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

Update prepared by
Climate Prediction Center / NCEP
October 6, 2008

Outline

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

Overview

- MJO activity continues with the enhanced phase located across the western Hemisphere. Eastward propagation has slowed in recent days.

- Based on the latest observations, moderate-to-weak MJO activity is expected to continue during the next 1-2 weeks.

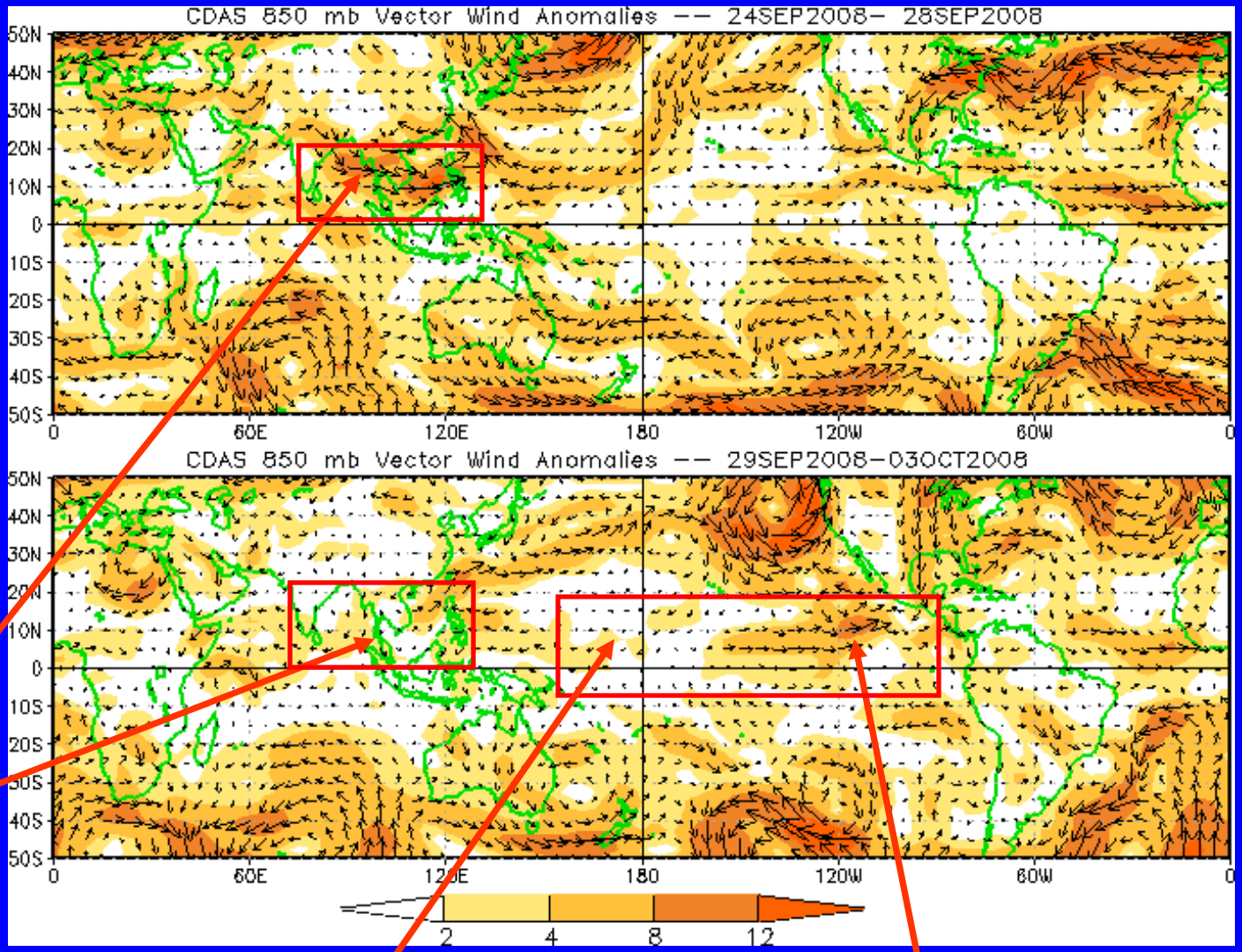
- During Week 1, the MJO is expected to contribute to enhanced rainfall across Mexico, Central America, western Africa and the equatorial Indian Ocean. Enhanced convection is expected to continue during Week 2 across the equatorial Indian Ocean.

- The current MJO increases the likelihood for tropical cyclone development across the eastern Pacific during Week 1 and the southern Gulf of Mexico and western Caribbean Sea during both Week 1 and Week 2.

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 decreased during the last five days across southeast Asia and the western Pacific.

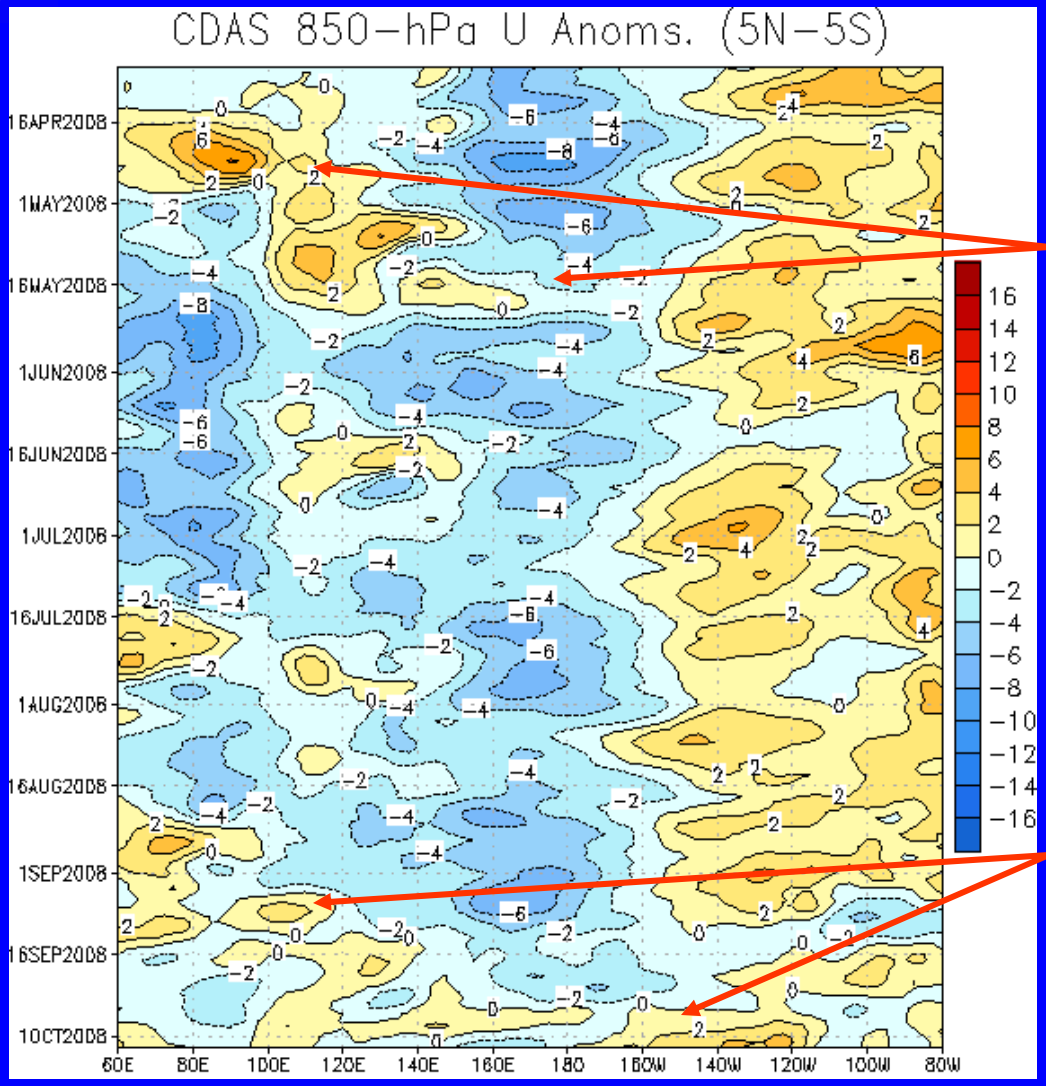
Easterly anomalies continued to decrease near the Date Line.

Westerly anomalies have increased across the east 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

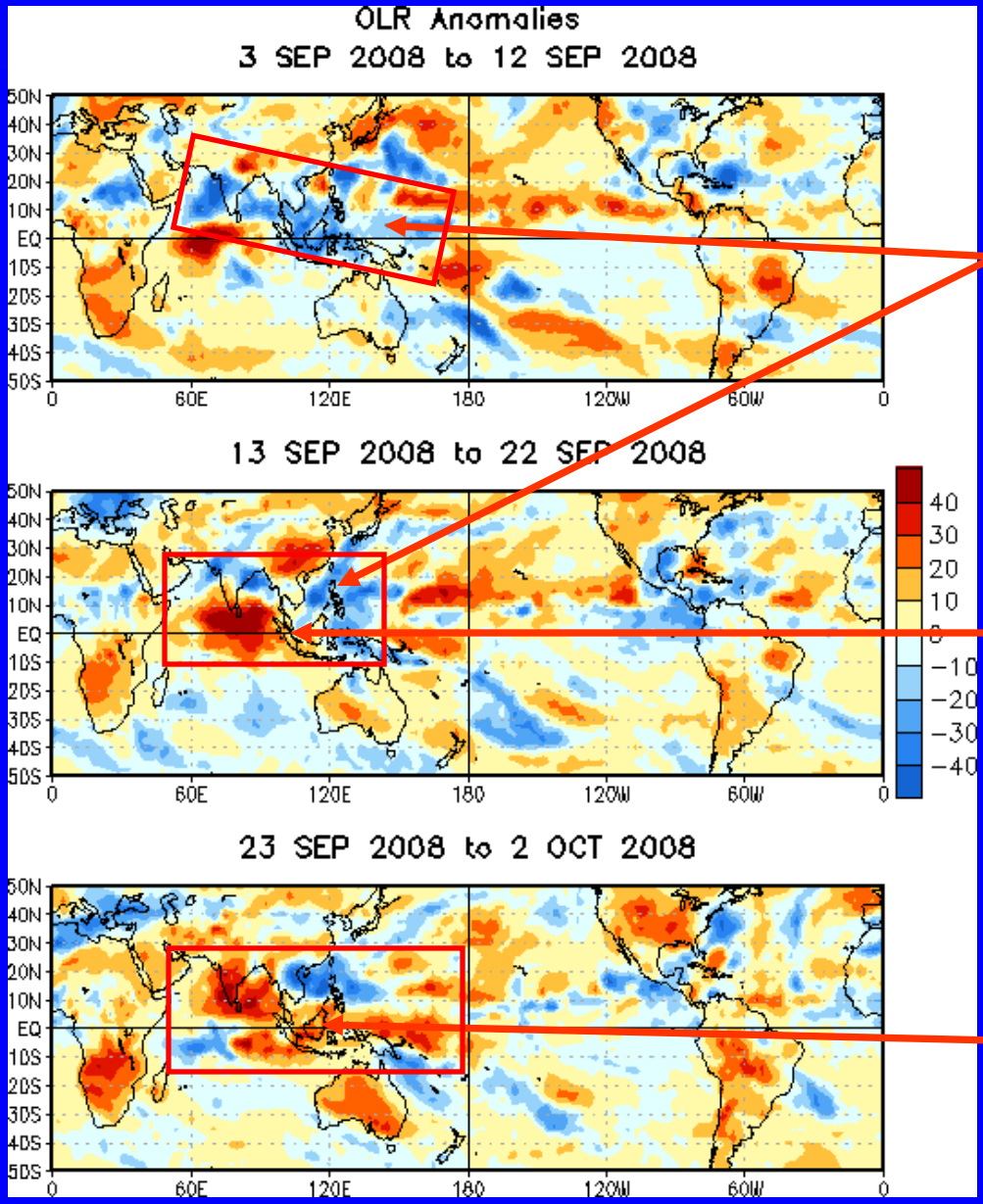
Longitude

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

Easterly anomalies prevailed across much of the eastern hemisphere from late May into August.

From mid-August to mid-September, westerly anomalies associated with the current MJO activity propagated eastward from the Indian Ocean into the Pacific.

OLR Anomalies: Last 30 days



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

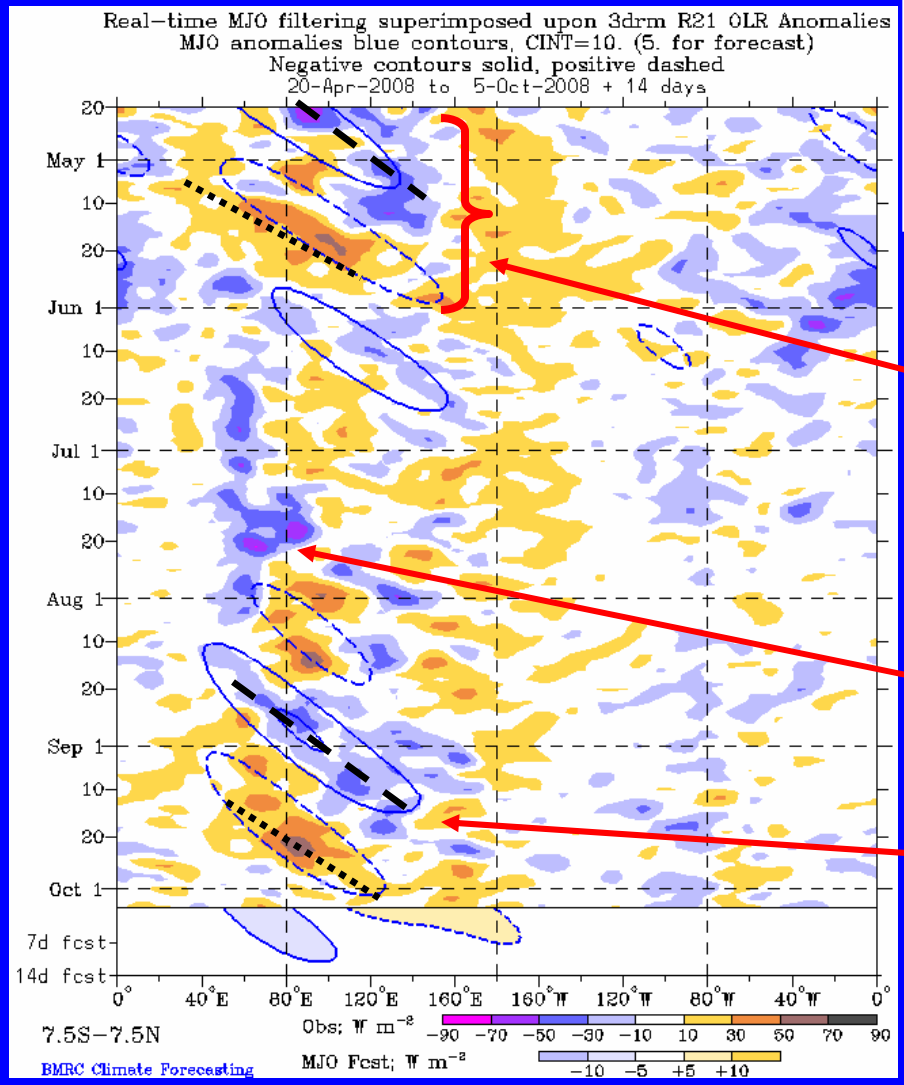
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

In early-mid September, enhanced convection shifted northeast to southern Asia, Indonesia and the western Pacific. The Atlantic Ocean experienced wet conditions during the period.

Suppressed convection intensified in mid-September across the equatorial Indian Ocean. Also, wet conditions developed over the eastern Pacific, Central America and Mexico.

Since late September, dry conditions have propagated northeast into India, Indonesia and the equatorial west 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)

MJO activity was evident during April 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.

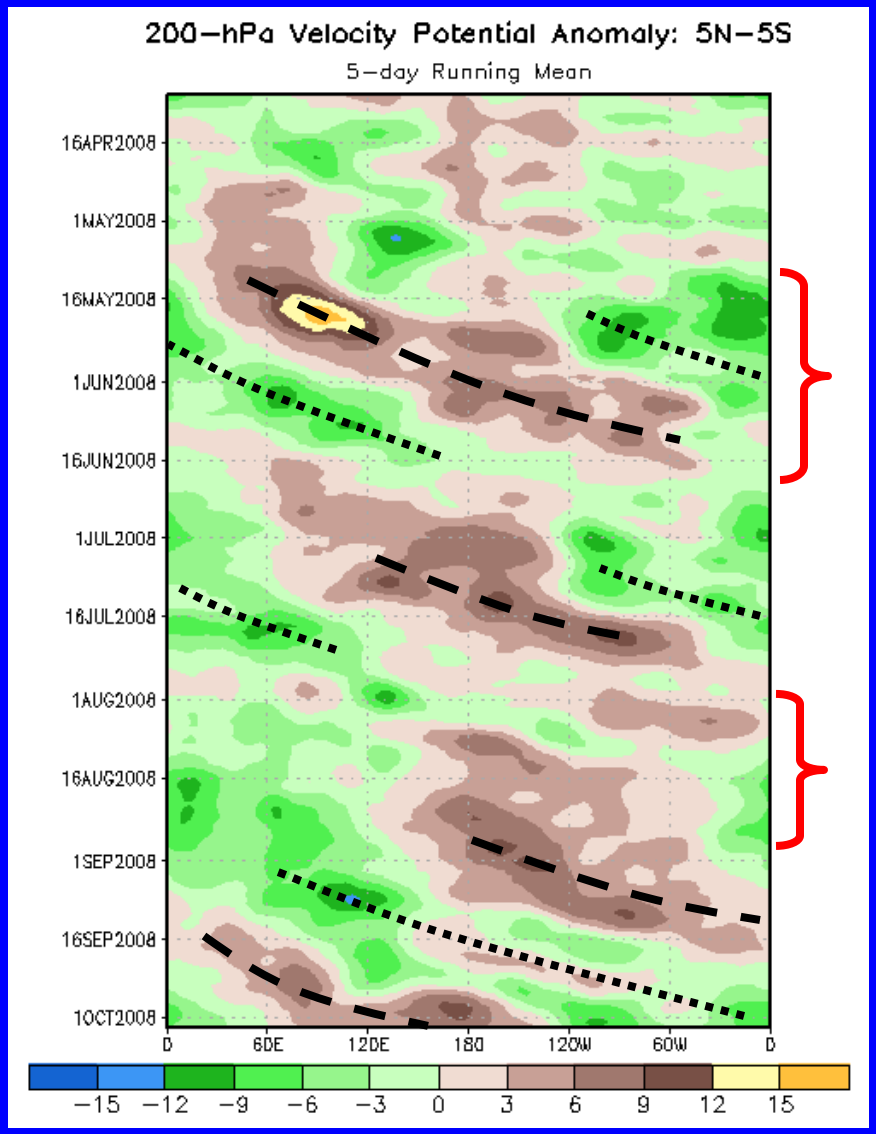
Persistent enhanced convection was evident across the western Indian Ocean from mid-June to early August.

Moderate MJO activity is evident since late August as enhanced convection developed across the Indian Ocean and shifted eastward. During mid-late September, suppressed convection shifted to Indonesia.

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.

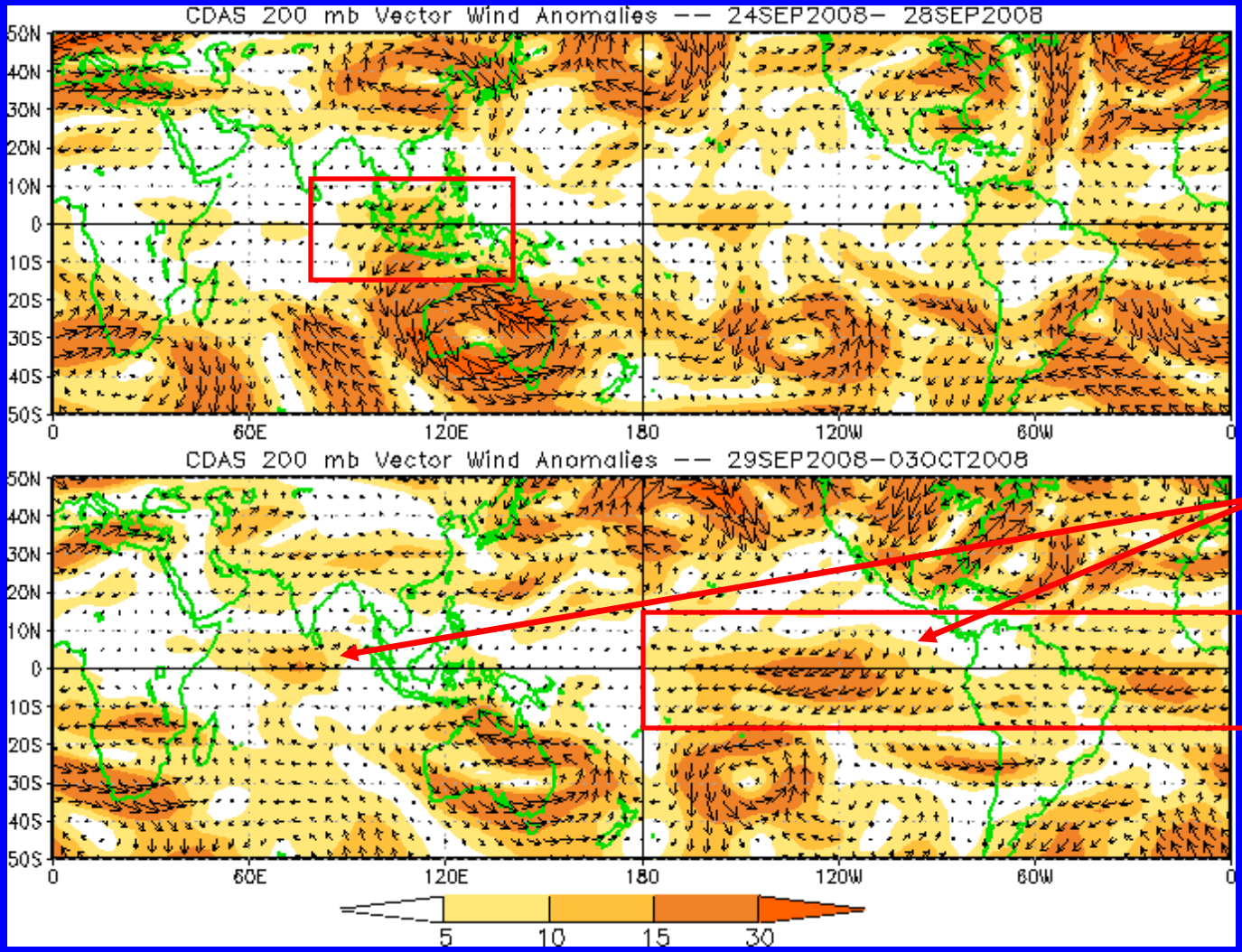
After weakening in late June, the MJO strengthened during mid-July.

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

The MJO strengthened in early September and eastward propagation has been observed during the month.

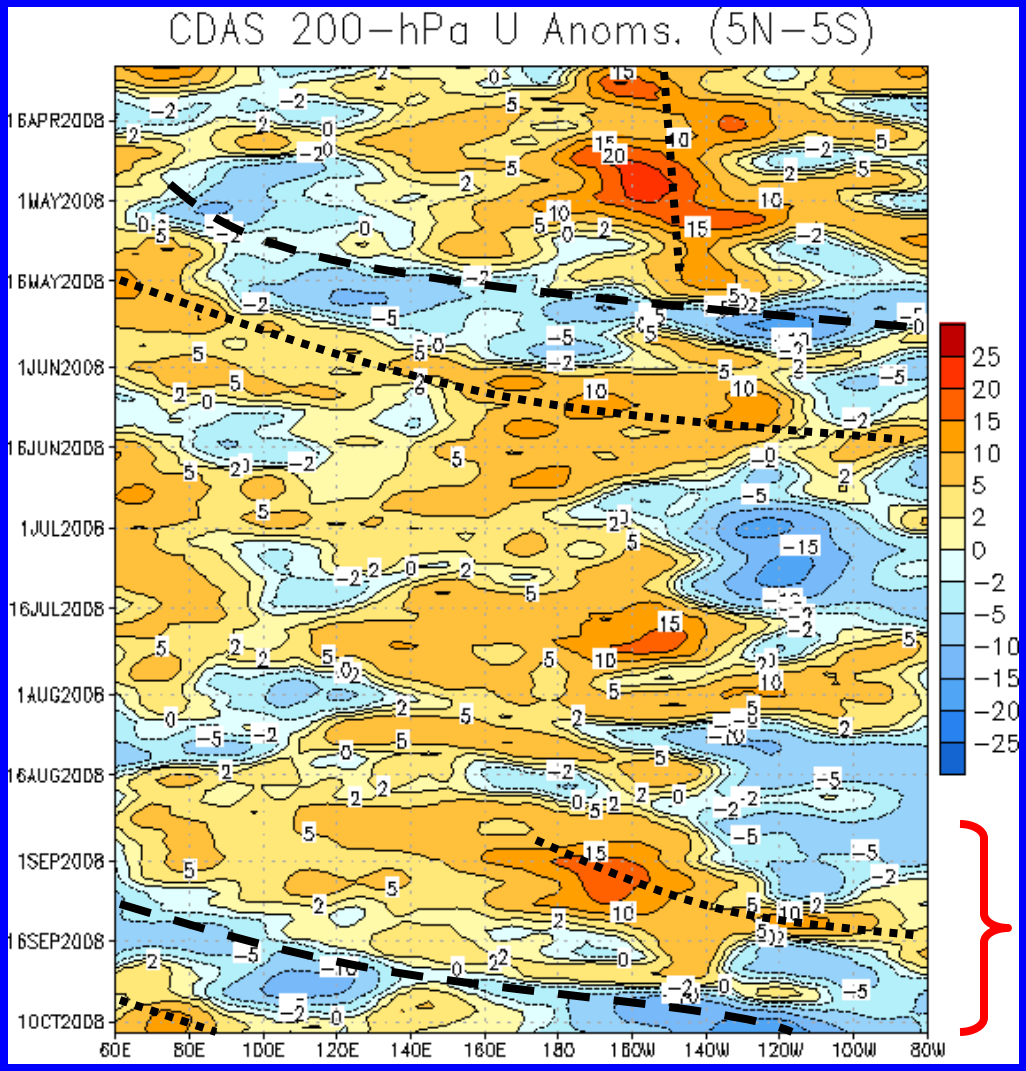
200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the magnitude of anomalous wind vectors



Easterly anomalies prevail across the western hemisphere and stretch from the Date Line to Africa. Also, westerly anomalies are evident across the equatorial Indian Ocean.

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



Time

Longitude

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

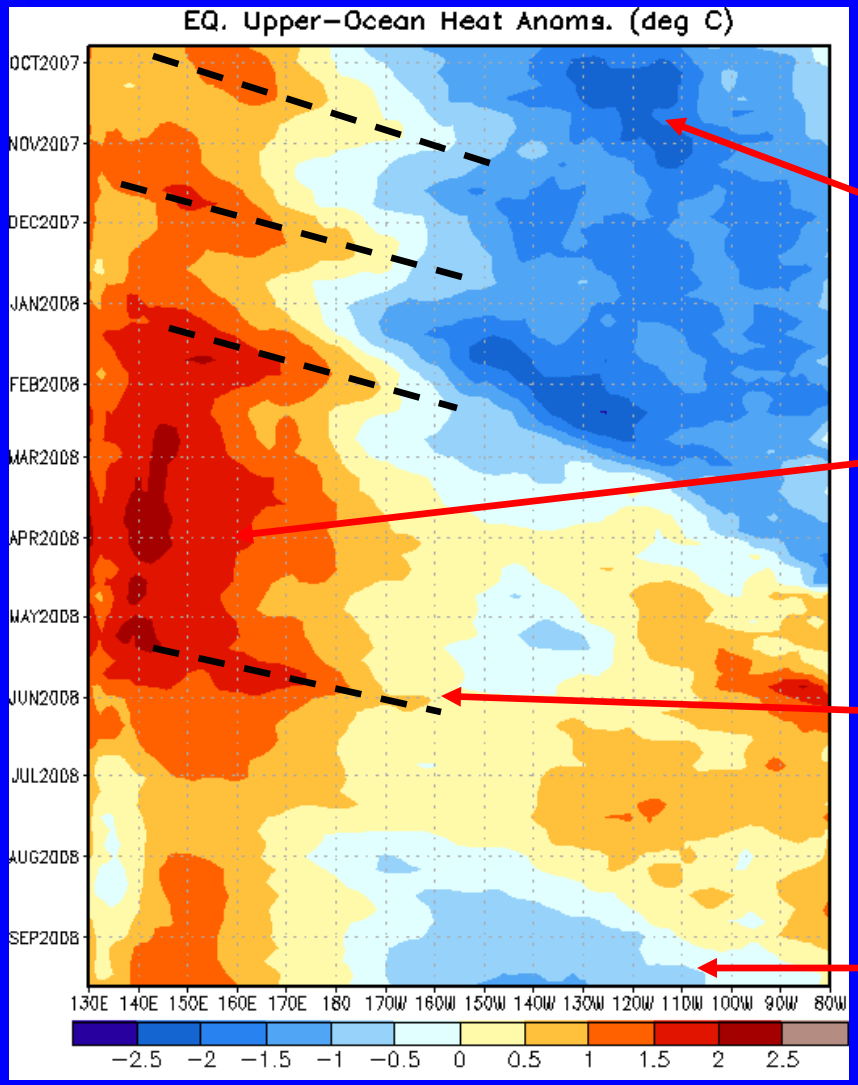
Easterly anomalies (blue shading) represent anomalous east-to-west flow

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 and easterly anomalies associated with the current MJO activity have shifted eastward during the past month.

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.

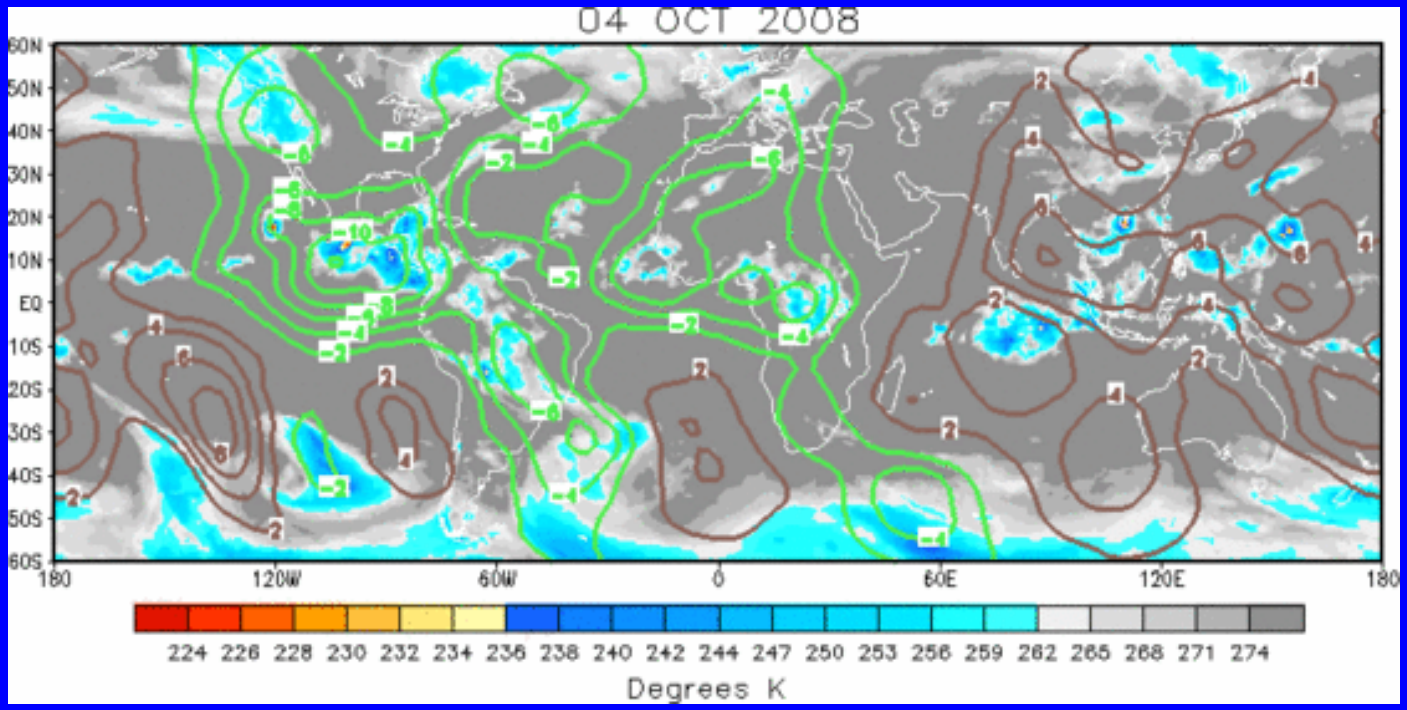
During June and July 2008, positive heat content anomalies encompassed much of the Pacific basin in part associated with a Kelvin wave initiated during May 2008.

During August 2008, negative anomalies started to develop east of the Date Line and during September the anomalies have increased and expanded 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



During the past week, upper-level divergence was centered across the western hemisphere, while upper-level convergence has shifted east across the Indian Ocean and into the west Pacific.

MJO Index -- Information

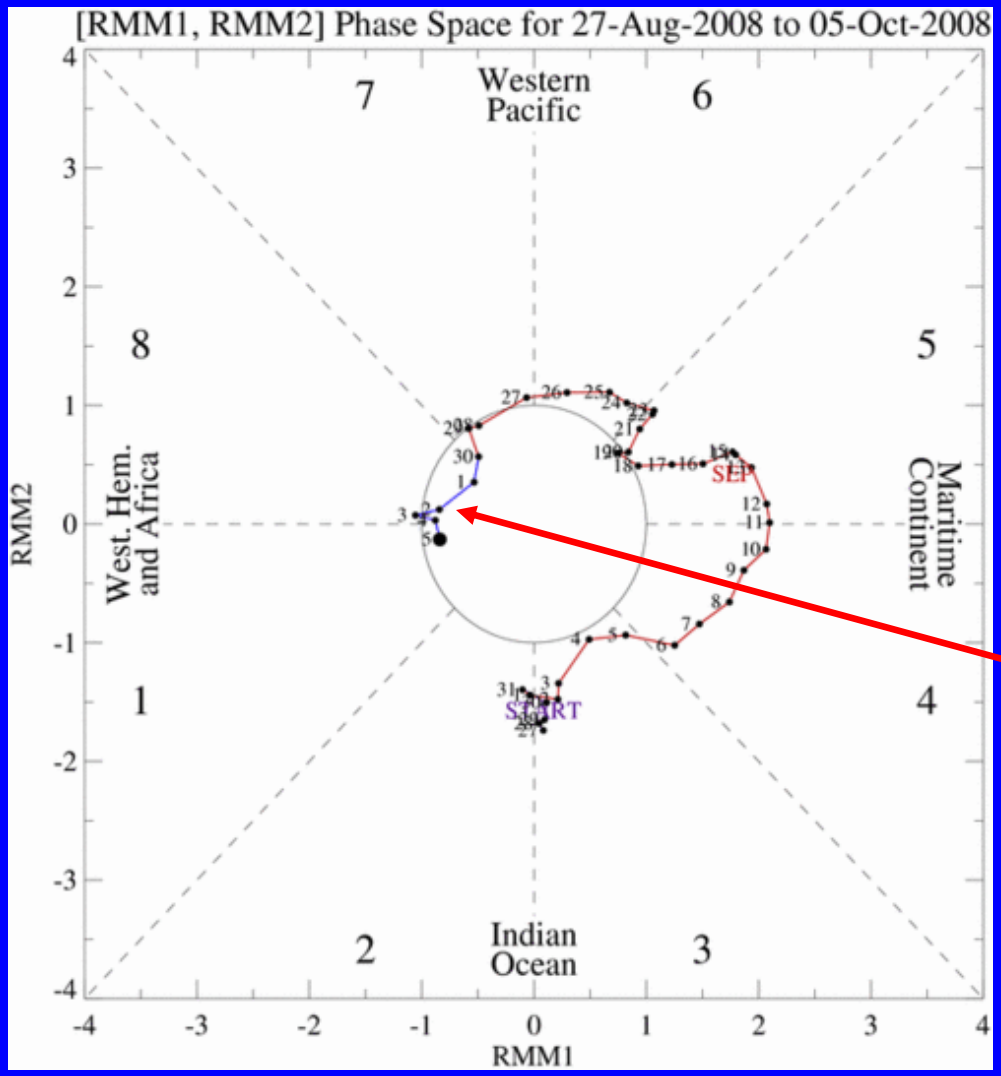
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

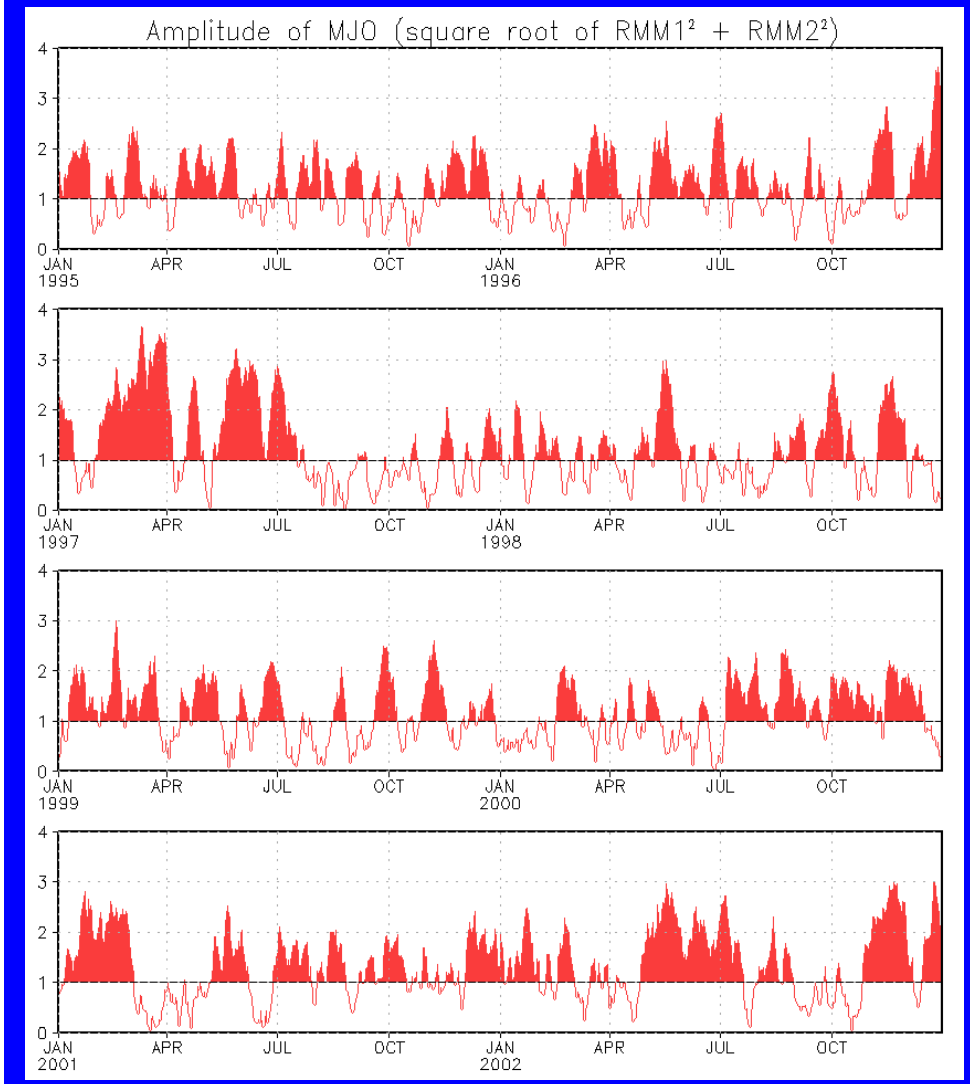
MJO Index -- Recent Evolution

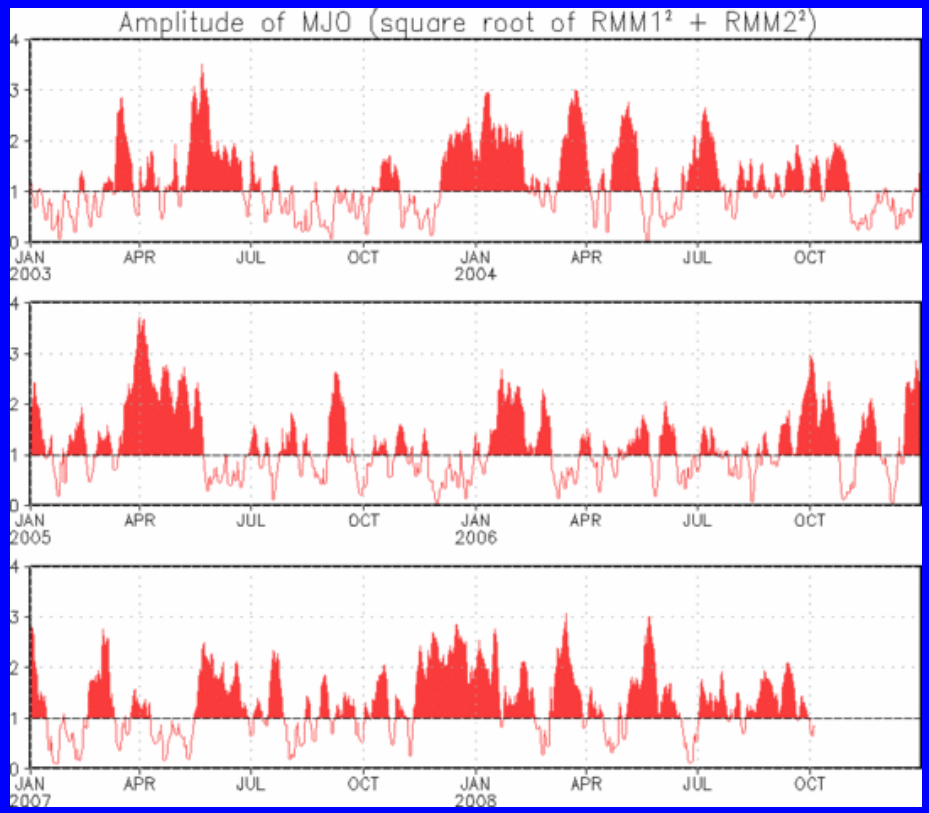


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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

The MJO index indicates continued MJO activity with the enhanced phase crossing the western Hemisphere. Eastward propagation has slowed in recent days.

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

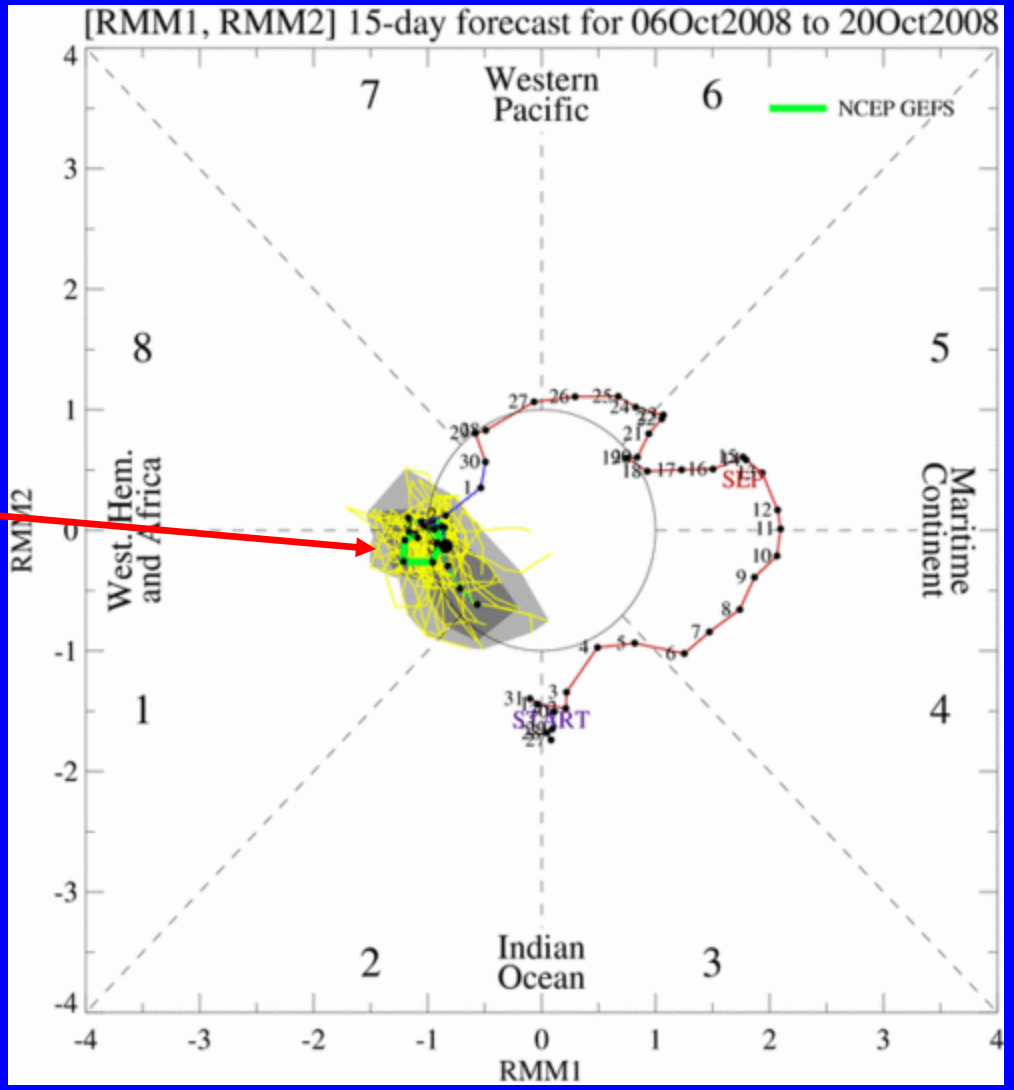
Ensemble GFS (GEFS) MJO Forecast

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

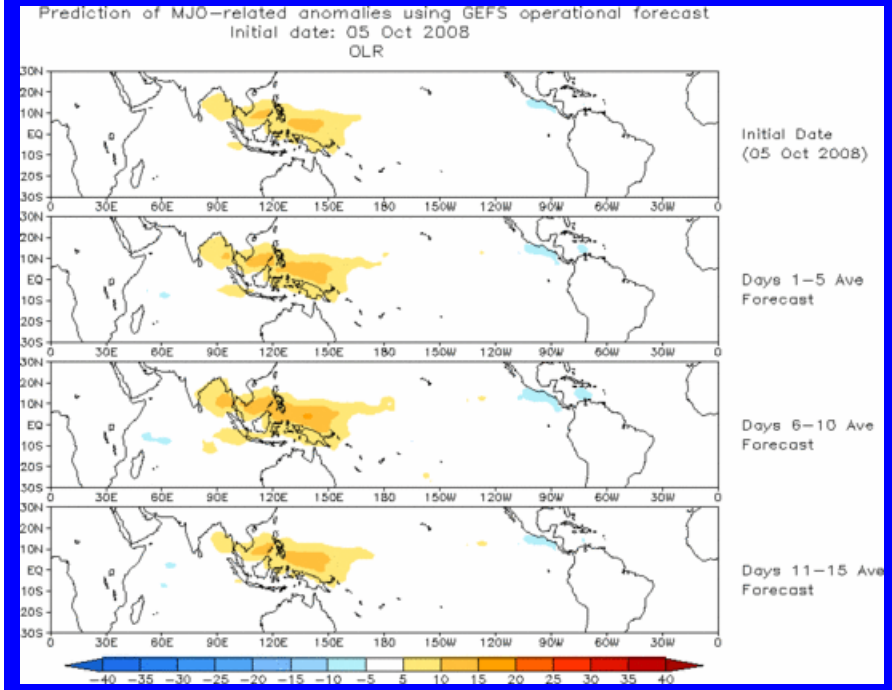
The GEFS forecasts very slow eastward propagation of the MJO during the forecast period.



Ensemble Mean GFS MJO Forecast

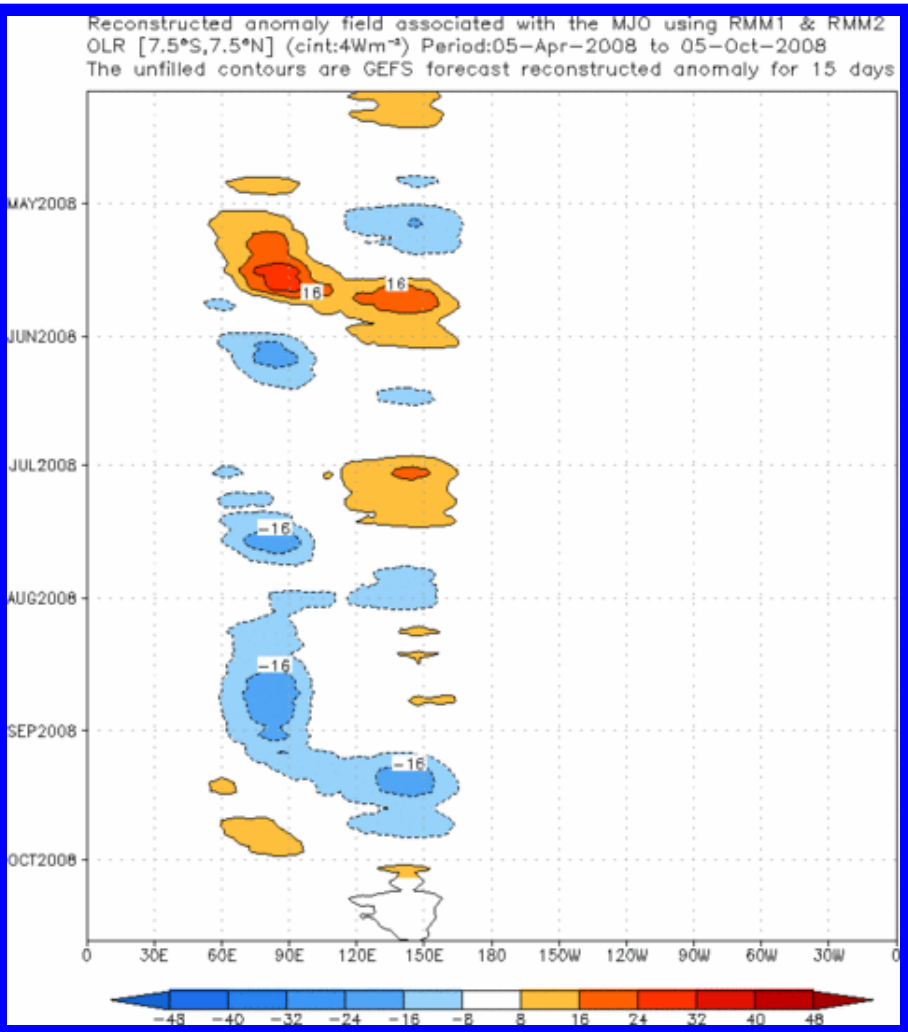
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



MJO associated suppressed convection is forecast to persist across sections of Indonesia and the western Pacific. Weak enhanced convection is forecast across parts of the eastern Pacific and Central America.

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



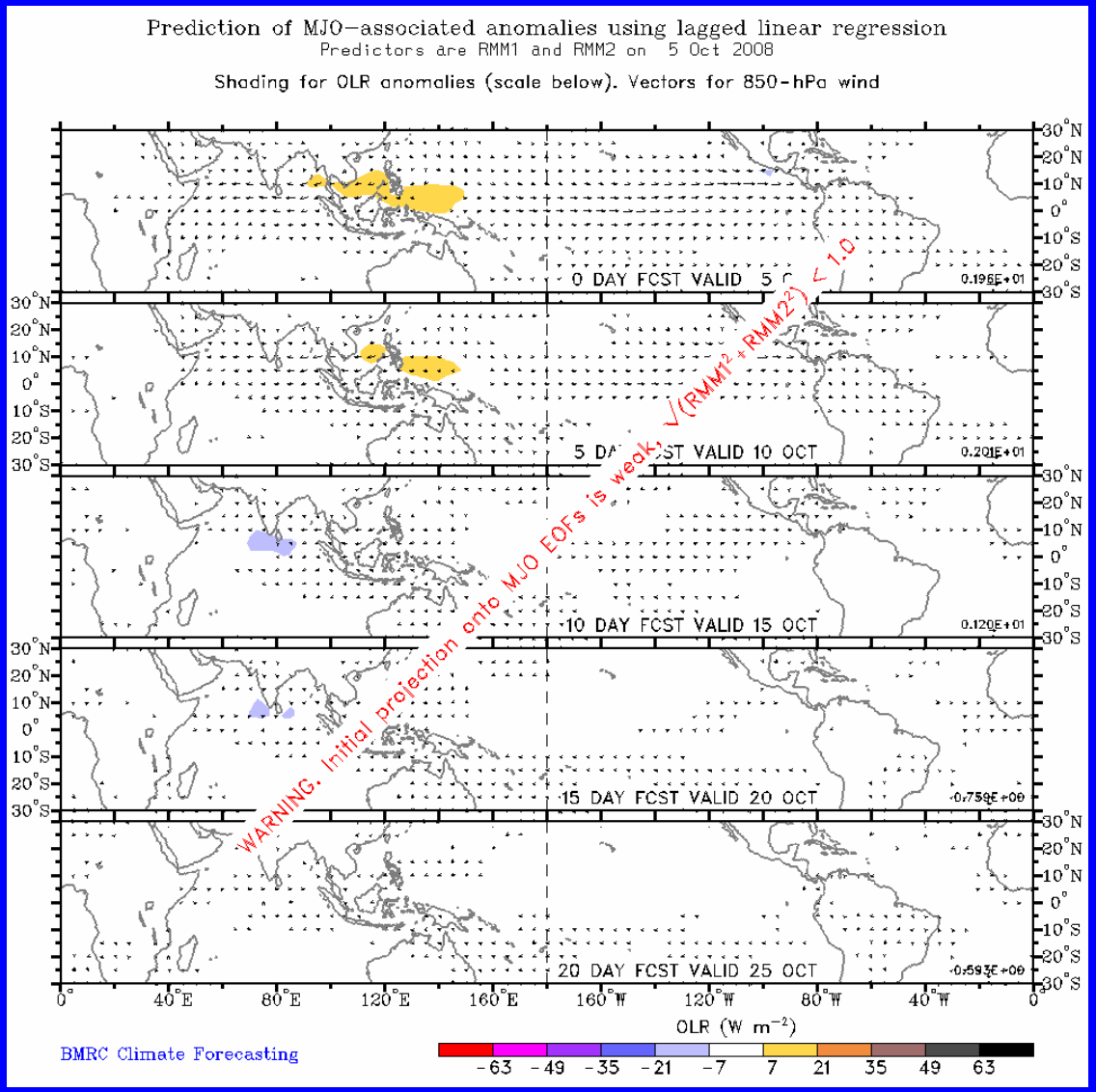
Statistical MJO Forecast

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

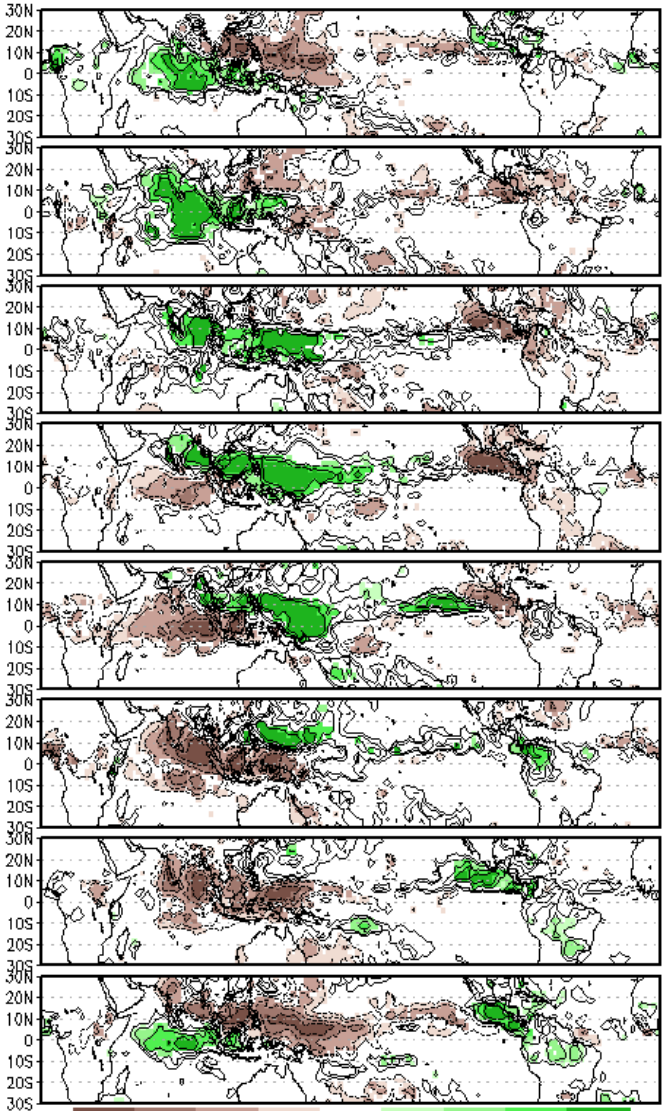
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The forecast indicates weak MJO activity during the next 1-2 weeks.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)