

Supplement of Atmos. Chem. Phys., 20, 2419–2443, 2020  
<https://doi.org/10.5194/acp-20-2419-2020-supplement>  
© Author(s) 2020. This work is distributed under  
the Creative Commons Attribution 4.0 License.



*Supplement of*

## **Relative effects of open biomass burning and open crop straw burning on haze formation over central and eastern China: modeling study driven by constrained emissions**

**Khalid Mehmood et al.**

*Correspondence to:* Shaocai Yu ([shaocaiyu@zju.edu.cn](mailto:shaocaiyu@zju.edu.cn)) and Pengfei Li ([lpf\\_zju@163.com](mailto:lpf_zju@163.com))

The copyright of individual parts of the supplement might differ from the CC BY 4.0 License.

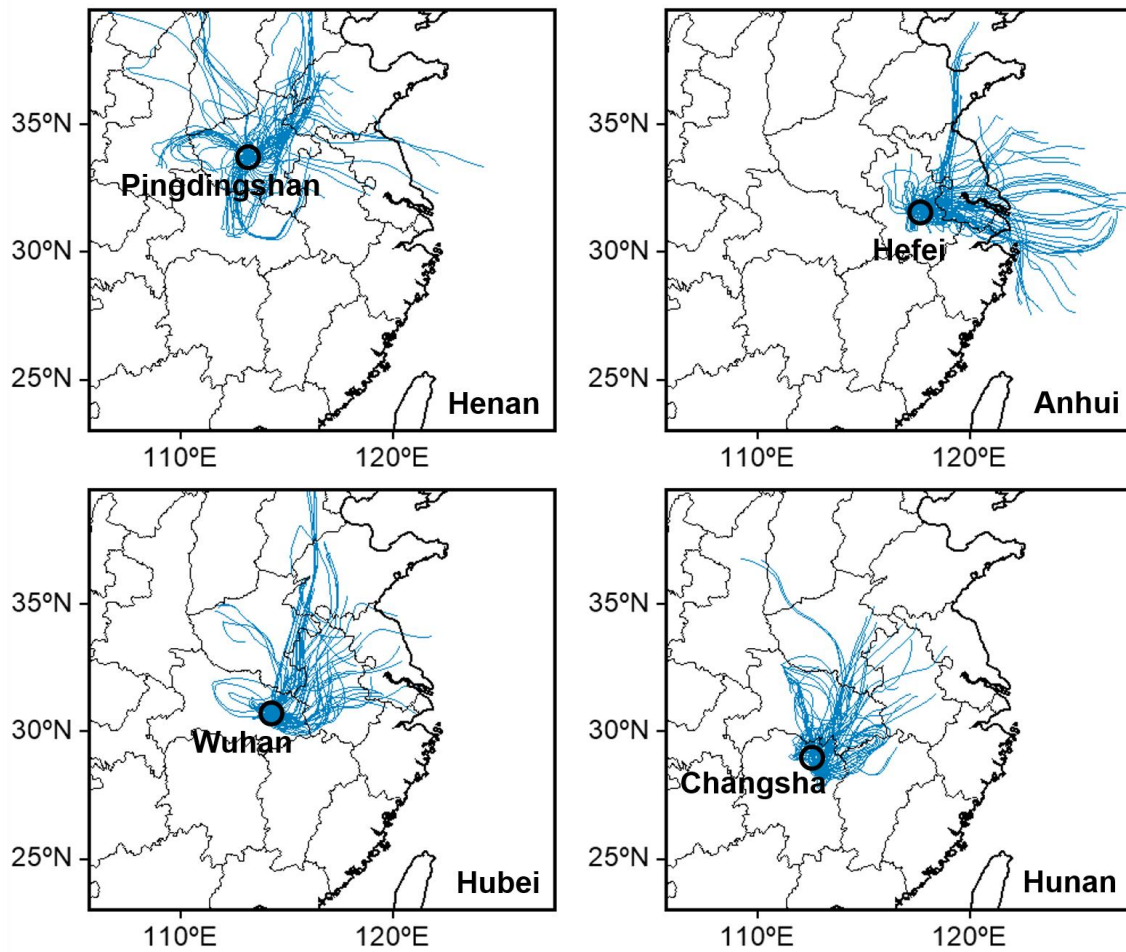


Figure S1. 48h backward trajectories during EP2 for four representative cities (Pingdingshan, Hefei, Wuhan and Changsha) for Henan, Anhui, Hubei and Hunan.

5

10

15 **Table S1. The fire-related parameters (i.e.,  $B_{\text{size}}$ ,  $P_{\text{topmax}}$ , and  $P_{\text{bottommax}}$ ) as a function of the fire size classes.**

Fire Class	1	2	3	4	5
Size	0~10	10~100	100~1000	1000~5000	>5000
$B_{\text{size}}$	0.4	0.6	0.75	0.85	0.9
$P_{\text{topmax}}$	160	2400	6400	7200	8000
$P_{\text{bottommax}}$	0	900	2200	3000	300

20

25

30

35

40

45 **Table S2. The activity related parameter (i.e.,  $B_{\text{hour}}$ ) as a function of hour of day.**

Hour	$B_{\text{hour}}$	Hour	$B_{\text{hour}}$
0	0.03	12	0.7
1	0.03	13	0.8
2	0.03	14	0.9
3	0.03	15	0.95
4	0.03	16	0.99
5	0.03	17	0.8
6	0.03	18	0.7
7	0.03	19	0.4
8	0.06	20	0.06
9	0.1	21	0.03
10	0.2	22	0.03
11	0.4	23	0.03

50

55

60

65

**Table S3. Detailed information for 5 monitoring sites of PM<sub>2.5</sub> composition.**

Station	Province	Latitude (E)	Longitude (N)	Altitude (m)	Station Type	PM <sub>2.5</sub> Compositions
Changsha	Hunan	113.06	28.21	45	Urban	
Qianyanzhou	Jiangxi	115.07	26.75	76	Rural/suburban	
Wuxi	Jiangsu	120.35	31.5	5	Urban	K <sup>+</sup> , SO <sub>4</sub> <sup>2-</sup> , NO <sub>3</sub> <sup>-</sup> , OC, and NH <sub>4</sub> <sup>+</sup>
Yucheng	Shandong	116.6	36.95	22	Rural/suburban	
Hefei	Anhui	117.27	31.86	24	Urban	

70 Table S4. Original OBB and OCSB emissions estimated in FINNv1.5 for EP1 ~ EP3 over CEC (Units: million moles for NMVOCs, SO<sub>2</sub>, CO, NH<sub>3</sub>, and NO<sub>x</sub> and tons for EC, OC, primary PM<sub>2.5</sub> and PM<sub>10</sub>).

Episode	Provinces	OBB									OCSB								
		NMVOCs	SO <sub>2</sub>	CO	NH <sub>3</sub>	NO <sub>x</sub>	EC	OC	PM <sub>2.5</sub>	PM <sub>10</sub>	NMVOCs	SO <sub>2</sub>	CO	NH <sub>3</sub>	NO <sub>x</sub>	EC	OC	PM <sub>2.5</sub>	PM <sub>10</sub>
EP1	Shanghai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jiangsu	8	0	29	1	1	5	25	44	54	8	0	28	1	1	5	23	41	49
	Zhejiang	30	1	182	6	4	26	287	553	634	11	0	38	1	1	7	31	55	67
	Anhui	16	0	61	2	2	11	55	97	118	16	0	57	2	2	10	47	83	100
	Fujian	21	0	119	4	4	19	161	305	364	13	0	45	2	2	8	37	66	79
	Jiangxi	17	0	98	3	3	16	146	263	311	10	0	36	1	1	6	30	53	64
	Shandong	37	0	136	4	5	24	116	208	254	36	0	128	4	5	22	106	187	226
	Henan	80	0	289	10	11	50	245	434	528	79	0	279	10	10	49	232	408	494
	Hubei	20	0	79	3	3	14	77	133	163	19	0	69	2	3	12	57	101	122
	Hunan	2	0	9	0	0	2	10	17	21	2	0	7	0	0	1	6	11	13
EP2	Shanghai	12	0	52	2	2	9	57	98	122	11	0	39	1	1	7	32	57	69
	Jiangsu	221	1	812	27	30	141	710	1260	1536	215	1	762	26	28	133	634	1115	1349
	Zhejiang	79	1	439	14	13	69	626	1154	1357	48	0	171	6	6	30	143	251	304
	Anhui	1355	8	4834	164	179	841	4067	7161	8678	1347	8	4778	163	177	832	3979	6993	8464
	Fujian	48	1	311	10	9	46	499	938	1111	17	0	59	2	2	10	49	86	105
	Jiangxi	26	1	163	5	4	24	260	488	567	10	0	36	1	1	6	30	52	63
	Shandong	262	2	950	32	35	166	804	1425	1733	259	1	919	31	34	160	766	1346	1629
	Henan	833	5	2983	101	111	519	2500	4411	5351	829	5	2941	100	109	512	2449	4304	5209
	Hubei	13	0	54	2	2	9	60	108	129	11	0	39	1	1	7	32	56	68
	Hunan	14	0	84	3	2	13	128	239	281	7	0	24	1	1	4	20	35	42
EP3	Shanghai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jiangsu	7	0	29	1	1	5	29	51	62	7	0	24	1	1	4	20	35	43
	Zhejiang	12	0	64	2	2	10	93	177	205	6	0	21	1	1	4	18	31	38
	Anhui	38	0	138	5	5	24	117	208	253	37	0	132	5	5	23	110	194	235
	Fujian	3	0	20	1	1	3	27	47	59	2	0	8	0	0	1	7	12	14
	Jiangxi	30	1	197	6	5	29	321	603	697	10	0	37	1	1	6	30	53	65
	Shandong	7	0	28	1	1	5	25	45	55	7	0	24	1	1	4	20	35	42
	Henan	15	0	56	2	2	10	47	84	102	15	0	54	2	2	9	45	78	95
	Hubei	4	0	14	0	1	2	14	26	32	3	0	11	0	0	2	9	16	19
	Hunan	27	1	200	6	5	28	339	649	748	5	0	16	1	1	3	14	24	29

**Table S5. The comparisons of the simulated PM<sub>2.5</sub> composition ( $\mu\text{g m}^{-3}$ ) in the BASE and OPT cases with the observations (OBS) as well as their corresponding NMB values (%).**

Composition	Time periods		Changsha		Hefei		Yucheng		Qianyanzhou		Wuxi	
			Values	NMB	Values	NMB	Values	NMB	Values	NMB	Values	NMB
K <sup>+</sup>	From 10 a.m., June 2 to 10 a.m., June 4	OBS	0.59		0.92		0.90		0.09		0.62	
		BASE	0.15	-74.64	0.18	-80.53	0.35	-61.12	0.22	149.12	0.12	-80.73
		OPT	0.21	-64.50	0.28	-69.71	0.45	-50.01	0.25	183.09	0.13	-79.12
	From 10 a.m., June 9 to 10 a.m., June 11	OBS	1.50		1.16		1.49		0.56		0.56	
		BASE	0.49	-67.34	0.55	-52.49	0.78	-47.67	0.41	-26.80	0.38	-32.23
		OPT	0.79	-47.34	0.89	-23.12	0.87	-41.63	0.45	-19.65	0.34	-39.37
	From 10 a.m., June 16 to 10 a.m., June 18	OBS	0.51		0.91		0.51		0.16		0.25	
		BASE	0.34	-33.36	0.54	-40.52	0.71	39.78	0.29	77.65	0.07	-72.05
		OPT	0.38	-25.52	0.78	-14.09	0.74	45.68	0.33	102.15	0.09	-64.07
SO <sub>4</sub> <sup>2-</sup>	From 10 a.m., June 2 to 10 a.m., June 4	OBS	20.48		10.95		13.11		12.56		16.21	
		BASE	11.40	-44.34	5.90	-46.12	8.70	-33.64	1.98	-84.24	9.64	-40.54
		OPT	24.12	17.77	13.54	23.64	15.34	17.01	3.45	-72.53	9.58	-40.91
	From 10 a.m., June 9 to 10 a.m., June 11	OBS	33.83		18.68		30.74		8.97		13.23	
		BASE	20.14	-40.47	14.70	-21.31	15.98	-48.01	2.55	-71.56	8.40	-36.53
		OPT	37.07	9.57	22.30	19.38	31.99	4.07	3.54	-60.52	9.00	-31.99
	From 10 a.m., June 16 to 10 a.m., June 18	OBS	18.94		27.05		21.86		20.95		12.00	
		BASE	13.75	-27.39	16.70	-38.26	8.71	-60.15	4.78	-77.19	6.85	-42.90
		OPT	23.64	24.83	28.90	6.85	18.05	-17.41	5.61	-73.23	7.40	-38.31
NO <sub>3</sub> <sup>-</sup>	From 10 a.m., June 2 to 10 a.m., June 4	OBS	9.34		8.48		7.49		1.93		6.35	
		BASE	10.97	17.49	5.39	-36.44	3.61	-51.81	1.03	-46.56	1.78	-71.96
		OPT	14.98	60.44	9.81	15.67	6.45	-13.90	2.62	35.94	1.95	-69.28
	From 10 a.m., June 9 to 10 a.m., June 11	OBS	11.57		3.20		12.72		0.60		1.82	
		BASE	9.70	-16.18	7.90	146.66	10.80	-15.13	1.85	207.90	0.98	-46.05
		OPT	12.45	7.58	8.50	165.40	14.45	13.56	2.95	390.98	0.97	-46.60
	From 10 a.m., June 16 to 10 a.m., June 18	OBS	4.85		28.33		15.89		2.22		12.27	
		BASE	7.40	52.45	20.00	-29.39	20.38	28.23	1.88	-15.36	14.95	21.82
		OPT	8.78	80.88	29.80	5.21	21.09	32.69	2.23	0.40	15.78	28.59
NH <sub>4</sub> <sup>+</sup>	From 10 a.m., June 2 to 10 a.m., June 4	OBS	10.26		9.03		8.45		5.46		9.17	
		BASE	8.45	-17.63	7.54	-16.53	3.78	-55.27	1.03	-81.14	13.50	47.27
		OPT	11.54	12.50	10.92	20.89	7.30	-13.61	1.75	-67.96	13.90	51.64
	From 10 a.m., June 9 to 10 a.m., June 11	OBS	17.68		8.54		15.26		3.71		4.76	
		BASE	11.06	-37.45	4.98	-41.72	13.45	-11.88	1.35	-63.59	2.01	-57.77
		OPT	17.37	-1.76	10.39	21.60	18.74	22.78	1.75	-52.80	3.32	-30.25
	From 10 a.m., June 16 to 10 a.m., June 18	OBS	8.62		21.87		14.95		10.14		9.74	
		BASE	3.84	-55.47	20.06	-8.29	14.20	-4.99	5.97	-41.11	8.70	-10.65
		OPT	10.43	20.94	28.78	31.57	17.64	18.03	6.78	-33.12	8.40	-13.73
OC	From 10 a.m., June 9 to 10 a.m., June 11	OBS	19.80		19.54		18.95		15.70		29.15	
		BASE	10.15	-48.74	10.30	-47.30	10.65	-43.81	6.12	-61.02	15.07	-48.30
		OPT	18.50	-6.57	15.50	-20.70	13.50	-28.77	8.12	-48.28	15.95	-45.28

**Table S6. The NMB and R values between observed and simulated surface chemical species over CEC in the BASE and OPT cases.**

Provinces	BASE case (NMB % /R)					OPT case (NMB % /R)				
	CO	SO <sub>2</sub>	NO <sub>2</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	CO	SO <sub>2</sub>	NO <sub>2</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>
<b>Henan</b>	-22.34/0.75	-29.05/0.69	-5.33/0.71	-24.73/0.74	-20.89/0.78	-12.25/0.89	-22.23/0.79	3.02/0.78	-1.28/0.90	-2.03/0.89
<b>Anhui</b>	-20.67/0.71	-28.02/0.71	-7.56/0.69	-19.32/0.70	-22.49/0.72	5.19/0.88	-26.85/0.81	-99.97/0.79	4.18/0.80	6.11/0.84
<b>Hubei</b>	-29.53/0.41	-30.35/0.42	-18.55/0.33	-32.97/0.31	-31.83/0.41	-13.61/0.62	-22.09/0.61	-12.59/0.42	-2.23/0.53	-3.06/0.61
<b>Hunan</b>	-11.99/0.63	-15.73/0.62	-17.01/0.66	-10.56/0.66	-15.62/0.69	9.08/0.81	-19.06/0.77	-17.13/0.76	8.21/0.74	6.23/0.79
<b>Jiangxi</b>	-14.86/0.65	-19.54/0.59	-17.96/0.61	-7.15/0.59	-12.63/0.61	6.39/0.71	-20.05/0.68	-19.98/0.78	5.22/0.56	7.16/0.62
<b>Zhejiang</b>	-17.03/0.79	-17.63/0.75	17.36/0.77	-5.23/0.81	-11.53/0.77	4.22/0.86	-19.35/0.79	19.08/0.86	3.45/0.80	3.45/0.85
<b>Fujian</b>	-29.63/0.74	-36.49/0.66	-36.86/0.69	-39.00/0.67	-24.51/0.77	-11.06/0.68	-36.52/0.75	-28.59/0.81	-22.00/0.64	-16.03/0.77
<b>Shandong</b>	-26.33/0.77	-33.15/0.57	-16.39/0.67	-28.51/0.84	-27.61/0.81	-15.04/0.80	-33.89/0.69	-17.16/0.70	-17.89/0.82	-12.09/0.86
<b>Jiangsu</b>	-28.03/0.73	-38.22/0.48	-27.43/0.60	-37.08/0.85	-33.49/0.83	-13.23/0.79	-38.00/0.77	-25.51/0.66	-29.17/0.79	-11.92/0.88
<b>Shanghai</b>	-24.49/0.81	-30.15/0.52	-6.07/0.63	-38.05/0.79	-30.09/0.73	-11.01/0.87	-26.85/0.81	-5.08/0.67	-13.63/0.81	-9.16/0.79



80 **Table S7. The NMB and R values between observed and simulated surface meteorological species over CEC in the OPT case.**

Provinces	OPT case (NMB %/R)			
	Temperature	Relative humidity	Wind speed	PBL height
<b>Henan</b>	-0.03/0.87	-0.05/0.71	0.19/0.61	-2.13/0.63
<b>Anhui</b>	0.06/0.72	-0.21/0.55	0.08/0.41	3.18/0.66
<b>Hubei</b>	-0.04/0.85	0.31/0.72	0.48/0.49	2.19/0.71
<b>Hunan</b>	-0.11/0.79	-0.24/0.67	0.96/0.49	3.49/0.51
<b>Jiangxi</b>	-0.28/0.80	-0.12/0.64	0.60/0.52	2.96/0.55
<b>Zhejiang</b>	-0.12/0.83	-0.12/0.72	0.90/0.38	-3.05/0.48
<b>Fujian</b>	-0.33/0.84	-0.36/0.66	0.75/0.52	4.96/0.67
<b>Shandong</b>	-0.36/0.81	-0.42/0.63	0.66/0.62	3.59/0.41
<b>Jiangsu</b>	-0.29/0.74	-0.41/0.64	0.86/0.55	4.03/0.62
<b>Shanghai</b>	-0.39/0.69	-0.45/0.59	0.94/0.71	4.11/0.59