

# A brief update on a framework for Benchmarking Simulated Precipitation in Earth System Models

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- Motivation: Precipitation Metrics Workshop (2019)
- Progress on Benchmarking Simulated Precipitation
- Possible connections with WGNE and WGCM

Joint WGNE/WGCM Session 8-10 November, 2022, Boulder, USA



# Benchmarking Simulated Precipitation in Earth System Models

## WORKSHOP REPORT



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**ENERGY**

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Science

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## Baseline and exploratory metrics

- A limited set of routine or baseline metrics are being advanced for repeat use benchmarking via development of a quasi-operational capability

Pendergrass et al., BAMS, 2020 <https://doi.org/10.1175/BAMS-D-19-0318.1>

- Exploratory metrics are being investigated for a variety of characteristics lacking well-established performance tests (e.g., ARs, TCs)

Leung, R. et al., J. Clim., 2022 <https://doi.org/10.1175/JCLI-D-21-0590.1>

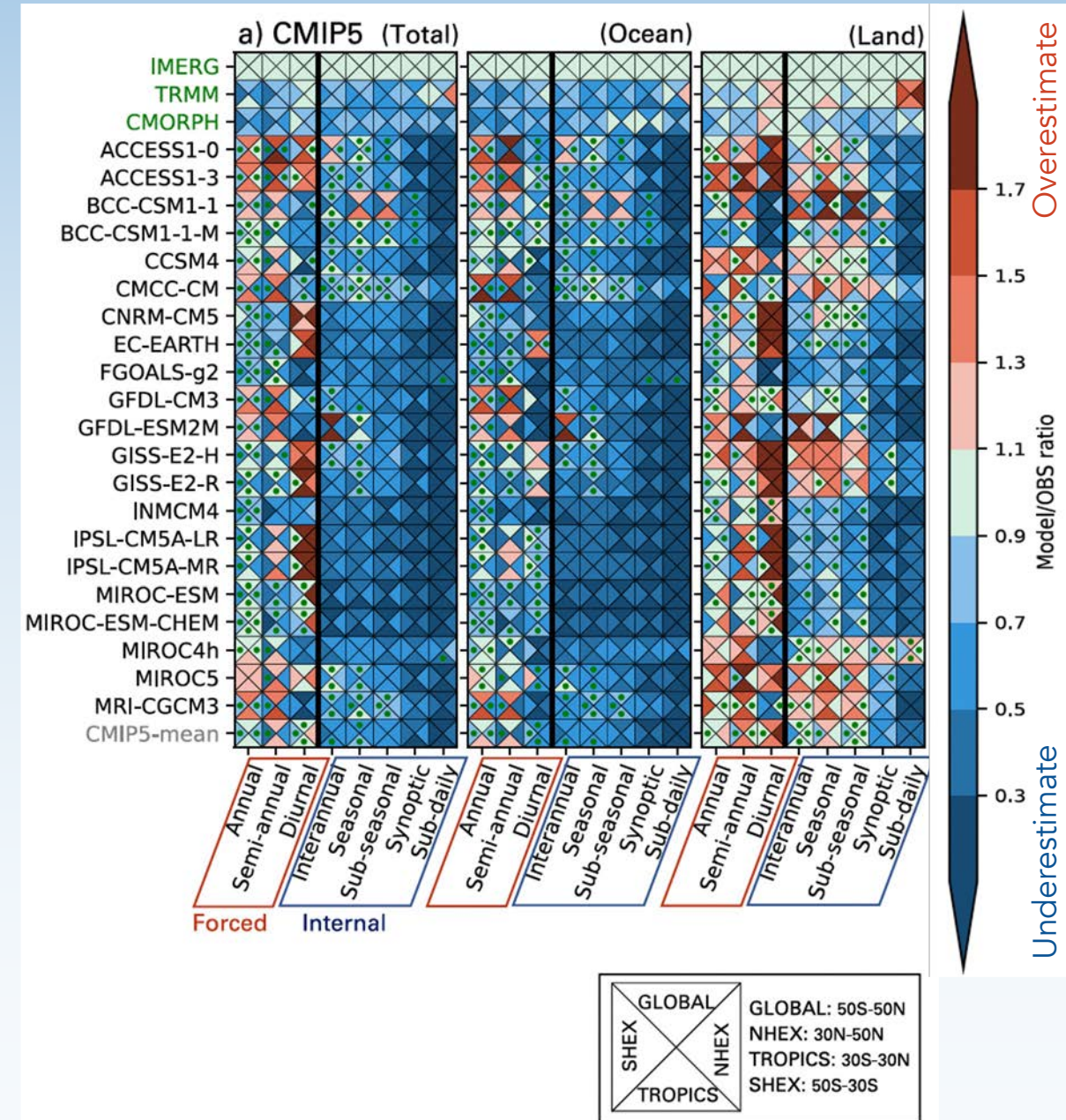
Several presentations at both WGNE and WGCM sessions in recent years have advocated for a more structured approach to gauging the consistency between observed and simulated precipitation in CMIP class models.



[illegible]



## Evidence of systematic muted variability at shorter time scales

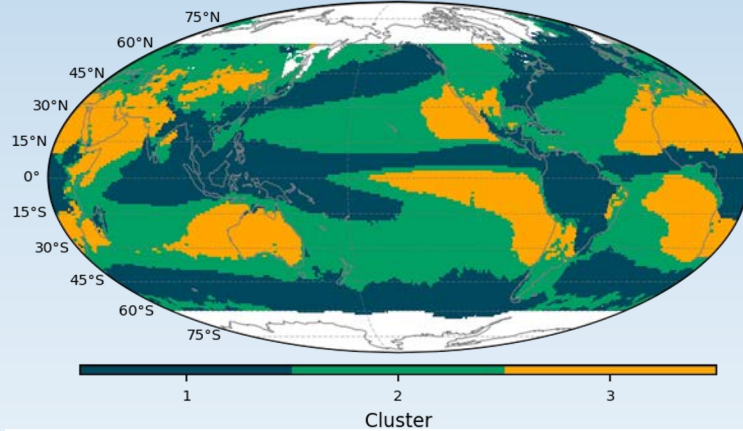




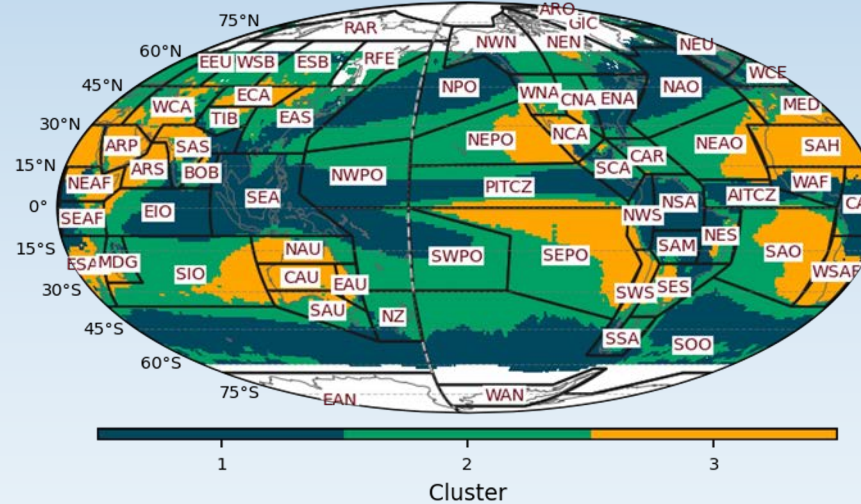
# Example: Framework for Benchmarking Simulated Precipitation Distribution in Regional Scales

Ahn, M. et al. 2022, GMD (under review)

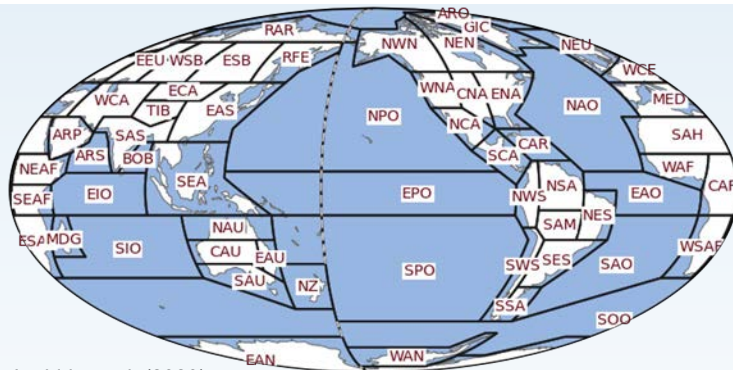
Clustering regions



IPCC AR6 regions with modified ocean regions

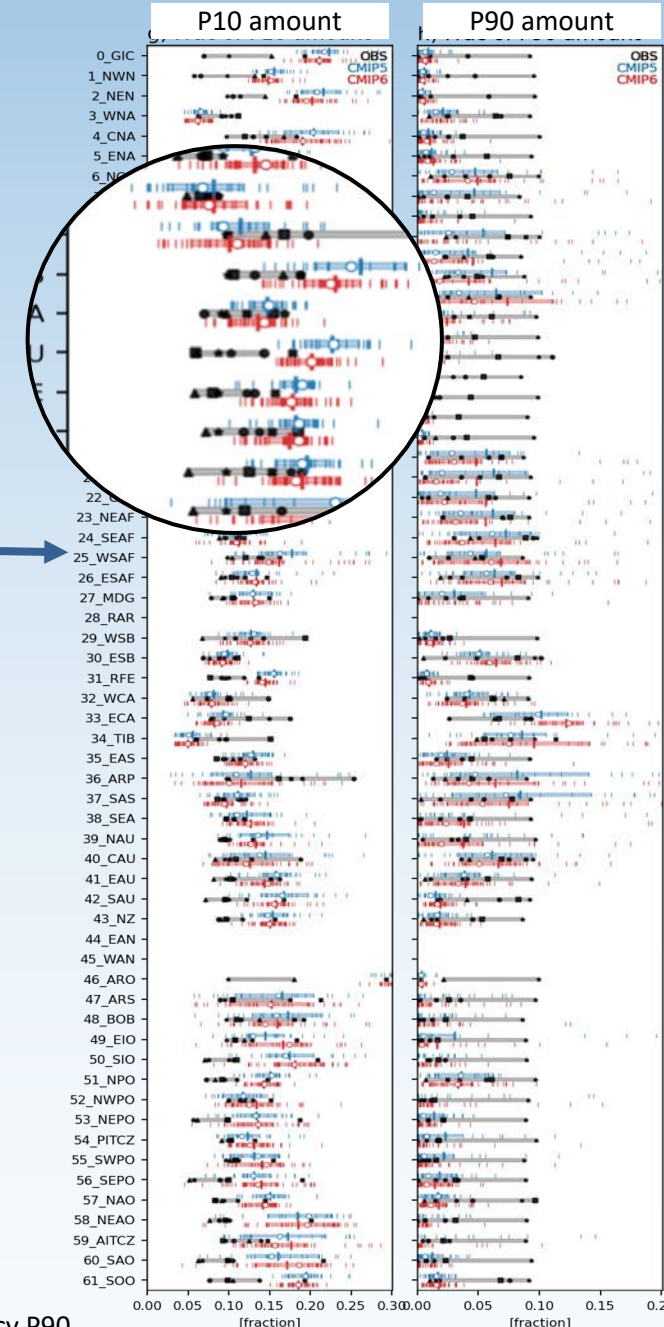
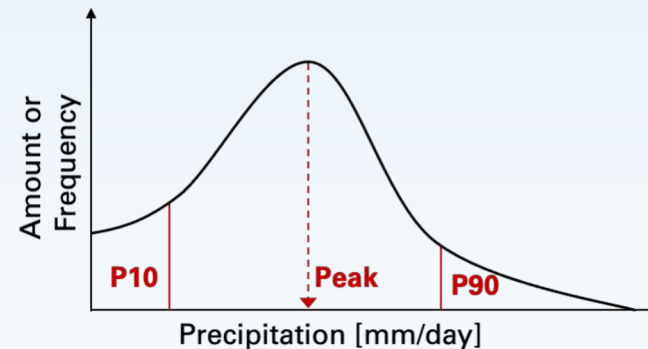


IPCC AR6 regions



Iturbide et al. (2020)

a) Amount or Frequency distribution



Applied metrics:

Amount peak, Amount P10, Amount P90, Frequency peak, Frequency P10, Frequency P90, Unevenness, FracPRdays, SDII, and Perkins score



- 
- obs4MIPs**  
Observations for Model Intercomparisons Project



# Example use of the archived precipitation benchmarking results



Version Controlled Archived Results available on GitHub  
[https://github.com/PCMDI/pcmdi\\_metrics\\_results\\_archive](https://github.com/PCMDI/pcmdi_metrics_results_archive)

Interested parties can apply the benchmarking software to their own simulations, and/or exploit the archived results of other CMIP and AMIP simulations.

PCMDI is using the archived results to provide interactive summary graphics with access to the underlying diagnostics from which the metrics were calculated.

A screenshot of the GitHub repository page for 'PCMDI/pcmdi\_metrics\_results\_archive'. The page shows the repository name, a search bar, and navigation tabs for Code, Issues, Pull requests, Actions, Projects, Wiki, Security, Insights, and Settings. The 'Code' tab is selected, showing a list of files: 'metrics\_results', 'scripts', 'test\_case(mean\_climate)', 'LICENSE', and 'README.md'. The 'README.md' file is open, displaying the PCMDI Metrics Package Database logo and a description: 'This repository is for the archive of the metrics results from the PCMDI Metrics Package (PMP) for CMIPs'. The right sidebar shows repository statistics: 24 commits, 2 stars, 5 watching, and 1 fork. It also lists contributors: lee1043 and msahn.

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```



## A word cloud shaped like a globe, centered around the theme of climate modeling. The most prominent words are "models", "precipitation", "model", "set", "observations", and "climate". Other visible words include "uncertainty", "variability", "cycles", "metrics", "aspects", "groups", "including", "global", "essential", "available", "simulations", "important", "effort", "processes", "well", "identify", "factors", "interactions", "temperature", "and", "hydrological". The words are arranged in various sizes and orientations, creating a textured, spherical appearance.

<https://pcmdi.llnl.gov/research/metrics/precip/>



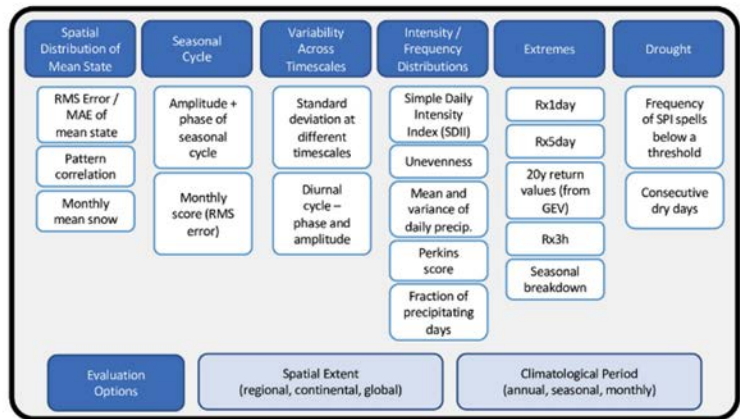


# PCMDI "Dive-down" example



## Benchmarking Simulated Precipitation

Welcome to the results site for benchmarking simulated precipitation in Earth System Models (ESMs)! This effort has been inspired by the outcomes of a July 2019 DOE workshop (Pendergrass, et al., 2019). That workshop was motivated by discussions that have taken place in recent years in various working groups of the WCRP including the Working Group on Numerical Experimentation (WGNE) and Working Group on Coupled Models (WGCM). This site was initially made public 2020/10/10 and will be regularly updated as our efforts advance, so check back here soon to see progress.



### Spatial Distribution of Mean State

- Taylor diagrams of spatial distribution (CMIP6-historical)

### Seasonal Cycle

- Line graph of domain averaged seasonal cycle with monthly mean (CMIP6-historical)
- Bar chart of RMS and RMSC for the seasonal cycle (CMIP6-historical)

### Variability Across Timescales (from Sub-daily to Interannual)

- Standard deviation at different timescales
  - Bar chart of domain averaged STD (CMIP6-historical)
  - Bar chart of domain averaged STD (CMIP5-historical)
  - Portrait chart of domain averaged STD (CMIP6-historical)
  - Portrait chart of domain averaged STD (CMIP5-historical)
- Spectral power at different timescales
  - Portrait chart of domain and frequency averaged spectral power (CMIP6-historical)
  - Portrait chart of domain and frequency averaged spectral power (CMIP5-historical)

[\[Go to CMIP5\]](#)

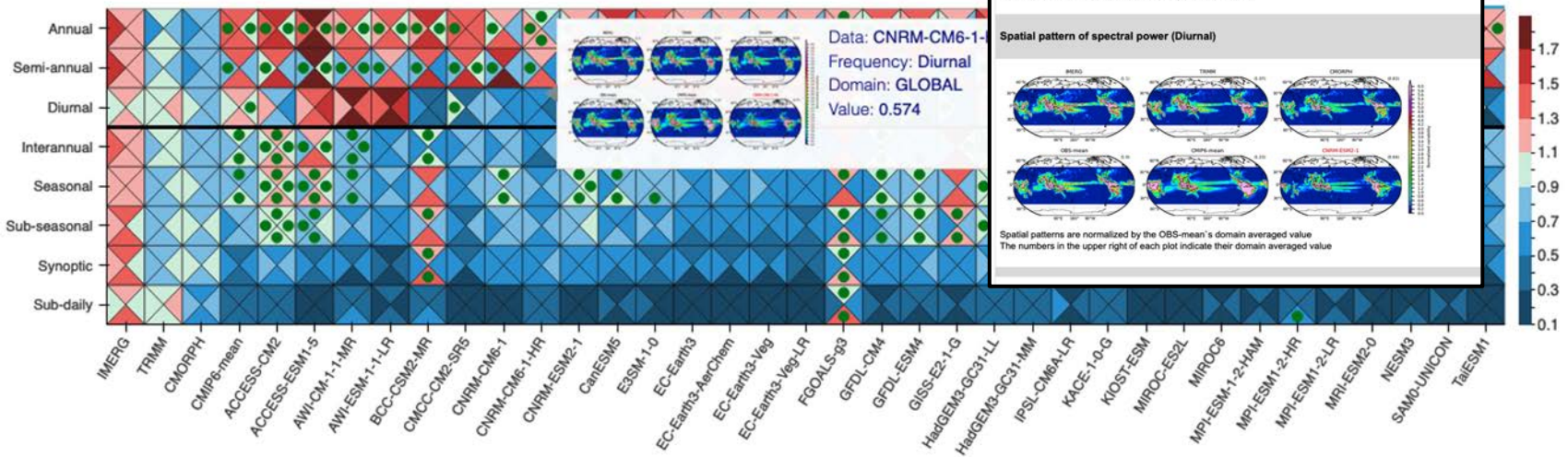
## Precipitation Variability across Timescales (CMIP6)

**Metric:** Model/Reference ratio of spectral power

**Domains in four-way triangles:** Global(50S-50N, Top), NHEX(30N-50N, Right), TROPICS(30S-30N, Bottom), SHEX(50S-30S, Left)

**Green dots indicate that models's metric value is in between observational range**

Reference data: OBS-mean    Reference data: IMERG    Reference data: TRMM    Reference data: CMORPH



<https://pcmdi.llnl.gov/research/metrics/precip/>



# Current status and potential uses



- A complete version expected early in 2023, but interested parties can use now via the PCMDI Metrics Package (PMP, [https://github.com/PCMDI/pcmdi\\_metrics](https://github.com/PCMDI/pcmdi_metrics)) or CMEC (<https://cmec.llnl.gov/>) driver.
- Can assist modelers in gauging improvements in simulated precipitation
- Results for AMIP and CMIP (historical) simulations will continue to be made available with performance changes documented across model versions
- Will be used to reproducibly document model improvements over time
- With a framework for v1.0, contributions and collaborations are welcome for the future!



- ## Some CMEC Compatible Packages

ILAMB / IOMB

## Coastal Storms Metrics

## Water Mass Balance (xWMT)

## Model Diagnostic Task Force (MDTF)

## Process-Oriented Diagnostics