



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

**Update prepared by  
Climate Prediction Center / NCEP  
August 31, 2009**



# Outline

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



# Overview

- The MJO has been incoherent during the past week.
- Dynamical model MJO forecasts vary considerably over the next two weeks. Some forecasts indicate a strengthening MJO signal over the period but little eastward propagation.
- Due to this uncertainty and review of the most recent observations, the MJO is forecast to remain weak during the next 1-2 weeks.

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

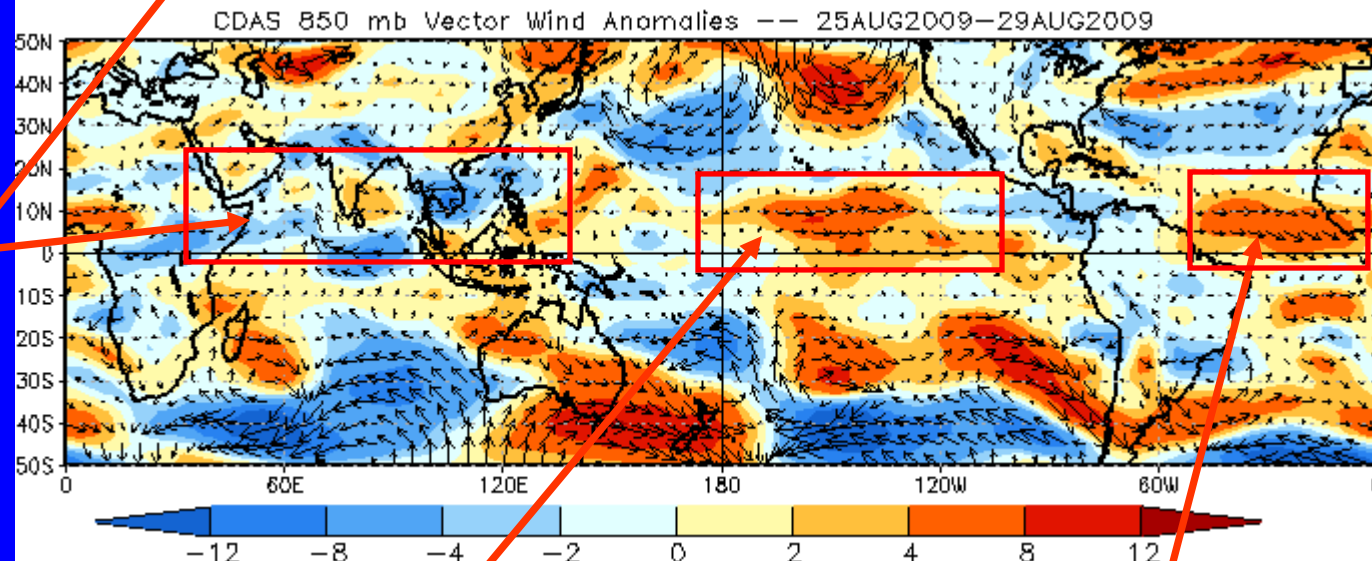
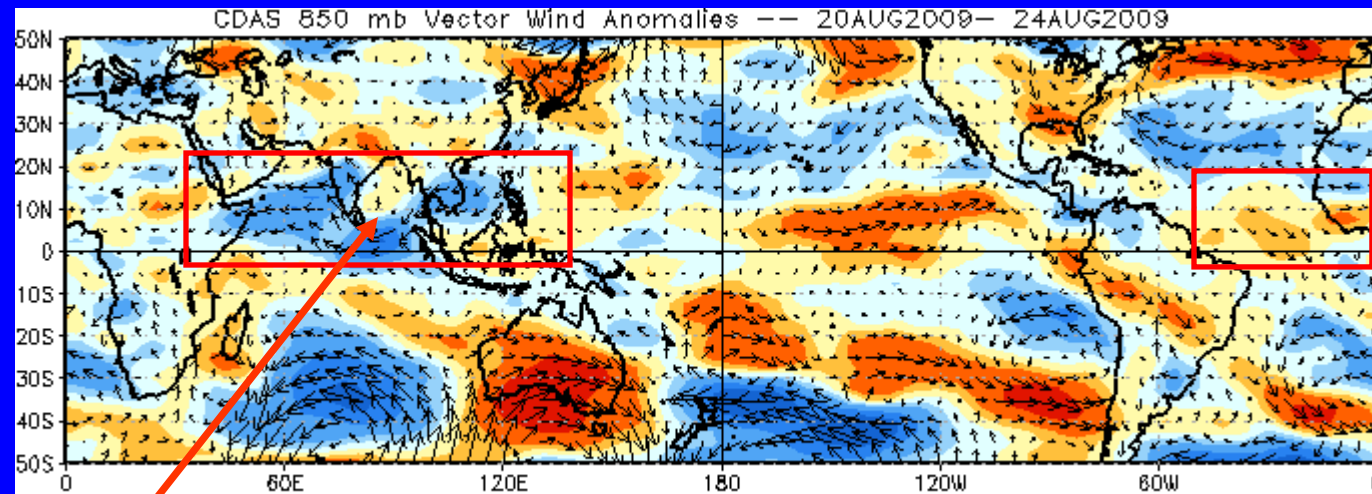


# 850-hPa Vector Wind Anomalies ( $\text{m s}^{-1}$ )

Note that shading denotes the zonal wind anomaly

Blue shades:  
Easterly anomalies

Red shades:  
Westerly anomalies



Easterly anomalies stretching from the Philippines across southern Asia to Africa weakened during the last five days.

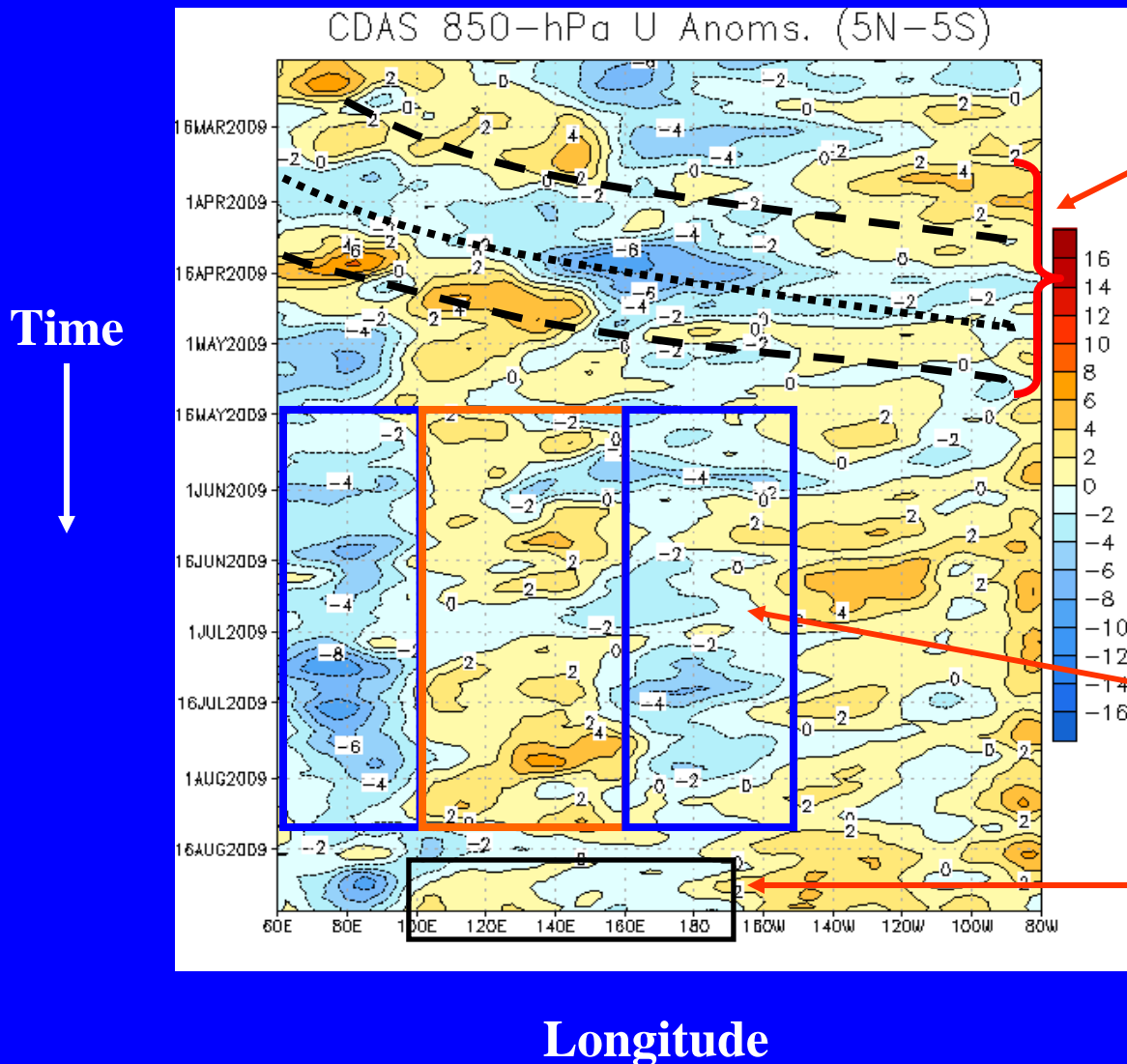
Strong westerly anomalies continued across the east-central Pacific during the last five days.

Westerly anomalies strengthened and expanded slightly north during the last five days across the tropical Atlantic.



# 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



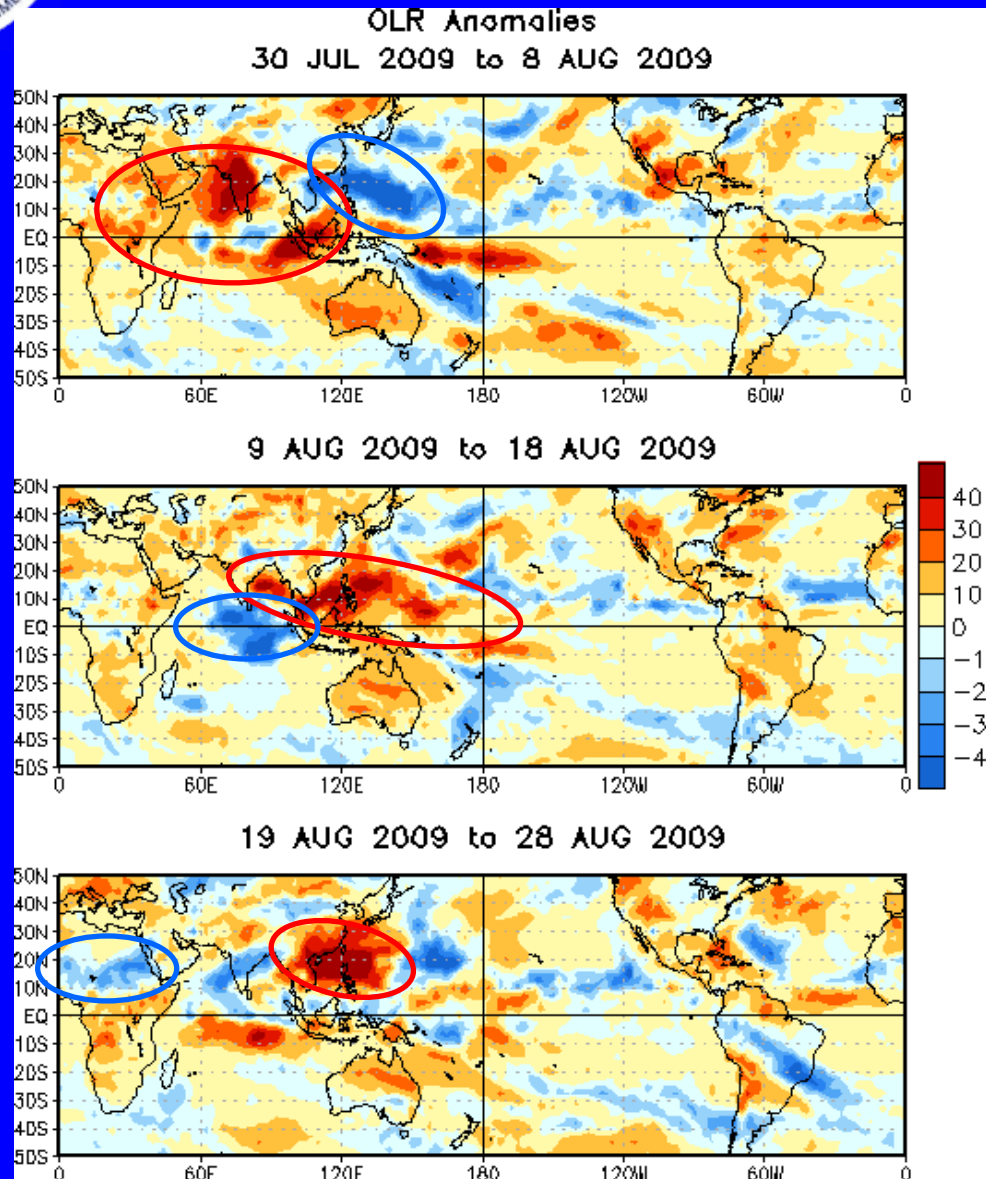
From mid-March to early May, a pattern of alternating eastward-propagating low-level westerly, easterly and again westerly anomalies, associated with the MJO, was evident over the Indian Ocean and equatorial Pacific.

During much of the period from May-early August, a persistent pattern of easterly (westerly) anomalies was present across the Indian Ocean and central Pacific (Indonesia). NOTE: This pattern is partly due to NH summertime biases in the CDAS 850-hPa winds.

Recently, the zonal wind is near average from the eastern Indian Ocean eastward to the west-central Pacific Ocean. The last week has seen an increase in easterly (westerly) anomalies across the Indian (eastern Pacific) oceans.



# OLR Anomalies: Last 30 days



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

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

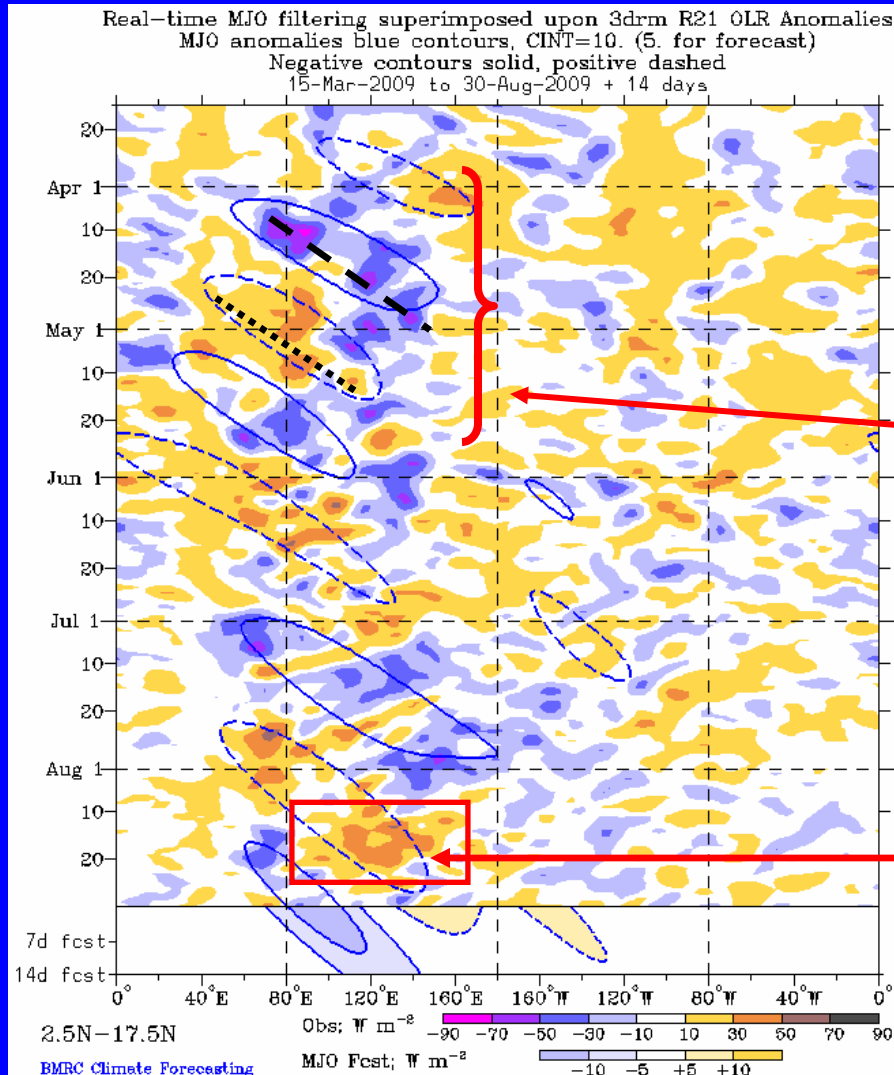
In late July to early August, suppressed convection was evident over most of the Indian Ocean, India and eastern Africa (red oval), while enhanced convection was strongest across the western Pacific northeast of the Philippines (blue oval).

During early-to-mid August, suppressed convection shifted eastward and stretched from the Bay of Bengal to the western Pacific and Maritime Continent while enhanced convection redeveloped across the equatorial Indian Ocean.

In late August, strong suppressed convection focused near the Philippines while rainfall across Africa increased markedly.



# Outgoing Longwave Radiation (OLR) Anomalies (2.5°N-17.5°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 (BOM) - Australia)

From mid-March into early May, areas of suppressed and enhanced convection shifted eastward in association with the MJO (also see equatorial version of this diagram at BOM as it is more suitable for the boreal Spring).

During mid-August, anomalous suppressed convection was evident across the Maritime continent and the western Pacific Ocean. Recently, convection is to close average across much of the globe in this latitudinal band.

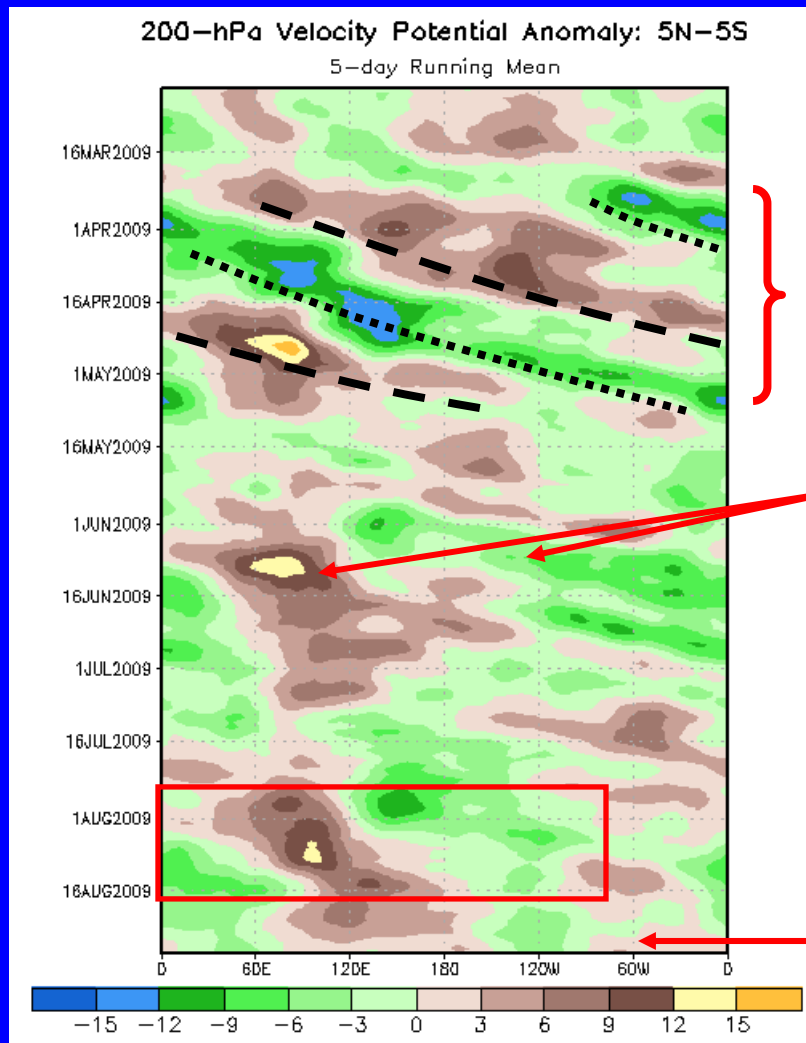


# 200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time  
↓



From mid-March to early May, eastward propagating velocity potential anomalies indicated moderate-to-strong MJO activity.

The MJO weakened in May.

Velocity potential anomalies increased in early June with some eastward propagation evident.

During early-mid August, anomalies increased with some eastward propagation due in part to considerable subseasonal variations.

Most recently, anomalies have weakened and become stationary.

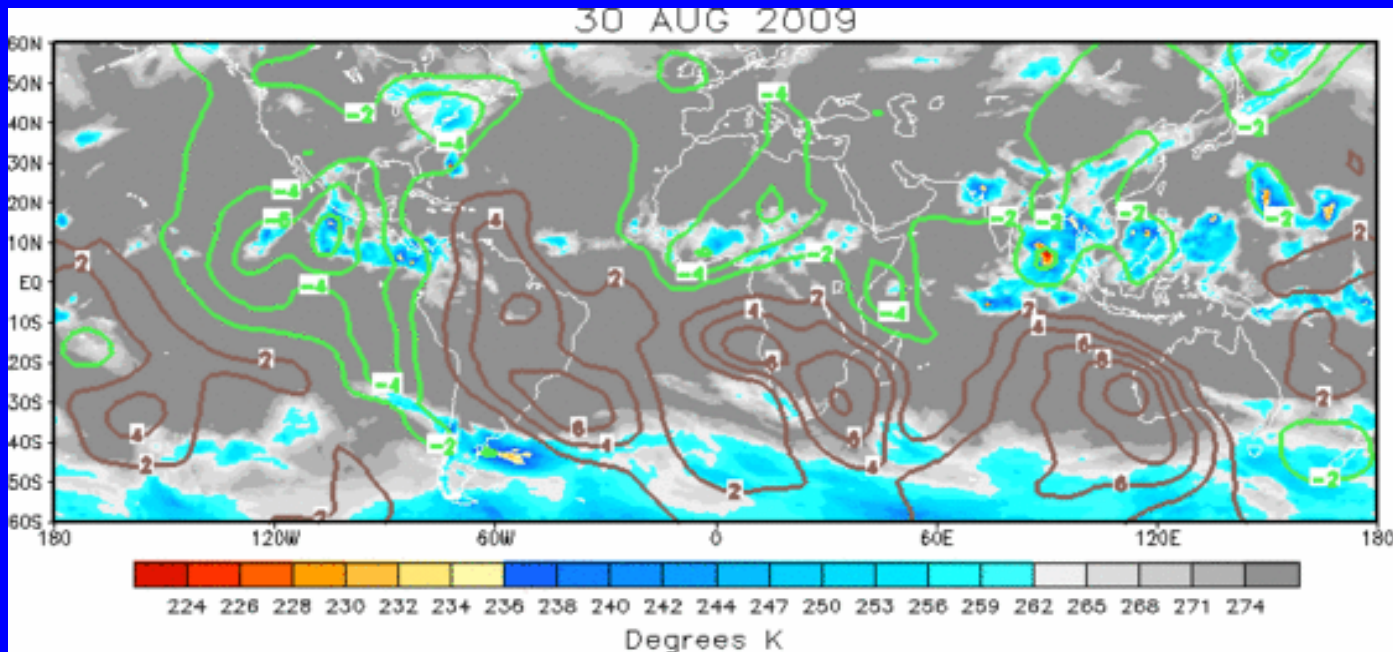




# IR Temperatures (K) / 200-hPa Velocity Potential Anomalies

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The latest map indicates decreased velocity potential anomalies and an incoherent MJO signal. Upper-level divergence is indicated mainly over the east-central Pacific and Africa.

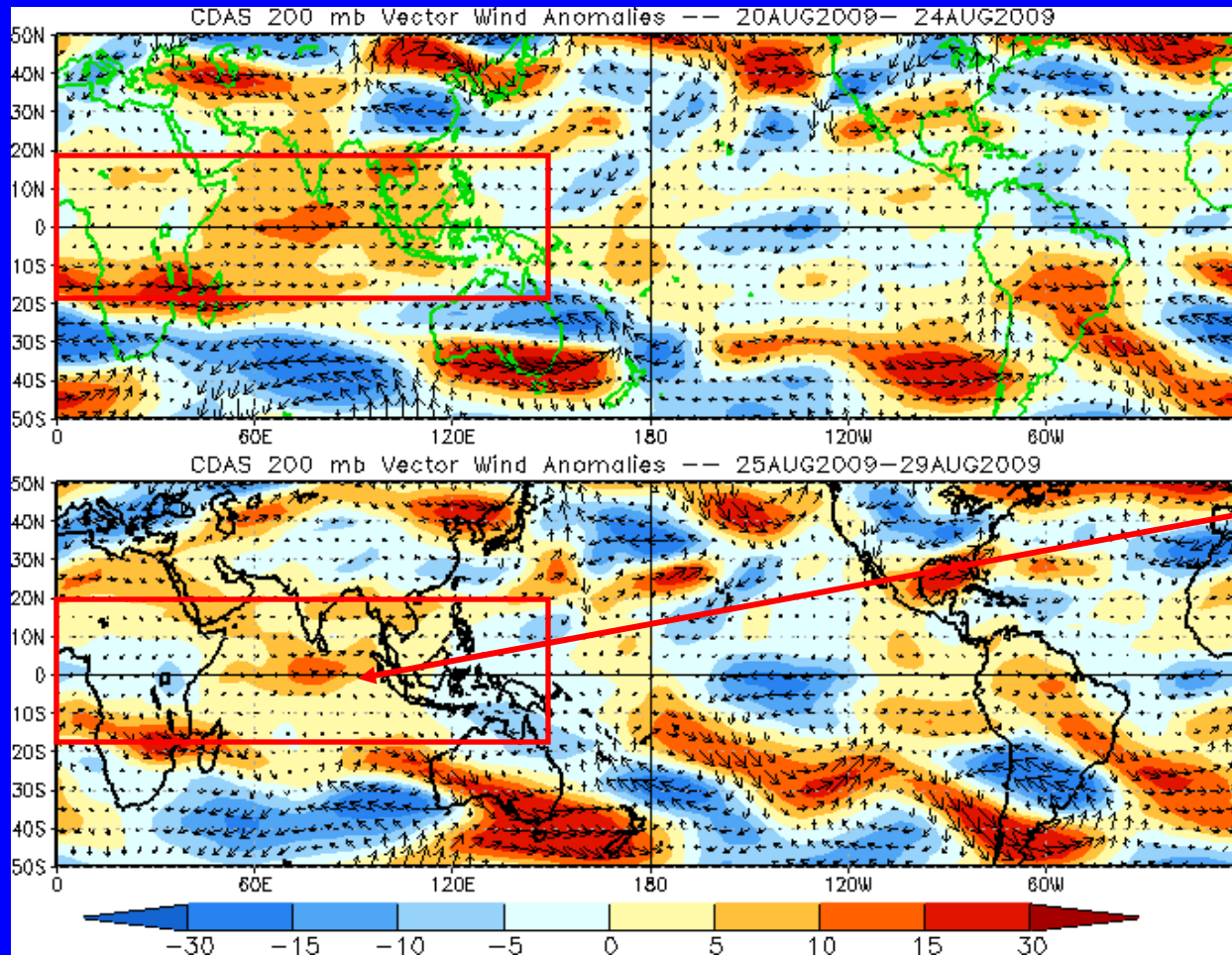


# 200-hPa Vector Wind Anomalies ( $m s^{-1}$ )

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



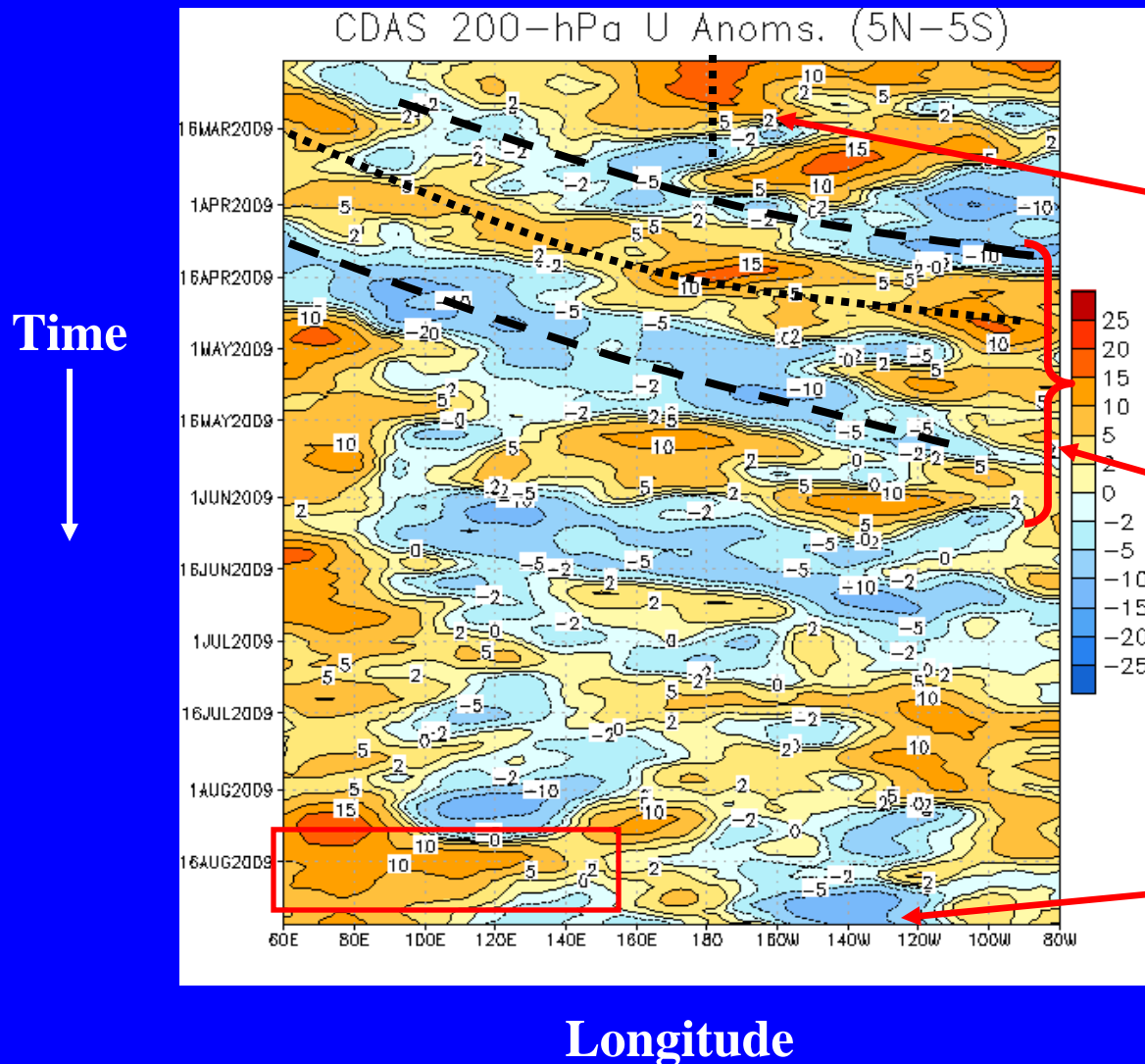
Westerly anomalies seen in the previous five days across the Indian Ocean and Maritime continent have weakened.



# 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



Persistent westerly anomalies were observed near the Date Line into March 2009. These anomalies are consistent with La Niña conditions.

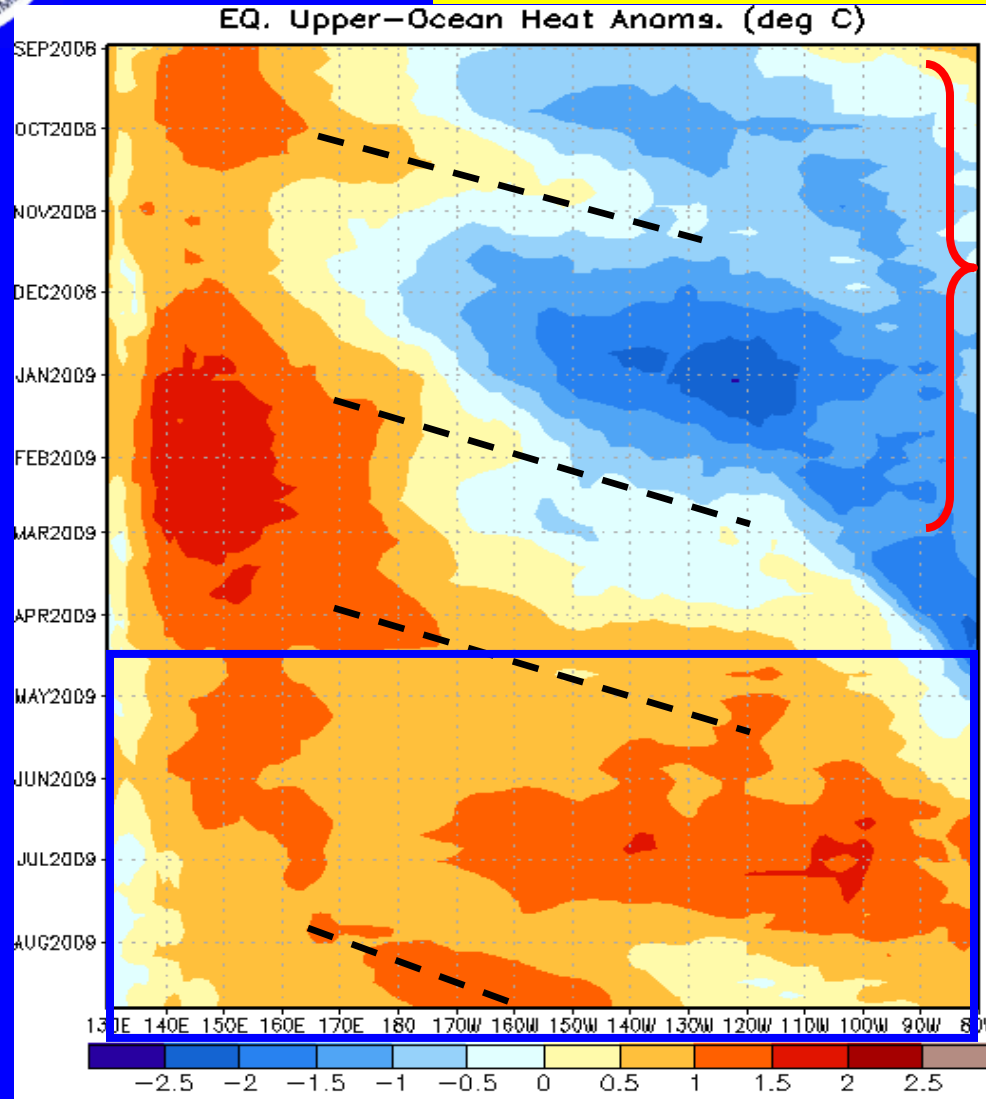
Alternating eastward-propagating easterly and westerly anomalies, consistent with MJO activity, were evident from mid-March to mid-May.

Westerly anomalies across the Indian Ocean and Maritime continent during the last two weeks have decreased while easterly anomalies have strengthened across the eastern Pacific.



# Weekly Heat Content Evolution in the Equatorial Pacific

Time  
↓



- During September 2008 – January 2009, negative heat content anomalies returned and then strengthened in the central and eastern equatorial Pacific as La Niña conditions redeveloped.
- The negative anomalies weakened during January-March 2009, with anomalies becoming positive since late March.
- 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.
- Recently, the downwelling phase of a Kelvin wave has shifted eastward.



# MJO Index -- Information

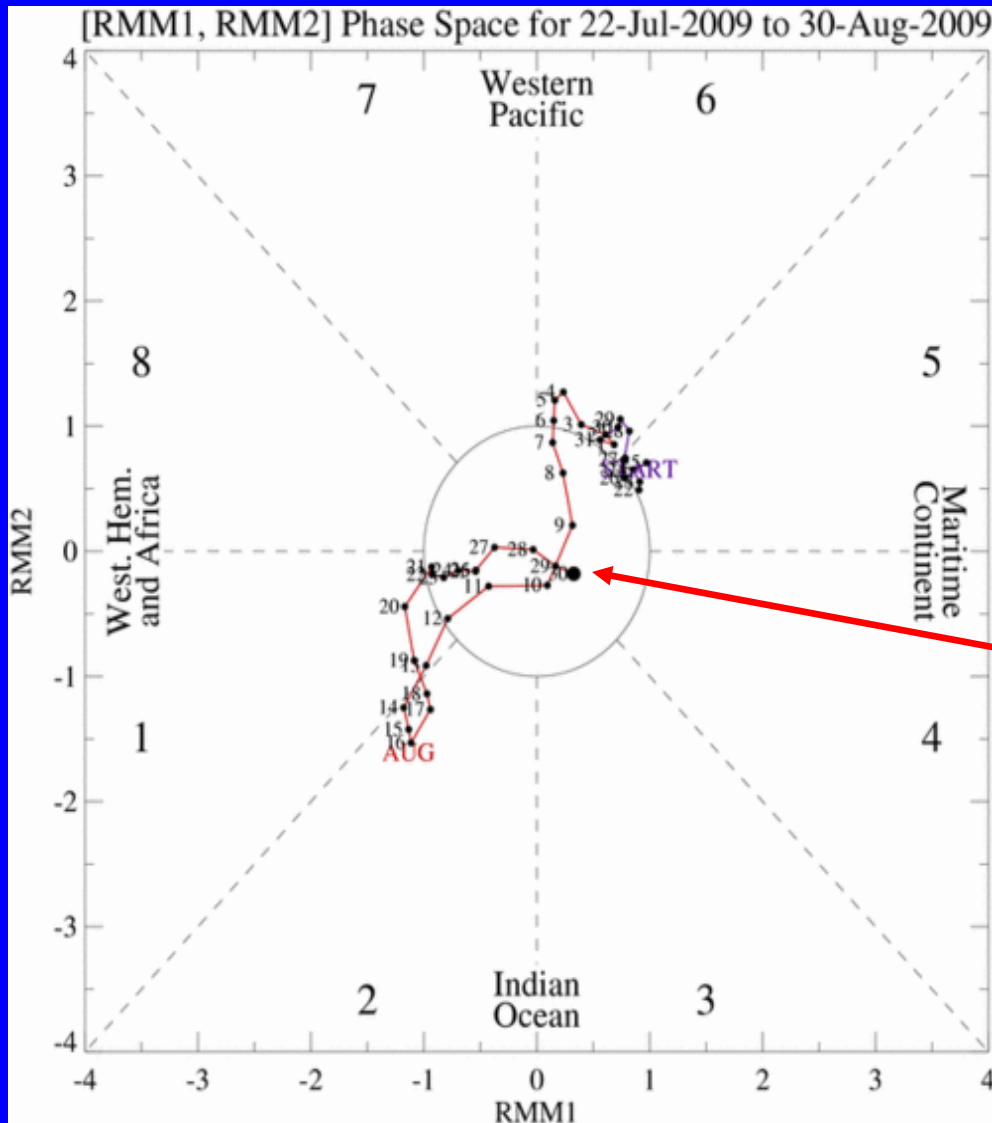
- The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).

**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 or when the ENSO signal is large.
- 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

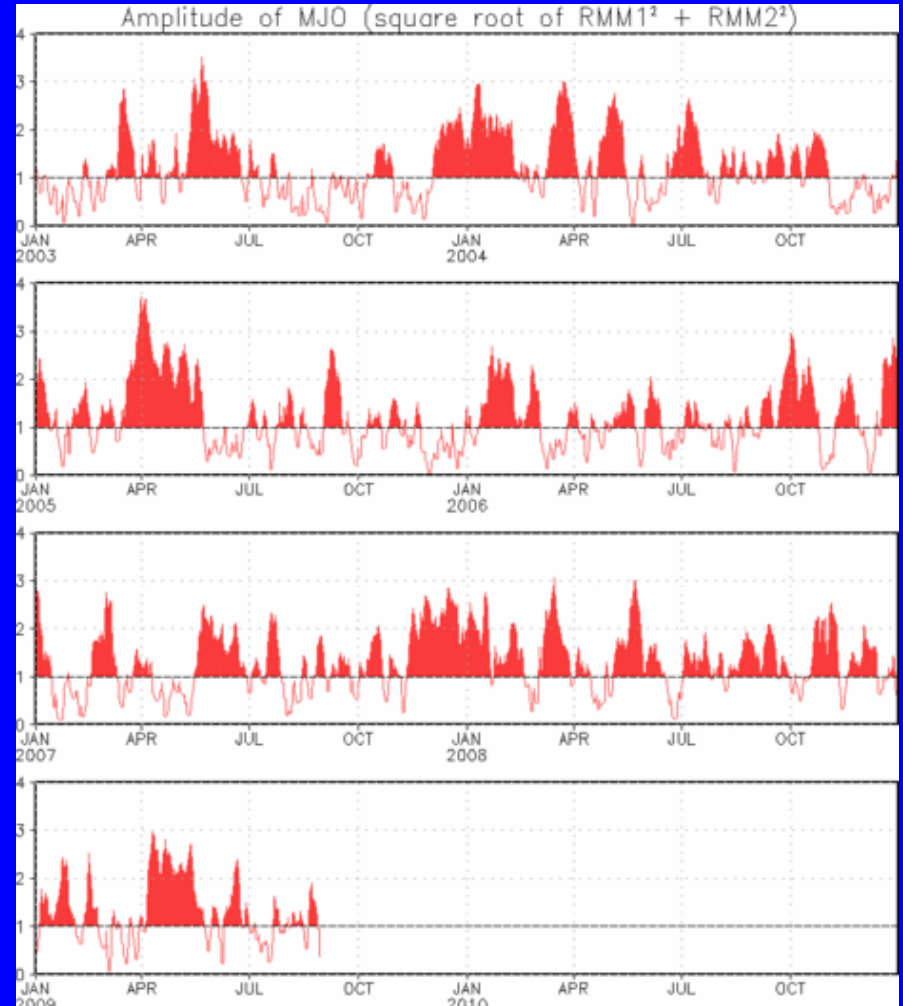
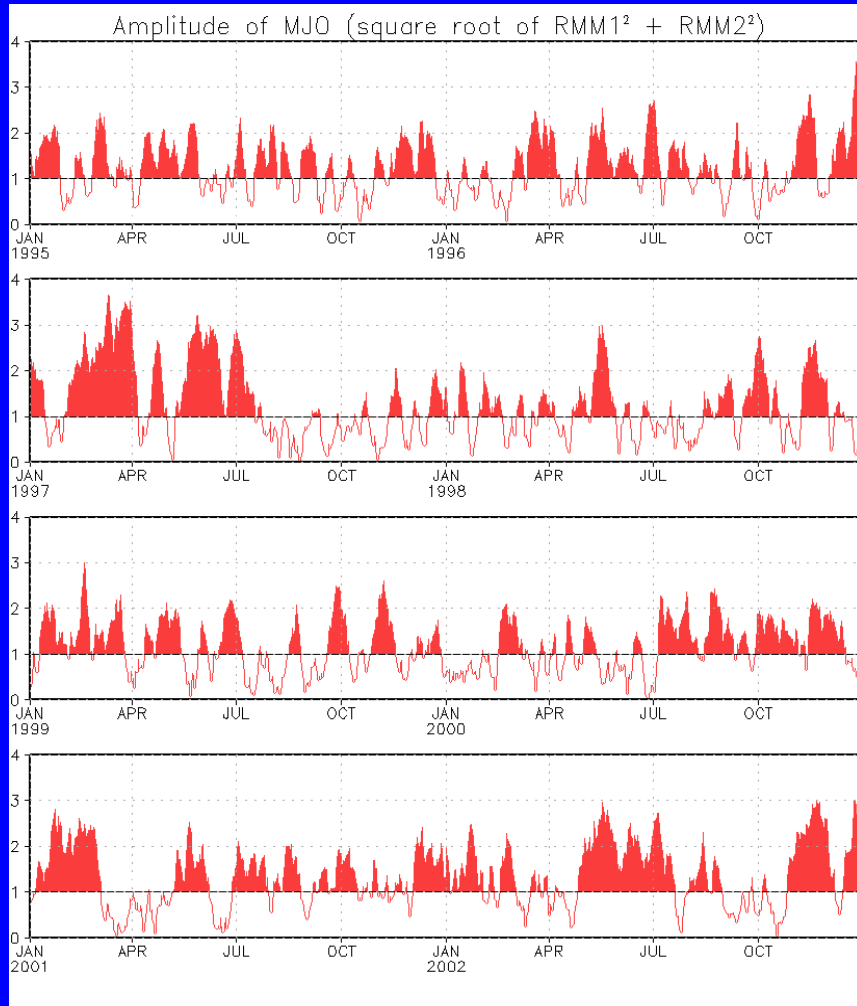


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index indicates incoherent MJO activity 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.**



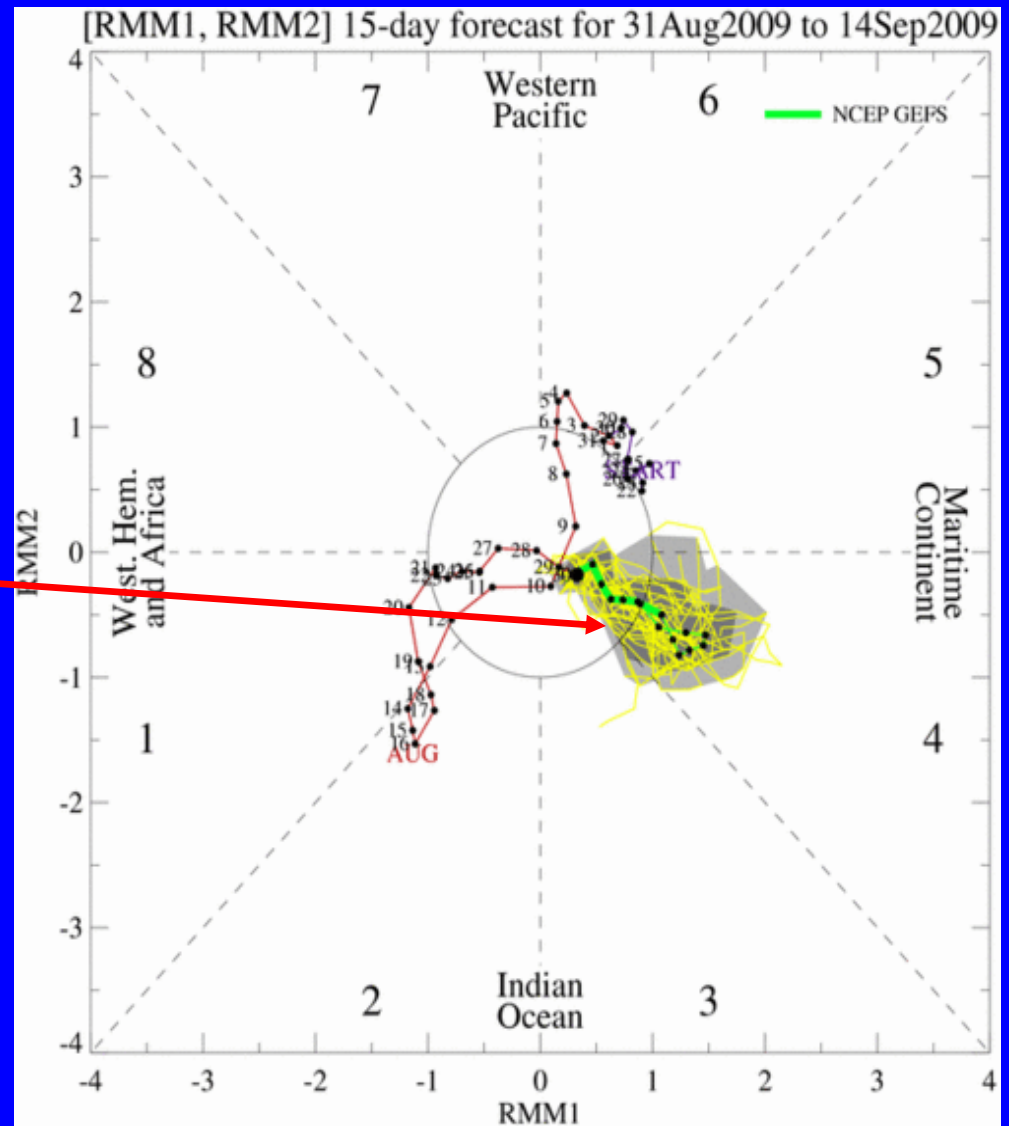
# Ensemble GFS (GEFS) MJO Forecast

**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 an increase in amplitude of the MJO index during Week-1 and early Week-2 with the enhanced convective phase near the western Maritime continent. No propagation is indicated however.



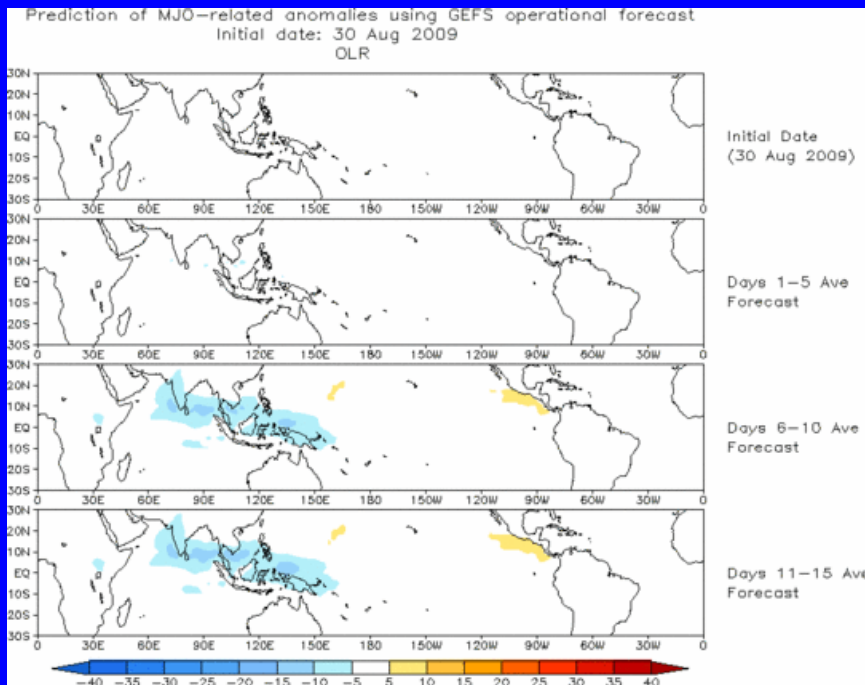




# Ensemble Mean GFS MJO Forecast

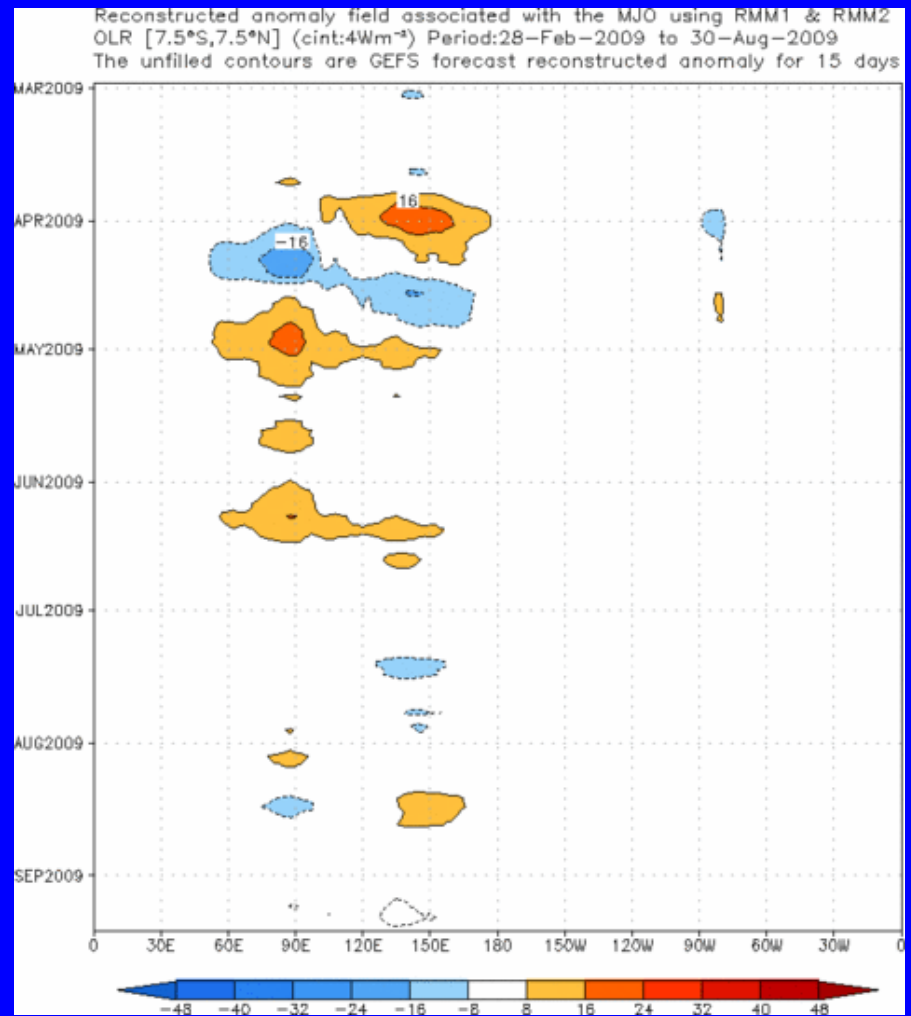
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

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



The GEFS ensemble mean forecasts little convective signal until weak enhanced convection over India and the Maritime continent during Week-2.

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





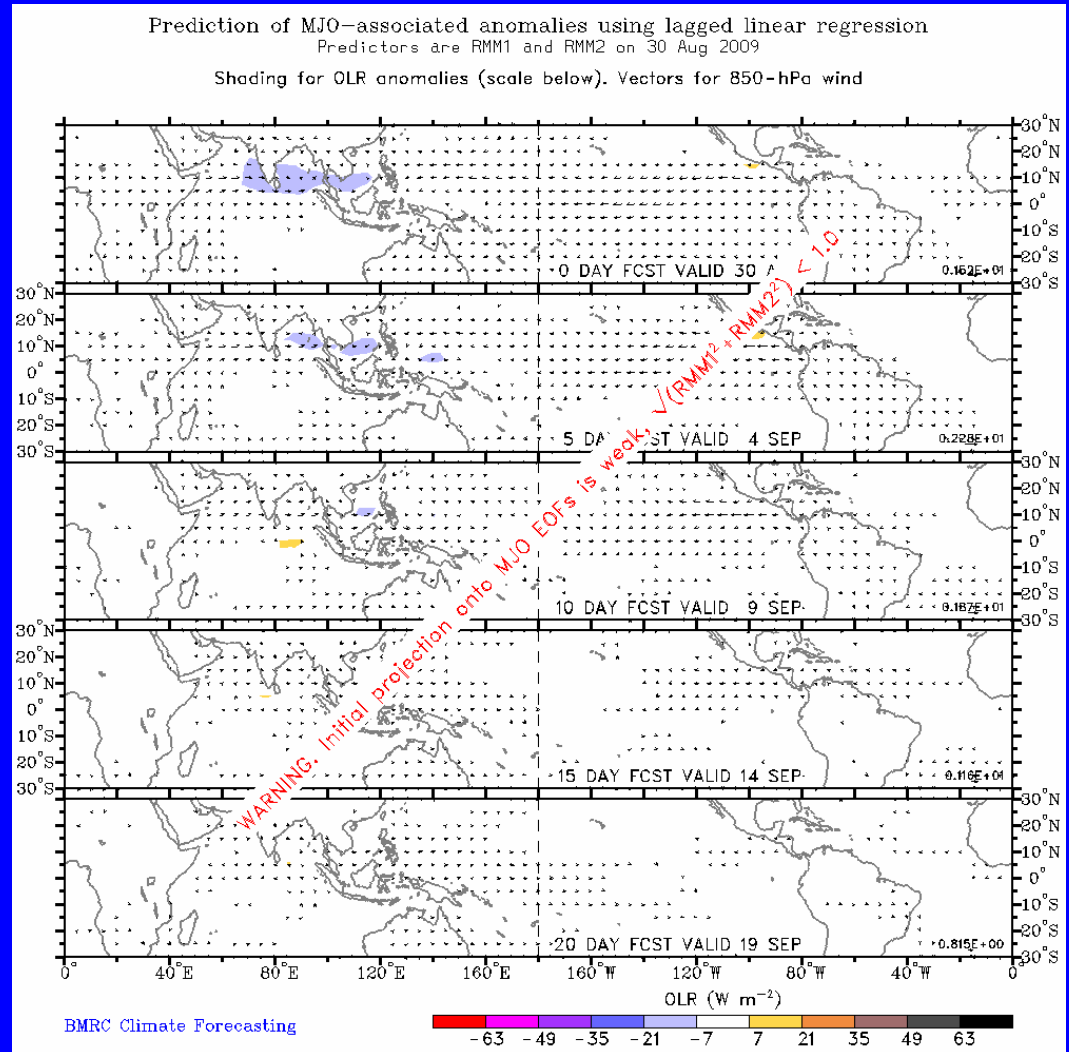
# Statistical MJO Forecast

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)

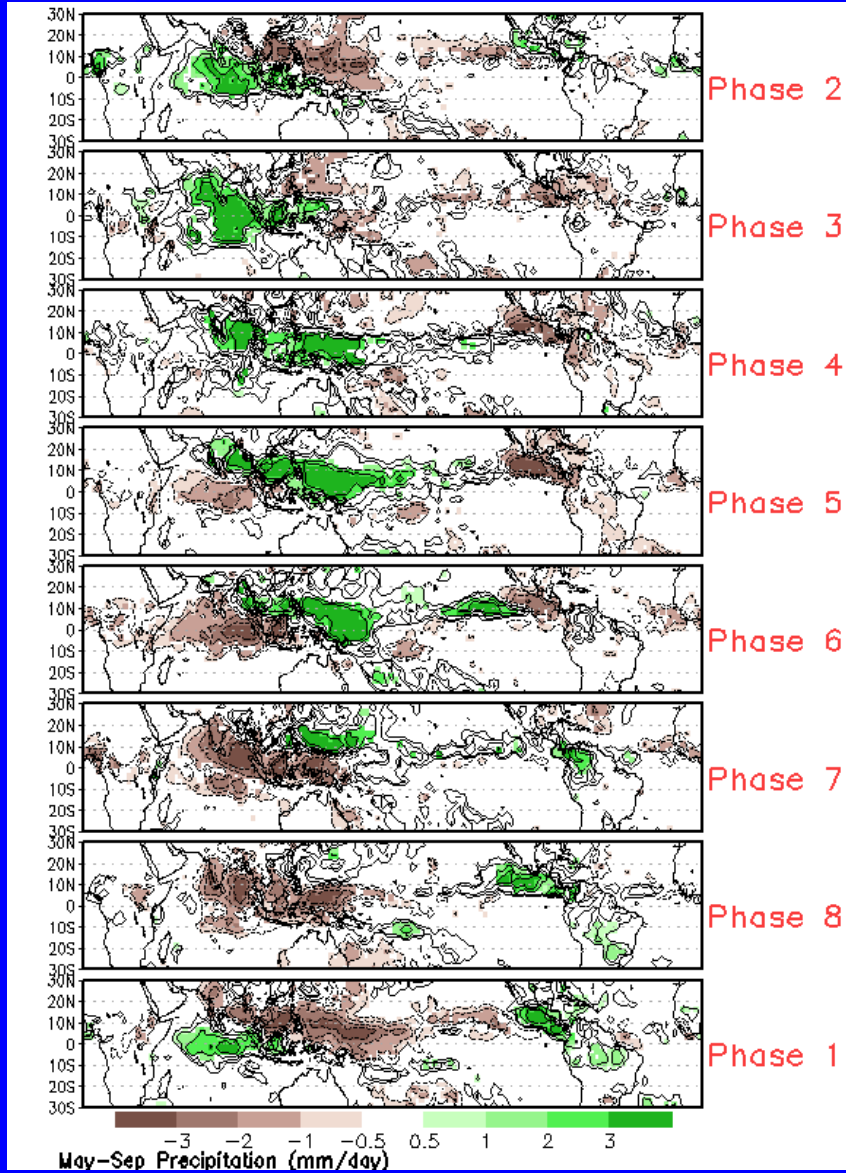
A statistical model forecasts no MJO activity during the next 1-2 weeks.





# MJO Composites – Global Tropics

## Precipitation Anomalies (May-Sep)



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

