

Geoengineering the Climate: Institutional and Governance Issues

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Geoengineering: Intentional manipulation of global-scale processes – e.g., to offset climate disruption from greenhouse gases

Two Main Types:

- Manipulate Carbon Cycle (CDR)
- Manipulate Solar Radiation (SRM)



Types of Geoengineering: a little more detail

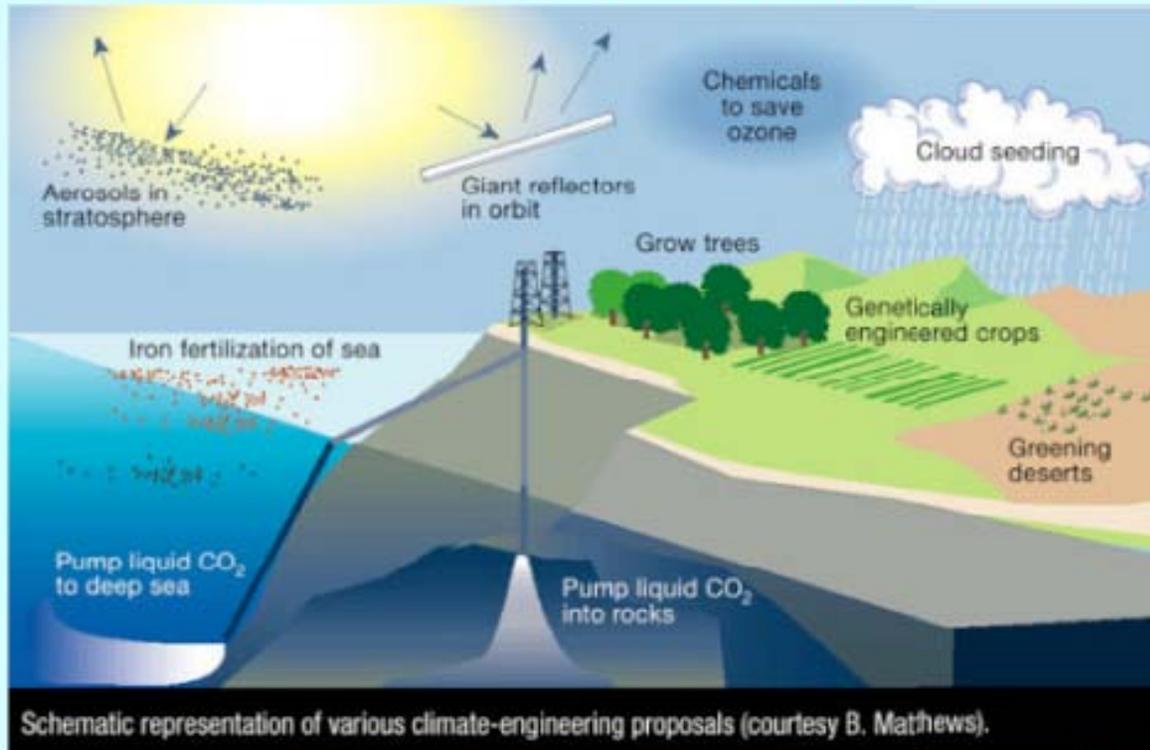
Carbon Dioxide Removal (not today)

- Capture and Sequester:
 - From smokestacks
 - From the free atmosphere
- Grow more forests (maybe genetically engineered)
- Bury charcoal
- Accelerate weathering of sedimentary rocks
- Fertilize the surface ocean (highest leverage with Iron)

Solar Radiation Management

- Shields in space (L1 point)
 - *Reflective aerosols in stratosphere (S, Al, engineered particles)*
 - Brighten clouds (e.g., by sea salt injection)
 - Brighten the ocean (lots of little bubbles)
 - White roofs, crops, surface reflectors, etc.
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Climate Intervention methods



Solar Radiation Management: Cheap, Fast, and Imperfect



SRM is Cheap

- High leverage: Grams offset Tons
- Stratospheric stability: Lifetimes ~ 1 year → Small injection rate maintains large stock
- Early estimates: Offset 21st-century forcing for ~ a few \$ Billions/yr
- I.e., Cost ~ zero: No fights over cost-sharing!
- Isn't cheap a good thing?? Hmm, maybe not in this case ...
 - Promotes naïve cheerleading (“No need to cut emissions!”)
 - Hard to control: within reach of ~ all states and many non-state actors



SRM is Fast

- Volcanic injections to stratosphere provide natural experiment: e.g., Pinatubo cooled world ~ 0.5 C in a few months
- vs. decades to slow warming through emissions reduction or CDR
- SRM: Only identified response that can cool Earth in a few years
- Could be deployed **after** unfavorable information on key uncertainties, in a “climate emergency”, due to ...
 - Continued failure to do serious emission reduction, OR ...
 - High climate sensitivity, OR ...
 - Severe impacts
- Potential for fast future intervention \rightarrow Major reduction of risks
- Most serious reason to develop, test, assess SRM capability



SRM is Imperfect

- Direct environmental risks – ozone loss, acid dep'n, whiter sky, ...
 - Identified risks look modest on preliminary study
 - BUT big uncertainties, potential “unknown unknowns”
- GHGs Plus SRM: Does not reproduce the original climate
 - Offset warming aloft (from GHGs) with cooling at surface (from SRM)
 - Global average: Control T → Over-control water; A drier world
 - Potentially large regional/seasonal disruptions: e.g., S. Asian monsoon
- Inertia: Severe impacts might be unstoppable once identified
- SRM has no effect on direct impacts of elevated CO₂
 - Ecosystems: disruption of competitive relationships
 - Ocean acidification



SRM in context:

Potentially useful roles for SRM

1. Contingency response to “climate emergency”

OK, BUT ...

- What counts as a climate emergency?
- Would we recognize one in time to make a difference?
- Who gets to say?



SRM in context:

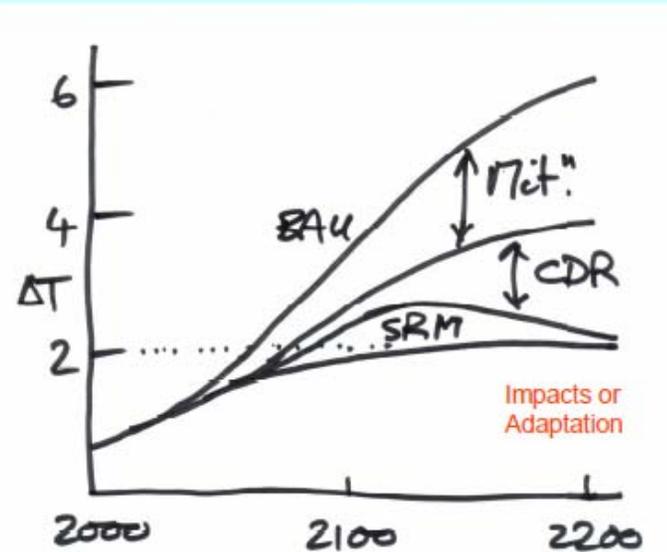
Potentially useful roles for SRM

2. Shave the peak off climate change in an optimal portfolio of responses

OK, BUT ...

- Could we do this?
- Who steers?

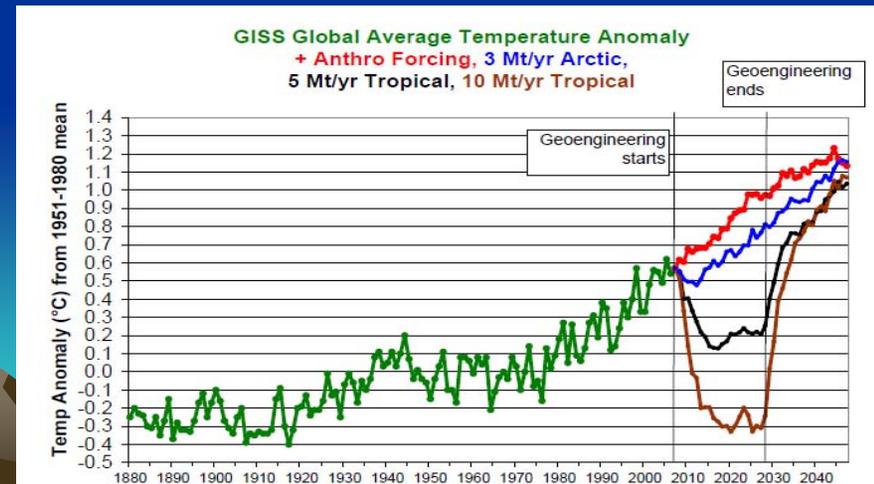
Mitigation, Adaptation & Geoengineering:
what, how much, and when ?



SRM in context:

Potentially dangerous roles for SRM

- “Distraction” (aka “Moral Hazard”)
 - Support for serious mitigation already woefully inadequate
 - Might too-rosy view of SRM efficacy and ease make it worse? (Early reaction says Yes)
 - Could it go opposite way?
- “Addiction”
 - Reversible in ~ 1 year is advantage when testing
 - But what if we rely on it to offset 2 C? 3C?
 - Turn it off → Get back avoided warming in 1 – 2 years!



SRM needs Legitimate International Governance:

To exploit the useful, avoid the dangerous

Failure Modes to Avoid:

- ***“Narrow” (just about SRM)***
 - Capability not developed – only option (if needed) is hasty, untested deployment
 - “1970s Nuclear” variant: Arrogant, hasty pursuit breeds mistrust and backlash, needed capability is lost
 - Crucial knowledge or technology secret, or under non-accountable control (state or firm)
 - Disorderly deployment makes BIG new source of international conflict:
 - Unilateral action by “rogue” group (State, terrorist group, apocalyptic cult, other)
 - Multiple competing/conflicting programs
 - Disagreement re what counts as an emergency, who controls deployment
 - Attribution of hostile intent
- ***“Broad” (SRM in context of total climate response – as above)***
 - Distraction: Naïve SRM boosterism undermines mitigation
 - Addiction: Growing reliance on SRM → Get stuck, can’t reverse course

SRM Governance: Objectives to Pursue

- Develop capability by promoting and regulating research, testing
- Share knowledge broadly re methods, performance, risks
- Link to international program of scientific research, monitoring, assessment
- Attract participation of ALL actors with capability/intent to do SRM
- Develop assessment/decision processes –to grow into legitimate regime to control future deployment
- Deter unilateral deployment
- Build (and earn!) broad public legitimacy

That's all!



SRM Governance: So what do we do now?

- ***DON'T try to negotiate a Treaty immediately:***
 - ***Don't know enough:*** Can't state useful norms, principles, without more knowledge, practice (at small scales)
 - Early Treaty likely to be controlled by opponents, enact prohibition (or constructive equivalent)
 - States that want the option (including the most responsible) likely to opt out
- ***INSTEAD:*** “Develop norms from the ground up, through decentralized process, linked with research and practice”
- ***OK ... But what does this mean?***



SRM Governance: Baby steps

(drawing on Asilomar discussions, March 22-26)

- Establish multilateral program for:
 - Joint research (and developing research guidelines)
 - Information sharing
 - Assessment, environmental monitoring, consultation
- Research guidelines: scrutiny and regulation depend on scale, potential risk
- Smallest, most benign (models, lab studies, tiny field “process” studies)
 - Current oversight (research agencies, envt reg’ns, permitting) is adequate
 - But steer to int’l cooperation in research, assessment, info sharing
- Biggest (Field studies ~ deployment): **SHOULD NOT PROCEED** until legitimate international governance in place – Moratorium
- In Between: Graduated system of increasing scrutiny, regulation, requirements for transparency as scale and risk expand



SRM Governance: Speculation on Further Steps

- Hardest challenge may be managing SRM in context of total climate response
 - Distinguish “Local” Assessment and Governance (this experiment) from “Global” (implied trajectory)
 - Concerns about slippery slope, moral hazard, addiction: ***Serious and legitimate***, need a forum
 - BUT assessment of individual proposed experiments is not the place for this discussion
 - Need responsible high-level policy-making – national and international – to define overall climate strategy
 - Absent that, incremental incentives favor bad futures
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SRM Governance: Potential Analogies (all imperfect)

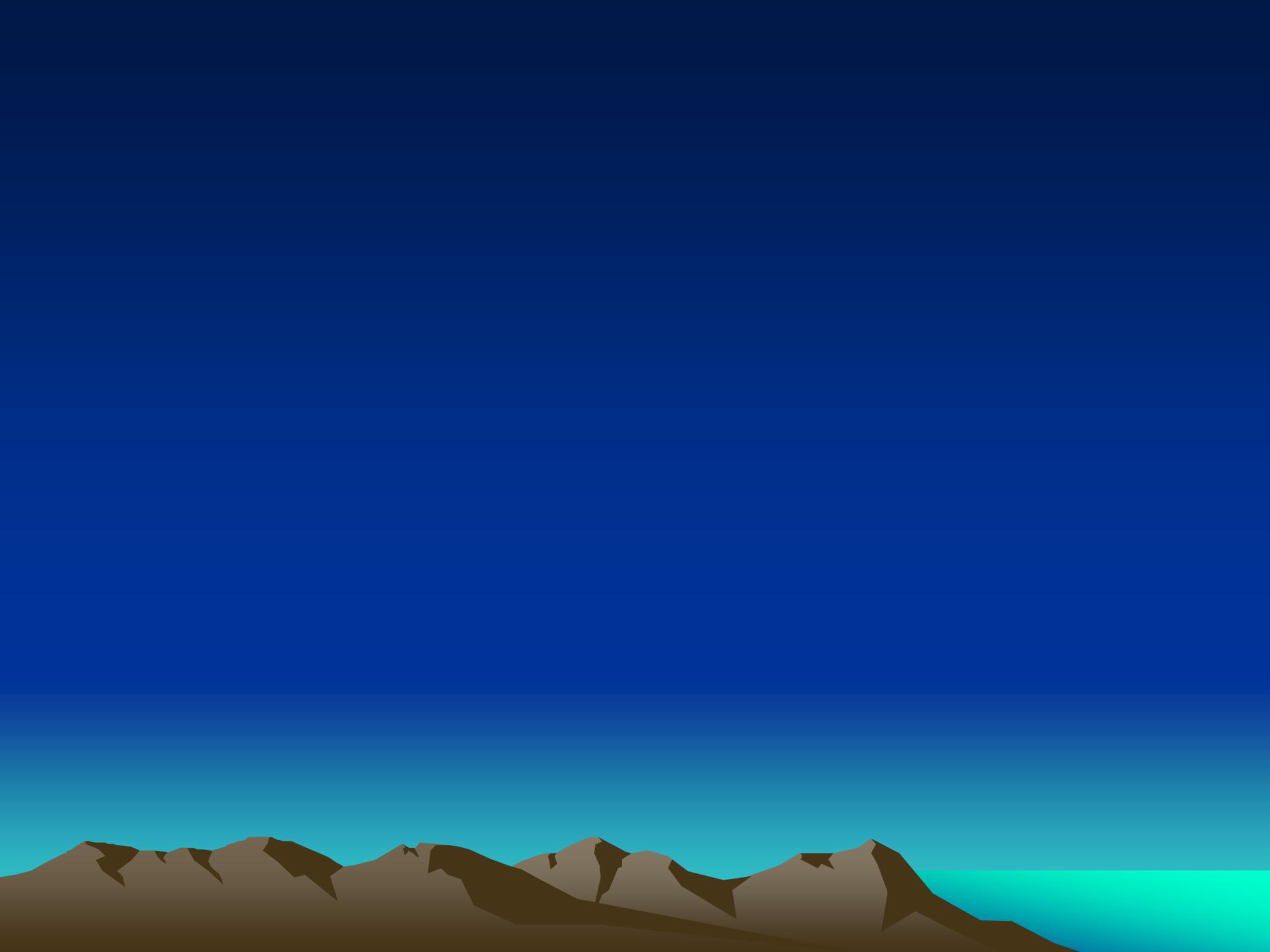
- Non-Proliferation Treaty
- Test-Ban Treaty
- ABM Treaty
- Law of the Sea – seabed resources regime
- Baruch Plan



SRM Wrapup

- Fast → Need SRM capability for prudent risk management
- Cheap → Worry about excessive reliance, unilateral deployment
- Imperfect → Must not supplant mitigation
- SRM needs legitimate international governance: to promote and regulate research, share knowledge, do assessments, deter unilateral use
- Don't pursue Treaty now: Instead develop joint research, monitoring, assessment, consultation
- Research guidelines: increase scrutiny and control as scale of intervention expands; moratorium on “large” interventions until governance in place
- Must build capability – aiming at future capacity for deployment decisions – without displacing mitigation or getting into fights





Asilomar again – “and in between” ...

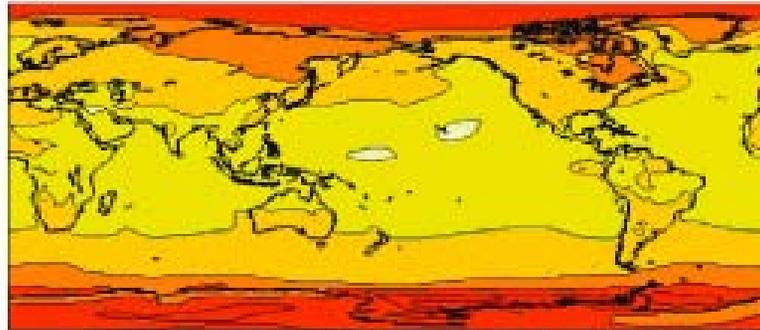
- Graduated system of increasing scrutiny, transparency, control as scale/risk expands
- Grows out of initial international cooperation on research, assessment of risks and societal implications (e.g., Royal Society/EDF/TWAS project)
- What’s big and what’s small?
 - Astonishing disagreement on numerical breakpoints (0.2 W/m², or .0002)
 - Provisional consensus: An institutional/process solution, not a numerical/algorithmic one
 - Analogy of “threshold review” by IRBs
- Functions to be added, strengthened as scale of proposed interventions expands
 - Independent assessment of risks, monitoring of interventions and results
 - Transparency, access to data and results (including disclosure requirements on private research and technology)
 - Decision-making, permitting re proposed interventions – including both technical/scientific assessment and public participation, consultation
 - Liability and compensation – No-fault over some defined zone of potential impacts?
- Hardest problem: “Local” assessment/governance (this experiment) vs. “Global” (implied trajectory, SRM in context of total climate response)
 - Concerns about slippery slope, moral hazard, addiction are **serious**, need a forum
 - BUT don’t confound this with risk assessment of this little experiment
 - Geoengineering gets extreme responses: Nutty boosters and opponents – Hawaii CO₂ expt



Stratospheric aerosols: approximate cancellation of warming

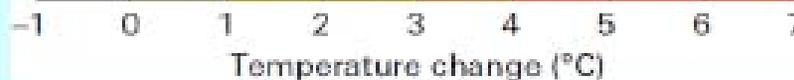
2 x CO₂

(a)



2 x CO₂
with SRM

(c)



From Caldeira
& Wood 2008

All options together

