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

Update prepared by
Climate Prediction Center / NCEP
June 15, 2009

Outline

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

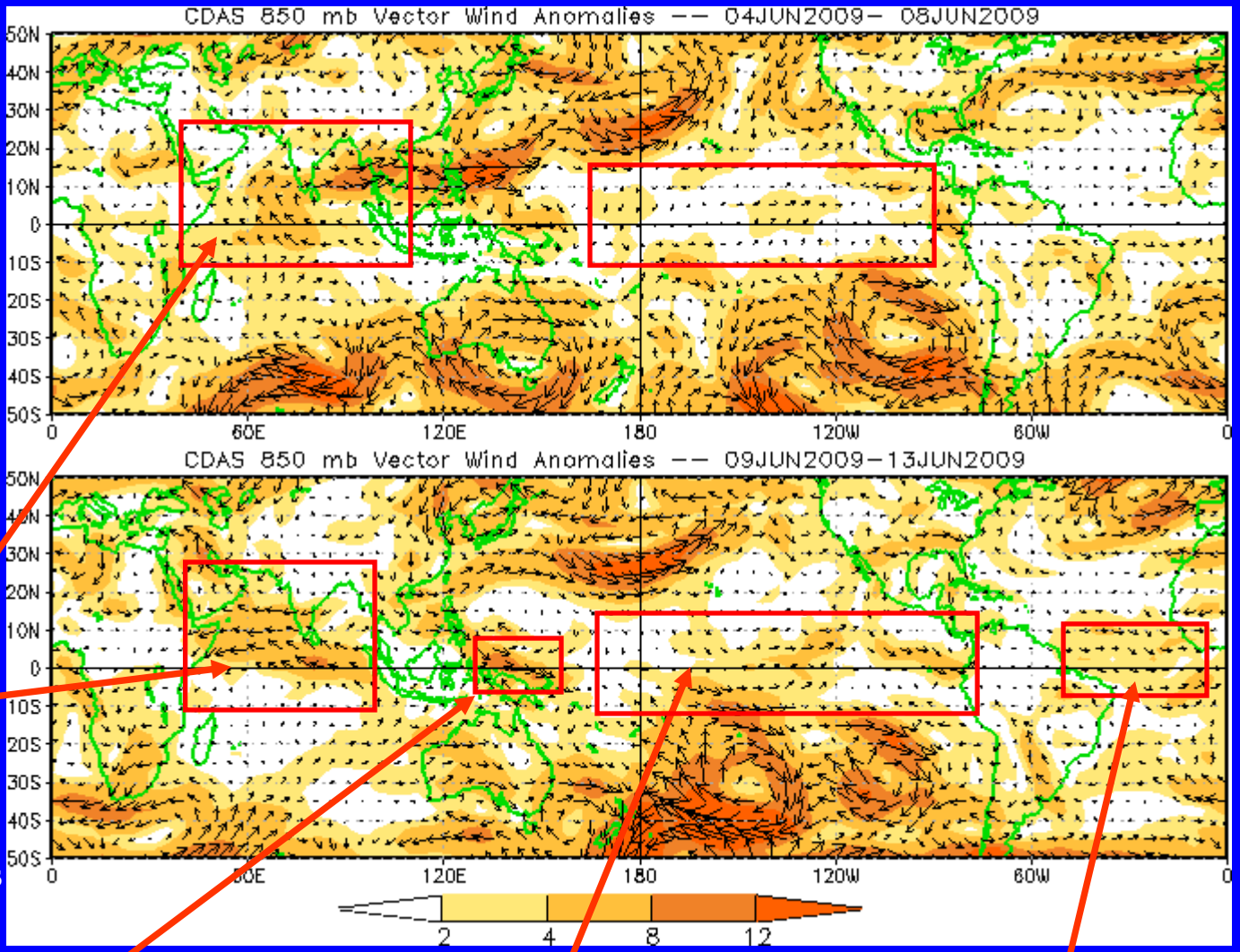
Overview

- The MJO strengthened during the past week with the enhanced convective phase located across the Western Hemisphere.
- Based on the latest observations and model forecasts, moderate MJO activity is expected during the next 1-2 week period.
- The MJO is anticipated to contribute to increased rainfall over the Americas and west-central Africa and decreased rainfall for southern India (Week-1 only) and parts of Southeast Asia and Maritime continent.
- The MJO is expected to elevate the risk of tropical cyclones across the eastern Pacific.

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



Anomalous easterly flow is now evident across the Indian Ocean. Flow into the Indian subcontinent is reduced.

A strong westerly wind burst has developed near Micronesia.

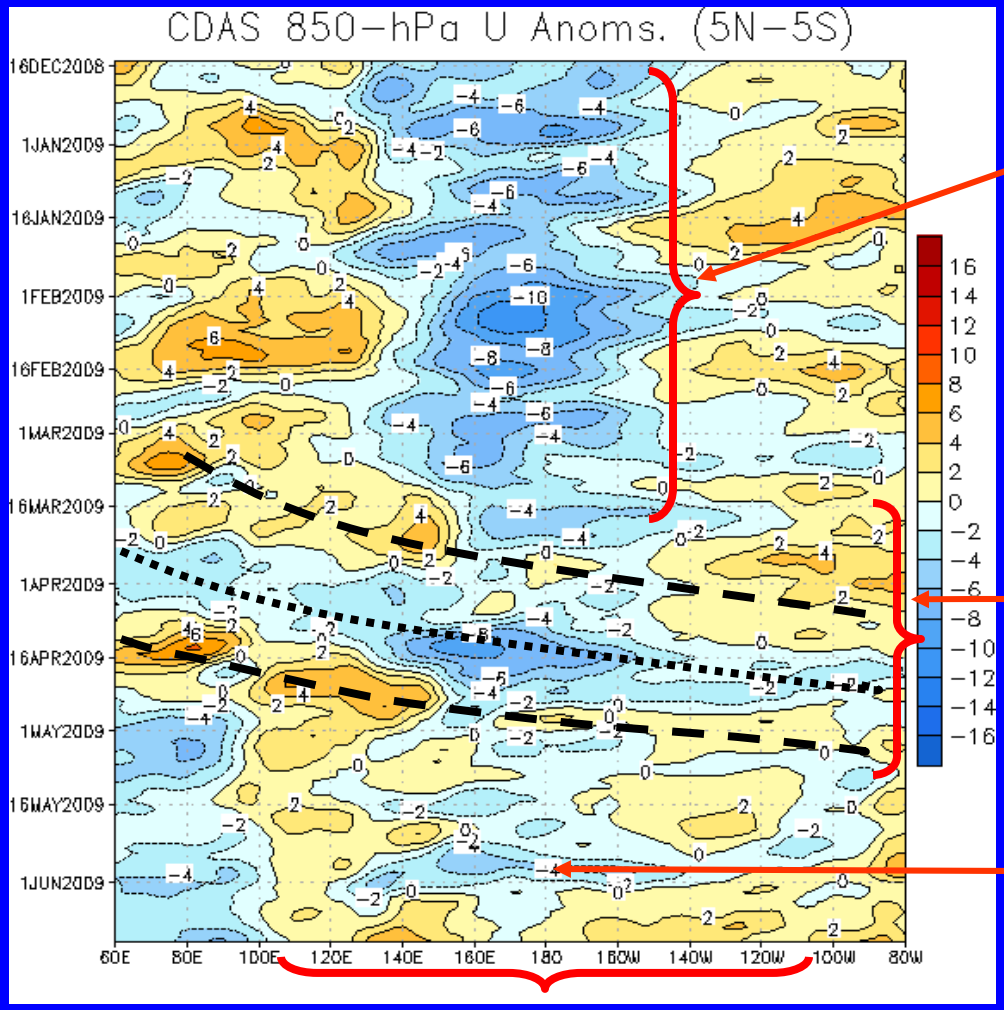
Low-level westerly anomalies have developed across much of the Central and Eastern Pacific Basins.

Westerly anomalies are evident across much of the tropical Atlantic into western Africa.

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.

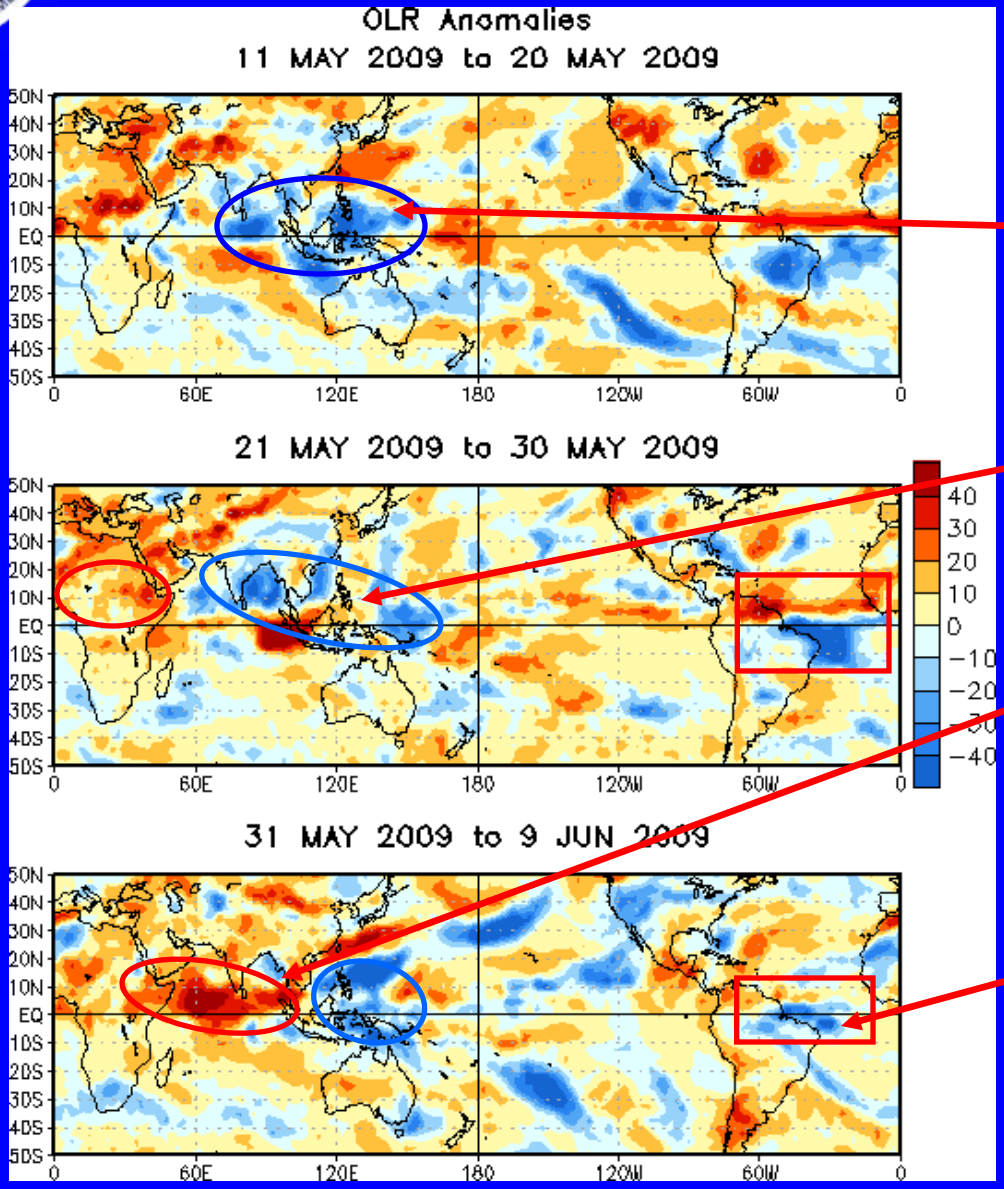
From mid-March to early May, a pattern of alternating low-level westerly, easterly and again westerly anomalies shifted eastward from the Indian Ocean through the equatorial Pacific associated with the MJO.

Easterly anomalies increased near and just west of the Date Line in late May but westerly wind anomalies are now evident across much of the Pacific basin.

OLR Anomalies: Last 30 days

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

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



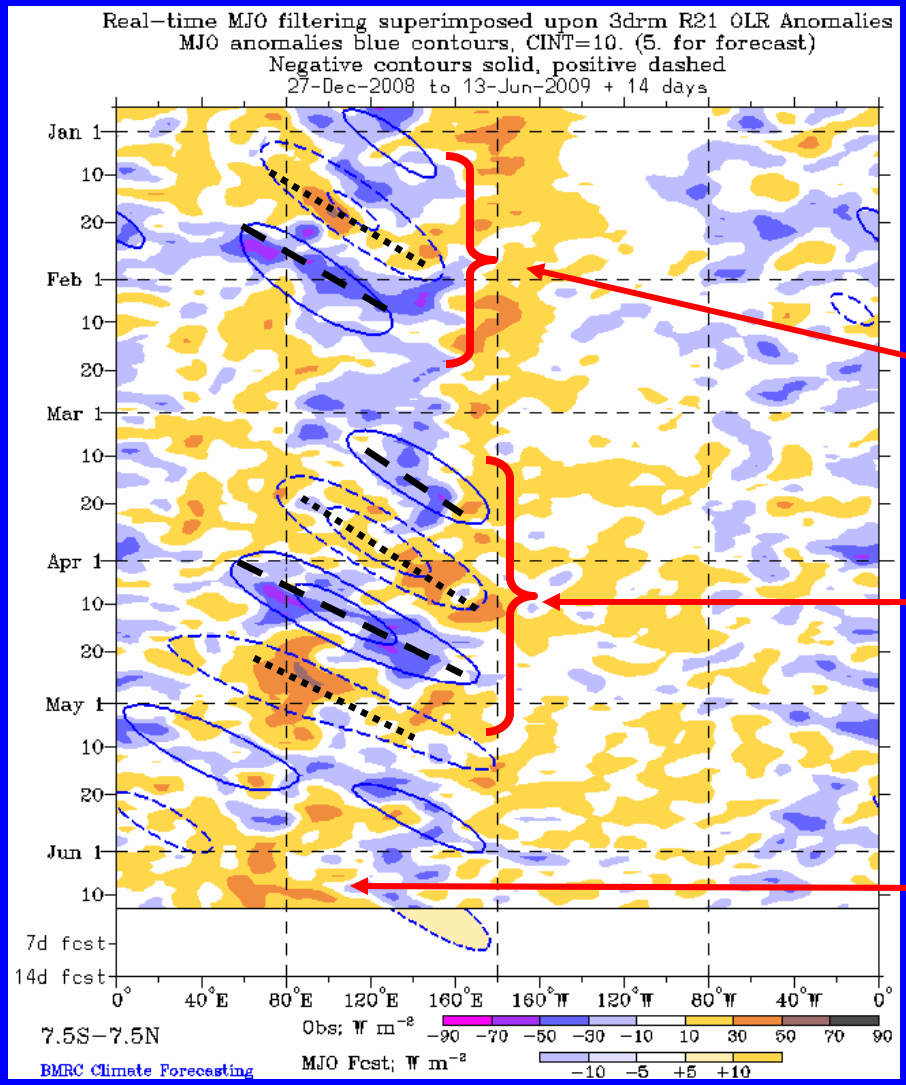
In mid-May, convection near the Philippines, the Maritime continent, and eastern Indian Ocean was slightly above average.

During late May, convection decreased across the Maritime continent and the Philippines while wet conditions moved into south Asia.

During late May and into early June, enhanced convection was focused across the western equatorial Pacific with suppressed convection across the Indian Ocean.

The couplet of suppressed (enhanced) convection evident has moved north and weakened.

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.

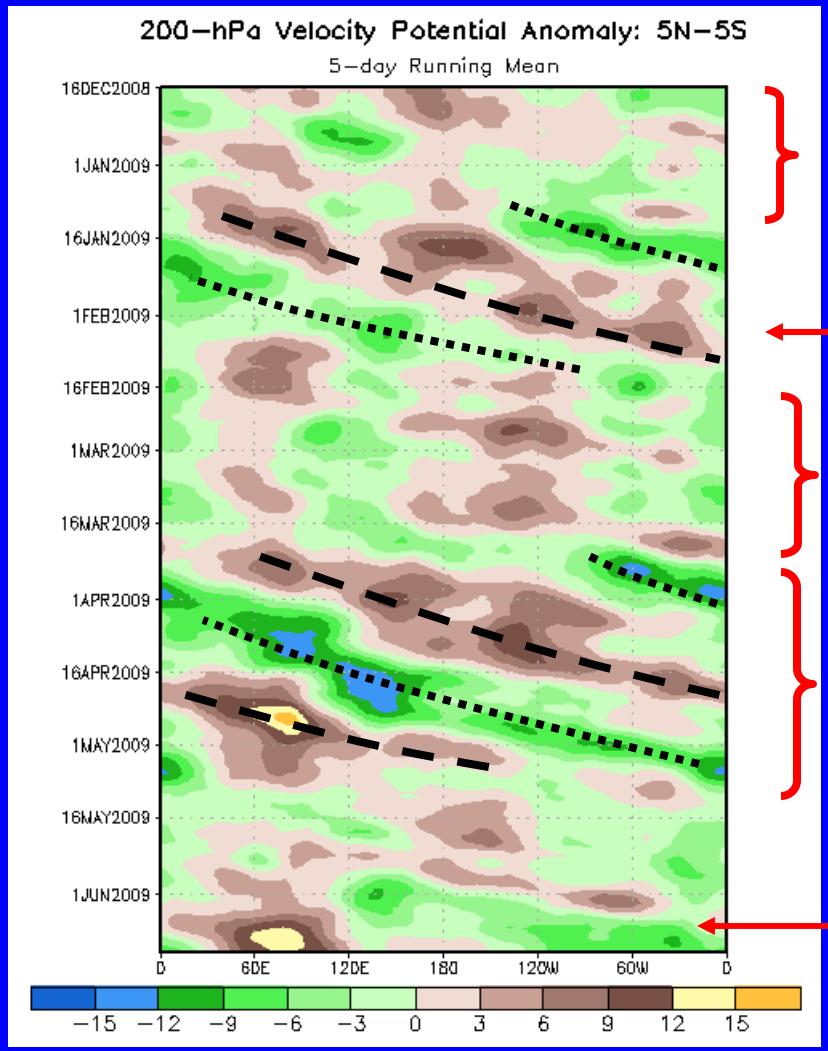
From mid-March into early May, areas of suppressed and enhanced convection shifted eastward in association with the MJO.

Since mid-May, convection has generally been close to average across much of the equatorial Tropics. A stronger area of suppressed convection over the Indian Ocean is now evident.

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

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.

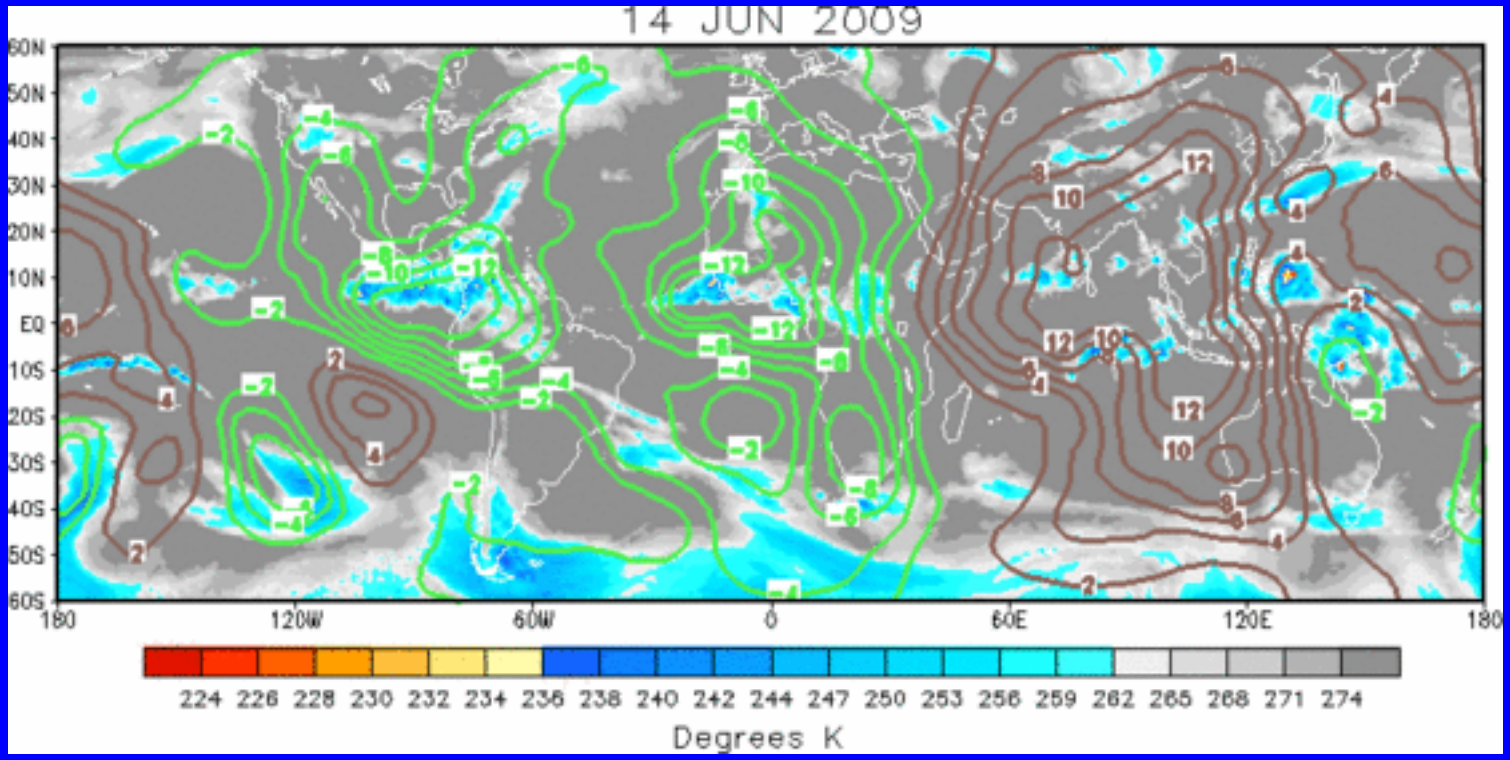
The MJO weakened in May.

Recent anomalies indicate that the MJO may be strengthening.

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

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

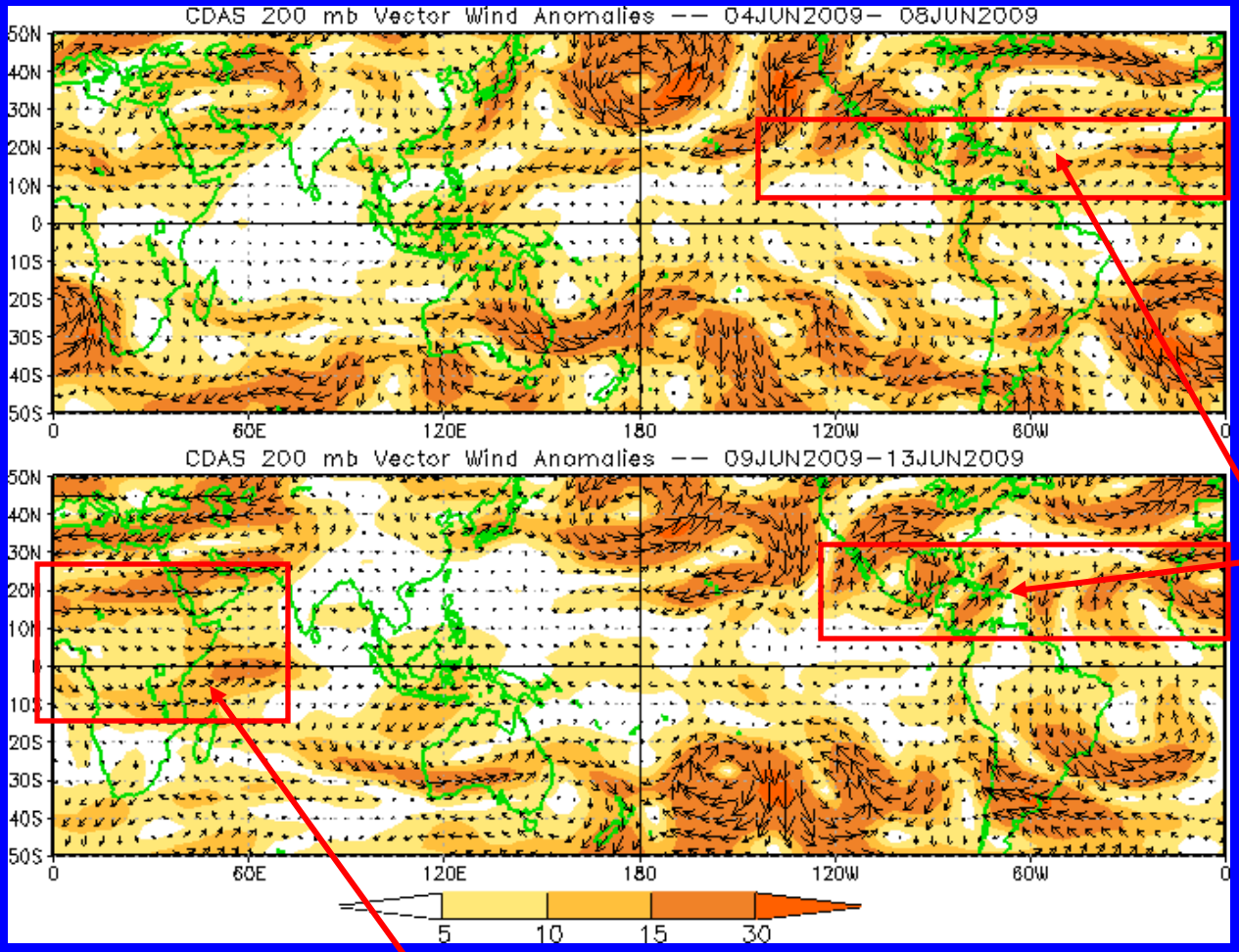
Negative anomalies (green contours) indicate favorable conditions for precipitation



The latest velocity potential pattern has increased in organization and indicates upper-level divergence across much of the Americas and the Atlantic Ocean basin while upper-level convergence is strongly indicated over the Indian Ocean.

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

Note that shading denotes the magnitude of anomalous wind vectors



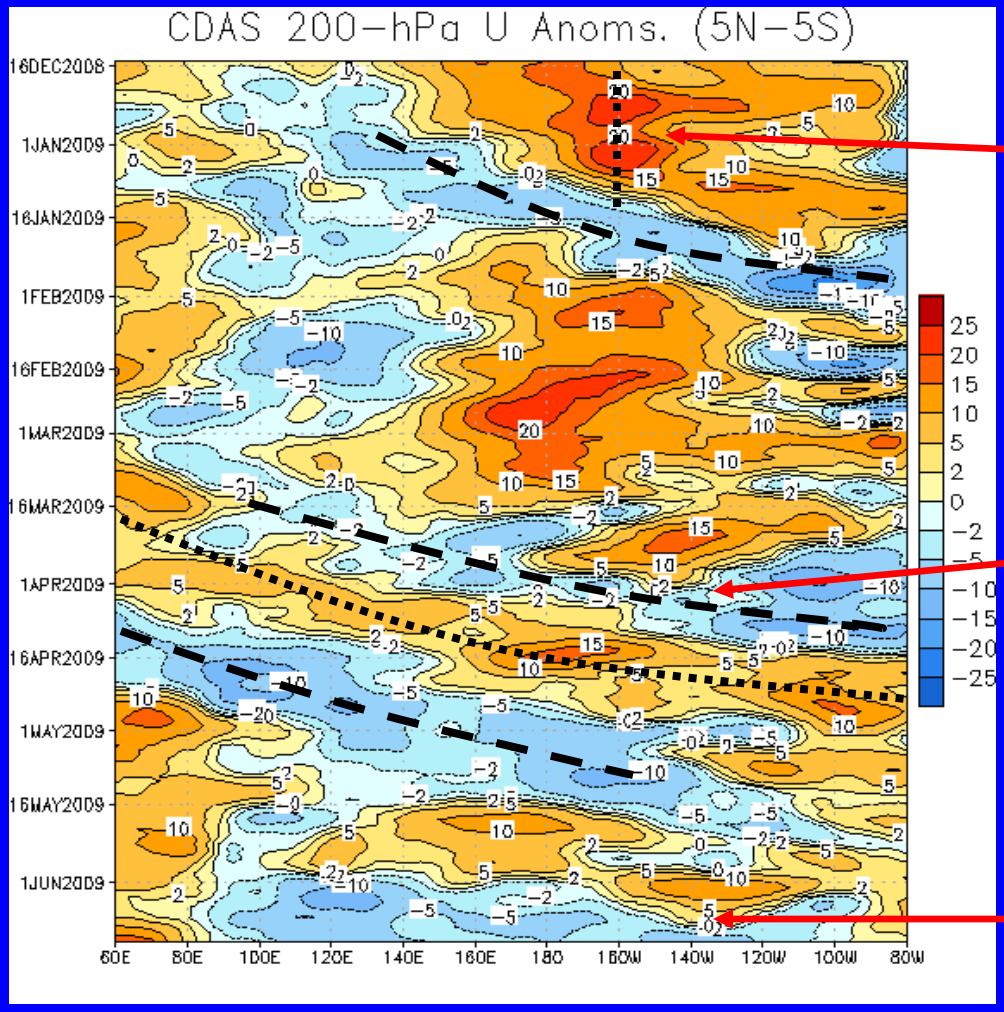
Extra-tropical interactions contributed to increased anomalies across the tropical Western Hemisphere.

Strong anomalous westerlies are evident across Africa during the last five 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

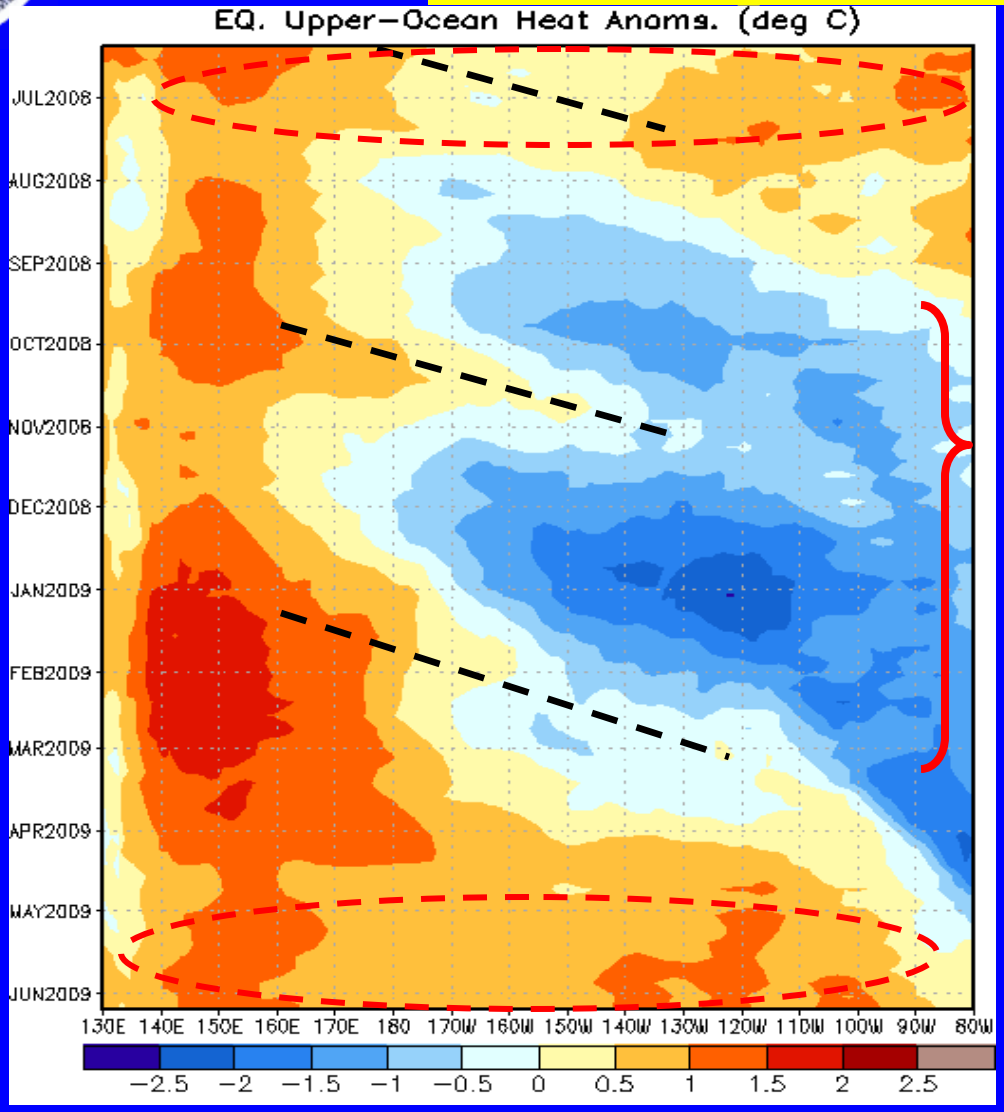
Longitude

Westerly anomalies strengthened markedly in December near the Date Line and persisted into January. These anomalies are consistent with La Nina conditions.

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

Most recently, easterly anomalies have developed over much of the Maritime continent and Pacific.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

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 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 resulted in increased heat content in the eastern half of the Pacific.

Positive anomalies have remained across much of the Pacific into June 2009.

MJO Index -- Information

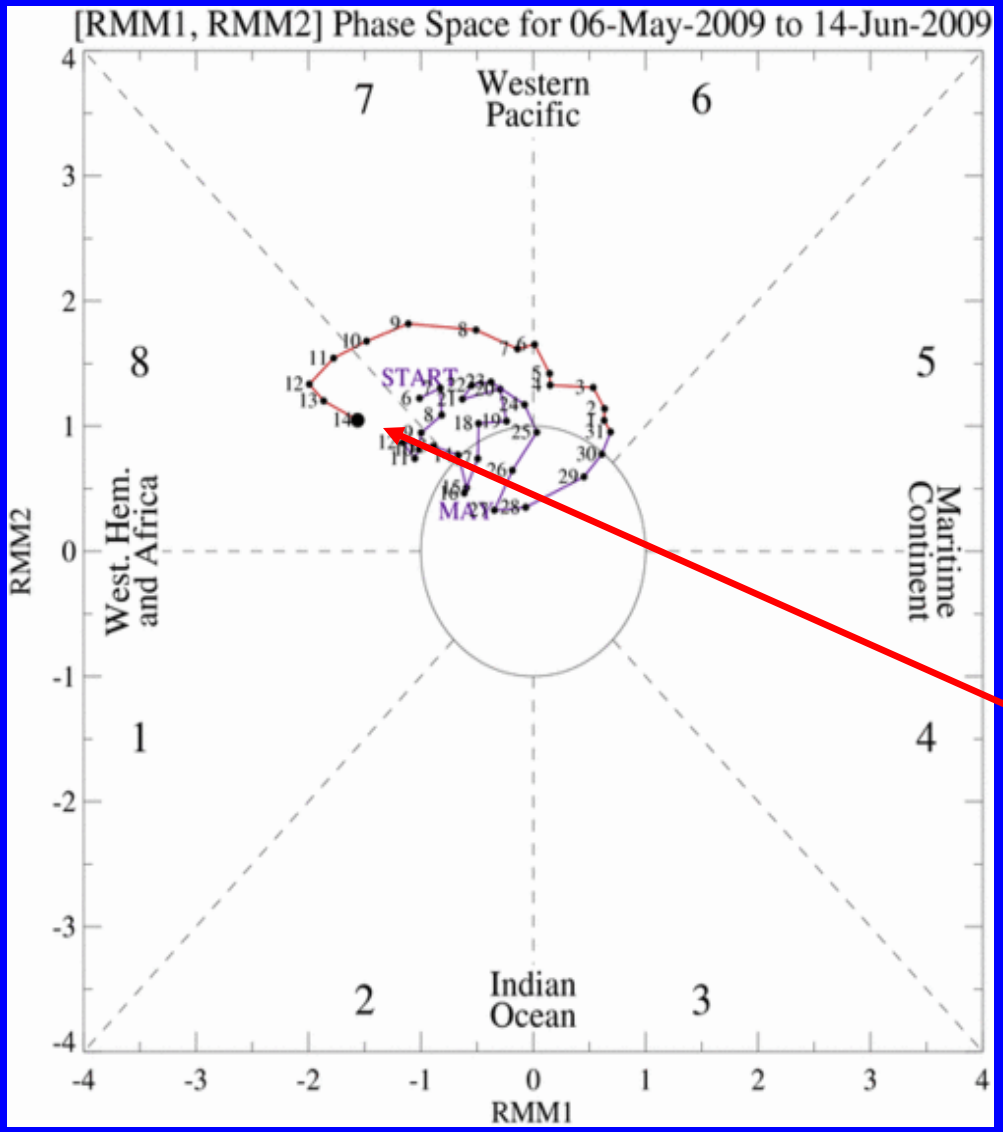
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

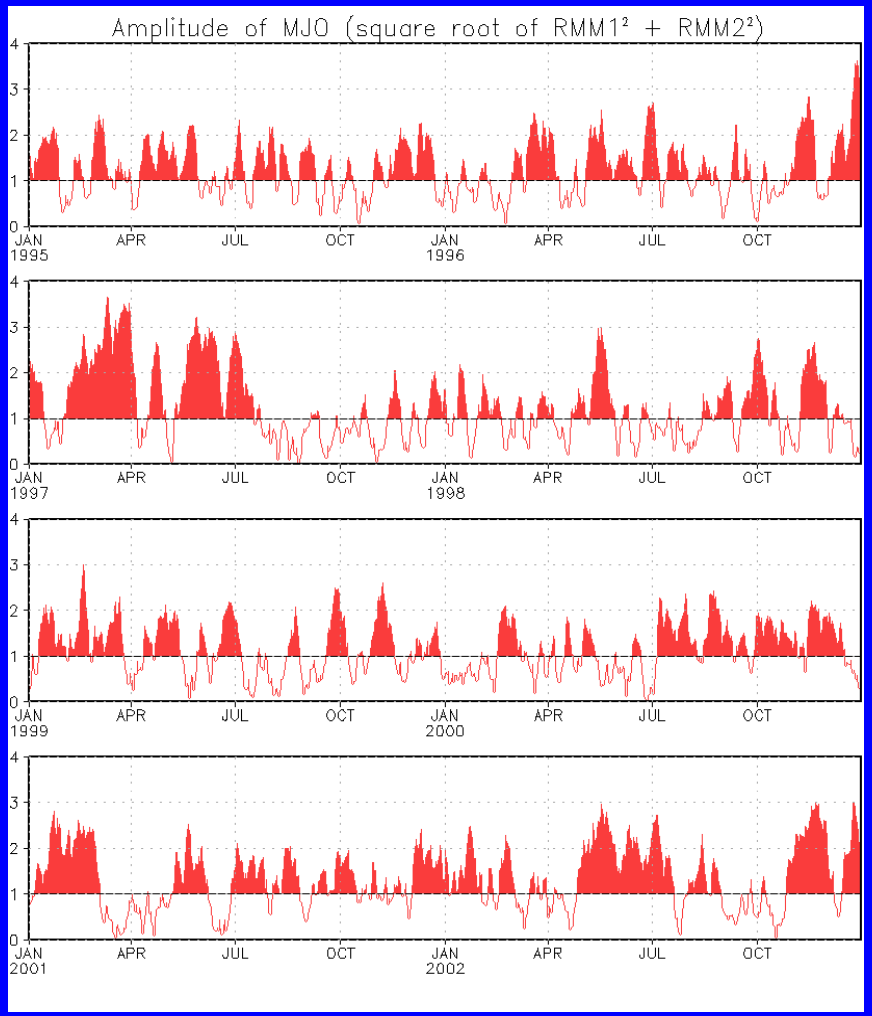
MJO Index -- Recent Evolution

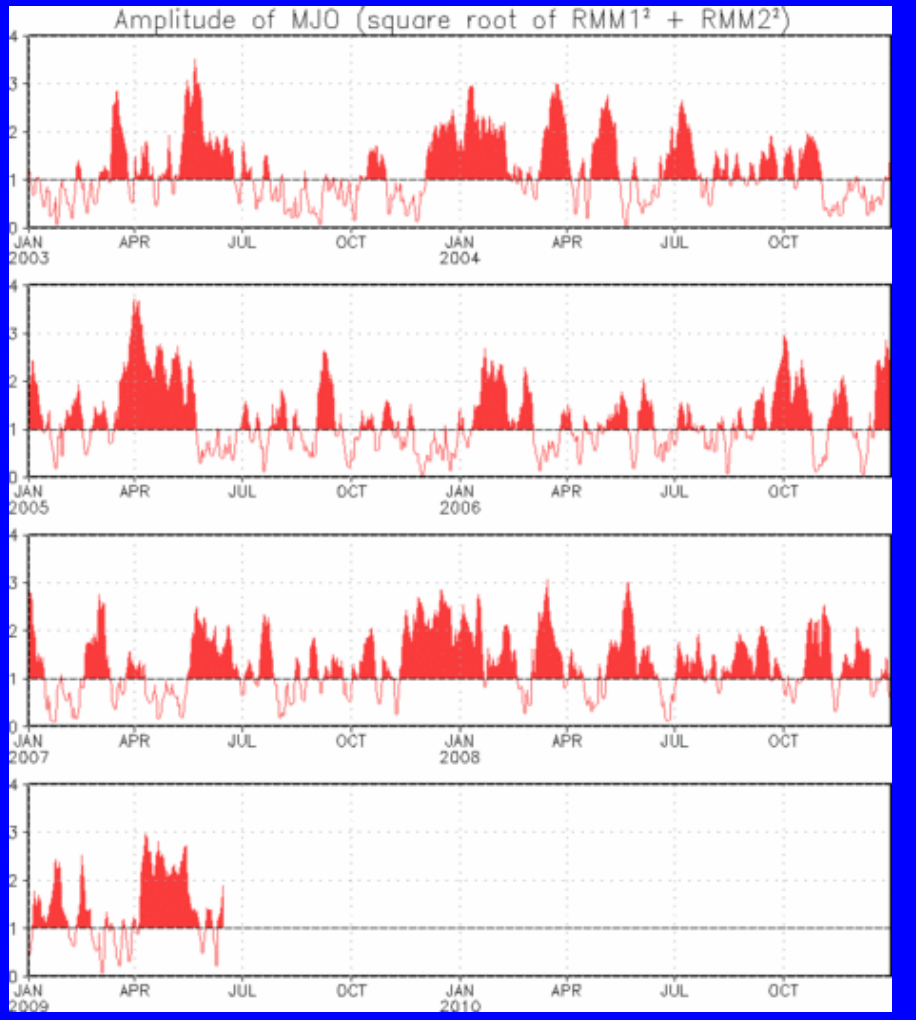


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

The MJO index indicates the enhanced convective phase shifted into the Western Hemisphere 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

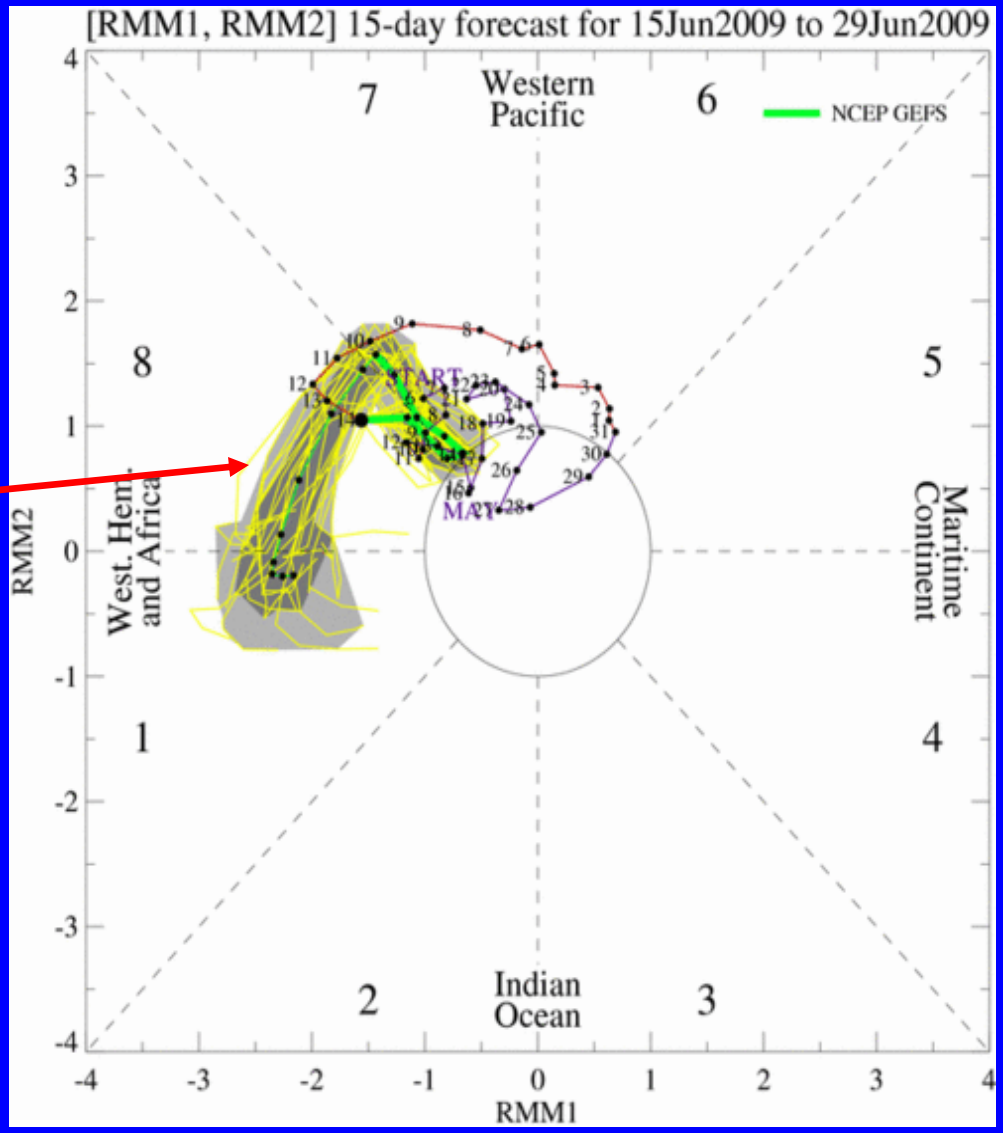
Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

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 indicate some eastward propagation of a MJO signal during Week-2 towards Africa.

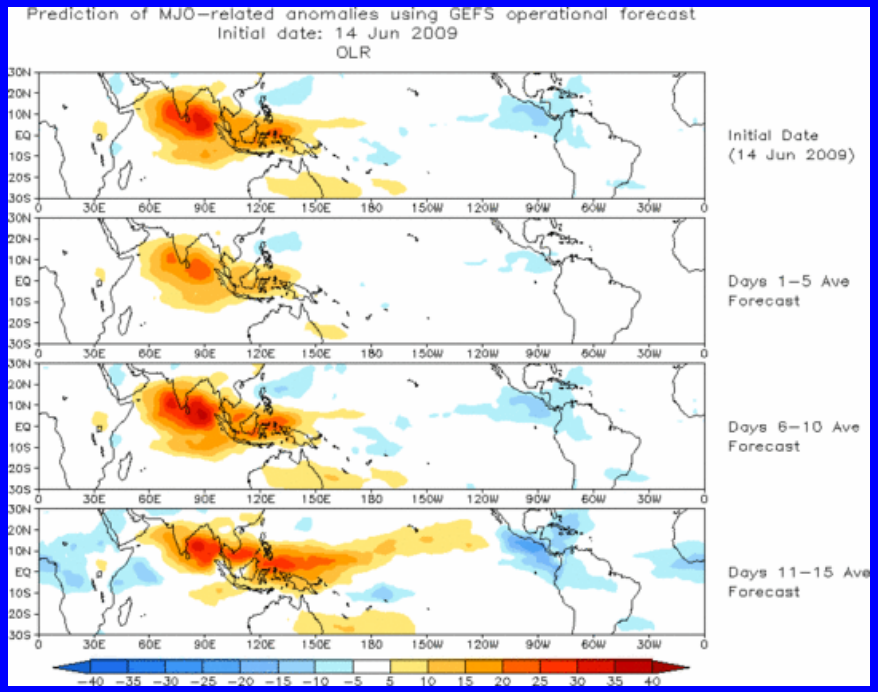
There is considerable uncertainty in the future evolution of the MJO later in the period as the spread increases.



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)

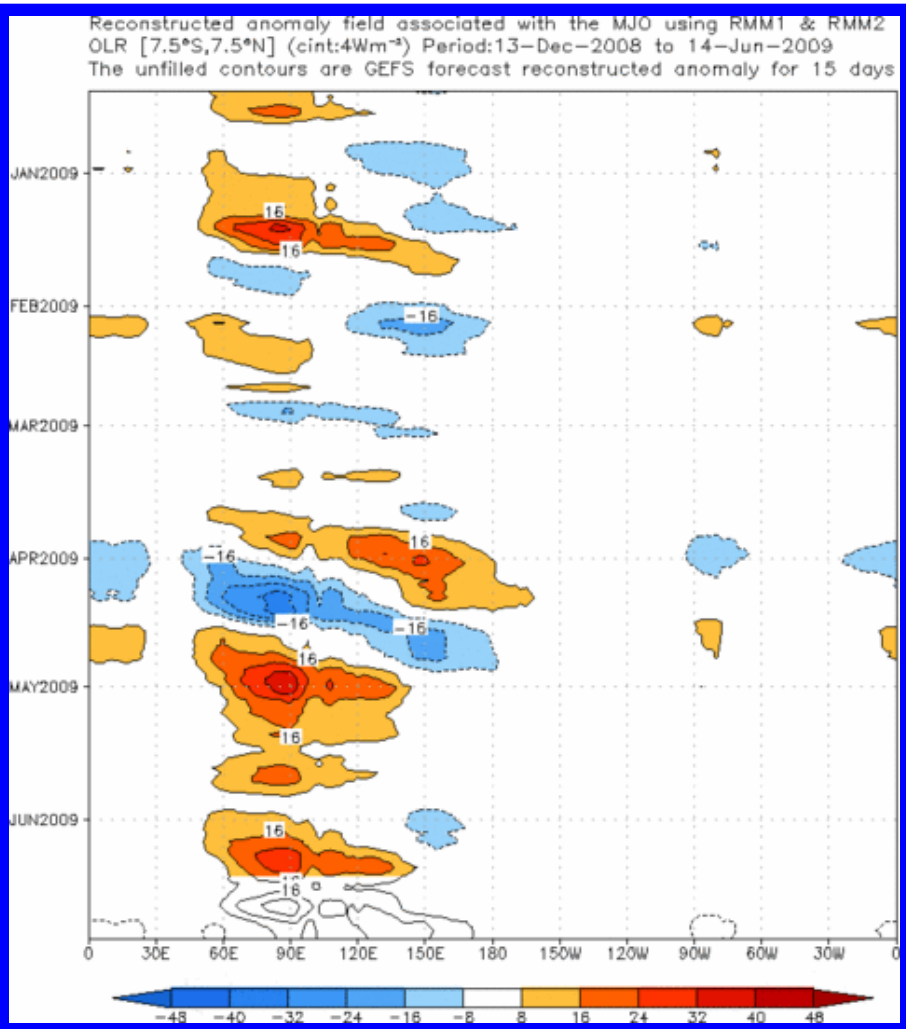
Spatial map of OLR anomalies for the next 15 days



Suppressed convection is forecast across the Indian Ocean, south Asia and the Maritime continent over the period with some eastward propagation.

Enhanced convection is forecast for Central America 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)

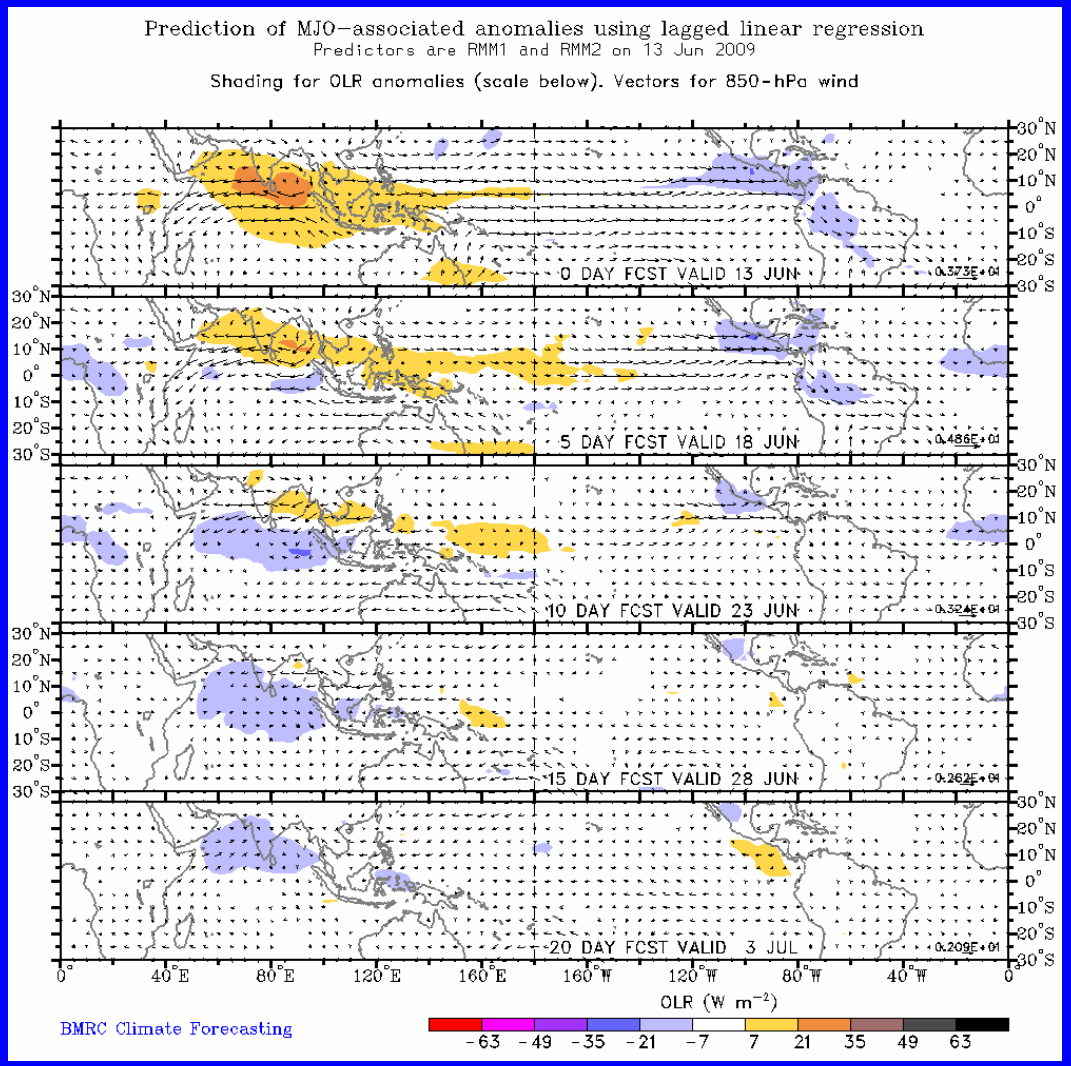
Spatial map of OLR anomalies and 850-hPa vectors for the next 20 days

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

A statistical forecast indicates moderate MJO activity during the next 1-2 weeks.

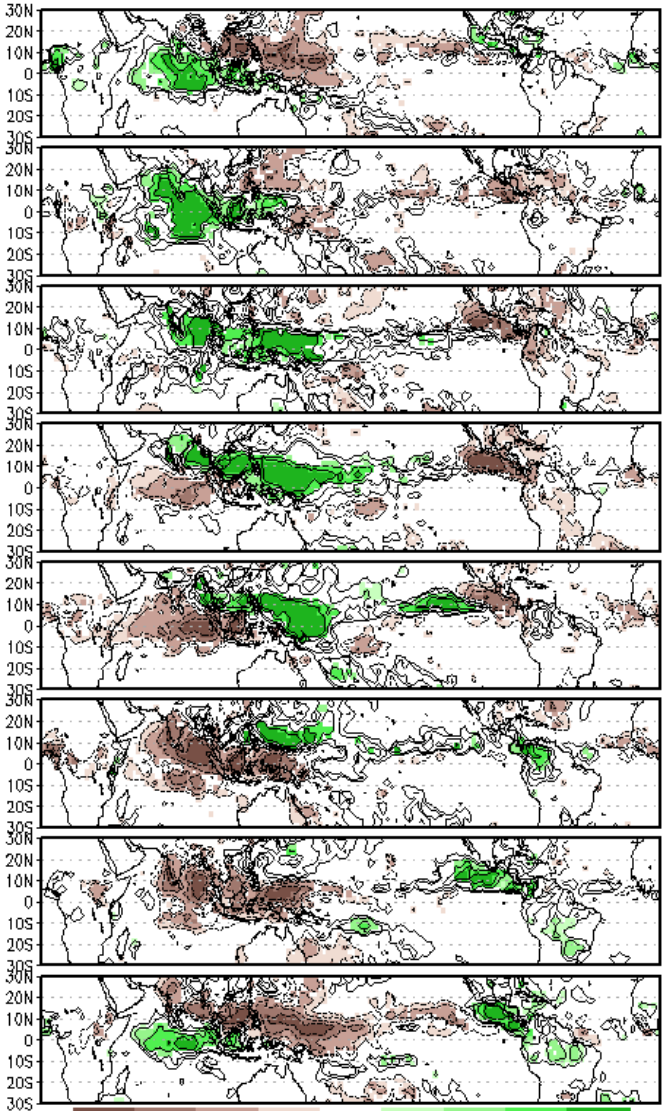
Suppressed convection is forecast across parts of South Asia and the Maritime continent during Week-1 with enhanced convection developing in Week-2 across the Indian Ocean.

Enhanced convection is indicated across Central America.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)