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

Update prepared by
Climate Prediction Center / NCEP
April 26, 2010

Outline

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

Overview

- The MJO has remained largely incoherent during the past week.
- Dynamical model MJO index forecasts indicate strengthening MJO activity during the next week with some eastward propagation by Week-2.
- Based on the latest model MJO forecasts, the MJO is expected to become more active with the enhanced convective phase located over the western hemisphere during Week-1 and shifting to Africa and potentially the Indian Ocean during Week-2.
- The MJO is expected to contribute to enhanced rainfall across pasts of Central America and Africa during Week-1 and the Indian Ocean in Week-2. Drier-than-average conditions are favored across parts of the Maritime continent and the western Pacific.

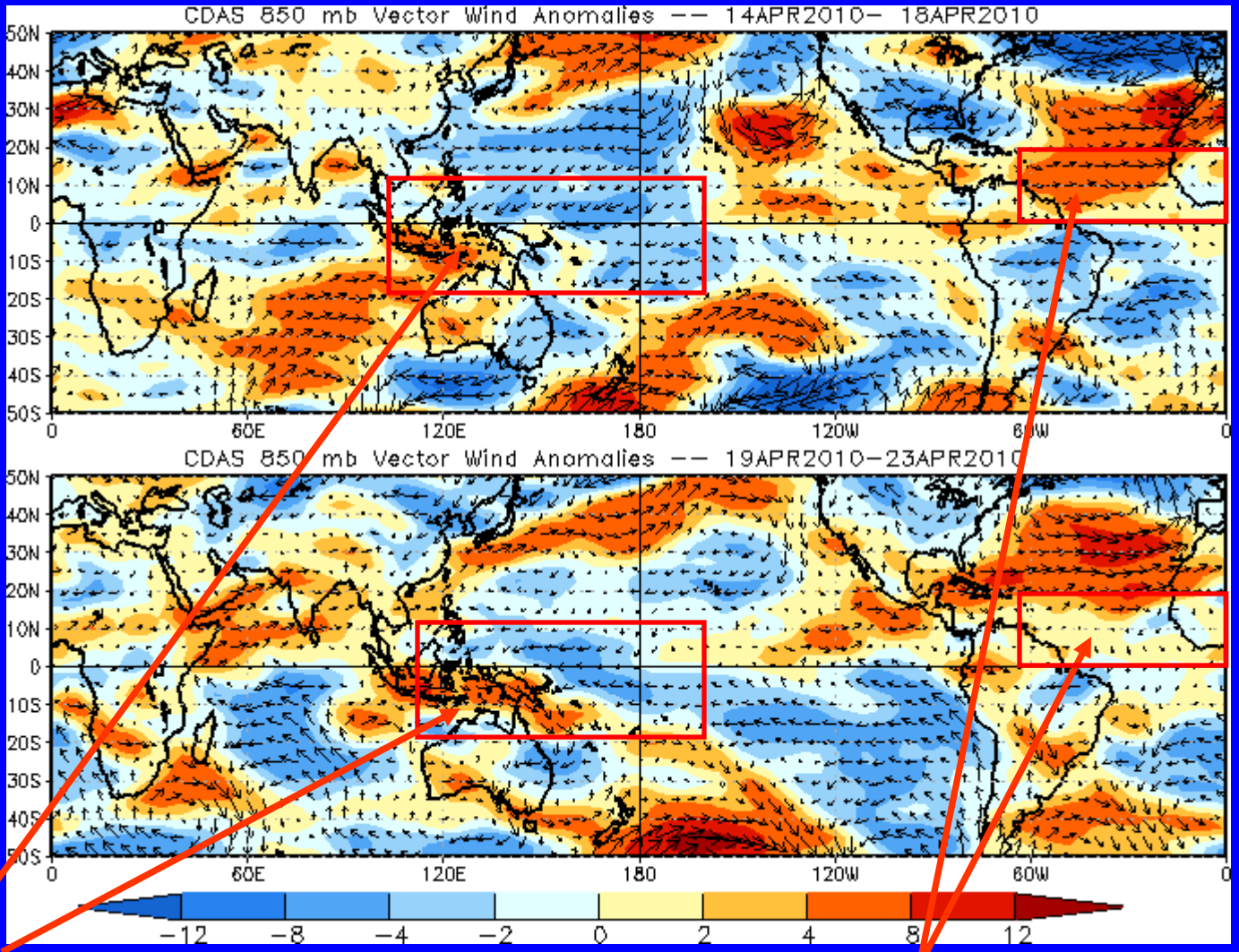
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



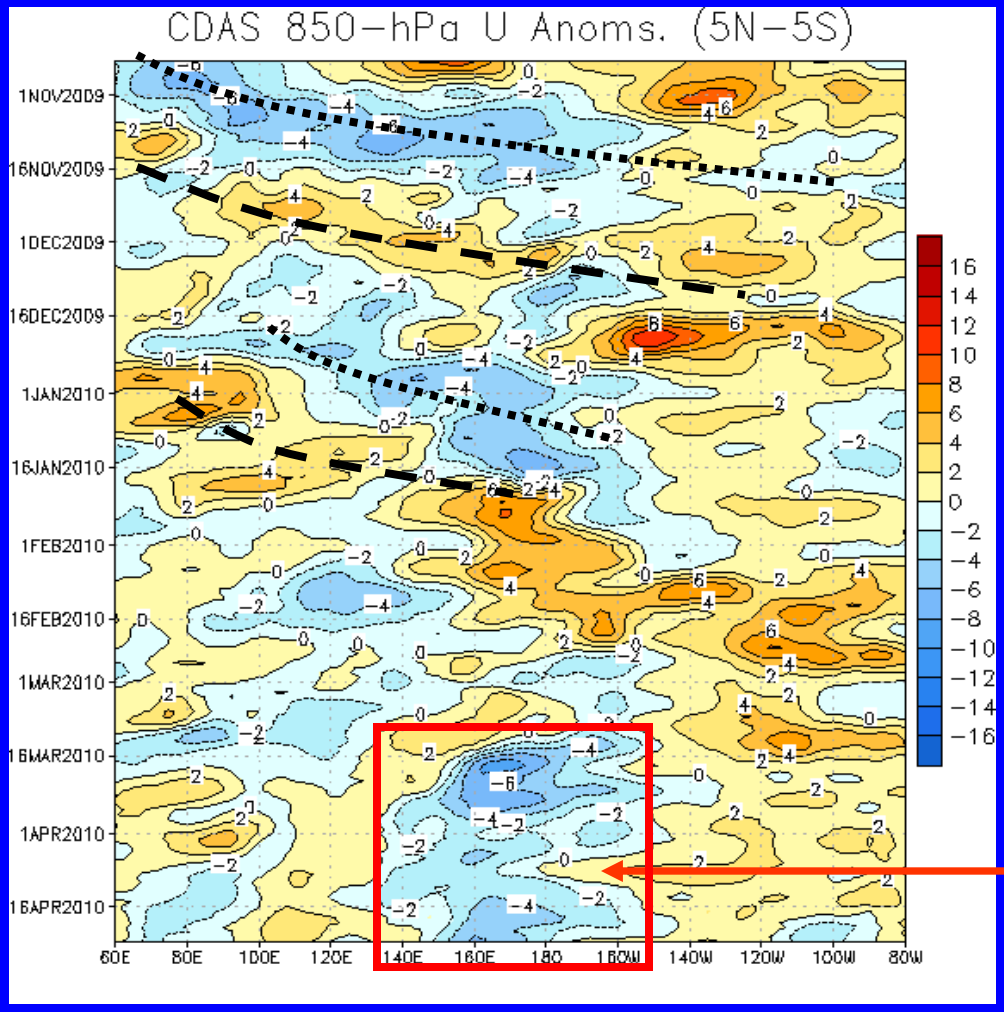
Westerly anomalies have continued over parts of the Maritime Continent while easterly anomalies have dominated the far western Pacific.

During the last five days, westerly anomalies weakened in the Atlantic north of the equator.

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

Easterly (dotted line) and westerly (dashed line) anomalies developed across the Indian Ocean and shifted eastward across the Date Line during late October and November associated with the MJO.

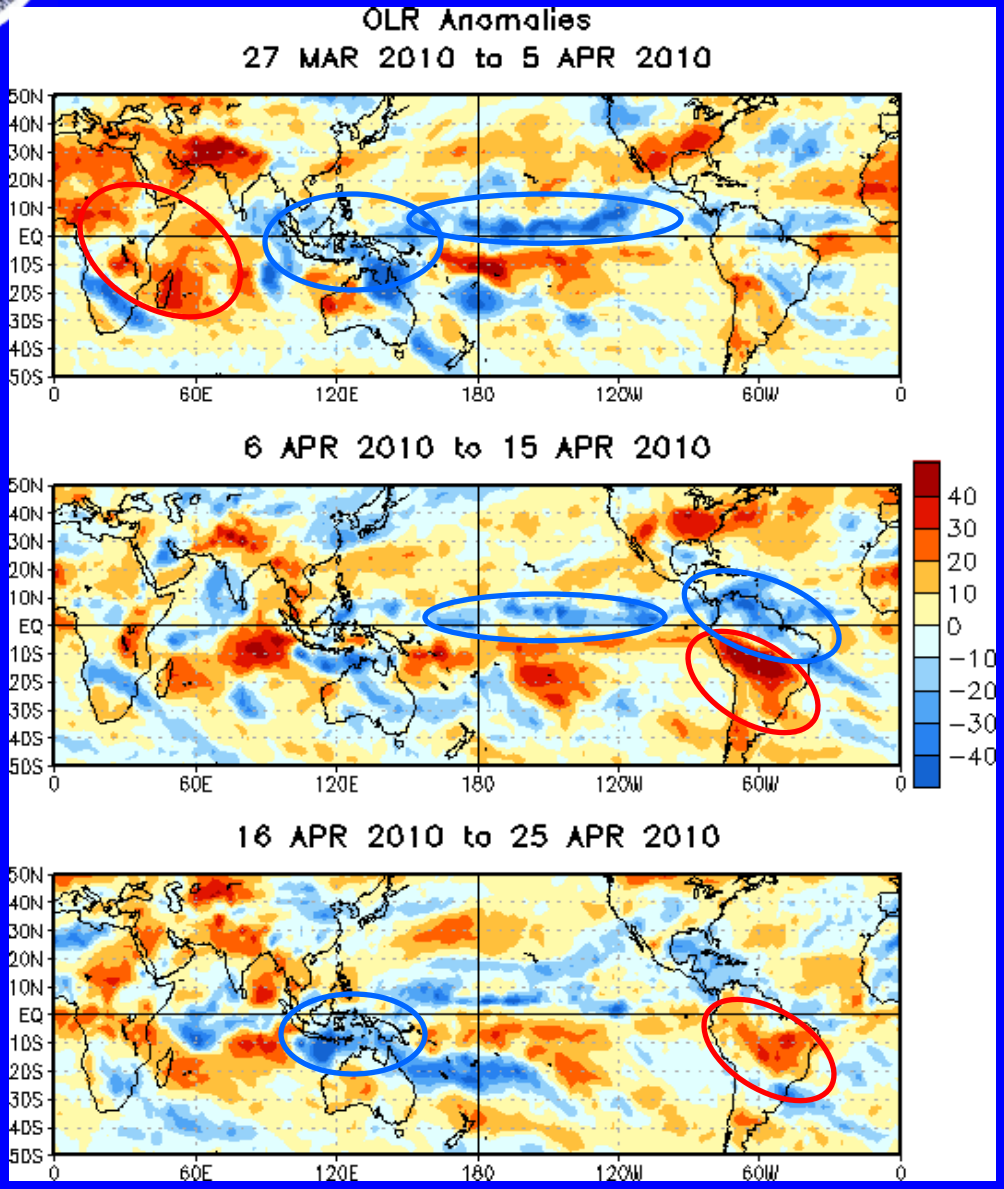
Weaker and shorter-lived MJO activity was evident during January.

Easterly anomalies have persisted in the west-central Pacific since mid-March (red box). Westerly anomalies continue in the eastern Pacific.

OLR Anomalies: Last 30 days

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

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

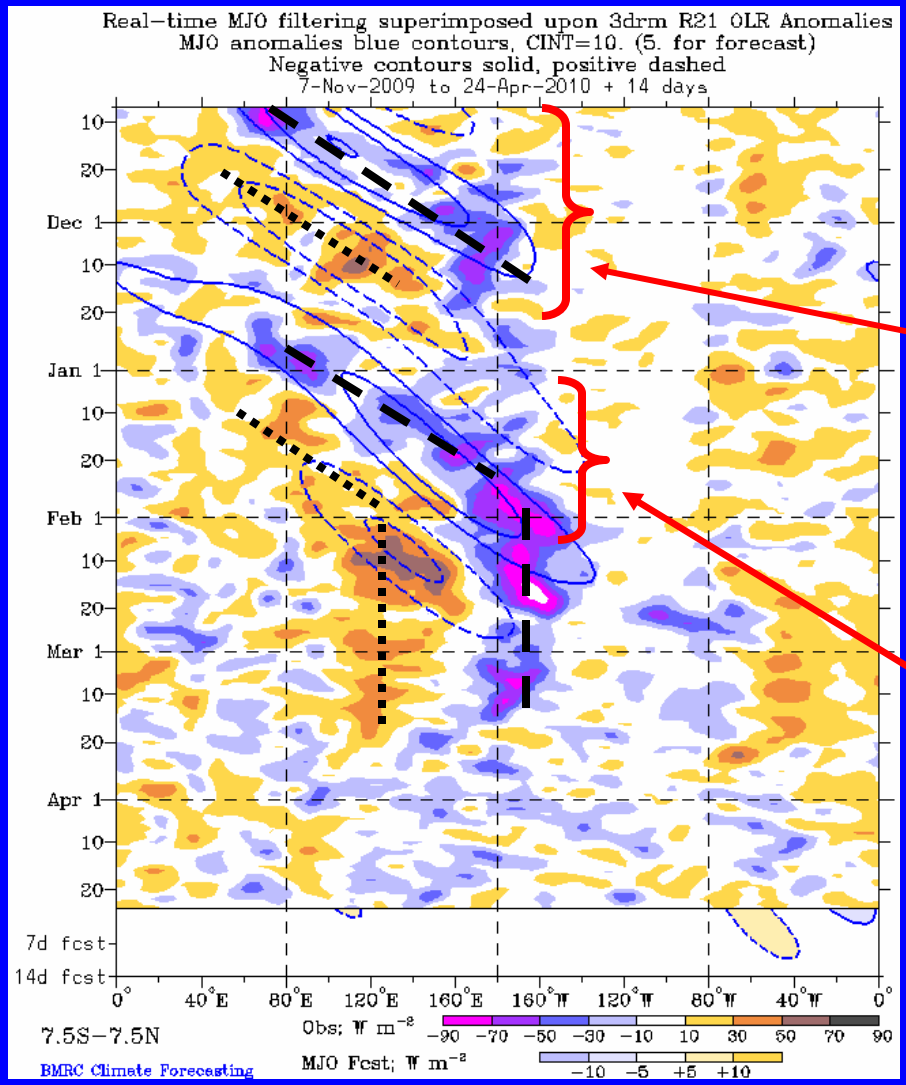


During late March to early April, enhanced convection was evident over the Maritime Continent and much of the equatorial Pacific. Suppressed convection was evident over east-central Africa and the western Indian Ocean.

In mid-April enhanced convection continued across the central Pacific while enhanced convection was apparent in northern South America. Suppressed convection developed in central South America.

During late April, anomalies weakened compared to earlier weeks. Enhanced convection was apparent over the southern Maritime Continent, while suppressed convection continued over central Brazil.

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 (BOM) - Australia)

During November to early December 2009, two periods of suppressed convection shifted eastward from the Indian Ocean into the western Pacific (dotted lines) and one episode of enhanced convection (dashed line).

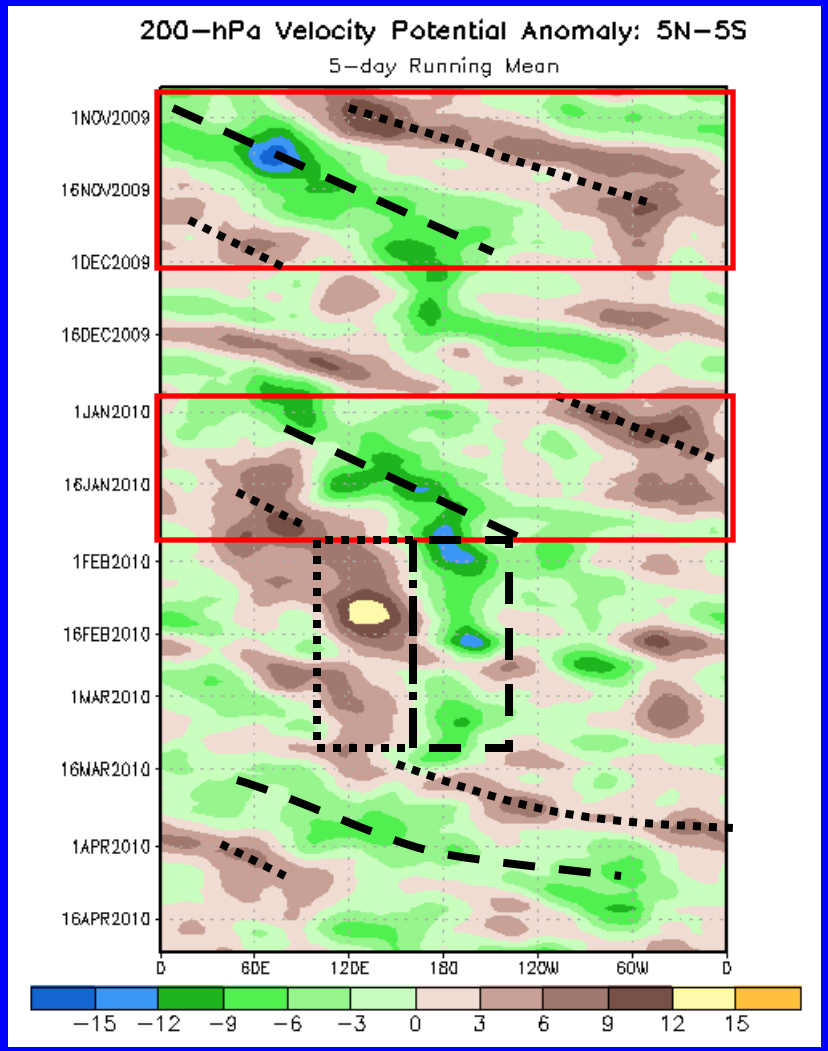
After a brief break during mid-late December, enhanced convection developed in the Indian Ocean and shifted eastward to the western and central Pacific during mid to late January. An area of suppressed convection across the Indian Ocean and Maritime Continent followed.

Since mid-March anomalies have been weak.

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

Eastward propagation associated with the MJO was evident during November and during early-mid January (red boxes).

During February and early March, the MJO weakened and anomalies became more stationary and incoherent on the intraseasonal time scale (black boxes).

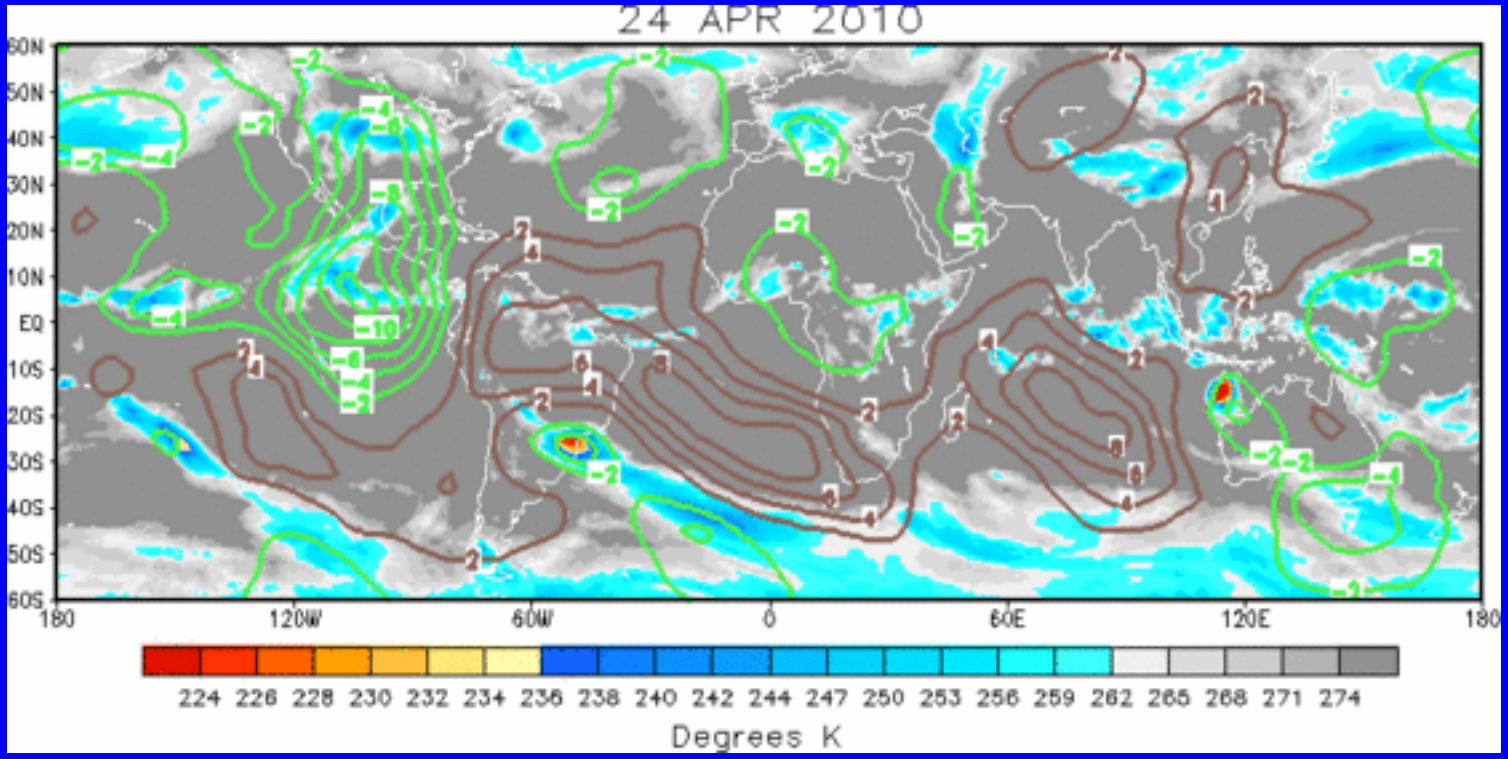
In mid-March, weak upper-level divergence (convergence) developed over Africa and the Indian Ocean (Maritime continent) and these anomalies propagated eastward.

Since mid-April anomalies have been weak and incoherent.

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

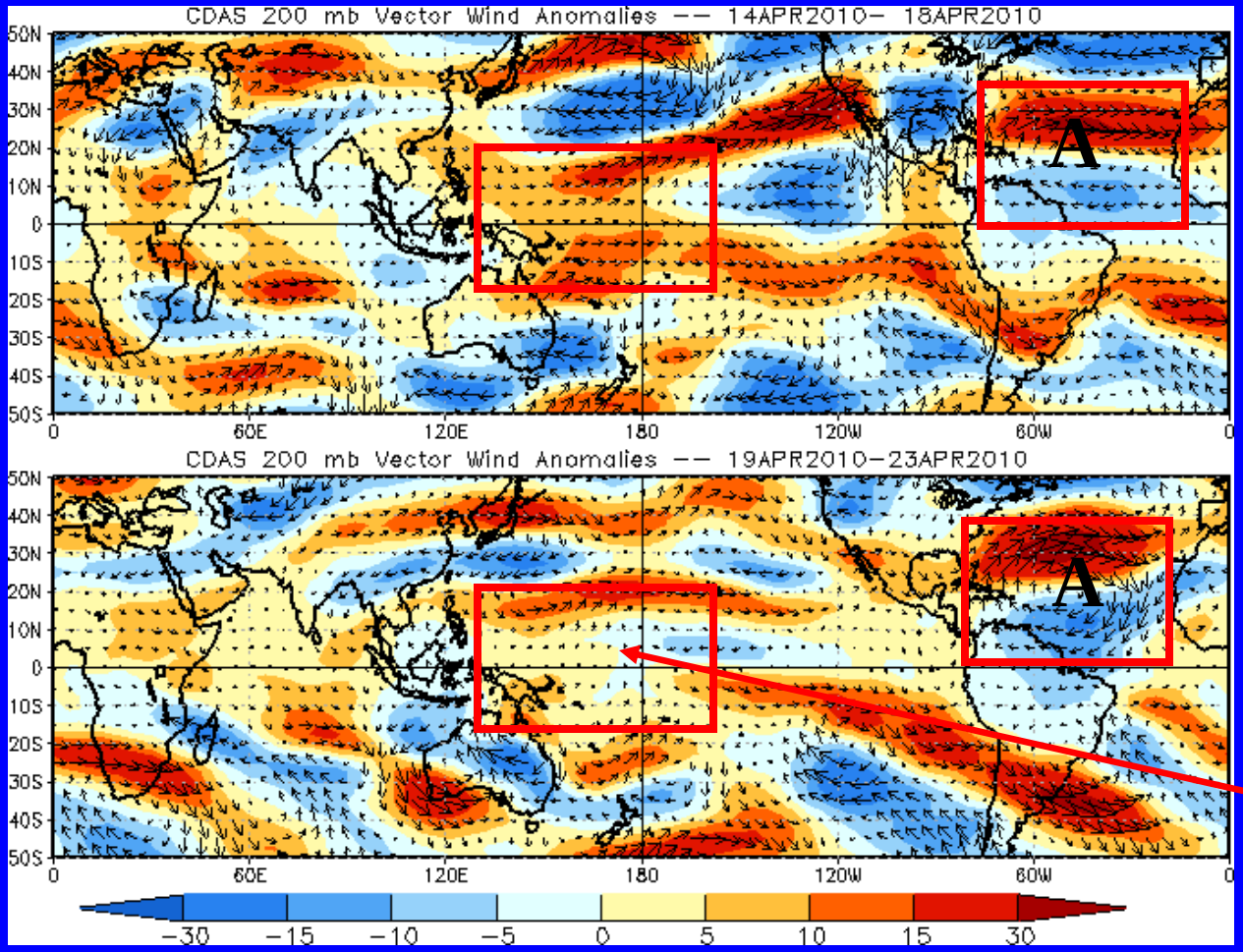
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The current anomalous velocity potential pattern is incoherent.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

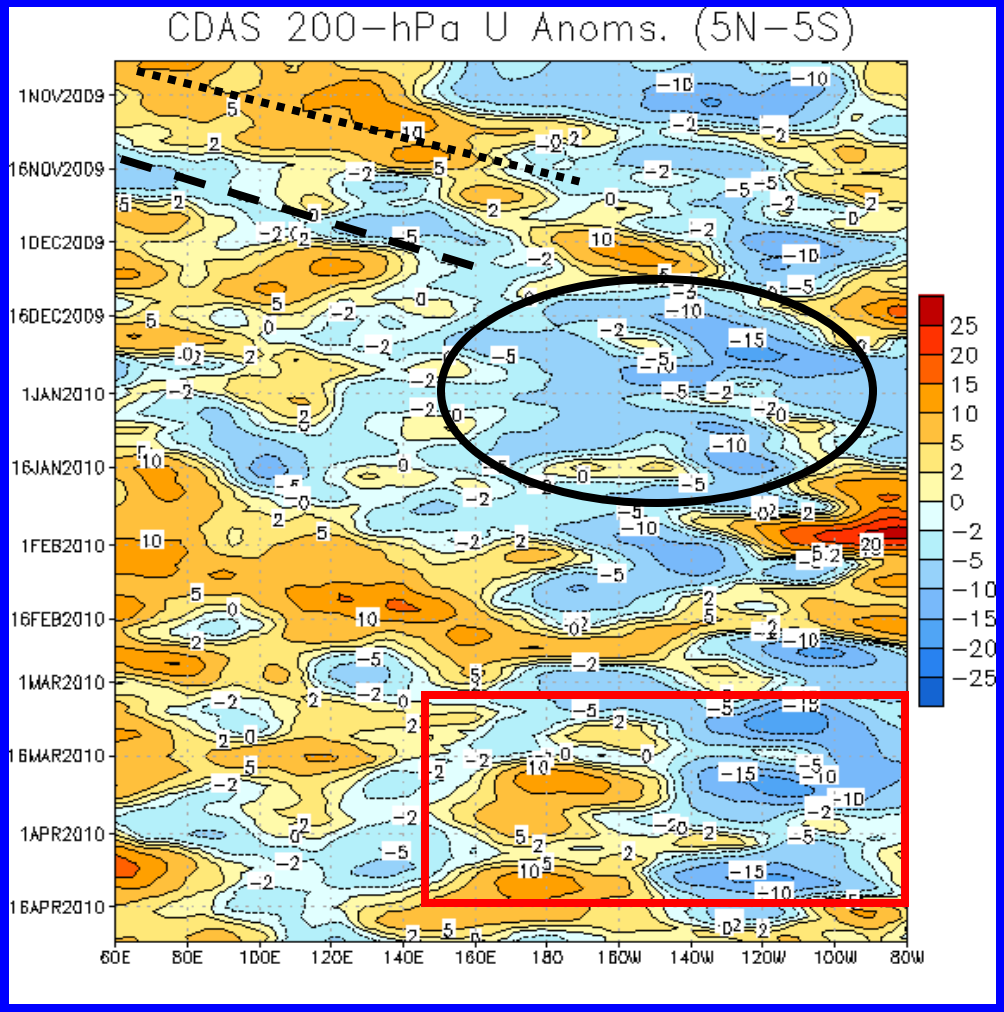
During the last to ten days, an anti-cyclonic circulation (red box, A) is evident north of South America and is most likely related to the persistent enhanced tropical convection across northern South America.

Westerly anomalies have weakened in the west-central Pacific.

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

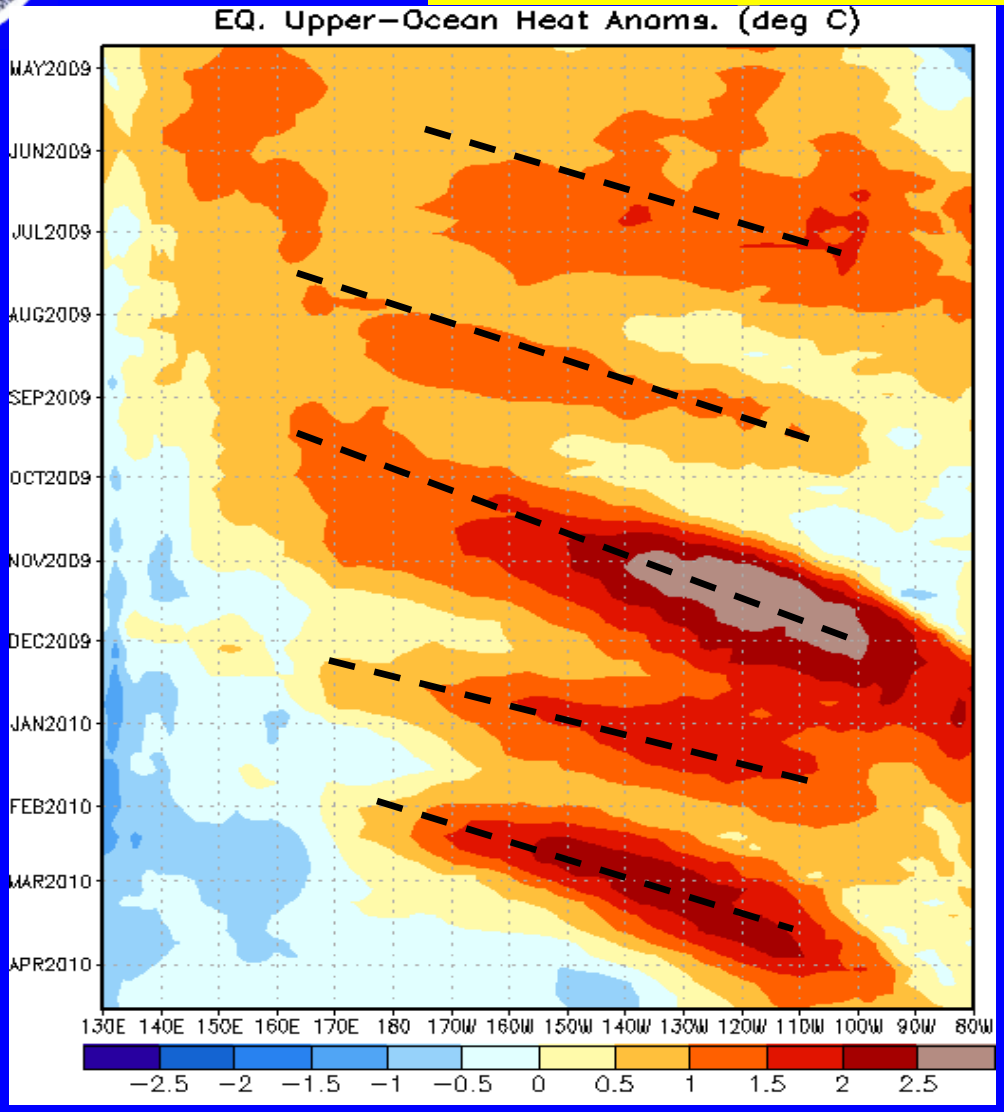
Longitude

Westerly (easterly) anomalies (dotted and dashed lines) shifted eastward across the Maritime Continent during November associated with the MJO.

Easterly anomalies dominated much of the central and eastern Pacific during the second half of December and most of January (black oval).

For several weeks, westerly anomalies have been in place in the central Pacific while easterlies have dominated the eastern Pacific (red box). Most recently, however, westerly anomalies developed in the eastern Pacific.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

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.

Multiple Kelvin waves shifted eastward between August and March 2010 (last four dashed black lines).

Heat content anomalies have decreased in the central and east-central Pacific in association with the upwelling phase of a Kelvin wave. Some below-average anomalies are now present as far east as 130W.

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).**

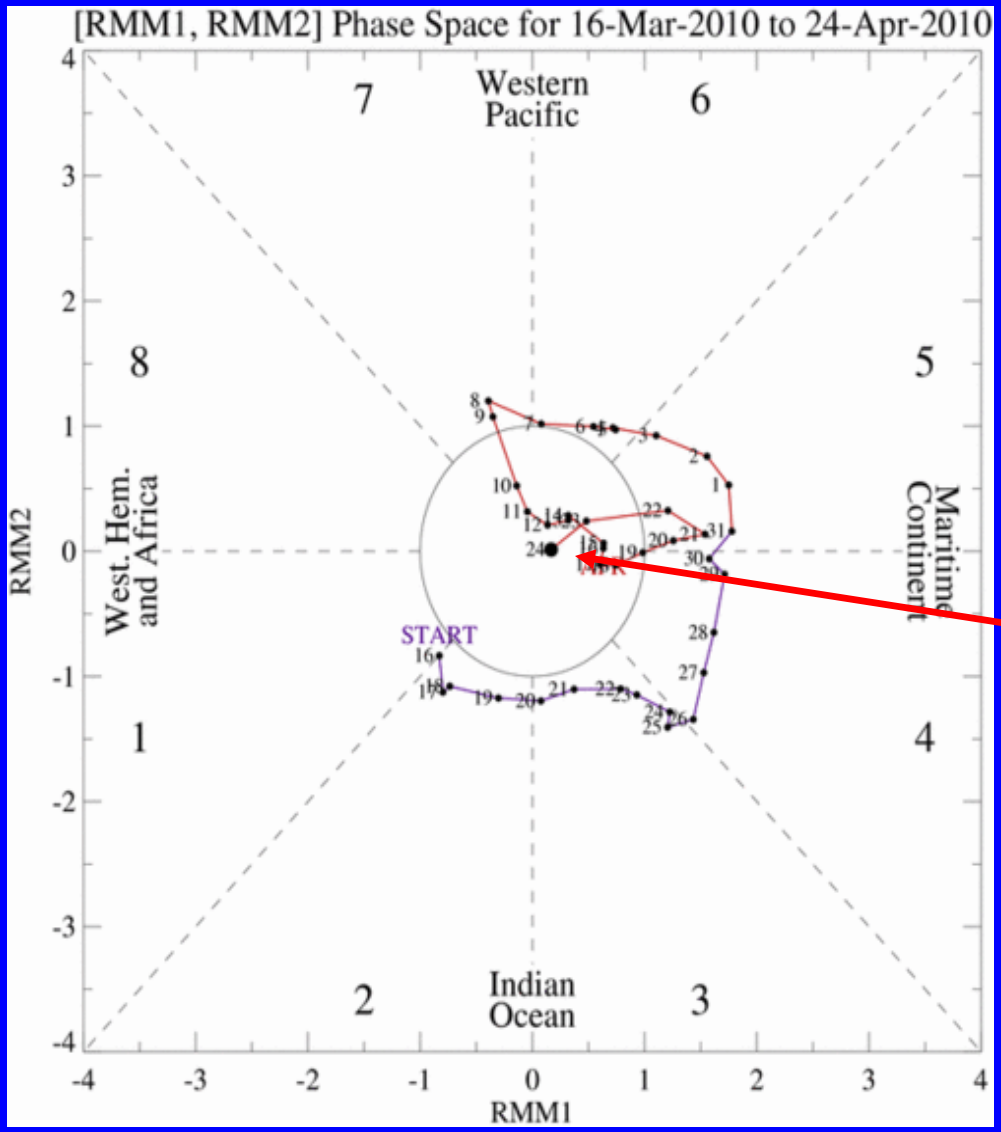
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review*, 132, 1917-1932.

- **The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.**

Gottschalck et al. 2010: A Framework for Assessing Operational Model MJO Forecasts: A Project of the CLIVAR Madden-Julian Oscillation Working Group, *Bull. Amer. Met. Soc.*, Accepted.

- **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).**

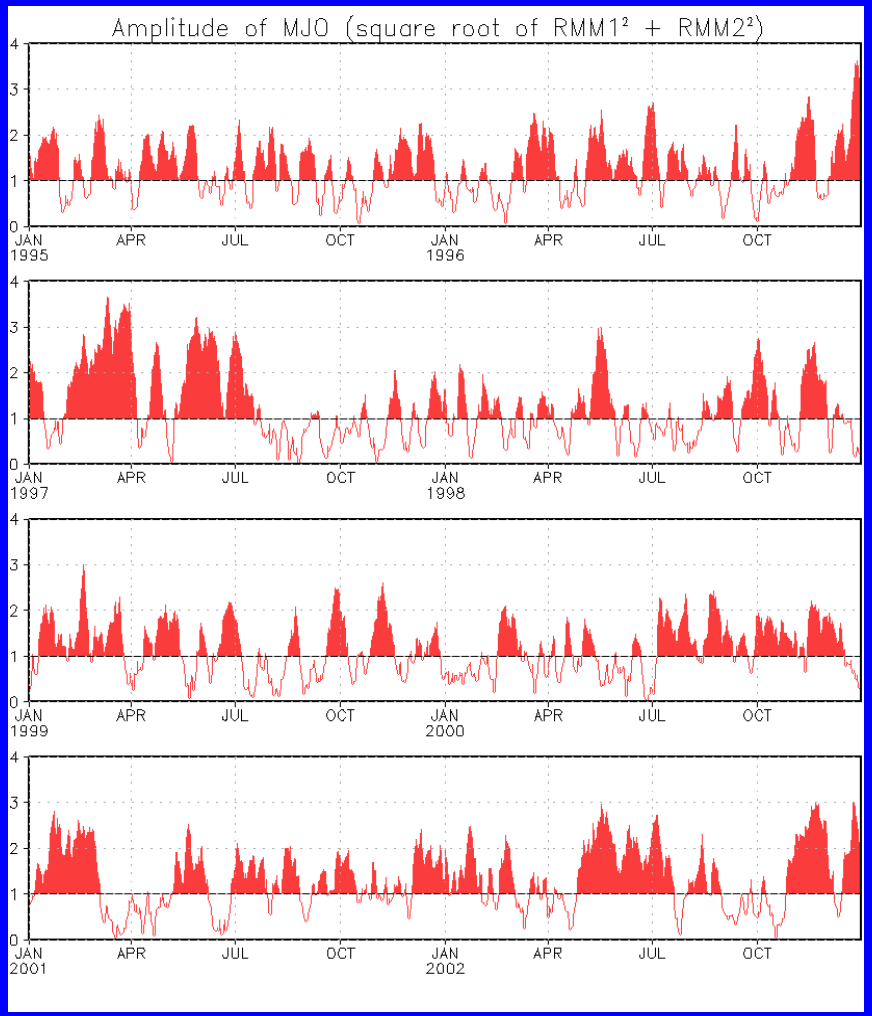
MJO Index -- Recent Evolution

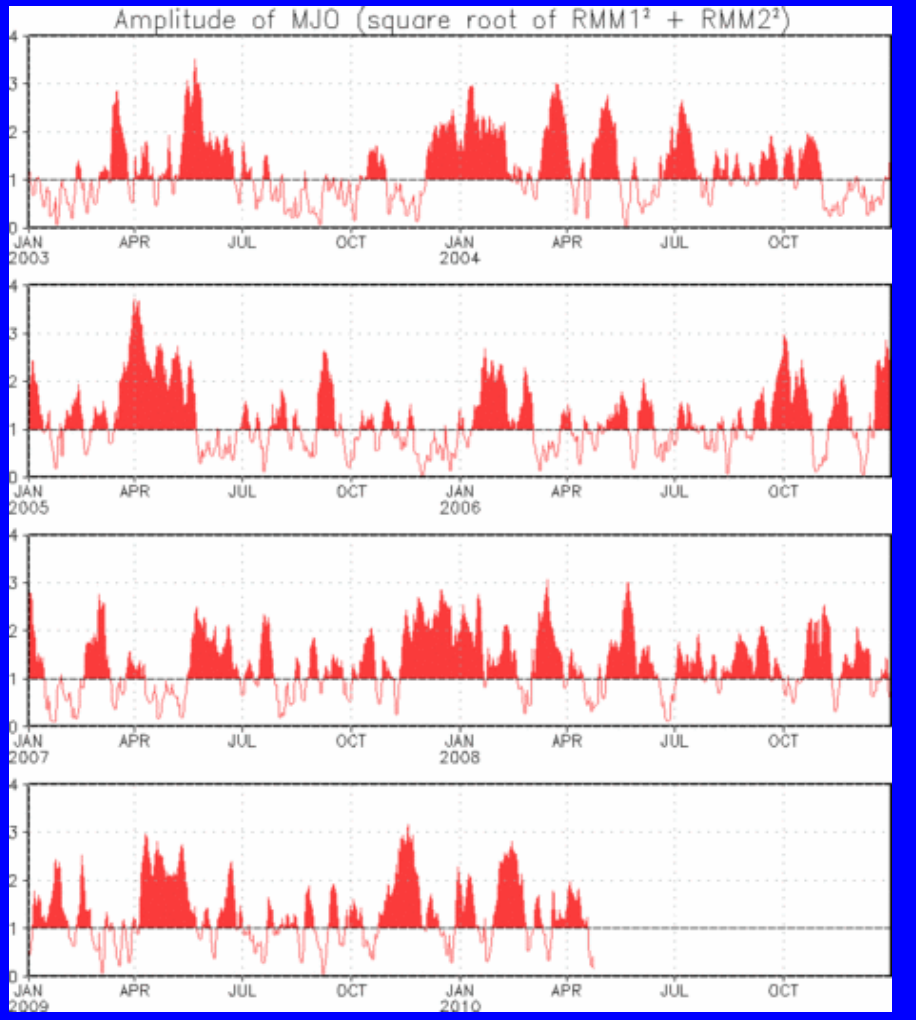


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

During the past week, the MJO index indicated an incoherent MJO signal.

MJO Index – Historical Daily Time Series





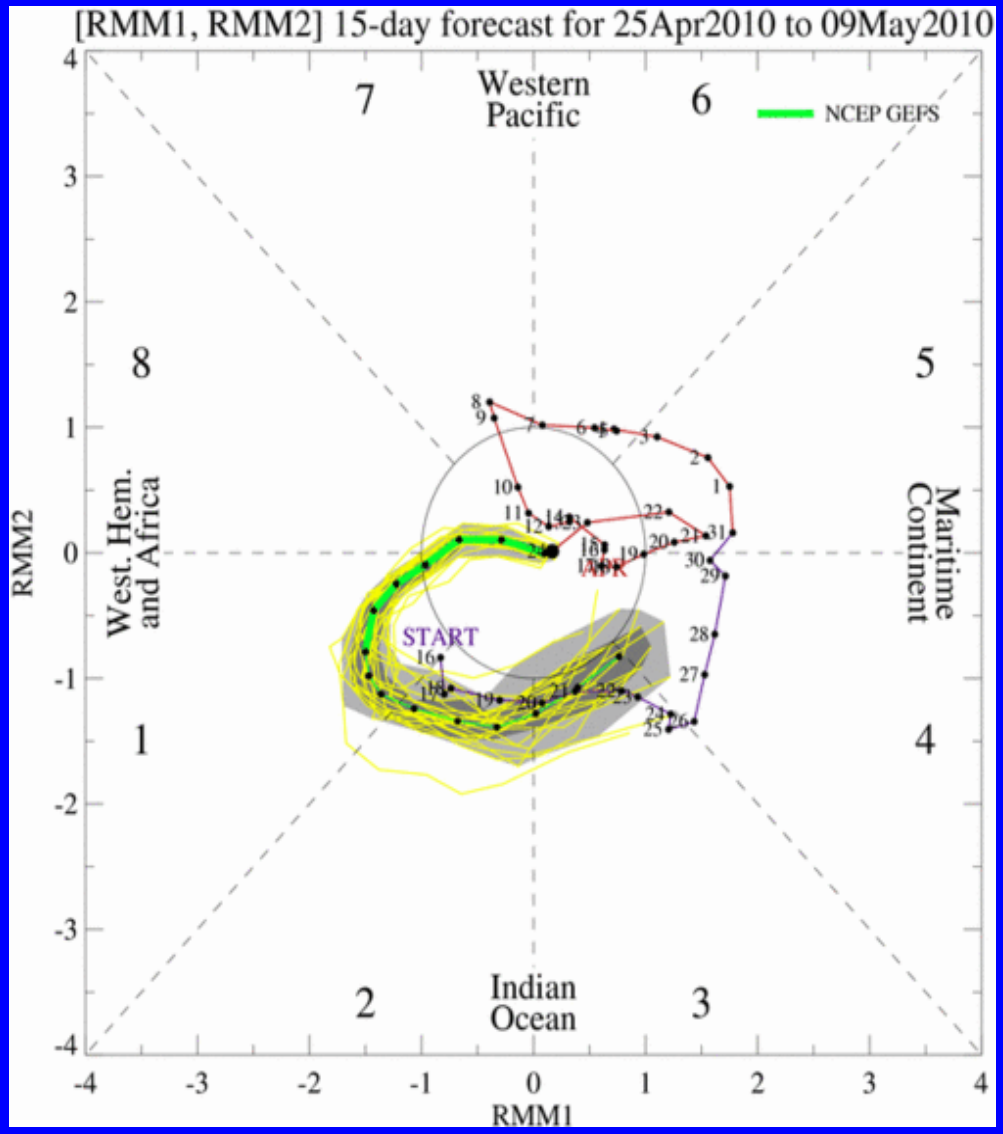
Time series of daily MJO index amplitude from 1995 to present.
Plots put current MJO activity in historical context.

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



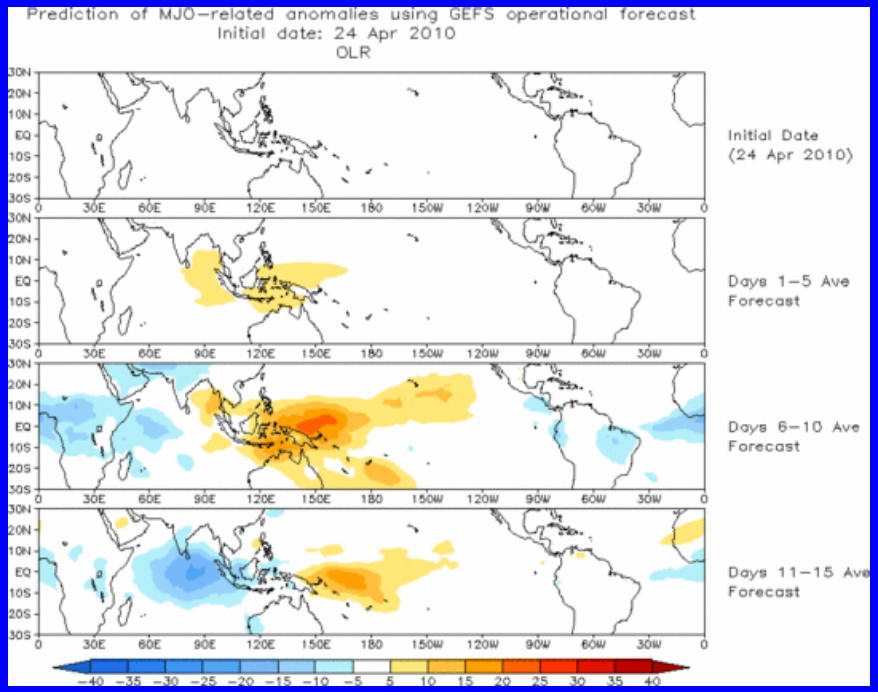
The GFS forecasts indicate a strengthening signal during Week-1 and eastward propagation during Week 2.

There is low spread in the ensemble forecast especially during Week-1 increasing confidence in the future evolution of the MJO.

Ensemble Mean GFS MJO Forecast

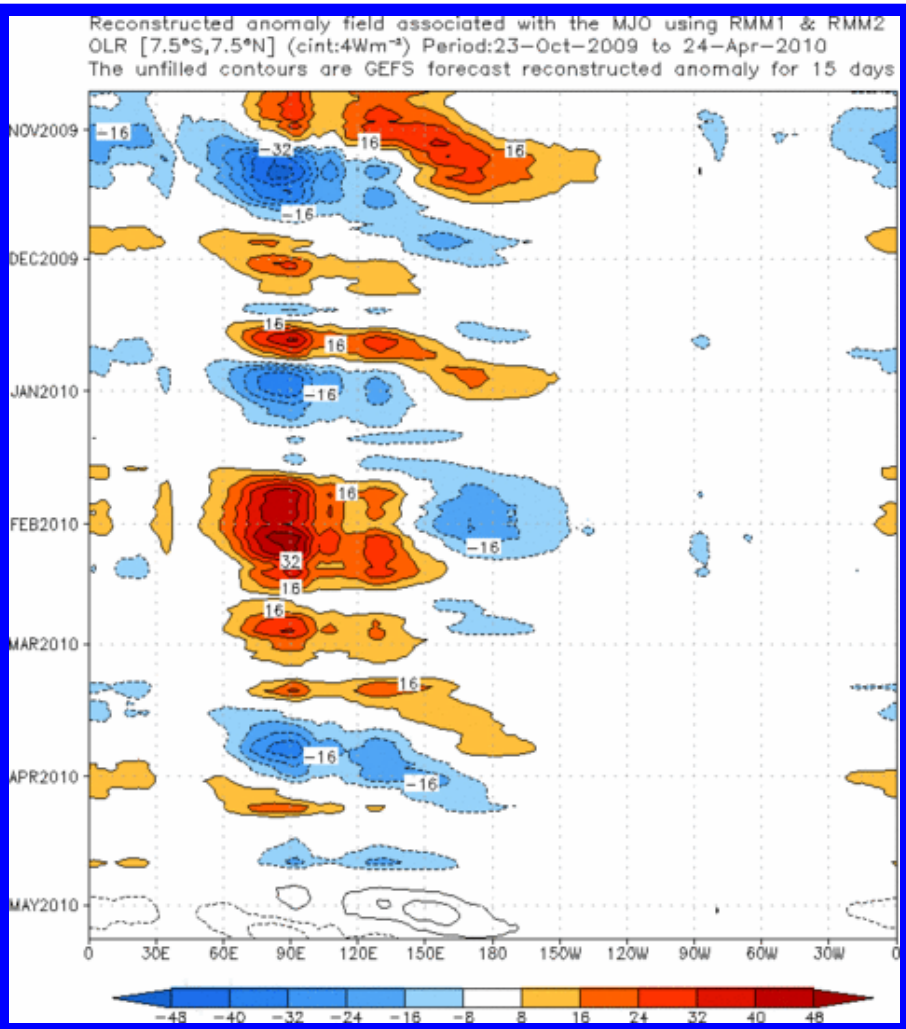
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecast, keyed to the MJO index forecast on slide 16, indicates enhanced (suppressed) convection over central America, Africa and the Indian Ocean (Maritime Continent and western Pacific) mainly 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



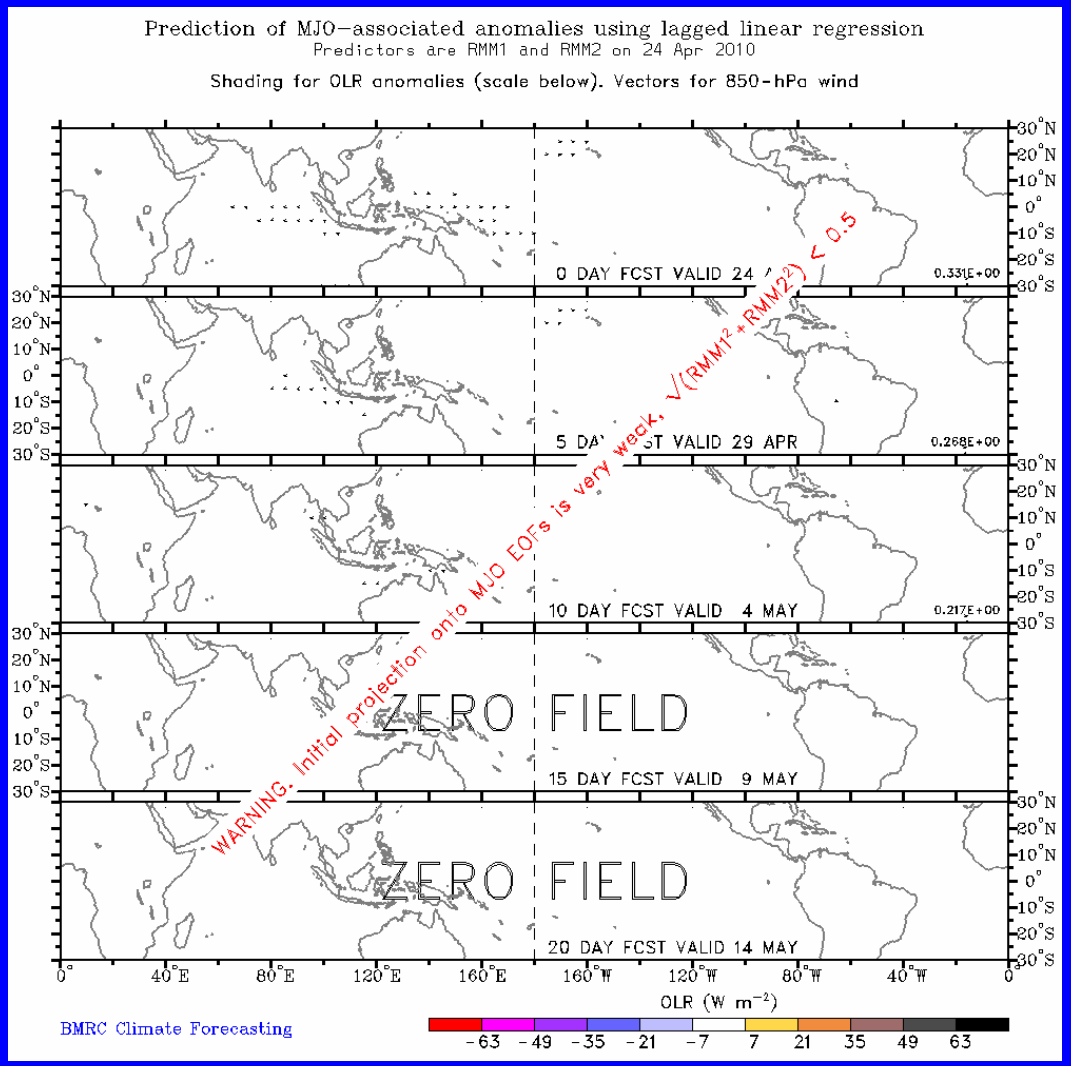
Statistical MJO Forecast

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 vectors for the next 20 days

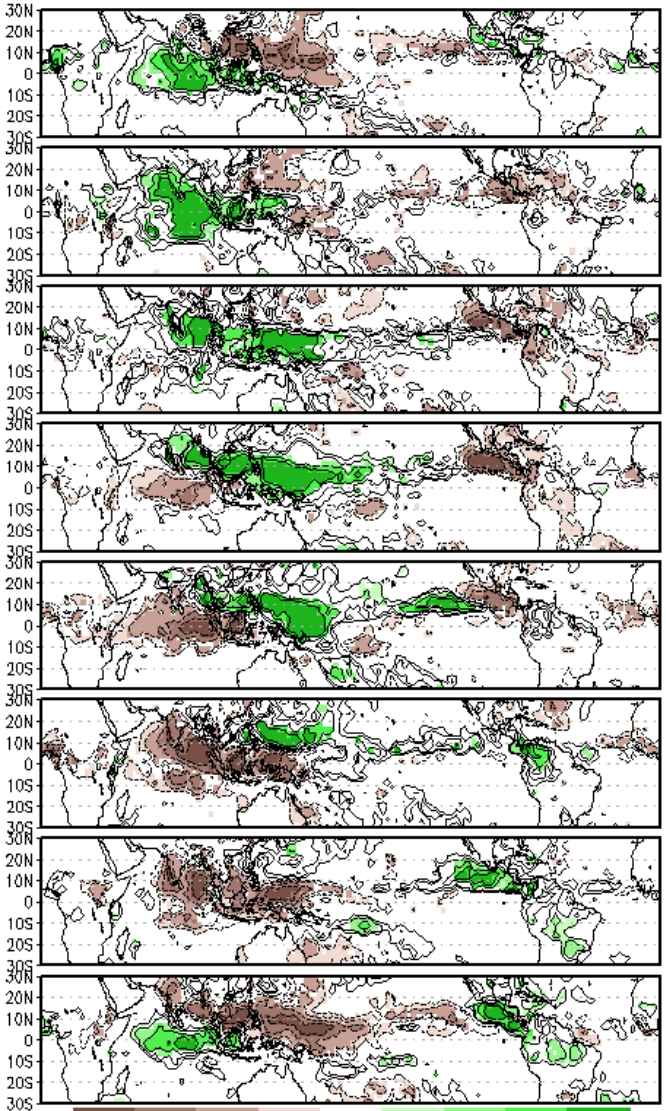
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical forecast indicates no MJO signal over the next two weeks.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)