The state of greenhouse gases in the atmosphere using global observations through 2010

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GLOBAL ATMOSPHERE WATCH

Executive summary

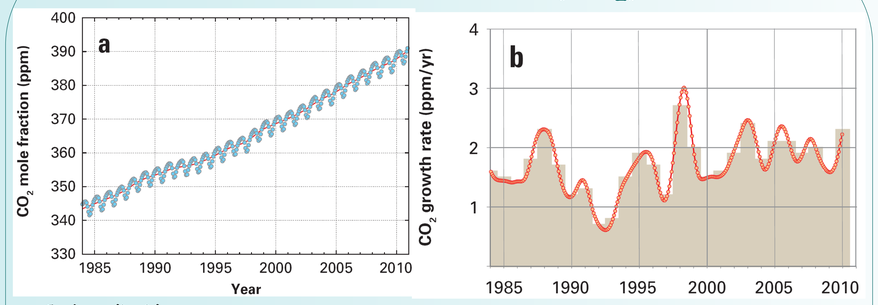
The latest analysis of observations from the WMO Global Atmosphere Watch Programme shows that the globally averaged mixing ratios of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) reached new highs in 2010, with CO_2 at 389.0 ppm, CH_4 at 1808 ppb and N_2O at 323.2 ppb. These values are greater than those in pre-industrial times (before 1750) by 39%, 158% and 20%, respectively. Atmospheric increases of CO_2 and N_2O from 2009 to 2010 are consistent with recent years, but they are higher than both those observed from 2008 to 2009 and those averaged over the past 10 years. Atmospheric CH_4 continues to increase, consistent with the past three years. The NOAA Annual Greenhouse Gas Index shows that from 1990 to 2010, radiative forcing by long-lived greenhouse gases increased by 29%, with CO_2 accounting for nearly 80% of this increase. Radiative forcing of N_2O exceeded that of CFC-12, making N_2O the third most important long-lived greenhouse gas.

Global abundances and increases for key greenhouse gases from the GAW global greenhouse gas monitoring network. Global abundances for 2010 are calculated as an average over twelve months.

	CO_2 (ppm)	CH_4 (ppb)	N_2O (ppb)
Global abundance in 2010	389.0	1808	323.2
2010 abundance relative to year 1750	139%	258%	120%
2009-10 absolute increase	2.3	5	0.8
2009-10 relative increase	0.59%	0.28%	0.25%
Mean annual absolute increase during last 10 years	1.97	2.6	0.75

Assuming a pre-industrial mixing ratio of 280 ppm for CO_2, 700 ppb for CH_4 and 270 ppb for N_2O

Carbon Dioxide (CO_2)



Carbon dioxide:
-contributes ~64% to radiative forcing by LLGHGs
- responsible for 85% of the increase in radiative forcing over the past decade
- and 81% over the last five years
- since 1750, atmospheric CO_2 has increased by 39%
- globally averaged CO_2 in 2010 was 389.0 ppm
- the increase from the year before was 2.3 ppm
- 2010 growth rate is higher than the average for the 1990s (~1.5 ppm/yr) and the average for the past decade (~2.0 ppm/yr)

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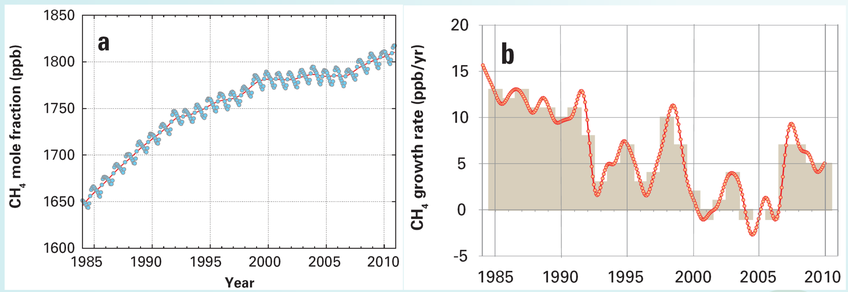
Methane (CH_4)



-**Methane** contributes ~18% to radiative forcing by LLGHGs
-anthropogenic sources account for around 60% of emissions
- before the industrial era, atmospheric methane was at ~700 ppb
- globally averaged CH_4 in 2010 was 1808 ppb
-the growth rate of CH_4 decreased from ~13 ppb/yr during the early 1980s to near zero from 1999 to 2006
-the 19 ppb rise from 2006 to 2009 was followed by a 5 ppb rise in 2010

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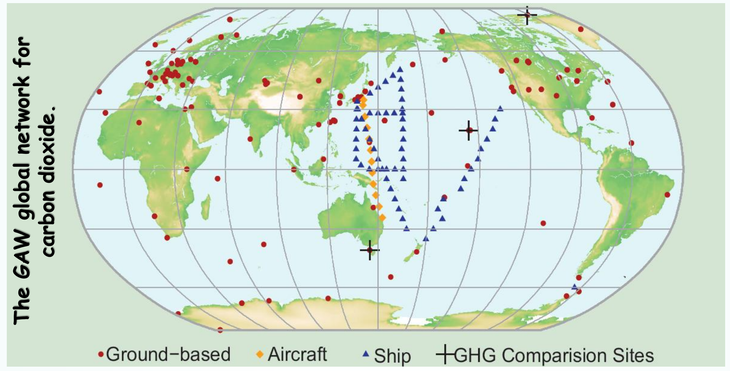
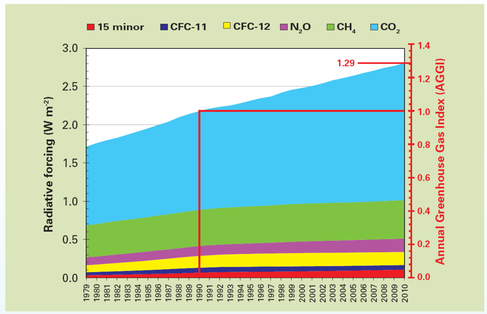
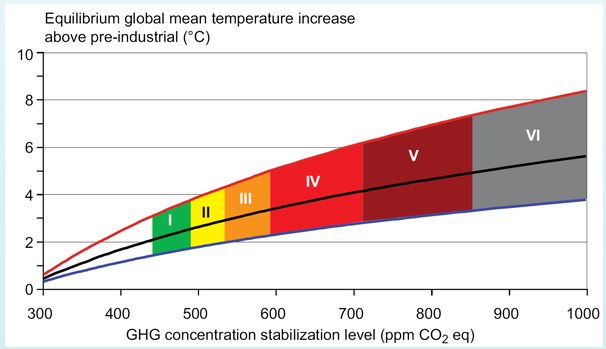




Atmospheric radiative forcing, relative to 1750, of all long-lived greenhouse gases and the 2010 update of the NOAA Annual Greenhouse Gas Index (AGGI). The reference year for the index is 1990 (AGGI = 1).

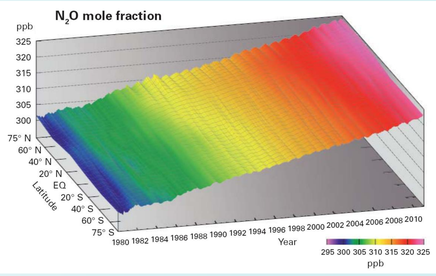
2010 level of total radiative forcing corresponds to CO_2-eq= 469.7 ppm



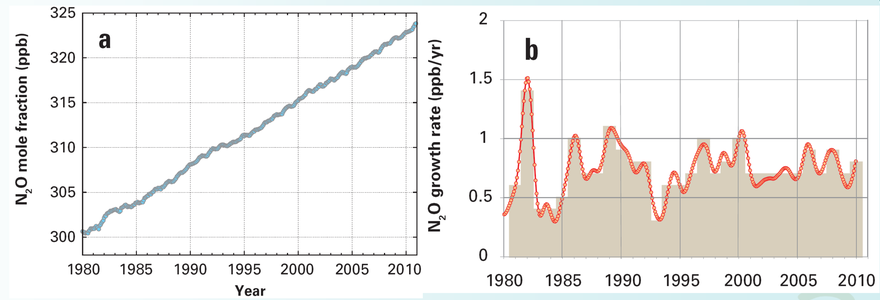
Relationship between global mean equilibrium temperature change and stabilization concentration of greenhouse gases using: (i) 'best estimate' climate sensitivity of 3 C (black), (ii) upper boundary of likely range of climate sensitivity of 4.5 C (red), (iii) lower boundary of likely range of climate sensitivity of 2 C (blue) – IPCC AR4, WG3

IMPACT

Nitrous oxide is now the third most important contributor to radiative forcing of long-lived greenhouse gases, recently surpassing CFC-12, and its impact on climate integrated over 100 years is 298 times greater than equal emissions of carbon dioxide (CO_2). It plays an important role in stratospheric ozone (O_3) destruction. The major anthropogenic source of N_2O to the atmosphere is the use of nitrogen containing fertilizers (including manure), which have profoundly affected the global nitrogen cycle. Reductions in the amounts of fertilizer applied to agricultural fields to better match the nitrogen needs of crops can reduce N_2O emissions. Such changes must be made carefully to avoid lower crop yields, which would raise concerns about global food security. The predominant use of fertilizers in the mid-latitudes of the northern hemisphere is responsible for the small inter-hemispheric gradient of ~1.2 ppb.



Nitrous Oxide (N_2O)



-**Nitrous oxide** contributes ~6% to radiative forcing by LLGHGs
-The third most important contributor to this total
-N_2O atmospheric abundance prior to industrialization was 270 ppb.
- anthropogenic sources may account for approximately 40% of total N_2O emissions
- globally averaged N_2O during 2010 reached 323.2 ppb
- increase from previous year is 0.8 ppb and that of from the pre-industrial level is 20%
- the mean growth rate has been 0.75 ppb/yr over the past 10 years

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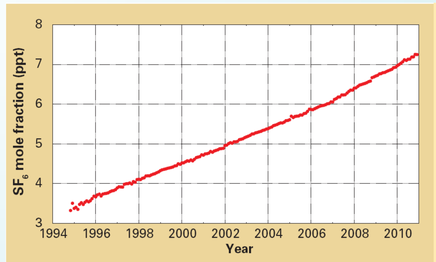
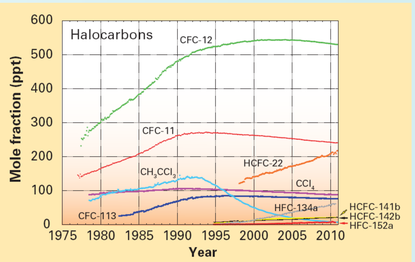
Other Greenhouse Gases



Monthly mean mole fraction of sulphur hexafluoride (SF_6) from 1995 to 2010 averaged over 18 stations.



Monthly mean mole fraction of the most important halocarbons from 1977 to 2010 averaged over the network (between 7 and 19 stations)

-SF_6 mixing ratio has increased to double that observed in the mid-1990s
-The ozone-depleting chlorofluorocarbons (CFCs), together with minor halogenated gases, contribute about 12% to radiative forcing by LLGHGs.
- While CFCs and most halons are decreasing, hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs), which are also potent greenhouse gases, are increasing at rapid rates, although they are still low in abundance
- Tropospheric ozone (O_3) has a relatively short lifetime. Its radiative forcing, however, appears to be comparable to that of the halocarbons, although much less certain.
- Many other pollutants (such as carbon monoxide, nitrogen oxides and volatile organic compounds), although insignificant as greenhouse gases, have an indirect effect on the radiative forcing through their impact on tropospheric ozone abundance.
-Aerosols (suspended particulate matter) are also short-lived substances that influence radiative forcing.

WMO GHG Bulletin is available on-line at www.wmo.int/gaw