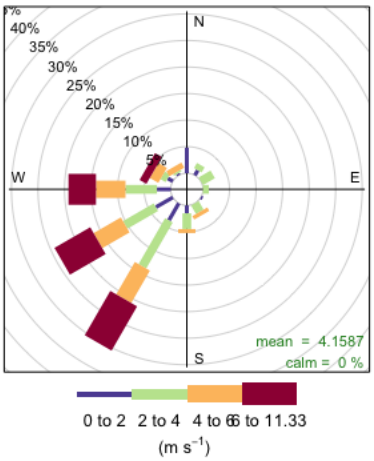
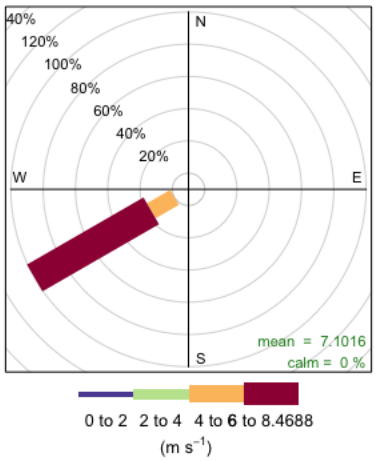


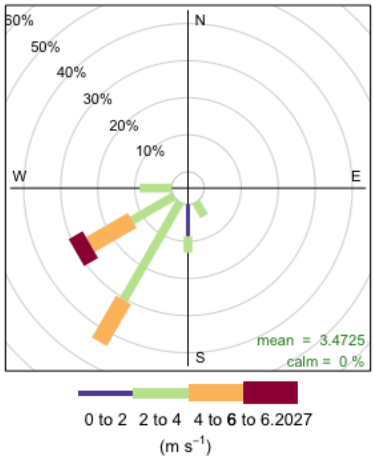
Figure S2: Average particle concentration and volume profiles for the OPC clusters



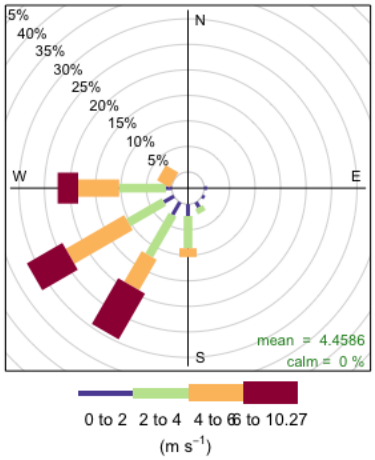
1 Frequency of counts by wind direction (%)



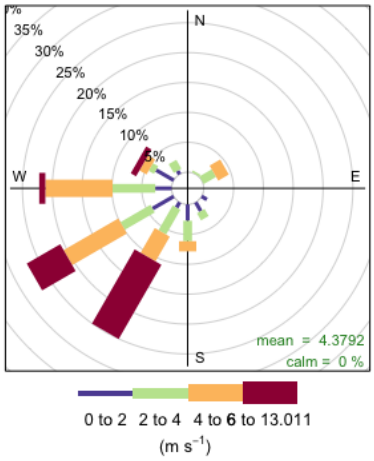
2 Frequency of counts by wind direction (%)



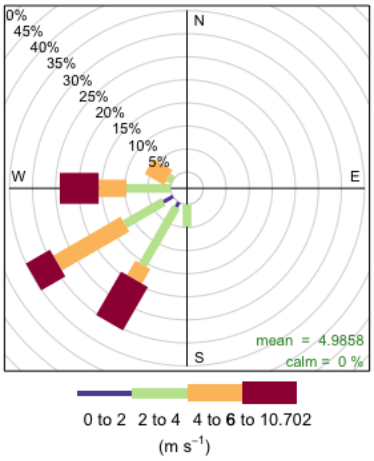
3 Frequency of counts by wind direction (%)



4 Frequency of counts by wind direction (%)

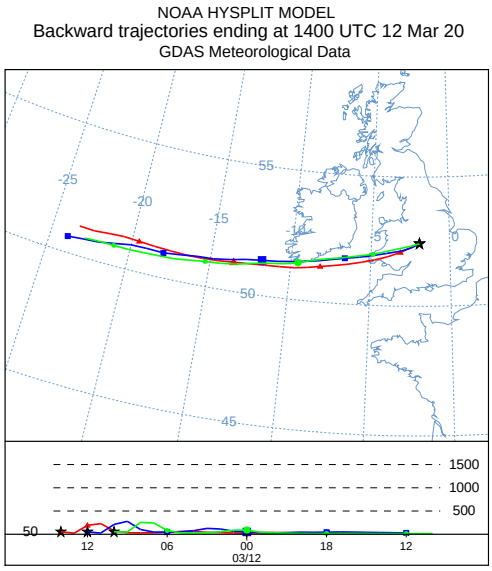


5 Frequency of counts by wind direction (%)



6 Frequency of counts by wind direction (%)

Figure S3: Wind direction profiles for the OPC clusters



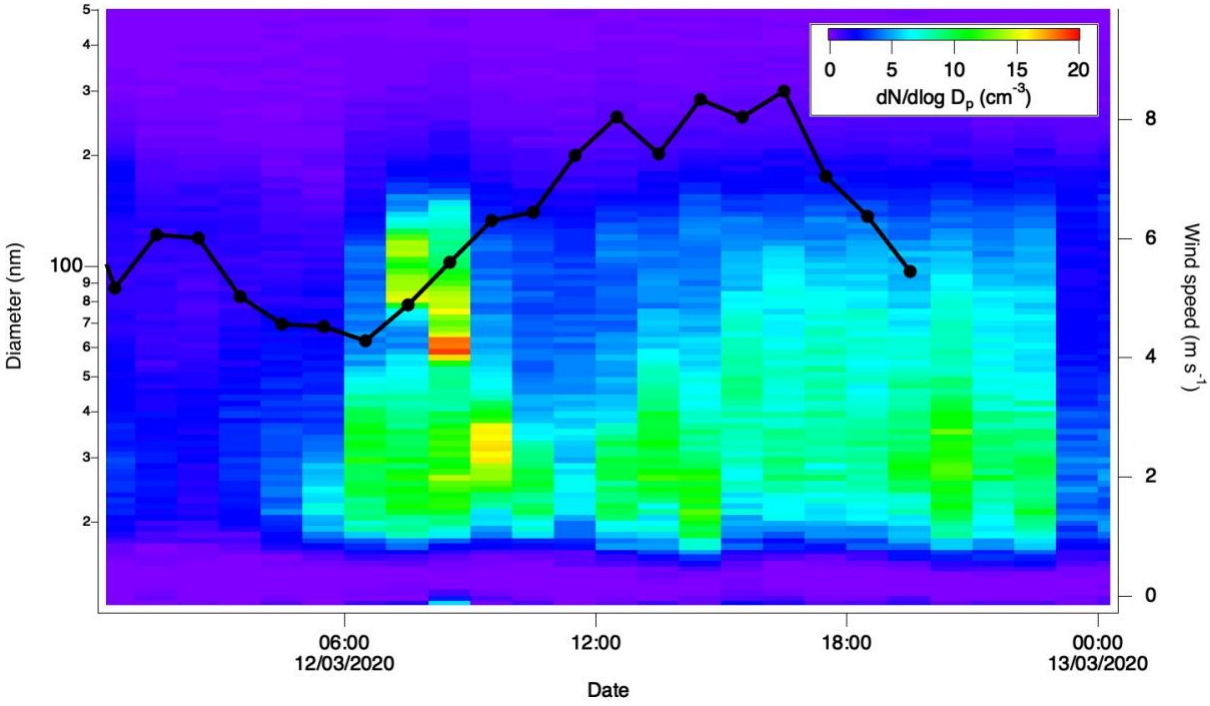


Figure S4: Particle size distribution on the 12th of March 2020 as found by the

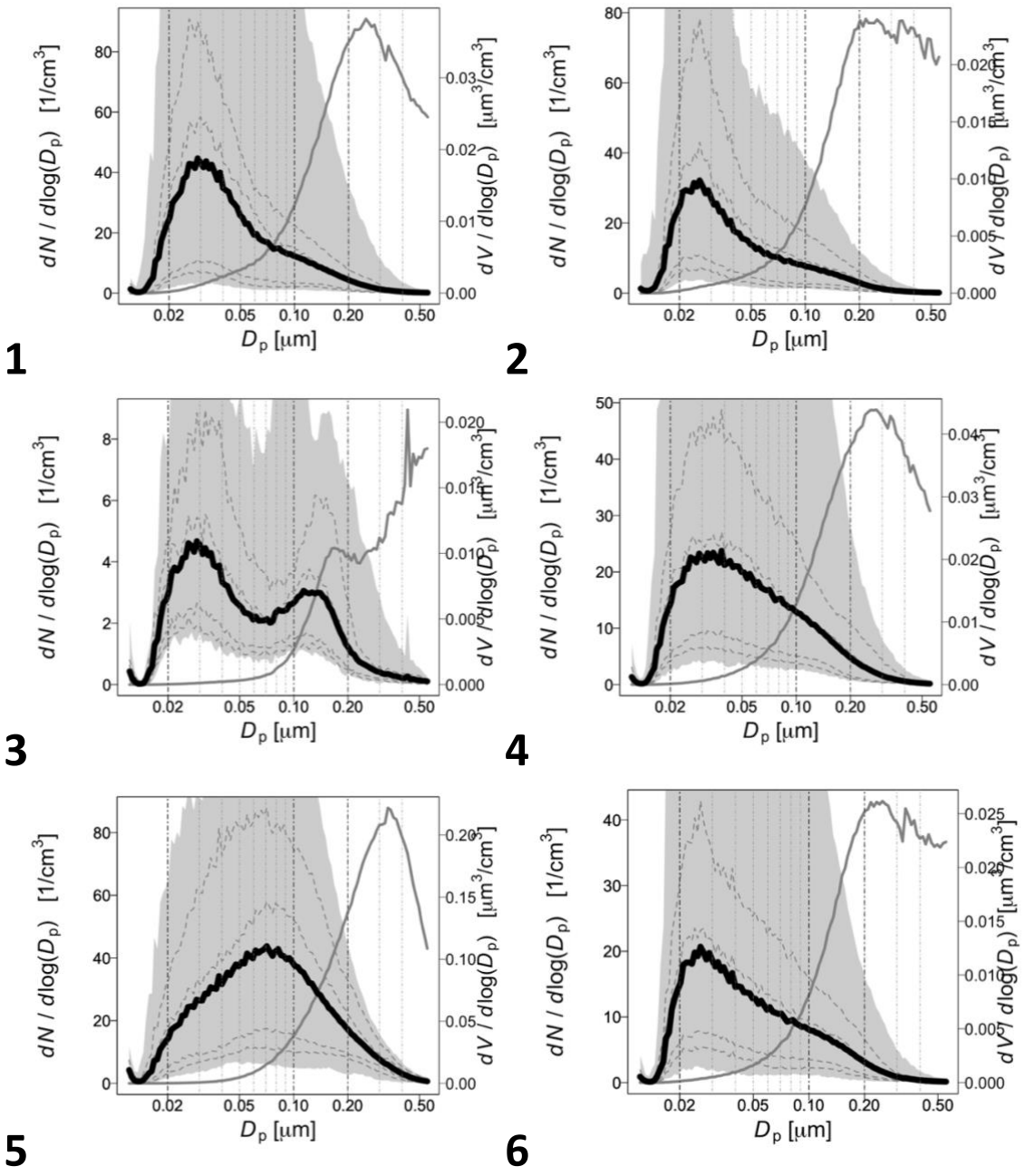
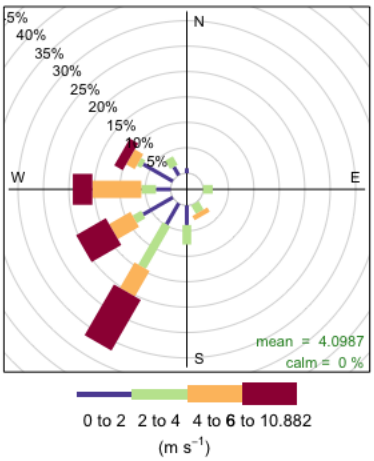
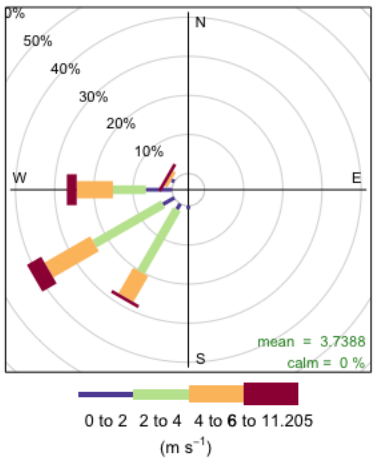


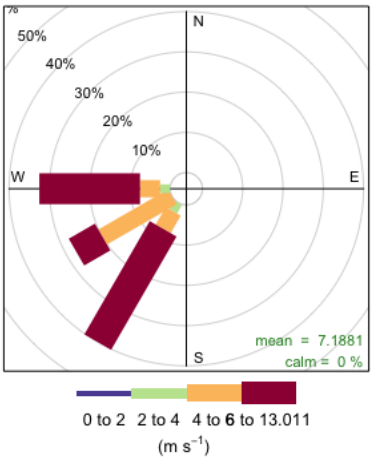
Figure S5: Average particle concentration and volume profiles for the SMPS clusters



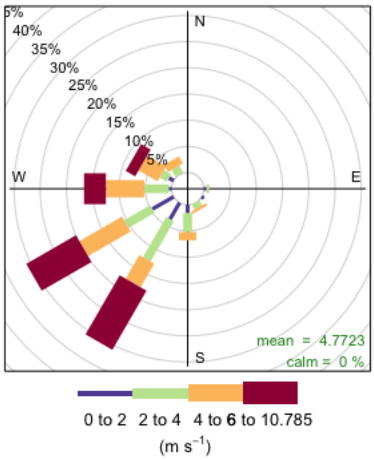
1 Frequency of counts by wind direction (%)



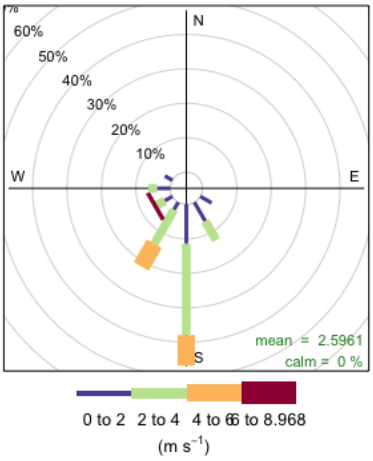
2 Frequency of counts by wind direction (%)



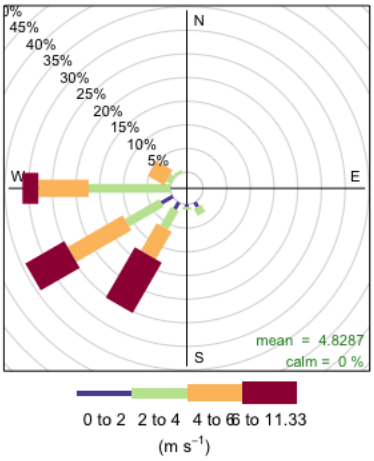
3 Frequency of counts by wind direction (%)



4 Frequency of counts by wind direction (%)



5 Frequency of counts by wind direction (%)



6 Frequency of counts by wind direction (%)

Figure S6: Wind direction profiles for the SMPS clusters

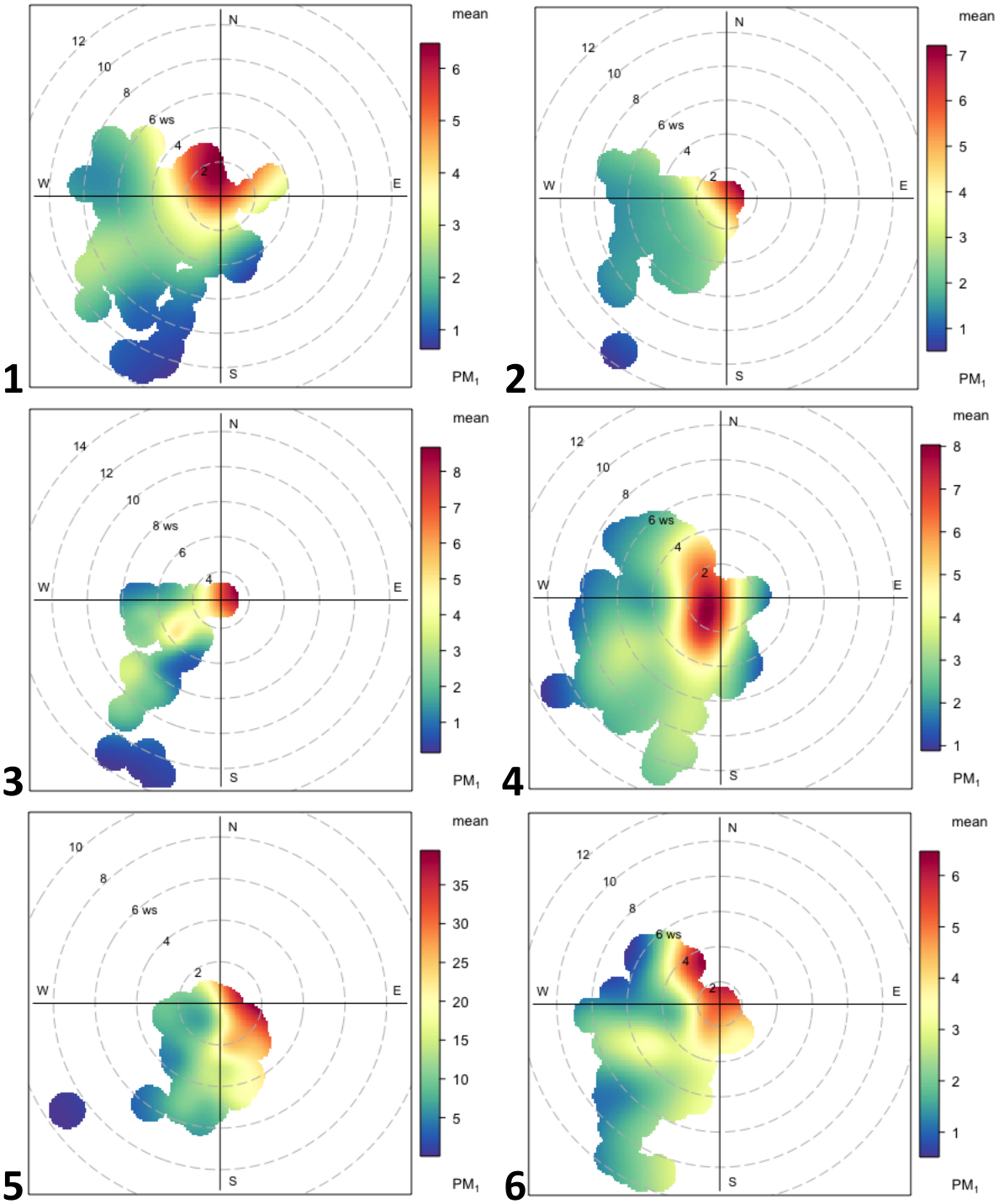


Figure S7: PM_1 polar plots of the clusters formed by the SMPS data