Year of Tropical Convection (YOTC)

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

Mitch Moncrieff (NCAR) & Duane Waliser (JPL/Caltech)

Co-chairs, YOTC Science Planning Group

WWRP World Weather Research Programme

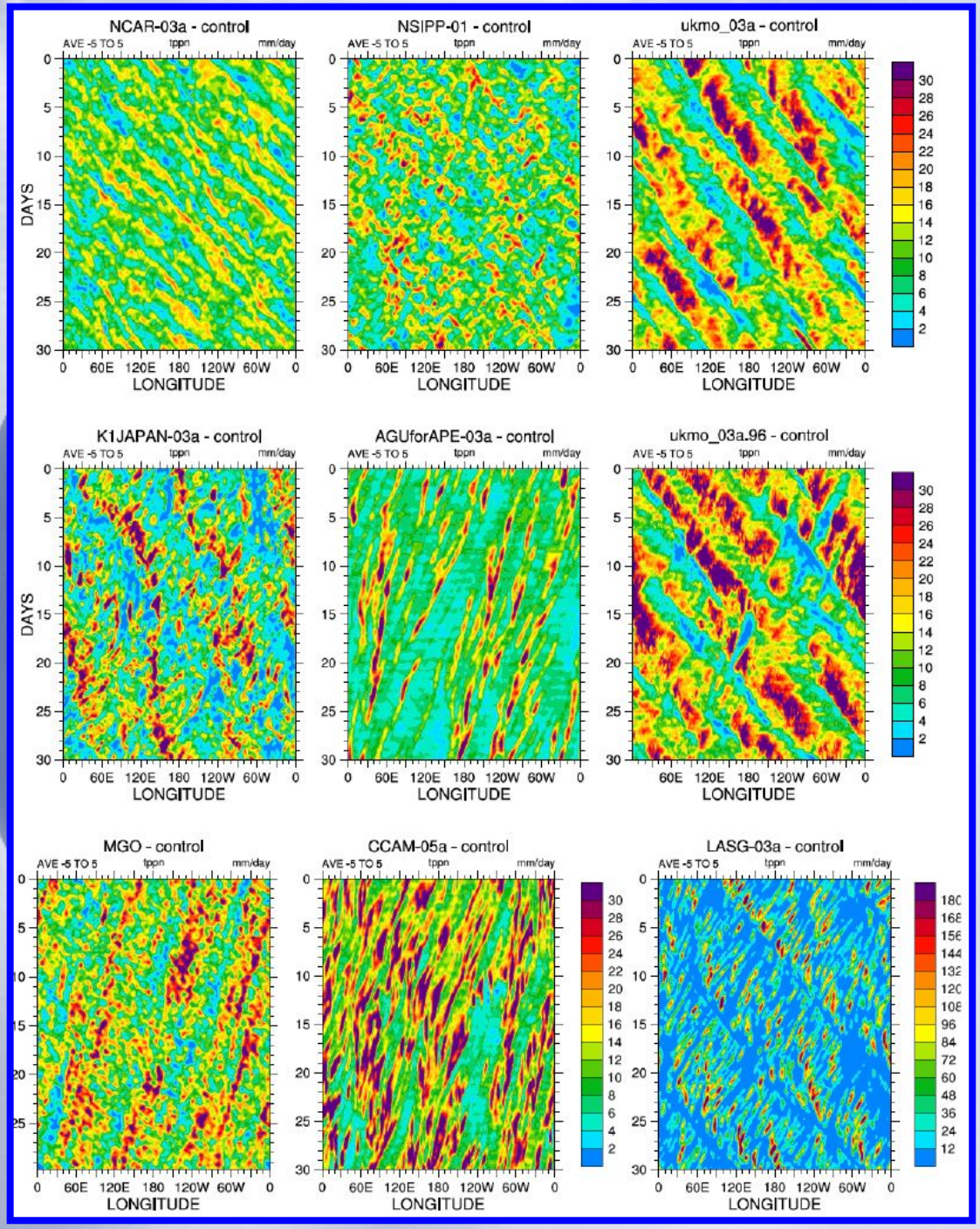
THORPEX A World Weather Research Programme

WMO

WCRP

A Contribution to Seamless Weather-Climate Prediction

AAMP10 & YOTC MJO TF:
Busan, Korea, June 18, 2010



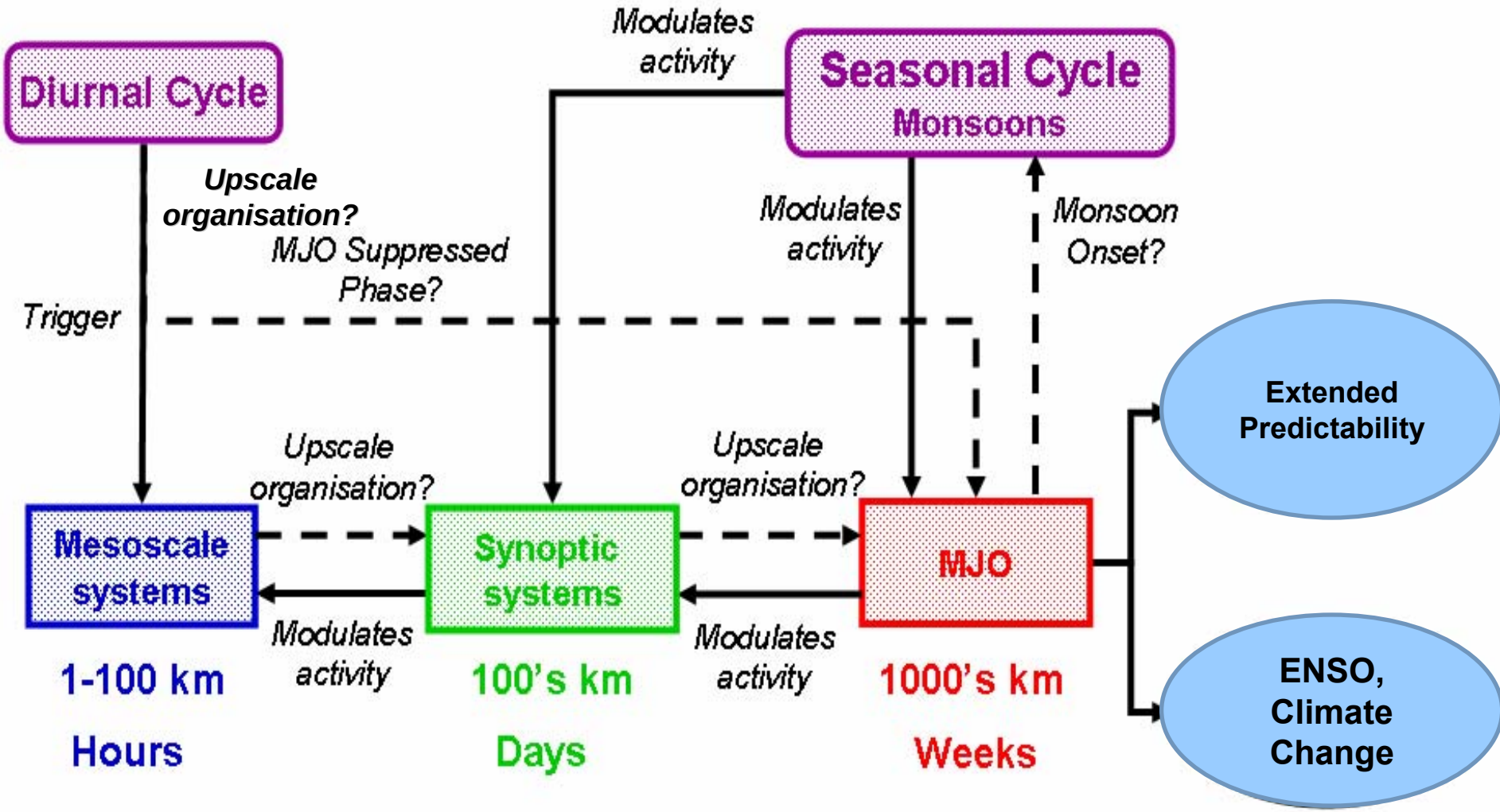
A Stark Demonstration of the "Tropical Convection Problem"

Aqua-Planet Climate Experiment

N Models => N Answers

Courtesy,
Dave Williamson, NCAR

Tropical Convection-Wave Continuum



2006 ICTP Workshop (Moncrieff et al. 2007)

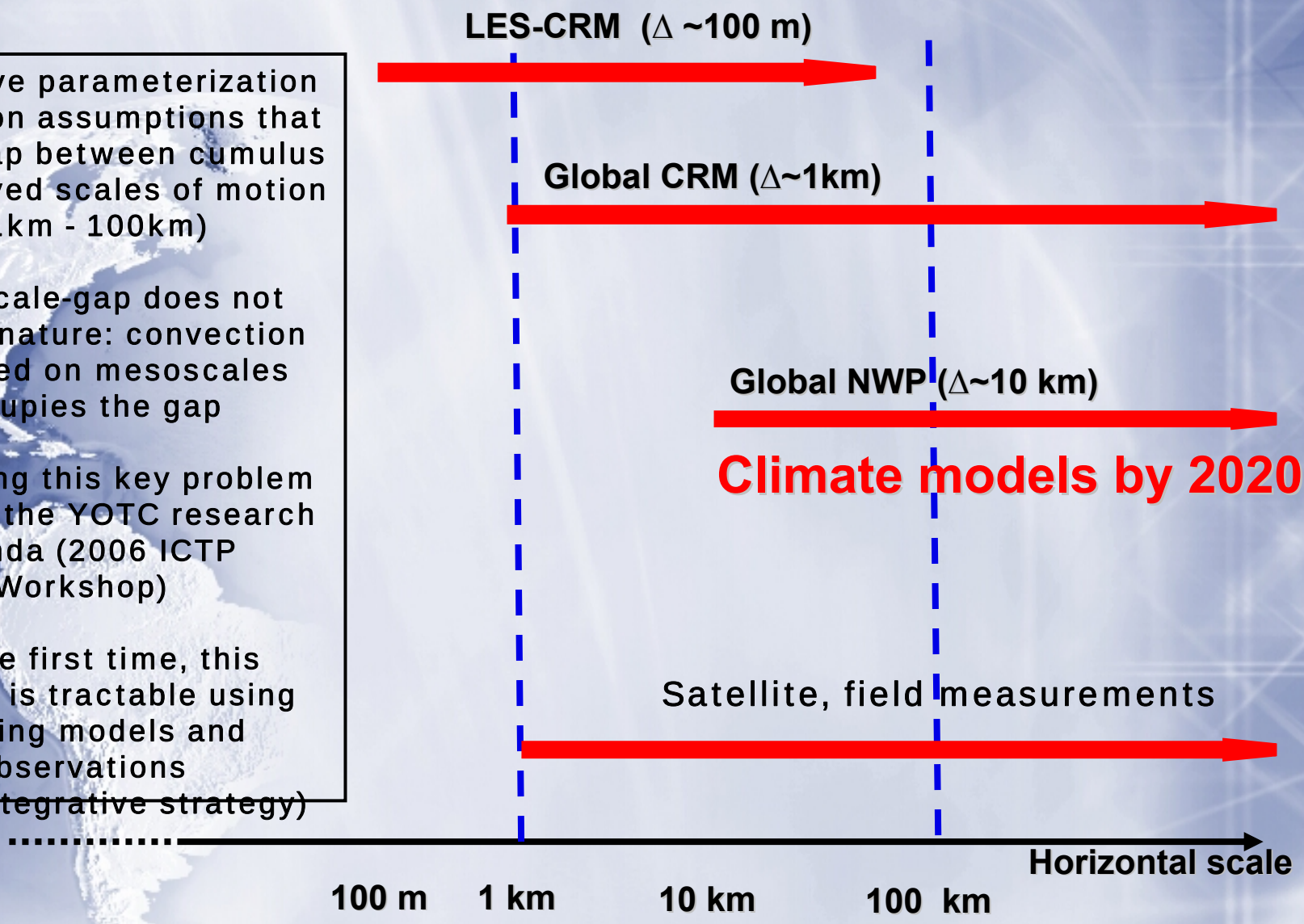
Bridging the Scale Gap

Convective parameterization is based on assumptions that imply a gap between cumulus and resolved scales of motion (~1km - 100km)

But a scale-gap does not exist in nature: convection organized on mesoscales occupies the gap

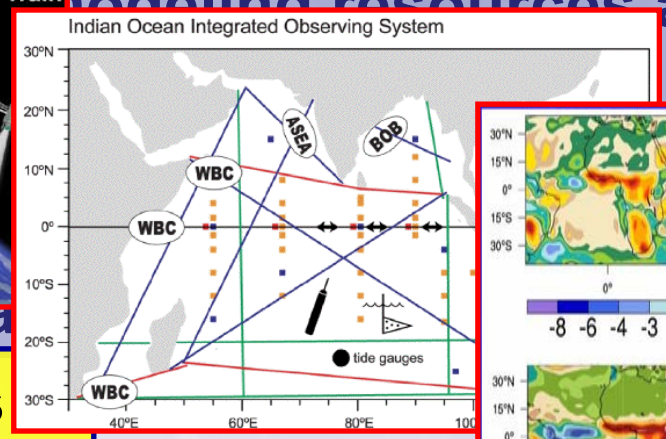
Addressing this key problem is part of the YOTC research agenda (2006 ICTP Workshop)

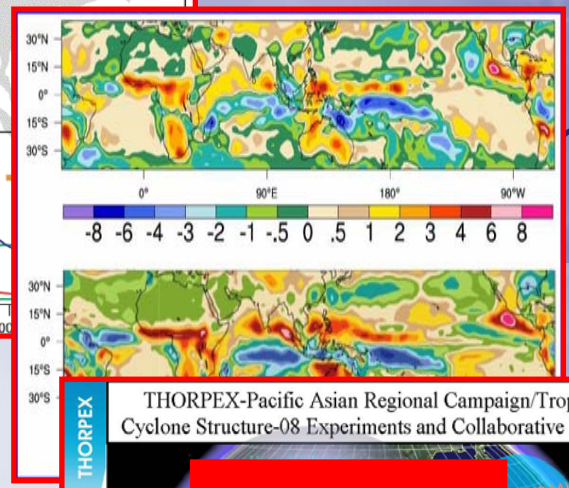
For the first time, this problem is tractable using existing models and observations (YOTC integrative strategy)



How to address this problem?

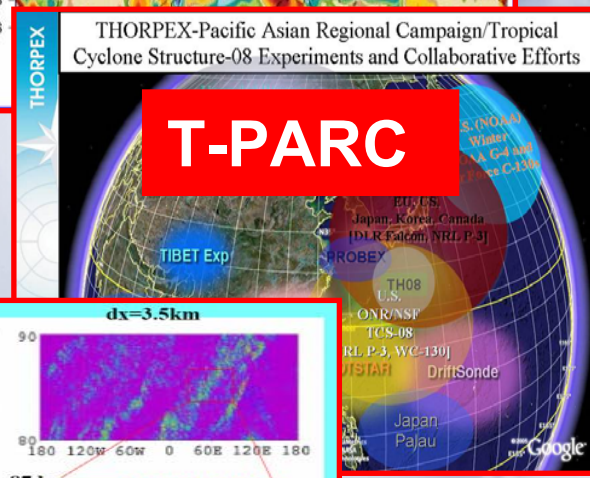
i.e. to simultaneously address the large-to-global scale and the scales of convective organization?

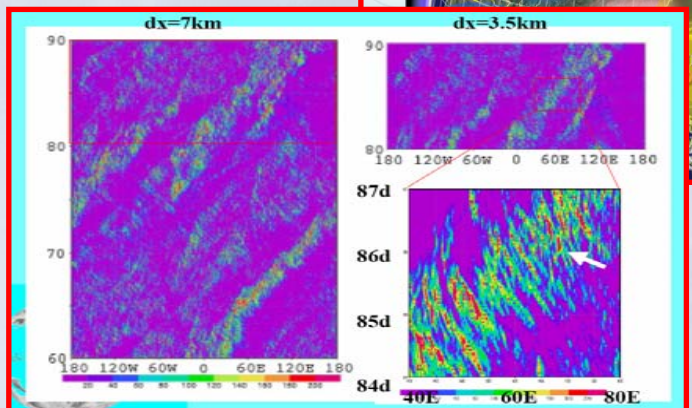




New/Improved Resources

- 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 Analysis
- Research Models (e.g., Regional & Global Cloud-System Resolving Models)





Develop a virtual "field -campaign" approach using 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)
- Field-camapigns (e.g., VOCALS, T-PARC, AMY)
- High-Resolution Deterministic Forecast Models & Global Analyses
- Research Models (e.g., Regional & Global Cloud-System Resolving Models)

+

Conceptual Framing

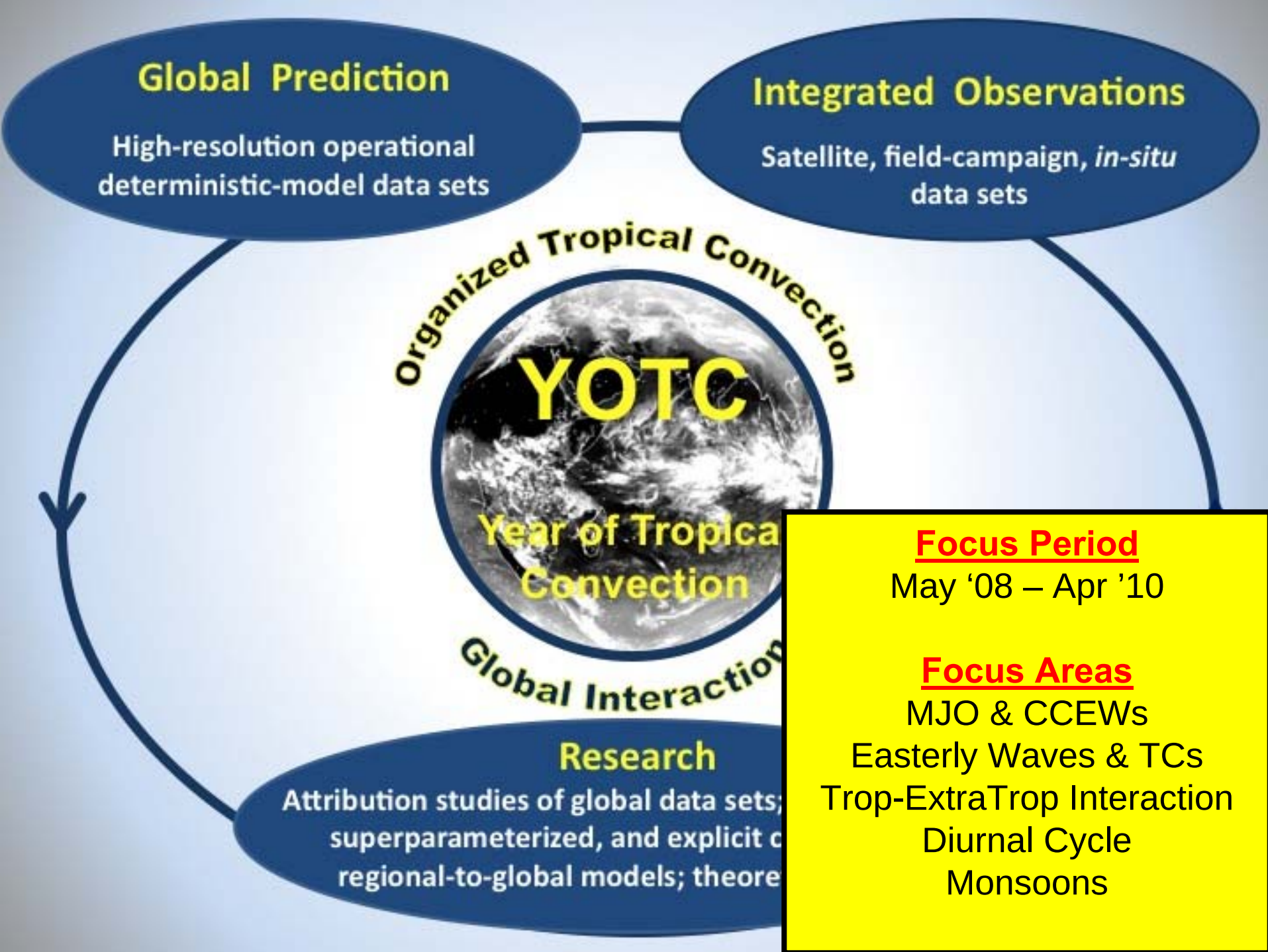
FGGE, GATE, TOGA COARE

=

YOTC

Focus "Year"

"Virtual Field-Campaign"


Global Prediction
High-resolution operational deterministic-model data sets
Integrated Observations
Satellite, field-campaign, in-situ data sets
Organized Tropical Convection
YOTC
Year of Tropica
Convection
Global Interaction
Research
Attribution studies of global data sets;
superparameterized, and explicit c
regional-to-global models; theore
Focus Period
May '08 – Apr '10
Focus Areas
MJO & CCEWs
Easterly Waves & TCs
Trop-ExtraTrop Interaction
Diurnal Cycle
Monsoons

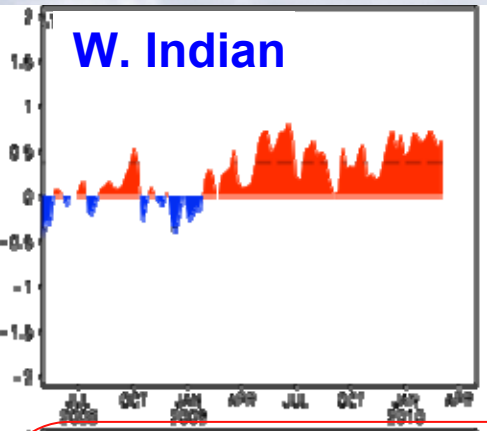
The "Year" of Tropical Convection (May 2008 to April 2010): Climate Variability and Weather Highlights

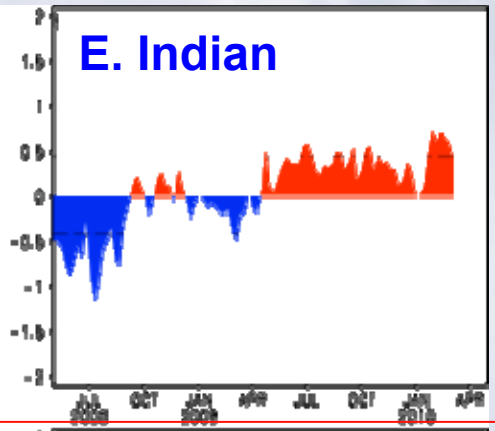
Many authors/contributions

BAMS Submission Expected in June

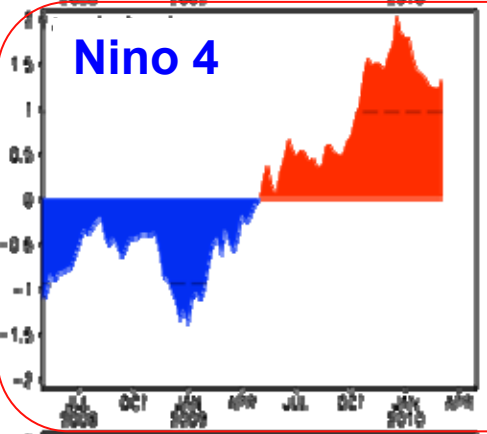
Background Conditions & Low Frequency SST

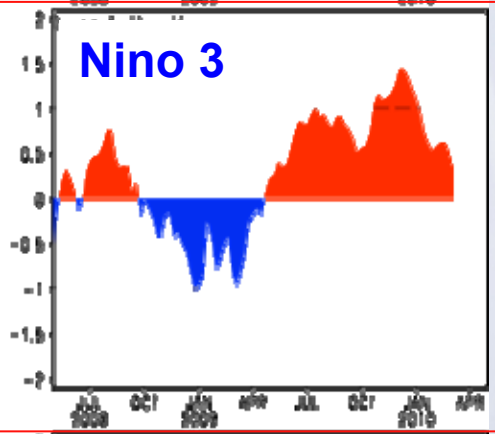
Tropical SSTs



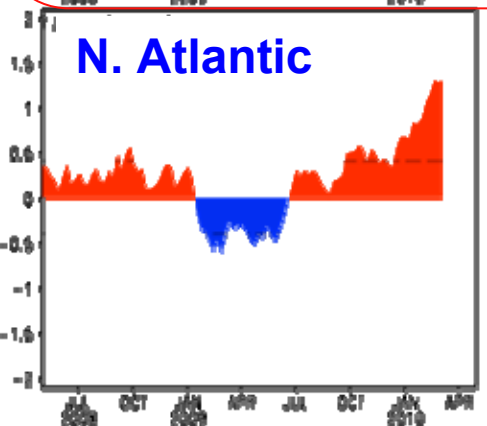


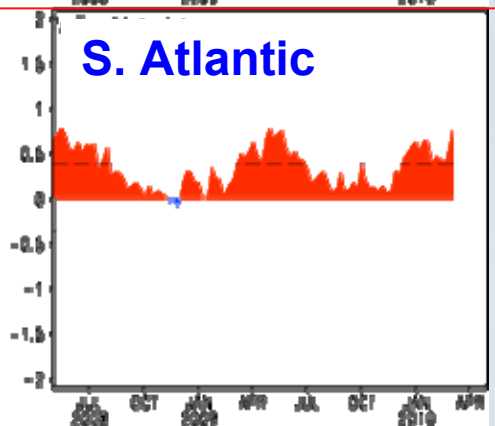
Mostly Warm in Year 2





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



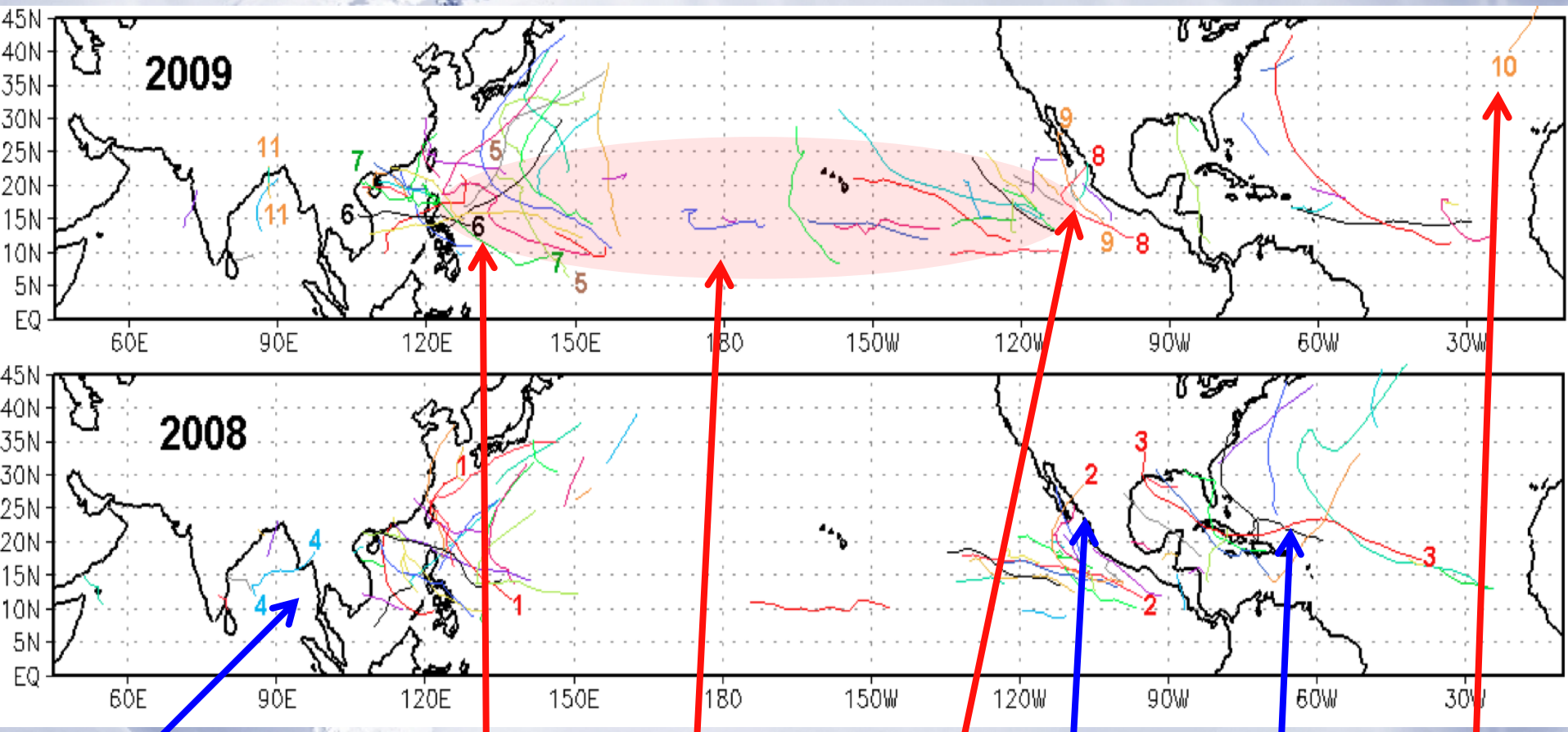


Mostly Warm Atlantic

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

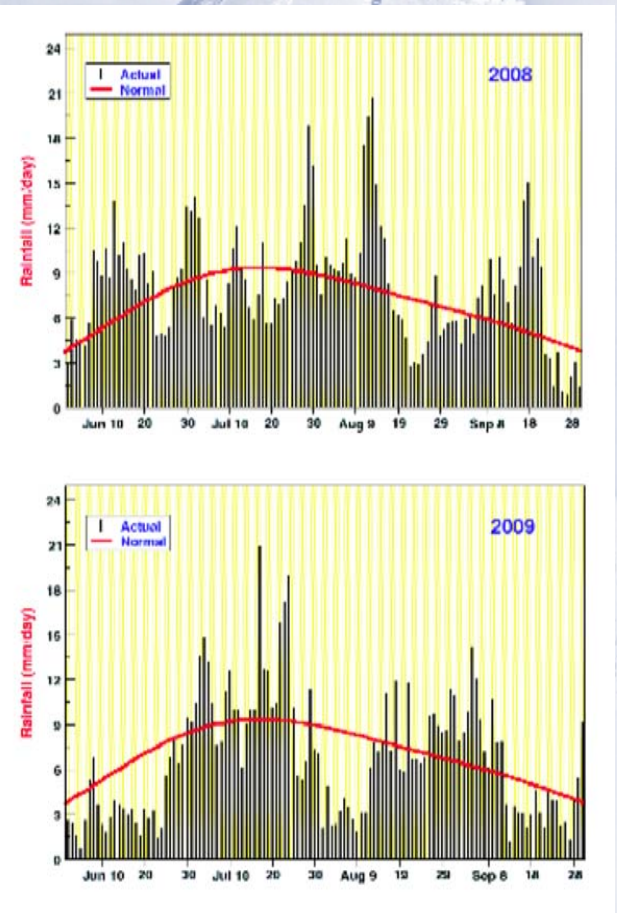
Ike - Largest size & Marko - smallest TC ever in this basin.

Grace

Summer Monsoons During YOTC

India
BN Goswami

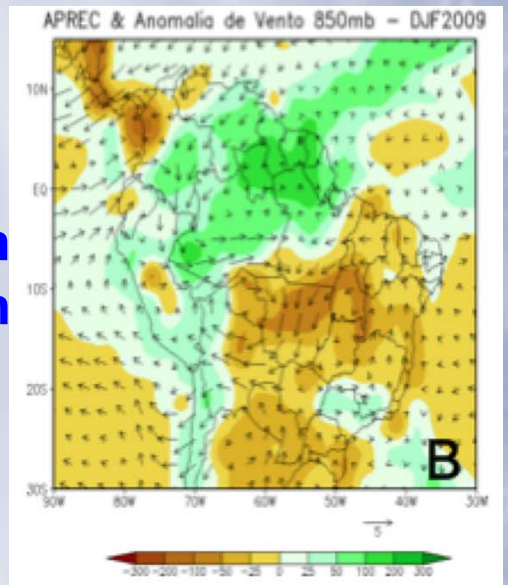
S. America
Jose Marengo



2008

"Normal"
98% AIR

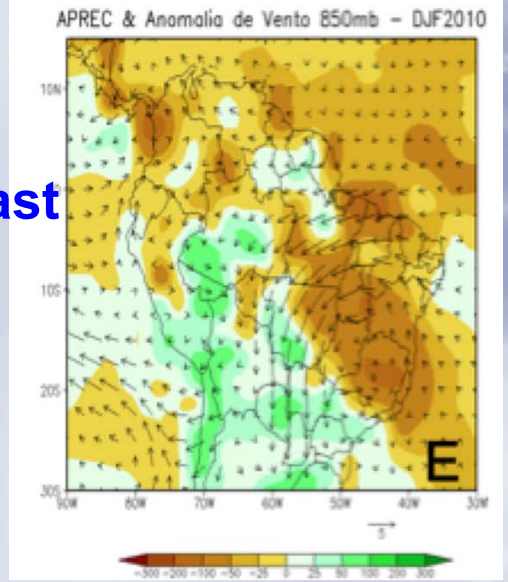
Wet-north
Dry-south



2009

Very Large
Drought
78% AIR

Dry-north/east
Wet-south

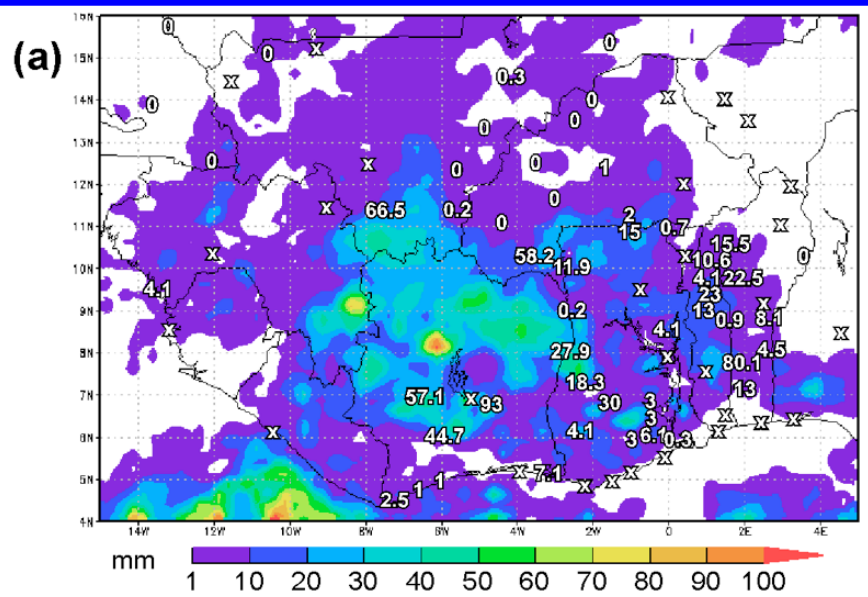


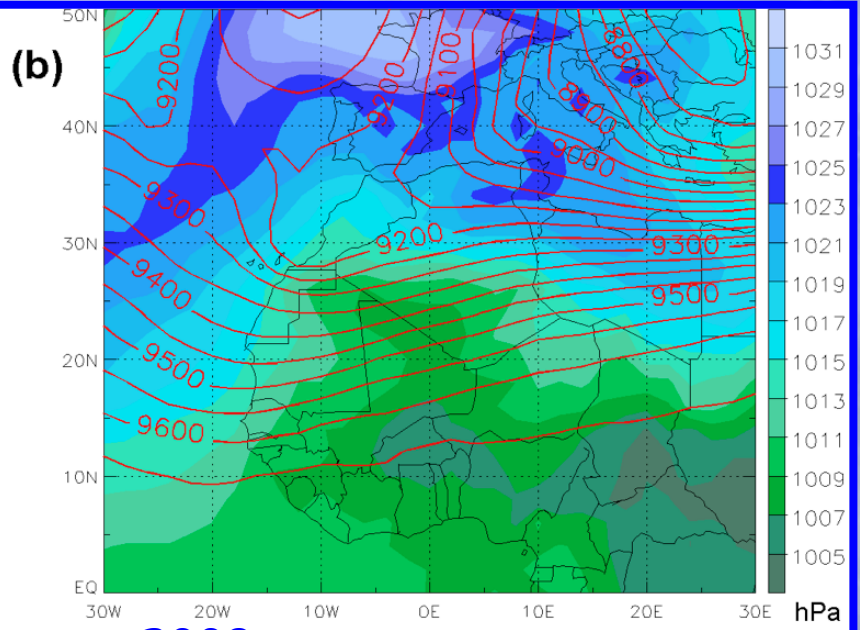
Breaks influenced by ISV

Extra-Tropical Impact on Tropical Convection

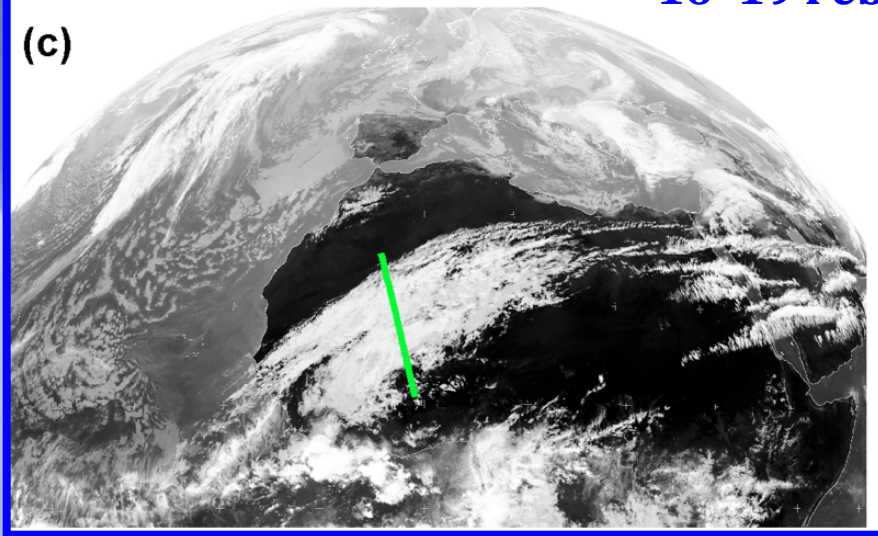
5 Significant DRY-Season Wet Episodes in W. Africa

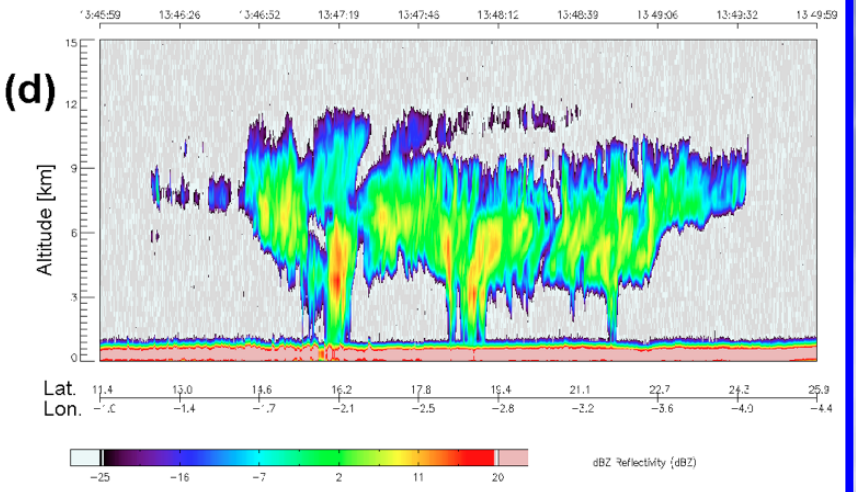
Peter Knippertz
Andrea Fink





16–19 February 2009

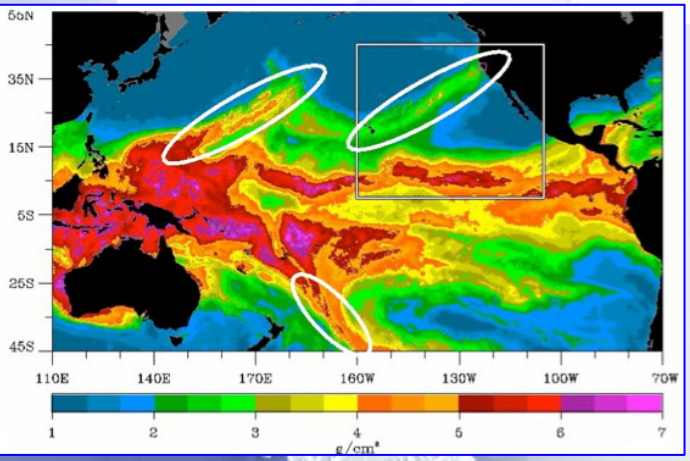




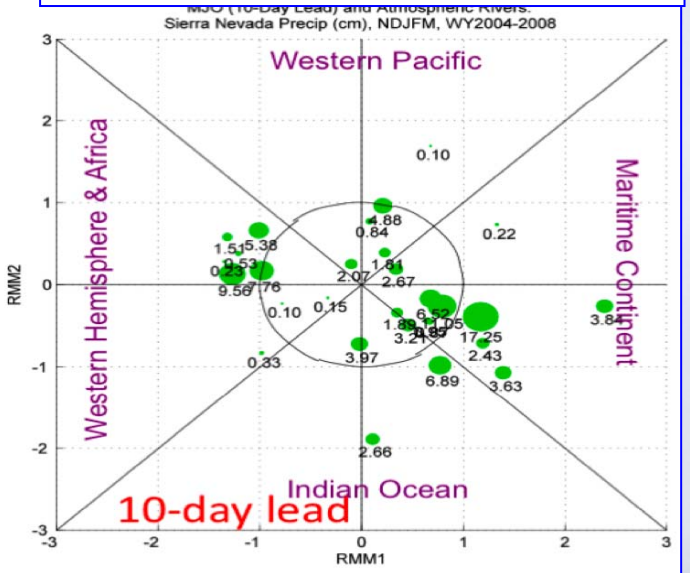
Atmospheric Rivers During YOTC

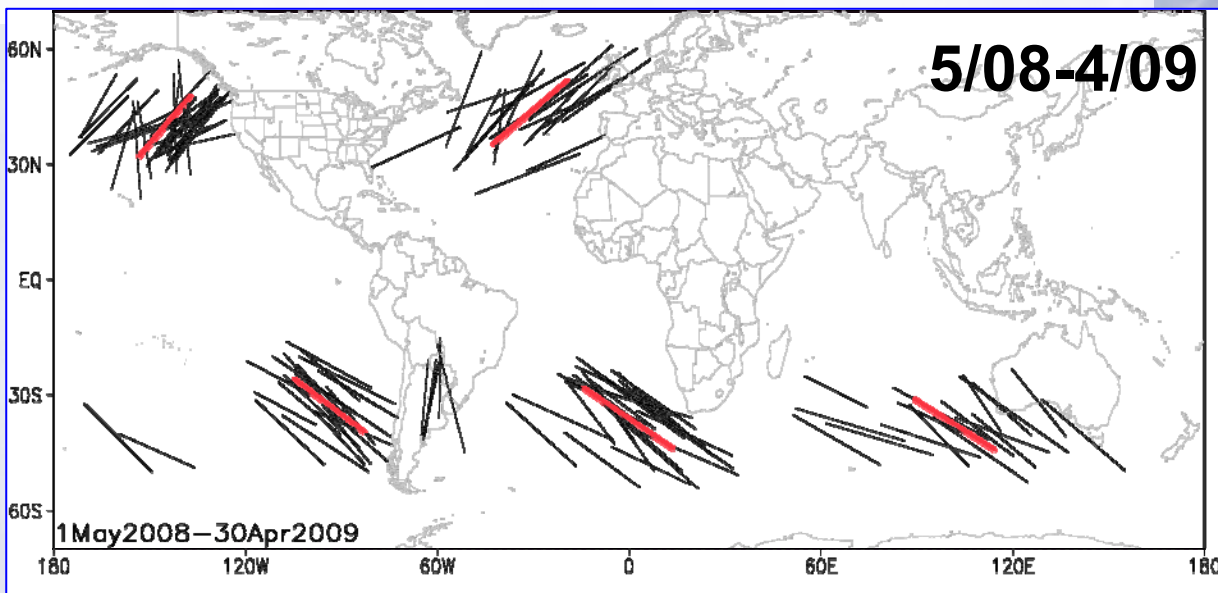
Tropical-Extratropical Interactions

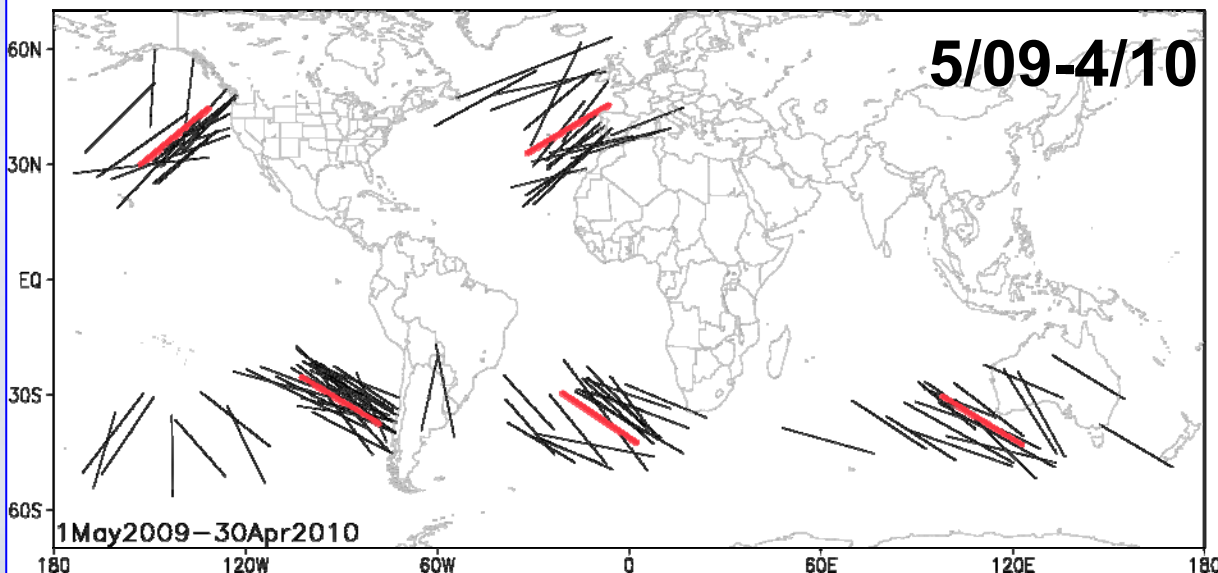
Bin Guan



MJO -> AR -> CA Precip



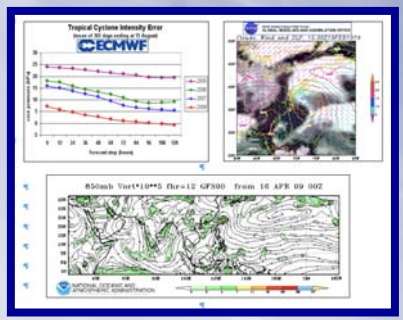




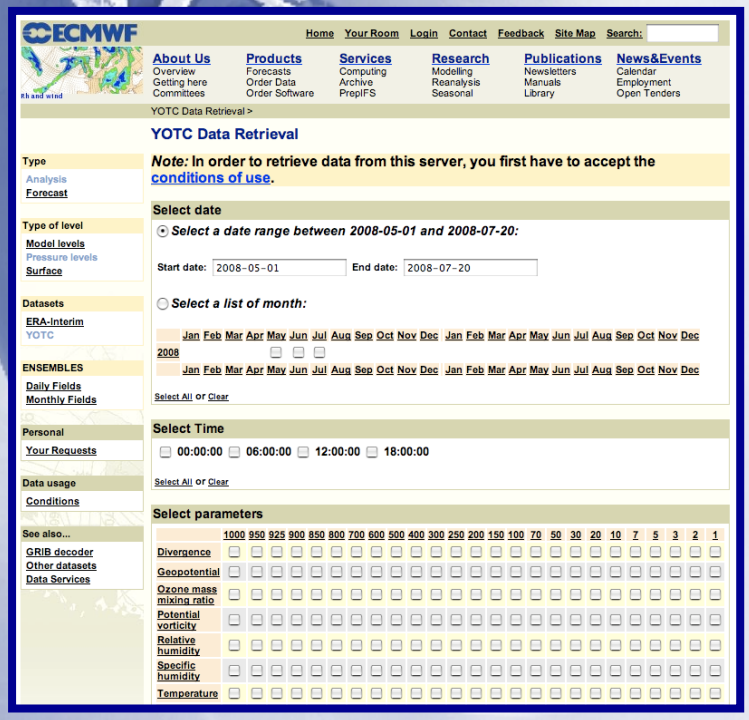
YOTC: Progress & Pl

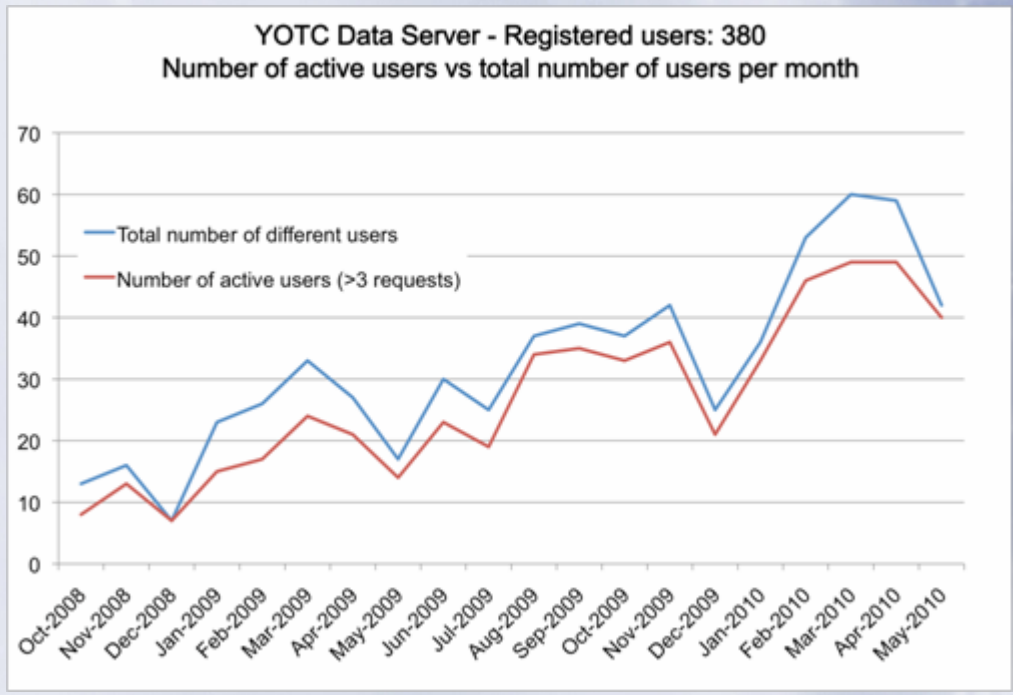
- **Science Plan –** Completed, WMO Technical Document.
- **Program Support/Information Specialist** – (Part-time): US THORPEX Exec Committee funding via U.S. NSF, NOAA, NASA.
- **Web site:** http://www.ucar.edu/yotc
- **Implementation Plan Drafted and Discussed/Approved at Workshop in Honolulu July 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 Science Workshop + WGNE Meeting, China, Spring

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)*

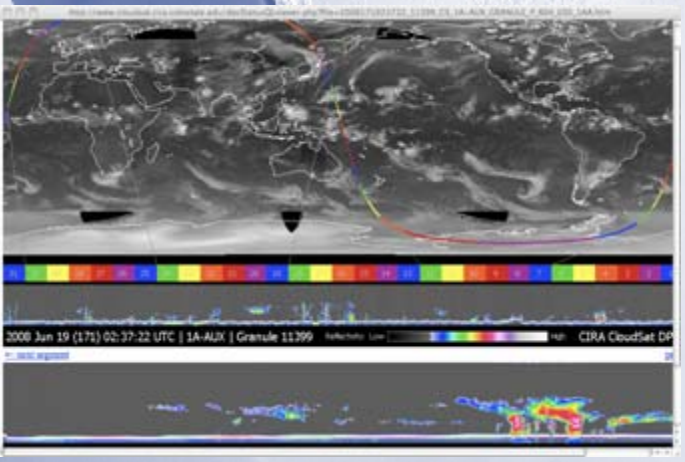


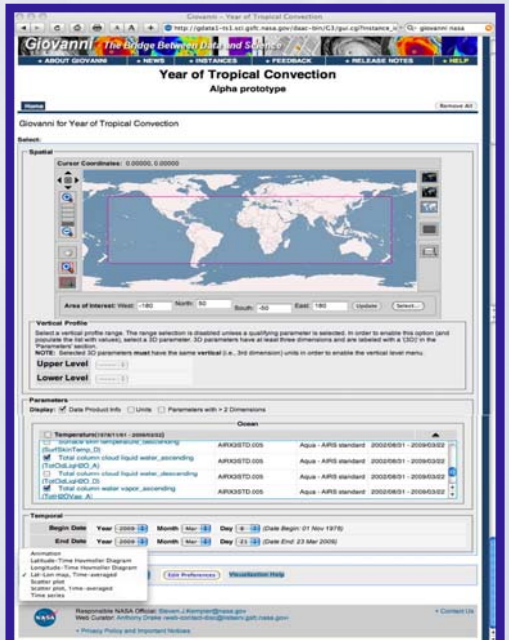


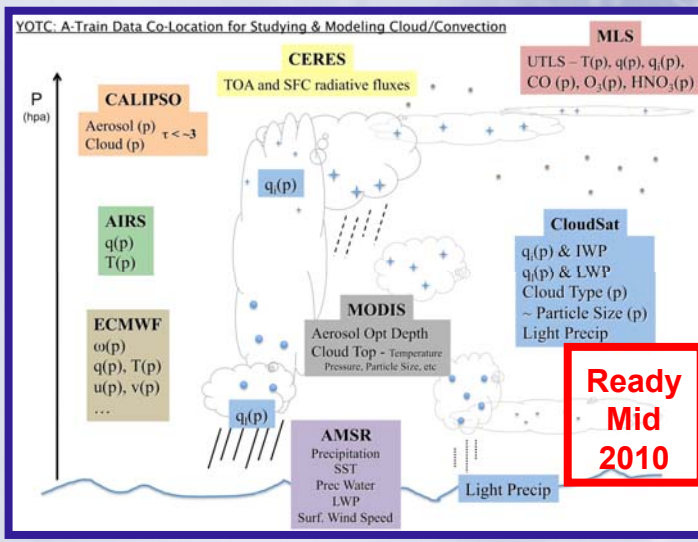
ECMWF-YOTC Replicated at NCAR in coming months.

YOTC: Satellite Data

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

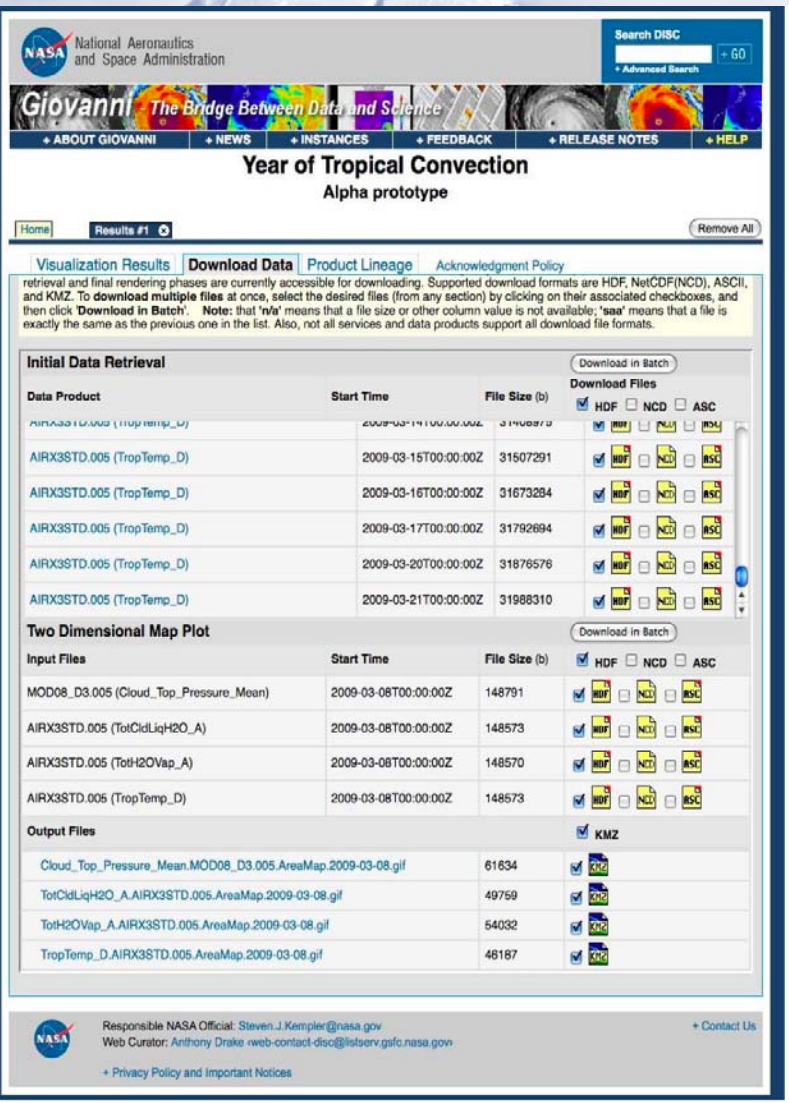


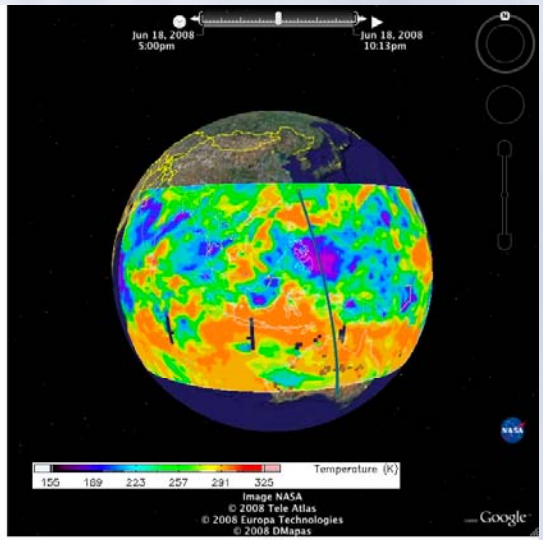


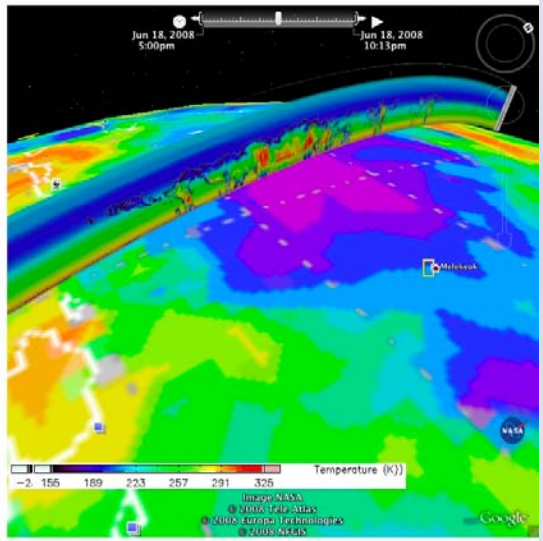


Satellite Data Analysis & Dissemination

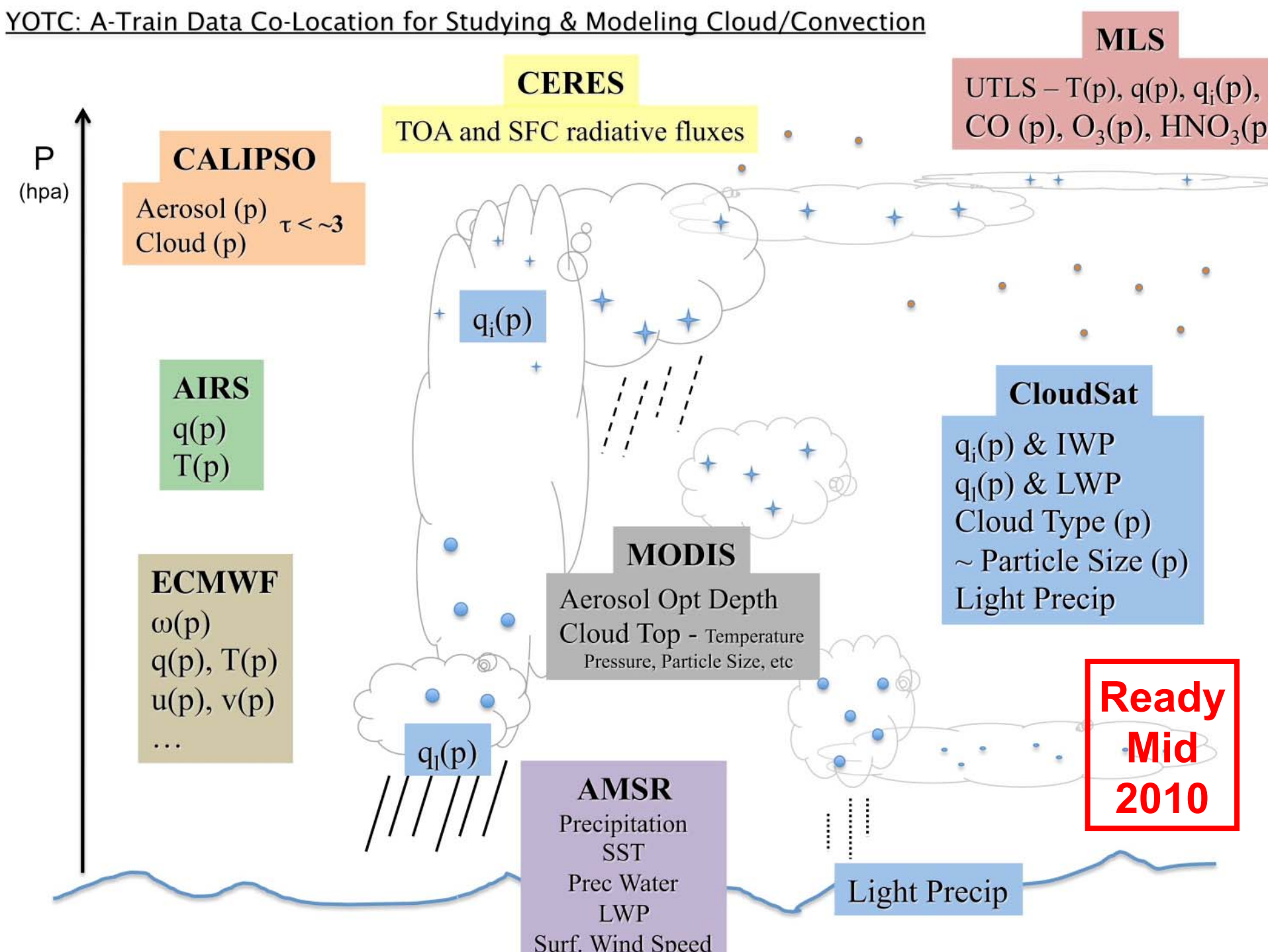
NASA Giovanni & A-Train Data Interfaces







AIRS
AMSR-E
CALIPSO
CERES
CloudSat
GPS
ISCCP
MLS
MODIS
PEHRRP
QuikSCAT
TRMM/TMI

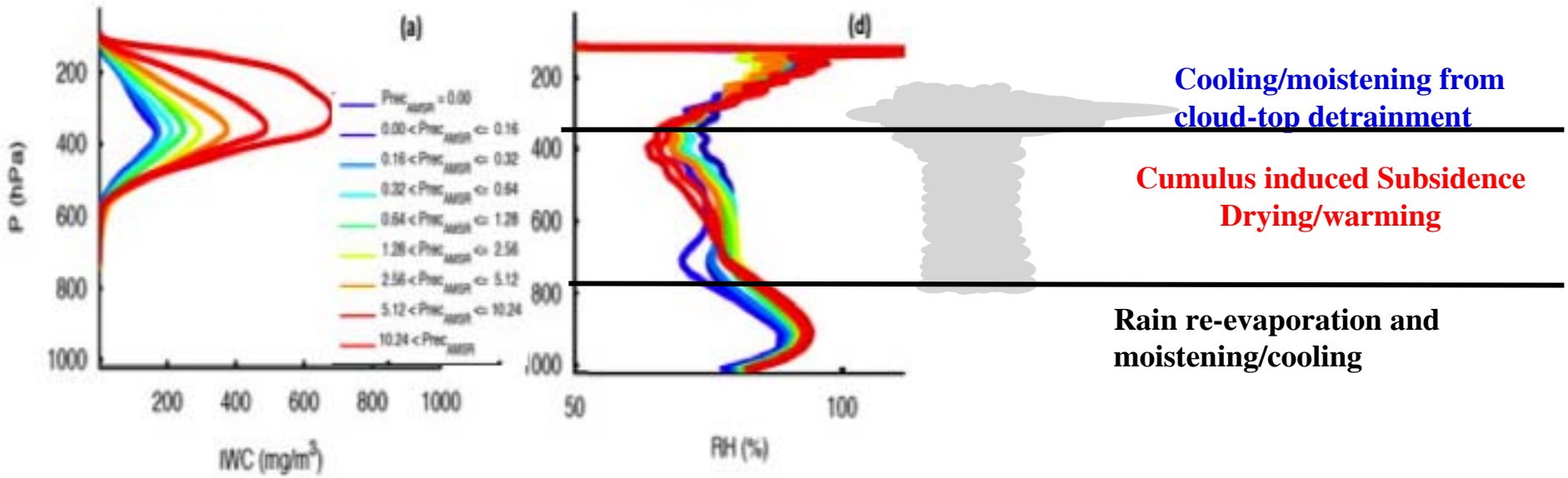

YOTC: A-Train Data Co-Location for Studying & Modeling Cloud/Convection
MLS
UTLS – T(p), q(p), q_i(p),
CO (p), O_3(p), HNO_3(p
CERES
TOA and SFC radiative fluxes
P
(hpa)
CALIPSO
Aerosol (p)
Cloud (p)
τ < ~3
q_i(p)
AIRS
q(p)
T(p)
CloudSat
q_i(p) & IWP
q_l(p) & LWP
Cloud Type (p)
~ Particle Size (p)
Light Precip
MODIS
Aerosol Opt Depth
Cloud Top - Temperature
Pressure, Particle Size, etc
ECMWF
ω(p)
q(p), T(p)
u(p), v(p)
…
q_l(p)
Ready
Mid
2010
AMSR
Precipitation
SST
Prec Water
LWP
Surf. Wind Speed
Light Precip

YOTC Satellite Data Application – Convective / Microphysics Moistening/Drying

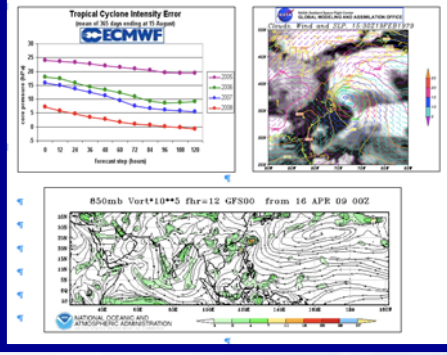
1 – month of A-Train & ECMWF Data

- *AMSR – Rain Rate*
- *CloudSat – IWC and Cloud Class*
- *ECMWF – Rel Hum*

  -> AIRS data a future possibility



YOTC: Field Programs & Synoptic Periods



- Overlapping field programs (e.g., T-PARC, VOCALS, AMY) benefit from and contribute to YOTC.
- A number of synoptic periods of interest identified and agreed upon -- *Pave the way for extended analysis on the observation data sets and frame many of the modeling experiments. A premise of YOTC is community focus along the lines that field programs provide.*

YOTC Implementation: 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. A number of CMIP5 Models as Proposed by WGNE/WGCM.
3. Multiple GCMs via GEWEX/EUCLIPSE project -> CFMIP2/GCSS.
4. NCAR CAM utilizing super-parameterization (SP-CAM).

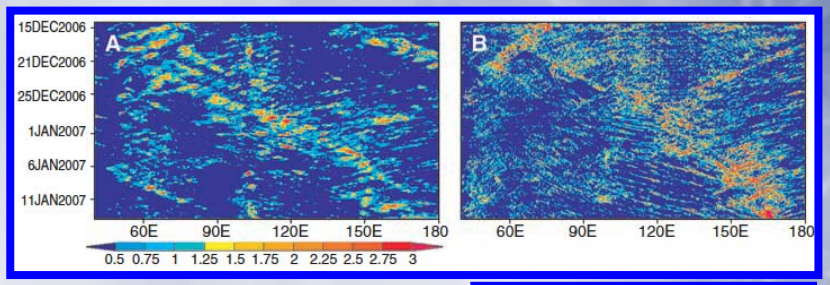
ABOVE GREATLY FACILITED VIA ECMWF YOTC CONTRIBUTION

MJO & Convectively-Coupled Equatorial Waves

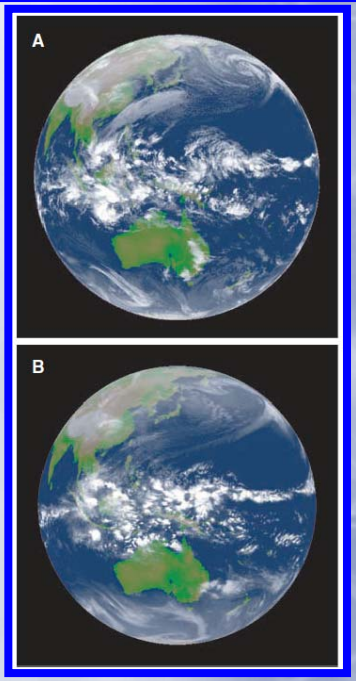
- High Resolution (~5-20km) MJO/CCEW hindcasts: UK *Cascade*, NICAM, GMAO GEOS, GMAO HiRes, CMMAP and GSFC MMFs, Rave/WRF.
- MJO multi-model 20-year hindcast experiment in (CLIVAR AAMP and AMY) to address prediction skill & predictability – extra output for YOTC.
- **WWRP-WCRP YOTC MJO Task Force Activities – more process-oriented simulation diagnostics, boreal summer forecast metrics, etc.**

MJO Case Study Experiments

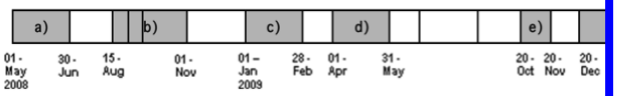
- 6 periods identified w/ help M. Wheeler
- ~5 modeling groups committed
- Details TBD Busan Mtg



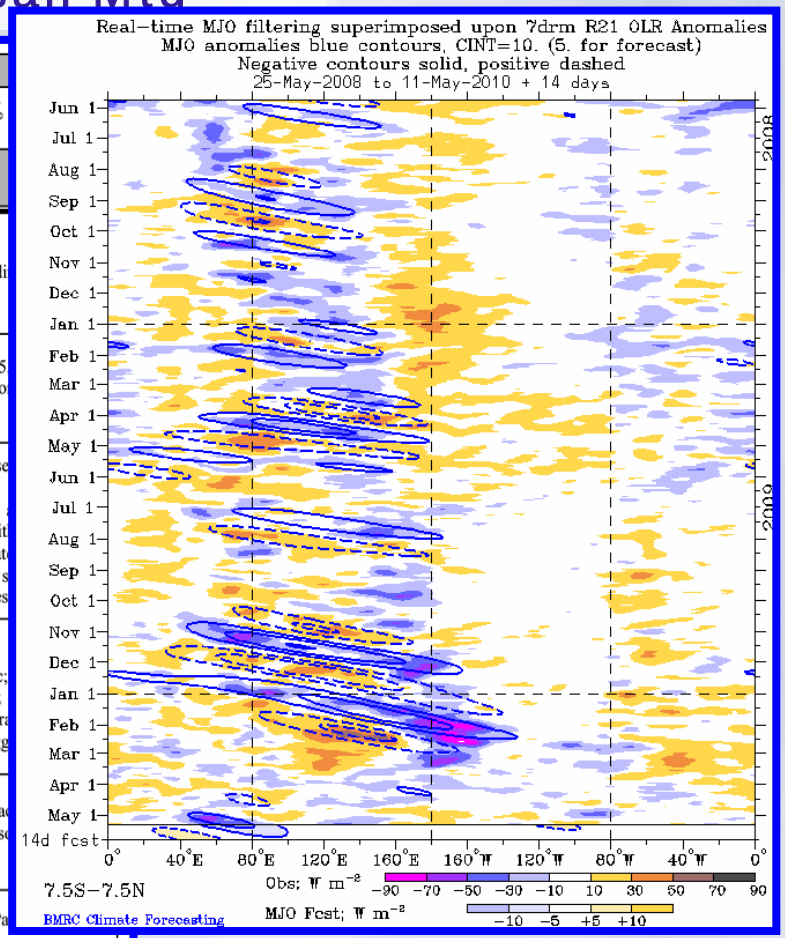
Miura et al. 2007



Dec 2006 MJO



Target Periods (priority)	Features
a) 01MAY2008 - 30JUN2008 (4)	- fast propagation of MJO into Bay of Bengal. - caused strong modulation of eastern Pacific ITCZ, includi embedded TCs.
b) 15AUG2008 - 01NOV2008 (5)	- MJO convective onset (in central IO) about Aug 15 suppressed period in mid-Sept, the second convective o Ocean occurred around Oct 12.
c) 01JAN2009 - 28FEB2009 (3)	- Weak sequence of the MJO that started with a suppresse IO from about 10-20 Jan. - MJO convection onset then followed in the IO on propagating into N Australia in early Feb; coincident wit Australia; strong compensating descent to south exacerbat temperature in NSW/Victoria that affected the wild fires; cyclones, i.e., association with severe weather (floods, fires
d) 01APR2009 - 31MAY2009 (2)	- strongest MJO in the YOTC period up to Hawaii confined to Indian Ocean and Tropical Western Pacific; propagation; convectively coupled Kelvin wave activity; westerly anomalies in Pacific; basin-wide SST increase; tra for MJO between La Nina and El Nino; MJO possibly trigg
e) 20OCT2009 - 20DEC2009 (1)	- strong MJO onset in Indian ocean; propagation into E. Pac El Nino conditions; effects on N-hemispheric weather seas climate.
f) 20DEC200 - 20FEB2009 (1)	- strong MJO onset in Indian Ocean; propagation into E. Pa southward in mid-Pacific region.



YOTC Implementation: Collaborative research

GEWEX Cloud System Study (GCSS):

- Extension of GEWEX Pacific Cross-section Intercomparison (GPCI) for June-August 2008 of YOTC: transition of stratocumulus, trade-cumulus, deep convection.

Tropical-Extratropical interaction

- Tropical – extratropical interaction studies (TPARC and TCS08) focusing on the life cycle and impacts of tropical convection on the prediction and predictability of mid-latitude weather (e.g., ET, storm tracks).

Easterly Waves and Tropical Cyclones

- Synergistic forecast and analysis study in the Atlantic sector of easterly waves, tropical cyclones and their modulation by intraseasonal variability. Cases during YOTC identified.

NCAR Tropical Channel Model (TCM) simulations:

- 4-km mesh, ECMWF T799 dataset for initial & meridional BCs.
- Maritime Continent 'prediction barrier': orographic, diurnal cycle, coastal effects on MJO

YOTC Implementation: Next Steps

- **Move forward with collaborative research identified at the July 2009 YOTC Implementation Planning Workshop – a multi-year effort.**
- **YOTC synoptic description article + motivational paper being drafted for e.g., BAMS and/or special issue.**
- **Expand involvement of nations in YOTC who are directly impacted by the tropical weather and climate (e.g., Africa, China, India, Korea, S. America) - WP AGU, S.A. AGU, WGNE + YOTC Science Workshop in China Spring 2011.**
- **1st YOTC MJO Task Force meeting along with Monsoon ISV Workshop June 2010, APCC, Busan.**
- **YOTC Research: Briefing of US agencies and inter-agency bodies e.g., US-CLIVAR, US THORPEX Executive Committee.**
- **Provide large-scale framework for the proposed 2011 DYNAMO field campaign focused on MJO onset in Indian Ocean.**

YOTC website

www.ucar.edu/yotc

Thanks for your attention