

Climate variability and weather highlights during the “Year”

Tropical convection, its organization and its large-to-global scale interaction

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**A Contribution to Seamless
Weather-Climate Prediction**

**YOTC Symposium
CMA, Beijing, May 2011**

DEVELOP A VIRTUAL “FIELD PROGRAM” WITH EXISTING RESOURCES WITH MODEL, PARAMETERIZATION & FORECAST IMPROVEMENT AS A CHIEF OBJECTIVE.

New/Improved Resources

- Satellite Observations (e.g., EOS)
- In-Situ Networks (ARM, CEOP)
- GOOS (e.g., TAO, PRADA, drifters)
- IOPs (e.g., VOCALS, T-PARC, AMY)
- High-Resolution Deterministic Forecast Models & Global Analyses
- Research Models [e.g., Regional and Global Cloud(-System) Resolving Models]

Conceptual Framing

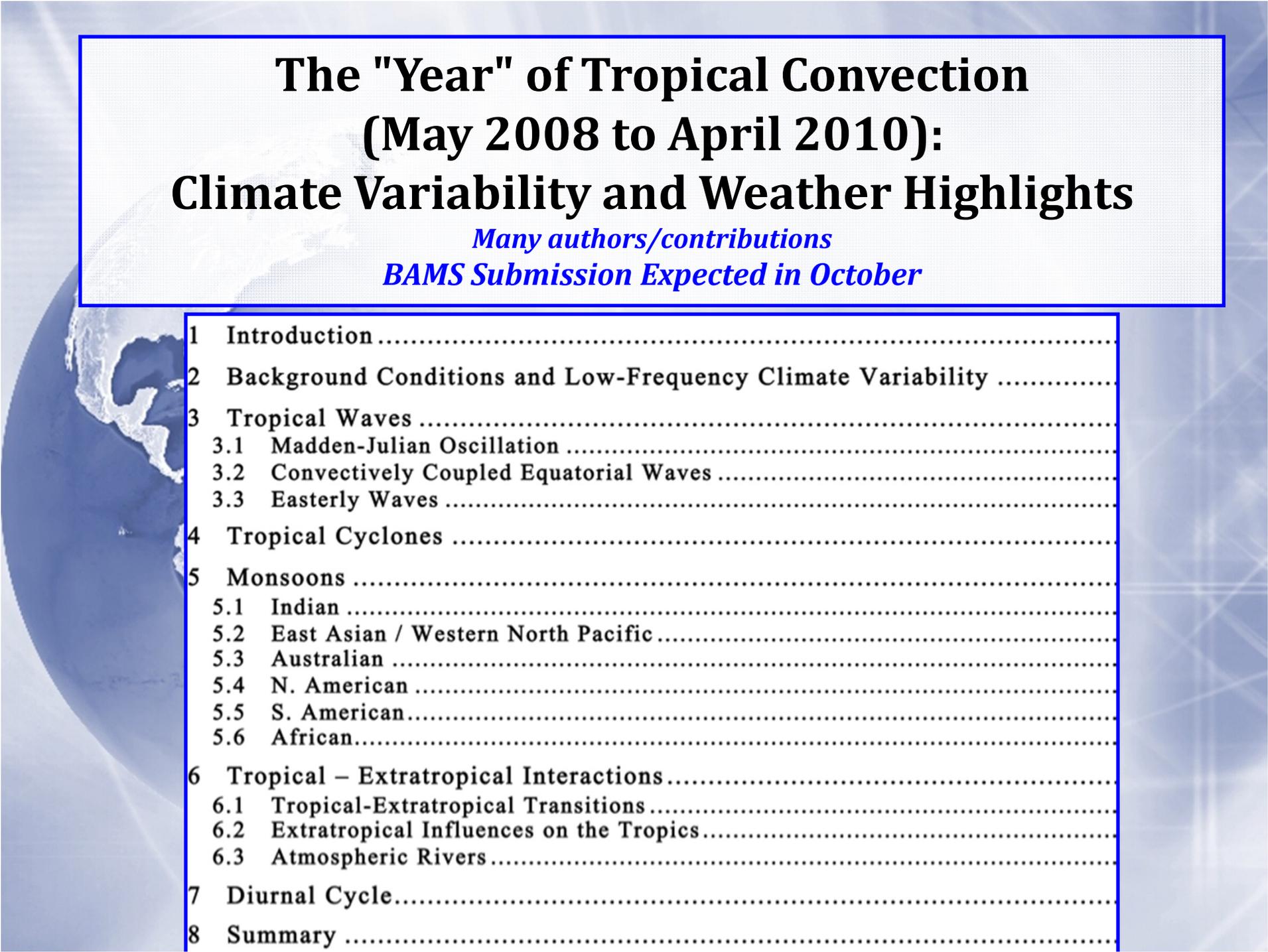
FGGE,
GATE,
TOGA
COARE

+

=

YOTC

Focus “Year”
Virtual IOP
May’08 – Apr’10

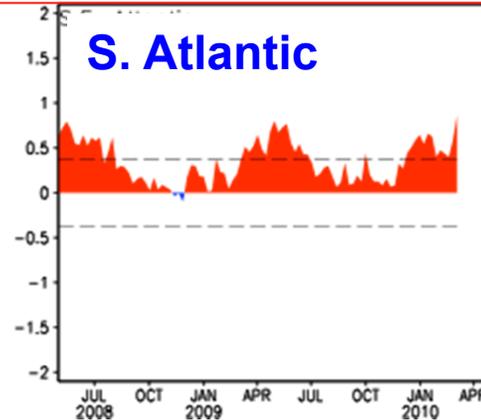
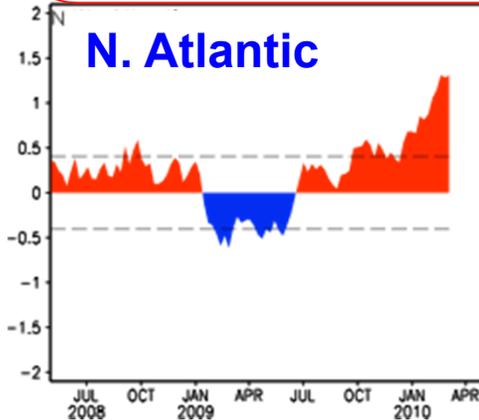
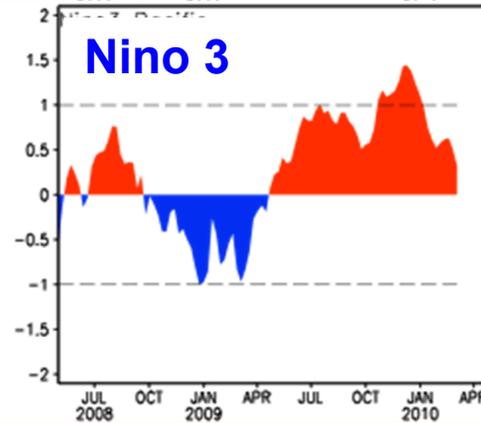
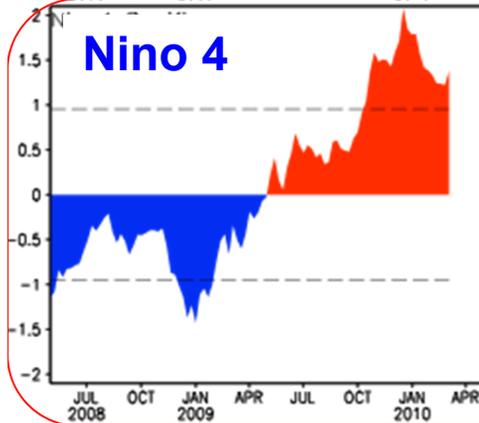
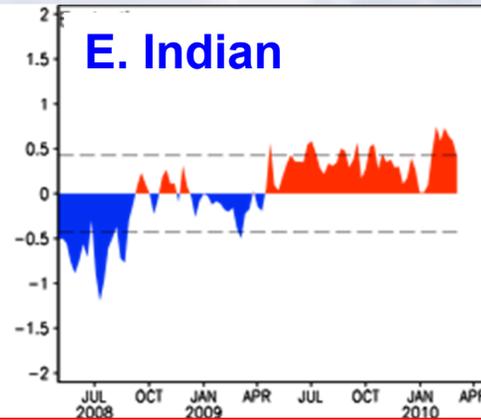
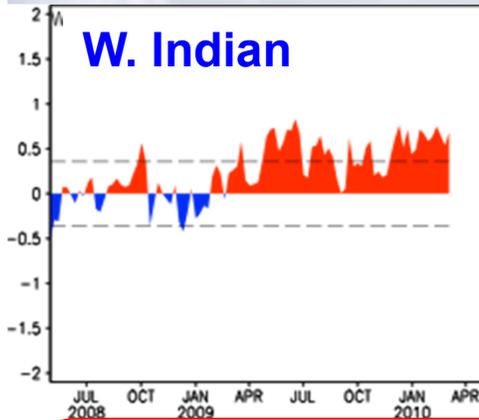


The "Year" of Tropical Convection (May 2008 to April 2010): Climate Variability and Weather Highlights

Many authors/contributions
BAMS Submission Expected in October

1	Introduction
2	Background Conditions and Low-Frequency Climate Variability
3	Tropical Waves
3.1	Madden-Julian Oscillation
3.2	Convectively Coupled Equatorial Waves
3.3	Easterly Waves
4	Tropical Cyclones
5	Monsoons
5.1	Indian
5.2	East Asian / Western North Pacific
5.3	Australian
5.4	N. American
5.5	S. American
5.6	African
6	Tropical – Extratropical Interactions
6.1	Tropical-Extratropical Transitions
6.2	Extratropical Influences on the Tropics
6.3	Atmospheric Rivers
7	Diurnal Cycle
8	Summary

Tropical SSTs



Background Conditions & Low Frequency SST

Warm in Year 2
Mostly +DMI

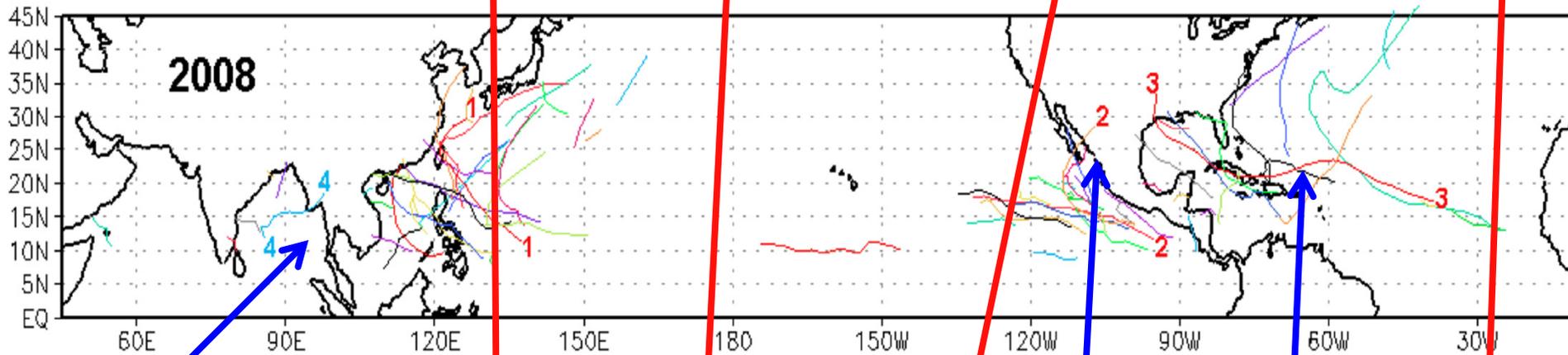
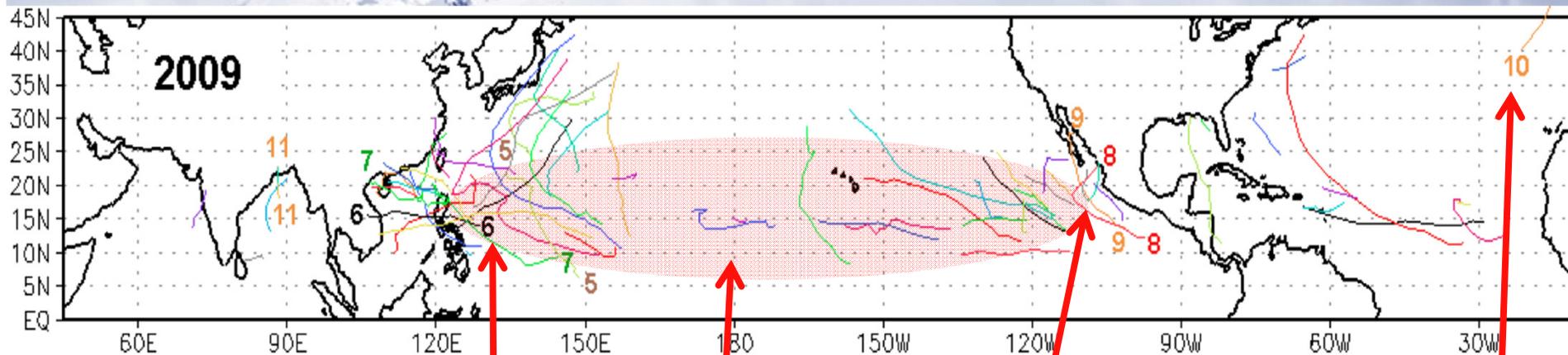
Year 1 – Modest La Nina
Year 2 – Modest El Nino

Mostly Warm Atlantic

Tropical Cyclone Occurrence During YOTC

Boreal Summer

Julian Hemming



Nargis, landfall over Myanmar, huge storm surge, 100,000 lives

Parma-1.8 m Rainfall

El Nino Modulation

Rick, 2nd Strongest

3 landfalls in Mexico

Ike - Largest size & Marko - smallest TC ever in this basin.

Grace

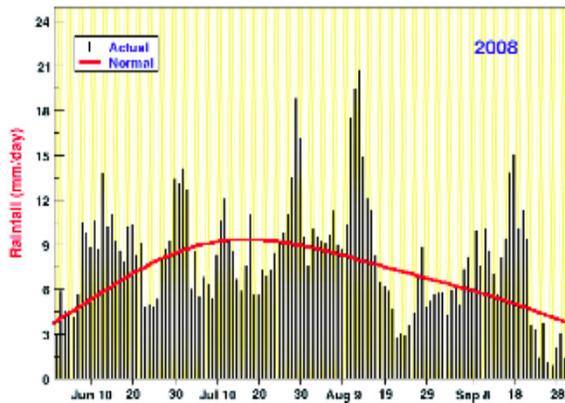
Summer Monsoons During YOTC

India
BN Goswami

S. America
Jose Marengo

2008

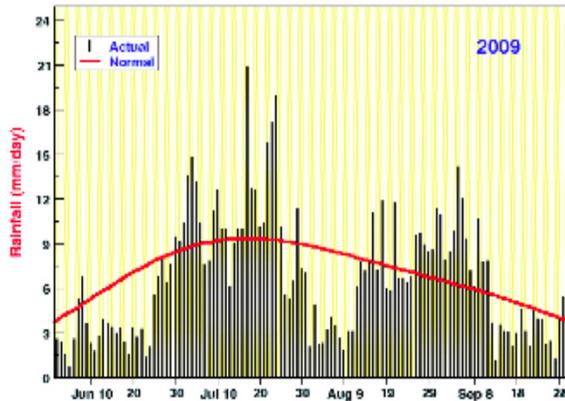
Wet-north
Dry-south



“Normal”
98% AIR

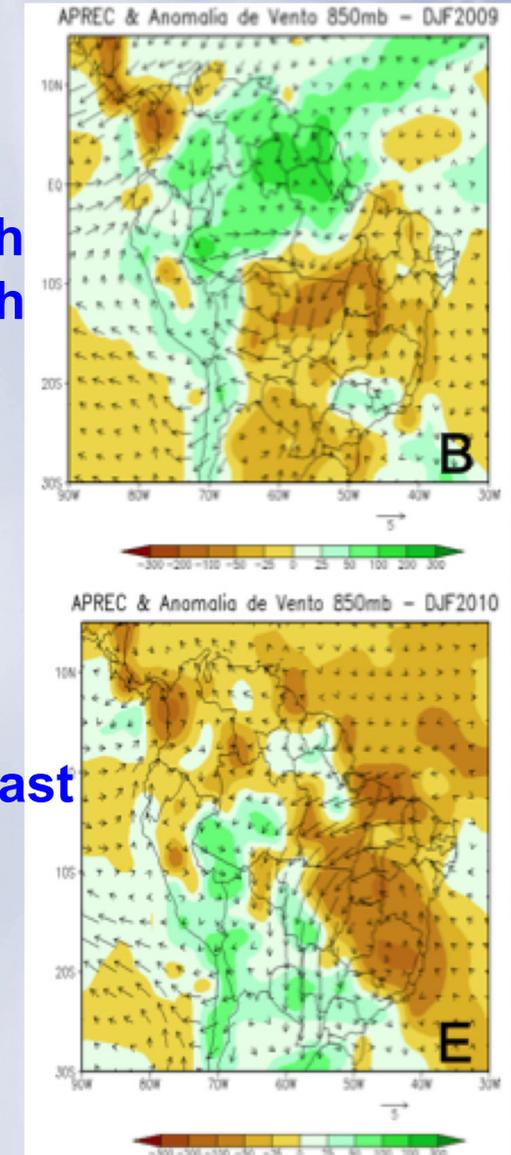
2009

Dry-north/east
Wet-south



Very Large
Drought
78% AIR

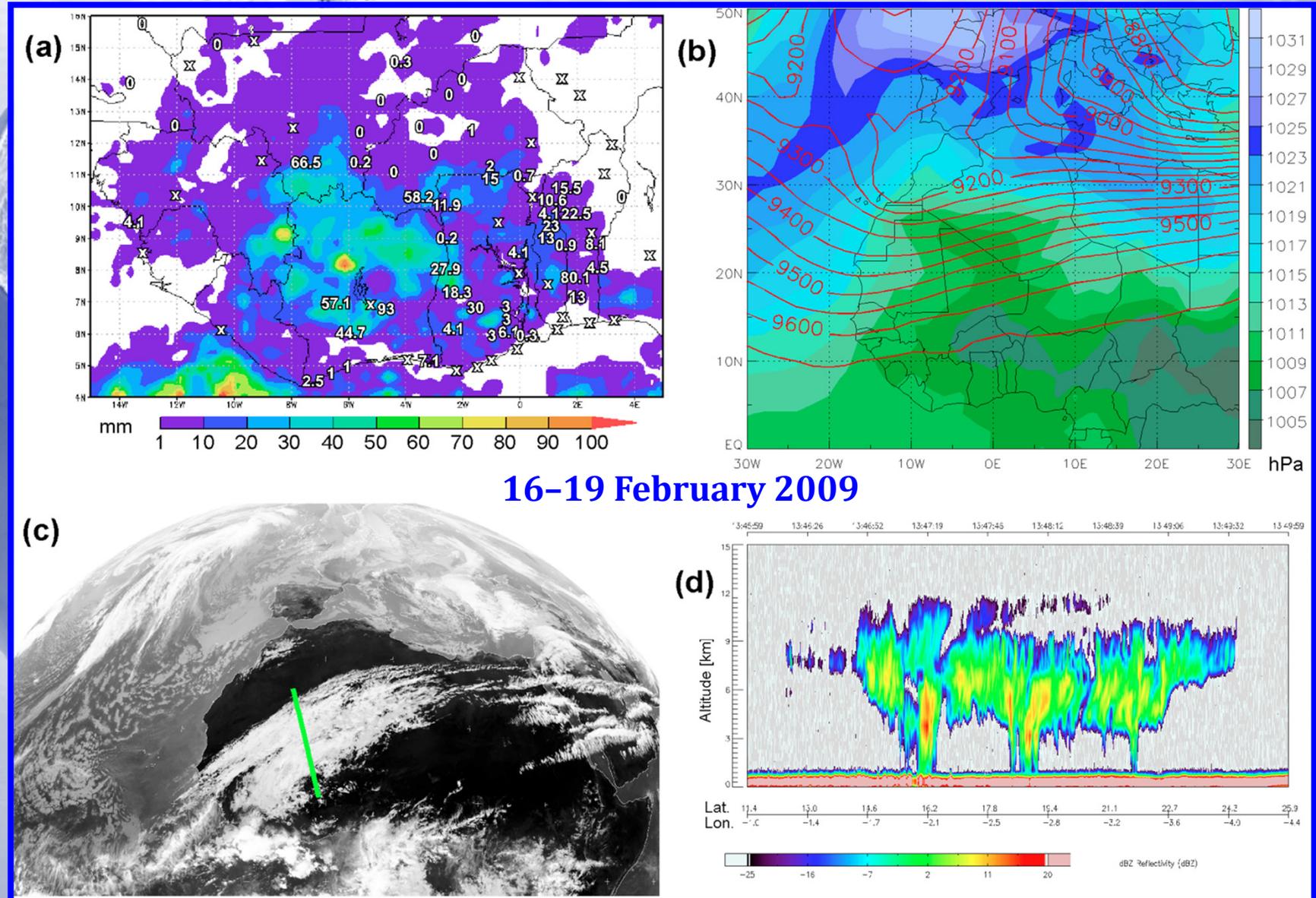
Breaks influenced by ISV



Extra-Tropical Impact on Tropical Convection

5 Significant DRY-Season Wet Episodes in W. Africa

Peter Knippertz
Andrea Fink

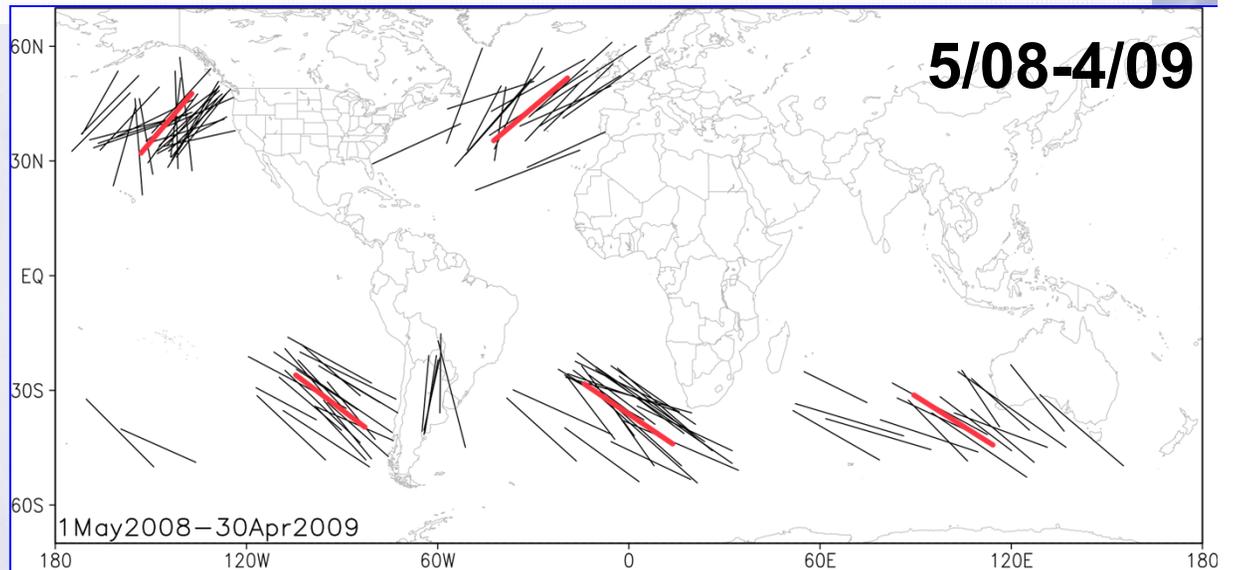
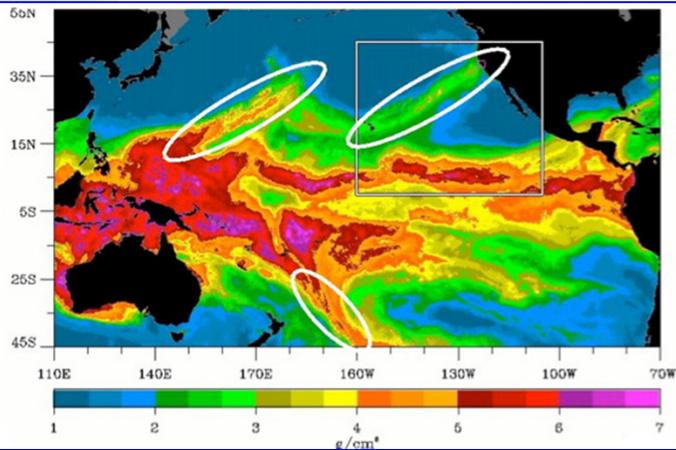


16-19 February 2009

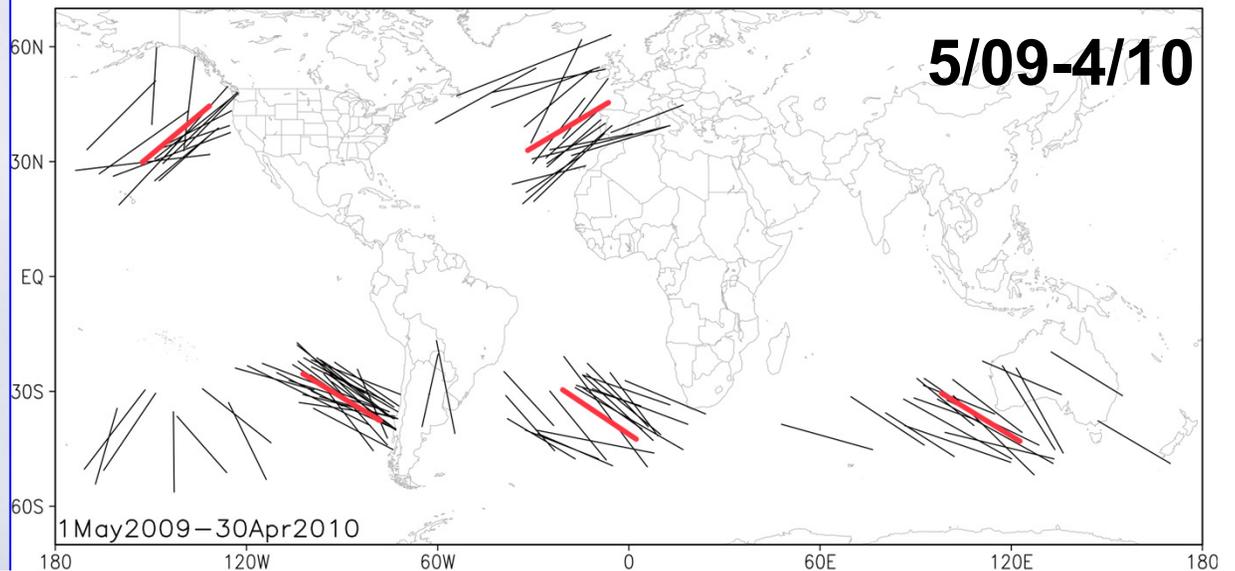
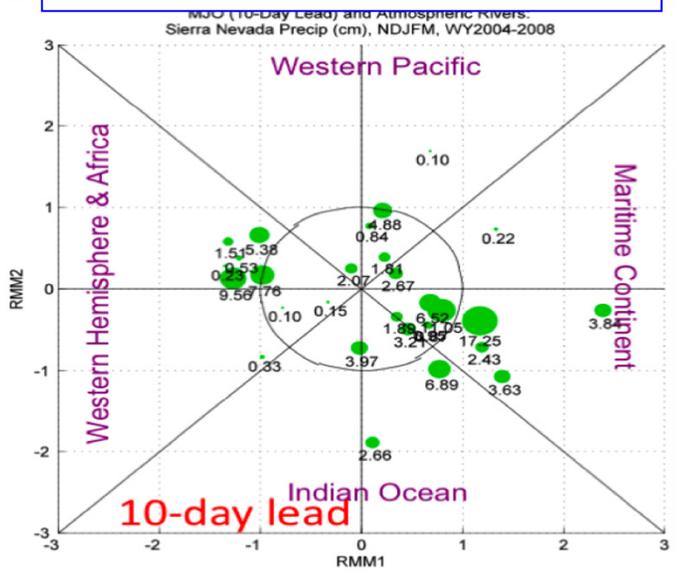
Atmospheric Rivers During YOTC

Tropical-Extratropical Interactions

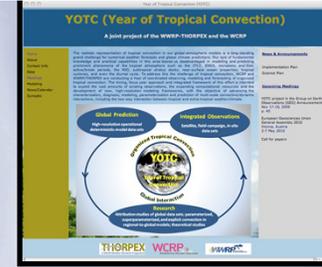
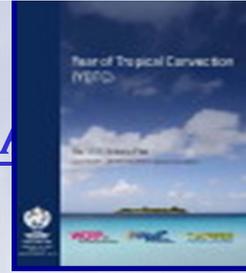
Bin Guan



MJO -> AR -> CA Precip

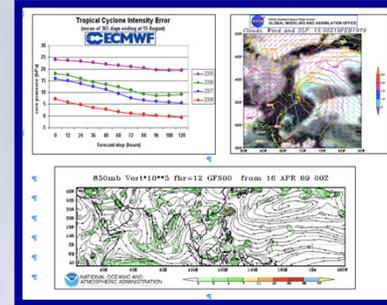


YOTC: PROGRESS & PLAN



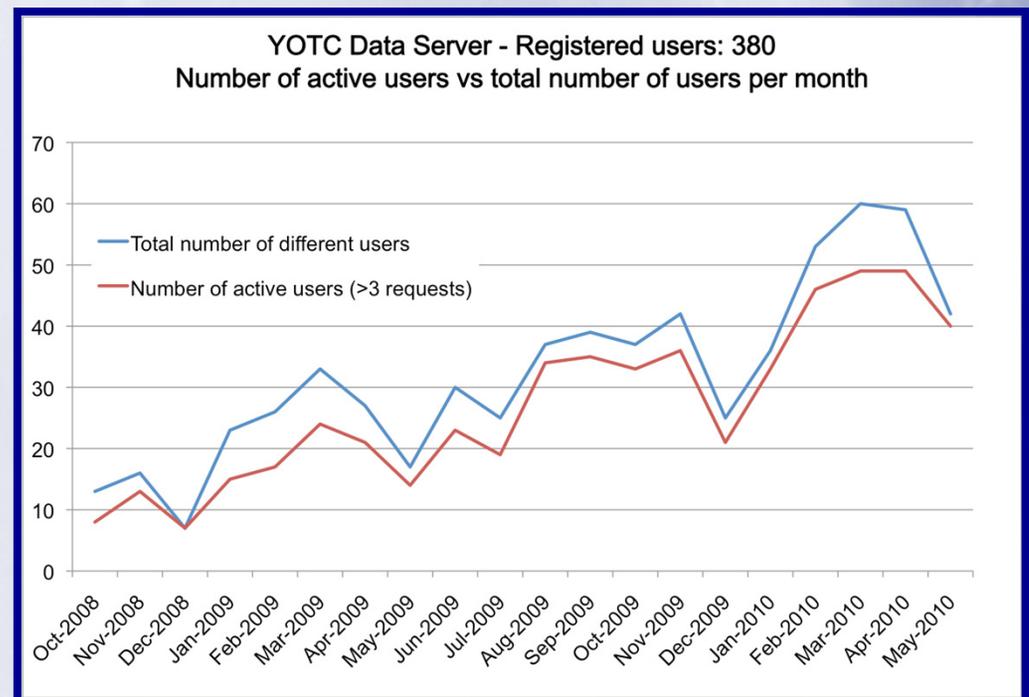
- **Science Plan** – Completed, WMO Technical Document.
- **Program Support/Information Specialist** – (Part-time): US THORPEX Exec Committee funding via U.S. NSF, NOAA, NASA.
- **Web site:** <http://www.ucar.edu/yotc>
- **Implementation Plan Drafted and Discussed/Approved at IP Meeting in Honolulu July 13-15, 2009.**
- **WCRP-WWRP/THORPEX YOTC MJO Task Force – 12/2009**
- **YOTC Science Sessions**– Fall AGU'08, AMS'09, Spring AGU'09, Fall AGU'09, WP-AGU'10, AGU of Americas 2010, **Fall AGU'10,**
- **MJO TF Meeting and MJO Workshop, Busan, June 2010.**
- **YOTC(+WGNE?) Science Workshop Meeting, China, May 2011.**

YOTC: ANALYSES, FORECASTS & SPECIAL DIAGNOSTICS



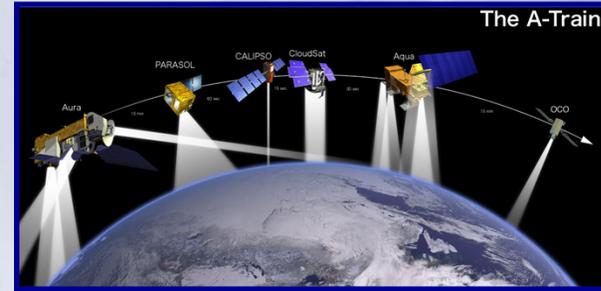
- High-resolution, global analysis and forecast data sets are being made available to the community from ECMWF, NCEP and GMAO/NASA. e.g. T799 = 25km ECMWF + diagnostic fields (as of Jan'10, T1279 = 16kms)

The screenshot shows the ECMWF website's 'YOTC Data Retrieval' page. It includes a navigation menu with links like 'Home', 'Your Room', 'Login', 'Contact', 'Feedback', 'Site Map', and 'Search'. The main content area is titled 'YOTC Data Retrieval' and contains several sections: 'Type' (Analysis, Forecast), 'Select date' (with a date range selector from 2008-05-01 to 2008-07-20), 'Select a list of month' (with a calendar view for 2008), 'Select Time' (with radio buttons for 00:00:00, 06:00:00, 12:00:00, and 18:00:00), and 'Select parameters' (a grid of checkboxes for various meteorological variables like Divergence, Geopotential, etc.).

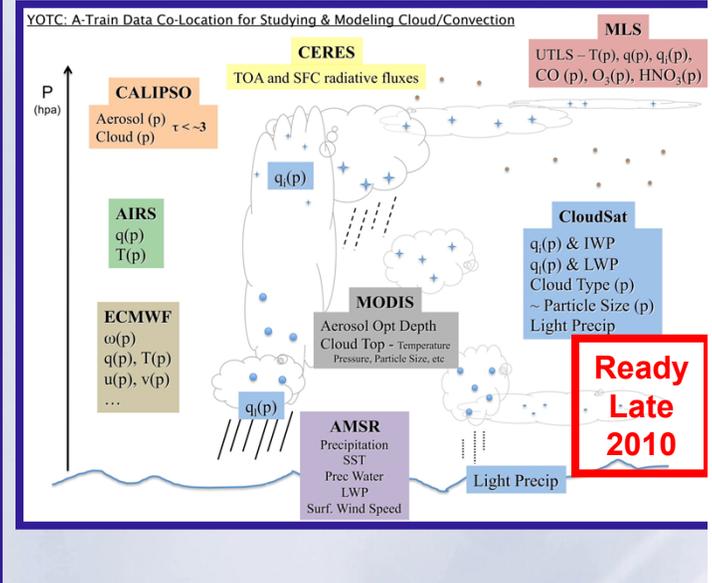
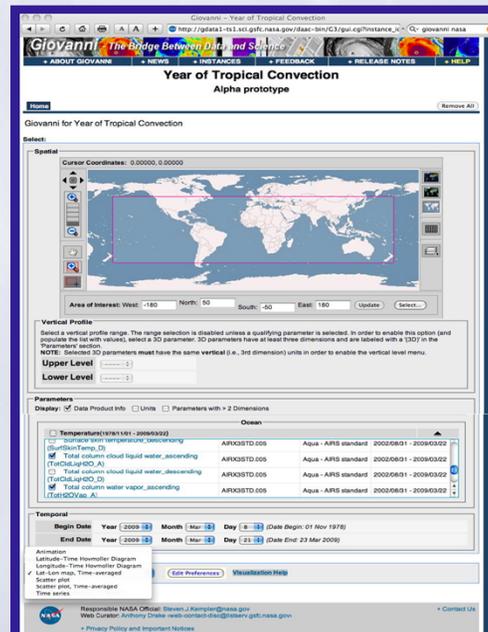
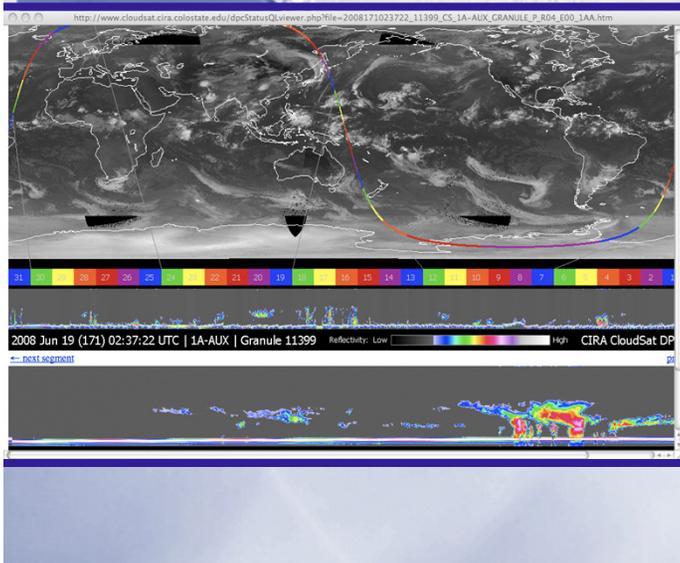


ECMWF-YOTC Replicated at NCAR in coming months.

YOTC: SATELLITE DATA



- Key satellite data (e.g., NASA A-Train, TRMM, geostationary) have been identified and funding secured from NASA for the:
 - Giovanni-based dissemination framework – **Now Available**
 - Multi-sensor CloudSat-Centric A-Train Data Set.



YOTC Implementation: Selected Collaborative research

Weather: initial-value problem (IVP) for climate (seamless prediction)

- ✧ Transpose-AMIP: 5-day hindcasts of YOTC period(s) by:
 1. DOE/PCMDI CAPT Program with NCAR CAM (and maybe GFDL).
 2. CMIP5 Transpose AMIP focus on YOTC - see subsequent slide.
 3. Multiple activities via EUCLIPSE project -> see P. Siebesma for details.

MJO & Convectively-Coupled Equatorial Waves

- ✧ High Resolution (~5-20km) MJO/CCEW hindcasts: UK Cascade, NICAM, GMAO GEOS, GMAO HiRes, CMMAP and GSFC MMFs, Rave/WRF.
see subsequent slides and proposed collaboration with GCSS.
- ✧ MJO multi-model 20-year hindcast experiment in (CLIVAR AAMP and AMY) to address prediction skill & predictability – extra output for YOTC.
see subsequent slide.
- ✧ **WWRP-WCRP YOTC MJO Task Force Activities –**
see subsequent slides.

GEWEX Cloud System Study (GCSS):

- ✧ Extension of GEWEX Pacific Cross-section Intercomparison (GPCI) for June-August 2008 of YOTC.

Transpose AMIP CMIP5 Model Evaluations

- 4 periods; 16 5-day hindcasts in each

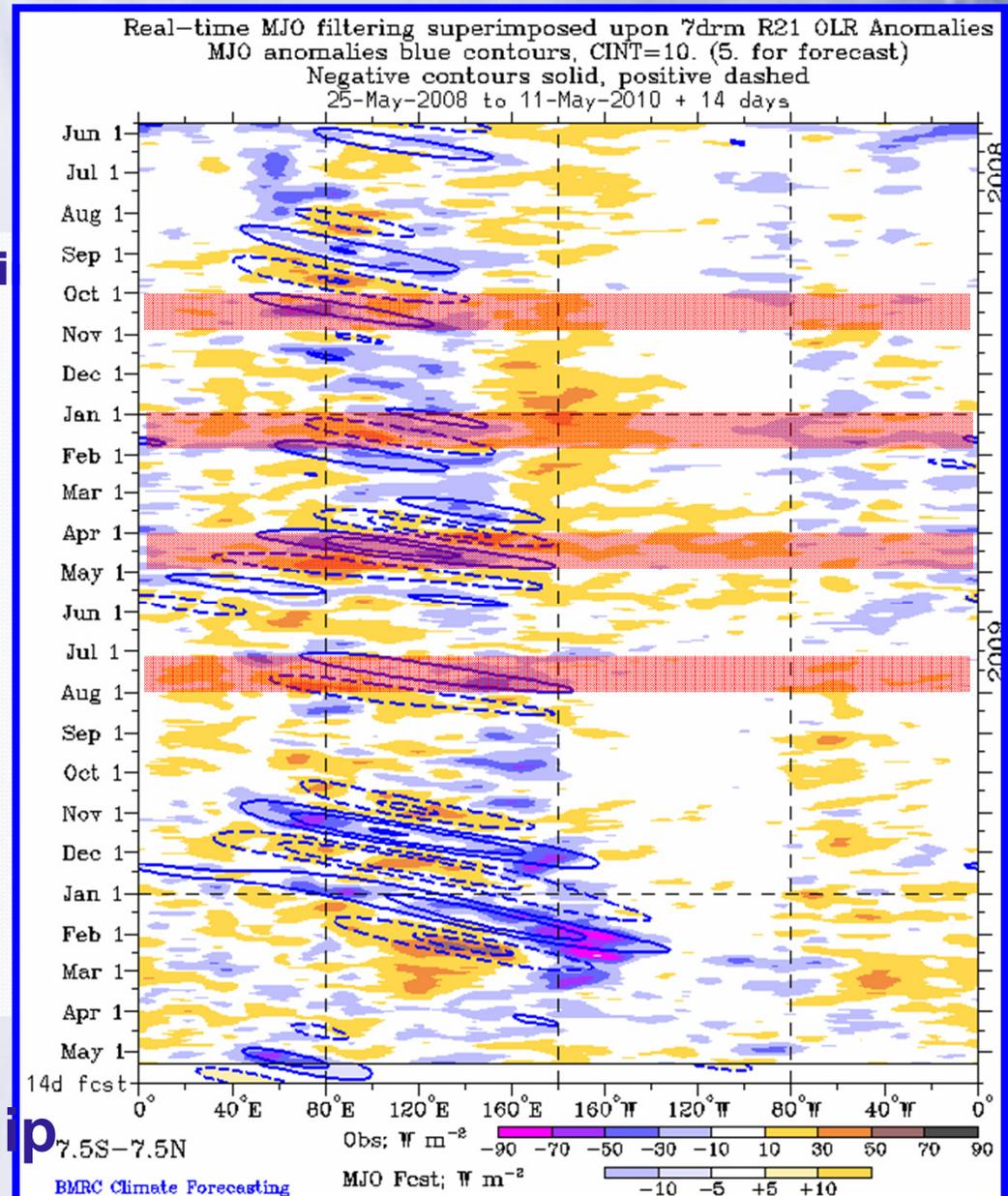
- 9 proposed subprojects – e.g. Cloud Regimes, Williams; MJO, Moncrieff.

- Modeling Group Pledges

- EC-Earth (Frank Selten)
- IPSL (Sandrine Bony)
- Met Office (Keith Williams)
- Meteo France (Michel Deque)
- MIROC (Masahide Kimoto)
- MPI (Bjorn Stevens)
- MRI (Masahide Kimoto)
- NCAR (David Williamson)

hadobs.metoffice.com/tamip

YOTC Period



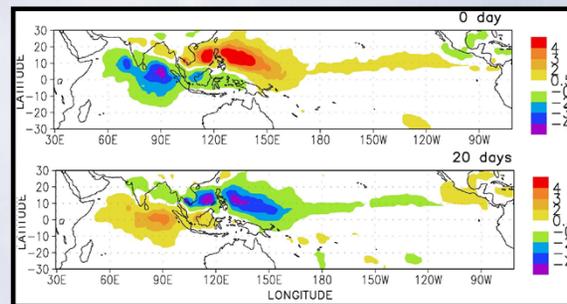
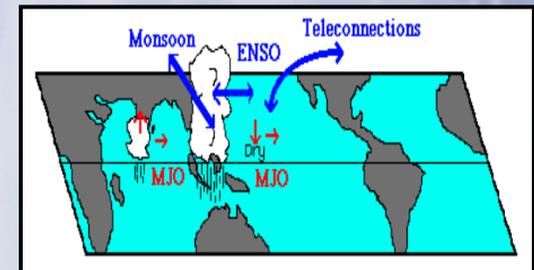
YOTC Implementation: Next Steps

- YOTC synoptic description article and companion framework article for BAMS: expected submission Oct 2010.
- YOTC+WGNE+AMY Science Workshop in China Sp'2011
MAY 16-18, 2011
- Move forward with collaborative research identified at the July 2008 YOTC Implementation Planning Workshop – a multi-year effort.
- Address multi-agency research funding for multi-year collaborative projects. Order of \$2⁺M/yr for 3+ years.
(MJO, TCs/EWs, monsoon, trop-extratrop, diurnal cycle)
- Help frame DYNAMO field campaign in 2011 focused on MJO onset in Indian Ocean.

WCRP-wwrp/THORPEX MJO TASK FORCE

Follows from the
US CLIVAR MJO
Working Group

Duane Waliser
JPL/Caltech/USA
Matthew Wheeler
ABOM/Australia



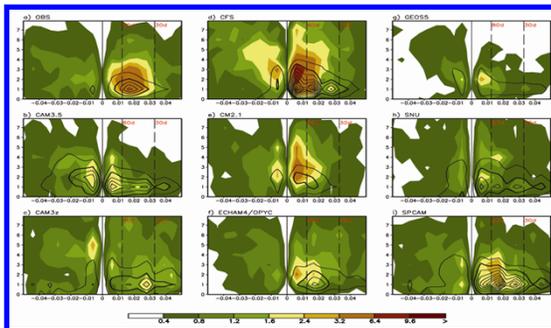
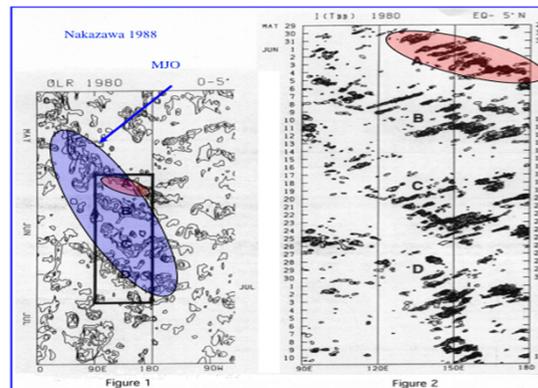
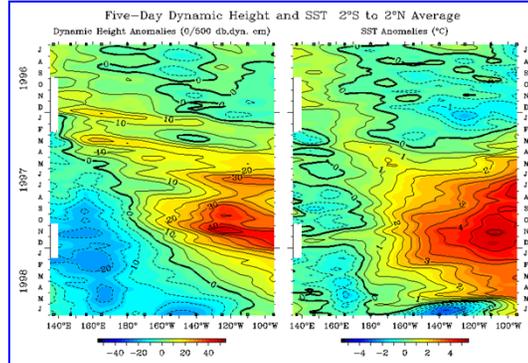
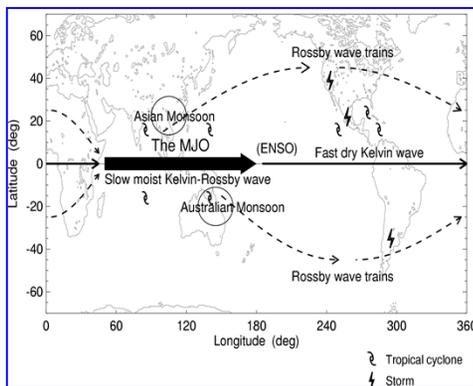
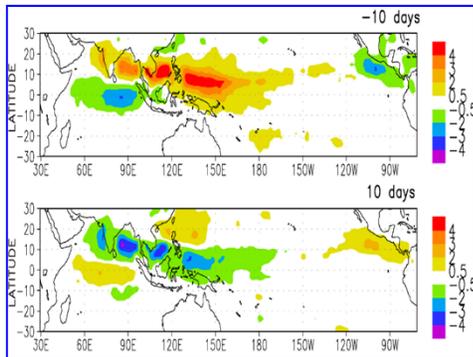
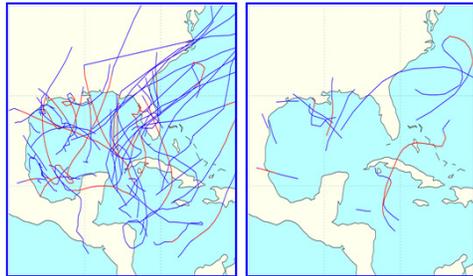
**Membership =>
Established 2010**

Duane Waliser (co-chair)
Matthew Wheeler (co-chair)
Ken Sperber
Harry Hendon
Eric Maloney
Xiouhua Fu
John Gottschalck
Richard Neale
Chidong Zhang
Daehyun Kim
Augustin Vintzileos
Frederick Vitart
Dave Raymond
Masaki Satoh
Hai Lin

Jet Propulsion Laboratory/Caltech
Centre for Australian Weather & Climate Research
Program for Climate Model Diagnostics and Intercomparison
Centre for Australian Weather and Climate Research
Colorado State University
University of Hawaii
National Centers for Environmental Prediction
National Center for Atmospheric Research
University of Miami
Seoul National University
National Centers for Environmental Prediction
European Centre for Medium-range Weather Forecasting
New Mexico Institute of Mining & Technology
Frontier Research Center for Global Change
Environment Canada

**WGCM-14, UKMO
Exeter, UK; October 2010**

MOTIVATION



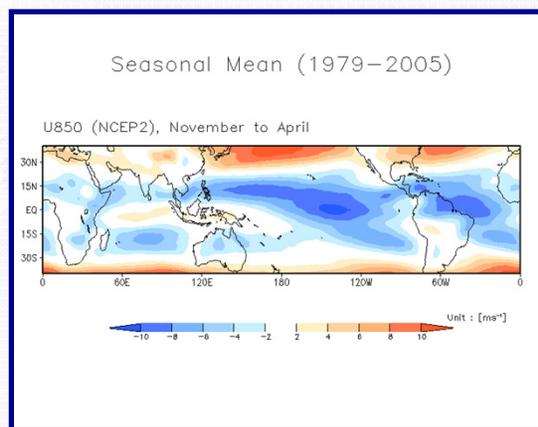
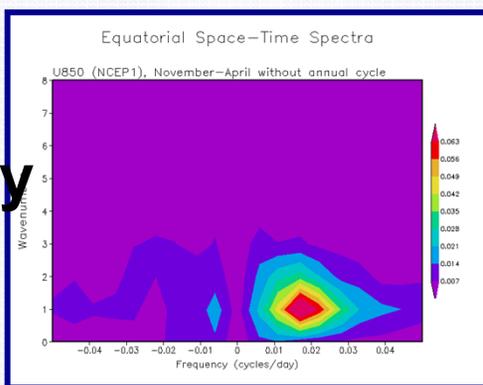
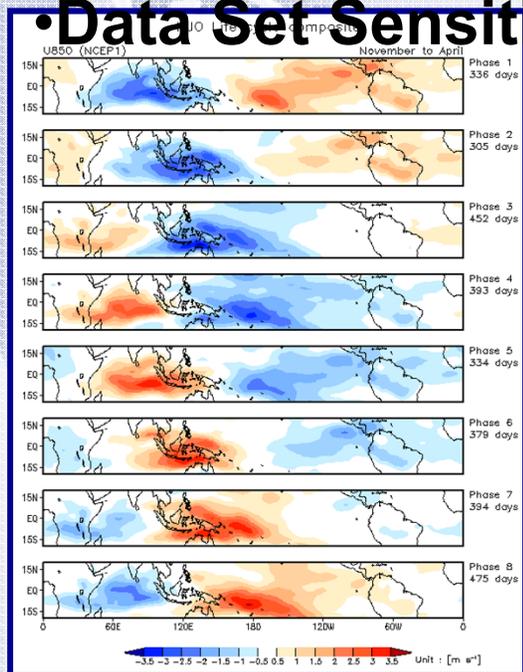
- The MJO is the dominant form of intraseasonal variability in the Tropics.
- The MJO impacts a wide range of weather & climate phenomena.
 - Monsoon Onset & Breaks
 - ENSO+IOD Interactions
 - Tropical Cyclone Modulation
 - Midlatitude Weather Impacts
 - Organization of Chl, Aerosols, Ozone, etc variability.
- Our weather & climate models have a poor representation of the MJO.
- Great benefit could be derived from better predictions of the MJO - Helps to bridge the gap between weather and seasonal predictions.

Figures: Maloney, PMEL/TAO, Nakazawa, MJO WG, Lin, Waliser

MJO SIMULATION DIAGNOSTICS FOR GCMs (MJOWG, J. CLIMATE, 2009)

Observation-Based Diagnostics

- Variability
- Life Cycle
- Mean-State
- Data Set Sensitivity



Web Display and Code Availability

Madden Julian Oscillation (MJO) Metrics

Introduction Description Observations Simulations

Observations - Level 2 metrics figure tables

1) FREQUENCY-WAVE SPECTRA (see Description)

a) Annual data

OLR	PRCP	U200	U850	U8fc
All season spectra (with annual cycle)				
AVHRR	CMAP TRMM GPCP	NCEP1 NCEP2 ERA40	NCEP1 NCEP2 ERA40	NCEP1

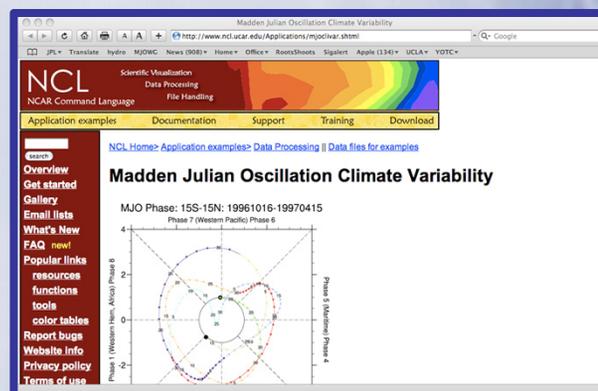
b) Seasonally stratified data

OLR	PRCP	U200	U850	U8fc
Seasonally stratified spectra (Winter: November to April, without annual cycle)				
AVHRR	CMAP TRMM GPCP	NCEP1 NCEP2 ERA40	NCEP1 NCEP2 ERA40	NCEP1
Seasonally stratified spectra (Summer: May to October, without annual cycle)				
AVHRR	CMAP TRMM GPCP	NCEP1 NCEP2 ERA40	NCEP1 NCEP2 ERA40	NCEP1

2) COMBINED EOFs (see Description)

a) Combined EOFs

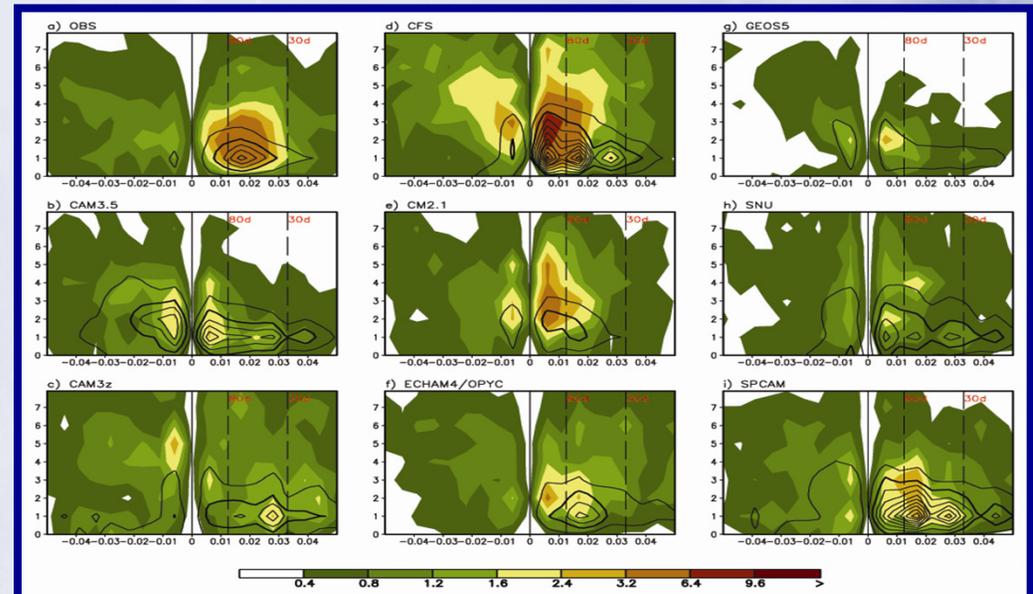
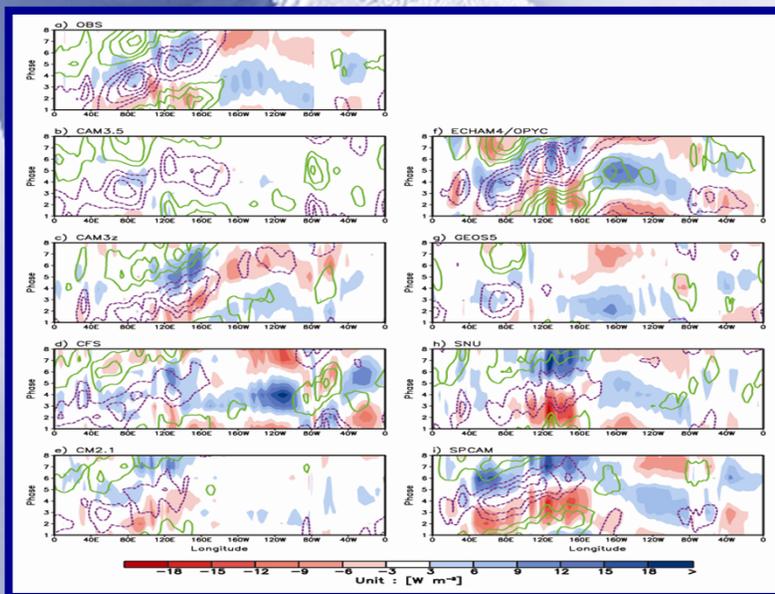
Adopted by NCAR/NCL



APPLICATION OF DIAGNOSTICS TO GCMs (KIM ET AL. J. CLIMATE, 2009)

Model (group)	Horizontal Resolution -AGCM	Vertical Resolution (top level) -AGCM	Cumulus parameterization	Integration	Reference
CAM3.5 (NCAR)	1.9° lat x 2.5° lon	26 (2.2hPa)	Mass flux (Zhang and McFarlane 1995)	20 years 01JAN1986-31DEC2005	Neale et al. (2007)
CAM3z (SIO)	T42(2.8°)	26 (2.2hPa)	Mass flux (Zhang and McFarlane 1995)	15 years 29JAN1980-23JUL1995	Zhang et al. (2005)
CFS (NCEP)	T62(1.8°)	64 (0.2hPa)	Mass flux (Hong and Pan 1998)	20 years	Wang et al. (2005)
CM2.1 (GFDL)	2° lat x 2.5° lon	24 (4.5hPa)	Mass flux (RAS; Moorthi and Suarez 1992)	20 years	Delworth et al. (2006)
ECHAM4 (OPYC+ PCMDI)	T42(2.8°)	19 (10hPa)	Mass flux (Tiedtke 1989, adjustment closure Nordeng 1994)	20 years	Roeckner et al. (1996), Sperber et al. (2005)
GEOS5 (NASA)	1° lat x 1.25° lon	72 (0.01hPa)	Mass flux (RAS; Moorthi and Suarez 1992)	12 years 01DEC1993-30NOV2005	To be documented
SNUAGCM (SNU)	T42(2.8°)	20 (10hPa)	Mass flux (Numaguti et al. 1995)	20 years 01JAN1986-31DEC2005	Lee et al. (2003)
SPCAM (CSU)	T42(2.8°)	26 (3.5hPa)	Superparameterization (Khairoutdinov and Randall 2003)	19 years 01OCT1985-25SEP2005	Khairoutdinov et al. (2005)

Applied to 8 GCMs
 CAM3.5, CAM-3Z, SPCAM,
 ECHAM4/OPYC,
 CFS, SNU, GFDL, GEOS5
CMMAP – MMF (uncoupled)
ECHAM4/OPYC (coupled)
Performed best. Still Challenges



OPERATIONAL FORECAST METRIC (GOTTSCHALCK ET AL. RAMS 2010)

w/ WGNE

Use of a common metric allows for:

- quantitative forecast skill assessment.
- targeted model improvements.
- friendly competition to motivate improvements.

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)

http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CLIVAR/clivar_wh.shtml

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](#)

- **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.

Note: Move cursor over product name to display. Click for larger size and info.

Phase Plots of MJO Index Forecasts					
NCPE	NCPO	NCFS	CMET	UKME	UKMA
ECMF	BOME	BOMA	BOMC	JMAN	CPTC

[RMM1, RMM2] 15-day forecast for 24Mar2008 to 07Apr2008

MJO Workshops

I. CLIVAR MJOWG Sponsored, Irvine, CA 2007



*New Approaches to Understanding,
Simulating, and Forecasting the
Madden-Julian Oscillation*

**Sperber and Waliser
BAMS Meeting Summary 2008**

II. WCRP/WWRP MJOTF + CLIVAR AAMP, Busan,



*Monsoon Intraseasonal
Variability Modeling
Workshop*
**BAMS Meeting Summary
In Preparation**

In late 2009, follow-on WCRP/WWRP Task Force established:
“.... the MJO Task Force should be formed within the framework of the joint WWRP/THORPEX/WCRP YOTC activity, and report to the JSC- WWRP, ICSC THORPEX and the SSG-

CLIVAR.”
TORs

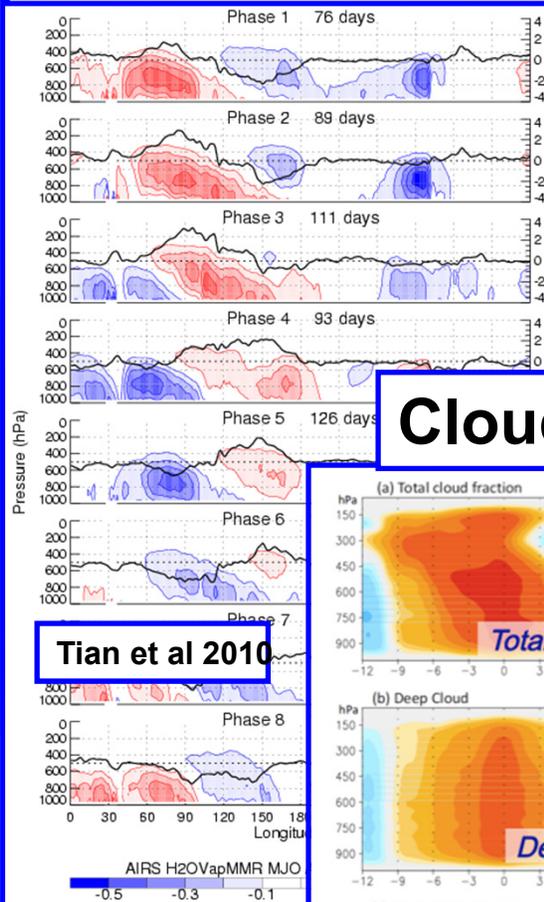
Overall goal: Facilitate improvements in the representation of the MJO in weather and climate models in order increase the predictive skill of the MJO and related weather and climate phenomena

- Develop process-oriented diagnostics/metrics to assess/guide physics and take advantage of more modern data (e.g. A-Train)
- Explore MJO multi-scale interactions and with emphasis on vertical structure and diabatic processes.
- Expand MJO forecast metrics: e.g., boreal summer & ensemble development.

PROCESS ORIENTED / VERTICAL STRUCTURE DIAGNOSTICS

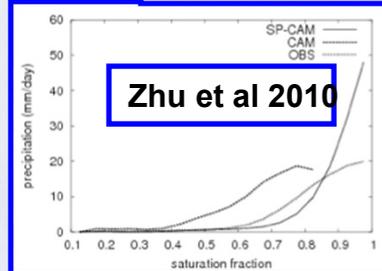
METRICS

AIRS Temp and WV

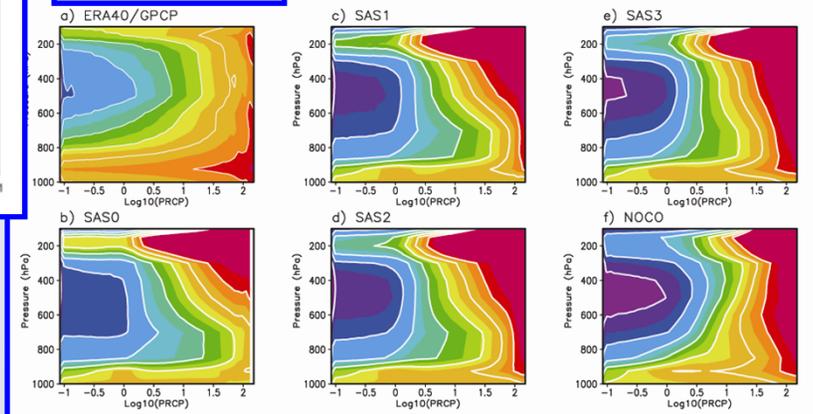


Tian et al 2010

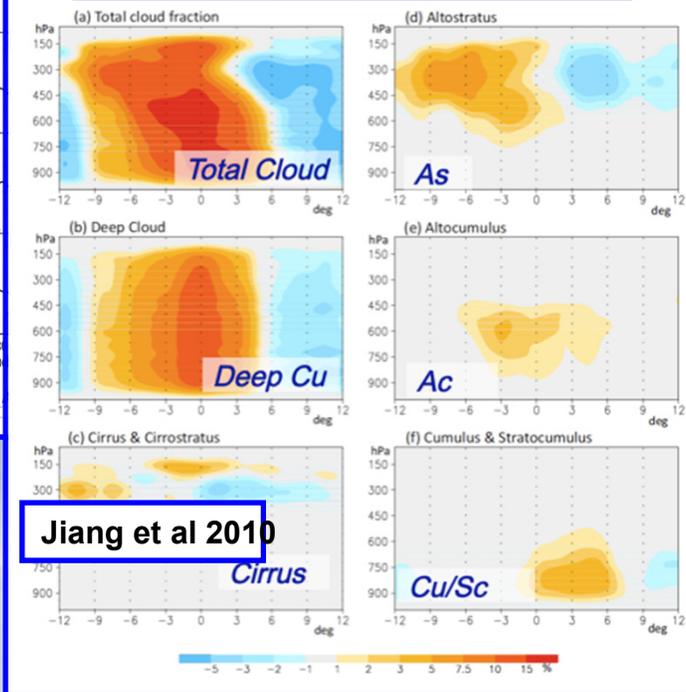
Moisture Precip Relationships



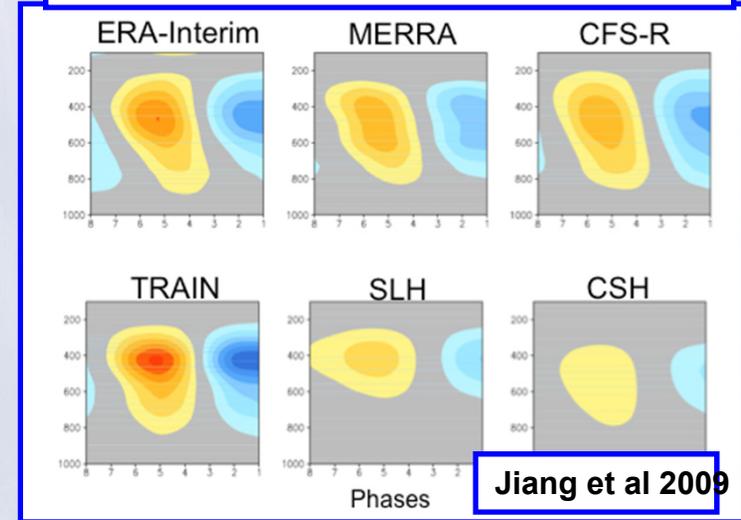
Kim et al 2009



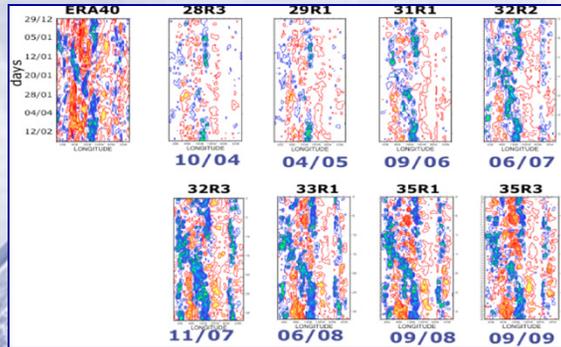
CloudSat Retrievals



TRMM Diabatic Heating



EXTENSIONS TO MJO FORECAST METRIC ACTIVITY



- MORE CENTER PARTICIPATION
- ASIAN SUMMER MONSOON
- MULTI-CENTER ENSEMBLES
- IMPACTS E.G. TC MODULATION

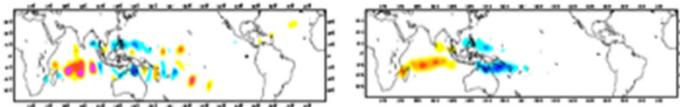
Tropical Cyclone Genesis Density

Nov-Apr 1989-2008; 32r3

Observations

Model

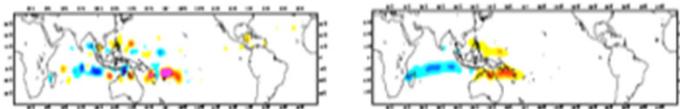
Phases 2+3



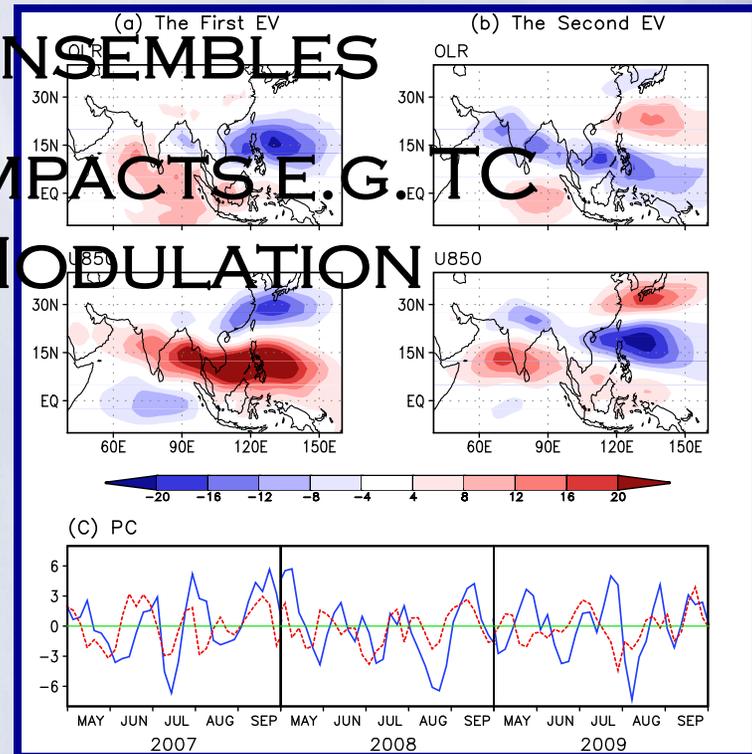
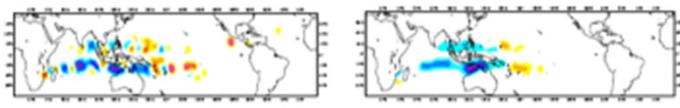
Phases 4+5



Phases 6+7



Phases 8+1



INTRASEASONAL VARIABILITY HINDCAST EXPERIMENT (ISVHE)

JOINT SPONSORSHIP: APCC, NOAA-CPO, MJO WG/TF, AAMP

ORGANIZERS: B. WANG, J. Y. LEE, H. HENDON, D. WALISER, I.S. KANG, SHUKLA

NOAA AND OPERATIONAL SUPPORT LED FROM U. HAWAII; B.WANG AND J.Y. LEE

- **Multi-year hindcast experiment specifically designed for ISV / MJO.**
- **Long simulation plus ensembles of ~45 day integrations every 5-10 days for 20 years.**
- **19 modeling groups participating in the experiment, 7 groups have submitted their data and 4 groups will submit their data within a month (as of June).**
- **Plans for predictability, prediction skill, impacts, simulation capability/diagnostic studies.**

OTHER ITEMS & RECOMMENDATION

- Planning for MJO TF Meeting – Possibly at WCRP OSC
- YOTC Transpose AMIP and other High-Res Experiments
Multi-model (e.g., CMIP5, CAM, SPCAM), 5-day forecast every YOTC day; also NICAM, GEOS, SPCAM for selected events
- DYNAMO (MJO Initiation/Indian Ocean) Support
- Items of Note:
 - NRC Report on ISI Prediction/Predictability : Sept 2010
 - ECMWF and POAMA Dynamical MJO Skill > Empirical

Recommendation: GCSS Subproject on MJO

- Leverages existing MJO programmatic framework and expertise but with need for GCSS expertise.
- Integrating cloud theme: shallow cu, congestus, deep cu, stratiform/anvil, cirrus

Overall Suggestions for WGNE Help

- Facilitate ECMWF data set to NCAR – may be a done deal already – **expect by END OF YEAR.**
- Encourage/guide/participate in MJO TF + GCSS proposed collaboration on MJO hindcast/simulations for YOTC
- Weigh in on uses of MJO forecast metrics – those hosted at CPC/NCEP.
- Facilitate adoption by forecast centers of expected boreal summer MJO forecast metrics from MJO TF.
- Suggest ideas for securing future research funding.
- Collaboration on YOTC science symposium greatly appreciated.
- Encourage collaborative activities such as T-AMIP, EUCLIPSE, ISVHE and use of these projects and resources on behalf of YOTC.