

Subject: CLIMATE INTERVENTION: SRM and CDR - AKA Geoengineering

Preface

The signs of a warming planet are all around us: rising seas, melting ice sheets, record-setting temperatures, with impacts cascading to ecosystems, humans, and our economy. At the root of the problem, anthropogenic greenhouse gas emissions to the atmosphere continue to increase, a substantial fraction of which diffuse into the ocean, causing ocean acidification and threatening marine ecosystems. Global climate is changing faster than at any time since the rise of human civilization, challenging society to adapt to those changes. If the current dependence on fossil fuel use continues, evidence from previous periods of high atmospheric greenhouse gas concentrations indicates that our release of fossil fuel carbon into Earth's atmosphere in the form of CO₂ will be recorded in the rock record as a major planet-wide event, marked by transgressions of shorelines, extinctions of biota, and perturbations of major biogeochemical cycles.

The specific topic of this report, "climate geoengineering," was often framed in terms of a last-ditch response option to climate change if climate change damage should produce extreme hardship. Such deliberate intervention in the climate system was often considered a taboo subject. Although the likelihood of eventually considering last-ditch efforts to address damage from climate change grows with every year of inaction on emissions control, there remains a lack of information on these ways of potentially intervening in the climate system. In 2012 the U.S. government, including several of the science agencies, asked the National Academy of Sciences to provide advice on this subject. The National Research Council (NRC) committee assembled in response to this request realized that **carbon dioxide removal (CDR) and albedo modification (SRM)** (i.e., modification of the fraction of short-wavelength solar radiation reflected from Earth back into space) have traditionally been lumped together under the term "geoengineering" **but are sufficiently different that they deserved to be discussed in separate volumes.**

Carbon dioxide removal strategies, discussed in the first volume, are generally of lower risk and of almost certain benefit given what is currently known of likely global emissions trajectories and the climate change future. Currently, cost and lack of technical maturity are factors limiting the deployment of carbon dioxide removal strategies for helping to reduce atmospheric CO₂ levels. In the future, such strategies could, however, contribute as part of a portfolio of responses for mitigating climate warming and ocean acidification. In the meantime, natural air CO₂ removal processes (sinks) consume the equivalent of over half of our emissions, a feature that might be safely and cost-effectively enhanced or augmented as explored in the first volume.

In contrast, albedo modification approaches show some evidence of being effective at temporarily cooling the planet, but at a currently unknown environmental price. The committee is concerned that understanding of the ethical, political, and environmental consequences of an albedo modification action is relatively less advanced than the technical capacity to execute it. In fact, one serious concern is that such an action could be unilaterally undertaken by a nation or smaller entity for their own benefit without international sanction and regardless of international consequences. A research basis is currently lacking to understand more about the potential results and impacts of albedo modification to help inform such decisions. These approaches are discussed in the second volume.

The committee's very different posture concerning the currently known risks of carbon dioxide removal as compared with albedo modification was a primary motivation for separating these climate engineering topics into two separate volumes. Terminology is very important in discussing these topics. "Geoengineering" is associated with a broad range of activities beyond climate (e.g., geological engineering), and even "climate engineering" implies a greater level of precision and control than might be possible. **The committee concluded that "climate intervention," with its connotation of "an action intended to improve a situation," most accurately describes the strategies covered in these two volumes.** Further, the committee chose to avoid the commonly used term of "solar radiation management" in favor of the more physically descriptive term "albedo modification" to describe a subset of such techniques that seek to enhance the reflectivity of the planet to cool the global temperature. Other related methods that modify the emission of infrared energy to space to cool the planet are also discussed in the second volume.

Transparency in discussing this subject is critical. In that spirit of transparency, this study was based on peer-reviewed literature and the judgments of the committee members involved; no new research was done as part of this study and all data and information used in this study are from entirely open sources. Moving forward, the committee hopes that these two new reports will help foster an ethos in which all research in this area is conducted openly, responsibly, and with transparent goals and results.

It is the committee's sincere hope that these topics will receive the attention and investment commensurate with their importance to addressing the coming potential climate crises. By helping to bring light to this topic area, carbon dioxide removal technologies could become one more viable strategy for addressing climate change, and leaders will be far more knowledgeable about the consequences of albedo modification approaches before they face a decision whether or not to use them.

In closing, I would like to thank my fellow committee members for all of their hard work to summarize the existing, fragmented science and to work toward consensus on extremely complex issues. As well, we greatly appreciate all of the time and effort volunteered by our colleagues who generously gave their time and talent to review these reports, speak at our committee meetings, and communicate with us during the study process. We would also like to thank the NRC staff for their superb efforts to assemble and make sense of the many moving parts of two separate reports.

Marcia McNutt, Chair
Committee on Geoengineering Climate:
Technical Evaluation and Discussion of Impacts

Additional video by BBC: <http://www.bbc.com/news/science-environment-30197085> **Geo-engineering: Climate fixes 'could harm billions'**

By David Shukman Science editor, BBC News
26 November 2014

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1. CLIMATE INTERVENTION: Reflecting Sunlight to Cool Earth (2015)

<http://www.nap.edu/catalog/18988/climate-intervention-reflecting-sunlight-to-cool-earth>

2. Climate Intervention: Carbon Dioxide Removal and Reliable

Sequestration:<http://www.nap.edu/catalog/18805/climate-intervention-carbon-dioxide-removal-and-reliable-sequestration>



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