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

Update prepared by
Climate Prediction Center / NCEP
December 14, 2009

Outline

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

Overview

- The MJO continued to weaken over the past week with El Nino conditions dominating the pattern of tropical rainfall.

- The MJO is expected to remain weak during the upcoming 1-2 week period. Although some dynamical MJO index forecast tools indicate an MJO signal emerging, this is likely due to a combination of factors other than a coherent MJO signal.

- The MJO is not expected to contribute substantially to anomalous tropical rainfall during the period.

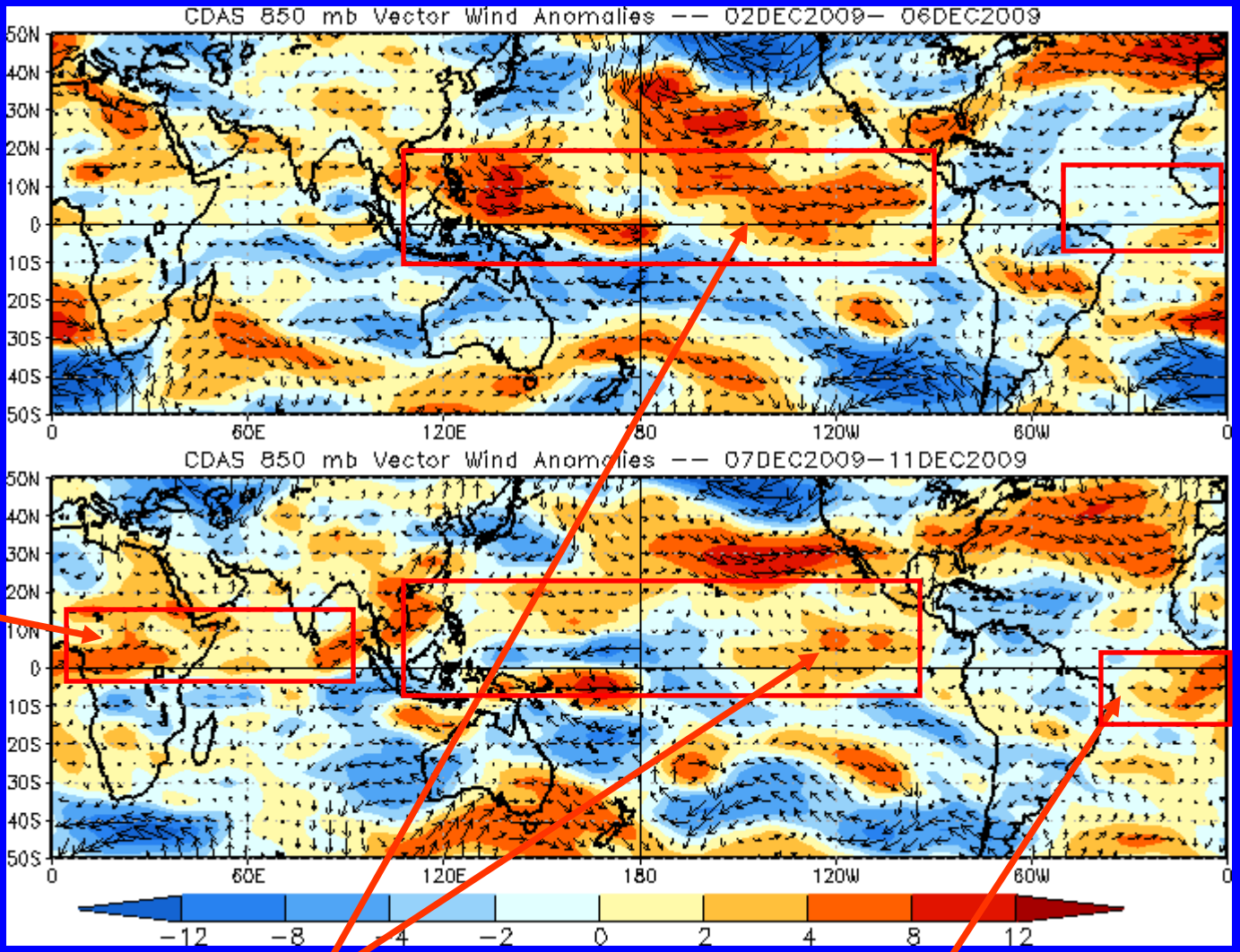
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly anomalies have increased across parts of central Africa and Indian Ocean.

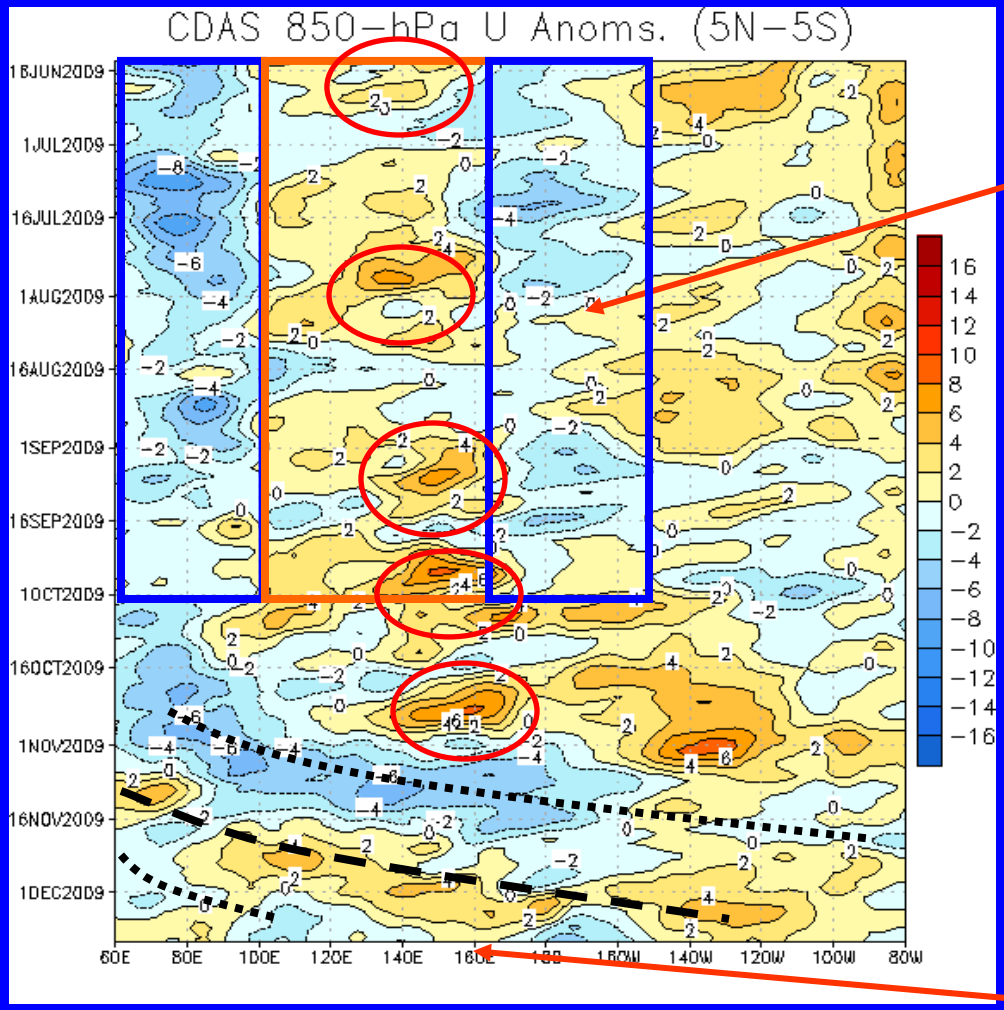
Westerly wind anomalies have weakened across the Pacific Basin with some easterly anomalies across the Central Pacific.

Westerly anomalies across the Gulf of Guinea have strengthened during the past 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

From June into September, easterly (westerly) anomalies prevailed across the Indian Ocean (Indonesia) (blue and orange boxes).

Several westerly wind bursts (red circles) occurred during this period. The westerly wind bursts became more frequent and stronger during September and October.

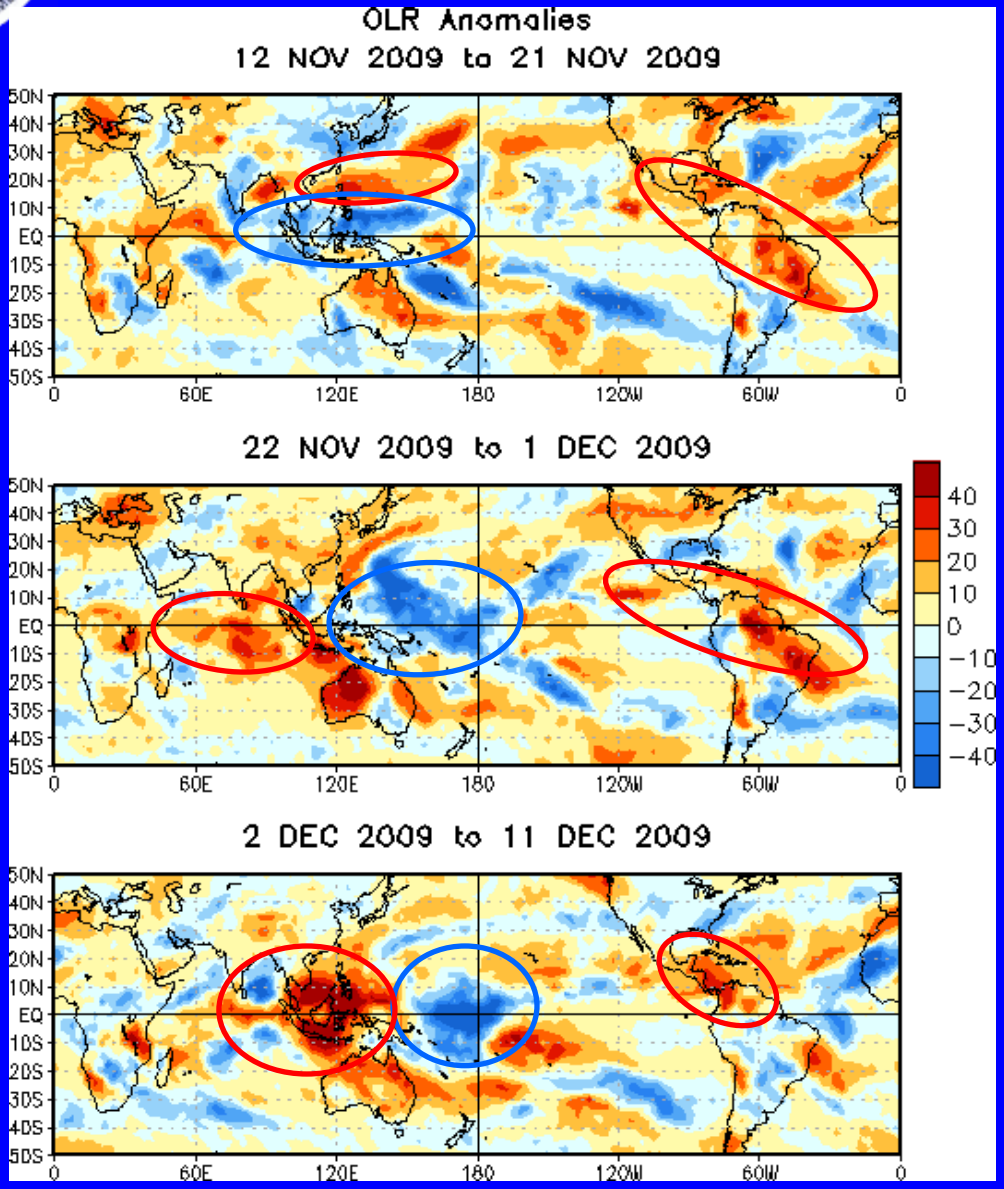
Easterly (dotted line) and westerly (dashed line) anomalies developed across the Indian Ocean and shifted eastward across the Date Line during late October and November.

Most recently, winds have become closer to average across parts of the Maritime continent and western 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)

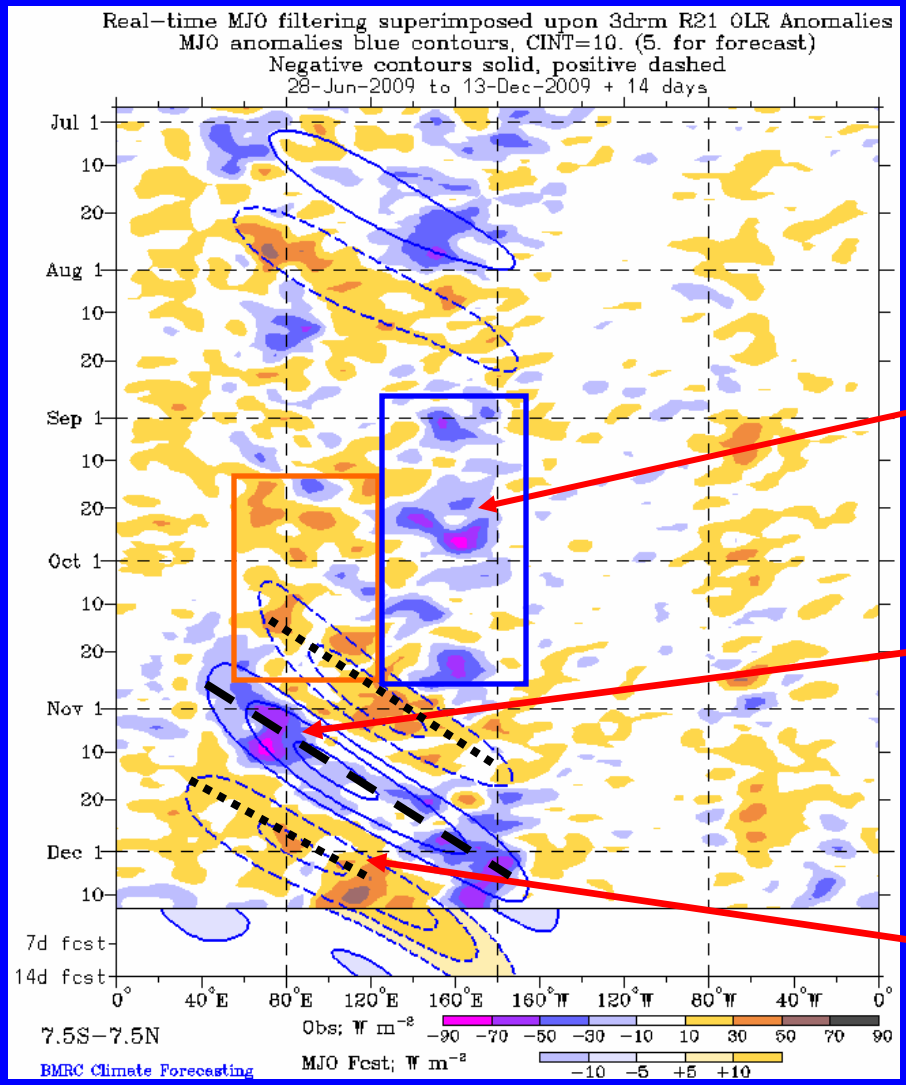


During mid November, suppressed convection (red ovals) was evident over parts of southeastern Asia and the Americas while enhanced convection developed across the Maritime Continent and portions of the Western Pacific.

During late November to early December, suppressed convection developed across the Indian Ocean and continued across northern South America. Enhanced convection associated with the MJO was noted across the western and central Pacific.

During early December, enhanced convection intensified over the central Pacific while suppressed convection prevailed across the Indian Ocean, the Maritime Continent and Central America.

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 (BOM) - Australia)

During most of September and October, generally enhanced (suppressed) convection has been evident across the western Pacific (eastern Indian Ocean) (blue and orange boxes).

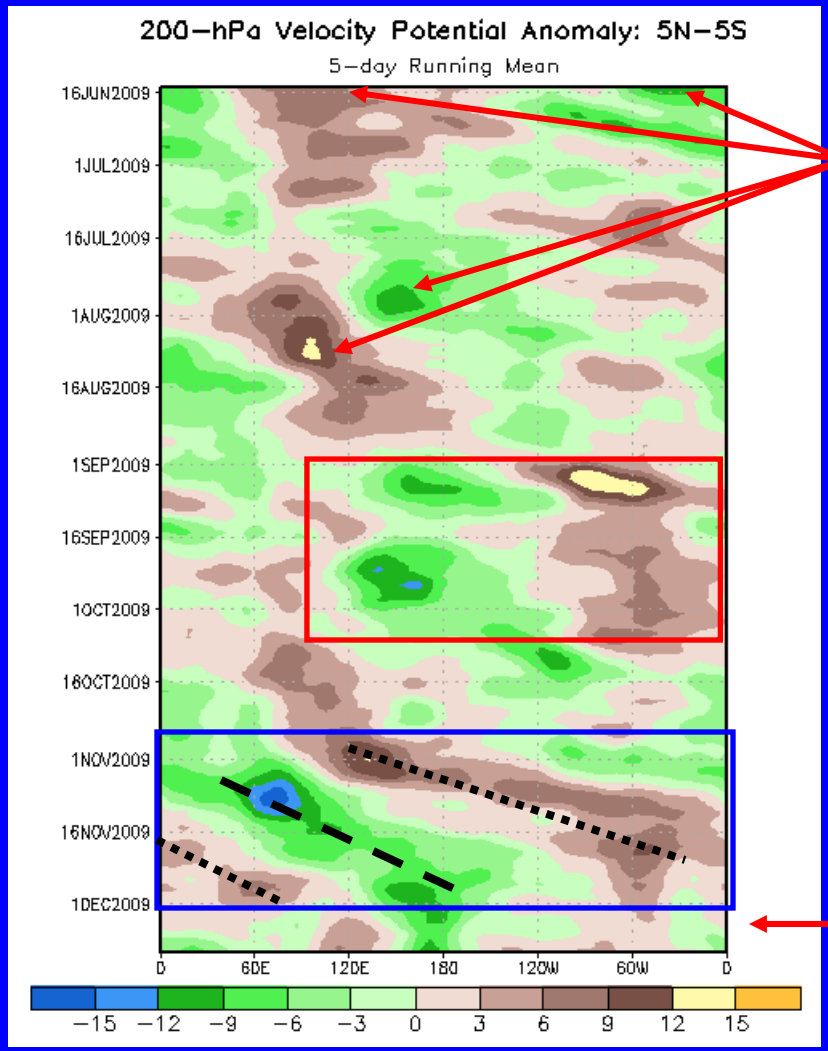
Beginning in late October, enhanced convection developed across Africa, shifted eastward across the Maritime Continent, and spread into the Pacific.

Suppressed convection once again has developed across the Indian Ocean and spread eastward during November and early December.

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

Velocity potential anomalies increased in mid June, late July, and early August due to several types of subseasonal variability with some eastward propagation evident.

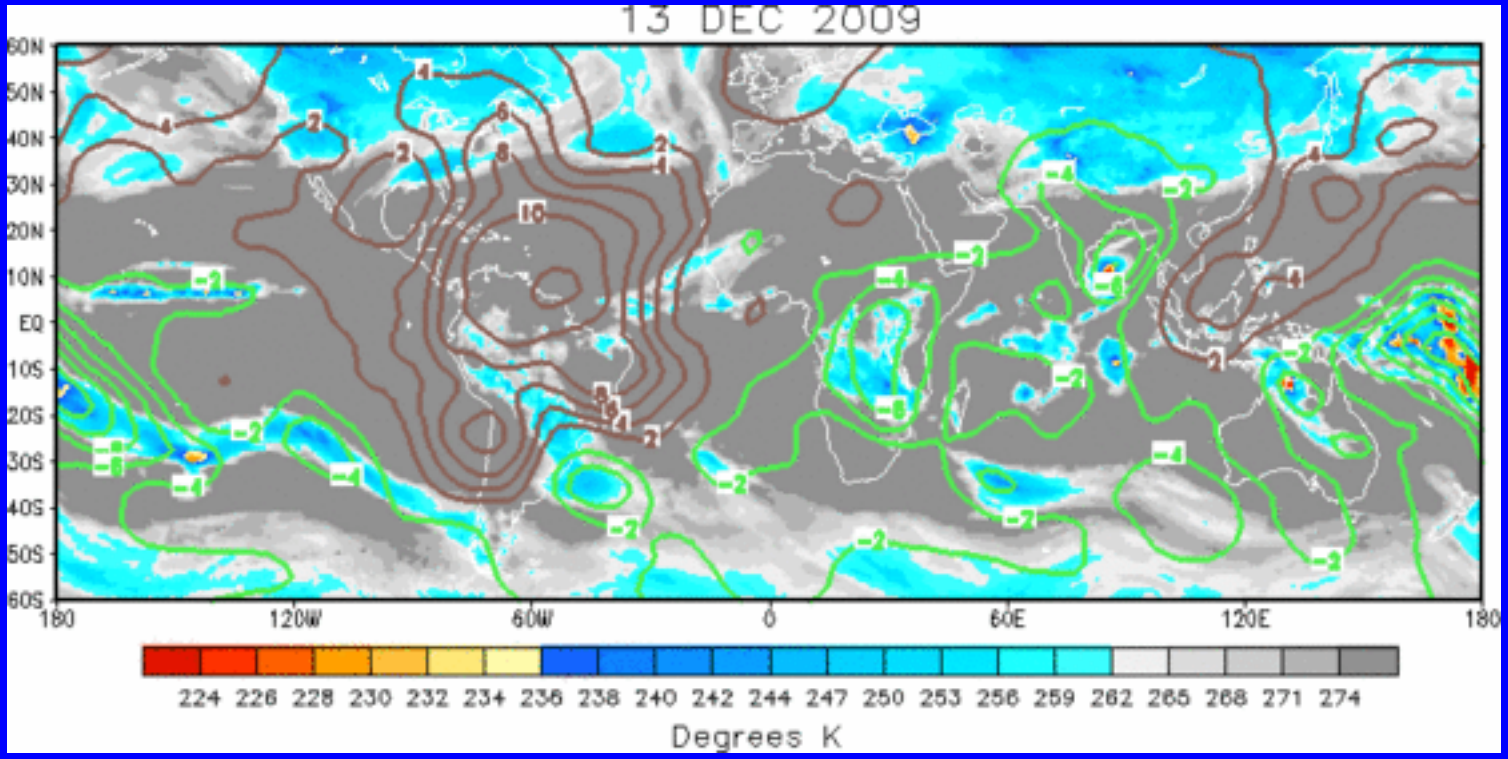
Anomaly intensity varied during September but the overall pattern remained generally persistent with upper-level divergence (convergence) across the western Pacific (parts of Western Hemisphere) (red box).

In late October and November, anomalies increased and eastward propagation has been evident associated with MJO activity (blue box). Most recently, the pattern has become somewhat stationary with enhanced upper-level divergence over the central Pacific and subsidence extending east to the Americas.

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

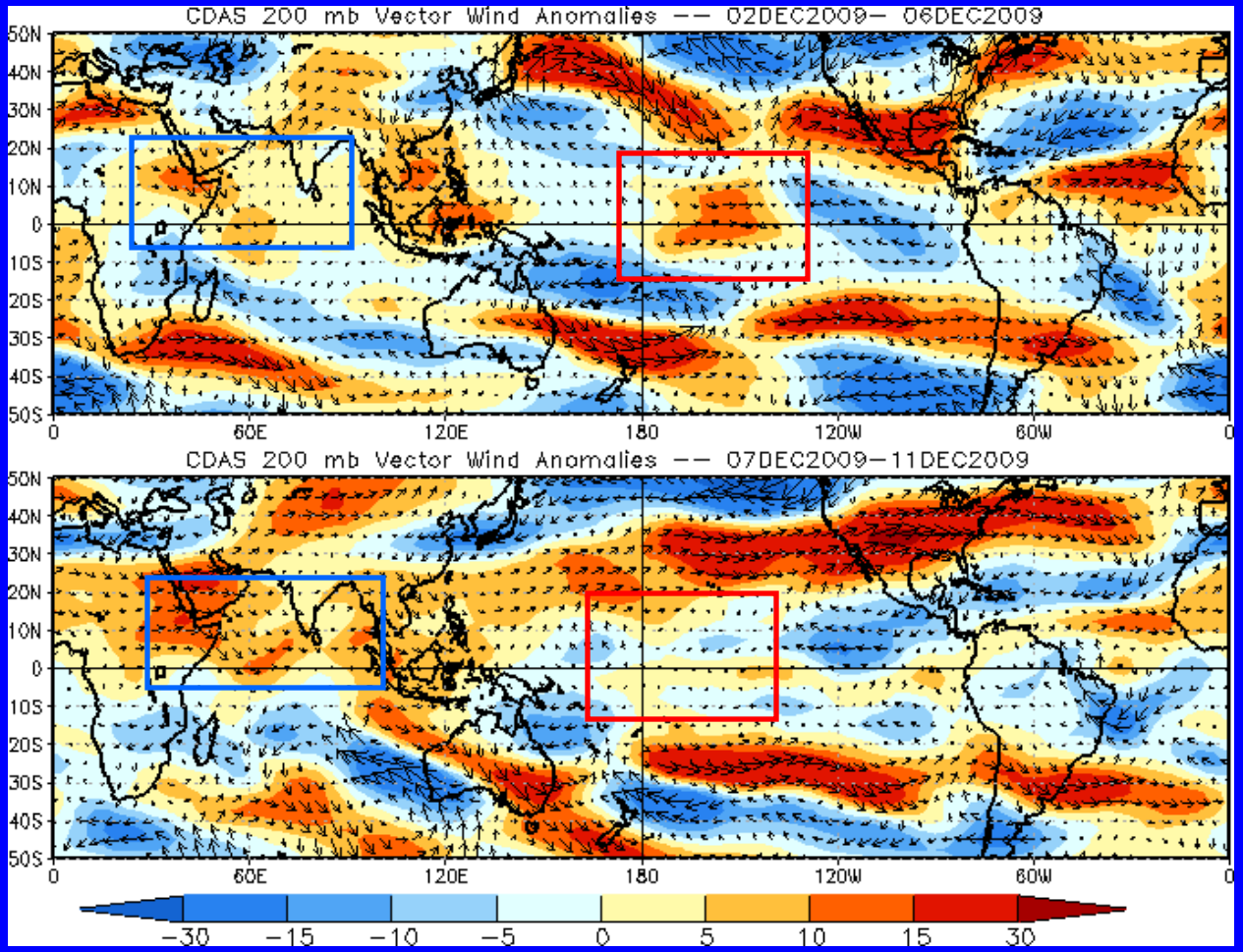
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The pattern of velocity potential anomalies is inconsistent with coherent MJO activity. Persistent upper-level divergence is located mainly across the Pacific Ocean region.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

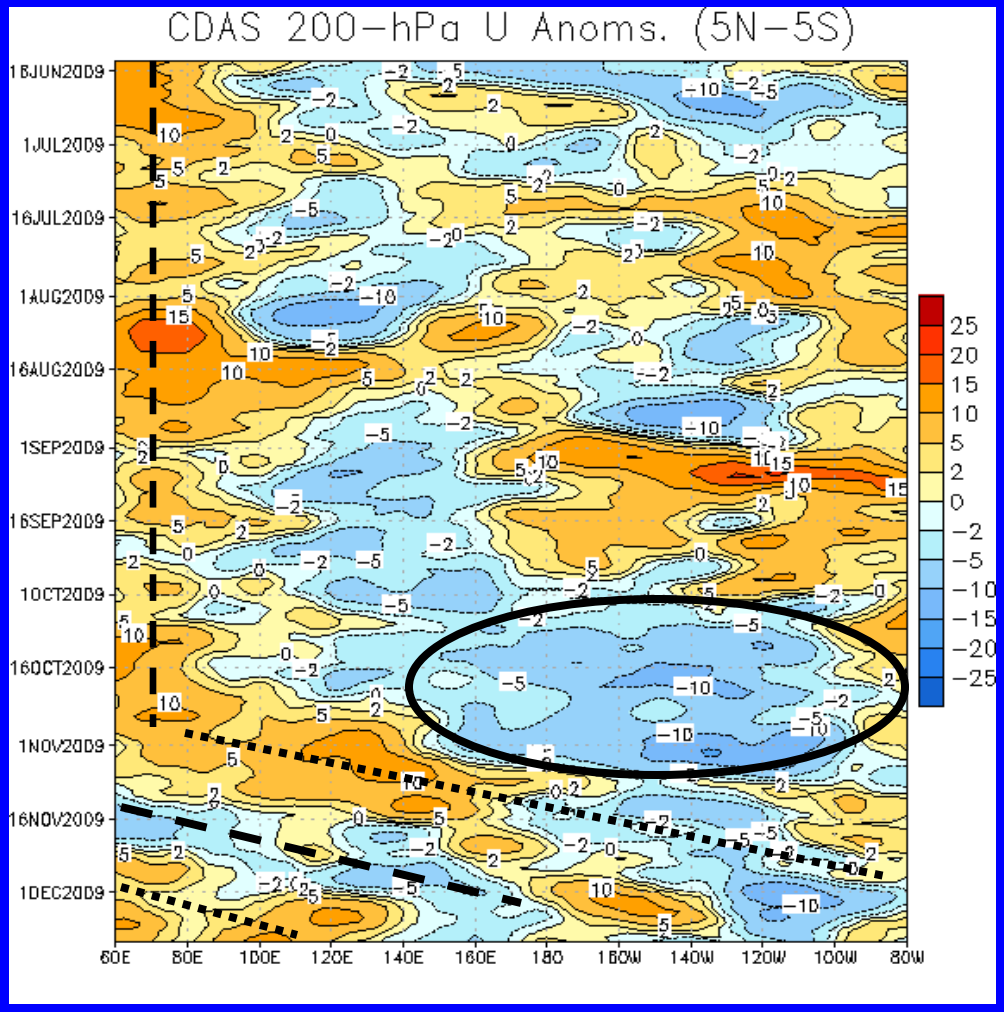
Westerly anomalies (red boxes) across the central Pacific have waned while westerly anomalies across the Indian Ocean and northern Africa increased (blue boxes).

Symmetry between the northern and southern hemisphere has increased.

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

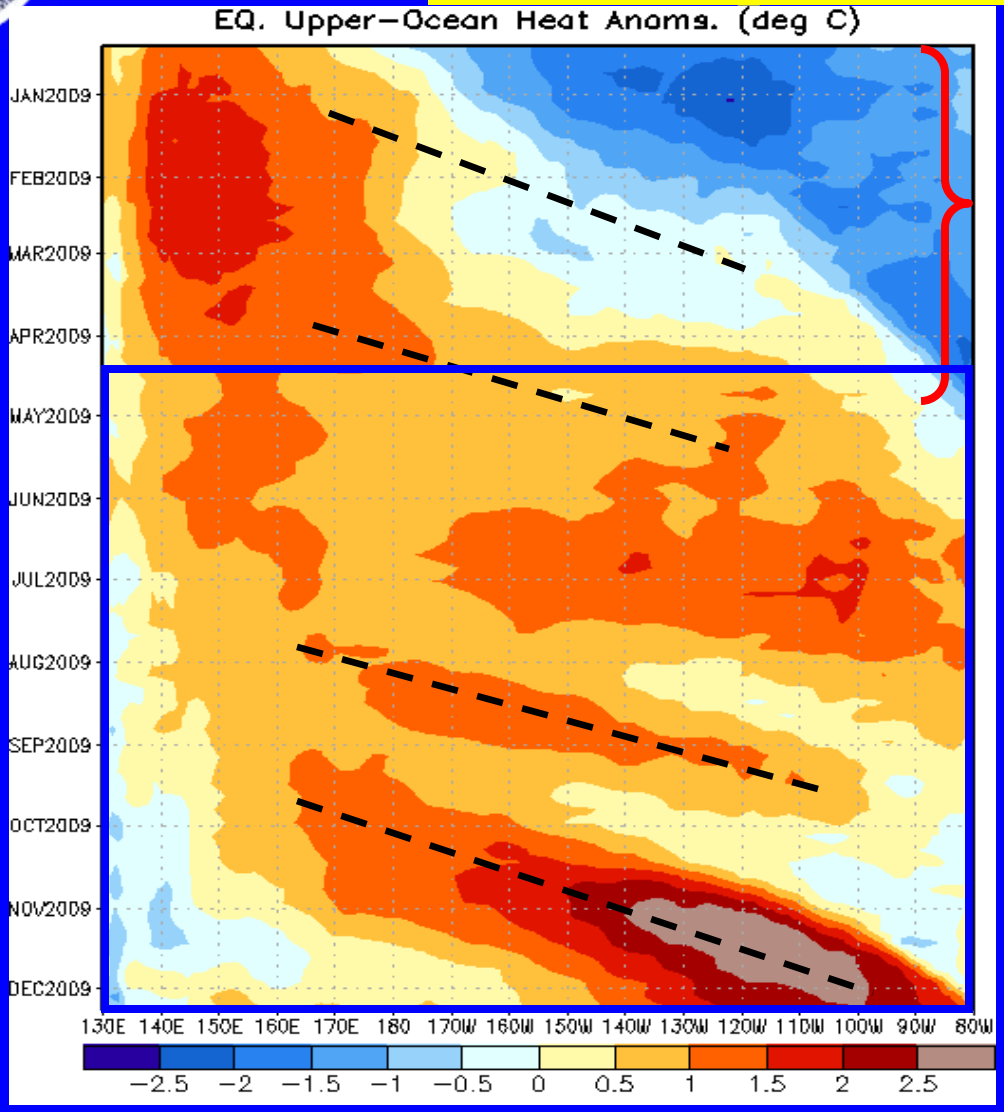
Longitude

Westerly anomalies across the Indian Ocean had persisted for much of the period since June 2009 (vertical dashed black line).

In early October, easterly anomalies rapidly replaced westerly anomalies across much of the Pacific (black solid oval).

Westerly (easterly) anomalies (dotted and dashed lines) shifted eastward across the Maritime Continent during late October and November and have recently reappeared in the Indian Ocean.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

During December 2008 – January 2009, negative heat content anomalies returned and then strengthened in the central and eastern equatorial Pacific as La Niña conditions redeveloped.

The negative anomalies weakened during January-March 2009, with anomalies becoming positive since late March.

In April 2009, the combined effects of an oceanic Kelvin wave and weaker easterly trade winds contributed to an increase in the upper-ocean heat content anomalies across the Pacific Ocean.

Since April 2009, heat content anomalies have remained above-average (blue box).

The downwelling phases of two Kelvin waves shifted eastward during August-September and late September-early November (last two dashed black lines).

MJO Index -- Information

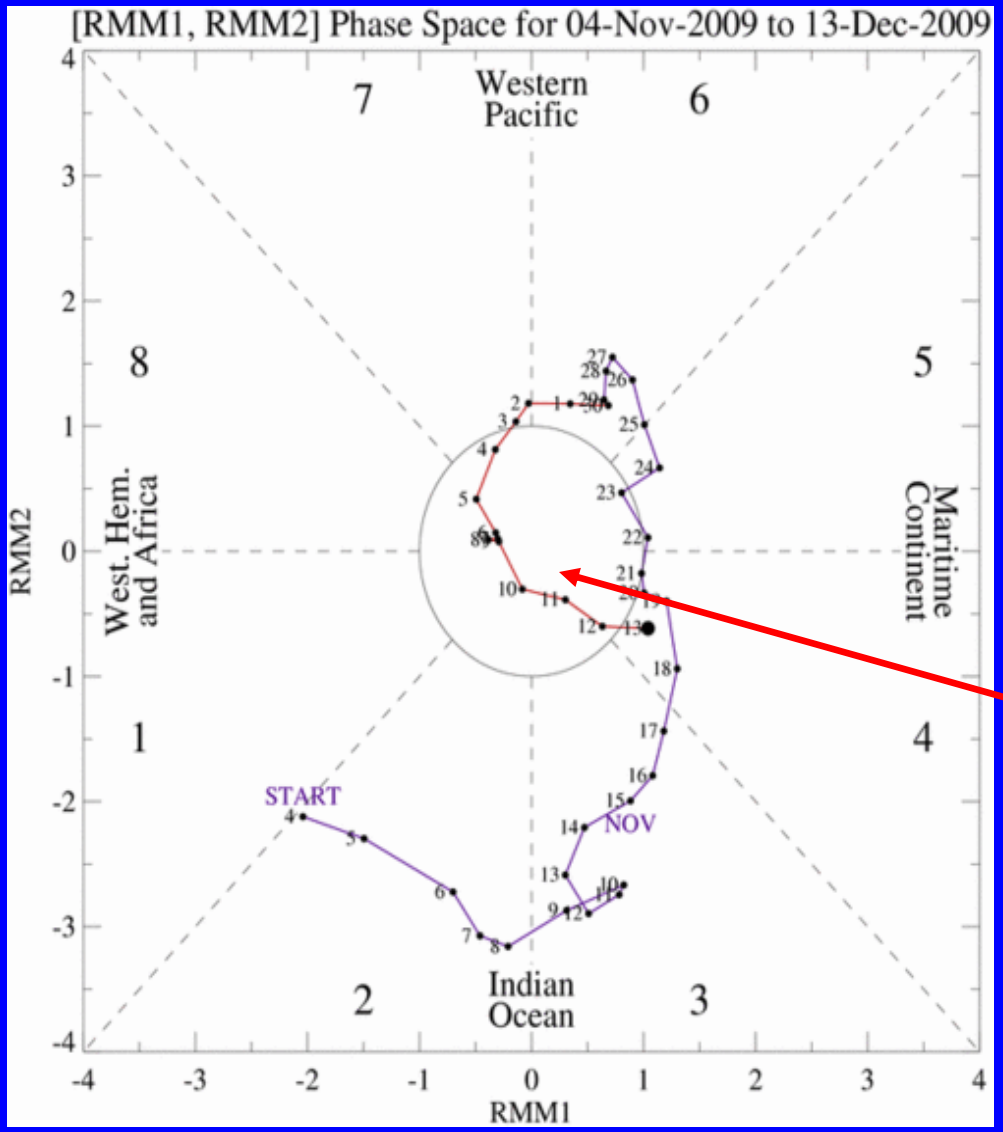
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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 or when the ENSO signal is large.**

- **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

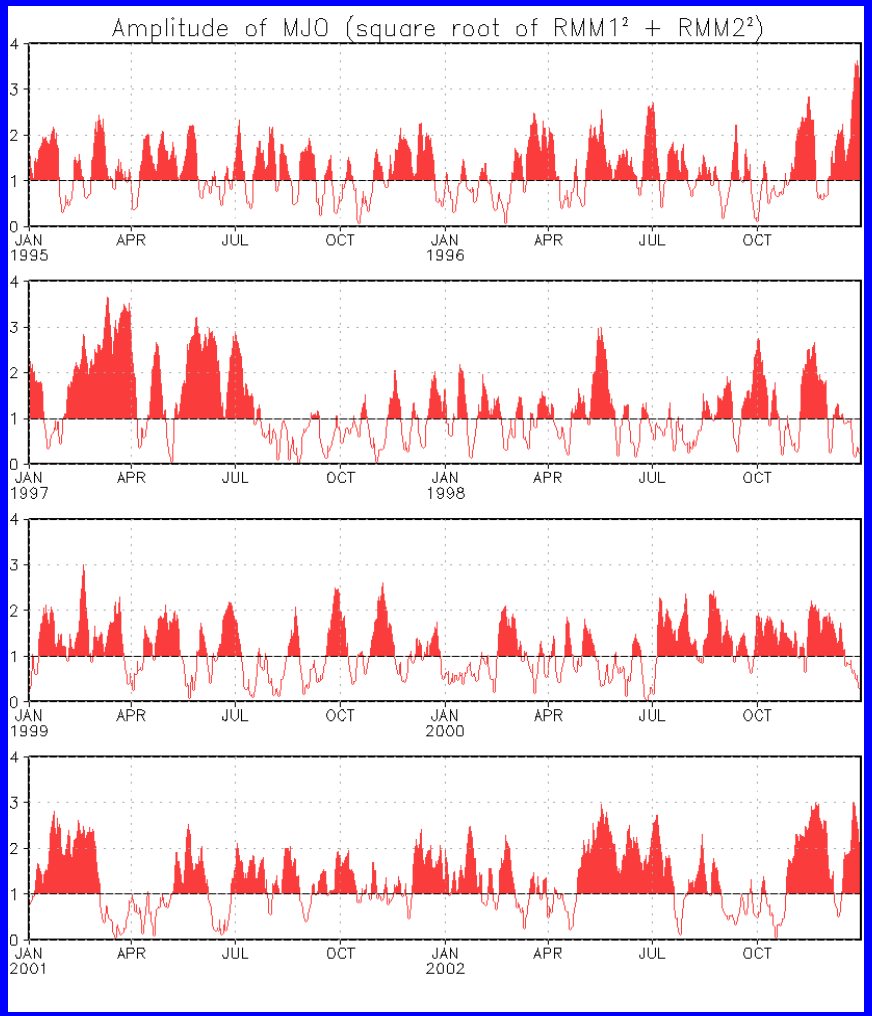


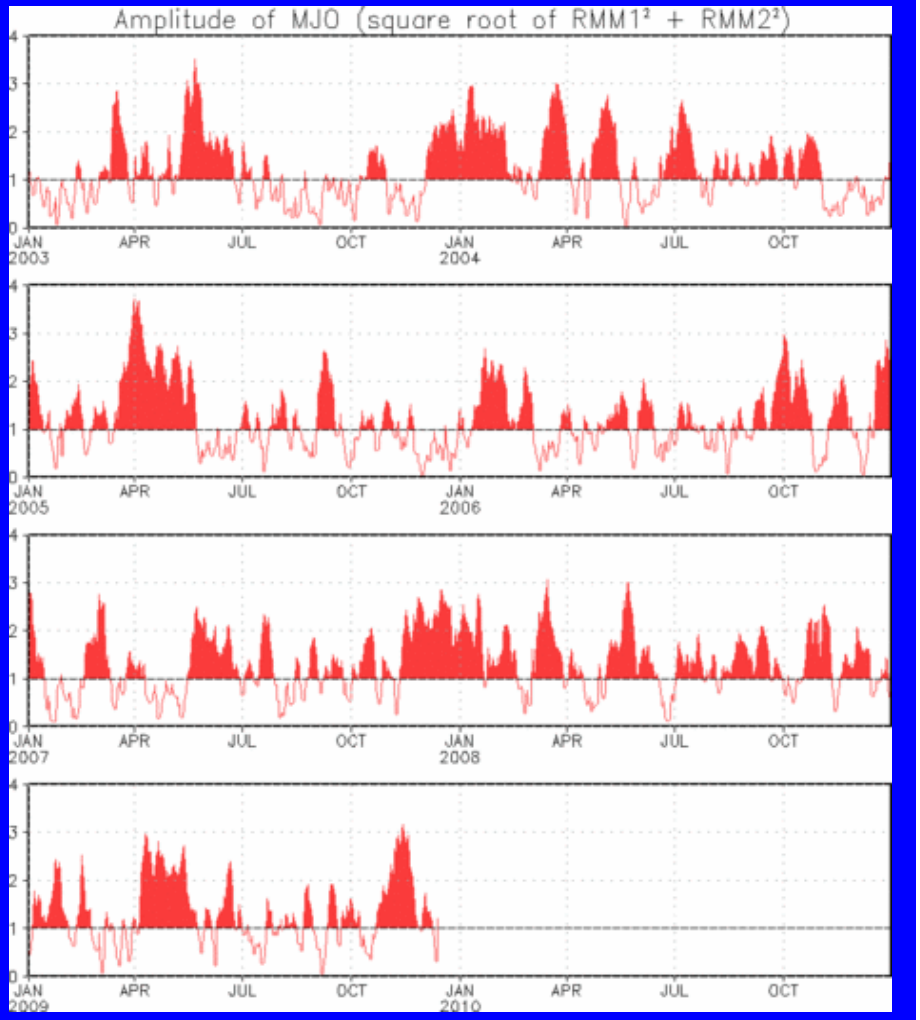
- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

The MJO index indicates a mainly weak signal over the past week.

The increase in amplitude most recently is likely arising from competing influences from wind and convection, which appear to be out of phase.

MJO Index – Historical Daily Time Series





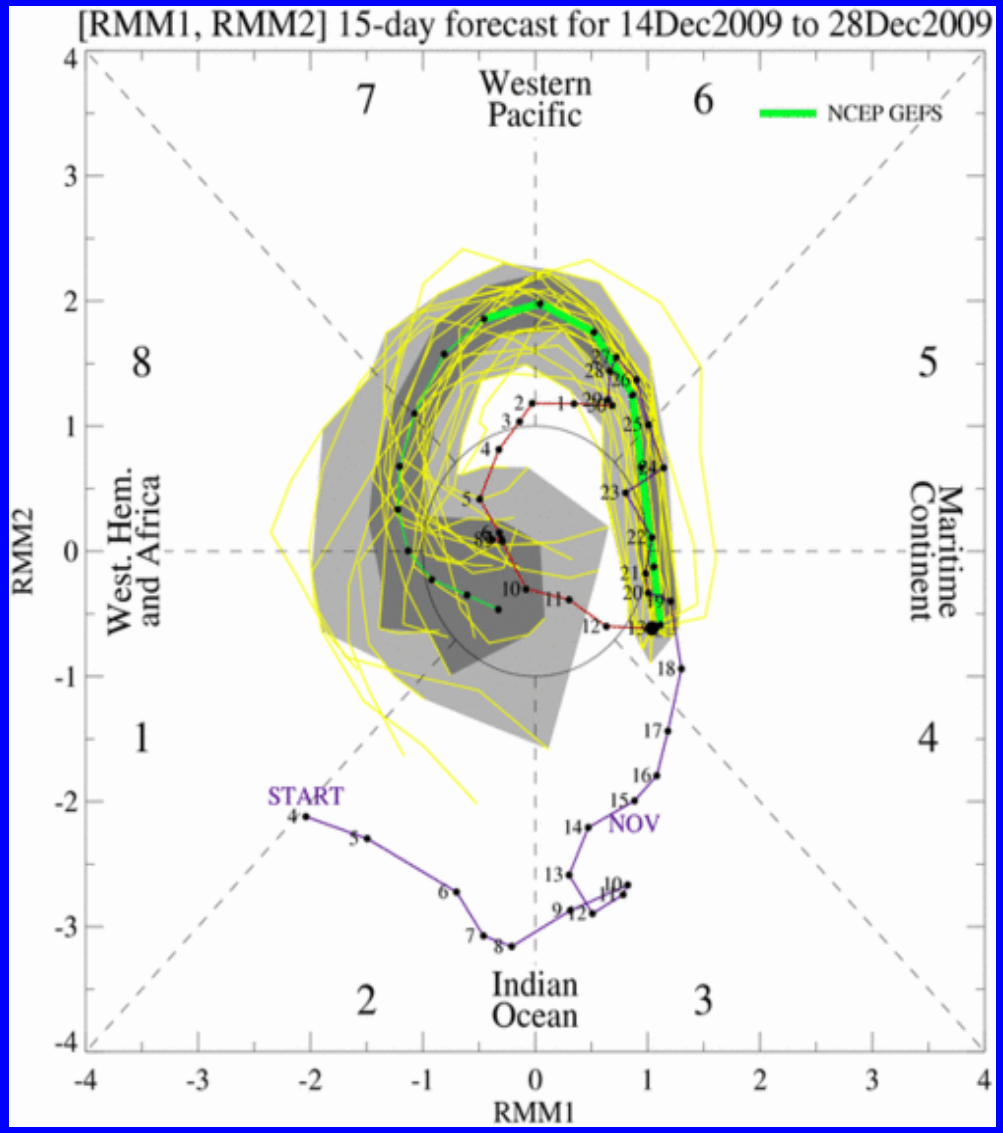
Time series of daily MJO index amplitude from 1995 to present. Plots put current MJO activity in historical context.

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



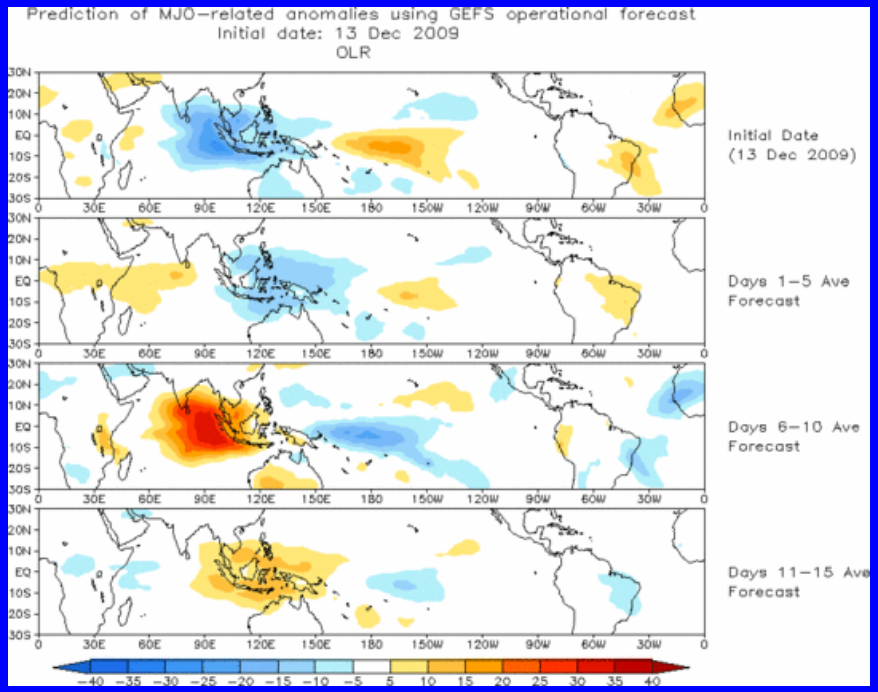
The GFS MJO index forecasts indicate a eastward propagating and strengthening MJO signal during the period.

The speed of propagation and location of the increase in amplitude (western/central Pacific) makes a combination of El Niño background conditions and other forms of subseasonal variability the likely cause for this forecast as opposed to a coherent, propagating MJO.

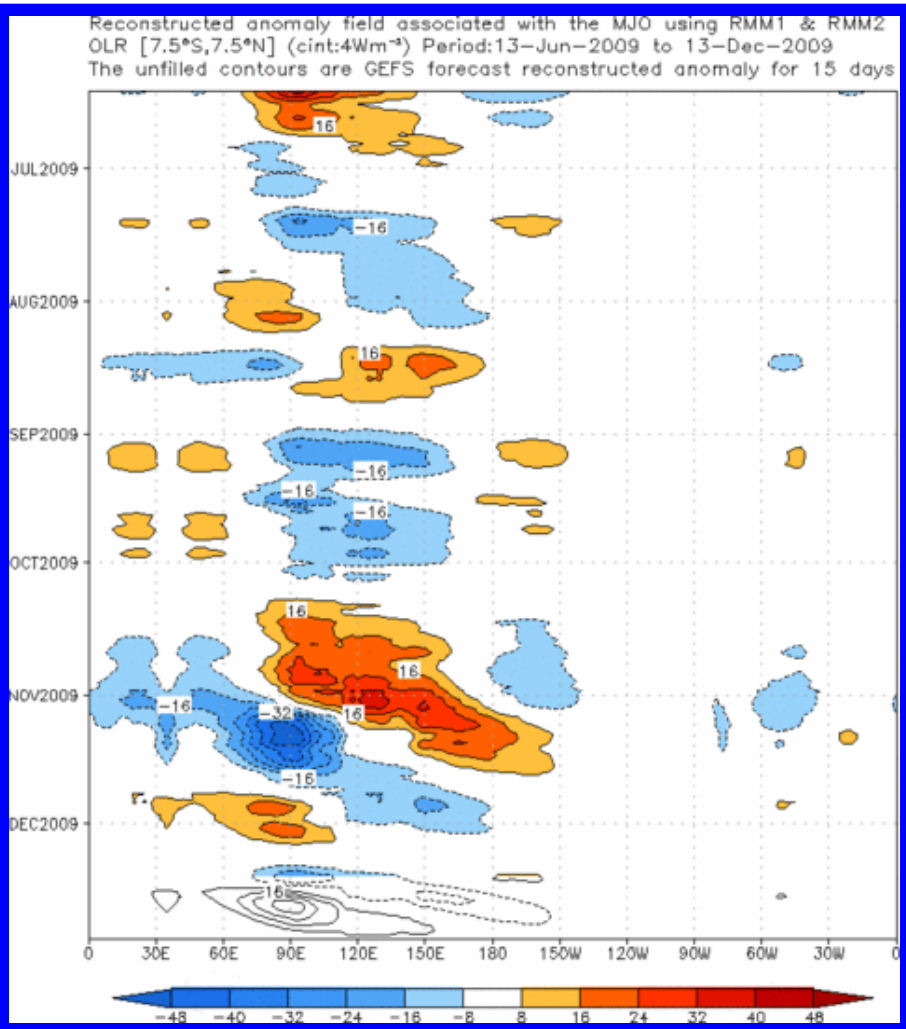
Ensemble Mean GFS MJO Forecast

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



The GEFS ensemble mean forecasts show some signal during Week-1, which would compete with the current El Niño conditions. Enhanced (suppressed) convection in the western Pacific (Indian Ocean) develops again during Week-2 and moves eastward.

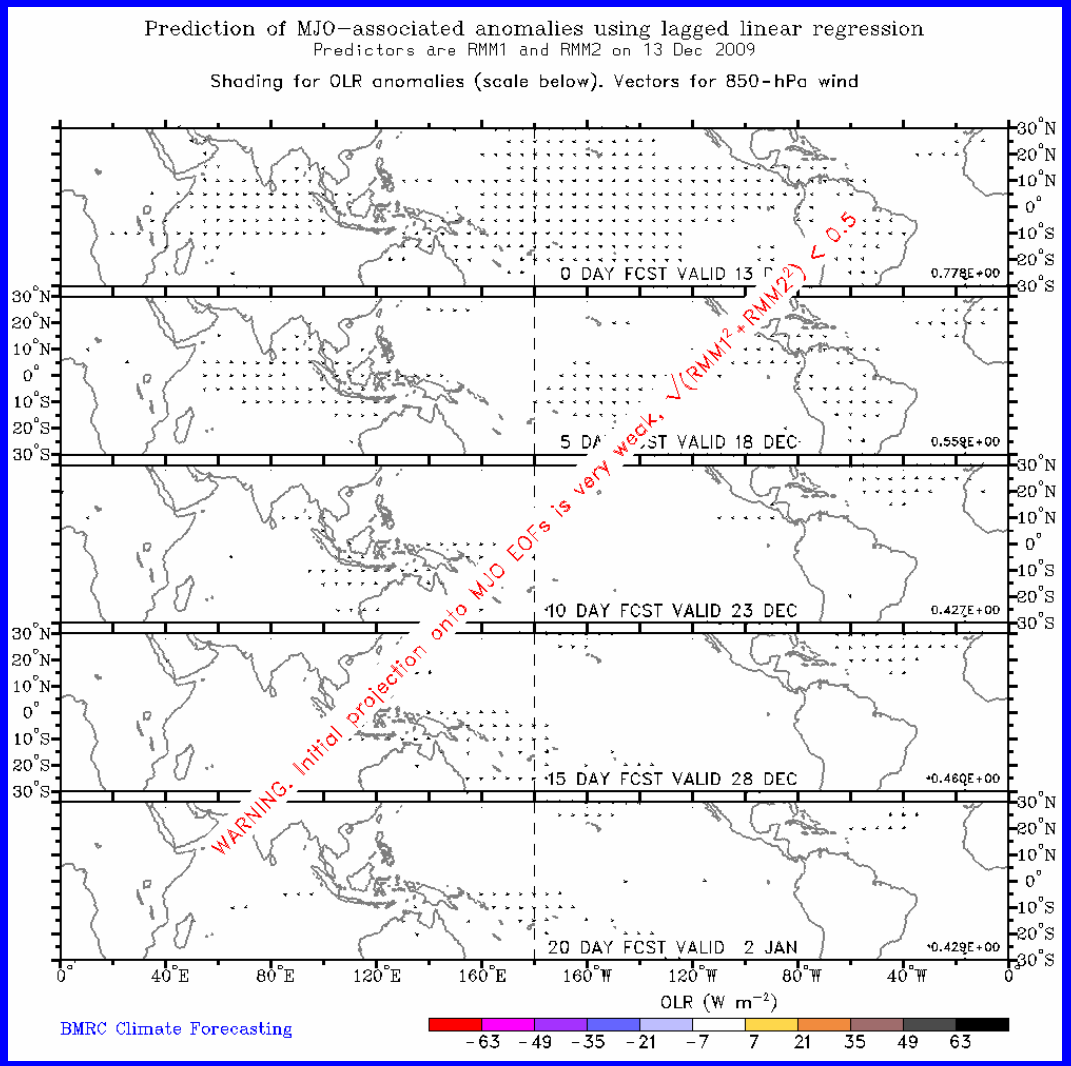
Statistical MJO Forecast

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 vectors for the next 20 days

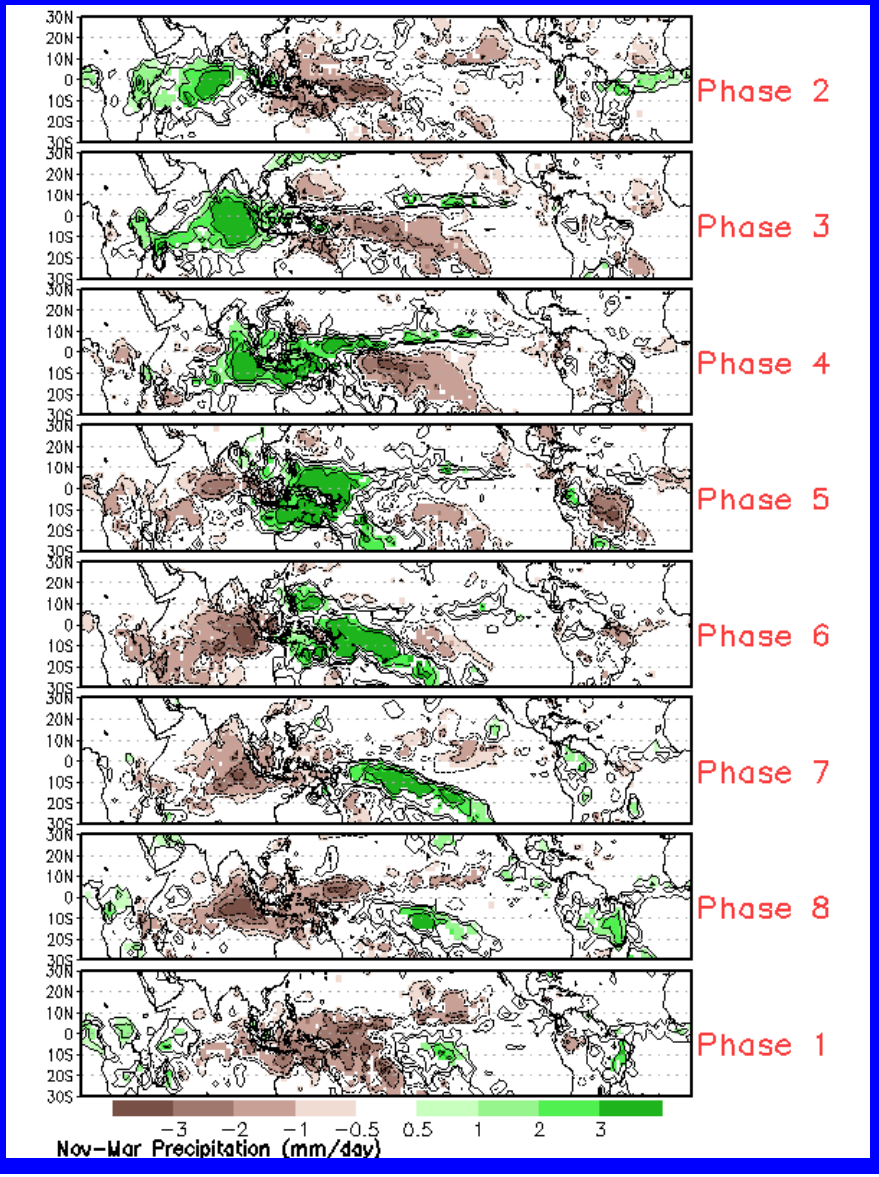
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

With the currently weak signal, the statistical forecasts do not indicate the development of any significant anomalies associated with the MJO.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)