Supplement of Atmos. Chem. Phys., 16, 9675–9691, 2016
http://www.atmos-chem-phys.net/16/9675/2016/
doi:10.5194/acp-16-9675-2016-supplement

Atmospheric Chemistry and Physics
Open Access

Supplement of

Impact of crop field burning and mountains on heavy haze in the North China Plain: a case study

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Table S1 National and provincial estimated amounts of crop production ($P_{i,k}$), CFB proportion (F_i), CO emission and CFB activities times (FC_i) in China in 2014.

Province	$P_{i,k}$[a] (Gg)			F_i[b] (%)	CO Emission (Mg)	FC_i
	Rice	Corn	Wheat			
Beijing	1	500	122	18.65	6.1	216
Tianjin	121	1014	586	20.75	22.5	308
Hebei	542	16707	14299	18.80	392.0	2222
Shanxi	6	9381	2591	17.50	111.9	974
Inner Mongolia	524	21861	1539	13.70	153.4	1868
Liaoning	4515	11705	28	16.70	152.7	2761
Jilin	5876	27335	1	15.00	255.2	2976
Heilongjiang	22510	33434	466	12.60	445.0	6603
Shanghai	841	26	186	27.70	26.5	201
Jiangsu	19120	2390	11604	33.05	969.6	2453
Zhejiang	5901	301	310	24.40	142.4	1278
Anhui	13946	4655	13936	28.40	786.9	5240
Fujian	4971	203	7	28.45	132.6	340
Jiangxi	20252	123	26	14.10	263.4	781
Shandong	1010	19883	22638	22.25	675.5	4152
Henan	5286	17321	33290	21.10	908.9	4725
Hubei	17295	2937	4216	17.65	371.5	1541
Hunan	26340	1886	103	28.75	721.5	716
Guangdong	10916	769	3	31.60	327.3	768
Guangxi	11661	2664	2	23.95	283.7	224
Hainan	1554			21.45	30.6	29
Chongqing	5032	2560	270	14.85	88.5	434
Sichuan	15265	7519	4232	15.35	324.5	1108
Guizhou	4032	3138	615	13.25	74.3	348
Yunnan	6661	7433	836	12.85	129.2	391
Tibet	5	24	237	12.30	2.9	8
Shaanxi	909	5396	4172	17.15	120.0	626
Gansu	35	5645	2716	13.70	67.8	130
Qinghai	0	187	349	12.55	5.1	6
Ningxia	618	2241	406	16.25	30.8	192
Xinjiang	762	6411	6423	16.15	151.5	135
Total	206507	215649	126209		8174	43754

a. The values were taken from NBS (2015). b. The values were taken from Wang and Zhang (2008) and Zhang Yisheng (Unpublished doctor thesis-in Chinese). Parameters $P_{i,k}$ and F_i are related to Equation 1 and FC_i is related to Equation 2 in the text.

Table S2. Parameters used in the calculation of the amount of CFB.

species	residue-to-crop ratio[a] (R_k)	dry residue fraction[b] (D_k)	combustion efficiency[b] (CE_k)
rice	1.00	0.89	0.93
corn	1.04	0.40	0.92
wheat	1.17	0.83	0.86

a. The values were taken from Xie et al. (2011). b. The values were taken from Street et al. (2003) and He et al. (2011). Parameters R, D, and E are related to Equation 4 in the text.

Table S3. Summary of CO EFs from CFB reported in the literature (g kg^{-1}).

location	Residue type	measurement approach	CO EF (g kg^{-1})	References
China				
	crop residue	chamber	52.0±18.9	Ni et al. (2015)
	Rice straw	tower	53.2 ± 17.9 [d]	Zhang et al. (2013)
	Rice straw	tower	110.6 ± 37.9[e]	Zhang et al. (2013)
	rice straw	chamber	87.1±30.3	McMeeking et al. (2009)
	corn stalk	chamber	114.7 ± 12.4	Zhang et al. (2008)
	wheat straw	chamber	141.2 ± 14.8	Zhang et al. (2008)
	rice straw	chamber	64.2 ± 4.9	Zhang et al. (2008)
	wheat straw	field measurement	60 ± 23	Li et al. (2007)
	corn stalk	field measurement	53 ± 4.0	Li et al. (2007)
Asia else				
India	wheat straw	field measurement	28 ± 20	Sahai et al. (2007)
Thailand	rice straw	field measurement	97±8	Kim Oanh et al. (2011)
Indonesia	rice straw	chamber	179.9± 39.8	Christian et al. (2003)
Vietnam	rice straw	field measurement	104[d]	Nguyen et al. (1994)
Vietnam	rice straw	field measurement	189[e]	Nguyen et al. (1994)
Japan	wheat straw	chamber	42	Hayashi et al. (2014)
Japan	wheat straw	chamber	77	Hayashi et al. (2014)
Japan	rice straw	chamber	27	Hayashi et al. (2014)
Japan	rice straw	chamber	59	Hayashi et al., (2014)
Japan	rice straw	chamber	44	Miura and Kanno (1997)
Japan	rice straw	chamber	70	Miura and Kanno (1997)
USA				
USA	wheat straw	field measurement	26–64	Air Sciences Inc. (2003)
USA	wheat straw		54	U.S.EPA. (1995)
USA	rice straw	wind tunnel	32.2	Jenkins et al. (1998)
USA	rice straw		41	U.S.EPA. (1995)
Mexico	crop residue	airborne measurements	85.56 ± 33.75	Yokelson et al. (2011)
Mexico	agricultural residues	airborne measurements	92	Andreae and Merlet. (2001)

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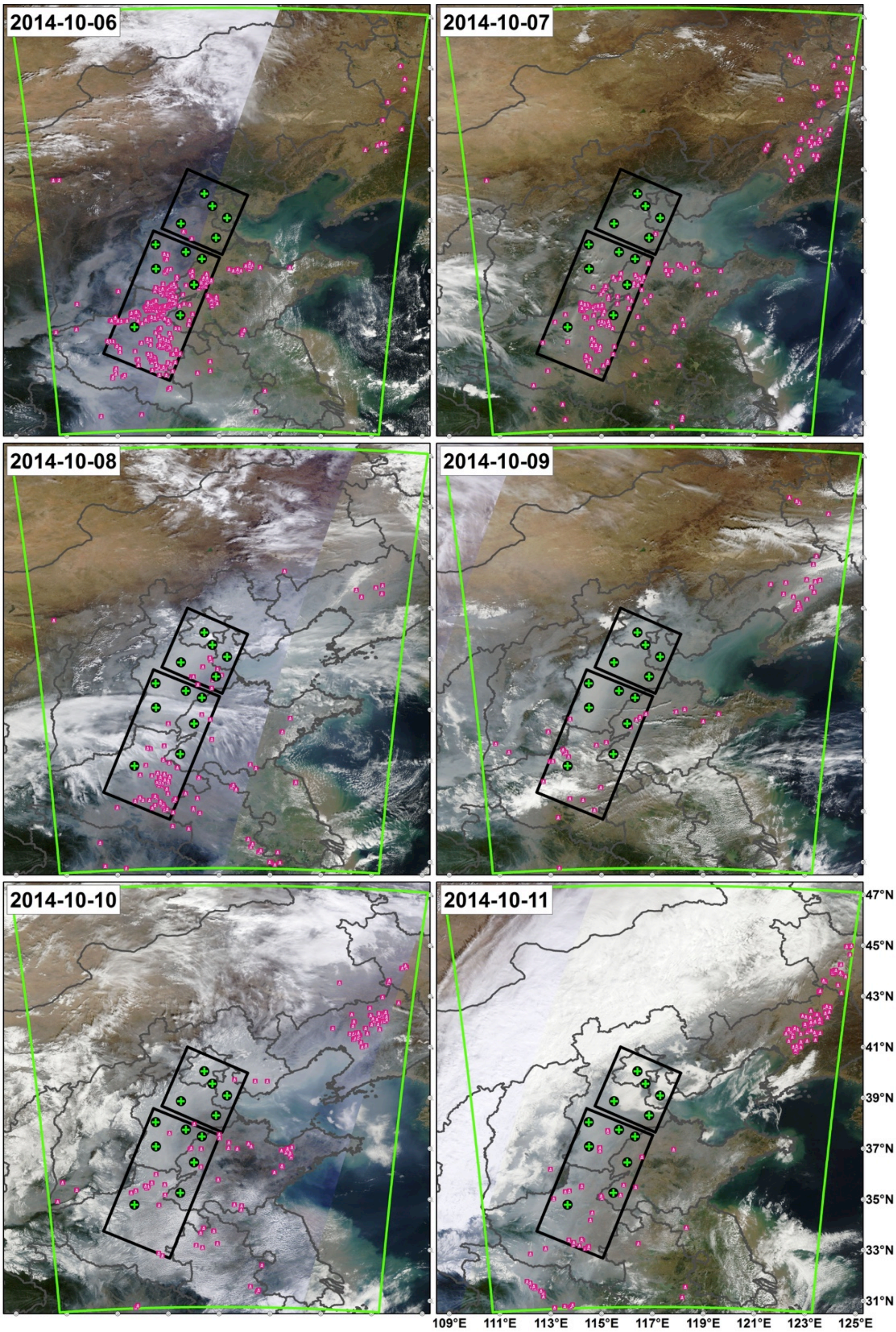

Fig. S1 Crop field burning captured by MODIS along with the background of MODIS real-time true color map from Oct. 6th to 11th.

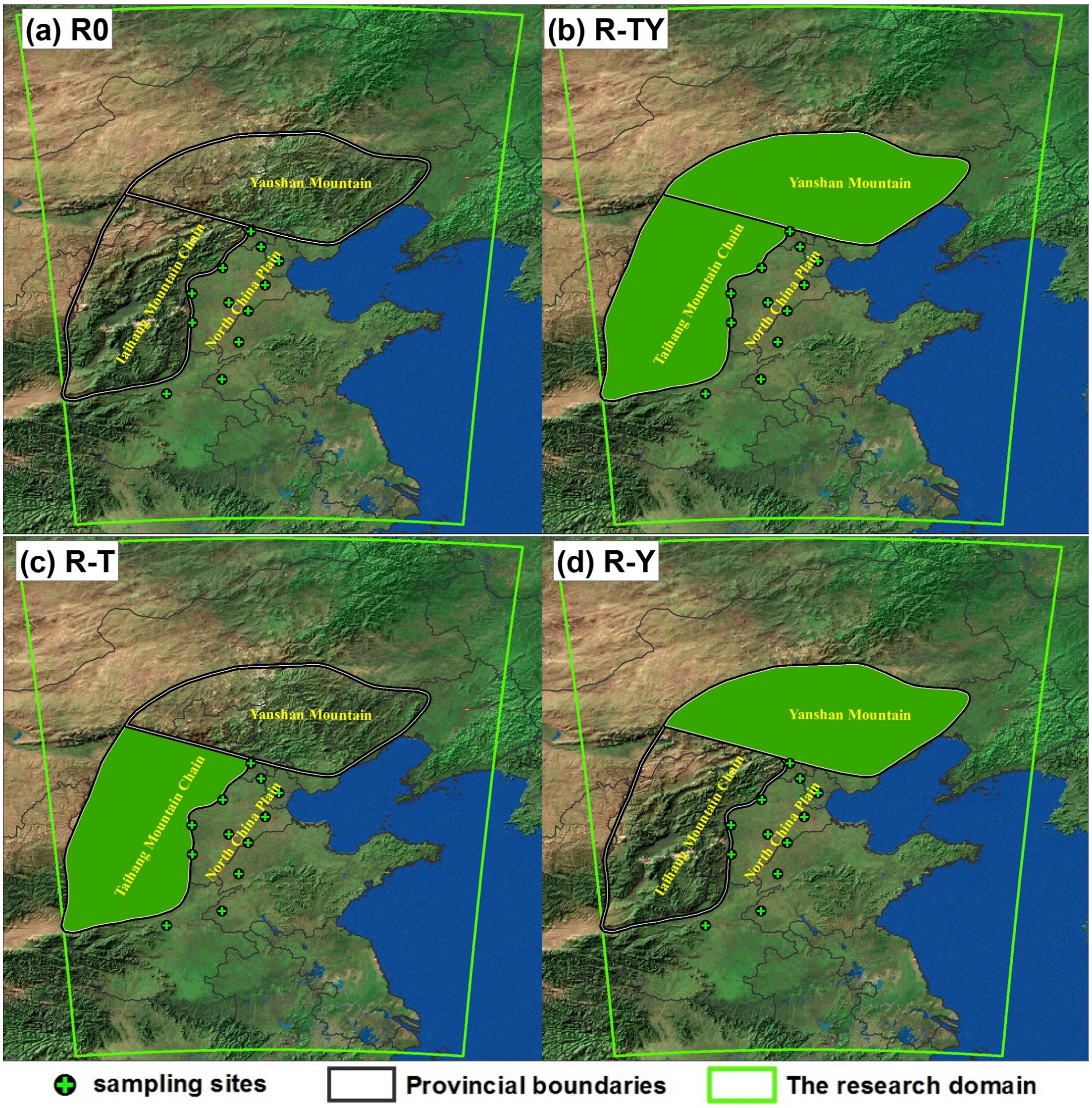

Fig. S2 The sensitivity experiments to mountain effects, including **(a)** the enclosing scope and sensitive configuration of remove behaviors for **(b)** both mountains of Taihang and Yanshan (R-TY), **(c)** Taihang Mountains (R-T) and **(d)** Yanshan Mountains (R-Y).

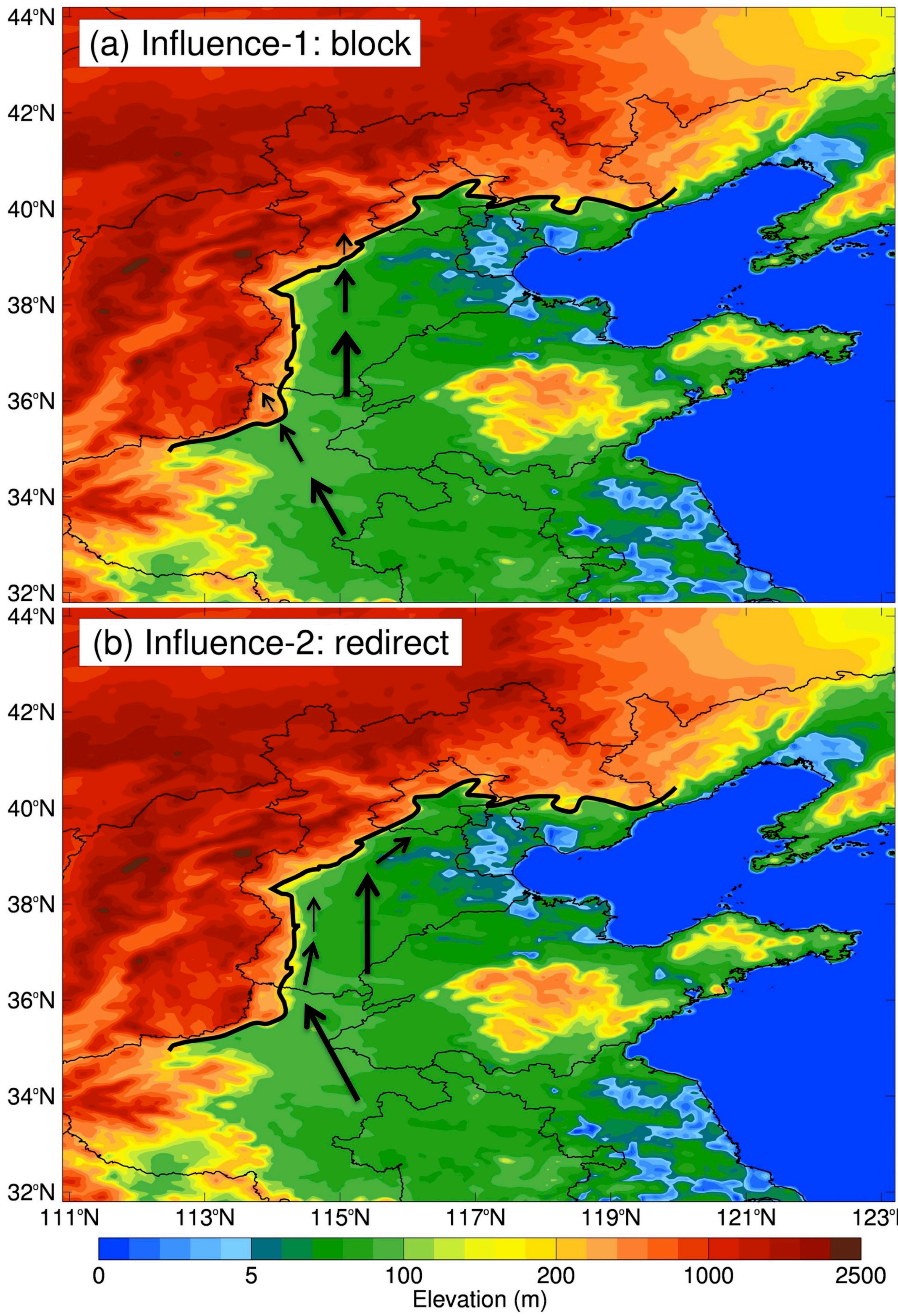

Fig. S3 The schematic pictures of mountains effect along with the topography of the NCP region. (a) Mountains block the airflows and cause pollutants accumulated at the foothill of mountains (Influence-2, block). (b) Mountains redirect the airflows, and cause pollutants move toward the downwind foothill areas (Influence-2, redirect). The 200-meter contour was highlighted with bold black line.