

Update on CO₂ emissions

To the Editor — Emissions of CO₂ are the main contributor to anthropogenic climate change. Here we present updated information on their present and near-future estimates. We calculate that global CO₂ emissions from fossil fuel burning decreased by 1.3% in 2009 owing to the global financial and economic crisis that started in 2008; this is half the decrease anticipated a year ago¹. If economic growth proceeds as expected², emissions are projected to increase by more than 3% in 2010, approaching the high emissions growth rates that were observed from 2000 to 2008^{1,3,4}. We estimate that recent CO₂ emissions from deforestation and other land-use changes (LUCs) have declined compared with the 1990s, primarily because of reduced rates of deforestation in the tropics⁵ and a smaller contribution owing to forest regrowth elsewhere.

Fossil fuel CO₂ emissions for the globe are computed from statistics on energy consumption at the country level^{6,7} and converted to CO₂ emissions by fuel type⁸. The growth in CO₂ emissions closely follows the growth in Gross Domestic Product (GDP) corrected for improvements in energy efficiency⁴. Thus, the contraction of GDP owing to the global financial crisis that began in 2008 was expected to cause a decrease in global CO₂ emissions. Emissions in 2008 grew at a similar rate to the previous eight years, but they decreased by 1.3% in 2009. Despite this drop, the 2009 global fossil fuel and cement emissions were the second highest in human history at 8.4 ± 0.5 Pg C (30.8 billion tons of CO₂), just below the 2008 emissions⁷.

This global decrease hides large regional differences. The largest decreases occurred in Europe, Japan and North America (for example, USA -6.9%, UK -8.6%, Germany -7%, Japan -11.8%, Russia -8.4%), whereas some emerging economies recorded substantial increases in their total emissions (for example, China +8%, India +6.2%, South Korea +1.4%).

The observed decrease of 1.3% in global fossil fuel emissions in 2009 is less than half of the decrease of 2.8% projected a year ago¹. That projection used a forecast from the International Monetary Fund for the annual real growth in world GDP² and assumed that the carbon intensity of world GDP (that is, the fossil fuel emissions per unit of GDP) would continue to improve following a

long-term trend reduction of carbon intensity of -1.7% yr⁻¹. The decrease in emissions was lower than projected for two reasons. First, the actual decrease² in GDP (-0.6%) was lower than forecast in October 2009 (-1.1%) because of continuing high GDP growth in China (+9.1%) and other emerging economies. Second, the carbon intensity of world GDP improved by only -0.7% in 2009, less than half of its long-term average, because of an increased share of fossil fuel CO₂ emissions coming from emerging economies with a relatively high carbon intensity and an increasing reliance on coal. Both globally and for emerging economies, the fraction of fossil fuel emissions from coal increased in 2009, as in 2008¹.

As the global economy recovers, the world GDP is projected to increase by 4.8% in 2010². Even if the carbon intensity of world GDP improves following its long-term average, global emissions will have increased again by more than 3% in 2010 (Fig. 1).

Historical CO₂ emissions from LUC were revised and updated to 2009 using new data on forest cover and land use — reported by each country and compiled by the Food and Agricultural Organization⁵ — and a LUC emission model⁹. The estimate of average 2000 to 2009 LUC emissions of 1.1 ± 0.7 Pg C yr⁻¹ has been revised downwards from the estimate that was made in 2009¹ (Fig. 1), primarily because of a downward revision of the rates of deforestation in tropical Asia. LUC emissions for the past decade are now lower than their 1990s level (1.5 ± 0.7 Pg C yr⁻¹), although the decadal difference is still below the uncertainty in the data and method. A recent decrease in LUC emissions would be consistent with the reported downward trends of deforestation detected from satellite data in the Brazilian Amazon¹⁰ and Indonesia¹¹. Temperate forest regrowth in Eurasia has constantly increased since the 1950s at a rate of 0.2 Pg C yr⁻¹ per decade. For the first time, according to our estimate, forest regrowth has overcompensated LUC emissions at temperate latitudes and has resulted in a small net sink of CO₂ (< 0.1 Pg C yr⁻¹) since 2000 in these latitudes.

Atmospheric CO₂ continued to increase, reaching a globally averaged concentration of 387.2 ppm at the end of 2009¹². The increase in atmospheric CO₂ of 3.4 ± 0.1 Pg C yr⁻¹ was among the lowest since 2000. This cannot be explained by

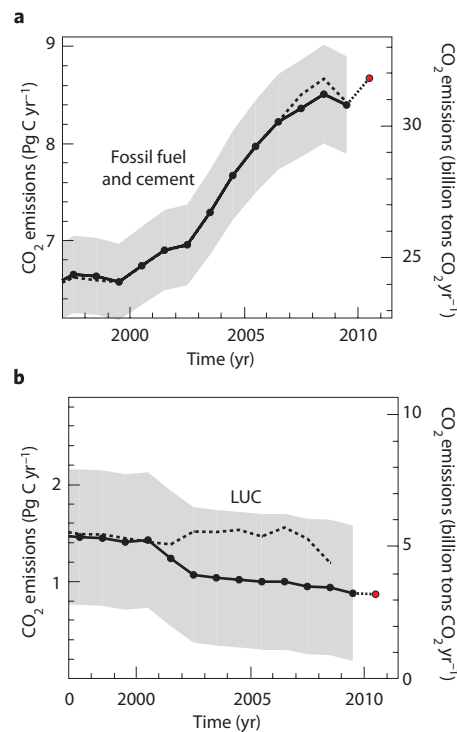


Figure 1 | Global CO₂ emissions since 1997 from fossil fuel and cement production (a) and LUC (b). Fossil fuel CO₂ emissions were based on United Nations Energy Statistics to 2007, and on BP energy data from 2007 onwards^{6,7}. Cement CO₂ emissions are from the US Geological Survey. LUC CO₂ emissions were based on the revised statistics of the Food and Agricultural Organization^{5,9}. Both sources of emissions are updated from ref. 1 (shown in black dashed line). Projections for 2010 are included in red.

the decrease in CO₂ emissions alone but is mainly caused by an increase in the land and ocean CO₂ sinks in response to the tail of the La Niña event that perturbed the global climate system from mid 2007 until early 2009. □

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