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

Update prepared by
Climate Prediction Center / NCEP
July 6, 2009

Outline

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

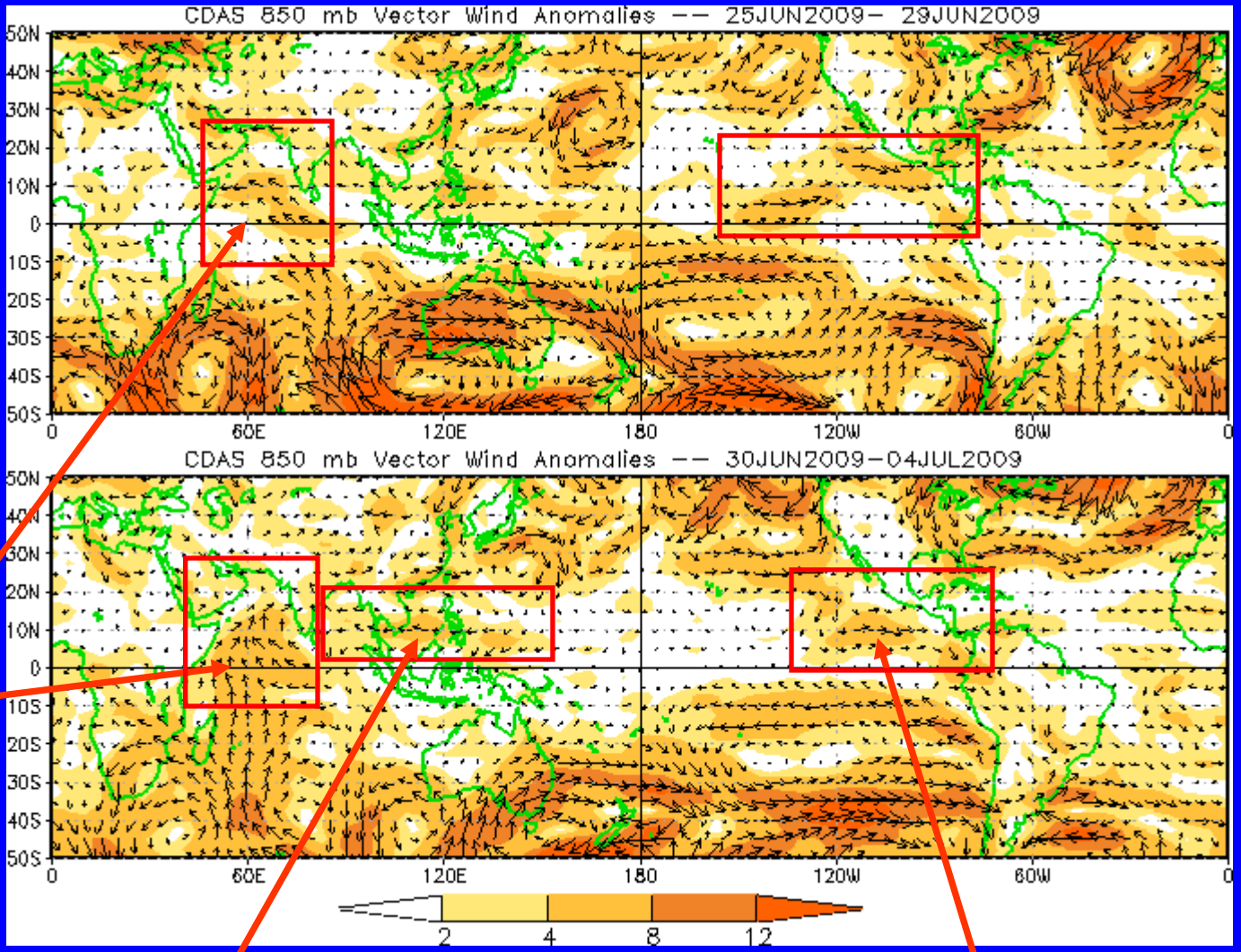
Overview

- The MJO remains weak.
- Based on the latest observations and model forecasts, significant MJO activity is not expected during the next 1-2 weeks.
- At the current time, the MJO is not forecast to contribute significantly to the pattern of tropical rainfall and tropical cyclogenesis.

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



A stronger monsoonal flow is evident across the Indian Ocean and India during the last five days.

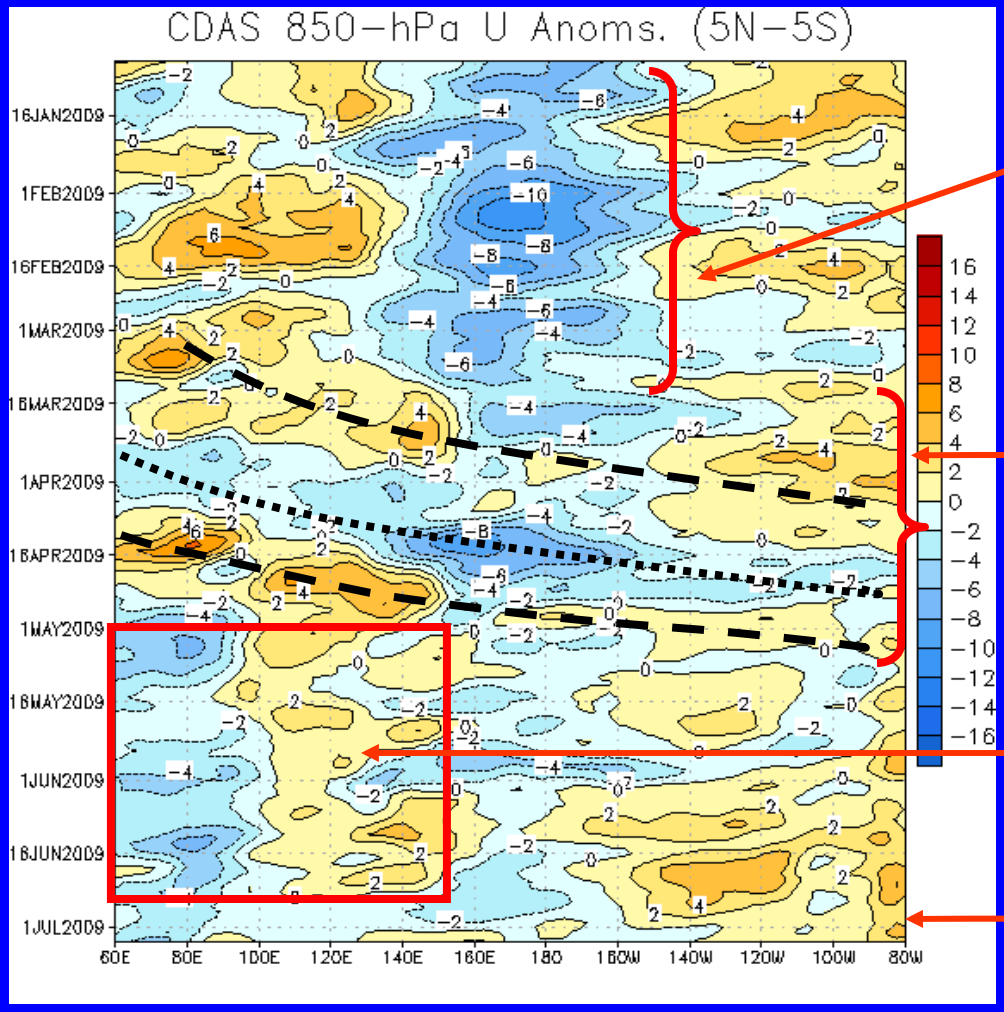
Easterly anomalies have strengthened across Southeast Asia and the western Pacific Ocean.

Westerly anomalies have weakened across the eastern Pacific 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

A persistent pattern of westerly (easterly) anomalies over the Indian Ocean (central Pacific Ocean) were in place from mid-December to mid-March.

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

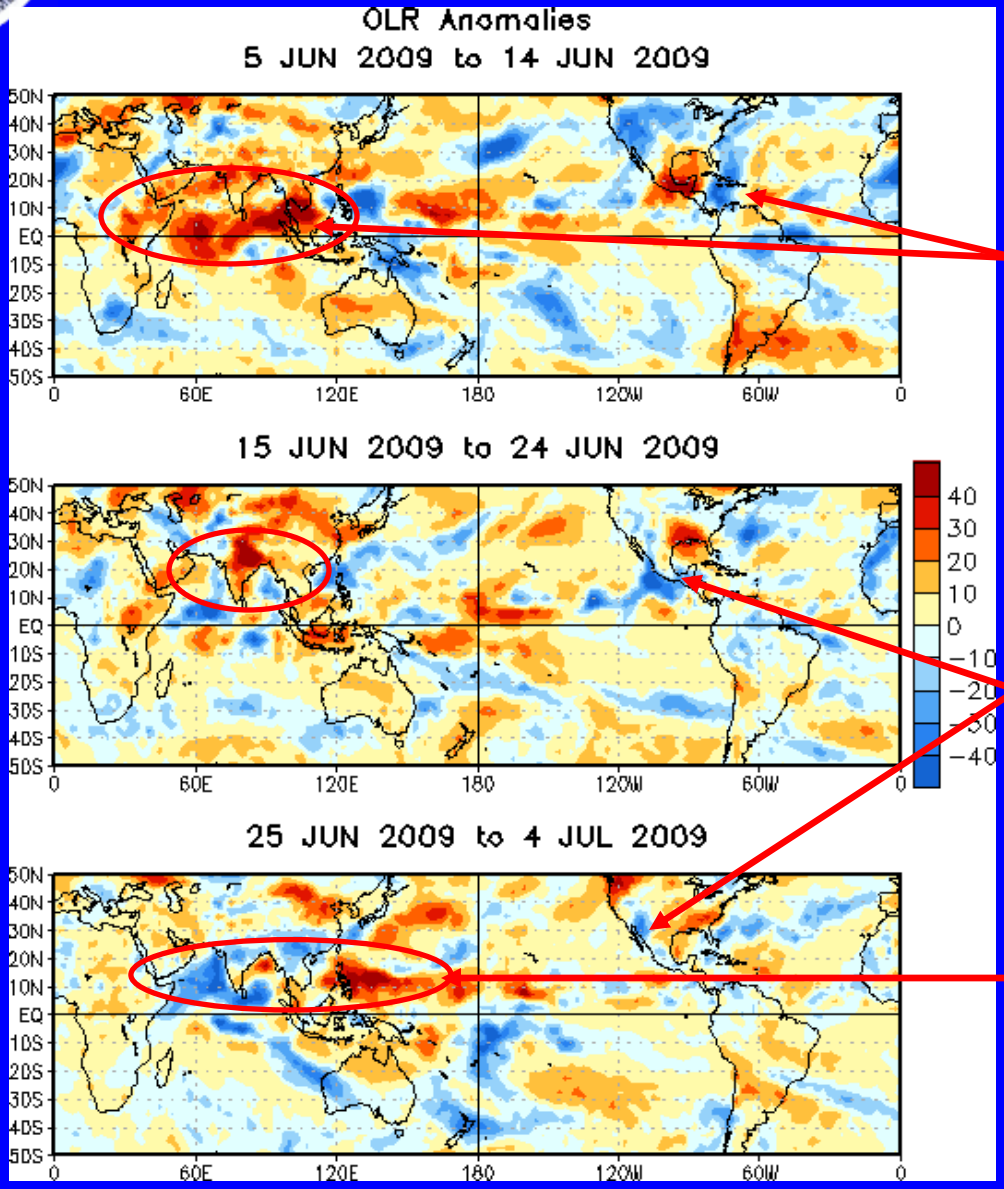
During May and much of June, a persistent pattern of easterly (westerly) anomalies is evident across the Indian Ocean (western Indonesia) areas.

The winds are now close to average across much of the Indian Ocean, Indonesia and western Pacific.

OLR Anomalies: Last 30 days

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

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

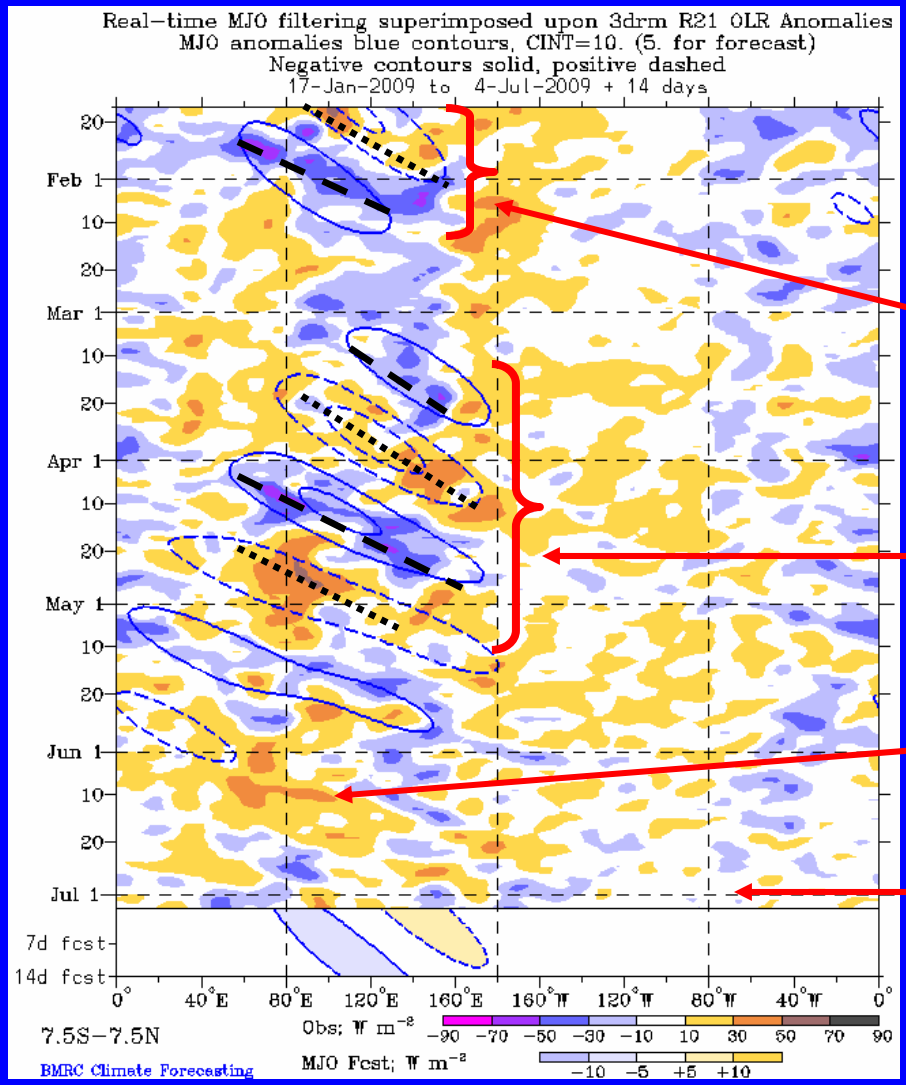


In early June, suppressed convection was strong across the Indian Ocean and southern Asia while wet conditions prevailed across the Caribbean Sea and Cuba.

Weakened monsoon systems continued in mid June as convection was below average. Enhanced convection was evident across the eastern Pacific stretching in the Southwest US.

Convection increased across the Arabian Sea and India by early July. At the same time, suppressed convection was indicated across the Philippines and western Pacific.

Outgoing Longwave Radiation (OLR) Anomalies (7.5°S-7.5°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 - Australia)

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

From mid-March into early May, areas of suppressed and enhanced convection shifted eastward in association with the MJO.

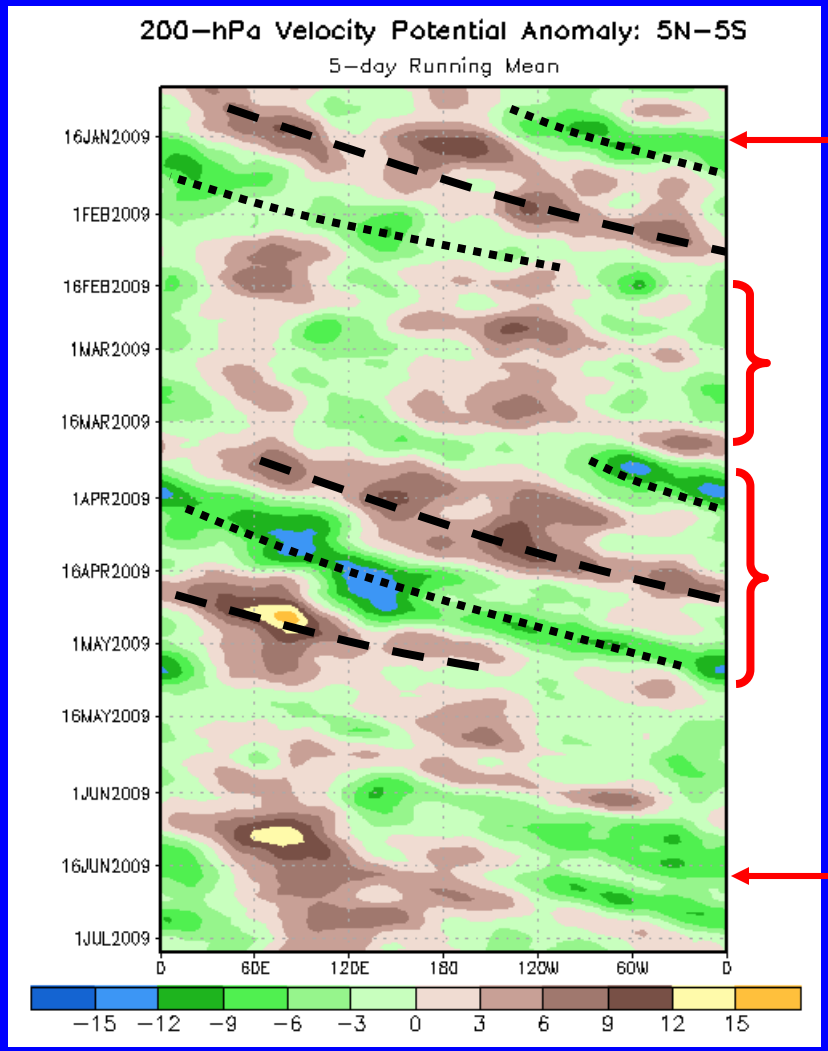
During the first half of June, suppressed convection prevailed across much of the Indian Ocean and Maritime Continent.

Most recently, equatorial convection is close to average across much of the Tropics.

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

Velocity potential anomalies increased as the MJO strengthened and shifted eastward during January to mid-February.

No coherent pattern was exhibited in the weak velocity potential anomalies from mid-February through early March.

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

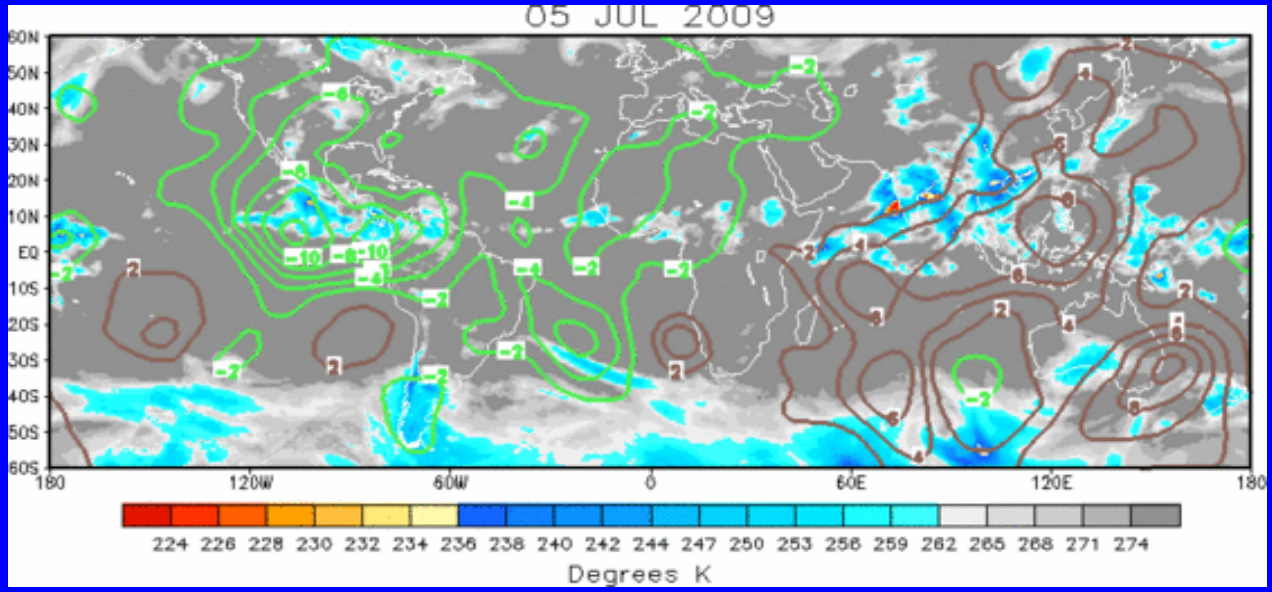
The MJO weakened in May.

Velocity potential anomalies increased during June as the MJO showed signs of strengthening. However, by late June any MJO signal disappeared.

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

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

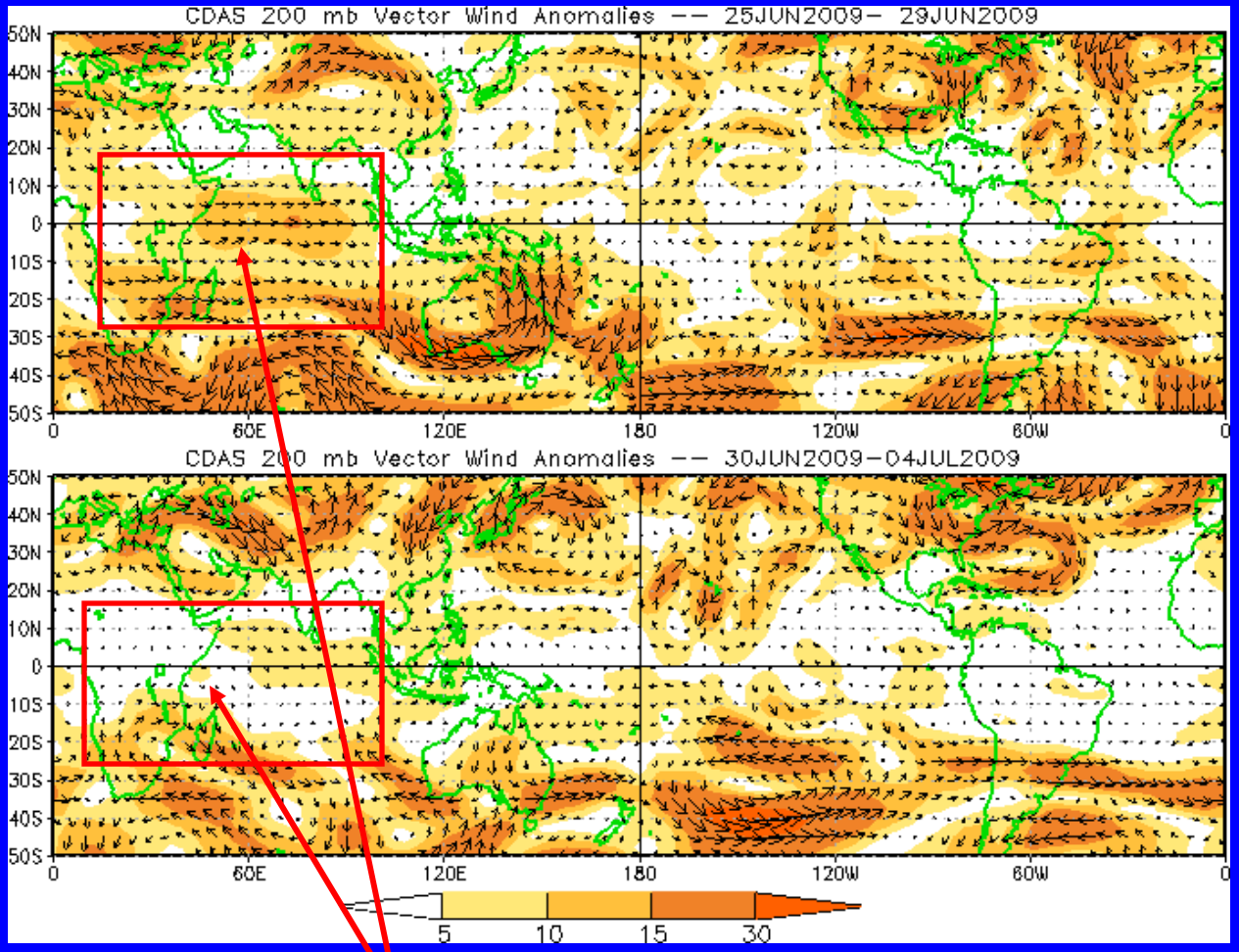
Negative anomalies (green contours) indicate favorable conditions for precipitation



The latest velocity potential pattern indicates a strong area of upper-level divergence across the eastern Pacific and Central America while upper-level convergence continues across the Maritime continent albeit with a decreased intensity.

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

Note that shading denotes the magnitude of anomalous wind vectors

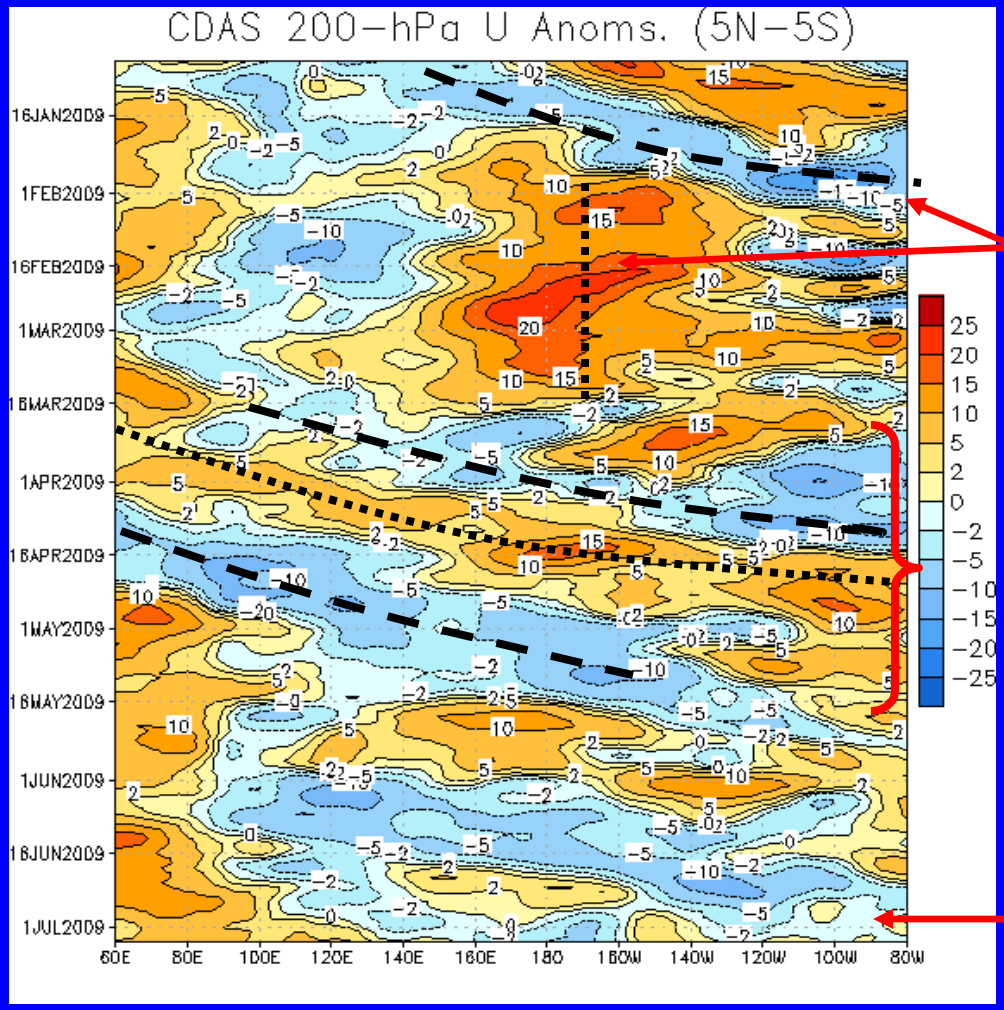


Anomalous westerlies over the Indian Ocean have decreased considerably.

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

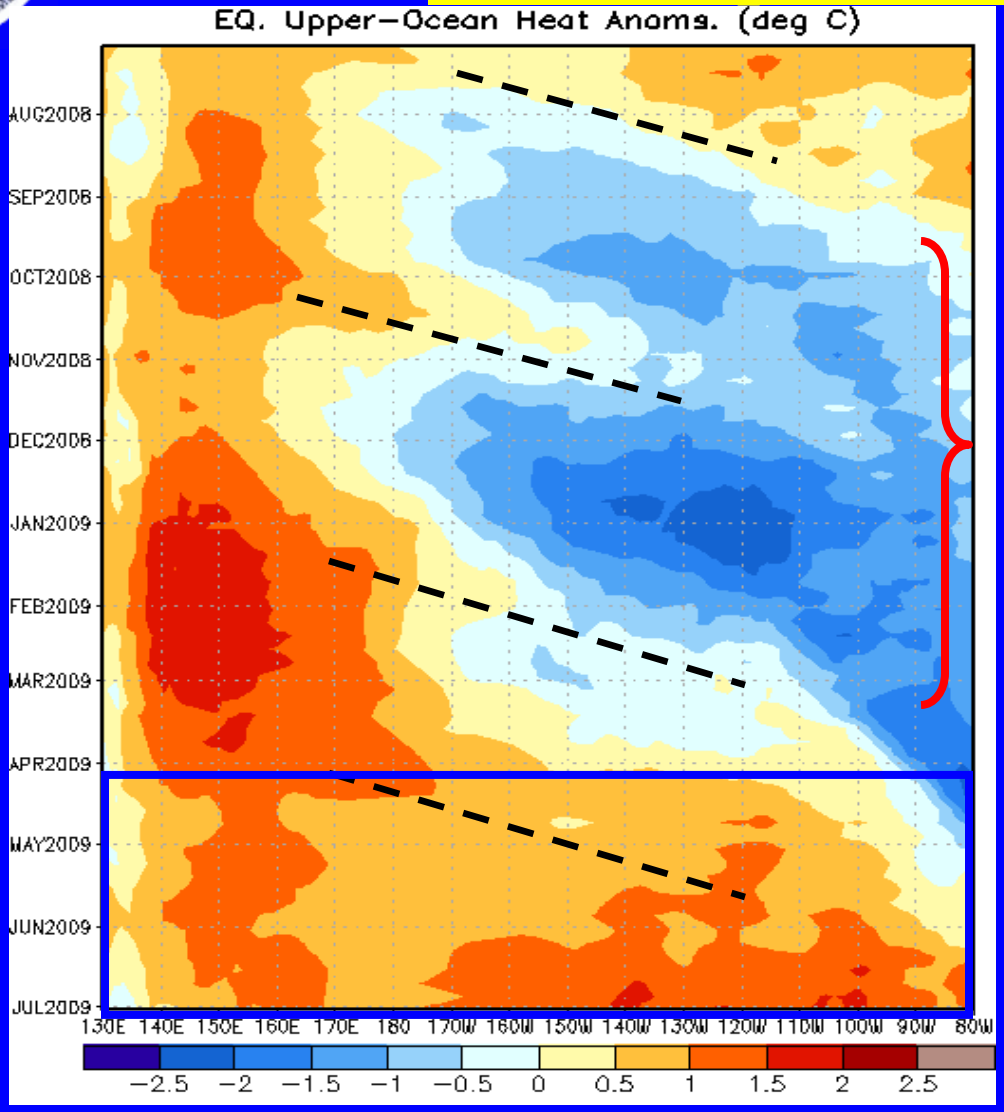
Longitude

Westerly anomalies strengthened markedly in late December 2008 near the Date Line and persisted into March 2009. These anomalies are consistent with La Nina conditions. The period was interrupted by MJO activity as easterly anomalies shifted eastward through this region during January.

Easterly and westerly anomaly patterns consistent with MJO activity shifted eastward from mid-March to the beginning of May

Outside of westerly anomalies across parts of the Indian Ocean, equatorial winds are close to average across much of the Tropics.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

During 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 increased/expanded eastward through early 2009. There was a pause in this increase during October as a Kelvin wave shifted eastward.

An eastward propagating Kelvin wave during April and May contributed to increased heat content in the eastern half of the Pacific.

Positive anomalies in the Pacific have increased in magnitude and coverage during May and June 2009 (blue box).

MJO Index -- Information

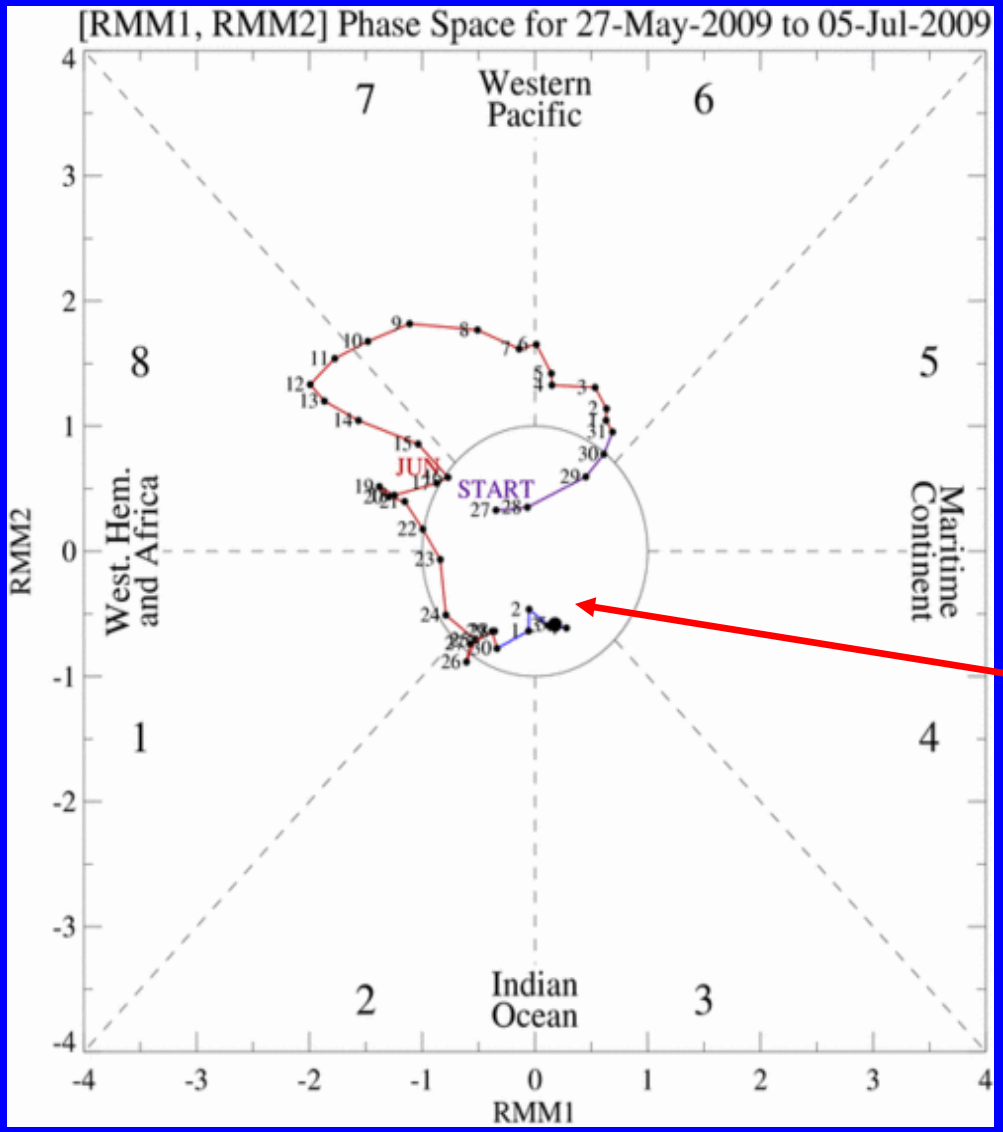
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

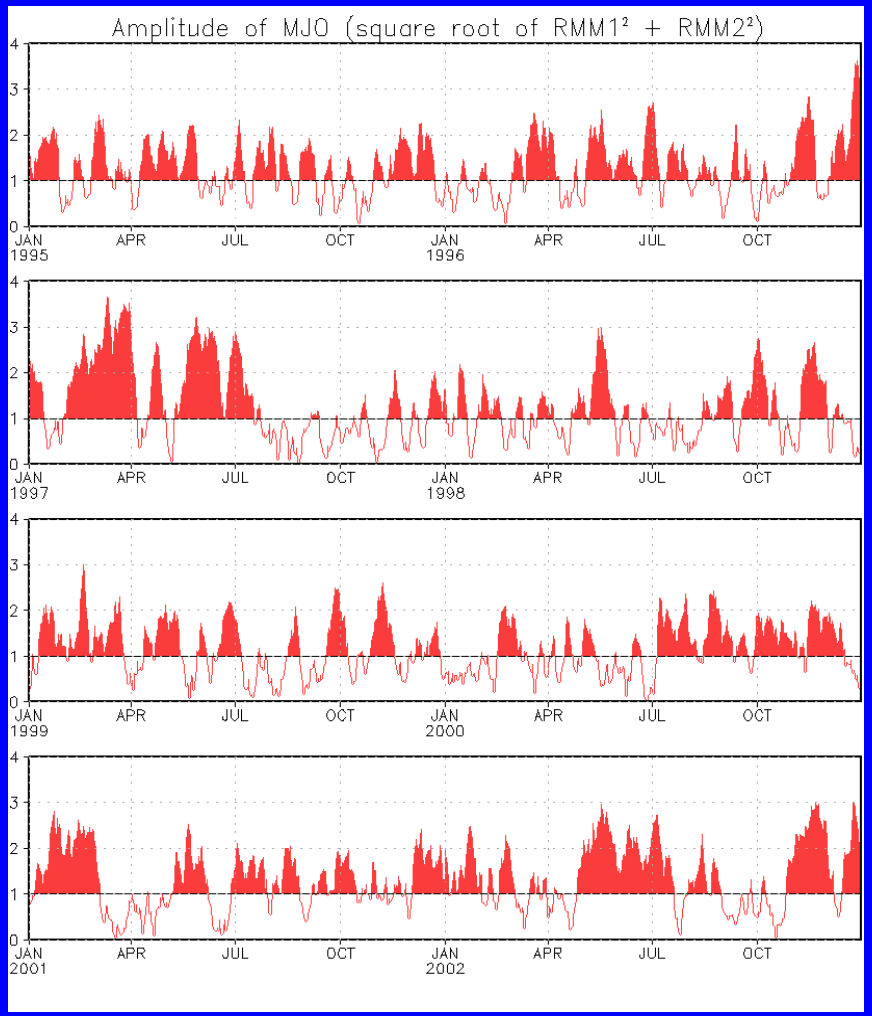
MJO Index -- Recent Evolution

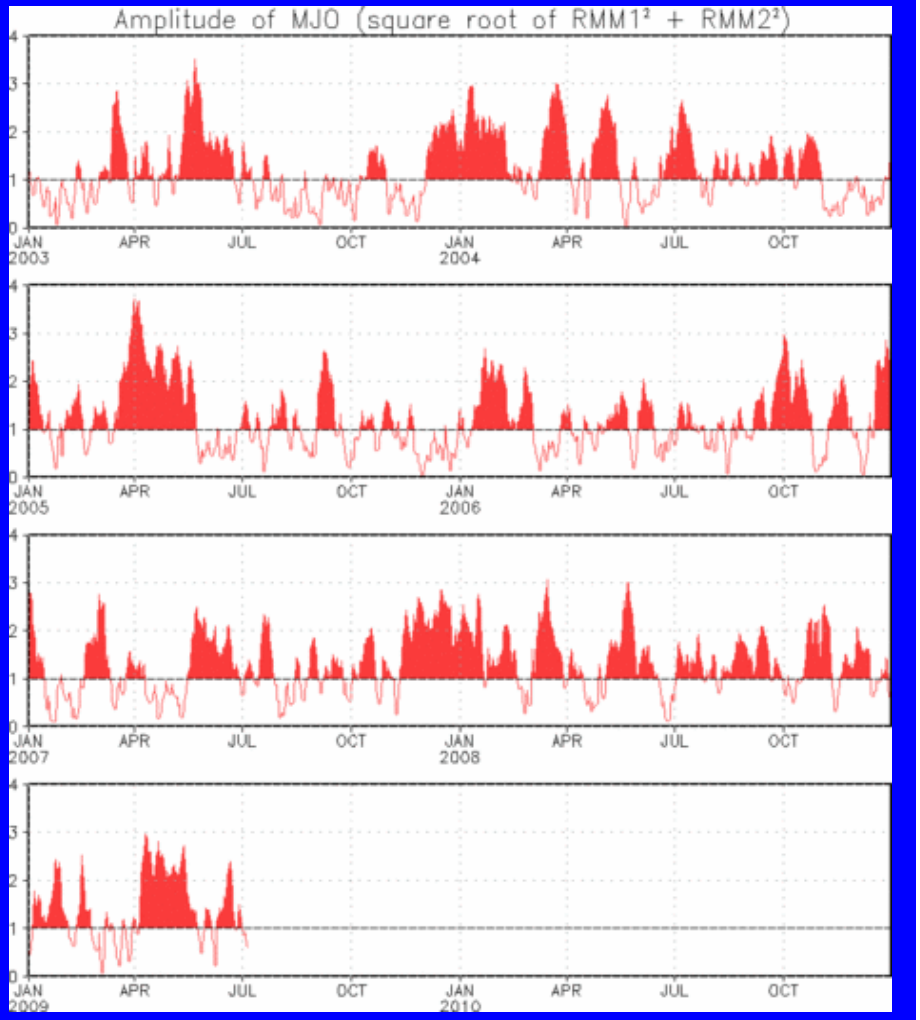


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

The MJO index continues to indicate a weak signal.

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.

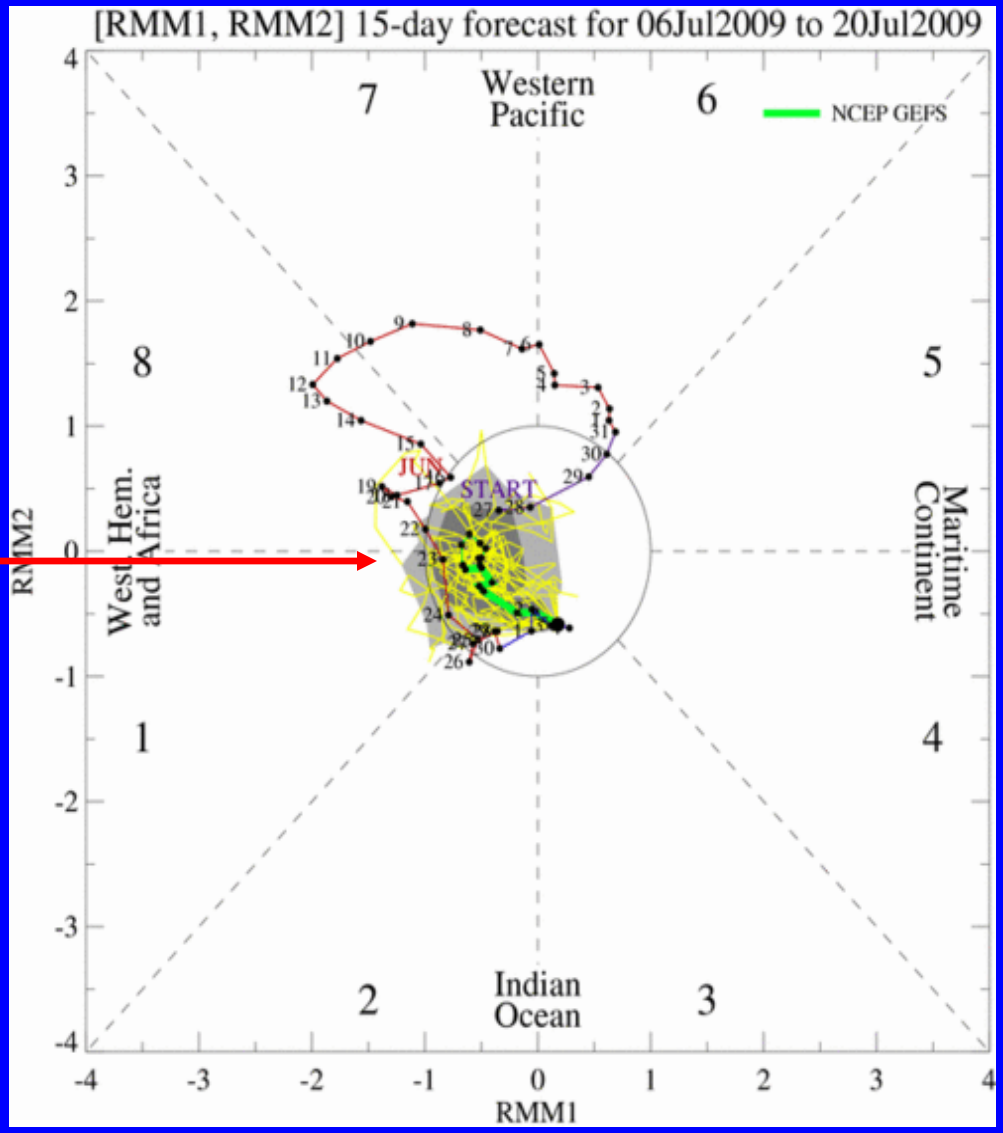
Ensemble GFS (GEFS) MJO Forecast

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

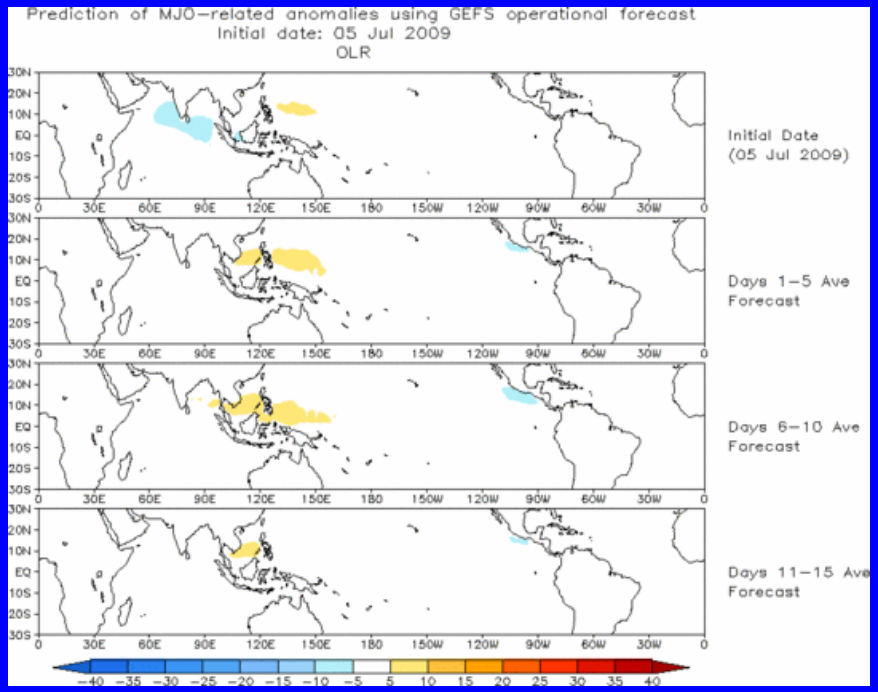
The GEFS forecasts little coherent MJO signal during the next 1-2 weeks as the signal is forecast to shift westward during the period.



Ensemble Mean GFS MJO Forecast

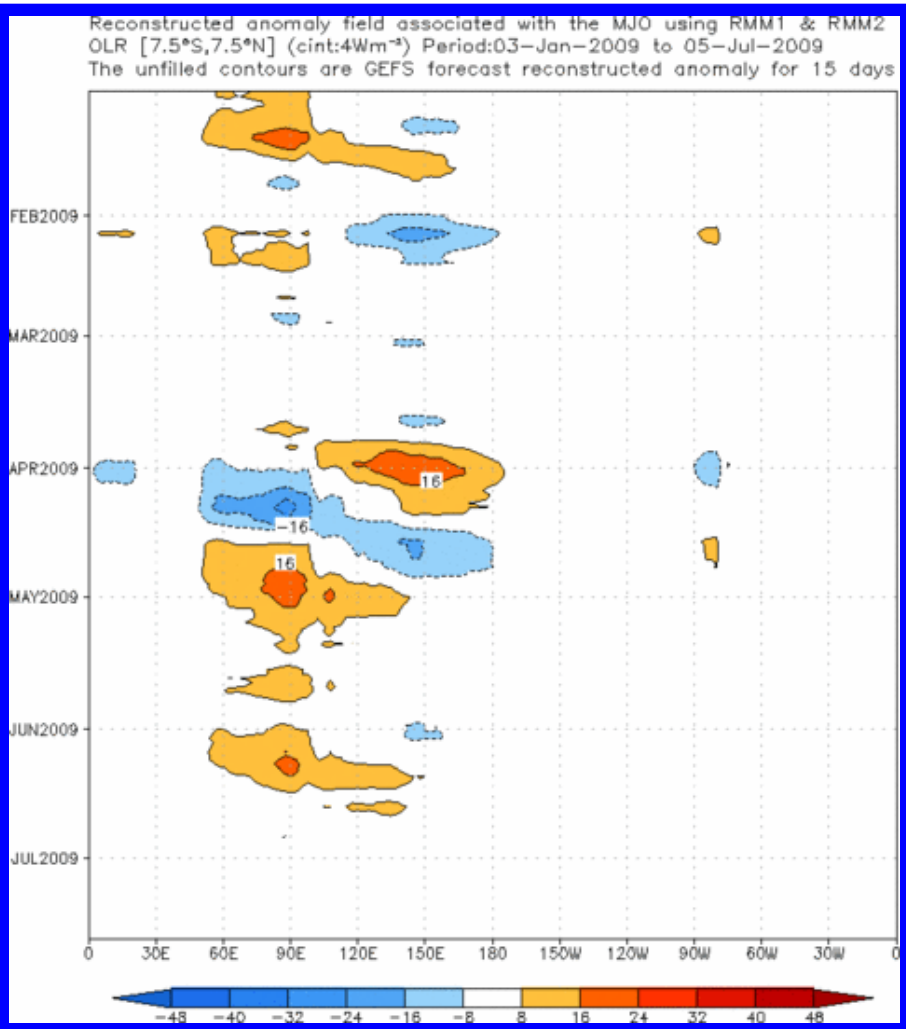
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



Very weak convective signals are indicated by the GEFS ensemble mean forecast.

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



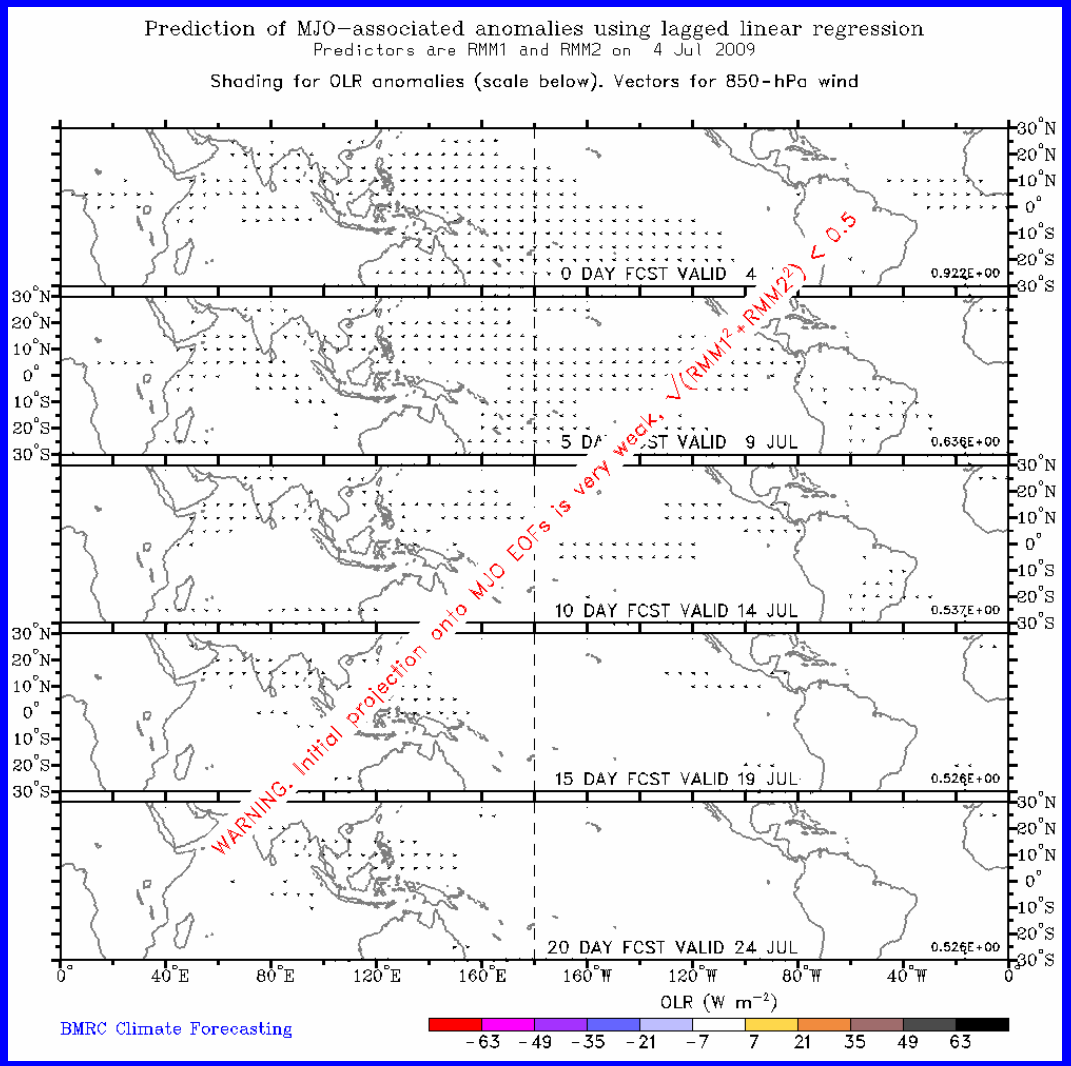
Statistical MJO Forecast

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

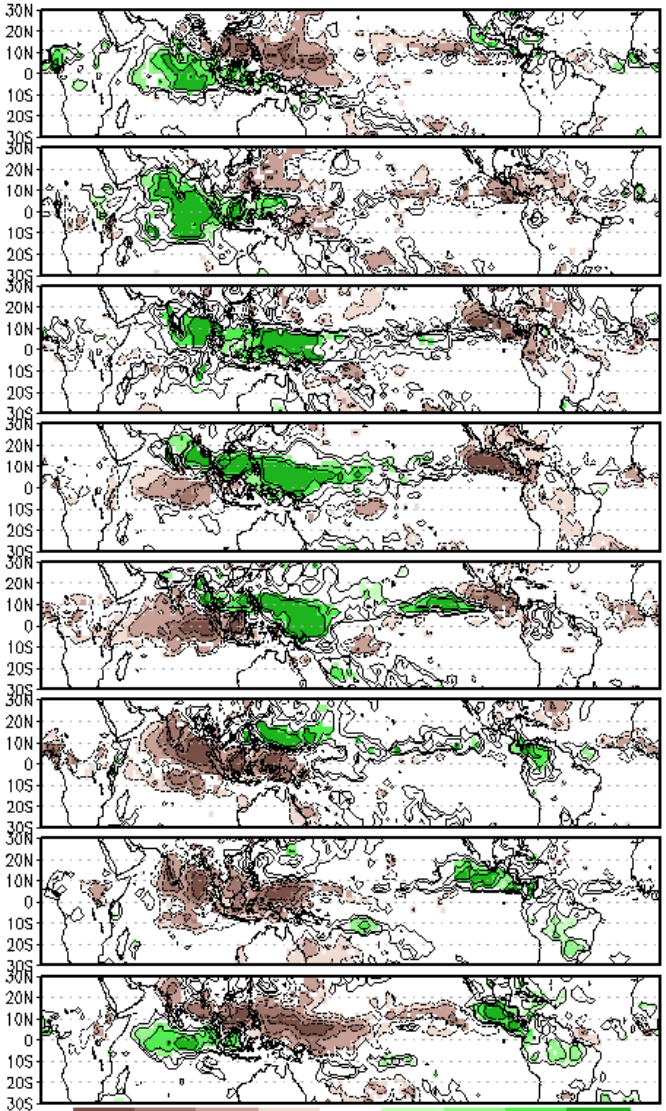
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

A statistical forecast indicates no MJO activity during the next 1-2 weeks.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)