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Monitoring global carbon emissions in 2022

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Global CO_2 emissions for 2022 increased by 1.5% relative to 2021 (+7.9% and +2.0% relative to 2020 and 2019, respectively), reaching 36.1 $GtCO_2$. These 2022 emissions consumed 13%–36% of the remaining carbon budget to limit warming to 1.5 °C, suggesting permissible emissions could be depleted within 2–7 years (67% likelihood).

The COVID-19 pandemic caused a record annual reduction in global carbon emissions in 2020, decreasing by 5.4% (1.9 $GtCO_2$) when compared with 2019 (refs. [1,2]). However, this drop was short-lived, as evidenced by global CO_2 emissions rebounding to near pre-pandemic levels in 2021, increasing by 6.3% (2.1 $GtCO_2$) (refs. [3–5]). Given the short timeline to meet international climate goals, and so limit anthropogenic warming to 1.5 or 2 °C, detailed and near-real-time tracking of global emissions is crucial. Here, we present and analyse daily, national and sector-specific CO_2 emissions for 2022 using near-real-time data from the Carbon Monitor project[1,2].

Global CO_2 emissions in 2022

In 2022, global CO_2 emissions from fossil fuel combustion and cement production reached 36.1 ± 0.3 $GtCO_2$ (Fig. 1). In comparison, emissions were 35.3, 33.4 and 35.5 $GtCO_2$ in 2019, 2020 and 2021, respectively, reflecting 2022 increases of 2.0%, 7.9% and 1.5% relative to those years. This 2021 to 2022 growth of 1.5% (0.9–2.6%) suggested by Carbon Monitor data is broadly consistent with other predictive approaches based on energy consumption, including 1.0 ± 0.9% growth projected by the Global Carbon Project (GCP)[6] and <1.0% from the International Energy Agency (IEA)[7]. These changes indicate recovery from the sharp COVID-19-related decrease in 2020, followed by growth beyond pre-pandemic levels. Accordingly, global CO_2 emissions might have returned to a pre-pandemic trend of continuous growth, suggesting that the peak of emissions has not yet been reached.

The sectoral breakdown of 2022 CO_2 emissions reveals broadly consistent patterns to previous years. Power accounted for 39.3% of the CO_2 emissions total, industry 28.9%, ground transportation 17.9%, residential 9.9%, international bunkers (international aviation and shipping) 3.1%, and domestic aviation 0.9%. In comparison to the rapid rebound in most sectors during 2021, the rate of emission increase slowed in 2022 (power: from + 6.9% to + 0.8%; industry: from + 5.7% to + 1.1%; ground transportation: from + 8.8% to + 2.5%; domestic aviation: from + 25.5% to −0.9%). The exception is for the international aviation sector, which saw a 44% rise in emissions during 2022 relative to 2021. Yet, international aviation carbon emissions have still not fully recovered and remain 25% lower than pre-pandemic levels of 2019.

While the sectoral breakdown remained similar, emissions from the world's top five emitters (23.3 $GtCO_2$ in total, contributing 65% of the global total) changed substantially in 2022. For example, China, the world's largest emitter, exhibited the first reduction in CO_2 emissions, perhaps due to the extended zero-COVID policy; year-on-year emissions grew 1.2% in 2020 (despite the pandemic) and 6.0% in 2021, but dropped 1.5% in 2022. However, emissions still remain 5.6% higher than pre-pandemic levels in 2019. USA and EU emissions increased by 3.2% and 0.5%, respectively, in 2022 (from 2021), reaching only slightly different levels to 2019 (0.9% less in the USA, and 0.4% higher in the EU). India's emissions continued to grow rapidly, increasing by 7% in 2022 relative to 2021 (7.9% higher than in 2019) and are on pace to surpass the EU as the world's third largest emitter in 2023. Emissions in Russia, the fifth largest emitter, increased each year from 2019 to 2021, but fell by 1.8% in 2022.

Thus, while most sectors and countries saw a 2022 slowdown in emission growth compared to 2021, the continued increase suggests that the global peak in emissions has yet to be reached. While the Intergovernmental Panel on Climate Change (IPCC)'s prediction that global emissions won't peak before 2025 remains consistent, this continued growth will further shrink the remaining carbon budget.

Carbon budget countdown

Estimates of the amount of carbon that can still be emitted while constraining anthropogenic warming to prescribed levels offer useful insights to track progress. According to the 2021 IPCC report[8], the remaining carbon budget starting from 2020 to limit anthropogenic warming to 1.5 °C and 2 °C above pre-industrial levels, is 400 $GtCO_2$ and 1,150 $GtCO_2$, respectively, with 67% likelihood, or 300 $GtCO_2$ and 900 $GtCO_2$ with 83% likelihood.

Global CO_2 emissions (including emissions from fossil and cement production, as well as land-use changes[6]) are rapidly depleting this budget. For example, with no overshooting scenarios, 2022 emissions used 10.0% of the 1.5 °C budget (67% likelihood), building on 9.9% from 2021 and 9.4% during 2020. Thus, 283 $GtCO_2$ remains. If the current growth rate of emissions persists, the 1.5 °C budget will therefore be exhausted within only 7.1 years (67% likelihood). For the 2 °C budget of 1,150 $GtCO_2$ (67% likelihood), 3.5% was used in 2022, leaving 1,033 $GtCO_2$; if emissions continue as they are, only 25.8 years remain until the budget is empty, 4.2 years earlier than previous estimates[3].

Newer estimates, however, indicate a smaller carbon budget than those of the IPCC. Specifically, starting from January 2022, it has been suggested that achieving the 1.5 °C Paris Agreement target leaves only 300 $GtCO_2$ with a 50% likelihood or 110 $GtCO_2$ with 66% likelihood[9]. According to this total, 2022 emissions used 36.5% of the 1.5 °C budget (66% likelihood), leaving 70 $GtCO_2$. If emissions continue, this budget would be used within 1.7 years. For 2 °C, only 1,265 $GtCO_2$ or 990 $GtCO_2$ remains with 50% and 66% likelihood, respectively. 2022 emissions used 4.1% of the 2 °C budget (66% likelihood), leaving 950 $GtCO_2$, which

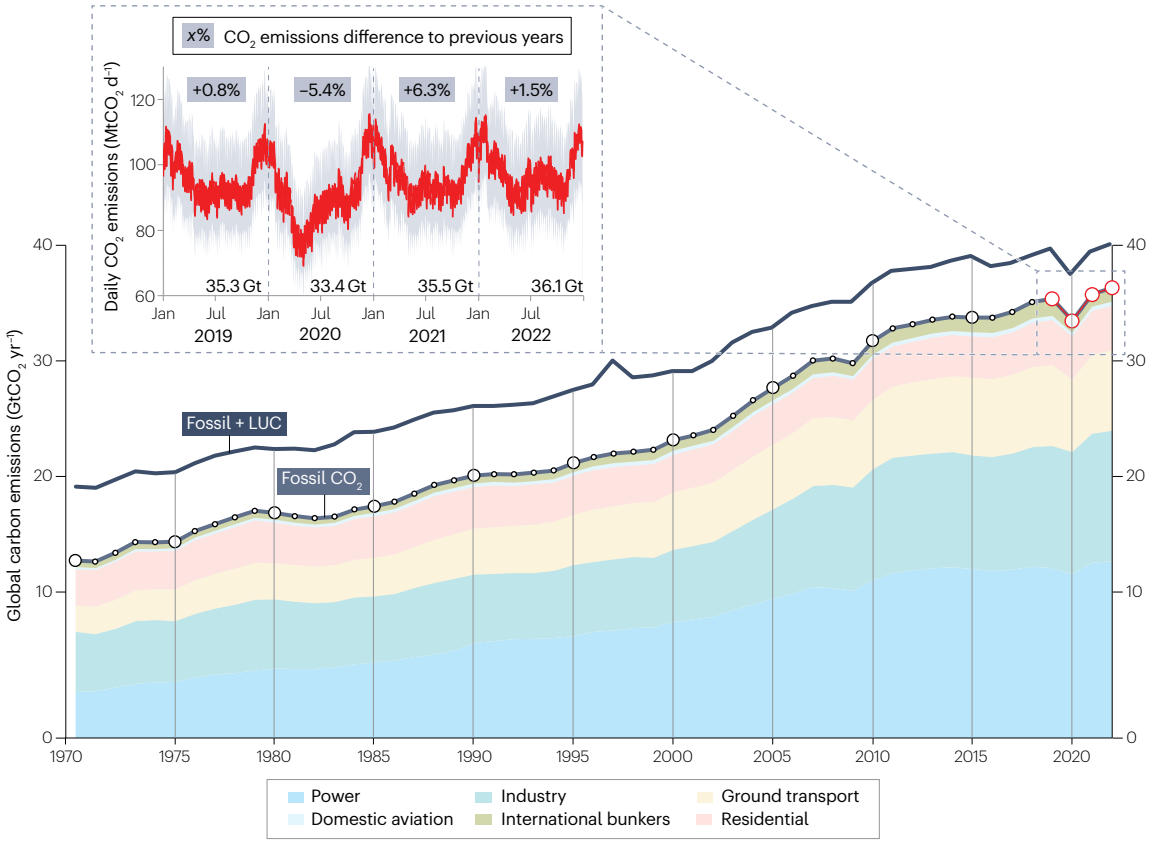

Fig. 1 | Global CO_2 emissions 1970–2022. Historical CO_2 emissions from fossil fuel combustion and the process of cement production ('Fossil CO_2')[10] coloured by industry sector, and those with land-use change (LUC) emissions[6] ('Fossil + LUC'). International bunkers describe emissions from international aviation and international shipping. The inset displays daily near-real-time CO_2 emissions since 2019 from the Carbon Monitor[1,2] initiative and year-on-year percent changes. Note that total emissions and percent changes have been revised slightly from earlier estimates[3]. Global CO_2 emissions continue to grow after a brief decline in 2020, which if it persists, it will use up the remaining 1.5 °C carbon budget within 2–7 years.

will be used up in 23.7 years. When considering the non-CO_2 contributors to anthropogenic warming, such as methane, nitrous oxide, and fluorinated gases, the remaining carbon budget becomes even smaller[9].

These estimates reveal that global carbon emissions continue to increase despite ongoing efforts to reduce fossil energy use, and as such, the time to meet international climate targets is dwindling. Accordingly, sectors such as power, transportation and industry, which contribute the largest to global CO_2 emissions, should make deeper decarbonization efforts and increase the proportion of renewable energy consumption. Furthermore, countries should take immediate action to achieve their net-zero commitments, requiring international cooperation and coordinated efforts to support the transition to a low-carbon economy and to ensure the success of global climate efforts. Continued monitoring of emissions in near-real-time is useful in determining as early as possible whether and to what extent mitigation efforts are successful.

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Competing interests

The authors declare no competing interests.

Related links

Carbon Monitor: https://carbonmonitor.org/