UCAR UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH

Stratospheric Injections Could Help Cool Earth, Computer Model Shows

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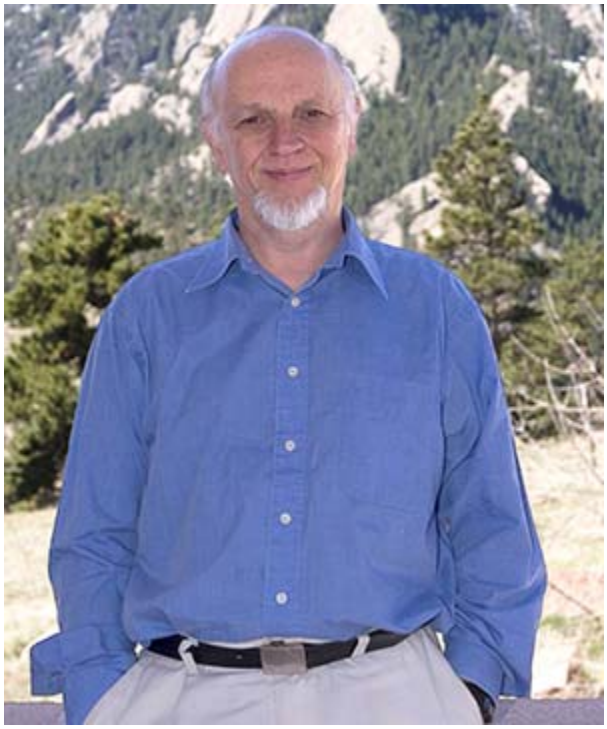
BOULDER—A two-pronged approach to stabilizing climate, with cuts in greenhouse gas emissions as well as injections of climate-cooling sulfates, could prove more effective than either approach used separately. This is the finding of a new study by Tom Wigley of the National Center for Atmospheric Research (NCAR), published in the September 14 issue of Science.

Wigley calculates the impact of injecting sulfate particles, or aerosols, every one to four years into the stratosphere in amounts equal to those lofted by the volcanic eruption of Mt. Pintabuto in 1991. If found to be environmentally and technologically viable, such injections could provide a "grace period" of up to 20 years before major cutbacks in greenhouse gas emissions would be required, he concludes.



Tom Wigley Click here or on the image to enlarge. (Photo by Carlye Calvin)

"A combined approach to climate stabilization has a number of advantages over either employed separately," says Wigley. His study was supported by the National Science Foundation, NCAR's primary sponsor.

The Science paper does not endorse any particular approach to reducing climate change, nor is it intended to address the many technical and political challenges involved in potential geoengineering efforts. Instead, it analyzes whether the much-discussed idea of injecting sulfates into the stratosphere could, in fact, slow down global warming and therefore provide more time for society to reduce the emissions of carbon dioxide.

If climate change were addressed only through mitigation (emissions reduction), then massive cuts in emissions would be needed in order to keep temperatures from rising more than 3.6 degrees Fahrenheit (2.0 degrees Celsius) over present levels. This amount of warming has often been cited as a benchmark of dangerous climate change.

Given the difficulties of making such massive cuts, scientists recently have begun to reexamine a variety of schemes proposed over the last few decades to reduce the impact of climate change through global-scale technological fixes. These approaches are often referred to as geoengineering. One strategy first proposed in the 1970s is to inject large amounts of sun-blocking sulfate particles into the stratosphere via aircraft or other means. The idea would be to cool the climate for a year or more with each injection, much as the largest volcanic eruptions do.

"Geoengineering could provide additional time to address the economic and technological challenges faced by a mitigation-only approach," says Wigley.

A model experiment with two scenarios

Using a computer model to track sunlight and other energy flowing into and out of the Earth system, Wigley examined two scenarios that project the impact of emissions on climate from now to the year 2400. In one scenario, total emissions would have to start dropping immediately, and would have to be cut by around 50 percent in the next 50 years, in order to keep global climate from warming by more than the 2 degrees C benchmark. An alternative scenario, the "overshoot" approach, allows a period of increasing total emissions, extending to the 2030s, before stringent cutbacks begin.

To see how geoengineering might change this picture, Wigley took the overshoot scenario and added three frequencies of Pinatubo-scale injections of sulfates into the stratosphere. The frequencies were equivalent to an eruption every year, every two years, and every four years. In all three cases, global temperature stayed approximately constant for the next 40 to 50 years. After 2050, the cumulative effect of greenhouse gases produced a slow temperature rise, though it was muted by the injections.

Injections on a scale equal to Pinatubo were examined because that volcanic eruption did not seriously disrupt the climate system beyond a short-term cooling, says Wigley.

No panacea

Geoengineering is not a panacea, Wigley notes. For example, carbon dioxide from fossil fuel burning has led to an increased acidification of Earth's oceans. Even if geoengineering could help limit global warming, the oceans would continue to acidify as greenhouse-gas emissions climb, threatening certain marine ecosystems.

Mitigation alone can potentially solve both the warming and ocean acidification problems, but it has its own set of difficulties, says Wigley. The rapid emissions reductions required to keep below the 2 degree C warming threshold would be costly, perhaps unacceptably so, and would pose severe technological challenges.

"A relatively modest geoengineering investment could reduce the economic and technological burden on mitigation by deferring the need for immediate or near-future cuts in carbon dioxide emissions," Wigley says.

About the article

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