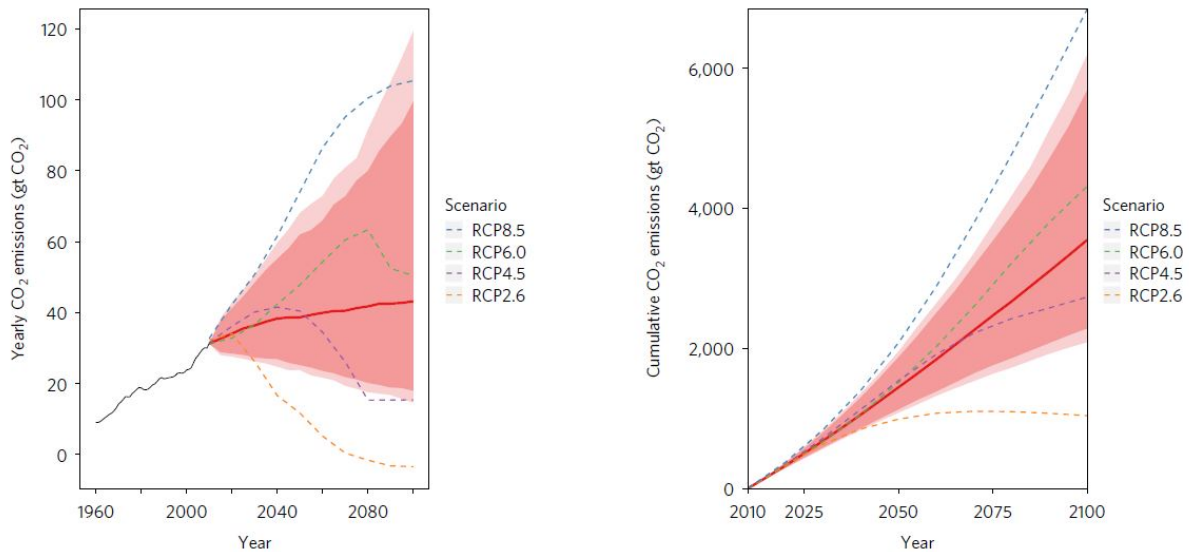


Earth likely to warm more than 2 degrees this century

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Global carbon emission projections through the year 2100, per year (left) and cumulative (right). Dotted lines show the four 'scenarios' from the latest IPCC climate report. The shaded area is the new statistically-driven approach, where the darker area is the 90 percent confidence interval, and lighter shading is the 95 percent confidence range. Credit: Adrian Raftery/University of Washington

Warming of the planet by 2 degrees Celsius is often seen as a "tipping point" that people should try to avoid by limiting greenhouse gas emissions. But the Earth is very likely to exceed that change, according to new University of Washington research. A study using statistical tools shows only a 5 percent chance that Earth will warm 2 degrees or less by

the end of this century. It shows a mere 1 percent chance that warming could be at or below 1.5 degrees, the target set by the 2016 Paris Agreement.

"Our analysis shows that the goal of 2 degrees is very much a best-case scenario," said lead author Adrian Raftery, a UW professor of statistics and sociology. "It is achievable, but only with major, sustained effort on all fronts over the next 80 years."

The new, statistically-based projections, published July 31 in *Nature Climate Change*, show a 90 percent chance that temperatures will increase this century by 2.0 to 4.9 C.

"Our analysis is compatible with previous estimates, but it finds that the most optimistic projections are unlikely to happen," Raftery said. "We're closer to the margin than we think."

The most recent report from the Intergovernmental Panel on Climate Change included future warming rates based on four scenarios for future carbon emissions. The scenarios ranged from "business-as-usual" emissions from growing economies, to serious worldwide efforts to transition away from [fossil fuels](#).

"The IPCC was clear that these scenarios were not forecasts," Raftery said. "The big problem with scenarios is that you don't know how likely they are, and whether they span the full range of possibilities or are just a few examples. Scientifically, this type of storytelling approach was not fully satisfying."

The new paper focuses instead on three quantities that underpin the scenarios for future emissions: total [world population](#), gross domestic product per person and the amount of carbon emitted for each dollar of economic activity, known as carbon intensity.

Using statistical projections for each of these three quantities based on 50 years of past data in countries around the world, the study finds a median value of 3.2 C (5.8 F) warming by 2100, and a 90 percent chance that warming this century will fall between 2.0 to 4.9 C (3.6 to 8.8 F).

"Countries argued for the 1.5 C target because of the severe impacts on their livelihoods that would result from exceeding that threshold. Indeed, damages from heat extremes, drought, extreme weather and sea level rise will be much more severe if 2 C or higher temperature rise is allowed," said co-author Dargan Frierson, a UW associate professor of atmospheric sciences. "Our results show that an abrupt change of course is needed to achieve these goals."

Raftery previously worked on United Nations projections for future world population. His 2014 study used Bayesian statistics, a common tool used in modern statistics, to show that world population is unlikely to stabilize this century. The planet likely will reach 11 billion people by 2100.

In the new study, Raftery expected to find that higher populations would increase the projections for global warming. Instead, he was surprised to learn that population has a fairly small impact. That is because most of the population increase will be in Africa, which uses few fossil fuels.

What matters more for future warming is the carbon intensity, the amount of carbon emissions produced for each dollar of economic activity. That value has dropped in recent decades as countries boost efficiency and enact standards to reduce [carbon emissions](#). How quickly that value drops in future decades will be crucial for determining future warming.

The study finds a wide range of possible values of [carbon](#) intensity over

future decades, depending on technological progress and countries' commitments to implementing changes.

"Overall, the goals expressed in the Paris Agreement are ambitious but realistic," Raftery said. "The bad news is they are unlikely to be enough to achieve the target of keeping warming at or below 1.5 degrees."

More information: Less Than 2°C Warming by 2100 Unlikely, *Nature Climate Change* (2017). [DOI: 10.1038/nclimate3352](https://doi.org/10.1038/nclimate3352)

Provided by University of Washington

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