SUPPORTING INFORMATION for

Deriving High-Resolution Emission Inventory of Open Biomass Burning in China based on Satellite Observations

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S1. $PM_{2.5}$ and NMVOC speciation

The 18 $PM_{2.5}$ species including OC, EC, sulfate, nitrate, H_2O, Na, Cl, NH_4^+, non-carbon organic matter (NCOM), Al, Ca, Fe, Si, Ti, Mg, K, Mn, and other species from different biomass types were allocated based on Li et al. (2007) As fewer studies have focused on NMVOC speciation emissions from open biomass burning records for China, the local NMVOC speciation database was still limited, especially in regards to forest and shrubland burning emissions. Thus, some local NMVOC speciation data from cropland fire emissions were used to estimate NMVOC speciation emissions. NMVOC speciation emissions for forest, shrubland and grassland burning were determined from the GFED4 database (see https://daac.ornl.gov/VEGETATION/guide-s/fire_emissions_v4.html). The NMVOC speciation included alkanes, alkenes, aromatics, alcohols, aldehydes, ketones, acids, esters, Halocarbons, compounds with N, and compounds with S.

Major components of $PM_{2.5}$ included OC, EC, NCOM, Cl, NH_4^+, accounting for 51.22%, 9.45%, 12.19%, 9.0%, 4.45%, respectively (Figure S9). In addition, high concentrations of OC were detected during heavier episodes occurring within the crop harvest season. Thus, as an important species, OC together with Cl^- and K^+ were considered as an indicator of biomass burning used in the source apportionment model.

For the NMVOC speciation, major species included aldehydes, alcohols, alkenes, and acids, for which we found values of 18.19%, 17.75%, 16.09% and 15.59%, respectively. These results differ from those of Wei, who argued that aromatics (33.8%) constitute the main emission species of biomass burning. Kudo et al. (2014) showed that such results might vary based on combustion conditions, as aromatics emissions in smoldering conditions was 4~5 times higher than those for flaming conditions. In fact, the separation of biomass burning into different phases could improve the accuracy of emission. However, as lacking the sufficient emission factors in different phases, we used the GEFD4 emission factor, which related more directly to flaming conditions of biomass burning and to Wei's burning measure for

smoldering conditions.

S2. Improvement of simulation accuracies

The CMAQ model system (Fu et al., 2014) was employed to evaluate the improvement of emission inventory. According to the table 1, the Heilongjiang was the larger emitter. So we chose the Harbin (the provincial capital of Heilongjiang) as a typical case study. The air quality simulation was carried out during a heavy pollution episode in October, 2013. The heavy pollution episode, with the highest hourly concentration of $PM_{2.5}$ more than 500μg m^{-3} and daily concentration of $PM_{2.5}$ 13 times higher than the limit of NAAQS (National ambient air quality standard), occurred synchronously to a high emission of open burning. The open burning emission inventory based on traditional top-town method, solely MODIS burned area product MCD64Al, combined MCD64Al and MCD14ML (This study) (Figure S8), were individually used to simulate air quality by CMAQ model. The parameter setting of CMAQ referred to Zhao et al (2014). Others emission inventories from power plant, industrial sector, domestic sector, and transportation sector were derived by Wang et al (2013). The observed $PM_{2.5}$ concentrations from a national air controlling monitor site "Songbeishangda" (45.82°N, 126.56°E) were used to compare with the simulated results.

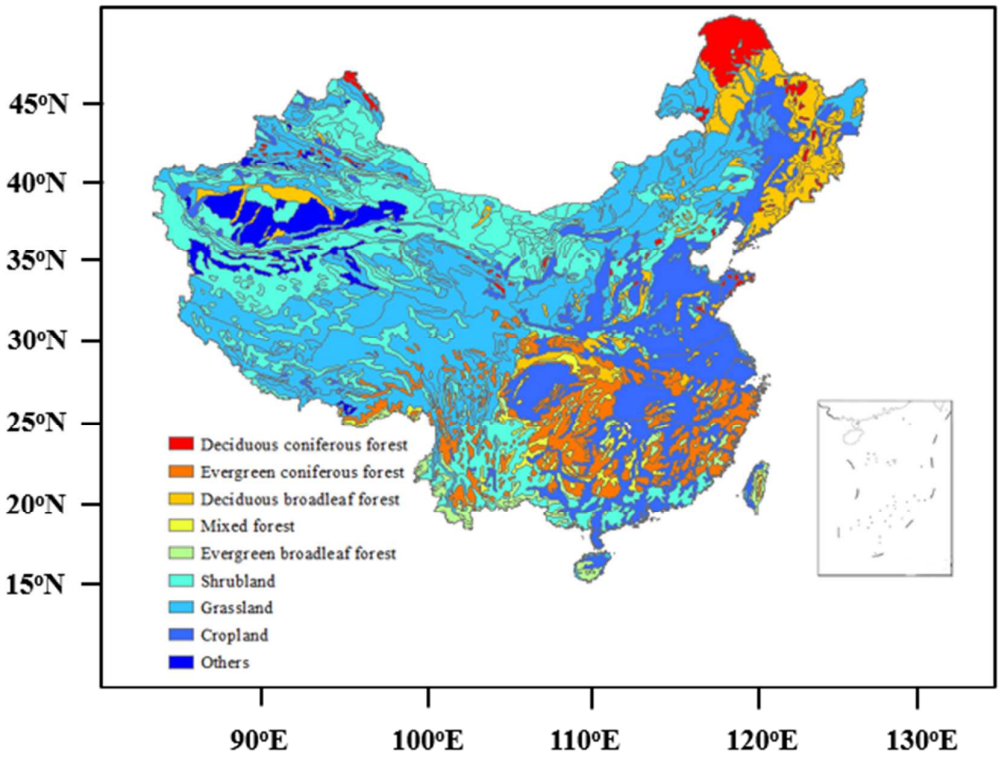
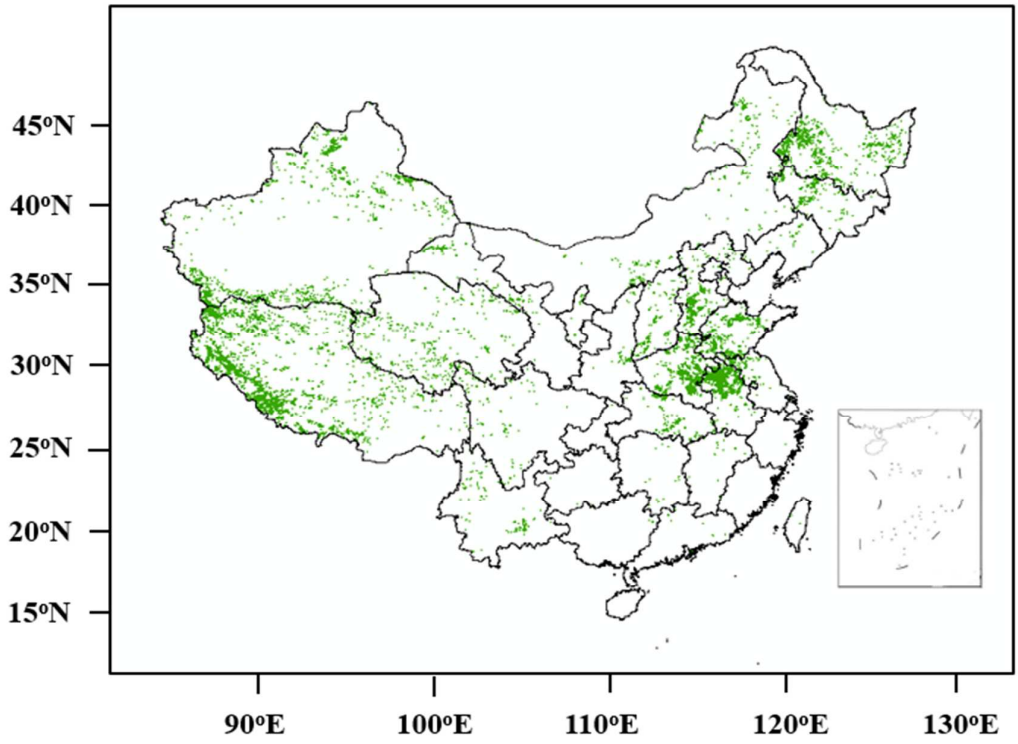


Figure S1. Distribution of major vegetation types in China (ECVMC, 2007)


45°N
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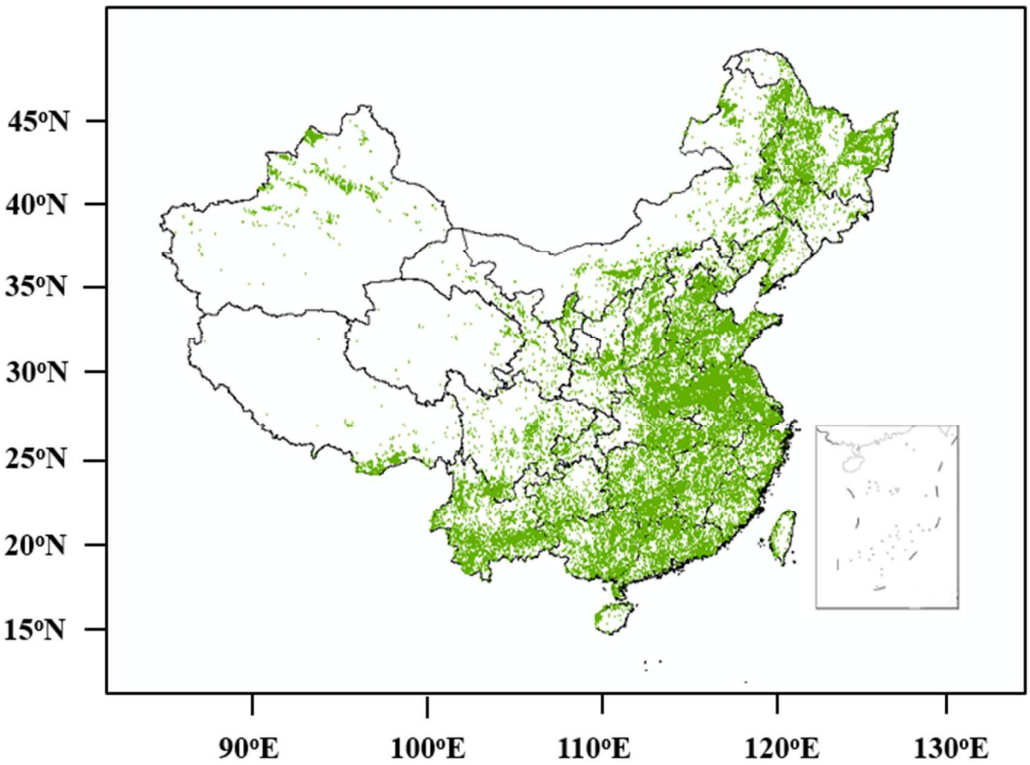
120°E
130°E

(a)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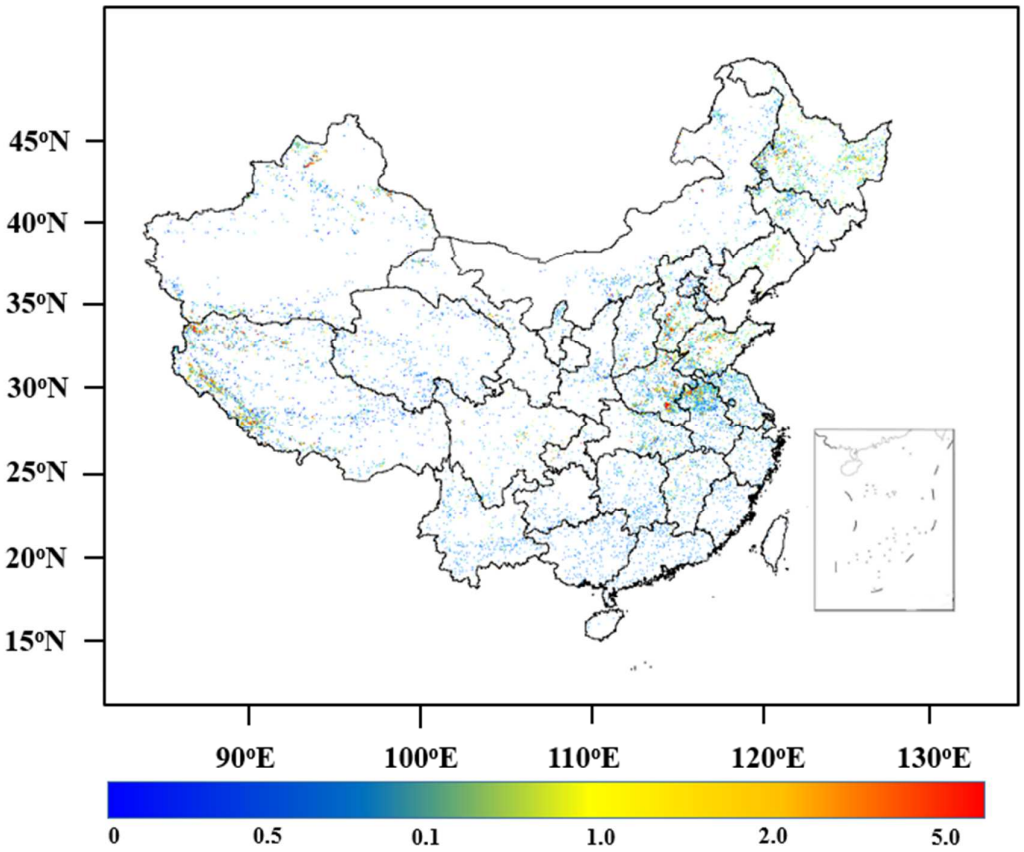
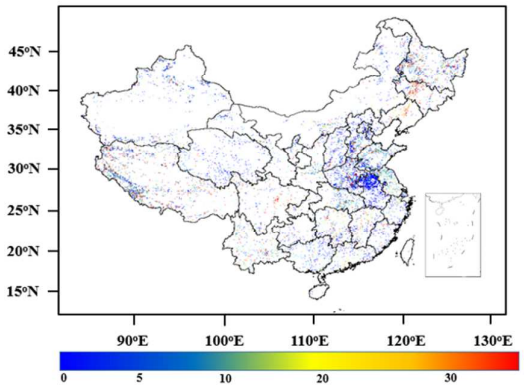
(b)



(c)

Figure S2. Distribution of fire burning in China from two satellite products in 2013 (a: data from MODIS burned area product MCD64Al; b: data from MODIS active fire product MCD14ML; c: burned area distribution by integrating the data a and b, unit: km^2/grid, grid resolution: 3km×3km)

Figure S3. Distribution of the national administrative divisions in China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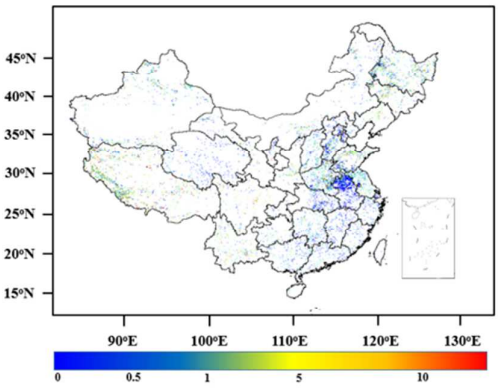
(a)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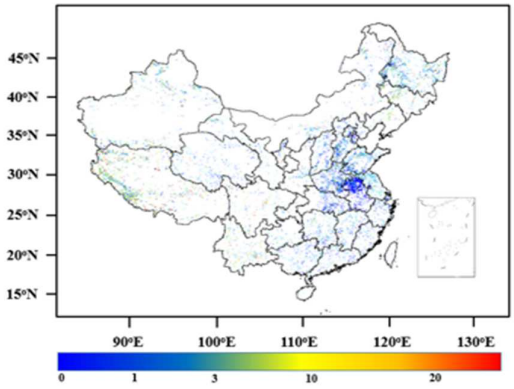
10

(b)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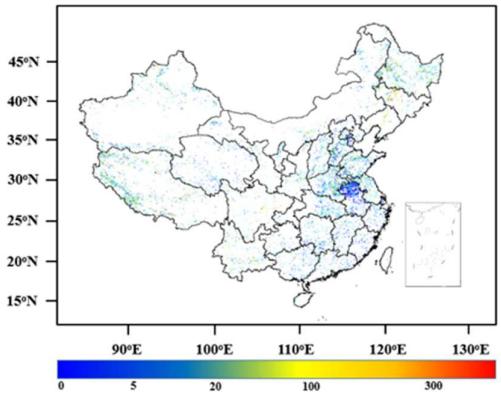
(c)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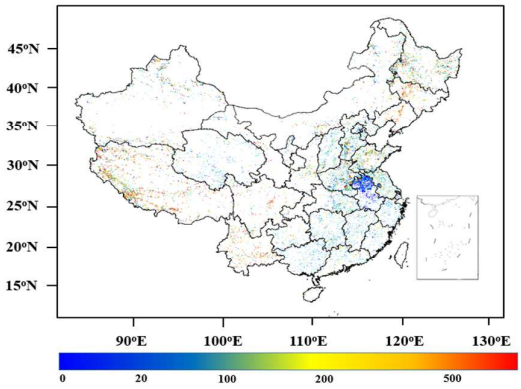
(d)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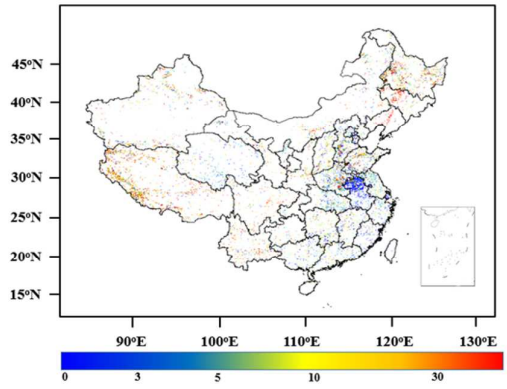
500

(e)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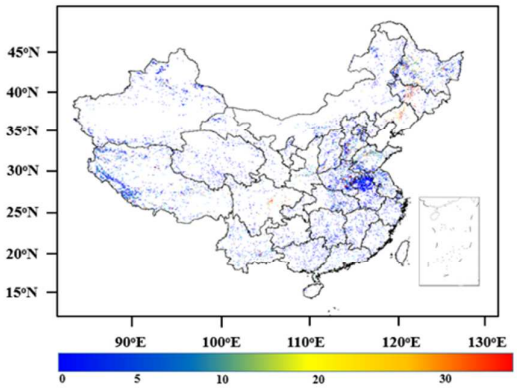
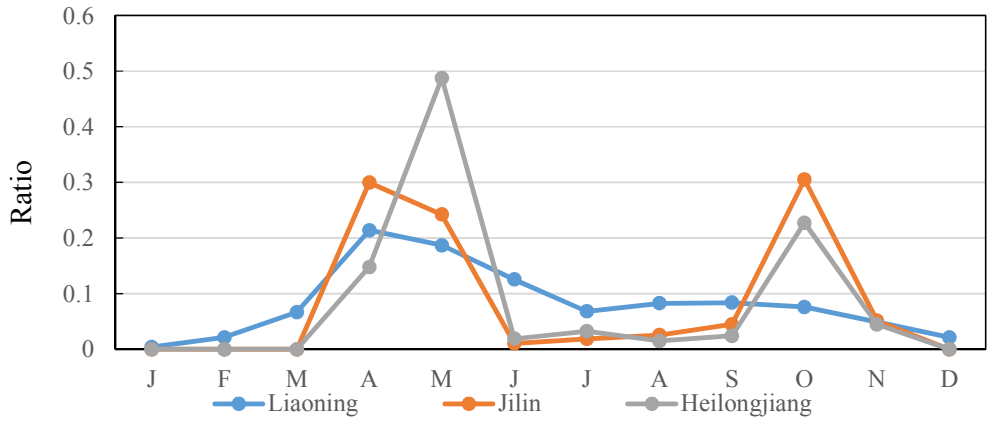
(f) OC

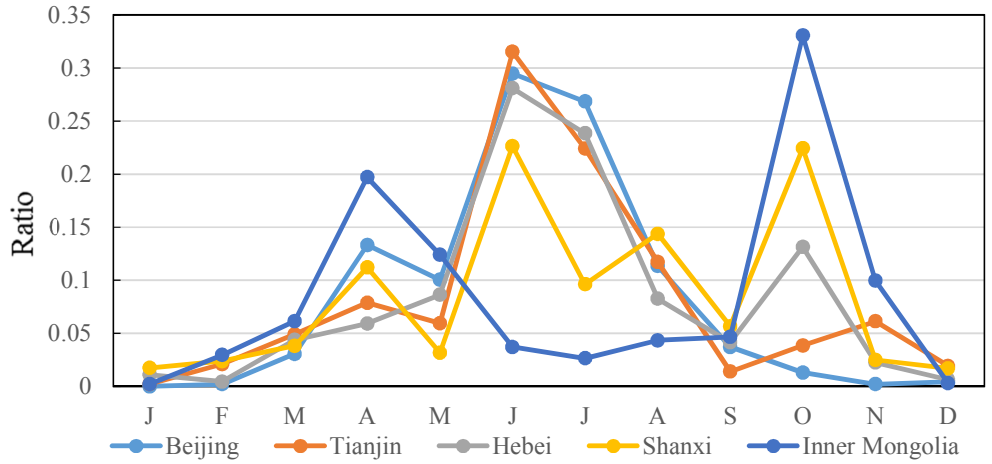


(g) NO_X

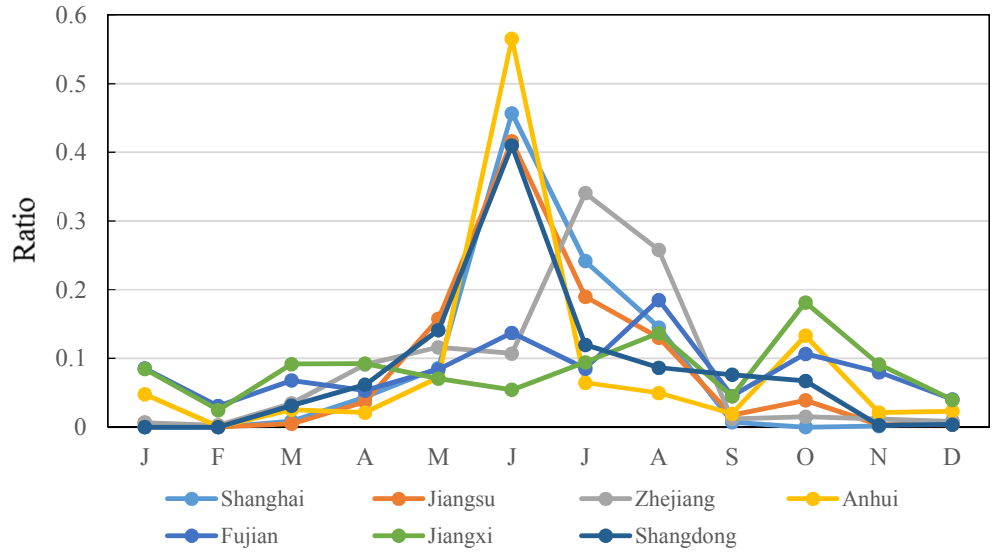
Figure S4. Spatial distribution of all species in China in 2013 (Unit: t/a) (a: CH_4, b: SO_2, c: NH_3, d: PM_{10}, e: CO; f: OC, g: NO_X)



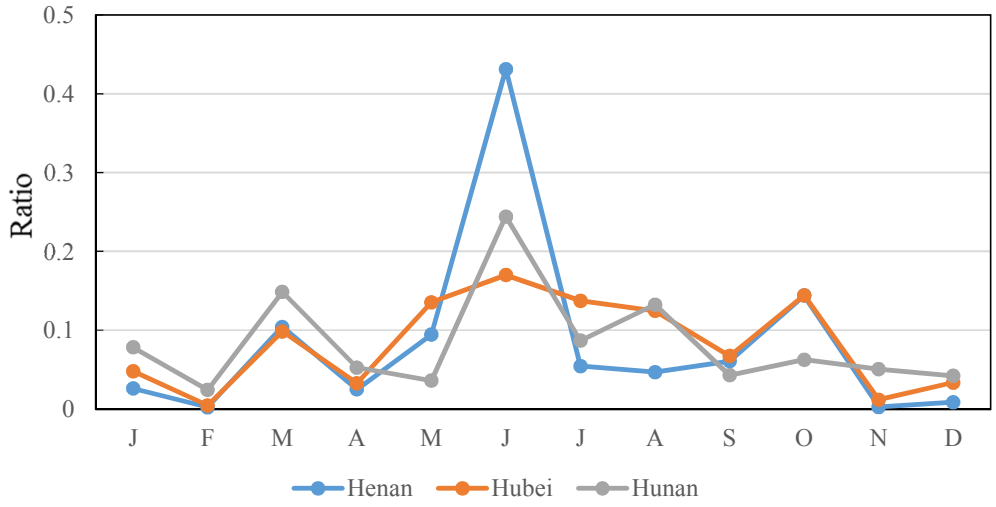
(a) Northeast China



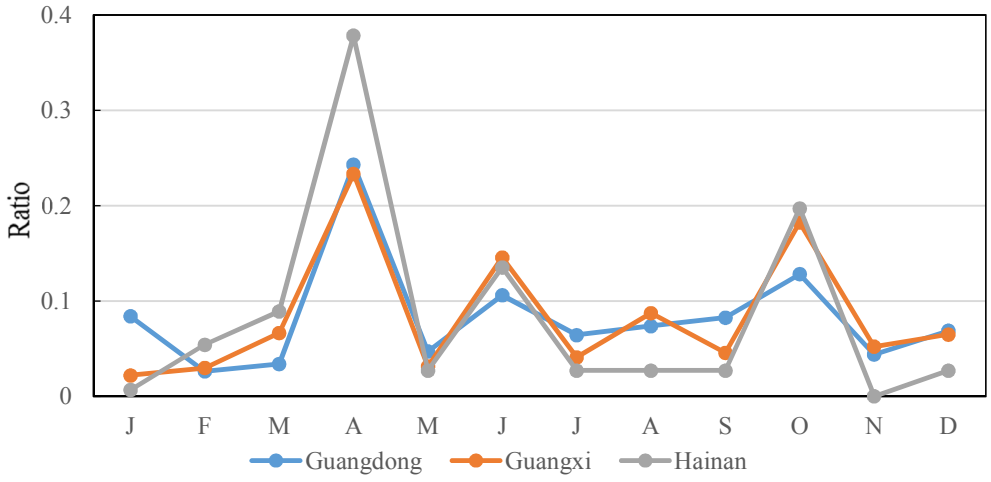
(b) North China



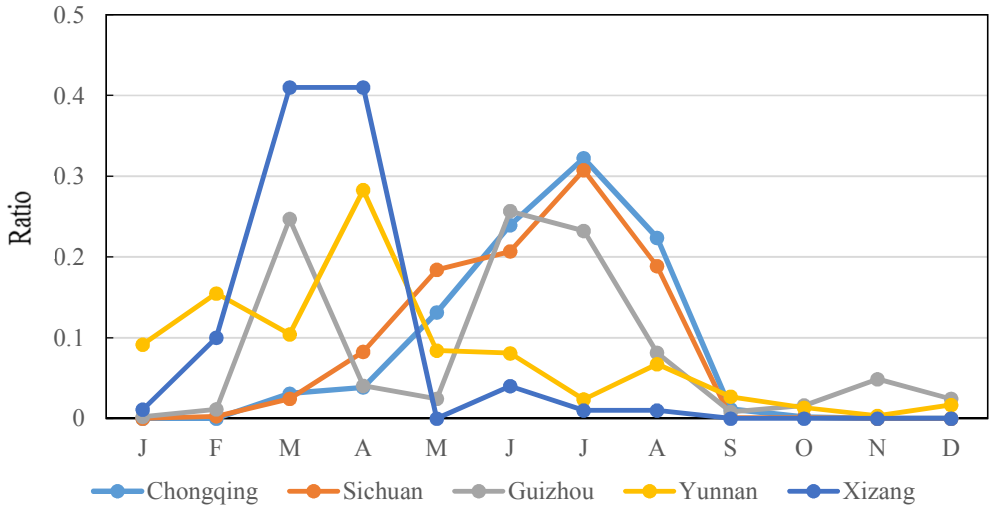
(c) East China



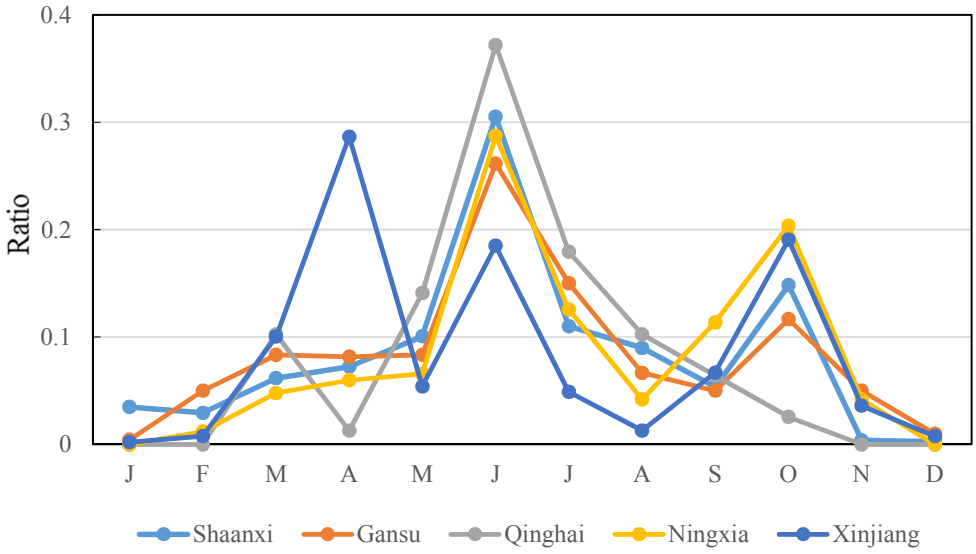
(d) Central China



(e) South China



(f) Southwest China



(g) Northwest China

Figure S5. Temporal distribution of open biomass burning emission for all provinces

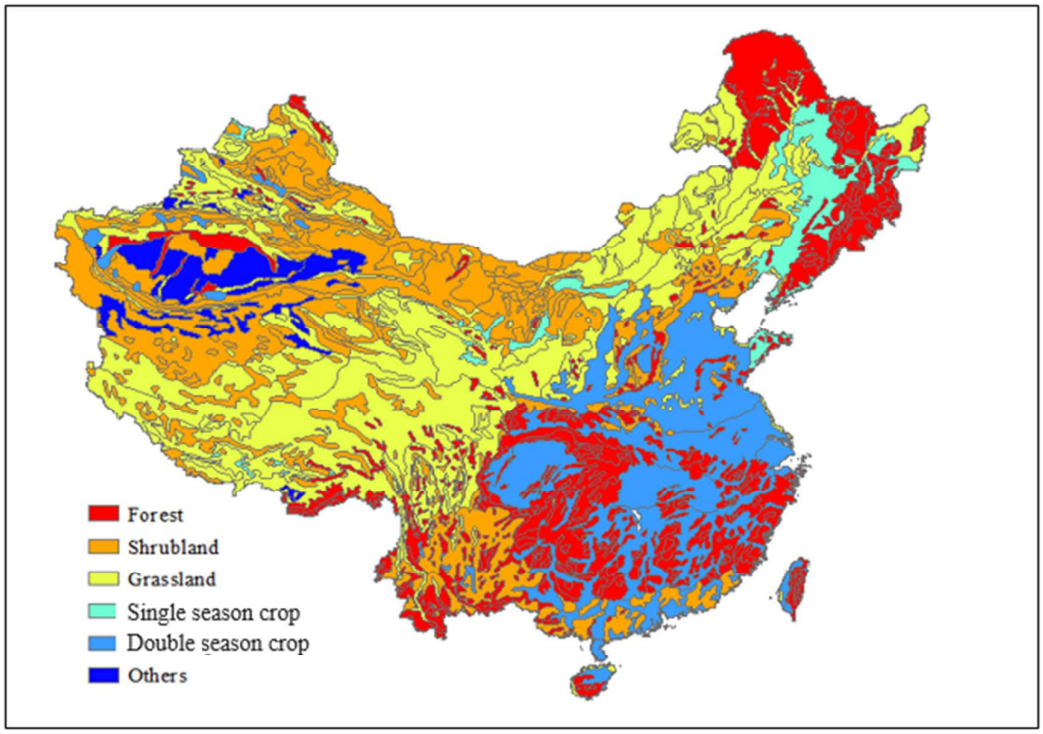


Figure S6. The distribution of crop and other vegetation type over China

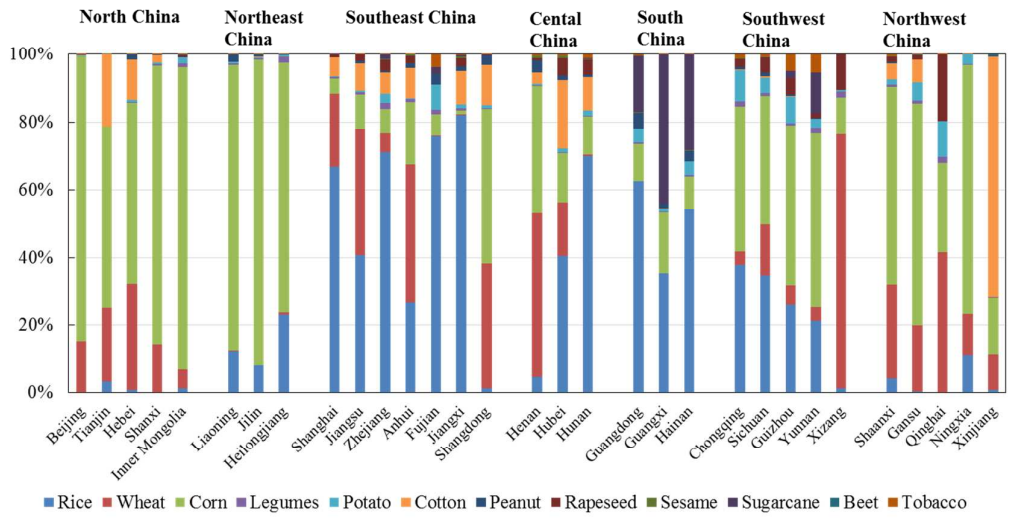


Figure S7. The percentage of $PM_{2.5}$ emission for each crop type in China

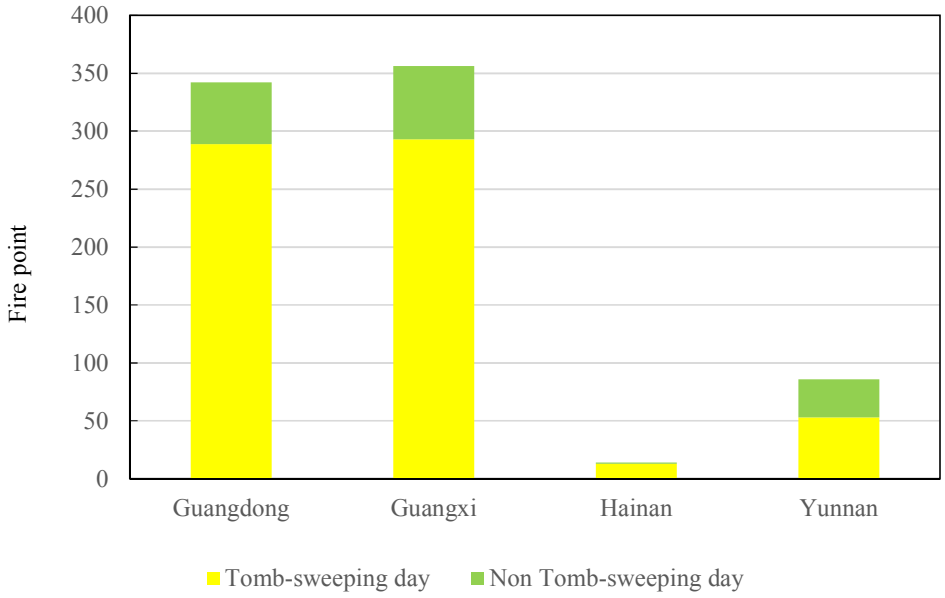
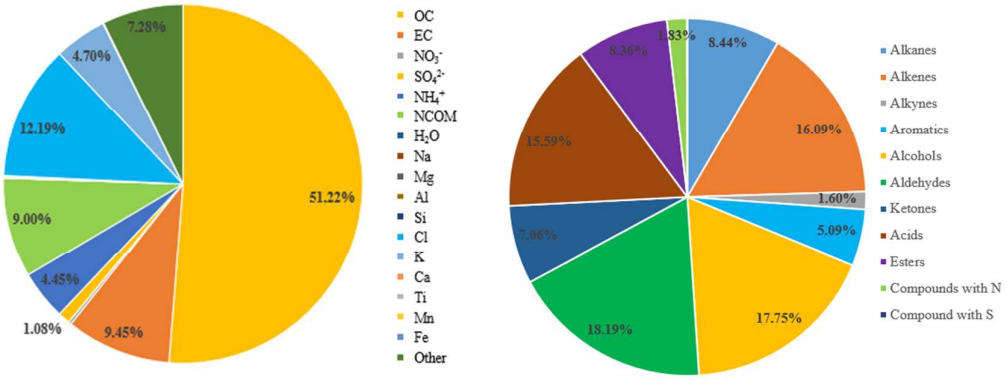


Figure S8. The number of fire point distributed in Tomb-sweeping day and non-Tomb-sweeping day in April



(a) (b)

Figure S9. Mapping of $PM_{2.5}$ speciation (a) and NMVOC speciation (b) for open biomass burning

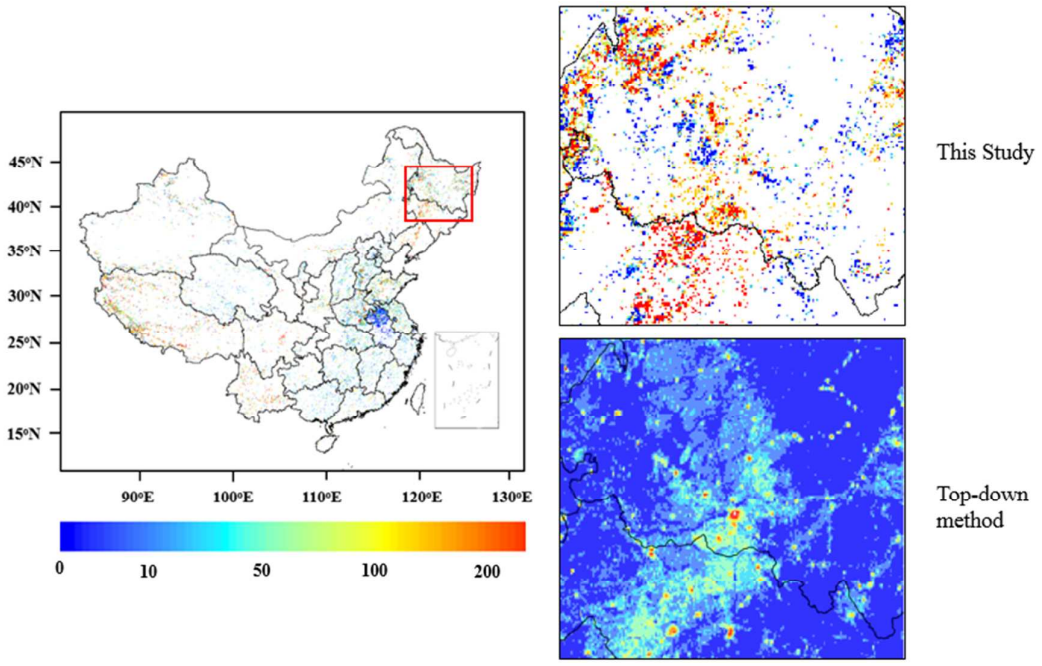


Figure S10. Comparison of open biomass emission inventory of $PM_{2.5}$ in Heilongjiang based two satellite products data (This study, right-top chart) and Top-town method (right-bottom chart)

Table S1. Provincial fuel loading (kt/km^2) for generic land cover classifications in China.

Province/regions	Forest[a]	Grassland[b]	Shrubland[c]
Northeast China			
Jilin	12.6	1.01	6.94
Liaoning	7.59	0.98	6.94
Heilongjiang	9.49	1.31	6.94
North China			
Hebei	5.45	0.86	6.94
Shanxi	5.25	0.74	6.94
Beijing	6.59	1.04	6.93
Tianjin	8.14	0.95	6.89
Nei Mongol	7.11	0.6	26.3
Central China			
Hubei	5.34	0.88	7.87
Hunan	4.79	0.8	17.4
Henan	5.66	0.77	6.94
East China			
Jiangsu	4.7	0.72	6.86
Zhejiang	3.51	0.86	18.4
Anhui	6.32	0.77	12.2
Fujian	6.29	0.85	18.9
Jiangxi	4.75	0.76	18.5
Shandong	4.26	0.78	6.94
Shanghai	6.09	0.93	6.86
South China			
Guangdong	5.28	0.76	18.5
Guangxi	6.84	0.8	16.6
Hainan	11	0.85	18.7
Southwest China			
Sichuan	10.5	1.25	15
Yunnan	12	0.9	17.7
Guizhou	7.92	0.83	17.2
Chongqing	10.5	1.2	15.1
Xizang	14.1	0.48	10.1

Northwest China			
Ningxia	7.68	0.35	6.93
Qinghai	9.39	0.91	7.72
Shaanxi	8.44	0.54	7.21
Xinjiang	11.1	0.54	6.94
Gansu	9.1	0.71	7.5

Note: the fuel loading of evergreen coniferous forest, evergreen broadleaf forest, deciduous coniferous forest, deciduous broadleaf forest all used the forest data.
[a] from Fang et al. (1996); [b] from Pu et al.(2004); [c] from Hu et al.(2006)
The unit of fuel loading in these studies converted from carbon storage (kg·c km^{-3}) to fuel loading (kg km^{-3}) by dividing 0.45 (Fang et al., 1996).

Table S2. The amount of burned primary crop residues in each province in 2013 (Unit: 10^6 kg of dry matter)

Province	Rice	Wheat	Corn	Legumes	Potato	Cotton	Peanut	Rapeseed	Sesame	Sugarcane	Beet	Tobacco
Northeast China												
Jilin	1521	0	9160	282	73	16	134	0	5	0	2	29
Liaoning	1369	9	5158	150	62	3	267	1	0	0	5	13
Heilongjiang	5996	128	10614	1921	162	0	17	0	1	0	37	43
North China												
Hebei	79	2289	2811	74	84	630	156	8	3	0	11	2
Shanxi	165	1366	3393	203	123	163	18	121	12	0	4	31
Beijing	0	21	83	1	0	0	1	0	0	0	0	0
Tianjin	12	63	112	1	0	45	0	0	0	0	0	0
Nei Mongol	50	198	2277	221	101	1	3	51	0	0	18	2
Central China												
Hubei	3018	917	596	101	96	846	109	751	60	17	0	41
Hunan	4611	24	407	113	127	364	45	584	7	44	0	84
Henan	874	7098	3952	252	112	349	754	269	118	17	0	111
East China												
Jiangsu	4325	3029	595	289	47	481	71	425	10	7	0	0
Zhejiang	1567	92	88	162	78	77	12	143	6	58	0	1
Anhui	1226	1465	469	182	19	231	71	195	14	6	0	7
Fujian	1355	2	64	103	179	0	65	8	1	53	0	78
Jiangxi	3607	5	26	98	65	241	72	211	16	39	0	16
Shandong	187	4881	4328	129	191	1143	553	7	0	0	0	36
Shanghai	156	39	6	4	1	7	0	4	0	0	0	0
South China												

Guangdong	2822	1	269	100	249	0	240	4	2	1398	0	27
Guangxi	2081	1	585	75	73	4	87	6	3	4863	0	12
Hainan	270	0	27	7	27	0	17	0	1	264	0	0
Southwest China												
Sichuan	2789	927	1677	295	480	24	105	672	2	34	0	80
Yunnan	1202	177	1615	420	208	1	13	152	0	1288	0	344
Guizhou	650	113	656	83	263	2	13	245	0	96	0	139
Chongqing	906	74	568	147	297	0	19	120	3	7	0	31
Xizang	1	26	3	3	0	0	0	10	0	0	0	0
Northwest China												
Ningxia	62	51	227	3	22	0	0	0	0	0	0	0
Qinghai	0	40	18	9	18	0	0	48	0	0	0	0
Shaanxi	0	0	0	0	0	0	0	0	0	0	0	0
Xinjiang	54	662	736	34	8	3236	2	17	0	0	48	0
Gansu	3	259	629	61	122	65	0	50	0	0	2	2
All	40957	23958	51148	5527	3288	7930	2845	4101	265	8190	128	1131

Note: the burned crop residues = food production × the ratio of grain-straw × the burned ratio of crop residues

(1) The food production data derived from Chinese Statistical Yearbook (CSY, 2014)

(2)The ratio of grain-straw and crop residues burning referred the studies by Tian et al. (2011)

Table S3. The emission factors and their standard deviation of multiple pollutants in generic land cover class (LCT) (g kg^{-1} Dry Matter)

Vegetation	LCT	CO	CH_4	NO_X	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	OC	BC	CO_2
Evergreen coniferous forest	Forest	118(45)	6(3.1)	1.8(0.7)	28(8.7)	1(0.3)	3.5(2.3)	13(5.9)	18.57	7.8[a](4.8)	0.2[a](0.2)	1514(121)
Evergreen broadleaved Forest	Forest	92(27)	5.1(2.0)	2.6(1.4)	24(-)	0.5(0.2)	0.8(1.2)	9.7(3.5)	13.86	4.7(2.7)	0.5[a(0.3)]	1663(58)
Deciduous coniferous Forest	Forest	118(45)	6(3.1)	3(0.7)	28(8.7)	1(0.3)	3.5(2.3)	13.6(5.9)	19.43	7.8[a(4.8)]	0.2[a(0.2)]	1514(121)
Deciduous broadleaved Forest	Forest	102(19)	5(0.9)	1.3(0.6)	11(8.7)	1(0.3)	1.5(0.4)	13(5.6)	18.57	9.2(4.8)	0.6(0.2)	1630(37)
Mixed Forest	Forest	102(19)	5(0.9)	1.3(0.6)	14(8.7)	1(0.3)	1.5(0.4)	13(5.6)	18.57	9.2(4.8)	0.6(0.2)	1630(37)
Grassland	Grassland	59(17)	1.5(0.9)	2.8(0.8)	9.3(2.3)	0.5(0.3)	0.5(0.4)	5.4(3.4)	7.71	2.6(1.2)	0.4(0.2)	1692(38)
Shrubland	Shurbland	68(17)	2.6(0.9)	3.9(0.8)	4.8(2.3)	0.7(0.3)	1.2(0.4)	9.3(3.4)	13.29	6.6(1.2)	0.5(0.2)	1716(38)
Rice	Cropland	64.2[b](4.9)	3.9[d](0.5)	1.81[b](0.39)	6.05[c](1.0)	0.147[e](0.1)	0.53[d](0.16)	7.57[d](0.03)	10.81	1.96[e](0.67)	0.52[e](0.21)	791[i](12.5)
Wheat	Cropland	60[f](23)	3.4[f](0.5)	3.3[f](1.00)	7.5[f](1.15)	0.85[f](0.31)	0.37[f](0.16)	7.6[f](1.9)	10.86	2.7[f](0.67)	0.49[f](0.17)	1557[i](85.8)
Corn	Cropland	53[f](8)	4.4[f](0.5)	4.3[f](1.0)	10[f](2.5)	0.44[f](0.01)	0.68[f](0.3)	10.4[f](1.3)	14.86	6.88[f](2.8)	1.55[f](0.86)	1261[i](59.9)
Legumes	Cropland	32.3[g](1.1)	3.9[d](0.5)	1.12[g](0.04)	8.64[d](2.38)	0.25[d](0.02)	0.53[d](0.15)	1.84[g](1.5)	2.63	1.08[g](0.05)	0.23[g](0.1)	1445[j](46)
Potato	Cropland	55.13[h](15.1)	3.9[h](0.5)	2.11[h](0.1)	8.64[h](1.36)	0.25[h](0.02)	0.53[h](0.15)	5.76[h](1.44)	8.23	2.03[h](1.05)	0.41[h](0.18)	1445[j](46)
Cotton	Cropland	68.34[d](1.99)	3.9[f](0.5)	2.68[a](0.58)	8.64[f](1.36)	0.23[d](0.02)	0.53[f](0.15)	11.7[d](5.96)	16.71	3.06[d](1.23)	0.57[d](0.24)	1445[j](46)
Peanut	Cropland	55.13[f](15.1)	3.9[f](0.5)	2.11[f](0.1)	8.64[f](1.36)	0.25[f](0.02)	0.53[f](0.15)	5.76[f](1.44)	8.23	2.03[f](1.05)	0.41[f](0.18)	1445[j](46)
Rapeseed	Cropland	34.3[g](1.69)	3.9[d](0.5)	1.12[g](1.56)	8.64[d](1.36)	0.25[d](0.02)	0.53[d](0.15)	3.32[g](1.48)	4.74	1.08[g](0.5)	0.23[g](0.1)	1445[j](46)
Sesame	Cropland	55.13[f](15.1)	3.9[f](0.5)	2.11[f](0.1)	8.64[f](1.36)	0.25[f](0.02)	0.53[f](0.15)	5.76[f](1.44)	8.23	2.03[f](1.05)	0.41[f](0.18)	1445[j](46)
Sugarcane	Cropland	40.08[c](9.22)	3.9[d](0.5)	2.01[c](0.1)	11.02[c](1.02)	0.25[d](0.02)	0.53[d](0.15)	4.12[c](1.64)	5.89	2.03[d](1.05)	0.41[d](0.18)	1445[j](46)
Beet	Cropland	55.13[h](15.1)	3.9[h](0.5)	2.11[h](0.1)	8.64[h](1.36)	0.25[h](0.02)	0.53[h](0.15)	5.76[h](1.44)	8.23	2.03[h](1.05)	0.41[h](0.18)	1445[j](46)
Tobacco	Cropland	55.13[h](15.1)	3.9[h](0.5)	2.11[h](0.1)	8.64[h](1.36)	0.25[h](0.02)	0.53[h](0.15)	5.76[h](1.44)	8.23	2.03[h](1.05)	0.41[h](0.18)	1445[j](46)

[a] From McMeeking et al (2008). Except cropland, others from Akagi et al. (2011) and GFED4 (https://daac.ornl.gov/VEGETATION/guides/fire_emissions_v4.html)

[b] from Zhang et al.(2008); [c] from Zhang et al.(2013) ; [d] from He et al.(2015); [e] from Cao et al.(2008). [f] is from He et al. (2015). [g] from Tang et al.(2014). [h] is the default following He et al. (2015); [i] from Zhang et al.(2009); [j] from Wang et al.(2008). All crop emission factor of PM_{10}, assume $PM_{2.5}/PM_{10}$=0.7

Table S4. Regional/Provincial emissions distribution for each pollutant from burning of forest in 2013 (unit: $Gg \cdot yr^{-1}$)

Region/Province	CO	CH_4	NO_X	VOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	OC	BC	CO_2
Northeast China	**598**	**30.5**	**11.3**	**118**	**5.06**	**12.2**	**70.1**	**100**	**43.5**	**2.36**	**7683**
Jilin	86.5	4.41	1.63	17.1	0.73	1.76	10.1	14.5	6.29	0.34	1110
Liaoning	30.8	1.57	0.58	6.08	0.26	0.63	3.61	5.15	2.24	0.12	395
Heilongjiang	481	24.5	9.05	95	4.07	9.77	56.4	80.5	35	1.9	6178
North China	**93.3**	**4.75**	**1.75**	**18.4**	**0.79**	**1.89**	**10.9**	**15.6**	**6.78**	**0.37**	**1198**
Hebei	18.7	0.95	0.35	3.7	0.16	0.38	2.19	3.14	1.36	0.07	241
Shanxi	14.9	0.76	0.28	2.94	0.13	0.3	1.75	2.49	1.08	0.06	191
Beijing	2.5	0.13	0.05	0.49	0.02	0.05	0.29	0.42	0.18	0.01	32
Tianjin	0.05	0	0	0.01	0	0	0.01	0.01	0	0	1
Nei Mongol	57.1	2.91	1.07	11.3	0.48	1.16	6.69	9.56	4.16	0.23	733
Central China	**149**	**7.57**	**2.8**	**29.4**	**1.27**	**3.01**	**17.4**	**24.9**	**10.8**	**0.59**	**1908**
Hubei	59.8	3.04	1.12	11.8	0.51	1.21	7	10	4.35	0.24	767
Hunan	45.5	2.32	0.86	8.98	0.39	0.92	5.33	7.62	3.31	0.18	584
Henan	43.4	2.21	0.82	8.57	0.37	0.88	5.08	7.27	3.16	0.17	557
East China	**284**	**14.5**	**5.34**	**55.9**	**2.39**	**5.75**	**33.2**	**47.5**	**20.6**	**1.11**	**3641**
Jiangsu	8.85	0.45	0.17	1.75	0.07	0.18	1.04	1.48	0.64	0.03	114
Zhejiang	2.5	0.13	0.05	0.49	0.02	0.05	0.29	0.42	0.18	0.01	32
Anhui	108	5.48	2.02	21.2	0.91	2.18	12.6	18	7.82	0.42	1380
Fujian	20.2	1.03	0.38	3.98	0.17	0.41	2.36	3.37	1.47	0.08	259
Jiangxi	51.4	2.62	0.97	10.1	0.43	1.04	6.02	8.6	3.74	0.2	660
Shandong	93.1	4.74	1.75	18.4	0.79	1.89	10.9	15.6	6.78	0.37	1196
Shanghai	0	0	0	0	0	0	0	0	0	0	0
South China	**36.1**	**1.84**	**0.69**	**7.12**	**0.31**	**0.73**	**4.23**	**6.02**	**2.62**	**0.15**	**463**
Guangdong	12	0.61	0.23	2.37	0.1	0.24	1.41	2	0.87	0.05	154
Guangxi	22.2	1.13	0.42	4.38	0.19	0.45	2.6	3.71	1.61	0.09	285
Hainan	1.87	0.1	0.04	0.37	0.02	0.04	0.22	0.31	0.14	0.01	24
Southwest China	**299**	**15.2**	**5.61**	**58.9**	**2.52**	**6.06**	**35**	**50**	**21.7**	**1.17**	**3831**
Sichuan	81.7	4.16	1.54	16.1	0.69	1.66	9.56	13.7	5.94	0.32	1048
Yunnan	108	5.48	2.02	21.2	0.91	2.18	12.6	18	7.82	0.42	1380
Guizhou	25.2	1.29	0.47	4.98	0.21	0.51	2.96	4.21	1.84	0.1	324
Chongqing	28.1	1.43	0.53	5.55	0.24	0.57	3.29	4.7	2.04	0.11	361
Xizang	55.9	2.85	1.05	11.1	0.47	1.14	6.55	9.35	4.07	0.22	718
Northwest China	**28.1**	**1.43**	**0.54**	**5.53**	**0.24**	**0.57**	**3.3**	**4.7**	**2.04**	**0.1**	**361**
Ningxia	0.82	0.04	0.02	0.16	0.01	0.02	0.1	0.14	0.06	0	11
Qinghai	1.07	0.05	0.02	0.21	0.01	0.02	0.13	0.18	0.08	0	14
Shaanxi	8.43	0.43	0.16	1.66	0.07	0.17	0.99	1.41	0.61	0.03	108
Xinjiang	9.37	0.48	0.18	1.85	0.08	0.19	1.1	1.57	0.68	0.04	120
Gansu	8.38	0.43	0.16	1.65	0.07	0.17	0.98	1.4	0.61	0.03	108
Total	**1487**	**76**	**28**	**293**	**13**	**30**	**174**	**249**	**108**	**6**	**19085**

Table S5. Regional/Provincial emissions distribution for each pollutant from burning of shrubland in 2013(unit: $Gg \cdot yr^{-1}$)

Region/Province	CO	CH_4	NO_X	VOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	OC	BC	CO_2
Northeast China	**191**	**4.86**	**9.06**	**30.07**	**1.62**	**1.62**	**17.45**	**24.22**	**8.4**	**1.29**	**4816**
Jilin	0	0.01	0.02	0.05	0	0	0.03	0.04	0.01	0	8
Liaoning	5	0.12	0.22	0.72	0.04	0.04	0.42	0.58	0.2	0.03	115
Heilongjiang	186	4.73	8.82	29.3	1.58	1.58	17	23.6	8.19	1.26	4693
North China	**304**	**7.71**	**14.4**	**47.83**	**2.57**	**2.57**	**27.8**	**38.48**	**13.37**	**2.05**	**7663**
Hebei	136	3.46	6.47	21.5	1.15	1.15	12.5	17.3	6	0.92	3439
Shanxi	27	0.68	1.27	4.21	0.23	0.23	2.44	3.38	1.18	0.18	674
Beijing	4	0.09	0.17	0.57	0.03	0.03	0.33	0.46	0.16	0.02	92
Tianjin	0	0.01	0.02	0.05	0	0	0.03	0.04	0.01	0	8
Nei Mongol	137	3.47	6.48	21.5	1.16	1.16	12.5	17.3	6.02	0.93	3450
Central China	**103**	**2.6**	**4.85**	**16.15**	**0.86**	**0.86**	**9.35**	**13**	**4.51**	**0.69**	**2582**
Hubei	2	0.04	0.07	0.25	0.01	0.01	0.14	0.2	0.07	0.01	40
Hunan	0	0	0	0	0	0	0	0	0	0	0
Henan	101	2.56	4.78	15.9	0.85	0.85	9.21	12.8	4.44	0.68	2542
East China	**3**	**0.07**	**0.13**	**0.42**	**0.02**	**0.02**	**0.25**	**0.34**	**0.12**	**0.02**	**68**
Jiangsu	0	0	0	0	0	0	0	0	0	0	0
Zhejiang	0	0	0	0	0	0	0	0	0	0	0
Anhui	0	0	0	0	0	0	0	0	0	0	0
Fujian	3	0.07	0.13	0.42	0.02	0.02	0.25	0.34	0.12	0.02	68
Jiangxi	0	0	0	0	0	0	0	0	0	0	0
Shandong	0	0	0	0	0	0	0	0	0	0	0
Shanghai	0	0	0	0	0	0	0	0	0	0	0
South China	**32**	**0.82**	**1.53**	**5.08**	**0.27**	**0.27**	**2.95**	**4.09**	**1.42**	**0.22**	**813**
Guangdong	18	0.46	0.85	2.83	0.15	0.15	1.64	2.28	0.79	0.12	453
Guangxi	14	0.36	0.68	2.25	0.12	0.12	1.31	1.81	0.63	0.1	360
Hainan	0	0	0	0	0	0	0	0	0	0	0
Southwest China	**1181**	**30.01**	**56**	**186.01**	**10**	**10**	**108.2**	**149.5**	**52.03**	**8.01**	**29822**
Sichuan	43	1.09	2.04	6.79	0.36	0.36	3.94	5.46	1.9	0.29	1087
Yunnan	93	2.37	4.4	14.7	0.79	0.79	8.54	11.8	4.11	0.63	2355
Guizhou	10	0.25	0.46	1.52	0.08	0.08	0.88	1.22	0.42	0.07	243
Chongqing	0	0	0	0	0	0	0	0	0	0	0
Xizang	1035	26.3	49.1	163	8.77	8.77	94.8	131	45.6	7.02	26137
Northwest China	**479**	**12.14**	**22.6**	**75.31**	**4.05**	**4.05**	**43.73**	**60.57**	**21.06**	**3.23**	**12060**
Ningxia	2	0.04	0.07	0.24	0.01	0.01	0.14	0.19	0.07	0.01	38
Qinghai	33	0.83	1.5	5.16	0.28	0.28	3	4.15	1.44	0.22	827
Shaanxi	6	0.16	0.3	0.99	0.05	0.05	0.58	0.8	0.28	0.04	159
Xinjiang	386	9.8	18.3	60.8	3.27	3.27	35.3	48.9	17	2.61	9735
Gansu	52	1.31	2.44	8.12	0.44	0.44	4.71	6.53	2.27	0.35	1301
Total	**2291**	**58**	**109**	**361**	**19**	**19**	**210**	**290**	**101**	**16**	**57823**

Table S6. Regional/Provincial emissions distribution for each pollutant from burning of grassland in 2013(unit: $Gg \cdot yr^{-1}$)

Region/Province	CO	CH_4	NO_X	VOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	OC	BC	CO_2
Northeast China	**24.55**	**0.62**	**1.17**	**3.87**	**0.21**	**0.21**	**2.25**	**4.07**	**1.08**	**0.16**	**247**
Jilin	22.5	0.57	1.07	3.55	0.19	0.19	2.06	3.73	0.99	0.15	245
Liaoning	2.05	0.05	0.1	0.32	0.02	0.02	0.19	0.34	0.09	0.01	2
Heilongjiang	0	0	0	0	0	0	0	0	0	0	0
North China	**79.19**	**2.03**	**3.75**	**12.48**	**0.67**	**0.67**	**7.25**	**13.16**	**3.53**	**0.53**	**1123**
Hebei	12.1	0.31	0.57	1.91	0.1	0.1	1.11	2.01	0.53	0.08	282
Shanxi	10.6	0.27	0.5	1.67	0.09	0.09	0.97	1.76	0.47	0.07	88
Beijing	0.21	0.01	0.01	0.03	0	0	0.02	0.04	0.01	0	2
Tianjin	2.18	0.06	0.1	0.34	0.02	0.02	0.2	0.37	0.1	0.01	20
Nei Mongol	54.1	1.38	2.57	8.53	0.46	0.46	4.95	8.98	2.39	0.37	731
Central China	**11.1**	**0.28**	**0.53**	**1.75**	**0.09**	**0.09**	**1.02**	**1.85**	**0.49**	**0.08**	**268**
Hubei	0	0	0	0	0	0	0	0	0	0	0
Hunan	0	0	0	0	0	0	0	0	0	0	0
Henan	11.1	0.28	0.53	1.75	0.09	0.09	1.02	1.85	0.49	0.08	268
East China	**0.92**	**0.02**	**0.05**	**0.14**	**0.01**	**0.01**	**0.08**	**0.17**	**0.04**	**0.01**	**20**
Jiangsu	0.78	0.02	0.04	0.12	0.01	0.01	0.07	0.14	0.03	0.01	17
Zhejiang	0	0	0	0	0	0	0	0	0	0	0
Anhui	0.14	0	0.01	0.02	0	0	0.01	0.03	0.01	0	3
Fujian	0	0	0	0	0	0	0	0	0	0	0
Jiangxi	0	0	0	0	0	0	0	0	0	0	0
Shandong	0	0	0	0	0	0	0	0	0	0	0
Shanghai	0	0	0	0	0	0	0	0	0	0	0
South China	**0.37**	**0.01**	**0.02**	**0.06**	**0**	**0**	**0.03**	**0.05**	**0.02**	**0**	**10**
Guangdong	0	0	0	0	0	0	0	0	0	0	0
Guangxi	0	0	0	0	0	0	0	0	0	0	0

Hainan	0.37	0.01	0.02	0.06	0	0	0.03	0.05	0.02	0	10
Southwest China	**207.2**	**5.26**	**9.82**	**32.65**	**1.76**	**1.76**	**18.92**	**34.36**	**9.11**	**1.41**	**5063**
Sichuan	17.7	0.45	0.84	2.79	0.15	0.15	1.62	2.95	0.78	0.12	399
Yunnan	5.48	0.14	0.26	0.86	0.05	0.05	0.5	0.91	0.24	0.04	124
Guizhou	0	0	0	0	0	0	0	0	0	0	0
Chongqing	0	0	0	0	0	0	0	0	0	0	0
Xizang	184	4.67	8.72	29	1.56	1.56	16.8	30.5	8.09	1.25	4540
Northwest China	**81.78**	**2.07**	**3.89**	**12.89**	**0.69**	**0.69**	**7.48**	**13.56**	**3.59**	**0.56**	**430**
Ningxia	0.76	0.02	0.04	0.12	0.01	0.01	0.07	0.12	0.03	0.01	2
Qinghai	36	0.91	1.71	5.67	0.3	0.3	3.29	5.97	1.58	0.24	40
Shaanxi	2.49	0.06	0.12	0.39	0.02	0.02	0.23	0.41	0.11	0.02	16
Xinjiang	35	0.89	1.66	5.52	0.3	0.3	3.2	5.81	1.54	0.24	321
Gansu	7.53	0.19	0.36	1.19	0.06	0.06	0.69	1.25	0.33	0.05	51
Total	**411**	**10**	**19**	**65**	**3**	**3**	**38**	**68**	**18**	**3**	**7327**

Table S7. Regional/Provincial emissions distribution for each pollutant from burning of cropland in 2013(unit: $Gg \cdot yr^{-1}$)

Region/Province	CO	CH_4	NO_X	VOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	OC	BC	CO_2
Northeast China	**1541**	**142.5**	**114.1**	**320.2**	**12.3**	**21.3**	**293.7**	**440**	**177.9**	**40.3**	**40407**
Jilin	503	44.1	38.9	99.6	4.1	6.7	97.3	147	61.5	13.9	13200
Liaoning	306	27.4	23	61.6	2.4	4.1	58.4	88	35.9	8.1	8024
Heilongjiang	732	71	52.2	159	5.8	10.5	138	205	80.5	18.3	19183
North China	**603.1**	**46.3**	**41.6**	**100.9**	**5.8**	**7.9**	**102**	**151.2**	**57.5**	**12.5**	**15818**
Hebei	314	22.9	20.2	48.9	3.1	4	50.3	73.3	25.6	5.5	8231
Shanxi	138	10.9	10.1	24.1	1.3	1.8	24.5	36.7	14.9	3.3	3614
Beijing	5.3	0.4	0.4	0.9	0.1	0.1	0.9	1.4	0.6	0.1	138
Tianjin	11.8	0.9	0.8	1.9	0.1	0.2	2	2.9	1	0.2	310
Nei Mongol	134	11.2	10.1	25.1	1.2	1.8	24.3	36.9	15.4	3.4	3525
Central China	**1122**	**96.1**	**63.6**	**204.8**	**10.4**	**15.8**	**175.2**	**249**	**75.6**	**16.3**	**29417**
Hubei	242	22.9	12.4	49.4	1.7	3.4	39.4	55.3	15	3.3	6335
Hunan	191	22.5	9.7	49.4	1.1	3.1	34.8	48.7	13.2	3.1	5012
Henan	689	50.7	41.5	106	7.6	9.3	101	145	47.4	9.9	18070

East China	**1361**	**119.3**	**77.1**	**254.4**	**12.6**	**19.4**	**216.2**	**306.7**	**92**	**19.8**	**35702**
Jiangsu	358	33	19.2	69.3	3.5	5.4	56	78.1	21.4	4.6	9401
Zhejiang	67	7.8	3.4	17.3	0.4	1.1	11.6	16.2	4.4	1	1757
Anhui	163	13.8	9	28.9	1.6	2.3	24.5	34.5	10	2.1	4271
Fujian	55.2	6.4	2.7	14.4	0.3	0.9	9.4	13.2	3.6	0.8	1448
Jiangxi	124	15.4	6.1	33.8	0.7	2.1	23.1	32	8.1	1.9	3259
Shandong	587	42.1	36.3	89	6	7.5	90.4	131	44	9.3	15380
Shanghai	7.1	0.8	0.4	1.7	0.1	0.1	1.2	1.7	0.5	0.1	186
South China	**389.5**	**27.3**	**20.6**	**103.7**	**2.5**	**5.9**	**57.5**	**82.7**	**25.6**	**5.7**	**10211**
Guangdong	148	13.6	7.6	39.1	0.9	2.3	23.8	33.7	9.8	2.2	3875
Guangxi	224	12.4	12.1	59.9	1.5	3.3	31.1	45.3	14.7	3.2	5878
Hainan	17.5	1.3	0.9	4.7	0.1	0.3	2.6	3.7	1.1	0.3	458
Southwest China	**610.3**	**55.8**	**36.1**	**131.6**	**4.6**	**8.6**	**98.6**	**143.1**	**49**	**11**	**16006**
Sichuan	258	25.1	15.1	54.7	2.1	3.8	42.4	61	20	4.5	6778
Yunnan	192	15.3	11.6	42.4	1.4	2.6	30	44.2	16	3.6	5026
Guizhou	82.9	7.6	4.9	17.5	0.6	1.1	13.3	19.3	6.7	1.5	2175
Chongqing	75.4	7.6	4.4	16.7	0.5	1.1	12.7	18.3	6.2	1.4	1976
Xizang	2	0.2	0.1	0.3	0	0	0.2	0.3	0.1	0	51
Northwest China	**470**	**32.5**	**26.7**	**70.7**	**3.4**	**5.1**	**76.6**	**109.7**	**32.9**	**6.9**	**12327**
Ningxia	16.4	1.4	1.2	3.1	0.2	0.2	2.9	4.4	1.7	0.4	430
Qinghai	5.3	0.4	0.3	0.9	0	0.1	0.7	0.9	0.3	0.1	138
Shaanxi	132	10.3	8.6	22.2	1.3	1.7	21.2	31	11.3	2.4	3455
Xinjiang	260	16	12.9	35	1.4	2.4	42.7	59.9	14.5	2.9	6829
Gansu	56.3	4.4	3.7	9.5	0.5	0.7	9.1	13.5	5.1	1.1	1475
Total	**6098**	**520**	**380**	**1185**	**52**	**84**	**1019**	**1482**	**510**	**112**	**159886**

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