Annex V: Historical Greenhouse Gas and Effective Radiative Forcing Tables.

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Introduction

Annex V presents, in tabulated form, data related to historical changes in greenhouse gas mixing ratios, and effective radiative forcing as assessed and used throughout Chapter 1, 2, 5, 6, and 7. Where available 90 % CL uncertainties on observed GHG mixing ratios are given. For each species, the abundances (given as dry air mole fraction: ppm = micromoles per mole (10^{-6}); ppb = nanomoles per mole (10^{-9}); and ppt = picomoles per mole (10^{-12}). Effective Radiative Forcing (ERF) is given in Wm^{-2}. Reference to data sources are provided. Observations are described in (Dlugokencky et al., 2011; Hall et al., 2011; Laube et al., 2016; Masarie and Tans, 2004; Montzka et al., 2009; Naus et al., 2019; Prinn et al., 2018; Rigby et al., 2014; Trudinger et al., 2004; Worton et al., 2006).

Chemical Abbreviations and Symbols

Well Mixed Greenhouse Gases (WMGHG)

CO2 carbon dioxide (KP, Kyoto Protocol gas)
CH4 methane (KP)
N2O nitrous oxide (KP)
HFC hydrofluorocarbon (a class of compounds: HFC-32, HFC-134a, …) (KP)
PFC perfluorocarbon (a class of compounds: CF4, C2F6, …) (KP)
SF6 sulphur hexafluoride (KP)
NF3 nitrogen trifluoride (KP)
CFC chlorofluorocarbon (a class of compounds: CFCl3, CF2Cl2, …) (MP, Montreal Protocol gas)
HCFC hydrochlorofluorocarbon1 (a class of compounds: HCFC-22, HCFC-141b, …) (MP)
CCl4 carbon tetrachloride (MP)
CH3CCl3 methyl chloroform (MP)

Table AV.1: Historical abundances of the Kyoto and Montreal greenhouse gases

a) Historical abundances of the Kyoto greenhouse gases: CO_2, CH_4, and N_2O

Year	CO_2 (ppm)	CH_4 (ppb)	N_2O (ppb)	Year	CO_2 (ppm)	CH_4 (ppb)	N_2O (ppb)	Year	CO_2 (ppm)	CH_4 (ppb)	N_2O (ppb)
1750	278.7±1.8	724.1±6.6	270.0±3.9	1965	320.1	1331.1	294.0	1993	356.7	1737.4	310.3
1850	286.7±2.1	807.6±10.0	272.5±4.0	1966	321.1	1342.3	294.4	1994	358.2	1742.9	310.8
1855	287.2	813.8	273.0	1967	321.7	1354.3	294.8	1995	360.0	1748.0	311.4
1860	288.0	822.7	273.6	1968	322.6	1371.7	295.2	1996	361.8	1750.1	312.3
1865	288.7	837.3	274.5	1969	323.5	1389.4	295.6	1997	362.9	1753.6	313.1
1870	289.4	852.8	275.3	1970	325.0	1411.1	296.1	1998	365.5	1764.0	313.9
1875	290.2	859.8	276.2	1971	325.6	1431.2	296.5	1999	367.6	1771.6	314.9
1880	291.3	869.1	276.9	1972	327.5	1449.3	296.9	2000	368.8	1773.0	317.3
1885	292.6	881.4	277.4	1973	330.0	1462.9	297.4	2001	370.4	1771.5	313.9
1890	294.1	896.7	277.9	1974	330.9	1476.2	297.8	2002	372.4	1772.4	317.3
1895	295.6	913.5	278.5	1975	330.9	1491.8	298.3	2003	375.0	1776.5	320.1
1900	297.2	925.8	279.2	1976	331.6	1509.1	298.8	2004	376.8	1776.0	320.1
1905	298.7	947.7	280.4	1977	333.4	1527.7	299.3	2005	378.8	1773.6	319.3
1910	300.7	975.0	282.1	1978	335.0	1546.9	299.8	2006	380.9	1773.9	320.1
1915	303.1	991.7	283.8	1979	336.6	1566.2	300.4	2007	382.7	1780.9	320.9
1920	305.4	1025.3	284.7	1980	338.8	1585.0	301.1	2008	384.8	1787.7	321.8
1925	306.8	1052.4	285.4	1981	340.0	1602.7	301.9	2009	386.3	1792.6	322.6
1930	307.5	1072.8	285.8	1982	340.8	1618.7	303.1	2010	388.6	1797.8	323.4
1935	309.1	1097.2	286.4	1983	342.4	1632.6	303.7	2011	390.5	1803.3	324.4
1940	312.1	1120.3	287.5	1984	344.0	1643.5	304.3	2012	392.5	1808.5	325.3
1945	313.0	1128.3	288.0	1985	345.5	1657.3	304.9	2013	395.2	1813.8	326.2
1950	313.4	1163.9	289.6	1986	346.9	1669.8	305.8	2014	397.1	1822.9	327.4
1955	314.9	1206.8	290.8	1987	348.6	1679.7	306.0	2015	399.4	1833.9	328.3
1960	317.0	1264.2	292.2	1988	351.2	1692.9	306.7	2016	402.9	1842.3	329.1
1961	317.6	1269.5	292.5	1989	352.8	1706.5	307.8	2017	405.0	1849.5	330.0
1962	318.4	1282.6	292.9	1990	354.0	1714.2	308.7	2018	407.4	1858.6	331.2
1963	319.0	1300.9	293.3	1991	355.3	1727.7	309.4	*Unc.*	*0.25*	*1.6*	*0.6*
1964	319.6	1317.4	293.6	1992	356.0	1735.3	309.9	*ERF*	*2.15*	*0.54*	*0.19*

Notes: 1750/1850 CO_2, CH_4, N_2O from multiple icecores assessed in Chapter 2 (Ahn et al., 2012; Bauska et al., 2015; MacFarling Meure et al., 2006; SIEGENTHALER et al., 2005). Mixing ratios from 1850- 1980/1984 are updated from the CMIP6 (Meinshausen et al., 2017) dataset, using a linear time-dependent offset correction function +2.38 ppm (CO_2), -0.65 ppb (CH_4) and -0.52 ppb (N_2O) in 1850 and 0 in 1980,1984 and 1980, respectively. CO_2 from NOAA network; CH_4, N_2O from merged NOAA, and AGAGE network. Uncertainties in CO_2, CH_4 and N_2O pertain to 2010. ERF(2018-1750) from Chapter 7.

b) Historical abundances of the Kyoto greenhouse gases: NF3, SF6, perfluorcarbons

Year	NF3 (ppt)	SF6 (ppt)	SO2F2 (ppt)	CF4 (ppt)	C2F6 (ppt)	C3F8 (ppt)	c-C4F8 (ppt)
1750	0.00	0.00	0.00	34.05	0.00	0.00	0.00
1850	0.00	0.00	0.00	34.05	0.00	0.00	0.00
1900	0.00	0.00	0.00	34.05	0.00	0.00	0.00
1910	0.00	0.00	0.00	34.10	0.01	0.00	0.00
1920	0.00	0.00	0.00	34.38	0.04	0.00	0.00
1930	0.00	0.00	0.00	34.91	0.10	0.00	0.00
1940	0.00	0.00	0.00	35.80	0.19	0.01	0.00
1950	0.00	0.00	0.00	38.02	0.40	0.01	0.00
1960	0.00	0.09	0.00	40.12	0.51	0.02	0.00
1970	0.00	0.32	0.01	43.40	0.62	0.03	0.14
1980	0.00	0.87	0.34	53.46	1.22	0.05	0.38
1990	0.01	2.36	0.68	63.82	2.07	0.12	0.77
2000	0.17	4.56	1.07	71.49	3.11	0.28	0.98
2010	0.73	7.01	1.63	78.30	4.09	0.54	1.26
2015	1.30	8.57	2.11	81.92	4.49	0.62	1.50
2018	1.83	9.59	2.41	84.57	4.76	0.67	1.69
Unc.	*0.1*	*0.06*	*0.05*	*0.2*	*0.1*	*0.02*	*n.a.*
ERF	*0*	*0.005*	*0*	*0.005*	*0.001*	*0*	*0.001*

Notes: Data merged from AR5 (1750;1850); CMIP6 compilation by Meinshausen et al.,(2017b) which was derived from NOAA and AGAGE network data, southern hemispheric air samples, archive air samples, firn air, and ice cores until ca. 1995, and data directly taken from merged AGAGE and NOAA networks, depending on date of availability. Uncertainties pertain to 2010. N.a.: not available. ERF(2018-1750) from Chapter 7.

c) Historical abundances of Kyoto Greenhouse Gases: HFCs

Year	HFC-134a (ppt)	HFC-23 (ppt)	HFC-32 (ppt)	HFC-125 (ppt)	HFC-143a (ppt)	HFC-152a (ppt)	HFC-227ea (ppt)	HFC-236fa (ppt)	HFC-245fa (ppt)	HFC-365mfc (ppt)	HFC-43-10mee (ppt)
1750	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1850	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1920	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1930	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1940	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1960	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1970	0.00	1.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1980	0.15	3.90	0.03	0.11	0.10	0.00	0.01	0.00	0.00	0.00	0.00
1990	0.46	8.33	0.05	0.13	0.48	0.18	0.01	0.00	0.00	0.01	0.00
2000	14.21	15.18	0.23	1.47	2.45	1.57	0.11	0.02	0.02	0.01	0.03
2010	57.54	23.25	4.09	8.80	10.81	6.16	0.66	0.09	1.34	0.55	0.20
2015	83.42	28.04	10.73	18.10	17.57	6.60	1.10	0.14	2.23	0.86	0.25
2018	101.82	31.15	16.50	26.30	22.42	7.01	1.46	1.05	2.84	1.05	0.28
Unc.	*1.0*	*0.5*	*n.a.*	*0.4*	*0.3*	*0.3*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
ERF	*0.016*	*0.006*	*0.002*	*0.006*	*0.004*	*0.001*	*0*	*0*	*0.001*	*0*	*0*

Notes: Data merged from AR5 (1750;1850); CMIP6 compilation by Meinshausen et al.,(2017b) which was derived from NOAA and AGAGE network data, southern hemispheric air samples, archive air samples, firn air, and ice cores until ca. 1995, and data directly taken from merged AGAGE and NOAA networks, depending on date of availability for various components. Uncertainties pertain to 2010. n.a.: not available. ERF(2018-1750) from Chapter 7.

d) Historical abundances of the Montreal Greenhouse Gases: CFCs and HCFCs

Year	CFC-12 (ppt)	CFC-11(ppt)	CFC-113 (ppt)	CFC-114 (ppt)	CFC-115 (ppt)	CFC-13 (ppt)	HCFC-22 (ppt)	HCFC-141b (ppt)	HCFC-142b (ppt)
1750	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1850	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1920	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1930	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
1940	0.00	0.00	0.47	0.01	0.00	0.03	0.32	0.00	0.00
1950	6.38	0.89	0.97	1.48	0.00	0.04	0.93	0.00	0.00
1960	31.61	10.24	1.95	3.94	0.00	0.05	2.25	0.00	0.00
1970	121.65	56.95	5.88	6.66	0.20	0.44	13.09	0.00	0.00
1980	303.96	166.79	20.17	10.13	1.75	1.20	44.55	0.00	0.41
1990	483.15	258.09	70.64	15.59	5.46	2.42	89.62	0.28	1.52
2000	542.20	259.18	82.09	16.40	8.16	2.83	141.76	12.70	11.43
2010	531.20	239.43	75.22	16.32	8.38	3.02	206.32	20.47	20.07
2015	517.31	230.98	72.02	16.02	8.46	3.14	233.33	24.22	22.19
2018	508.37	227.79	70.37	16.00	8.62	3.21	244.04	24.39	22.32
Unc.	*4.4*	*0.7*	*0.4*	*n.a.*	*n.a.*	*n.a.*	*4.5*	*0.6*	*0.6*
ERF	*0.163*	*0.059*	*0.021*	*0.005*	*0.002*	*0.001*	*0.051*	*0.004*	*0.004*

Notes: 1750/1850 from AR5. CFC-13 from Vollmer et al. (2016); until 1900-1979 from CMIP6 dataset in (Meinshausen et al., 2017), which was derived from NOAA and AGAGE network data, southern hemispheric air samples, archive air samples, firn air, and ice cores. 1980-1995 AGAGE, or data directly taken from merged AGAGE and NOAA networks, depending on date of availability for various components. Uncertainties pertain to 2010. N.a.: not available. ERF(2018-1750) from Chapter 7.

e) Historical abundances of the Montreal Greenhouse Gases: CH3CCl3, CCl4, CH3BR, CHCl3 and Halons

Year	CH3CCl3 (ppt)	CCl4 (ppt)	CH3Cl (ppt)	CH3Br (ppt)	CH2Cl2 (ppt)	CHCl3 (ppt)	Halon-1211 (ppt)	Halon-1301 (ppt)	Halon-2402 (ppt)
1750	0.00	0.03	457.00	5.30	6.91	4.50	0.00	0.00	0.00
1850	0.00	0.03	457.00	5.30	6.91	4.50	0.00	0.00	0.00
1900	0.00	0.03	457.00	5.30	6.91	4.50	0.00	0.00	0.00
1910	0.00	0.03	457.00	5.30	6.91	4.50	0.00	0.00	0.00
1920	0.00	1.18	457.00	5.30	6.91	4.50	0.00	0.00	0.00
1930	0.00	4.06	457.00	5.30	6.91	4.68	0.00	0.00	0.00
1940	0.00	14.09	457.00	5.66	6.91	4.93	0.00	0.00	0.00
1950	0.00	35.50	475.73	6.06	7.86	5.33	0.03	0.00	0.00
1960	1.70	53.21	512.23	6.50	10.46	6.04	0.02	0.00	0.00
1970	17.68	76.97	540.66	7.06	14.26	7.00	0.04	0.00	0.02
1980	85.93	93.84	548.50	7.77	17.86	8.26	0.71	0.38	0.15
1990	129.34	106.20	549.83	8.69	20.15	9.68	2.44	1.85	0.37
2000	45.46	98.04	547.45	8.99	18.35	7.52	4.13	2.82	0.48
2010	7.55	87.31	538.08	7.14	28.00	7.27	4.12	3.21	0.46
2015	3.08	81.65	546.99	6.65	37.51	8.67	3.66	3.31	0.42
2018	1.90	78.78	551.18	6.58	42.10	9.37	3.37	3.31	0.40
Unc.	*0.5*	*2.2*	*5*	*0.2*	*5*	*n.a.*	*0.1*	*0.1*	*0.2*
ERF	*0*	*0.013*	*0.001*	*0*	*0.001*	*0*	*0.001*	*0.001*	*0*

Notes: 1750/1850 from AR5. ERF(2018-1750) from Chapter 7.

Table AV.2: Effective Radiative Forcing (Wm^{-2}) timeseries from 1750-2018

year	CO2	CH4	N2O	Other WMGHG	O3 TROP	O3 STRAT	H2O STRAT	Contrails	Aerosol radiation interactions	Aerosol cloud interactions	BC on snow	Land use	Volcanic	Solar	Total anthropogenic	Total natural	Total
1750	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.07	0.00	0.26	0.26
1850	0.16	0.05	0.01	0.00	0.02	0.00	0.01	0.00	-0.01	-0.04	0.01	-0.02	0.18	-0.02	0.18	0.16	0.35
1900	0.36	0.12	0.03	0.00	0.05	0.00	0.02	0.00	-0.05	-0.26	0.01	-0.05	0.19	-0.06	0.23	0.13	0.36
1910	0.42	0.15	0.04	0.00	0.06	0.00	0.02	0.00	-0.07	-0.38	0.02	-0.06	0.19	-0.04	0.20	0.15	0.35
1920	0.51	0.17	0.05	0.00	0.08	0.00	0.02	0.00	-0.08	-0.41	0.02	-0.07	0.19	-0.02	0.29	0.17	0.46
1930	0.55	0.20	0.05	0.00	0.10	0.00	0.03	0.00	-0.10	-0.45	0.02	-0.08	0.18	0.00	0.32	0.18	0.50
1940	0.63	0.22	0.06	0.00	0.11	0.00	0.03	0.00	-0.12	-0.52	0.02	-0.08	0.18	0.02	0.36	0.20	0.56
1950	0.66	0.24	0.07	0.01	0.14	0.00	0.03	0.00	-0.15	-0.59	0.03	-0.09	0.18	0.03	0.35	0.21	0.57
1960	0.72	0.29	0.07	0.03	0.19	-0.01	0.04	0.01	-0.21	-0.77	0.04	-0.10	0.18	0.07	0.29	0.25	0.54
1970	0.86	0.36	0.09	0.08	0.23	-0.02	0.05	0.01	-0.33	-0.96	0.04	-0.11	0.08	0.05	0.30	0.13	0.43
1980	1.10	0.43	0.10	0.19	0.27	-0.04	0.06	0.02	-0.37	-1.03	0.05	-0.11	0.11	0.08	0.66	0.19	0.85
1990	1.34	0.49	0.12	0.30	0.30	-0.07	0.06	0.02	-0.37	-1.03	0.06	-0.11	0.14	0.08	1.13	0.22	1.35
2000	1.58	0.51	0.15	0.34	0.32	-0.06	0.07	0.03	-0.32	-0.93	0.06	-0.12	0.17	0.09	1.63	0.26	1.89
2010	1.88	0.52	0.17	0.36	0.34	-0.05	0.07	0.03	-0.33	-0.97	0.09	-0.12	0.14	-0.03	1.97	0.11	2.08
2015	2.03	0.53	0.18	0.37	0.35	-0.05	0.07	0.04	-0.30	-0.90	0.09	-0.12	0.14	0.01	2.30	0.15	2.44
2018	2.15	0.54	0.19	0.38	0.35	-0.05	0.07	0.04	-0.28	-0.83	0.08	-0.12	0.14	-0.05	2.53	0.09	2.62

Note:

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