New research highlights the key role of ozone in climate change

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A composite image of the Western hemisphere of the Earth. Credit: NASA

Many of the complex computer models which are used to predict climate change could be missing an important ozone 'feedback' factor in their calculations of future global warming, according to new research led by the University of Cambridge and published today (1 December) in the journal *Nature Climate Change*.

Computer models play a crucial role in informing climate policy. They are used to assess the effect that carbon emissions have had on the Earth's climate to date, and to predict possible pathways for the future of our climate.

Increasing computing power combined with increasing scientific knowledge has led to major advances in our understanding of the climate system during the past decades. However, the Earth's inherent complexity, and the still limited computational power available, means that not every variable can be included in current models. Consequently, scientists have to make informed choices in order to build models which are fit for purpose.

"These models are the only tools we have in terms of predicting the future impacts of climate change, so it's crucial that they are as accurate and as thorough as we can make them," said the paper's lead author Peer Nowack, a PhD student in the Centre for Atmospheric Science, part of Cambridge's Department of Chemistry.

The new research has highlighted a key role that ozone, a major component of the stratosphere, plays in how climate change occurs, and the possible implications for predictions of global warming. Changes in ozone are often either not included, or are included a very simplified manner, in current climate models. This is due to the complexity and the sheer computational power it takes to calculate these changes, an important deficiency in some studies.

In addition to its role in protecting the Earth from the Sun's harmful ultraviolet rays, ozone is also a greenhouse gas. The ozone layer is part of a vast chemical network, and changes in environmental conditions, such as changes in temperature or the atmospheric circulation, result in changes in ozone abundance. This process is known as an atmospheric chemical feedback.

Using a comprehensive atmosphere-ocean chemistry-climate model, the Cambridge team, working with researchers from the University of East Anglia, the National Centre for Atmospheric Science, the Met Office and the University of Reading, compared ozone at pre-industrial levels with how it evolves in response to a quadrupling of CO2 in the atmosphere, which is a standard climate change experiment.

What they discovered is a reduction in global surface warming of approximately 20% - equating to 1° Celsius - when compared with most models after 75 years. This difference is due to ozone changes in the lower stratosphere in the tropics, which are mainly caused by changes in the atmospheric circulation under climate change.

"This research has shown that ozone feedback can play a major role in global warming and that it should be included consistently in climate models," said Nowack. "These models are incredibly complex, just as the Earth is, and there are an almost infinite number of different processes which we could include. Many different processes have to be simplified in order to make them run effectively within the model, but what this research shows is that ozone feedback plays a major role in climate change, and therefore should be included in models in order to make them as accurate as we can make them. However, this particular feedback is especially complex since it depends on many other climate processes that models still simulate differently. Therefore, the best option to represent this feedback consistently might be to calculate ozone changes in every model, in spite of the high computational costs of such a procedure.

"Climate change research is all about having the best data possible. Every climate model currently in use shows that warming is occurring and will continue to occur, but the difference is in how and when they predict warming will happen. Having the best models possible will help make the best climate policy."

More information: The paper, "A large ozone-circulation feedback and its implications for global warming assessments" is published in the journal *Nature Climate Change*. DOI: 10.1038/nclimate2451

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