Vertical Structure and Diabatic Processes of the MJO
A Global Model Evaluation Project

Jon Petch (Met Office), Duane Waliser (JPL)
Xianan Jiang (JPL/Caltech), Prince Xavier (Met Office)
Nick Klingaman & Steve Woolnough (NCAS - Climate)

© Crown copyright Met Office

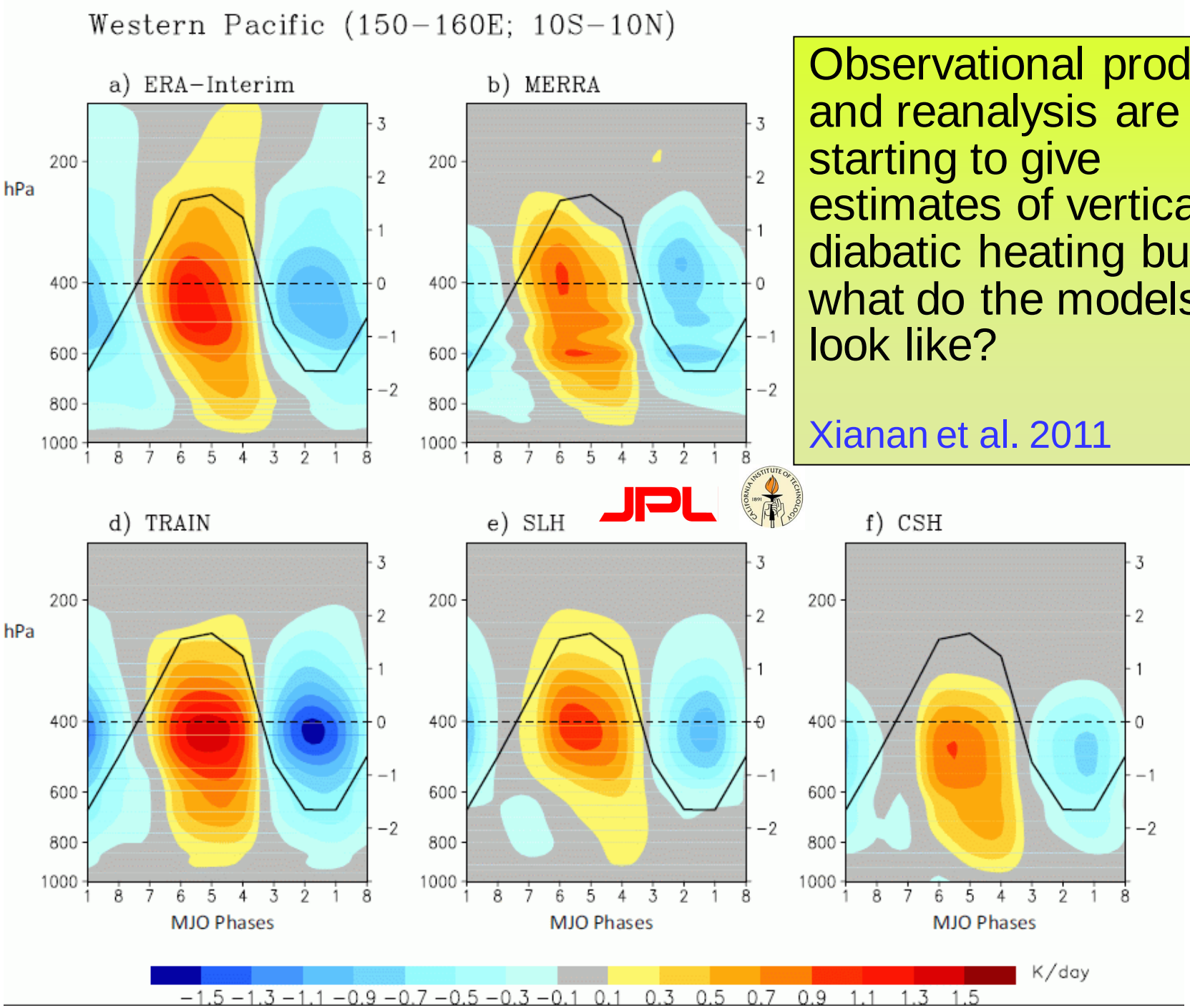
- Motivation
- The groups and data involved
  - GASS
  - MJO Task Force
  - YOTC
- The 3 components
  - Climate simulations
  - Short range hindcast
  - Medium range
- Contacts and further information

© Crown copyright Met Office

Motivation

- The Madden-Julian Oscillation (MJO; Madden and Julian 1971; 1994):
  - exerts pronounced influences on global climate and weather systems (Lau and Waliser 2005; Zhang 2005)
  - represents a primary sources of predictability on subseasonal time scales (e.g., Waliser 2005; Gottschalck et al. 2010)
- Current GCMs exhibit limited capability in representing this prominent tropical variability mode (e.g., Slingo et al. 1996; Slingo et al. 2005; Lin et al. 2006; Kim et al. 2009).
- The fundamental physics of the MJO are still elusive.
- MJO theories emphasize instability arising from various feedbacks between diabatic heating and large-scale dynamics

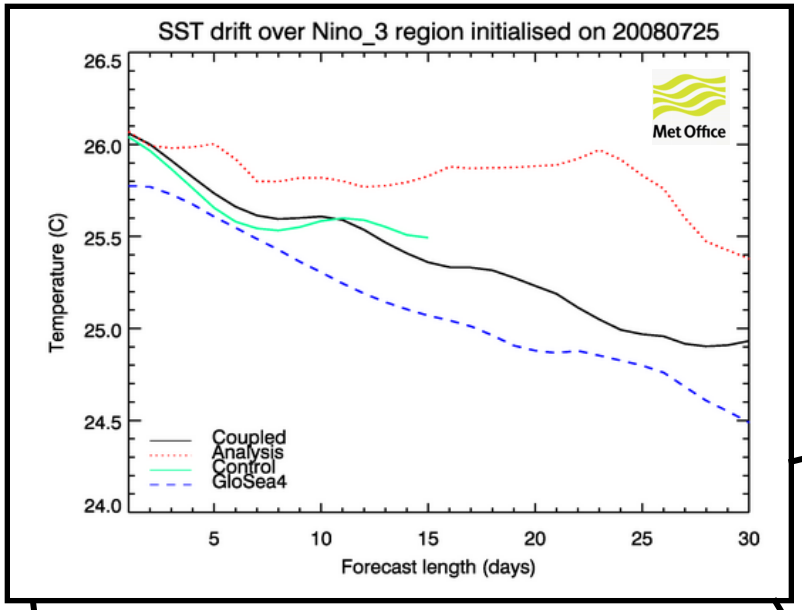
© Crown copyright Met Office



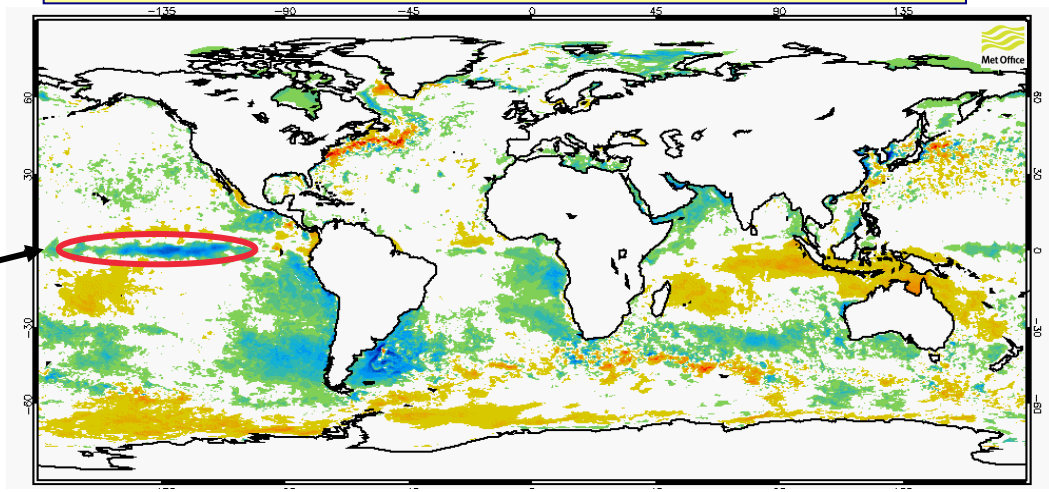
Observational products and reanalysis are starting to give estimates of vertical diabatic heating but what do the models look like?

Xianan et al. 2011

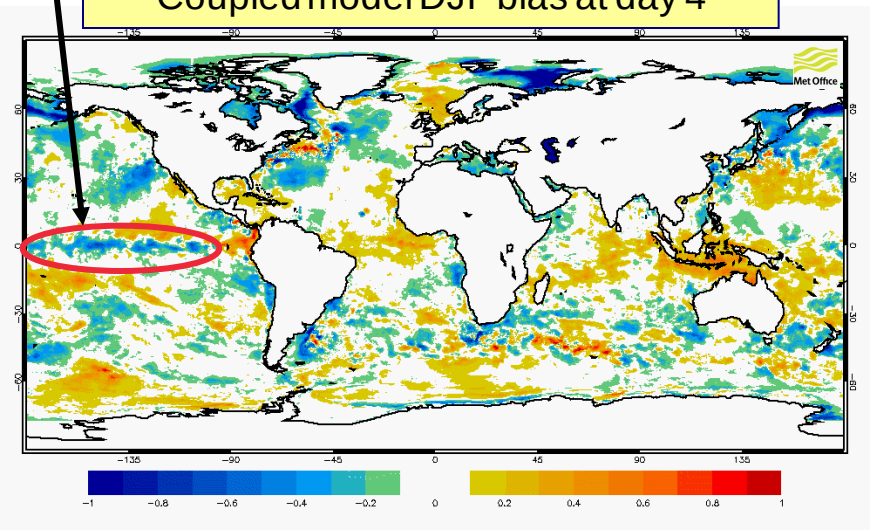
Climate model biases can often be seen in short range forecasts – useful tool…



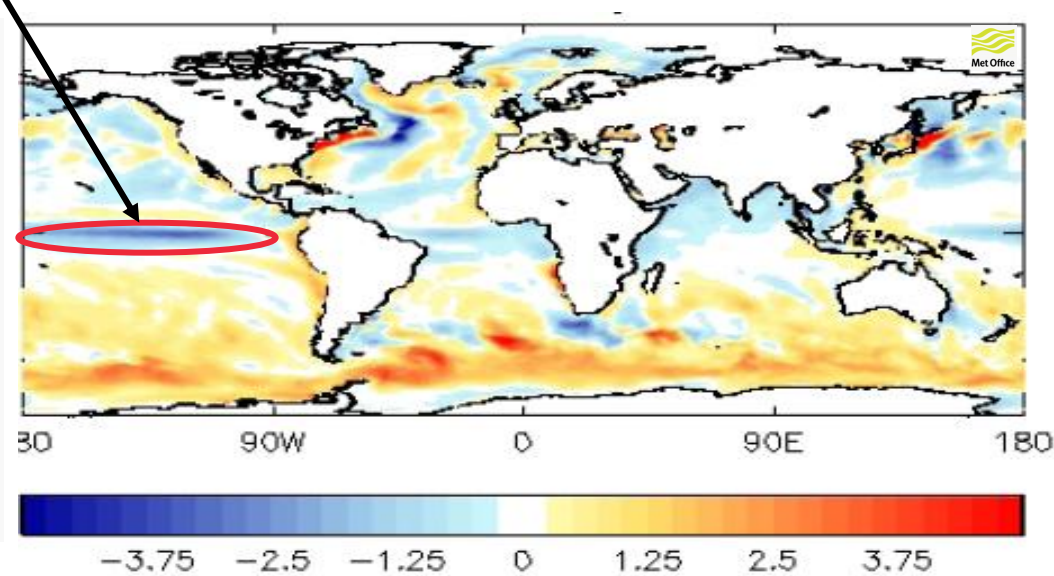
Coupled model DJF bias at day 30



Coupled model DJF bias at day 4



Seasonal DJF bias

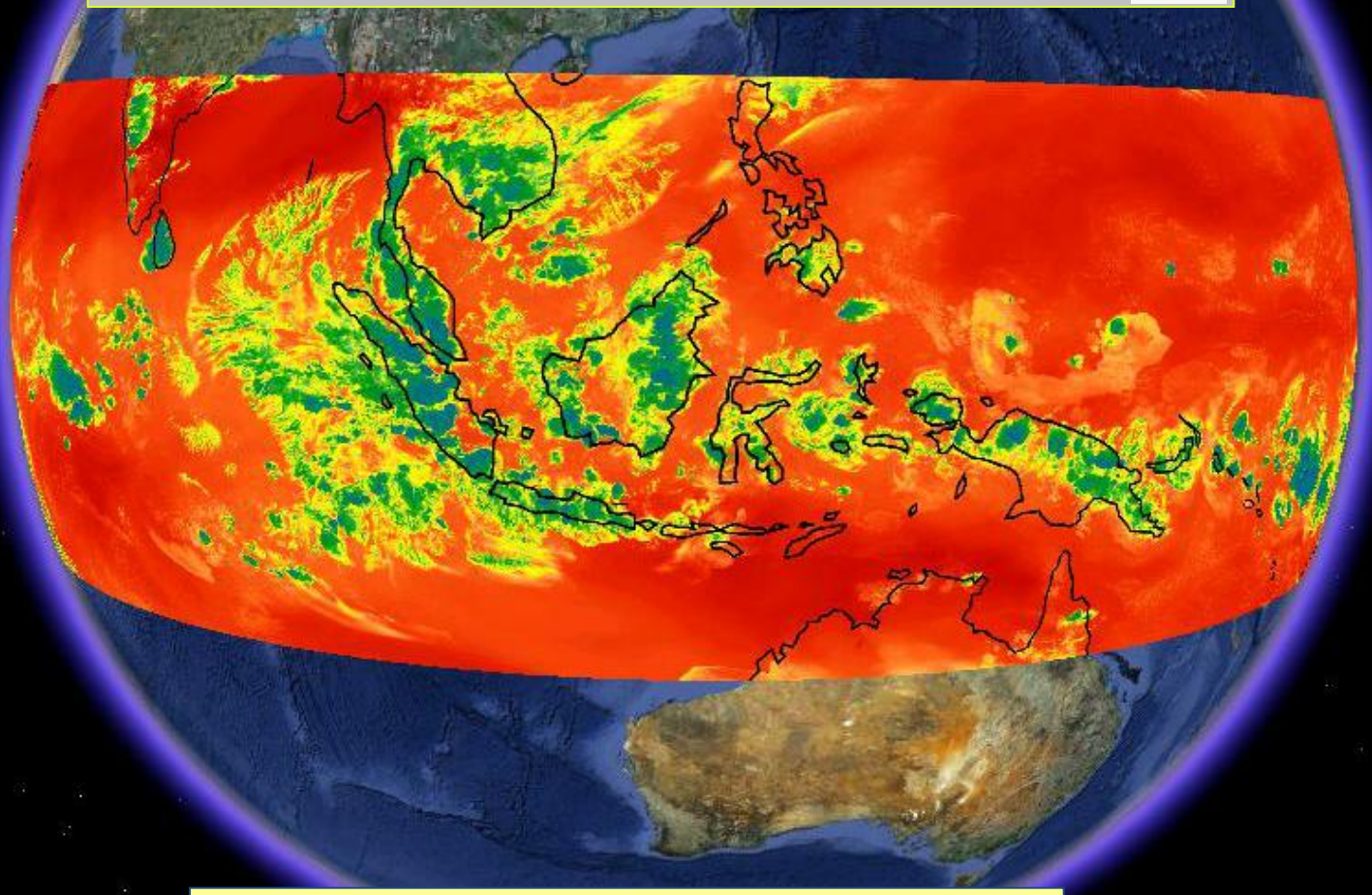


© Crown copyright Met Office

Once we learn from the climate models we can design a focused hierarchical modelling effort.

e.g. CASCADE MJO runs: 2 billion grid points

- Domain: 140° lon and 40° latitude
- 1.5km resolution (70 levs)



•Google Earth image of OLR from model

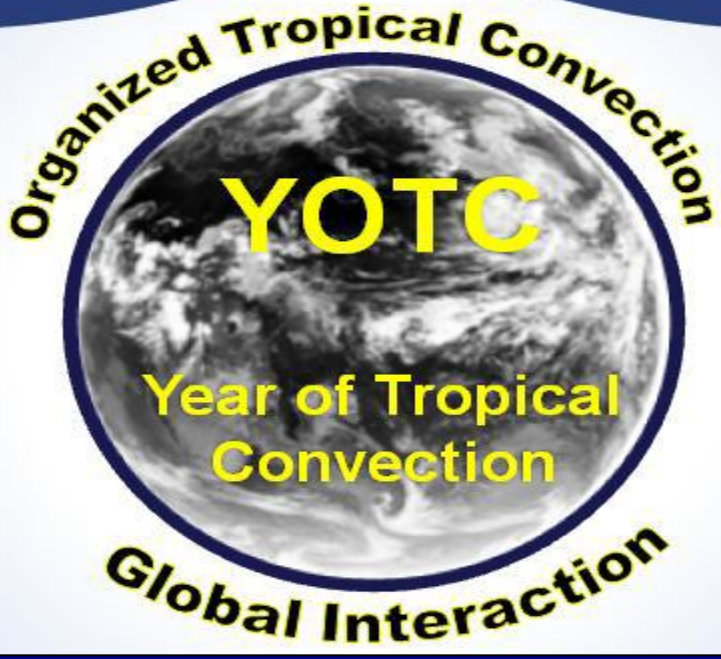
The YOTC Framework: a "Virtual Field Campaign" utilizing existing new/improved resources with model, parameterization and forecast improvement

Global Prediction

High-resolution analyses forecasts & physical processes data base

Integrated Observations

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



Primary Research Areas

- MJO
- Convectively coupled waves
- Monsoon
- Trop-Extratrop interaction
- Easterly Waves
- Tropical Cyclones
- Diurnal Cycle

YOTC Focus Period

May 2008 –Apr 2010

ECMWF T799 (25 km) analysis, forecasts, & special diagnostics

The MJO Task Force

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

GASS

GEWEX WCRP Atmospheric System Studies

- GCSS and GABLS now work as part of one group – **GASS: Global Atmospheric System Studies**
- You will still see the GCSS and GABLS “names” for now as they are well recognised in the community

A community who carry out and use observations, process studies and model experiments with a **focused goal of developing and improving the representation of the atmosphere** in weather and climate models.

© Crown copyright Met Office

Specific objectives of the model inter-comparison are to characterise the diabatic heating and moistening profiles associated with the MJO in climate models and consider:

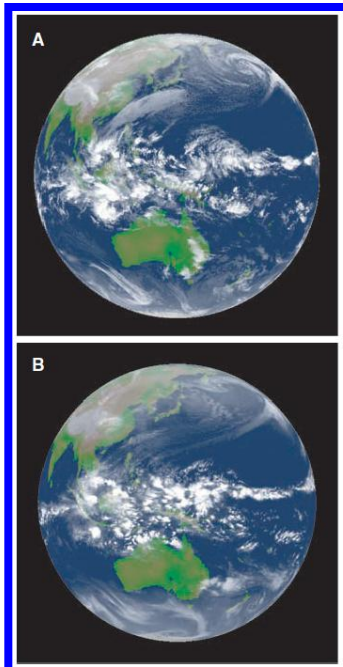
- the contributions of the models physical parametrizations
- the evolution as a function of forecast lead time
- the utility of the satellite and reanalysis products in evaluating model simulations of the MJO

Three components to the project:

1. **climate simulation** – multi-year simulations coupled or atmosphere only

2. **short range hindcasts** – daily 48hr forecasts during ~20 days of the MJO

3. **medium range hindcasts** – 20 day initialized forecasts



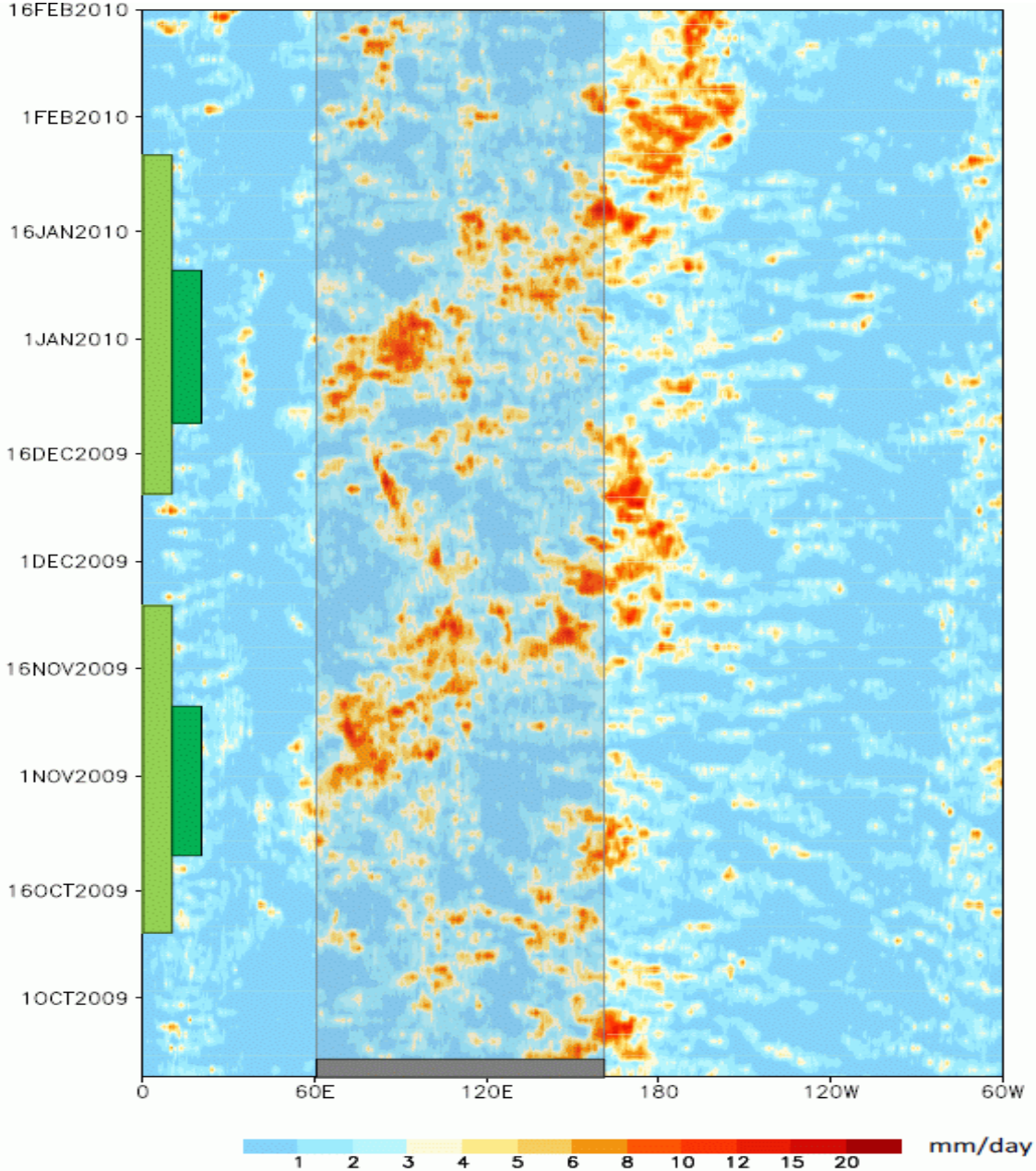
© Crown copyright Met Office

Vertical Structure and Diabatic Processes of the MJO:
Global Model Evaluation Project
MJO Task Force/YOTC and GASS

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

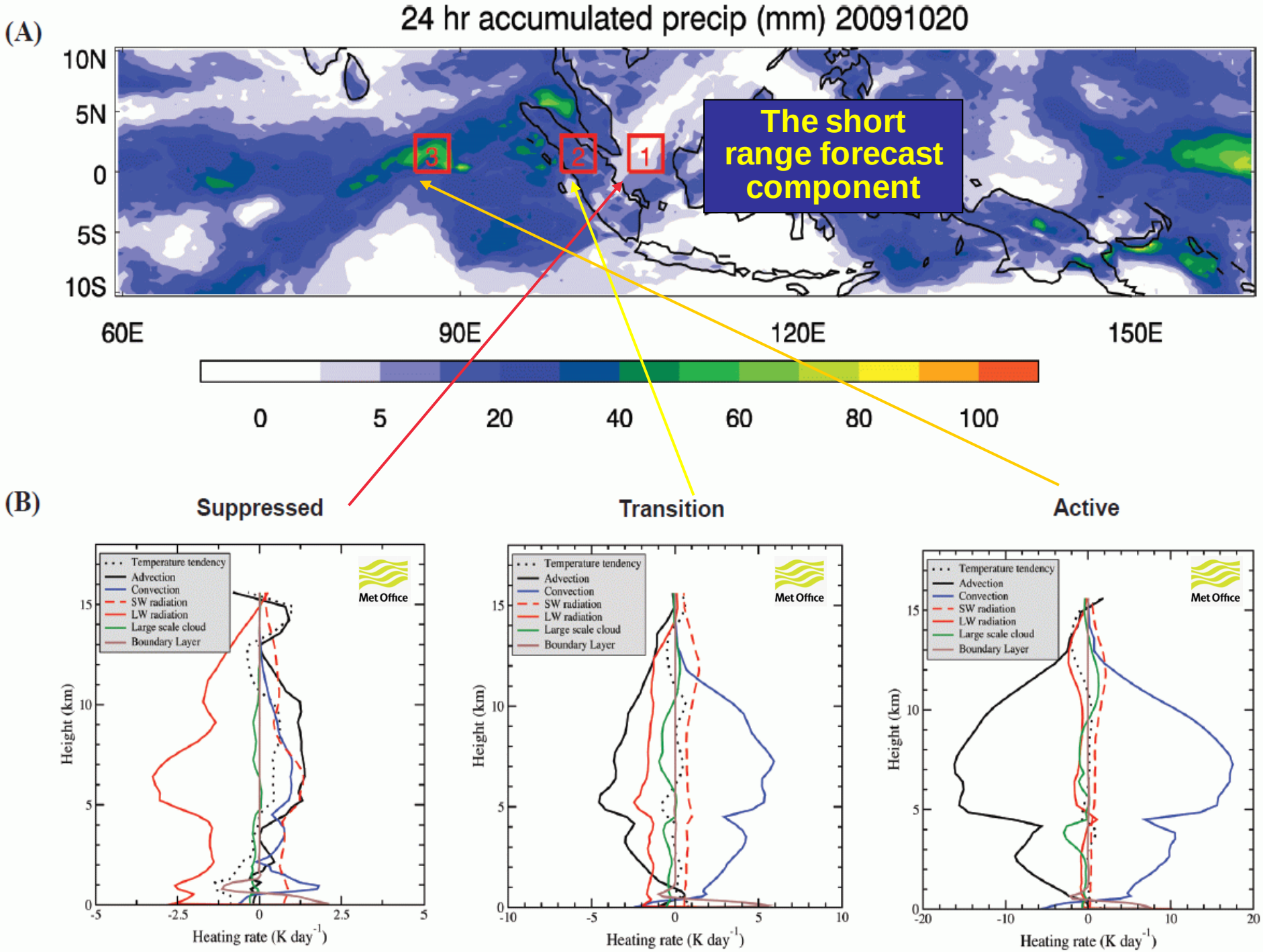
Commitments: About 12 Modeling Groups with AGCM and/or CGCM



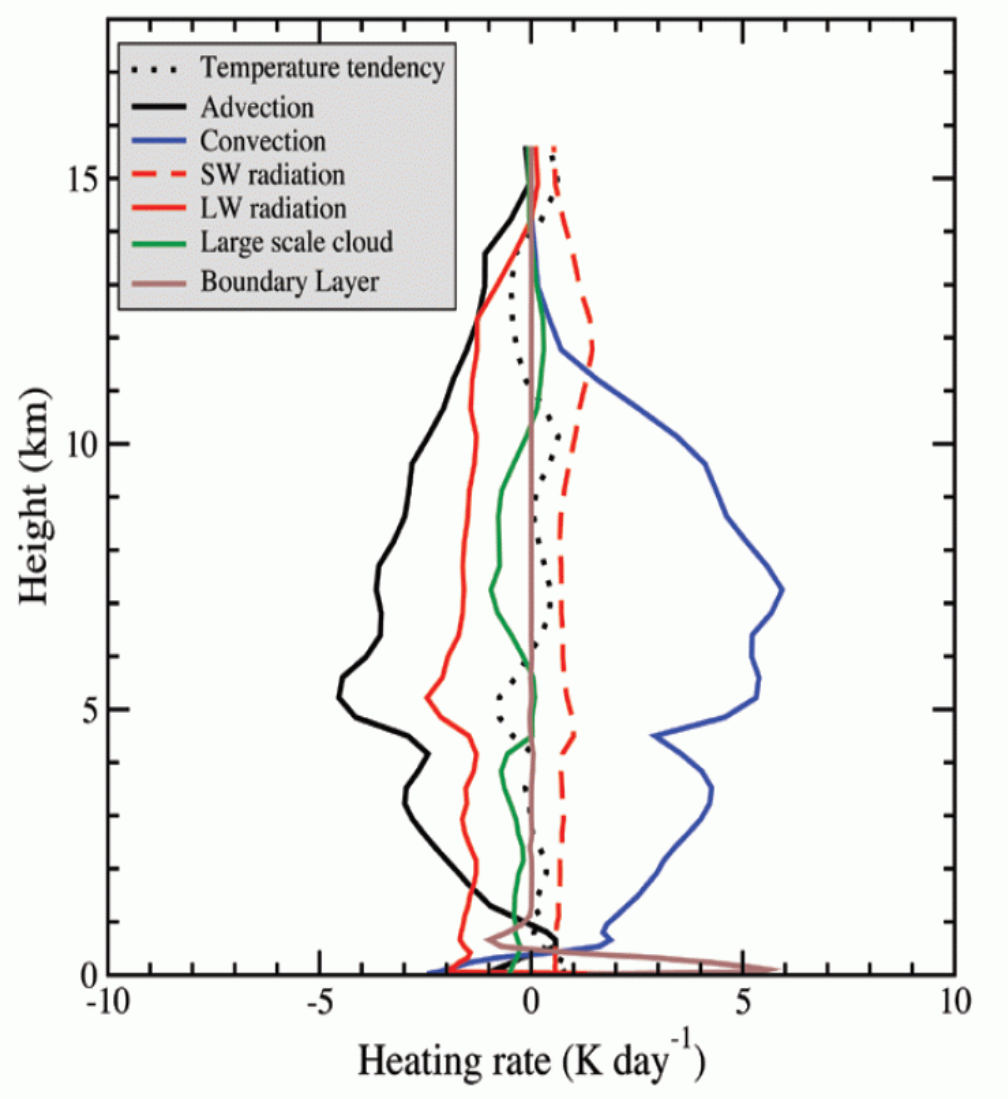
Periods for 20d hindcasts

Periods for 2d hindcasts

Longitude belts for outputs from 2d hindcasts


(A)
24 hr accumulated precip (mm) 20091020
10N
5N
0
5S
10S
60E
90E
120E
150E
3
2
1
The short range forecast component
0
5
20
40
60
80
100
(B)
Suppressed
Transition
Active
Temperature tendency
Advection
Convection
SW radiation
LW radiation
Large scale cloud
Boundary Layer
Met Office
Height (km)
Heating rate (K day^{-1})

Physical tendencies [heating]



© Crown copyright Met Office

Likely participants (so far)

Model	Institution	Experiment[1]		
		20 year Climate	Short-term Hindcast	Long-term Hindcast
GEOS-5 AGCM	NASA	X	X	X
IPRC GCM	University of Hawaii	X	X	X
SPCAM	Colorado State University	X	X	X
NASA GISS	LDEO	X	X	X
GEM model	Environment Canada	X	X	X
NICAM	AORI, Univ. of Tokyo	-	X	X
MRI-GCM	MRI	X	X	X
CWB AGCM	CWB, Taiwan	X	X	X
WRF	PNNL	X	X	X
CCSM4	COLA and GMU	tbc		
CFS T62L60	PNU, Korea	X	X	X
IFS	ECMWF		X	X
ECHAM	ZMAW	tbc		
MetUM GA3.0	Met Office UK	X	X	X
MetUM + KPP	NCAS-Climate, Reading	X		X
INGV	CMCC	tbc		
HiRAM	GFDL	X	X	X
CCSM4, CESM1	NCAR	X	X	X