

# Coupled Model Intercomparison Project Phase 6 (CMIP6): Design and Organization

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(CMIP Panel)

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**V. Balaji** (WGCM Infrastructure Panel co-chair with K. Taylor)

Please see the CMIP Panel website for additional information and updates:

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

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The final CMIP6 Design, possibly with small modifications to the here presented figures and wording, will be published in a GMD Special Issue together with a description of the CMIP6-Endorsed MIPs and the forcing datasets. This Special Issue opens 30 April 2015.

# Coupled Model Intercomparison Project (CMIP)

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

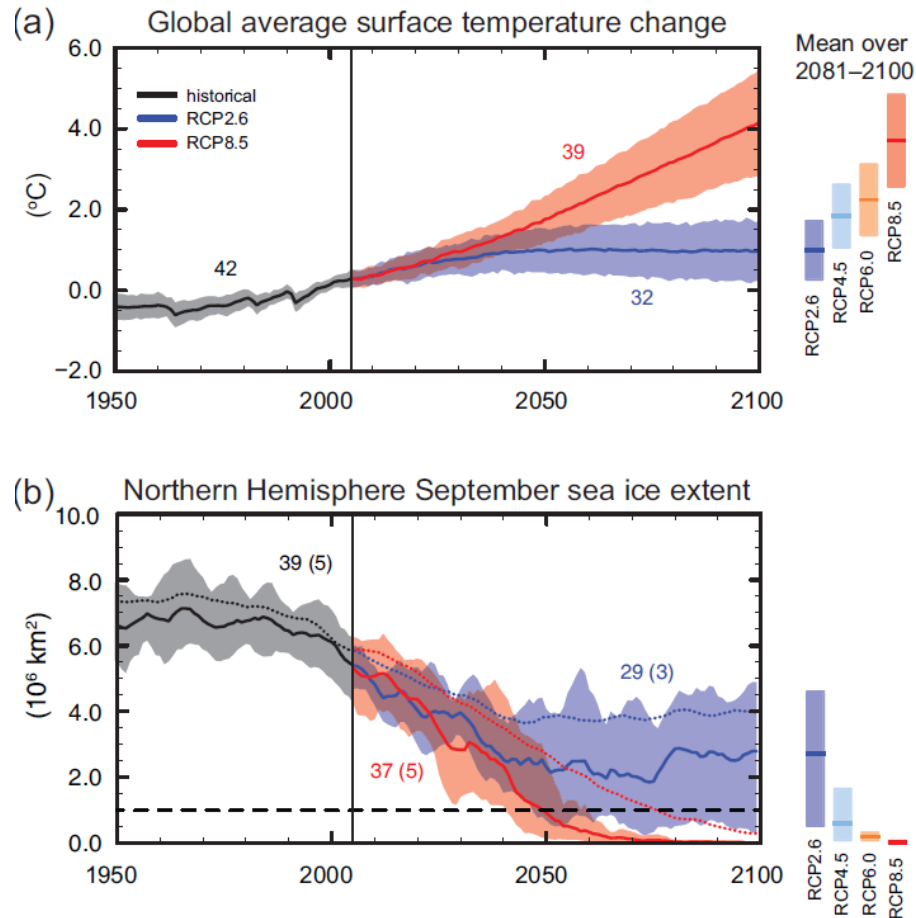
**Objective:** Understanding of past, present and future climate variability and change through a coordinated multi-model experiment design.

**Coordinated** across multiple climate science communities within WCRP and beyond (e.g., AIMES, IAMC)

- Since 1995, **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 regularly supported IPCC Assessment Reports with a coordinated set of multi-model simulations

Relative to the 1986-2005 average



**Figure SPM.7**

## WG I AR5

### 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 also relevant for WG II & 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.

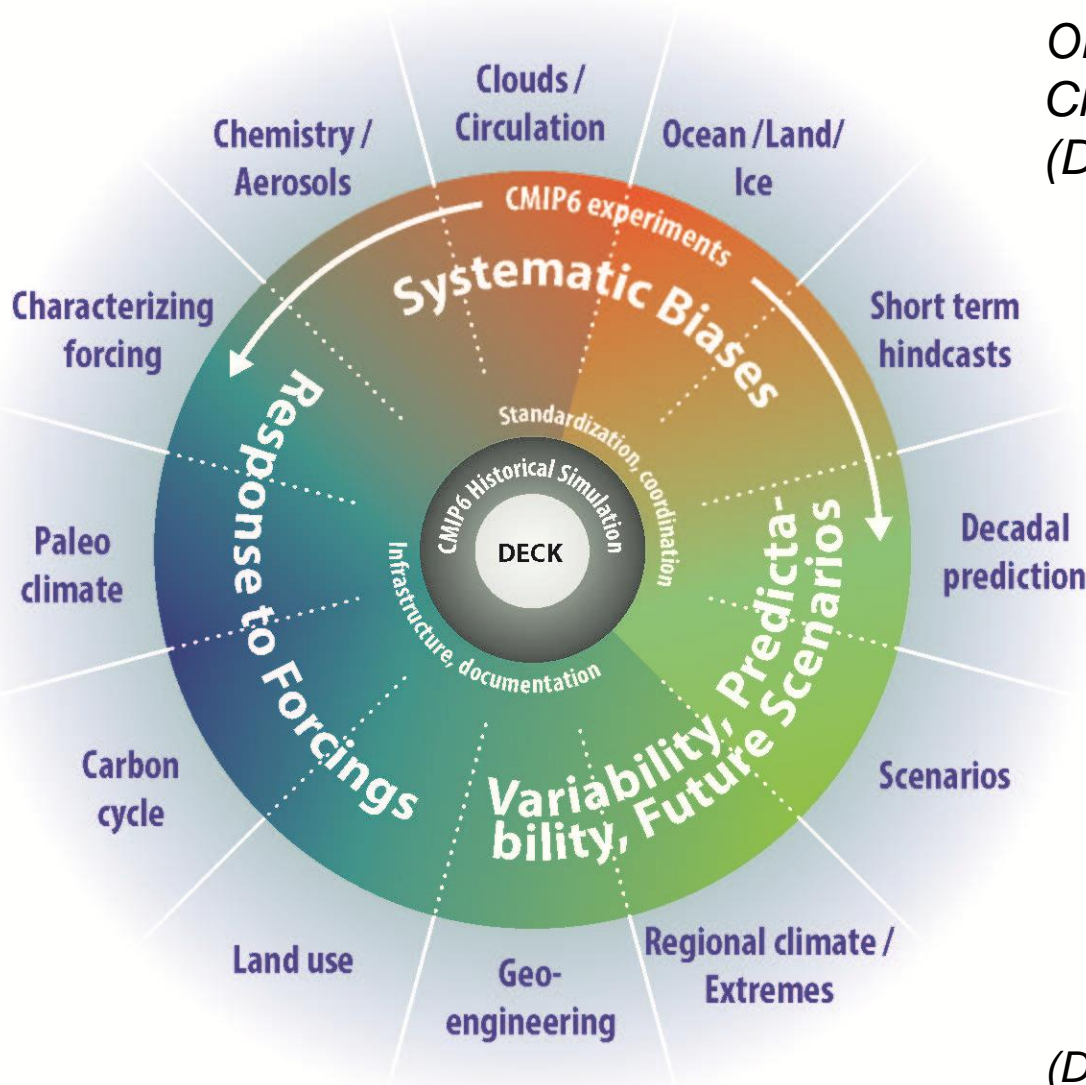


# CMIP6 Design: Scientific Focus

- The **scientific backdrop** for CMIP6 is the six **WCRP Grand Challenges**, and an additional theme encapsulating questions related to **biogeochemical forcings and feedbacks**.
  1. Clouds, Circulation and Climate Sensitivity
  2. Changes in Cryosphere
  3. Climate Extremes
  4. Regional Climate Information
  5. Regional Sea-level Rise
  6. Water Availability
  7. Biogeochemical forcings and feedbacks (AIMES & WGCM)
- 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?

**WCRP Grand Challenges:** (1) Clouds, circulation and climate sensitivity, (2) Changes in cryosphere, (3) Climate extremes, (4) Regional climate information, (5) Regional sea-level rise, and (6) Water availability, plus an additional theme on “Biogeochemical forcings and feedbacks”

*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 CO<sub>2</sub> increase
- iv. Abrupt 4xCO<sub>2</sub> run

**CMIP6 Historical Simulation (entry card for CMIP6)**

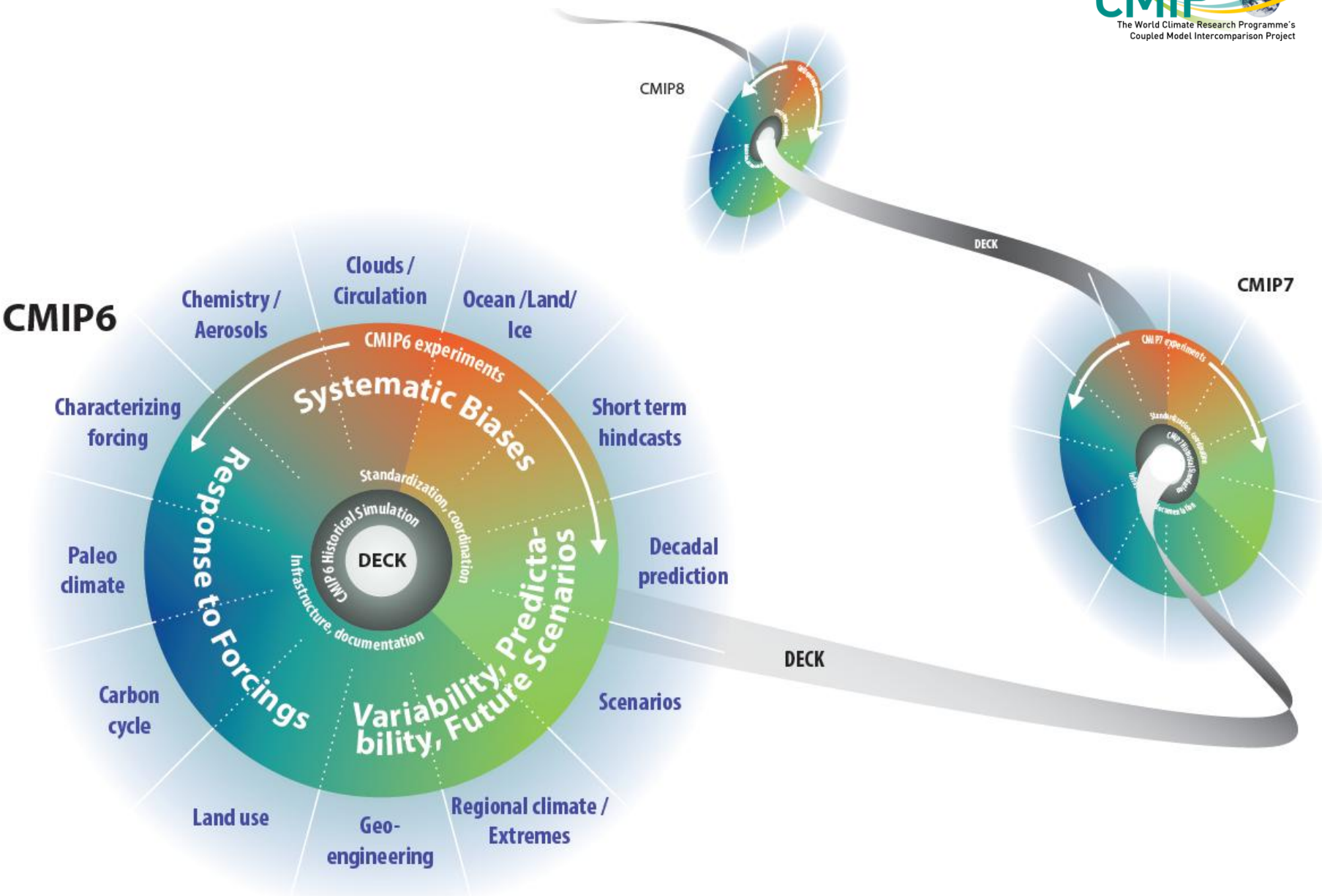
- v. Historical simulation using CMIP6 forcings (1850-2014)

*(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



# CMIP Continuity



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

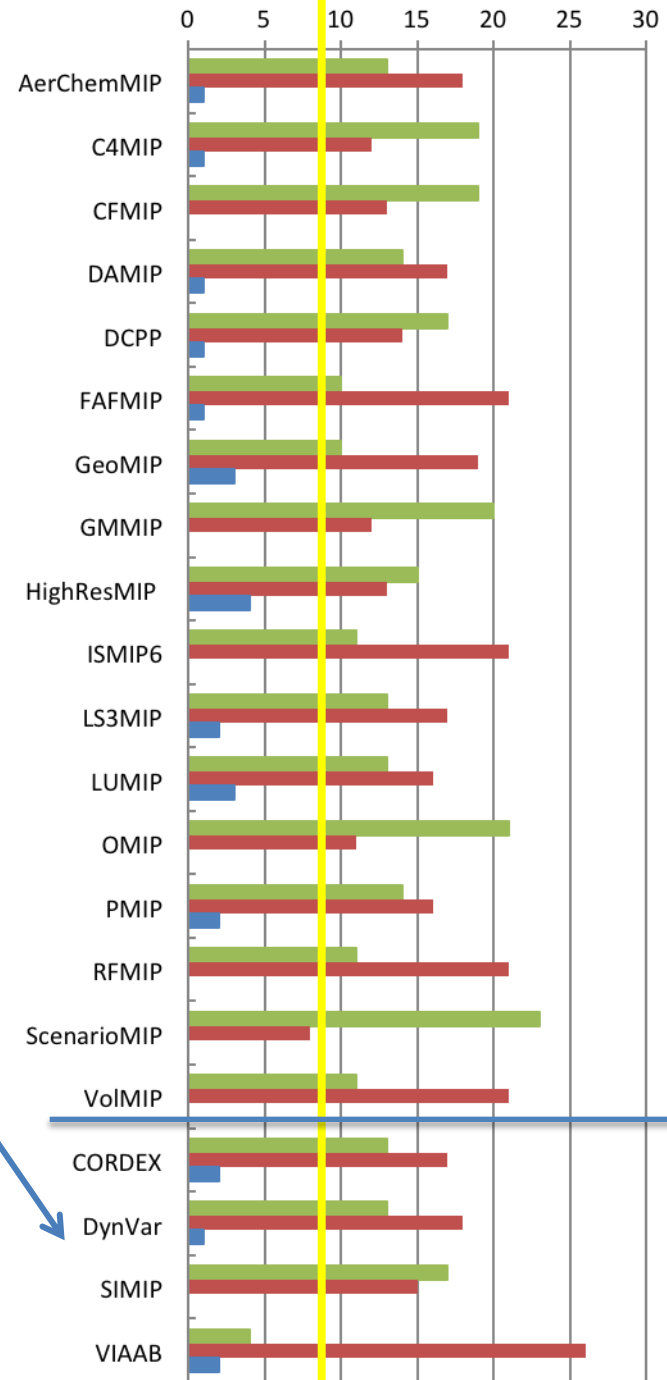
# CMIP6- Endorsed MIPs

## 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.

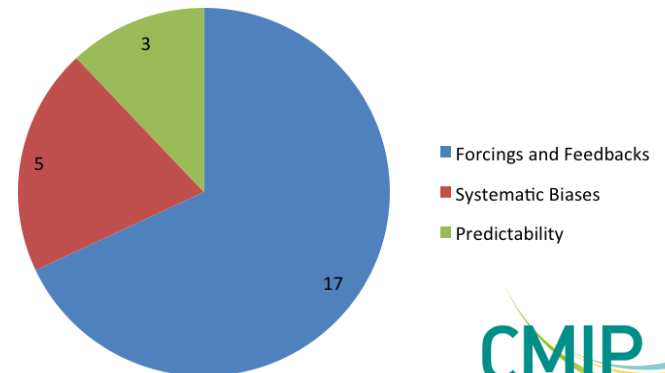
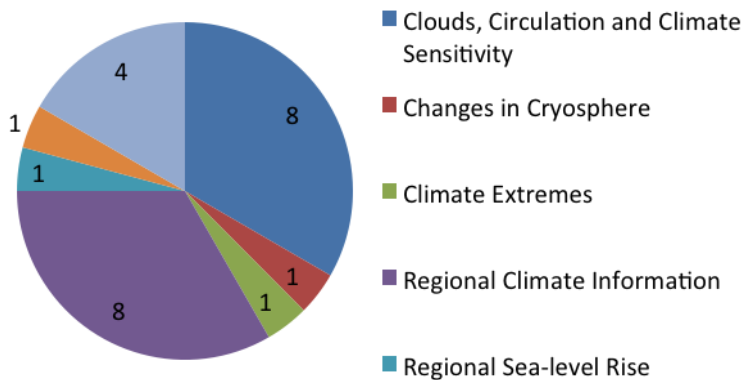
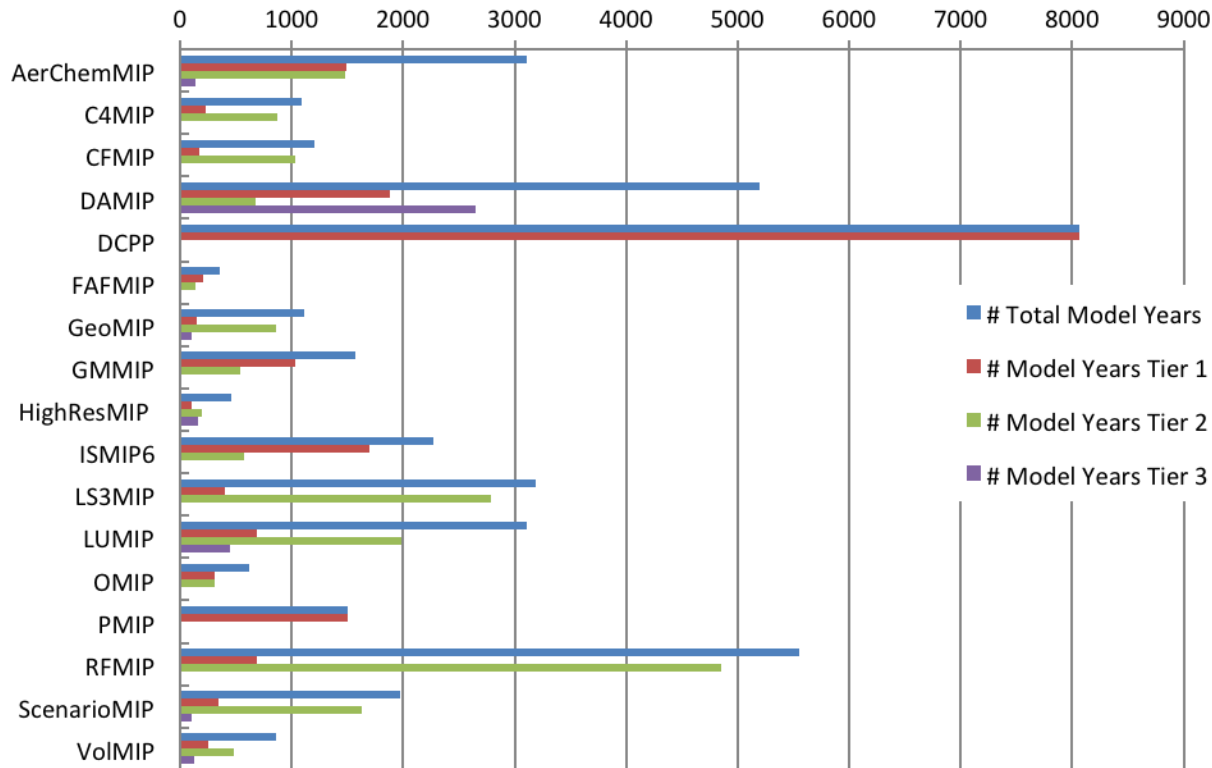
\* For "Diagnostic-MIPs" only non-experimental criteria apply

Final Endorsed MIPs and latest status of modelling group engagement



# CMIP6- Endorsed MIPs

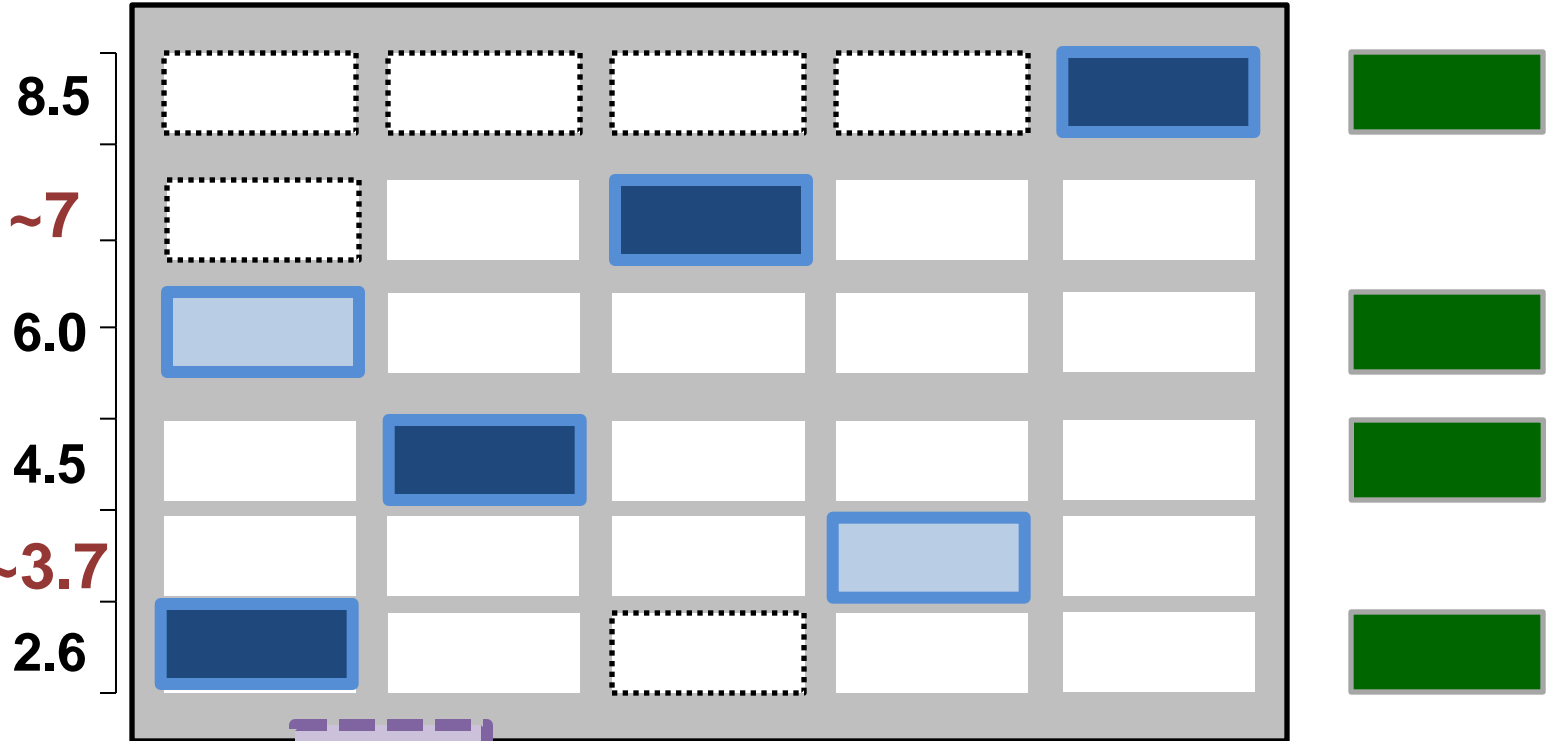


# Future Scenarios in CMIP6 (Current Proposal)

## Shared Socioeconomic Pathways

	SSP1 Sustainability	SSP2 Middle of the Road	SSP3 Regional Rivalry	SSP4 Inequality	SSP5 Fossil-fueled Development	CMIP5 simulations
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Climate (RCPs)  
↑  
2100 forcing level (W/m<sup>2</sup>)



ScenarioMIP Tier 1

ScenarioMIP Tier 2

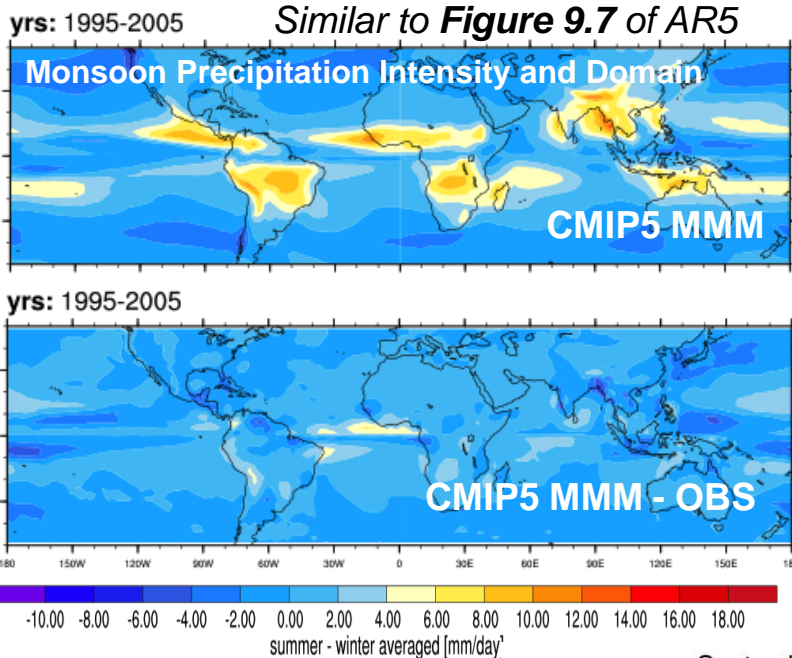
CORDEX  
DAMIP  
DCPP  
RFMIP

AerChemMIP  
LUMIP (switch  
LU SSP1-2.6)  
HighResMIP

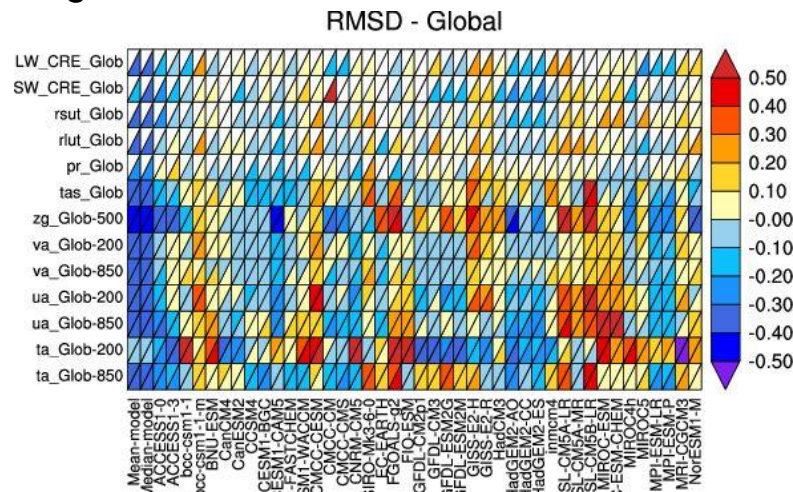
C4MIP / C4MIP-E  
GeoMIP  
ISMIP6-E  
HighResMIP  
LS3MIP, ScenarioMIP-E

# 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 Earth System Model Evaluation Tool <http://www.pa.op.dlr.de/ESMValTool>  
 and PCMDI metrics package



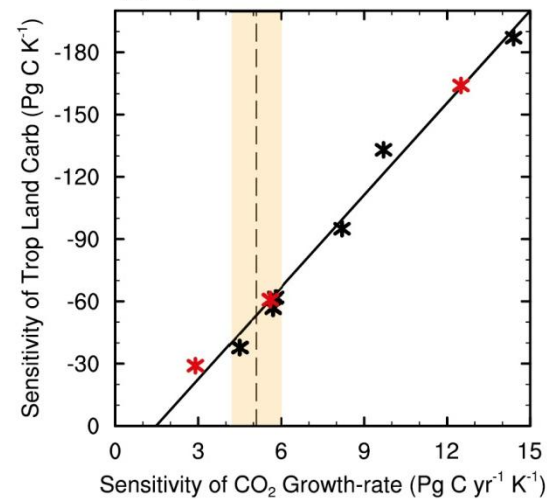
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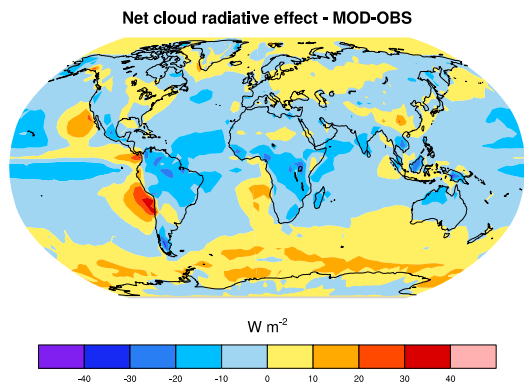
Similar to **Figure 9.7 of AR5**

**LINK TO PROJECTIONS**

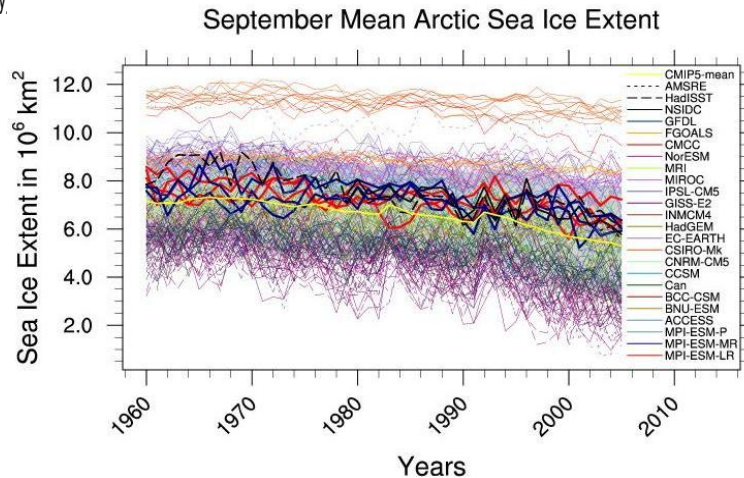
(b) Tropical Land carbon feedback



Similar to **Figure 9.24 of AR5**

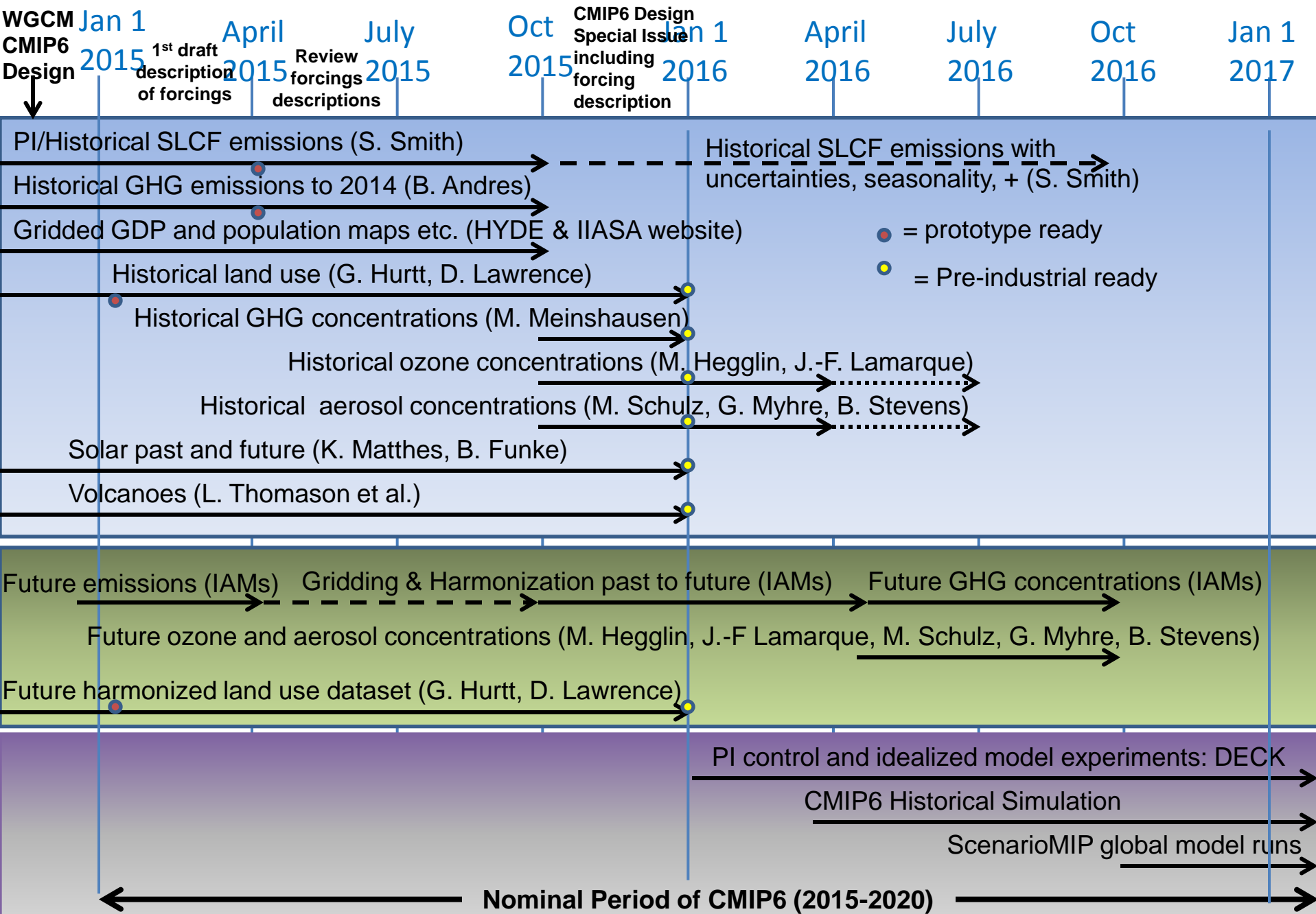


Similar to **Figure 9.5 of AR5**



Similar to **Figure 9.24 of AR5**

# CMIP6 Timeline



# CMIP and CMIP6 Cycle

## CMIP Cycle

1. **Coordination of Data Request DECK** (coordinated and technically overseen by WIP, scientifically overseen by CMIP Panel, in close collaboration with modelling groups)
2. **ESGF Data Archive and Related Functionality** (overseen by WIP)
3. **Register Model for CMIP and Run and Submit DECK Experiments** (model groups)
4. **Documentation of Models and Simulations** (WIP in collaboration with model groups)

## CMIP6 Cycle

1. **Defining the MIP set:** open call for MIP proposals ✓
2. **Harmonization Phase:** WGCM reviews and harmonizes experiments across the MIPs for synergies and similar experimental design in collaboration with MIP co-chairs ✓
3. **Endorsement of MIPs by CMIP Panel + WGCM co-chairs** ✓
4. **Coordination of CMIP6 Data Request (DECK+)** (coordinated and technically overseen by WIP, scientifically overseen by CMIP Panel, in close collaboration with modelling groups)
5. **Preparation of Forcings** (“Forcing Group” and overseen by CMIP Panel)
6. **Documentation of CMIP6 Experimental Design in a Special Issue Overview** (CMIP Panel + WGCM Co-chairs) + Papers from CMIP6-Endorsed MIPs + Papers on Forcing Datasets)
7. **Model Execution CMIP6 Historical Simulation** (DECK & CMIP6 Historical Simulation to be run for each model configuration used in the subsequent CMIP6-Endorsed MIPs)
8. **Routine Model Evaluation:** as soon as output from CMIP6 Historical Simulation is submitted
9. **Model Execution MIP experiments and submission to ESGF** (model groups)
10. **Additional Model Analysis:** by wider community



# Summary and Outlook



## CMIP6 Status

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

## CMIP6 Evaluation and Scenarios

- Climate model evaluation central part of CMIP6, research on emergent constraints ongoing, including uncertainty assessments in projections.
- New scenarios span the same range as the RCPs, but fill critical gaps for intermediate forcing levels.
- Several scenarios (but not all) of the SSP/RCP matrix will be run with coupled climate models, but some only in Tier 2; need to justify the choices well and consider the selection in our interpretation.

## 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 (April 2015 - December 2016)

- Overview of the CMIP6 Design and Organization
- Experimental design from all CMIP6-Endorsed MIPs (submission by end of 2015)
- Description of the CMIP6 forcing data