TH23C: Coordinated Model Evaluation Capabilities (CMEC) for CMIP DECK and Historical Simulations

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CMEC

Coordinated Model Evaluation Capabilities

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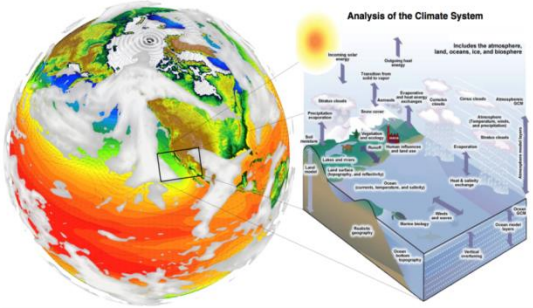
Meeting Structure

- DOE Welcome – Gary Geernaert
- Programmatic Introduction – Renu Joseph
- CMEC & PCMDI Metrics Package (PMP) – Peter Gleckler
- ILAMB & IOMB – Forrest Hoffman
- TECA – Travis O'Brien
- Discussion and Q&A – Bill Collins

Climate and Environmental Sciences Division



Atmospheric Science

- Atmospheric Radiation Measurement Climate Research Facility
- Atmospheric System Research

Modeling

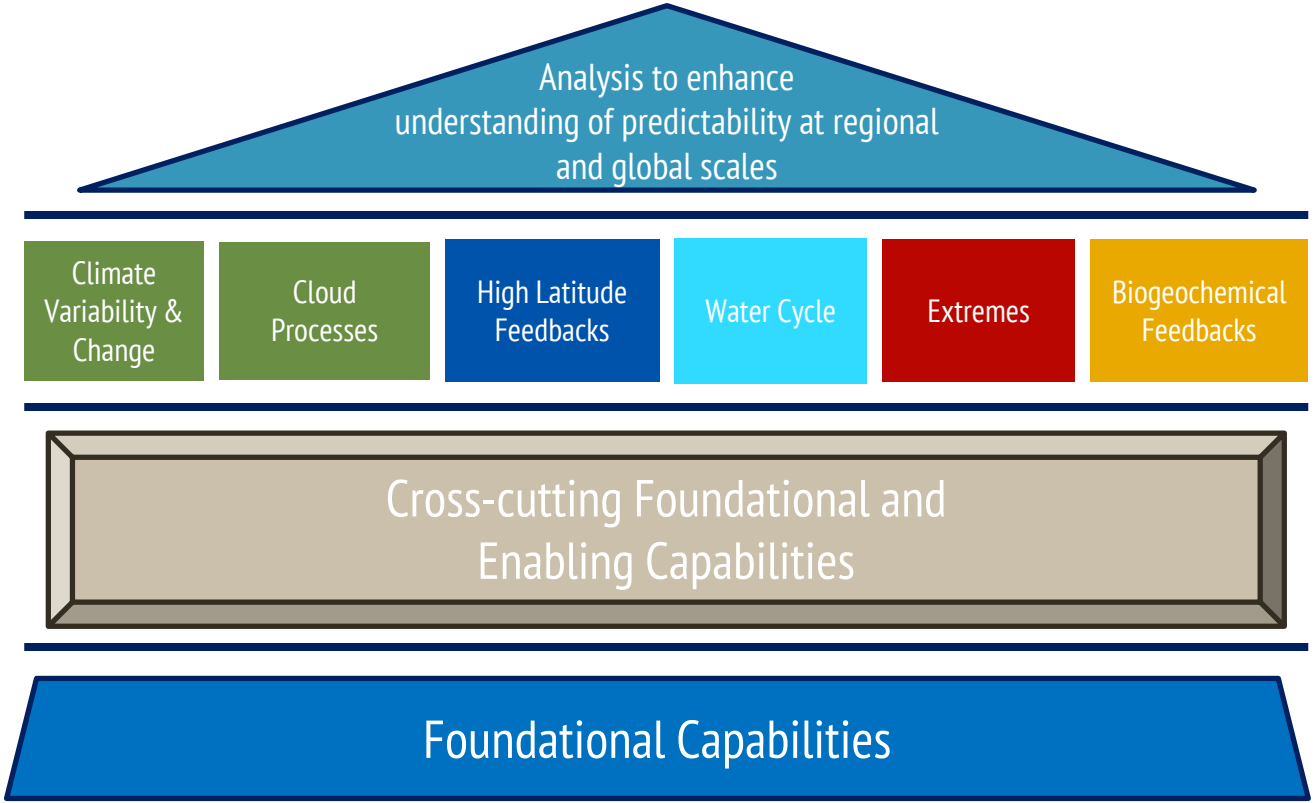
- Earth System Modeling
- Regional and Global Climate Modeling
- Integrated Assessment Research

Environmental System Science

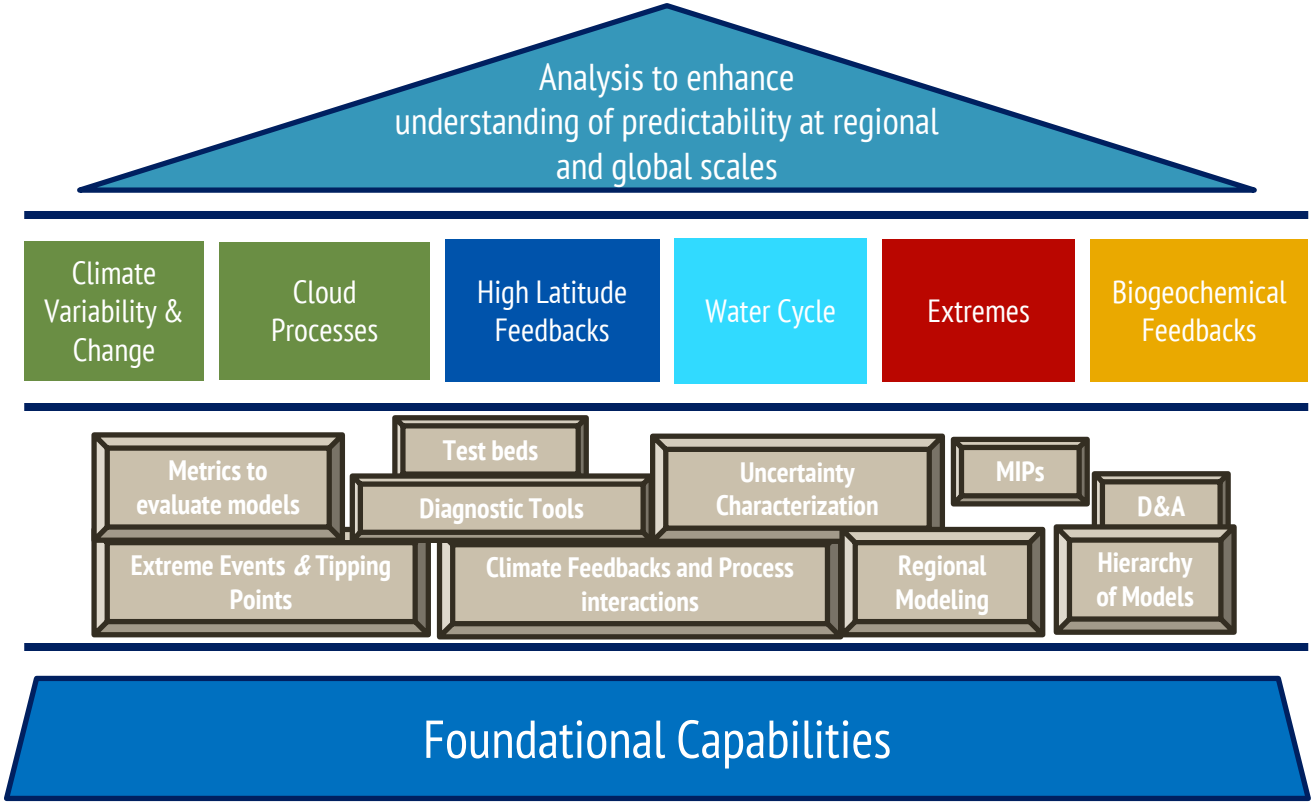
- Terrestrial Ecosystem Science
- Subsurface Biogeochemical Research
- Environmental Molecular Sciences Laboratory

Data Informatics

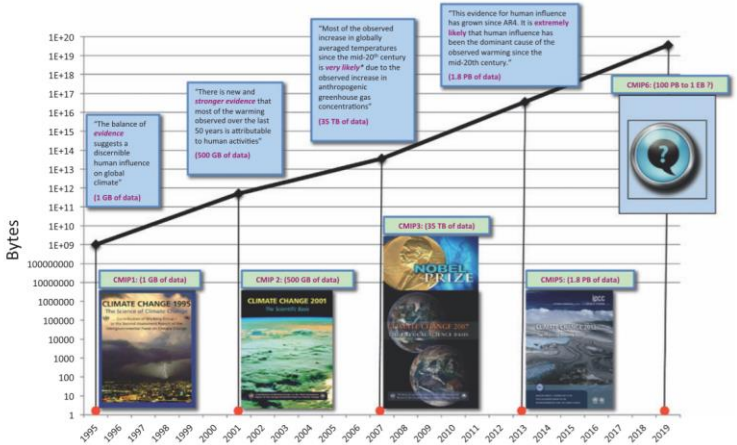
Regional and Global Climate Modeling



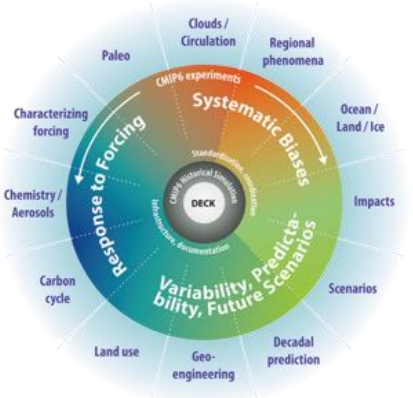
Regional and Global Climate Modeling



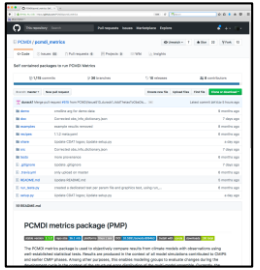
Motivation

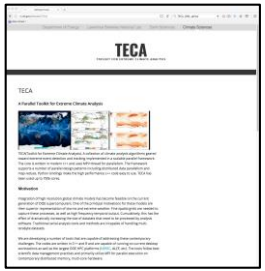


- The rapid growth in number, scale and complexity of simulations necessitates efficient analysis
- Established model evaluation methods need to be routinely applied and results accessible
- Community-based building blocks are a viable mechanism to accomplish this, and to explore new scientific frontiers



DOE is developing several model evaluation packages





Within RGCM:

- PCMDI Metrics Package (PMP)
- The International Land Model Benchmarking (ILAMB) Package
- The International Ocean Model Benchmarking (IOMB) Package
- Parallel Toolkit for Extreme Climate Analysis (TECA)

- These are highly complementary, and collectively capture an extensive suite of model evaluation characteristics
- They will help accelerate research for CMIP6 synthesis papers

CMEC is an attempt to coordinate the development of these efforts and provide results via a common portal

Establishing protocols for coordinating model evaluation capabilities, starting within RGCM

Akin to the grass roots development of CMIP data conventions, CMEC strives to coordinate analysis capabilities via:

- Protocols for input data and interoperability
- Strategies for software accessibility and documentation
- Provenance guidelines to ensure reproducibility

Like the establishment of CMIP, this is going to be a process

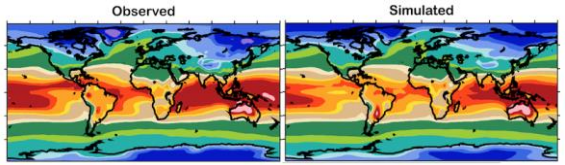
What can we expect from CMEC?

- More directly contribute to model development (via useful quick feedback)
- Make model evaluation results more accessible
- Excelerate science by fusing capabilities to address new and difficult to tackle hypotheses
- Facilitate national and international assessments

The PCMDI Metrics Package (PMP)

https://github.com/PCMDI/pcmdi_metrics

The PMP provides a diverse suite of relatively robust high level summary statistics comparing models and observations across realms and space and time scales



- Includes metrics and underlying diagnostics from:
  - PCMDI research
  - Collaborations with expert teams (e.g., CLIVAR ENSO group)

- Working with 5 modeling groups (E3SM, GFDL, NCAR, IPSL, ACCESS)
- Leveraging DOE supported python based tools (UV-CDAT)
- Developing end-to-end documented provenance to ensure reproducibility

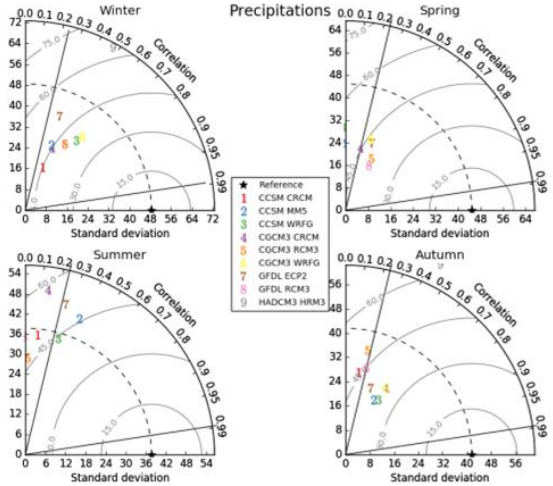
The PCMDI Metrics Package (v1.1.x)

Prototyped on experience with climatological summaries

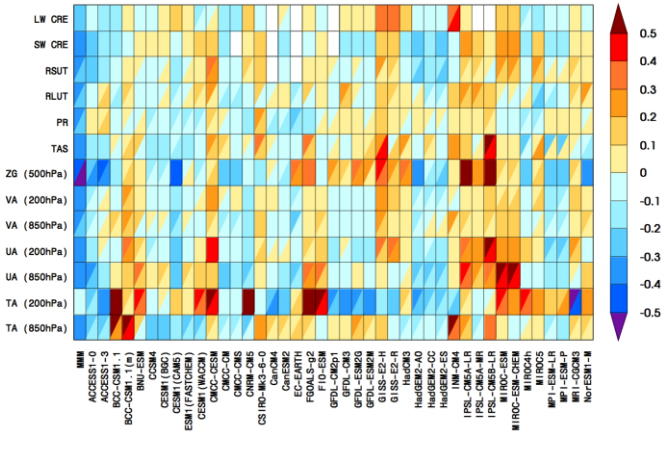
PCMDI metrics used in the IPCC TAR, AR4 and AR5 to:

1) Gauge model improvements over time
2) Identify the strengths and weaknesses of different models

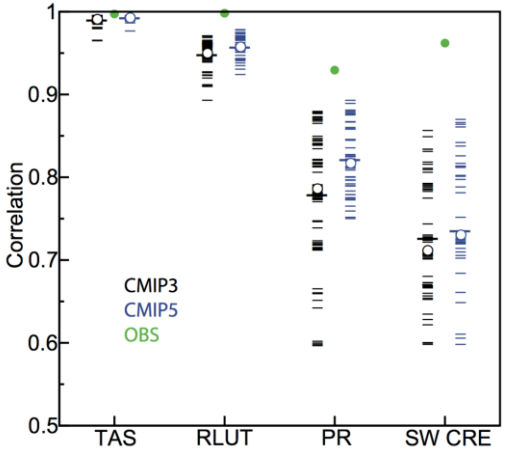
AR4 Chapter 8



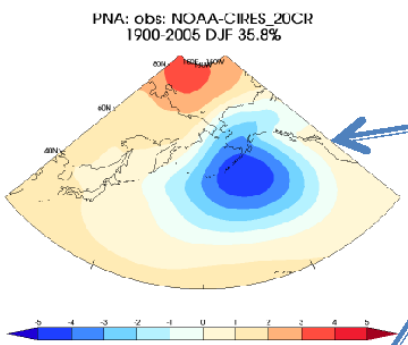
AR5 Chapter 9



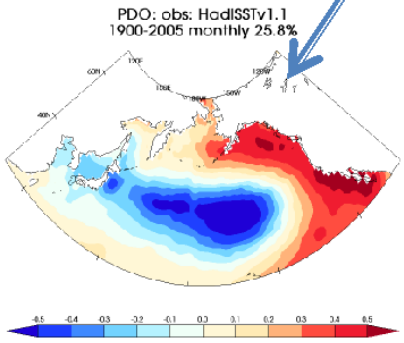
AR5 Chapter 9



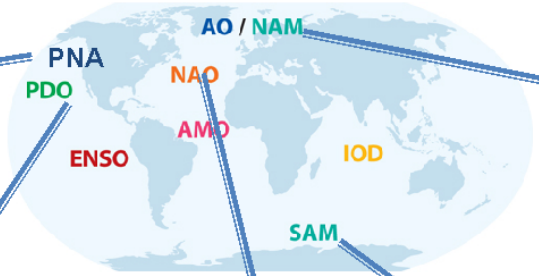
Extra-tropical Modes of Variability
Generally defined by EOF leading mode in observations

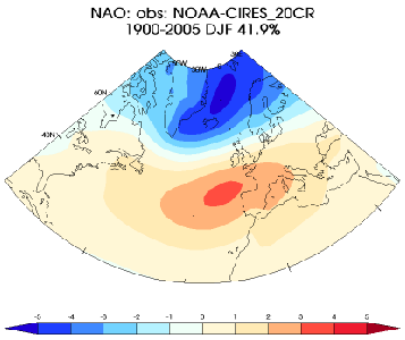


PNA: Pacific North American Pattern
(20CR, SLP)

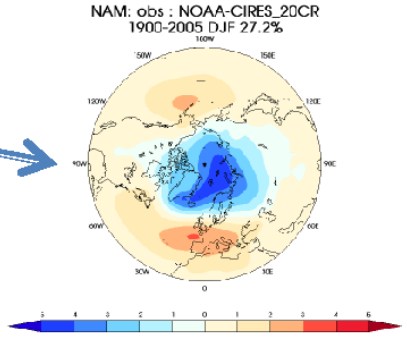


PDO: Pacific Decadal Oscillation
(HadISSTv1.0, SST)

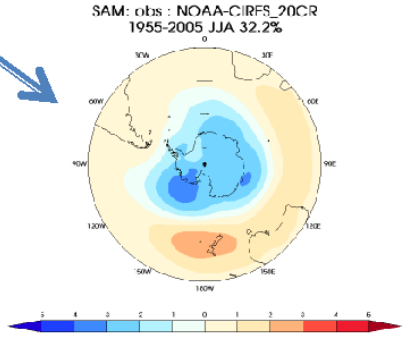




NAO: Northern Atlantic Oscillation
(20CR, SLP)

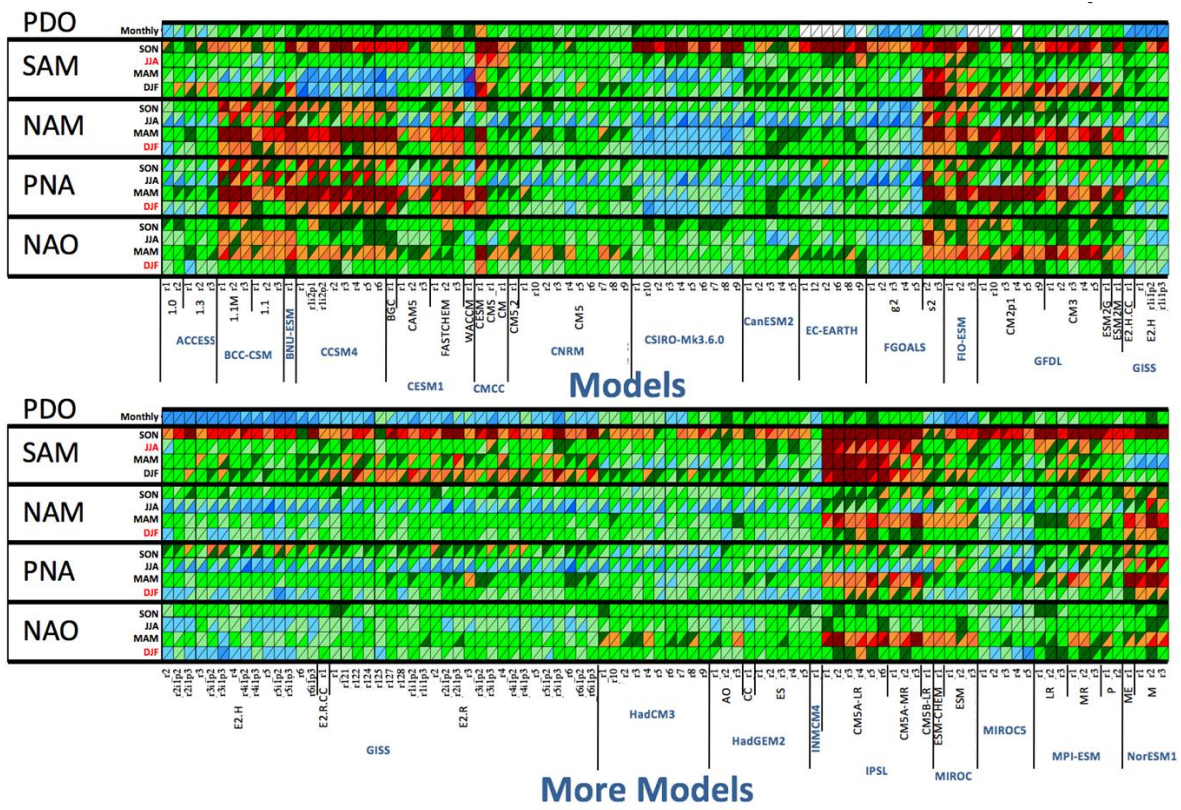


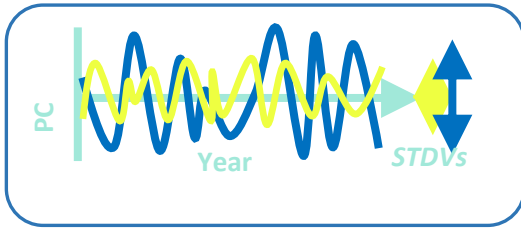
NAM: Northern Annular Mode
(20CR, SLP)

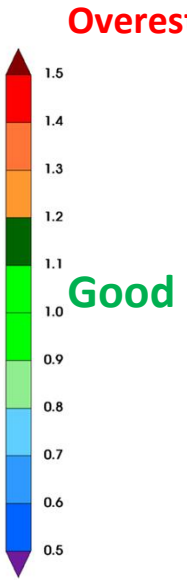


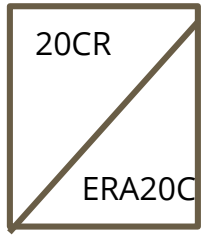
SAM: Southern Annular Mode
(20CR, SLP)

Simulated/reference amplitude ratios CMIP5 historical simulations (1900-2005)









Lee et al., 2017, in review

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The PCMDI Metrics Package (PMP)

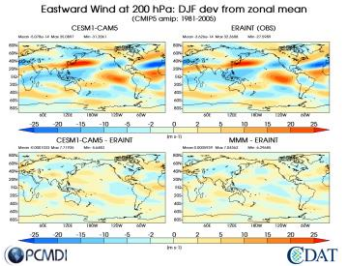
Implemented

- Orthogonal decompositions of climatological physical characteristics at regional to global scales
- Extra-tropical modes of variability
- ENSO (collaboration with CLIVAR panel)
- High frequency characteristics of simulated precipitation
- Regional monsoon precipitation indices
- Sector scale sea-ice

In Progress

- Cloud properties (collaboration with S. Klein's group)
- Extensive ocean T&S (ARGO) metrics based on PCMDI research
- Tropical waves
- Working with expert teams to establish targeted benchmarks (e.g., WCRP precipitation group, ocean panel)

PMP highlights



- Delivering new metrics to E3SM and other modeling groups for model development purposes
- High level summaries for CMIP6 will be readily accessible and serve as a de facto test of all new CMIP DECK + Historical simulations
- Leveraging six generations of MIPs to track model improvements since 1990
- An increasingly diverse set of metrics will further expose compensating errors

International Land Model Benchmarking (ILAMB) Package

CMEC | Coordinated Mo

https://pcmdi.github.io/CMEC/index.html

Search

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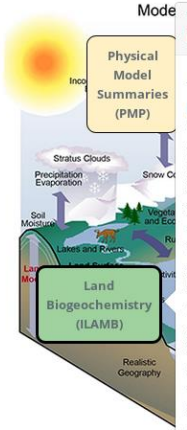
Coordinated Model Evaluation Capabilities

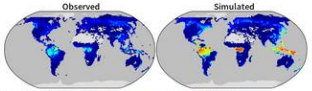
Coordinated Model Evaluation Capabilities (CMEC) is an effort to bring together a diverse set of analysis packages that have been developed to facilitate the systematic evaluation of Earth System Models (ESMs). Currently, CMEC includes three capabilities that are supported by the U.S. Department of Energy, 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 a efforts directly supported by DOE and other US and international agencies.



The International Land Model Benchmarking Package

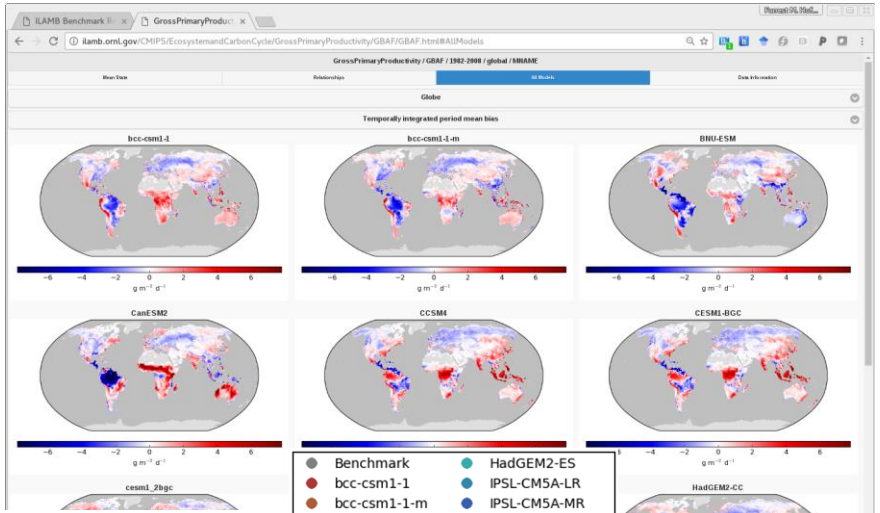
The International Land Model Benchmarking (ILAMB) Package

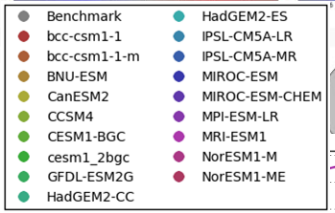
ILAMB provides a variety of in-depth diagnostics of more than 24 terrestrial biogeochemical and hydrological model variables on annual and inter-annual time scales. It compares these variables with over 60 site-based, regional, and global observational data sets, and scores model performance based on a combination bias, RMSE, and seasonal cycle metrics. Relationships between many biogeochemical variables and physical driver variables are calculated from model results and compared with observational estimates. ILAMB is useful for detailed exploration of land biogeochemical and hydrological model responses and provides an interactive interface designed to enable the user to more rapidly understand the underlying drivers of those responses.

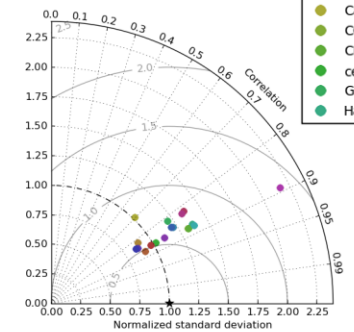


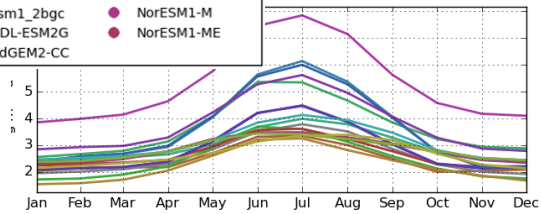
Quick links: Repository and Installation

A primary motivation for CMEC is to analyze model simulations tha
Model Intercomparison Project (CMIP). Virtually every institution w
development of ESMs contributes simulations to CMIP. The 6th an
2014; Eyring et al., 2016) includes a partial but fundamental shift av
the advent of an ongoing core of benchmarking experiments know
Evaluation, Characterization of Klima – Klima being the German word for climate). The DECK includes a









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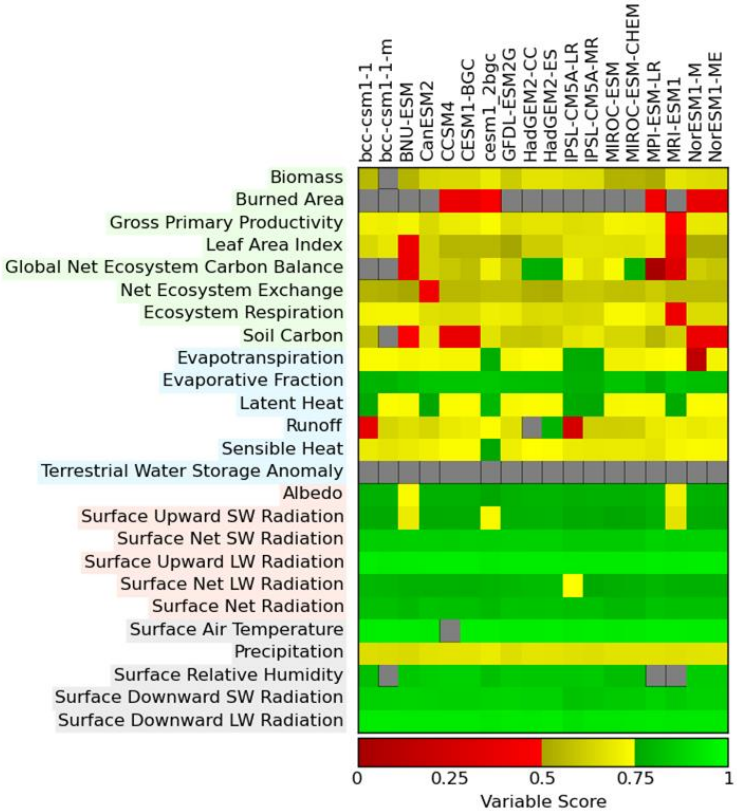
International Land Model Benchmarking (ILAMB) Package

- Provides systematic assessment of land model results compared with observations
- Scores model performance across a wide range of independent benchmark data sets
- Includes comparison of functional relationships (variable-to-variable comparisons)
- Written in Python and runs in parallel
- Produced from an international community coordination effort for designing metrics
- Supported primarily by RUBISCO SFA with support for metrics from E3SM and new observational data from NGEE Arctic & Tropics



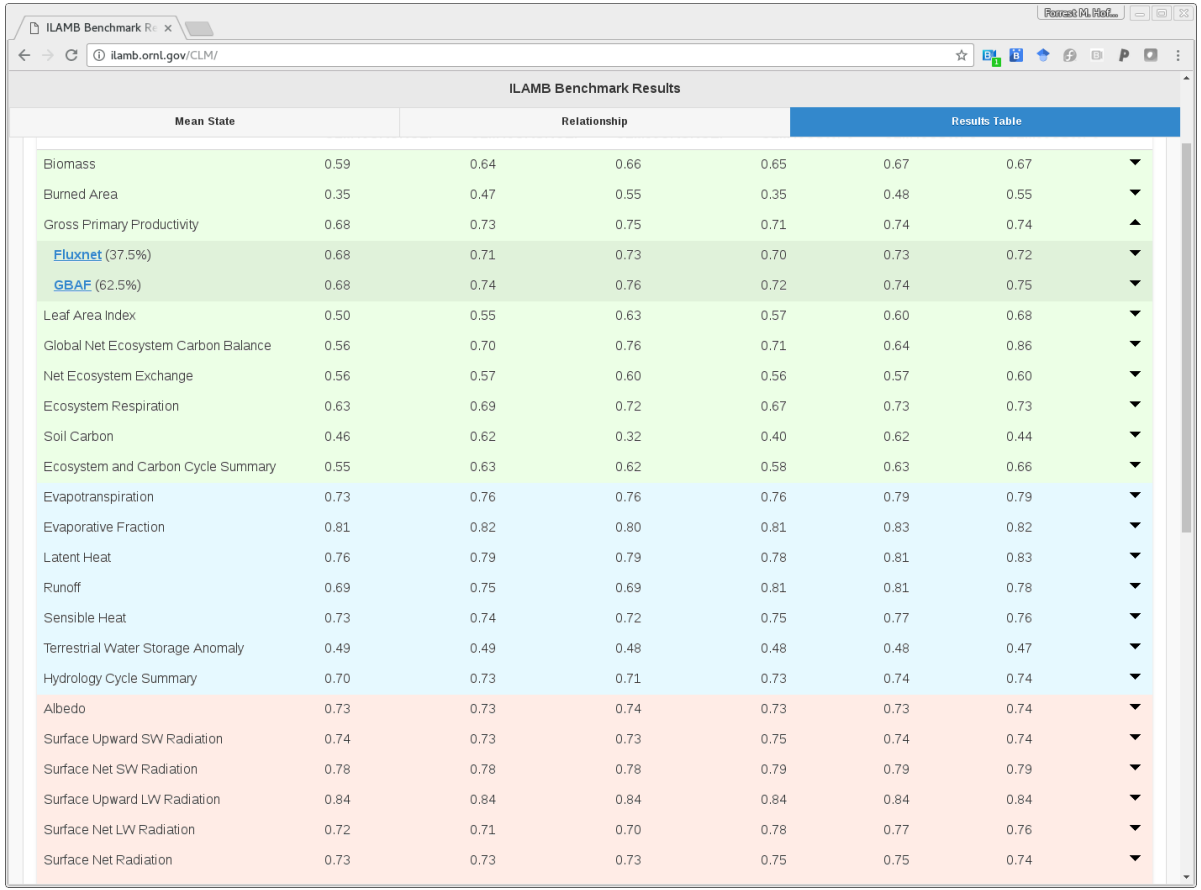
International Land Model Benchmarking (ILAMB) Package

- We invested effort in providing a rich hierarchical user interface
- The top level overview provides “portrait plots” of absolute and relative model scores
- Scores are aggregated from multiple data sets and metrics for each variable

ILAMB Package Features

- Currently integrates analysis of 25 variables in 4 categories from ~60 datasets
  - aboveground live biomass, burned area, carbon dioxide, gross primary production, leaf area index, global net ecosystem carbon balance, net ecosystem exchange, ecosystem respiration, soil carbon
  - evapotranspiration, latent heat, sensible heat, runoff, evaporative fraction, terrestrial water storage anomaly
  - albedo, surface upward SW + LW radiation, surface net SW + LW radiation, surface net radiation
  - surface air temperature, precipitation, surface relative humidity, surface downward SW +LW radiation
- Graphics and scoring system
  - plots and scores model performance for annual mean, bias, relative bias, RMSE, seasonal cycle phase, spatial distribution, interannual variability, variable-to-variable comparisons
  - includes global maps, time series plots averaged over specific regions, individual measurement sites, functional relationship plots, capability to zoom in on specific regions
- Open Source (https://www.ilamb.org/)
  - ILAMBv2.2 is available at https://www.bgc-feedbacks.org/software/

ILAMB Package Results Table

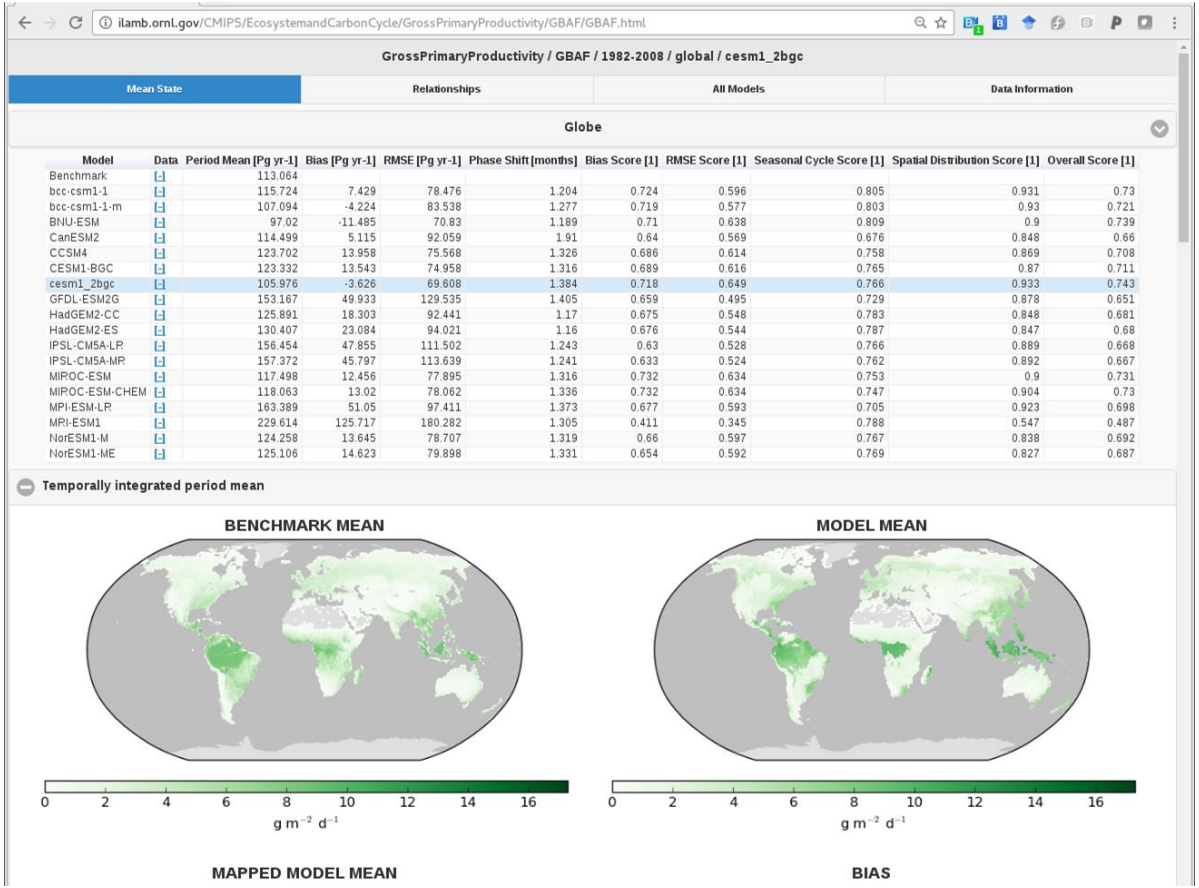


ILAMB Benchmark Results

	Mean State		Relationship		Results Table	
Biomass	0.59	0.64	0.66	0.65	0.67	0.67
Burned Area	0.35	0.47	0.55	0.35	0.48	0.55
Gross Primary Productivity	0.68	0.73	0.75	0.71	0.74	0.74
Fluxnet (37.5%)	0.68	0.71	0.73	0.70	0.73	0.72
GBAF (62.5%)	0.68	0.74	0.76	0.72	0.74	0.75
Leaf Area Index	0.50	0.55	0.63	0.57	0.60	0.68
Global Net Ecosystem Carbon Balance	0.56	0.70	0.76	0.71	0.64	0.86
Net Ecosystem Exchange	0.56	0.57	0.60	0.56	0.57	0.60
Ecosystem Respiration	0.63	0.69	0.72	0.67	0.73	0.73
Soil Carbon	0.46	0.62	0.32	0.40	0.62	0.44
Ecosystem and Carbon Cycle Summary	0.55	0.63	0.62	0.58	0.63	0.66
Evapotranspiration	0.73	0.76	0.76	0.76	0.79	0.79
Evaporative Fraction	0.81	0.82	0.80	0.81	0.83	0.82
Latent Heat	0.76	0.79	0.79	0.78	0.81	0.83
Runoff	0.69	0.75	0.69	0.81	0.81	0.78
Sensible Heat	0.73	0.74	0.72	0.75	0.77	0.76
Terrestrial Water Storage Anomaly	0.49	0.49	0.48	0.48	0.48	0.47
Hydrology Cycle Summary	0.70	0.73	0.71	0.73	0.74	0.74
Albedo	0.73	0.73	0.74	0.73	0.73	0.74
Surface Upward SW Radiation	0.74	0.73	0.73	0.75	0.74	0.74
Surface Net SW Radiation	0.78	0.78	0.78	0.79	0.79	0.79
Surface Upward LW Radiation	0.84	0.84	0.84	0.84	0.84	0.84
Surface Net LW Radiation	0.72	0.71	0.70	0.78	0.77	0.76
Surface Net Radiation	0.73	0.73	0.73	0.75	0.75	0.74

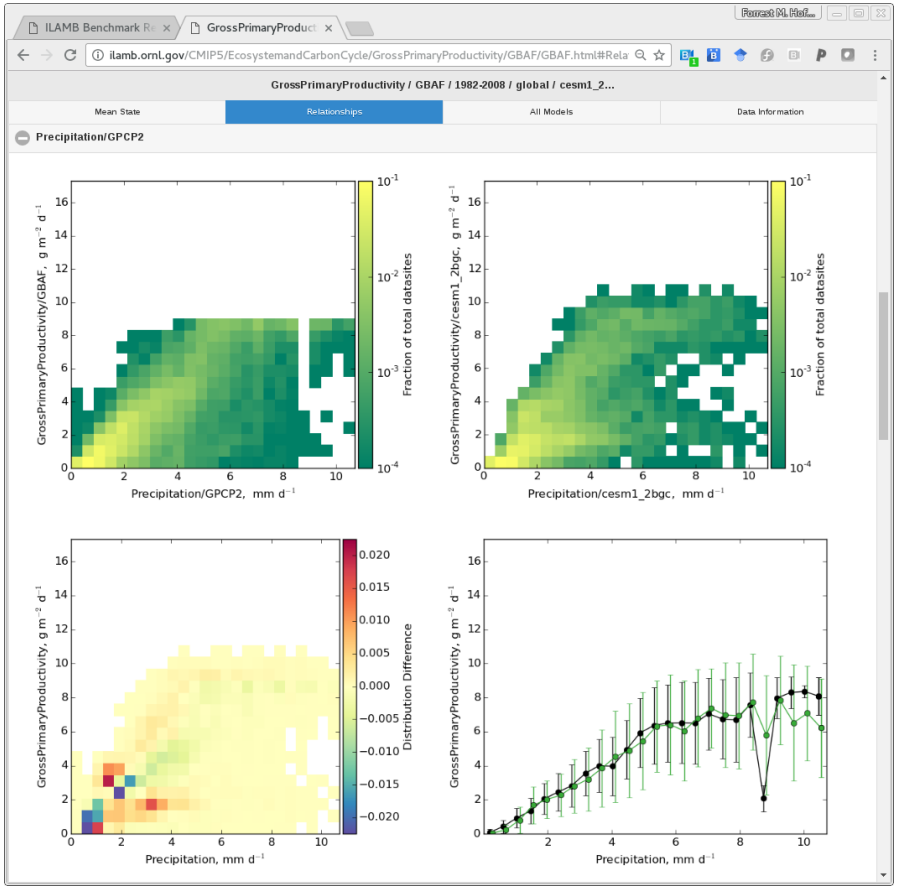
- Results Table shows scores for each model (columns) by variable (rows)
- Each variable is a “pull-down” for multiple data sets (see GPP for Fluxnet and GBAF)
- Clicking on the data set opens a new browser tab with tabular and graphical diagnostics

ILAMB Package Model Table



- Models can be selected individually and diagnostics update
- Separate statistics and figures are produced for pre-defined regions
- Relationships tab contains variable-to-variable comparisons
- Data provenance provided in Data Information tab

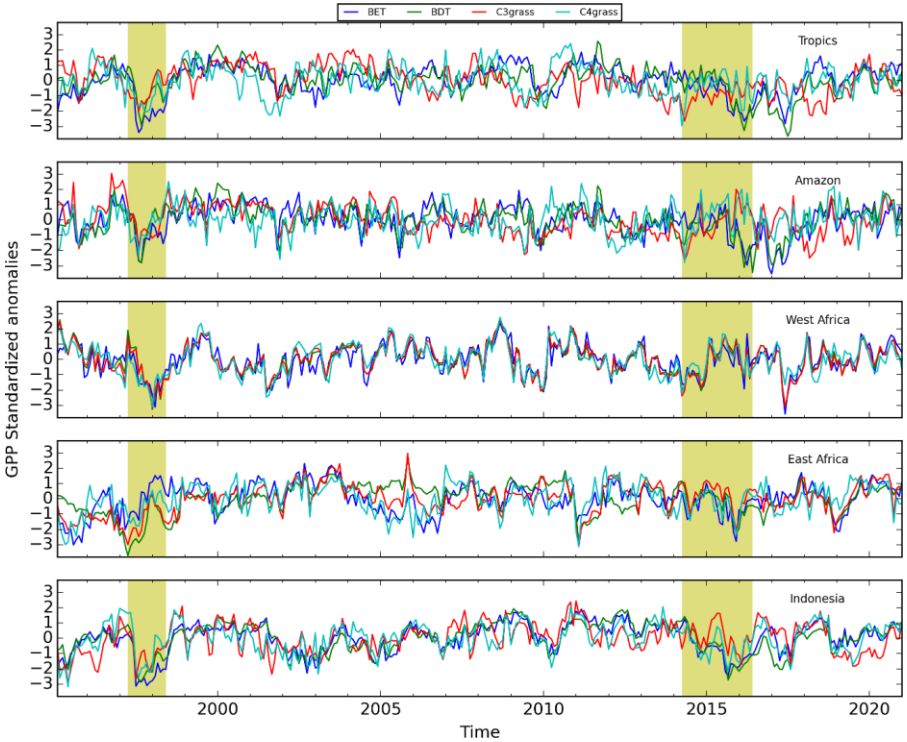
ILAMB Functional Relationships

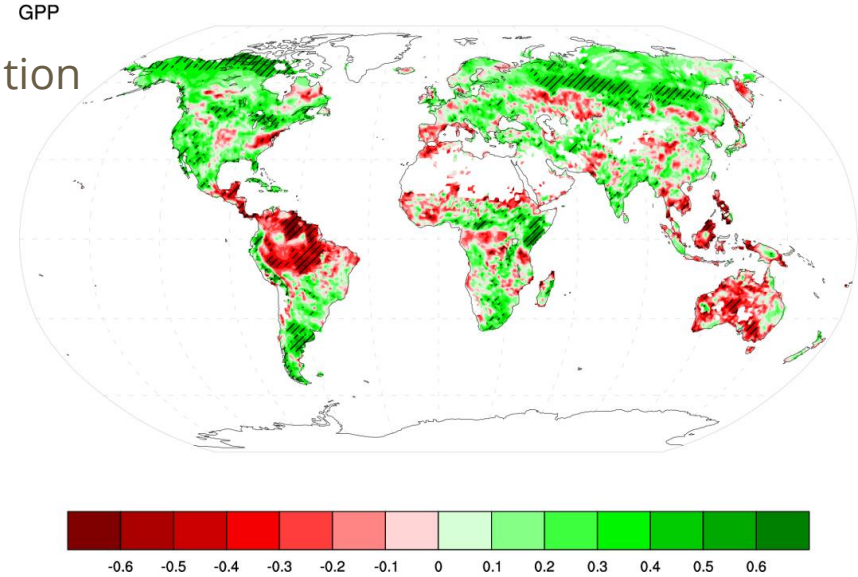


- Variable-to-variable comparisons provide a better way to understand model responses to forcing
- Shown here is GPP vs. Precipitation for a single model compared with observations
- Differences in distribution of points suggests regimes in which model errors are most significant
- Histogram-style line plots indicate if model exhibits overall relationships emerging from observational data

El Niño Modeling with E3SM for NGEE Tropics

Systematic evaluation of model results leads to creation of new phenomenon- and region-specific metrics

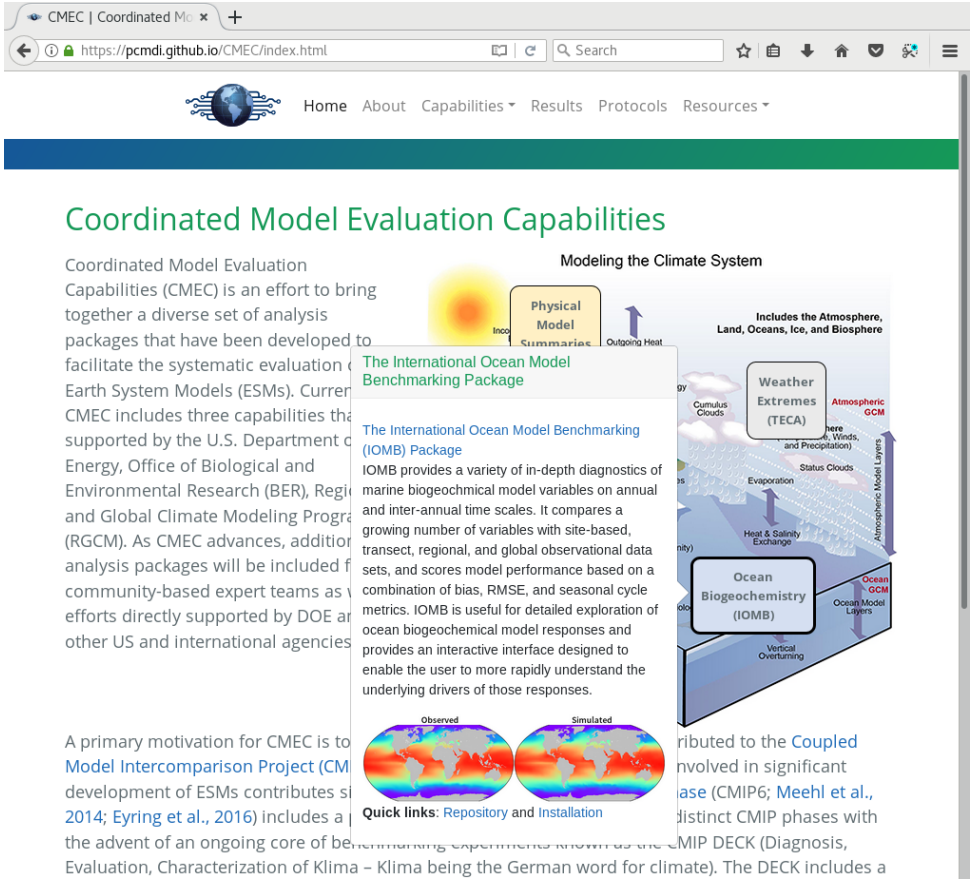


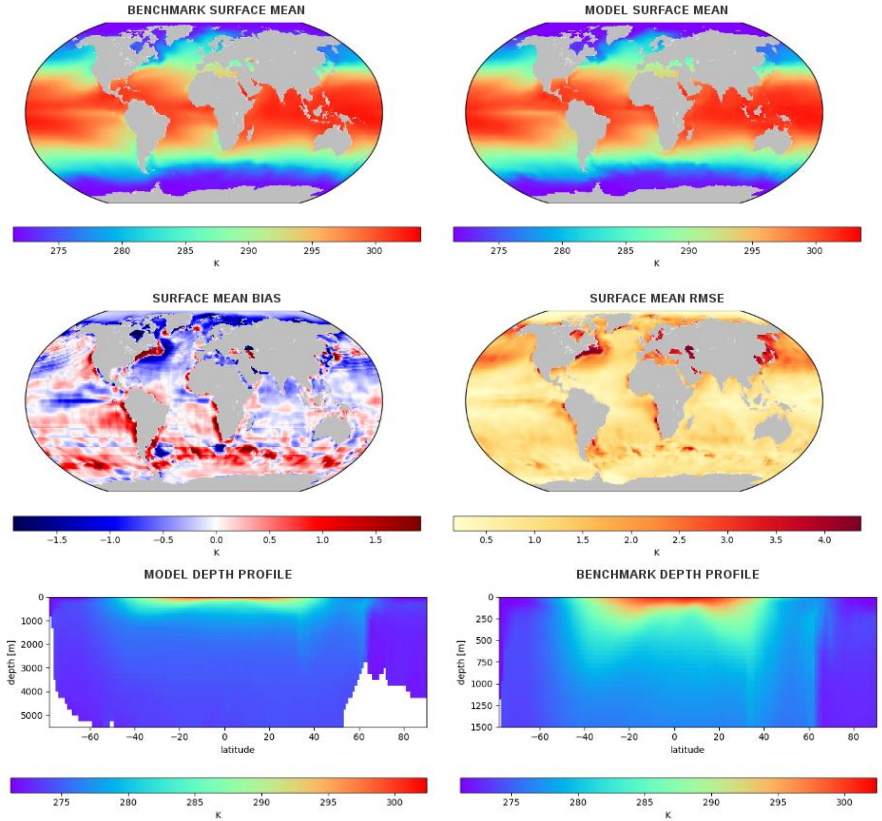


Correlation of annual gross primary production with 5-month averages of sea surface temperatures over the Niño 3.4 region (November--February) during 1995--2016. The hatching indicates locations where the correlation is at a 90% confidence level or higher.

PFT-level tropical ecosystem responses to ENSO-induced drought (left).

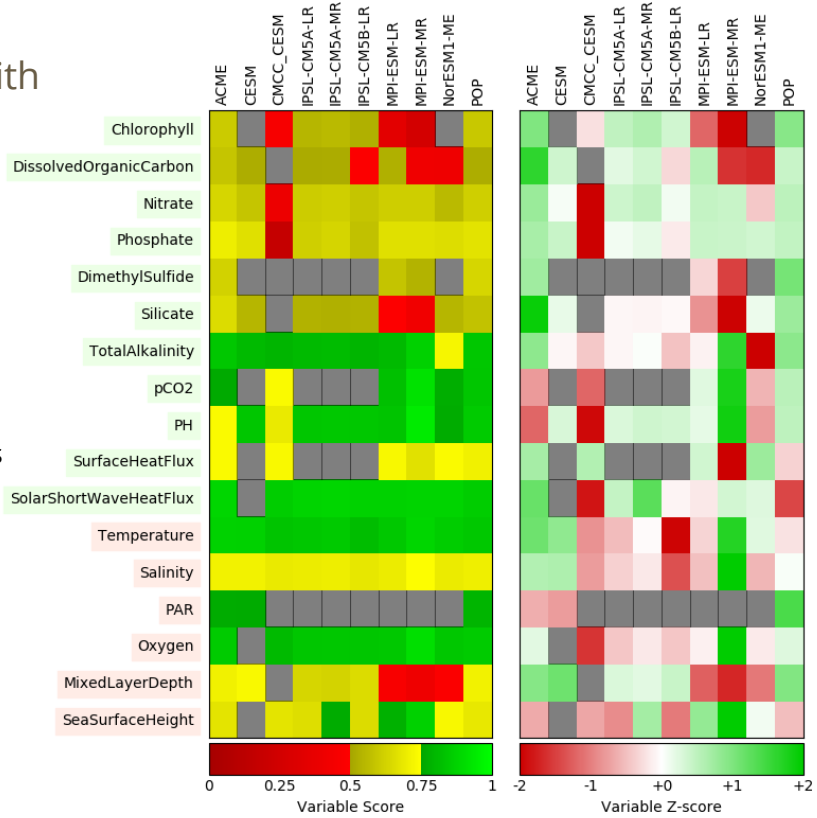
International Ocean Model Benchmarking (IOMB) Package





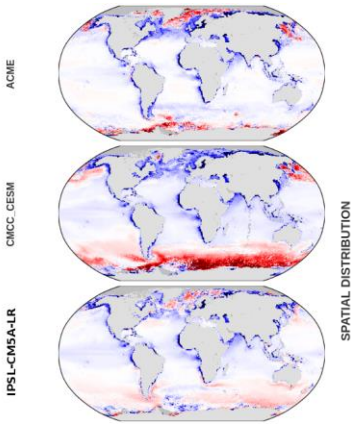
International Ocean Model Benchmarking (IOMB) Package

- Evaluates ocean biogeochemistry results compared with observations (global, regional points, and ship tracks)
- Scores model performance across a wide range of independent benchmark data
- Leverages ILAMB code base; also runs in parallel
- Will be released to the community soon

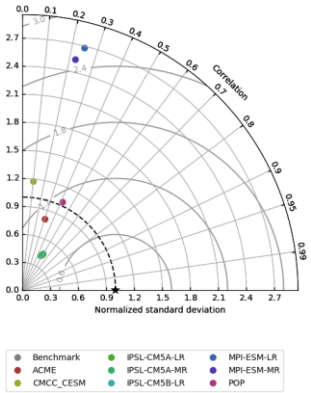


Chlorophyll / SeaWIFS

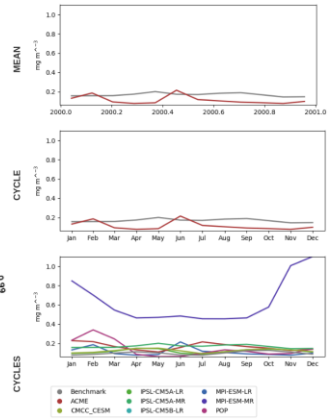
Bias



Spatial Distribution

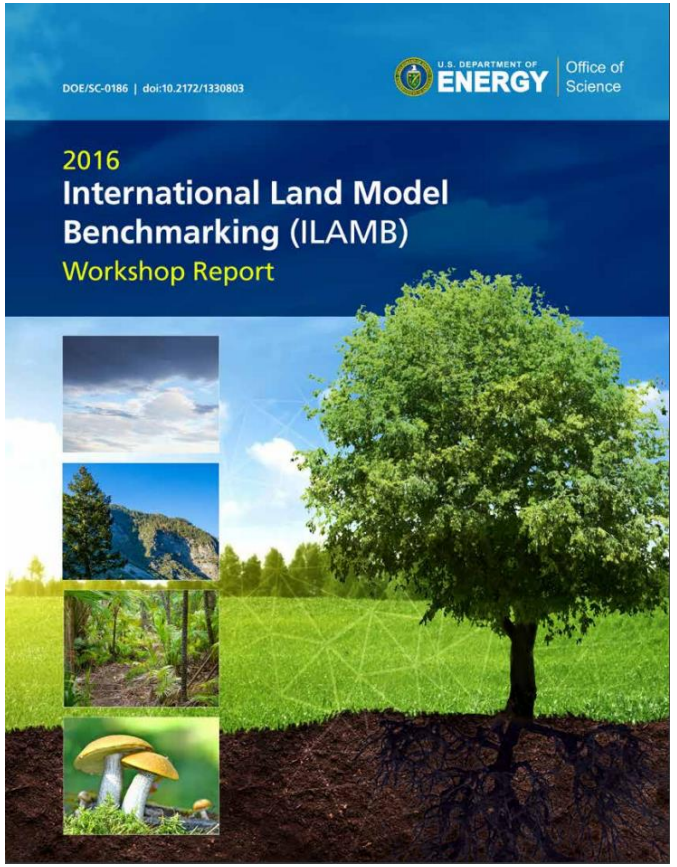


Annual & Seasonal Cycles

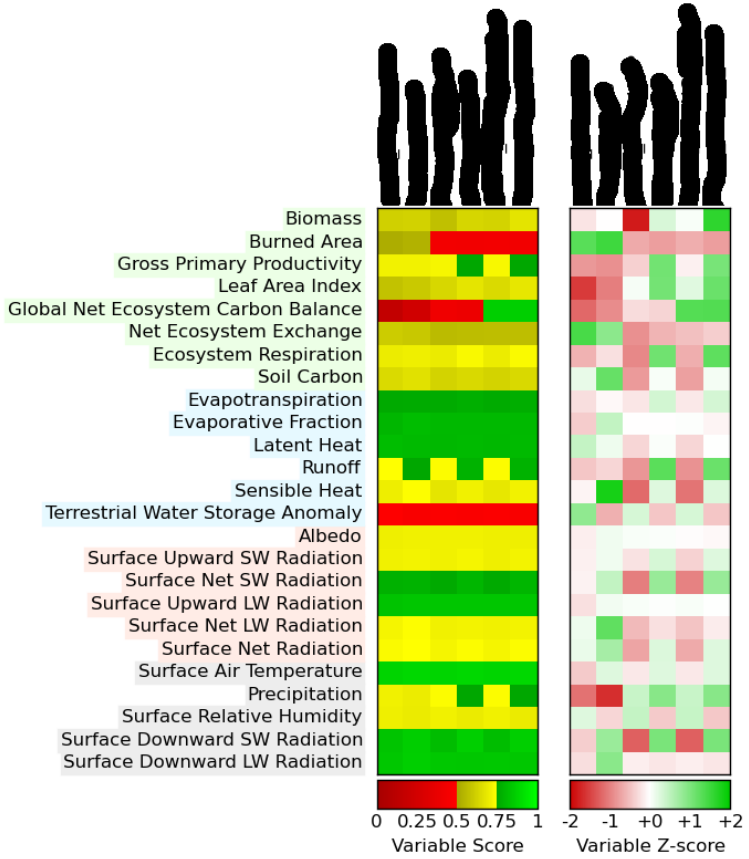


ILAMB and IOMB Target Uses

- ILAMB is designed for use by
  - Individual modelers/model developers - for verification
  - Modeling centers - to track model performance evolution
  - Model intercomparison experiments - for multi-model analysis
- ILAMB is being used & developed by the international land model community
  - DOE E3SM - Workflow and Land Model Intercomparison
  - NSF / DOE CESM at NCAR - Workflow (land and ocean)
  - University of New South Wales / PALS / modelevaluation.org - Analysis engine
  - CEH / JULES / EartH2Observe - Published analysis
  - NOAA GFDL - Adding it to their toolkit
  - NASA ABoVE / NOAA NSIDC - Permafrost metrics
  - University of Tokyo / GSWP3 - Runoff metrics and evaluation
- IOMB is being used & developed by E3SM & CESM so far



E3SM Land Model (ELM) Intercomparison

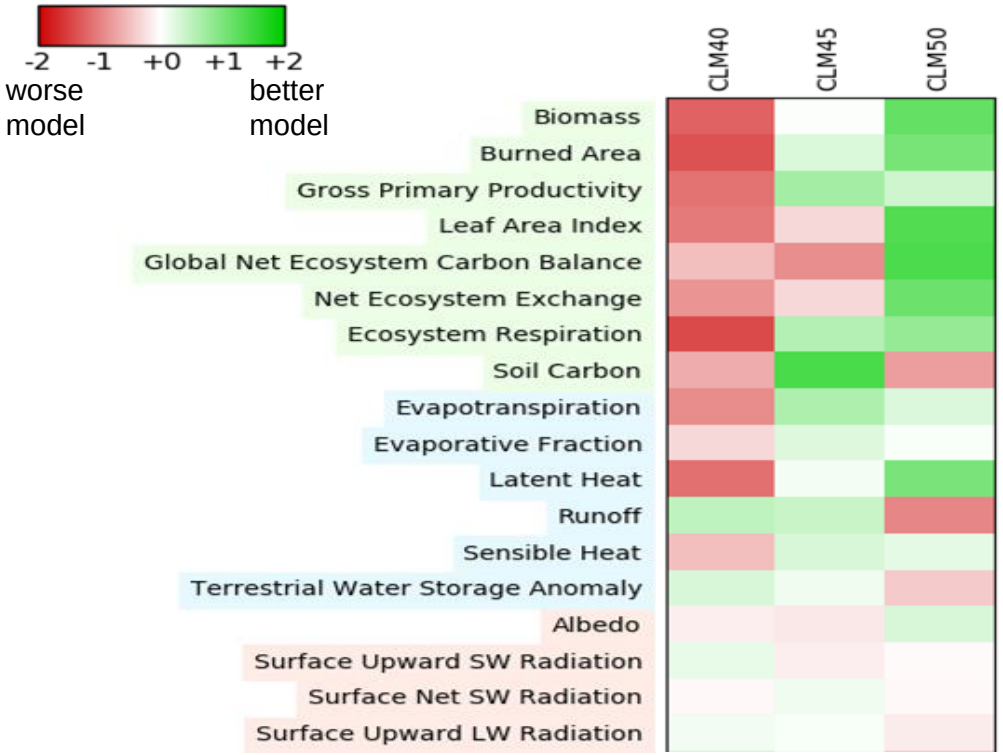


Gross Primary Productivity / GBAF / 1982-2008

		Download Data	Period Mean (original grids) [Pg yr-1]	Model Period Mean (intersection) [Pg yr-1]	Model Period Mean (complement) [Pg yr-1]	Benchmark Period Mean (intersection) [Pg yr-1]	Benchmark Period Mean (complement) [Pg yr-1]	Bias [g m-2 d-1]	RMSE [g m-2 d-1]	Phase Shift [months]	Bias Score [1]	RMSE Score [1]	Seasonal Cycle Score [1]	Spatial Distribution Score [1]	Overall Score [1]
Benchmark	[-]		118.810												
[redacted]	[-]		111.448	102.592	8.851	118.383	0.427	-0.037	1.573	1.244	0.727	0.648	0.812	0.862	0.739
[redacted]	[-]		105.181	97.013	8.162	118.383	0.427	-0.185	1.536	1.254	0.737	0.654	0.798	0.865	0.741
[redacted]	[-]		138.154	128.193	9.954	118.383	0.427	0.542	1.614	1.181	0.745	0.644	0.825	0.864	0.744
[redacted]	[-]		137.237	127.339	9.891	118.383	0.427	0.523	1.619	1.139	0.746	0.642	0.825	0.865	0.744
[redacted]	[-]		126.756	117.893	8.856	118.383	0.427	0.281	1.404	1.335	0.790	0.685	0.801	0.899	0.772
[redacted]	[-]		125.544	116.790	8.748	118.383	0.427	0.255	1.412	1.303	0.789	0.681	0.802	0.900	0.771

- An enhanced version of ILAMB is being used to assess multiple land biogeochemistry formulations in ELM
- The ELM Intercomparison, led by Ben Bond-Lamberty, is using ILAMB and other tools and metrics to identify optimal model configurations

ILAMB assessing several generations of CLM



- ILAMB was used as an integral part of CLM5.0 development
- Improvements in mechanistic treatment of hydrology, ecology, and land use with many more moving parts
- Simulation improved even with enhanced complexity
- Observational datasets not always self-consistent
- Forcing uncertainty confounds assessment of model development (not shown)

Lawrence et al., in prep

ILAMB and IOMB Development

- Openly developed in Python using Git repository
  - https://bitbucket.org/ncollier/ilamb
  - Patches welcome! We have had features and bugfixes submitted by users
- Roughly biannual releases
  - v2.0 - May 2016
  - v2.1 - March 2017
  - v2.2 - November 2017
- Development activity
  - Develop new benchmarks for E3SM and modeling working groups
  - Adapt the ILAMB core to address community needs (ocean, high latitude, diurnal cycle)
  - Address computing environments and performance (laptops, clusters, NERSC, OLCF & ALCF)
  - Hone and improve the current methodology ***with research community***
  - Continually improve documentation and tutorials (Provided at major meetings)
- Tracking use through software DOIs, workshop engagement, and interactive website visits — Many users will simply look at results!

TECA: Toolkit for Extreme Climate Analysis

Home Abo rces

Coordinated Model Ev

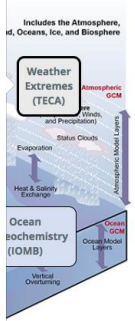
Coordinated Model Evaluation Capabilities (CMEC) is an effort to bring together a diverse set of analysis packages that have been developed to facilitate the systematic evaluation of Earth System Models (ESMs). Currently, CMEC includes three capabilities that are supported by the U.S. Department of Energy, 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 a efforts directly supported by DOE and other US and international agencies.

The Toolkit for Extremes Climate Analysis

The Toolkit for Extremes Climate Analysis (TECA)

TECA is a high-performance, general purpose tool for detecting discrete weather events, such as tropical cyclones, in climate model output. Its core is a map-reduce framework, implemented in C++, that utilizes MPI and OpenMP parallelism. It features Python bindings for the core architecture, which allows rapid prototyping new detectors while taking advantage of the high-performance parallelism of the C++ core.

Quick links: Repository, Installation, and documentation



A primary motivation for CMEC is to ana ed to the Coupled Model Intercomparison Project (CMIP). ed 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.

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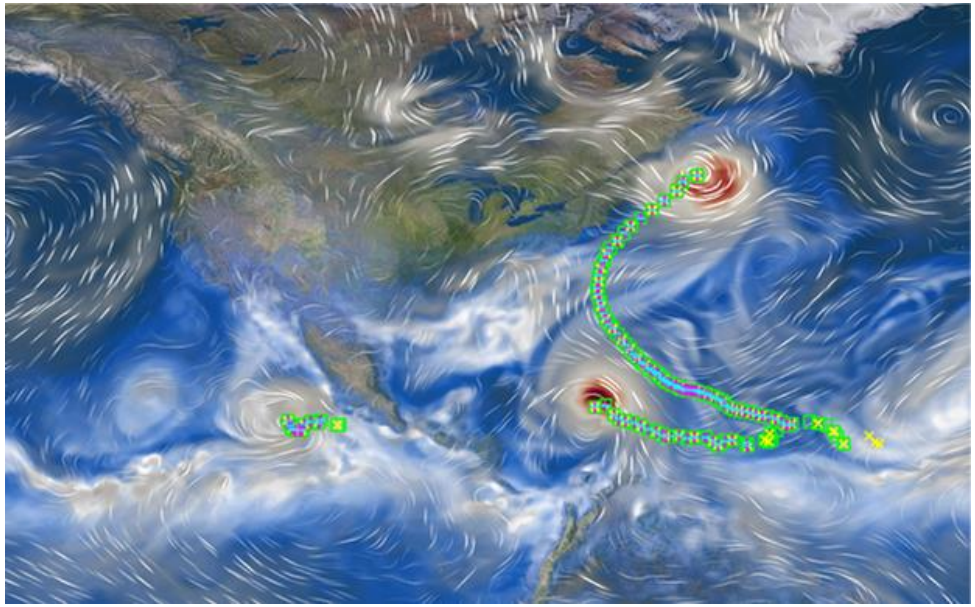
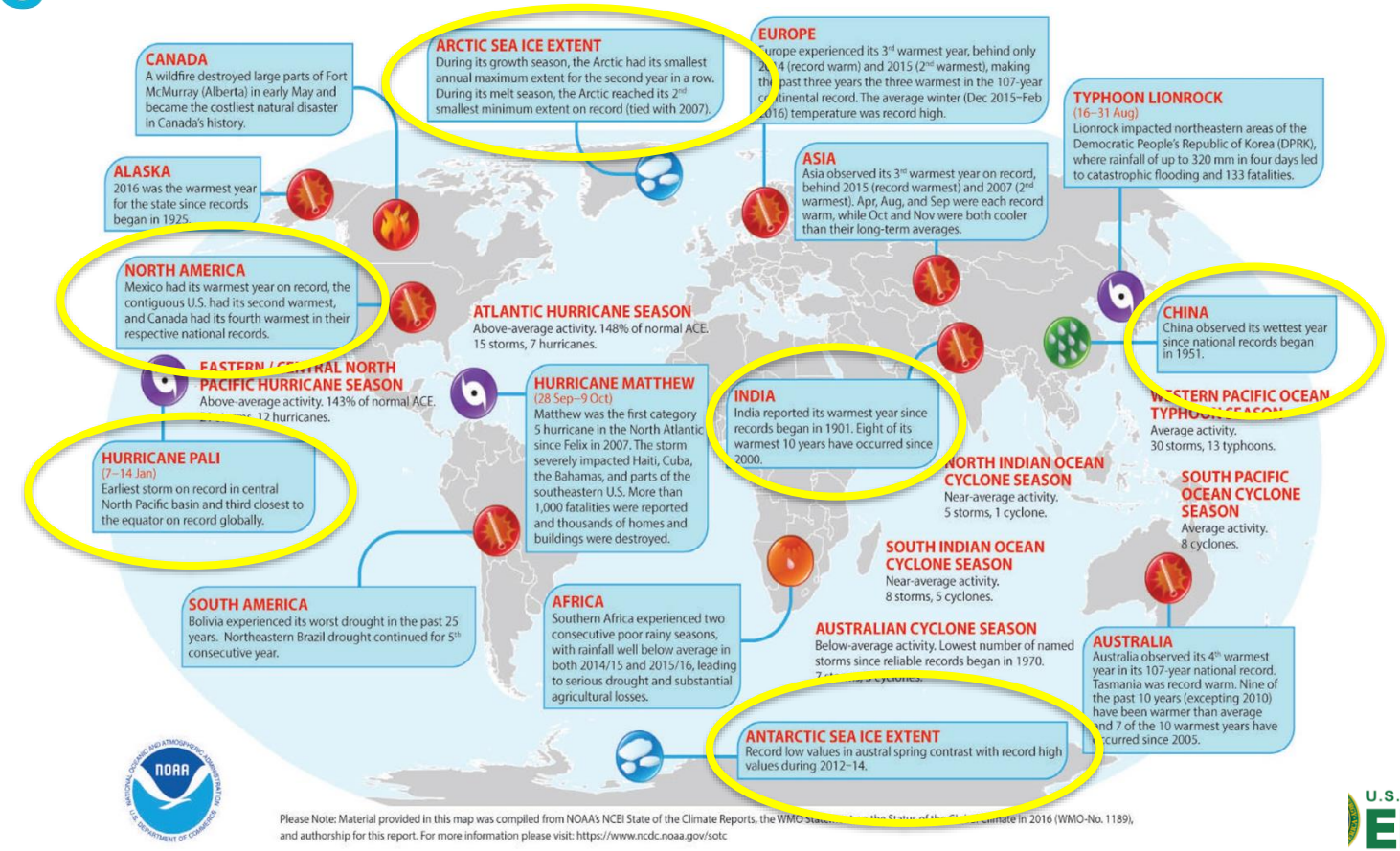
TECA: Toolkit for Extreme Climate Analysis

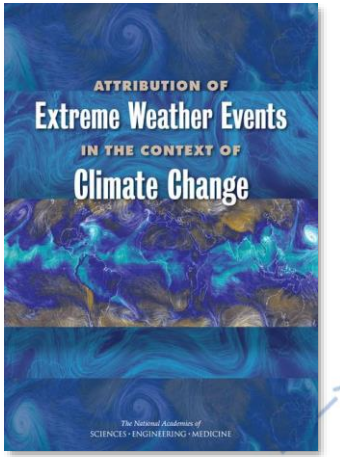
- TECA is a tool for detecting discrete weather events in climate output.
- The main use case is for research on extremes...



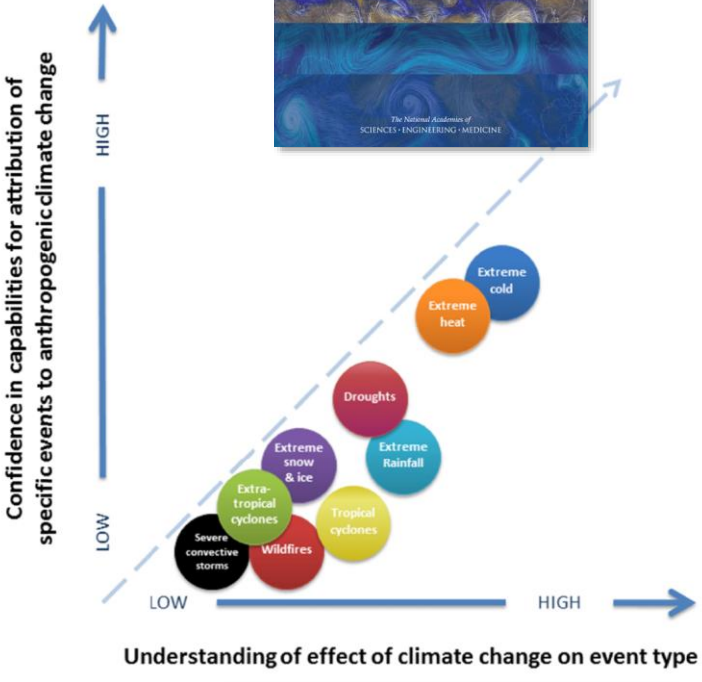
2016 was an eventful year for extreme weather



CMEC



● = high ◎ = medium ○ = low	Capabilities of Climate Models to Simulate Event Class	Quality/Length of the Observational Record	Understanding of Physical Mechanisms that Lead to Changes in Extremes as a Result of Climate Change
Extreme cold events	●	●	●
Extreme heat events	●	●	●
Droughts	◎	◎	◎
Extreme rainfall	◎	◎	◎
Extreme snow and ice storms	◎	○	◎
Tropical cyclones	○	○	◎
Extratropical cyclones	◎	○	○
Wildfires	○	◎	○
Severe convective storms	○	○	○



*"Bringing multiple scientifically appropriate approaches together, including **multiple models** and **multiple studies** helps distinguish results that are robust from those that are much more sensitive to how the question is posed and the approach taken."*

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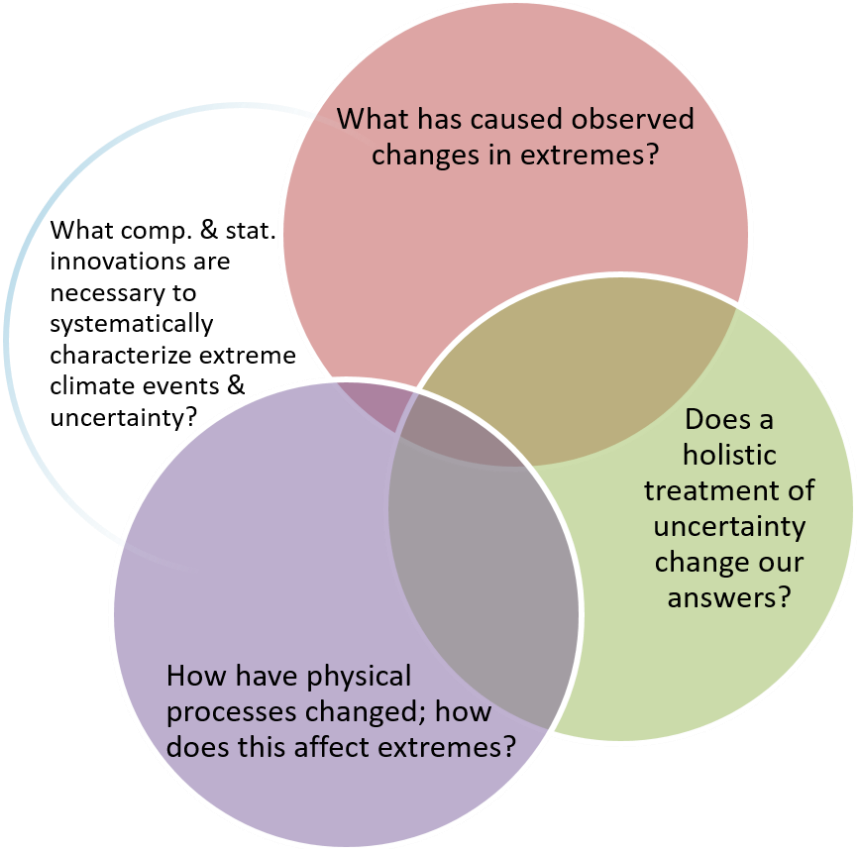
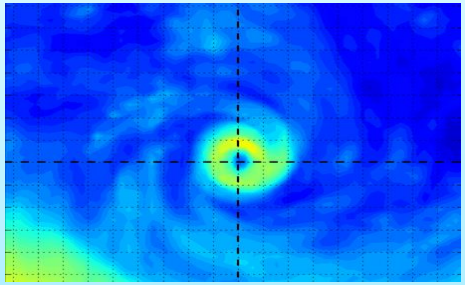
CASCADE Key Questions



CASCADE Produces Community Data Analysis Tools

TECA

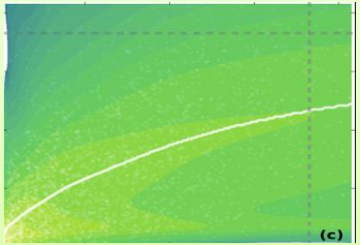
bitbucket.org/lbl-cascade/teca



- Fast, scalable event detection
- TC, AR, and ETC detection
- Python API for add'l algorithms

fastKDE

dist. via ***bitbucket*** and ***pip***



- Fast, robust PDF estimation
- Multidimensional

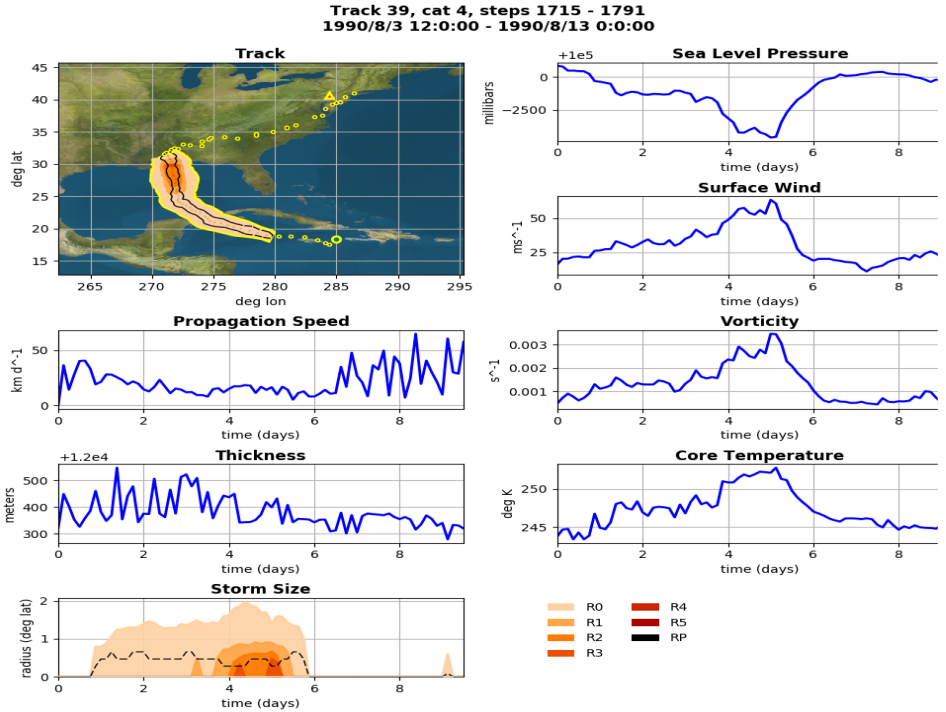
climextRemes

dist. via ***CRAN*** & ***UV-CDAT***

- Flexible extreme value analysis
- R and Python packages

TECA: Toolkit for Extreme Climate Analysis

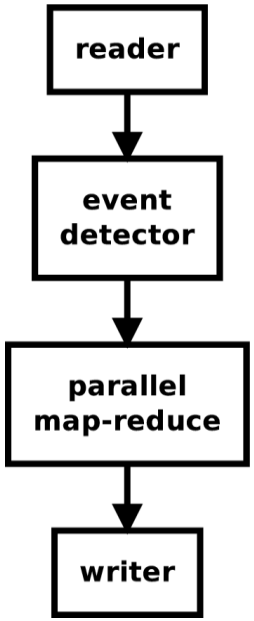
- Detects extreme weather events
- Leverages map-reduce framework:
  map—candidate detection
  reduce—stitch paths
- Efficient and highly parallel: analyzed extratropical cyclones in all of CMIP5 in 1 hour
- Python interface for rapid detector prototyping



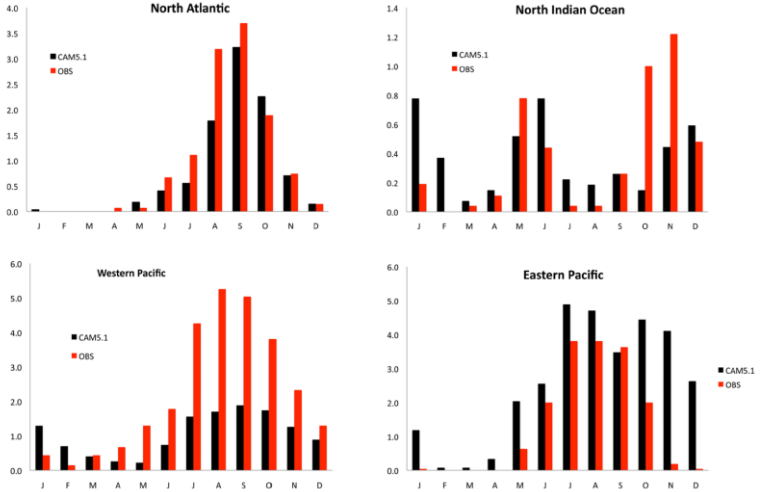
Download at https://github.com/LBL-EESA/TECA

TECA2: A platform for feature detection/classification

- TECA2 allows ***easy exploration*** of existing algorithms, and construction of new ones.
- Simple input machinery allows easy tuning and analysis of parameters
- "Snap-together" pieces form high-performance pipelines that can execute on DOE's HPC platforms
    - Several **reusable** components fit into multiple pipelines
    - Components and pipelines can be built using **Python**
- TECA2's parallelism is best-in-class (MPI + threads): **makes efficient use of Cori KNL.**



Evaluating TC Statistics in Climate Models



Objective: Objectively assess what is to be gained from high horizontal resolution in the Community Atmospheric Model, CAM5.1 enabled by current generation DOE supercomputers.

Research: At resolutions of 25km, global atmospheric models realistically simulate many types of extreme weather. We find that fvCAM5.1 reproduces observed hurricane frequencies and intensities. Furthermore, the model more accurately simulates extreme daily precipitation than CMIP5-class models.

Impact: High resolution climate models provide new capabilities to examine future changes in extreme storms and precipitation in ways that the CMIP5 models cannot. As high resolution models become mainstream, confidence in projected changes in extreme weather will be increased.

TECA's Userbase

- A tiered system for supporting DOE science and the broader community:
  - CASCADE researchers
  - DOE Collaborators (Hyperion, University projects)
  - Broader community

TECA's value within DOE

- Capability to analyze extremes w/ a focus on events that matter for natural and managed systems: especially energy and water
- Allows a process/phenomena focused analysis of extremes
- Permits analysis of DOE model biases, focused on the actual weather events that bring biases: e.g., Western US precip biases and ARs

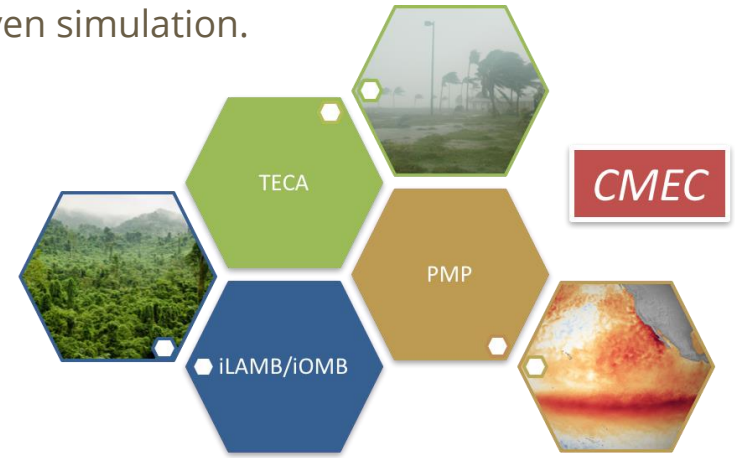
TECA's value within broader community

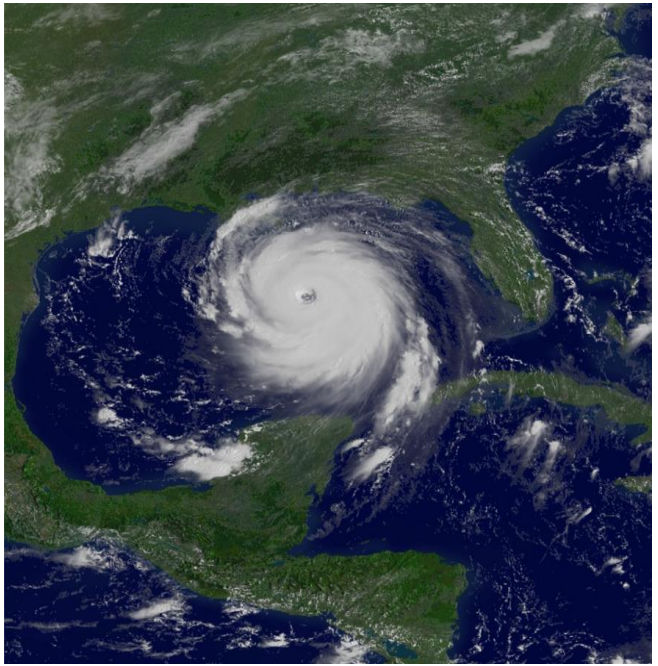
- Capability to analyze extremes with a focus on events that matter for natural and managed systems
- Allows a process/phenomena-focused analysis of extremes
- Permits analysis of climate model biases, focused on the actual weather events that bring biases

CMEC - Joint Analysis of Variability, Extremes and BGC

CMEC Component	Role
PMP	Quantify errors in mean and variability
TECA	Quantify errors in extremes
ILAMB/IOMB	Quantify errors in BGC cycles

CMEC could provide a simple, federated tool for simultaneously characterizing climate, extremes, and BGC cycles in a given simulation.





CMEC beyond a prototype experiment

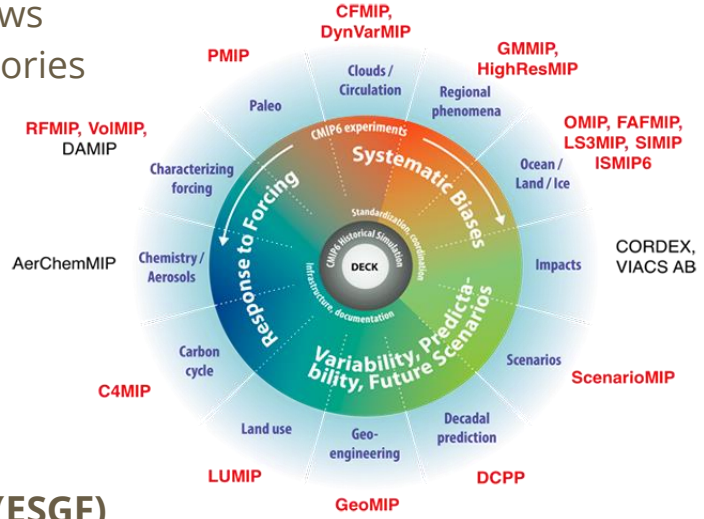
- Target audiences:
  - E3SM community: particularly critical for FATES-based versions w/ variable resolution
  - International climate community: hi-res coupled simulations will become common in 5-10 year timeframe

PMP-ILAMB-IOMB-TECA synergies

- Exploring scientific linkages will be an integral part of CMEC research and will provide a unique set of CMIP6 synthesis papers
- Establishing CMEC protocols is an ongoing collaborative effort
- Content and objectives are highly complementary, with nominal overlap to routinely verify techniques

Coordination within CMEC

- **PMP, ILAMB, IOMB, and TECA currently**
  - Adopt same standards used for all CMIP model data.
  - Provide Python interfaces for building analytical workflows
  - Enable open access using standardized software repositories
- **Continued coordination will focus on CMIP6**
  - **Evaluation of CMIP6 results:**
    - Climate Record: Historical and DECK Experiments
    - Land BGC: Historical, C4MIP, LUMIP, LS3MIP
    - Ocean BGC: Historical, C4MIP, OMIP
    - Climate Extremes: HighResMIP
  - **Connections with the Earth System Grid Federation (ESGF)**
    - Automated retrieval of model results
    - Provision of CMEC results to benefit community
    - Offering data ordering options from within diagnosis pages
  - **Federation via shared designs and methods**



Discussion and Q&A

- What other capabilities would you like to see as part of CMEC that would provide value to your research as well as benefit the scientific community?
- What needs should we anticipate for benchmarking the next generation of ESMs with increased complexity/resolution?
- In particular, what additional evaluation capabilities are needed for CMIP6 Historical & DECK experiments, or for related MIPs (C^4MIP, LS3MIP, LUMIP, HighResMIP)?
- Is there interest in other teams working on co-development of these tools?
- Any other questions, suggestions, or comments?

CMEC

Coordinated Model Evaluation Capabilities

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