# 32 The Intervention of Climate Science

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## Introduction

In 2020, the United States Congress ordered the US National Oceanic and Atmospheric Administration (NOAA) to set up a new research initiative. Designed to improve knowledge of "Earth's radiation budget," the initiative funds projects that inquire into the balance between, on the one hand, energy that reaches Earth from the sun, and, on the other hand, energy that leaves Earth, in the form of heat emitted from the planet's surface or when sunlight is reflected back into space. "Earth's radiation budget," the initiative's website informs, "determines the climate of the Earth and makes our planet hospitable for life." Funded research projects use the standard repertoire of climate science methods, such as computer modeling and observation from aircraft and satellites. By 2022, a total of 23 million USD had been committed to the initiative.

In the journal *Science*, an atmospheric scientist at NOAA is quoted saying that the initiative constitutes "very basic science" (Voosen, 2023, p. 628). Indeed, most if not all the projects seem like they might just as well be funded under any climate science funding program. Earth's radiation budget is not at all a new field of study. And yet, the ERB initiative, as NOAA calls it, is different. It is different in that it presents itself as directed expressly at the study of "climate intervention," a term NOAA uses to describe strategies for actively changing the composition of the atmosphere. Such changes may increase the fraction of incoming sunlight that is reflected away from Earth and back into space, for example by making clouds brighter and increasing their longevity, or by adding reflective particles to the atmosphere. By studying the effects of particles and clouds on Earth's radiation budget, scientists are thus also studying how an out-of-balance radiation budget might be intervened in for it to once again become balanced. What is, on the one hand, "very basic science" studying processes that have kept climate scientists busy for decades, is, at the same time, also a set of projects developing strategies for "climate intervention." What is different about the ERB initiative thus is not necessarily a qualitative difference in the kind of research it funds. Rather, it stands apart from other research initiatives in announcing the study of climate intervention as its intention. We may thus take the ERB initiative as a prompt for asking: what, exactly, *is* a science of climate?

What the ERB initiative displays is the intimate relationship between climate science and climate intervention – in Ian Hacking's terms, between **representing** and **intervening** in the science of climate. This intimacy is often overlooked. It is more common to think of climate science as primarily concerned with representation. In this view, climate models, satellite observations, and other methods, such as the counting of tree rings or the analysis of ice cores, allow scientists to represent with increasing accuracy the global climate and the mechanisms that govern its behavior, independent of any intervention into that object. Intervention is thought of as standing apart. Intervention is what humans may decide to do, or not to do, with the theoretical

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knowledge that science provides. But, I argue, such a strict separation between representation and intervention does not hold up. Questioning it has important consequences for how we might think about climate science and about the forms of collective life that we build with it.

"The harm comes from," writes Hacking in his classic text, *Representing and Intervening*, "a single-minded obsession with representation and thinking and theory, at the expense of intervention and action and experiment" (Hacking, 1983, p. 131). Hacking's "harm" is an idealist philosophy in which humans cannot know what really exists independent of human thought. In this chapter, I use the example of climate science to show how lines of inquiry from STS and neighboring fields – lines of inquiry that, like Hacking, emphasize the importance of "intervention and action and experiment" – can help us rethink the politics of science. My concern in doing so, however, is different from Hacking's. Unlike Hacking, I am not primarily interested in the ontological question of what is real, or the epistemological question of how we can know. Instead, I am interested in the political question of what is *good*.

In what follows, I will elaborate three ways in which an interventionist redescription of climate science can show us that climate science is both more and less than we conventionally take it to be. In its most basic formulation, my argument is that climate science is a form of "intervention and action and experiment" at the scale of the entire planet, or in even less words: that climate science writ large is a science of geoengineering. Thus, as we commit to a form of life built out together with a science of planetary climate, we also commit to a world in which intervening in the planetary climate is not a contingent, but a necessary feature.

**Experiment**

Contemporary knowledge of the planetary environment, and with it of the planetary climate, was importantly developed from interventions into that environment. These interventions often were highly destructive: acts of large-scale destruction and contamination could be studied as experiments whose traces became evidence of planetary interconnectedness and systematicity. First and foremost, in the mid-twentieth century, it was the tracing of the spread of radioactive material released in nuclear explosions ("tests") through the atmosphere and ocean and through plants, animals, and humans, which formed the basis for a scientific knowledge of the "planetary environment" as we understand it today – as all-encompassing, total, systematic, everything connected to everything else. Global warming itself can be seen as another such act of destruction, in which the massive-scale extraction and burning of hydrocarbons provided new opportunities for studying ocean, atmosphere, and land as an integrated, volatile, and total planetary environment.

Scientists were quick to use the language of "experiment" in connection with these destructive interventions into what, during the 1980s, came to increasingly be called the "Earth system." Oceanographer Roger Revelle and chemist Hans Suess concluded a now-famous 1957 paper on the accumulation of carbon dioxide in the atmosphere from industrial activity, by stating that "Human beings are now carrying out a large scale geophysical experiment of a kind that could not have happened in the past nor be reproduced in the future" (Revelle and Suess, 1957, p. 19). Similarly, the physicist Stephen Schneider gave his popular science book the title "Laboratory Earth," in which he wrote that "Much of what we do to the environment is an experiment with Planet Earth, whether we intend it to be or not" (Schneider, 1996, p. 8). The experimental opportunities that come with changes to the planetary environment are also on display when scientists study volcanic eruptions as "natural experiments" that can inform about the complex chemistry and physics of the atmosphere. The scientists funded under NOAA's ERB initiative, too, are open to what the already-mentioned article in *Science* calls "missions of opportunity": science projects in which volcanic eruptions or massive wildfires would be used to understand how the climate system works – and how, consequently, it can be manipulated.

As scientists learn to study nuclear explosions, hydrocarbon burning, volcanic eruptions, and wildfires as planetary-scale "experiments," and as they record and interpret these "experiments" in all their similarities and differences with ever greater technical sophistication, they develop new possibilities for planetary intervention. These possibilities are contained in the equations of climate science. From undirected "experiments" in planetary intervention, a *scientific* form of planetary intervention – a science of geoengineering – can be developed: climate science.

## Geoengineering

The interventionist and often destructive origins of contemporary planetary environmental science are well-known and documented. However, most existing scholarship assumes that this origin leaves no trace on the scientific knowledge thus generated. Once established, science does not carry with it baggage from its provenance. This should by now seem surprising. My argument is that, instead, originating in planetary-scale intervention, today's climate science is a science of intervention at the scale of the entire planet.

Today, when people speak of "climate intervention," they often mean, like NOAA in the ERB initiative, what others (including in this volume) have referred to as "climate engineering" or "geoengineering." This is not a sharply defined category and what one will subsume under it is, as with any act of categorization, a decision that is at once scientific and political (Schäfer and Low 2018; see Schubert, Chapter 31, this volume). For a while, a prominent categorization held that "geoengineering the climate," as the UK Royal Society called it in an influential 2009 report, has two subcategories: carbon dioxide removal and solar radiation management. Carbon dioxide removal could range from planting trees or combining bioenergy production with carbon capture and storage to the filtering of ambient air or the manipulation of oceanic biochemistry. Solar radiation management could include placing mirrors in space, brightening clouds, or introducing reflective particles into the stratosphere. It is solar radiation management that NOAA means when it says "climate intervention."

"Climate engineering" or "geoengineering" is usually considered apart from other approaches to addressing climate change, such as renewable energy technologies or legal and financial mechanisms designed to curb carbon dioxide emissions. There are certainly differences between all of them. But if we examine them from the standpoint of climate science, we also see a crucial similarity: each approach is justified as a strategy for managing a changing planetary climate and they all rely on climate science for their claims of effectiveness, benefits, and risks. We might thus also say that climate science describes an object in need of management – the changing planetary climate – and at the same time supplies strategies for effecting such management. By extension, we might reasonably conclude that approaches to managing global climate – from renewables to carbon markets to sunlight-scattering particles, and whatever may in the future come to be included in the list – constitute variants of geoengineering, and that such geoengineering today is a dominant concern in collective social life. The differences between these variants of geoengineering are internal differences; choosing one over the other does not mean leaving the world of geoengineering.

The most familiar shape that this takes in the present is in the attempt to manage the composition of the planetary atmosphere by reducing the number of planet-heating molecules, carbon dioxide prime among them, that gets released from furnaces, smokestacks, vehicles, and other sources. Ambitions to massively build out infrastructures of renewable energy, to establish new financial markets for carbon trading, or to implement policy instruments such as carbon taxes, form part of this attempt. They are justified by the same logic that is also used to justify carbon dioxide removal or solar radiation management. In this sense, critics of what NOAA calls climate intervention, who instead insist on the massive-scale production of wind or solar energy or on the expansion of natural gas production as a "bridge technology" or on the transition to a "hydrogen economy" – these critics, too, participate in the form of social life that makes geoengineering one of its important organizing logics.

But schemes for intervening in the planetary climate date back to the very origins of climate science, long predating contemporary worry about anthropogenic climate change. Already when the scientific idea of a planet-spanning order of heat distribution first took shape in the late 18th century, it emerged together with schemes for how that order might be manipulated (Schäfer and Mauelshagen, 2021). As Johann Gottfried Herder wrote in his "Reflections on the philosophy of the history of mankind": "Now it is no question that, just as the climate is the embodiment of powers and influences that both plant and animal contribute to and that serves all life in mutual connection, humans are made masters of the Earth also in that they may change it through art" (Herder, 2002 [1784–1791], p. 244, my translation). Another thinker of the day, the French natural philosopher Comte de Buffon, noted widespread puzzlement over the fact that Paris and Quebec experienced such different weather despite occupying roughly the same latitude on the globe. His explanation was that

> Paris and Quebec are about at the same latitude and at the same elevation on the globe; Paris would thus be as cold as Quebec, if France and all the countries that neighbor it were as bereft of people, as covered with forest, as bathed in waters as are the lands that neighbor Canada. To cleanse, to reclaim and people a country, is to provide it with warmth for many thousands of years.
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> (Buffon, 2018 [1781], p. 126)

To Buffon, a hospitable climate – hospitable to a European sense of comfort – would come with the "cleansing," "reclaiming," and "peopling" of a country so characteristic of settler colonial expansion.

Scientific representations of climate were, from the very start, thus always also blueprints for how climate – and with it, people – might be manipulated. How, precisely, such manipulation might be effected has differed across history and geography. At the same time, and as is evident in the quotes from both Herder and Buffon, knowing and manipulating the global climate were deeply implicated in the colonial expansion of European powers into the Americas (see Mahony, Chapter 2, this volume). As Prussian geographer Alexander von Humboldt noted in a discussion of the historical advancement of climate science: "The progress of 'Climatology' has been remarkably favored by the extension of European civilization to two opposite coasts, by its transmission from our western shores to a continent which is bounded on the east by the Atlantic Ocean" (Humboldt 1858, 318). A science of climate at the scale of an integrated planetary whole was possible only with geographical expansion at planetary scale. Consequently, as more than one power came to lay claims to global representation, *whose* science of climate would produce the binding representations of planetary environment became a matter of politics – a **planetary geopolitics** in which dominance meant the ability to devise prevailing strategies for geoengineering the planetary environment.

## Geopolitics

Climate science is thus always also a geopolitics. Consider computer modeling. In the late 1980s, a controversy broke out when Western scientists insisted that in the assessments of the newly founded Intergovernmental Panel on Climate Change (IPCC), predictions of future climate should be made exclusively from computer models. This was opposed by Soviet scientists who specialized in the paleo-analog method. In the paleo-analog method, future climates were known in analogy to past climates, based on the record that ancient atmospheres have registered in soil, ice, trees, and corals. A crucial difference between computer modeling and the paleo-analog method was that Western computer modelers saw a potentially catastrophic future in their models, while Soviet paleoclimatologists concluded from the paleo-analog method that, while the climate was certainly changing under human influence, what that change would look like was highly uncertain and possibly quite positive. A meeting was called to resolve the controversy. The invitation letter read: "This is not just an academic issue; the forecasts from the two techniques are different and may have different policy implications, and so it is important that the issue is resolved amongst those who are best equipped to deal with it" (Skodvin, 2000, p. 140; compare also Doose, 2022).

At the meeting – held on November 20–21, 1989, less than two weeks after the Berlin wall had fallen – computer modelers unequivocally declared the planetary past too idiosyncratic to serve as a tool for predicting the future. This would henceforth be the sole prerogative of computer models. The modeler's position and their victory over the specialists of the paleo-analog method was confirmed in the IPCC's first assessment report, and even in its publication history. Bert Bolin, Swedish meteorologist and first chairman of the IPCC, referred to the controversy by noting that "scientific as well as practical difficulties arose" from the Soviet Union's leadership in the IPCC's Working Group 2: "This was finally resolved when one of the co-chairmen of the working group, M. Tegart, Australia, together with some of his Australian colleagues took on the task of compiling and editing the final report" (Bolin, 2007, p. 65). As a result, the leader of the Soviet IPCC delegation and chair of Working Group 2, Yuri Izrael, was not named as an editor on the cover of the Working Group 2 report. The Working Group 1 report, edited by computer modeler and initiator of the November meeting John Houghton, declared upon its publication in 1990 that "In conclusion, the paleo-analogue approach is unable to give reliable estimates of the equilibrium climatic effect of increases in greenhouse gases." In the IPCC's predictions of future climate, the report continued, paleoclimatology's main use would be to "provide useful data against which to test the performance of climate models" (Houghton, Jenkins, and Ephraums, 1990, p. 159).

At stake in this controversy was the very question of who would define the problem of climate change and devise solutions to it. With the end of the Cold War, one particular science rose to global dominance: Earth System Science, a cybernetic science of planetary systematicity developed in the US during the 1980s and based on computer modeling and remote sensing with satellites. It is in Earth System Science that the possibility of Earth system management appears in particularly stark relief. In 1999, the physicist John Schellnhuber wrote of a "geo-cybernetic task" that confronts Earth system scientists, a task that "can be summed up in three fundamental questions. First, what kind of world do we have? Second, what kind of world do we want? Third, what must we do to get there?" Schellnhuber proceeds to offer a "menu from which humanity can select its master principle, or suitable combinations thereof, for Earth-system control," a manual to be further elaborated and put into operation by fellow Earth system scientists (Schellnhuber, 1999). Earth System Science's cybernetic concept of a volatile and highly interconnected Earth system subject to "feedback" while offering "leverage points" for intervention is largely uncontested today. It is within this conceptualization of the planetary environment that geoengineering, in its many contemporary variants, today seems most plausible and necessary.

Questions about the geopolitics of geoengineering are thus always also questions about the geopolitics of climate science – whose climate science provides the basis for making and attacking claims about geoengineering's necessity and its risks and benefits and their distribution? But at a more basic level, loosening the grip that geoengineering has on contemporary politics would require a rethinking of what it would look like to worry about climate change without the technoscientific interventionism of climate science controlling all possible responses. While some commentators argue about whether solar radiation management can or cannot be governed at all, it might thus be just as pertinent to ask: Can climate science be governed at all?

## Conclusion

In this chapter, using the example of climate science, I have shown some possibilities that arise within an STS that denies a strict separation between representing and intervening and how, from an interventionist redescription of climate science, we can develop new political questions about the forms of social life and social order with which a science of planetary climate is **co-produced** (Jasanoff, 2004).

To study this form of life in which a science of planetary climate plays such an important organizing role, we must position ourselves outside of the presuppositions that underwrite it, and thus outside of the presuppositions of climate science. We must approach climate science as one form that human creativity takes, a form of creativity that participates in shaping the kind of collective social life that humans build out today, while itself being shaped by prevailing forms of social life and social order. An investigation of this kind would not ask about the necessity or riskiness of different strategies for intervening in the planetary climate. Nor would it hinge upon uncertainty or a formally calculated ratio of costs to benefits at the global scale. It would instead ask why and how those questions arise in the first place, and on whose terms. It would interrogate who has the power to raise such questions, and who has the power to answer them. It would critically assess what questions and answers are possible, and which are impossible. Finally, it would consider what might be gained and what might be lost as a science of planetary climate comes to define the possibilities and impossibilities by which humans organize their collective life. What are the hierarchies of harm that a form of life organized around a science of planetary climate establishes for itself? What tradeoffs does it accept? What is expendable to it, and what must be preserved at all costs? In short: is it *good*?

## Further Reading

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