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The Truth About Geoengineering

Science Fiction and Science Fact

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The failure to make much progress at the UN Climate Change Conference in Doha, Qatar this winter was yet another reminder that the world might soon face extreme climate shifts. In response, it is becoming increasingly likely that governments will adopt risky strategies, known as “geoengineering,” to rapidly cool the planet. Four years ago, in order to raise awareness about geoengineering, we published “**The Geoengineering Option**” in *Foreign Affairs*. Almost nobody thought that such tactics -- which included spraying particles into the upper atmosphere to make the earth more reflective, akin to how big volcanoes cool the planet -- were a particularly good option. The risks were simply too great and the unknowns too many. Still, if reliable data and specific models showed that climate change was about to get out of hand, we wrote, such drastic measures might start to look more appealing. The world could no longer ignore the geoengineering option, and we argued that a major science program should begin to explore it.

These days, barely a month goes by without new research that shows that the planet’s climate could be more sensitive to global warming than experts previously thought. For example, some ice sheets now appear a lot less stable than scientists had imagined. And new estimates of how much the sea will rise when ice sheets melt far surpass the best estimates of just a few years ago. It is clear that, unchecked, climate change won’t just menace natural ecosystems; it will

also cause severe harm to humans and could even threaten national security. And, because governments have made barely any progress in controlling the emissions that cause global warming -- the 2000s saw the most rapid growth in emissions of carbon dioxide and other warming gases since the 1970s -- it's not so crazy to imagine that some nation will launch an emergency geoengineering scheme, perhaps before its viability and consequences are understood.

Since we wrote our essay, press coverage of geoengineering has exploded. The topic makes for good copy: it is weird, sexy, and steeped in exotic science. The term is also incredibly vague, including both techniques for removing carbon dioxide from the air and technology that could rapidly change the amount of sunlight reflected back to space and cool the planet. That method is often termed solar radiation management (SRM).

Carbon dioxide removal schemes include everything from planting trees to fertilizing the oceans in an attempt to cajole great blooms of phytoplankton. Both hinge on photosynthesis, which sucks carbon dioxide from the air; carbon dioxide is the chief long-term cause of global warming. These techniques also include installing scrubbers almost anywhere on the planet, which can strip carbon dioxide out of the atmosphere. Such removal strategies are intriguing, but seem likely to cost hundreds of billions of dollars a year and would take decades to have much of an effect.

In contrast, SRM technologies could cool the planet in just a few months by tinkering with the planet's energy balance. The usual proposals involve spraying material into the stratosphere, where it would turn into reflective clouds, or blowing seawater into the air, with a similar effect. The clouds could deflect just enough incoming sunlight to offset, crudely, the number of degrees human emissions have warmed the planet. Flying a fleet of high-altitude aircraft that spray particles into the upper atmosphere would cost perhaps ten billion dollars per year -- a pittance for a country that is suffering from severe climate change and seeks a quick solution.

Most carbon dioxide removal schemes appear relatively safe, although tinkering with a fragile ecosystem by fertilizing the ocean does involve risks. In contrast, SRM raises serious political and policy questions. Although quick and cheap, messing with the complex and imperfectly understood climate system, which is already stressed by warming gases, could end badly. Severe side effects might, for example, include a shift in the seasonal monsoons that many countries rely on for rainfall and agriculture, or accelerate the destruction of the ozone layer. No one knows whether it would be possible to predict and offset all such harmful side effects or how much it might cost. Further, once an SRM system is deployed for an extended period of time, stopping it suddenly would lead to even more rapid and severe climate change as the mask is lifted. Another wrinkle is that some aspects of climate change, such as degraded coral reefs, might be irreversible, and, since the driving forces behind the destruction would remain, it would be particularly irresponsible to deploy SRM without an accompanying program to control carbon emissions.

Given the real and imagined dangers, a movement to regulate geoengineering has been gaining momentum. In the fall of 2010, 193 governments adopted a nonbinding decision under the

United Nations Convention on Biological Diversity that would all but ban testing of geoengineering systems. Most environmental NGOs seem to be opposed to even talking about geoengineering out of fear that it might distract from the urgent task of controlling emissions or encourage governments to go ahead with their own projects.

The missing ingredient in all this controversy, though, is arguably the most important: the science. Since 2009, there has been a significant increase in geoengineering research. So far, however, the research is almost exclusively devoted to modeling. It has not yet really moved on to the next stages -- careful monitoring nature's own geoengineering processes (for example, volcanic eruptions) and small-scale field tests. There has been some limited field work on ocean fertilization, with less than encouraging results.

The result is that the scientific community knows little more than it did four years ago about how geoengineering would actually work or what its consequences would be. These technologies might not be well understood when and if they are needed, and could be deployed prematurely. In the growing efforts to regulate geoengineering, governments and activists are flying blind as they conjure up new regulations.

Since 2009, several proposals have been made for new SRM research, including by the United Kingdom's Royal Society, the U.S. Bipartisan Policy Center, and a variety of other scientific groups. Yet funding for serious laboratory, modeling, and field study has not followed, in part because government officials fear the political spotlight that follows this kind of research. Indeed, when White House science adviser John Holdren broached the topic some years ago, he quickly retreated after a blizzard of controversy.

Getting started on serious research need not be expensive. When managed correctly, a well-designed scientific research program also needn't be that controversial if government funders and scientists follow some simple guidelines. Small-scale field trials in the upper atmosphere to test components of an SRM system are particularly urgent. The countries with the leading atmospheric research programs already have the rockets, satellites, and aircraft technologies needed to deploy, instrument, and gather data from tests. For now, research doesn't even require much new investment, since better knowledge of the upper atmosphere overlaps heavily with broader needs of climate research.

The key is to draw a sharp line between studies that are small enough to avoid any noticeable or durable impact on the climate or weather and those that are larger and, accordingly, carry larger risks. (In a recent **paper**, Ted Parson, a scientist at the Emmett Center for Climate Change and Law, and David Keith, an engineer at Harvard, suggested some reasonable limits.) A smart research program begins with small tests, for example to study whether and how very fine particles in the stratosphere might clump together and how long they will persist. Results would be essential to develop guidelines for larger experiments down the road.

Such small-scale tests should not be viewed as the camel's nose under the tent. As the results are analyzed, it is likely that deficiencies of SRM will become more apparent. And the public, far from seeing SRM as a silver bullet, could become yet more concerned about climate change

and about the fact that failures to control emissions have made even terribly risky options plausible.

In 1891, Sir Arthur Conan Doyle's Sherlock Holmes admonished Dr. Watson, "It is a capital mistake to theorize before one has data." And right now, the politics of geoengineering are far ahead of the science. As the 2010 decision within the Conventional on Biological Diversity shows, fears about geoengineering are leading to counterproductive policy schemes. More practical understanding of what is at stake could help reorient the debate, and if the science is funded and published openly, then best practices and norms for behavior will emerge. In time, those norms and new information will make it easier to focus treaty negotiations -- if they prove necessary at all -- on the aspects of geoengineering that actually need formal intergovernmental regulation.

That nations are talking seriously about climate engineering is a sign of just how sick the planet has become. In 2009, we presented geoengineering as an intriguing research project that had potentially profound political consequences. Since then, the politics and public discourse have run quickly, but the research has not. Until the science gets serious, the politics won't reflect what's really at stake. Meanwhile, the planet keeps warming and the day when geoengineering might be needed draws nearer.

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