

Supplement of Geosci. Model Dev. Discuss., 8, 9373–9413, 2015
<http://www.geosci-model-dev-discuss.net/8/9373/2015/>
doi:10.5194/gmdd-8-9373-2015-supplement
© Author(s) 2015. CC Attribution 3.0 License.



Supplement of

Air Quality Modeling with WRF-Chem v3.5 in East and South Asia: sensitivity to emissions and evaluation of simulated air quality

M. Zhong et al.

Correspondence to: M. Zhong (min.zhong@emory.edu) and E. Saikawa (eri.saikawa@emory.edu)

The copyright of individual parts of the supplement might differ from the CC-BY 3.0 licence.

Table S1: Air Pollution Index (API) and corresponding daily mean PM₁₀ concentrations (Source: http://jcs.mep.gov.cn/hjzl/200604/t20060426_76155.htm).

API	Daily mean PM ₁₀ (ug m ⁻³)
50	50
100	150
200	350
300	420
400	500
500	600

Table S2a. Description of API derived PM₁₀ observation sites from the website of Ministry of Environmental Protection of P. R. China, <http://datacenter.mep.gov.cn/>

Site	Province	Region	Latitude (°N)	Longitude (°E)
Anshan	Liaoning	Northeast	41.11	122.99
Baoji	Shanxi	NorthChina	34.36	107.24
Beihai	Guangxi	SouthChina	21.48	109.12
Beijing	Beijing	NorthChina	39.9	116.4
Changchun	Jilin	Northeast	43.83	125.32
Changde	Hunan	CentralChina	29.03	111.7
Changsha	Hunan	CentralChina	28.23	112.94
Changzhi	Shanxi	NorthChina	36.2	113.12
Chengdu	Sichuang	Southwest	30.57	104.06
Chifeng	Neimengg	NorthChina	42.26	118.89
Chongqin	Chongqin	Southwest	29.56	106.55
Dalian	Liaoning	Northeast	38.91	121.62
Datong	Shanxi	NorthChina	40.07	113.3
Deyang	Sichuang	Southwest	31.12	104.4
Fushun	Liaoning	Northeast	41.88	123.96
Guangzhou	Guangdon	SouthChina	23.13	113.26
Guiyan	Guizhou	Southwest	26.65	106.63
Haerbin	Heilongj	Northeast	45.8	126.54
Haikou	Hainan	SouthChina	20.02	110.33
Hangzhou	Zhejiang	EastChina	30.27	120.16
Hefei	Anhui	EastChina	31.82	117.23
Huhehot	Neimengg	NorthChina	40.84	111.75
Jinan	Shandong	EastChina	36.65	117.12
Jingzhou	Hubei	CentralChina	30.33	112.24
Jining	Shandong	EastChina	35.42	116.59
Jiujiang	Jiangxi	EastChina	29.71	116
Kaifeng	Henan	CentralChina	34.8	114.31
Kunmin	Yunnan	Southwest	24.88	102.83
Lanzhou	Gansu	Northwest	36.06	103.84
Lhasa	Xizang	Southwest	29.65	91.14
Liuzhou	Guangxi	SouthChina	24.32	109.42
Luzhou	Sichuang	Southwest	28.87	105.44
Mianyan	Sichuang	Southwest	31.46	104.68
Mudanjiang	Heilongj	Northeast	44.55	129.63
Nanchang	Jiangxi	EastChina	28.68	115.86
Nanchong	Sichuang	Southwest	30.83	106.11
Nanjing	Jiangsu	EastChina	32.06	118.8
Nanning	Guangxi	SouthChina	22.82	108.37
Ningbo	Zhejiang	EastChina	29.86	121.54
Pingding	Henan	CentralChina	33.77	113.19
Qingdao	Shandong	EastChina	36.08	120.38
Qiqihaer	Heilongj	Northeast	47.35	123.92

Quanzhou	Fujian	EastChina	24.87	118.68
Guilin	Guangxi	SouthChina	25.27	110.29
Qujing	Yunnan	Southwest	25.49	103.8
Rizhao	Shandong	EastChina	35.47	119.4
Shanghai	Shanghai	EastChina	31.22	121.46
Shantou	Guangdon	SouthChina	23.29	116.54
Shaoguan	Guangdon	SouthChina	24.81	113.6
Shenyang	Liaoning	Northeast	41.81	123.43
Shenzhen	Guangdon	SouthChina	22.54	114.06
Shijiazhuang	Hebei	NorthChina	38.04	114.5
Shizuishan	Ningxia	Northwest	38.98	106.38
Taian	Shandong	EastChina	36.2	117.09
Tianjin	Tianjin	NorthChina	39.2	117.4
Weifang	Shandong	EastChina	36.71	119.16
Weinan	Shanxi	NorthChina	34.5	109.51
Wuhan	Hubei	CentralChina	30.59	114.31
Wuhu	Anhui	EastChina	31.35	118.43
Urumqi	Xinjiang	Northwest	43.83	87.62
Xiamen	Fujian	EastChina	24.52	118
Xian	Shanxi	NorthChina	34.25	109.09
Xining	Qinghai	Northwest	36.62	101.78
Yangquan	Shanxi	NorthChina	37.86	113.58
Yantai	Shandong	EastChina	37.46	121.44
Yinchuan	Ningxia	Northwest	38.49	106.23
Zaozhuang	Shandong	EastChina	34.81	117.32
Zhanjiang	Guangdon	SouthChina	21.26	110.36
Zhengzhou	Henan	CentralChina	34.74	113.63
Zibo	Shandong	EastChina	36.81	118.06
Zigong	Sichuang	Southwest	29.34	104.78

Table S2b. Description of observation sites with direct measurements.

Site	Country or Region	Latitude (°N)	Longitude (°E)
Lulin ¹	Taiwan	23.46	120.87
Happo ¹	Japan	36.68	137.8
Hedo	Japan	26.85	128.26
Oki	Japan	36.28	133.18
Rishiri	Japan	45.12	141.24
Sado-seki	Japan	38.25	138.4
Tappi	Japan	41.27	141.35
Yusuhara ¹	Japan	33.38	132.93
Xiamen	China	24.467	118.133
Jinyunshan ¹	China	29.820	106.382
Zhuhai	China	22.267	113.567
Godavari	Nepal	27.609	85.352

Note1: The altitude is 2860m for Lulin, 1850m for Happo, 790m for Yusuhara, and 800m for Jinyunshan.

Table S3. Provincial differences of monthly emissions and provincial difference of 14-day mean concentrations between REAS and EDGAR in July 2007.

Provinces in China	Emission difference (REAS-EDGAR) / EDGAR (%)				Concentration difference (REAS-EDGAR) / EDGAR (%)			
	PM ₁₀	CO	SO ₂	NO _x	PM ₁₀	O ₃	SO ₂	NO ₂
Anhui	61.8	56.4	-26.2	50.6	48.0	18.0	-28.0	43.7
Beijing	98.4	238.1	-42.3	32.0	43.8	19.5	-21.1	27.1
Chongqing	46.1	57.8	78.5	59.5	39.3	19.6	69.3	46.7
Fujian	-10.5	62.0	-49.9	74.6	8.5	11.8	-54.1	60.1
Guangdong	43.0	67.0	-20.2	49.0	14.2	9.5	-25.7	51.0
Gansu	37.1	24.7	-31.7	27.6	1.7	13.6	-22.2	28.6
Guangxi	23.7	141.9	45.8	21.2	15.8	9.4	45.0	28.3
Guizhou	21.5	205.7	244.2	68.9	25.1	13.7	220.8	58.7
Hainan	-10.2	19.8	11.4	60.5	-1.1	-8.4	13.6	61.8
Hebei	150.6	548.6	45.2	92.8	48.2	20.7	28.0	65.9
Henan	135.0	104.7	22.2	107.3	66.6	17.8	22.5	95.2
Heilongjiang	9.9	90.0	-51.4	65.8	17.0	13.3	-52.3	57.7
Hunan	73.4	92.9	5.1	59.0	25.4	18.7	1.5	53.3
Hubei	6.0	-49.9	44.9	76.6	41.9	23.8	15.1	51.2
Jilin	51.9	131.4	-13.2	109.0	43.0	19.2	-1.3	111.9
Jiangsu	74.2	311.8	-3.0	108.1	45.9	13.0	-5.4	95.6
Jiangxi	84.8	57.0	11.3	36.6	25.6	20.0	6.9	54.5
Liaoning	80.7	14.4	1.6	68.5	43.9	16.2	-8.4	52.5
Inner Mongolia	-0.4	11.4	-57.4	37.7	4.3	13.9	-47.5	32.1
Ningxia	41.5	84.4	62.6	86.5	4.2	13.2	25.9	66.3
Qinghai	3.2	-48.0	-59.2	-44.8	-5.6	4.2	-45.9	-41.9
Shaanxi	8.3	29.5	-4.4	16.6	20.9	16.1	-8.6	11.9
Sichuan	33.9	94.0	-1.9	11.0	25.0	11.0	6.9	13.7
Shandong	118.6	344.8	98.1	143.9	70.3	19.9	75.3	118.1
Shanghai	36.2	340.8	55.9	193.5	33.9	1.3	67.2	258.2
Shanxi	160.1	98.4	74.9	122.8	35.7	15.9	31.2	79.1
Tianjin	-27.5	295.9	-54.1	-8.8	52.0	24.7	-23.0	6.5
Xinjiang	3.3	18.8	32.7	58.3	2.1	11.2	26.5	54.8
Tibet	-53.1	5.1	-79.2	-69.1	1.9	4.1	-64.3	-58.1
Yunnan	111.4	93.4	182.8	84.7	15.6	13.5	175.6	75.8
Zhejiang	52.6	144.2	-37.6	74.6	29.9	26.1	-39.4	66.0

Table S5. Statistical measures for seasonal variation of model simulations and observation in the year 2007. The unit of Obs and Model is $\mu\text{g m}^{-3}$ for PM_{10} , and ppbv for O_3 , SO_2 and NO_2 . Other statistical indicators and associated units are described in Table 2.

Species	month	Count	Obs	Model	<i>r</i>	NMB	MFB	MFE	NMSE
PM_{10}	Jan	1718	132.33	100.03	0.39	-24.41	-32.95	53.25	0.56
	Apr	1805	101.43	86.45	0.37	-14.77	-22.81	45.71	0.46
	Jul	1589	82.45	80.40	0.37	-2.49	-9.86	48.13	0.36
	Oct	1762	92.42	89.19	0.38	-3.50	-13.43	46.69	0.36
O_3	Jan	194	40.87	46.73	-0.02	14.34	15.83	21.93	0.09
	Apr	181	60.50	54.31	0.51	-10.23	-9.55	16.87	0.05
	Jul	168	35.18	43.58	0.78	23.87	25.98	30.16	0.10
	Oct	169	40.59	47.21	0.43	16.31	18.20	25.10	0.08
SO_2	Jan	294	13.29	10.57	0.70	-20.43	-22.85	59.42	1.17
	Apr	286	6.67	7.44	0.70	11.60	7.69	61.58	1.25
	Jul	251	4.82	8.25	0.74	71.14	30.77	74.02	1.90
	Oct	269	5.80	8.91	0.54	53.67	24.42	69.58	2.17
NO_2	Jan	124	27.43	20.23	0.43	-26.25	-56.20	76.37	0.71
	Apr	120	22.58	13.43	0.61	-40.52	-67.90	74.07	0.72
	Jul	124	17.54	12.17	0.73	-30.60	-54.99	62.01	0.47
	Oct	124	20.56	14.12	0.53	-31.32	-40.78	66.88	0.68

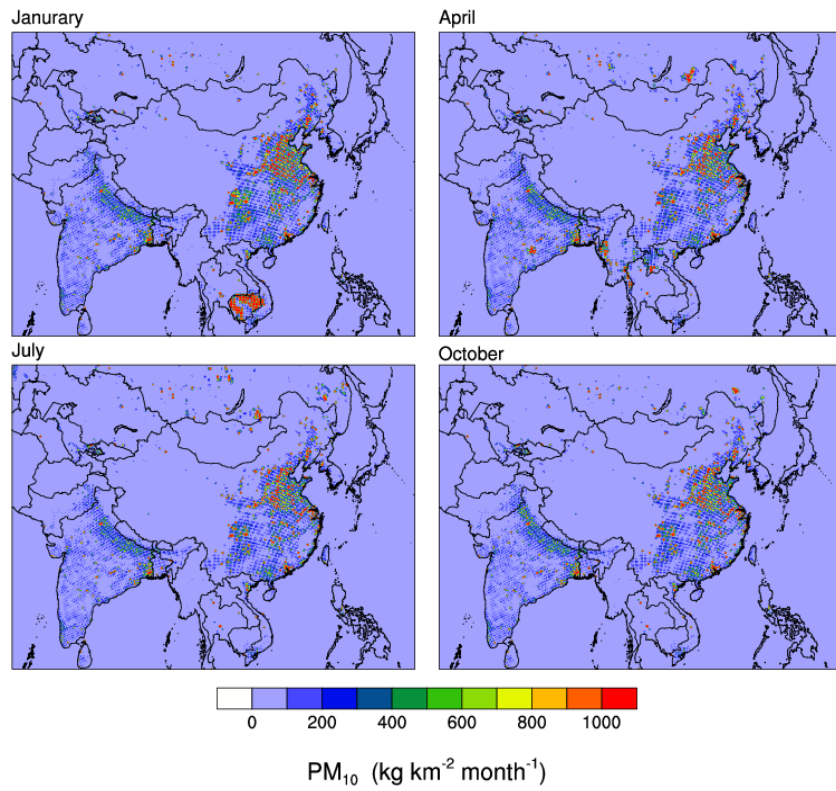


Figure S1. Monthly emissions of anthropogenic primary PM₁₀.

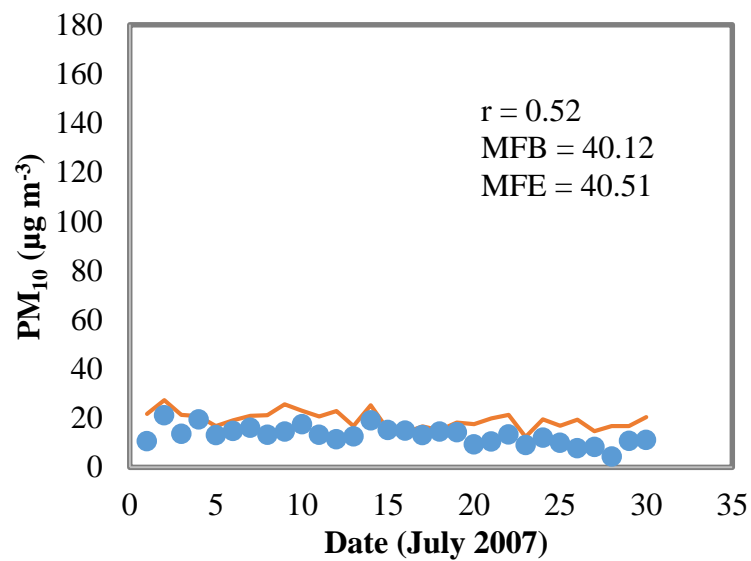
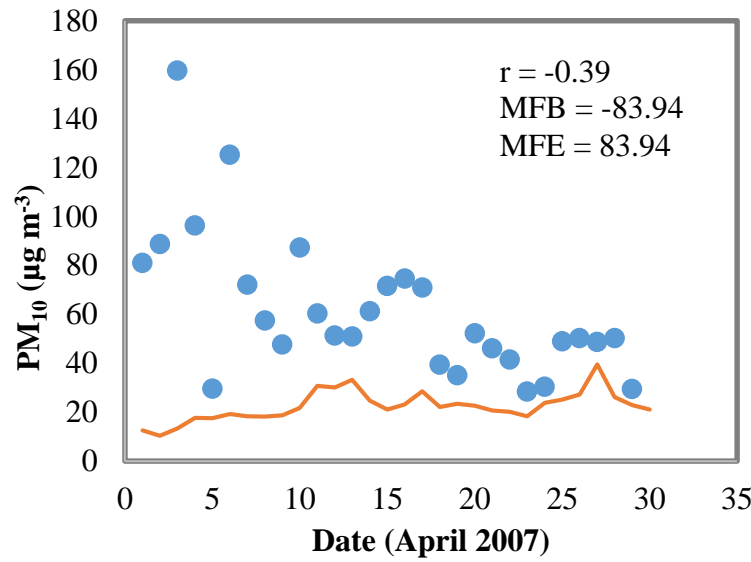
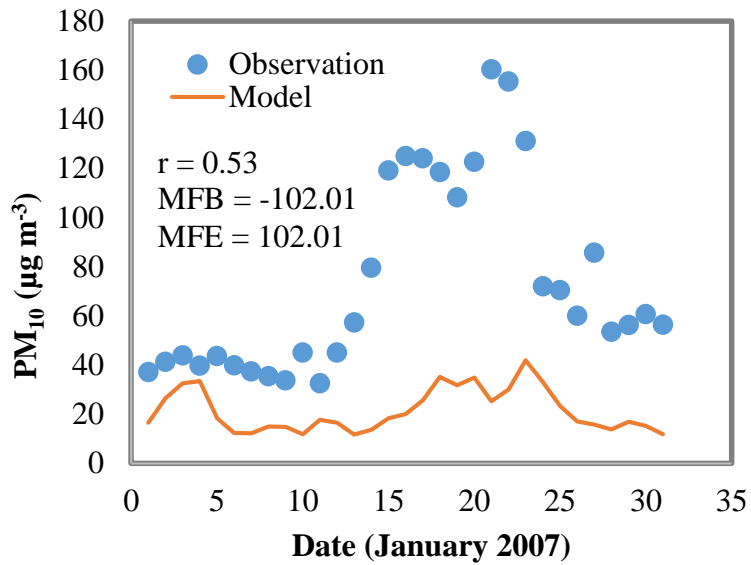


Figure S2. Comparison of observed (blue) and simulated (orange) daily mean PM₁₀ concentrations in January (top), April (middle), and October (bottom) 2007 at Godavari, Nepal.