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Their View: **Climate control exists**, but who gets the remote?

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Imagine being able to **control** the temperature of the Earth like a home thermostat, turning it down a few notches to reduce the effects of global warming. That's the goal of solar geoengineering. By spraying aerosols into the stratosphere, we could block a fraction of inbound sunlight and temporarily cool the Earth.

But just as home thermostats are notorious for setting off domestic squabbles — she bumps it up to 72, he ratchets it down to 64 —solar geoengineering could spark serious conflicts, ranging from sanctions to war between world powers.

The question is: How should we approach technology with such lifesaving potential, when it could also disrupt the international order on a scale not seen since the advent of the atom bomb?

Long treated as an illegitimate child of the **climate**-science community and rarely mentioned in polite company, solar geoengineering is now coming of age. The Royal Society, the oldest scientific academy in the world, mainstreamed the issue with the publication of the seminal report "Geoengineering the **Climate**" in 2009. Many institutions have published their own major reports since then, and the U.S. National Academy of Sciences is scheduled to release one in February. Meanwhile, the first small-scale, real-world experiments are taking shape and, if they can secure funding, could begin within two years.

This more serious consideration is due in part to the realization that reducing carbon emissions won't solve our **climate** problems; it can only stop things from getting worse. Put bluntly, if we miraculously stopped all CO2 emissions immediately, the Earth would keep warming for decades, and much of the CO2 emitted since the Industrial Revolution would remain in the atmosphere, altering the **climate**, for millennia. Even the so-called breakthrough **climate** agreements between the U.S. and China and at a global conference in Lima, Peru, last year commit the world to massive new quantities of greenhouse gases in the decades ahead, which will speed **climate** change.

We mislead ourselves if we assume that we can easily adapt to the rising sea levels, desertification and intensifying storms that will accompany this change. Hurricane Sandy hit one of the richest areas in the wealthiest, most technologically advanced country, and it still caused dozens of deaths and more than $60 billion in damage.

And so attention is turning to solar geoengineering, also known as solar radiation management. Although the concept of injecting sulfur dioxide into the stratosphere has so far been tested only using computer simulations, there's high confidence that it would work to cool the Earth because it would mimic the well-understood cooling effect of large volcanic eruptions. A gram of aerosol in the stratosphere, delivered perhaps by high-flying jets, could offset the warming effect of a ton of carbon dioxide by a factor of 1 million to 1. The tiny sulfate aerosols would stay up there, reflecting away a small amount of sunlight, for a year or two, so the material would need to be continually renewed for as long as the cooling effect was needed.

A consistent and growing body of evidence indicates that this technology would be fast-acting — reducing global temperatures immediately after deployment — and relatively cheap, costing an average of $1 billion a year over the next half century to cut the rate of warming in half.

It wouldn't eliminate the need to cut emissions, as it would only mask the symptoms of **climate** change. It would create an approximate and artificial balance between the warming effect of greenhouse gases trapping heat in the lower atmosphere and the cooling effect of aerosols reflecting away solar energy in the upper atmosphere.

We don't yet have a full understanding of what the side effects would be — whether this technique would result in ozone loss, for example, or changed weather patterns. But early evidence from **climate** modeling overwhelmingly indicates that it would make the planet more livable for people and ecosystems.

The major worry should be the politics of it. In that arena, solar geoengineering could be a mess.

Because there's no one "right" temperature, some nations would probably want more cooling, some less and others none at all. Russia and Canada, for example, might desire moderate warming — this would defrost some of their enormous swaths of frozen tundra, allowing farming or mineral extraction. On the other hand, tropical states such as Brazil and Indonesia, threatened with rising seas or crop losses caused by record temperatures, might prefer that temperatures be locked at today's levels or even lowered.

But since solar geoengineering would be cheap enough that all but the very poorest countries could deploy it, we could see individual nations trying to tinker on behalf of the entire planet.

Conventional **climate** negotiations have often been bogged down by the "free-rider problem." Nations realize that they would see only a fraction of the future benefits from painful and expensive cuts to their own energy use, so they

prefer to shift the burden to others. Geoengineering, by contrast, would present a rare case of what Harvard economist Martin Weitzman calls the "free-driver problem": Presumably every country would want some **control** over the thermostat, but only the country that desired the greatest degree of cooling would get its wish.

It's possible to deter smaller nations using the traditional tools of statecraft, but what if the deployer were a great power, backed by nukes? It is hard to see many ways, politically speaking, that unilateral geoengineering could end well.

Even the most powerful states, however, might not be prepared to be global pariahs and geoengineer against the wishes of the rest of the world. Indeed, there would be a range of pressures against unilateral action, from shaming and sanctions to military force and "counter-geoengineering" — deliberately releasing short-lived warming agents to cancel out any cooling.

Given those pressures, nations might be more likely to form coalitions to decide when and how to use solar geoengineering. Such self-selecting clubs could have rules for entry. For example, having a say could be contingent on meeting certain carbon emissions targets.

A consensus-based U.N. agreement might be more widely seen as legitimate than a coalition, but getting nearly 200 countries to agree on exactly where to set the global thermostat is implausible. The most extreme positions would have effective veto power, and it could prove impossible to find a way forward that suited all parties. As such, in the absence of agreement, but in the presence of real desperation over **climate** change, we might be back where we started, with states prepared to act alone or in small coalitions.

The messy politics of geoengineering shouldn't deter us from exploring it. It may be our best option for reducing **climate** risk until we get better **control** over greenhouse gas emissions. But the countries of the world will need to figure out how to manage its development prudently and equitably. We cannot wish the politics away.