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

Update prepared by
Climate Prediction Center / NCEP
November 30, 2009

Outline

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

Overview

- The MJO signal continued to shift eastward during the past week with the enhanced convective phase centered over the western Pacific Ocean.

- MJO forecast tools are somewhat contradictory. Some dynamical model forecasts indicate a weakening MJO signal while statistical tools show a more coherent MJO signal during the next 1-2 weeks.

- The MJO is expected to contribute to enhanced (suppressed) rainfall across the western Pacific (Indian Ocean/Maritime continent) throughout the period.

- There are enhanced chances for above-average precipitation for primarily the central US West coast during the Week-2 period associated with both the current MJO activity and El Nino.

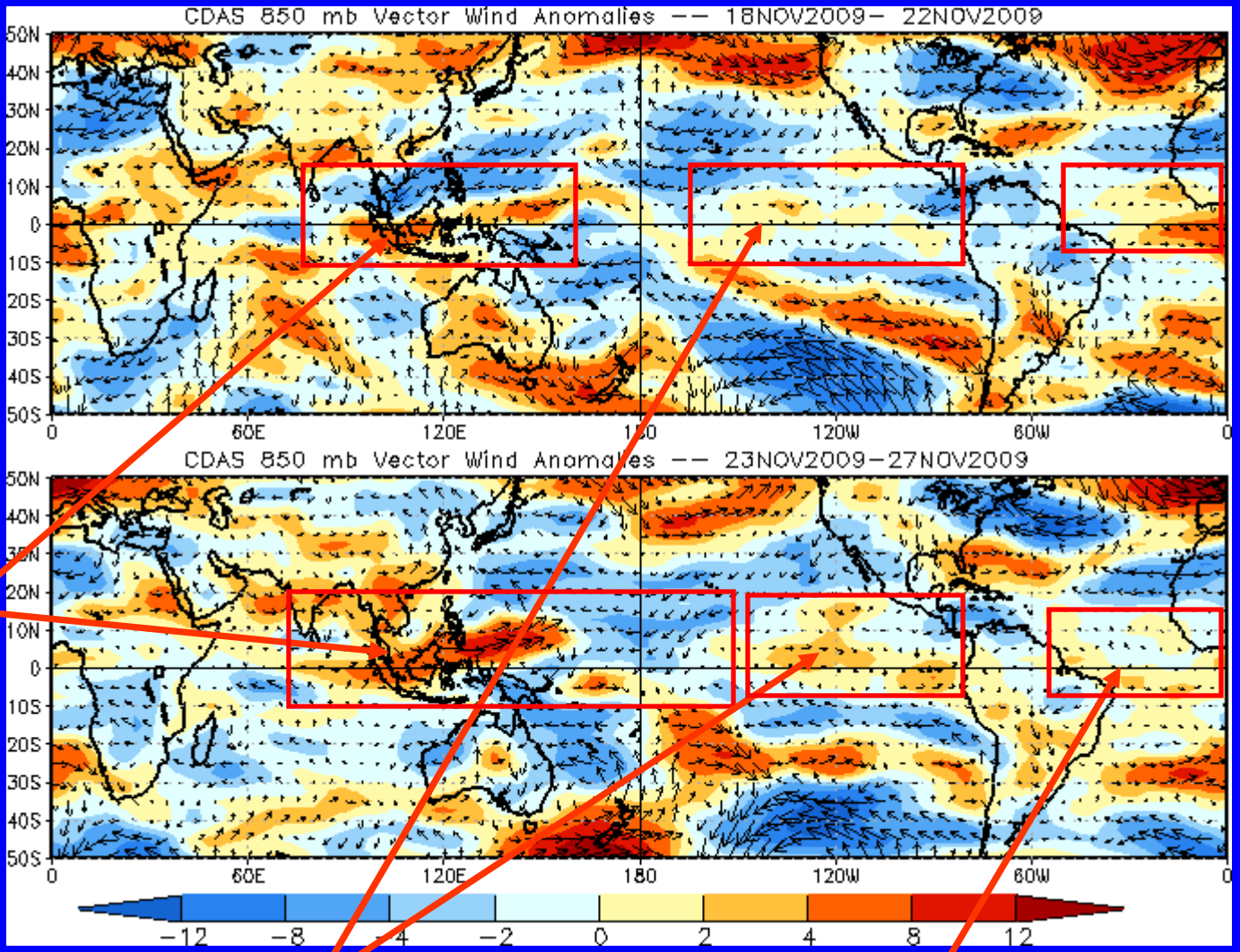
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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 and expanded across the Maritime continent and into the western Pacific during the last five days.

Easterly anomalies have increased across the central Pacific

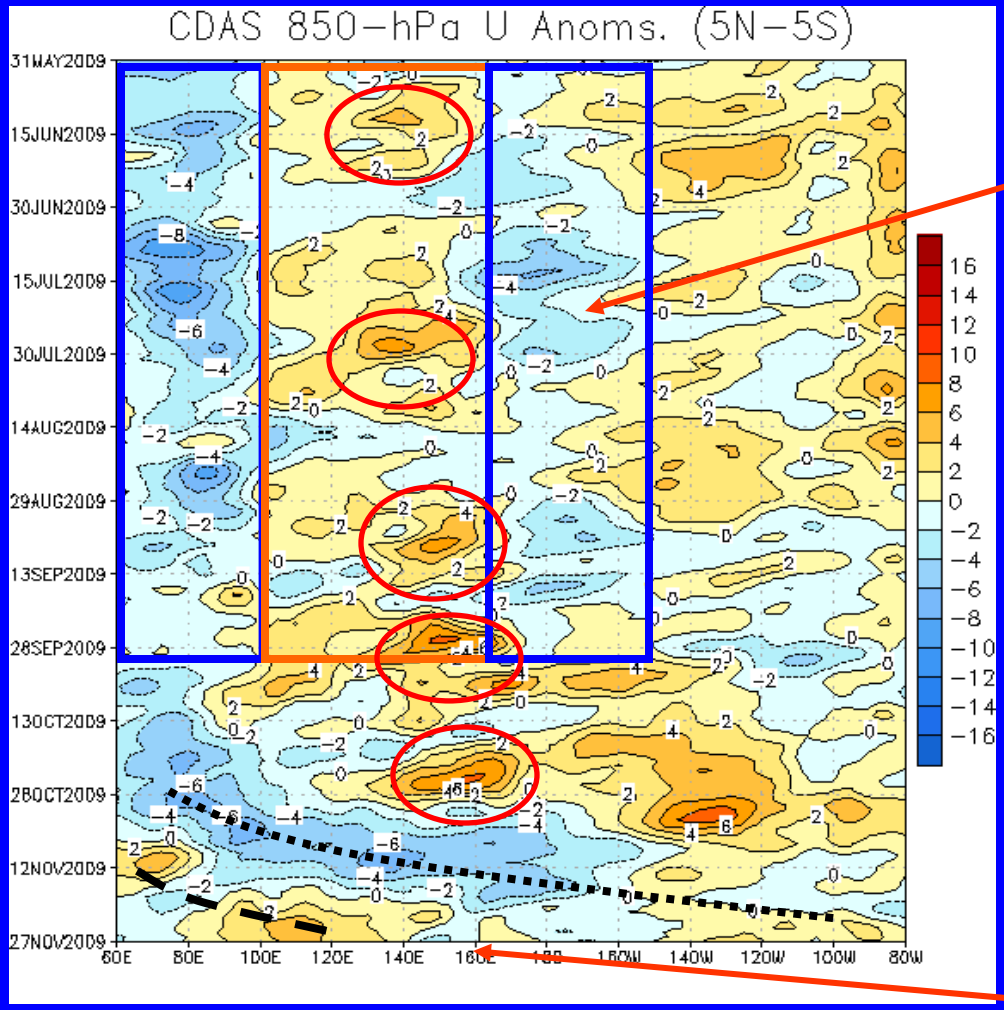
Westerly anomalies have increased over the eastern Pacific during the last five days.

Westerly anomalies have decreased across the Atlantic Ocean and Africa 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

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.

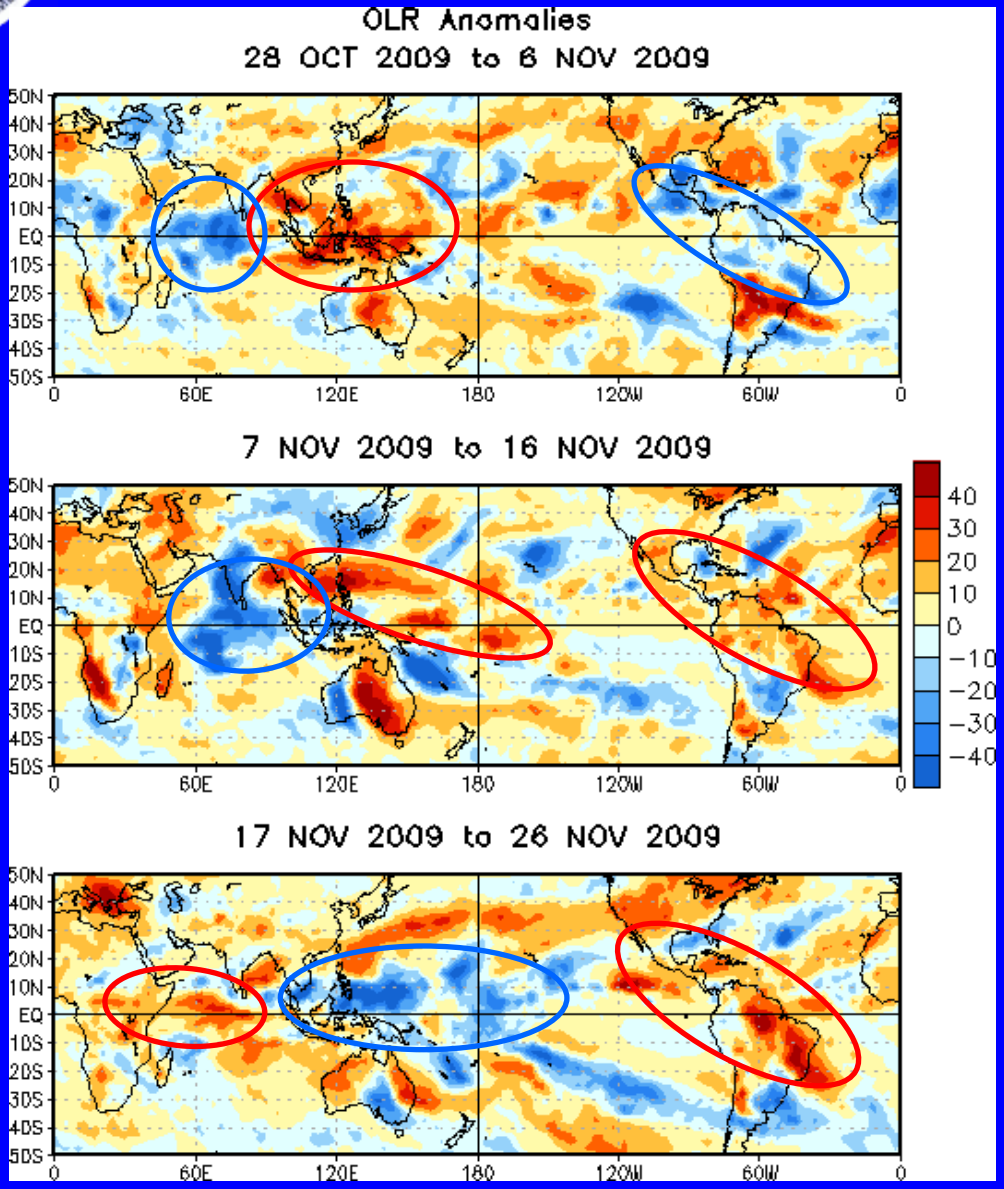
Easterly anomalies developed across the Indian Ocean in late October and shifted eastward across the Date Line during November (dotted line).

Most recently, westerly anomalies have developed across the Maritime continent and west Pacific (dashed line).

OLR Anomalies: Last 30 days

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

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

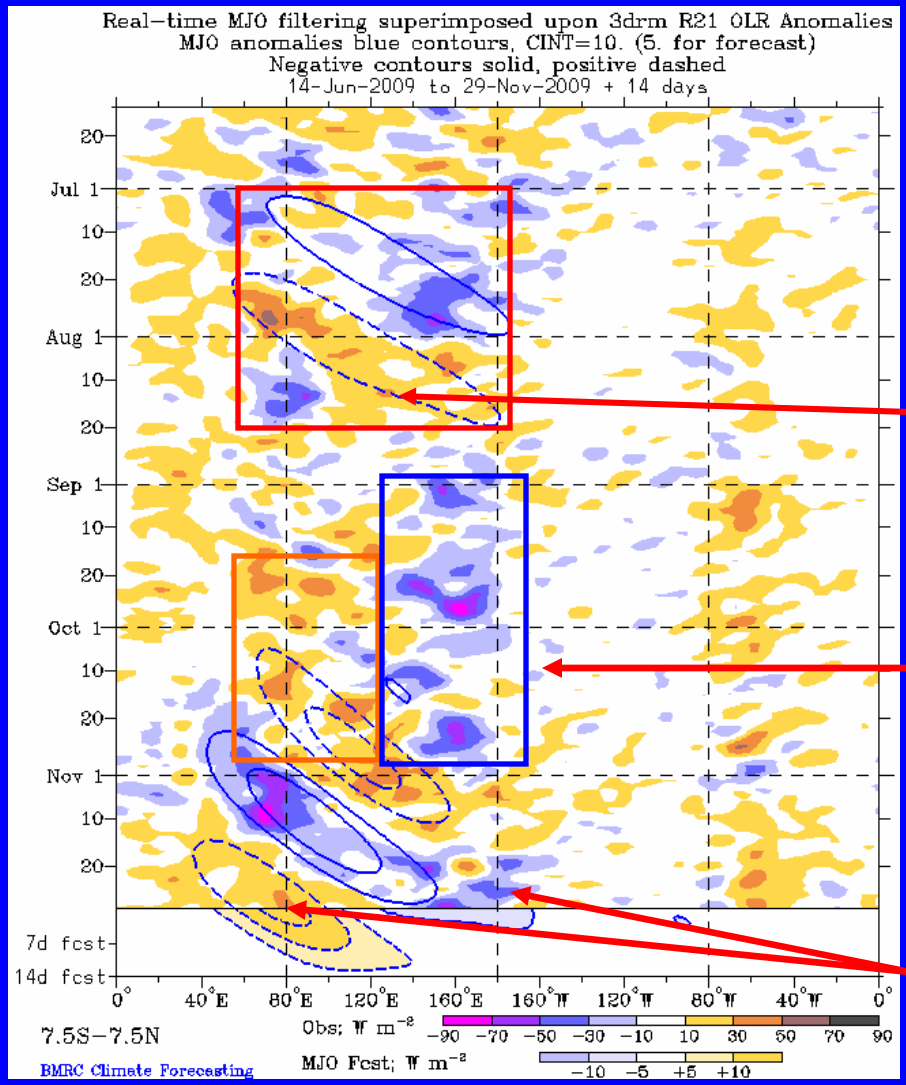


During late October-early November, suppressed convection (red oval) was evident over parts southern Asia and the Maritime continent while enhanced convection developed across the western Indian Ocean and the Americas.

During early-mid November, suppressed convection shifted eastward towards the western Pacific and was entrenched across the Americas and eastern Africa. Enhanced convection was noted across the central Indian Ocean.

During mid-late November, enhanced convection continued to shift eastward across the Maritime continent and into the west Pacific while suppressed convection prevailed across Indian Ocean and the Americas.

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)

Several types of subseasonal variability – including weak MJO activity – combined to produce generally enhanced (suppressed) convection across the Maritime continent and western Pacific during July (August).

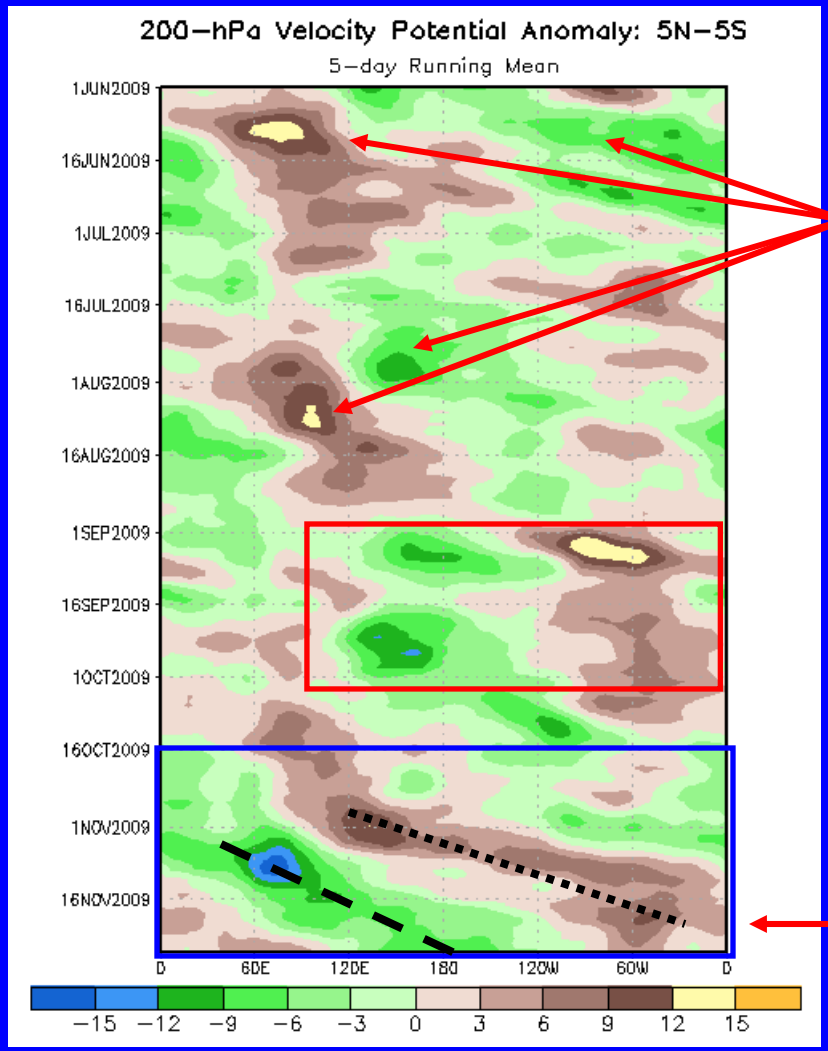
During most of September and October, generally enhanced (suppressed) convection has been evident across the western Pacific (eastern Indian Ocean) (blue and orange boxes).

Beginning in late October, enhanced convection developed across Africa and has shifted eastward across the Maritime Continent into the Pacific. Suppressed convection is once again developing across the Indian Ocean and Maritime Continent.

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 early June and late July due to several types of subseasonal variability with some eastward propagation evident.

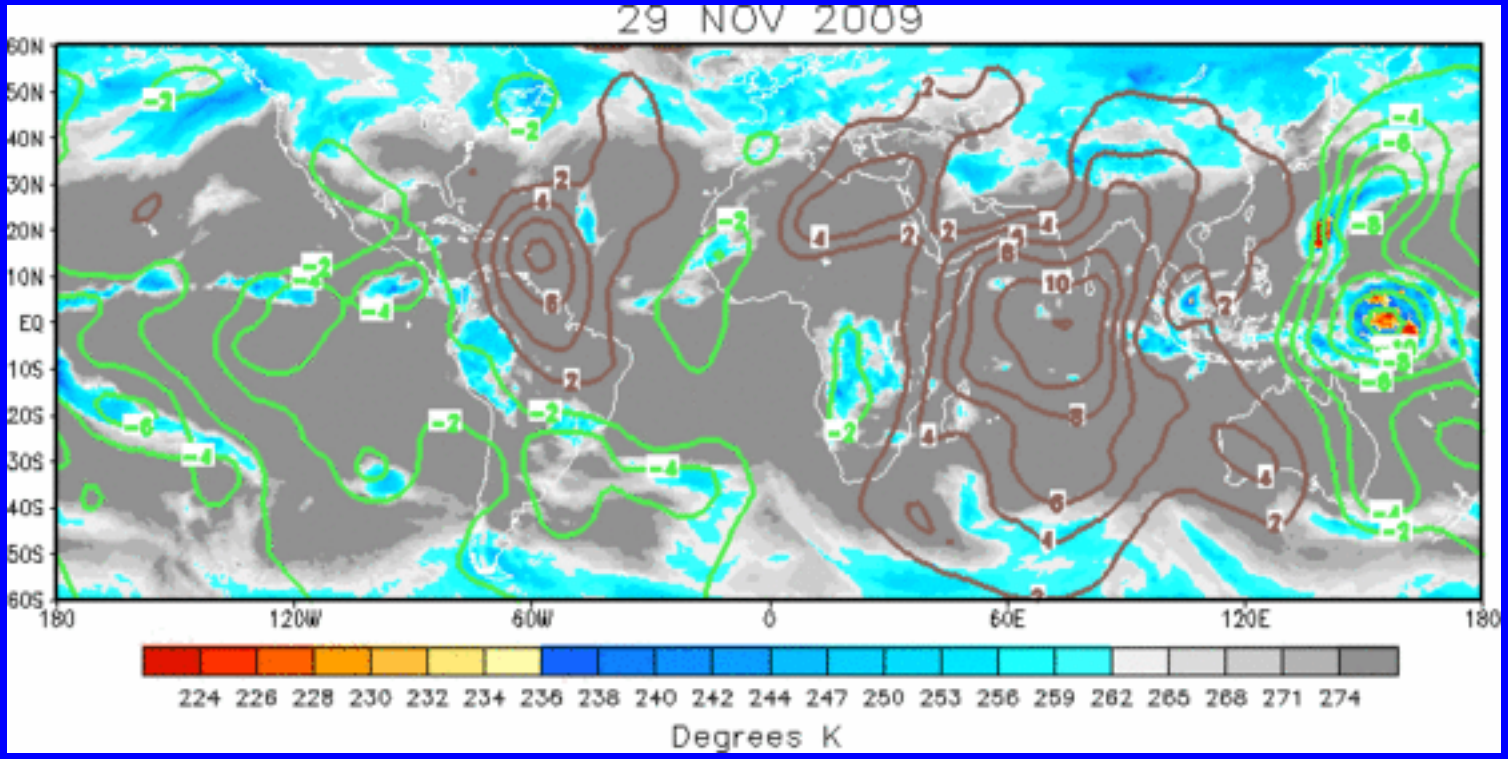
Anomalies increased during September but the overall pattern remained generally persistent with upper-level divergence (convergence) across the western Pacific (parts of Western Hemisphere) (red box).

In late October and November, anomalies increased and eastward propagation has been evident associated with the current MJO activity (blue box).

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

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

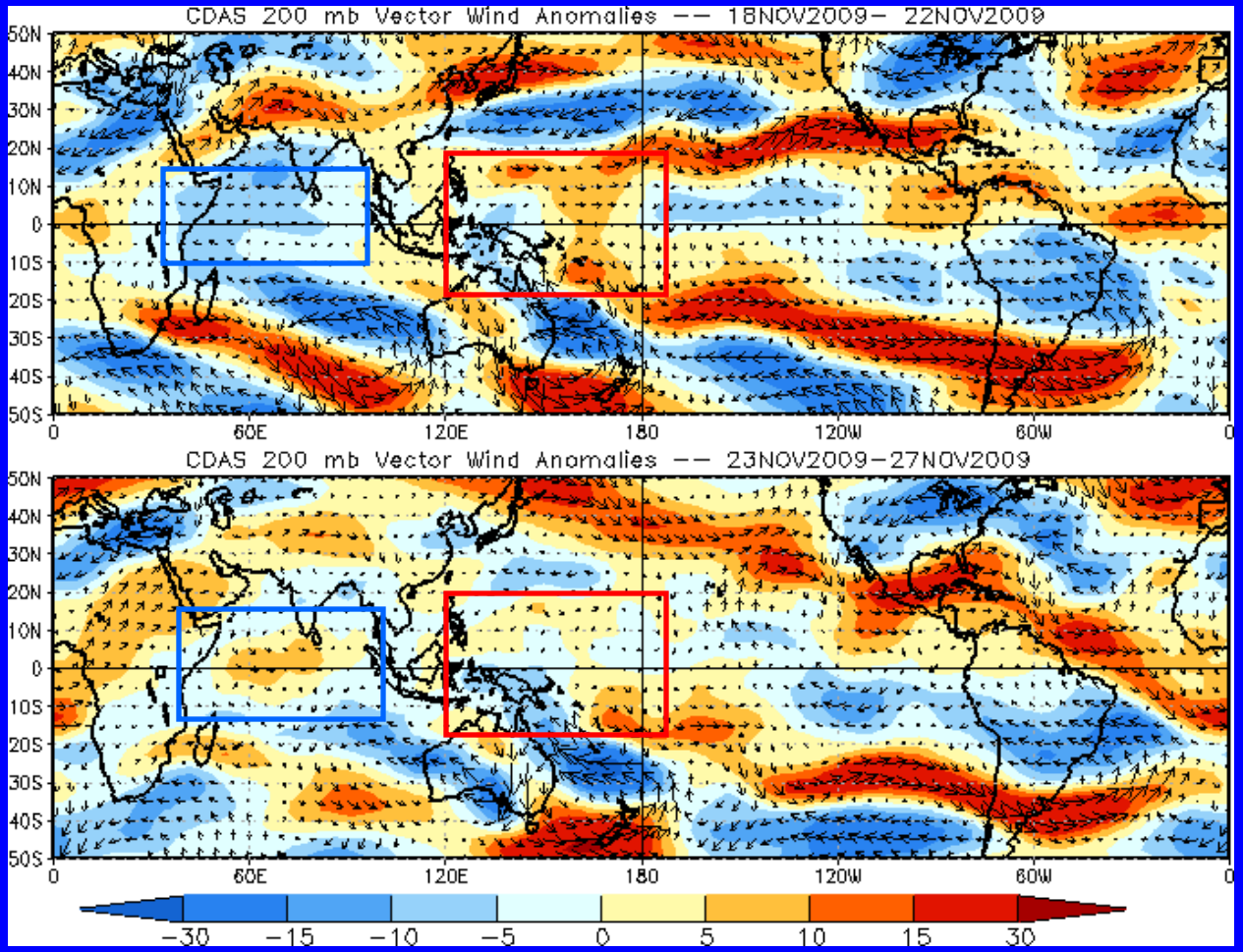
Negative anomalies (green contours) indicate favorable conditions for precipitation



Recently the velocity potential anomalies indicate a less coherent pattern with upper-level divergence mainly across the Pacific region with upper-level convergence evident over the Indian Ocean.

The pattern has been propagating eastward during the past week.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

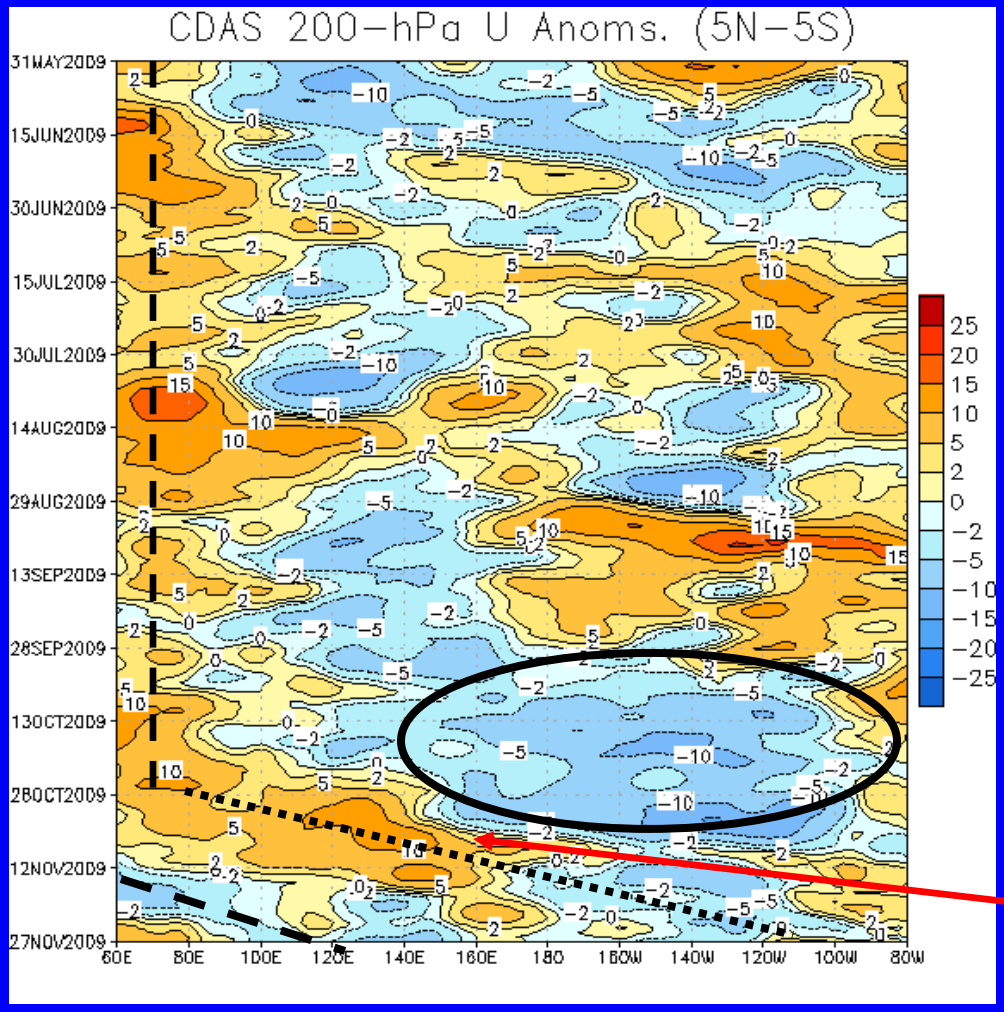
Westerly anomalies (red boxes) across the west Pacific during the previous five days have diminished.

Easterly anomalies across the Indian Ocean have diminished and been replaced by weak westerly anomalies (blue boxes).

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

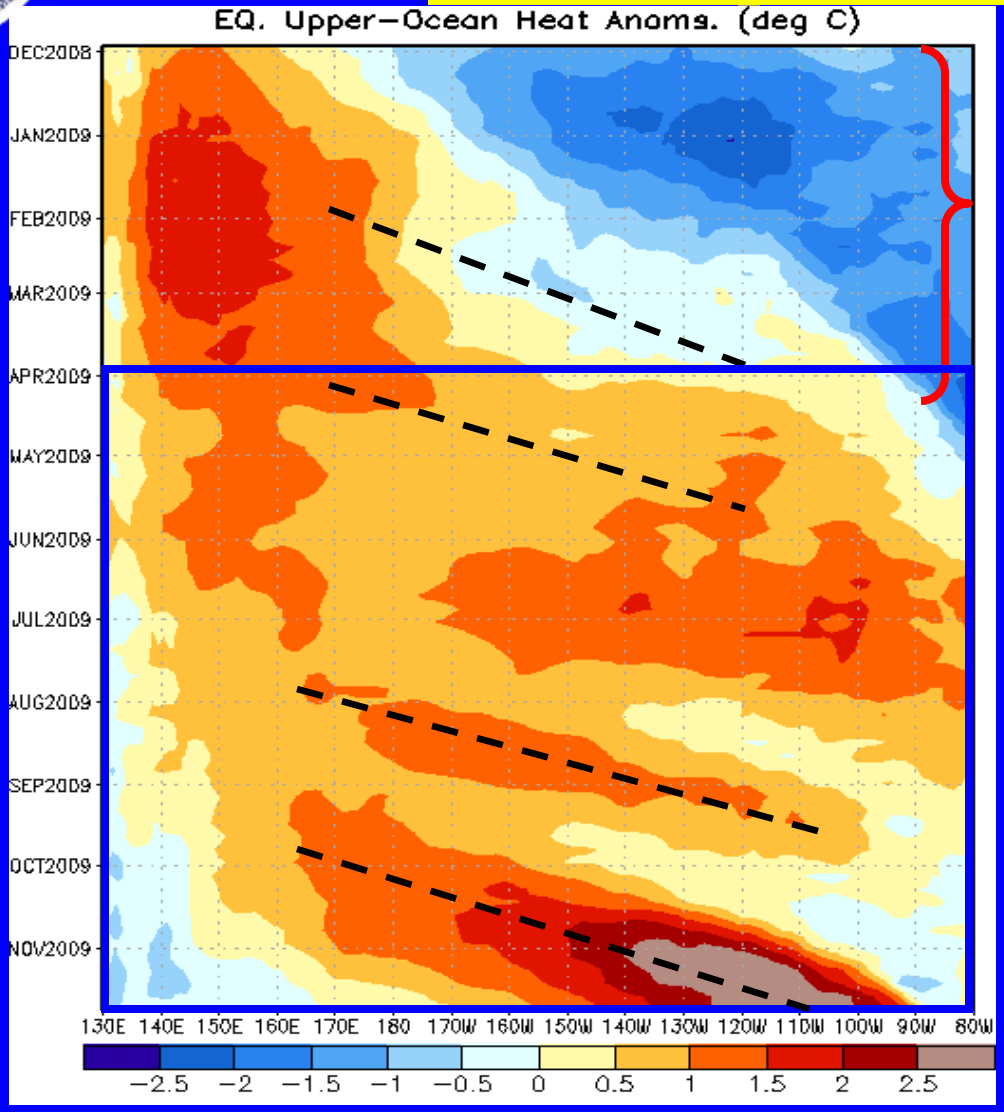
Longitude

Westerly anomalies across the Indian Ocean have 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 anomalies shifted eastward across the Maritime Continent during late October and early 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 phase of two Kelvin waves have shifted eastward during August-September and late September-early November (last two dashed black lines).

MJO Index -- Information

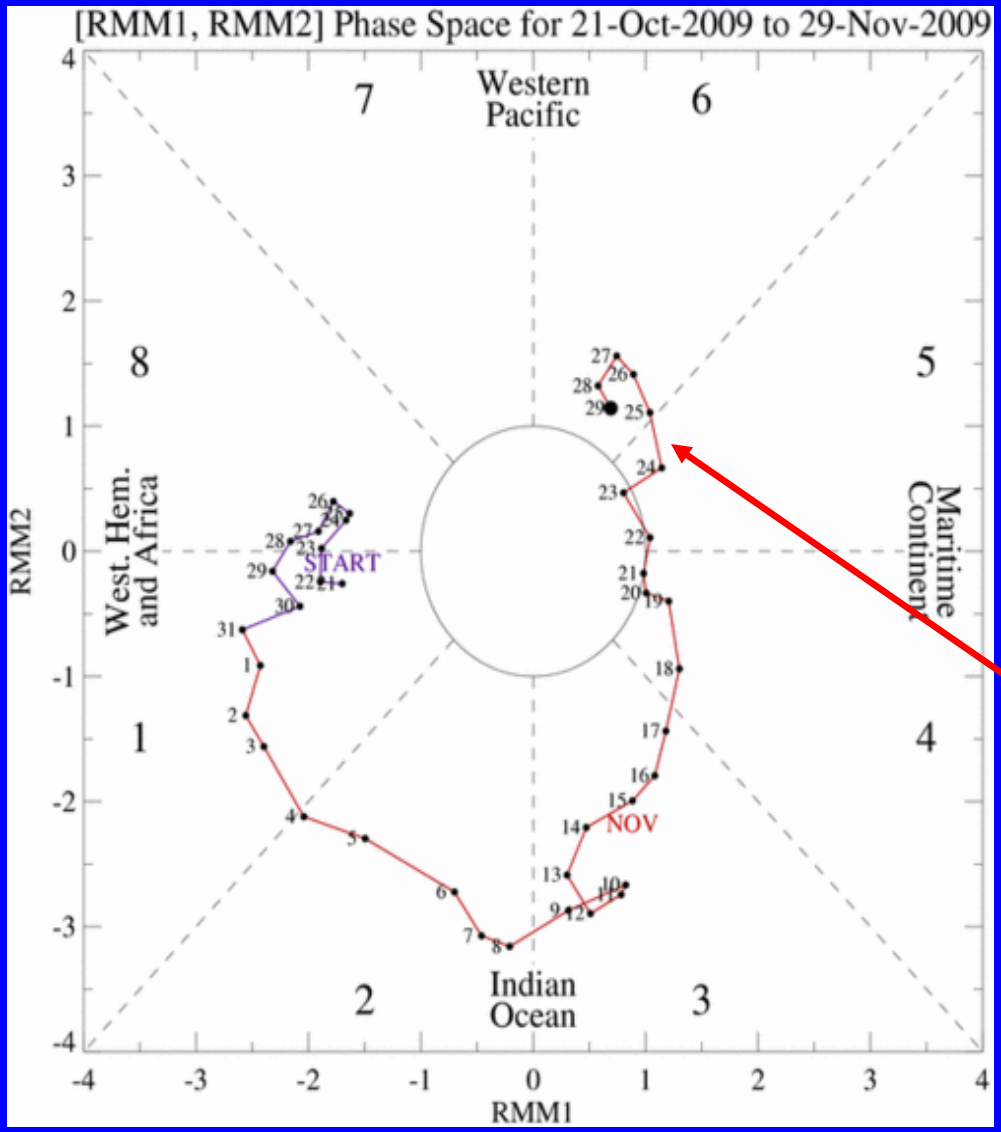
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

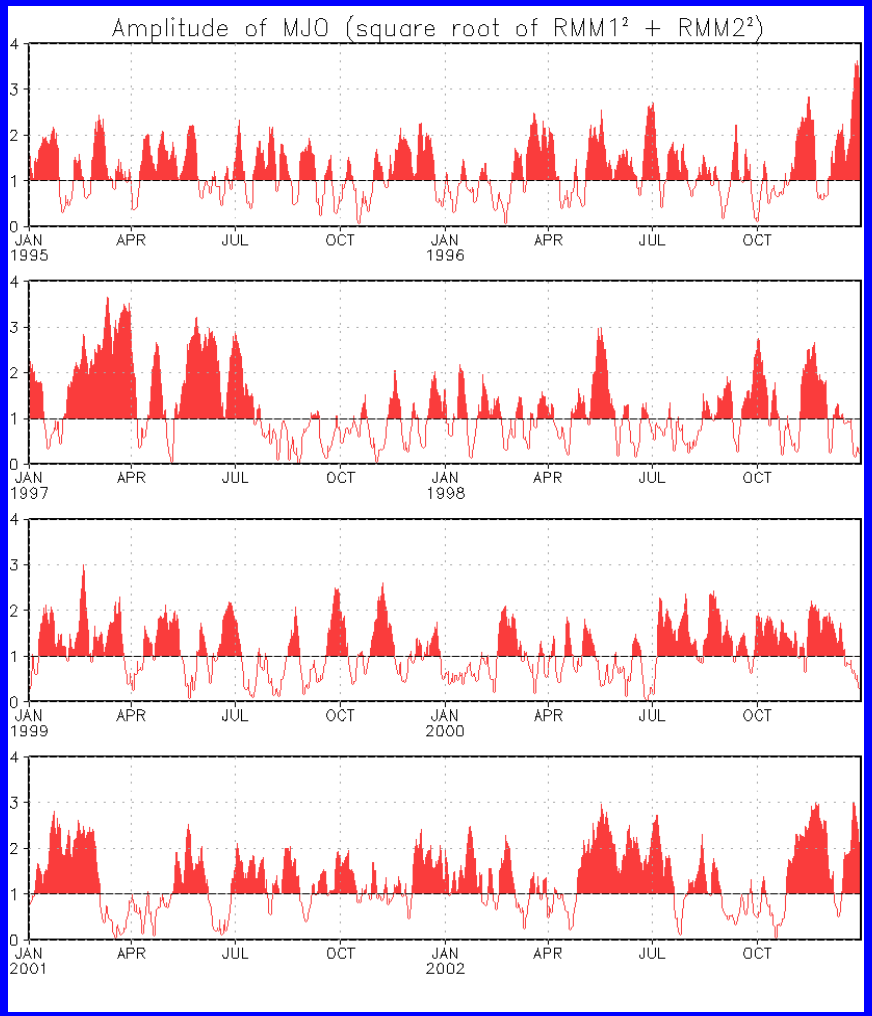
MJO Index -- Recent Evolution

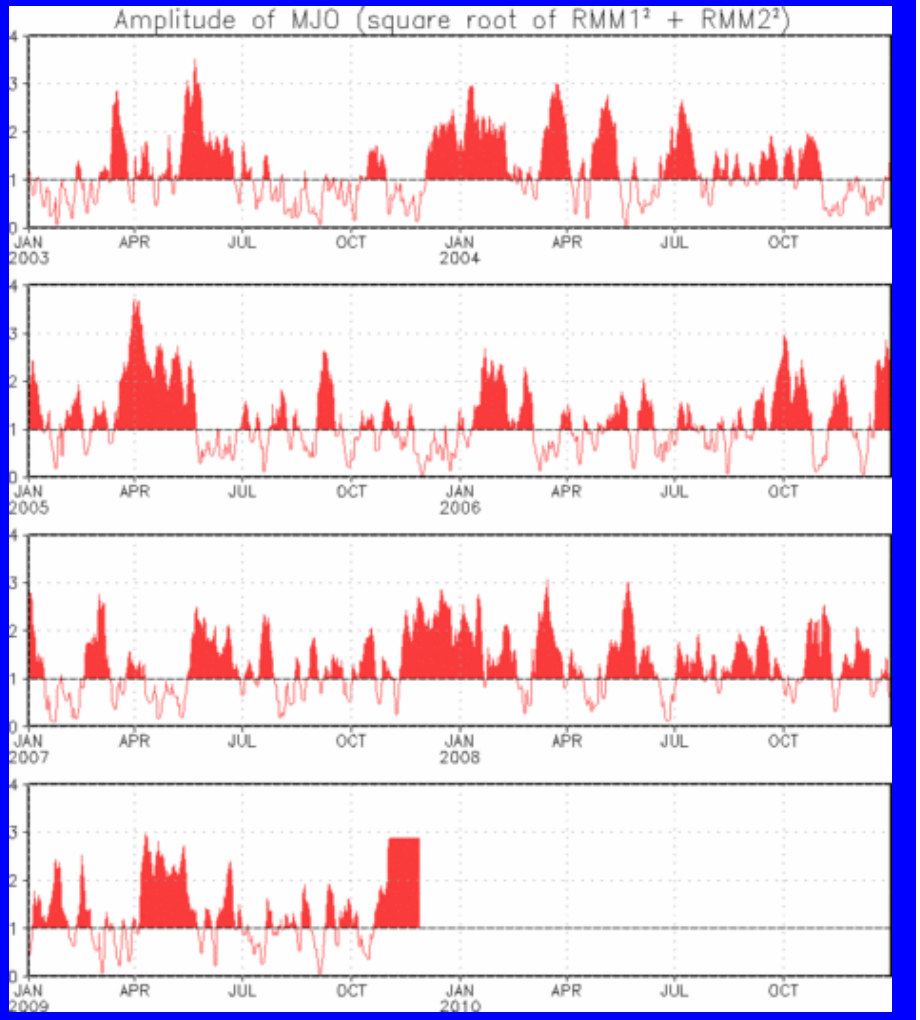


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

The MJO index indicates a decrease in amplitude and reduced eastward propagation in recent 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.

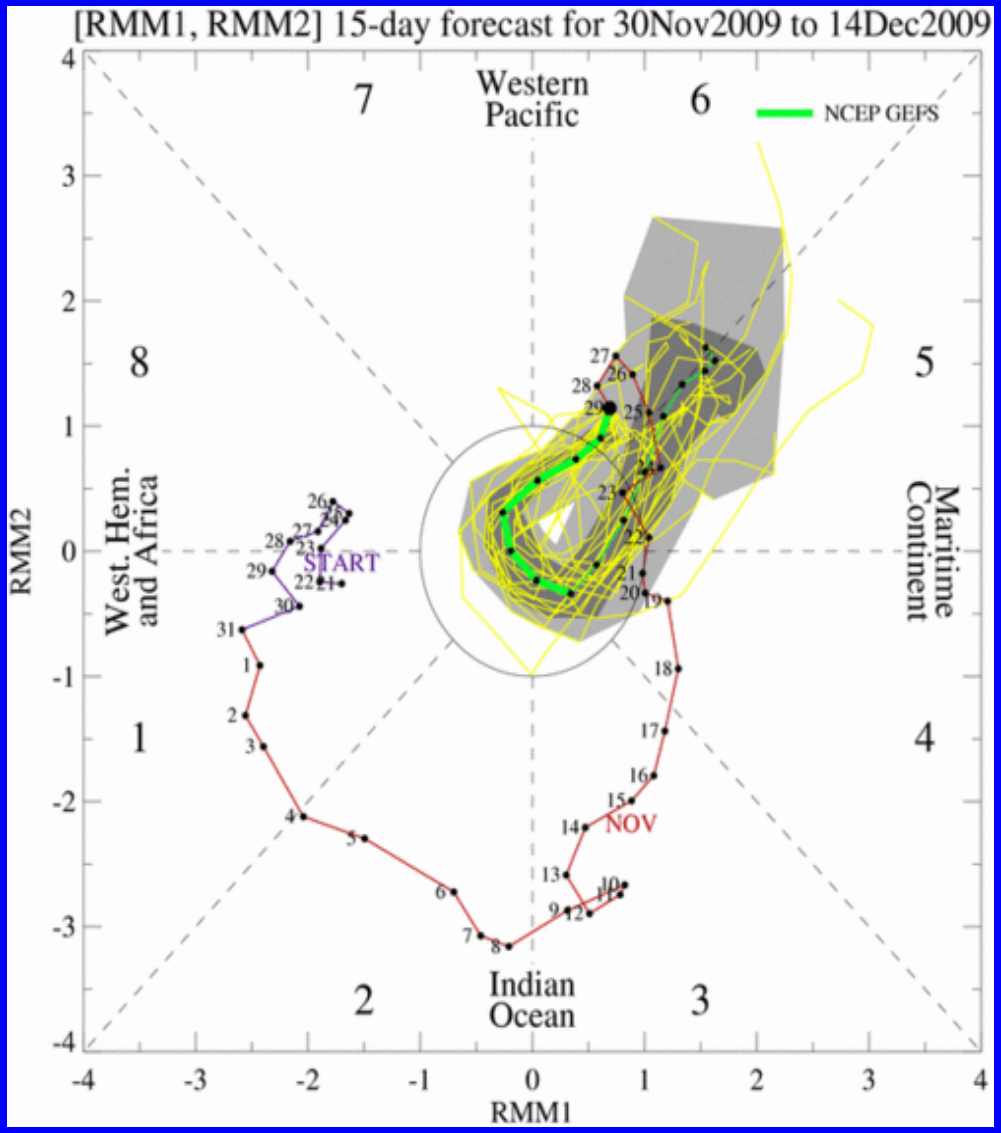
Ensemble GFS (GEFS) MJO Forecast

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

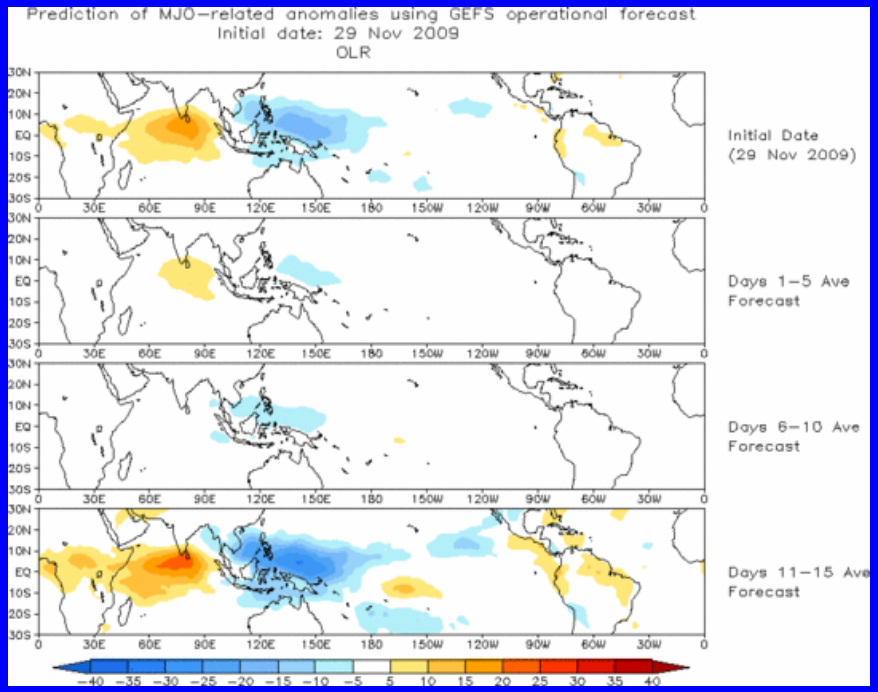
The GFS MJO index forecasts indicate a weakening MJO signal during the period with a high degree of uncertainty.



Ensemble Mean GFS MJO Forecast

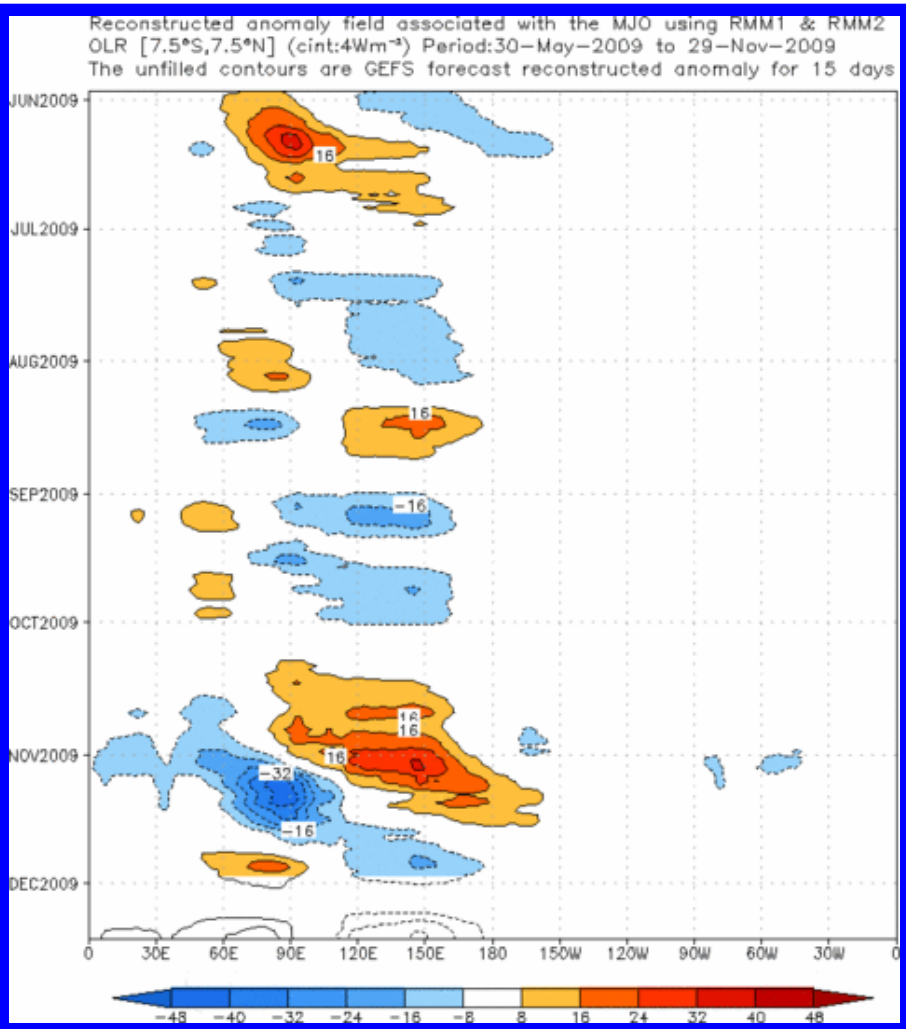
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



With diminished amplitude and no eastward propagation, the GEFS ensemble mean forecasts enhanced (suppressed) convection to persist in the western Pacific (Indian Ocean) early in the period and again during Week-2.

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



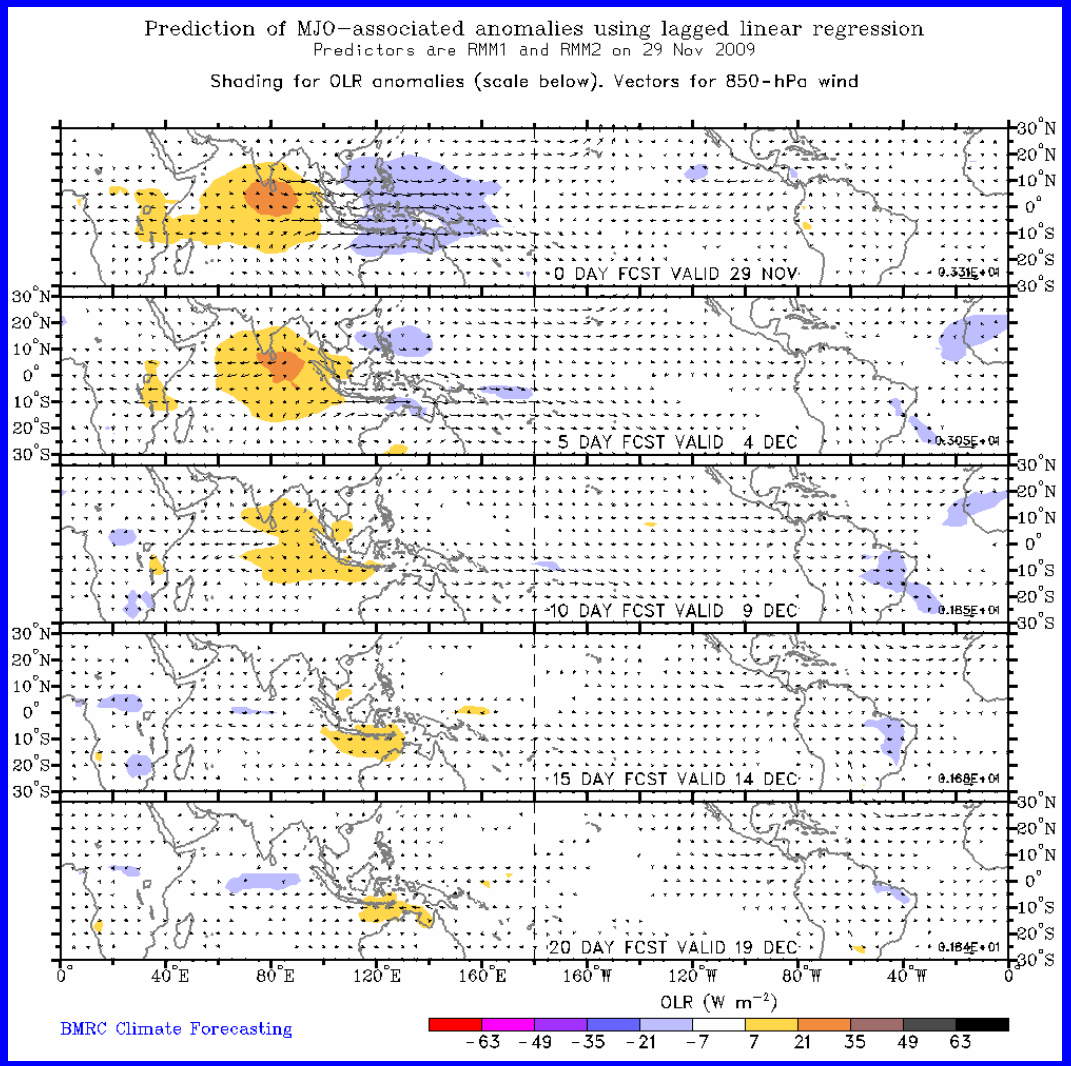
Statistical MJO Forecast

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 vectors for the next 20 days

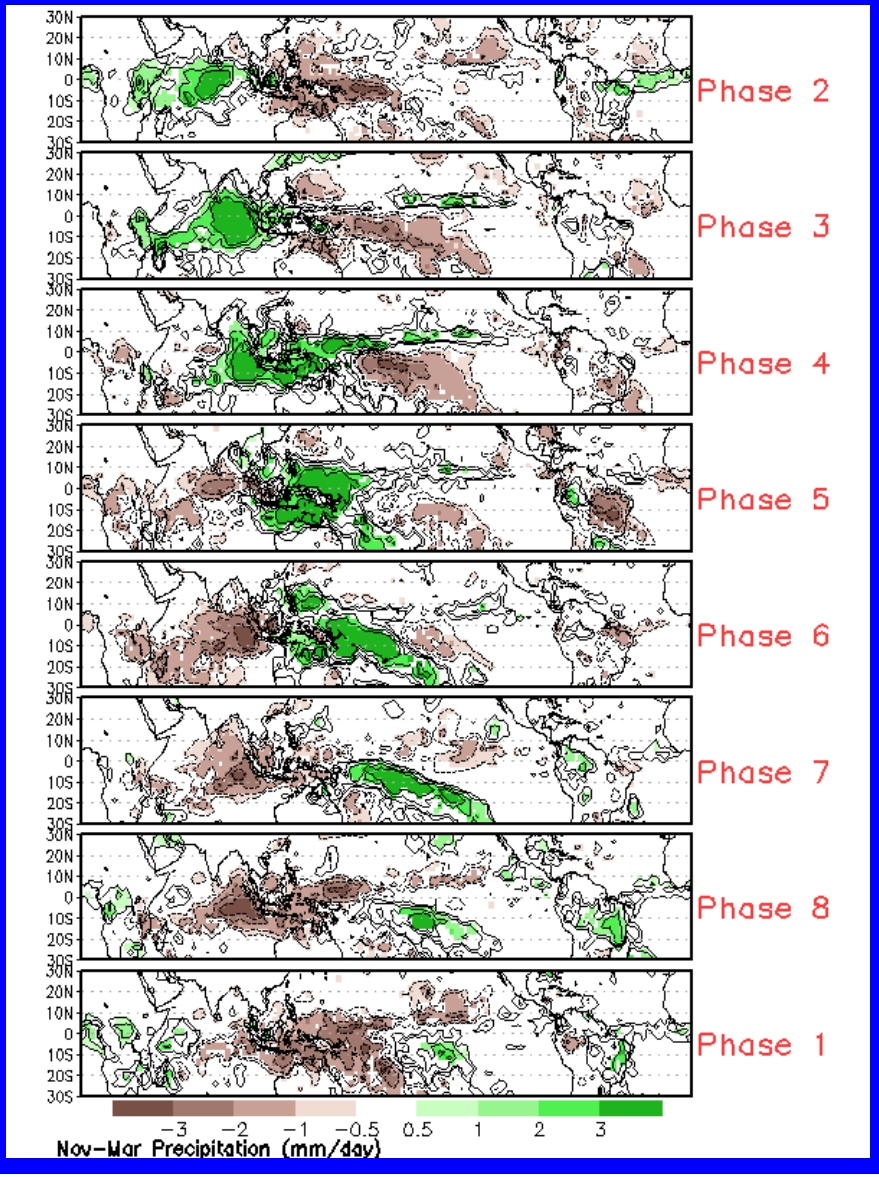
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical model forecast differs considerably from the dynamical model forecast. A moderate signal is evident and shows enhanced convection diminishing across the Maritime Continent and western Pacific with suppressed convection shifting across the Indian Ocean and into the Maritime Continent.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)