Possible questions that ScenarioMIP (and other related MIPs) could address, and implications for scenarios

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On behalf of ScenarioMIP

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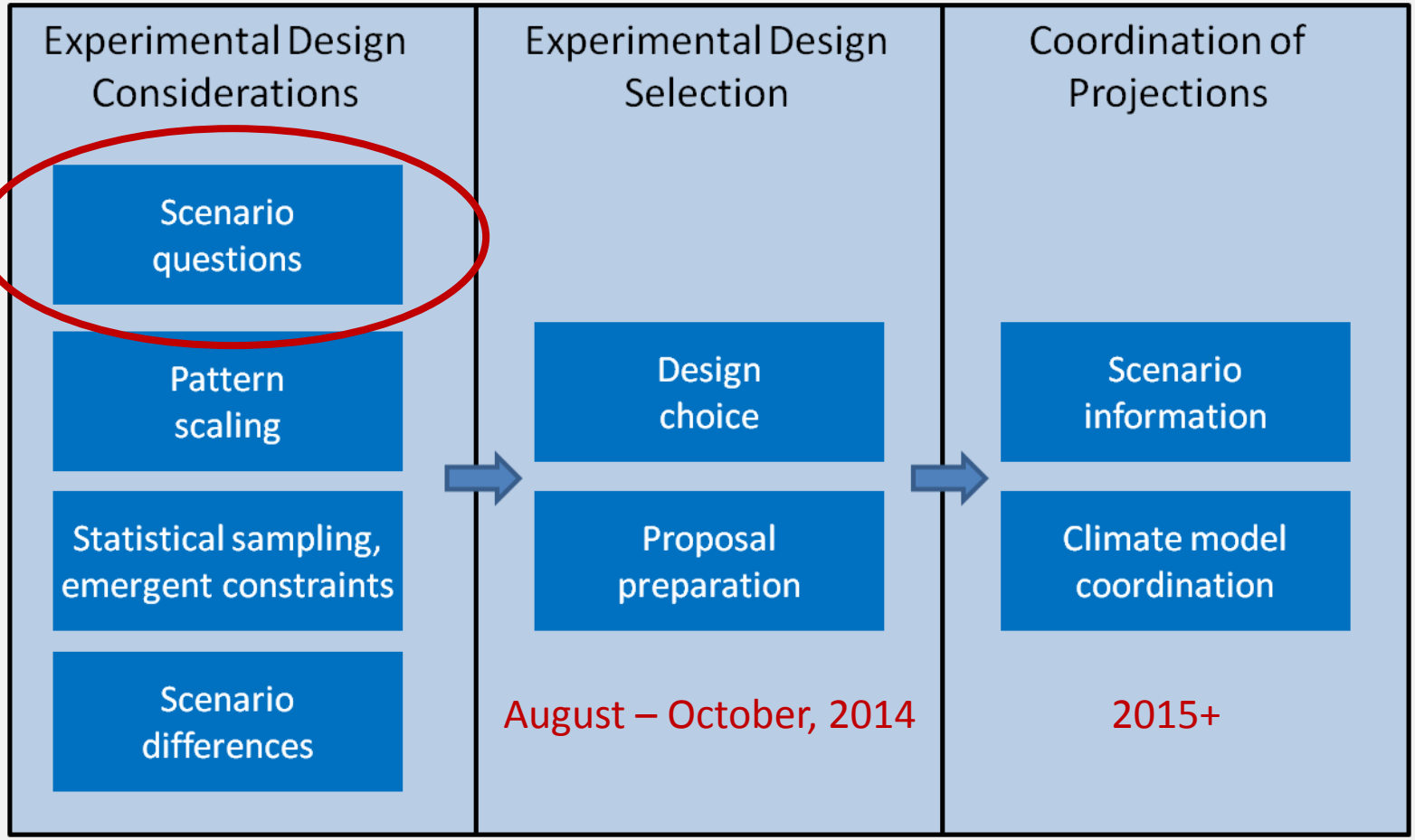
ScenarioMIP



Outline

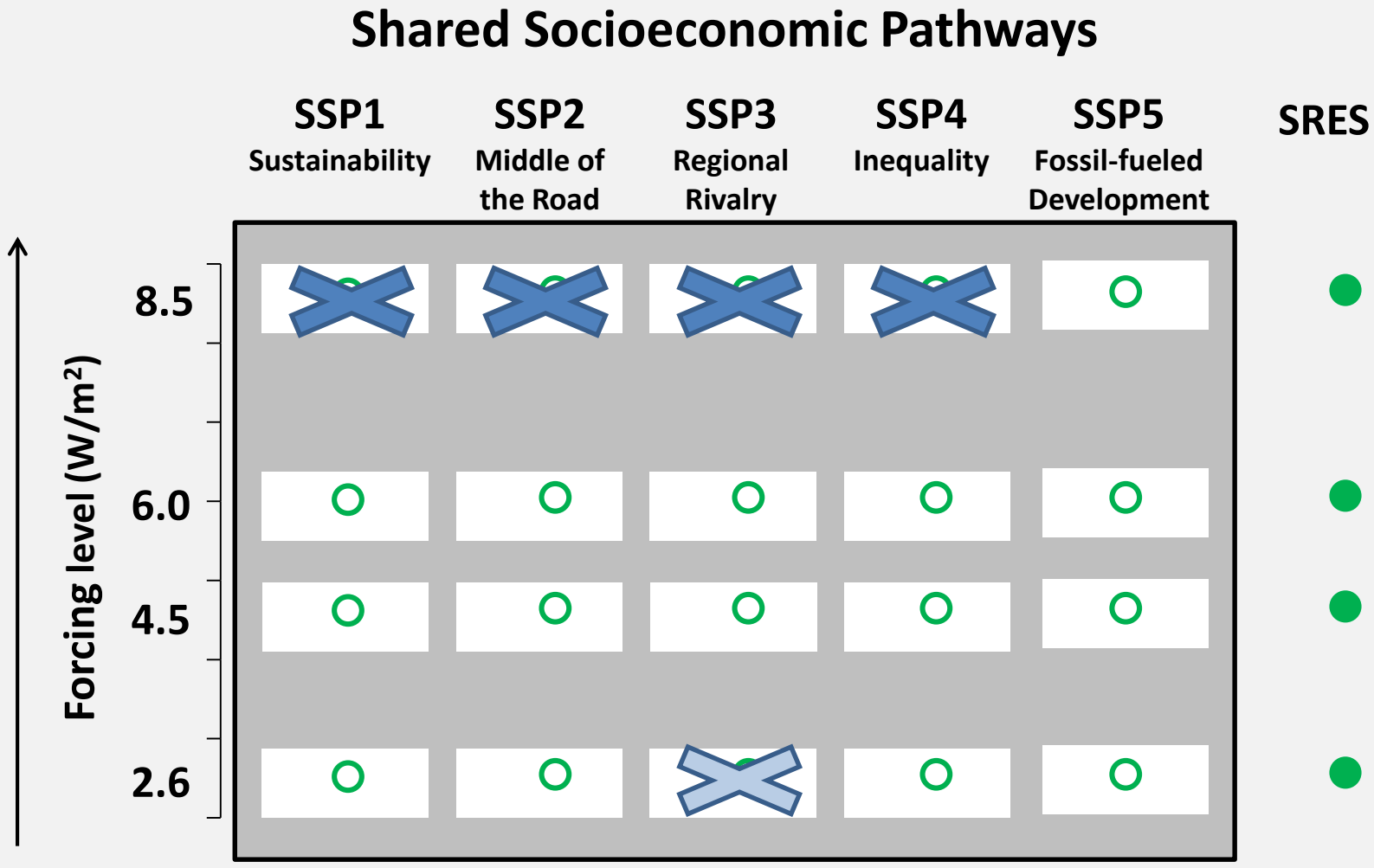
CMIP6 context and logic of ScenarioMIP approach to identifying questions and scenarios

Types of scenarios that could be run (pros/cons)

Detlef:

Possible **sets of specific scenarios** (usually combining types)

The Scenario Matrix Architecture



CMIP6 and Scientific Questions

Main criteria for endorsement of a MIP

- The MIP addresses at least one of the key **science questions** of CMIP6

CMIP6 science questions

WCRP Grand Challenges: clouds, circulation, and climate sensitivity; changes in cryosphere; climate extremes; regional climate information; regional sea level rise; water availability; biospheric forcings and feedbacks

How does the Earth system respond to forcing?

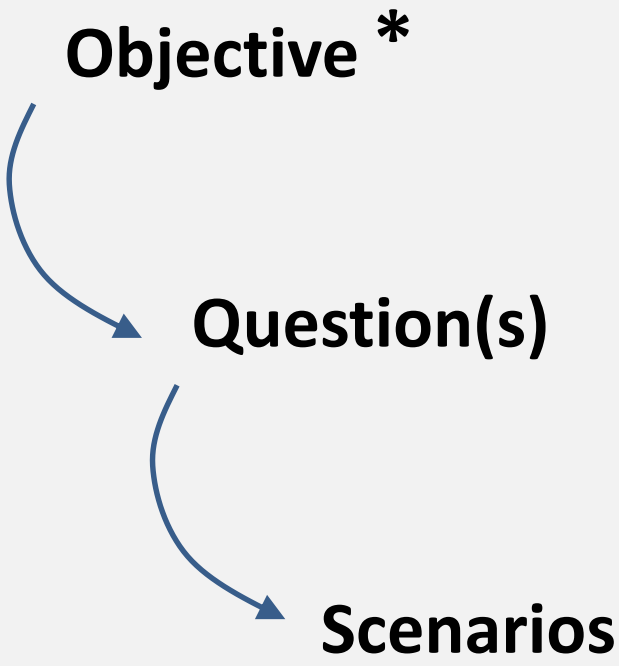
What are the origins and consequences of systematic model biases?

How can we assess future climate changes given climate variability, climate predictability, and **uncertainties in scenarios**?

CMIP6 and Scientific Questions

For each proposed experiment to be included in CMIP6:

- the experimental design,
- the **science question and/or gap** being addressed with this experiment,
- possible synergies with other MIPs,
- **potential benefits of the experiment** to (A) climate modeling community, (B) Integrated Assessment Modelling (IAM) community, (C) Impacts Adaptation and Vulnerability (IAV) community, and (D) policy makers.



* Should warrant having a large number of GCMs running the same scenarios in order to address the objective.

Possible ScenarioMIP Objectives

Objective 1: Provide climate information for policy-relevant radiative forcing pathways in order to **support a broad range of impact, adaptation, and mitigation research**.

Examples: SRES (CMIP3), RCPs (CMIP5), ?? (CMIP6)

Objective 2: Address specific research questions related to the **climate effects of particular forcing components**.

Examples: Role of land use, SLCFs, carbon sinks, overshoot, specific types of geoengineering, etc.

Objective 1

Support a broad range of impact, mitigation, and adaptation research.

Question

How does the Earth system respond, globally and regionally, to policy-relevant pathways of emissions of trace gases, aerosols, its precursors and land use that are not captured by the RCPs?

* CMIP6 Question: How does the Earth system respond to forcing?

Scenarios

General Purpose Scenarios

Targeted questions addressed by other communities!

Objective 2

Better understand the climate effects of particular aspects of forcing pathways relevant to scenario-based research.

Question(s)

Do plausible alternative land use or SLCF pathways, assuming the same global atmospheric radiative forcing as the RCPs, lead to substantially different global or regional climate or carbon cycle outcomes? How much do plausible alternative shapes of forcing pathways (e.g. overshoot) matter? Geoengineering vs mitigation?

Scenarios

Targeted scenarios, e.g. controlled variants of RCPs.

Current ScenarioMIP Perspective

- Objective 1, supporting a broad range of research with general purpose scenarios, is top priority
  - Many more users, larger impact than targeted scenarios
  - Potentially larger need; without them, there may be no climate information available
- Some combination with Objective 2 may be possible
  - However: relevant targeted questions might be better addressed by other MIPs
- ScenarioMIP should focus on plausible future scenarios rather than idealized experiments

General Purpose Scenarios

Updated RCPs

SSP baselines

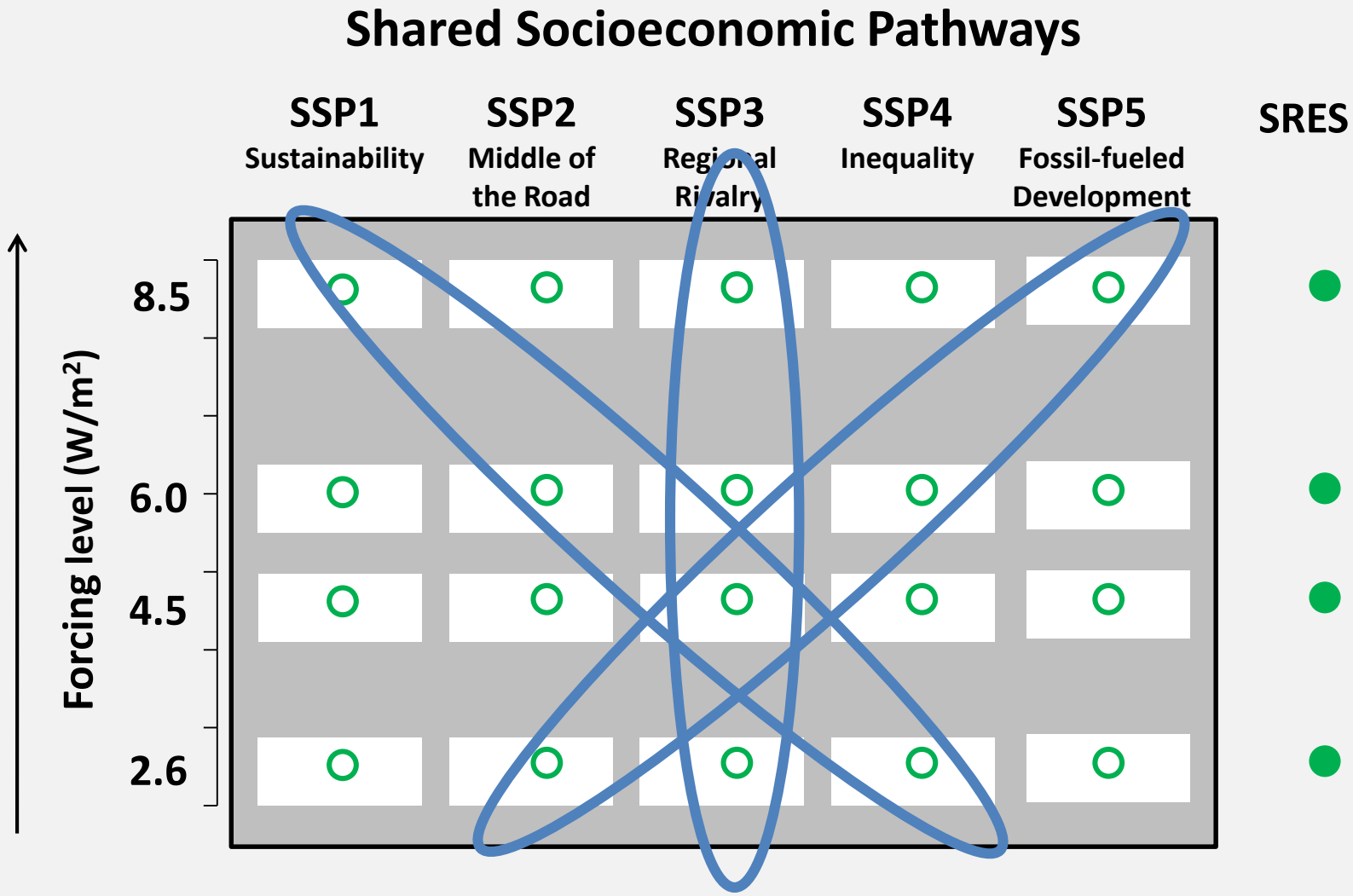
Additional mitigation RCPs

Overshoot scenario

GP: Updated RCPs

Same global average forcing pathways as current RCPs, but generated with current IAMs based on SSPs

The Scenario Matrix Architecture



GP: Updated RCPs

Same global average forcing pathways as current RCPs, but generated with current IAMs based on SSPs

Pros

- RCPs based on SSPs rather than SRES
- updated IAM (and climate) models (credibility?)
- consistency between new climate outcomes and new SSP-based IAM scenarios

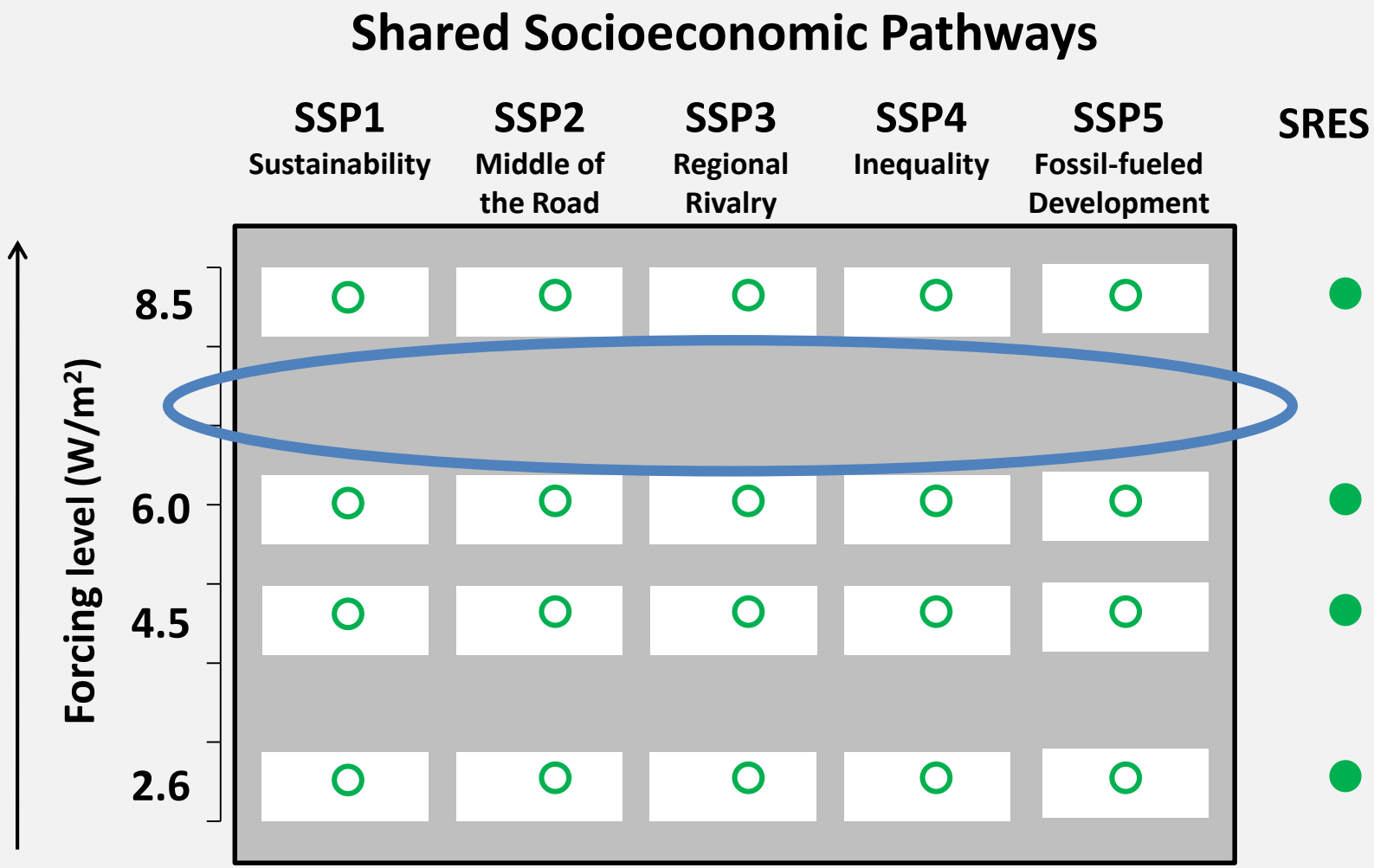
Cons

- unclear whether climate outcomes based on updated RCPs will differ significantly from current RCPs
- won’t be able to learn much from climate differences between CMIP5 and CMIP6 RCPs (too many things changed at same time)

GP: SSP baselines

One or more baseline scenarios between RCP 6.0 and 8.5. Driven by specific SSP(s), or by “average” baseline in this space (e.g., an RCP 7.0?)

The Scenario Matrix Architecture



GP: SSP baselines

One or more baseline scenarios between RCP 6.0 and 8.5. Driven by specific SSP(s), or by “average” baseline in this space (e.g., an RCP 7.0?)

Pros

- addresses principal gap in currently available climate information for SSP-RCP matrix – no information available for unmitigated baselines that do not happen to be close to forcing pathways of RCPs
- facilitates IAV work on avoided impacts (requires baseline climate)

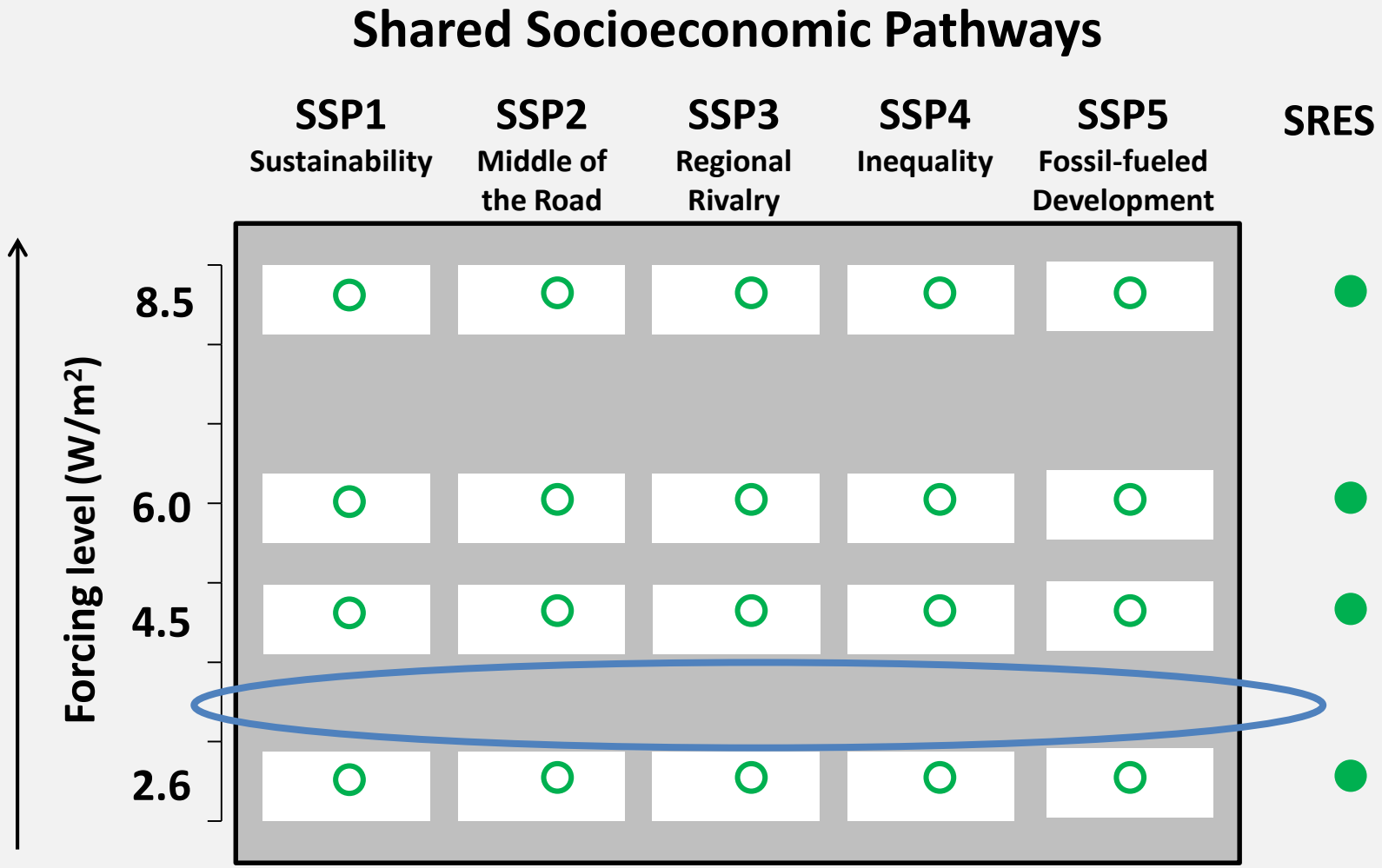
Cons

- baselines may already be close enough to existing RCPs

GP: Additional mitigation RCPs

New RCP(s) covering mitigation scenarios of interest that are not in current RCP set; e.g. RCP 3.7

The Scenario Matrix Architecture



GP: Additional mitigation RCPs

New RCP(s) covering mitigation scenarios of interest that are not in current RCP set; e.g. RCP 3.7

Pros

- provides climate information for evaluating impacts of scenarios of high interest to mitigation policy (3.7)
- may be increasingly relevant if RCP2.6 comes to be seen as implausible
- could provide good test for simplest pattern scaling test (between 4.5 and 2.6)

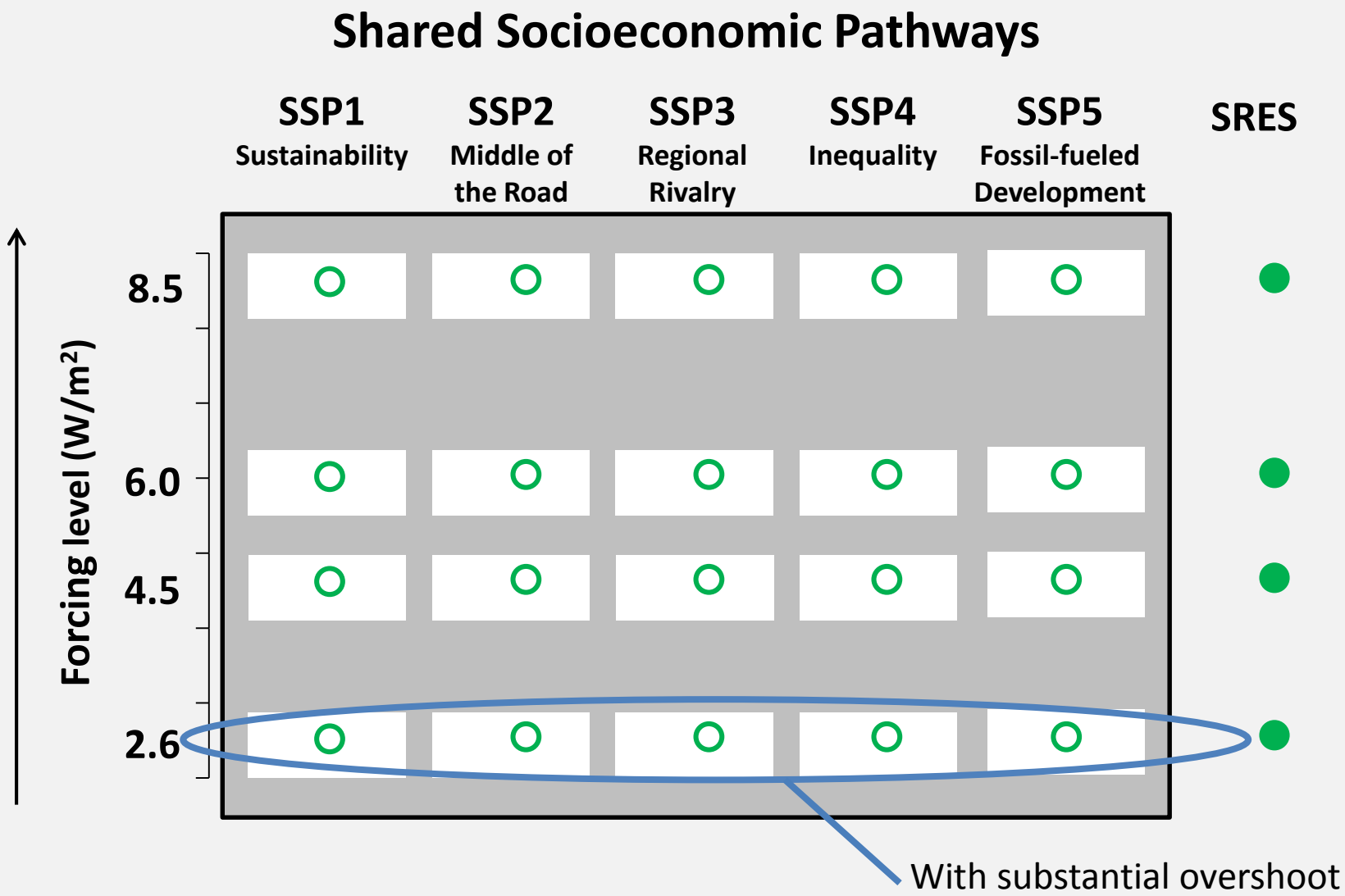
Cons

- forcing pathway may be too close to existing RCPs to produce interesting results

GP: Overshoot scenario

Realistic or idealized forcing overshoot scenario, large or small overshoot, possibly relative to an existing RCP (e.g. 2.6)

The Scenario Matrix Architecture



GP: Overshoot scenario

Realistic or idealized forcing overshoot scenario, large or small overshoot, possibly relative to an existing RCP (e.g. 2.6)

Pros

- Interesting to climate scientists (also meets objective 2!)
- Relevant to current IAM implementations of RCP2.6 (i.e., a new variant of RCP2.6?)
- Potentially very relevant to policy

Cons

- May require new IAM scenario to be developed (may not be part of current SSP-RCP set)

Targeted Scenarios

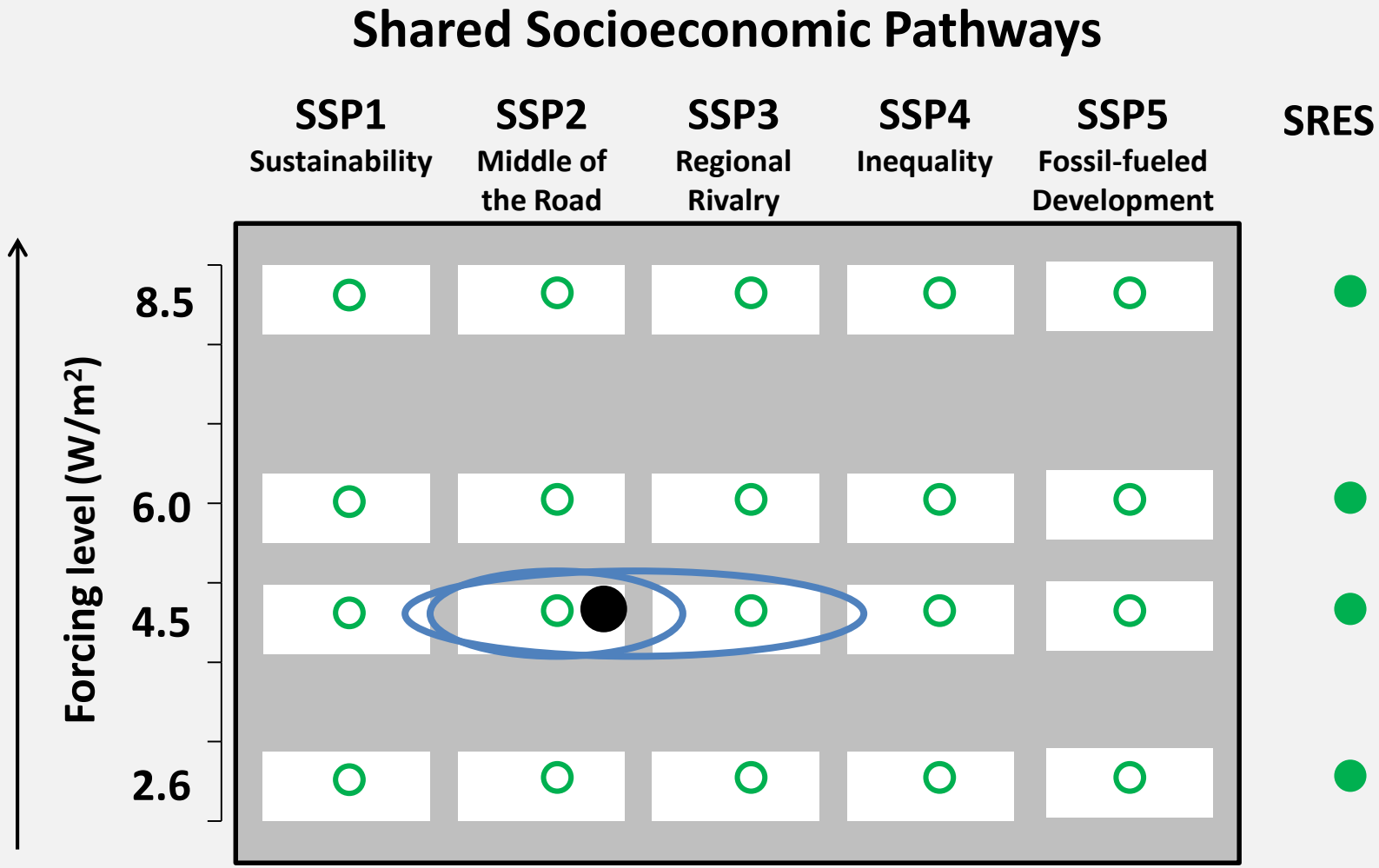
RCP land use variants

- Compare regional/global climate outcomes, allowable emissions outcomes, of two plausible alternative land use pathways that assume the same global atmospheric forcing.

RCP Short-Lived Climate Forcer (SLCF) variants

- Compare regional/global climate outcomes of two plausible alternative pathways of SLCF emissions (especially aerosols and precursors) that assume the same global atmospheric forcing.

The Scenario Matrix Architecture



RCP land use variants

Specific SSP-RCP scenario(s) to use will depend on details of IAM scenarios.

Pros

- addresses important open question in scenario framework: are CMIP5 simulations inconsistent with new SSP-based scenarios

Cons

- Risk of large investment in what turns out to be negative result (phase 1 experiments useful here)
- Possibly best addressed by LUMIP, possibly with idealized experiments

RCP SLCF variants

Specific SSP-RCP scenario(s) to use will depend on details of IAM scenarios.

Pros

- addresses important open question in scenario framework: are CMIP5 simulations inconsistent with new SSP-based scenarios
- Could explicitly address policy questions related to air quality

Cons

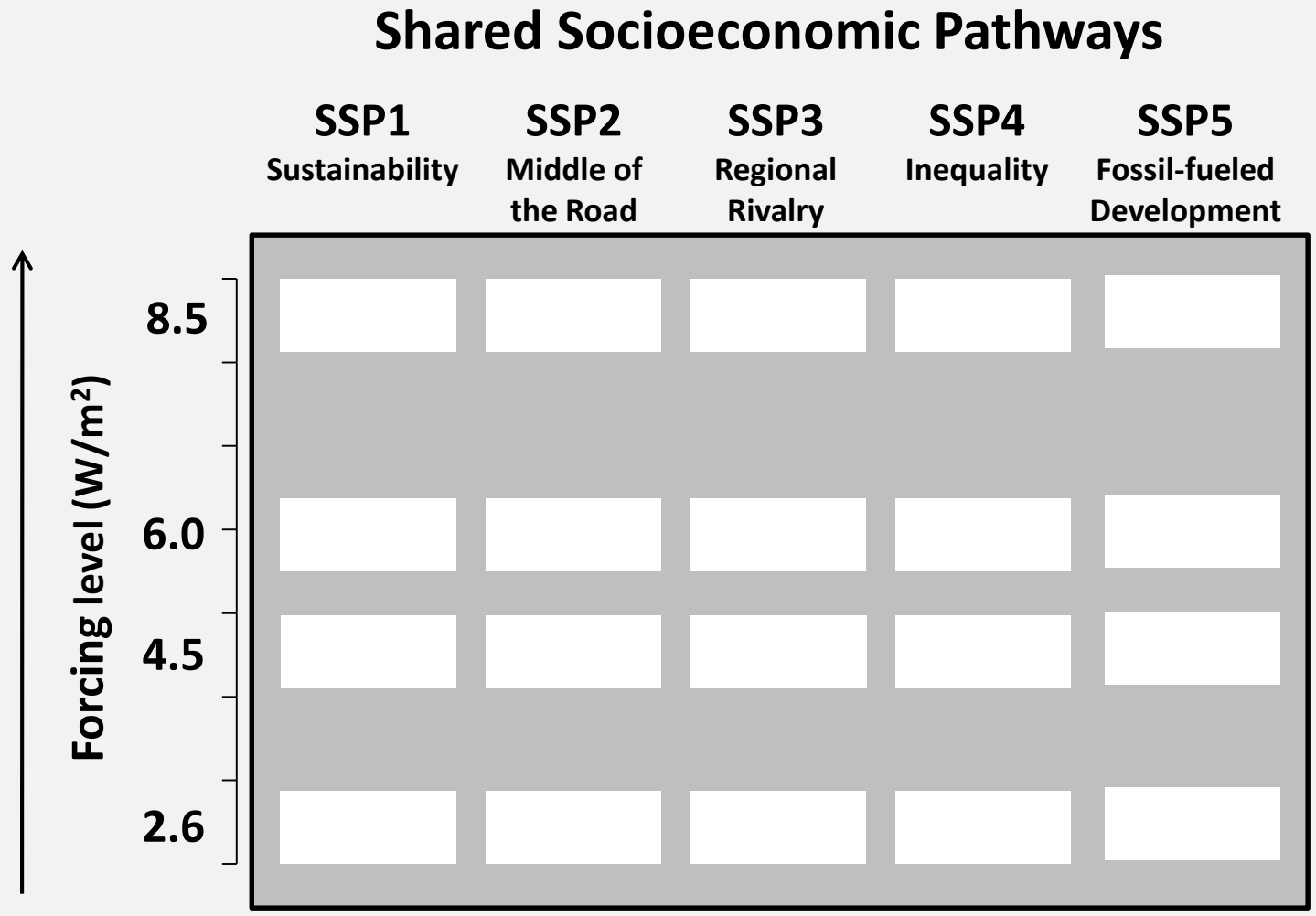
- Risk of large investment in what turns out to be negative result (phase 1 experiments useful here)
- Possibly best addressed by AerChemMIP, possibly with idealized experiments

Scenario Types

- General Purpose Scenarios
  - Updated RCPs
  - SSP baselines
  - Additional mitigation RCPs
  - Overshoot scenario
- Targetd Scenarios
  - RCP land use variants
  - RCP Short-Lived Climate Forcer (SLCF) variants

Extra slides

The Scenario Matrix Architecture



- What are the relative contributions to uncertainty in outcomes (climate, impacts) of societal pathway (SSP), IAM model, impact model, climate model, model parameters?
- What are the implications of the highest and lowest plausible forcing scenarios?
- What impacts are avoided by mitigation?

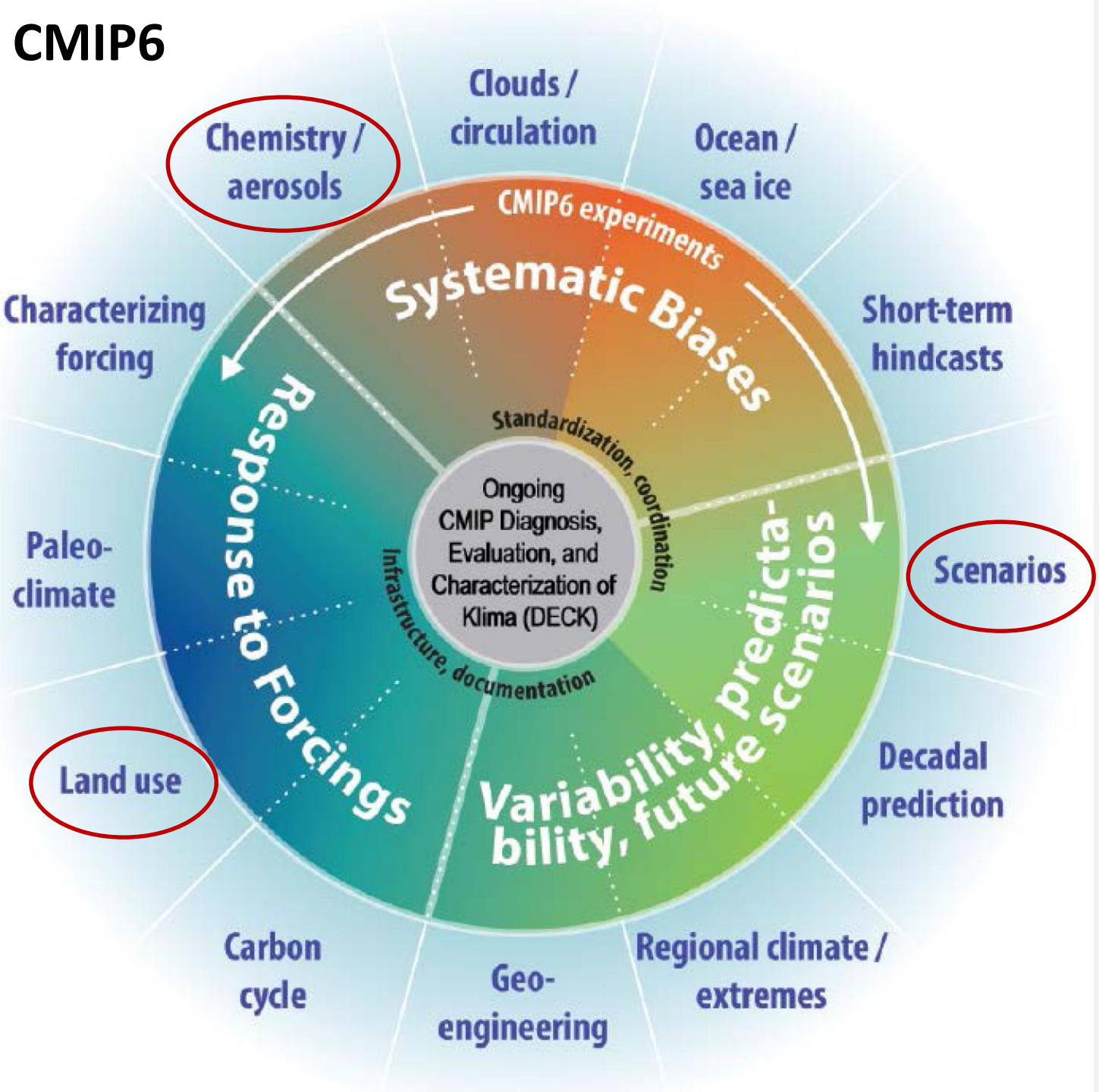
Relation to other MIPs

LUMIP

AerChemMIP

(might not include this, presentation getting long)

CMIP6


Clouds / circulation
Chemistry / aerosols
Ocean / sea ice
CMIP6 experiments
Systematic Biases
Characterizing forcing
Short-term hindcasts
Standardization, coordination
Response to Forcings
Ongoing CMIP Diagnosis, Evaluation, and Characterization of Klima (DECK)
Variability, predictability, future scenarios
Paleo-climate
Scenarios
Infrastructure, documentation
Land use
Decadal prediction
Carbon cycle
Geo-engineering
Regional climate / extremes