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

Update prepared by
Climate Prediction Center / NCEP
October 20, 2008

Outline

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

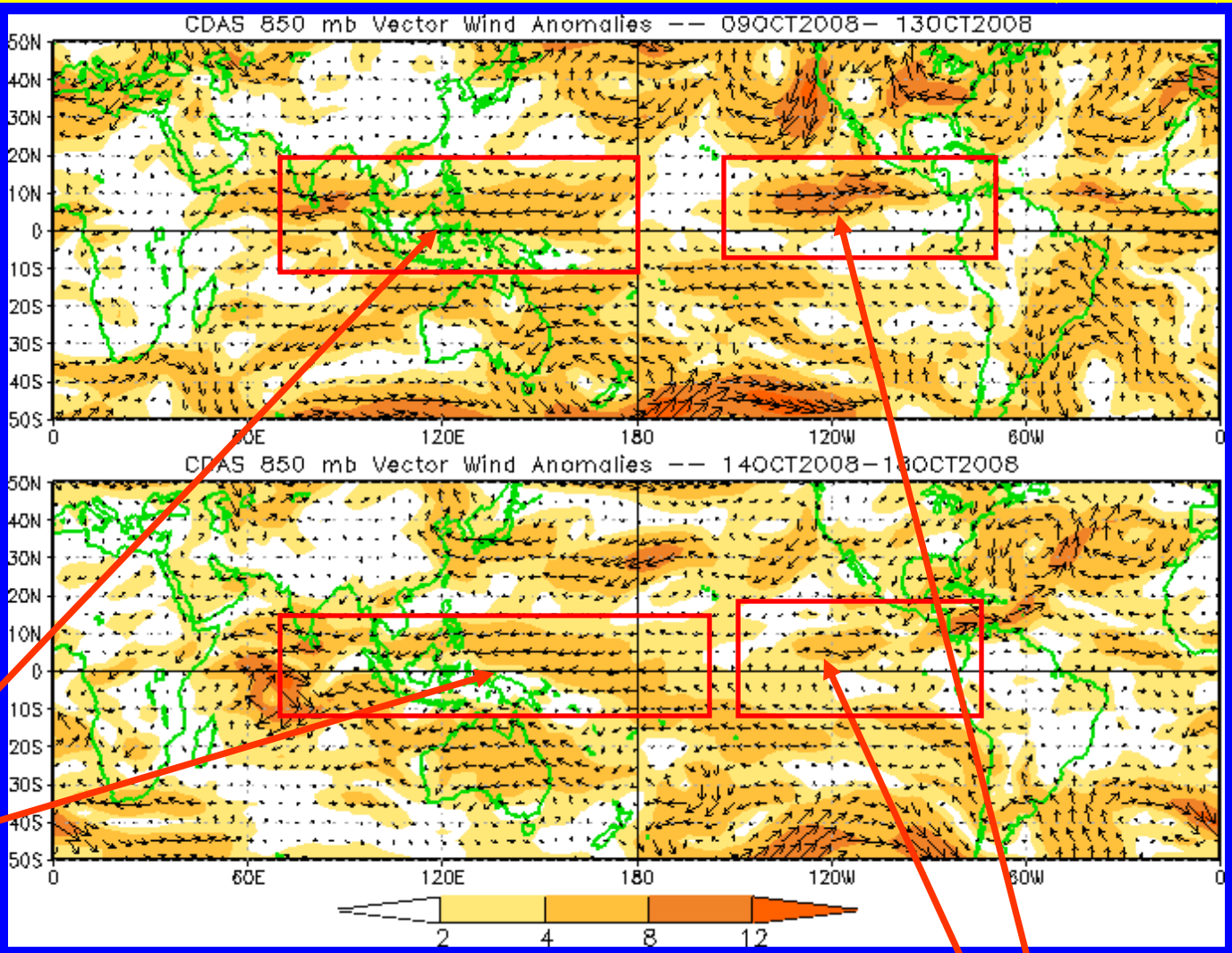
Overview

- MJO activity continues with the enhanced phase entering the Indonesia region.
- Based on the latest observations and model forecasts, moderate-to-strong MJO activity is expected to during the next 1-2 weeks.
- During Week 1, the MJO is expected to contribute to enhanced rainfall across the eastern Indian Ocean and Maritime Continent. Enhanced rainfall is expected to shift into the west Pacific during Week 2 at the same time suppressed rainfall develops in the Indian Ocean. Suppressed rainfall will continue across interior Brazil.
- The current MJO increases the likelihood for tropical cyclone development across the Arabian Sea during Week 1 and Bay of Bengal during the entire 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



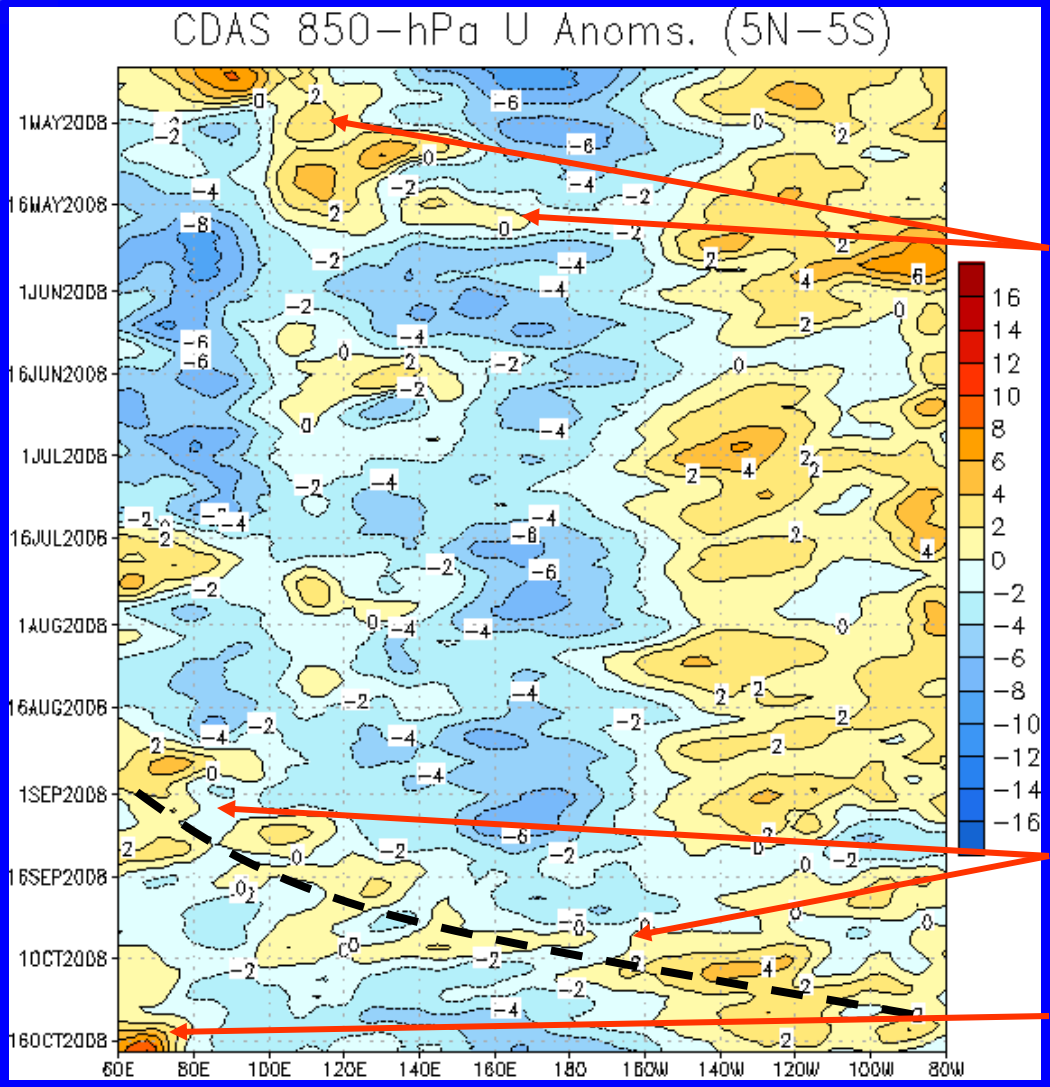
Easterly anomalies persist across the eastern Indian Ocean, Maritime Continent, and the western Pacific.

Westerly anomalies have weakened 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.

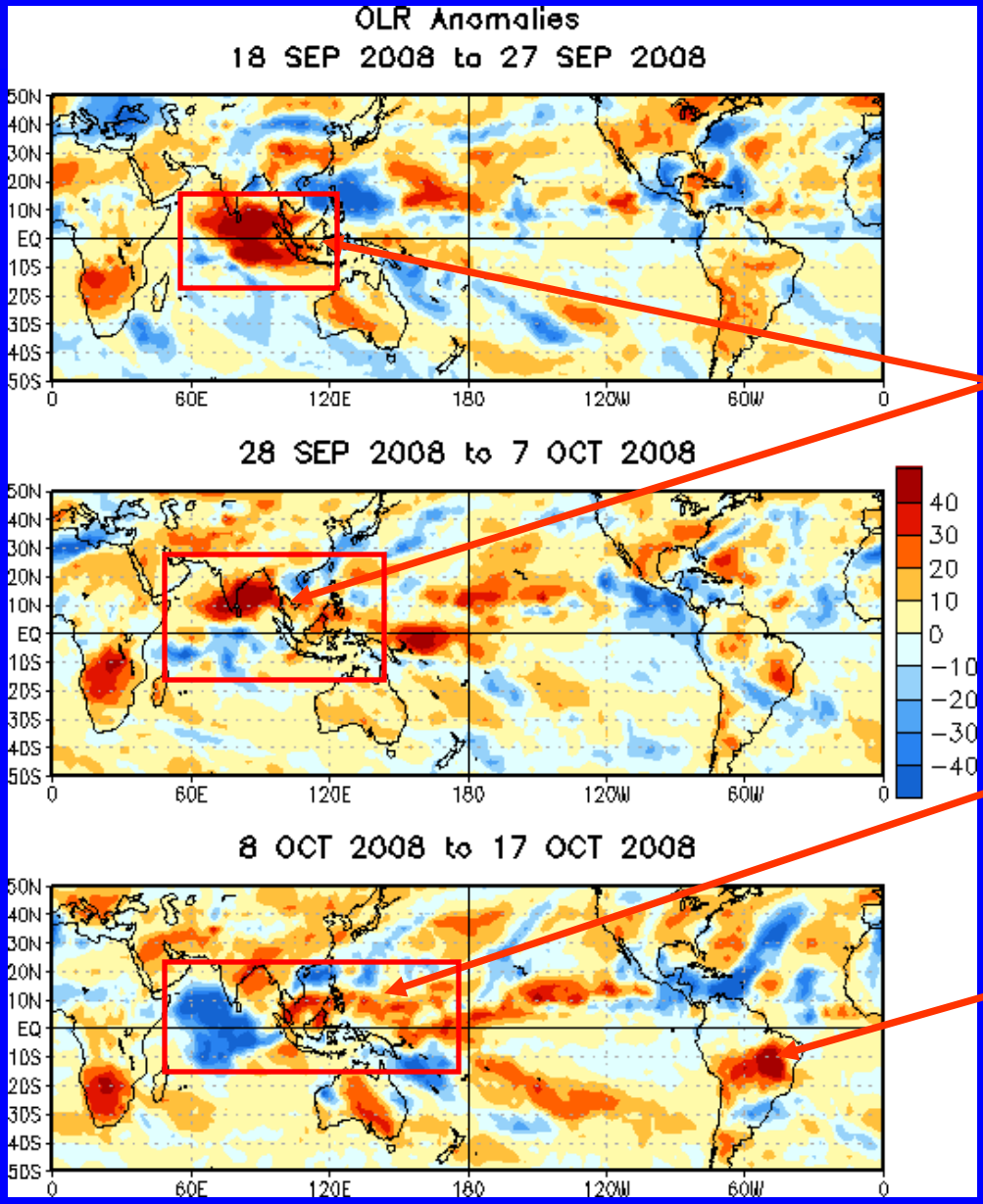
Beginning in September, anomalous westerlies associated with the current MJO activity shifted from the Indian Ocean across the Pacific.

These westerly anomalies have reentered the Indian Ocean during mid-October.

OLR Anomalies: Last 30 days

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

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

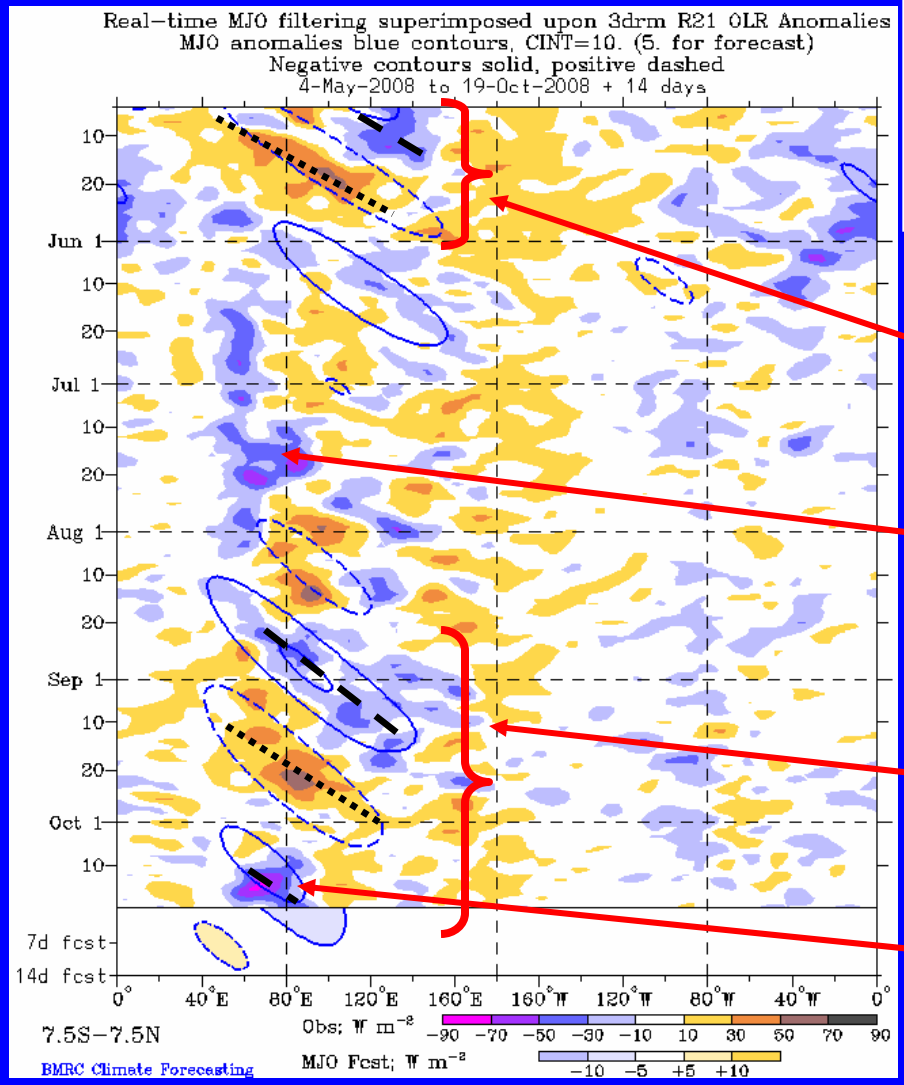


In late September, suppressed convection shifted into India and the Maritime Continent while wet conditions persisted over the eastern Pacific and Central America.

In early to mid-October, dry conditions persisted across the equatorial west Pacific while enhanced convection developed across the Indian Ocean.

Dry conditions continued across interior Brazil during early-mid October.

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 early 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.

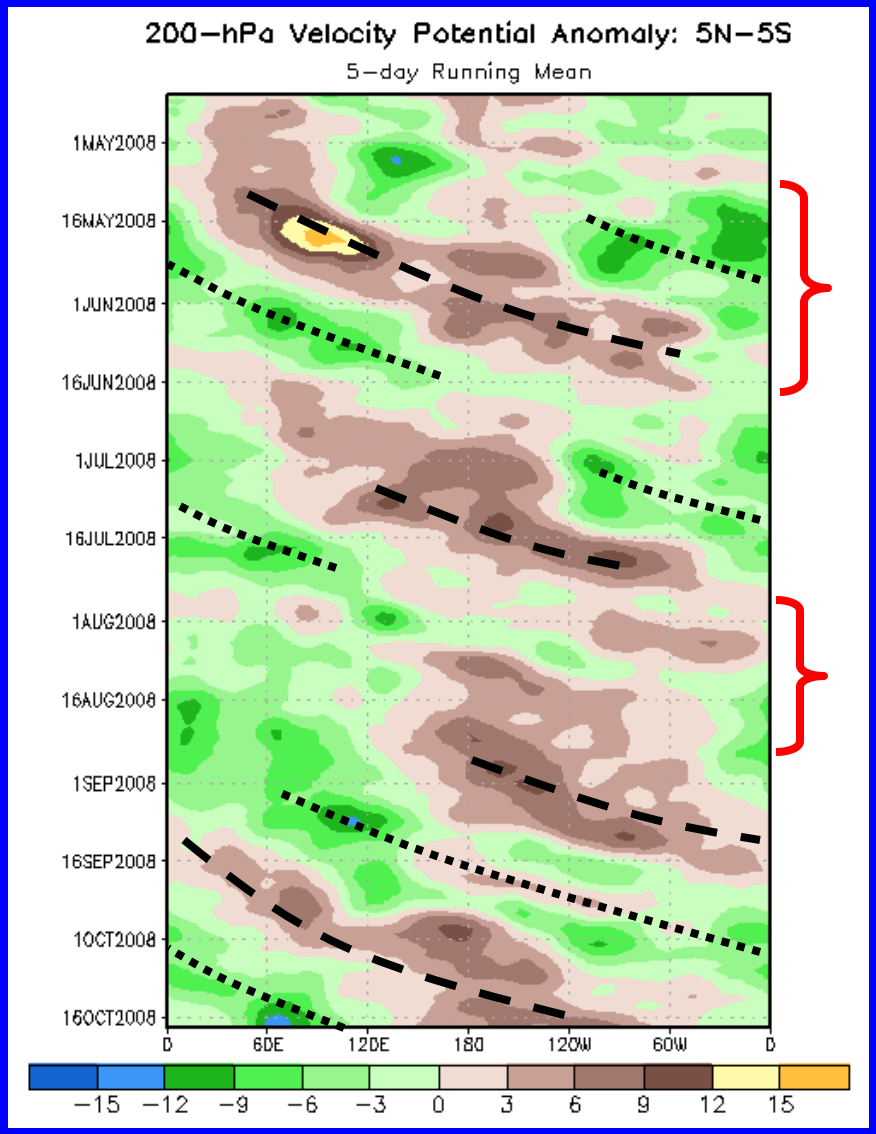
Moderate MJO activity initiated in late August as enhanced convection developed across the Indian Ocean and shifted eastward followed by suppressed convection during September.

In early to mid-October, strong convection reinitiated across the Indian Ocean associated with the renewed enhanced phase of the MJO.

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

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

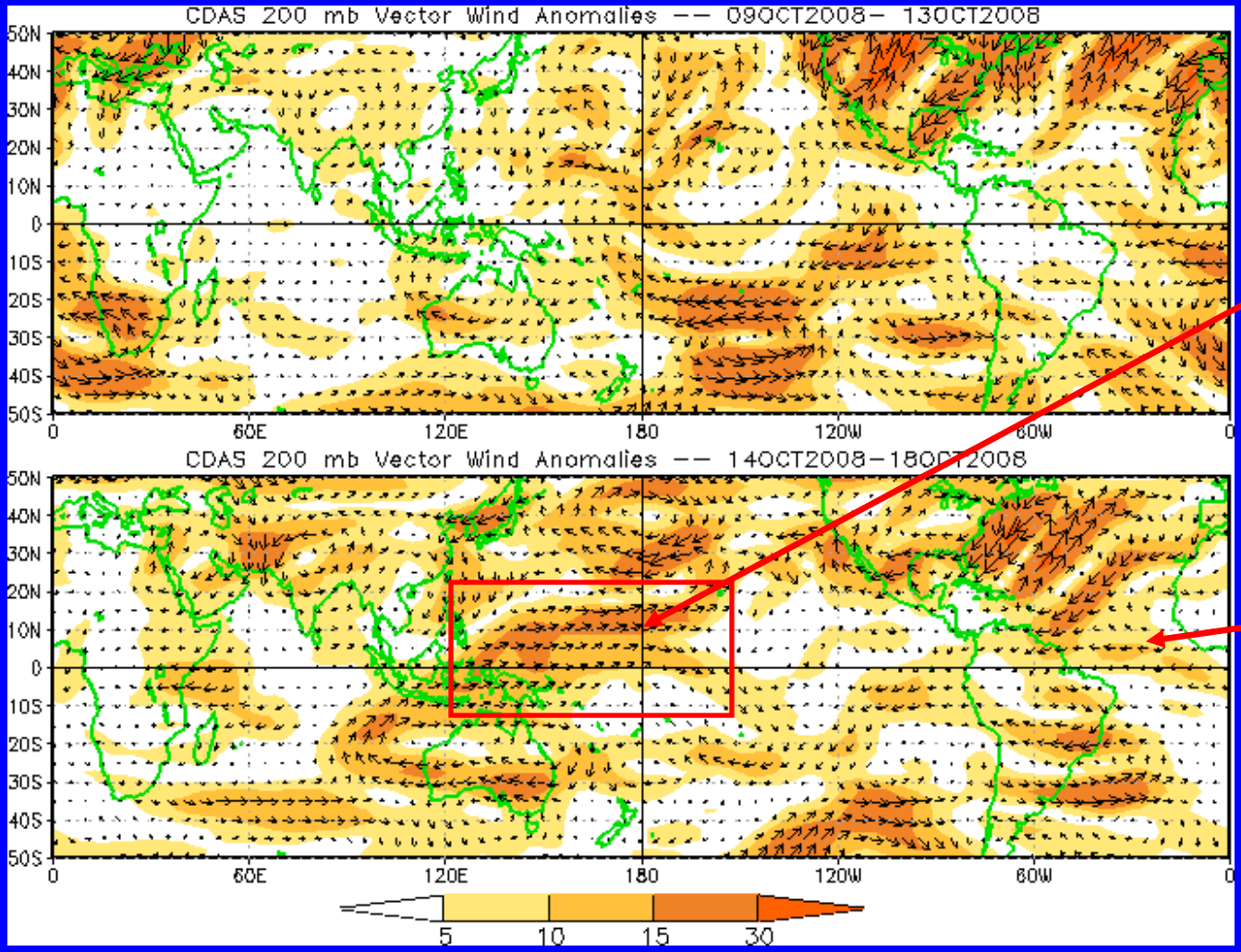
After weakening in late June, the MJO strengthened during mid-July.

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 from September into mid-October. The anomalies have increased in recent days.

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

Note that shading denotes the magnitude of anomalous wind vectors



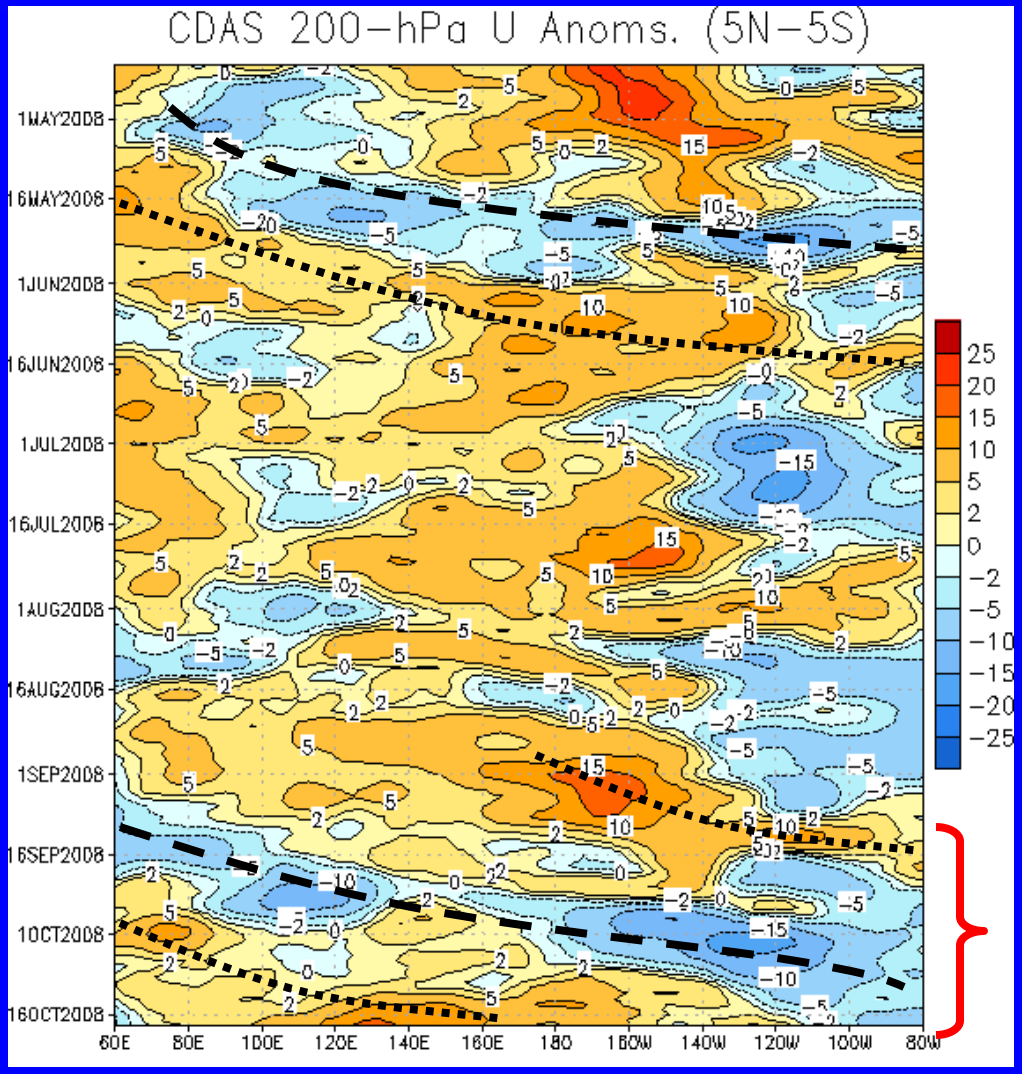
Westerly anomalies have organized across the western Pacific and are associated with the MJO enhanced convection across the Indian Ocean

Easterlies anomalies associated with the suppressed phase of MJO are located across the Atlantic and South America.

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



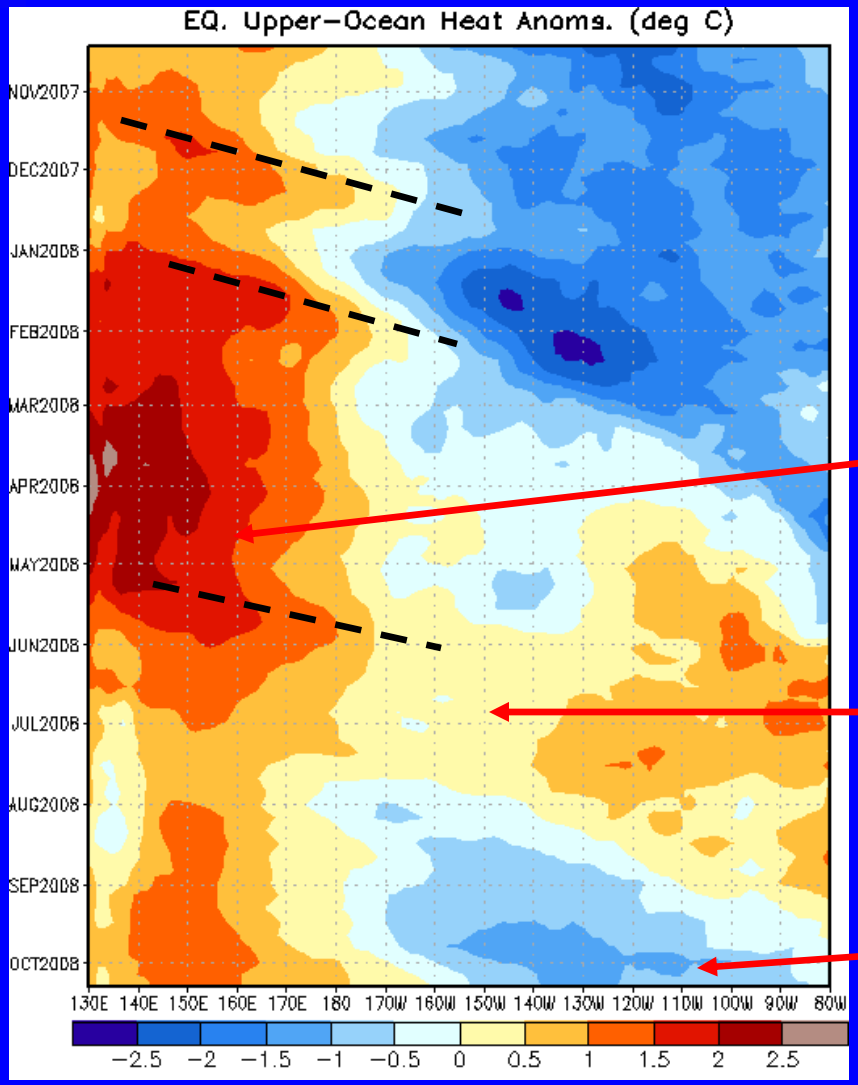
Time

Longitude

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 six weeks.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

Beginning in February, increasingly positive anomalies developed across parts of the western and central Pacific but have since decreased.

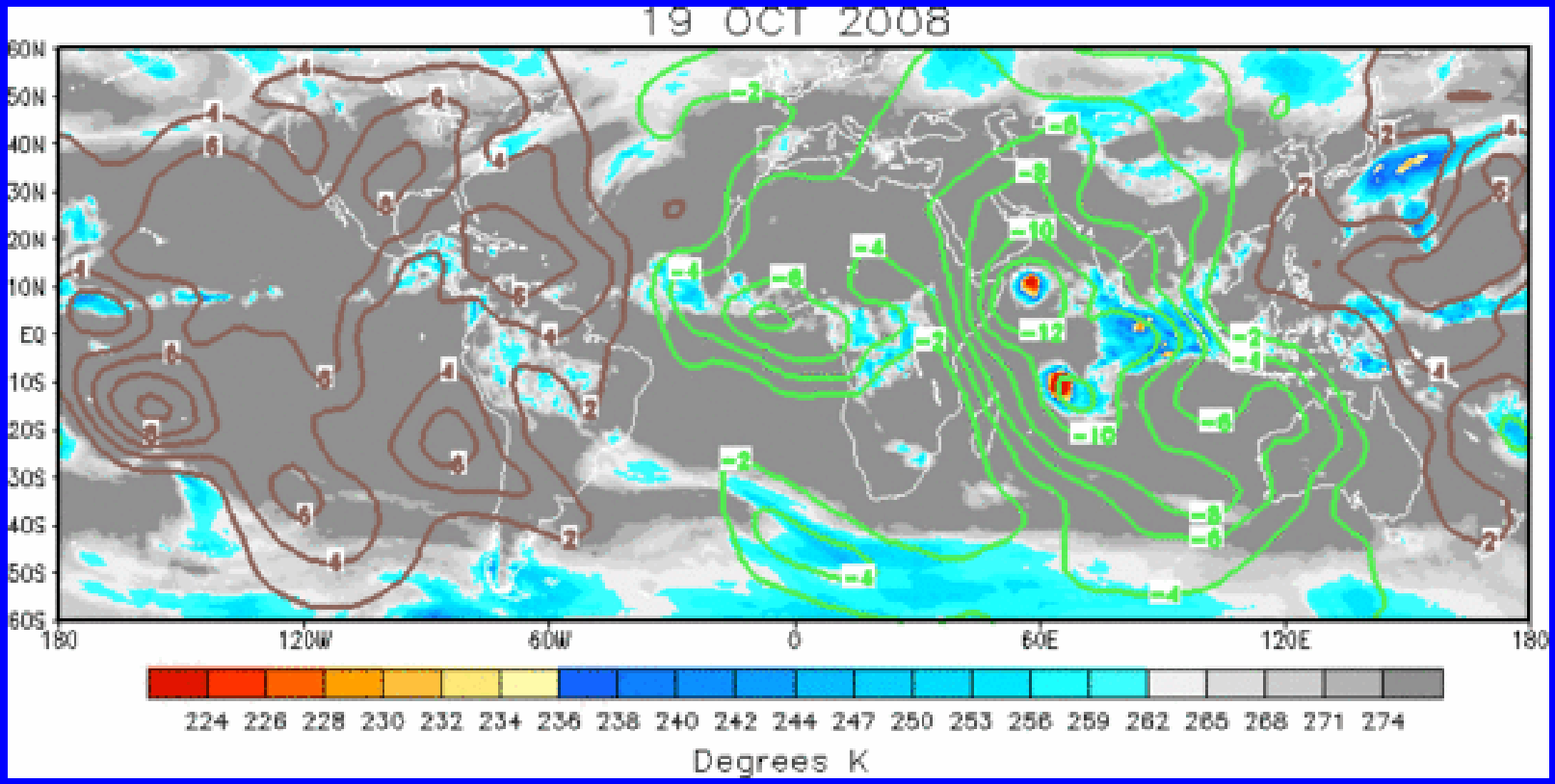
During June and July 2008, positive heat content anomalies encompassed much of the Pacific basin in part associated with a Kelvin wave initiated during May 2008.

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 has progressed further across the Indian Ocean while upper-level convergence continues across much of the Pacific Ocean and extended to now include the Americas.

MJO Index -- Information

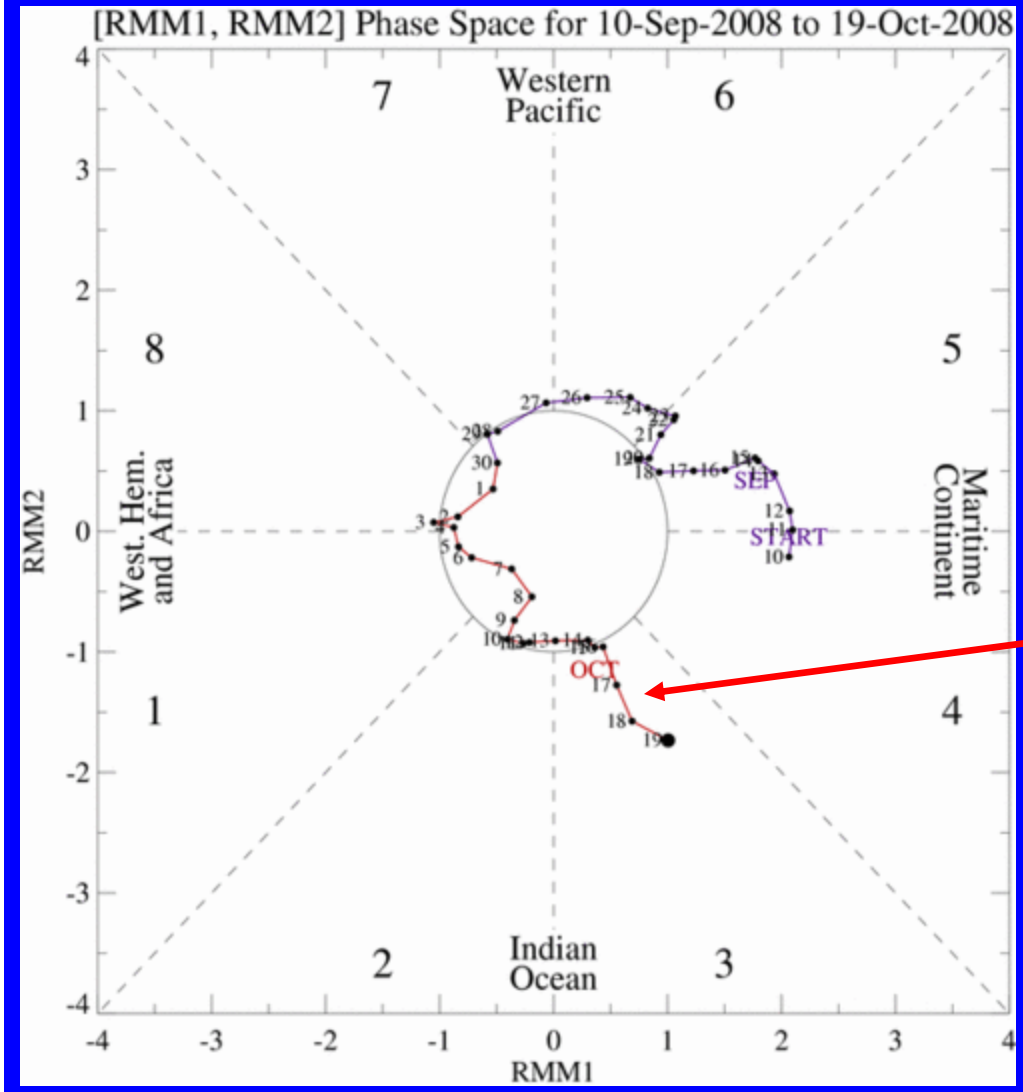
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

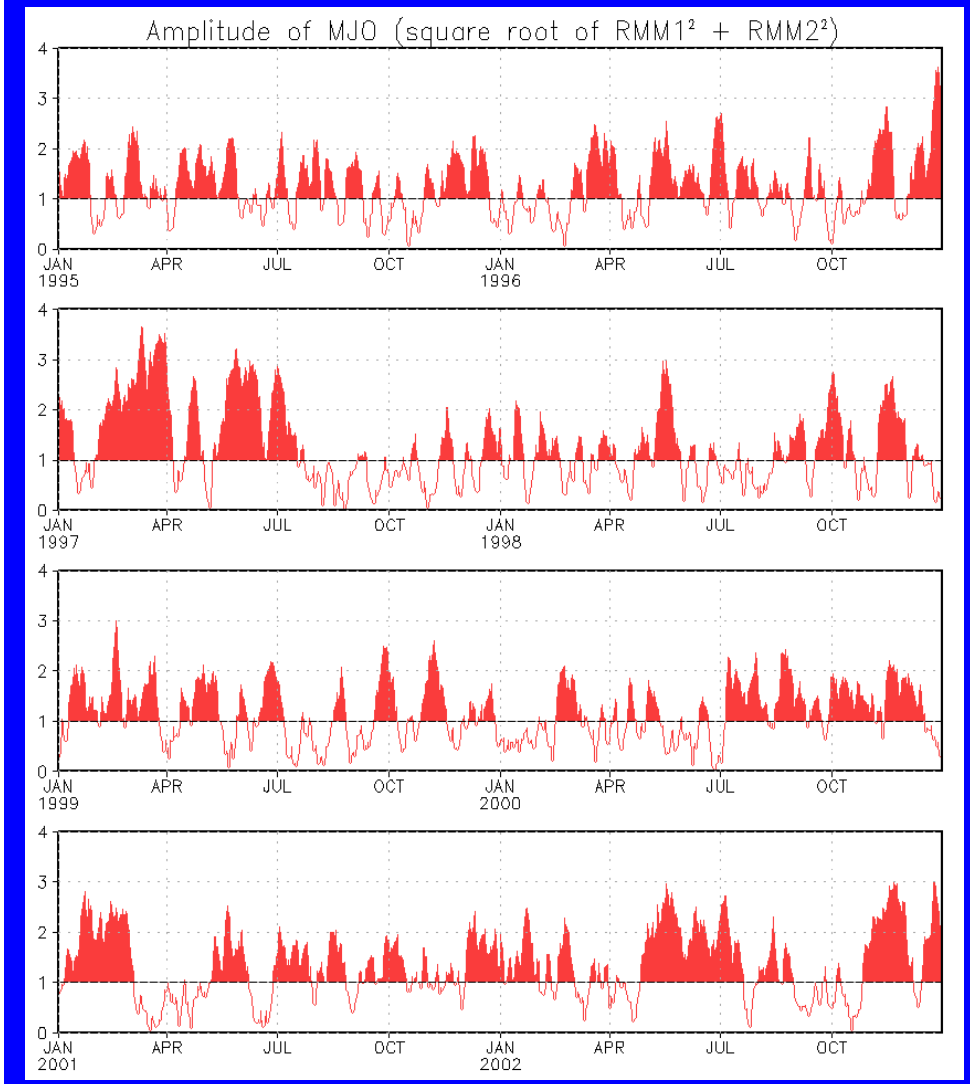
MJO Index -- Recent Evolution

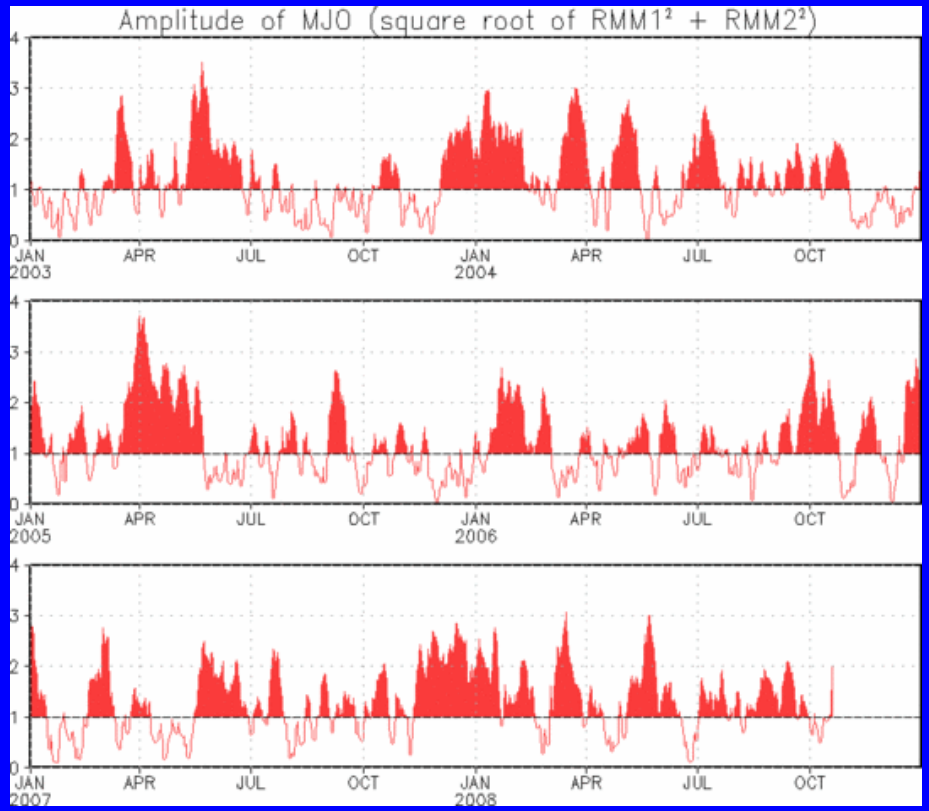


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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

The MJO index indicates a strengthening MJO signal during the past several days.

MJO Index – Historical Daily Time Series





Time series of daily MJO index amplitude from 1995 to present

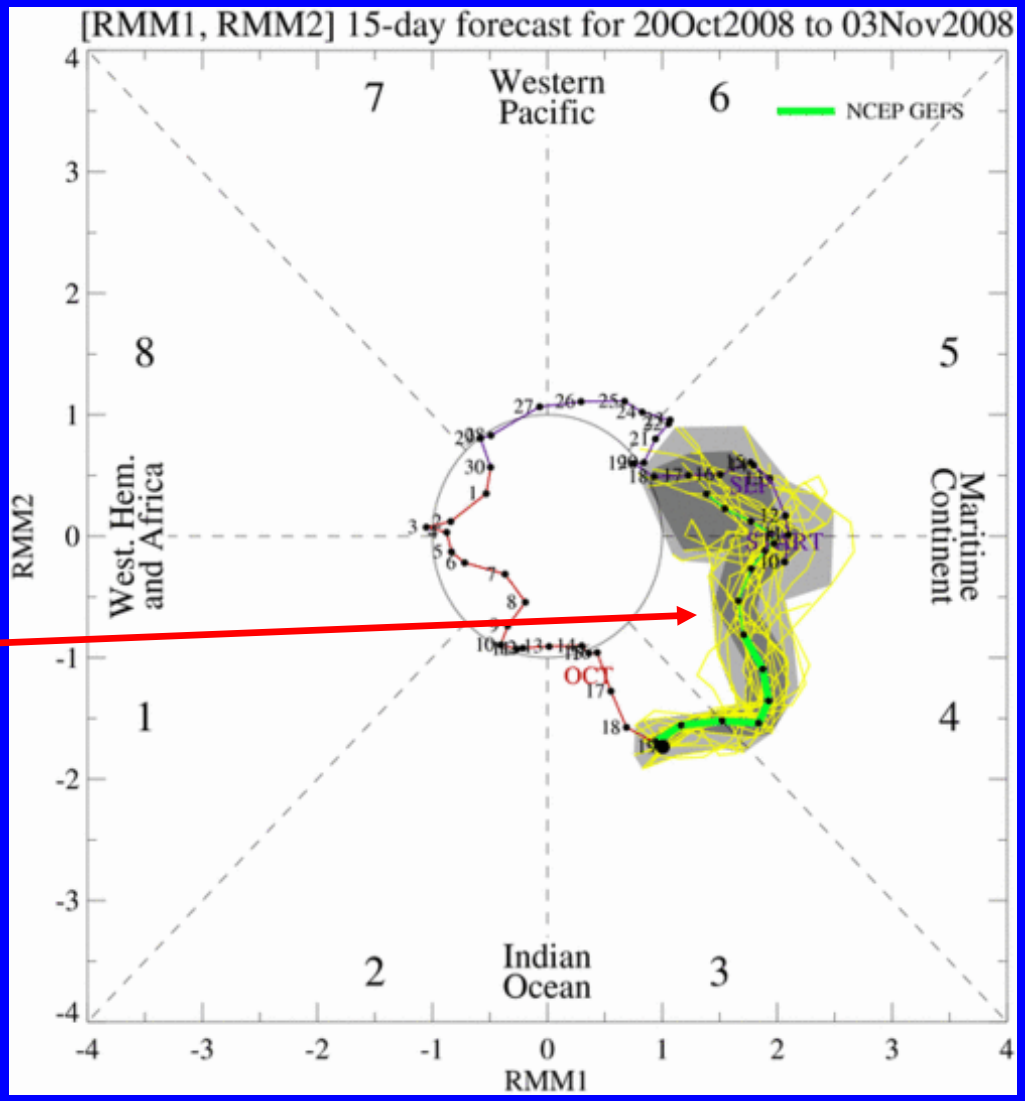
Plots put current MJO activity in historical context

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



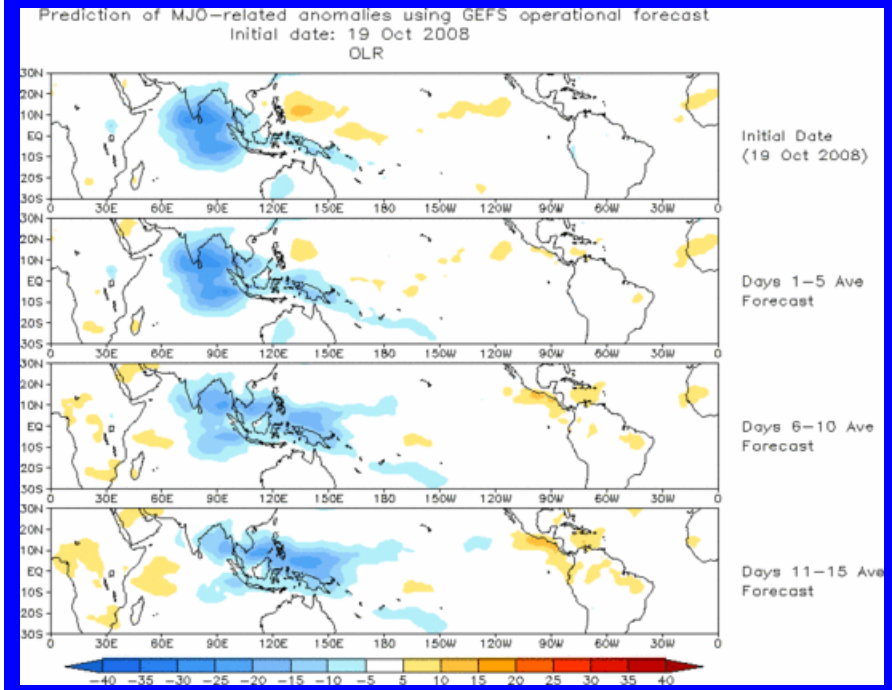
The GEFS forecasts a strengthening MJO during the next two weeks.

Spread is low during much of the period indicating high confidence in MJO strength and propagation.

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)

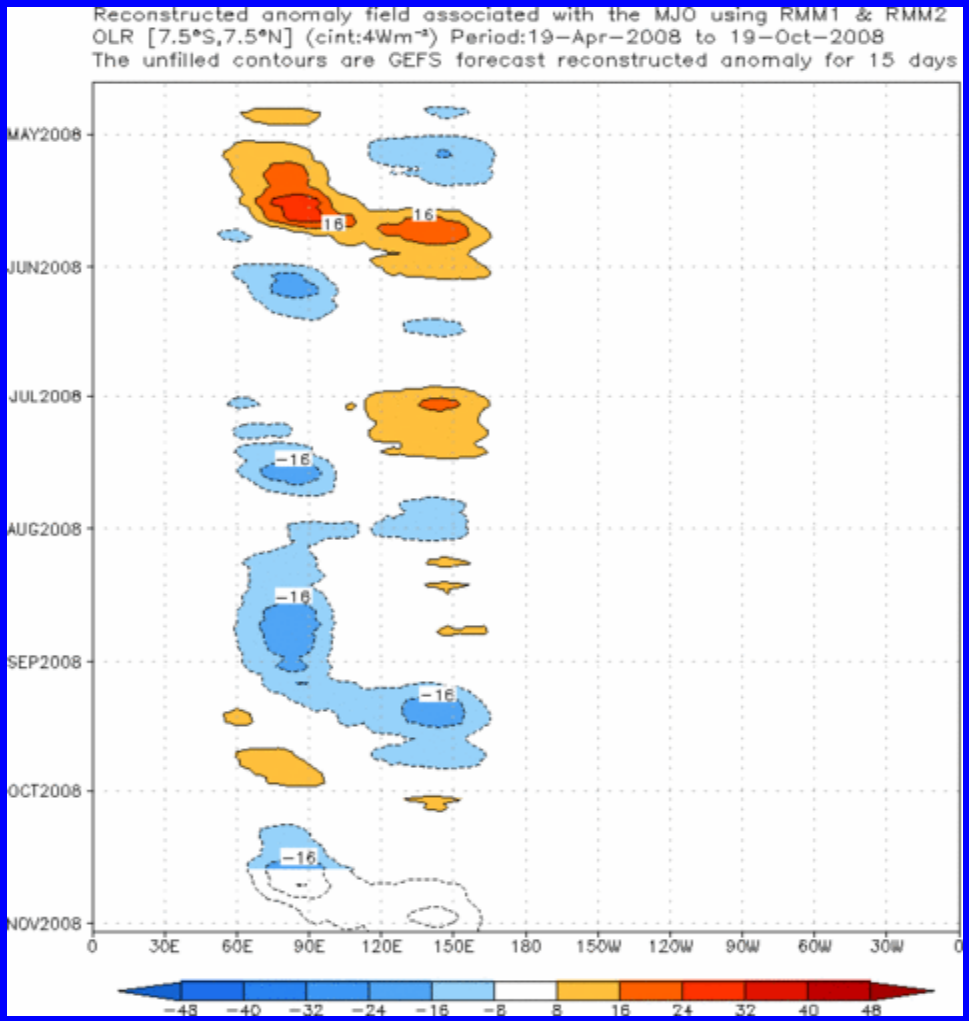
Spatial map of OLR anomalies for the next 15 days



MJO associated enhanced convection is forecast to shift into the west Pacific.

Weak dry conditions are expected across parts of Central and South America as well as Africa later in 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

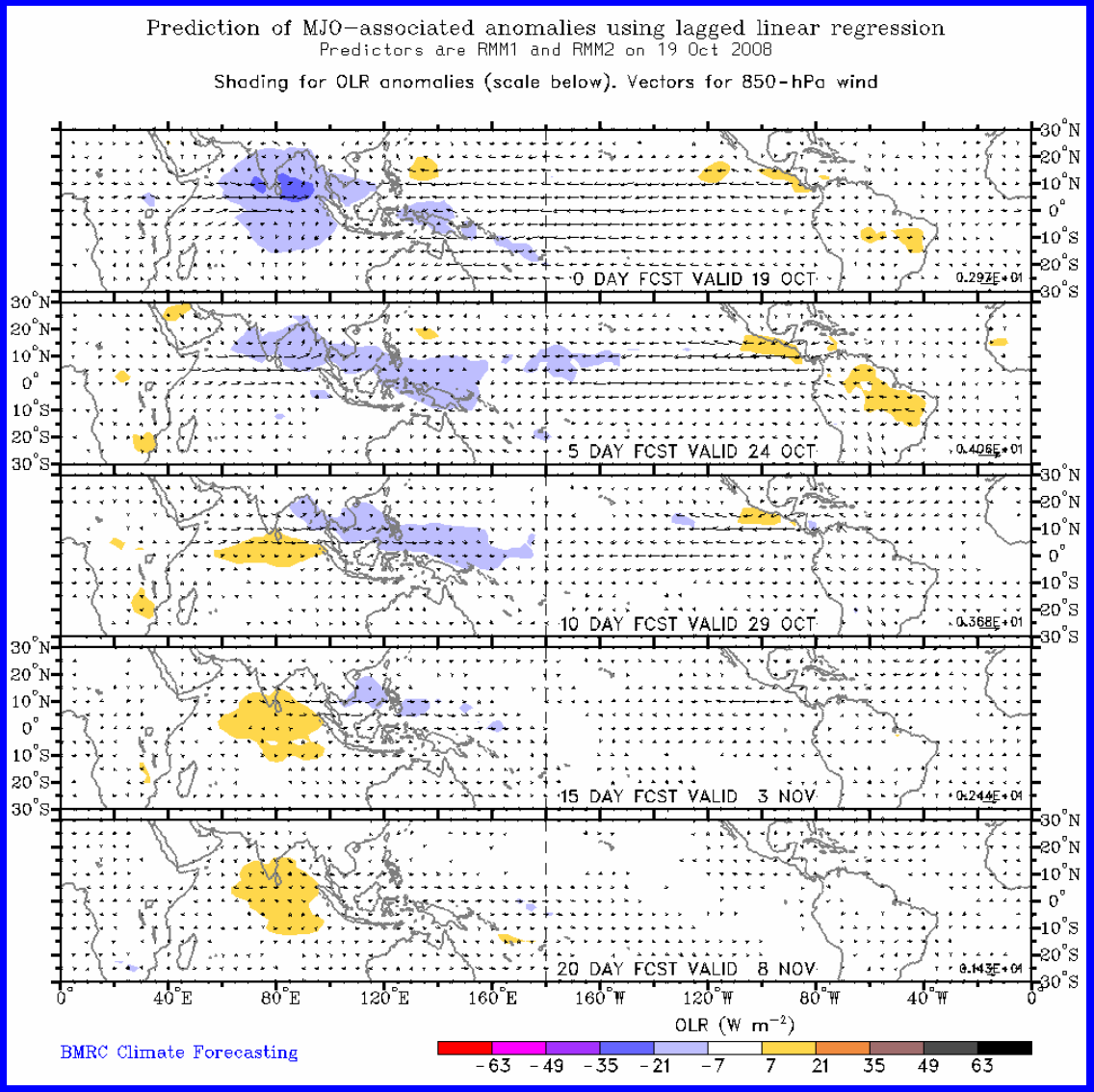
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

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

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

The forecast indicates enhanced convection spreading into the west Pacific.

Suppressed convection develops across the Indian Ocean during later in the period.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)

850-hPa Wind Anomalies (Nov-Mar)