# Madden-Julian Oscillation: Recent Evolution, Current Status and Predictions

**Update prepared by**
**Climate Prediction Center / NCEP**
**March 22, 2010**

# Outline

- Overview
- Recent Evolution and Current Conditions
- MJO Index Information
- MJO Index Forecasts
- MJO Composites

# Overview

- The MJO has showed some signs of strengthening during the past week but any MJO activity is weak.

- Most dynamical model MJO index forecasts indicate continued eastward propagation of a weak signal across the Maritime continent during the next two weeks but other coherent tropical subseasonal variability is likely contributing in part to this behavior.

- Not all observational fields indicate MJO activity and so it is too early to determine whether this subseasonal variation will mature into a coherent MJO event.

- Rainfall stretching from the eastern Indian Ocean to the far western Pacific (including drought areas) is expected due to a combination of this subseasonal tropical variability. Also, there are elevated chances for tropical cyclogenesis for areas in the eastern Indian Ocean (Week -1) and waters north-northeast of Australia (Week-1 and Week-2).

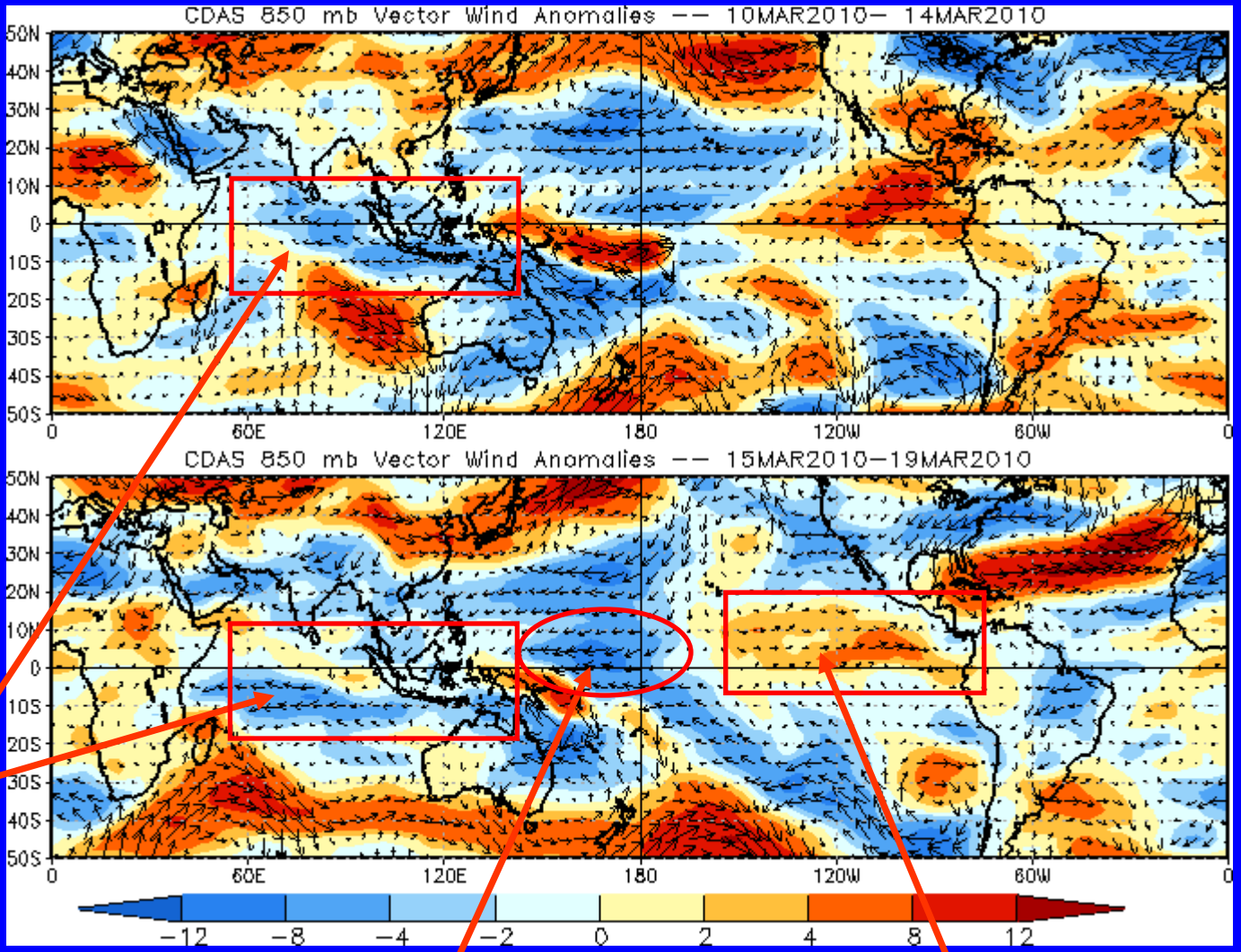
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

# 850-hPa Vector Wind Anomalies (m $s^{-1}$)

Note that shading denotes the zonal wind anomaly

**Blue shades**: Easterly anomalies

**Red shades**: Westerly anomalies




Easterly anomalies over the Indian Ocean and Indonesia weakened in some areas during the last five days.

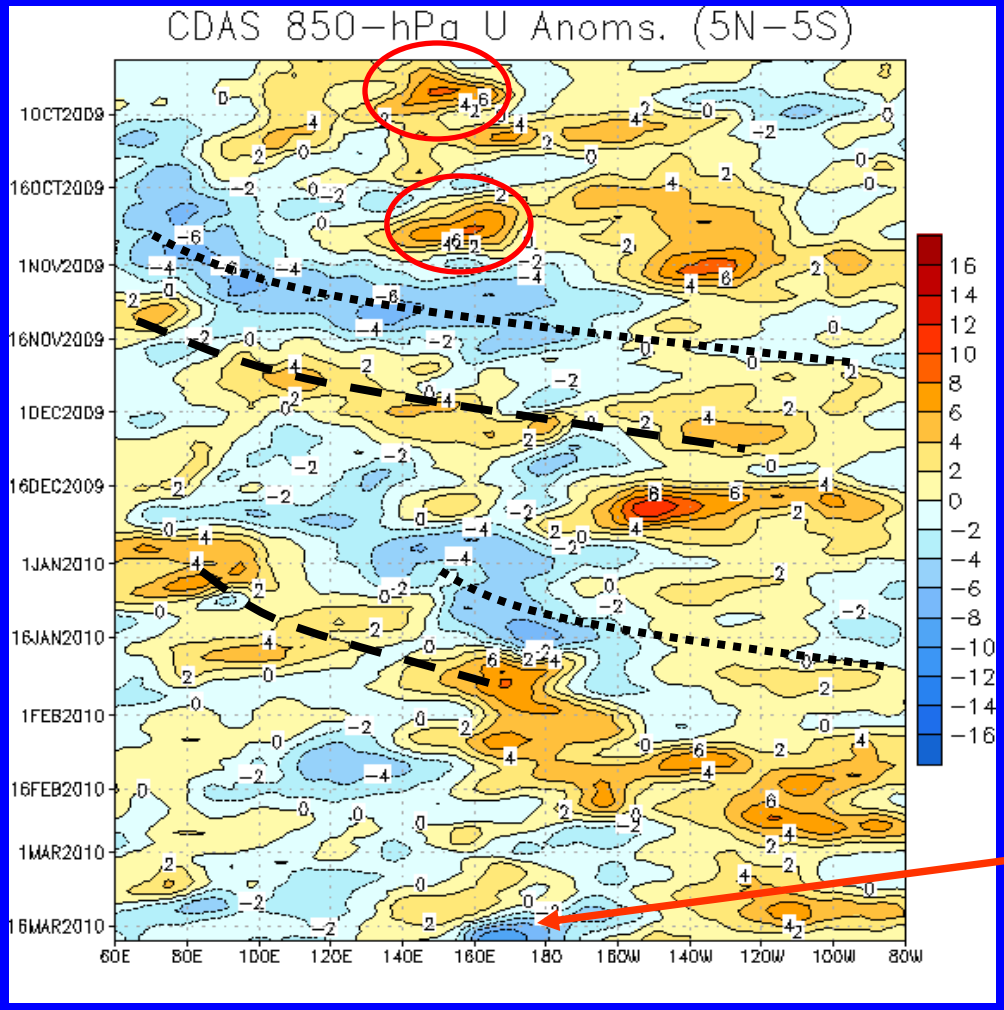
Easterly anomalies near the Date Line expanded south of the equator during the last five days.

Westerly anomalies weakened across the eastern Pacific during the last five days.

# 850-hPa Zonal Wind Anomalies (m $s^{-1}$)

**Westerly anomalies (orange/red shading) represent anomalous west-to-east flow**

**Easterly anomalies (blue shading) represent anomalous east-to-west flow**




Time

Longitude

**Westerly wind bursts (red circles) occurred during September and October.**

**Easterly (dotted line) and westerly (dashed line) anomalies developed across the Indian Ocean and shifted eastward across the Date Line during late October and November associated with the MJO.**

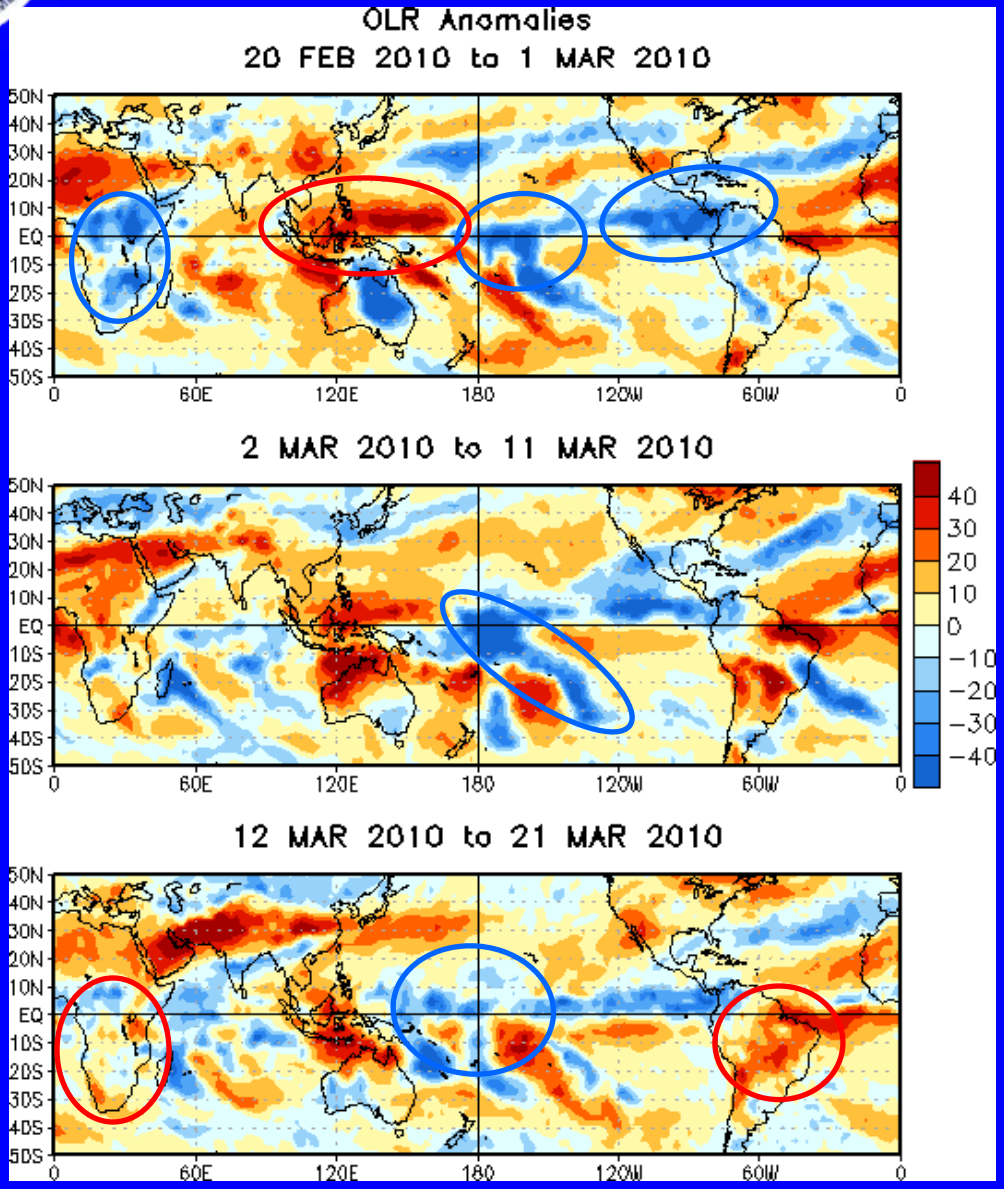
**Weaker and shorter-lived MJO activity was evident during January.**

**Winds during March have been close to average across much of the deep Tropics although most recently easterly anomalies have increased just west of the Date Line.**

# OLR Anomalies: Last 30 days

**Drier-than-normal conditions, positive OLR anomalies (yellow/red shading)**

**Wetter-than-normal conditions, negative OLR anomalies (blue shading)**

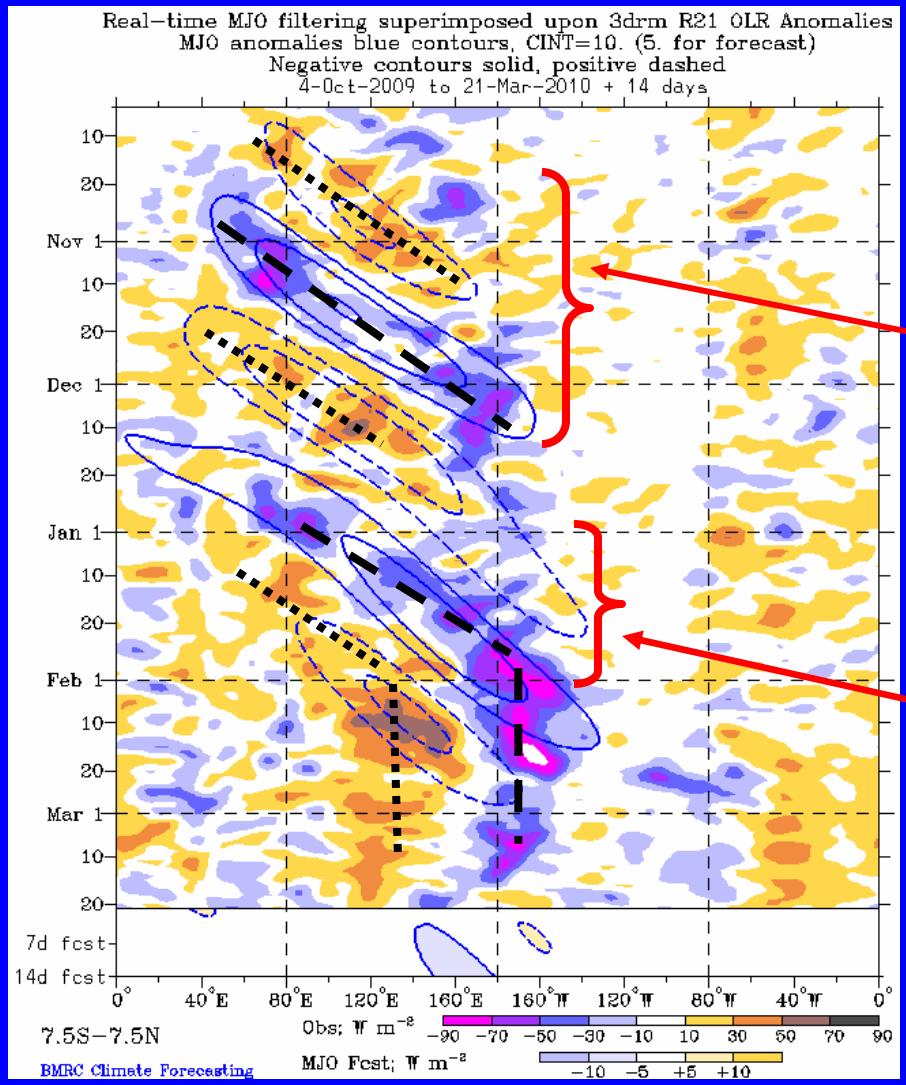



**Enhanced (suppressed) convection (blue/red ovals) continued across the central Pacific (Maritime continent) regions during late February. Wet conditions were also evident from the eastern Pacific to the Caribbean and across Africa.**

**During early March, enhanced convection extended eastward in the central Pacific south of the equator.**

**In mid March, wet conditions over most of Africa eased and much of South America observed drier-than-average conditions. Enhanced convection also weakened across the west-central Pacific.**

# Outgoing Longwave Radiation (OLR) Anomalies (7.5°S-7.5°N)




Time

Longitude

**Drier-than-normal conditions, positive OLR anomalies (yellow/red shading)**

**Wetter-than-normal conditions, negative OLR anomalies (blue shading)**

**(Courtesy of the Bureau of Meteorology (BOM) - Australia)**

**During October to early December 2009, two periods of suppressed convection shifted eastward from the Indian Ocean into the western Pacific (dotted lines) and one episode of enhanced convection (dashed line).**

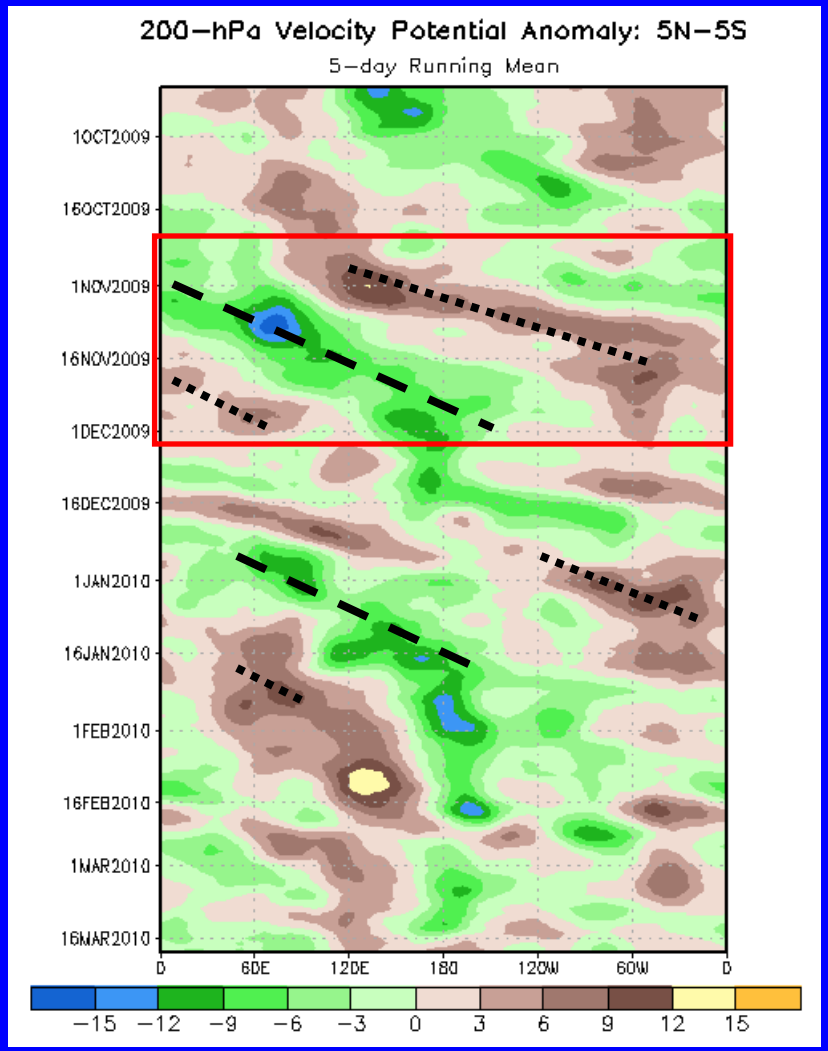
**After a brief break during mid-late December, enhanced convection developed in the Indian Ocean and shifted eastward to the western and central Pacific during mid to late January. An area of suppressed convection across the Indian Ocean and Maritime Continent followed.**

**During February and March these anomalous areas became stationary and most recently have weakened.**

# 200-hPa Velocity Potential Anomalies (5°S-5°N)

**Positive anomalies (brown shading) indicate unfavorable conditions for precipitation**

**Negative anomalies (green shading) indicate favorable conditions for precipitation**




**Time**

**Longitude**

**In late October and November, anomalies increased and eastward propagation was evident associated with MJO activity (red box).**

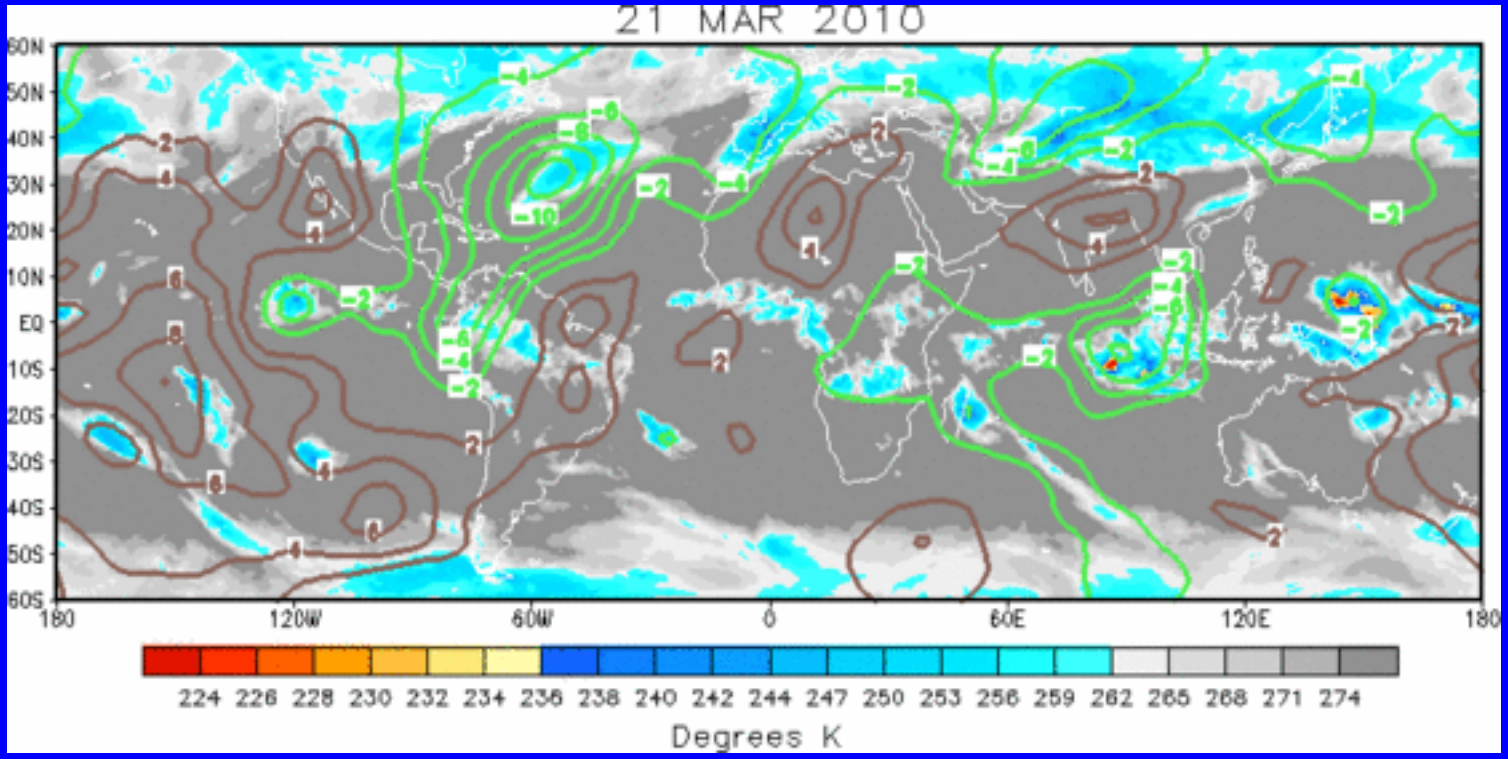
**Eastward propagation associated with the MJO was again evident during early-mid January.**

**During February, the MJO weakened and anomalies became more stationary and incoherent on the intraseasonal time scale in March.**

# IR Temperatures (K) / 200-hPa Velocity Potential Anomalies

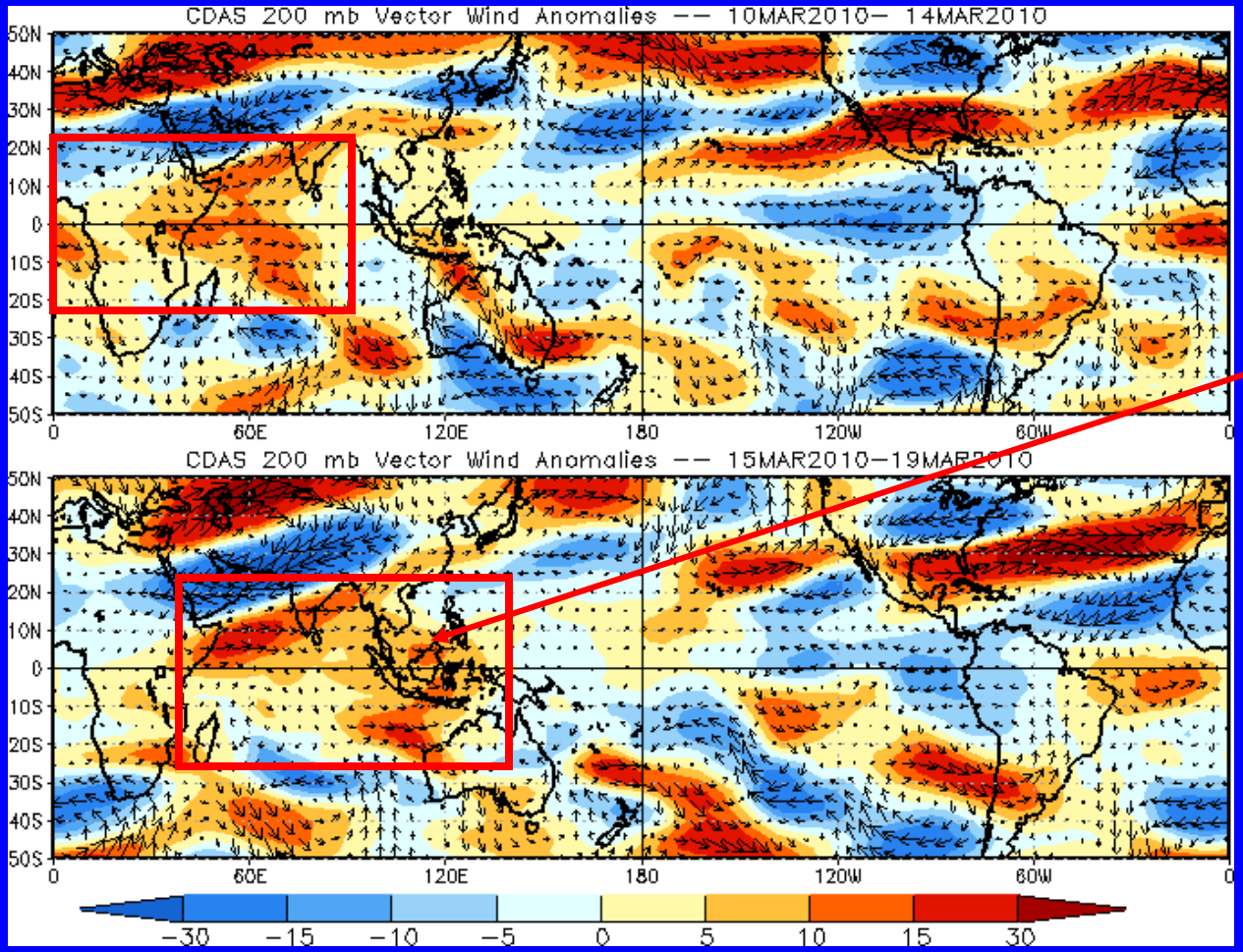
**Positive anomalies (brown contours) indicate unfavorable conditions for precipitation**

**Negative anomalies (green contours) indicate favorable conditions for precipitation**




**The anomalous velocity potential pattern is not coherent, however, a large-scale area of upper-level convergence is indicated across the west-central Pacific.**

# 200-hPa Vector Wind Anomalies (m $s^{-1}$)




**Note that shading denotes the zonal wind anomaly**

**Blue shades: Easterly anomalies**

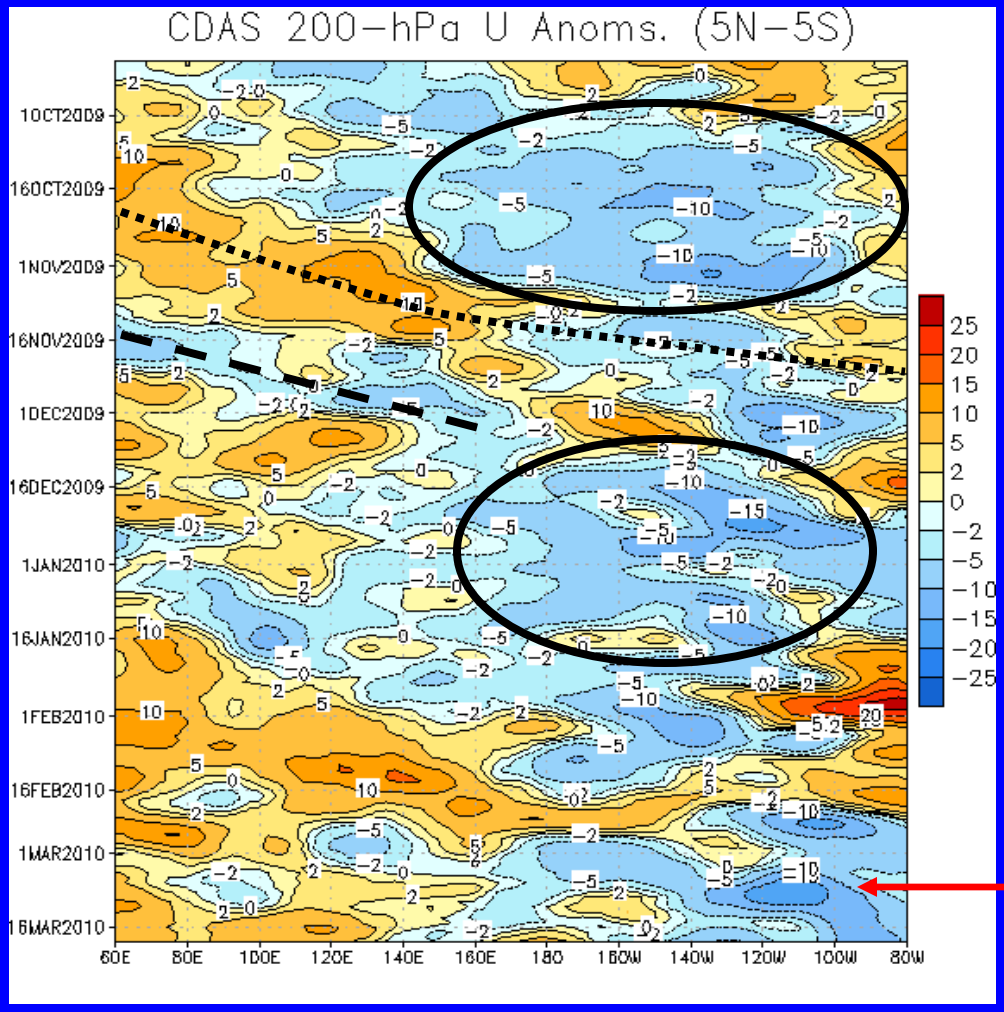
**Red shades: Westerly anomalies**

**During the last five days westerly anomalies have shifted eastward from near Africa to the western Maritime continent (red boxes).**

# 200-hPa Zonal Wind Anomalies (m $s^{-1}$)

**Westerly anomalies (orange/red shading) represent anomalous west-to-east flow**

**Easterly anomalies (blue shading) represent anomalous east-to-west flow**




Time

Longitude

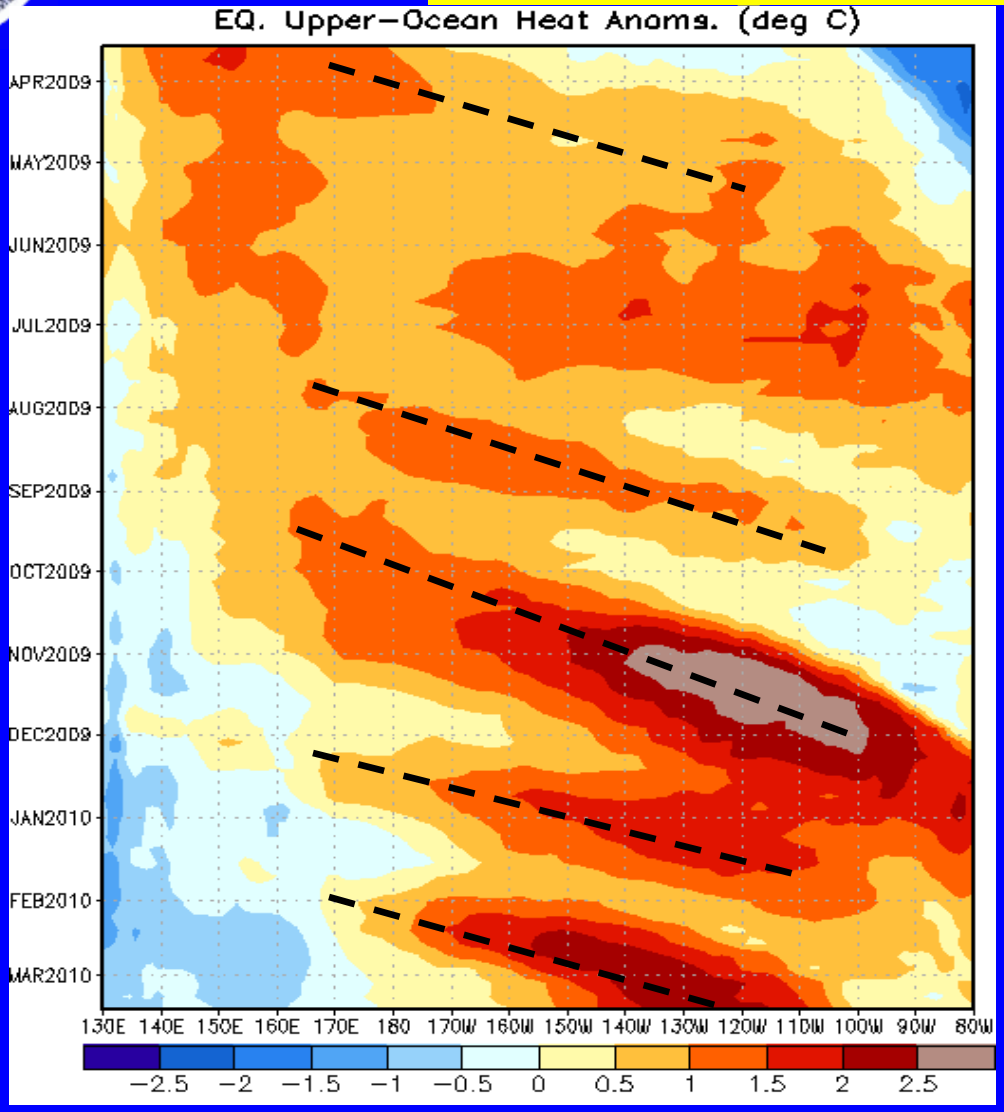
**In early October, easterly anomalies rapidly replaced westerly anomalies across much of the Pacific (black solid oval).**

**Westerly (easterly) anomalies (dotted and dashed lines) shifted eastward across the Maritime Continent during late October and November associated with the MJO.**

**Easterly anomalies dominated much of the central and eastern Pacific during the second half of December and January.**

**During March easterly anomalies have been evident over the eastern Pacific Ocean – a change from late January and early February.**

# Weekly Heat Content Evolution in the Equatorial Pacific




Time

Longitude

In April 2009, the combined effects of an oceanic Kelvin wave and weaker easterly trade winds contributed to an increase in the upper-ocean heat content anomalies across the Pacific Ocean.

Since April 2009, heat content anomalies have remained above-average.

Multiple Kelvin waves shifted eastward between August and March 2010 (last four dashed black lines).

West of the Date Line, some below-average anomalies are now present.

# MJO Index -- Information

- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

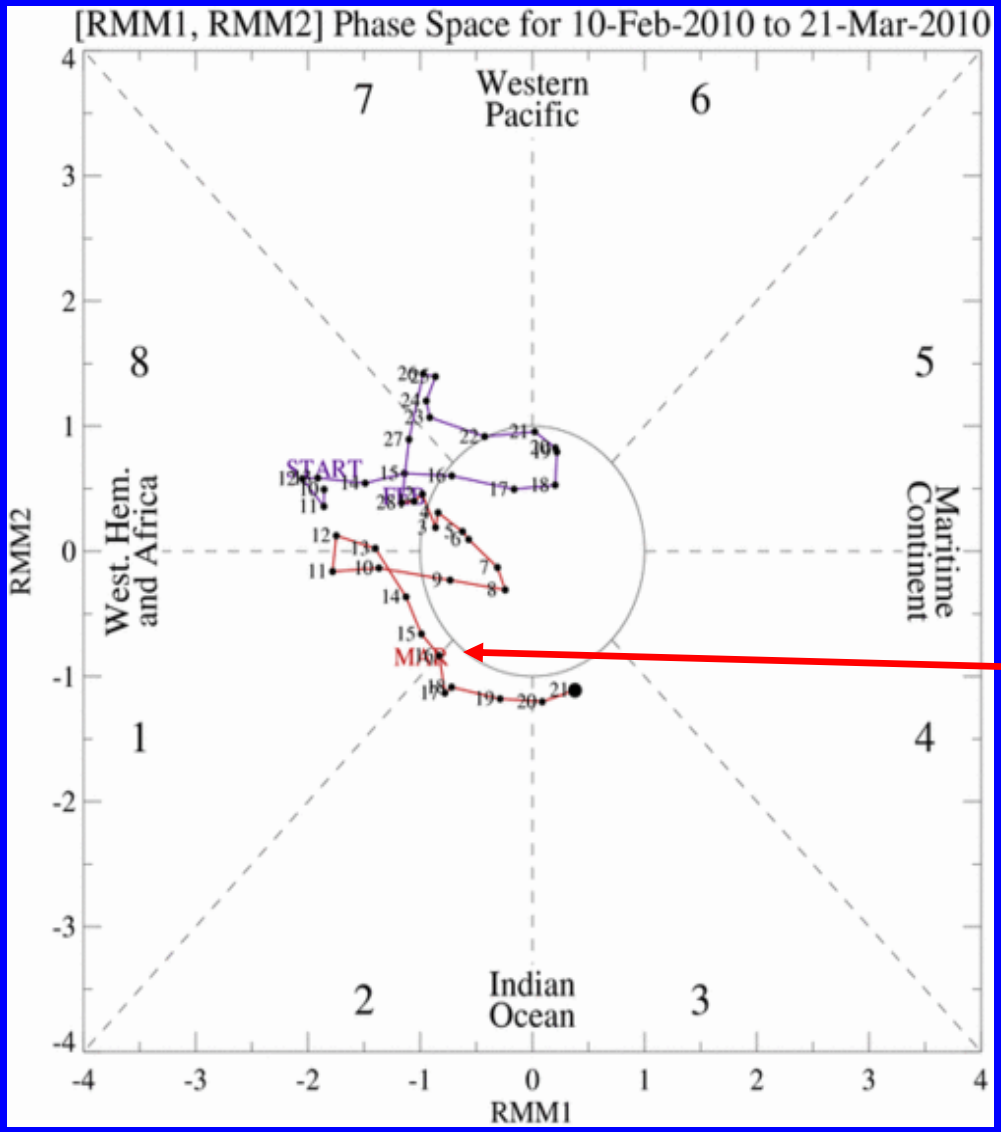
**Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review*, 132, 1917-1932.**

- **The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.**

**Gottschalck et al. 2010: A Framework for Assessing Operational Model MJO Forecasts: A Project of the CLIVAR Madden-Julian Oscillation Working Group, *Bull. Amer. Met. Soc.*, Submitted.**

- **The index is based on a combined Empirical Orthogonal Function (EOF) analysis using fields of near-equatorially-averaged 850-hPa and 200-hPa zonal wind and outgoing longwave radiation (OLR).**

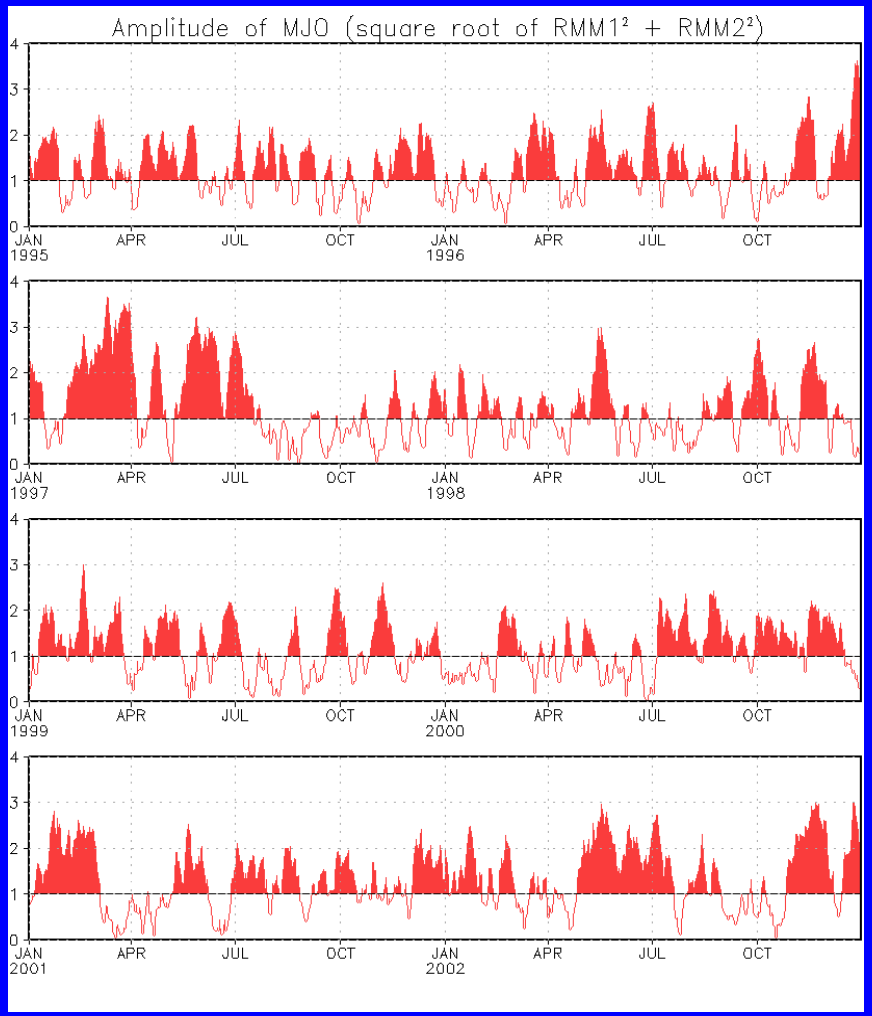
# MJO Index -- Recent Evolution

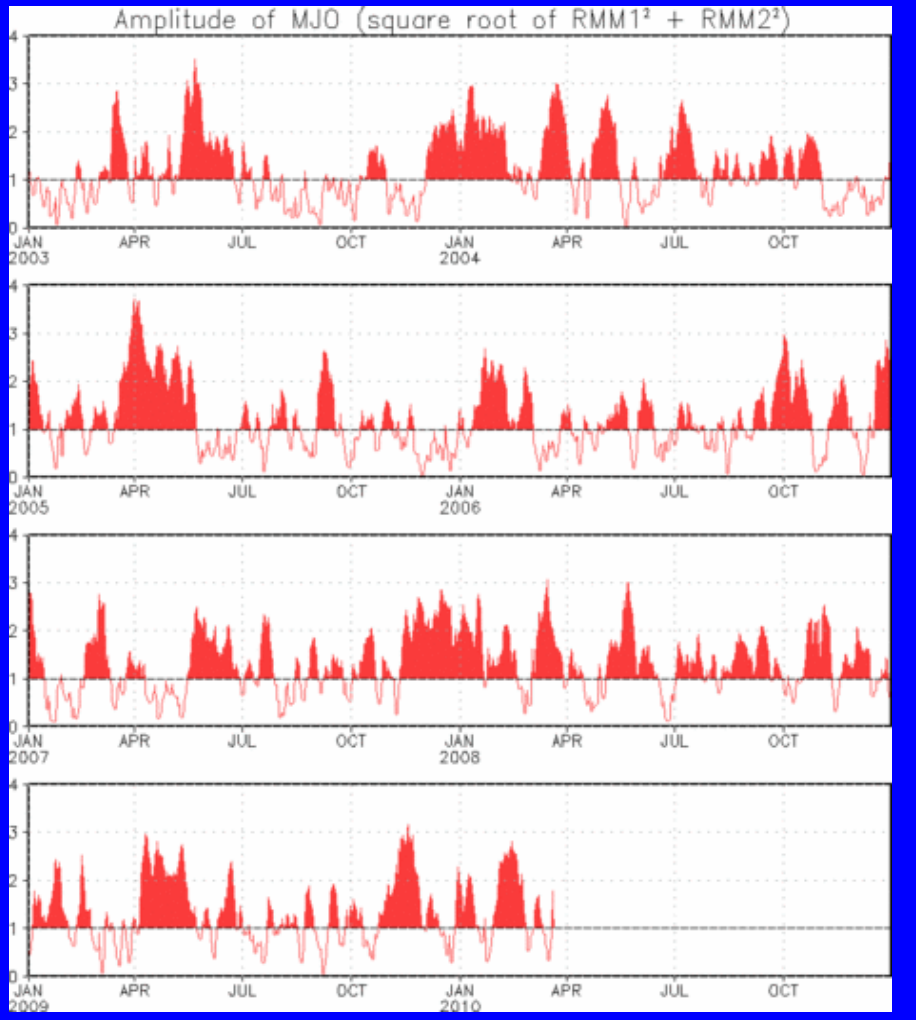



- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance from the origin is proportional to MJO strength**
- **Line colors distinguish different months**

**The MJO index indicates an eastward propagating signal during the past week with the center located across the eastern Indian Ocean.**

# MJO Index – Historical Daily Time Series




**Time series of daily MJO index amplitude from 1995 to present.**
**Plots put current MJO activity in historical context.**

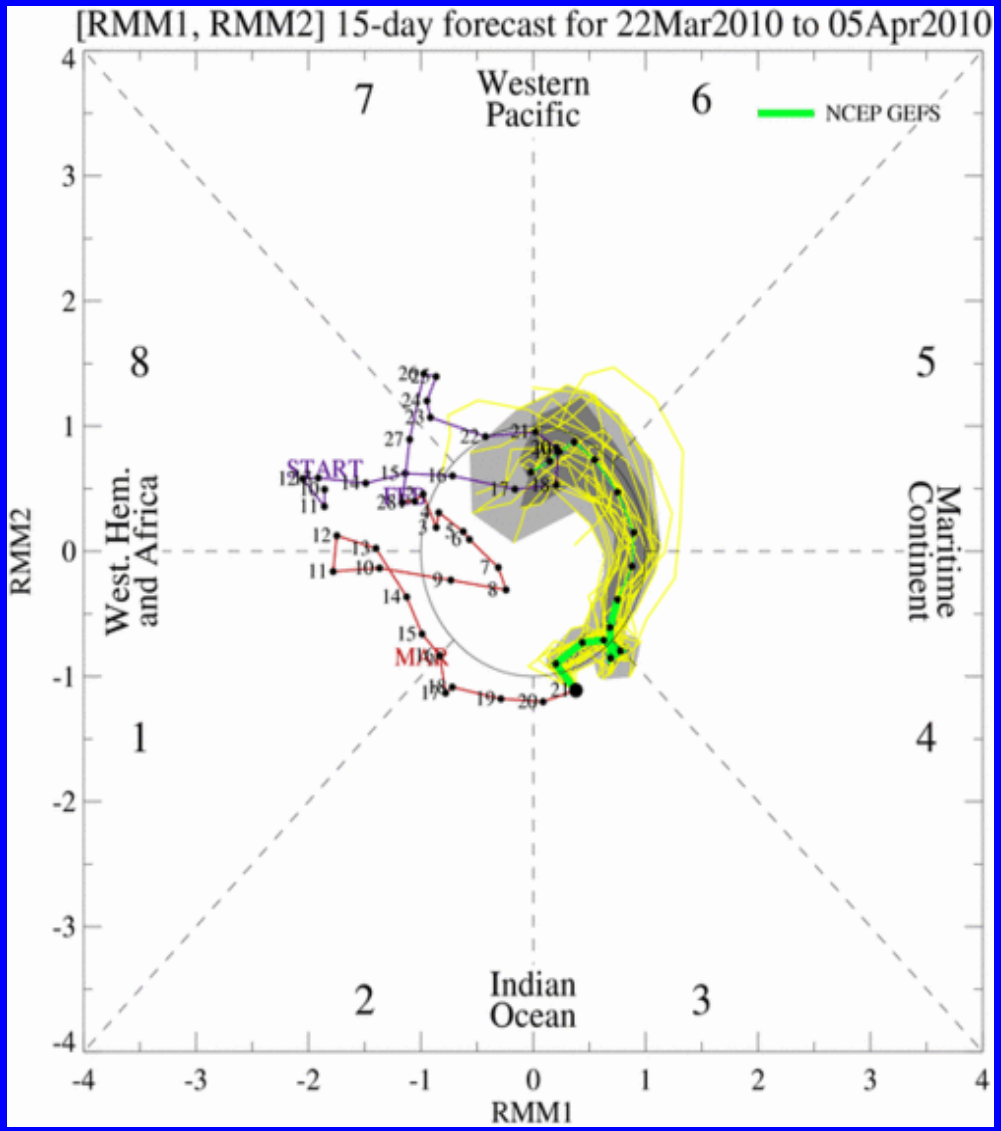
# Ensemble GFS (GEFS) MJO Forecast

**Yellow Lines – 20 Individual Members**
**Green Line – Ensemble Mean**

**RMM1 and RMM2 values for the most recent 40 days and forecasts from the ensemble Global Forecast System (GEFS) for the next 15 days**

**light gray shading: 90% of forecasts**
**dark gray shading: 50% of forecasts**

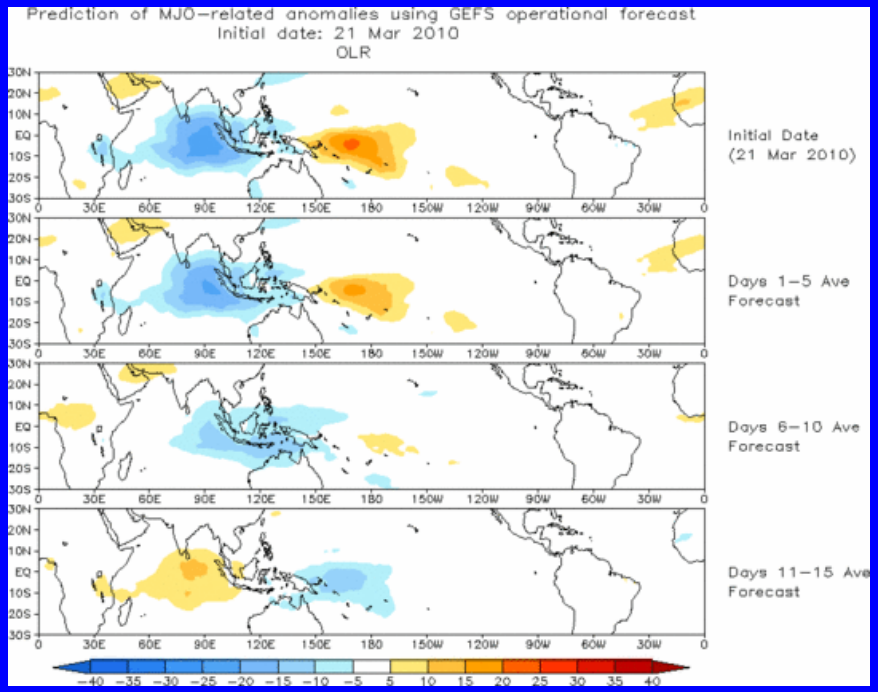
**The GFS forecasts indicate a weak but eastward propagating signal during the next the 1-2 weeks.**



# Ensemble Mean GFS MJO Forecast

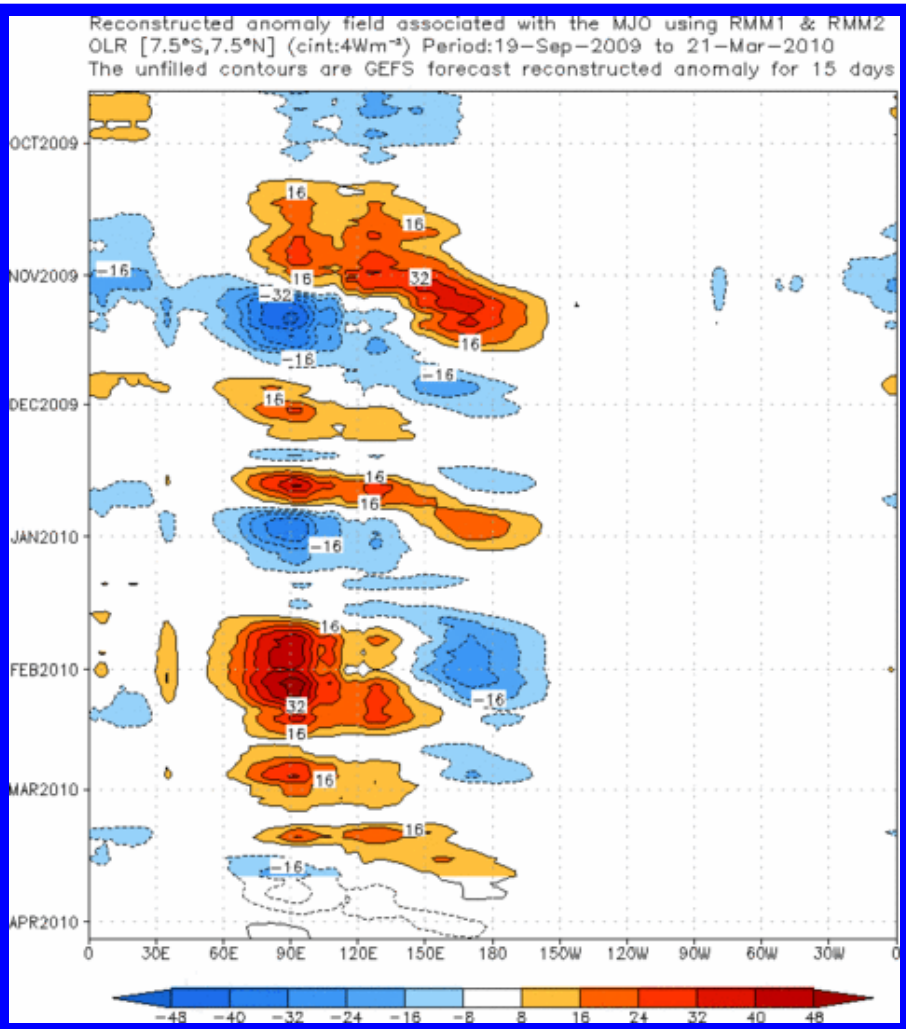
**Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)**

**Spatial map of OLR anomalies for the next 15 days**




**The GEFS ensemble mean forecast indicates weak enhanced convection (blue shades) shifting from the Indian Ocean to the Maritime continent over the period.**

**Time-longitude section of (7.5°S-7.5°N) OLR anomalies for the last 180 days and for the next 15 days**



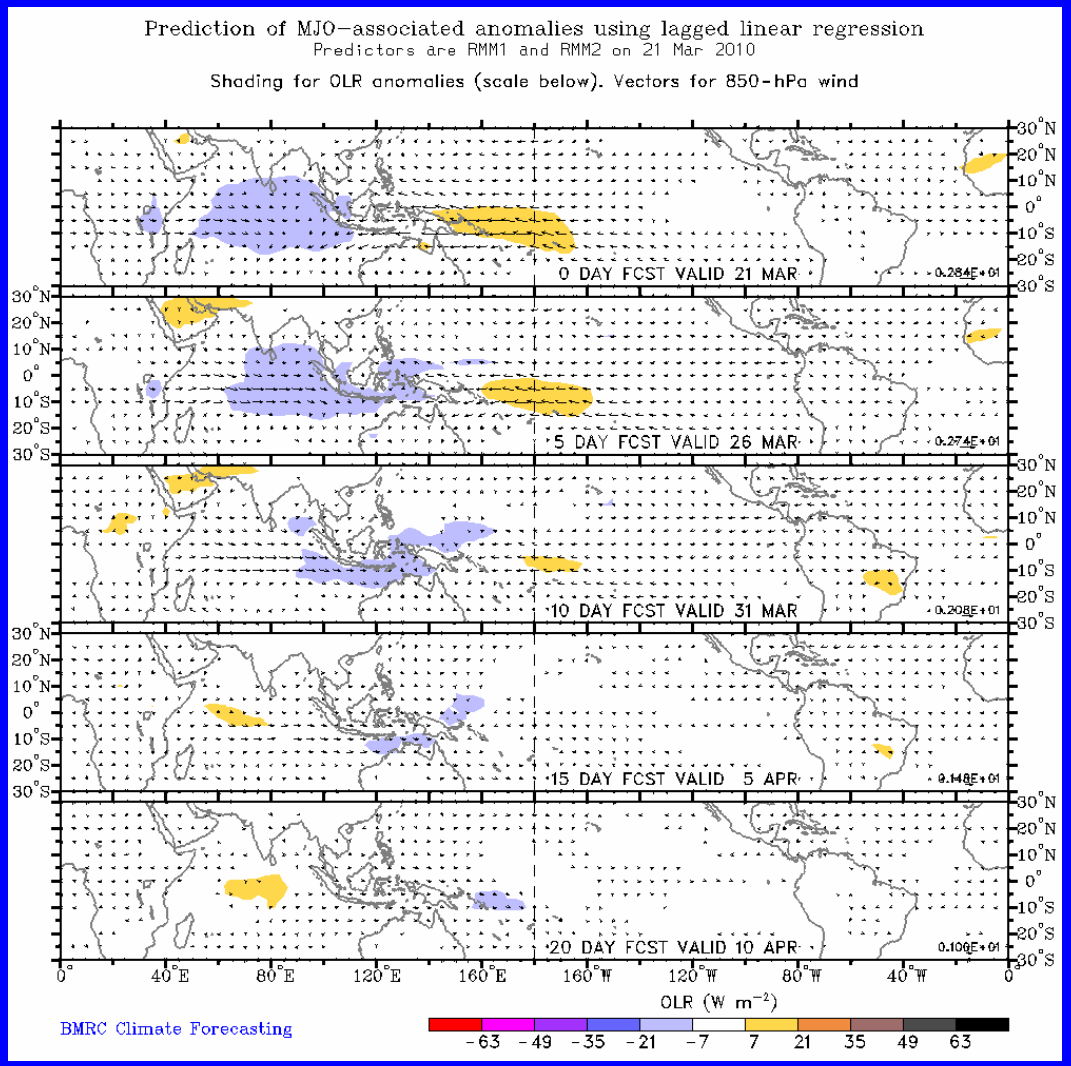
# Statistical MJO Forecast

**Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)**

**Spatial map of OLR anomalies and 850-hPa vectors for the next 20 days**

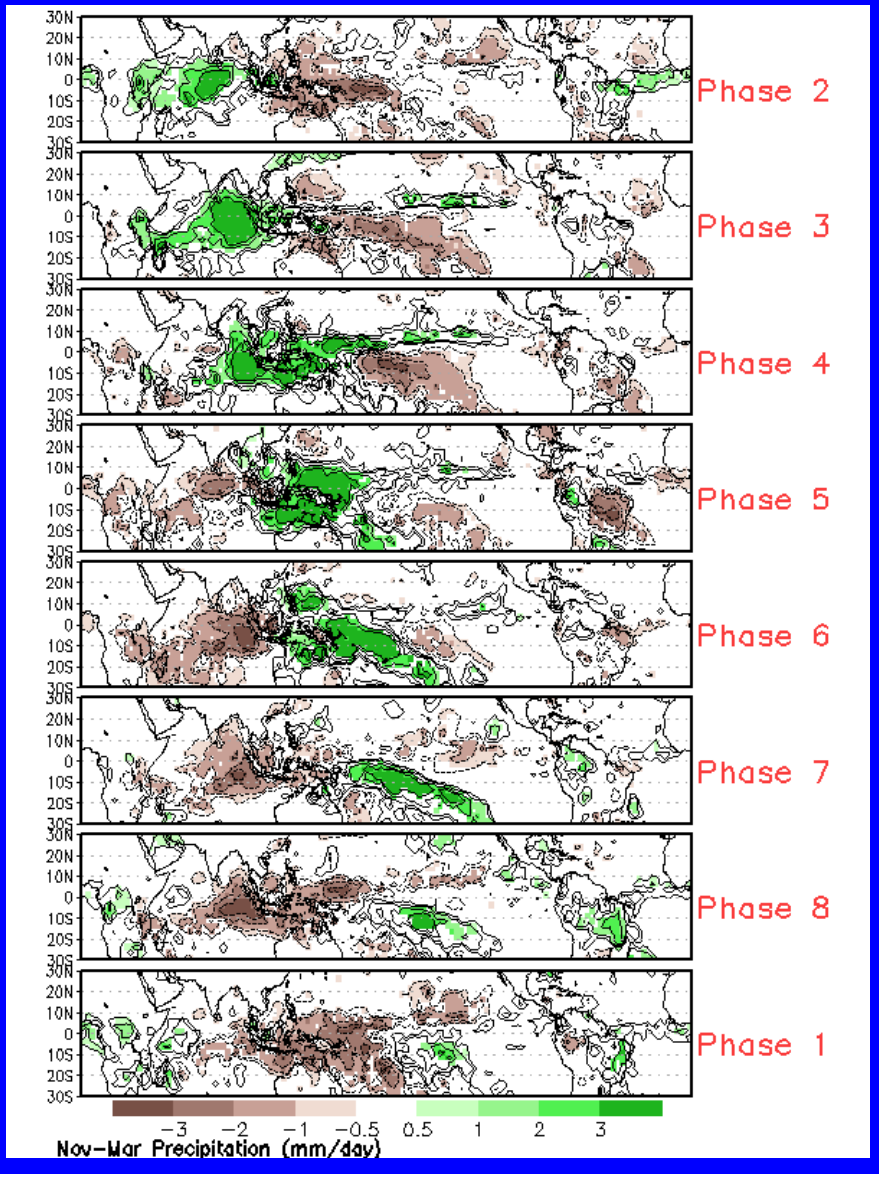
**(Courtesy of the Bureau of Meteorology Research Centre - Australia)**

**The statistical forecast indicates weak MJO activity with enhanced convection shifting east from the Indian Ocean to the Maritime continent over the next two weeks.**



# MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)




850-hPa Wind Anomalies (Nov-Mar)