

# GEOENGINEERING: (RE)PROGRAMMING THE EARTH

when everything is  
**programmable:**  
LIFE IN A COMPUTATIONAL AGE

If global warming's effects hit faster than previously expected and the global community remains unwilling to make economic and technological changes swiftly enough to head off disaster, large-scale geoengineering projects may need to be deployed to hold down temperatures. Doing so without causing unwanted side effects will demand a sophisticated understanding of the earth's processes and the development of models and simulations that more accurately reflect geophysical and human systems. An equally complex issue will be the international political and economic debates and power struggles certain to arise as geoengineering moves to the forefront of possible responses to rapid climate disruption.

## BETTER MODELING AND MONITORING TOOLS

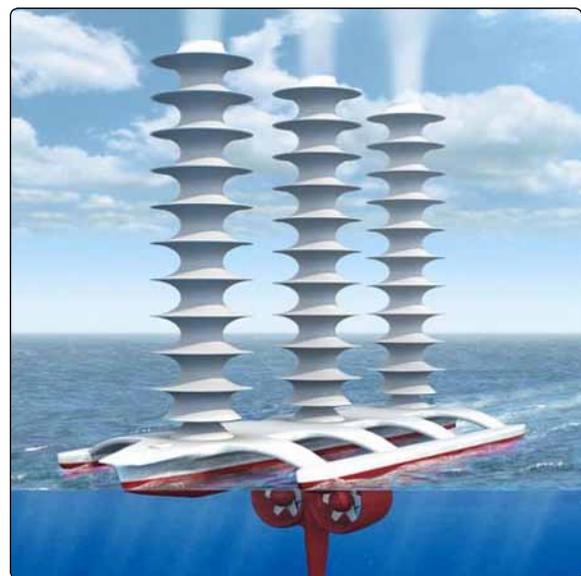
One key element of any geoengineering proposal will be an effort to more accurately model and predict changes to rainfall patterns, cloud formation, and ozone concentrations. The sheer complexity of the global climate system virtually guarantees that geoengineering projects will have some level of impact in monsoon zones resulting from aggressive modifications. Close monitoring will be called for, and in cases where unwanted results are unavoidable, mitigation and adaptation efforts will become necessary.

## NEW GLOBAL INSTITUTIONS

The global nature of climate disruption and the near certainty that any geoengineering effort will directly affect multiple countries will put enormous pressure on traditional geopolitical systems. Setting up, deploying, managing, and monitoring a geoengineering project will demand international coordination. At the very least, issues around evaluation of impacts, liability, and reparations for damages will come to existing international bodies such as the United Nations and the World Court. As most geoengineering proposals require a long-term commitment, the need for new institutions focusing on climate engineering oversight will eventually become overwhelming.

## STRUGGLES OVER CONTROL

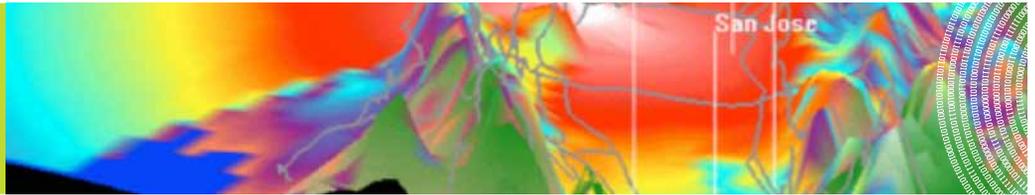
Just as climate change affects different regions of the world in different ways, the effects of geoengineering will vary by location. As a result, the duration and intensity of geoengineering efforts will provoke intense political disputes, with some countries seeking a more limited geoengineering effort and others a more aggressive program. At the same time, the technologies required for geoengineering are within the capabilities of most developed nations, leading to the possibility of unsanctioned efforts, counter-engineering efforts by those seeking to limit geoengineering, or manipulation of climate systems for geopolitical goals. Thus, the potential for rogue use, micro-level use, and weaponization must be taken into consideration.



Geoengineering prototype for cloud-seeding ships



# ENABLING TECHNOLOGIES



**Simulation:**  
Modeling possibility space

**Cloud Computing:**  
Supercomputing on demand

**Location-based Computing:**  
Everything knows where it is

**Pervasive Wireless:**  
Continuous connection

**Sensors and Sensor Networks:**  
Everything in its right place

## Signals:

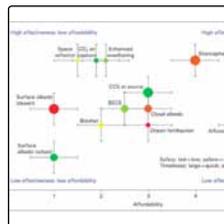
### MIT'S INTEGRATED GLOBAL SYSTEMS MODEL (BETTER MODELING AND MONITORING TOOLS)



The MIT Integrated Global System Model (IGSM), a comprehensive tool analyzing human–climate system interactions, has been developed by the MIT Joint Program on the Science and Policy of Global Change. The model seeks to answer questions about how effective and costly specific policy measures to alleviate climate change would be, how oceanic and terrestrial uptake of carbon dioxide and other greenhouse gases will be affected by changing climate, and which nations, regions, and economic sectors are most likely to be affected.

Source: <http://globalchange.mit.edu/igsm/#igsm>

### GEOENGINEERING THE CLIMATE (NEW GLOBAL INSTITUTIONS)



A report entitled *Geoengineering the Climate: Science, Governance and Uncertainty* was released by the UK's distinguished Royal Society science academy in September 2009. The report, researched and written over a period of 12 months by 12 leading academics representing science, economics, law, and social science, lays out in detail current geoengineering options, along with a comprehensive breakdown of potential benefits and drawbacks. This report is particularly notable because it demonstrates the attention the subject of geoengineering is now receiving from mainstream scientists.

Source: <http://royalsociety.org/Geoengineering-the-climate/>

### “THE GEOENGINEERING OPTION” (STRUGGLES OVER CONTROL)



In the March/April 2009 issue of *Foreign Affairs*, Stanford Law School professor David G. Victor and four other authors laid out the issues in an article entitled “The Geoengineering Option: A Last Resort Against Global Warming?” This piece was the first high-profile article about geoengineering aimed at policymakers, not scientists (or the general public), indicating that geoengineering is a political issue, not just a scientific one. Victor writes that if the efforts to control the emissions that cause global warming are tardy or fail, “then geoengineering is a Plan B that is filled with troubles, but better than nothing.”

Source: <http://www.foreignaffairs.com/articles/64829/david-g-victor-m-granger-morgan-jay-apt-john-steinbruner-and-kat/the-geoengineering-option?page=show>

### What difference does this make?

Geoengineering offers a way of holding off the worst effects of global warming but doesn't resolve the underlying problem. It will push the development of much more sophisticated and powerful tools for simulating and monitoring global systems as well as of international institutions to manage the process.

#### SUBSTANTIALLY IMPROVED TOOLS FOR MODELING GEOPHYSICAL SYSTEMS

The most powerful supercomputers today are pushed to their limits with advanced climate modeling. Creating and maintaining a geoengineering program that maximizes its effectiveness at moderating temperatures while minimizing undesirable results will require information systems many times more powerful than today's best. That, in turn, will have spin-off benefits across the spectrum of issues demanding more powerful computing.

#### EXTENSION OF GEOENGINEERING EFFECTS ACROSS BORDERS

Although geoengineering practices can be implemented locally, resulting changes will affect regional and global environments. Without international cooperation, disputes are inevitable over locally implemented processes with broader geographic implications and impacts.

#### STRENGTHENING OF INTERNATIONAL INSTITUTIONS IN ORDER TO MANAGE THE PROCESS

The risks of political conflicts derailing any geoengineering effort are substantial, and a great deal of attention will be paid to building and maintaining global governance mechanisms. These will also include mechanisms for helping to mitigate both unintended consequences and the results of existing warming.



**What to do differently?**

**The advent of geoengineering as a way of moderating global warming will not mean that efforts to reduce carbon emissions are unnecessary or lower in priority. Organizations should still focus on aggressive cuts to emissions.**

**TAKE ADVANTAGE OF INTEGRATED CLIMATE-ECONOMY MODELING SYSTEMS TO BETTER GAUGE SUSTAINABILITY IMPACTS**

Large organizations, especially those with an international reach, can use these tools to gather more precise information about both existing impacts and the effects of policy changes. Global institutions may be willing to fold these results into broader models.

**WATCH FOR INCREASED COOPERATION AND POLICY COORDINATION BETWEEN LARGE INTERNATIONAL POWERS AS A SIDE EFFECT OF INCREASED CLIMATE COORDINATION**

Successful geoengineering will require functioning international coordination. This will inevitably have effects across a wide array of transnational issues, particularly economic issues.

**PREPARE CONTINGENCY PLANS FOR ENVIRONMENTAL EMERGENCIES**

One known drawback to geoengineering programs is that if they are stopped abruptly (due to accident, changed policy, or attack), temperature conditions will rebound quickly and may exceed the previous peak temperatures for a time. Once under way, a geoengineering program can be stopped safely only if carbon levels are brought down; otherwise, the potential for crisis as a result of abrupt cessation will persist.



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