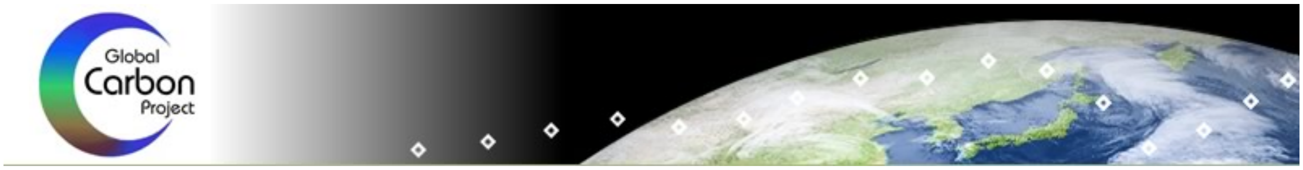

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Global Carbon Budget
Highlights

Emissions from fossil fuels and cement

CO_2 emissions from fossil fuels burning and cement production increased by 3% in 2011, with a total of 9.5±0.5 PgC emitted to the atmosphere (34.7 billion tonnes of CO_2). These emissions were the highest in human history and 54% higher than in 1990 (the Kyoto Protocol reference year). In 2011, coal burning was responsible for 43% of the total emissions, oil 34%, gas 18%, and cement 5%.

CO_2 emissions from fossil fuels burning and cement production are projected to increase by 2.6% in 2012, to a record high of 9.7±0.5 PgC (35.6 billion tonnes of CO_2).

CO_2 emissions from fossil fuel and other industrial processes are calculated by the Carbon Dioxide Information Analysis Center of the US Oak Ridge National Laboratory. For the period 1959 to 2009 the calculations were based on United Nations Energy Statistics and cement data from the US Geological Survey, and for the years 2010 and 2011 the calculations were based on BP energy data.

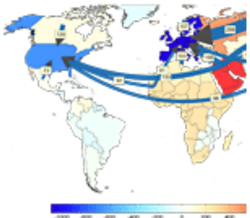
Uncertainty of the global fossil fuel CO_2 is estimated at ±5% (±1 sigma bounds based on the 10% at ±2 sigma bounds published by Andres et al. 2012).

Uncertainty of emissions from individual countries can be larger. The 2012 projection of 2.6% growth is based on the world GDP projection of 3.3% made by the International Monetary Fund and our estimate of improvements in the fossil intensity of the economy of 0.7%.

Regional fossil fuel emissions

The biggest contributors to global emissions in 2011 were China (2.5 PgC, 28%), the United States (1.5 PgC, 16%), the European Union (EU27; 1.0 PgC, 11%), and India (0.6 PgC, 7%). Contributions to global emissions growth in 2011 were largest from China (0.226 PgC above 2010 levels, 9.9% growth) and India (0.043 PgC, 7.5%). Emissions from USA were down by 0.028 (-1.8%) and EU27 down by 0.029 PgC

(-2.8%). Developing nations accounted for 60% of all emissions in 2011. Average per capita emissions of developed countries (Annex B) were 3.0tC/person, several times larger than those of developing countries (non-Annex B) which were 0.9tC/person. China's per capita emissions were 1.8 tC/person and are now close to the average of 2.0 in the EU-27. India's per capita emissions were much below at 0.5 tC/person.



Consumption-based fossil fuel emissions

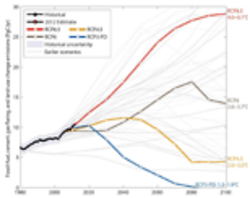
Consumption-based emissions allocate emissions to where goods and services are consumed (not where they are produced and emissions released). The net emission transfer via international trade between developing countries (non-Annex B countries) and developed countries (Annex B countries) has increased from 0.03 PgC in 1990 to 0.38 PgC in 2010, with an average annual growth rate of 10%. The increase in net emission transfers of 0.35 PgC from 1990 to 2008 compares with the emission reduction of 0.2 PgC in developed countries.

This accounting framework tries to address the growing issue of countries outsourcing CO_2 emissions by consuming goods, which are manufactured outside of the country. In 2010 (the latest year with consumption data), the biggest emitters from a territorial-based perspective were China (26%), USA (18%), EU (12%), and India (7%), while the biggest emitters from a consumption-based perspective were China (22%), USA (18%), EU (15%), and India (6%).

Emissions from land-use change

CO_2 emissions from deforestation and other land-use change were 0.9±0.5 PgC in 2011. For the period 2002-2011, land-use change emissions accounted for 10% of all emissions from human activity (fossil fuel, cement, land-use change). The data suggest an overall decrease trend in land-use change emissions particularly since 2000. The implementation of new land policies, higher law enforcement to stop illegal deforestation, and new afforestation and regrowth of previously deforested areas could all have contributed to this decline.

Total emissions from human activity in 2011 (fossil fuel, cement, land-use change) were 10.4±0.7 PgC. Emissions from land-use change were 36% of the total human emissions in 1960, 18% in 1990, and 9% in 2011. Uncertainty for all land-use change emission estimates remains large. CO_2 emissions from land-use change are mainly based on forest statistics of the Food and Agriculture Organization and a bookkeeping method, and include interannual variability in deforestations based on fire activity from year 1997 onwards.



Emission pathways

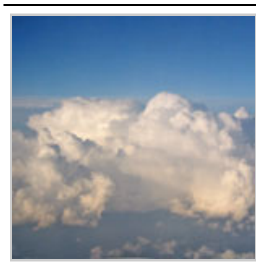
Current trajectories of fossil fuel emissions are tracking some of the most carbon intensive emission scenarios used in the Intergovermental Panel of Climate Change (IPCC). The current trajectory is tracking the Representative Concentration Pathway 8.5 (of the latest family of IPCC scenarios) that takes the planet to about 4°C to 6.1°C above pre-industrial times by 2100.

Long-term emissions scenarios are designed to represent a range of plausible emission trajectories as input for climate change research. The IPCC process has resulted in four generations of emissions scenarios: Scientific Assessment 1990 (SA90), IPCC Scenarios 1992 (IS92), Special Report on Emissions Scenarios (SRES), and the evolving Representative Concentration Pathways (RCPs) to be used in the upcoming IPCC Fifth Assessment Report. The RCPs were developed by the research community as a new, parallel process of scenario development, whereby climate models are run using the RCPs while simultaneously socioeconomic and emission scenarios are developed that span the range of the RCPs and beyond.

CO_2 removals by natural sinks

Of the total emissions from human activities during the period 2002-2011, 46% accumulated in the atmosphere, 26% in the ocean and 28% on land. During this period, the size of the natural sinks have grown almost at the same pace as the growth in emissions, although year-to-year variability is large. Climate phenomena such as the warm Southern Oscillation-El Niño can even turn the net land sink into a net source for brief periods.

The ocean sink is estimated by using an ensemble of 6 ocean-process models for 1959-2009, and with a subset of these models for 2010-11. The models were normalized to the observed mean land and ocean sinks for 1990-2000, estimated from a range of oceanic and atmospheric observations. Models were forced with meteorological data from the US national Centers for Environmental Prediction and atmospheric CO_2 concentration . The land sink is calculated as the residual of the sum of all sources minus the sum of the atmosphere and ocean sinks.



Atmospheric CO_2

The annual growth rate of atmospheric CO_2 was 1.70±0.09 ppm in 2011 (ppm = parts per million), slightly below the average growth rate of 2 ppm of the past 10 years (2002-2011). The average growth rate for the decade 1990-1999 was 1.5±0.1 ppm, and was 1.6±0.1 for the decade 1980-1989. The atmospheric CO_2 concentration was 390 ppm in 2011 on average, 40% above the concentration at the start of the Industrial Revolution (about 278 ppm in 1750). The

present concentration is the highest during at least the last 800,000 years.

The accumulation of atmospheric CO_2 in 2011 was 3.6±0.2 Pg C, with a total cumulative of 161.3 PgC since the beginning of atmospheric high precision measurements in 1959 and 240 PgC since 1750. The rates of atmospheric CO_2 accumulation are influenced by both the anthropogenic emissions and the net uptake by natural sinks (ocean and land), and their interannual variability is large.

Accumulation of atmospheric CO_2 is the most accurately measured quantity in the global carbon budget. The uncertainty around the annual growth rate based on the multiple stations dataset ranges between 0.11 and 0.72 PgC yr1, with a mean of 0.61 PgC yr1 for 1959–1980 and 0.18 PgC yr1 for 1980–2011, when a larger set of stations were available.

The data is provided by the US National Oceanic and Atmospheric Administration Earth System Research Laboratory and includes data from the Scripps Institution of Oceanography.