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

**Update prepared by**
**Climate Prediction Center / NCEP**
**May 4, 2009**

# Outline

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

# Overview

- Moderate-to-strong MJO activity continued during the past week with the suppressed convective phase now centered over the eastern Maritime Continent.

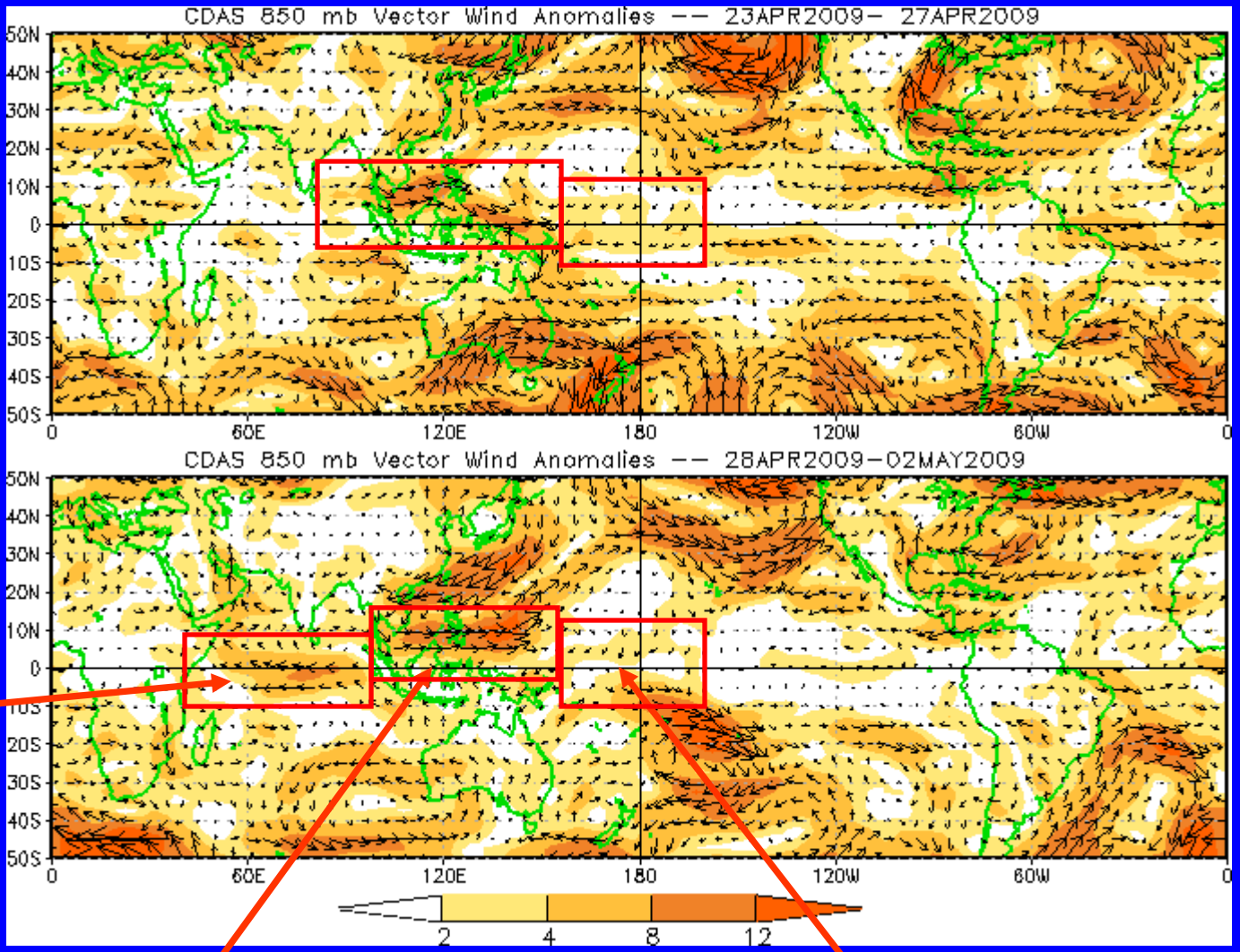
- The MJO is expected to continue during the next 1-2 weeks.

- The MJO is anticipated to suppress rainfall across much of the Maritime Continent during the period while wet conditions are expected for parts of the Americas during Week-1, Africa over the entire period, and southern India during 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 magnitude of anomalous wind vectors




**Low-level easterly anomalies have developed across the Indian Ocean during the last five days.**

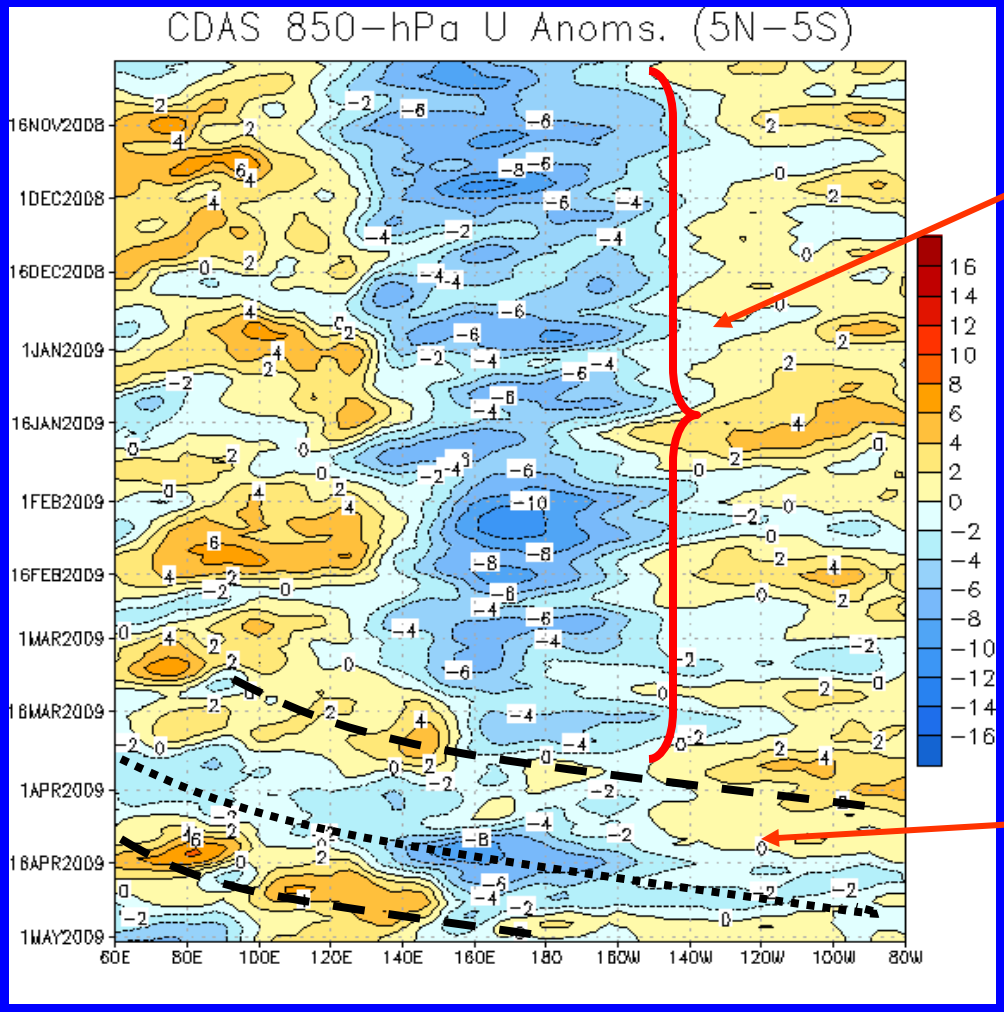
**Low-level westerly wind anomalies persist just north of the Maritime Continent.**

**Easterly wind anomalies have dissipated during the last 5-10 days over the western and central equatorial Pacific.**

# 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**

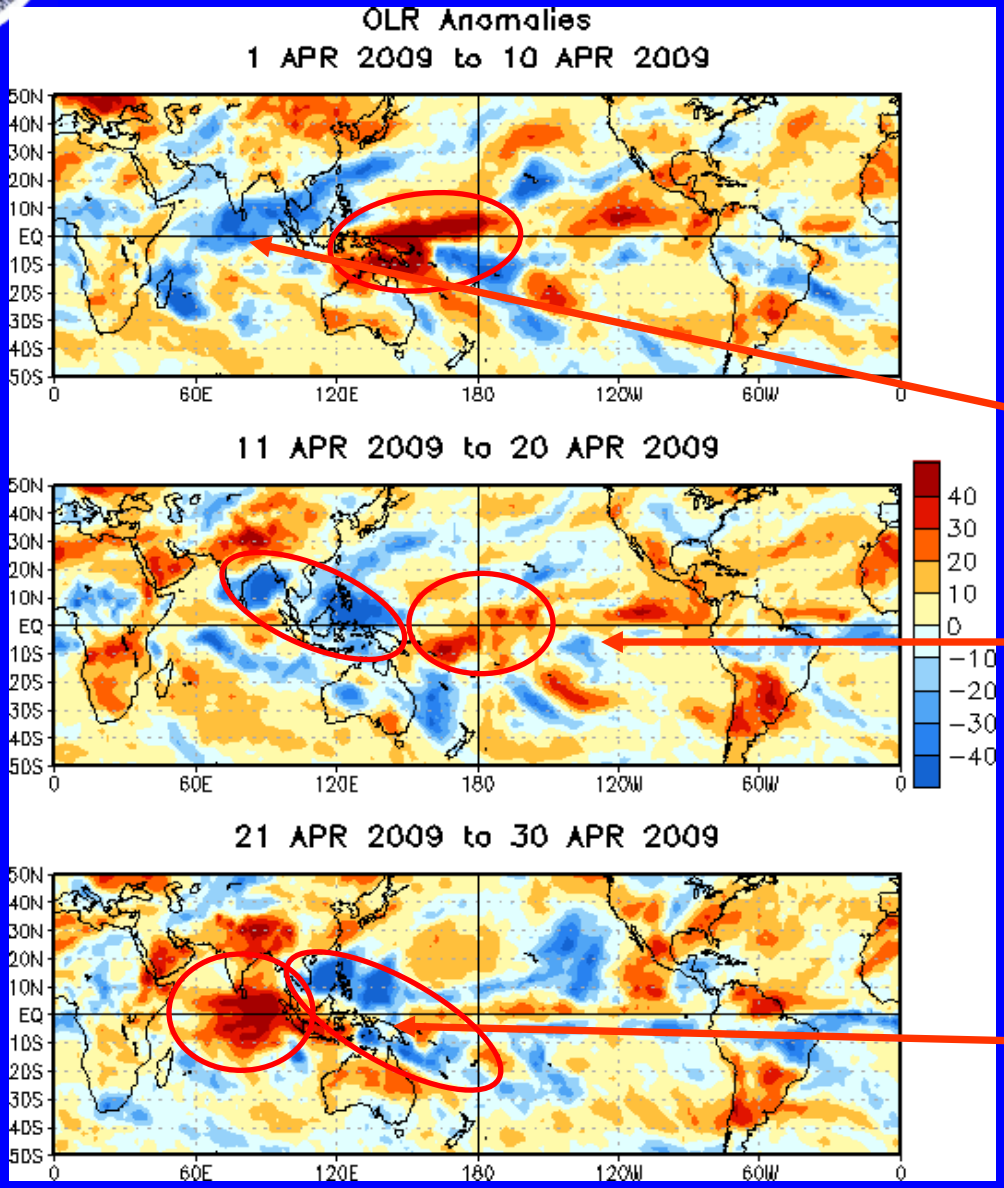
**A persistent pattern of westerly (easterly) anomalies over the Indian Ocean (central Pacific Ocean) has been in place since October.**

**Since the second half of March, a pattern of alternating low-level westerly, easterly and again westerly anomalies have shifted eastward from the Indian Ocean through the equatorial Pacific associated with the current MJO activity.**

# OLR Anomalies: Last 30 days

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

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

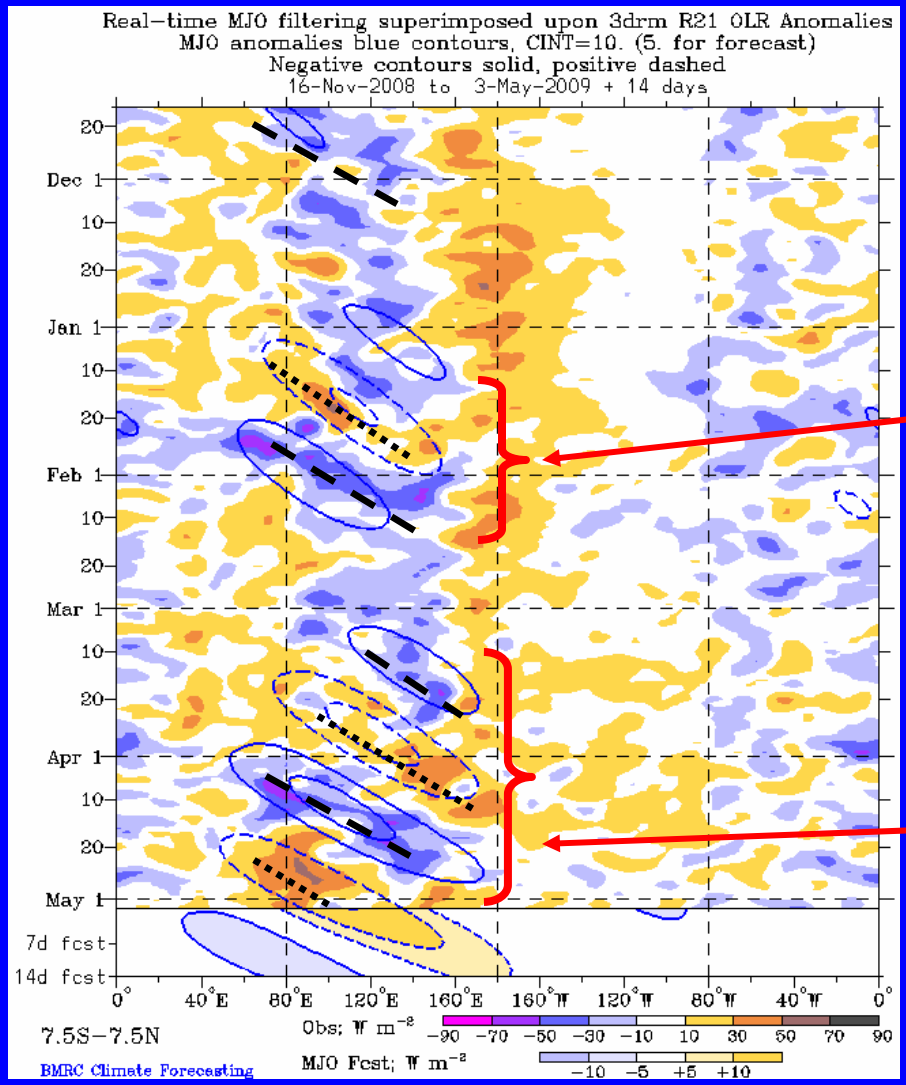



During early April, suppressed convection was observed over the eastern Maritime Continent and western Pacific Ocean, while wet conditions developed across the Indian Ocean, Bay of Bengal, and Southeast Asia.

During mid April, enhanced convection shifted eastward over the eastern Maritime Continent, while suppressed convection continued over the central Pacific.

More recently, suppressed convection has strengthened across the Indian Ocean, while enhanced convection weakened over the Maritime Continent.

# 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 - Australia)**

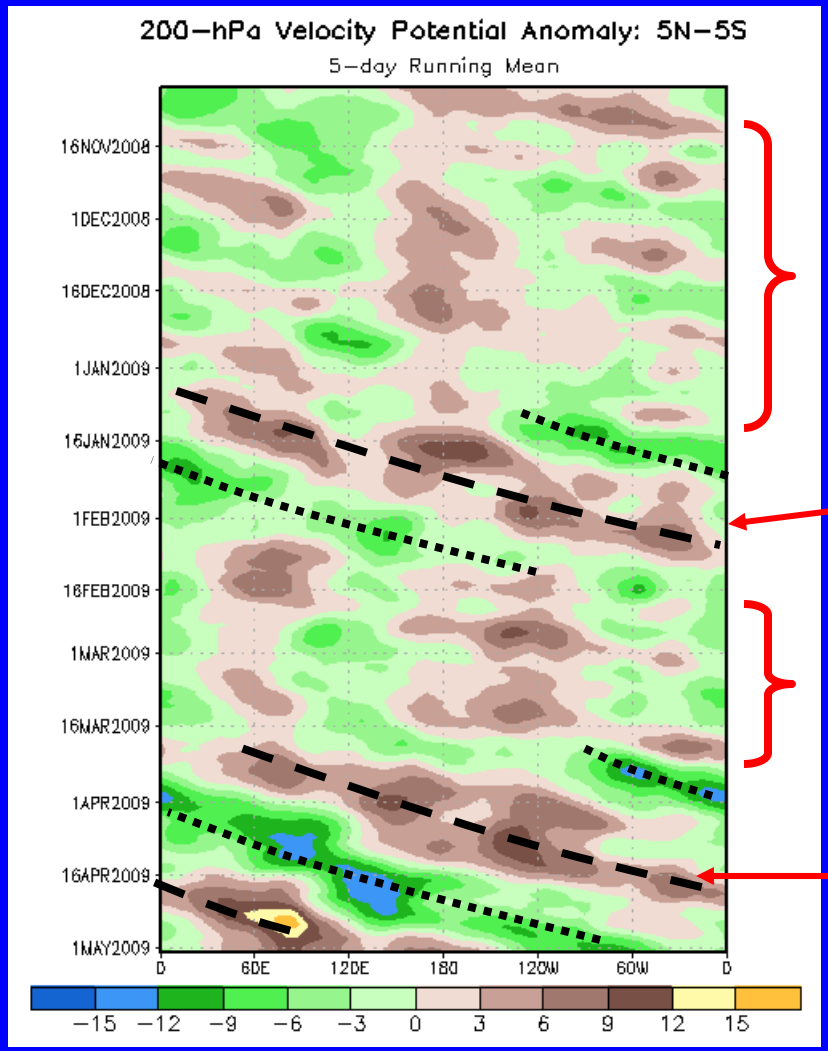
**From mid-January to mid-February, eastward movement of suppressed (enhanced) convection is observed from the Indian Ocean to portions of Indonesia and the western Pacific.**

**Since mid-March, areas of suppressed and enhanced convection have shifted eastward in association with the current MJO activity.**

# 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

From mid-November to mid-January, the subseasonal activity organized on a faster time scale and the MJO was weak or incoherent.

Velocity potential anomalies increased as the MJO strengthened and shifted eastward during January to mid-February.

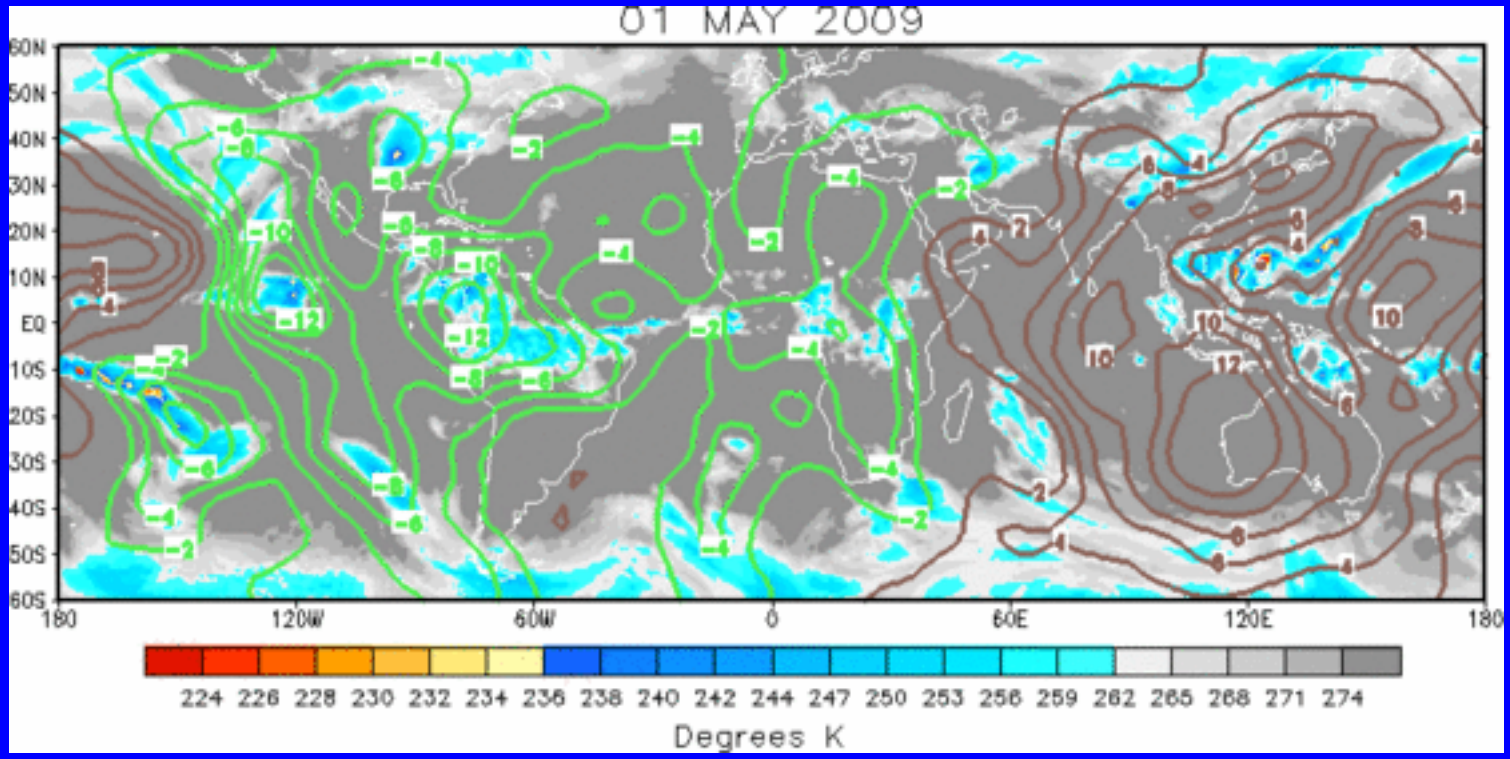
The velocity potential anomalies were weak late February and early March.

Since mid-March, eastward propagating velocity potential anomalies indicate MJO activity.

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

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

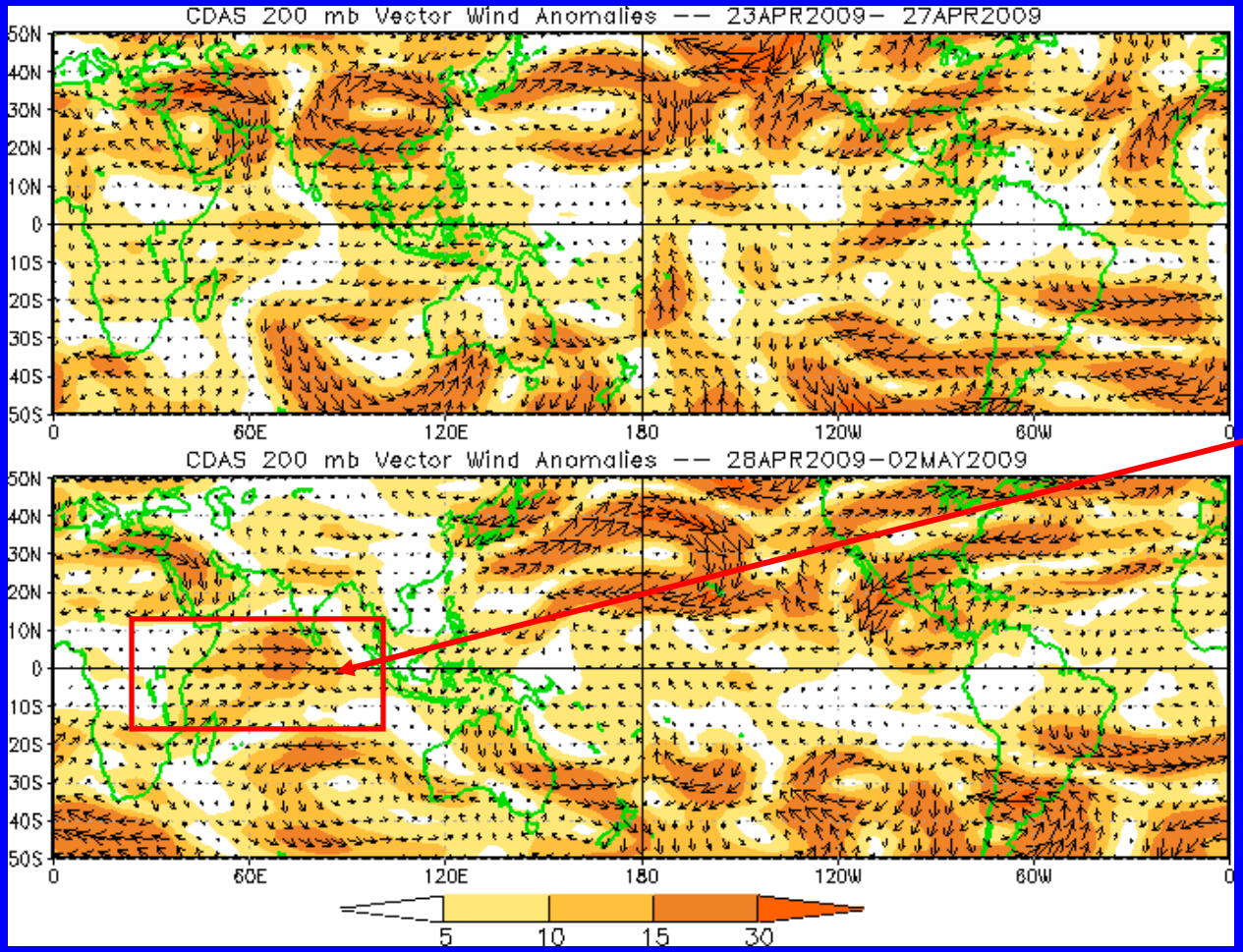
**Negative anomalies (green contours) indicate favorable conditions for precipitation**




**A coherent velocity potential spatial pattern is evident with large-scale anomalous upper-level divergence (convergence) centered over the Americas (Indian Ocean and Maritime Continent).**

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

**Note that shading denotes the magnitude of anomalous wind vectors**

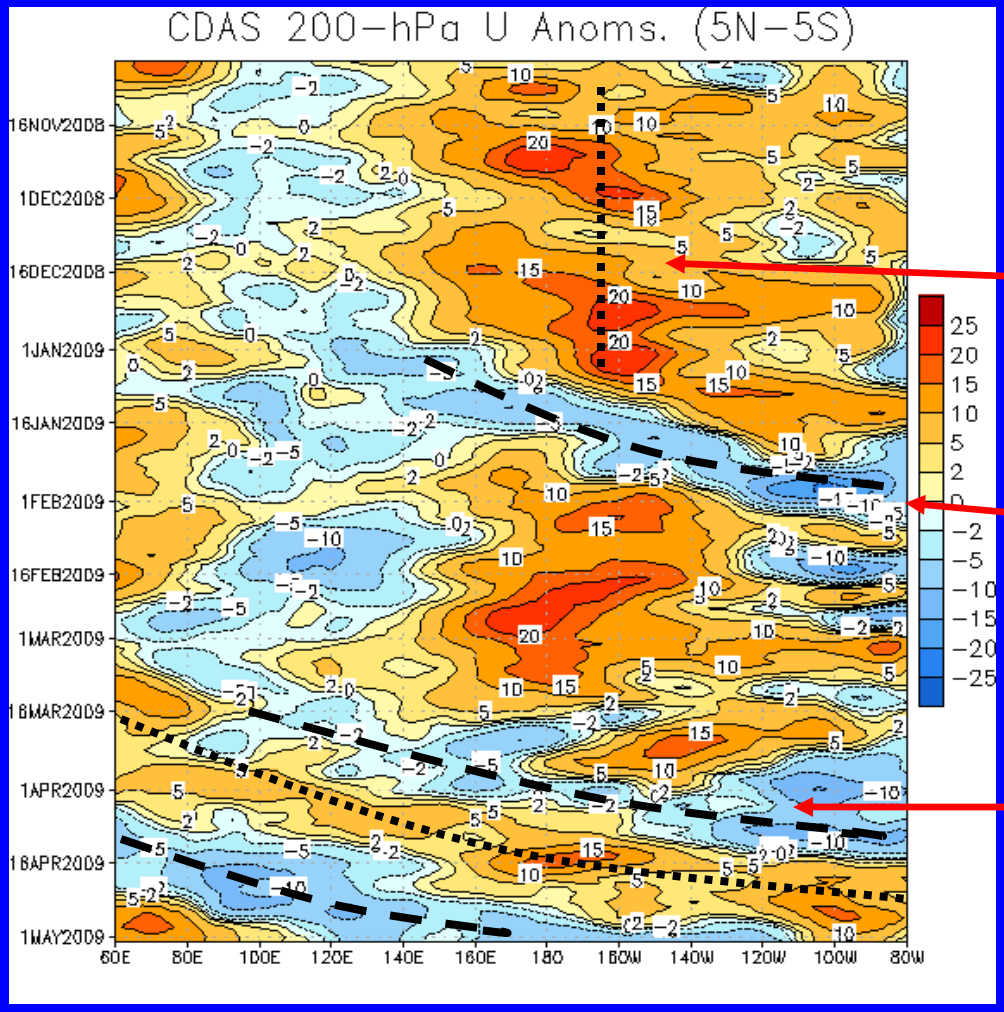



**Westerly anomalies have entered and strengthened across the Indian Ocean during the last five to ten days.**

# 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**

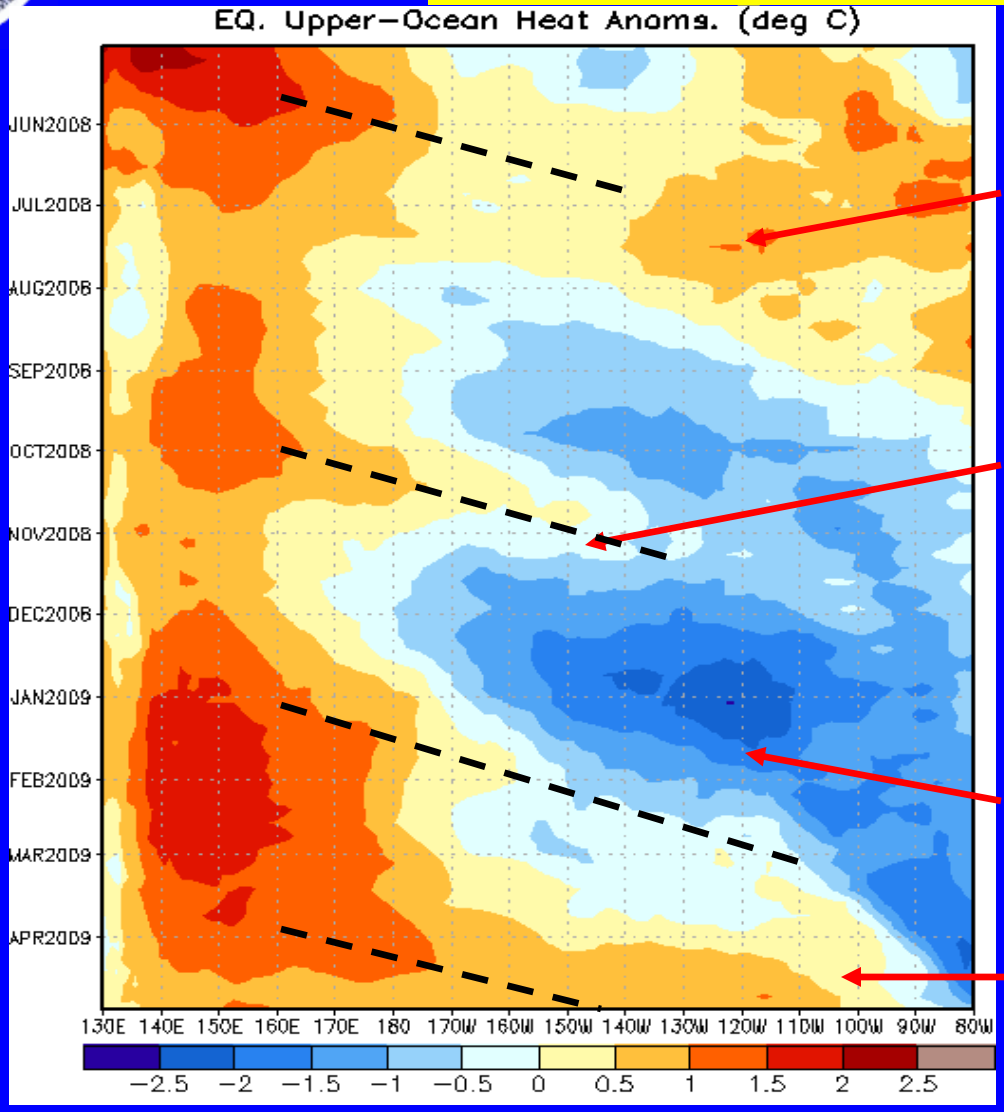
**Longitude**

**Westerly anomalies strengthened markedly in mid-November near the Date Line and persisted through December. These anomalies are consistent with La Nina conditions.**

**Eastward propagation is evident during January associated with MJO activity.**

**Easterly and westerly anomalies continue to shift eastward associated with current MJO.**

# Weekly Heat Content Evolution in the Equatorial Pacific




Time

Longitude

During June and July 2008, positive heat content anomalies encompassed much of the Pacific basin.

During August 2008, negative anomalies started to develop east of the Date Line and have increased and expanded eastward. There was a pause in this increase during October as a Kelvin wave shifted eastward.

During November 2008 – January 2009, negative anomalies increased across the Pacific but became less negative during February.

Recently, an eastward propagating Kelvin wave has increased heat content in the eastern half of the Pacific.

# MJO Index -- Information

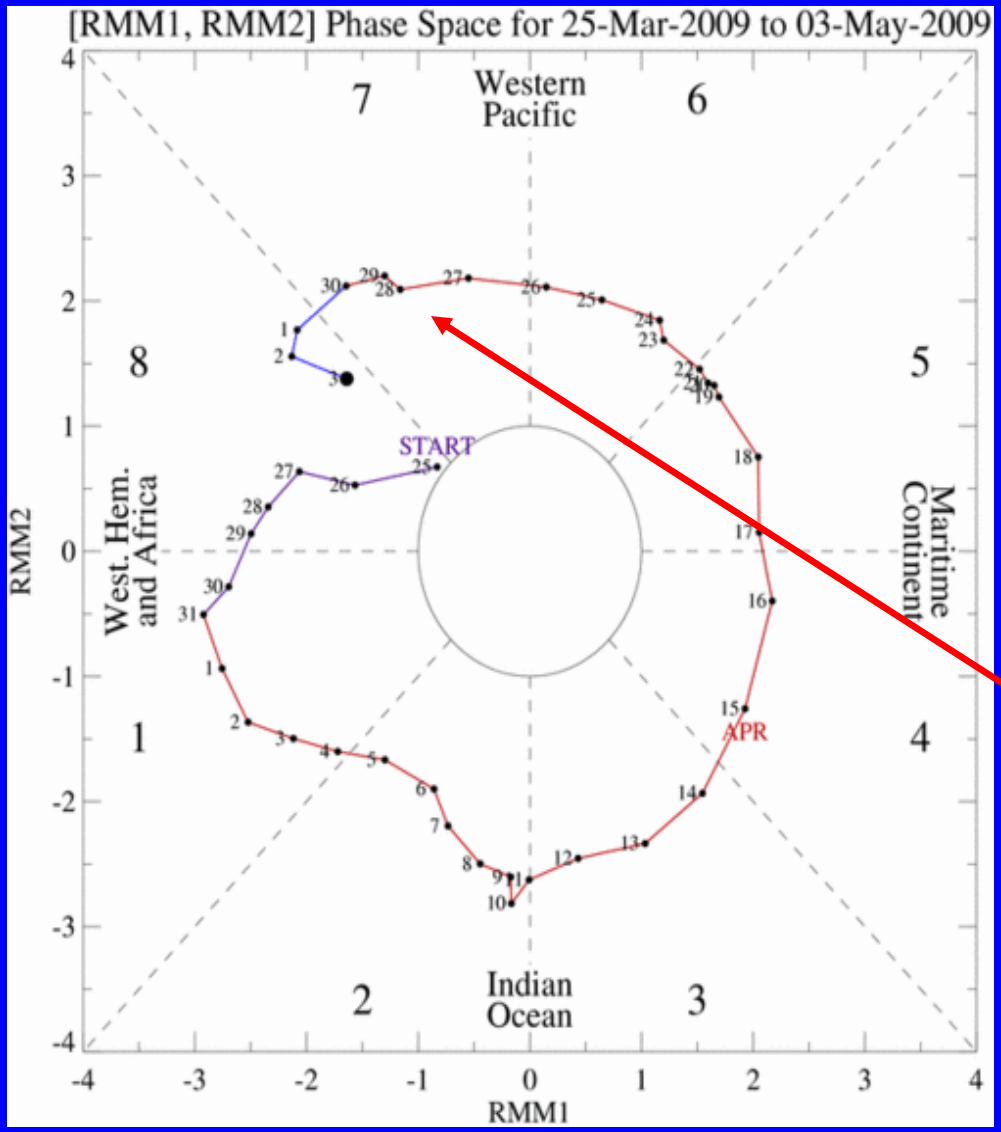
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

**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 nearly identical to that described in WH2004 but small deviations from the BMRC figure are possible at times due to differences in input data and methodology. These typically occur during weak MJO periods.**

- **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).**

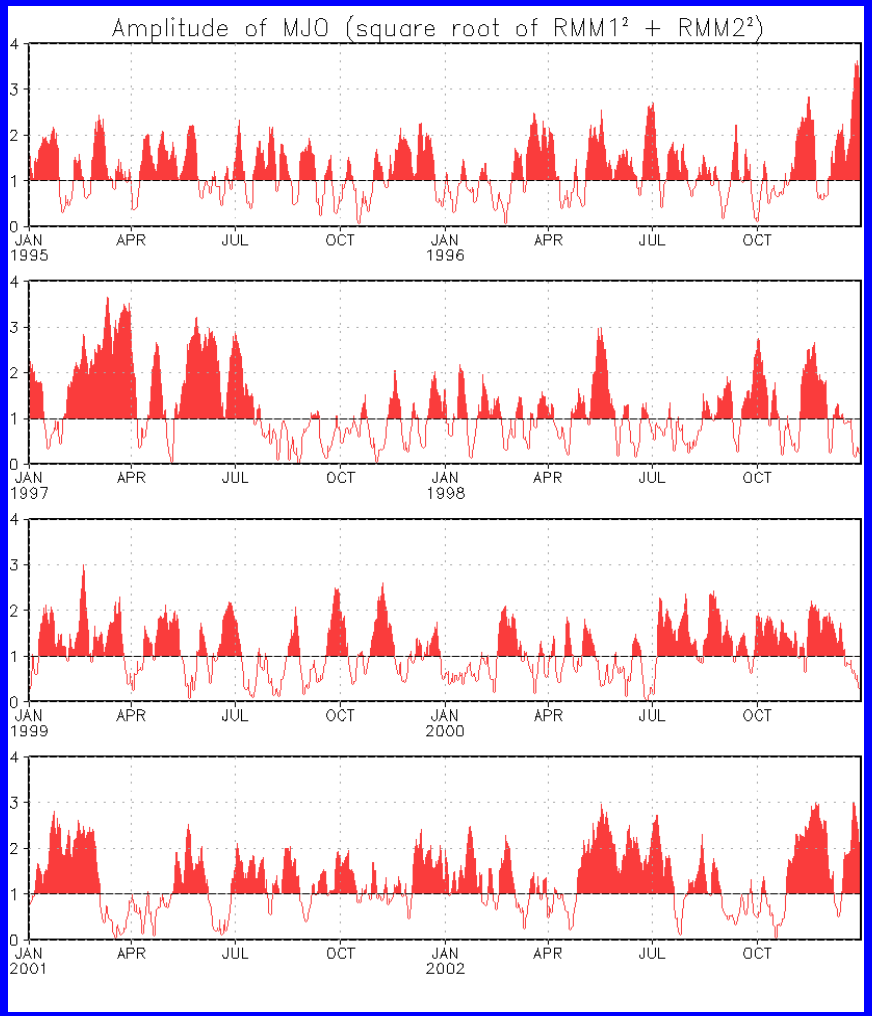
# MJO Index -- Recent Evolution

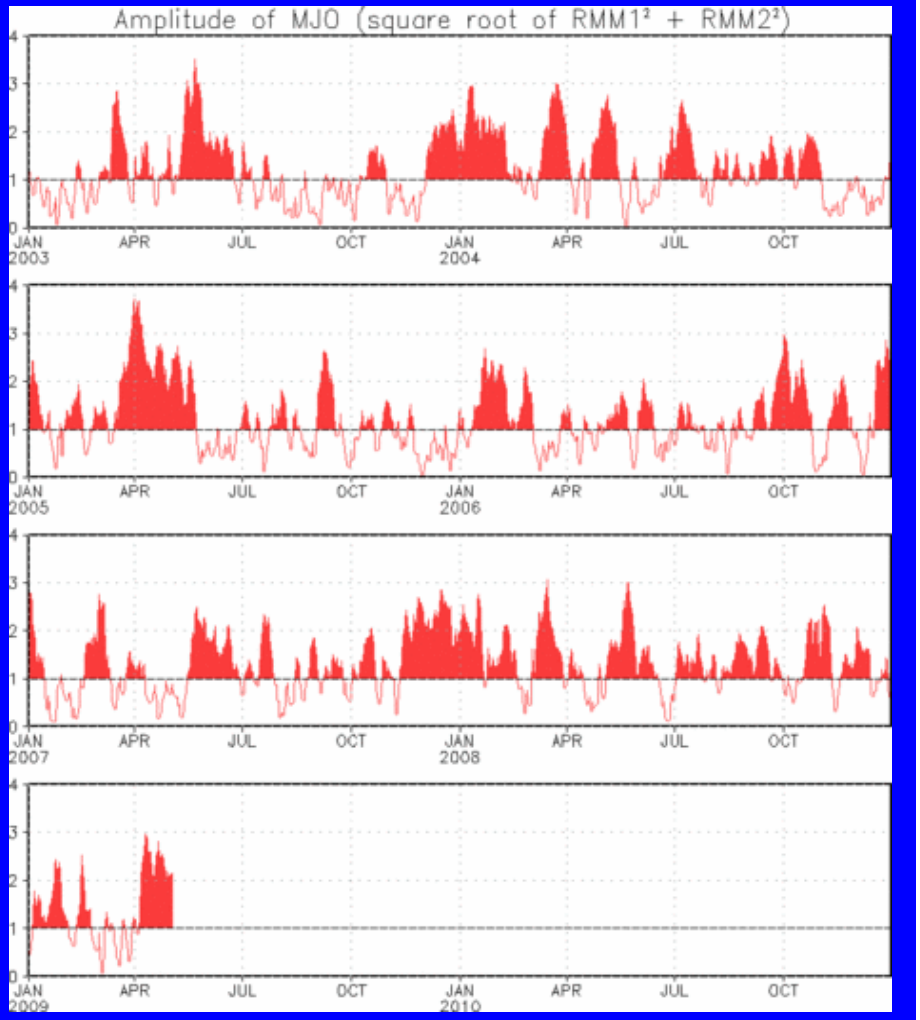



- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

**The MJO index indicates moderate-to-strong activity has shifted through phase 7 during the past week.**

# 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.**

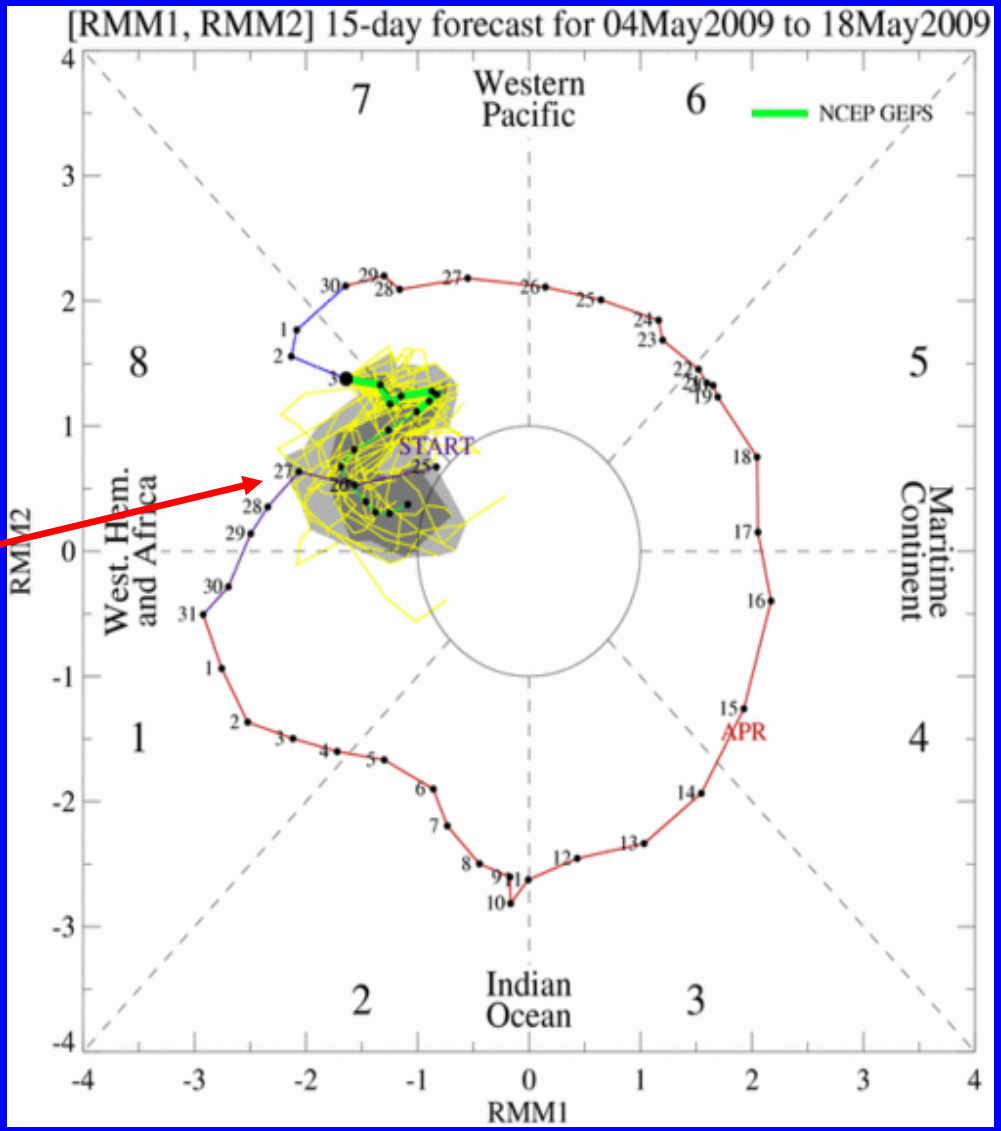
# Ensemble GFS (GEFS) MJO Forecast

**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**

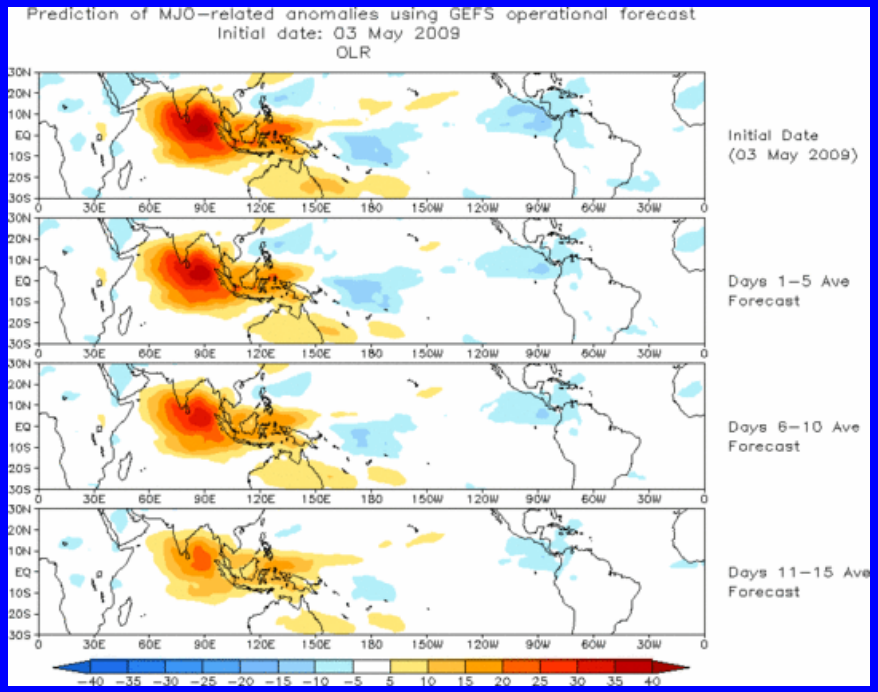
**The GEFS forecasts predict that the MJO signal will continue to slowly shift east although uncertainty is larger than in recent days.**



# Ensemble Mean GFS MJO Forecast

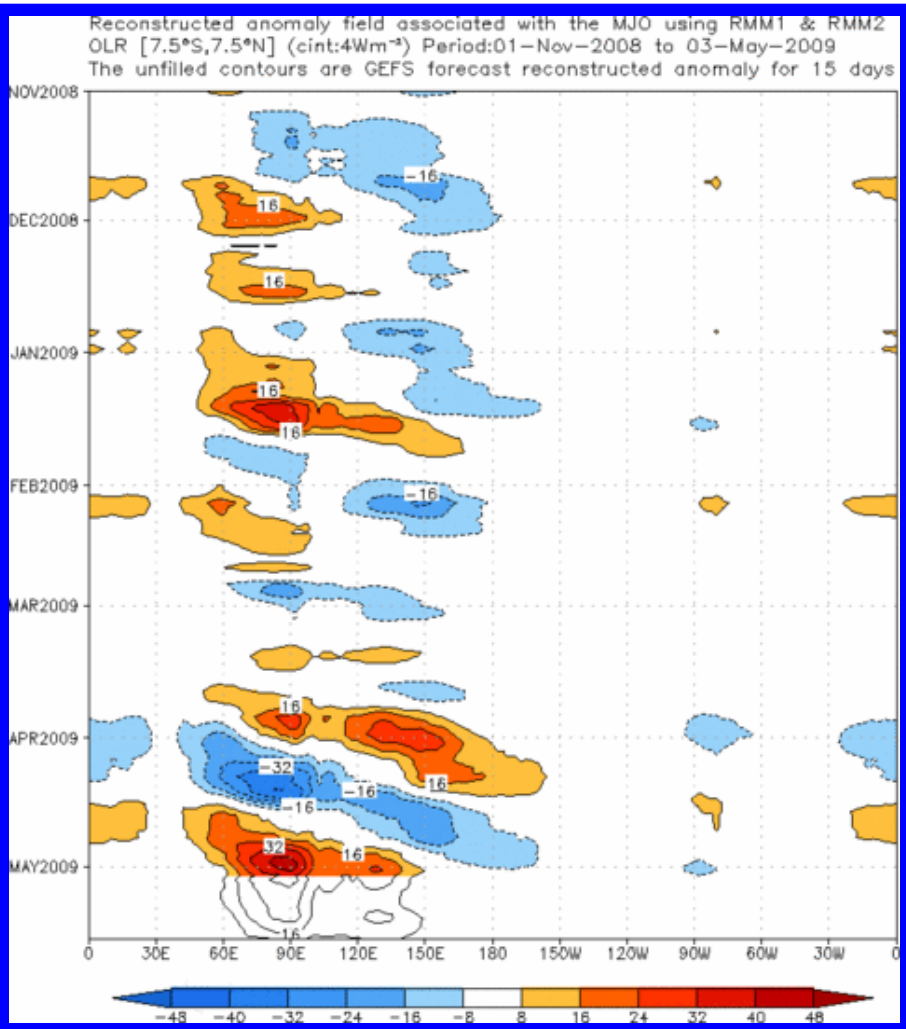
**Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)**

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




**Suppressed convection is expected to persist across the Indian Ocean and Maritime Continent for much of the period. Enhanced convection is anticipated to continue across the Western Hemisphere.**

**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

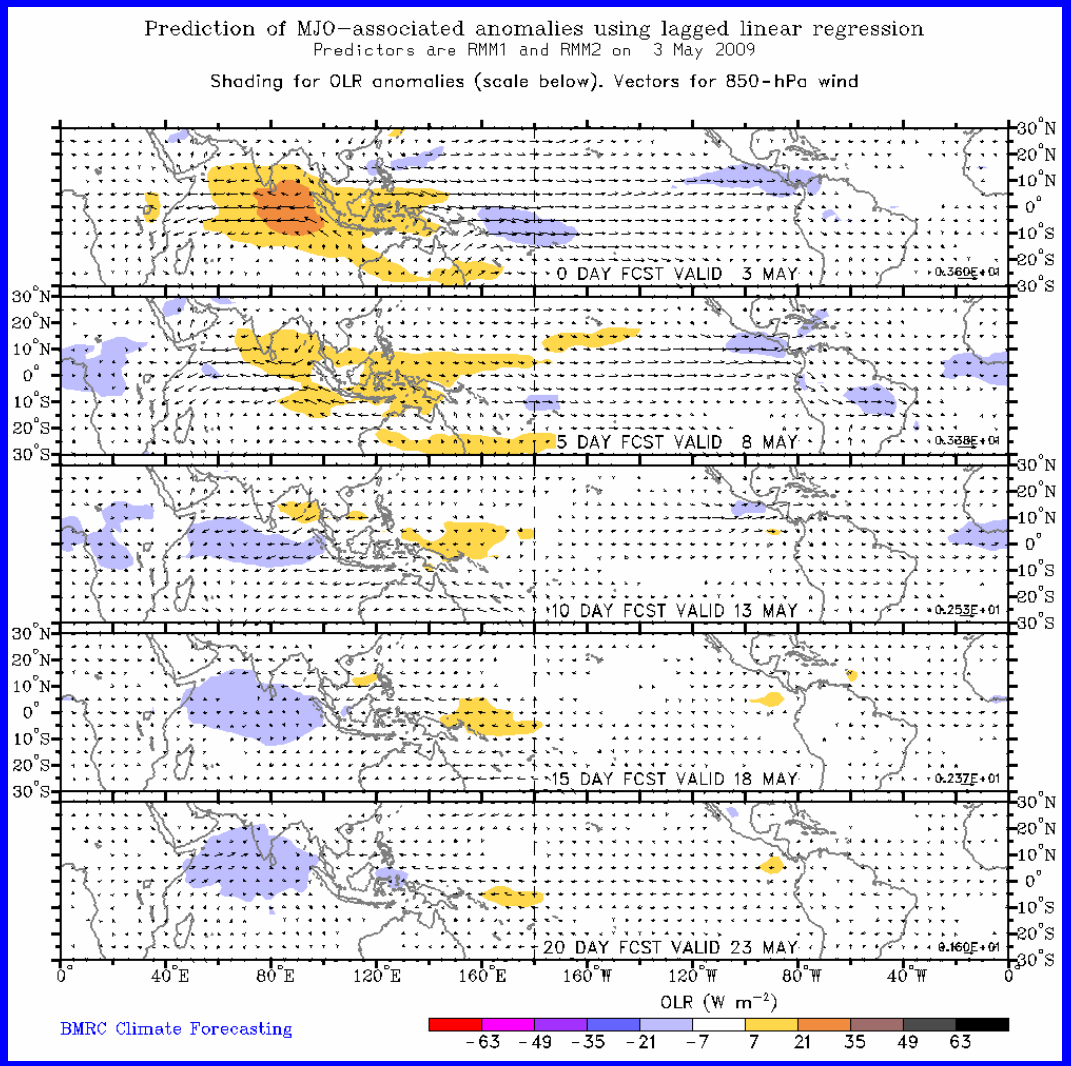
**Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)**

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

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

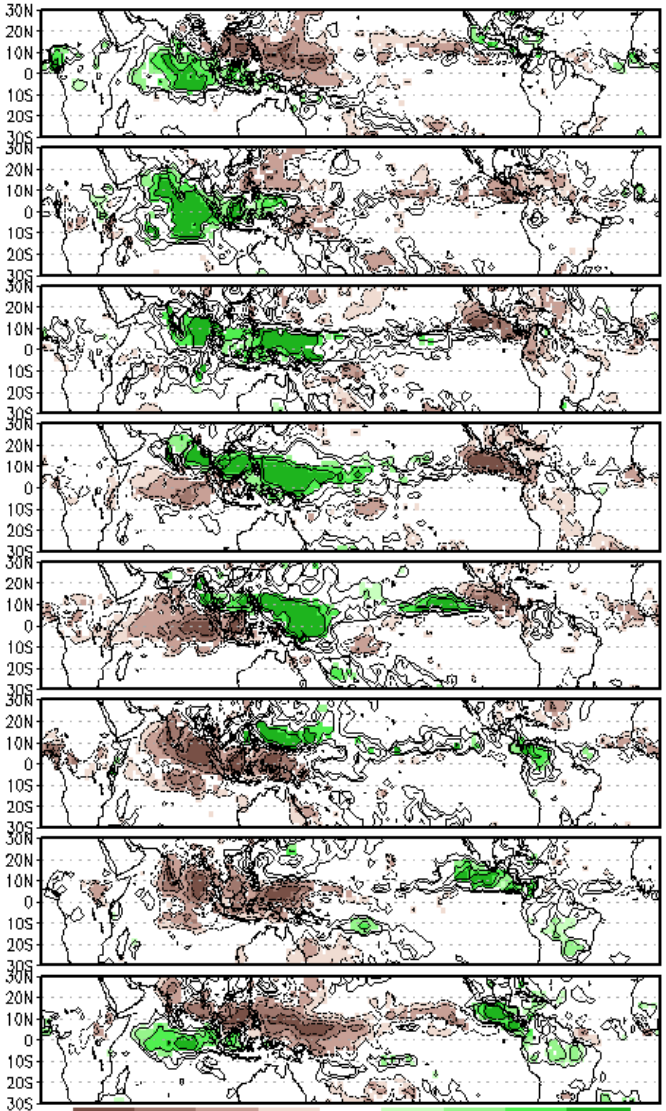
**A statistical MJO forecast indicates suppressed convection shifting from the Indian Ocean to the western Pacific during the next 1-2 weeks.**

**Simultaneously, enhanced convection is expected to shift eastward and strengthen over Africa and the Indian Ocean.**



# MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)




850-hPa Wind Anomalies (May-Sep)