

Coupled Model Intercomparison Project Phase 6 (CMIP6): Goals and Status

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<http://www.wcrp-climate.org/index.php/wgcm-cmip/about-cmip>



Knowledge for Tomorrow



CMIP: Toward understanding past, present and future climate

(organized by the WCRP Working Group on Coupled Modelling (WGCM))

- Since 1995, the **Coupled Model Intercomparison Project (CMIP)** has coordinated climate model experiments involving multiple international modeling teams.
- CMIP has led to a better understanding of past, present and future climate change and variability.
- CMIP has developed in phases, with the simulations of the fifth phase, CMIP5, now mostly completed.
- Though analyses of the CMIP5 data will continue for at least several more years, science gaps and outstanding science questions have prompted preparations to get underway for the **sixth phase of the project (CMIP6)**.
- CMIP's central goal is to advance scientific understanding of the Earth system.

Climate Model Projections WG I AR5

- Largely based on Coupled Model Intercomparison Phase 5 (CMIP5) simulations -

Relative to the 1986-2005 average

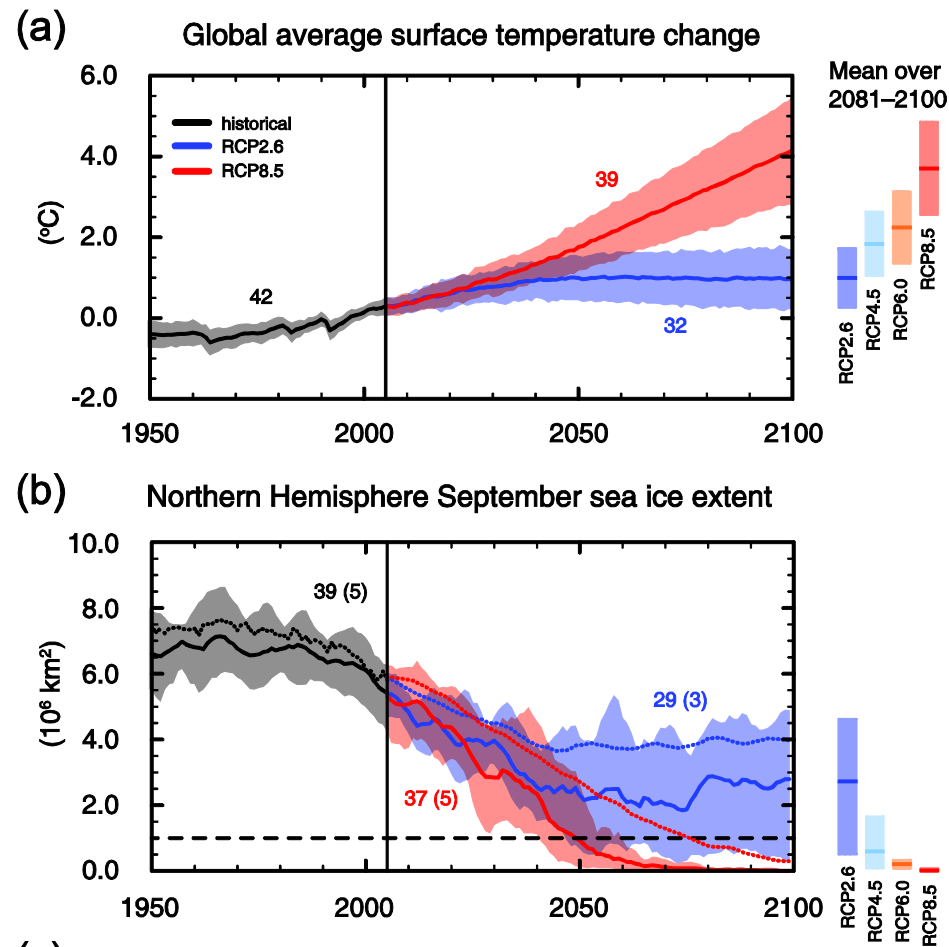


Figure SPM.7

Process Understanding

Chapter 6: Carbon and other Biogeochemical Cycles

Chapter 7: Clouds and Aerosols

From Forcing to Attribution of Climate Change

Chapter 8: Anthropogenic and Natural Radiative Forcing

Chapter 9: Evaluation of Climate Models

Chapter 10: Detection and Attribution of Climate Change: from Global to Regional

Future Climate Change and Predictability

Chapter 11: Near-term Climate Change: Projections and Predictability

Chapter 12: Long-term Climate Change: Projections, Commitments and Reversibility

Integration

Chapter 13: Sea Level Change

Chapter 14: Climate Phenomena and their Relevance for Future Regional Climate Change

Process understanding and projections including uncertainty estimates relevant for WG II and III

CMIP6 Organization

- **CMIP Panel** (V. Eyring (chair), J. Meehl, B. Stevens, R. Stouffer, K. Taylor) which is responsible for direct coordination of CMIP and overseeing the whole CMIP process.
- Sub-committee of **WCRP's Working Group of Coupled Modelling** (WGCM, co-chairs S. Bony and C. Senior).
- **WGCM Infrastructure Panel** (WIP, co-chairs V. Balaji & K. Taylor): Establishes standards and policies for sharing climate model output; puts the data request together technically (M. Jukes).

CMIP6 Design

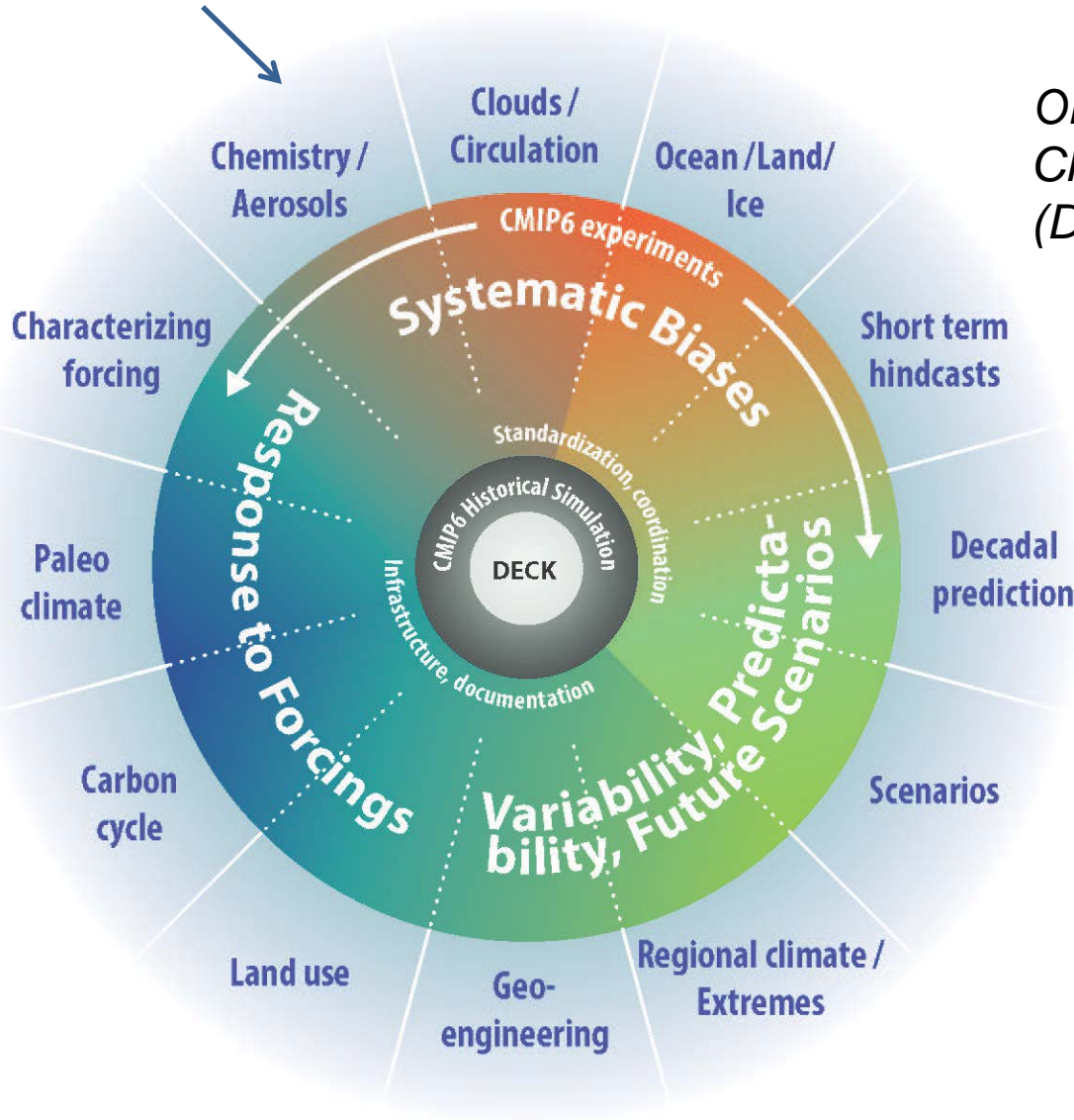
- Based on the summer 2013 CMIP5 survey and Aspen & WGCM/AIMES 2013 meetings
- Initial proposal for the design of CMIP6 (Meehl et al., EOS, 2014).
- Feedback on this initial CMIP6 proposal has been solicited over the year from modeling groups and model analysts until September 2014.
- The WGCM and the CMIP Panel have then finalized the CMIP6 design at the WGCM 18th session (October 2014, Grainau) in consultation with the model groups and MIP co-chairs.



CMIP6 Design: Scientific Focus

- The **scientific backdrop** for CMIP6 is the **WCRP Grand Challenges**:
 1. Clouds, Circulation and Climate Sensitivity
 2. Changes in Cryosphere
 3. Climate Extremes
 4. Regional Sea-level Rise
 5. Water Availability
 6. Decadal Predictability (pending)
 7. Biogeochemical forcings and feedbacks (pending)
- The specific experimental design is focused on **three broad scientific questions**:
 1. How does the Earth System respond to forcing?
 2. What are the origins and consequences of systematic model biases?
 3. How can we assess future climate changes given climate variability, predictability and uncertainties in scenarios?

CMIP6-Endorsed Model Intercomparison Projects (MIPs)



Ongoing Diagnosis, Evaluation, and Characterization of Klima (DECK) Experiments

DECK (entry card for CMIP)

- i. AMIP simulation (~1979-2014)
- ii. Pre-industrial control simulation
- iii. 1%/yr CO₂ increase
- iv. Abrupt 4xCO₂ run

CMIP6 Historical Simulation (entry card for CMIP6)

- v. Historical simulation using CMIP6 forcings (1850-2014)

(DECK & CMIP6 Historical Simulation to be run for each model configuration used in the subsequent CMIP6-Endorsed MIPs)

Note: The themes in the outer circle of the figure might be slightly revised at the end of the MIP endorsement process

CMIP6-Endorsed MIPs

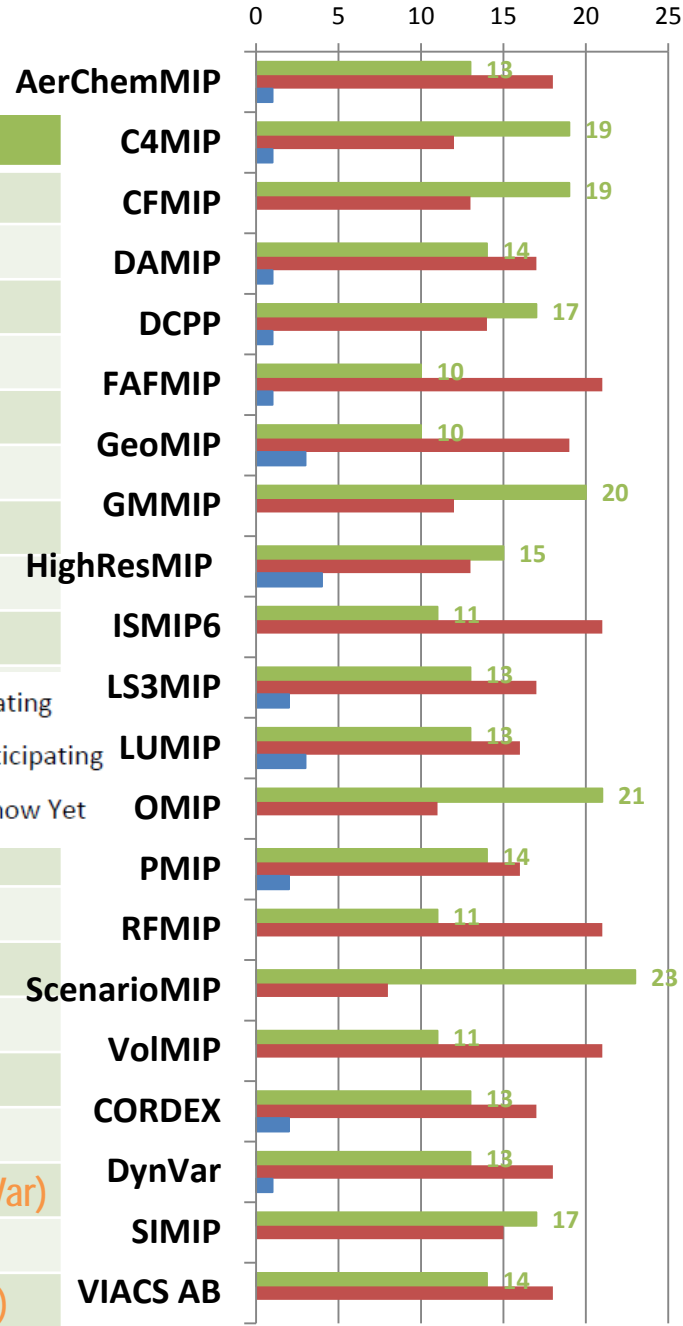
Main Criteria for Endorsement

1. The MIP and its experiments address at least one of the key science questions of CMIP6.
2. The MIP demonstrates connectivity to the DECK experiments and the CMIP6 Historical Simulation.
3. The MIP adopts the CMIP modeling infrastructure standards and conventions.
4. All experiments are tiered, well-defined, and useful in a multi-model context and don't overlap with other CMIP6 experiments.
5. Unless a Tier 1 experiment differs only slightly from another well-established experiment, it must already have been performed by more than one modeling group.
6. A sufficient number of modelling centers (~8) are committed to performing all of the MIP's Tier 1 experiments and providing all the requested diagnostics needed to answer at least one of its science questions.
7. The MIP presents an analysis plan describing how it will use all proposed experiments, any relevant observations, and specially requested model output to evaluate the models and address its science questions.
8. The MIP has completed the MIP template questionnaire.
9. The MIP contributes a paper on its experimental design to the CMIP6 Special Issue.
10. The MIP considers reporting on the results by co-authoring a paper with the modelling groups.

* For "Diagnostic-MIPs" only non-experimental criteria apply

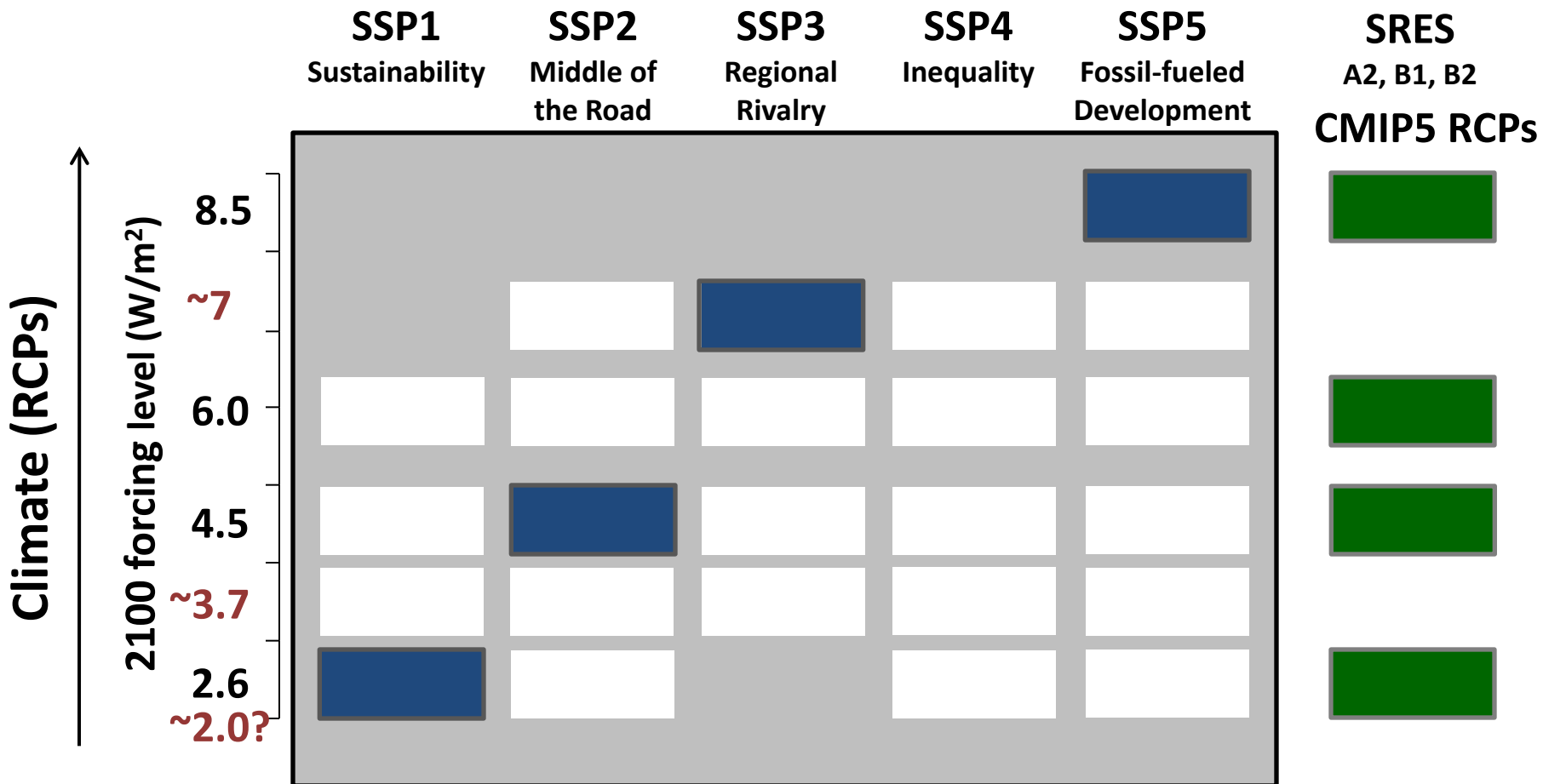
CMIP6-Endorsed MIPs and Model Groups' Commitments to Participate in each MIP

	Long Name of MIP (Short Name of MIP)
1	Aerosols and Chemistry Model Intercomparison Project (AerChemMIP)
2	Coupled Climate Carbon Cycle Model Intercomparison Project (C ⁴ MIP)
3	Cloud Feedback Model Intercomparison Project (CFMIP)
4	Detection and Attribution Model Intercomparison Project (DAMIP)
5	Decadal Climate Prediction Project (DCPP)
6	Flux-Anomaly-Forced Model Intercomparison Project (FAFMIP)
7	Geoengineering Model Intercomparison Project (GeoMIP)
8	Global Monsoons Model Intercomparison Project (GMMIP)
9	High Resolution Model Intercomparison Project (HighResMIP)
10	Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6)
11	Land Surface, Snow and Soil Moisture MIP (LS3MIP)
12	Land-Use Model Intercomparison Project (LUMIP)
13	Ocean Model Intercomparison Project (OMIP)
14	Paleoclimate Modelling Intercomparison Project (PMIP)
15	Radiative Forcing Model Intercomparison Project (RFMIP)
16	Scenario Model Intercomparison Project (ScenarioMIP)
17	Volcanic Forcings Model Intercomparison Project (VoIMIP)
18	Coordinated Regional Climate Downscaling Experiment (CORDEX)
19	Dynamics and Variability of the Stratosphere-Troposphere System (DynVar)
20	Sea-Ice Model Intercomparison Project (SIMIP)
21	Vulnerability, Impacts & Adaptation and Climate Services AB (VIACS AB)



ScenarioMIP Design

Shared Socioeconomic Pathways

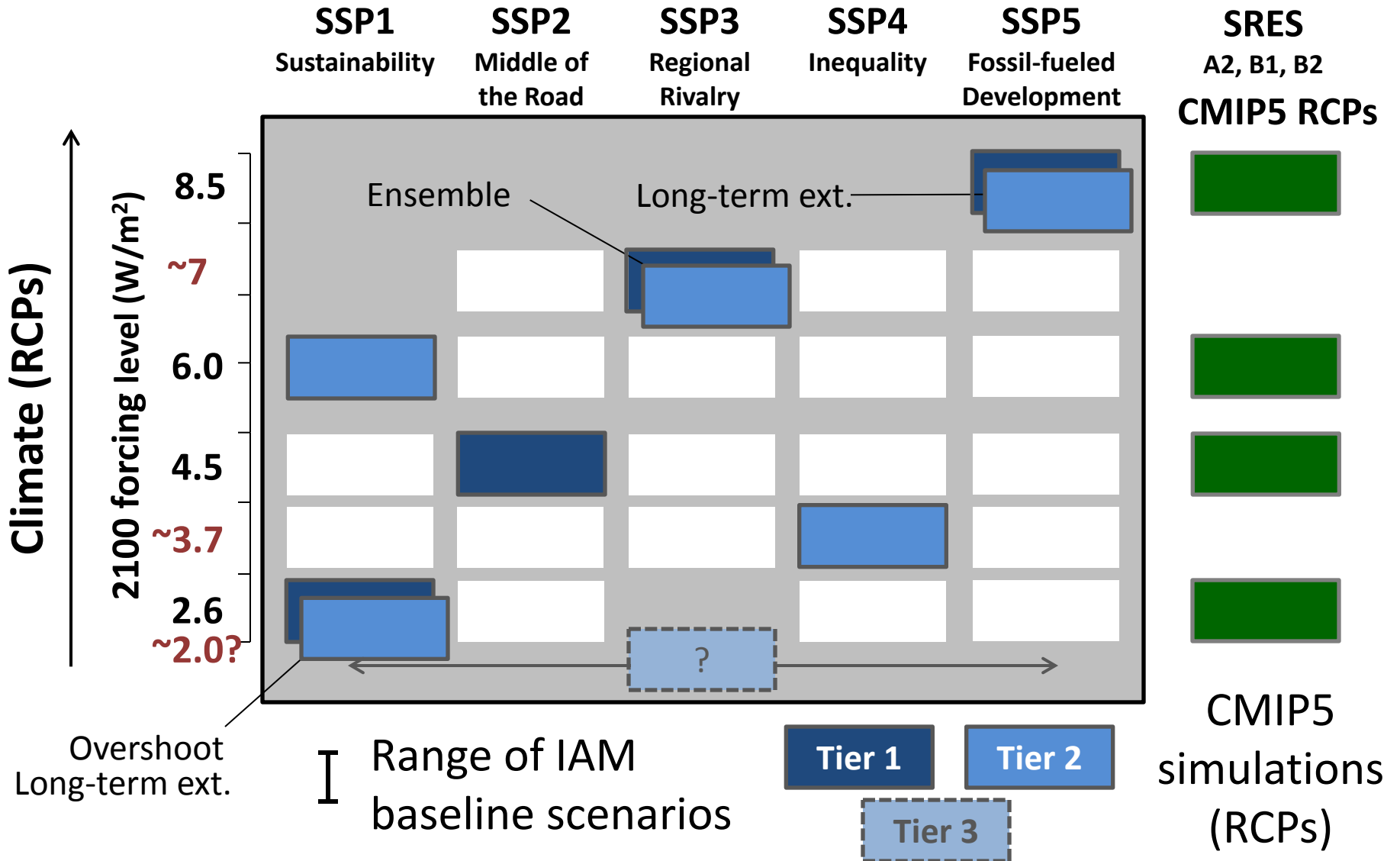


Tier 1: Continuing the CMIP6 Historical Simulation (1850-2014) into the future (2015 – 2100)

Co-chairs: Brian O'Neill, Claudia Tebaldi, Detlef van Vuuren

ScenarioMIP Design

Shared Socioeconomic Pathways



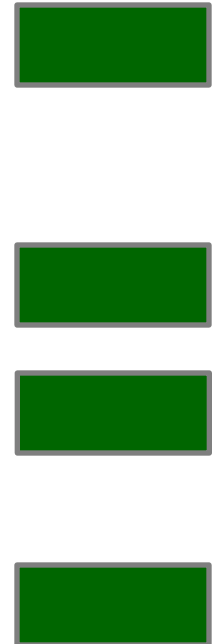
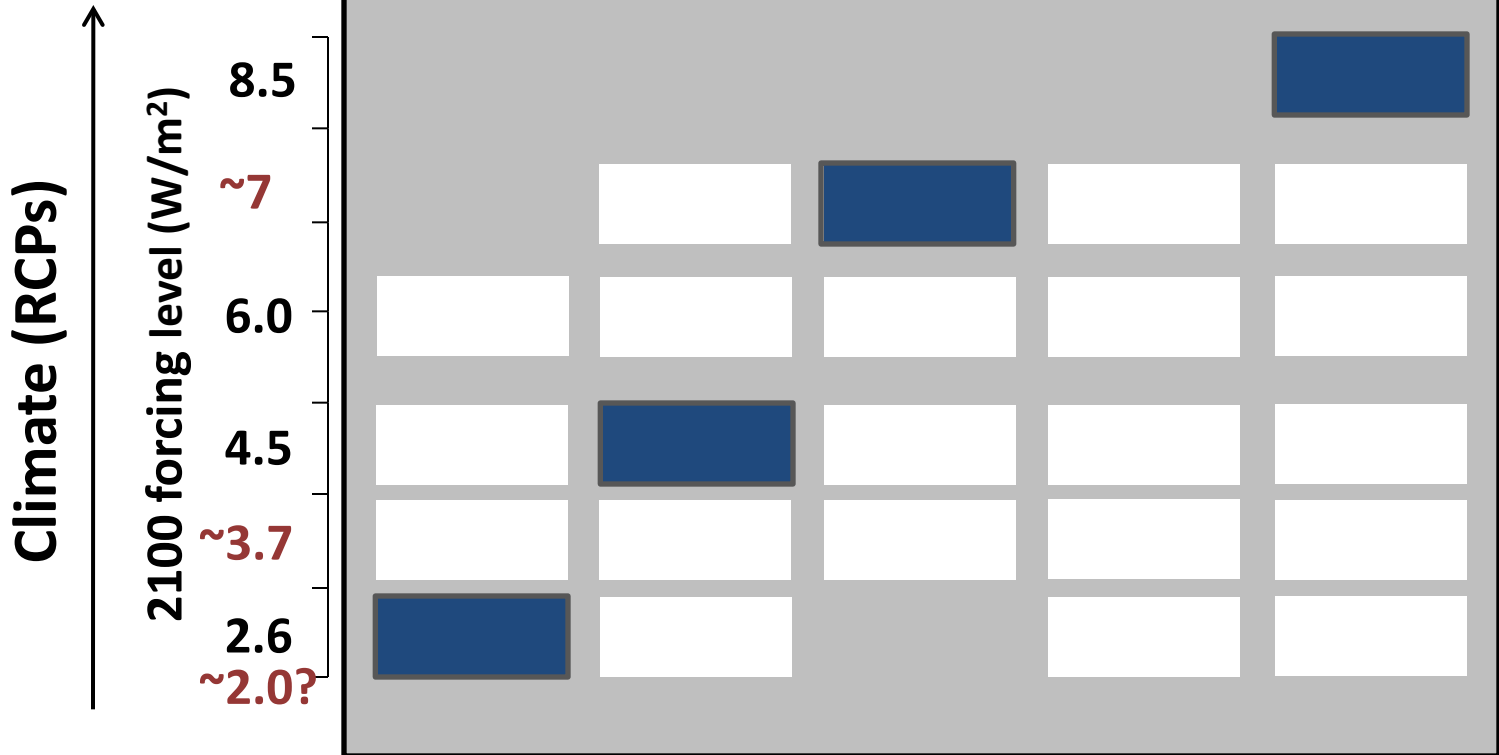
ScenarioMIP Design

Shared Socioeconomic Pathways

Tier 1

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

SRES
A2, B1, B2
CMIP5 RCPs



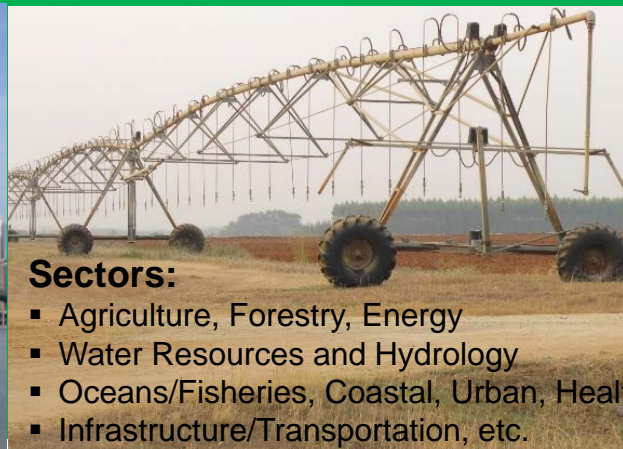
CORDEX	AerChemMIP	C4MIP / C4MIP-E
DAMIP	(reduced NTCF)	GeoMIP
DCPP	LUMIP (switch LU	ISMIP6-E
HighResMIP	SSP1-2.6)	HighResMIP
RFMIP		LS3MIP

The Vulnerability, Impacts, Adaptation and Climate Services (VIACS) Advisory Board

Co-chairs: Alex Ruane and Claas Teichmann

Building bridges between the Modeling and Applications communities

- A historic development in our field that provides, for the first time in CMIP, an avenue for a more formal communication with the VIACS community -



Sectors:

- Agriculture, Forestry, Energy
- Water Resources and Hydrology
- Oceans/Fisheries, Coastal, Urban, Health
- Infrastructure/Transportation, etc.

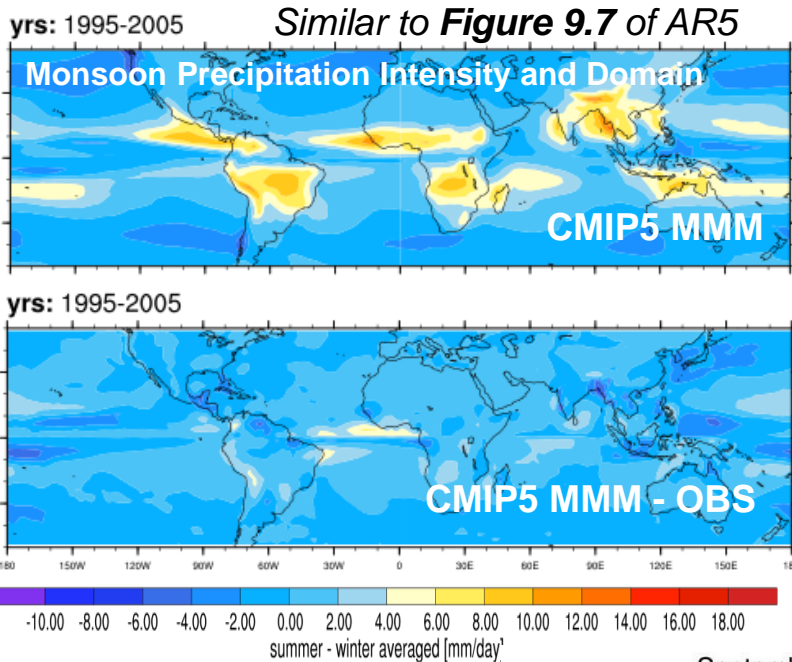
Projects and Programs:

- TGICA, CORDEX, ICONICS
- WCRP WGRC
- ISI-MIP, AgMIP, WaterMIP

- **Facilitates two-way communication around science and application goals:**
 - Informed use of model outputs
 - Design of online diagnostics, metrics, and visualizations of relevance to society.
- **Feedback from VIACS community so far has included several strong messages:**
 - Most VIACS applications are grounded in CMIP6 Historical & ScenarioMIP simulations.
 - Large diversity in requests for variables (beyond temperature and rainfall) and experiment priorities from different sectors).

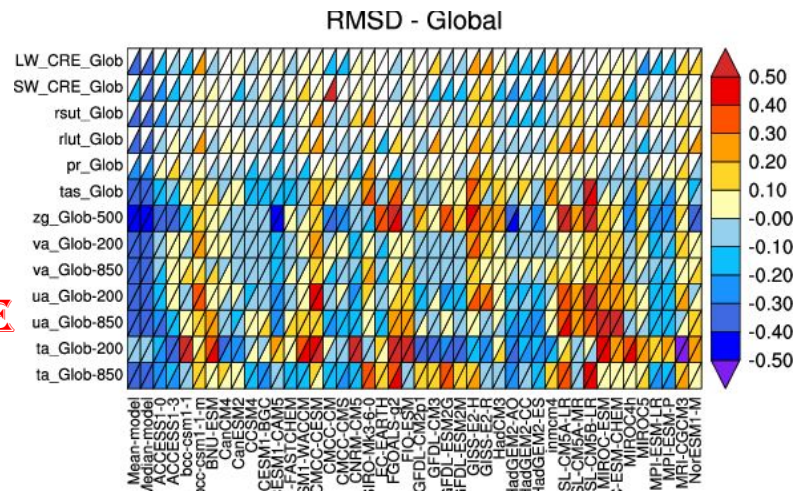
Routine Benchmarking and Evaluation Central Part of CMIP6

CMIP evaluation tool to produce well-established analyses as soon as model output becomes available e.g., Community-developed ESM Evaluation Tool <http://www.pa.op.dlr.de/ESMValTool> (Eyring et al., GMDD, 2015) and PCMDI metrics package - *Link to WGNE/WGCM Climate Model Metrics Panel*



**RUNNING
ALONG-SIDE
THE ESGF**

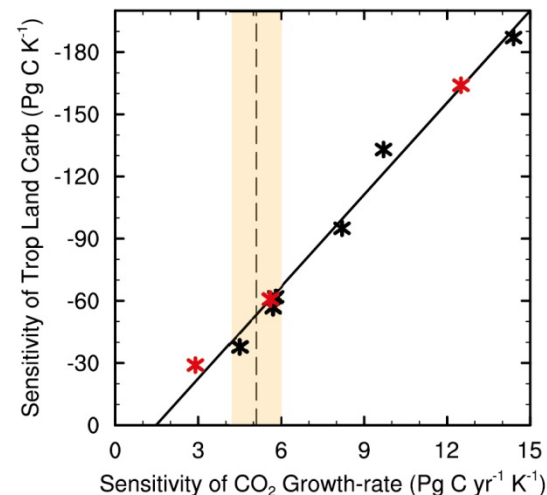
**AR5
CHAPTER 9**



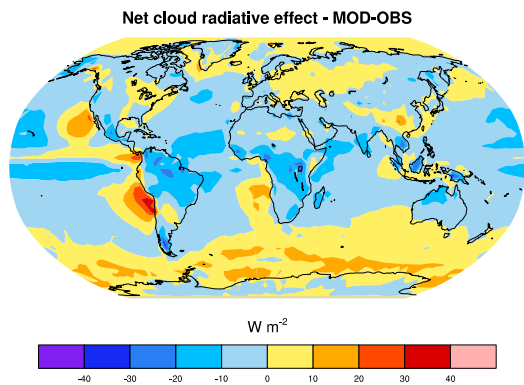
Similar to **Figure 9.7 of AR5**

LINK TO PROJECTIONS

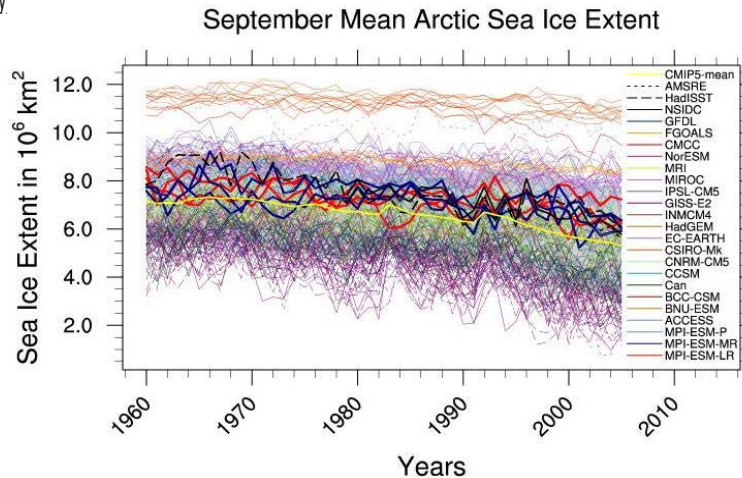
(b) Tropical Land carbon feedback



Similar to **Figure 9.24 of AR5**



Similar to **Figure 9.5 of AR5**



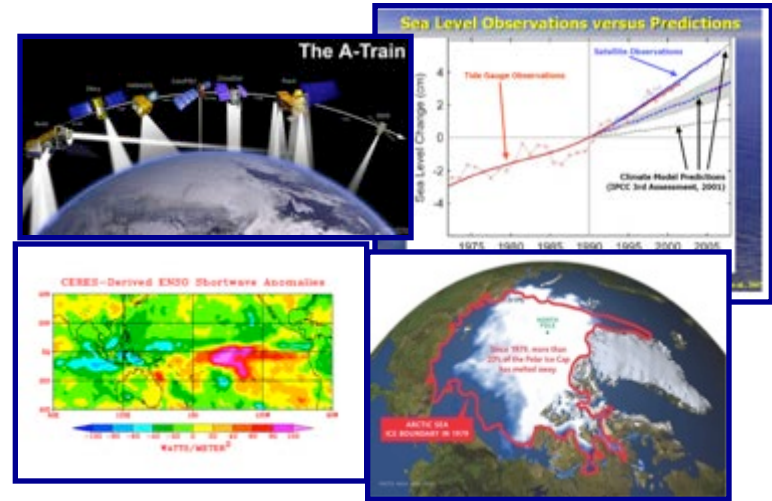
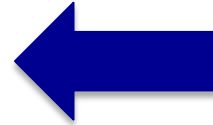
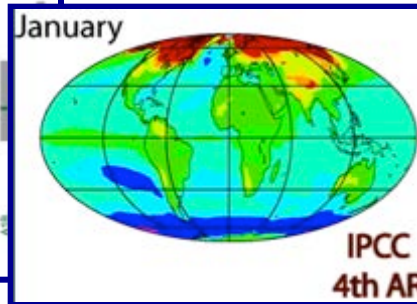
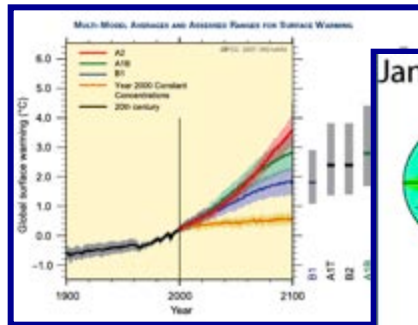
Similar to **Figure 9.24 of AR5**

Under-Exploited Observations for Model Evaluation

Observations for Model Intercomparison Projects (obs4MIPs)

WDAC Task Team on Observations for Model Evaluation

CMIP6



How to bring as much observational scrutiny as possible to the CMIP/IPCC process?

How to best utilize the wealth of satellite observations for the CMIP/IPCC process?

- Obs4MIPs has defined a set of technical specifications and criteria for developing observational data sets that are technically aligned with CMIP model output (with common file format, data and metadata structure).
- Over 50 datasets that conform to these standards are now archived on the ESGF alongside CMIP model output ([Teixeira et al., 2014](#)), including ESA CCI data
- Data users have enthusiastically received Obs4MIPs

Possible CCMI contributions to CMIP6

- From CCMI Workshop 2014 in Lancaster -



1. Apply as CMIP6-Endorsed MIP

- fill template available on the CMIP Panel website in time for the WGCM meeting (i.e. by end of Sep 2014)
- Possibly do this as AerChemMIP jointly with AeroCOM

2. Emissions and Concentrations

- Update IGAC/SPARC ozone database for CMIP6 models with prescribed ozone
- Contribute to the update of the historical emissions and harmonization with scenarios
- Possibly provide aerosol concentrations in collaboration with AeroCom (under discussion whether really needed)

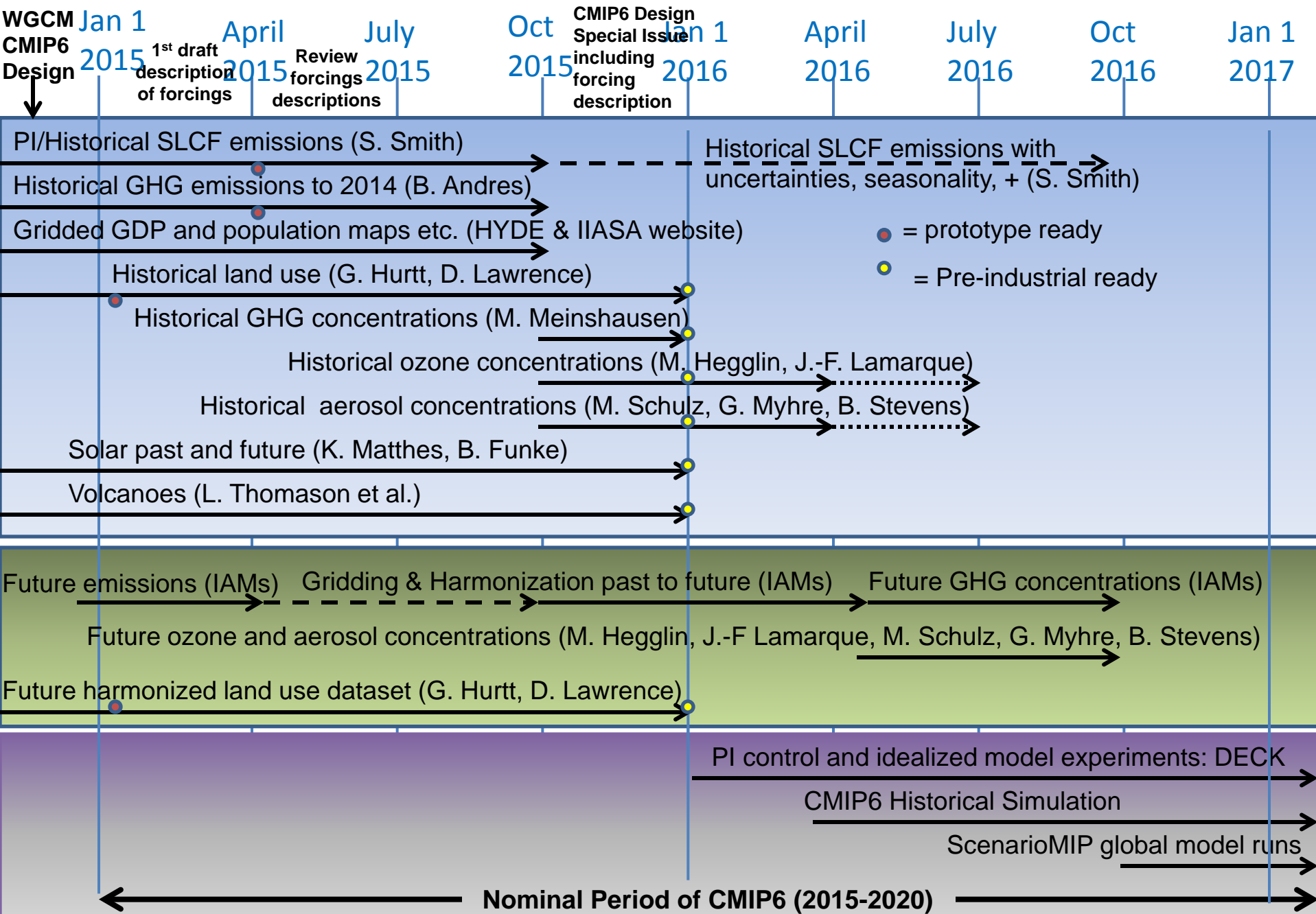
3. CMIP6 data request

- Ensure that the data required for CCMI studies are included at the frequency required
- Separate into models with interactive and without interactive chemistry
- Follow CMIP standards in future CCMI data requests

4. Model evaluation and observations

- Evaluate chemistry-climate interactions in the CMIP-DECK/CMIP6 simulations
- Implement diagnostics & performance metrics into the ESMValTool for routine use
- Contribute observations that are required for a more in depth analysis and evaluation of chemistry-climate interactions to the Obs4MIPs archive (requires observations to be in CMIP format and accompanied by a technical note)

CMIP6 Timeline



CMIP6 Status

Summary and Outlook

- CMIP6 Organization and Design finalized
- CMIP6 MIP endorsement of April 2015 proposals finalized
- Timelines in place for forcing datasets
- CMIP6 Simulation Period (2016-2020)
- Infrastructure in preparation (including data request)

CMIP6 Participating Model Groups: > 30 using a hierarchy of models

CMIP6 Scenarios

- New scenarios span the same range as the RCPs, but fill critical gaps for intermediate forcing levels and questions for example on short-lived species and land-use.
- Propagation of uncertainties across WGs important

Several CMIP6-Endorsed MIPs and the CMIP Evaluation Activity are related to Regional Climate Projections and their Use in Impacts & Risk Analysis Studies

- Requires continuous coordination

Workshops/meetings

- 18-20 October 2015: WGCM-19 (Dubrovnik, Croatia)
- 20-23 October 2015: WCRP/FP7 EMBRACE Workshop on CMIP5 Model Analysis and Scientific Plans for CMIP6 (Dubrovnik, Croatia)

Geosci. Model Dev. Special Issue on CMIP6 (July 2015 - December 2016)

- Overview of the CMIP6 Design and Organization (Eyring et al., in prep, GMD, 2015)
- Experimental design from all CMIP6-Endorsed MIPs (submission by 31 March 2016)
- Description of the CMIP6 forcing data
- Description of evaluation procedures (including obs4MIPs) and Infrastructure

<http://www.wcrp-climate.org/index.php/wgcm-cmip/about-cmip>