

Observations for Climate Model Evaluation

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Program for Climate Model Diagnosis and Intercomparison, LLNL



Talk outline

- Some context: WCRP coordinated climate model experimentation
 - Evaluating climate models: observational challenges
 - Obs4MIPs and WDAC oversight
 - Seeking common ground
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WCRP's Coordinated Climate Modeling Experimentation:

The MIPs

WCRP Climate Model Intercomparisons (MIPs)

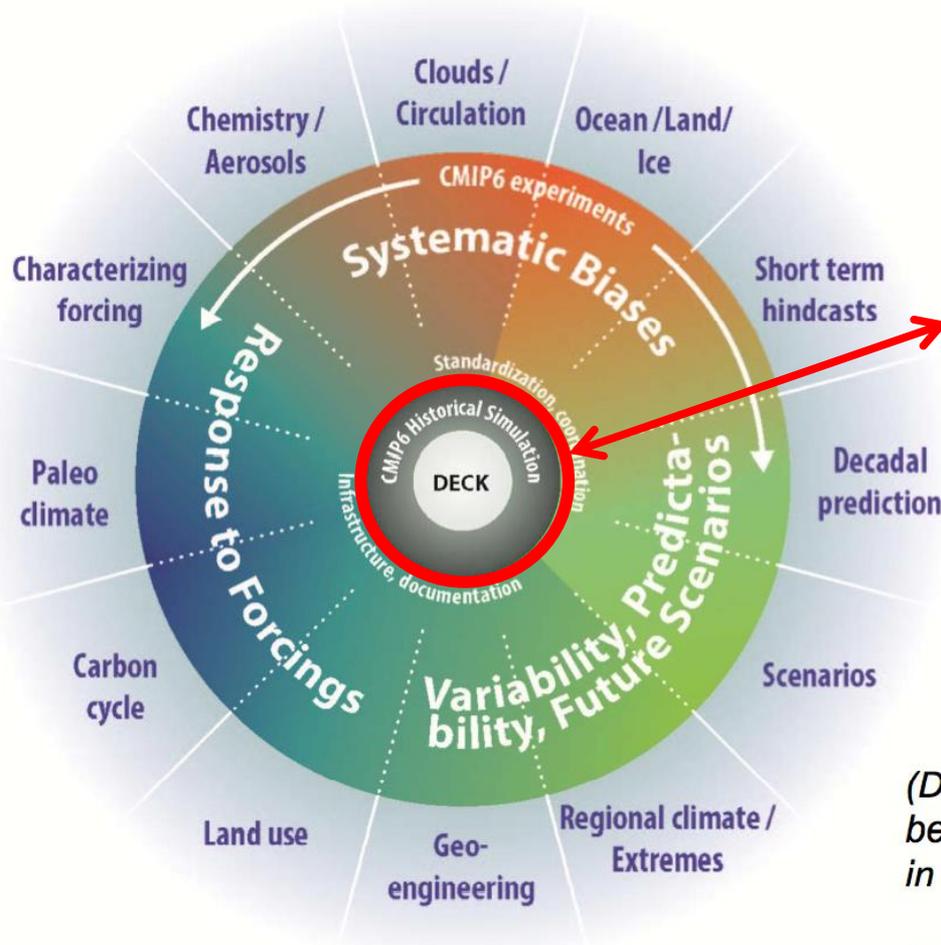
1990 - 1995	Atmospheric Model Intercomparison Project (AMIP)		
1995 - 2000	Coupled Model Intercomparison Project (CMIP) AMIP2		
2000 – 2003	CMIP2 PMIP, CFMIP...	<i>gigabytes</i>	
2003 – 2009	CMIP3	<i>terabytes</i>	<i>CF data conventions</i>
2009 – Present	CMIP5 [#]	<i>petabytes</i>	<i>Data becomes distributed</i>

CMIP simulations enable a large body of research assessed by the IPCC

[#]AMIP, CFMIP and PMIP become coordinated with CMIP

CMIP6 and the future of CMIP

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”



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)

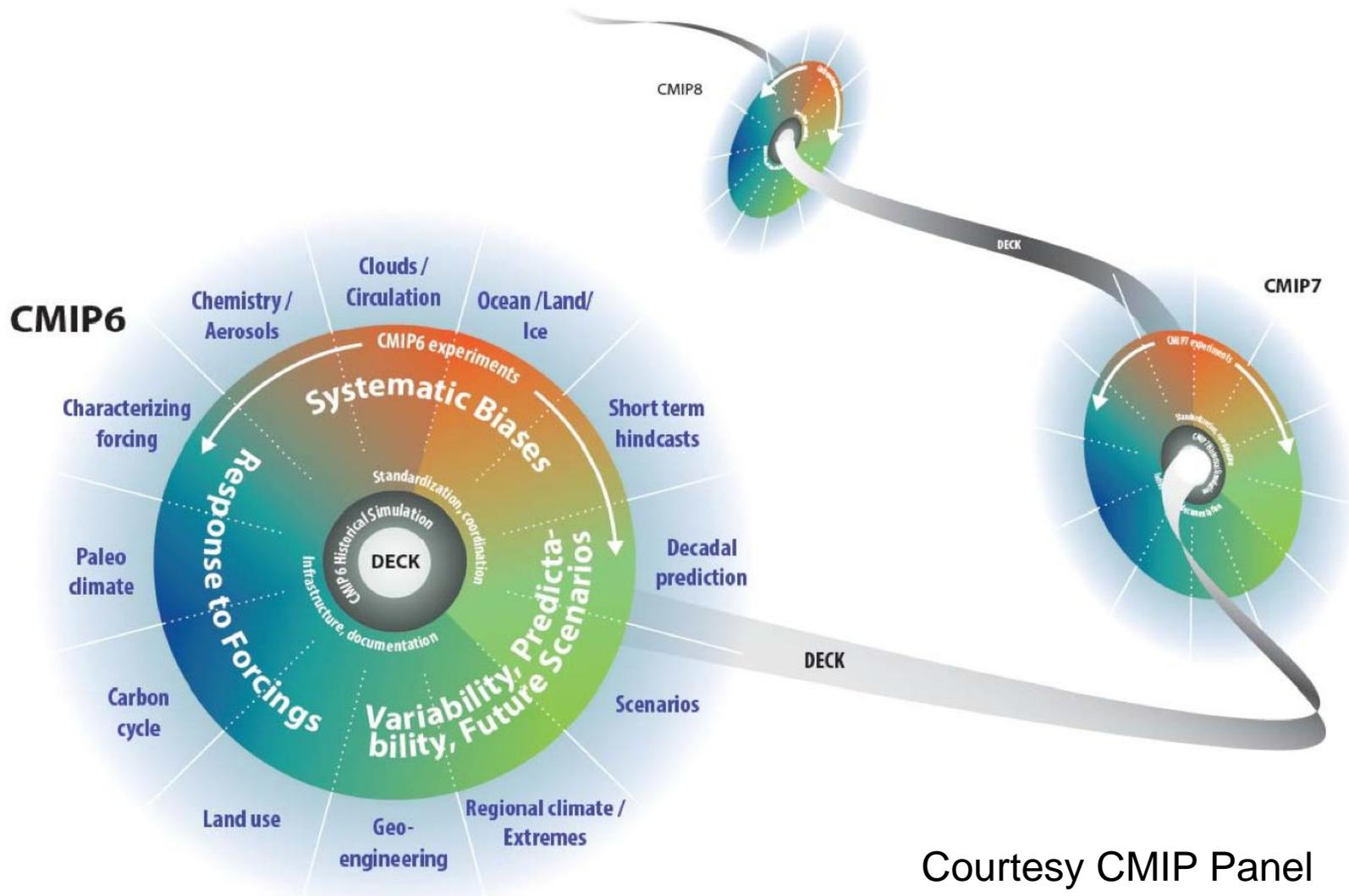
- v. Historical simulation using CMIP6 forcings (1850-2014)

(DECK & CMIP6 Historical Simulation to be run for each model configuration used in the subsequent CMIP6-Endorsed MIPs)

With proto-DECK experiments (LMIP, OMIP etc.) in CMIP6 Tier1

WGCM CMIP Panel currently working to finalize CMIP6 design

CMIP Continuity



Courtesy CMIP Panel

CMIP Infrastructure

“Nuts and bolts”

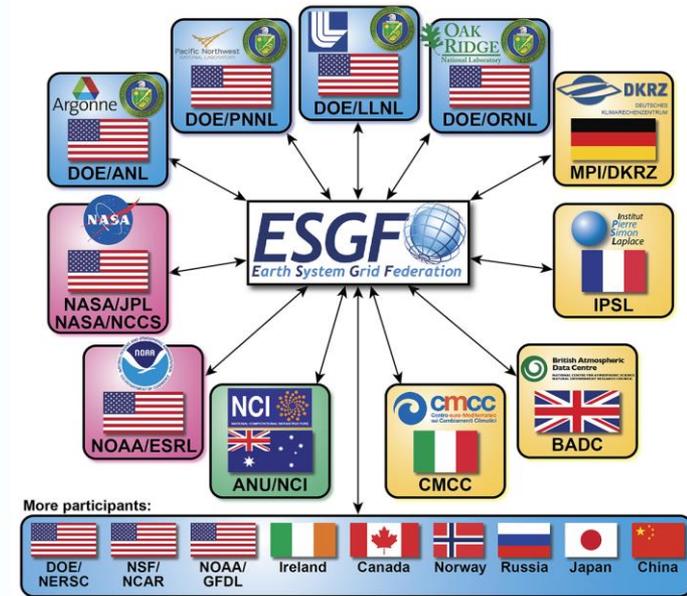
- Experiment protocol (AMIP, Historical, PIControl, etc.)
 - Climate Forecast (**CF**) Convention (as applied in CMIP)
 - Software to ensure data is compliant: CMOR, CF-checker
 - Distribution: Earth System Grid Federation (ESGF); targets CF
 - Earth System CoG: Interface to ESGF, well suited for coordinated projects
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Data accessibility for WCRP Climate Model Intercomparisons (MIPs):

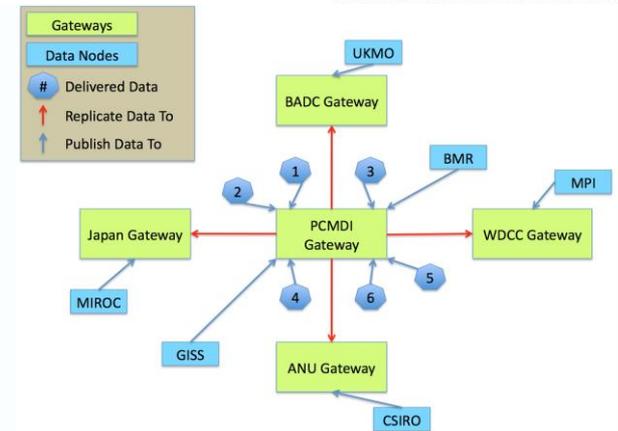
Since CMIP5, data is now distributed via the Earth System Grid Federation (**ESGF**)

ESGF is open source and its use is steadily expanding

Numerous efforts underway to expand capabilities (e.g., sub-setting data and server side calculations)



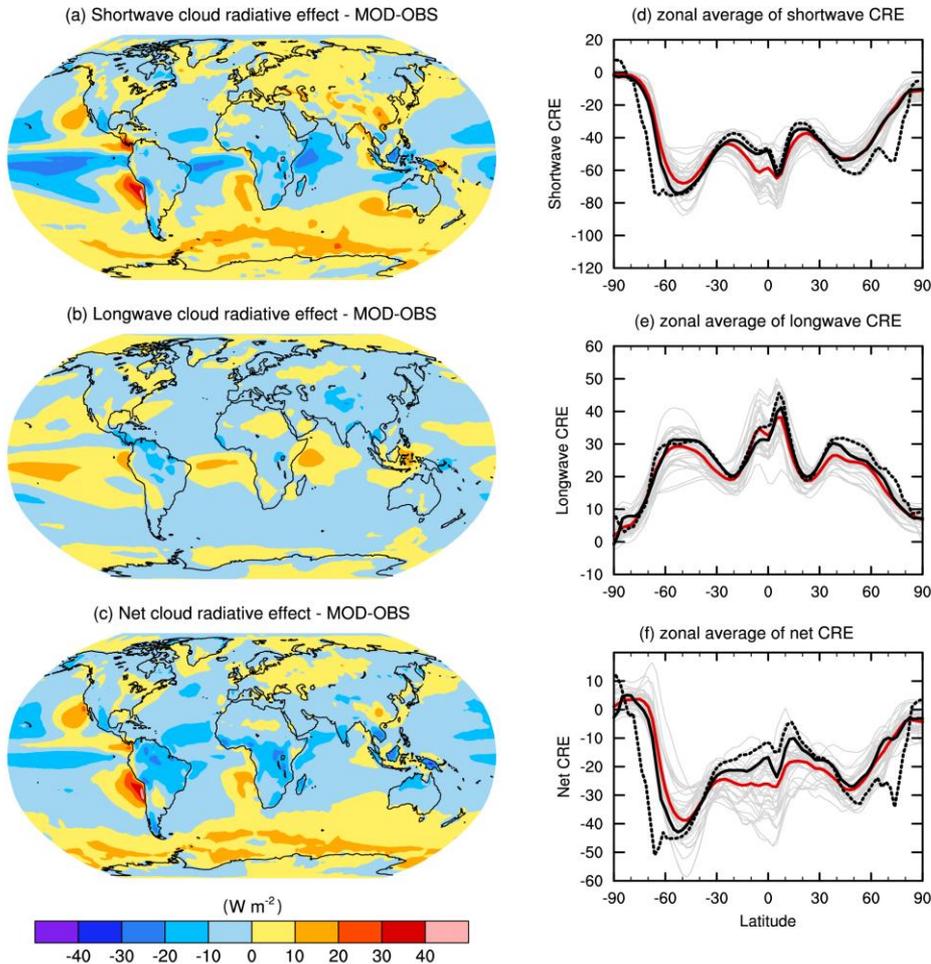
**Additional participants could not be illustrated in this figure.*



Observational for climate model evaluation



Established use of ECVs for model evaluation



Example

Cloud radiative effects

A first order issue for climate models

Substantial biases persist

Often of use in tuning procedures

Figure 9.5, IPCC AR5 WGI

ECVs for climate model evaluation and development

- Many ECV products are valuable for climate model evaluation and research (i.e., already being used)
 - Some existing underutilized data may become more useful for model evaluation with additional work/processing
 - Multiple estimates (e.g., alternate instrument) are usually helpful
 - A great deal of interest in ECV “observational ensembles”
 - ECVs not designed to target model development
- 

Challenges: Improved use of observations for climate model evaluation

- Quantitative estimates of measurement/processing/sampling uncertainties becoming increasingly important – generally this very hard
 - Often a fair (model-to-observation) comparison is difficult
 - Many observational data sets can be useful for model evaluation but how does one choose which to use? Systematic evaluation is one approach
 - Targeting key processes is especially helpful but data is lacking in many cases
 - Accuracy of some measurements may already be good enough; many are not
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Obs4MIPs

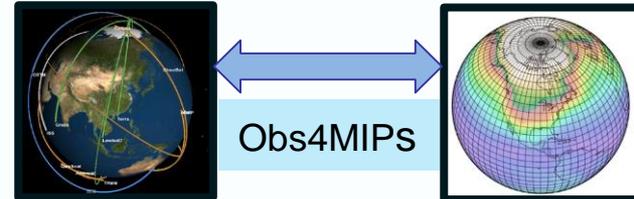
Obs4MIPs

**Objective: To make observational data more accessible
for evaluation of CMIP class simulations**

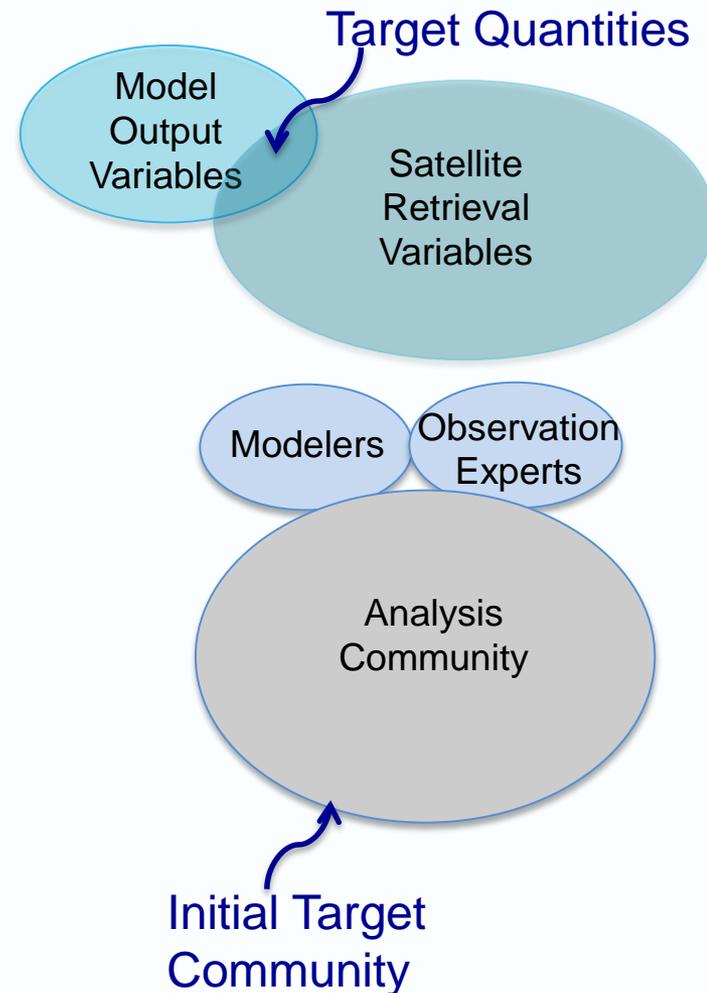


obs4MIPs: The 4 Commandments

Began as a NASA pilot project, now expanding as a WCRP project with WDAC oversight



1. Use the **CMIP Standard Model Output** as guideline for **selecting observations**.
2. Observations to be **structured the same as CMIP Model output** (e.g. NetCDF, CF Convention).
3. Hosted **on the ESGF** side by side with CMIP model output.
1. Include a **Technical Note** for each **variable** describing observation and use for model evaluation (at graduate student level).



obs4MIPs: Current Set of Satellite Observations

Sorted by CF Variable *Long Name*

Air Temperature

Ambient Aerosol Optical Thickness at 550 nm

CALIPSO 3D Clear fraction

CALIPSO 3D Undefined fraction

CALIPSO Clear Cloud Fraction

CALIPSO Cloud Fraction

CALIPSO High Level Cloud Fraction

CALIPSO Low Level Cloud Fraction

CALIPSO Mid Level Cloud Fraction

CALIPSO Scattering Ratio

CALIPSO Total Cloud Fraction

Cloud Fraction retrieved by MISR

CloudSat 94GHz radar Total Cloud Fraction

CloudSat Radar Reflectivity CFAD

Fraction of Absorbed Photosynthetically Active Radiation

ISCCP Cloud Area Fraction (Joint histogram of opt thickness and CTP)

ISCCP Mean Cloud Albedo (Cloud-fraction weighted & daytime)

ISCCP Mean Cloud Top Pressure (Cloud-fraction weighted & daytime)

ISCCP Mean Cloud Top Temperature (Cloud-fraction weighted & daytime)

ISCCP Total Cloud Fraction (daytime only)

Leaf Area Index

Mole Fraction of O3

Many contributions
from CFMIP-OBS

and
NASA

Near-Surface Wind Speed

PARASOL Reflectance

Precipitation

Sea Surface Height Above Geoid

Sea Surface Temperature

Specific Humidity

Surface Downwelling Clear-Sky LW

Surface Downwelling Clear-Sky SW

Surface Downwelling LW

Surface Downwelling SW

Surface Upwelling Clear-Sky SW

Surface Upwelling LW

Surface Upwelling SW

TOA Incident SW

TOA Outgoing Clear-Sky LW

TOA Outgoing Clear-Sky SW

TOA Outgoing LW

TOA Outgoing SW

Total Cloud Fraction

Water Vapor Path

WDAC Observations for Model Evaluation Task Team

Terms of Reference

1. Establish data/metadata standards for observational and reanalysis data sets that are consistent with standards used in major climate model intercomparison efforts (e.g., CMIP)
 2. Encourage the application of these standards to well-established observational datasets that have demonstrated utility for model evaluation.
 3. Provide guidance and oversight to obs4MIPs, including the organization of data hosted on ESGF. Establish criteria and a process by which contributed datasets are accepted for inclusion.
 5. Seek community input and feedback on the value of products conforming to the standards, and refine and extend the standards, as necessary, to meet any additional or evolving needs.
 6. Coordinate above activities with major climate model intercomparison efforts (e.g., CMIP) and liaise with other related WCRP bodies
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WDAC Observations for Model Evaluation Task Team Membership

Peter Gleckler, co-chair, PCMDI
Duane Waliser, co-chair, JPL/NASA
Sandrine Bony, IPSL
Mike Bosilovich, GSFC/NASA
Helene Chepfer, IPSL
Veronika Erying, DLR
Robert Ferraro, JPL/NASA
Pierre-Phillipe Mathieu, ESA
Roger Saunders, UKMO
Jörg Schulz, EUMETSAT
Karl Taylor, PCMDI
Jean-Noël Thépaut, ECMWF



Data access and project connectedness

The screenshot shows the Obs4MIPs website interface. At the top, it identifies the University of Colorado Boulder and the Earth System Grid Federation (ESGF). The main navigation bar includes 'Home', 'About Us', 'Governance', and 'Contact Us'. A sidebar on the left lists 'Obs4MIPs' categories like 'Home', 'How to cite', 'Products', and 'Visitors'. The central content area is titled 'Observations for Climate Model Intercomparisons' and provides a detailed description of the project's purpose and goals. It includes a list of criteria for data inclusion and a section on upcoming efforts for CMIP6. On the right, there are utility boxes for 'Search & Download Data', 'Read News', and 'Browse Projects'. The footer contains contact information and links to various organizational pages.

University of Colorado Boulder

Welcome to the Earth System Grid Federation. You are at the CoG-CU node. ESGF

Welcome, Guest. | Login | Create Account

Obs4MIPs

Home About Us Governance Contact Us

Technical Support

Observations for Climate Model Intercomparisons

Obs4MIPs (Observations for Model Intercomparisons) is an activity to make observational products more accessible for climate model intercomparisons.

To Get Data - Please go to the "Search Data" box or "Advanced Data Search" link to the right.

A wide variety of observationally-based datasets are used for climate model evaluation. Obs4MIPs refers to a limited collection of well-established and documented datasets that have been organized according to the 5th Coupled Model Intercomparison Project (CMIP5) model output requirements and made available on the Earth System Grid Federation (ESGF). Each Obs4MIPs dataset corresponds to a field that is output in one or more of the CMIP5 experiments. This technical alignment of observational products with climate model output can greatly facilitate model data comparisons. Guidelines have also been developed for Obs4MIPs product documentation that is of particular relevance for model evaluation. This effort was initiated with support from NASA and the U.S. Department of Energy (DOE) and has now expanded to include contributions from a broader community including CFMIP-OBS and products that rely on ESA satellites.

To summarize, products currently available via Obs4MIPs are:

1. Directly comparable to a model output field defined as part of CMIP5
2. Open to contributions from all data producers that meet the Obs4MIPs requirements
3. Well documented, with traceability to track product version changes
4. Served through ESGF (and directly available through this COG).

Efforts are underway to coordinate obs4MIPs with CMIP6

Last Update: Nov. 7, 2014, 4:57 p.m. by Robert Ferraro

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No Comments

Project Activity

ESGF sponsors and partners DoE Office of Science | IS-ENES | NASA | NOAA | NCI | NSF

CoG version 2.10.0 ESGF P2P Version 1.7.1-phoenix-release-master

Earth System CoG sponsors and partners NOAA | NASA | NSF | DoE Office of Science | IS-ENES

http://www.earthsystemcog.org cog_support@list.woc.noaa.gov | privacy policy

obs4MIPs data are available through the CoG

The CoG is directly connected to ESGF

CMIP6 is expected to be hosted on the CoG along with many related projects (e.g., ana4MIPs and CREATE-IP)

obs4MIPs planning for CMIP6 – future “requirements”

Meeting (NASA HQ) in 2014, facilitated discussion between experts in model development and evaluation, and experts in satellite data products. Selected consensus recommendations that applied to all of the meeting topic areas:

- Expand the inventory of included datasets
- Include higher frequency satellite data and model output. Could be limited to an observationally-rich “golden period”
- Reliable and defensible error characterization/estimation of observations is a high priority, and obs4MIPs should press harder for the improvements
- Include datasets in support of off-line simulators (prime example: COSP—Cloud Feedback Model Intercomparison Project [CFMIP] Observation Simulator Package)
- Collocated observations, including sparser in-situ datasets, are particularly valuable for diagnosing certain processes - inclusion in obs4MIPs should therefore be encouraged
- Precise definitions of data products (what’s actually being reported), including biases, and precise definitions of the model output variables are required.

Seeking common ground



WDAC TOR's relevant to Copernicus and obs4MIPs

To promote

- coordinated assessment and comparison of climate-data products, including those from reanalyses
 - research for continuing improvement in the processing and reprocessing of climate data
 - development of mechanisms for archival and preservation of, access to and analysis of data, and associated meta data
 - standards for product generation, including global and regional reanalyses
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Personal perspective

- There are many challenges associated with organizing a diverse suite of observations and making them easily accessible
 - We should strive to not re-invent too many wheels
 - Ideally we would have a common foundation from which to build on for multiple and diverse purposes
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Can we adopt and build on a common language? (the secret to CMIP's success)

Based on more than a decade of grass roots development

Demonstrated success for multiple purposes

Worth exploring how it could be adopted to meet additional needs or...

At a minimum, alternate solutions should be mapped to the CF conventions where possible

