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

Update prepared by
Climate Prediction Center / NCEP
May 11, 2009

Outline

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

Overview

- The MJO has weakened during the past week with the enhanced convective phase centered over the Western Hemisphere and Africa.

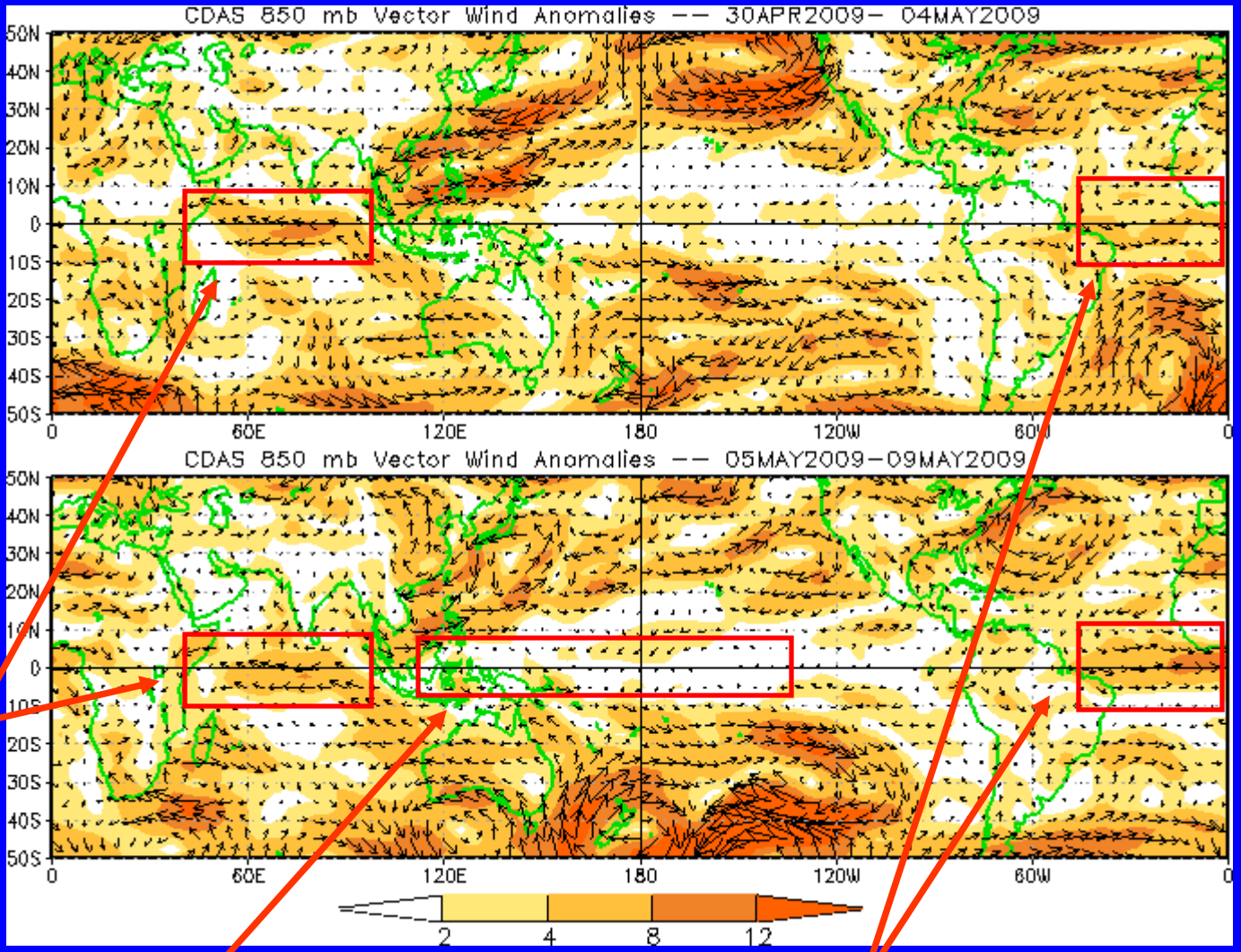
- There is considerable uncertainty for the future evolution of the MJO and most model forecasts indicate little or no propagation during the next two weeks.

- Partly linked to the MJO, enhanced rainfall is expected across parts central Africa during the entire period and the equatorial Indian Ocean during Week-2.

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 easterly anomalies continued across the equatorial Indian Ocean.

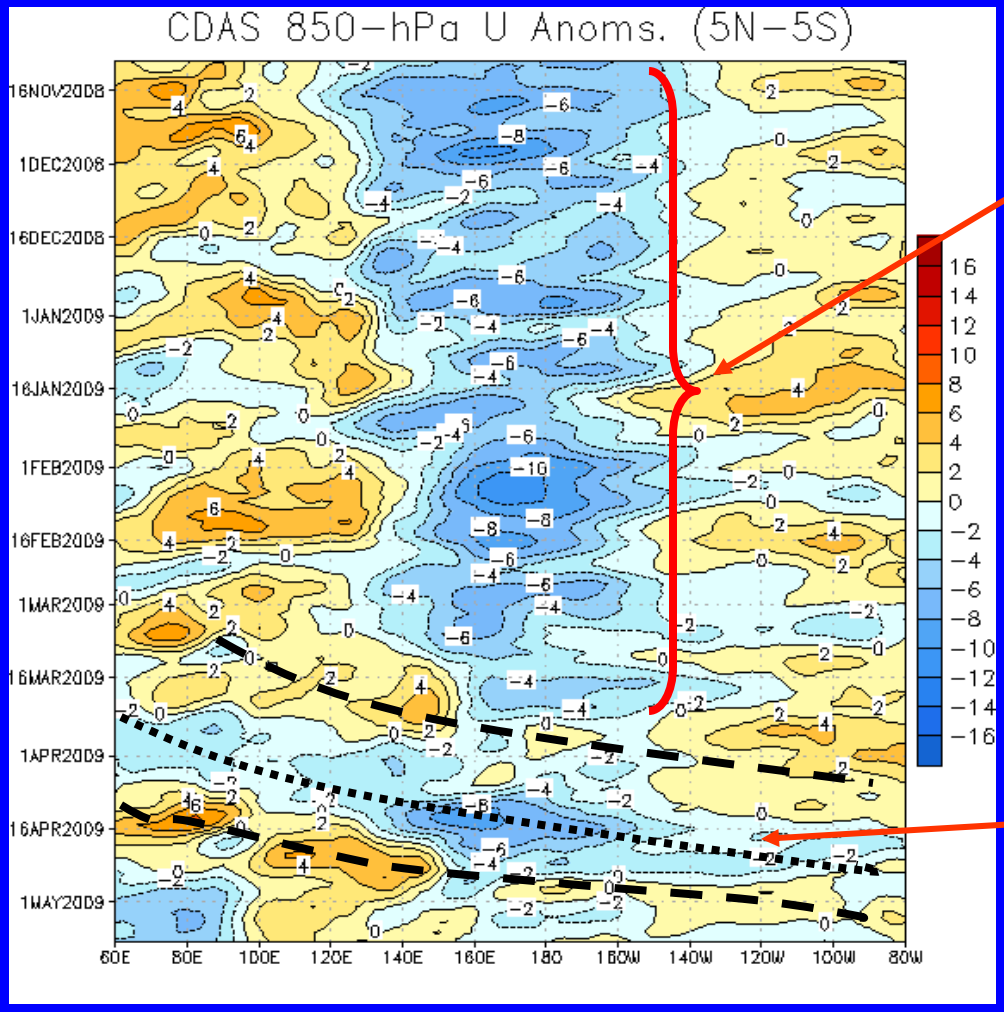
Equatorial winds are near average for much of Indonesia and Pacific Ocean.

Westerly anomalies strengthened over the equatorial Atlantic during the last 5 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

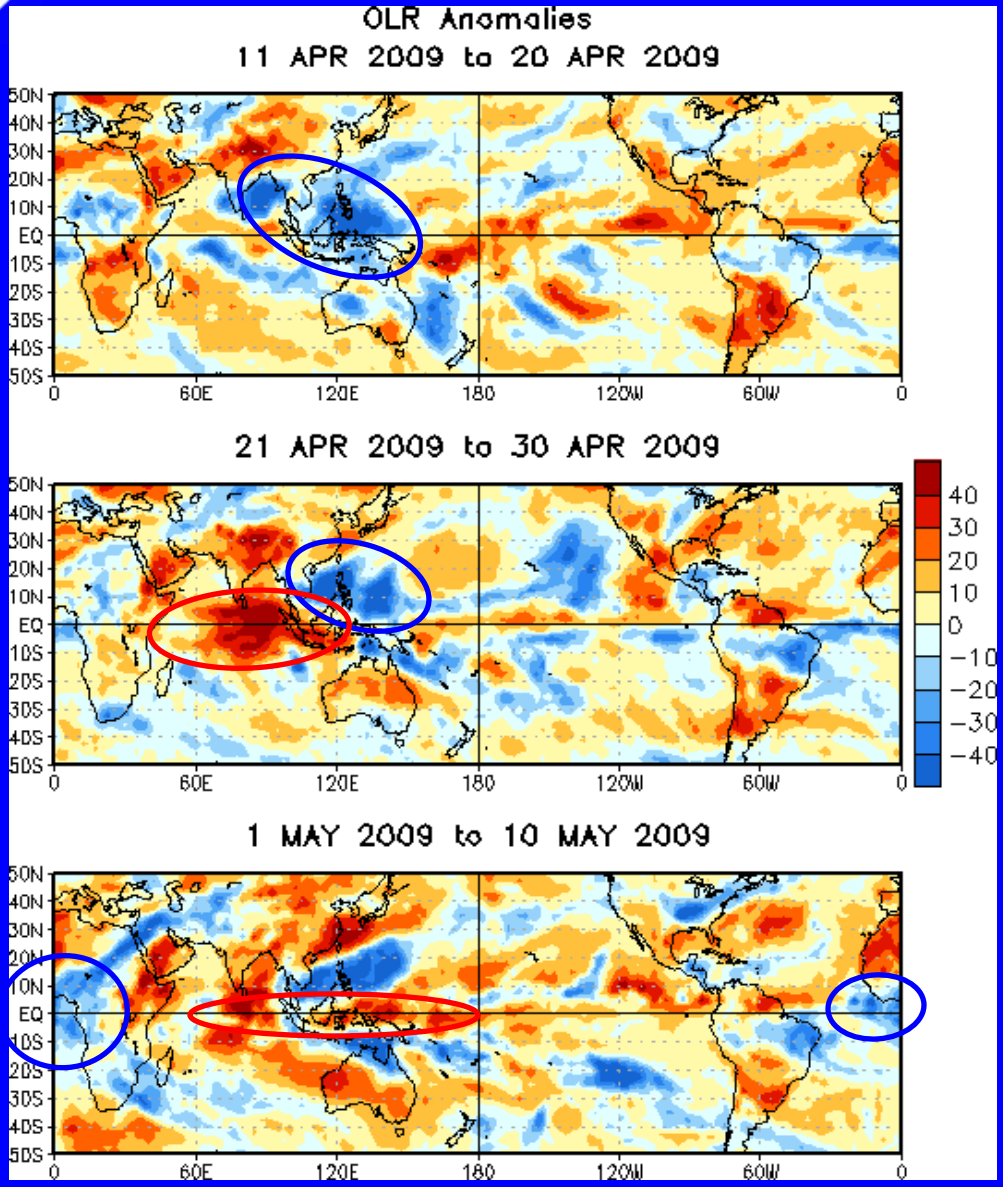
A persistent pattern of westerly (easterly) anomalies over the Indian Ocean (central Pacific Ocean) were in place from October to mid-March.

Since the second half of March, a pattern of alternating low-level westerly, easterly and again westerly anomalies have shifted eastward from the Indian Ocean through the equatorial Pacific associated with the MJO.

OLR Anomalies: Last 30 days

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

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

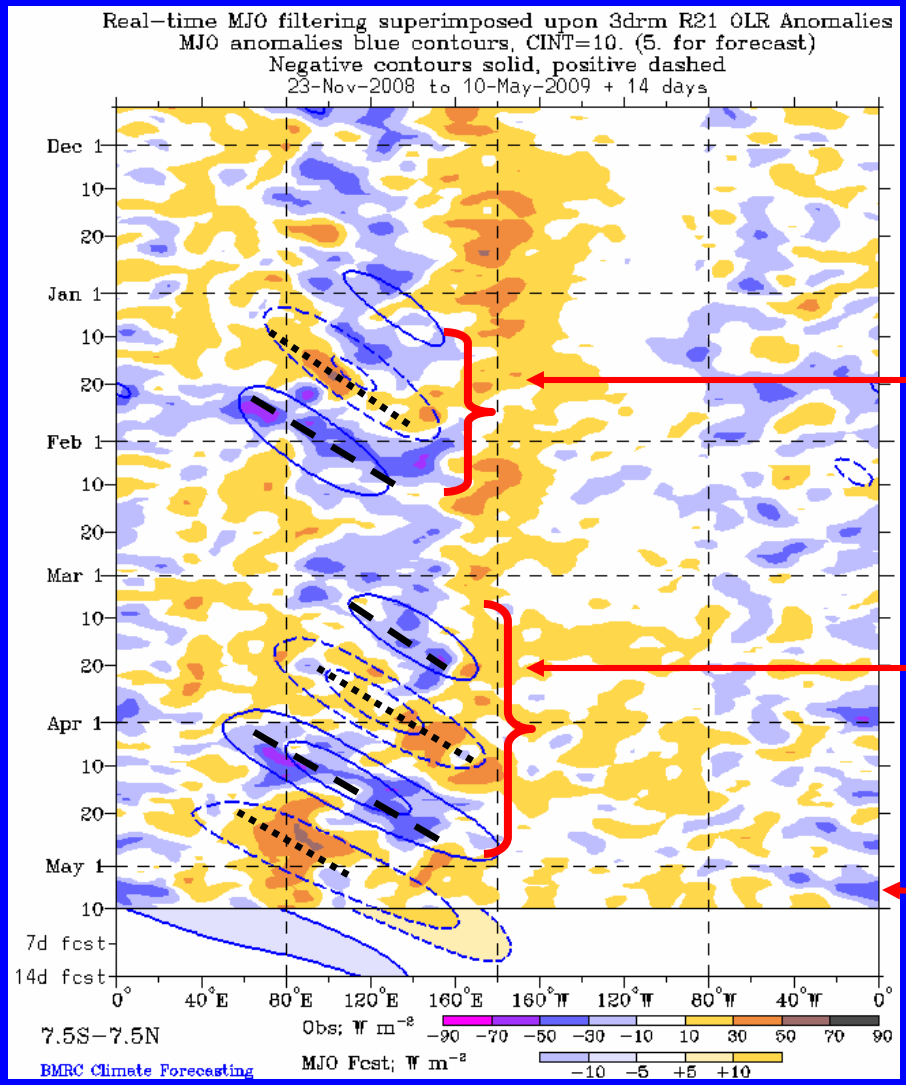


During mid April, enhanced convection shifted eastward over the Maritime Continent and western Pacific.

In late April, enhanced convection focused across the western Pacific and the Philippines while at the same time suppressed convection developed across the Indian Ocean.

Suppressed convection expanded across the equatorial Maritime Continent in early May while enhanced convection intensified over western Africa.

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)

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.

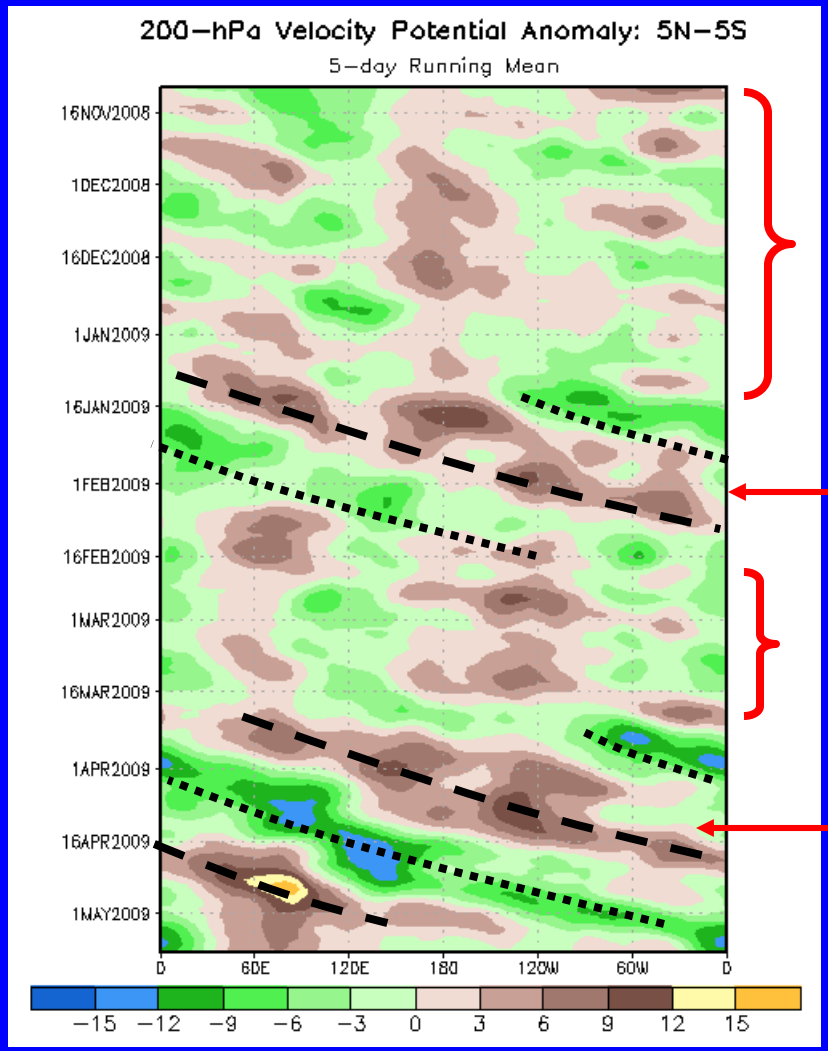
Since mid-March, areas of suppressed and enhanced convection have shifted eastward in association with the MJO.

Recently, coherent propagation of convective anomalies near Indonesia has decreased while enhanced convection has increased across Africa.

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-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.

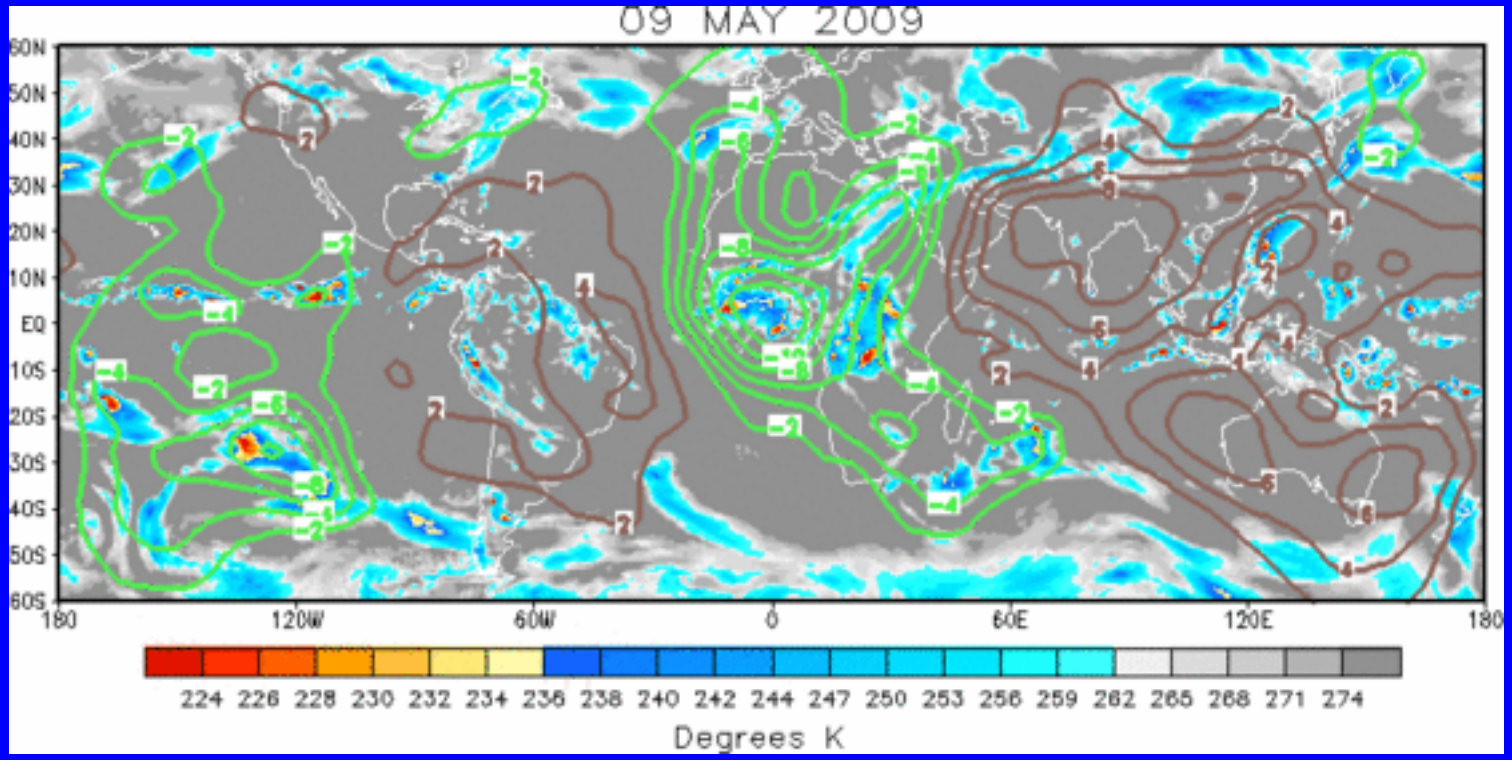
The velocity potential anomalies were small from mid-February through early March.

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

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

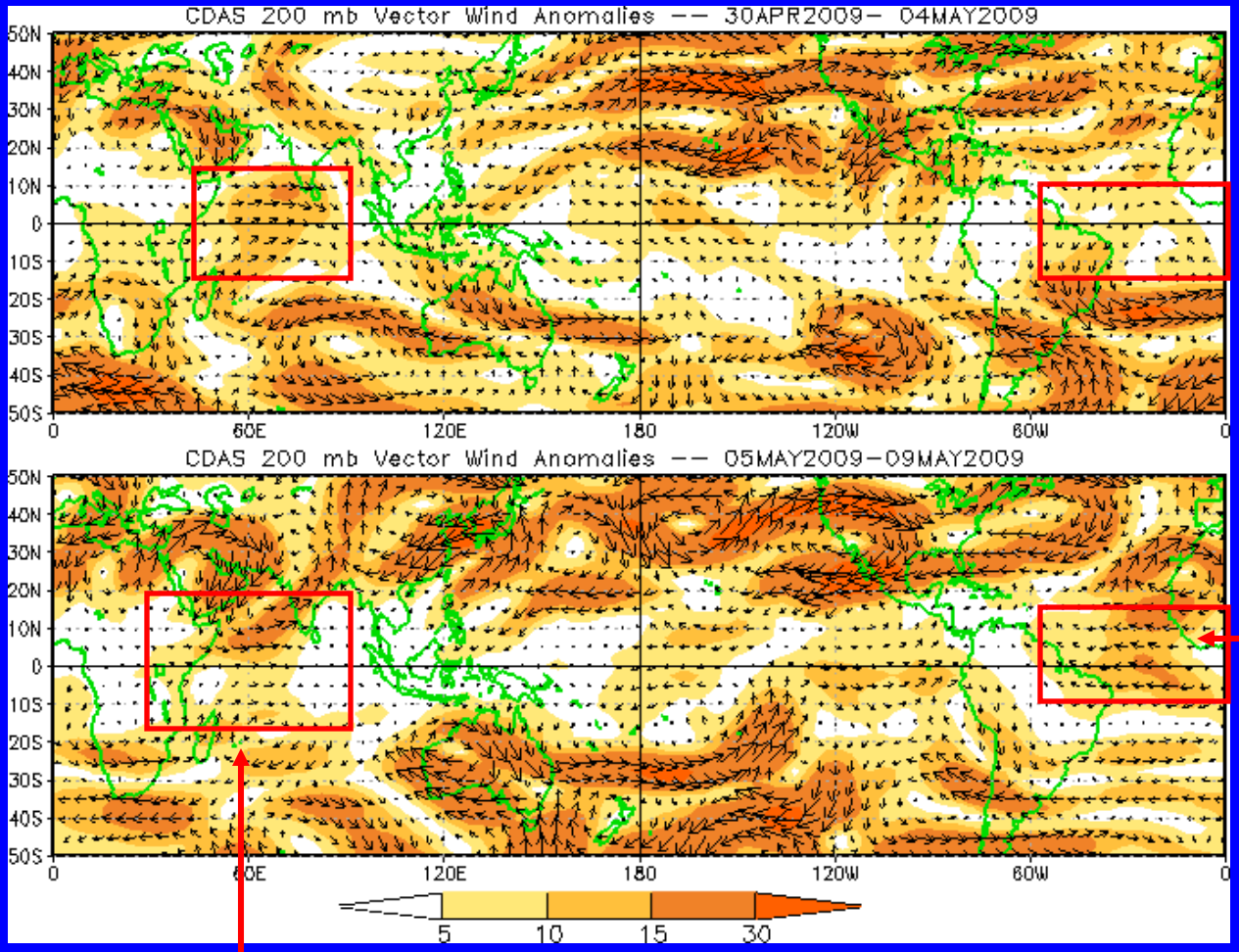


The velocity potential spatial pattern has become less coherent during the past week.

The strongest large-scale anomalous upper-level divergence is located across Africa while the upper-level convergence over the Indian Ocean and Indonesia has weakened.

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

Note that shading denotes the magnitude of anomalous wind vectors



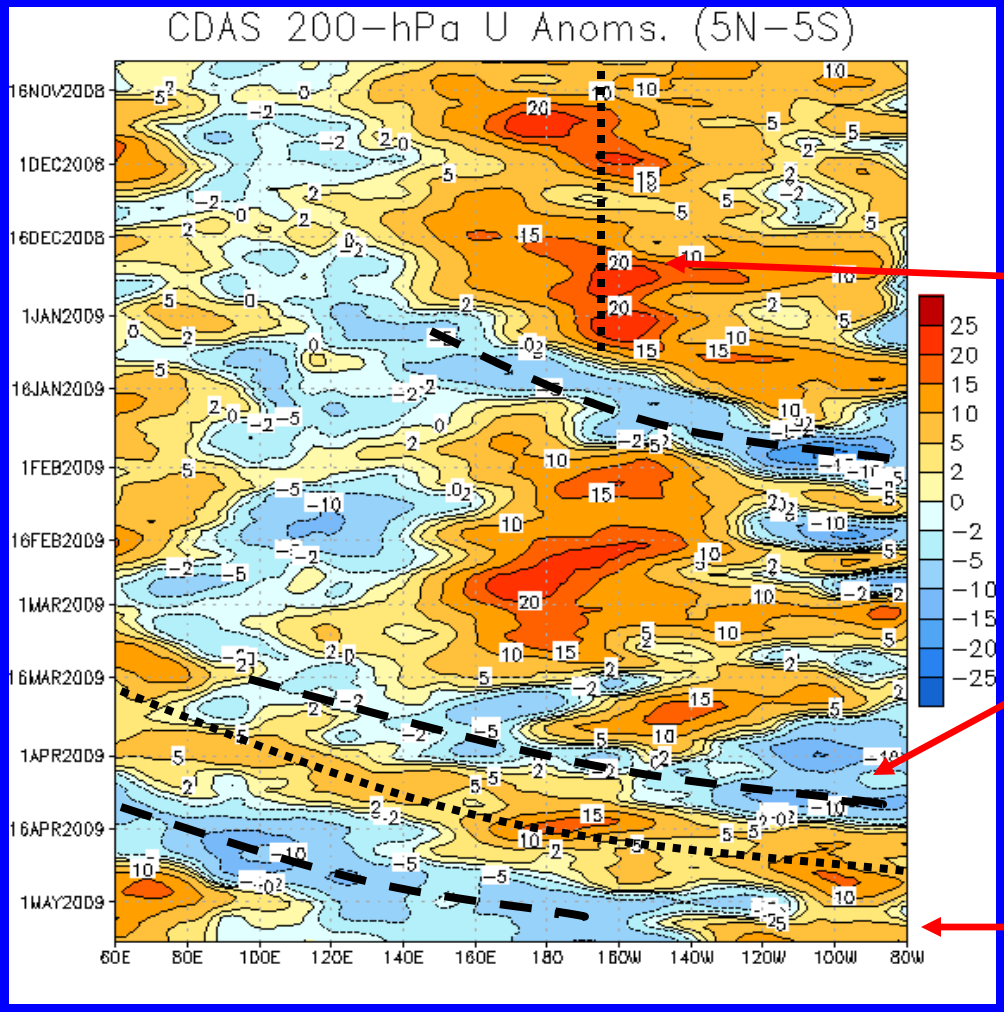
Easterly anomalies developed across the Equatorial Atlantic during the last five days.

Westerly anomalies continue across the Indian Ocean during the last five 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

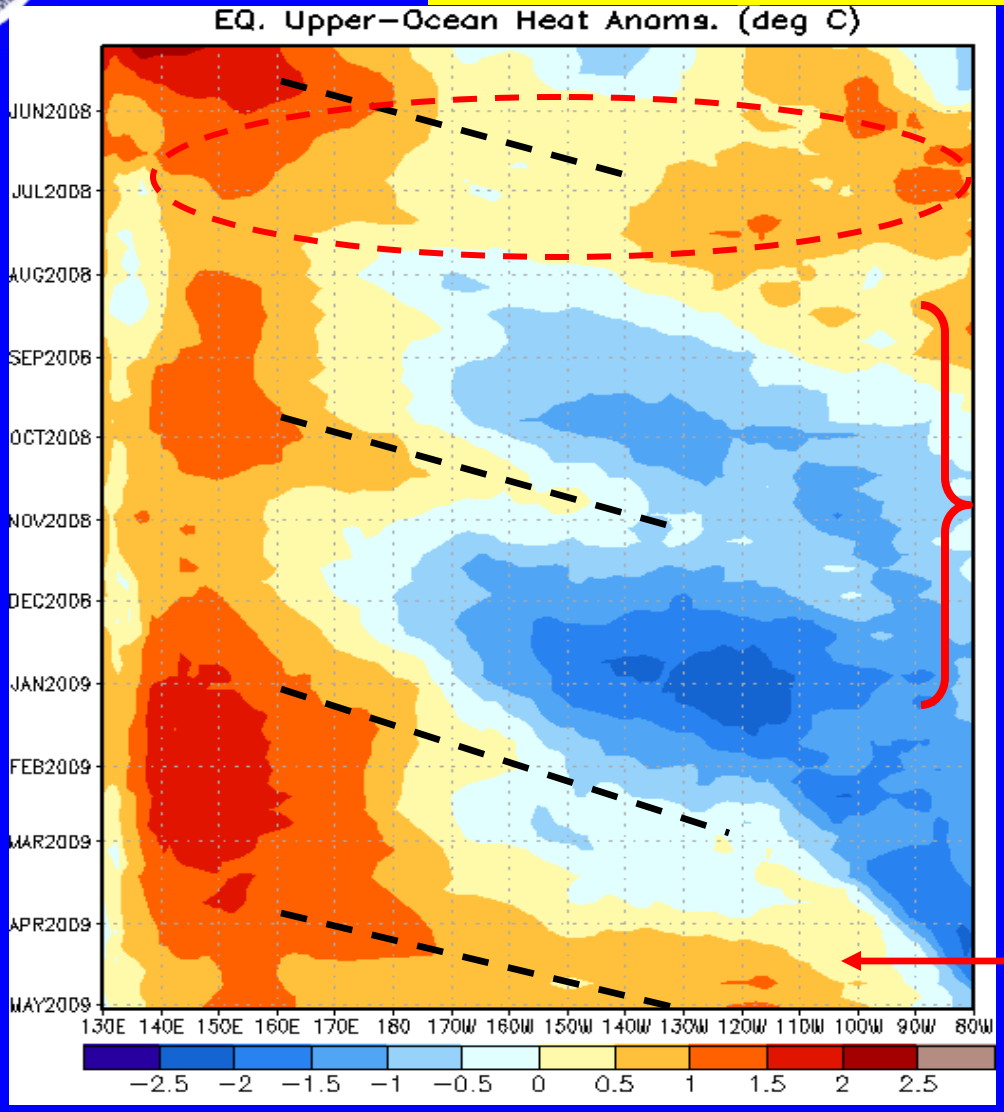
Longitude

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

Easterly and westerly anomalies shifted eastward from mid-March to the beginning of May associated with the MJO.

Most recently, coherent propagation has decreased with easterly anomalies evident from Indonesia to just east of the Date Line.

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 increased/expanded eastward through early 2009. There was a pause in this increase during October as a Kelvin wave shifted eastward.

Recently, an eastward propagating Kelvin wave has increased heat content in the eastern half of the Pacific.

MJO Index -- Information

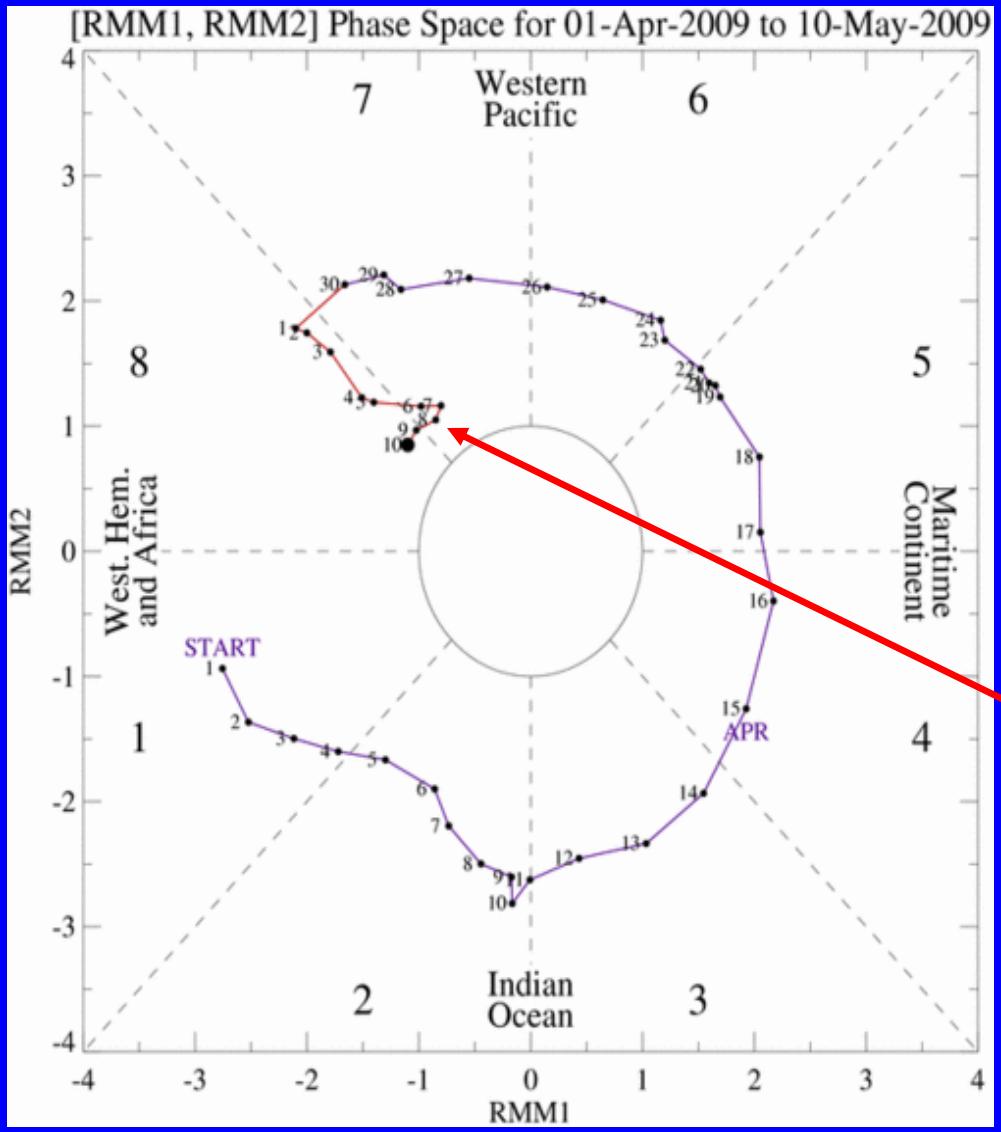
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

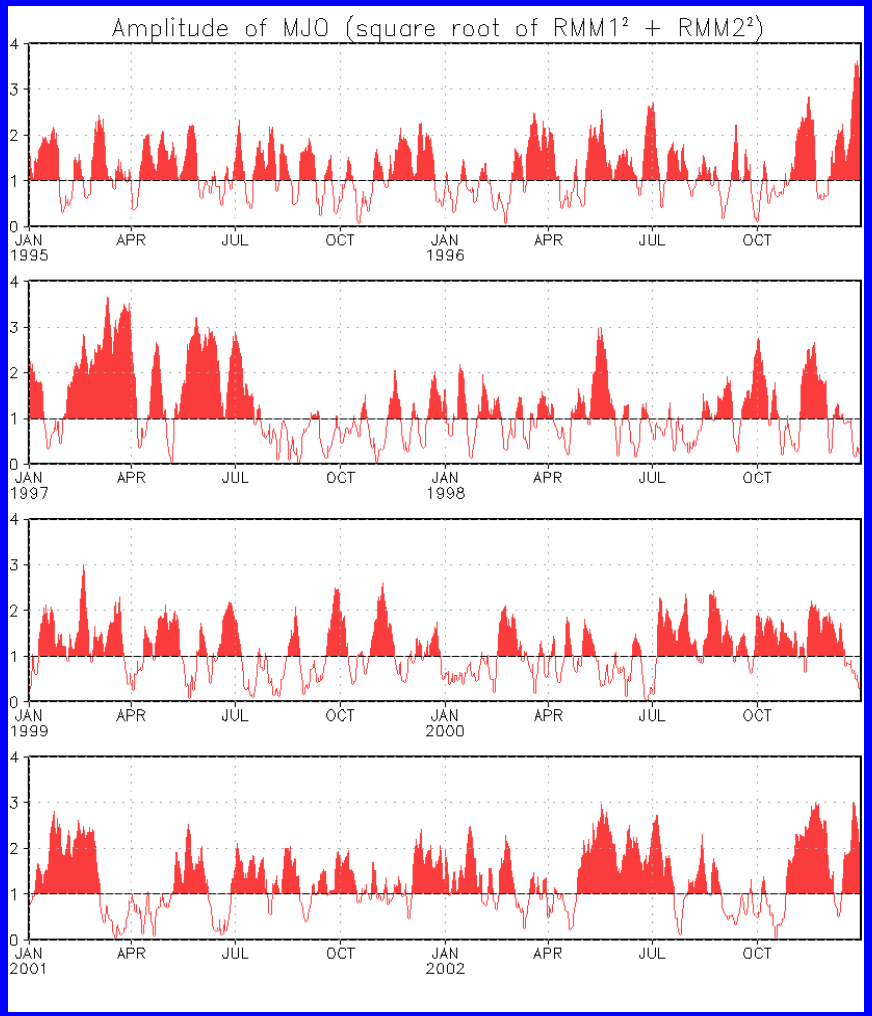
MJO Index -- Recent Evolution

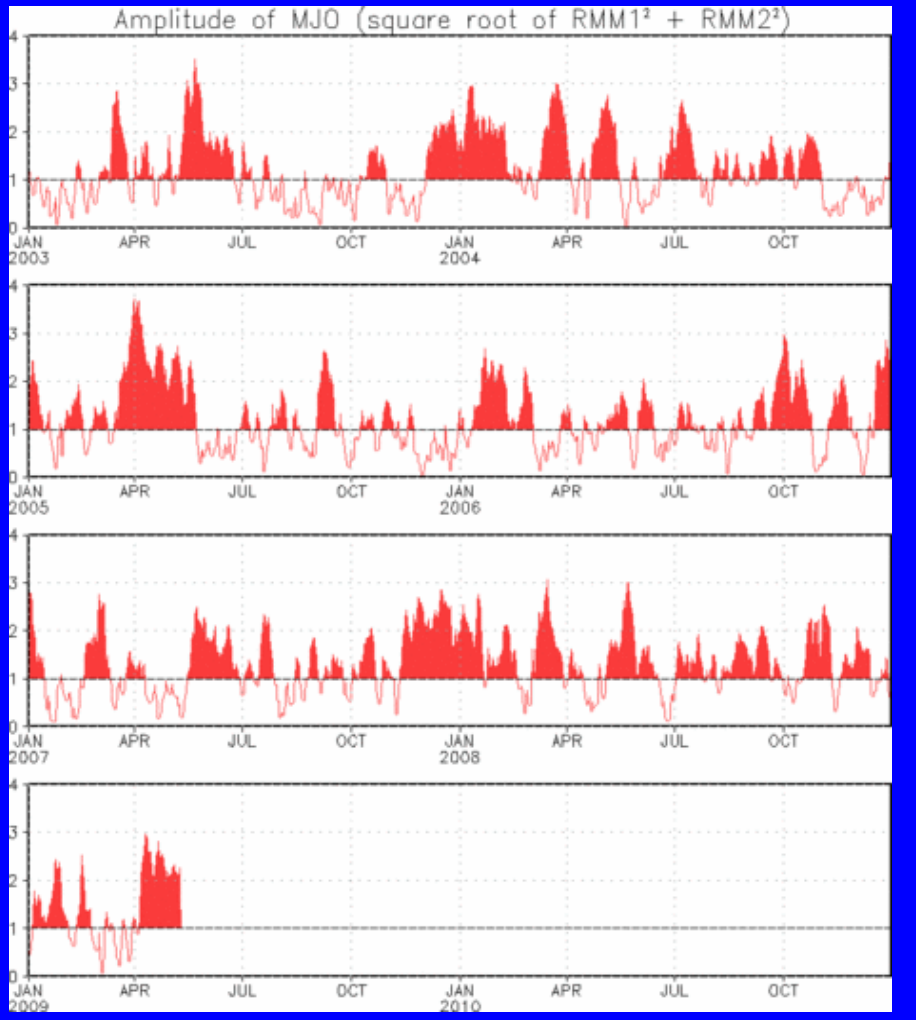


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The index indicates that the MJO has weakened and stalled over the Western Pacific/Western Hemisphere (phase 7/ 8) 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.

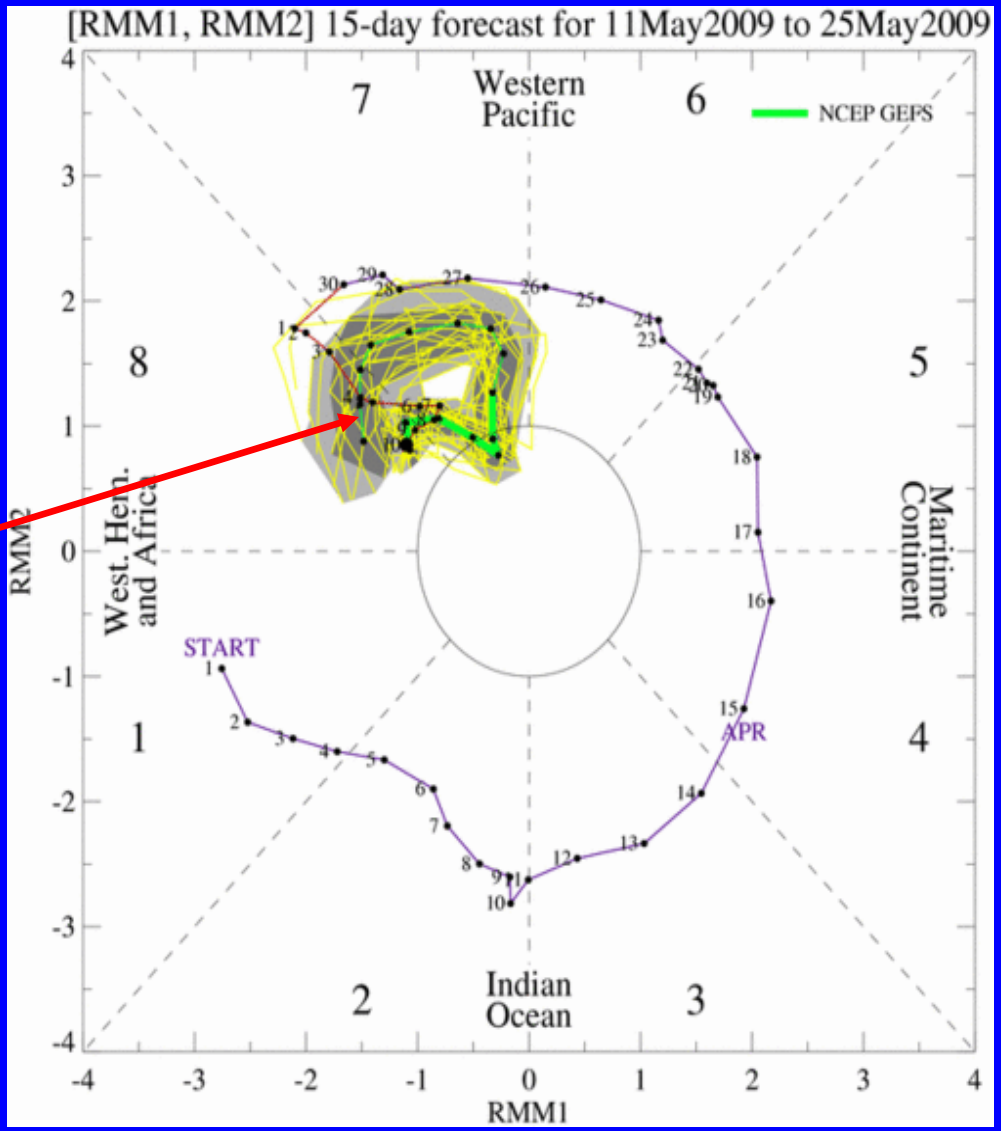
Ensemble GFS (GEFS) MJO Forecast

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

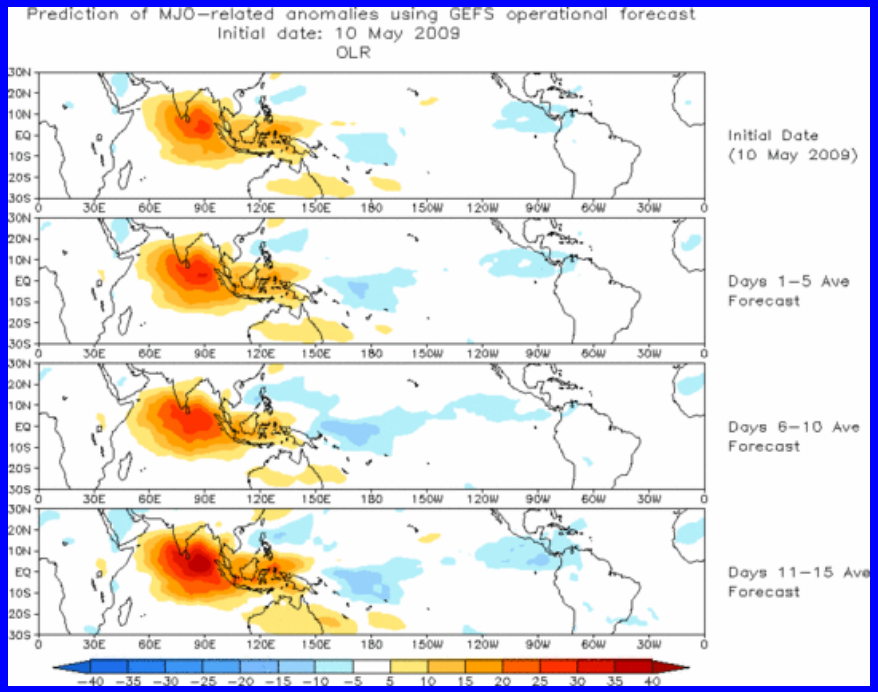
The GEFS forecasts indicate that there will be little or no propagation of the MJO during the next two weeks.



Ensemble Mean GFS MJO Forecast

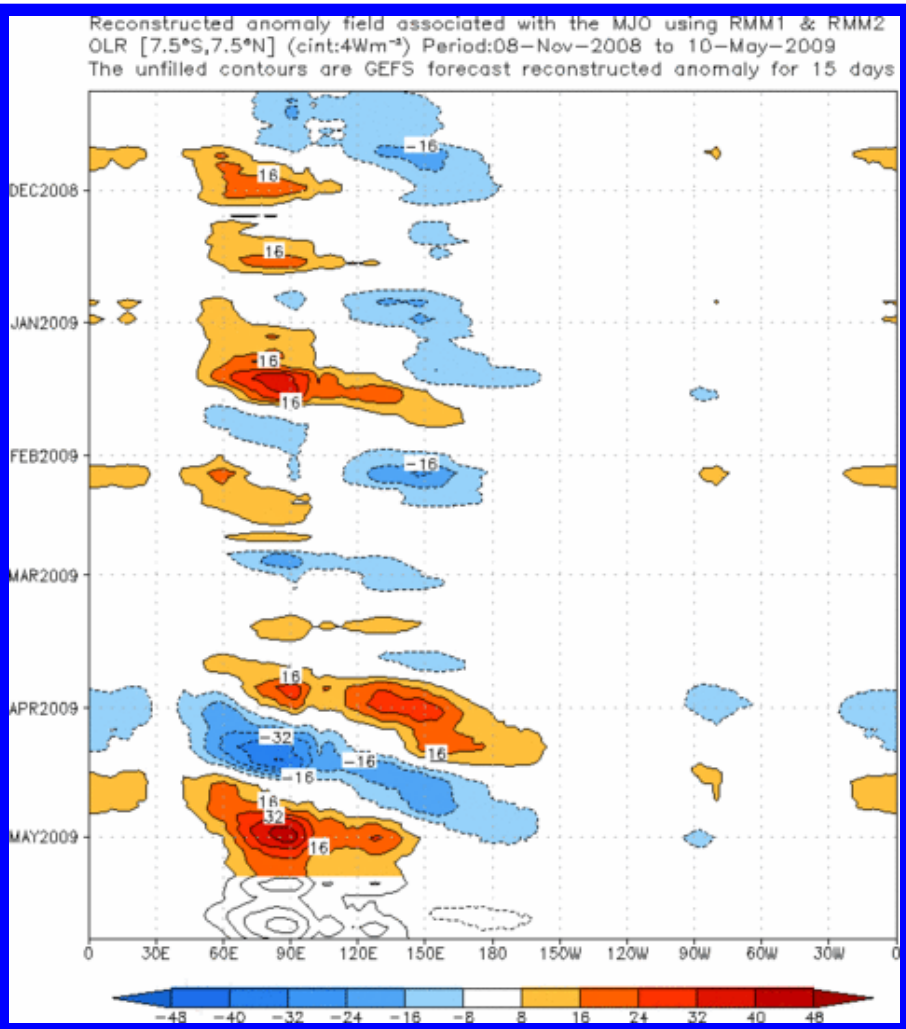
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



Suppressed convection is expected to persist across the Indian Ocean and Maritime Continent for much of the period. Slightly enhanced convection is predicted to continue across the Western Hemisphere.

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

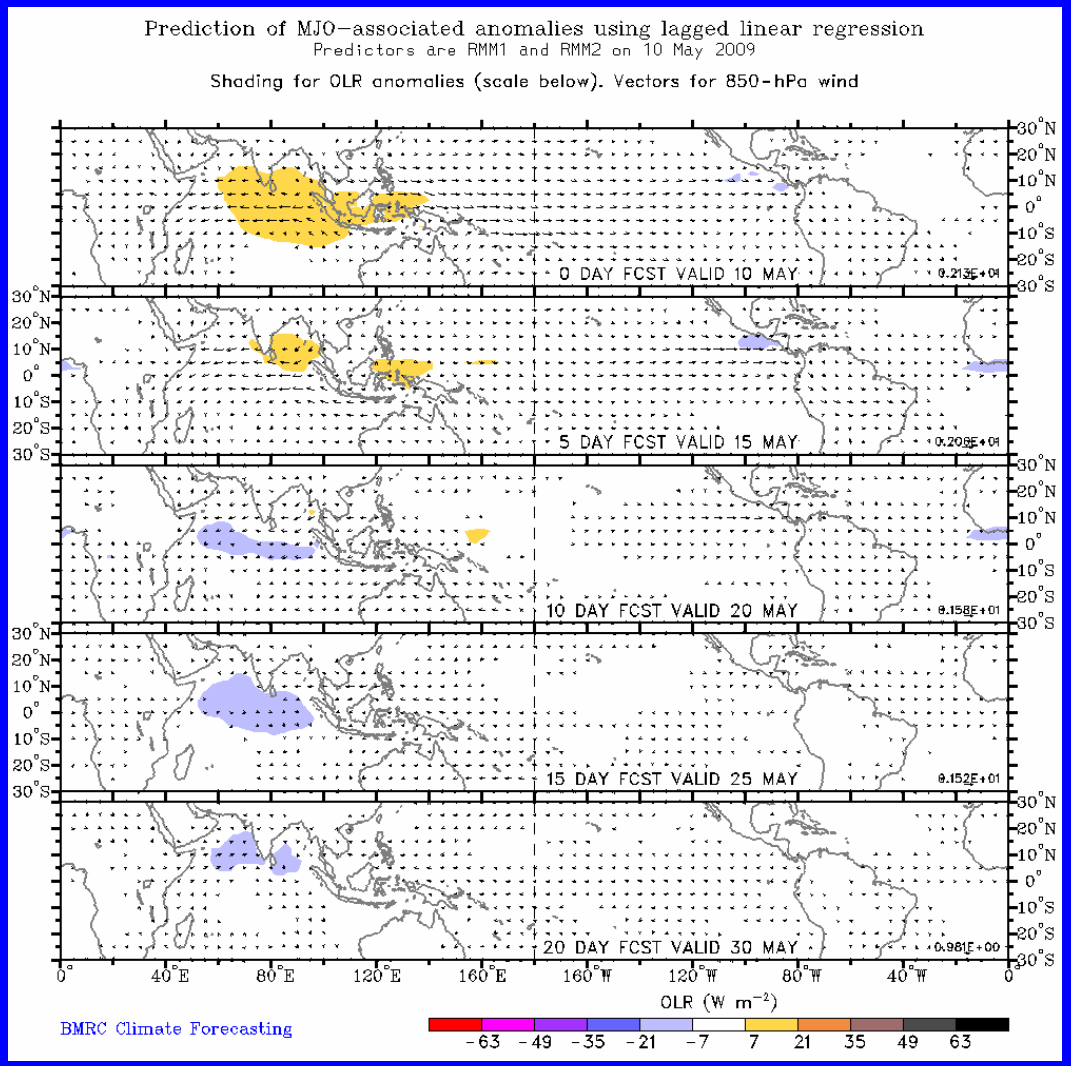
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies and 850-hPa wind vectors for the next 20 days

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

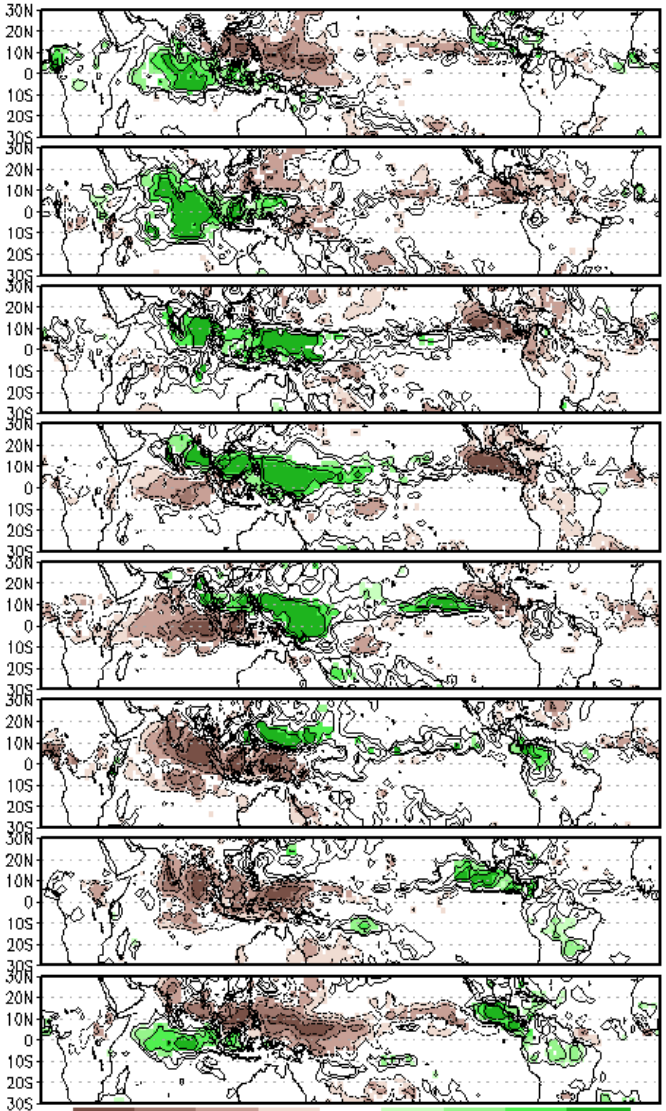
A statistical MJO forecast indicates suppressed convection weakening during the next 1-2 weeks.

Weak enhanced convection is expected to develop over the Indian Ocean later in the period.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)