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

- The MJO strengthened during the past week with the enhanced phase centered across western Indonesia.

- Recent observations indicate the MJO may be shifting eastward although considerable uncertainty exists with the current MJO model forecasts.

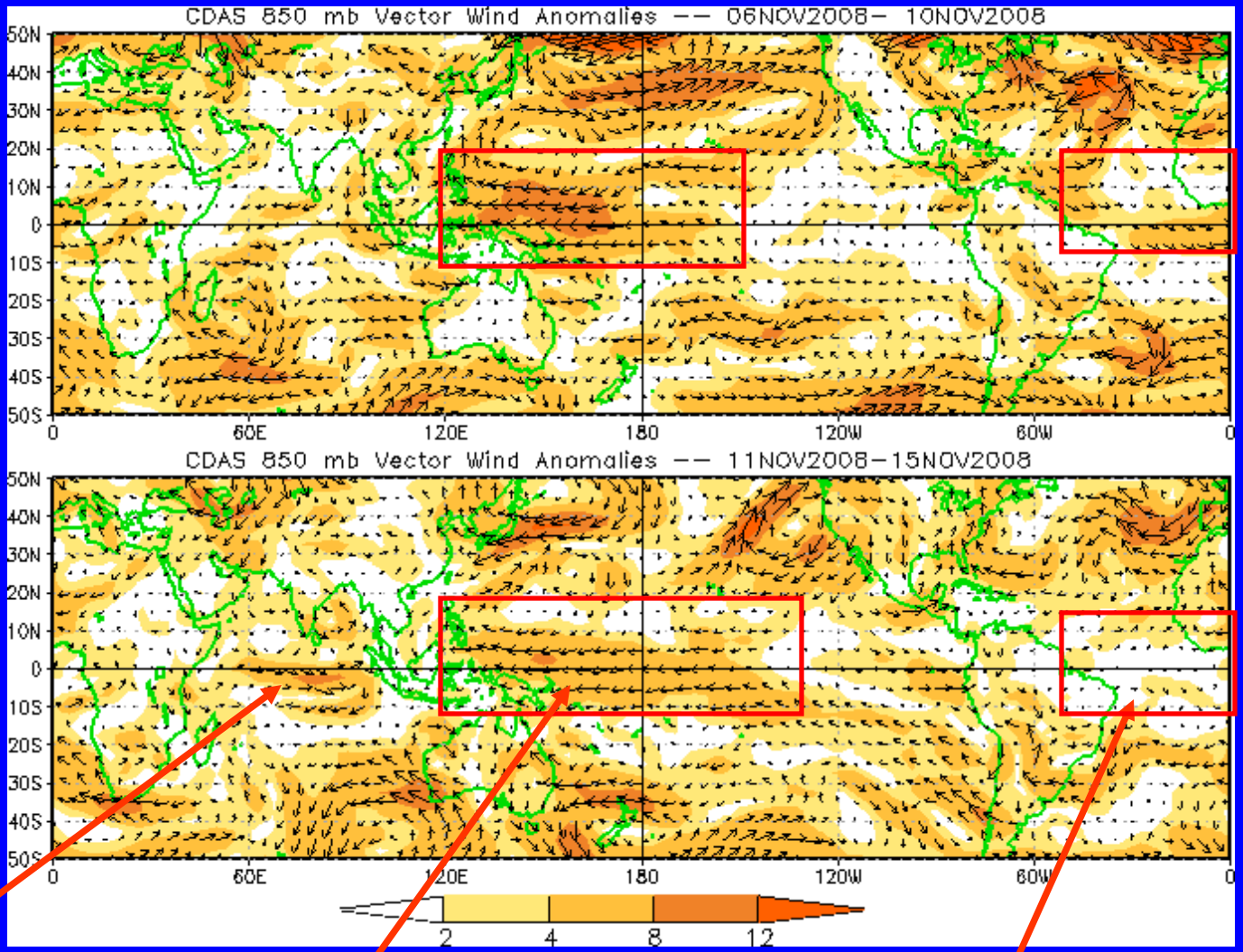
- The MJO is expected to contribute to enhanced convection for the eastern Indian Ocean and Indonesia during the upcoming 1-2 week period. Favorable conditions for tropical cyclogenesis are also expected for parts of the southern Indian Ocean throughout the period.

- The uncertainty in the future strength and evolution of the MJO makes the designation of specific impacts for the US unclear at the current time.

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 strengthened over the eastern Indian Ocean during the last five days.

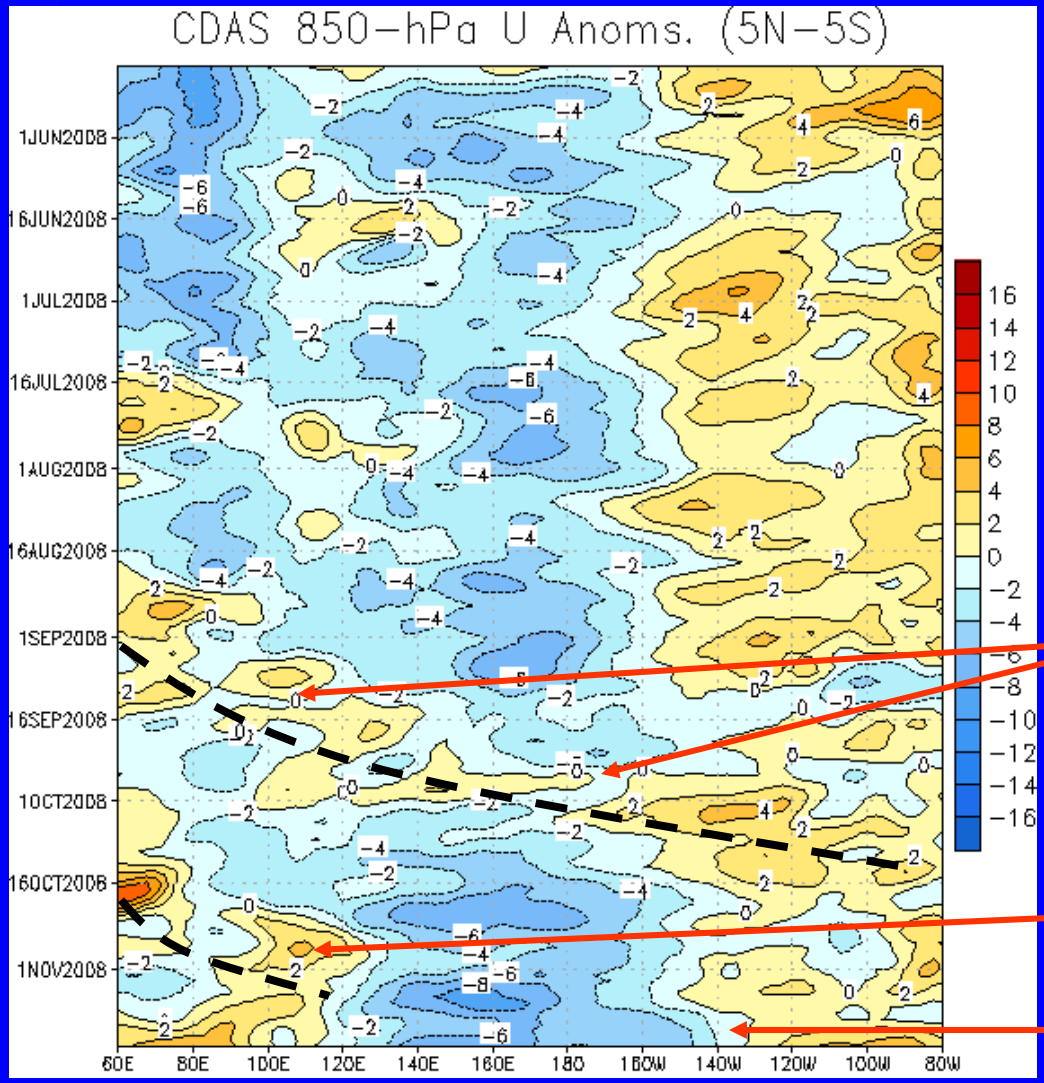
Easterly anomalies have decreased in the western Pacific Ocean but have expanded eastward.

Westerly anomalies have decreased 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

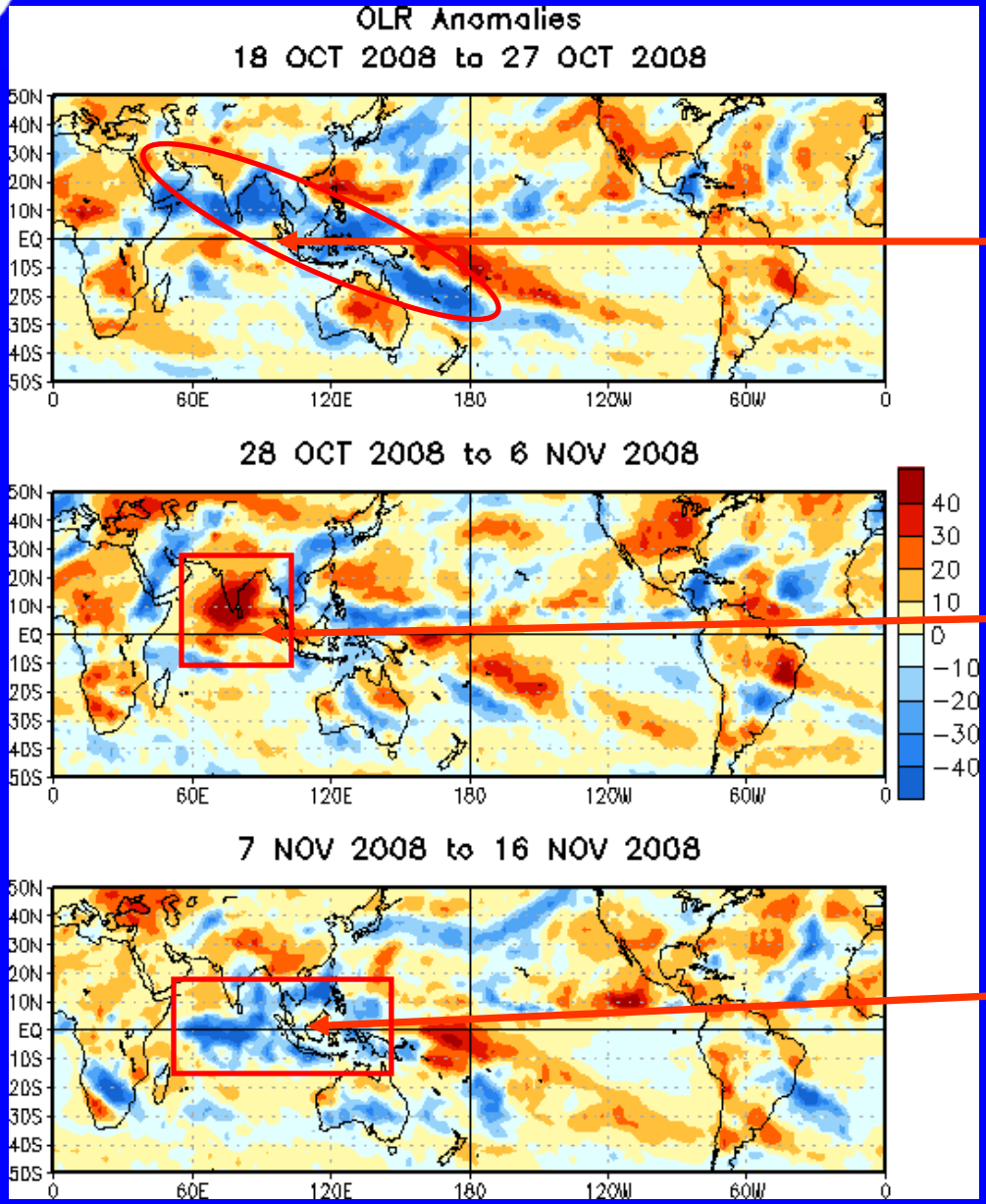
Longitude

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 reentered the Maritime Continent during late October, but its eastward progress stalled. The pattern of easterly anomalies over the Pacific has expanded eastward.

OLR Anomalies: Last 30 days



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

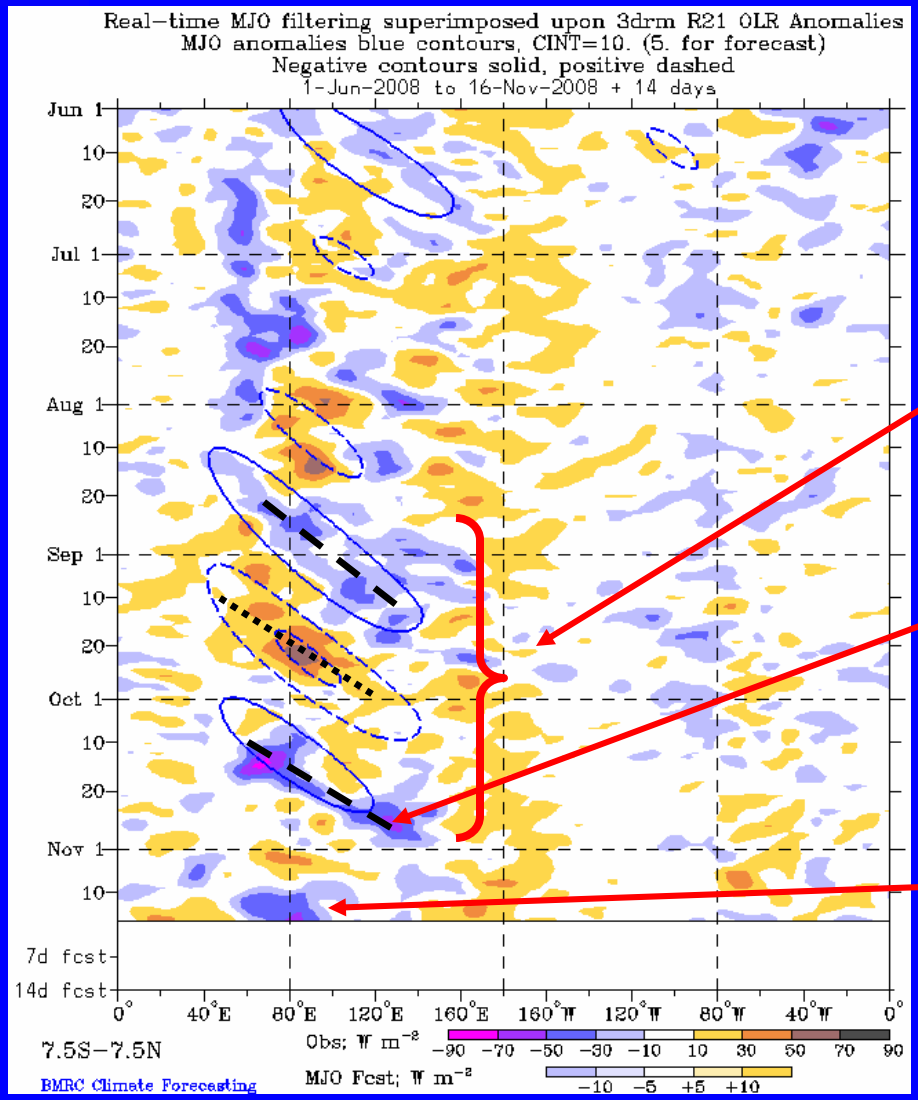
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

In mid-to-late October, enhanced convection extended eastward from the Arabian Sea Bay of Bengal to the South Pacific Convergence Zone (SPCZ) region (southeast of Papua New Guinea).

During late October and early November, anomalous convection became less coherent over the Eastern Hemisphere. Strong anomalous suppression developed over India.

Enhanced convection again developed across the equatorial Indian Ocean, parts of Southeast Asia and the Maritime continent.

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)

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

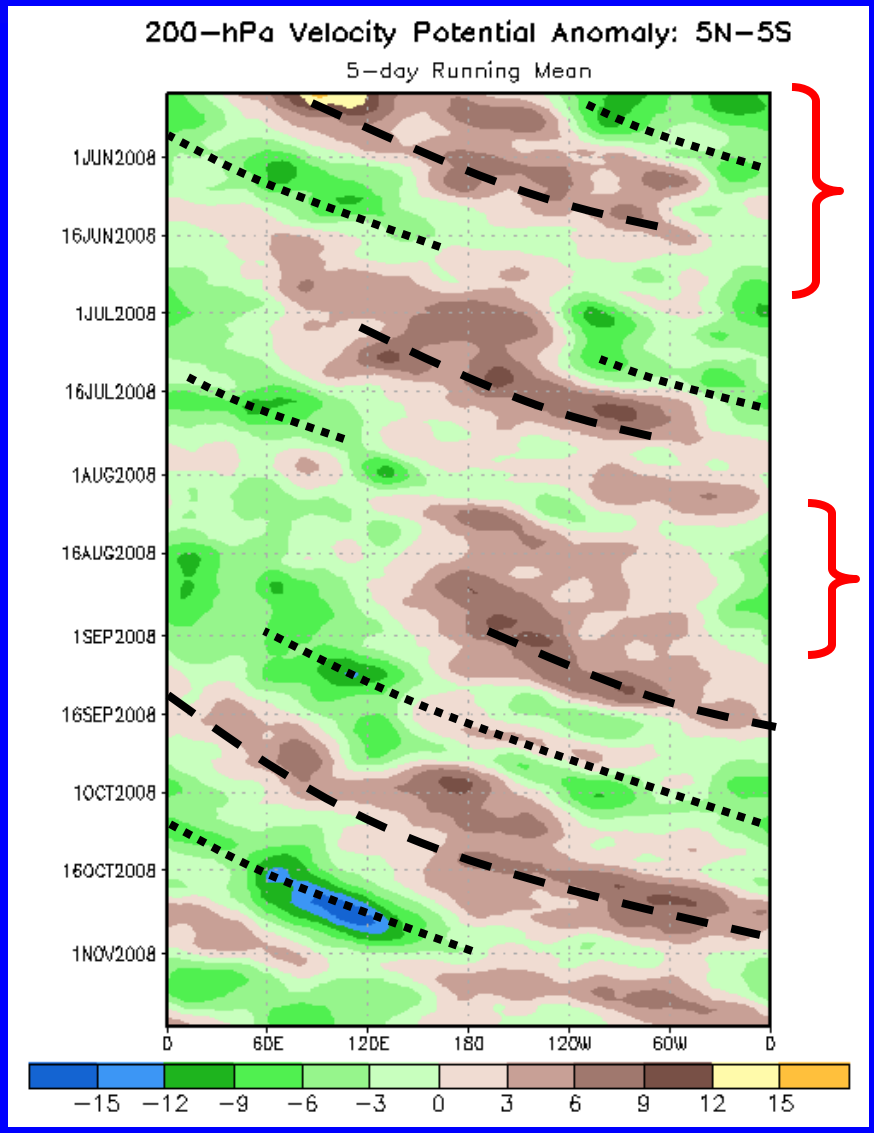
In October, strong convection reinitiated across the Indian Ocean and progressed eastward to the Maritime Continent.

During early November, convection was closer to average over much of the equatorial Indian and western Pacific Oceans. However, in recent days, enhanced convection is evident across 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

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.

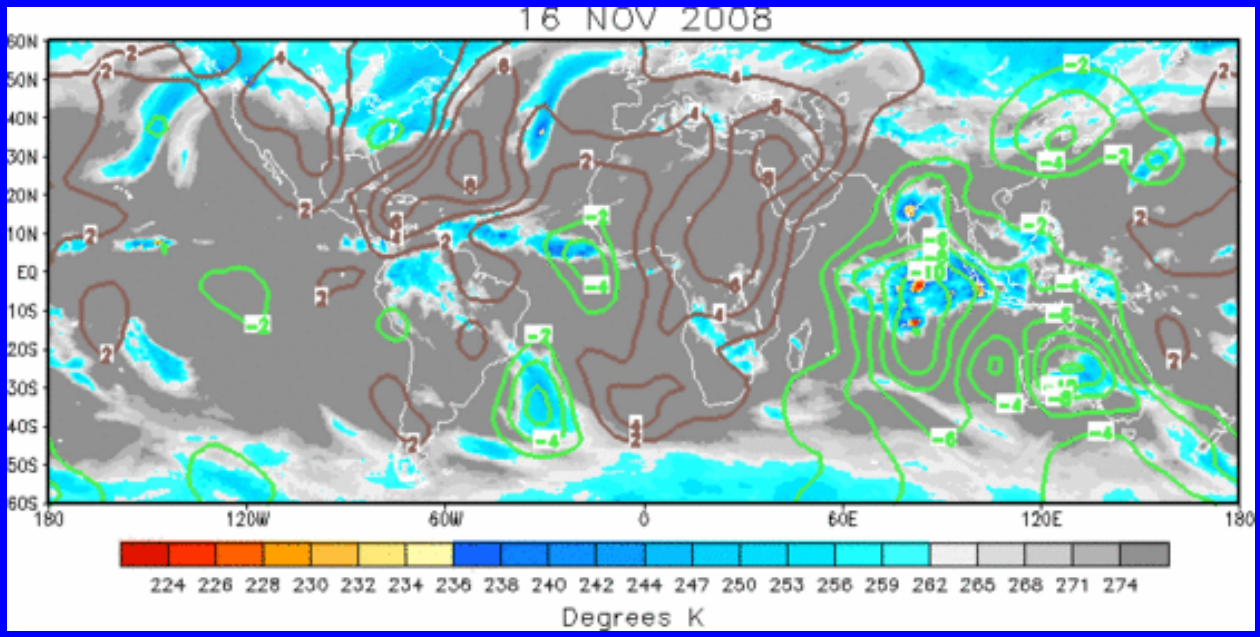
The MJO strengthened in early September and eastward propagation was observed from September through mid-October.

The MJO became less coherent during late October but some eastward movement continues.

IR Temperatures (K) / 200-hPa Velocity Potential Anomalies

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

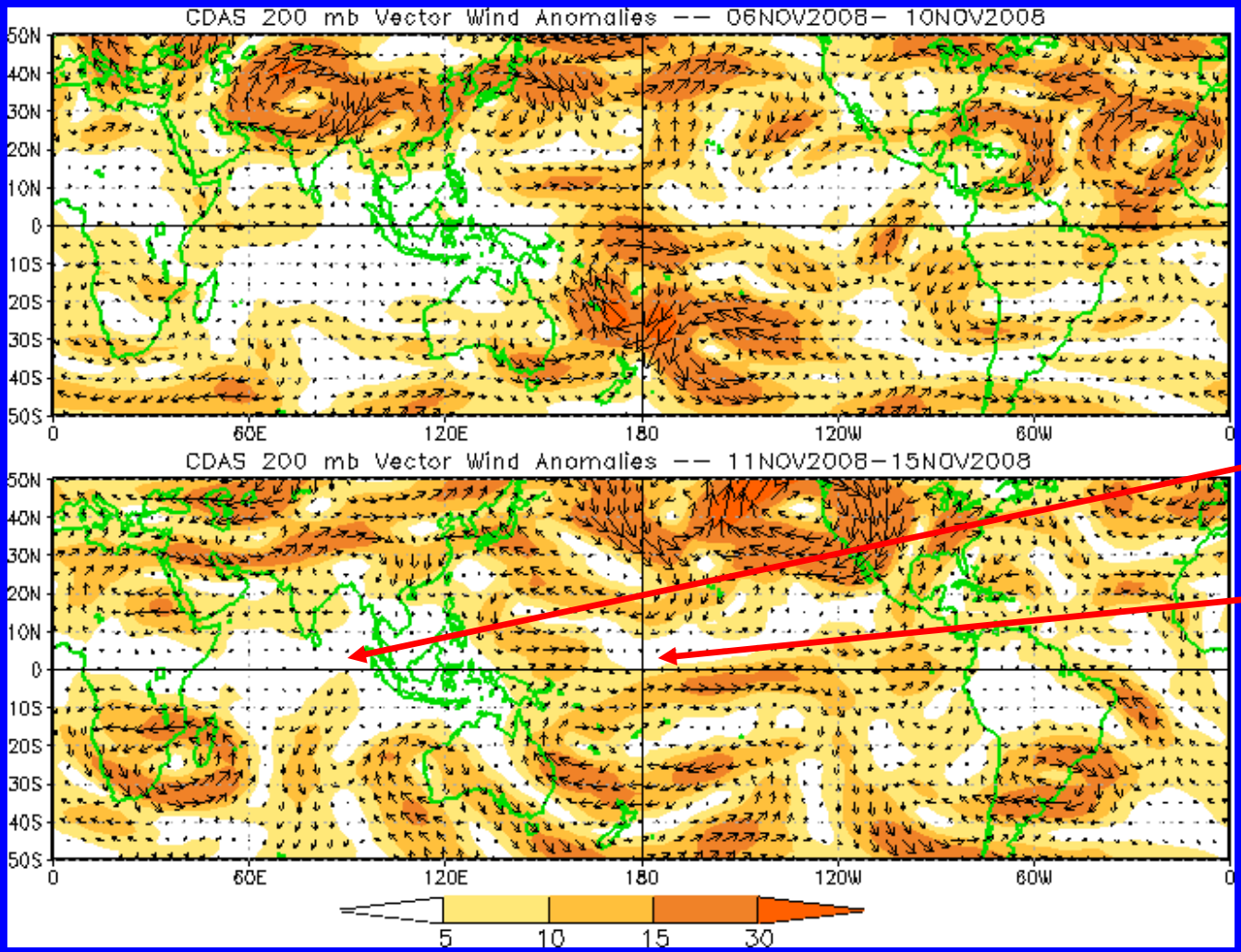
Negative anomalies (green contours) indicate favorable conditions for precipitation



The velocity potential pattern shows that upper-level convergence has become better organized across parts of the Atlantic Ocean and Africa, while upper-level divergence is focused across Indian Ocean.

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

Note that shading denotes the magnitude of anomalous wind vectors

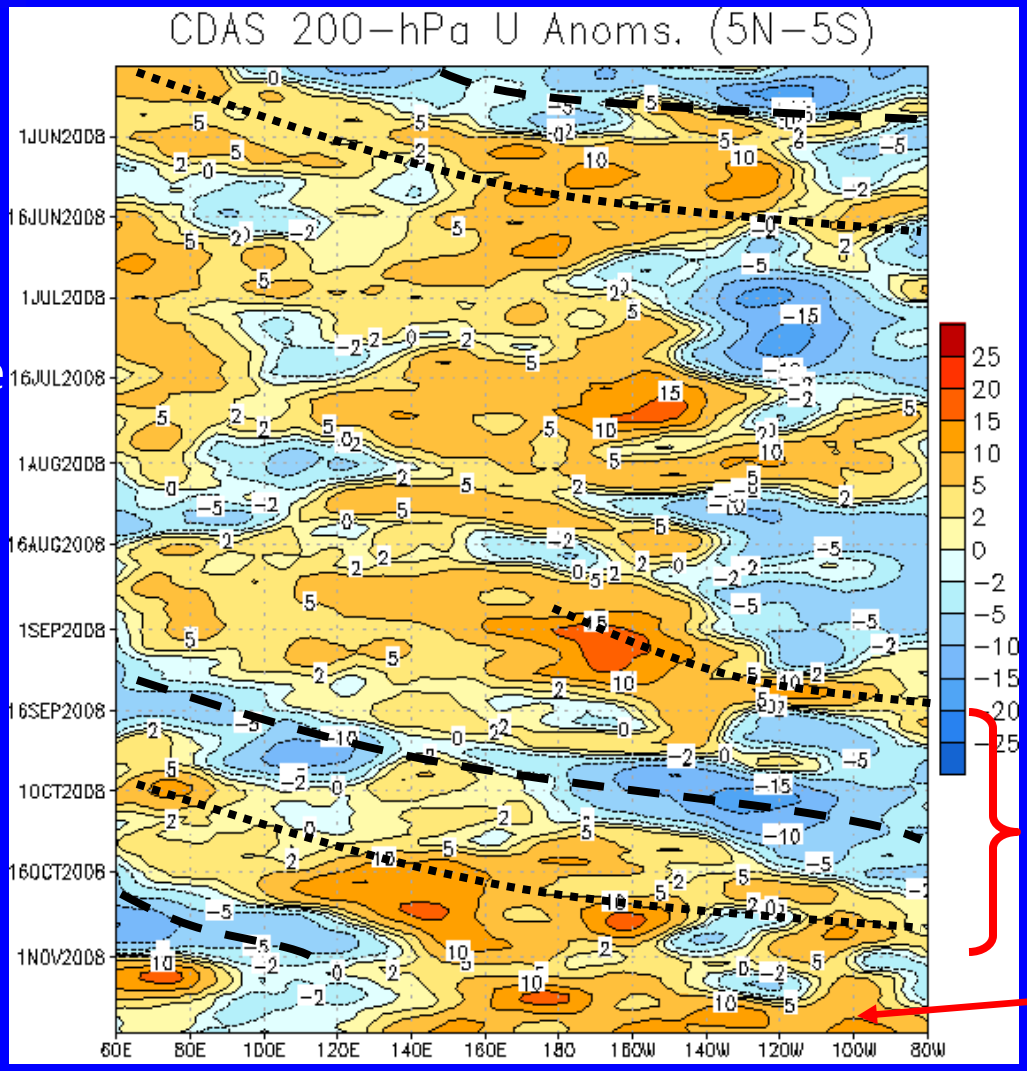


Westerly anomalies weakened across the equatorial Indian Ocean while strengthening across the Pacific Ocean.

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

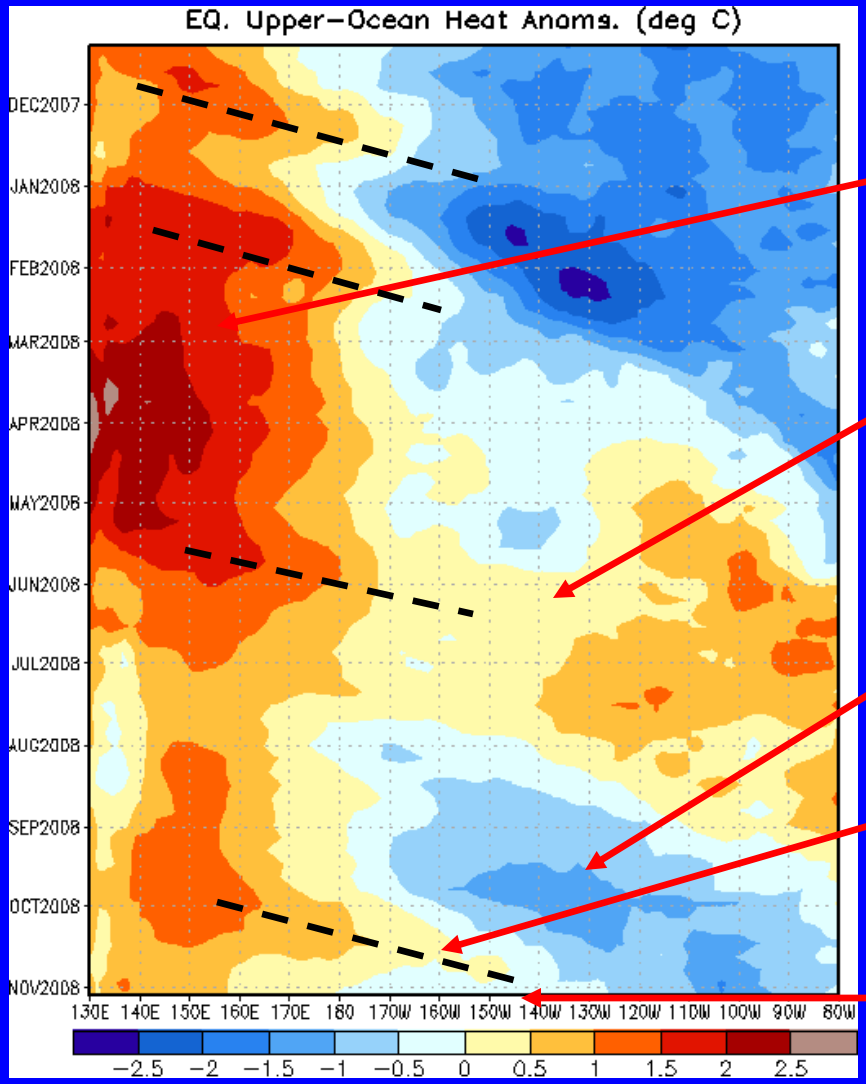
Longitude

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 September and October.

More recently, westerly anomalies have expanded eastward from the Date Line to the east Pacific Ocean.

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.

Recently, negative anomalies have reappeared east of the Date Line.

MJO Index -- Information

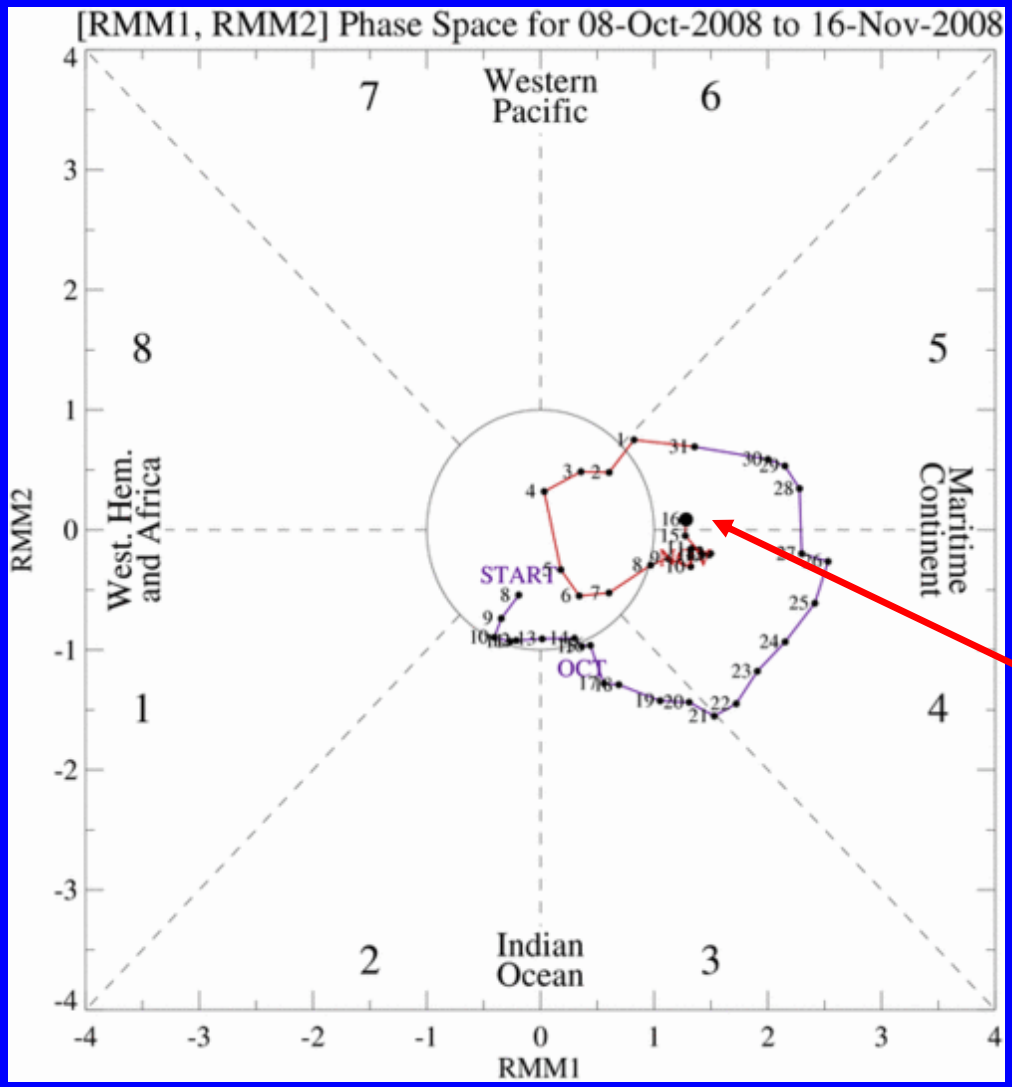
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

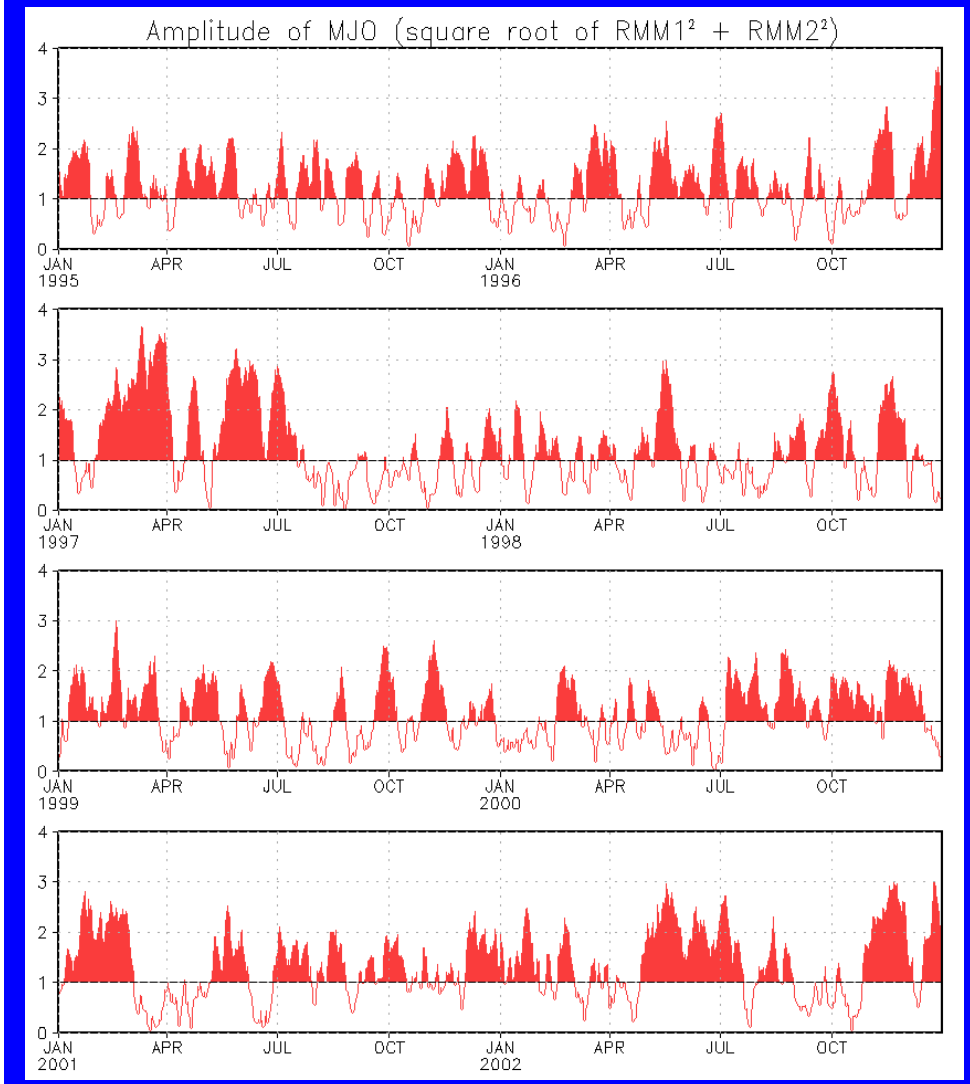
MJO Index -- Recent Evolution

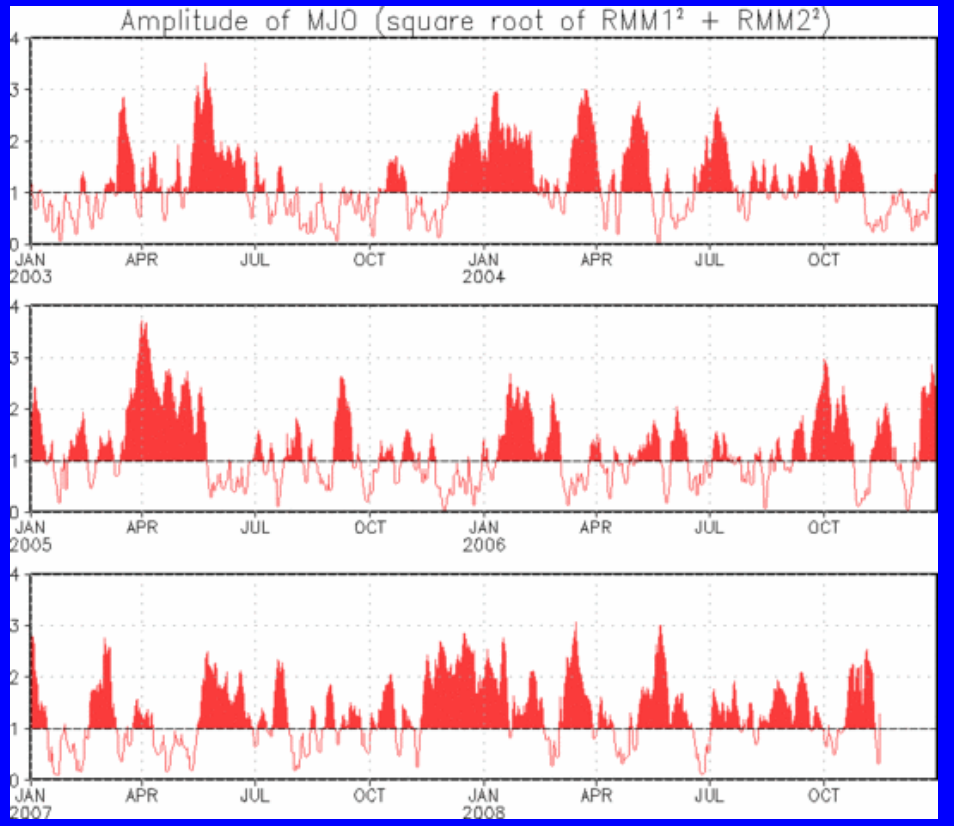


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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

The amplitude of the MJO index has increased during the last week, although eastward movement is not apparent.

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

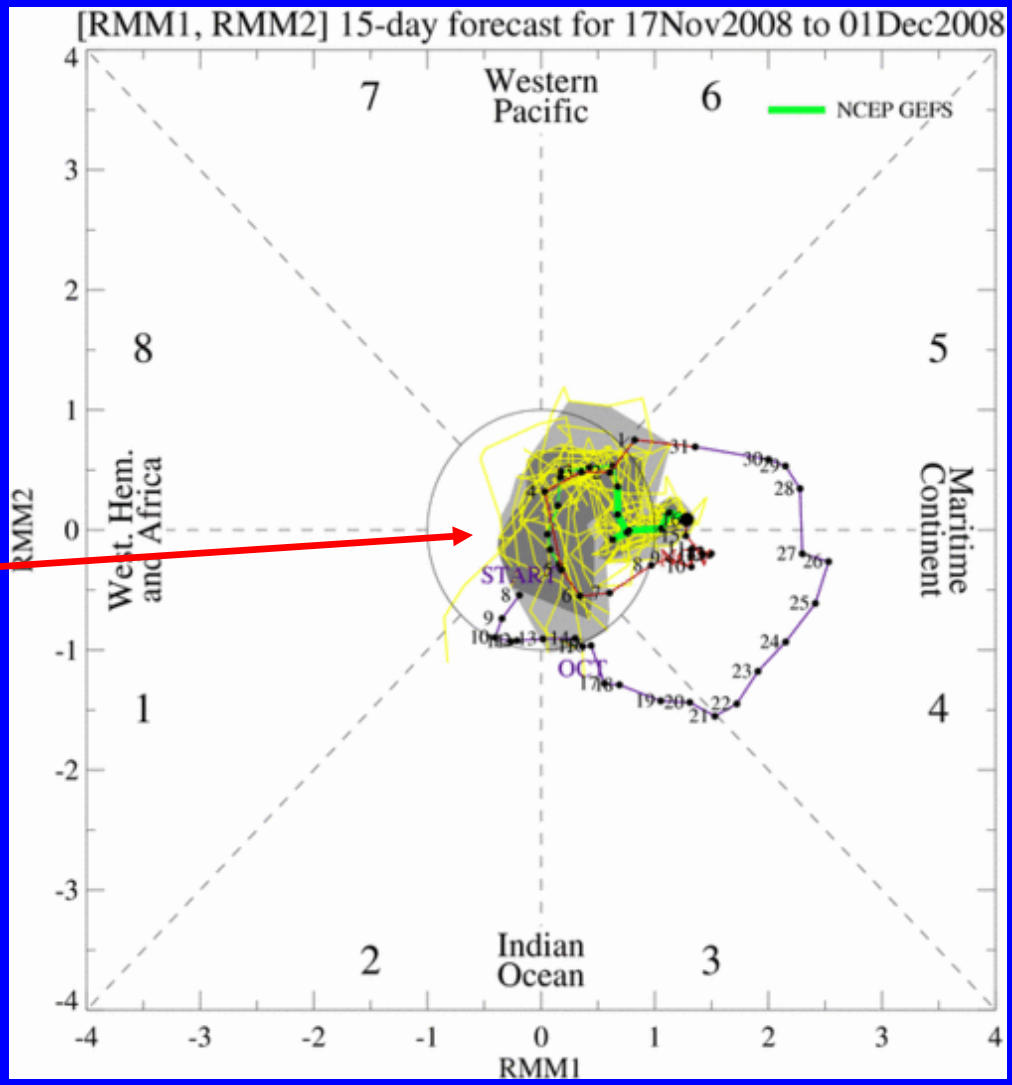
Ensemble GFS (GEFS) MJO Forecast

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

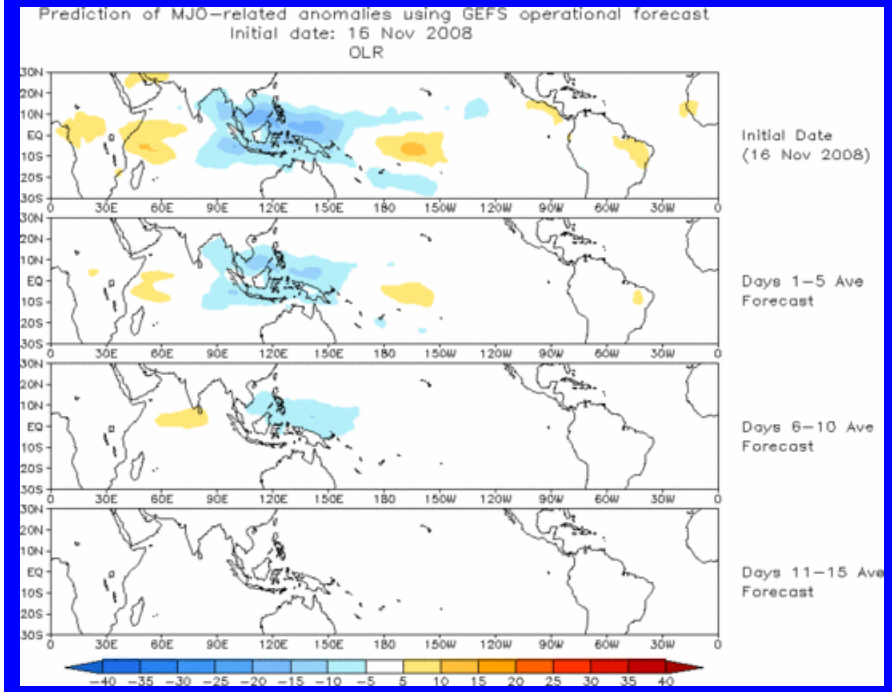
The GEFS forecasts predict the MJO index to decrease during the upcoming 1-2 week period with a considerable uncertainty.



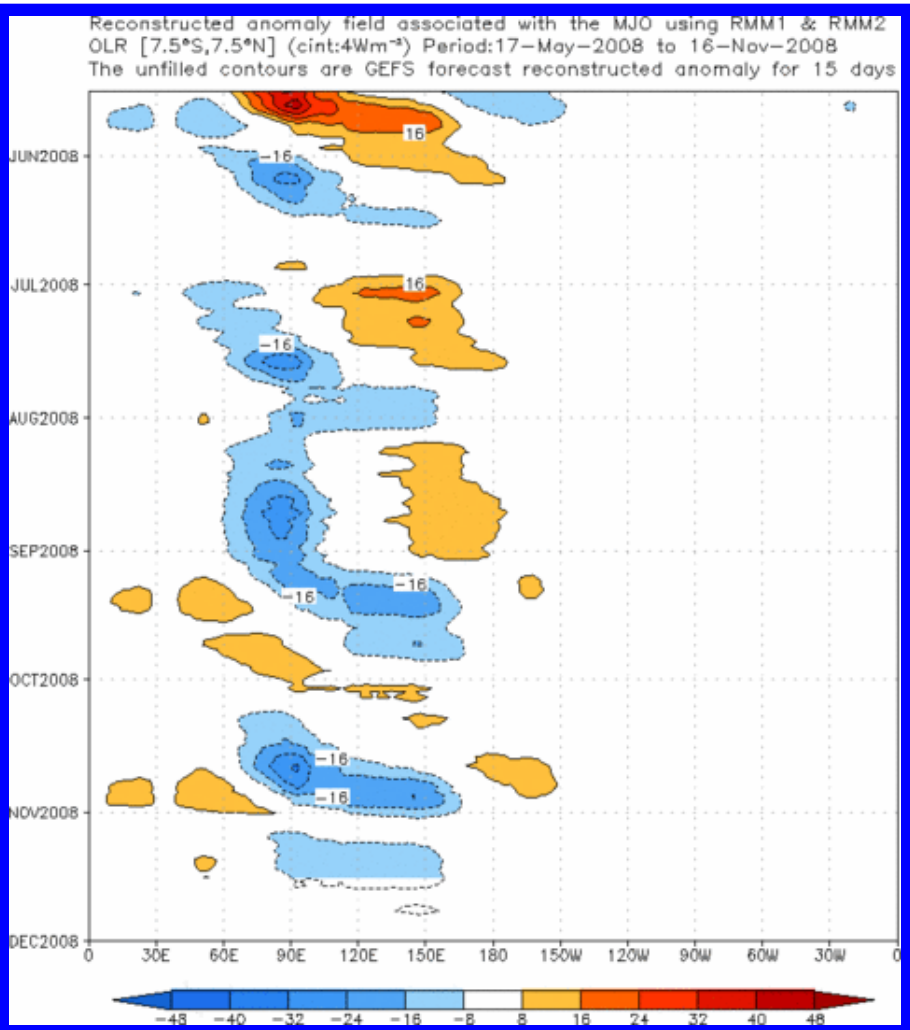
Ensemble Mean GFS MJO Forecast

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 decrease over the Maritime Continent during the period associated with a forecasted weakening MJO signal.

Statistical MJO Forecast

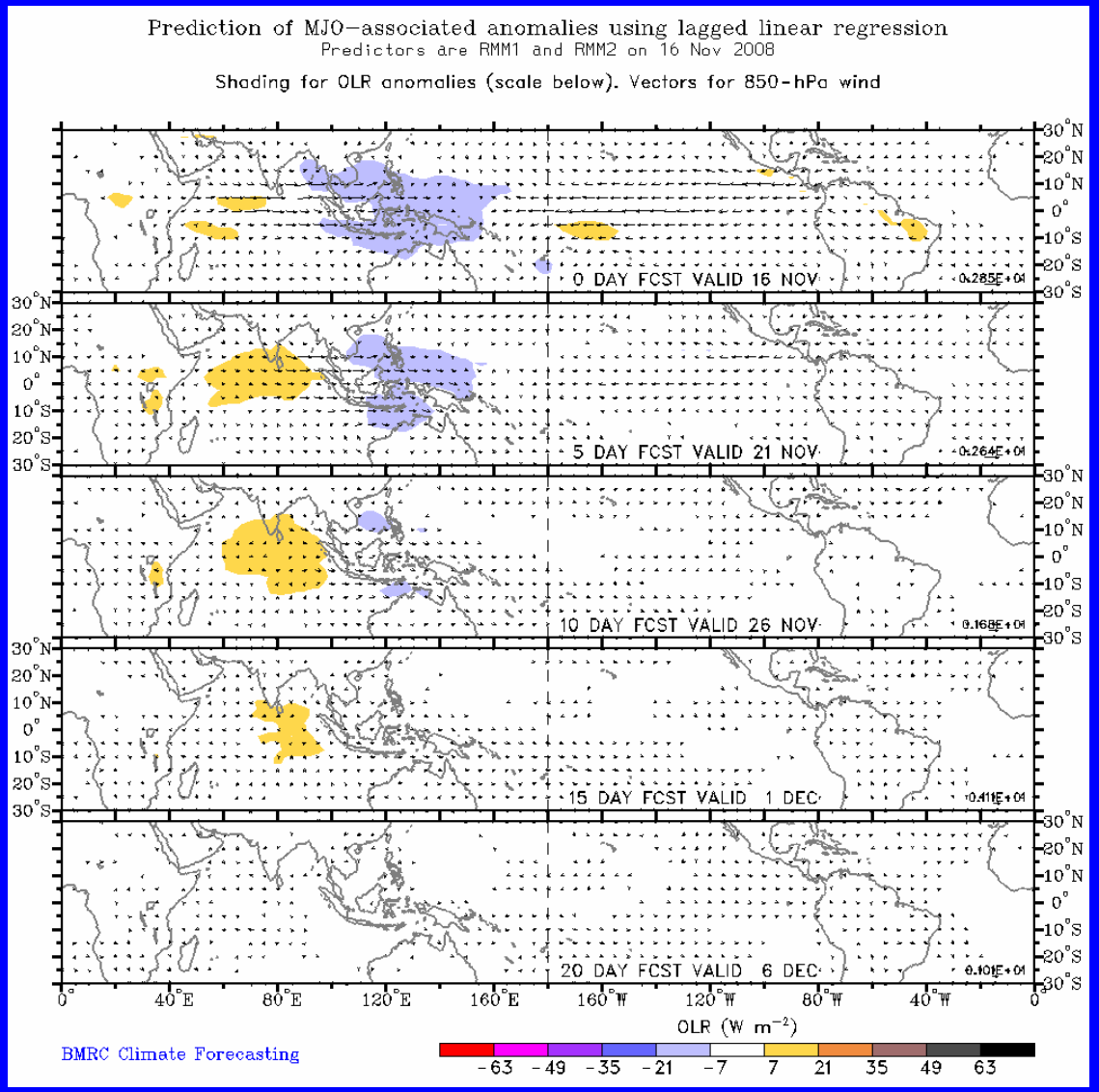
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

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

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

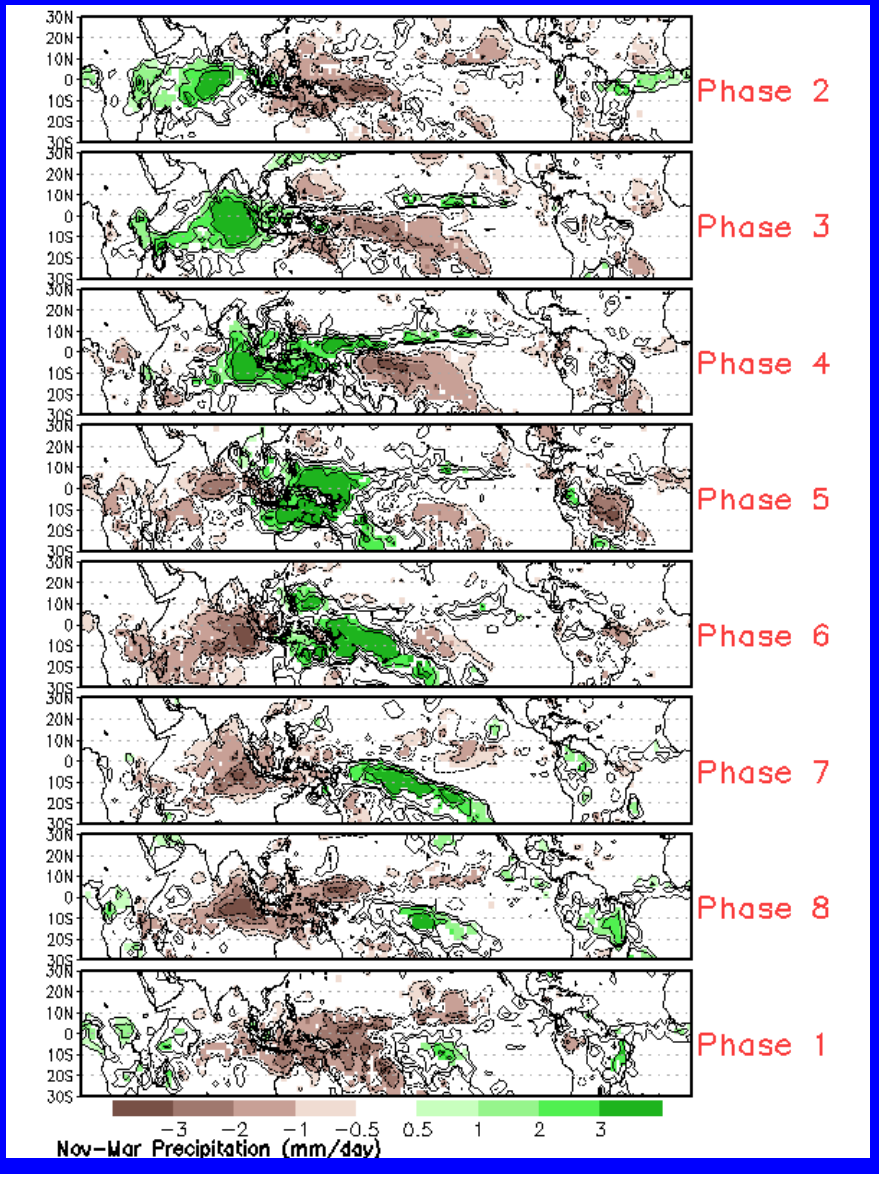
The forecast is for generally weak MJO activity.

Decreasing enhanced convection across the Maritime continent is expected during the period with dry conditions over the Indian Ocean.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)