Supplementary materials for

Simultaneous measurements of chemical compositions of fine particles during winter haze period in urban sites in China and Korea

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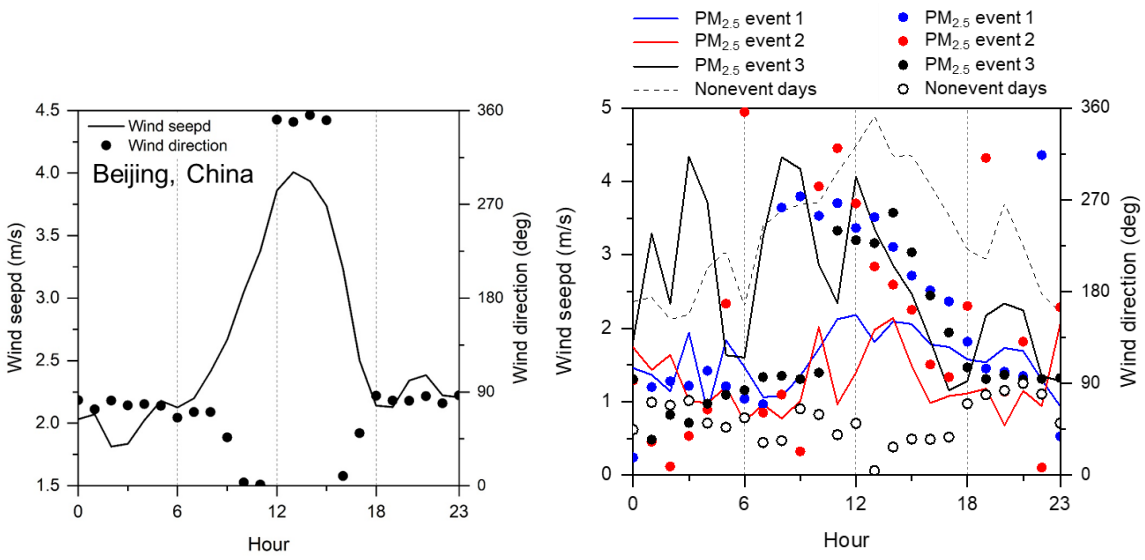
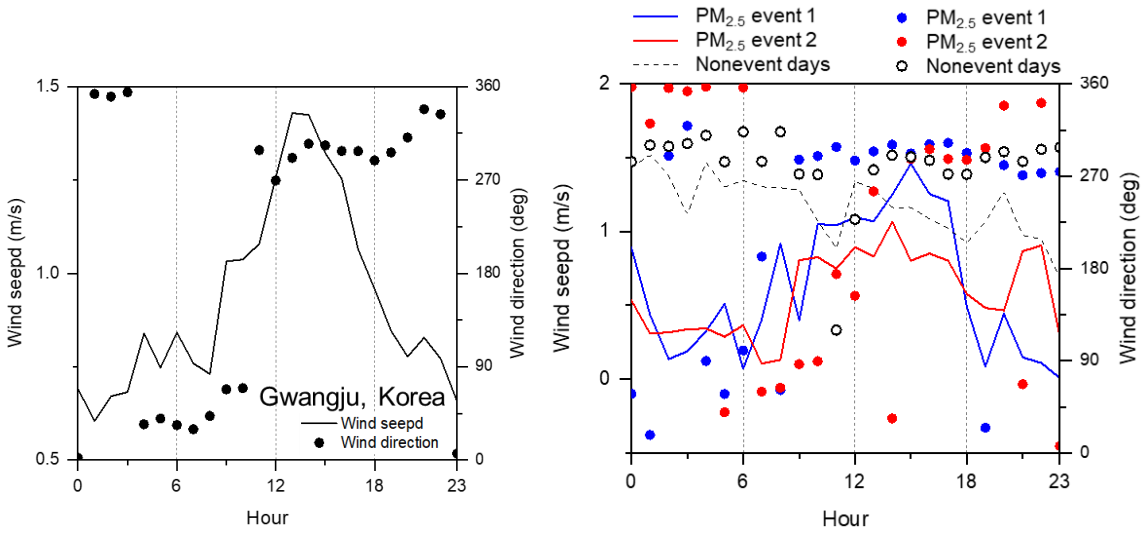


(a)



(b)

Figure S1. Daily variations of wind speed during all sampling periods and $PM_{2.5}$ events at (a) Beijing and (b) Gwangju.

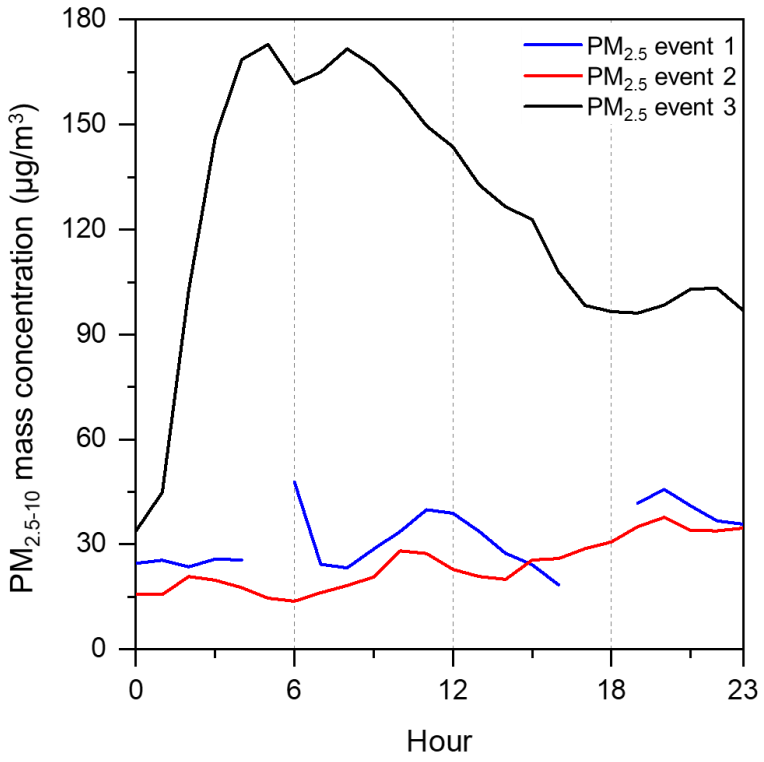


Figure S2. Hourly variations of $PM_{2.5-10}$ mass concentrations in the Beijing $PM_{2.5}$ events 1, 2, and 3.

Table S1. A summary of measured parameters at Beijing and Gwangju sites.

	Beijing site	Gwangju site
Name and location	Peking University Changping campus (PKU CP) (40°14'44.6"N 116°11'33.3"E)	Gwangju Institute of Science and Technology campus (GIST) (35°13'41.1"N, 126°50'36.3"E)
Sampling period	Jan 3, 2018 – Feb 2, 2018 (31 days)	
$PM_{2.5}$ filter sampling		
Ions	Ion chromatography (IC) (850 Professional IC, Metrohm, Switzerland)	
OC/EC	Lab OC-EC aerosol analyzer (5L, Sunset laboratory, USA)	
WSOC	Total organic carbon analyzer (TOC) (Sievers 900, General Electric, USA)	
Elements	Energy dispersive-X-ray fluorescence (ED-XRF) (Cooper environmental service, USA)	
Organic compounds	Gas chromatography-electron impact-mass spectrometry (GC-EI-MS) (7890A GC, 5975C MS, Agilent, USA) Fourier transform-ion cyclotron resonance-mass spectrometry (FT-ICR-MS) (SolariX XRTM system, Bruker Daltonics, USA) Two-dimensional gas chromatography/high resolution mass spectrometry (GC×GC/HRMS) (7890A, Agilent, USA and Pegasus GC–HRT 4D, LECO, USA)	
Pb isotope	Multicollector-inductively coupled plasma-mass spectrometry (MC-ICP-MS) (Thermo Scientific, USA)	
Oxidative potential	UV/Vis spectrometer (SpectraMax M2, Molecular Devices, USA)	
Cell toxicity	-	Microplate reader (SpectraMax M2, Molecular Devices, USA)
On-line $PM_{2.5}$ measurements		
PM_{10} mass concentration	TEOM[a)] (TH-2000Z1, Wuhan Tianhong Instruments, China)	OPS (3330, TSI, USA), OPC (1.108, Grimm, Germany)
$PM_{2.5}$ mass concentration	TEOM[a)] (TH-2000Z1, Wuhan Tianhong Instruments, China)	OPS (3330, TSI, USA), OPC (1.108, Grimm, Germany)
PM_1 mass concentration	-	OPS (3330, TSI, USA), OPC (1.108, Grimm, Germany)
Number size distribution	-	SMPS (CPC (3022, TSI, USA) and DMA (3081, TSI, USA))
BC concentration	-	Aethalometer (AE-51, Magee Scientific, USA)
Gas measurements		
O_3	O_3 analyzer (49i, Thermo Scientific, USA)	O_3 analyzer (400E, Teledyne API, USA)[b)]
NO_2	NO_x analyzer (42i, Thermo Scientific, USA)	NO_x analyer (200E, Teledyne API, USA)[b)]
CO	CO analyzer (48i, Thermo Scientific, USA)	CO analyzer (300E, Teledyne API, USA)[b)]
SO_2	SO_2 analyzer (43i, Thermo Scientific, USA)	SO_2 analyzer (100E, Teledyne API, USA)[b)]
Meteorology	AWS (Met One Instruments, USA)	AWS (PortLogTM, RainWise, USA)
Air mass data	HYSPLIT (National Oceanic and Atmospheric Administration (NOAA))	
Satellite data	MODIS (level 2 data) (NASA)[c)]	

a) Tapered Element Oscillating Microbalance

b) National air quality monitoring network station operated by Korea Environment Corporation (http://www.airkorea.or.kr/index)

c) MODIS (Moderate Resolution Imaging Spectroradiometer) (https://ladsweb.modaps.eosdis.nasa.gov/)

Table S2. Average concentrations of gases (NO_2, SO_2, O_3, and CO) and meteorological data (temperature, relative humidity, and wind speed) at Beijing and Gwangju sites during all sampling periods, nonevent days, and $PM_{2.5}$ events.

	Beijing site					Gwangju site			
	All sampling periods	Nonevent days	$PM_{2.5}$ event 1 (Jan 13, 2018)	$PM_{2.5}$ event 2 (Jan 15, 2018)	$PM_{2.5}$ event 3 (Jan 16, 2018)	All sampling periods	Nonevent days	$PM_{2.5}$ event 1 (Jan 18, 2018)	$PM_{2.5}$ event 2 (Jan 20-21, 2018)
NO_2 (ppbv)	17.0±11.5	4.0±2.4	45.1	31.5	16.2	13.9±5.4	9.9±3.1	17.4	16.6±2.4
SO_2 (ppbv)	3.5 ± 1.8	1.3±0.5	7.7	5.3	3.3	4.7±0.5	4.3±0.05	5.3	4.9±0.4
O_3 (ppbv)	15.2±7.4	23.7±1.9	2.9	4.8	16.7	24.3±7.2	26.1±0.8	24.4	22.8±1.1
CO (ppbv)	711.5±443.2	240.7±66.2	1801.2	1252.0	706.8	540.4±121.7	426.4±50.4	766.7	754.2±47.1
Temp (℃)	-3.9±3.2	-5.6±2.0	-2.7	-2.7	0.4	-0.8±3.9	-2.8±2.3	4.7	2.0±0.6
RH (%)	26.6±8.0	20.7±3.8	34.7	40.8	30.3	66.5±11.9	83.8±4.1	71.6	64.8±2.6
WS (m/s)	2.6±0.8	3.3±0.6	1.6	1.3	2.6	0.5±0.4	0.9±0.5	0.3	0.2±0.02

Temp.: temperature
RH: relative humidity
WS: wind speed

Table S3. Average concentrations and mass fractions (%) of chemical components (ions, OC, EC, and elements) in $PM_{2.5}$ at Beijing and Gwangju sites from 3 Jan 2018 to 1 Feb 2018.

	Beijing site		Gwangju site	
	Concentration (μg/m³)	**Fraction in $PM_{2.5}$ (%)**	**Concentration (μg/m³)**	**Fraction in $PM_{2.5}$ (%)**
$PM_{2.5}$ mass	62.5±34.1		26.8±13.9	
Ions				
Cl^-	1.6±1.5	2.3±1.2	0.5±0.2	2.0±0.6
NO_3^-	5.7±7.2	5.0±5.1	6.2±4.3	20.9±6.1
SO_4^{2-}	3.5±2.2	5.6±1.8	3.3±1.8	13.2±5.3
Na^+	0.4±0.3	0.7±0.3	0.2±0.1	0.9±0.6
NH_4^+	2.8±3.0	3.8±2.2	3.1±1.9	11.4±1.8
K^+	0.5±0.4	0.7±0.4	0.2±0.1	0.8±0.2
Mg^{2+}	0.2±0.1	0.4±0.2	0.03±0.03	0.2±0.1
Ca^{2+}	1.8±0.7	3.3±1.1	0.08±0.05	0.3±0.1
Total ions	15.1±14.0	21.7±8.1	13.5±7.7	49.6±6.9
Carbonaceous species				
OC	15.3±9.3	24.6±7.0	4.4±2.1	16.9±3.6
WSOC	2.5±2.0	4.0±1.4	2.9±1.5	10.9±2.2
WISOC	13.0±7.6	20.1±7.5	1.6±0.9	6.0±2.8
EC	2.1±1.5	3.2±1.3	0.9±0.4	3.5±1.1
Total carbon	17.4±10.3	27.8±7.5	5.3±2.5	20.5±4.5
Elements (ng/m³)				
Na	312.3±168.1	0.4±0.2	81.6±58.4	0.4±0.2
Mg	666.0±362.9	1.1±0.4	37.1±36.9	0.1±0.1
Al	2106.6±1379.3	3.5±1.3	152.8±112.2	0.6±0.3
Si	7371.0±4791.5	12.3±4.6	417.3±334.2	1.7±1.1
P	N.D.	N.D.	N.D.	N.D.
S	1721.9±1004.9	2.8±0.8	1533.2±785.0	6.3±2.3
Cl	1096.0±1366.4	1.1±0.9	270.5±238.1	1.0±0.6
K	1539.9±956.4	2.5±0.7	185.1±141.8	0.7±0.4
Ca	4729.7±2216.9	8.1±2.3	90.0±82.2	0.2±0.1
Sc	12.7±10.3	0.03±0.02	11.2±7.7	0.06±0.04
Ti	143.6±144.8	0.2±0.1	N.D.	N.D.
V	10.2±6.3	0.02±0.01	N.D.	N.D.
Cr	8.3±7.4	0.01±0.01	3.4±1.5	0.02±0.02
Mn	105.5±52.5	0.2±0.05	11.9±6.6	0.04±0.02
Fe	3075.9±1810.2	5.1±1.6	144.1±108.2	0.6±0.3
Co	24.3±17.6	0.04±0.02	2.7±1.4	0.01±0.01
Ni	N.D.	N.D.	4.6±2.2	0.02±0.02
Cu	N.D.	N.D.	2.2±2.3	0.007±0.006
Zn	55.4±51.8	0.07±0.05	29.3±18.8	0.1±0.05
Ga	16.6±9.3	0.03±0.01	3.2±3.1	0.01±0.002
As	8.7±8.6	0.01±0.009	5.6±4.4	0.02±0.02
Se	5.5±4.1	0.009±0.01	2.6±2.3	0.01±0.009
Br	10.2±9.1	0.01±0.009	8.7±5.4	0.03±0.02
Rb	4.7±3.8	0.006±0.004	6.5±2.3	0.03±0.02
Sr	21.1±15.9	0.03±0.02	3.2±2.0	0.01±0.01
Y	10.8±12.3	0.02±0.02	5.7±3.3	0.03±0.03
Zr	11.7±11.0	0.02±0.01	5.8±4.8	0.03±0.03
Nb	8.6±7.6	0.01±0.009	5.1±5.4	0.02±0.01
Mo	48.4±44.2	0.05±0.05	N.D.	N.D.
Ag	8.0±4.8	0.02±0.01	7.5±0.5	0.04±0.02
Cd	14.9±6.5	0.03±0.01	14.0±2.6	0.06±0.05
In	16.8±11.9	0.04±0.03	5.9±4.0	0.03±0.02
Sn	82.6±72.4	0.1±0.07	154.3±130.0	0.4±0.3
Sb	9.2±5.1	0.02±0.01	41.4±35.7	0.2±0.1
Cs	43.4±18.3	0.08±0.005	70.5±27.4	0.3±0.1
Ba	44.7±36.9	0.2±0.01	N.D.	N.D.
La	33.4±21.6	0.1±0.09	34.8±20.0	0.2±0.09
Ce	12.9±10.8	0.04±0.05	40.4±17.1	0.2±0.1
Sm	27.5±20.3	0.04±0.02	8.6±5.8	0.05±0.04
Eu	24.5±23.6	0.04±0.03	5.0±4.6	0.02±0.02
Tb	56.3±46.7	0.1±0.1	16.4±24.2	0.04±0.04
Hf	25.7±13.6	0.05±0.03	10.8±8.5	0.04±0.03
Ta	14.1±13.8	0.03±0.03	8.7±6.1	0.04±0.03
W	31.7±24.3	0.07±0.06	4.5±5.2	0.02±0.02
Ir	23.0±16.7	0.03±0.01	10.4±6.0	0.04±0.02
Au	N.D.	N.D.	N.D.	N.D.
Hg	N.D.	N.D.	2.1±1.5	0.01±0.008
Pb	43.2±29.0	0.06±0.02	15.9±12.1	0.05±0.03
Total elements (μg/m³)	22.4±12.4	35.9±12.1	2.9±1.5	11.7±3.5

N.D.: not detected