Pollute the Planet for Climate’s Sake?

The source of the proposal was almost as remarkable as the idea itself. In the August issue of *Climatic Change*, Paul Crutzen, who won the Nobel Prize for helping work out the chemistry of ozone destruction in the stratosphere, resurrected an oft-disparaged suggestion: Create a global haze by spewing megatons of sulfuric debris into the stratosphere to shade the planet and rein in greenhouse warming. “A few years ago, I would have said, ‘I’m not touching that,’” says the Max Planck Institute for Chemistry researcher. Now, however, he finds the “grossly disappointing international political response” to global warming’s threat so disturbing that the notion of deliberately contaminating the stratosphere looks less and less crazy.

Bad idea, respond some climate scientists. It would be applying a Band-Aid to the problem with ever-increasing greenhouse gas emissions. Best not even to talk about it. Worth looking at, say others. Given the surprises that may be lurking in the greenhouse, desperate countermeasures could come in handy. Thanks to Crutzen’s stature, this scientific and ethical debate is blossoming as the climate community begins to take a hard look at geoengineering climate.

Supporters of at least studying the idea seem to have some momentum for now. “Crutzen’s paper created some sort of phase change, making geoengineering a respectable topic of conversation,” says climate modeler Kenneth Caldeira of the Carnegie Institution Department of Global Ecology at Stanford University.

Geoengineering as a fix for global warming has been a topic of usually sotto voce conversation since the 1970s, when the Soviet climatologist Mikhail Budyko suggested Earth could be cooled by adding tiny sunlight-reflecting particles to the stratosphere. Nature soon served up a couple of striking examples of how it might be done when the volcano El Chichón erupted in 1982 and Mount Pinatubo erupted in 1991. The long-lived stratospheric debris of Pinatubo—water droplets laced with sulfuric acid derived from the volcano’s sulfur—reflected enough sunlight back into space to cool Earth on average 0.5°C for a year or two following the eruption. That’s about the size of the warming of the past century.

Pulling off a “human volcano” to counteract global warming would take some wherewithal. Pinatubo put up 10 million tons of sulfur, most of which fell out of the stratosphere within 2 or 3 years. So humans looking to cool the greenhouse by stratospheric shading would have to send millions of tons of sulfur tens of kilometers into the air every year, perhaps century after century, in order to renew the continually depleted shield of haze. The resulting acid rain would be minor compared to current levels, say proponents. People have discussed delivery methods from balloons, big guns, and giant planes. To ease the burden of lifting megaton masses, the late Edward Teller—father of the hydrogen bomb and “Star Wars” missile defense advocate—proposed substituting more efficient reflectors for sulfur, something metallic and perhaps engineered like tiny retroreflectors.

A volcanic chill. Humans might loft sulfur into the stratosphere to counteract global warming; Mount Pinatubo did in 1991.
Voilà! Cloak of Invisibility Unveiled

Just 5 months after predicting it should be possible, a team of physicists has produced a cloaking device that renders an object invisible—at least when viewed in microwaves of a particular wavelength.

The cloak is hardly perfect: Instead of an all-concealing sphere, it’s a ring that works only for microwaves zipping along in a plane. The microwaves must also be polarized perpendicular to the plane. And even then, the cloak reflects some of the waves and casts a slight shadow. Nevertheless, “it’s a very good achievement,” says Ulf Leonhardt, a theorist at the University of St. Andrews in the United Kingdom. “It’s surprising that it’s as simple as it is and that it works so well.”

The cloak embodies the theory laid out by theorist John Pendry of Imperial College London and experimenters David Schurig and David Smith, who work in the electrical and computer engineering department at Duke University in Durham, North Carolina. In May, the team showed that, in principle, it’s possible to ferry electromagnetic waves such as light around an object by surrounding it with a “metamaterial”: an assemblage of tiny rods and C-shaped rings (Science, 26 May, p. 1120). The waves would then pass as if the object weren’t there, rendering it invisible.

The electromagnetic waves cause the electrons in the rings and rods to slosh, and the sloshing, in turn, affects the speed at which the waves travel through the material. If the speed varies in the right way within the cloak, the waves will curve around the object. The theory predicts only how the speed of the waves must vary; it leaves it to experimenters to design the material.

When Schurig, Smith, and colleagues worked out the details, they found that their two-dimensional device required only C-shaped copper rings nested side by side. The team also simplified the parameters specified by the theory. The changes made the metamaterial easier to build but also left the cloak slightly reflective, as the team reports online this week in Science (www.sciencemag.org/cgi/content/abstract/1133628). “The goal of this paper was to demonstrate that we more or less have the mechanism and that we can design the materials to the parameters,” Schurig says.

Even the simplified cloak is a significant advance, says Costas Soukoulis, a theorist at Iowa State University in Ames and the U.S. Department of Energy’s Ames Laboratory. “This is very, very important that experiments have produced what theorists had predicted,” Soukoulis says. Microwave cloaks might be useful for eluding radar, he says.

It may take years for researchers to make a cloak for visible light. Still, most believe such a thing should be possible now that a cloak for microwaves has been built. After all, not seeing is believing.  

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