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

**Update prepared by**
**Climate Prediction Center / NCEP**
**August 24, 2009**

# Outline

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

# Overview

- The patterns of tropical rainfall and winds continue to reflect considerable subseasonal variations but generally incoherent MJO activity.

- Dynamical model forecasts of the MJO are contradictory and most do not forecast coherent MJO activity during the next 1-2 weeks.

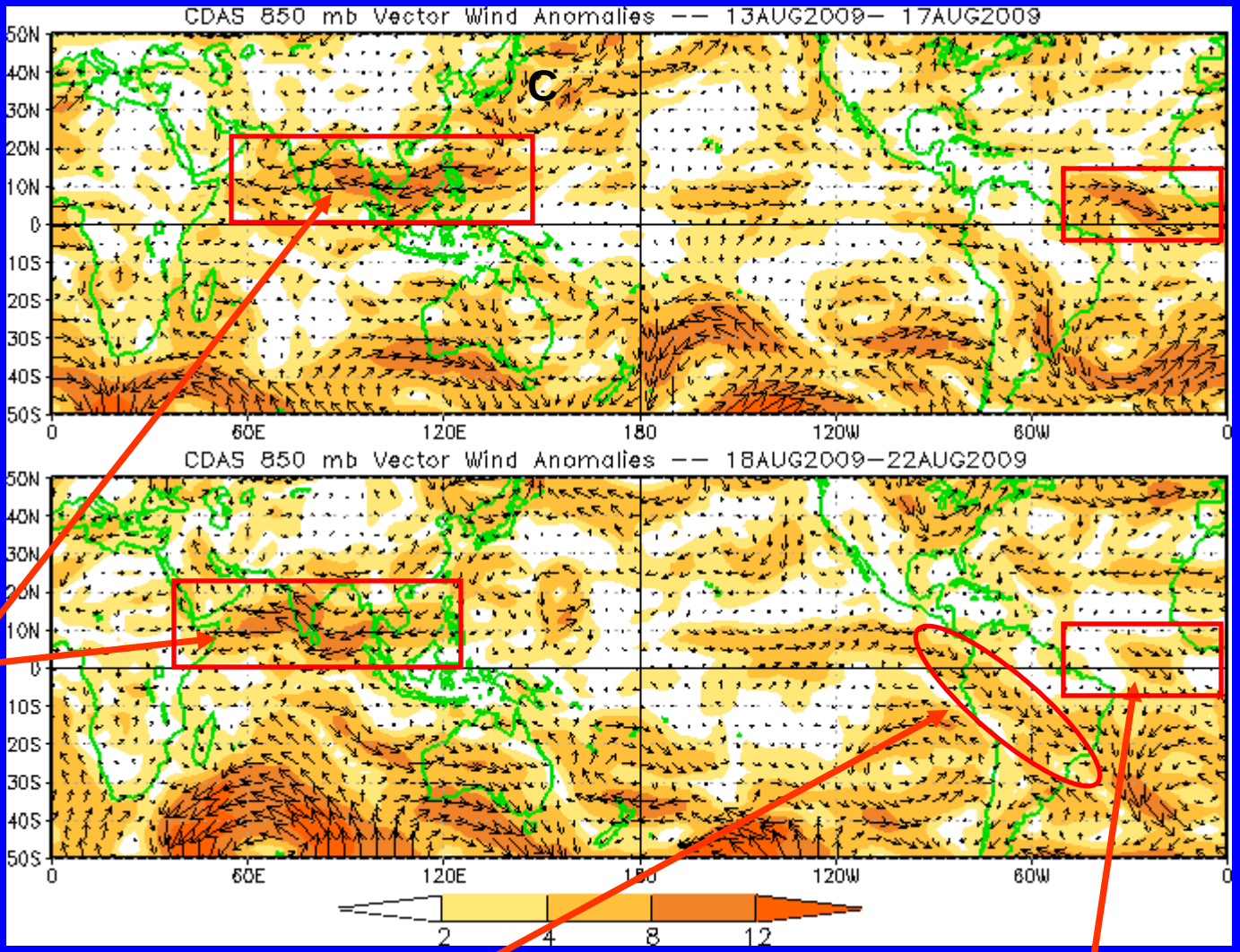
- The continuation of subseasonal variability is likely to result in increased (decreased) rainfall for India (the Philippines) during Week-1. The focus of enhanced (suppressed) rainfall is forecast to shift to the western Pacific (Indian Ocean) during Week-2.

- Elevated risks for tropical cyclone activity remain for both the eastern Pacific and Atlantic Ocean basins throughout the period.

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




**Easterly anomalies across southern Asia shifted slightly westward during the last five days.**

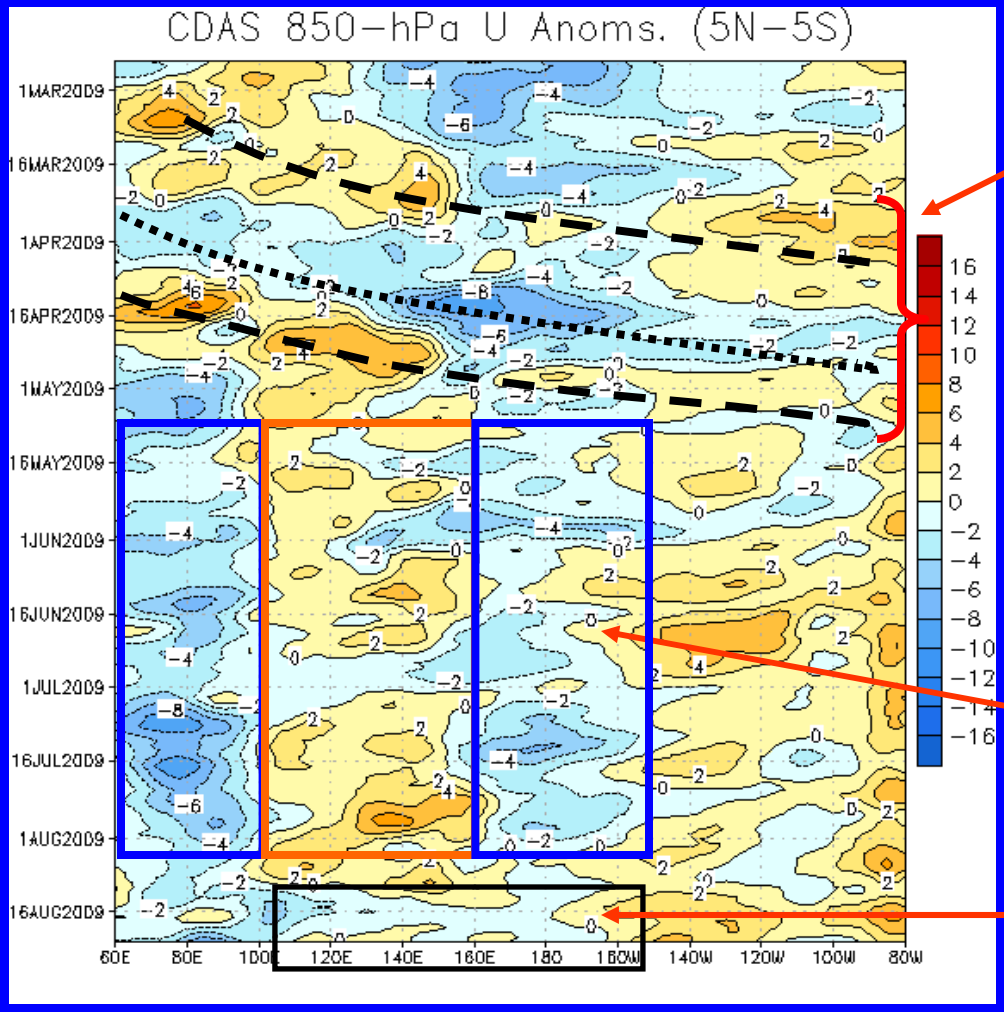
**Strong anomalous northwesterly flow persisted over western South America during the last five to ten days.**

**Westerly anomalies weakened over the tropical Atlantic during the last five days.**

# 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

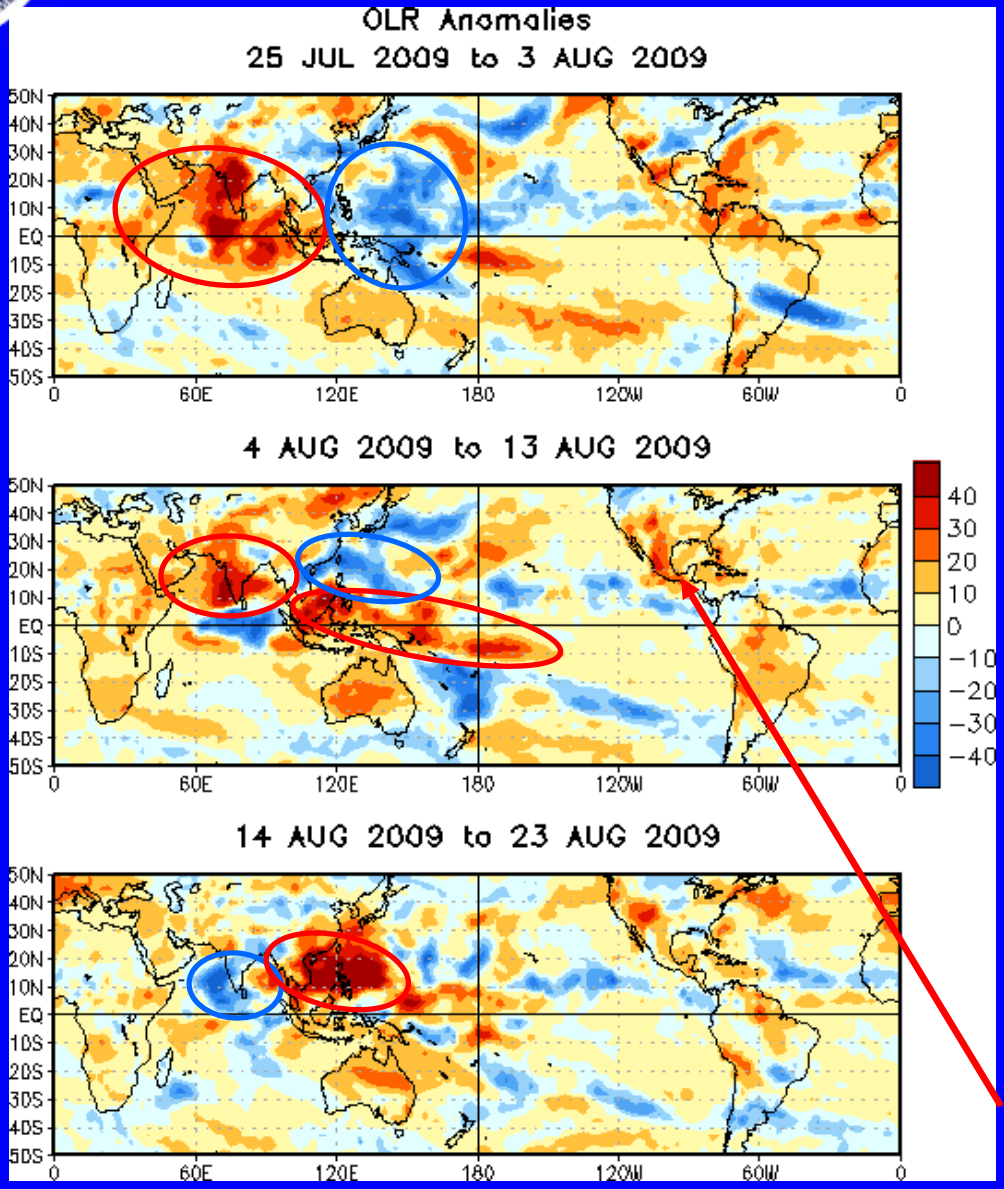
Longitude

**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 central Pacific Ocean.**

# OLR Anomalies: Last 30 days




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

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

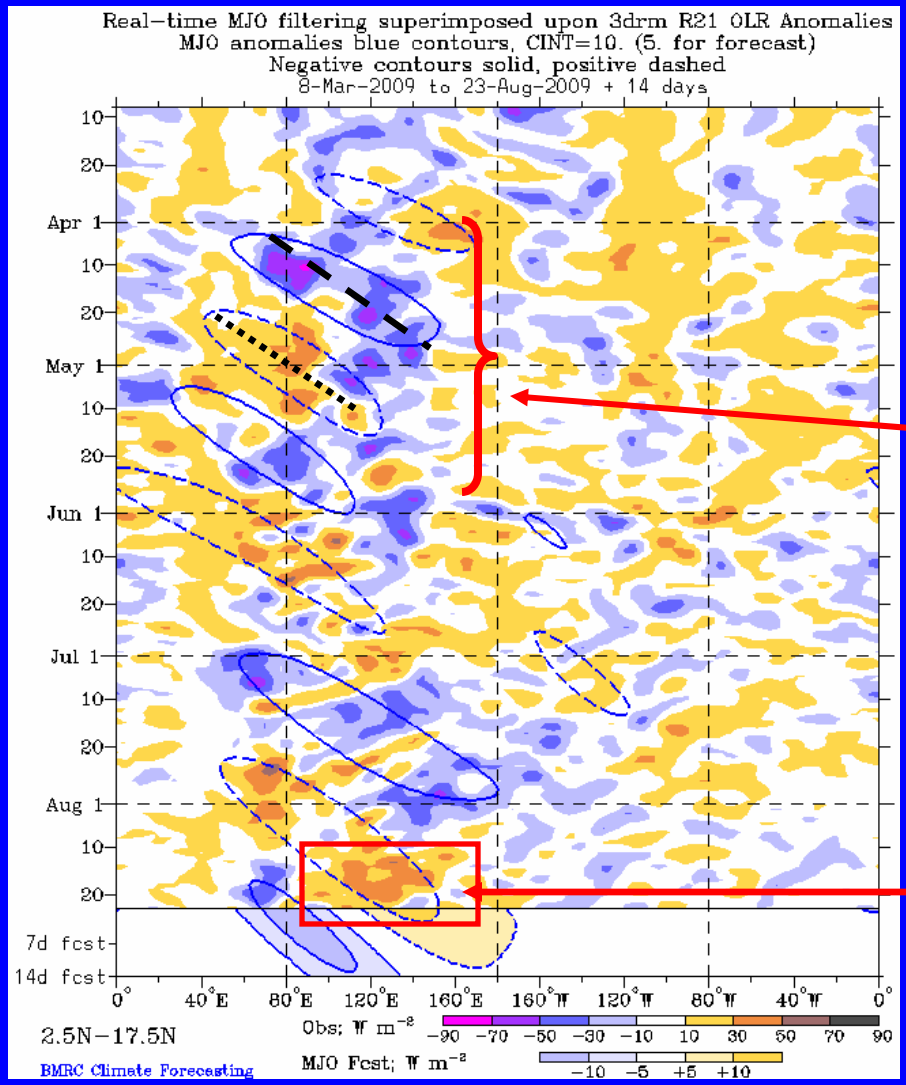
**In late July to early August, areas of suppressed convection were evident over the Indian Ocean, India and eastern Africa (red oval), while enhanced convection was evident across the western and central tropical Pacific (blue oval).**

**During early-to-mid August, suppressed convection was evident over India and the Maritime Continent while enhanced convection was evident northeast of the Philippines.**

**In mid-to-late August, enhanced convection developed over the central Indian Ocean and India while suppressed convection intensified over the Philippines and expanded over the southwest North Pacific.**

**Suppressed convection is evident over Central America and Mexico throughout the period.**

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

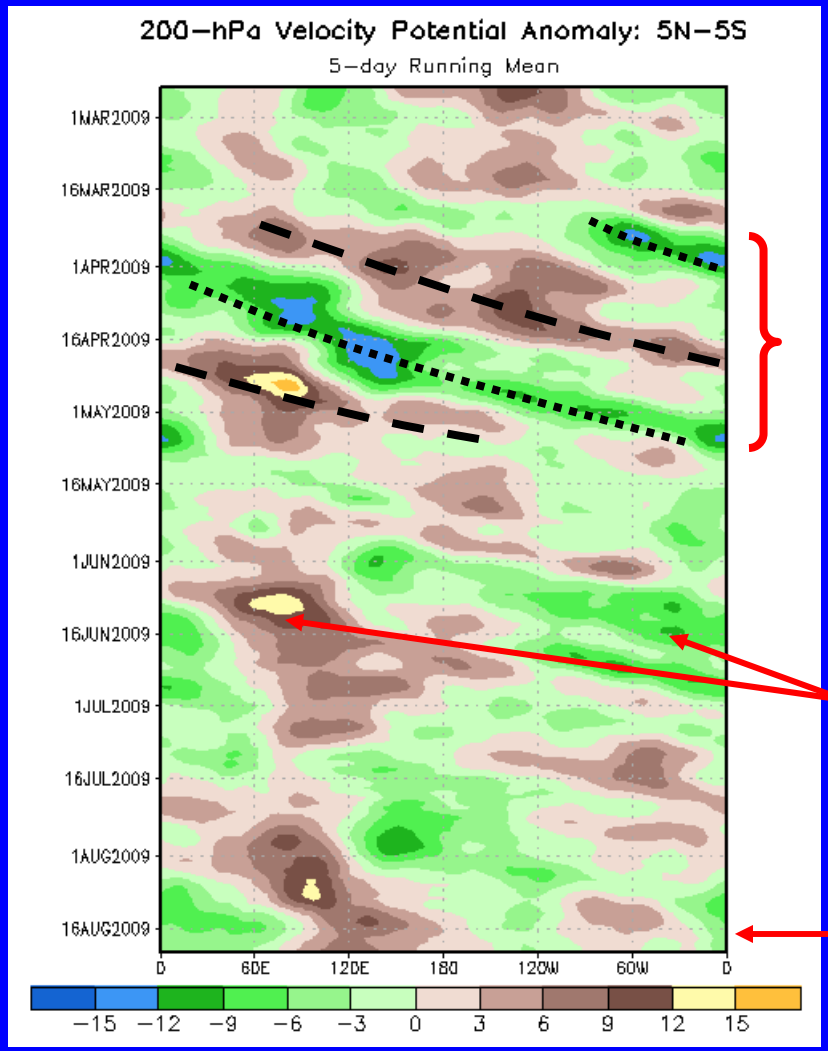
**From mid-March into early May, areas of suppressed and enhanced convection shifted eastward in association with the MJO (also see equatorial version of this diagram at BOM as it is more suitable for the boreal Spring).**

**During the last two weeks, anomalous suppressed convection has developed across the Maritime continent and the western Pacific 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**




Time

Longitude

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

The MJO weakened in May.

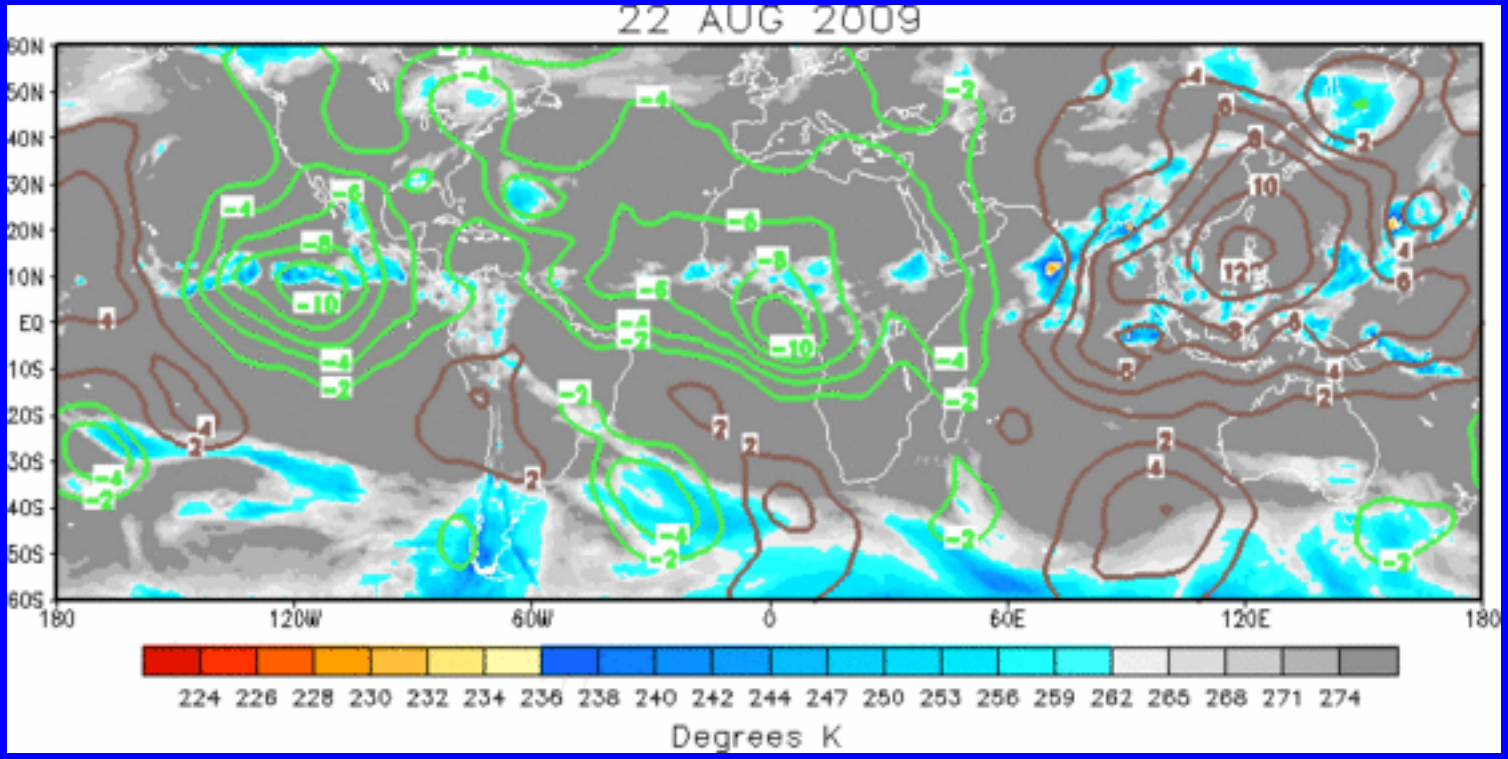
Velocity potential anomalies increased in early June with some eastward propagation evident.

During August positive anomalies strengthened over the Indian Ocean and Indonesia while negative anomalies expanded eastward over the central Pacific in early August but have since decreased.

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

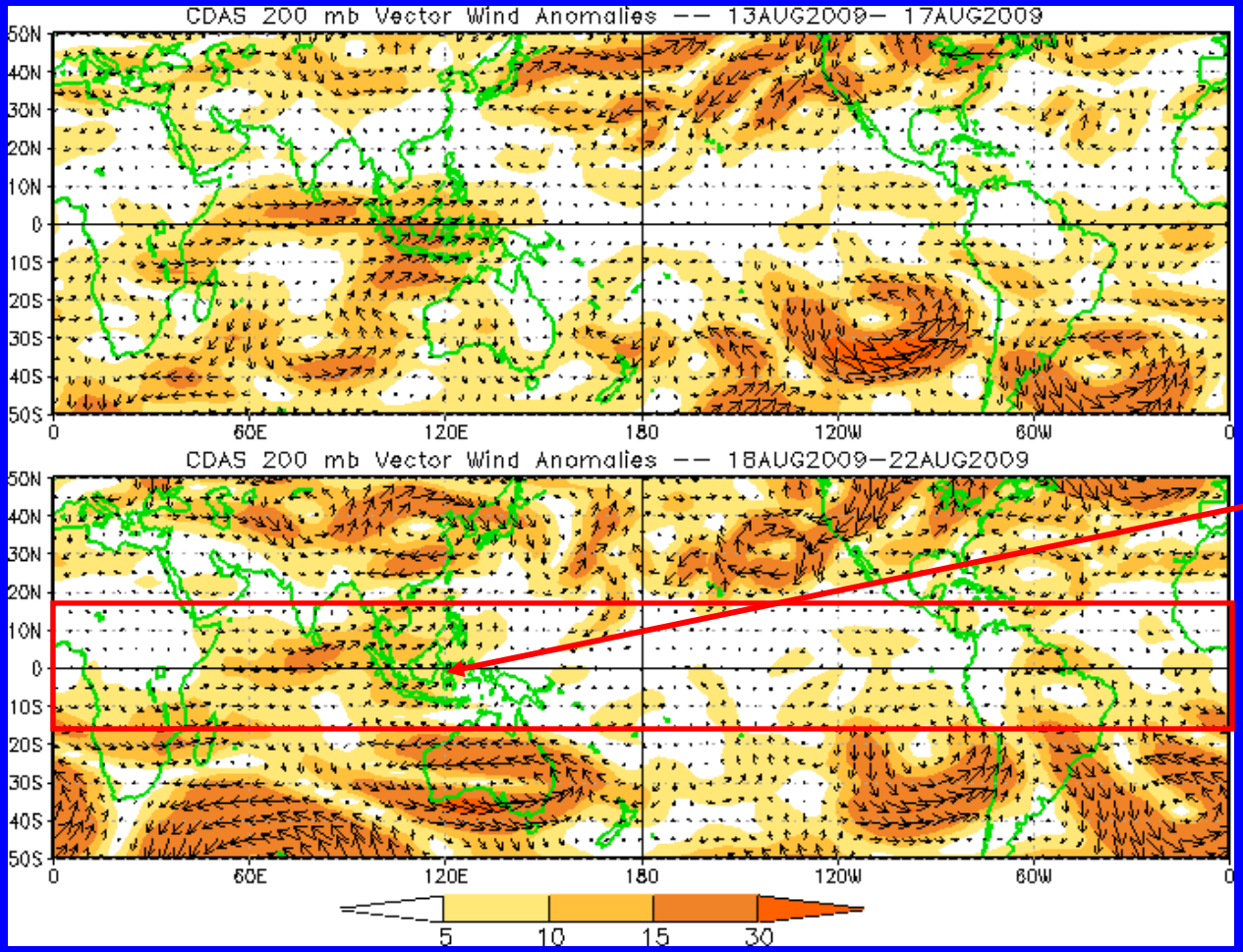
**Positive anomalies (brown contours) indicate unfavorable conditions for precipitation**

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




**The latest velocity potential anomalies indicate upper-level convergence from the Indian Ocean to just east of the Date Line, while upper-level divergence is indicated over the eastern Pacific Ocean extending eastward across Africa.**

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



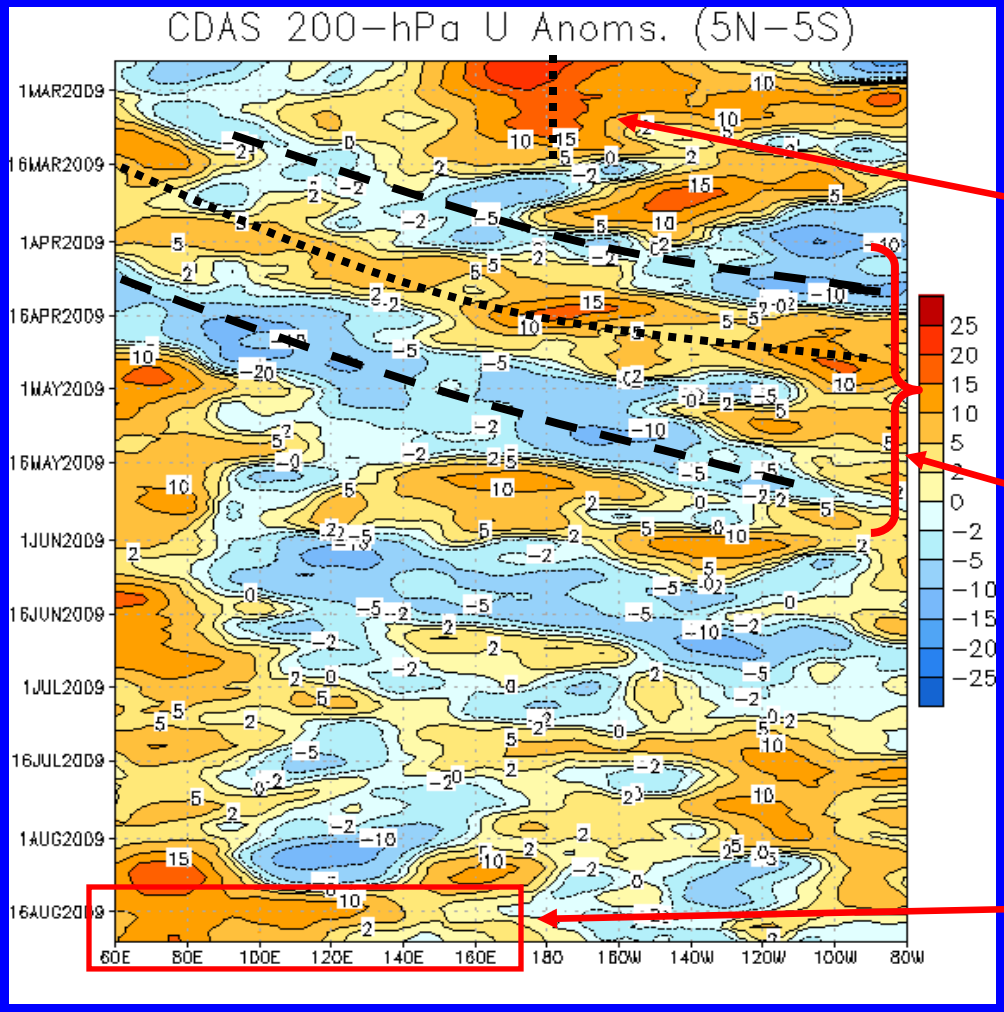

**Note that shading denotes the magnitude of anomalous wind vectors**

**Weak wind anomalies are seen across most of global tropics (15N-15S) except for westerly anomalies over the Indian Ocean and Maritime Continent which have persisted 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

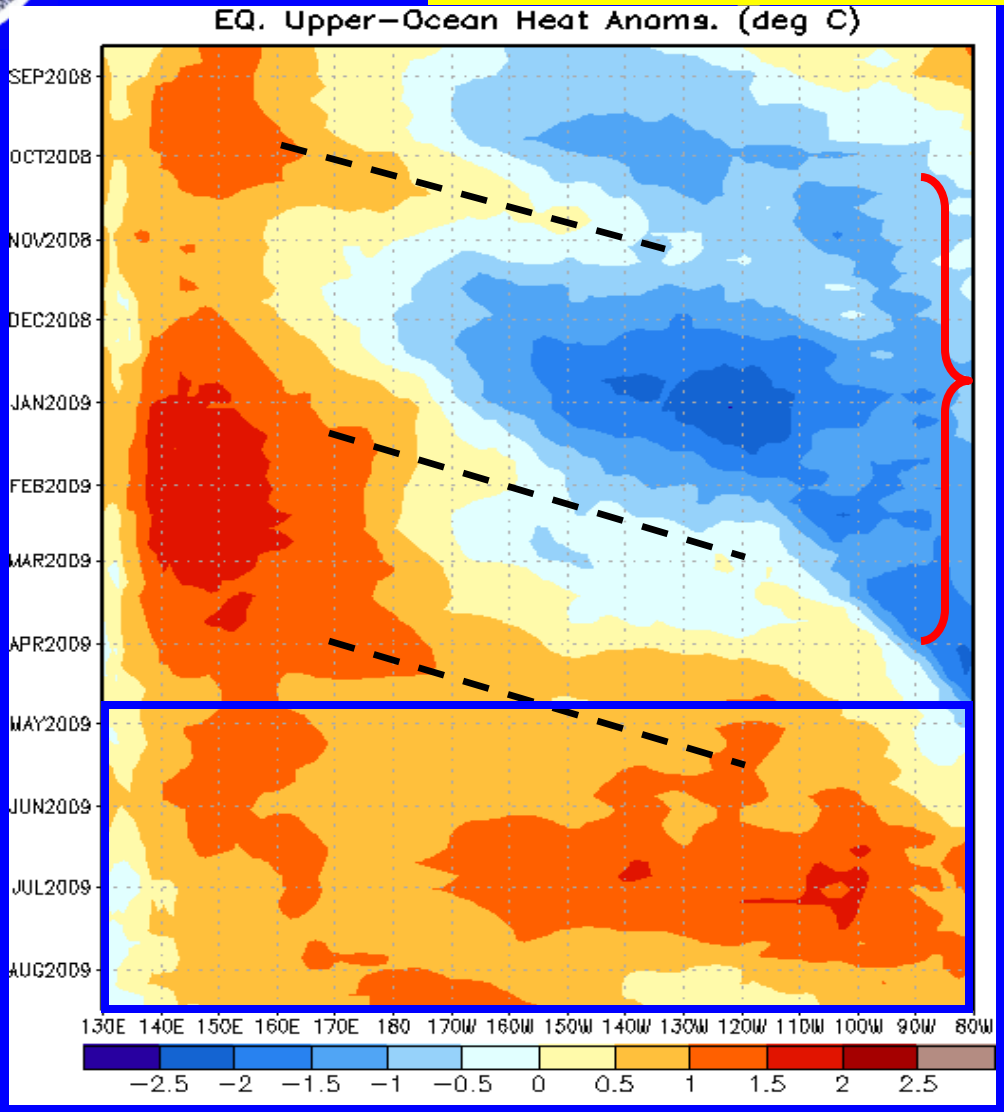
Longitude

**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.**

**During the last two weeks, westerly anomalies persisted across the Indian Ocean, Maritime continent and the western Pacific Ocean.**

# Weekly Heat Content Evolution in the Equatorial Pacific




Time

Longitude

- 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 then, heat content anomalies have remained above-average.

# MJO Index -- Information

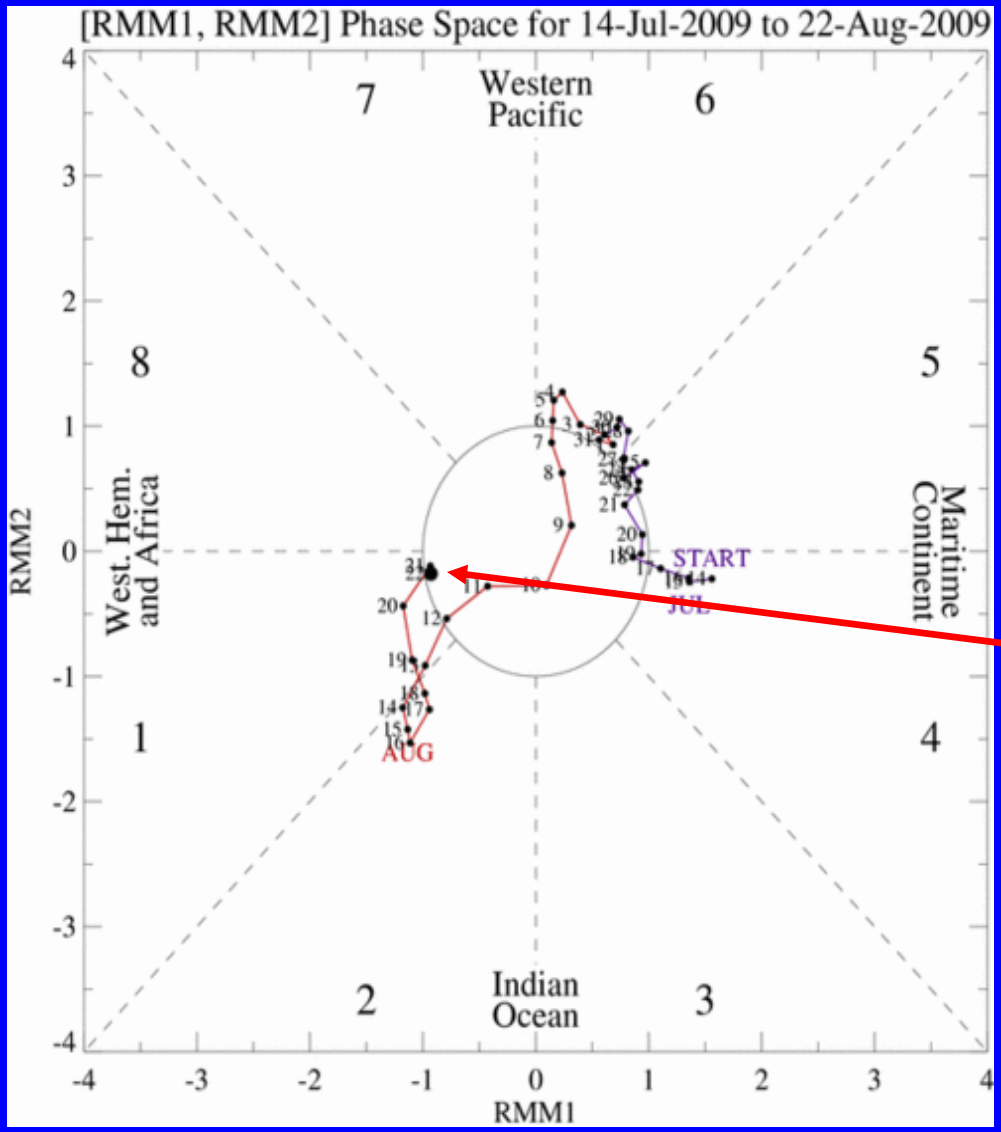
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

**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).**

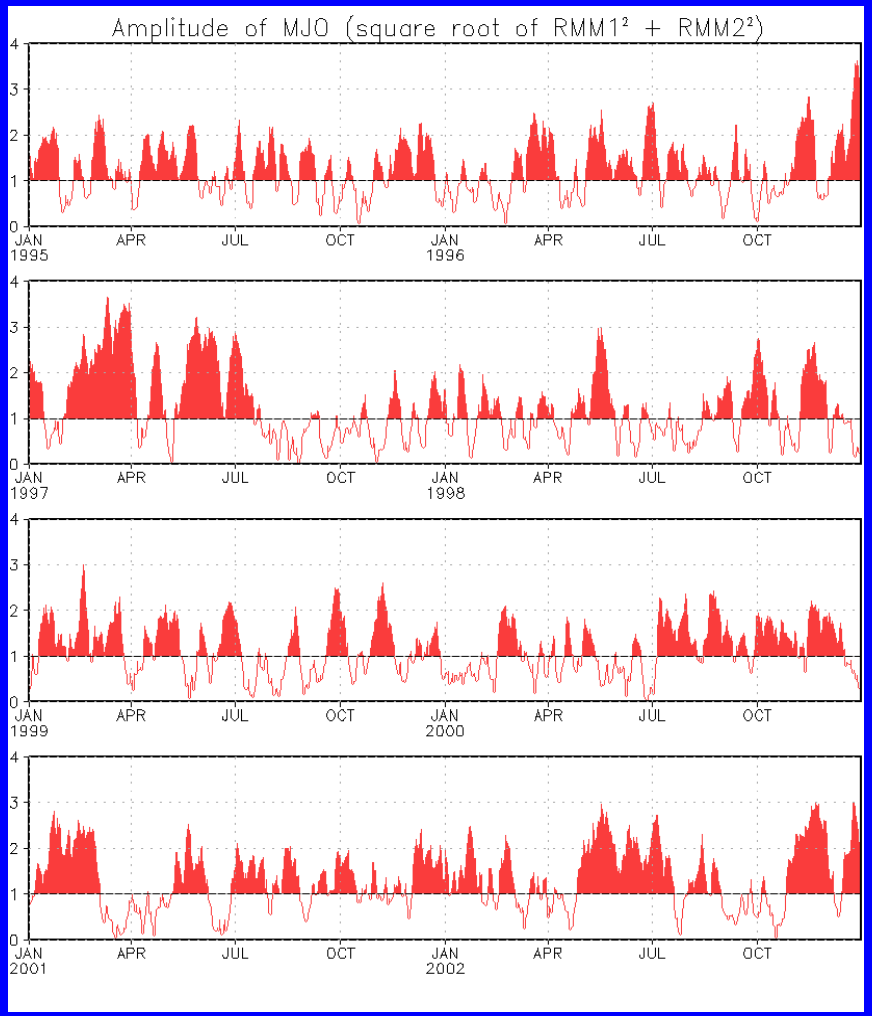
# MJO Index -- Recent Evolution

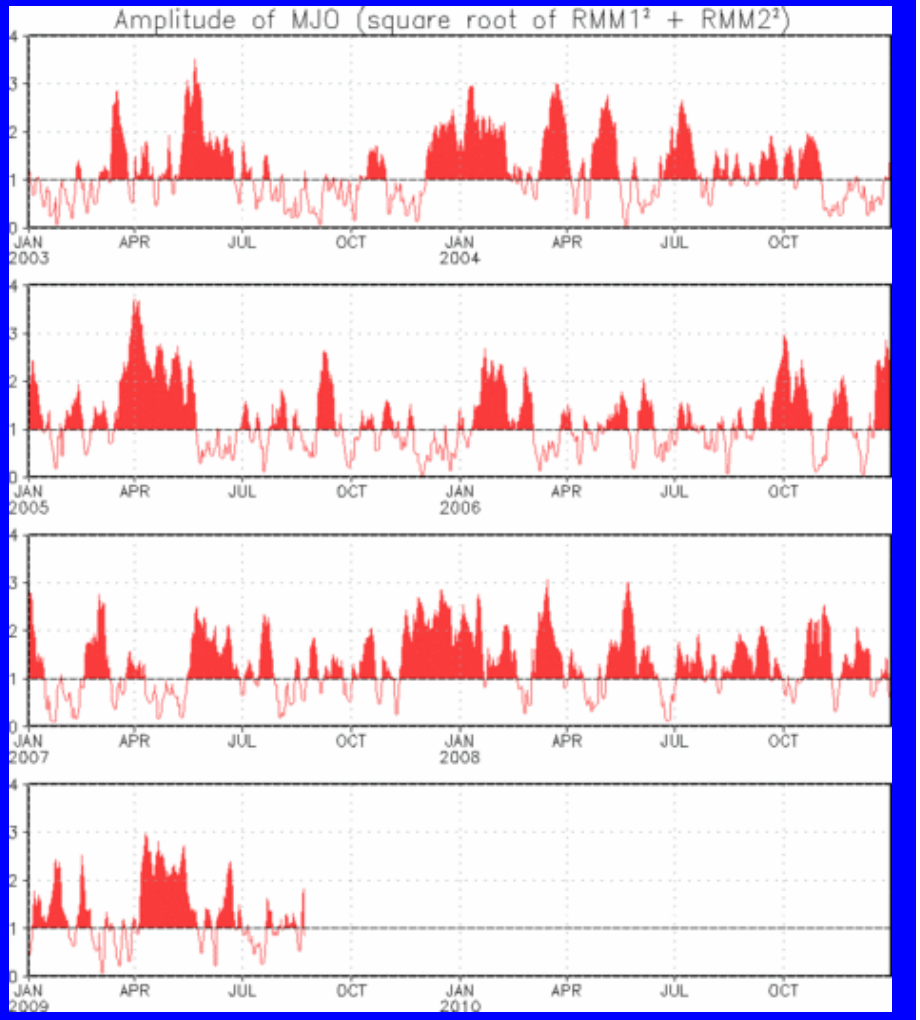



- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

**During the past week, the MJO index indicates a decrease in amplitude with no 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.**

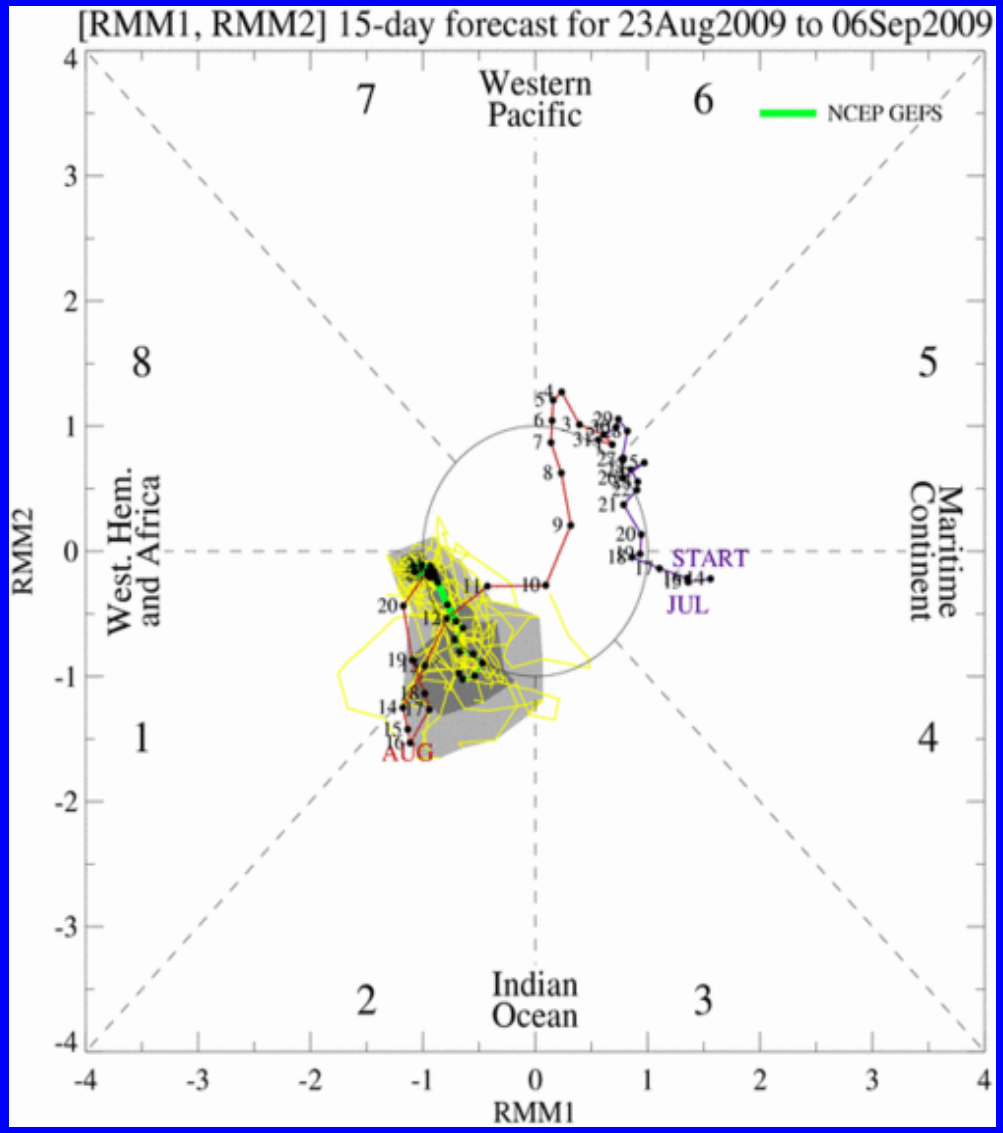
# Ensemble GFS (GEFS) MJO Forecast

**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**

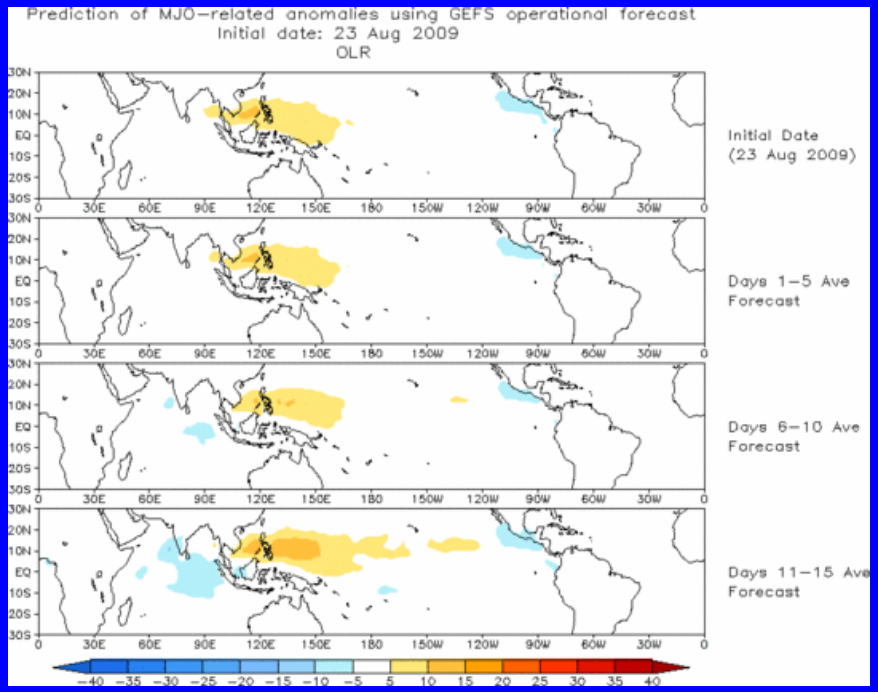
**The GEFS forecasts little change in the amplitude of the MJO index with slight eastward propagation during the period.**



# Ensemble Mean GFS MJO Forecast

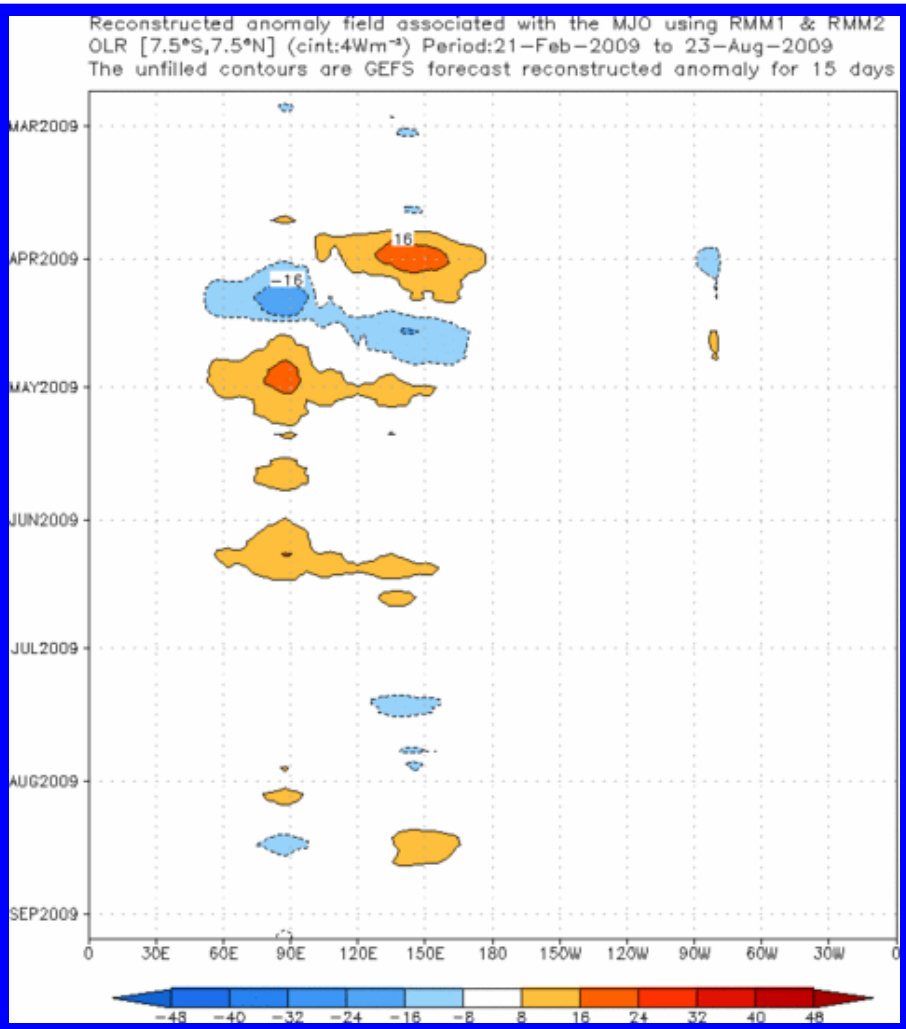
**Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)**

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




**The GEFS ensemble mean forecasts weak suppressed convection over the western Pacific Ocean during Week-1 and Week-2 periods.**

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



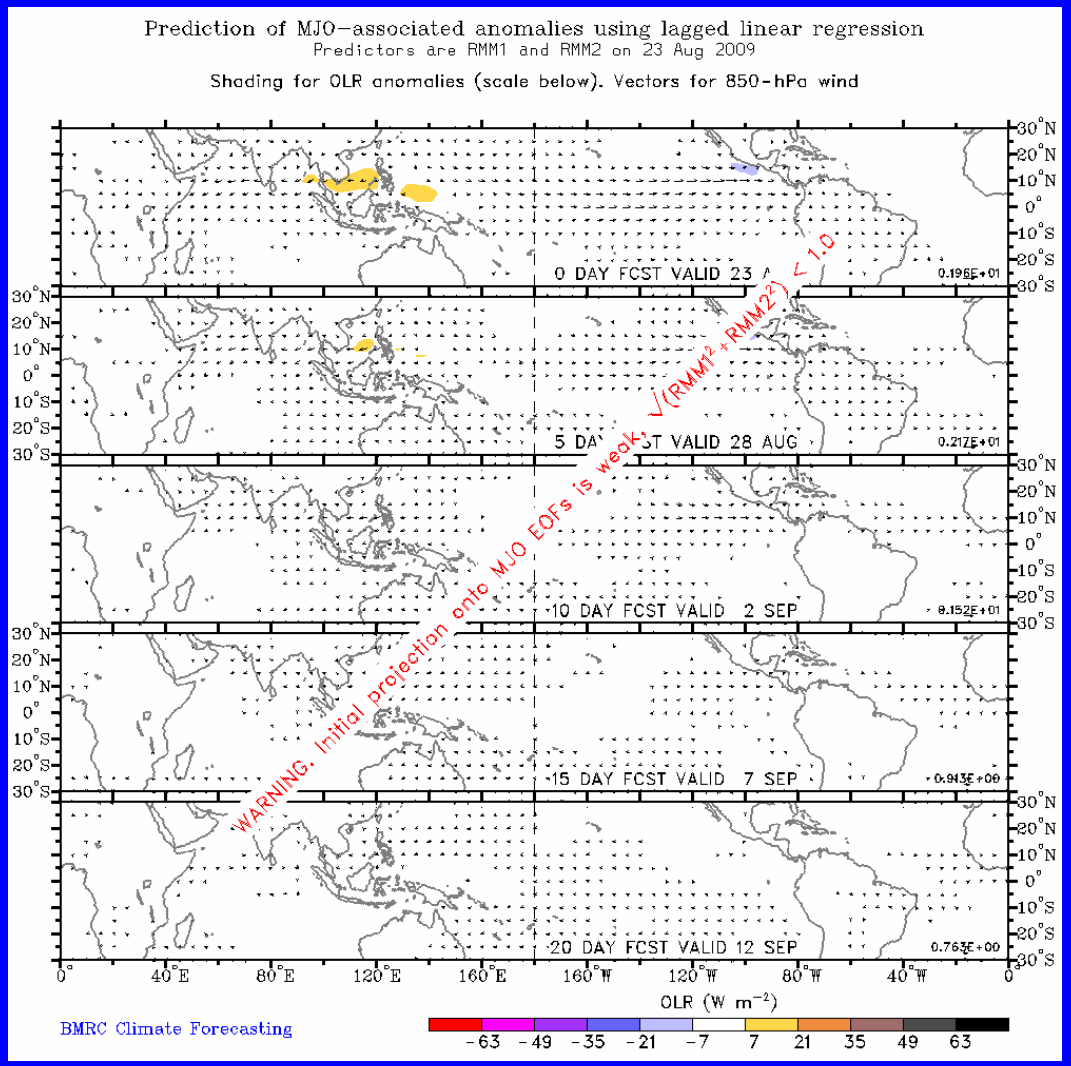
# Statistical MJO Forecast

**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**

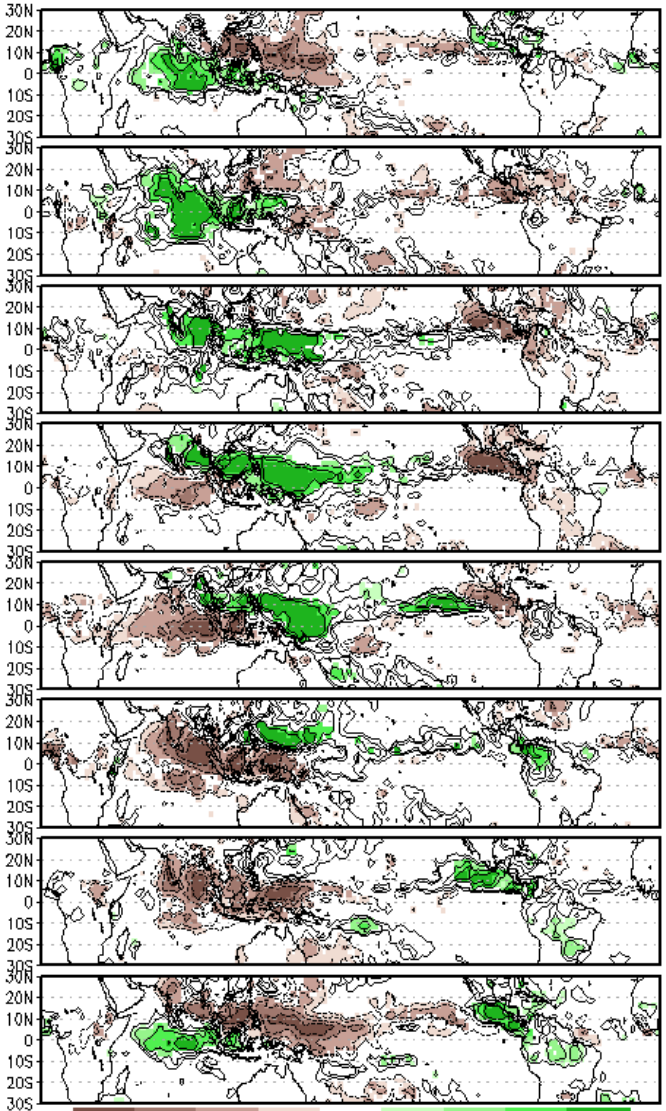
**(Courtesy of the Bureau of Meteorology Research Centre - Australia)**

**A statistical model forecasts weak MJO activity during the next 1-2 weeks.**



# MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)




850-hPa Wind Anomalies (May-Sep)