Preparation of a more systematic evaluation of blocking and extreme for the upcoming CMIP7 via the PCMDI Metrics Package

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Background and Motivation

- The **CMIPs** span more than **3 decades of climate model development.** A key question is **how has model performance improved** during this time?
- The PCMDI Metrics Package (PMP), an open-source Python software package for comprehensive and systematic model evaluation, aims to address this question with the key goals:
  - **Provide an objective synthesis** of the growing number of simulations.
  - More **directly contribute to model development** through quick feedback contrasting the latest model development version to the preceding CMIP archives.
- The PMP leverages the DOE-supported CMIP data conventions, archives (across MIPs), and Python-based tools (e.g., xarray, xCDAT).
- To date, **mean climate, ENSO, extra-tropical modes, MJO, cloud feedback, monsoon, and precipitation benchmarking metrics are implemented in the PMP** (https://github.com/PCMDI/pcmdi_metrics).
- Implementation of blocking metrics is in progress, and Implementation of extreme metrics recently completed.

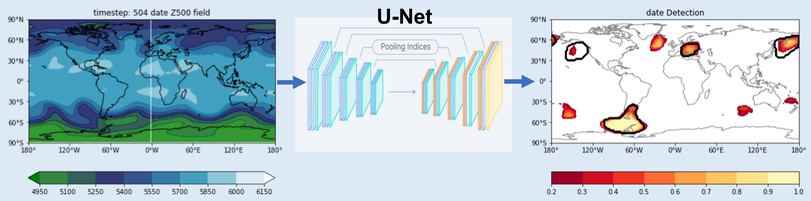
PCMDI Metrics Package

xarray

xCDAT Xarray Climate Data Analysis Tools

Evaluation Metrics

Atmospheric Blocking



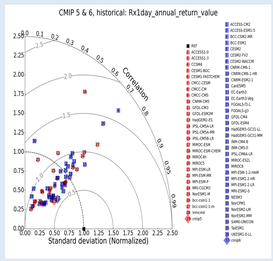
Blocking Metrics development: Please check the other poster by Valkonen et al. "Changing atmospheric blocking; new insights with novel machine learning detection"

Extremes

Non-stationary Generalized Extreme Value statistical method:

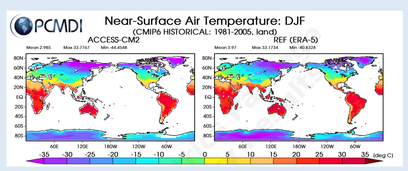
- Calculate selected extreme daily indices and their return values for temperature and precipitation
- Evaluate model performance of these indices and their return values in replicating similar quantities calculated from gridded land based daily observations

Precipitation Extreme (Wehner et al., 2020,2021)

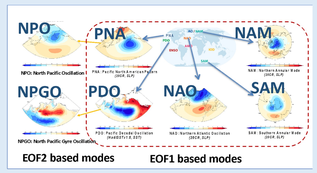


Other relevant metrics

Potentially relevant metrics available in the PMP includes:



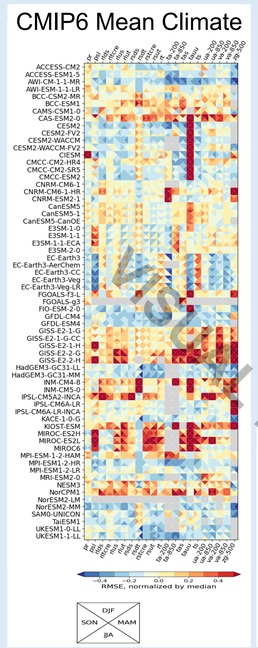
Mean Climate (Gleckler et al., 2008)



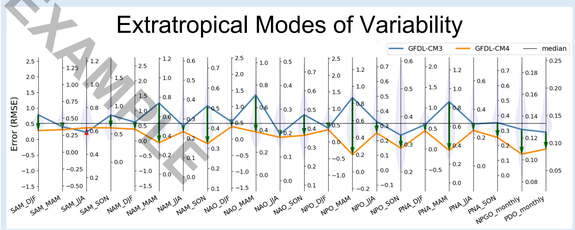
Extratropical Modes of Variability (Lee et al., 2019, 2021)

PLAN for CMIP7 Model Benchmarking

- Model development can leverage the PMP to **track performance evolution in the development cycle**.



- Visual examples taken from the usage of PMP for contrasting performance of two different versions (i.e., GFDL-CM3 & GFDL-CM4) for mean climate.
- Similar assessment will be enabled for CMIP7 by the implementation of the blocking and extreme metrics to the PMP.



Remarks

- PMP provides collective evaluation capabilities. We are improving the PMP to be more readily available for the CMIP7 Benchmarking.
- We are in process of finalizing implementations of blocking and extreme metrics into the PMP.
- PMP results interactive web-viewer system (https://pcmdi.llnl.gov/research/metrics) will help navigate metrics and accompanying diagnostics obtained from the upcoming CMIP7 models.

Lee et al., 2023: Systematic and Objective Evaluation of Earth System Models: PCMDI Metrics Package (PMP) version 3. Geoscientific Model Development (under review), EGUsphere [preprint], doi: 10.5194/egusphere-2023-2720

PCMDI Earth System Model Evaluation Project

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