

## LIST OF SUPPLEMENTARIES

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**Table S1** List of Continuous Air Quality Monitoring Stations in Malaysia

<b>ID</b>	<b>Station</b>	<b>ID</b>	<b>Station</b>	<b>ID</b>	<b>Station</b>	<b>ID</b>	<b>Station</b>	<b>ID</b>	<b>Station</b>
CA01R	Kangar, Perlis (SU)	CA15W	Batu Muda, Kuala Lumpur (SU)	CA29J	Segamat, Johor (SU)	CA43T	Paka, Terengganu (I)	CA57Q	Samalaju, Sarawak (I)
CA02K	Langkawi, Kedah (SU)	C16W	Cheras, Kuala Lumpur (U)	CA30J	-	CA44T	Kuala Terengganu (U)	CA58Q	Bintulu, Sarawak (SU)
CA03K	Alor Setar, Kedah (SU)	CA17W	Putrajaya (SU)	CA31J	Batu Pahat, Johor (SU)	CA45T	Besut, Terengganu (SU)	CA59Q	Mukah, Sarawak (R)
CA04K	Sungai Petani, Kedah (SU)	CA18B	Kuala Selangor, Selangor (R)	CA32J	Kluang, Johor (R)	CA46D	Tanah Merah, Kelantan (SU)	CA60Q	Kapit, Sarawak (R)
CA05K	Kulim, Kedah (I)	CA19B	Petaling Jaya, Selangor (SU)	CA33J	Larkin, Johor (U)	CA47D	Kota Bharu, Kelantan (SU)	CA61Q	Sibu, Sarawak (SU)
CA06P	Seberang Jaya, Pulau Pinang (U)	CA20B	Shah Alam, Selangor (U)	CA34J	Pasir Gudang, Johor (U)	CA48S	Tawau, Sabah (SU)	CA62Q	Sarikei, Sarawak (R)
CA07P	Seberang Perai, Pulau Pinang (SU)	CA21B	Klang, Selangor (SU)	CA35J	Pengerang, Johor (I)	CA49S	Sandakan, Sabah (SU)	CA63Q	Samarahan, Sarawak (R)
CA08P	Minden, Pulau Pinang (U)	CA22B	Banting, Selangor (SU)	CA36J	Kota Tinggi, Johor (SU)	CA50S	Kota Kinabalu, Sabah (SU)	CA64Q	Sri Aman, Sarawak (R)
CA09P	Balik Pulau, Pulau Pinang (SU)	CA23N	Nilai, N. Sembilan (SU)	CA37C	Rompin, Pahang (R)	CA51S	Kimanis, Sabah (SU)	CA65Q	Kuching, Sarawak (U)
CA10A	Taiping, Perak (SU)	CA24N	Seremban, N. Sembilan (U)	CA38C	Temerloh, Pahang (SU)	CA52S	Keningau, Sabah (B)	CA66J	Tangkak, Johor (SU)
CA11A	Tasek, Ipoh, Perak (U)	CA25N	Port Dickson, N.Sembilan (SU)	CA39C	Jerantut, Pahang (SU)	CA53L	Labuan (SU)		
CA12A	Pegoh, Ipoh, Perak (SU)	CA26M	Alor Gajah, Melaka (R)	CA40C	Indera Mahkota, Pahang (SU)	CA54Q	Limbang, Sarawak (R)		
CA13A	Seri Manjung, Perak (R)	CA27M	Bukit Rambai, Melaka (SU)	CA41C	Balok Baru, Pahang (I)	CA55Q	ILP Miri, Sarawak (R)		
CA14A	Tanjung Malim, Perak (SU)	CA28M	Bandaraya Melaka (U)	CA42T	Kemaman, Terengganu (I)	CA56Q	Miri, Sarawak (SU)		

Note: SU - sub urban; U - urban; I - industrial; R - rural; B - background

**Table S2** Calculation for PM<sub>2.5</sub> Air Pollutant Index (IT-2 2018)

API	Breakpoint of concentration	Equation for API
<b>X = PM<sub>2.5</sub> (24 h average, unit: µg/m<sup>3</sup>)</b>		
0-50	0 < X < 12.0	$API = \left( \frac{50 - 0}{12.0 - 0} \right) \times (X - 0) + 0$
51-100	12.1 ≤ X ≤ 50.4	$API = \left( \frac{100 - 51}{50.4 - 12.1} \right) \times (X - 12.1) + 51$
101-150	50.5 ≤ X ≤ 55.4	$API = \left( \frac{150 - 101}{55.4 - 50.5} \right) \times (X - 50.5) + 101$
151-200	55.5 ≤ X ≤ 150.4	$API = \left( \frac{200 - 151}{150.4 - 55.5} \right) \times (X - 55.5) + 151$
201-300	150.5 ≤ X ≤ 250.4	$API = \left( \frac{300 - 201}{250.4 - 150.5} \right) \times (X - 150.5) + 201$
301-400	250.5 ≤ X ≤ 350.4	$API = \left( \frac{400 - 301}{350.4 - 250.5} \right) \times (X - 250.5) + 301$
401-500	350.5 ≤ X ≤ 500.4	$API = \left( \frac{500 - 401}{500.4 - 350.5} \right) \times (X - 350.5) + 401$

**Table S3** Malaysia Ambient Air Quality Standard (MAAQS) (DOE, 2019)

PARAMETER	AVERAGING TIME	UNIT	MALAYSIA AMBIENT AIR QUALITY STANDARD		
			IT-1 (2015)	IT-2 (2018)	STANDARD (2020)
PM <sub>10</sub>	1 YEAR	µg/m <sup>3</sup>	50	45	<b>40</b>
	24 HOURS	µg/m <sup>3</sup>	150	120	<b>100</b>
PM <sub>2.5</sub>	1 YEAR	µg/m <sup>3</sup>	35	25	<b>15</b>
	24 HOURS	µg/m <sup>3</sup>	75	50	<b>35</b>
SO <sub>2</sub>	1 HOUR	µg/m <sup>3</sup>	350	300	<b>250</b>
		ppm	0.135	0.115	<b>0.095</b>
	24 HOURS	µg/m <sup>3</sup>	105	90	<b>80</b>
		ppm	0.040	0.035	<b>0.030</b>
CO	1 HOUR	mg/m <sup>3</sup>	35	35	<b>30</b>
		ppm	30.6	30.6	<b>26.2</b>
	8 HOURS	mg/m <sup>3</sup>	10	10	<b>10</b>
		ppm	8.75	8.75	<b>8.75</b>
NO <sub>2</sub>	1 HOUR	µg/m <sup>3</sup>	320	300	<b>280</b>
		ppm	0.170	0.160	<b>0.150</b>
	24 HOURS	µg/m <sup>3</sup>	75	75	<b>70</b>
		ppm	0.040	0.040	<b>0.037</b>
O <sub>3</sub>	1 HOUR	µg/m <sup>3</sup>	200	200	<b>180</b>
		ppm	0.100	0.100	<b>0.090</b>
	8 HOURS	µg/m <sup>3</sup>	120	120	<b>100</b>
		ppm	0.060	0.060	<b>0.050</b>

**Table S4** Descriptive Statistics of PM<sub>2.5</sub> for the 65 Continuous Air Quality Monitoring Stations in Malaysia

Descriptive statistics (Quantitative data):

Statistic	CA01R	CA02K	CA03K	CA04K	CA05K	CA06P	CA07P	CA08P	CA09P	CA10A	CA11A	CA12A
Minimum	3.1	2.0	3.3	3.9	5.3	7.0	4.6	5.7	2.8	4.5	6.7	7.6
Maximum	83.1	73.6	84.1	89.5	124.8	115.2	117.7	151.7	173.2	135.5	124.6	107.5
1st Quartile	8.4	8.3	8.9	11.6	10.5	14.6	12.5	12.3	10.3	11.9	13.8	14.8
Median	11.7	11.8	12.7	15.8	15.1	18.9	16.6	16.6	14.9	17.2	18.1	18.8
3rd Quartile	16.4	15.8	17.9	22.9	20.8	24.7	22.9	22.2	21.6	24.5	23.3	24.7
Mean	14.1	13.4	15.3	18.9	17.4	21.2	19.3	19.3	18.2	20.0	20.7	21.2
Standard deviation	9.2	8.0	10.1	10.9	10.6	10.5	10.7	12.2	14.2	12.3	12.4	10.8
Statistic	CA13A	CA14A	CA15W	CA16W	CA17W	CA18B	CA19B	CA20B	CA21B	CA22B	CA23N	CA24N
Minimum	5.6	2.5	6.9	8.6	7.0	5.1	8.0	8.1	8.5	7.9	7.5	4.5
Maximum	144.1	86.5	140.7	136.0	147.3	140.4	151.4	163.0	154.8	135.5	158.5	129.8
1st Quartile	12.1	6.7	16.4	17.4	17.3	12.9	19.8	20.0	21.4	16.5	18.7	11.4
Median	16.6	9.2	21.6	22.5	22.4	18.2	25.0	25.4	27.2	22.6	25.0	16.3
3rd Quartile	23.5	13.4	28.5	28.5	29.2	25.2	31.6	32.8	34.8	30.7	33.6	22.9
Mean	20.0	11.3	24.7	25.5	26.0	21.4	27.9	28.6	30.5	26.1	28.4	19.6
Standard deviation	14.1	8.2	15.6	14.9	16.1	14.6	14.7	15.3	15.9	15.7	17.0	14.3

Statistic	CA25N	CA26M	CA27M	CA28M	CA29J	CA31J	CA32J	CA33J	CA34J	CA35J	CA36J
Minimum	5.4	4.1	5.6	3.2	2.9	2.9	2.6	5.2	4.6	4.1	2.6
Maximum	150.2	129.4	137.2	153.7	117.7	124.0	104.7	111.2	83.9	75.2	80.4
1st Quartile	12.4	12.3	14.5	12.6	11.0	11.3	10.3	15.5	13.0	9.6	8.2
Median	16.8	17.9	19.8	17.6	16.1	16.4	14.8	20.6	18.4	14.0	11.7
3rd Quartile	23.9	26.9	27.8	24.9	23.7	24.4	21.6	26.5	24.0	19.3	16.3
Mean	20.8	21.7	23.0	21.1	19.6	19.3	17.3	22.5	19.8	15.7	13.4
Standard deviation	15.0	14.8	14.6	14.5	14.3	12.6	11.1	11.2	9.8	8.7	8.1

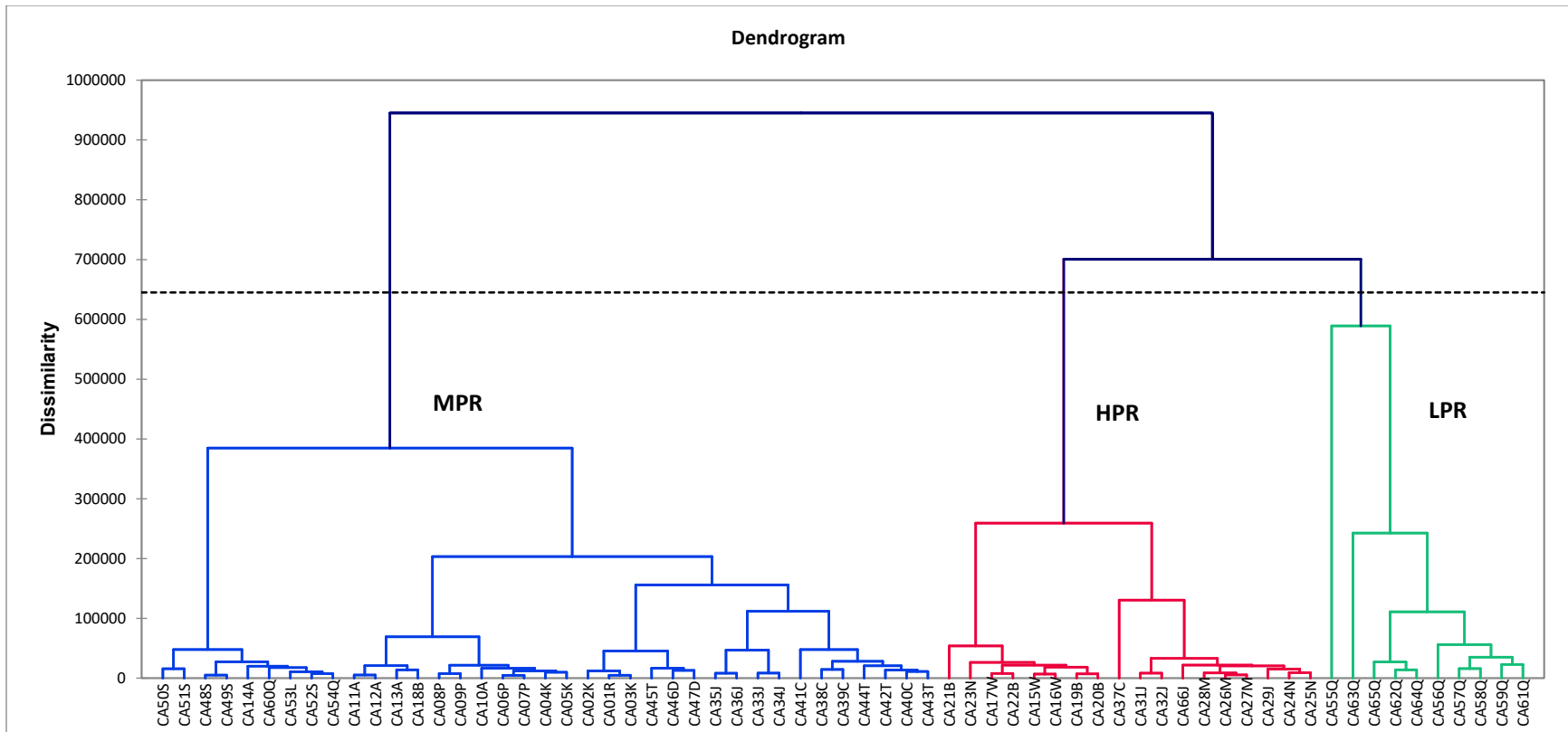
Descriptive statistics (Quantitative data):

Statistic	CA66J	CA37C	CA38C	CA39C	CA40C	CA41C	CA42T	CA43T	CA44T	CA45T	CA46D
Minimum	5.1	2.5	4.7	1.7	2.9	3.5	4.0	2.3	3.0	2.6	3.4
Maximum	188.3	200.7	107.7	98.3	114.9	121.2	119.2	100.3	99.9	72.6	80.7
1st Quartile	12.9	9.7	12.1	7.4	9.2	12.7	11.2	8.2	12.0	9.4	11.3
Median	17.5	15.1	16.8	12.0	13.0	17.4	15.4	11.4	16.6	13.0	16.6
3rd Quartile	25.2	23.0	24.0	19.3	19.2	24.1	20.8	16.5	22.3	18.2	23.3
Mean	21.5	20.1	20.0	15.3	16.3	20.5	17.9	13.9	18.5	14.9	18.5
Standard deviation	15.8	20.4	13.0	12.3	12.8	13.3	11.5	10.1	10.8	8.8	9.9

Statistic	CA47D	CA48S	CA49S	CA50S	CA51S	CA52S	CA53L	CA54Q	CA55Q	CA56Q	CA57Q	CA58Q
Minimum	3.7	3.3	3.5	2.5	2.2	4.2	3.2	2.6	3.2	3.5	3.3	3.6
Maximum	79.2	93.2	77.9	162.8	80.5	53.5	65.9	66.8	345.0	126.4	97.3	110.6
1st Quartile	11.0	6.4	8.2	7.1	5.1	8.2	8.1	6.1	7.7	9.9	8.6	10.8
Median	16.8	7.7	9.8	10.7	7.6	10.8	11.0	8.3	10.9	13.6	11.2	14.8
3rd Quartile	23.4	9.0	11.8	15.9	11.9	15.4	15.6	12.7	17.3	19.5	15.7	20.5
Mean	18.7	8.4	10.8	13.1	10.3	12.8	13.3	10.4	19.1	17.9	14.2	17.8
Standard deviation	10.5	5.9	5.4	10.0	9.0	6.8	8.5	7.1	34.6	14.9	10.8	12.4

Statistic	CA59Q	CA60Q	CA61Q	CA62Q	CA63Q	CA64Q	CA65Q
Minimum	3.1	2.5	4.6	2.6	1.9	3.3	4.4
Maximum	147.9	73.9	186.0	179.8	382.6	172.5	214.5
1st Quartile	7.3	6.1	9.7	7.0	5.9	6.4	9.1
Median	9.4	8.1	13.0	9.9	8.7	8.6	11.7
3rd Quartile	13.2	11.1	17.9	14.1	14.3	12.8	16.5
Mean	13.3	10.3	17.4	14.3	16.5	14.1	18.0
Standard deviation	14.8	8.3	16.9	17.1	30.7	19.8	22.9

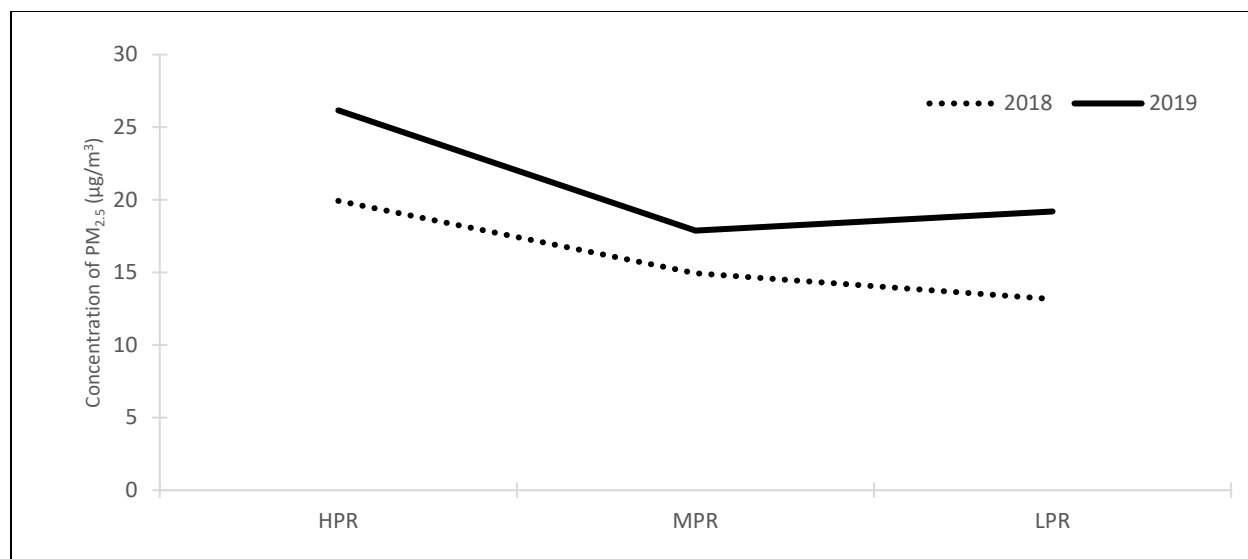


**Figure S5** Clustering the stations using Agglomerative Hierarchical Cluster (AHC)



**Table S6** List of stations based on High Pollution Regions (HPR), Medium Pollution Regions (MPR) and Low Pollution Regions (LPR)

Cluster 1 (HPR)			Cluster 2 (MPR)				Cluster 3 (LPR)				
CA15W	Batu Muda, Kuala Lumpur (SU)	CA27M	Bukit Rambai, Melaka (SU)	CA01R	Kangar, Perlis (SU)	C14A	Tanjung Malim, Perak (R)	CA45T	Besut, Terengganu (SU)	CA55Q	ILP Miri, Sarawak (R)
CA16W	Cheras, Kuala Lumpur (U)	CA28M	Bandaraya Melaka (U)	CA02K	Langkawi, Kedah (SU)	CA18B	Kuala Selangor, Selangor (R)	CA47D	Kota Bharu, Kelantan (SU)	CA56Q	Miri, Sarawak (SU)
CA17W	Putrajaya (SU)	CA29J	Segamat, Johor (SU)	CA03K	Alor Setar, Kedah (SU)	CA33J	Larkin, Johor (U)	CA48S	Tawau, Sabah (SU)	CA57Q	Samalaju, Sarawak (I)
CA19B	Petaling Jaya, Selangor (SU)	CA31J	Batu Pahat, Johor (SU)	CA04K	Sungai Petani, Kedah (SU)	CA34J	Pasir Gudang, Johor (U)	CA49S	Sandakan, Sabah (SU)	CA58Q	Bintulu, Sarawak (SU)
CA20B	Shah Alam, Selangor (U)	CA32J	Kluang, Johor (R)	CA05K	Kulim, Kedah (I)	CA35J	Pengerang, Johor (I)	CA50S	Kota Kinabalu, Sabah (SU)	CA59Q	Mukah, Sarawak (R)
CA21B	Klang, Selangor (SU)	CA37C	Rompin, Pahang (R)	CA06P	Seberang Jaya, Pulau Pinang (U)	CA36J	Kota Tinggi, Johor (SU)	CA51S	Kimanis, Sabah (I)	CA62Q	Sarikei, Sarawak (R)
CA22B	Banting, Selangor (R)	CA66J	Tangkak, Johor (SU)	CA07P	Seberang Perai, Pulau Pinang (SU)	CA38C	Temerloh, Pahang (SU)	CA52S	Keningau, Sabah (B)	CA63Q	Samarahan, Sarawak (R)
CA23N	Nilai, N. Sembilan (SU)	CA61Q	Sibu, Sarawak (SU)	CA08P	Minden, Pulau Pinang (U)	CA39C	Jerantut, Pahang (SU)	CA53L	Labuan (SU)	CA64Q	Sri Aman, Sarawak (R)
CA24N	Seremban, N. Sembilan (U)			CA09P	Balik Pulau, Pulau Pinang (SU)	CA40C	Indera Mahkota, Pahang (SU)	CA54Q	Limbang, Sarawak (R)	CA65Q	Kuching, Sarawak (U)
CA25N	Port Dickson, N. Sembilan (SU)			CA10A	Taiping, Perak (SU)	CA41C	Balok Baru, Pahang (I)	CA60Q	Kapit, Sarawak (R)		
CA26M	Alor Gajah, Melaka (R)			CA11A	Tasek, Ipoh, Perak (U)	CA42T	Kemaman, Terengganu (I)	CA46D	Tanah Merah, Kelantan (SU)		
				CA12A	Pegoh, Ipoh, Perak (SU)	CA43T	Paka, Terengganu (I)	CA47D	Kota Bharu, Kelantan (SU)		
				CA13A	Seri Manjung, Perak (R)	CA44T	Kuala Terengganu				



**Figure S7** Annual average concentration of PM<sub>2.5</sub> for High Pollution Regions (HPR), Medium Pollution Regions (MPR) and Low Pollution Regions (LPR)

**Table S8** Descriptive statistics for PM<sub>2.5</sub> in High Pollution Regions (HPR), Medium Pollution Regions (MPR) and Low Pollution Regions (LPR)

	<b>HPR</b>	<b>MPR</b>	<b>LPR</b>
Minimum	2.5	1.7	1.9
Maximum	210.7	190.6	407.2
1st Quartile	13.8	9.3	7.8
Median	19.8	13.8	11.0
3rd Quartile	27.7	20.2	16.5
Mean	23.0	16.4	16.2
Skewness	3.5	3.3	7.4
Kurtosis	20.0	21.2	82.1

**Table S9** Correlation between PM<sub>2.5</sub> and other pollutants for each region

<b>HPR</b>	PM <sub>2.5</sub>	PM <sub>10</sub>	NO <sub>2</sub>	SO <sub>2</sub>	CO	O <sub>3</sub>
	1					
PM <sub>2.5</sub>	(0.00)					
	<b>0.981</b>	1				
PM <sub>10</sub>	(<0.01)	(0.00)				
	0.304	0.303	1			
NO <sub>2</sub>	(<0.01)	(<0.01)	(0.00)			
	0.320	0.323	0.238	1		
SO <sub>2</sub>	(<0.01)	(<0.01)	(<0.01)	(0.00)		
	<b>0.777</b>	<b>0.781</b>	<b>0.570</b>	0.194	1	
CO	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(0.00)	
	0.398	0.394	0.045	0.288	0.249	1
O <sub>3</sub>	(<0.01)	(<0.01)	(0.227)	(<0.01)	(<0.01)	(0.00)
<b>MPR</b>	PM <sub>2.5</sub>	PM <sub>10</sub>	NO <sub>2</sub>	SO <sub>2</sub>	CO	O <sub>3</sub>
	1					
PM <sub>2.5</sub>	(0.00)					
	<b>0.978</b>	1				
PM <sub>10</sub>	(<0.01)	(0.00)				
	0.398	0.388	1			
NO <sub>2</sub>	(<0.01)	(<0.01)	(0.00)			
	0.498	0.478	0.335	1		
SO <sub>2</sub>	(<0.01)	(<0.01)	(<0.01)	(0.00)		
	<b>0.790</b>	<b>0.789</b>	<b>0.513</b>	0.283	1	
CO	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(0.00)	
	<b>0.606</b>	<b>0.637</b>	0.165	0.373	0.448	1
O <sub>3</sub>	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(0.00)
<b>LPR</b>	PM <sub>2.5</sub>	PM <sub>10</sub>	NO <sub>2</sub>	SO <sub>2</sub>	CO	O <sub>3</sub>
	1					
PM <sub>2.5</sub>	(0.00)					
	<b>0.978</b>	1				
PM <sub>10</sub>	(<0.01)	(0.00)				
	0.478	0.480	1			
NO <sub>2</sub>	(<0.01)	(<0.01)	(0.00)			
	0.044	0.060	-0.016	1		
SO <sub>2</sub>	(0.236)	(0.104)	(0.674)	(0.00)		
	<b>0.786</b>	<b>0.778</b>	0.421	0.107	1	
CO	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(0.00)	
	<b>0.556</b>	<b>0.554</b>	0.200	0.320	0.473	1
O <sub>3</sub>	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(0.00)

() indicates *p*-value in Pearson analysis; number in bolds represent strong correlation ( $r > 0.5$ )

**Table S10** Correlation between PM<sub>2.5</sub> and meteorological parameters for each region

<b>HPR</b>	PM2.5	Humidity	Temp	Wind Speed
	1			
PM <sub>2.5</sub>	(0.00)			
	-0.206	1		
Humidity	(<0.01)	(0.00)		
	0.191	-0.310	1	
Temp	(<0.01)	(<0.01)	(0.00)	
	-0.099	<b>-0.603</b>	-0.109	1
Wind Speed	(0.008)	(<0.01)	(0.003)	(0.00)
<b>MPR</b>	PM2.5	Humidity	Temp	Wind Speed
	1			
PM2.5	(0.00)			
	-0.397	1		
Humidity	(<0.01)	(0.00)		
	0.394	-0.350	1	
Temp	(<0.01)	(<0.01)	(0.00)	
	0.159	<b>-0.592</b>	0.070	1
Wind Speed	(<0.01)	(<0.01)	(0.06)	(0.00)
<b>LPR</b>	PM2.5	Humidity	Temp	Wind Speed
	1			
PM2.5	(0.00)			
	-0.475	1		
Humidity	(<0.01)	(0.00)		
	0.267	<b>-0.549</b>	1	
Temp	(<0.01)	(<0.01)	(0.00)	
	-0.114	0.035	-0.054	1
Wind Speed	(0.002)	(0.344)	(0.143)	(0.00)

() indicates *p*-value in Pearson analysis; number in bolds represent strong correlation ( $r > 0.5$ )