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 shifted eastward during the past week with enhanced convection now focusing most strongly across portions of the Western Hemisphere.

- Based on the most recent observations, it is expected that the MJO will continue to shift quickly eastward. Currently, MJO model forecasts indicate considerable spread for the future evolution of the MJO during the next 1-2 weeks.

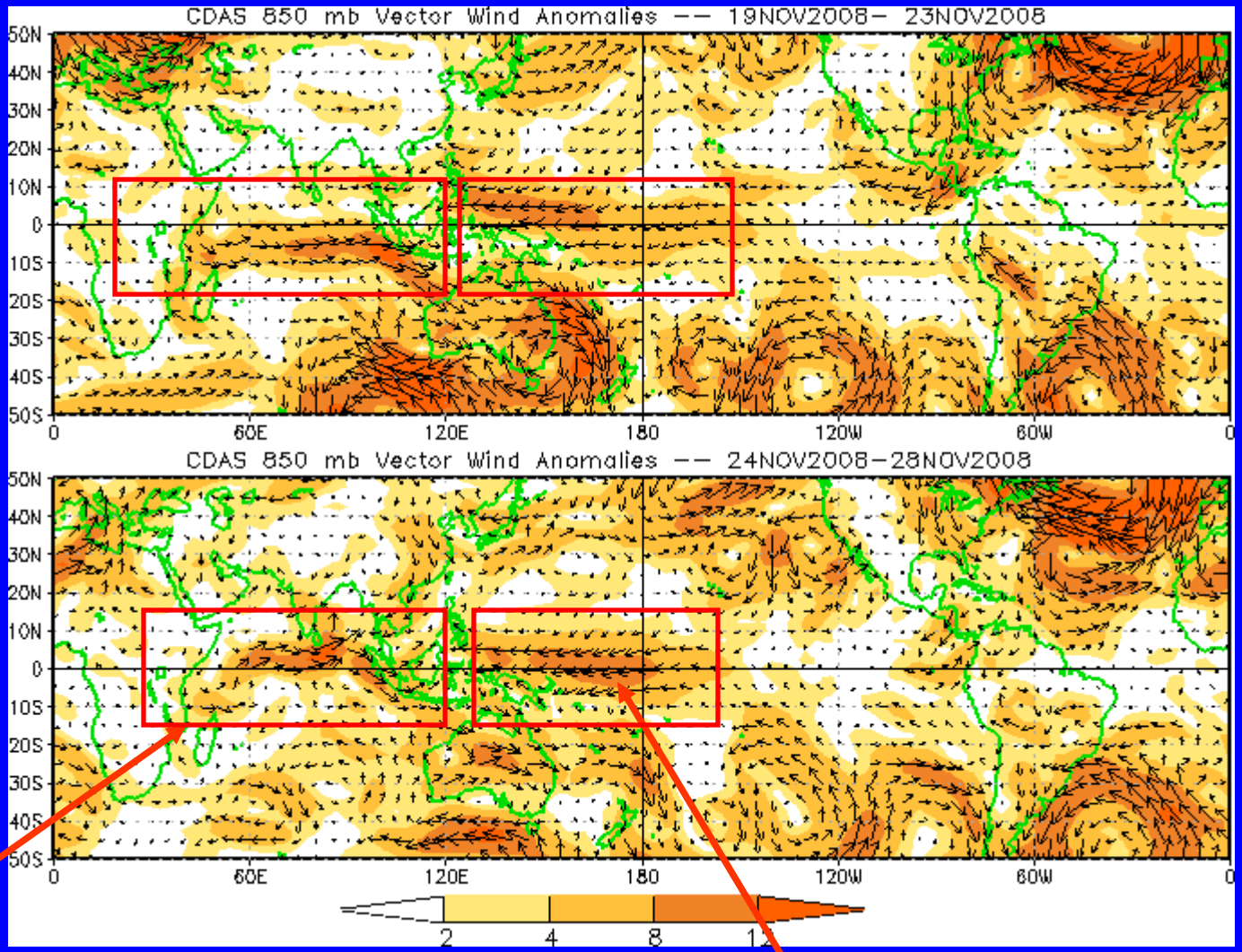
- During Week-1, the MJO is expected to contribute to enhanced convection across South America, eastern Indonesia and parts of the South Pacific Convergence Zone (SPCZ). The chances for elevated rainfall increase during Week-2 across Southeast Africa and the southwestern Indian Ocean.

- The MJO is expected to suppress convection across parts of the equatorial Indian Ocean and western Indonesia 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



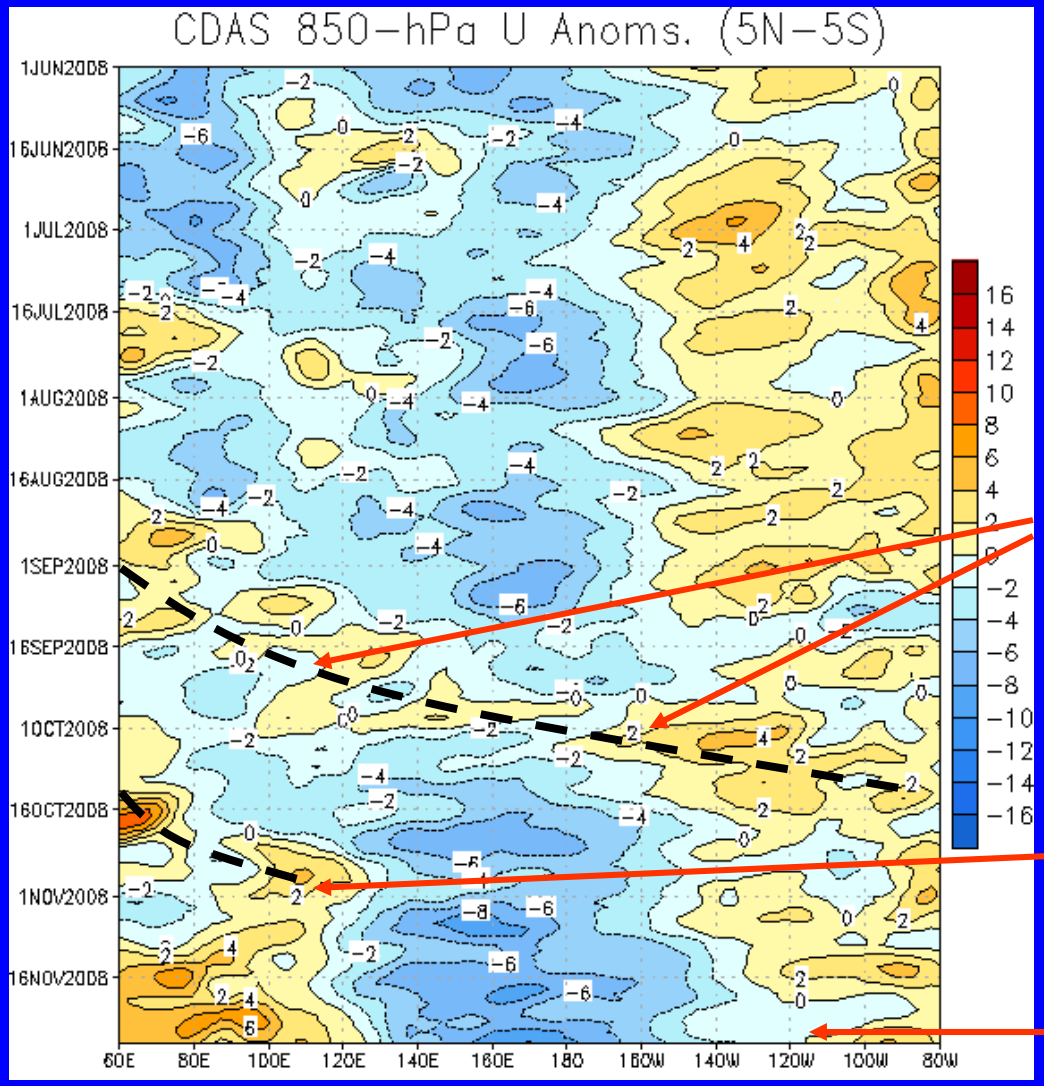
Westerly anomalies have continued over the eastern Indian Ocean and western Maritime Continent.

The core of the easterly anomalies have shifted eastward towards the central Pacific Ocean.

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

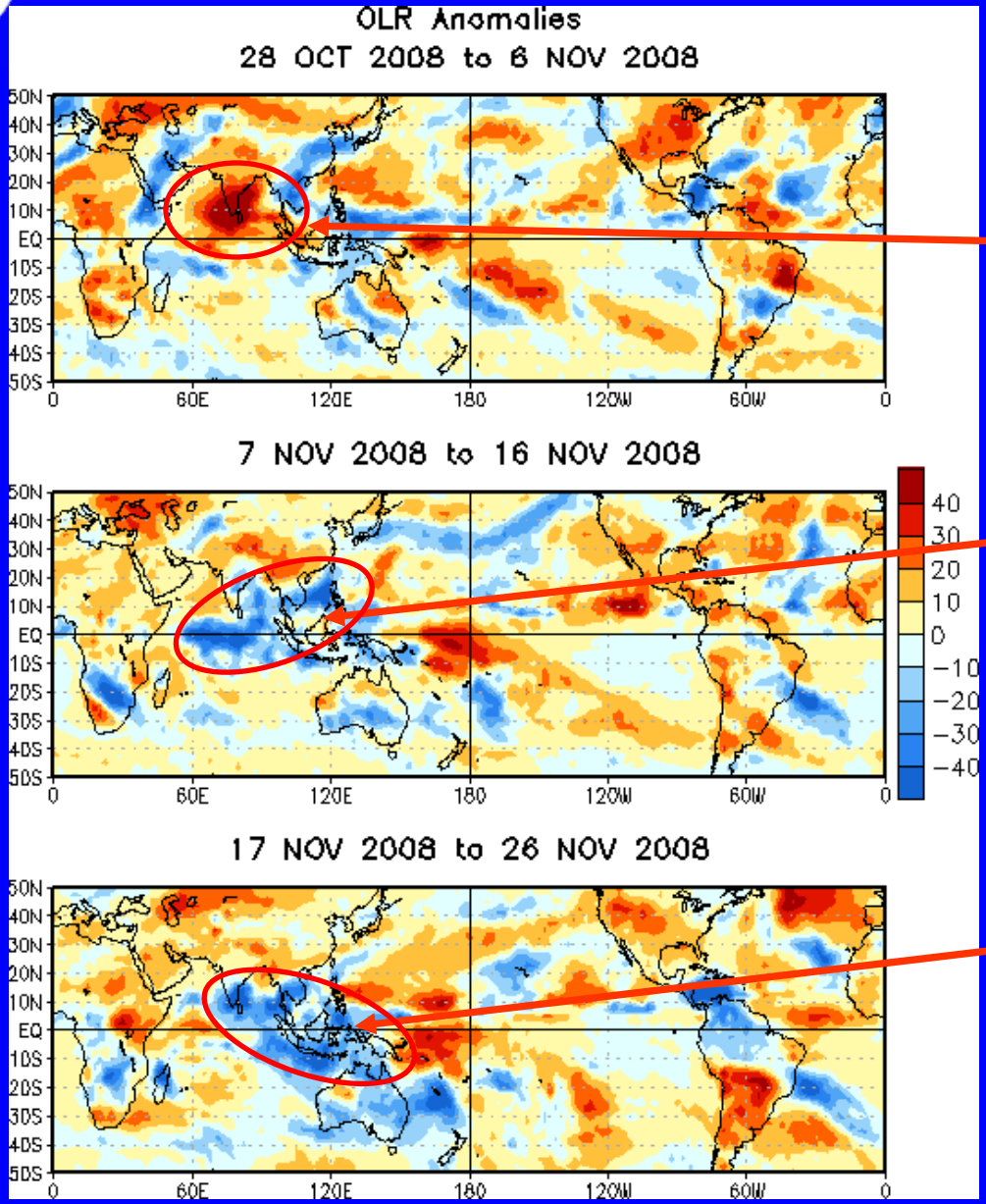
Easterly anomalies prevailed across much of the eastern hemisphere from late May into August.

Beginning in September, anomalous westerlies associated with the MJO 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 central Pacific has remained stationary and has expanded to the eastern Pacific.

OLR Anomalies: Last 30 days



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

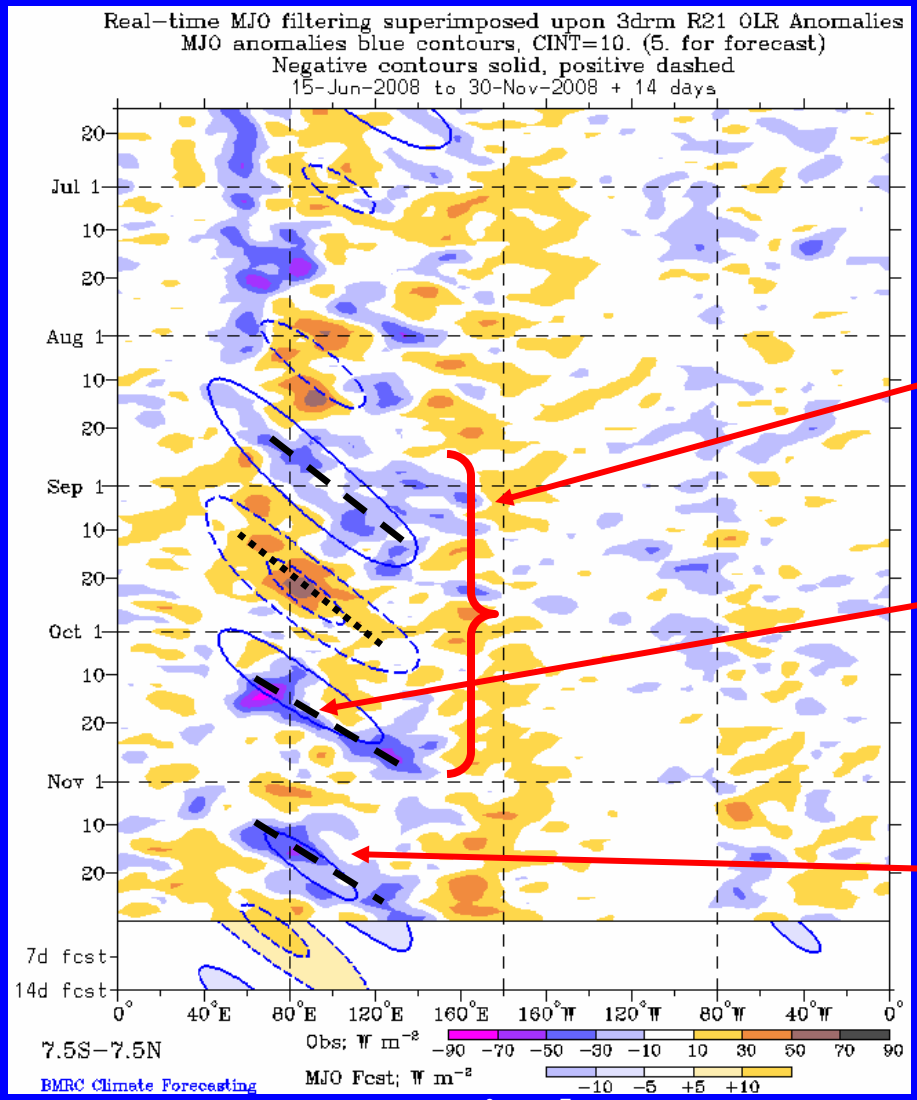
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

In late October and early November, suppressed convection was evident across India.

During the mid-November, enhanced convection developed over the equatorial Indian Ocean, Indonesia, and the South China Sea.

During mid-late November, enhanced convection strengthened and extended from India to the Maritime Continent and northern Australia.

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.

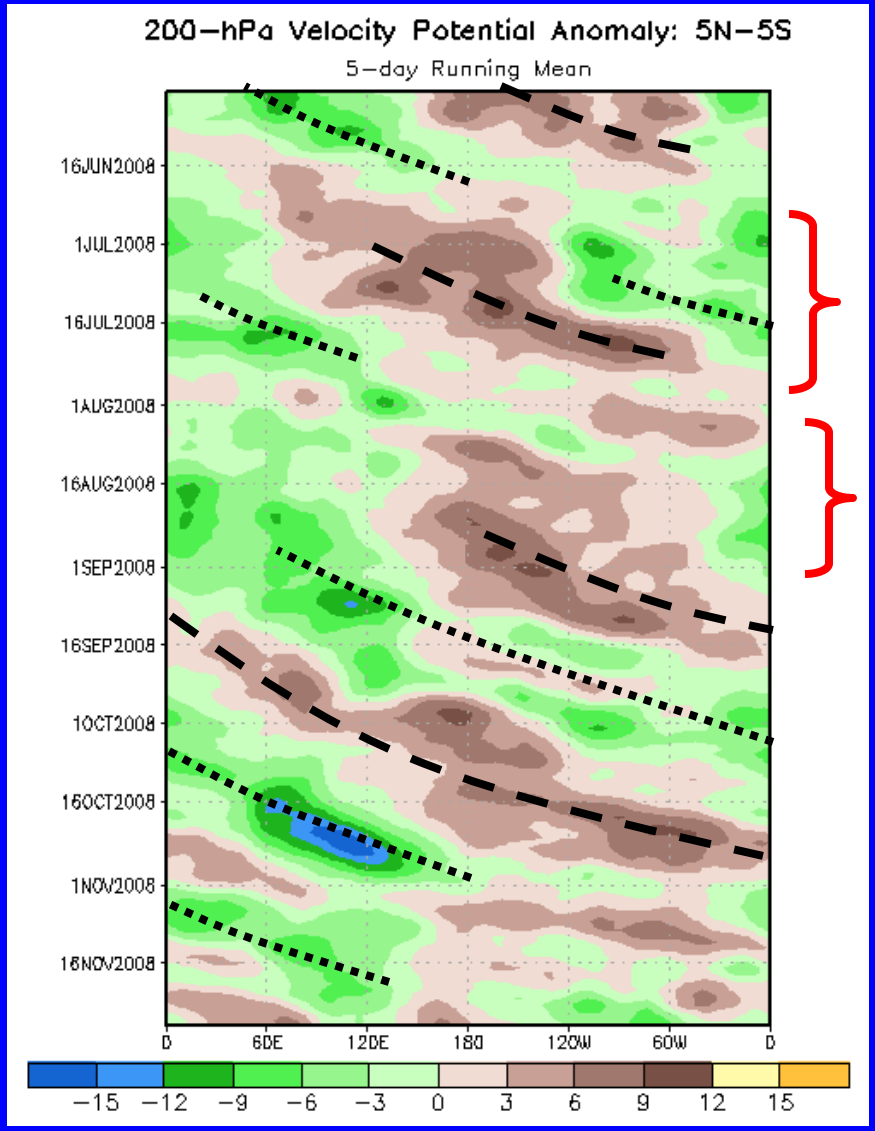
In October, strong convection reinitiated across the Indian Ocean and progressed eastward to the Maritime Continent.

During mid-November, the MJO strengthened and enhanced convection shifted from the equatorial Indian Ocean to the Maritime Continent. The suppressed phase of the MJO is now entering this region.

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.

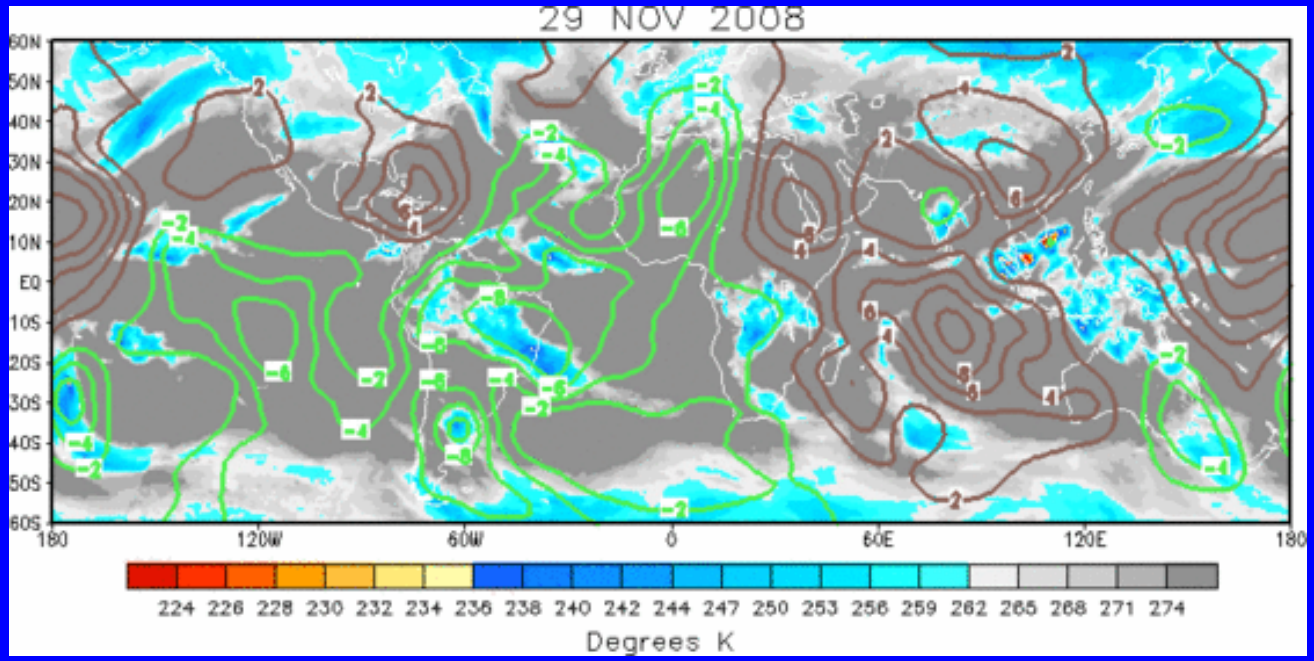
The MJO strengthened in early September and eastward propagation was observed from September through mid-October.

The MJO became less coherent during the month of November.

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

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

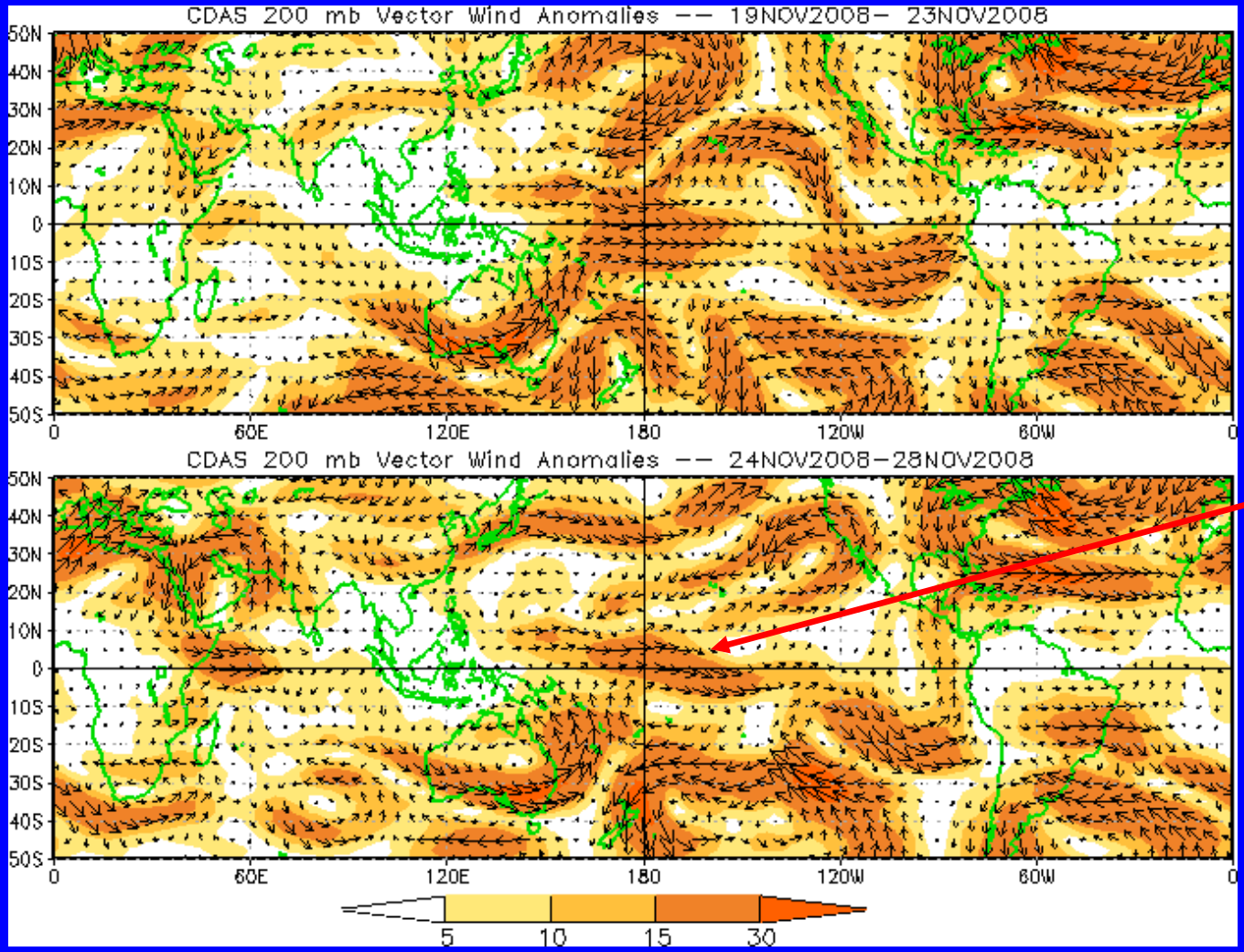
Negative anomalies (green contours) indicate favorable conditions for precipitation



The velocity potential pattern shows upper-level divergence over the Atlantic Ocean and South America. Upper-level convergence is evident across the Indian and western Pacific oceans.

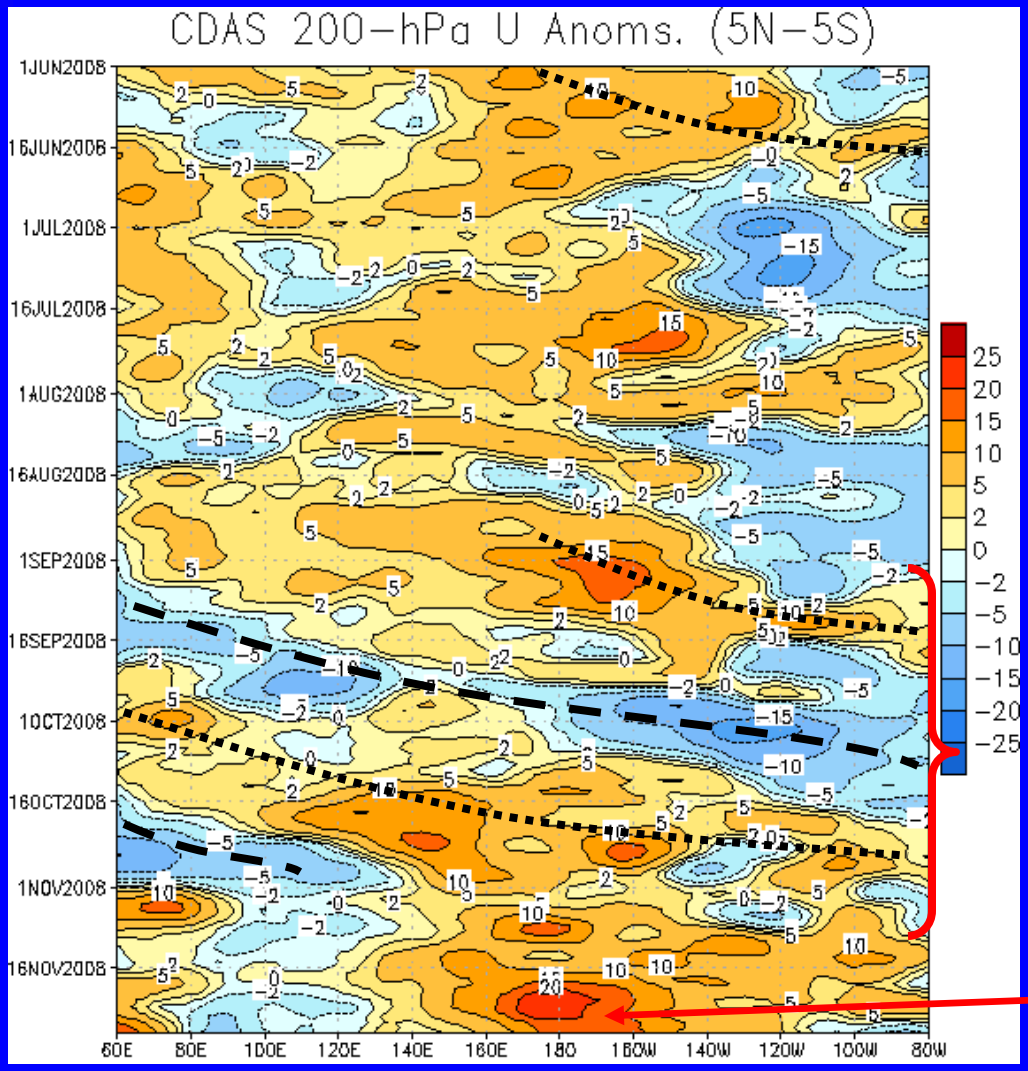
200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the magnitude of anomalous wind vectors



Westerly anomalies have remained over the equatorial Pacific Ocean during the last five days.

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



Time

Longitude

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

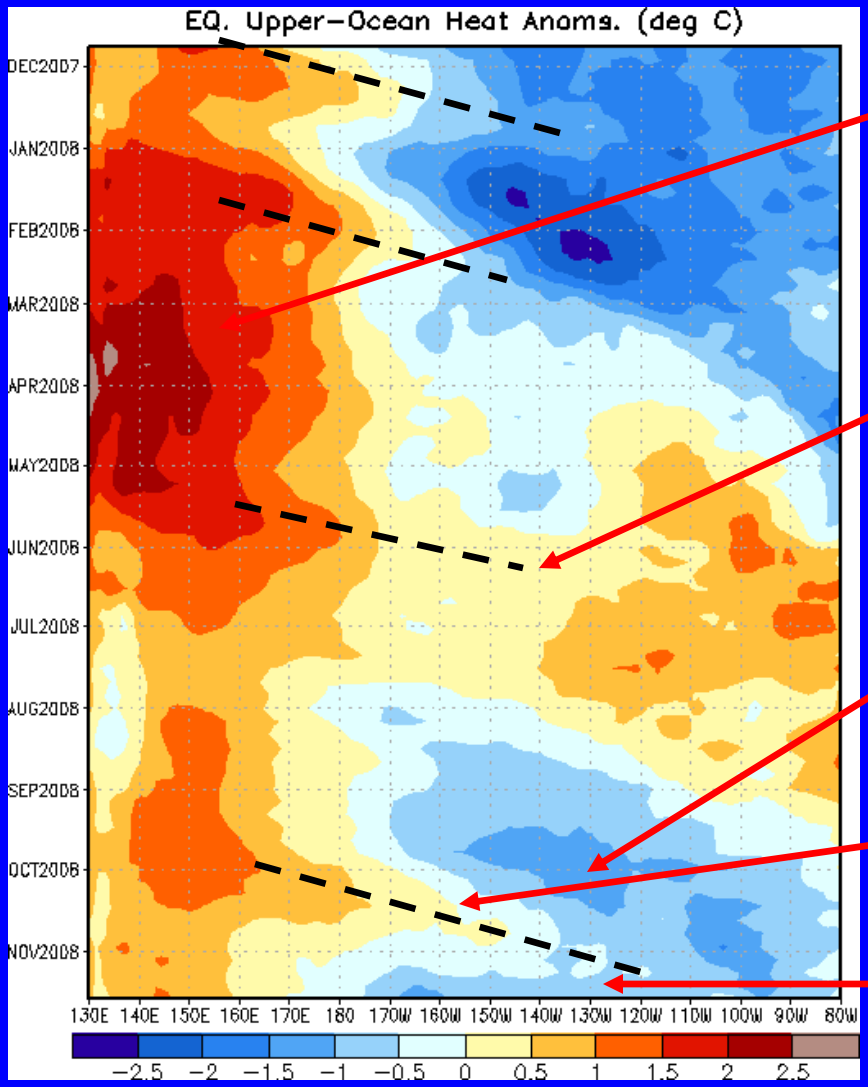
Easterly anomalies (blue shading) represent anomalous east-to-west flow

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 MJO activity shifted eastward during September and October.

More recently, westerly anomalies have strengthened over the central 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.

During November, negative anomalies reappeared east of the Date Line.

MJO Index -- Information

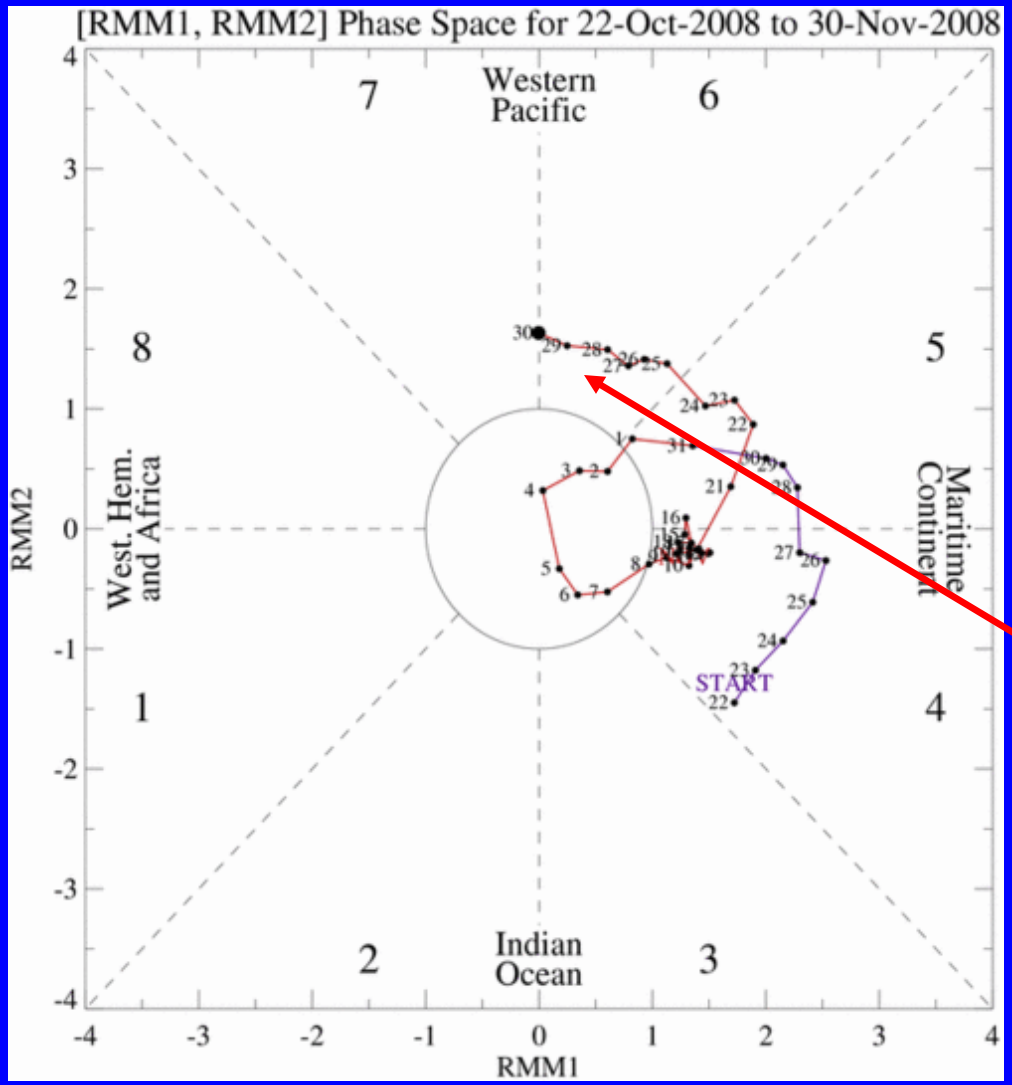
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

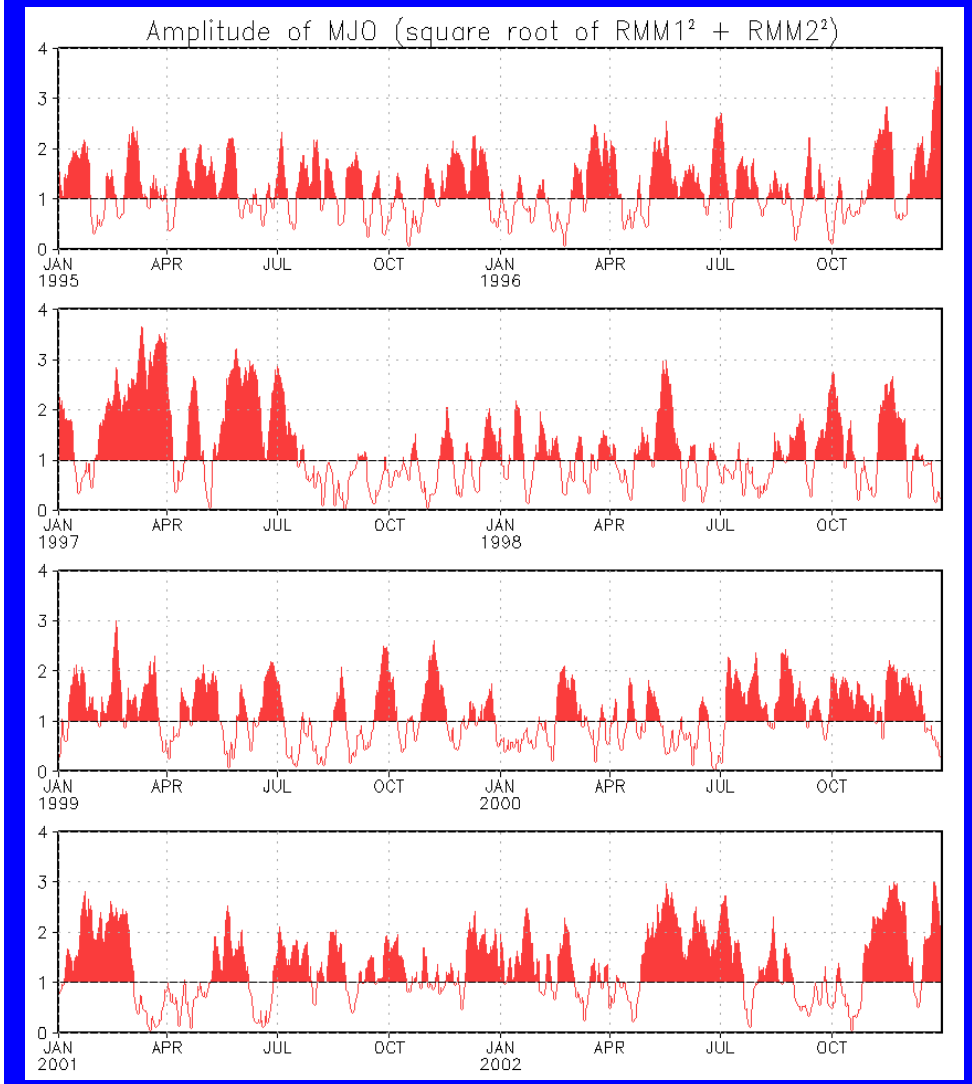
MJO Index -- Recent Evolution

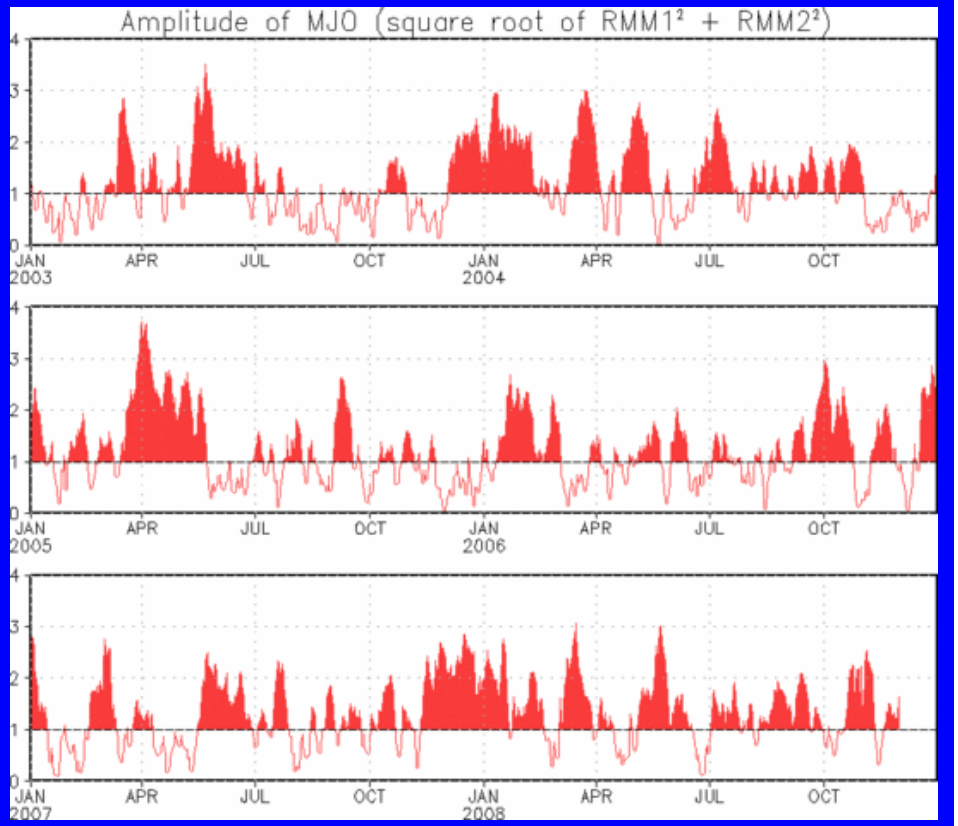


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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

The MJO signal has shifted eastward during the last 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

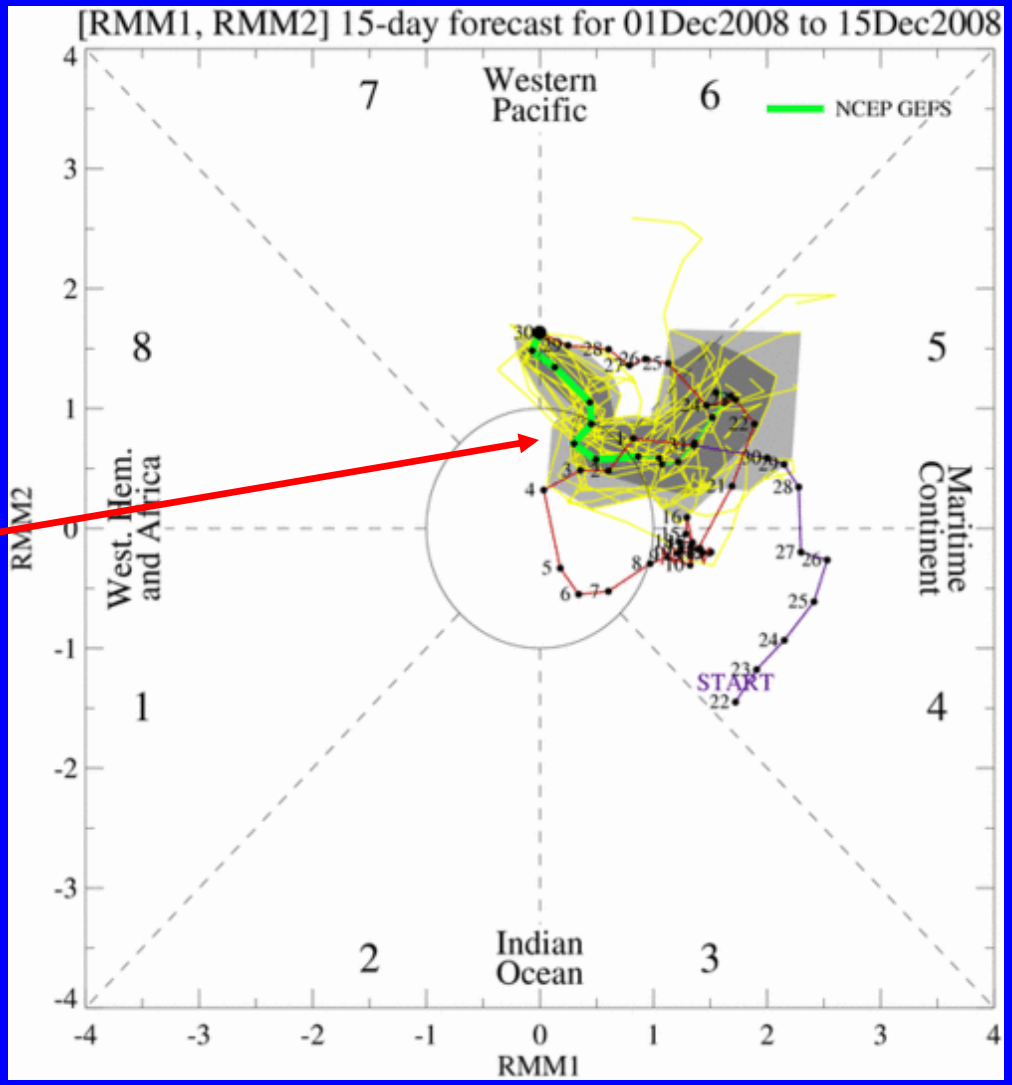
Ensemble GFS (GEFS) MJO Forecast

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

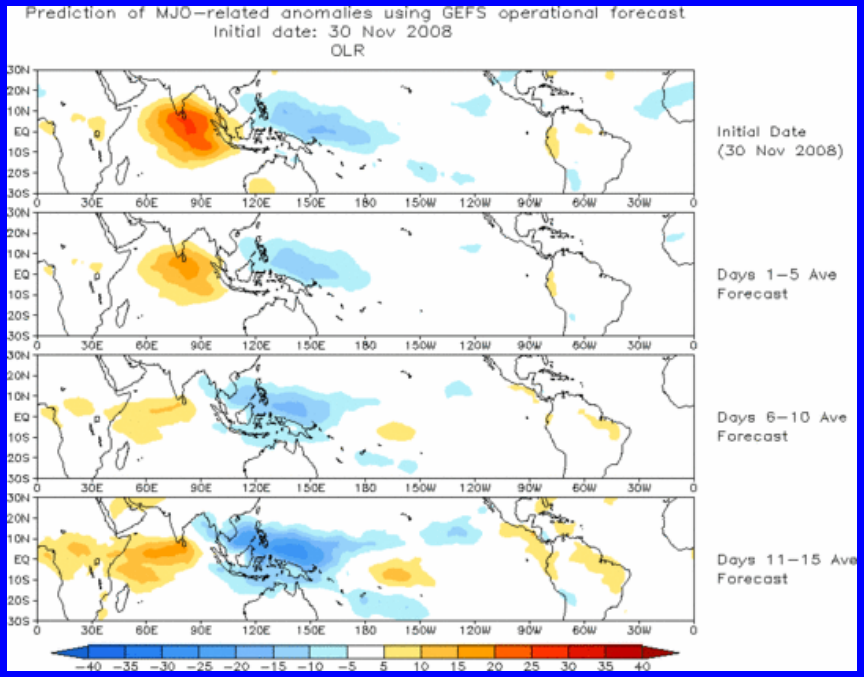
The GEFS forecasts predict the MJO index to shift westward and decrease in amplitude during the upcoming week.



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)

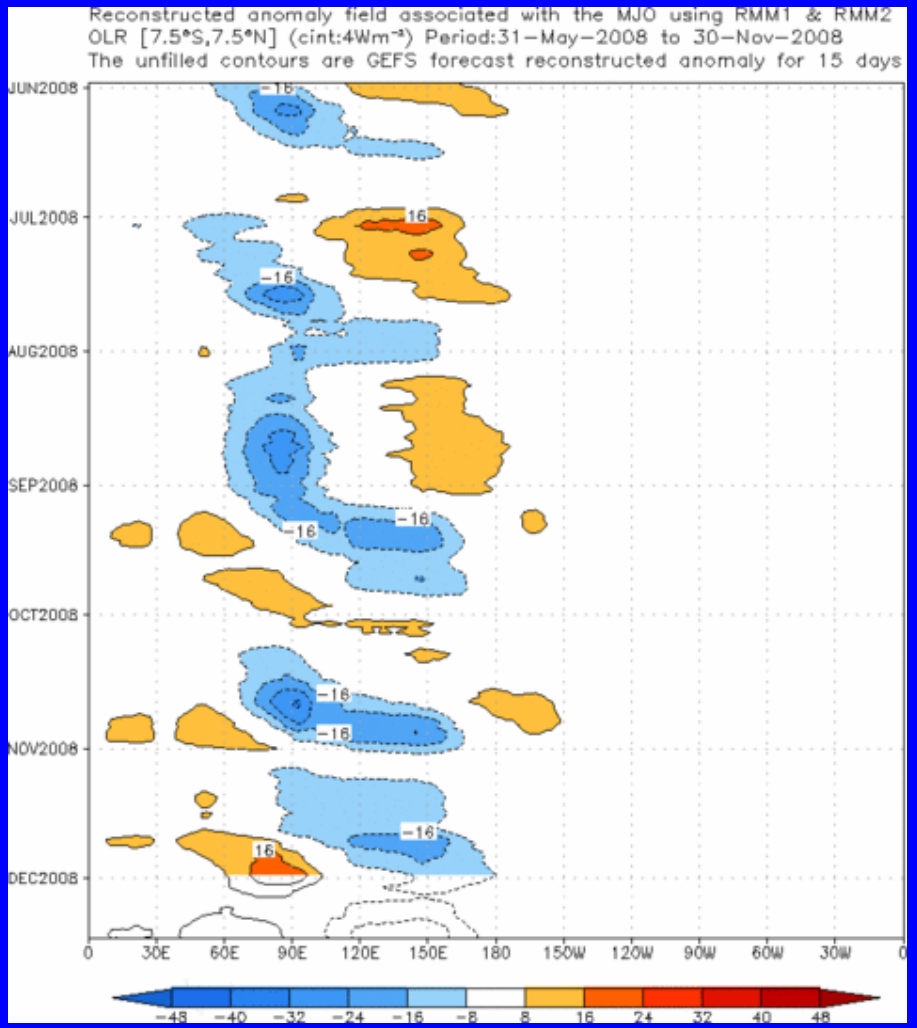
Spatial map of OLR anomalies for the next 15 days



MJO-related enhanced convection is forecast to impact much of the western Pacific Ocean and Maritime continent during the period.

Suppressed convection id forecast for portions of the Indian Ocean.

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

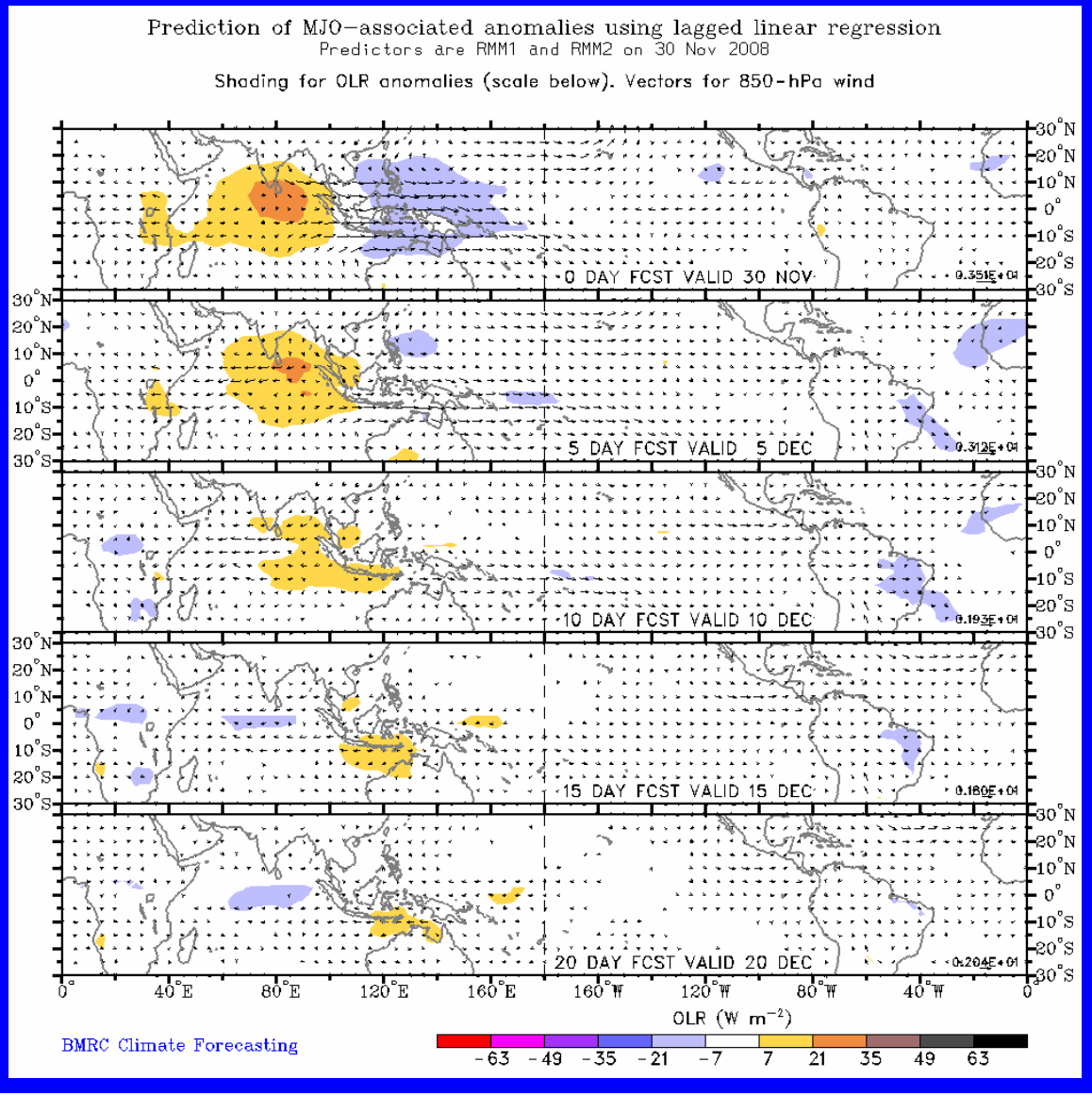
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

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

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

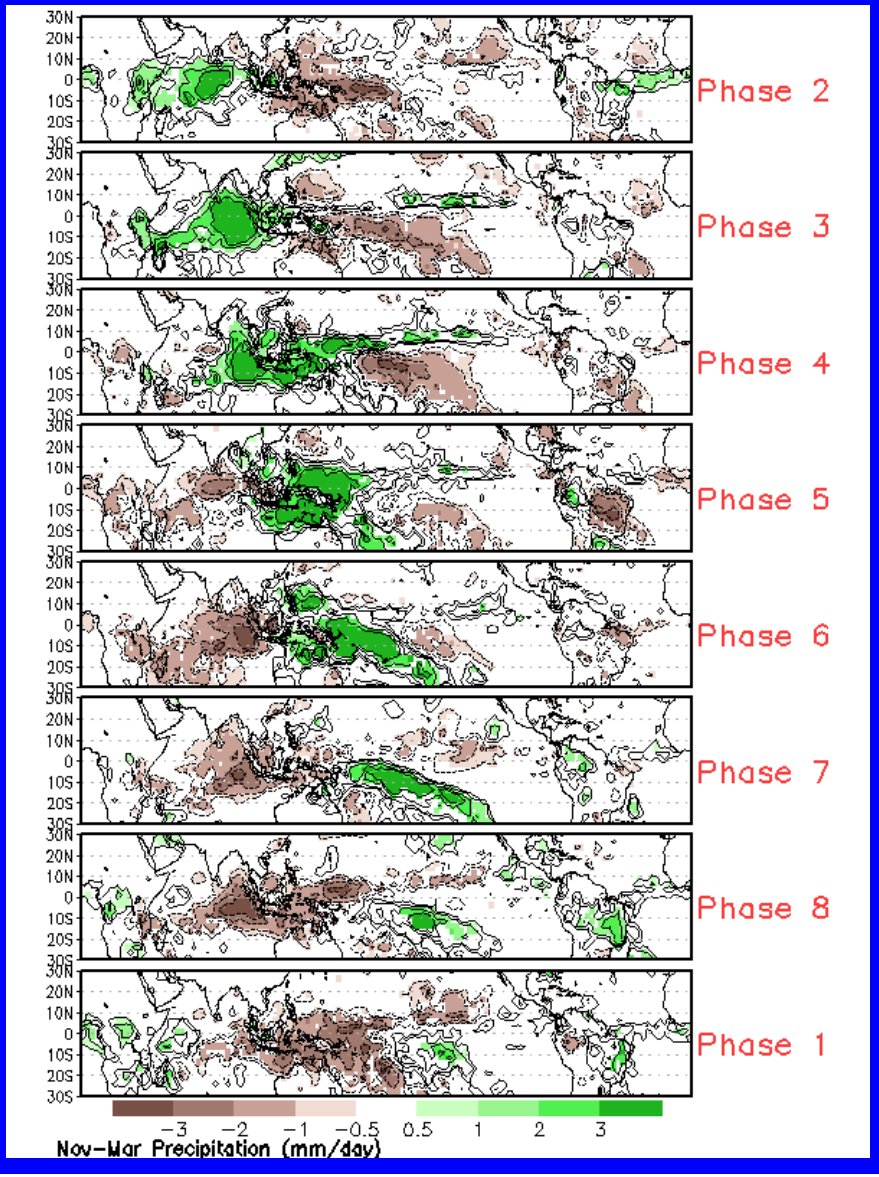
MJO activity is predicted to weaken over the next 2 weeks.

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



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)