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

Update prepared by
Climate Prediction Center / NCEP
October 19, 2009

Outline

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

Overview

- The MJO has shown some signs of strengthening during the past week but the patterns of anomalous convection and wind continue to be impacted strongly by other subseasonal tropical variability and ENSO.

- Uncertainty remains high as to whether the current signal will further strengthen and become a more coherent MJO as some model MJO index forecasts indicate.

- A stronger more coherent MJO during the period would favor increased chances for wet conditions across parts of the eastern Pacific, Central America and Africa and dry conditions across the Maritime continent.

- The threat for tropical cyclone activity would be elevated for the western Caribbean Sea and parts of the eastern Pacific.

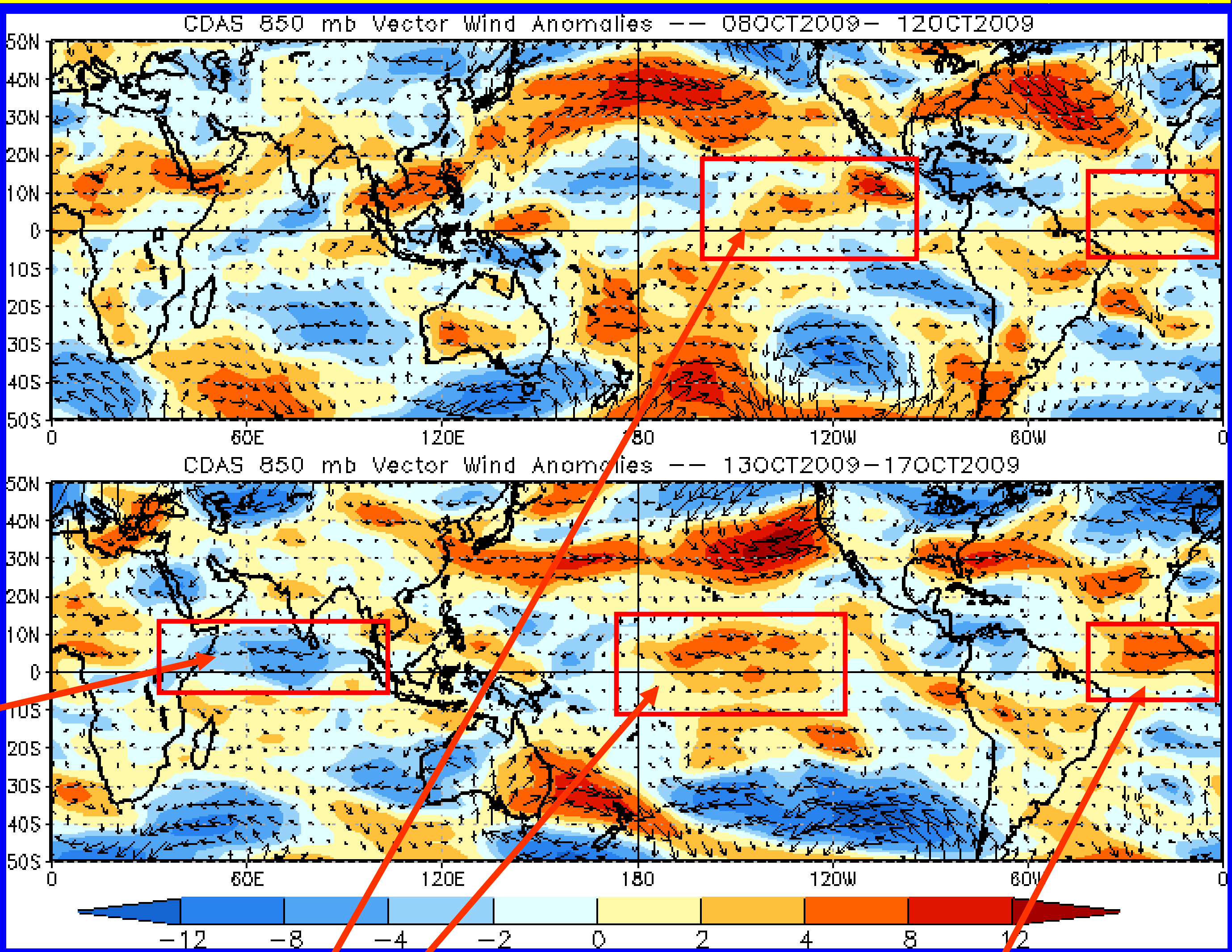
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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 have returned to the Indian Ocean during the last five days.

Westerly anomalies continued across the equatorial central Pacific during the last five days.

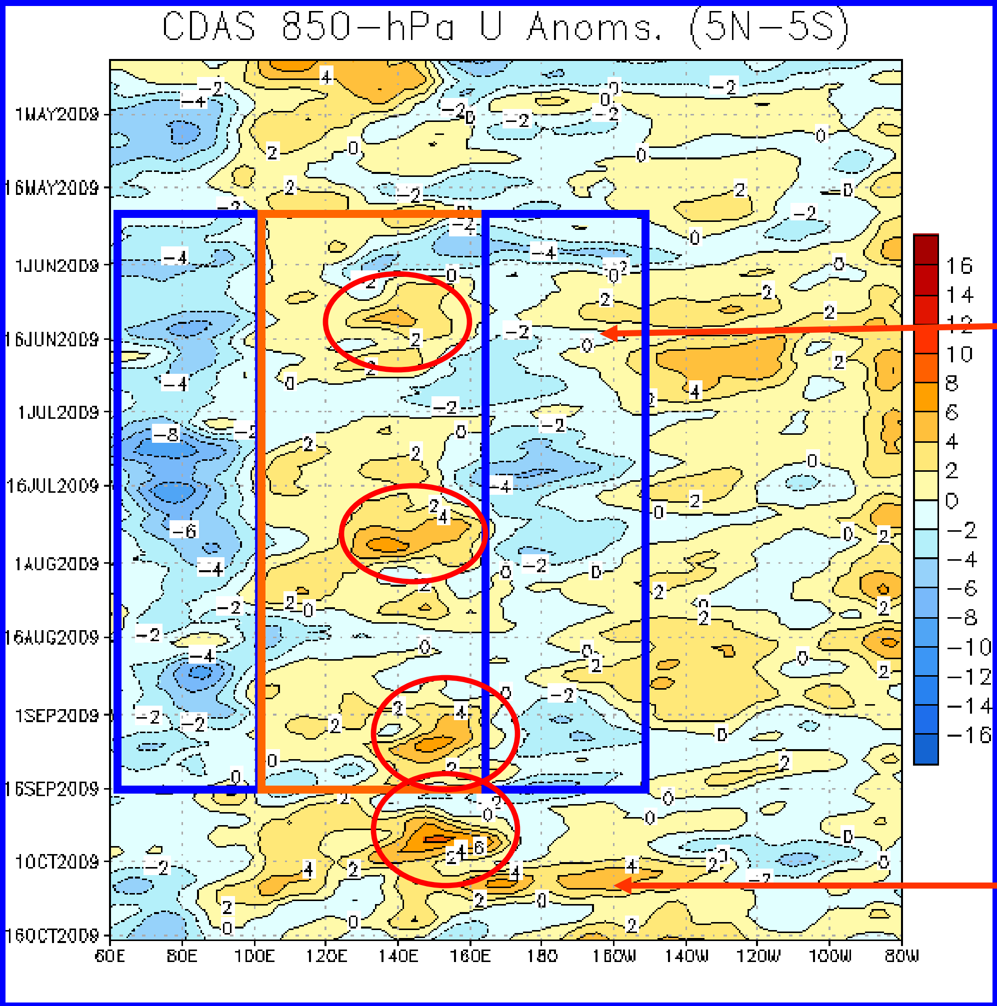
Westerly anomalies continued across the Atlantic and Africa during the last ten days.

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



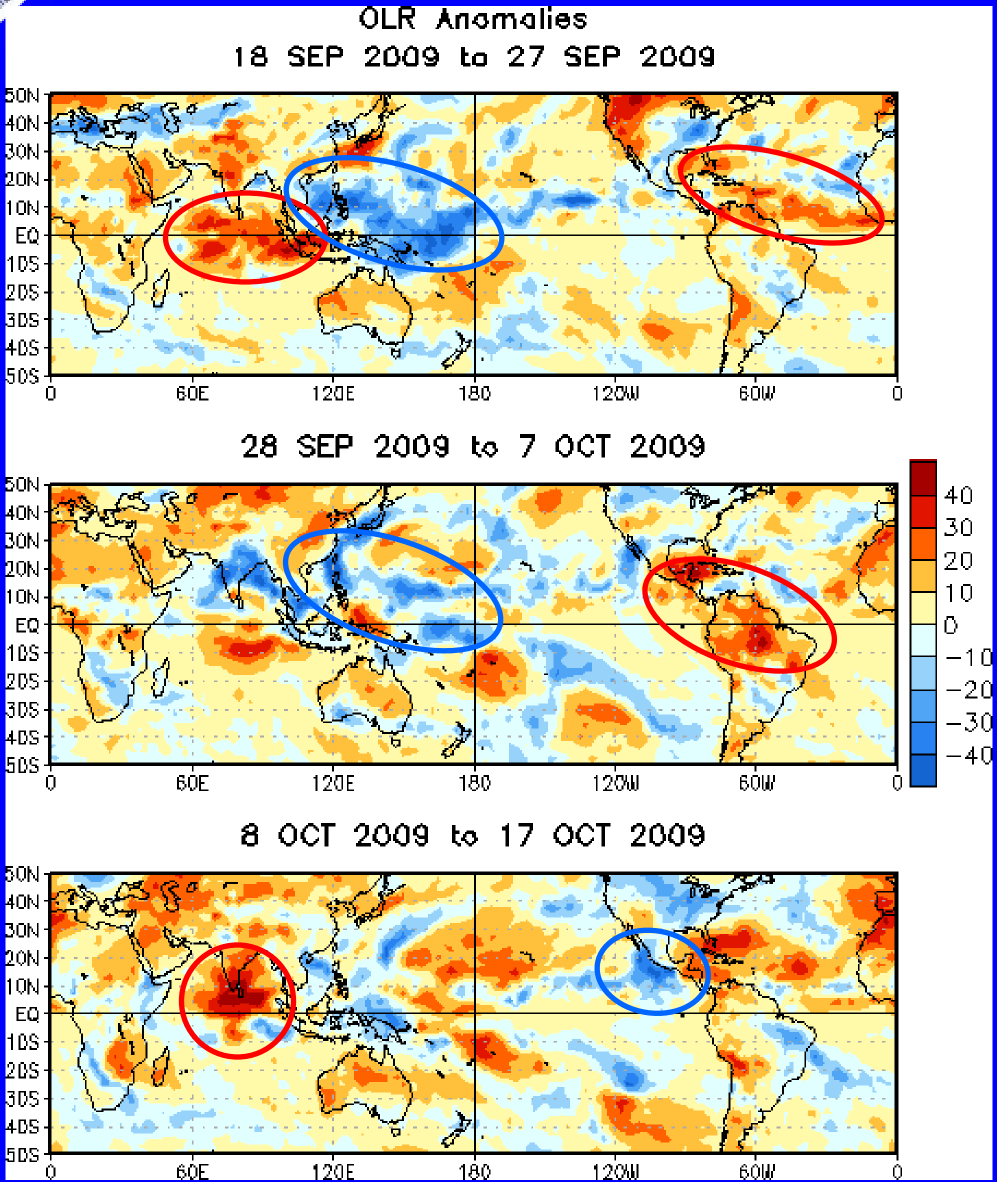
Longitude

From May into September, easterly (westerly) anomalies have mainly prevailed across the Indian Ocean (Indonesia).

A few westerly wind bursts (red circles) have occurred during this period and are evident in mid-June, late July, early September and late September. There has also been a slow gradual shift eastward of the westerly anomalies over the entire period.

Westerly wind anomalies shifted rapidly across the Date Line during early October.

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-to-late September enhanced convection (blue oval) was widespread across the western Pacific while areas of suppressed convection (red ovals) were evident over the Indian Ocean and Atlantic.

During late September into early October, enhanced convection diminished across the western Pacific while suppressed convection prevailed across Central America and northern South America.

Anomalous convection was mixed across the western Pacific during mid-October while suppressed convection developed near India and enhanced convection further increased west of Mexico.

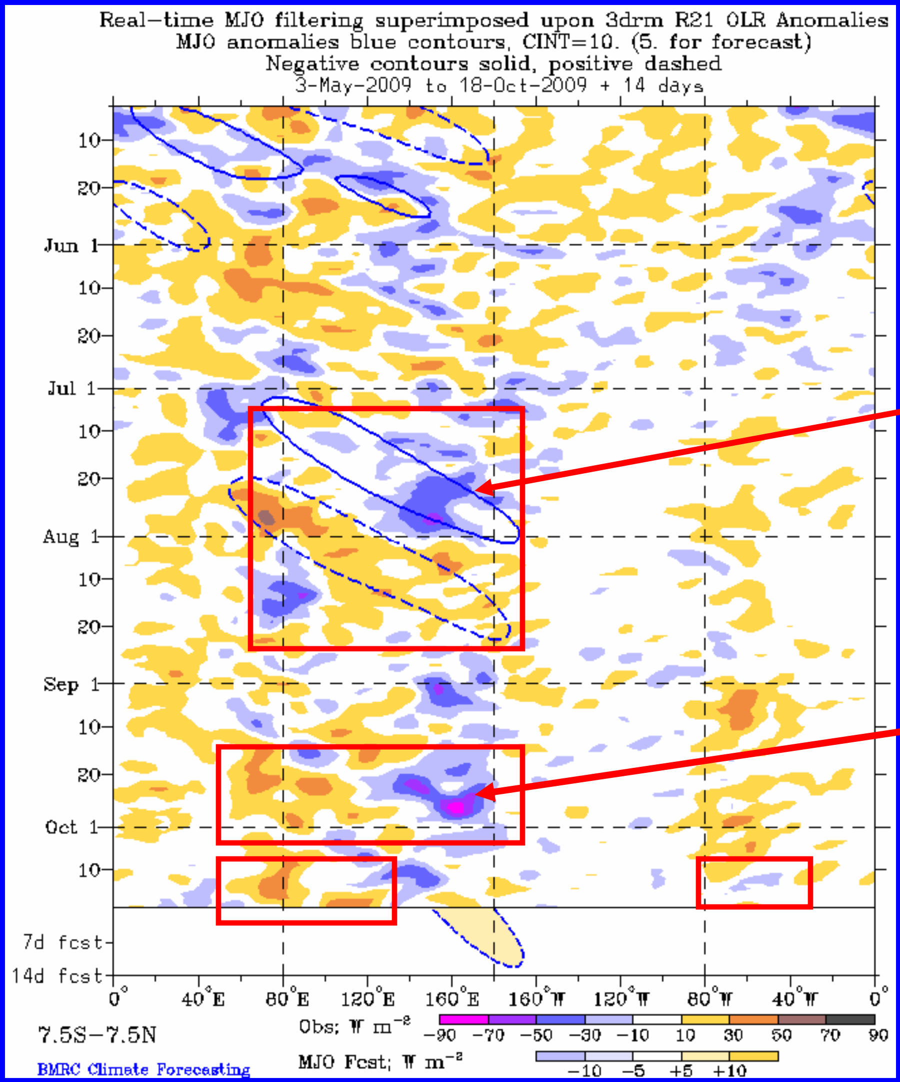
Outgoing Longwave Radiation (OLR) Anomalies (7.5°S-7.5°N)

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)

Time



Longitude

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).

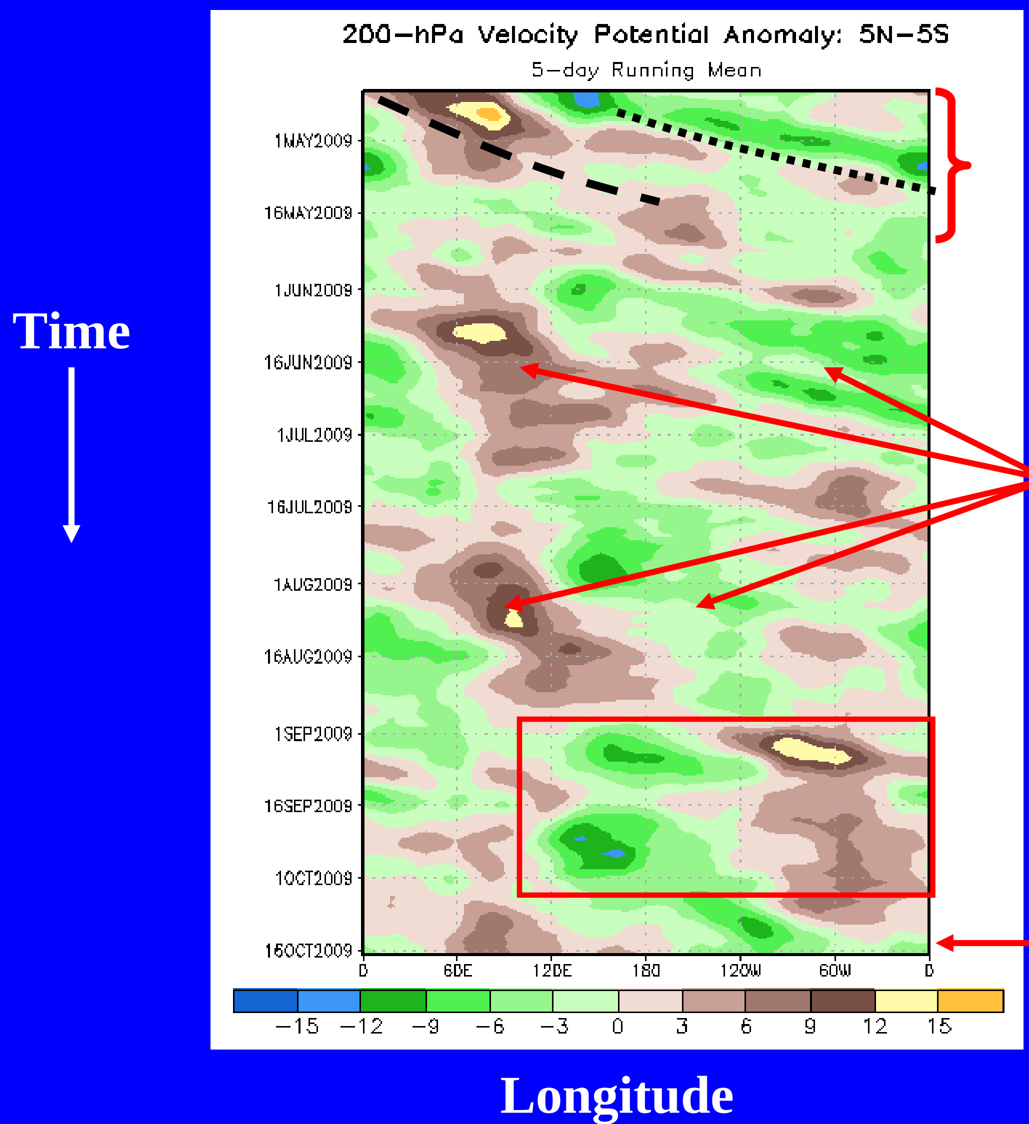
During late September, suppressed (enhanced) convection became prevalent over the Indian ocean (western Pacific).

Most recently, drier than average conditions between 80W and 40W have eased as weak suppressed convection is evident across the Indian Ocean (lower red boxes).

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



From mid-April to early May, eastward propagating velocity potential anomalies indicated moderate-to-strong MJO activity.

The MJO weakened in May.

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

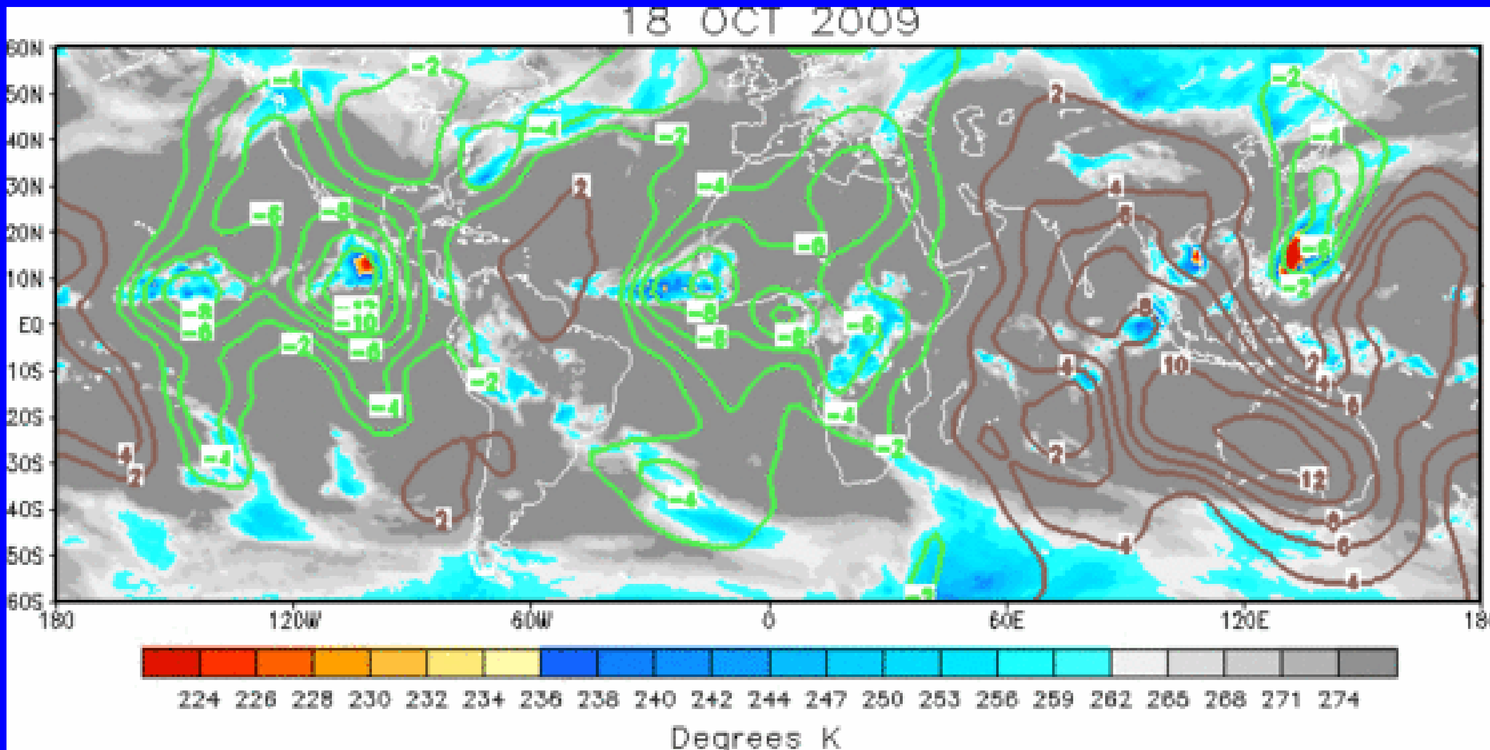
Anomalies increased during September but the overall pattern remained generally persistent with upper-level divergence (convergence) across the western Pacific (parts of Western Hemisphere) (red box).

Recently, there is evidence of an eastward shift of negative anomalies across the Pacific.

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



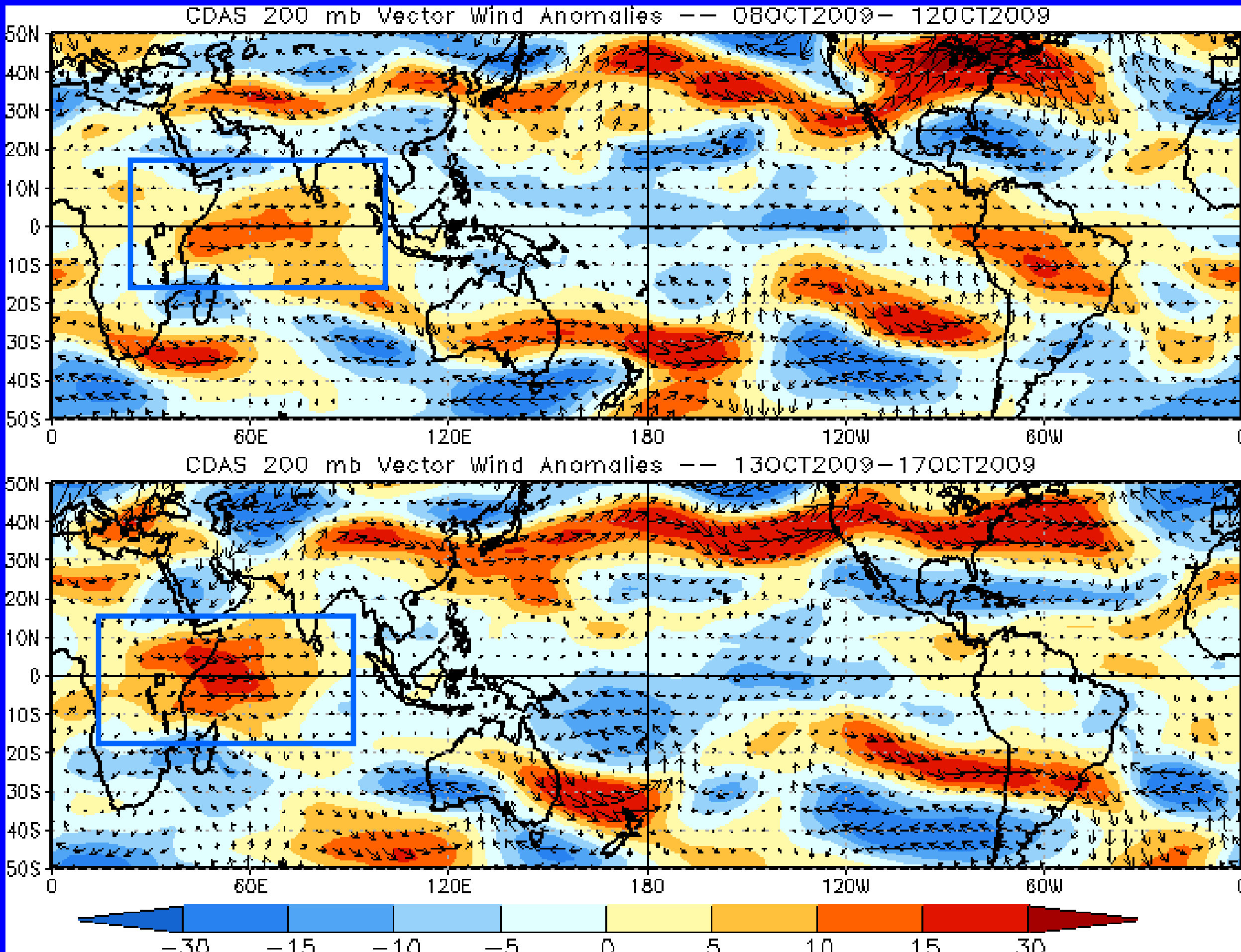
Velocity potential anomalies indicate strong upper-level divergence across the eastern Pacific Ocean with upper-level convergence across the Indian Ocean and western Pacific. This pattern has been shifting eastward.

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

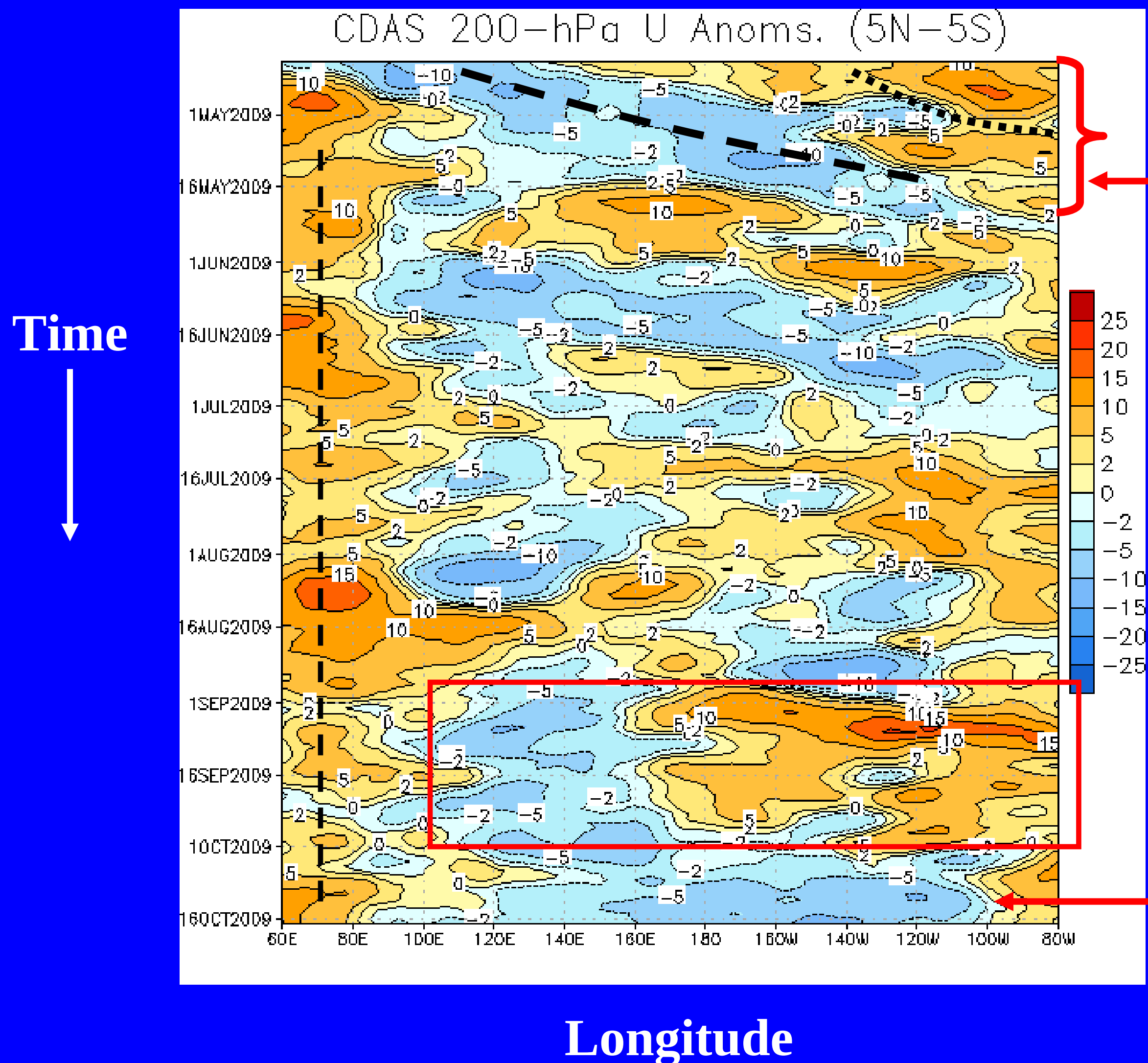


Westerly anomalies have persisted across the Indian Ocean and Africa during the last ten days (blue boxes).

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



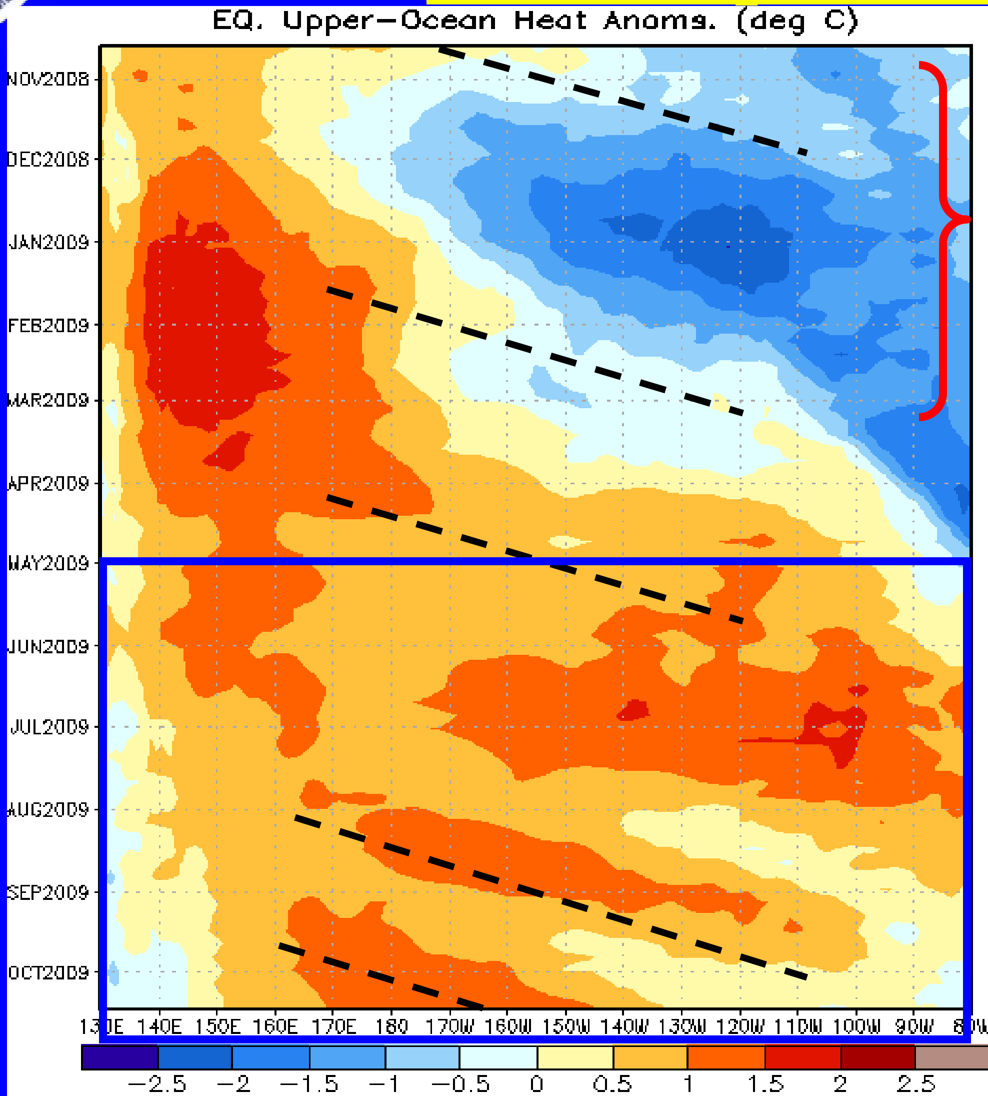
Alternating eastward-propagating easterly and westerly anomalies, consistent with MJO activity, were evident from mid-April to mid-May.

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 Western Hemisphere.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

- **During September 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 October (last two dashed black line).**

MJO Index -- Information

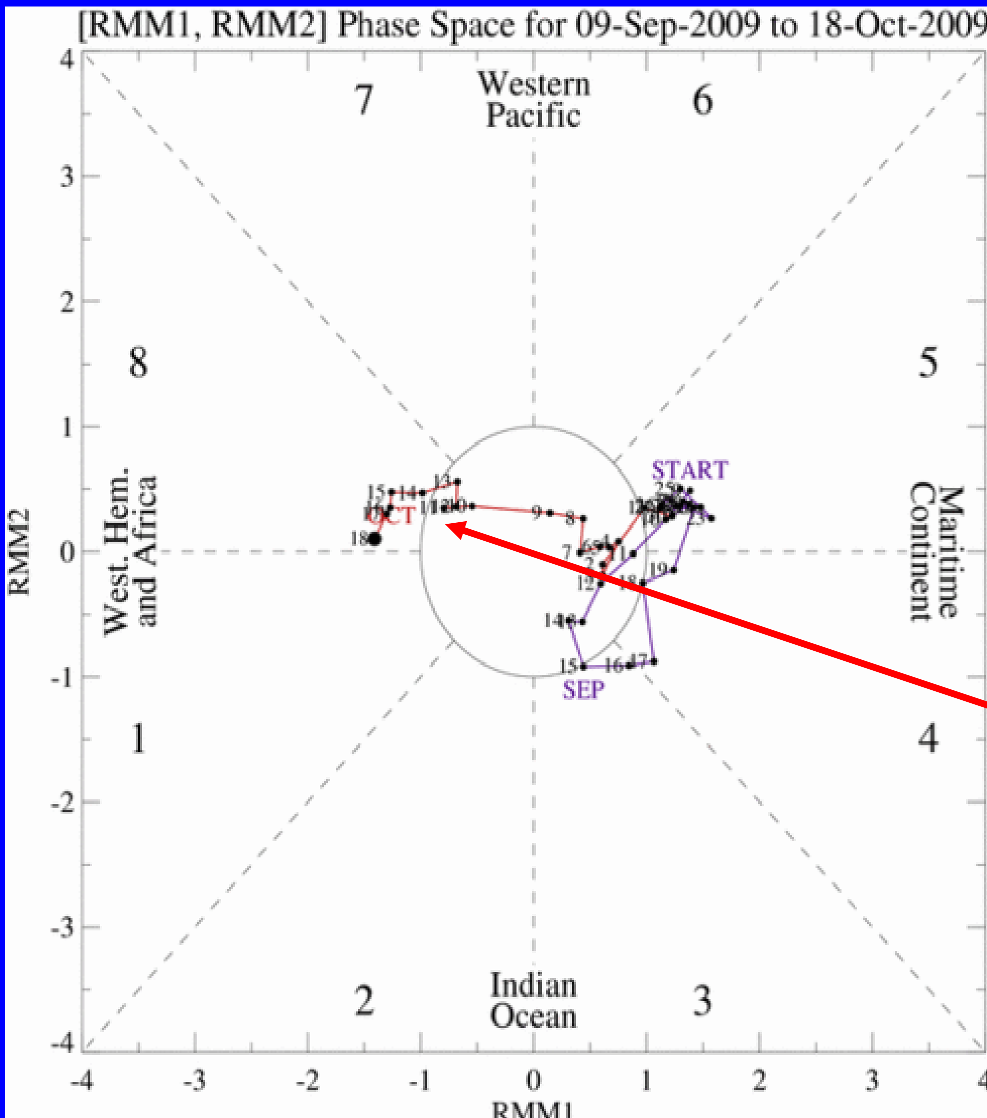
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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 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).**

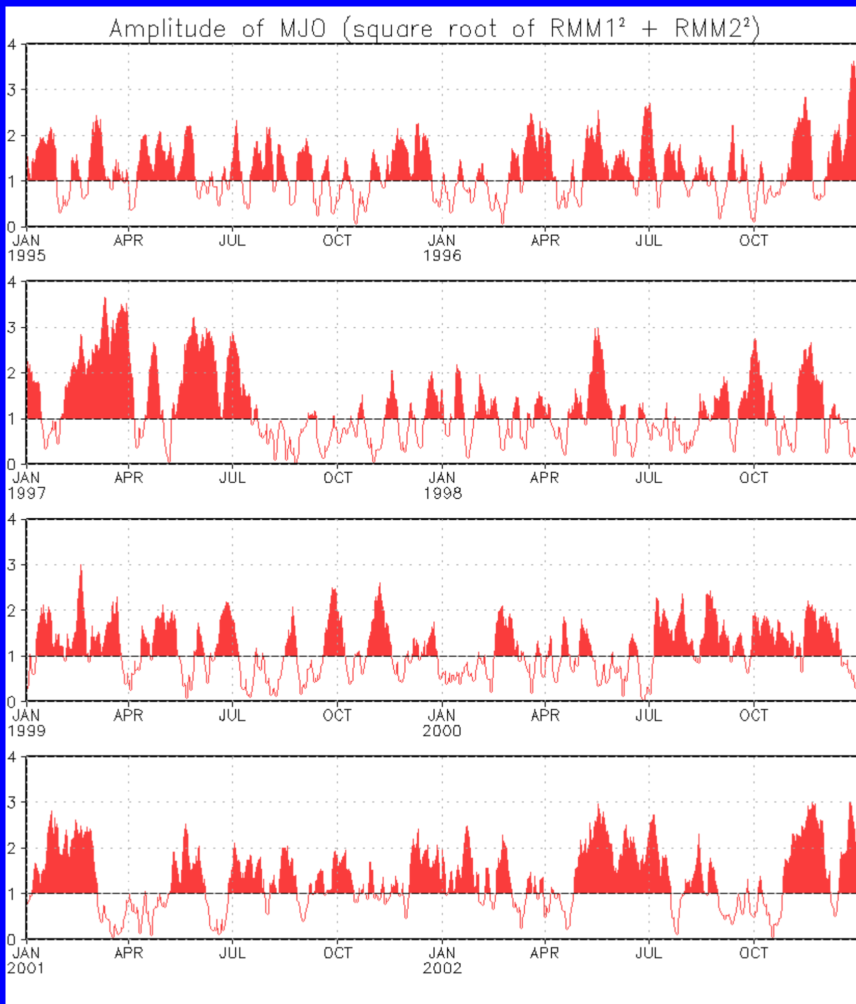
MJO Index -- Recent Evolution

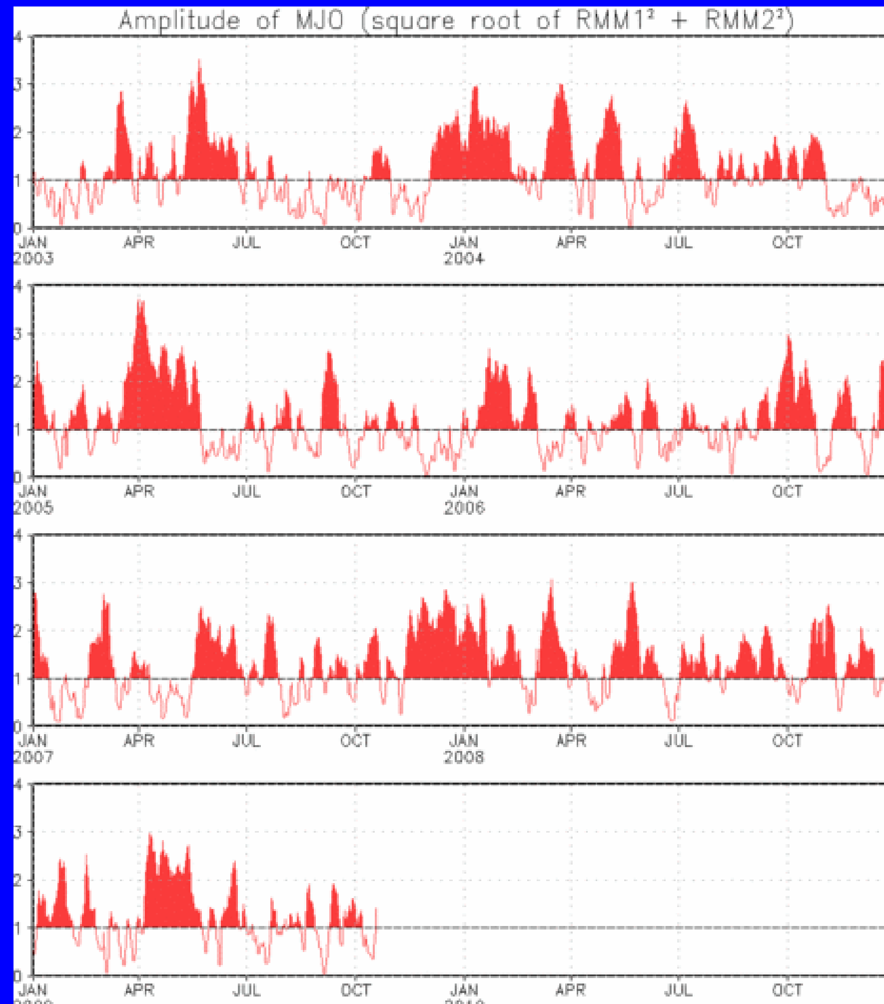


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index has remained generally weak during the past few weeks but has increased in amplitude recently.

MJO Index – Historical Daily Time Series





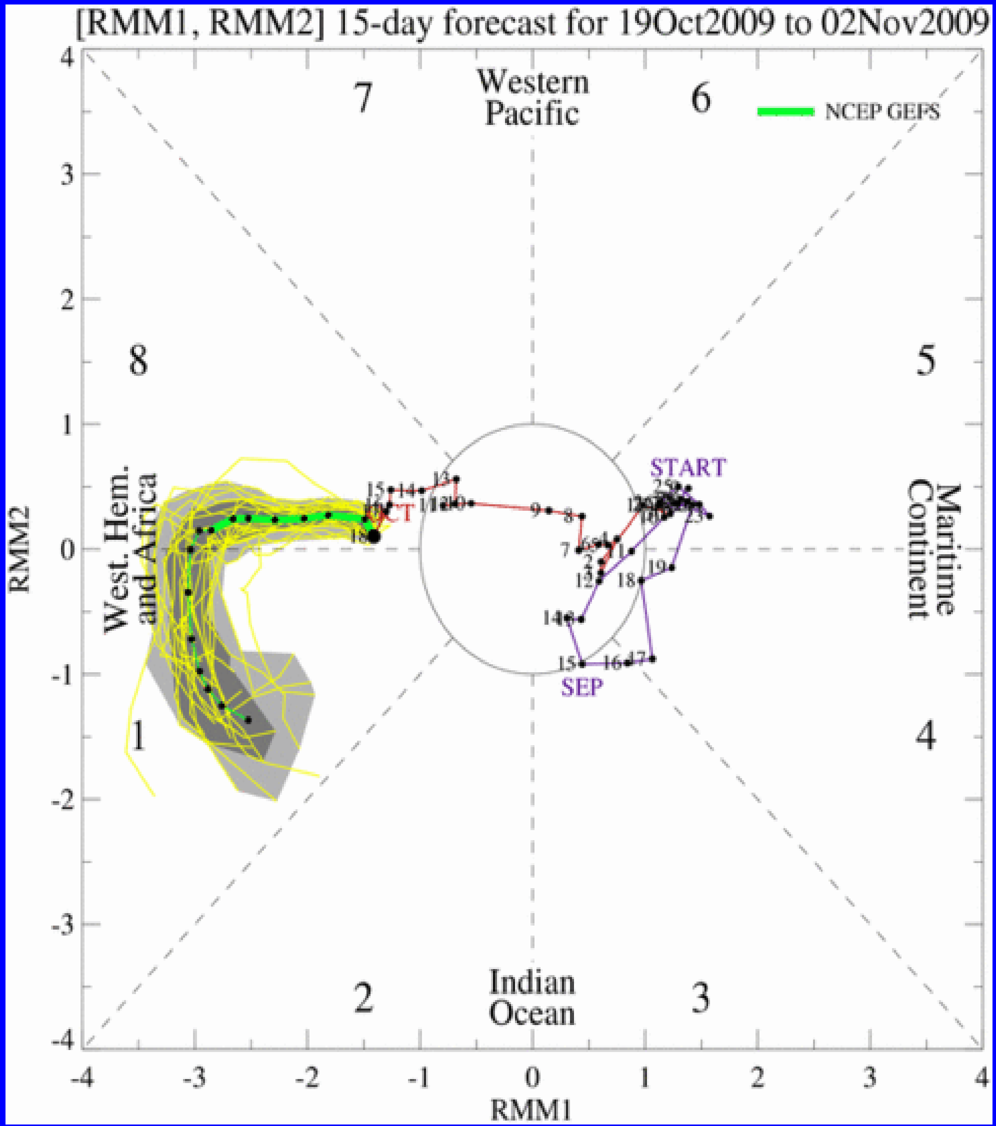
Time series of daily MJO index amplitude from 1995 to present. Plots put current MJO activity in historical context.

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

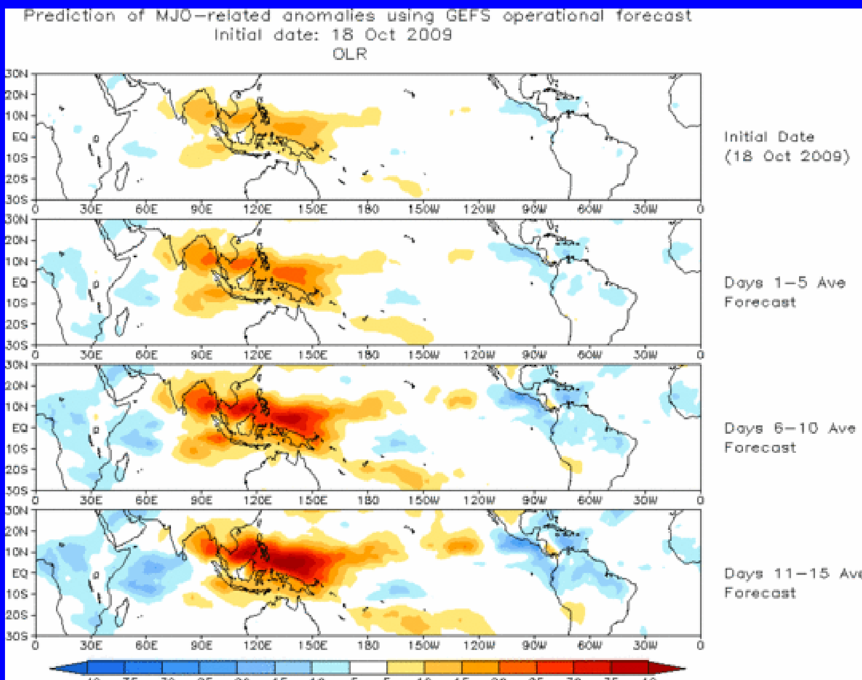


The GFS ensemble mean MJO index forecast indicates a strengthening MJO signal with eastward propagation noted during Week-2.

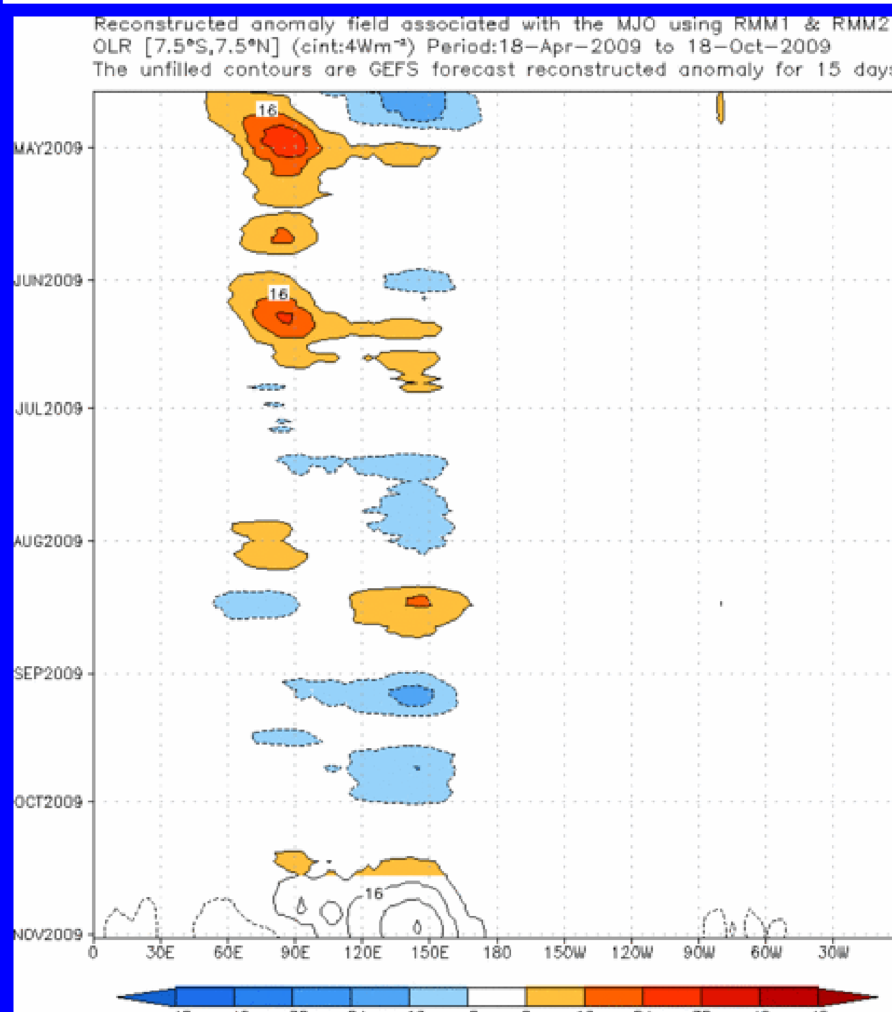
Ensemble Mean GFS MJO Forecast

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 stretching from southern India to the Maritime Continent during the period with the strongest signal during Week-2.

Enhanced convection is indicated across Central America and northern South America.

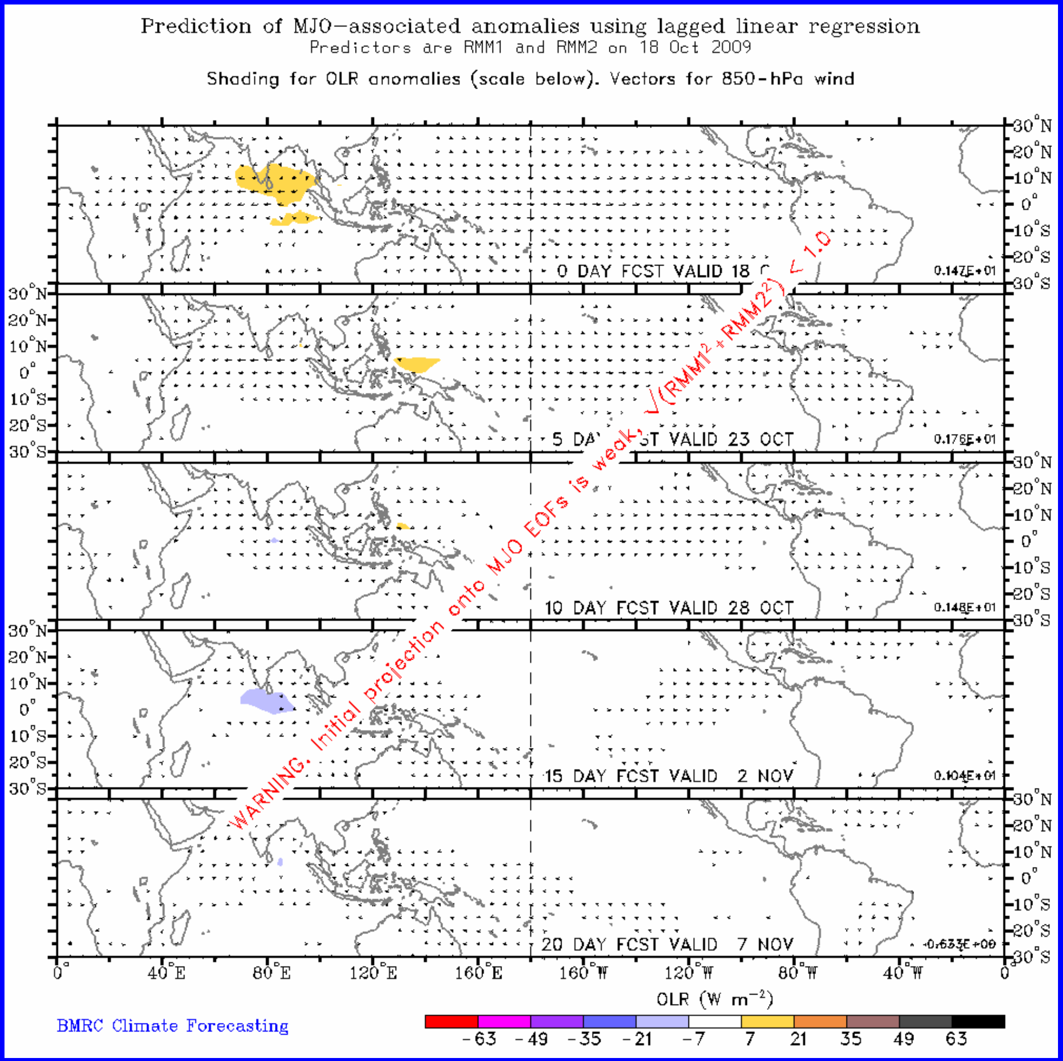
Statistical MJO Forecast

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

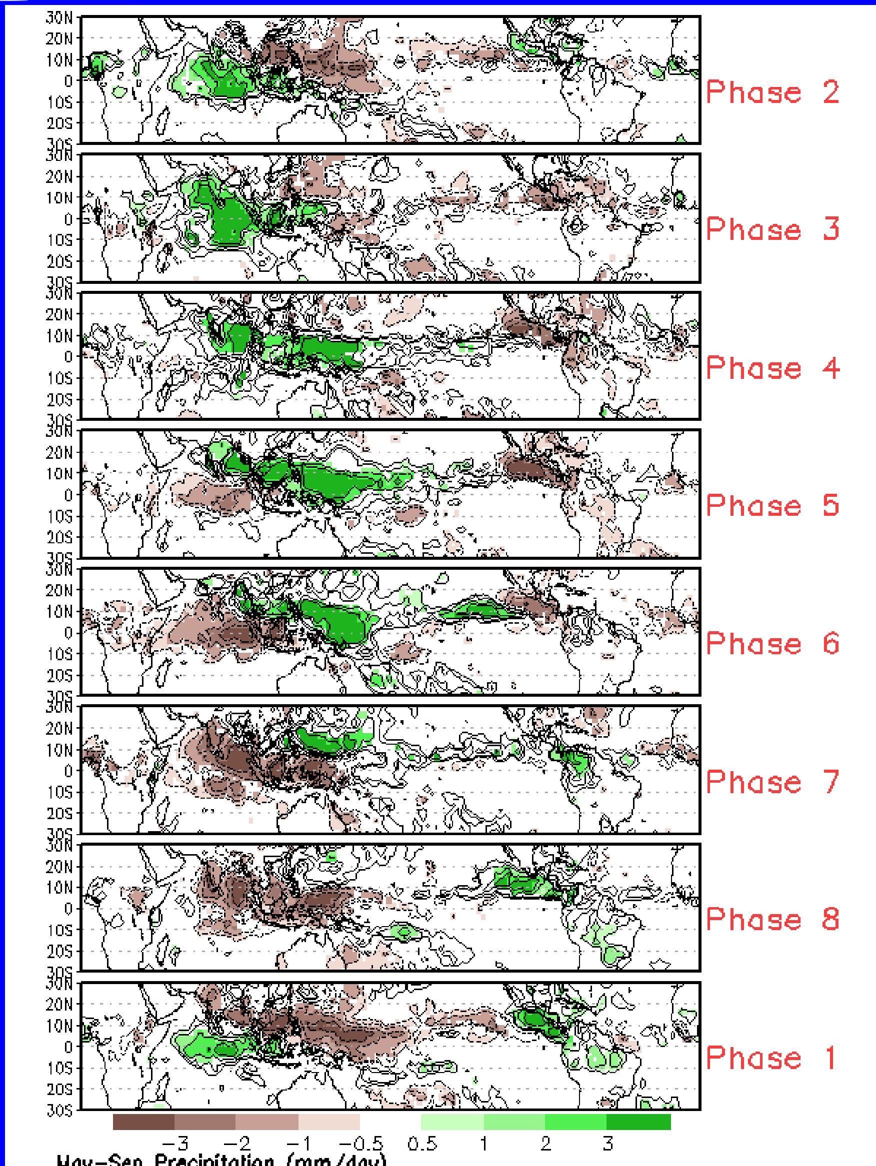
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

A statistical model forecasts weak MJO activity during the next 1-2 weeks.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)