



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

**Update prepared by
Climate Prediction Center / NCEP
April 27, 2009**



Outline

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



Overview

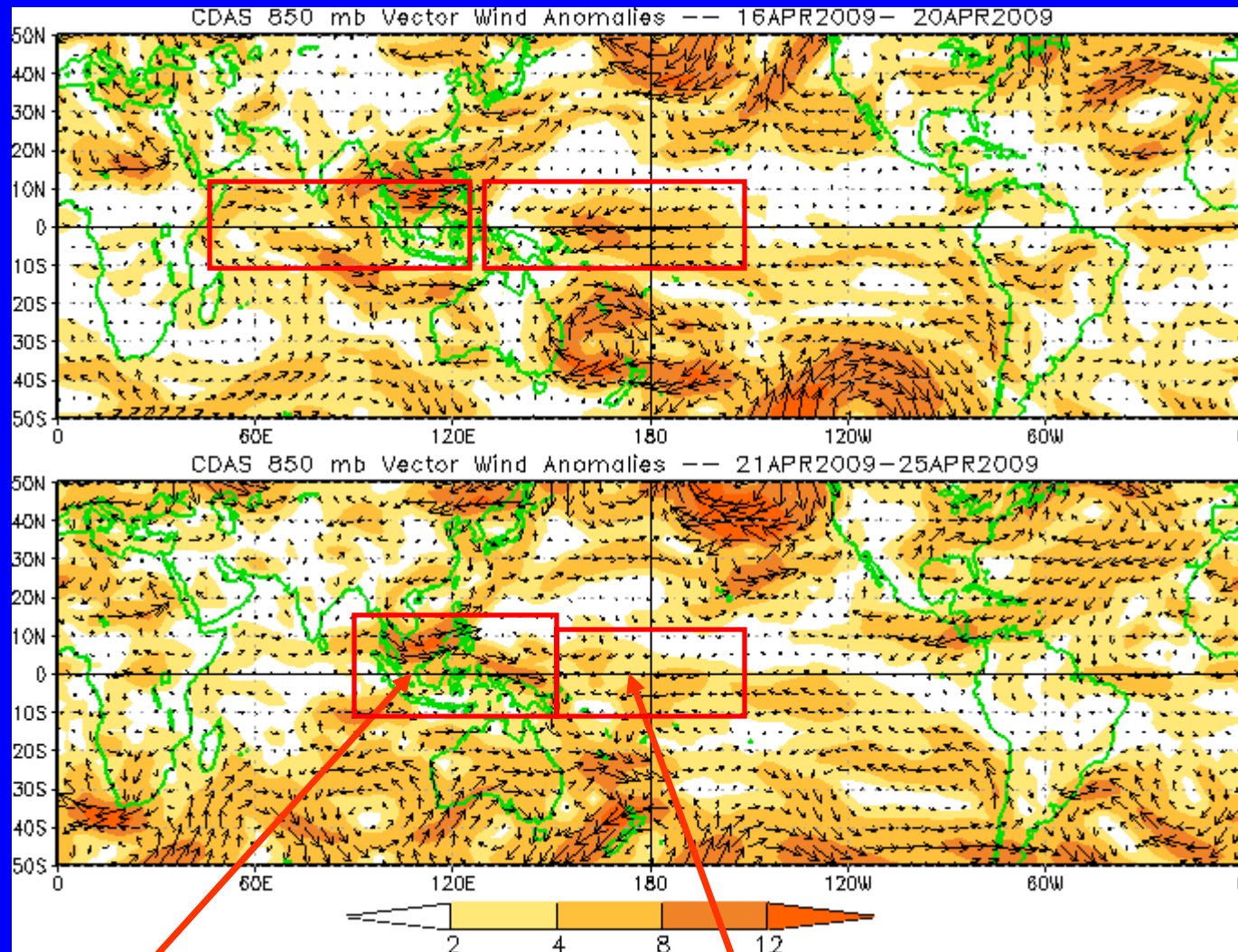
- **Moderate MJO activity continued during the past week with the enhanced convective phase now centered over the western Pacific.**
- **The MJO is expected to continue during the next 1-2 weeks, however, some of the model forecasts indicate a weakening of the MJO during Week-2.**
- **The MJO is anticipated to suppress rainfall across the Indian Ocean and the Maritime Continent over the period. Wet conditions are expected across parts of the western Pacific during Week-1 and parts of South America and Africa for both Week-1 and 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



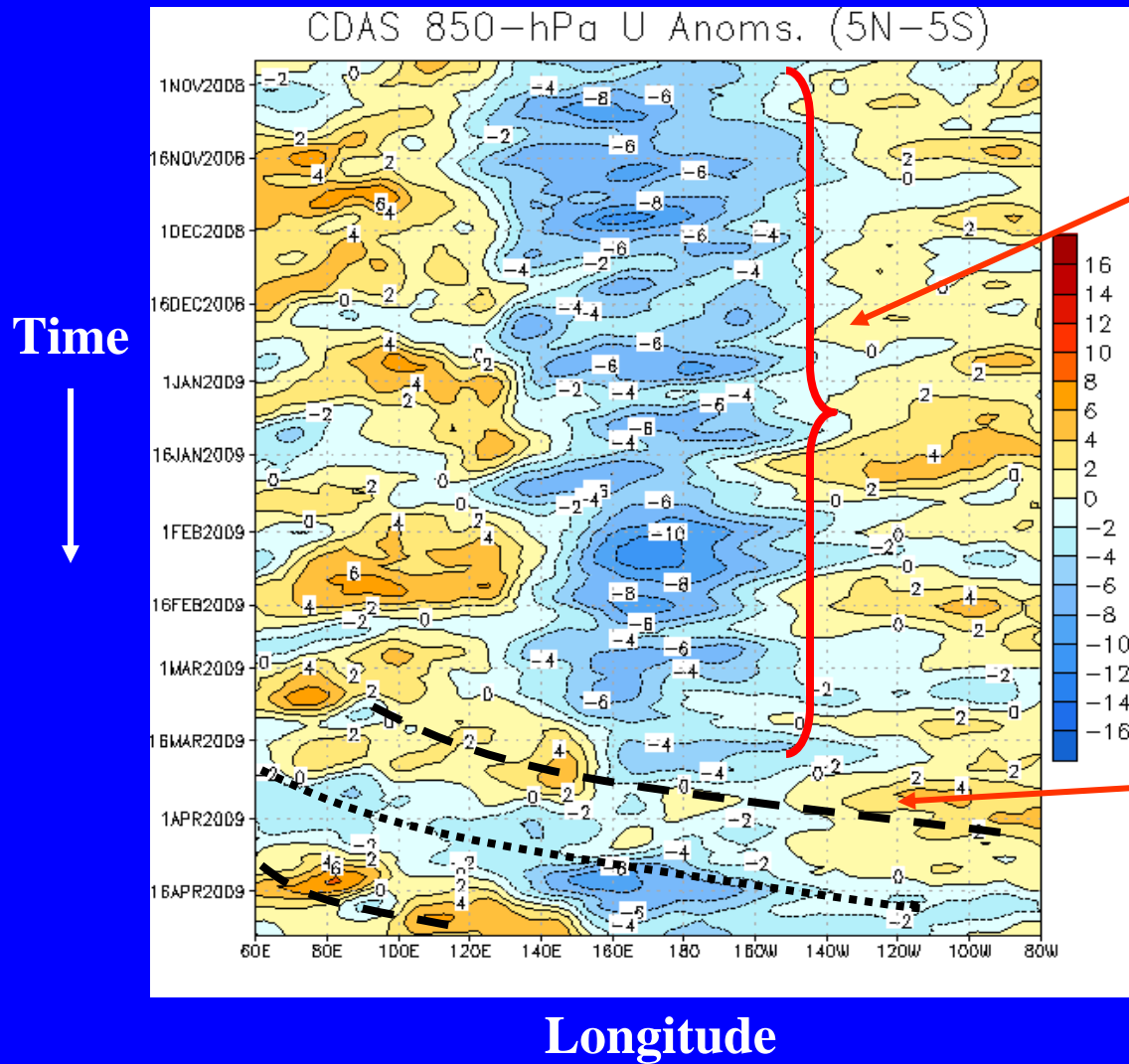
Low-level westerly wind anomalies have shifted east and are located over the Maritime Continent.

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



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



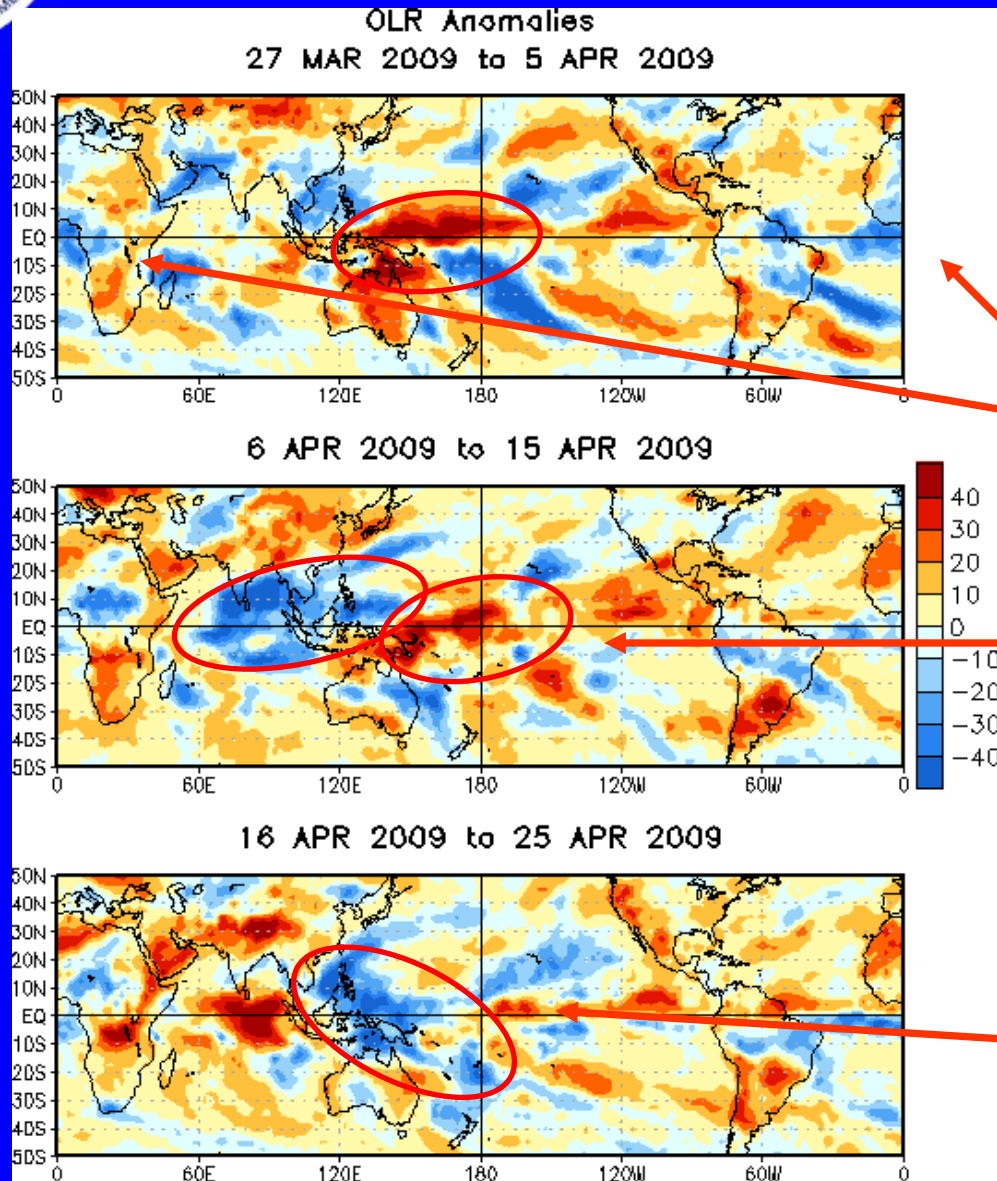
A persistent pattern of westerly (easterly) anomalies stretching from the Indian Ocean to the central Pacific Ocean has been in place since October with a few breaks in late December and mid-January.

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 current MJO activity.



OLR Anomalies: Last 30 days

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



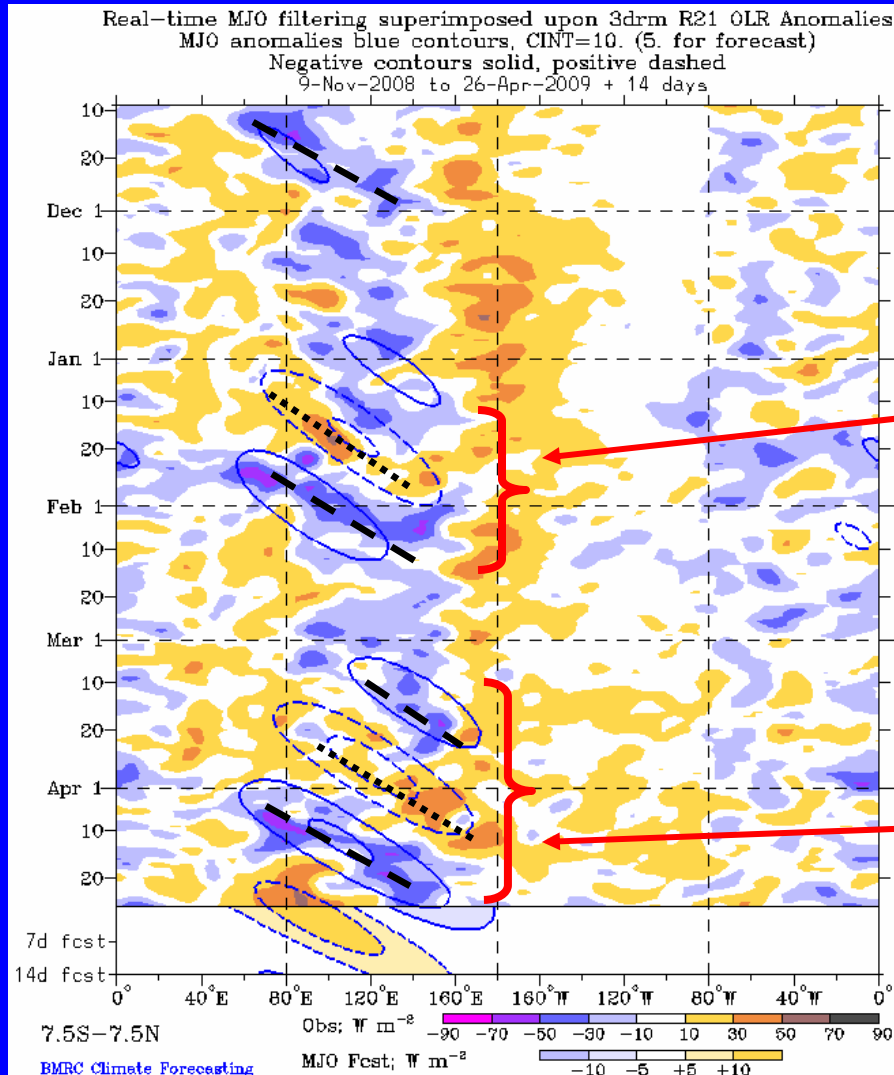
During late March and early April, suppressed convection stretched from Australia to the western Pacific Ocean while wet conditions developed across the Gulf of Guinea portion of Africa.

During early-mid April, enhanced convection emerged over the Indian Ocean, Bay of Bengal and western Indonesia while suppressed convection continued across the western Pacific.

More recently, enhanced convection has shifted eastward and is now centered over the Maritime Continent.



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 - Australia)

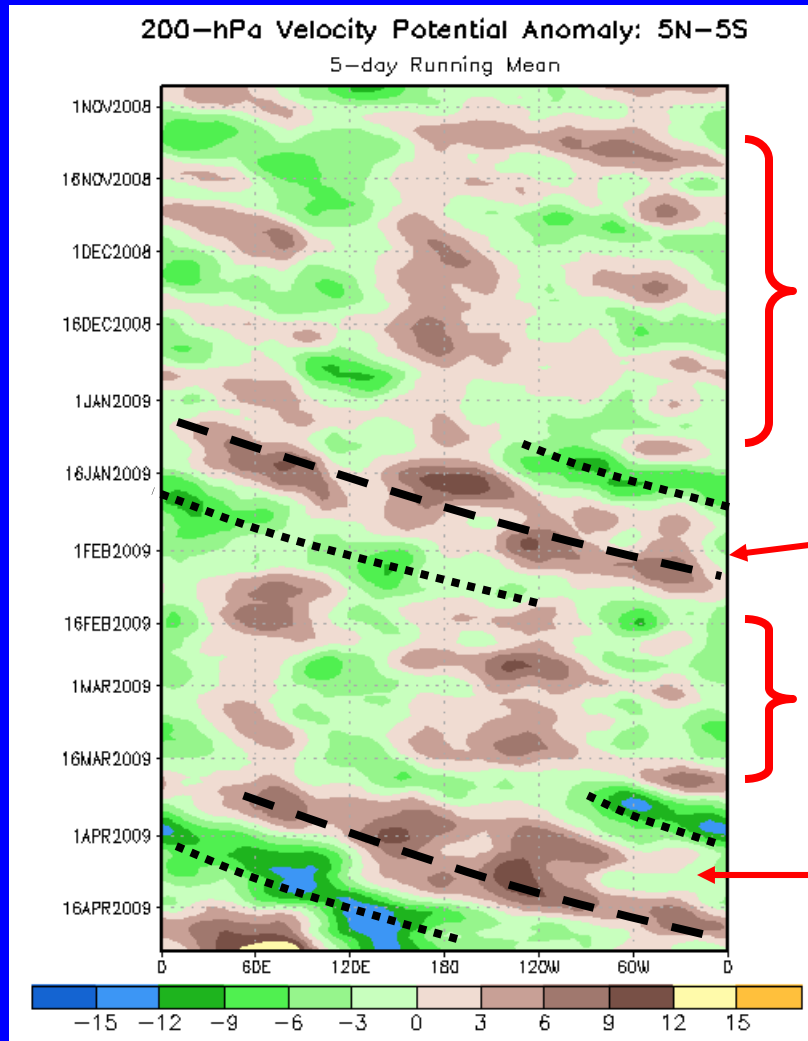
From mid-January to mid-February, eastward movement of suppressed (enhanced) convection is observed from the Indian Ocean to portions of Indonesia and the western Pacific.

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



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.

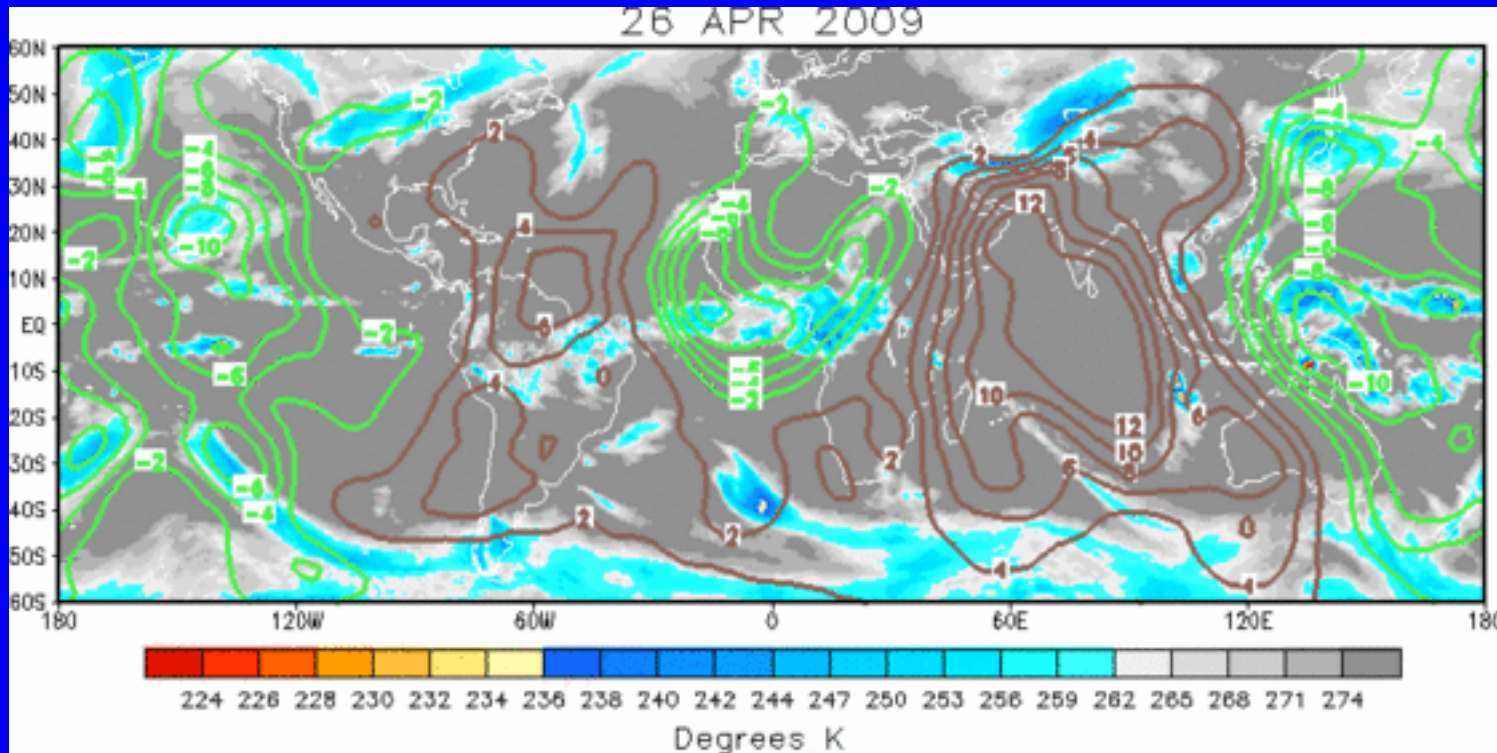
Since mid-March, eastward propagating velocity potential anomalies indicate MJO activity.



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



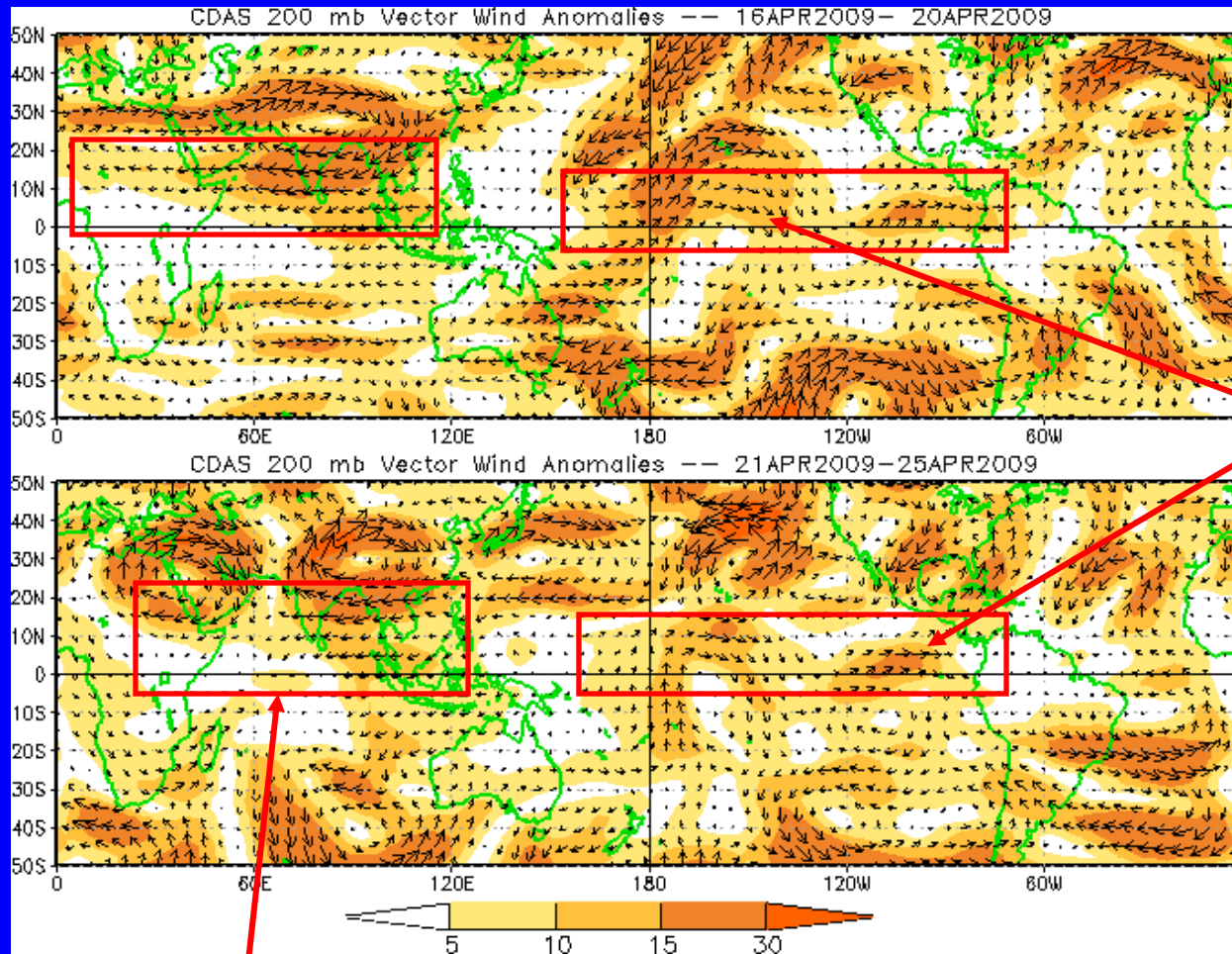
A coherent velocity potential spatial pattern is evident with large-scale anomalous upper-level divergence (convergence) centered over the Pacific Ocean (Indian Ocean).

Regional scale upper-level divergence is also apparent over western Africa.



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

Note that shading denotes the magnitude of anomalous wind vectors



Westerly anomalies continue over the central and eastern Pacific during the last 5-10 days.

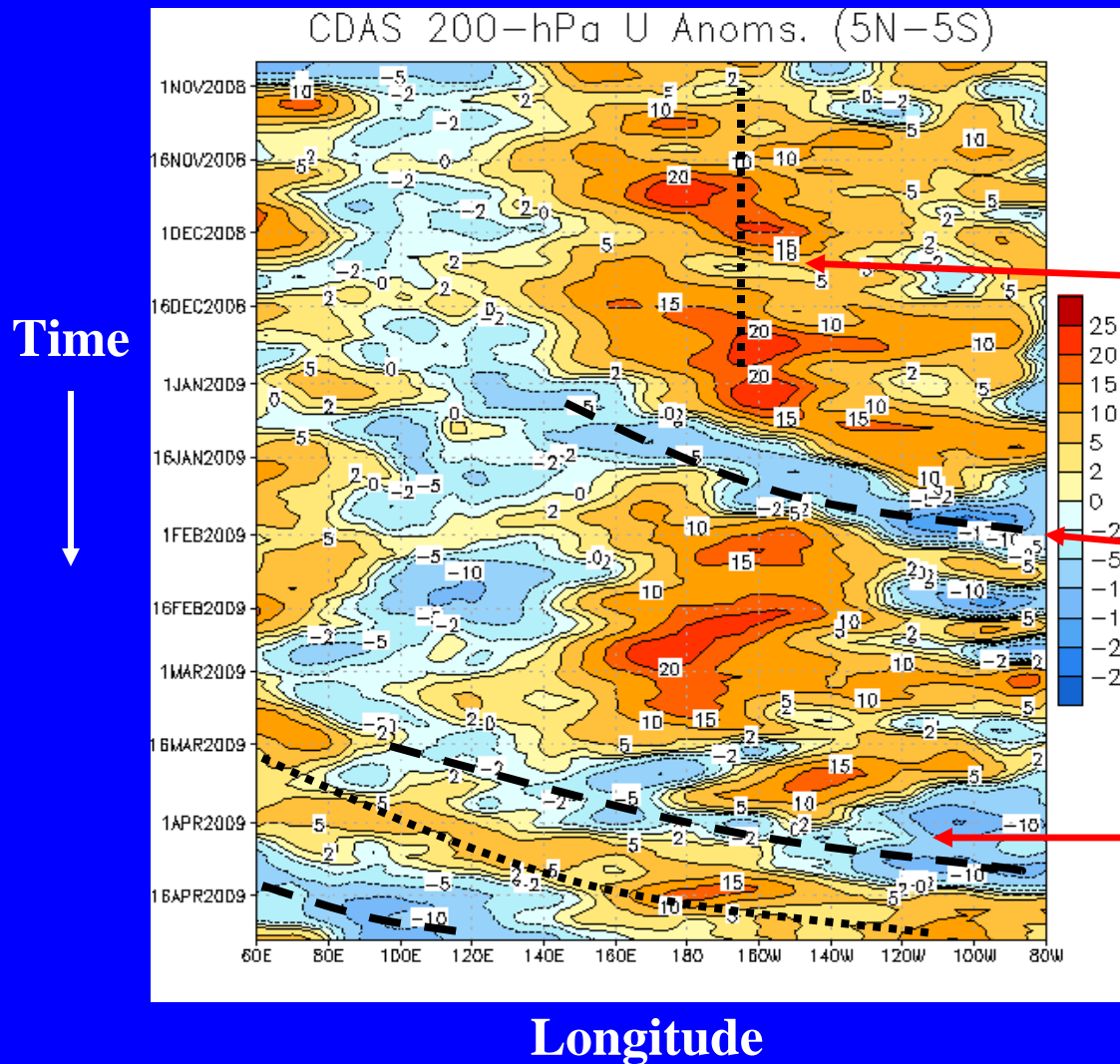
Easterly anomalies, just north of the equator have been evident during the last 5-10 days.



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



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.

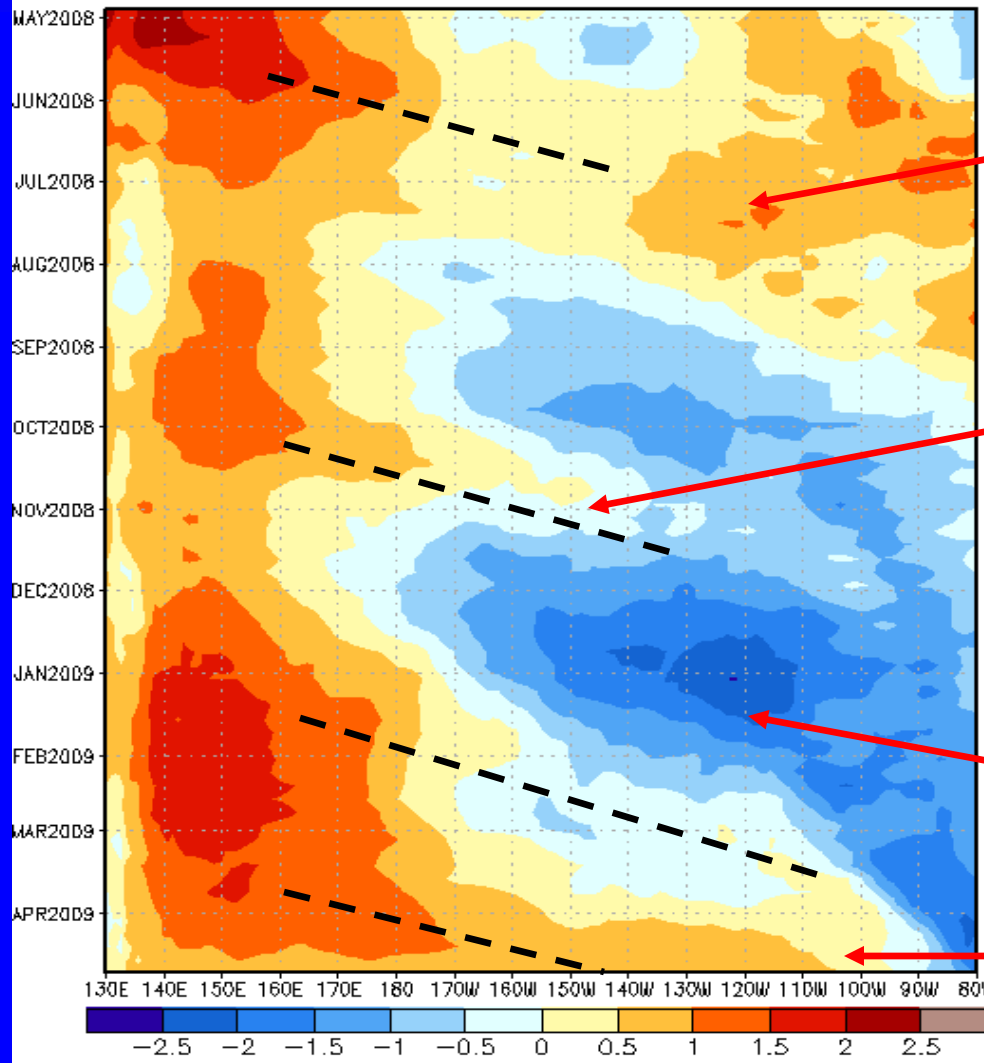
First easterly and later westerly anomalies shifted eastward from the Indian Ocean across the Pacific - associated with current MJO.



Weekly Heat Content Evolution in the Equatorial Pacific

EQ. Upper-Ocean Heat Anoms. (deg C)

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 eastern half of the Pacific.



MJO Index -- Information

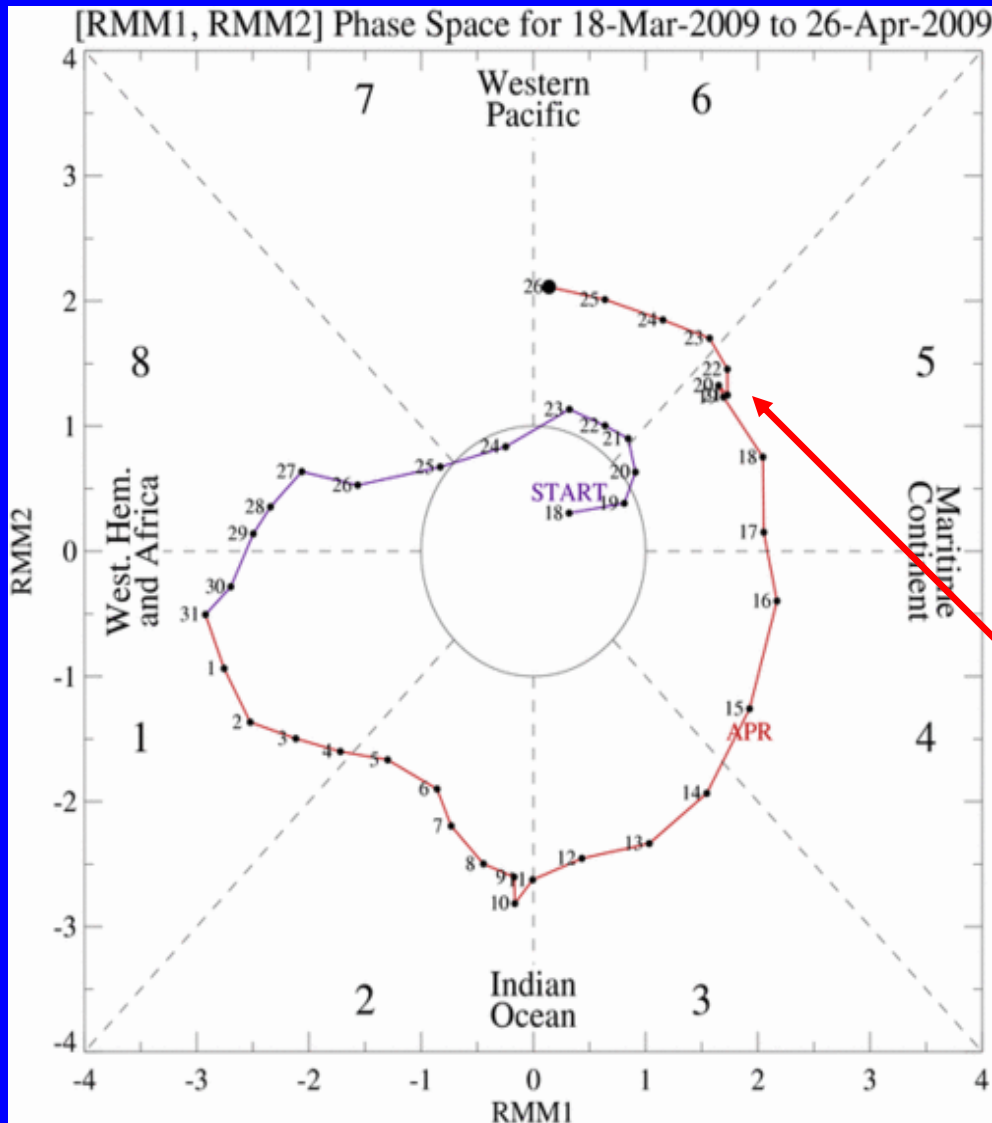
- The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).

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

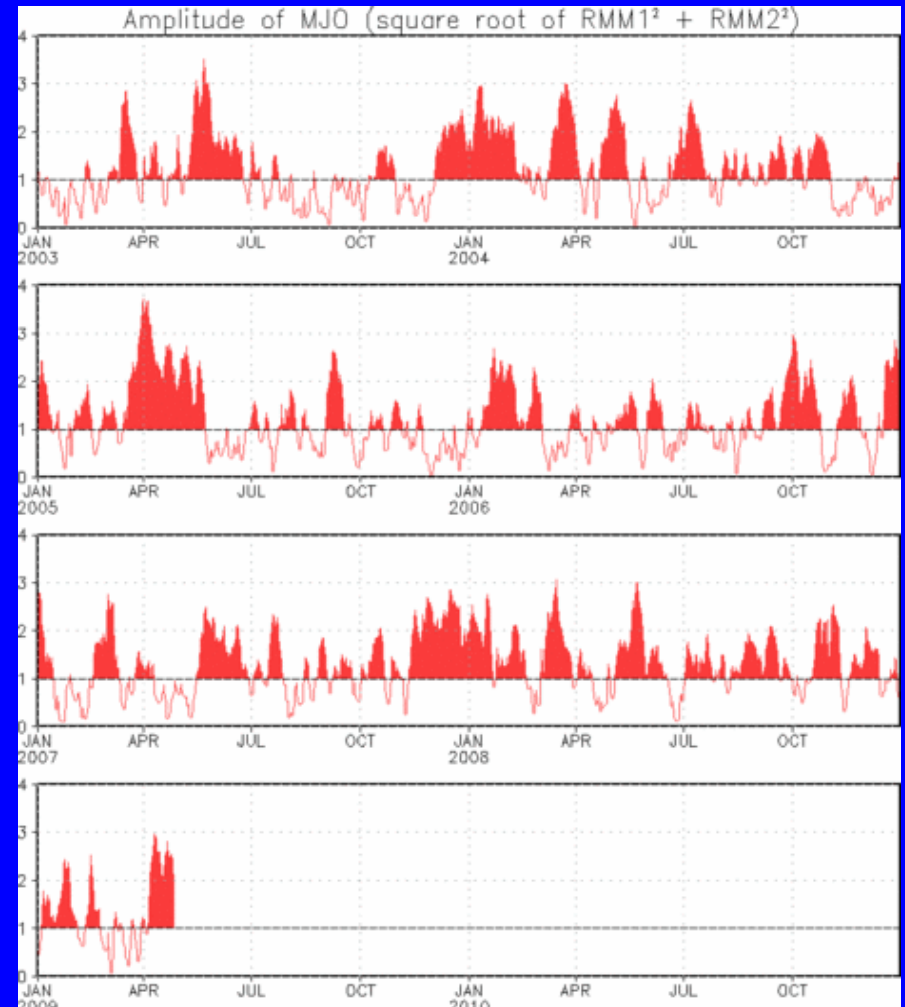
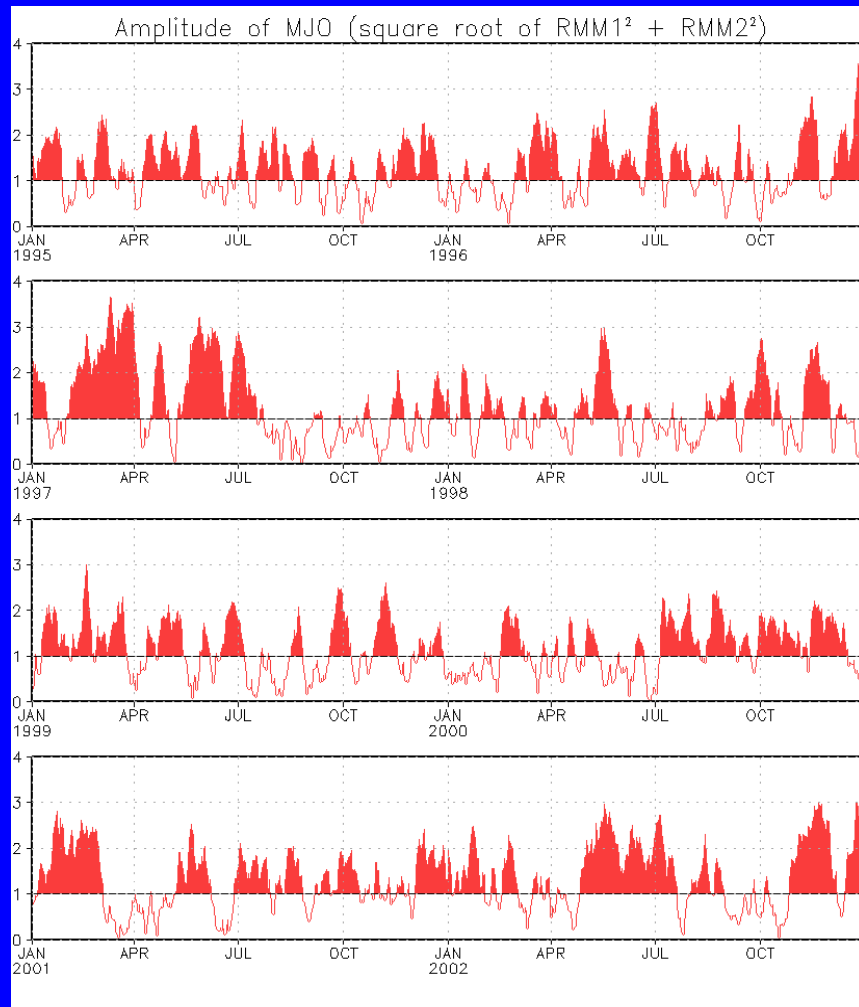


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index shows moderate activity has shifted through phase 6 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.**



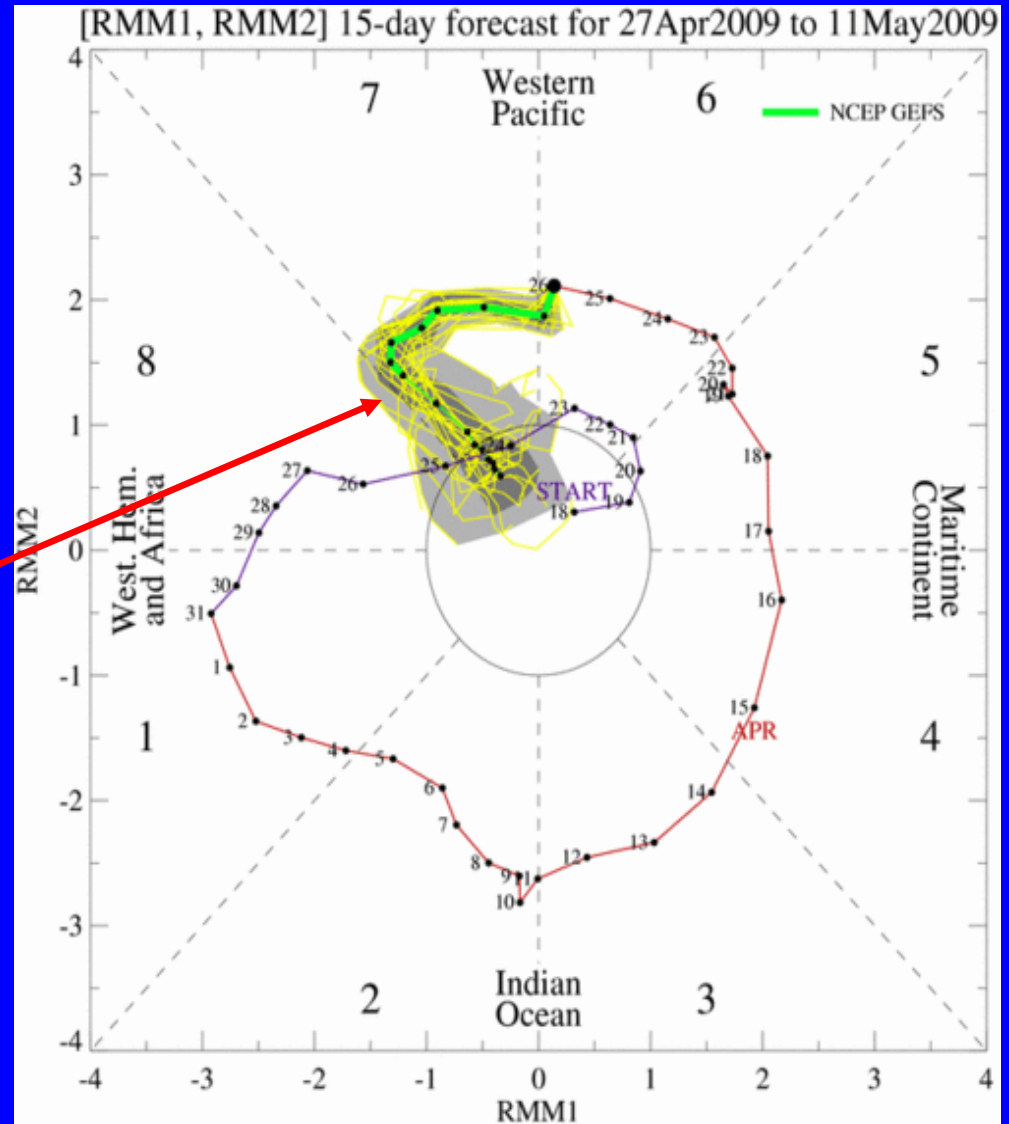
Ensemble GFS (GEFS) MJO Forecast

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 as it shifts across the western Pacific during Week-1. During Week-2, the MJO signal is expected to weaken.

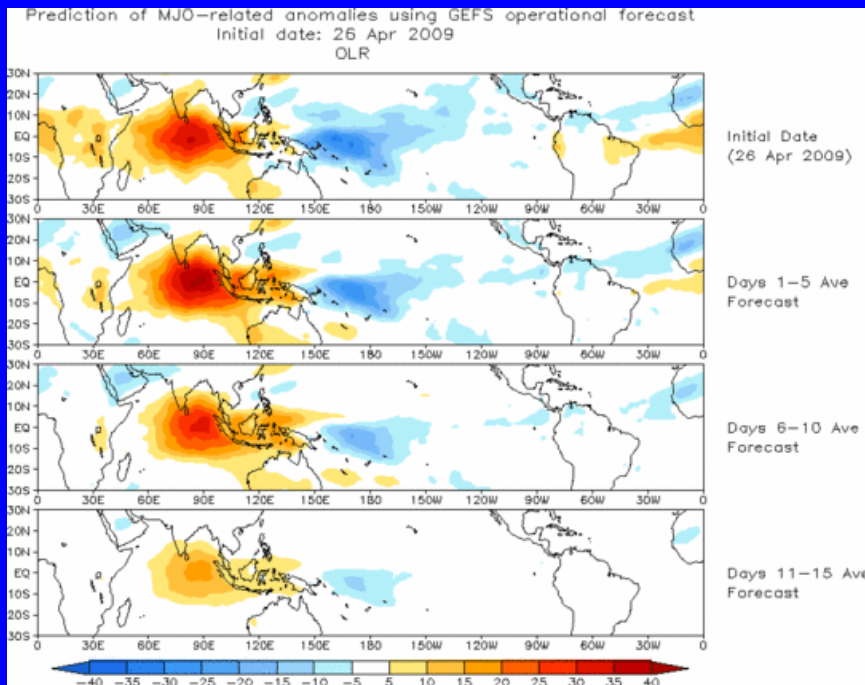




Ensemble Mean GFS MJO Forecast

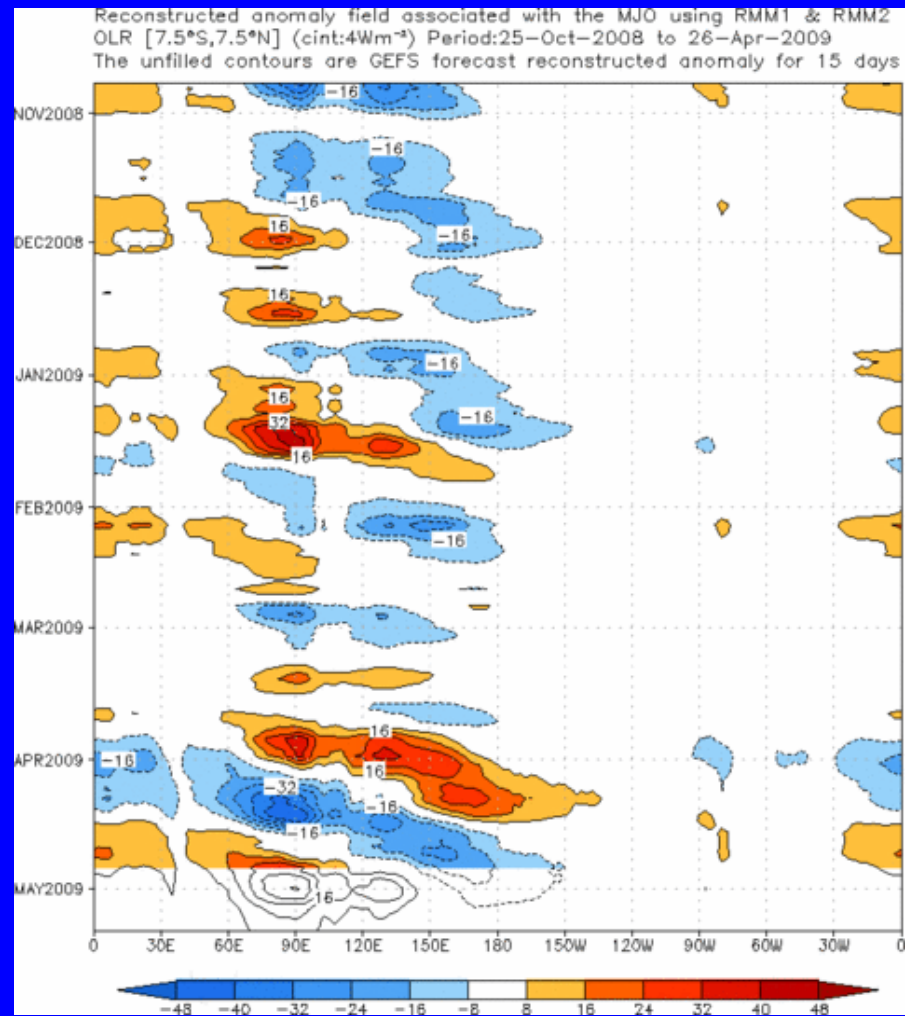
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



Enhanced convection is expected to slowly decrease across the western Pacific during the period while suppressed convection is anticipated to persist in the Indian Ocean and western Maritime Continent.

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



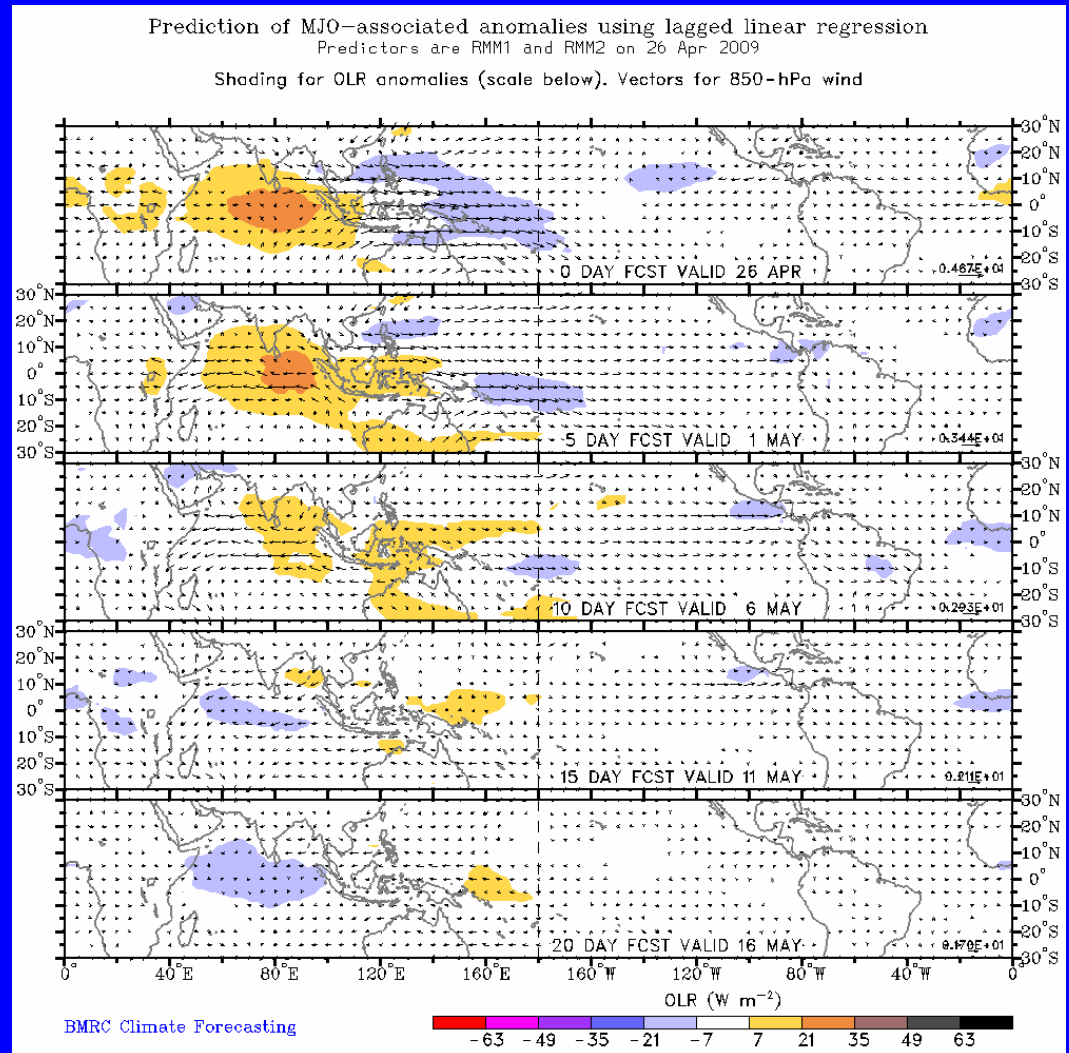


Statistical MJO Forecast

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)

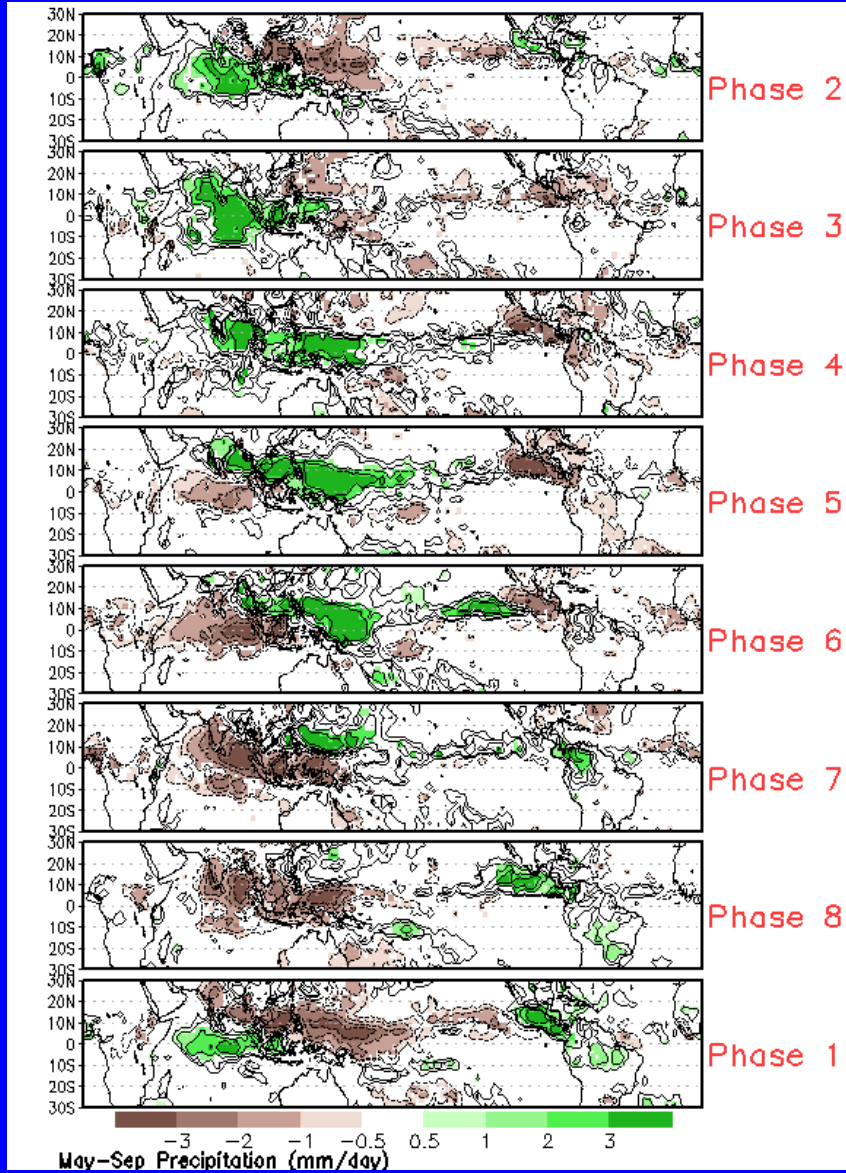
A statistical MJO forecast indicates suppressed convection shifting from the Indian Ocean across the Maritime Continent during the next 1-2 weeks.





MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)

