

Year of Tropical Convection (YOTC)

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

Duane Waliser, JPL/Caltech

Mitch Moncrieff, NCAR

Co-chairs, YOTC Science Planning Group

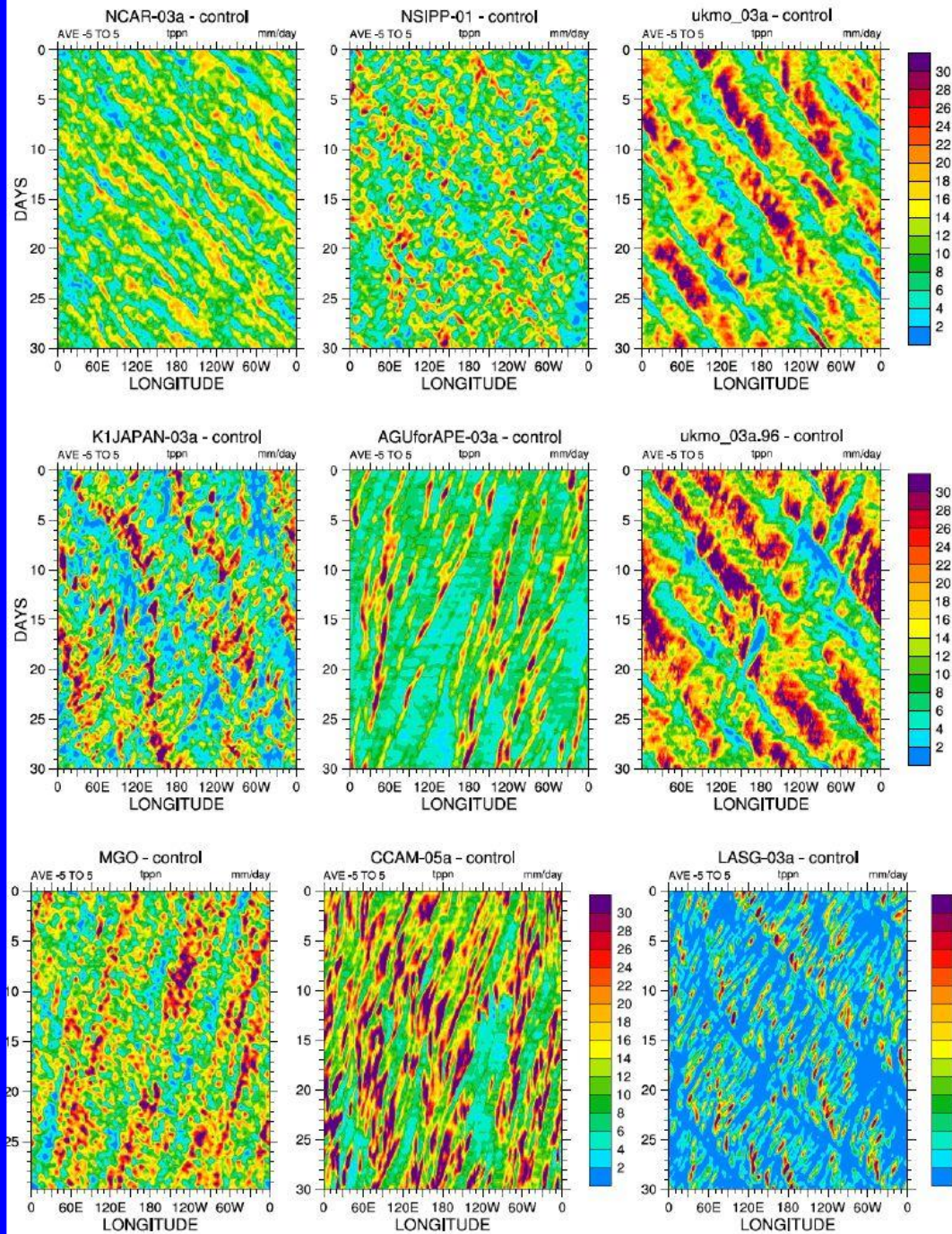


**A Contribution to Seamless
Weather-Climate Prediction**

A STARK DEMONSTRATION OF THE “TROPICAL CONVECTION PROBLEM”

Aqua-Planet Experiment

N Models => N Answers

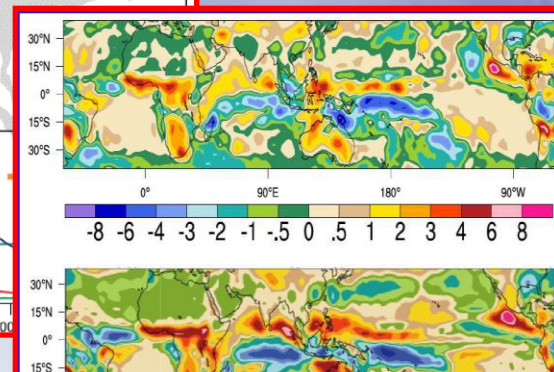
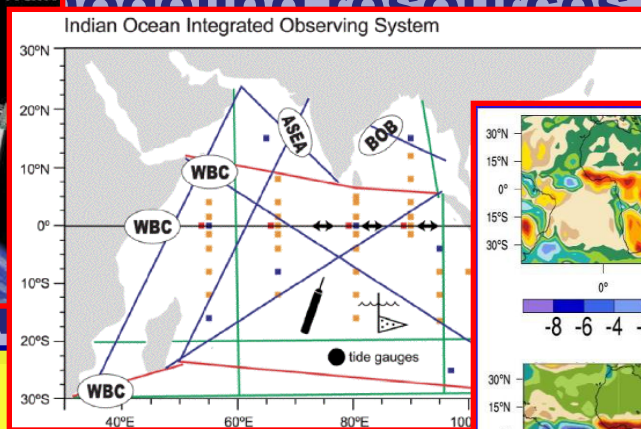


COURTESY,
DAVE WILLIAMSON, NCAR

The tropical atmosphere-ocean-land systems have never been so well observed.

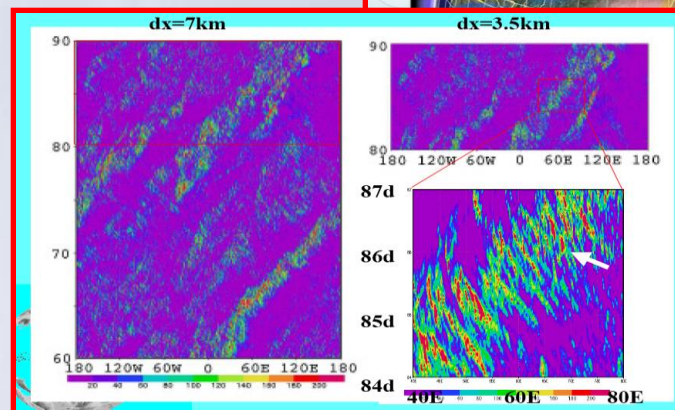
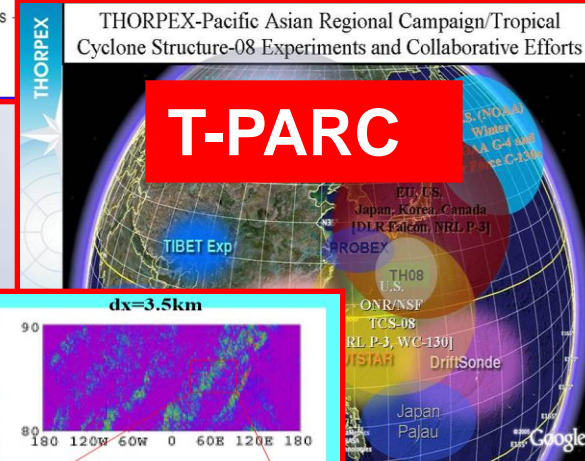
HOW TO ADDRESS THIS PROBLEM?

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 Analyses
- Research Models [e.g., Regional and Global Cloud(-System) Resolving Models]



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

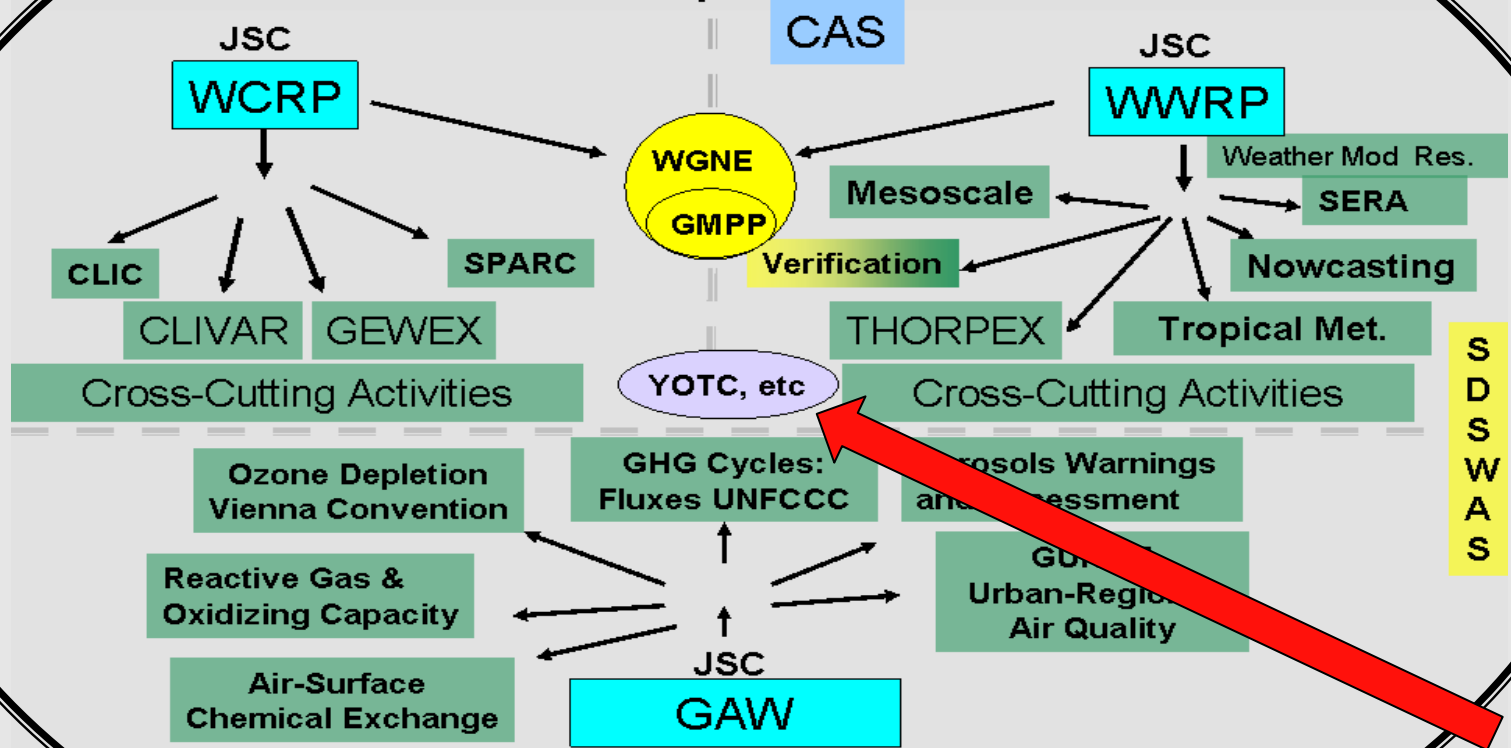
**Focus
“Year”
Virtual
IOP**

Prediction

Assessments

Observations

WMO Research Programme Components



S
D
S
W
A
S

Priority
Joint
Research
Activity

Service Delivery

Capacity Building

29 April 08
Weather, Climate, Water and Air Quality

WWRP JSC 2008

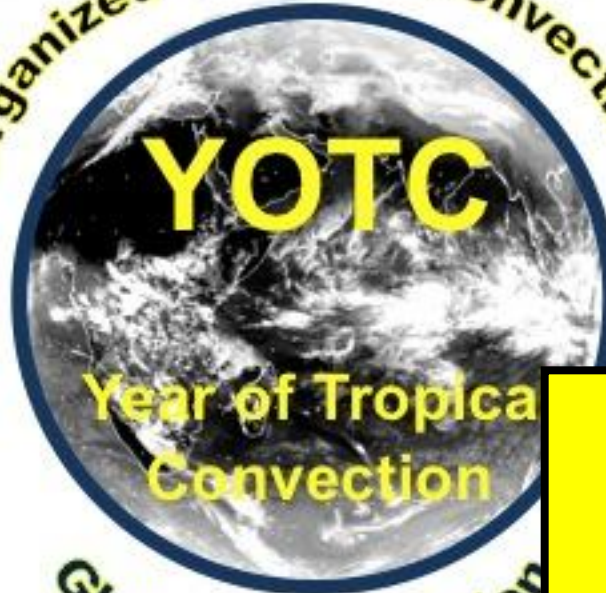
Global Prediction

High-resolution operational deterministic-model data sets

Integrated Observations

Satellite, field-campaign, *in-situ* data sets

Organized Tropical Convection



Year of Tropical Convection

Global Interaction

Research

Attribution studies of global data sets; superparameterized, and explicit regional-to-global models; theoretical

Focus Period

May '08 – Apr '10

Focus Areas

MJO & CCEWs
Easterly Waves & TCs
Trop-ExtraTrop Interaction
Diurnal Cycle
Monsoons



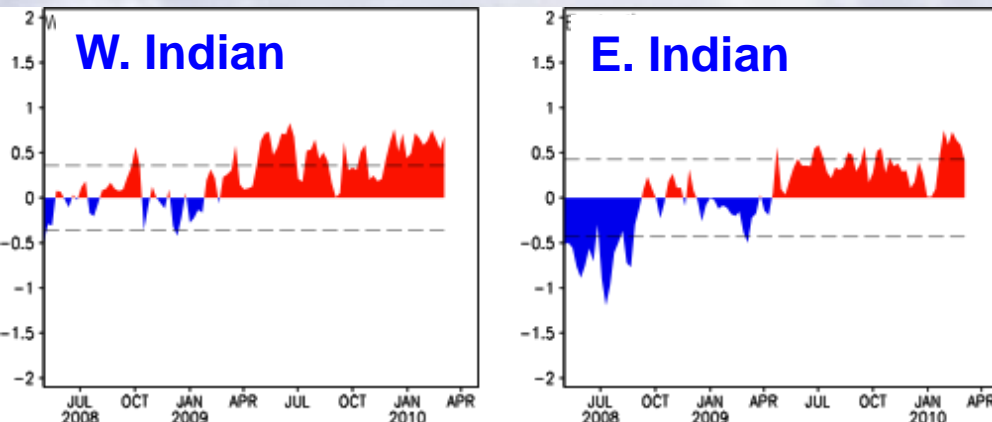
The "Year" of Tropical Convection (May 2008 to April 2010): Climate Variability and Weather Highlights

Many authors/contributions
BAMS Submission Expected in June

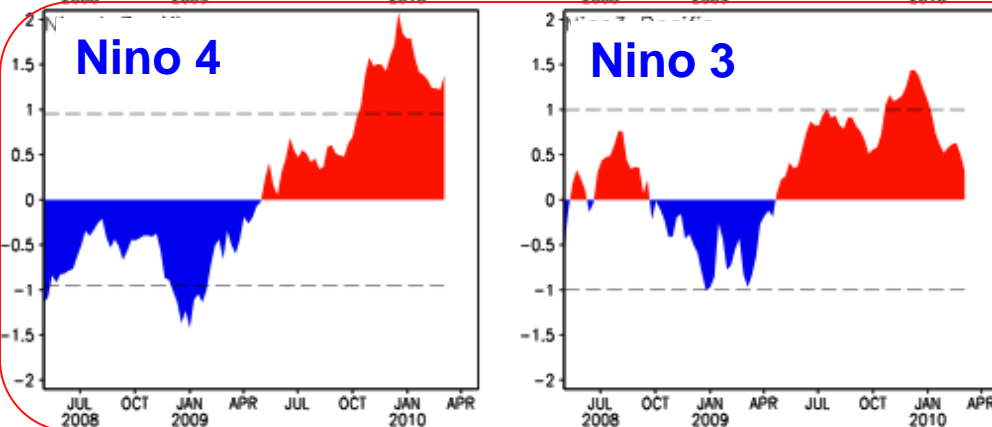
1	Introduction
2	Background Conditions and Low-Frequency Climate Variability
3	Tropical Waves
3.1	Madden-Julian Oscillation
3.2	Convectively Coupled Equatorial Waves
3.3	Easterly Waves
4	Tropical Cyclones
5	Monsoons
5.1	Indian
5.2	East Asian / Western North Pacific
5.3	Australian
5.4	N. American
5.5	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

Background Conditions & Low Frequency SST

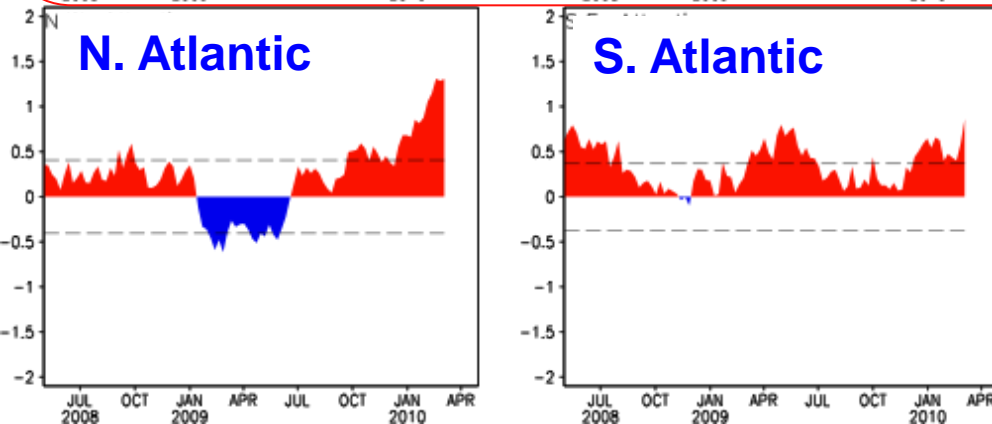
Tropical SSTs



Warm in Year 2
Mostly +DMI



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

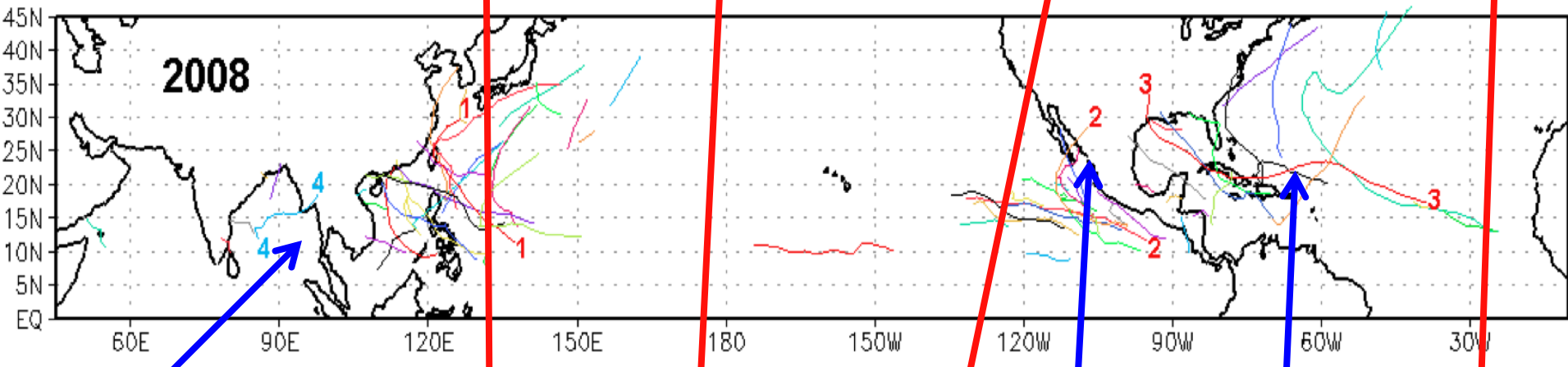
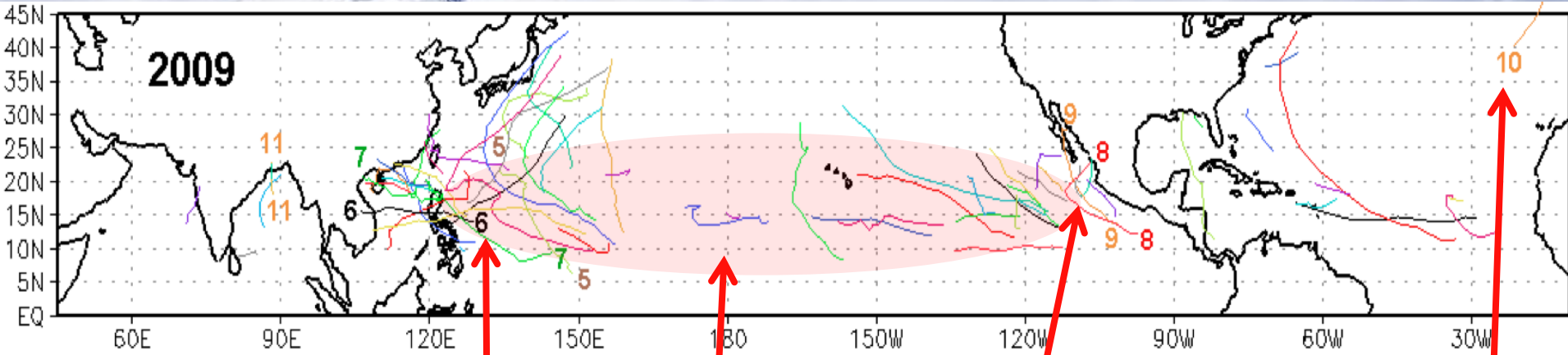


Mostly Warm Atlantic

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

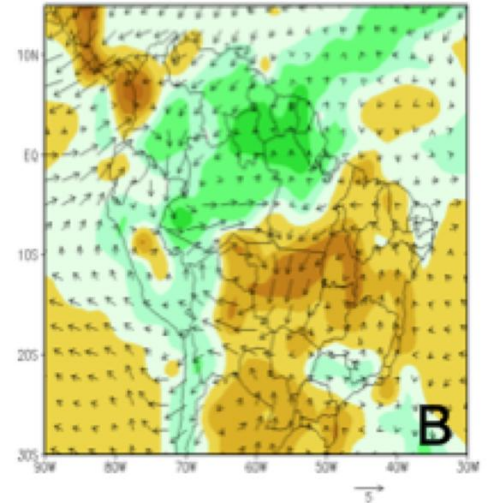
S. America
Jose Marengo

2008

“Normal”
98% AIR

Wet-north
Dry-south

APREC & Anomalia de Vento 850mb - DJF2009

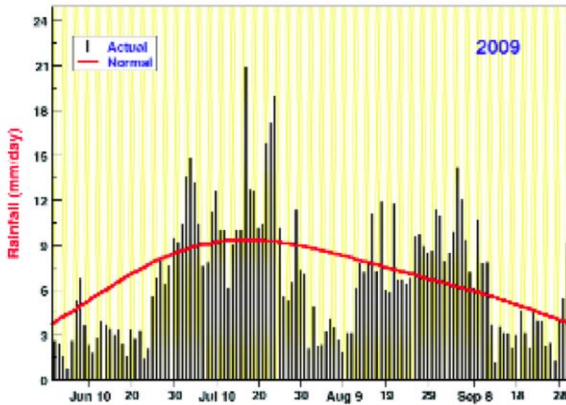
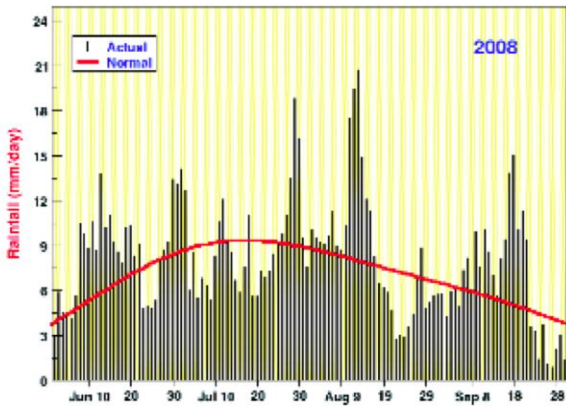
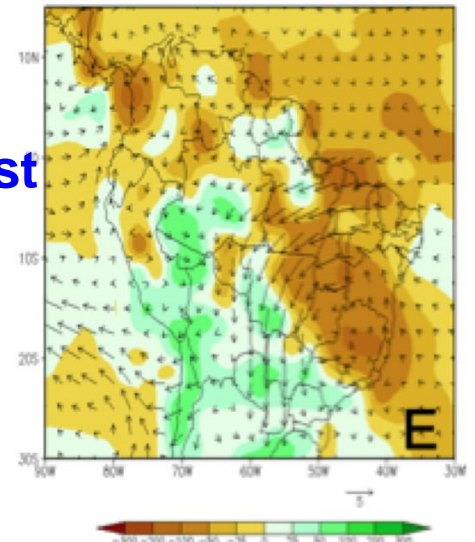


2009

Very Large
Drought
78% AIR

Dry-north/east
Wet-south

APREC & Anomalia de Vento 850mb - DJF2010

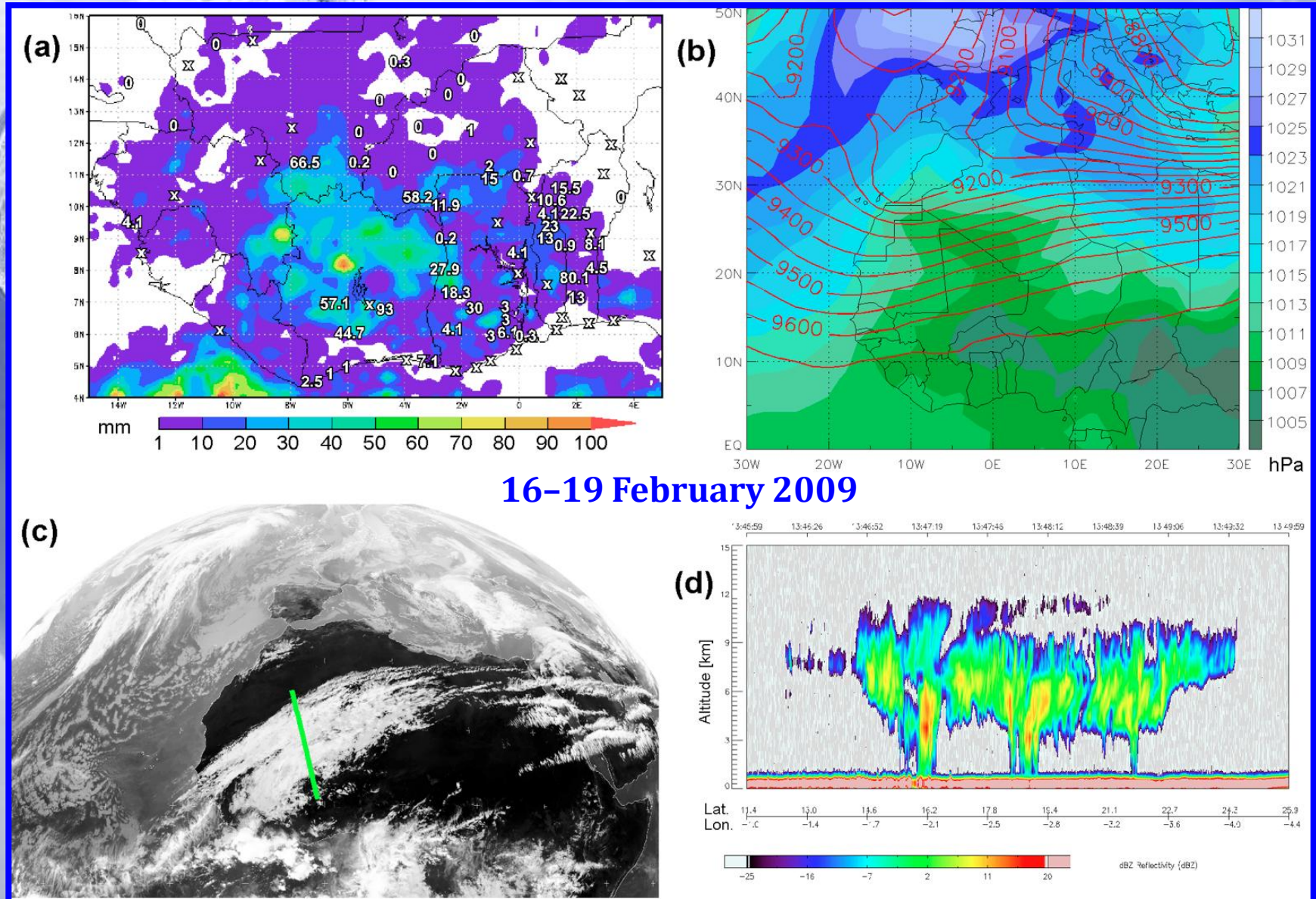


Breaks influenced by ISV

Extra-Tropical Impact on Tropical Convection

5 Significant DRY-Season Wet Episodes in W. Africa

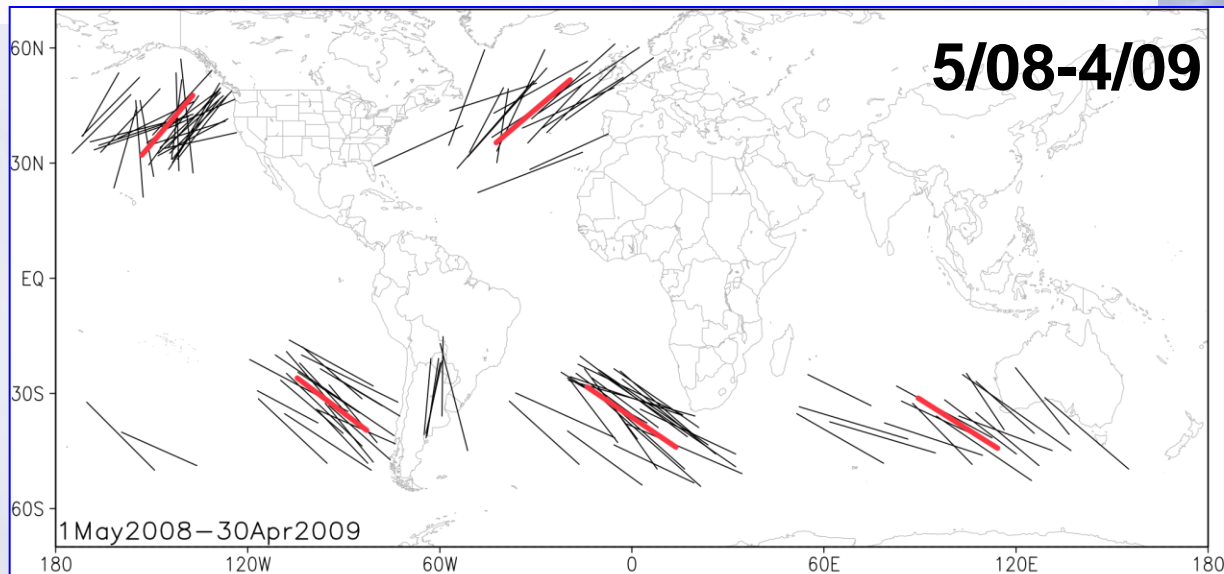
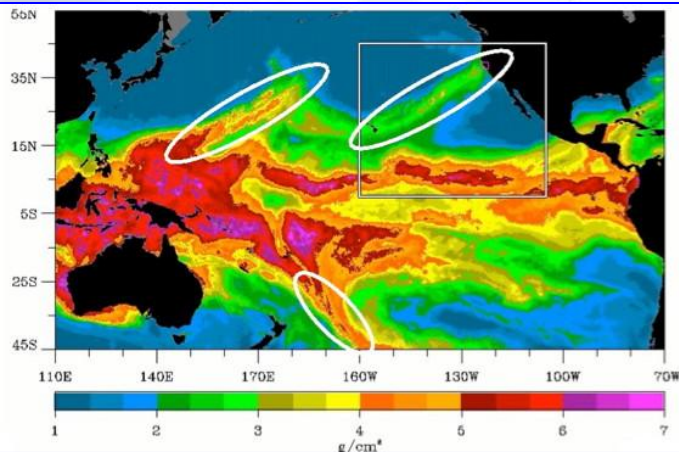
Peter Knippertz
Andrea Fink



Atmospheric Rivers During YOTC

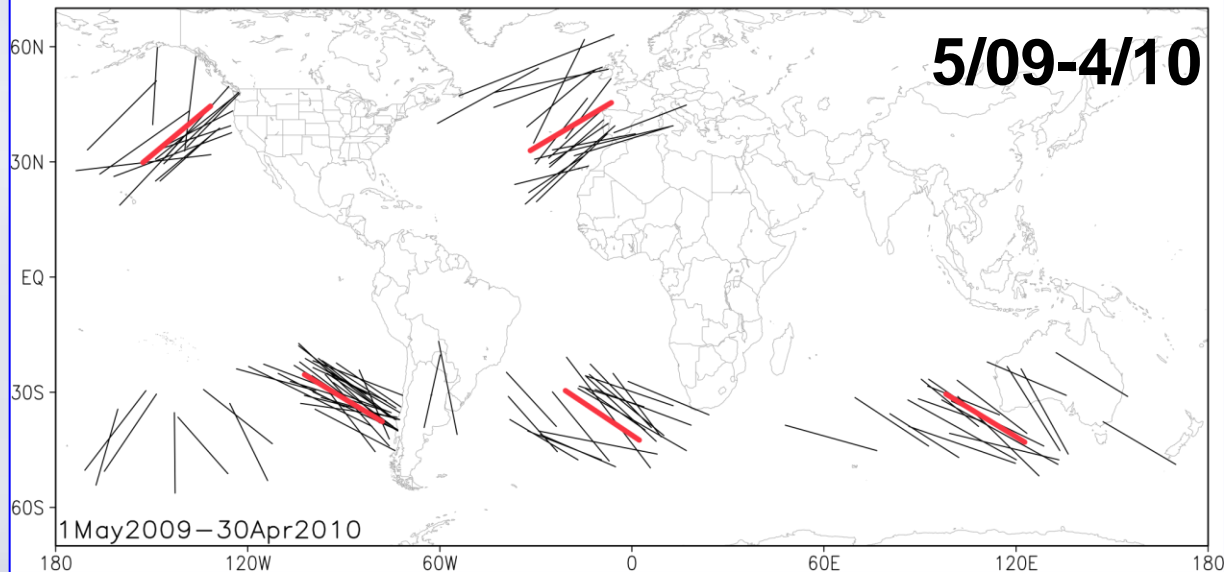
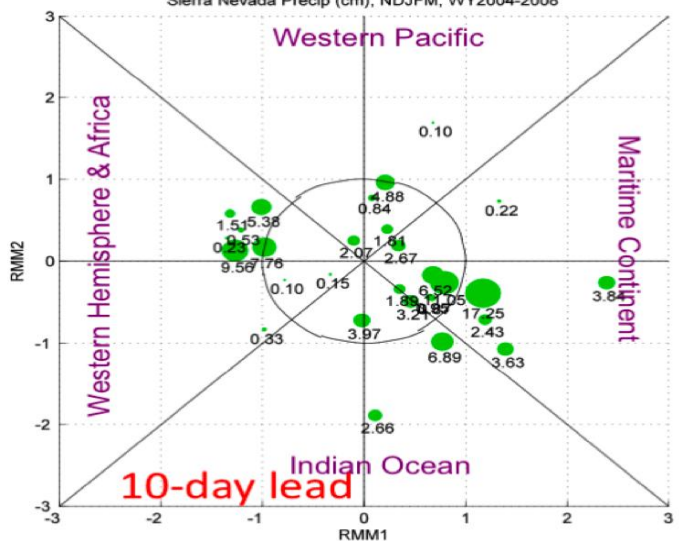
Tropical-Extratropical Interactions

Bin Guan

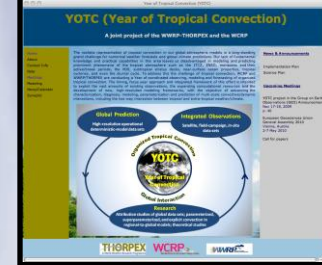


MJO -> AR -> CA Precip

MJO (10-Day Lead) and Atmospheric Rivers.
Sierra Nevada Precip (cm), NDJFM, WY2004-2008

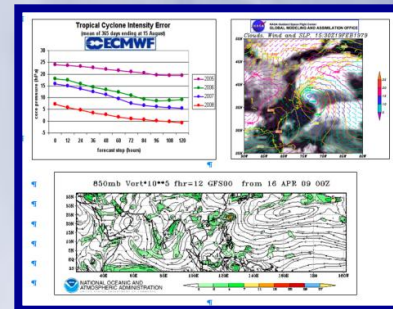


YOTC: PROGRESS & PLAN



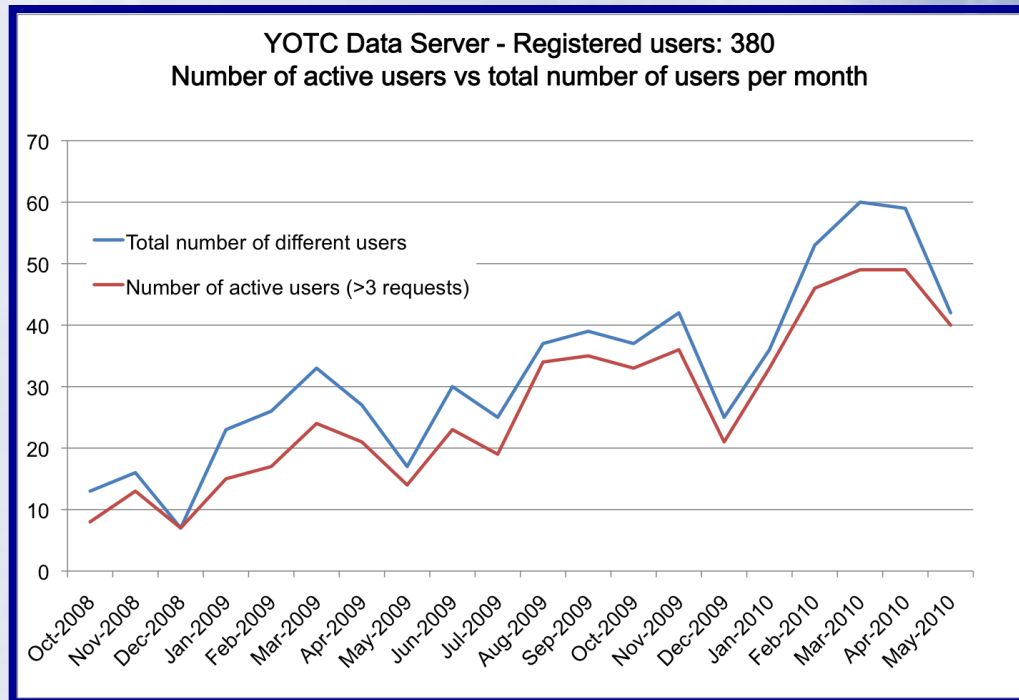
- **Science Plan** – Completed, WMO Technical Document.
- **Program Support/Information Specialist** – (Part-time): US THORPEX Exec Committee funding via U.S. NSF, NOAA, NASA.
- **Web site:** <http://www.ucar.edu/yotc>
- **Implementation Plan Drafted and Discussed/Approved at IP Meeting in Honolulu July 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 Science Workshop + WGNE Meeting, China, Spring 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 YOTC Data Retrieval web interface. 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 for 2008-05-01 to 2008-07-20), 'Datasets' (ERA-Interim, YOTC), 'ENSEMBLES' (Daily Fields, Monthly Fields), 'Personal' (Your Requests), 'Data usage' (Conditions), and 'Select parameters' (a grid of checkboxes for various meteorological parameters like Divergence, Geopotential, etc.).

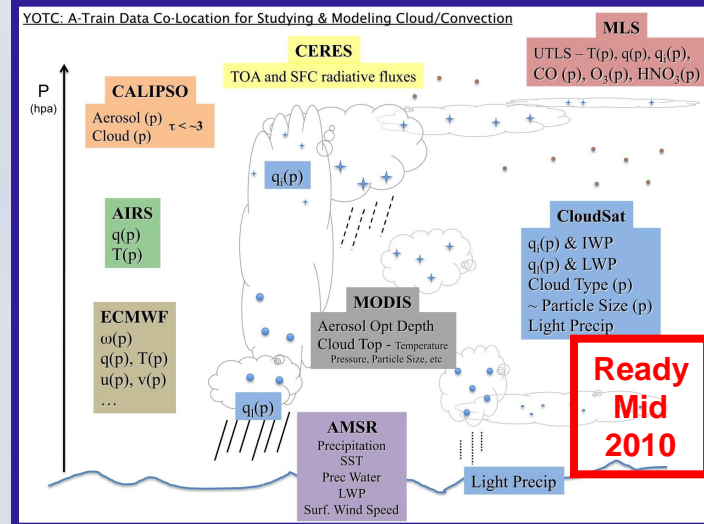
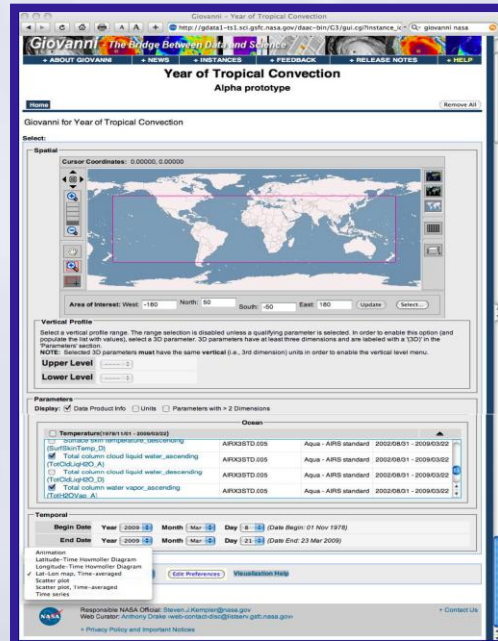
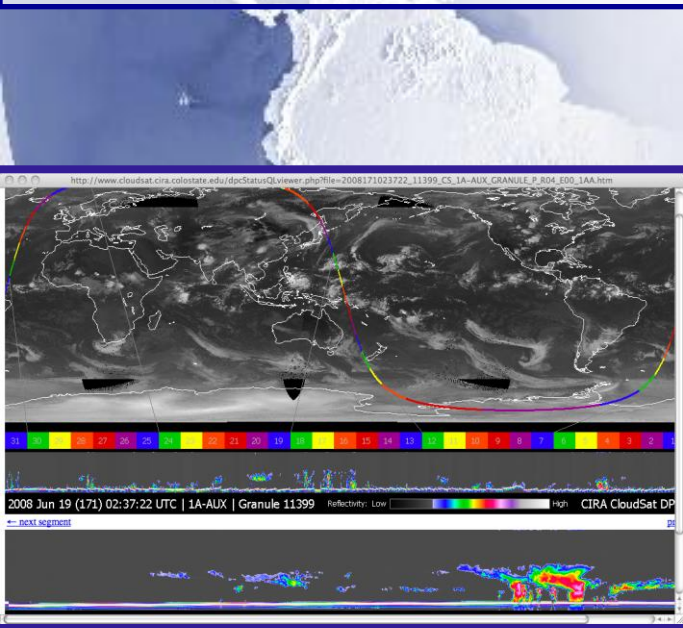


ECMWF-YOTC Replicated at NCAR in coming months.

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.



SATELLITE DATA ANALYSIS & DISSEMINATION

NASA Giovanni & A-Train Data Interfaces

NASA National Aeronautics and Space Administration

Search DISC + GO
Advanced Search

Giovanni The Bridge Between Data and Science

+ ABOUT GIOVANNI + NEWS + INSTANCES + FEEDBACK + RELEASE NOTES + HELP

Year of Tropical Convection

Alpha prototype

Home Results #1 Remove All

Visualization Results **Download Data** Product Lineage Acknowledgment Policy

retrieval and final rendering phases are currently accessible for downloading. Supported download formats are HDF, NetCDF(NCD), ASCII, and KMZ. To download multiple files at once, select the desired files (from any section) by clicking on their associated checkboxes, and then click 'Download in Batch'. Note: that 'n/a' means that a file size or other column value is not available; 'naa' means that a file is exactly the same as the previous one in the list. Also, not all services and data products support all download file formats.

Initial Data Retrieval

Download in Batch

Data Product	Start Time	File Size (b)	Download Files
AIRX3STD.005 (TropTemp_D)	2009-03-14T00:00:00Z	31408979	<input checked="" type="checkbox"/> HDF <input type="checkbox"/> NCD <input type="checkbox"/> ASC
AIRX3STD.005 (TropTemp_D)	2009-03-15T00:00:00Z	31507291	<input checked="" type="checkbox"/> HDF <input type="checkbox"/> NCD <input type="checkbox"/> ASC
AIRX3STD.005 (TropTemp_D)	2009-03-16T00:00:00Z	31673284	<input checked="" type="checkbox"/> HDF <input type="checkbox"/> NCD <input type="checkbox"/> ASC
AIRX3STD.005 (TropTemp_D)	2009-03-17T00:00:00Z	31792694	<input checked="" type="checkbox"/> HDF <input type="checkbox"/> NCD <input type="checkbox"/> ASC
AIRX3STD.005 (TropTemp_D)	2009-03-20T00:00:00Z	31876576	<input checked="" type="checkbox"/> HDF <input type="checkbox"/> NCD <input type="checkbox"/> ASC
AIRX3STD.005 (TropTemp_D)	2009-03-21T00:00:00Z	31988310	<input checked="" type="checkbox"/> HDF <input type="checkbox"/> NCD <input type="checkbox"/> ASC

Two Dimensional Map Plot

Download in Batch

Input Files	Start Time	File Size (b)	Download Files
MOD08_D3.005 (Cloud_Top_Pressure_Mean)	2009-03-08T00:00:00Z	148791	<input checked="" type="checkbox"/> HDF <input type="checkbox"/> NCD <input type="checkbox"/> ASC
AIRX3STD.005 (TotCldLiqH2O_A)	2009-03-08T00:00:00Z	148573	<input checked="" type="checkbox"/> HDF <input type="checkbox"/> NCD <input type="checkbox"/> ASC
AIRX3STD.005 (TotH2OVap_A)	2009-03-08T00:00:00Z	148570	<input checked="" type="checkbox"/> HDF <input type="checkbox"/> NCD <input type="checkbox"/> ASC
AIRX3STD.005 (TropTemp_D)	2009-03-08T00:00:00Z	148573	<input checked="" type="checkbox"/> HDF <input type="checkbox"/> NCD <input type="checkbox"/> ASC

Output Files

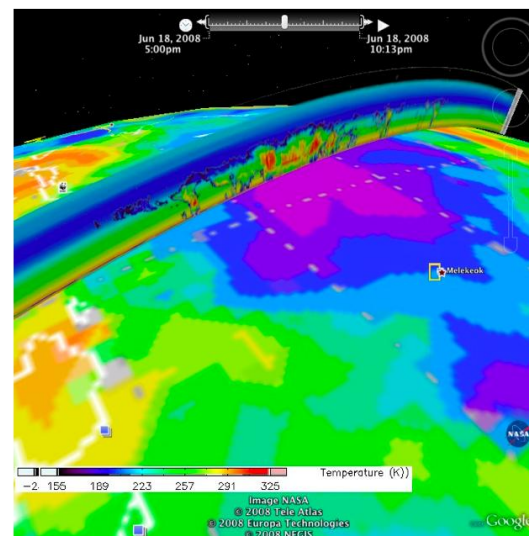
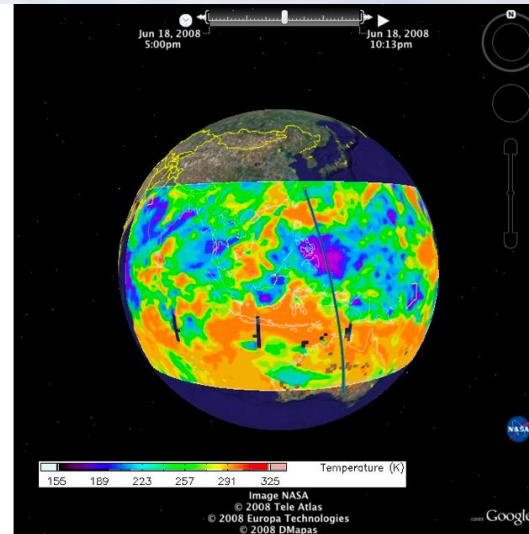
KMZ

Output File	File Size (b)	Download Files
Cloud_Top_Pressure_Mean.MOD08_D3.005.AreaMap.2009-03-08.gif	61634	<input checked="" type="checkbox"/> KMZ
TotCldLiqH2O_A.AIRX3STD.005.AreaMap.2009-03-08.gif	49759	<input checked="" type="checkbox"/> KMZ
TotH2OVap_A.AIRX3STD.005.AreaMap.2009-03-08.gif	54032	<input checked="" type="checkbox"/> KMZ
TropTemp_D.AIRX3STD.005.AreaMap.2009-03-08.gif	46187	<input checked="" type="checkbox"/> KMZ

Responsible NASA Official: Steven J. Kempler@nasa.gov
Web Curator: Anthony Drake web-contact-disc@listserv.gsfc.nasa.gov

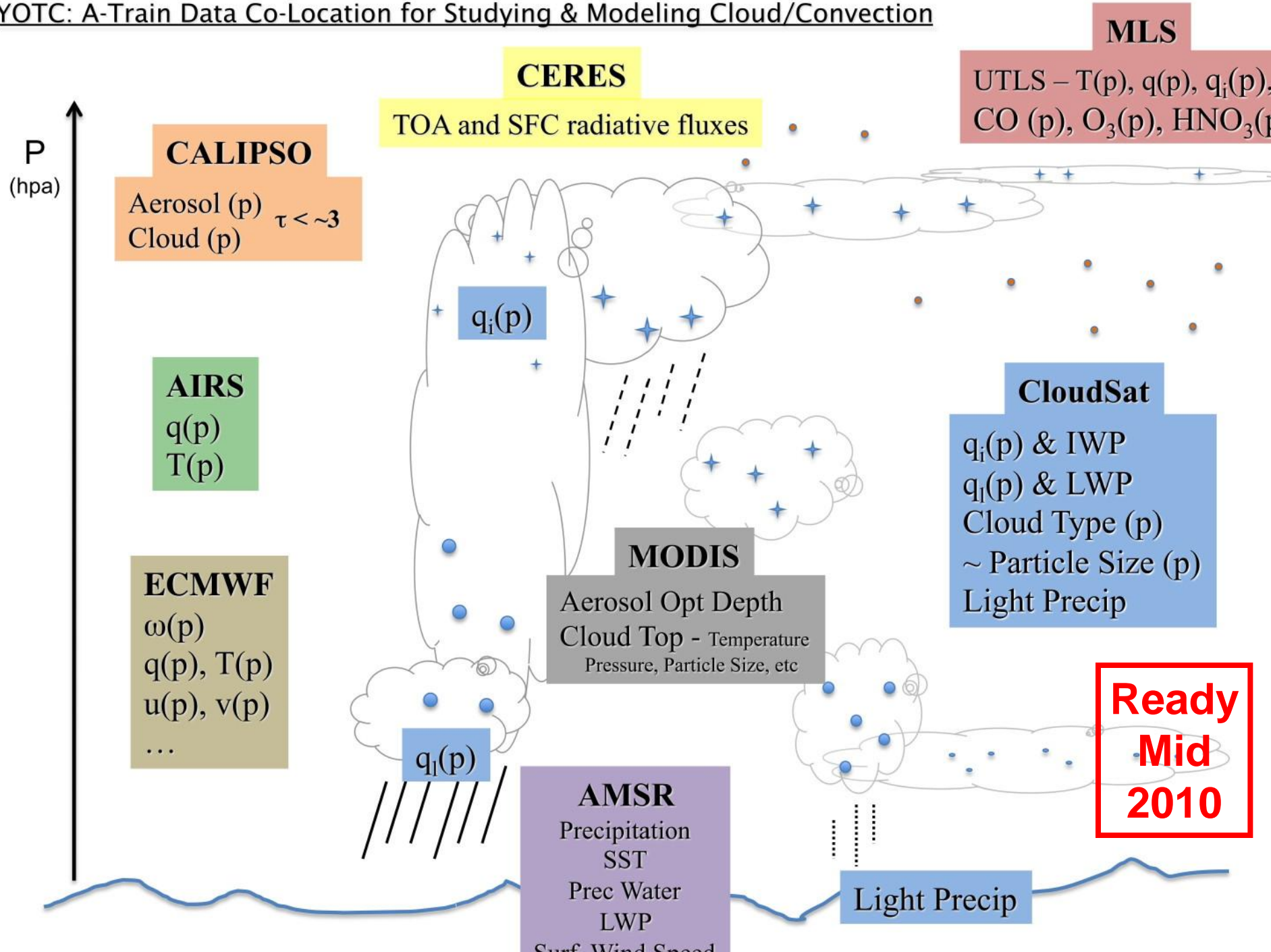
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AIRS
AMSR-E
CALIPSO
CERES
CloudSat
GPS
ISCCP
MLS
MODIS
PEHRRP
QuikSCAT
TRMM/TMI

YOTC: A-Train Data Co-Location for Studying & Modeling Cloud/Convection

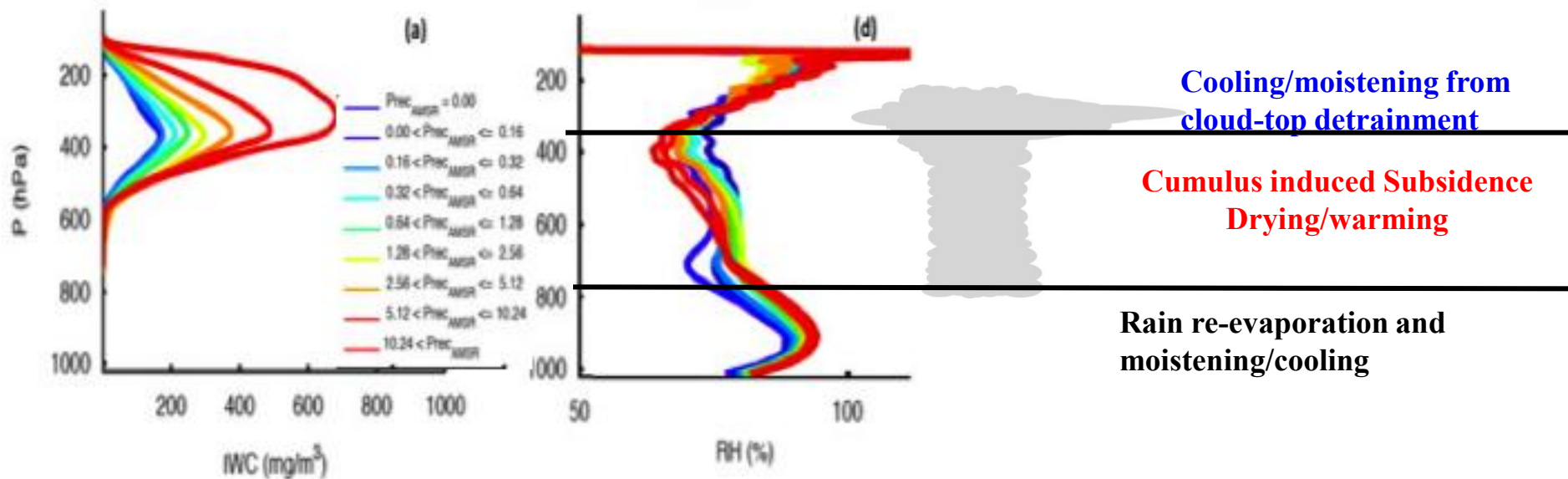


YOTC SATELLITE DATA APPLICATION – CONVECTIVE / MICROPHYSICS

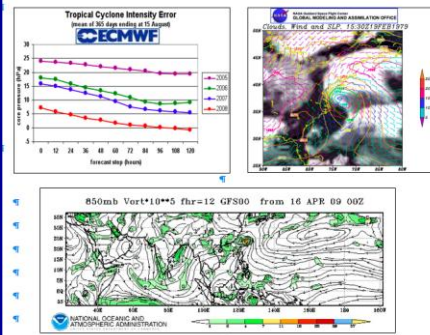
MOISTENING / DRYING

1 – month of A-Train & ECMWF Data

- AMSR – Rain Rate
- CloudSat – IWC and Cloud Class
- ECMWF – Rel Hum
-> Need to replace with AIRS



YOTC: FIELD PROGRAMS & SYNOPTIC PERIODS



- Overlapping field programs (e.g., T-PARC, VOCALS, AMY) that benefit from and contribute to YOTC were discussed.
- A number of synoptic periods of interest have been identified and agreed upon (e.g. late May 2008 – early July 2009). *These 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 FACILITATED VIA ECMWF YOTC CONTRIBUTION

MJO & Convectively-Coupled Equatorial Waves

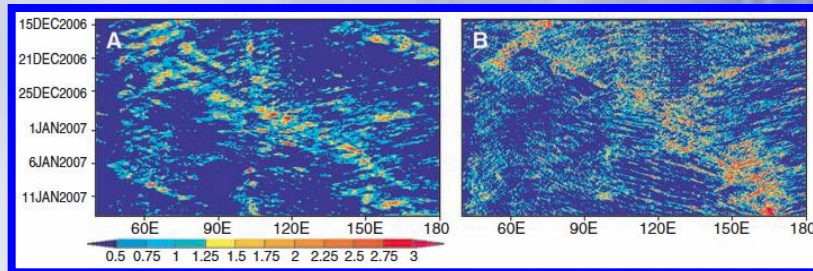
- ✧ High Resolution (~5-20km) MJO/CCEW hindcasts: UK Cascade, NICAM, GMAO GEOS, GMAO HiRes, CMMAP and GSFC MMFs, Rave/WRF.
- ✧ MJO multi-model 20-year hindcast experiment in (CLIVAR AAMP and AMY) to address prediction skill & predictability – extra output for YOTC.
- ✧ **WWRP-WCRP YOTC MJO Task Force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

MJO Case Study Experiments

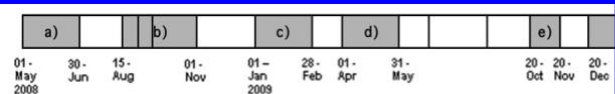
- 6 periods identified w/ help M. Wheeler

- ~5 modeling groups committed

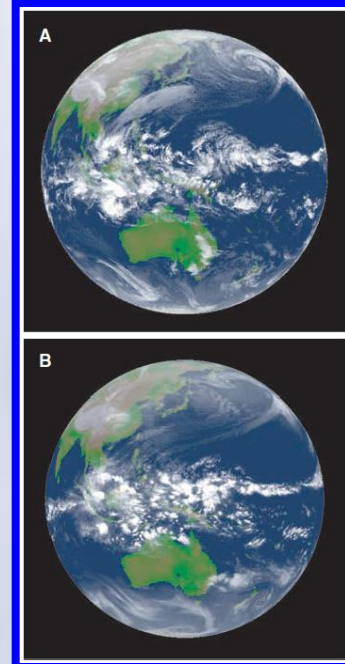
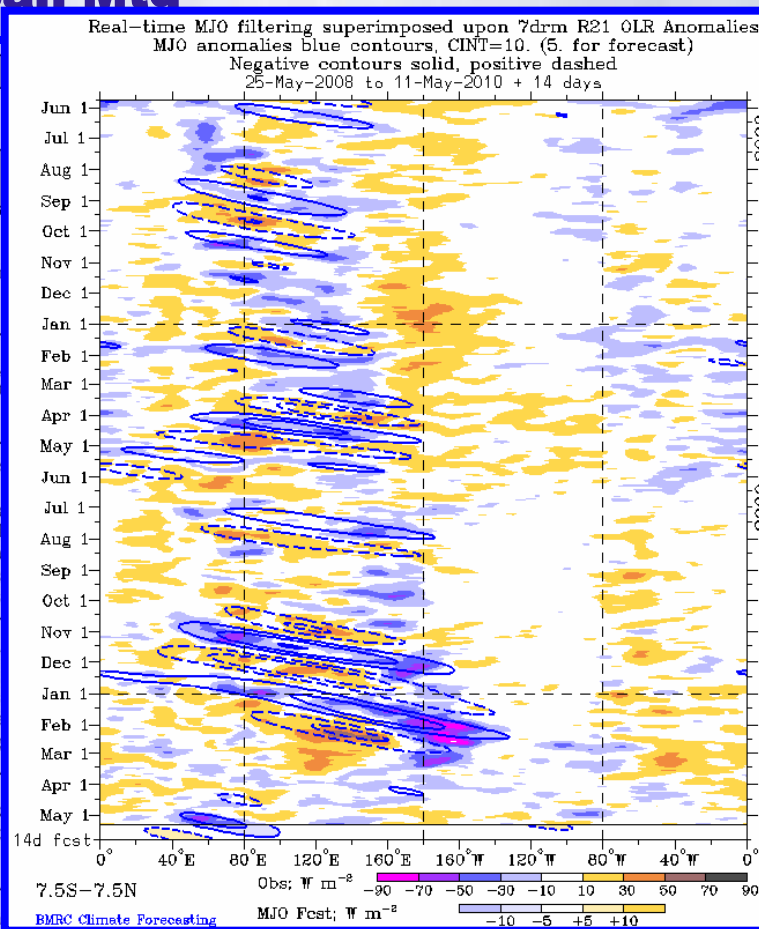
- Details TBD Busan Mtg



Miura et al. 2007



Target Periods (priority)	Features
a) 01MAY2008 - 30JUN2008 (4)	- fast propagation of MJO into Bay of Bengal. - caused strong modulation of eastern Pacific ITCZ, including embedded TCs.
b) 15AUG2008 - 01NOV2008 (5)	- MJO convective onset (in central IO) about Aug 15 suppressed period in mid-Sept, the second convective onset in the IO occurred around Oct 12.
c) 01JAN2009 - 28FEB2009 (3)	- Weak sequence of the MJO that started with a suppressed period in the IO from about 10-20 Jan. - MJO convection onset then followed in the IO on 28 Feb, propagating into N Australia in early Feb; coincident with a strong compensating descent to south exacerbating temperature in NSW/Victoria that affected the wild fires; strong MJO activity in the IO, i.e., association with severe weather (floods, fires)
d) 01APR2009 - 31MAY2009 (2)	- strongest MJO in the YOTC period up to Hawaii; MJO confined to Indian Ocean and Tropical Western Pacific; MJO propagation; convectively coupled Kelvin wave activity; westerly anomalies in Pacific; basin-wide SST increase; transition for MJO between La Nina and El Nino; MJO possibly triggered by El Nino.
e) 20OCT2009 - 20DEC2009 (1)	- strong MJO onset in Indian ocean; propagation into E. Pacific; MJO onset in Indian ocean; propagation into E. Pacific; El Nino conditions; effects on N-hemispheric weather season.
f) 20DEC2009 - 20FEB2010 (1)	- strong MJO onset in Indian Ocean; propagation into E. Pacific; MJO onset in Indian Ocean; propagation into E. Pacific; southward in mid-Pacific region.



Dec 2006 MJO

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

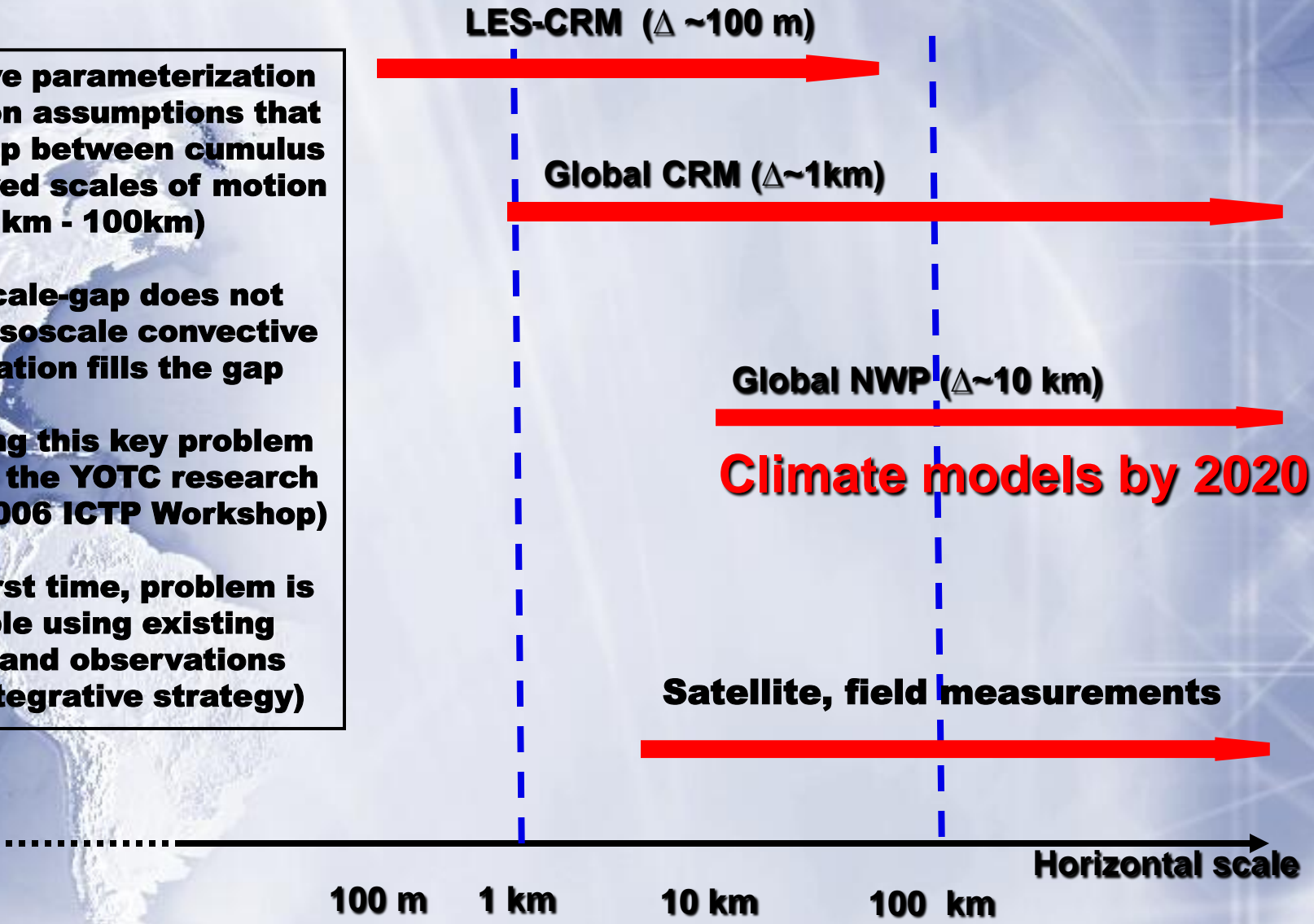
- Move forward with collaborative research identified at the July 2008 YOTC Implementation Planning Workshop – a multi-year effort.
- YOTC synoptic description article(s) e.g., BAMS and/or special issue – drafts expected May 2010.
- Expand involvement of tropical interests in YOTC (e.g., Africa, China, India, Korea, S. America) -> WP AGU, S.A. AGU, WGNE + YOTC Science Workshop in China Sp'2011
- Planning first YOTC MJO Task Force meeting along with Monsoon ISV Workshop June 2010, APCC, Busan.
- 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.

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 : mesoscale convective organization fills the gap

Addressing this key problem is high on the YOTC research agenda (2006 ICTP Workshop)

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



Bridging the Scale Gap

Tropical Convection-Wave Continuum

