CARNEGIE COUNCIL
The Voice for Ethics in International Affairs

FORUM *for*
CLIMATE ENGINEERING
ASSESSMENT

"A briefing and discussion on solar geoengineering: science, ethics and governance" to be held on 16 May 2017 at 12:00 UTC/GMT (8:00 EDT New York, 13:00 BST London, 14:00 CEST Geneva, 17:30 IST New Delhi)


Janos Pasztor


Simon Nicholson


Doug MacMartin


Pablo Suarez


Tom Ackerman


Arunabha Ghosh


Ted Parson


Holly Jean Buck


David Morrow

FORUM *for*
CLIMATE ENGINEERING
ASSESSMENT

SCHOOL *of* INTERNATIONAL SERVICE
AMERICAN UNIVERSITY • WASHINGTON, DC

- The **Forum for Climate Engineering Assessment** (FCEA) is a research and public policy initiative based at American University, Washington, D.C.

- Established in 2013 to build a more robust and inclusive climate engineering conversation

- Major work:
  - International governance
  - Public and civil society deliberation and participation
  - Human rights and other dimensions of international law

info@ceassessment.org

Notes & Major Objectives for the Webinar

- Briefing on the state of scientific understanding and current thinking on governance
- Solar Radiation Management (SRM) in the context of climate action agenda
- The 1.5C target
- Further resources and continuing the conversation

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Douglas MacMartin
Professor of Mechanical and Aerospace Engineering, Cornell University and Professor of Computing and Mathematical Sciences, California Institute of Technology

- Could solar geoengineering be considered to avoid peak warming in an overshoot scenario?
- What do we know about SRM from climate model projections?
- What do we not know that we would need to; what research is needed?

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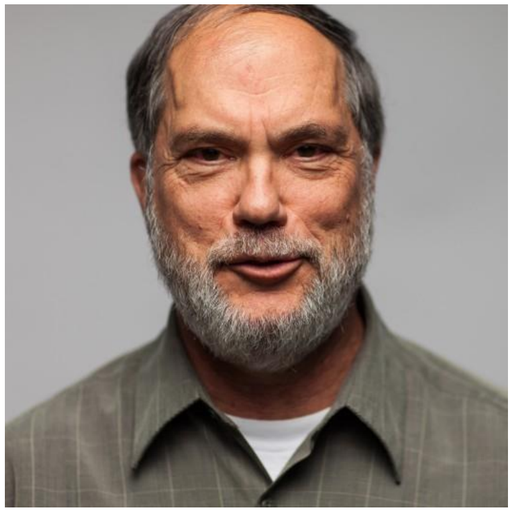

Thomas Ackerman
Director, Joint Institute for the Study of the Atmosphere and Ocean,
University of Washington

- How would we use solar climate engineering in a realistic scenario?
- Is there an optimal climate associated with climate engineering and who gets to pick that optimal climate?
- How long will it take to detect an applied solar climate engineering forcing and are we willing to wait that long?
- How long will it take us to do the research required to understand solar climate engineering?

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Pablo Suarez is Associate Director for Research and Innovation at the Red Cross Red Crescent Climate Centre

- What are the humanitarian dimensions of solar geoengineering?
- How can we improve linkages between science, policy and humanitarian practice when thinking about solar geoengineering as a possible tool?
- How might we ensure that the interests of the most vulnerable are considered and addressed when considering these technologies?

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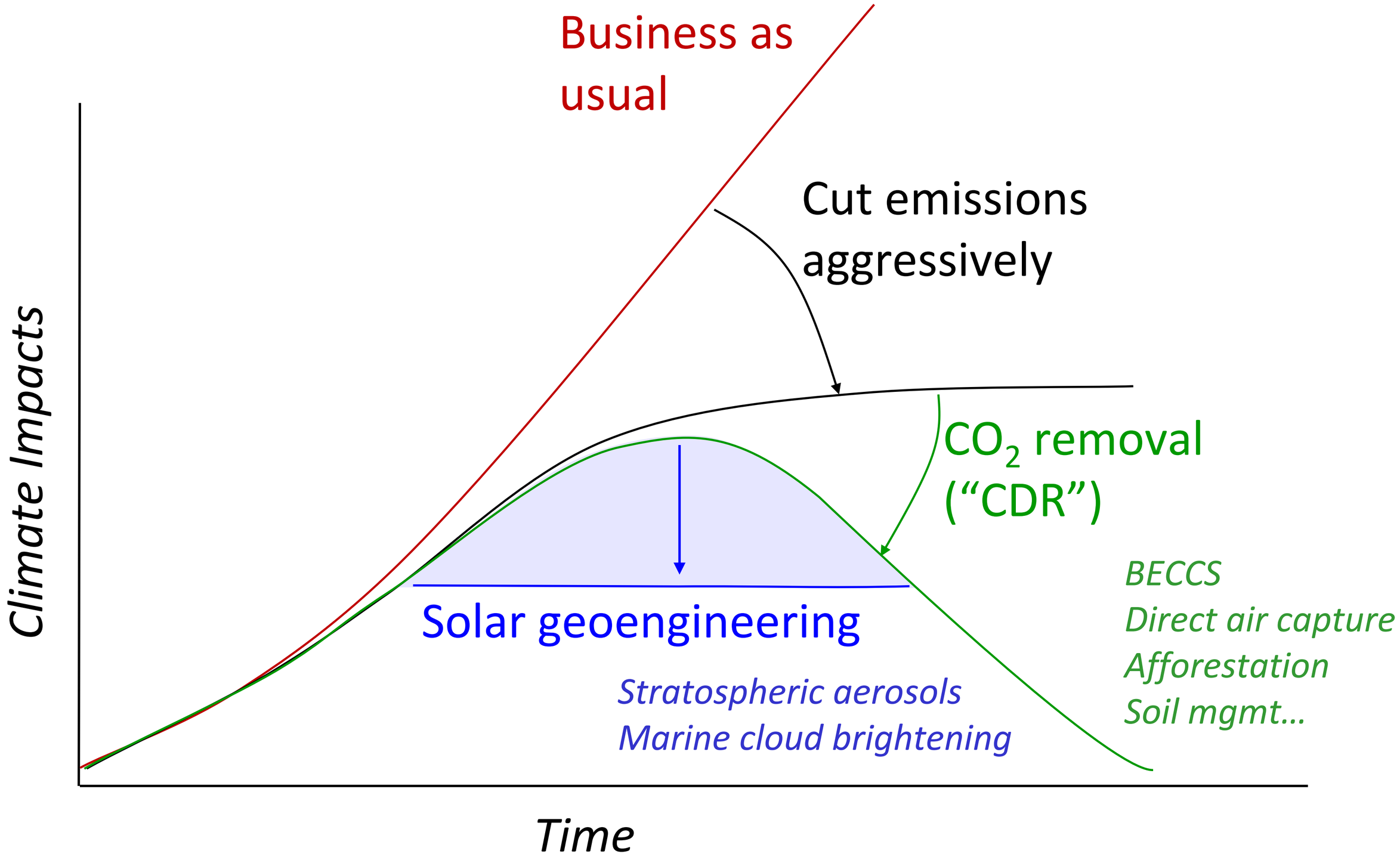
Geoengineering:
What is it?
What role might it play?
What do we know?

Douglas MacMartin

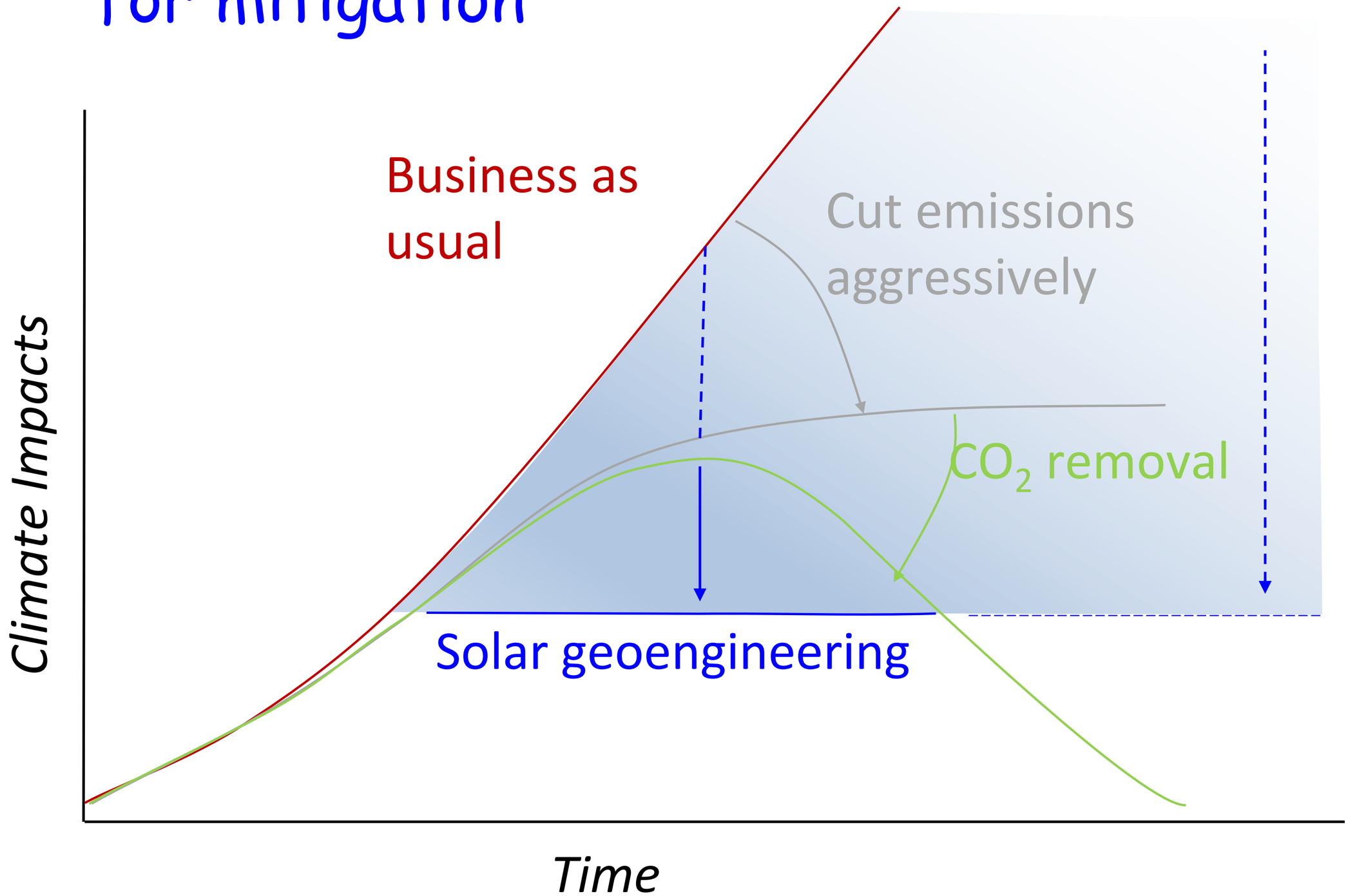
Mechanical and Aerospace Engineering, Cornell University

Computing + Mathematical Sciences, California Institute of Technology

Role for geoengineering?



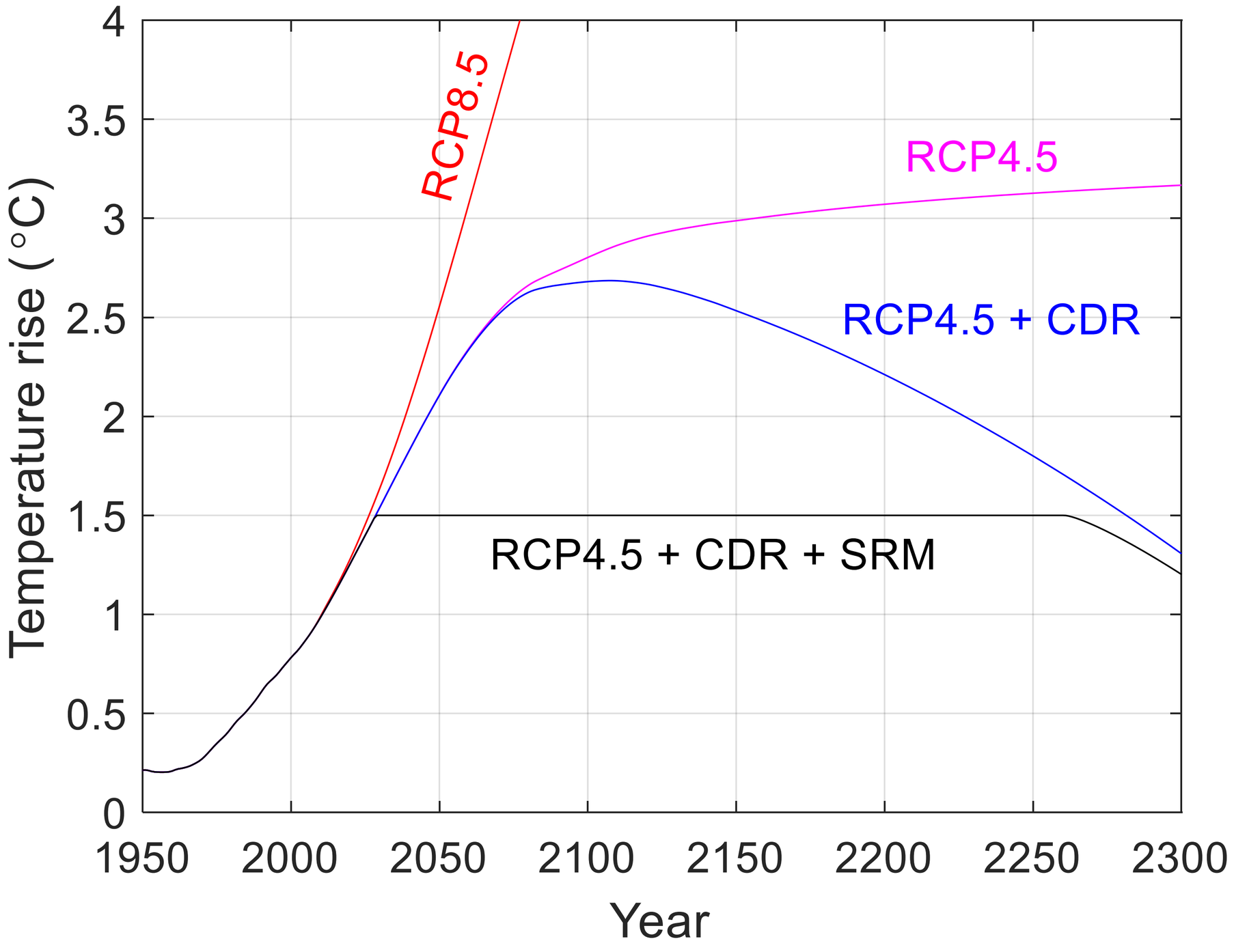
Solar geoengineering is not a substitute for mitigation



Solar geoengineering as a substitute for mitigation requires high forcing and a practically indefinite commitment.

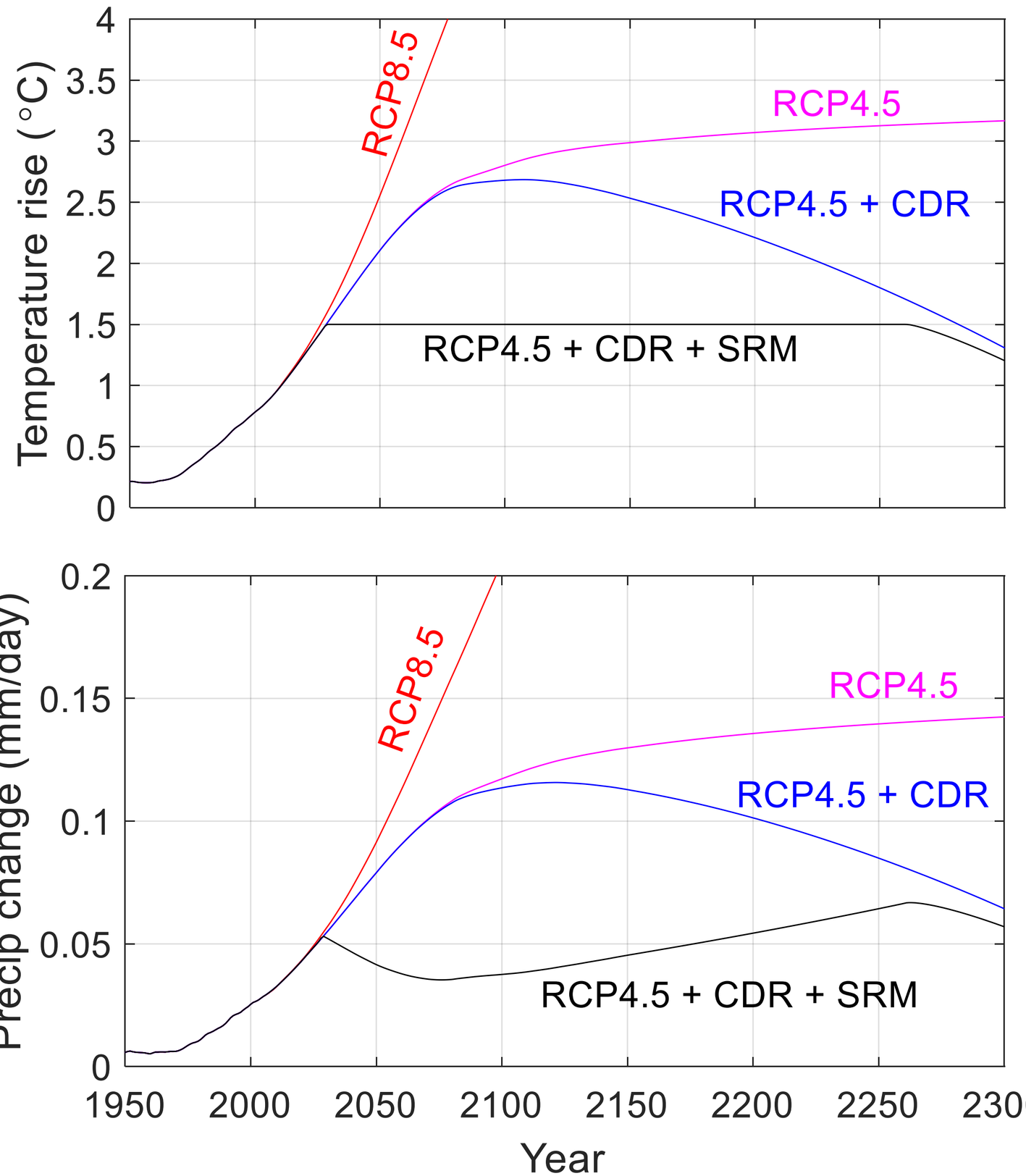
A specific scenario…

- Climate response estimated from simple model
- "CDR" level is chosen to reduce CO_2 at 1ppm per year
  - Of order 15 Gt per year
- Temperature overshoots are measured in centuries



Not all variables respond the same way

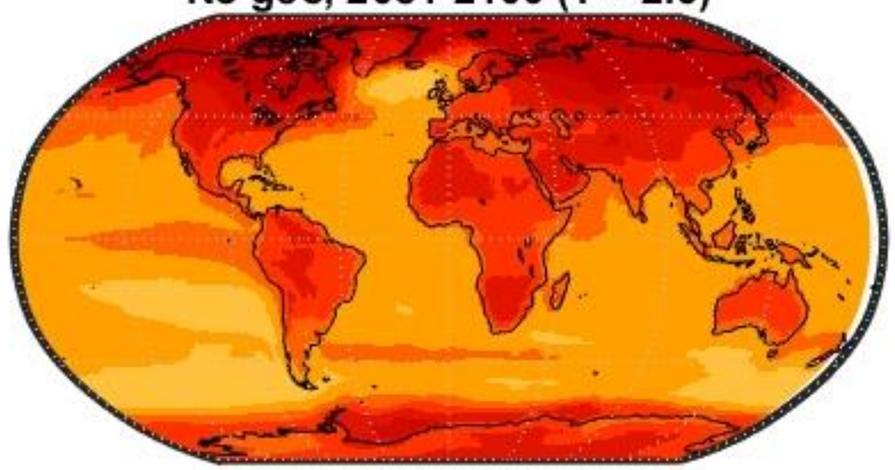
- Solar geoengineering would overcompensate global mean precipitation
- Other variables like ocean pH would hardly be affected

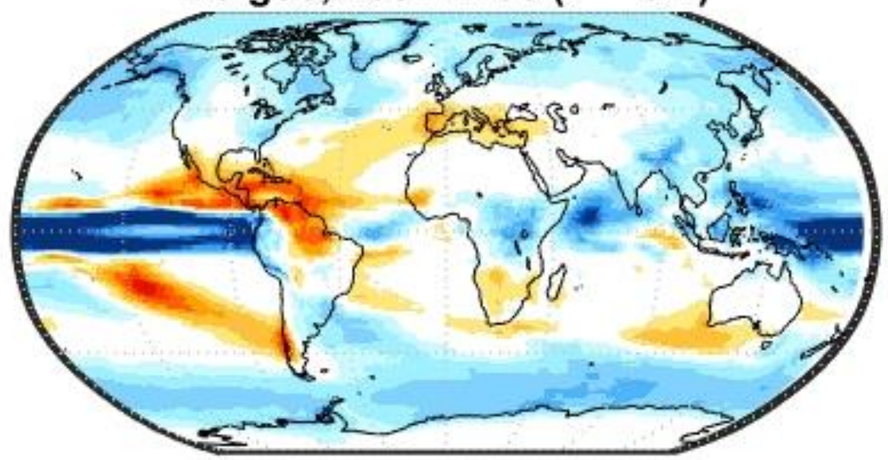


Median over 12 models:

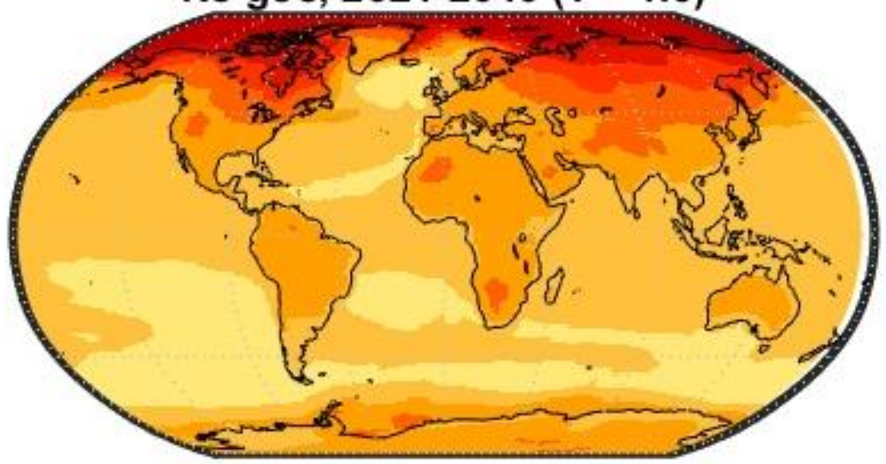
- Temperature is reduced everywhere
- Precipitation changes are reduced in most places
- Median hides model uncertainty!
- Solar reduction; not same as stratospheric aerosols

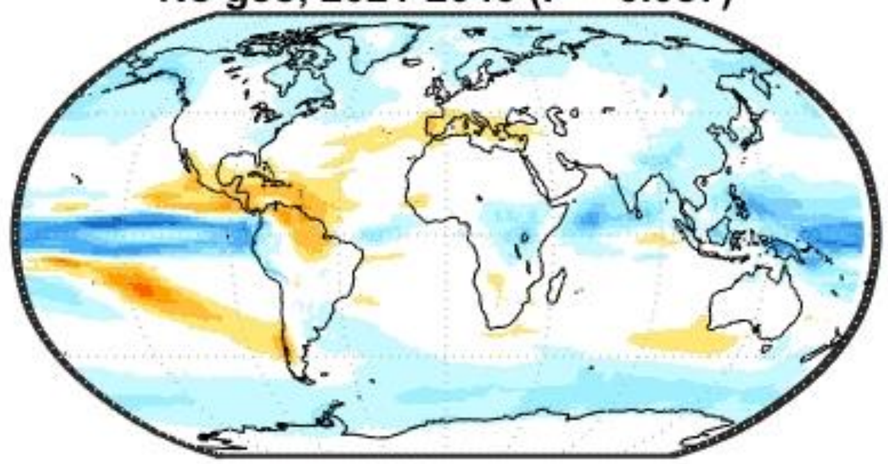
2.6°C, no geo



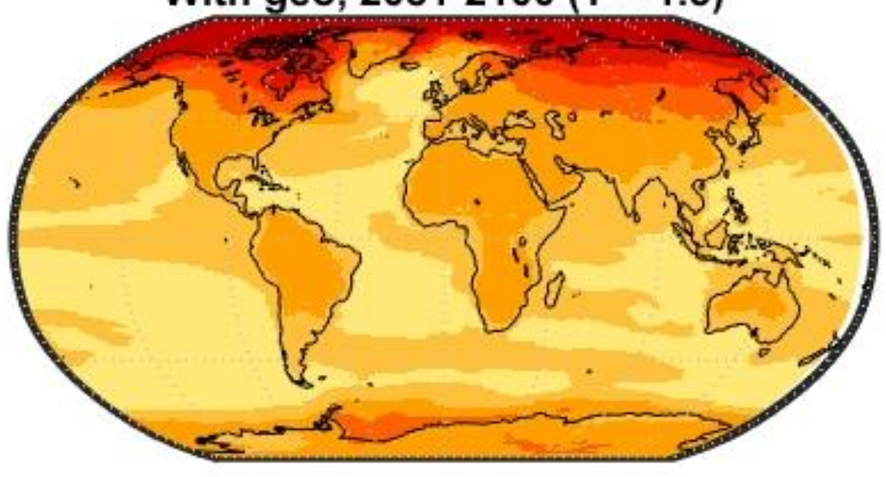


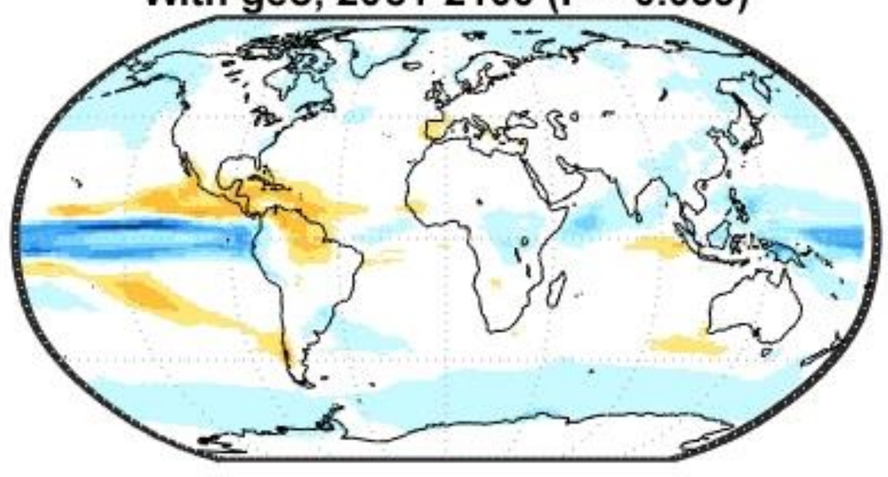
1.6°C, no geo

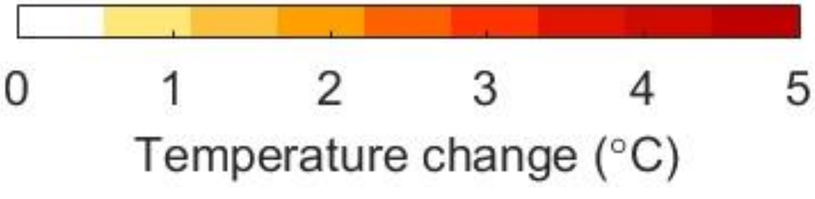




2.6°C → 1.5°C, geo







Options

CO_2-removal

- BECCS (bio-energy with carbon capture and sequestration)
- Direct air capture (DAC)
- Afforestation/reforestation
- Carbon-smart soil management
- Enhanced mineral weathering
- Ocean iron fertilization??

- Typically some combination of slow, expensive, hard to scale
- Low climate risk but could be significant other issues if deployed at scale

Solar geoengineering

- Stratospheric aerosols
  - Guaranteed to “work”, relatively straightforward to implement
- Marine cloud brightening
  - Cloud aerosol interactions
- Cirrus cloud thinning??
- Ocean albedo, land albedo,…

- Cools quickly
- Doesn’t affect the climate the same way as increased CO_2
- Novel risks, both climate and socio-political

Stratospheric Aerosol Geoengineering: What don't we know?

- What size distribution of aerosol particles are created?
- Effect on stratospheric dynamics and heating, atmospheric chemistry
- What is the effect on cirrus clouds? (A positive or negative feedback?)
- Regional precipitation response remains uncertain (ditto for CO_2)
- Effect on ecosystems? Impacts?
- The answers to all

This will take a LOT of research

- … can we design the system given uncertainty, nonlinearity, and variability?
- What are the limits to how well we can know the system?
- Societal response:
  - Would people emit more CO_2?
  - Would people blame everything on the deployment?
  - How might this be governed, how would amount be adjusted over time?

"Forcing"

"Response" & impacts

Strategic

Societal Feedbacks

Summary

Context:

- IPCC scenarios that meet 2°C target require
  - Aggressive reductions in emissions, combined with
  - Negative emissions (or CO_2 removal), typically as BECCS
- 1.5°C is much harder than 2°C
- Current INDC commitments are more likely to lead to 3°C

A strategic approach for managing climate change

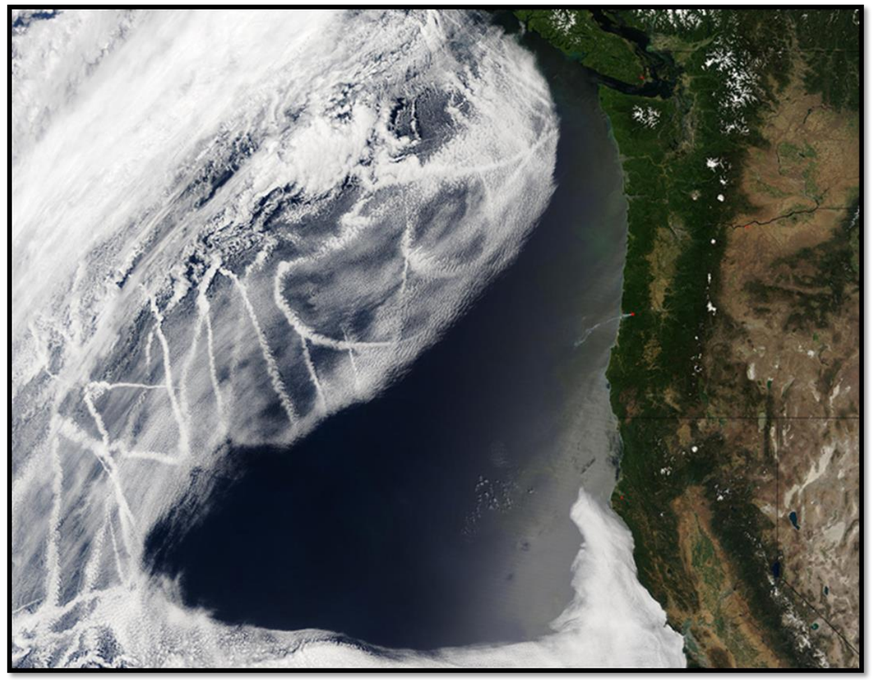
- Developing capability for CO_2 removal is essential
- It is plausible that an additional, limited deployment of solar geoengineering could reduce aggregate climate risks
  - Not enough is known today to make informed decisions
  - Raises challenging issues in ethics, governance, etc.

A Strategy for the Use of Solar Climate Engineering

Tom Ackerman
Professor, Department of Atmospheric Sciences
Director, Joint Institute for the Study of the Atmosphere and Ocean
University of Washington

Solar climate engineering

- Deliberate modification of climate system to prevent global warming
- How would we do it (current ideas)?
  - Stratospheric aerosol injection
  - Marine cloud brightening



Solar Climate Engineering: Rule #1

- If you start SCE without any program to stabilize CO_2 concentrations, you are committing to use SCE forever (or have a climate disaster)
  - No stabilization means you have to increase SCE each year to offset increase in CO_2
  - If you stop doing SCE, the climate will warm rapidly => about a decade to warm to value with no SCE
  - Ethically wrong to commit succeeding generations to a process that they cannot stop

Testing a strategy for the use of SCE: a climate model study following the outline of MacMartin

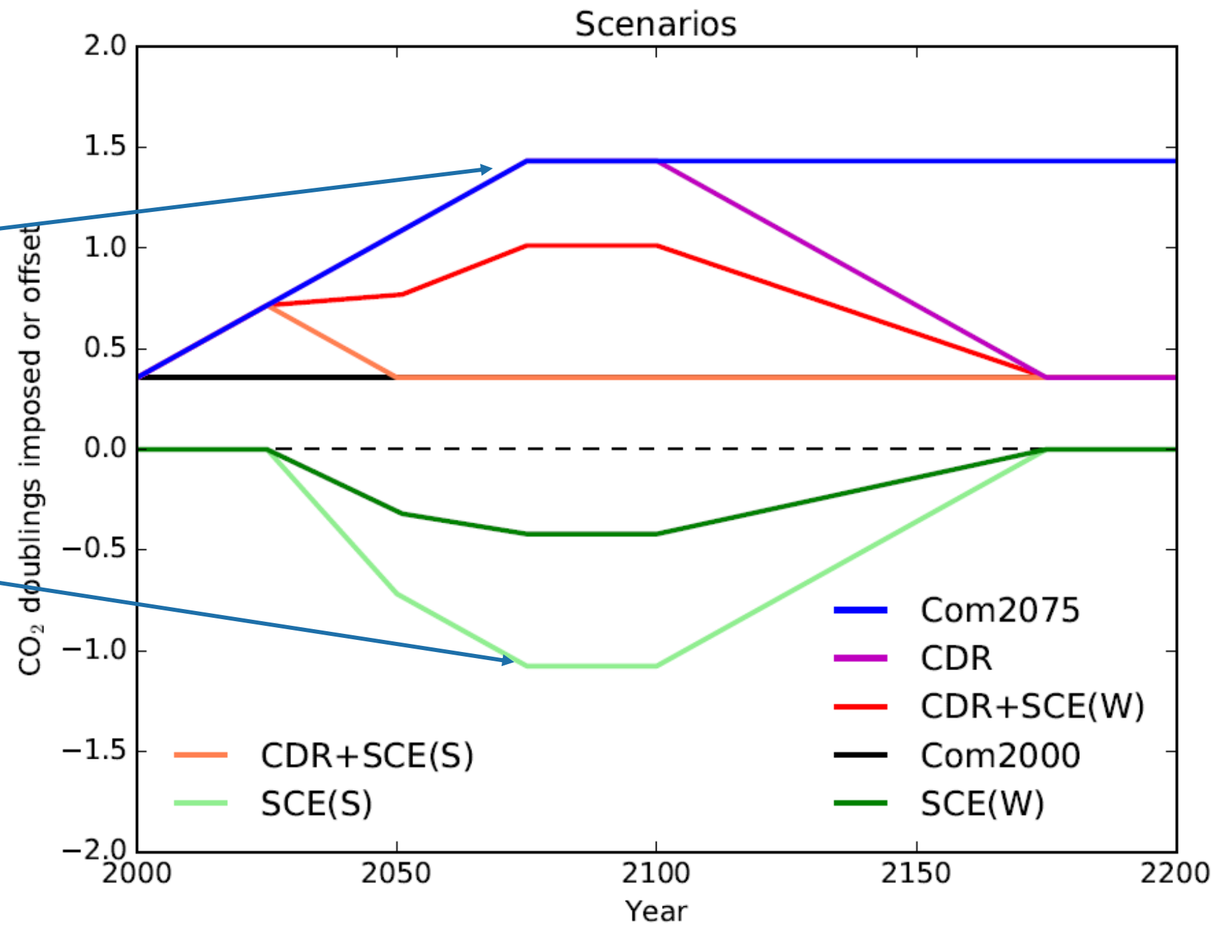
- Assume a scenario of
  - Increasing CO2 with time, then stabilizing at a high concentration
  - Increasing CO2, then stabilization, then removal
- Combine the second scenario with solar dimming (as a surrogate for solar climate engineering)
- Choose a combination of the two forcings to maintain
  - A roughly constant global forcing (and roughly constant global average temperature)
  - An intermediate temperature between no warming and large warming

Forcing scenarios

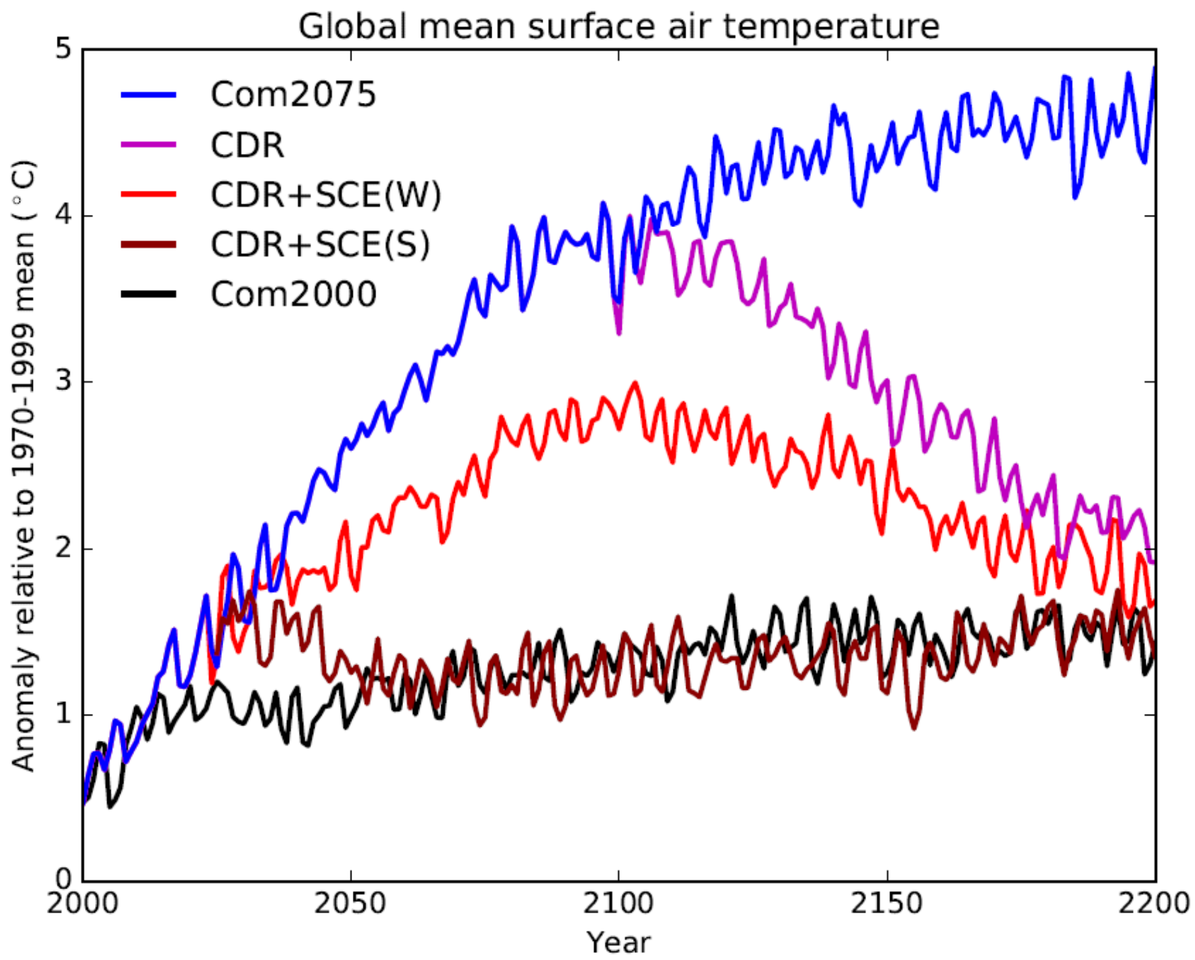
Max. CO_2 concentration = 778 ppm

Max. solar reduction = 2.5% (Strong case)

Max. solar reduction = 1.0% (Weak case)



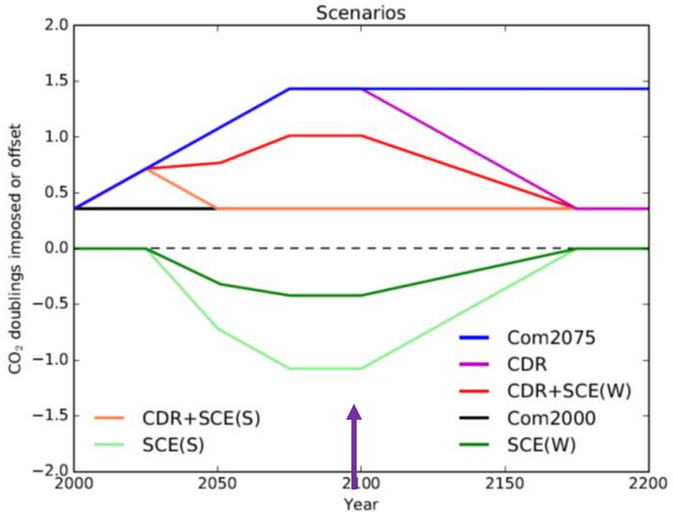
Global mean temperature

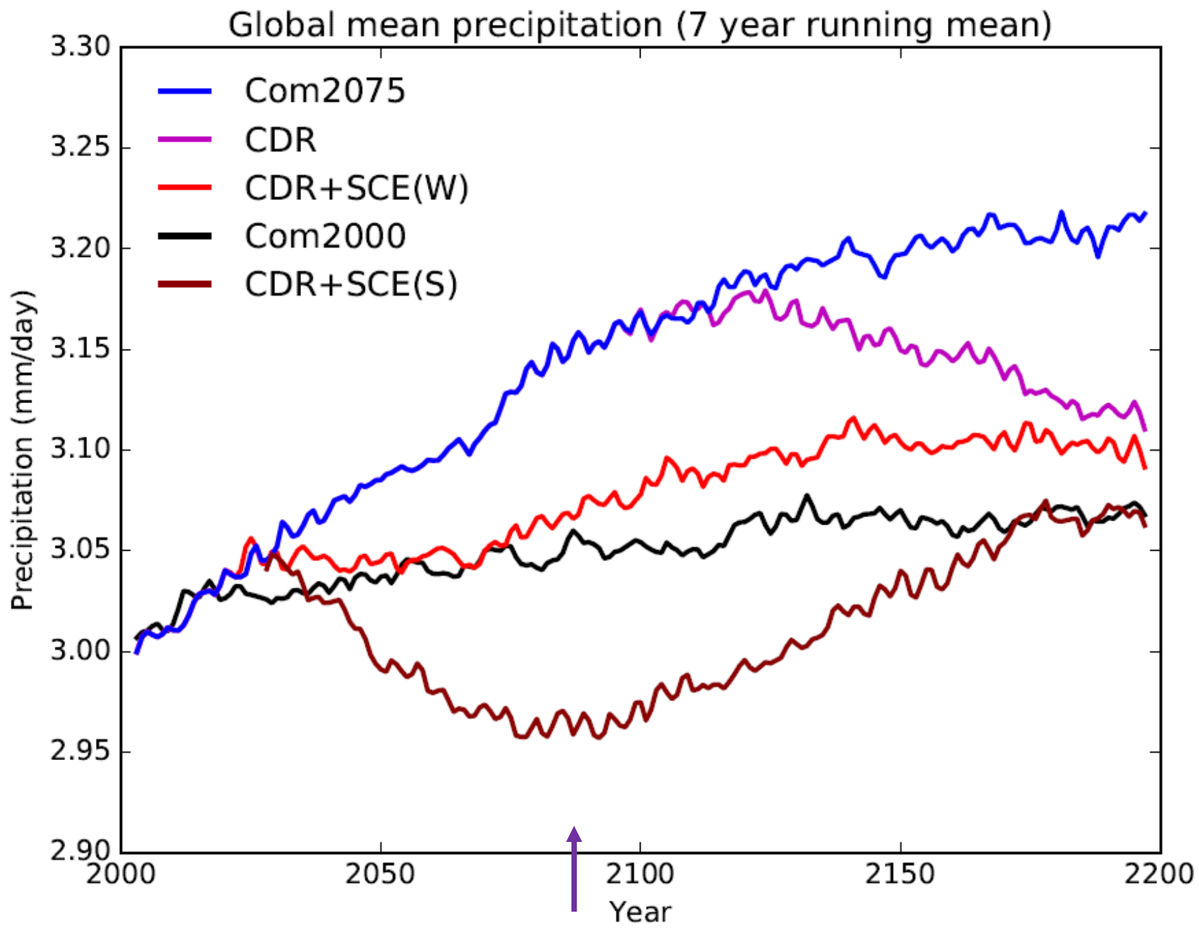


T_{sfc} as anomaly relative to 1970-99 mean

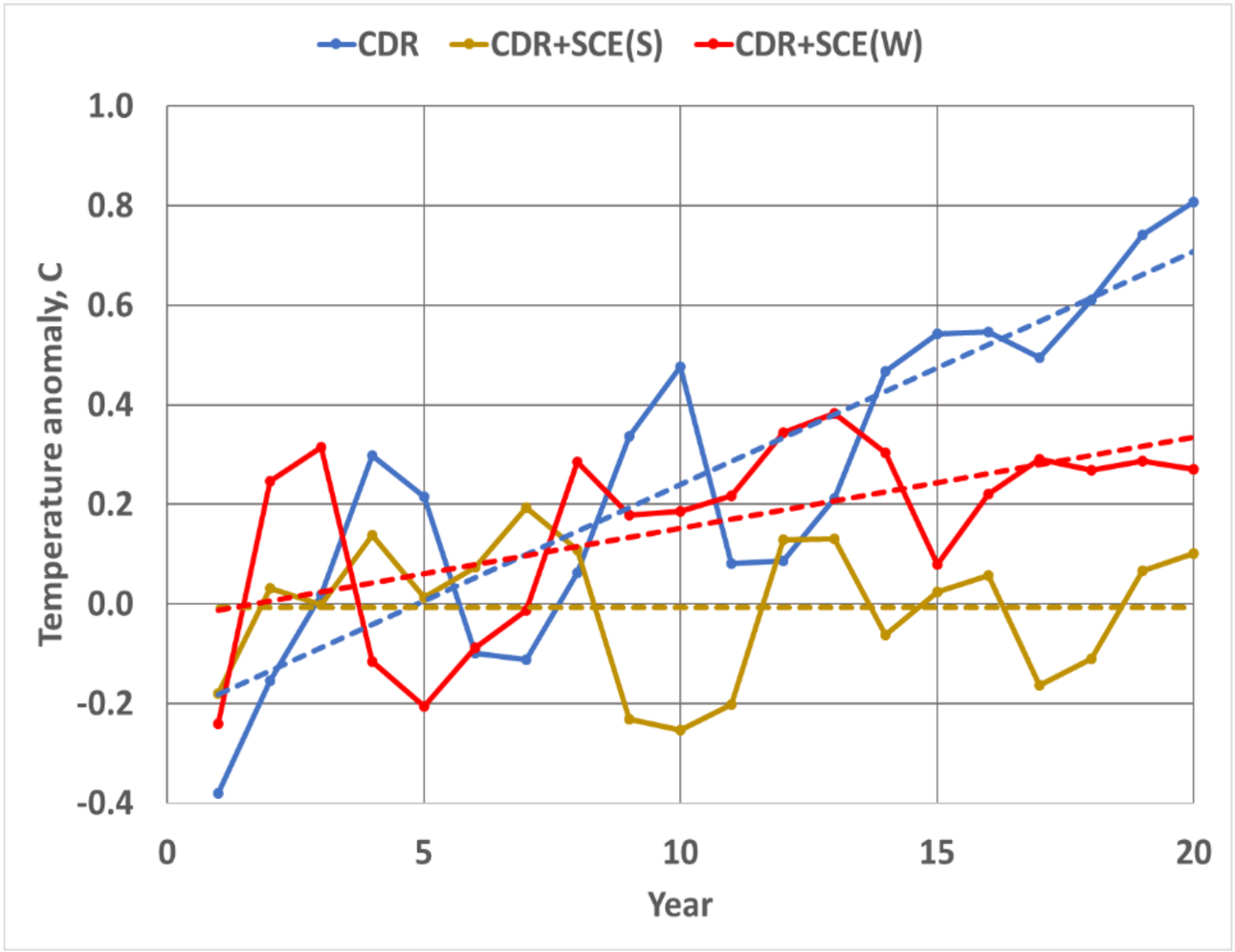
Global mean precipitation

- Precipitation increases with increased CO_2 => warmer atmosphere
- SCE slows the hydrologic cycle for simulations with the same T_{sfc}
- Reduced solar heating reduces evaporation





Detection of solar climate engineering



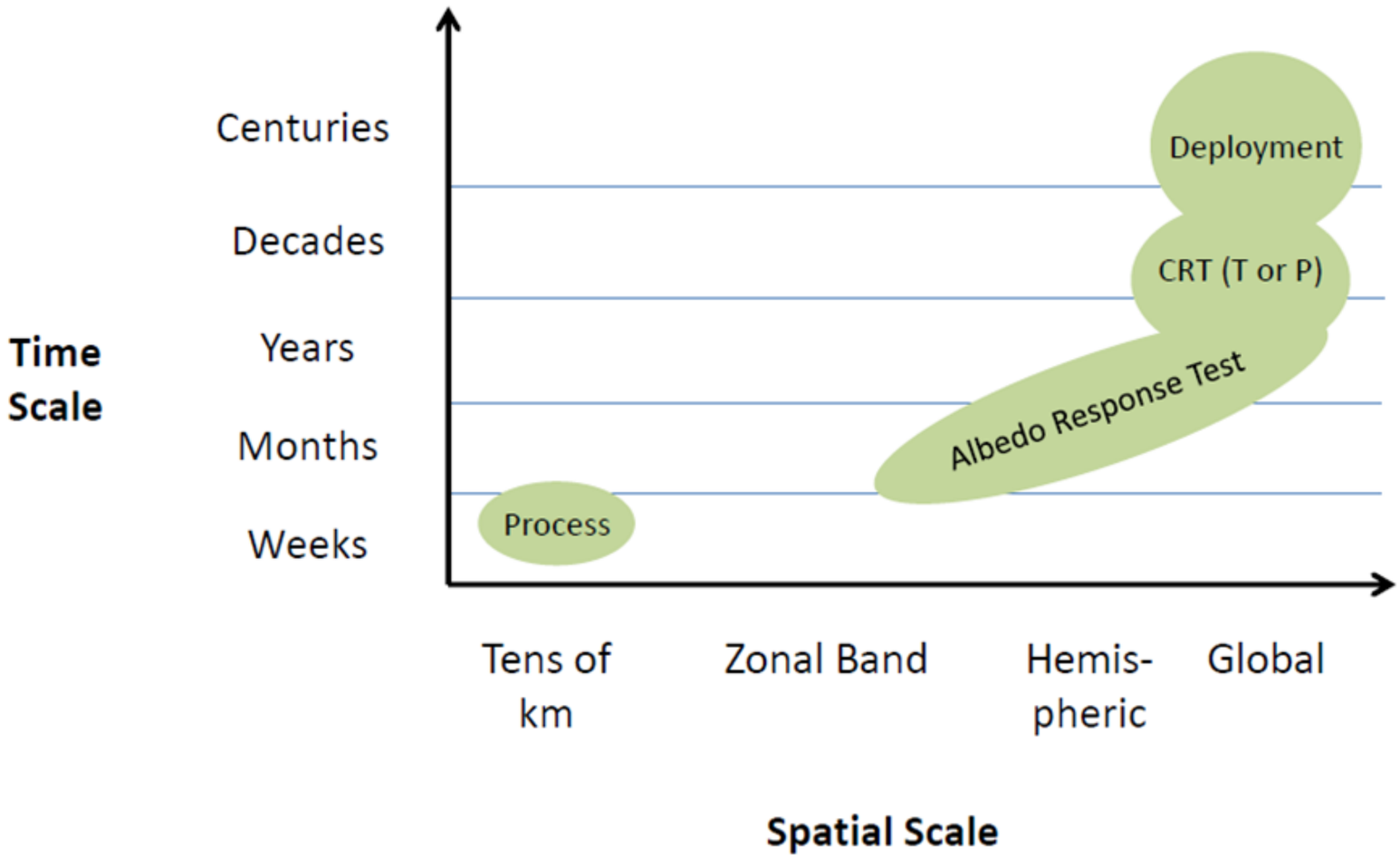
<u>Temperature anomaly time series</u>

- Model years 2025 to 2044
- Plotted relative to the average of the first five years of each series
- Dotted lines are a linear best fit to the data

How many years will it take to detect a clear signal in surface temperature?

(best case scenario – smooth forcing functions)

How do we get to deployment (if desirable)?



- Process studies – investigating MacMartin's questions *(Years 1 – 10)*
- Albedo response – can we increase solar reflectivity? *(Years 6 – 15)*
- Climate response – can we change T or P? *(Years 11 – 20)*

Responsible deployment is 20 years away <u>at best</u>

Lenferna et al., 2017: Relevant Climate Response Tests for Stratospheric Aerosol Injection: A Combined Ethical and Scientific Analysis. **Earth's Future**

Lessons learned

- SCE can be used to reduce climate warming while waiting for CO2 removal to take place => *there may be a role for SCE*
- SCE impacts *both* the hydrologic cycle and global surface temperature
  - Who gets to pick the “right” climate? What about regional variability?
- Detection of early signal is problematic
  - It will take us *at least a decade* to know if we are actually cooling climate
- We need 15 to 20 years of research to know if SCE is doable

Exciting, Terrifying Times...

by Pablo Suarez, Ph.D.

Associate director for research and innovation

RED CROSS/RED CRESCENT
CLIMATE CENTRE

International Federation
of Red Cross and Red Crescent Societies

The Netherlands Red Cross

2010: Two Geoengineering Questions from Red Cross

1. How will the most vulnerable help make geoengineering decisions?

2. Who will pay for humanitarian work in a geoengineered world?

2017: RCCC perspective

Earth's Future

RESEARCH ARTICLE
10.1002/2016EF000464

Special Section:
Crutzen +10: Reflecting upon 10 years of geoengineering research

Key Points:
- Geoengineering decisions are a humanitarian concern: the deliberate manipulation of the global climate can impact vulnerable people not included in decisions
- The Paris Agreement aspiration to keep global warming below 2°C did not aim to endorse SRM, but rather ambitious mitigation pathways
- If resources must be directed towards exploring geoengineering options, the needs and role of the most vulnerable should be given full consideration
- In the past 10 years, humanitarian players have been largely absent from discussions on geoengineering research and governance; a more proactive and anticipatory engagement is warranted

Geoengineering: A humanitarian concern

Pablo Suarez[1,2] and Maarten K. van Aalst[1,2,3,4]

[1]Red Cross Red Crescent Climate Centre, The Hague, The Netherlands, [2]Frederic S. Pardee Center for the Study of the Longer-Range Future, Boston University, Boston, Massachusetts, USA, [3]Department of Science, Technology, Engineering and Public Policy, University College London, London, UK, [4]International Research Institute for Climate and Society, Columbia University, New York, New York, USA

Abstract The humanitarian sector is active at the global frontline of climate impacts, and has a track record in influencing the climate change policy agenda. Geoengineering is a humanitarian concern: the potential for deliberate large-scale intervention in the Earth's climate system has major implications in terms of impacts on the most vulnerable. Yet, so far the humanitarian community has largely been absent from geoengineering deliberations. Geoengineering may be perceived as too theoretical, too complex, and not imminent enough to merit attention. However, early engagement by the sector is imperative to ensure that humanitarian considerations are integrated into policy decisions. Those who can suffer the worst outcomes need to be involved; especially given the plausibility of "predatory geoengineering" where recklessly self-concerned actions may result in harmful consequences to others. This paper explores the humanitarian dimensions of geoengineering, specifically relating to solar radiation management (SRM). Drawing from the engagement of the Red Cross Red Crescent Climate Centre in SRM discussions, we discuss how to improve linkages between science, policy and humanitarian practice. We further propose the creation of a geoengineering risk management framework to ensure that the interests of the most vulnerable are considered and addressed - including the voices of all stakeholders.

1. Introduction

Less than two decades ago, science began loudly warning about the potential for climate change to trans-

AGU PUBLICATIONS

“The potential for [geoengineering] has major implications in terms of impacts on the most vulnerable”

Red Cross Red Crescent Climate Centre, The Hague, The Netherlands, [2]Frederick S. Pardee Center for the Study of the Longer-Range Future, Boston University, Boston, Massachusetts, USA, [3]Department of Science, Technology,

“No one likes to be a rat in someone else’s laboratory”

Special Section:
Crutzen +10: Reflecting upon 10 y
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Key P

- Geoengineering decisions are a humanitarian concern: the deliberate manipulation of the global climate can i
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“Potentially delusional assumptions of rationality”

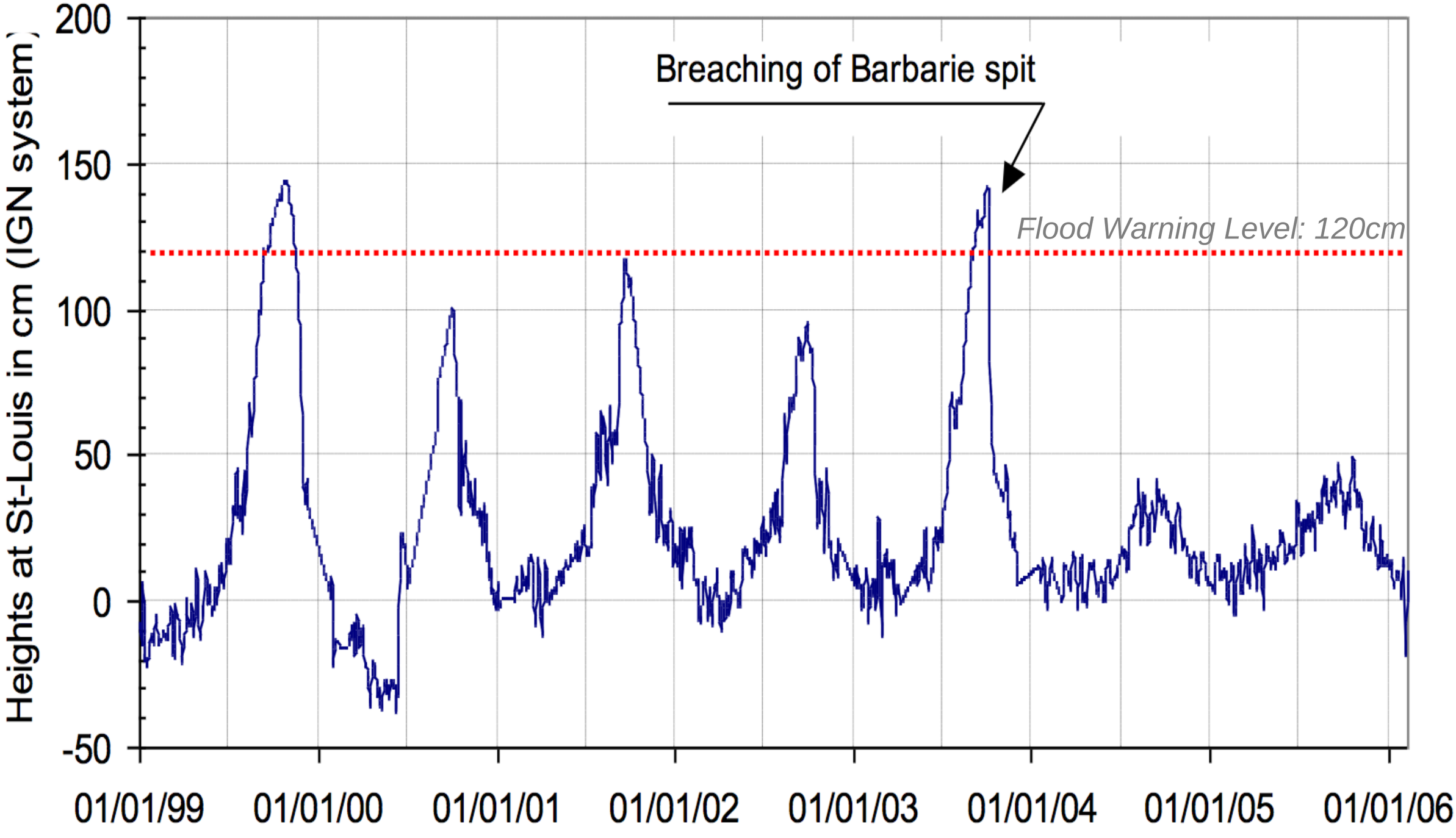
pose the creation of a geoengineering risk management framework to ensure that the interests of the

“Predatory Geoengineering”

Less than two decades ago, science began loudly warning about the potential for climate change to trans-


2003
2004
2009
Doun Baba Dièye
0
1 km
2 km

Change in flood patterns since the intervention




2003

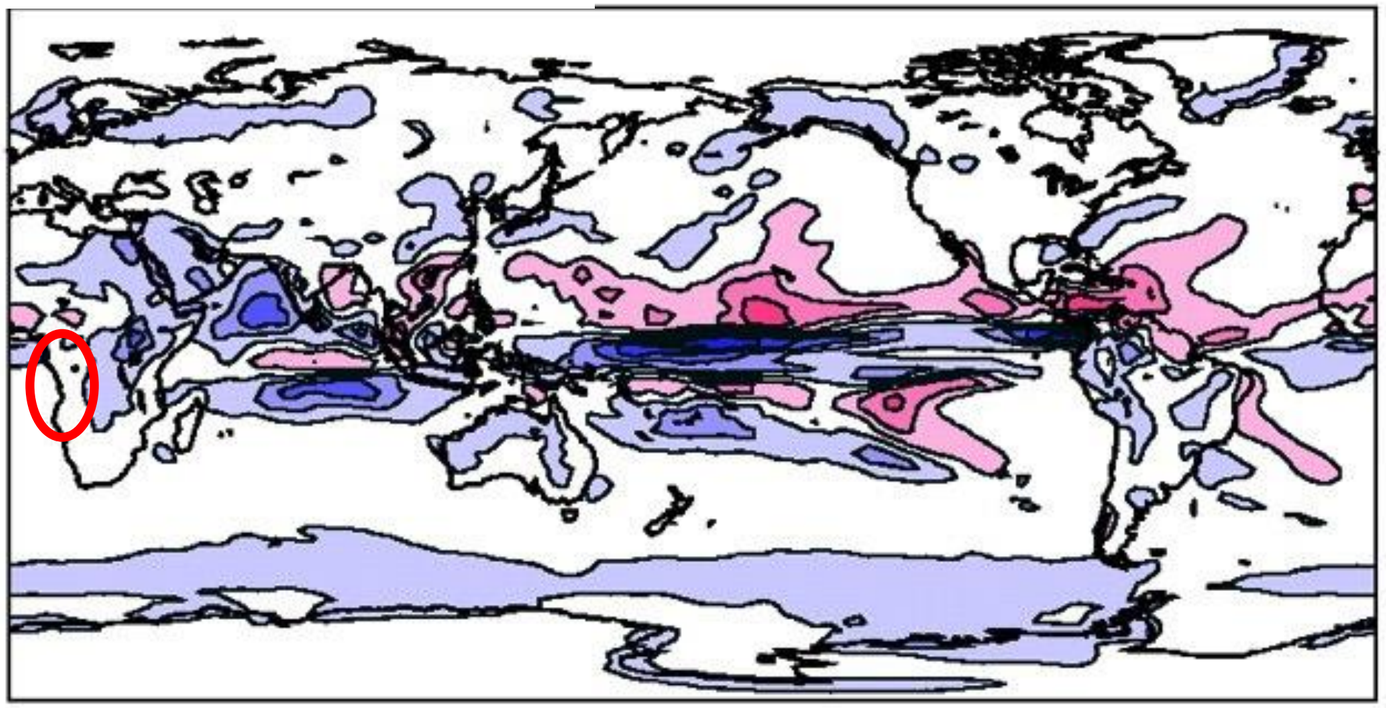

2009


2013

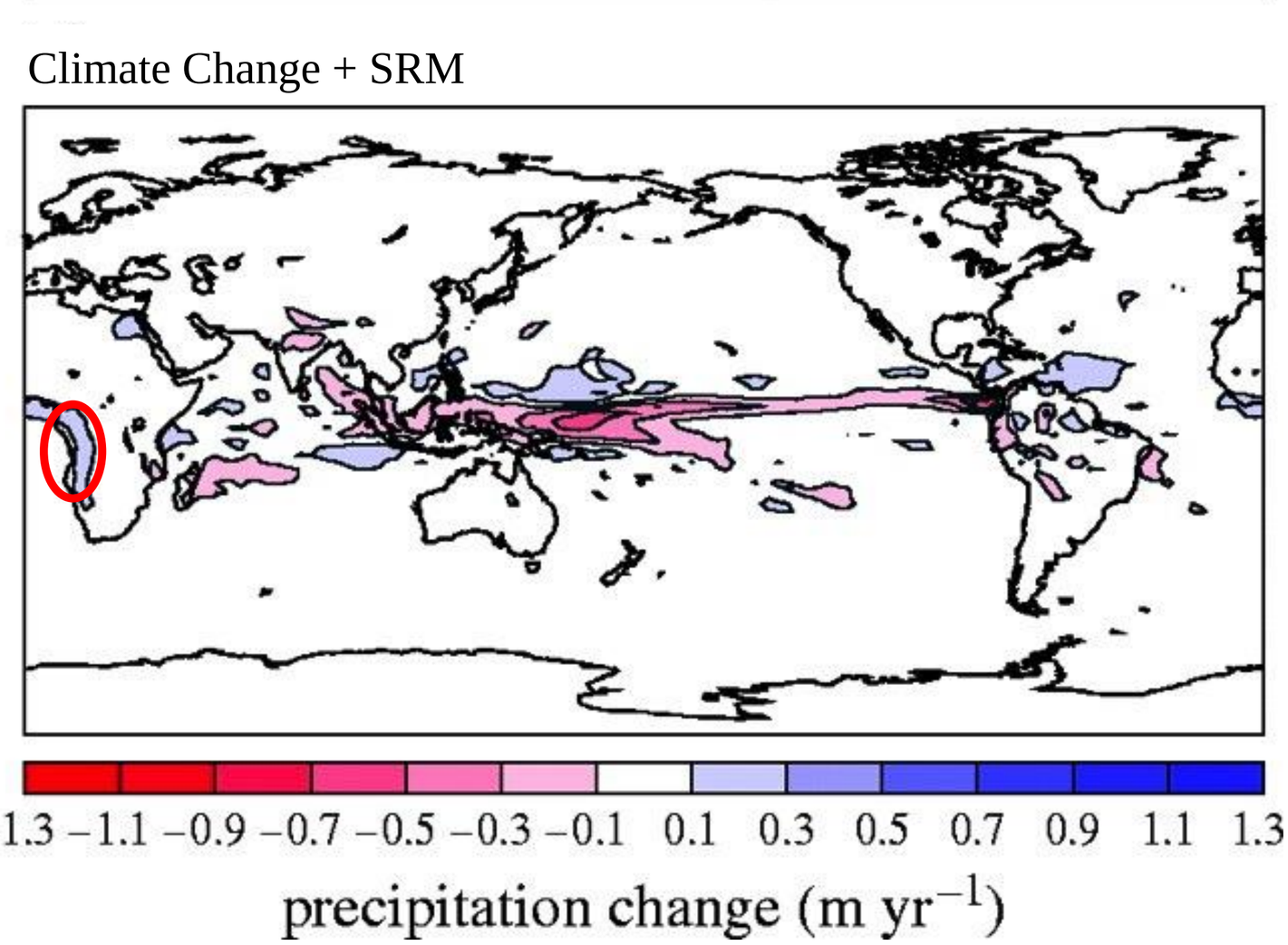

2016

Arriving Doun Baba Dièye, 2009

Climate Change, No SRM



Climate Change + SRM



(Caldeira & Wood 2008)

Climate
Futures Series

17th February
13:30-14:30
(Geneva time)

Join using the link below

The Rise of Geoengineering & **its potential impacts for the Humanitarian Sector**

The potential for deliberate large-scale intervention in the Earth's climate system has major implications in terms of impacts on the most vulnerable. Early engagement by the humanitarian community is imperative to ensure that humanitarian considerations are integrated into policy decisions. Those who can suffer the worst outcomes need to be involved; especially given the plausibility of "predatory geoengineering" where recklessly self-concerned actions may result in harmful consequences to others.

Our Speakers

Who will explore what Geoengineering is and will discuss how to improve linkages between science, policy and humanitarian practice.

He has advised humanitarian and development organizations in more than 50 countries.

He researches and teaches at University of Lugano, University College London, and Boston University.

Pablo Suarez
Leading research and innovation with the Red Cross Red Crescent Climate Centre

He has worked near the interface between climate science, energy technology, and public policy for twenty-five years.

First prize in Canada's national physics prize exam, MIT's prize for excellence in experimental physics and one of TIME magazine's Heroes of the Environment.

Dr. David Keith
Professor of Applied Physics in Harvard's School of Engineering

Using the future to change the present.

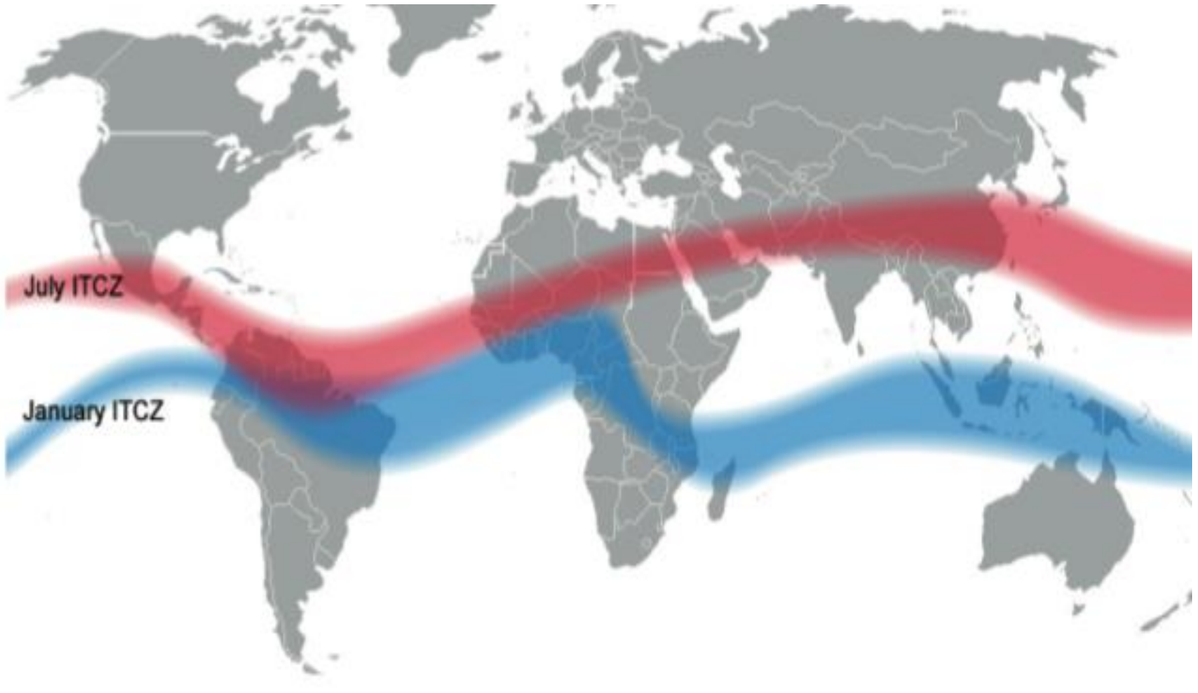
An initiative of
International Federation of Red Cross and Red Crescent Societies

solferino academy

More Geoengineering Questions

“Landscapes” vs. “Cloudscapes” ?

Whose Hand on the Thermostat ?



What if unilateral deployment becomes imminently likely ?

What role for IFRC & humanitarians ?

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Empirical social science research on solar geoengineering – A brief review

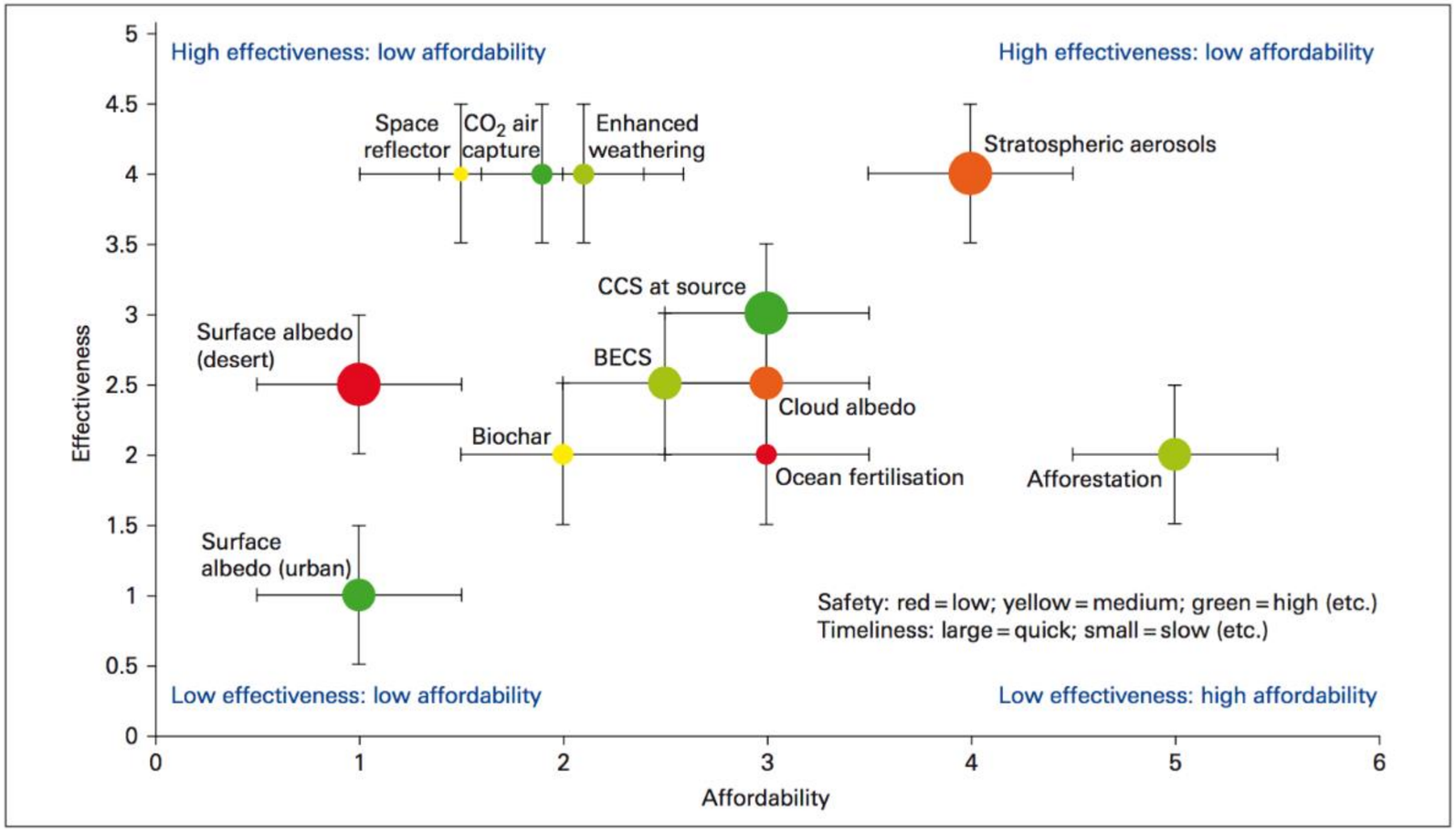
- Overview
- Research questions
- Methods (and methodological challenges)
- Key findings
- Future needs

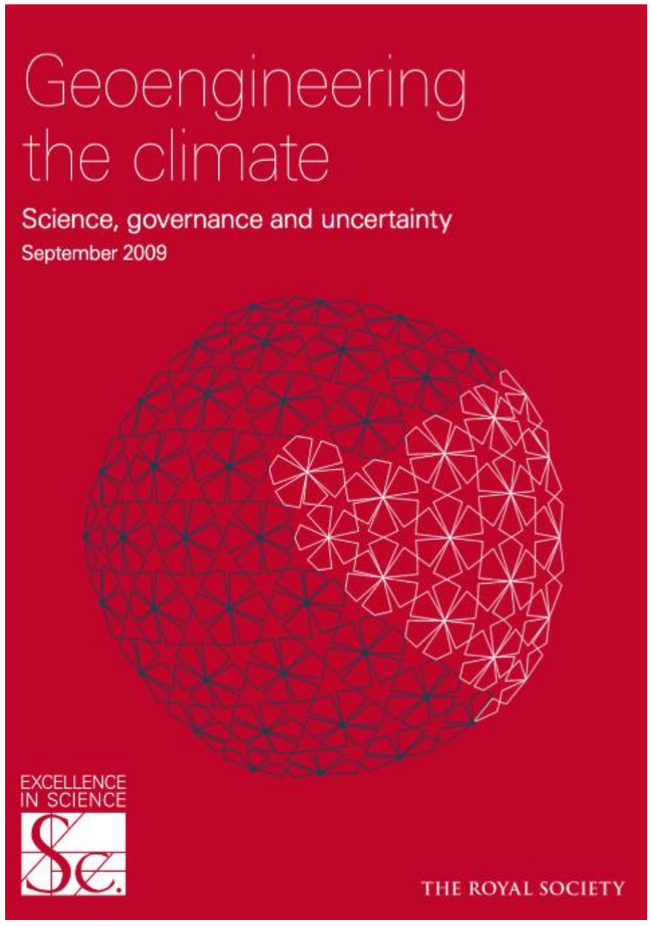
~30 empirical studies (2009 – present)

- About half large-n studies
  - Surveys, experimental studies
  - Germany, US, Canada, UK, New Zealand…
    - Recently, 6-country comparison by Visschers et al (2017), including China

- About half deliberative, small-n studies
  - Focus groups, public engagement workshops
  - UK, Sweden, Japan

Figure 5.1. Preliminary overall evaluation of the geoengineering techniques considered in Chapters 2 and 3





Legacy of the 2009 Royal Society report:

Various and comparable options

the size of the symbols reflects their precision (but note that the error bars are not really as large as they should be, just to avoid confusing the diagram). This diagram is tentative and approximate and should be treated as no more than a preliminary and somewhat illustrative attempt at visualising the results of the sort of multi-criterion evaluation that is needed. It may serve as a prototype for future analyses when more and better information becomes available. However, even this preliminary visual presentation may already be useful, simply because an ideal method would appear as a large green symbol in the top right-hand quadrant of the figure, and no such symbol exists. The nearest approximation is for stratospheric aerosols, which is coloured amber, because of uncertainties over its side-effects, as discussed in Section 3.3.3.

Examples of research questions: large-n surveys and experimental studies

- How widespread is public knowledge of solar geoengineering?
- How does the public perceive solar geoengineering? (Mercer et al, 2011)
- What factors drive public perceptions of solar geoengineering? (Merk et al, 2015)
- How do personal characteristics influence perception of the measures, and can they explain differences in acceptance between uninformed and knowledgable respondents? (Braun et al, 2017)
- How convincing is the moral hazard argument? Does it interfere with willingness to mitigate?(Merk et al, 2016)
- Does considering geoengineering galvanize support for existing climate policies rather than reduce it? (Corner and Pidgeon, 2014)
- Does hearing about SRM affects people's support for higher energy taxes, or their trust in climate science? (Fairbrother, 2016)
- Do framings of geoengineering as "natural" affect support for it? (Corner and Pidgeon, 2015)

	Measuring Public Opinion	Soliciting Public Opinion	Public Deliberation
rationale	making sense of what risks are socially acceptable	transparency, public oversight, information sharing, science communication	normative (right thing to do in a democracy) substantive (improves science) instrumental (makes effort more likely to succeed)
examples of methods	large-n surveys experimental studies	focus groups public hearings	deliberative workshops collaborative forums citizen juries

Wil Burns & Jane Flegal (2015), Climate Geoengineering and the Role of Public Deliberation: A Comment on the US NAS Recommendations on Public Participation, Climate Law

W Carr, CJ Preston, L Yung, B Szerszynski, D Keith, A Mercer (2013) Public engagement on solar radiation management and why it needs to happen now, Climatic Change

D Fiorino (1990), Citizen participation and environmental risk: a survey of institutional mechanisms, Science, Technology and Human Values

Gene Rowe & Lynn J. Frewer (2005), A Typology of Public Engagement Mechanisms, Science, Technology and Human Values

Methodological challenges

- Unfamiliarity
- Expert framing
- Constructed publics

Findings

- Remarkably similar concerns cited across developed world – especially about controllability; nuanced views with high ambiguity. Controllability concerns are about both ecological and social controllability.

- Conditions of support include scientific robustness, ability to anticipate side-effects, research efficacy, effective governance, and democracy (Macnaghten and Szerszynski, 2013)*

- Differing findings on whether how much information people have on SRM affects their acceptance of it —Mercer et al. (2011) found that it has no substantial effect; other studies indicate that more information reduces acceptance information lowers acceptance for SRM (Macnaghten & Szerszynski, 2013; Sütterlin and Siegrist, 2016)*

- Kahan et al (2015) found that subjects given information about geoengineering took climate change more seriously*

- Perception of the seriousness of climate change increases acceptance of SRM (Mercer et al., 2011; Merk et al., 2015; Pidgeon et al., 2012)*

- Visschers et al (2017) indicated that “people from countries that are less prepared to mitigate and adapt to climate change seem to be more supportive of SRM”*

- See also Burns et al (2016), “**What do people think when they think about solar geoengineering? A review of empirical social science literature, and prospects for future research.”**

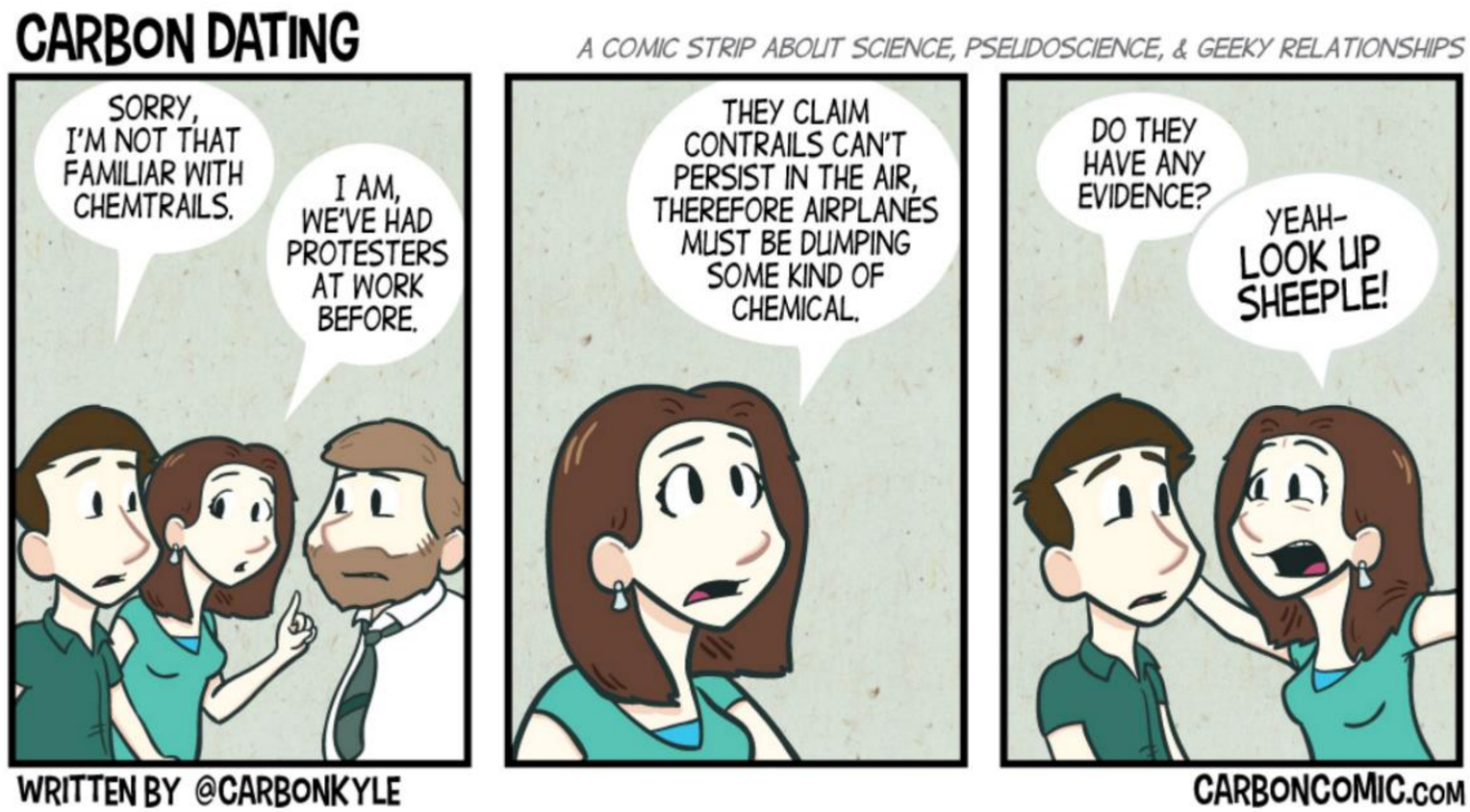
How useful is the existing work?

- Most of these questions would deserve more studies to answer them conclusively
- Many compare SRM to other CE technologies
- Only capture a point in time – not how attitudes change over time
- No deliberative studies in the US, where climate skepticism plays a larger role
- Fast-moving context – question of data's shelf-life
- Very limited cultural context

The general public ≠ the vocal public

In this media ecology, what the majority thinks or “accepts” is not the only relevant thing to study

Chemtrails: evolution into anti-solar geoengineering movement



Why don’t we know more?

- Social science research can be expensive.
- It’s tough to build international collaborations on social science on geoengineering, because people are focusing limited resources on present pressing challenges.
- Many social scientists would rather focus on mitigation or adaptation.
- There are more insights from non-peer reviewed work, i.e. SRMGI discussions

Future research needs: international, mixed-method, and comprehensive

- How citizens seek, find, and interpret information about climate engineering

- Worldwide understandings about climate engineering, in order to incorporate people's visions, preferences, concerns, or goals into the research process — particularly beyond the global north, with research designed by social scientists in the global south

ETHICS

OF SOLAR GEOENGINEERING

IN TEN MINUTES

DAVID MORROW

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A PLEA FOR CONTEXT

Ethical concerns about solar geoengineering should be seen in the context of future climate change, not in relation to the present climate.

ETHICS OF DEPLOYMENT

1. Justice
2. Precaution
3. Nature

JUSTICE

- **Distributive Justice.** Solar geoengineering creates risks and potential benefits. Deployment could distribute those more or less fairly.
- **Procedural Justice.** Institutions for governing solar geoengineering should allow for fair decision-making processes.
- **Intergenerational Justice.** Solar geoengineering could either help or hinder us in fulfilling our responsibilities to future generations.

PRECAUTION

- The Precautionary Principle admits of many interpretations, yielding contradictory advice about solar geoengineering.
- The Precautionary Principle generally counsels against taking grave risks, such as deploying solar geoengineering.
- But precaution also requires minimizing global warming, and solar geoengineering could help with that.

NATURE

- Version 1: By deploying solar geoengineering, humans would be intensifying their interference with Nature when they should be reducing it.
- Version 2: By deploying solar geoengineering, humanity transgresses some boundary and violates its proper relationship with Nature.
- Version 3: By deploying solar geoengineering, humanity invites disaster by trying to control things that are beyond its powers.

Research raises many of the same ethical issues as deployment, plus concerns about research with human subjects.

This is why governance of research is closely related to governance of deployment.

Time for geoengineering governance?

Dr Arunabha Ghosh
CEO
Council on Energy, Environment and Water

FCEA-C2G2 Webinar Briefing on Solar Geongineering
16 May 2017

CEEW: among the world's 20 best climate think-tanks

Energy Access

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Greenhouse Gases and
Monitoring, Reporting, Verification

Risks and Adaptation

Technology, Trade & Finance

CEEW research on climate engineering governance

Council on Energy, Environment and Water

21 June 2011 | Lima, Peru

CEEW Lecture

International Cooperation and the Governance of Geoengineering

Keynote Lecture to the Expert Meeting on Geoengineering, Intergovernmental Panel on Climate Change

ARUNABHA GHOSH

Geoengineering Our Climate?

Ethics, Politics and Governance

Working Paper
25 February, 2014
www.geoengineeringourclimate.com

Council on Energy, Environment and Water

Collaborators: Royal Society, UK; Environmental Defense Fund (EDF); Academy of Sciences of the Developing World (TWAS)

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March 2011 | Chicheley, United Kingdom

CEEW Working Paper 2011/1

Does Geoengineering Need a Global Response – and of What Kind?

Working Paper of The Solar Radiation Management Governance Initiative

JASON BLACKSTOCK AND ARUNABHA GHOSH


Business Standard

HOTSTAR SCORES BIG THIS IPL INNINGS

JACK MA SEES DECADES OF PAIN AS INTERNET UPENDS OLD ECONOMY

Time for geoengineering governance?

INFLEXION POINTS

ARUNABHA GHOSH

Environmental Institutions, International Research Programmes, and Lessons for Geoengineering Research

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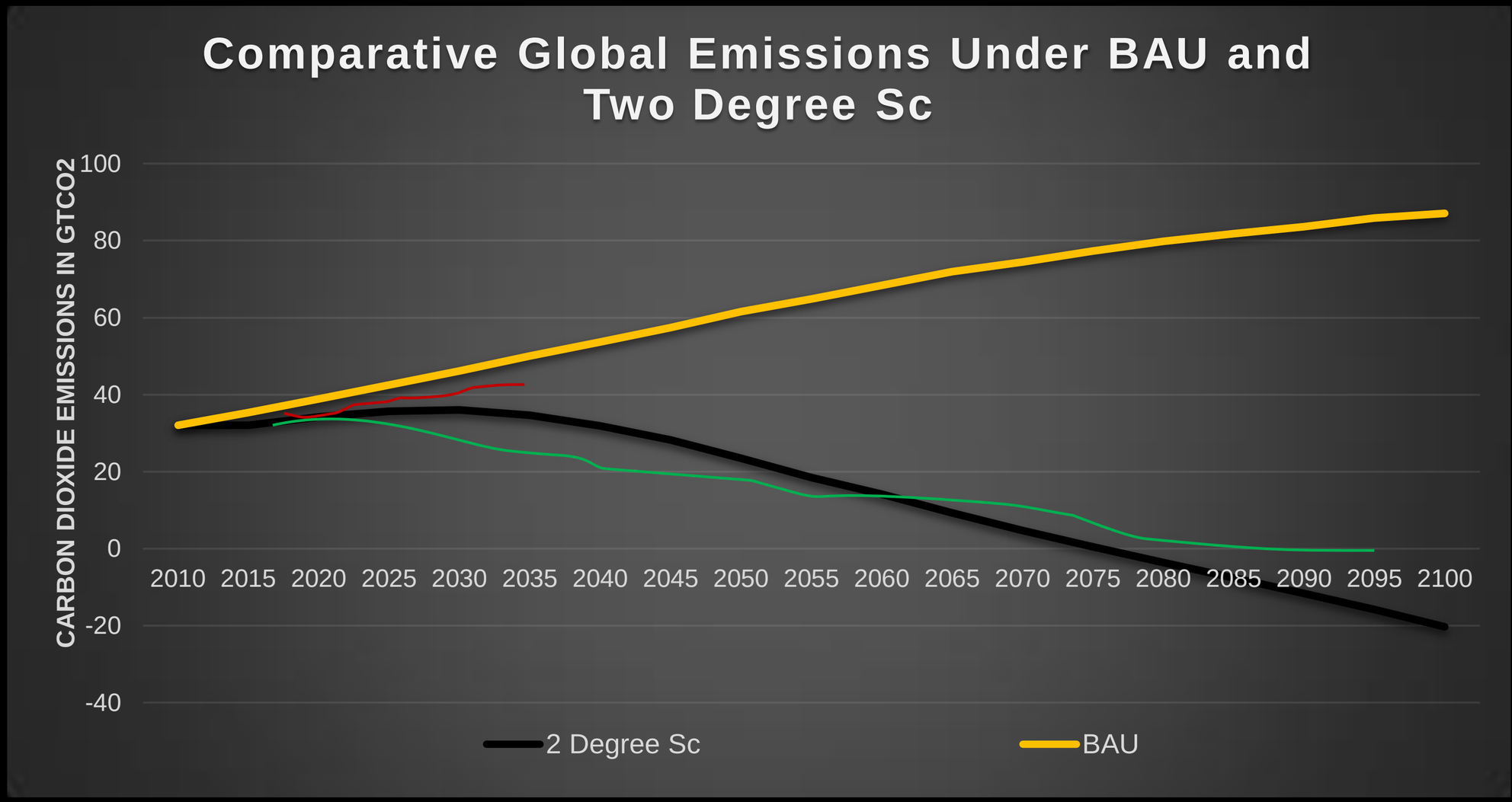
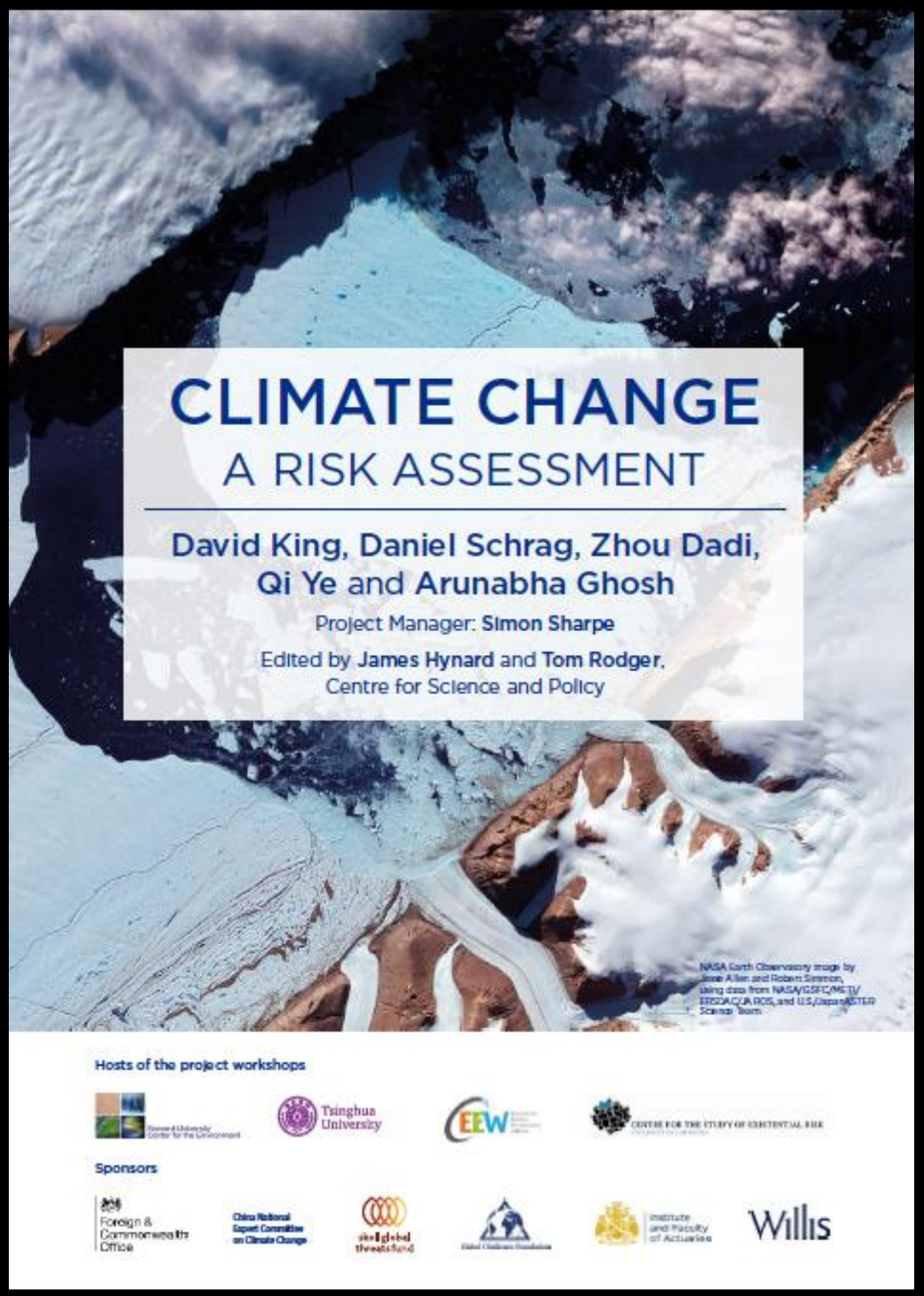
earthscan from Routledge | IASS | Institute for Science, Innovation and Society, University of Oxford | climate | CEEW

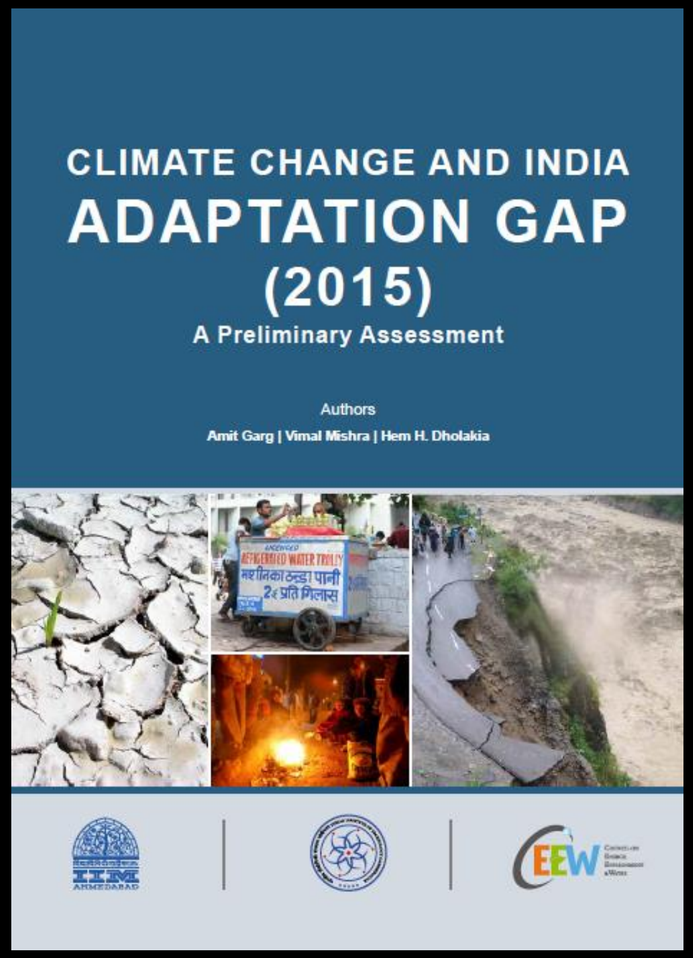
Have incentives for CGE increased?

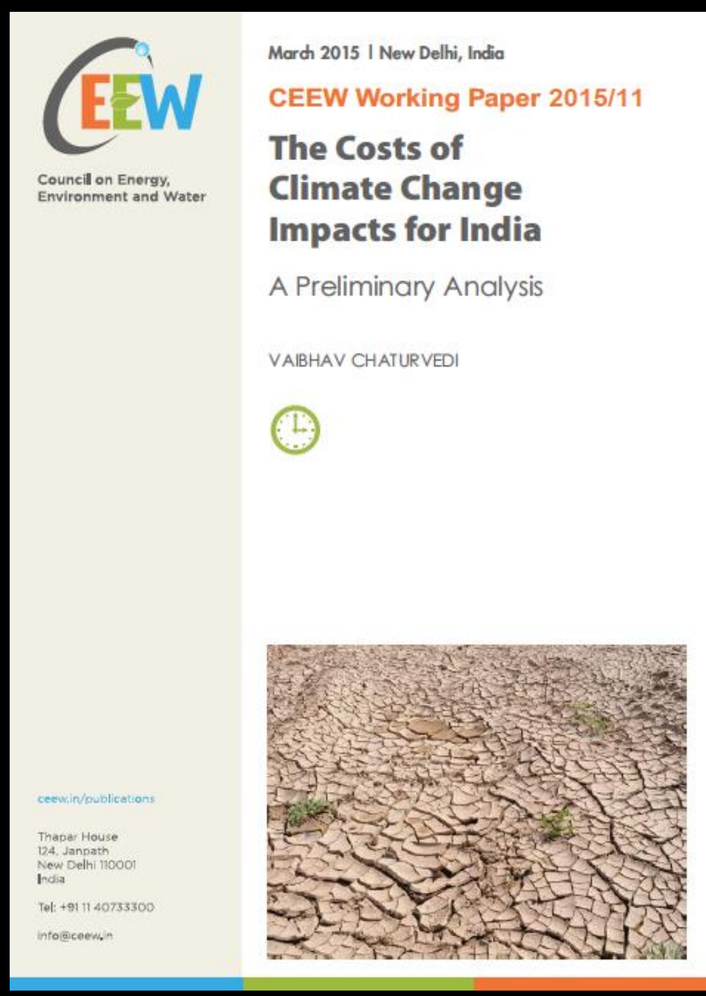
The judgment of Paris



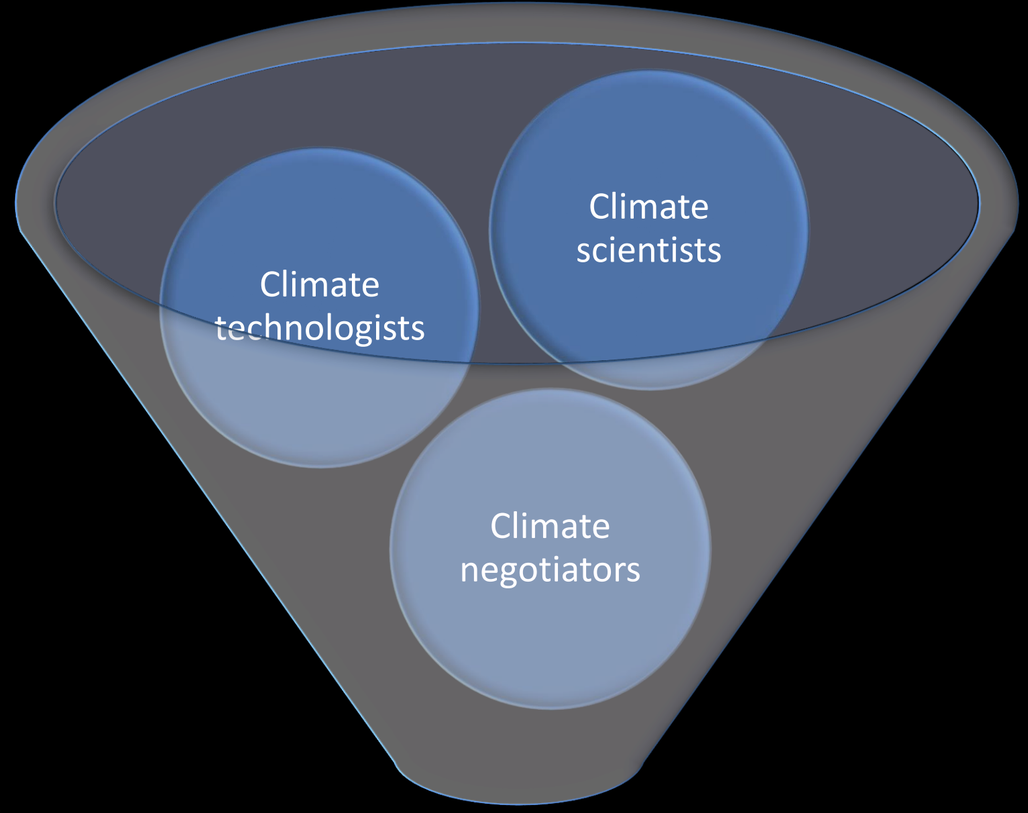
How quickly do we end up in a CGE world?

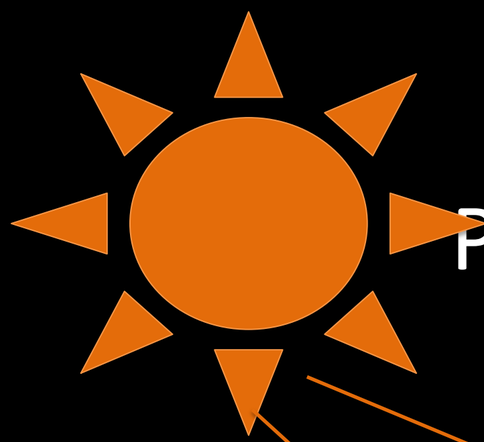




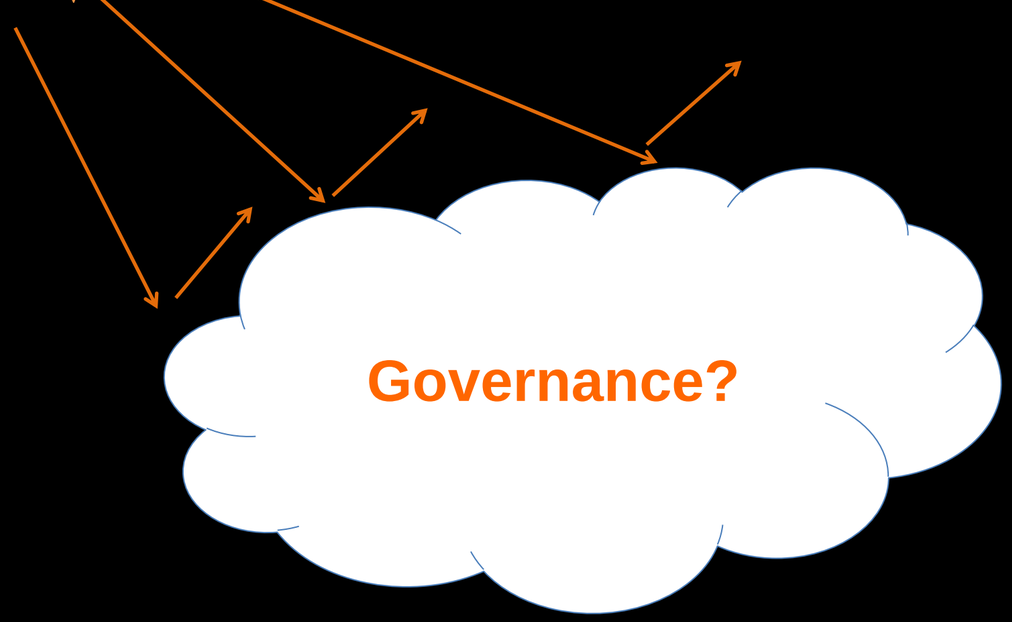


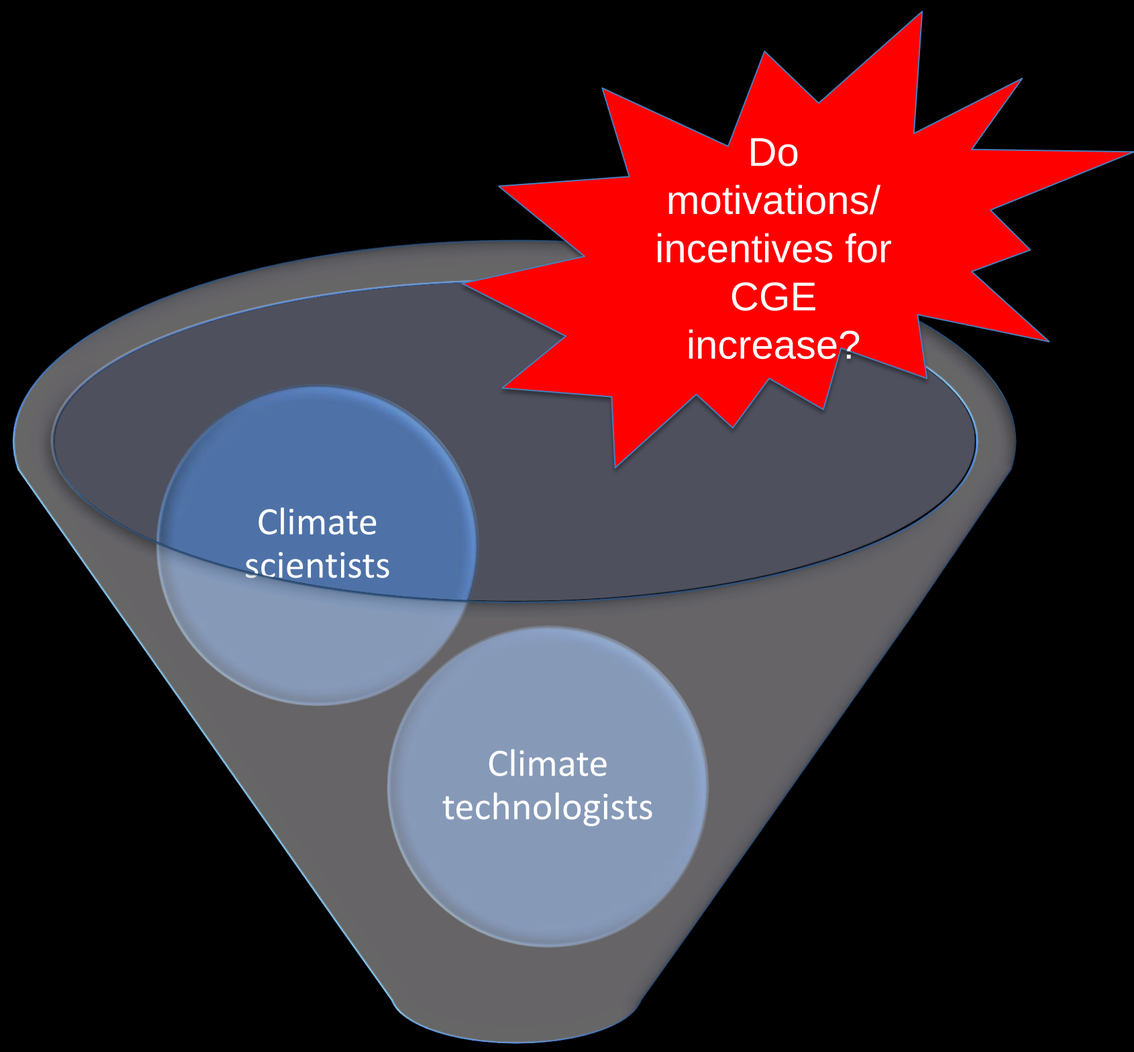
What is missing in our communication of the need for CGE research?





Paris Agreement





PA if US withdrew

But how easy will governance be?

Centralised or decentralised governance?

	Material concerns		Ethical concerns	
	Maintain flexibility	*Constrain others*	*Process legitimacy*	*Outcome legitimacy*
Making decisions	Scope of governance limited	Scope of governance broad	Inclusive process vs. Ease of decision-making in small groups	Equally weighted voting rules vs. Capability-driven voting
Monitoring actions	Self-reporting	Institutional reporting plus verification	Inclusiveness of review procedures	Quality and timeliness of reporting
Resolving disputes	Decentralised adjudication, including market instruments	Centralised adjudication plus centralised/ decentralised enforcement	Ease of access to dispute settlement forums	Ability to enforce decisions against powerful countries

SOURCE: Ghosh (2014)

Is national governance enough?

- Scenario 1: Privately funded research
- Scenario 2: Small number of countries collaborate on field experiments
- Scenario 3: Research groups in several countries collaborate
- Scenario 4: Large economy unilaterally acts
- Scenario 5: Small island state/ coalition of vulnerable countries use(s) its/their sovereignty!!!

SOURCE:

International governance via which forums?

- Potentially applicable to **all geoengineering methods**
  - ENMOD
  - UNFCCC
  - CBD

- Potentially applicable to **specific methods**
  - Montreal Protocol on stratospheric aerosols
  - MARPOL for marine cloud brightening
  - Outer Space Treaty for solar arrays

- Potentially applicable to **activities within or impacting upon specific method**
  - UNCLOS

- Potentially applicable to **specific substances**
  - Sulphates: IMO, CLRTAP, Montreal Protocol
  - Space Mirrors: Outer Space Treaties

- Potentially applicable over **geographical or spatial limitations**
  - CLRTAP limited to UNECE
  - IMO
  - Outer Space Treaties

- Whether mandates are adapted or new institutions are created, states will have to decide on **what functions to assign to these institutions**

SOURCE: Blackstock and Ghosh (2011)

What next for SRM governance?

Who do we consult, how do we consult, and for how long?

- **PUBLIC INFORMATION**: one-way flow of information from proponent to participants
- **PUBLIC CONSULTATION**: one-way flow of information from participants to proponent
- **PUBLIC PARTICIPATION**: bi-directional flow of information for maximum information exchange

What if they said no?

How do we design international research programmes?

- **RESEARCH CAPACITY**
  - Localised research
  - ITER/CERN: Sourcing inputs from developing countries for larger research infrastructure
  - Mapping out institutions in poorer countries to include them in research collaborations
  - Research on ethical, legal, social and political issues

- **FLEXIBLE FUNDING**
  - In-kind support: staff, material inputs, institutional resources
  - CGIAR Fund, 2009: to balance donors and researchers

- **RESPONSIBILITY & LIABILITY**
  - Explicit clauses when research creates international institutions e.g. CERN
  - Flexible options also available: European initiative for Implementing Geological Disposal of Radioactive Waste Technology Platform (IGD-TP)

- **INTELLECTUAL PROPERTY & ACCESS TO DATA**
  - HGP; Bermuda Principles: data released within 24 hours
  - CERN: tighter rules but “open science” model; dissemination takes precedence over revenues
  - ITER: royalty-free access to other members

- **COOPERATION & INSTITUTIONAL DESIGN**
  - Voluntary or formal agreement
  - Scope, thresholds and rules
  - Transparency: codes of conduct; self-report; independent review

Who are the stakeholders? And whose feedback counts?

	Scientists	Investors	Social Scientists	Negotiators/ Advisers	Governments / Legislatures	International organisations	People/ Civil society
Scientists	Peer review	Return on investment	Governance for research necessary	Governance for research necessary	Publicly funded research needs oversight	Unilateral CE research vs. international partnerships	With prior informed consent
Investors	Avoid private CE experiments	For-profit vs. philanthropy	External oversight necessary	Who owns the IP?	Who owns the IP?	Who owns the IP?	No
Social scientists	Too much governance studies	Too much governance studies	Peer review	You might be legitimising CGE research	Have you consulted everyone	Have you consulted everyone	You might be legitimising CGE research
Negotiators/Advisers	Consider all tech options	Consider all tech options	Do no harm	Preserve maximum flexibility	Preserve maximum flexibility	Do no harm	Keep some options off the table
Governments / Legislatures	Respect scientific freedom	Don't over regulate	External oversight necessary	Need to constrain others	Unilateral action unwarranted	Unilateral action unwarranted	Regulate
International organisations	Don't impose moratorium	Don't impose moratorium	Appropriate levels of regulation	Need to constrain others	Appropriate levels of regulation	No clear regulatory regime	Impose moratorium
People/ Civil society	Respect scientific freedom	Investment does not need consent	Different positions on CGE research	Views are respected but not final	Democratic process to be respected	Democratic process to be respected	Different positions on CGE research

SOURCE: Author

Some conclusions…and difficult questions

- Paris changed how climate technology development is viewed
  - So the demand for **more participative public-private research** will increase: climate engineers should think about this modality

- Paris might have implicitly opened up the world of CE
  - But it is important to **discuss *all* technologies**!

- If it's going to take 20 years of modelling, are we likely to develop any clear governance mechanisms *now*?

- But that means it is even more important to explain why and how CE/SRM research is a ***continuation* of climate science and climate technology research**

- Stakeholders are no longer just interested academic researchers (in the sciences and the social sciences)
  - **Stakeholder engagement is long and hard**
  - **And inconclusive**
  - **Need to find the right forums**

- A **progressively inclusive approach to SRM governance**?
  - National-level scientific assessments
  - National stakeholder consultations to understand perceptions
  - National policymaking and legislation
  - Voluntary reporting to international forums
  - Public-private governance and independent peer review *and* oversight
  - Plurilateral or multilateral intergovernmental registry, reporting and accountability

THANK YOU

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UCLA | SCHOOL OF LAW

Solar Geoengineering: Governance Challenges and Responses

Webinar on Solar Geoengineering

16 May, 2017

Edward A. (Ted) Parson
Dan and Rae Emmett Professor of Environmental Law
Faculty co-Director, Emmett Institute on Climate Change and the Environment,

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Solar Geoengineering: Context for Governance

Structural Characteristics relevant for governance

- Fast (~ 1 year) impact, controllability, termination: Several potential uses
- Low cost (direct deployment): a feature or a bug?
- Imperfect offset to environmental harms of elevated CO_2

Implications for potential use (based on early, limited knowledge)

- May reduce risks, in ways that Mitigation and Adaptation cannot
- May be necessary to meet 1.5°C or even 2°C targets (more so each year!)

- New, potentially serious risks: environmental, political
- Balance of likely benefit and risk? Don't know
- Need Research, and Governance

Informing Decisions about Solar Geo: What is needed?

Research

- Develop and refine methods
- Modeling – realistic methods and scenarios, consider more impacts
- Field tests (start very small)
- Structures for Control, Transparency, Cooperation, Re-assessment

Assessment

- Feasibility, Effectiveness: Red/blue team approach?
- Direct environmental risks: Assessment and research must co-evolve
- Risks dependent on how used (or misused): Imply need for …

Governance

- Severe, novel challenges to governance (mostly international)
- Based in structural characteristics of solar geo interventions
- Urgently require examination and deliberation

Examples of Governance Challenges

Control

- High leverage, low direct cost → Widespread capability

Legitimate Decision-making (Whether, when, how to use)

- Many decisions (not just on/off)
- Worldwide impacts
- Uncertain regional differences (perhaps with some control?)

Interactions with Mitigation, Adaptation, Carbon Removal

- How to make these mutually supporting?
- How to define (and implement) a coherent climate strategy?

Political vs. Technical decisions (If solar geo ever used)

- Monitoring and Control
- Attribution (under uncertainty, variability, and greenhouse heating)

Liability and Compensation

Avoiding and Managing Conflict

Governance of Research

- Avoid damaging early mis-steps, Slippery Slope

Governance Challenges and Responses
How (and Where) to start the conversation

Desired Ingredients:

- Broad international representation
- Expertise, experience: international relations and institutions, governance design
- Ability to conduct open, exploratory, speculative investigations
- Not stuck in current positions, current view of possibilities (Conditions will change)
- Rich linkage with advancing scientific knowledge, but distinct from it

Existing bodies not well suited

- Not FCCC (for now):
  - Need open exploration, avoid press for early decisions
- Not IPCC:
  - Explore potentially workable political solutions
  - Not based on Scientific expertise or authority, peer-reviewed literature

Possible Model: A World Commission on Climate Engineering

- Senior commission – Experience, expertise, judgment (Scholarly and practical)
- Broad international representation
- Not current office-holders or proxies (but maybe former …)
- Appropriate Charge, Sponsorship, Mandate, Resources

Questions, Discussion …

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CARNEGIE COUNCIL
The Voice for Ethics in International Affairs

FORUM *for*
CLIMATE ENGINEERING
ASSESSMENT

"A briefing and discussion on solar geoengineering: science, ethics and governance" to be held on 16 May 2017 at 12:00 UTC/GMT (8:00 EDT New York, 13:00 BST London, 14:00 CEST Geneva, 17:30 IST New Delhi)


Janos Pasztor


Simon Nicholson


Doug MacMartin


Pablo Suarez


Tom Ackerman


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