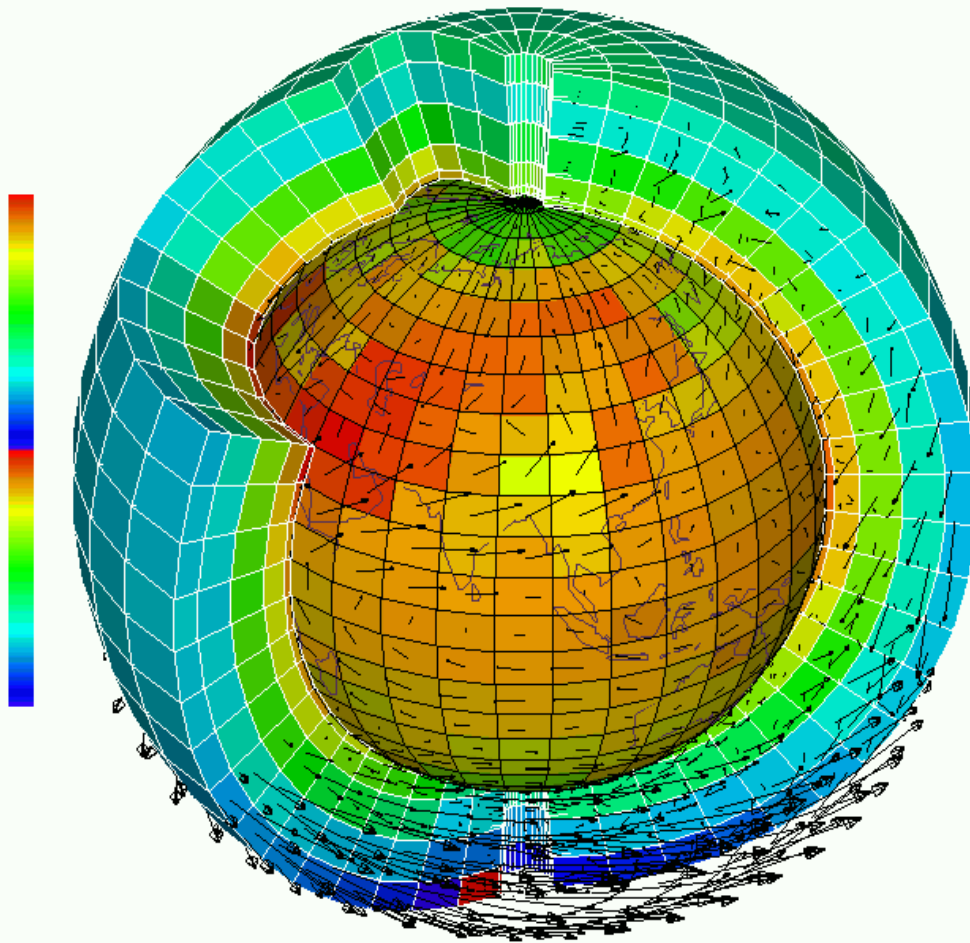


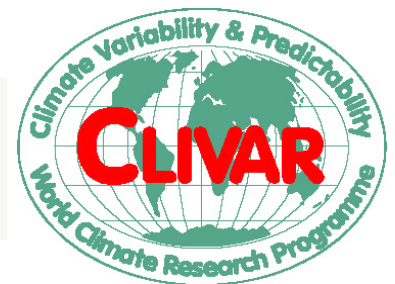
The JSC/CLIVAR Working Group on Coupled Models (WGCM) Report to CLIVAR SSG-18

Sandrine Bony & Jerry Meehl
WGCM co-chairs

Paris, May 2011



WCRP
World Climate Research Programme



Contribution of WGCM to CLIVAR Imperatives :

CLIVAR Imperatives :

- Anthropogenic climate change
- Decadal variability, predictability and prediction

CLIVAR Imperative :

- Improved atmosphere and ocean component models of Earth System Models

CMIP5 Status

At least 21 modelling groups participating

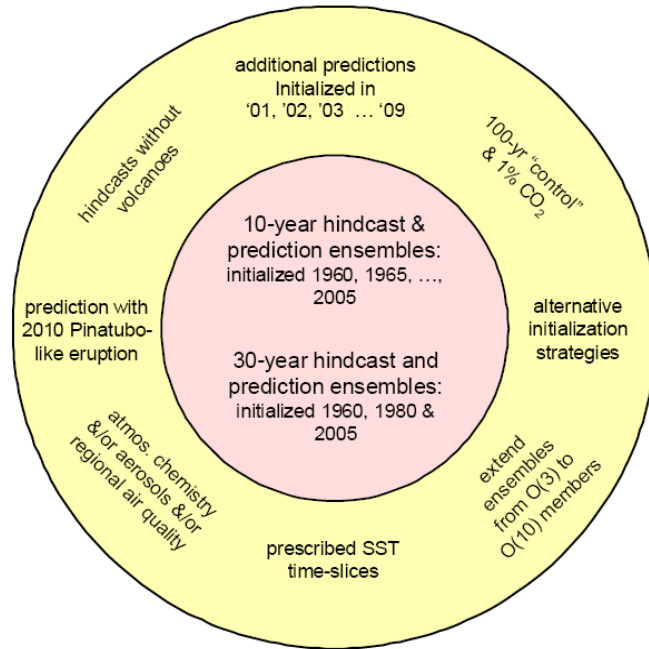
Primary Group	Country	Model	Primary contact
CAWCR	Australia	ACCESS	Tony Hirst
BCC	China	BCC-CSM1.1	Tongwen Wu
GCESS	China	BNU-ESM	Duoying Ji
CCCMA	Canada	CanESM2, CanCM4, CanAM4	Greg Flato
CCSM	USA	CESM1, CCSM4	Jim Hurrell
RSMAS	USA	CCSM4(RSMAS)	Ben Kirtman
CMCC	Italy	CMCC-CESM, CM, & CMS	S. Gualdi, C. Cagnazzo
CNRM/CERFACS	France	CNRM-CM5	D. Salas-Mélia, L.Terray
CSIRO/QCCCE	Australia	CSIRO-Mk3.6	Leon Rotstayn
EC-EARTH	Europe	EC-EARTH	Wilco Hazeleger
MPI-M	Germany	ECHAM6/MPIOM-HR & LR	M. Giorgetta, S. Legutke
?	China	FGOALS-G2.0, S2.0 & gl	Tianjun Zhou
GFDL	USA	GFDL-HIRAM-C360, C180, CM2.1, CM3, ESM2G, ESM2M	R. Stouffer, T. Delworth, B. Wyman, L. Horowitz
MOHC	UK	HadCM3, CM3Q, GEM2-AO, GEM2-ES	Mat Collins, Chris Jones
NMR/KMA	Korea / UK	HadGEM2-AO	Hyo-Shin Lee
INM	Russia	inmcm4	Evgeny Volodin
IPSL	France	IPSL-CM5A-LR, CM5A-MR, CM5B	Jean-Louis Dufresne
MIROC	Japan	MIROC5, 4m, 4h, ESM, ESM-CHEM	M. Watanabe, S. Emori, M. Ishii, M. Kimoto, A. Abe, M. Kawamiya, T. Nozawa
MRI	Japan	MRI-AM20km, AM60-km, CGM3, ESM1	Shoji Kusunoki
NorClim	Norway	NorESM	Trond Iversen / Mats Bentsen
NASA/GISS	USA	GISS-E2-H, GISS-E2-H-CC, GISS-E2-R, GISS-E2CS-H, GISS-E2CS-R	Gavin Schmidt
NASA/GSFC	USA	?	Max Suarez

40+ models

K. Taylor (PCMDI)

CMIP5 is organized around several sets of simulations

“Near-Term” Experiments (decadal, up to 2035)

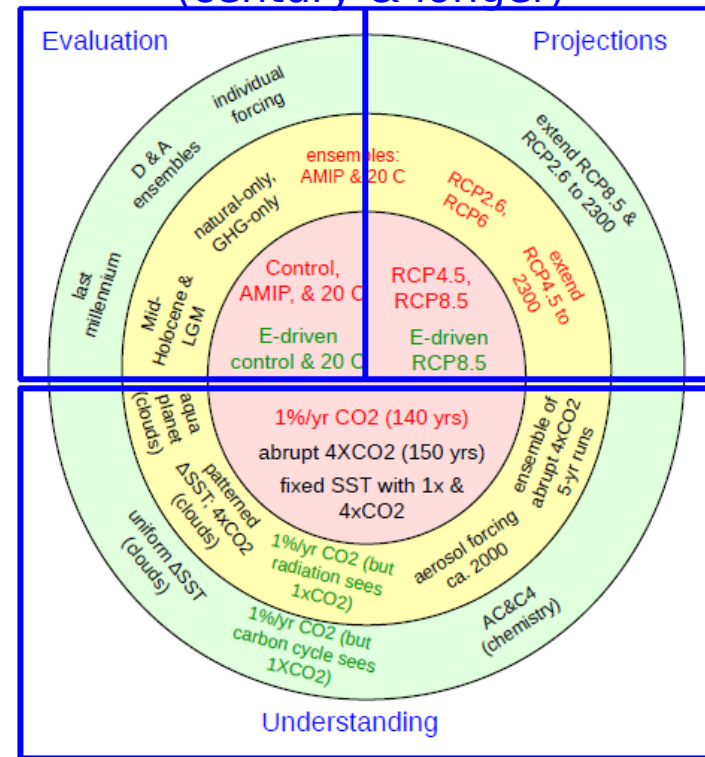


Overseen by the **WGCM-WGSIP Decadal Climate Prediction Panel**
(chair: George Boer)

- 10-year & 30-year hindcasts and predictions
- climate predictability
- impact of initialization methods
- impact quality of the ocean initial state

Nb of models: CORE: 17, Tier1: 3-10
Mean Resol: 1.3 deg (atm); 0.8 deg (ocean)

“Long-Term” Experiments (century & longer)

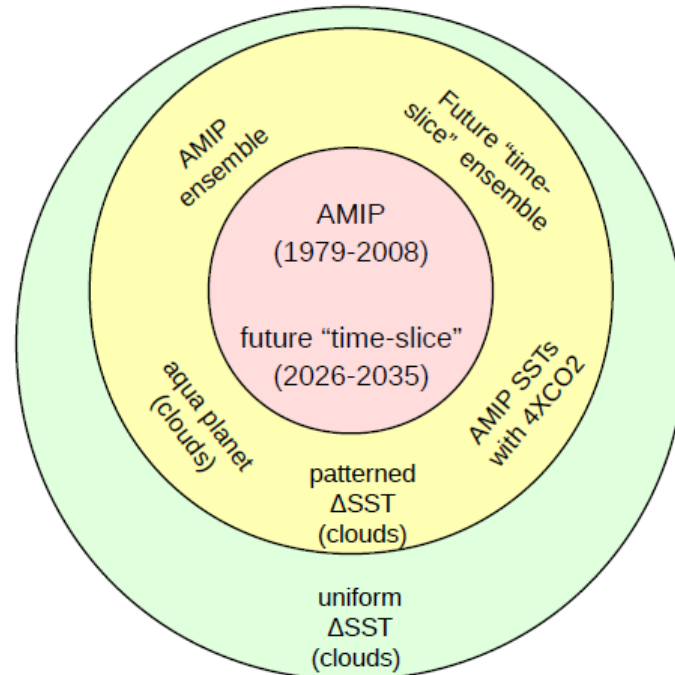


- current climate, paleo-climates (PMIP)
- satellite simulator + process outputs(CFMIP)
- RCPs; with/without carbon feedbacks
- radiative forcings;
- physical (e.g. clouds) & biogeochemical (carbon, aerosols) feedbacks
- idealized expts (e.g. aqua-planet)

Nb of models: CORE: 15-27, Tier1,2: 7-15
Mean Resol: 2.1 deg (atm) ; 0.9 deg (ocean)

CMIP5 is organized around several sets of simulations

“Time Slices” Experiments (1979-2008 + 2026-2035)



Atmosphere-only experiments :

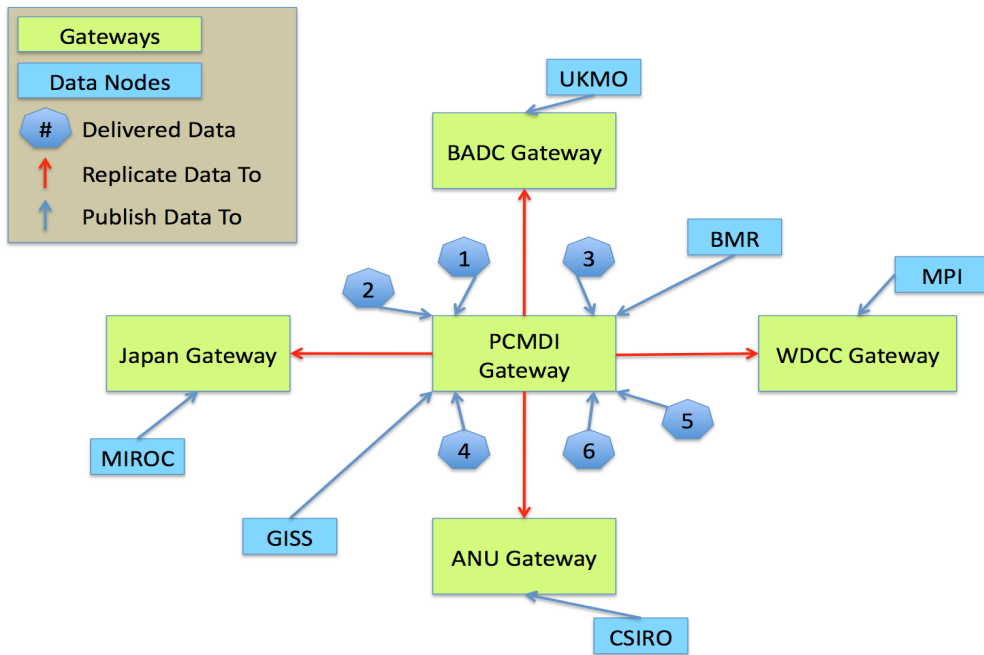
For models that require enormous computing resources (very high resol, chemistry, etc).

- explore the impact of higher resolution
- regional effects of climate change
- air quality implications of climate change
- extreme events (e.g. tropical cyclones)

Nb of models: at least 4
Resolution: 0.2 → 0.6 deg (atm)

Access to CMIP5 data : The Earth System Grid (ESG) is up and running !

Model output will be served by federated centers around the world and will appear to be a single archive :



As of May 3rd 2011:

- 8 models have started to publish their CMIP5 outputs on the ESG
- many more models will be available by this summer
- 635 users already registered
- CMIP5 analysis is about to start !

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Advanced Search

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Search Categories

- Project
- < Any Project
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- Institute
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- > CNRM-CM5
- > CanESM2
- > GISS-E2-H
- > GISS-E2-R
- > HadGEM2-ES
- > bcc-csm1-1
- > inmcm4
- > model ipsl-cm5a-lr
- Experiment
- > 1pctCO2
- > abrupt4xCO2
- > amip
- > esmControl
- > esmFdbk1
- > esmFdbk2
- > esmFixClim1
- > esmFixClim2
- > esmHistorical
- > esmrcp85
- > historical
- > historicalExt
- > historicalGHG
- > historicalMisc
- > historicalNat
- > piControl
- > rcp26
- > rcp45
- > rcp85
- > sstClim
- > sstClim4xCO2
- Frequency
- Product
- Realm
- Variable
- Ensemble

Total Number of Results: 1370

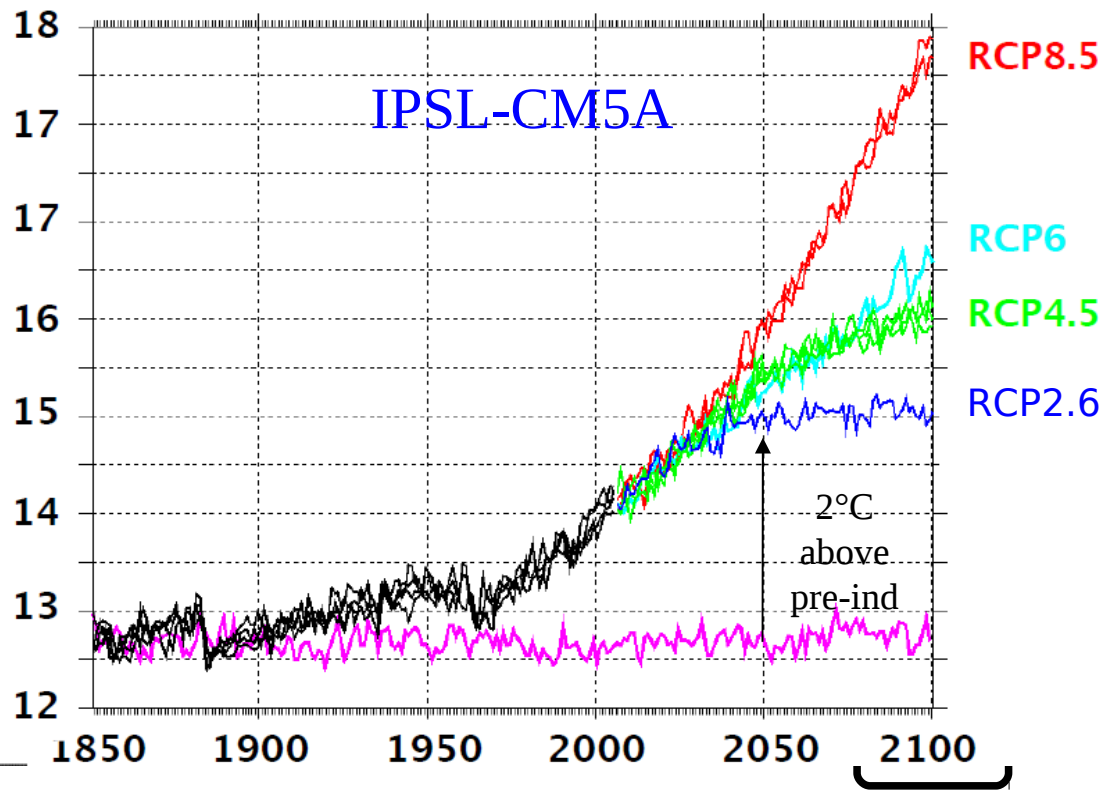
1-10 of 1370 results | 11-20 | 21-30 | 31-40 | 41>

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Description: CanESM2 model output prepared for CMIP5 other historical forcing
Authorization: Guest Users
 Data Center: ESG-PCMDI
- project=CMIP5 / IPCC Fifth Assessment Report, model=Institute for Numerical Mathematics, experiment=1 percent per year CO2, time_frequency=day, modeling realm=ocean, ensemble=r1i1p1, version=20110323
Description: inmcm4 model output prepared for CMIP5 1 percent per year CO2
Authorization: Guest Users
 Data Center: ESG-PCMDI
- project=CMIP5 / IPCC Fifth Assessment Report, model=NASA Goddard Institute for Space Studies, GISS-E2-H, experiment=historical, time_frequency=mon, modeling realm=ocean, ensemble=3i1p1, version=20110414
Description: GISS-E2-H model output prepared for CMIP5 historical
Authorization: Guest Users
 Data Center: ESG-PCMDI
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Description: inmcm4 model output prepared for CMIP5 1 percent per year CO2
Authorization: Guest Users
 Data Center: ESG-PCMDI
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 Data Center: ESG-PCMDI
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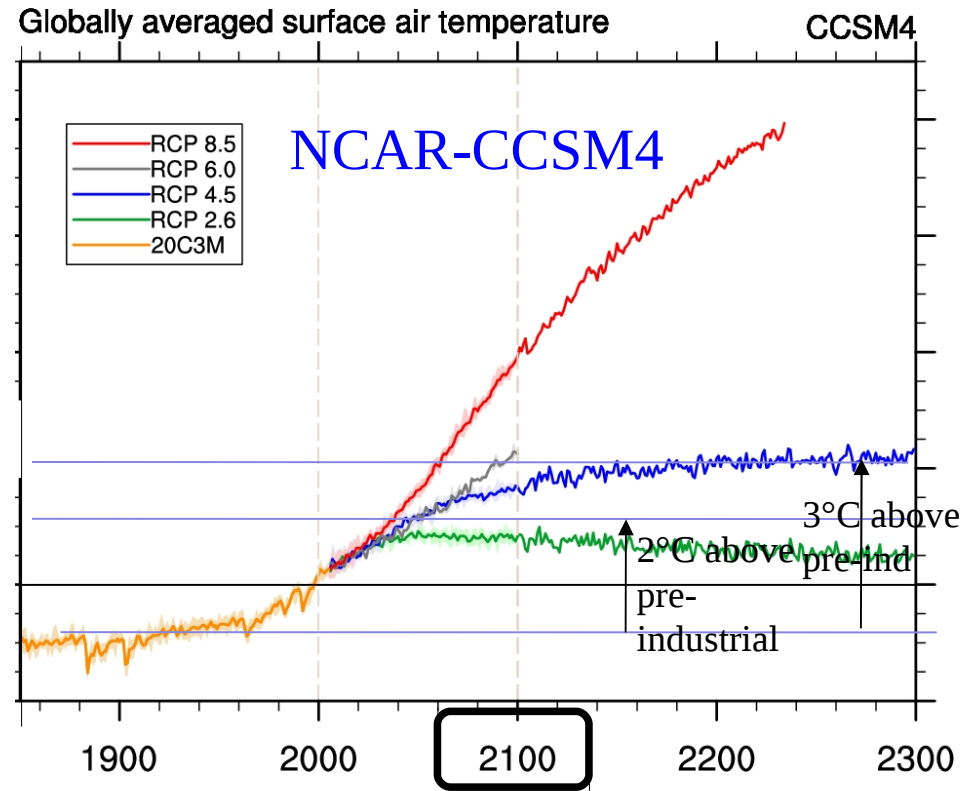
CMIP5 Status

- **At least 21 global modeling groups will participate** in CMIP5. Likely that about 5 groups will have 50 km class AOGCMs for decadal prediction, at least 10 groups will have ESMs, several groups will have high-resolution time slice AGCMs (<50 km).
- The full sets of forcings (20th and 21st century) for all four RCPs, and the list of model outputs, are available. Simulations or outputs preparation are in progress.
- Model outputs will be accessed via **the Earth System Grid** (distributed grid technology) for many groups, and some will send their model data directly to PCMDI; all CMIP5 data will be accessed from PCMDI web page with registration; The ESG is **now up and running**; 635 users (as of Apr 2011) already registered.
- An extensive **documentation** of the models and of model experiments will be available for CMIP5 through EU Metafor (standardized vocabulary and documentation), and US Earth System Curator projects (web-based tools for ingesting metadata).
- **Output from 8 models are now available**; Many model runs available by June 2011, but will continue to arrive during 2011; Analyses of model data will begin mid-2011, and will continue through mid-2012 for assessment in the IPCC AR5. (**final deadline for papers to be assessed in the AR5: July 31, 2012**)
- CMIP5 model simulations and analyses will continue well beyond AR5 deadlines.

Evolution of the global mean surface temperature in 2 CMIP5 climate models

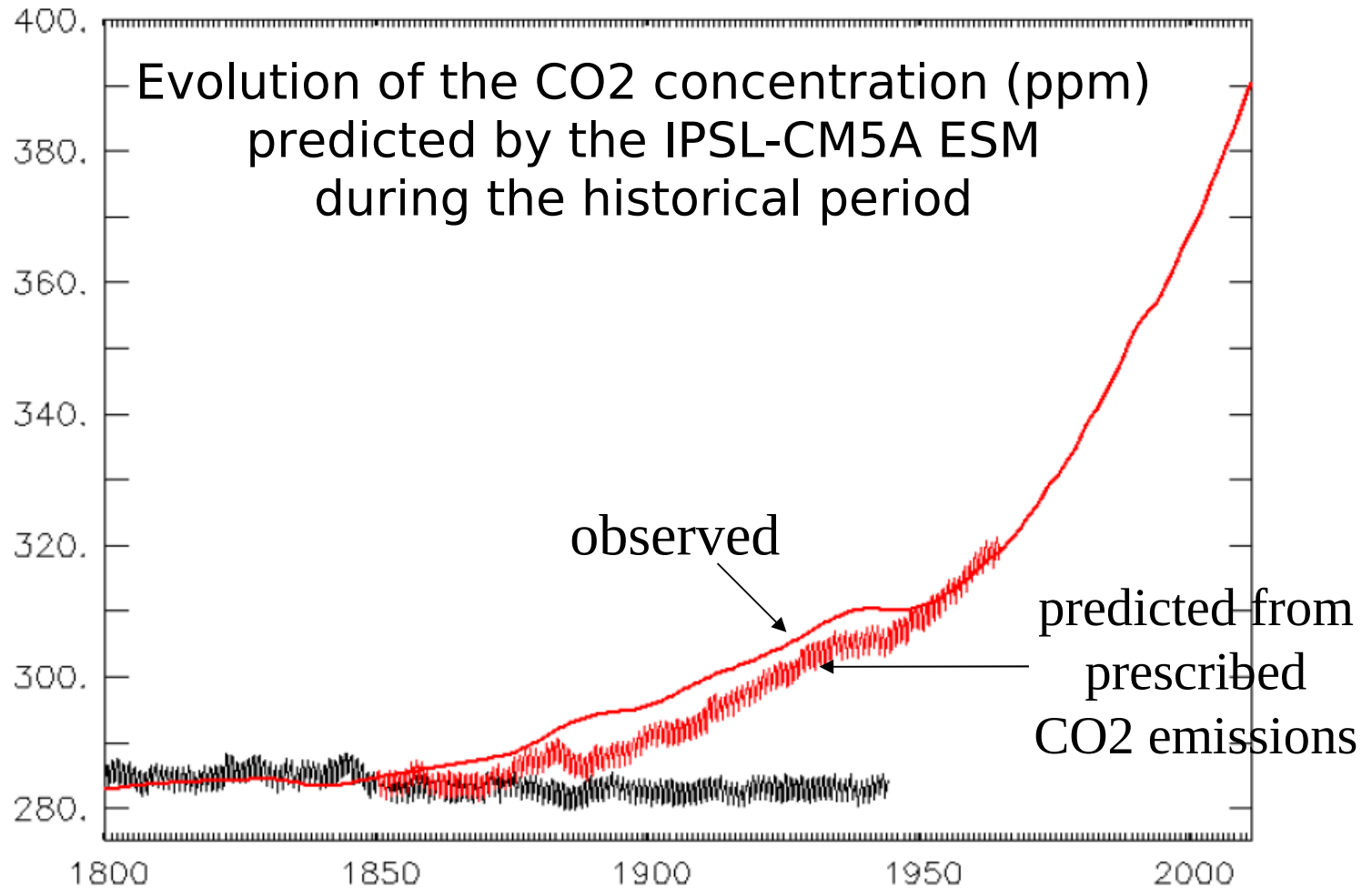


Courtesy J.-L. Dufresne

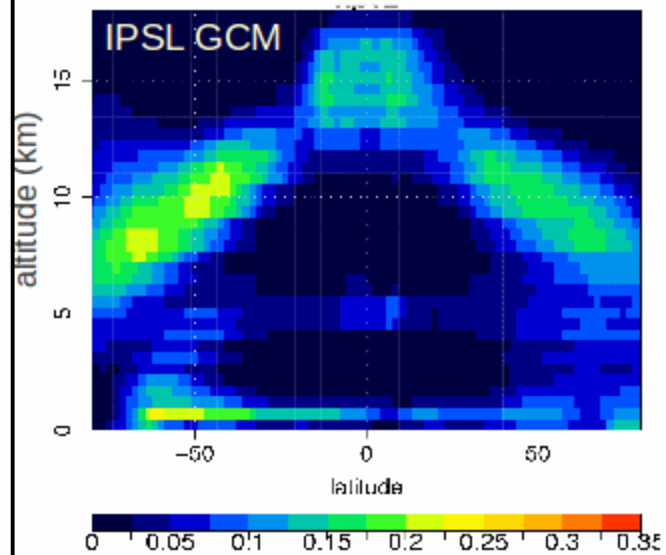
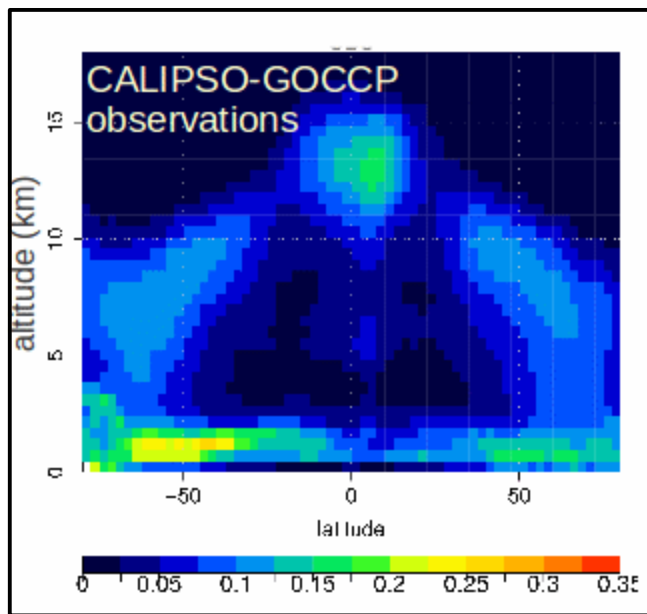


Courtesy G. A. Meehl

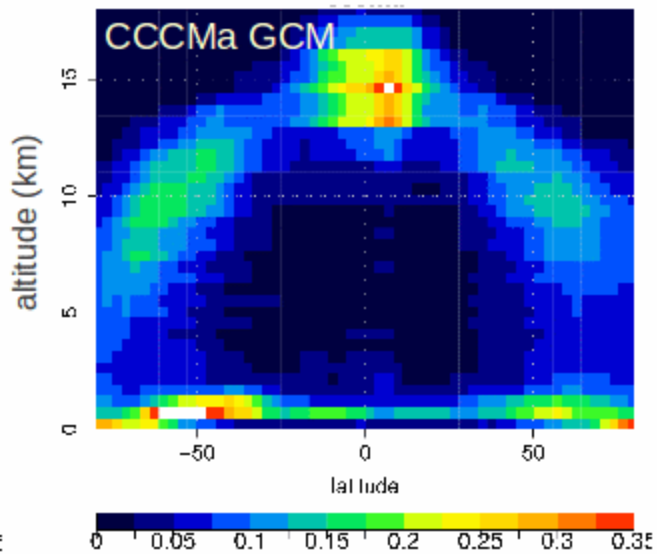
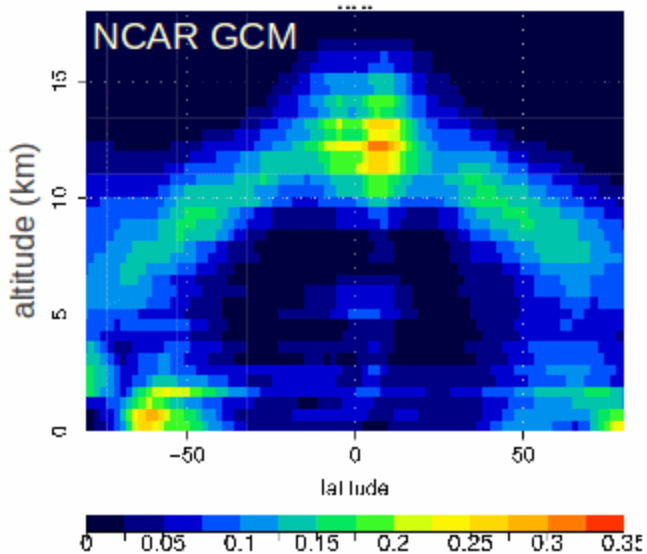
About 15 ESMs including an interactive carbon cycle will participate in CMIP5



Evaluation of the 3D distribution of clouds simulated by global climate models and observed by CALIPSO



WGCM/CFMIP



WGCM current events and plans related to CMIP5 (part 1)

- **BAMS article describing CMIP5** submitted (Taylor, Stouffer and Meehl, 2011)
- **Decadal Climate Prediction Panel white paper** on bias correction in decadal predictions completed and posted to PCMDI web page
- **CMIP5 Special Issue of CLIVAR Exchanges** (Thanks to Anna Pirani !)
 - Editorial - Visbeck, Hurrell, Pirani
 - WCRP - Asrar
 - Introduction to CMIP5 - Meehl and Bony
 - Long Terms simulations - Stouffer et al
 - Decadal climate prediction - Doblas-Reyes et al
 - AIMES contribution (RCPs, IAM handshake) - Hibbard et al
 - PMIP - Braconnot et al
 - CFMIP - Bony et al
 - Aerosols - Boucher et al
 - ESMs and C4MIP - Friedlingstein et al
 - Stratosphere-resolving models - Manzini et al
 - Ocean modeling - Griffies et al
 - CORDEX - Jones et al
 - Metafor - Guilyardi et al
 - Satellite observations for CMIP5 - Teixeira et al
 - ESG - TBD

WGCM current events and plans related to CMIP5 (part 2)

- **Encourage/coordinate community groups to write introductory papers** regarding aspects of the CMIP5 dataset (e.g. , CFMIP for cloud forcing/response, PMIP for paleo, Metrics panel, etc.) to contribute to IPCC AR5
- **CMIP5 session at WCRP OSC October 2011**
C34: Global Model Evaluation and Projections: CMIP5 and Other Model Intercomparisons
(conveners G. Meehl, D. Waugh, J. Fasullo, K. Williams)
emphasis is on new CMIP5 analyses, results from CMIP3 and other model intercomparisons also welcome, and could also include results pertaining to, for example, reanalyses, transpose AMIP, and quantitative performance metrics
- **CMIP5 Workshop** hosted by International Pacific Research Center (IPRC), University of Honolulu, Hawaii, **March 5-9, 2012**, comparable to the CMIP3 Workshop held there in 2005, similar “short presentation/poster” format

Contribution of WGCM to CLIVAR Imperatives :

CLIVAR Imperatives :

- Anthropogenic climate change
- Decadal variability, predictability and prediction

CLIVAR Imperative :

- Improved atmosphere and ocean component models of Earth System Models

WCRP-WWRP-THORPEX

Model Evaluation and Development Survey

Idea emerged in parallel at CLIVAR SSG-16
and at WGNE → joint efforts

A. Pirani (CLIVAR)

C. Jakob (WGNE), S. Bony (WGCM), B. van den Hurk (GLACE)

J. Meehl (WGCM), B. Kirtman (WGSIP), S. Griffies (WGOMD)
M. Miller (WGNE), G. Brunet (WWRP), A. Dickinson (THORPEX)
T. Busalacchi, G. Asrar (WCRP)



WCRP-WWRP-THORPEX

Model Evaluation and Development Survey

Questions :

- Given your interest, what would you consider/identify as the KEY uncertainties/deficiencies/problems of current models ?
- Do you see a particular gap (in knowledge, in observations or in practice) that would need to be filled?
- Do you see any particular resource or opportunity within the modeling/process study/observational/theoretical community

Responses :

- More than 120 responses received
About 20 responses are group or lab-wide responses
- About 30 modeling centers (50% climate modeling center, 50% NWP center) and 44 Universities represented
- Synthesis : on-going



Main outcomes :

1. Key problems of climate models :

- **in the physical climate system**
- convection, clouds, precipitation, land-sfc processes, ocean eddies & mixing
- errors in mean climate and tropical variability

2. Key obstacles to progress :

- boundaries between disciplines/communities
- lack of understanding of process-climate relationships and attribution of model errors
- lack of observations or insufficient use of avail observations

3. Solutions proposed :

- **encourage integrated research teams** (cf Climate Process Teams) & facilitate communication/coordination among communities
- design coordinated model experiments more specifically focused on process-climate relationships and on the understanding of inter-model differences (resolution, parameterizations, etc)
- facilitate the use of available observations

WGNE/WGCM Climate Model Metrics Panel

Members selected according to their relevant scientific contributions and membership or liaison efforts in key CLIVAR, WCRP and related programs:

P. Gleckler (PCMDI), Chair – WGNE
B. Ebert (BMRC) – JWGFVR WWRP/WGNE
V. Eyring (DLR) – WGCM/SPARC/AC&C
P. Friedlingstein (Uni. Exeter) – IGBP
H. Hewitt (Met Office) – WGOMD
R. Pincus (NOAA) – GEWEX/GCSS
K. Taylor (PCMDI) – CMIP5/WGCM

Objectives

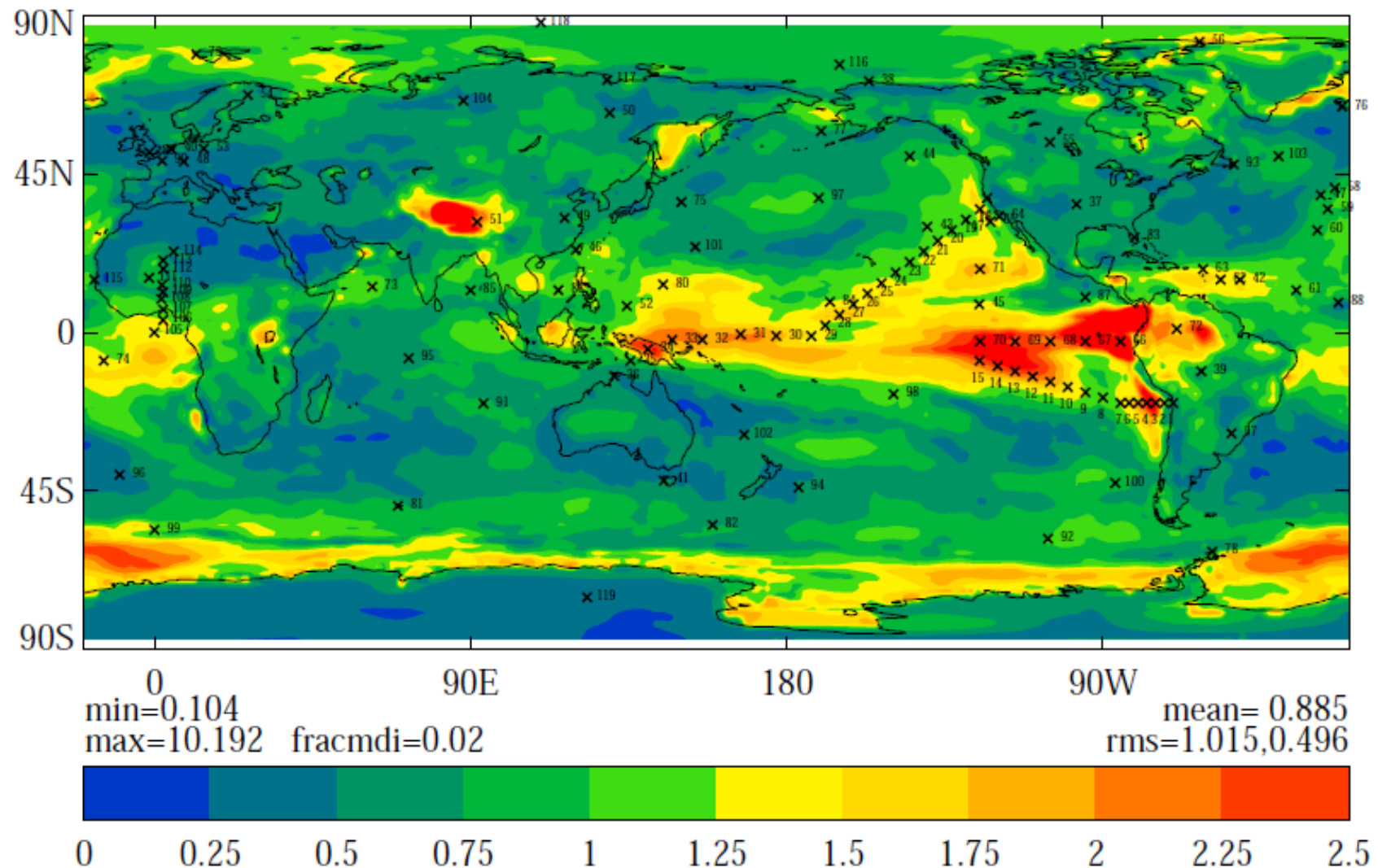
- identify and promote a limited but diverse set of metrics in an attempt to establish routine community benchmarks for climate models
- facilitate development and adoption of increasingly in-depth metrics via coordination with other CLIVAR/WCRP metrics activities (e.g., CFMIP, MJO task force, CLIVAR AAMP and ocean basin panels)

————→ Contribution of CLIVAR panels and WGs welcome

Facilitating connections between global climate modelling, observations and processes

<p>Observations for MIPs evaluation (same format, structure, as CMIP5 output)</p> <ul style="list-style-type: none">- NASA-PCMDI initiative- to be extended over time (e.g. NOAA)- CFMIP-obs initiative- archived on the ESG- used by the metrics panel	<p>WGCM/CFMIP-GCSS process diagnostics on 120 sites (part of CMIP5 output)</p> <ul style="list-style-type: none">- Comparison with data from instrumented sites and past campaigns- High-frequency outputs- Opportunity for climate-processes-observations interactions	<p>WGNE-WGCM “Transpose-AMIP” intercomparison</p> <ul style="list-style-type: none">- Evaluation of climate models in NWP mode- Facilitation of comparisons between models and data from field experiments- Connection to YOTC (tropical convection)
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CFMIP/GCSS/CMIP5 model outputs at selected locations (120 locations, high-frequency, detailed cloud diagnostics)

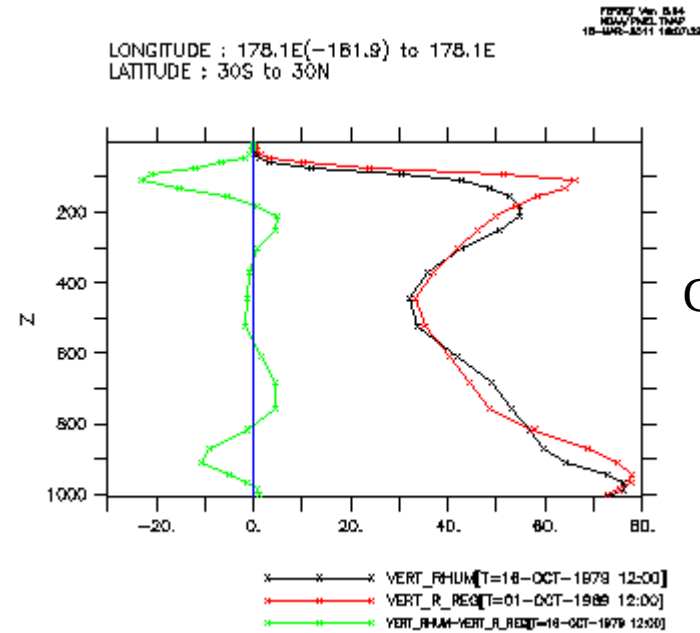
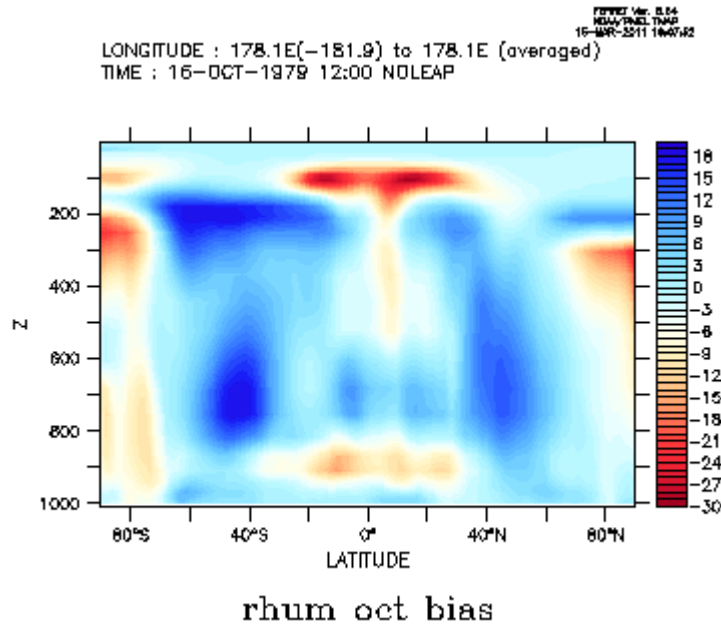


- ARM, CEOP, CloudNet instrumented sites
- GPCI / Tropical West & South East Pacific / AMMA transects
- Field experiments / GCSS case studies
- Locations of large inter-model spread of cloud feedbacks (CMIP3)

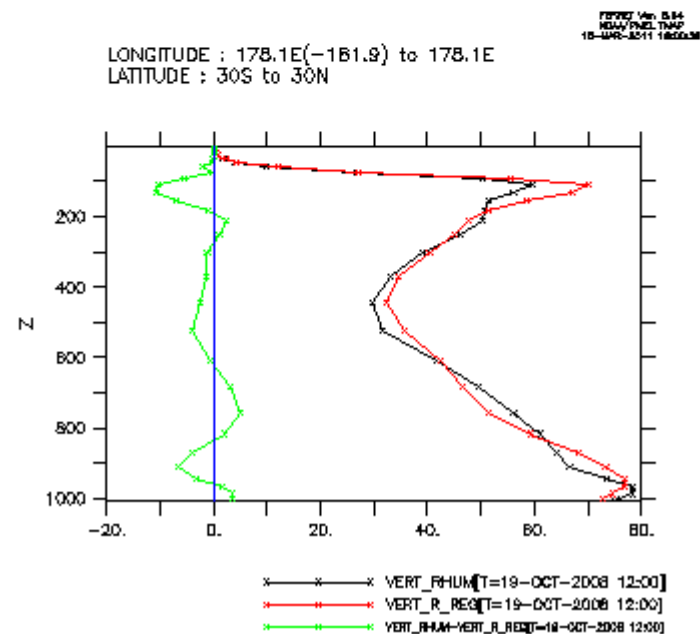
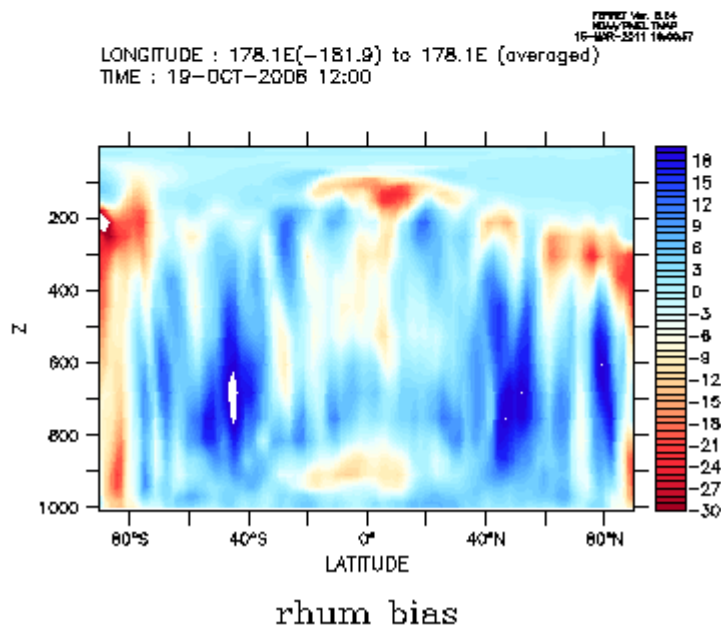
WGCM annual meetings

- **14th WGCM meeting held at the UK MetOffice**, Exeter, 4-6 October 2010
- **First-ever joint meeting between WGCM and WGNE**, Boulder, 19-22 October 2011
- **16th WGCM meeting planned on September 2012 in Hamburg**, Germany (3rd International Conference on Earth System Modelling, 16-21 September).

Relative Humidity Bias of the IPSL-LMDZ GCM : Transpose-AMIP simulation (15 Oct 2008) & climatological simulation



Climatological
mean
(10 years)



Forecast
Day + 5

CFMIP-GCSS Intercomparison of Large Eddy Simulation Models with Single Column Models (CGILS)



Global Energy and Water Cycle Experiment

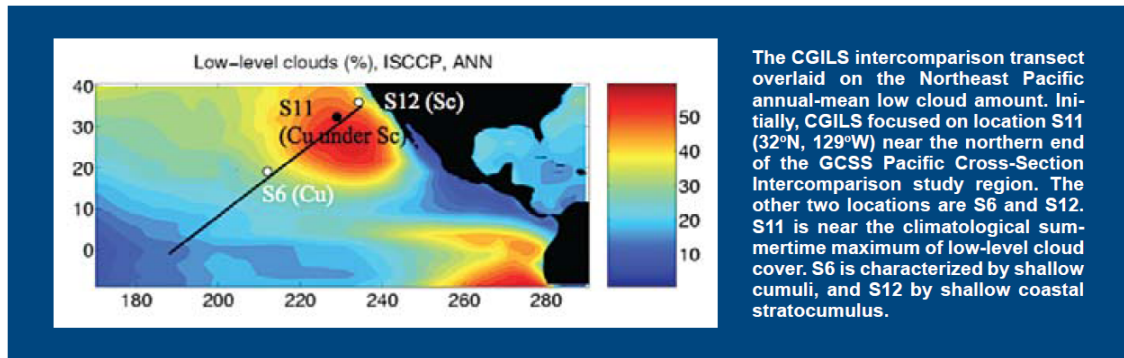
NEWS

Vol. 20, No. 2



May 2010

GCSS Teams with CFMIP to Understand the Physical Mechanisms of Low Cloud Feedbacks in Climate Models



- Large-scale forcing for 3 types of PBL clouds
- CTRL & +2K experiments
- Same experiments performed by SCMs and LES models

Objectives :

- To understand the physical mechanisms of subtropical low cloud feedbacks in GCMs by using Single-Column Models (SCMs)
- Assess the physical credibility of model physics/cloud feedbacks by comparing SCM results with equivalently forced Large Eddy Simulations (LES) models

A joint activity between CFMIP and the GEWEX Cloud System Study (GCSS) Boundary Layer WG

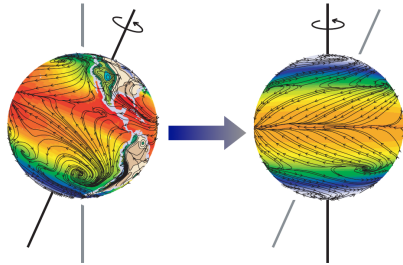
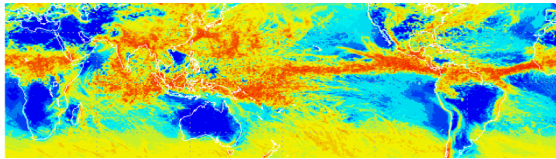
Led by Minghua Zhang (Stony Brook) & Chris Bretherton (U. Washington)

Participating models : 16 SCMs & 5 LES

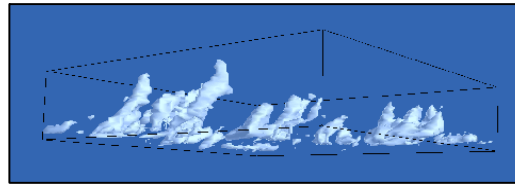
Models	Model Institution	Participants
SCM 16		
CAM4	National Center for Atmospheric Research (NCAR), USA	Minghua Zhang, Chris Bretherton
CAM5	NCAR, USA	Cecile Hannay, Minghua Zhang
CCC	Canadian Climate Center, Canada	Phil Austin
CSIRO	Australian Commonwealth Scientific and Research Organization	Charmaine Franklin
ECHAM5	Swiss Federal Institute of Technology, Switzerland	Colombe Siegenthaler-Le Drian, Isotta Francesco, Ulrike Lohman
ECHAM6	Max-Planck Institute of Meteorology, Germany	Suvarchal Kumar, Bjorn Stevens
ECMWF	European Centre for Medium-Range Weather Forecasting	Martin Koehler
GFDL	Geophysical Fluid Dynamics Laboratory, USA	Chris Golaz, Ming Zhao
GISS	Goddard Institute for Space Studies, USA	Tony DelGenio, Audrey Wolf
GSFC	Goddard Space Flight Center, USA	Andrea Molod, Max Suarez, Julio Bacmeister
JMA	Japanese Meteorological Center, Japan	Hideaki Kawai
KNMI	Royal Netherlands Meteorological Institute, The Netherlands	Roel Neggers, Pier Siebesma
LMD	Laboratory of Dynamic Meteorology, France	Florent Briant, Sandrine Bony, Dufresne Jean-Louis
SNU	Seoul National University, Korea	Sing-Bin Park, In-Sik Kang
UKMO	Met Office, United Kingdom	Adrian Lock, Mark Webb
UWM	University of Wisconsin at Madison, USA	Vincent Larson, Ryan Senkbeil
DALES	Technical University Delft, The Netherlands	Stephan de Roode, Pier Siebesma
SAM	System for Atmospheric Models-University of Washington/Stony Brook University, USA	Peter Blossey, Chris Bretherton, Marat Khairoutdinov
UCLA	University of California at Los Angeles, USA	Irina Sandu, Bjorn Stevens
UCLA/Langley	NASA Langley Research Center, USA	Anning Cheng, Kuan-man Xu

Cloud Feedback Model Inter-comparison Project Phase-2 CFMIP-2 (www.cfmip.net)

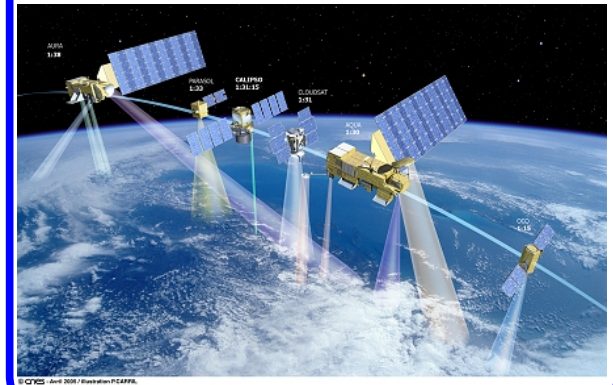
GCM analysis through a hierarchy of models



Process studies (in-situ obs, LES/CRMs)



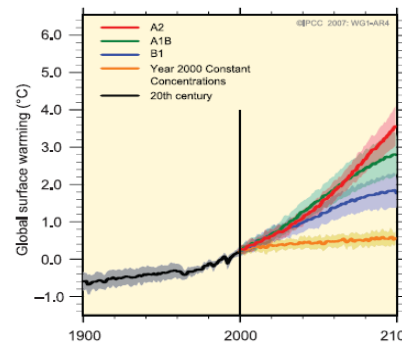
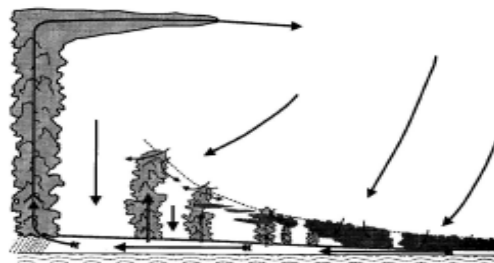
Satellite observations & simulators (COSP)



Understanding

Evaluation

Assessment of cloud-climate feedbacks



Observations useful for the evaluation of model clouds through COSP

CLIMSERV

SERVICE DE DONNEES ET DE CALCUL DE L'IPSL

Link available from www.cfmip.net



CFMIP Observations

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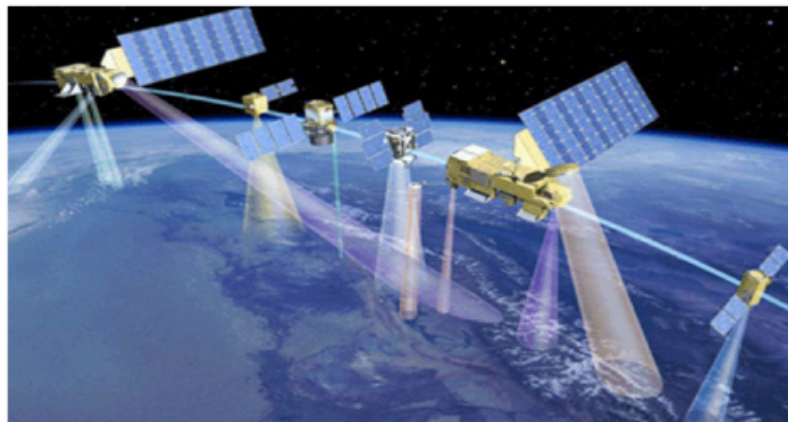
Observations for COSP, the CFMIP Observations Simulator Package

The Cloud Feedback Model Intercomparison Program has designed a protocol to evaluate clouds in climate and weather prediction models based on satellite observations (http://cfmip.metoffice.com/CFMIP2_experiments_March20th2009.pdf)

Index de l'article

- [CFMIP Observations](#)
- [CALIPSO-GOCCP](#)
- [CERES Data](#)
- [CLOUDSAT Data](#)
- [ISCCP Data](#)
- [MISR Data](#)
- [PARASOL Data](#)

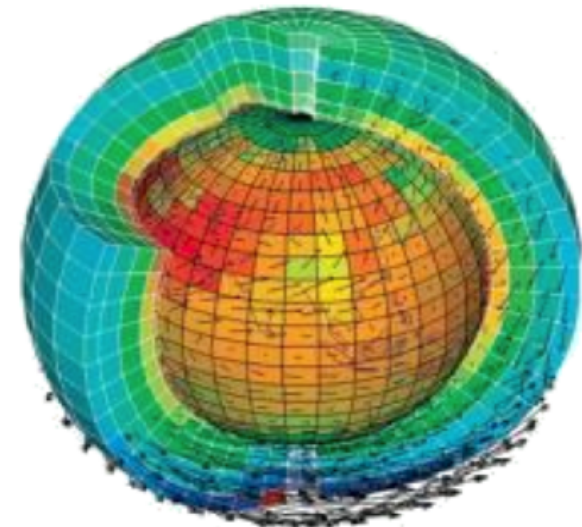
A-train :
CALIPSO / CLOUDSAT / CERES / PARASOL



+ ISCCP + MISR



Climate Models



Current priorities for the metrics panel

- Finalize initial set of metrics following feedback from WGCM, WGNE and modeling groups
- Launch website where results will eventually be posted with explanation of the panel objectives, limitations of metrics, etc. This will be a resource pointing to other metrics activities, and will include a repository for code contributions
- Prepare manuscript to document the goals panel, and use its limited set to examine if/how models have improved over time (e.g., CMIP3 to CMIP5)

The panel's metrics to be presented in a transparent manner

Some of the panel's selection criteria for metrics:

- easy to calculate, reproduce and interpret, established in the peer-reviewed literature
- must provide all codes/documentation for the limited set of metrics
- Clarity of exactly which observational dataset has been used
 - Example: JPL and PCMDI are currently working to establish guidelines for how selected NASA datasets will be made available specifically for model evaluation. The data will be structurally aligned to facilitate comparison with CMIP5 data and made readily available. There will be specific requirements for documenting each observational product/version. Other major data providers (e.g., NOAA) have expressed interest in following these guidelines.