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

Update prepared by
Climate Prediction Center / NCEP
November 2, 2009

Outline

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

Overview

- The MJO signal has strengthened during the past week with the enhanced convective phase generally centered across Africa.

- Model MJO index forecasts are in reasonable agreement for the MJO signal to shift across the Indian Ocean over the period.

- Based on recent observations and the aforementioned model forecasts, the MJO is forecast to remain active during the next 1-2 weeks.

- Enhanced rainfall associated with the MJO is expected to result in wet conditions across eastern Africa and the equatorial Indian Ocean and aid dry conditions across parts of Indonesia during the period.

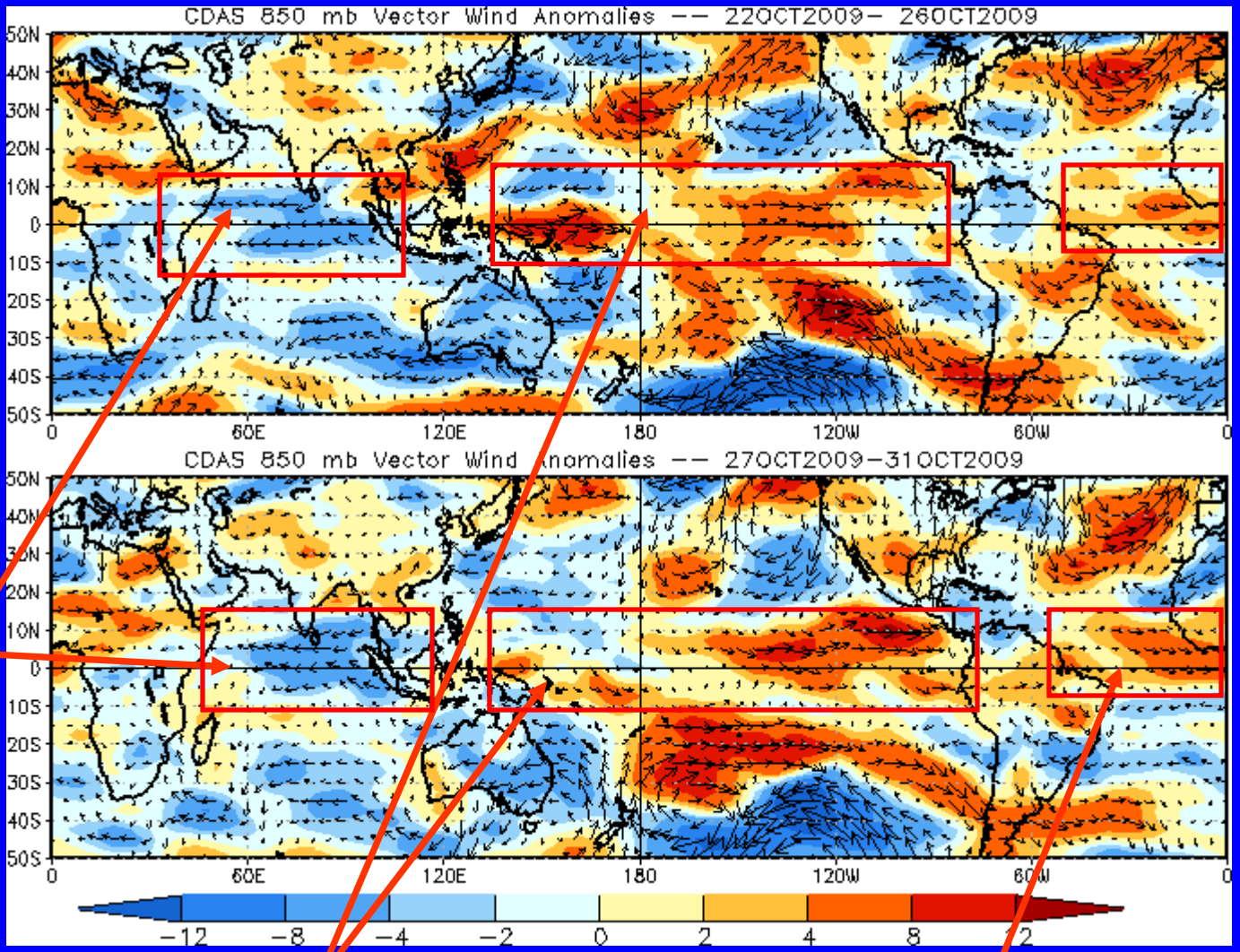
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Easterly anomalies continued across the Indian Ocean but weakened near the Horn of Africa.

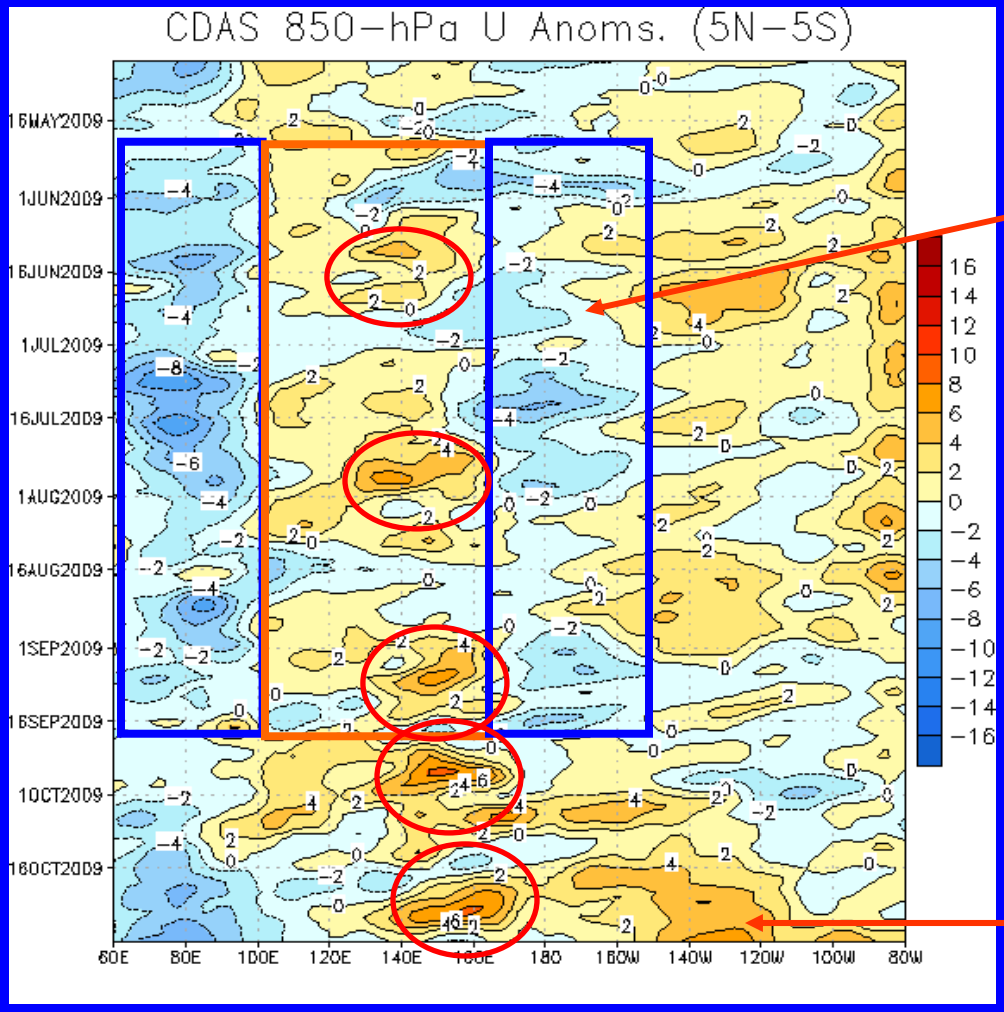
Westerly anomalies continued across much of the equatorial Pacific during the last five to ten days.

Westerly anomalies continued across the Atlantic and Africa during the last five to ten 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 May 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 and are evident in mid-June, late July, and early September.

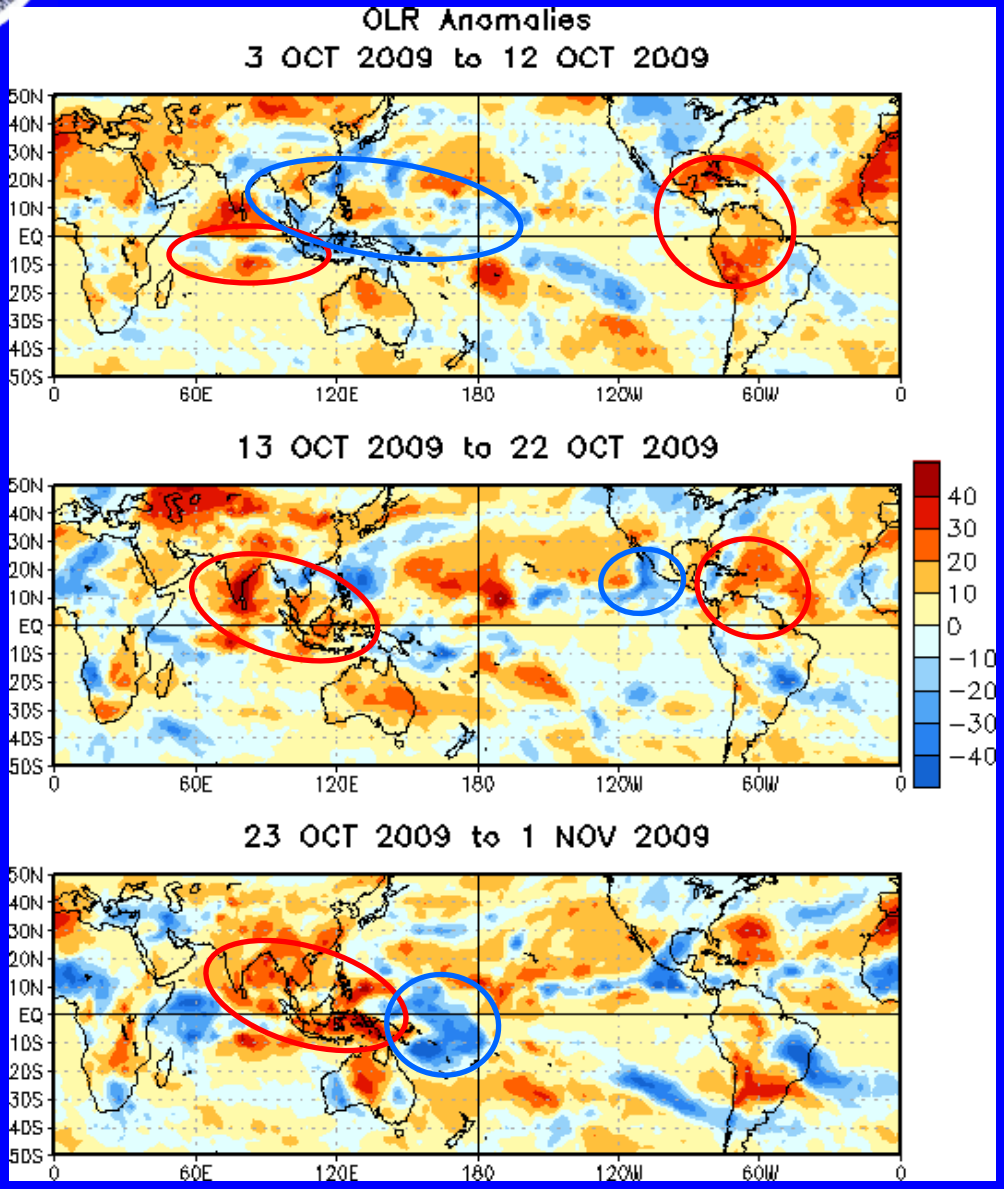
There has also been a slow gradual shift eastward of the westerly anomalies over the entire period.

The westerly wind bursts (red circles) became more frequent and stronger during September and October. Also, westerly wind anomalies have expanded and now span the entire equatorial Pacific Basin.

OLR Anomalies: Last 30 days

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

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

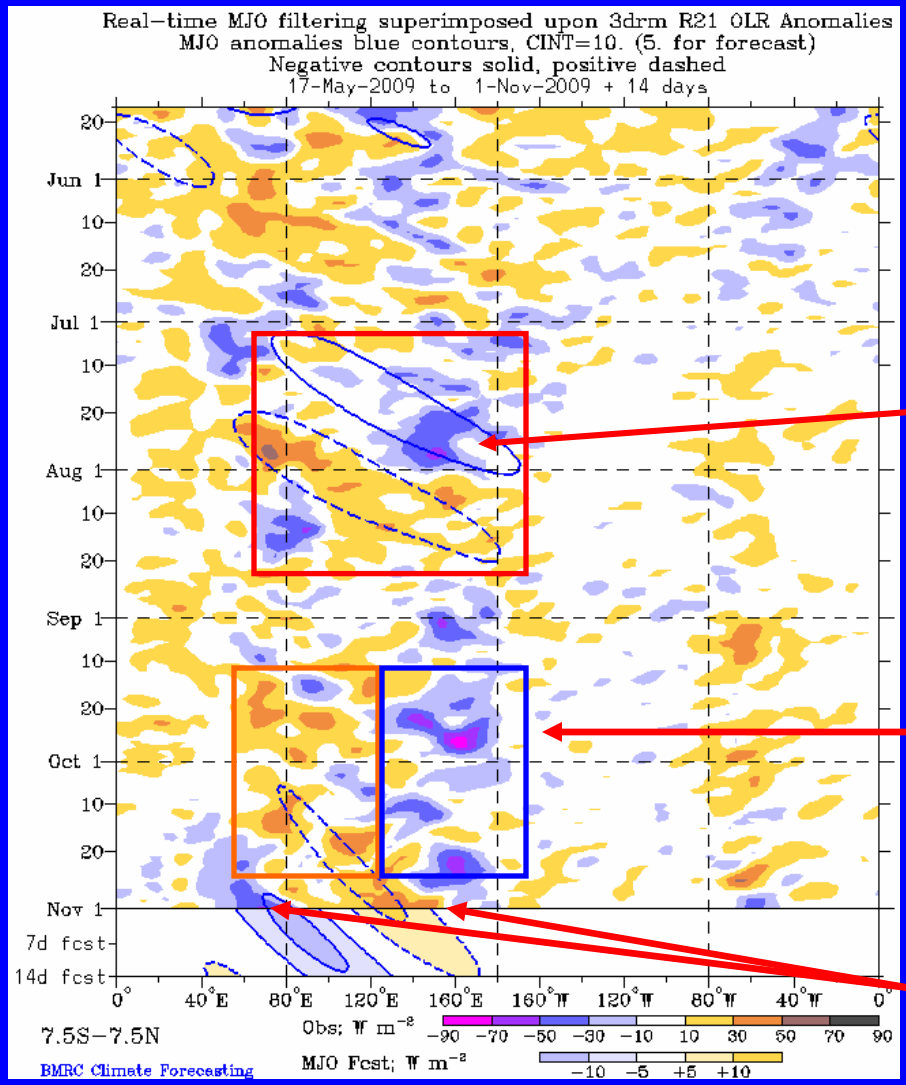


During early-to-mid October, enhanced convection (blue oval) diminished across much of the western Pacific. Areas of suppressed convection (red ovals) were evident over parts of the Indian Ocean, Americas and Caribbean Sea.

During mid October, suppressed convection developed over parts of southern Asia and the western Maritime continent while continuing across the Caribbean Sea and western Atlantic. Enhanced convection was noted across parts of the eastern Pacific.

During late October, suppressed convection shifted slightly eastward across the Maritime continent while enhanced convection reemerged just west of the Date Line in the Pacific.

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).

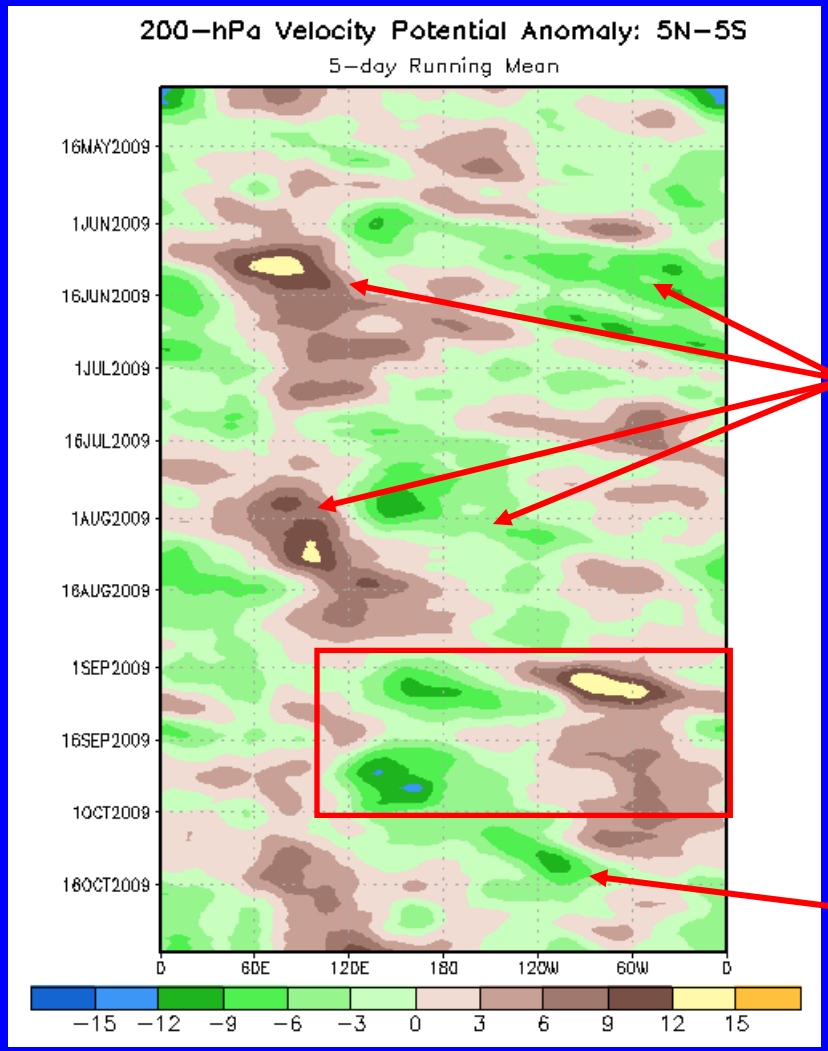
During most of September and October, generally enhanced (suppressed) convection has been evident across the western Pacific (eastern Indian Ocean) (blue and orange boxes).

In the second half of October, enhanced convection developed near eastern Africa and suppressed convection moved slightly eastward.

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

The MJO was weak during most of May.

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

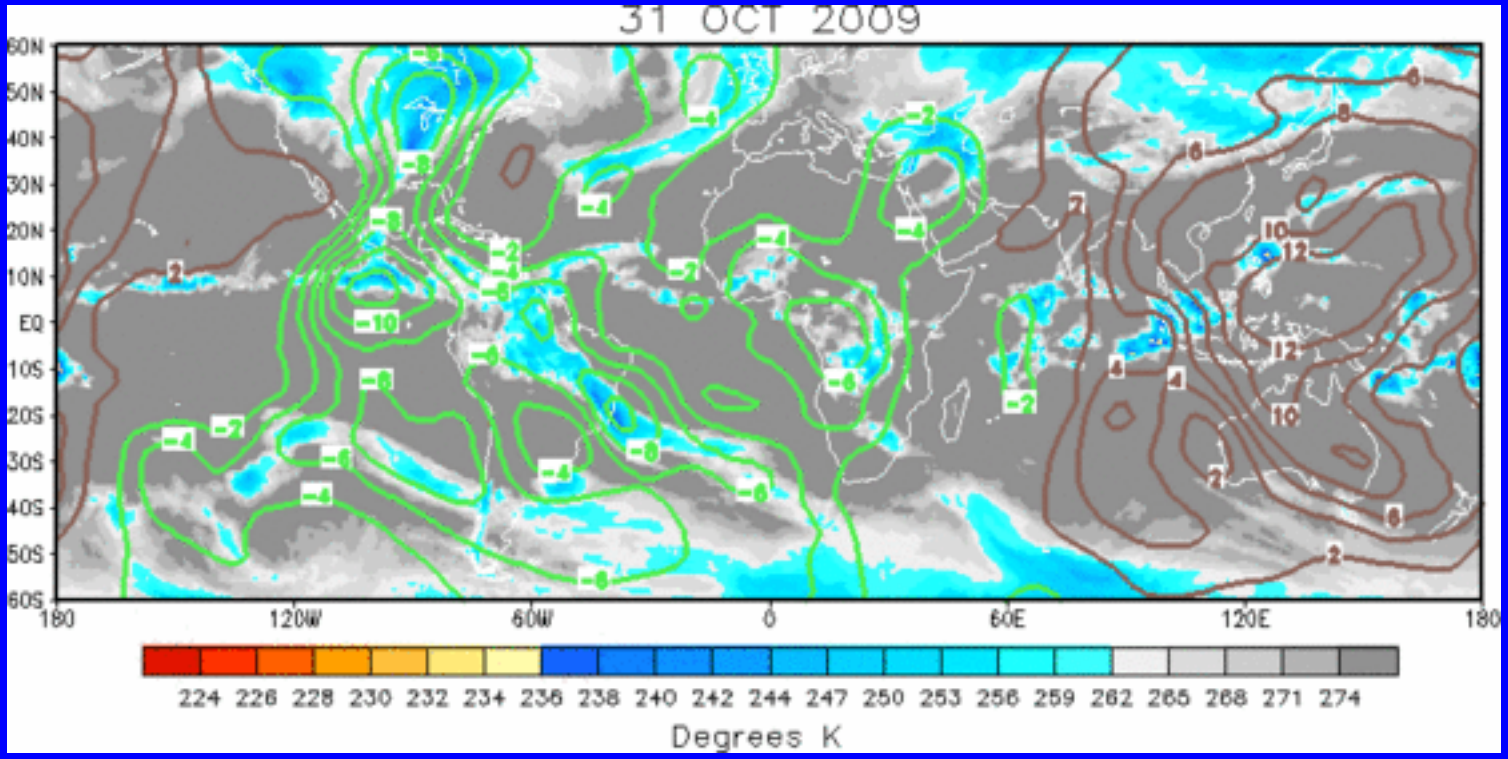
Anomalies increased during September but the overall pattern remained generally persistent with upper-level divergence (convergence) across the western Pacific (parts of Western Hemisphere) (red box).

There was an eastward shift of the pattern during early-mid October but this short-lived.

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

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

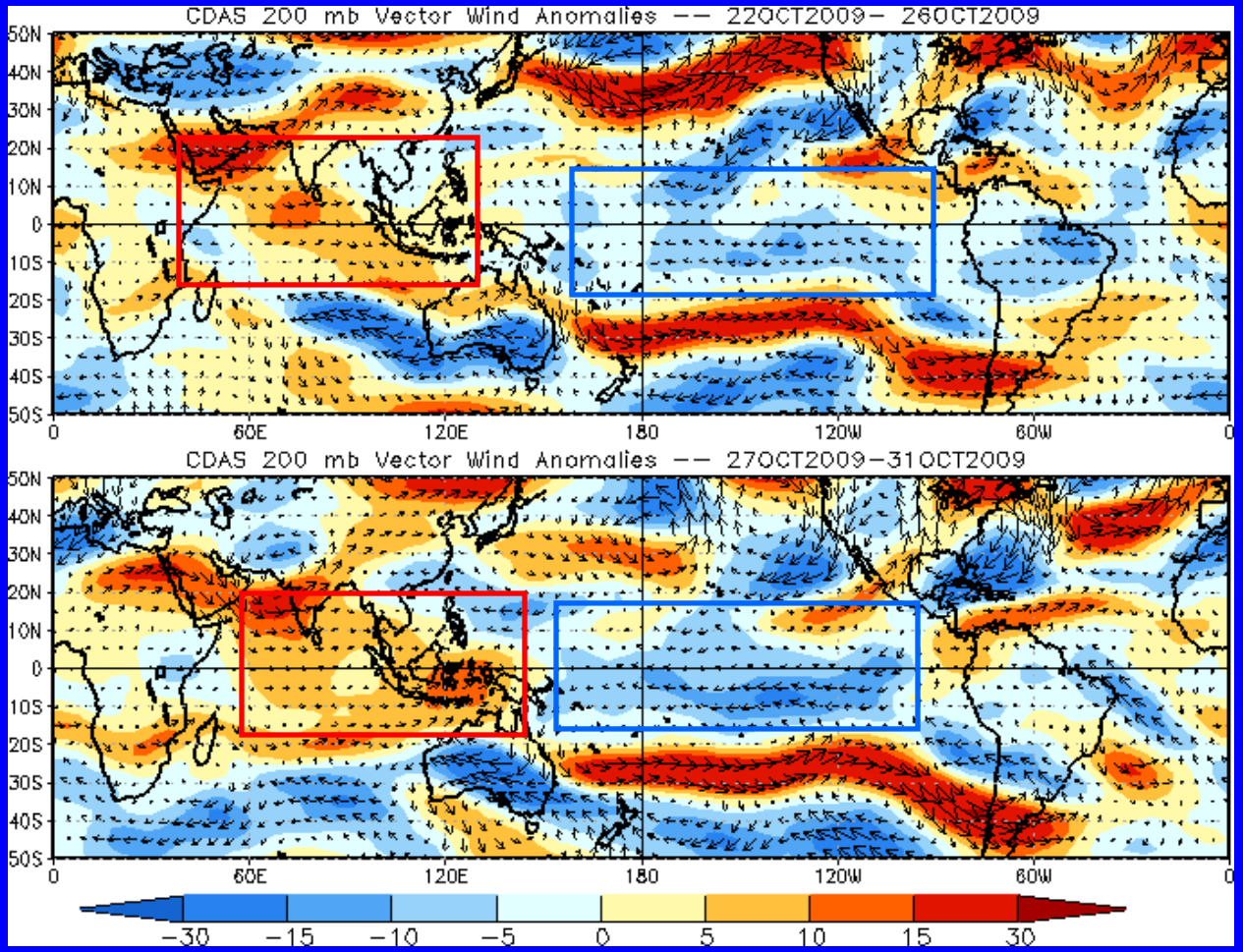
Negative anomalies (green contours) indicate favorable conditions for precipitation



Velocity potential anomalies indicate upper-level divergence across much of the western Hemisphere and Africa with upper-level convergence focused over the Maritime continent and western Pacific.

The pattern has generally remained stationary over the last few weeks.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

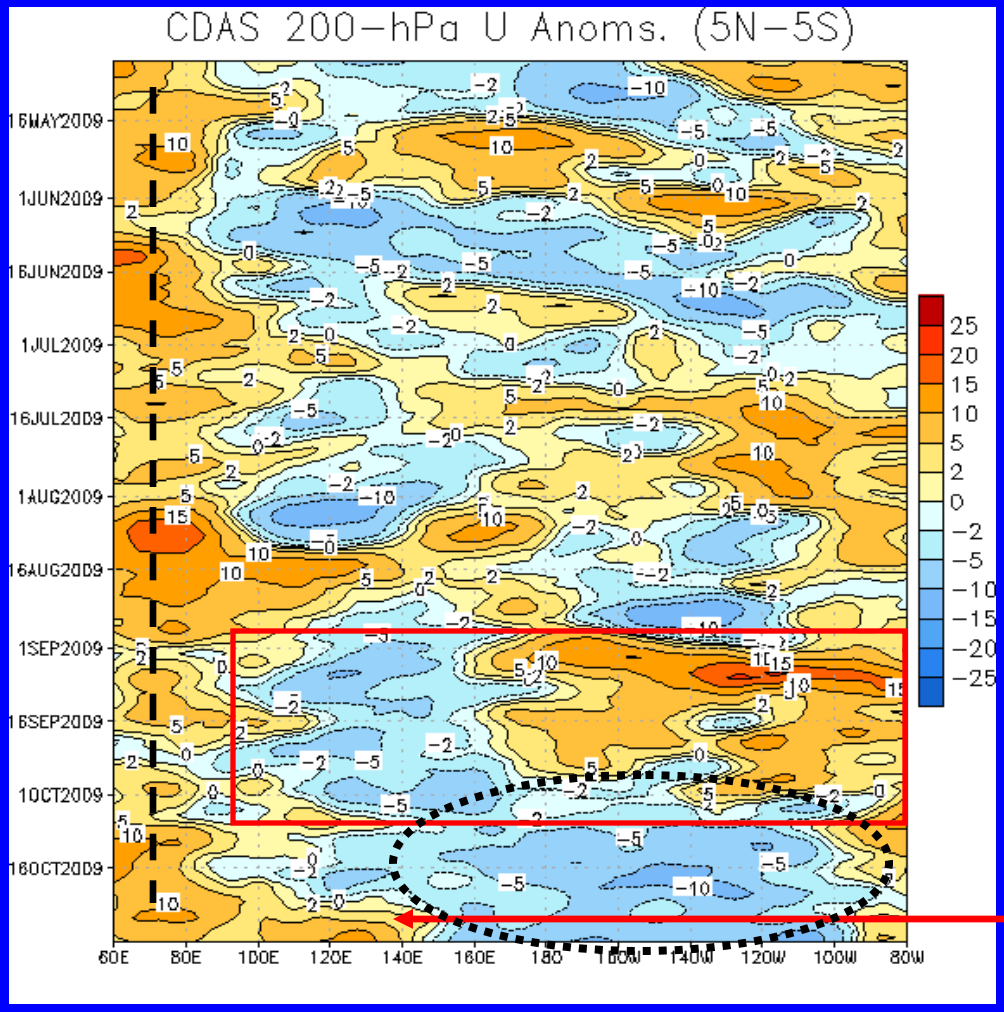
Westerly anomalies persisted across the Indian Ocean (red boxes) during the last five days with a slight eastward expansion to include the Maritime continent.

Easterly anomalies continued across the Pacific during the last five to ten days (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

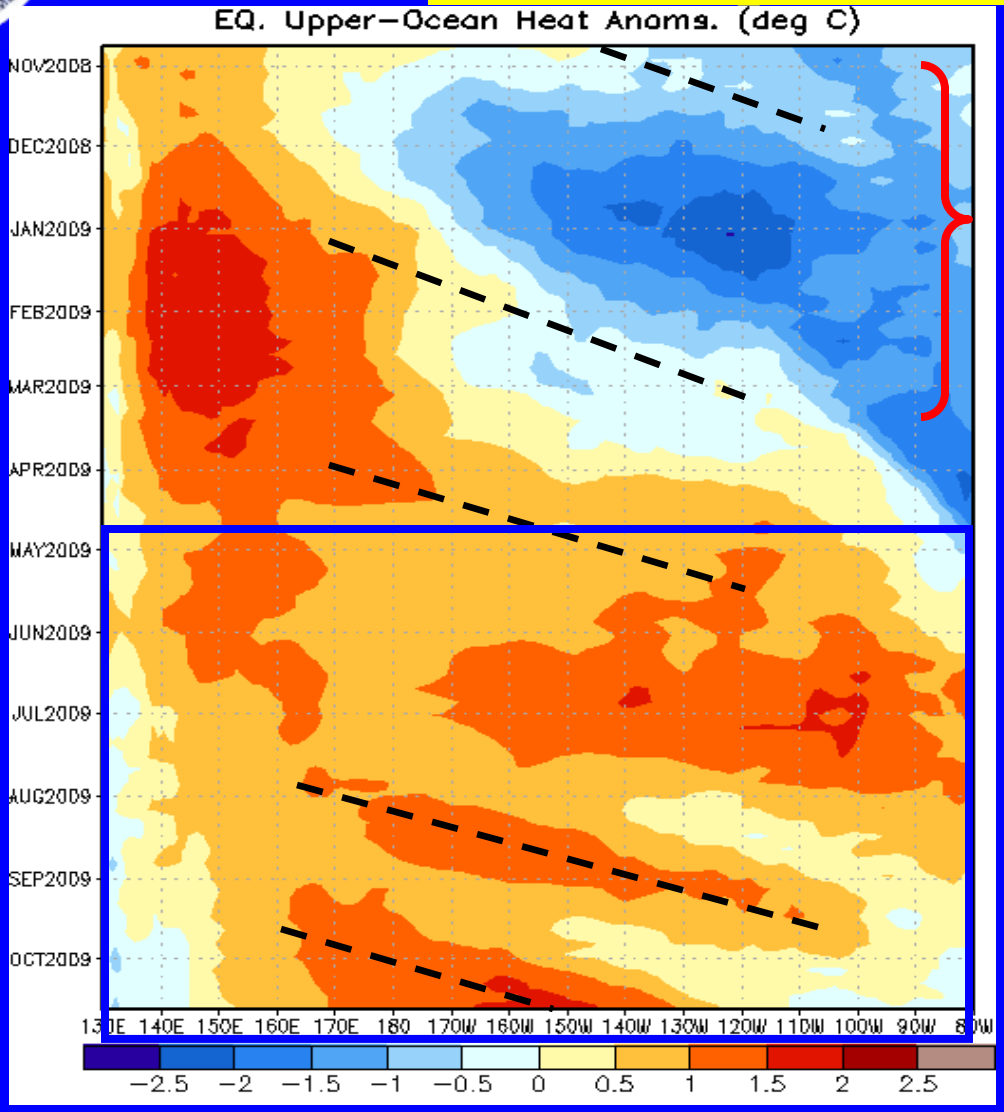
Westerly anomalies across the Indian Ocean have persisted since May 2009 (vertical dashed black line).

During September easterly (westerly) anomalies remained generally persistent across Indonesia and the western Pacific (Western Hemisphere) (red box).

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

Westerly anomalies expanded eastward across the Maritime Continent in the last week.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

During November 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/mid October (last two dashed black lines).

MJO Index -- Information

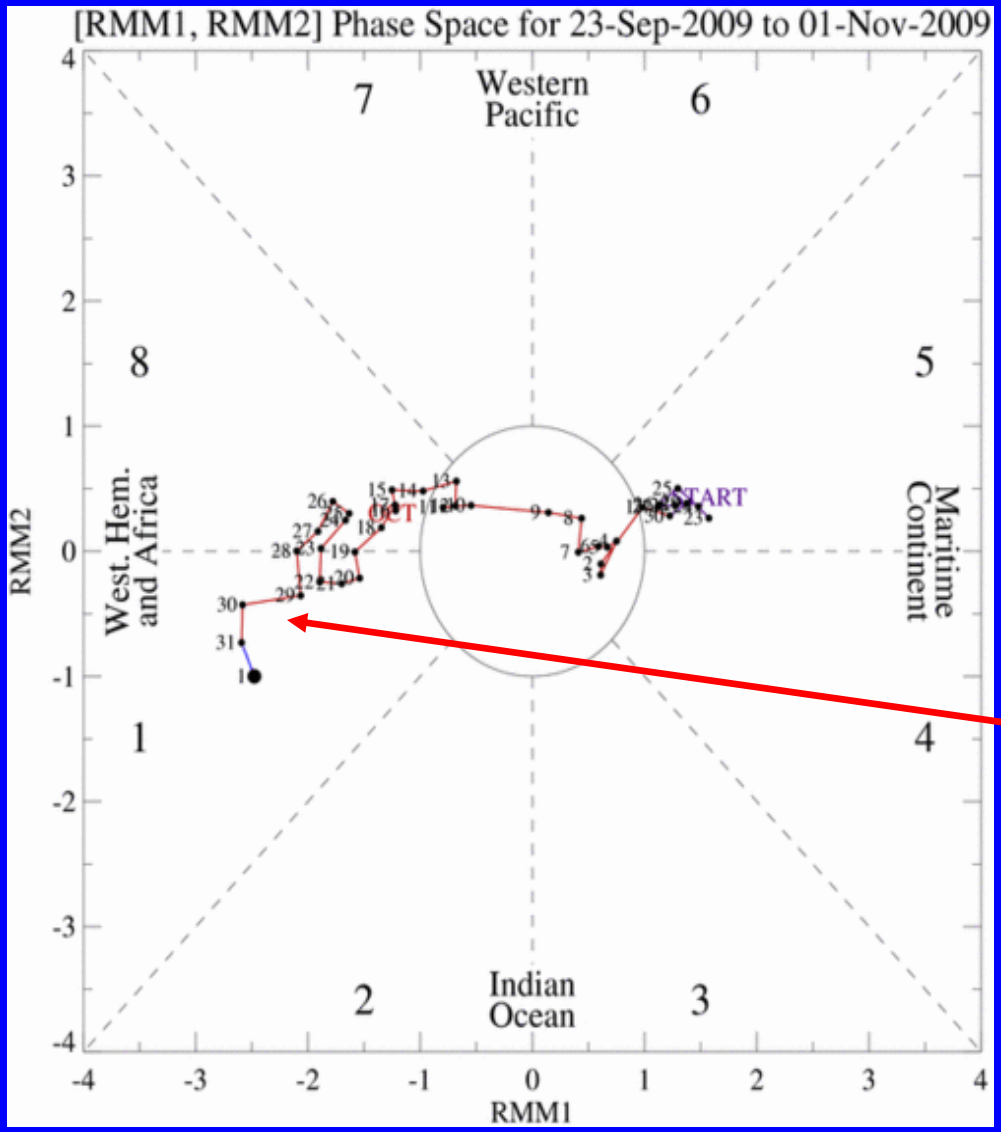
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

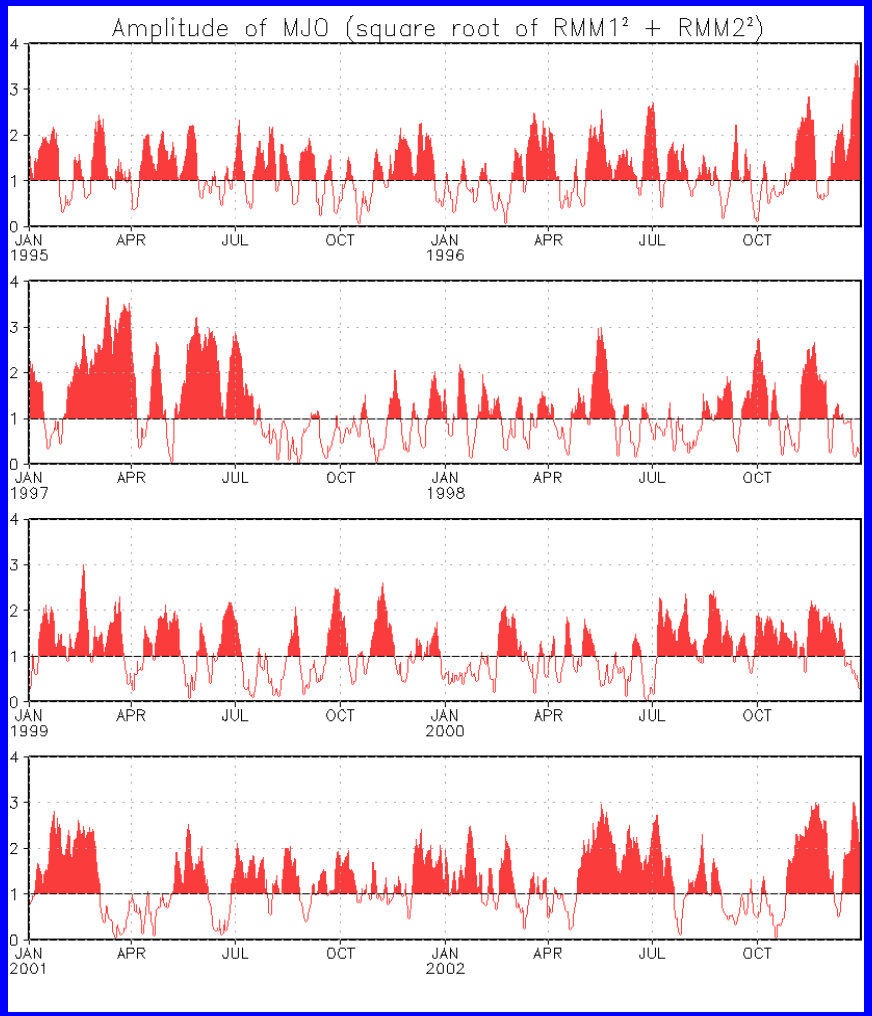
MJO Index -- Recent Evolution

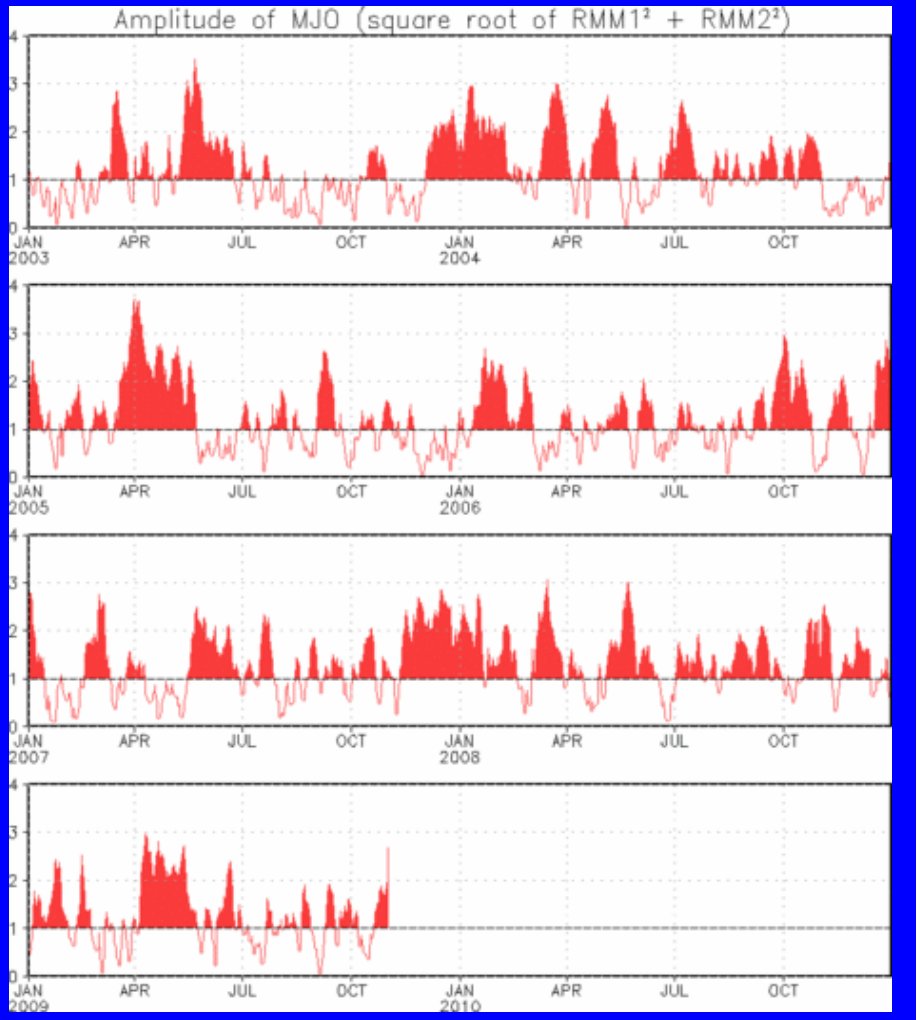


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

The MJO index has shown an increase in amplitude and eastward propagation 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.

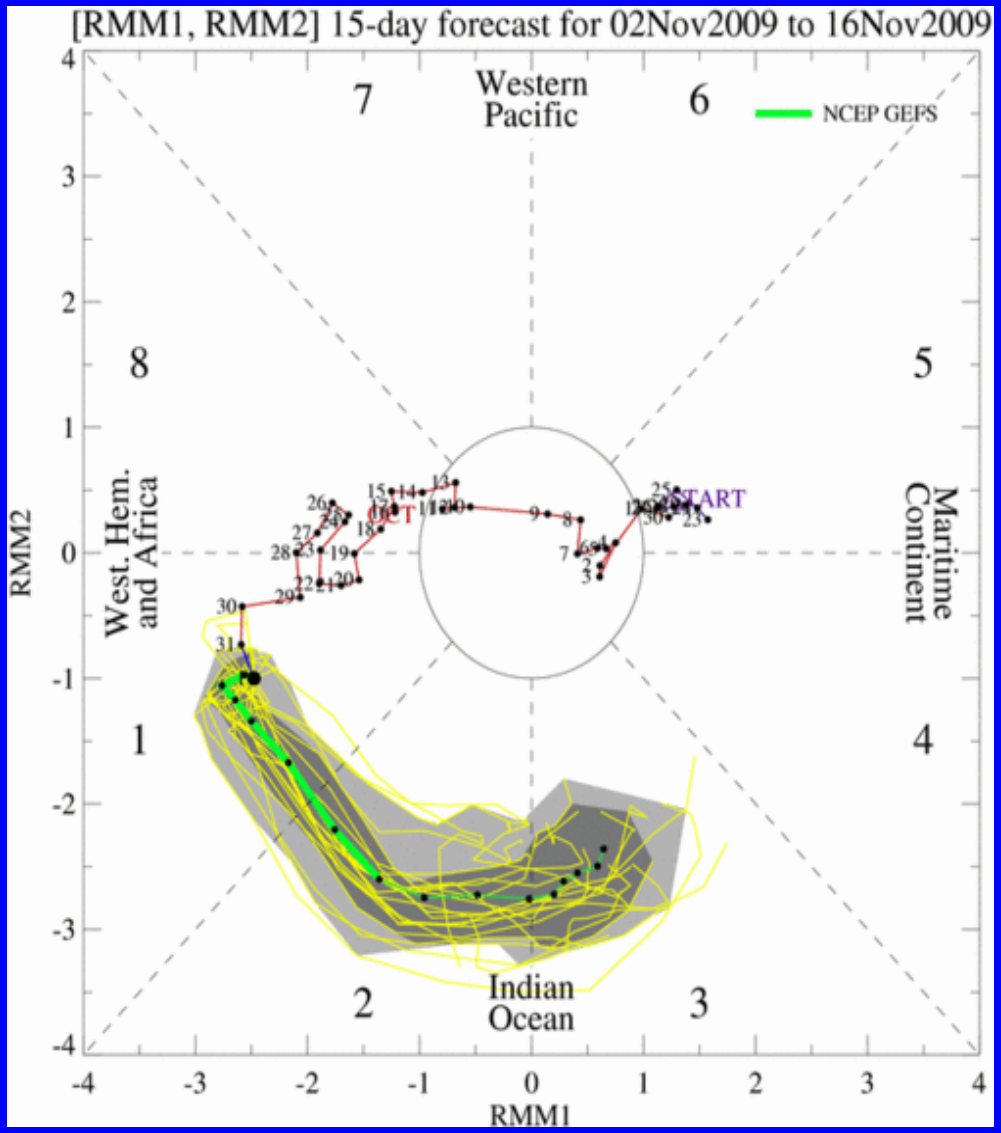
Ensemble GFS (GEFS) MJO Forecast

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

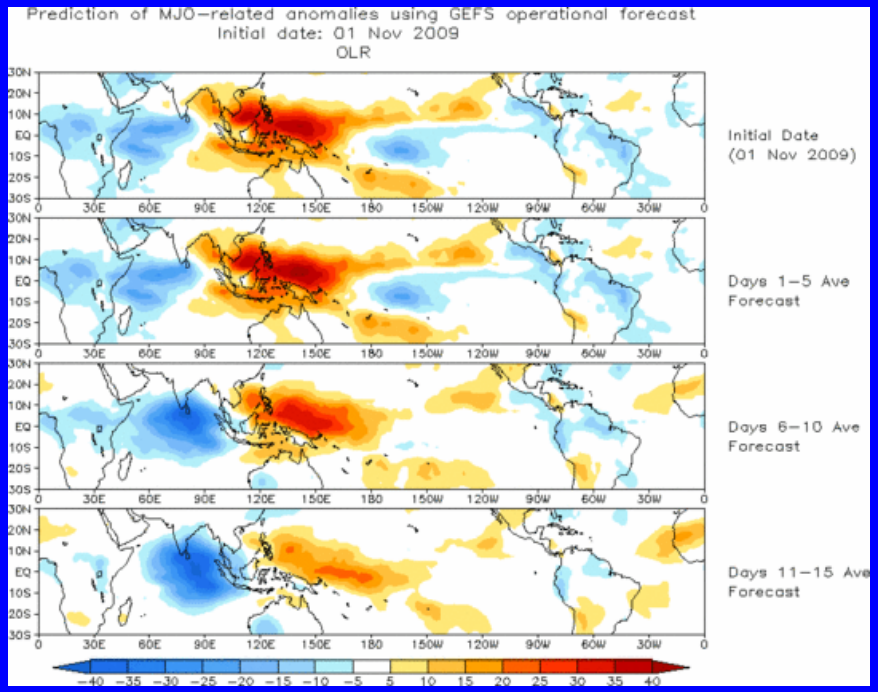
The GFS MJO index forecasts indicate a strong MJO signal during the period with eastward propagation for most of the period.



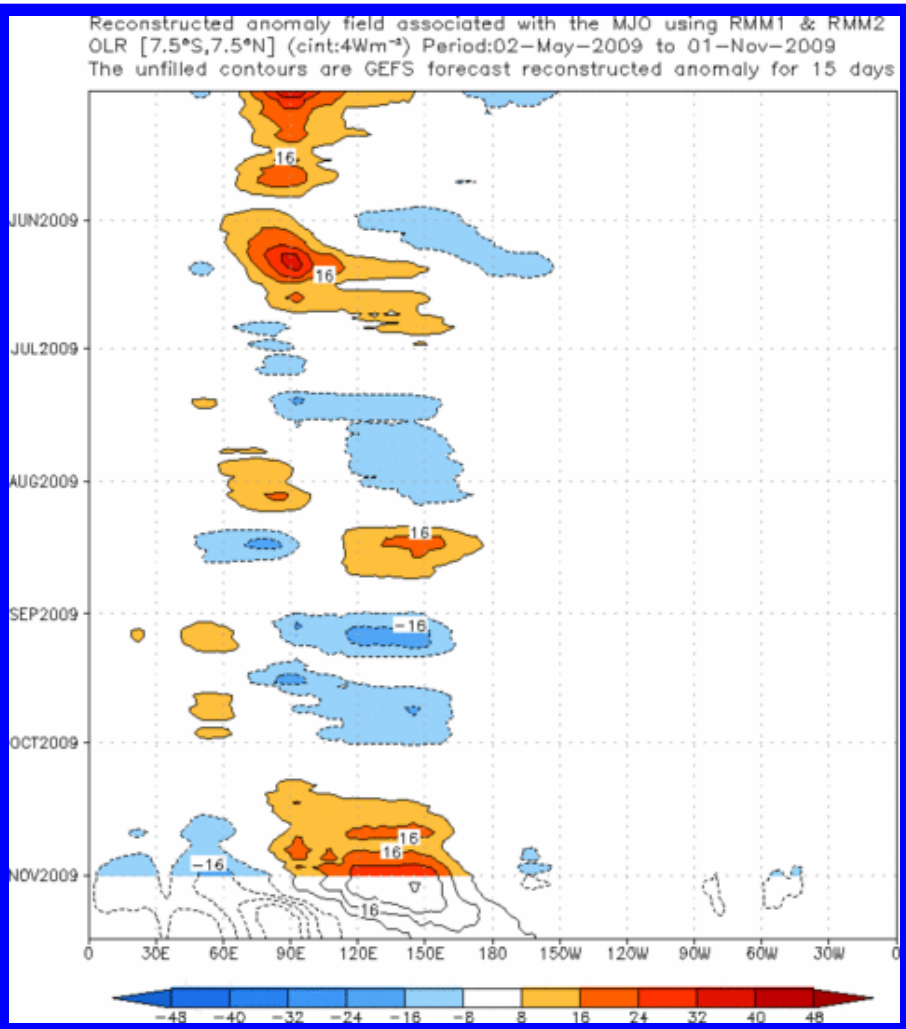
Ensemble Mean GFS MJO Forecast

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



The GEFS ensemble mean forecasts suppressed convection slowly shifting eastward from the Maritime Continent into the western Pacific and enhanced convection in the Indian Ocean.

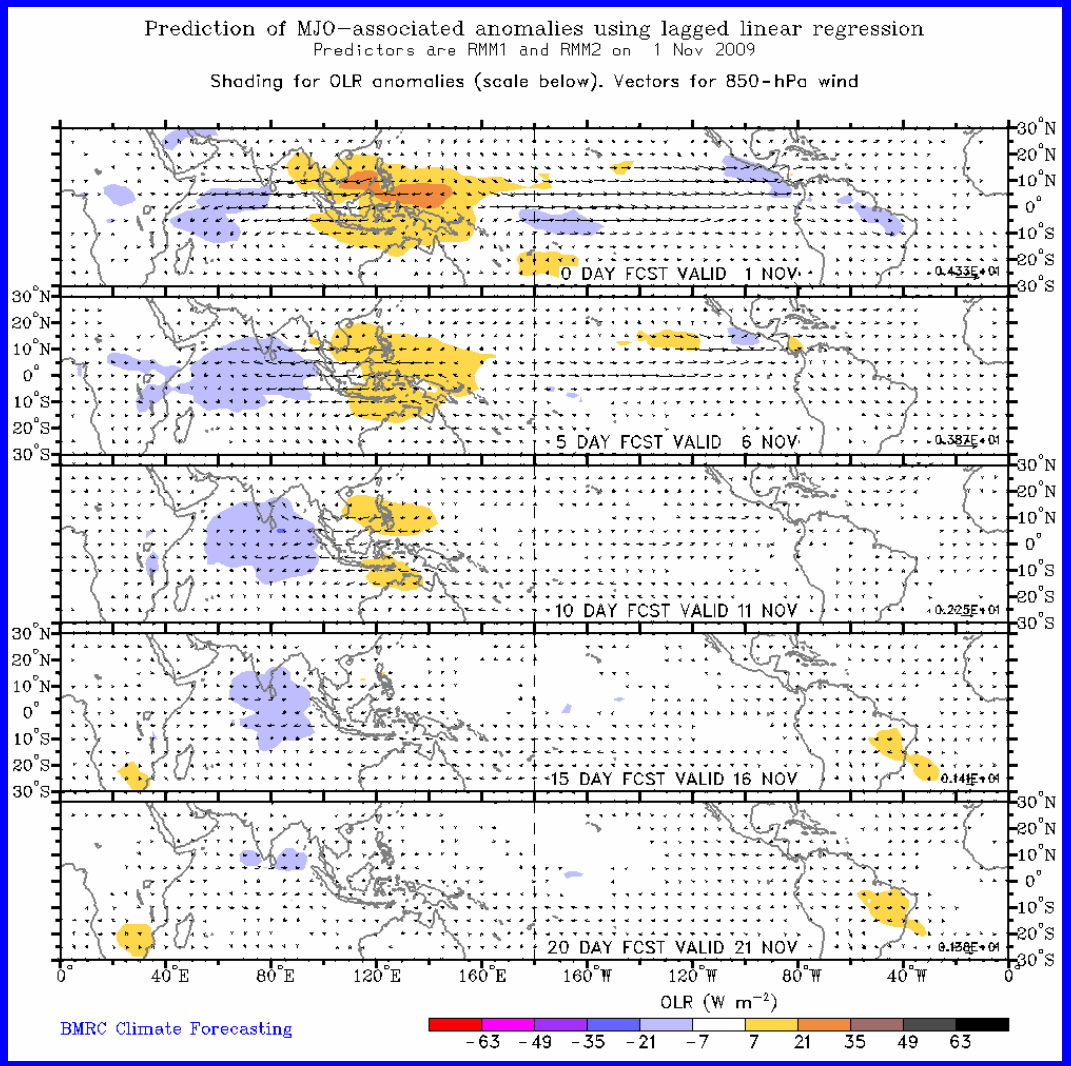
Statistical MJO Forecast

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

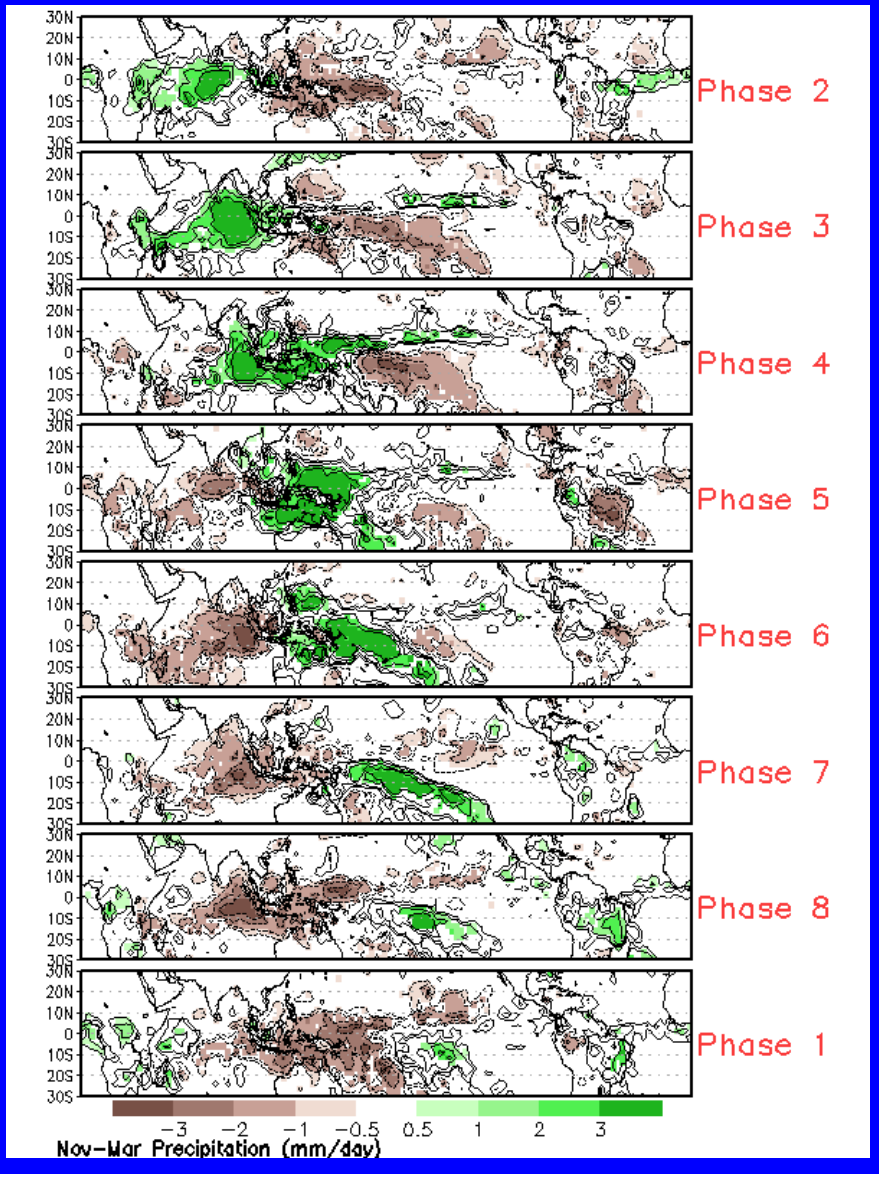
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical model forecast is a bit more progressive than the dynamical models. A weak signal is evident and shows enhanced convection across the Indian Ocean during Week-1.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)