WGNE links with the Working Group on Coupled Modeling (WGCM)

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Talk outline

- Brief history of AMIP/CMIP, CMIP5 and the IPCC AR5
- WGCM planning for CMIP6
- High resolution experimentation in CMIP6 – WGNE involvement?
- Climate model metrics and the WGNE/WGCM metrics panel
- Discussion: High resolution and metrics

AMIP began with WGNE

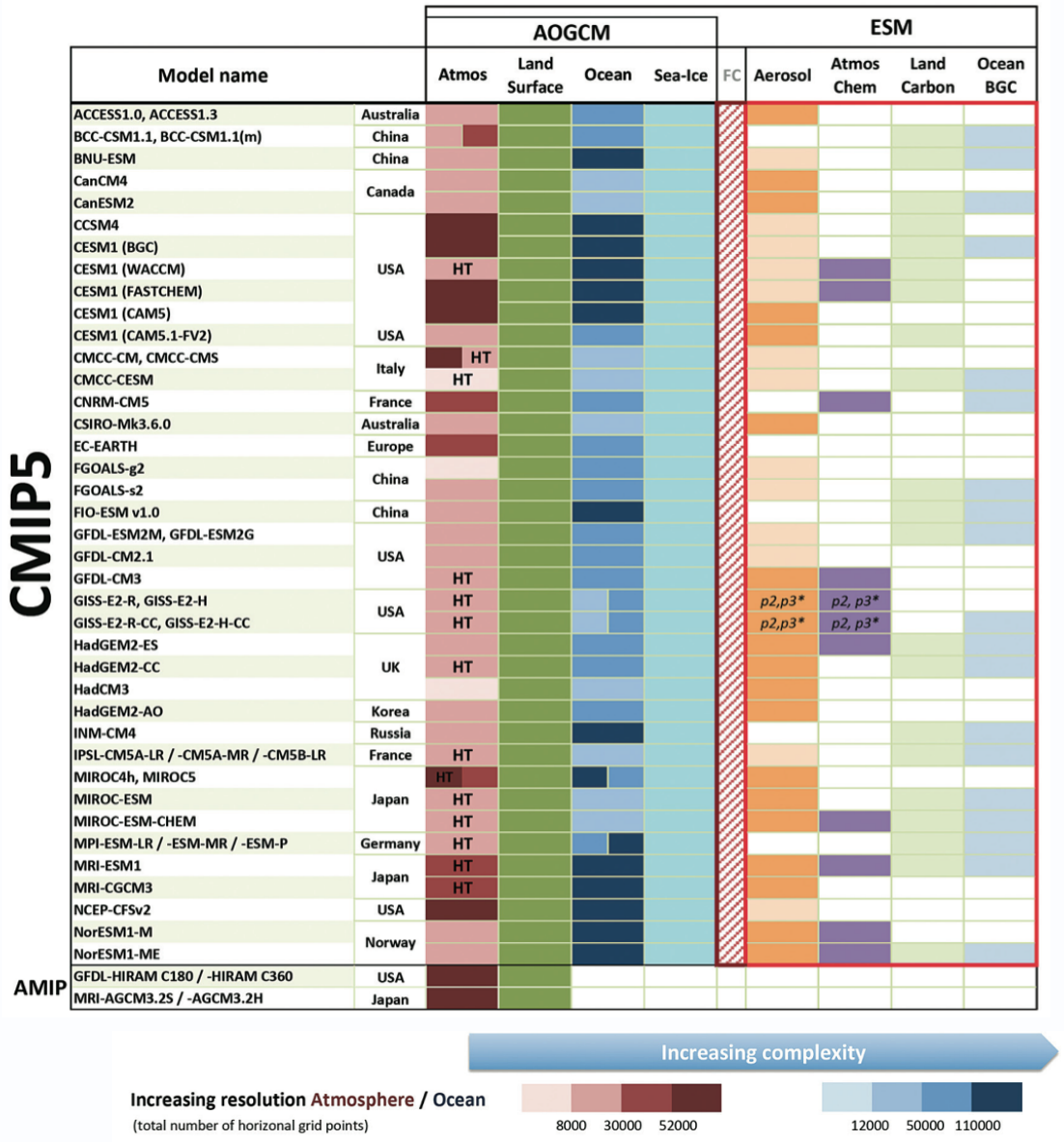
~1990: The Atmospheric Model Intercomparison Project (AMIP) was initiated by PCMDI with WGNE oversight

- 30 AGCMs performed a common experiment (prescribed SST & sea-ice 1979-1988)
- "Standard model output" and "diagnostic subprojects"

1995 - 2000 AMIP2 – tighter experimental protocol, more extensive diagnostics

2000 – 2003	CMIP2	gigabytes
2003 – 2009	CMIP3#	terabytes
2009 – Present	CMIP5	petabytes

AMIP subsumed to be a part of CMIP (with links between WGNE and WGCM)



Models Contributed to CMIP5

Depending on how you count them, ~ 50 models

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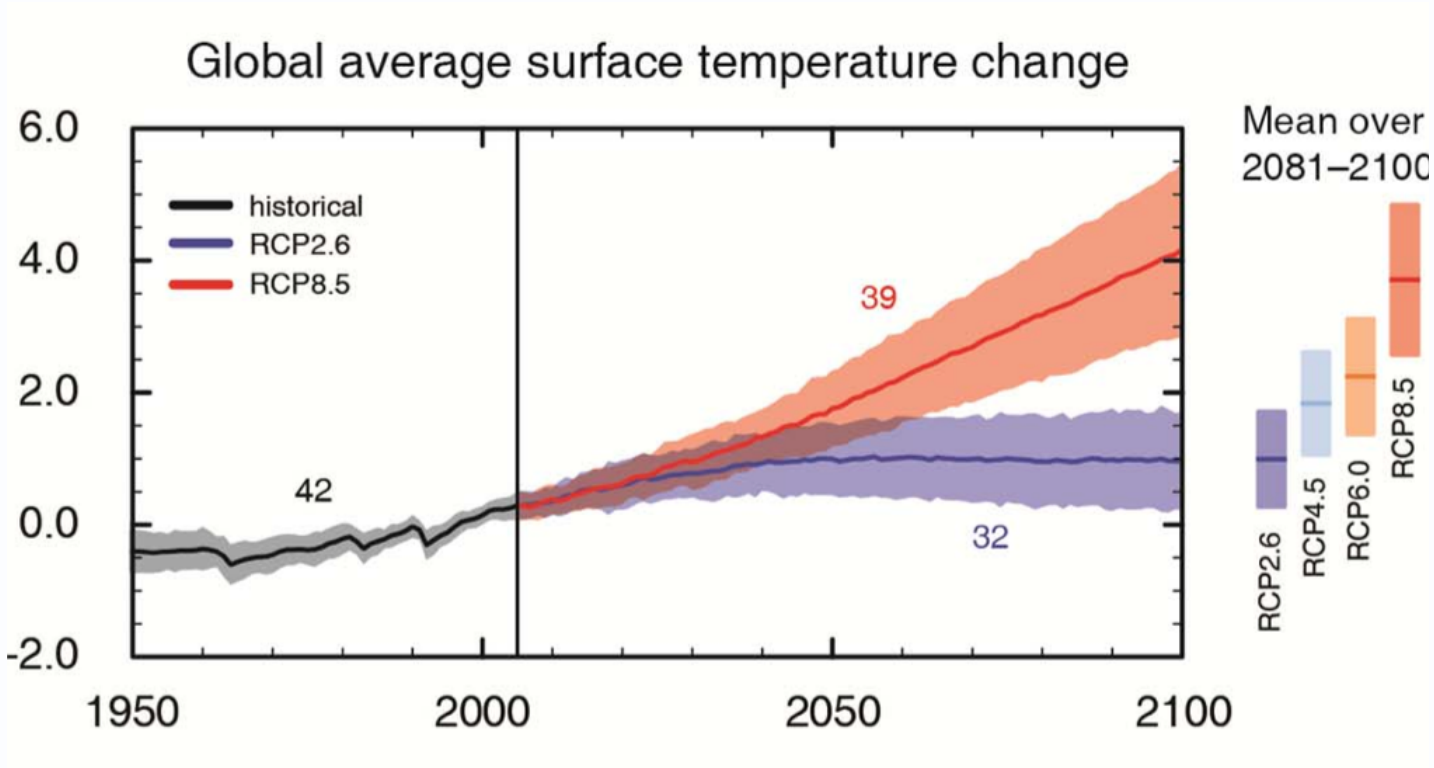
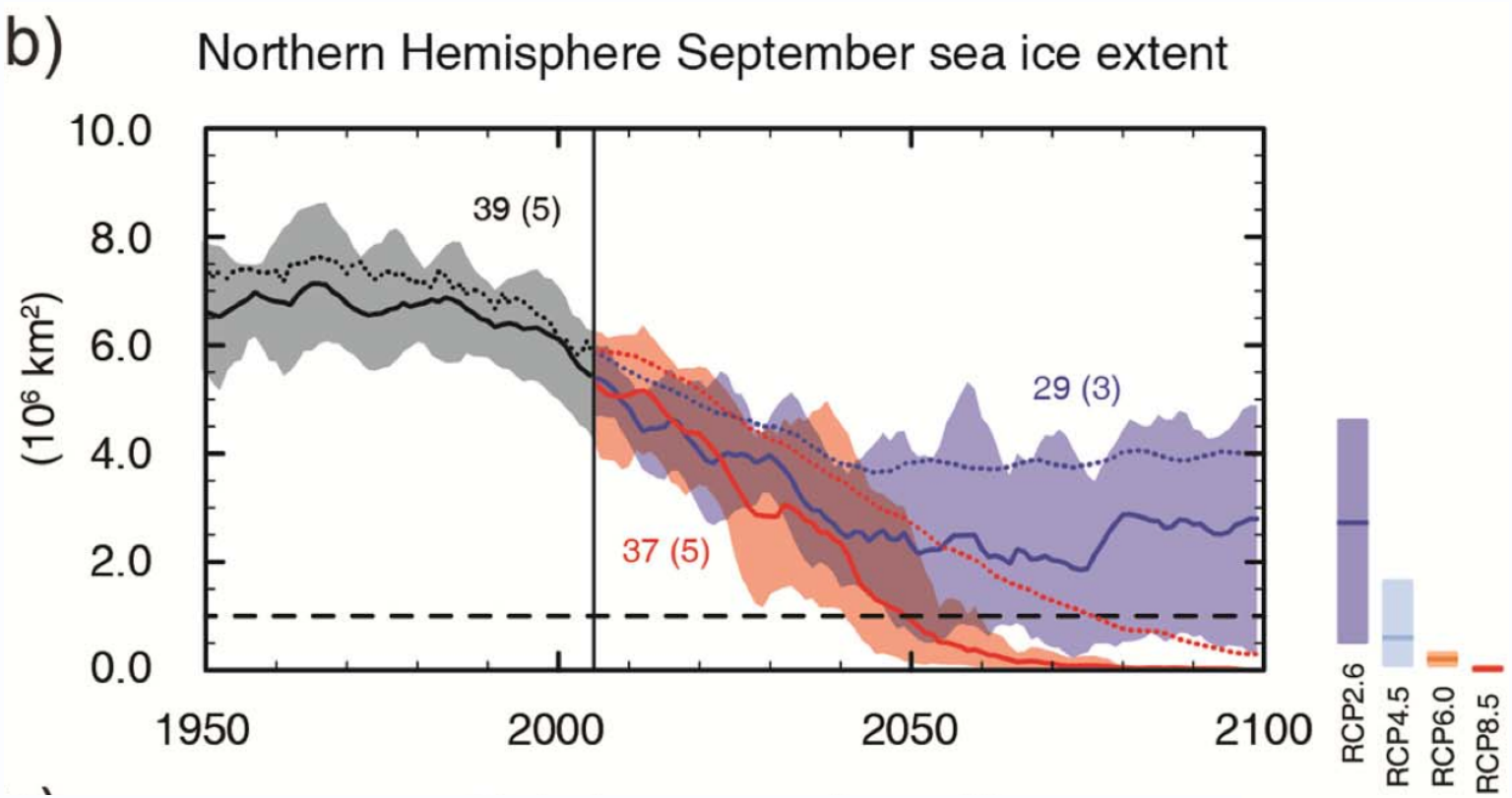
Multi-Model Projections from CMIP5 for different forcing scenarios



All models treated equally

Multi-Model Projections from CMIP5 for different forcing scenarios



A subset of 5 models averaged together, selected by how well they simulate the present day annual cycle and observed trends (sea ice loss)

High Resolution in CMIP5

Some groups performed “high resolution” AMIP simulations, notably:
GFDL-HIRAM **~25km** and MRI-AGCM3.25 **~20-km**

A variety of studies compare these simulations to their coarser resolution counterparts (e.g., TC, blocking).

High resolution “time slices” also performed

CMIP6 planning underway

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Climate Model Intercomparisons: Preparing for the Next Phase

PAGES 77–78

Since 1995, the Coupled Model Intercomparison Project (CMIP) has coordinated climate model experiments involving multiple international modeling teams. Through CMIP, climate modelers and scientists from around the world have analyzed and compared state-of-the-art climate model simulations to gain insights into the processes, mechanisms, and consequences of climate variability and climate change. This has led to a better understanding of past, present, and future climate, and CMIP model experiments have routinely been the basis for future climate change assessments made by the Intergovernmental Panel on Climate Change (IPCC) [e.g., IPCC, 2013, and references therein].

CMIP has developed in phases, with the simulations of the fifth phase, CMIP5, now mostly completed. Though analyses of the CMIP5 data will continue for at least several more years, science gaps and outstanding science questions have prompted preparations for the sixth phase of the project (CMIP6). This brief overview of the initial proposed design of CMIP6 is meant to inform interested research communities and to encourage discussion and feedback for consideration in the evolving experiment design (see Figure 1). A more complete description and further information are available at http://www.wcrp-climate.org/index.php/wgcm-cmip/wgcm-cmip6 and in the additional supporting information in the online version of this article.

Scientific Focus and Structure

The proposed scientific backdrop for CMIP6 consists of the six grand challenges of the World Climate Research Programme (WCRP)—encapsulating questions related to clouds, circulation, and climate sensitivity; changes in cryosphere; climate extremes; regional climate information; regional sea level rise; and water availability—with an additional theme involving biospheric forcings and feedbacks. The specific experiment design would focus on three broad questions: How does the Earth system respond to forcing? What are the origins and consequences of systematic model biases? How can we assess future climate changes given climate variability, climate predictability, and uncertainties in scenarios?

Within this scientific framework, a more distributed organization for CMIP6 than in previous phases of CMIP is proposed. This would fall under the oversight of the CMIP Panel (see Figure 1), wherein an ongoing activity, CMIP, is distinguished from a particular phase of CMIP, now CMIP6. This structure involves two basic components.

First, CMIP (inner part of Figure 1) would be composed of two elements: in one, researchers would run a small set of standardized

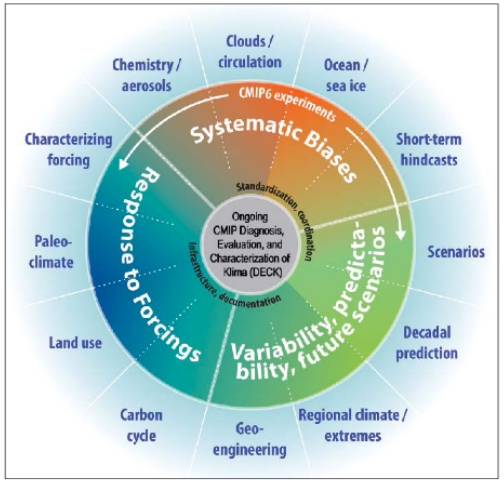

Fig. 1. Schematic of the proposed experiment design for phase 6 of the Coupled Model Intercomparison Project (CMIP6). The inner ring and surrounding black text involve standardized functions of all CMIP, including ongoing [redacted] (DECK) experiments (klima is German for "climate"). The middle ring shows science topics related specifically to CMIP6 to be addressed by the MIPs, with illustrative (and likely not complete) MIP topics shown in the outer ring. This framework is superimposed on the scientific backdrop for CMIP6—the six grand challenges of the World Climate Research Programme

A new paradigm in CMIP6:

Ongoing CMIP Diagnosis, Evaluation and Characterization of Klima (DECK experiments)

Related MIPs, closely coordinated with CMIP6 (e.g., CFMIP, PMIP, ...)

As was done with CMIP5, all related MIPs to use the CMIP infrastructure (e.g., metadata/data conventions)

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A HighresMIP for CMIP6?

Early stages of planning, but there seems to be a greater interest in an organized high resolution experiment for CMIP6

A focus likely to continue on AMIP simulations, and future time slices

Given WGNE experience with the grey zone and other efforts, it is hoped there could be some WGNE involvement this time

At a minimum, WGNE could provide feedback on the experimental design

Ideally, some NWP centers would contribute simulations

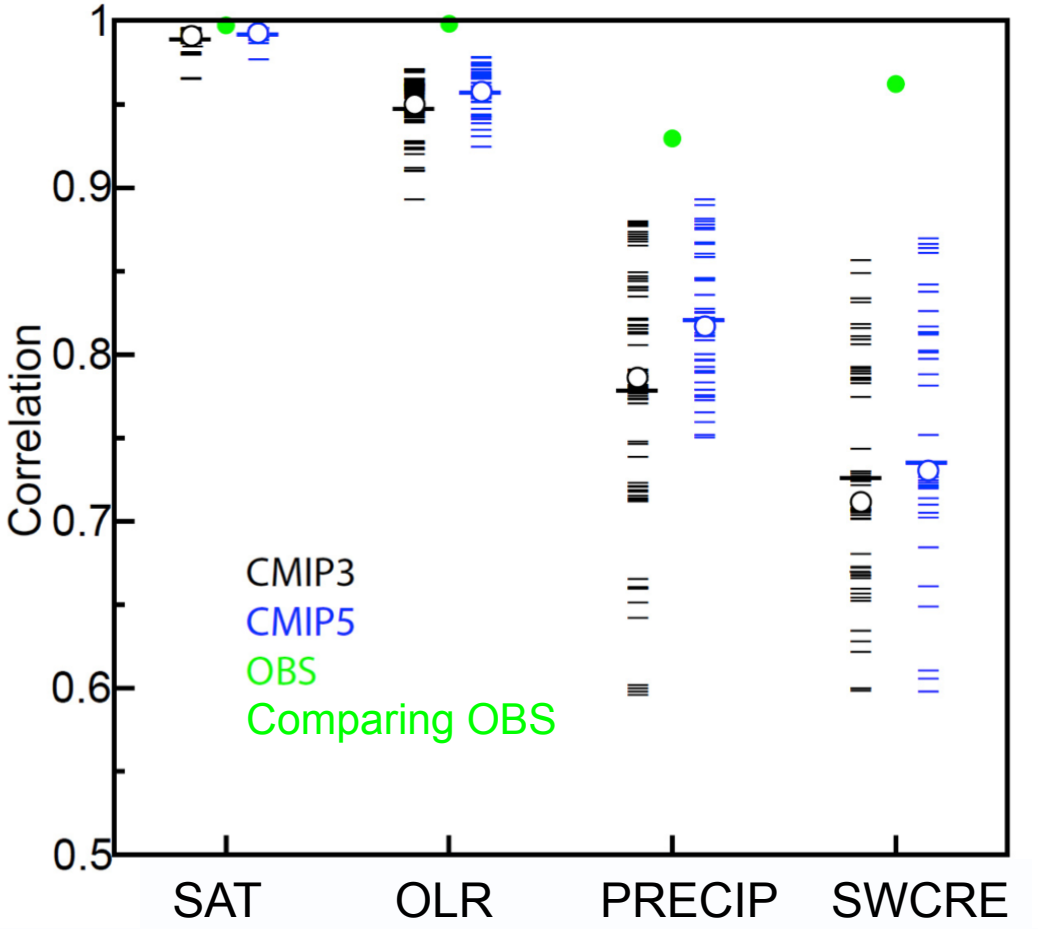
Climate Model Performance Metrics

Model metrics: some examples

Model Metrics: Objective measures of model skill, usually based on model agreement with observations as a scalar value

- Global measures of the mean state
- Response to external forcings (e.g., diurnal and annual cycles, volcanic eruptions, response increasing GHGs)
- Intrinsic variability (e.g., shorter and longer term modes of variability (ENSO, NAO, MJO, etc).
- Process-oriented measures and co-variability relationships
- Conservation constraints
- Regional model performance
- Relationships between present day observations and projection responses (climate sensitivity)

Performance metrics in IPCC AR5

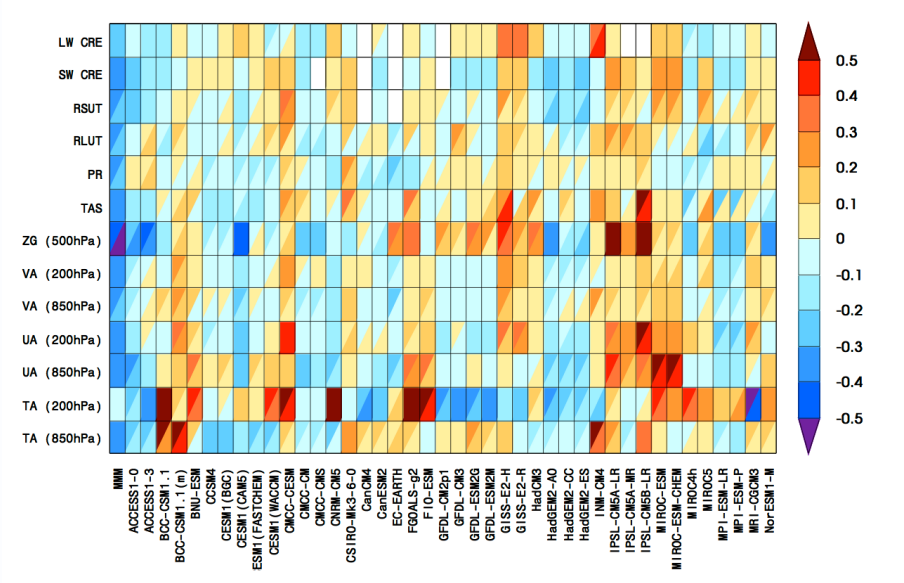


Many examples of incremental improvements since CMIP3

Improvement not uniform, but little/no evidence of performance deterioration

IPCC AR5 FAQ 9.6

Assessing model strengths and weaknesses



AR5 WGI Figure 9.7

Annual cycle performance portraits

Some models clearly simulating mean state better than others

but

Which metrics to choose?

Many errors are correlated

Collapse to a single skill score?

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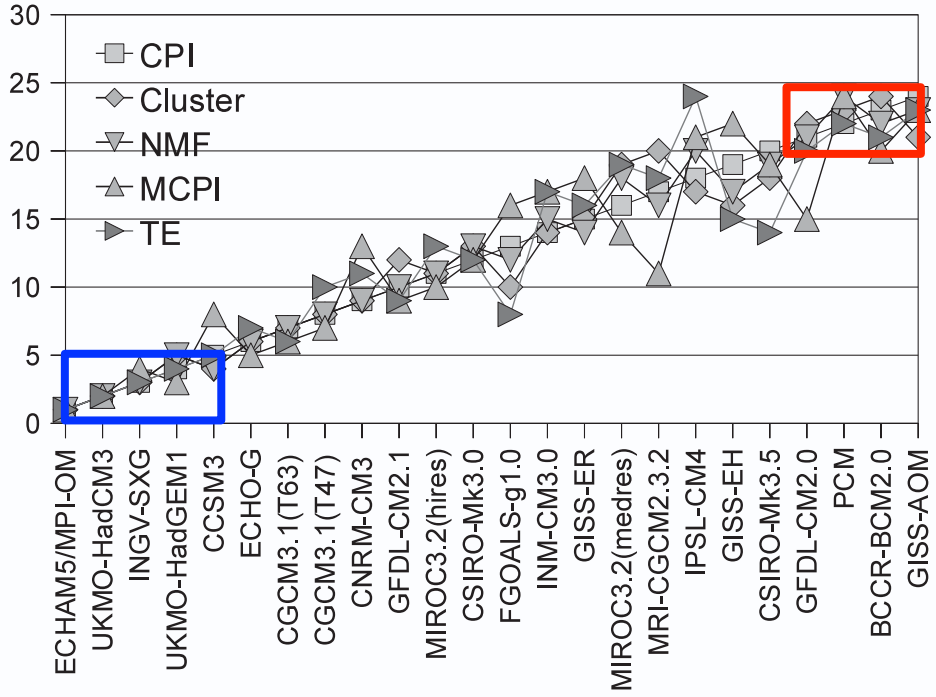
Robust evaluation of the mean climate?

Ranking CMIP3 performance
Using multiple multivariate methods



Nishii et al., 2012, *JAMS*

Significant 1-to-N ranking differences

Some consistency across methods (e.g., top 5 / bottom 5)

At some level robust evaluation of the mean climate appears possible

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The WGNE/WGCM Climate Model Metrics Panel

http://www-metrics-panel.llnl.gov/wiki

Members selected by relevant and diverse experience, and potential to liaison with key WCRP activities:

Beth Ebert (BMRC) – JWGV/WWRP, WMO forecast metrics

Veronika Eyring (DLR Germany) – WGCM/SPARC/CMIP6, stratosphere

Pierre Friedlingstein (U. Exeter) – IGBP, carbon cycle

Peter Gleckler (PCMDI), chair – WGNE, atmosphere

Simon Marsland (CSIRO) – WGOMD, ocean

Robert Pincus (NOAA) – GEWEX/GCSS, clouds/radiation

Karl Taylor (PCMDI) – WGCM, CMIP5

Helene Hewitt (U.K. Met Office) – ocean and sea-ice

Brief review of the metrics panel effort

The metrics panel is not doing science

Quantifying model agreement with observations, with a broad perspective, not necessarily identifying the causes of model errors

Assessing different aspects of model skill, but not combining them into an overall measure of model performance

Providing a useful complement to in-depth diagnosis, not a last word on model performance

Focusing on performance metrics (comparison with observations), not projection reliability metrics

From standardized experiments (DECK) to routine performance benchmarking

In a few cases, we have well-established and fairly robust measures of model performance (notably the climatological mean state)

The metrics panel is attempting to establish a diverse set of routine benchmarks, and to facilitate further research of increasingly targeted metrics (e.g., ENSO, monsoon, MJO)

PCMDI metrics package
(In support of the metrics panel)

- Includes software, observational data, and a database of results from all CMIP models
- For a variety of observables, computes routine seasonal metrics (RMS, bias, correlation, MSE)
- Currently in alpha testing at 3 CMIP modeling groups, with a target of reaching all groups this year.
- Built on python. Some installation required, but modeling groups can incorporate into their own analysis stream
- May be of interest to some NWP centers?

Discussion

- High resolution AMIP historical and time slice experiments

- Climate model metrics – performance benchmarking in CMIP6