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# Geoengineering

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GAO's look into federal efforts related to  
geoengineering

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# GAO Work Related to Geoengineering

- December 2009: Began work on study for Chairman Bart Gordon, House Committee on Science and Technology (Issued September 23, 2010)
  1. What is the state of geoengineering science?
  2. Describe recent federal involvement in geoengineering research
  3. Examine the views of experts and federal officials about the extent to which federal laws and international agreements apply to geoengineering and identify governance challenges.
- March 2010: Testimony before House Committee on Science and Technology
- Pending: Technology Assessment for Chairman Gordon

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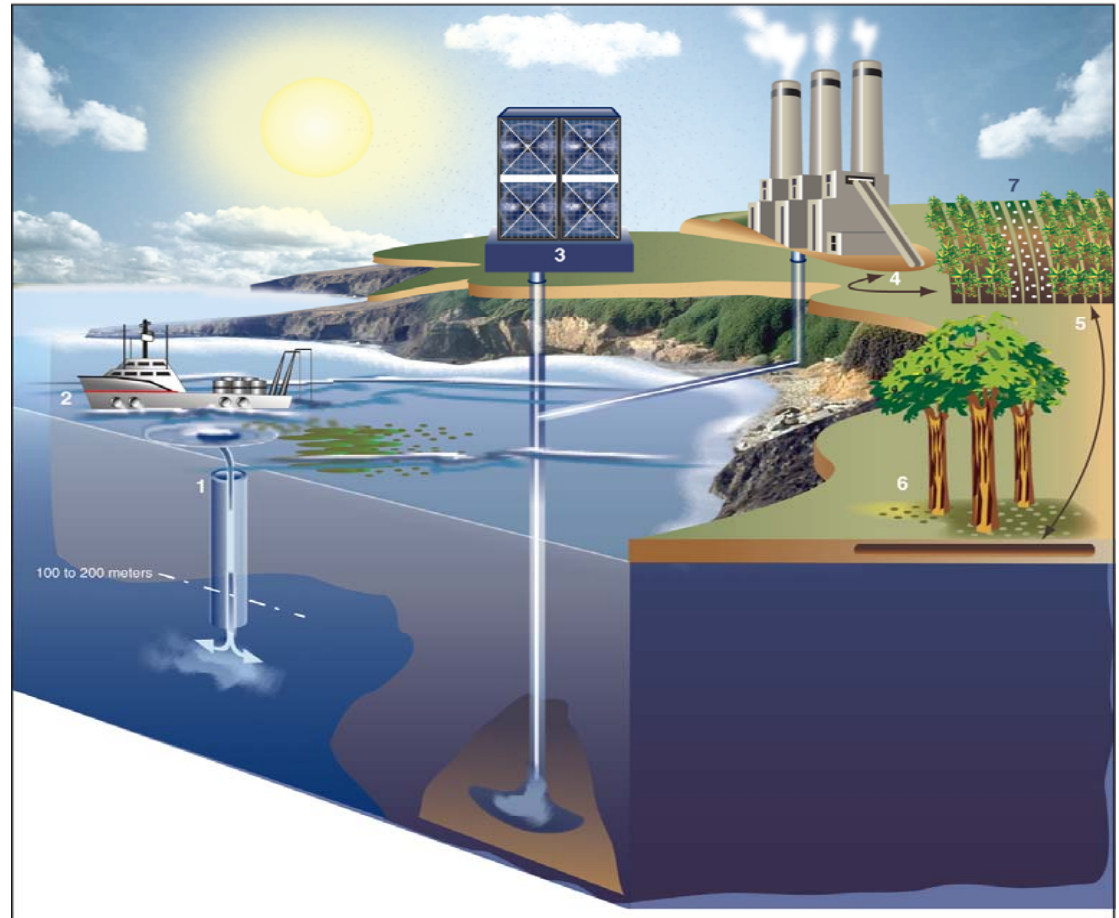
# Defining Geoengineering

- Royal Society (2009)
  - large-scale deliberate interventions in the earth's climate system to diminish climate change or its potential impacts
  - Carbon Dioxide Removal (CDR)
  - Solar Radiation Management (SRM)
- No common definition in academia or government

# State of Geoengineering Science

## ■ CDR

- ❑ Enhanced upwelling / downwelling
- ❑ Ocean fertilization
- ❑ Direct air capture
- ❑ Biomass for energy
- ❑ Biochar
- ❑ Afforestation
- ❑ Land-based enhanced weathering



Source: Lawrence Livermore National Laboratory and GAO analysis of various sources.

# State of Geoengineering Science

## ■ SRM

- ❑ Reflective mirrors in space
- ❑ Stratospheric aerosol injection
- ❑ Cloud-brightening
- ❑ Painting roofs white
- ❑ Planting more reflective crops
- ❑ Covering desert surfaces with reflective material



Source: Lawrence Livermore Laboratory and GAO analysis of various sources.

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# State of Geoengineering Science

- CDR and SRM differ in important ways and present different challenges for research and governance
- For both, major uncertainties remain
  - Technical feasibility (especially at scale)
  - Effects on climate
  - Unintended effects
  - Regulation of research and possible deployment
  - Political/Economic/Ethical concerns

# Federal Agencies We Identified As Potentially Involved In Geoengineering Research

## ■ Relevant federal research activities

- Information gathered from 13 USGCRP participating agencies
- 8 federal agencies reported research activity related to geoengineering in FY09-10
  - (One agency reported activity prior to FY 09)



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# We Divided Federal Geoengineering Research Into Three Categories

- ❑ activities focused on conventional mitigation strategies that are directly applicable to a proposed geoengineering approach,
- ❑ activities related to fundamental scientific efforts that could be generally applied to geoengineering,
- ❑ activities focused directly on a specific geoengineering approach that does not overlap with a conventional carbon mitigation strategy



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# Examples Of Federal Geoengineering Research

- **Conventional Mitigation Research Activity Generally Applicable to Geoengineering**
  - Soil carbon sequestration in existing and alternative agricultural systems
- **Fundamental Scientific Research Activities Relevant to Geoengineering**
  - Comprehensive Earth System Modeling to support research on the carbon cycle, climate system processes, and interfaces between atmospheric chemistry and climate
- **Research into a Specific Geoengineering Approach**
  - Study to perform systems analysis and cost estimates for large-scale, direct, physical capture of carbon dioxide from the air

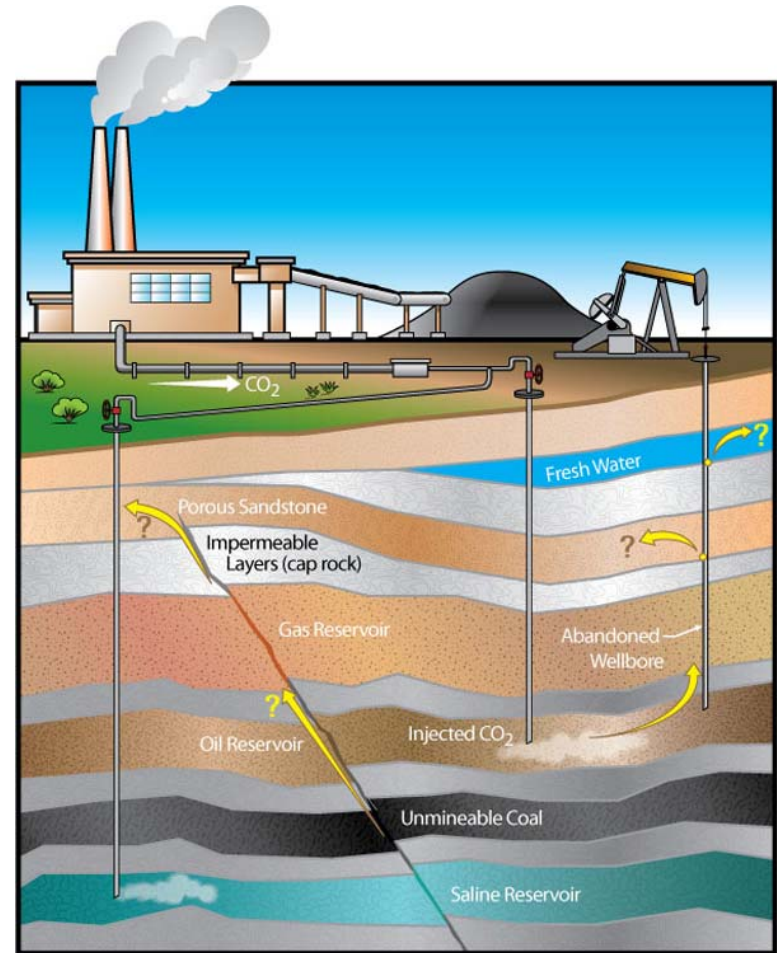
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# Laws and Regulations Related to Geoengineering

- Little national or international regulation activity directly addressing geoengineering because limited geoengineering research to date
- Geoengineering governance poses several unique challenges such as nationally sponsored activities having significant regional and/or global consequences

# Laws and Regulations that May Apply to Geoengineering

- EPA has taken steps to regulate geologic sequestration of CO<sub>2</sub> under the **Safe Drinking Water Act**
- Officials have stated that they can regulate certain sub-seabed sequestration as well as ocean fertilization using the **Marine Protection, Research and Sanctuaries Act**



(From Los Alamos National Labs)

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# Other Laws and Regulations that May Apply to Geoengineering

- ❑ Resource Conservation and Recovery Act (RCRA)
- ❑ Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)
- ❑ Clean Air Act
- ❑ National Environmental Policy Act (NEPA)
- ❑ Endangered Species Act

# International Agreements that May Apply to Geoengineering

- Geoengineering has been addressed formally by the Parties of 2 agreements at the time of our report
  - London Convention/London Protocol
    - Ocean fertilization
    - Geologic Sequestration
  - Convention on Biological Diversity
    - Ocean fertilization



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# Treaties that May Apply to Geoengineering

- Several other treaties have the standing to address geoengineering, either on a case by case basis or more generally depending on what they regulate, including:
  - ❑ **General**-Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD)
  - ❑ **Atmosphere**-Convention on Long-Range Transboundary Air Pollution
  - ❑ **Space**-Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space

## Concluding Observations and a Question

- International consensus on climate strategies may continue to be elusive
- The timing and severity of climate change is uncertain and its impacts will likely not be evenly distributed
- Similarly, the perceived costs and benefits associated with geoengineering research and deployment will differ across boundaries and regions
- As in other notable controversial research endeavors, legal and extra-legal constraints on research and deployment will also differ across boundaries

Question:

- What does this imply for appropriately managing the risk associated with geoengineering research and deployment in the United States?

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# GAO Publications

- See <http://www.gao.gov> for our geoengineering reports
  - GAO-10-546T, March testimony before House Science and Technology Committee
  - GAO-10-903, Full report on geoengineering (With Chairman Gordon, pending public release)
  - Technology Assessment (pending)

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