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

Update prepared by
Climate Prediction Center / NCEP
September 22, 2008

Outline

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

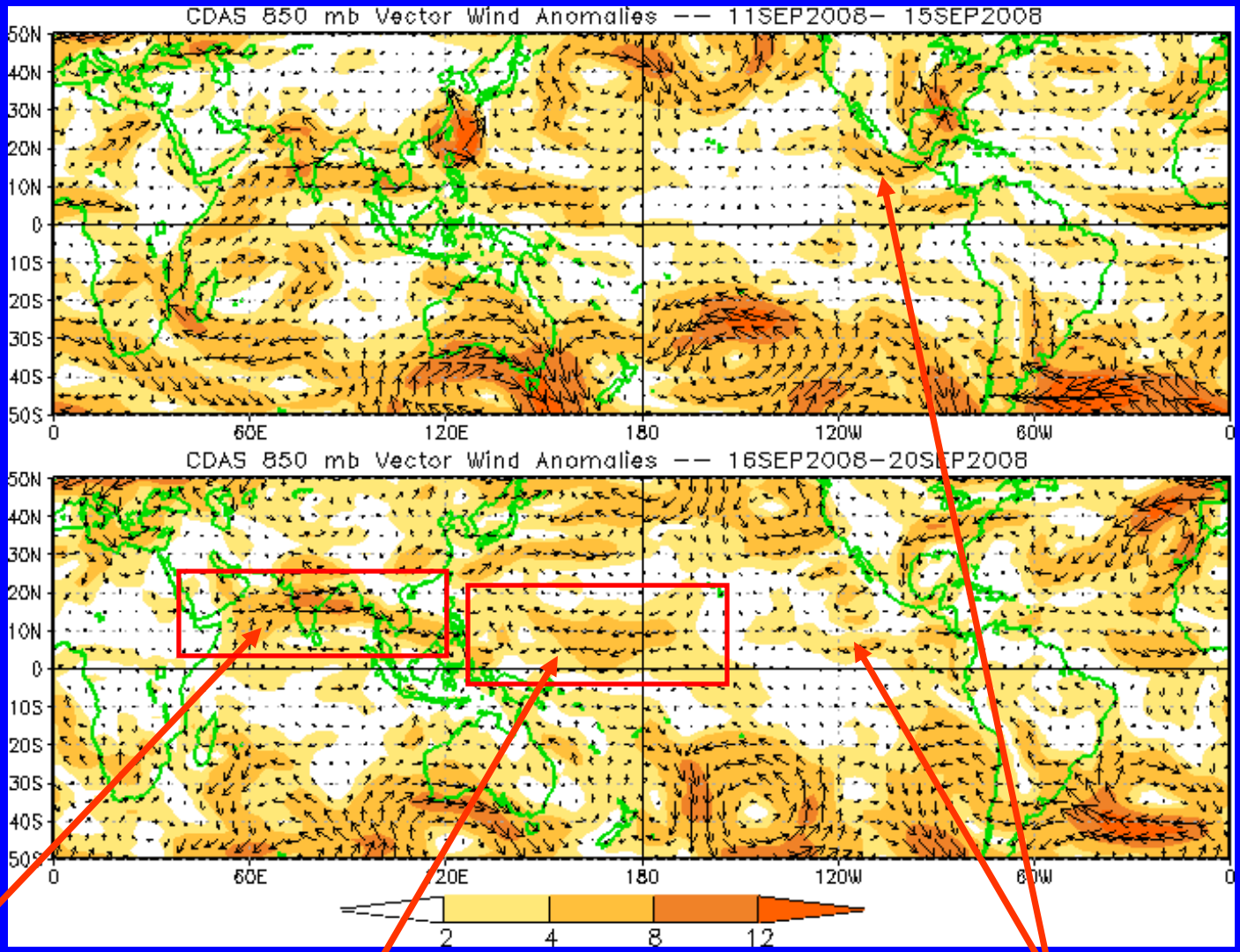
Overview

- MJO activity continues with the enhanced phase centered across the Pacific.
- Based on the latest observations and some forecast tools, moderate MJO activity is expected to continue during the next 1-2 weeks.
- During Week 1, the MJO is expected to contribute to enhanced rainfall across parts of the eastern Pacific, Mexico, Central America and the Caribbean. Drier-than-average conditions are expected across sections of the Indian Ocean, India and Indonesia.
- These patterns of anomalous convection are expected to continue for most of the above areas during Week 2.
- The current MJO will increase the likelihood for tropical cyclone development across parts of the western Atlantic basin 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



Westerly anomalies have increased across southern Asia and the South China Sea during the last five to ten days.

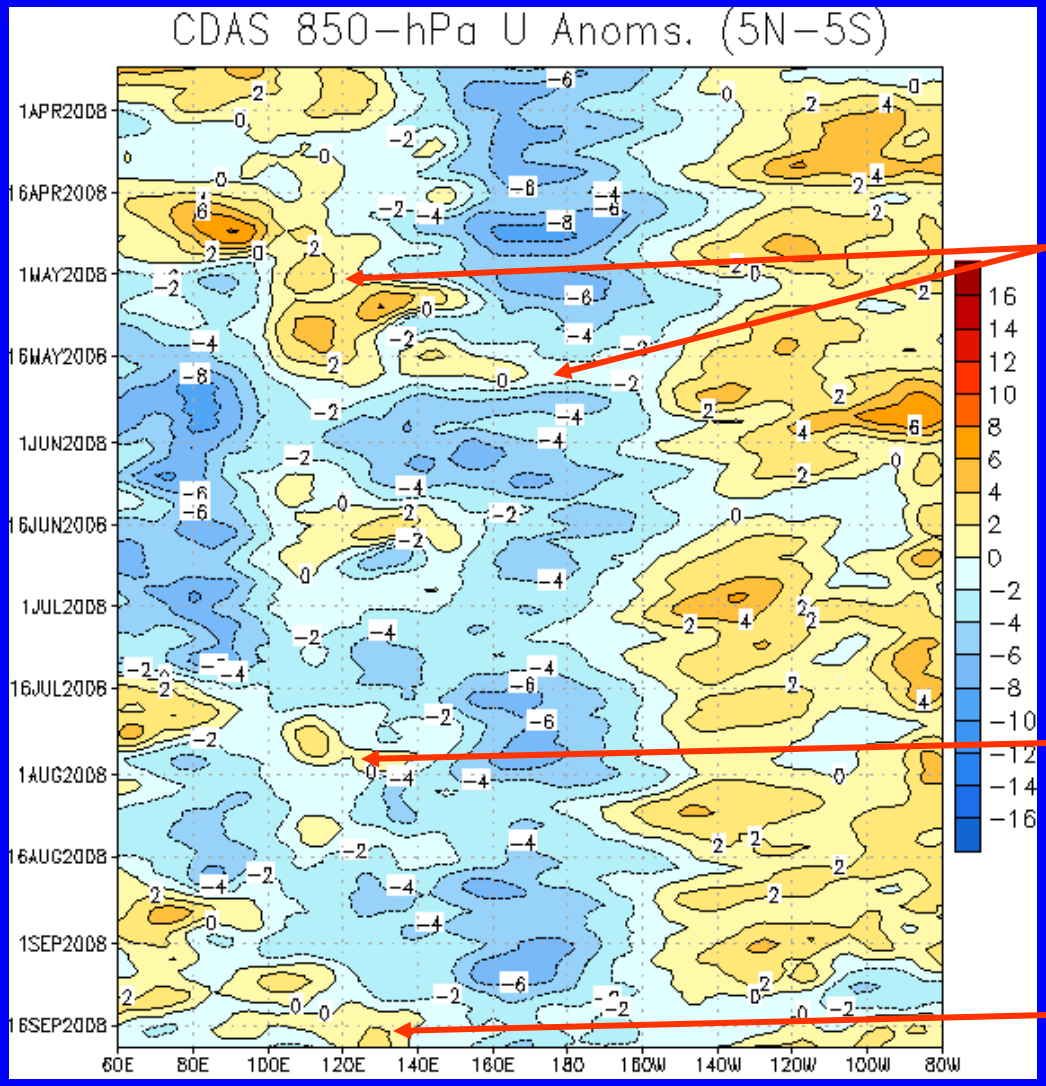
Easterly anomalies have decreased across the western Pacific during the last five days.

Westerly anomalies have decreased 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

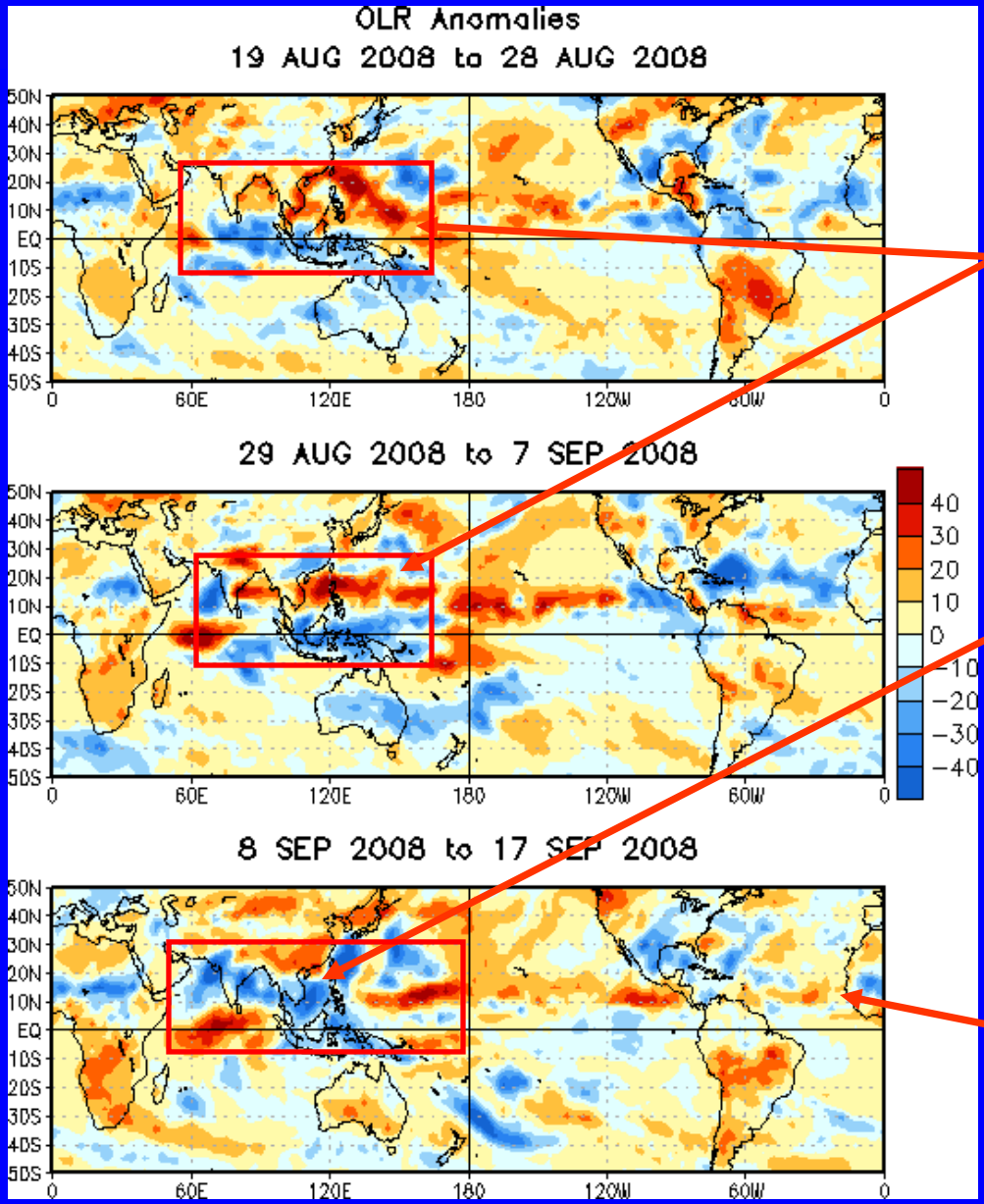
During mid-May, easterlies weakened across the western Pacific associated with moderate MJO activity.

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 weak MJO activity.

Westerly anomalies associated with the current MJO activity have propagated eastward to the Maritime continent from the Indian Ocean.

OLR Anomalies: Last 30 days



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

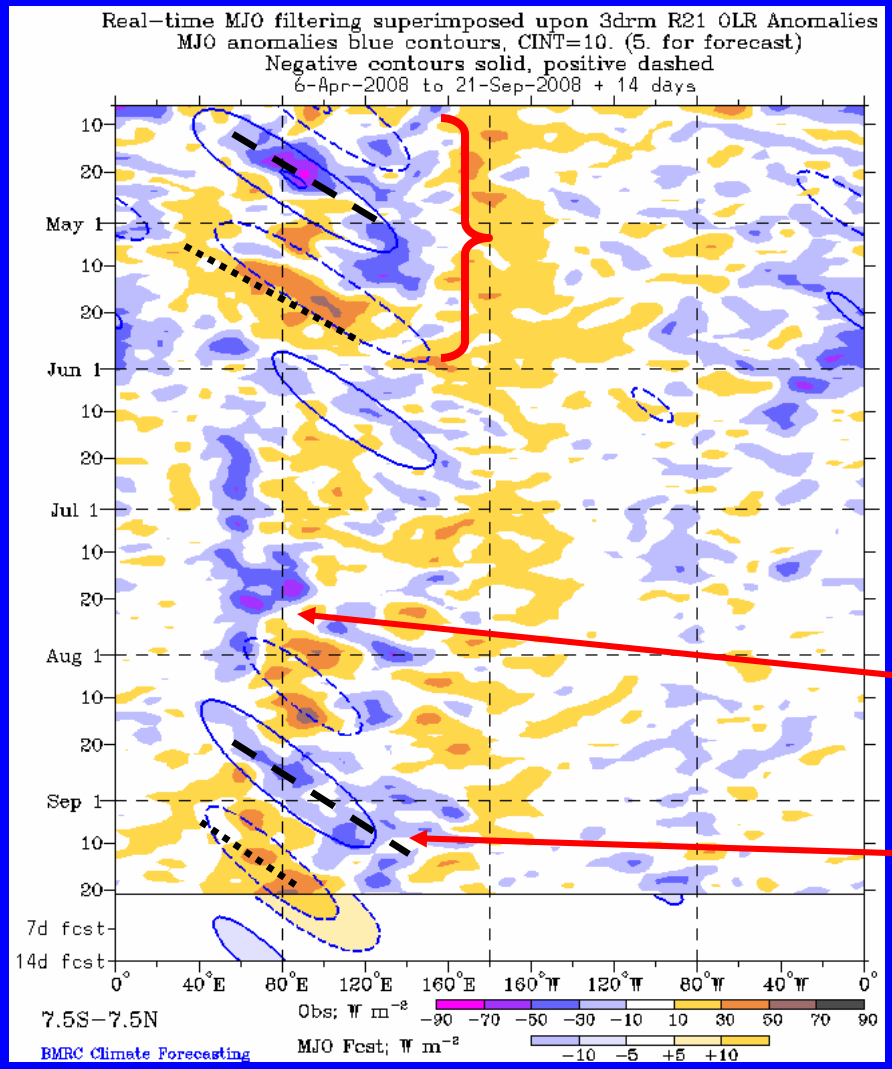
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

In late August and early September, dry conditions propagated north while enhanced convection developed across the equatorial Indian Ocean and parts of Indonesia.

During early September, enhanced convection began to shift northeastwards into southern Asia and the western Pacific Ocean. Dry conditions are now evident across the equatorial Indian Ocean as well.

Convection across the Atlantic Ocean was near average during the middle portion of September after the active period in late August and early September.

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 late-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.

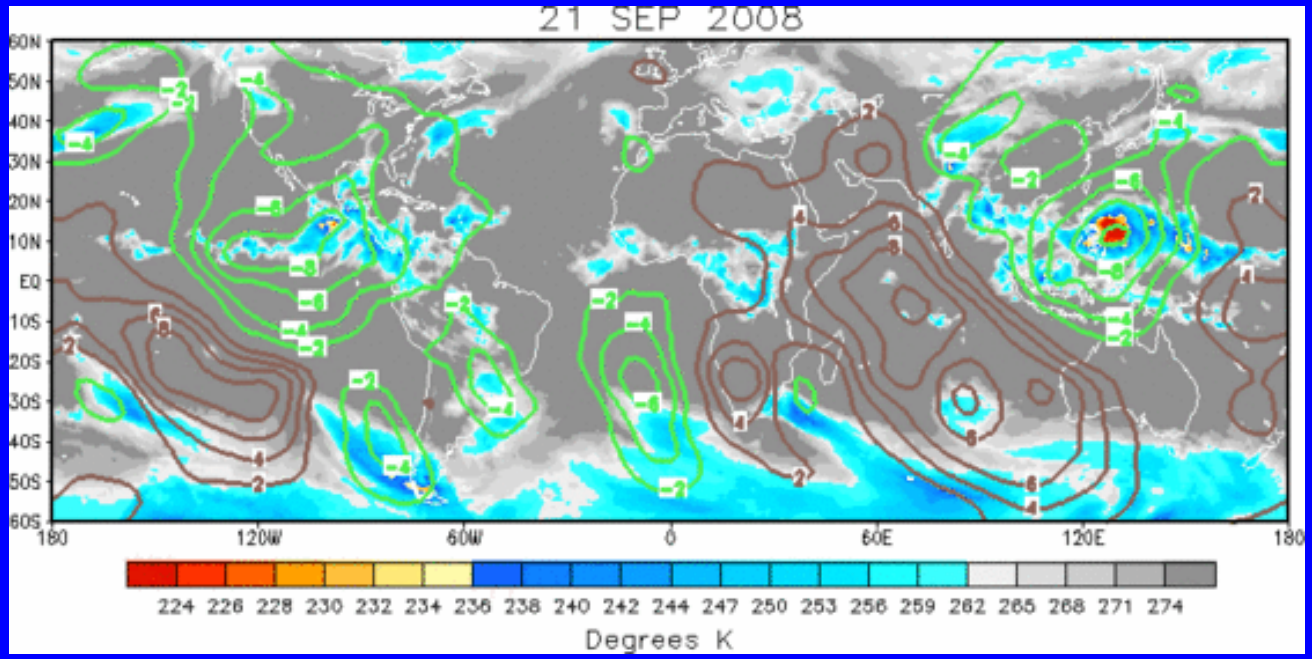
Persistent enhanced convection was evident across the western Indian Ocean from mid-June to early August.

Enhanced convection developed across the Indian Ocean during late August and has propagated eastward. Dry conditions have developed along the equator in the Indian Ocean and has also shifted eastward.

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

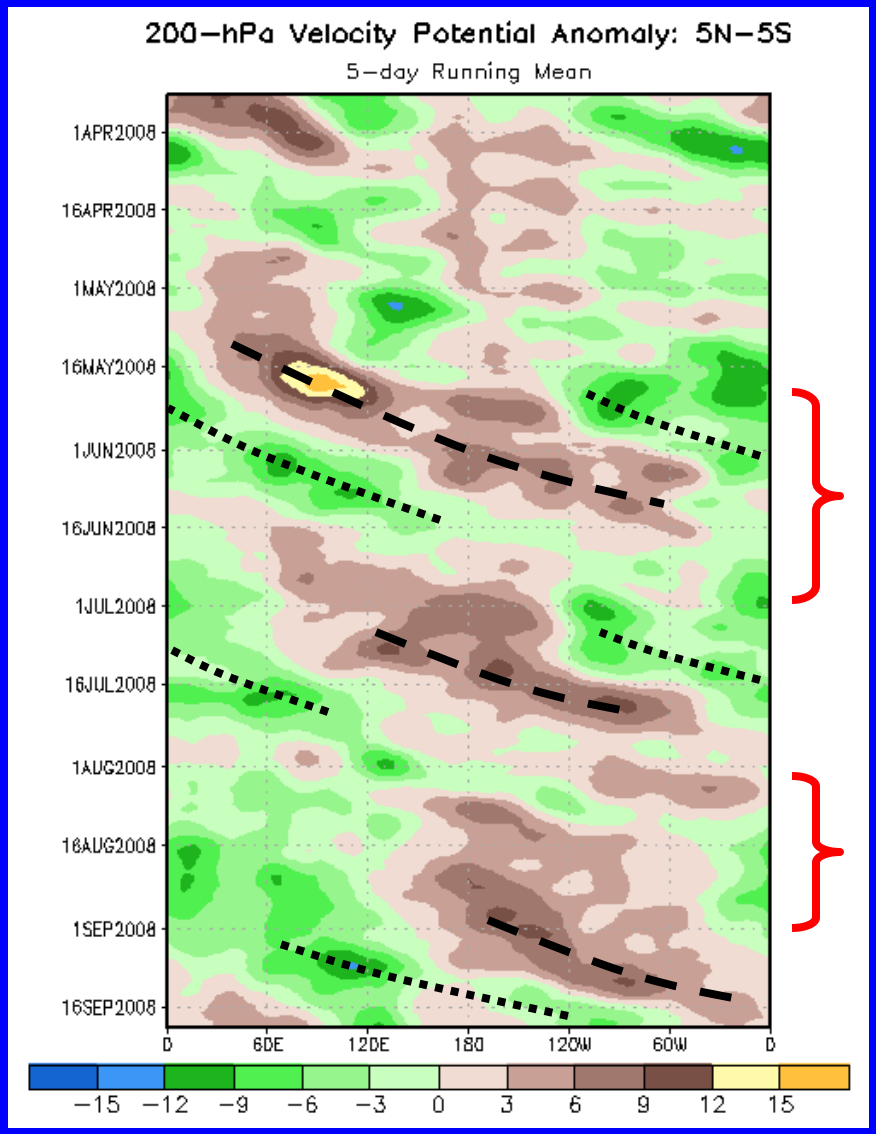


Upper-level divergence has shifted eastward to the eastern Pacific and Central America region while upper-level convergence has decreased across the Atlantic basin and is mainly centered across Africa and the Indian Ocean.

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

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.

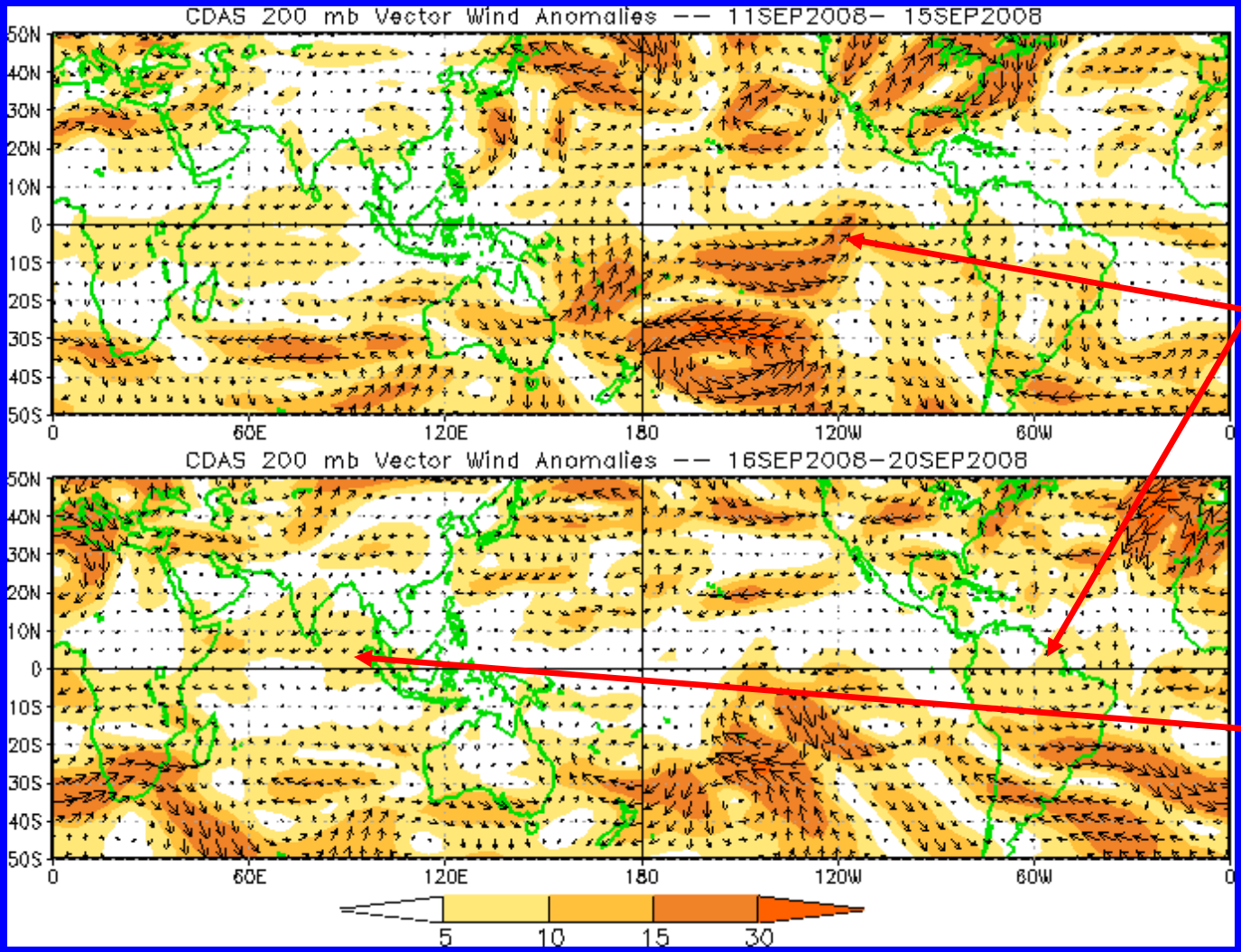
After weakening in late June, the MJO strengthened during mid-July.

From early-mid August into early September, the MJO was weak as a more stationary pattern was evident.

The MJO has strengthened and eastward propagation has been observed during the past couple of weeks.

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

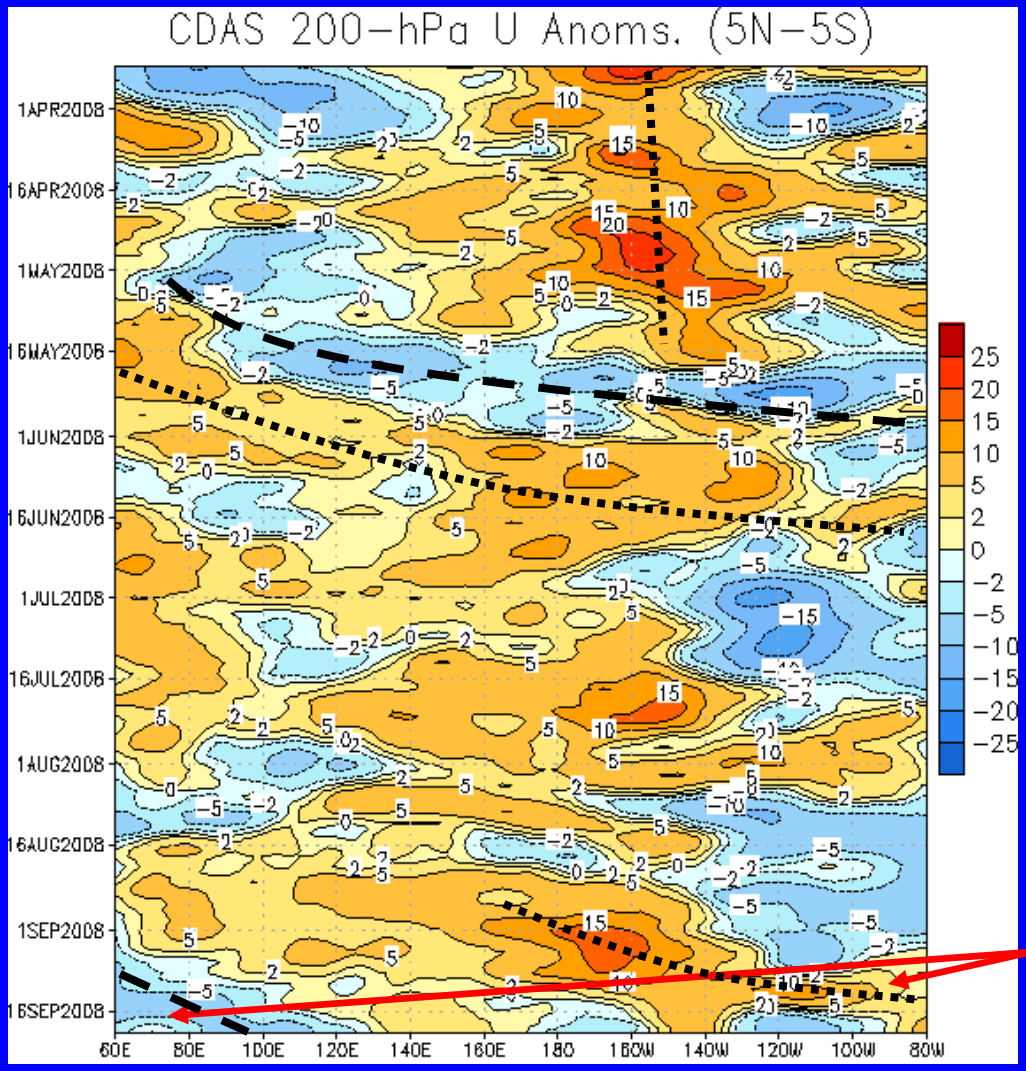
Note that shading denotes the magnitude of anomalous wind vectors



Upper-level westerly anomalies have shifted eastward to the eastern Pacific and South America during the past five days.

Easterly anomalies are now evident across the Indian Ocean and Africa.

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



Time

Longitude

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

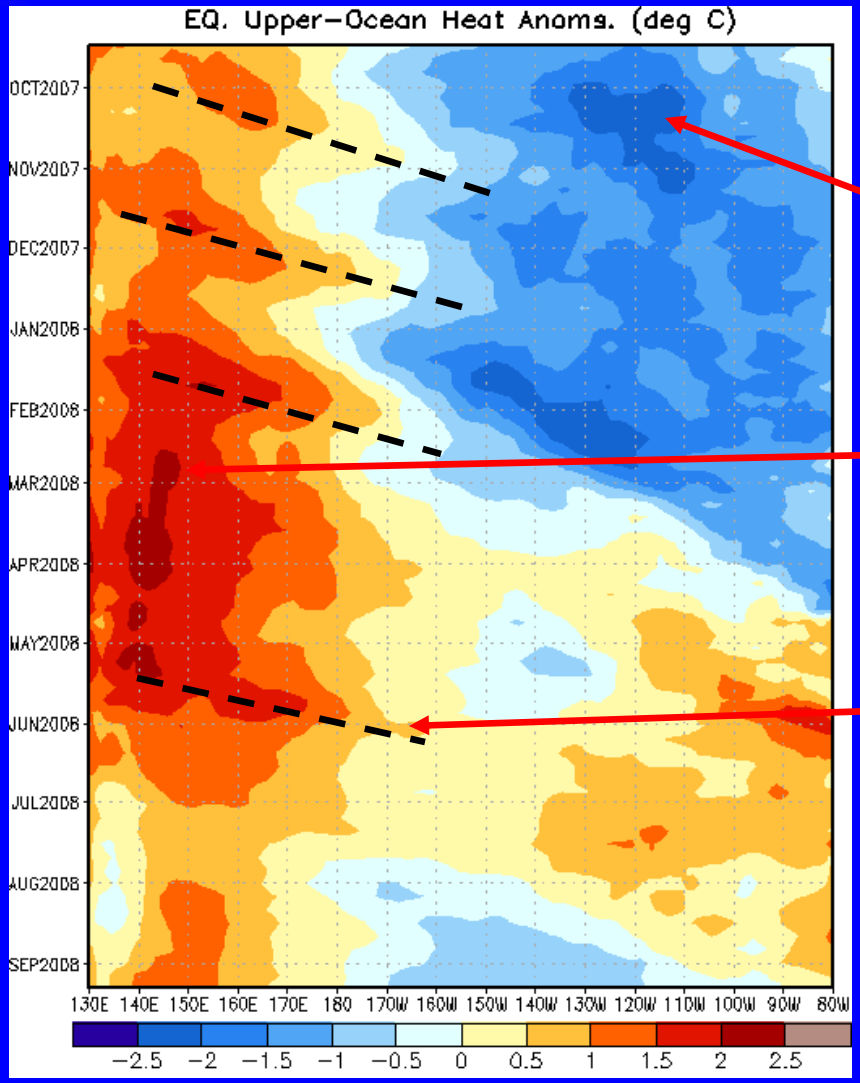
Easterly anomalies (blue shading) represent anomalous east-to-west flow

The MJO was weak or incoherent for much of the period from March 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.

Westerly anomalies have shifted eastward to the eastern Pacific during the past week while easterly anomalies are now present across the Indian Ocean.

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

MJO Index -- Information

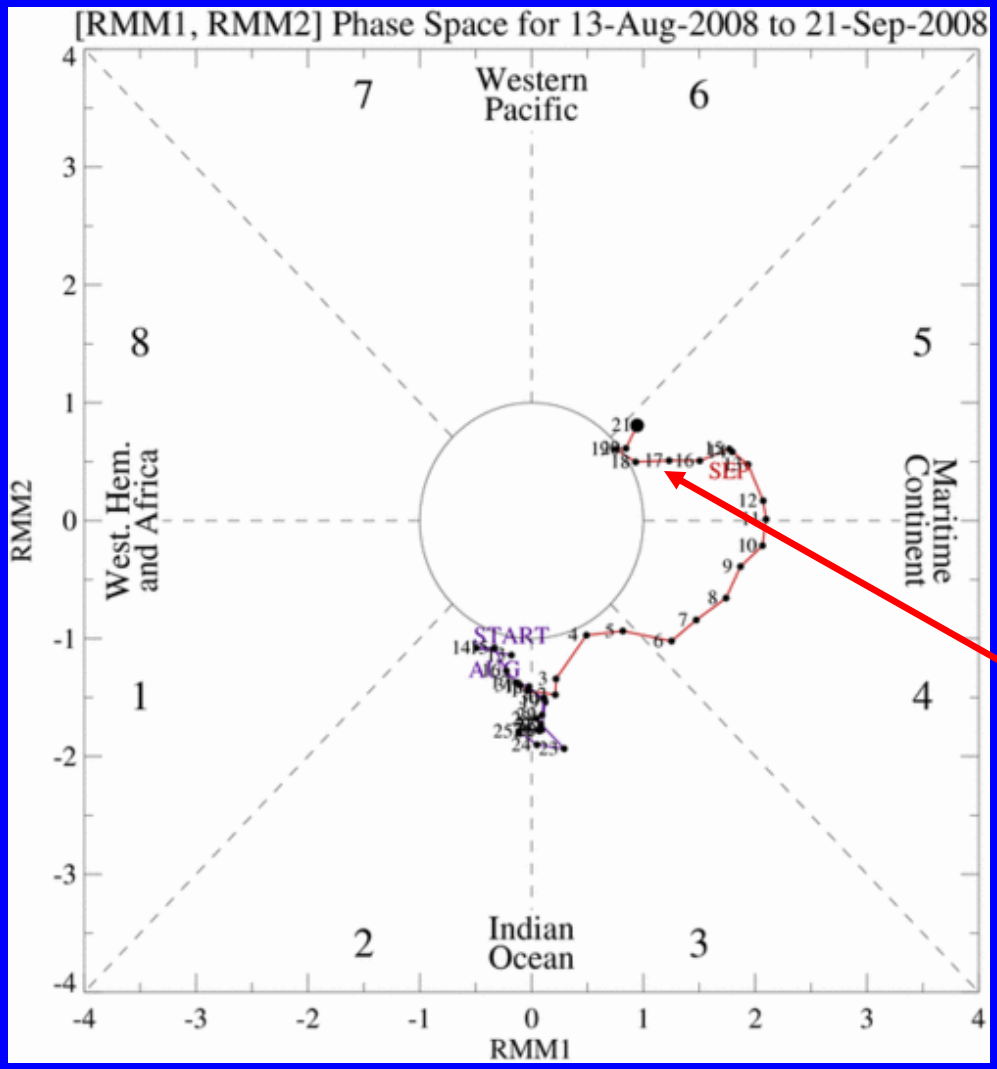
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

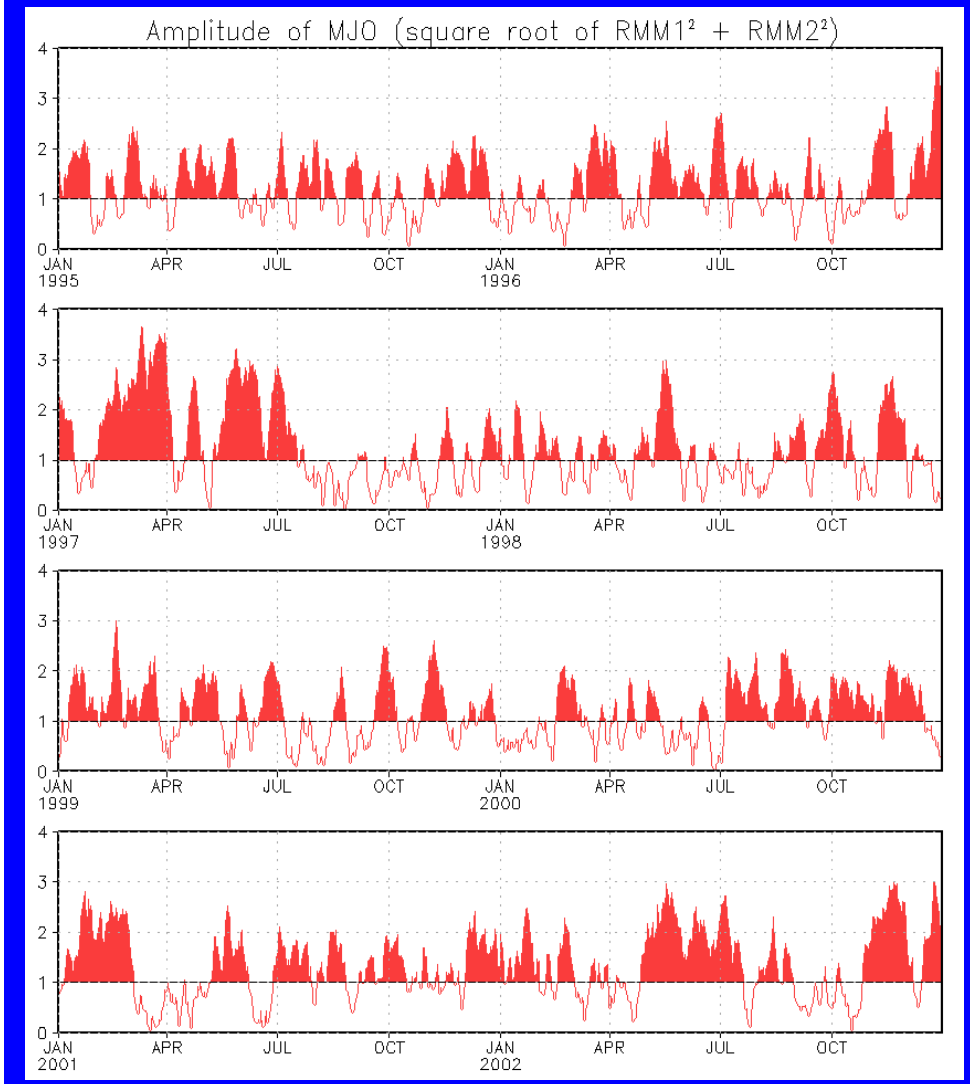
MJO Index -- Recent Evolution

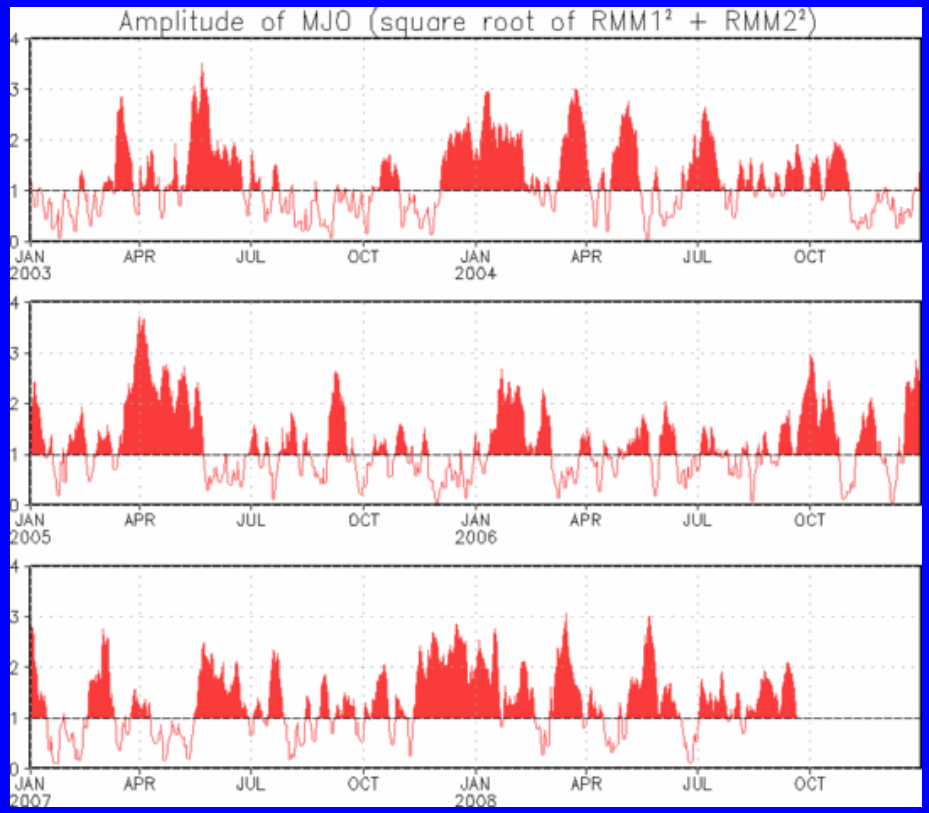


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation**
- **Distance from the origin is proportional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

The MJO amplitude has decreased and eastward propagation has slowed 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

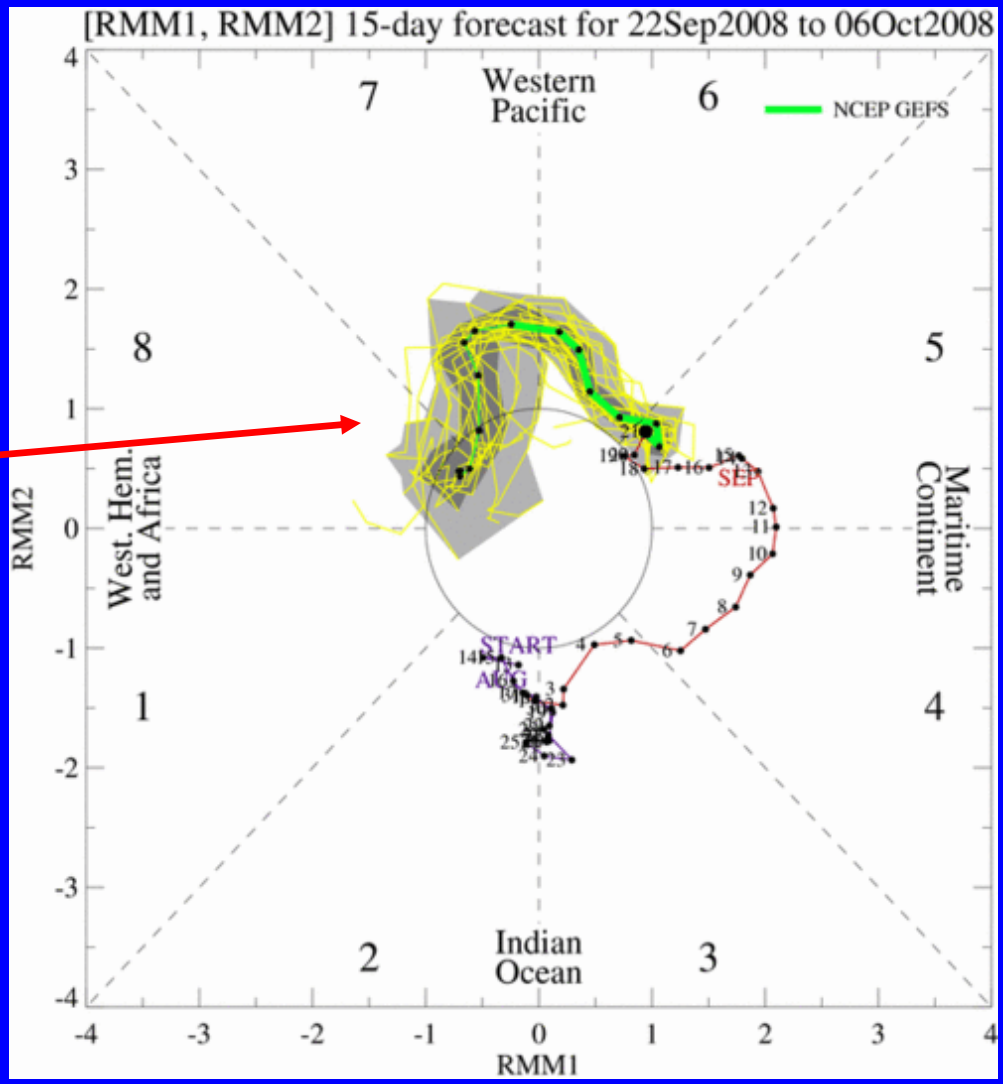
Ensemble GFS (GEFS) MJO Forecast

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

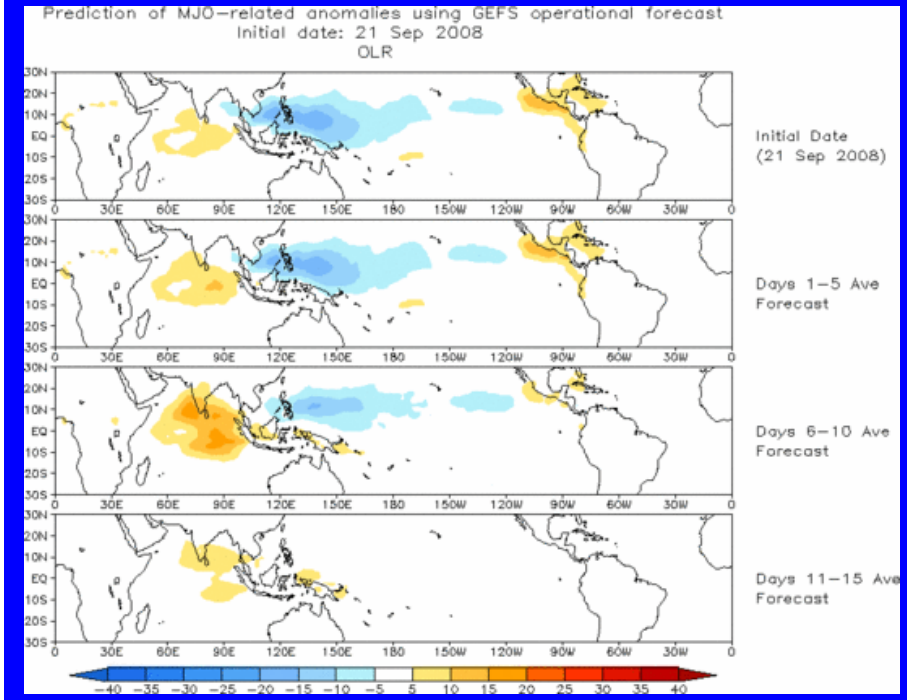
The GEFS indicates continued eastward propagation during the next 1-2 weeks with some increase in amplitude.



Ensemble Mean GFS MJO Forecast

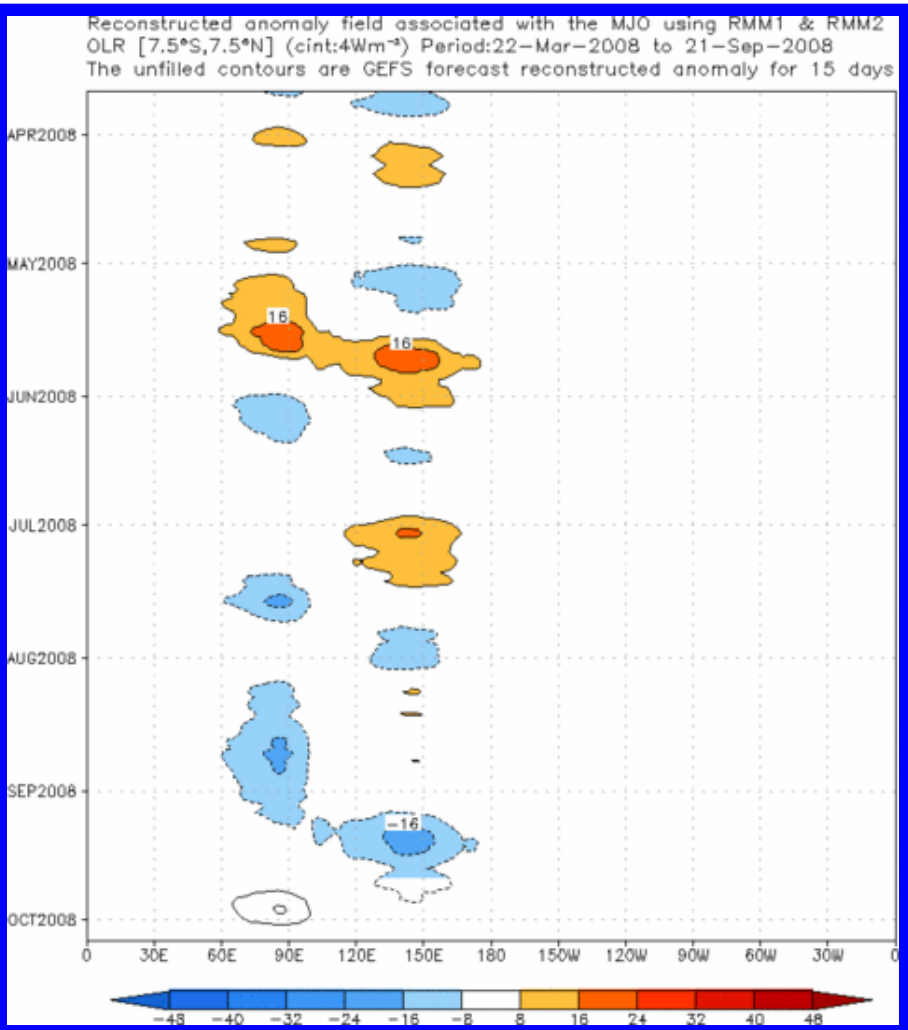
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The forecast indicates MJO-associated enhanced convection across the western Pacific decreasing during the period. Suppressed conditions are forecast for the Indian Ocean and southern India.

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)

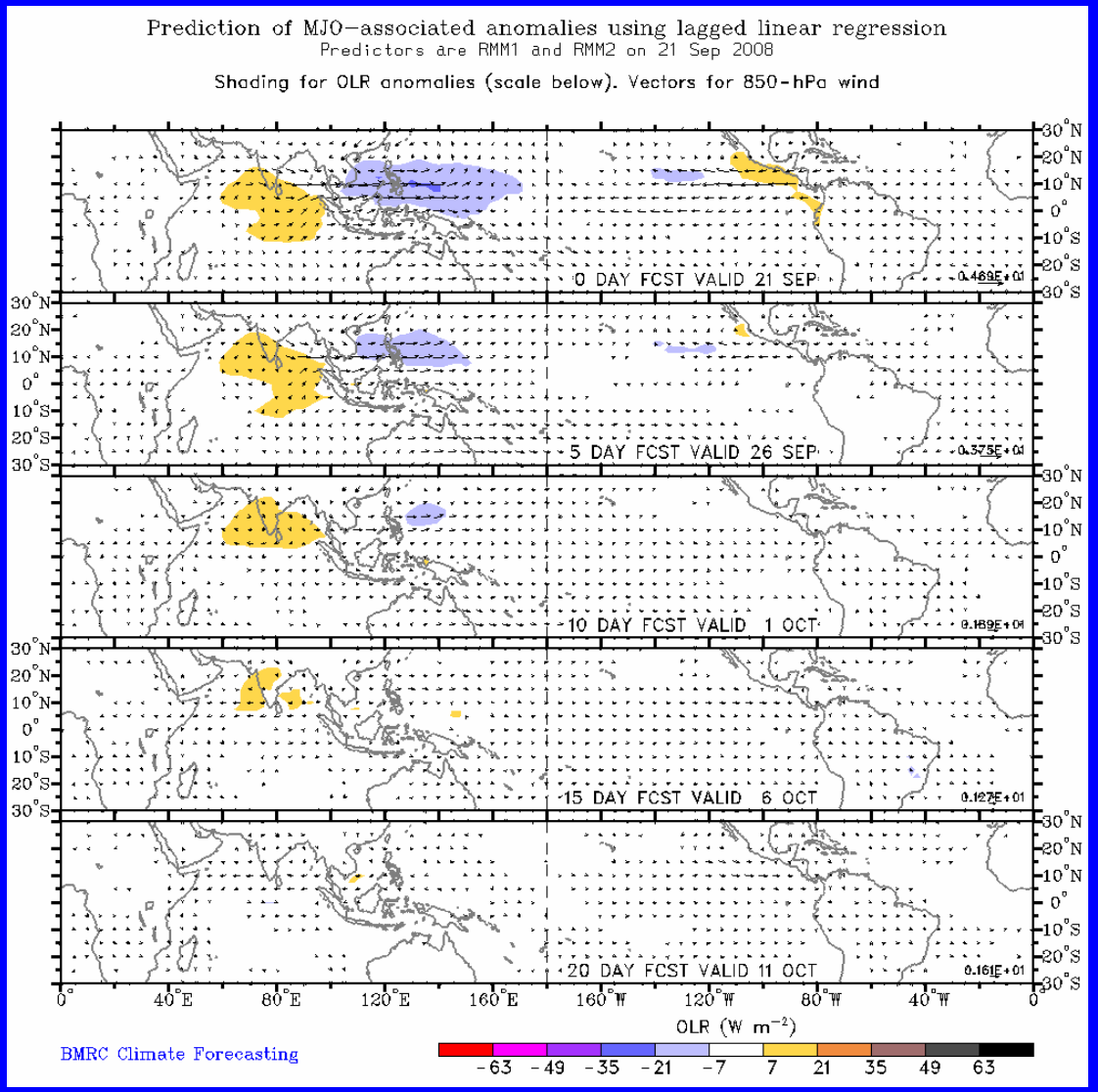
Spatial map of OLR anomalies and 850-hPa wind vectors for the next 20 days

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

Weak MJO activity is forecast during the next two weeks.

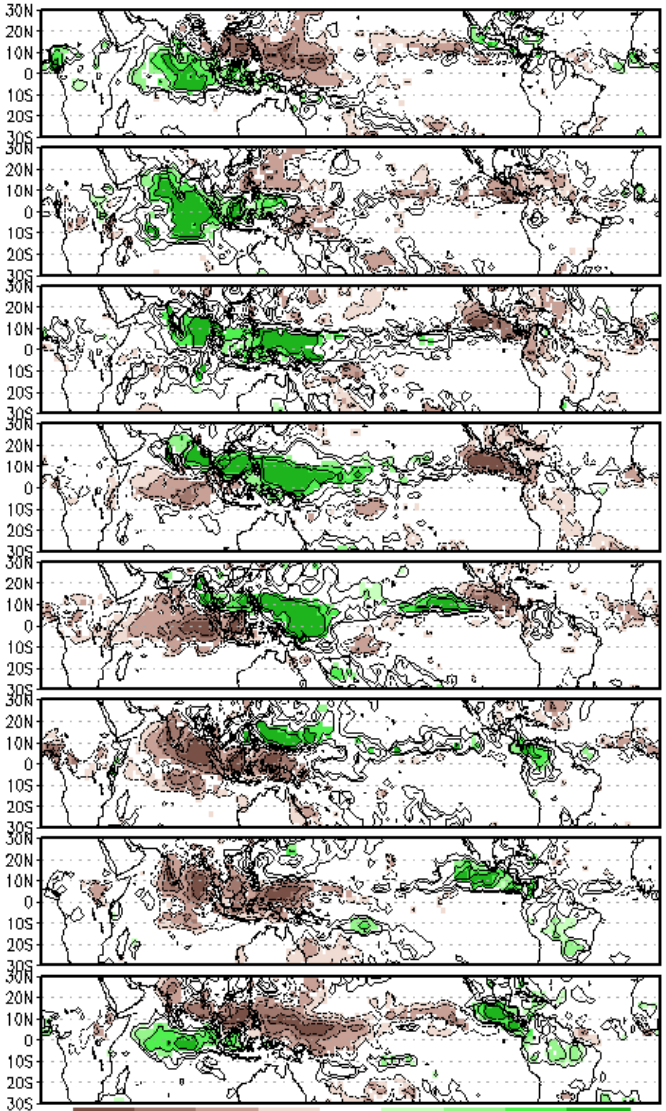
Enhanced convection is expected to decrease over the period across the western Pacific.

Suppressed convection is forecast to for southern India during the period.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)