

# ScenarioMIP: Progress report and open questions

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Scenario MIP Co-chairs:

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Contributions/feedback from additional IAM/IAV researchers:  
Kate Calvin, Shinichiro Fujimori, Elmar Kriegler, Keywan Riahi,  
participants in EMF Snowmass Session on ScenarioMIP, Aug 1, 2014

AGCI Workshop on Climate Change Impacts and Integrated Assessment, Aspen, CO

August 4-8, 2014

# ScenarioMIP Objectives

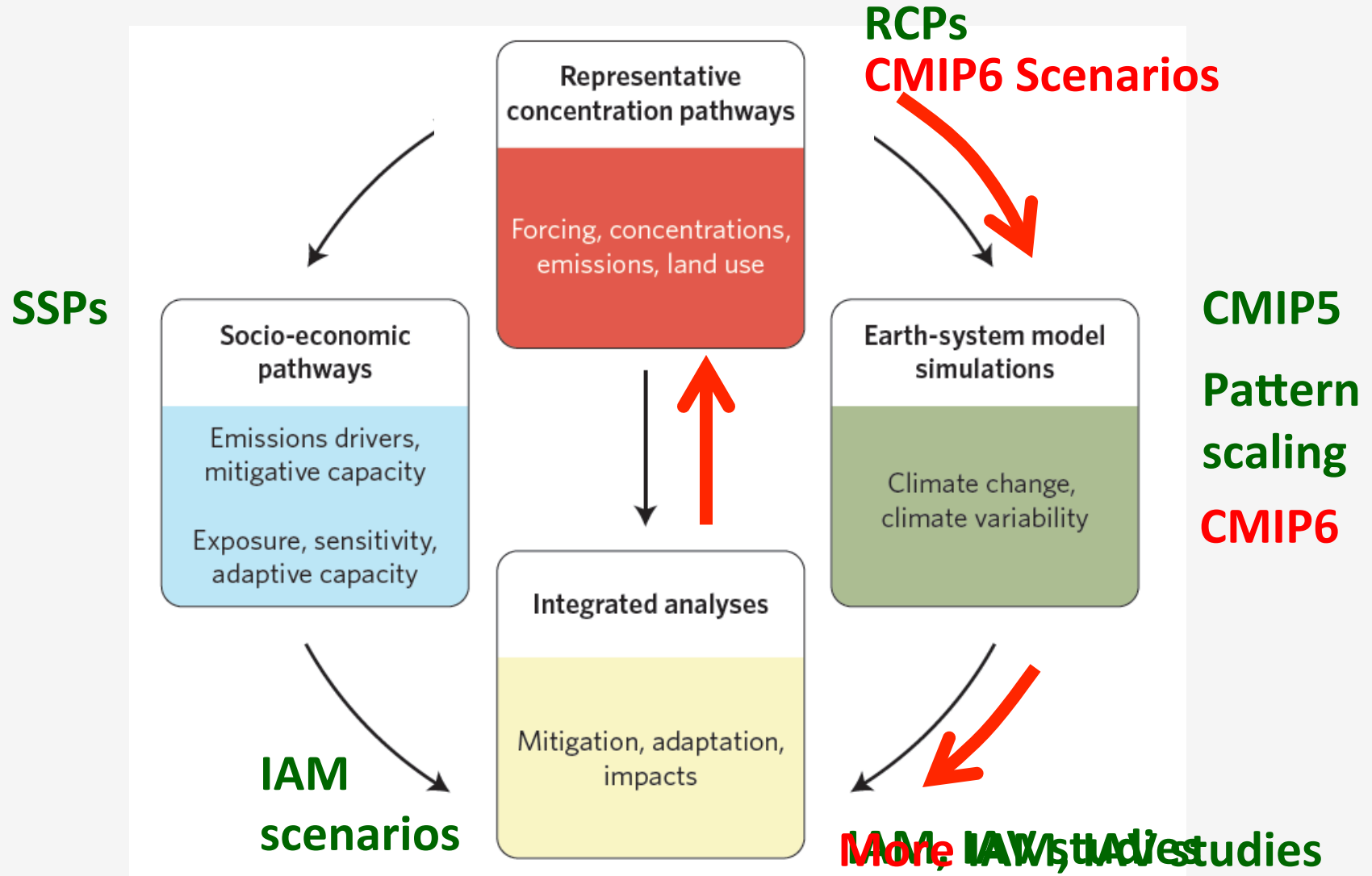
<https://www2.cgd.ucar.edu/research/mips/scenario-mip>

Define and recommend an **experimental design for future scenarios** to be run by climate models as part of CMIP6

Coordinate the provision of **IAM scenario information** to climate modeling groups

Coordinate the production of **climate model simulations** and facilitate provision of output

# The Scenario Process: CMIP6 and Scenario MIP



# Progress on SSPs/IAM scenarios since last year

## SSPs completed

Papers on narratives and quantification of drivers submitted to special issue

Quantitative projections of drivers available online in IIASA database

## IAM scenarios improved, especially in terms of land use

Beta versions for testing/review to be released start of 2015

# Shared Socioeconomic Pathways (SSPs)

## Narratives

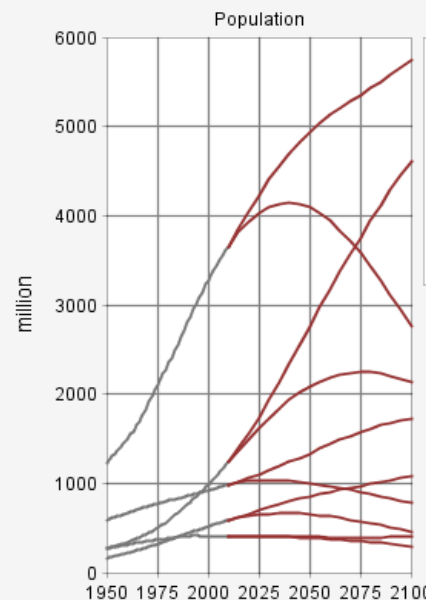
Qualitative description  
of broad patterns of  
development  
Logic relating elements  
of narrative to each  
other



**SSP1** Sustainability  
**SSP2** Middle of the Road  
**SSP3** Regional Rivalry  
**SSP4** Inequality  
**SSP5** Fossil-fueled  
Development

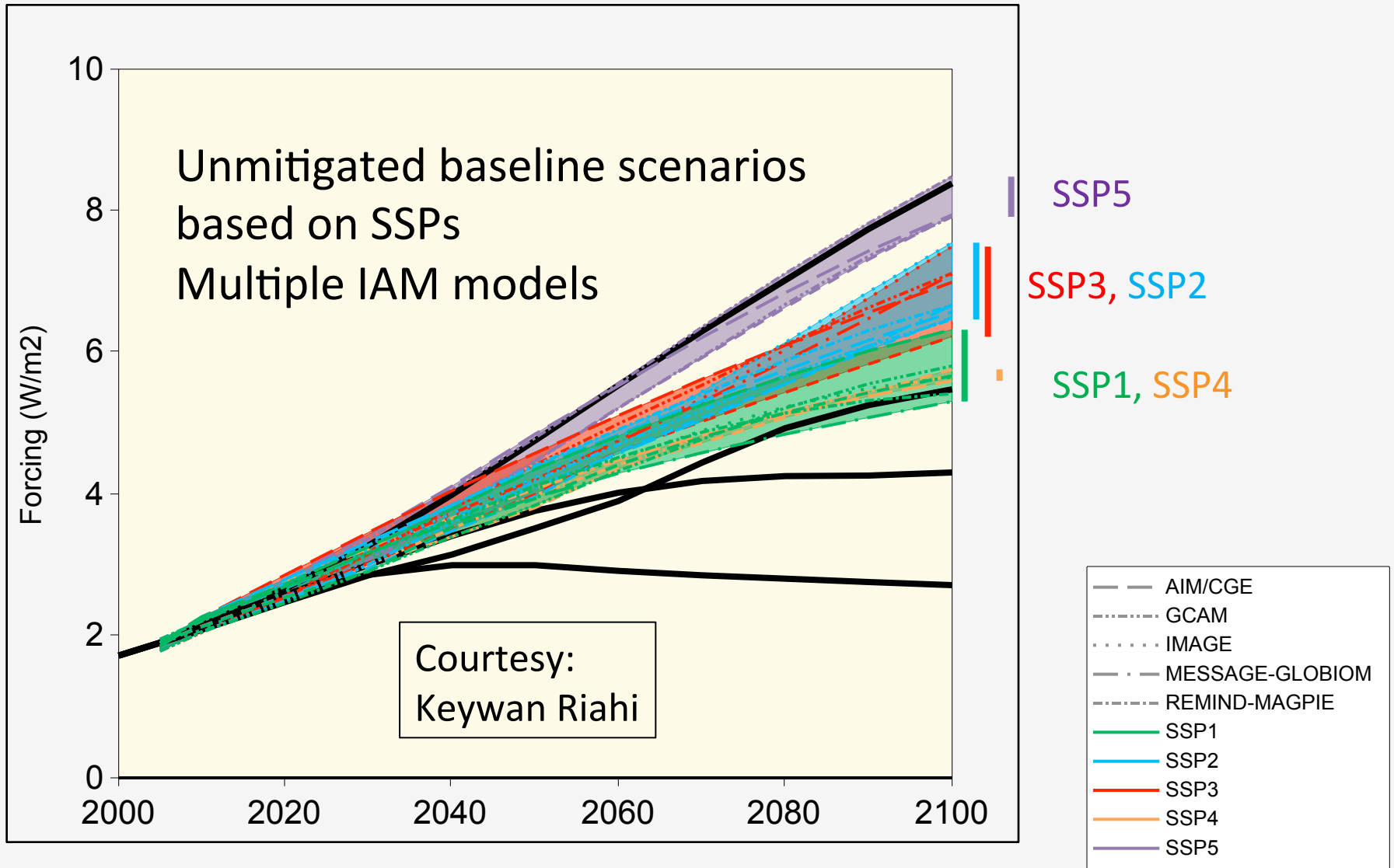
## Quantitative elements

Population  
Education  
Urbanization  
Income



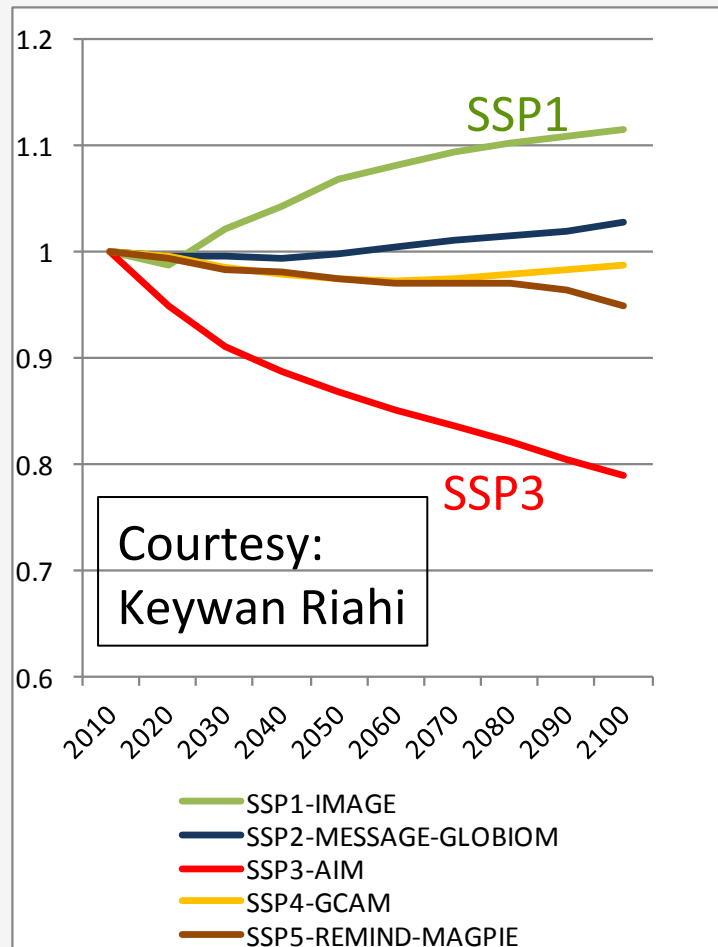
Country-specific  
data, all SSPs,  
available in  
database hosted  
by IIASA

# IAM Scenarios – Radiative Forcing (see Keywan’s talk, Tuesday lunch)

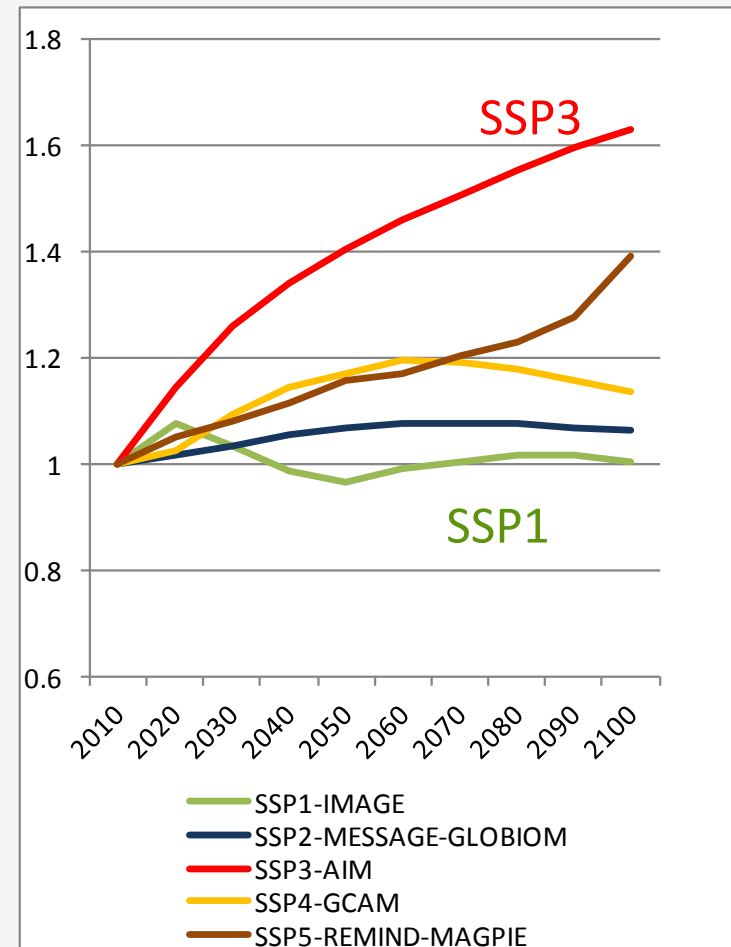


# IAM Scenarios – Land Use Change (see Keywan’s talk, Tuesday lunch)

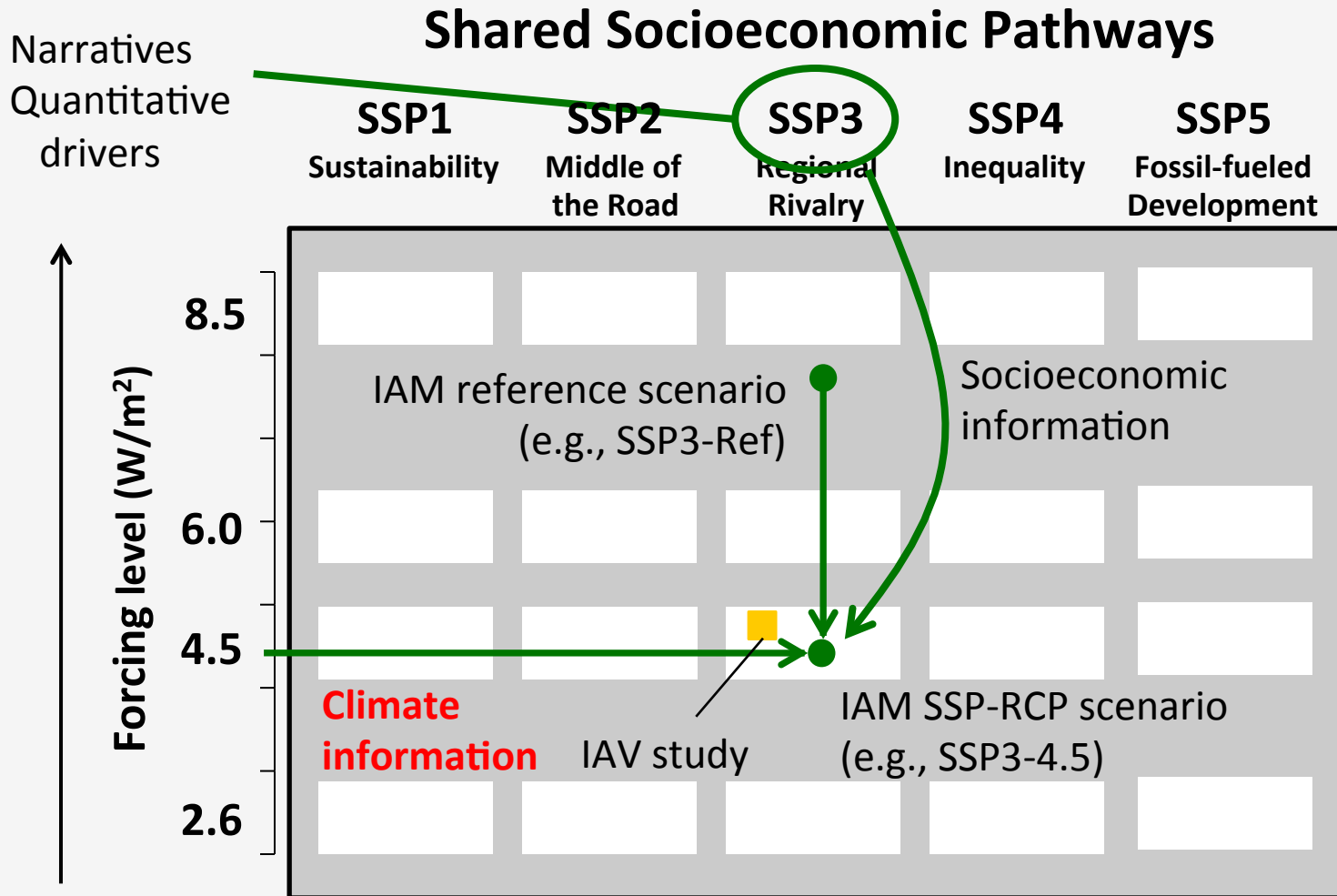
## Forest land



## Cropland



# The Scenario Matrix Architecture

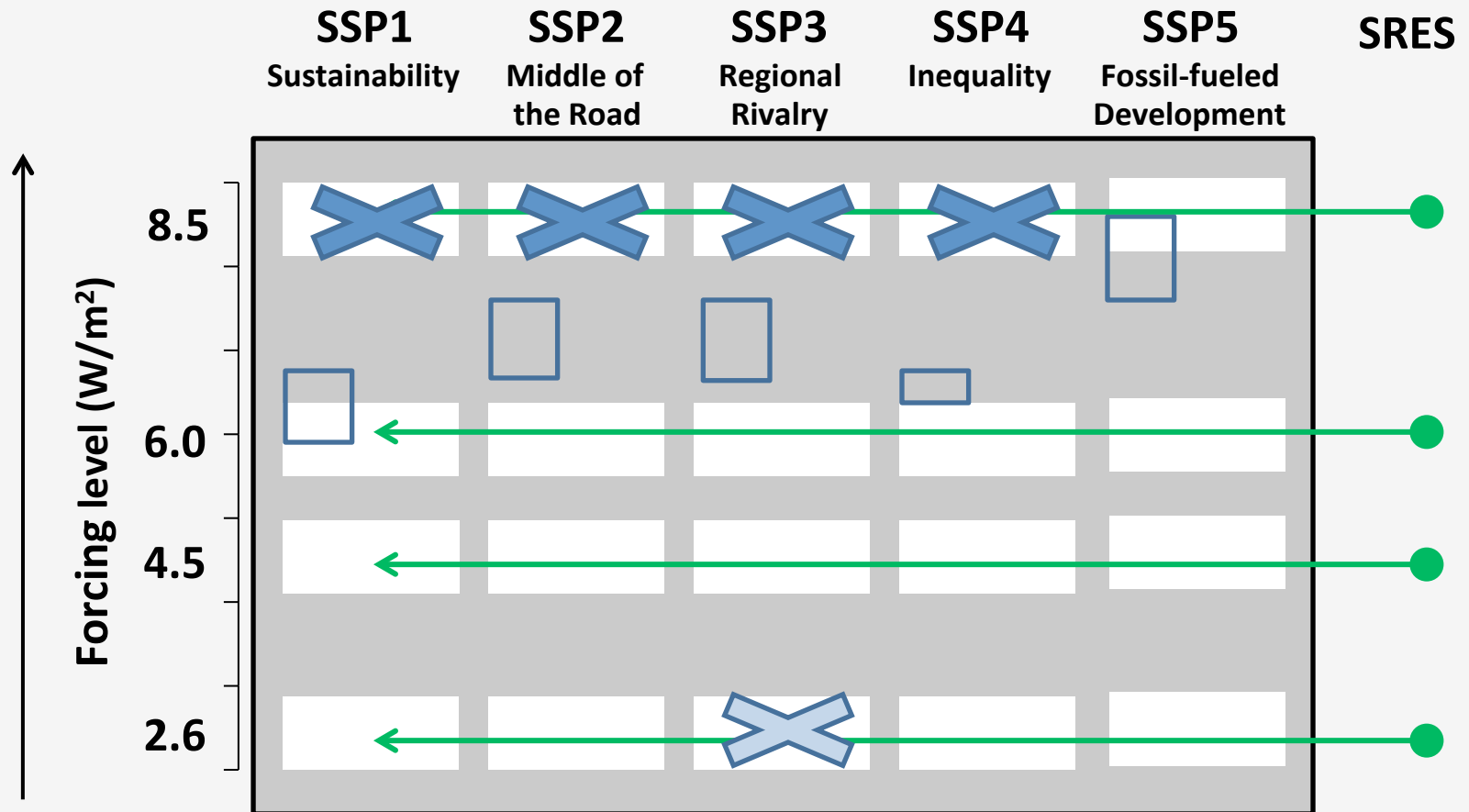




# Current status of climate information (CMIP5)

- CMIP5 RCP sims
- ✕ Infeasible
- SSP ref. scens.

## Shared Socioeconomic Pathways



# Open questions one year ago

What questions would scenarios address?

What is the most effective statistical design for ScenarioMIP?

Sampling a scenario x climate model space? Ensemble size?

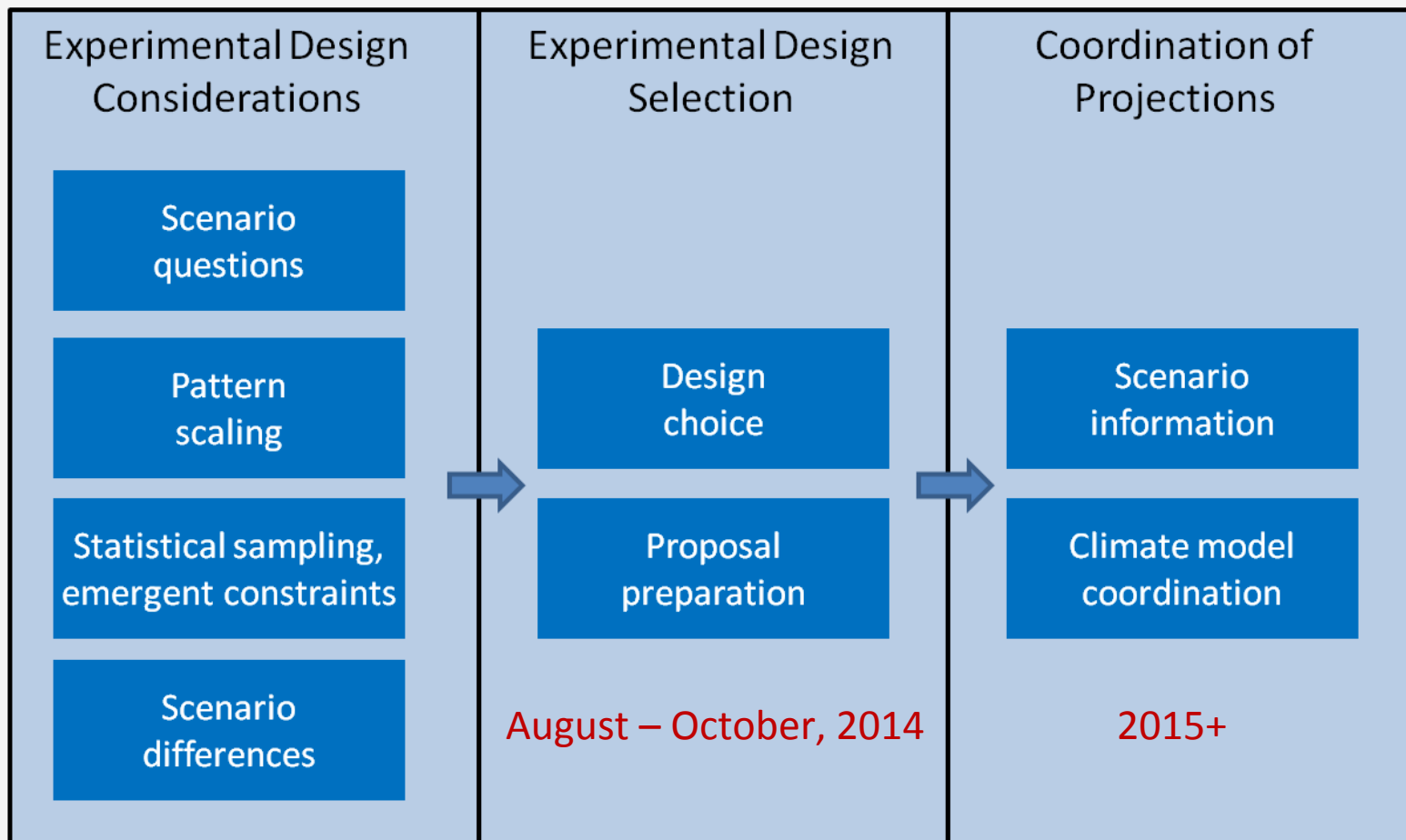
Can we rely on pattern scaling to provide climate information for some scenarios?

How different should scenarios be, in terms of global or regional forcing, to warrant CMIP6 climate model runs?

Given the above considerations, what design, with a small number of scenarios, would best meet needs?

One (of several) early ideas: scenario pairs

# ScenarioMIP – what has happened since then



# Conclusions from Task 2-4

(see Claudia's talk Tuesday)

## Pattern scaling

Has not yet been shown to be sufficiently accurate such that it could substitute for missing GCM simulations

May be sufficient for some applications, high potential for learning more

## Statistical design

Sampling GCM x scenario space not workable

Ensemble size an open question

## Scenario differences

Global forcing: Scenarios should differ by  $\geq 0.4$  C ( $\sim 1$  W/m<sup>2</sup>)

Regional forcing: Still an open question

# CMIP6 and Scientific Questions

## WCRP Grand Challenges:

Clouds, circulation, and climate sensitivity

Changes in cryosphere

Regional climate information

Water availability

Climate extremes

Regional sea level rise

Bios. forcings/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?

# Category 1: Scenarios for Integration

Support integration of climate science, IAM and IAV research

Address overarching CMIP6 scientific questions

Allow for broad use addressing a wide range of specific scientific questions

Used by multiple research communities (climate modeling, IAM, IAV, policy)

# Questions addressed by Scenarios for Integration

**How does the Earth system respond to forcing?** -> *for forcing pathways relevant to IAM and IAV research communities and to policy*

**How can we assess future climate changes given ... uncertainties in scenarios?** -> *for forcing pathways spanning a range of uncertainties in global and regional forcing relevant to IAM/IAV/policy*

How will plausible future forcing pathways affect **global and regional climate and sea level rise, climate extremes, water availability, and biospheric feedbacks**, and how will these affect impacts as well as mitigation and adaptation possibilities?

# Category 2: Targeted Scenarios

Address one or a small number of specific scientific questions

Used by a narrower range of research communities (primarily climate modeling)



# Questions addressed by Targeted Scenarios

How does the Earth system respond to forcing?  
How can we assess future climate changes given  
... uncertainties in scenarios?

What is the uncertainty in global and regional climate change due to uncertainty in **land use** and **SLCF** emissions, and how does it compare to multi-model uncertainty in the response to a given forcing pathway?

How much do plausible alternative shapes of forcing pathways (e.g. **overshoot**) matter?

# Current ScenarioMIP Perspective

Scenarios for integration a top priority

Some combination with targeted scenarios may be possible

However: relevant targeted questions might be better addressed by or together with other MIPs

ScenarioMIP should focus on plausible future scenarios rather than idealized experiments

# Types of Scenarios for Integration

Updated RCPs

SSP baselines

Additional mitigation RCPs

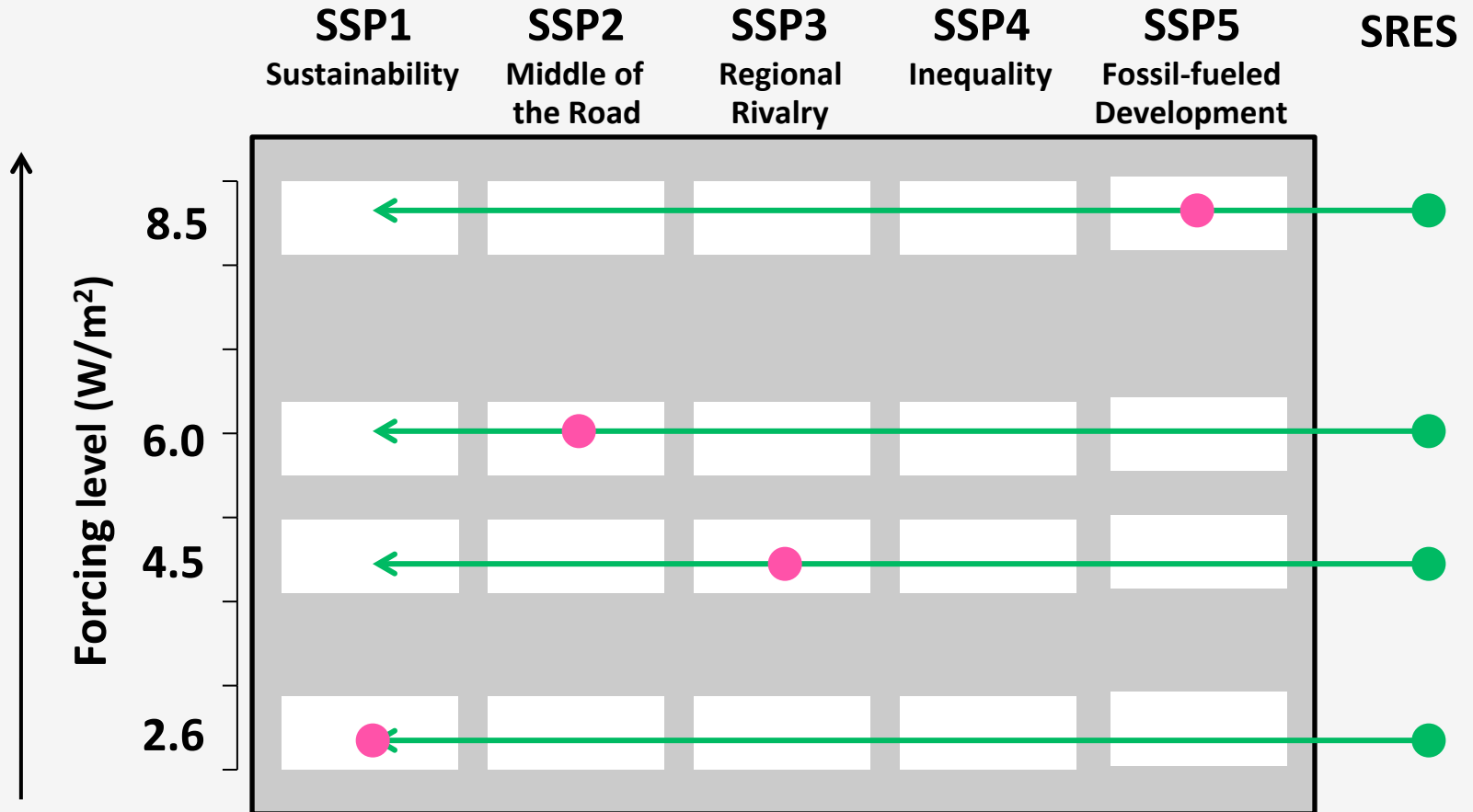
# Updated RCPs

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

# Updated RCPs

● Original RCPs      ● Updated RCPs

## Shared Socioeconomic Pathways



# Updated RCPs

## Motivation

RCPs based on SSPs rather than SRES

Updated IAM (and climate) models; improved credibility?

Consistency between new climate outcomes and new SSP-based IAM scenarios

## Key questions (to be able to evaluate this type of scenario)

Will regional forcing (LUC and aerosols) be very important to outcomes?

Will there be substantial change in climate model simulations in CMIP6 over CMIP5?

Will IAV researchers primarily want to use new simulations?

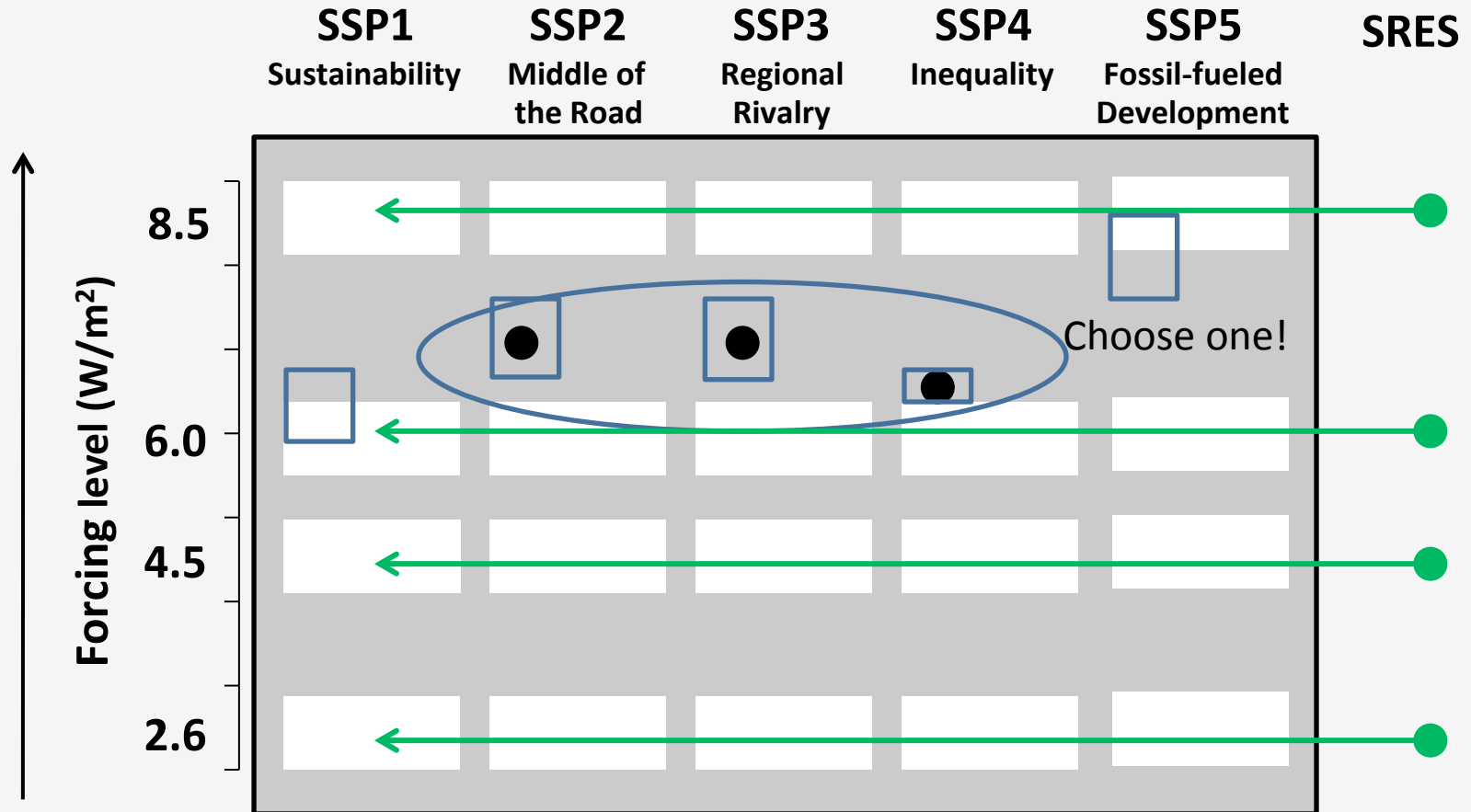
# SSP Baseline Scenarios

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?)

# SSP Baseline Scenarios

- Original RCPs
- SSP baseline range
- SSP baseline scens.

## Shared Socioeconomic Pathways





# SSP Baseline Scenarios

## Motivations

Fills gap in currently available climate information – 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)

Could provide opportunity for high forcing scenario with pessimistic development pathway (e.g., SSP3)

## Key questions

Are baseline forcing pathways sufficiently different from RCPs?

Are baselines important to impact assessment?

Is it important to have climate information for high forcing scenario with a pessimistic development pathway?

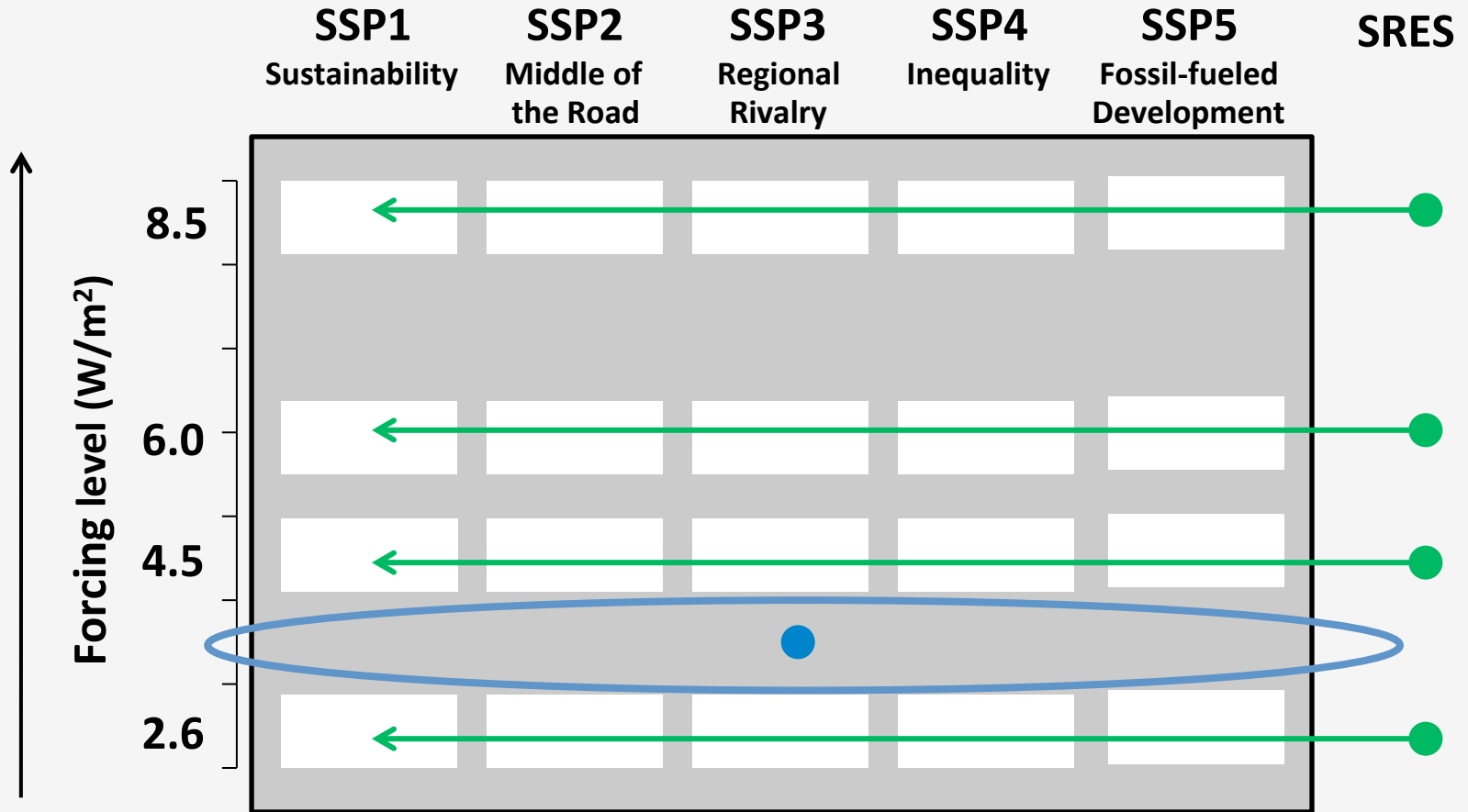
# Additional mitigation RCPs

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

# Additional Mitigation RCPs

● Original RCPs      ● RCP 3.7

## Shared Socioeconomic Pathways



# Additional mitigation RCPs

## Pros

Fills gap in currently available climate information – no information available for evaluating impacts of scenario 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)

## Key questions

Will an RCP 3.7 scenario have sufficiently different climate outcomes from RCP 4.5 and 2.6?

Could it be pattern scaled between RCP 4.5 and 2.6?

# Targeted Scenarios

## RCP land use variants, RCP SLCF variants

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

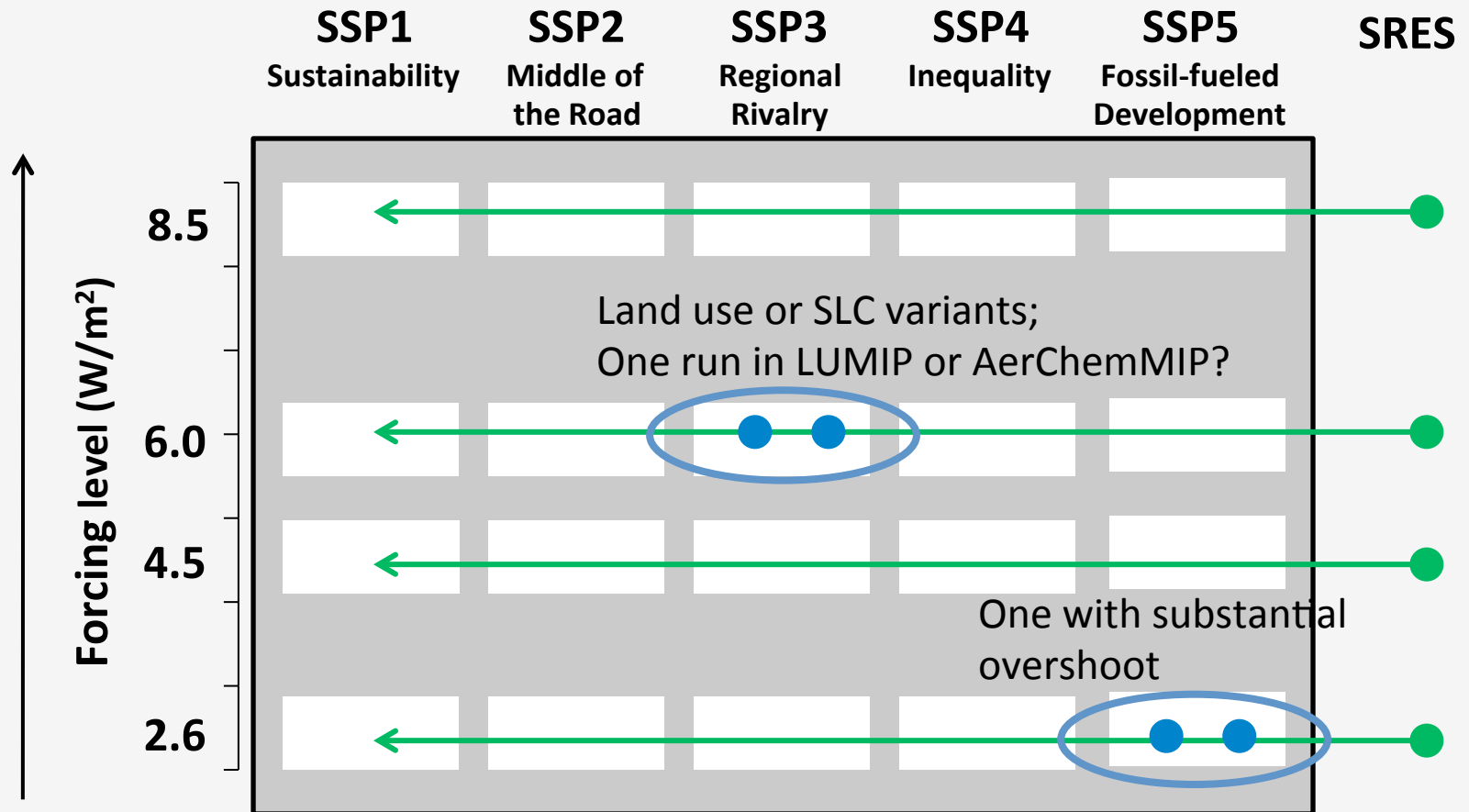
## Overshoot scenario

Compare regional/global climate outcomes of substantial overshoot scenario (possibly relative to RCP 2.6).

# Targeted Scenarios

● Original RCPs      ● RCP variants

## Shared Socioeconomic Pathways



# RCP land use/SLCF variants

## Pros

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

## Key questions

How much do we know already about how sensitive climate is to regional land use/SLCF differences?

How much more will we know in the near future?

What is the capacity of LUMIP/AerChemMIP to work together on these variants (e.g., scenario from ScenarioMIP compared with plausible variant in LUMIP/AerChemMIP)?

# Overshoot scenario

## Motivation

Interesting climate science and IAM/IAV question

Relevant to current IAM implementations of RCP2.6 (i.e., a new variant of RCP2.6?)

Potentially very relevant to policy

## Key questions

How plausible is a substantial overshoot scenario?

Is it feasible to develop a new IAM scenario with substantial overshoot within the required time frame?



# Scenario Selection: Criteria and Questions

Cover the range of climate outcomes

For how long can CMIP5 simulations be relied on to fill this need?

Do climate modelers anticipate substantial changes in projections relative to CMIP5?

Will running only a subset of the range bias research and information for policy?

What is the importance of land use/SLCF effects to scenario consistency?

Fill in the gaps in the current set of RCPs

How important is climate information for SSP baselines, RCP 3.7 scenario?

Set of scenarios should have a logic relevant to integrated communities

Address critical targeted questions about land use and SLCFs

What is the capacity for other MIPs to take on targeted scenarios?

