

# Scenarios for Impacts, Adaptation and Vulnerability Research

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JGCRI

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# Acknowledgements



**Pacific Northwest**  
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- ▶ Brian O'Neill
- ▶ Detlef vanVuuren
- ▶ Claudia Tebaldi
- ▶ Keywan Riahi
- ▶ Jae Edmonds
- ▶ Kate Calvin
- ▶ John Weyant
- ▶ Bob Vallario
- ▶ And a host of others!

# Topics Covered

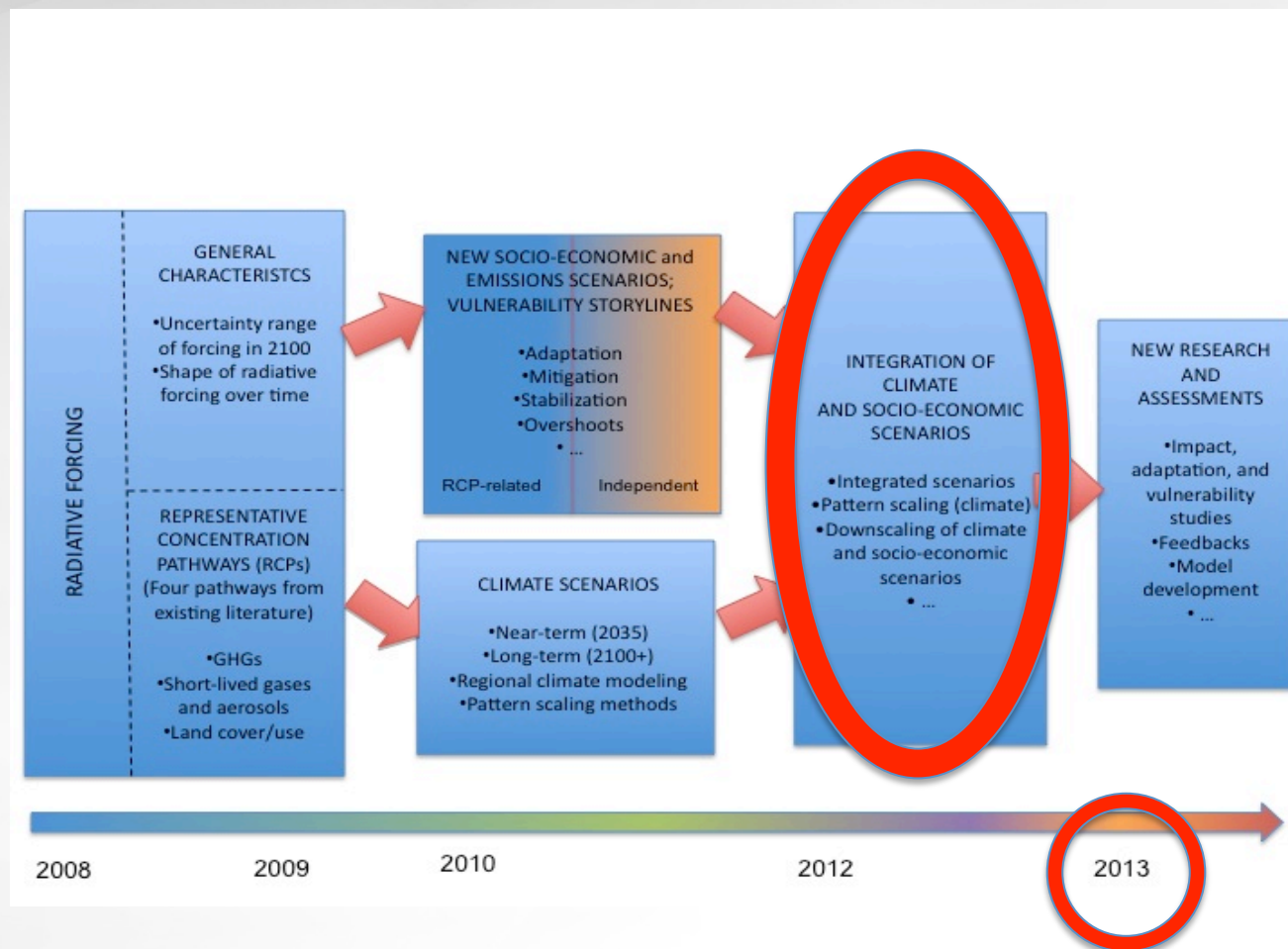
- ▶ Recap: parallel process
- ▶ RCPs, CMIP5, and climate simulations/scenarios
- ▶ Socioeconomic scenarios (SSPs) and derivative IAM scenarios
- ▶ CMIP6 planning: Scenario-MIP
- ▶ US scenarios for IAV research and agency use
- ▶ Next steps and open questions

# The Origins of the “Parallel Process”

- ▶ IAM scenarios were originally developed for (i) climate modeling; and (ii) policy analysis
- ▶ Emissions scenarios were commissioned and approved by the IPCC, and handed off in a linear process to ESMs (and IAV modelers)
- ▶ The ‘parallel process’ replaced this process and was developed for a variety of reasons
  - Increase usability of scenarios for IAV research
  - Address several research questions more systematically
    - Carbon cycle feedbacks
    - Importance of land cover and short-lived species in regional projections
    - ‘End-to-end’ analysis of implications of stabilization levels
  - Avoid re-running only slightly-modified emissions scenarios in GCMs/ESMs
  - Improve synthesis products (e.g., IPCC Synthesis Report)

# Status of Parallel Process

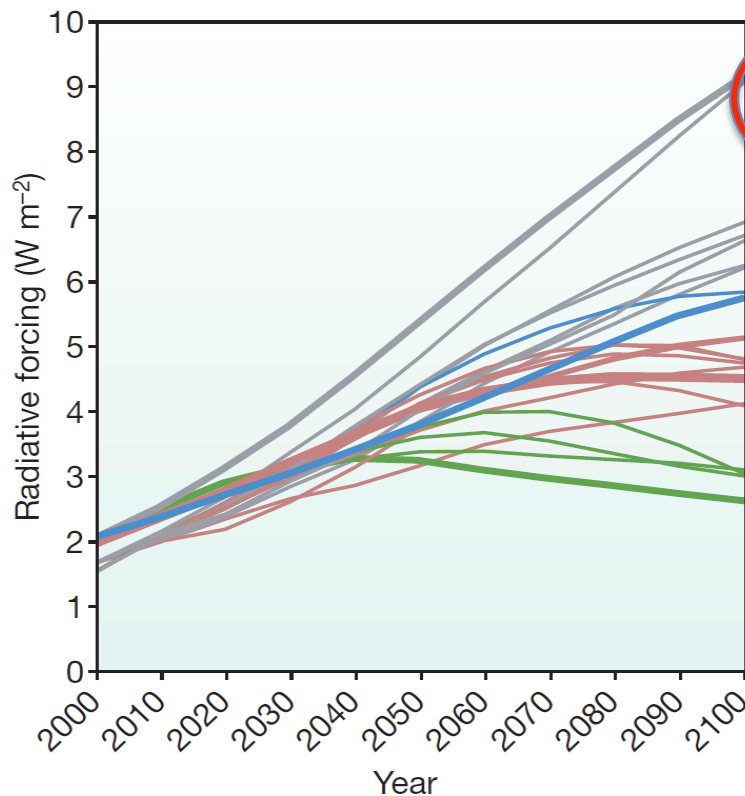
- ✓ Representative Concentration Pathways (RCPs) delivered
- ✓ New socioeconomic scenarios (SSPs) completed and IAM scenarios in development
- ✓ Planning for CMIP6 underway
- NOTE: a full cycle of the process has not yet been completed!



Source: Moss et al. 2010

# Representative Concentration Pathways (RCPs)

The climate modeling community wanted 4 levels of radiative forcing that would span the emissions literature.



## Forcings from IAMs

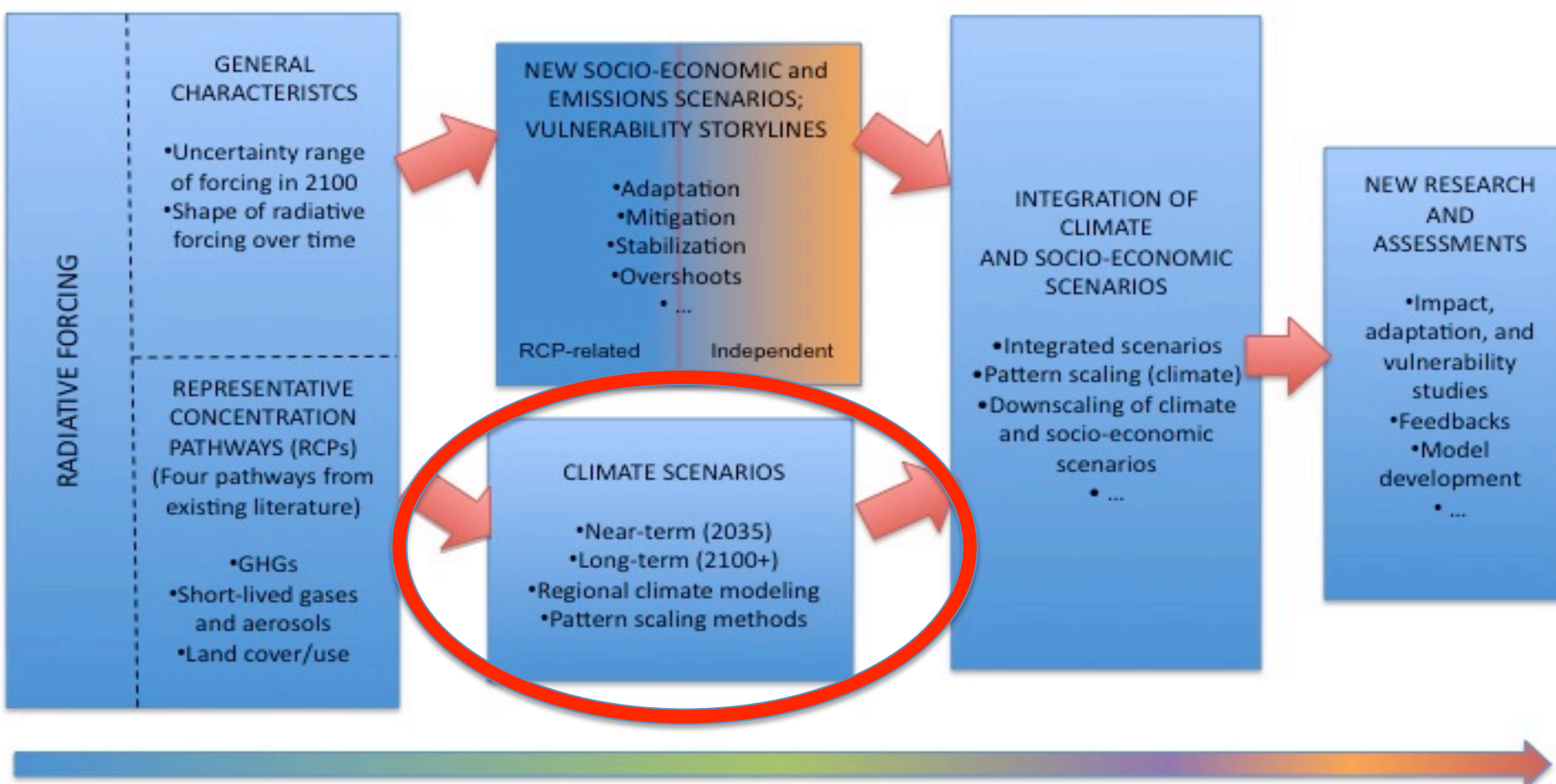
- Greenhouse gases: CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, CFCs, HFC's, PFC's, SF<sub>6</sub>
- Emissions of chemically active gases: CO, NO<sub>x</sub>, NH<sub>4</sub>, VOCs
- Derived GHG's: tropospheric O<sub>3</sub>
- Emissions of aerosols: SO<sub>2</sub>, BC, OC
- Land use and land cover [NEW]

Is RCP 8.5 the reference for the other RCPs?

**NO!**

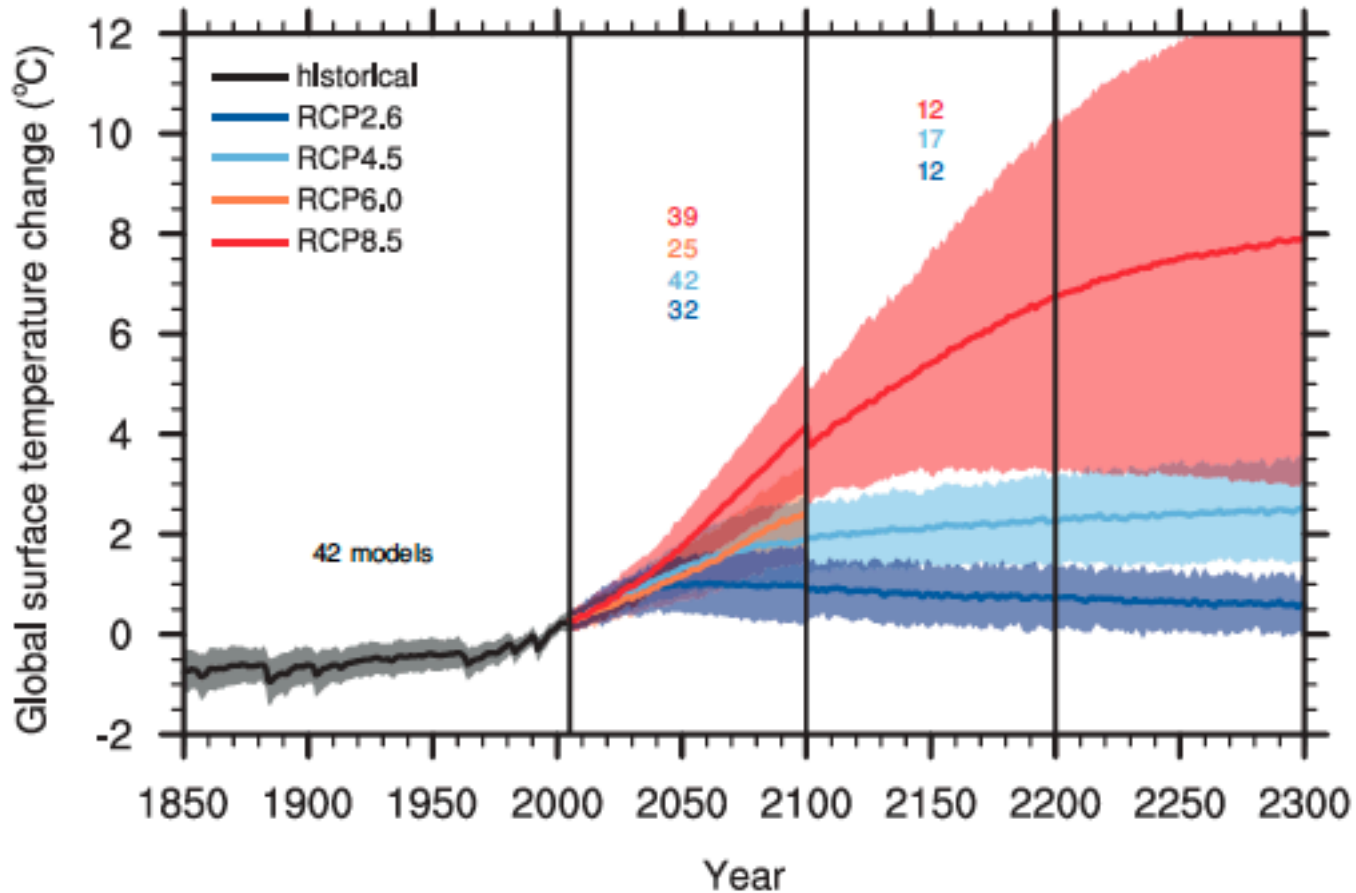


# Climate Scenarios



Source: Moss et al. 2010

# Results: CMIP5, RCP Concentration-driven Simulations

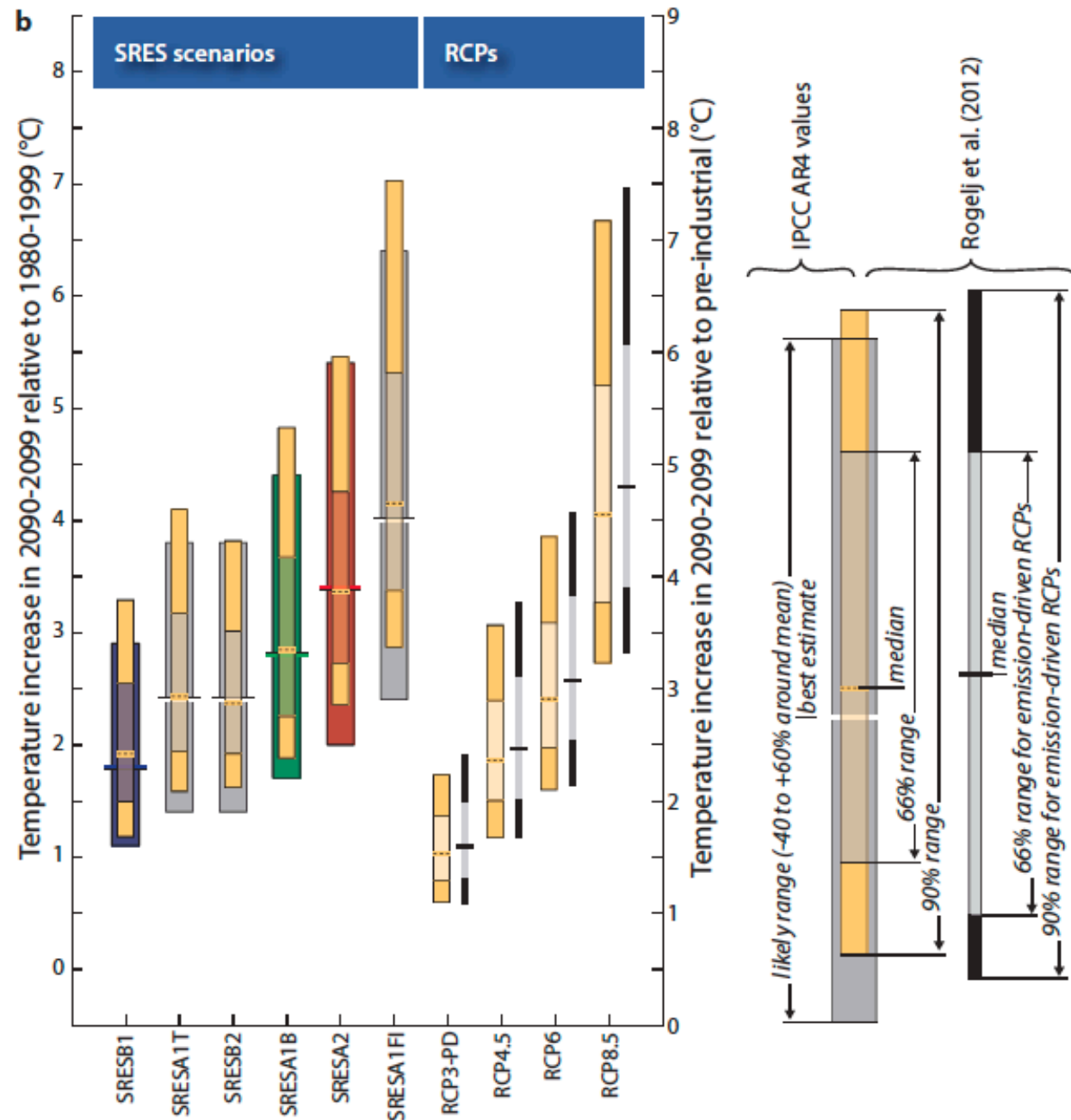


IPCC WG1, AR5, CH. 12,  
Fig. 12.5



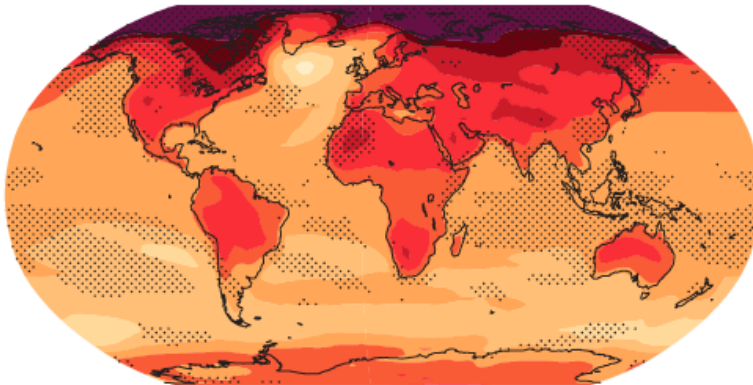
# SRES and RCP temperature projections

IPCC WG1, AR5, CH. 12,  
Fig. 12.40

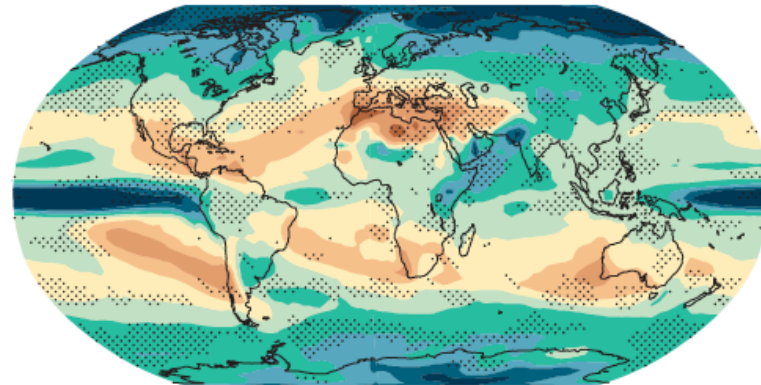


# Temperature and Precipitation Patterns: CMIP3 and 5 Compared

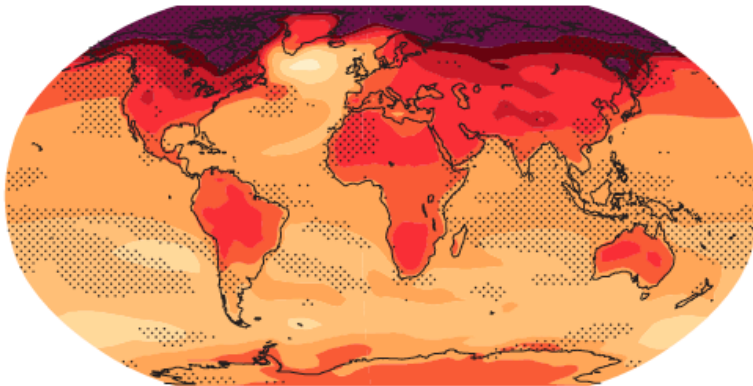
temperature scaled by global T ( $^{\circ}\text{C}$  per  $^{\circ}\text{C}$ )  
CMIP3 : 2080-2099



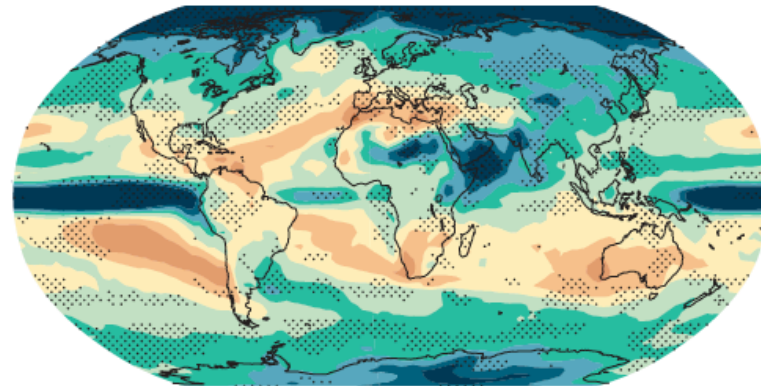
precipitation scaled by global T (% per  $^{\circ}\text{C}$ )  
CMIP3 : 2080-2099



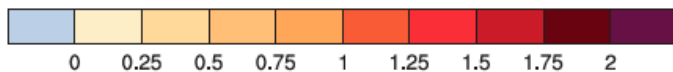
CMIP5 : 2081-2100



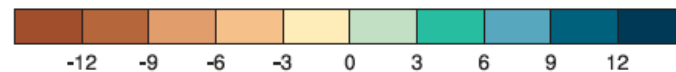
CMIP5 : 2081-2100



( $^{\circ}\text{C}$  per  $^{\circ}\text{C}$  global mean change)



(% per  $^{\circ}\text{C}$  global mean change)



# RCP-Based Climate Data

[http://ipcc-data.org/sim/gcm\\_monthly/AR5/index.html](http://ipcc-data.org/sim/gcm_monthly/AR5/index.html)

## Data Distribution Centre

ipcc  
INTERGOVERNMENTAL PANEL ON climate change

WHO UNEF

Google™ Custom Search   **Advanced search**

Location: [Home](#); [Data](#); [Simulations](#); [AR5](#);

### AR5 GCM data

Climate model results provide the basis for important components of IPCC assessments, including the understanding of climate change and the projections of future climate change and related impacts. The IPCC's Fifth Assessment Report (AR5) relies heavily on the [Coupled Model Intercomparison Project, Phase 5 \(CMIP5\)](#), a collaborative climate modelling process coordinated by the [World Climate Research Programme \(WCRP\)](#).

The CMIP5 archive has evolved through and beyond the IPCC 5th Assessment process, with modelling groups eager to contribute their best available data to the research community. The IPCC DDC provides access to two snapshots of the CMIP5 archive in the World Data Center Climate (WDCC):

- (i) [the IPCC Working Group I snapshot](#), and
- (ii) [the DDC Reference snapshot](#).

The IPCC WGI snapshot was collected at ETH Zurich to support the [IPCC WGI AR5](#) assessment process, including the production of CMIP5-based figures in the WGI AR5 report. This dataset is a subset of the data in the CMIP5 archive on March 15, 2013 (the cutoff date for literature to be included in the WGI AR5 report). A selected subset of this data can be ordered on storage media, details are given [here](#).

The DDC Reference snapshot was collected by the [World Data Center Climate \(WDCC\)](#) at the [DKRZ](#) in Germany, the [British Atmospheric Data Centre \(BADC\)](#) in the UK and the [Program for Climate Model Diagnosis and Intercomparison \(PCMDI\)](#) University of California in the US. The DDC Reference snapshot is more extensive than the WGI snapshot: It contains data that was discussed in the scientific literature and thus contributed indirectly to the IPCC 5th Assessment Report. The reference snapshot is also based on the status of the CMIP5 data archive as of March 15, 2013.<sup>1</sup>

CMIP5 data provided through the IPCC DDC has undergone a [quality control procedure](#). To find individual information on data, data creation and data quality for an experiment, please follow the links in the tables on the two data access pages above.

As noted above, the CMIP5 archive is evolving and in some cases the data used in the IPCC 5th Assessment Report may have been superseded. Latest versions for all experiments are available in the Earth System Grid Federation (ESGF) at [http://cmip-pcmdi.llnl.gov/cmip5/data\\_portal.html](http://cmip-pcmdi.llnl.gov/cmip5/data_portal.html). For corrections of data sets published under later versions please look at the [errata page](#) hosted by PCMDI.

Further information on CMIP5 can be found on [this page](#), including:

- [experiment design](#),
- [requested variables](#),
- [output format NetCDF/CF](#) (Information on NetCDF tools), and
- [output structure - Data Reference Syntax](#).

#### CMIP5 Data License Statement

These data were first published under the license of CMIP5. Terms of use for CMIP5 are applied for DDC-AR5 data. They are provided at <http://cmip-pcmdi.llnl.gov/cmip5/terms.html>. Data from some modelling centres are licensed for use in non-commercial research and for educational purposes, other for unrestricted use. Please refer to the [terms of use for the CMIP5 modeling groups](#) for details.

DDC-AR5 data should be cited by its DataCite DOI and according to the [citation recommendation of CMIP5](#).

#### Acknowledgements:

The World Data Center for Climate (WDCC) acknowledges the international modeling groups for providing their data for analysis, the Program for Climate Model Diagnosis and Intercomparison (PCMDI) for collecting and distributing the model data, the JSC/CLIVAR Working Group on Coupled Modelling (WGCM) and their Coupled Model Intercomparison Project (CMIP) and Climate Simulation Panel for organizing the model data analysis activity, and the IPCC WG1 TSU for technical support.

This work, including access to the data and technical assistance, is provided by the German Climate Computing Centre (DKRZ), with funding from the Federal Ministry for Education and Research.

<sup>1</sup> Please note that the full CMIP5 data archive continues to be updated with new results, corrections etc. in contrast to the two archives available from the DDC.

Content last modified: 22 April 2014

**IPCC Site**

**DDC Home**

**About the DDC**

**Guidance on the use of data**

**Scenario process for AR5**

**Data: Observations**

**Data: Simulations**

**SRES Emissions scenarios**

**IS92 Emissions scenarios**

**Projected CO2 emissions and concentrations**

**Climate model output**

**AR5 (2013)**

**AR4 (2007): SRES scenarios**

**TAR (2001): SRES scenarios**

**SAR (1995): IS92 scenarios**

**FAR (1990): 1st Assessment report**

**Climate model: period-averages**

**Climate model: global-means (AR4)**

**Data: Synthesis**

**Visualisation**

**Quick links**

**IPCC Reports**

 **DKRZ**  
DEUTSCHES KLIMARECHENZENTRUM

 **WDCC**  
CLIMATE

# New RCP Simulations of Interest

## CESM RCP8.5 Large Ensemble

1920-2080

30 members, different initial conditions

See <http://www2.cesm.ucar.edu/models/experiments/LENS>

## CESM RCP4.5 Medium Ensemble

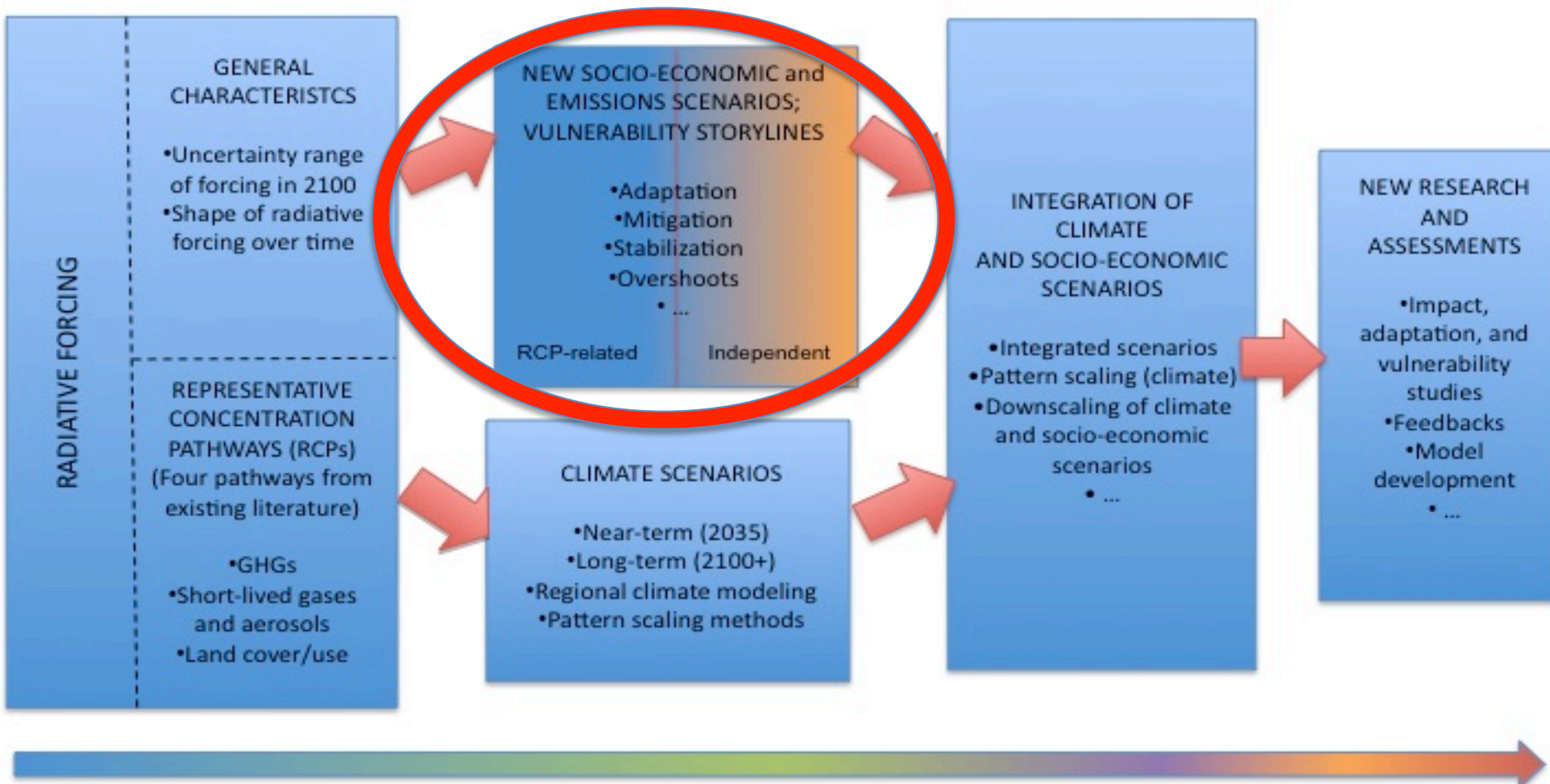
Same protocol as Large Ensemble

~15 members

Still in production, tentatively available in fall or winter

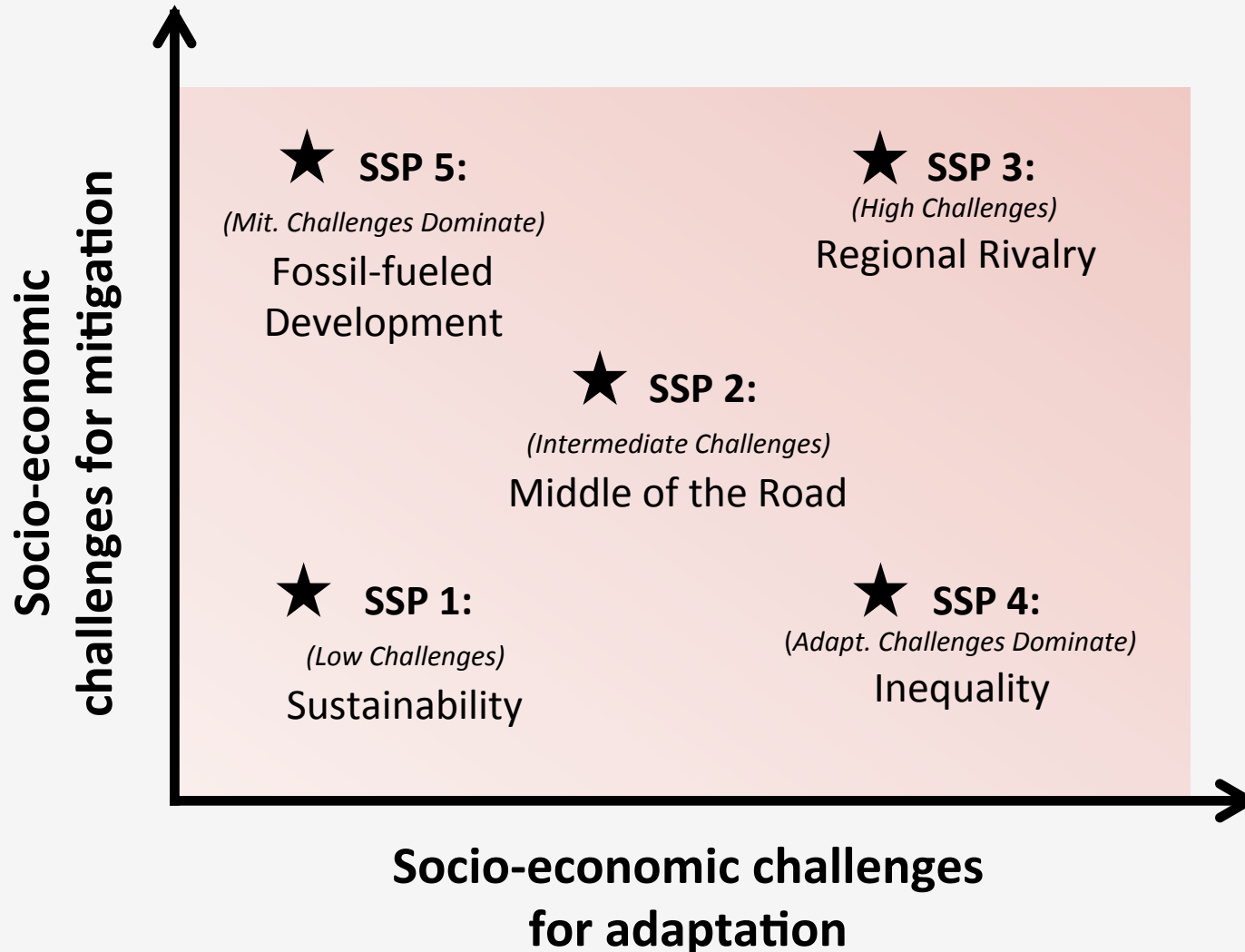


# Socio-Economic Scenarios: SSPs



Source: Moss et al. 2010

# SSP Logic and (Final?) Names





# Shared Socioeconomic Pathways (SSPs)

## Narrative

Qualitative description

of broad pattern  
development

Logic relating elements  
of narrative to each  
other

## Quantitative

Population

Education

Urbanization

Income

**SSP1** Sustainability

Middle of the Road

Global Rivalry

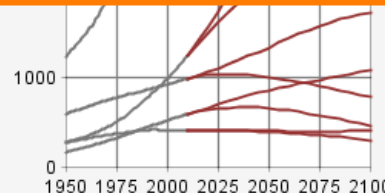
Quality

Fossil-fueled Development

Which SSP is the reference for the other  
SSPs?

**Each SSP is a  
reference scenario  
and will have policy  
variants (SPAs)**

Country-specific data, all  
available in  
base hosted by IIASA

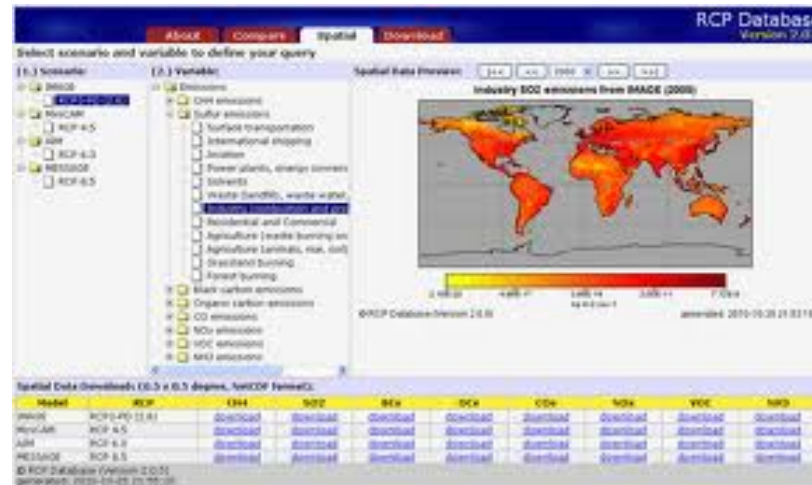


Source: Brian O'Neill

# Development of Socioeconomic Scenarios Based on SSPs – IAM Quantification

- ▶ Six IAM teams are working to develop scenarios based on the SSPs

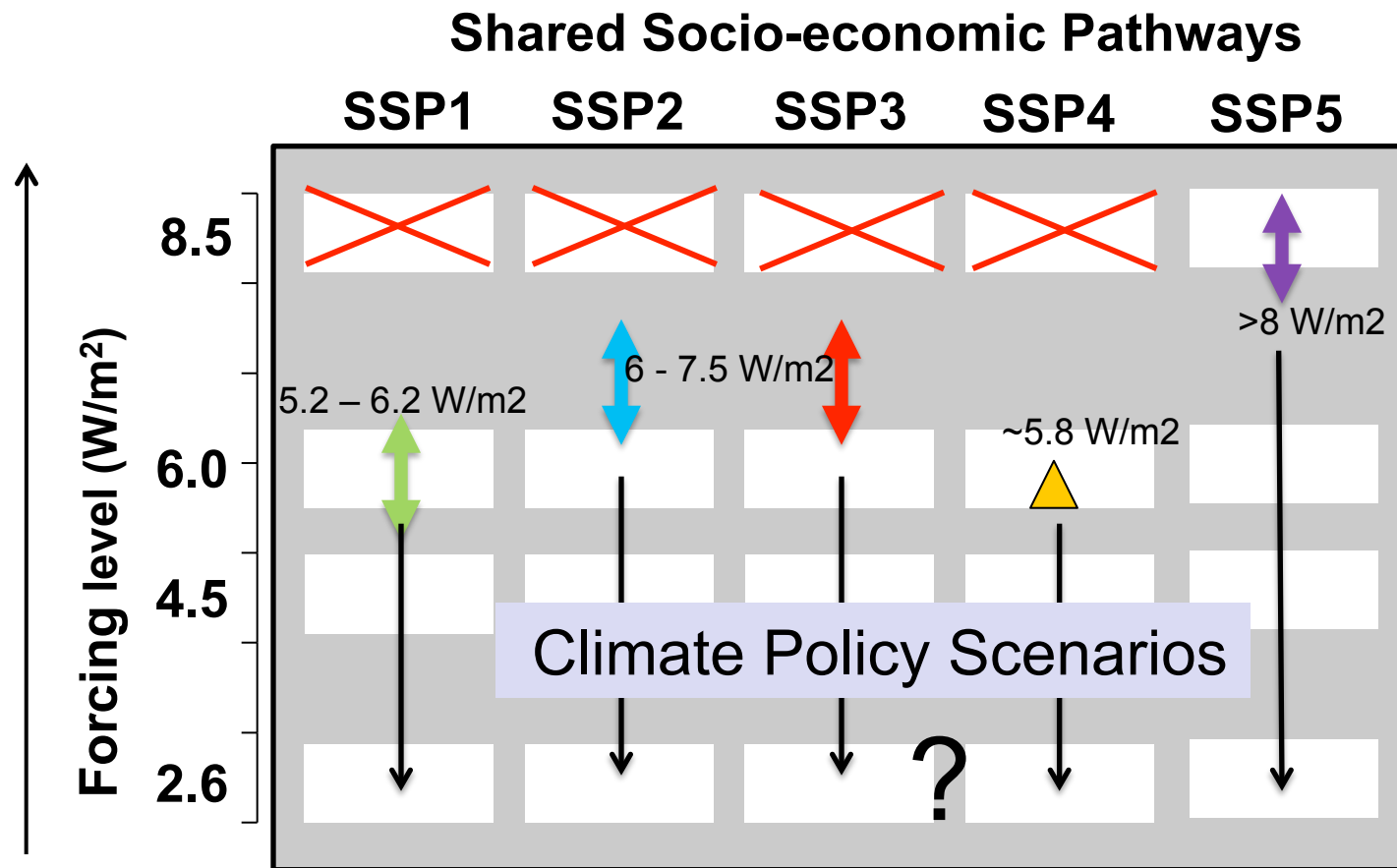
- AIM
- GCAM
- IMAGE
- MESSAGE
- ReMIND
- WITCH



IIASA RCP Data  
Archive

- ▶ SSP Reference Scenarios AND Mitigation Scenarios designed to allow matching to CMIP5 climate scenarios

# SSP/RCP combinations based on reference IAM scenarios



# Shared Policy Assumptions

## Key:

**F1:** Fragmentation until 2020, and full regional cooperation thereafter.

**F2:** Fragmentation until 2020, and linear transition to a globally uniform carbon price by 2040 of all countries. [RCP2.6 feasibility test]

**F3:** Fragmentation until 2020, after which model regions with an average per capita income of \$12600\$/yr join

**LP:** Price all land use emissions at the level of carbon prices in the energy sector

**LN:** Limited pricing of land use emissions, due to major implementation barriers and in order to limit impact on food prices

**LD:** Price all land use emissions at the level of carbon prices in the energy sector, unless this leads to afforestation or elimination of deforestation before 2030, in which case the control of CO2 land use emissions (but not the pricing of Non-CO2 agricultural emissions) should be reduced, at least until 2030

<b>SSP5-SPA5:</b> F2 + LP (high mitigation challenge due to the combination of high fossil fuel baseline emissions, very high energy demand, and delays in mitigation (for some regions up to 2040) (F2))		<b>SSP3-SPA3:</b> F3 + LN  (high mitigation challenge due to high baseline emissions, major delays (F3), and very limited participation of land in mitigation (LN))
	<b>SSP2-SPA2:</b> F2 + LD (intermediate mitigation challenge due to intermediate assumptions for i) baseline emissions, ii) energy demand, iii) delays (F2), and iv) land participation (LD))	
<b>SSP1-SPA1:</b> F1 + LP (low mitigation challenge due to the combination of low baseline fossil fuel emissions, low energy demand, no delays beyond 2020 (F1), and full participation of land mitigation)		<b>SSP4-SPA4:</b> F1 + LD (or F1 + LN)  (low mitigation challenge due to no delays beyond 2020 (F1), relatively low energy demand combined with intermediate assumptions for land mitigation (LD) and intermediate assumptions for baseline emissions). Challenges in SSP4 will most likely be between SSP1 and SSP2.

A

# ICONICS

► Co-Chairs: Kris Ebi and Tom Kram

► Goals:

- Complete SSPs
- Establish coordinating 'infrastructure' for IAV-IAM agenda for scenario application

► Working Groups

- SSP Narratives
- IAV-IAM Handshake
- IAM quantitative drivers
- IAV quantitative elements
- Nested scenarios
- Roadmap for future IAV-IAM collaboration on scenarios

► Website:

- Thanks to Bas van Ruijven!

The screenshot shows the official website of the International Committee on New Integrated Climate Change Assessment Scenarios (ICONICS). The header includes navigation links for CGD Home, NESL, About, Sections, Modeling, Research, Publications, Events, Opportunities, People, and For Staff. The main banner features a world map and the text 'ICONICS | International Committee on New Integrated Climate Change Assessment Scenarios'. Below this is a section for 'Interdisciplinary Projects' with a breadcrumb trail: Home » Research » Interdisciplinary Projects. The main content area is titled 'ICONICS' and 'INTERNATIONAL COMMITTEE ON NEW INTEGRATED CLIMATE CHANGE ASSESSMENT SCENARIOS'. It describes the committee's mission to develop new socioeconomic scenarios and lists two key goals: a) Complete Shared Socioeconomic Pathways (SSPs) and b) Facilitate establishment of a research program. A sidebar on the right contains links for Home, Committee Membership, Working Groups, Events, Past Events, Publications, Projects, Outreach, and a mailing list subscription. At the bottom, there are three columns: 'UCAR/NCAR SHARE' with social media icons, 'NESL | NCAR EARTH SYSTEM LAB' with a list of divisions and contact info, and 'CGD | CLIMATE & GLOBAL DYNAMICS' with organizational charts and contact info. The page number '19' is visible in the bottom right corner.

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Search

ICONICS | International Committee on New Integrated Climate Change Assessment Scenarios

Interdisciplinary Projects Home » Research » Interdisciplinary Projects

ICONICS

INTERNATIONAL COMMITTEE ON NEW INTEGRATED CLIMATE CHANGE ASSESSMENT SCENARIOS

The ICONICS committee aims to organize the process of developing new socioeconomic scenarios to facilitate interdisciplinary research and assessment on climate change mitigation and adaptation. The **ICONICS Committee** was proposed in November 2011 in Boulder, Colorado, at the Workshop on **The Nature and Use of New Socioeconomic Pathways for Climate Change Research**. Shortly thereafter, members of the IAM and IAV communities self-organized a Joint IAV-IAM Committee on Development and Use of Socioeconomic Scenarios to:

a) Complete Shared Socioeconomic Pathways (SSPs) including narratives and quantification from models and other sources; and

b) Facilitate establishment of a research program and limited coordinating infrastructure for a long term IAV-IAM agenda for development and application of integrated scenarios beyond the IPCC AR5.

The work of the committee is organized into several **working groups**.

More information on the process of developing new socioeconomic scenarios can be found here:

[Background information on the new scenario process](#)

PUBLICATIONS

All publications  
Special Issue on the Shared Socioeconomic Pathways (SSPs)  
Special Issue on the Quantification of the new Shared Socioeconomic Pathways (SSPs) for climate change research of the Global Environmental Change journal

ICONICS MAILING LIST

If you want to stay informed about the activities of the ICONICS committee and other news on the development of the new socioeconomic scenarios for climate change research, please subscribe to our **ICONICS Mailing List**.

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CGD Division Office  
Phone: 303.497.1740  
Fax: 303.497.1314

19

# Data availability and resolution

All data will be publicly available at the SSP database

Already available (national data)

GDP

Population (structure, education, tot)

Urbanization

IAM scenario data by end of the year

Energy

Land-use

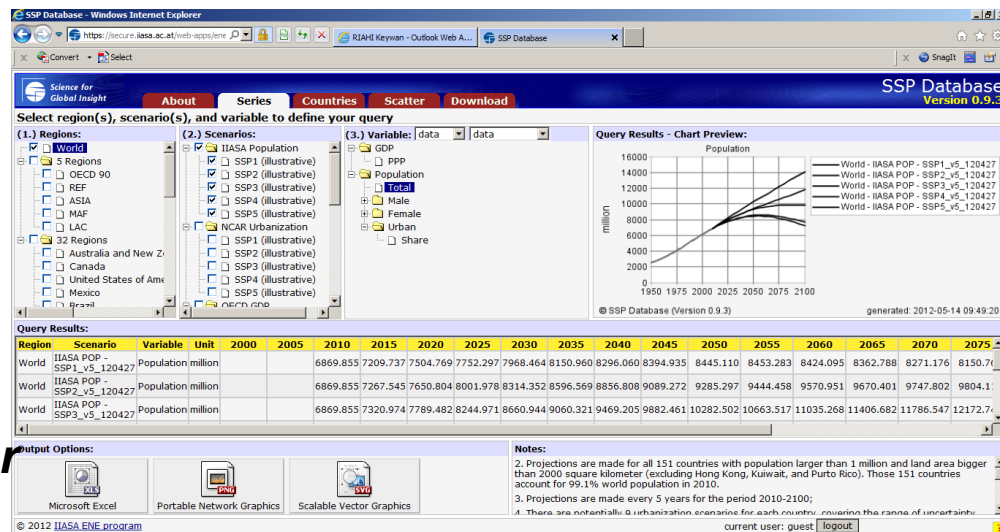
Emissions

Forcing & Temperature

Other relevant indicators (energy/carbon price, economic feedbacks, etc..)

Resolution: 5 World Regions (more details available from IAM teams 10-26 regions)

At the moment there are no concrete plans for spatial downscaling (assess user needs)  
(individual efforts for downscaling: NCAR, IMPRESSIONs, IIASA, and other projects)



<https://secure.iiasa.ac.at/web-apps/ene/SspDb>



# SSP Timeline

- Beta-version of IAM scenarios will become available for comments by end of 2014
- Submission of selected papers (eg overview paper) around the same
- Parallel community/paper review
- Present beta-SSP scenarios at the IPCC Scenarios Meeting in February (not fixed yet!)
- Finalization of scenarios and SI mid 2015

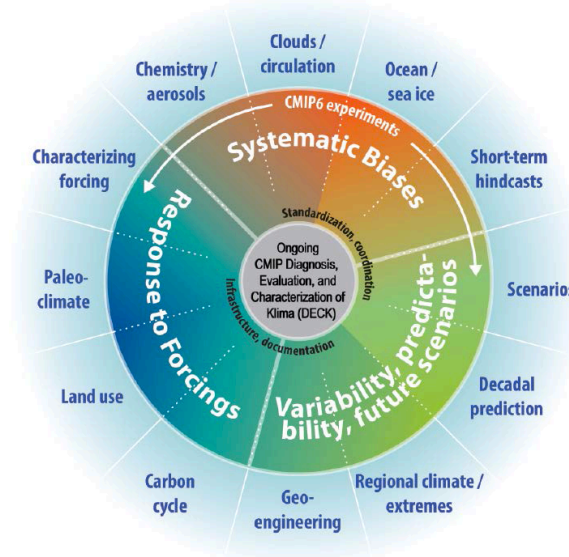
# Organizing Interdisciplinary Model Intercomparisons

## Objective

- Coordinate the next phase of climate science using stylized experiments and scenarios

## Approach

- Through 2 workshops, participants identified emerging issues for the Coupled Model Intercomparison Project 6<sup>th</sup> phase (CMIP6)
- Three themes were identified: Earth system response to forcing; systematic model biases; and variability, predictability, and uncertainties.
- A small set of standard experiments are planned for model diagnosis and evaluation.
- Additional topics are addressed through specialized MIPs which model teams can join given interest and resource constraints.



**Proposed experimental design for CMIP6. The inner circle describes experiments that all CMIP participants would join. The middle ring shows broad science topics to be addressed in specific MIPs depicted in the outer ring. A new ScenarioMIP is developing coordinated experiments with IAM and IAV researchers.**

## Impact

- While CMIP5 analyses will continue, plans for CMIP6 must be developed to coordinate future model experiments.
- Possible foci for scenarios includes overshoot futures, short-lived climate forcers, land use, and climate risk at different forcing levels.
- Additional workshops in 2014 and 2015 are planned to continue the planning process.

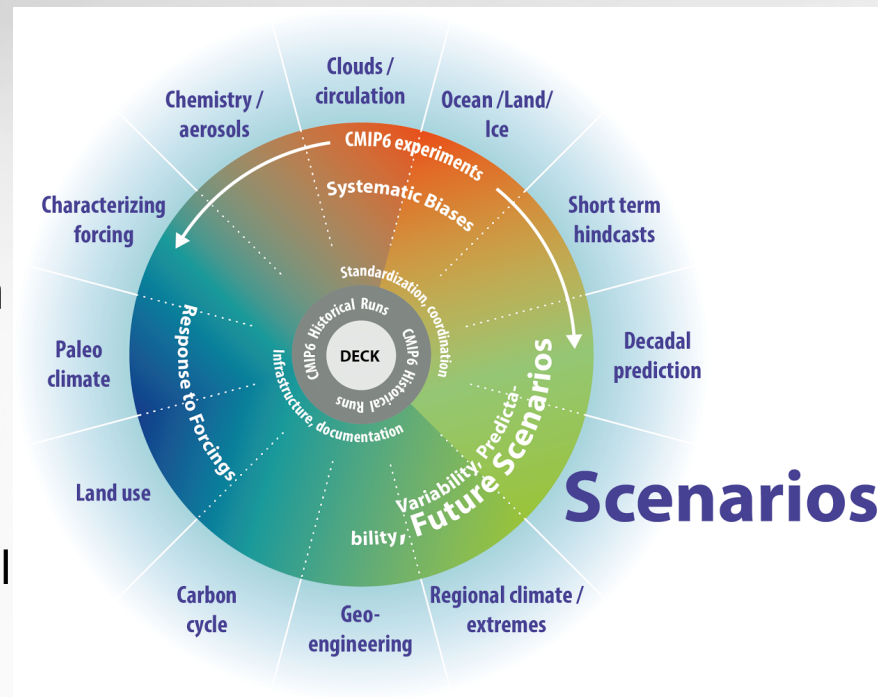
# Overview of MIPs that have applied for CMIP6 Endorsement

- Applications must develop a proposal that follows an extensive template

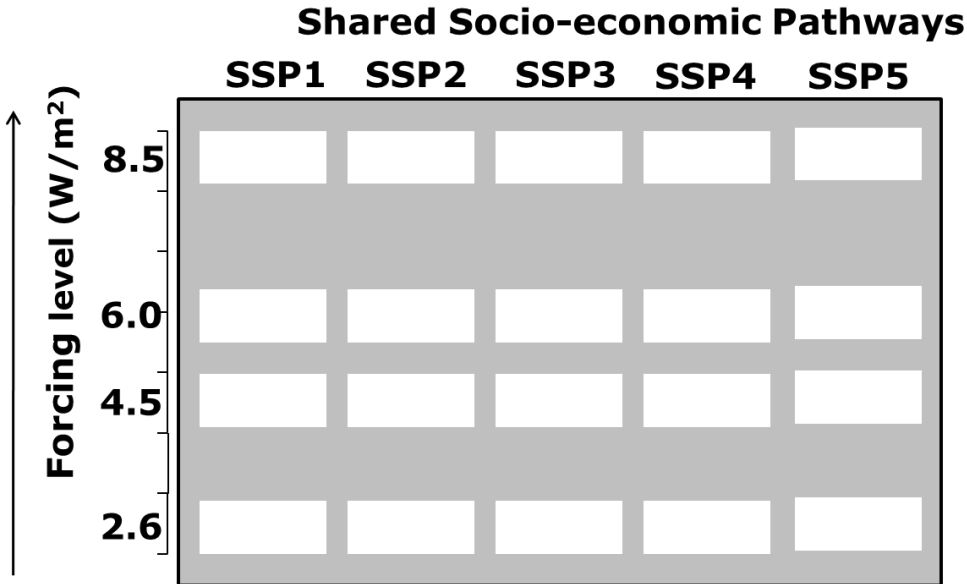
	Short name of MIP	Long name of MIP
1	AerChemMIP	Aerosols and Chemistry Model Intercomparison Project
2	C4MIP	Coupled Climate Carbon Cycle Model Intercomparison Project
3	CFMIP	Cloud Feedback Model Intercomparison Project
4	DAMIP	Detection and Attribution Model Intercomparison Project
5	DCPP	Decadal Climate Prediction Project
6	FAFMIP	Flux-Anomaly-Forced Model Intercomparison Project
7	GDDEX	Global Dynamical Downscaling Experiment
8	GeoMIP	Geoengineering Model Intercomparison Project
9	GMMIP	Global Monsoons Model Intercomparison Project
10	HighResMIP	High Resolution Model Intercomparison Project
11	ISMIP6	Ice Sheet Model Intercomparison Project for CMIP6
12	JCOMM*	Coordinated Ocean Wave Climate Project
13	LS3MIP	Land Surface, Snow and Soil Moisture
14	LUMIP	Land-Use Model Intercomparison Project
15	nonlinMIP	Non-linear Model Intercomparison Project
16	OCMIP6	Ocean Carbon Cycle Model Intercomparison Project, Phase 6
17	PDRIP	Precipitation Driver and Response Model Intercomparison Project
18	PMIP	Palaeoclimate Modelling Intercomparison Project
19	RFMIP	Radiative Forcing Model Intercomparison Project
20	ScenarioMIP**	Scenario Model Intercomparison Project
21	SensMIP	Sensitivity Model Intercomparison Project
22	VolMIP	Volcanic Forcings Model Intercomparison Project
<b>Diagnostic MIPs (i.e., no proposed experiments rather requesting that certain output is archived and/or contributing to the evaluation)</b>		
23	CORDEX	Coordinated Regional Climate Downscaling Experiment
24	DynVar	Dynamics and Variability of the Stratosphere-Troposphere System
25	VIAAB	VIA Advisory Board for CMIP6

# ScenarioMIP

- ▶ Co-Chairs: Brian O'Neill; Claudia Tebaldi; Detlef van Vuuren
- ▶ Scientific Steering Committee: Pierre Friedlingstein; George Hurtt; Reto Knutti; Jean-Francois Lamarque; Jason Lowe; Jerry Meehl; Richard Moss; Ben Sanderson; Veronica Eyring
- ▶ Goals:
  - Define and recommend an experimental design for future scenarios to be part of CMIP6.
  - Support scenario-based research in IAM, IAV, and ESM communities
  - Promote integration across these communities
  - Provide IAM scenario information to climate modeling groups



# The Scenario Matrix Architecture

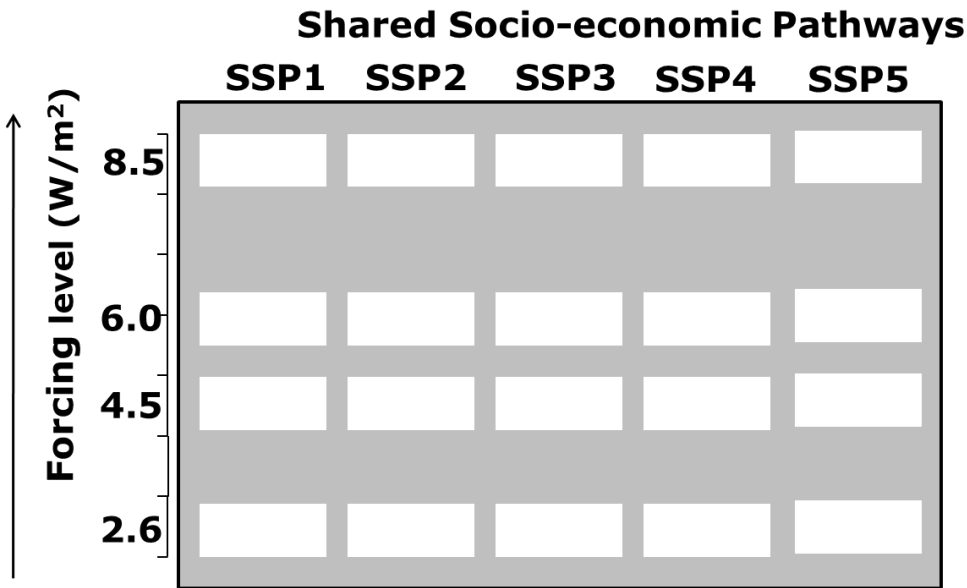


## Considerations in selection:

- Represent the full range and intermediate levels
- Be useful for specific questions in other MIPs
- Add new scenarios for specific policy questions (gap)

- Useful as design for IAV and IAM work / overall integration. But not specifically ScenarioMIP → Too many runs / problems with resolution
- How to design ScenarioMIP so that it can contribute to this scheme?
  - Options considered : Statistical sampling (EMF/AGCI), pattern scaling (workshop), selected runs [note issue of pairing IAM and CM/ESM runs]
- At this point selected runs still found to be most useful

# ScenarioMIP Experimental Design



**Exact selection complex and depends on unanswered questions:**

- Relationships with other MIPs
- Finalisation of IAM scenarios
- DECK
- Choices to be made together with relevant research communities
- Expected sensitivity of ESM models to land-use and forcing differences

**Therefore decision now to present basic idea – and further fill in early 2015.**

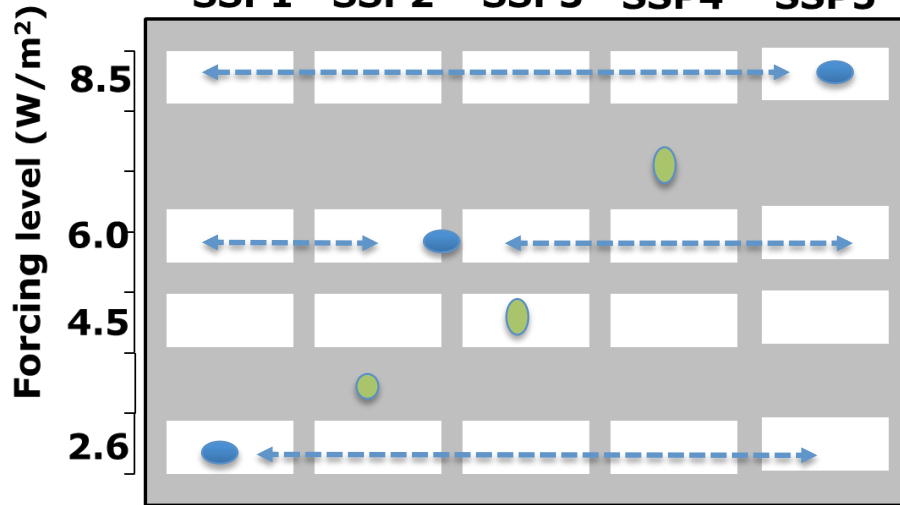
Source: Detlef VanVuuren



# ScenarioMIP Experimental Design

## Shared Socio-economic Pathways

SSP1 SSP2 SSP3 SSP4 SSP5



**Tier1 -> High/Medium/Low 3 SSP-based “RCP levels”:** new versions of RCPs based on forcings derived from the newly developed Shared Socio-Economic Pathways

**Tier2 -> High/Medium/Low 2 Gap scenarios+1 SSP-based RCP:** new pathways falling in between the RCPs, also based on the new SSPs + ensembles member for 1 tier-1



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# SCENARIOS OF CHANGE WITHIN THE U.S.

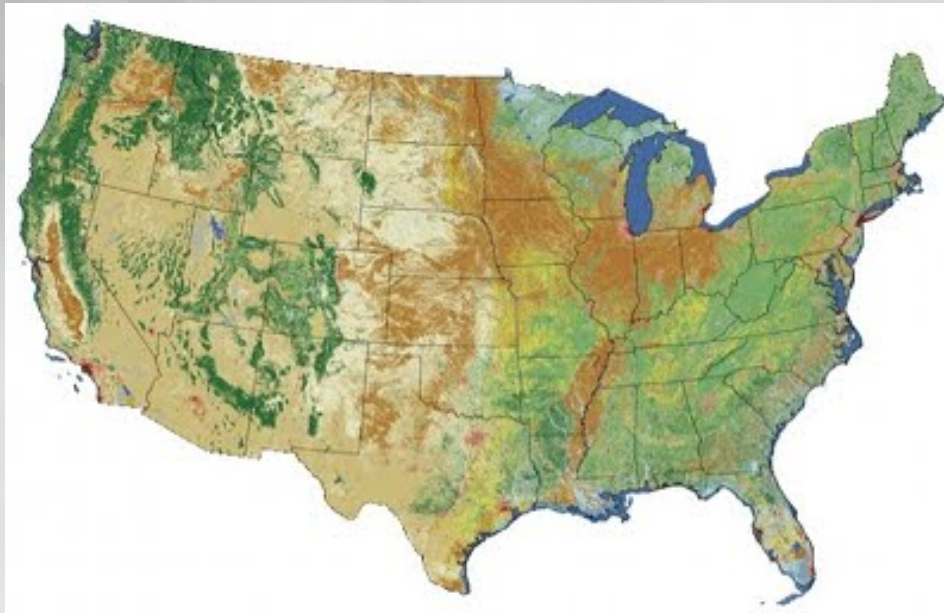
# Expanded Need for Scenarios for the United States

- ▶ National climate assessments have always required scenarios as inputs to coordinate across multiple chapters and synthesize results
- ▶ Three completed assessments have relied mostly on products produced for the Intergovernmental Panel on Climate Change
- ▶ 3<sup>rd</sup> National Climate Assessment (NCA) used existing IPCC scenarios but started to move towards development of scenarios tailored to US needs
  - Regional climate change ‘outlooks’
  - Sea level rise scenarios for evaluation of risks
  - Population and land use scenarios that downscaled IPCC results
  - Available through <http://scenarios.globalchange.gov>

# Uses of Tiered US National Scenarios

- ▶ 3<sup>rd</sup> NCA scenarios were not widely used – why?
- ▶ Several federal agencies and partners are interested in tiered national scenarios to support research and management, including
  - Vulnerability assessments and infrastructure planning and investment
  - Biomass and bioenergy assessments
  - Water resources assessments and planning
  - Fire management
  - Ecosystems assessments and conservation, including carbon accounting, biodiversity assessment, and forest and rangeland management
  - Coastal planning
  - Greenhouse gas (GHG) reporting and analysis of climate policy
- ▶ New USGCRP ‘affinity group’ created: Scenarios and Interpretive Sciences Working Group
  - Bob Vallario and Anne Grambsch, co-chairs
  - Facilitating development of a broader community of interest in scientific uses of scenarios

# Interagency Workshops on Subnational Population and Land Use/Cover Scenarios



**NLCD Land Cover Classification Legend**

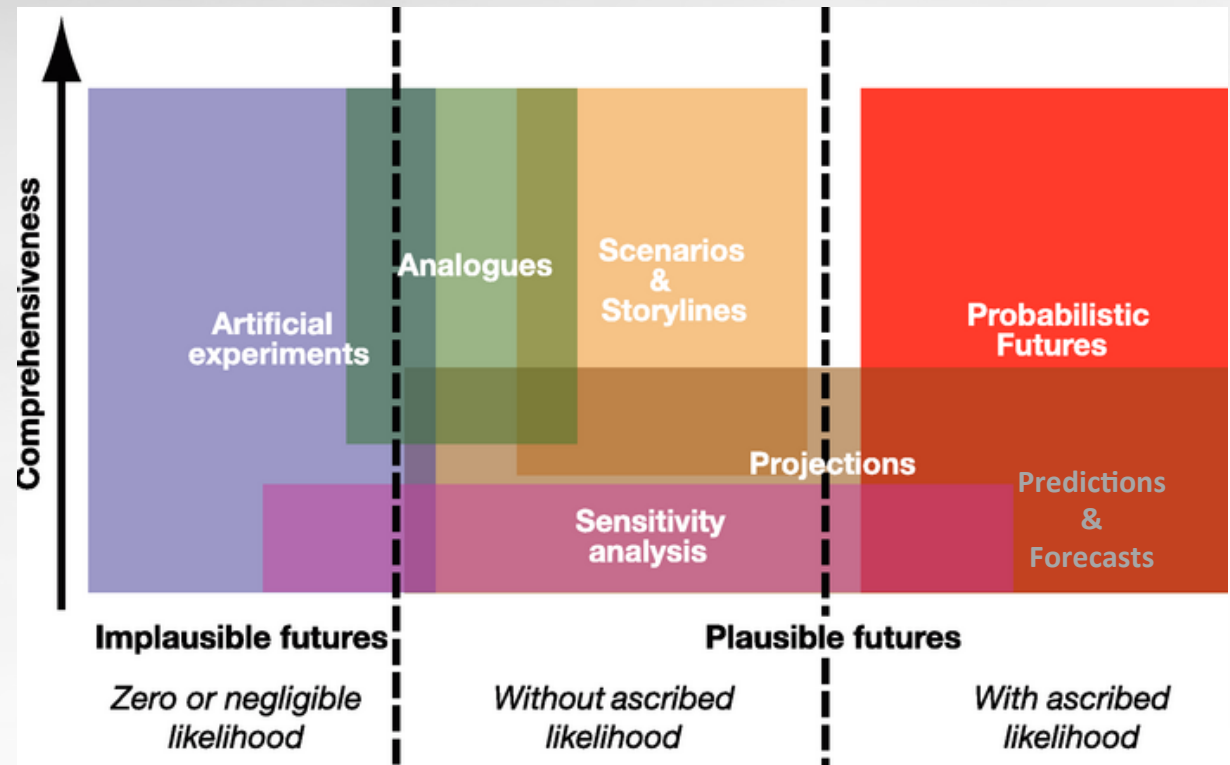
11	Open Water
12	Perennial Ice/Snow
21	Developed, Open Space
22	Developed, Low Intensity
23	Developed, Medium Intensity
24	Developed, High Intensity
31	Barren Land
41	Deciduous Forest
42	Evergreen Forest
43	Mixed Forest
51	Dwarf Scrub*
52	Shrub/ Scrub
71	Grassland/ Herbaceous
72	Sedge/ Herbaceous *
74	Moss *
81	Pasture Hay
82	Cultivated Crops
90	Woody Wetlands
95	Emergent Herbaceous Wetlands

\* Alaska Only

- ▶ Objectives: Evaluate needs and methods for preparation of national land use and population scenarios
- ▶ Topics:
  - Desired characteristics and potential uses?
    - Attributes of land use/cover and population of interest?
    - Spatial scales?
    - Time scales?
    - What uncertainties are most important?
  - Existing data and scenarios?
    - Connections to SSPs?
  - Methods?
  - Programmatic needs/issues?
- ▶ Held June 2014
- ▶ Reports and next steps pending

# Concluding Thoughts

- ▶ RCPs, CMIP5 scenarios, SSPs provide basis for IAV research
- ▶ Increasing prominence in research – non-modeling IAV research an exception
- ▶ Need to continue clarifying terminology and interpretation, especially for non-technical audiences







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# Discussion

# **Pattern Scaling, Climate Model Emulators, and their Application to the New Scenario Process**

**April 23-25, 2014, NCAR, Boulder, CO**

Sponsors: IMAGE and CGD, NCAR

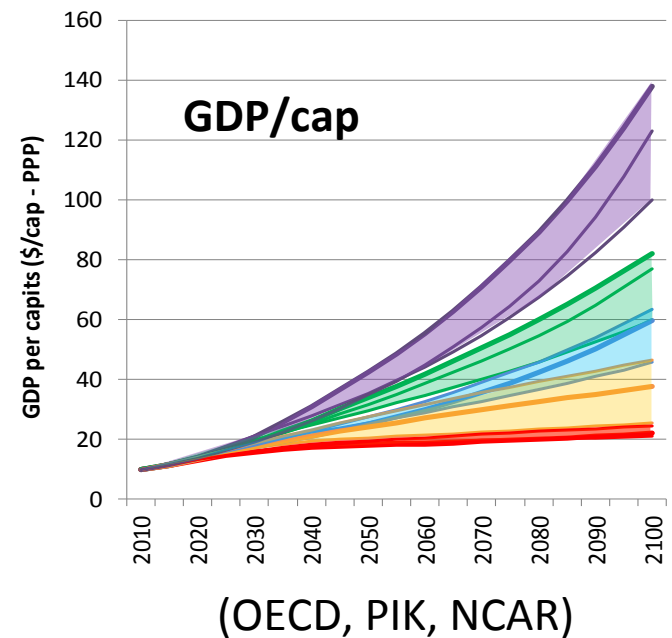
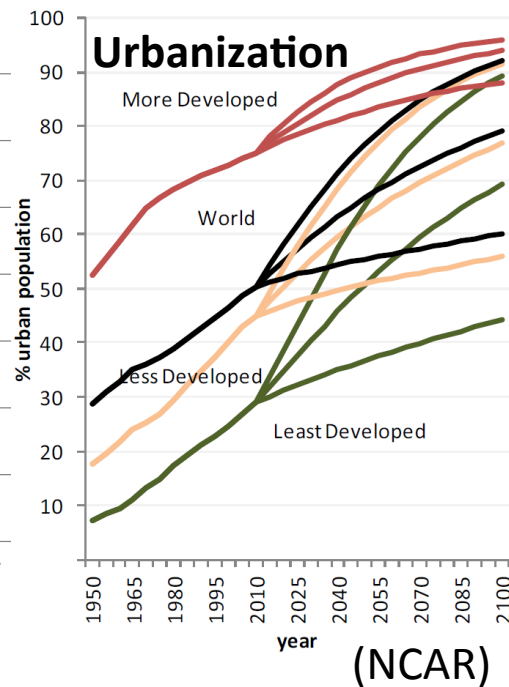
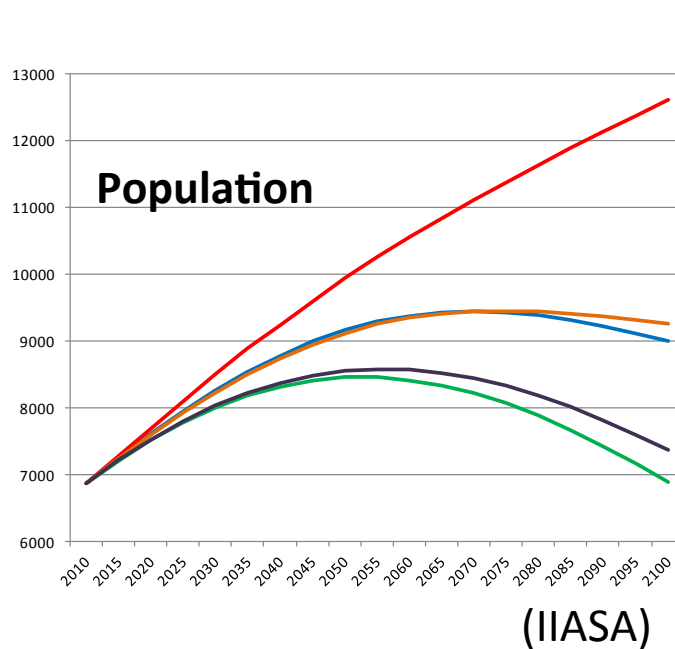
Organizing committee: Claudia Tebaldi, Brian O'Neill, Tim Carter and James Murphy

Preliminary pattern scaling/emulation  
conclusion:

*“Pattern scaling has not yet been shown to be sufficiently accurate to comprehensively meet the needs of users, such that it could substitute for GCM simulations.”*

[However, things may not be quite as bad as they seem.]

# SSP Quantitative Drivers



# Additional SSP Quantitative Information

## Within-country income distribution

Beginnings of coordination between World Bank, IIASA, University of Denver, NCAR, SEI. Need for targeted meeting.

## Global spatial population distribution

NCAR version of SSP5 complete, other SSPs by early fall

Useful to coordinate this field: MIT, US EPA, NCAR, CUNY, etc.

## Interest in additional spatial variables

Urban land cover (NCAR)

Energy/emissions (IIASA)

Population characteristics (urban/rural, age, income, education; NCAR, IIASA)

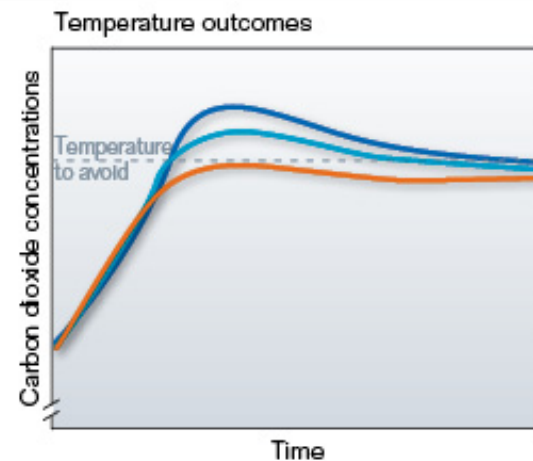
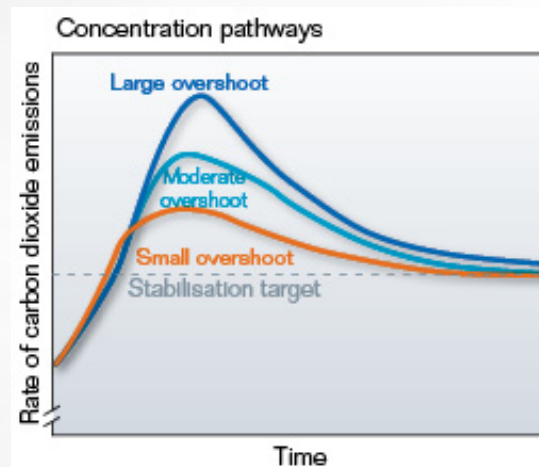
# Overshoot futures

## ► Example science questions:

- Do the carbon cycle and climate system exhibit “reversibility”?
- Is the effect of emitting a ton and withdrawing a ton of CO<sub>2</sub> symmetric?
- Are there methane feedbacks (high latitude outgassing, clathrate destabilization)?
- Does overshoot matter for ice sheets?
- Are there terrestrial system thresholds and is recovery possible?
- Technology and cost implications?
- Likelihood of overshooting concentration target and still not exceeding temperature target?

## ► Design questions:

- How high to peak?
- How fast to decline?
- Use existing CMIP5 archive?
- ECP 6 to 4.5)
- ...





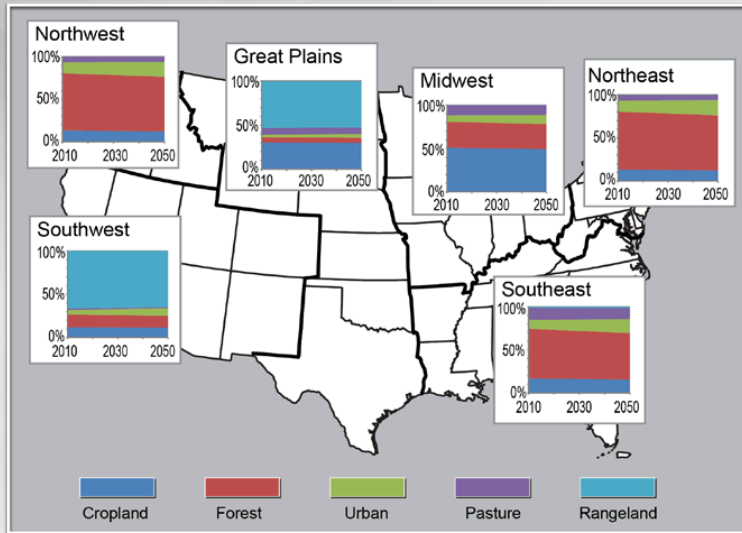
# Short Lived Climate Forcers

- ▶ Example science questions:
  - How do pollutants affect weather and climate?
  - What is the role of climate change on atmospheric composition?
  - Are there co-benefits to mitigating air pollutants and/or greenhouse gases?
  - What are climate impacts of SLCF at smaller scales (requires coordination w CORDEX community)?
  - Direct effects on terrestrial systems (e.g., crops)?
  - How large a difference in emissions is required to detect changed climate patterns at different scales?
- ▶ Design questions:
  - Variants to existing RCPs or new SSP-RCP scenarios?
  - Controlled variations in regional as well as global emissions?
  - Constant 2015 emissions as idealized high-SO<sub>2</sub> experiment?
  - How many models/ensemble members in order to support D&A of regional or global effects?



# Land use/cover change

Projected Land Covers (2010-2050)



- ▶ Example science questions:
  - Can the effects of land use and land use change on climate be isolated?
  - Cost of mitigation and energy system dynamics under different land-based mitigation options?
  - Effect on temperature, precipitation, biogeochemistry and regional patterns under different land cover scenarios? (coordinate with CORDEX?)
  - How big does the difference in land use need to be to detect changed outcomes at different scales?
  - Interactions of land use changes and water scarcity?
- ▶ Scenario design issues
  - Similar set as for SLCF – stylized experiments vs scenarios, capturing regional variation systematically, ...

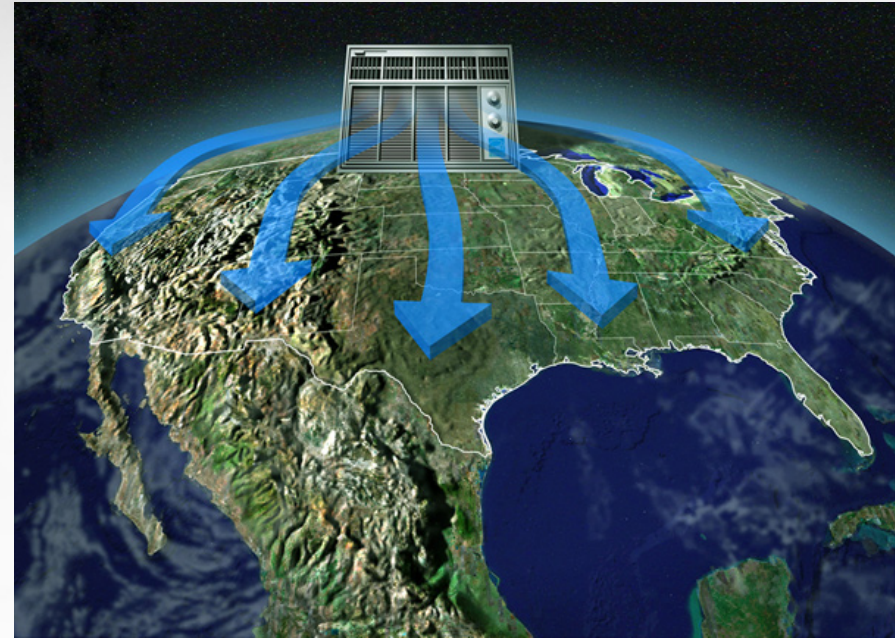
# Benefits of mitigation

## Example science questions:

- ▶ Unmitigated impacts?
- ▶ Damages avoided with different levels of mitigation?
- ▶ Sensitivity of impacts to both changing socioeconomic & climate conditions

## Scenario design issues:

- ▶ Which scenarios? What is the design philosophy? (e.g., best and worst case?)
- ▶ Tradeoffs between numbers of scenarios, ensemble size for a given scenario?
- ▶ Use of sampling matrix? – Will it work?
- ▶ ...



The Onion, 2007