An update on the PCMDI Metrics Package (PMP)

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PCMDI

Further enhancing the scientific value of CMIP

The primary deliverable of CMIP research continues to be via publications, however, there are at least three reasons to routinely produce and document well-established model evaluation results:

- Advance the science more efficiently (less re-inventing the wheel)
- Facilitate national assessments, the IPCC process, etc.
- More directly contribute to model development (via quick feedback)

Community-based building blocks are a viable mechanism to accomplish this, thanks to the design target provided by the CMIP data conventions.

Examples: ESMValTool, CVDP, the PCMDI Metrics and ILAMB Packages

An incomplete list of topics related to “model evaluation metrics”

- Succinct performance summaries, monitoring performance changes
- Process-oriented comparisons
- Use in model tuning
- Exploring the dependence between different models
- Comparing error characteristics of MME and PPE
- Weighting model projections
- “Emergent constraints”

The PCMDI Metrics Package (PMP)

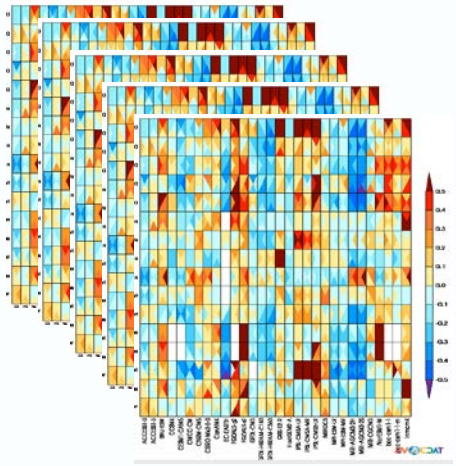
https://github.com/PCMDI/pcmdi_metrics

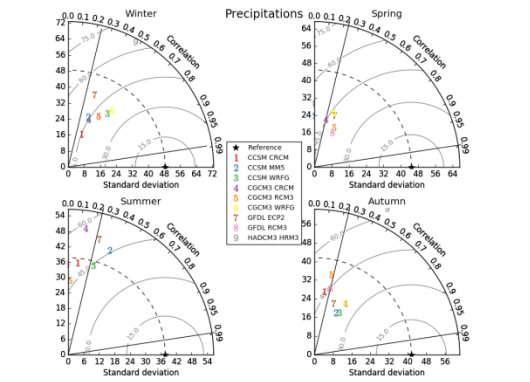
- Emphasizes a diverse suite of summary statistics objectively comparing models and observations across space and time scales, providing a database for knowledge discovery by researchers and model developers
- Traceability at all stages to ensure reproducibility
- Open source tools and databases built on the basic building blocks of UV-CDAT
- Includes numerous workhorse utilities designed specifically for CMIP conventions
- All python code is now publicly available on github
- Designed to enable the research community to contribute new analysis
- Currently testing with 5 modeling groups.

The PCMDI Metrics Package (v1.1x)

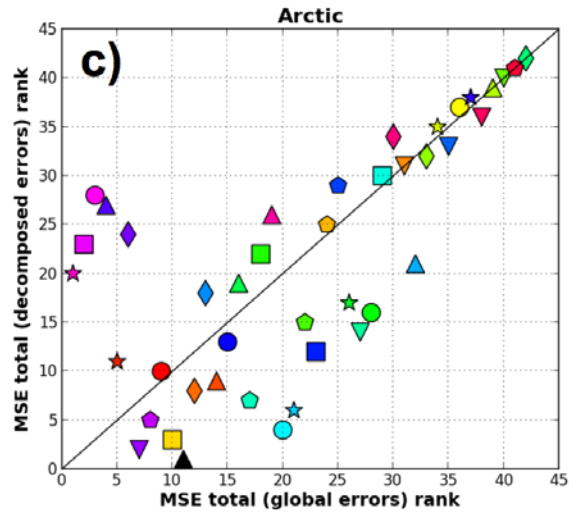
Climatological statistics for all AMIP, Historical and control runs

Taylor and Portrait Plots: orthogonal error statistics in space and time



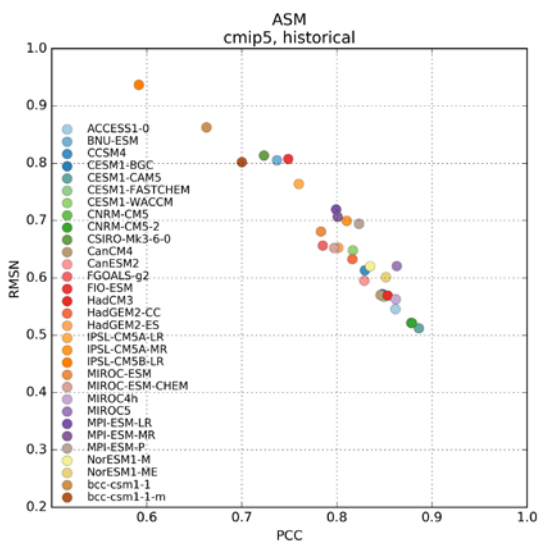


Sector scale sea ice



Ivanova et al., 2016

Monsoon Region Precipitation Indices

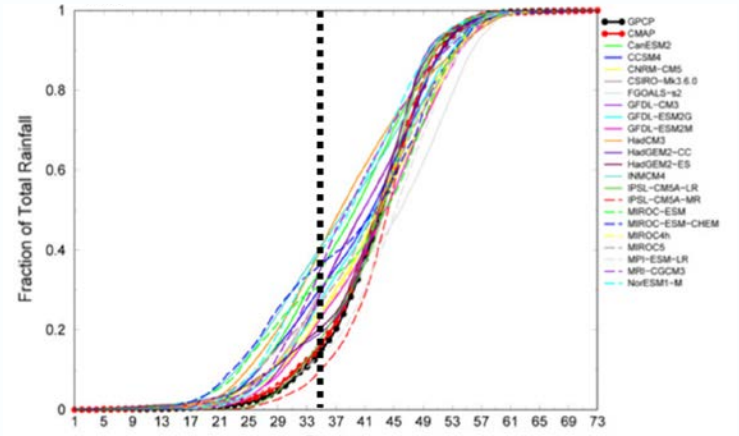


Wang et al., 2014

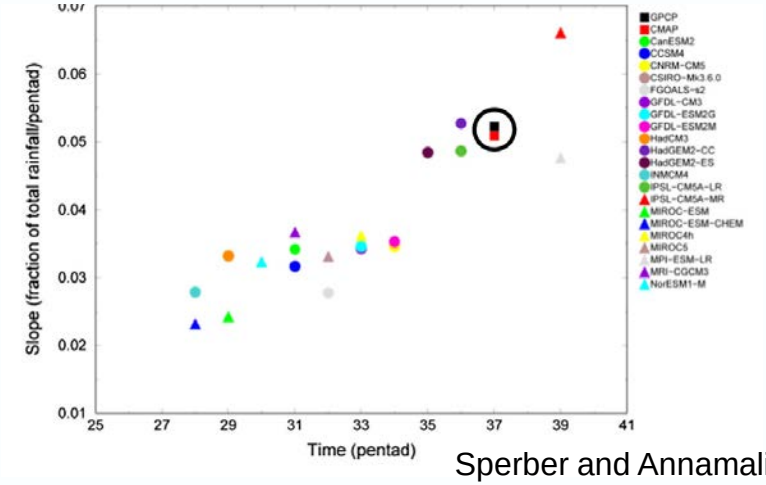
The PCMDI Metrics Package (v1.1x)

Composites and variability

Sahel fractional annual precip accumulation

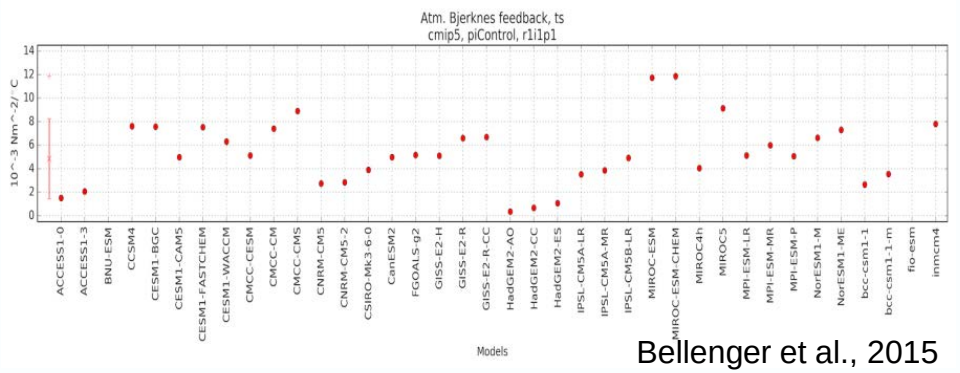


Sahel monsoon avg precip rate vs onset



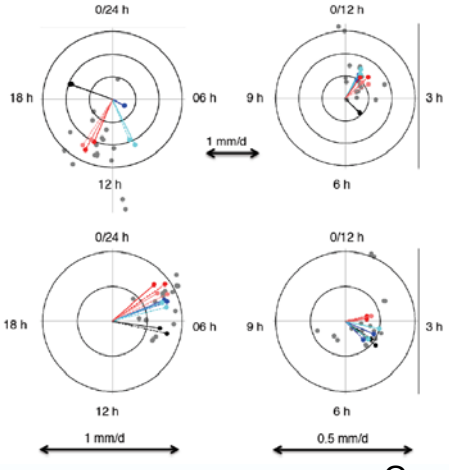
Sperber and Annamali, 2014

ENSO “process-oriented” metrics



Bellenger et al., 2015

Diurnal cycle of precipitation



Covey et al., 2016

The PMP primary deliverable

- A database of summary statistics objectively comparing models and observations across space & time scales
- Results organized using JavaScript Object Notation (JSON), a lightweight data-interchange format, readily accessible by python and many other languages
- Plots are generated via Matplotlib and VCS but users of the database can display results with other tools.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UV-CDAT capabilities essential to the PMP

https://github.com/UV-CDAT/uvcdat

- A long-standing challenge for UV-CDAT has recently been resolved: it is now made available via Anaconda. This is a game changer.

- Key building blocks:
  - CDMS (Climate Data Management System) with cdscan
  - MV on numpy (provides masking capabilities)
  - cdutil (a diverse suite of useful climate data extractions)
  - genutil (statistics, specialized analysis tools, etc)

- Many other valuable open source analysis tools included in the UV-CDAT build (R, scipy, ESMF built into CDMS, ….)

UV-CDAT is supported by DOE, NASA and NOAA

Observations in the PMP - Alignment with CMIP

- obs4MIPs is helping to more closely align a diverse community of data experts with the modeling community
- Key to this is ensuring consistency between the data conventions of model output and observational data
- CMOR is used by most CMIP modeling groups to ensure conventions are properly applied. CMOR3, to be used for CMIP6, has been generalized to work with gridded observations
- PMP is using CMOR3 to organize observations to ensure they can be readily compared to models and analogously organized

CMOR = Climate Model Output Rewriter

Towards more systematic and efficient model evaluation

- Collectively, the PMP, ESMValTool, ILAMB and other packages offer the possibility to more systematically evaluate models
- More quickly and openly relay to modelling centers and analysts a diverse suite of simulations characteristics, including the extent to which long-standing model errors remain evident in newer models
- The PMP will be applied to all DECK and relevant CMIP6 simulations as soon as they are published on ESGF, with results made accessible…

Ultimately enable modeling groups to leverage analysis community expertise to more systematically evaluate simulations during model development

Summary and next steps

The PMP is a python based approach developed to rapidly provide objective comparisons between observations and new models in the context of all earlier generations of CMIP and AMIP

- Open source, with codes and database available to ensure reproducibility
- Currently being exercised on yellowstone and applied to development runs
- It will be propagated to all interested CMIP modeling groups
- We are seeking additional collaborations to help bring an increasingly diverse suite of summaries to modelers and researchers

Gleckler, P. J., C. Doutriaux, P. J. Durack, K. E. Taylor, Y. Zhang, and D. N. Williams, E. Mason, and J. Servonnat (2016), A more powerful reality test for climate models, *Eos, 97,* doi 10.1029/2016EO051663