

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

Veronika Eyring, Sandrine Bony, Jerry Meehl, Cath Senior, Bjorn Stevens, Ron Stouffer, Karl Taylor (CMIP Panel)



23 September 2016

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

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

Contact for questions: CMIP Panel Chair Veronika Eyring (email: Veronika.Eyring@dlr.de)

Reference:

Eyring, V., Bony, S., Meehl, G. A., Senior, C. A., Stevens, B., Stouffer, R. J., and Taylor, K. E.: [Overview of the Coupled Model Intercomparison Project Phase 6 \(CMIP6\) experimental design and organization](#), Geosci. Model Dev., 9, 1937-1958, doi:10.5194/gmd-9-1937-2016, 2016.

Coupled Model Intercomparison Project (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 in a **multi-model framework**.
- CMIP defines **common experiment protocols, forcings and output**.
- CMIP has developed in phases, with the simulations of the fifth phase, CMIP5, now completed, and the planning of the sixth phase, i.e. CMIP6, well underway.
- 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.

CMIP6 Organization

- **CMIP Panel** (V. Eyring (chair), S. Bony, J. Meehl, C. Senior, B. Stevens, R. Stouffer, K. Taylor) which is responsible for direct coordination of CMIP and overseeing the whole CMIP process.
- **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 Experimental Design

Based on an extensive period (three 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 been 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.

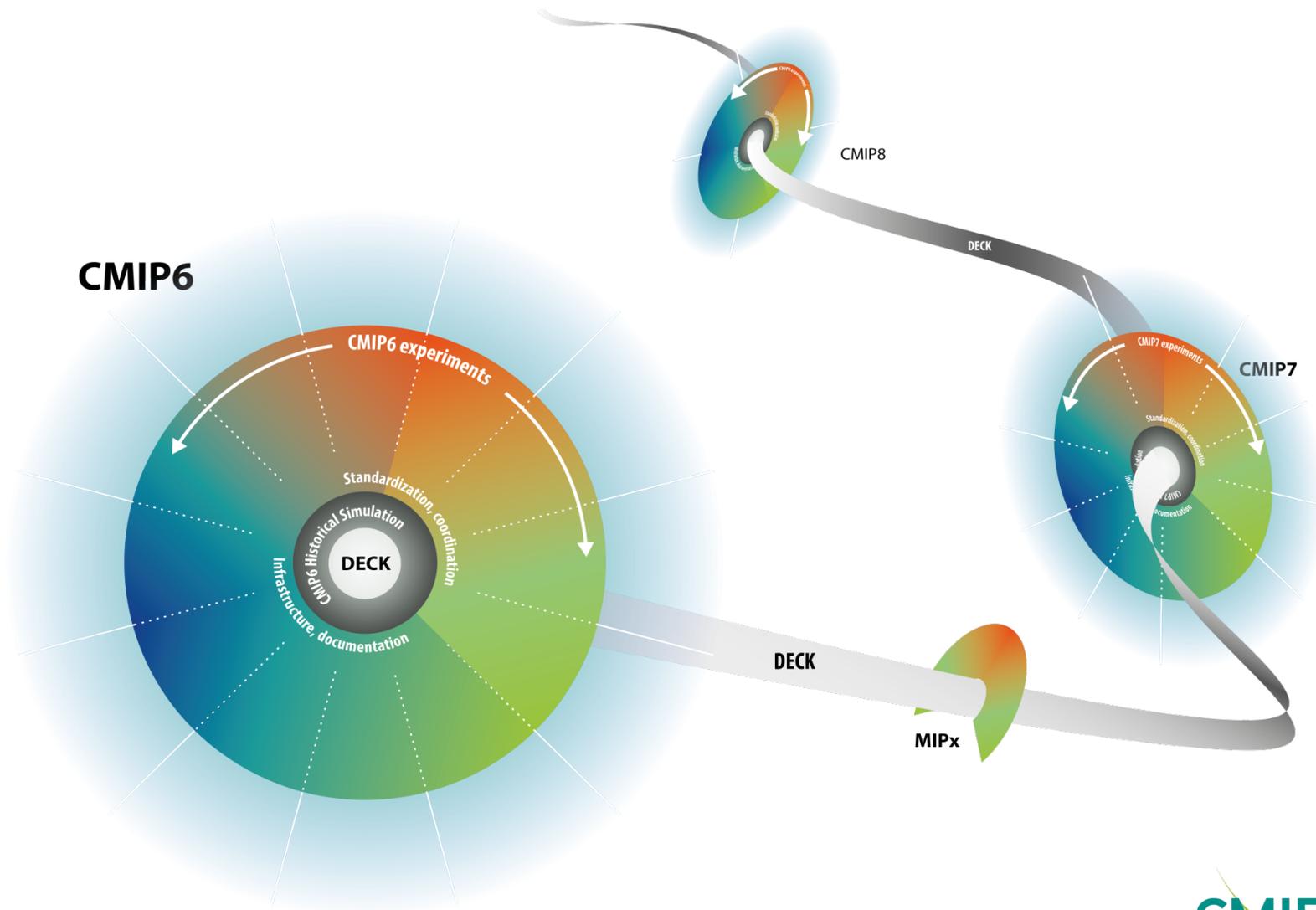


CMIP6 Design: Scientific Focus

- The **scientific backdrop** for CMIP6 is the **WCRP Grand Science Challenges**:
 1. Clouds, Circulation and Climate Sensitivity
 2. Changes in Cryosphere
 3. Climate Extremes
 4. Regional Sea-level Rise
 5. Water Availability
 6. Near-Term Climate Prediction
 7. Biogeochemical Cycles and Climate Change
- 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?

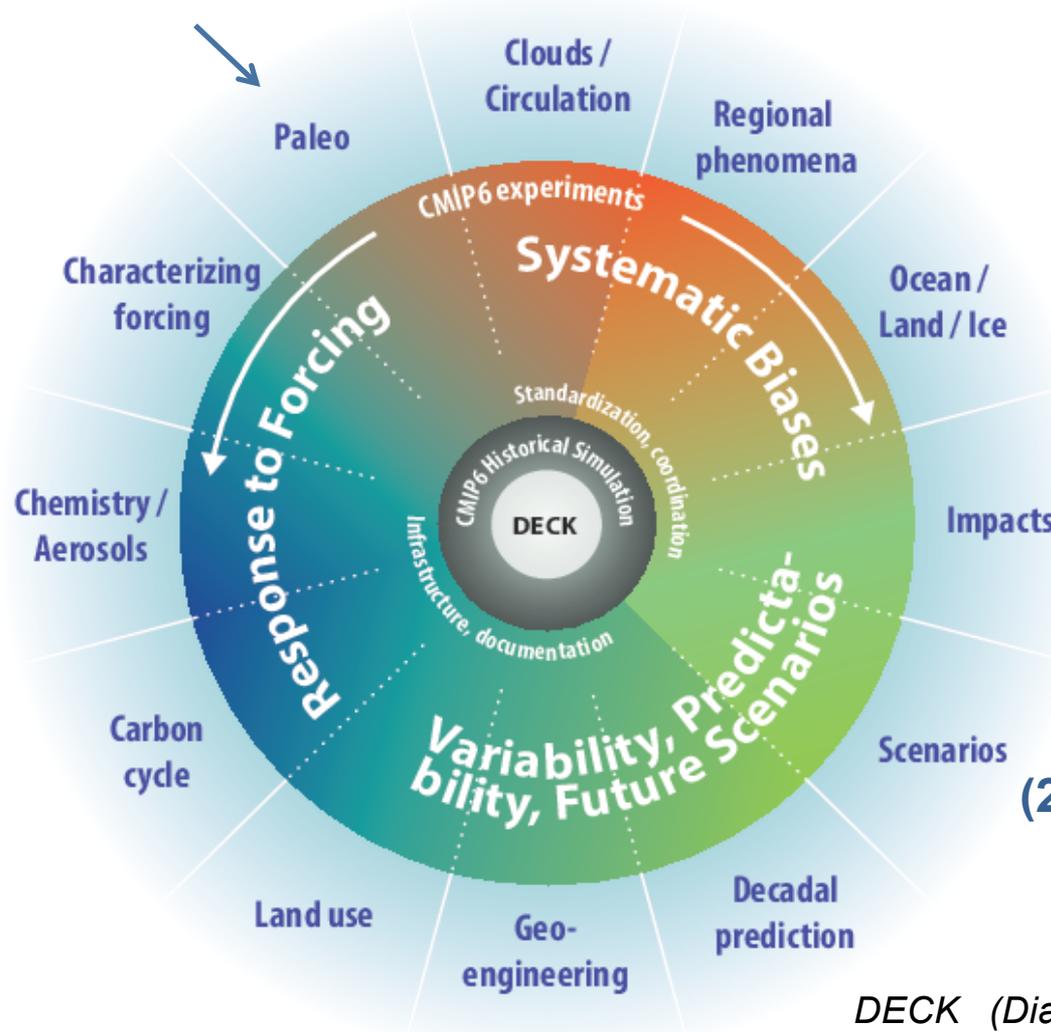
CMIP Continuity

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



CMIP: a More Continuous and Distributed Organization

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



(1) A handful of common 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

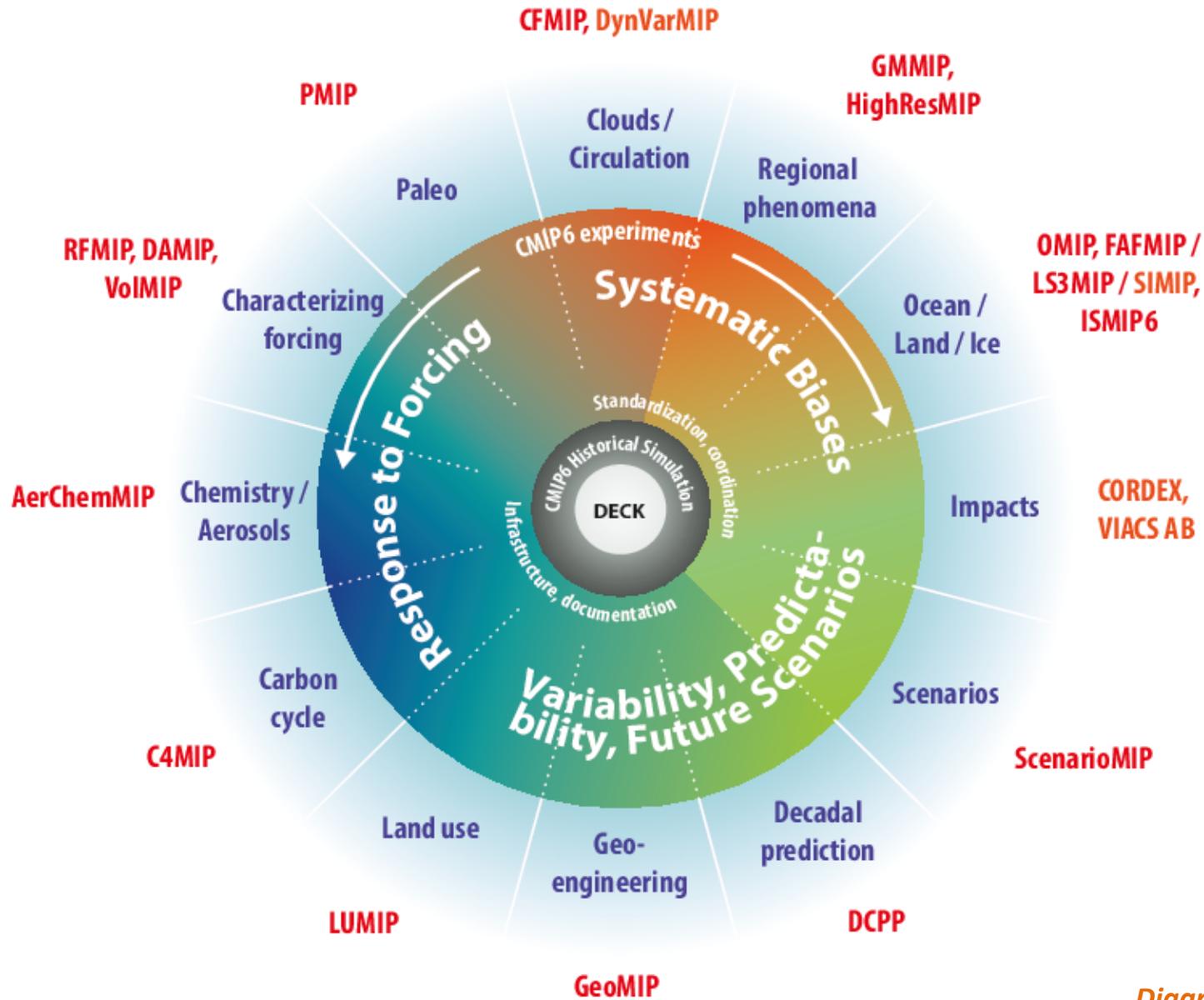
CMIP6 Historical Simulation (entry card for CMIP6)

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

(2) Standardization, coordination, infrastructure, documentation

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

21 CMIP6-Endorsed MIPs



Diagnostic 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.

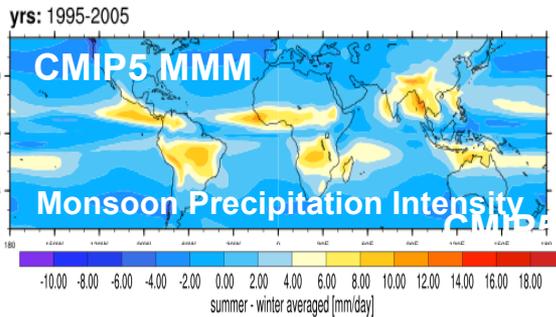
* For "Diagnostic-MIPs" only non-experimental criteria apply

How to characterize the wide variety of models in CMIP6?

- Routine Benchmarking and Evaluation Central Part of CMIP6 -

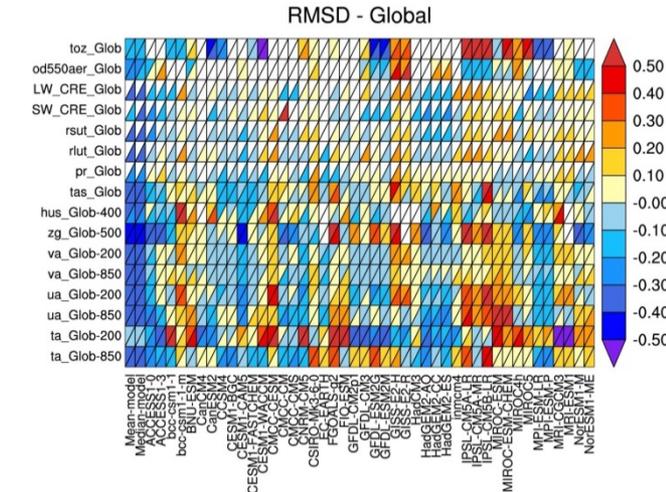
Tools such as the community-developed **Earth System Model Evaluation Tool (ESMValTool, Eyring et al., ESMValTool, GMD (2016b))** that includes other software packages such as the **NCAR CVDP (Phillips et al., 2014)** and the **PCMDI Metrics Package (PMP, Gleckler et al., EOS (2016))** to produce well-established analyses as soon as CMIP model output is submitted.

Similar to **Figure 9.7 of AR5**



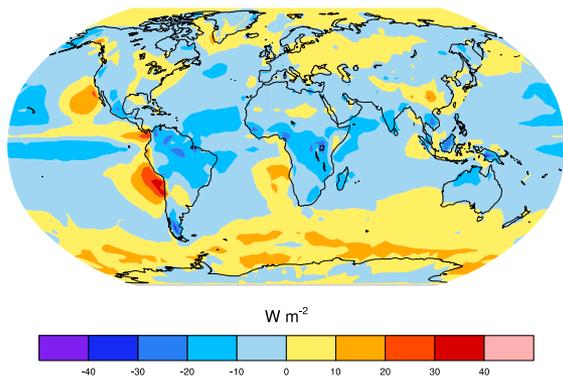
Broad Characterization of Model Behavior
(incl. IPCC AR5 Chap 9 & 12 diagnostics in ESMValTool)

Running alongside the ESGF

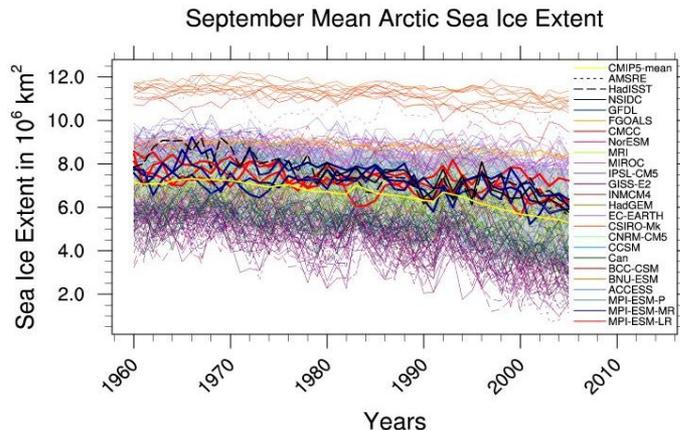


Similar to **Figure 9.5 of AR5**

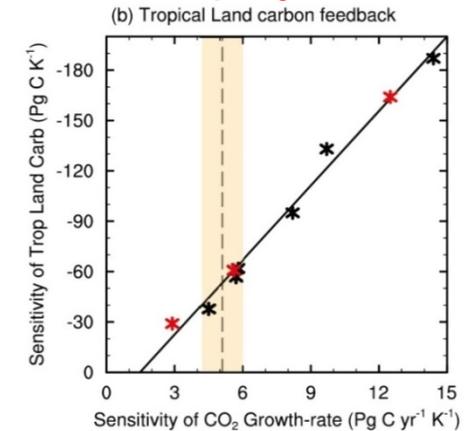
Net Cloud radiative effect against CERES EBAF



Similar to **Figure 9.24 of AR5**



Link to projections

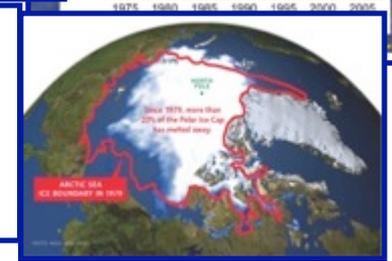
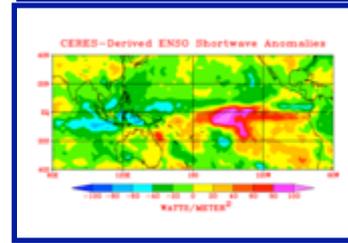
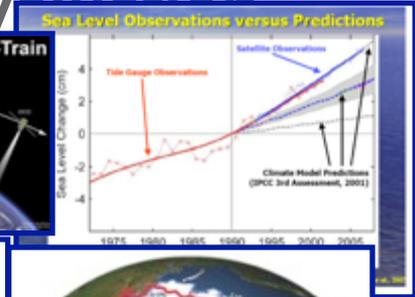
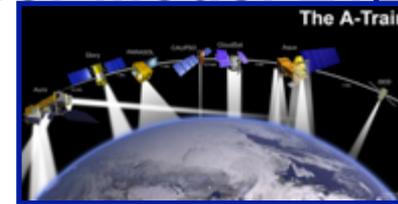
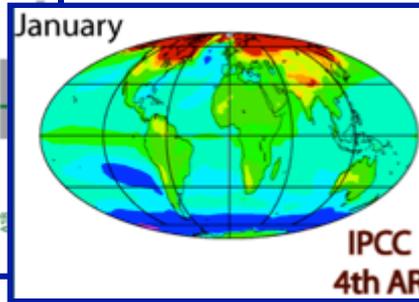
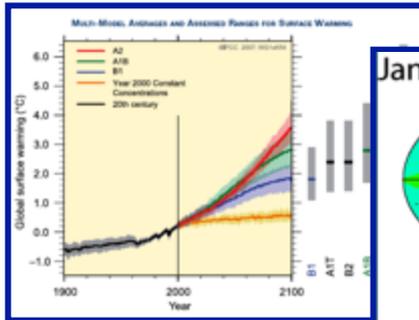


Similar to **Figure 9.24 of AR5**

Under-Exploited Observations for Model Evaluation Observations for Model Intercomparison Projects (obs4MIPs) CCI Status updated at end.

WDAC Task Team on Observations for Model Evaluation

CMIP6

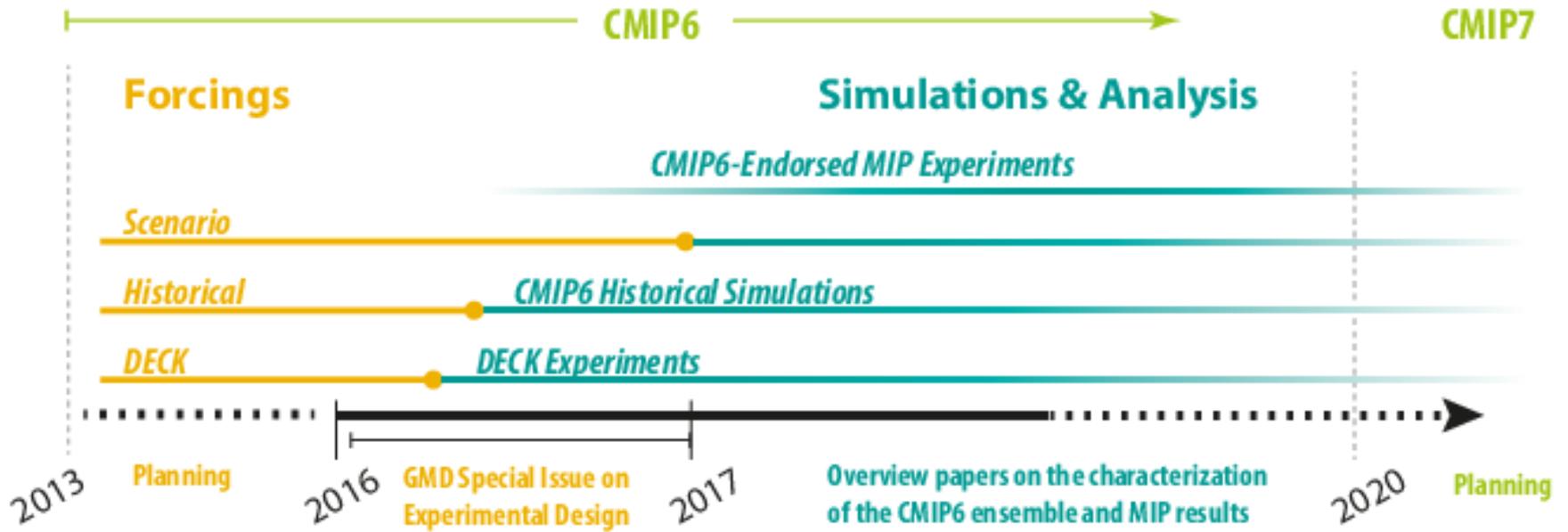


How to bring as much observational scrutiny as possible to the CMIP/IPCC process?

- 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



CMIP6 Timeline



Status and Outlook

CMIP6 Status

- CMIP6 Experimental Design finalized
- Forcing datasets for DECK and CMIP6 historical simulations finalized
- CMIP6 Simulation Period (2016-2020)
- Infrastructure in preparation (including data request) by WGCM Infrastructure Panel (WIP)

CMIP6 Participating Model Groups: > 30 using a wide variety of different model versions

21 CMIP6-Endorsed MIPs that build on the DECK and CMIP historical simulations to address a large range of specific questions with WCRP Grand Challenges as scientific backdrop.

CMIP6 Climate Projections part of a CMIP6-Endorsed MIP (ScenarioMIP)

- 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.
- Forcings for future scenarios available by end of 2016, climate model projections expected to be available within the 2018-2020 time frame.

A Central Goal of CMIP6 is Routine Evaluation of the Models with Observations

- Efforts to develop community tools and to couple them to the ESGF are underway

Geosci. Model Dev. Special Issue on CMIP6

- Overview of the CMIP6 Experiment Design and Organization (Eyring et al., GMD, 2016)
- Experimental design from all CMIP6-Endorsed MIPs
- Description of the CMIP6 forcing data and infrastructure

=> We expect CMIP6 to continue CMIP's tradition of major scientific advances

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

Obs4MIPS Status

- Dataset call last spring for CMIP6
- Now over 175 datasets submitted and about 50 are complete
- Good response from CCI teams
- The proposed submissions must have a short user guide document for each dataset
- The submissions are undergoing a peer review process but it is taking a time.....
- Monthly teleconfs to update status on the submitted datasets
- Please contact me or Veronika Eyring to update status of datasets you submitted.