

Ethics & Issues Surrounding Geo-Engineering

“Climate and Society”

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Today's Presentation

- What is Climate Engineering (Geo-Engineering)?
- Four ethically-relevant impacts of climate engineering
- Five basic ethical concerns about engaging in Climate Engineering
- Critique of the four prevalent arguments supporting Climate Engineering research
- Lessons from ethical analogies to Climate Engineering research; how to approach Climate Engineering research



The views expressed in this presentation are solely my own, and do not represent the position of NOAA, the Department of Commerce, or the U.S. government.

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Context for Today's Presentation

- The earth's climate is changing rapidly
- Human emissions of greenhouse gases are at fault
- The impacts of climate change could be profound and could disrupt life as we know it
- The world is failing in its efforts to mitigate emissions of greenhouse gases
- Scientists are trying to figure out whether anything can be done to avoid a climate catastrophe
- A proposed solution is climate engineering (geo-engineering)

What is Climate Engineering?

Climate Engineering (CE) is the intentional modification of the climate in order to reduce or offset the effects of increasing greenhouse gas concentrations

Two primary classes of Climate Engineering

- Carbon Dioxide Removal (CDR)
- Solar Radiation Management (SRM)

Many other geo-engineering schemes have been proposed

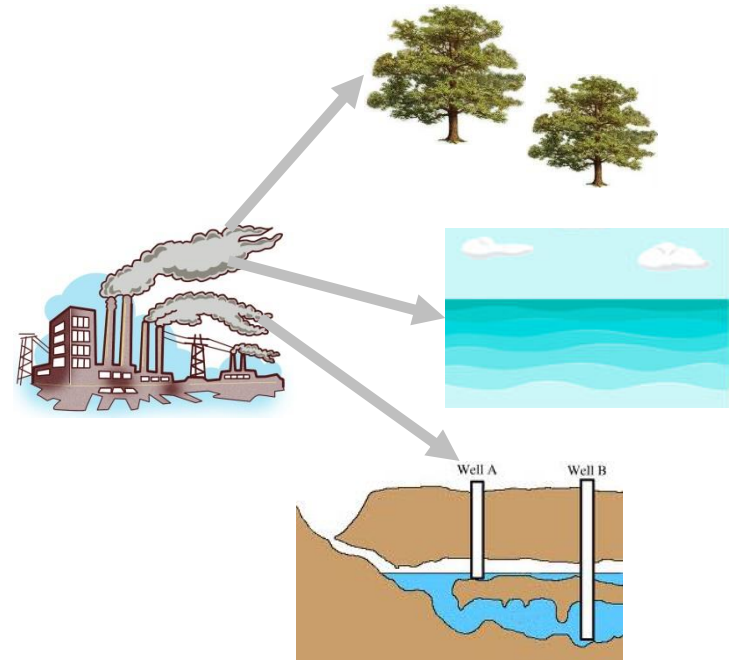
Carbon Dioxide Removal (CDR)

Concept: Reduce the amount of greenhouse warming

Approach: Remove CO₂ from the atmosphere

Proposed schemes for removing CO₂ include:

- **Plant more trees** (“Afforestation”)
 - Store carbon dioxide biologically on land
- **Induce growth of more plankton in the ocean** (“Ocean Fertilization”)
 - Store carbon dioxide biologically in the ocean
 - Would require dumping iron or other nutrients in ocean
- **Collect carbon dioxide or other greenhouse gases from the air** (“Sequestration”)
 - Store carbon dioxide underground or via other techniques



Take away points about Carbon Dioxide Removal:

- Seeks to slow or reverse changes in a natural system (global carbon cycle) that has undergone large anthropogenic perturbations
- Cooling impact on climate would be relatively slow

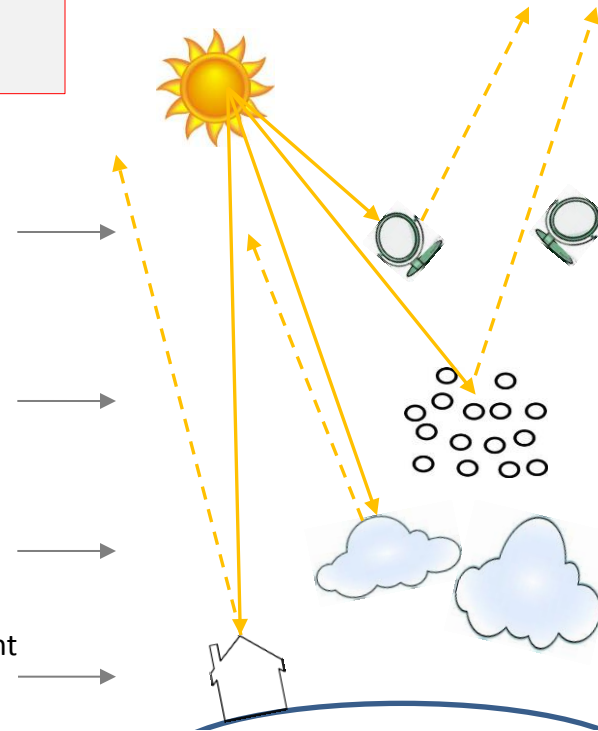
Solar Radiation Management (SRM)

Concept: Cool the Earth by shading it from the sun

Approach: Reflect more sunlight back to space

Proposed schemes for reflecting sunlight include:

- **Place mirrors in orbit** above the atmosphere
 - Would require thousands of orbiting mirrors
- **Inject aerosol particles into the stratosphere**
 - Simulate impact of large volcanic eruptions
 - Would require constant replenishment
- **Brighten clouds** by seeding methods to make more, smaller droplets
 - Would require constant replenishment
- **Paint house roofs white**, cover ground with mirrors, plant light-colored crops, etc



Take away points about Solar Radiation Management:

- *Seeks to produce a novel state* that maintains high concentrations of greenhouse gases while attempting to limit their climatic effects
- Cooling impact on climate would be rapid

Ethically-Relevant Impacts of Climate Engineering

- Alteration of climate on global scale
 - Impact millions-to-billions of people, animals, ecosystems
- Manifestation regionally heterogeneous
 - Winners and losers
- Some methods would create a novel state of nature
 - ... to boldly go where no person has gone before
- Unanticipated side-effects, highly uncertain
 - Cannot be more certain than certainty of climate models
 - Risks inherently unbounded
 - Many unknown impacts
 - Some could be irreversible
 - Some could be very damaging
 - Hubris ...?

Basic Ethical Concerns about Climate Engineering

- **Moral Hazard** – CE as an alternative to mitigating GHG emissions
 - Increase “political inertia”
 - “Quick fix” culture
- **Intergenerational Hazard** – SRM would presuppose long-term commitment
 - Abrupt stop worse than gradual warming
 - Political institutions/budgets/commitments don’t last centuries or millennia
- **Misuse of Knowledge** – Nefarious use possible
 - Regional impacts make possible strategic military or hostile use
 - Historical military interest in weather modification; DARPA interest in CE
 - Rogue states or terrorists
 - Implications for “transparency” of research
- **Opportunity Cost** – Money diverted from other endeavors
 - Mitigation or adaptation
 - Green technologies
 - Paying down liability to future generations¹
- **Moral Authority** – Potential for unilateral implementation
 - Who has the moral authority to impact millions-to-billions of people?

* Derived from Morrow, Kopp and Oppenheimer, Environ. Res. Lett. 4, p 1-8 (2009)

Rationale for Considering Climate Engineering

Four major arguments have been invoked to justify climate engineering

- Cost Effectiveness Argument
- Research First Argument
- Lesser Evil Argument
- We're Doing it Anyway Argument

Rationale for Considering Climate Engineering

Cost Effectiveness Argument

CE is cheap and administratively simple relative to its alternative

- Denies that CE is bad, claims that it is good
- Claims moral high ground

* Stephen Gardiner, in "Climate Ethics," Gardiner, Caney, Jamieson and Shue, Eds., Oxford Univ Press, p 284-312 (2010)

Rationale for Considering Climate Engineering

Cost Effectiveness Argument

CE is cheap and administratively simple relative to its alternative

- **Not cheap or simple**
 - **Costs of unexpected surprises**
 - For example, silting of dams, introduction of invasive species, ozone hole, etc
 - **Geo-political impacts neither simple nor cheap**
 - Social , economic, political, and military costs of unilateral CE
- **Not comprehensive**
 - **Not all damage induced by climate change is offset by CE**
 - For example, ocean acidification due to CO₂ emissions
- **Moral high ground??**
 - **Continues poor human relationship with nature**
 - Costs of species extinction, deforestation, etc
 - Costs associated with continuing unsustainable consumption and production



Cost assessments are analogous to estimating the cost of surgery as the price of the scalpel

Rationale for Considering Climate Engineering

Research First Argument

Knowledge is good ... so do research while declaring moratorium on deployment

- Claims that all “knowledge” is good
- Agnostic on inherent good or evil of CE
- Claims to be amoral, defers moral evaluation

* Stephen Gardiner, in “Climate Ethics,” Gardiner, Caney, Jamieson and Shue, Eds., Oxford Univ Press, p 284-312 (2010)

Rationale for Considering Climate Engineering

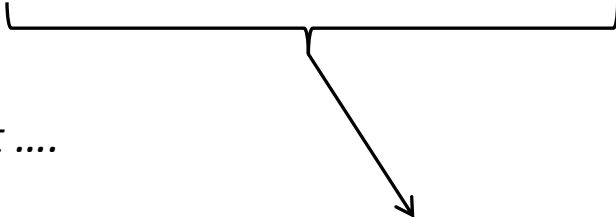
Research First Argument

Knowledge is good ... so do research while declaring moratorium on deployment

- **Some knowledge not worth pursuing**

- Research takes too long to complete
- No principle exists for transition from research to deployment

Food for thought

- 
- Would we ever know enough to gamble on CE?
 - What constitutes an “emergency?”
 - What principle would govern when that risk would be acceptable? Panic ...?
 - Therefore, before pursuing CE, shouldn't we first figure out how to deal with the great Philosopher Rumsfeld's “unknown unknowns” ...?

Rationale for Considering Climate Engineering

Research First Argument

Knowledge is good ... so do research while declaring moratorium on deployment

- **Some knowledge not worth pursuing**
 - Research takes too long to complete
 - No principle exists for transition from research to deployment
- **Some projects are morally bad**
 - For example, new ways to commit genocide ...?
- **Institutional Momentum – “If you build it they will come.”**
 - Powerful institutions that lobby for project
 - Elite scientists with personal interest in project
 - Justification of sunk costs
- **Moratorium is unenforceable**
 - Rogue scientists or nations can deploy CE based on published research
 - “Gentlemen’s agreement” among scientists lacks legitimacy for international governance

Classic example:
Star Wars



Research First argument claims that scientific research and ethical constraints are separable

Rationale for Considering Climate Engineering

Lesser Evil Argument


- Concedes that CE is bad
- Claims moral high ground nonetheless

* Stephen Gardiner, in "Climate Ethics," Gardiner, Caney, Jamieson and Shue, Eds., Oxford Univ Press, p 284-312 (2010)

Rationale for Considering Climate Engineering

Lesser Evil Argument

Arming the Future Argument (Gardiner, 2010) *

- 
- Reducing emissions is the best way to address climate change
 - Little progress has been made in reducing emissions
 - There is little reason to believe this will change in the near future
 - If it doesn't, then at some point we may end up having to choose between allowing catastrophic climate impacts or engaging in climate engineering
 - Both are bad options
 - Climate engineering is less bad
 - Therefore, if forced to choose, we should choose climate engineering
 - But if we don't start researching climate engineering now, we will not be in a position to choose should the above scenario arise
 - Therefore, we should start doing such research now


* Stephen Gardiner, in "Climate Ethics," Gardiner, Caney, Jamieson and Shue, Eds., Oxford Univ Press, p 284-312 (2010)

Issues with the “Lesser Evil” Justification for Climate Engineering


- **False Premise 1:** Only options are climate change or CE
 - Green technology? Adaptation/refugee “superfund?” Strategic solar panel reserve?
- **False Premise 2:** CE is indisputably less evil than climate change
 - CE-induced geo-political catastrophe could exceed climate catastrophe
 - Unilateral CE, inequitable CE, predatory CE, retaliatory CE
 - CE risks to nature unbounded (and perhaps unboundable)
- **Moral Corruption** – Defense of self-interest; self-deception; beliefs that excuse inaction
 - *Morally extenuating circumstances* ... or passing the buck?
- **Moral Schizophrenia** – Climate catastrophe reflects society’s moral dereliction of duty
 - Preparing for emergency beyond our control versus preparing for an emergency caused by our own moral failure
 - Claiming moral obligation to pursue a “lesser evil” solution while simultaneously rejecting non-evil alternatives because of self interest
- **Governance Conundrum** – Same political entities that cannot mitigate climate change govern CE
 - Why would US or international political system exercise more ethical stewardship of CE than of climate change?
 - Who has moral authority to decide to deploy CE?

The “We’re Doing it Anyway” Argument

A currently popular “moral high ground” argument among proponents of CE is that ethical reservations over intentional modification of the climate system are moot ...

- 
- We know that GHG emissions are causing climate change
 - But we keep emitting GHGs anyway
 - Therefore, we are knowingly engaging in modification of the climate system
 - So CE should be viewed simply as a way to do it more intelligently.

Exaggeration? Sophistry?

- Has society *really* made a conscious decision to cause climate change?
 - {
 Knowingly retaining old technology that causes climate change
 versus
 Intentionally introducing technology for the purpose of causing climate change
-  **“Common sense morality”**¹: asymmetry between what is brought about intentionally and what is an inadvertent result of action
 - Intentionally running over a pedestrian viewed as worse than doing so accidentally

¹ Re “common sense morality” see Dale Jamieson, “Ethics and Intentional Climate Change,” *Climate Change* 33, p 323-336 (1996)

A Few Key Take-Away Points

Climate Engineering Ethics

- The dramatic CE schemes have highly uncertain impacts (... hubris?)
 - Solar radiation management
 - Ocean fertilization
- Could impact billions of people and life forms
- Winners and losers =>
 - Inequitable (... and who decides?)
 - Potential for geo-political catastrophe
- Could discourage mitigation (moral hazard)
- Stopping could be more dangerous than never starting (... intergenerational hazard)
- Could be very expensive
 - Diverts dear money from green technology (... opportunity cost)
 - Unexpected surprises
 - Geo-political costs
- No rules of the road (governance)

Political Reality

- Many ethical reservations about CE research have been articulated
- Notwithstanding, strong momentum is building to pursue CE research and possibly even limited-scale deployment
 - Many scientific organizations (e.g., AGU, AMS, National Academy of Sciences, Royal Society ...) favor CE research
 - Peer pressure among scientists frowns on objecting to research
 - Quick fix politics in a quick fix culture appears to favor CE research



If CE research is likely to proceed, how can it best be managed to mitigate ethical risks?

Biomedical Research

.... for Perspective

- The ethical issues confronted by CE research are not unique
 - Analogous issues in genetics, medical research on human subjects, etc.
- Since World War II, the biomedical world has developed consensus on regulations to mitigate ethical issues

Climate Engineering Experiment =

Biomedical Clinical Trial



Why should climate research be held to a lower ethical & safety standard than biomedical research?

US Regulations Codify Ethical Constraint/Oversight of Biomedical Research on Human Subjects¹

Oversight required by Institutional Review Boards

- Approve, modify, or disapprove all research activities
- Diverse and extramural membership
- No personal interest in research
- Informed consent required
- Minimization of risks required
- Equitable selection of subjects required

Ethical Principles Governing Biomedical Research

- **Respect for Persons** = Autonomy
 - Informed consent, Protect the vulnerable
- **Beneficence** = Welfare of the research participant
 - First do no harm, Maximize benefits
- **Justice** = Equitable distribution of costs and benefits

¹ 45 CFR 46 (1974) applies to DHHS; 21 CFR 50, 56 (1980) applies to FDA; the Common Rule (1991) extends DHHS rules on protection of human subjects to 15 federal departments and agencies + CIA + Homeland Security

Why Does Oversight Matter?

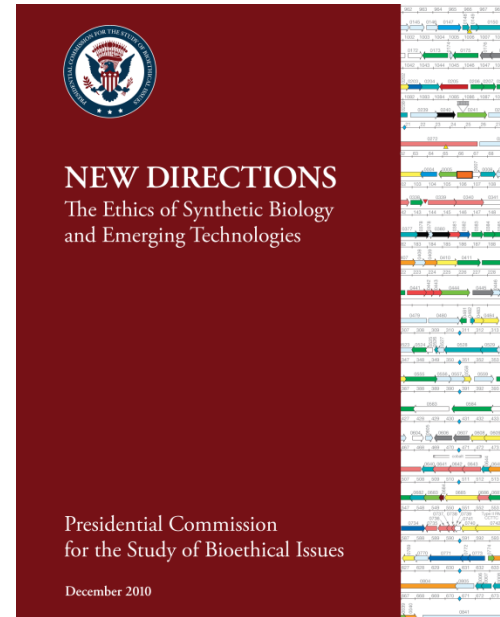
- **US Public Health Service Tuskegee syphilis experiments (1932-1972)**
 - Observed impoverished people in Alabama who were infected with syphilis, without informing them of the diagnosis and without treating them when curative antibiotics became available
 - Led to the Belmont Report (1979)
- **US Public Health Service Guatemala syphilis experiment (1946-1948)**
 - Intentionally infected mental patients, prisoners and others with STDs
 - Funded by NIH
 - Formal apology by US Government (2010)

Current Example of Biomedical Oversight



Presidential Commission for the Study of Bioethical Issues

- Created: November 2009
- **Function: Advise the President on bioethical issues** that may emerge from advances in biomedicine and related areas of science and technology
- **Goal:** Identify and promote policies and practices that ensure scientific research, health care delivery, and technological innovation are **conducted in an ethically responsible manner**



Synthetic Biology encompasses the design and construction of new biological functions and *systems not found in nature*

How does synthetic biology differ from climate engineering?

Current Example of Biomedical Oversight

National Science Advisory Board for Biosecurity

- Created: March 2004
- **Function: Advise federal departments and agencies on dual use research** and recommend strategies for its oversight, taking into consideration national security concerns and the needs of the research community.
- **Goals** include developing a **code of conduct for scientists** and laboratory workers that can be adopted by federal agencies, as well as by professional organizations and institutions



THE SECRETARY OF HEALTH AND HUMAN SERVICES
WASHINGTON, D.C. 20201

CHARTER

NATIONAL SCIENCE ADVISORY BOARD FOR BIOSECURITY

AUTHORITY

42 U.S.C. 217a, section 222 of the Public Health Service Act, as amended and Pub. L. 109-417, section 205 of the Pandemic and All-Hazards Preparedness Act. The National Science Advisory Board for Biosecurity (NSABB) is governed by the provisions of the Federal Advisory Committee Act, as amended (5 U.S.C. app.), which sets forth standards for the formation and use of advisory committees.

OBJECTIVES AND SCOPE OF ACTIVITIES

The purpose of the NSABB is to provide, as requested, advice, guidance, and leadership regarding biosecurity oversight of dual use research, defined as biological research with legitimate scientific purpose that may be misused to pose a biologic threat to public health and/or national security. The NSABB will provide advice on and recommend specific strategies for the efficient and effective oversight of federally conducted or supported dual use biological research, taking into consideration both national security concerns and the needs of the research community to foster continued rapid progress in public health and agricultural research. Toward this end, the NSABB will also include providing strategies to raise awareness of dual use issues relevant to the life science and related interdisciplinary research communities. NIH will manage and provide support services for the NSABB.

DESCRIPTION OF DUTIES

The NSABB will be composed of subject matter experts who are not full-time employees of the Federal Government as well as ex officio members from Federal entities



Dual Use Research is research designed for the benefit of society that develops techniques that provide ***opportunities for misuse***

How does dual use research differ from climate engineering?

The Washington Post

is outside metropolitan Washington.

MD DC VA SU

Rain 60/49 • Tomorrow: Partly sunny 59/43 • DETAILS, B10

WEDNESDAY, DECEMBER 21, 2011

washingtonpost.com • 7

Scientists asked to withhold details of lab-created flu

BY DAVID BROWN

Scientists seeking to fight future pandemics have created a variety of “bird flu” potentially so dangerous that a federal advisory panel has for the first time asked two science journals to hold back on publishing details of research.

In the experiments, university-based scientists in the Netherlands and Wisconsin created a

version of the H5N1 influenza virus that is highly lethal and easily transmissible between ferrets, the lab animals that most closely mirror human beings in flu research.

Members of the **National Science Advisory Board for Biosecurity**, which was created after the anthrax bioterrorism attacks of 2001, worried that such a hazardous strain might be intentionally

or accidentally released into the world if directions for making it were generally known.

After weeks of reviewing papers describing the research, the NSABB said Tuesday it had recommended that the experiments’ “general conclusions” be published but not “details that could enable replication of the experiments by those who would seek to do harm.”

“Censorship is considered the ultimate sin of original research. However, we also have an imperative to keep certain research out of the hands of individuals who could use it for nefarious purposes,” said Michael T. Osterholm, a member of the board who is also director of the Center for Infectious Disease Research and Policy at the University of Minnesota. “It is not unexpected that these two

things would clash in this very special situation.”

The board cannot stop publication. Its advice went to the Department of Health and Human Services, whose leaders asked the authors of the papers and the journals reviewing them — Science, published in Washington, and Nature, published in London

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Biomedical Ethical Norms Applicable to Climate Engineering Research¹

Regulatory framework proposed to *precede* experimentation

- **Parameters governing research required:**
 - Acceptable levels of risk
 - Limits on local and regional climate perturbations,
 - Duration and scale of experiments, etc.
- **Review Board oversight required:**
 - Reach normative judgments about whether proposed studies are within those parameters, warrant risks, etc.
 - Required at all levels: International, National, NOAA
- **Broad representation required:**
 - Absent objective standards for judgments, Review Boards must
 - Entrain scientists, ethicists, lawyers, policymakers, stakeholders

¹ Morrow, Kopp and Oppenheimer, "Toward Ethical Norms and Institutions for Climate Engineering Research," Environ. Res. Lett. 4, p.1-8 (2009)

Food for Thought

Rocking the Boat

Gavin Schmidt*

“Think of the climate as a small boat on a rather choppy ocean. Under normal circumstances the boat will rock to and fro, and there is a finite risk that the boat could be overturned by a rogue wave. But now one of the passengers has decided to stand up and is deliberately rocking the boat ever more violently. Someone suggests that this is likely to increase the chances of the boat capsizing. Another passenger then proposes that with his knowledge of chaotic dynamics he can counterbalance the first passenger and indeed, counter the natural rocking caused by the waves. But to do so he needs a huge array of sensors and enormous computational resources to be ready to react efficiently but still wouldn’t be able to guarantee absolute stability, and indeed, since the system is untested it might make things worse.”

“So is the answer to a known and increasing human influence on climate an ever more elaborate system to control the climate?
Or should the person rocking the boat just sit down?”

* Gavin Schmidt, “Geoengineering in Vogue,” Real Climate, June 28. Available at <http://www.realclimate.org/index.php/archives/2006/06/geo-engineering-in-vogue/>

Conclusions and Recommendations

- Moral hazard
 - Intergenerational hazard
 - Misuse of knowledge & issue of transparency
 - Opportunity costs
 - Moral Authority
 - Unanticipated costs
 - Geo-political catastrophe
 - Inadequate solution
 - Perpetuation of unsustainability
 - No end point to research
 - Institutional momentum
 - Unenforceable moratorium
 - Unboundable risks to nature
 - Moral corruption
 - Moral schizophrenia
 - Governance conundrum
 - Informed consent
 - Beneficence
 - Justice
- Climate Engineering poses major, unresolved ethical problems
 - Ethics and scientific research are not separable; waiting to address ethical issues until considering deployment is too late
 - Ethical norms and standards governing Climate Engineering research must be established cooperatively by scientists, ethicists, lawyers, policymakers and stakeholders **before** embarking on research
 - Ethical oversight & constraint must be entrained in CE research in a manner analogous to biomedical research



The role of the “climate ethicist” needs to become as ingrained in climate research as that of the “bioethicist” in biomedical research

Selected Literature on Ethical Considerations Related to Climate Engineering

- See Professor Dale Jamieson's publications at: <http://as.nyu.edu/object/dalejamieson.html>
 - Dale Jamieson, Ethics and Intentional Climate Change, *Climatic Change* **33**, 323-336, 1996; http://as.nyu.edu/docs/IO/1192/Ethics_and_Intentional_Climate_Change.pdf
 - Geoengineering as a Response to Climate Change: An Urgent Problem Meets a Bad Concept, 2010 (Video): <http://www.princeton.edu/pei/events/jamieson111610/>
- Stephen Gardiner, Is Geoengineering the 'Lesser Evil'?, *Env. Res. Lett. Talking Point*, <http://environmentalresearchweb.org/cws/article/opinion/27600>, April 18, 2007
- Stephen Gardiner, Is 'Arming the Future' with Geoengineering Really the Lesser Evil?, in *Climate Ethics*, Gardiner, Caney, Jamieson and Shue, Eds., Oxford Univ Press, 284-312, 2010; <http://folk.uio.no/gasheim/Gar2010b.pdf>
- Clive Hamilton, No, we should not just 'at least do the research', *Nature* 496, 139, 2013; http://www.nature.com/polopoly_fs/1.12777!/menu/main/topColumns/topLeftColumn/pdf/496139a.pdf
- David R. Morrow, Robert E. Kopp and Michael Oppenheimer, Toward ethical norms and institutions for climate engineering research, *Environ. Res. Lett.* **4**, 1-8, 2009; http://iopscience.iop.org/1748-9326/4/4/045106/pdf/1748-9326_4_4_045106.pdf
- Climate Ethics: A Roundtable Discussion at NYU, October 28, 2010 (Video): <http://www.youtube.com/watch?v=8haOsIltT3c>
- Geoengineering the Climate: Science, Governance and Uncertainty, The Royal Society, 2009; http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2009/8693.pdf
- Alex Hanafi and Steven P. Hamburg, The Solar Radiation Management Governance Initiative: Advancing the International Governance of Geoengineering Research. Opinion Article, *Geoengineering Our Climate Working Paper and Opinion Article Series*. 2013. Available at <http://wp.me/p2zsRk-6e>.

Questions for Class Consideration

1. Shades of Gray

We are caught between ethical dilemmas:

- Failure to mitigate climate change poses ethical problems
- Climate engineering poses ethical problems

Is there a point at which climate change becomes so severe that we should engage in climate engineering research? Deployment? If so, when?

2. Extreme Case

Climate engineering schemes range from mild (e.g., painting roof tops white or planting trees) to extreme (e.g., placing 10,000 mirrors in space, fertilizing the ocean, seeding the atmosphere with aerosols) intervention in the environment.

Is there a point where it would be preferable to aggressively intervene in the energy infrastructure and economy? If so, when?