DYNAMO (Dynamics of the MJO): The US Participation in CINDY2011

(Cooperative Indian Ocean Experiment on Intraseasonal Variability in Year 2011)

and

Coordination between CINDY/DYNAMO and AMIE

(ACRF MJO Investigation Experiment)

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Background I: Importance of the MJO/TIV

- Monsoons, ENSO, IODZM
- Teleconnections, extratropical circulation/weather
- Extreme events (midlat rainfall, tropical storm/cyclones)
- Earth's rotation rate, length of the day
- Atmospheric and oceanic chemistry and biosystem (ozone, CO_2, aerosols, chlorophyll)
- Prediction potential (> 20 days)

Background II: Challenges presented by the MJO

- ***A poster child of numerical model deficiency***
- inability to consistently/knowingly reproduce the MJO/TIV by global climate models
- limited intraseasonal dynamical prediction skill (< 15 days) –particularly low prediction skill during the initiation of the MJO and during the passage of the MJO over the Maritime Continents
- poor understanding of the mechanisms for the MJO/TIV, especially their convective initiation and evolution
- lack of in situ observations in the equatorial Indian Ocean

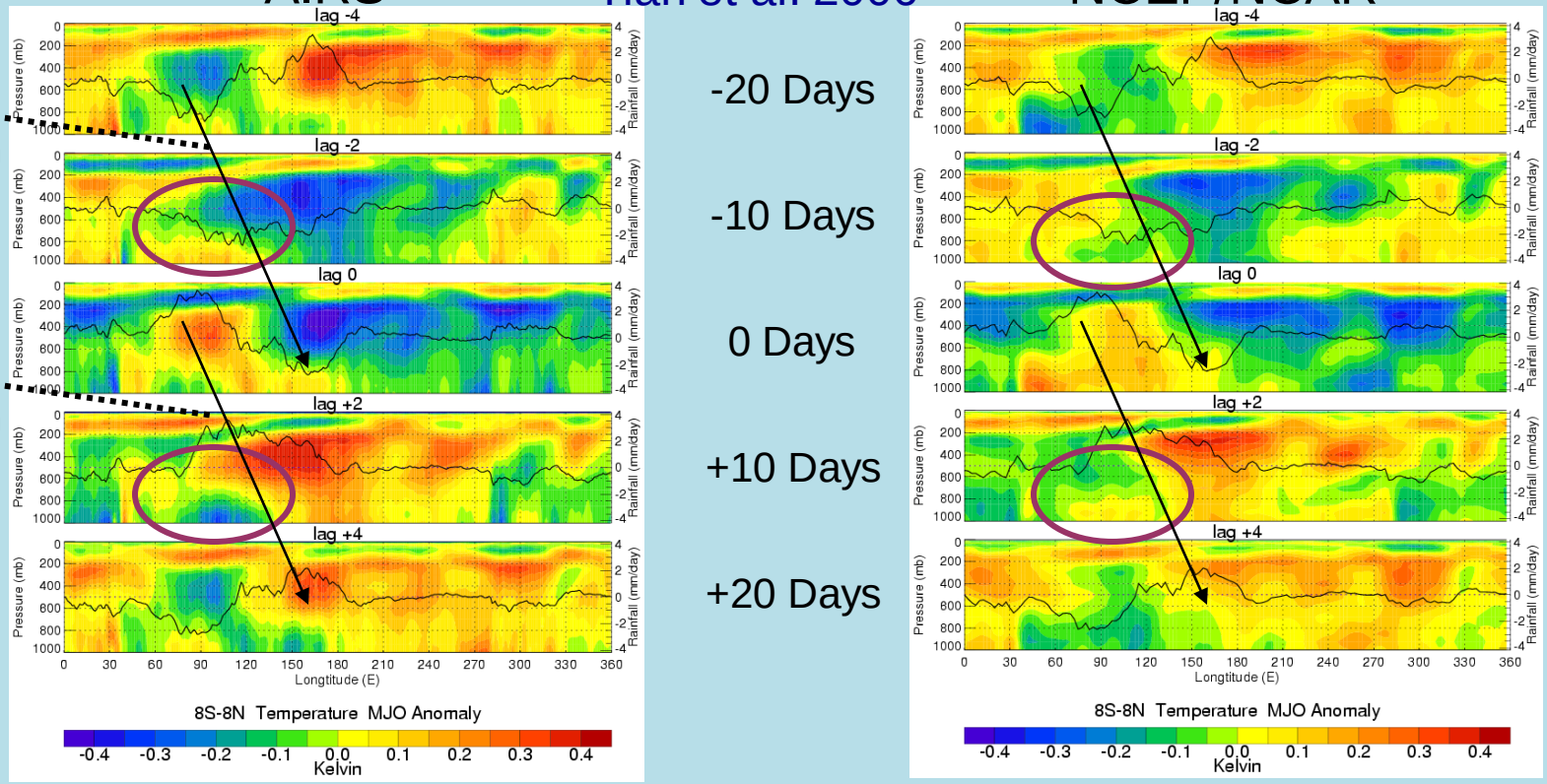
Pressure-Longitude Diagrams of Temperature Anomaly Along Equator for the MJO

TRMM Rainfall Anomaly Shown as Line Plot (right axis); Panels Separated by 10 Days

AIRS | Tian et al. 2006 | NCEP/NCAR

Eastward propagation of "dry" phase

Eastward propagation of "wet" phase



-20 Days

-10 Days

0 Days

+10 Days

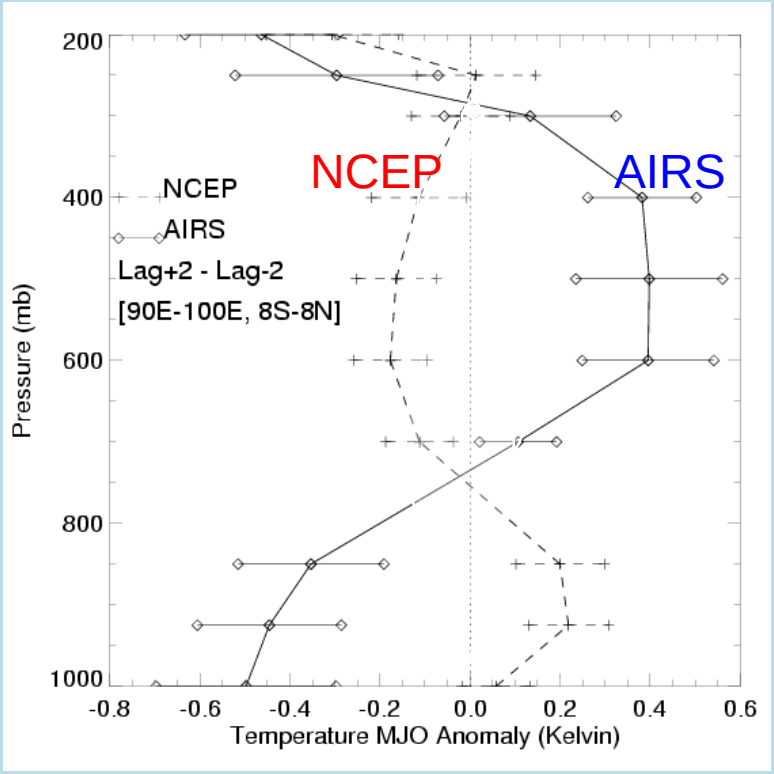
+20 Days

- The plots above are composite MJO structures based on 8 NH winter events.
- The ovals - over the Indian Ocean - highlight important differences between AIRS and NCEP/NCAR vertical temperature structure. <u>This difference is shown more concisely in the next slide.</u>
- In AIRS, a boundary-layer temperature anomaly precedes the tropospheric temperature anomaly in a somewhat consistent way for both the Indian and western Pacific Ocean. This doesn't appear to be the case for the NCEP/NCAR results.

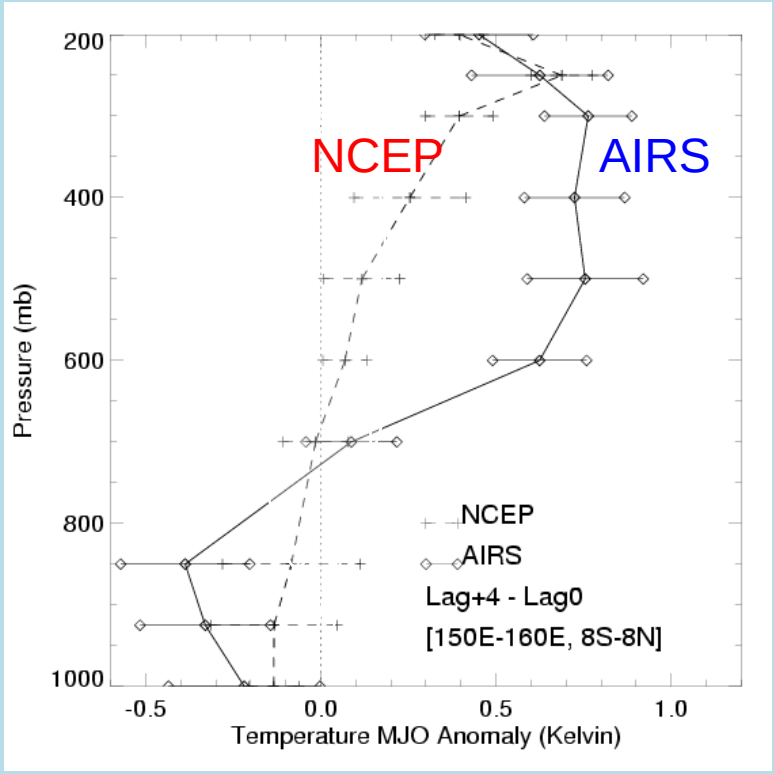
Vertical Profiles of Temperature Anomaly In the Indian & W.Pacific Ocean for the MJO

Tian et al. 2006

Indian



Western Pacific Ocean



- The above temperature profiles were taken from the composite AIRS and NCEP/NCAR MJO structures shown on the previous slide.
- The plot on the left shows the profiles over the Indian Ocean for Lag + 2 pentads (*disturbed*) minus Lag -2 pentads (*suppressed*). The NCEP/NCAR profile is less consistent with the implied conditions - i.e. positive precipitation anomalies.
- The plot on the right shows the profiles over the western Pacific Ocean for Lag +4 pentads (*disturbed*) - Lag 0 pentads (*suppressed*). The AIRS data exhibit stronger boundary-layer (tropospheric) cooling (warming) compared to the NCEP/NCAR for the implied conditions - i.e. positive precipitation anomalies.

Scientific Rationale for CINDY2011/DYNAMO/AMIE

• Convective initiation over the Indian Ocean and weakening over the Maritime Continents are the least understood aspects of the MJO;

• Hypothesis testing requires continuous time series of vertical structures of convective systems and heat/moisture budgets – *available only from field campaigns*;

• No such time series from the equatorial Indian Ocean is available to date.

Hypotheses

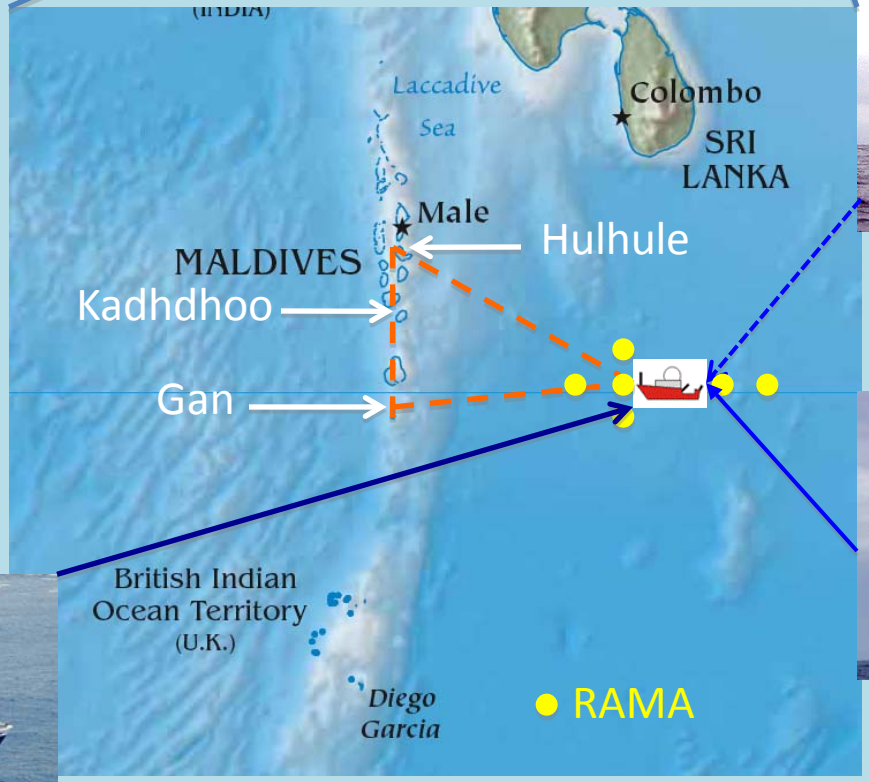
MJO initiation:

- Energy recharge-discharge
- Previous circumnavigating MJO
- Extratropical influences
- Stochastic convective forcing

MJO weakening over the Maritime Continents

- Energy drainage by the diurnal cycle
- Lack of surface moisture flux over land
- Reduced moisture convergence due to topographic effects on winds

A Preliminary Plan for CINDY2011/DYNAMO/AMIE

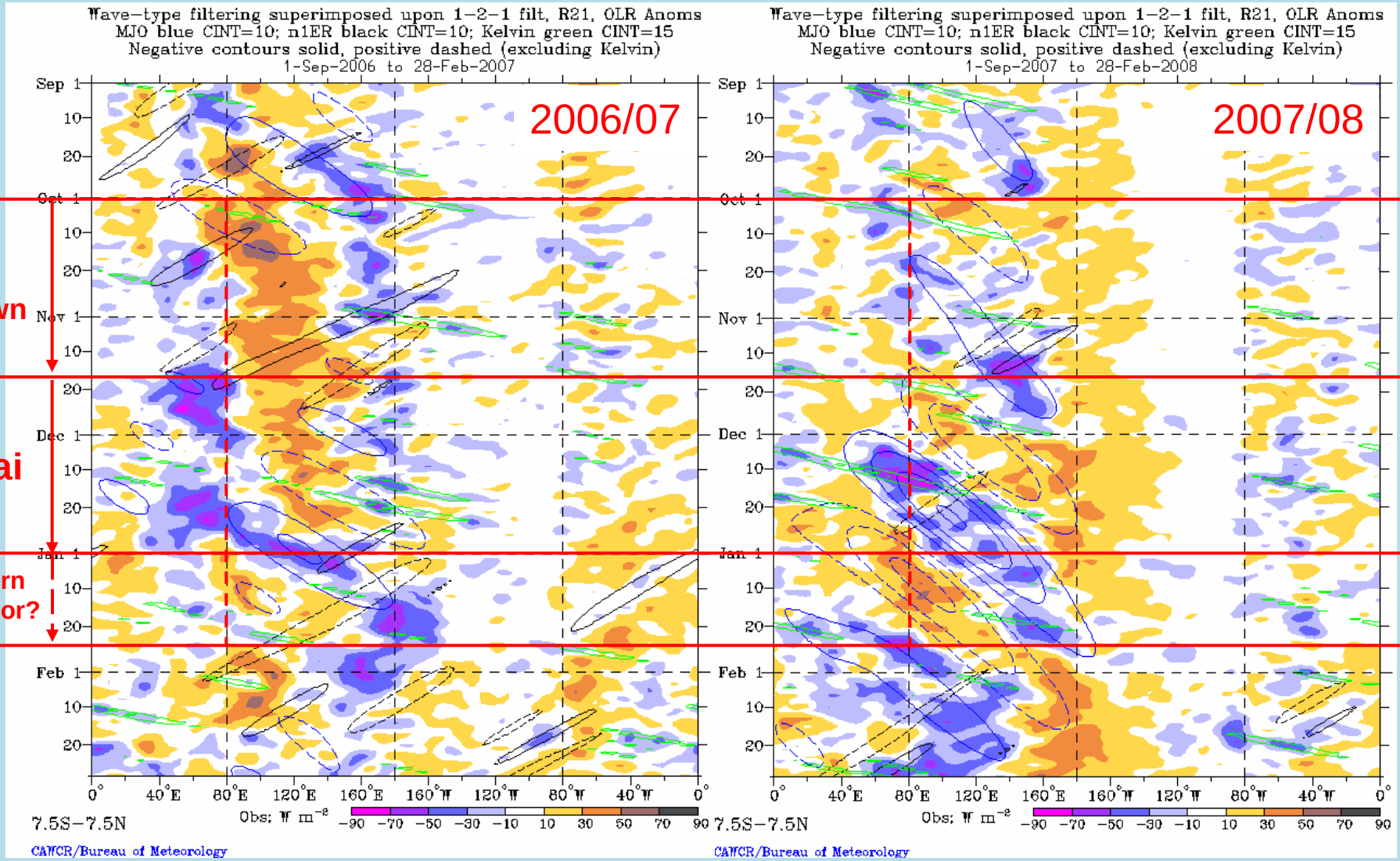


R/V Ron Brown

R/V MIRAI

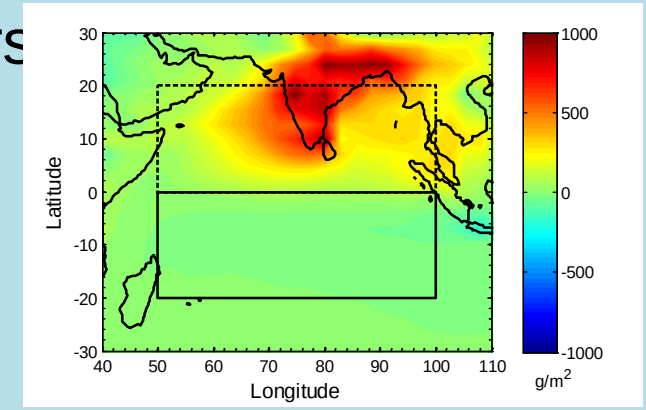
R/V Southern Surveyor

International Ship Relay

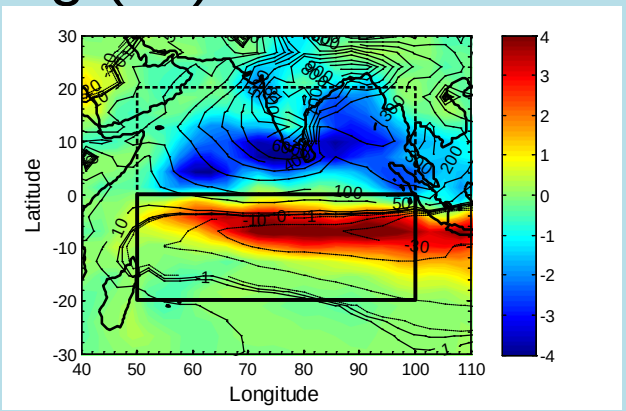


Main observations/instruments of CINDY/DYNAMO/AMIE (90-120 days in the IO and 6 months at Manus)

- atmospheric soundings (IO and Manus) and Q1/Q2 estimates (IO)
- precipitation radar (IO and Manus)
- ARSCL (cloud radar, lidar, ceilometer) (Manus)
- surface energy fluxes (IO and Manus)
- full radiation/met package (IO - AMF2 and Manus)
- aerosol (IO)
- upper ocean turbulence and mixing (IO)
- others



Black carbon anomaly difference.



Precipitation anomaly difference composite color, black carbon anomaly contour.

CINDY/DYNAMO/AMIE Coordination

- A rare opportunity for monitoring convective initiation and evolution of the MJO from its birth in the Indian Ocean to its middle age crisis over the Maritime Continents;
- Provide observational constraints and initial conditions for model simulation/validation/development and hypothesis testing in two contrasting large-scale environments;