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Can Solar Geoengineering Be Used as a Weapon?

The premise that solar geoengineering is weaponizable is either false or grossly overstated. It is time to leave such distractions behind and focus more squarely on the real dilemmas of this otherwise promising technology.

The sun rises behind Saint Michael's Church and Glastonbury Tor, in Glastonbury, Britain on November 4, 2020. REUTERS/Peter Cziborra

Blog Post by Guest Blogger for the Internationalist

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The following is a guest post by Joshua Horton, research director, geoengineering, at the Harvard Kennedy School; and David Keith, professor of public policy and professor of engineering at Harvard University.

Solar geoengineering—the idea of using technology to reflect a small fraction of incoming sunlight away from Earth to partially offset climate change—poses many problems, including its potential to discourage emissions cuts, its uncertain distributive consequences, and the possibility that suddenly stopping implementation might result in dangerously rapid warming. And yet available evidence shows that moderate use of solar geoengineering may offer an opportunity to mitigate climate hazards beyond what is possible even if all emissions could be eliminated tomorrow. In our view, the prospect that solar geoengineering could significantly reduce risks for the world's poorest, reducing income inequality, is a strong basis for pursuing research and international governance.

Debate on solar geoengineering, however, is haunted by a concern that such technology might be weaponized. This concern stems from longstanding military interest in weather modification technologies, most notably the U.S. use of cloud-seeding during the Vietnam War, which led to adoption of the 1976 Environmental Modification Convention (ENMOD) restricting hostile use of environmental modification techniques. It also stems from suggestions that governance of nuclear weapons may serve as a useful analog for governance of solar geoengineering.

Fears about the dual-use nature of solar geoengineering are sometimes stated explicitly (e.g., at 51:30 in this recent *Rolling Stone* debate), but more often implied in terms of vaguely defined security threats or speculation about "predatory geoengineering." In a recent guest blog for the *Internationalist*, for example, Elizabeth Chalecki argues that "Just as nuclear fission can produce both weapons and energy, so too can geoengineering provide benefits if applied judiciously;" unsaid but insinuated is that solar geoengineering might also be used to wage war, which justifies placing it under international control in the same way the Baruch Plan of 1946 sought to internationalize atomic energy. (For other recent examples see here and here.)

The premise that solar geoengineering is weaponizable, however, is either false or grossly overstated and inapplicable to those technologies that might plausibly be deployed. Precision is a defining attribute of weaponry; indeed, the so-called revolution in military affairs has made it the most prized attribute for many strategists, as exemplified by the dominant role now played by precision-guided munitions. One hallmark of solar geoengineering, however, would be its *imprecision*.

Take stratospheric aerosol injection (SAI), which would disperse aerosols in the stratosphere to reflect sunlight and reduce some harmful aspects of climate change. SAI is the most prominent type of solar geoengineering and the one most associated with fears about weaponization. Yet injected materials cannot be contained along lines of latitude and would quickly encircle the globe. Some north-south control is possible,

but only at a very crude level using just a few knobs like dispersing in equatorial versus polar regions or in northern versus southern hemispheres. Only *climate* effects —changes in average temperature and precipitation—could plausibly be induced; *weather* control at the level of individual storms or heat waves would be impossible to engineer. Moreover, there would be several steps between any induced climate *change* and the types of climate *impacts*—like changes in water availability or crop yields—that might affect states and societies in a somewhat predictable manner. There is simply no physical basis for believing that significant—large compared to natural variability —impacts could be targeted at the level of the nation-state.

Thus, SAI would be much too imprecise to function as a useful weapon. To take just one scenario, suppose the United States wished to attack Venezuela. The most predictable damage the United States could inflict using SAI would be a reduction in precipitation caused by dispersing aerosols solely in the southern hemisphere; doing so would shift the Intertropical Convergence Zone (ITCZ), an equatorial band of tropical rainfall northward, leading to decreased rainfall over Caribbean South America. But since the ITCZ circles the globe, this action would disrupt (sub)tropical precipitation worldwide. Indiscriminate climate modification of this nature would surely not be welcomed by China (America's principal rival), India (the linchpin of America's Indo-Pacific strategy), or Mexico (America's southern neighbor and third largest trading partner).

Furthermore, the effect would be slow-moving within Venezuela, requiring perhaps years to determine whether reduced rainfall was responsible for observed impacts like droughts or food shortages. And it would be even harder to link this intervention to combat readiness, battlefield conditions, and other operational variables with clear implications for warfighting. Whatever strategic or tactical benefits might accrue to the United States, they would be dwarfed by the costs, risks, and uncertainties produced by worldwide rainfall disruptions affecting friends and enemies alike. SAI lacks the minimum level of precision—in space, time, and effect—implicit in the concept of a

weapon.

The other two solar geoengineering technologies regularly discussed—low-level marine cloud brightening (MCB) using seawater spray to block incoming sunlight, and high-altitude cirrus cloud thinning (CCT) via dissipative seeding to enable more outgoing heat to escape the atmosphere—could be deployed with far more precision in space and time, yet it would still be extraordinarily difficult to use them to produce strong local effects, and such effects would inevitably cause significant distant consequences. It is conceivable that if MCB or CCT were deployed at global scale then they could be fine-tuned using meteorological data to enable limited weather control. But this is unproven, and even if possible, the physical consequences might be too diffuse or easily countered to have significant military value.

This is not to say that weaponization is utterly impossible. If solar geoengineering was implemented using low-Earth orbiting sunshades adjustable in real time, then some more precise military applications are imaginable. Yet this form of solar geoengineering is so far from practical reality as to be science fiction.

Weaponization might therefore be at least theoretically possible in a few exceptional cases, but in terms of real world policy relevance, the kinds of solar geoengineering that might plausibly be deployed in the next half-century—including SAI—would simply not be weaponizable. This conclusion does not depend on any assumption of goodwill, but instead follows directly from an understanding of the physical limits of practical technologies. For this reason, serious assessments of solar geoengineering—like the recently released National Academies of Sciences report—ignore the issue altogether.

This is encouraging, and yet the persistence of hints and suggestions that solar geoengineering might be weaponizable has the cumulative effect of helping shift attention away from hard, unavoidable problems toward more fantastical concerns regarding nebulous threats to national and global security. As discussions about solar

geoengineering start to move from academic forums to policy circles, it is time to leave such distractions behind and focus more squarely on those aspects of this otherwise promising technology with real potential to cause harm and destabilize world politics.