

Preparing for Phase 6 of the Coupled Model Intercomparison Project (CMIP6)

Date: 14 May 2014, see updates on the CMIP Panel website
<http://www.wcrp-climate.org/index.php/wgcm-cmip/about-cmip>

- Initial proposal for the design of CMIP6 to inform interested research communities and to encourage discussion and feedback for consideration in the evolving experiment design.



- This proposal is based on

Meehl, G. A., R. Moss, K. E. Taylor, V. Eyring, R. J. Stouffer, S. Bony and B. Stevens, Climate Model Intercomparisons: Preparing for the Next Phase, Eos Trans. AGU, 95(9), 77, 2014.

- **Feedback on this initial CMIP6 proposal is being solicited over the next year from modeling groups and model analysts.** Please send comments to CMIP Panel chair, Veronika Eyring, Veronika.Eyring@dlr.de by September 2014. The WGCM and the CMIP Panel will then iterate on the proposed experiment design, with the intention to **finalize it at its meeting in October, 2014.**

CMIP6: 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)**.
- We describe here an **initial proposal for the design of CMIP6** to inform interested research communities and to encourage discussion and feedback for consideration in the evolving experiment design.

Initial CMIP6 Proposal: Scientific Focus

- It is proposed to use as the **scientific backdrop** for CMIP6 the six **WCRP Grand Challenges**, and an additional theme encapsulating questions related to **biospheric 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. AIMES theme for collaboration: biospheric forcings and feedbacks
- The specific experimental design would be 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?

Initial CMIP6 Proposal: A Distributed Organization under the oversight of the CMIP Panel

CMIP would be comprised of two elements:

- 1. Ongoing CMIP Diagnostic, Evaluation and Characterization of Klima (DECK) experiments:** a small set of standardized experiments that would be performed whenever a new model is developed.

The DECK experiments are chosen to provide **continuity across past and future phases of CMIP**, to evolve only slowly with time, and to take advantage of what is already **common practice in many modeling centers**:

- i. an AMIP simulation (~1979-2010);
 - ii. a multi-hundred year pre-industrial control simulation;
 - iii. a 1%/yr CO₂ increase simulation to quadrupling to derive the transient climate response;
 - iv. an instantaneous 4xCO₂ run to derive the equilibrium climate sensitivity;
 - v. a simulation starting in the 19th century and running through the 21st century using an existing scenario (RCP8.5).
- 2. Standardization, coordination, infrastructure, and documentation functions** that make the simulations and their main characteristics performed under CMIP available to the broader community.

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CMIP Phase 6 (CMIP6):

- **CMIP6-Endorsed MIPs** would propose additional experiments, and modeling groups could choose a subset of these to run according to their interest, computing and/or human resources and funding constraints.
- The MIPs would also likely have additional experiments that would not be part of CMIP6 but would be of interest and relevant to their respective communities.

Participation

- The ongoing nature of the proposed CMIP/CMIP6 structure means that anyone at any time could download model data for analysis.
- A scientist or group of scientists could send a 'Request for a **CMIP6-Endorsed MIP**' at any time to the CMIP Panel Chair (see template on CMIP webpage).

CMIP6-Endorsed MIPs

- Request for **CMIP6-Endorsed MIPs** should be sent to the CMIP Panel Chair.
- **CMIP6-Endorsed MIPs**
 - can make full use of the ESGF infrastructure.
 - They can propose that part or all of their experiments be included in CMIP6.

The main criteria for MIPs to be endorsed for CMIP6 are

- The MIP addresses at least one of the key science questions of CMIP6;
- The MIP follows CMIP standards in terms of experimental design, data format and documentation;
- A sufficient number of modeling groups have agreed to participate in the MIP;
- The MIP builds on the shared CMIP DECK experiments;
- A commitment to contribute to the creation of the CMIP6 data request and to analyze the data.
- A commitment to identify or contribute possible observations/reanalysis to obs4MIPs/ana4MIPs for model evaluation and improved process understanding.

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

ScenarioMIP (Scenario Model Intercomparison Project)

Contact: Brian O'Neill, Claudia Tebaldi, Detlef van Vuuren

Another new concept proposed for CMIP6 is a “ScenarioMIP”

The main objectives of the ScenarioMIP are:

- 1. Define and recommend an experimental design for future scenarios** to be run by climate models as part of CMIP6.
- 2. Coordinate the provision of IAM scenario information to climate modeling groups**, including emissions, concentrations, and land use datasets, coordinating with LUMIP, AerChemMIP, C4MIP, the Integrated Assessment Modeling Consortium (IAMC) and other groups as necessary.
- 3. Coordinate the production of climate model simulations** and facilitate provision of output sufficient to support scenario-based research in the impact/adaptation and integrated assessment communities.

A number of research questions have been identified that require cooperation with integrated assessment and impacts-adaptation-vulnerability researchers. These include

- an overshoot scenario as noted above,
- emissions of short-lived climate forcers and air quality/climate interactions,
- land use and land cover change,
- integrated analysis of impacts and responses;
- climate risk related to variability estimates.

See <https://wiki.ucar.edu/pages/viewpage.action?pageId=282605664>

Model Evaluation

- **A CMIP benchmarking and evaluation software package** (made available to everyone, for example through the WGNE/WGCM metrics panel wiki) would produce well-established analyses as soon as model results become available.
- The objective is to enable routine model evaluation and to aid the model development process by providing feedback concerning systematic model errors in the individual models.

Communication

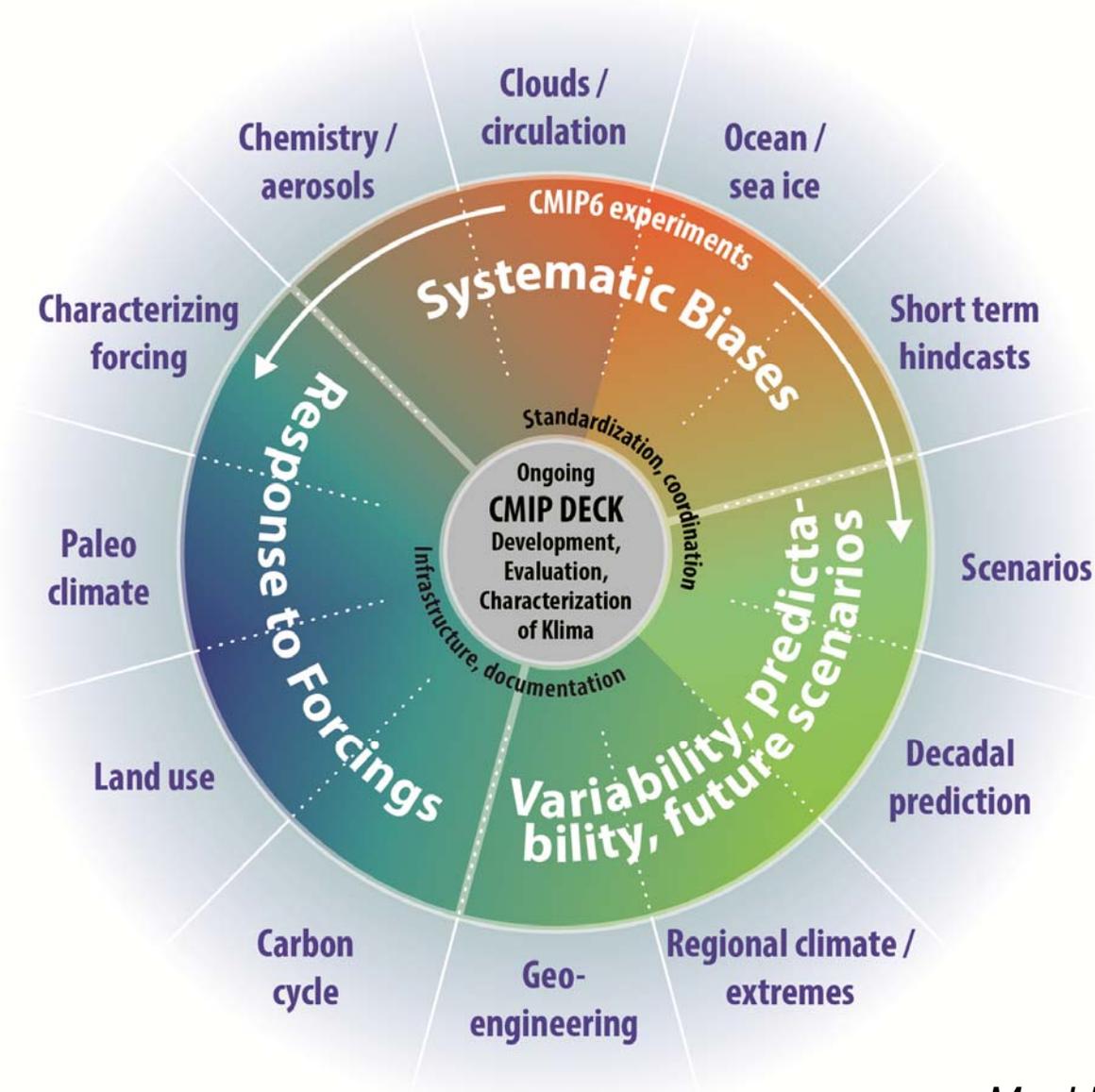
The new distributed nature of CMIP6 requires WGCM and the CMIP Panel to play a strong role in facilitating communication between MIPs, and between the MIPs and the modeling groups.

Next Steps and Time Line

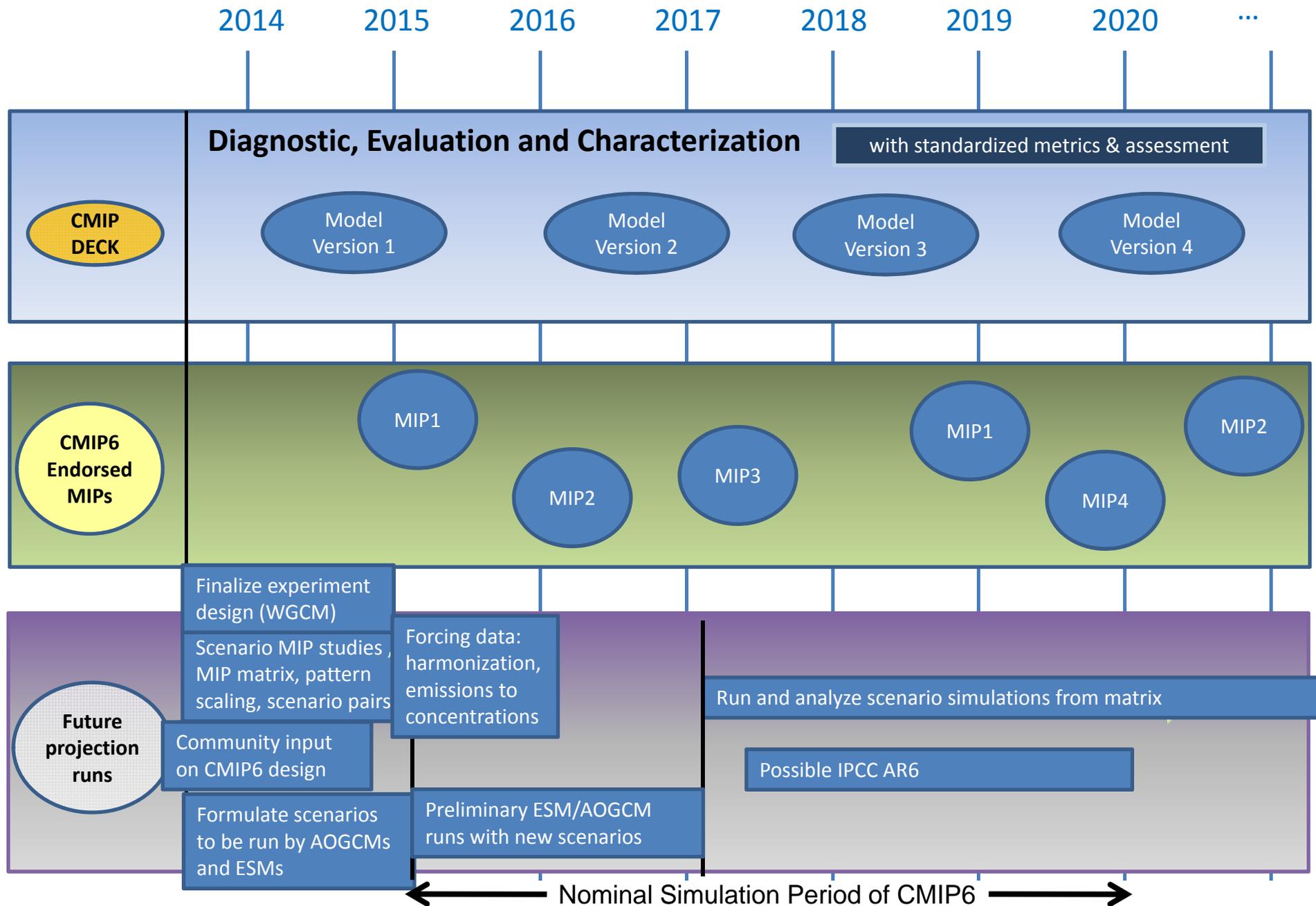
- The overall data preparation will follow procedures developed in CMIP5.
- The historical emissions would be made available in spring 2015, and the emissions for the future climate scenarios by the end of 2015.
- Analyses of CMIP6 data would be ongoing, with the simulation phase of CMIP6 running for five years, from 2015 to 2020, followed by many more years of model analysis.
- The runs for the ScenarioMIP would probably occur near the end of the CMIP6 cycle, and thus likely begin in 2017 and continue into 2018.
- A possible IPCC AR6 that would likely assess CMIP6 simulations could take place from roughly 2017 to 2020, but when or even whether there will be an AR6 will not be known until 2015 at the earliest. Even without an AR6, CMIP6 will still operate, as previous phases of CMIP have, to provide a set of state-of-the-art global climate model simulations as a resource for the international climate science community.

Meehl et al., EOS, 2014

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 “biospheric forcings and feedbacks”



CMIP6 Timeline



Initial CMIP6 Proposal: Acknowledgements

- The authors acknowledge the Aspen Global Change Institute (AGCI) for hosting a CMIP6 planning workshop in August 2013 as part of its traditionally landmark summer interdisciplinary sessions.
- NASA, NOAA, DOE, and NSF, as well as the international global change communities, the WCRP and IGBP, all provided support for the workshop.
- The CMIP6 proposal presented here substantially draws on conclusions from that workshop, and the authors acknowledge contributions from, and discussions with, the AGCI workshop participants, as well as subsequent discussions at the WGCM meeting in October, 2013, in Victoria, Canada, joint with the Analysis, Integration and Modeling of the Earth System (AIMES).
- A related workshop convened by the Energy Modeling Forum is documented here: <http://emf.stanford.edu/events/series/snowmass/> .