

Climate Hacking Is Barking Mad

You can't fix the Earth with these geoengineering proposals, but you can sure make it worse.

By Raymond T. Pierrehumbert



We would be insane to mess with the atmosphere.

Photo illustration by Juliana Jimenez Jaramillo. Photo by Frank Bienewald/LightRocket via Getty Images

Some years ago, in the question-and-answer session after a **lecture** at the American Geophysical Union, I described certain geoengineering proposals as “barking mad.” The remark went rather viral in the geoengineering community. The climate-hacking proposals I was referring to were schemes that attempt to cancel out some of the effects of human-caused global warming by squirting various substances into the atmosphere that would reflect more sunlight back to space. Schemes that were lovingly called “solar radiation management” by geoengineering boosters. Earlier I had **referred to the perilous state** such schemes would put our Earth into as being analogous to the fate of poor **Damocles**, cowering under a sword precariously suspended by a single thread.

This week, the National Research Council (NRC) is **releasing a report** on climate engineering that deals with exactly those proposals I found most terrifying. The report even recommends the creation of a research program addressing these proposals. I am a co-author of this report. Does this mean I’ve had a change of heart?

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The nearly two years’ worth of reading and animated discussions that went into this study have convinced me more than ever that the idea of “fixing” the climate by hacking the Earth’s reflection of sunlight is wildly, utterly, howlingly barking mad. In fact, though the report is couched in language more nuanced than what I myself would prefer, there is really nothing in it that is inconsistent with my earlier appraisals.

Even the terminology used in the report signals a palpable change in the framing of the discussion. The actions discussed for the most part are referred to as “climate intervention,” rather than “climate engineering” (or the common but confusing term geoengineering). Engineering is something you do to a system you understand very well, where you can try out new techniques thoroughly at a small scale before staking peoples’ lives on them. **Hacking the climate** is different—we have only one planet to live on, and can’t afford any big mistakes. Many of the climate “engineering” proposals are akin to turning the world’s whole population into passengers on a largely untested new fleet of hypersonic airplanes.

Most previous literature has referred to schemes to increase the proportion of sunlight reflected back to space as solar radiation management, as if it were something routine and businesslike, along the lines of “inventory management” or “personnel management.” It is far from clear, however, that solar radiation can be *managed* in any meaningful sense of the word. The NRC report instead uses the more neutral term “albedo modification.” Albedo is the scientific term for the proportion of sunlight reflected back to space. If the Earth had 100 percent albedo, it would reflect all sunlight back to space and be a frozen ice ball some tens of degrees above absolute zero, heated only by the trickle of heat leaking out from its interior. Earth’s current albedo is about 30 percent, with much of the reflection caused by clouds and snow cover. I myself prefer the term “albedo hacking,” but “albedo modification” does pretty well. My colleague and report co-author **James Fleming** has called such schemes “untested and untestable, and dangerous beyond belief.” (A companion report also discusses less problematic, if currently expensive, schemes for removing carbon dioxide from the atmosphere. Many of those would be well worth doing if they ever became economical.)

The report describes albedo modification frankly as involving large and partly unknown risks. It states outright that albedo modification “should not be deployed” and emphasizes that the main focus in climate protection should continue to be reduction of CO₂ emissions. If we continue to let CO₂ build up in the atmosphere and attempt to offset the effects by increasingly extreme albedo modification, the report states, that situation is one of “profoundly increasing risk.” This is a far cry from the cartoonish portrayal of albedo modification as the cheap and obvious method of choice **in *Superfreakonomics* or by Newt Gingrich.**

Two albedo modification schemes are singled out for detailed scrutiny. The first of these, called stratospheric aerosol modification, works high up in the atmosphere—in the layer known as the stratosphere—and involves injecting substances such as sulfur dioxide that lead to the creation of tiny particles that scatter sunlight back to space. It’s modeled on what happens in the wake of large volcanic eruptions. The second, called marine cloud brightening, works close to the Earth’s surface and involves injection of particles (usually created from salt spray) that either directly reflect sunlight or modify low-level clouds in a way that makes them more reflective. Both

techniques have the glaring problem that the albedo-modifying effects disappear within a few weeks to a few years, whereas the climate effects of the CO₂ we emit will persist for millennia, even if we ultimately kick the fossil fuel habit. That means that if the CO₂ we have emitted at some time heats the Earth to the point where something intolerably bad starts to happen, active albedo modification would need to be continually maintained basically forever. When has humanity ever managed to sustain a concerted complex technological enterprise for centuries, let alone millennia? An awful lot can happen in a thousand years, much of which we have no way to anticipate. The report recognizes that such a millennial commitment would be unprecedented in human history.

The take-home message is that *it is not possible to use albedo modification to counteract peak CO₂-induced warming without maintaining the climate intervention without interruption for millennia*. At least, that's the case unless we learn how to actively suck CO₂ out of the atmosphere. The problem of millennial commitment makes it exceedingly imprudent to count on albedo modification to get and keep us out of a climate emergency. Absent effective CO₂-removal techniques, albedo modification cannot be seen as a temporary measure that can give us time to get our act together to eliminate CO₂ emissions. And if at any point albedo modification actions are ceased abruptly, the world would be faced with the rapid release of a century or more of pent-up warming. This is why I refer to such a world as “Damocles world.” A lot could happen in a thousand years that might force abrupt termination of albedo modification, but to just mention one possibility: Think of what an attractive target most of the proposed deployment systems (e.g. tethered balloons or fleets of lumbering stratospheric aircraft) would be for terrorists, or for nations who believe rightly or wrongly that they are being harmed by albedo modification.

Temporary deployment scenarios, which are used to delay warming rather than limit its ultimate magnitude, are also considered in the report, which takes no stance on what form of deployment is most likely if the world is ever driven to that stage. I myself think the temporary deployment scenarios are highly implausible, and are mainly shopped by albedo-modification boosters as a less threatening way to get the **camel's nose** in the tent. I think that if people realized how little albedo modification can do for climate without taking on a millennial commitment, and that even such modest goals

come within reach only when CO₂ emissions reductions are so successful you hardly need albedo modification at all, a lot of the enthusiasm for the technology—already feeble outside the small circle of boosters—would evaporate.

Albedo hacking in the face of high CO₂ would put the Earth in a state that has no real analogue in all of human history. In fact, the state you create by such an action is somewhat like the state the Earth was in some 250 million years ago during the Permian period, when the sun was dimmer but atmospheric CO₂ was higher. A more disturbing comparison involves what would happen if albedo hacking ends abruptly: That would risk warming of a magnitude unseen since the Paleocene-Eocene rapid warming event some 55 million years ago, but at a rate that is probably unprecedented in all of Earth history. The hacking would also transform a substantial amount of direct sunlight into diffuse sunlight, altering the environment for all green plants on land.

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