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# Climate Change Geoengineering: Philosophical Perspectives, Legal Issues, and Governance Frameworks

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# Introduction

## *The Emerging Salience of Geoengineering*

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What has become increasingly clear over the last few years is that the international community is not even close to tackling the global warming problem in a way that will avert profound climatic consequences. Paragraph 1 of the 2009 Copenhagen Accord formally incorporates "the scientific view that the increase in global temperature should be below two degrees Celsius."[1] In fact, that scientific view is changing as more and more climate researchers come to realize that a two degrees Celsius increase over preindustrial levels threatens serious disruptions of the earth's biosphere.

The current increase in global temperatures of .8 degrees Celsius is already having a significant deleterious effect. Glaciers are melting,[2] sea levels are rising,[3] a third of Arctic sea ice is disappearing in the summer,[4] the oceans are 30 percent more acidic,[5] and the average moisture content of the earth's air has increased by 5 percent, leading to more extreme weather.[6] Prominent NASA scientist Jim Hansen echoed the views of many climatologists when he declared, "warming [of two degrees Celsius] is a guarantee of global disasters."[7]

[1] Copenhagen Accord, art. 1, Dec. 18, 2009, *available at* http://unfccc.int/files/meetings/cop15/application/pdf/cop15cphauv.pdf (last visited Aug. 7, 2012).

[2] CLIMATE CHANGE 2007: *The Physical Science Basis: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* 109 (Z. Manning et al. eds., 2007).

[3] *Id.* at 111; CLIMATE CHANGE & SEA LEVEL RISE: CONSEQUENCES OF CLIMATE CHANGE ON THE OCEANS, Climate Institute, http://www.climate.org/topics/sea-level/index.html (last visited Aug. 7, 2012).

[4] ARCTIC REPORT CARD: UPDATE FOR 2011, TRACKING RECENT ENVIRONMENTAL CHANGES, SEA ICE (D. Perovich et al. eds., 2011), *available at* http://www.arctic.noaa.gov/reportcard/sea_ice.html (last visited Aug. 7, 2012).

[5] ROYAL SOCIETY, OCEAN ACIDIFICATION DUE TO INCREASING ATMOSPHERIC CARBON DIOXIDE: POLICY DOCUMENT 12/05 25–30 (J. Raven et al. eds., 2005), *available at* http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2005/9634.pdf (last visited Aug. 7, 2012).

[6] CLIMATE CHANGE 2007, *supra* note 2, at 105.

[7] Interview by World Watch Institute with James Hansen, 21 WORLD WATCH MAG. 6, (July/Aug. 2008), *available at* http://www.worldwatch.org/node/5775.

But even the prospects of keeping global warming within the two degrees threshold seem extremely unlikely from today's vantage point. The best scientific estimates are that we can collectively release roughly 565 more gigatons of carbon into the atmosphere by midcentury and stay within the two degrees Celsius threshold; however at current growth rates of approximately 3 percent per year (which show no signs of abating) we are on track to considerably exceed that threshold.[8] Despite considerable scientific consensus about the dangers we are facing, and a well-funded climate change movement that has galvanized citizens from around the world, on balance the political will to make the necessary effort to reduce carbon emissions does not exist. What is more, it does not seem likely to come about within the time frame necessary to stave off very serious consequences.

With this political reality in the foreground, we asked eleven of the world's most prominent students of climate change law and policy to contribute to this book on "the deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change,"[9] commonly called *geoengineering* or *climate modification*. Although the prospect of global actors embarking upon major climate modification projects in the hope of countering climate change terrifies some and excites others, few doubt that it could well be in our collective future. As long as the threat of climate change continues to grow and geoengineering technologies are within reach, the tantalizing hope of a geoengineering "fix" will only grow more attractive to many.

This consideration of large-scale geoengineering projects raises many serious legal, policy, and philosophical issues that are explored in the pages that follow. We did not intend this volume to be an advocacy book to either promote or discredit geoengineering as a response to climate change. Rather, in the hopes of helping inform the debate that is emerging, we invited contributors with a wide range of perspectives. At the most general level the questions break down into two broad categories: how do we decide and who decides. Is a decision to embark upon a large-scale and potentially risky project to modify the global climate ever justified? If so, in a world that lacks a global legislature capable of making collective climate modification decisions, who should determine whether to authorize potentially risky projects? To the extent states or private actors undertake such ventures without the blessings of the international community generally, what rights do those who oppose such actions have? Although the methodologies used by our contributors are diverse, and there is considerable overlap in their approaches, generally speaking, the first

[8] P. Friedlingstein, R.A. Houghton, G. Marland, J Hackler, T.A. Boden, T.J. Conway, J.G. Canadell, M.R. Raupach, P. Ciais & C. Le Quéré, *Update on CO2 Emissions*, 3 NATURE GEOSCIENCE 811 (Dec. 2010).

[9] The Royal Society, *Geoengineering the Climate: Science, Governance and Uncertainty* (Sept. 2009), at 11, http://royalsociety.org/Geoengineering-the-climate/ (last visited on Mar. 28, 2011).

three contributors to this volume ground their chapters in ethics and philosophy whereas the remaining contributors ground theirs in law and governance. We have, therefore, chosen to organize the volume along those lines.

In Chapter 1, "Geoengineering and Moral Schizophrenia: What Is the Question?," Stephen M. Gardiner contends that two questions are central to the ethics of geoengineering. The justificatory question asks: "Under what future conditions might geoengineering become justified?" The nature of the future conditions he considers include, for example, the nature and extent of the climate change threat to be confronted, and other background global circumstances, including the existing governance mechanisms, individual protections, and compensation provisions. The contextual question asks: "What is the ethical context of the push toward geoengineering, and what are its implications?" Gardiner argues that early discussions of geoengineering often marginalized both questions because participants in those discussions tended to view their consideration as luxuries that we could not afford given the emergency nature of the climate change problem. Gardiner concludes that such emergency arguments are ethically shortsighted, and morally schizophrenic. In reaching this conclusion, Gardiner employs two abstract examples. Although both are extreme and idealized, according to Gardiner even the imperfect analogies provide reasons for concern about our current predicament. Ethically serious discussion of geoengineering should confront ethical problems, rather than hide behind overly simplistic appeals to moral emergency. As Michael Stocker puts it in his seminal discussion of moral schizophrenia, "to refuse to do so bespeaks a malady of the spirit."

In Chapter 2, "The Ethical Foundations of Climate Engineering," Clive Hamilton argues that the idea that the planet's optimal temperature should be set through a process of calculation reflects a particular conception of the world and the nature of humans that emerged first with the Scientific Revolution and later Enlightenment philosophy. This conception, according to Hamilton, holds that the human being is a self-legislating subjective entity, distinct from the rest of the world and guided by its cognitive abilities. It is, says Hamilton, the basis of the technological thinking now being applied in plans to engineer the climate. Hamilton suggests that solar radiation management is the culmination of the transition to the mechanical conception of nature and the parallel emergence of philosophies built on the idea of the autonomous rational subject exercising control over an inert environment. These conceptions, and the consequentialist ethics they gave rise to, are now challenged by earth-system science itself. The earth under the Anthropocene is not mere putty to be shaped at will by humans.

In Chapter 3, "The Psychological Costs of Geoengineering: Why It May Be Hard to Accept even if It Works," Gareth Davies observes that debates about climate change and geoengineering often revolve around "quantitative and concrete considerations,"

such as economic and environmental impacts. Such considerations, however, he argues "are often quite divorced from their real psychological importance for most people, the fear, uncertainty, and hope that they may inspire." Davies suggests that an assessment of the psychological "losses" associated with climate geoengineering may explain far more than economic, climatic, or material factors about the basis of the opposition to geoengineering. The primary three losses, Davies argues, are: relative status, security, and hope. Davies suggests that many members of the environmental movement would suffer a diminution of relative status if their moral and political standing was undercut by a solution that did not require fundamentally transforming society. In terms of security, geoengineering could undermine security by offering only partial solutions "between mitigation and climate management" and "entail a probabilistic approach to policy" that many would find disconcerting. Finally, if geoengineering were to remove climate change as a threat, Davies contends that the hope of deep ecologists that climate change would justify their fundamental tenets would be dashed.

In Chapter 4, "Geoengineering and Climate Management: From Marginality to Inevitability," Jay Michaelson makes the case that geoengineering, or *climate management* as he calls it, "is the only approach to climate change that can act as a compromise between liberals and libertarians, greens and browns." It appeals to conservatives, he argues, because it protects economic interests, is in line with market ideology, uses technology rather than restraints on behavior, and avoids government regulation. He argues that to liberals, its appeal may not be intuitive, but that their acceptance of it is necessary if they wish to actually make progress on climate change, given real world political realities. Michaelson acknowledges that liberals have legitimate concerns about embarking on climate management initiatives. Those concerns range from equitable considerations, including the giving of "free passes" to polluters, to the potential risks and costs of projects, including cataclysmic warming in the case of cessation of solar radiation management and the dangers that rogue actors could pose. He argues, however, that these concerns are answerable in every case.

In Chapter 5, "Climate Change and the Anthropocene Era," Lee Lane advocates assessing the judiciousness of climate geoengineering through the lens of a Weberian "ethic of responsibility." He focuses "on knowing the likely consequences of our policy choices and accepting responsibility for them rather than on more abstract ethical precepts." Lane argues that greenhouse gas control measures would yield minimal net financial gains and impose extremely high costs; moreover, such controls could upset existing trade regimes, depress agricultural production, and roil bilateral relationships between major states, including the United States and China. Lane also argues that there are many imposing political barriers to effective implementation of international greenhouse gas controls. The case for geoengineering

lies in the fact that the potential benefits are "very large compared to the estimated costs of developing and deploying it." Although Lane acknowledges risk associated with deployment, including potential shutdown of monsoons in Asia, he argues that the benefits would still substantially outweigh such costs, especially if such costs are weighed against the impacts of climate change under a business-as-usual scenario. Finally, Lane outlines a way forward for developing a regime to govern climate geoengineering, suggesting that regime structure will be dependent "on both the distribution of relative power as well as the need to hold down the transaction costs of managing the system."

In Chapter 6, "Political Legitimacy in Decisions about Experiments in Solar Radiation Management," David Morrow, Robert Kopp, and Michael Oppenheimer maintain that making good policy decisions about solar radiation management (SRM) requires a better understanding than we currently have of the effectiveness and side effects of various SRM technologies. The authors argue, however, that gaining such understanding would require multiyear global trials. Observing that such trials would be ethically problematic because they would expose persons, animals, and ecosystems to serious risks, the authors go on to explore under what conditions such trials would be ethically acceptable. They conclude that such acceptability depends upon approval of the trials by an appropriate international body (i.e., one with the political legitimacy to authorize the trial). The authors endorse Buchanan and Keohane's "Complex Standard" for global political legitimacy: a global political institution is legitimate if it enjoys widespread support from democratic states; meets certain substantive conditions, such as avoidance of serious injustices and the production of better outcomes than feasible alternative institutions; and has certain epistemic virtues, such as transparency and accountability. Morrow, Kopp and Oppenheimer survey several global institutions as possible analogs for an SRM governance institution, including those for governing nuclear weapons and for managing the Antarctic environment.

In Chapter 7, "Geoengineering and the Myth of Unilateralism: Pressures and Prospects for International Cooperation," Joshua Horton addresses one of the primary concerns of geoengineering opponents (as well as some proponents): the specter of unilateral deployment. Horton argues that unilateral deployment is unlikely for several reasons. To begin with, a state that chooses to unilaterally deploy a geoengineering option would face the possibility of deployment of the same or other geoengineering options by other states, potentially impairing the effectiveness of this approach. This would, Horton argues, necessitate coordination of deployment with other actors. Moreover, in the case of SRM, the so-called termination problem (the potential for a huge spike in warming should solar deflection once embarked upon be terminated; see Burns, Chapter 9, infra) would encourage states reluctant to make an indefinite commitment on their own to coordinate their efforts

internationally. Finally, Horton contends that the availability of countermeasures "would serve as perhaps the most potent check on unilateral deployment of geoengineering technologies such as stratospheric aerosol injections." Horton also maintains that multilateralism in geoengineering research and potential deployment can be fostered by a portfolio of tactics known as "international management theory."

In Chapter 8, "International Legal Regimes and Principles Relevant to Geoengineering," Albert Lin assesses the potential role of international law in governing potential research and development and deployment of geoengineering options. Although concluding that no international agreement directly regulates geoengineering, Lin argues that a number of relevant treaties and principles of international law may play a role in geoengineering governance. Lin initially discusses a series of treaties that may extend to geoengineering options in a general sense, including the United Nations Framework Convention on Climate Change, the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, and the Convention on Biological Diversity. Lin then turns to "media-specific" treaties that may apply only to particular types of geoengineering projects, such as the London Convention/London Protocol, and the Law of the Sea Convention (ocean iron fertilization (OIF)); the Convention on Long-Range Transboundary Air Pollution; the Montreal Protocol (SRM options injecting particles into the atmosphere), and the Outer Space Treaty (space-based options). Finally, Lin suggests that there are several international norms that might be apposite, including norms calling for transboundary environmental impact assessment, and the prohibition on inflicting transboundary harm, as well as norms with less certain application, including the precautionary principle and the principle of intergenerational equity.

In Chapter 9, "Climate Geoengineering: Solar Radiation Management and its Implications for Intergenerational Equity," this book's coeditor, William Burns, examines the extent to which the emerging global norms requiring that our present-day actions take into account intergenerational equity legally constrain SRM geoengineering options. Burns contends that ceasing the use of SRM technologies would pose the threat of a "termination effect," a huge multi-decadal pulse of warming that could overwhelm many ecosystems and human institutions. Moreover, some SRM approaches could delay replenishment of the stratospheric ozone layer by as much as seventy years. Such long-term deleterious consequences, the author argues, would violate the principle of intergenerational equity by potentially denying future generations an environment of commensurate quality to that we currently enjoy because of either technological failure or societal choice. Moreover, the threat of a termination effect might compel future generations to continue the use of SRM technologies, even if they deemed these technologies to be morally unacceptable because of the collateral effects. This would violate the intergenerational principle

of conservation of options. The chapter concludes that viable options exist to reduce greenhouse gas emissions, which would preclude the need to threaten the interests of future generations.

In Chapter 10 "Ocean Iron Fertilization: Science, Law, and Uncertainty," Randall Abate adds his voice to the discussion of OIF. However, in contrast to Chapter 11, the author expresses considerable skepticism about the potential effectiveness of OIF's ability enhance the oceanic sink for carbon dioxide through the addition of iron to stimulate phytoplankton growth, as well as our capability of meeting the substantial monitoring and verification challenges. In addition to examining the role that existing international regimes could play in the regulation of OIF, Abate addresses potentially applicable domestic laws in the United States (i.e., the Marine Protection, Research and Sanctuaries Act and the National Environmental Policy Act). The chapter concludes with detailed recommendations for establishing "an effective international law framework to regulate OIF." Abate outlines two broad options in this context. The first is the establishment of an independent regime to address geoengineering. Such a regime could be patterned on the UN Environmental Modification Convention. Alternatively, geoengineering research in particular could be regulated under a new international treaty regime, or a less-formal international research consortia. A second option would be to harmonize existing treaties, with the International Maritime Organization serving as the implementing body given its oversight of several relevant regimes, including the London Convention and the London Protocol. At the domestic level in the United States, Abate also suggests coordination of federal responses, including the possibility of establishing a working group.

In Chapter 11, "Ocean Iron Fertilization: Time to Lift the Research Taboo," Kirsten Güssow, Andreas Oschlies, Alexander Proelss, Katrin Rehdanz, and Wilfried Rickels make the case for pursuing research of OIF. Although concluding that OIF may have the potential to sequester comparable amounts of carbon dioxide as forest sequestration techniques, the authors acknowledge substantial uncertainties that necessitate further research. The remainder of the chapter is devoted to legal issues related to potential deployment of an OIF approach. The authors set forth a framework that could integrate OIF into the Clean Development Mechanism of the Kyoto Protocol and include a discussion of methods to account for permanence and leakage. The chapter examines the applicability of international treaty regimes to OIF, including the United Nations Convention for the Law of the Sea, the Convention on Biological Diversity, and the London Convention and London Protocol. The authors conclude that the application of the precautionary principle, often invoked by those who oppose climate geoengineering because of their potential negative impacts could cut in favor of OIF deployment given the threat posed by unchecked climate change.

In Chapter 12, "Remaking the World to Save It: Applying U.S. Environmental Laws to Climate Engineering Projects," Tracy Hester examines the potential applicability of U.S. environmental laws to climate geoengineering research. Pertinent statutes cited by the author include the National Weather Modification Policy Act of 1972, the Clean Air Act, the Clean Water Act, the Endangered Species Act, the Marine Protection, the Research and Sanctuaries Act, and the National Environmental Policy Act. The chapter also examines the potential for judicial review of geoengineering via common law nuisance claims. Hester concludes by noting that the federal government may need to begin drafting strategies and establishing standards for approval or rejection of projects, and that specific agencies may wish to explore options to stop projects that pose excessive dangers or evoke strong public reactions.