Record High for Global Greenhouse Gas Emissions

Katie Auth | November 27, 2013

As climate negotiators, experts, and activists assembled in Warsaw, Poland, hoping to lay the groundwork for a global climate agreement in 2015, newly released data revealed continued growth in emissions of atmospheric carbon dioxide (CO₂) and other major greenhouse gases, as well as a shifting geographic distribution of emissions.

According to the Global Carbon Project, CO₂ emissions from fossil fuel combustion and cement production reached 9.7 gigatons of carbon (GtC) in 2012, with a ±5 percent uncertainty range.¹ This is the highest annual total to date—and it is 58 percent higher than emissions in 1990, the year often used as a benchmark for emissions trends.² Coal (43 percent) and oil (33 percent) accounted for the majority of these emissions, with natural gas (18 percent), cement production (5 percent), and flaring (1 percent) making up the remainder.³ (See Figure 1.) The Global Carbon Project’s projection for 2013 is 9.9 ± 0.5 GtC, indicating growth of approximately 2 percent.⁴

Recent U.S. government and World Bank moves to limit international financing for new coal projects signal a desire to shift away from this particularly carbon-intensive resource.⁵ For now, however, coal remains a major driver of CO₂ emissions. Although it made up 43 percent of global emissions in 2012, coal accounted for 54 percent of the increase that year, reflecting in part rising coal use in countries currently undergoing energy sector transitions.⁶ Coal-related emissions increased, for example, in Germany (4.2 percent) and Japan (5.6 percent)—both of which are phasing out nuclear power plants.⁷ Oil, gas, and cement accounted for 18 percent, 21 percent, and 6 percent of the global increase in 2012 respectively.⁸ (See Figure 2.)

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¹. [Global Carbon Project](http://carbontracker.org)
². [International Energy Agency](http://www.iea.org)
³. [World Bank](http://www.worldbank.org)
⁴. [Carbon Dioxide Information Analysis Center](http://cdiac.ornl.gov)
⁵. [World Bank](http://www.worldbank.org)
⁶. [International Energy Agency](http://www.iea.org)
⁷. [National Nuclear Safety Administration](http://www.nnsa.doe.gov)
⁸. [World Bank](http://www.worldbank.org)

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Figure 1. | Share in 2012 CO₂ emissions from fossil fuels and cement (%)

- Coal
- Oil
- Gas
- Cement
- Flaring

Figure 2. | Share in 2012 increase in CO₂ emissions from fossil fuels and cement (%)

- Coal
- Oil
- Gas
- Cement
- Flaring
Although CO₂ is the primary greenhouse gas emitted through human activities, it is not the only one with significant warming effects. Other major long-lived greenhouse gases include methane (CH₄), nitrous oxide (N₂O), and chlorofluorocarbons (CFCs), particularly CFC-12 and CFC-11. Each gas’s contribution to climate change depends on such factors as the length of time it remains in the atmosphere, how strongly it absorbs energy, and its atmospheric concentration.

Primarily as a result of fossil fuel combustion as well as deforestation and land use change, the mean atmospheric concentration of CO₂ stood at approximately 393.9 parts per million (ppm) in 2012, an increase of more than 40 percent since 1750 and of 24 percent since the Scripps Institution of Oceanography began keeping records in 1959; the Institution’s initial 2013 average from January through September is 396.2 ppm. (See Figure 3.) Scientists have suggested that the CO₂ concentration will need to be reduced to at least 350 ppm if we hope to maintain a climate similar to that which has supported human civilization to date. Atmospheric CO₂ concentration increased by 2.2 ppm in 2012 alone, which exceeds the average annual increase over the past 10 years. The slightly lower annual increase in 2011 (1.84 ppm) has been attributed in part to unusually high levels of land carbon uptake in 2010 and 2011 associated with La Niña weather patterns.

The atmospheric concentrations of other major long-lived greenhouse gases have also increased. Globally averaged CH₄ concentration increased by 6 parts per billion (ppb) in 2012, reaching a new high of approximately 1,819 ppb. CH₄ is the third most abundant greenhouse gas in the atmosphere, after CO₂ and water vapor; on a per molecule basis, however, methane has a more potent warming impact on the climate. Although atmospheric CH₄ levels declined during 1983–99 and remained relatively constant during 1999–2006, they have been increasing since 2007. Attributing this renewed growth rate to specific factors is difficult, but some analysts suggest that the causes include warm Arctic temperatures and increased precipitation in the tropics. The measured concentration in 2012 represents an overall increase of approximately 169 percent since 1750.

The increasing concentration of these gases in the atmosphere has significant warming impacts. The combined heating effect (or “radiative forcing”) of major long-lived GHGs (particularly CO₂, CH₄, N₂O, CFC-12, and CFC-11), as measured by the Annual Greenhouse Gas Index of the U.S. National Oceanic and Atmospheric Administration, reached 1.32 in 2012. This indicates a 32 percent increase...
since 1990 and a 63 percent increase since 1980.20 Because of its abundance, CO₂ has played a particularly large role in this, accounting for approximately 80 percent of radiative forcing by long-lived GHGs between 1990 and 2012.21 (See Figure 4.) A significant decline in the global use of CFCs has limited net radiative forcing. If the 1987 Montreal Protocol had not regulated these ozone-depleting gases, it is estimated that they would have contributed additional radiative forcing equivalent to more than half that of CO₂ between 1990 and 2012.22

Although in 2010 the parties to the United Nations Framework Convention on Climate Change agreed that the increase in average global temperature since the pre-industrial period must be kept below 2 degrees Celsius, many projections now put the climate on track for warming that is significantly above that. The Global Carbon Project foresees a 3.2–5.4 degrees Celsius “likely” increase in temperature.23 A World Bank report projects an approximate 20 percent likelihood of exceeding a 4 degrees Celsius increase by 2100 if current mitigation commitments and pledges are not fully implemented.24

Emissions data from 2012 also highlight the shifting geographical and historical complexity that makes international negotiations so contentious. Global distribution of emissions in 2012 looks very different than it did in 1990, when the Kyoto Protocol was established. At that time, industrial countries accounted for 62 percent of emissions; by 2012, that figure had dropped to 37 percent, reflecting rapid industrialization and development in emerging economies and shifting patterns in production and consumption.25

Annual growth rates highlight the rapidly growing climate importance of large, emerging economies. China’s emissions rose by 5.9 percent in 2012, an increase that accounted for 71 percent of that year’s global increase.26 The United States and Australia, although both still major emitters, experienced reductions of 0.05 percent and 11.6 percent respectively.27 In 2012, the top four emitters of CO₂ were China (2,625.73 million tons of carbon, or MtC), the United States (1,396.791 MtC), India (611.2263 MtC), and the Russian Federation (491.8403 MtC).28

**Figure 4. | Global Radiative Forcing by GHG (1990-2012)**
Fossil fuel and cement emissions in these countries have been on dramatically different trajectories, making for contentious relations between U.S. and Chinese climate negotiators.\textsuperscript{29} (See Figure 5.) Although China now accounts for more emissions than the United States does, the U.S. cumulative total since 1959 of 68,908 MtC is still 71 percent higher than that of China, the next largest emitter at 40,279.22 MtC.\textsuperscript{30} In 2012, per capita emissions in China equaled those of the 28 members of the European Union at 1.9 tons—still far below the U.S. figure of 4.4 tons but significant in highlighting changing distribution patterns.\textsuperscript{31}

Although international climate negotiations have traditionally focused on the role and responsibility of nation states, new analyses point to the significant role of corporate entities in emitting greenhouse gases. Overall, investor-owned corporations have been responsible for 21.71 percent of CO\textsubscript{2} and CH\textsubscript{4} fossil fuel and cement emissions since 1750, with state-owned corporations responsible for an additional 19.84 percent, highlighting potential new ways to frame responsibility for climate mitigation.\textsuperscript{32}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure5.png}
\caption{Trends in Share of Global Fossil Fuel and Cement CO\textsubscript{2} Emissions}
\end{figure}

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Boden, Marland, and Andres, op. cit. note 1.


Le Quéré et al., op. cit. note 4.

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Boden, Marland, and Andres, op. cit. note 1.


Le Quéré et al., op. cit. note 4.

WMO, op. cit. note 12.


The Fourth Assessment Report of the Intergovernmental Panel on Climate Change defines “radiative forcing” as “a measure of the influence a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system and is an index of the importance of the factor as a potential climate change mechanism.”

Butler and Montzka, op. cit. note 16.

Ibid.

Ibid.

Le Quéré et al., op. cit. note 4.


Le Quéré et al., op. cit. note 4.

Boden, Marland, and Andres, op. cit. note 1.
27 Ibid.
28 Ibid.
29 Ibid.
31 Boden, Marland, and Andres, op. cit. note 1.