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The state of greenhouse gases in the atmosphere using global observations through 2011

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The Global Atmosphere Watch (GAW) Programme of the World Meteorological Organization (WMO) provides a framework for global observations and assessment of the state and development of atmospheric composition, including greenhouse gases. It puts stringent requirements on the quality of the observations, and these requirements are evaluated every two years. Results of global analysis of the observational data are reported annually in the WMO/GAW Annual Greenhouse Gas Bulletin. Bulletin No. 8 represents the results for the year 2011. This bulletin highlights the importance of carbon sinks (ocean and terrestrial biosphere) for anthropogenic CO_2 emissions. Observations used for global analysis are collected at more than 100 sites worldwide for CO_2 and CH_4 and at a smaller number of sites for other greenhouse gases. Globally averaged dry-air mole fractions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) reached new highs in 2011, with CO_2 at 390.9 ± 0.1 ppm, CH_4 at 1813 ± 2 ppb and N_2O at 324.2 ± 0.1 ppb. These values constitute 140%, 259% and 120% of pre-industrial (before 1750) levels, respectively. The increase of the annual mean CO_2 mole fraction from 2010 to 2011 amounted to 2.0 ppm, which is greater than the average growth rate for the 1990s (~ 1.5 ppm/yr) and is equal to the average for the past decade (~ 2.0 ppm/yr). The globally averaged CH_4 mole fraction increased by 5 ppb from 2010 to 2011. The growth rate of CH_4 decreased from ~ 13 ppb/yr during the early 1980s to near zero during 1999–2006. Since 2007, atmospheric CH_4 has been increasing again, averaging ~ 5 ppb/yr. The growth rate of N_2O in 2011 was 1.0 ppb/yr, which is substantially greater than the average over the last 10 years (0.75 ppb/yr). The NOAA Annual Greenhouse Gas Index (AGGI) has been defined as the ratio of total radiative forcing due to long-lived greenhouse gases for any year for which adequate global measurements exist to that which was present in 1990. The AGGI in 2011 was 1.30 (corresponding to 2.84 W/m^2 of global radiative forcing, relative to 1750, of all long-lived greenhouse gases). The AGGI indicates an increase in radiative forcing by all long-lived greenhouse gases of 30% since 1990 and of 1.2% from 2010 to 2011, while the radiative forcing by all long-lived greenhouse gases in 2011 corresponded to a CO_2-equivalent mole fraction of 473 ppm (http://www.esrl.noaa.gov/gmd/aggi).