

A new carbon budget framework provides a clearer view of our climate deadlines

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Damon Matthews: "The wide range of carbon budget estimates in the literature has contributed to both confusion and inaction in climate policy circles." Credit: Concordia University

Just how close are the world's countries to achieving the Paris Agreement target of keeping climate change limited to a 1.5°C increase

above pre-industrial levels?

It's a tricky question with a complex answer. One approach is to use the remaining [carbon budget](#) to gauge how many more tons of carbon dioxide we can still emit and have a chance of staying under the target laid out by the 2015 international accord. However, estimates of the remaining carbon budget have varied considerably in previous studies because of inconsistent approaches and assumptions used by researchers.

Nature Communications Earth and Environment just published a paper by a group of researchers led by Damon Matthews, professor in the Department of Geography, Planning and Environment. In it, they present a new framework for calculating the remaining carbon budget that is able to generate a much narrower estimate and its uncertainty.

The researchers estimate that between 230 and 440 billion more tons of CO₂ from 2020 onwards can be emitted into the atmosphere and still provide a reasonable chance of limiting [global warming](#) to 1.5°C. This is the same as five to 10 years of current emission levels.

"The wide range of carbon budget estimates in the literature has contributed to both confusion and inaction in climate policy circles," explains Matthews, the Concordia Research Chair in Climate Science and Sustainability. "This is the first time we have gone through all the uncertainties and included them in a single estimate."

Uncertainties included

Matthews identifies five key uncertain parameters affecting the remaining carbon budget.

The first is the amount of observed warming that has occurred to date; the second is the amount of CO₂ that has been emitted over the past 150

years; the third uncertainty is the amount of warming we are experiencing that is due to CO₂ vs. non-CO₂ greenhouse gas emissions; fourth is the future non-CO₂ contributions to warming; and last is the amount of warming that has not yet occurred as a result of emissions already in the atmosphere.

Using a new set of equations, the researchers were able to relate these parameters to each other and calculate a unified distribution of the remaining carbon budget.

The 440 billion tons of CO₂ is a median estimate, however, giving us a 50/50 chance of meeting the 1.5°C target. The researchers' uncertainty range runs from 230 billion tons before net-zero, which would give us a 67 percent chance of meeting the target, to 670 billion tons for a one-in-three chance.

These numbers are based on accounting for geophysical uncertainties (those related to scientific understanding of the climate system), but not socioeconomic ones (those relating to [human decisions](#) and socioeconomic systems). The decisions humans make in the near-term matter greatly and have the potential to either increase or decrease the size of the remaining carbon budget. In the new framework, these decisions could add (or remove) as much as 170 billion tons of CO₂ to the median carbon budget estimate.

A window of opportunity

The COVID-19 pandemic has presented humans with an opportunity, Matthews argues. The year 2020 experienced a noticeable drop in emissions from 2019 due in large part to reduced human mobility. If we are able to direct recovery investments in ways that would continue this decrease (rather than allowing emissions to rebound) we would greatly increase our chances of remaining under the 1.5°C Paris Agreement

target.

Another source of cautious optimism lies with the incoming Biden administration in the United States, which has made climate change a priority.

"I am optimistic that having national leadership in the US that can mobilize efforts on climate change will make a big difference over the coming years," Matthews adds. "The momentum is shifting in the right direction, but it is still not happening fast enough."

More information: H. Damon Matthews et al, An integrated approach to quantifying uncertainties in the remaining carbon budget, *Communications Earth & Environment* (2021). [DOI: 10.1038/s43247-020-00064-9](https://doi.org/10.1038/s43247-020-00064-9)

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