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

Update prepared by
Climate Prediction Center / NCEP
November 3, 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 Maritime continent and western Pacific Ocean.

- Based on the latest observations and model forecasts, moderate-to-strong MJO activity is expected during the next 1-2 weeks with the enhanced phase shifting eastward from the western Pacific to the Western Hemisphere.

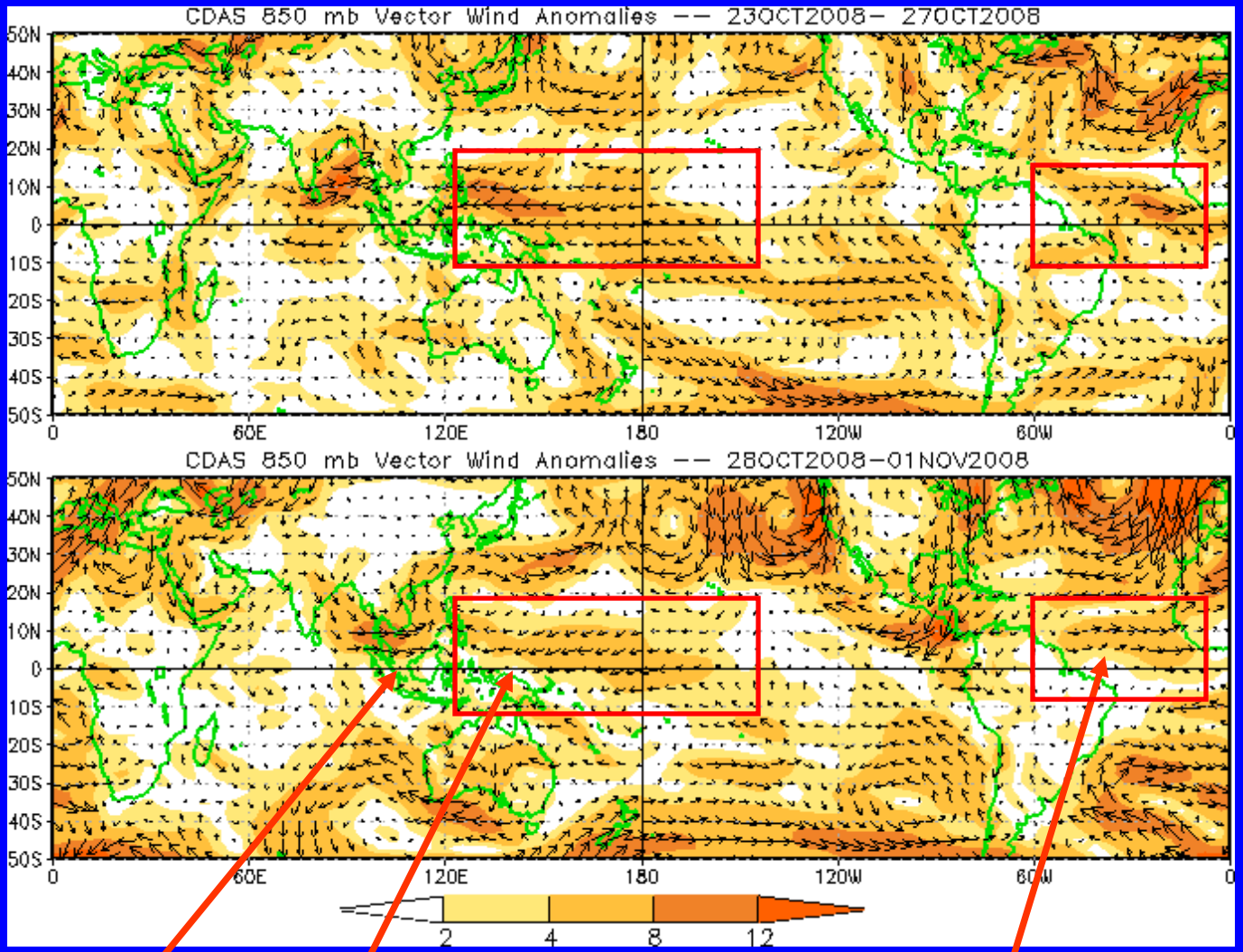
- During Week-1 the MJO is expected to contribute to enhanced rainfall across Central America and the western Pacific with suppressed rainfall for the west-central Indian Ocean. Enhanced convection extending from Central America to interior Brazil is expected during Week-2.

- The current point in the seasonal cycle makes impacts to the US very uncertain. The likelihood of impacts increases over the course of November so it is more likely that the next cycle of the MJO (mid-Nov to Dec) will more strongly affect the US.

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 developed over the western Maritime Continent.

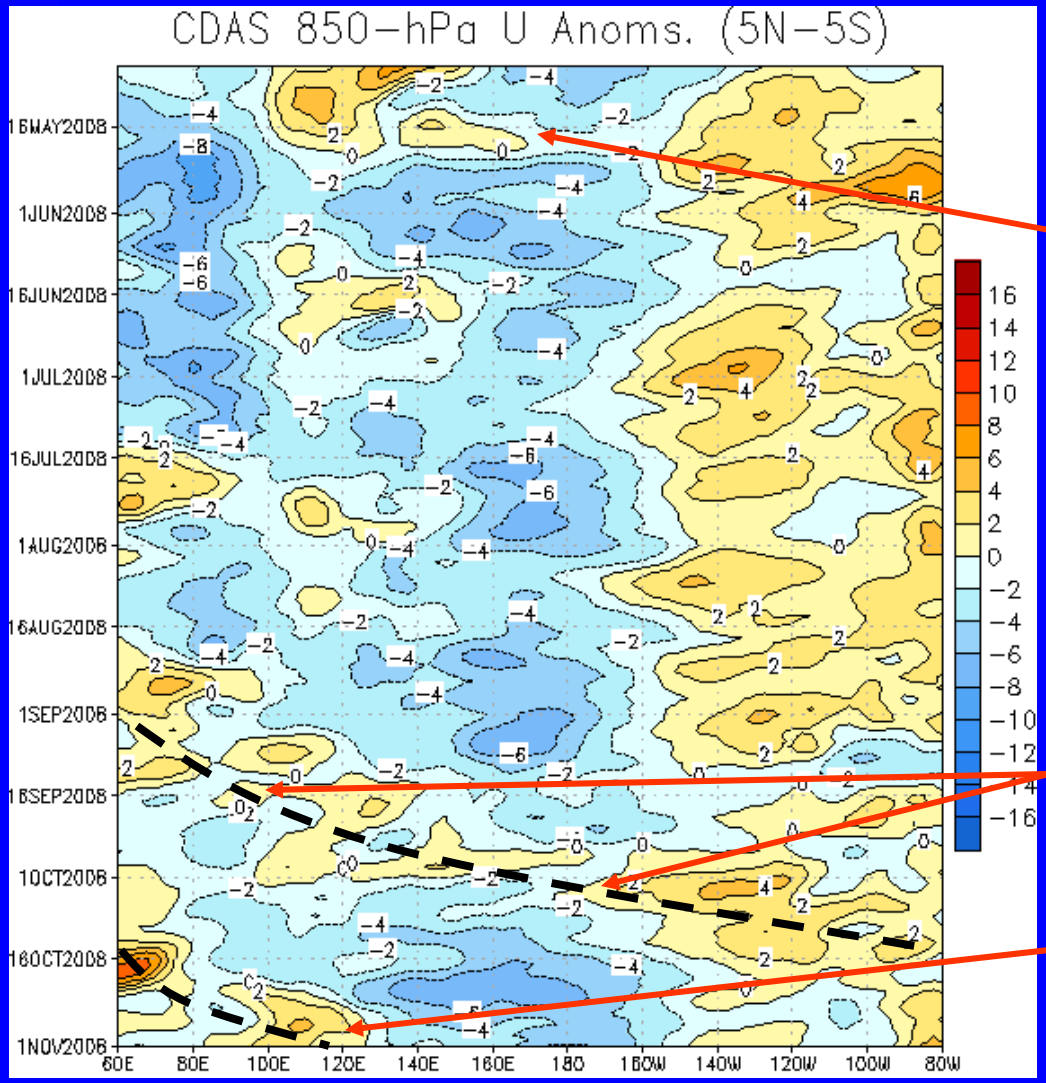
Easterly anomalies have weakened in the western Pacific Ocean.

Westerly anomalies have persisted across the Atlantic 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

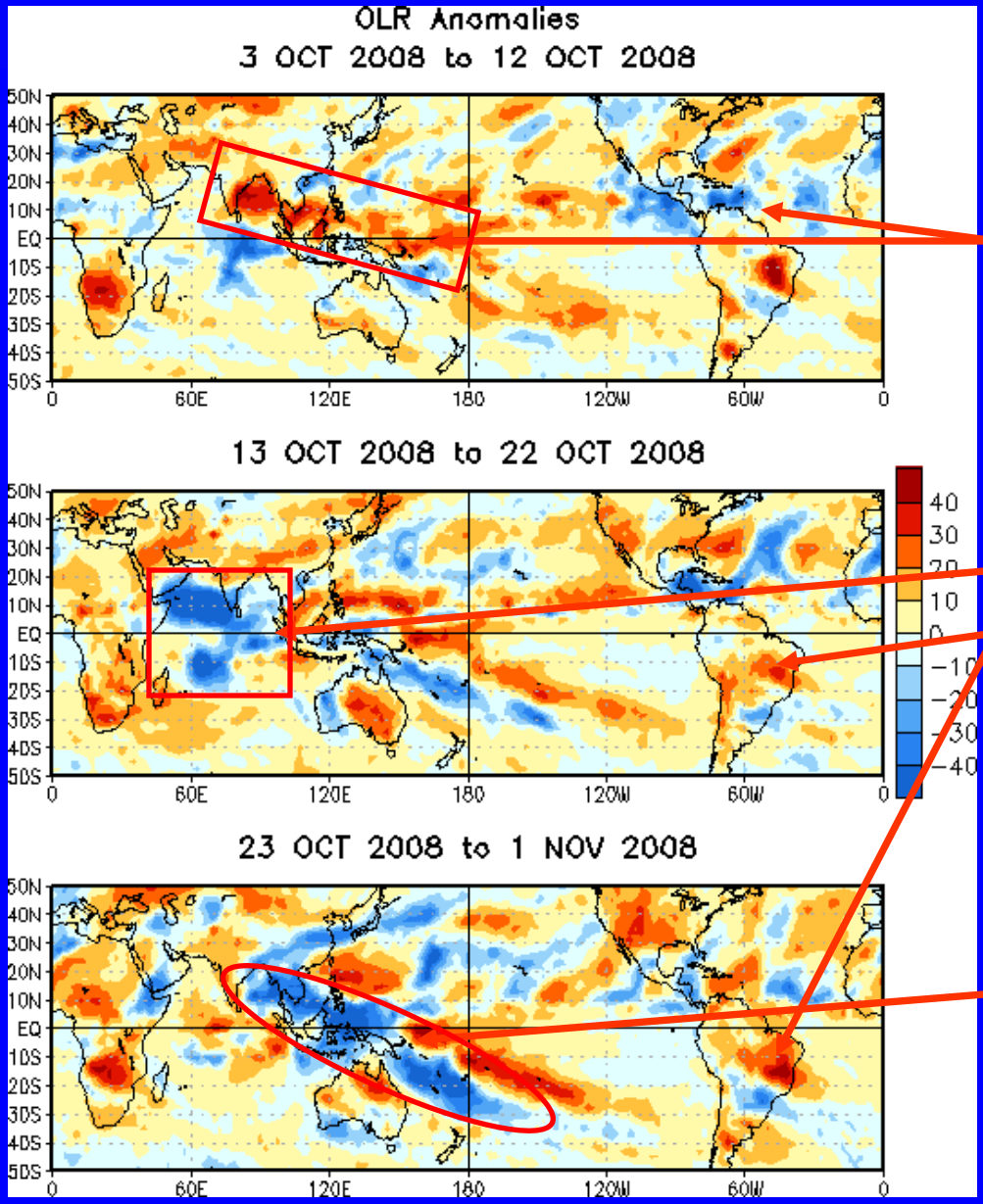
During mid-May, easterlies weakened across the western Pacific associated with moderate MJO activity.

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 Maritime Continent during late October while easterly anomalies have continued to shift eastward.

OLR Anomalies: Last 30 days



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

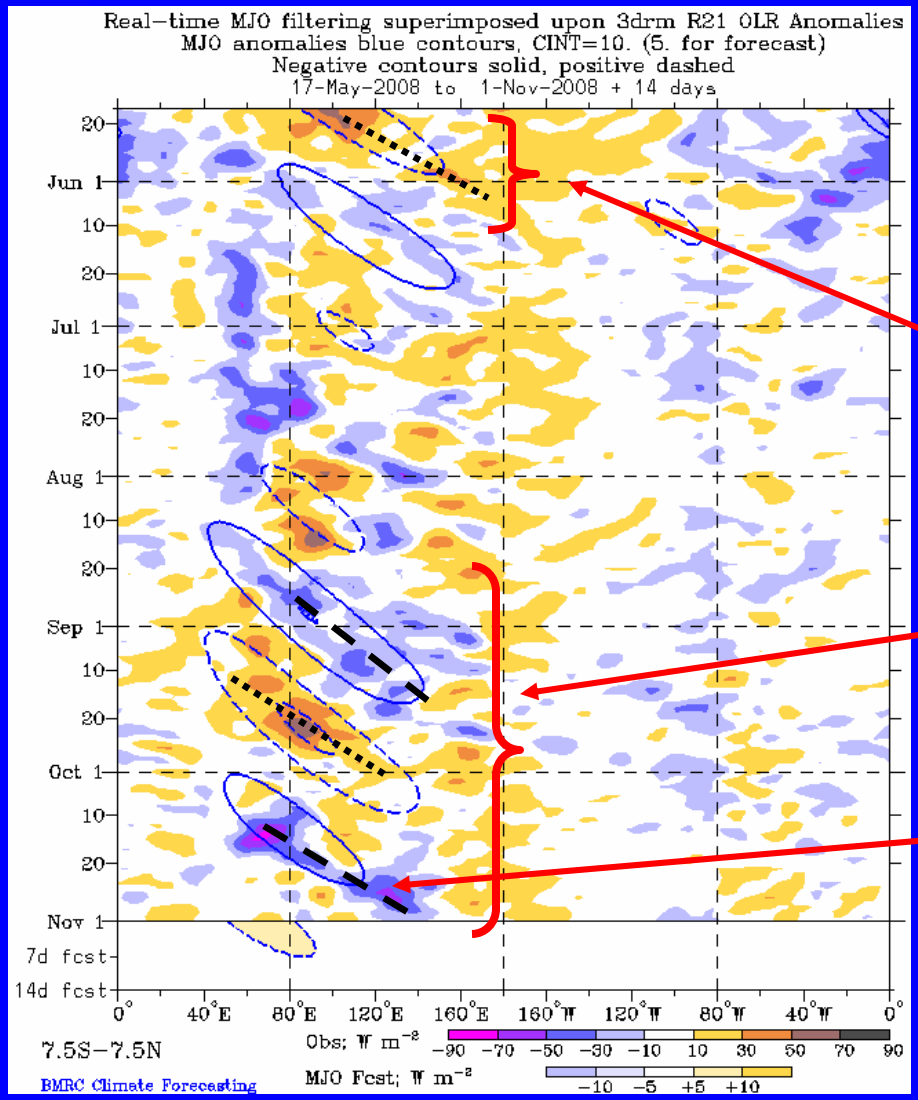
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

In early October, suppressed convection had shifted northeastwards and was observed from India to the western Pacific. Wet conditions prevailed across the eastern Pacific and Central America.

In mid-October, enhanced convection developed across the equatorial Indian Ocean and Arabian Sea while dry conditions continued across interior Brazil throughout October.

In late-October, enhanced convection shifted eastward from the Indian Ocean to Indonesia and the far western Pacific. Dry conditions continued across portions of 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 during late May as suppressed convection organized across the Indian Ocean and shifted eastward.

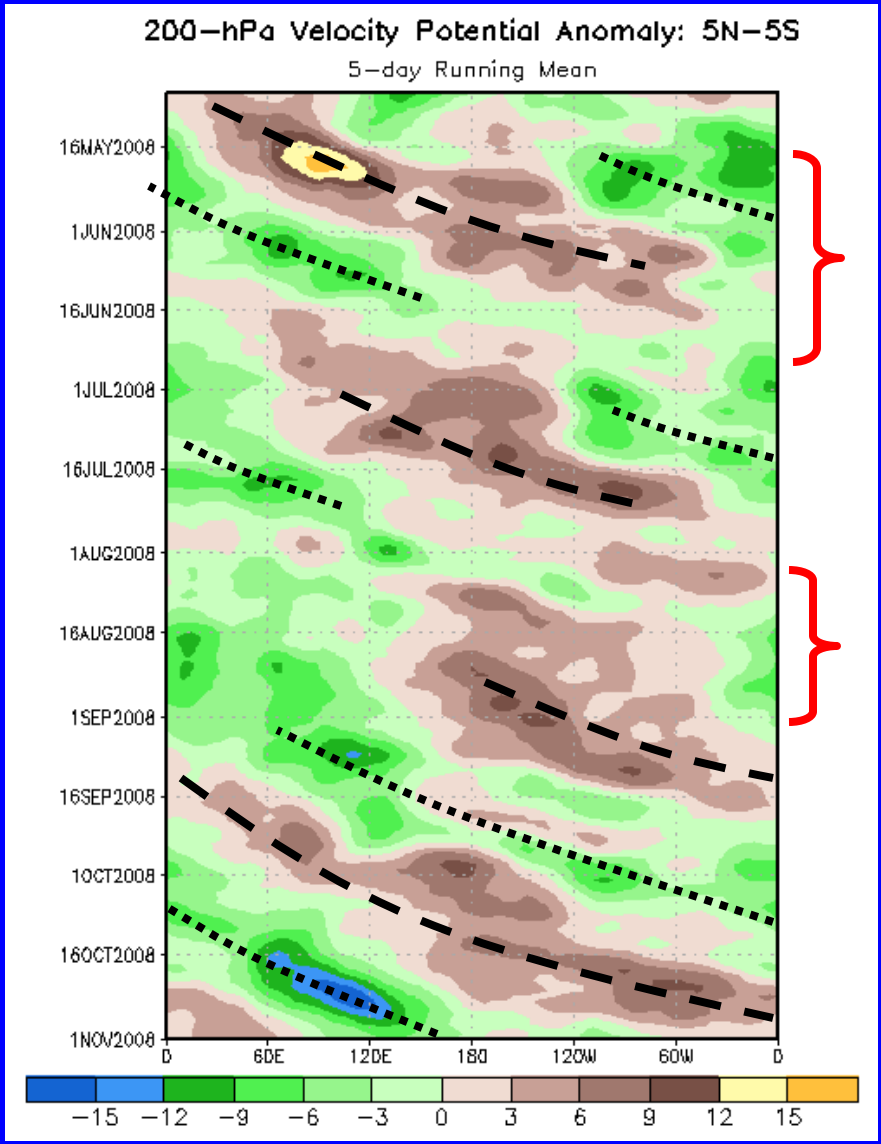
Moderate MJO activity initiated in late August as enhanced convection developed across the Indian Ocean and shifted eastward followed by suppressed convection during September.

In October, strong convection reinitiated across the Indian Ocean and progressed eastward to the Maritime Continent and is associated with the 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



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

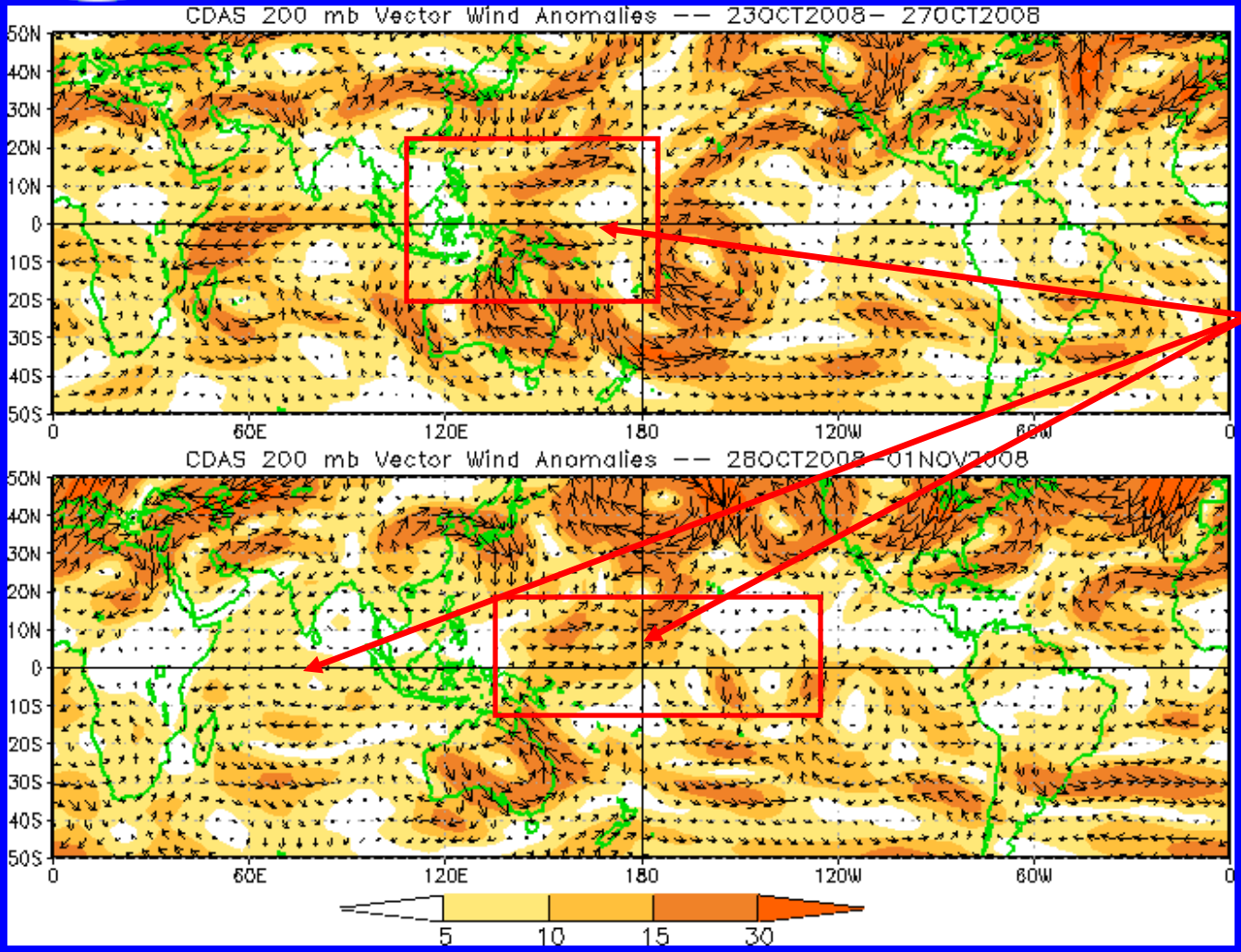
After weakening in late June, the MJO strengthened during mid-July.

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 late October.

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

Note that shading denotes the magnitude of anomalous wind vectors



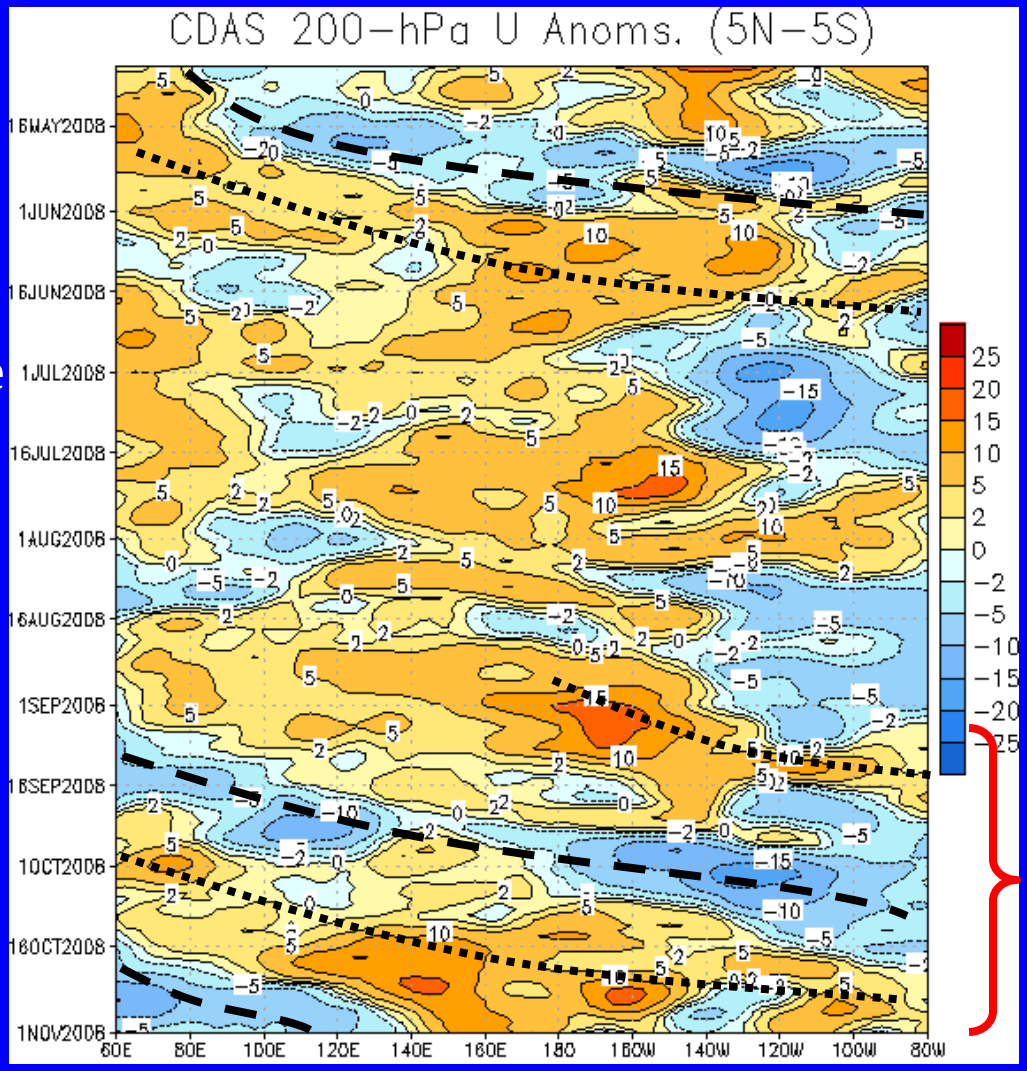
Westerly anomalies have organized across the western Pacific and shifted east, while easterly anomalies continue across the equatorial Indian Ocean.

These anomalies are consistent with an MJO centered across Indonesia and the western Pacific.

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



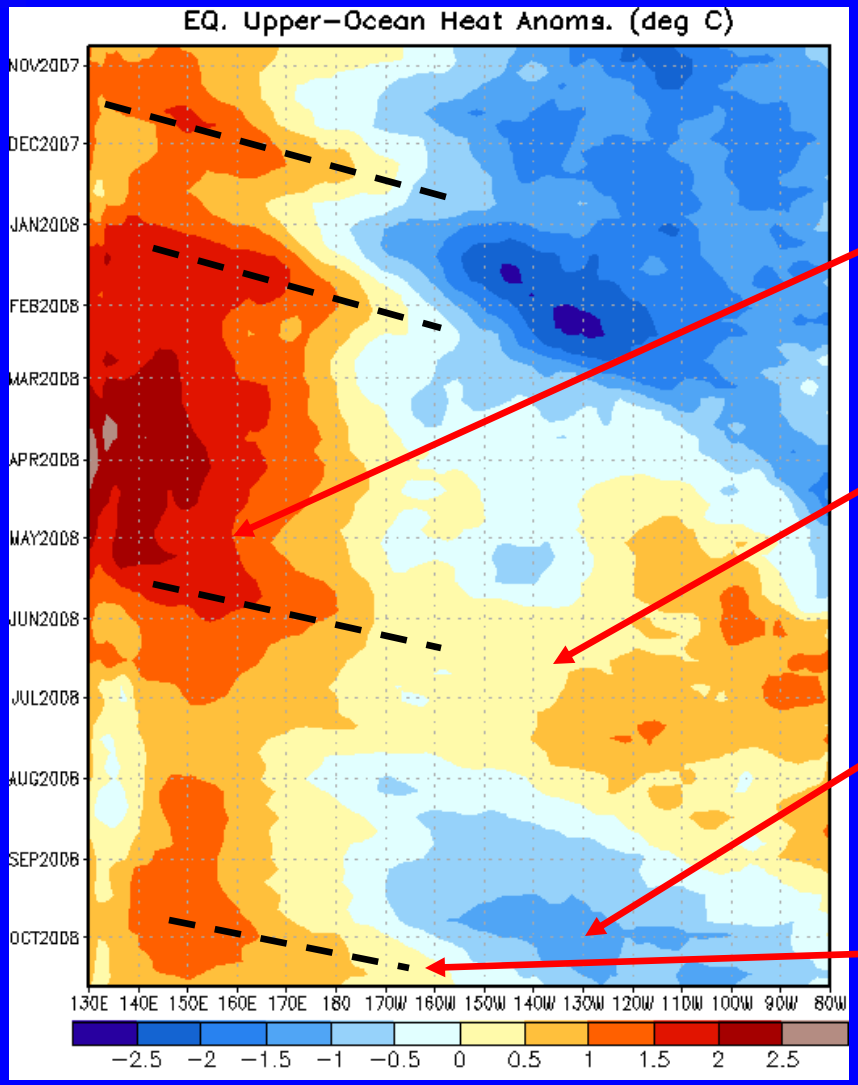
Time

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 two months.

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.

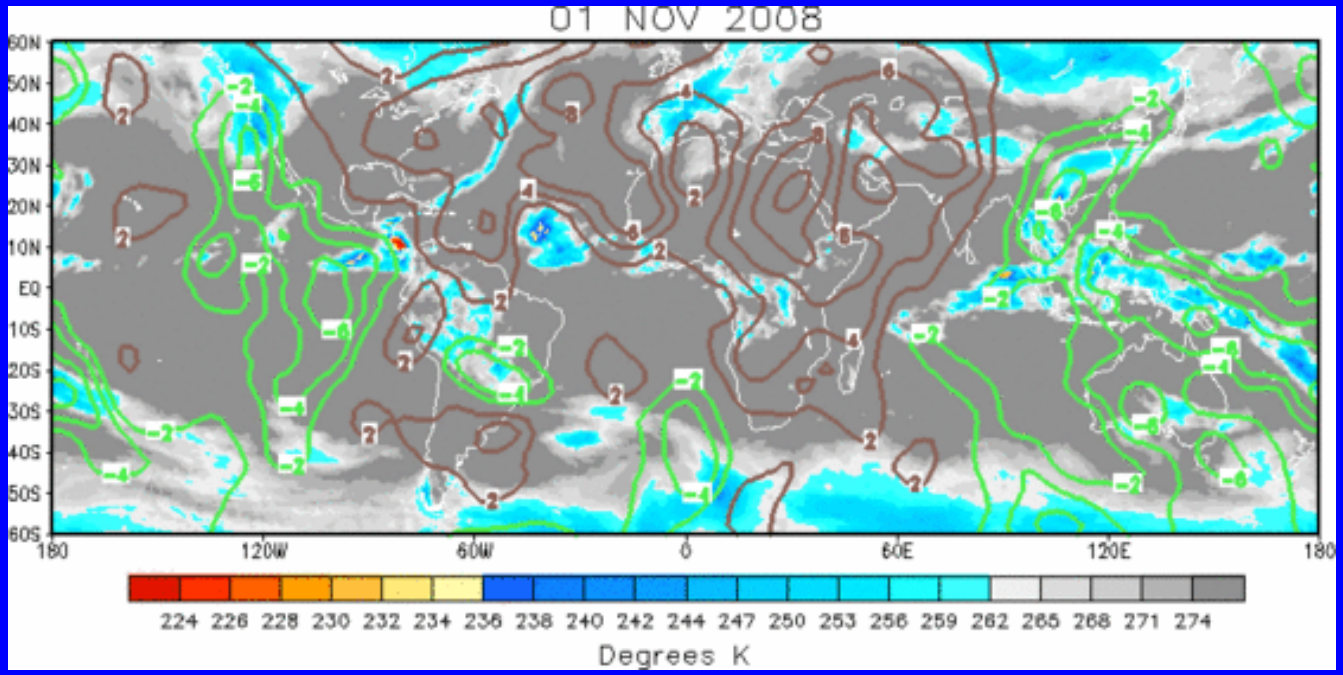
During August 2008, negative anomalies started to develop east of the Date Line and during September and early October the anomalies have increased and expanded eastward.

During late September, positive anomalies shifted eastward in associated with a Kelvin wave that was initiated during September 2008.

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 across the Pacific Ocean basin while upper-level convergence stretches from the Atlantic Ocean to the western Indian Ocean.

MJO Index -- Information

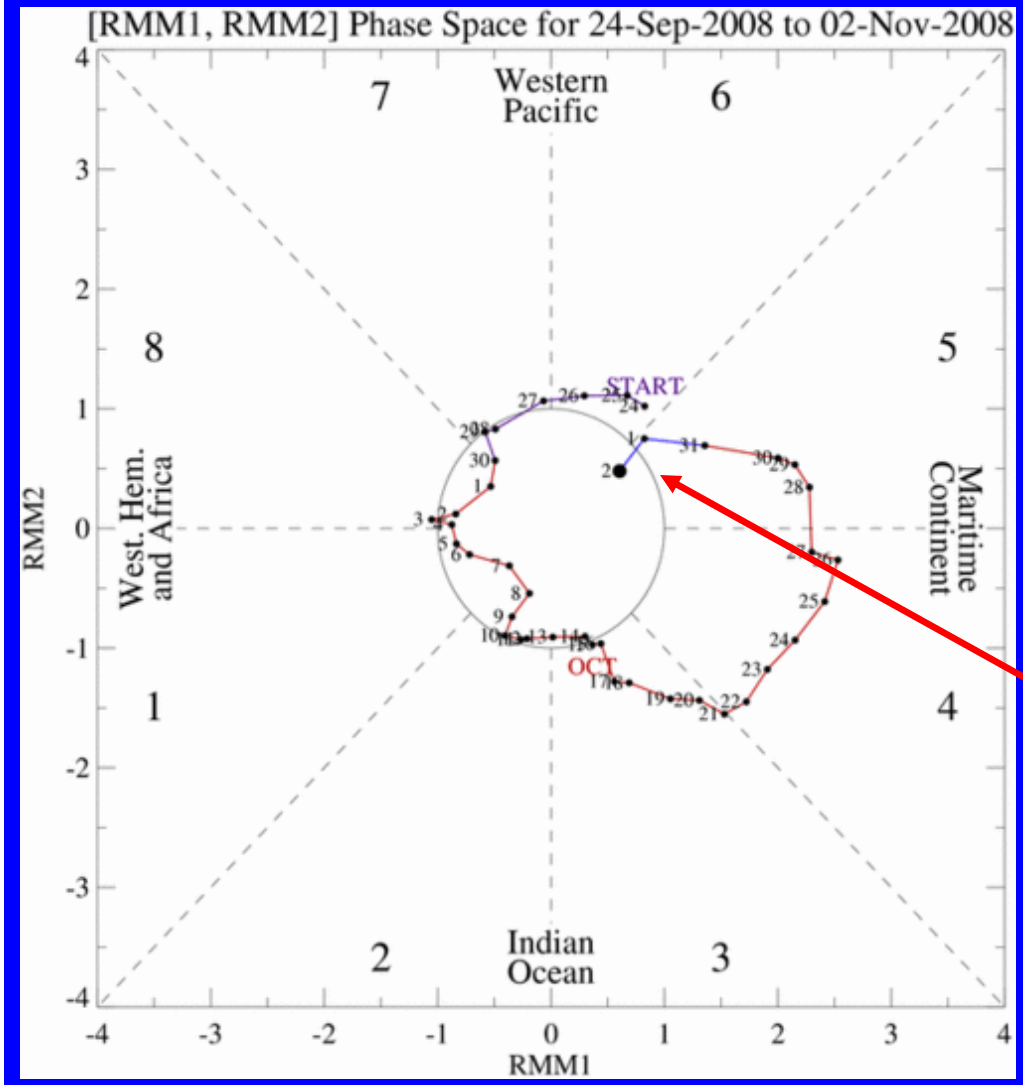
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

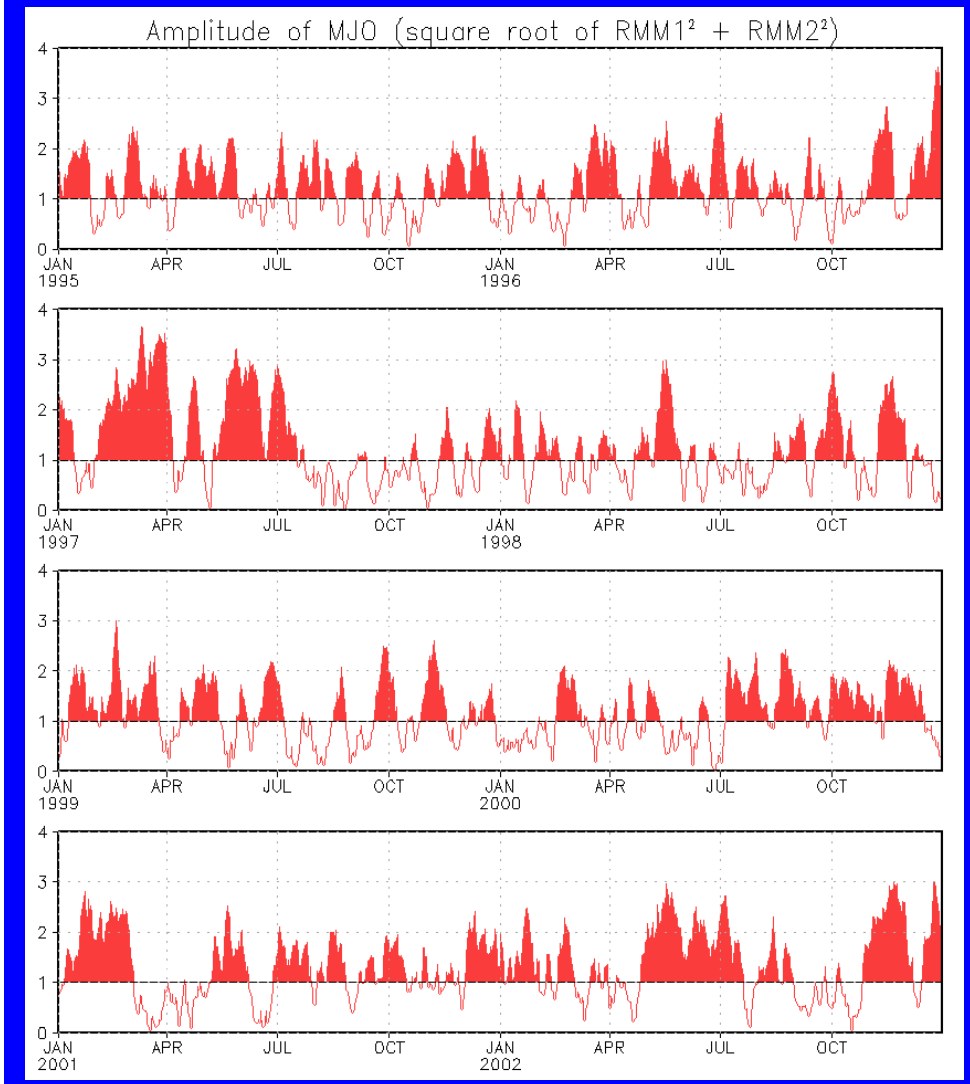
MJO Index -- Recent Evolution

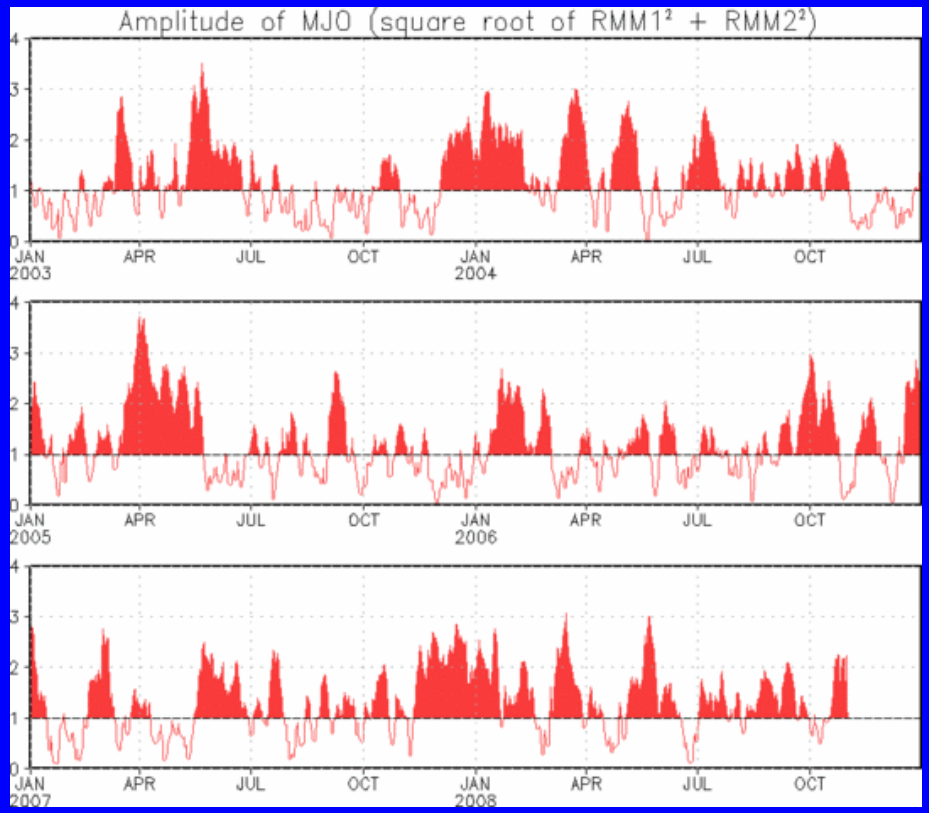


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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

The MJO index indicates a continued MJO signal albeit with a weaker amplitude.

MJO Index – Historical Daily Time Series





Time series of daily MJO index amplitude from 1995 to present

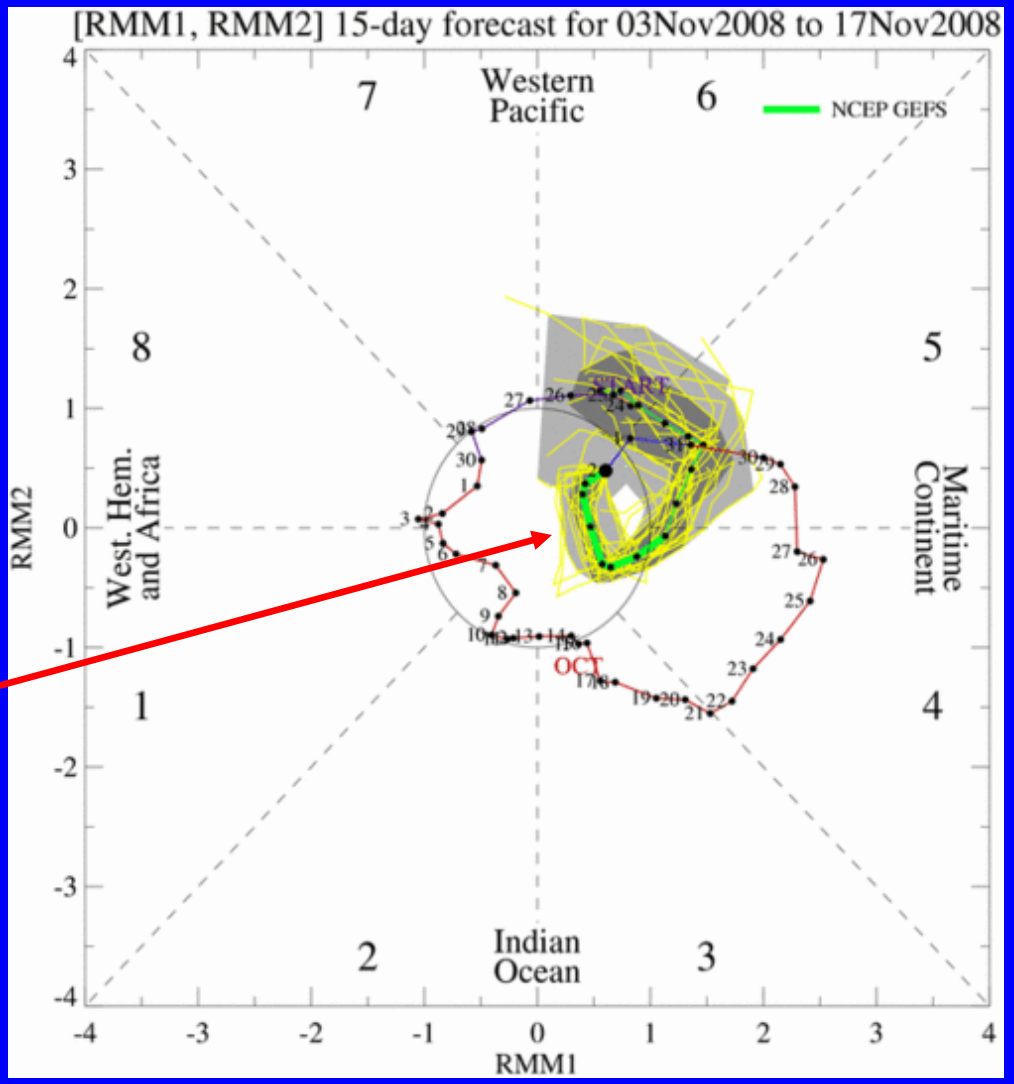
Plots put current MJO activity in historical context

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

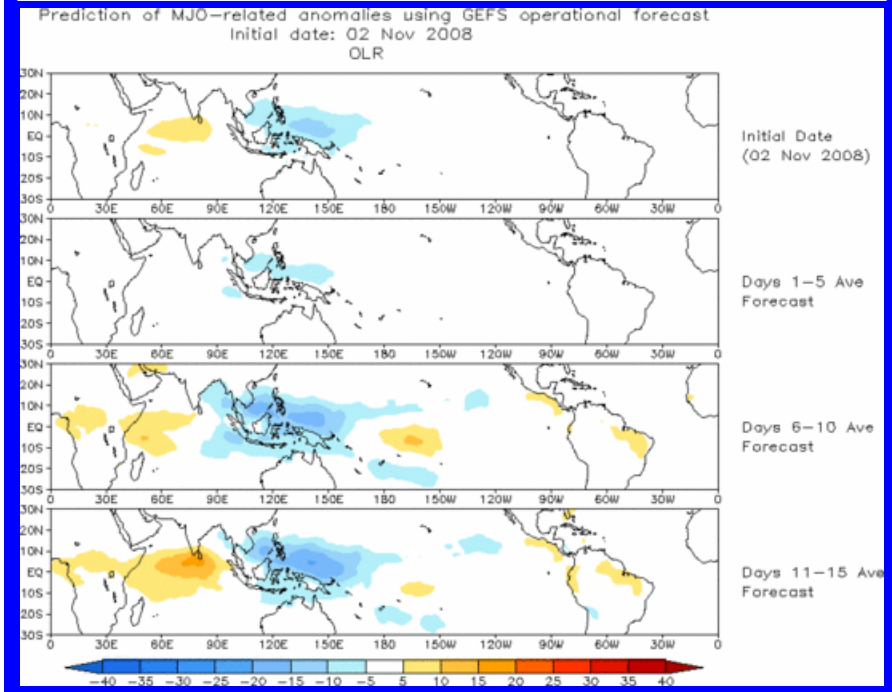


The GEFS forecasts predict a weakening MJO signal during Week 1 but renewed propagation later in the period.

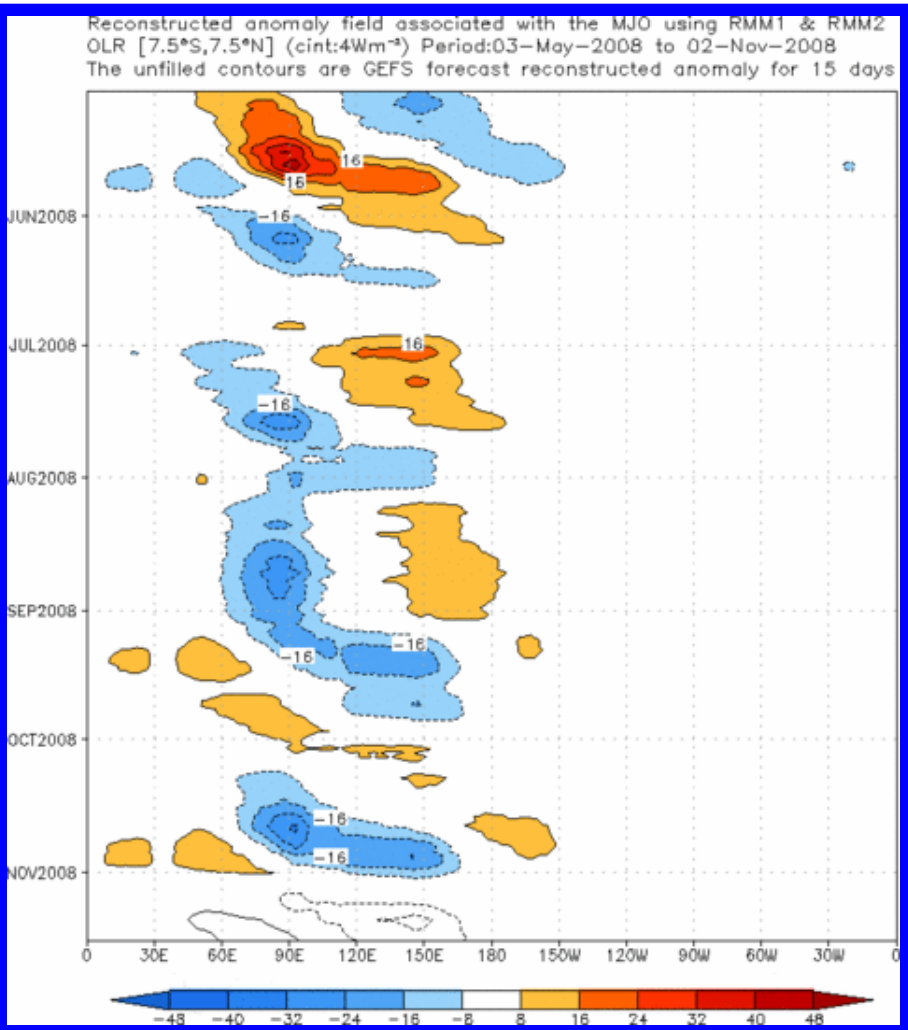
Ensemble Mean GFS MJO Forecast

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



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



MJO associated enhanced convection is forecast to remain weak over the Maritime Continent during Week 1 but increase later during the period.

Dry conditions are expected across Africa and the Indian Ocean in Week 2.

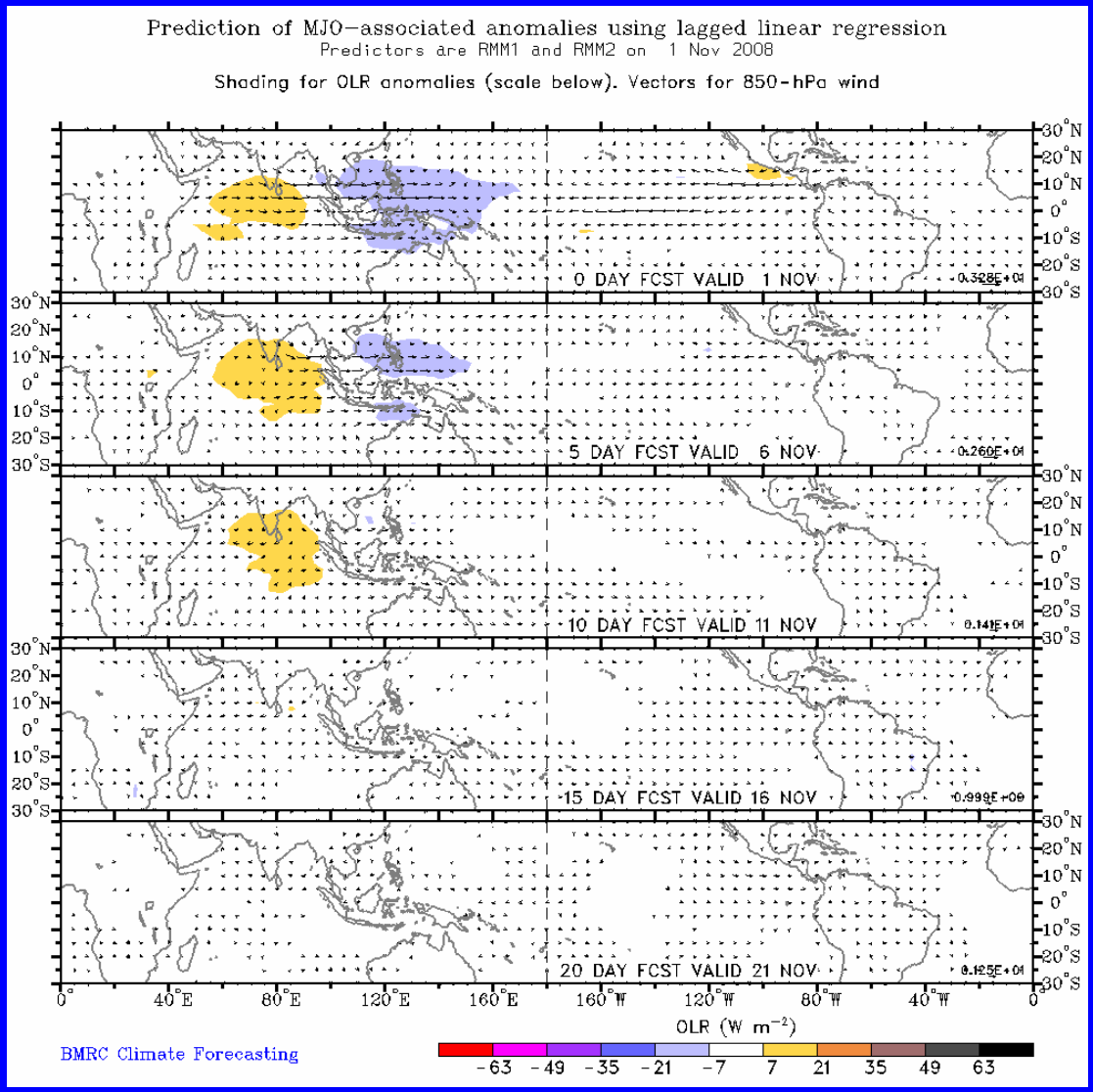
Statistical MJO Forecast

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

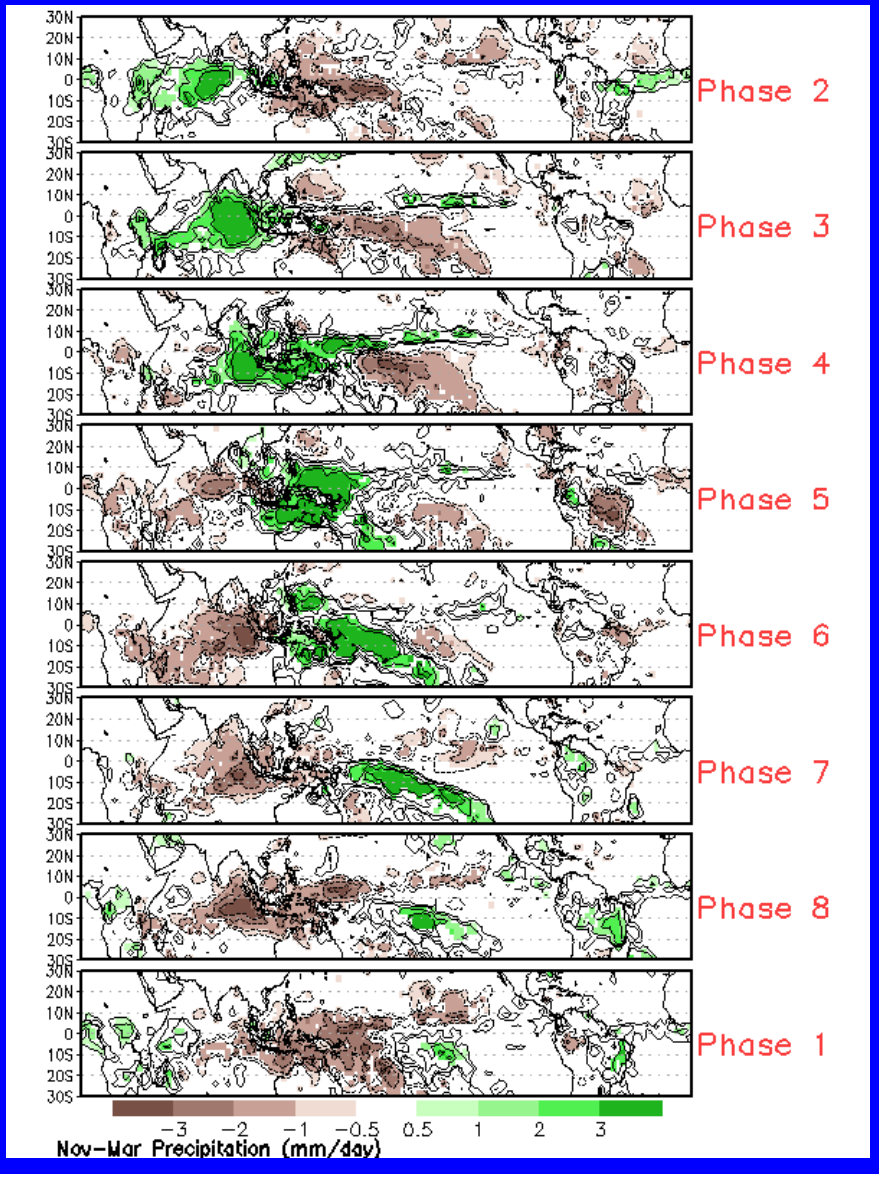
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The forecast indicates enhanced convection diminishing over the Maritime Continent, while suppressed convection develops across the Indian Ocean.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)