



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

**Update prepared by  
Climate Prediction Center / NCEP  
April 7, 2008**



# Outline

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



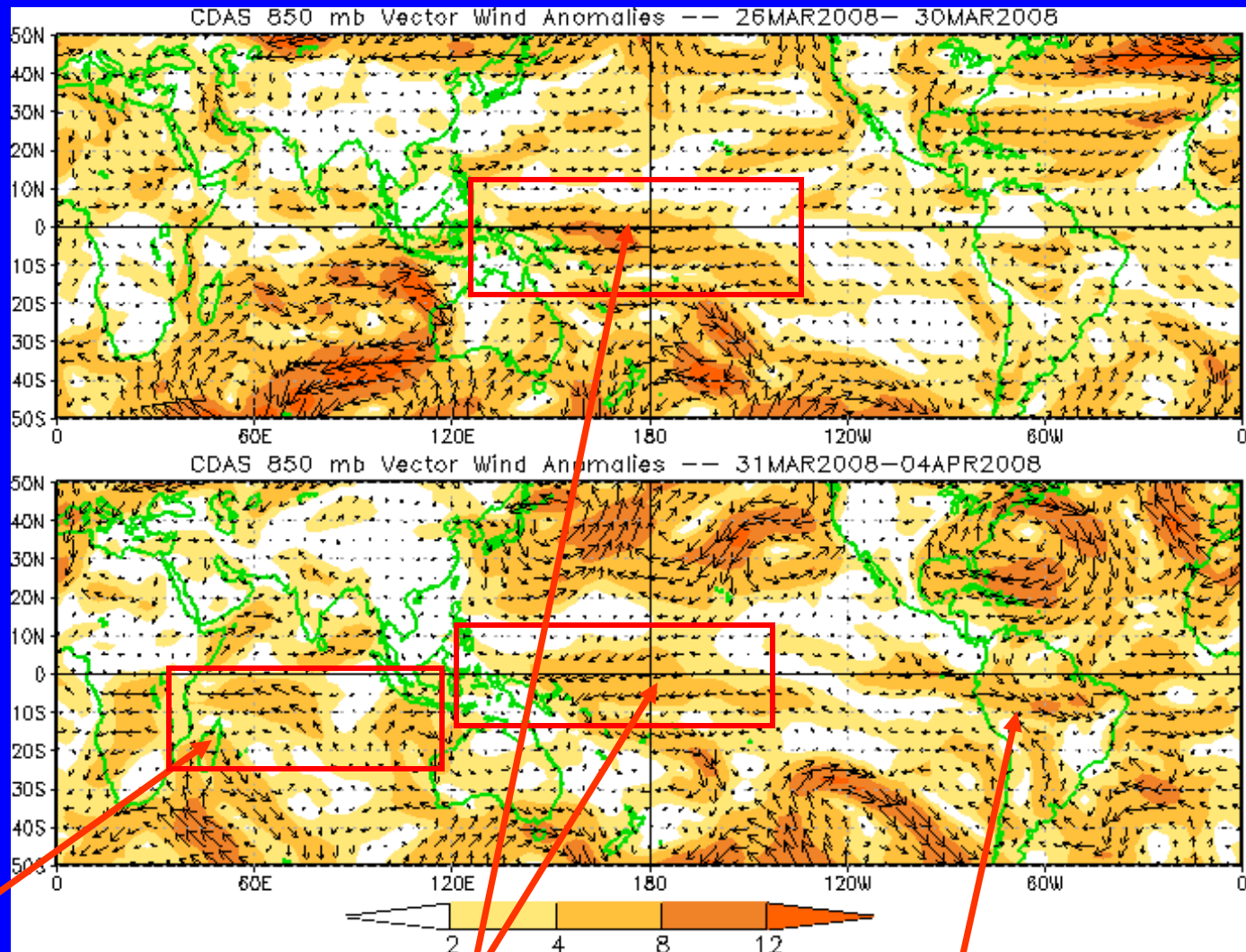
# Overview

- **The MJO remains weak with the convectively enhanced phase now located across the western hemisphere.**
- **Generally weak MJO activity is expected to continue during the next 1-2 weeks.**
- **During week 1, enhanced tropical rainfall - in part associated with the MJO - is expected across parts of South America, the Atlantic Ocean, and Africa while dry conditions are anticipated for portions of the equatorial Indian Ocean.**
- **It is expected that enhanced rainfall will focus across equatorial Africa and the western Indian Ocean during week 2.**



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

Note that shading denotes the magnitude of anomalous wind vectors



Westerly anomalies across the southern Indian Ocean have decreased during the last five days.

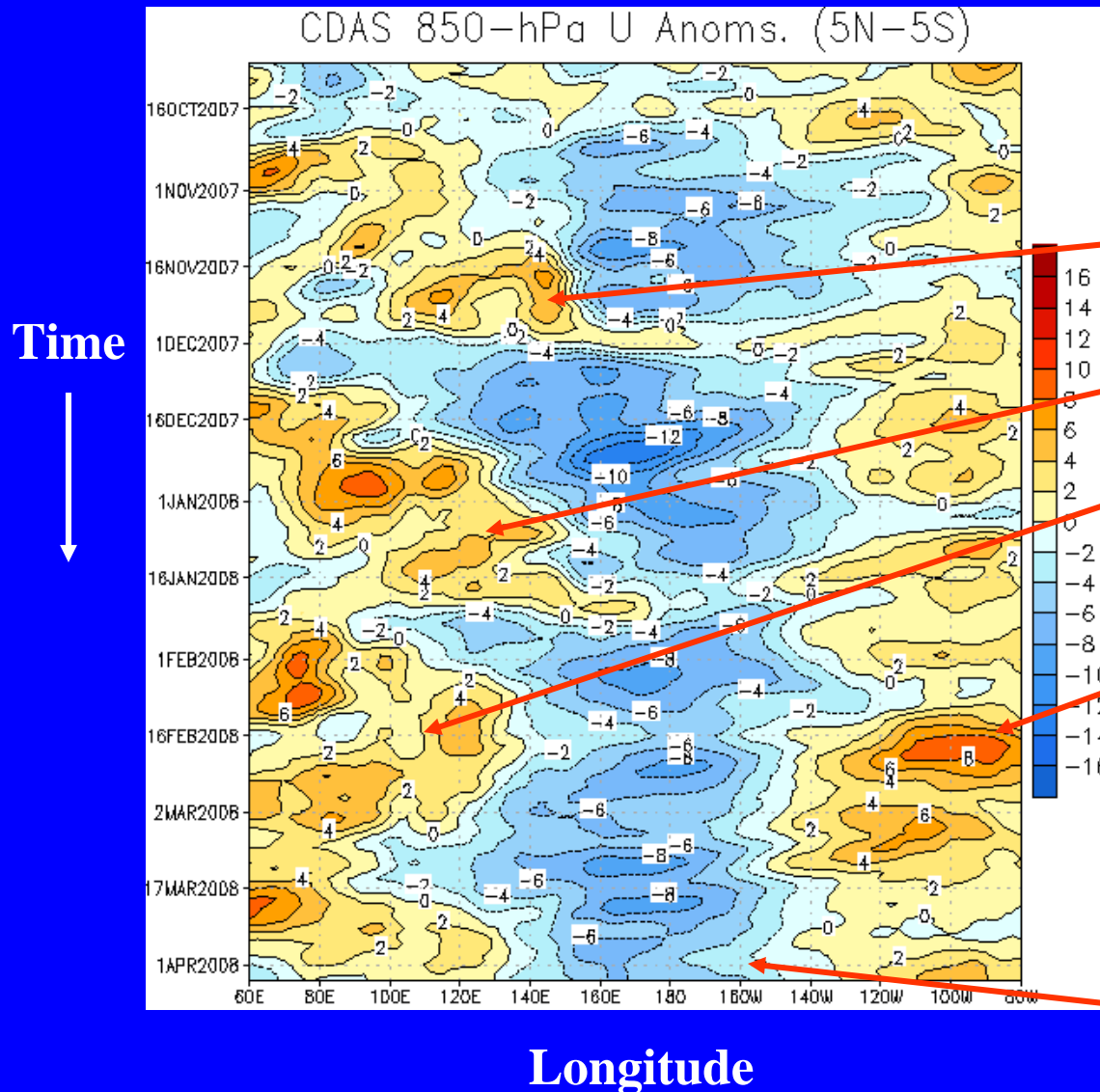
Easterly anomalies remain across the western Pacific but are slightly weaker during the last five days.

Westerly anomalies have increased across the equatorial western hemisphere.



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

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



Moderate-to-strong MJO activity was evident from late October to mid-late February as shown by westerly anomalies shifting eastward from the Indian Ocean across Indonesia and a weakening of the easterlies at the Date Line during early December, mid-January and mid-February.

Westerly anomalies increased during mid-February across the eastern Pacific.

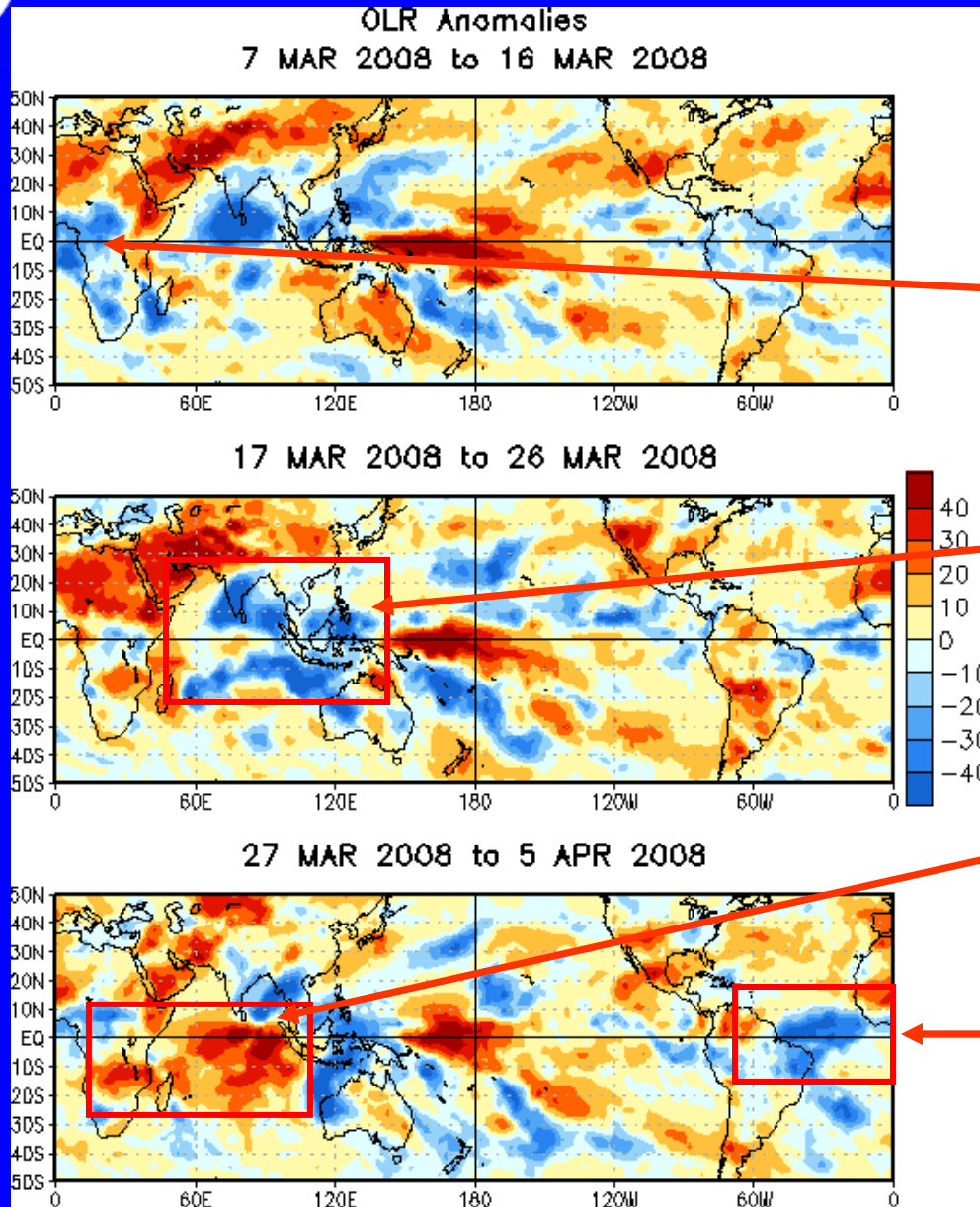
In late March, westerly anomalies shifted eastward to Indonesia but recently winds have become closer to average.

Low-level easterlies remain entrenched across much of the west-central Pacific.



# OLR Anomalies: Last 30 days

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



Enhanced convection was evident across the equatorial Atlantic and Africa during early-mid April.

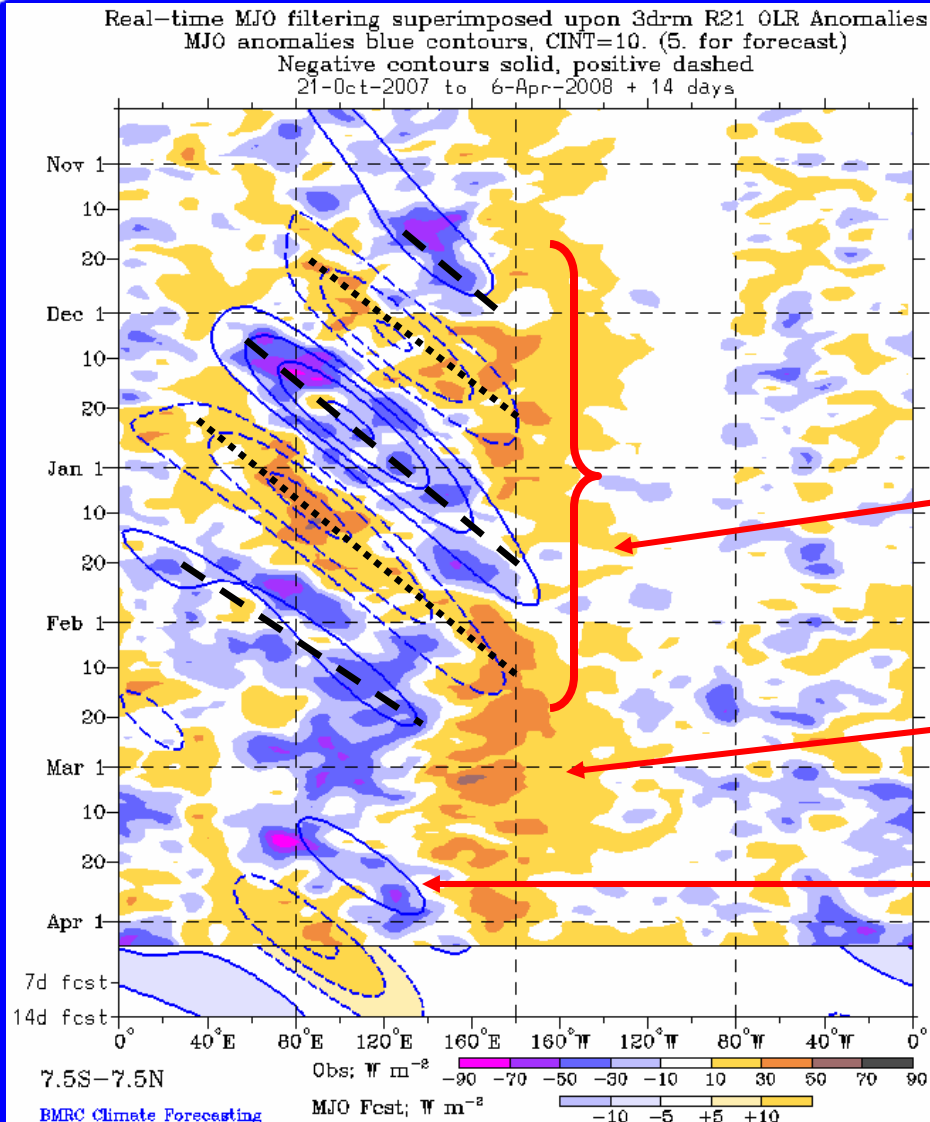
In part associated with the MJO, enhanced convection rapidly shifted eastward to the Maritime continent.

Dry conditions were observed across parts of the Indian Ocean during late March and early April.

Wet conditions continue across portions of the Atlantic Ocean, South America, and Africa.



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



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

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

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

**Moderate-to-strong MJO activity was evident from mid-November to mid-February with coherent eastward propagation of enhanced (suppressed) convection indicated by the dashed (dotted) lines.**

**From mid-February to early-mid March, a more stationary pattern of anomalous convection was evident.**

**Enhanced convection across the Indian Ocean shifted east during mid-late March and dry conditions have developed across the equatorial Indian Ocean in recent days.**

**Time**  
↓

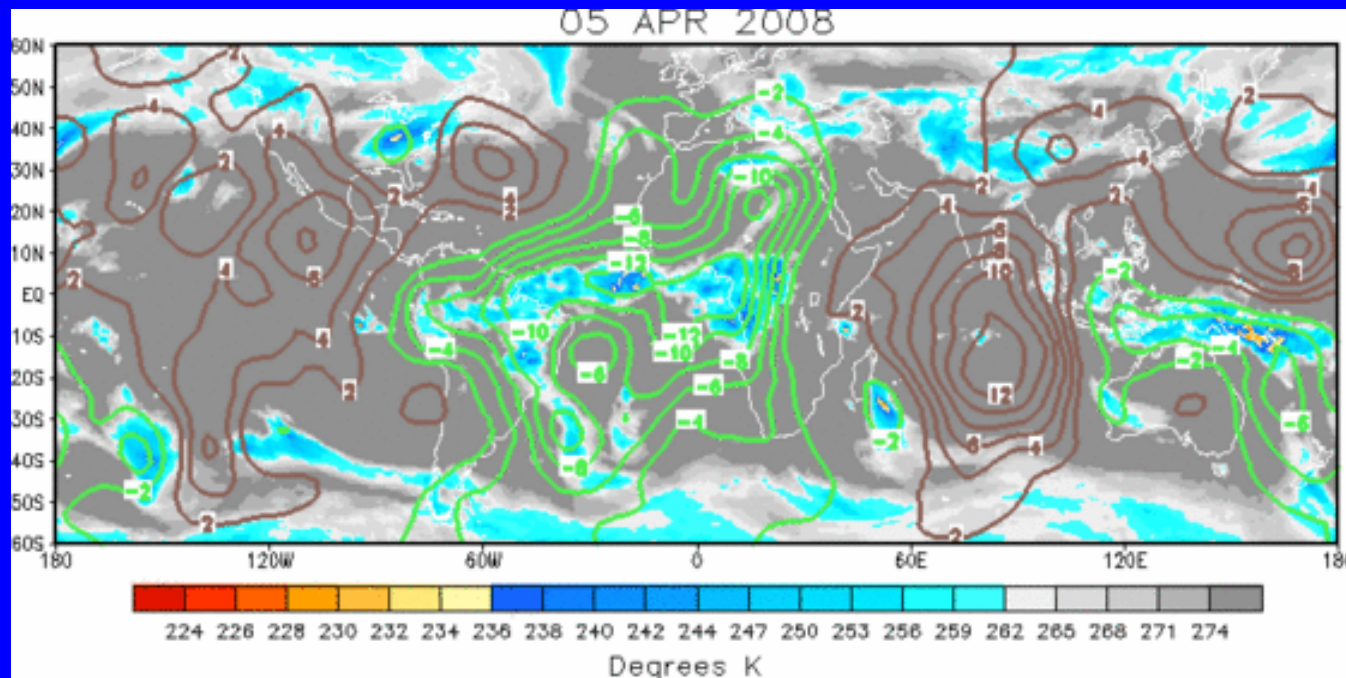
**Longitude**



# 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 current global velocity potential anomalies indicate a pattern of strong upper-level divergence across South America, the Atlantic Ocean and western Africa while upper-level convergence prevails across the Indian Ocean.



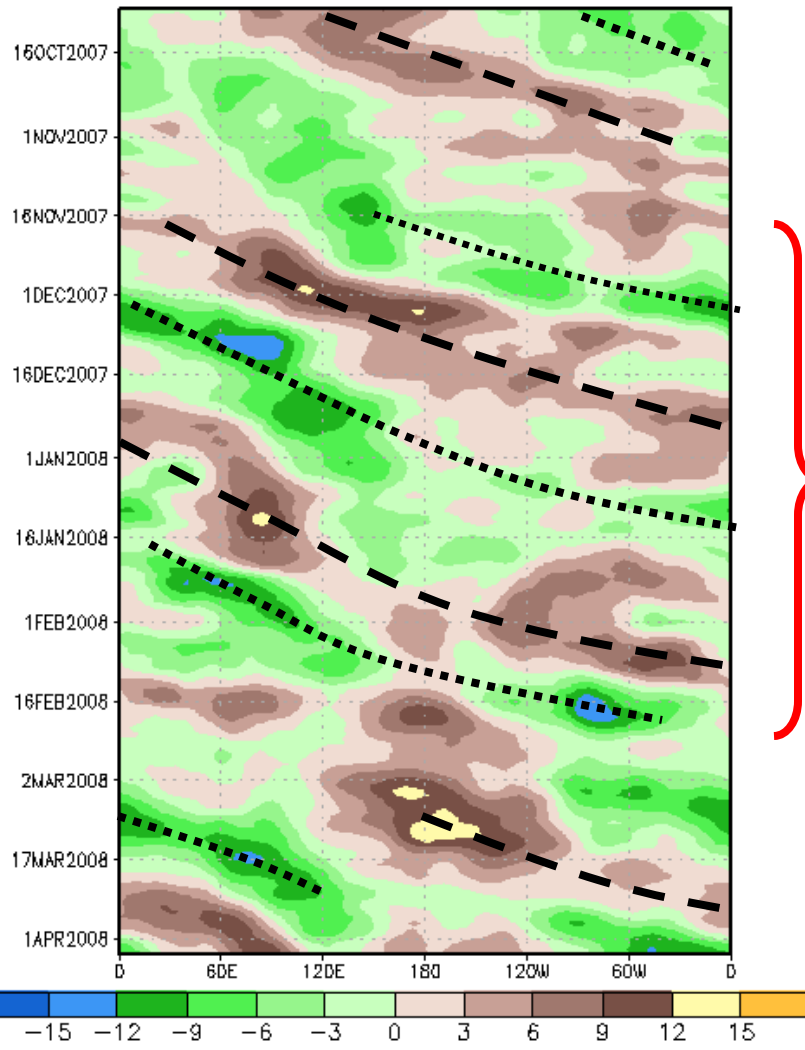


# 200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

200-hPa Velocity Potential Anomaly: 5N-5S  
5-day Running Mean



Time



Moderate-to-strong MJO activity developed in mid-November and continued into mid-February.

The MJO weakened during the second half of February.

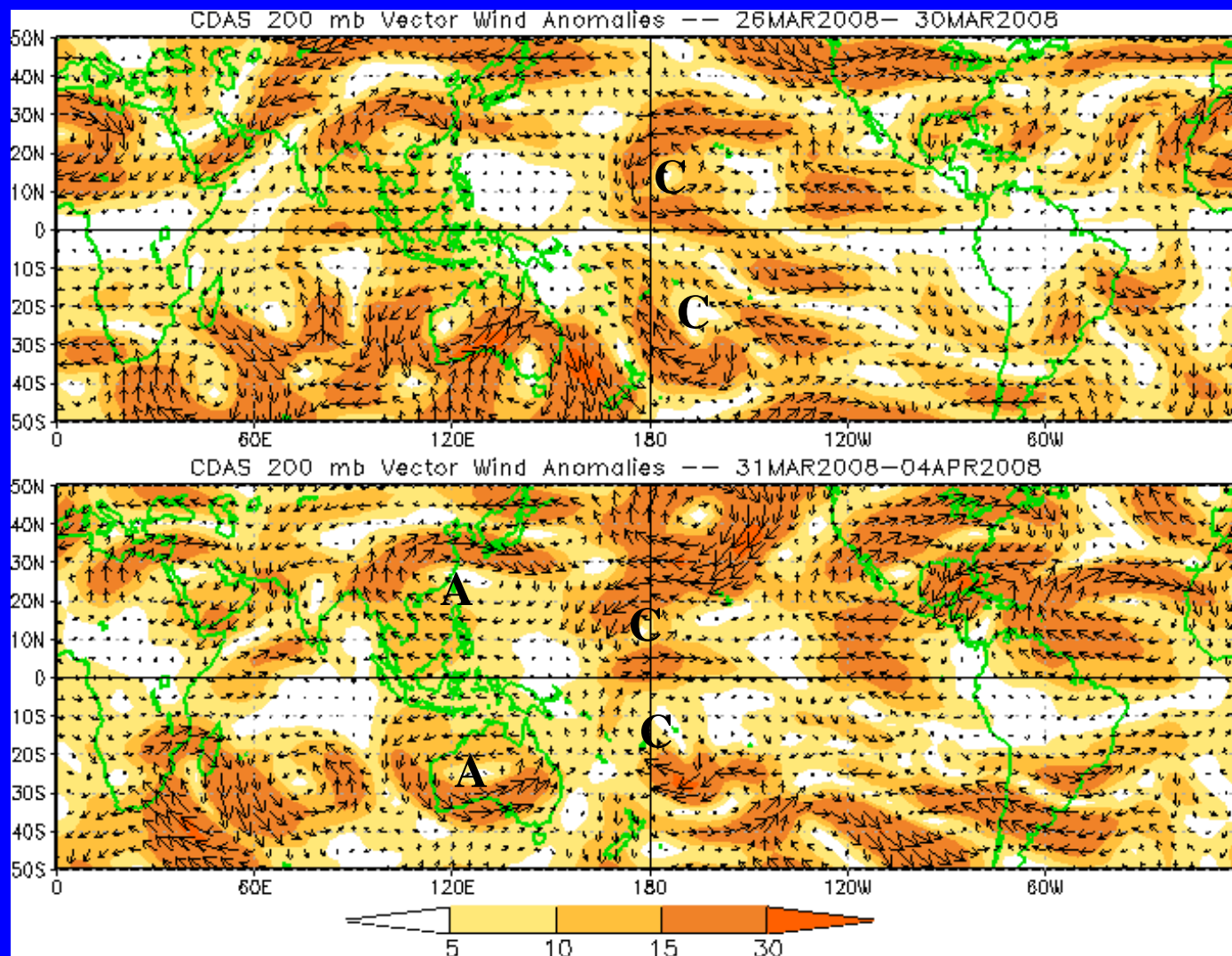
During early-mid March, velocity potential anomalies increased and some eastward propagation is evident.

Longitude



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

Note that shading denotes the magnitude of anomalous wind vectors



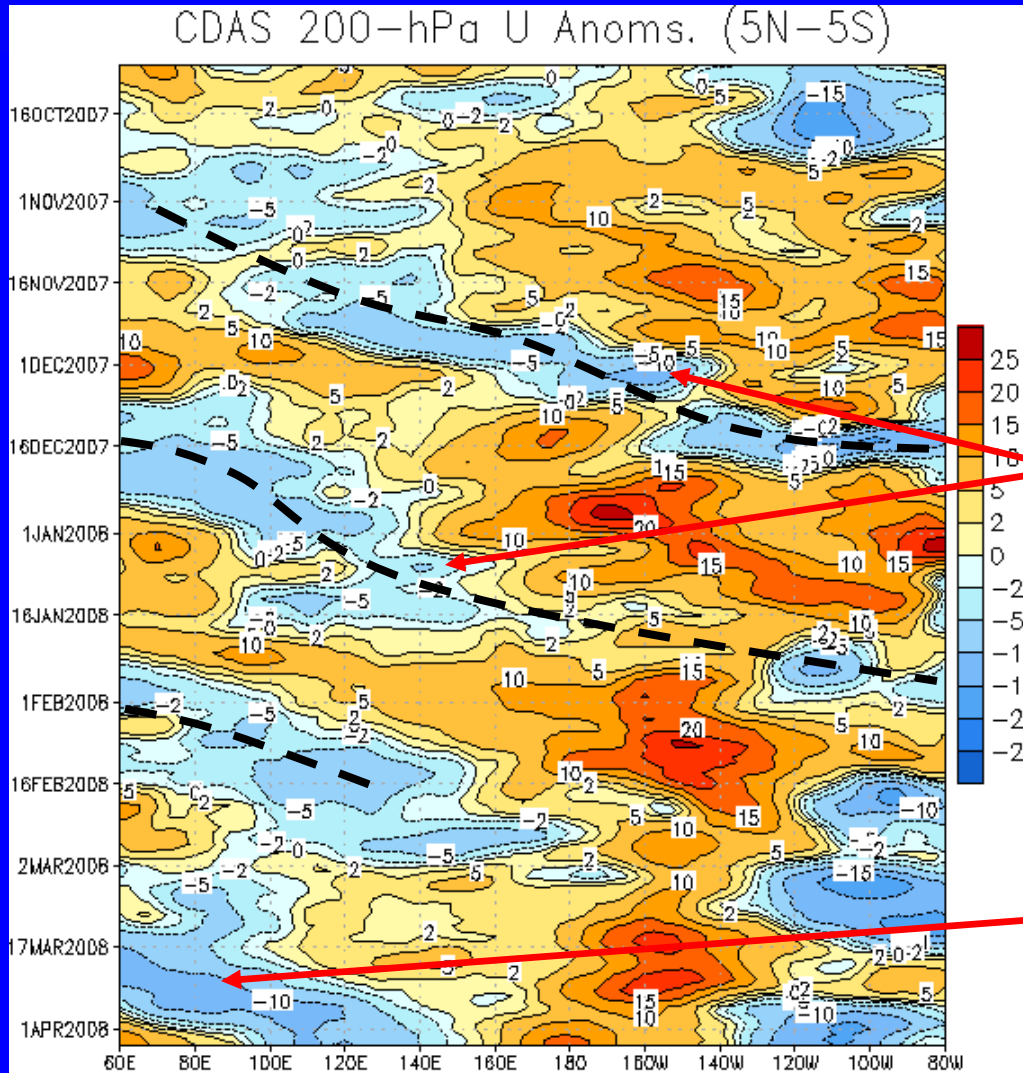
Well defined cyclonic circulations (C) are evident north and south of the equator near the Date Line.

Also, anti-cyclonic circulations are evident north and south of the equator near the Maritime continent during the last ten days.



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

Time



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

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

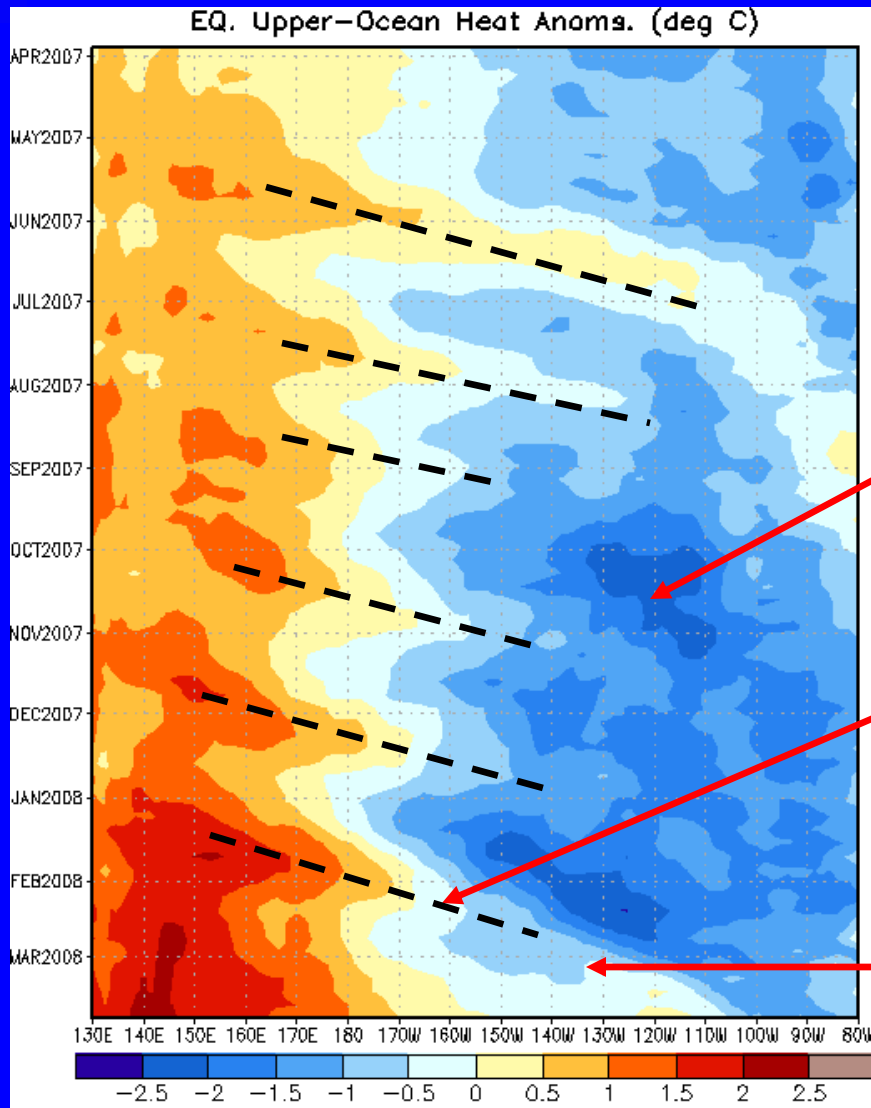
MJO activity is evident in the upper-levels by eastward propagation of easterly anomalies (dashed lines) globally from early November to mid-February.

During March, easterly anomalies propagated quickly eastward from the western hemisphere to the Maritime continent region.



# Weekly Heat Content Evolution in the Equatorial Pacific

Time  
↓



Longitude

Kelvin wave activity (downwelling phases indicated by dashed lines) has been observed since May and has affected the sub-surface temperature departures at varying degrees across the Pacific Ocean. The strongest wave occurred during May and June.

During September and October, negative heat content anomalies increased markedly across the eastern Pacific Ocean.

From late January into early February, increasingly positive anomalies developed across the western Pacific and shifted eastward associated with the latest downwelling Kelvin wave.

Negative anomalies have decreased during the last few weeks across the central 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).

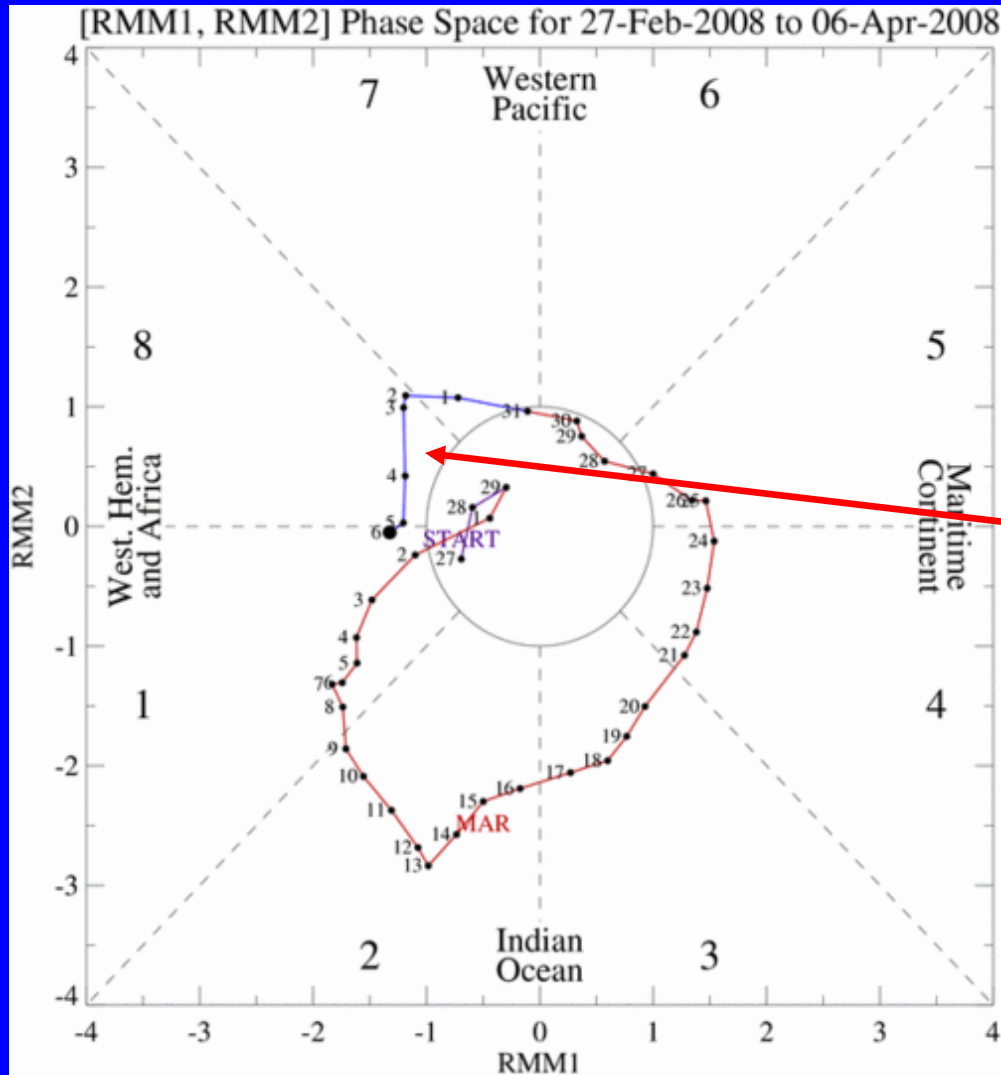
**Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review*, 132, 1917-1932.**

- 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

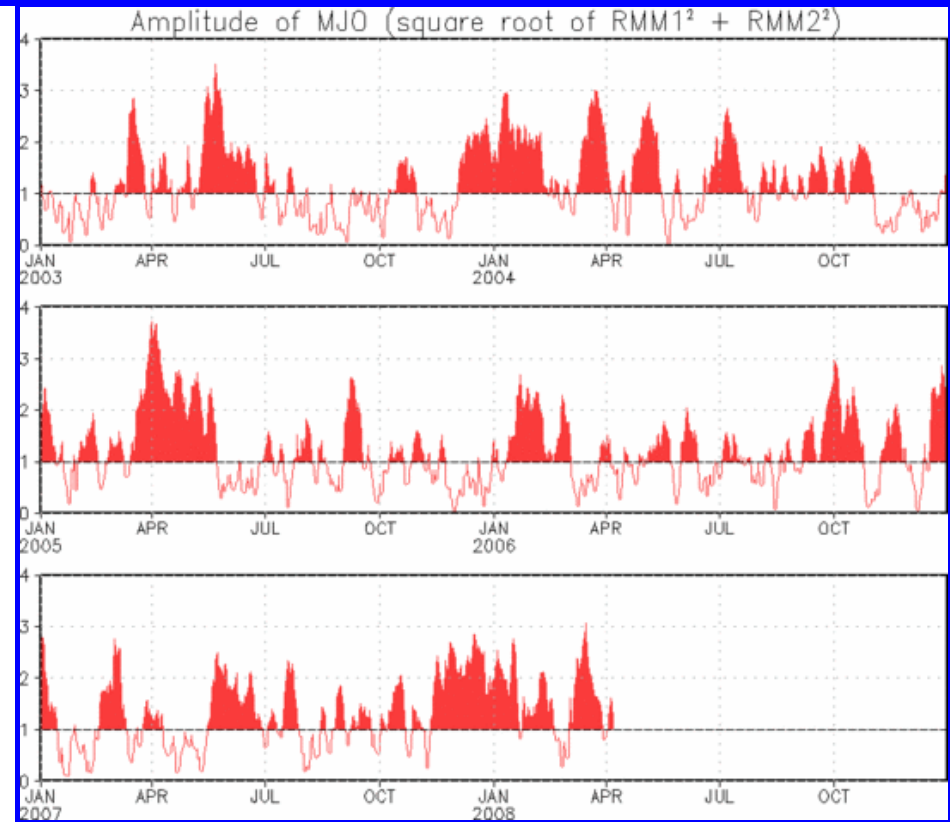
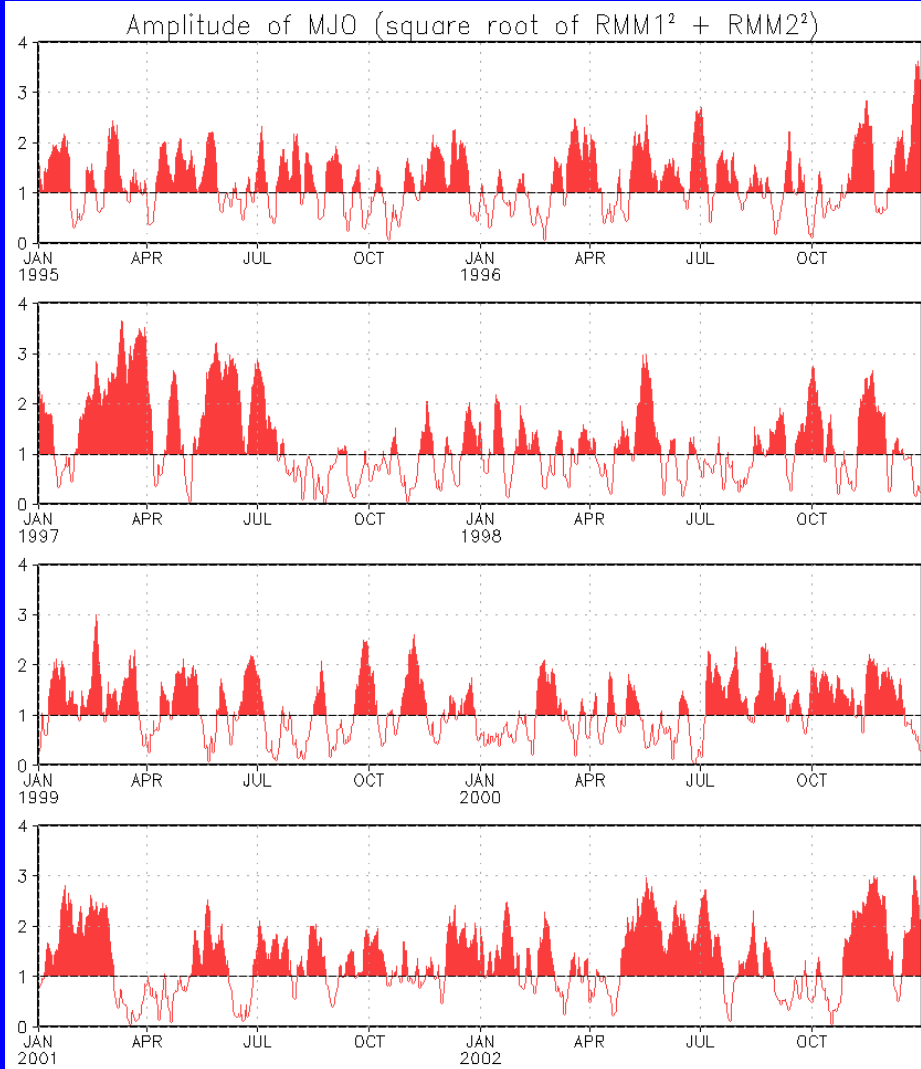
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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



The MJO signal has increased slightly during the past week with a continued eastward propagation.



# 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 MJO Forecasts

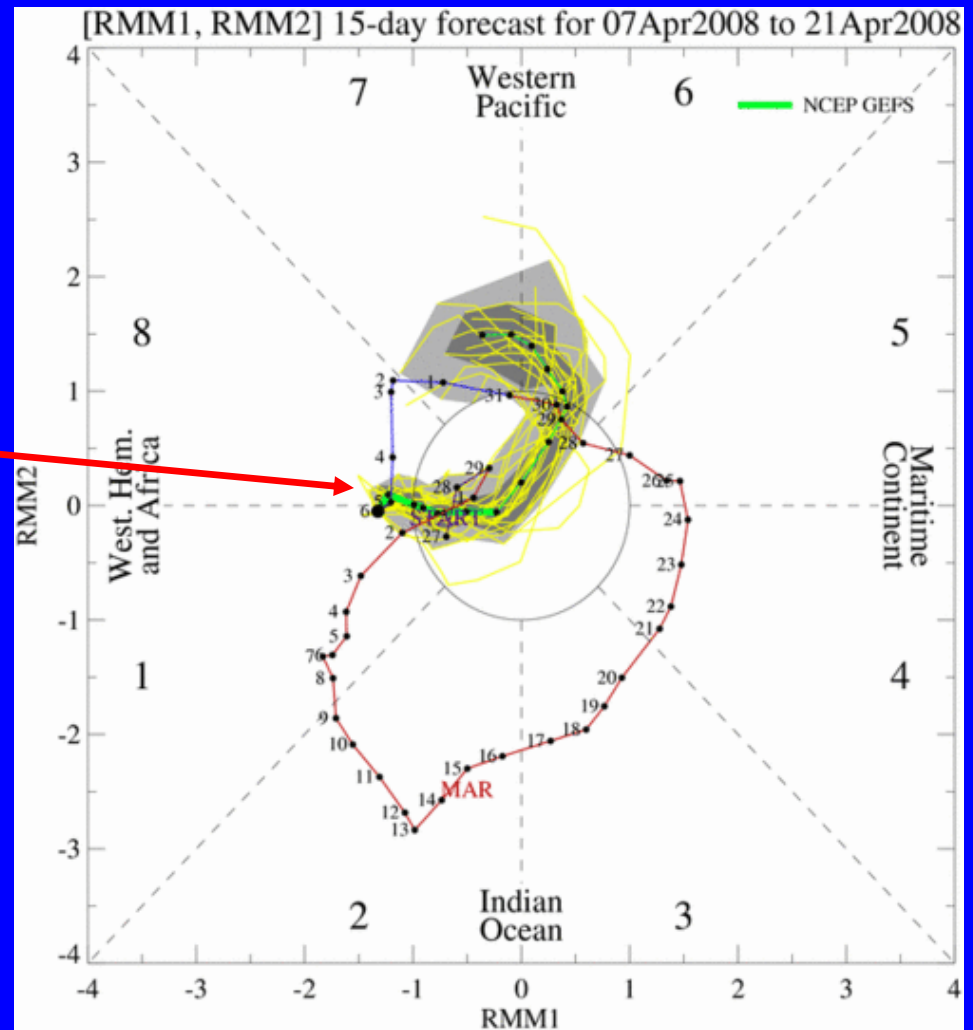
**Yellow Lines** – 20 Individual Members  
**Green Line** – Ensemble Mean

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 predicts a weakening of the MJO signal during the next week with little propagation.

Considerable uncertainty exists for the future evolution of the MJO during the next 1-2 weeks.





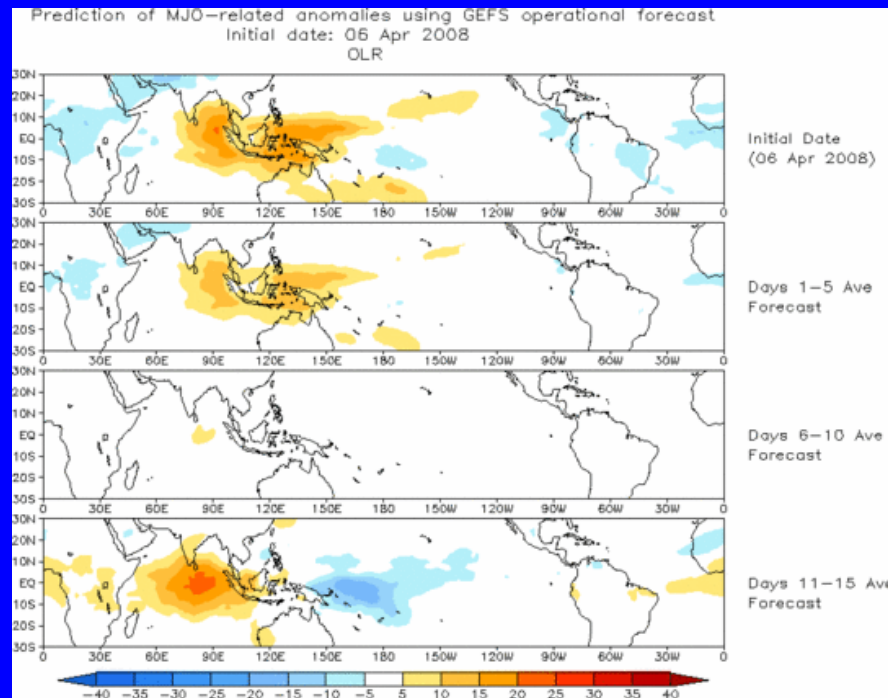


# Ensemble Mean GFS MJO Forecast

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)

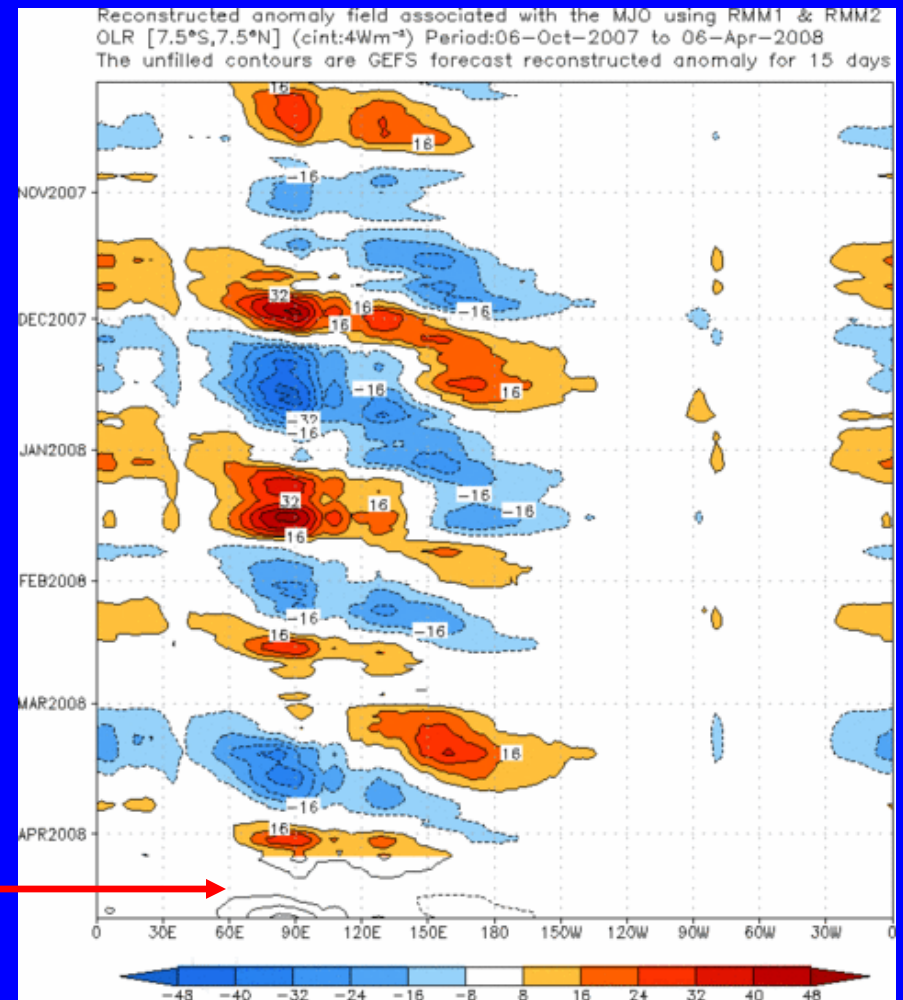
Spatial map of OLR anomalies for the next 15 days

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



MJO-related suppressed convection is forecast over portions of the Indian Ocean and Maritime continent during much of the period.

Little propagation is evident.



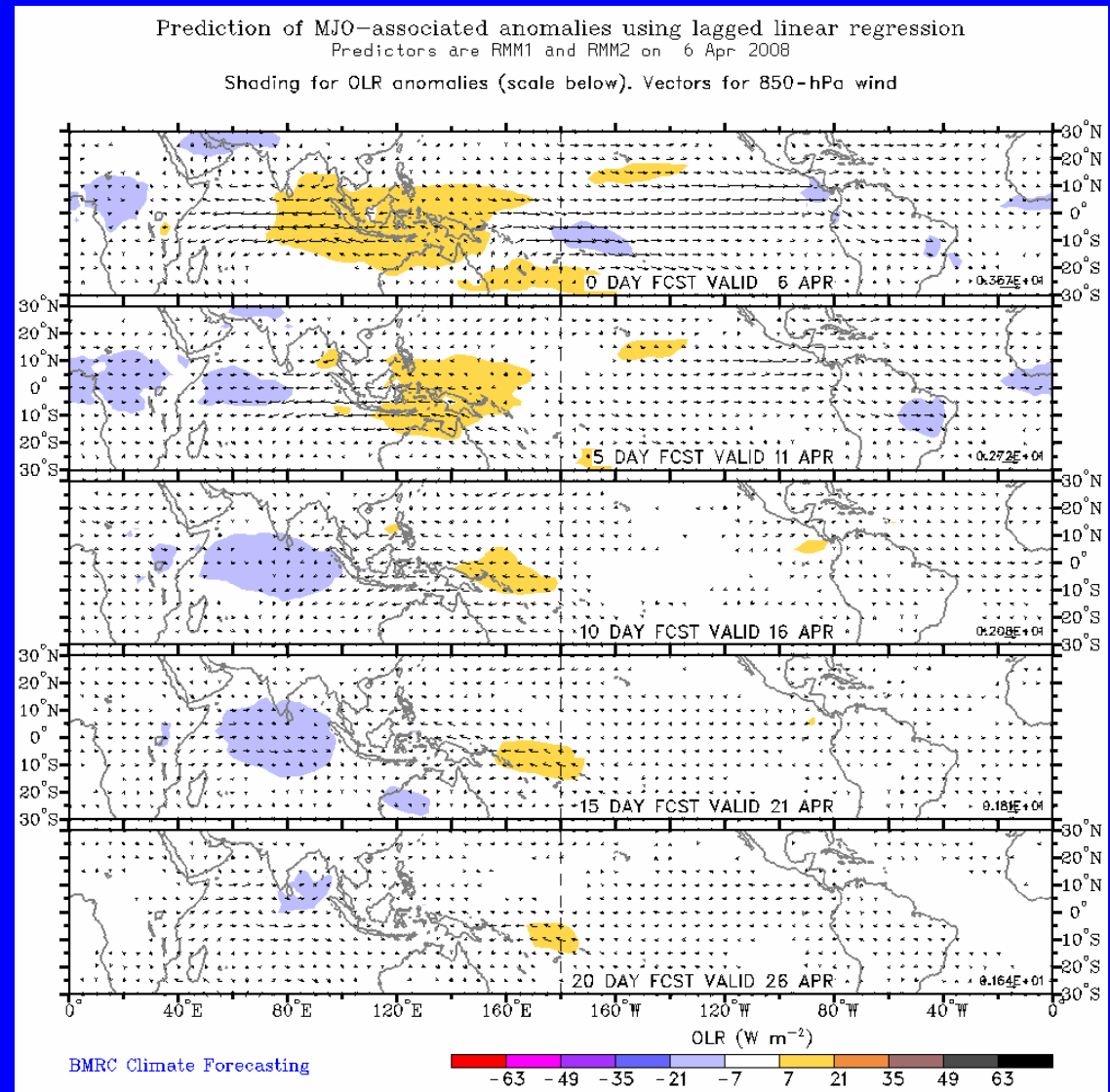


# Statistical MJO Forecast

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)

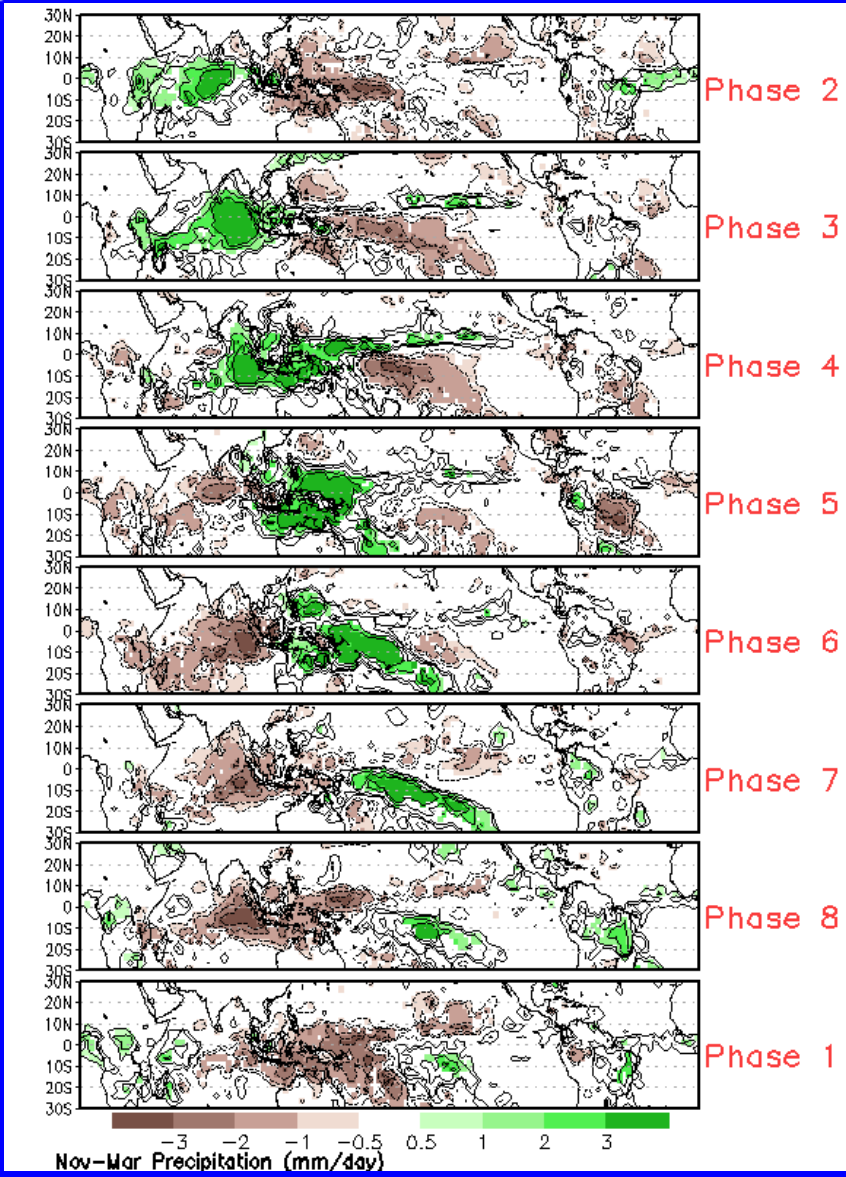
The statistical method forecasts suppressed convection over the Maritime continent during much of week 1 with enhanced convection developing across the Indian Ocean in week 2.





# MJO Composites – Global Tropics

## Precipitation Anomalies



## 850-hPa Wind Anomalies

