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

Update prepared by
Climate Prediction Center / NCEP
October 5, 2009

Outline

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

Overview

- The MJO remained weak during the past week.

- The patterns of anomalous convection and winds are a result of a combination of several factors including other subseasonal variability and ENSO.

- Based on the most recent observations and model MJO forecasts, the MJO is expected to remain not active during the next two weeks.

- The MJO is not expected to contribute substantially to the patterns of tropical rainfall over the period.

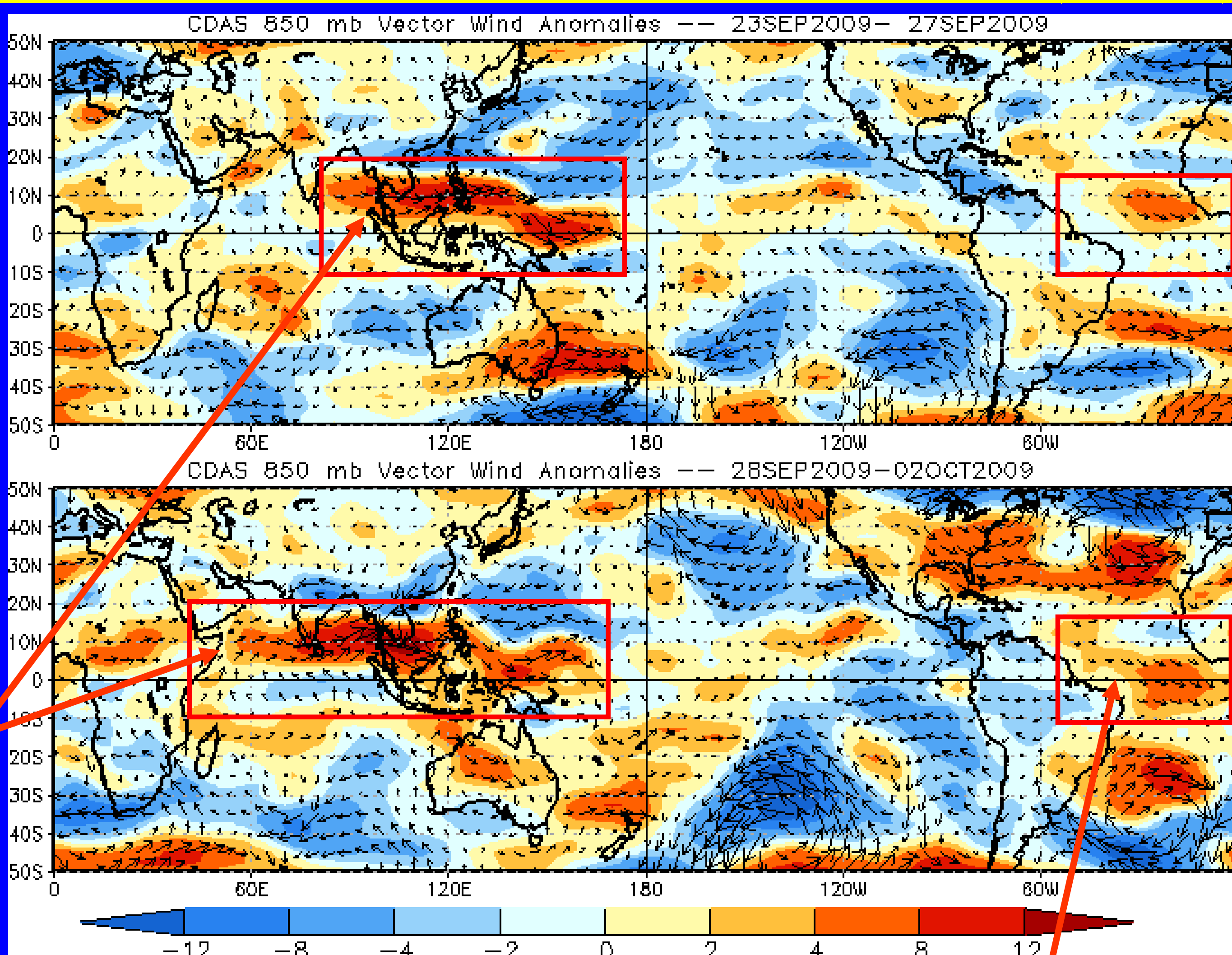
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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 continued and increased in coverage from the Arabian Sea to the west Pacific during the past five days.

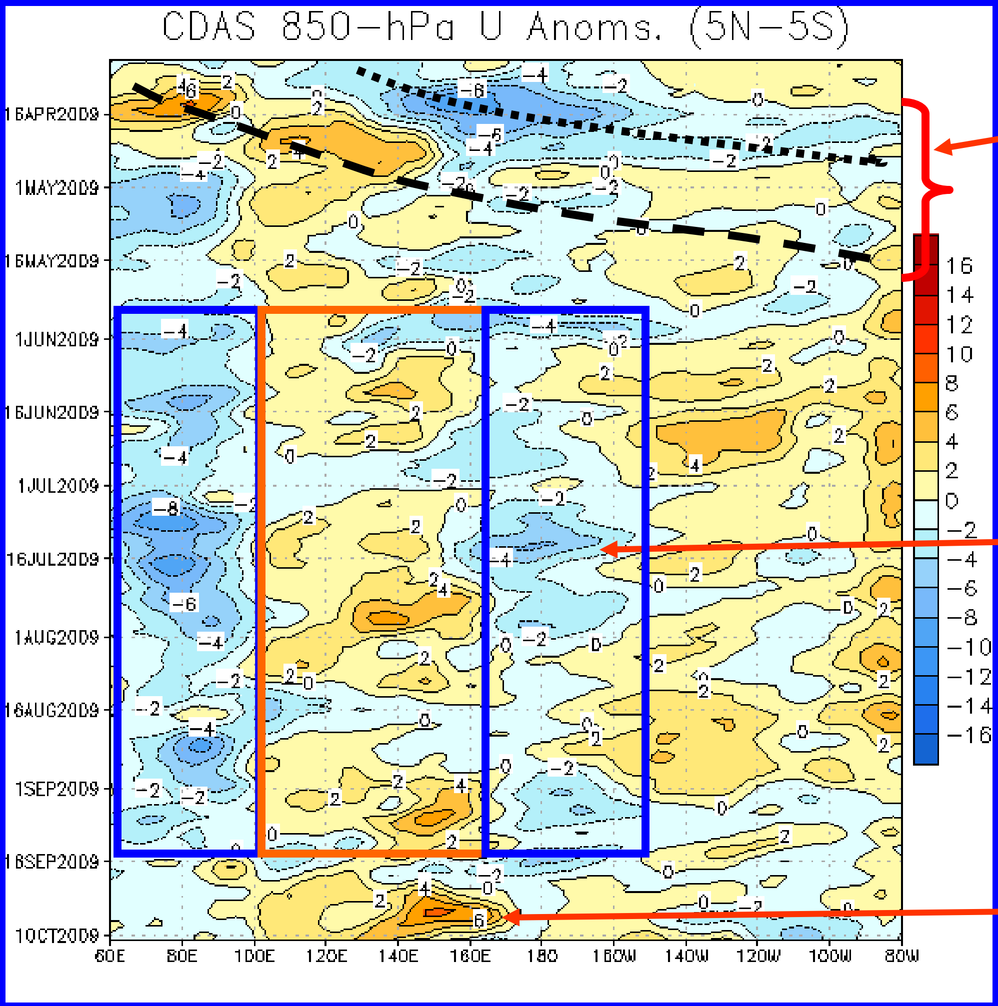
Westerly anomalies continued across the Atlantic during the last five days.

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



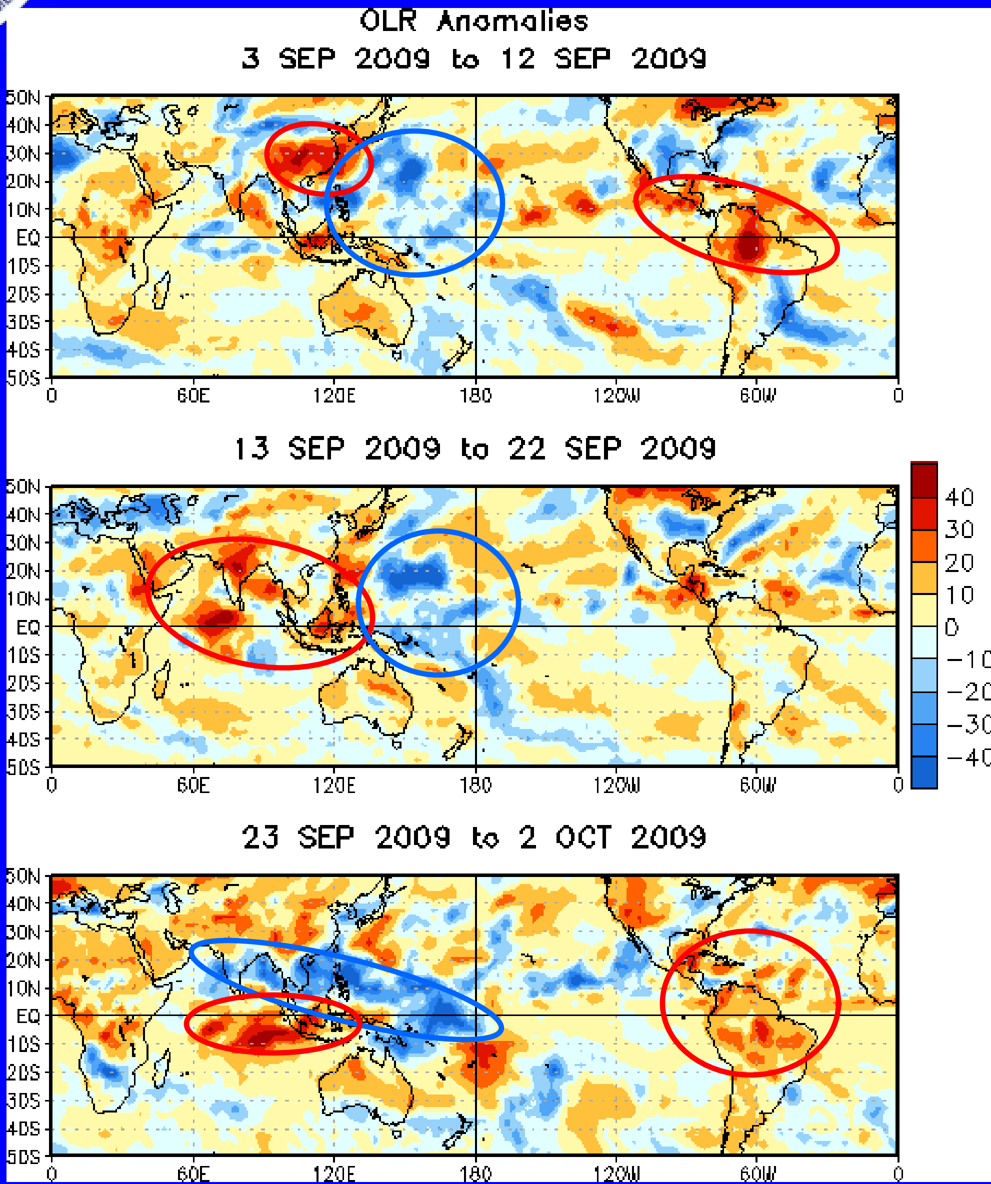
Longitude

During April and early May, a pattern of alternating eastward-propagating low-level easterly and then westerly anomalies, associated with the MJO, was evident over the Indian Ocean and equatorial Pacific.

From May into September, easterly (westerly) anomalies have mainly prevailed across the Indian Ocean (Indonesia). A few westerly wind bursts occurred during the period and are evident in late July and early September. There has also been a slow gradual shift eastward of the westerly anomalies over the period.

Most recently, strong westerly wind anomalies are again evident near 150E.

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 September, suppressed convection (red ovals) was evident across southern China and Taiwan and parts of central and South America while enhanced convection (blue ovals) continued in the western Pacific.

During mid September, enhanced convection continued across the western Pacific with areas of suppressed convection over India and parts of the Maritime continent.

During late September and early October, a large area of enhanced convection stretched from India to the western Pacific. Suppressed convection continued across the Americas and returned to the equatorial Indian Ocean.

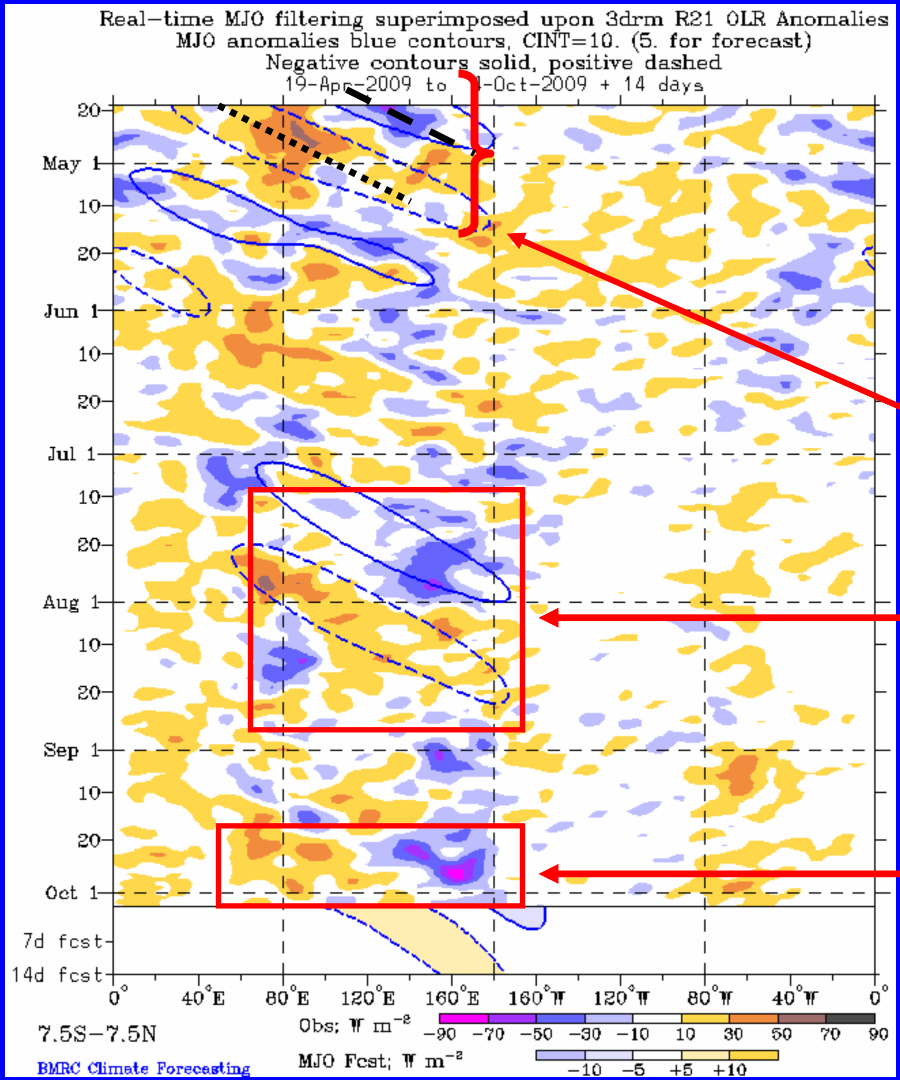
Outgoing Longwave Radiation (OLR) Anomalies (7.5°S-7.5°N)

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

From April into early May, areas of suppressed and enhanced convection shifted eastward in association with the MJO.

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).

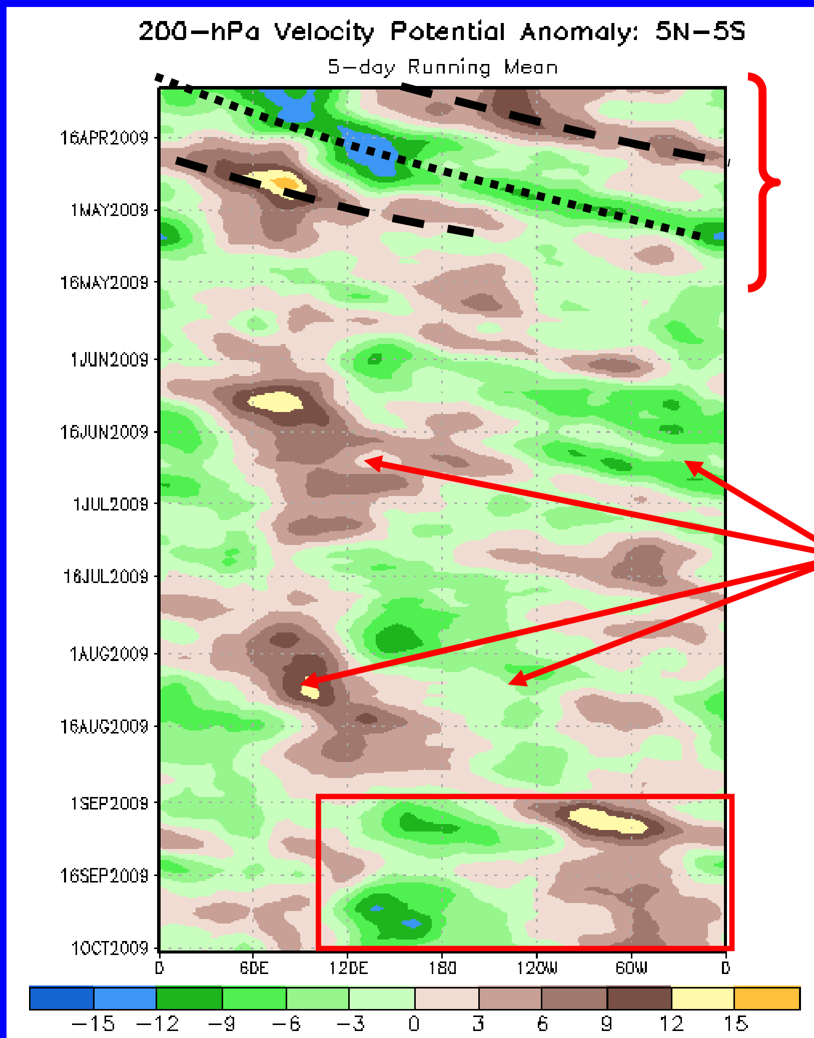
During the last two weeks, enhanced (suppressed) convection has become prevalent over the western Pacific (Indian ocean).

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

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

The MJO weakened in May.

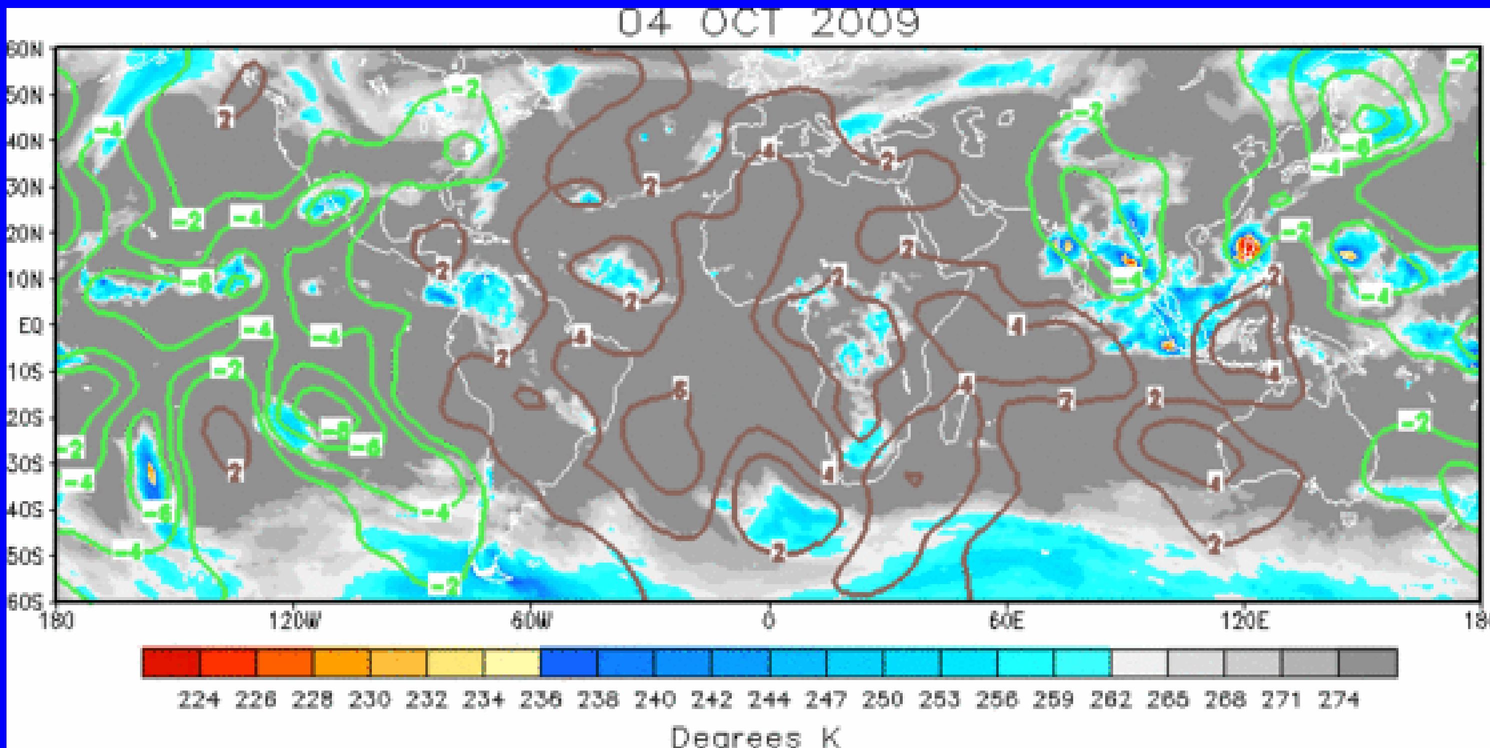
Velocity potential anomalies increased in early June and late July due to several types of subseasonal variability with some eastward propagation evident.

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

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

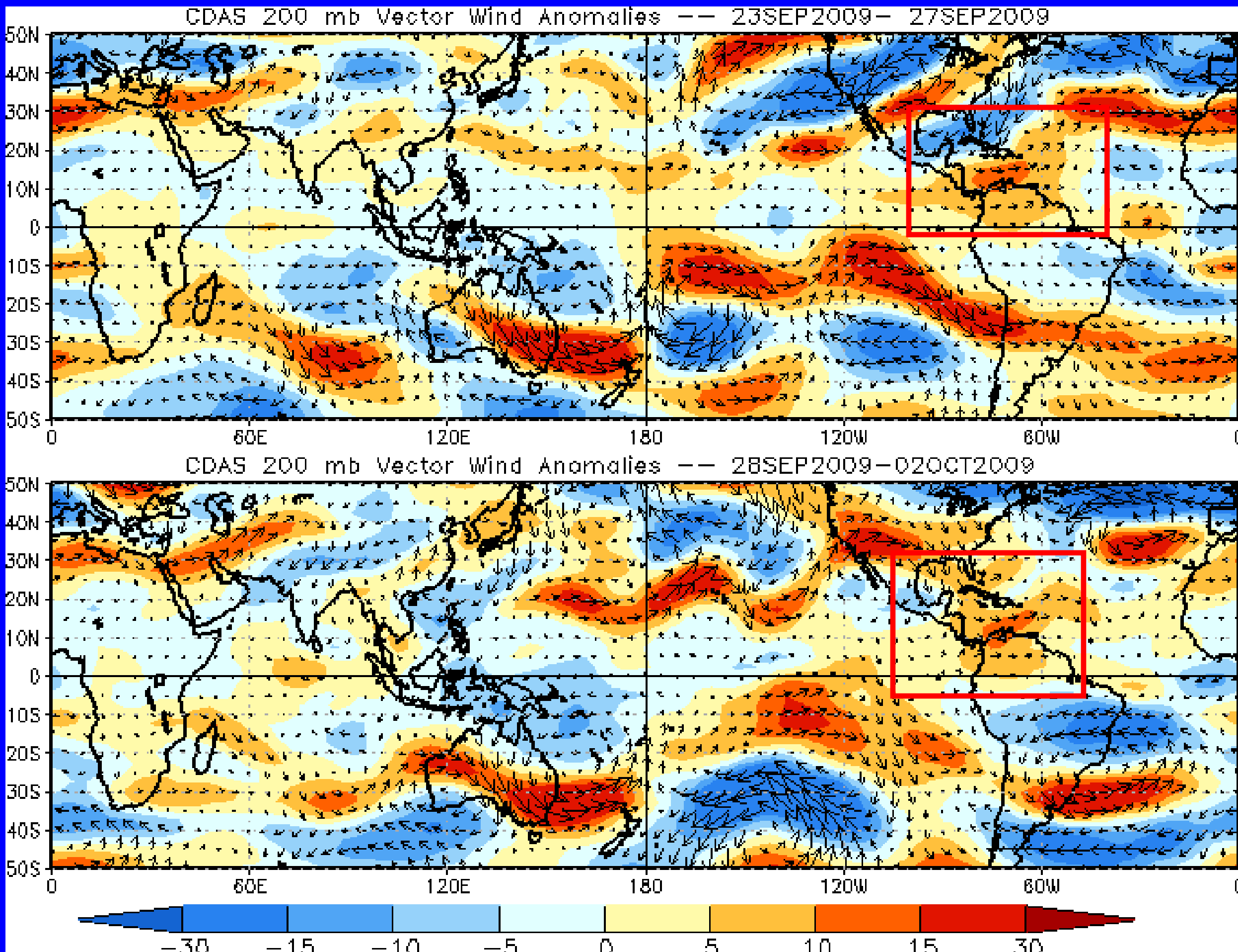
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



Velocity potential anomalies indicate upper-level divergence across much of the Pacific Ocean with upper-level convergence across portions of the Atlantic ocean and Africa.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

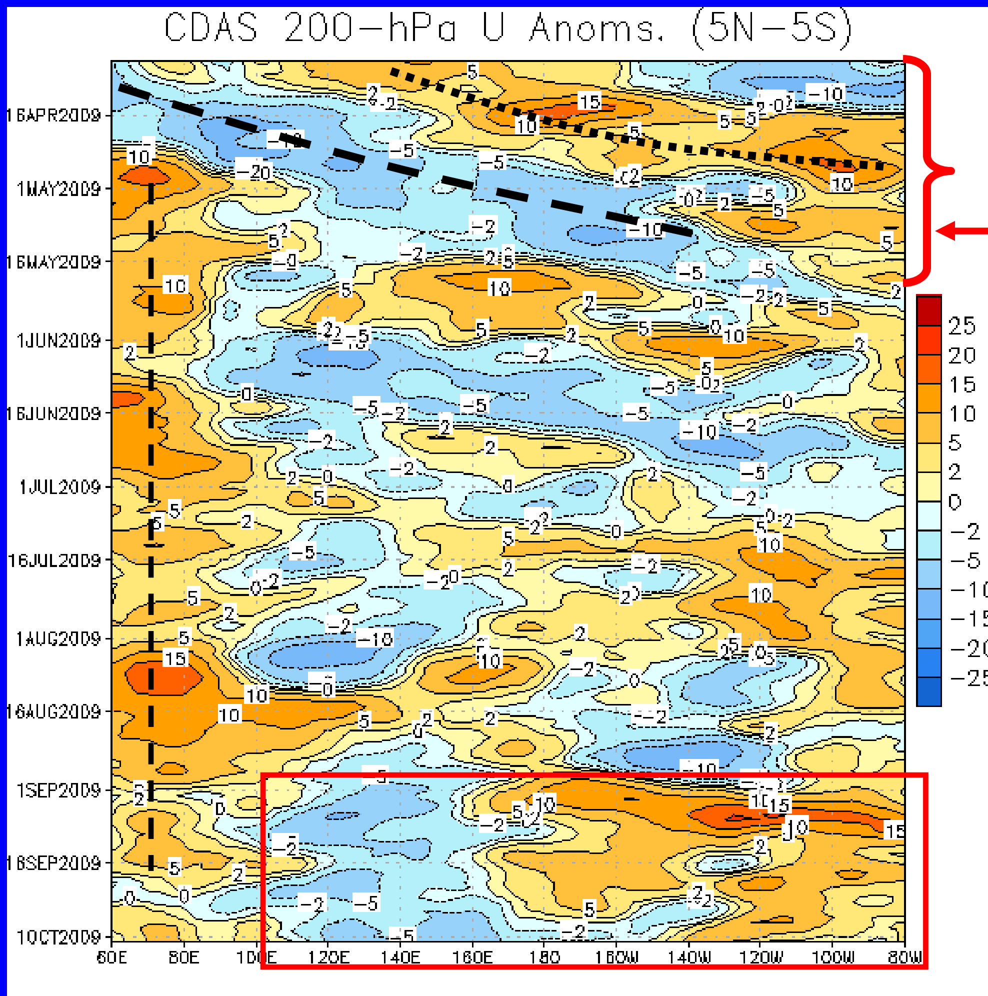
Westerly anomalies continued across much of the Caribbean Sea and western Atlantic (red boxes) during the last five to ten days.

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

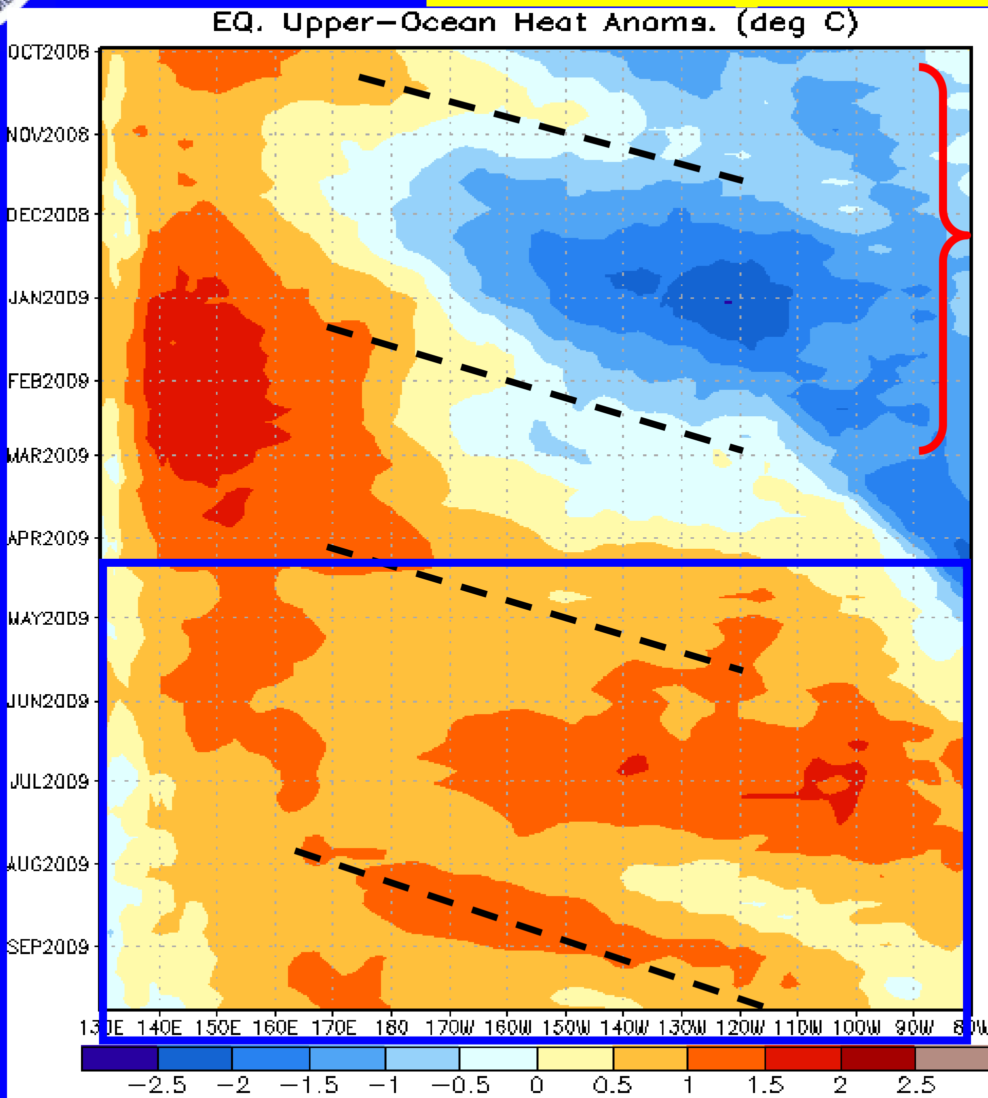
Alternating eastward-propagating easterly and westerly anomalies, consistent with MJO activity, were evident from mid-March to mid-May.

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

Easterly (westerly) anomalies have remained generally persistent across Indonesia (Western Hemisphere) during much of September (red box).

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 a Kelvin wave has shifted eastward during August and September (last dashed black line).**

MJO Index -- Information

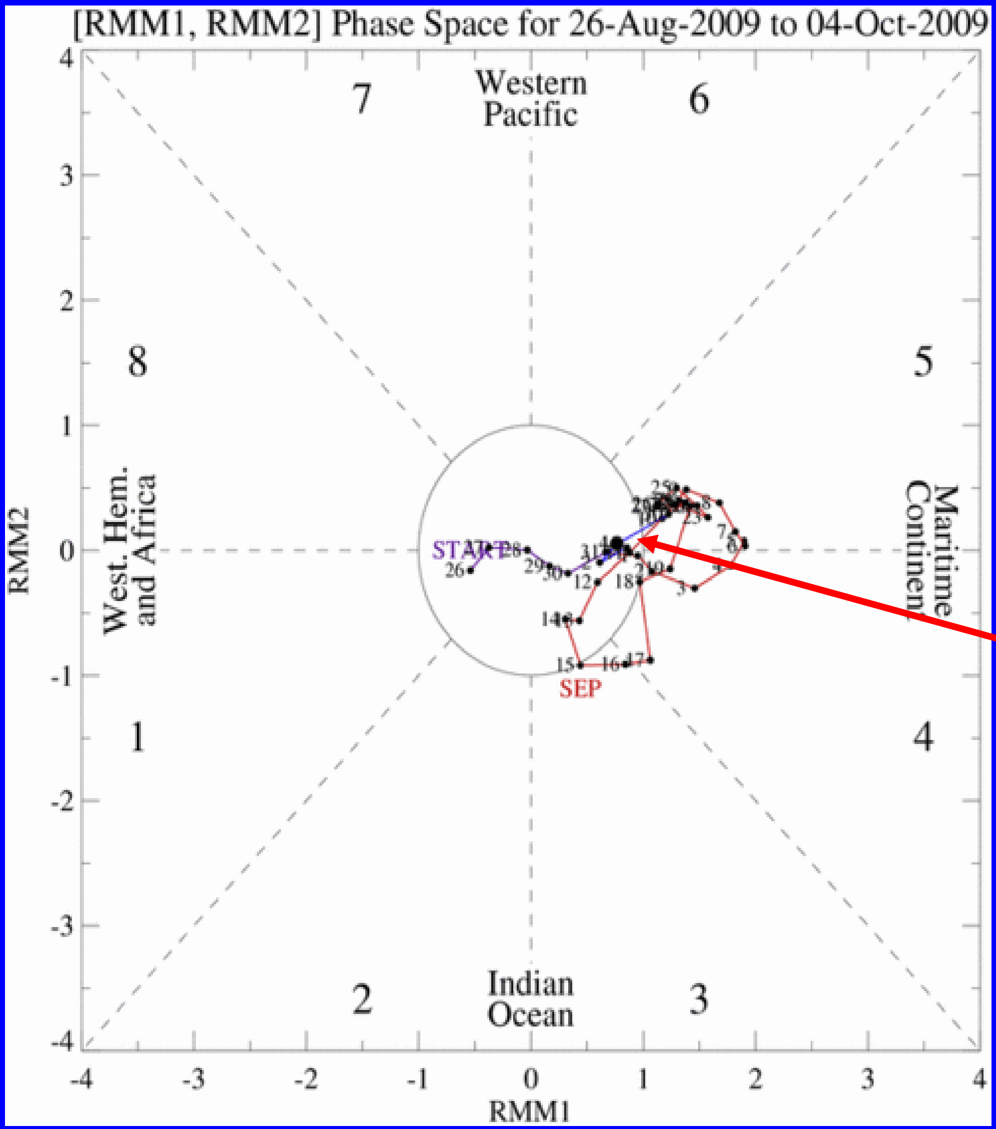
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

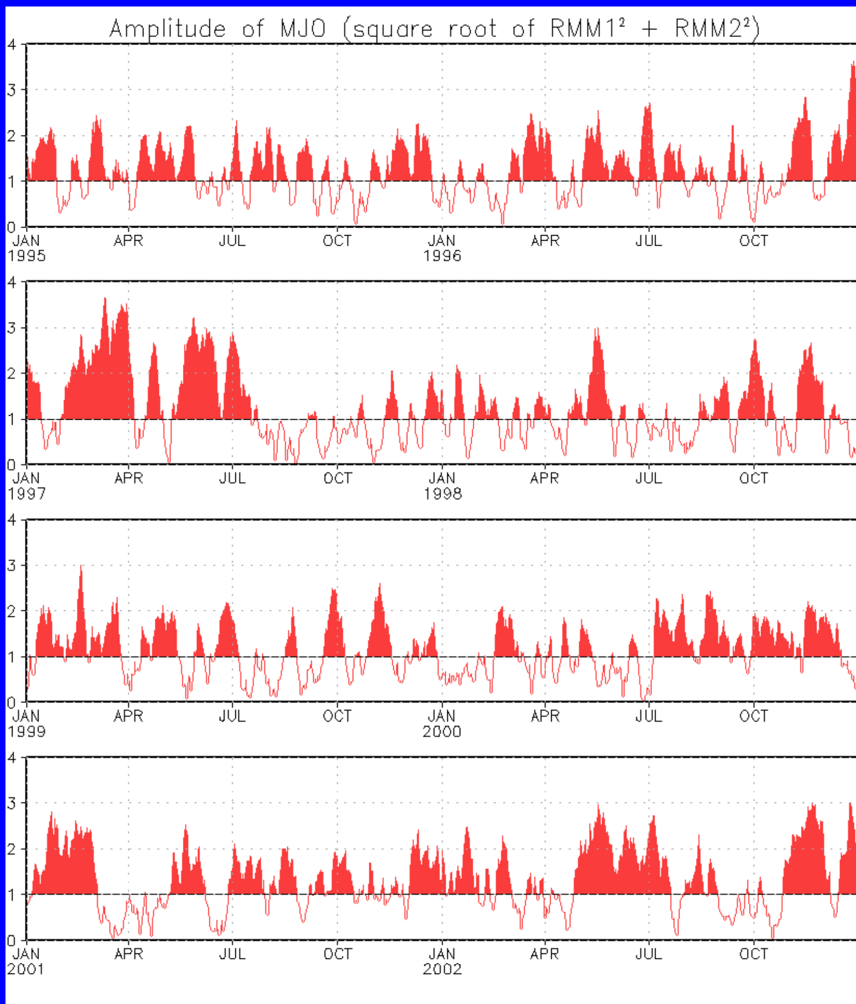
MJO Index -- Recent Evolution

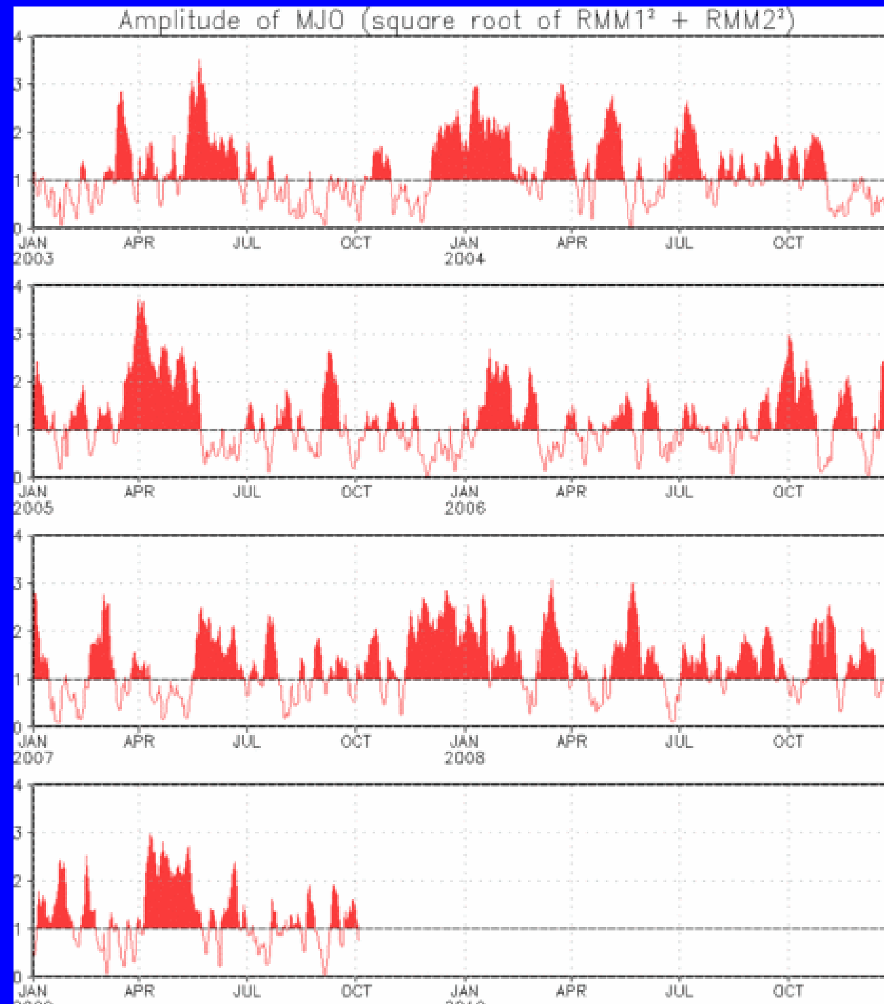


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The amplitude of the MJO index has weakened during the past week and has shown no eastward movement.

MJO Index – Historical Daily Time Series





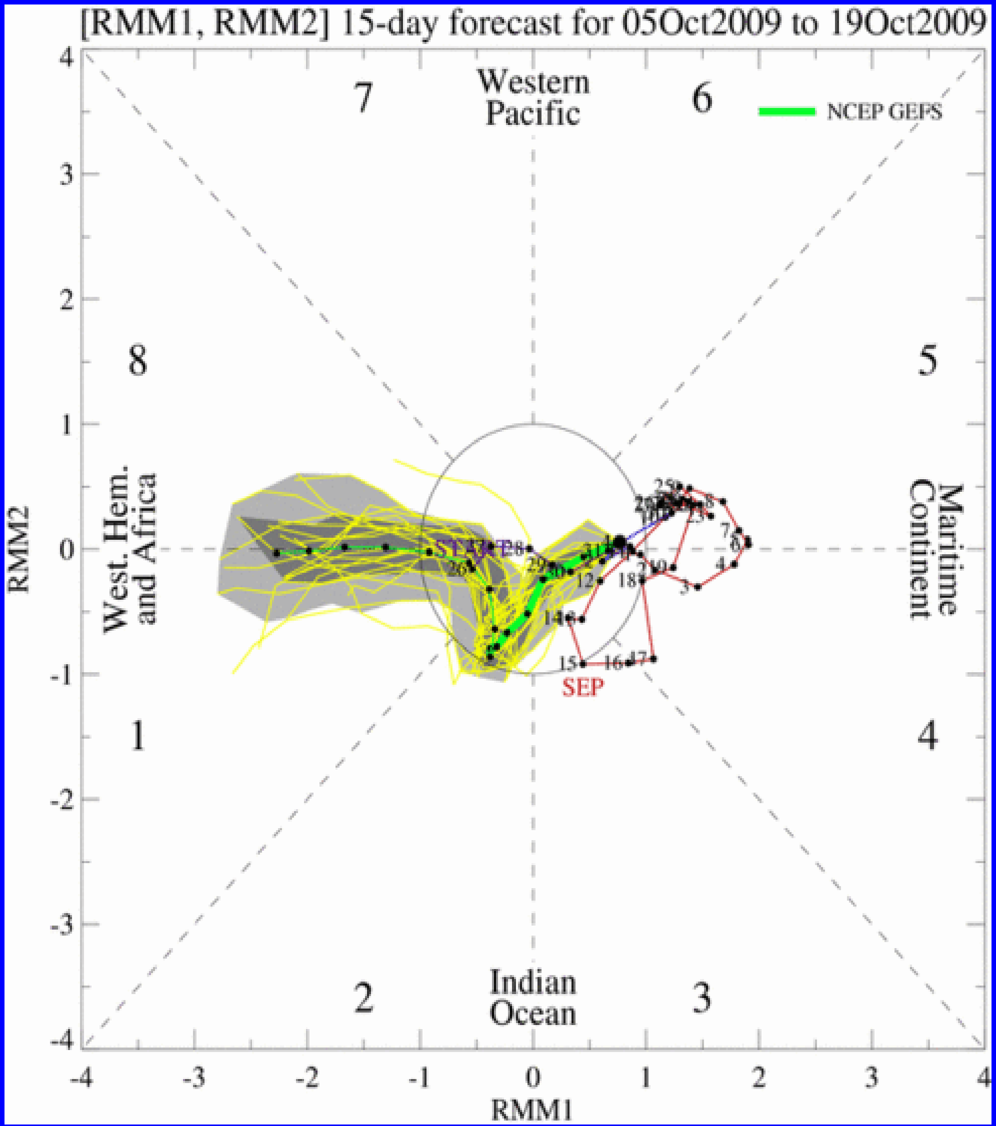
Time series of daily MJO index amplitude from 1995 to present. Plots put current MJO activity in historical context.

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

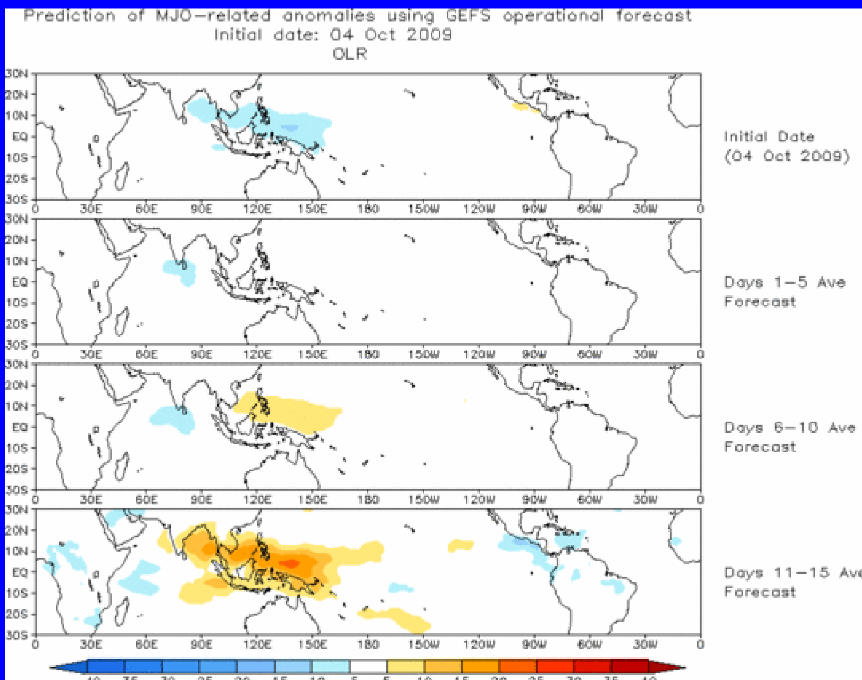


The GEFS forecasts of the MJO index indicate a weak MJO signal during much of the period.

Ensemble Mean GFS MJO Forecast

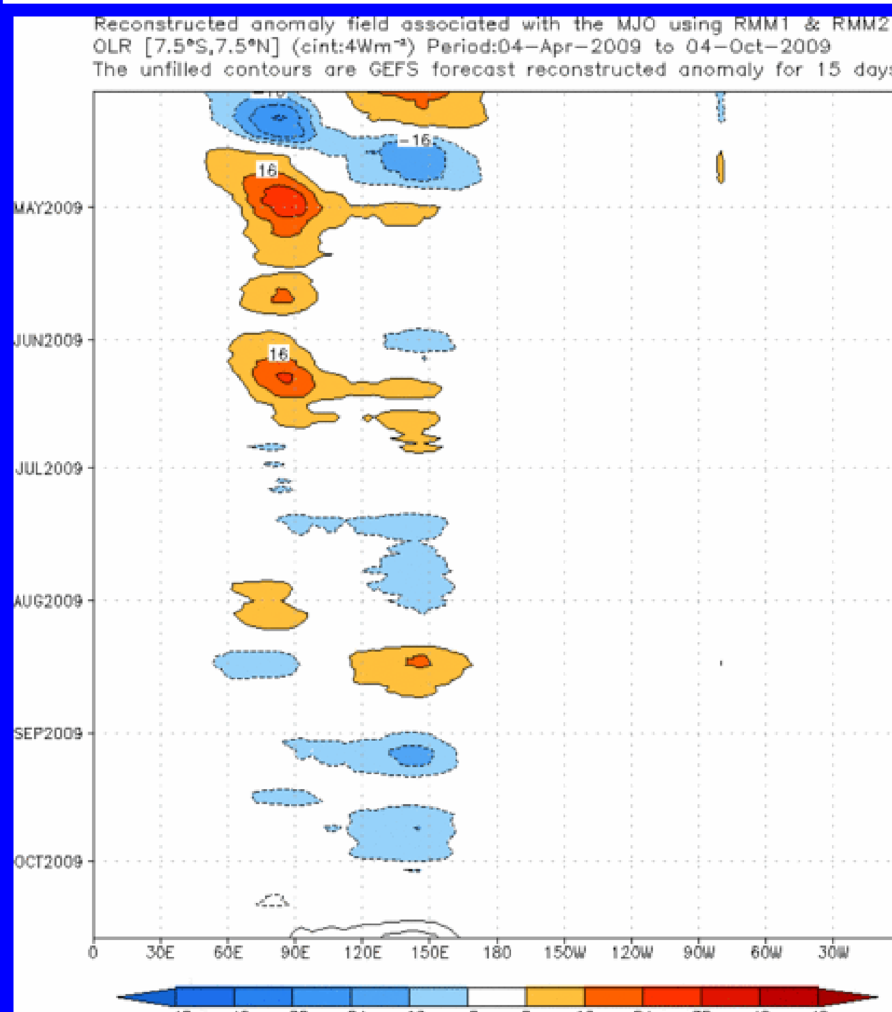
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecasts generally weak anomalies during most of the period. Suppressed convection is indicated late in the period across parts of western Pacific.

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



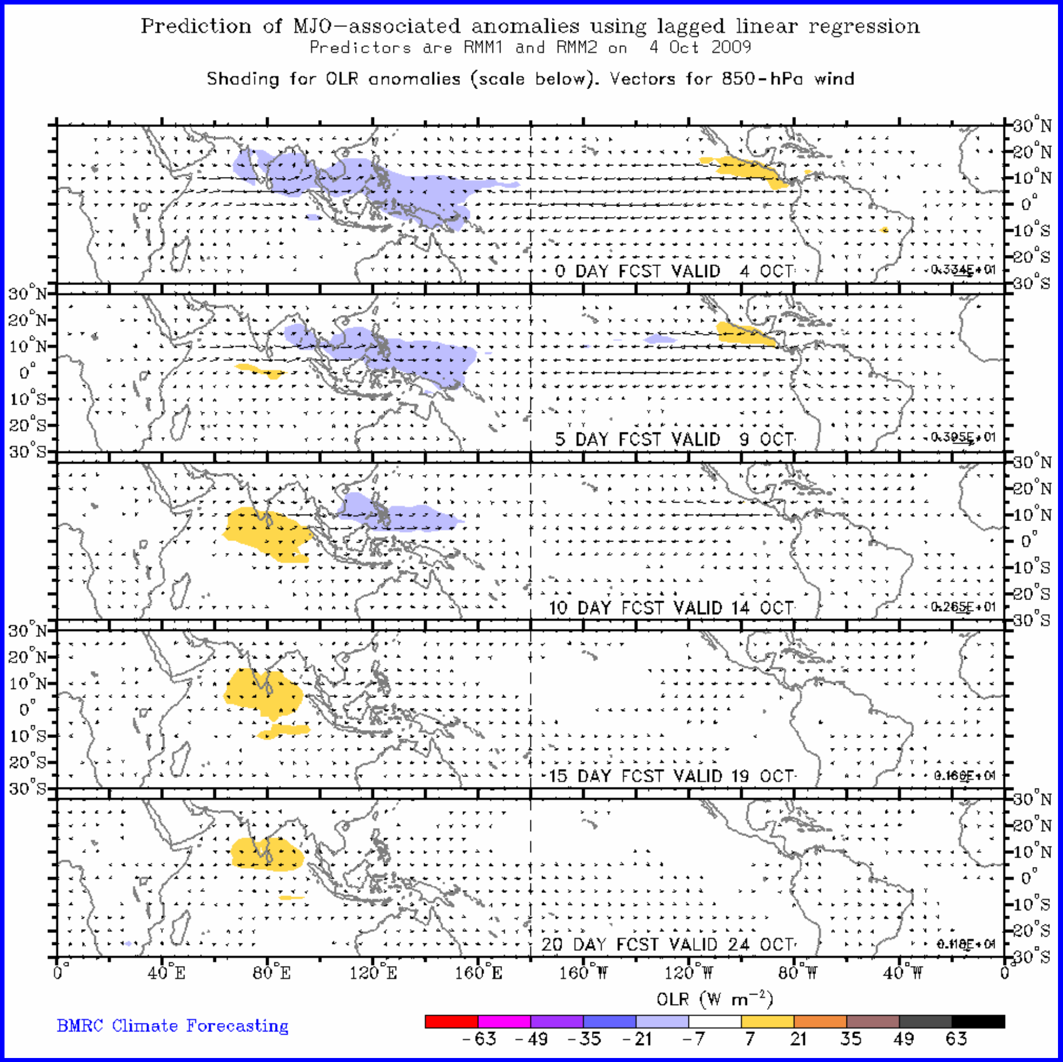
Statistical MJO Forecast

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

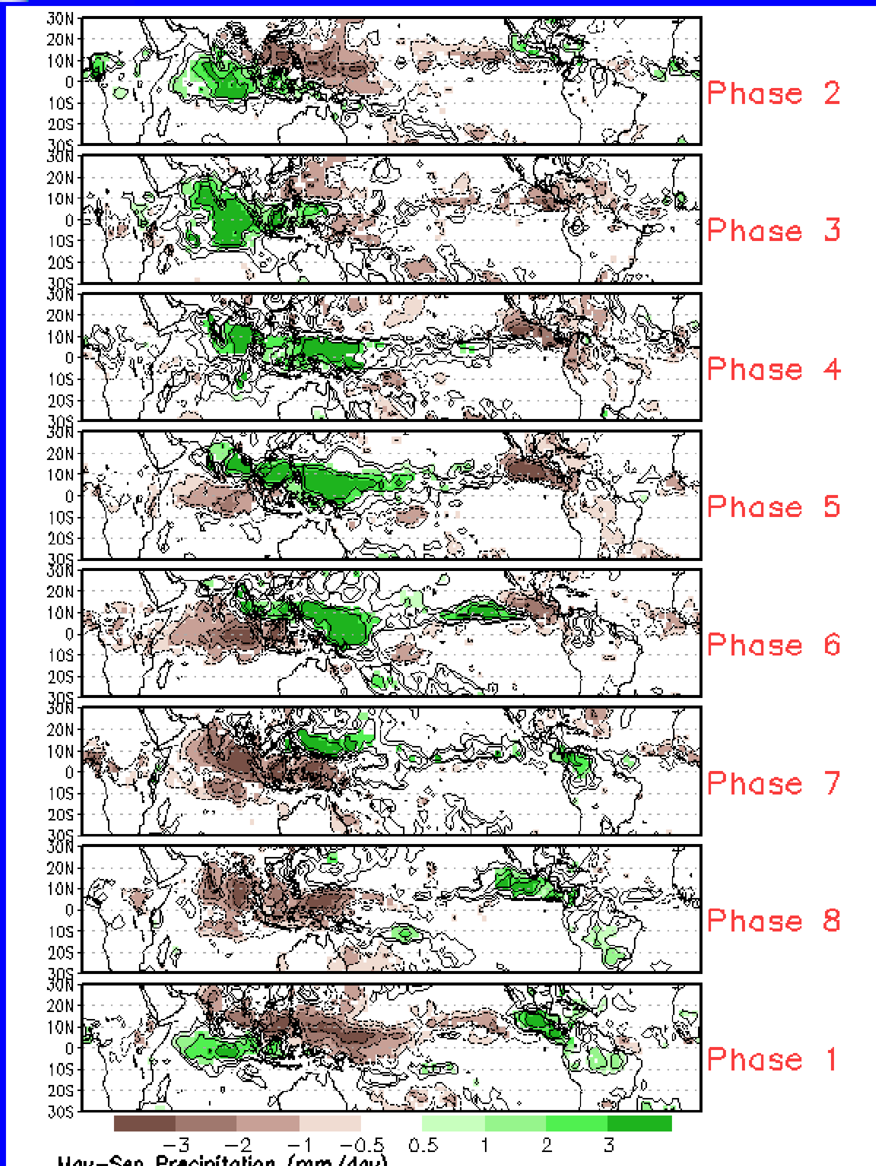
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

A statistical model forecasts weak MJO activity during the next 1-2 weeks with enhanced convection diminishing in the western Pacific by Week-2.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)