Producing the Inevitability of Solar Radiation Modification in Climate Politics

Jeroen Oomen

It's a climate emergency! As UN Secretary-General António Guterres proclaims, "The era of global boiling has arrived," and emergency measures are inching into view.[1] Increasingly, the prospect of an apocalyptic climate future acts to justify invasive technological proposals that might safeguard humanity from catastrophe. One such set of proposed technologies is solar radiation modification (SRM), also known as solar geoengineering, climate engineering, or climate-altering technologies. As a concept, SRM describes a diverse set of speculative technologies aiming to reduce global warming by manipulating the Earth's energy budget. This manipulation can take various forms and scales. Proposals such as stratospheric aerosol injection (SAI) and marine cloud brightening (MCB) would aim to reduce incoming solar radiation by scattering and reflecting sunlight coming into the climate system. Cirrus cloud thinning (CCT) would stimulate outgoing long wave radiation by dispersing wispy clouds that trap heat. The most controversial of these proposals, especially in the case of SAI and MCB, aim to cool the planet at a global scale, although more regional proposals exist. All these proposals are deeply uncertain and controversial, both from a technical and political point of view.[2]

Jeroen Oomen, Utrecht University, Utrecht, Netherlands (j.j.oomen@uu.nl)

Ethics & International Affairs, 2024, page 1 of 15.

doi:10.1017/S0892679424000273

Because of these uncertainties, supportive scientists and scientific bodies typically present SRM as a set of radical technologies that come into view "given the severity of climate change." SRM, on this view, is not ethically and politically desirable in and of itself but may become a necessity "to slow climate warming and reduce climate impacts."[3] This argument for the climatic necessity of SRM research is compelling. The 1.5° Celsius and even the 2° Celsius climate targets set by the Paris Climate Agreement are likely unattainable, given that the dramatic cuts advocated by the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) are not materializing.[4] There are good reasons to research technological proposals that may alleviate some of the suffering and damage caused by climate change. Already, heat waves, storms, floods, and droughts plague both terrestrial and oceanic environments.

Yet scientific and climatic reasons for SRM in the face of severe climate change can only partially account for political and policy interest in SRM. Importantly, scientific and climatic reasons will only partially steer SRM's eventual governance, as these factors will combine with other political considerations. This potential entanglement is the focus of this contribution. Here, I investigate how these speculative technologies come into view politically. In my view, SRM is not a radical option but rather a logical extension of the logics of climate (geo)politics and climate science. Both historically and currently, SRM fits into unspoken but tightly controlled political and discursive rules within which climate politics operates. To make my argument, I briefly address several practices that push SRM into the heart of climate politics as an idea that has gained political traction over the past decade(s). These include the ways in which science is called upon to address (and depoliticize) global concerns; implicit assumptions about geopolitical configurations; and the ways in which predominant images of the future are mobilized for political ends. Importantly, this is an explorative argument, not intended to be fully proven or wholly consistent. Instead, I intend to raise questions about the political fit between SRM and climate politics. As I address in the final part of this essay, the ethical implications of my explorative argument are threefold. First, it implies that SRM might be an instrument of mitigation deterrence—implicitly as much as explicitly. Second, ethical responsibility and political value debates are at risk of becoming invisible once SRM becomes embedded in the prevailing regime. And third, SRM use might become inevitable, despite the good intentions of careful researchers and skeptical policymakers.

https://doi.org/10.1017/S0892679424000273 Published online by Cambridge University Press

The Contested Governance of SRM

Both the science and the politics of SRM are uncertain. It remains unclear how SRM schemes will affect rainfall patterns, temperature distributions, and ecological and biological systems. There are some indications about their relative impacts, but the exact consequences of SRM implementation are impossible to predict.[5] Moreover, it would likely be difficult to disentangle the exact effects of SRM from climate and weather variability even after implementation. Its cooling effects are relatively straightforward, especially for SAI, though they will probably be unevenly distributed. Self-evidently, there are also significant differences between the main proposed technologies, such as SAI and MCB, in terms of technical approach, direct climatic effects, possible unexpected consequences, and political sensitivities. The distribution of risks will depend on the specific technologies and the manner of their implementation. Because of uncertainties about model fidelity as well as the complexity of the climate system, the potential risks and exact efficacy of these technologies remain uncertain.[6]

SRM's geophysical uncertainties tie into its (geo)political uncertainties. Exerting deliberate global climate control would have deep (geo)political, ecological, and even military repercussions.[7] The risks and benefits of such interventions will certainly not be equally distributed, although it is difficult to say in advance with any certainty how they might differ. This raises a host of ethical, political, and governance concerns, which typically center on two domains. The first domain questions the *governance* and *governability* of SRM implementation: "Who controls the thermostat?" What kind of political organization fits with geoengineering? Might it be possible to implement SRM in a safe, ethically sound, and democratic manner? Given the technologies' uncertain and invasive nature, political scientists worry that SRM may lead to overt geopolitical conflict, be incompatible with democratic forms of governance, lock in centralized governance systems, and become militarized and securitized.[8] Beyond these concerns about the deployment and governance of such technologies, the second domain centers on the question of how SRM—research or the prospect of implementation—might influence climate politics at large. This domain ties into more immediate fears about the potential of SRM to derail mitigation commitments.[9] Critics also raise the question of whether currently developing narratives, frames, and discourses might make the implementation of these technologies inevitable.[10] At the same time, there is a noted absence of strong regulatory frameworks for both research and deployment,

https://doi.org/10.1017/S0892679424000273 Published online by Cambridge University Press

leading to differing opinions about how to govern SRM.[11] Because of these myriad concerns, in 2022, a group of critical academics, including both social and natural scientists, wrote a perspective article calling for a nonuse agreement on SRM, one that would constrain not only the use of these technologies but also their development and incorporation in conventional climate governance.[12] For the sake of transparency: I was one of that piece's lead authors. Our proposal was understandably met with criticism from other academics and journalists, as many thought the piece needlessly prohibitive, as well as naïve about the necessity for climate intervention research.[13] These differences of opinion notwithstanding, proponents of SRM research agree that the *use* of SRM should be constrained for the foreseeable future. At the same time, they insist that—given the severity of the climate crisis—research into any technologies that might limit future suffering should be stimulated and applauded.[14]

Underlying this contestation, one finds differing readings of what is at stake, typically connected to a differing reading of politics. By and large, proponents of SRM research seem to aim for a structured, organized, institutionalized, and often multilateral governance process. Horton and colleagues, for example, outline several potential approaches to SRM governance that might be fair and democratic.[15] In principle, such constructive forms of governance might be possible. However, for many of those supporting a strict nonuse agreement, including myself, although such forms of constructive governance might not be impossible in principle, they do seem exceedingly unlikely in political practice. Global governance and politics, by design, are not just, fair, structured, organized, or democratic. They are not even necessarily state or institution led. In a similar vein, most of those skeptical of SRM development think that (implicit, explicit, and insidious) SRM promises will harm conventional mitigation, while many proponents of research and development think mitigation deterrence is unproven and uncertain.[16] These differences bring into view a third avenue of governance concerns, one that consistently and implicitly structures the academic debate on SRM yet is rarely made explicit. It concerns the questions of how politics functions and how political change happens. To me, these are the central questions we ought to be asking about SRM, certainly at this moment in time. What are the social, political, and material forces that pull SRM into the center of climate science and politics; and what are the social, political, and material forces that may push SRM out of those centers? And what are the ethical and political consequences of these forces? By and large, clear-eyed attention to how SRM already is and would be

https://doi.org/10.1017/S0892679424000273 Published online by Cambridge University Press

governed in practice remains underdeveloped, with some notable exceptions.[17] Similarly, again with some exceptions, detailed investigation of how SRM comes into view politically, scientifically, and culturally remains a niche concern.[18] Yet such questions have huge consequences for the development, governance, and eventual implementation of these technologies. As such, I would argue that the most important geopolitical questions around SRM are: What are the mechanisms and practices that bring these speculative technologies into view? What makes them attractive (or unattractive) on the geopolitical stage? What discourses, interests, and developments push these technologies onto center stage? What sites of governance exist for SRM beyond the hallowed halls of state policy and multilateral agreement?

Producing the Inevitability of SRM

In the debate on SRM, the political question about SRM is often positioned as a question of how to ensure good governance.[19] Centering on this question often singles out institutional and governmental mechanisms as key forms of governance. In such a view, SRM remains largely ungoverned. Institutional frameworks are sparse. Beyond the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques and a partial moratorium from the UN Convention on Biological Diversity, few legal frameworks explicitly govern SRM. Yet governance is not just procedural, legalistic, or institutional. Politics and governance extend beyond official institutional, state-centered, and multilateral avenues. This means that understanding the politics of SRM requires a broader view of governance,[20] as well as the recognition that norms and conventions—some codified in law, some in the form of common law—already structure climate politics.[21] It requires a broader view of politics, as SRM is not just a technological solution to climate change but also the outflow of a particular way of relating to nature, the result of a specific scientific infrastructure, and a response to a particular way of doing environmental politics. These broader phenomena may bring SRM into view as a potential response to climate change without adequate political or ethical deliberation.

To fully appreciate what I consider the ongoing normalization of SRM as a policy option, we need to investigate such broader forms of governance—including the implicit conventions, norms, and epistemological confines of climate politics, climate science, and culture at large—more carefully. To do so, it is important to

https://doi.org/10.1017/S0892679424000273 Published online by Cambridge University Press

recognize that governance and politics are largely symbolic and imagined. As such, politics and its required authority relies on explicit and implicit repetition and policing of norms.[22] Simply put, social performance enacts and reproduces the power and authority of governance systems. Because of the symbolic nature of the social world, implicit rules of conduct, norms, and conventions, and discursive frames are crucially important in shaping both political and scientific debates. It is through such enactment, through implicit rules of conduct—both in terms of what to say and how to say it—that governance takes place in practice. This also largely applies to scientific authority. As such, a key question for SRM governance ought to be: How does this social disciplining work, and how do norms and conventions come into being? How might they push SRM into the political reality or pull it out of it? And, my main concern: How could they produce a sense of inevitability around the eventual use of SRM? I contend that SRM fits neatly into unspoken but tightly controlled political and discursive rules within which climate politics and climate science operate. Such rules enforce dominant discourses and concerns by policing what is considered appropriate behavior.

An early example of such disciplining took place in the early debate around geoengineering in the 1990s and 2000s, notably seeking to keep geoengineering *out* of climate politics. At the time, climate scientists and political actors were reluctant to engage with geoengineering technologies. Fearing that alternative technological solutions might distract from conventional mitigation, scientists and observers made sure their colleagues knew the research was undesirable—and, in many cases, an unwise career investment. For a time, even adaptation was anathema. In the eyes of David Keith, arguably the most authoritative person flaunting this restriction, for decades "a de-facto taboo against serious work on geoengineering discouraged quantitative work; little was done."[23] Yet this social disciplining can cut both ways. Both the increasing normalization of SRM proposals today and the early success of the science-policy interface that refused to engage these technologies have relied on social conventions being actively enforced, enacted, performed, and policed by those in the science-policy interface. Studying the (geo)politics and ethics of SRM requires detailed attention to how such norms and discourses come to be, and how SRM becomes an object that can be governed.[24] In the remainder of this essay, I outline three brief examples of the increasing normalization of SRM, not as clinching arguments but rather as avenues for further study: depoliticization through scientific authority,

https://doi.org/10.1017/S0892679424000273 Published online by Cambridge University Press

governance through epistemological confinement, and the normalization of SRM through cultural aspirations.

Depoliticization through Scientific Authority

Implicit forms of governance, such as norms and conventions, will determine how and when solar geoengineering might appear as an option for climate policy. The question is how those norms arise and how people come to adhere to them. According to Aarti Gupta and Ina Möller, such de facto governance of geoengineering has already emerged. Drawing on Arie Rip's chapter on the de facto governance of nanotechnologies,[25] Gupta and Möller analyze "sources of governance that are *unacknowledged and unrecognized* as seeking to govern, even as they exercise governance effects."[26] Distinct from "de jure governance," which refers to formal institutional and legal governance mechanisms, or explicit norm setting, "de facto governance" concerns the implicit norms set through social convention. Gupta and Möller showcase two examples of de facto governance in which scientific assessments codified geoengineering and SRM as a space of research, defining what geoengineering (and SRM) would be as an object of governance and prefiguring the contemporary political debate in the process: first, the 2009 Royal Society report on geoengineering—which shifted the debate on geoengineering away from the association of hubris that had developed in the 1970s and 1980s—and, second, the 2015 National Research Council report on climate intervention—which confined the epistemological boundaries of the debate to "a heating system with two knobs, either of which can be used to set the global mean temperature."[27] These reports set boundaries for both the scientific and subsequent political development of geoengineering.[28] In doing so, they

> had the effect of recasting the original hubristic framing of [climate engineering] techniques. Both depict controversial [climate engineering] issues as manageable (or 'governable'), hence settling the 'whether to govern' question, even as they authoritatively intervene to shape the 'what' question. In so doing, these framings and acts of demarcation have contributed to shifting the focus of governance debates from first-order 'what, if, and whether' questions to 'how, when, and who,' i.e., to questions of (technical) design.[29]

Because of the authority of these reports, such framings have steered the discussion of geoengineering at large as well as SRM specifically in the years after their publication.

https://doi.org/10.1017/S0892679424000273 Published online by Cambridge University Press

Governance through Epistemological Confinement

Implicit epistemological boundaries prefigure political debates, as such boundaries determine what kinds of knowledge are deemed to be policy relevant and how to acquire knowledge about the climate system or the future. Whether set through reports or scientific traditions, epistemological demarcation structures climate politics. Amitav Ghosh rightfully observes that affluent countries view climate change as a technoeconomic problem in which the solution to climate change is one of technological development and economic management.[30] It is a view that isolates "the climate crisis" as a concern from other geopolitical issues, as well as concerns about justice, ethics, and historical responsibility. Agnostic about ethical concerns, this technoeconomic framing is deeply embedded in the United Nations Framework Convention on Climate Change. As Bentley Allan observes,

> Climate governance is oriented to the precise control of CO_2e levels rather than to precautionary action or societal steering. The geophysical climate that appears in [general circulation models] links easily, via the unit tCO_2e to economic models that promise precise control of the climate using pricing mechanisms and carbon sink projects. In short, the geophysical frame ports into a policy discourse centered on levers to precisely manipulate tCO_2e. This premise can be extended to support and legitimate geoengineering.[31]

In this framing, science and technology help not only to address climate change but also to depoliticize it.[32] This demarcation of science from politics—of fact provision from political value judgments—has a long history.[33] According to Allan, the governance of climate change emerged through a global epistemology based on the development of the geophysical sciences through military interests. As a result, climate politics gets conducted with an emphasis on prediction and control, in which geoengineering technologies—both carbon dioxide removal and SRM—appear as "an insurance policy taken out against the possibility of climate disaster."[34] This is important, because "climate engineering technologies—and climate engineering as an imagined *set of approaches* to climate change—rely on . . . a synoptic view of selective reality. Through the development of a global epistemology, it became possible to imagine 'whole Earth' technological interventions."[35] In that sense, implicit rules about what forms of knowledge count as appropriate,[36] the "corridor" of acceptable policy options,[37] and the ways in which to research climate futures are all subject to implicit norms and conventions that are heavily policed in the science-policy interface.[38]

https://doi.org/10.1017/S0892679424000273 Published online by Cambridge University Press

Normalization through Cultural Aspirations

In practice, climatic considerations and the distaste of climate scientists will not be the only considerations at play in decision-making around SRM. To understand the political reality of SRM, it is crucial to understand the wider social, cultural, and political norms, conventions, and developments that work to push SRM into view, as well as the ones that work against the normalization of these technologies. As is visible in climate politics at large, concerns about the future of the climate are always mediated by other concerns, such as justice, geopolitical power, economic considerations, and the securitization of the environment. Even ideas about "the good life," about a life worth living, deeply affect the political reality of SRM. Climate politics has historically been accompanied by the insistence that people "don't have to give up a quality of life," as U.S. climate envoy John Kerry stated in 2021. From U.S. President George Bush Sr.'s statement in the early 1990s that the American lifestyle was not up for debate to Kerry's more recent assertion that "50% of the reductions we have to make to get to net zero are going to come from technologies that we don't yet have,"[39] ideas about how life ought to be lived will also influence implicit decision-making around SRM.[40]

In addition to the good life, considerations of geopolitical power, control over energy flows, and the military application of SRM will also be influential.[41] In practice, geopolitical concerns about military power and cultural dreams of material affluence often trump climatic and justice considerations. Alongside such explicit political interests, we can already witness SRM being normalized. A growing group of scientists has called for intensifying SRM research, arguing it might be "the most rapid way to potentially counter some near-term climate warming."[42] At the same time, SRM is being prepackaged for its adoption in a wider policy regime, by trading terms with a problematic connotation—such as "geoengineering," "climate intervention," and "solar radiation *management*"—for more policy-friendly alternatives.[43] For instance, the Paris Peace Forum now consistently speaks about "climate-altering technologies"; those proposing solar geoengineering at a smaller scale, such as refreezing the Arctic, want to engage in "climate restoration." Meanwhile, integrated assessment modeling investigates the potential economic benefits of SRM research, fitting the technoeconomic frame of climate politics.[44] Newspapers and magazines feature articles on these technologies too, adding to the implicit normalization of SRM. Such developments have political effects, as they weave together cultural aspirations and speculative technologies, normalizing

https://doi.org/10.1017/S0892679424000273 Published online by Cambridge University Press

these ideas in the process. Soon, SRM might not be "policed out" of the science-policy interface, but rather "policed in."

In short, SRM (1) fits the epistemological boundaries of climate politics, (2) fulfills the political desire to depoliticize the climate crisis in a technoeconomic framing, and (3) might simultaneously correspond to and reinforce dominant aspirations in which technological advancements safeguard the lifestyles of affluent countries.

The Ethics of Inevitability

SRM is not inevitable yet. It remains a deeply controversial range of speculative technologies. However, without critical scrutiny of the cultural, epistemological, and political drivers that may produce a sense of inevitability around these technologies, SRM could rapidly normalize in ways that are hard to foresee and difficult to counter. Such normalization would have at least three important ethical implications.

First and foremost, the implicit normalization of SRM as a key instrument of climate policy might simultaneously render it the next instrument of mitigation deterrence. Problematically, such mitigation deterrence would be hard to prove empirically, as overt attempts to delegitimize or delay mitigation commitments would combine with implicit, barely noticeable shifts in priorities. Still, the refusal to accept fundamental value debates about lifestyle—as evidenced by John Kerry's statement—pushes into view the promise of ever-more-speculative technologies. Likewise, geopolitical interests in maintaining control over the global flow of energy might lock in a twinned interest in continued use of fossil fuels and SRM. This could lead to ethical concerns, as (the prospect of) SRM could contribute to the suggestion that resource- and energy-intensive lifestyles in the Global North can continue indefinitely. This suggestion could lead to mitigation deterrence, as well as to the intensification of other resource extraction, which could contribute to severe ecological and climatic effects in the future; even if SRM were to be (partially) successful. To some extent, such assumptions are already present in the scenarios presented by the IPCC as commensurate with the 1.5° and 2° Celsius climate targets.[45] If SRM were to fail—or be used for reasons other than climatic stability—the poorest and most vulnerable would suffer from that lack of mitigation commitment.

Second, the implicit normalization of SRM might place ethical responsibility and political value debates at risk of becoming invisible. Processes of de facto

https://doi.org/10.1017/S0892679424000273 Published online by Cambridge University Press

governance might, as I have outlined above, curate particular debates about the governability of SRM. Once SRM becomes embedded in the prevailing regime, democratic decision-making about these technologies might be difficult, as important discursive parameters will already have been set. As a result, de facto governance and epistemological confinement could limit whose voice is made to matter in geopolitical debates over the future of the earth.

These two concerns feed into a third concern; namely that the use of SRM might become inevitable, despite the good intentions of most people involved. The dynamics described above, as well as mitigation deterrence and a lopsided political debate about the potential of these technologies, might create a political discourse that produces the idea that SRM is the only recourse for climate politics. Moreover, as tech entrepreneurs and military establishments take notice (and fund the development) of these technologies, scientific and climatic considerations might take a back seat to other concerns, such as geopolitical, economic, or military interests.[46] Such normalization of SRM does not necessarily happen deliberately. Instead, implicit processes could render the fit between SRM and the regime of climate governance ever tighter. The political career of carbon dioxide removal (CDR) is a cautionary tale. In the late 2010s, the status of CDR as a controversial geoengineering technology shifted rapidly.[47] While many at first considered CDR undesirable and unfeasible at scale, the adoption of the Paris Agreement and subsequent modeling efforts created a notion of CDR's necessity. Despite serious worries about whether CDR can deliver at the scales projected in the models remaining, as well as the potential risks and costs of such technologies, CDR is now an embedded assumption in climate politics. Yet those model runs suffered from the same epistemological confinement and de facto governance that SRM encounters today. It is a detail most policymakers do not realize, let alone the public and opportunistic opinions. In the same way, the coming years might produce the inevitability of SRM in climate politics.

Conclusion

There is an increasingly tight fit between the global regime of climate politics and the promise of SRM technologies. To address SRM in isolation from its broader geopolitical and societal trends mistakes the nature of geopolitical decision-making: it means missing the centripetal forces that work to render SRM an inescapable part of climate politics. It also means missing the establishment of norms and conventions that "police" SRM into climate politics. In

https://doi.org/10.1017/S0892679424000273 Published online by Cambridge University Press

scientific, political, and popular debate, SRM seems increasingly accepted as a technology of last resort. SRM is fast becoming part of the mainstream portfolio for environmental politics. Backstage, the countries with the worst track records on mitigation listen intently to the promises of these technologies. Front stage, entrepreneurs sell cooling credits—to nearly everyone's dismay—while scientific academies and disciplinary associations call for more research should society request these technologies at some stage.[48] Within this regime, SRM appears not as a radical option but rather as a logical extension and consequence of current rationales. We ought to be clear eyed about this and seriously investigate the governance and normalization of these technologies in practice. To do or not to do SRM ought to be a (geo)political question and an ethical concern, not a case of de facto normalization. Otherwise, there is a significant risk SRM will become unavoidable in the drama that is environmental politics.

Notes

[1] "Hottest July Ever Signals 'Era of Global Boiling Has Arrived' Says UN Chief," *UN News*, United Nations, July 27, 2023, news.un.org/en/story/2023/07/1139162.

[2] National Academies of Sciences, Engineering, and Medicine, *Reflecting Sunlight: Recommendations for Solar Geoengineering Research and Research Governance* (Washington, D.C.: National Academies Press, 2021); IPCC, *Climate Change 2022: Mitigation of Climate Change*, Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, ed. Priyadarshi R. Shukla, Jim Skea, Raphael Slade, Roger Fradera, Minal Pathak, Alaa Al Khourdajie, Malek Belkacemi, et al. (Cambridge, U.K.: Cambridge University Press, 2022); National Research Council, *Climate Intervention: Carbon Dioxide Removal and Reliable Sequestration* (Washington, D.C.: National Academies Press, 2015); and National Academies of Sciences, Engineering, and Medicine, *Reflecting Sunlight*.

[3] "An Open Letter regarding Research on Reflecting Sunlight to Reduce the Risks of Climate Change," climate-intervention-research-letter.org.

[4] IPCC, *Climate Change 2022*; and Gloria Dickie, "Despite COP28 Deal on Fossil Fuels, 1.5C Goal Likely Out of Reach," Reuters, December 14, 2023, www.reuters.com/sustainability/climate-energy/despite-cop28-deal-fossil-fuels-15c-goal-likely-out-reach-2023-12-14/.

[5] National Academies of Sciences, Engineering, and Medicine, *Reflecting Sunlight*.

[6] See, for example, Ben Kravitz and Douglas G. MacMartin, "Uncertainty and the Basis for Confidence in Solar Geoengineering Research," *Nature Reviews Earth & Environment* 1, no. 1 (January 2020), pp. 64–75; Tapio Schneider, Colleen M. Kaul, and Kyle G. Pressel, "Solar Geoengineering May Not Prevent Strong Warming from Direct Effects of CO_2 on Stratocumulus Cloud Cover," *Proceedings of the National Academy of Sciences* 117, no. 48 (November 16, 2020), pp. 30179–85; and National Academies of Sciences, Engineering, and Medicine, *Reflecting Sunlight*.

[7] Duncan McLaren and Olaf Corry, "Clash of Geofutures and the Remaking of Planetary Order: Faultlines Underlying Conflicts over Geoengineering Governance," *Global Policy* 12, Supp. 1 (April 2021), pp. 20–33, onlinelibrary.wiley.com/doi/10.1111/1758-5899.12863; National Academies of Sciences, Engineering, and Medicine, *Reflecting Sunlight*; and Danielle N. Young, "Considering Stratospheric Aerosol Injections beyond an Environmental Frame: The Intelligible 'Emergency' Techno-Fix and Preemptive Security," *European Journal of International Security* 8, no. 2 (May 2023), pp. 262–80.

[8] For such concerns, see McLaren and Corry, "Clash of Geofutures and the Remaking of Planetary Order"; Duncan McLaren and Olaf Corry, "'Our Way of Life Is Not Up for Negotiation!': Climate Interventions in the Shadow of 'Societal Security,'" *Global Studies Quarterly* 3, no. 3, ksad037 (July 2023), pp. 1–14; Bronislaw Szerszynski, Matthew Kearnes, Phil Macnaghten, Richard Owen, and Jack Stilgoe, "Why Solar Radiation Management Geoengineering and Democracy Won't Mix,"

https://doi.org/10.1017/S0892679424000273 Published online by Cambridge University Press

Environment and Planning A: Economy and Space 45, no. 12 (December 2013), pp. 2809–16; Jean Chemnick and E&E News, "U.S. Blocks U.N. Resolution on Geoengineering," *Scientific American*, March 15, 2019, www.scientificamerican.com/article/u-s-blocks-u-n-resolution-on-geoengineering/; and Catriona McKinnon, "Sleepwalking into Lock-In? Avoiding Wrongs to Future People in the Governance of Solar Radiation Management Research," *Environmental Politics* 28, no. 3 (2019), pp. 441–59.

[9] Duncan McLaren, "Mitigation Deterrence and the 'Moral Hazard' of Solar Radiation Management," *Earth's Future* 4, no. 12 (November 2016), pp. 596–602; and Jeroen Oomen, *Imagining Climate Engineering: Dreaming of the Designer Climate* (New York: Routledge, 2021).

[10] Frank Biermann and Ina Möller, "Rich Man's Solution? Climate Engineering Discourses and the Marginalization of the Global South," *International Environmental Agreements: Politics, Law and Economics* 19, no. 2 (April 2019), pp. 151–67; Jonas Anshelm and Anders Hansson, "The Last Chance to Save the Planet? An Analysis of the Geoengineering Advocacy Discourse in the Public Debate," *Environmental Humanities* 5, no. 1 (2014), pp. 101–23; and Aarti Gupta and Ina Möller, "De Facto Governance: How Authoritative Assessments Construct Climate Engineering as an Object of Governance," *Environmental Politics* 28, no. 3 (April 2019), pp. 480–501.

[11] For examples of these diverging opinions, see Sikina Jinnah, Simon Nicholson, David R. Morrow, Zachary Dove, Paul Wapner, Walter Valdivia, Leslie Paul Thiele, et al., "Governing Climate Engineering: A Proposal for Immediate Governance of Solar Radiation Management," *Sustainability* 11, no. 14, 3954 (July 2019); and Jesse L. Reynolds, *The Governance of Solar Geoengineering: Managing Climate Change in the Anthropocene* (Cambridge, U.K.: Cambridge University Press, 2019).

[12] Frank Biermann, "It Is Dangerous to Normalize Solar Geoengineering Research," *Nature* 595, no. 7865 (July 2021), p. 30; and Frank Biermann, Jeroen Oomen, Aarti Gupta, Saleem H. Ali, Ken Conca, Maarten A. Hajer, Prakash Kashwan, et al., "Solar Geoengineering: The Case for an International Non-Use Agreement," *WIREs Climate Change* 13, no. 3, e754 (January 17, 2022).

[13] Edward A. Parson, Holly J. Buck, Sikina Jinnah, Juan Moreno-Cruz, and Simon Nicholson, "Toward an Evidence-Informed, Responsible, and Inclusive Debate on Solar Geoengineering: A Response to the Proposed Non-Use Agreement," *WIREs Climate Change*, e903 (2024).

[14] "Open Letter regarding Research on Reflecting Sunlight."

[15] Joshua B. Horton, Jesse L. Reynolds, Holly Jean Buck, Daniel Callies, Stefan Schäfer, David W. Keith, and Steve Rayner, "Solar Geoengineering and Democracy," *Global Environmental Politics* 18, no. 3 (August 2018), pp. 5–24.

[16] For a more in-depth investigation of such differences, see Oomen, *Imagining Climate Engineering*.

[17] Duncan P. McLaren, "Whose Climate and Whose Ethics? Conceptions of Justice in Solar Geoengineering Modelling," *Energy Research & Social Science* 44 (October 2018), pp. 209–21; Ina Möller, *The Emergence of Geoengineering: How Knowledge Networks Form Governance Objects* (New York: Cambridge University Press, 2023); Julia Schubert, *Engineering the Climate: Science, Politics, and Visions of Control* (Manchester: Mattering Press, 2021); Julia Schubert, "Science-State Alliances and Climate Engineering: A 'Longue Durée' Picture," *WIREs Climate Change* 13, no. 6, e801 (November 2022); and Gupta and Möller, "De Facto Governance."

[18] See, for example, James Rodger Fleming, *Fixing the Sky: The Checkered History of Weather and Climate Control* (New York: Columbia University Press, 2010); Jeremy Baskin, *Geoengineering, the Anthropocene and the End of Nature* (Cham, Switzerland: Springer International, 2019); Oomen, *Imagining Climate Engineering*; and Oliver Morton, *The Planet Remade: How Geoengineering Could Change the World* (Princeton, N.J.: Princeton University Press, 2016).

[19] Douglas G. MacMartin, Peter J. Irvine, Ben Kravitz, and Joshua B. Horton, "Technical Characteristics of a Solar Geoengineering Deployment and Implications for Governance," *Climate Policy* 19, no. 10 (November 26, 2019), pp. 1325–39; Jesse L. Reynolds, "Is Solar Geoengineering Ungovernable? A Critical Assessment of Governance Challenges Identified by the Intergovernmental Panel on Climate Change," *WIREs Climate Change* 12, no. 2, e690 (November 2020); and Reynolds, *Governance of Solar Geoengineering*.

[20] Joshua B. Horton and Barbara Koremenos, "Steering and Influence in Transnational Climate Governance: Nonstate Engagement in Solar Geoengineering Research," *Global Environmental Politics* 20, no. 3 (August 2020), pp. 93–111.

[21] Reynolds, "Is Solar Geoengineering Ungovernable?"; and Reynolds, *Governance of Solar Geoengineering*.

[22] Maarten A. Hajer, *Authoritative Governance: Policy-Making in the Age of Mediatization* (Oxford: Oxford University Press, 2009); Yaron Ezrahi, *Imagined Democracies: Necessary Political Fictions* (New York: Cambridge University Press, 2012); and Jeroen Oomen, Jesse Hoffman, and Maarten A. Hajer, "Techniques of Futuring: On How Imagined Futures Become Socially Performative," *European Journal of Social Theory* 25, no. 2 (May 2022), pp. 252–70.

[23] David W. Keith, *A Case for Climate Engineering* (Cambridge, Mass.: MIT Press, 2013), p. 92. See also P. Oldham, B. Szerszynski, J. Stilgoe, C. Brown, B. Eacott, and A. Yuille, "Mapping the Landscape of Climate Engineering," *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 372, no. 2031, 20140065 (December 28, 2014).

[24] Olaf Corry, *Constructing a Global Polity: Theory, Discourse, and Governance* (Houndsmills, U.K.: Palgrave MacMillan, 2013); Bentley B. Allan, "Producing the Climate: States, Scientists, and the Constitution of Global Governance Objects," *International Organization* 71, no. 1 (Winter 2017), pp. 131–62; and Möller, *The Emergence of Geoengineering*.

[25] Arie Rip, "De Facto Governance of Nanotechnologies," ch. 4 in *Futures of Science and Technology in Society* (Wiesbaden: Springer Fachmedien, 2018), pp. 75–96.

[26] Gupta and Möller, "De Facto Governance," p. 481.

[27] National Research Council, *Climate Intervention: Reflecting Sunlight to Cool Earth* (Washington, D.C.: National Academies Press, 2015), p. 33.

[28] Ibid., p. 27.

[29] Gupta and Möller, "De Facto Governance," p. 495.

[30] Amitav Ghosh, *The Nutmeg's Curse: Parables for a Planet in Crisis* (Chicago: University of Chicago Press, 2021).

[31] Allan, "Producing the Climate," p. 153.

[32] Erik Swyngedouw, "The Non-Political Politics of Climate Change," in "The Politics of Climate Change," special issue, *ACME: An International Journal for Critical Geographies* 12, no. 1 (2013), pp. 1–8, acme-journal.org/index.php/acme/article/view/948/; and Anneleen Kenis and Matthias Lievens, "Searching for 'the Political' in Environmental Politics," *Environmental Politics* 23, no. 4 (2014), pp. 531–48.

[33] Sheila Jasanoff, "Humility in the Anthropocene," *Globalizations* 18, no. 6 (2021), pp. 839–53.

[34] Allan, "Producing the Climate," p. 155.

[35] Oomen, *Imagining Climate Engineering*, p. 194.

[36] McLaren, "Whose Climate and Whose Ethics?"

[37] Silke Beck and Jeroen Oomen, "Imagining the Corridor of Climate Mitigation—What Is at Stake in IPCC's Politics of Anticipation?," *Environmental Science & Policy* 123 (September 2021), pp. 169–78.

[38] Lisette van Beek, Maarten Hajer, Peter Pelzer, Detlef van Vuuren, and Christophe Cassen, "Anticipating Futures through Models: The Rise of Integrated Assessment Modelling in the Climate Science-Policy Interface since 1970," *Global Environmental Change* 65, 102191 (November 2020); Lisette van Beek, Jeroen Oomen, Maarten Hajer, Peter Pelzer, and Detlef van Vuuren, "Navigating the Political: An Analysis of Political Calibration of Integrated Assessment Modelling in Light of the 1.5 C Goal," *Environmental Science & Policy* 133 (July 2022), pp. 193–202; and Silke Beck and Martin Mahony, "The IPCC and the New Map of Science and Politics," *WIREs Climate Change* 9, no. 6, e547 (November 2018).

[39] John Kerry, quoted in Jessica Murray, "Half of Emissions Cuts Will Come from Future Tech, Says John Kerry," *Guardian*, May 16, 2021, www.theguardian.com/environment/2021/may/16/half-of-emissions-cuts-will-come-from-future-tech-says-john-kerry.

[40] Ibid.

[41] See, for example, Alan Robock, "The CIA Asked Me about Controlling the Climate—This Is Why We Should Worry," *Guardian*, February 17, 2015, www.theguardian.com/commentisfree/2015/feb/17/cia-controlling-climate-geoengineering-climate-change; and Kevin Surprise, "Geopolitical Ecology of Solar Geoengineering: From a 'Logic of Multilateralism' to Logics of Militarization," *Journal of Political Ecology* 27, no. 1 (2020), pp. 213–35.

[42] "Letter of Support for Research on Atmospheric Aerosols and Their Potential to Increase the Reflection of Sunlight from the Atmosphere to Address Climate Risk," open letter by Sarah J. Doherty, Philip J. Rasch, Robert Wood, Jim Haywood, Piers M. Forster, James E. Hansen, Govindasamy Bala, et al., February 27, 2023, in "Open Letter regarding Research on Reflecting Sunlight."

[43] In our forthcoming book *Captured Futures: Rethinking The Drama of Environmental Politics* (Oxford University Press, 2025), Maarten Hajer and I introduce the notion of "pre-packaging" SRM technologies.

[44] See, for example, Mariia Belaia, Juan B. Moreno-Cruz, and David W. Keith, "Optimal Climate Policy in 3D: Mitigation, Carbon Removal, and Solar Geoengineering," *Climate Change Economics* 12, no. 3, 2150008 (August 2021); Anthony R. Harding, Katharine Ricke, Daniel Heyen, Douglas G. MacMartin, and Juan Moreno-Cruz, "Climate Econometric Models Indicate Solar Geoengineering Would Reduce Inter-Country Income Inequality," *Nature Communications* 11, no. 1, 227 (January 2020); and Anthony R. Harding, Mariia Belaia, and David W. Keith, "The Value of Information about Solar Geoengineering and the Two-Sided Cost of Bias," *Climate Policy* 23, no. 3 (2023), pp. 355–65.

https://doi.org/10.1017/S0892679424000273 Published online by Cambridge University Press

[45] Tejal Kanitkar, Akhil Mythri, and T. Jayaraman, "Equity Assessment of Global Mitigation Pathways in the IPCC Sixth Assessment Report," *Climate Policy* 24, no. 8 (2024), pp. 1129–48.

[46] James Temple, "This London Nonprofit Is Now One of the Biggest Backers of Geoengineering Research," *MIT Technology Review*, June 14, 2024, www.technologyreview.com/2024/06/14/1093778/foundations-are-lining-up-to-fund-geoengineering-research/; and Young, "Considering Stratospheric Aerosol Injections beyond an Environmental Frame."

[47] Beck and Mahony, "The IPCC and the New Map of Science and Politics"; Beck and Oomen, "Imagining the Corridor of Climate Mitigation"; and van Beek et al., "Navigating the Political."

[48] See, for example, National Academies of Sciences, Engineering, and Medicine, *Reflecting Sunlight*; World Commission on the Ethics of Scientific Knowledge and Technology, UNESCO, *Report of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) on the Ethics of Climate Engineering*, SHS/COMEST-13/2023/1 REV (Paris: UNESCO, November 28, 2023), unesdoc.unesco.org/ark:/48223/pf0000386677.

Abstract: This essay investigates the fit between solar radiation modification (SRM) and climate politics. Researchers, activists, and politicians often present SRM technologies as "radical." According to this frame, SRM comes into view as a last-ditch effort to avoid climate emergencies. Such a rationale may be applicable to the scientists researching the potential of SRM, yet it only partially accounts for political and policy interest in SRM. In this contribution, I argue that there is an increasingly tight fit between the promise of SRM technologies and the global regime of climate politics. Within this regime, SRM may not be a radical option but is more of a logical extension of current rationales. I argue that SRM corresponds to tightly controlled discursive rules within which climate politics operates, leading to a shifting narrative on the feasibility, desirability, and necessity of SRM. The ethical implications of this tight fit are threefold. First, it implies that SRM might be an instrument of mitigation deterrence, implicitly as much as explicitly. Second, ethical responsibility and political value debates are at risk of becoming invisible once SRM becomes embedded in the prevailing regime. Third, SRM use might become inevitable, despite the good intentions of most people involved.

Keywords: solar radiation modification, de facto governance, normalization, climate change, geoengineering, climate politics