More-severe climate model predictions could be the most accurate: study

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Climate model simulations are used to predict how much warming should be expected for any given increase in the atmospheric concentration of carbon dioxide and other greenhouse gases. New work from Carnegie's Ken Caldeira and Patrick Brown indicates that the climate models that project greater amounts of warming this century are the ones that best align with observations of the current climate. Credit: public domain

The climate models that project greater amounts of warming this century are the ones that best align with observations of the current climate, according to a new paper from Carnegie's Patrick Brown and Ken Caldeira published by *Nature*. Their findings suggest that the models used by the Intergovernmental Panel on Climate Change, on average, may be underestimating future warming.

Climate model simulations are used to predict how much warming should be expected for any given increase in the atmospheric concentration of carbon dioxide and other greenhouse gases.

"There are dozens of prominent global climate models and they all project different amounts of global warming for a given change in greenhouse gas concentrations, primarily because there is not a consensus on how to best model some key aspects of the climate system," Brown explained.

Raw climate model results for a business-as-usual scenario indicate that we can expect global temperatures to increase anywhere in the range of 5.8 and 10.6 degrees Fahrenheit (3.2 to 5.9 degrees Celsius) over preindustrial levels by the end of the century—a difference of about a factor of two between the most- and least-severe projections.

Brown and Caldeira set out to determine whether the upper or lower end of this range is more likely to prove accurate. Their strategy relied on the idea that the models that are going to be the most skillful in their projections of future warming should also be the most skillful in other contexts, such as simulating the recent past. Brown and Caldeira's study eliminates the lower end of this range, finding that the most likely warming is about 0.9 degrees Fahrenheit (0.5 degrees Celsius) greater than what the raw model results suggest.

The researchers focused on comparing model projections and

observations of the spatial and seasonal patterns of how energy flows from Earth to space. Interestingly, the models that best simulate the recent past of these energy exchanges between the planet and its surroundings tend to project greater-than-average warming in the future.

"Our results suggest that it doesn't make sense to dismiss the most-severe global warming projections based on the fact that climate models are imperfect in their simulation of the current climate," Brown said. "On the contrary, if anything, we are showing that model shortcomings can be used to dismiss the least-severe projections."

The uncertainty in the range of future warming is mostly due to differences in how models simulate changes in clouds with global warming. Some models suggest that the cooling effect caused by clouds reflecting the Sun's energy back to space could increase in the future while other models suggest that this cooling effect might decrease.

"The models that are best able to recreate current conditions are the ones that simulate a reduction in cloud cooling in the future and thus these are the models that predict the greatest future warming," Brown explained.

"It makes sense that the models that do the best job at simulating today's observations might be the models with the most reliable predictions," Caldeira added. "Our study indicates that if emissions follow a commonly used business-as-usual scenario, there is a 93 percent chance that global warming will exceed 4 degrees Celsius (7.2 degrees Fahrenheit) by the end of this century. Previous studies had put this likelihood at 62 percent."

More information: Greater future global warming inferred from Earth's recent energy budget, *Nature* (2017). nature.com/articles/doi:10.1038/nature24672