



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

**Update prepared by  
Climate Prediction Center / NCEP  
February 9, 2009**



# Outline

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



# Overview

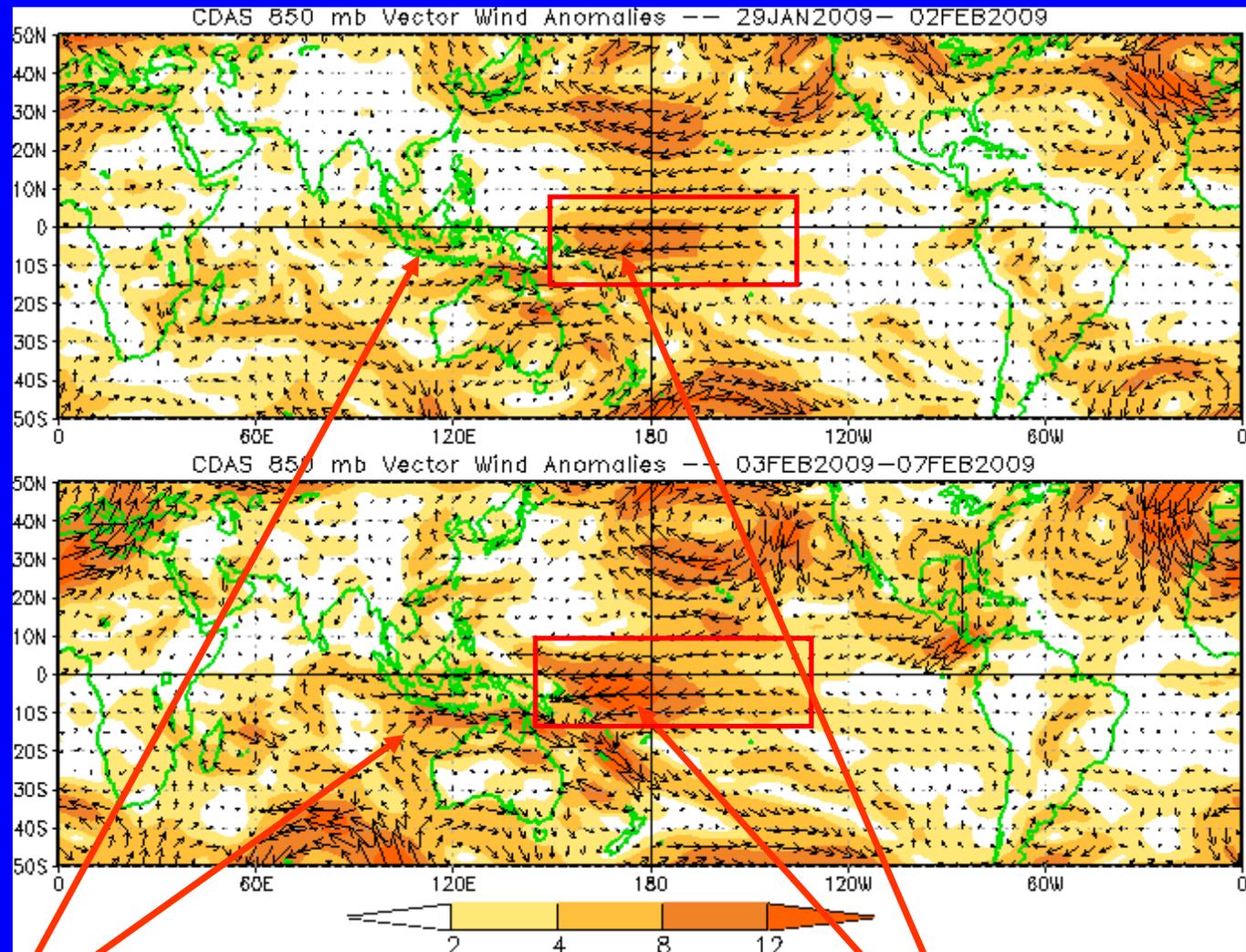
- The MJO has weakened.
- The MJO is expected to weaken further during the next 1-2 weeks with enhanced convection mainly attributed to La Nina and focused across the Maritime Continent.
- Above-average rainfall is expected for the Maritime Continent, northern Australia and the SPCZ during the next 1-2 weeks. The threat for tropical cyclone activity continues for waters northwest of Australia.
- As tropical convection continues across Indonesia the circulation and impacts across the U.S on average are expected to be consistent with La Nina.

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



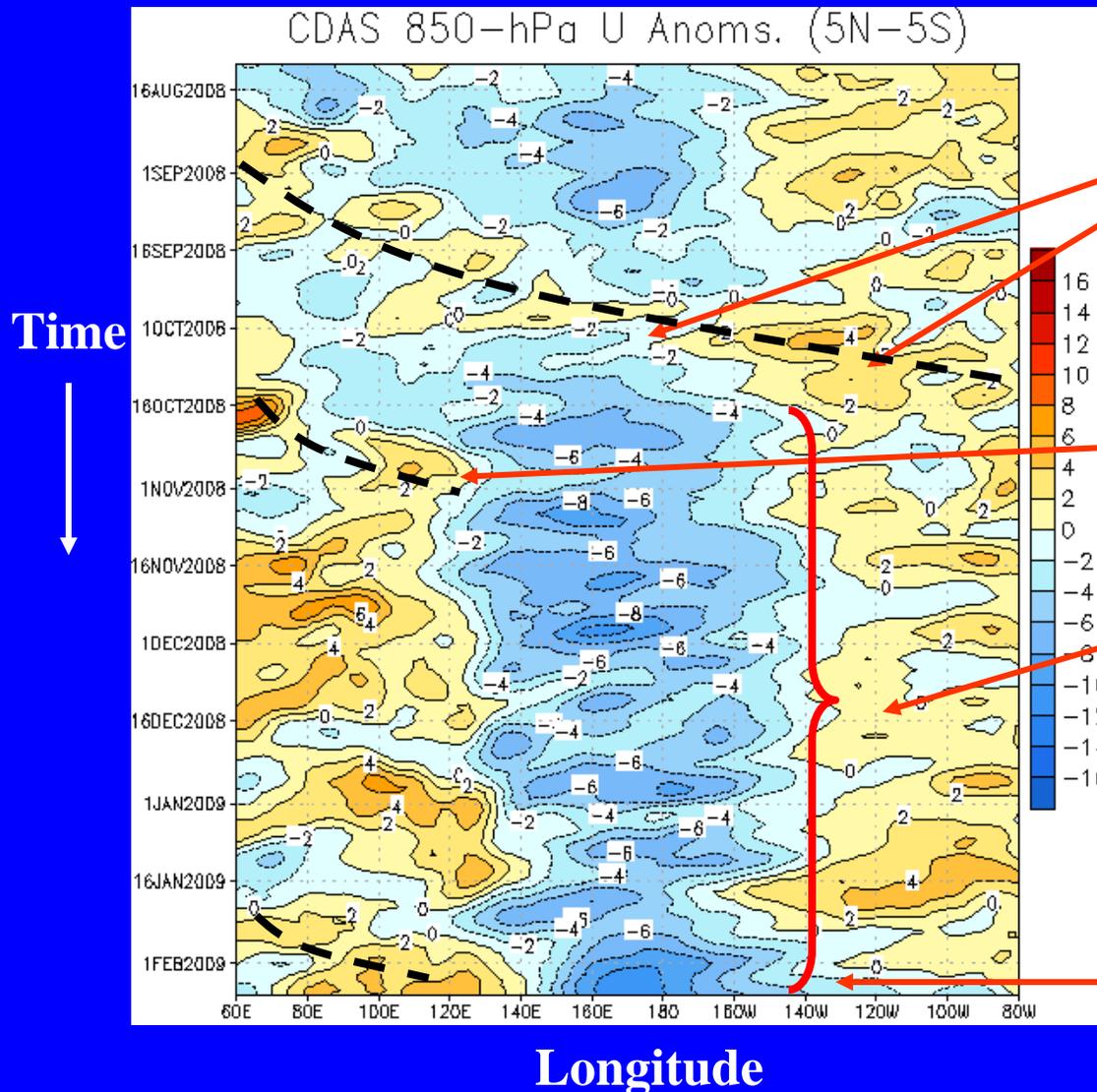
Westerly anomalies have shifted eastward mainly south of the equator over the Maritime Continent, northern Australia and the South Pacific Convergence Zone.

During the last ten days, easterly anomalies have strengthened across the equatorial western and central Pacific.



# 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



Beginning in September, anomalous westerlies associated with the MJO shifted from the Indian Ocean across the Pacific.

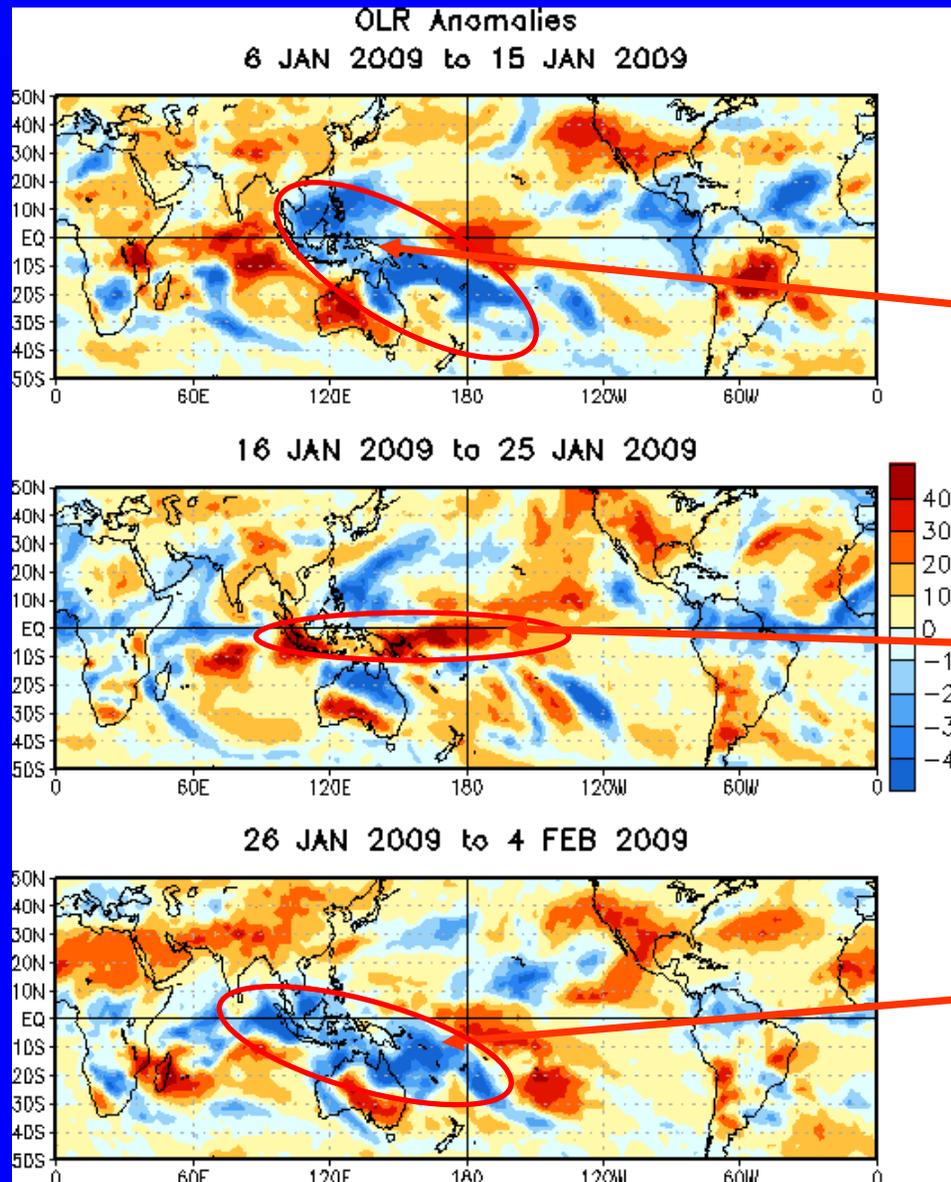
These westerly anomalies reentered the Maritime Continent during late October but eastward progress stalled.

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

After a break in mid-January - associated with the MJO - westerly anomalies have once again developed across the Indian Ocean and Maritime Continent. Easterly anomalies have also increased near 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)

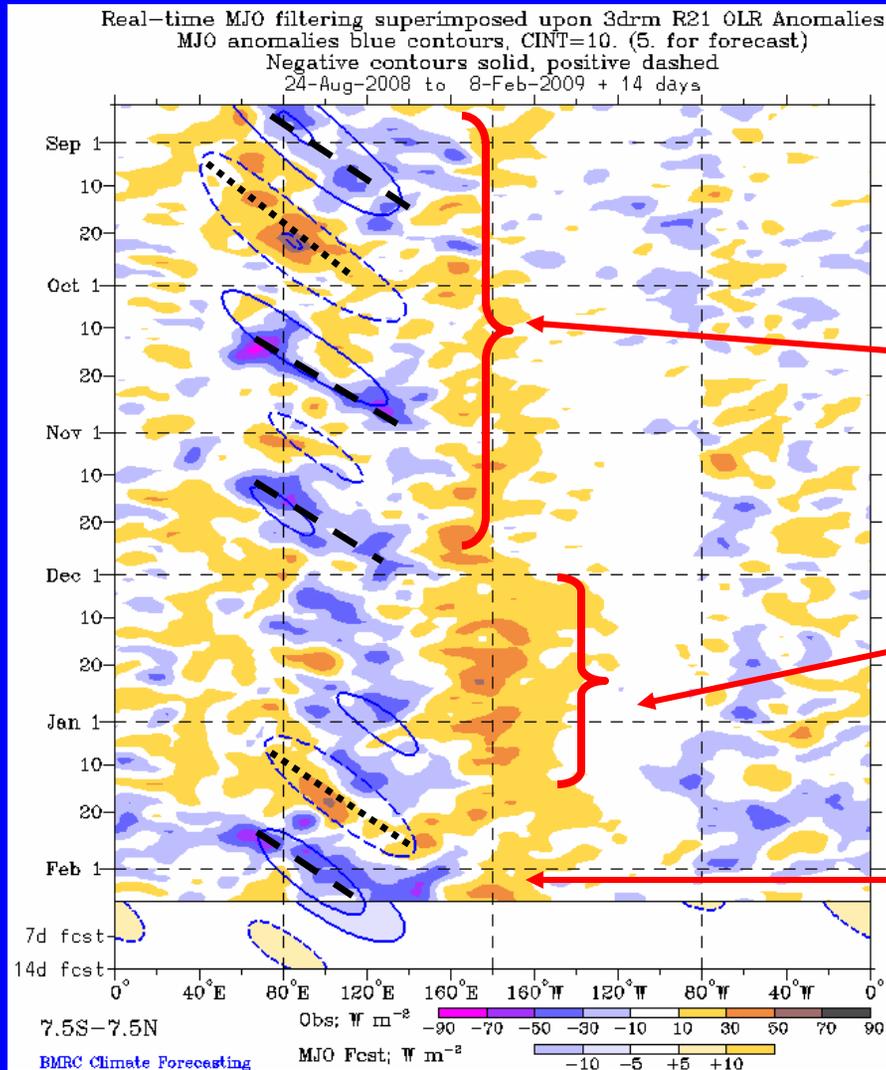
During early to mid January, enhanced convection continued across the western Pacific, northern Australia and the South Pacific Convergence Zone (SPCZ). At the same time, dry conditions intensified across the Indian Ocean and northeast Brazil.

In mid-to-late January, convection decreased across the equatorial Maritime Continent, while enhanced convection split north and south of the equator.

Enhanced convection quickly re-developed across the Indian Ocean and Maritime Continent during late January to early February.



# 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)

Moderate MJO activity was most evident from late August to mid-November as enhanced (suppressed) convection developed across the Indian Ocean and shifted eastward during the period.

In December and January, anomalous convection was generally stationary and consistent with La Nina conditions.

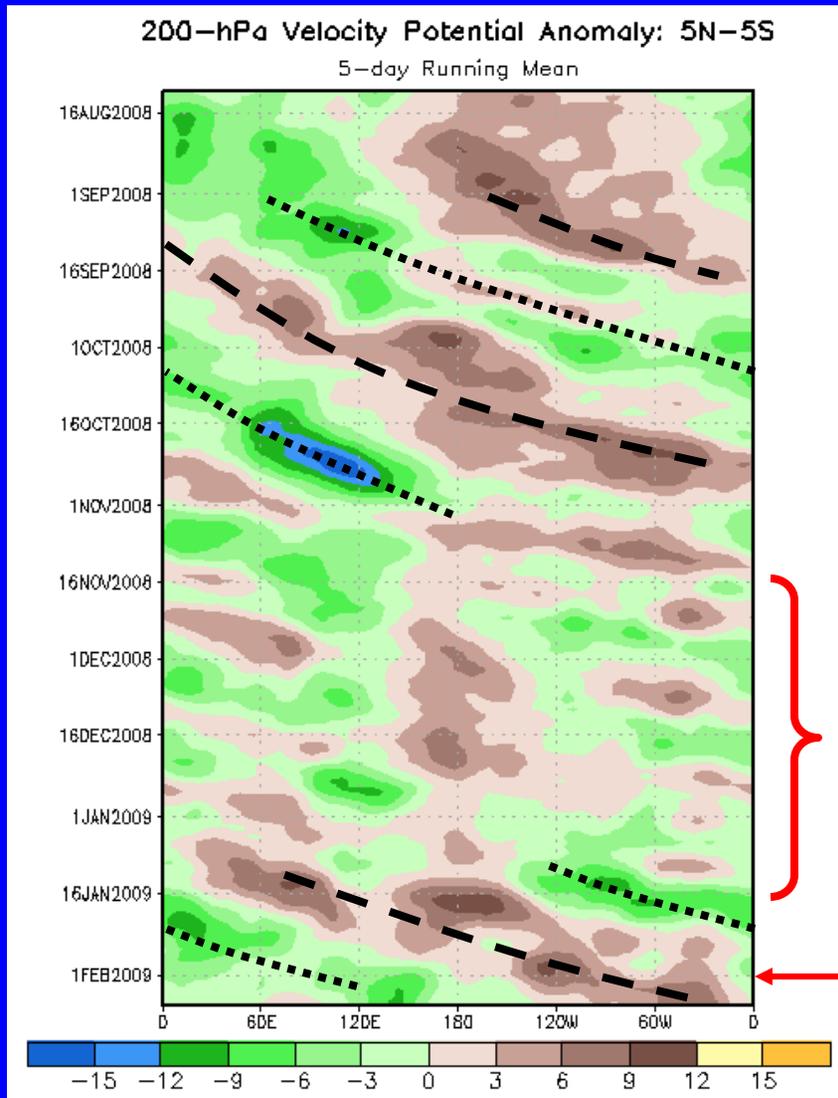
From mid-January to early February, eastward movement of suppressed (enhanced) convection is observed from the Indian Ocean to portions of Indonesia and the western Pacific.



# 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



The MJO strengthened in early September and eastward propagation was observed from September through October.

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

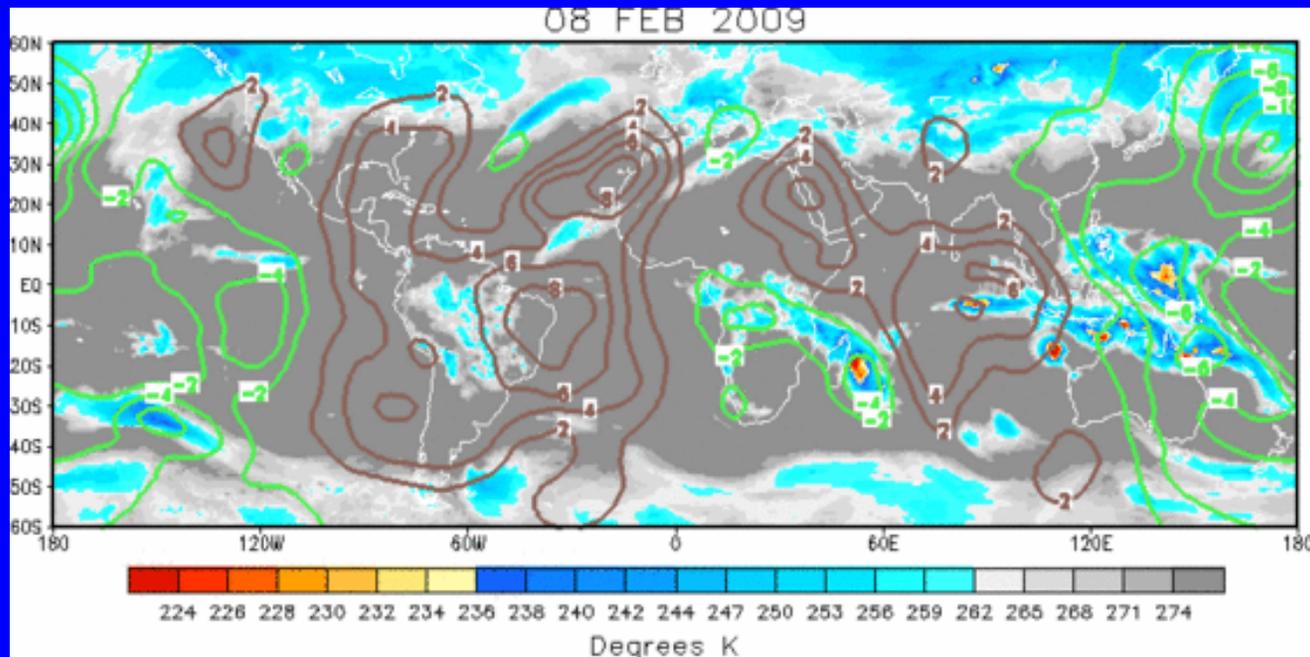
Velocity potential anomalies have increased as the MJO strengthened and show eastward movement during the past month.



# 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



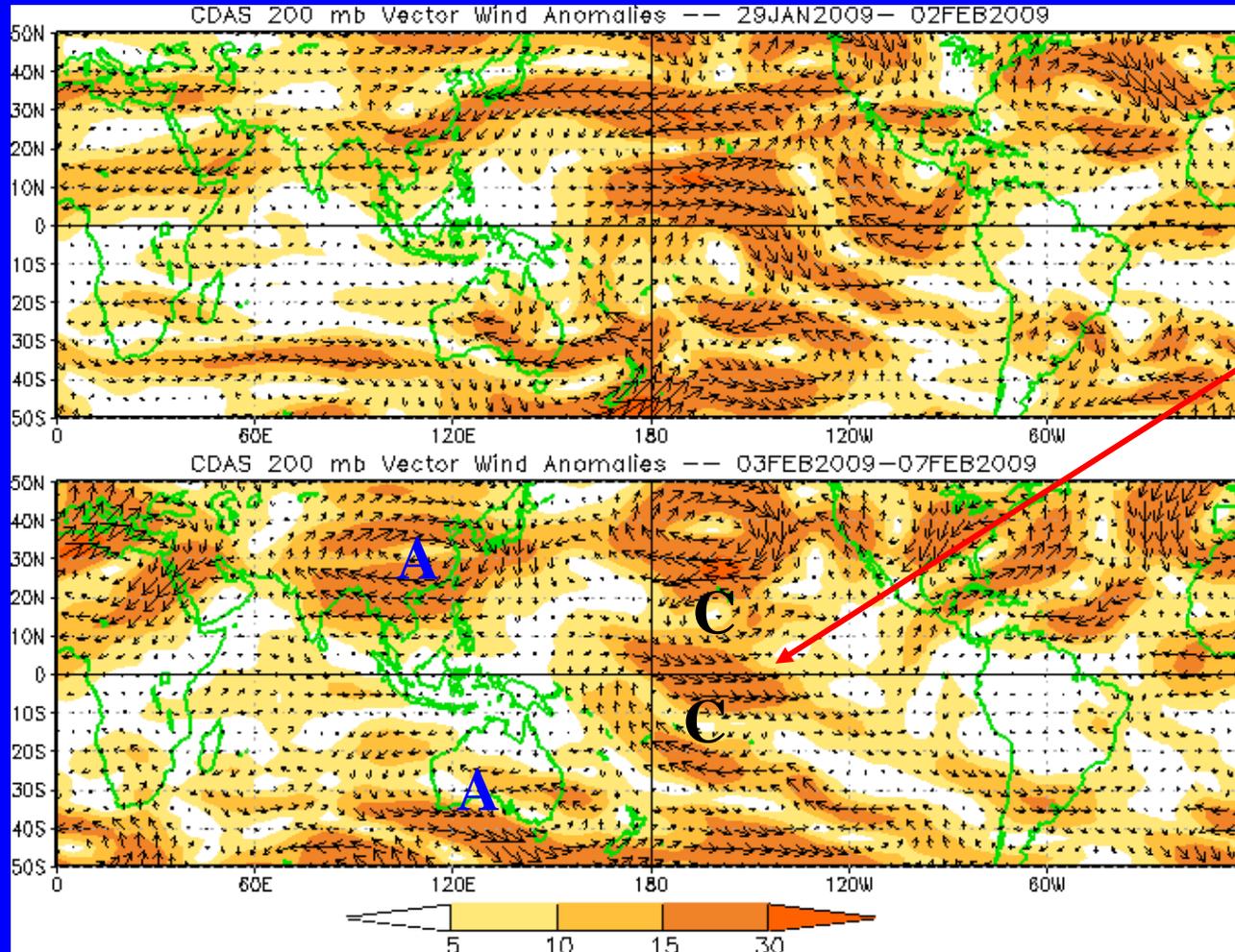
The velocity potential anomalies indicate a somewhat weakened pattern.

Upper-level divergence has shifted to include the Maritime Continent and parts of the Pacific but is weak. Upper-level convergence extends across the Americas and the Atlantic Ocean.



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

Note that shading denotes the magnitude of anomalous wind vectors



Westerly anomalies have increased during the last five days across the equatorial Pacific Ocean.

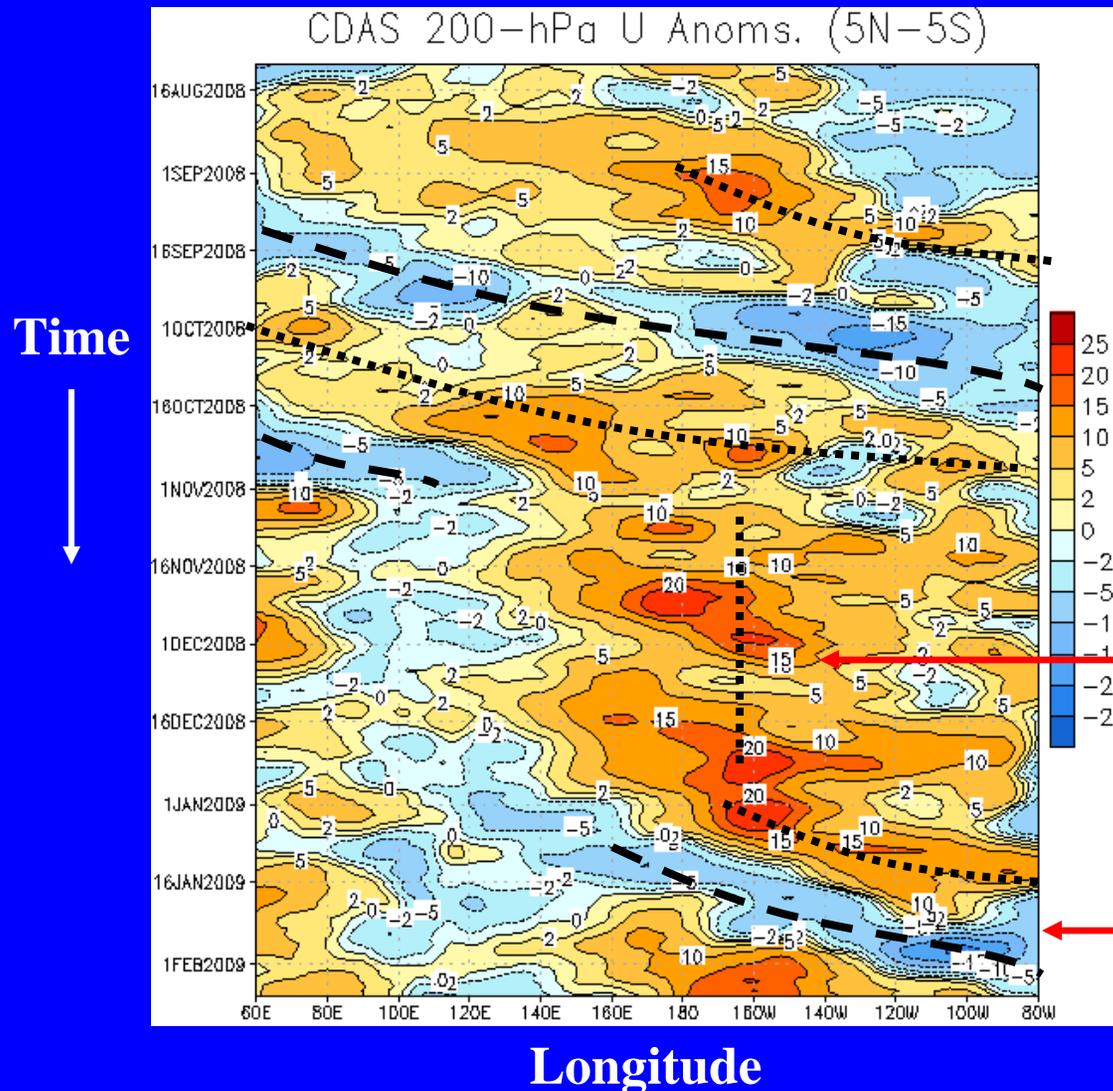
Cyclonic (C) and anti-cyclonic (A) circulations are evident north and south of the equator across the central Pacific and Eastern Hemisphere respectively. They are associated in part with anomalous suppressed and enhanced convection in the deep tropics.



# 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



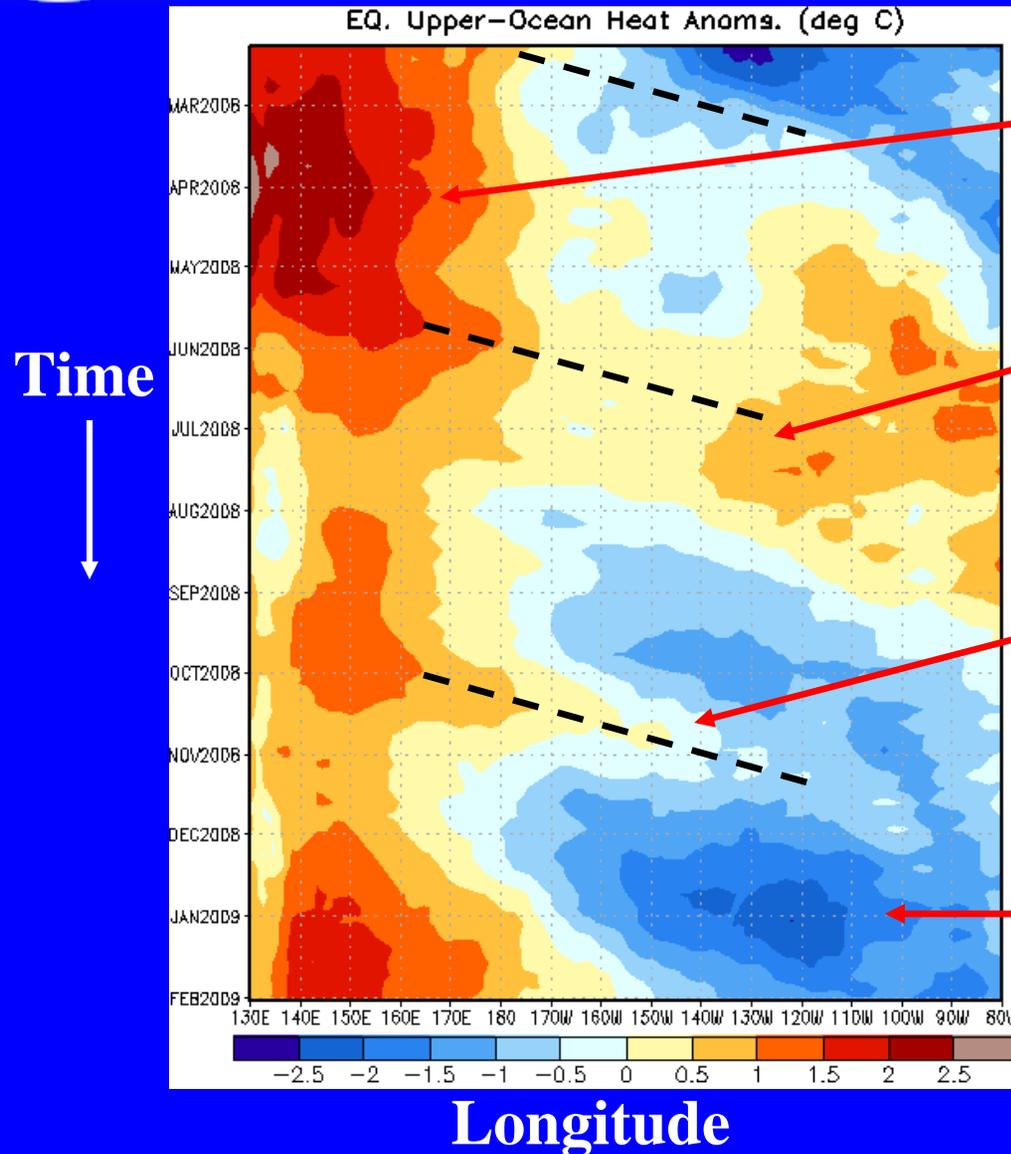
Westerly and easterly anomalies associated with the MJO activity shifted eastward during September and October.

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 the recent MJO activity.



# Weekly Heat Content Evolution in the Equatorial Pacific



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.

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, December and January negative anomalies increased across 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).

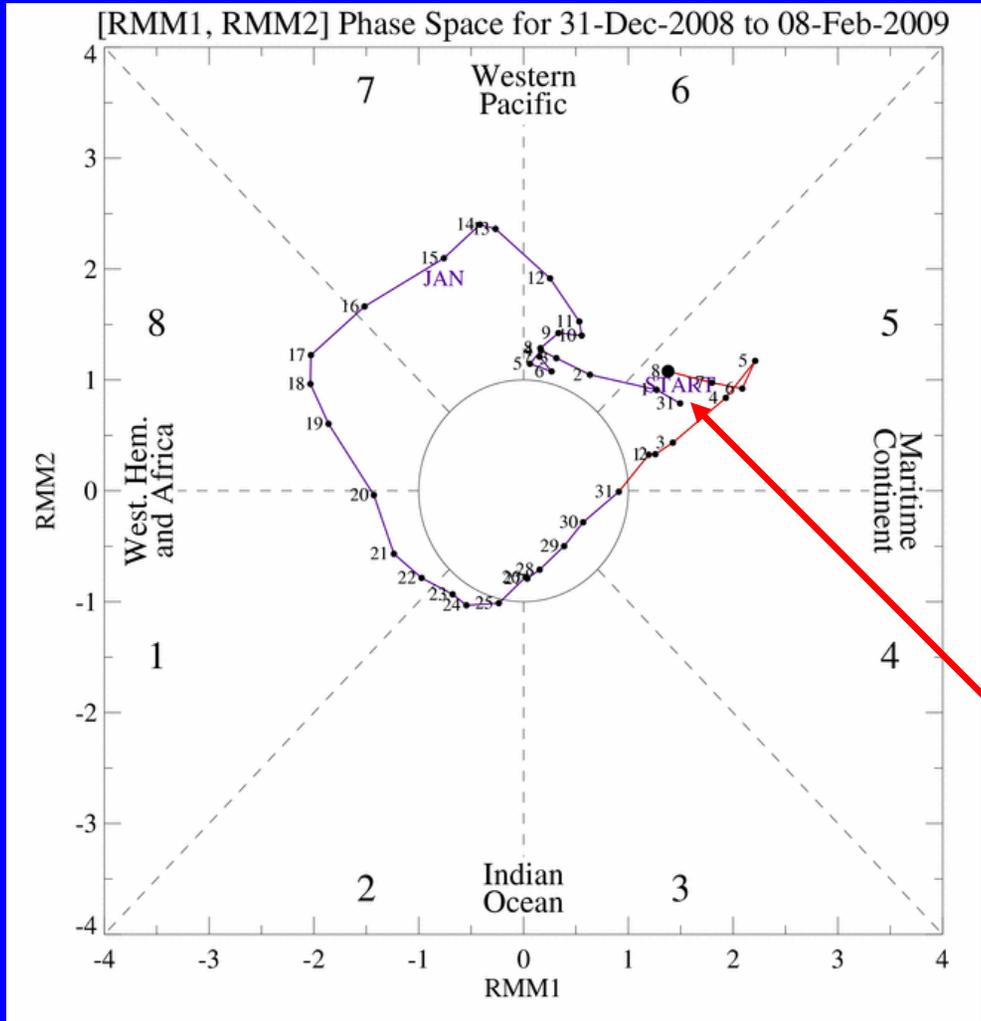
**Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review*, 132, 1917-1932.**

- 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

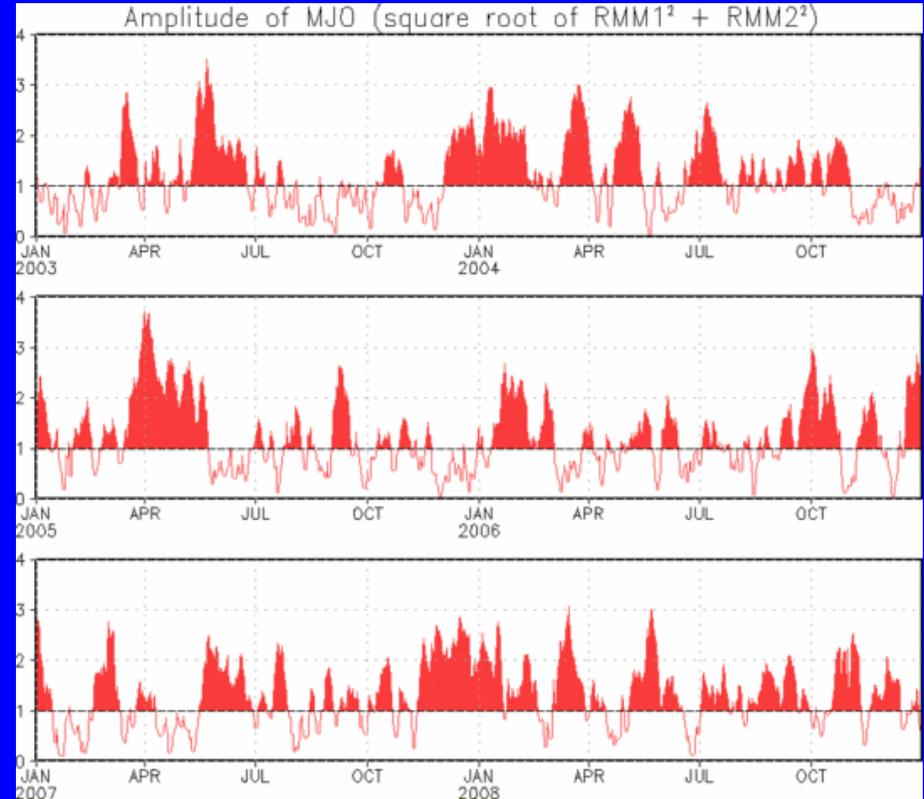
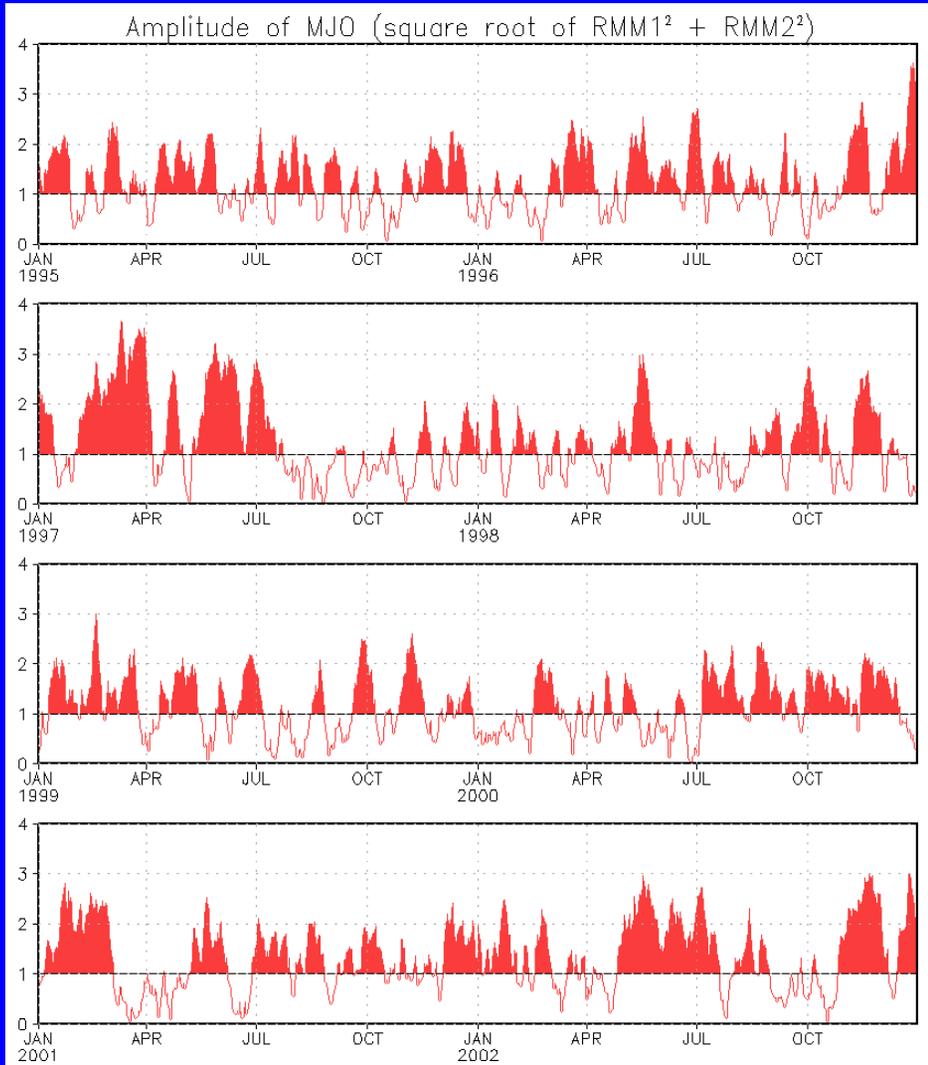
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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



The MJO index amplitude has increased but indicates eastward propagation has decreased over 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**



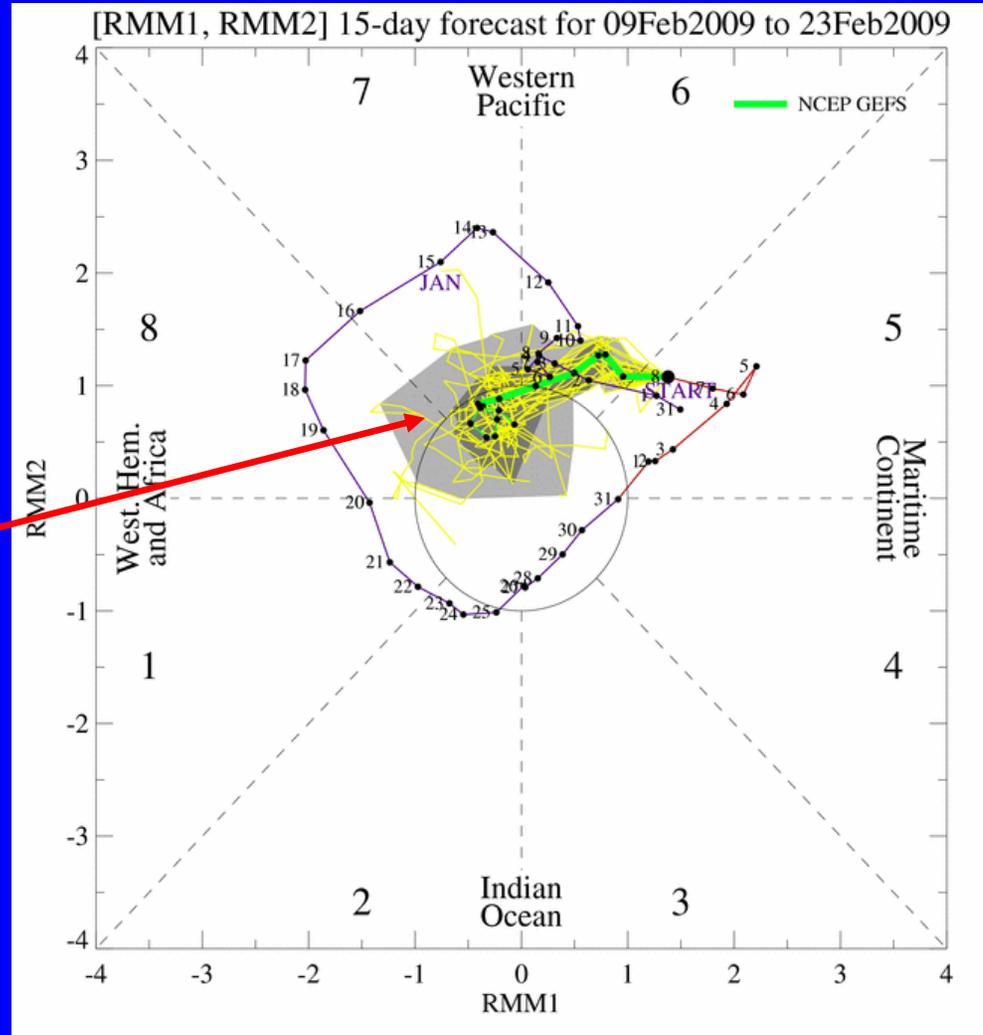
# Ensemble GFS (GEFS) MJO Forecast

**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 weakening MJO activity over the next 1-2 weeks.

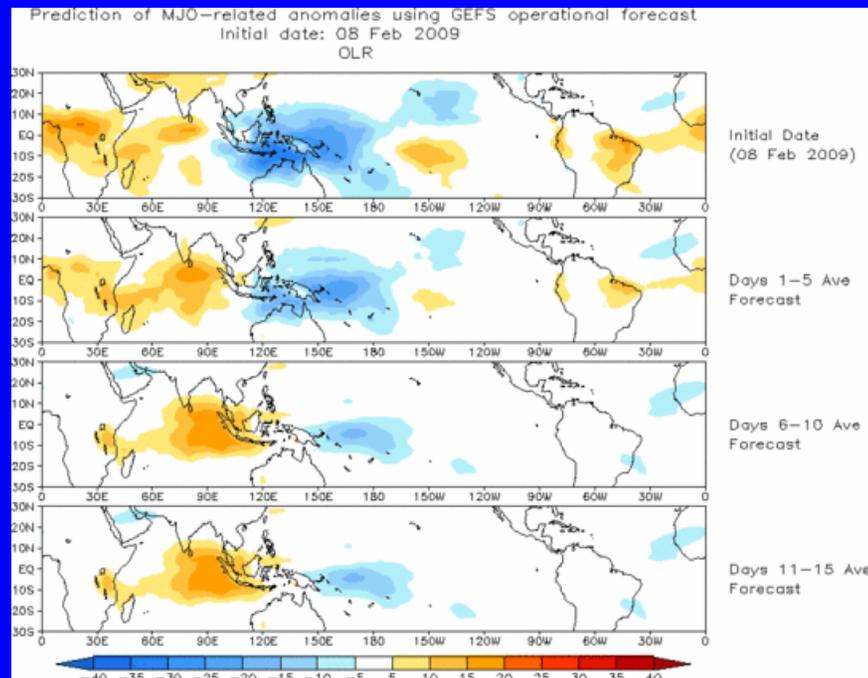




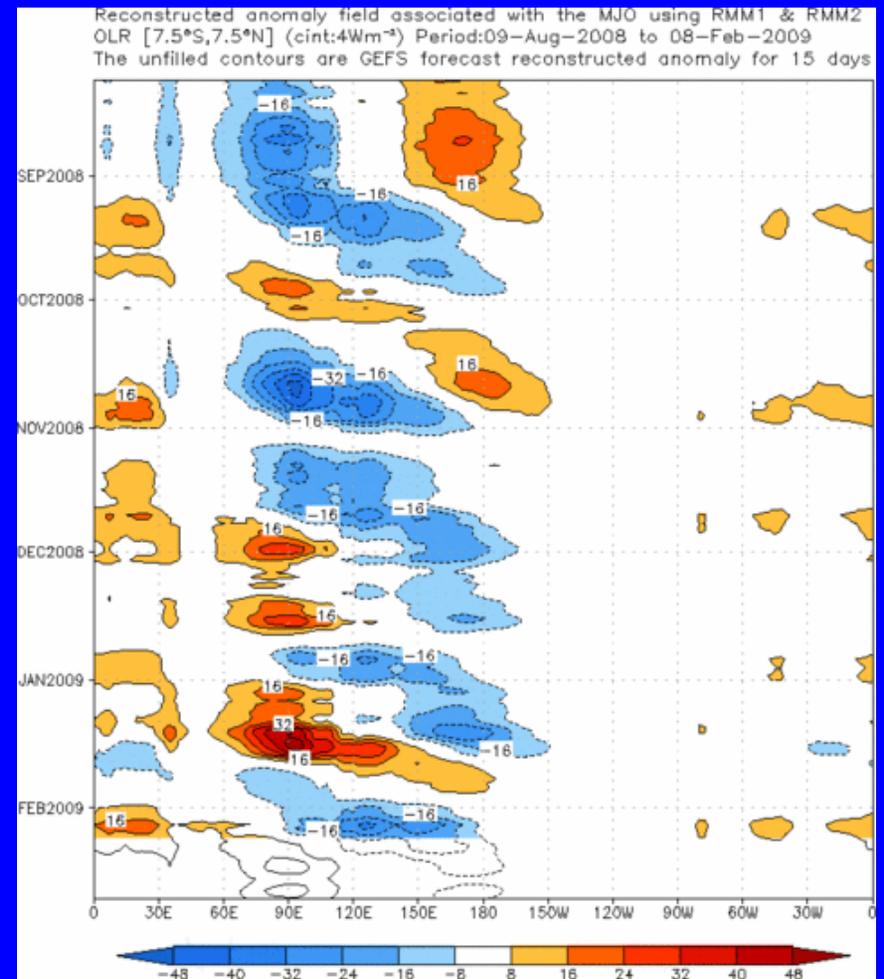
# Ensemble Mean GFS MJO Forecast

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



Enhanced convection is expected to weaken and slowly shift eastward into the western Pacific while suppressed convection develops over the Indian Ocean during the period.



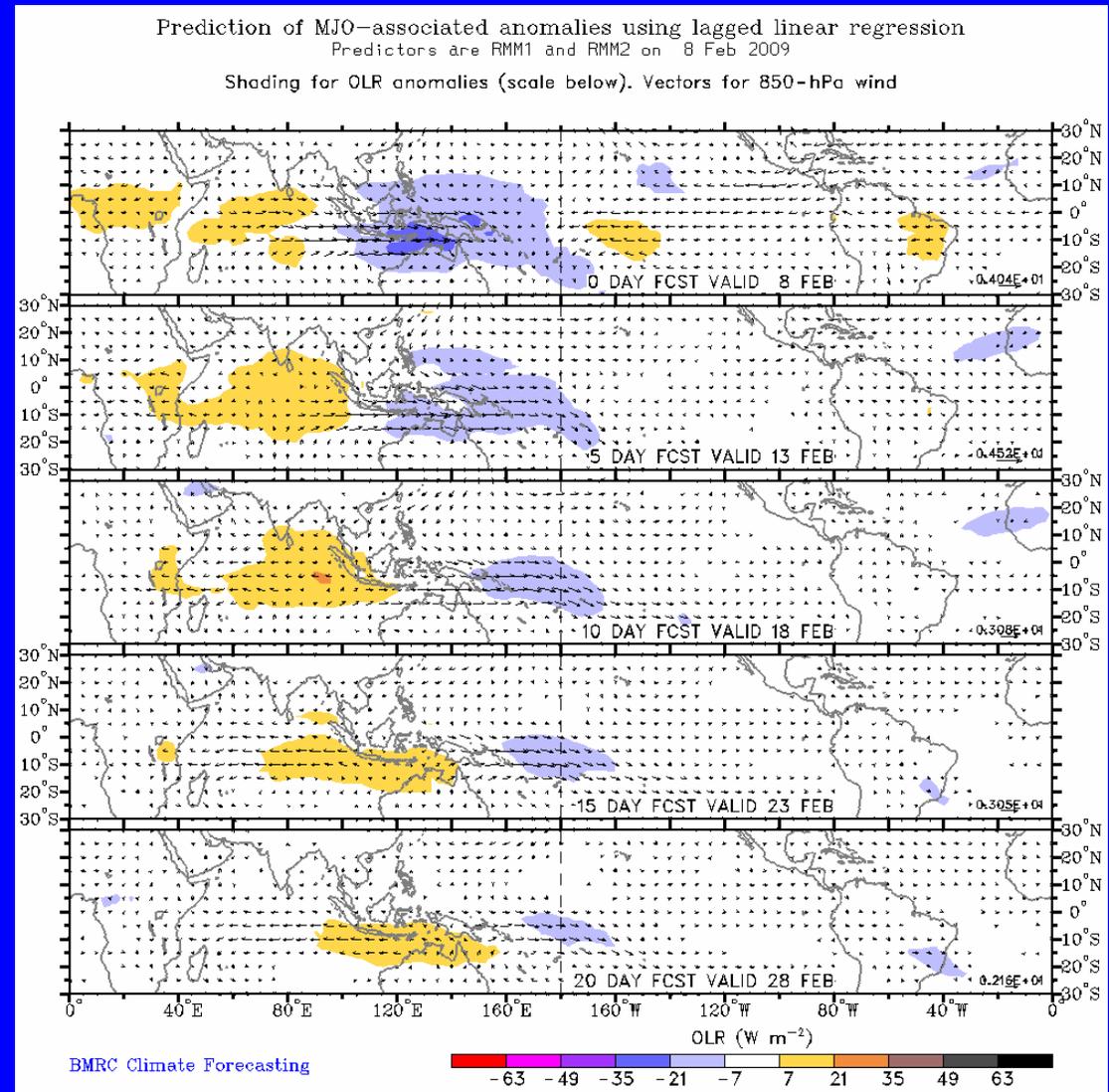
# Statistical MJO Forecast

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 weak MJO activity as enhanced convection shifts eastward from Indonesia and suppressed convection enters the Maritime Continent.





# MJO Composites – Global Tropics

## Precipitation Anomalies (Nov-Mar)

## 850-hPa Wind Anomalies (Nov-Mar)

