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OP-ED CONTRIBUTOR

## How to Cool the Globe

By KEN CALDEIRA

DESPITE growing interest in clean energy technology, it looks as if we are not going to reduce emissions of carbon dioxide anytime soon. The amount in the atmosphere today exceeds the most pessimistic forecasts made just a few years ago, and it is increasing faster than anybody had foreseen.

Even if we could stop adding to greenhouse gases tomorrow, the earth would continue warming for decades — and remain hot for centuries. We would still face the threat of water from melting glaciers lapping at our doorsteps.

What can be done? One idea is to counteract warming by tossing small particles into the stratosphere (above where jets fly). This strategy may sound far-fetched, but it has the potential to cool the earth within months.

Mount Pinatubo, a volcano in the Philippines that erupted in 1991, showed how it works. The eruption resulted in sulfate particles in the stratosphere that reflected the sun's rays back to space, and as a consequence the earth briefly cooled.

If we could pour a five-gallon bucket's worth of sulfate particles per second into the stratosphere, it might be enough to keep the earth from warming for 50 years. Tossing twice as much up there could protect us into the next century.

A 1992 report from the National Academy of Sciences suggests that naval artillery, rockets and aircraft exhaust could all be used to send the particles up. The least expensive option might be to use a fire hose suspended from a series of balloons. Scientists have yet to analyze the engineering involved, but the hurdles appear surmountable.

Seeding the stratosphere might not work perfectly. But it would be cheap and easy enough and is worth investigating.

This is not to say that we should give up trying to reduce greenhouse gas emissions. Ninety-nine percent of the \$3 billion federal Climate Change Technology Program should still go toward developing climate-friendly energy systems. But 1 percent of that money could be put toward working out geoengineered climate fixes like sulfate particles in the atmosphere, and developing the understanding we need to ensure that they wouldn't just make matters worse.

Think of it as an insurance policy, a backup plan for climate change.

Which is the more environmentally sensitive thing to do: let the Greenland ice sheet collapse and polar bears become extinct, or throw a little sulfate in the stratosphere? The second option is at least worth looking into.

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