



Coordinated Model Evaluation Capabilities

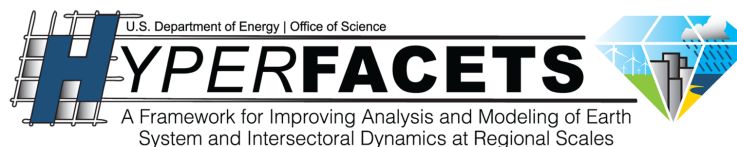
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... A growing number of collaborators



Motivating the coordination of model evaluation capabilities

- The number of model analysis packages has been steadily growing.
- Little coordination between separate projects, often requiring extensive developer-intervention when others want to use a particular code.
- Modular approach to capability building has important advantages.
- Some technical and scientific coordination between independent efforts would benefit the research community and could accelerate progress towards systematic model evaluation.

CMEC Project Goals

1. Develop robust **standards** for metrics and diagnostics packages.
2. Develop accompanying tools for **coordinated execution** of analysis packages (and optional visualization/interaction of metrics and diagnostics package output).
3. Build **connections across projects and agencies** related to model evaluation activities.

It is hoped that CMEC can provide conventions and standards to guide the analysis community much in the way the CF-conventions were leveraged to establish the CMIP data standards

Pathways for development of CMEC compliant model analysis capabilities

1 Contribution to existing established packages

Examples



PCMDI Metrics
Package



ILAMB

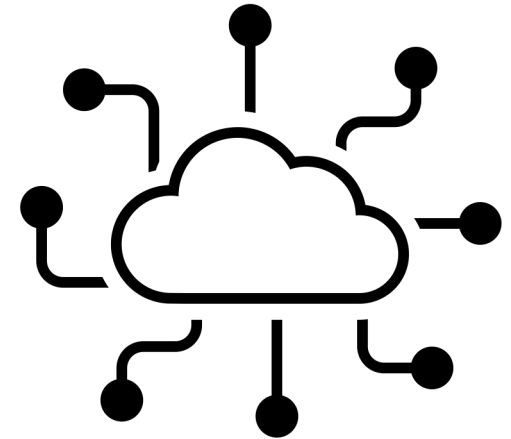
International Land Model
Benchmarking Project



TECA

Toolkit for Extreme
Climate Analysis

2 Development of targeted
standalone packages by
small teams or individuals
(e.g., Github code for an
individual paper)



CMEC Status report

cmeclnl.gov

Conventions for generalized code operation and standard output have been developed and are currently being implemented/tested with multiple packages

CMIP6 results are being routinely updated and made public for several capabilities:

- The PCMDI Metrics Package (PMP)
- International Land Model Benchmarking Project (ILAMB)

CMEC | Coordinated Model Evaluation

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Coordinated Model Evaluation Capabilities

Coordinated Model Evaluation Capabilities (CMEC) is an effort to bring together a diverse set of analysis packages that have been developed to facilitate the systematic evaluation of Earth System Models (ESMs). Currently, CMEC includes three capabilities that are supported by the U.S. Department of Energy, Office of Biological and Environmental Research (BER), Regional and Global Climate Modeling Program (RGCM). As CMEC advances, additional analysis packages will be included from community-based expert teams as well as efforts directly supported by DOE and other US and international agencies.

Modeling the Climate System

Includes the Atmosphere, Land, Oceans, Ice, and Biosphere

Physical Model Summaries (PMP)

Weather Extremes (TECA)

Land Biogeochemistry (ILAMB)

Ocean Biogeochemistry (IOMB)

Key processes shown in the diagram include: Incoming Solar Radiation, Outgoing Heat Energy, Evaporative and Heat Energy Exchanges, Precipitation, Snow Cover, Aerosols, Cumulus Clouds, Status Clouds, Soil Moisture, Vegetation and Ecology, Human Influences and Land Use, Runoff, Sea Ice, Ocean Temperature and Salinity, Heat & Salinity Exchange, Vertical Overturning, and Marine Biology.

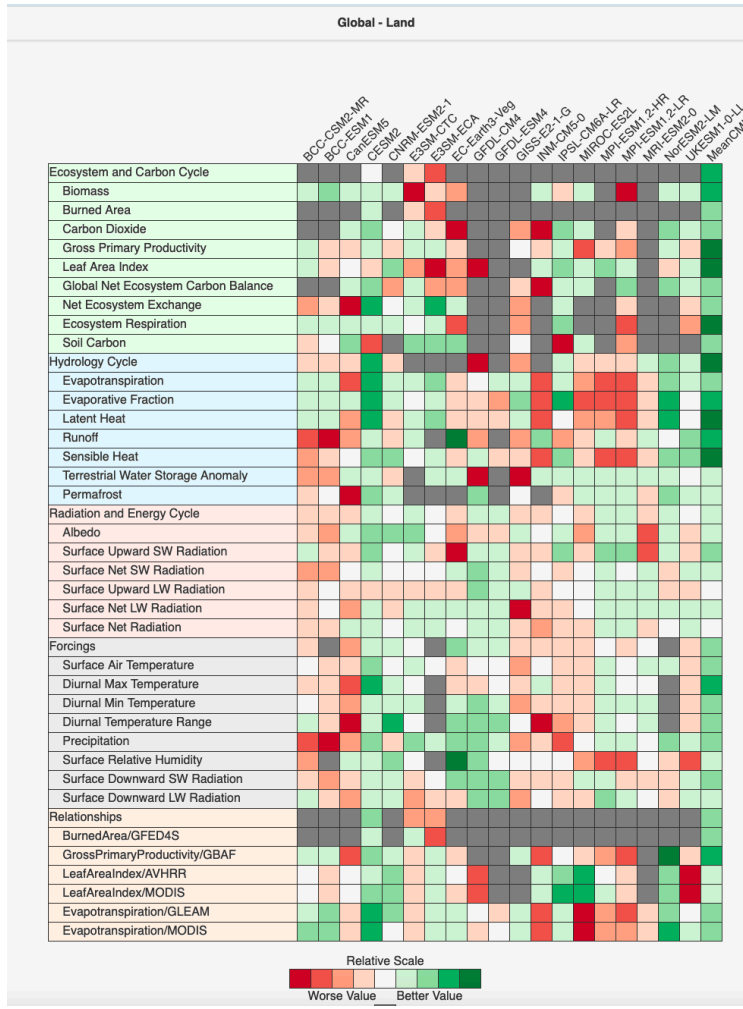
A primary motivation for CMEC is to analyze model simulations that are contributed to the [Coupled Model Intercomparison Project \(CMIP\)](#). Virtually every institution worldwide involved in significant development of ESMs contributes simulations to CMIP. [The 6th and latest phase \(CMIP6; Meehl et al., 2014; Eyring et al., 2016\)](#) includes a partial but fundamental shift away from distinct CMIP phases with the advent of an ongoing core of benchmarking experiments known as the CMIP DECK (Diagnosis, Evaluation, Characterization of Klima – Klima being the German word for climate). The DECK includes a short list of experimental configurations that are routinely performed by ESM developers during their model development process. The DECK and “Historical” simulations provide a basis from which ESMs can be compared with available observations.

To date, many ad hoc analysis packages have been developed to target selected aspects of ESM simulations. With the growing scope of CMIP and expectations for efficient “quick look” results, there is a clear need for the community of CMIP analysts to work together. CMEC is establishing a framework for the developers of these capabilities to collaborate and to deliver a unified set of results.

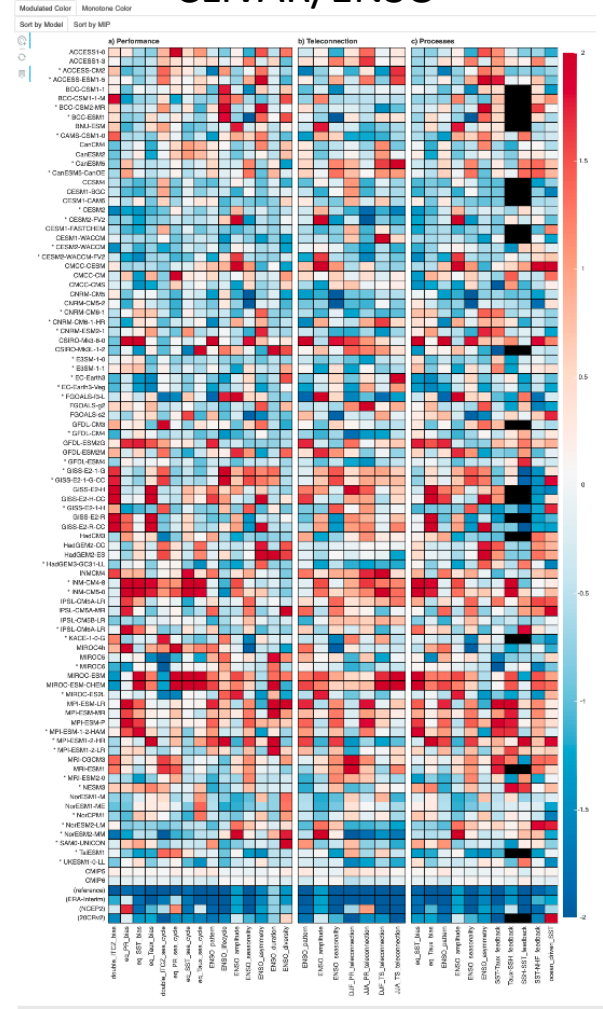
Coordinated Model Evaluation

Summary statistics (metrics) with access to underlying diagnostics

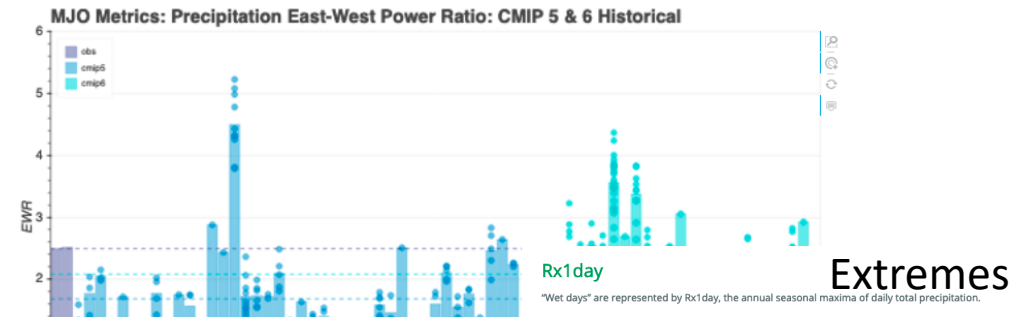
ILAMB biogeochemistry



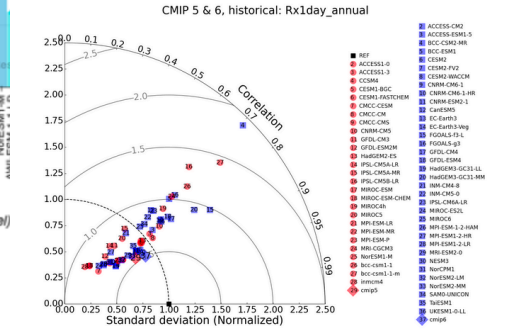
CLIVAR/ENSO



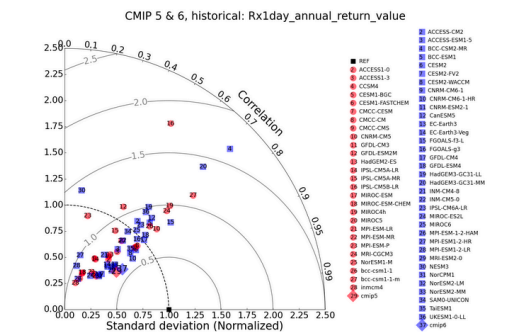
MJO task force metrics



Rx1day Extremes



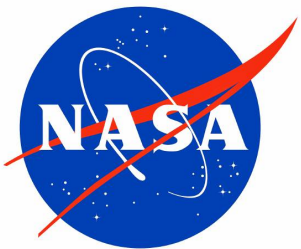
Return Value



CMEC Standards for Metrics and Diagnostics

- **Compatibility with CMEC effectively requires:**
 - A (JSON) file that provides metadata on the package being executed
 - A (bash) script that allows for “lowest common denominator” execution of the analysis module
 - CMEC-compliant output
- **“Lowest common denominator” (LCD) execution** – modules run over:
 - Path to the base directory of the metric module
 - Path to the observational data and model data
 - Path where output should be written
 - List of modules to be executed (and their configuration name)

A possible cross-agency solution



There are substantial overlaps among agency interests when it comes to model evaluation (and within DOE across programs).

CMEC is building towards a US cross-agency collaborative for metric and process-oriented diagnostics (PODs) development activities.

CMEC standards have been developed in collaboration with the NOAA Model Diagnostics Task Force (MDTF).



Next steps

- Work to ensure an increasing number of existing packages are fully-compliant with CMEC conventions
- Publish and promote CMEC conventions, encouraging broader adoption in the community
- Broaden the application of the CMEC standards beyond metrics, e.g., to include process-oriented diagnostics

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