Supplementary Material

Spatiotemporal characteristics of $PM_{2.5}$ and PM_{10} at 23 cities and background sites in China

Lizhong Xu[1], Stuart Batterman[2] *, Fang Chen[3], Jiabing Li [1], Xuefen Zhong[4], Yongjie Feng[5], Rao Qinghua[3], Feng Chen[6]

[1] College of Environmental Science and Engineering, Fujian Normal University, Fuzhou, 350007, China

[2] School of Public Health, University of Michigan, Ann Arbor, Michigan, 48104, US

[3] College of Ocean Science and Biochemistry Engineering, Fuqing Branch of Fujian Normal University, Fuqing, 350300, China

[4] China Petrochemical Fujian Oil Production Company, Fuzhou, 350007, China

[5] Henan Langtian Environmental Protection Technology Company, Zhengzhou, 450000, China

[6] Fuzhou Environmental Monitoring Station, Fuzhou, 350007, China

Contents

Table S1. Comparison of PM level from different sources (indicated below).

Site	City	City-wide $PM_{2.5}$ concentration				City-wide PM_{10} concentration			
		Apr 2013-Mar 2014 (excluding contrast site) *1	Apr 2013-Mar 2014 (including contrast site) *1	Mar 2013-Feb 2014 (including contrast site) *2	Jan 2013-Dec 2013 (offical statement)	Apr 2013-Mar 2014 (excluding contrast site) *1	Apr 2013-Mar 2014 (including contrast site) *1	Mar 2013-Feb 2014 (including contrast site)*2	Jan 2013-Dec 2013 (offical statement)
S1	Harbin	74	71	73	81	112	110	107	119*3
S2	Changchun	64	63	60	73	110	113	111	129*4
S3	Beijing	85	84	87	89.5	115	112	109	108*5
S4	Shijiazhuan	148	143	144		295	284	287	
S5	Zhengzhou	100	99	95	108	155	157	154	170*6
S6	Taiyuan			69		136	133	137	
S7	Xi'an	95	97	97	105	170	171	181	190*7
S8	Yinchuan	50	46	43	51	111	103	101	118*8
S9	Lanzhou	64	60	66		142	136	148	153*9
S10	Xining	65	63	67	70	139	133	156	163*10
S11	Chengdu	93	89	89	97	141	132	145	150*11
S12	Chongqing	69	68	67	70	100	98	100	106*12
S13	Guiyang	51	49	52	53	73	71	75	86*13
S14	Kunming	41	37	37	42	78	72	70	82*14
S15	Nanning	60	59	58	57	92	92	89	90*15
S16	Guanzhou	53	52	52	53	74	73	72	72*16
S17	Fuzhou	34	33	34	36	62	66	66	64*17
S18	Xiamen	36	34		36	61	56		62*18
S19	Haikou	33	31	27	27	53	51	46	47*19
S20	Hefei	89	87	86	88	120	123	125	115*20
S21	Wuhan	90	89	92	94	127	124	135	124*21
S22	Changsha	76	77	81		91	93	103	
S23	Zhuzhou	83	81		77	108	106		101*22

*1: calculated by our data
*2: cited from Wang (2014) except noted
*3: http://www.hrbhbj.gov.cn/zwxx/hjzl/hjzkgb/2014/06/9629.htm?id=8a8182814641cbbf014664a7c3670738
*4: http://www.ccepb.gov.cn/sjzx/zkgb/201410/t20141020_1332835.htm
*5: http://www.bjepb.gov.cn/bjepb/413526/413663/413717/413719/index.html
*6: http://www.cdhb.gov.cn/quality/detail.aspx?contentid=6291
*7: http://www.sjzhb.gov.cn/cyportal2.3/template/site00_article@sjzhbj.jsp?article_id=297e62b94a6a7ded014acdeea5a33210&parent_id=402882663fe4de03013fe4e9defe025e&parentType=0&siteID=site00&f_channel_id=null&a1b2dd= 7xaac
*8: http://www.hnep.gov.cn/tabid/435/InfoID/11750/Default.aspx
*9: http://www.xaepb.gov.cn/websac/cat/2008824.html
*10 http://www.nxep.gov.cn/pdf/2013gongbao1.pdf
*11 http://lz.lanzhou.cn/system/2014/06/05/010638426_01.shtml
*12 http://www.xnepb.gov.cn/Article/Content/?id=6271
*13 http://www.cdepb.gov.cn/cdepbws/Web/Template/GovDefaultInfo.aspx?cid=652&aid=94EB60E000B94D908FB6315681195623
*14 http://www.cepb.gov.cn/doc/2014/06/03/13821.shtml
*15 http://www.ghb.gov.cn/doc/201465/997424092.html
*16 http://www.kmepb.gov.cn/zwgk/hmhjzkgb/2013nkmhjzlgb/20624.htm
*17 http://www.nnhb.gov.cn/contents/c8ed7c74-52f8-4a27-98f0-ff21a890b769.shtml
*18 http://www.gzepb.gov.cn/zwgk/hjgb/201403/P020140317428714304067.pdf
*19 http://www.fzhjbh.gov.cn/5606-152/gov_statistics/InfoShow.aspx
*20 http://www.xmepb.gov.cn/zwgk/ghcw/hjzlgb/201501/t20150112_1033710.htm
*21 http://www.hkhbj.gov.cn/hjzl/hjjb/default.aspx
*22 http://www.hfepb.gov.cn/NewsNR.aspx?NewsID=14679
*23 http://www.whemc.cn/news/2015217/n02201669.html
*24 http://www.lusong.gov.cn/hjbf/20150108/104542.shtml

Table S2. Annual and seasonal average concentrations of $PM_{2.5}$ and PM_{10} at city and contrast sites in µg m^{-3}. St. Dev. denotes standard deviation. COV denotes coefficient of variation (%).

Site	$PM_{2.5}$ Concentration										PM_{10} Concentration									
	Urban					Contrast					Urban					Contrast				
Code	Year	Win	Spr	Sum	Fall	Year	Win	Spr	Sum	Fall	Year	Win	Spr	Sum	Fall	Year	Win	Spr	Sum	Fall
S1	74	131	48	31	87	61	111	42	25	69	112	172	91	60	126	89	139	74	48	98
S2	63	91	56	36	72	53	89	48	24	54	117	133	132	81	128	78	121	84	38	72
S3	85	105	79	76	80	67	84	67	60	58	115	133	124	99	104	86	87	105	75	63
S4	148	250	115	92	148	97	136	85	64	111	295	401	267	222	300	190	222	201	145	201
S5	100	132	86	75	102	102	136	81	86	102	155	184	148	126	160	166	194	150	153	165
S6	65	119	62	53	-	52	62	49	49	47	137	152	146	106	-	95	93	113	88	82
S7	95	163	73	50	75	116	205	81	56	106	170	251	162	95	130	196	290	150	130	207
S8	50	76	43	26	47	28	41	24	17	26	111	132	128	61	108	63	73	74	42	59
S9	64	72	63	52	67	43	59	37	27	45	142	133	159	127	146	113	119	128	85	117
S10	65	85	63	51	58	54	69	58	37	49	139	152	173	107	115	103	127	118	67	95
S11	93	150	85	53	76	57	88	53	36	51	141	212	137	89	113	74	95	78	52	68
S12	69	113	52	40	72	40	63	30	27	34	100	152	84	69	95	65	99	55	39	56
S13	51	79	46	26	52	33	55	28	14	33	73	96	72	49	79	49	68	52	25	48
S14	39	44	43	26	40	23	23	28	14	23	78	71	87	65	75	40	39	53	24	37
S15	60	92	50	23	67	54	86	46	24	59	92	135	78	42	107	83	124	69	43	93
S16	53	74	52	29	55	49	63	42	23	49	74	96	71	45	83	64	80	57	39	63
S17	34	47	39	22	29	26	45	28	17	24	66	70	79	56	59	41	41	59	28	32
S18	36	47	41	22	33	28	38	29	17	23	61	70	70	43	63	41	60	49	23	33
S19	33	48	30	17	30	24	34	27	10	26	53	67	52	35	53	46	49	50	31	45
S20	87	139	72	50	91	73	103	55	49	87	120	180	111	92	121	116	152	103	80	129
S21	90	151	65	42	91	72	132	50	31	79	127	192	103	65	149	98	153	77	63	112
S22	76	121	56	34	90	76	111	70	31	90	91	110	94	57	113	95	125	96	58	100
S23	82	122	65	33	91	71	105	50	30	77	108	152	94	49	120	103	136	95	47	110
Average	70	107	60	42	71	56	84	48	33	57	116	150	116	80	116	91	117	91	62	91
St.Dev.	26	48	19	19	28	26	42	19	19	28	50	73	47	41	50	44	60	39	37	49
COV (%)	38	45	31	47	39	45	50	39	57	49	43	49	41	51	43	48	51	43	61	54

Table S3. Spatial autocorrelation indices (Moran's I and Geary's C) for $PM_{2.5}$ and PM_{10} at urban and contrast sites, and for urban increments. Based on annual average concentrations. Bolded values exceed standard error.

Metric	Lag (km)	Pairs of Neighbors	Year or Season									
			Annual		Winter		Spring		Summer		Fall	
PM2.5 - Urban												
Moran's I	0-500	26	**0.536**	(0.182)	0.409	(0.182)	**0.545**	(0.182)	**0.802**	(0.182)	**0.575**	(0.182)
	500-1000	80	0.040	(0.083)	0.026	(0.083)	0.070	(0.083)	0.169	(0.083)	-0.057	(0.083)
	1000-1500	76	-0.201	(0.092)	-0.201	(0.092)	-0.193	(0.092)	-0.248	(0.092)	-0.122	(0.092)
	1500-2000	39	-0.236	(0.137)	-0.138	(0.137)	-0.371	(0.137)	**-0.620**	(0.137)	-0.115	(0.137)
	2000-2500	20	-0.239	(0.190)	-0.166	(0.190)	-0.267	(0.190)	-0.332	(0.190)	-0.274	(0.190)
Geary's C	0-500	26	0.542	(0.216)	0.623	(0.216)	0.535	(0.216)	0.384	(0.216)	0.491	(0.216)
	500-1000	80	0.814	(0.158)	0.835	(0.158)	0.776	(0.158)	0.633	(0.158)	0.874	(0.158)
	1000-1500	76	1.322	(0.127)	1.311	(0.127)	1.300	(0.127)	1.343	(0.127)	1.239	(0.127)
	1500-2000	39	1.290	(0.229)	1.199	(0.229)	1.382	(0.229)	1.683	(0.229)	1.203	(0.229)
	2000-2500	20	0.924	(0.385)	0.883	(0.385)	1.030	(0.385)	1.126	(0.385)	1.048	(0.385)
PM2.5 - Contrast												
Moran's I	0-500	26	**0.577**	(0.182)	0.425	(0.182)	**0.510**	(0.182)	**0.843**	(0.182)	**0.588**	(0.182)
	500-1000	80	-0.040	(0.083)	-0.042	(0.083)	-0.038	(0.083)	0.093	(0.083)	-0.095	(0.083)
	1000-1500	76	-0.240	(0.092)	-0.246	(0.092)	-0.144	(0.092)	-0.337	(0.092)	-0.230	(0.092)
	1500-2000	39	-0.089	(0.137)	0.066	(0.137)	-0.226	(0.137)	-0.422	(0.137)	0.006	(0.137)
	2000-2500	20	-0.064	(0.190)	0.008	(0.190)	-0.182	(0.190)	-0.160	(0.190)	-0.022	(0.190)
Geary's C	0-500	26	0.502	(0.216)	0.565	(0.216)	0.589	(0.216)	0.532	(0.216)	0.486	(0.216)
	500-1000	80	1.138	(0.158)	1.222	(0.158)	1.061	(0.158)	0.815	(0.158)	1.150	(0.158)
	1000-1500	76	1.223	(0.127)	1.149	(0.127)	1.169	(0.127)	1.403	(0.127)	1.253	(0.127)
	1500-2000	39	0.958	(0.229)	0.803	(0.229)	1.121	(0.229)	1.319	(0.229)	0.871	(0.229)
PM10 - Urban												
Moran's I	0-500	26	0.459	(0.182)	0.236	(0.182)	**0.601**	(0.182)	**0.615**	(0.182)	0.346	(0.182)
	500-1000	80	0.206	(0.083)	0.138	(0.083)	0.277	(0.083)	0.209	(0.083)	0.111	(0.083)
	1000-1500	76	-0.200	(0.092)	-0.190	(0.092)	-0.199	(0.092)	-0.235	(0.092)	-0.116	(0.092)
	1500-2000	39	**-0.527**	(0.137)	-0.280	(0.137)	**-0.752**	(0.137)	**-0.616**	(0.137)	-0.353	(0.137)
	2000-2500	20	-0.224	(0.190)	-0.163	(0.190)	-0.292	(0.190)	-0.216	(0.190)	-0.252	(0.190)
Geary's C	0-500	26	0.693	(0.216)	0.837	(0.216)	0.536	(0.216)	0.625	(0.216)	0.832	(0.216)
	500-1000	80	0.610	(0.158)	0.730	(0.158)	0.537	(0.158)	0.581	(0.158)	0.641	(0.158)
	1000-1500	76	1.350	(0.127)	1.330	(0.127)	1.300	(0.127)	1.362	(0.127)	1.307	(0.127)
	1500-2000	39	1.602	(0.229)	1.305	(0.229)	1.840	(0.229)	1.709	(0.229)	1.462	(0.229)
	2000-2500	20	0.864	(0.385)	0.819	(0.385)	1.019	(0.385)	0.880	(0.385)	0.908	(0.385)
PM10 - Contrast												
Moran's I	0-500	26	**0.618**	(0.182)	0.405	(0.182)	**0.728**	(0.182)	**0.861**	(0.182)	**0.519**	(0.182)
	500-1000	80	0.069	(0.083)	0.003	(0.083)	0.159	(0.083)	0.131	(0.083)	0.009	(0.083)
	1000-1500	76	-0.272	(0.092)	-0.226	(0.092)	-0.239	(0.092)	-0.393	(0.092)	-0.251	(0.092)
	1500-2000	39	-0.334	(0.137)	-0.089	(0.137)	**-0.624**	(0.137)	-0.472	(0.137)	-0.207	(0.137)
	2000-2500	20	-0.041	(0.190)	0.019	(0.190)	-0.204	(0.190)	-0.031	(0.190)	0.038	(0.190)
Geary's C	0-500	26	0.498	(0.216)	0.585	(0.216)	0.466	(0.216)	0.456	(0.216)	0.555	(0.216)
	500-1000	80	0.989	(0.158)	1.151	(0.158)	0.750	(0.158)	0.844	(0.158)	1.052	(0.158)
	1000-1500	76	1.296	(0.127)	1.186	(0.127)	1.317	(0.127)	1.438	(0.127)	1.276	(0.127)
	1500-2000	39	1.208	(0.229)	0.946	(0.229)	1.604	(0.229)	1.336	(0.229)	1.088	(0.229)

Table S4. Spearman rank correlation coefficients for daily PM concentrations across sites. Top: City sites $PM_{2.5}$ (below diagonal in red) and PM_{10} (above diagonal in blue). Bottom: Contrast sites $PM_{2.5}$ (below diagonal in red) and PM_{10} (above diagonal in blue). Heat map shows absolute values exceeding 0.3, 0.5 and 0.7 as darker colors.

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23
Urban Sites PM2.5/PM10																							
S1		0.76	0.37	0.44	0.34	0.37	0.39	0.45	0.19	0.17	0.30	0.31	0.25	-0.03	0.39	0.36	0.18	0.26	0.32	0.31	0.43	0.21	0.51
S2	0.87		0.39	0.38	0.32	0.39	0.36	0.46	0.20	0.14	0.27	0.21	0.20	0.01	0.35	0.31	0.19	0.23	0.38	0.27	0.30	0.26	0.43
S3	0.37	0.42		0.65	0.41	0.55	0.28	0.38	0.23	0.17	0.12	0.17	0.14	0.04	0.09	0.11	0.04	0.05	0.10	0.09	0.06	-0.01	0.13
S4	0.54	0.54	0.71		0.60	0.59	0.48	0.43	0.15	0.18	0.30	0.34	0.34	0.00	0.32	0.31	0.11	0.12	0.21	0.27	0.33	0.18	0.44
S5	0.39	0.39	0.43	0.63		0.35	0.43	0.32	0.18	0.12	0.27	0.30	0.24	-0.01	0.23	0.17	0.05	0.00	0.16	0.37	0.29	0.17	0.23
S6	0.50	0.46	0.64	0.62	0.33		0.46	0.59	0.28	0.34	0.34	0.26	0.23	0.10	0.24	0.30	0.21	0.25	0.17	0.27	0.35	0.22	0.33
S7	0.42	0.39	0.29	0.48	0.45	0.40		0.57	0.11	0.39	0.58	0.52	0.43	0.10	0.43	0.42	0.17	0.32	0.15	0.41	0.51	0.37	0.48
S8	0.59	0.56	0.31	0.46	0.35	0.51	0.58		0.36	0.46	0.50	0.44	0.42	0.21	0.45	0.38	0.31	0.37	0.35	0.42	0.52	0.39	0.52
S9	0.35	0.33	0.17	0.15	0.20	0.25	0.21	0.43		0.53	0.24	0.20	0.21	0.16	0.14	0.13	0.18	0.22	0.20	0.25	0.22	0.21	0.23
S10	0.35	0.30	0.08	0.18	0.14	0.40	0.39	0.49	0.50		0.49	0.35	0.31	0.22	0.20	0.23	0.26	0.31	0.11	0.27	0.29	0.30	0.30
S11	0.41	0.41	0.15	0.34	0.35	0.35	0.54	0.52	0.32	0.49		0.77	0.64	0.31	0.54	0.47	0.39	0.44	0.33	0.49	0.57	0.45	0.52
S12	0.43	0.38	0.15	0.41	0.40	0.36	0.47	0.50	0.29	0.39	0.77		0.71	0.21	0.60	0.54	0.28	0.39	0.43	0.51	0.63	0.55	0.58
S13	0.38	0.36	0.09	0.36	0.32	0.21	0.39	0.47	0.30	0.35	0.65	0.76		0.46	0.70	0.53	0.26	0.39	0.43	0.46	0.57	0.59	0.61
S14	0.10	0.17	-0.14	0.04	0.02	-0.04	0.16	0.27	0.08	0.21	0.36	0.40	0.58		0.25	0.11	0.23	0.24	0.06	0.08	0.23	0.13	0.16
S15	0.45	0.45	0.05	0.31	0.29	0.09	0.37	0.51	0.22	0.32	0.56	0.67	0.70	0.48		0.69	0.29	0.47	0.64	0.55	0.63	0.70	0.75
S16	0.43	0.43	0.11	0.33	0.27	0.14	0.35	0.44	0.20	0.31	0.53	0.60	0.58	0.31	0.71		0.43	0.62	0.52	0.46	0.69	0.60	0.73
S17	0.33	0.33	-0.03	0.12	0.06	0.07	0.19	0.36	0.21	0.32	0.45	0.38	0.43	0.29	0.45	0.57		0.66	0.27	0.24	0.35	0.19	0.34
S18	0.34	0.33	-0.01	0.11	0.04	0.13	0.22	0.34	0.21	0.30	0.46	0.44	0.49	0.32	0.48	0.64	0.80		0.34	0.37	0.51	0.44	0.55
S19	0.39	0.41	0.04	0.14	0.20	0.00	0.14	0.34	0.28	0.17	0.38	0.50	0.53	0.23	0.66	0.50	0.37	0.36		0.43	0.37	0.46	0.57
S20	0.52	0.46	0.14	0.41	0.44	0.23	0.35	0.51	0.36	0.31	0.44	0.52	0.46	0.22	0.57	0.48	0.39	0.38	0.48		0.62	0.61	0.64
S21	0.56	0.51	0.13	0.42	0.43	0.27	0.48	0.57	0.25	0.37	0.56	0.67	0.61	0.39	0.61	0.63	0.45	0.48	0.44	0.76		0.70	0.78
S22	0.45	0.42	0.04	0.34	0.31	0.14	0.43	0.48	0.22	0.29	0.53	0.68	0.68	0.36	0.71	0.68	0.39	0.47	0.44	0.65	0.84		0.89
S23	0.56	0.49	0.08	0.43	0.35	0.26	0.43	0.52	0.31	0.36	0.56	0.66	0.70	0.35	0.75	0.71	0.48	0.53	0.59	0.71	0.80	0.94	

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23
Contrast Sites PM2.5/PM10																							
S1		0.70	0.31	0.36	0.31	0.25	0.38	0.34	0.32	0.20	0.18	0.30	0.25	-0.02	0.31	0.35	-0.03	0.33	0.18	0.25	0.30	0.24	0.42
S2	0.79		0.23	0.37	0.33	0.40	0.44	0.44	0.27	0.28	0.33	0.47	0.32	0.21	0.37	0.21	-0.03	0.34	0.23	0.31	0.44	0.37	0.45
S3	0.38	0.30		0.65	0.31	0.53	0.18	0.39	0.20	0.06	0.09	0.16	0.03	0.04	0.04	0.17	0.03	0.02	0.07	0.05	-0.11	0.01	-0.04
S4	0.46	0.46	0.65		0.50	0.48	0.46	0.37	0.25	0.21	0.22	0.33	0.14	0.02	0.18	0.25	0.04	0.06	0.04	0.23	0.16	0.22	0.25
S5	0.36	0.32	0.36	0.53		0.21	0.38	0.21	0.25	0.02	0.12	0.24	0.08	-0.06	0.07	0.05	-0.16	-0.03	0.02	0.18	0.19	0.14	0.16
S6	0.38	0.33	0.69	0.60	0.38		0.22	0.44	0.18	0.16	0.15	0.14	0.05	0.11	0.03	0.09	0.12	0.11	0.07	0.15	0.04	0.08	0.05
S7	0.49	0.48	0.25	0.50	0.43	0.35		0.48	0.31	0.32	0.43	0.50	0.32	-0.04	0.34	0.28	0.06	0.14	0.01	0.40	0.50	0.31	0.29
S8	0.45	0.47	0.32	0.37	0.26	0.43	0.59		0.35	0.38	0.36	0.37	0.29	0.21	0.28	0.21	0.20	0.23	0.05	0.24	0.34	0.24	0.25
S9	0.50	0.41	0.17	0.29	0.25	0.26	0.57	0.42		0.38	0.29	0.25	0.32	0.27	0.26	0.33	0.18	0.31	0.11	0.31	0.20	0.26	0.31
S10	0.22	0.19	0.05	0.17	0.00	0.16	0.30	0.37	0.34		0.33	0.35	0.25	0.32	0.25	0.24	0.27	0.31	-0.05	0.20	0.29	0.23	0.20
S11	0.32	0.39	0.08	0.28	0.26	0.17	0.51	0.40	0.41	0.27		0.61	0.46	0.35	0.47	0.28	0.28	0.35	0.11	0.36	0.43	0.39	0.29
S12	0.38	0.39	0.16	0.36	0.36	0.21	0.46	0.39	0.44	0.30	0.66		0.58	0.35	0.63	0.46	0.20	0.41	0.39	0.39	0.60	0.61	0.50
S13	0.39	0.37	-0.04	0.17	0.19	0.00	0.37	0.33	0.44	0.17	0.45	0.59		0.57	0.61	0.46	0.31	0.36	0.31	0.37	0.48	0.55	0.48
S14	-0.01	0.09	-0.11	-0.07	-0.03	-0.11	-0.01	0.08	0.12	0.14	0.29	0.38	0.47		0.25	0.10	0.37	0.24	-0.02	0.10	0.19	0.18	0.16
S15	0.37	0.43	-0.04	0.21	0.22	0.04	0.38	0.43	0.42	0.33	0.50	0.61	0.68	0.35		0.58	0.13	0.37	0.58	0.56	0.51	0.67	0.63
S16	0.41	0.34	0.15	0.26	0.19	0.11	0.26	0.29	0.39	0.11	0.30	0.47	0.51	0.12	0.63		0.24	0.51	0.36	0.44	0.49	0.45	0.62
S17	0.25	0.20	-0.11	0.07	-0.08	0.01	0.25	0.26	0.28	0.33	0.35	0.37	0.39	0.25	0.33	0.44		0.65	-0.10	0.11	0.04	0.22	0.19
S18	0.28	0.17	-0.06	0.02	-0.07	0.03	0.15	0.19	0.28	0.23	0.28	0.29	0.31	0.14	0.34	0.51	0.68		0.00	0.31	0.26	0.34	0.47
S19	0.33	0.34	0.02	0.07	0.16	0.03	0.17	0.23	0.32	0.24	0.22	0.42	0.51	0.18	0.66	0.42	0.20	0.12		0.30	0.11	0.44	0.42
S20	0.36	0.28	0.07	0.28	0.38	0.14	0.36	0.27	0.37	0.10	0.32	0.33	0.34	0.04	0.50	0.46	0.16	0.24	0.29		0.60	0.63	0.51
S21	0.49	0.49	0.12	0.37	0.40	0.15	0.59	0.49	0.44	0.19	0.46	0.57	0.60	0.24	0.57	0.56	0.33	0.28	0.35	0.62		0.62	0.64
S22	0.39	0.43	0.03	0.26	0.32	0.10	0.37	0.34	0.41	0.25	0.36	0.58	0.60	0.16	0.71	0.56	0.27	0.29	0.58	0.59	0.72		0.83
S23	0.46	0.47	0.01	0.32	0.33	0.07	0.36	0.37	0.45	0.17	0.38	0.50	0.59	0.20	0.70	0.69	0.35	0.41	0.53	0.57	0.77	0.90	

Table S5. Results of factor analyses for $PM_{2.5}$ and PM_{10}. Results shown for six cases: Top: Untransformed $PM_{2.5}$ data at city sites; ranked $PM_{2.5}$ data at contrast sites (using Spearman correlation coefficients), and untransformed $PM_{2.5}$ data at contrast sites. Bottom: same but for PM_{10}. Blue cells have factor loadings below -0.5; yellow cells have factor loadings above 0.5. Eigenvalues and variance explained also shown.

	PM2.5 City Sites					Ranked PM2.5 Contrast Sites					PM2.5 Contrast Sites				
Factor No.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Eigen value	10.8	3.7	1.5	1.4	1.2	9.8	3.6	1.5	1.3	1.1	9.2	4.3	1.7	1.2	1.1
Variance explained	47.0	16.1	6.6	6.0	5.3	42.7	15.6	6.5	5.5	4.8	40.0	18.8	7.2	5.0	4.7
Factor Loadings															
S1	0.30	0.18	-0.19	-0.81	0.22	0.31	0.48	0.47	0.37	-0.31	0.70	0.24	-0.39	-0.32	0.09
S2	0.27	0.26	-0.31	-0.77	0.17	0.44	0.51	0.24	0.44	-0.20	0.61	0.36	-0.50	-0.18	0.06
S3	-0.04	0.86	-0.24	-0.23	-0.03	-0.09	0.87	0.03	-0.01	0.15	0.03	0.93	-0.07	-0.02	-0.01
S4	0.03	0.95	-0.19	-0.07	0.01	-0.34	0.23	-0.03	0.04	0.74	-0.21	0.57	0.51	0.02	-0.06
S5	0.06	0.90	-0.17	-0.02	0.16	0.08	0.74	-0.05	-0.01	0.23	-0.07	0.83	-0.10	-0.06	0.12
S6	0.21	0.45	-0.71	-0.31	0.07	0.22	0.78	0.11	0.19	-0.30	0.25	0.70	-0.53	0.03	0.04
S7	0.14	0.14	-0.81	-0.36	0.04	0.22	0.67	0.00	-0.11	-0.46	0.19	0.35	-0.79	0.12	-0.16
S8	0.02	0.45	-0.68	-0.04	0.41	0.03	0.83	0.03	0.21	-0.07	-0.01	0.75	-0.35	-0.01	0.16
S9	0.16	0.23	-0.83	-0.10	0.22	0.30	0.42	0.10	0.45	-0.60	0.25	0.21	-0.83	-0.01	0.23
S10	0.43	0.23	-0.45	-0.20	0.53	0.31	0.35	0.00	0.60	-0.40	0.29	0.27	-0.52	0.00	0.56
S11	0.16	-0.06	-0.10	-0.25	0.83	0.42	0.20	0.15	0.55	-0.46	0.35	0.00	-0.54	-0.04	0.49
S12	0.35	0.23	-0.32	0.02	0.66	0.17	0.06	0.06	0.78	0.10	0.16	0.06	-0.01	0.03	0.79
S13	0.62	0.25	-0.43	0.08	0.37	0.55	0.28	0.21	0.48	-0.24	0.42	0.19	-0.47	0.33	0.47
S14	0.67	0.19	-0.55	-0.03	0.19	0.67	0.29	0.13	0.33	-0.15	0.46	0.21	-0.48	0.47	0.32
S15	0.78	0.02	-0.51	-0.08	0.16	0.85	0.11	0.09	0.29	-0.21	0.70	-0.06	-0.41	0.42	0.14
S16	0.64	-0.23	-0.38	0.16	-0.04	0.72	-0.10	-0.39	0.37	0.21	0.16	-0.08	0.03	0.85	0.05
S17	0.81	-0.03	-0.35	-0.29	0.12	0.86	0.12	0.25	0.14	-0.26	0.80	-0.07	-0.37	0.28	0.16
S18	0.88	0.09	-0.11	-0.27	0.12	0.73	0.04	0.36	0.22	-0.28	0.87	-0.03	-0.16	0.09	0.19
S19	0.81	-0.01	-0.10	-0.43	0.05	0.80	0.07	0.26	0.24	-0.29	0.87	-0.01	-0.22	0.16	0.16
S20	0.83	0.06	0.06	-0.14	0.32	0.42	-0.01	0.48	0.59	-0.06	0.64	0.18	-0.10	0.20	0.54
S21	0.85	0.16	0.09	-0.07	0.28	0.28	-0.16	0.58	0.53	-0.02	0.68	0.01	0.12	0.09	0.49
S22	0.65	-0.08	-0.09	-0.49	0.09	0.72	0.11	0.44	0.00	-0.11	0.82	-0.09	-0.15	0.05	0.03
S23	0.51	-0.01	-0.10	-0.16	0.48	0.24	0.07	0.77	0.07	0.00	0.55	-0.03	-0.13	0.06	0.37

	PM10 City Sites					Ranked PM10 Contrast Sites					PM10 Contrast Sites				
Factor No.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Eigen value	9.8	3.3	2.0	1.5	1.3	9.4	3.2	2.1	1.6	1.1	8.4	3.4	2.7	1.5	1.2
Variance explained	42.4	14.5	8.9	6.6	5.6	40.7	13.7	9.1	6.9	4.6	36.5	14.9	11.8	6.5	5.4
Factor Loadings															
S1	0.35	-0.19	0.04	-0.69	0.33	0.43	-0.26	-0.08	-0.10	0.74	0.42	0.25	0.01	-0.27	-0.72
S2	0.26	-0.27	0.32	-0.71	0.22	0.22	-0.26	0.13	0.02	0.78	0.20	0.20	-0.28	-0.39	-0.70
S3	-0.04	-0.91	0.02	-0.15	0.17	-0.01	-0.94	-0.03	-0.08	0.01	0.02	0.93	0.02	-0.06	-0.01
S4	0.07	-0.94	0.05	-0.08	0.17	0.11	-0.83	0.06	-0.07	0.28	0.06	0.88	-0.10	-0.14	-0.18
S5	0.13	-0.82	0.17	0.00	0.18	0.15	-0.86	0.12	0.10	0.02	0.01	0.85	-0.25	-0.01	-0.07
S6	0.23	-0.44	-0.01	-0.21	0.68	0.21	-0.60	0.21	-0.38	0.37	0.21	0.67	-0.06	-0.51	-0.13
S7	0.10	-0.20	0.00	-0.25	0.82	0.12	-0.30	0.07	-0.66	0.33	0.06	0.26	0.07	-0.82	-0.09
S8	0.22	-0.44	0.42	-0.30	0.45	0.03	-0.77	0.21	0.07	0.24	0.05	0.70	-0.41	-0.09	0.03
S9	0.16	-0.13	0.21	-0.25	0.83	0.33	-0.08	0.18	-0.41	0.66	0.27	0.04	-0.13	-0.82	-0.35
S10	0.40	-0.27	0.62	-0.09	0.33	0.05	-0.31	0.51	-0.01	0.56	0.11	0.29	-0.74	-0.28	-0.08
S11	0.08	-0.01	0.72	-0.15	0.02	0.26	-0.16	0.41	0.05	0.43	0.17	0.00	-0.61	-0.18	-0.11
S12	0.07	-0.09	0.83	0.13	0.11	-0.14	-0.14	0.60	0.24	0.56	0.09	0.16	-0.83	0.01	-0.04
S13	0.60	-0.19	0.33	0.23	0.49	0.43	-0.12	0.54	0.06	0.46	0.54	0.12	-0.47	-0.40	-0.03
S14	0.62	-0.24	0.07	0.20	0.60	0.61	-0.19	0.47	-0.09	0.33	0.71	0.23	-0.21	-0.37	0.04
S15	0.77	-0.08	0.12	0.22	0.45	0.62	-0.11	0.65	0.02	0.17	0.76	0.05	-0.34	-0.30	0.10
S16	0.54	-0.08	0.31	0.52	-0.20	0.19	-0.09	0.88	0.15	-0.01	0.37	0.09	-0.61	0.04	0.47
S17	0.86	-0.06	-0.02	-0.06	0.39	0.87	-0.03	0.27	-0.06	0.23	0.92	0.01	0.01	-0.23	-0.10
S18	0.88	-0.10	0.12	-0.22	0.17	0.72	-0.04	0.18	0.21	0.49	0.75	0.01	-0.22	0.01	-0.41
S19	0.88	-0.11	0.11	-0.26	0.11	0.69	0.02	0.37	0.08	0.41	0.80	0.01	-0.24	-0.07	-0.32
S20	0.60	-0.04	0.57	-0.11	-0.12	0.13	-0.16	0.44	0.69	0.05	0.05	0.25	-0.71	0.31	-0.08
S21	0.77	-0.09	0.43	-0.15	-0.06	0.37	0.00	0.29	0.57	0.52	0.56	0.03	-0.52	0.16	-0.39
S22	0.74	-0.03	-0.08	-0.33	0.16	0.88	-0.19	-0.13	0.01	-0.04	0.82	0.11	0.24	0.03	-0.06
S23	0.68	0.05	0.39	0.04	0.12	0.51	-0.09	0.11	0.48	0.23	0.65	-0.01	-0.33	0.01	-0.01

Table S6. Comparison of weekend and weekday concentrations across study period at each site. Table shows median concentrations in ug m^{-3} for $PM_{2.5}$ and PM_{10} at city and contrast sites, the ratio of these concentrations, and p-value from Mann-Whitney tests (1-sided, 2 independent samples). P-values below 0.05 are highlighted.

	PM2.5 City				PM2.5 Contrast				PM10 City				PM10 Contrast			
Site	Weekend Median	Weeday Median	Ratio: Weekend/Weekday	MW p-value, 1-sided	Weekend Median	Weeday Median	Ratio: Weekend/Weekday	MW p-value, 1-sided	Weekend Median	Weeday Median	Ratio: Weekend/Weekday	MW p-value, 1-sided	Weekend Median	Weeday Median	Ratio: Weekend/Weekday	MW p-value, 1-sided
S1	48	44	1.09	0.24	34	32	1.06	0.49	89	78	1.14	**0.04**	75	66	1.14	0.13
S2	56	43	1.31	**0.00**	42	36	1.15	0.05	111	97	1.15	**0.00**	62	51	1.22	**0.01**
S3	71	62	1.15	**0.04**	53	46	1.15	0.14	111	98	1.14	**0.04**	68	70	0.96	0.43
S4	127	115	1.10	0.16	90	75	1.20	0.31	289	270	1.07	0.09	184	172	1.07	0.35
S5	93	83	1.12	**0.02**	88	82	1.08	0.06	151	141	1.07	**0.03**	152	150	1.01	0.08
S6	63	54	1.18	**0.02**	53	38	1.39	**0.03**	137	126	1.08	**0.02**	87	83	1.05	0.25
S7	70	75	0.94	0.49	88	85	1.04	0.34	143	144	0.99	0.49	153	163	0.94	0.47
S8	43	42	1.04	0.15	24	24	1.00	0.20	107	97	1.11	0.08	56	53	1.06	0.26
S9	63	59	1.06	0.27	40	37	1.07	0.20	132	128	1.03	0.44	98	99	0.98	0.44
S10	63	63	1.00	0.48	47	50	0.93	0.12	132	137	0.96	0.31	85	94	0.90	0.06
S11	74	78	0.95	0.46	52	47	1.12	0.10	123	127	0.97	0.47	67	68	0.99	0.15
S12	56	55	1.03	0.48	32	34	0.94	0.35	87	85	1.02	0.38	52	55	0.95	0.29
S13	43	46	0.93	0.48	25	28	0.91	0.47	69	68	1.02	0.28	40	44	0.91	0.43
S14	37	35	1.05	0.16	23	19	1.18	0.19	75	72	1.05	0.14	38	35	1.09	0.21
S15	49	50	0.98	0.34	46	46	1.00	0.34	83	77	1.08	0.38	78	70	1.12	0.15
S16	48	46	1.05	0.48	48	42	1.14	0.18	68	65	1.05	0.44	60	59	1.02	0.32
S17	31	29	1.07	0.47	19	24	0.79	0.12	61	62	0.98	0.45	34	37	0.91	0.22
S18	33	32	1.06	0.36	22	25	0.88	0.32	59	57	1.03	0.46	36	34	1.07	0.44
S19	30	24	1.27	0.12	17	17	1.03	0.12	52	44	1.18	0.09	39	36	1.07	0.14
S20	78	69	1.13	**0.04**	66	59	1.12	**0.04**	115	105	1.09	0.12	107	97	1.10	0.12
S21	75	74	1.02	0.15	53	55	0.96	0.38	122	109	1.12	0.23	85	85	0.99	0.22
S22	63	59	1.06	0.19	65	64	1.01	0.19	87	79	1.10	0.25	92	87	1.06	0.20
S23	72	66	1.10	0.10	62	57	1.09	0.20	98	93	1.05	0.12	100	91	1.10	0.13
Average	60	57	1.07	0.25	47	44	1.05	0.21	109	103	1.06	0.23	80	78	1.03	0.24
No. Differences (P<0.05)				5				2				5				1
No. Differences (P<0.10)				6				4				8				3

Figure S1. Locations of the 23 cities. Site numbers correspond to abbreviations in Table 1.

Figure S2. Contrast versus urban annual average concentrations at the 23 cities for $PM_{2.5}$ (left) and PM_{10} (right).

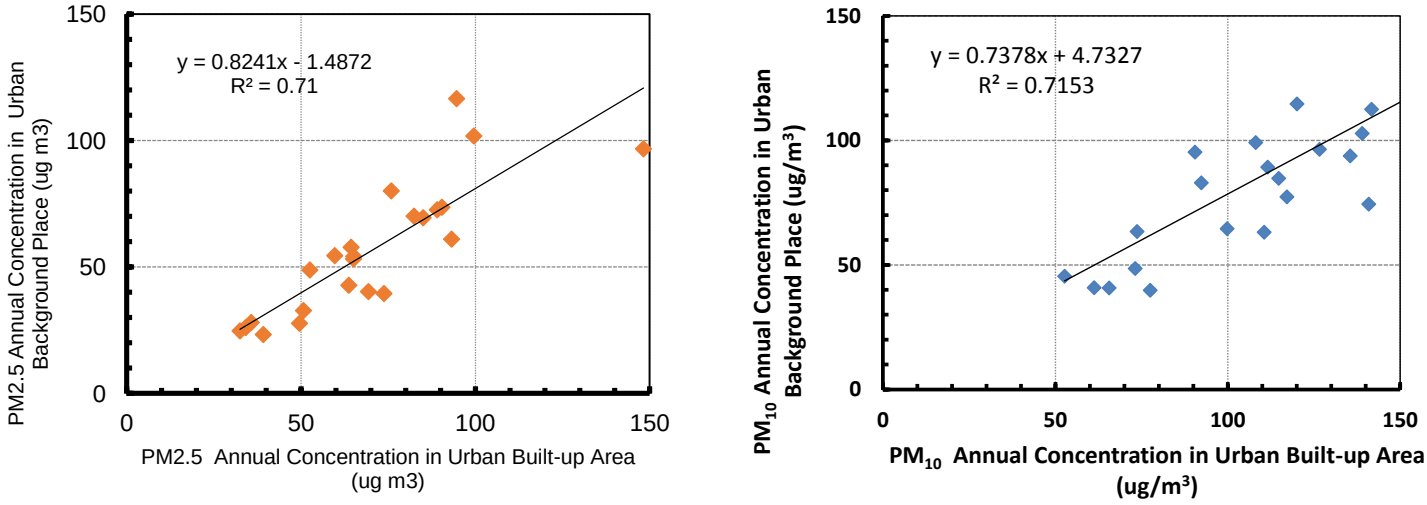

Figure S3. Annual average $PM_{2.5}$ and PM_{10} concentrations by region. Error bars shows standard deviation among sites in region.

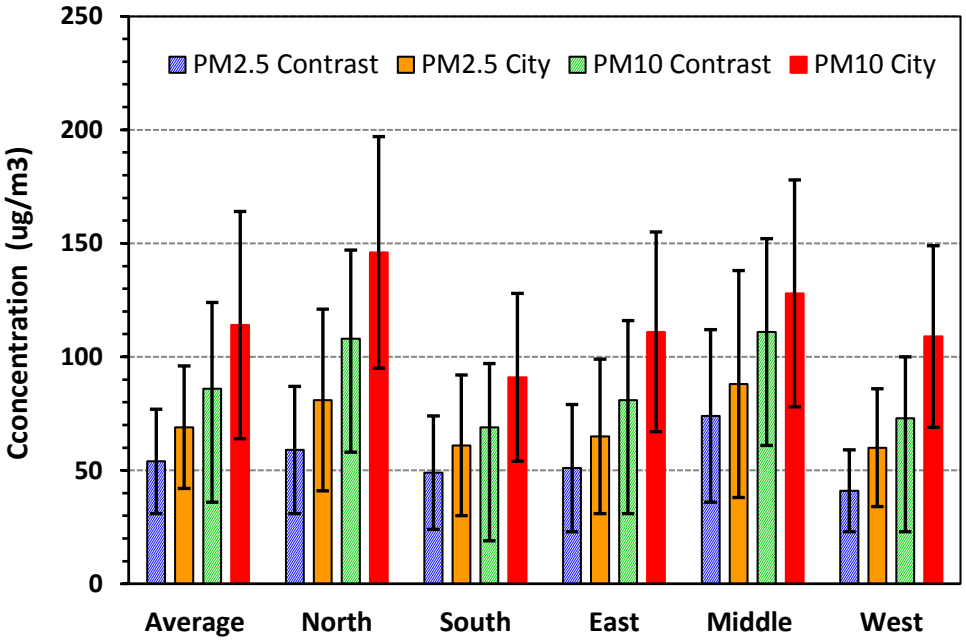

Figure S4. Contrast and urban increment concentrations for PM_{10} by deciles at each site, plus 23-site average.

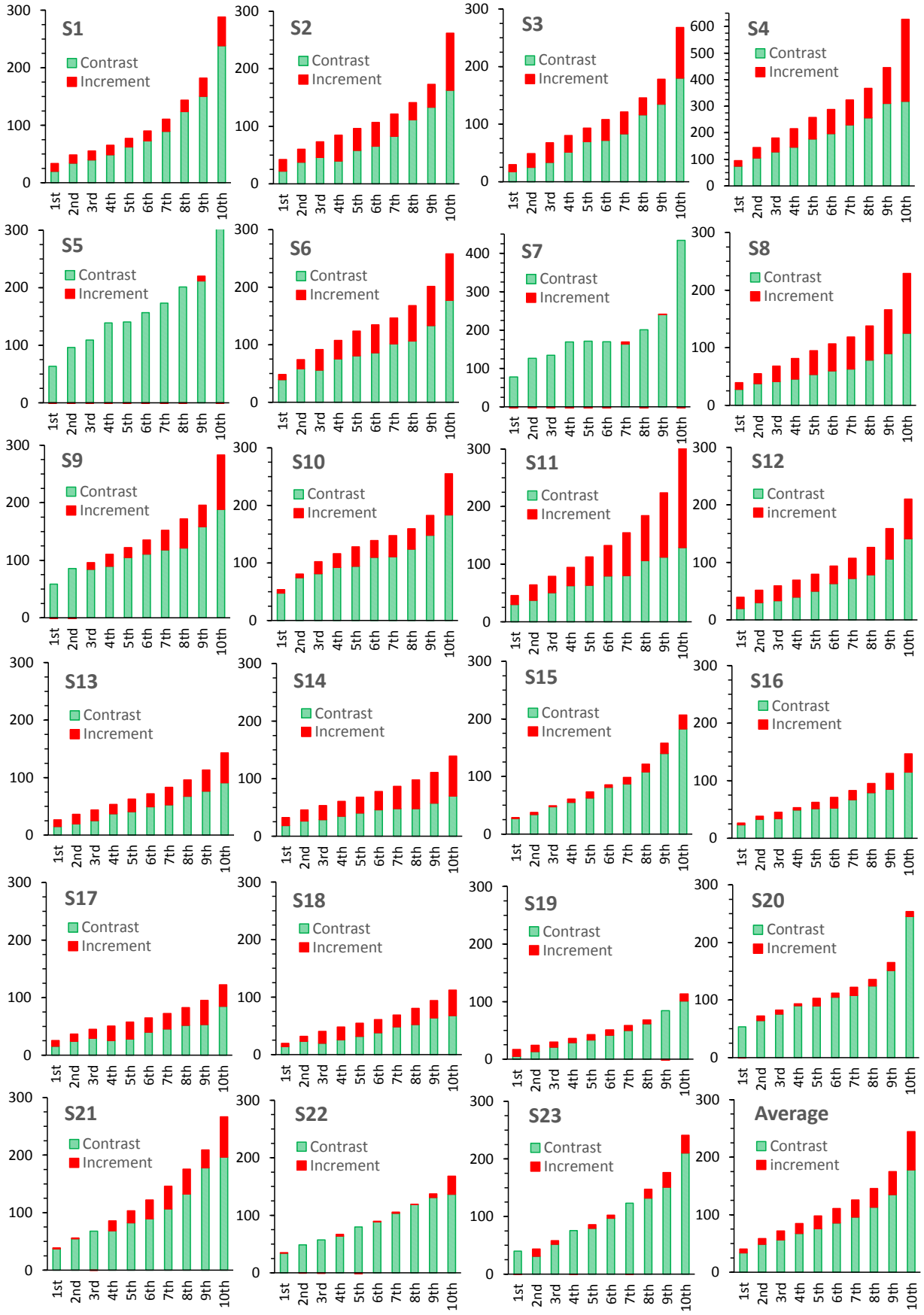

Figure S5. Trends of $PM_{2.5}$ and PM_{10} concentrations over pollution episodes in February 2014 at (A) Shijiazhuang (S4) and (B) Haikou (S19).

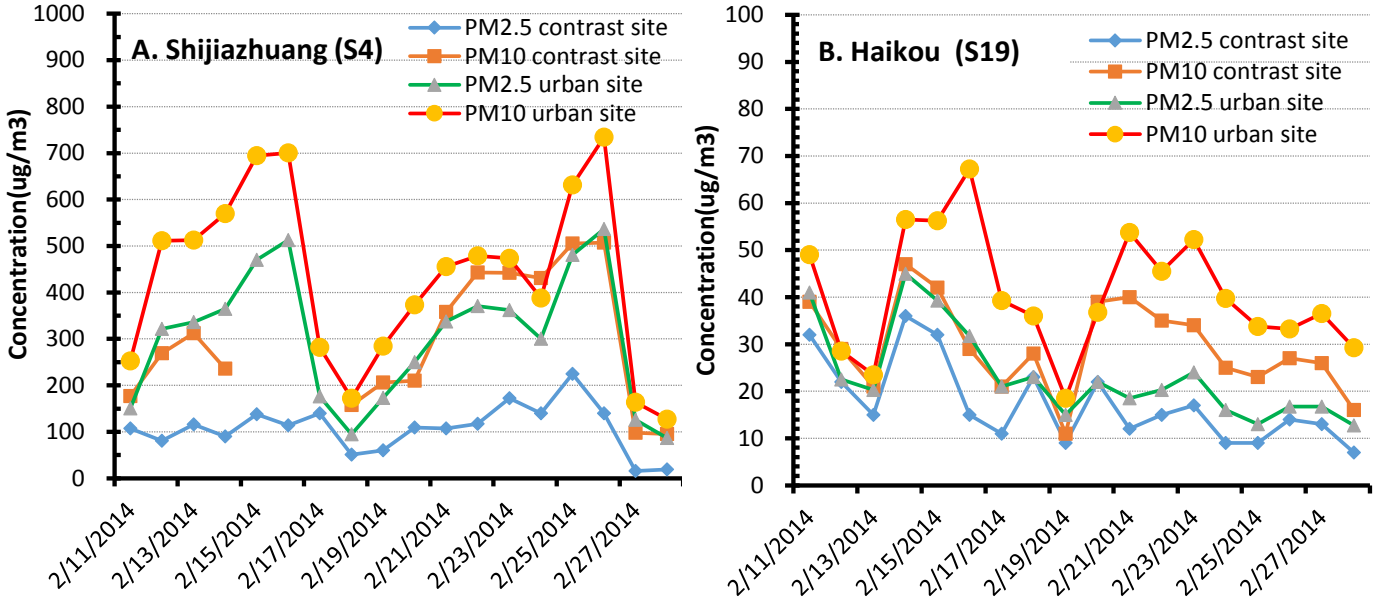

Figure S6. Weekend/weekday ratios of $PM_{2.5}$ and PM_{10} concentrations at city and contrast sites for study period (1-year period; top) for winter period (Dec., Jan., Feb.; bottom).