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The state of greenhouse gases in the atmosphere using global observations through 2012

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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. These requirements are reviewed by the greenhouse gas science and measurement community at biennial WMO/IAEA Meetings on Carbon Dioxide, Other Greenhouse Gases, and Related Tracer Measurement Techniques. The 17^{th} meeting was held in Beijing, China, on 10 – 14 June 2013 (http://ggmt-2013.cma.gov.cn/dct/page/1). Results of global analysis of the observational data are reported annually in the WMO/GAW Annual Greenhouse Gas Bulletin. Bulletin No. 9 represents an update of the results for the year 2012 (extended version is available at http://www.wmo.int/pages/prog/arep/gaw/ghg/ghg9-en-online.html). The cover story of this bulletin presents the attribution of methane sources in the context of the renewed growth of the global average methane mole fraction in 2007. The bulletin is prepared by the WMO/GAW Scientific Advisory Group for Greenhouse Gases (http://www.wmo.int/pages/prog/www/CBS/Lists_WorkGroups/CAS/opag-epac/gaw%20sag%20ghg) in collaboration with the World Data Center for Greenhouse Gases.

Observations used for global analysis are collected at more than 100 marine and terrestrial 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) derived from this network reached new highs in 2012, with CO_2 at 393.1$\pm$0.1 ppm, CH_4 at 1819$\pm$1 ppb and N_2O at 325.1$\pm$0.1 ppb. These values constitute 141%, 260% and 120% of pre-industrial (before 1750) levels, respectively. The increase of the annual mean CO_2 mole fraction from 2011 to 2012 amounted to 2.2 ppm, which is greater than the average growth rate for the 1990s ($\sim$1.5 ppm yr^{-1}) and for the past decade ($\sim$2.0 ppm yr^{-1}). The globally averaged CH_4 mole fraction increased by 6 ppb from 2011 to 2012. The growth rate of CH_4 decreased from $\sim$13 ppb yr^{-1} during the early 1980s to near zero during 1999–2006. Since 2007, atmospheric CH_4 has been increasing again, averaging $\sim$5 ppb yr^{-1}. The growth rate of N_2O in 2012 was 0.9 ppb yr^{-1}, which is greater than the average growth rate over the last 10 years (0.75 ppb yr^{-1}). 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 2012 was 1.32 (corresponding to 2.87 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 32% since 1990 and of 1.2% from 2011 to 2012, while the radiative forcing by all long-lived greenhouse gases in 2012 corresponded to a CO_2-equivalent mole fraction of 475.6 ppm (http://www.esrl.noaa.gov/gmd/aggi).