Who Can Govern from a House on Fire? International Order, State Responsibility, and the Problem of Solar Radiation Modification

Danielle N. Young

The increasingly visible consequences of climate change are leading scientists and policymakers to consider trying to cool global temperatures through intentional, wide-scale intervention into the climate, broadly known as geoengineering. On the week of June 26, 2023, the European Union called for talks on the risks of geoengineering,[1] while the United States quietly released a report on solar radiation modification (SRM)—particularly stratospheric aerosol injection (SAI), in which reflective particles are sprayed into the stratosphere to partially block incoming solar radiation—in response to a mandate from Congress to develop a governance framework for solar geoengineering research.[2] Solar geoengineering strategies, particularly SAI, may provide a means of cooling global temperatures relatively quickly, which is why they are receiving increased consideration, and political commitments to constraining warming to the Paris Agreement's target increase of 1.5 degrees Celsius are increasingly out of reach without some kind of substantial technological intervention. There are, however, significant risks and many unknowns in this fragmented area of scientific research.

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Analyses of the risks of solar geoengineering are currently dominated by assessments of its potential environmental impacts, and a "risk-risk" framing is emerging in which the potential environmental consequences of solar geoengineering are compared to the potential consequences of unmitigated climate change.[3] However, while such environmentally focused assessments are important, the motivations for developing and deploying a technology with planetary-level impacts such as SAI may not be solely or even primarily driven by environmental concerns or scientific assessments.[4] Solar geoengineering strategies, particularly SAI, may become politically appealing as an "emergency" response to climate change as political actors come under more pressure to act in response to climate impacts, whether or not scientifically established thresholds for their use have been established, let alone met. There is also a long history of powerful states jockeying for position and status via attempts to assert mastery and control over the environment,[5] and via control over scientific knowledge and technological developments.[6] There is arguably a case to be made that the environmental risks of solar geoengineering are far less than those of unmitigated climate change, although the assumption that unmitigated climate change is the necessary consequence of not pursuing solar geoengineering is problematic because it does not adequately reflect ongoing or planned mitigation efforts and may give the impression that the choice is to live in a world where nothing is done about climate change or to live in a world where SRM is used, which may make SRM look far more desirable. The political obstacles to effective governance and safe, well-informed development and deployment of SRM remain underexamined.

Not least of these obstacles is the increasing instability of international order writ large, including the nuclear arms control regime, which is sometimes referenced as a potential roadmap for geoengineering governance.[7] Effective governance of solar geoengineering would always be challenging due to the level of close cooperation that its safe, fair use entails, but current international conditions may see solar geoengineering rapidly drift into a fraught arena of political confrontation and strategic competition that would compound its already substantial scientific physical risks. It is important to assess the potential harms and benefits of SRM strategies within the broader context in which they may be developed and deployed, not just in terms of their environmental impacts. Just as decisions about how to respond to climate change have not been taken primarily on the basis of what is better or worse for the environment, decision-making about SRM will not occur in a political vacuum. There are several factors that indicate that political

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conditions only tangentially related to climate considerations will play a role in decision-making processes about solar geoengineering. First, the extant international order continues to fail to meet the growing challenges of climate change,[8] and the COVID-19 pandemic has exposed a deeply dysfunctional system of international cooperation.[9] The Russian invasion of Ukraine, nuclear saber rattling, interference in elections, and broader disregard for the rules of international order call into question how effective or cohesive the international order remains, and there are questions about how the political center of gravity in international order may continue to shift or transform as a result of China's continued economic rise and political and military expansion.[10] Second, and closely related, the United States remains at the center of the existing international order and wields by far the greatest capacity to develop and deploy solar geoengineering programs, but internal political instability and ambivalence about international governance regimes may lead the United States to act as a barrier to robust international governance, rather than a facilitator.[11] Third, there have already been attempts to introduce solar geoengineering experimentation without local consultation,[12] and every incidence will heighten suspicion that these proposed interventions are simply a continuation of long-standing practices of intervention that increase the vulnerability and exploitation of the populations whose climate fragility has been largely brought about by those with geoengineering capabilities.[13]

Introducing a new governance regime of any kind into this context would be difficult. To create and implement one with such potentially serious environmental and political consequences may be insurmountable, certainly without more serious and sustained reflection and engagement, including with those most likely to be affected and least likely to be able to take the lead on development and deployment.

An Unraveling Order, Increasing Conflict, and the Problem of Mistrust

Whether it is the U.S.-led international order, a "rule-based" international order, or the liberal international order (LIO), international order since World War II has been comprised of active institutions with global reach. These institutions, such as the United Nations, the International Monetary Fund, the World Bank, and the World Trade Organization, have been subject to continuous critique

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since their inception for their role in reproducing practices of exploitation rooted in imperialism,[14] but they remain part of a central architecture that facilitates some level of international cooperation between key actors. However, there is systemic stress on international order stemming from ongoing international conflicts, persistent problems in the governance of global challenges like nuclear weapons and climate change,[15] and rising economic inequality and the concomitant spread of right-wing populism.[16] The nuclear governance regime, central to contemporary international order by any name, has been described as unraveling or in crisis[17] even prior to the Russian invasion of Ukraine in 2022. Instability in the nuclear governance realm does not bode well for the international governance of emerging solar geoengineering technologies, not least because the nuclear weapons governance regime has sometimes been raised as a potentially analogous governance regime that might serve as a roadmap.[18] Key treaties governing nuclear weapons have lapsed, and SRM strategies, particularly SAI, may become a source of conflict and confrontation rather than cooperation if the unraveling of nuclear governance leads to an unrestrained arms race between the major nuclear powers.[19] Realistically, only states with major industrial capacity could deploy and sustain an SAI program with the scale and scope necessary to quickly lower global temperatures,[20] and this aligns closely to the capabilities and capacities of major nuclear powers. A race to control the atmosphere would have lower entry point costs for states that have the infrastructural capabilities to develop and deploy SAI.

Interest in and funding for solar geoengineering research remains concentrated in the Global North, particularly in the United States,[21] and there have been public suggestions that an SAI or other large-scale SRM program could be launched by the United States on behalf of the rest of the world until governance has been established.[22] However, this may not be acceptable to other nuclear powers, and the U.S. track record suggests that it would not tolerate other major powers attempting to set the proverbial thermostat,[23] which creates the possibility for serious geopolitical confrontation. The potential for conflict in this arena is compounded by increasing internal instability in the United States and how that affects international order more broadly.

The 2016 election of Donald J. Trump to the U.S. presidency arguably marked a turning point in which the United States showed itself to be less willing and much less able to lead the international order it was integral to forging and has been central to maintaining for decades.[24] During the Trump administration, the United

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States stepped back from key international institutions and organizations that it had helped establish in the latter half of the twentieth century, and its partners in those institutions and organizations, primarily concentrated in Europe, are also beginning to reevaluate their relationships with the United States as a result of the uncertainty caused by the country's internal instability.[25] The political trajectory of the United States has implications for the future of international order in general, and is likely to be particularly significant in relation to the future governance of solar geoengineering research and deployment. In addition, populations who are more vulnerable to climate change have often experienced nuclear and environmental imperialism at the hands of the United States and other nuclear powers in the past, intensifying problems of mistrust.[26]

Solar geoengineering proposals have been met with hostility and suspicion in some developing and climatologically vulnerable regions,[27] despite increasingly being framed as a humanitarian option designed to help vulnerable nations cope with the rapidly escalating consequences of climate change.[28] An illustrative example of this problem is the proposed Stratospheric Controlled Perturbation Experiment (SCoPEx) that the Keutsch Group at Harvard University announced it was developing in 2014. The experiment would have injected a small amount of calcium carbonate into the stratosphere using a high-altitude balloon fitted with airboat propellers to help disperse the aerosols.[29] SCoPEx would have been the first stratospheric field test of SAI, which involves injecting sulfates or other substances into the atmosphere to minimize the amount of solar radiation that reaches Earth.[30]

The ScoPEx experiment itself would have created no lasting, discernible change to Earth's atmosphere, but it represented a major step toward realizing a technological response to climate change that might lower global temperatures by masking the greenhouse gas effect until greenhouse gases could be drawn out of the atmosphere, a response that has long been considered taboo because of the potential for adverse and unpredictable consequences.[31] When the project was first proposed, the SCoPEx test was to take place in the southwestern United States. However, in 2020 the Keutsch Group announced that the SCoPEx experiment would instead be conducted in Sweden in June of 2021 in cooperation with the Swedish Space Corporation.[32] The SCoPEx test balloon was meant to be released over Kiruna, Sweden, the home of the Sámi Parliament of Sweden and part of the ancestral homeland of the Sámi, an indigenous Finno-Ugric people who strongly objected to the experiment. In an open letter to the SCoPEx Advisory Committee

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at Harvard University, the Saami Council, an NGO that represents members from the Sámi peoples across Sweden, Norway, Finland, and Russia, pointed out that, to its knowledge, the project organizers had not applied for permits with the Swedish government, or consulted with the broader Swedish research community, the public, or the Sámi people about the project. It also admonished the advisory committee for failing to include representatives from any of the potentially affected groups or any non-U.S. participants in what is meant to be an independent advisory board.[33] In a reversal, after months of strong objections from the Sámi and a variety of environmental groups, the SCoPEx Advisory Committee recommended a pause to the experiment, which has since been cancelled entirely. Trust and clear communication about the purpose and potential value of any solar geoengineering program will be vital to establishing effective international governance of these potential interventions, as the first forays into experimentation have contributed to an atmosphere of mistrust, informed by vulnerable populations' historical experience with environmental exploitation and the imposition of technological interventions.

Governing Solar Geoengineering: For the Environmentally Vulnerable or the Materially Powerful?

There is recognition of the need for governance of solar geoengineering as well as some of the challenges associated with it. However, there are already concerns that the populations and places most affected by climate change will be further marginalized by solar geoengineering programs because the resources required to research, develop, deploy, and maintain different SRM strategies, particularly SAI, are concentrated in the hands of actors with advanced industrial capacity and infrastructure.[34] The actors that bear the most responsibility for the ecological breakdown that has seemingly necessitated SRM technologies are putting themselves in charge of a planetary gamble without effective oversight or governance.

The United Nations Environment Assembly (UNEA), which describes itself as "the world's highest-level decision-making body for matters related to the environment,"[35] met in February of 2024 to consider, among other proposals, a resolution to establish an expert group based in the United Nations Environment Programme to assess the state of knowledge about solar geoengineering. This is the second time that a Swiss-led resolution to assess geoengineering was submitted

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for consideration at UNEA, the first being in 2019, and it is the second time that such a resolution faltered and was withdrawn due to failure to reach an agreement about how or whether to move forward at UNEA-6.[36]

In 2019, the United States and Saudi Arabia led efforts to quash the resolution because they objected to the inclusion of carbon dioxide removal techniques and SRM under the same umbrella, and insisted that the Intergovernmental Panel on Climate Change (IPCC) rather than UNEA should provide an assessment of SRM. The United States further objected to other participants' emphasis on providing a broader assessment of SRM's risks, benefits, and implications beyond a narrow scientific analysis to include social, political, economic, and justice concerns. Reflecting on the 2019 failure to reach an agreement about how to proceed with discussions about SRM—including whether and where to hold such discussions—the Swiss-led resolution focused specifically on SRM technologies and the proposal was significantly pared down to request a repository of what is known about SRM, in part to better identify important gaps in knowledge. There was significantly more engagement from developing countries in this round about their concerns with moving forward, including the potential for shifting away from greenhouse gas mitigation, the kinds of diverse assessments they would like to see, and where and how a repository of SRM knowledge should be managed. In addition, opponents of the 2019 Swiss-led resolution wanted an assessment of SRM from the IPCC which has since been included in their most recent Assessment Report. However, the United States again led efforts to quash the resolution, moving the goalposts by now insisting that an assessment should be based in the World Meteorological Organization through its World Climate Research Programme and, crucially, it strongly objected to including anything but "objective" scientific analysis of SRM, dismissing the inclusion of any assessment of political, ethical, social, or other implications of the technology, and resisted efforts to expand the scope of membership in the expert group.[37]

While a coalition of African states, with the support of many of the most climate-vulnerable states, first wanted the resolution to include a global governance mechanism for the nonuse of SRM, it also requested a mandatory compilation of expert knowledge and member state positions that would be inclusive and demanded better and broader access to information about SRM. This was flatly rejected by the small, U.S.-led group, casting stark light on any claims that SRM might be led by the climate vulnerable or driven by their interests; they have asked for what they want and been refused by the United States,

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where most SRM research is concentrated. This second failure, an insistence on "science-only" considerations of SRM, also implicates solar geoengineering governance as a battleground to exclude or escape political and ethical contestation by thoroughly subjugating it to the scientific knowledge and capacities of powerful actors, many of which are the greatest historical contributors to climate change.[38]

Conclusion

There may well be a case for arguing that some form of SRM, especially an SAI program, could be necessary to help those parts of the world suffering the most from climate change, but vulnerable populations have reason to doubt that solar geoengineering would be deployed for humanitarian motives. People are and have been suffering and none of the top polluters have been serious enough about mitigation.[39] Indeed, the impasse over the future of solar geoengineering governance highlighted by the withdrawal of the Swiss-led resolution at the sixth session of UNEA, or UNEA-6, in early 2024 suggests that it is not the priorities and desires of more climate-vulnerable populations that are driving the trajectory of solar geoengineering research and development. SAI can only be practically deployed and maintained by countries with large-scale industrial capacities, such as the major nuclear powers, which are increasingly and dangerously at odds. Effective governance will require deeper engagement with the broader political context into which it would be introduced—it cannot be bracketed off from either historically informed concerns or contemporary conditions because of both its environmental *and* political and ethical risks. Perhaps the key ethical risk of solar geoengineering is that it will simply reproduce the hierarchical, exploitative, and exclusionary practices that have created the conditions of the climate crisis, particularly for poor, developing, and climate-vulnerable populations. Such an ethical risk must be taken seriously in assessing the risks of solar geoengineering beyond scientific environmental assessments as governance debates continue and governance frameworks are developed.

This roundtable covers a range of critical views about proposed solar geoengineering technologies and the possibilities for their governance. This contribution has focused on the international political context in which such governance might be developed and the very real possibility that these technologies and the institutions established to govern them may reproduce and reinforce existing problems with climate colonialism or the marginalization of climate-vulnerable

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populations. Duncan McLaren's contribution makes the case that knowledge about solar geoengineering derived from Earth-systems modeling is a dangerously inadequate basis for making decisions about solar geoengineering because it does not—and largely cannot—account for nonideal deployments that may be used for competitive or malicious purposes. Governance proposals that start from the assumption that solar geoengineering will be developed and deployed primarily to benefit the environment under coordinated, cooperative conditions are dangerously naïve. In their contribution, Stacy VanDeveer, Frank Biermann, Rakhyun Kim, Carol Bardi, and Aarti Gupta argue that governance that ensures the nonuse of planetary solar geoengineering is the only ethically justifiable approach and explore three pathways that involve different configurations of decentralized, regional, and bottom-up initiatives through which nonuse may become the norm for solar geoengineering governance. In a contrast that also serves as a warning, the contribution by Jeroen Oomen explores how practices and assumptions within climate politics more broadly may be working to shift the conceptualization of SRM as a radical technology of last resort to a technology of inevitable necessity, in part by depoliticizing scientific authority. What all of these contributions hold in common is the urgent necessity to take seriously the ethical and political challenges presented by solar geoengineering and its governance, which cannot be anticipated or addressed solely through assessments of their potential environmental benefits and risks.

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Abstract: This essay argues that the possibility of governing the development and deployment of solar radiation modification (SRM) technology is predicated on the assumption of a liberal international order informed by an understanding of state responsibility. However, this order is experiencing a period of disruption that has placed stress on extant and emerging global governance regimes and brought the assumption of their efficacy and viability into doubt. In addition, international order and existing global governance of technologies with planetary implications, such as nuclear weapons, have become the increasing focus of criticism because of the inequities embedded within these institutions, calling into question how much of a roadmap the existing governance architecture can or should provide. Leading developers and proponents of SRM have advocated for cooperative, transparent, science-led governance, which parallels the language of early nuclear governance advocates, but there is a long history of displacement and disruption of indigenous and otherwise marginalized populations without meaningful consultation to accommodate technological developments driven by powerful, industrialized countries. Developing an ethical framework for the governance of SRM will be challenging under the current conditions of increasing tensions and confrontations between major powers that may have non–climate-related interests in developing and controlling SRM technology. This essay will reflect on whether the current international order, stable or unstable, is capable of producing ethical governance of SRM.

Keywords: solar geoengineering, international order, geopolitics, climate colonialism

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