Report on Inter-Community Scenario Planning Process

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Topics

- Status report on current process
- Update on recent meetings
- Update on CMIP6 planning process
- Thoughts about next steps: define research issues and continue to discuss experimental design across communities

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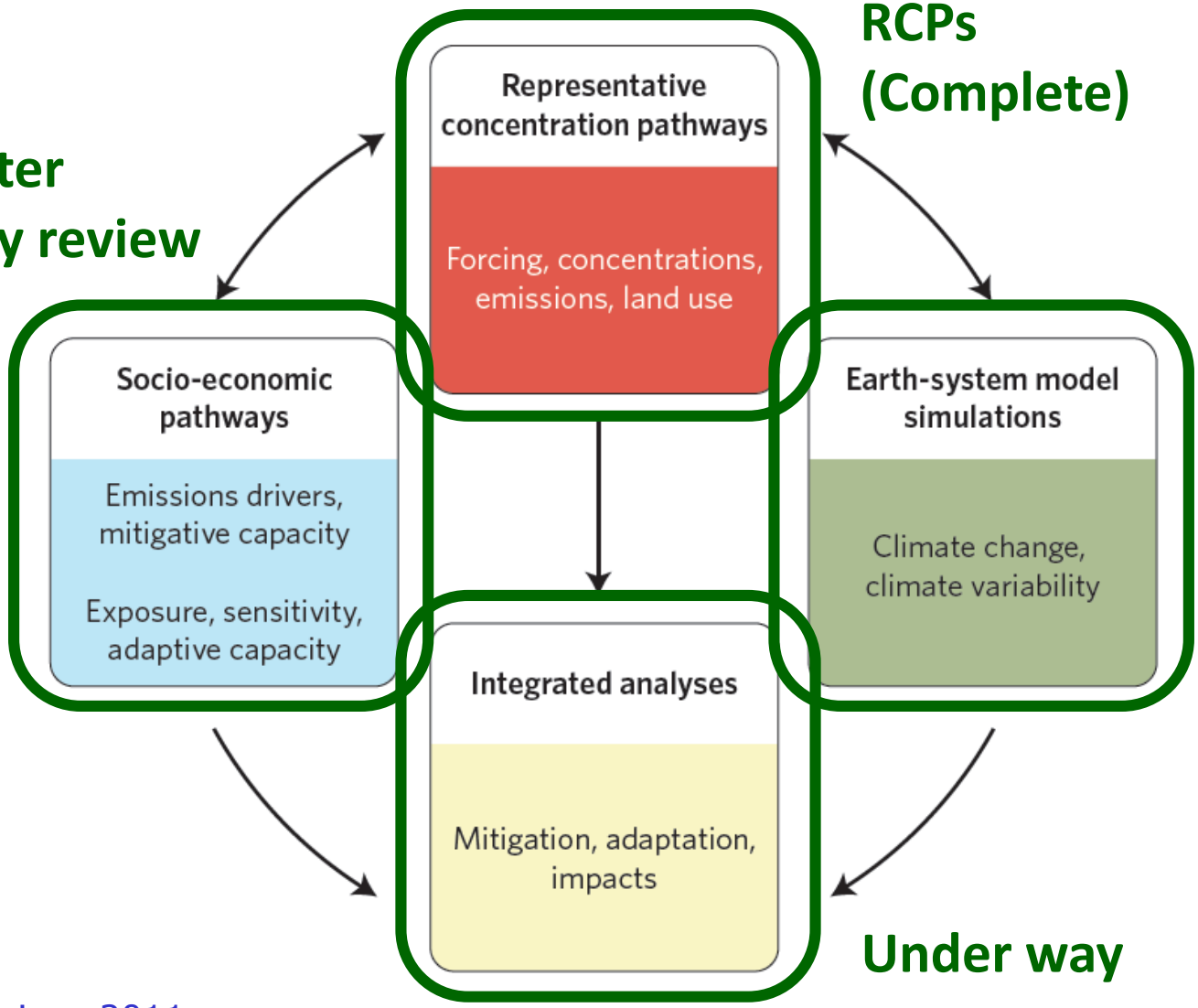
- Thanks to Jerry Meehl for the CMIP6 slides!

The Parallel Process



RCPs (Complete)

Refined after community review

CMIP5 (Initial runs complete)

Under way

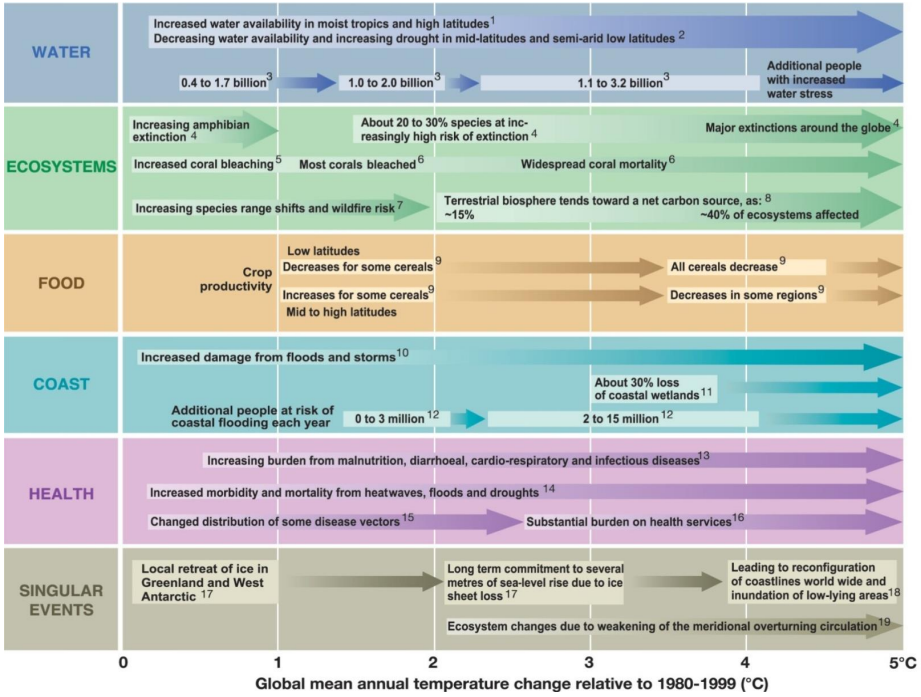
O'Neill & Schweizer, 2011.

Scenarios – what level of coordination can we achieve?

- What have we learned in the first round of the new scenario process (both scientifically and in terms of process)?
- Are we already behind?
- Can we anticipate key policy and science questions?
- What scenario research design can efficiently meet community needs and address these questions?

Why coordinate scenarios?

- Coordinate synthesis in assessments (IPCC, US NCA, …)
  - Inputs to climate modeling, e.g., SRES, RCPs
  - Inputs to diverse IAV research (in conjunction with climate scenarios)
  - Inputs to CIRA, PESETA, etc.
- Sponsors expect it
- Make a virtue of necessity: Address science and societally-relevant questions that require collaboration



IPCC AR4,
WGII, Table 20.8

A series of workshops/meetings has been informally exploring ideas for scenario coordination

- Sustainable Global Climate Mitigation Scenarios Workshop
  May 29-31, SESYNC, Annapolis MD
- Societal Dimensions Working Group Meeting
  CESM Workshop, June 20, Breckenridge CO
- Feedbacks and Uncertainties in Integrated Assessment Models and Scenarios
  EMF CCIAV, July 31-August 2, Snowmass CO
- Next Generation Climate Change Experiments Needed to Advance Knowledge and for Assessment of CMIP6
  Aspen Global Change Institute, August 4-9, Aspen CO
- US National Academy of Sciences, BASC-BECS Joint Roundtable
  November 13, Washington DC

In addition, planning for a new round of intercomparisons is also underway

- CMIP6, under auspices of World Climate Research Program, WGCM
  - Most recently at WGCM meeting with CMIP6 Panel, October 1-3, Victoria BC Canada
- EMF30 Kickoff
  - Here and now
- IAV model intercomparisons will continue
  - ISI-MIP
  - AgMIP
  - …

CMIP Update

- CMIP: A set of ongoing model development, evaluation, and characterization experiments (called the DEC)
  - To gain basic information about model performance and sensitivit

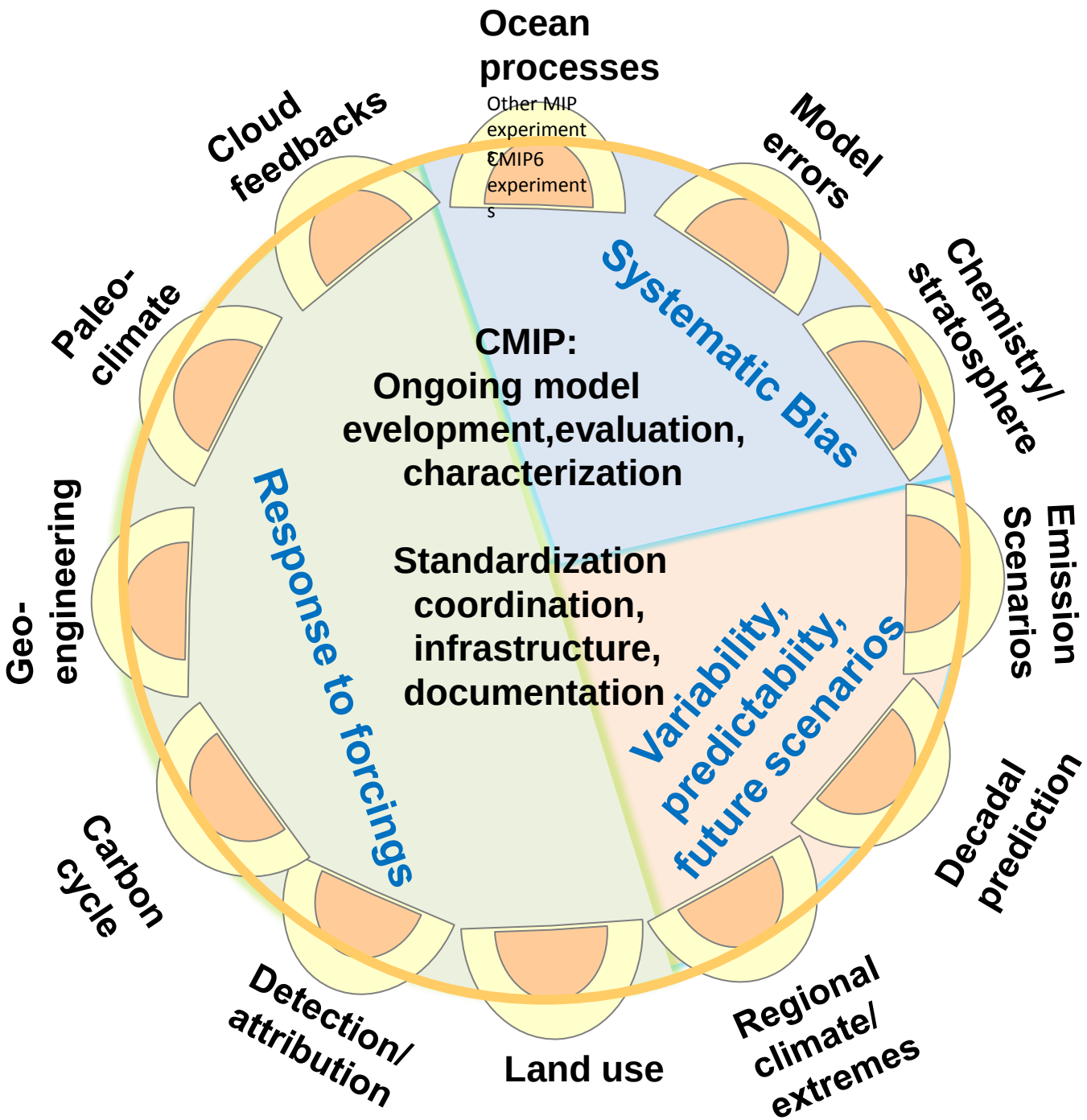
- Current thinking on DEC:

AMIP (~1979-2010)
Pre-industrial control
1%/yr CO_2 to quadrupling
Instantaneous 4xCO2
Historical simulation-> RCP8.5 as is
(concentrations for AOGCMs, emissions/concentrations for ESMs?)

- Expected to remain relatively constant –
  which is rationale for use of current RCP8.5

MIPS

- Vary across CMIP cycles (e.g., those for CMIP6 will evolve from CMIP5)
- Each MIP designs experiments that contribute to the CMIP6 science questions and thus target wider participation of many modeling groups
- Some use of “scenarios”, but mostly stylized experiments



"Scenario MIP"

Evolving membership: (not clear how formal the group is at this point…)

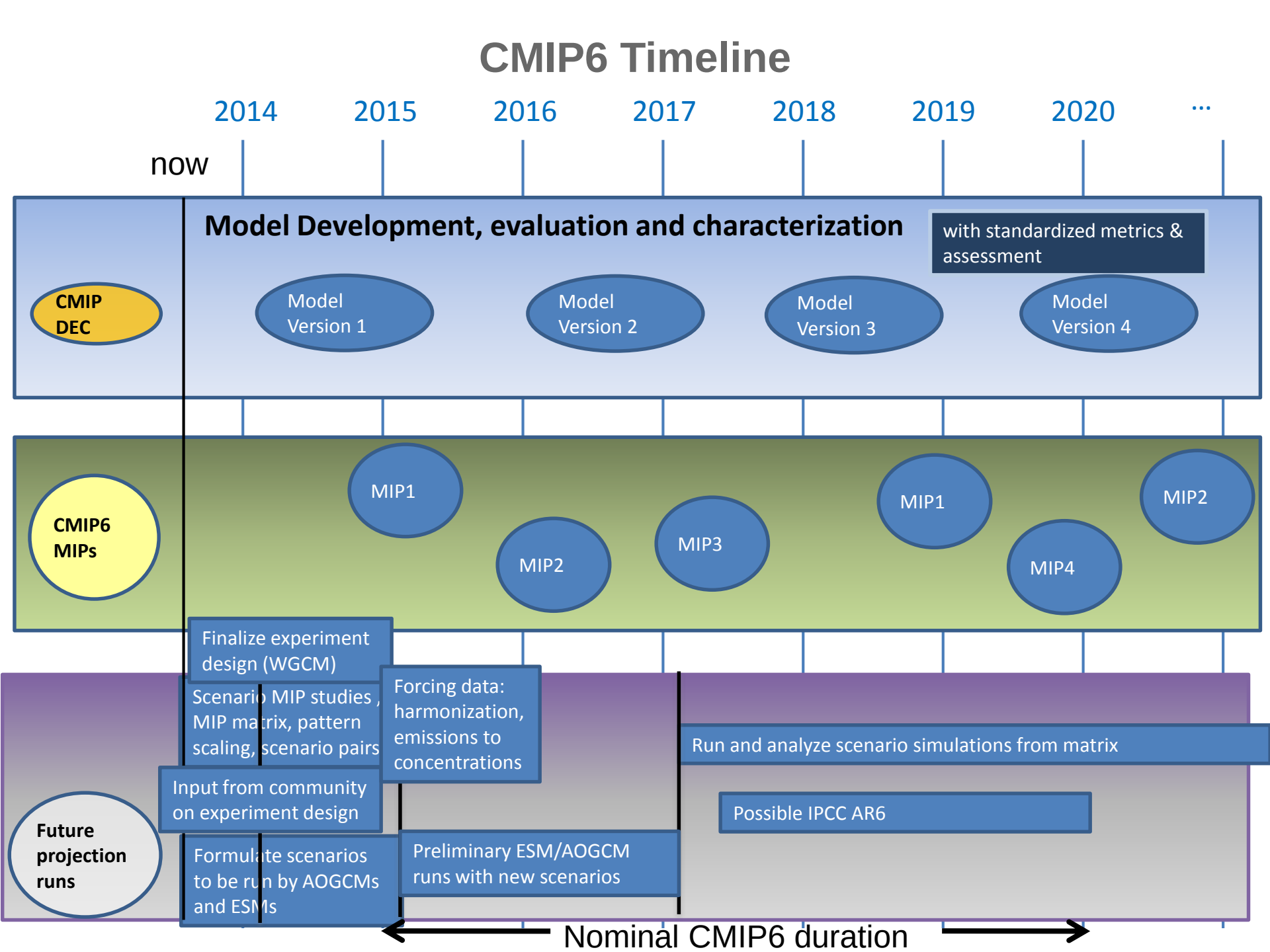
Currently: Jerry Meehl, Veronika Eyring, Claudia Tebaldi*, Wilco Hazeleger, Detlef van Vuuren*, Brian, O'Neill, Richard Moss, Ben Sander, Reto Knutti, George Hurtt, Jean-Francois Lamarque

Tasks:

1. Address pattern scaling (workshop at NCAR April 2014)
2. Conduct proof-of-concept for scenario MIP matrix --subsample CMIP5 models to see if a carefully chosen sample can produce information in the full multi-model ensemble
3. Address choice of scenario pairs considering aerosols, land use/land cover, short-lived forcers, and an overshoot scenario

A **pair of two new scenarios** (high/low) run by all models with new 20th century (to 2015) and 21st century forcings
(new emissions and concentrations need to be generated)

*Scenario MIP matrix, modeling groups that subscribe run a **pair of two additional new scenarios** (models selected to sample scenario pair space)


CMIP6 Timeline
2014
2015
2016
2017
2018
2019
2020
...
now
Model Development, evaluation and characterization
with standardized metrics & assessment
CMIP DEC
Model Version 1
Model Version 2
Model Version 3
Model Version 4
CMIP6 MIPs
MIP1
MIP2
MIP3
MIP1
MIP4
MIP2
Finalize experiment design (WGCM)
Scenario MIP studies , MIP matrix, pattern scaling, scenario pairs
Forcing data: harmonization, emissions to concentrations
Run and analyze scenario simulations from matrix
Input from community on experiment design
Possible IPCC AR6
Future projection runs
Formulate scenarios to be run by AOGCMs and ESMs
Preliminary ESM/AOGCM runs with new scenarios
Nominal CMIP6 duration

Next steps

- Window of opportunity leading up to 3rd Quarter 2014
- Define experiments that address common issues

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_2 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? (e.g., ECP 6 to 4.5)
  - …

SLCFs

- 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-SO2 experiment?
  - - How many models/ensemble members in order to support D&A of regional or global effects?

Land use/cover change

- 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:

  - 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?
  - …

How does this relate to EMF-30?

- Consider the opportunity for collaboration with the ESM and IAV research communities as you refine the questions you will address and the scenarios you will choose
- Most of what you do will likely be independently motivated
- But there is a potential benefit from trying to steer the collaboration in directions you think would be productive

Backup Slides

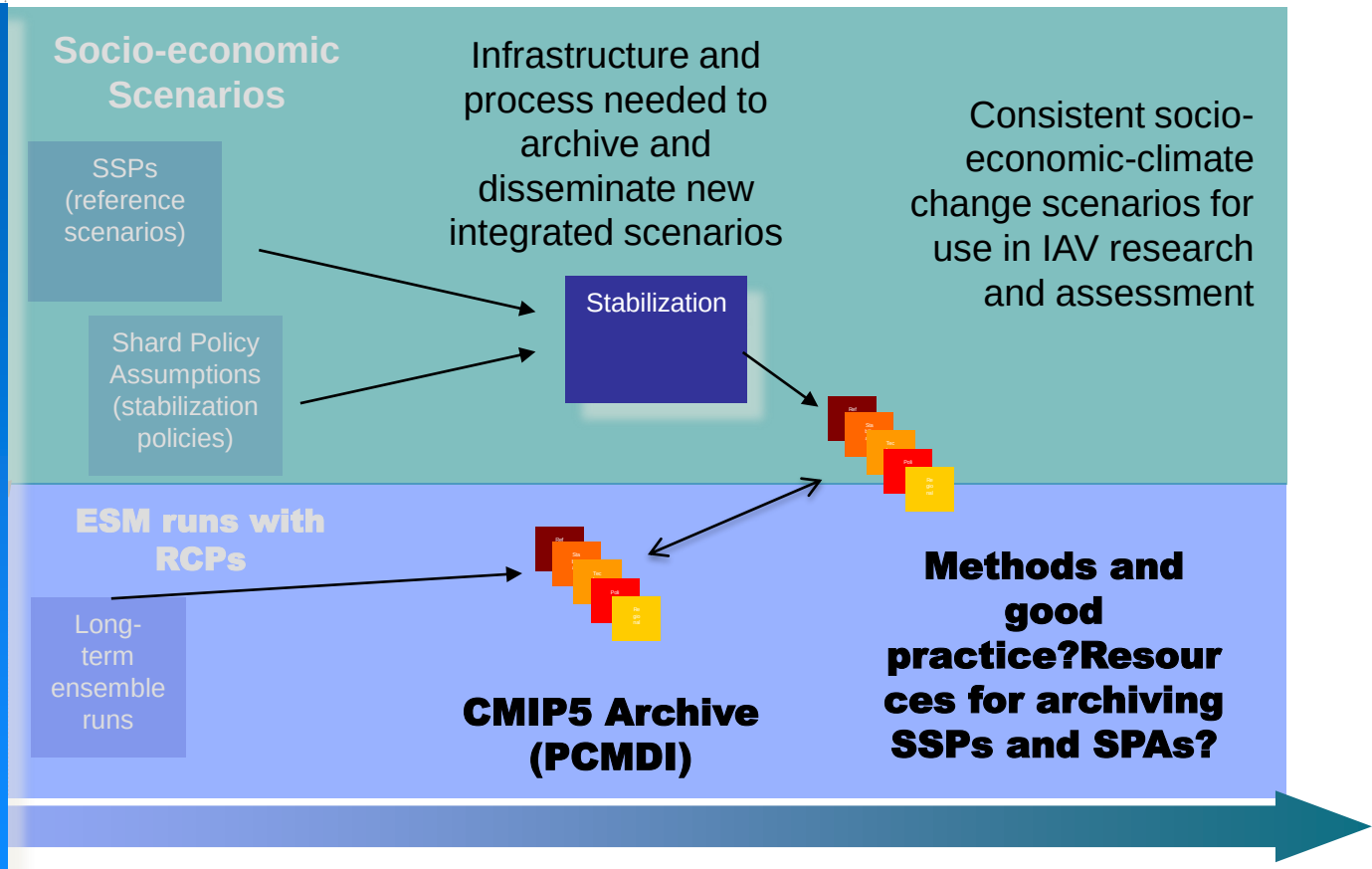
Framing CMIP6 within the WCRP Grand Challenges and AIMES biogeochemistry

Clouds, Circulation and Climate Sensitivity
Changes in Cryosphere
Climate Extremes
Regional Climate Information
Regional Sea-level Rise
Water Availability

AIMES theme for collaboration: biospheric forcings and feedbacks

Improve tools for linking socio-economic and climate scenarios

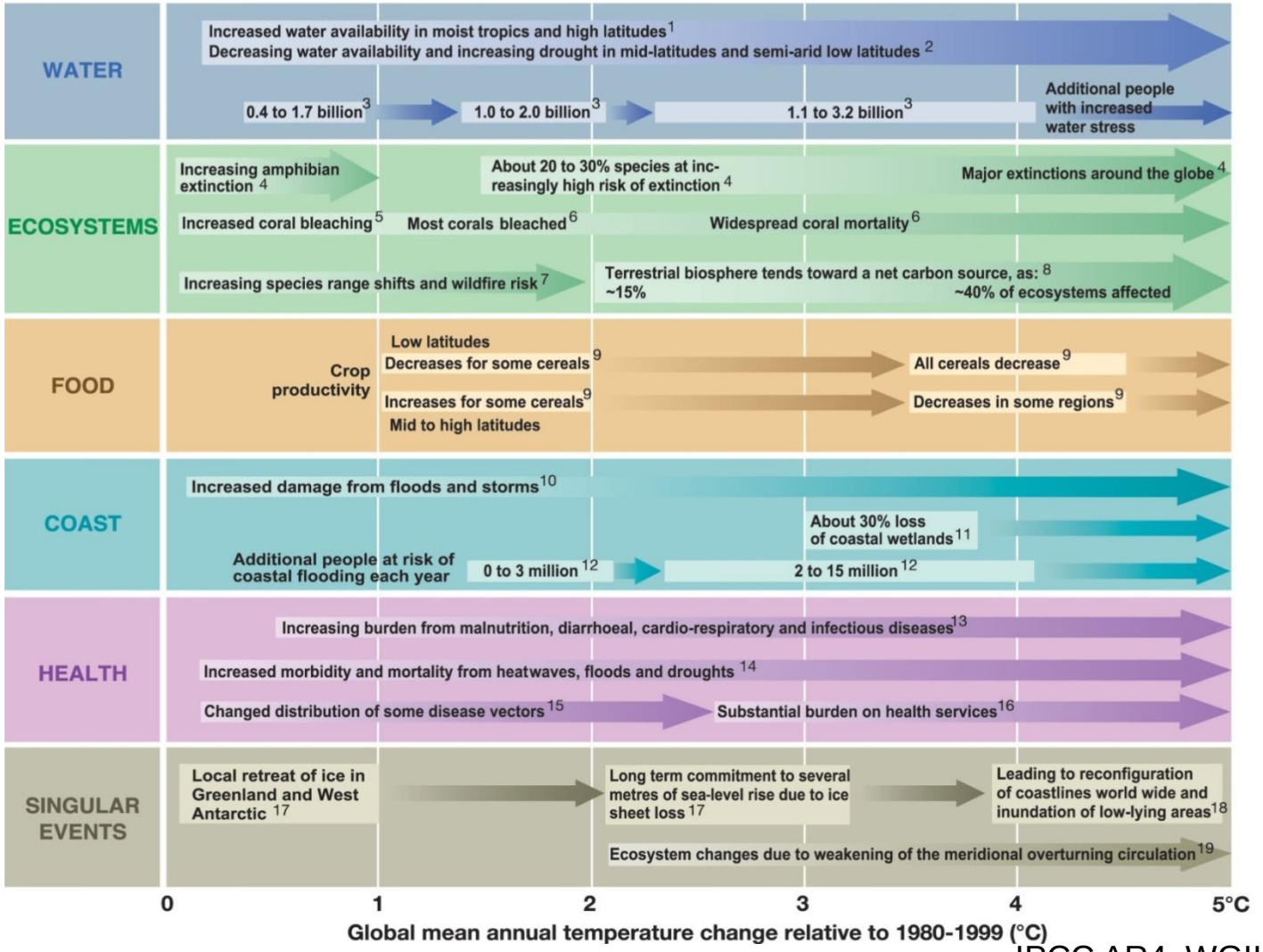
Needed for impact and regional mitigation assessments: integrated socioeconomic and climate scenarios in an accessible format



Drivers of RCP process (from Hibbard et al. 2007)

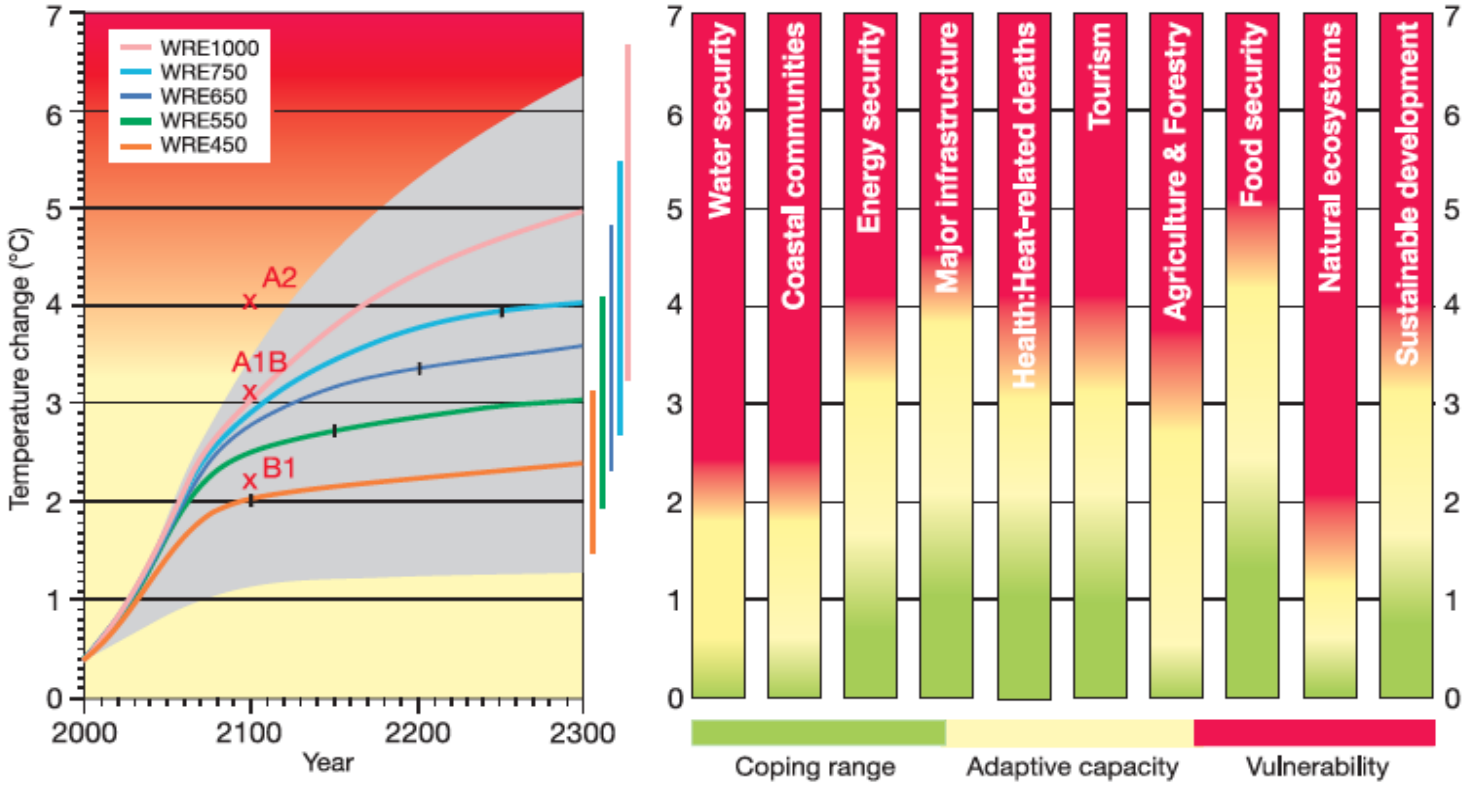
- Explore stabilization cases
- Decadal prediction, higher resolution (0.5º–1º)
  - Scenario variations of pollutants to assess weather impacts
- Centennial runs, lower resolution (~2º)
  - Quantify carbon cycle feedbacks in the Earth system

1. Scenarios as method to coordinate synthesis



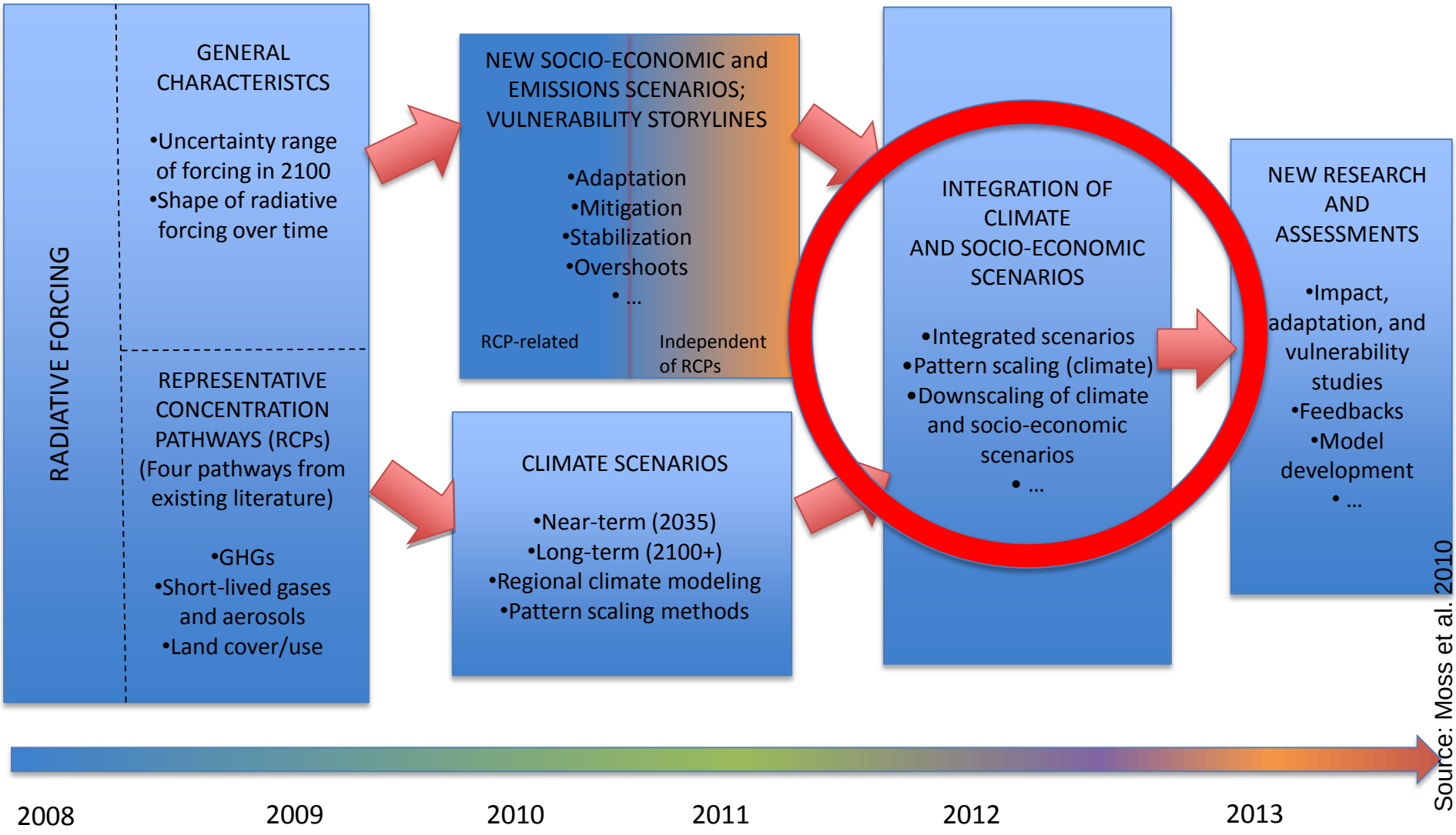
IPCC AR4, WGII, Table 20.8

Synthesis, IPCC Australia/New Zealand



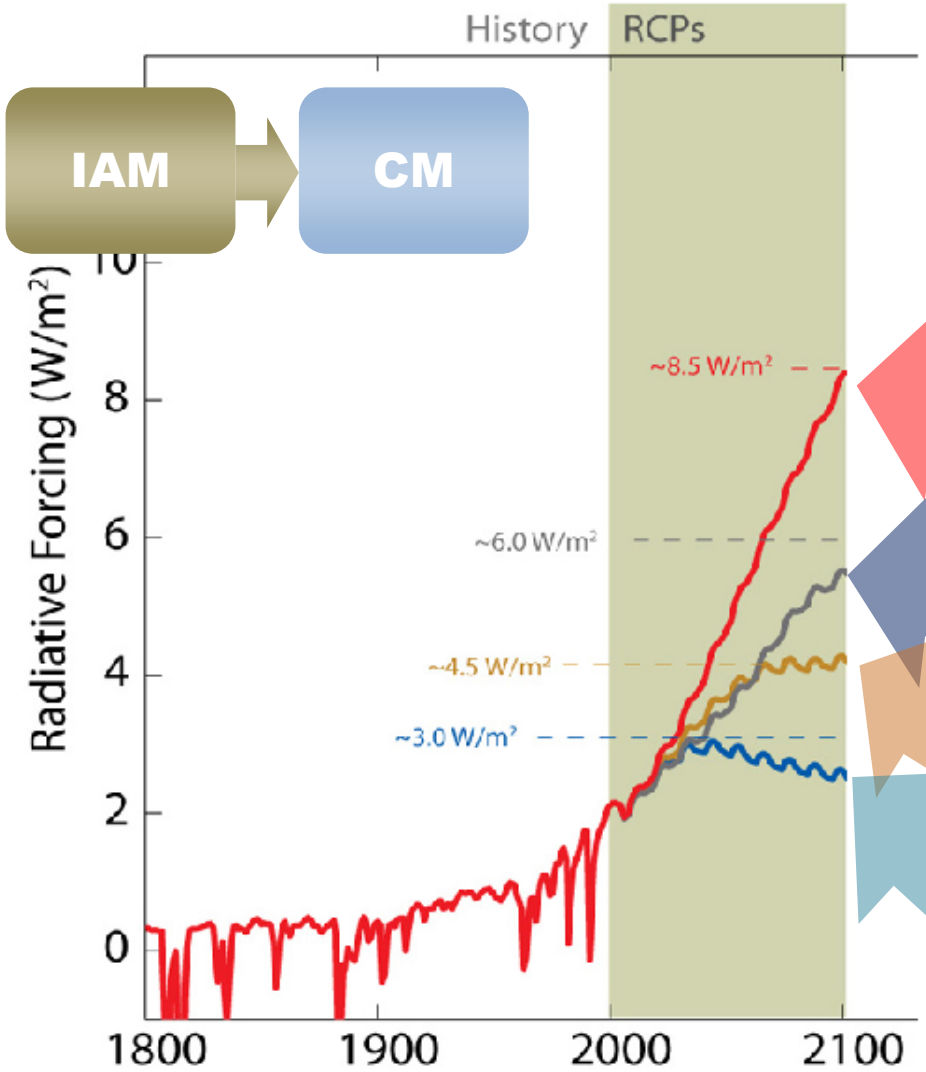
Source: IPCC AR4 WG II Ch 11, Fig 11.4

Improve integration and data sharing



Source: Moss et al. 2010

2. Scenarios as inputs to ESMs: Representative Concentration Pathways (RCPs)



- The climate modeling community wanted 4 levels of radiative forcing that would span the emissions literature.
  - 8.5 Wm^{-2} (RCP 8.5, *1350ppm CO_2-e*)
  - 6.0 Wm^{-2} (RCP 6.0, *850ppm CO_2-e*)
  - 4.5 Wm^{-2} (RCP 4.5, *650ppm CO_2-e*)
  - 2.6 Wm^{-2} (RCP 2.6, *450ppm CO_2-e*)

CLIMATIC CHANGE
Volume 109, Numbers 1-2 (2011), 5-31,
DOI: 10.1007/s10584-011-0148-z

Content of RCP database

- Data for climate modelers or atmospheric chemists
  http://www.iiasa.ac.at/web-apps/tnt/RcpDb/

FORCING AGENTS

GHG Emissions and Concentrations from IAMs

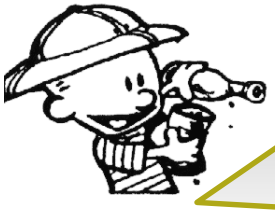
- Greenhouse gases: CO_2, CH_4, N_2O, CFCs, HFC's, PFC's, SF_6
- Emissions of chemically active gases: CO, NO_x, NH_4, VOCs
- Derived GHG's: tropospheric O_3
- Emissions of aerosols: SO_2, BC, OC
- **Land use and land cover [NEW]**

EXTENSIONS

- **Extension of scenarios to 2300—ECPs.**

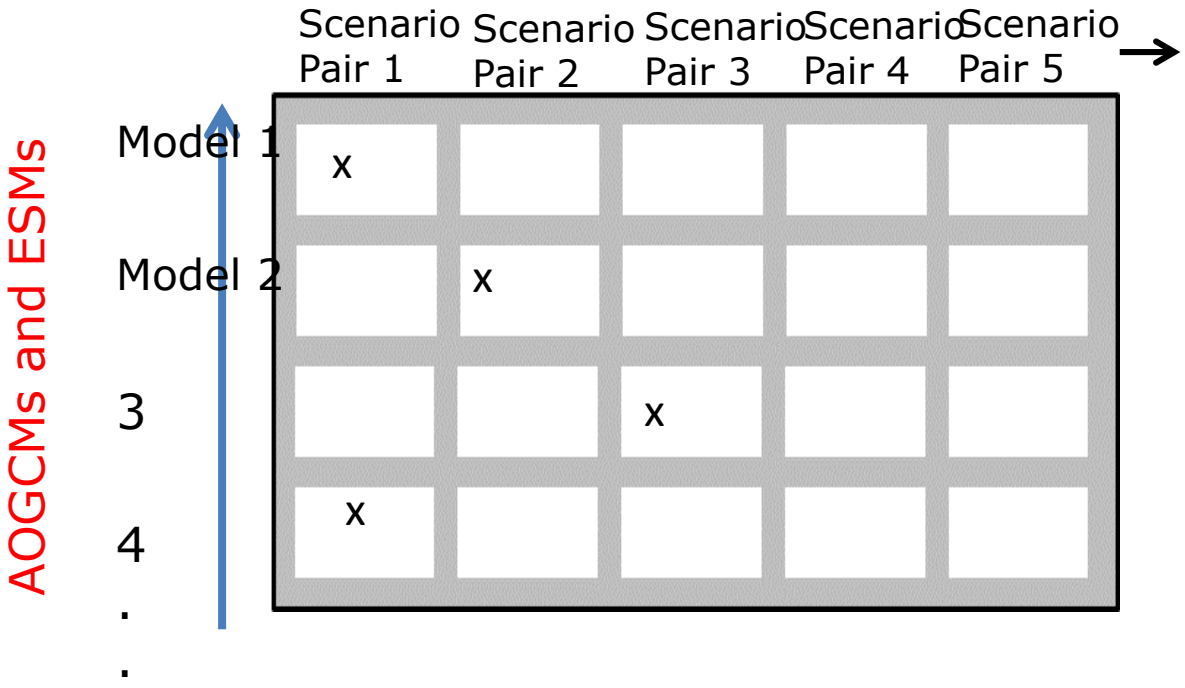
WHAT YOU WON'T FIND

- **You will not find an integrated set of detailed socioeconomic storylines and scenarios (e.g., no common reference scenario)**



Sample different combinations of scenario pairs and AOGCMs/ESMs (sampled in an appropriate way, e.g. climate sensitivity, enough realizations)

Paired non-mitigation/mitigation scenarios



IAM and climate modeling community decides which scenario pairs make most sense:

1. baseline/mitigation scenario pairs for research on benefits of mitigation related to land use change, short lived climate forcers, etc.
2. An overshoot scenario