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## Supplementary Information for “*Optimization of Emission Reduction Target in Beijing–Tianjin–Hebei Region: An Atmospheric transfer coefficient matrix perspective*”

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Table S1. Concentrations monitored by air quality monitoring stations in Beijing.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Beijing		2016/1/1	106	176
		2016/1/2	124	266
		2016/1/3	83	247
		2016/1/4	33	37
		2016/1/5	38	34
		2016/1/6	35	25
		2016/1/7	28	13
		2016/1/8	43	35
		2016/1/9	74	76
	1. Wanshou Temple	2016/1/10	55	46
	2. West Park officials	2016/1/11	25	11
	3. Changping Dingling	2016/1/12	30	14
	4. Dongsì	2016/1/13	49	26
	5. Temple of Heaven	2016/1/14	73	73
	6. Shunyi New Town	2016/1/15	84	100
	7. Changping Town	2016/1/16	71	123
	8. Chaoyang Agricultural Exhibition Hall	2016/1/17	29	37
	9. Huairou town	2016/1/18	18	10
	10. Haidian Wanliu	2016/1/19	62	62
	11. Shijingshan city	2016/1/20	78	117
	12. Chaoyang Olympic Sports Center	2016/1/21	68	131
		2016/1/22	16	13
		2016/1/23	12	9
		2016/1/24	24	13
		2016/1/25	43	28
		2016/1/26	37	35
		2016/1/27	79	98
		2016/1/28	80	121
		2016/1/29	55	62
		2016/1/30	48	50
		2016/1/31	30	18
Average concentrations			52.6	67.94

Table S2. Concentrations monitored by air quality monitoring stations in Tianjin.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Tianjin		2016/1/1	79	176
		2016/1/2	137	334
		2016/1/3	53	94
		2016/1/4	63	104
		2016/1/5	45	37
		2016/1/6	51	45
		2016/1/7	36	26
		2016/1/8	45	30
	1. Qinjian street	2016/1/9	98	188
	2. Dazhigu No.8 road	2016/1/10	70	117
	3. Qianjin street	2016/1/11	44	27
	4. Huaihe street	2016/1/12	41	28
	5. Yuejin Road	2016/1/13	73	72
	6. No.4 street	2016/1/14	101	104
	7. Yongming road	2016/1/15	107	175
	8. Hanbei road	2016/1/16	46	82
	9. Tuanpowa	2016/1/17	46	60
	10. Hexi Yijing road	2016/1/18	29	23
	11. Jingu Road	2016/1/19	58	39
	12. Binshui Xidao	2016/1/20	70	61
	13. Dali Road	2016/1/21	50	54
	14. Zhongshan North Road	2016/1/22	24	25
	15. Xisi Road	2016/1/23	14	11
		2016/1/24	28	21
		2016/1/25	56	47
		2016/1/26	52	39
		2016/1/27	82	80
		2016/1/28	77	88
		2016/1/29	36	22
		2016/1/30	55	40
		2016/1/31	39	39
Average concentrations			58.2	73.81

Table S3. Concentrations monitored by air quality monitoring stations in Hengshui.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Hengshui	1. Hengshui City Environmental Protection Bureau 2. Electrical Machine North Factory 3. Environmental Monitoring Station	2016/1/1	61	171
		2016/1/2	105	375
		2016/1/3	83	380
		2016/1/4	57	135
		2016/1/5	45	58
		2016/1/6	64	121
		2016/1/7	48	69
		2016/1/8	80	179
		2016/1/9	82	248
		2016/1/10	76	276
		2016/1/11	48	53
		2016/1/12	60	98
		2016/1/13	76	129
		2016/1/14	73	123
		2016/1/15	90	168
		2016/1/16	77	204
		2016/1/17	45	95
		2016/1/18	57	122
		2016/1/19	58	81
		2016/1/20	70	91
		2016/1/21	73	132
		2016/1/22	39	56
		2016/1/23	26	37
		2016/1/24	26	39
		2016/1/25	55	89
		2016/1/26	61	83
		2016/1/27	73	106
		2016/1/28	98	170
		2016/1/29	37	60
		2016/1/30	38	53
		2016/1/31	66	143
Average concentrations			62.8	133.68

Table S4. Concentrations monitored by air quality monitoring stations in Baoding.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Baoding	1. Huadian II 2. Reception Center 3. City Monitoring Station 4. Natatorium 5. Film Factory 6. Surface water Company	2016/1/1	149	243
		2016/1/2	180	395
		2016/1/3	130	282
		2016/1/4	72	154
		2016/1/5	66	128
		2016/1/6	90	186
		2016/1/7	68	114
		2016/1/8	87	182
		2016/1/9	116	244
		2016/1/10	88	145
		2016/1/11	56	78
		2016/1/12	78	160
		2016/1/13	101	209
		2016/1/14	102	178
		2016/1/15	117	210
		2016/1/16	86	153
		2016/1/17	62	87
		2016/1/18	62	85
		2016/1/19	84	123
		2016/1/20	112	230
		2016/1/21	82	124
		2016/1/22	35	41
		2016/1/23	25	34
		2016/1/24	38	31
		2016/1/25	91	143
		2016/1/26	86	104
		2016/1/27	118	204
		2016/1/28	112	126
		2016/1/29	64	60
		2016/1/30	53	58
		2016/1/31	67	116
Average concentrations			86.4	149.26

Table S5. Concentrations monitored by air quality monitoring stations in Cangzhou.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Cangzhou	1. Municipal Environmental Protection Agency 2. TV Broadcast Station 3. Cangxian Urban Construction Bureau	2016/1/1	69	167
		2016/1/2	104	296
		2016/1/3	60	135
		2016/1/4	81	90
		2016/1/5	57	50
		2016/1/6	74	79
		2016/1/7	46	32
		2016/1/8	64	73
		2016/1/9	95	186
		2016/1/10	73	161
		2016/1/11	49	34
		2016/1/12	54	58
		2016/1/13	86	127
		2016/1/14	103	179
		2016/1/15	109	177
		2016/1/16	70	99
		2016/1/17	57	76
		2016/1/18	54	57
		2016/1/19	68	51
		2016/1/20	70	61
		2016/1/21	55	64
		2016/1/22	25	31
		2016/1/23	19	23
		2016/1/24	26	24
		2016/1/25	43	49
		2016/1/26	38	39
		2016/1/27	41	33
		2016/1/28	44	67
		2016/1/29	20	29
		2016/1/30	29	40
		2016/1/31	34	43
Average concentrations			58.6	84.84

Table S6. Concentrations monitored by air quality monitoring stations in Chengde.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Chengde	1. Ligong 2. Bank of China 3. Economic and Technological Development Zone 4. Cultural Center	2016/1/1	69	107
		2016/1/2	87	149
		2016/1/3	81	130
		2016/1/4	20	19
		2016/1/5	36	20
		2016/1/6	28	26
		2016/1/7	18	17
		2016/1/8	35	29
		2016/1/9	54	50
		2016/1/10	36	41
		2016/1/11	22	18
		2016/1/12	24	19
		2016/1/13	35	27
		2016/1/14	56	48
		2016/1/15	58	56
		2016/1/16	37	65
		2016/1/17	30	53
		2016/1/18	15	19
		2016/1/19	44	42
		2016/1/20	57	44
		2016/1/21	50	50
		2016/1/22	11	18
		2016/1/23	6	17
		2016/1/24	10	16
		2016/1/25	36	30
		2016/1/26	48	41
		2016/1/27	60	54
		2016/1/28	64	70
		2016/1/29	51	46
		2016/1/30	32	36
		2016/1/31	28	25
Average concentrations			39.9	44.58

Table S7. Concentrations monitored by air quality monitoring stations in Handan.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Handan	1. East Sewage Factory 2. Municipal Environmental Protection Agency 3. CongTai Park 4. Mine Hospital	2016/1/1	78	122
		2016/1/2	153	332
		2016/1/3	152	268
		2016/1/4	74	84
		2016/1/5	66	74
		2016/1/6	65	93
		2016/1/7	71	140
		2016/1/8	80	152
		2016/1/9	68	158
		2016/1/10	93	220
		2016/1/11	53	45
		2016/1/12	56	54
		2016/1/13	76	114
		2016/1/14	68	60
		2016/1/15	78	100
		2016/1/16	94	162
		2016/1/17	52	91
		2016/1/18	51	70
		2016/1/19	77	112
		2016/1/20	76	92
		2016/1/21	91	153
		2016/1/22	49	58
		2016/1/23	34	34
		2016/1/24	46	32
		2016/1/25	59	46
		2016/1/26	58	37
		2016/1/27	83	125
		2016/1/28	96	130
		2016/1/29	64	90
		2016/1/30	41	43
		2016/1/31	57	74
Average concentrations			72.9	108.55



Table S8. Concentrations monitored by air quality monitoring stations in Langfang.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Langfang	1. Environmental Monitoring Supervision Center 2. TCM Medical Material Company 3. Economic and Technological Development Zone 4. Hebei University of Technology 5. North China Institute of Aerospace	2016/1/1	115	287
		2016/1/2	137	350
		2016/1/3	55	160
		2016/1/4	54	79
		2016/1/5	45	41
		2016/1/6	46	43
		2016/1/7	34	21
		2016/1/8	39	23
		2016/1/9	103	186
		2016/1/10	73	136
		2016/1/11	35	21
		2016/1/12	45	35
		2016/1/13	71	76
		2016/1/14	92	153
		2016/1/15	97	169
		2016/1/16	55	89
		2016/1/17	32	30
		2016/1/18	22	16
		2016/1/19	55	54
		2016/1/20	86	127
		2016/1/21	59	78
		2016/1/22	28	23
		2016/1/23	24	13
		2016/1/24	39	20
		2016/1/25	72	64
		2016/1/26	48	39
		2016/1/27	96	160
		2016/1/28	93	112
		2016/1/29	51	42
		2016/1/30	62	66
		2016/1/31	40	42
Average concentrations			61.4	88.87

Table S9. Concentrations monitored by air quality monitoring stations in Qinhuangdao.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Qinhuangdao	1. City Monitoring Station 2. Shanhai Pass 3. City government 4. Beidaihe Environmental Protection Bureau 5. Contruction Plazz 6. Wenming District	2016/1/1	98	137
		2016/1/2	80	134
		2016/1/3	44	42
		2016/1/4	54	56
		2016/1/5	43	21
		2016/1/6	45	34
		2016/1/7	47	31
		2016/1/8	44	22
		2016/1/9	57	39
		2016/1/10	24	18
		2016/1/11	36	25
		2016/1/12	46	35
		2016/1/13	40	24
		2016/1/14	45	28
		2016/1/15	45	60
		2016/1/16	24	41
		2016/1/17	28	35
		2016/1/18	31	22
		2016/1/19	36	20
		2016/1/20	37	29
		2016/1/21	41	40
		2016/1/22	32	33
		2016/1/23	18	12
		2016/1/24	31	14
		2016/1/25	62	34
		2016/1/26	57	38
		2016/1/27	87	79
		2016/1/28	69	73
		2016/1/29	22	14
		2016/1/30	33	21
		2016/1/31	52	39
Average concentrations			45.4	40.32

Table S10. Concentrations monitored by air quality monitoring stations in Shijiazhuang.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Shijiazhuang		2016/1/1	122	283
		2016/1/2	169	474
		2016/1/3	139	336
		2016/1/4	88	148
		2016/1/5	67	75
		2016/1/6	85	138
		2016/1/7	69	109
		2016/1/8	66	88
		2016/1/9	94	202
		2016/1/10	95	206
		2016/1/11	46	49
	1. Chemical College	2016/1/12	67	105
	2. Worker hospital	2016/1/13	77	88
	3. High-tech zone	2016/1/14	61	43
	4. Northwest Water Company	2016/1/15	92	120
	5. Fenglong Montain	2016/1/16	86	181
	6. People's Hall	2016/1/17	58	112
	7. 22 Central South Campus	2016/1/18	44	53
	8. Shiji Park	2016/1/19	81	128
	9. Xi'nan College	2016/1/20	91	181
		2016/1/21	89	164
		2016/1/22	39	58
		2016/1/23	30	39
		2016/1/24	33	17
		2016/1/25	53	33
		2016/1/26	56	40
		2016/1/27	100	154
		2016/1/28	106	169
		2016/1/29	66	108
		2016/1/30	47	68
		2016/1/31	57	85
Average concentrations			76.5	130.77

Table S11. Concentrations monitored by air quality monitoring stations in Tangshan.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Tangshan	1. Supply and marketing cooperatives 2. Ceramics Company 3. No. 12 middle school 4. Xiaoshan Station 5. Commodities Bureau 6. Radar station	2016/1/1	102	206
		2016/1/2	133	342
		2016/1/3	94	183
		2016/1/4	66	72
		2016/1/5	48	46
		2016/1/6	59	64
		2016/1/7	40	33
		2016/1/8	54	36
		2016/1/9	90	134
		2016/1/10	60	75
		2016/1/11	56	48
		2016/1/12	45	36
		2016/1/13	44	29
		2016/1/14	80	88
		2016/1/15	109	159
		2016/1/16	67	76
		2016/1/17	55	66
		2016/1/18	59	37

2016/1/19	84	44
2016/1/20	80	74
2016/1/21	62	86
2016/1/22	38	44
2016/1/23	22	18
2016/1/24	21	16
2016/1/25	53	44
2016/1/26	58	51
2016/1/27	84	81
2016/1/28	92	105
2016/1/29	49	39
2016/1/30	62	60
2016/1/31	54	42
<hr/>		
<b>Average concentrations</b>	<b>65.2</b>	<b>78.52</b>
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Table S12. Concentrations monitored by air quality monitoring stations in Xingtai.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Xingtai	1. Dahuo fountain 2. Xingtai Normal College 3. Road and Bridge Corporation 4. Environment protection office	2016/1/1	142	239
		2016/1/2	180	405
		2016/1/3	172	362
		2016/1/4	85	140
		2016/1/5	70	74
		2016/1/6	95	128
		2016/1/7	78	120
		2016/1/8	94	142
		2016/1/9	99	217
		2016/1/10	112	275
		2016/1/11	50	50
		2016/1/12	72	76
		2016/1/13	72	78
		2016/1/14	74	76
		2016/1/15	86	102
		2016/1/16	100	166
		2016/1/17	64	108
		2016/1/18	67	102
		2016/1/19	85	114
		2016/1/20	98	150
		2016/1/21	97	142
		2016/1/22	57	70
		2016/1/23	32	42
		2016/1/24	46	42
		2016/1/25	66	56
		2016/1/26	68	56
		2016/1/27	96	113
		2016/1/28	112	130
		2016/1/29	71	100
		2016/1/30	36	44
		2016/1/31	59	77
Average concentrations			85	128.9

Table S13. Concentrations monitored by air quality monitoring stations in Zhangjiakou.

City	Air Quality Monitoring Station	Date	Monitored Concentrations (Unit: $\mu\text{g}/\text{m}^3$ )	
			NO <sub>2</sub>	PM <sub>2.5</sub>
Zhangjiakou	1. People's Park 2. Probe factory 3. Century Compound 4. North Pumping Station	2016/1/1	56	70
		2016/1/2	36	44
		2016/1/3	26	29
		2016/1/4	15	16
		2016/1/5	19	18
		2016/1/6	20	22
		2016/1/7	20	19
		2016/1/8	22	20
		2016/1/9	33	27
		2016/1/10	18	22
		2016/1/11	12	15
		2016/1/12	20	20
		2016/1/13	20	17
		2016/1/14	24	21
		2016/1/15	51	45
		2016/1/16	64	95
		2016/1/17	10	19
		2016/1/18	12	17
		2016/1/19	29	24
		2016/1/20	33	29
		2016/1/21	16	23
		2016/1/22	7	14
		2016/1/23	6	16
		2016/1/24	15	16
		2016/1/25	26	23
		2016/1/26	30	26
		2016/1/27	42	40
		2016/1/28	27	28
		2016/1/29	45	48
		2016/1/30	14	16
		2016/1/31	17	17
Average concentrations			25.3	27.61

Table S14. Parameterization scheme for WRF.

Model Parameterization	WRF
Domain setting	D1: 1,320 km × 1,320 km; D2: 864 km × 960 km
Microphysical process scheme	WSM6
Longwave radiation scheme	New Goddard
Solar radiation scheme	RRTM
Surface layer scheme	Pleim Xiu
Boundary layer scheme	ACM2
Cumulus convection scheme	Kain–Fritsch

Table S15. Parameterization used in CALPUFF.

Model Parameterization	CALPUFF	Model Parameterization	CALPUFF
Model version	6.42	Vertical diffusion	Gaussian
Domain setting	576 km × 738 km	Chemical mechanism flag (MCHEM)	MESOPUFF II
Nested grids	Single layer grid	Plume rise	Briggs Plume Rise
Horizontal resolution	6 km	Terrain adjustment	Partial Plume Path Adjustment
Number of vertical layers	11	Building downwash	ISC method
Horizontal diffusion	Gaussian	Dry deposition	Vertical Structure and Mass Depletion/Resistance Deposition



Table S16. The transfer coefficient matrix of NO<sub>x</sub>.

NO <sub>x</sub> (Unit: ×10 <sup>-3</sup> μg/m <sup>3</sup> •t)	Emission City													
	Receptor	Beijing	Baoding	Handan	Liangfang	Cangzhou	Hengshui	Tianjin	Shijiazhuang	Qinhuangdao	Chengde	Tangshan	Xingtai	Zhangjiakou
Beijing	3.31	0.35	0	0.24	0	0.52	0	0.35	0.09	0	0.25	0	0.3	
Baoding	0.72	4.08	0.04	0.08	0.23	0.28	0	1.46	0.17	0	0.99	0	0.03	
Handan	0.14	0.14	3.64	0.3	1.24	0.01	0.09	0.54	0.01	0.41	0.01	0.32	0.01	
Liangfang	0.71	0.24	0.13	3.6	0.22	0.03	0.01	0.89	0.03	0.19	0.07	0.02	0.05	
Cangzhou	0.39	1.11	1.01	0.21	3.51	0.06	0.02	2.01	0.06	0.1	0.13	0.09	0.02	
Hengshui	0.23	0.02	0	0	0	3.04	0	0.01	0.07	0	0.1	0	0.04	
Tianjin	0.03	0.03	1.19	0.06	0.27	0	5.17	0.11	0	0.41	0	3.29	0	
Shijiazhuang	1.93	1.86	0.14	0.37	0.41	0.17	0	4.66	0.11	0.02	0.43	0.01	0.08	
Qinhuangdao	0.05	0.16	0	0.01	0.02	1.75	0	0.05	1.73	0	1.81	0	0.01	
Chengde	0.09	0.05	0.31	1.15	0.16	0	0.05	0.22	0.01	3.27	0.01	0.2	0	
Tangshan	0.17	0.81	0	0.02	0.03	1	0	0.24	0.39	0	4.1	0	0.01	
Xingtai	0.08	0.05	2.46	0.23	0.54	0	1.03	0.27	0	1.45	0	4.81	0	
Zhangjiakou	0.05	0	0	0.03	0	0	0	0	0	0	0	0	0.84	
Sum	7.9	8.9	8.92	6.3	6.63	6.86	6.37	10.81	2.67	5.85	7.9	8.74	1.39	

Table S17. The transfer coefficient matrix of PM<sub>2.5</sub>.

PM <sub>2.5</sub> (Unit: ×10 <sup>-3</sup> μg/m <sup>3</sup> •t)	Emission City												
Receptor	Qinhuangdao	Tianjin	Handan	Xingtai	Cangzhou	Chengde	Baoding	Langfang	Beijing	Hengshui	Tangshan	Shijiazhuang	Zhangjiakou
Qinhuangdao	24.67	14.62	8.94	18.41	9.28	8.53	4.35	23.08	5.22	8.56	9.38	5.95	4.13
Tianjin	5.18	36.63	10.11	8.79	15.62	2.17	5.18	20.88	3.41	7.12	12.43	6.54	1.58
Handan	1.8	4.06	56.23	9.32	16.09	1.15	22.33	6.12	0.65	12.98	1.5	32.02	1.84
Xingtai	9.77	8.26	14.13	57.19	9.25	3.11	6.72	15.03	3.41	30.98	5.61	10.73	6.23
Cangzhou	2.18	6.94	34.05	8.84	35.94	1.58	12.2	9.31	1.28	8.5	2.87	15.95	1.61
Chengde	7.56	8.2	2.63	3.89	3.5	20.79	1.51	6.02	23.12	1.99	23.16	1.83	1.67
Baoding	0.53	1.01	6.68	2.34	2.86	0.24	58.59	1.56	0.12	5.32	0.33	21.24	0.64
Langfang	6.15	20.3	19.72	21.33	25.08	2.57	8.93	44.87	3.09	14.58	7.16	12.08	2.35
Beijing	2.34	6.96	2.61	3.79	3.28	2.72	1.35	5.37	29.01	3.14	15.15	1.95	0.83
Hengshui	2.49	2.98	21.02	13.48	7.8	0.97	17.46	5.19	0.7	57.51	1.44	32.84	2.65
Tangshan	3.48	15.47	3.91	5.17	4.81	2.92	2.53	8.95	12.02	4.38	40.34	3.24	0.98
Shijiazhuang	0.91	1.52	15.71	4.43	5.35	0.5	49.74	2.35	0.29	11.7	0.63	59.02	1.14
Zhangjiakou	5.83	2.66	1.53	3.48	1.71	3.6	0.64	3.46	1.74	1.32	2.48	0.94	12.55
Sum	72.89	129.61	197.27	160.46	140.57	50.85	191.53	152.19	84.06	168.08	122.48	204.33	38.2

Table S18. The maximum allowable emissions and the emissions variation ratio of two pollutants under different emission scenarios.

(a) NO <sub>x</sub>					
Region	S0	S1	S1 Variation Ratio	S2	S2 Variation Ratio
ZJK	7.47	4.26	-0.43	9.79	0.31
CD	14.78	7.83	-0.47	18.77	0.27
QHD	3.48	2.09	-0.40	3.83	0.10
BJ	25.90	12.17	-0.53	26.94	0.04
CZ	5.81	3.31	-0.43	5.92	0.02
TJ	27.79	16.39	-0.41	25.84	-0.07
HS	8.06	3.38	-0.58	5.32	-0.34
XT	11.24	5.73	-0.49	7.31	-0.35
TS	30.87	23.15	-0.25	19.75	-0.36
LF	9.90	5.05	-0.49	5.25	-0.47
BD	17.37	8.51	-0.51	9.03	-0.48
HD	17.59	8.97	-0.49	8.97	-0.49
SJZ	23.64	13.48	-0.43	9.69	-0.59
Average variation ratios	15.68	8.79	-0.44	11.95	-0.23

(b) PM <sub>2.5</sub>					
Region	S0	S1	S1 Variation Ratio	S2	S2 Variation Ratio
ZJK	3.89	2.22	-0.43	7.12	0.83
QHD	2.00	1.16	-0.42	3.44	0.72
CD	7.48	4.34	-0.42	8.61	0.15
TJ	10.62	4.46	-0.58	6.48	-0.39
HD	8.83	4.50	-0.49	3.71	-0.58
XT	6.77	3.93	-0.42	2.78	-0.59
HS	4.74	2.42	-0.49	1.85	-0.61
TS	7.57	4.16	-0.45	2.95	-0.61
CZ	3.18	1.78	-0.44	1.21	-0.62
BJ	8.25	5.20	-0.37	2.64	-0.68
BD	10.33	4.85	-0.53	2.99	-0.71
LF	4.95	2.13	-0.57	1.39	-0.72
SJZ	9.88	5.04	-0.49	2.67	-0.73
Average variation ratios	6.81	3.55	-0.48	2.59	-0.46

Table S19. The GDP and the variation ratio of GDP under different emission scenarios.

Region	S0	S1	S1 Variation Ratio	S2	S2 Variation Ratio
BD	1.40	0.68	-0.51	0.69	-0.51
BJ	31.46	15.14	-0.52	31.12	-0.01
CD	0.37	0.20	-0.46	0.47	0.26
CZ	0.87	0.50	-0.43	0.82	-0.05
HD	1.67	0.85	-0.49	0.84	-0.50
HS	0.49	0.21	-0.57	0.31	-0.37
LF	1.11	0.56	-0.50	0.56	-0.50
QHD	1.14	0.68	-0.40	1.34	0.17
SJZ	3.94	2.22	-0.44	1.57	-0.60
TJ	21.92	12.62	-0.42	19.80	-0.10
TS	4.07	3.01	-0.26	2.55	-0.37
XT	0.39	0.20	-0.48	0.24	-0.38
ZJK	0.82	0.46	-0.43	1.11	0.37
Average variation ratios	5.36	2.87	-0.46	4.72	-0.12

Table S20. The variation ratio of GDP in three hypothetical cases.

Region	Unchanged		Emission Intensity		Emission Intensity	
	Emission Intensity		Reduced by 20%		Reduced by 50%	
	S1	S2	S1'	S2'	S1''	S2''
ZJK	-0.43	0.37	-0.29	0.71	0.14	1.73
CD	-0.46	0.26	-0.33	0.57	0.07	1.51
QHD	-0.40	0.17	-0.25	0.47	0.20	1.35
BJ	-0.52	-0.01	-0.40	0.24	-0.04	0.98
CZ	-0.43	-0.05	-0.29	0.18	0.14	0.89
TJ	-0.42	-0.10	-0.28	0.13	0.15	0.81
HS	-0.57	-0.37	-0.46	-0.22	-0.14	0.25
TS	-0.26	-0.37	-0.08	-0.22	0.48	0.25
XT	-0.48	-0.38	-0.35	-0.23	0.04	0.24
LF	-0.50	-0.50	-0.37	-0.37	0.00	0.01
HD	-0.49	-0.50	-0.36	-0.37	0.02	0.00
BD	-0.51	-0.51	-0.39	-0.39	-0.02	-0.02
SJZ	-0.44	-0.60	-0.29	-0.50	0.13	-0.21
Average variation ratios	-0.46	0.12	-0.32	0.00	0.09	0.60

Table S21. Emission reduction ratio in scenario S1 (relative to 2016).

Unit: %

	BJ	TJ	SJZ	CD	ZJK	QHD	TS	LF	BD	CZ	HS	XT	HD
NO <sub>x</sub>	53	25	43	43	43	40	41	49	51	47	58	49	49
PM <sub>2.5</sub>	37	45	49	44	43	42	58	57	53	42	49	42	49

Note: The data come from information not yet made public by the government.

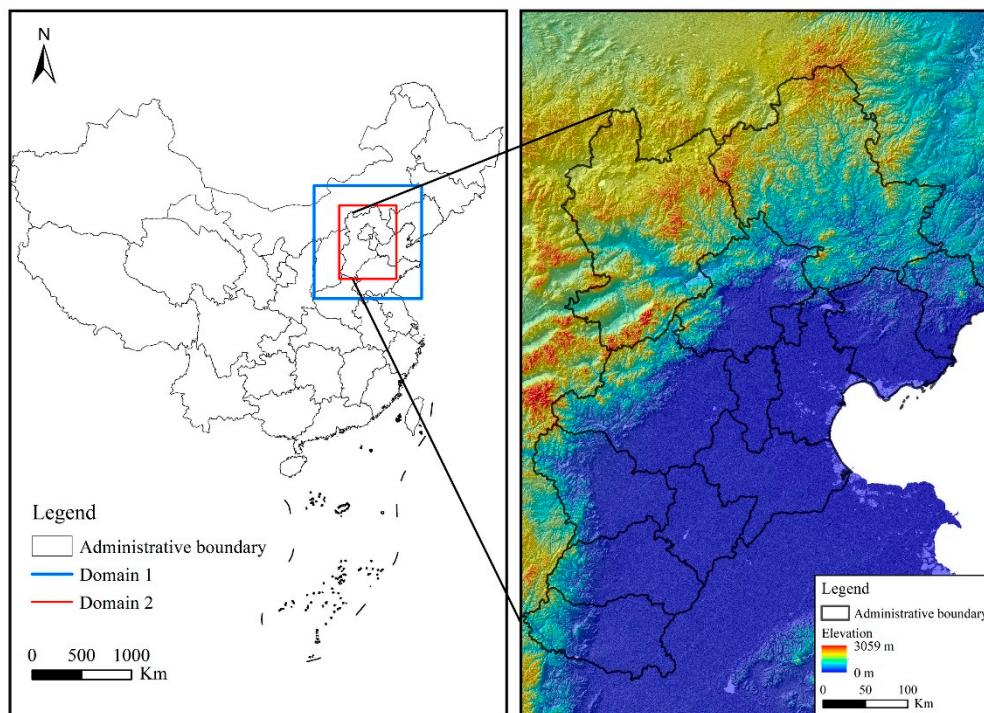


Figure S1. Domain coverage.