



3.9

Trends in greenhouse gas emissions

	Carbon dioxide emissions		Methane emissions				Nitrous oxide emissions				Other greenhouse gas emissions	
	average annual % growth ^a	% change ^b	Total thousand metric tons of carbon dioxide equivalent	% change ^b	% of total		Total thousand metric tons of carbon dioxide equivalent	% change ^b	% of total		Total thousand metric tons of carbon dioxide equivalent	% change ^b
					Industrial	Agricultural			Industrial	Agricultural		
1990–2005	1990–2005	2005	1990–2005	2005	2005	2005	1990–2005	2005	2005	2005	2005	1990–2005
Afghanistan	-9.3	-73.5	..	..	..	..	..	..	..	..	..	..
Albania	-0.9	-51.9	2,170	-2.7	11.5	70.0	1,390	-40.6	0.0	97.1	50	..
Algeria	3.9	78.6	24,310	30.9	66.3	15.3	10,330	17.7	7.2	89.1	110	-52.2
Angola	4.1	93.5	37,020	171.6	11.6	39.1	28,350	454.8	0.0	35.9	0	..
Argentina	2.0	39.2	94,340	14.9	13.0	63.9	83,410	28.2	0.2	97.7	930	-50.5
Armenia	0.3	3.6	2,300	-25.6	25.2	50.9	450	-50.5	0.0	93.3	10	..
Australia	1.3	25.9	116,840	12.3	24.6	61.5	114,500	7.9	1.3	94.9	4,580	74.8
Austria	1.5	27.8	7,210	-12.2	14.6	50.1	4,620	-19.5	9.1	85.3	3,310	173.6
Azerbaijan	-3.2	-31.8	11,550	-20.4	45.2	45.4	4,040	-0.5	0.0	93.6	50	-72.2
Bangladesh	6.8	160.1	92,530	13.4	11.6	69.2	37,100	65.5	0.0	91.9	0	..
Belarus	-3.3	-41.3	16,620	-13.6	43.0	38.8	10,360	-32.2	32.3	65.6	440	..
Belgium	-0.2	3.6	7,610	-25.6	17.0	59.7	9,650	-14.2	12.0	65.4	9,380	7,115.4
Benin	8.0	259.0	4,840	77.3	8.9	47.5	4,660	119.8	0.0	68.0	0	..
Bolivia	3.0	68.2	27,120	74.4	2.8	34.5	28,300	97.8	0.0	43.3	0	..
Bosnia and Herzegovina	16.0	280.4	2,850	42.5	51.9	32.6	1,020	-10.5	0.0	82.4	850	84.8
Botswana	4.2	110.0	4,480	3,346.2	17.9	71.9	2,460	..	0.0	96.3	0	..
Brazil	3.3	60.6	421,820	47.7	3.0	67.1	300,300	31.8	3.2	74.4	7,760	46.7
Bulgaria	-3.1	-41.0	6,140	-35.8	31.9	32.7	5,880	-55.6	29.9	64.5	650	..
Burkina Faso	1.8	33.6	..	..	..	..	..	..	..	..	..	..
Burundi	1.1	15.1	..	..	..	..	..	..	..	..	..	..
Cambodia	1.0	19.5	14,890	..	5.4	71.5	3,820	..	0.0	74.1	0	..
Cameroon	4.5	131.5	15,110	43.9	17.9	56.0	14,540	75.4	0.0	85.0	890	9.9
Canada	1.8	25.4	103,830	25.1	46.6	22.2	51,390	1.4	4.5	86.7	11,010	-14.1
Central African Republic	1.8	27.7	..	..	..	..	..	..	..	..	..	..
Chad	2.9	-2.6	..	..	..	..	..	..	..	..	..	..
Chile	4.7	87.1	19,560	37.8	12.1	29.9	12,590	54.1	6.9	88.7	10	..
China	4.6	131.2	995,760	11.2	34.2	50.0	566,680	24.5	3.0	92.7	119,720	1,285.6
Hong Kong, China	2.4	47.3	1,090	-7.6	40.4	0.9	200	-4.8	0.0	5.0	330	..
Colombia	-0.7	2.1	61,690	25.4	15.7	55.1	24,530	16.0	0.9	78.0	330	73.7
Congo, Dem. Rep.	-5.3	-46.0	5,750	115.4	49.6	11.8	2,250	174.4	0.0	15.6	0	..
Congo, Rep.	1.9	70.6	50,320	81.5	7.7	26.3	38,680	99.5	0.0	23.2	0	..
Costa Rica	5.3	150.4	2,450	-34.1	1.6	58.0	2,850	-17.2	0.0	98.9	0	..
Cote d'Ivoire	2.0	61.5	15,320	183.2	11.2	20.6	12,350	402.0	0.0	25.0	0	..
Croatia	1.8	-6.9	3,690	-6.6	44.2	29.8	3,590	5.9	22.3	63.8	720	7.5
Cuba	-1.8	-24.1	9,490	-4.0	6.4	62.4	8,330	-39.0	8.0	87.4	110	..
Czech Republic	-1.5	-26.0	14,930	-32.9	58.7	17.2	6,570	-38.8	16.4	75.0	3,530	17,550.0
Denmark	-1.3	-7.4	4,920	-12.9	16.3	67.7	7,380	-26.2	7.7	78.6	1,460	461.5
Dominican Republic	5.4	96.3	5,960	12.9	4.0	62.1	2,850	-31.2	0.0	96.1	0	..
Ecuador	3.2	76.8	12,890	5.9	16.3	57.4	8,500	-3.8	0.0	97.6	0	..
Egypt, Arab Rep.	5.9	130.0	32,960	41.8	31.2	44.2	27,810	63.8	11.5	85.6	1,820	-19.1
El Salvador	5.4	144.5	3,200	16.8	12.5	48.1	2,250	9.8	0.0	95.1	0	..
Eritrea	11.2	..	2,410	15.3	7.5	77.6	2,350	75.4	0.0	99.1	0	..
Estonia	-2.8	-35.8	1,230	-52.9	43.1	35.0	610	-62.6	0.0	83.6	60	..
Ethiopia	8.0	165.9	47,740	22.1	10.0	77.2	63,130	24.4	0.0	98.6	0	..
Finland	1.5	5.1	5,470	-26.1	10.2	30.3	5,330	-11.6	27.0	59.5	1,030	368.2
France	0.1	4.0	43,520	-23.3	10.7	71.1	78,090	-11.7	12.1	77.3	27,010	151.5
Gabon	-8.9	-74.9	2,040	-34.6	79.9	4.4	420	-77.3	0.0	57.1	0	..
Gambia, The	3.2	50.0	..	..	..	..	..	..	..	..	..	..
Georgia	-8.8	-72.3	4,330	-25.2	29.6	51.7	3,390	0.0	17.4	49.3	10	..
Germany	1.8	178.1	58,100	-47.1	45.7	39.2	69,470	-10.3	13.3	74.2	41,980	273.8
Ghana	4.7	94.3	8,630	62.5	10.7	49.6	10,520	131.7	0.0	88.6	170	-10.5
Greece	2.3	32.0	7,410	16.0	9.7	39.1	13,090	0.2	3.3	91.3	1,620	105.1
Guatemala	6.2	125.0	8,990	51.9	11.3	42.7	7,980	66.9	0.0	70.8	0	..
Guinea	2.0	34.1	..	..	..	..	..	..	..	..	..	..
Guinea-Bissau	1.9	29.8	..	..	..	..	..	..	..	..	..	..
Haiti	6.9	77.9	3,740	30.3	6.4	61.2	4,290	73.7	0.0	98.4	0	..

Trends in greenhouse gas emissions

3.9

	Carbon dioxide emissions		Methane emissions				Nitrous oxide emissions				Other greenhouse gas emissions	
	average annual % growth ^a		Total thousand metric tons of carbon dioxide equivalent	% change ^b	% of total		Total thousand metric tons of carbon dioxide equivalent	% change ^b	% of total		Total thousand metric tons of carbon dioxide equivalent	% change ^b
	1990-2005	1990-2005			2005	1990-2005			2005	2005		
Honduras	7.6	186.9	5,380	7.2	5.8	71.9	3,860	8.7	0.0	97.9	0	..
Hungary	-0.5	-6.2	11,050	-22.3	52.6	18.3	8,760	-26.7	20.7	76.0	1,540	102.6
India	4.8	106.3	712,330	13.9	14.7	64.8	300,680	33.5	0.5	93.0	9,510	18.7
Indonesia	5.7	181.0	224,330	24.5	36.2	41.2	69,910	16.1	0.3	72.6	900	-34.8
Iran, Islamic Rep.	4.9	106.9	95,060	73.7	64.7	21.8	66,140	36.0	0.9	97.6	1,560	-26.8
Iraq	3.6	74.2	10,980	-1.3	48.7	14.7	3,990	-39.3	0.0	93.0	470	20.5
Ireland	2.6	38.3	3,660	-68.3	24.3	32.0	12,320	-4.0	0.2	92.6	2,050	1,763.6
Israel	4.9	92.0	1,170	15.8	9.4	36.8	1,820	-4.2	0.0	83.5	1,140	35.7
Italy	0.9	14.2	36,670	-13.3	19.1	37.7	37,200	4.6	23.7	70.5	27,710	480.9
Jamaica	2.0	27.6	1,160	-4.9	3.4	47.4	1,020	-16.4	0.0	96.1	0	..
Japan	0.9	13.8	53,480	-7.3	30.0	13.4	23,590	-26.2	8.4	49.3	70,570	165.7
Jordan	4.0	101.4	1,610	49.1	13.0	24.2	1,240	6.9	0.0	93.5	10	..
Kazakhstan	-3.6	-37.2	28,270	-48.9	49.1	37.9	5,530	-76.6	0.0	90.2	0	..
Kenya	4.8	90.5	20,310	4.6	18.0	65.0	19,060	-12.7	0.0	96.4	0	..
Korea, Dem. Rep.	-10.4	-66.2	10,650	8.7	29.0	36.4	23,160	152.0	0.0	97.5	860	186.7
Korea, Rep.	4.2	87.2	31,280	14.0	18.5	31.1	22,020	132.3	56.6	36.1	8,700	61.1
Kuwait	2.7	115.6	11,200	64.7	93.9	1.5	540	116.0	0.0	81.5	390	56.0
Kyrgyz Republic	-5.5	-55.8	3,520	-24.8	10.5	72.2	3,260	-23.1	0.0	98.8	60	..
Lao PDR	15.5	520.7	..	..	..	..	..	..	..	..	..	..
Latvia	-5.9	-55.5	2,290	-47.0	40.6	29.3	1,390	-48.3	0.0	88.5	110	..
Lebanon	4.1	85.7	980	34.2	12.2	18.4	1,020	37.8	0.0	93.1	0	..
Lesotho	..	..	..	..	..	..	..	..	..	..	..	..
Liberia	3.1	1.6	..	..	..	..	..	..	..	..	..	..
Libya	2.9	48.5	8,540	-2.4	77.6	8.9	2,050	-28.3	0.0	91.7	290	190.0
Lithuania	-4.2	-42.6	3,650	-52.8	44.1	38.1	2,860	-31.3	0.0	90.2	150	..
Macedonia, FYR	-0.8	-33.9	..	..	..	..	..	..	..	..	..	..
Madagascar	8.4	198.9	..	..	..	..	..	..	..	..	..	..
Malawi	4.1	65.2	..	..	..	..	..	..	..	..	..	..
Malaysia	7.4	333.9	25,510	19.8	57.2	22.3	9,920	-14.5	3.9	64.3	530	-44.8
Mali	2.1	33.9	..	..	..	..	..	..	..	..	..	..
Mauritania	-6.1	-38.1	..	..	..	..	..	..	..	..	..	..
Mauritius	6.2	133.1	..	..	..	..	..	..	..	..	..	..
Mexico	0.5	12.3	120,100	25.3	22.2	39.6	75,500	7.5	1.2	90.1	3,160	63.7
Moldova	-8.1	-66.2	2,590	-45.8	43.6	30.9	970	-70.3	0.0	94.8	360	..
Mongolia	-1.7	-12.0	4,840	-34.4	2.9	83.9	22,850	128.5	0.0	99.6	0	..
Morocco	4.0	104.4	13,240	46.0	2.6	41.6	15,510	7.9	0.0	75.2	0	..
Mozambique	4.1	88.6	11,680	23.9	16.9	64.3	9,930	236.6	0.0	99.7	0	..
Myanmar	6.1	165.3	60,840	51.5	6.8	70.0	25,900	80.0	0.0	66.8	10	..
Namibia	51.7	34,883.6	4,260	-1.4	4.7	89.9	4,620	9.0	0.0	99.1	0	..
Nepal	9.4	395.9	36,040	6.6	10.4	80.5	7,100	24.6	0.0	88.5	0	..
Netherlands	-0.2	-10.0	15,180	-21.4	23.6	49.2	16,800	-13.0	33.8	51.5	5,300	-10.9
New Zealand	2.4	33.4	27,490	0.4	10.4	82.3	27,960	-17.6	0.1	99.4	820	105.0
Nicaragua	4.4	47.9	6,350	35.4	4.7	80.2	3,210	-14.4	0.0	96.9	0	..
Niger	-0.4	1.0	..	..	..	..	..	..	..	..	..	..
Nigeria	6.2	152.1	78,290	31.2	45.5	33.7	39,030	39.1	0.0	87.1	80	-33.3
Norway	3.4	74.7	12,080	58.5	61.8	14.3	4,680	-11.5	37.8	53.0	1,770	-64.5
Oman	8.3	206.3	4,260	110.9	76.1	12.9	1,140	31.0	0.0	96.5	0	..
Pakistan	4.5	97.4	110,300	33.2	14.1	66.3	80,040	44.5	0.8	96.4	620	-11.4
Panama	4.4	88.1	3,040	2.4	4.3	72.4	2,070	-17.9	0.0	95.7	0	..
Papua New Guinea	3.6	82.7	..	..	..	..	..	..	..	..	..	..
Paraguay	3.7	71.5	17,750	51.8	1.7	70.9	12,870	29.0	0.0	81.8	0	..
Peru	3.3	76.0	21,510	24.6	6.4	48.1	18,720	30.9	0.0	89.4	80	..
Philippines	3.9	70.7	44,860	15.5	8.0	66.7	18,940	5.3	0.1	95.6	350	250.0
Poland	-1.2	-13.0	60,060	-33.3	67.0	18.4	26,110	-17.3	22.3	72.5	1,270	176.1
Portugal	2.7	47.3	7,140	-4.2	8.0	52.9	7,000	1.2	9.9	80.7	1,050	707.7
Puerto Rico	-8.9	-82.1	..	..	..	..	..	..	..	..	..	..

	Carbon dioxide emissions		Methane emissions				Nitrous oxide emissions				Other greenhouse gas emissions	
	average annual % growth ^a 1990–2005	% change ^b 1990–2005	Total thousand metric tons of carbon dioxide equivalent 2005	% change ^b 1990–2005	% of total		Total thousand metric tons of carbon dioxide equivalent 2005	% change ^b 1990–2005	% of total		Total thousand metric tons of carbon dioxide equivalent 2005	% change ^b 1990–2005
					Industrial 2005	Agricultural 2005			Industrial 2005	Agricultural 2005		
Romania	-3.5	-42.6	23,260	-45.0	52.4	30.1	11,790	-52.3	25.9	69.6	2,220	48.0
Russian Federation	-2.6	-33.5	501,380	-20.6	77.3	7.9	42,650	-67.0	8.0	76.2	56,600	192.1
Rwanda	1.6	14.6	..	..	..	..	..	..	..	..	..	..
Saudi Arabia	2.2	93.0	63,500	59.9	91.8	1.9	7,720	-6.2	0.0	92.1	1,530	-32.3
Senegal	2.9	61.9	6,340	14.2	4.7	75.9	10,250	64.8	0.0	99.0	10	..
Serbia ^c	-2.4	-59.8	6,720	-47.7	16.4	59.2	4,700	-48.2	11.1	81.5	840	147.1
Sierra Leone	5.3	181.3	..	..	..	..	..	..	..	..	..	..
Singapore	0.8	34.2	1,260	70.3	27.0	4.8	7,970	4,327.8	95.7	0.8	1,300	225.0
Slovak Republic	-1.6	-28.8	5,290	-29.0	54.3	19.5	2,760	-40.6	32.2	58.0	710	7,000.0
Slovenia	0.8	-17.6	1,630	-6.3	20.9	47.9	1,100	2.8	0.0	88.2	210	-63.8
Somalia	44.7	3,123.5	..	..	..	..	..	..	..	..	..	..
South Africa	1.2	23.2	59,200	13.3	54.3	23.8	29,250	10.5	7.3	82.7	2,600	79.3
Spain	3.4	62.2	38,010	20.1	11.3	44.1	48,520	37.5	3.5	85.7	15,050	239.0
Sri Lanka	8.0	193.1	10,280	0.0	12.3	61.8	3,130	29.9	0.0	89.1	0	..
Sudan	6.5	97.3	67,310	69.3	21.5	73.3	59,750	51.6	0.0	96.2	0	..
Swaziland	10.8	125.0	..	..	..	..	..	..	..	..	..	..
Sweden	-0.2	-1.9	6,460	-15.8	6.5	41.5	6,070	-4.1	8.4	76.8	1,620	63.6
Switzerland	-0.2	-3.6	4,150	-13.4	8.7	68.0	2,840	-10.4	8.1	78.2	3,310	335.5
Syrian Arab Republic	2.9	90.9	7,960	37.0	33.8	34.7	9,430	20.0	2.8	94.9	0	..
Tajikistan	-10.0	-77.7	3,270	-11.4	10.1	68.5	1,590	-48.9	0.0	99.4	120	50.0
Tanzania	3.9	100.2	39,460	46.9	20.3	63.5	31,690	36.0	0.0	84.3	0	..
Thailand	6.2	182.9	78,840	14.4	9.4	76.1	27,990	31.2	0.7	87.9	940	-40.5
Timor-Leste	..	..	..	..	..	..	..	..	..	..	..	..
Togo	4.7	79.0	2,840	58.7	14.8	48.6	5,470	174.9	0.0	88.8	0	..
Trinidad and Tobago	4.0	93.1	3,820	52.2	78.0	1.0	360	5.9	0.0	91.7	0	..
Tunisia	3.2	65.7	4,390	17.4	32.1	34.2	7,230	69.7	4.1	94.2	30	..
Turkey	3.6	75.2	23,140	-14.5	15.3	59.5	47,950	8.3	9.0	88.0	1,480	-47.9
Turkmenistan	2.5	30.2	23,060	-30.6	81.8	15.2	3,200	-22.9	20.0	78.8	250	..
Uganda	7.4	183.8	..	..	..	..	..	..	..	..	..	..
Ukraine	-5.1	-52.2	75,640	-48.3	68.9	15.7	23,270	-66.5	41.6	54.2	1,390	2,216.7
United Arab Emirates	6.9	126.3	34,250	79.2	96.8	1.7	2,730	193.5	0.0	90.5	480	118.2
United Kingdom	-0.3	-4.0	39,400	-41.8	35.7	50.7	65,480	-4.4	37.1	52.2	14,030	138.6
United States	1.3	20.4	810,280	-5.5	56.4	18.4	456,210	10.5	5.5	74.7	108,420	18.8
Uruguay	1.2	42.2	17,700	25.4	0.6	90.3	15,630	3.0	0.0	99.6	20	..
Uzbekistan	13.1	1,602.7	51,480	23.7	70.1	23.2	14,660	2.3	0.3	98.3	760	..
Venezuela, RB	2.6	26.2	65,730	58.3	42.0	33.6	26,460	21.9	0.1	77.8	2,300	72.9
Vietnam	11.9	376.0	75,080	41.7	17.8	66.8	37,470	169.2	0.0	94.9	10	..
West Bank and Gaza	..	..	..	..	..	..	..	..	..	..	..	..
Yemen, Rep.	4.5	110.2	9,040	95.7	44.5	27.7	7,080	38.6	0.0	98.9	10	..
Zambia	-1.1	-3.2	16,770	70.8	5.7	68.6	11,410	137.7	3.7	65.1	0	..
Zimbabwe	-3.2	-31.2	10,400	-4.1	24.8	60.4	10,160	13.3	0.0	97.1	20	..
World	1.6 w	29.5 w	6,607,490 s	7.0 w	34.8 w	43.1 w	3,787,800 s	14.0 w	5.2 w	82.6 w	601,890 s	126.9 w
Low income	0.9	39.4	742,160	32.7	21.1	59.3	477,730	53.9	0.2	89.6	2,730	96.4
Middle income	2.0	43.1	4,255,740	8.6	32.2	46.4	2,179,990	13.7	3.3	84.8	221,040	244.3
Lower middle income	3.8	93.5	2,731,100	14.2	27.8	51.7	1,448,600	25.7	2.4	86.7	139,690	428.9
Upper middle income	-0.6	-8.3	1,524,640	-0.2	39.9	36.9	731,390	-4.3	5.1	81.0	81,350	115.3
Low & middle income	1.9	42.9	4,997,900	11.6	30.5	48.3	2,657,720	19.3	2.8	85.7	223,770	241.2
East Asia & Pacific	4.2	123.4	..	..	30.5	51.9	..	..	2.2	90.0	..	..
Europe & Central Asia	-2.3	-29.3	851,260	-26.2	69.1	16.2	215,350	-46.5	15.6	77.5	67,550	163.6
Latin America & Carib.	1.9	33.4	929,970	36.0	10.7	57.9	645,520	24.6	1.9	80.8	14,700	38.4
Middle East & N. Africa	4.4	96.8	209,070	47.8	52.0	25.9	151,830	29.4	3.4	92.0	4,300	-15.7
South Asia	4.8	106.7	961,480	15.3	14.1	66.0	428,050	37.6	0.5	93.4	10,130	16.3
Sub-Saharan Africa	2.0	40.3	..	..	24.4	49.4	..	..	0.6	78.5	..	..
High income	1.3	26.9	1,609,590	-5.0	47.9	26.9	1,130,080	3.2	10.7	75.3	378,120	89.4
Euro area	1.2	43.2	232,220	-25.9	22.2	47.6	303,960	-3.1	12.8	76.4	135,750	236.8

a. Calculated using the least squares method, which accounts for ups and downs of all data points in the period (see Statistical methods). b. Calculated as the change in emission since 1990, which is the baseline for Kyoto Protocol requirements. c. Includes Kosovo and Montenegro.

About the data

Greenhouse gases—which include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride—contribute to climate change.

Carbon dioxide emissions, largely a by-product of energy production and use (see table 3.7), account for the largest share of greenhouse gases. Anthropogenic carbon dioxide emissions result primarily from fossil fuel combustion and cement manufacturing. Burning oil releases more carbon dioxide than burning natural gas, and burning coal releases even more for the same level of energy use. Cement manufacturing releases about half a metric ton of carbon dioxide for each metric ton of cement produced.

Methane emissions result largely from agricultural activities, industrial production landfills and wastewater treatment, and other sources such as tropical forest and other vegetation fires. The emissions are usually expressed in carbon dioxide equivalents using the global warming potential, which allows the effective contributions of different gases to be

compared. A kilogram of methane is 21 times as effective at trapping heat in the earth's atmosphere as a kilogram of carbon dioxide within 100 years.

Nitrous oxide emissions are mainly from fossil fuel combustion, fertilizers, rainforest fires, and animal waste. Nitrous oxide is a powerful greenhouse gas, with an estimated atmospheric lifetime of 114 years, compared with 12 years for methane. The per kilogram global warming potential of nitrous oxide is nearly 310 times that of carbon dioxide within 100 years.

Other greenhouse gases covered under the Kyoto Protocol are hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Although emissions of these artificial gases are small, they are more powerful greenhouse gases than carbon dioxide, with much higher atmospheric lifetimes and high global warming potential.

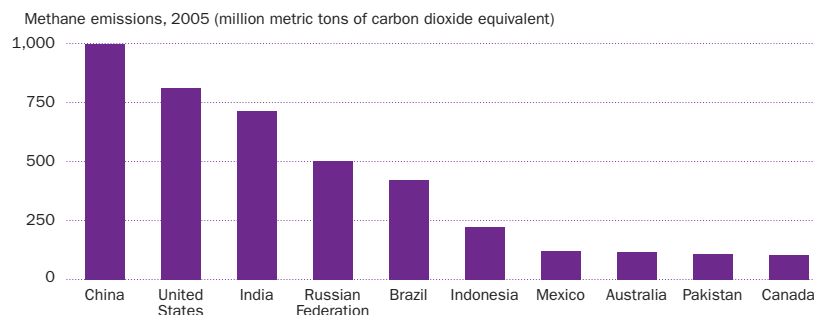
For a discussion of carbon dioxide sources and the methodology behind emissions calculation, see *About the data* for table 3.8.

Definitions

- **Carbon dioxide emissions** are emissions from the burning of fossil fuels and the manufacture of cement and include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.
- **Methane emissions** are emissions from human activities such as agriculture and from industrial methane production.
- **Industrial methane emissions** are emissions from the handling, transmission, and combustion of fossil fuels and biofuels.
- **Agricultural methane emissions** are emissions from animals, animal waste, rice production, agricultural waste burning (nonenergy, on-site), and savannah burning.
- **Nitrous oxide emissions** are emissions from agricultural biomass burning, industrial activities, and livestock management.
- **Industrial nitrous oxide emissions** are emissions produced during the manufacturing of adipic acid and nitric acid.
- **Agricultural nitrous oxide emissions** are emissions produced through fertilizer use (synthetic and animal manure), animal waste management, agricultural waste burning (nonenergy, on-site), and savannah burning.
- **Other greenhouse gas emissions** are by-product emissions of hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

The 10 largest contributors to methane emissions account for about 62 percent of emissions

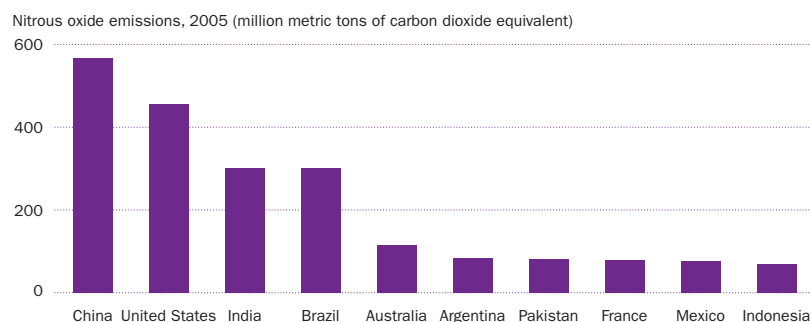
3.9a



Source: Table 3.9.

The 10 largest contributors to nitrous oxide emissions account for about 56 percent of emissions

3.9b



Source: Table 3.9.

Data sources

Data on carbon dioxide emissions are from the Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States. Data on methane, nitrous oxide, and other greenhouse gases emissions are compiled by the International Energy Agency.