Supplementary Information

"Particulate Matter Distributions in China during a Winter Period with Frequent Pollution Episodes (January 2013)"

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1. Comparison of $PM_{2.5}$ data from the BMEMC and those from the U.S. Embassy in Beijing

As shown in Figure S-1, daily $PM_{2.5}$ concentrations reported by the U.S. Embassy in Beijing correlates very well with those published by Beijing Municipal Environmental monitoring Center (BMEMC). $PM_{2.5}$ daily concentration from the U.S. Embassy is ~25% higher than that from BMEMC. This is possibly attributed to sampling locations. The former was measured at an urban site inside the U.S. Embassy while data from BMEMC is the average of 35 sites including urban, rural, roadside, and background sites. The slope is used to calculate the $PM_{2.5}$ level in Beijing during January 1st to January 12th.

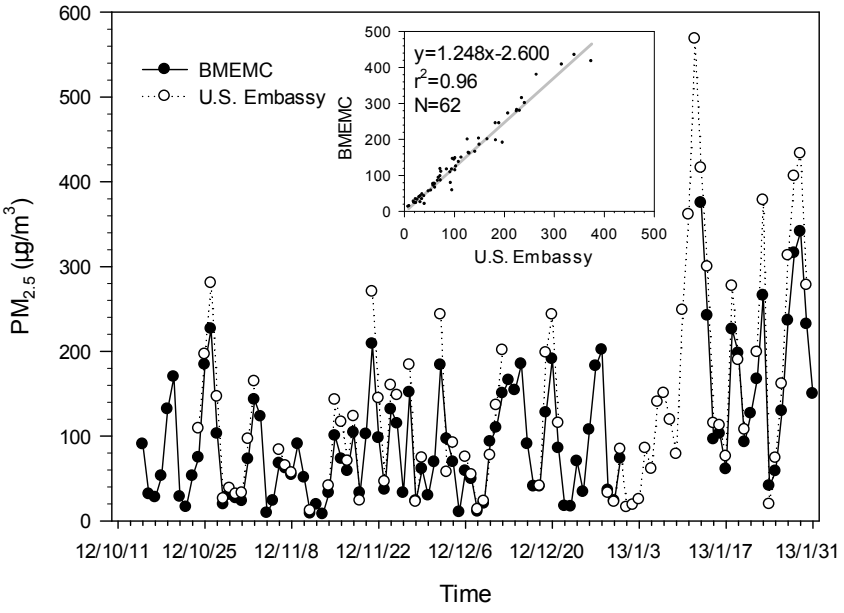

Figure S-1. Comparison of daily $PM_{2.5}$ from the BMEMC and those the U.S. Embassy in Beijing

2. Estimation of daily PM_{10} from the API value

For the days when PM_{10} was reported as the primary pollutant, daily PM_{10} concentrations were derived from the API using the following equation:

$$C = \left[(I - I_{low})/(I_{high} - I_{low})\right] \times \left((C_{high} - C_{low})\right) + C_{low} \qquad \text{(S-1)}$$

where C is the concentration of PM_{10}, I is the reported API values. I_{low} and I_{high} represent API grading limits that are lower and larger than I, respectively; C_{high} and C_{low} denote the PM_{10} concentrations corresponding to I_{high} and I_{low}, respectively.

3. List of 74 national cities and their pollutant concentrations

Table S-1. List of 74 national cities in this study and their monthly average concentrations of six pollutants in January 2013. NCP(JJJ) means the Jing-Jin-Ji (Beijing, Tianjin, and Heibei provience) area. It is included in the NCP (North China Plain). YRD and PRD are the Yangtze River Delta and the Pearl River Delta, respectively.

City	Province	latitude	longitude	$PM_{2.5}$ μg/m^3	PM_{10} μg/m^3	SO_2 μg/m^3	NO_2 μg/m^3	CO mg/m^3	O_3 μg/m^3	Area	Number of sites
Beijing	Beijing	39.9	116.4	169	194	73	95	3.9	14	NCP(JJJ)	35
Baoding	Hebei	38.9	115.5	271	371	197	93	3.9	51	NCP(JJJ)	5
Cangzhou	Hebei	38.3	116.8	78	177	102	33	2.8	59	NCP(JJJ)	1
Chengde	Hebei	41.0	117.9	85	138	80	60	1.9	22	NCP(JJJ)	5
Handan	Hebei	36.6	114.5	278	424	220	90	4.4	13	NCP(JJJ)	4
Hengshui	Hebei	37.7	115.7	236	413	177	80	3.5	13	NCP(JJJ)	3
Langfang	Hebei	39.5	116.7	233	309	122	76	4.2	15	NCP(JJJ)	3
Qinhuangdao	Hebei	39.9	119.6	112	194	108	60	3.0	34	NCP(JJJ)	5
Shijiazhuang	Hebei	38.0	114.5	302	541	279	99	4.9	15	NCP(JJJ)	6
Tangshan	Hebei	39.6	118.2	223	290	196	93	4.6	29	NCP(JJJ)	6
Xingtai	Hebei	37.1	114.5	324	535	269	113	5.2	20	NCP(JJJ)	4
Zhangjiakou	Hebei	40.7	114.5	65	124	124	48	1.4	48	NCP(JJJ)	5
Tianjin	Tianjin	39.1	117.3	157	228	148	74	3.7	20	NCP(JJJ)	15
Zhengzhou	Henan	34.8	113.6	215	321	99	66	5.2	22	NCP	9
Jinan	Shandong	36.6	117.0	228	352	220	105	3.1	21	NCP	8
Qingdao	Shandong	36.1	120.4	137	183	132	64	2.0	45	NCP	9
Huaian	Jiangsu	33.6	119.0	138	194	35	45	1.4	30	NCP	5
Lianyungang	Jiangsu	34.7	119.3	88	134	75	61	1.8	32	NCP	4
Suqian	Jiangsu	34.0	118.3	89	108	54	42	1.6	69	NCP	4
Xuzhou	Jiangsu	34.3	117.2	122	186	92	67	2.9	23	NCP	7
Yancheng	Jiangsu	33.4	120.2	128	143	39	44	1.2	67	NCP	4

Nantong	Jiangsu	32.0	120.9	118	180	40	44	1.3	36	YRD,NCP	5
Taizhou	Jiangsu	32.4	119.9	134	200	53	51	1.6	33	YRD,NCP	3
Yangzhou	Jiangsu	32.4	119.4	109	151	40	55	1.5	28	YRD,NCP	4
Changzhou	Jiangsu	31.8	120.0	139	174	65	95	1.6	30	YRD	5
Nanjing	Jiangsu	32.1	118.8	136	209	74	73	2.0	28	YRD	9
Suzhou	Jiangsu	31.3	120.6	111	127	48	73	1.3	25	YRD	6
Wuxi	Jiangsu	31.6	120.3	142	156	63	60	2.3	36	YRD	6
Zhenjiang	Jiangsu	32.2	119.5	124	173	45	60	1.2	31	YRD	4
Shanghai	Shanghai	30.7	121.2	97	120	36	66	1.3	37	YRD	10
Hangzhou	Zhejiang	30.2	120.1	113	136	44	72	1.6	21	YRD	11
Huzhou	Zhejiang	30.9	120.1	134	173	37	79	1.6	24	YRD	3
Jiaxing	Zhejiang	30.8	120.7	133	142	75	99	3.2	40	YRD	3
Ningbo	Zhejiang	29.9	121.6	87	125	48	64	1.4	30	YRD	8
Shaoxing	Zhejiang	30.0	120.6	128	174	82	75	1.2	35	YRD	2
Taizhou	Zhejiang	28.6	121.4	84	119	29	57	1.5	33	YRD	3
Zhoushan	Zhejiang	30.0	122.2	51	73	19	39	0.7	34	YRD	3
Dongwan	Guangdong	23.0	113.8	80	102	41	58	1.3	48	PRD	5
Foshan	Guangdong	23.0	113.1	82	121	42	68	1.6	33	PRD	8
Guangzhou	Guangdong	23.2	113.4	82	102	23	77	1.2	31	PRD	11
Huizhou	Guangdong	23.0	114.4	65	97	19	36	1.2	61	PRD	5
Jiangmen	Guangdong	22.6	113.1	80	110	37	51	1.7	35	PRD	4
Shenzhen	Guangdong	22.6	114.2	62	95	17	53	1.5	65	PRD	11
Zhaoqing	Guangdong	23.1	112.5	65	84	29	46	1.5	43	PRD	4
Zhongshan	Guangdong	22.5	113.4	82	110	32	68	1.2	40	PRD	4
Zhuhai	Guangdong	22.3	113.5	71	97	22	59	1.3	66	PRD	4
Hefei	Anhui	31.8	117.2	142	173	41	50	1.6	28	other	10
Chongqing	Chongqing	29.6	106.5	79	167	43	43	1.1	28	other	15
Fuzhou	Fujian	26.1	119.3	52	73	8.7	43	1.0	23	other	6
Xiamen	Fujian	24.6	118.1	45	68	24	48	0.9	57	other	4
Kanzhou	Gansu	36.1	103.8	97	141	79	51	2.3	16	other	3
Nanning	Guangxi	22.8	108.3	97	123	26	47	1.5	33	other	7
Guiyang	Guizhou	26.6	106.8	86	119	82	40	1.1	32	other	10
Haikou	Hainan	20.0	110.4	48	69	8.8	24	1.0	61	other	5
Harbin	Heilongjiang	45.7	126.6	205	264	78	81	1.9	21	other	12
Wuhan	Hubei	30.6	114.2	189	214	68	81	2.0	27	other	10
Changsha	Hunan	28.2	113.0	164	179	50	73	2.0	20	other	10
Hohhot	Inner Mongolia	40.8	111.7	118	182	137	47	3.7	33	other	8
Nanchang	Jiangxi	28.7	115.9	121	181	78	57	1.5	39	other	7
Changchun	Jilin	43.8	125.3	190	249	107	69	1.9	50	other	10
Dalian	Liaoning	38.6	121.6	95	136	106	43	1.2	33	other	10
Shenyang	Liaoning	41.8	123.5	192	257	244	49	2.9	21	other	11

Yinchuan	Ningxia	38.5	106.1	99	177	196	54	2.2	32	other	6
Xining	Qinghai	36.7	101.7	98	171	73	43	2.8	18	other	4
Xi'an	Shaanxi	34.3	109.0	210	301	114	77	3.8	27	other	13
Taiyuan	Shanxi	37.9	112.5	122	184	128	40	1.7	23	other	9
Chengdu	Sichuan	30.7	104.0	168	224	53	74	2.0	28	other	8
Lasa	Tibet	29.6	91.1	38	84	70	28	1.5	87	other	6
Urumqi	Xinjiang	43.9	87.6	206	289	85	95	4.6	9.7	other	7
Kunming	Yunnan	25.0	102.7	57	113	35	48	1.8	39	other	7
Jinhua	Zhejiang	29.1	119.7	107	147	56	65	1.8	24	other	3
Lishui	Zhejiang	28.4	119.9	81	96	49	46	1.1	59	other	3
Quzhou	Zhejiang	29.0	118.9	113	147	47	51	1.2	26	other	3
Wenzhou	Zhejiang	28.0	120.7	91	131	24	66	1.0	21	other	4

4. The new China National Ambient Air Quality Standard (CNAAQS 2012) and the World Health Organization Air Quality Guideline (AQG 2005)

Table S-2 class II values for the six pollutants in CNAAQS 2012 and AQG 2005. Except for those specified, daily average concentrations are given. Class II values in CNAAQS 2012 apply for residential, commercial, cultural, industrial, and rural areas.

	CNAAQS 2012	AQG 2005
$PM_{2.5}$	75μg/m^3	25μg/m^3
PM_{10}	150μg/m^3	50μg/m^3
SO_2	150μg/m^3	20μg/m^3
NO_2	80μg/m^3	40μg/m^3 (annual mean)
CO	4mg/m^3	--
O_3	160μg/m^3 (daily maximum 8-hour O_3 concentrations)	50μg/m^3 (8-hour average)

5. Gaseous pollutants in January 2013

Figure S-2 shows the variations of four gaseous pollutants (SO_2, NO_2, CO, and O_3) during January 2013. SO_2, NO_2, and CO had similar patterns with $PM_{2.5}$ and PM_{10}. They increased rapidly at the beginning of January 2013 and remained at a high level throughout the month. However, O_3 had a different variation. As shown in Figure S-2(d), daily maximum 8-hr O_3 concentrations decreased sharply on January 5th and

slowly increased throughout the month.

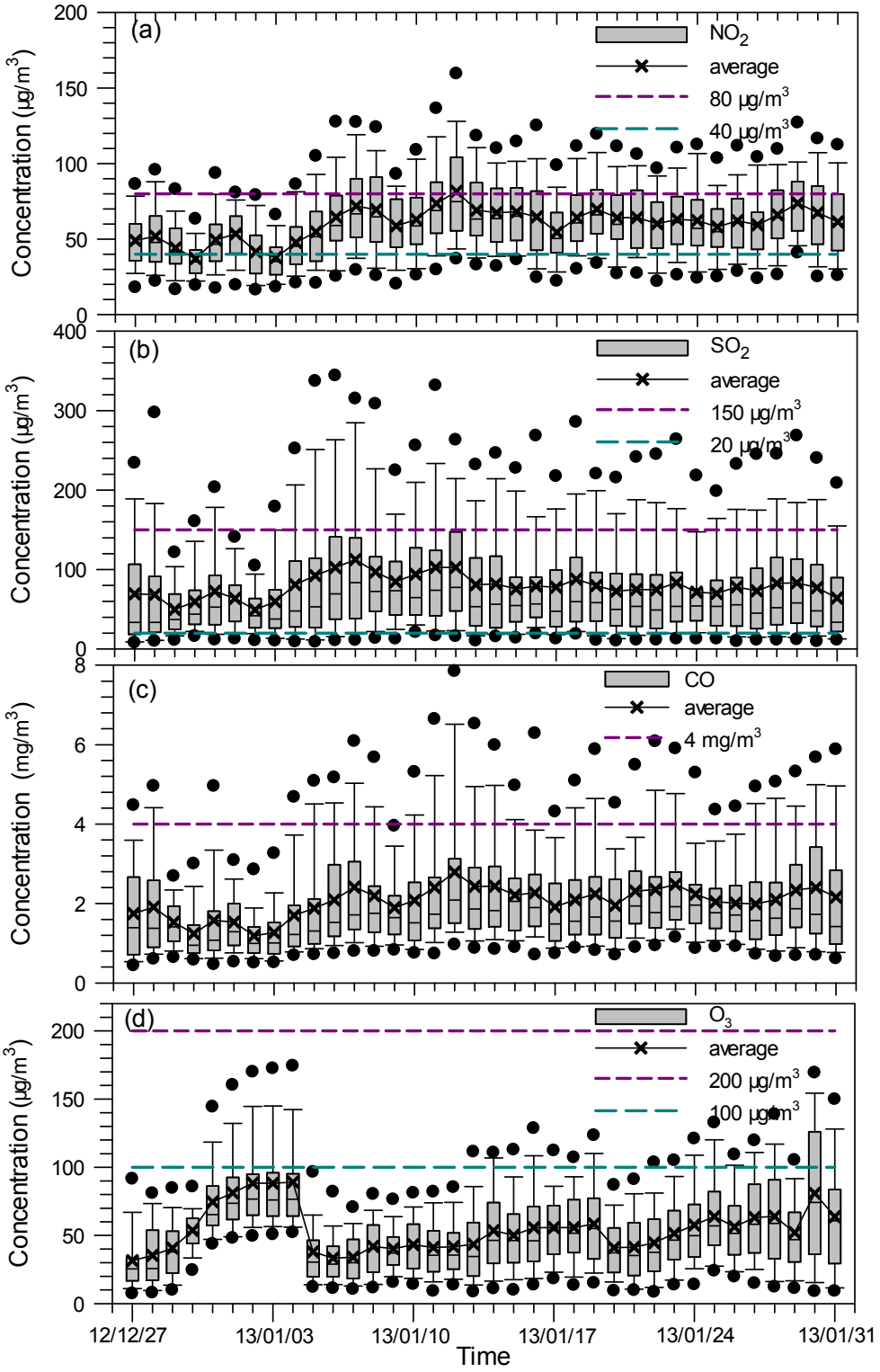

Figure S-2. Statistical result of daily average (a) NO_2, (b) SO_2, (c) CO, and (d) daily maximum 8-hr O_3 concentrations in 74 cities. The short dash lines and long dash lines are the class II values for the new China air quality standard (CNAAQS 2012) and the WHO guideline (AQG 2005),

respectively. In a single box plot, the central rectangle spans the first quartile to the third quartile. The segment inside the rectangle shows the median. The whiskers above and below the box show the locations of the 10^{th} and 90^{th} percentiles. The points above and below the whiskers show the 5^{th} and 95^{th} percentiles.

6. PM_{10} Concentration during 1952 London Great Smog

At the time of London Great Smog, the concentration of black smoke (BS) rather than PM_{10} was measured. During the first few days of the event, smoke concentrations increased from 0.49 mg/m^3 to 2.46 mg/m^3, and then continued to rise to 4.46 mg/m^3 on the two most polluted days (Authority, 2002). PM_{10} concentration can be estimated from smoke concentration by assuming a ratio of PM_{10}/BS. Hoek et al. (1997) reported that most PM_{10}/BS values at 28 sites in 10 countries in Europe were between 0.5 and 1.5 and measurements in London from 1955 to 1962 showed that the average ratio of total suspended particulate (TSP) to black smoke was 2. The ratio of PM_{10} to TSP is often assumed to be 0.5. Therefore, we used the PM_{10}/BS ratio of 1 in this study to estimate PM_{10} concentrations during the London Great Smog. The same ratio was also used in examining the health effects of particulate matter exposures (Dockery and Pope 1994). The maximum PM_{10} concentration in the London Great Smog was then estimated to be 4460 μg/m^3 which is reasonable considering that the monthly average PM_{10} level in December 1952 was reported to be ~3000 μg/m^3 (Davis et al., 2002).

Reference

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