Standardizing Assumptions for Policy-Relevant Solar Geoengineering Scenarios

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Future policymakers will need good information on solar geoengineering options and impacts

Thought experiment	In the year 2035 representatives at the United Nations are meeting to discuss whether and how to deploy global solar geoengineering. What information should everyone have?
Partial answer	Different stakeholders will want to know different things, but whatever information you want, you'll want to have it for a range of possible global deployment options across a range of plausible futures.
Our project	Devise a standardized set of assumptions about possible global deployments of solar geoengineering – **the Solar Geoengineering Pathways (SGPs)** – to structure the research needed to understand feasibility, costs, impacts, and risks.
Project goals	Over a series of several workshops of experts: 1) outline those sets of assumptions, and 2) suggest important research questions that could be addressed using those assumptions and/or deviations from them.

Solar Geoengineering Pathways (SGPs) should meet three criteria: range, simplicity, and comparability

Range	The SGPs should allow and encourage researchers to explore a wide range of **plausible use cases** for global solar geoengineering, **embedded in a wide range of plausible climate futures.**
Simplicity	The SGPs should be **easily explainable**, at least in outline, to policymakers, their advisors, civil society, and to researchers across a range of disciplines.
Comparability	The SGPs should share assumptions with one another and with major climate scenarios to **enable people to compare results across SGPs and to compare futures with solar geoengineering to futures without it.**

Current thinking: Have a small set of fixed assumptions and parameters to allow for a wide range of research

What is fixed:

broad assumptions

- global
- *solar* geoengineering

four global temperature targets as representative policy goals / plausible use / reference cases

- halve warming each year
- cap warming at 2.0°C
- cap warming at 1.5°C
- cool to 1.0°C

other constraints

- start date: no implementation before 2035
- cooling rate: SG pathways cool no faster than 0.4°C/decade (following Parker & Irvine (2018))

What can vary (everything else):

background conditions

- RCPs
- SSPs

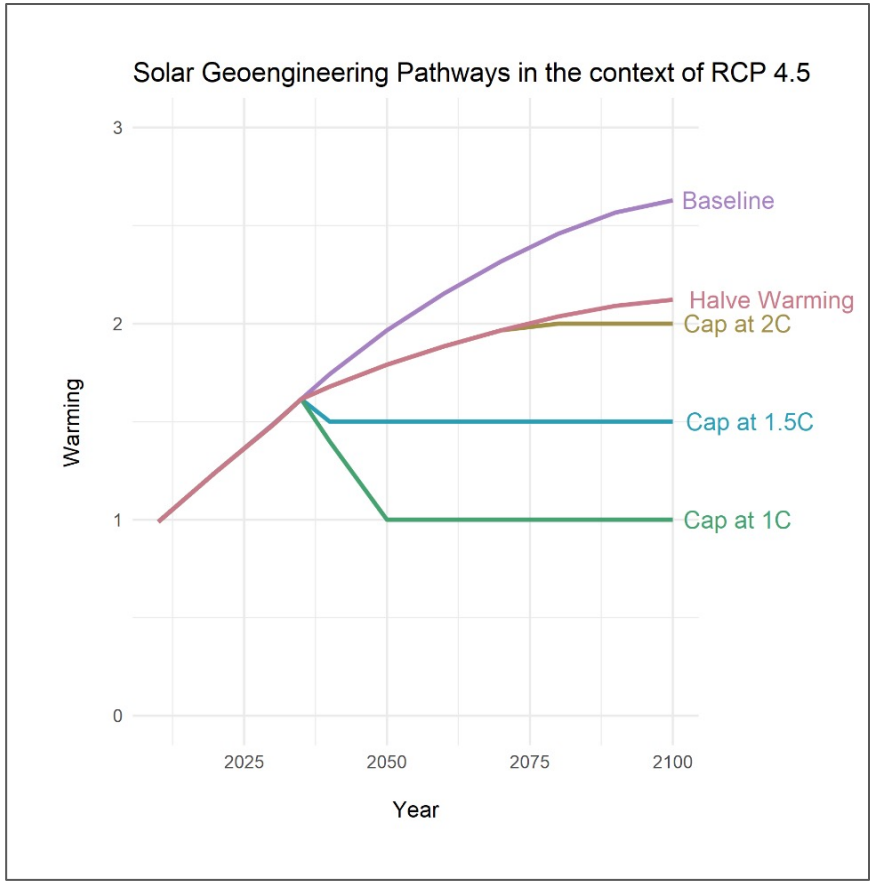
technology

- stratospheric aerosol injection
- marine cloud brightening
- cirrus cloud thinning

method of deployment

- altitude, latitude, etc.

Focusing on high-level solar geoengineering policy goals yields a small number of modular pathways



- This sample chart shows these four SGPs in the context of RCP 4.5, based on temperature projections from a climate model called MAGICC.
- Each pathway could be “plugged into” different contexts, such as different SSP/RCP combinations.
- Researchers could study:
  - different ways of implementing each pathway in various contexts
  - deviations from these pathways
- Impacts and inputs would differ by context and implementation.

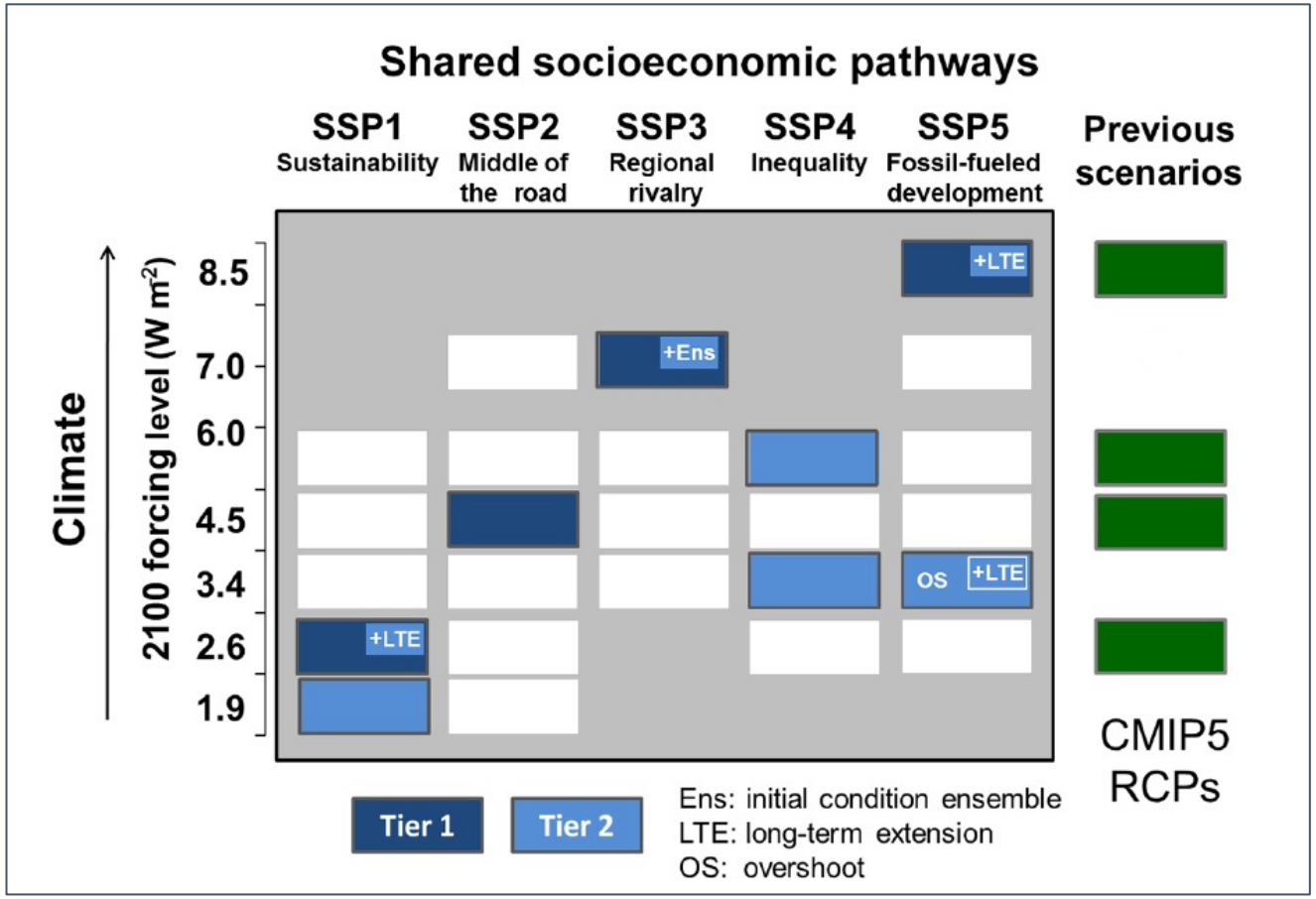
Flagging scenarios of special interest can help guide research while retaining flexibility

A Possible Precedent

ScenarioMIP mitigates the "scenario explosion" problem by designating some scenarios as especially high priority for modeling or study.

Implications for Our Project

- We could identify specific scenarios as especially important to study in connection with some or all SGPs.
- The comparability criterion suggests using some combination of SSP and RCP.



O'Neill et al. 2016. "The Scenario Modeling Intercomparison Project (ScenarioMIP) for CMIP6." *Geoscientific Model Development* 9: 3461–3482. DOI 10.5194/gmd-9-3461-2016

Solar Geoengineering Pathways could be used for a range of studies

Research area	Sample research question using this framework
Comparative assessment	How do key regional climate variables and adaptation needs differ between “SGP 1.5” in the context of RCP 6.0 and RCP 1.9 without solar geoengineering?
Deployment optimization	Assuming “SGP 1.5” under RCP 4.5, how do different latitudes and altitudes of injection of stratospheric aerosols affect key climate variables in different regions? Which produces the most equitable outcome?
Political economy	How would different international political alignments, incentives, and governance structures – along with mitigation efforts – affect the likelihood of following “SGP 1.5”?
Risk assessment	What would be the impact of unanticipated events, such as termination shock or large volcanic eruptions, under specific ways of implementing “SGP 2.0” or “SGP 1.5” in the context of RCP 6.0, RCP 4.5, or RCP 2.6?
Engineering analysis	What would it take to achieve “SGP 1.0” via marine cloud brightening under various RCPs?

Thank you.

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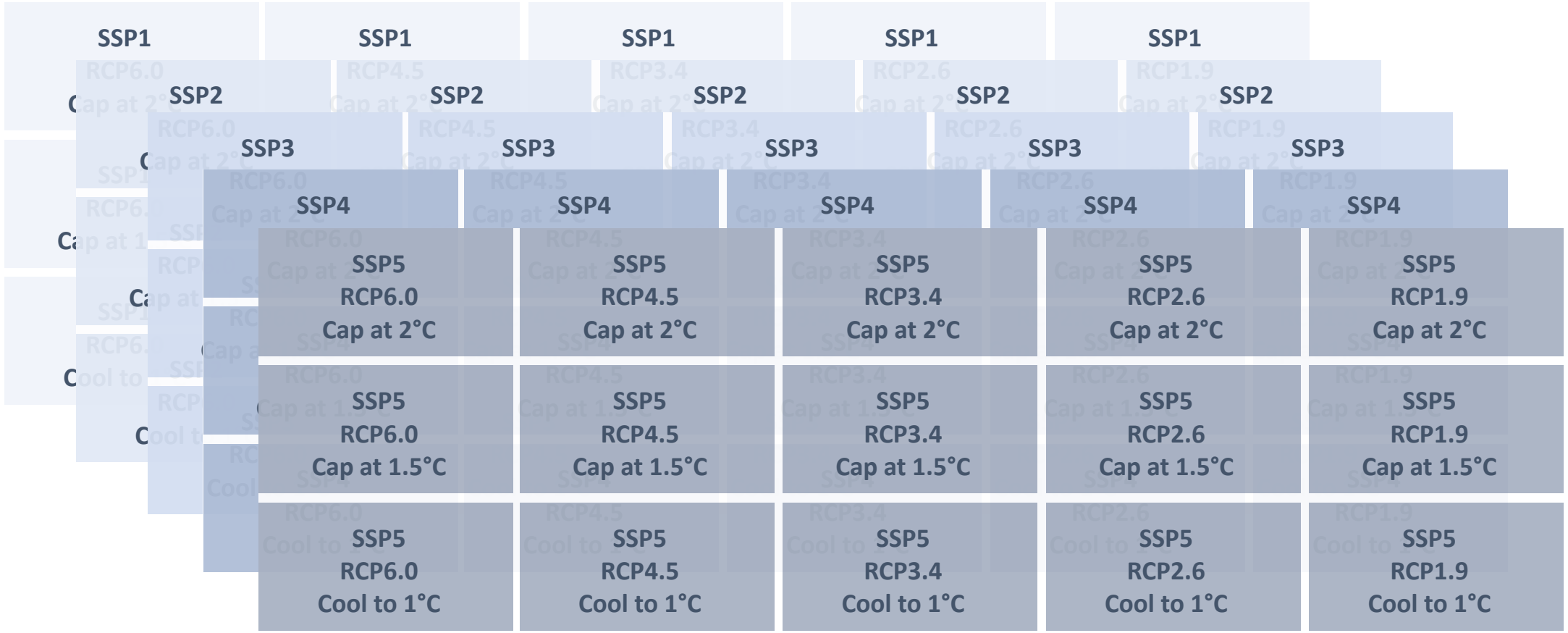
additional slides

Standardized assumptions help structure research

Example	Description	Function in Research Community
Shared Socioeconomic Pathways	• Standardized assumptions about possible socioeconomic futures • No (explicit) climate policies	• Allow researchers to explore a range of possible socioeconomic futures, while ensuring comparability across studies
Representative Concentration Pathways	• Standardized assumptions about GHG concentrations, derived from possible radiative forcing levels in 2100	• Allow researchers to explore range of mitigation pathways, while ensuring comparability across studies
Shared Policy Assumptions	• Standardized assumptions about when and where climate policies are implemented	• Help standardize some key assumptions in integrated assessment modeling studies, making results more directly comparable
GeoMIP, GLENS	• Standardized scenarios of solar geoengineering deployment, used to answer physical science questions	• Enable multi-model comparisons of possible impacts of solar geoengineering

Combining possible uses with the full suite of major climate scenarios creates an infeasibly large scenario set

The sample matrix below shows a simple but intractable approach: there are too many scenarios here for climate modelers to investigate them all because it would require too much computer time.



Challenging issues so far:

- regional SG implementation?

- building bridge between research and modeling community (with model feasibility and computing time constraints) and policy community (looking for applicability and multiple political goals)