Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) Experimental Design and Organization

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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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CMIP: Understanding past, present and future climate

- CMIP is a project of the World Climate Research Programme (WCRP)'s Working Group of Coupled Modelling (WGCM)

- 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 has developed in phases, with the simulations of the fifth phase, CMIP5, now 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).**

- CMIP's central goal is to advance scientific understanding of the Earth system.

- CMIP model simulations have also been regularly assessed as part of the IPCC Climate Assessments Reports and various national assessments.

CMIP
The World Climate Research Programme's
Coupled Model Intercomparison Project

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. Juckes).

CMIP6 Design

Based on an extensive period (two years) of community consultation

- 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 being solicited 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.

CMIP
The World Climate Research Programme's
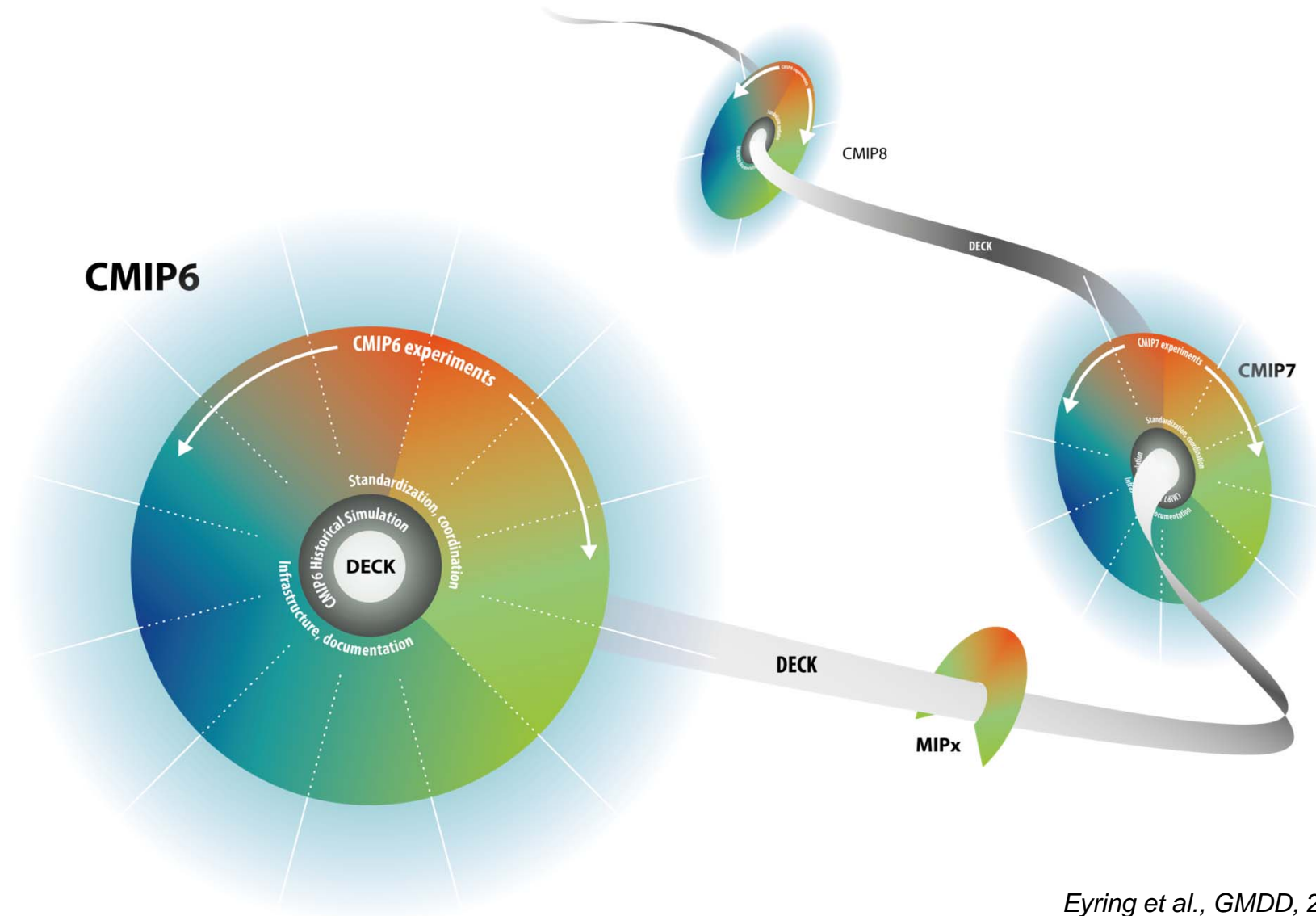Coupled Model Intercomparison Project

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?

CMIP

The World Climate Research Programme's
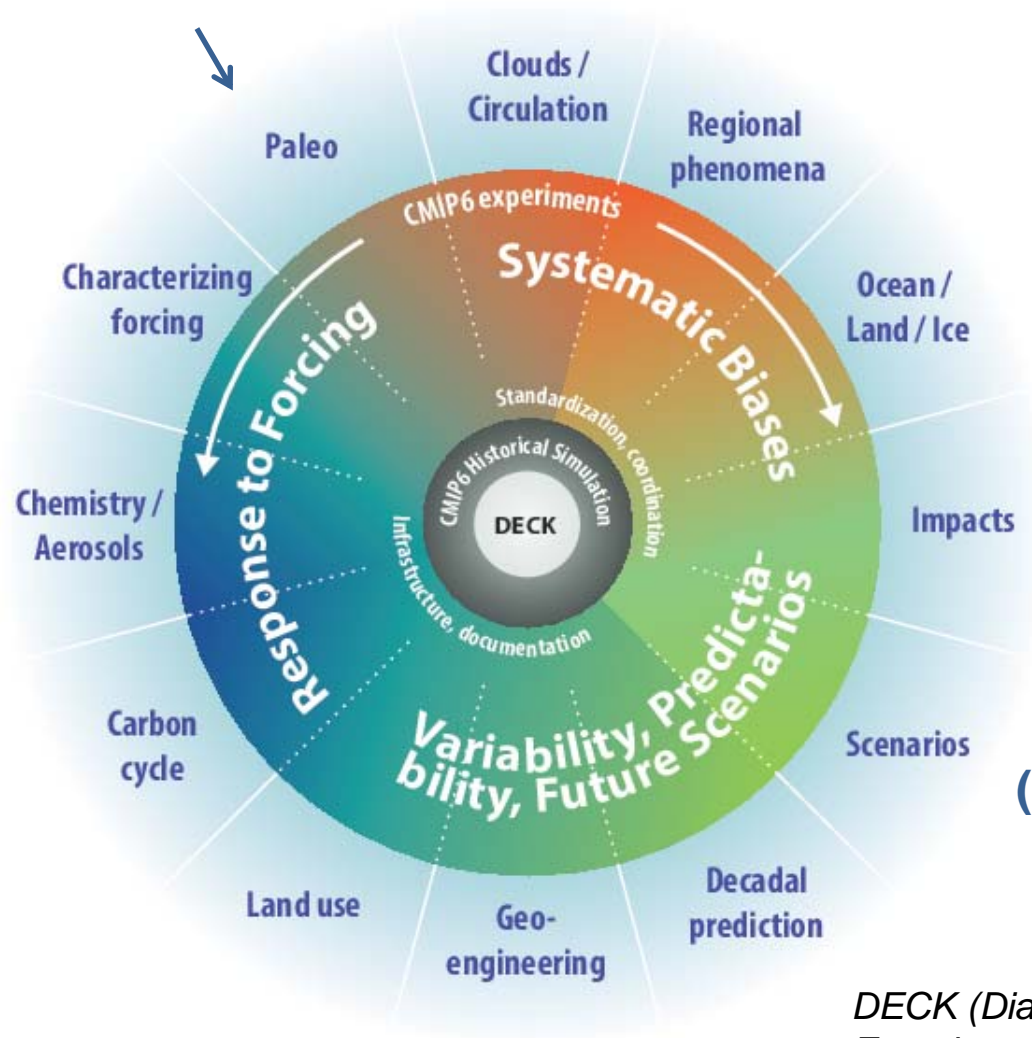Coupled Model Intercomparison Project

CMIP Continuity

A common suite of experiments for each phase of CMIP provides an opportunity to construct a multi-model ensemble using model output from various phases of CMIP

Eyring et al., GMDD, 2015

CMIP: a More Continuous and Distributed Organization

(3) CMIP-Endorsed Model Intercomparison Projects (MIPs)

Eyring et al., GMDD, 2015

(1) A handful of common experiments

DECK (entry card for CMIP)
i. AMIP simulation (~1979-2014)
ii. Pre-industrial control simulation
iii. 1%/yr CO_2 increase
iv. Abrupt 4xCO_2 run

CMIP6 Historical Simulation (entry card for CMIP6)
v. Historical simulation using CMIP6 forcings (1850-2014)

(2) Standardization, coordination, infrastructure, documentation

DECK (Diagnosis, Evaluation, and Characterization of Klima Experiments) & CMIP6 Historical Simulation to be run for each model configuration used in CMIP6-Endorsed MIPs
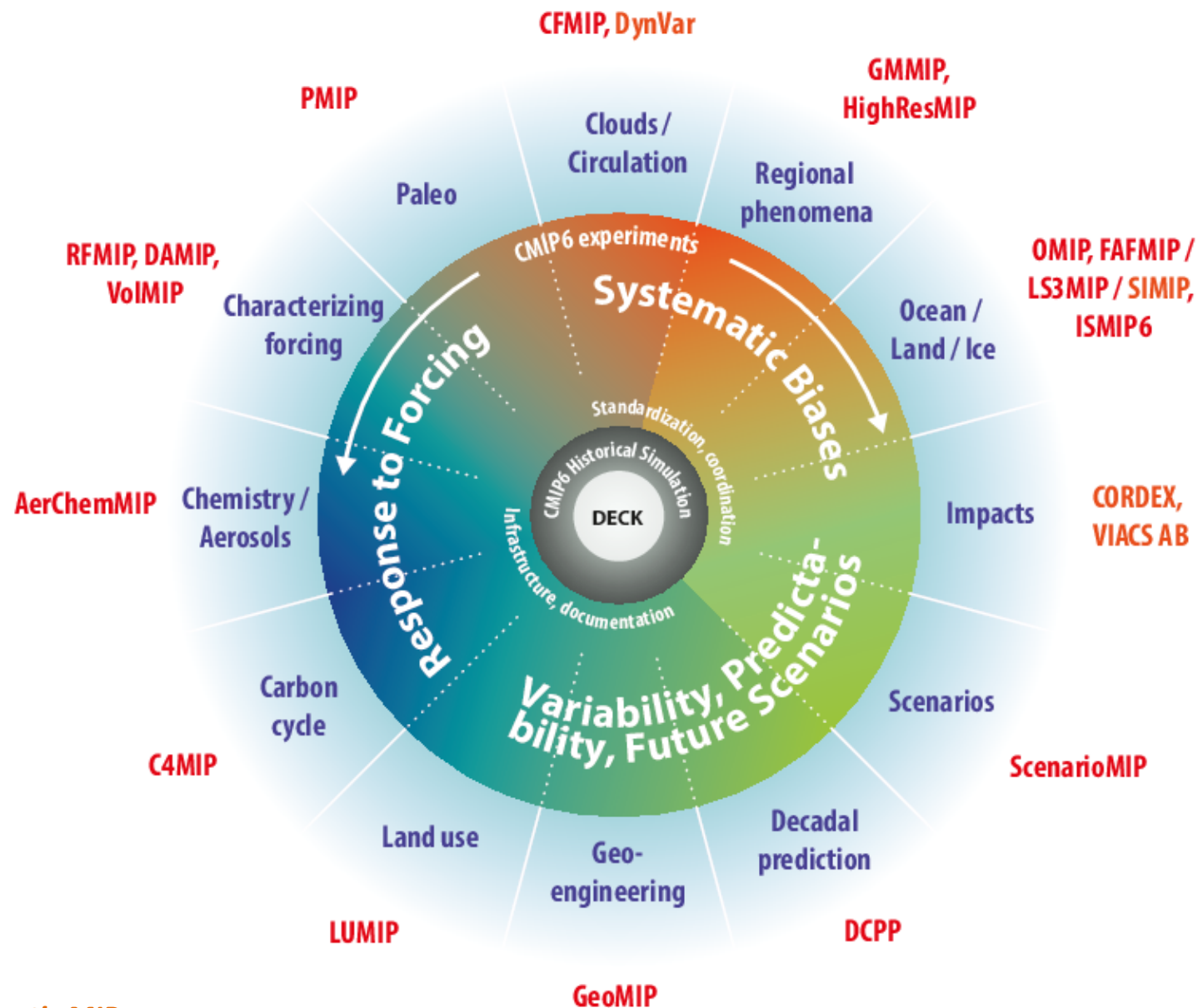
CMIP6-Endorsed MIPs
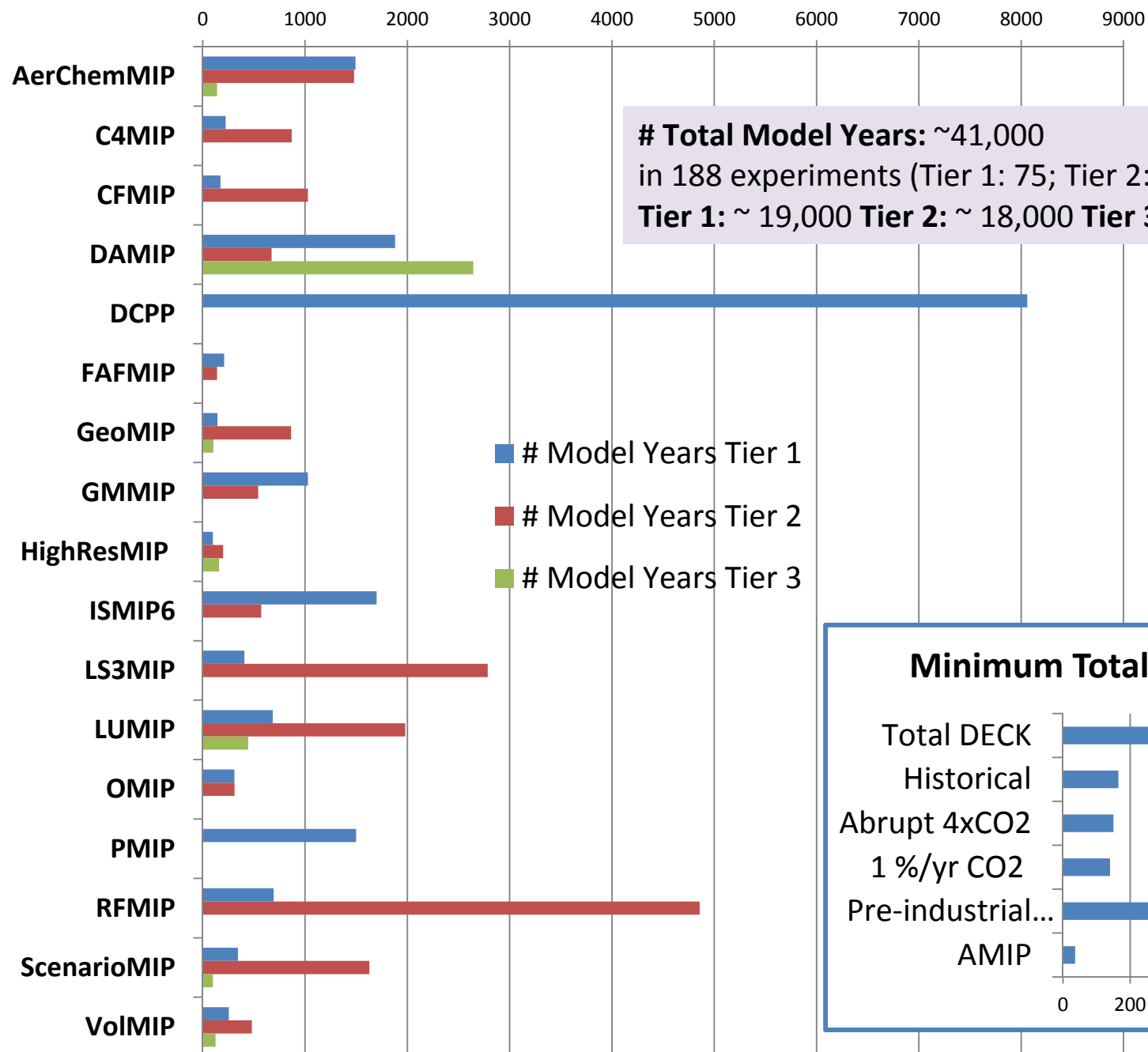
Main Criteria for Endorsement

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.

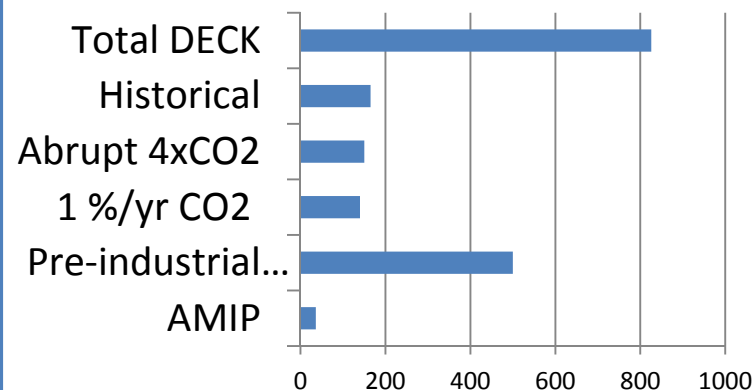* For "Diagnostic-MIPs" only non-experimental criteria apply

21 CMIP6-Endorsed MIPs

CMIP

The World Climate Research Programme's
Coupled Model Intercomparison Project

CFMIP, DynVar

PMIP

RFMIP, DAMIP, VolMIP

AerChemMIP

C4MIP

LUMIP

GeoMIP

GMMIP, HighResMIP

OMIP, FAFMIP / LS3MIP / SIMIP, ISMIP6

CORDEX, VIACS AB

ScenarioMIP

DCPP

Clouds / Circulation
Regional phenomena
Paleo
Ocean / Land / Ice
Characterizing forcing
Impacts
Chemistry / Aerosols
Scenarios
Carbon cycle
Decadal prediction
Land use
Geo-engineering

CMIP6 experiments
Systematic Biases
Response to Forcing
Variability, Predicta-bility, Future Scenarios
Standardization, coordination
CMIP6 Historical Simulation
DECK
Infrastructure, documentation

Diagnostic MIPs

CMIP
The World Climate Research Programme's
Coupled Model Intercomparison Project

Total Model Years: ~41,000
in 188 experiments (Tier 1: 75; Tier 2: 88; Tier 3: 25)
Tier 1: ~ 19,000 **Tier 2:** ~ 18,000 **Tier 3:** ~4,000

- # Model Years Tier 1
- # Model Years Tier 2
- # Model Years Tier 3

Minimum Total # Years DECK

Total DECK
Historical
Abrupt 4xCO2
1 %/yr CO2
Pre-industrial...
AMIP

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, 2015b) and PCMDI metrics package
(Gleckler et al., EOS, subm.) - *Link to WGNE/WGCM Climate Model Metrics and Diagnostic Panel*
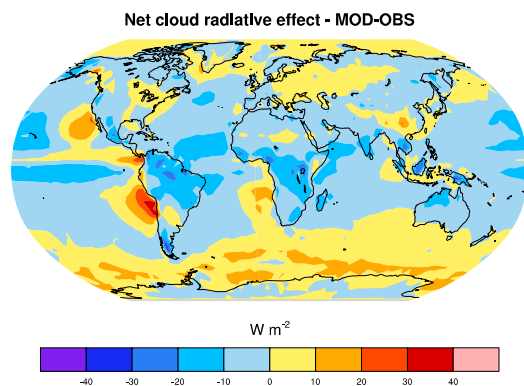

Similar to Figure 9.7 of AR5
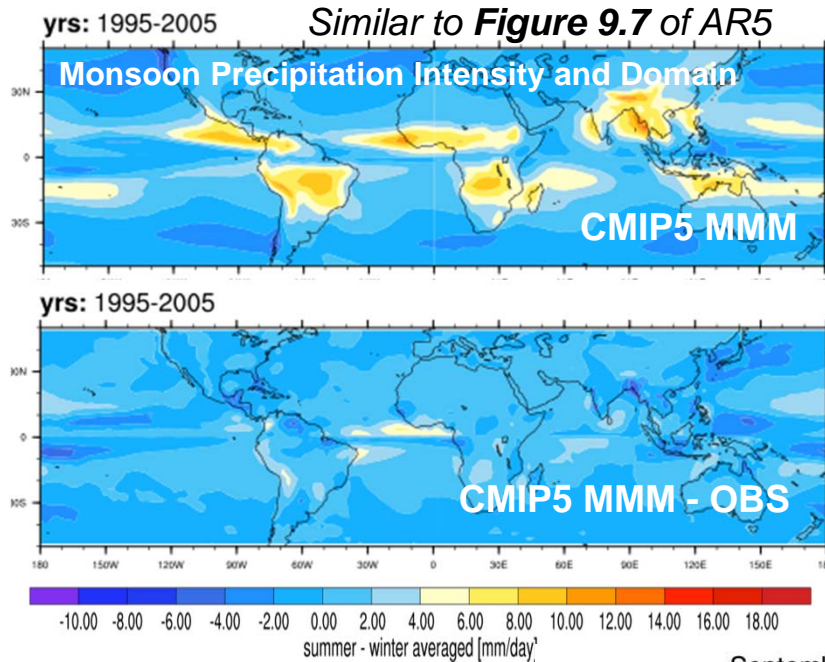
RUNNING ALONG-SIDE THE ESGF

AR5 CHAPTER 9
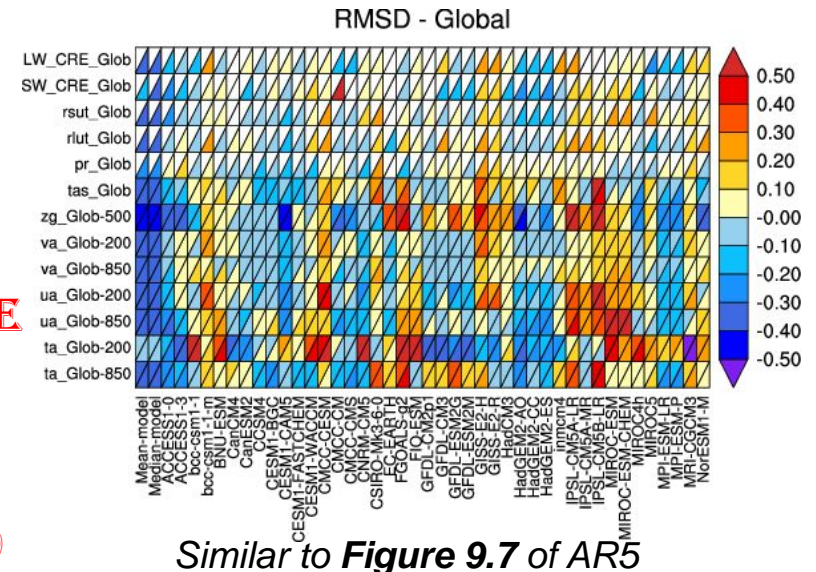
Similar to Figure 9.7 of AR5

LINK TO PROJECTIONS

Similar to Figure 9.5 of AR5
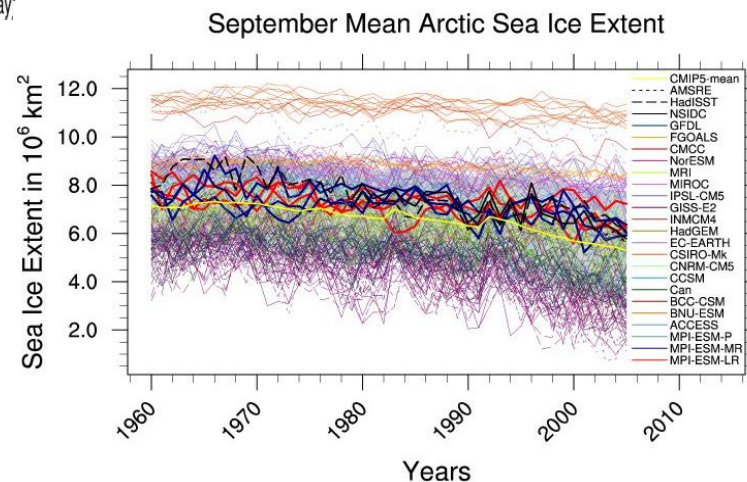
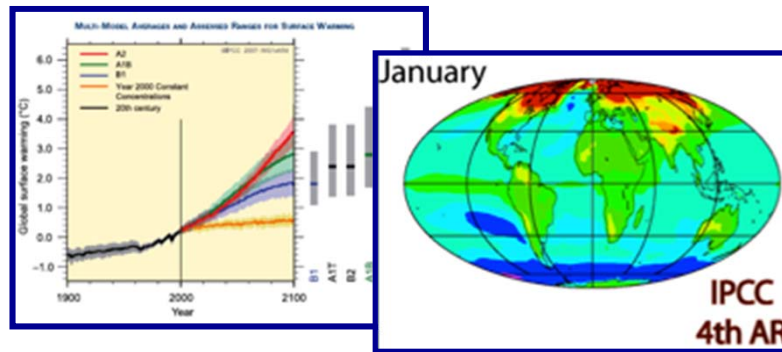*Similar to Figure 9.24 of AR5*
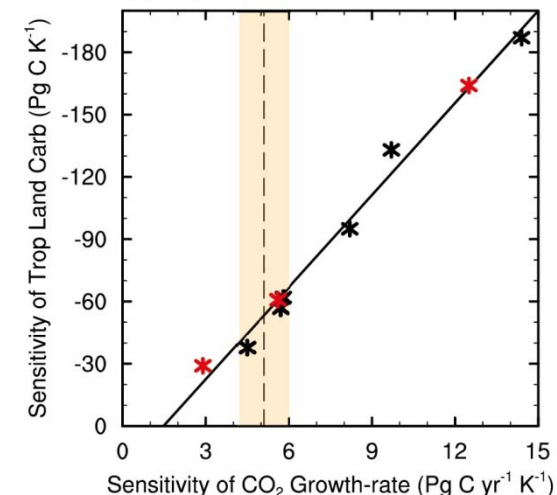
Similar to Figure 9.24 of AR5

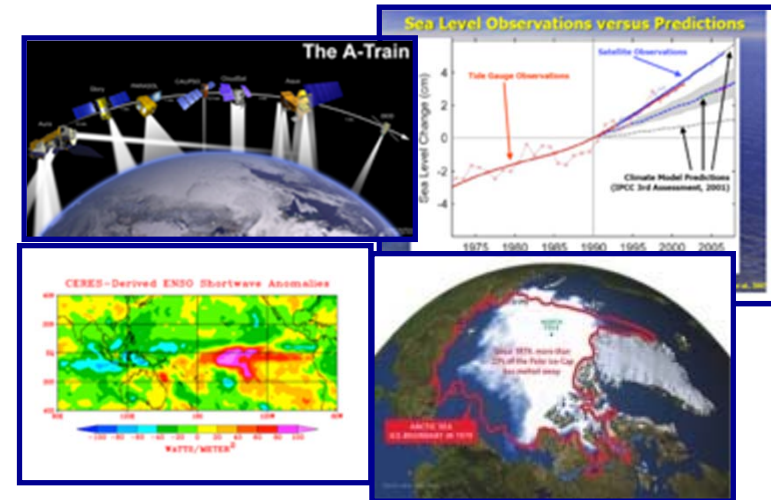*Under-Exploited Observations for Model Evaluation*

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 process?

How to best utilize the wealth of satellite observations for the CMIP 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

CMIP6 Timeline

Eyring et al., GMDD, 2015
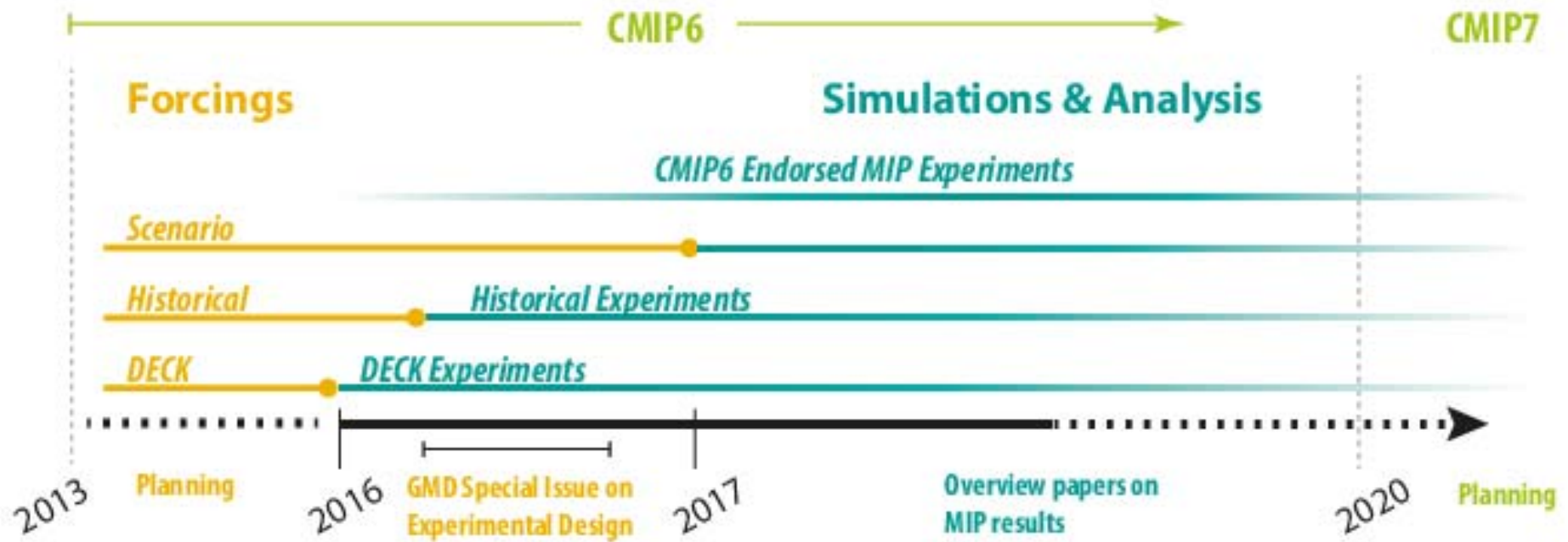
Status and Outlook

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)
- 31 Oct - 4 November 2016: WGCM-20 (Princeton, USA)

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

- Overview of the CMIP6 Design and Organization (Eyring et al., GMDD, 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