

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

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20 October 2015

Workshop on CMIP5 Model Analysis and Scientific Plans for CMIP6

Dubrovnik, Croatia

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

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

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



CMIP: Understanding past, present and future climate

- Since 1995, **CMIP** has coordinated climate model experiments involving multiple international modeling teams worldwide.
- CMIP has led to a better understanding of past, present and future climate change and variability.
- CMIP model simulations have also been regularly assessed as part of the IPCC Climate Assessments Reports and various national assessments.
- CMIP is a project of the World Climate Research Programme (WCRP)'s Working Group of Coupled Modelling (WGCM)
- CMIP's central goal is to advance scientific understanding of the Earth system.
- 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 early for the **sixth phase of the project (CMIP6)**.

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 an extensive period (two years) of community consultation

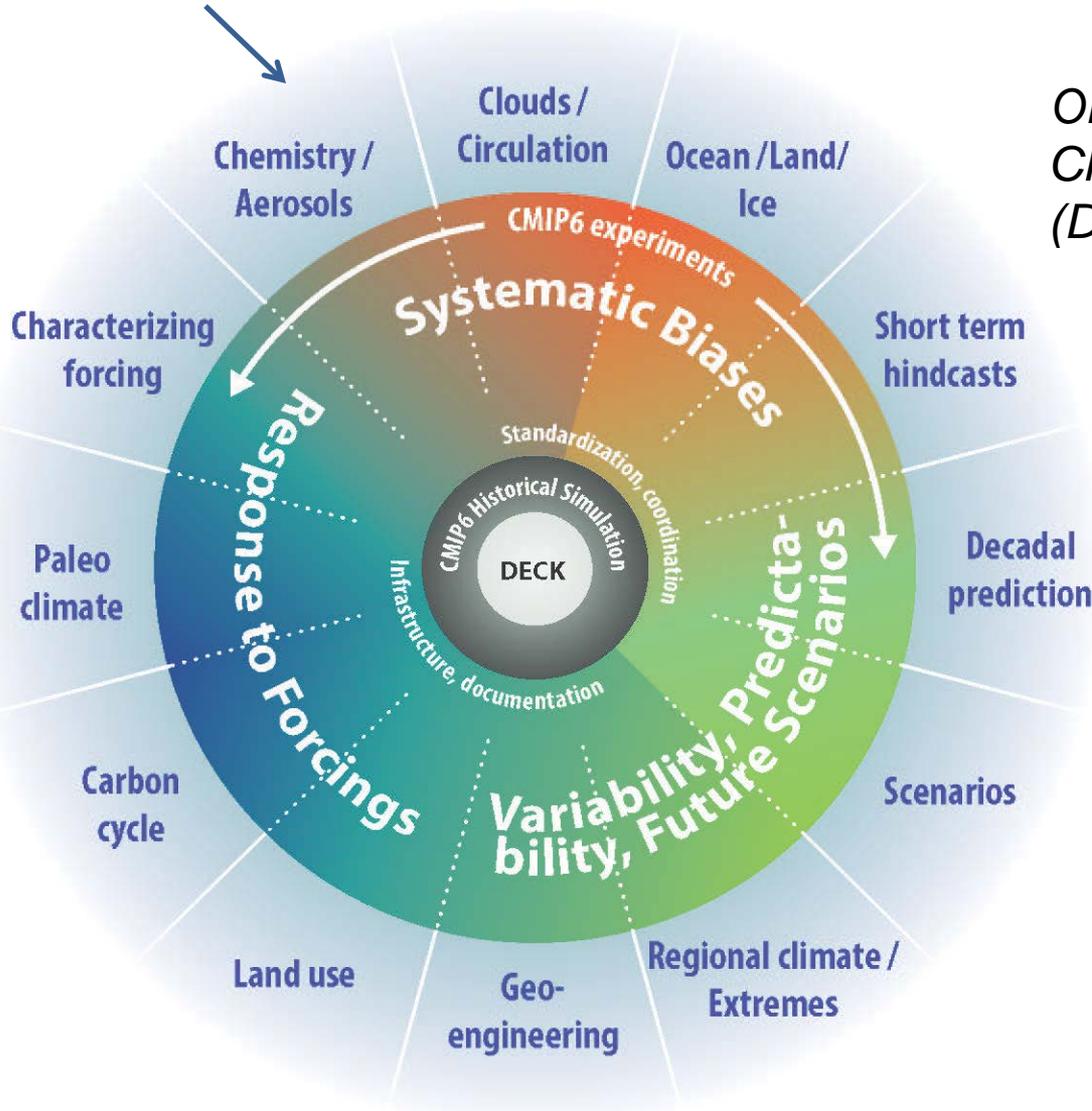
- Based on the summer 2013 CMIP5 survey and Aspen & WGCM/AIMES 2013 meetings
- Initial proposal for the design of CMIP6 (Meehl et al., EOS, 2014).
- Feedback on this initial CMIP6 proposal has been solicited over the year from modeling groups and model analysts until September 2014.
- The WGCM and the 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

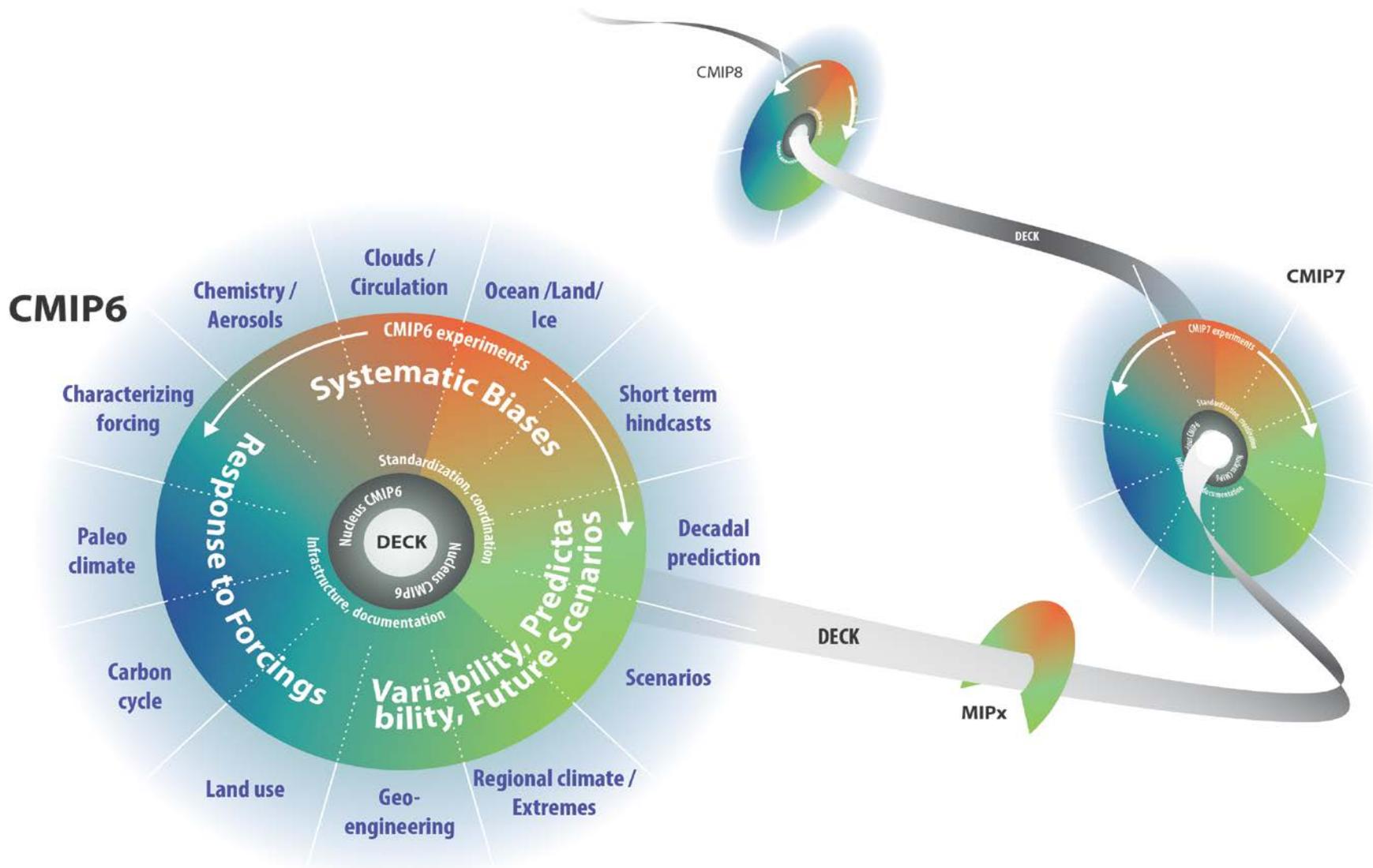
CMIP6 Historical Simulation (entry card for CMIP6)

- 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

CMIP Continuity



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

0 5 10 15 20 25

AerChemMIP

C4MIP

CFMIP

DAMIP

DCPP

FAFMIP

GeoMIP

GMMIP

HighResMIP

ISMIP6

LS3MIP

LUMIP

OMIP

PMIP

RFMIP

ScenarioMIP

VoIMIP

CORDEX

DynVar

SIMIP

VIACS AB

Long Name of MIP (Short Name of MIP)

1 Aerosols and Chemistry Model Intercomparison Project (AerChemMIP)

2 Coupled Climate Carbon Cycle Model Intercomparison Project (C4MIP)

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)

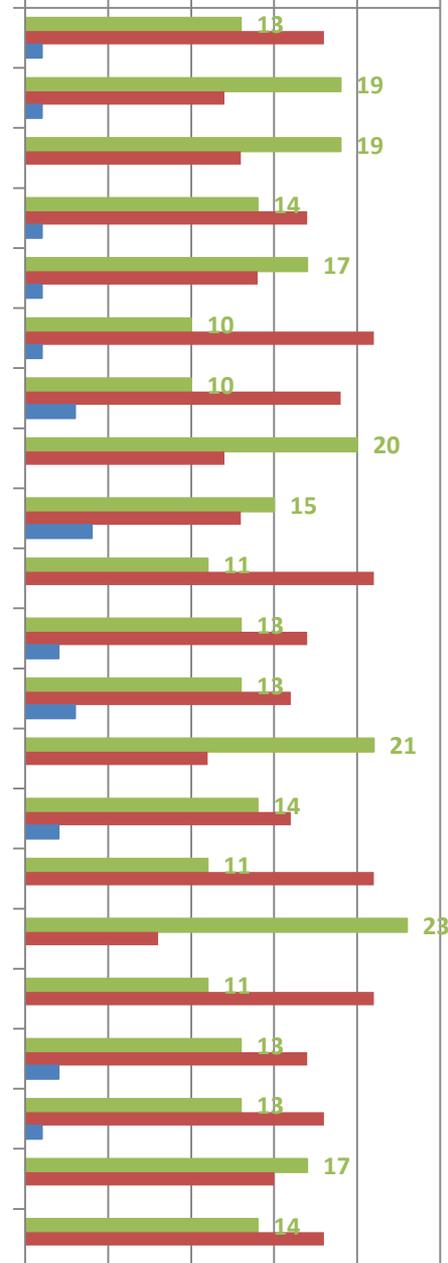
20 Sea-Ice Model Intercomparison Project (SIMIP)

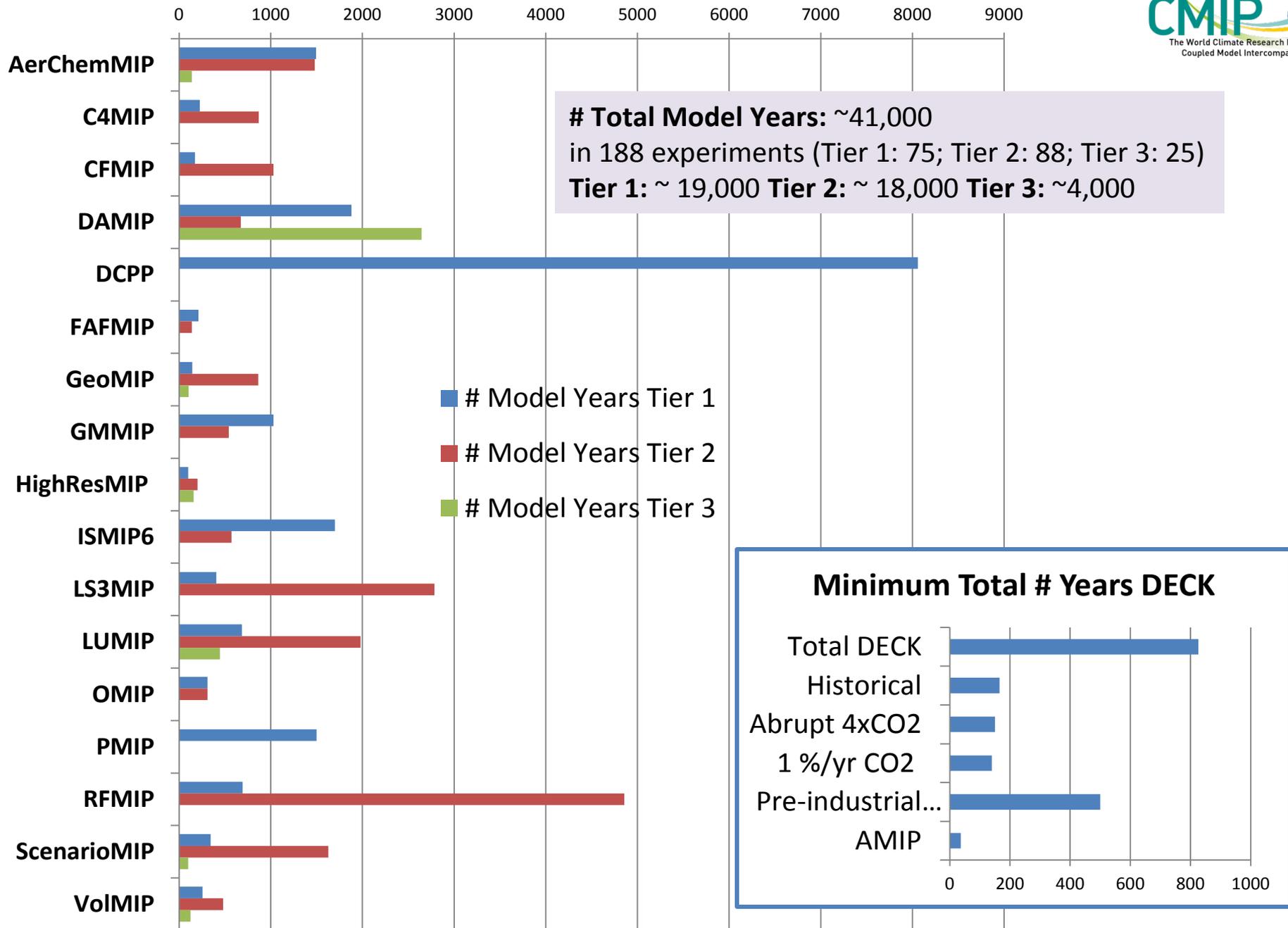
21 Vulnerability, Impacts & Adaptation and Climate Services AB (VIACS AB)

■ Participating

■ Not Participating

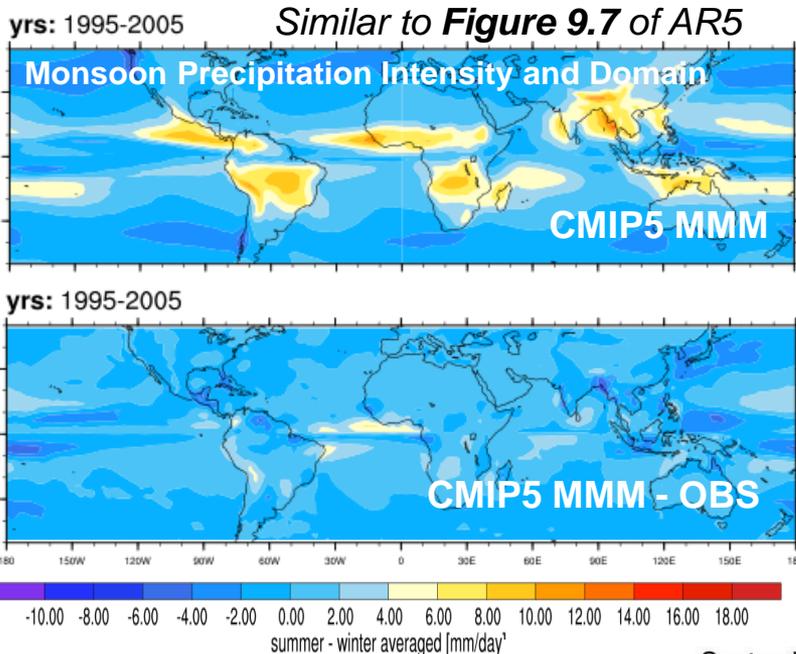
■ Don't Know Yet





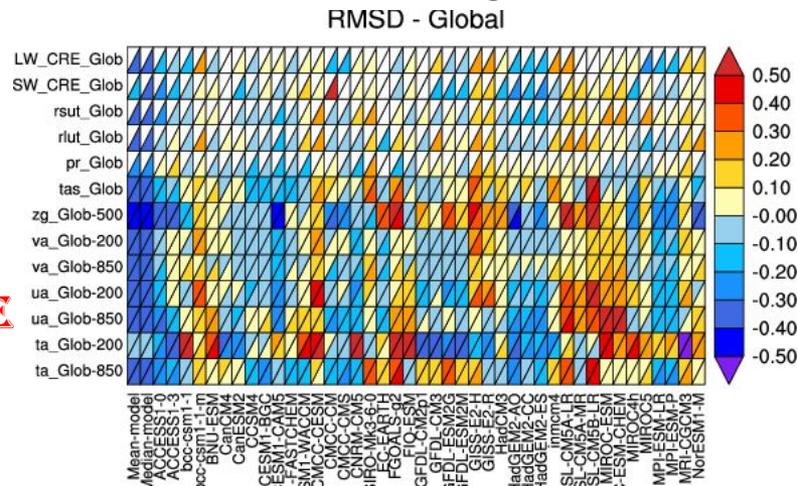
Routine Benchmarking and Evaluation Central Part of CMIP6

CMIP evaluation tool to produce well-established analyses as soon as model output becomes available e.g., Community-developed ESMValTool (Eyring et al., GMDD, 2015) and PCMDI metrics package (Gleckler et al., EOS, in press) - [Link to WGNE/WGCM Climate Model Metrics and Diagnostic Panel](#)



**RUNNING
ALONG-SIDE
THE ESGF**

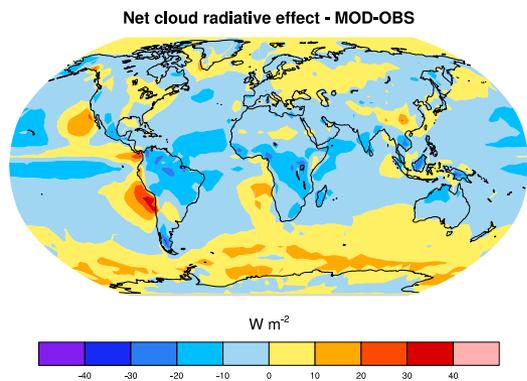
**AR5
CHAPTER 9**



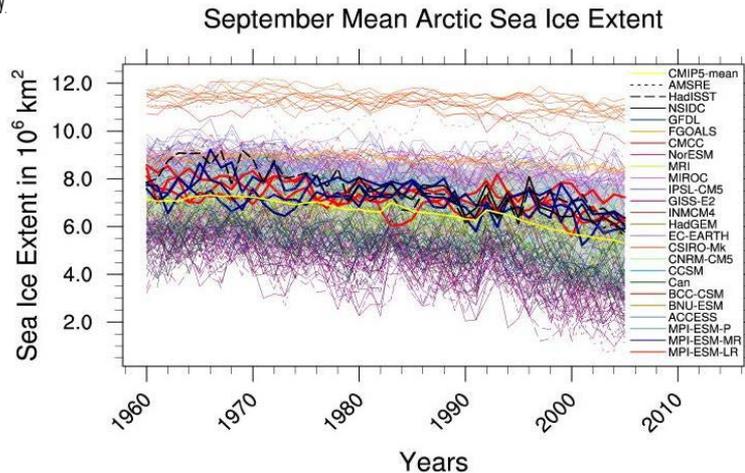
Similar to **Figure 9.7 of AR5**

LINK TO PROJECTIONS

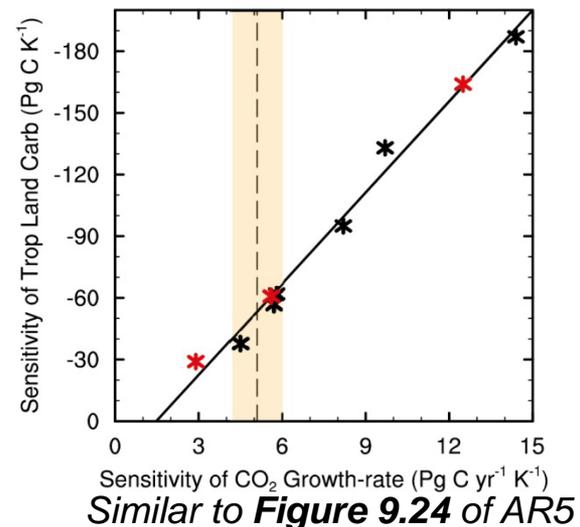
(b) Tropical Land carbon feedback



Similar to **Figure 9.5 of AR5**



Similar to **Figure 9.24 of AR5**

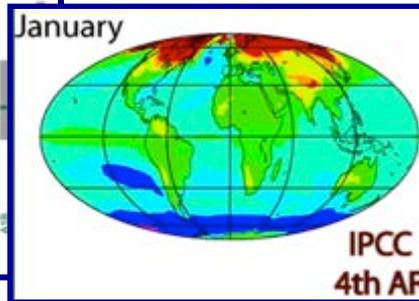
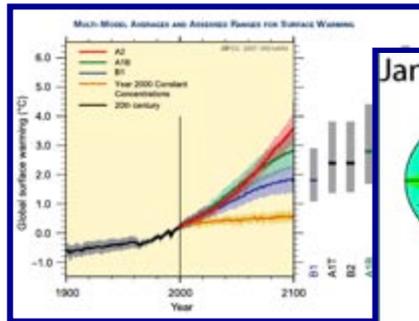


Under-Exploited Observations for Model Evaluation

Observations for Model Intercomparison Projects (obs4MIPs)

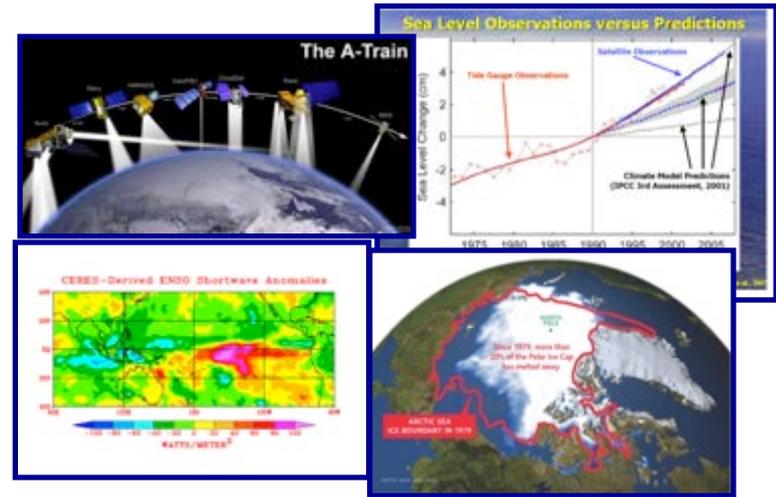
WDAC Task Team on Observations for Model Evaluation

CMIP6



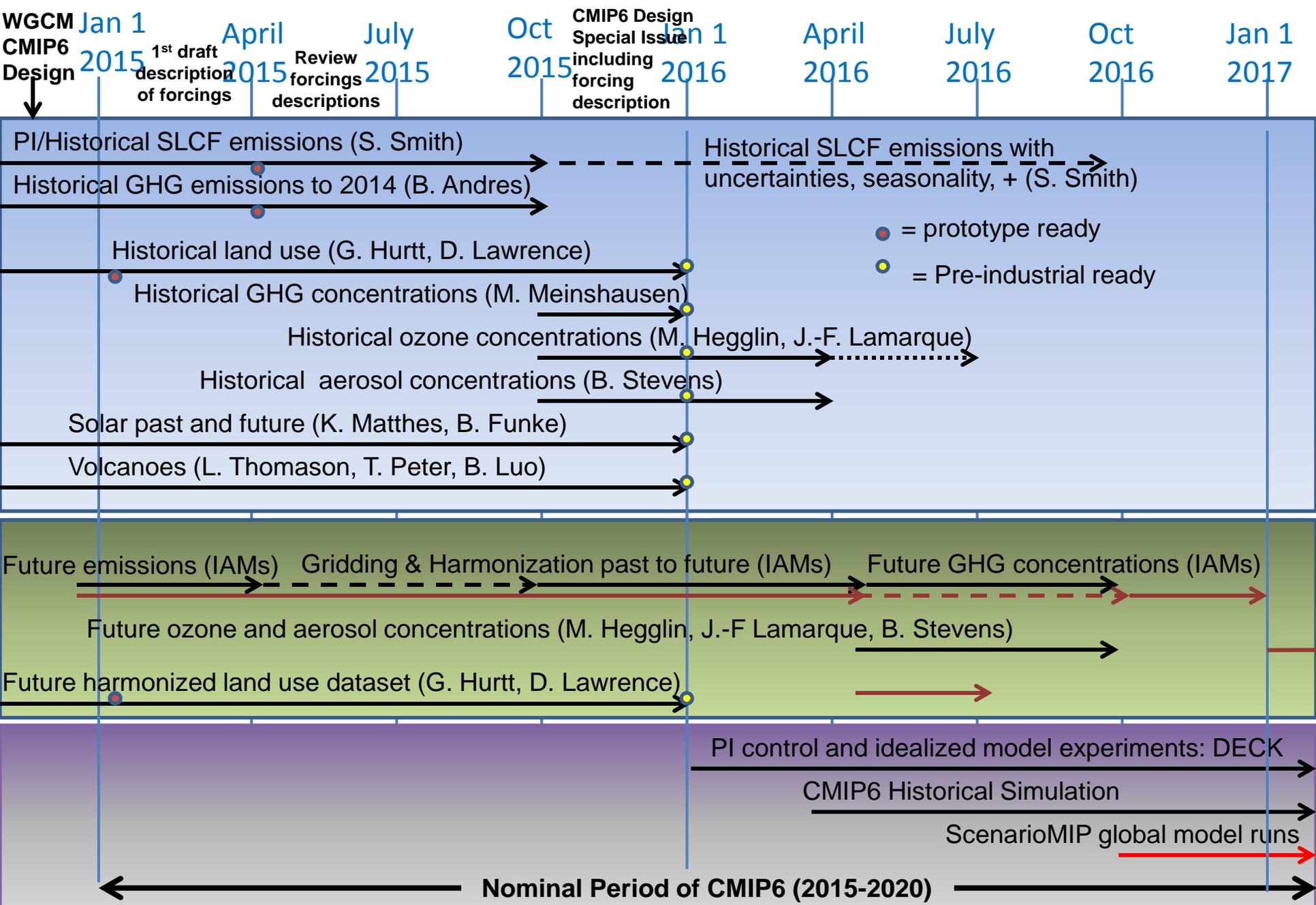
How to bring as much observational scrutiny as possible to the CMIP/IPCC process?

- 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



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

CMIP6 Timeline



Status and Outlook

CMIP6 Status

- 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) by WGCM Infrastructure Panel (WIP)

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.

A central goal of CMIP6 is routine evaluation of the models with observations

- Coordinated by the WGNE / WGCM climate diagnostics and metrics panel in collaboration with the CMIP Panel

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>

CMIP6 Special Issue in GMD

| 1 | CMIP6 Experimental Design & Organisation | Overview |
|----|---|---|
| 2 | AerChemMIP | CMIP6-Endorsed MIP |
| 3 | C ⁴ MIP | CMIP6-Endorsed MIP |
| 4 | CFMIP | CMIP6-Endorsed MIP |
| 5 | DAMIP | CMIP6-Endorsed MIP |
| 6 | DCPP | CMIP6-Endorsed MIP |
| 7 | FAFMIP | CMIP6-Endorsed MIP |
| 8 | GeoMIP | CMIP6-Endorsed MIP |
| 9 | GMMIP | CMIP6-Endorsed MIP |
| 10 | HighResMIP | CMIP6-Endorsed MIP |
| 11 | ISMIP6 | CMIP6-Endorsed MIP |
| 12 | LS3MIP | CMIP6-Endorsed MIP |
| 13 | LUMIP | CMIP6-Endorsed MIP |
| 14 | OMIP | CMIP6-Endorsed MIP |
| 15 | PMIP | CMIP6-Endorsed MIP |
| 16 | RFMIP | CMIP6-Endorsed MIP |
| 17 | ScenarioMIP | CMIP6-Endorsed MIP |
| 18 | VoMIP | CMIP6-Endorsed MIP |
| 19 | CORDEX* | CMIP6-Endorsed MIP |
| 20 | DynVar* | CMIP6-Endorsed MIP |
| 21 | SIMIP* | CMIP6-Endorsed MIP |
| 22 | VIACS AB* | CMIP6-Endorsed MIP |
| 23 | Historical SLCF and GHG Emissions | Forcings DECK and Historical Simulation |
| 24 | Global Gridded Land-use Forcing Datasets | Forcings DECK and Historical Simulation |
| 25 | Historical GHG concentrations | Forcings DECK and Historical Simulation |
| 26 | Ozone and Stratospheric Water Vapor Concentrations | Forcings DECK and Historical Simulation |
| 27 | Aerosol Concentrations | Forcings DECK and Historical Simulation |
| 28 | Solar forcing | Forcings DECK and Historical Simulation |
| 29 | Stratospheric Aerosol Data Set | Forcings DECK and Historical Simulation |
| 30 | Future Emissions | Forcings DECK and Historical Simulation |
| 31 | AMIP SSTs and Sea Ice Datasets | Forcings DECK and Historical Simulation |
| 32 | WGCM Infrastructure Panel (WIP) | Infrastructure |
| 33 | CMIP6 Data Request | Infrastructure |
| 34 | WGNE/WGCM climate model diagnostics and metrics panel | Model Evaluation |
| 35 | WDAC Task Team on Observations for Model Evaluation | Model Evaluation |