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

Update prepared by
Climate Prediction Center / NCEP
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Outline

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

Overview

- Although the MJO index amplitude is significant, the MJO remains weak as no eastward propagation has been evident during the last month.

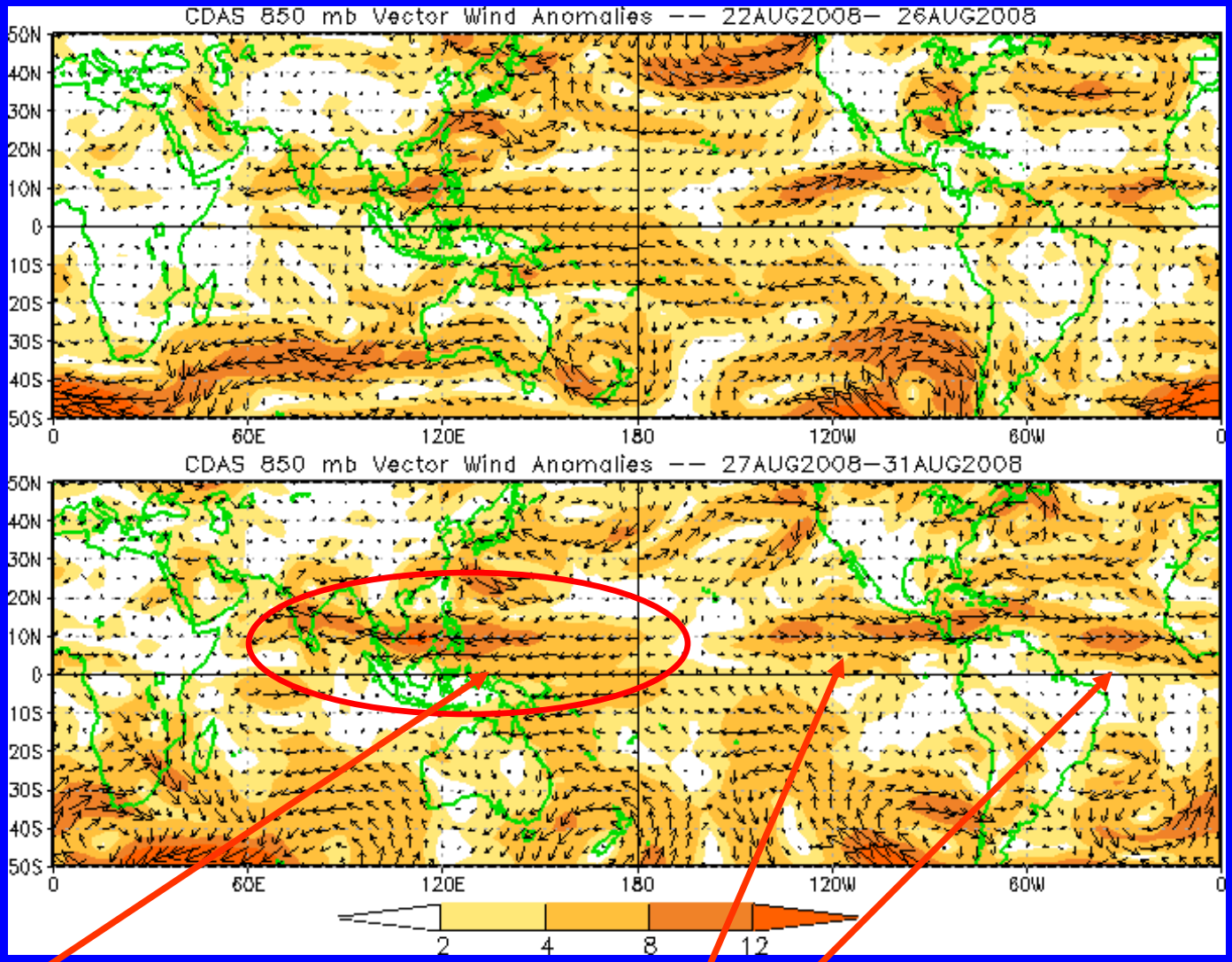
- At the current time, most forecast tools do not indicate a strengthening MJO during the upcoming period although some indicate eastward movement.

- The prospects for eastward propagation of the MJO needs to be closely monitored. Due to the persistent nature of the large-scale pattern, the MJO is expected 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 (m s^{-1})

Note that shading denotes the magnitude of anomalous wind vectors



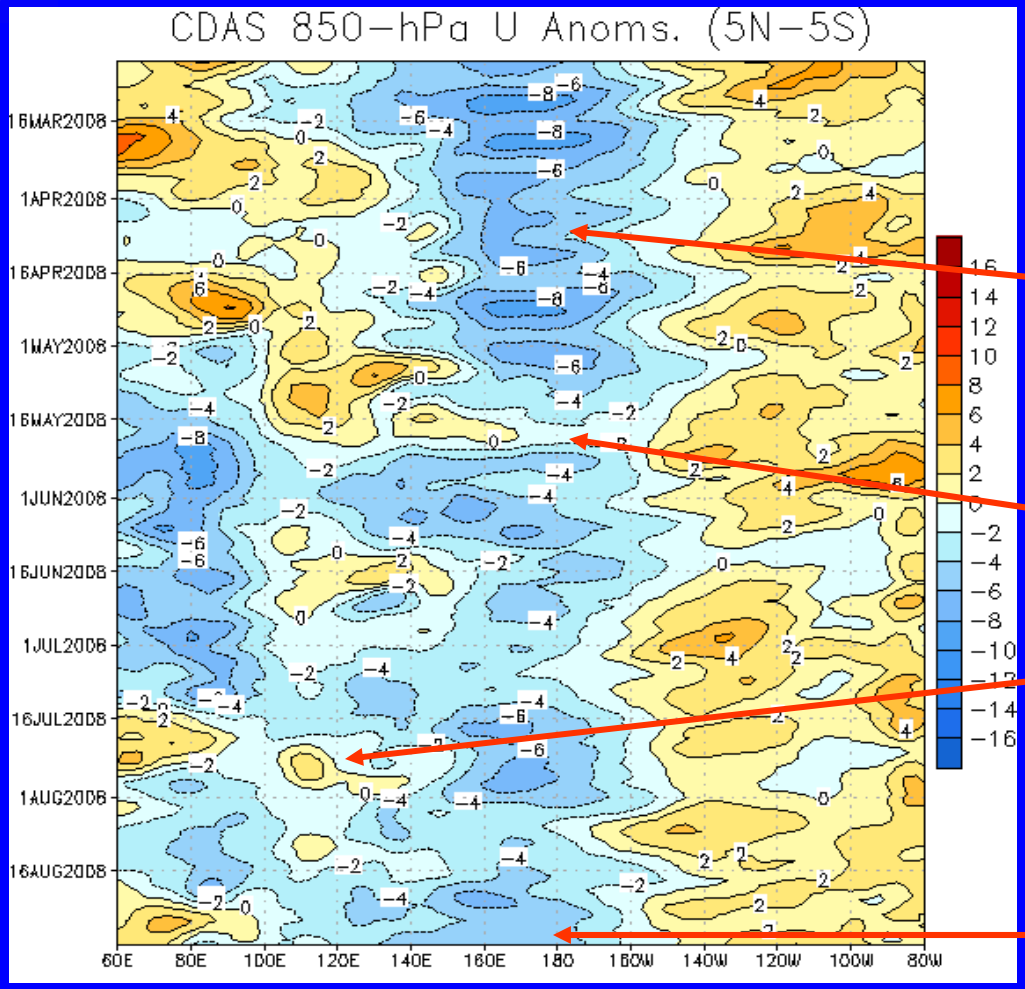
Low-level easterly anomalies continue across the western Pacific extending to India.

Westerly anomalies remained strong across the eastern Pacific, the tropical eastern Atlantic and 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

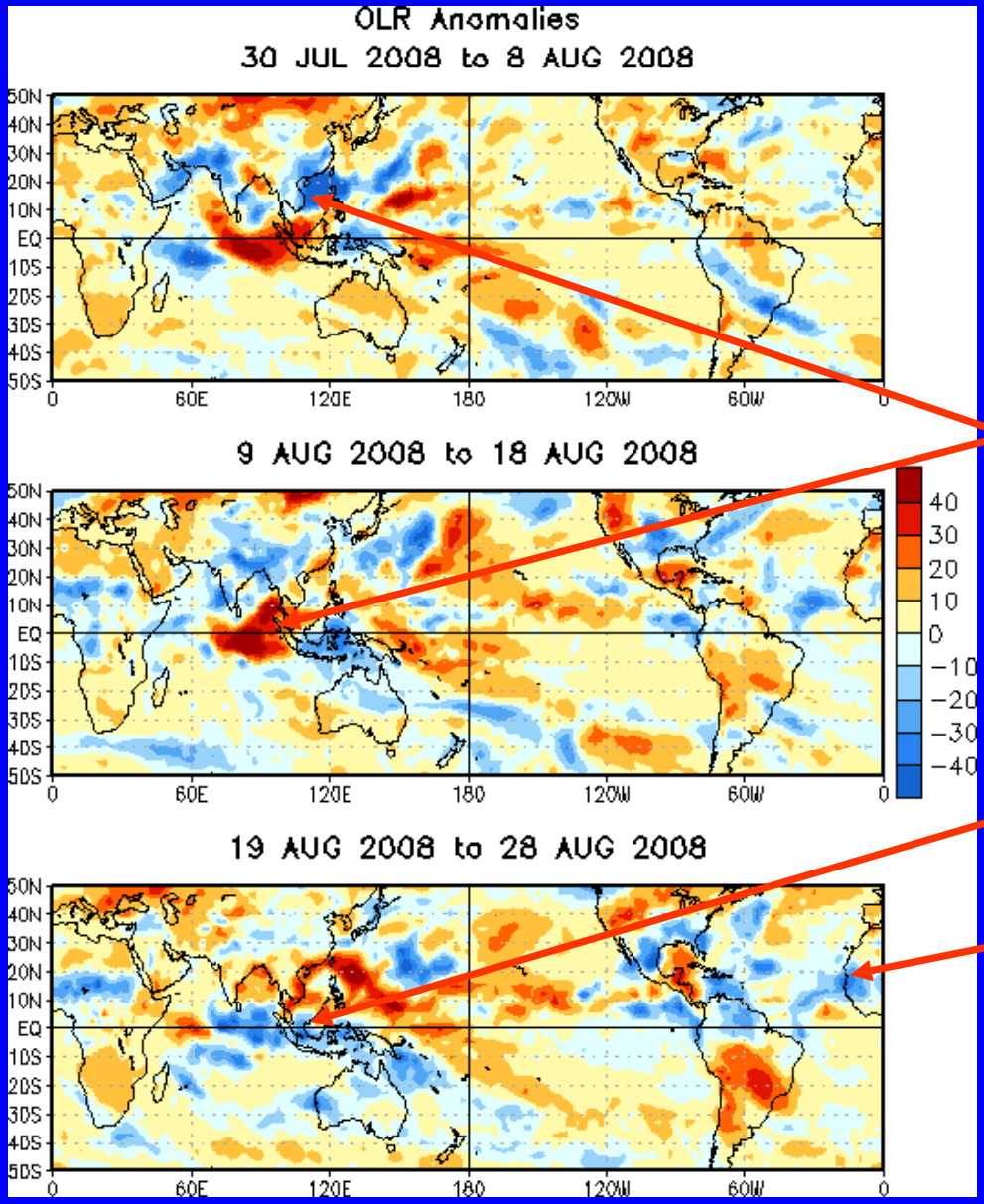
MJO activity was weak during much of March and April with strong anomalous easterlies continuing near the Date Line.

During mid-May, easterlies weakened across the western Pacific associated with moderate MJO activity.

Easterly anomalies have prevailed across much of the eastern hemisphere since late May. Westerly anomalies were evident across parts of the Indian Ocean and Indonesia during the second half of July associated with the most recent MJO activity.

Easterly anomalies persisted in the west-central Pacific, while westerly anomalies in the western and central Indian Ocean weakened.

OLR Anomalies: Last 30 days



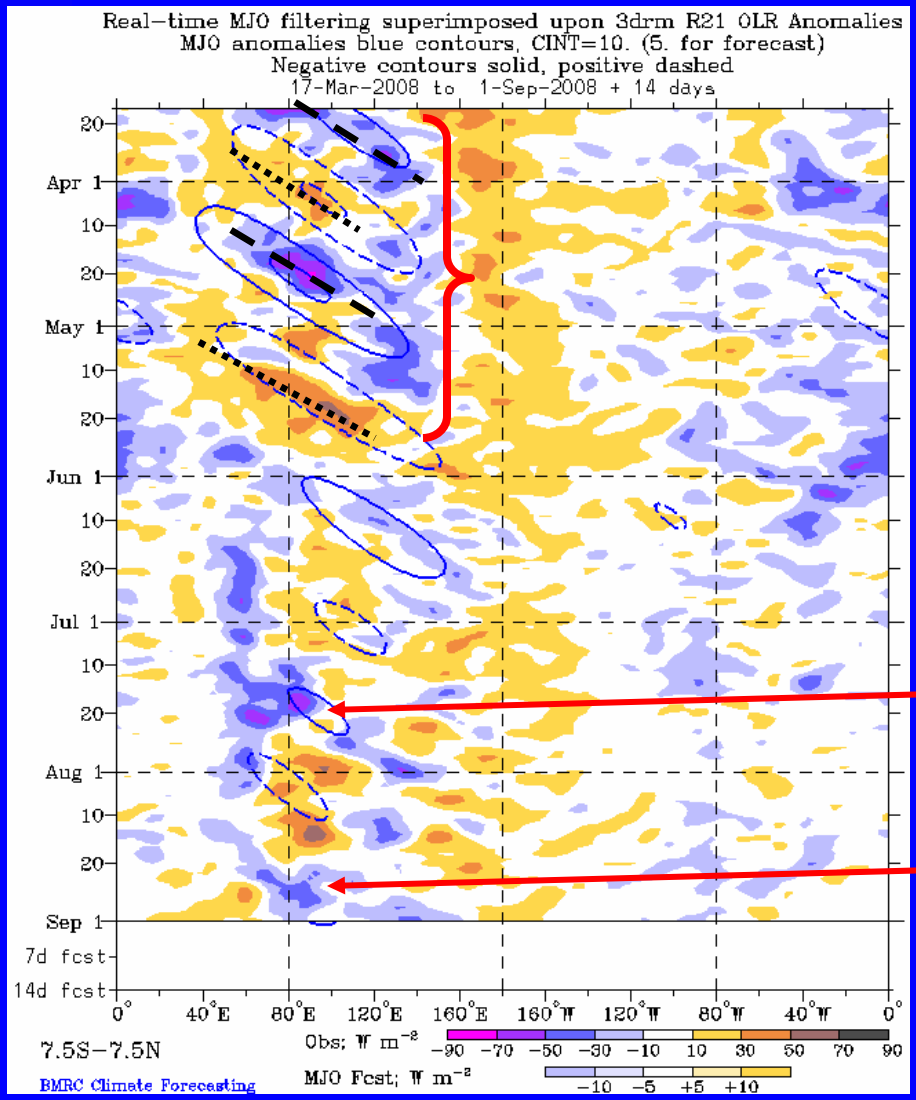
Drier-than-normal conditions, positive OLR anomalies (yellow/red shading)

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

Northward propagation of enhanced convection from the Indian Ocean to Asia and the development of drier-than-average conditions in the eastern Indian Ocean were evident during early-mid-August.

Enhanced convection developed across the equatorial Indian Ocean in mid to late August while wet conditions were evident across much of Mexico, northern South America the Atlantic and western Africa.

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)

MJO activity was evident from mid-March into early June at varying levels of intensity. The strongest MJO activity occurred as strong suppressed convection organized across the Indian Ocean and shifted eastward during mid-to-late May.

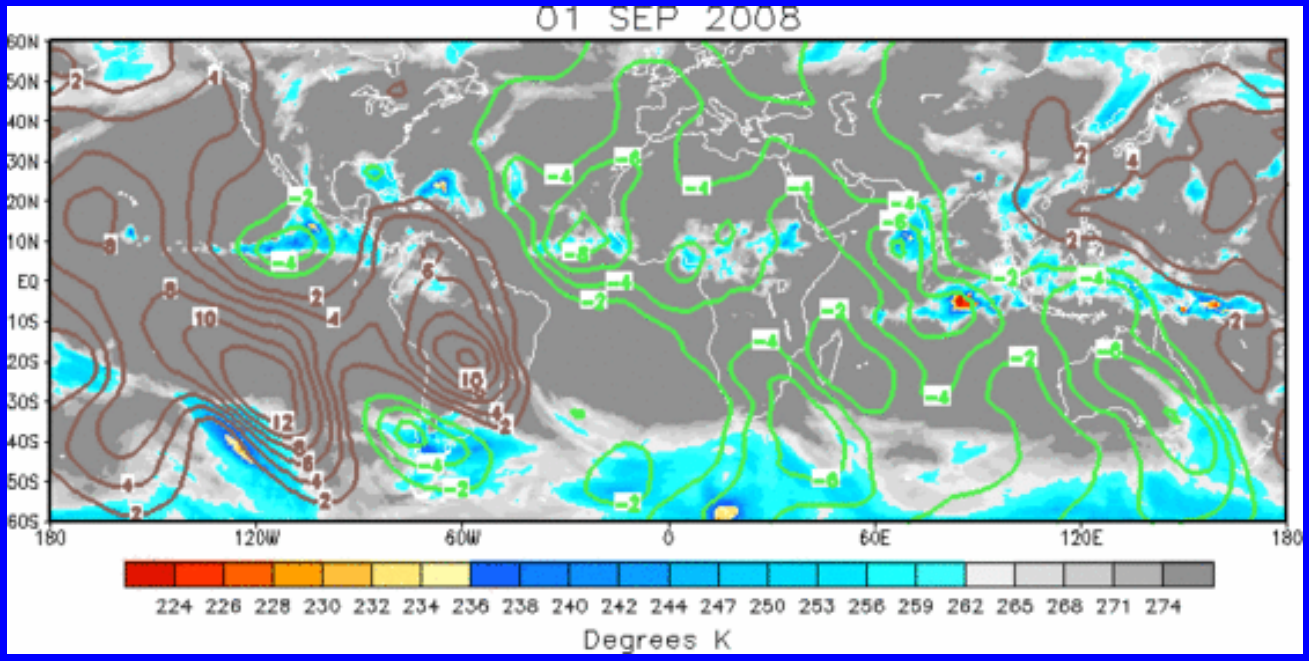
Persistent enhanced convection was evident across the western Indian Ocean from mid-June to early August.

Enhanced convection is evident across the eastern Indian Ocean during mid-to-late August with rapid eastward propagation not associated with the MJO.

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

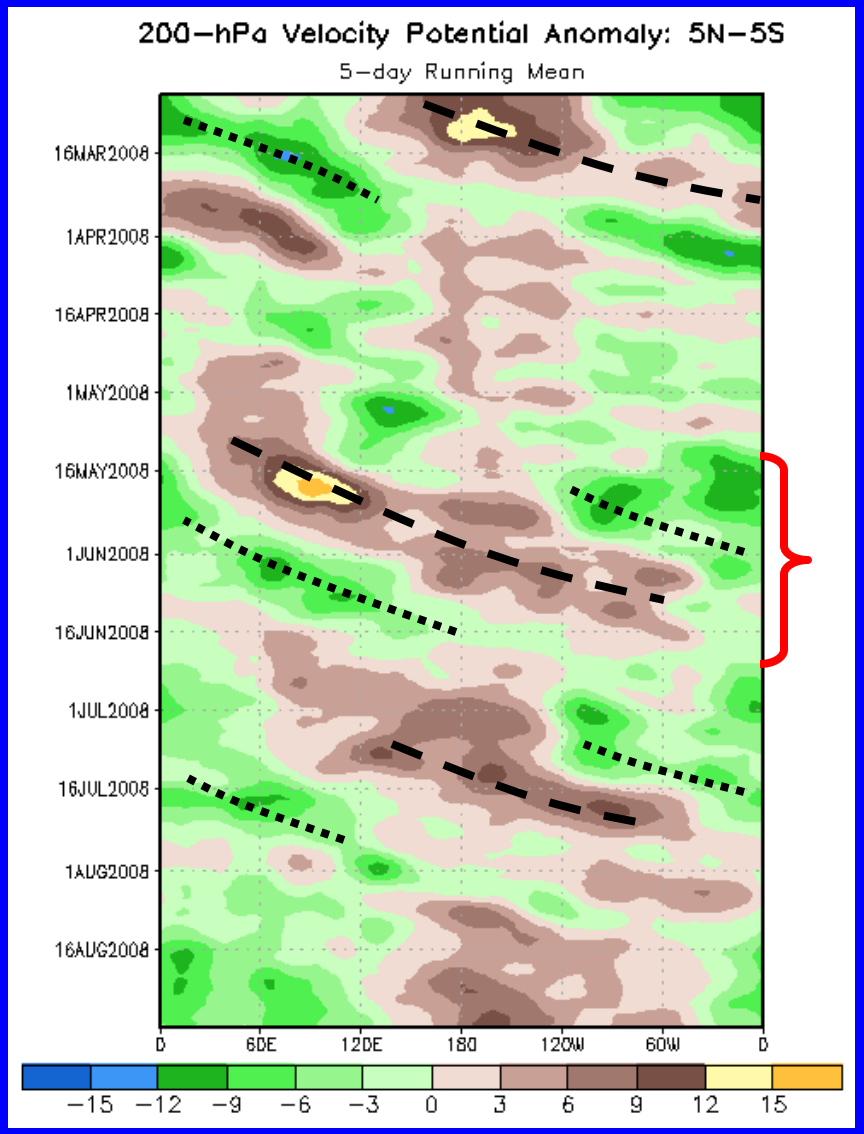


Upper-level divergence continues across Africa, the Atlantic Ocean, and the equatorial eastern Pacific during the past week. Upper-level convergence continues across the western and central Pacific Ocean.

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

Weak-to-moderate MJO activity was evident during March.

The MJO was largely incoherent during the month of April.

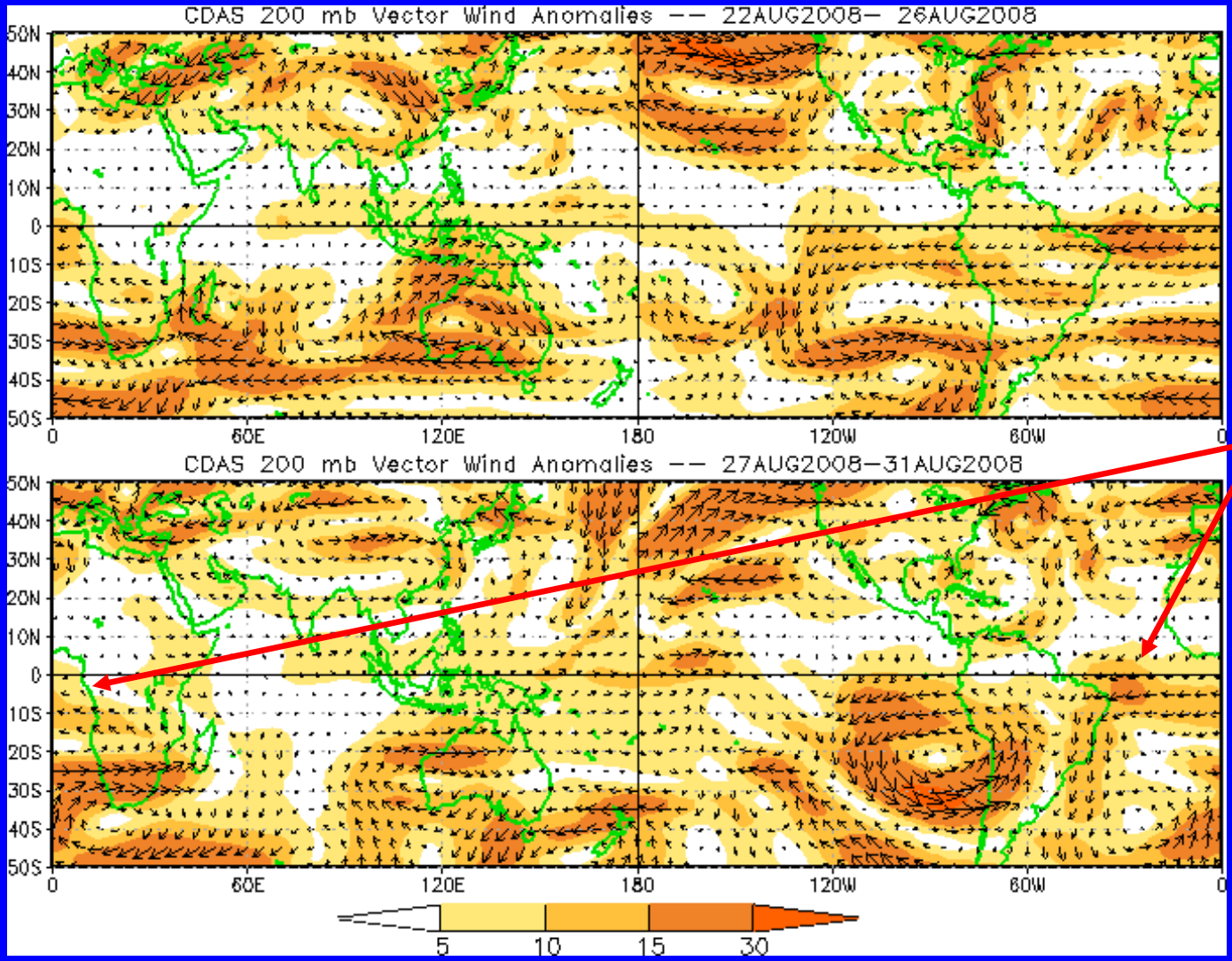
A moderate-to-strong MJO was observed from mid-May through mid-June as eastward propagation was more coherent and longer-lived.

After weakening in late June, the MJO strengthened during mid-July.

Since mid-August the MJO has been weak as a more stationary pattern in upper-level divergence and convergence is evident.

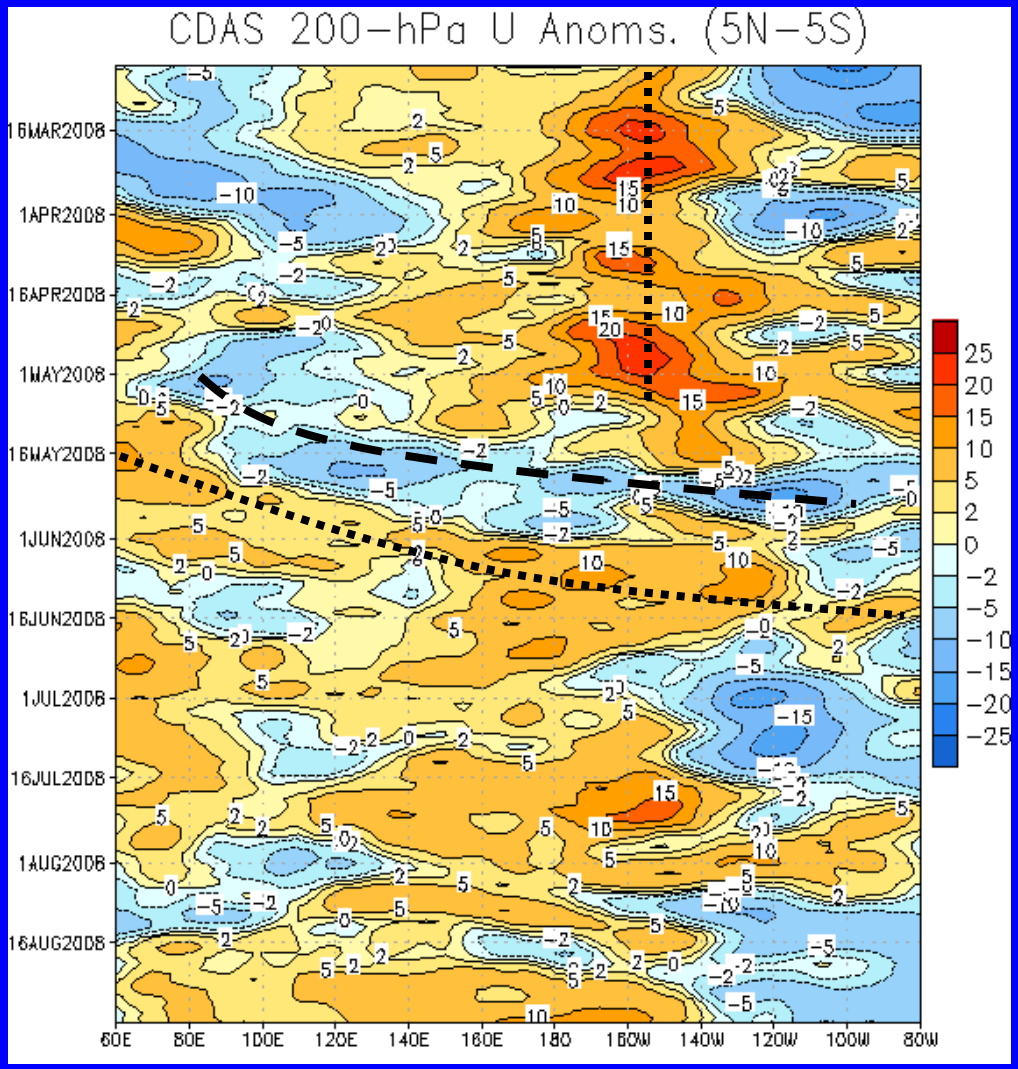
200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the magnitude of anomalous wind vectors



Upper-level easterly anomalies persisted across equatorial Africa and the Atlantic Ocean while westerly anomalies are evident across Indonesia and the western Pacific.

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



Time

Longitude

Westerly anomalies (orange/red shading) represent anomalous west-to-east flow

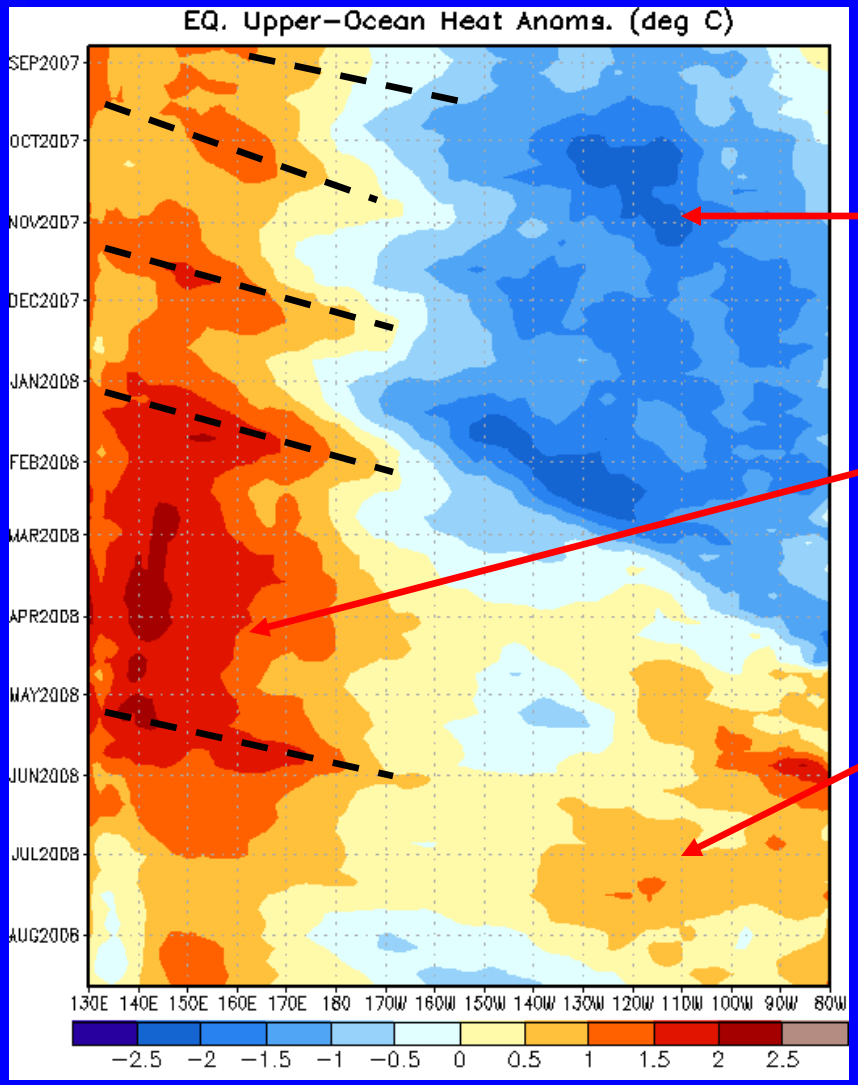
Easterly anomalies (blue shading) represent anomalous east-to-west flow

The MJO was weak or incoherent for much of the period from mid-February through April and upper-level winds indicate generally strong and persistent westerly anomalies near and east of the Date Line.

During May and early June, eastward propagation was evident in the upper-level wind field and was associated with the moderate-to-strong MJO activity during this time.

Easterly (westerly) anomalies continue in the eastern Pacific (Indian/western Pacific) Oceans.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

During September and October, negative heat content anomalies increased markedly across the eastern Pacific Ocean and continued until February 2008.

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 in part associated with a Kelvin wave initiated during May 2008.

During early to mid-August 2008, negative anomalies started to develop near and east of the Date Line in response to enhanced easterly surface winds.

MJO Index -- Information

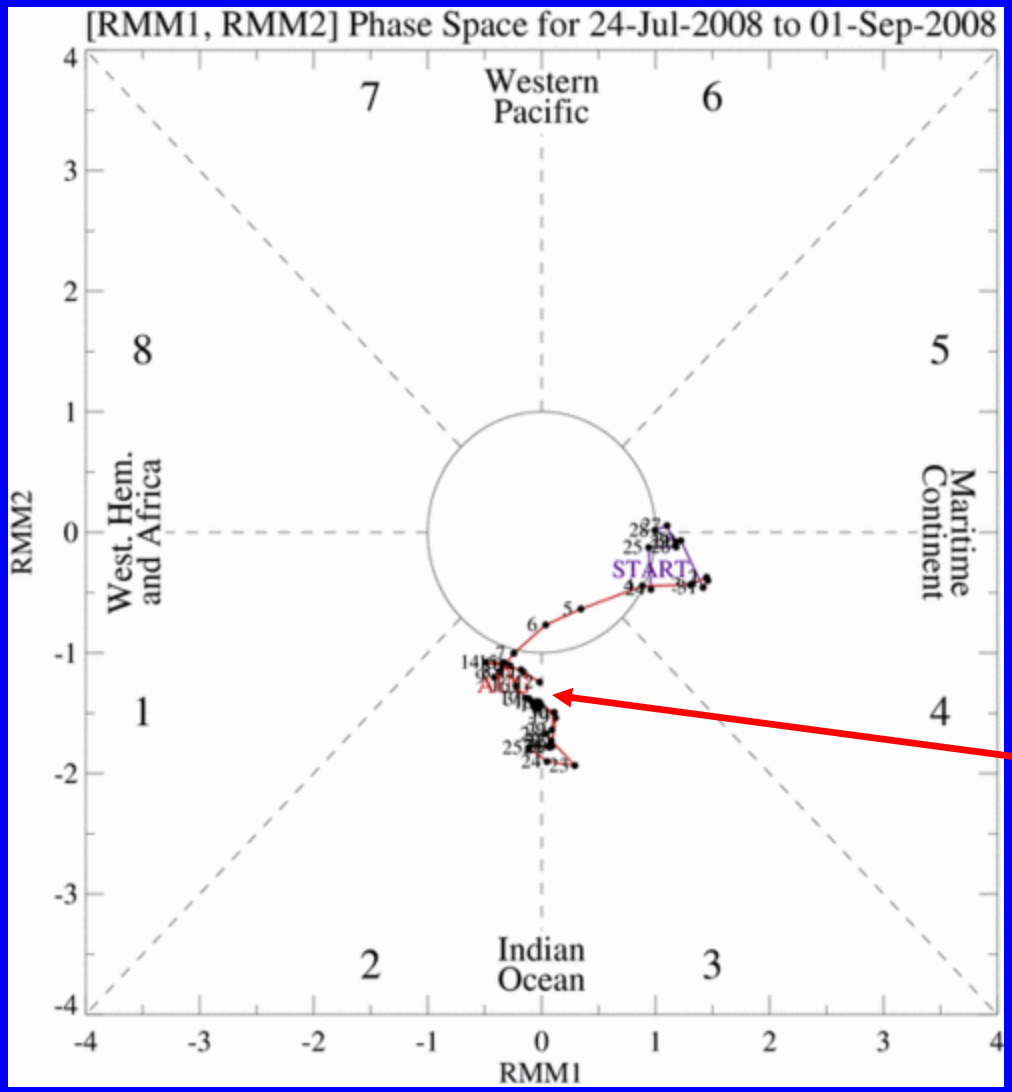
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

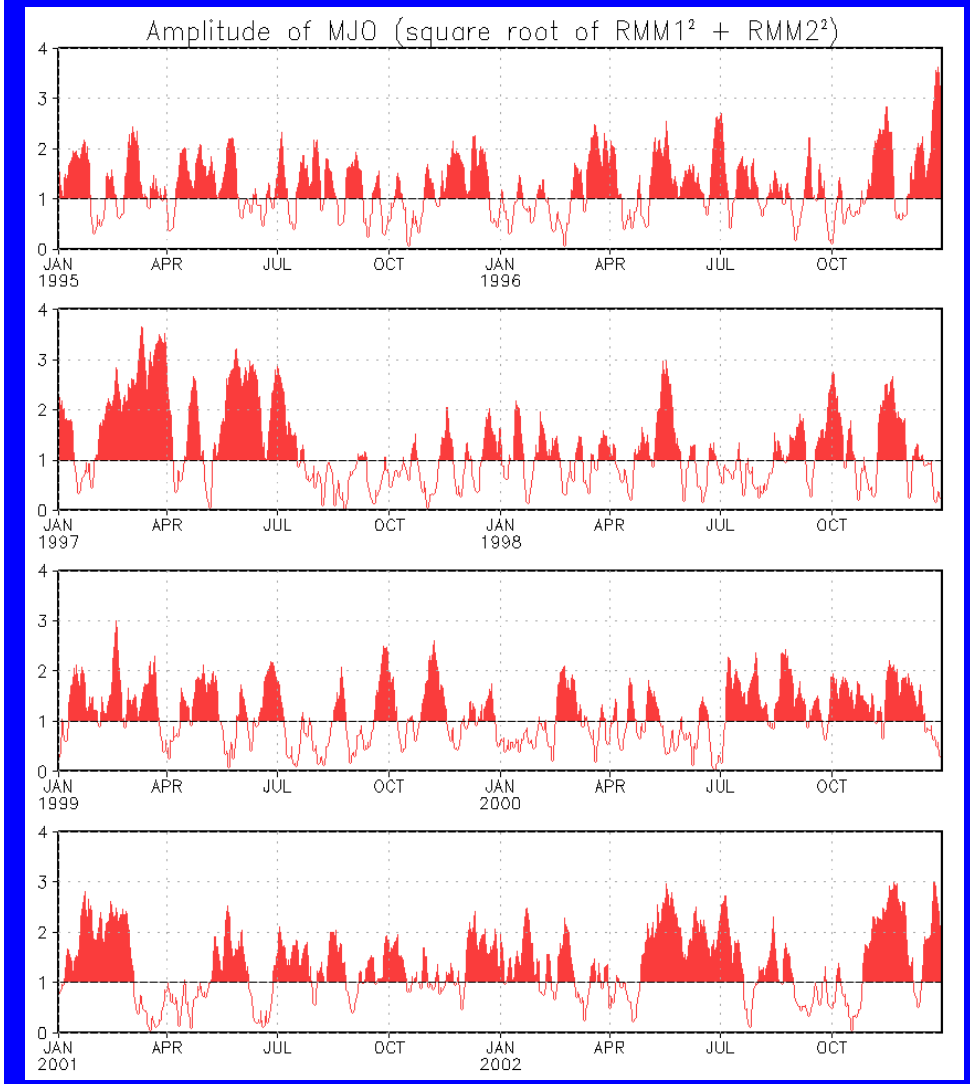
MJO Index -- Recent Evolution

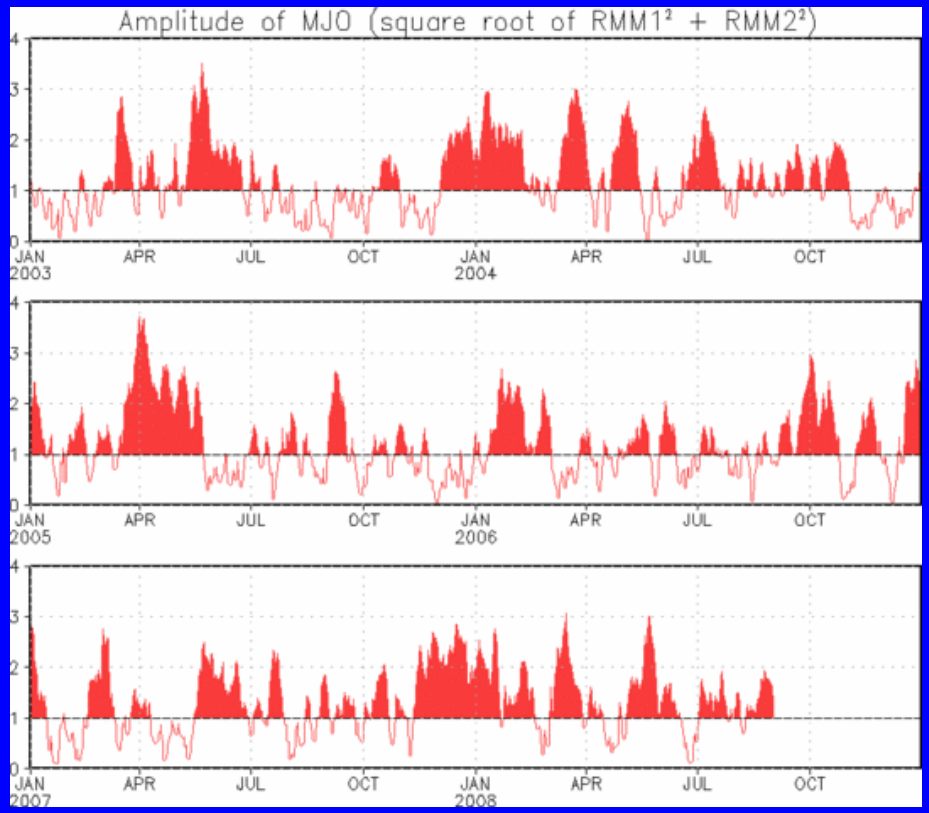


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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

The MJO signal continued to exhibit no eastward propagation. The amplitude, however, remains significant.

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

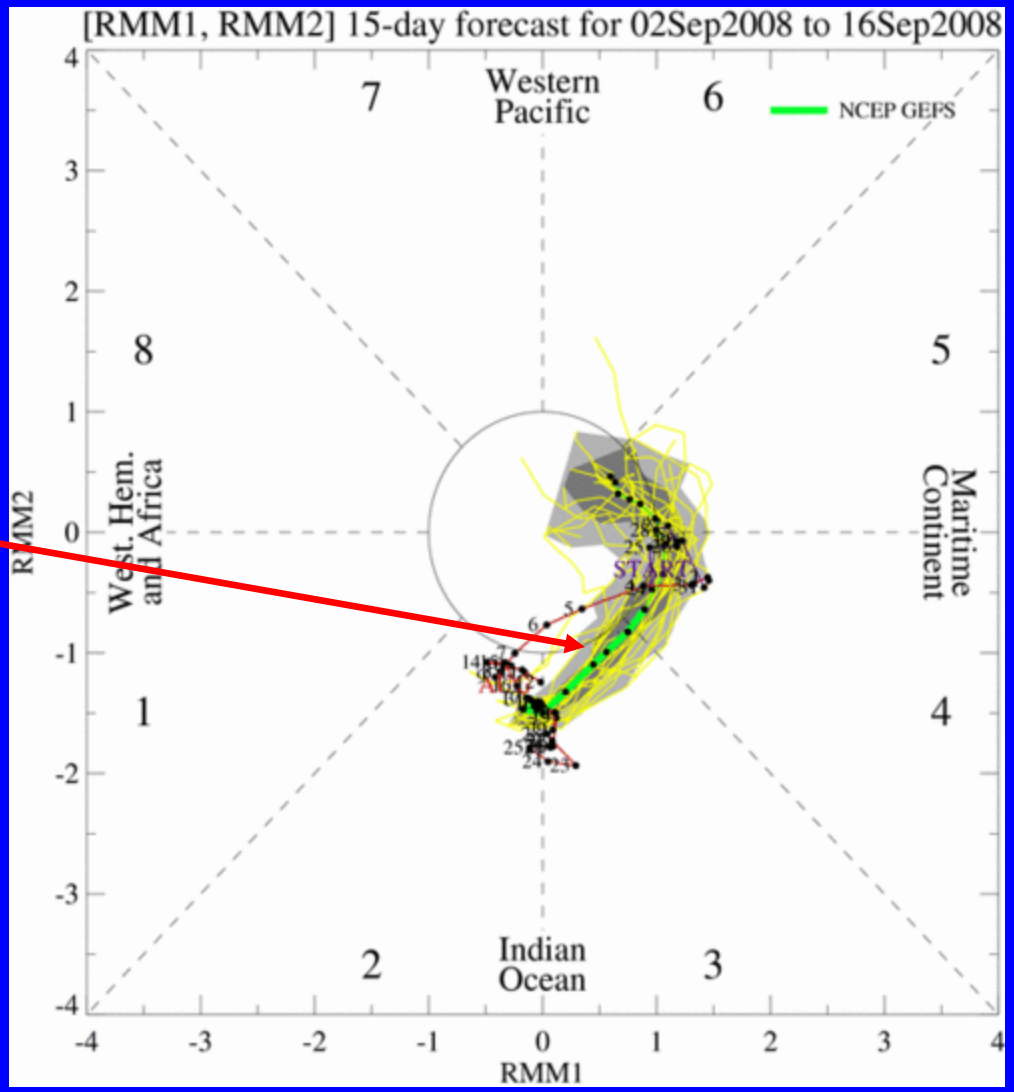
Ensemble GFS (GEFS) MJO Forecast

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

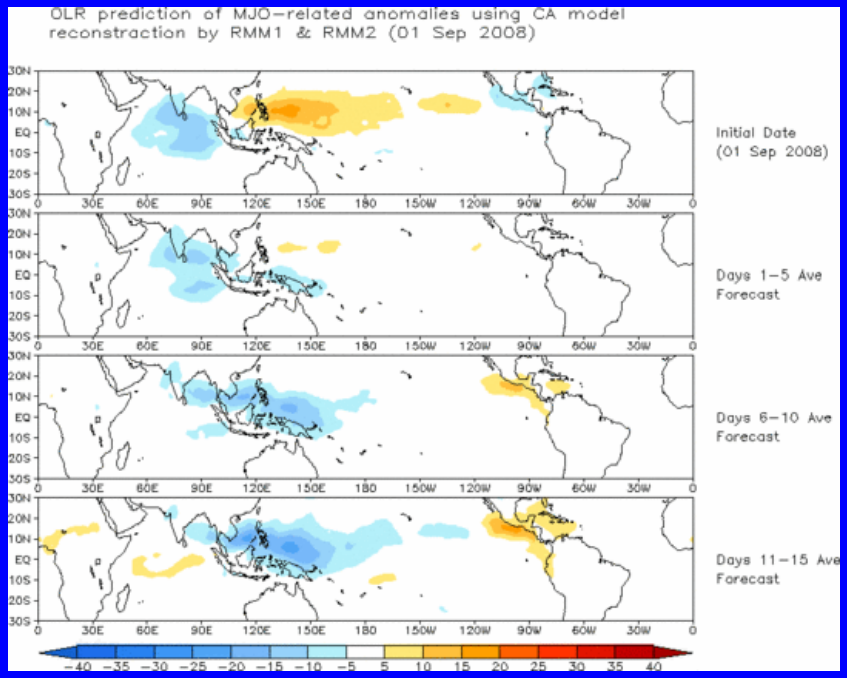
The GEFS predicts some eastward propagation of the MJO signal during the period.



Ensemble Mean GFS MJO Forecast

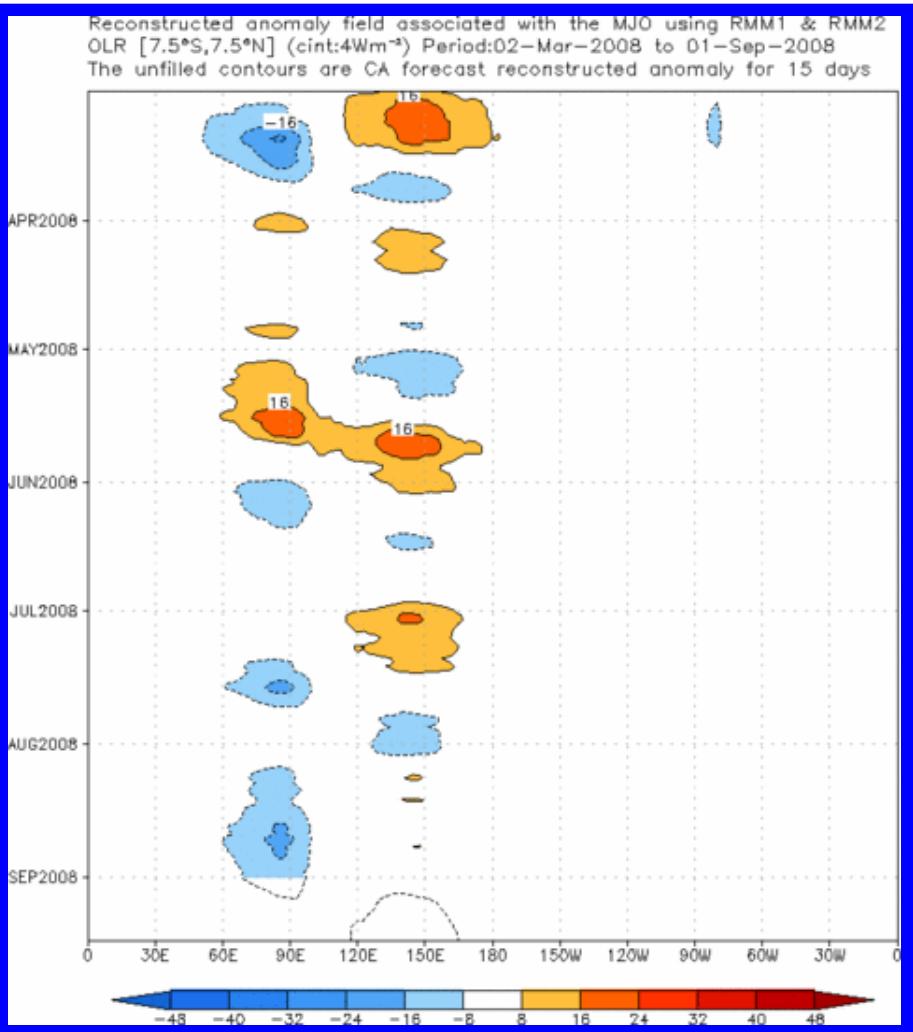
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The forecast indicates MJO-associated enhanced convection shifting eastward from the Indian Ocean into the western Pacific.

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



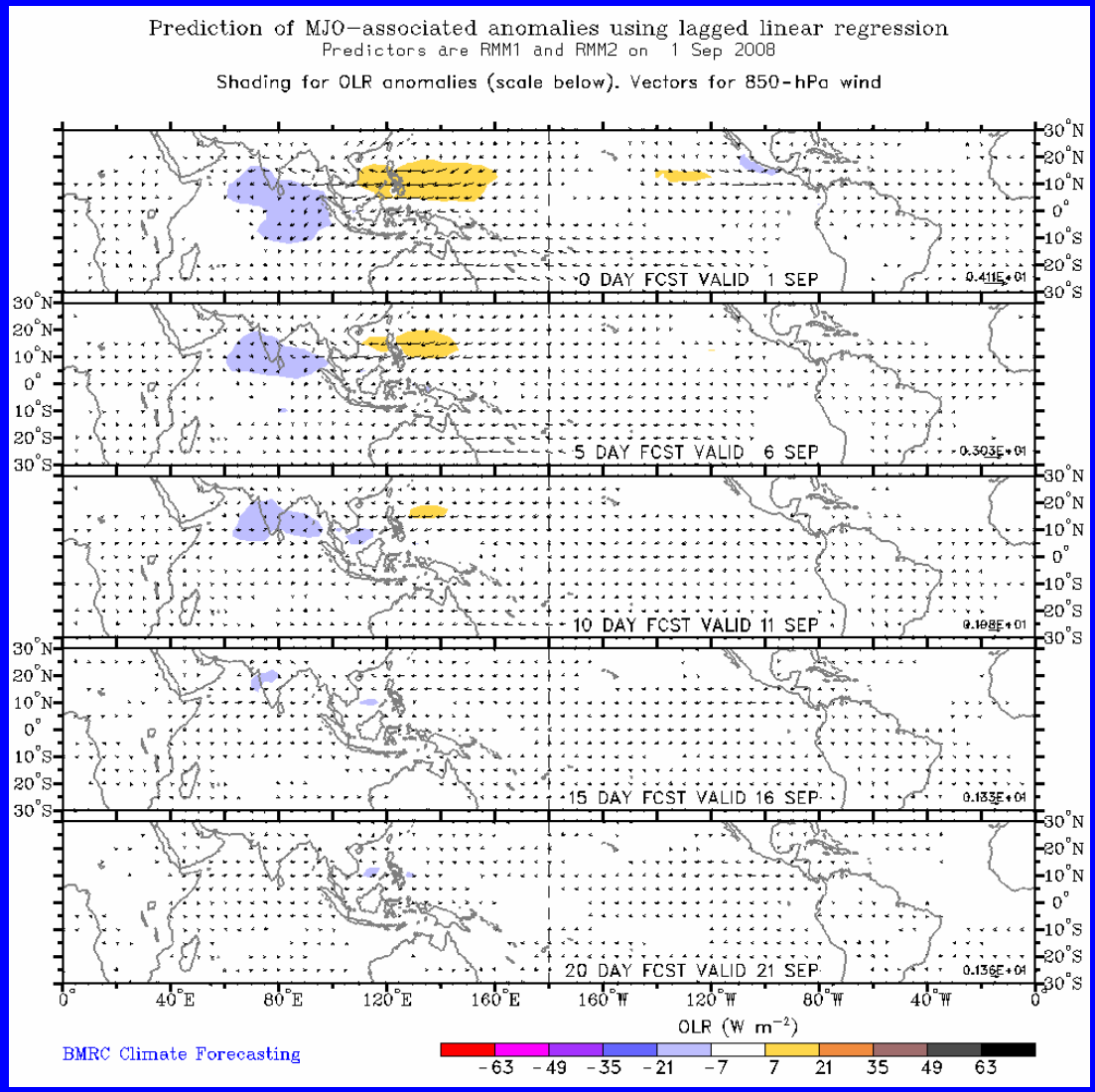
Statistical MJO Forecast

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 wind vectors for the next 20 days

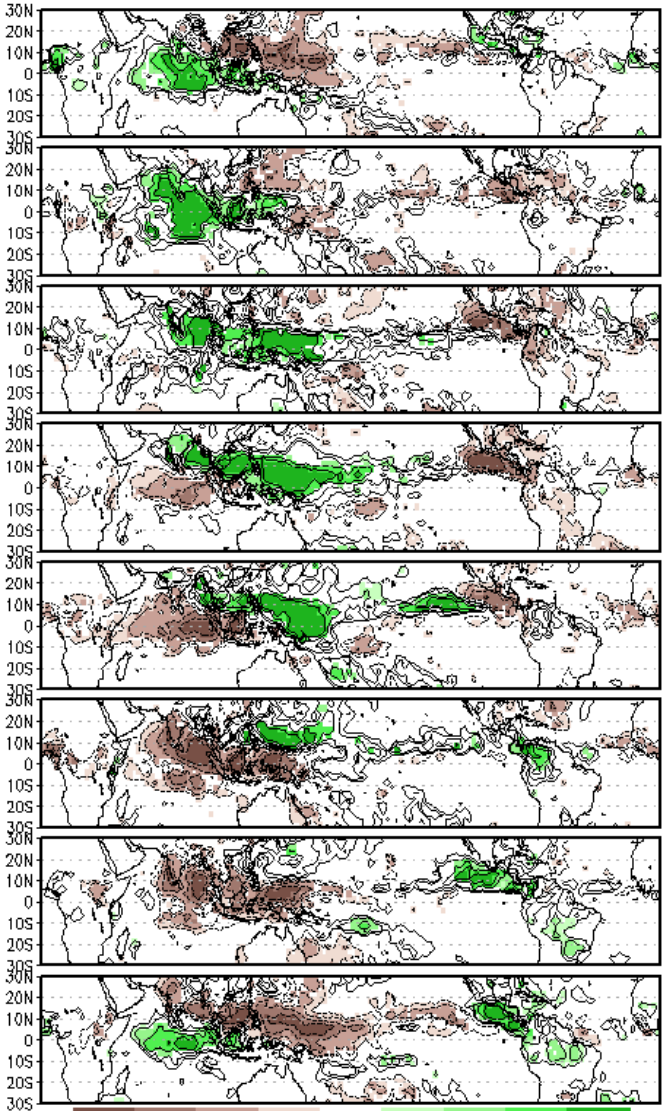
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

Weak MJO activity is forecast during the next two weeks with enhanced convection over the north central Indian Ocean and suppression over the western Pacific.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)