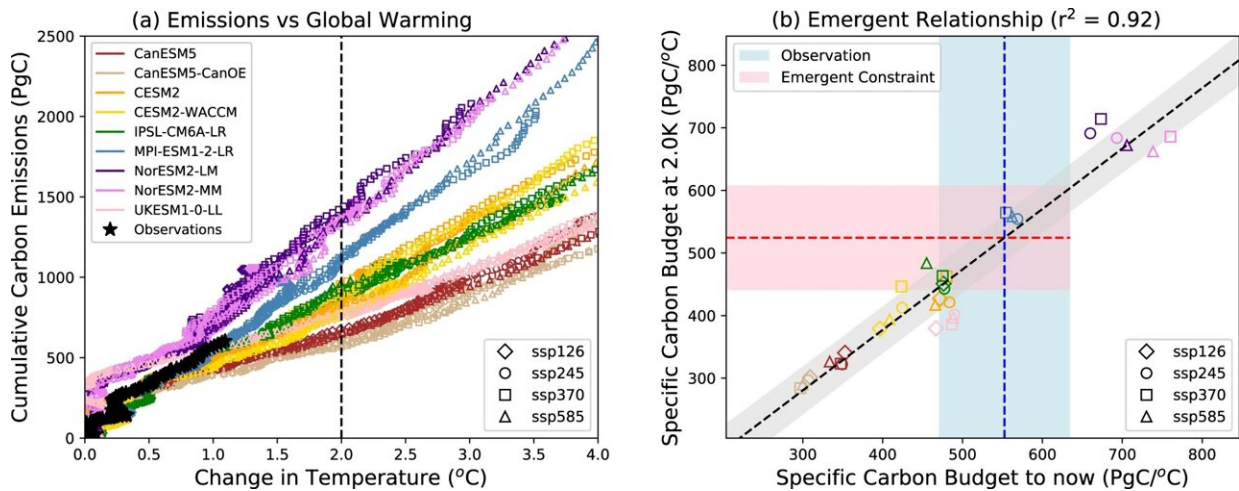


# A better handle on the emissions budget for the Paris climate targets

March 8 2024, by Alex Morrison



Relationship between cumulative emissions and global warming, for the historical simulations plus four different SSP scenarios (ssp128, ssp245, ssp370, ssp585). Panel (a) plots cumulative emissions since 1850 (diagnosed using Eq. 1) against global warming since 1850 for each of the nine CMIP6 ESMs (colored symbols) and the Global Carbon Project (GCP) plus global mean temperature observations (black stars). The values shown here are 10-year centered means to minimize the impact of interannual variability. The different symbols denote mean values taken from each of the SSP scenarios. Panel (b) shows the emergent relationship between the specific carbon budget (in PgC/°C) for 2 °C of global warming and the specific carbon budget to ‘now’ (based on the 10-year means for 2011 to 2020). The vertical blue dashed line shows the observational estimate of the latter, with the light-blue bar showing an estimate of the (66%) uncertainty in this estimate. The horizontal pink bar shows the resulting emergent constraint on the specific carbon budget for 2 °C of global warming, with the red dashed line indicating the central estimate. Credit: *Nature Communications* (2024). DOI:

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A team of scientists from the University of Exeter, Met Office, and Imperial College have found a new way to calculate the total carbon emissions consistent with the Paris climate targets of 1.5°C and 2°C of global warming.

Although the exceptionally warm climate in 2023 was close to exceeding the 1.5°C level, the Paris targets relate to the average warming over ten or more years.

The new study answers the question: how much carbon have we got left before we pass the Paris limits?

About 15 years ago, [climate scientists](#) discovered a remarkably useful fact about climate change. Despite the vast complexity of the climate system, global warming depends overwhelmingly on the total carbon dioxide emissions since pre-industrial times.

This discovery opened up the possibility of defining total carbon budgets consistent with the Paris targets and led to the definition of Net Zero as the point at which global warming essentially stops. The problem is that the Earth System Models used to make climate projections disagree hugely about how much global warming we will get for a billion tons of carbon emissions.

The new study solves this problem by showing that observed global warming and estimated carbon emissions up to the current day are a really good indicator of how much [carbon emissions](#) are left before we pass the Paris climate targets. The authors do this by what they call an "Emergent Constraint," which is a fancy name for something quite

simple.

Basically, they look at results from all of the available Earth System Models, which form a lovely straight line linking emissions per °C of global warming up to now with emissions for a given level of future global warming. This means that the best estimates of [global warming](#) and emissions up to the current day can be converted simply into estimates of the total carbon budget for the Paris climate targets.

The good news is that the new study estimates emissions budgets that are at least 10% larger than the average value for the models. The bad news is that if humankind continues to emit carbon at the current rate, we have a little more than a decade before we exceed the Paris 1.5°C target, even for decade-mean warming.

Co-author Chris Jones from the Met Office said, "This emergent constraint is elegant and powerful. It both uses observations to narrow the possible range of future emissions but also lets us consider other greenhouse gases than just CO<sub>2</sub>. In this way, the remaining carbon budget is made much more policy relevant."

Lead author Peter Cox, Director of the Global Systems Institute at the University of Exeter, said, "Our study clarifies the climate problem that needs to be solved, and we hope that it will stimulate greater efforts to reduce our emissions to Net Zero."

The work is [published](#) in the journal *Nature Communications*.

**More information:** Peter M. Cox et al, Emergent constraints on carbon budgets as a function of global warming, *Nature Communications* (2024). [DOI: 10.1038/s41467-024-46137-7](https://doi.org/10.1038/s41467-024-46137-7)

Provided by University of Exeter

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