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Capital Weather Gang

Major new climate study rules out less severe global warming scenarios

An analysis finds the most likely range of warming from doubling carbon dioxide to be between 4.1 to 8.1 degrees Fahrenheit.

By Andrew Freedman and Chris Mooney
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The current pace of human-caused carbon emissions is increasingly likely to trigger irreversible damage to the planet, according to a comprehensive international study released Wednesday. Researchers studying one of the most important and vexing topics in climate science — how sensitive the Earth's climate is to a doubling of the amount of carbon dioxide in the atmosphere — found that warming is extremely unlikely to be on the low end of estimates.

These scientists now say it is likely that if human activities — such as burning oil, gas and coal along with deforestation — push carbon dioxide to such levels, the Earth's global average temperature will most likely increase between 4.1 to 8.1 degrees Fahrenheit (2.3 and 4.5 degrees Celsius). The previous and long-standing estimated range of climate sensitivity, as first laid out in a 1979 report, was 2.7 to 8.1 degrees Fahrenheit (1.5 to 4.5 Celsius).

If the warming reaches the midpoint of this new range, it would

be extremely damaging, said Kate Marvel, a physicist at NASA's Goddard Institute of Space Studies and Columbia University, who called it the equivalent of a "five-alarm fire" for the planet.

The new range is narrower than previous studies, but shows at least a 95 percent chance that a doubling of carbon dioxide, which the world is on course to reach within the next five decades or so, would result in warming greater than 3.6 degrees Fahrenheit (2 degrees Celsius) relative to preindustrial temperatures. That is the threshold beyond which scientists say the Earth will suffer dangerous effects — disruptive sea level rise, intolerable heat waves and other extreme weather and permanent damage to ecosystems.

Staying below that is still possible. If steep emissions cuts are made in the near-term, a doubling of carbon dioxide levels could be avoided. But if a doubling does occur, there would be a 6 to 18 percent chance of exceeding the upper bound defined by the study of 8.1 Fahrenheit (4.5 Celsius).

The study by 25 researchers from around the world and published in the journal Reviews of Geophysics is the result of a four-year effort sponsored by the World Climate Research Program. It includes a narrower projected sensitivity range that has a two out of three chance of occurring, of 4.7 to 7 degrees Fahrenheit (2.6 to 3.9 Celsius).

The "Holy Grail" of climate science

For decades, climate scientists have been seeking to answer the question of how much global temperatures would climb if the amount of carbon dioxide in the Earth's atmosphere were to double. This measure was estimated in a 1979 study from the National Research Council led by Massachusetts Institute of Technology professor Jule Charney.

The "Charney Report" concluded that the planet's climate sensitivity was most likely within the range of 2.6 to 8.1 degrees Fahrenheit (1.5 to 4.5 Celsius).

Ever since, researchers have tried to narrow that range, contending with myriad uncertainties in how the oceans and atmosphere respond to historical changes in solar output, the planet's orbit, past periods with higher amounts of carbon dioxide in the air as well as feedback, such as how various cloud types act to trap or reflect heat energy. In addition, scientists have wrestled with uncertainties in models that simulate past, present and future climate change.

"Constraining climate sensitivity has been something of a Holy Grail in climate science for some time," said study co-author Zeke Hausfather, director of climate and energy at the Breakthrough Institute.

The climate sensitivity question has taken on new urgency as some of the newest computer models developed for the U.N. Intergovernmental Panel on Climate Change (IPCC) , due in a report next year, show a higher climate sensitivity than earlier models.

The new result narrows the range from what Charney and his colleagues calculated while raising the lower bound.

Multiple lines of evidence pointing in the same direction

To produce the study, the group of researchers worked like detectives, breaking up into teams that sifted through multiple sources of evidence. Some of the data examined include instrument records since the industrial revolution, paleoclimate records from coral reefs and ice cores that provide evidence of prehistoric temperatures, as well as satellite observations and

intricate models of how the climate system works.

To reach their new, authoritative estimates, the researchers required that multiple lines of evidence point to the same general conclusion and that this be explained without being the result of a bias that influences one or more sources of evidence.

“An important part of the process was to ensure that the lines of evidence were more or less independent,” said lead author Steven Sherwood, a climate scientist at the University of New South Wales’s ARC Center of Excellence for Climate Extremes, in a news release. “You can think of it as the mathematical version of trying to determine if a rumor you hear separately from two people could have sprung from the same source; or if one of two eyewitnesses to a crime has been influenced by hearing the story of the other one,” Sherwood said.

Andrew Dessler, a climate scientist at Texas A&M University who was not involved in the study, called this “a tour de force of climate science.” He said via email that the study, “Really, really kills the skeptical argument that climate sensitivity is low.”

“It would have been great if the skeptics had been correct and climate sensitivity was, say, 1.5°C, but that’s not the world we live in.”

Knowing the climate sensitivity range could enable better decision-making

The term “climate sensitivity” might seem like an academic construct, a metric that matters more in the grand theories and computer models of scientists than it does in our everyday lives.

In fact, the study has a message that matters to us a great deal: There is basically little or no chance that we are going to get

lucky and find that the warming caused by our activities turns out to be minor.

There are at least two main lines of evidence that lead to the conclusion, based on the study. The first is simply the warming that has already occurred since the industrial revolution.

Currently, with atmospheric concentrations of carbon dioxide at 415 parts per million (compared with a preindustrial level of 280 parts per million), the world is about halfway toward doubling atmospheric carbon dioxide (560 parts per million). And already, the Earth has warmed by at least 1 degree Celsius (1.8 degrees Fahrenheit) preindustrial temperatures.

The new research finds that, in light of this, there is strong evidence refuting the notion that a doubling of carbon dioxide would only cause around 2.6 degrees (1.5 Celsius) of warming.

At the same time, researchers rejected the idea that there is any factor in the climate system that will counteract the warming trend in a meaningful way.

In the past, climate change contrarians and doubters have said that clouds might be such a factor. For instance, if as the planet warms the overall size, composition or surface area of clouds increases, they could reflect more sunlight from Earth, which would cool the planet some. But the study finds that isn't likely to happen.

"We find that a negative total cloud feedback is very unlikely," the authors write, concluding that for this reason the climate sensitivity cannot be very low.

"The uncertainty is really asymmetric here," Marvel said in an interview. "We can be very confident in ruling out sensitivities on the low end. So basically what we're saying here is that there

is really no evidence for any sort of natural response, any sort of big, stabilizing feedback, that in the absence of human actions, is going to save us from climate change."

But Gavin Schmidt, the study's co-author and Marvel's colleague at NASA Goddard, offered some optimism, noting that collective action by nations could prevent the doubling of carbon dioxide in the atmosphere.

"The primary determinant of future climate is human actions," Marvel said.

Andrew Freedman
Andrew Freedman edits and reports on extreme weather and climate science for the Capital Weather Gang. He has covered science, with a specialization in climate research and policy, for Axios, Mashable, Climate Central, E&E Daily and other publications. Follow

Chris Mooney
Chris Mooney is a Pulitzer Prize winning reporter covering climate change, energy, and the environment. He has reported from the 2015 Paris climate negotiations, the Northwest Passage, and the Greenland ice sheet, among other locations, and has written four books about science, politics and climate change. Follow