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

Update prepared by
Climate Prediction Center / NCEP
April 13, 2009

Outline

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

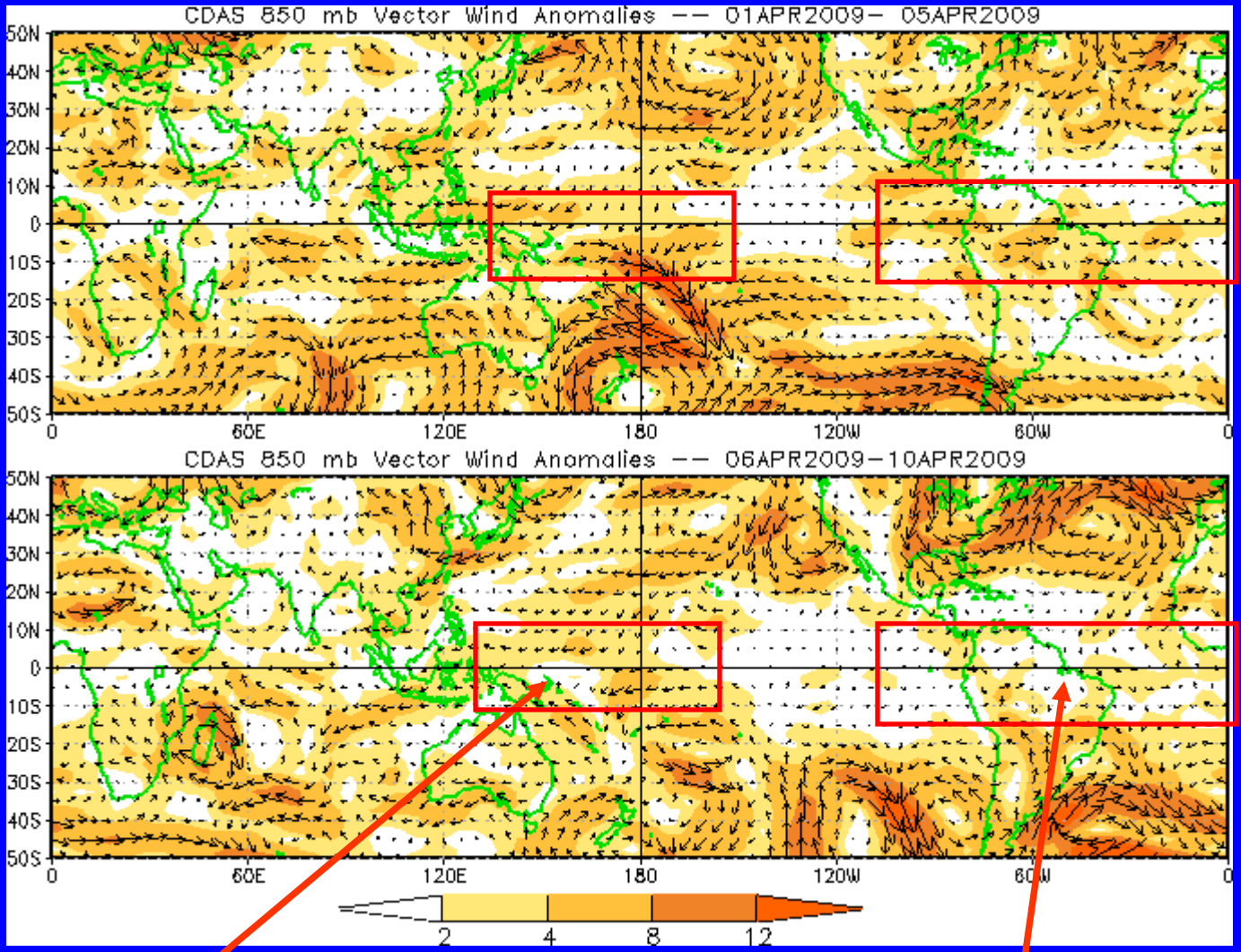
Overview

- Moderate-to-strong MJO activity continued during the past week with the enhanced convective phase centered over the Indian Ocean.
- Moderate-to-weak MJO activity is expected to continue during the next 1-2 weeks with the enhanced convective phase shifting to the Maritime Continent by the end of the period.
- The MJO is anticipated to increase rainfall across the eastern Indian Ocean and western Maritime Continent during Week 1 and then shift slightly eastward becoming centered on the Maritime Continent during Week-2.
- Impacts of the current MJO on the U.S. during the next 1-2 weeks are unclear.

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 magnitude of anomalous wind vectors



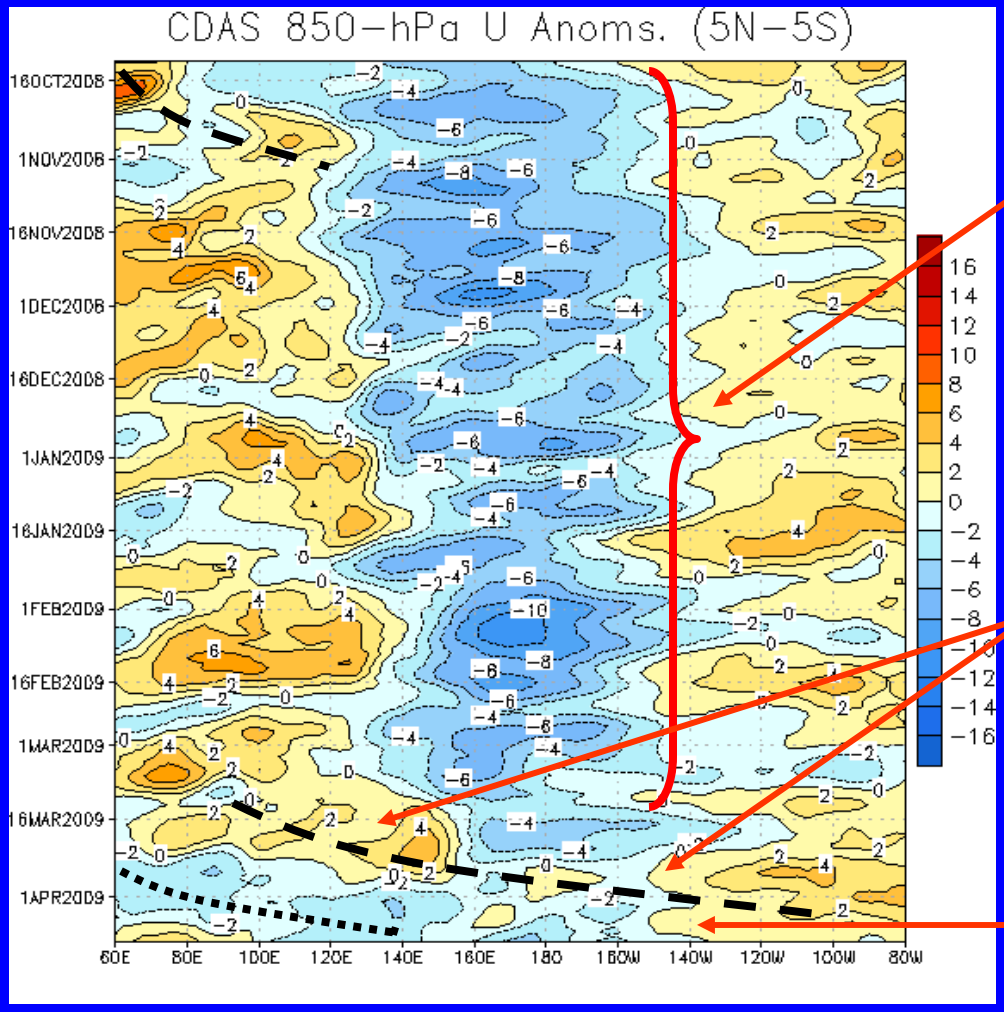
Low-level wind anomalies have weakened over the western and central equatorial Pacific.

Westerly anomalies have weakened during the last five days over the eastern Pacific, S. America, and Atlantic Ocean.

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

A persistent pattern of westerly (easterly) anomalies stretching from the Indian Ocean to the central Pacific Ocean has been in place since October with a few breaks in late December and mid-January.

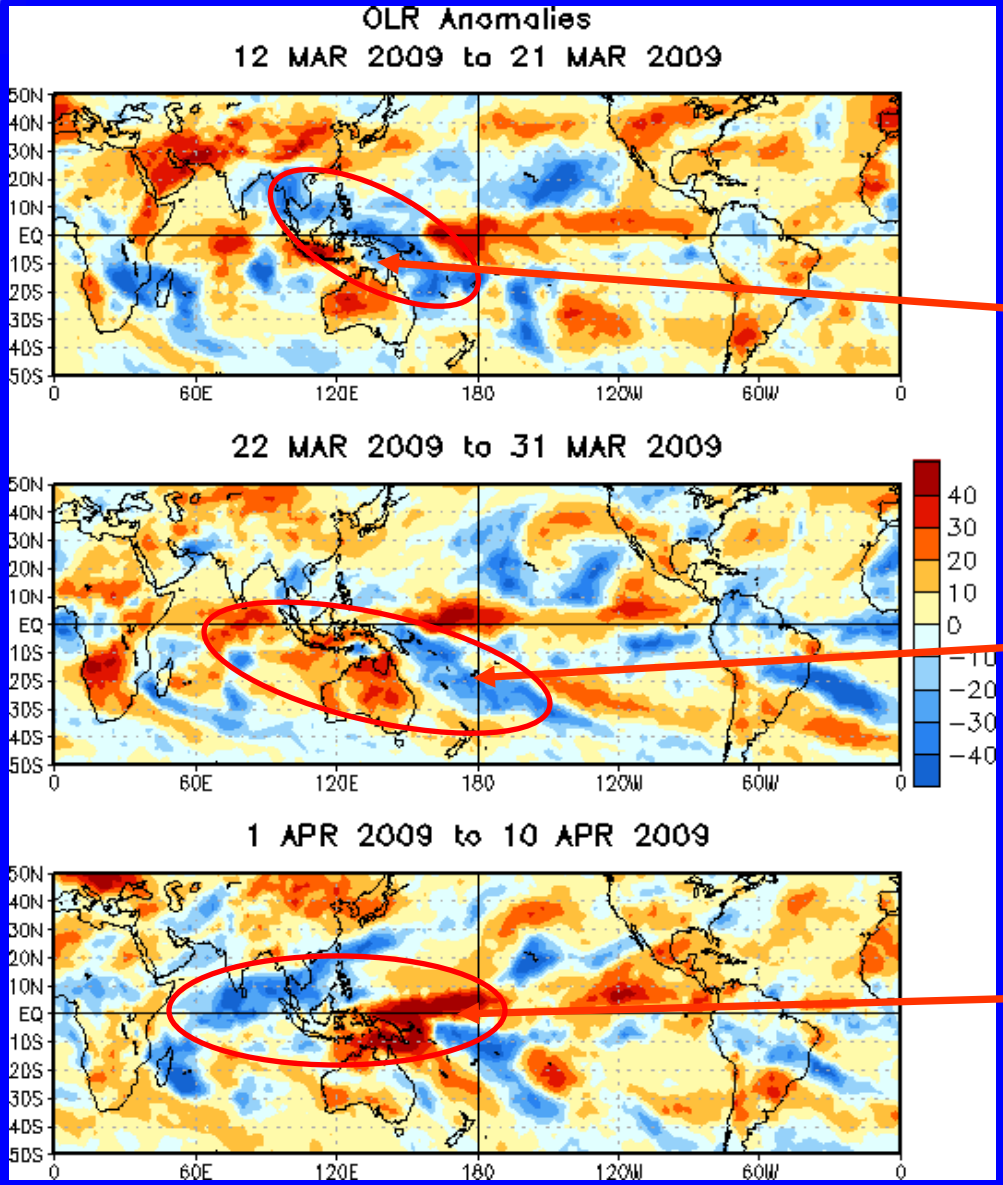
During the second half of March, westerly anomalies shifted eastward from the Indian Ocean through the equatorial Pacific.

Recently, low-level easterly anomalies have also shifted eastward from the Indian Ocean to near the Date 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)

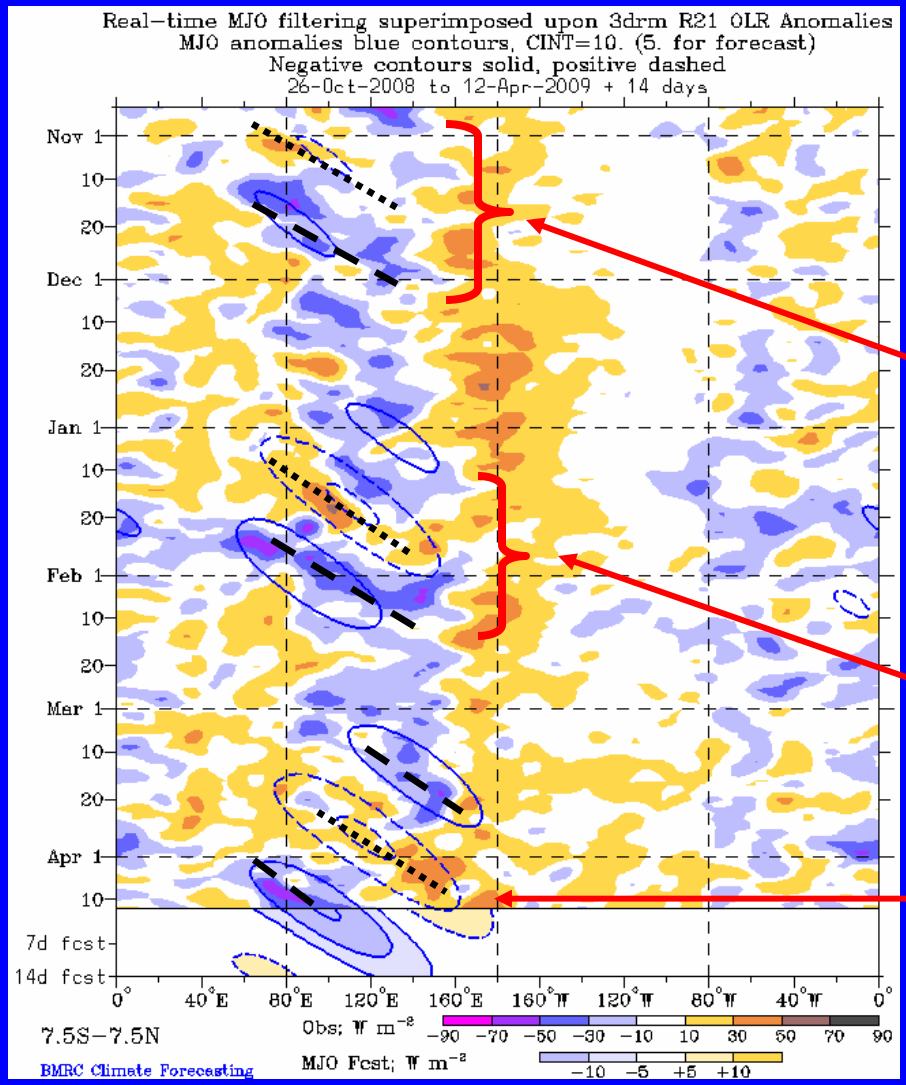


During mid March, convection was enhanced and extended from India through Papua New Guinea in a northwest-to-southeast pattern.

In late March, enhanced convection shifted eastward and became centered over the SPCZ while dry conditions continued over Australia and Indonesia.

During early April, enhanced convection developed across parts of the Indian Ocean and western Indonesia. Suppressed convection strengthened over Australia and the eastern Maritime Continent.

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 - Australia)

Moderate MJO activity was evident during October and November as enhanced (suppressed) convection developed across the Indian Ocean and shifted eastward during the period.

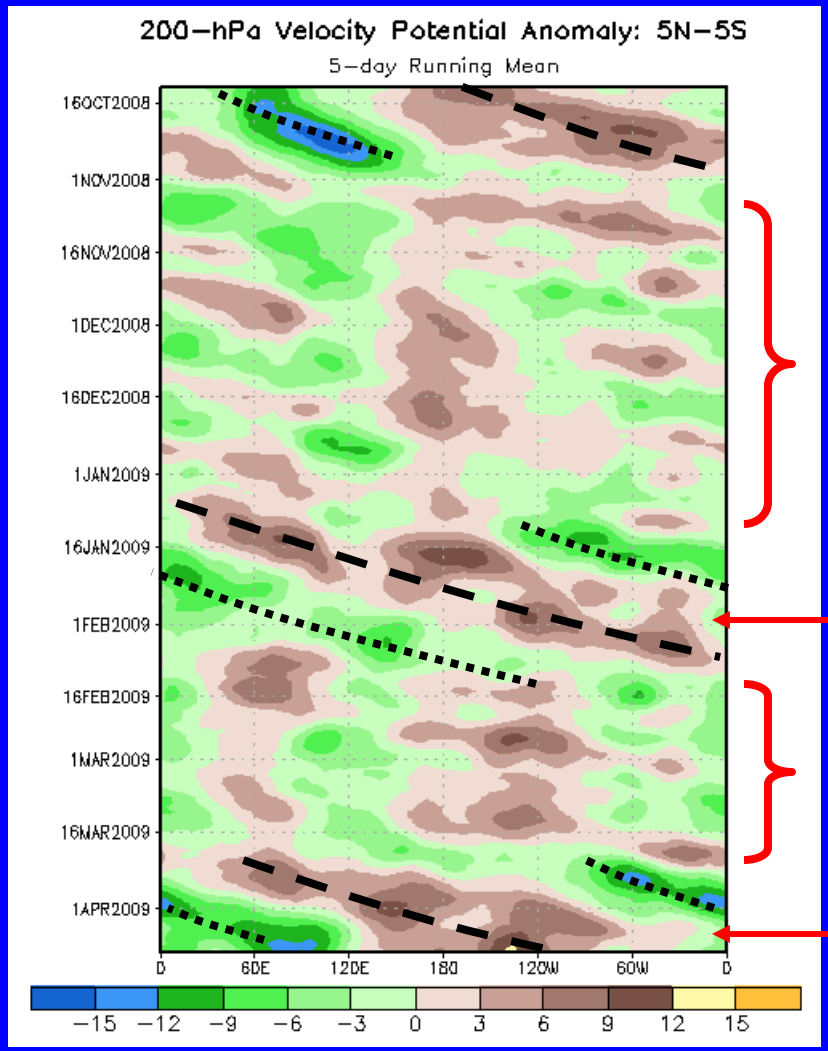
From mid-January to mid-February, eastward movement of suppressed (enhanced) convection is observed from the Indian Ocean to portions of Indonesia and the western Pacific.

Recently, suppressed convection has shifted from the western to the eastern Maritime Continent. Enhanced convection has emerged over the Indian Ocean associated with current MJO activity.

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 strengthened in early September and eastward propagation was observed from September through October.

From mid-November to mid-January, the subseasonal activity organized on a faster time scale and the MJO was weak or incoherent.

Velocity potential anomalies increased as the MJO strengthened and shifted eastward during January to mid-February.

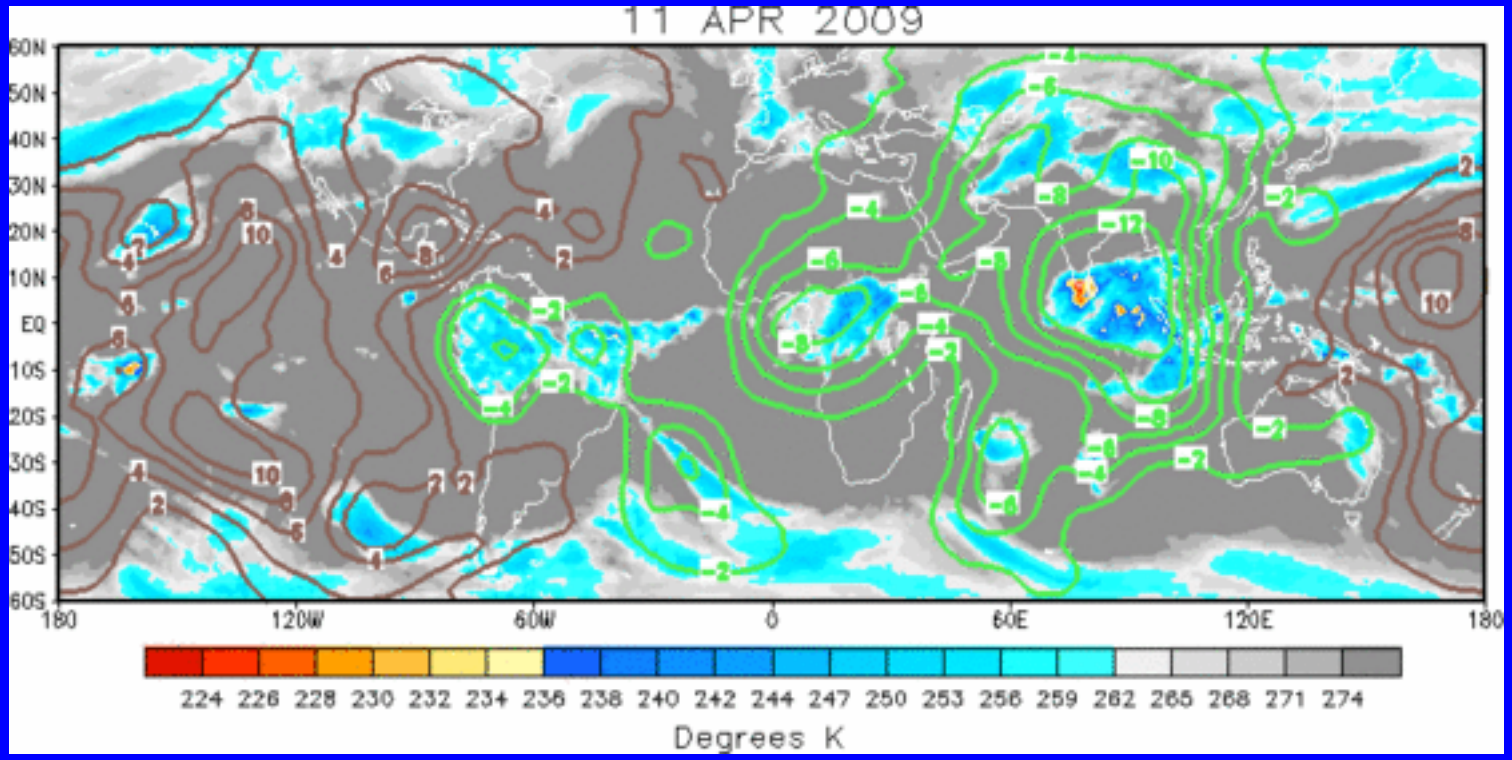
The velocity potential anomalies were weak late February and early March.

Since mid-March, eastward propagating velocity potential anomalies indicate the MJO has been active.

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

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

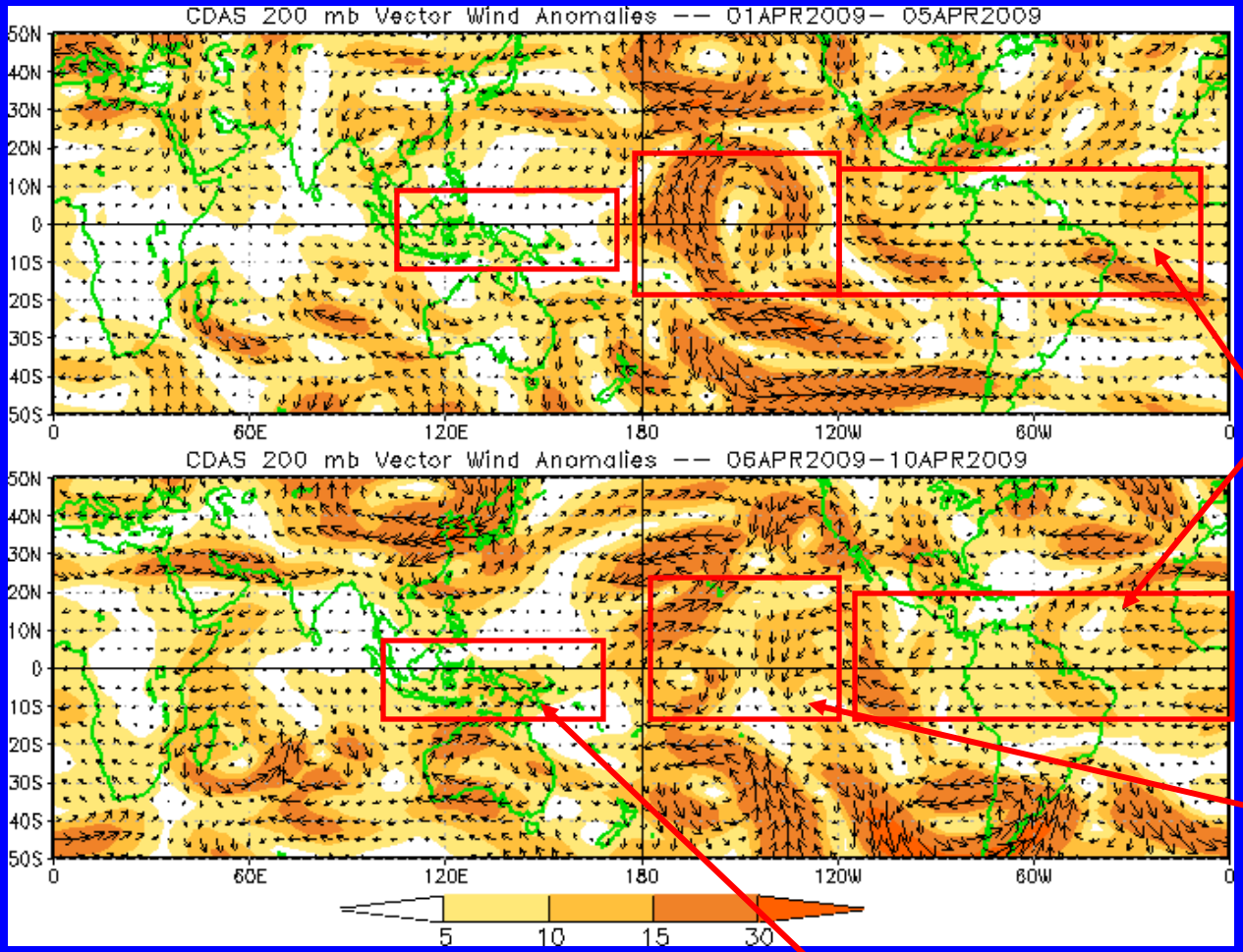
Negative anomalies (green contours) indicate favorable conditions for precipitation



A coherent velocity potential spatial pattern is evident with large-scale anomalous upper-level divergence (convergence) over South America, Africa, and the Indian Ocean (Pacific Ocean).

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

Note that shading denotes the magnitude of anomalous wind vectors



Easterly anomalies have remained nearly stationary over the Western Hemisphere during the last five days.

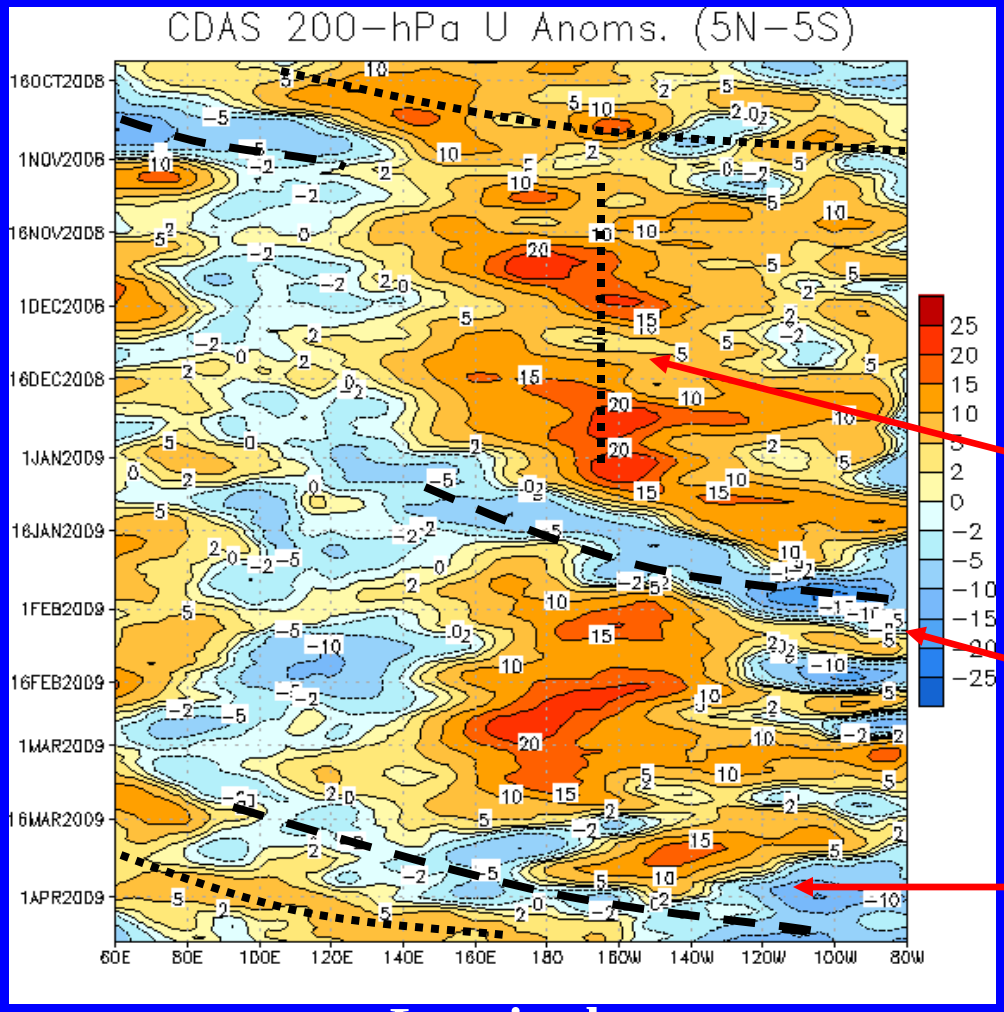
Cross-equatorial flow continues over the Pacific Ocean just east of the Date Line.

Westerly anomalies have strengthened over the Maritime Continent.

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

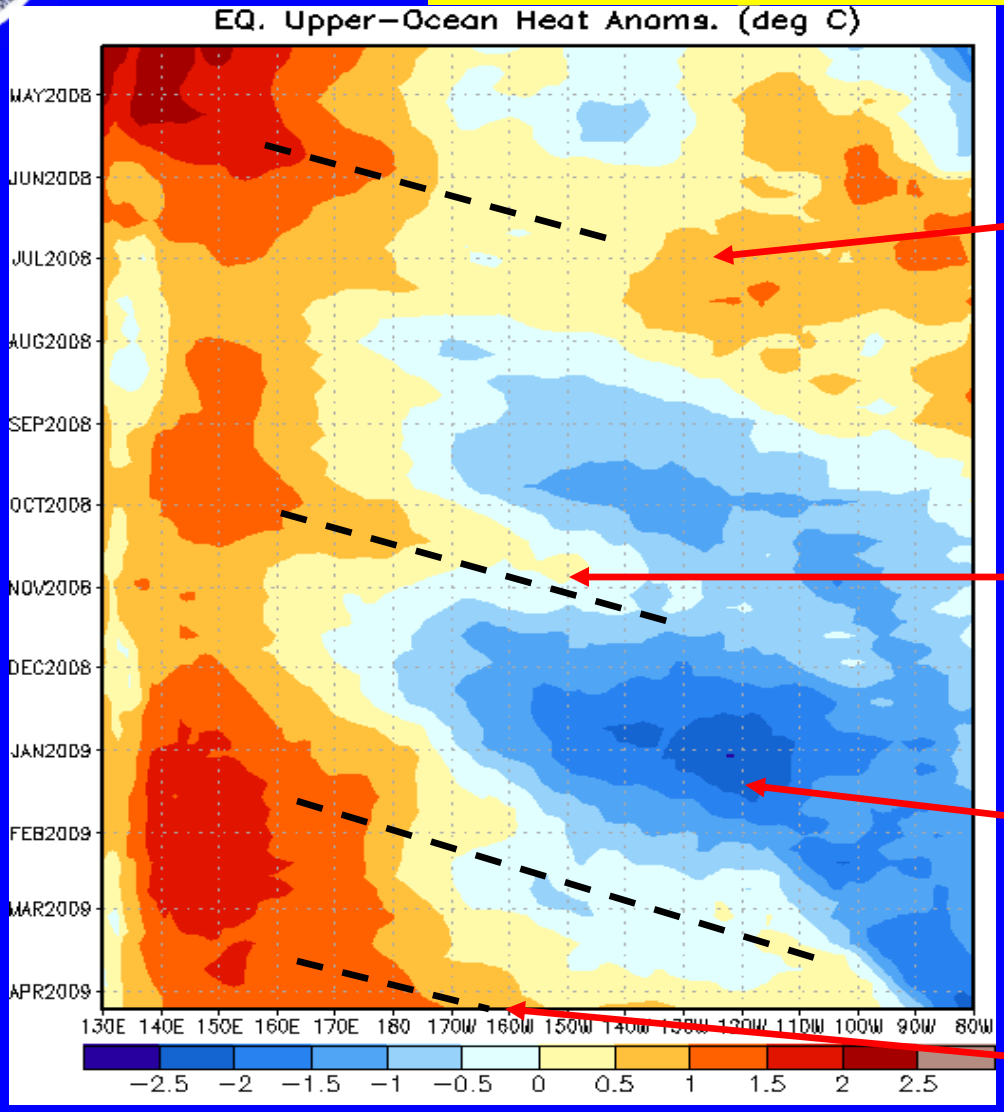
Westerly and easterly anomalies associated with the MJO activity shifted eastward during October.

Westerly anomalies strengthened markedly in mid-November near the Date Line and persisted through December. These anomalies are consistent with La Nina conditions.

Eastward propagation is evident during January associated with MJO activity.

Easterly and westerly anomalies continue to shift eastward associated with MJO activity.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

During June and July 2008, positive heat content anomalies encompassed much of the Pacific basin.

During August 2008, negative anomalies started to develop east of the Date Line and have increased and expanded eastward. There was a pause in this increase during October as a Kelvin wave shifted eastward.

During November 2008 – January 2009, negative anomalies increased across the Pacific but became less negative during February.

Recently, an eastward propagating Kelvin wave has increased heat content in the central and east-central Pacific.

MJO Index -- Information

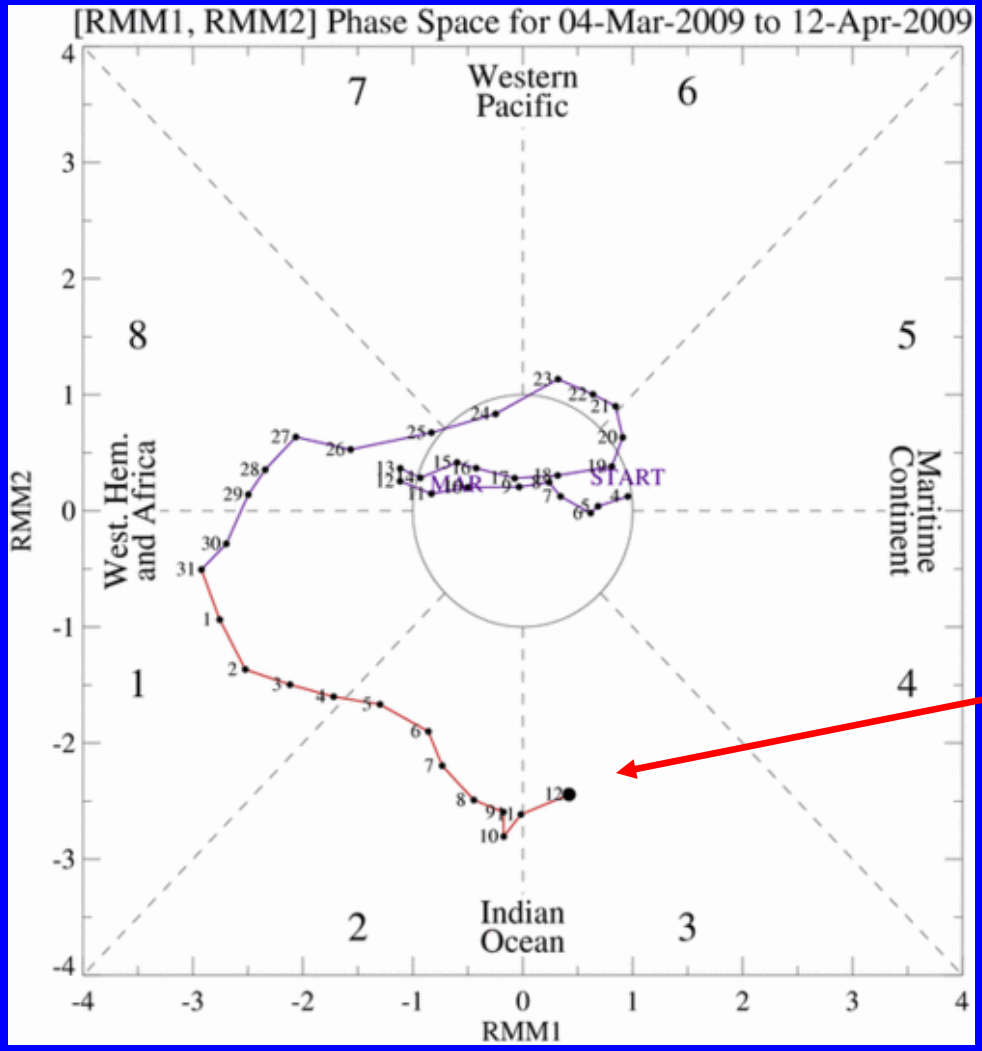
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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.**

- **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).**

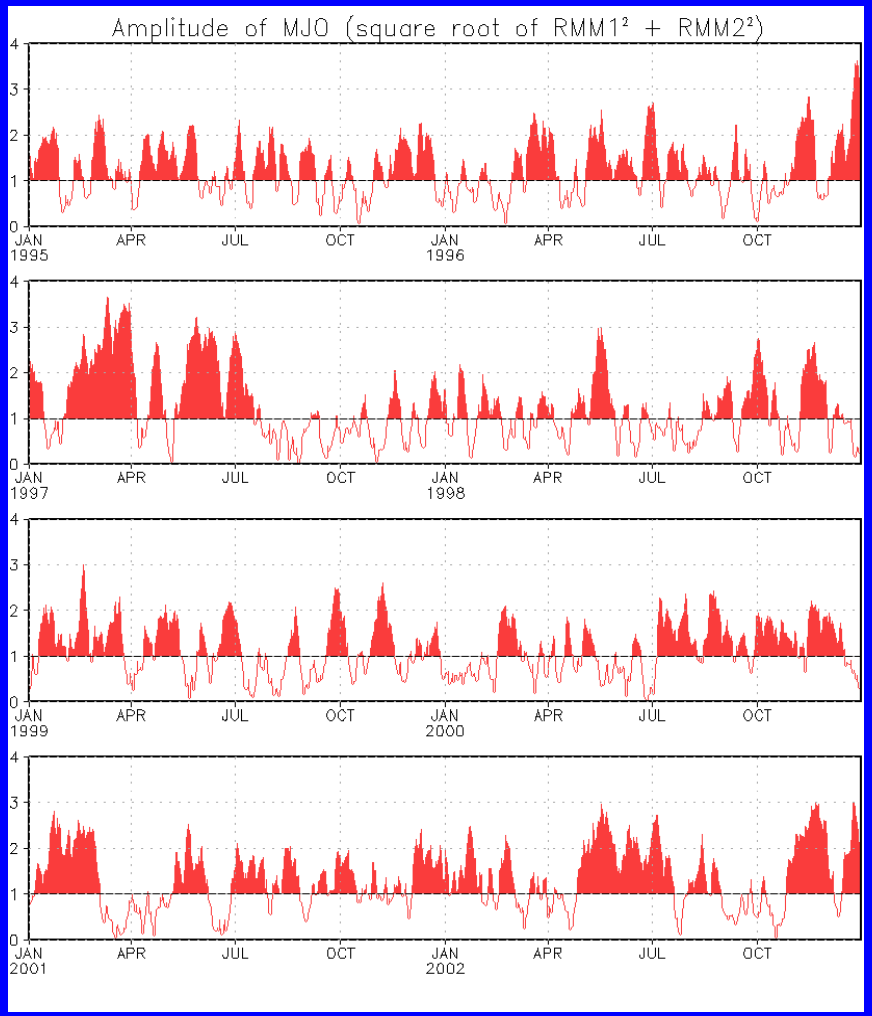
MJO Index -- Recent Evolution

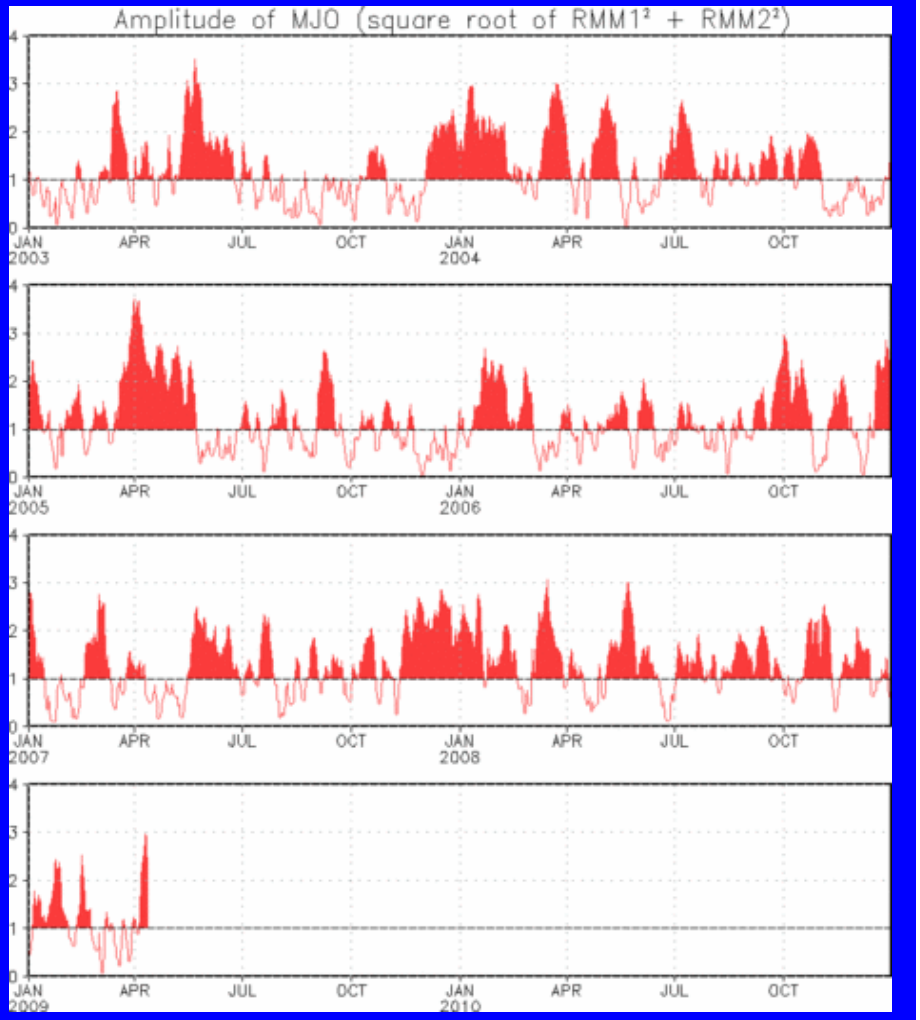


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

The MJO index shows strong activity has shifted through Phase 2 during the past 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.

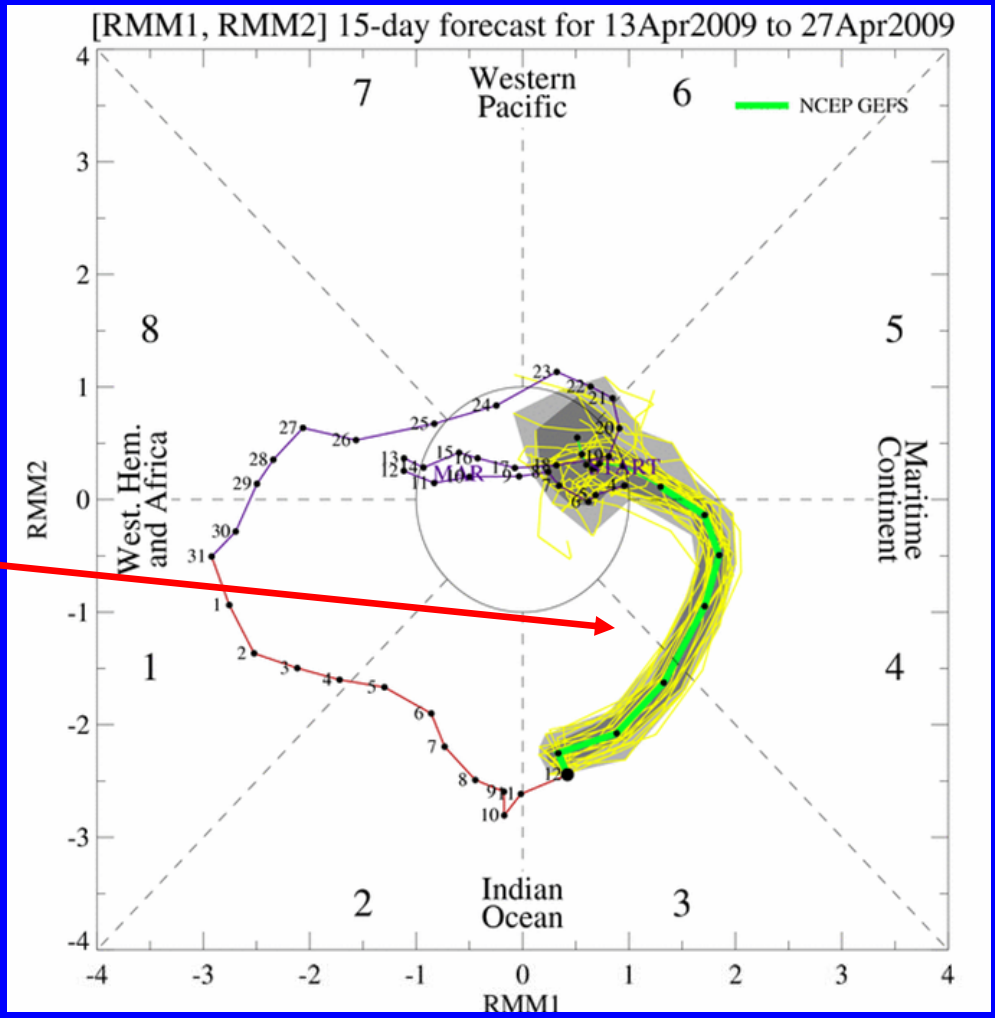
Ensemble GFS (GEFS) MJO Forecast

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

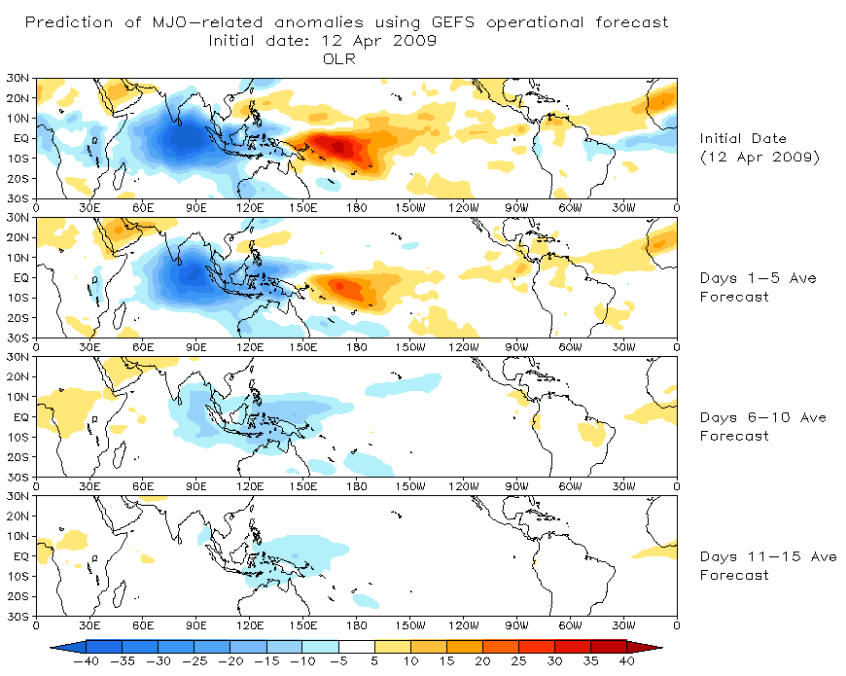
The GEFS forecasts predict the MJO signal to continue at moderate strength as it shifts to the Maritime Continent over the period.



Ensemble Mean GFS MJO Forecast

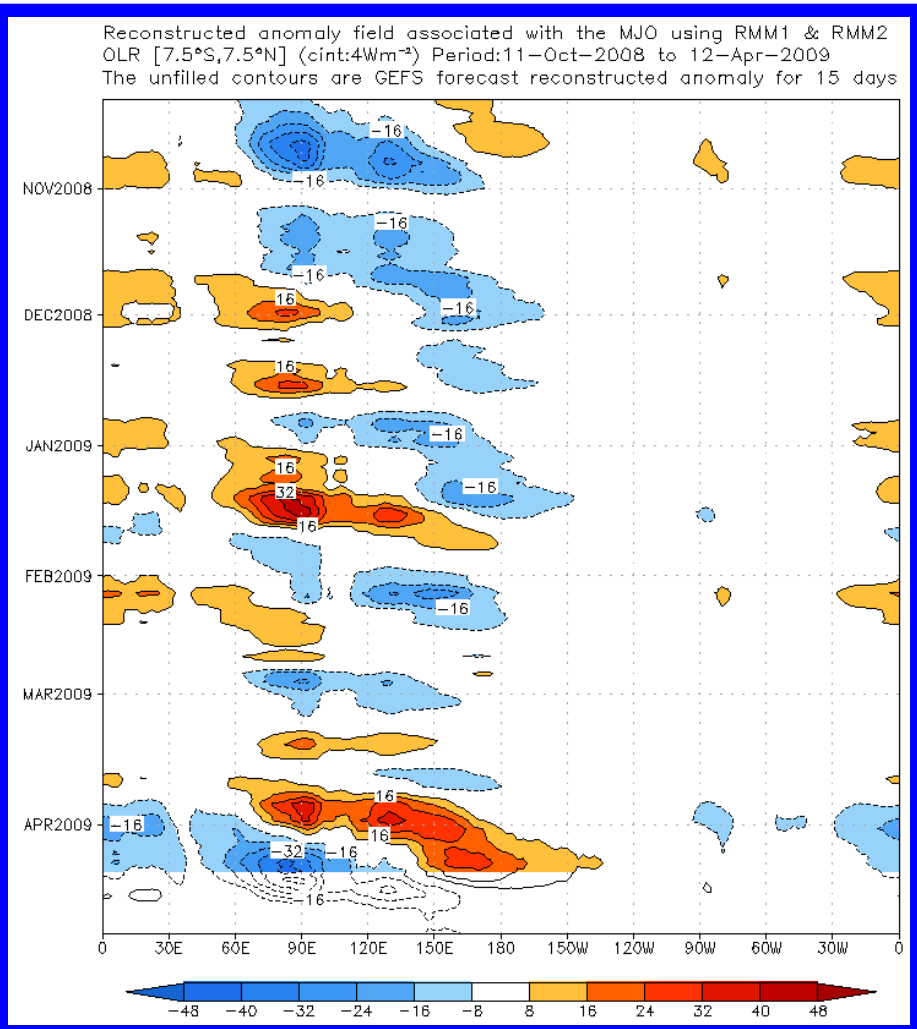
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



During Week-1, enhanced convection is expected for the Indian Ocean and the western Maritime continent. Enhanced convection is expected to weaken and shift slightly eastward 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



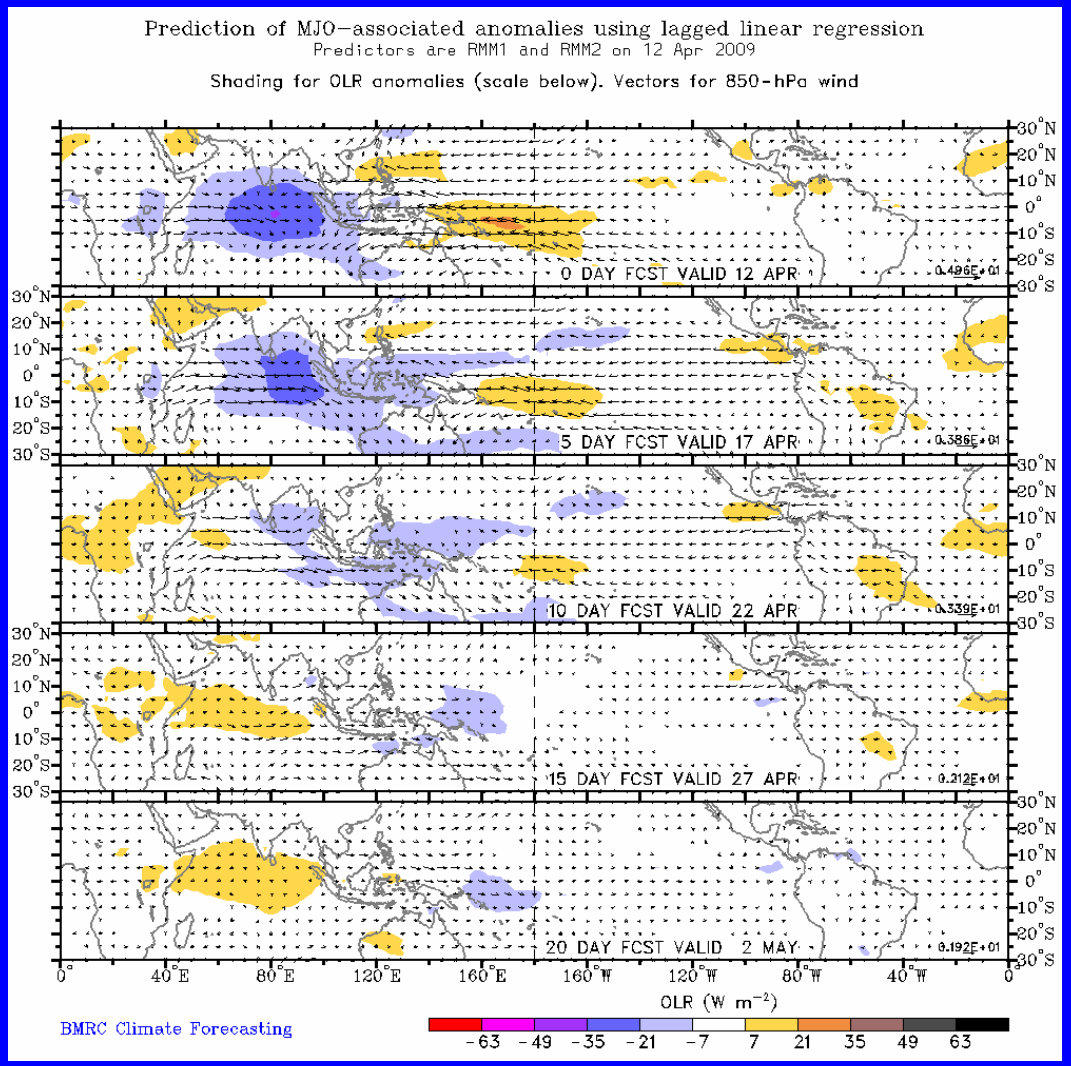
Statistical MJO Forecast

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 wind vectors for the next 20 days

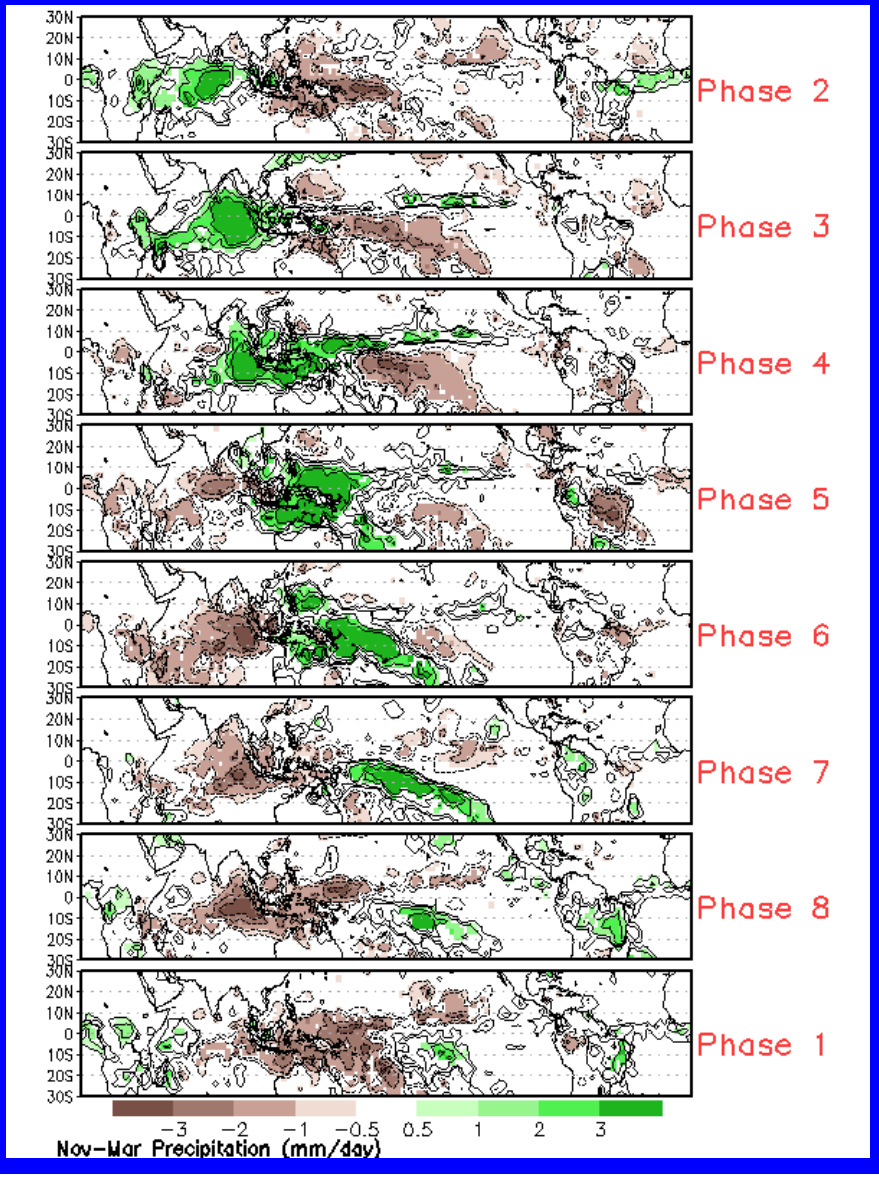
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

A statistical MJO forecast indicates enhanced convection shifting from the Indian Ocean to the Maritime Continent over the next 1-2 weeks.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)