

Geoengineering model: Solar-radiation management could have unwanted regional impacts

Adding aerosols to the atmosphere will not counter global warming in all regions.

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By Richard A. Lovett

Attempting to offset global warming by injecting sunlight-reflecting gases into the upper atmosphere isn't the quick fix for global climate change that advocates believe it might be, a new study finds.

In a paper published July 18 in *Nature Geoscience*, Kate Ricke, a climate physicist at Carnegie Mellon University in Pittsburgh, Pennsylvania, and her colleagues show, by modeling, that not only could solar-radiation management lead to declines in rainfall in the long term, but its effects will also vary by region. Some places will be over-cooled by atmospheric changes that are too small to be effective for their neighbors.

The gases under consideration are sulfur compounds that would produce sulfate aerosols in the upper atmosphere. Geoengineering advocates have proposed injecting large quantities of these materials into the stratosphere, either by shooting them up in artillery shells or releasing them from high-flying airplanes.

Once there, they would disperse into a thin, bright haze that would reflect enough sunlight back into space to partially or completely offset global warming.

The goal would be to mimic the effects of volcanoes eruptions such as the 1991 eruption of Mount Pinatubo in the Philippines, which blasted enough sulfates into the stratosphere to temporarily reduce the global temperature by nearly half a degree. Geoengineers propose mimicking this on ever-expanding scales, so that increasing levels of greenhouse gases are offset by ever-greater levels of sunlight reduction.

The new study found that it is fairly easy to design sulfate-injection scenarios that keep the temperature stable until 2080. But, unfortunately, the change in sunlight alters other weather patterns. "It changes the distribution of energy in the troposphere so that it becomes more convectively stable," Ricke says. The result: decreasing precipitation.

Temporary fix

Regional effects are also important. For example, Ricke says, her study found that levels of sulfate that kept China closest to its baseline climate were so high that they made India cold and wet. Those that were best for India caused China to overheat. She notes, however, that both countries fared better either way than under a no-geoengineering policy.

The modelers also found that all of these effects get worse with time. "The compensation is imperfect," Ricke says. "The longer you do it, the more imperfect it becomes."

Thus, she says, this type of geoengineering is at best a temporary fix--something people working in the field had always known because it does nothing to prevent the accumulation of carbon dioxide and the resulting acidification of the oceans. "But it might be even more temporary than people had expected."

Other scientists are impressed. "I think the paper is great," says Ken Caldeira, a climate scientist at the Carnegie Institution for

Science's Department of Global Ecology, in Stanford, Calif. "I offered Kate a post-doc based on these results."

Alan Robock, a geophysicist at Rutgers University in New Brunswick, N.J., agrees. "It confirms that it is not possible to control both temperature and precipitation using stratospheric geoengineering," he says.

Cloud computing

The researchers used a global climate model, called HadCM3L, from the Hadley Centre for Climate Prediction and Research in Exeter, UK. To run their simulations, however, they made use of climateprediction.net, a climate-forecasting experiment in which thousands of people volunteer to have their home computers do climate simulations when inactive. "This is something that people can sign up for on home computers that sit idle most of the day," Caldeira says. "When the computer notices it is idle for a while, it starts running climate models."

Caldeira and Robock are impressed by the use of Climateprediction.net, but Caldeira points out that as the team only used one model, some of Ricke's specific findings, such as the details of the India-China disparity, might be model-specific.

"I don't think climate modeling is at the point where we should trust one single model at that scale," Caldeira says. "But I think the results are robust in the sense that it's the kind of issue that people will need to face. The qualitative idea is that you're going to have differential results in different regions, and that's going to cause people to want different amounts of this stuff up there, if they want any of it up there at all."

Ricke agrees. "We don't intend these results to give a definitive indication of what's going to happen," she says. "It's more an illustration of the type of regional effect you would see."

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