WCRP Working Group on Coupled Models (WGCM)

Co-chairs: Gerald Meehl and Sandrine Bony

WGCM promotes balance between
simulation – evaluation – understanding

WGCM Missions

- **Review and foster the development of coupled climate models (AOGCMs) and Earth System Models (ESMs, usually defined as an AOGCM with at least a coupled carbon cycle, can also have dynamic vegetation, chemistry, aerosols, etc.)**

  Connect to IGBP AIMES (carbon cycle, ESM development), WGNE (processes and atmospheric model improvement), WGSIP (decadal climate prediction)

- **Coordinate model experiments and inter-comparisons:**
  - better understand natural climate variability
  - predict the climate response to natural & anthropogenic perturbations
  - assess the climate predictability at the decadal timescale

  CMIP (with many MIPs/partners), CMIP Panel in WGCM,
  PMIP (with IGBP/PAGES),
  CFMIP
  Decadal Climate Prediction Panel (WGSIP/WGCM)
  Transpose-AMIP (WGNE/WGCM),
  CORDEX (JSC/WGCM)

- **Promote and facilitate model validation and diagnosis of shortcomings, and understanding processes and feedbacks in the climate system**

→ joint WCRP-WWRP-THORPEX “survey on model evaluation and improvement”
→ Metrics panel (WGNE/WGCM)
→ facilitating connections between global modelling / observations / processes
Obs4MIPs, CFMIP/GCSS station outputs, CFMIP observations simulator (COSP)

The most recent WGCM meeting: Hamburg, Sept. 2012

One day joint with Working Group on Seasonal to Interannual Prediction (WGSIP)

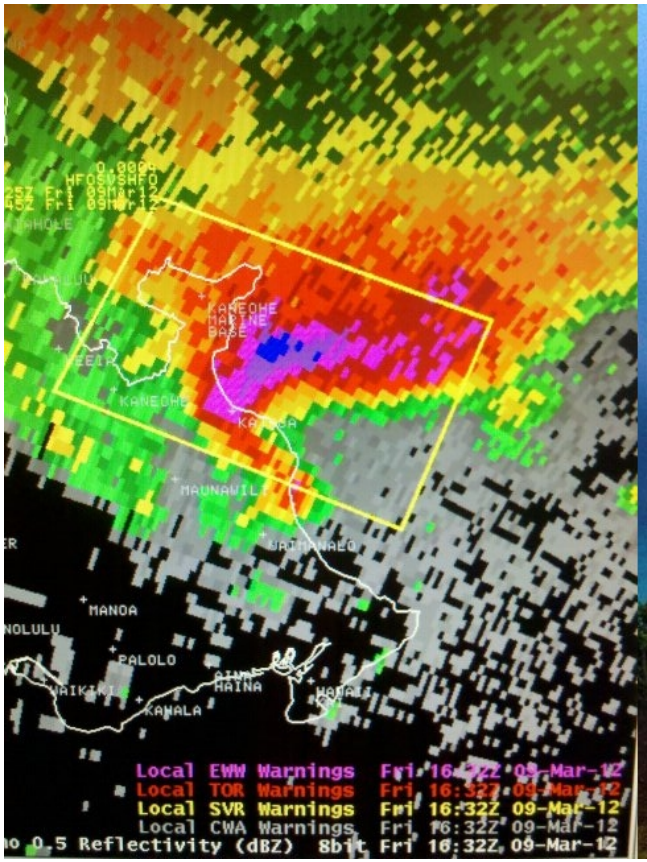
CMIP5 Model Analysis Workshop

March 5-9, 2012
Hosted by the International Pacific Research Center (IPRC) at the University of Hawaii, Honolul

Organized by WGCM
Format of workshop: Short-presentation/poster (following the format of the CMIP3 Model Analysis Workshop in March, 2005)
About 160 participants (out of about 240 abstracts submitted)

To foster CMIP5 model analyses, WGCM proposes to have regular model analyses workshops, next one likely in 2015

Program Committee (Gerald Meehl, Sandrine Bony, Ron Stouffer, John Mitchell, Karl Taylor, Curt Covey, Mojib Latif)



The week of the workshop saw an EF1 tornado and damage, massive hail (at sea level in the tropics), lightning…in Hawaii

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In spite of some delays in model availability and challenges in downloading model data, CMIP5 ended up being farther along than similar stages in CMIP3

CMIP5 includes 53 AOGCMs, 10 performed decadal and long term experiments, 8 performed decadal only, 45 performed long term only, 26 modeling groups, 20 countries
--18 decadal climate prediction simulation sets
--13 high-top models (with top layer pressure < 0.01 hPa)
--19 Earth System Models (included carbon cycle and performed emission-driven experiments)
--High resolution time slice experiments: 4 models (resolutions between 20 and 60 km)
--700 registered users so far
(CMIP3 had 23 AOGCMs, 16 modeling groups, 11 countries)

CMIP5 approaching 2 petabytes (compared to 31 terabytes in CMIP3)
Over 300 peer-reviewed paper published so far

The concern that the spread of future projections from the new generation of AOGCMs with more complexity, or from ESMs with coupled carbon cycle, would be wildly greater than from the AOGCMs of CMIP3 was unfounded—spread of projections in CMIP5 AOGCMs comparable to CMIP3, and most first generation ESMs well-behaved and produce comparable first order results to AOGCMs, but with all their additional capabilities

Patterns of future change of temperature and precipitation, equilibrium climate sensitivity, and spread among CMIP5 models similar to previous generations of models and we better understand the spread due to CMIP5 addressing feedbacks and processes; this increases confidence in these results

Characteristics of model simulations in CMIP5 either similar to CMIP3 or improved; little appears to have degraded

Some quantities showed considerable improvement (e.g. rate of sea ice loss in Arctic, reduction in cloud brightness, representation of MJO) or decreased model spread (e.g. AMOC, seasonal cycle of precipitation in Caribbean, Greenland ice sheet mass balance from temperature and precipitation, Nino3 standard deviation)

Some things have not significantly improved (e.g. double ITCZ, Arctic clouds and atmospheric circulation, Antarctic sea ice loss, southern ocean too warm, SPCZ too zonal, tropical Atlantic SST gradient weak)

CMIP5 provides many more capabilities and new types of climate change information

-- carbon cycle feedback, quantifying sources and sinks of carbon for land vs ocean, allowable emissions for different levels of mitigation in the RCP scenarios, ocean acidification, physiological effects of vegetation changes
-- high resolution time slices to study tropical cyclones
-- decadal climate prediction for short term climate change and possible climate shifts (understanding the early-2000s hiatus)
--paleoclimate simulations that allow analysis of climate response across past, present and future climates, and that provide "out of sample" insights to build model credibility and provide possible constraints on nature and magnitude of future climate change
--analysis of cloud feedbacks
--revisiting of forcing and feedback better helps to interpret the spread of model projections
--attempts to relate 20th century model biases to projections

New types of CMIP5 multi-model results:
--AMO more predictable than PDO
--critical thresholds for Arctic sea ice loss
--regional climate regimes like Indian Ocean Dipole and connections to east African rainfall
--South Pacific Convergence Zone studies
--ocean wave heights
--changes in monsoon onset characteristics
--role of salinity and patterns of changes connected to hydrological cycle and ocean response
-- effects of aerosols on Atlantic SSTs/hurricanes
-- tracking regional ocean heat content changes and relation to regional patterns of sea level rise
--better quantification of factors affecting cloud feedback
-- mechanisms for regional precipitation and temperature changes and extremes—Caribbean drying, SE US wetter, connecting Arctic sea ice loss to European cold extremes, atmospheric rivers and extreme precipitation, importance of circulation changes, blocking; what will not change in a future climate is also useful information

Grand Challenge GC4 overseen by WGCM:
"Clouds, Circulation and Climate Sensitivity"

Proposed targeted research around 5 initiatives:

1. Climate and hydrological sensitivity
2. Leveraging the past record
3. Coupling clouds to circulations
4. Changing patterns
5. Towards more reliable models

GC4 Specific foci:

Climate and hydrological sensitivity, the coupling between heating and circulation, and the impact of anthropogenic forcings on large-scale climate patterns

Aerosols: not a first-order problem for climate sensitivity and long-term precipitation projections, but GC addresses how aerosol radiative forcings impact the large-scale atmospheric circulation, temperature and precipitation patterns

"Easy aerosols“ (Aiko Voigt, Bjorn Stevens, Sandrine Bony): set of idealized experiments where 3-D distributions of scattering and absorbing aerosol radiative properties prescribed;
study the modeled atmospheric response (large-scale circulation, precipitation) to aerosols

Missing piece: aerosol emissions to aerosol radiative properties

Tropospheric aerosols:
In IGBP: IGAC (International Global Atmospheric Chemistry) and ACCMIP

Atmospheric Chemistry & Climate Model Intercomparison Project (ACCMIP)
Co-Chairs:
Drew Shindell, NASA GISS, and Jean-Francois Lamarque, NCAR

ACCMIP: extensive coordinated model simulations, diagnostics, and evaluations of the effect of short-lived species on climate, in coordination with CMIP5.
Main focus: role of tropospheric ozone and aerosols http://www.giss.nasa.gov/projects/accmip/

ACCMIP is mostly being absorbed by
CCMI (Chemistry-Climate Model Initiative) an IGAC/SPARC initiative,
led by Veronika Eyring and Jean-Francois Lamarque.
(points of contact on the steering committee for aerosols:
Andrew Gettelman, Drew Shindell and Gunnar Myhre)

Shindell and Myhre are strongly involved in **AEROCOM (Aerosol Comparisons between Observations and Models, a European project)** to make a connection with that group. (AEROCOM: advancement of the understanding of the global aerosol and its impact on climate)

Need to address aerosol effects better in CMIP6 (connect to AEROCOM)

WGCM/WGSIP interface

Decadal climate prediction

Coordinating experimental design for CMIP5 (and CMIP6)

Decadal climate predication Panel (Joint between WGCM and WGSIP) designed to oversee decadal climate prediction experiments and issues that arise in CMIP5 (and CMIP6), and to more broadly deal with questions related to decadal climate prediction:

George Boer (WGSIP, chair)
Ron Stouffer (WGCM)
Mojib Latif
Ben Kirtman (WGSIP)
Gerald Meehl (WGCM)
Doug Smith
Scott Power
Karl Taylor (WGCM)

Planning for CMIP6:

Assume CMIP6 would be comparable to CMIP5--involving several communities, with a core set of experiments with calibration idealized experiments (e.g. 1% runs, 4XCO2, etc.), historical and future prediction/projection runs, and several layers of other experiments (but other coordination schemes may be incorporated)

rely on ESGF for data archival/access

(comments made related to de-coupling CMIP from the IPCC assessment cycle, but recognizing the reality of having models that would be state-of-the-art for IPCC assessment, not ruling out other MIPs that would occur out of cycle due to facilitation of ESGF)

Experiment specification, requires sufficient detail far enough in advance for effective configuration, and finalize prioritized fields early

CMIP6 should have continuity with CMIP5

Try to retain continuity with scenarios, though IAM community and our community may need to adjust or add sensitivity experiments (e.g. aerosols, land use change, 2C warming bigger peak and decline in RCP2.6)

Details of land-use change that are adapted by each group need to be addressed

Modeling groups would like CMIP6 to be smaller than CMIP5; But there are more research communities that want their experiments to be part of CMIP6 which would make it bigger…

TIMING

CMIP5:

exploratory Aspen Global Change Institute workshop: August 2006
Iterations on experimental design in research community: 2006-2008
WGCM approved experimental design: 2008 (duration of CMIP5 2008-2013)
Modeling groups receive scenario info from IAM groups: 2010 and start runs
CMIP5 model analysis workshop: March 2012
deadline for papers assessed in IPCC AR5: July 2012
WGI AR5 report published: late 2013
Ongoing analysis of CMIP5 data: 2013 until CMIP6 data available ~2017

CMIP6:

exploratory Aspen Global Change Institute workshop: August 2013
Iterations on experimental design in research community: 2013-2015
WGCM approve experimental design: 2015 (duration of CMIP6 2015-2020)
Modeling groups receive scenario info from IAM groups: 2017 and start runs
CMIP6 model analysis workshop: 2018
deadline for papers assessed in IPCC AR6: 2019
WGI AR6 report published: 2020
Ongoing analysis of CMIP6 data: 2020 onward

Scenario process leading to CMIP6:

WGCM-related planning: 2013

International Workshop on Seasonal to Decadal Prediction (May 13-16, 2013, Toulouse, France)

Sustainable Global Climate Mitigation Scenarios Workshop (May 29-31, National Center for Socio-Environmental Synthesis (SESYNC, Annapolis, MD)

Societal Dimensions Working Group Meeting, CESM Workshop (June 20, 8:30-12 noon, Breckenridge, CO)

Energy Modeling Forum, Climate Change Impacts and Integrated Assessment, (August 1-2, Snowmass CO) Organized jointly by the Integrated Assessment Modeling Consortium (IAMC) and WGCM

Next generation climate change experiments needed to advance knowledge and for assessment of CMIP6 (August 4-9, Aspen Global Change Institute, Aspen, CO) Organized jointly by WGCM, AIMES, IAMC, and other partners (WCRP co-sponsor)

Possible US National Academy of Sciences Board on Atmospheric Sciences and Climate (BASC)/Board on Environmental Change and Society (BECS) session on scenarios, fall 2013

WGCM meeting, Oct. 2013, Victoria, Canada
joint with Analysis, Integration and Modeling of the Earth System (AIMES)

More CMIP6 issues:

Land use –aerosols—ESM applications— SSPs show different outcomes from RCPs?

reversibility or geo-engineering

More idealized experiments, e.g. 1% runs but for other forcings, idealized aerosol, ozone, land use, like the 1% runs

Decadal prediction and extremes

systematic biases

Very high res time slice exps for tropical cyclones and other aspects of storms and circulation changes

Higher res coupled simulations for tropical cyclones, extremes, and circulation changes

Coupled land ice for global and regional sea level rise

Data management: Promote CMOR as standard protocol, output could be directly saved into CMOR format

“near-exabyte” scale of CMIP6—need to recognize and plan for how to handle that data volume

Evaluation: International approach to evaluation, metrics panel useful, expanded role, semi-regular model analysis workshops

Logistics: High frequency temporal data desirable for some experiments—perhaps have a different fields list for different experiments, prioritize fields, check what fields are being used from CMIP5

make data access easier -- secure funding for ESGF, data access and retrieval need for scriptable and need better download methods

metafor needs work in concept and application