

Supplementary Material

Sulfur Dioxide and Primary Carbonaceous Aerosol Emissions in China and India, 1996–2010

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International shipping and aviation are not included.

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International shipping and aviation are not included.

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International shipping and aviation are not included.

Table S1. Emissions of SO₂, BC, and OC in China by sector and fuel type (Gg/year)^a

	1996	2000	2004	2008	2010
SO₂					
Power plants	9104 (-17%–19%)	9959 (-17%–19%)	15655 (-18%–18%)	12486 (-21%–24%)	6587 (-21%–23%)
Industry	11436 (-22%–26%)	8559 (-22%–24%)	11890 (-21%–23%)	16370 (-21%–23%)	20388 (-20%–23%)
Residential	3212 (-33%–37%)	1947 (-30%–35%)	2048 (-30%–33%)	2365 (-31%–36%)	2931 (-31%–37%)
Transport	499 (-18%–20%)	614 (-17%–18%)	865 (-18%–20%)	819 (-19%–21%)	857 (-20%–22%)
Coal	22737 (-18%–19%)	19448 (-17%–18%)	27697 (-17%–18%)	28881 (-18%–20%)	27372 (-19%–21%)
Oil	709 (-12%–13%)	845 (-12%–13%)	1363 (-13%–14%)	1274 (-14%–15%)	1352 (-15%–15%)
Biofuel	89 (-75%–118%)	87 (-74%–118%)	126 (-77%–127%)	129 (-75%–115%)	127 (-75%–123%)
Other	716 (-28%–41%)	699 (-33%–55%)	1273 (-37%–64%)	1756 (-37%–66%)	1912 (-38%–65%)
Forest & savanna burning	14 (-55%–71%)	23 (-54%–71%)	10 (-56%–72%)	14 (-52%–62%)	14 (-52%–63%)
Agricultural waste burning	54 (-86%–120%)	51 (-87%–115%)	52 (-85%–116%)	58 (-84%–113%)	58 (-86%–118%)
Total	24318 (-17%–18%)	21153 (-15%–17%)	30520 (-16%–16%)	32112 (-16%–18%)	30834 (-17%–19%)
BC					
Power plants	12 (-79%–177%)	11 (-80%–188%)	14 (-83%–230%)	19 (-93%–316%)	21 (-93%–324%)
Industry	527 (-61%–128%)	370 (-61%–140%)	437 (-58%–139%)	510 (-56%–120%)	501 (-58%–128%)
Residential	790 (-68%–196%)	639 (-65%–160%)	826 (-63%–169%)	888 (-63%–154%)	936 (-62%–155%)
Transport	92 (-38%–54%)	139 (-36%–53%)	194 (-37%–51%)	259 (-38%–57%)	283 (-41%–59%)
Coal	849 (-66%–171%)	518 (-66%–160%)	576 (-64%–165%)	636 (-62%–143%)	662 (-65%–152%)
Oil	141 (-34%–50%)	205 (-34%–47%)	290 (-33%–48%)	396 (-35%–50%)	434 (-36%–51%)
Biofuel	418 (-73%–201%)	417 (-72%–181%)	583 (-72%–197%)	620 (-73%–188%)	619 (-72%–201%)
Other	14 (-94%–373%)	18 (-93%–364%)	21 (-92%–372%)	24 (-93%–356%)	25 (-93%–352%)
Forest & savanna burning	12 (-51%–79%)	19 (-46%–65%)	10 (-52%–99%)	13 (-48%–84%)	12 (-46%–69%)
Agricultural waste burning	90 (-49%–64%)	86 (-48%–62%)	88 (-48%–65%)	97 (-48%–64%)	97 (-48%–64%)
Total	1524 (-49%–113%)	1263 (-43%–89%)	1569 (-43%–97%)	1787 (-41%–84%)	1850 (-42%–85%)
OC					
Power plants	12 (-85%–170%)	10 (-81%–161%)	11 (-84%–170%)	10 (-87%–182%)	11 (-86%–180%)
Industry	520 (-64%–127%)	359 (-66%–136%)	405 (-63%–143%)	446 (-60%–130%)	384 (-62%–137%)
Residential	2150 (-58%–111%)	1893 (-58%–121%)	2519 (-58%–122%)	2670 (-58%–118%)	2790 (-58%–119%)
Transport	85 (-57%–155%)	152 (-61%–164%)	197 (-59%–167%)	241 (-60%–159%)	260 (-59%–154%)
Coal	1120 (-58%–112%)	685 (-58%–110%)	740 (-56%–105%)	821 (-56%–109%)	850 (-58%–114%)
Oil	102 (-51%–131%)	175 (-55%–142%)	229 (-54%–143%)	284 (-54%–138%)	308 (-53%–130%)
Biofuel	1528 (-66%–137%)	1533 (-65%–144%)	2138 (-65%–140%)	2234 (-65%–138%)	2257 (-66%–143%)
Other	17 (-95%–357%)	21 (-94%–391%)	25 (-94%–372%)	28 (-94%–339%)	30 (-94%–374%)
Forest & savanna burning	127 (-45%–53%)	212 (-39%–43%)	88 (-40%–61%)	126 (-35%–49%)	126 (-38%–44%)
Agricultural waste burning	427 (-60%–98%)	409 (-61%–104%)	419 (-61%–106%)	467 (-60%–104%)	463 (-60%–105%)
Total	3322 (-42%–75%)	3035 (-41%–76%)	3638 (-44%–85%)	3959 (-43%–82%)	4033 (-44%–84%)

^aThe percentages in the parentheses represent the 95% CI around the mean.

Table S2. Emissions of SO₂, BC, and OC in India by sector and fuel type (Gg/year)^a

	1996	2000	2004	2008	2010
SO₂					
Power plants	2550 (-18%-18%)	3251 (-17%-18%)	3791 (-18%-19%)	4708 (-18%-19%)	5236 (-18%-19%)
Industry	1945 (-22%-24%)	1973 (-21%-23%)	2102 (-22%-24%)	2544 (-26%-28%)	2784 (-26%-28%)
Residential	374 (-32%-38%)	321 (-29%-34%)	350 (-30%-35%)	543 (-37%-45%)	583 (-38%-47%)
Transport	263 (-25%-28%)	225 (-24%-27%)	207 (-24%-26%)	192 (-19%-20%)	144 (-17%-17%)
Coal	3375 (-21%-23%)	3779 (-21%-22%)	4559 (-21%-22%)	6019 (-21%-23%)	6730 (-21%-22%)
Oil	1533 (-15%-16%)	1732 (-15%-16%)	1593 (-14%-15%)	1638 (-14%-14%)	1661 (-14%-15%)
Biofuel	87 (-43%-59%)	84 (-42%-59%)	87 (-44%-59%)	99 (-43%-59%)	99 (-42%-57%)
Other	138 (-26%-28%)	175 (-27%-32%)	210 (-29%-31%)	232 (-30%-33%)	257 (-31%-33%)
Forest & savanna burning	17 (-56%-68%)	15 (-54%-68%)	17 (-55%-69%)	14 (-52%-63%)	17 (-54%-67%)
Agricultural waste burning	36 (-87%-113%)	33 (-84%-113%)	36 (-85%-112%)	42 (-86%-116%)	44 (-87%-113%)
Total	5185 (-15%-15%)	5819 (-14%-15%)	6502 (-15%-16%)	8044 (-16%-18%)	8807 (-16%-17%)
BC					
Power plants	3 (-80%-158%)	4 (-79%-157%)	4 (-81%-172%)	5 (-83%-178%)	5 (-83%-187%)
Industry	155 (-54%-116%)	168 (-57%-126%)	198 (-60%-134%)	217 (-58%-126%)	227 (-57%-127%)
Residential	402 (-59%-143%)	421 (-62%-157%)	481 (-62%-152%)	563 (-60%-144%)	579 (-60%-133%)
Transport	80 (-41%-56%)	88 (-40%-52%)	88 (-40%-54%)	107 (-39%-51%)	111 (-40%-53%)
Coal	177 (-62%-120%)	172 (-64%-134%)	209 (-65%-133%)	276 (-64%-128%)	295 (-65%-127%)
Oil	117 (-34%-46%)	126 (-34%-43%)	124 (-34%-44%)	153 (-34%-44%)	159 (-34%-45%)
Biofuel	338 (-65%-169%)	373 (-66%-173%)	426 (-66%-170%)	449 (-66%-176%)	454 (-66%-164%)
Other	8 (-94%-358%)	10 (-93%-353%)	12 (-92%-343%)	14 (-92%-342%)	15 (-92%-357%)
Forest & savanna burning	19 (-52%-90%)	17 (-51%-95%)	19 (-51%-88%)	16 (-48%-77%)	19 (-49%-82%)
Agricultural waste burning	60 (-49%-63%)	56 (-47%-65%)	59 (-49%-62%)	71 (-48%-63%)	74 (-47%-64%)
Total	718 (-40%-82%)	753 (-41%-90%)	850 (-42%-91%)	979 (-41%-86%)	1015 (-41%-80%)
OC					
Power plants	6 (-89%-233%)	8 (-86%-209%)	10 (-88%-222%)	12 (-90%-238%)	14 (-90%-234%)
Industry	155 (-58%-112%)	166 (-60%-118%)	195 (-61%-122%)	208 (-61%-114%)	214 (-60%-118%)
Residential	1379 (-58%-128%)	1476 (-60%-131%)	1725 (-60%-132%)	1899 (-58%-131%)	1946 (-58%-129%)
Transport	52 (-42%-69%)	61 (-44%-72%)	56 (-42%-62%)	58 (-38%-53%)	54 (-36%-49%)
Coal	203 (-60%-121%)	186 (-60%-119%)	226 (-61%-123%)	322 (-64%-128%)	346 (-63%-126%)
Oil	67 (-36%-55%)	76 (-38%-58%)	70 (-37%-52%)	75 (-33%-45%)	72 (-31%-41%)
Biofuel	1313 (-60%-135%)	1438 (-61%-136%)	1676 (-61%-136%)	1763 (-61%-141%)	1792 (-60%-140%)
Other	9 (-95%-353%)	11 (-94%-349%)	14 (-93%-362%)	17 (-93%-360%)	17 (-94%-368%)
Forest & savanna burning	157 (-44%-64%)	142 (-41%-57%)	158 (-42%-59%)	133 (-40%-60%)	157 (-41%-57%)
Agricultural waste burning	287 (-60%-103%)	269 (-60%-104%)	285 (-60%-101%)	340 (-60%-105%)	354 (-61%-107%)
Total	2035 (-42%-86%)	2122 (-44%-91%)	2429 (-45%-94%)	2651 (-44%-95%)	2739 (-44%-92%)

^aThe percentages in the parentheses represent the 95% CI around the mean.

Table S3. Net emission factors of SO₂, BC, and OC for China by sector and fuel type ^a

Sector	Fuel type	1996	2000	2004	2008	2010	
SO ₂	Power plants	Coal	920.9 (782.3–1058.5)	849.3 (719.9–976.2)	795.6 (674.5–913.5)	433.2 (349.5–526.2)	204.1 (166.2–246.1)
		Oil	211.7 (185.4–239.3)	210.4 (182.4–237.5)	213.2 (185.5–241.4)	198.4 (175.7–222.2)	198.5 (174.7–222.1)
	Industry	Coal	608.7 (496.4–730.6)	549.2 (449.9–660.1)	477.1 (387.1–575.2)	427.8 (349.8–516.1)	438.2 (357.2–527.2)
		Oil	212.1 (186.8–238.8)	198.6 (175.2–222.7)	206.6 (182.2–231.4)	195.5 (173.3–218.1)	195.6 (173.1–219.3)
	Residential	Coal	746.5 (603.8–905.0)	687.2 (559.7–791.0)	660.0 (539.7–791.0)	662.1 (535.2–798.2)	662.4 (535.9–800.9)
		Oil	147.8 (128.4–167.2)	146.8 (127.1–166.2)	146.7 (126.8–166.5)	143.8 (124.1–164.6)	143.9 (123.7–164.5)
	Transport	Biofuel	12.3 (3.4–23.7)	12.1 (3.4–23.8)	12.5 (3.0–25.5)	12.2 (3.4–24.0)	12.0 (3.4–23.3)
		On-road diesel	131.2 (105.1–157.9)	91.1 (72.7–109.6)	74.8 (53.6–95.5)	28.1 (19.2–37.6)	5.1 (3.4–7.0)
	Open burning	On-road gasoline	23.2 (18.6–27.9)	23.2 (18.5–27.9)	23.2 (18.6–27.9)	10.6 (8.5–12.7)	2.3 (1.8–2.7)
		Off-road oil	216.2 (176.9–261.0)	206.6 (168.2–249.7)	254.8 (203.2–313.2)	251.4 (198.0–310.9)	251.5 (198.5–310.0)
Forest & savanna		0.6 (0.3–1.0)	0.7 (0.3–1.0)	0.6 (0.3–0.9)	0.6 (0.3–0.9)	0.6 (0.3–1.0)	
Agricultural waste		0.4 (0.1–0.8)	0.4 (0.1–0.8)	0.4 (0.1–0.8)	0.4 (0.1–0.8)	0.4 (0.1–0.8)	
BC	Power plants	Coal	1.2 (0.2–3.4)	0.9 (0.2–2.7)	0.7 (0.1–2.3)	0.6 (0.0–2.7)	0.6 (0.0–2.7)
		Oil	0.8 (0.1–2.6)	0.8 (0.1–2.5)	0.8 (0.1–2.7)	0.6 (0.1–2.1)	0.6 (0.1–2.2)
	Industry	Coal	29.0 (10.5–67.6)	23.8 (7.8–59.0)	17.9 (6.4–45.5)	13.3 (4.9–31.3)	10.3 (3.4–25.8)
		Oil	25.5 (15.2–39.6)	31.9 (18.8–49.1)	28.8 (17.0–45.0)	35.5 (20.9–54.8)	35.3 (21.0–54.7)
	Residential	Coal	80.5 (7.3–405.6)	65.2 (6.9–337.9)	62.2 (6.5–333.7)	54.0 (6.1–261.3)	53.0 (6.1–261.3)
		Oil	58.3 (18.7–138.4)	58.5 (19.0–137.1)	63.8 (20.2–150.5)	70.8 (23.4–171.9)	70.6 (22.6–169.2)
	Transport	Biofuel	58.1 (18.0–160.0)	58.4 (18.5–155.1)	58.0 (19.0–157.4)	59.0 (18.3–162.8)	58.8 (18.7–164.0)
		On-road diesel	78.9 (48.0–116.8)	78.1 (48.0–115.0)	71.9 (41.3–110.7)	66.8 (34.0–111.1)	63.8 (30.0–113.1)
	Open burning	On-road gasoline	11.6 (2.8–33.0)	15.6 (3.1–51.0)	14.4 (2.6–47.4)	13.3 (2.4–43.0)	12.6 (2.2–39.6)
		Off-road oil	44.9 (25.0–71.8)	39.8 (22.2–64.1)	37.9 (21.3–61.0)	30.3 (18.3–46.2)	30.0 (18.2–45.6)
Forest & savanna		0.6 (0.3–0.9)	0.6 (0.3–0.9)	0.6 (0.3–1.1)	0.6 (0.3–1.0)	0.6 (0.3–0.9)	
Agricultural waste		0.7 (0.5–1.0)	0.7 (0.5–1.0)	0.7 (0.5–1.0)	0.7 (0.5–1.0)	0.7 (0.5–1.0)	
OC	Power plants	Coal	1.2 (0.1–3.3)	0.8 (0.1–2.2)	0.5 (0.1–1.5)	0.3 (0.0–0.9)	0.3 (0.0–0.9)
		Oil	0.4 (0.0–1.4)	0.4 (0.0–1.4)	0.4 (0.0–1.4)	0.3 (0.0–1.2)	0.3 (0.0–1.2)
	Industry	Coal	29.6 (10.4–67.6)	24.7 (7.8–59.8)	17.9 (6.1–43.8)	12.7 (4.7–29.7)	8.6 (2.9–21.4)
		Oil	7.9 (4.6–12.5)	9.9 (5.8–15.6)	9.0 (5.2–14.2)	11.0 (6.4–17.2)	10.9 (6.4–17.1)
	Residential	Coal	146.7 (36.9–425.2)	129.5 (34.7–375.4)	126.9 (35.4–345.6)	124.4 (35.4–346.7)	121.8 (35.1–334.7)
		Oil	19.1 (6.9–44.9)	19.2 (6.9–43.6)	20.3 (6.9–47.0)	22.0 (7.2–53.3)	21.9 (7.1–53.4)
	Transport	Biofuel	213.3 (84.7–478.4)	213.8 (86.1–483.4)	212.5 (88.0–455.5)	212.0 (86.9–464.2)	215.2 (83.7–486.0)
		On-road diesel	24.1 (14.4–36.9)	23.9 (14.4–36.1)	22.1 (12.5–34.4)	20.5 (10.3–35.0)	19.6 (9.1–35.2)
	Open burning	On-road gasoline	43.7 (8.3–142.5)	73.0 (10.8–242.1)	67.3 (9.6–230.1)	61.0 (8.5–206.7)	58.1 (8.7–200.1)
		Off-road oil	19.8 (12.1–30.3)	20.2 (12.3–31.3)	18.9 (11.6–28.7)	15.5 (9.7–23.3)	15.5 (9.7–23.3)
Forest & savanna		5.9 (4.2–7.6)	6.0 (4.5–7.7)	5.2 (3.5–7.7)	5.7 (4.2–7.8)	5.9 (4.4–7.6)	
Agricultural waste		3.3 (1.5–6.1)	3.3 (1.6–6.1)	3.3 (1.5–6.2)	3.3 (1.5–6.1)	3.3 (1.6–6.3)	

^aThe values in the parentheses represent the 95% CI around the mean.

Table S4. Net emission factors of SO₂, BC, and OC for India by sector and fuel type ^a

Sector	Fuel type	1996	2000	2004	2008	2010
SO ₂	Power plants	534.4 (433.8–634.9)	545.9 (444.7–647.7)	551.7 (450.3–655.7)	543.8 (442.5–643.8)	542.2 (443.5–642.5)
	Coal (g/GJ)	1226.9 (1051.0–1403.0)	1249.3 (1068.0–1430.0)	1176.7 (1004.0–1344.4)	1162.7 (997.5–1334.7)	1163.9 (997.9–1333.6)
	Industry	388.5 (309.2–476.2)	365.2 (284.2–451.9)	377.2 (294.7–469.9)	386.8 (299.2–480.0)	385.7 (299.5–478.9)
	Coal (g/GJ)	1064.6 (874.7–1270.1)	1116.1 (916.3–1337.6)	1109.2 (912.2–1322.1)	984.8 (812.3–1172.0)	985.3 (816.9–1172.4)
	Residential	432.7 (307.5–574.7)	440.1 (313.9–584.3)	448.4 (318.4–597.4)	451.6 (316.8–598.8)	452.0 (321.4–596.6)
	Coal (g/GJ)	154.5 (128.0–181.3)	148.9 (123.0–174.4)	162.5 (137.2–186.7)	145.0 (122.4–167.5)	131.8 (110.4–153.7)
	Oil	13.8 (8.1–21.1)	12.4 (7.1–18.9)	11.1 (6.4–17.3)	12.0 (6.9–18.6)	11.9 (7.0–18.4)
	Biofuel	216.2 (173.7–259.1)	155.7 (124.5–186.5)	138.7 (110.8–167.0)	67.8 (54.1–81.3)	23.1 (18.5–27.8)
	On-road diesel (g/GJ)	80.5 (64.2–96.7)	44.6 (35.6–53.6)	44.7 (35.3–53.6)	38.0 (30.4–45.7)	33.5 (26.7–39.9)
	On-road gasoline	209.0 (173.9–247.0)	207.3 (173.5–244.4)	160.3 (133.2–190.0)	166.0 (138.8–196.7)	161.7 (135.0–192.8)
	Off-road oil	0.5 (0.3–0.8)	0.6 (0.3–0.9)	0.5 (0.2–0.8)	0.5 (0.2–0.7)	0.5 (0.3–0.8)
	Forest & savanna (g/kg)	0.4 (0.1–0.8)	0.4 (0.1–0.8)	0.4 (0.1–0.8)	0.4 (0.1–0.8)	0.4 (0.1–0.8)
BC	Power plants	0.7 (0.1–1.9)	0.7 (0.1–1.8)	0.6 (0.1–1.7)	0.5 (0.1–1.6)	0.5 (0.1–1.6)
	Coal (g/GJ)	0.4 (0.1–1.2)	0.4 (0.1–1.3)	0.3 (0.1–1.1)	0.3 (0.1–1.0)	0.3 (0.1–1.0)
	Industry	44.3 (13.3–109.9)	52.4 (14.5–136.8)	57.1 (15.2–149.8)	44.2 (12.6–111.3)	41.3 (11.7–105.3)
	Coal (g/GJ)	43.2 (25.5–66.5)	41.1 (24.3–63.1)	41.4 (24.7–63.7)	47.0 (28.1–72.2)	46.9 (28.1–72.8)
	Residential	130.1 (28.4–387.2)	133.1 (29.7–390.2)	134.5 (30.4–400.1)	136.7 (29.7–402.7)	134.1 (28.2–397.2)
	Coal (g/GJ)	5.3 (0.7–17.1)	5.1 (0.7–16.4)	4.5 (0.7–14.4)	4.5 (0.7–14.4)	4.5 (0.7–14.1)
	Biofuel	54.2 (19.2–140.2)	55.4 (19.0–145.8)	55.5 (19.1–149.8)	55.4 (19.2–150.6)	55.4 (19.3–146.7)
	On-road diesel (g/GJ)	78.1 (47.7–116.1)	78.1 (48.7–113.6)	77.5 (47.8–114.7)	76.0 (47.0–112.2)	74.9 (46.3–111.8)
	On-road gasoline	16.0 (2.9–38.0)	14.9 (2.8–35.1)	10.7 (2.2–24.6)	7.5 (1.8–16.8)	6.1 (1.6–13.2)
	Off-road oil	34.8 (18.3–57.2)	36.7 (19.6–59.4)	34.7 (18.4–57.1)	31.7 (17.4–51.1)	31.6 (16.9–51.1)
	Forest & savanna (g/kg)	0.6 (0.3–1.0)	0.6 (0.3–1.1)	0.6 (0.3–1.1)	0.6 (0.3–0.9)	0.6 (0.3–1.0)
	Agricultural waste	0.7 (0.5–1.0)	0.7 (0.5–1.0)	0.7 (0.5–1.0)	0.7 (0.5–1.0)	0.7 (0.5–1.0)
OC	Power plants	1.5 (0.2–5.1)	1.5 (0.1–5.0)	1.5 (0.1–5.1)	1.5 (0.1–5.3)	1.5 (0.1–5.1)
	Coal (g/GJ)	0.2 (0.0–0.7)	0.2 (0.0–0.7)	0.2 (0.0–0.6)	0.2 (0.0–0.5)	0.2 (0.0–0.5)
	Industry	41.4 (14.5–96.9)	47.4 (15.4–116.0)	51.9 (16.6–126.7)	40.3 (12.8–96.6)	37.4 (11.8–90.5)
	Coal (g/GJ)	13.3 (7.6–21.0)	12.7 (7.3–19.9)	12.8 (7.5–20.1)	14.5 (8.5–22.6)	14.5 (8.5–22.6)
	Residential	191.9 (42.0–554.4)	193.9 (43.1–574.1)	199.9 (44.3–585.9)	202.9 (43.3–604.6)	200.3 (44.5–600.5)
	Coal (g/GJ)	8.9 (2.4–24.2)	8.4 (2.3–22.5)	7.4 (2.0–20.0)	7.2 (2.0–18.8)	7.2 (1.9–19.7)
	Biofuel	210.7 (88.7–476.1)	213.6 (87.1–486.6)	218.5 (87.9–493.6)	217.3 (88.0–498.1)	218.9 (89.3–509.7)
	On-road diesel (g/GJ)	23.9 (14.2–36.5)	23.9 (14.5–36.0)	23.7 (14.4–35.8)	23.3 (14.1–35.1)	23.0 (13.9–34.7)
	On-road gasoline	83.1 (36.6–166.4)	76.7 (33.7–151.9)	52.2 (23.7–100.5)	31.7 (15.1–59.7)	23.1 (11.7–41.8)
	Off-road oil	16.2 (9.3–25.4)	17.3 (10.1–27.6)	16.5 (9.5–26.3)	15.4 (9.2–24.4)	15.4 (9.0–24.4)
	Forest & savanna (g/kg)	4.9 (3.3–7.2)	5.1 (3.5–7.3)	4.8 (3.1–7.1)	4.6 (3.0–6.8)	4.9 (3.3–7.2)
	Agricultural waste	3.3 (1.6–6.2)	3.3 (1.6–6.3)	3.3 (1.6–6.0)	3.3 (1.6–6.3)	3.3 (1.5–6.3)

^aThe values in the parentheses represent the 95% CI around the mean.

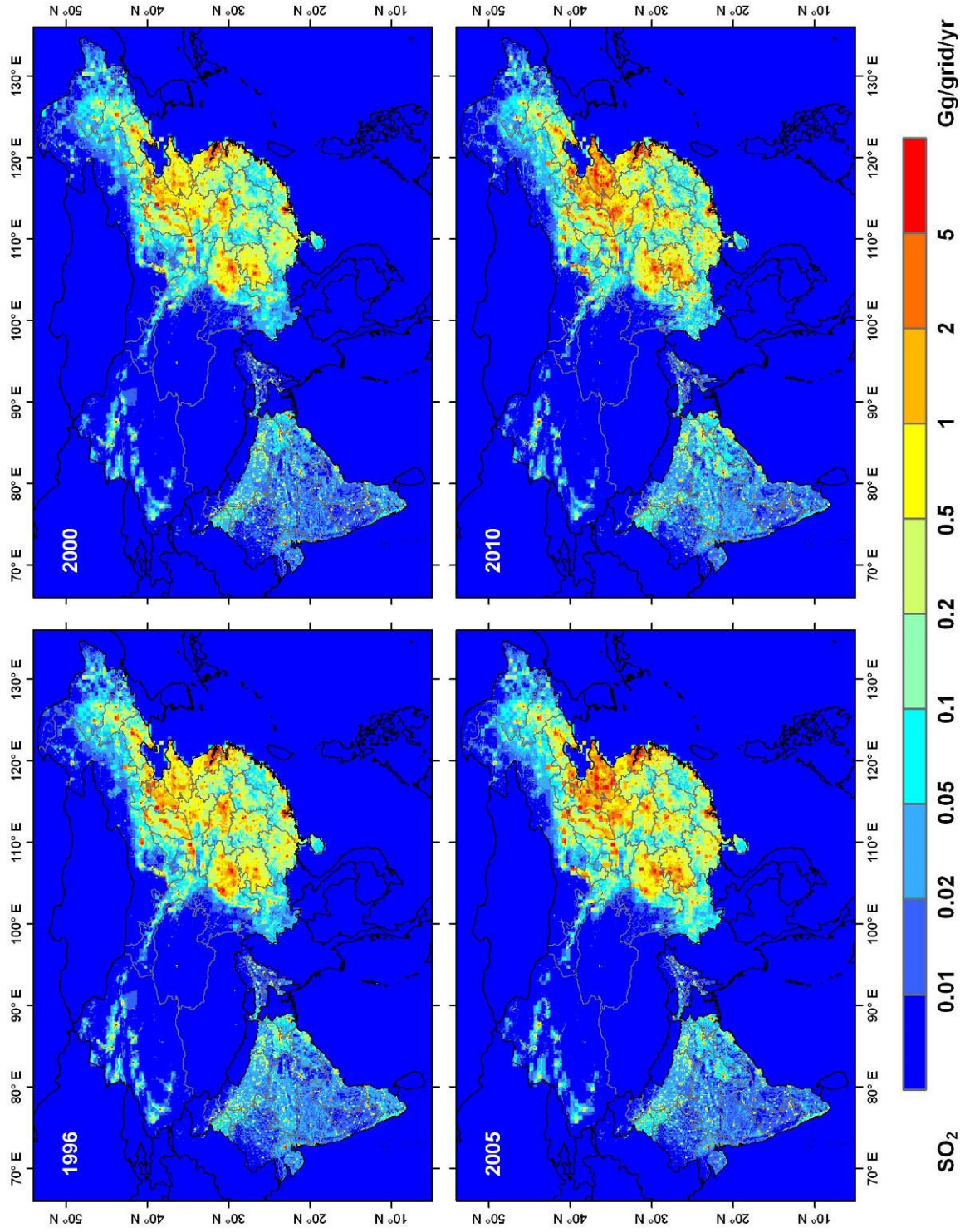


Fig. S1. Emission distributions of SO₂ at 0.1° × 0.1° resolution in 1996, 2000, 2005, and 2008. International shipping and aviation are not included.

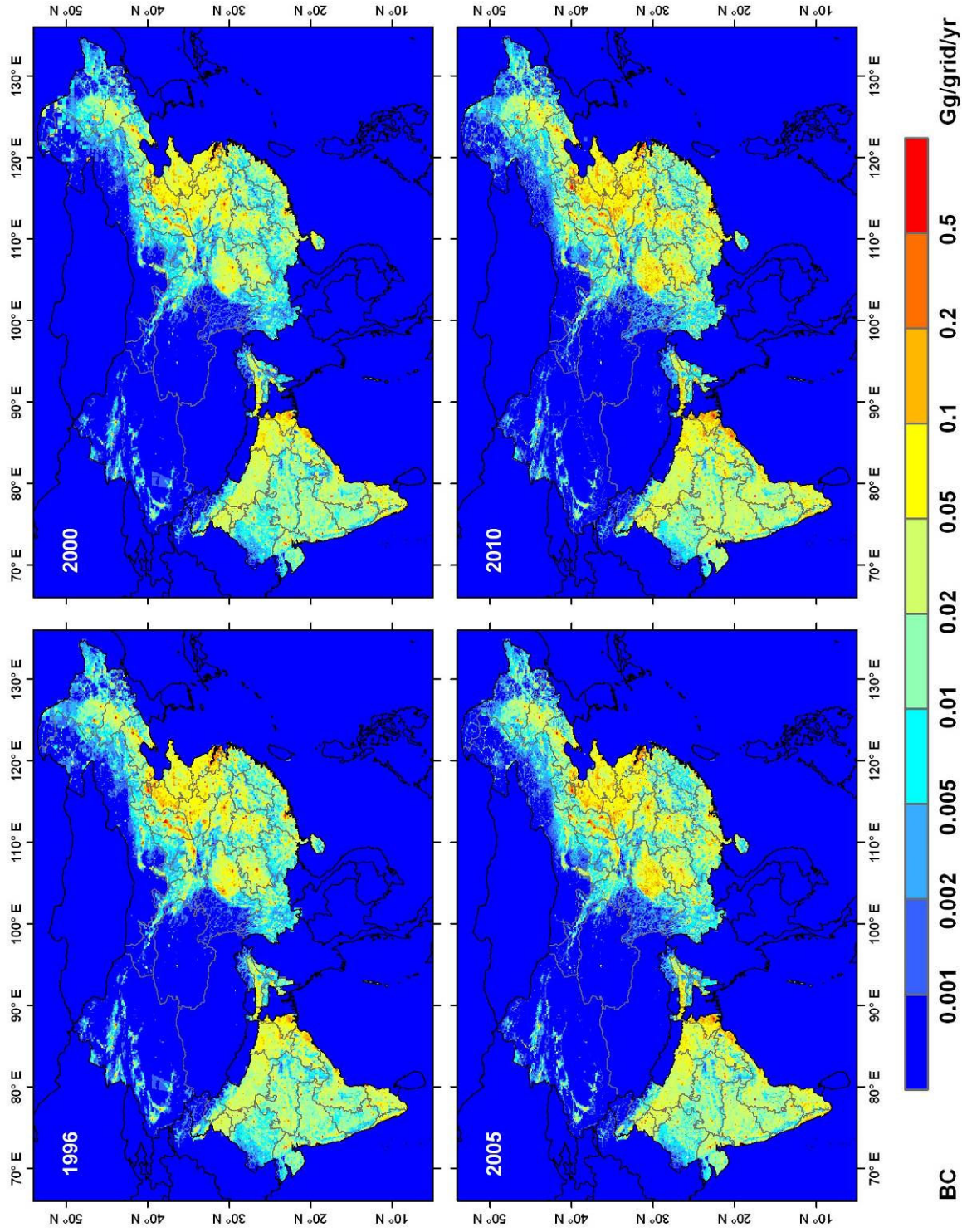


Fig. S2. Emission distributions of BC at $0.1^\circ \times 0.1^\circ$ resolution in 1996, 2000, 2005, and 2008. International shipping and aviation are not included.

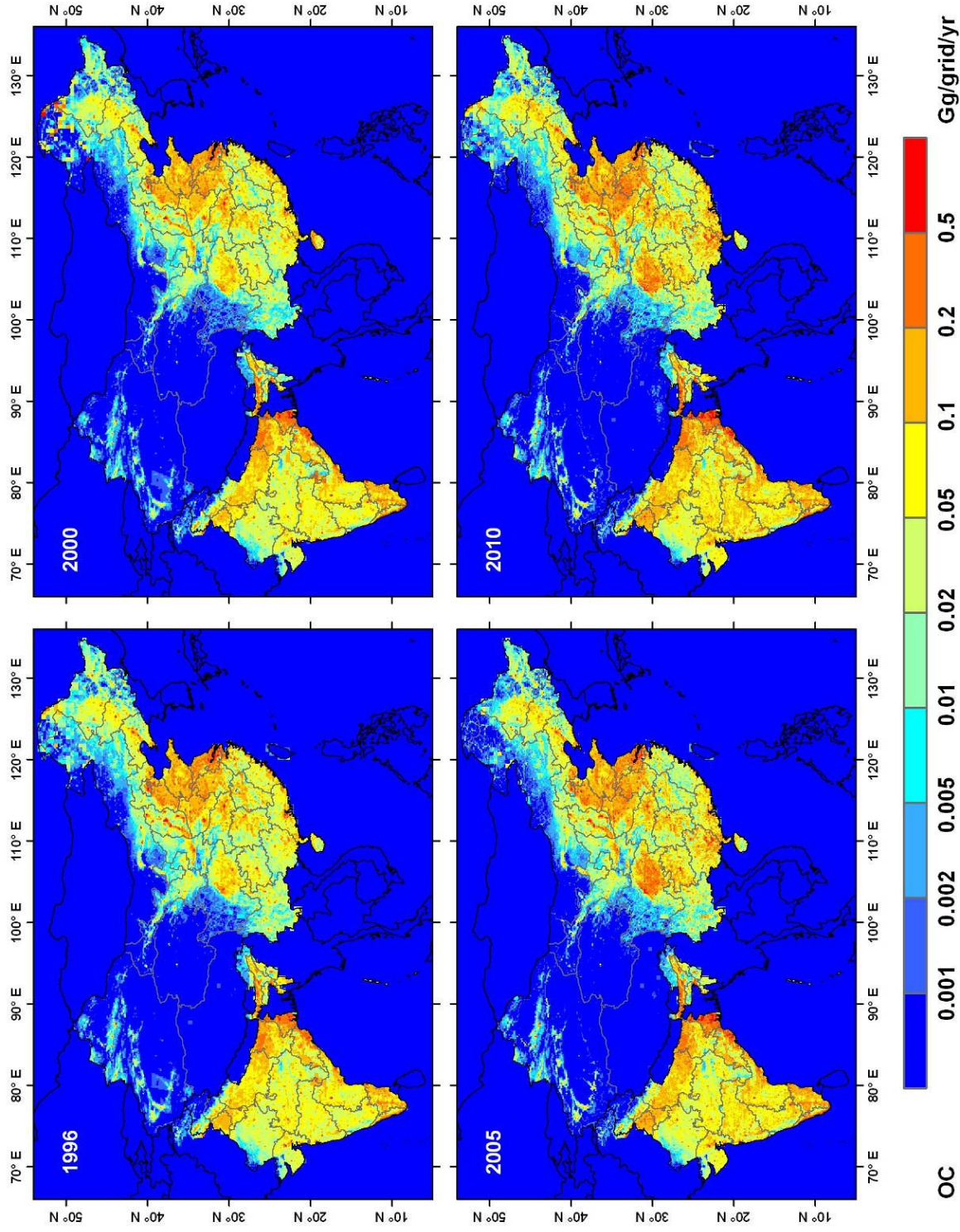


Fig. S3. Emission distributions of OC at $0.1^\circ \times 0.1^\circ$ resolution in 1996, 2000, 2005, and 2008. International shipping and aviation are not included.