

Climate worst-case scenarios may not go far enough, cloud data shows

Modelling suggests climate is considerably more sensitive to carbon emissions than thought

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Sat 13 Jun 2020 07.00 BST

Last modified on Sat 13 Jun 2020 07.01 BST



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Experts say the projections have the potential to be 'incredibly alarming'. Photograph: Alamy

Worst-case global heating scenarios may need to be revised upwards in light of a better understanding of the role of clouds, scientists have said.

Recent modelling data suggests the climate is considerably more sensitive to carbon emissions than previously believed, and experts said the projections had the potential to be “incredibly alarming”, though they stressed further research would be needed to validate the new numbers.

Modelling results from more than 20 institutions are being compiled for **the sixth assessment** by the United Nations Intergovernmental Panel on Climate Change, which is due to be released next year.



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Compared with the last assessment in 2014, 25% of them show a sharp upward shift from 3C to 5C in climate sensitivity – the amount of warming projected from a doubling of atmospheric carbon dioxide from the preindustrial level of 280 parts per million. This has shocked many veteran observers, because assumptions about **climate sensitivity** have been relatively unchanged since the 1980s.

“That is a very deep concern,” Johan Rockström, the director of the Potsdam Institute for Climate Impact Research, said. “Climate sensitivity is the holy grail of climate science. It is the prime indicator of climate risk. For 40 years, it has been around 3C. Now, we are suddenly starting to see big climate models on the best supercomputers showing things could be worse than we thought.”

He said climate sensitivity above 5C would reduce the scope for human action to reduce the worst impacts of global heating. “We would have no more space for a soft landing of 1.5C [above preindustrial levels]. The best we could aim for is 2C,” he said.

Worst-case projections in excess of 5C have been generated by several of the world’s leading climate research bodies, including the UK Met Office’s Hadley

Centre and the EU's Community Earth System Model.

Timothy Palmer, a professor in climate physics at Oxford University and a member of the Met Office's advisory board, said the high figure initially made scientists nervous. "It was way outside previous estimates. People asked whether there was a bug in the code," he said. "But it boiled down to relatively small changes in the way clouds are represented in the models."

The role of clouds is one of the most uncertain areas in climate science because they are hard to measure and, depending on altitude, droplet temperature and other factors, can play either a warming or a cooling role. For decades, this has been the focus of fierce academic disputes.

Previous IPCC reports tended to assume that clouds would have a neutral impact because the warming and cooling feedbacks would cancel each other out. But in the past year and a half, a body of evidence has been growing showing that the net effect will be warming. This is based on finer resolution computer models and advanced cloud microphysics.

"Clouds will determine humanity's fate – whether climate is an existential threat or an inconvenience that we will learn to live with," said Palmer. "Most recent models suggest clouds will make matters worse."

In a recent paper in the journal *Nature*, (<https://www.nature.com/articles/d41586-020-01484-5>) Palmer explains how the new Hadley Centre model that produced the 5+C figure on climate sensitivity was tested by assessing its accuracy in forecasting short-term weather. This testing technique had exposed flaws in previous models, but in the latest case, the results reinforced the estimates. "The results are not reassuring – they support the estimates," he wrote. He is calling for other models to be tested in a similar way.

"It's really important. The message to the government and public is, you have to take this high climate sensitivity seriously. [We] must get emissions down as quickly as we can," he said.

The IPCC is expected to include the 5+C climate sensitivity figure in its next report on the range of possible outcomes. Scientists caution that this is a work in progress and that doubts remain because such a high figure does not fit with historical records.

Catherine Senior, head of understanding climate change at the Met Office

Hadley Centre, said more studies and more data were needed to fully understand the role of clouds and aerosols.

“This figure has the potential to be incredibly alarming if it is right,” she said. “But as a scientist, my first response is: why has the model done that? We are still in the stage of evaluating the processes driving the different response.”

While acknowledging the continued uncertainty, Rockström said climate models might still be underestimating the problem because they did not fully take into account tipping points in the biosphere.

“The more we learn, the more fragile the Earth system seems to be and the faster we need to move,” he said. “It gives even stronger argument to step out of this C