

1 Supplement of

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3 **Effects of O₃-vegetation interactions on meteorology and air quality**
4 **in China using a two-way coupled land-atmosphere model**

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6 **Table S1.** Physics options used in model simulations

Atmospheric process	Scheme
Cloud microphysics	Morrison double-moment scheme
Cumulus parameterization	Grell-3D scheme
Longwave radiation	RRTMG scheme
Shortwave radiation	Goddard scheme
Land-surface physics	Noah-MP land surface model
Planetary boundary layer	Mellor-Yamada-Janjic scheme

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8 **Table S2.** The location information of the major cities used for meteorology evaluation. NE is
9 northeastern China, NC is northern China, CC is central China, EC is eastern China, SC is southern
10 China, SW indicates southwestern China, and NW is northwestern China.

City	Lon	Lat	Region	City	Lon	Lat	Region
Haerbin	126.34	45.56	NE	Shanghai	121.27	31.24	EC
Changchun	125.13	43.54	NE	Hangzhou	120.10	30.14	EC
Shenyang	123.31	41.44	NE	Nanchang	115.55	28.36	EC
Huhehaote	111.34	40.51	NC	Xiamen	118.04	24.29	EC
Beijing	116.13	39.99	NC	Shenzhen	114.00	23.32	SC
Tianjin	117.21	39.17	NC	Guangzhou	113.29	23.13	SC
Taiyuan	112.35	37.37	NC	Nanning	108.13	22.38	SC
Zhengzhou	113.39	34.43	CC	Haikou	110.15	20.00	SC
Wuhan	114.03	30.36	CC	Chongqing	107.22	29.53	SW
Changsha	112.55	28.13	CC	Guiyang	106.44	26.35	SW
Jinan	117.00	36.36	EC	Kunming	102.39	25.00	SW
Nanjing	118.54	31.56	EC	Yinchuan	106.12	38.28	NW
Hefei	117.18	31.47	EC	Xining	101.45	36.44	NW

11 **Table S3.** Evaluation results of surface temperature at 2 m (T_{2m}) in 26 major cities. NE is northeastern
 12 China, NC is northern China, CC is central China, EC is eastern China, SC is southern China, SW
 13 indicates southwestern China, and NW is northwestern China. Mean_obs (Mean_simu) is the mean value
 14 of observation (model simulation); SD_obs (SD_simu) is the standard deviation of the observation
 15 (model simulation); IOA is the index of agreement; CORR is the correlation coefficient; MB is the mean
 16 bias.

City	Region	Mean_obs	SD_obs	Mean_simu	SD_simu	IOA	CORR	MB
Haerbin	NE	22.58	3.16	22.19	3.21	0.94	0.91	-0.39
Changchun	NE	22.62	3.22	22.05	3.00	0.94	0.93	-0.57
Shenyang	NE	23.84	2.79	23.95	2.84	0.94	0.89	0.11
Huhehaote	NC	21.26	2.88	23.52	3.04	0.81	0.88	2.27
Beijing	NC	26.54	2.59	28.25	2.80	0.83	0.86	1.71
Tianjin	NC	26.54	2.52	27.41	2.73	0.90	0.87	0.87
Taiyuan	NC	21.25	2.88	23.52	3.04	0.81	0.88	2.27
Zhengzhou	CC	27.57	2.89	26.66	2.79	0.92	0.91	-1.01
Wuhan	CC	27.30	2.98	26.53	2.55	0.93	0.90	-0.76
Changsha	CC	27.25	3.08	26.65	2.87	0.92	0.89	-0.60
Jinan	EC	26.49	2.81	25.65	2.65	0.90	0.87	-0.84
Nanjing	EC	26.76	3.29	26.32	3.00	0.96	0.93	-0.44
Hefei	EC	27.14	3.20	26.38	2.86	0.94	0.93	-0.76
Shanghai	EC	27.09	3.32	25.93	2.82	0.93	0.94	-1.16
Hangzhou	EC	27.60	3.38	26.26	3.00	0.91	0.91	-1.35
Nanchang	EC	28.30	3.08	27.42	2.82	0.9	0.85	-0.88
Xiamen	EC	28.04	1.75	27.40	1.22	0.77	0.72	-0.63
Shenzhen	SC	29.03	1.39	28.65	0.86	0.65	0.53	-0.39
Guangzhou	SC	28.29	1.55	28.85	1.55	0.75	0.65	0.56
Nanning	SC	28.14	1.63	27.67	1.74	0.82	0.72	-0.47
Haikou	SC	28.93	1.38	29.25	1.06	0.77	0.66	0.31
Chongqing	SW	26.69	3.24	24.84	2.79	0.83	0.87	-1.84
Guiyang	SW	22.43	2.15	21.37	2.00	0.82	0.79	-1.06
Kunming	SW	20.49	1.57	18.63	1.64	0.65	0.75	-1.86
Yinchuan	NW	23.49	2.97	24.64	3.15	0.93	0.93	1.15

Xining	NW	16.9	2.77	12.46	2.87	0.60	0.85	-4.44
Average		25.87	2.79	25.02	2.57	0.85	0.85	-0.84

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Table S4. Same for Table S3 but for relative humidity at 2 m (RH_{2m}).

City	Region	Mean_obs	SD_obs	Mean_simu	SD_simu	IOA	CORR	MB
Haerbin	NE	72.25	10.52	70.32	15.31	0.86	0.81	-1.78
Changchun	NE	69.78	12.27	74.89	13.57	0.82	0.78	5.10
Shenyang	NE	71.26	11.68	70.73	13.02	0.86	0.77	-0.53
Huhehaote	NC	50.52	14.24	49.89	13.02	0.79	0.70	-0.63
Beijing	NC	62.17	14.69	48.05	13.58	0.71	0.77	-14.12
Tianjin	NC	66.37	13.25	55.75	12.44	0.75	0.77	-10.62
Taiyuan	NC	66.72	12.98	57.38	15.03	0.76	0.73	-9.3
Zhengzhou	CC	67.24	14.00	63.76	15.27	0.83	0.72	-3.48
Wuhan	CC	81.20	8.84	85.88	9.27	0.76	0.68	4.68
Changsha	CC	79.40	10.74	90.57	7.12	0.64	0.67	11.17
Jinan	EC	66.49	14.48	67.22	15.19	0.88	0.79	0.74
Nanjing	EC	78.51	10.83	87.07	9.82	0.77	0.83	8.56
Hefei	EC	79.55	9.68	85.79	11.06	0.82	0.82	6.26
Shanghai	EC	76.98	9.55	89.14	8.31	0.63	0.73	12.16
Hangzhou	EC	76.52	10.88	90.33	7.49	0.63	0.85	13.81
Nanchang	EC	77.08	10.76	88.42	9.43	0.70	0.79	11.34
Xiamen	EC	83.09	9.00	91.65	4.89	0.62	0.72	8.56
Shenzhen	SC	79.82	7.54	92.03	3.77	0.50	0.62	12.21
Guangzhou	SC	82.05	6.78	87.39	7.48	0.68	0.61	5.34
Nanning	SC	83.01	5.89	90.25	6.37	0.62	0.63	7.23
Haikou	SC	80.17	5.94	83.95	5.03	0.66	0.55	3.78
Chongqing	SW	76.28	11.00	88.16	7.34	0.63	0.70	11.86
Guiyang	SW	82.46	8.64	95.04	3.84	0.52	0.65	12.57
Kunming	SW	78.03	7.70	93.82	4.21	0.42	0.57	15.79
Yinchuan	NW	52.63	14.01	42.99	13.70	0.77	0.76	-9.65
Xining	NW	63.22	12.66	73.97	14.49	0.72	0.75	10.75

Average		73.87	10.86	80.25	9.36	0.69	0.72	6.38
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Table S5. Same for Table S3 but for wind speed at 10 m (WS_{10m}).

City	Region	Mean_obs	SD_obs	Mean_simu	SD_simu	IOA	CORR	MB
Haerbin	NE	2.47	1.16	3.08	1.78	0.75	0.68	0.62
Changchun	NE	2.30	0.89	3.16	1.91	0.61	0.64	0.86
Shenyang	NE	1.88	0.74	3.00	1.72	0.50	0.53	1.12
Huhehaote	NC	2.76	0.88	2.46	1.30	0.57	0.41	-0.30
Beijing	NC	1.81	0.59	2.20	1.35	0.52	0.43	0.38
Tianjin	NC	2.09	0.70	2.59	1.27	0.58	0.47	0.49
Taiyuan	NC	2.06	0.81	2.12	1.12	0.66	0.46	0.07
Zhengzhou	CC	1.75	0.54	2.46	1.26	0.48	0.48	0.71
Wuhan	CC	1.79	0.75	2.02	1.25	0.63	0.50	0.23
Changsha	CC	2.15	0.93	2.58	1.47	0.65	0.55	0.45
Jinan	EC	1.89	0.81	2.84	1.44	0.61	0.60	0.95
Nanjing	EC	2.31	0.96	2.68	1.41	0.72	0.62	0.36
Hefei	EC	1.91	0.66	2.67	1.40	0.61	0.63	0.76
Shanghai	EC	2.36	0.86	3.32	1.84	0.57	0.54	0.97
Hangzhou	EC	2.04	0.61	2.45	1.46	0.53	0.47	0.41
Nanchang	EC	2.23	0.76	2.55	1.50	0.55	0.48	0.31
Xiamen	EC	2.29	0.73	3.12	1.58	0.54	0.49	0.83
Shenzhen	SC	1.93	0.91	3.27	1.74	0.47	0.39	1.35
Guangzhou	SC	1.92	0.81	2.38	1.23	0.59	0.44	0.45
Nanning	SC	2.11	0.72	2.75	1.48	0.56	0.51	0.64
Haikou	SC	2.11	0.58	2.85	1.57	0.45	0.39	0.74
Chongqing	SW	1.92	0.68	2.09	1.24	0.55	0.44	0.17
Guiyang	SW	2.44	0.81	3.18	1.71	0.59	0.57	0.74
Kunming	SW	2.13	0.79	2.34	1.24	0.57	0.51	0.21
Yinchuan	NW	1.76	0.56	2.75	1.36	0.38	0.30	0.99
Xining	NW	1.16	0.43	3.07	1.40	0.22	0.16	1.91
Average		2.02	0.74	2.52	1.40	0.55	0.47	0.50

23 **Table S6.** The location information of the major cities used for air pollutants evaluation. NE is
 24 northeastern China, NC is northern China, CC is central China, EC is eastern China, SC is southern
 25 China, SW indicates southwestern China, and NW is northwestern China

City	Lon	Lat	Region	City	Lon	Lat	Region
Haerbin	126.65	45.74	NE	Hangzhou	120.08	30.21	EC
Changchun	125.35	43.83	NE	Nanchang	115.88	28.68	EC
Shenyang	123.44	41.81	NE	Xiamen	118.12	24.56	EC
Huhehaote	111.67	40.80	NC	Shenzhen	114.16	22.60	SC
Beijing	116.40	40.05	NC	Guangzhou	113.35	23.19	SC
Tianjin	117.32	39.10	NC	Nanning	108.32	22.80	SC
Shijiazhuang	114.50	38.03	NC	Haikou	110.37	20.01	SC
Taiyuan	112.52	37.86	NC	Chengdu	104.01	30.70	SW
Zhengzhou	113.65	34.78	CC	Chongqing	106.51	29.58	SW
Wuhan	114.25	30.54	CC	Guiyang	106.70	26.54	SW
Changsha	112.98	28.21	CC	Kunming	102.71	25.01	SW
Jinan	116.98	36.65	EC	Yinchuan	106.16	38.49	NW
Nanjing	118.78	32.06	EC	Xining	101.71	36.65	NW
Hefei	117.25	31.85	EC	Lanzhou	103.83	36.05	NW
Shanghai	121.45	31.21	EC	Xi'an	108.99	34.30	NW

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39 **Table S7.** Evaluation results of O₃ concentration in 30 major cities. NE is northeastern China, NC is
 40 northern China, CC is central China, EC is eastern China, SC is southern China, SW indicates
 41 southwestern China, and NW is northwestern China. Mean_obs (Mean_simu) is the mean value of
 42 observation (model simulation); SD_obs (SD_simu) is the standard deviation of the observation (model
 43 simulation); IOA is the index of agreement; CORR is the correlation coefficient; MB is the mean bias.

City	Region	Mean_obs	SD_obs	Mean_simu	SD_simu	IOA	CORR	MB
Haerbin	NE	29.51	10.84	39.21	15.89	0.74	0.79	9.55
Changchun	NE	34.68	12.49	44.40	16.93	0.74	0.71	9.68
Shenyang	NE	38.75	12.22	49.02	17.44	0.67	0.60	9.90
Huhehaote	NC	39.58	9.67	52.91	22.26	0.61	0.74	13.64
Beijing	NC	45.09	14.61	82.16	36.92	0.43	0.64	37.12
Tianjin	NC	39.67	12.58	75.41	31.98	0.41	0.60	35.80
Shijiazhuang	NC	35.73	11.50	76.13	30.20	0.30	0.32	40.69
Taiyuan	NC	35.40	11.95	68.05	24.95	0.43	0.64	32.94
Zhengzhou	CC	40.81	11.23	79.43	24.14	0.37	0.55	38.68
Wuhan	CC	35.06	10.98	42.43	17.23	0.69	0.62	7.55
Changsha	CC	29.44	9.47	52.40	16.10	0.46	0.60	23.11
Jinan	EC	47.42	15.00	73.47	26.57	0.54	0.63	25.88
Nanjing	EC	35.75	14.83	44.73	20.58	0.70	0.60	8.80
Hefei	EC	30.82	9.29	53.69	21.92	0.45	0.58	22.56
Shanghai	EC	40.14	13.60	42.34	21.29	0.77	0.68	2.84
Hangzhou	EC	33.10	12.70	47.11	20.55	0.62	0.60	14.09
Nanchang	EC	31.45	10.33	52.61	16.47	0.50	0.61	21.44
Xiamen	EC	23.23	7.11	22.73	13.34	0.72	0.73	-0.24
Shenzhen	SC	21.30	8.80	26.83	15.68	0.74	0.75	5.59
Guangzhou	SC	23.96	11.55	34.46	16.80	0.67	0.62	10.75
Nanning	SC	21.83	7.09	36.10	9.84	0.49	0.60	14.38
Haikou	SC	17.94	5.44	38.29	11.70	0.33	0.58	20.77
Chengdu	SW	34.47	10.49	52.48	15.95	0.48	0.44	18.06
Chongqing	SW	28.04	10.66	50.50	17.74	0.47	0.54	22.59
Guiyang	SW	23.37	7.03	36.74	11.15	0.50	0.56	13.67
Kunming	SW	23.07	9.41	29.63	10.41	0.71	0.65	6.93

Yinchuan	NW	37.98	9.77	45.79	16.26	0.60	0.51	7.95
Xining	NW	33.67	8.04	46.29	12.31	0.48	0.39	12.64
Lanzhou	NW	31.07	7.24	45.01	10.69	0.43	0.33	14.03
Xi'an	NW	35.83	9.89	62.31	15.65	0.41	0.50	26.64
Average		32.71	10.60	49.61	18.66	0.55	0.59	17.01

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45 **Table S8.** Same for Table S7 but for PM_{2.5} concentration.

City	Region	Mean_obs	SD_obs	Mean_simu	SD_simu	IOA	CORR	MB
Haerbin	NE	27.61	15.73	29.64	15.56	0.61	0.46	1.88
Changchun	NE	32.25	17.12	41.62	18.63	0.60	0.50	9.10
Shenyang	NE	36.64	15.79	48.46	19.35	0.59	0.46	11.51
Huhehaote	NC	24.72	12.70	33.57	14.00	0.69	0.60	9.15
Beijing	NC	57.32	34.04	63.16	33.56	0.76	0.62	6.60
Tianjin	NC	52.70	21.88	69.74	26.38	0.60	0.47	17.29
Shijiazhuang	NC	63.17	30.31	79.08	31.86	0.63	0.51	16.88
Taiyuan	NC	45.38	20.08	57.07	22.46	0.65	0.50	12.35
Zhengzhou	CC	53.70	20.01	75.15	28.17	0.51	0.40	22.22
Wuhan	CC	39.00	18.66	119.54	51.38	0.23	0.23	79.72
Changsha	CC	38.17	19.58	71.13	36.26	0.32	0.17	33.01
Jinan	EC	59.41	21.22	71.71	27.65	0.57	0.39	12.82
Nanjing	EC	39.60	21.41	97.02	42.29	0.37	0.40	56.94
Hefei	EC	45.70	22.23	88.54	37.62	0.36	0.25	42.70
Shanghai	EC	37.60	20.15	53.74	36.41	0.67	0.65	16.56
Hangzhou	EC	36.80	15.73	78.62	37.11	0.34	0.33	42.22
Nanchang	EC	26.53	14.82	52.86	26.55	0.30	0.06	26.68
Xiamen	EC	20.31	9.07	33.12	15.13	0.54	0.58	13.29
Shenzhen	SC	17.55	10.23	23.79	16.02	0.72	0.67	6.48
Guangzhou	SC	28.37	12.04	39.84	16.85	0.55	0.43	11.94
Nanning	SC	23.58	12.48	23.19	15.26	0.55	0.31	-0.01
Haikou	SC	12.89	5.09	12.51	7.12	0.73	0.60	-0.10
Chengdu	SW	38.90	17.04	81.81	23.00	0.35	0.25	43.26
Chongqing	SW	35.57	11.67	99.64	55.52	0.17	0.10	64.97

Guiyang	SW	24.73	11.45	46.55	24.40	0.40	0.37	22.00
Kunming	SW	20.58	7.95	43.50	16.38	0.27	0.09	23.50
Yinchuan	NW	37.58	12.57	36.18	10.60	0.52	0.26	-1.07
Xining	NW	34.43	9.97	35.40	7.83	0.43	0.10	1.01
Lanzhou	NW	40.08	11.20	38.44	10.74	0.42	0.10	-1.67
Xi'an	NW	37.54	14.21	51.39	22.44	0.29	-0.06	14.56
Average		36.38	16.25	57.97	25.85	0.48	0.36	21.87

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47 **Table S9.** Same for Table S7 but for PM₁₀ concentration

City	Region	Mean_obs	SD_obs	Mean_simu	SD_simu	IOA	CORR	MB
Haerbin	NE	49.97	22.28	33.43	16.39	0.48	0.23	-16.69
Changchun	NE	64.85	26.37	46.96	20.01	0.57	0.37	-18.17
Shenyang	NE	65.87	24.76	55.69	21.29	0.58	0.37	-10.48
Huhehaote	NC	73.91	34.15	35.23	14.74	0.48	0.32	-38.35
Beijing	NC	77.62	34.51	69.73	35.62	0.66	0.47	-12.22
Tianjin	NC	86.85	29.80	77.05	27.91	0.57	0.32	-9.62
Shijiazhuang	NC	112.95	43.39	89.21	33.36	0.57	0.38	-22.72
Taiyuan	NC	92.85	33.83	64.29	24.10	0.53	0.33	-27.86
Zhengzhou	CC	106.03	38.35	85.01	29.74	0.53	0.25	-20.24
Wuhan	CC	75.09	33.90	146.68	55.86	0.32	0.10	70.72
Changsha	CC	60.95	25.17	78.86	37.25	0.35	0.02	17.95
Jinan	EC	109.76	36.25	79.76	28.80	0.50	0.24	-29.46
Nanjing	EC	67.36	31.43	110.38	44.53	0.43	0.24	42.44
Hefei	EC	75.26	32.05	101.85	39.47	0.38	0.07	26.55
Shanghai	EC	53.28	24.10	61.88	39.24	0.65	0.51	6.67
Hangzhou	EC	58.97	23.13	89.18	38.61	0.41	0.23	30.61
Nanchang	EC	58.92	27.94	59.00	27.19	0.32	-0.11	0.49
Xiamen	EC	38.16	15.05	41.73	16.40	0.64	0.46	4.01
Shenzhen	SC	33.21	14.04	31.00	17.64	0.75	0.63	-1.92
Guangzhou	SC	46.43	15.72	49.09	17.91	0.59	0.36	3.18
Nanning	SC	47.81	22.05	25.27	15.88	0.43	0.20	-22.20
Haikou	SC	28.74	8.36	14.45	7.43	0.48	0.47	-13.99

Chengdu	SW	67.66	28.12	95.59	24.48	0.45	0.22	28.31
Chongqing	SW	60.32	18.46	116.20	59.89	0.19	-0.11	56.90
Guiyang	SW	46.40	18.07	50.72	25.52	0.49	0.22	4.50
Kunming	SW	42.19	15.16	48.03	17.26	0.36	0.03	6.45
Yinchuan	NW	85.20	29.22	39.92	11.06	0.41	0.01	-45.23
Xining	NW	71.24	28.07	41.86	8.21	0.36	-0.14	-29.35
Lanzhou	NW	92.69	31.45	41.43	10.99	0.39	-0.03	-51.28
Xi'an	NW	82.08	29.32	58.34	23.75	0.26	-0.26	-23.00
Average		67.58	26.44	66.34	27.37	0.47	0.22	-1.21

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Table S10. Same for Table S7 but for SO₂ concentration

City	Region	Mean_obs	SD_obs	Mean_simu	SD_simu	IOA	CORR	MB
Haerbin	NE	2.89	0.83	2.73	1.47	0.49	0.30	-0.14
Changchun	NE	2.90	0.90	4.33	2.51	0.41	0.42	1.49
Shenyang	NE	5.78	2.50	7.75	4.32	0.55	0.43	2.04
Huhehaote	NC	4.91	1.78	1.77	1.52	0.47	0.48	-3.12
Beijing	NC	1.67	1.16	6.31	3.60	0.30	0.47	4.67
Tianjin	NC	4.42	2.14	9.50	4.23	0.34	0.26	5.05
Shijiazhuang	NC	7.04	3.53	11.95	3.79	0.53	0.49	4.99
Taiyuan	NC	8.48	4.01	8.85	4.72	0.69	0.53	0.47
Zhengzhou	CC	4.73	2.45	7.77	3.14	0.60	0.58	3.04
Wuhan	CC	4.11	1.18	38.60	12.06	0.05	0.06	34.57
Changsha	CC	5.08	1.52	4.53	2.72	0.66	0.59	-0.49
Jinan	EC	9.86	3.58	10.07	4.09	0.60	0.55	0.21
Nanjing	EC	5.16	2.00	8.62	3.74	0.52	0.60	3.37
Hefei	EC	3.98	1.15	4.71	2.14	0.47	0.46	0.70
Shanghai	EC	3.85	1.07	11.19	5.15	0.22	0.57	7.39
Hangzhou	EC	3.51	1.04	6.35	2.25	0.36	0.41	2.86
Nanchang	EC	6.97	2.61	2.67	1.74	0.54	0.57	-4.24
Xiamen	EC	4.28	1.63	5.83	1.95	0.53	0.48	1.60
Shenzhen	SC	2.75	0.59	5.98	2.39	0.27	0.65	3.27

Guangzhou	SC	4.42	1.12	7.17	2.75	0.32	0.25	2.75
Nanning	SC	3.41	0.78	0.89	0.66	0.31	0.65	-2.54
Haikou	SC	1.99	0.48	1.86	0.67	0.62	0.45	-0.11
Chengdu	SW	4.36	1.35	16.35	4.69	0.14	0.16	12.09
Chongqing	SW	4.01	1.28	37.89	13.02	0.04	-0.27	34.19
Guiyang	SW	2.75	0.90	2.91	1.33	0.54	0.47	0.15
Kunming	SW	5.46	2.41	2.35	0.91	0.46	0.31	-3.11
Yinchuan	NW	6.90	2.92	5.27	1.56	0.56	0.39	-1.63
Xining	NW	7.87	3.92	2.76	0.76	0.46	0.32	-5.10
Lanzhou	NW	4.57	1.78	2.49	0.89	0.49	0.32	-2.07
Xi'an	NW	3.47	1.20	6.31	2.35	0.36	0.34	2.88
Average		4.72	1.79	8.37	3.29	0.42	0.41	3.68

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Table S11. Same for Table S7 but for NO₂ concentration

City	Region	Mean_obs	SD_obs	Mean_simu	SD_simu	IOA	CORR	MB
Haerbin	NE	16.92	4.48	10.94	3.53	0.43	0.15	-5.96
Changchun	NE	18.41	5.53	12.63	4.60	0.45	0.17	-5.79
Shenyang	NE	16.73	4.59	16.94	7.15	0.44	0.13	0.26
Huhehaote	NC	16.33	4.03	2.70	1.20	0.32	0.34	- 13.63
Beijing	NC	17.90	4.04	12.59	4.77	0.53	0.40	-5.31
Tianjin	NC	16.38	5.15	18.89	8.21	0.45	0.19	2.42
Shijiazhuang	NC	16.75	5.60	20.20	4.44	0.54	0.32	3.51
Taiyuan	NC	18.93	4.63	9.35	3.54	0.43	0.39	-9.53
Zhengzhou	CC	19.77	5.79	15.91	4.40	0.63	0.48	-3.87
Wuhan	CC	18.09	5.34	45.34	10.56	0.26	0.45	27.24
Changsha	CC	12.96	3.18	11.29	4.38	0.45	0.16	-1.64
Jinan	EC	17.34	4.93	15.39	3.03	0.48	0.20	-1.88
Nanjing	EC	17.26	4.45	35.08	8.33	0.28	0.35	17.56
Hefei	EC	14.25	3.69	23.09	5.28	0.32	0.10	8.77

Shanghai	EC	15.76	5.58	22.91	10.62	0.60	0.67	7.36
Hangzhou	EC	16.27	4.13	30.89	6.75	0.33	0.50	14.71
Nanchang	EC	12.14	3.39	8.19	4.08	0.43	0.17	-3.85
Xiamen	EC	12.44	4.09	20.29	4.24	0.48	0.52	7.94
Shenzhen	SC	13.60	3.88	18.61	6.48	0.64	0.72	5.10
Guangzhou	SC	18.14	4.60	24.73	7.64	0.32	-0.06	6.63
Nanning	SC	12.58	3.32	3.71	1.10	0.35	0.34	-8.91
Haikou	SC	7.47	2.04	4.23	1.28	0.54	0.67	-3.19
Chengdu	SW	22.64	6.07	32.26	6.48	0.45	0.32	9.73
Chongqing	SW	16.85	3.88	25.82	7.15	0.28	0.00	9.16
Guiyang	SW	12.21	3.00	6.38	2.25	0.42	0.30	-5.87
Kunming	SW	12.73	2.92	10.85	2.46	0.41	0.08	-1.91
Yinchuan	NW	13.66	4.29	8.66	1.90	0.49	0.29	-4.97
Xining	NW	15.84	4.23	8.96	1.50	0.39	0.16	-6.89
Lanzhou	NW	21.33	6.37	6.24	1.75	0.39	0.34	- 15.10
Xi'an	NW	18.34	4.91	12.63	2.96	0.44	0.06	-5.66
Average		16.08	4.41	17.45	4.96	0.42	0.30	1.39

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57 **Table S12.** Same for Table S3 but for CO concentration

City	Region	Mean_obs	SD_obs	Mean_simu	SD_simu	IOA	CORR	MB
Haerbin	NE	604.76	128.08	318.23	85.86	0.42	0.49	-287.81
Changchun	NE	607.61	129.67	367.93	97.64	0.49	0.57	-239.92
Shenyang	NE	652.10	206.92	443.19	120.09	0.58	0.59	-209.41
Huhehaote	NC	650.10	159.32	216.99	65.73	0.35	0.46	-432.03
Beijing	NC	669.52	222.85	516.17	181.88	0.68	0.58	-150.27
Tianjin	NC	877.87	251.89	563.59	180.45	0.50	0.36	-315.39
Shijiazhuang	NC	661.22	202.62	670.87	155.67	0.61	0.41	12.88

Taiyuan	NC	878.46	210.97	431.27	123.49	0.42	0.39	-444.05
Zhengzhou	CC	916.78	183.34	543.18	120.33	0.43	0.48	-372.60
Wuhan	CC	686.56	159.73	860.37	185.96	0.44	0.19	174.05
Changsha	CC	620.73	119.95	492.53	115.36	0.62	0.59	-125.66
Jinan	EC	839.20	209.23	498.36	107.33	0.44	0.28	-339.40
Nanjing	EC	683.48	151.53	682.18	159.70	0.70	0.54	-4.61
Hefei	EC	668.11	152.90	552.05	118.06	0.61	0.47	-116.28
Shanghai	EC	566.49	133.34	463.19	201.93	0.72	0.76	-100.36
Hangzhou	EC	612.86	110.80	569.58	127.97	0.70	0.54	-40.73
Nanchang	EC	762.10	137.02	399.52	100.50	0.35	0.23	-358.75
Xiamen	EC	397.98	101.69	362.96	68.35	0.69	0.63	-33.06
Shenzhen	SC	623.00	87.86	335.10	109.18	0.37	0.62	-286.51
Guangzhou	SC	656.52	97.80	465.13	96.83	0.42	0.28	-189.46
Nanning	SC	655.01	91.87	256.69	67.07	0.27	0.37	-396.97
Haikou	SC	463.22	87.64	231.31	63.76	0.38	0.40	-228.82
Chengdu	SW	731.12	140.38	631.05	97.18	0.51	0.21	-98.10
Chongqing	SW	700.28	110.34	585.25	163.36	0.53	0.36	-109.59
Guiyang	SW	485.69	95.08	359.60	106.94	0.58	0.56	-124.75
Kunming	SW	637.47	119.32	320.97	48.26	0.35	0.27	-315.67
Yinchuan	NW	697.14	215.64	223.29	46.61	0.37	0.07	-473.20
Xining	NW	787.17	177.28	223.20	30.69	0.31	0.18	-563.77
Lanzhou	NW	753.03	171.71	214.66	39.52	0.31	0.11	-538.13
Xi'an	NW	884.64	141.49	409.88	87.75	0.32	0.40	-472.05
Average		679.26	149.99	451.07	112.14	0.49	0.42	-226.83

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62 **Table S13.** Summary of studies about O₃ damage effect.

Study Domain	Simulation Period	Model	Results	References
The Whole Globe	2002-2009	CLM4.5SP	GPP (-): 8-12% TR (-): 2-2.4%	Lombardozzi et al. (2015)
	2000-2020 JJA	CESM v1.2.2	LAI (-): 5% TR (-): 6.4% globally T ₂ (+): up to 2.0 O ₃ (+): 4-6ppbv	Sadiq et al. (2017)
	2000-2022	CESM v1.1.1	LH (-): larger than 4% T ₂ (+): up to 1.5 K	Arnold et al. (2018)
	20 years	NASA ModelE2-YIBs	O ₃ (+): 2.1ppbv (Eastern China), 1.6ppbv (Eastern U.S.), 1.3 ppbv (Western Europe)	Gong et al. (2020)
The United States	1998-2007	YIBs	GPP (-): 4-8%	Yue et al. (2014)
	2007-2012 May 1 to September 30	WRF-Chem v3.7.1	LH (-): 10-27 W/m ² T ₂ (+): 0.6-2.0 Rainfall (-): 0.9-1.4 mm/d Runoff (-): 0.1-0.17mm/d	Li et al. (2016)
	2009-2014 June-September	WRF-Chem v3.9	LH (-): 9-11 W/m ² T ₂ (+): 0.6-0.7 Rainfall (-): 0.15-0.21 mm/d GPP (-): 30-38%	Li et al. (2018)
India	2005	WRF-Chem v3.2.2	Crop Yield (-): 2.1-5.3%	Ghude et al. (2014)
China	2010	NASA ModelE2-YIBs	NPP (-): 14%	Yue et al. (2017)
	Oct 2012- Dec 2013	RegCM-CHEM4-YIBs	GPP (-): 12.1 ± 4.4% (35% in summer)	Xie et al. (2019)

63 Note: “+” means increase, “-” means decrease

