

# Year of Tropical Convection (YOTC)

*Accomplishments and Near-Term Activities*

**A Paradigm for Applying the Benefits of Field Campaign Focus to the Study of Multi/Global-Scale Study of Earth System Processes**

Duane Waliser, JPL  
Mitch Moncrieff, NCAR  
Co-chairs, YOTC Science Planning Group

*Plus  
MJO Task Force*

**WGNE  
Toulouse, France  
Nov 2012**



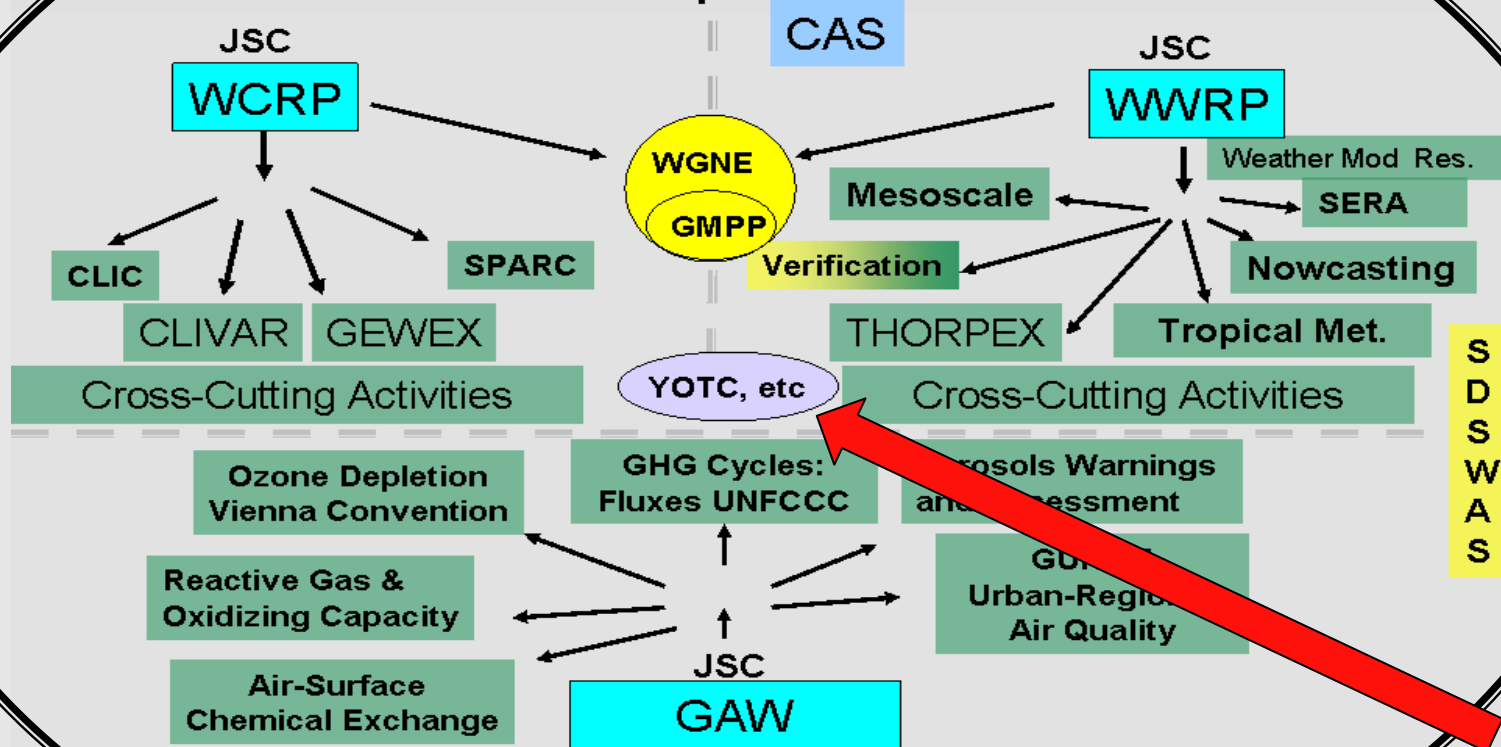
**\* Weather-Climate Intersection Research \***  
**\* Seamless Prediction \***

# Prediction

## Assessments

## Observations

### WMO Research Programme Components



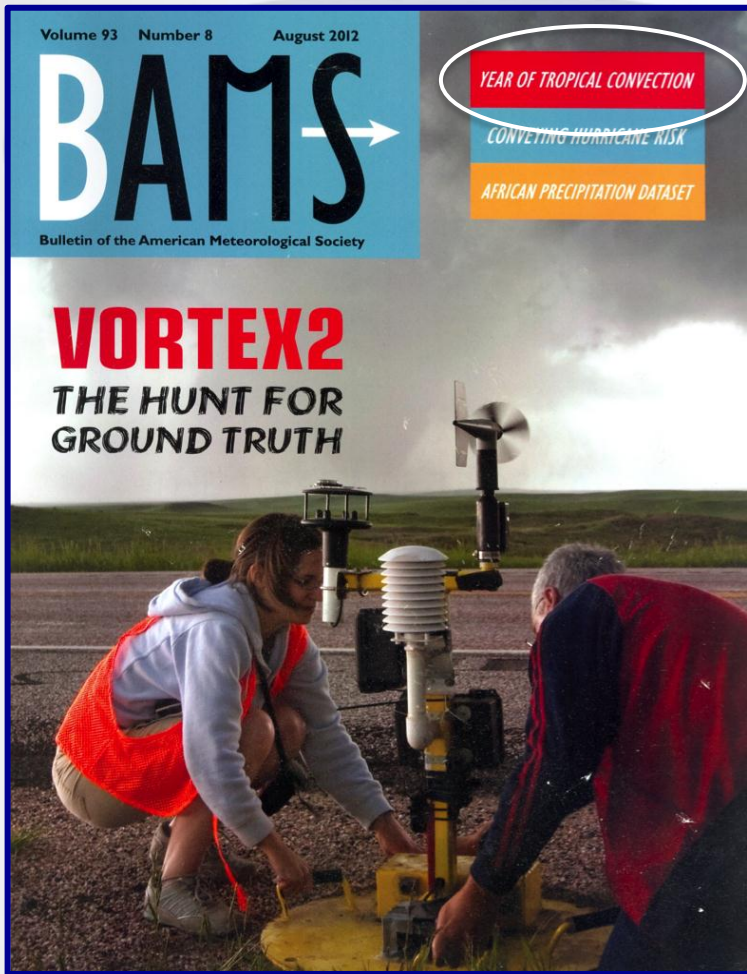
29 April 08

Weather, Climate, Water and Air Quality

Joint  
Research  
Activity

## Service Delivery

## Capacity Building



## PROGRESS AND DIRECTION IN TROPICAL CONVECTION RESEARCH

YOTC International Science Symposium

BY MITCHELL W. MONCRIEFF, DUANE E. WALISER, AND JAMES CAUGHEY

# MULTISCALE CONVECTIVE ORGANIZATION AND THE YOTC VIRTUAL GLOBAL FIELD CAMPAIGN

BY MITCHELL W. MONCRIEFF, DUANE E. WALISER, MARTIN J. MILLER,  
MELVYN A. SHAPIRO, GHASSEM R. ASRAR, AND JAMES CAUGHEY

Vastly improved satellite and in situ measurements, data assimilation, and modeling make possible a virtual field study of multiscale Earth system problems, such as convective organization and its interaction with larger-scale circulation.

## THE “YEAR” OF TROPICAL CONVECTION (MAY 2008–APRIL 2010) Climate Variability and Weather Highlights

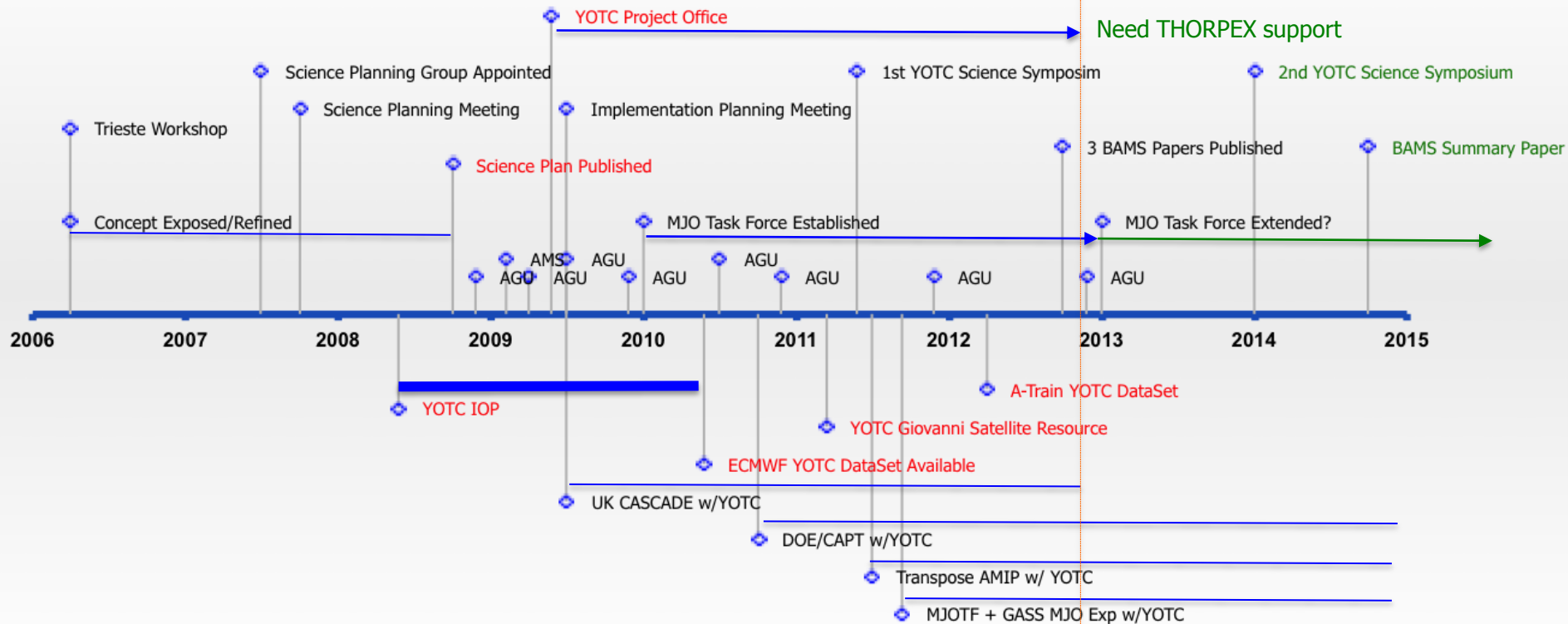
BY DUANE E. WALISER, MITCHELL W. MONCRIEFF, DAVID BURRIDGE, ANDREAS H. FINK, DAVE GOCHIS,  
B. N. GOSWAMI, BIN GUAN, PATRICK HARR, JULIAN HEMING, HUANG-HSUNG HSU, CHRISTIAN JAKOB, MATT JANIGA,  
RICHARD JOHNSON, SARAH JONES, PETER KNIPPERTZ, JOSE MARENGO, HANH NGUYEN, MICK POPE, YOLANDE SERRA,  
CHRIS THORNCROFT, MATTHEW WHEELER, ROBERT WOOD, AND SANDRA YUTER

May 2008–April 2010 provided a diverse array of scientifically interesting and socially important weather and climate events that emphasizes the impact and reach of tropical convection over the globe.

Also Over 40 publications referencing YOTC

# YOTC: Summary of Progress & Timeline

## YOTC Timeline

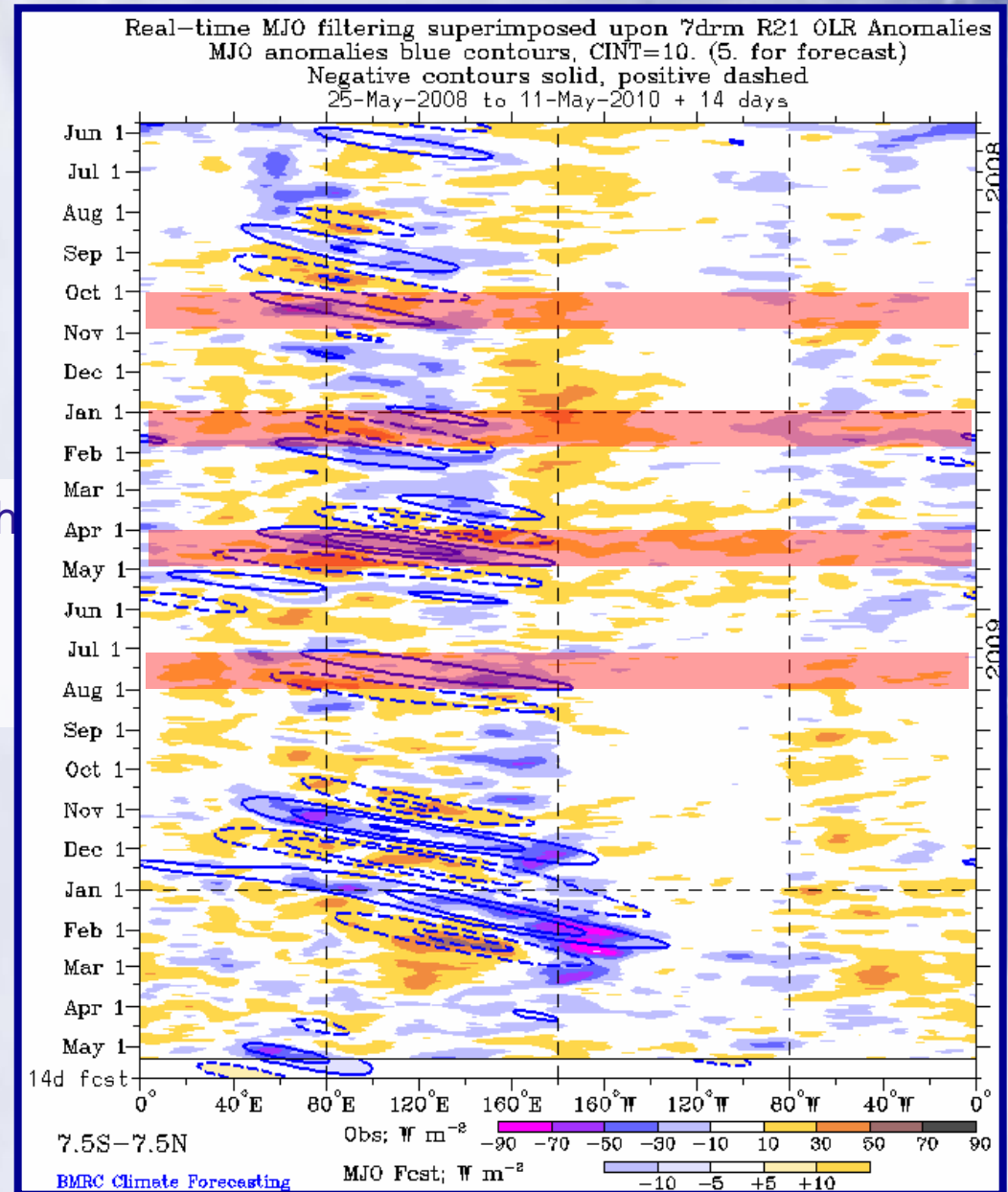


### A Number of MJO Task Force Accomplishments Not Shown

- MJO Metric for CMIP & Climate Metrics Panel (Sperber and Kim, 2012)
- Operational Implementation of MJO Forecast Metric (Gottschalck et al. 2010) w/ WGNE
- Develop Forecast Metric for Boreal Summer Subseasonal Variability (Lee et al. 2012)
- MJO Workshop on Modeling Monsoon Intraseasonal Variability, Busan, 2011, (Hendon et al. 2011, BAMS)
- Significant ongoing work on process-oriented MJO/Atmos Physics Metrics (2-3 papers in preparation)
- Co-support/develop first robust multi-model hindcast experiment for subseasonal variability; ISVHE.

# Transpose AMIP CMIP5 Model Evaluations

## YOTC Period



- 4 periods; 16 5-day hindcasts in each
- 9 Subprojects.
- 8 Modeling Groups

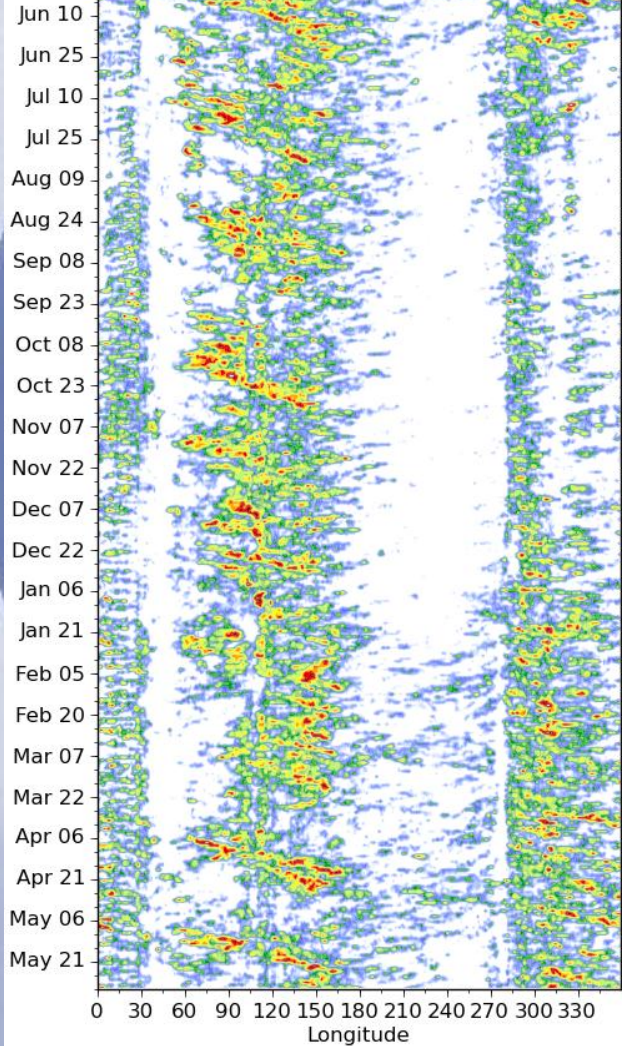
[hadobs.metoffice.com/tamip](http://hadobs.metoffice.com/tamip)

# Transpose AMIP – CAPT/DOE

## Utilizing YOTC Period/ECMWF Analysis

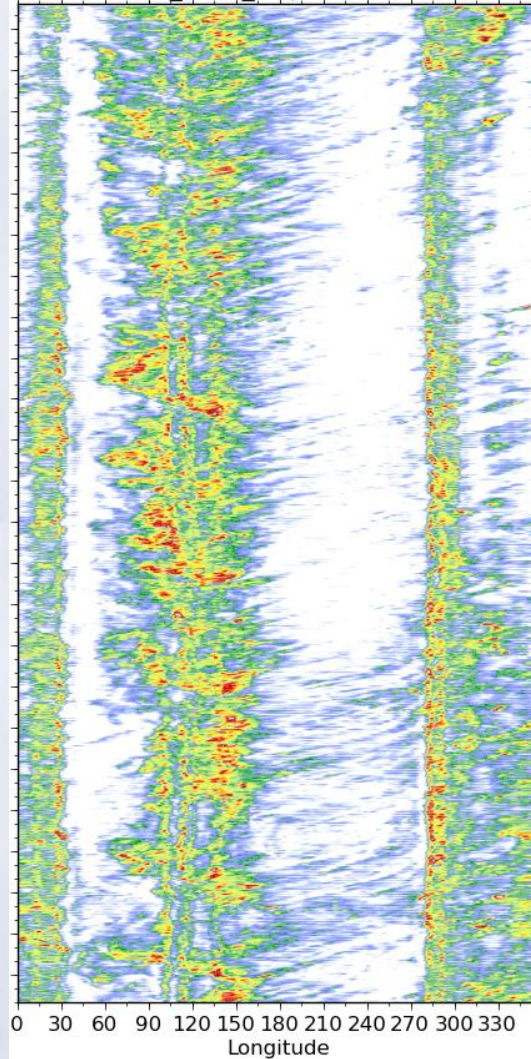
TRMM

TRMM 5.0S to 5.0N



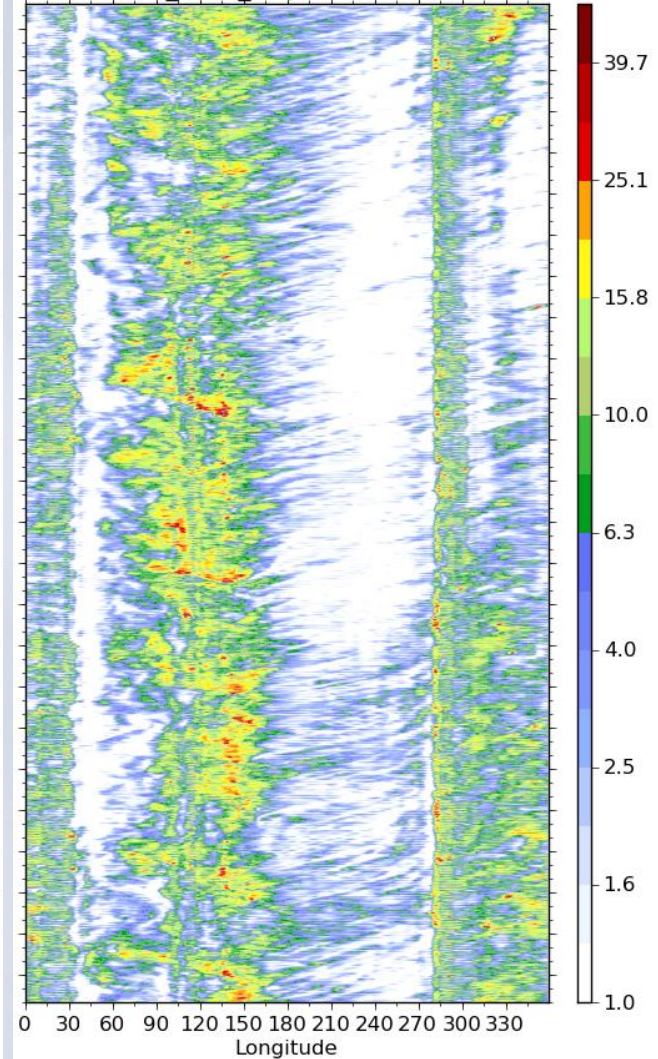
CAM4 – Day 2

CAM4-Y RAIN Day2 5.0S to 5.0N



CAM5 – Day 2

CAM5 RAIN Day2 5.0S to 5.0N



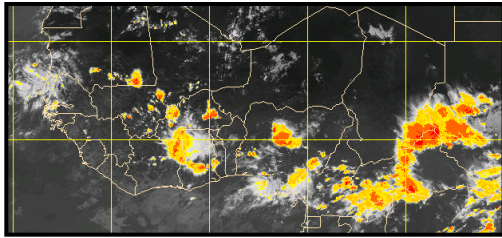
Courtesy S. Klein (PCMDI)

Cascade uses the UK Met Office Unified Model at cloud-system-resolving resolutions over large, limited-area tropical domains.

### Case Studies

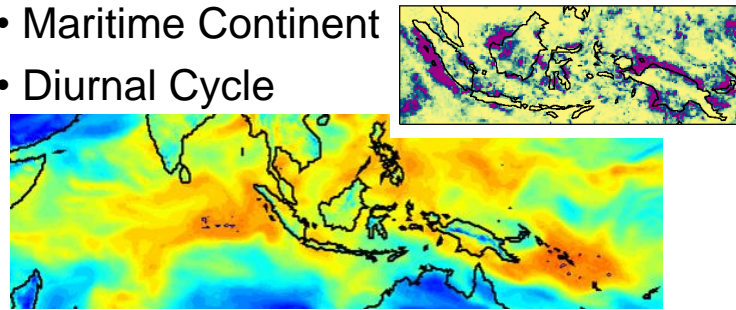
#### West Africa (AMMA cases)

- African Easterly Waves
- Diurnal Cycle



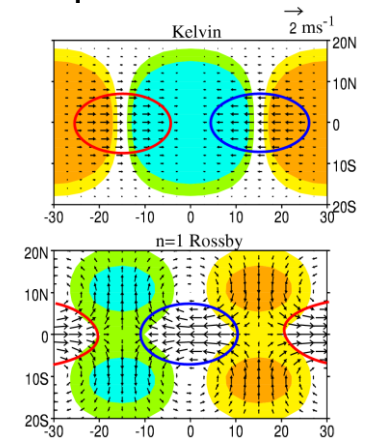
#### Warm Pool (using YOTC ECMWF for lateral boundaries and sci. analysis)

- MJO (YOTC cases)
- Maritime Continent
- Diurnal Cycle



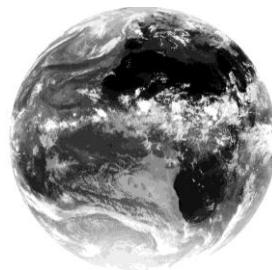
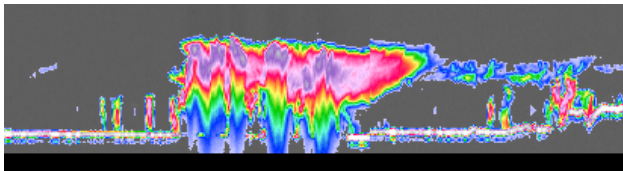
#### Idealised

- Warm Pool Convection
- Equatorial Waves



#### Model Evaluation against Observations

- CloudSat/CALIPSO: vertical cloud properties
- GERB/SEVIRI/MTSAT: horizontal and time

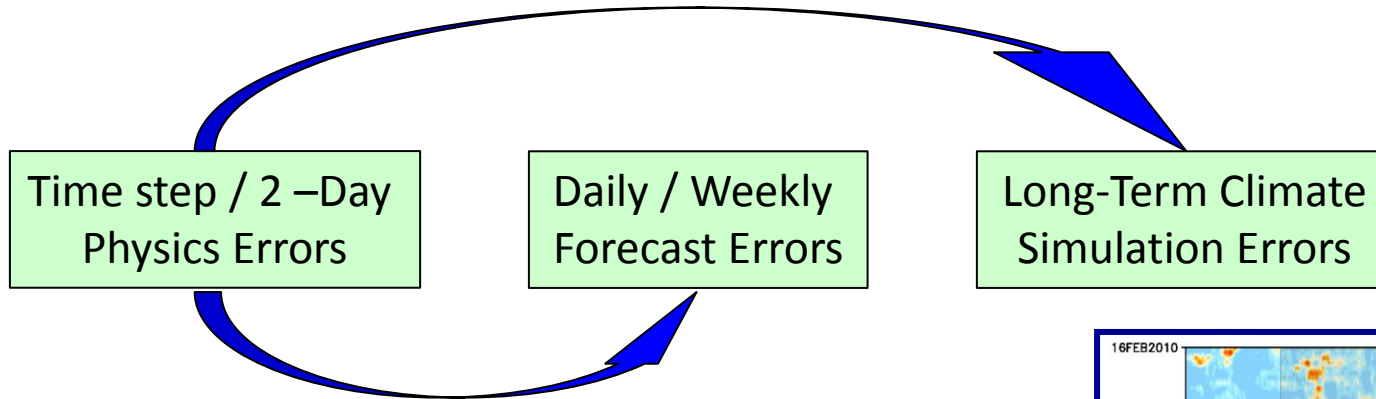


#### Synthesis

- Analysis of scale interactions
- Insight into physical processes
- Compare with climate / NWP resolution
- Conclusions for parameterization

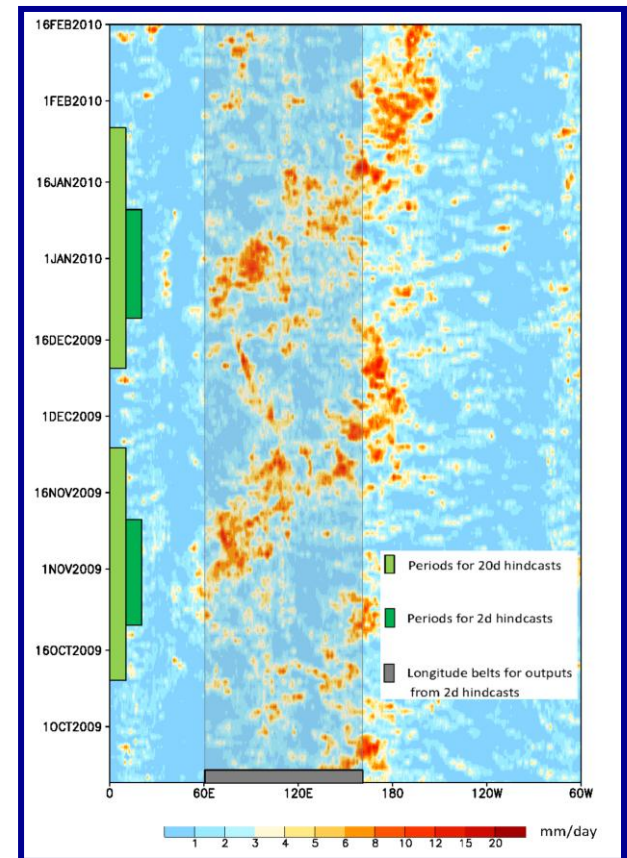
# Vertical Structure and Diabatic Processes of the MJO: *Global Model Evaluation Project*

MJO Task Force/YOTC and GASS



- 1. climate simulation** – multi-year simulations coupled or atmosphere only
- 2. short range hindcasts** – daily 48hr lead during ~20 days of the MJO
- 3. medium range hindcasts** – daily 20-day lead time

[www.ucar.edu/yotc/mjodiab.html](http://www.ucar.edu/yotc/mjodiab.html)





# Vertical Structure and Diabatic Processes of the MJO: *Global Model Evaluation Project*

MJO Task Force/YOTC and GASS



[www.ucar.edu/yotc/mjodiab.html](http://www.ucar.edu/yotc/mjodiab.html)

## Model Experiment

## Science Focus

## Exp. POC

I. **20 Yr Climatological Simulations**  
(1991-2010 if AGCM)  
6-hr, Global Output  
Vertical Structure, Physical Tendencies

Model MJO Fidelity  
Vertical structure  
Multi-scale Interactions:  
(e.g., TCs, Monsoon, ENSO)

**UCLA/JPL**  
X. Jiang  
D. Waliser

II. **2-Day MJO Hindcasts**  
YOTC MJO Cases E & F (winter 2009)\*  
Time Step, Indo-Pacific Domain Output  
Very Detailed Physical/Model Processes

Heat and moisture budgets  
Model Physics Evaluation  
(e.g. Convection/Cloud/BL)  
*Short range Degradation*

**Met Office**  
P. Xavier  
J. Petch

III. **20-Day MJO Hindcasts**  
YOTC MJO Cases E & F (winter 2009)\*  
3-hr, Global Output  
Elements of I & II

MJO Forecast Skill  
State Evolution/Degradation  
Elements of I & II

**NCAS/Walker in.**  
N. Klingaman  
S. Woolnough

\*DYNAMO Case TBD

Commitments: Over 40 Modeling Groups with AGCM and/or CGCM



# Participants

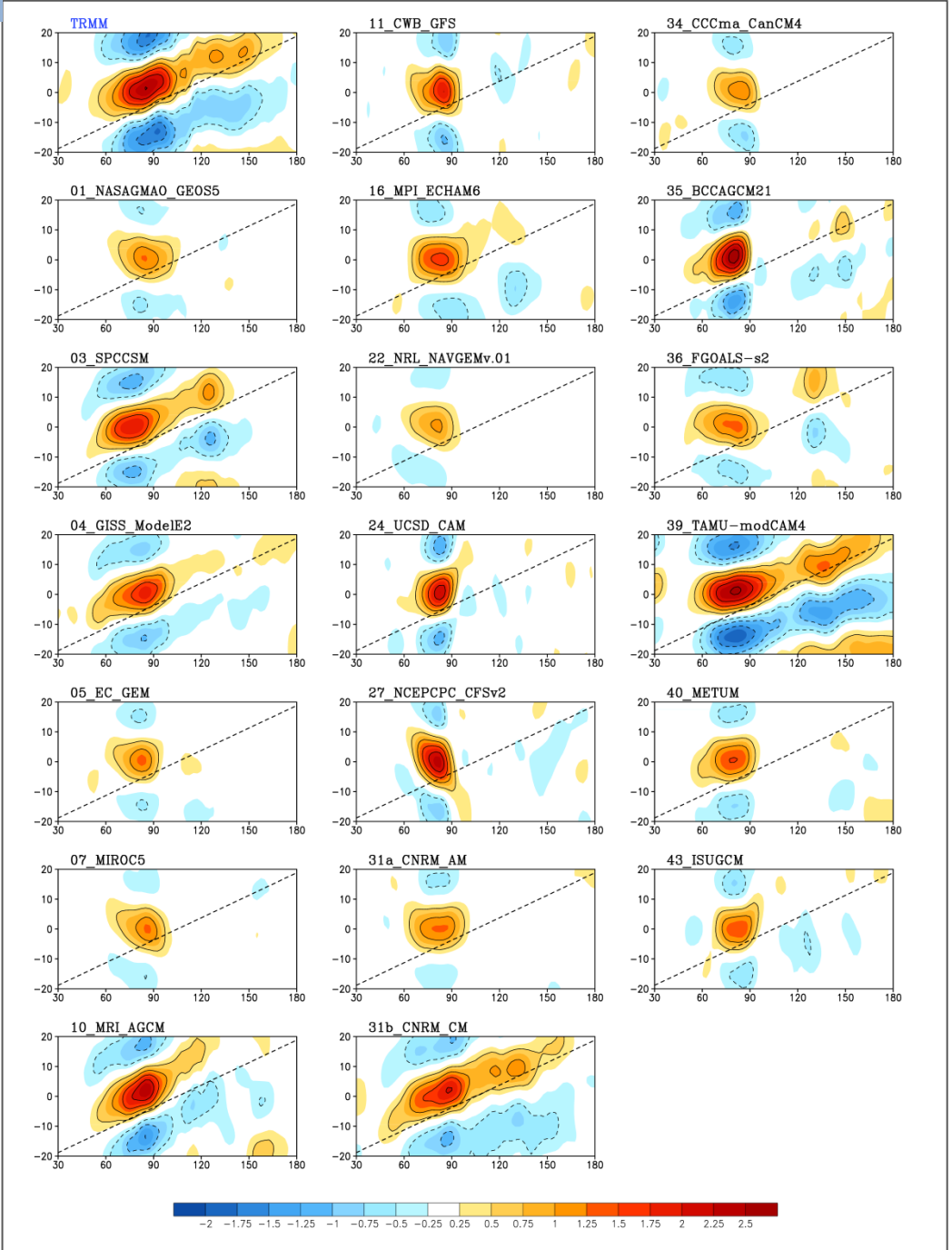


No	Model	Point of Contact	Institution	Experiment		
				Climatological Simulation	Short-term Hindcast	Long-term Hindcast
01	GEOS-5 AGCM	Siegfried Schubert; Hailan Wang	NASA/GMAO	X	X	X
02	IPRC GCM	Xiouhua Fu; Baoqiang Xiang	University of Hawaii	X		
03	SPCCSM / SPCAM	David Randall; Charlotte Demott; Cristiana Stan	Colorado State University COLA	X		
		Mike Pritchard (UW)	UCSD		X	X
04	NASA GISS	Daehyun Kim; Anthony Del Genio	LDEO	X		X
05	GEM model	Hai Lin	Environment Canada	X		
06	NICAM	Masaki Satoh ; Tomoe Nasuno	AORI, Univ. of Tokyo JAMSTEC	-		X
07	MIROC	Tomoki Miyakawa	AORI/Univ. Tokyo	X	X	X
10	MRI-GCM	Eiki SHINDO; Akio Kitoh	MRI	X	X	X
11	CWB AGCM	Mong-Ming Lu; Hsin-Hsing Chia; Hsiao-Chung Tsai	CWB, Taiwan	X		
12	WRF	Samson M Hagos	PNNL		X	
15	IFS	Frederic Vitart	ECMWF	-	X	X
16	ECHAM	Traute Crueger	ZMAW	X	-	-
17	MetUM GA3.0	Prince Xavier	Met Office UK		X	X
22	NAVGEM	Jim Ridout; Maria Flatau	NRL	X		X
24	CAM3/CAM5	Guang Zhang	UCSD	X	-	-
27	CFSv2	Wanqiu Wang	NCEP/CPC	X	-	-
30	GFSv2	Arindam Chakraborty	Indian Institute of Science	-	-	X
31a	CNRM_AM	Gilles Bellon	CNRM/France	X	-	-
31b	CNRM_CM					
34	CanCM4	John Scinocca; Bill Merryfield; Ajaya Mohan	CCCma	X	X	X
35	BCCAGCM2.1	Tongwen Wu, Jie Zhang	National Climate Center, China	X		
36	FGOALS2.0-s	Wenting Hu	LASG/IAP, China	X	-	-
37	ECHAM5-SIT	Wan-Ling Tseng; Noel Keenlyside	Univ of Bergen	X	-	-
39	Modified CAM4	Courtney Schumacher; Cara-Lyn Lappen	TAMU	X		
40	METUM	Hongyan Zhu	BoM, Australia	X	-	-
43	ISUGCM	Xiaoqing Wu	Iowa State University	X	-	-

# Lag-regression of rainfall with Indian Ocean (70-90E; 5S-5N) base point

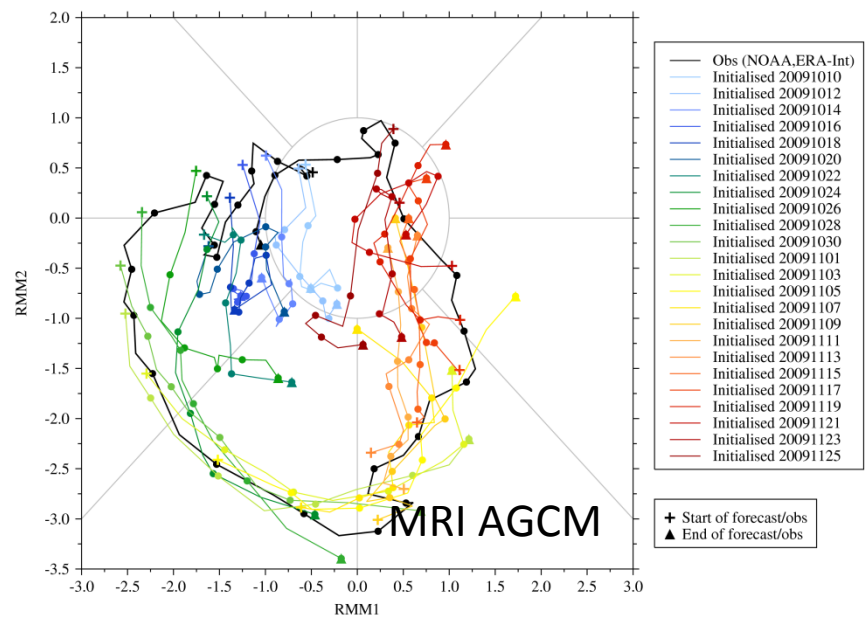
20-90day filtered

dash line – 5 m/s

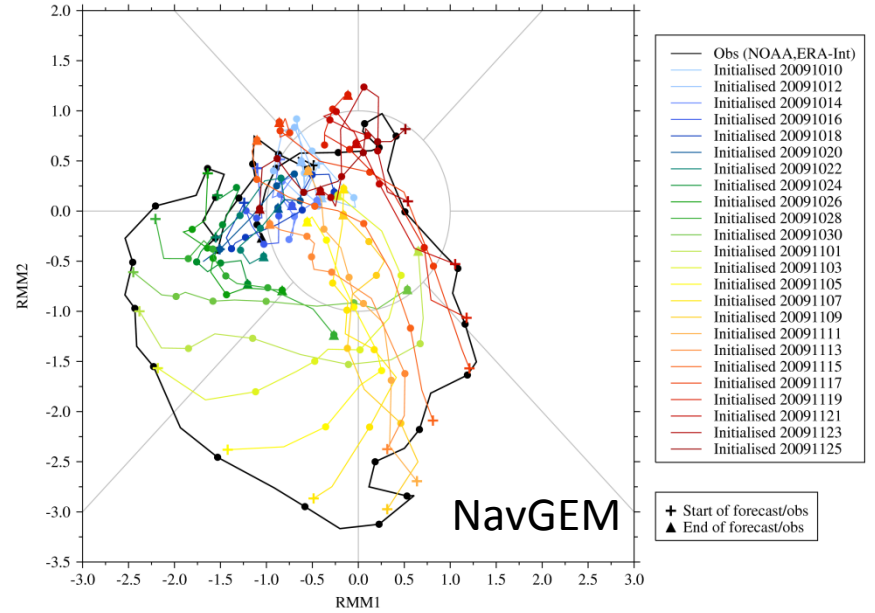
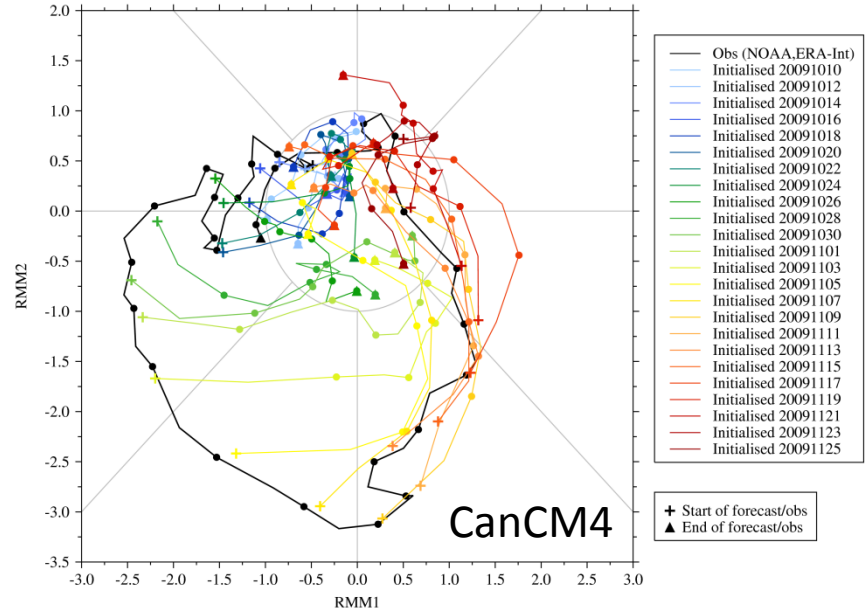
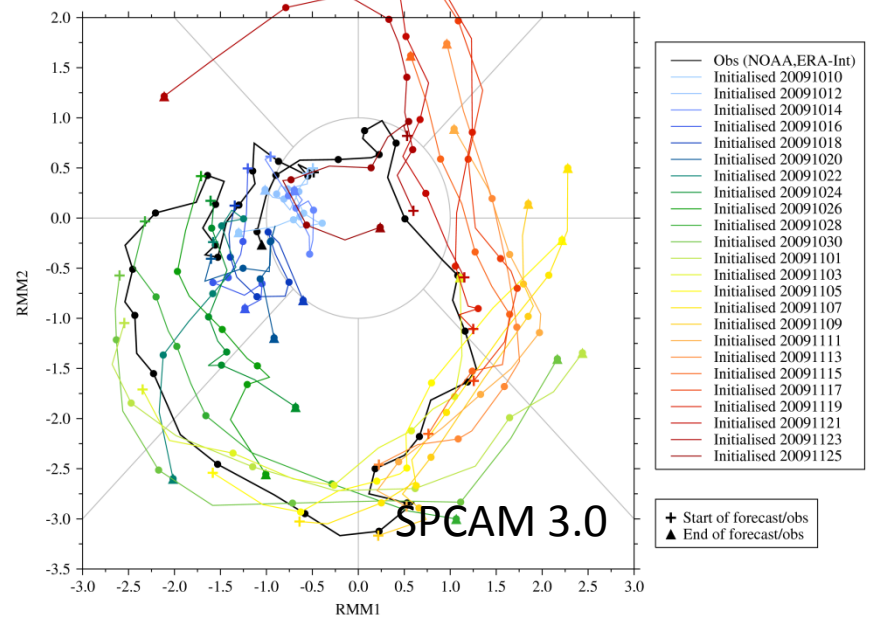


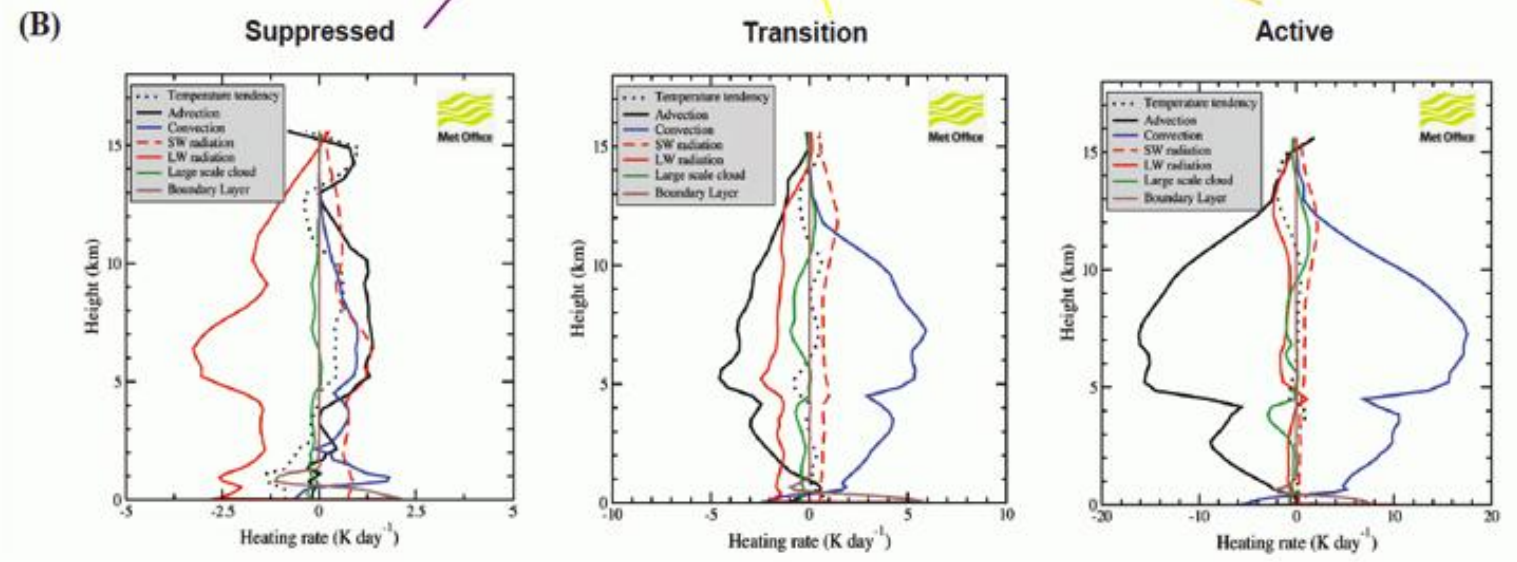
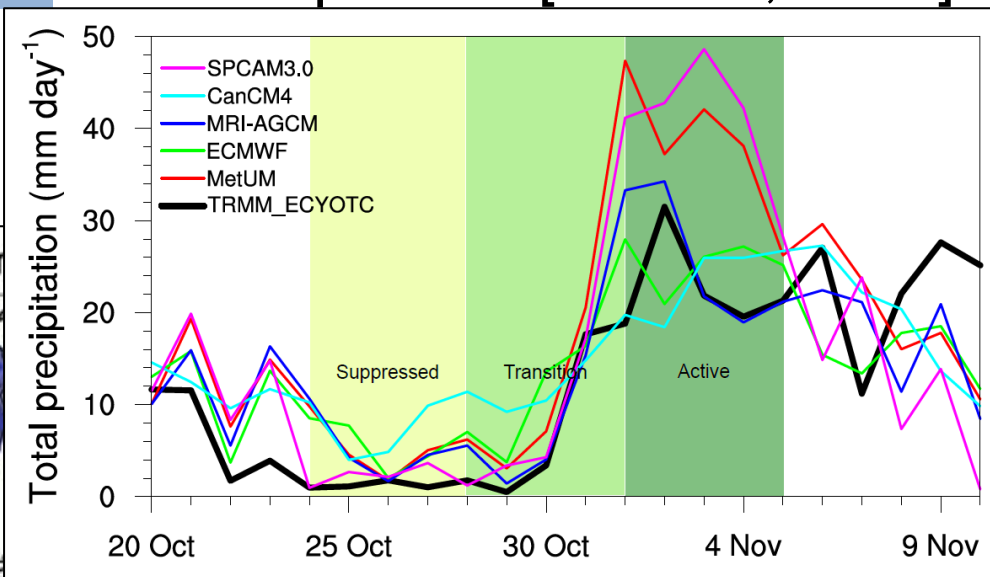
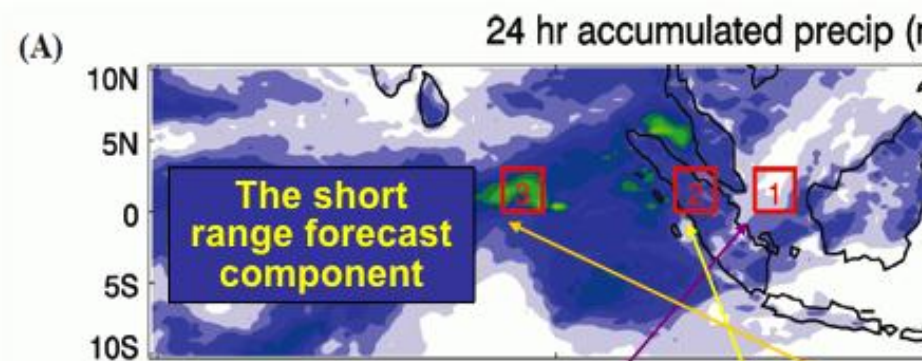
# RMM indices at constant start date

RMM indices with lead time from MRI-AGCM for initialisation dates 20091010-20091125



RMM indices with lead time from SPCAM3 for initialisation dates 20091010-20091125





## Plans and Approximate Timeline

*Apr 2012 : Initial Deadline for Model Submission*

*Sep 2012 : Very Preliminary Results at Pan-GASS Meeting*

*-> Alert Modeling Groups of 3<sup>rd</sup> Hindcast Case from DYNAMO*

*Dec 2012 : FINAL Deadline for Submissions for Initial Publications*

*-> Adjust exp framework based on experience to optimize DYNAMO case*

*-> Call for DYNAMO case*

*Apr 2013 : Potential Side Workshop w/ WGNE SE Workshop*

*Jun 2013 : Draft Papers & Public Availability of Model Output*

*Sep 2013 : Submission of 3 Initial Papers on 3 Components*

*Fall 2013 : Summary Paper/Workshop: Recommend high-priority process modelling needs identified from the 3 initial analyses.*

*-> Likely to utilize DYNAMO case for GASS-like process modelling study*



# MJO Task Force : Background

- Established in Jan 2010 for an initial term of 3 years
- Sponsor: WCRP-WWRP/THORPEX under their YOTC Project
- Follow on from the success of US CLIVAR MJO Working Group
- Website: [www.ucar.edu/yotc/mjo.html](http://www.ucar.edu/yotc/mjo.html)

## Members

Matthew Wheeler	Centre for Australian Weather and Climate Research ( <b>co-chair</b> )
Eric Maloney	Colorado State University ( <b>co-chair</b> )
Duane Waliser	Jet Propulsion Laboratory/Caltech
Ken Sperber	PCDMI/Lawrence Livermore National Laboratory
Xiouhua Fu	University of Hawaii
Jon Gottschalck	National Centers for Environmental Prediction
Richard Neale	National Center for Atmospheric Research
Chidong Zhang	University of Miami
Daehyun Kim	Columbia University
Augustin Vintzileos	National Centers for Environmental Prediction
Masaki Satoh	Frontier Research Center for Global Change
Hai Lin	Environment Canada
Prince Xavier	UK Met Office
June-Yi Lee	University of Hawaii
Steve Woolnough	University of Reading

## Important others and former members

X. Jiang, N. Klingaman, J. Petch, F. Vitart, J. Benedict, H. Hendon, D. Raymond

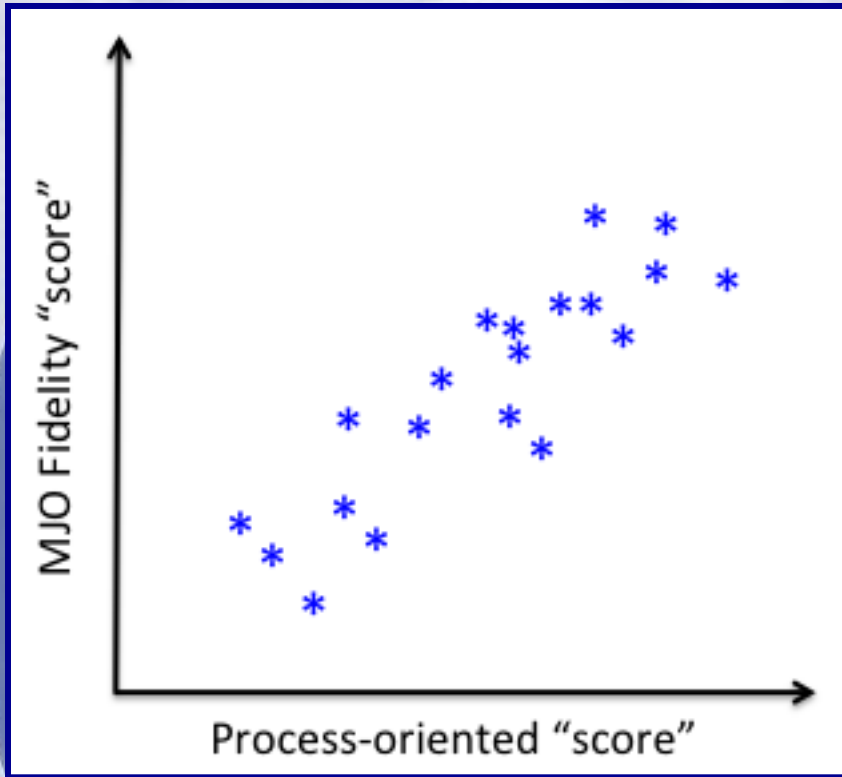
**Overall Goal:** Facilitate improvements in the representation of the MJO in weather and climate models in order increase the predictive skill of the MJO and related weather and climate phenomena.

### Organized into 4 Subprojects

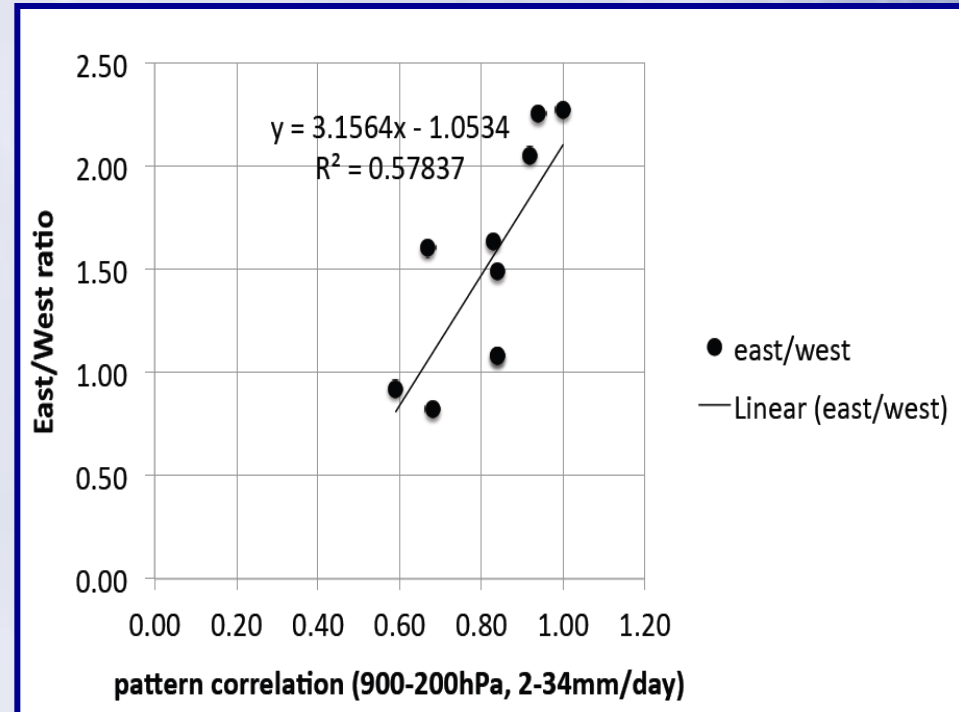
- ✧ MJO metric(s) for WGNE/WGCM Climate Metrics Panel  
(leads: *K. Sperber, D. Kim*)
- ✧ Process-oriented diagnostics/metrics for MJO simulation  
(leads: *D. Kim, P. Xavier, E. Maloney*)
- ✧ Boreal summer monsoon ISV monitoring and forecast metrics  
(leads: *J.-Y. Lee, M. Wheeler, A. Vintzileos*)
- ✧ MJO TF + GASS Multi-Model Diabatic Processes Experiment  
(leads: *D. Waliser, X. Jiang, J. Petch, P. Xavier, S. Woolnough, N. Klingaman*)



# MJO TF Subproject: Metric/Diagnostic Goals



Combine performance metrics (y-axis) and process diagnostic (x-axis) to provide pathways to understanding and improving MJO model performance.



# CLIVAR MJO WG Item III: Operational MJO Forecast Metric

(Gottschalck et al. BAMS, 2010)



## Use of a common metric allows for:

- quantitative forecast skill assessment.
- targeted model improvements.
- friendly competition to motivate improvements.
- developing a multi-model ensemble forecast.

National Weather Service  
Climate Prediction Center

Home Site Map News Organization

HOME > Climate & Weather Linkage > US CLIVAR MJO Index Forecast Comparisons

### US CLIVAR MJO Working Group

#### Forecast Metrics

- [Forecasts](#)
- [Methodology](#)
- [Verification](#)
- [References](#)

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- **Forecasts**

A key for the label headings in the figure box is provided below. Click on the headings for larger size images and specific model-related information.

## Center Participation

**US – NCEP**

**ECMWF**

**United Kingdom**

**Brazil**

**US – NRL**

**India**

**Taiwan**

**Australia**

**Japan**

**Canada – CMC**

10 operation centers, 20 data streams, 13 ensemble forecasts (with 4 – 51 members)

Outreach

About Us

Our Mission

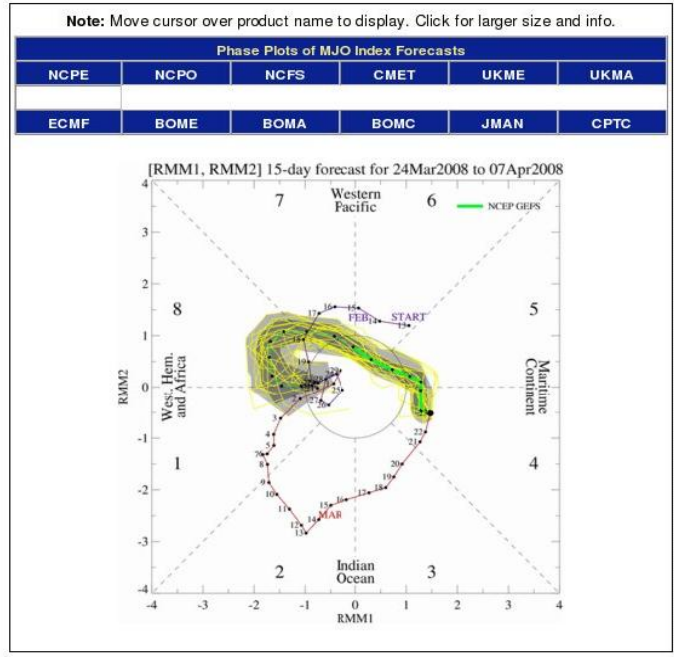
Who We Are

Contact Us

CPC Information

CPC Web Team

USA.gov



# MJO TF Subproject: Boreal Summer ISV Forecast Metric

## Boreal Summer Monsoon Intraseasonal Oscillation

# MISO

Welcome to the monitoring page on Boreal summer monsoon intraseasonal provides the latest information on ISO over the Asian monsoon region using 04:00 UTC on every Wednesday.

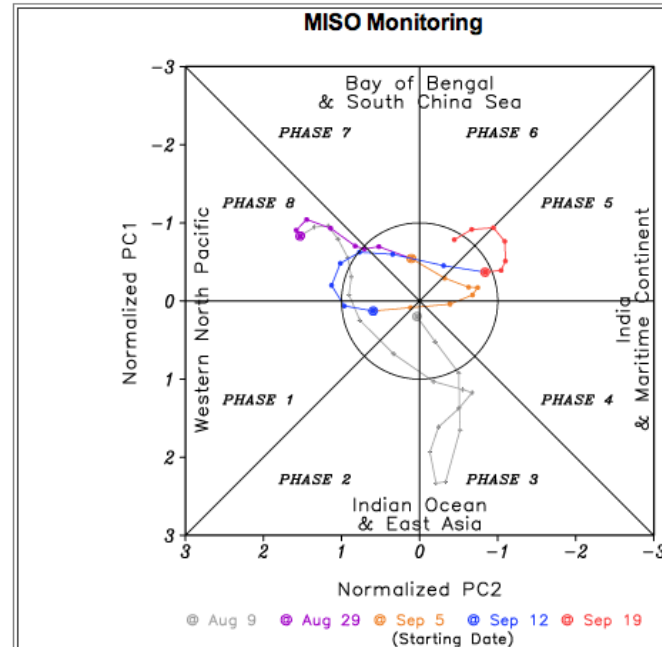
[Home](#)

[Introduction](#)

[Definition of MISO Index](#)

[Real-time Monitoring](#)

[Data and Program](#)

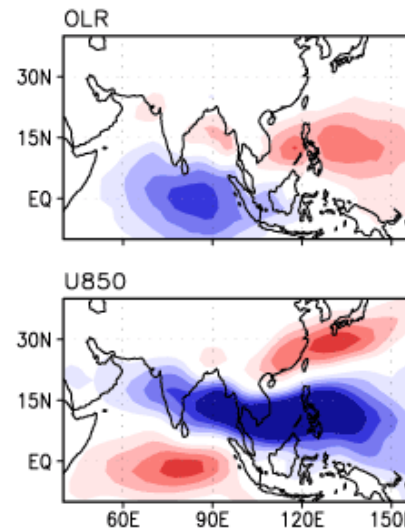


An metric tailored for boreal summer ISV operational monitoring and forecasting applications.

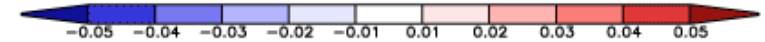
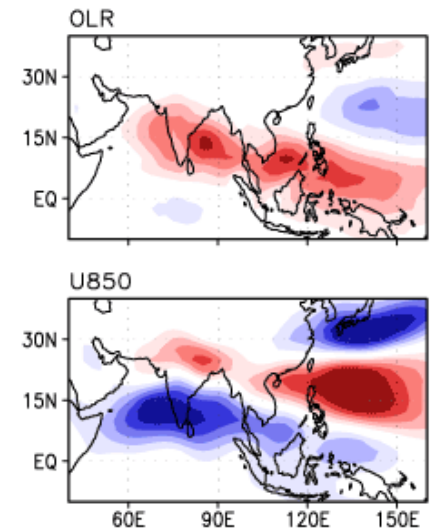
*Based on Lee et al. (2012)*

### The First and Second EOF Modes

(a) The First EV



(b) The Second EV



(c) PC

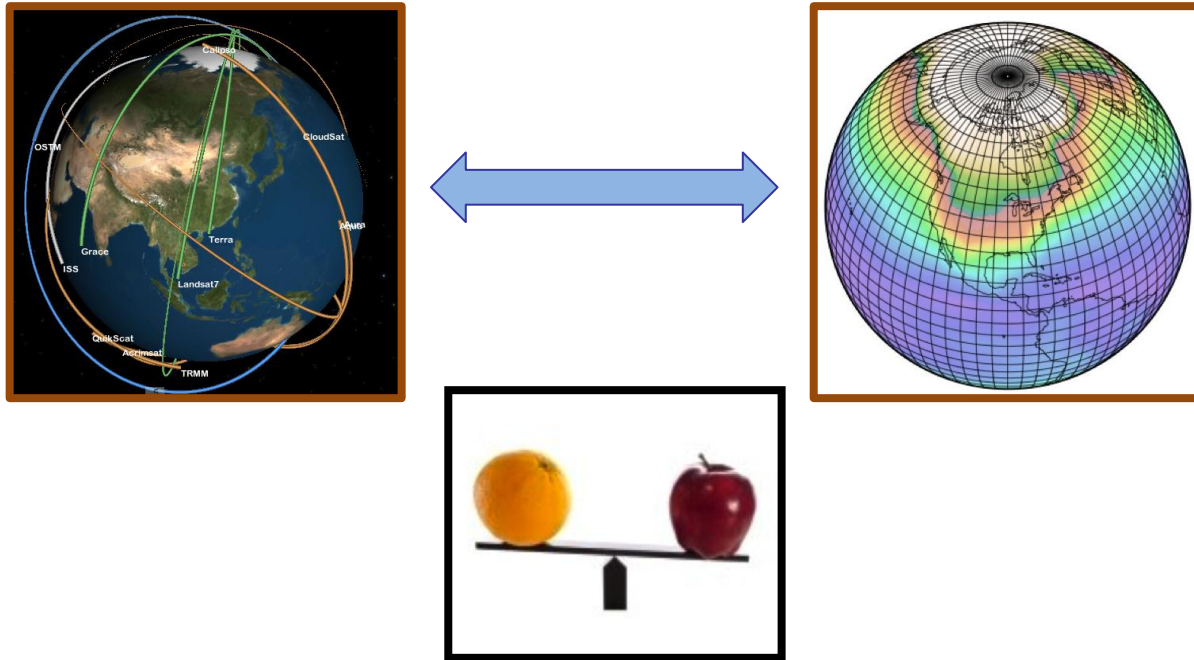
Contacts:

June-Yi Lee & Bin Wang

IPRC/U. Hawaii

<http://iprc.soest.hawaii.edu/users/jylee/miso/miso.htm>

# Satellite observations for CMIP5/IPCC Model Evaluation



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*Many Acknowledgements  
JPL/NASA, PCMDI  
NASA obs4MIPs Working Group  
WCRP encouragement/support via WGCM/CFMIP  
Significant IT support via ESGF developments, PCMDI & NASA  
Many data providers NASA, NOAA, CFMIP, CNES, etc*

# Model and Observation Overlap

For what quantities are these comparisons viable?



CMOR Table Armon: Monthly Mean Atmospheric Fields and Some Surface Fields

(All Saved on the Atmospheric Grid)

Taylor et al. 2008

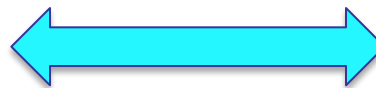
pheny	long name	units	comment	specimen	output variable name
1	Near-Surface Air Temperature	K	near surface (causally 2 meters) air temperature		tas
2	Surface Temperature	K	"skin" temperature (i.e., SST for seas area)		ts
3	Daily Maximum Near-Surface Air Temperature	K	monthly mean of the daily maximum near surface (causally 2 meters) air temperature		tasmax
4	Daily Minimum Near-Surface Air Temperature	K	monthly mean of the daily minimum near surface (causally 2 meters) air temperature		tasmin
5	Sea Level Pressure	Pa	sea, in general, the same as surface pressure		slp
6	Surface Air Pressure	Pa	sea, in general, the same as near sea-level pressure		slp
7	Eastward Near-Surface Wind	m s <sup>-1</sup>	near surface (causally 10 meters) eastward component of wind		uas
8	Northward Near-Surface Wind	m s <sup>-1</sup>	near surface (causally 10 meters) northward component of wind		vas

~120 ocean  
 ~60 land  
 ~90 atmos  
 ~50 cryosphere



Current NASA Missions ~14  
 Total Missions Flown ~ 60  
 Many with multiple instruments  
 Most with multiple products (e.g. 10-100s)  
 Many cases with the same products

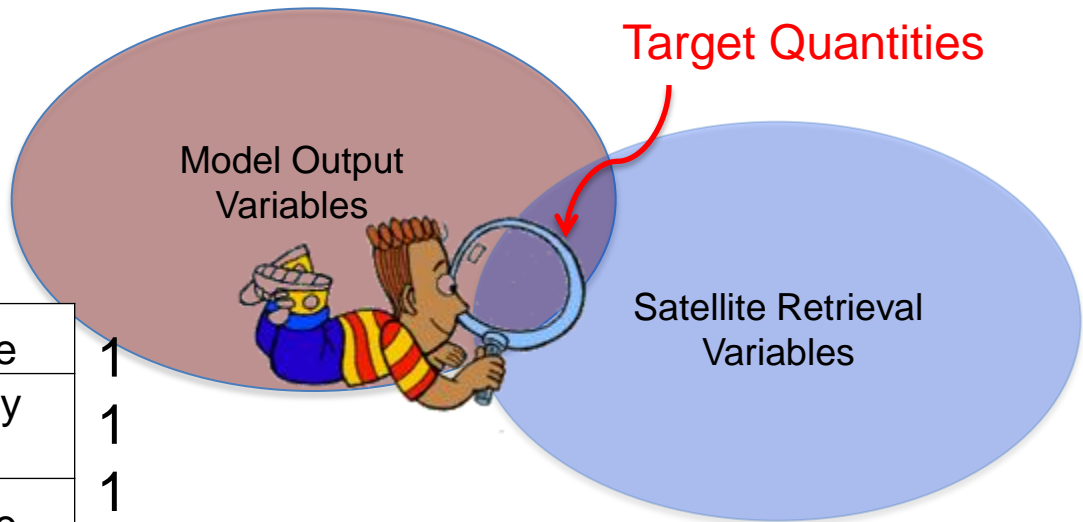
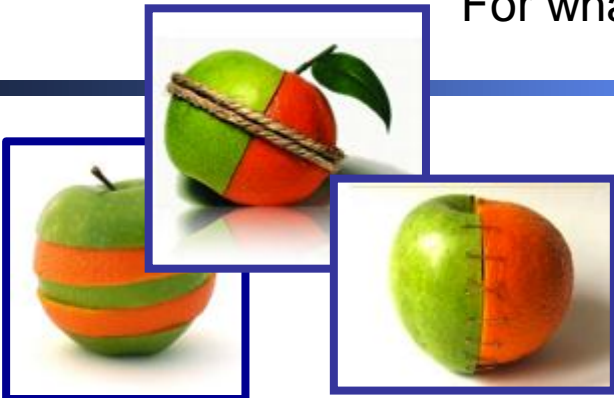
Over 300 Variables in (monthly) CMIP Database



Over 1000 satellite-derived quantities

# Model and Observation Overlap

For what quantities are these comparisons viable?



AIRS ( $\geq 300$ hPa)	Atm temp profile	1
	Specific humidity profile	1
MLS ( $< 300$ hPa)	Atm temp profile	1
	Specific humidity profile	1
QuikSCAT	Ocean surface winds	~4
TES	Ozone profile	1
AMSR-E	SST	1
TOPEX/JASON	SSH	1
CERES	TOA radiation fluxes	~6
TRMM	Total precipitation	1
MODIS	Cloud fraction	1
	Net primary production	3

## Present efforts are working to provide:

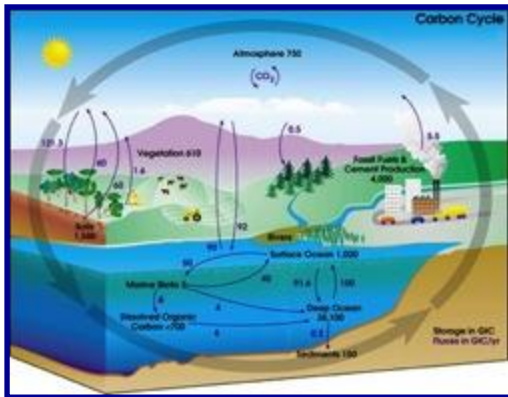
- CFMIP cloud-related products (much of this completed)
- MISR (land) and MODIS (ocean) AOD
- Sea Ice (NSIDC)
- CALIPSO Aerosol Optical Extinction Profile
- CERES surface radiation budget
- MODIS Land (e.g. albedo, LAI, FPAR)

Discussions with ESA's CMUG & CEOS Climate Working Group & WDAC to expand holdings.

# Satellite Observations for CMIP and IPCC ARs

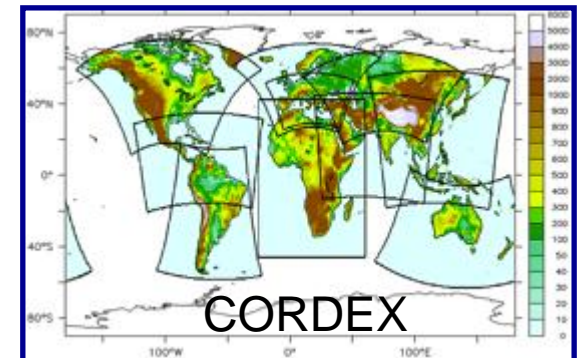
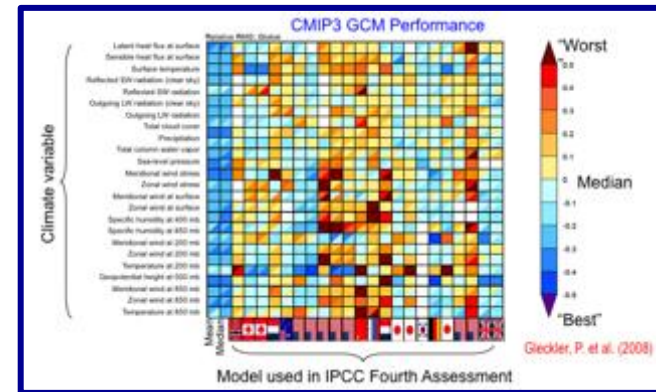
*Why is this timely for AR5 and beyond?*

Model Scoring w/ Observations: “1 model – 1 vote” to weighting projections based on obs metrics (e.g. WGCM/WGNE Metrics Panel)



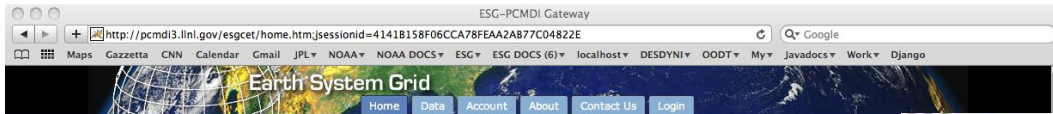
Earth System Modeling (e.g. Coupled Carbon-Climate): added complexity, more degrees of freedom, need for observational constraints; many assets here / on horizon.

Decadal Predictions: Downscaling GCMs with regional models is key to many decision-support issues; systematic application of observations for regional model evaluation is even less mature than for GCMs.



# Satellite Observations for CMIP5 Simulations

## Data Available Now on Earth System Grid



ESG Gateway hosted by the Program for Climate Model Diagnosis and Intercomparison

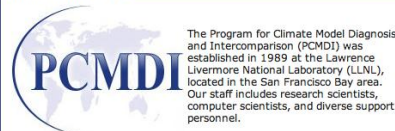
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#### Welcome to PCMDI



The PCMDI mission is to develop improved methods and tools for the diagnosis and intercomparison of general circulation models (GCMs) that simulate the global climate. The need for innovative analysis of GCM climate simulations is apparent, as increasingly more complex models are developed, while the disagreements among these simulations and relative to climate observations remain significant and poorly understood. The nature and causes of these disagreements must be accounted for in a systematic fashion in order to confidently use GCMs for simulation of putative global climate change.

#### Status of the CMIP5 Archive

- 3/23/2011: HadGEM2-ES (UK Met Office / Hadley Centre) datasets are available from BADC.
- 3/23/2011: Inmcm4 datasets are now available from the PCMDI server.
- 4/4/2011: Some GISS-E2-R datasets are available.
- 4/11/2011: GISS-E2-R historical datasets are available.
- 4/13/2011: CNRM-CM5 datasets for piControl, historical and xxCO2 runs are accessible for all realms but ocean and sea-ice.
- 4/20/2011: IPSL-CM5A-LR piControl and historical datasets are available to the CMIP5 research group.
- 4/21/2011: CCCMA / CanESM2 datasets are available.
- 4/21/2011: BCC datasets will be available at the end of April.

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User: guest

## PCMDI Gateway



ESG Gateway hosted at the NASA Jet Propulsion Laboratory

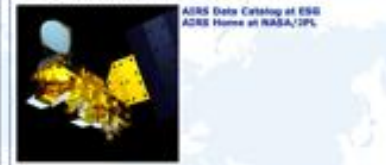
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- > IPSL
- > NERC
- > NASA-GISS
- > NASA-JPL
- Model
- Experiment
- Frequency
- Product
- Realm
- Atmosphere
- > Land
- > Land Sea
- > Ocean
- > Sea Ice
- Variable
- > air pressure
- > air pressure at cloud top
- > air pressure at convective cloud base
- > air pressure at convective cloud top
- > air pressure at sea level
- > air temperature
- > area fraction
- > atmosphere cloud condensed water content
- > atmosphere cloud ice content
- > atmosphere heat diffusivity
- > atmosphere momentum

#### Atmospheric Infrared Sounder (AIRS)



#### Midwave Limb Sounder (MLS)



#### Tropospheric Emission Spectrometer (TES)



#### Quick Links

- Getting Started Guide
- Create Account
- Browse Catalogs
- Search for Data

#### ESG Federation

- PCMDI Gateway
- BADC Gateway
- DNM Gateway
- NASA JPL Gateway
- NCAR Gateway
- NERSC Gateway
- ORNL Gateway

## NASA & IPSL Nodes



# Satellite Observations for IPCC / Climate Modeling

## *Future Emphases and Needs*

- Identify additional observations to include in this activity (broader participation). Efforts to provide broader governance are underway WCRP (e.g. WDAC).
- Continue links to WGCM/WGNE Climate Metrics Panel.
- Continue to work with the ESG community and PCMDI to facilitate the means to utilize the satellite data.
- Encourage missions to develop products analogous to model output, including satellite simulators for more direct comparisons with observed quantities (e.g. COSP, but for other processes/ES components).
- Encourage modeling community to develop the means to output quantities analogous to satellite retrieved quantities.
- Workshop planned for fall 2013 to begin planning for CMIP6.
- Cultivate more coherent input from the modeling community on observations critical to model development/evaluation and reducing projection uncertainties. *This could/should include WGNE, WGCM, WMAC/WDAC.*

# NASA Planned New Missions (2011-2023)

