Table S1. Carbon isotope analysis of BC sources in the atmosphere

Pt	Region	Site	Lat	Lon	Alt (m)	Year	Mon	Season	f_{bb} (%)	References
1	Arctic	Zeppelin	78.9	11.9	478	2009	Jan_ Mar	winter	52±15	Winiger et al., 2015
2	Arctic	Abisko	68.4	19.1	359	2011-13	Jan_ Mar	winter	35±10	Winiger et al., 2016
3	Arctic	Abisko	68.4	19.1	359	2011-13	Apr_ Aug	summer	58±15	Winiger et al., 2016
4	Arctic	Barrow	71.2	-156.6	0	2012-13	Dec_ Feb	winter	32±9	Barrett et al., 2015
5	Arctic	Barrow	71.2	-156.6	0	2012-13	Feb_ Mar	winter	51±6	Barrett et al., 2015
6	South Asia	MCOH	6.8	73.3	0	2006	Jan_ Mar	winter	68±6	Gustafsson et al., 2009
7	South Asia	SINH	18.3	73.7	0	2006	Mar_ Apr	spring	46±8	Gustafsson et al., 2009
8	South Asia	MCOH	6.8	73.3	0	2008-09	Dec_ Mar	winter	53±5	Budhavant et al., 2015
9	South Asia	MCOH	6.8	73.3	0	2008-09	Mar_ Nov	summer	53±11	Budhavant et al., 2015
10	South Asia	SINH	18.3	73.7	0	2008-09	Dec_ Mar	winter	56±3	Budhavant et al., 2015
11	South Asia	SINH	18.3	73.7	0	2008-09	Mar_ Nov	summer	48±8	Budhavant et al., 2015
12	North America	SLC	40.7	-111.8	1426	2012-2014	annual	summer	11±1.1	Mouteva et al., 2017
13	North America	Mexico City	19.5	-99.1	2240	2006	Mar	spring	16±4	Aiken et al., 2010
14	Europe	MAG	46.8	6.9	204	2008-10	Dec_ Feb	winter	30±11	Herich et al., 2011
15	Europe	MAG	46.8	6.9	204	2008-10	Jun_ Aug	summer	2±7	Herich et al., 2011
16	Europe	Göteborg	57.7	11.9	20	2005	Feb	winter	12±4	Szidat et al., 2009
17	Europe	Göteborg	57.7	11.9	20	2006	Jun	summer	12±3	Szidat et al., 2009
18	Europe	Råö	57.3	11.9	10	2005	Feb	winter	38±5	Szidat et al., 2009
19	Europe	Zurich	47.3	8.5	410	2002	Aug	summer	8±1	Szidat et al., 2004
20	Europe	Zurich	47.3	8.5	410	2003	Feb	winter	29±5	Szidat et al., 2006
21	Europe	Zurich	47.3	8.5	410	2003	Mar	spring	15±5	Szidat et al., 2006
22	Europe	Zurich	47.3	8.5	410	2006	Jan	winter	29±4	Sandradewi et al., 2008a
23	Europe	Dübendorf	47.4	8.6	440	2007	Oct	fall	36±3	Zhang et al., 2012
24	Europe	Roveredo	46.2	9.1	298	2005	Jan	winter	60±6	Szidat et al., 2007
25	Europe	Roveredo	46.2	9.1	298	2005	Mar	spring	58±6	Szidat et al., 2007
26	Europe	Roveredo	46.2	9.1	298	2005	Dec	winter	74±10	Sandradewi et al., 2008b
27	Europe	Moleno	46.3	8.9	254	2005	Feb	winter	17±7	Szidat et al., 2007
28	Europe	Reiden	47.2	7.9	457	2006	Feb	winter	30±4	Sandradewi et al., 2008a
29	Europe	Massongex	46.2	6.1	400	2006	Nov	fall	36±4	Perron et al., 2010
30	Europe	Massongex	46.2	6.1	400	2006	Dec	winter	36±4	Perron et al., 2010
31	Europe	Saxon	46.1	7.1	460	2006	Dec	winter	32±4	Perron et al., 2010
32	Europe	Sion	46.2	7.3	505	2006	Dec	winter	20±3	Perron et al., 2010
33	Europe	Brigerbad	46.3	7.9	650	2006	Dec	winter	31±4	Perron et al., 2010
34	Europe	Payerne	46.8	6.9	456	2006	Jan	winter	60±4	Zhang et al., 2012
35	Europe	Payerne	46.8	6.9	456	2006	Jun	summer	44±3	Zhang et al., 2012
36	Europe	Barcelona	41.3	2.1	80	2009	Mar	spring	15±3	Minguillón et al., 2011
37	Europe	Barcelona	41.3	2.1	80	2009	Jul	summer	9±4	Minguillón et al.,

										2011
38	Europe	Montseny	41.8	2.3	720	2009	Mar	spring	37±4	Minguillón et al., 2011
39	Europe	Montseny	41.8	2.3	720	2009	Jul	summer	23±5	Minguillón et al., 2011
40	East Asia	Tokyo	35.6	139.6	40	2004	Oct	fall	36.4	Yamamoto et al., 2007
41	East Asia	Tokyo	35.6	139.6	40	2004	Dec	winter	33.8	Yamamoto et al., 2007
42	East Asia	Tokyo	35.6	139.6	40	2004	Feb	winter	32.6	Yamamoto et al., 2007
43	East Asia	Tokyo	35.6	139.6	40	2004	Apr	spring	41.3	Yamamoto et al., 2007
44	East Asia	Tokyo	35.6	139.6	40	2004	Jun	summer	37.7	Yamamoto et al., 2007
45	East Asia	Tokyo	35.6	139.6	40	2004	Aug	summer	35.8	Yamamoto et al., 2007
46	East Asia	Xi'an	34.2	108.9	0	2013	Jan	winter	25±3	Zhang et al., 2015
47	East Asia	Beijing	39.9	116.4	0	2013	Jan	winter	30±2	Zhang et al., 2015
48	East Asia	Shanghai	31.3	121.5	0	2013	Jan	winter	21±2	Zhang et al., 2015
49	East Asia	Guangzhou	23.1	113.4	0	2013	Jan	winter	48±5	Zhang et al., 2015
50	East Asia	Beijing	39.9	116.4	0	2013	Jan	winter	26±2	Andersson et al., 2015
51	East Asia	Shanghai	31.3	121.5	0	2013	Jan	winter	32±2	Andersson et al., 2015
52	East Asia	Guangzhou	23.1	113.4	0	2013	Jan	winter	32±2	Andersson et al., 2015
53	East Asia	Beijing	39.9	116.4	0	2010	Feb	winter	17±4	Chen et al., 2013
54	East Asia	Shanghai	31.3	121.5	0	2010	Jan	winter	17±4	Chen et al., 2013
55	East Asia	Xiamen	24.5	118	0	2009	Dec	winter	13±3	Chen et al., 2013
56	East Asia	KCOG	33.3	126.2	0	2011	Mar	winter	25±6	Chen et al., 2013
57	East Asia	SCCO	24.6	118.1	0	2009	Jan	winter	22±3	Chen et al., 2013
58	Tibet	Jilong	28.2	86	4166	2013	Apr	spring	45	Li et al., 2016
59	Tibet	Jilong	28.2	86	4166	2013	Jun	winter	41	Li et al., 2016
60	Tibet	Nielamu	28.2	86	4166	2013	Nov	fall	40	Li et al., 2016
61	Tibet	Dhunche	28.1	85.3	2051	2014	Jan	winter	49	Li et al., 2016
62	Tibet	Dhunche	28.1	85.3	2051	2013	Aug	summer	16	Li et al., 2016
63	Tibet	Dhunche	28.1	85.3	2051	2013	Sep	fall	41	Li et al., 2016
64	Tibet	Bode	27.7	85.4	1386	2014	Jan	winter	42	Li et al., 2016
65	Tibet	Bode	27.7	85.4	1386	2013	Apr	spring	33	Li et al., 2016
66	Tibet	Bode	27.7	85.4	1386	2013	Aug	summer	16	Li et al., 2016
67	Tibet	Bode	27.7	85.4	1386	2013	Nov	fall	28	Li et al., 2016
68	Tibet	Zhongba	29.7	84	4704	2013	Apr	spring	70	Li et al., 2016
69	Tibet	Jomsom	28.8	83.7	3048	2013	Apr	spring	57	Li et al., 2016
70	Tibet	Pokhara	28.2	84	813	2013	Jul	summer	26	Li et al., 2016
71	Tibet	Pokhara	28.2	84	813	2013	Apr	spring	65	Li et al., 2016
72	Tibet	Lumbini	27.5	83.3	100	2013	Apr	spring	58	Li et al., 2016
73	Tibet	Lumbini	27.5	83.3	100	2013	Jul	summer	42	Li et al., 2016
74	Tibet	Lumbini	27.5	83.3	100	2013	Oct	fall	53	Li et al., 2016
75	Tibet	Lumbini	27.5	83.3	100	2013	Dec	winter	49	Li et al., 2016
76	Tibet	Namco	30.8	91	4730	2013	Apr	spring	54	Li et al., 2016

77	Tibet	Namco	30.8	91	4730	2014	Jun	summer	63	Li et al., 2016
78	Tibet	Namco	30.8	91	4730	2014	Jul	summer	49	Li et al., 2016
79	Tibet	Namco	30.8	91	4730	2013	Nov	fall	58	Li et al., 2016
80	Tibet	Lulang	29.8	94.7	3326	2014	Jun	summer	20	Li et al., 2016
81	Tibet	Lulang	29.8	94.7	3326	2014	Jul	summer	23	Li et al., 2016
82	Tibet	Lhasa	29.6	91	3640	2014	Jan	winter	18	Li et al., 2016
83	Tibet	Lhasa	29.6	91	3640	2013	Apr	spring	24	Li et al., 2016
84	Tibet	Lhasa	29.6	91	3640	2013	Jun	summer	7	Li et al., 2016

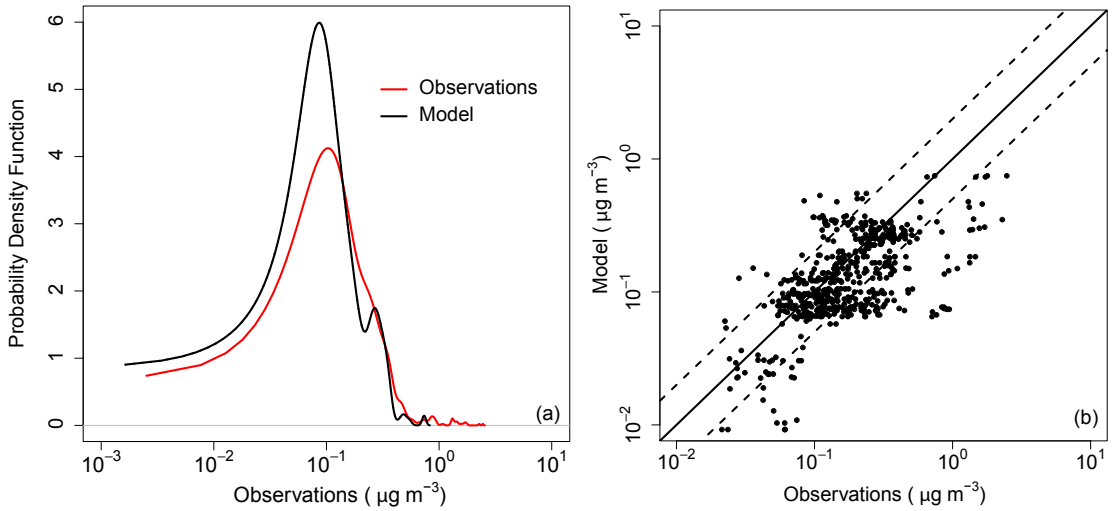

Figure S1. (a) Probability density function of observed (red line) and GEOS-Chem simulated (black) BC concentrations in surface air (µg m^{-3}) and (b) Observed and GEOS-Chem simulated annual BC concentrations in surface air. Data are for 2007–2009. Solid line is 1:1 ratio line and dashed lines are 1:2 (or 2:1).

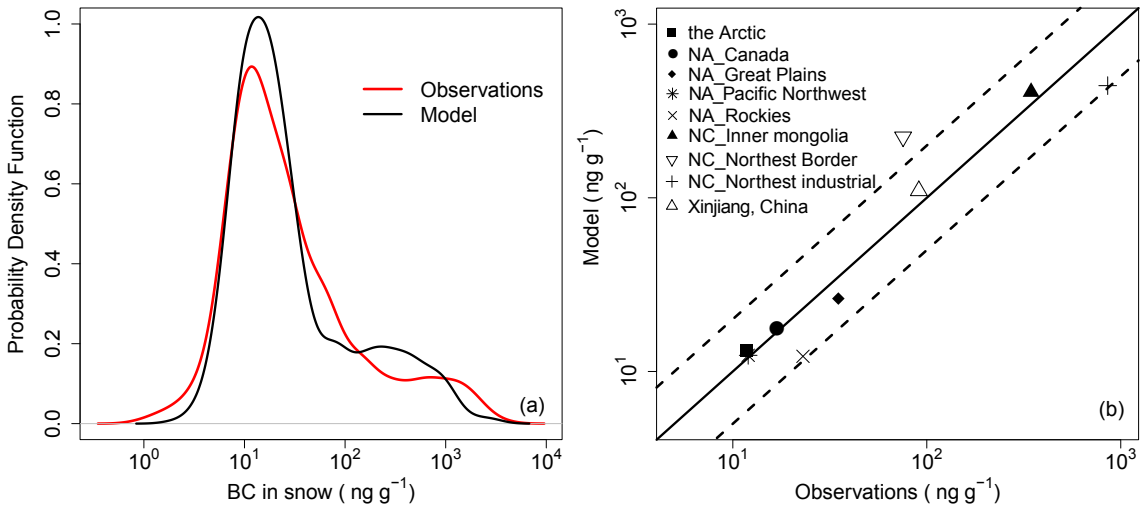

Figure S2. (a) Probability density function of observed (red line) and GEOS-Chem simulated (black) BC concentration in snow (ng g^{-1}) and (b) medians of observed and simulated BC in snow (ng g^{-1}) in the Arctic, North America (Canada, the Great Plains, the Pacific Northwest, and the Rockies, as defined in Doherty et al., 2014)), Northern China (Inner Mongolia, Northeast Border and Northeast Industrial, as defined by Wang et al., 2013), and Xinjiang, China. The regions are symbol-coded. Solid line – 1:1 ratio line; dashed lines – 1:2 (or 2:1) ratio lines.

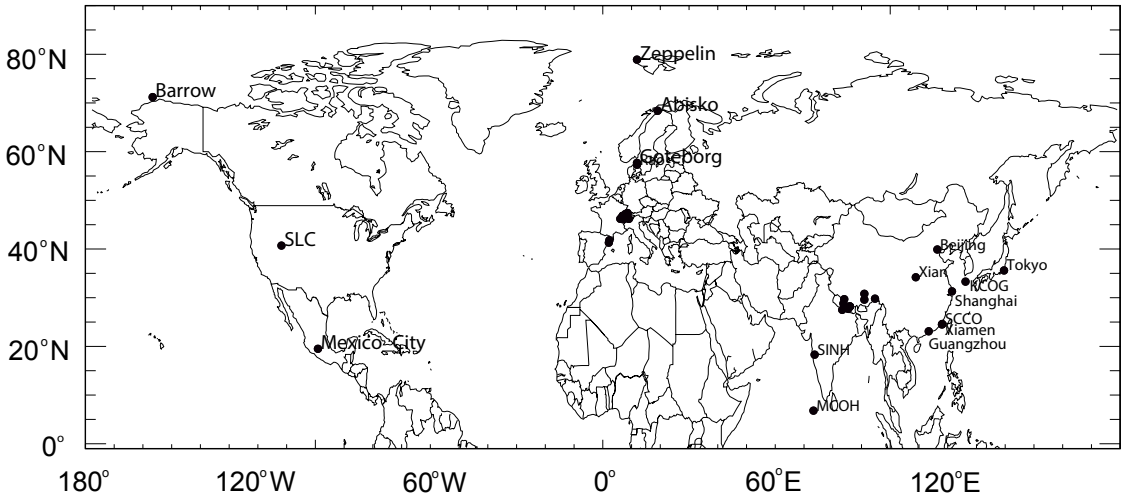

Figure S3. Carbon isotope measurement stations of BC as listed in Table S1.

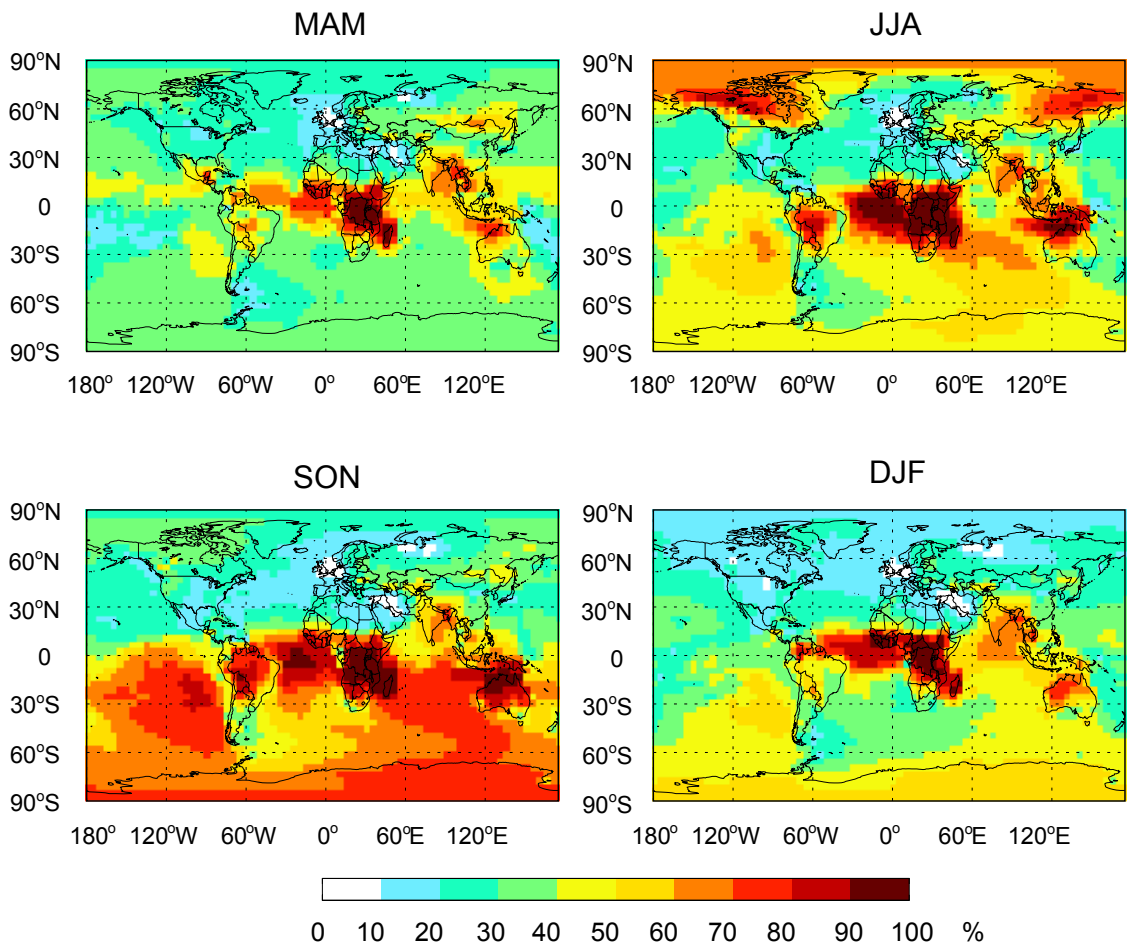

Figure S4. Average f_{bb} of BC in surface atmosphere during March–May (MAM), June–August (JJA), September–November (SON) and December–February (DJF) for 2007–2013.

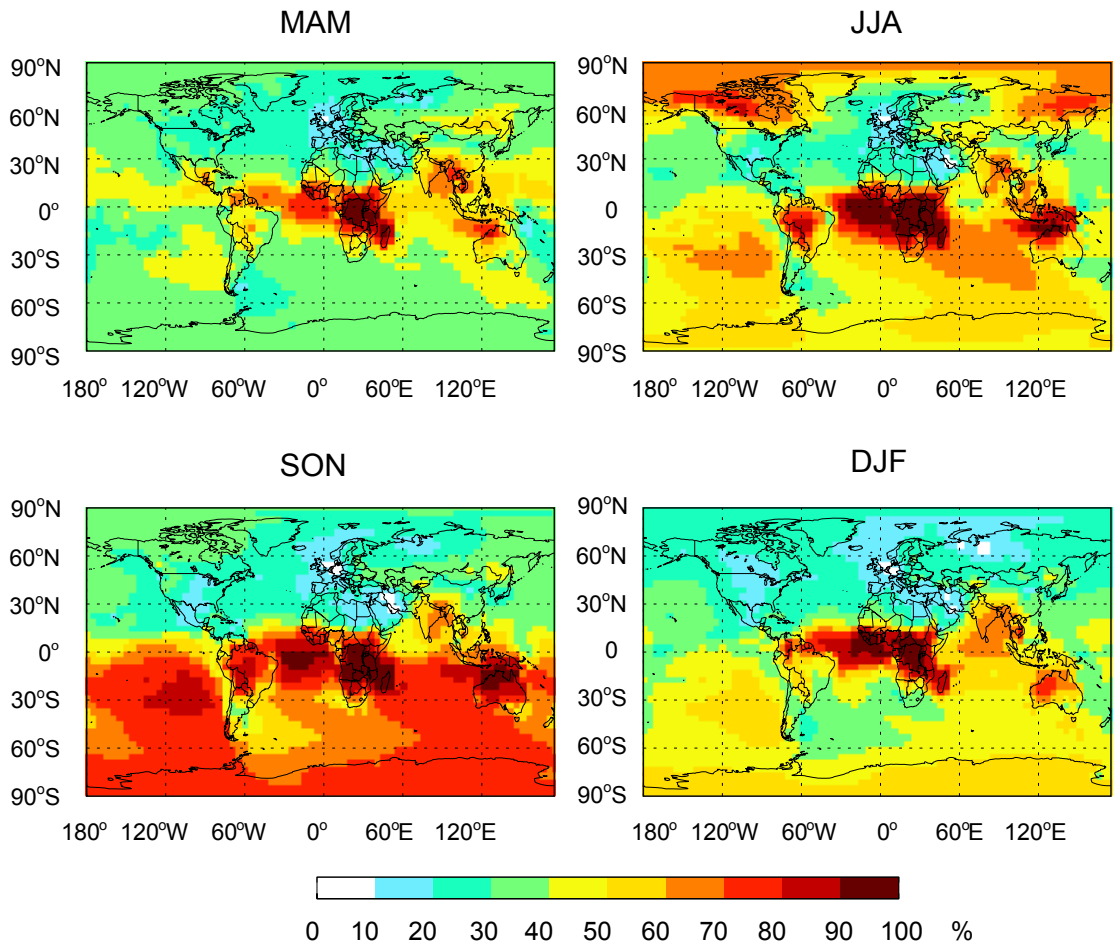

Figure S5. Same as Figure S4, but for BC deposition.

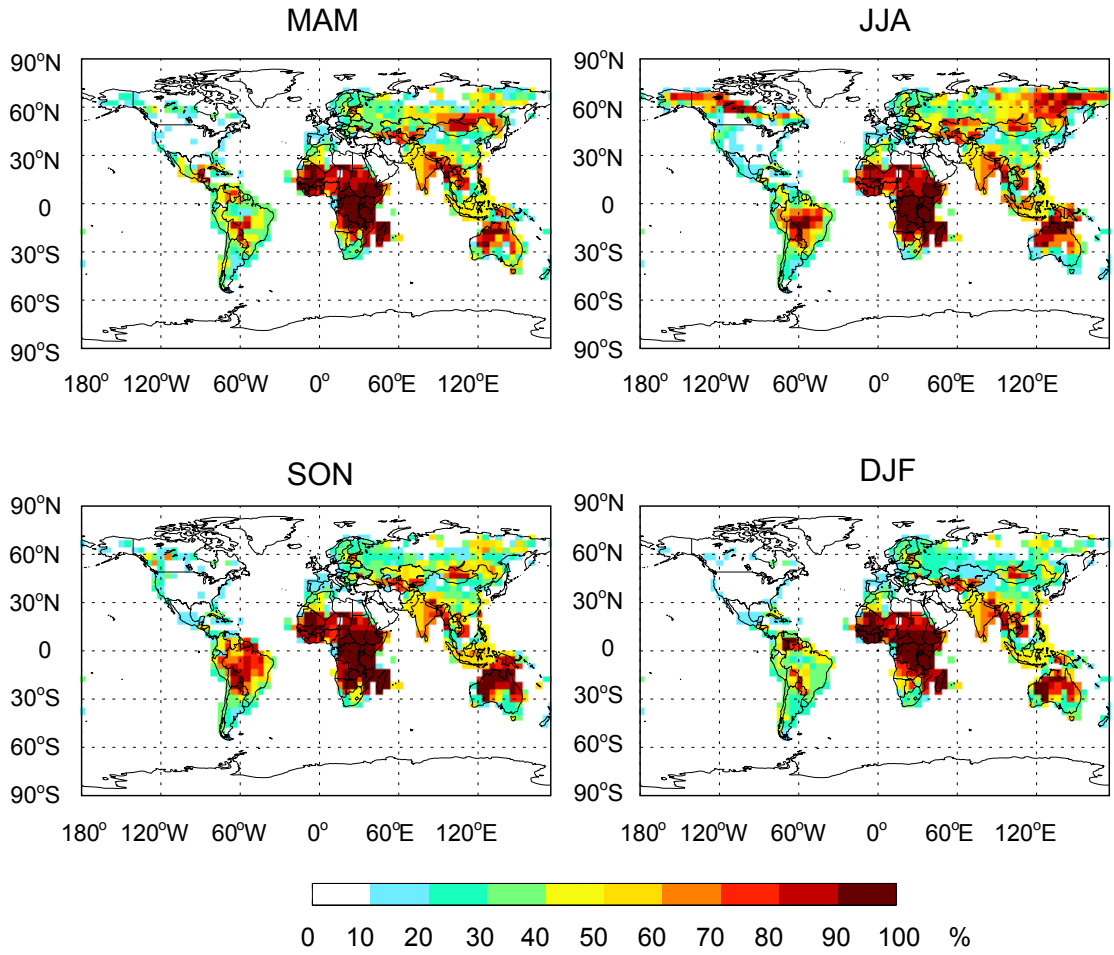

Figure S6. Same as Figure S4, but for BC emissions.

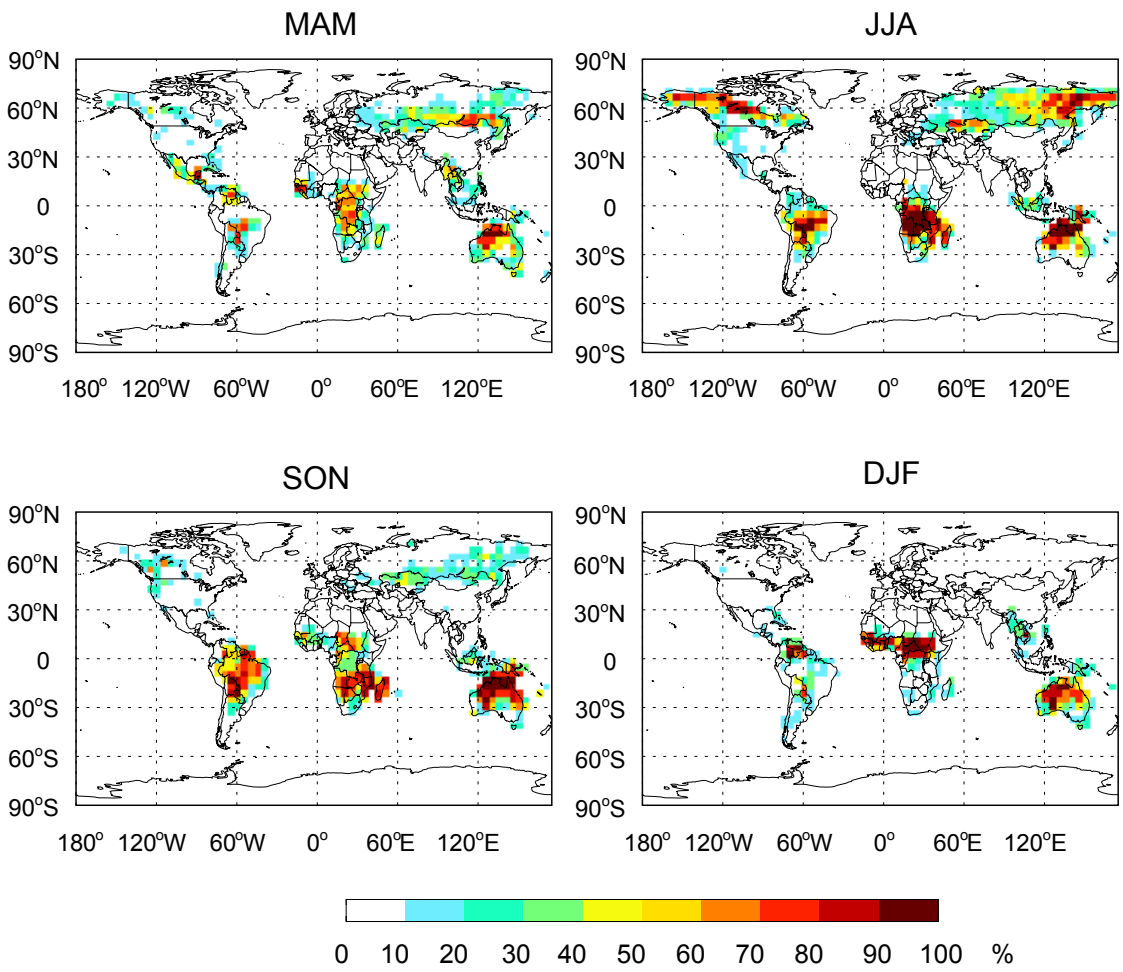

Figure S7. Average contribution of open burning to BC emissions (%) during March–May (MAM), June–August (JJA), September–November (SON) and December–February (DJF) for 2007–2013.

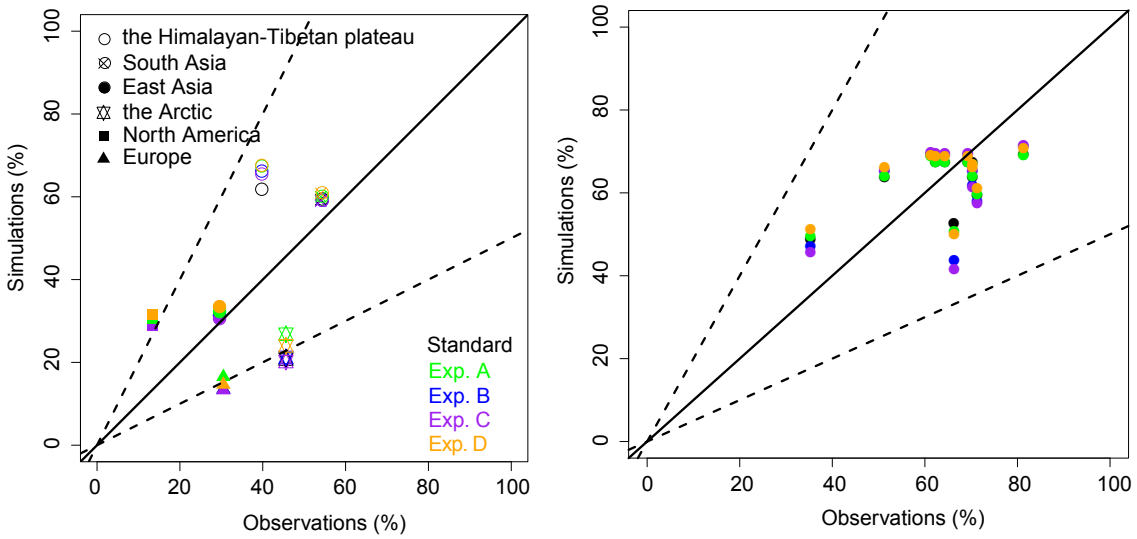

Figure S8. Observed and GEOS-Chem simulated mean f_{bb} (%) (a) of BC in the atmosphere in the six regions in Northern Hemisphere and (b) of BC deposited in snow over the Tibetan plateau. The regions are symbol-coded and the simulations are color-coded (see text for details). Solid lines are 1:1 and dashed lines are 1:2 (or 2:1).