



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

**Update prepared by  
Climate Prediction Center / NCEP  
September 8, 2008**



# Outline

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



# Overview

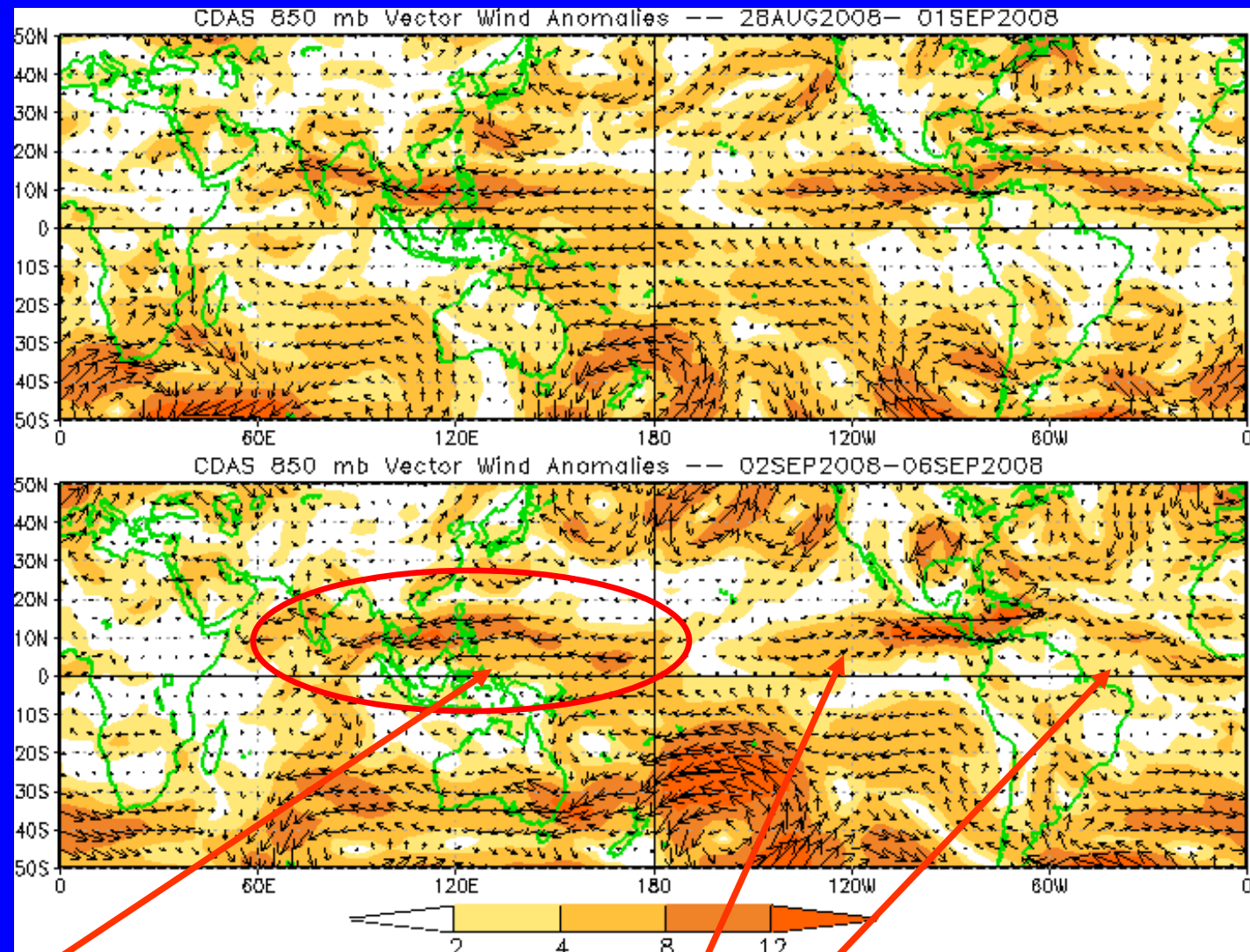
- **The MJO has strengthened during the past week with the enhanced phase centered across western Indonesia.**
- **Based on recent observations and model forecast tools, moderate MJO activity is expected during the next 1-2 weeks.**
- **The MJO will contribute to suppressed (enhanced) rainfall for parts of western Africa and the equatorial Indian Ocean (Southeast Asia and the western Pacific) during Week 1. Dry conditions may develop across Central America and southern Mexico during Week 2.**
- **The strengthening MJO will likely result in a substantial decrease in the Atlantic basin tropical cyclone activity.**

**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 ( $\text{m s}^{-1}$ )

Note that shading denotes the magnitude of anomalous wind vectors



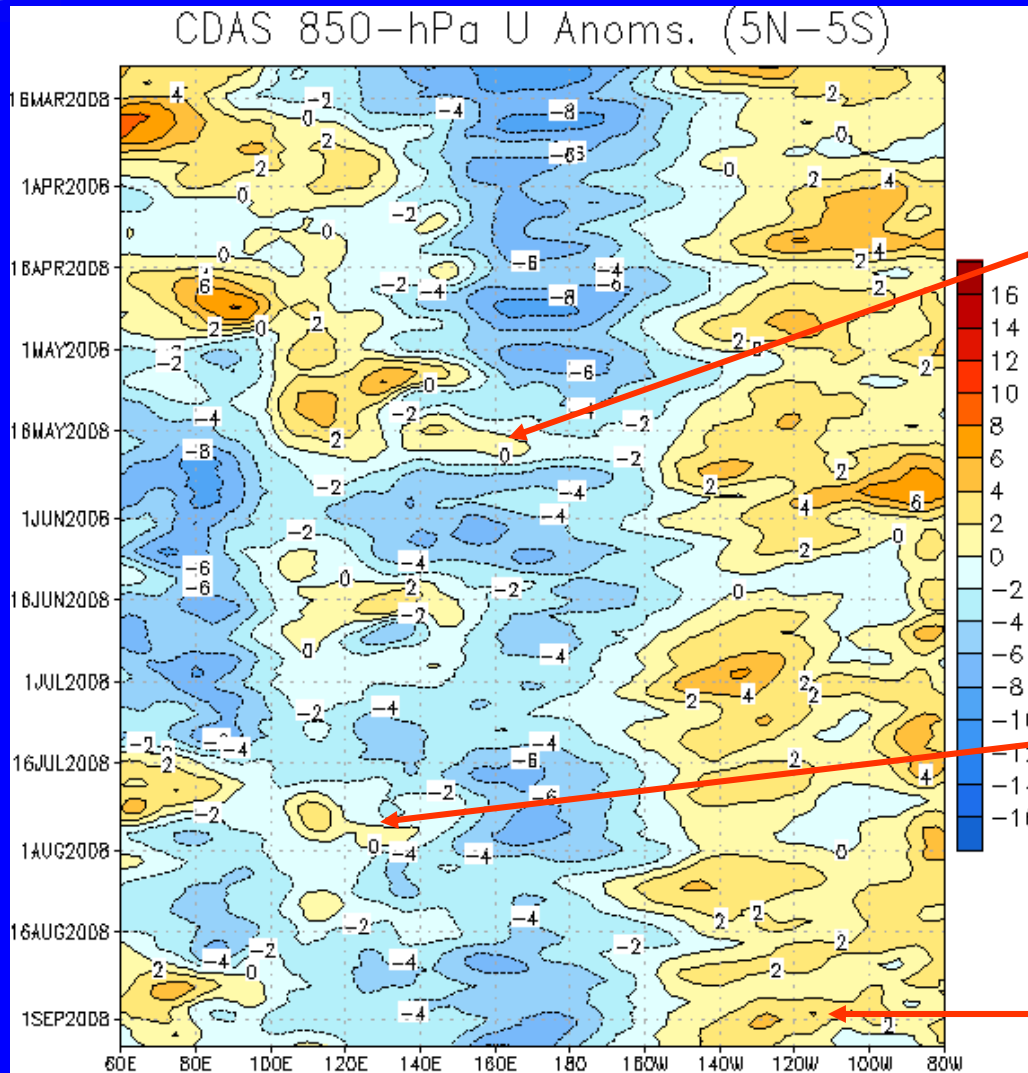
Low-level easterly anomalies continue across the western Pacific and extend to India.

Westerly anomalies remained strong across the eastern Pacific, the tropical Atlantic and western Africa.



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

Time



Longitude

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

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

During mid-May, easterlies weakened across the western Pacific associated with moderate MJO activity.

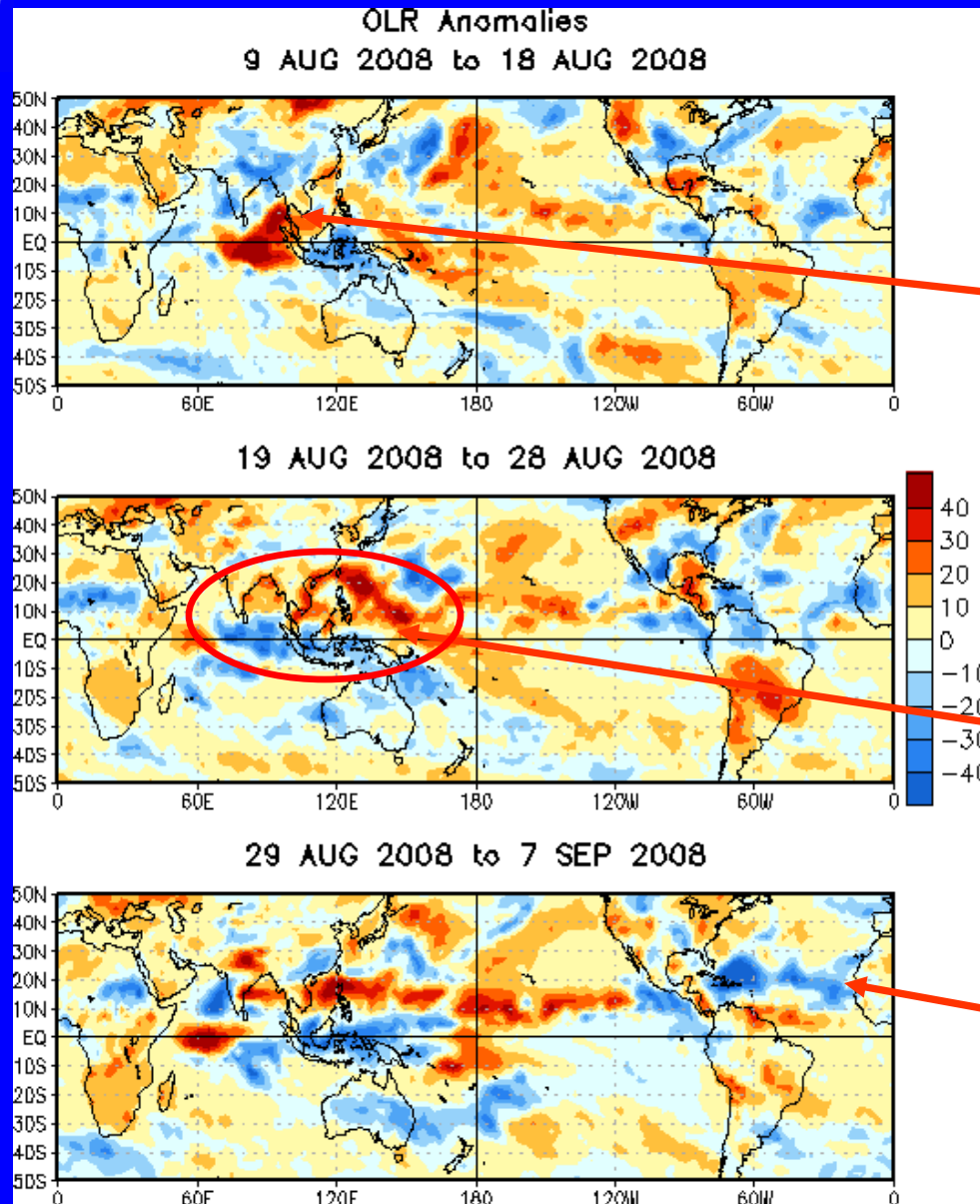
Easterly anomalies have prevailed across much of the eastern hemisphere since late May.

Westerly anomalies were evident across parts of the Indian Ocean and Indonesia during the second half of July associated with weak MJO activity.

Most recently, easterly anomalies near the Date Line and westerly anomalies in the east-central Pacific have increased.



# OLR Anomalies: Last 30 days



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

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

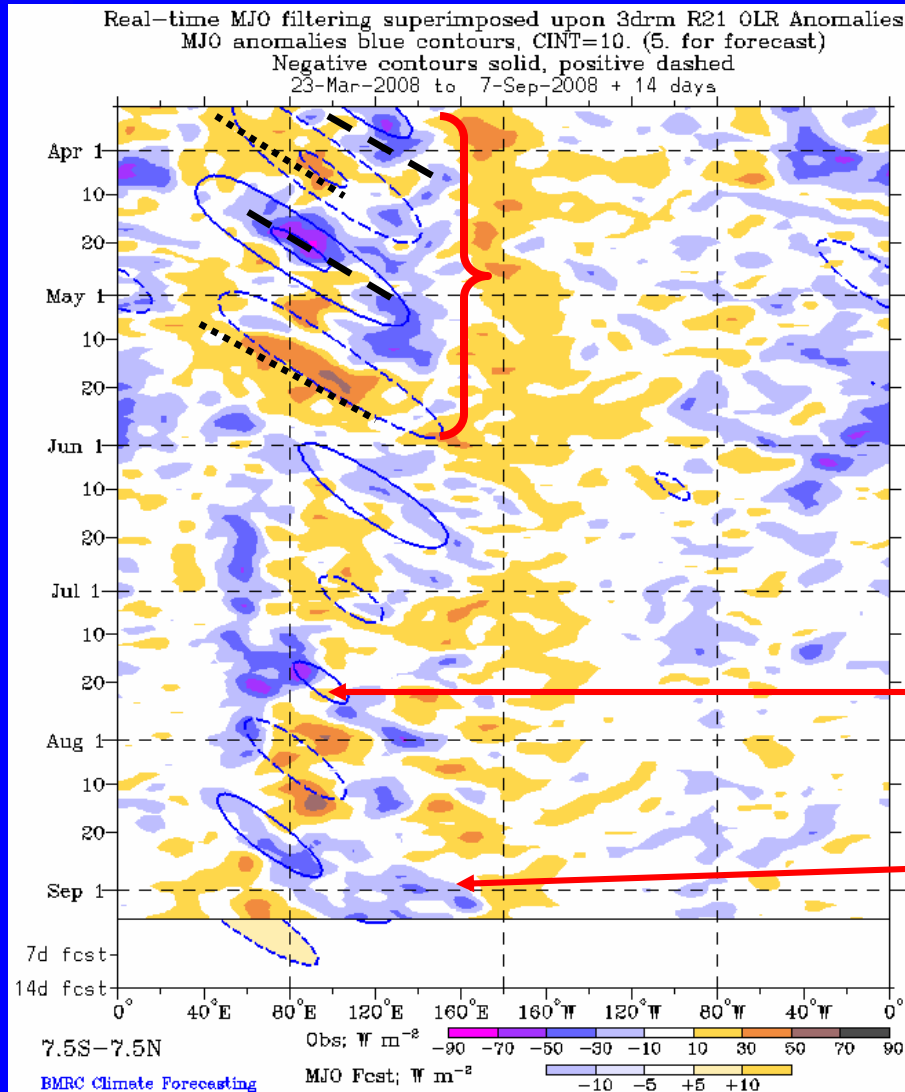
Northward propagation of enhanced convection from the Indian Ocean to parts of southern Asia and the development of drier-than-average conditions in the eastern Indian Ocean were evident during early-mid-August.

In late August, dry conditions propagated north while enhanced convection developed across the equatorial Indian Ocean and parts of Indonesia.

Wet conditions were evident across the Atlantic Ocean and the Caribbean due to a very active period of tropical cyclone activity.



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



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)

MJO activity was evident from mid-March into early June at varying levels of intensity. The strongest MJO activity occurred as strong suppressed convection organized across the Indian Ocean and shifted eastward during mid-to-late May.

Persistent enhanced convection was evident across the western Indian Ocean from mid-June to early August.

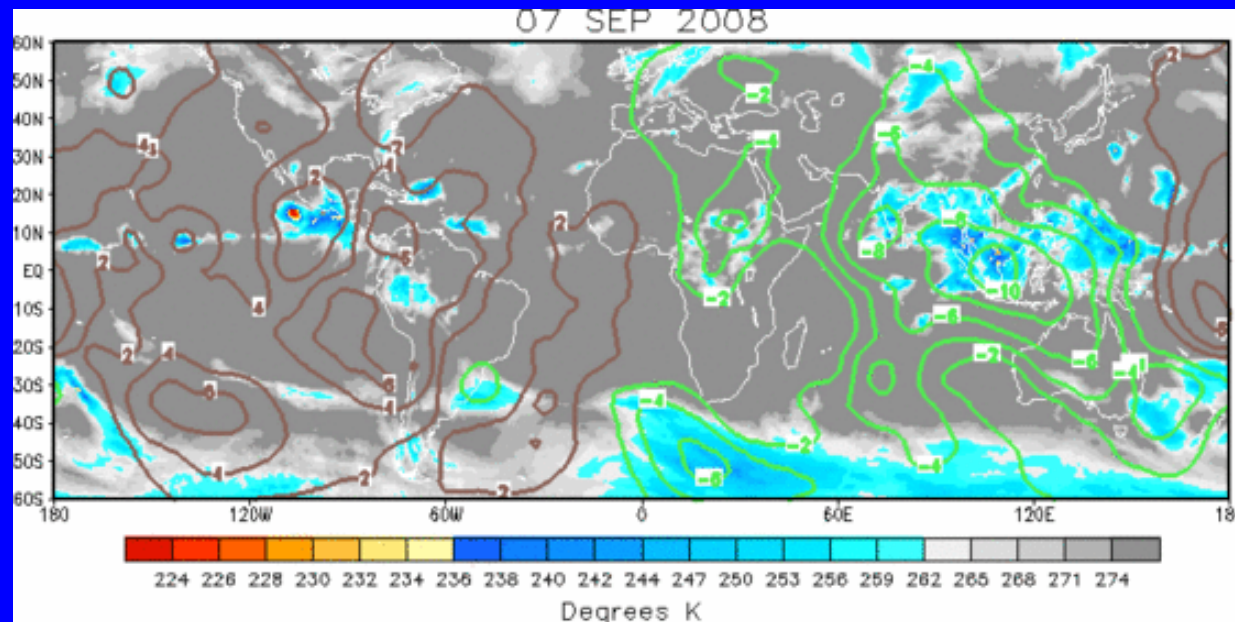
Enhanced convection developed across the Indian Ocean during late August and has shown some eastward propagation.



# 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



Upper-level divergence continues across Africa and has increased across the Indian Ocean and Indonesia. Upper-level convergence continued across much of the Pacific Ocean and has developed over the Atlantic. The pattern has shifted eastward in recent days.



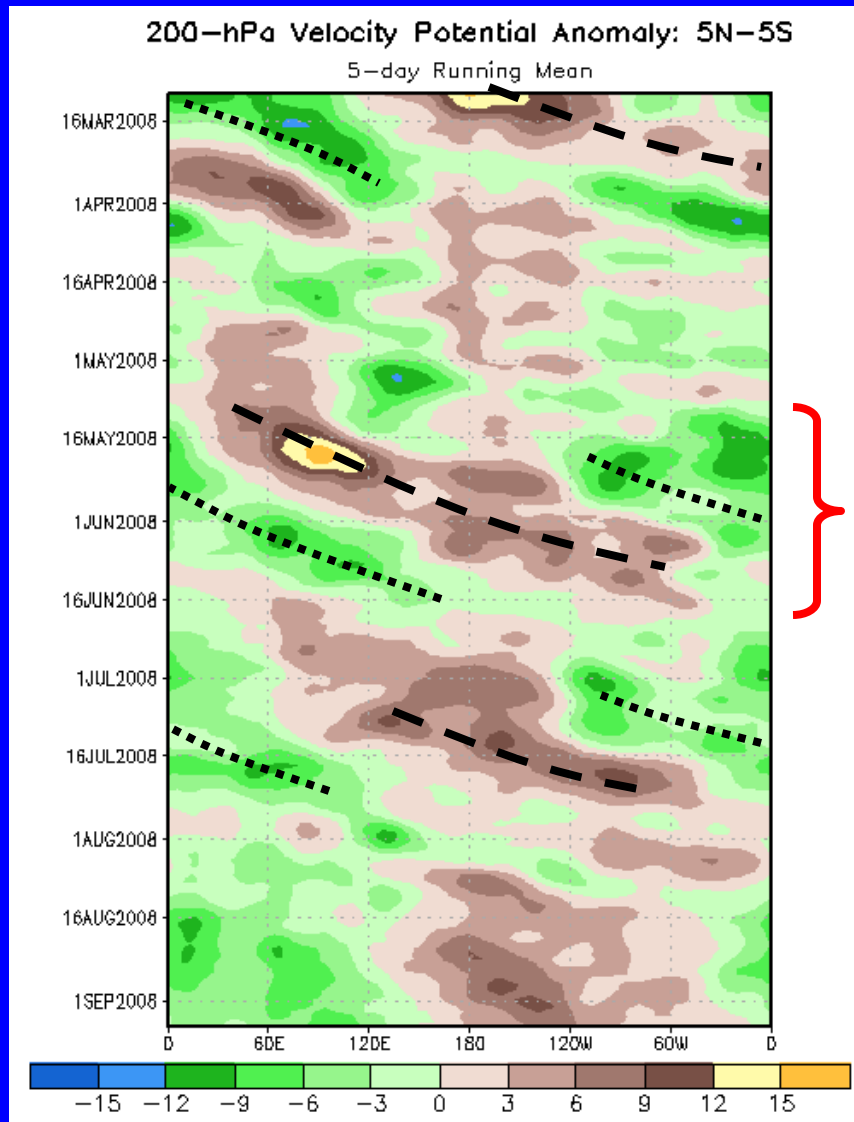


# 200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time



Longitude

Weak-to-moderate MJO activity was evident during March.

The MJO was largely incoherent during the month of April.

A moderate-to-strong MJO was observed from mid-May through mid-June as eastward propagation was more coherent and longer-lived.

After weakening in late June, the MJO strengthened during mid-July.

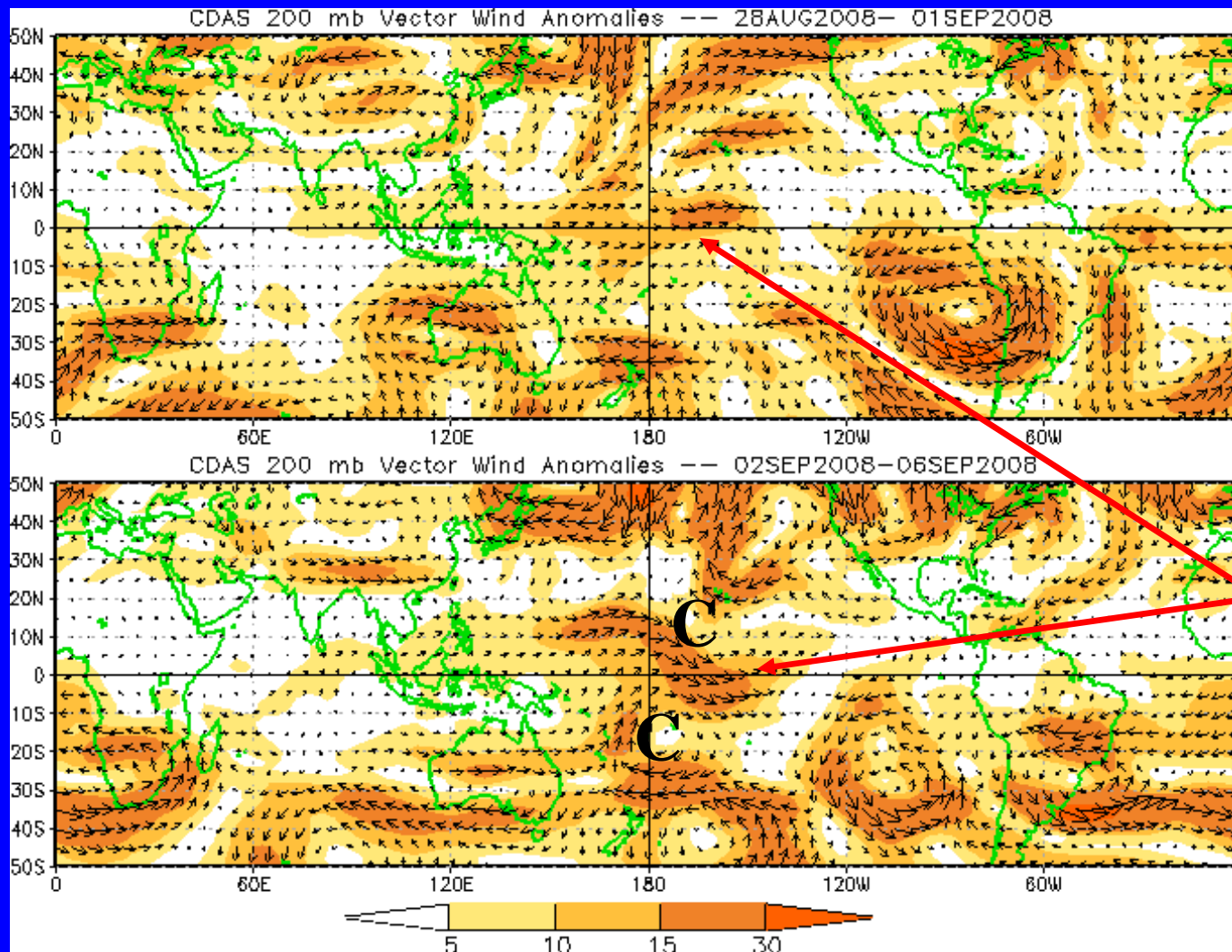
Since early-mid August, the MJO has been weak as a more stationary pattern in upper-level divergence and convergence was evident.

Some eastward propagation has been observed, however, during the past week.



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

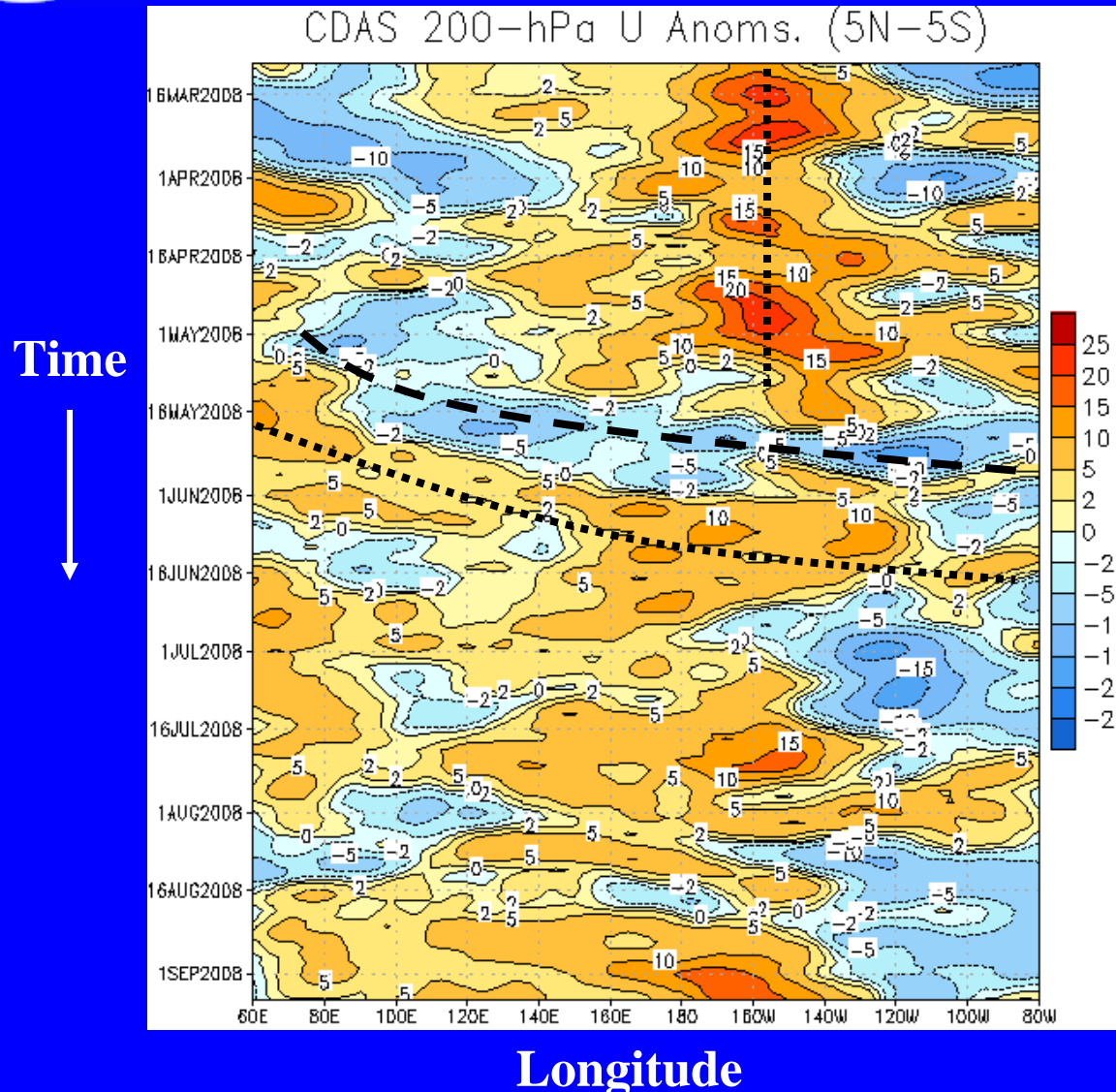
Note that shading denotes the magnitude of anomalous wind vectors



Upper-level westerly anomalies have markedly increased across the equatorial Pacific Ocean during the last ten days with cyclones (C) north and south of the equator.



# 200-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

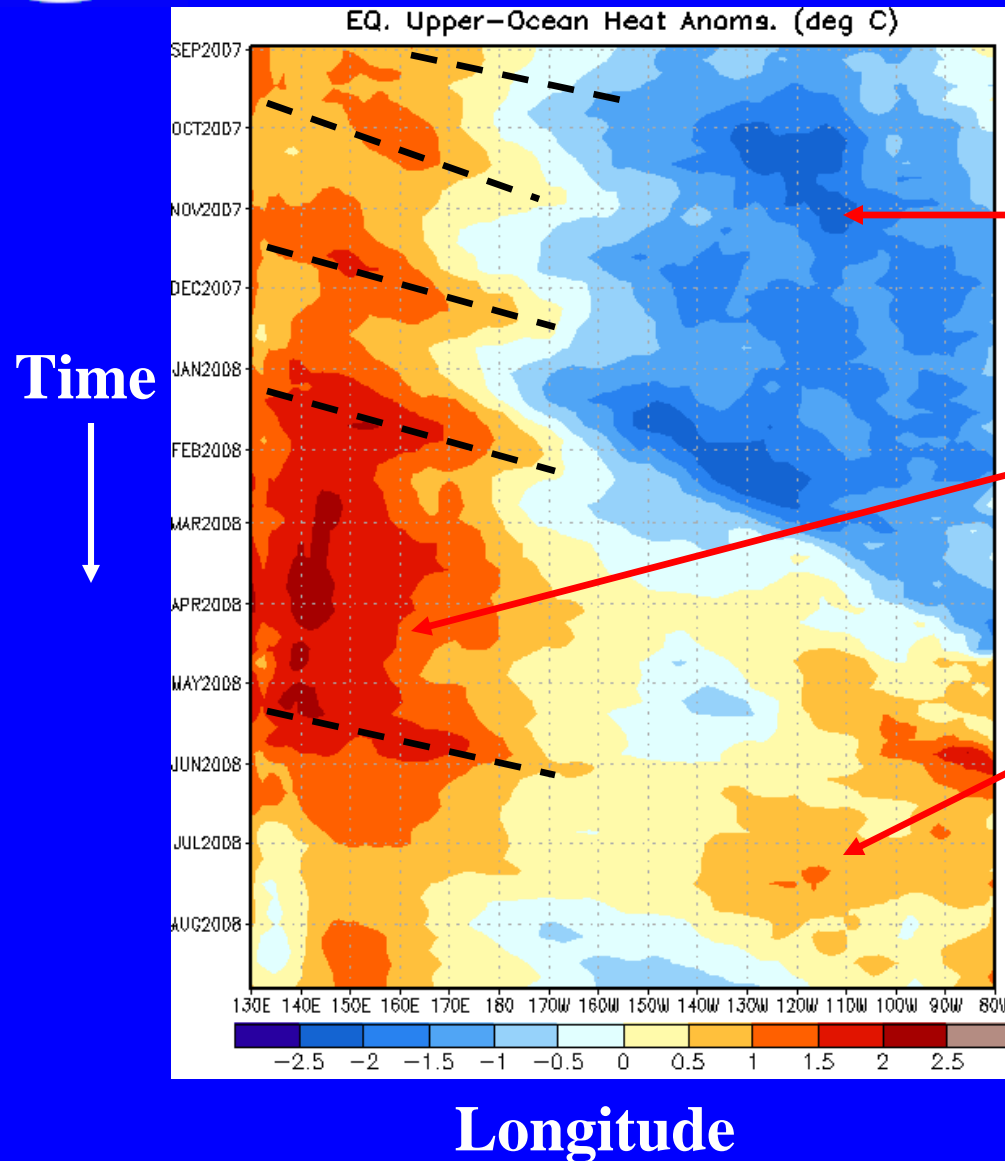
The MJO was weak or incoherent for much of the period from mid-February through April and upper-level winds indicate generally strong and persistent westerly anomalies near and east of the Date Line.

During May and early June, eastward propagation was evident in the upper-level wind field and was associated with the moderate-to-strong MJO activity during this time.

The pattern of persistent easterly (westerly) anomalies continues in the eastern (western) Pacific.



# Weekly Heat Content Evolution in the Equatorial Pacific



During September and October, negative heat content anomalies increased markedly across the eastern Pacific Ocean and continued until February 2008.

Beginning in February, increasingly positive anomalies developed across parts of the western and central Pacific but have since decreased.

During June and July 2008, positive heat content anomalies encompassed much of the Pacific basin in part associated with a Kelvin wave initiated during May 2008.

During early to mid-August 2008, negative anomalies started to develop near and east of the Date Line in response to enhanced easterly surface winds.



# 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).

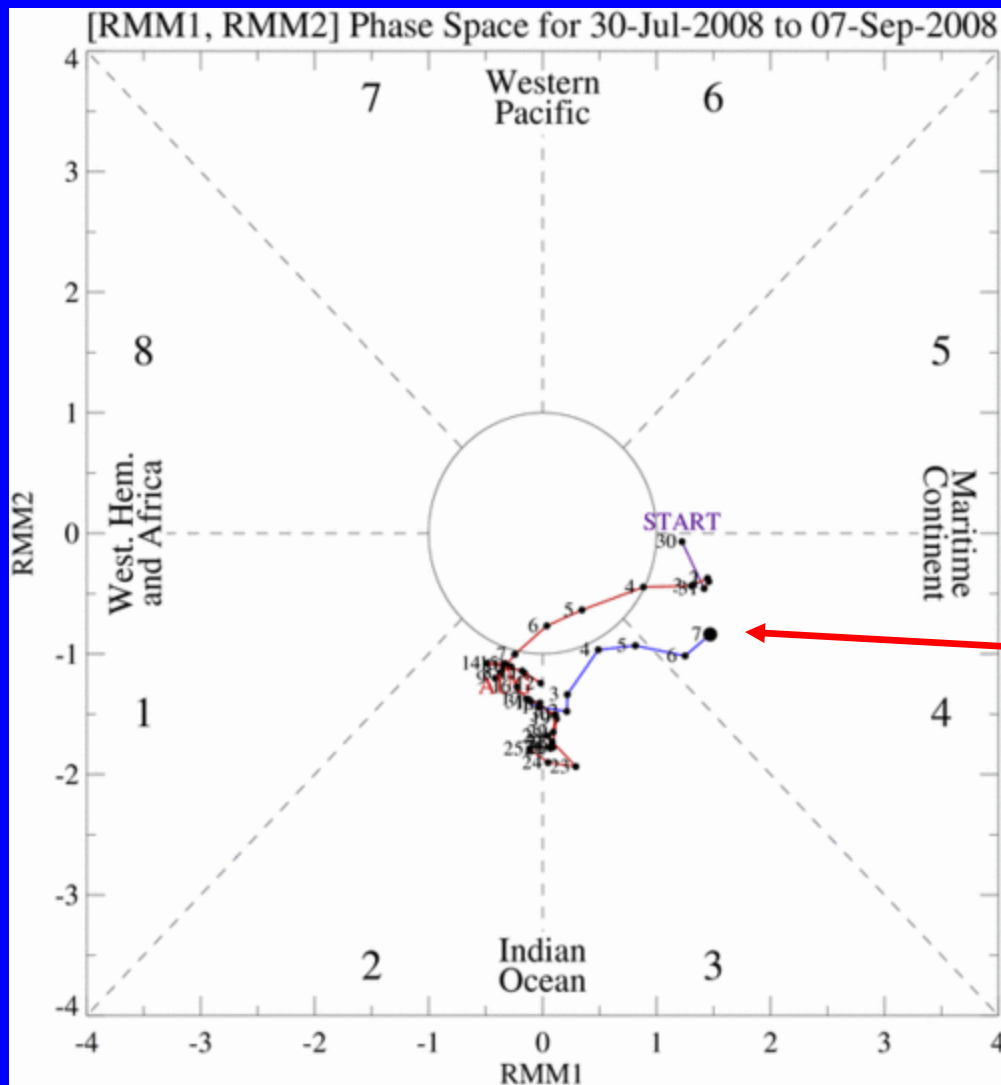
**Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review*, 132, 1917-1932.**

- 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

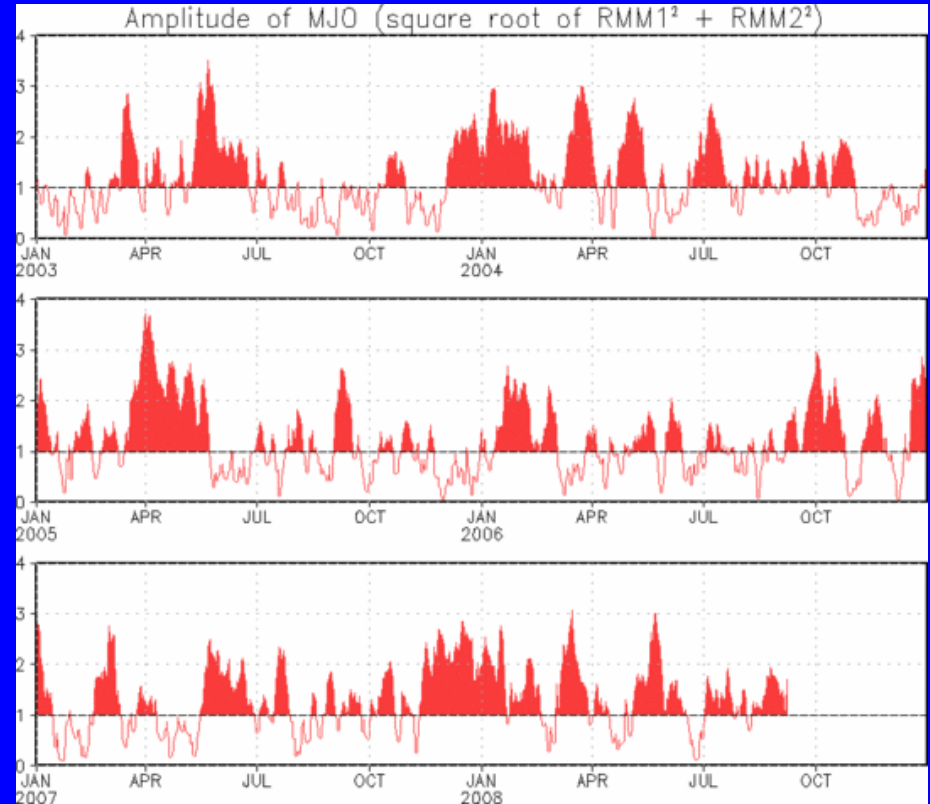
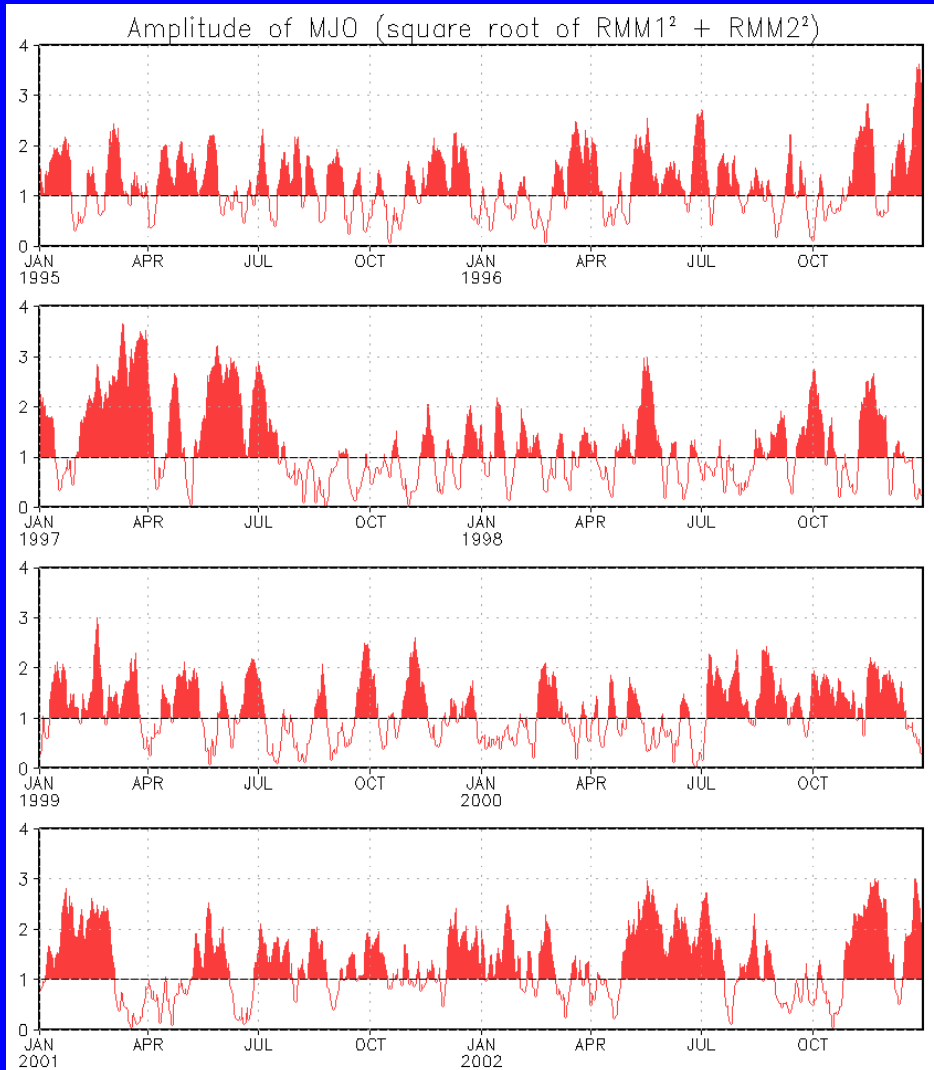
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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



The MJO index has shown some eastward propagation in recent days with an increase in amplitude.



# 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**



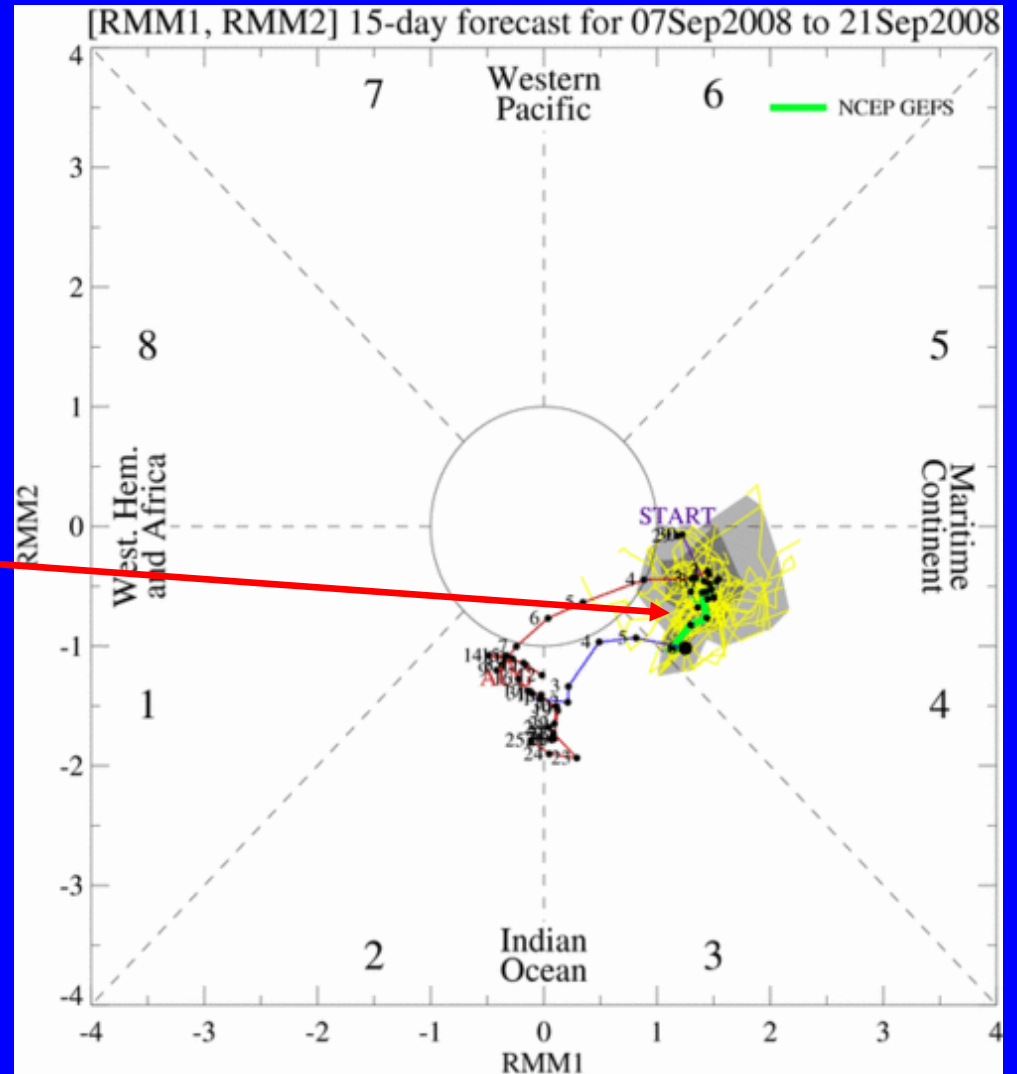
# Ensemble GFS (GEFS) MJO Forecast

**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 predicts some eastward propagation of the MJO signal early but uncertainty increases later during the period.



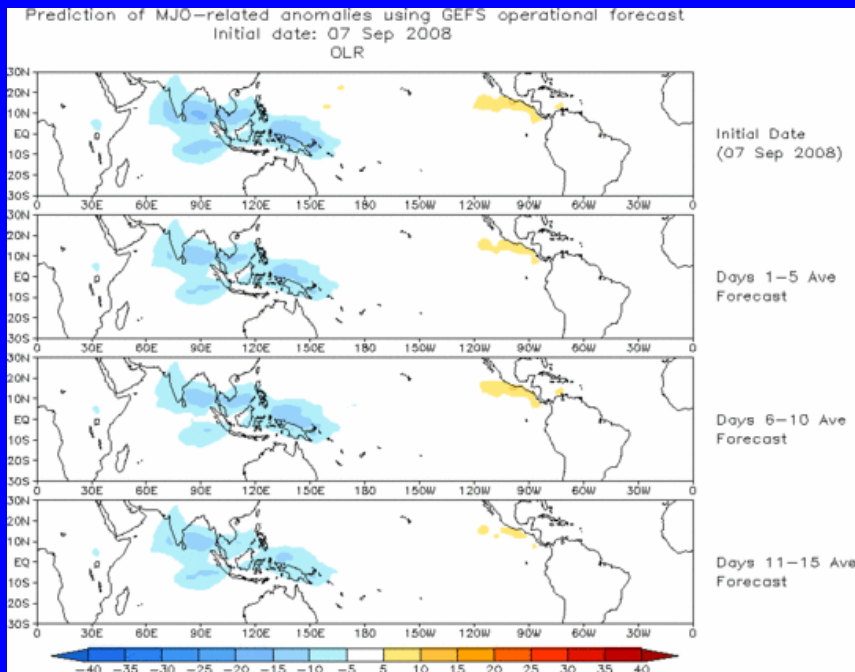




# Ensemble Mean GFS MJO Forecast

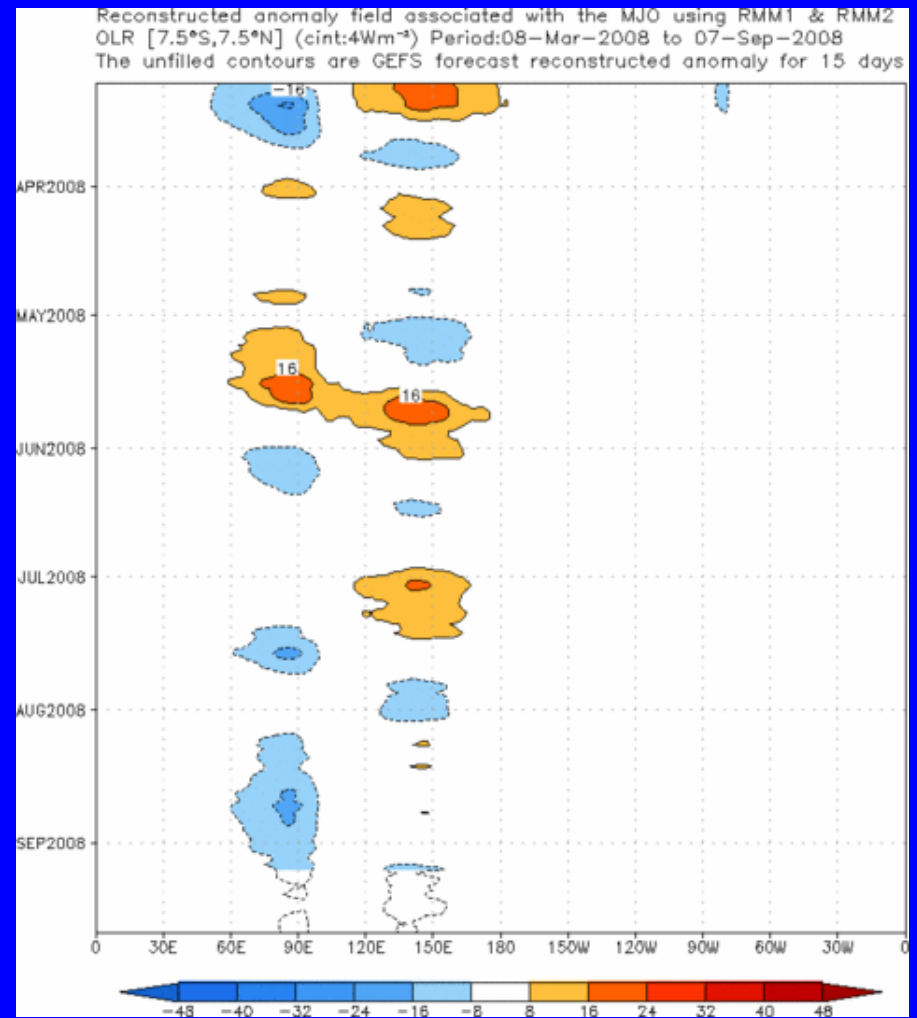
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The forecast indicates MJO-associated enhanced convection persisting across the Indian Ocean, southern Asia and the western Pacific throughout 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)

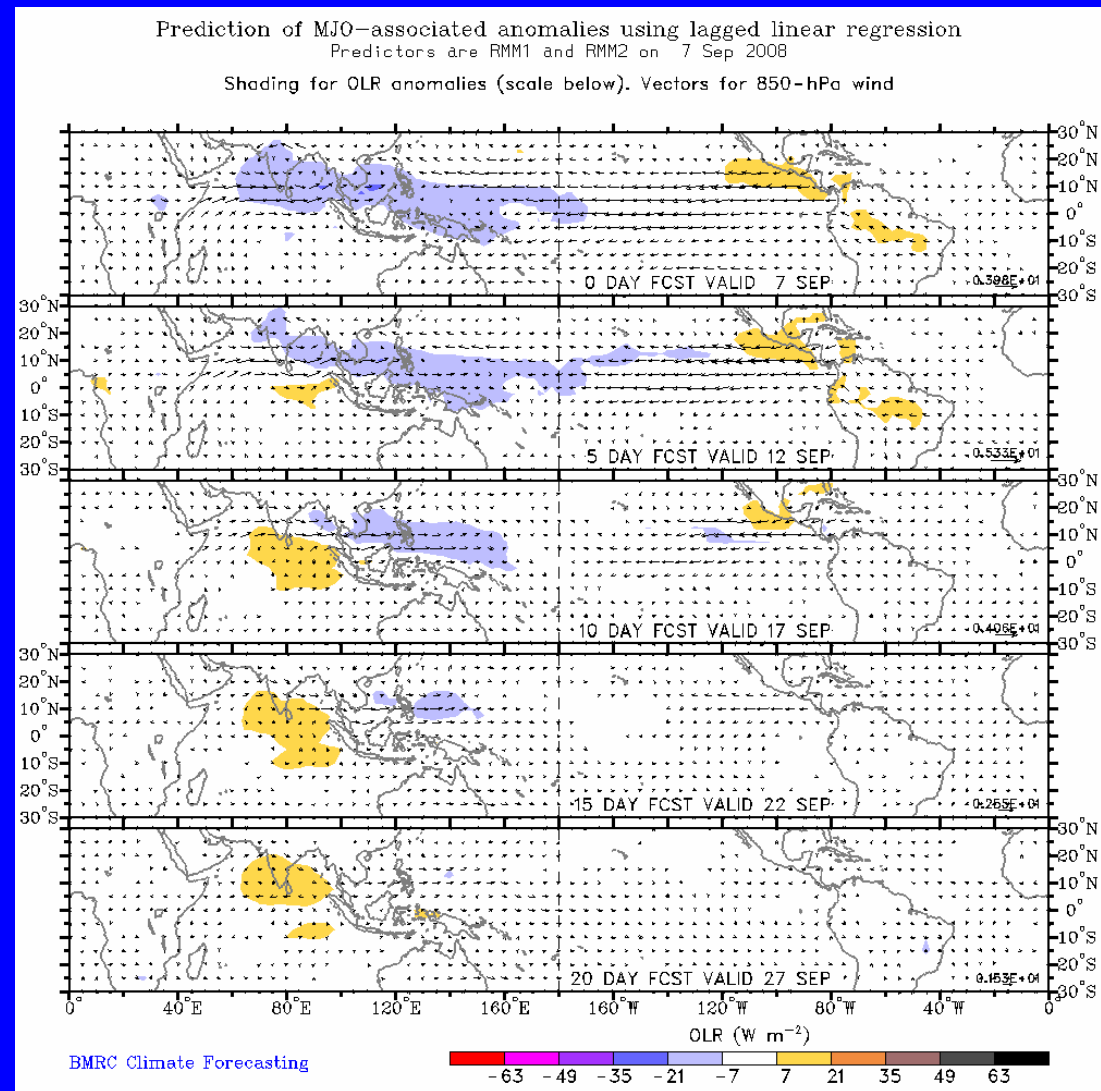
Spatial map of OLR anomalies and 850-hPa wind vectors for the next 20 days

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

Moderate MJO activity is forecast during the next two weeks.

Enhanced convection is expected to slowly shift northeastwards from the Indian Ocean to parts of the far western Pacific.

Suppressed convection is expected to develop across the equatorial Indian Ocean.





# MJO Composites – Global Tropics

## Precipitation Anomalies (May-Sep)

## 850-hPa Wind Anomalies (May-Sep)

