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

Update prepared by
Climate Prediction Center / NCEP
April 12, 2010

Outline

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

Overview

- Weak MJO activity continued during the past week with the enhanced convective phase now located across the Western Hemisphere.

- Most statistical and dynamical model MJO index forecasts indicate a weakening of the signal during the next two weeks. However, recent observations, particularly upper-level variables, still indicate MJO activity ongoing.

- Based on the latest observations, weak MJO activity is forecast to continue, although uncertainty is high for whether this MJO activity continues.

- The MJO is expected to contribute to suppressed rainfall across the eastern Indian Ocean during Week-1 and enhanced rainfall across northern South America (Week-1) and parts of Africa (Week-1 and Week-2).

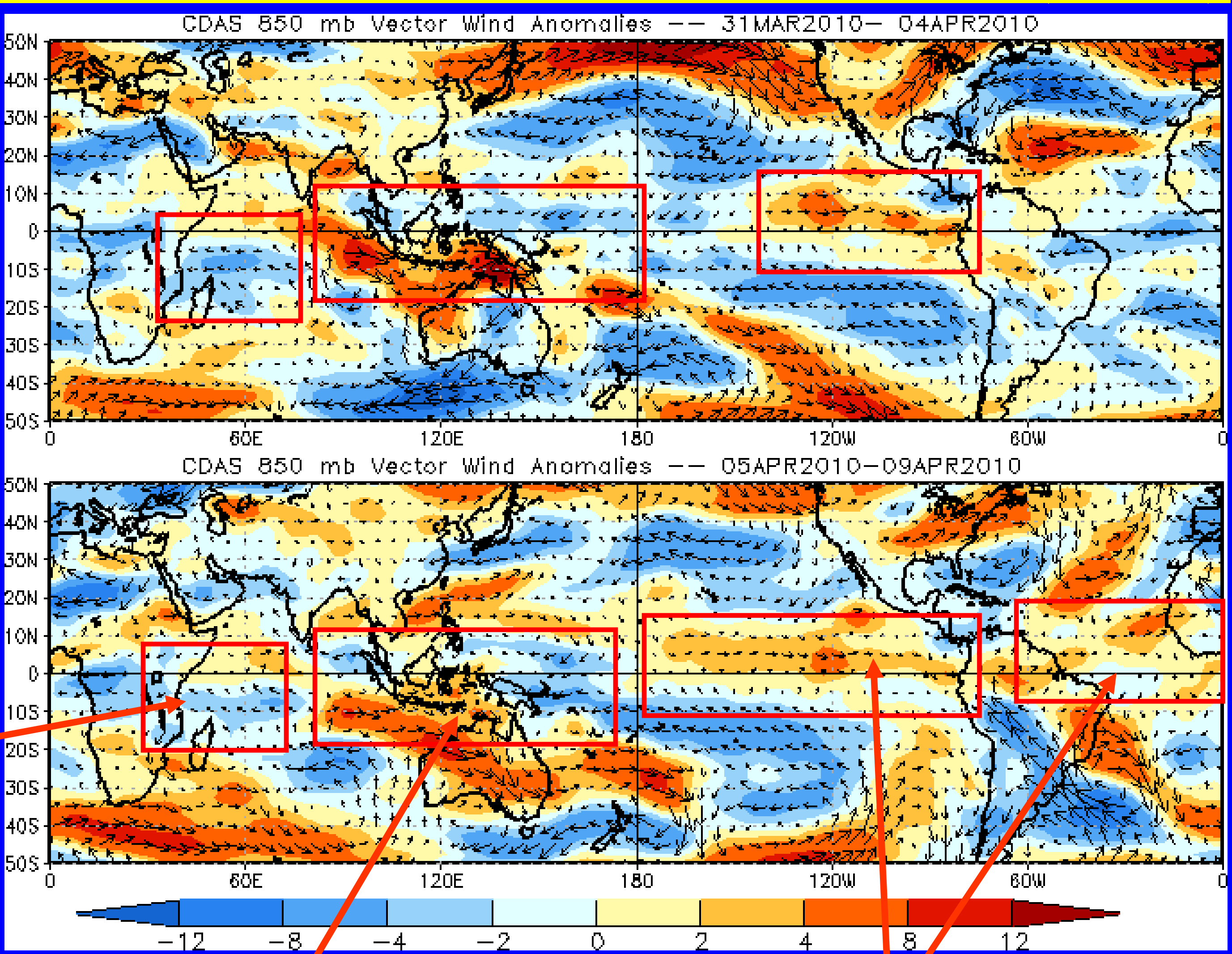
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Easterly anomalies have continued in the western Indian Ocean.

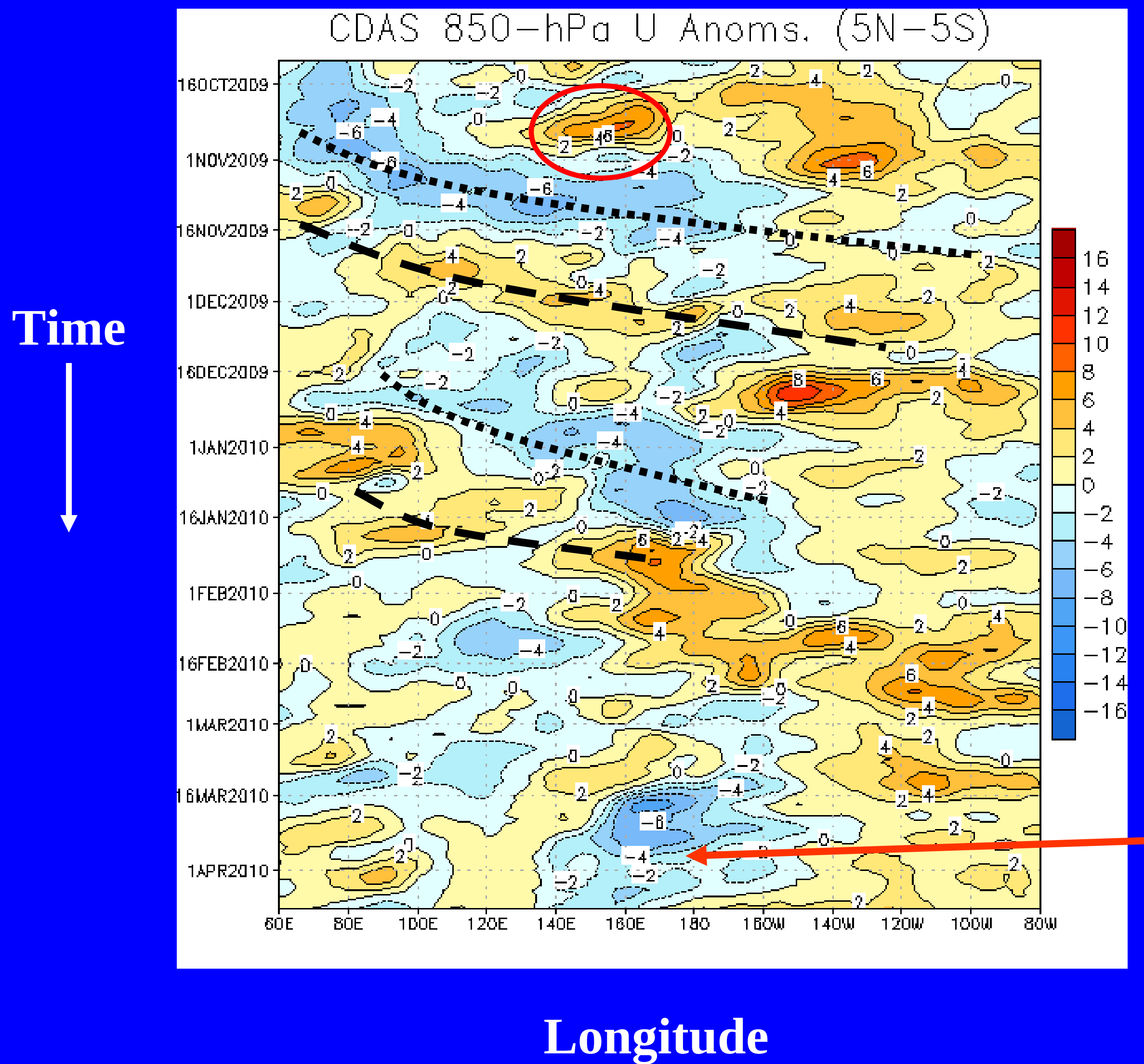
Westerly anomalies have continued over parts of the Maritime Continent while easterly anomalies have dominated the far western Pacific.

During the last five days, westerly anomalies continued across the eastern and central Pacific while easterly anomalies became westerly anomalies in the Atlantic.

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



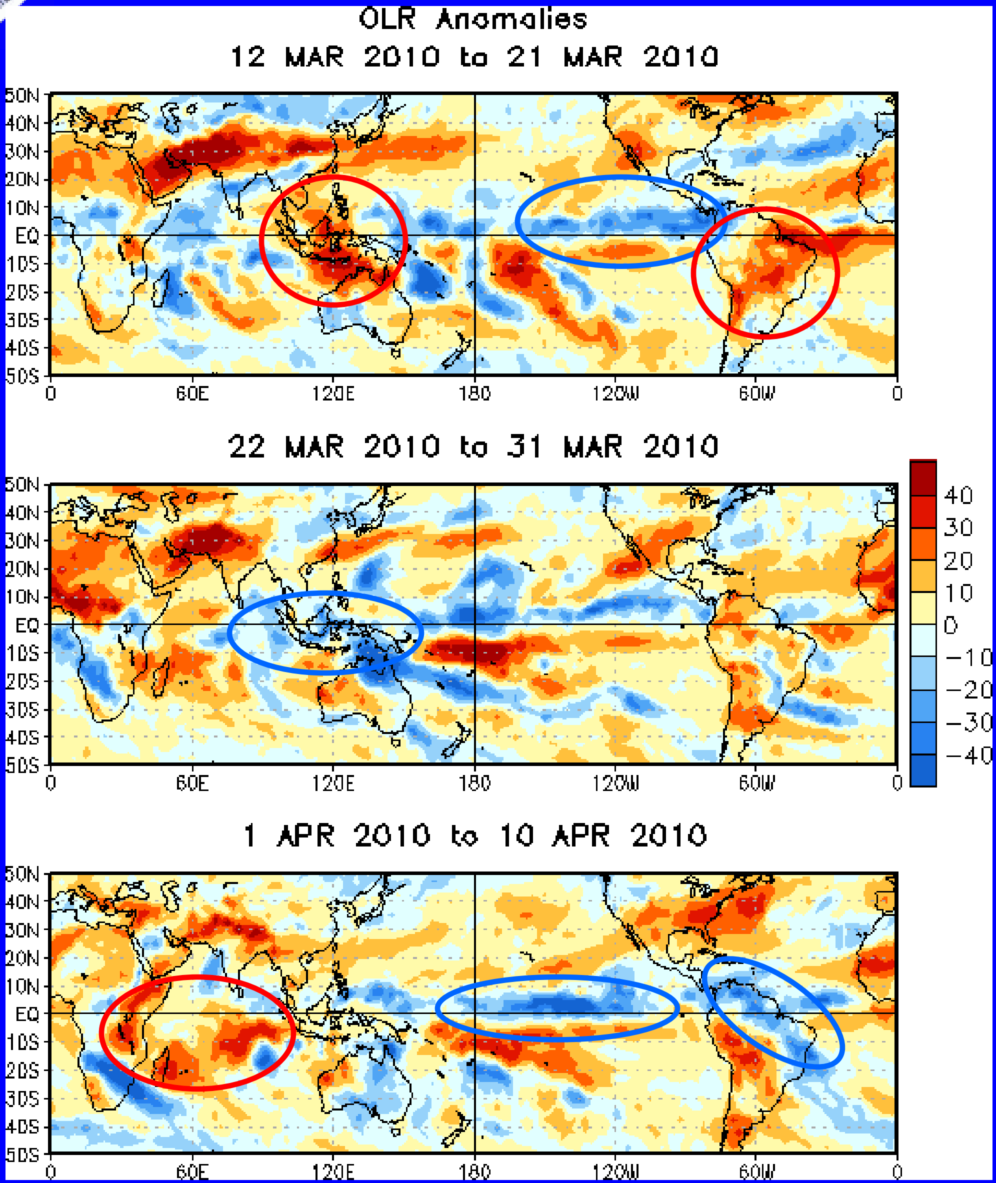
Westerly wind bursts (red circle) occurred during October.

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.

OLR Anomalies: Last 30 days



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

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

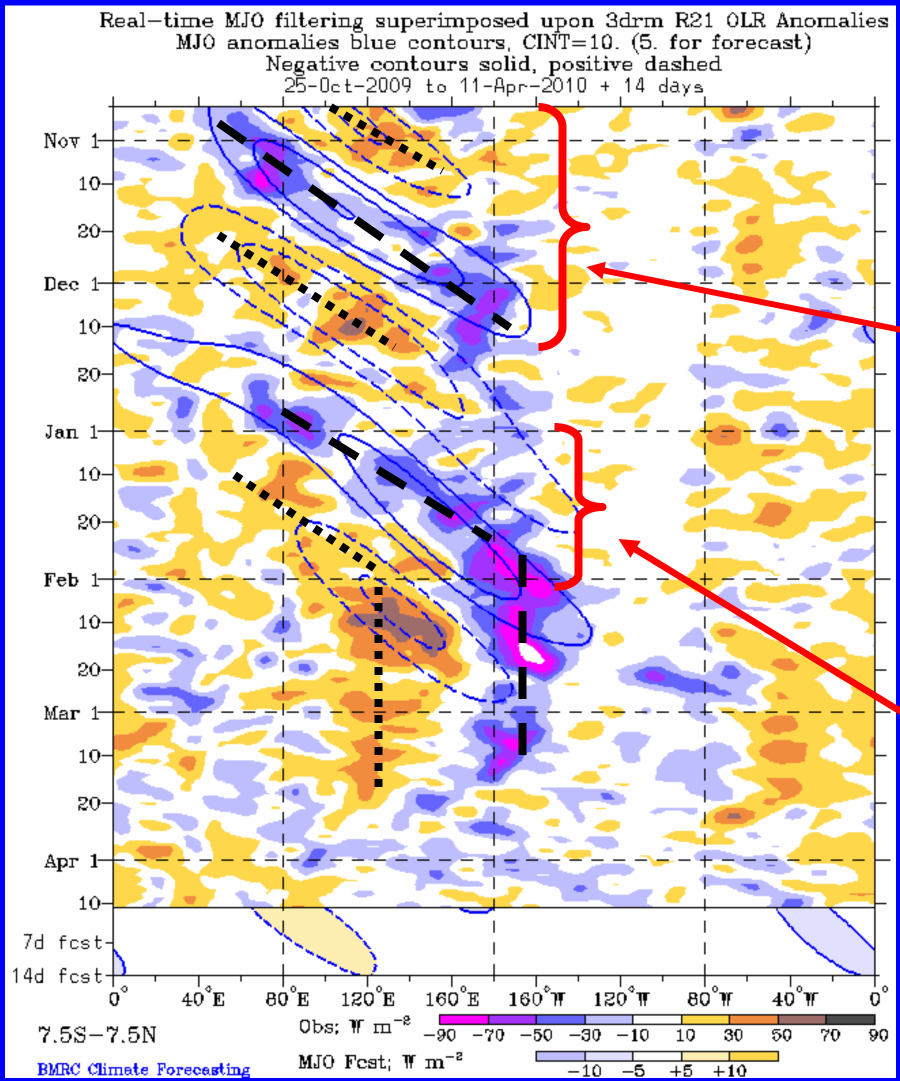
During mid-March, enhanced convection was evident across parts of the central and the eastern Pacific and suppressed convection was evident over Indonesia and South America.

In late March, anomalous convection was less coherent but enhanced convection was evident over the Maritime Continent and parts of the central and eastern Pacific.

During early April suppressed convection developed in east-central Africa and the Indian Ocean while enhanced convection developed over northern South America. Enhanced convection continued over the central and eastern Pacific.

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 October 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.

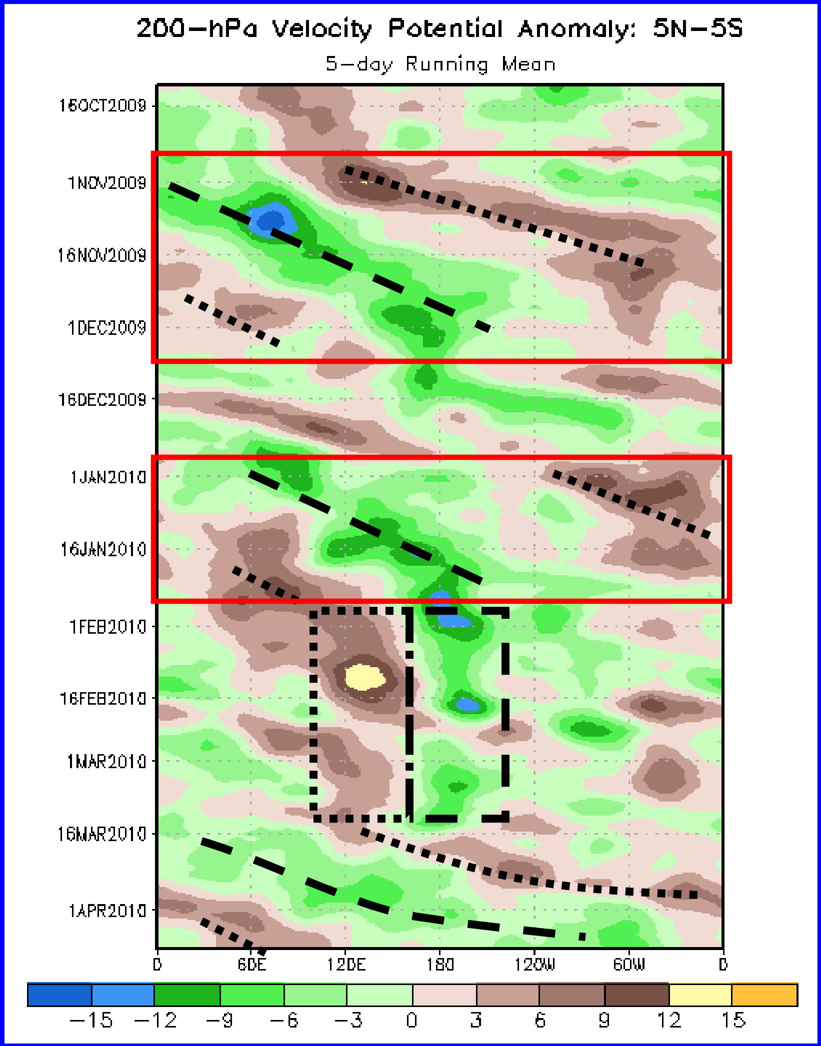
Since mid-March anomalies have been weak.

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 late October and November and during early-mid January (red boxes).

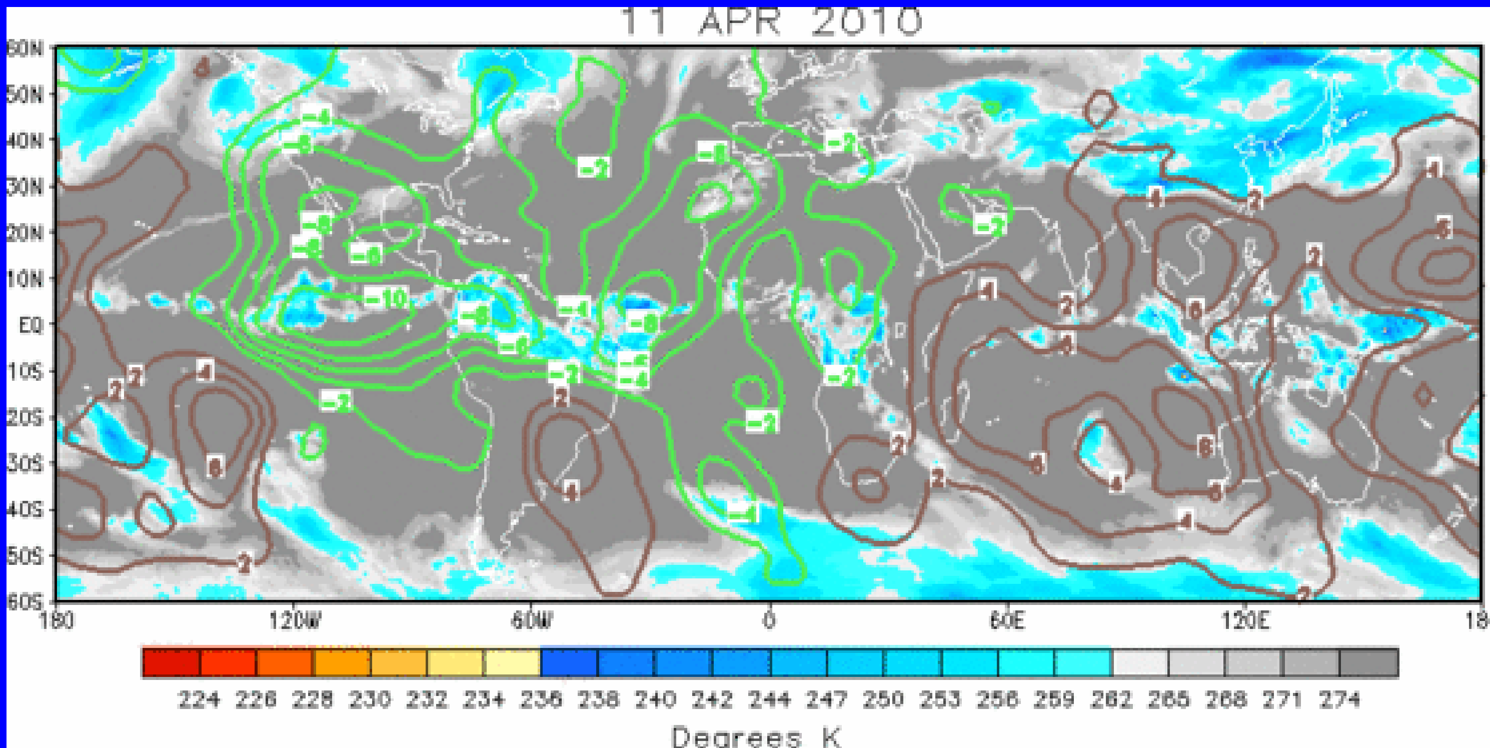
During February and early March, the MJO weakened and anomalies became more stationary and incoherent on the intraseasonal time scale (black boxes).

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

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



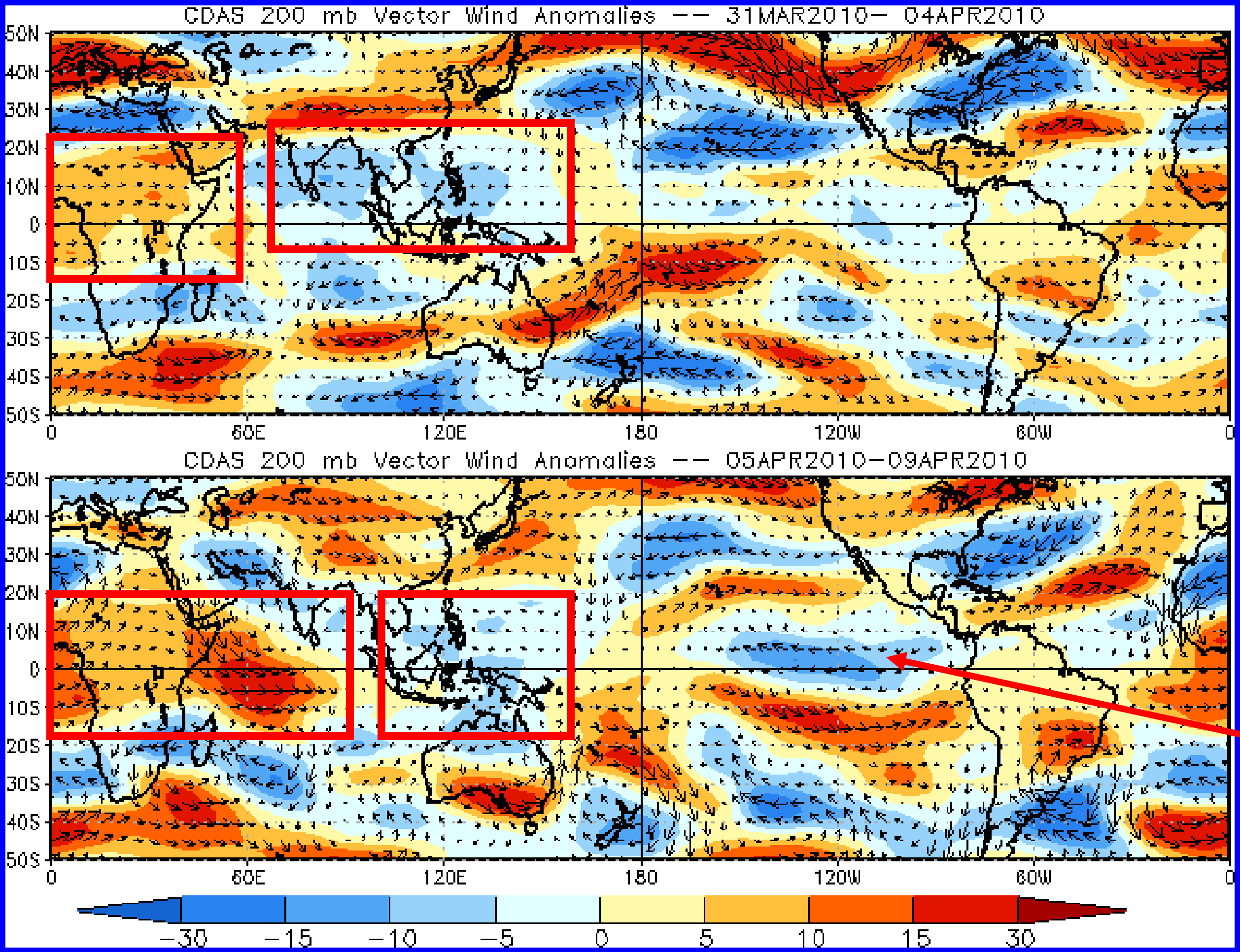
The anomalous velocity potential pattern is coherent and has propagated eastward in recent weeks. Upper-level divergence is indicated mainly across the western hemisphere while upper-level convergence is indicated mainly over the eastern hemisphere.

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

Note that shading denotes the zonal wind anomaly

<u>Blue shades</u>: Easterly anomalies

<u>Red shades</u>: Westerly anomalies



During the last five days westerly anomalies have strengthened across Africa and the western Indian Ocean while weak easterly anomalies have continued across the far western Pacific (red boxes). Some upper-level confluence is apparent over the eastern Indian Ocean.

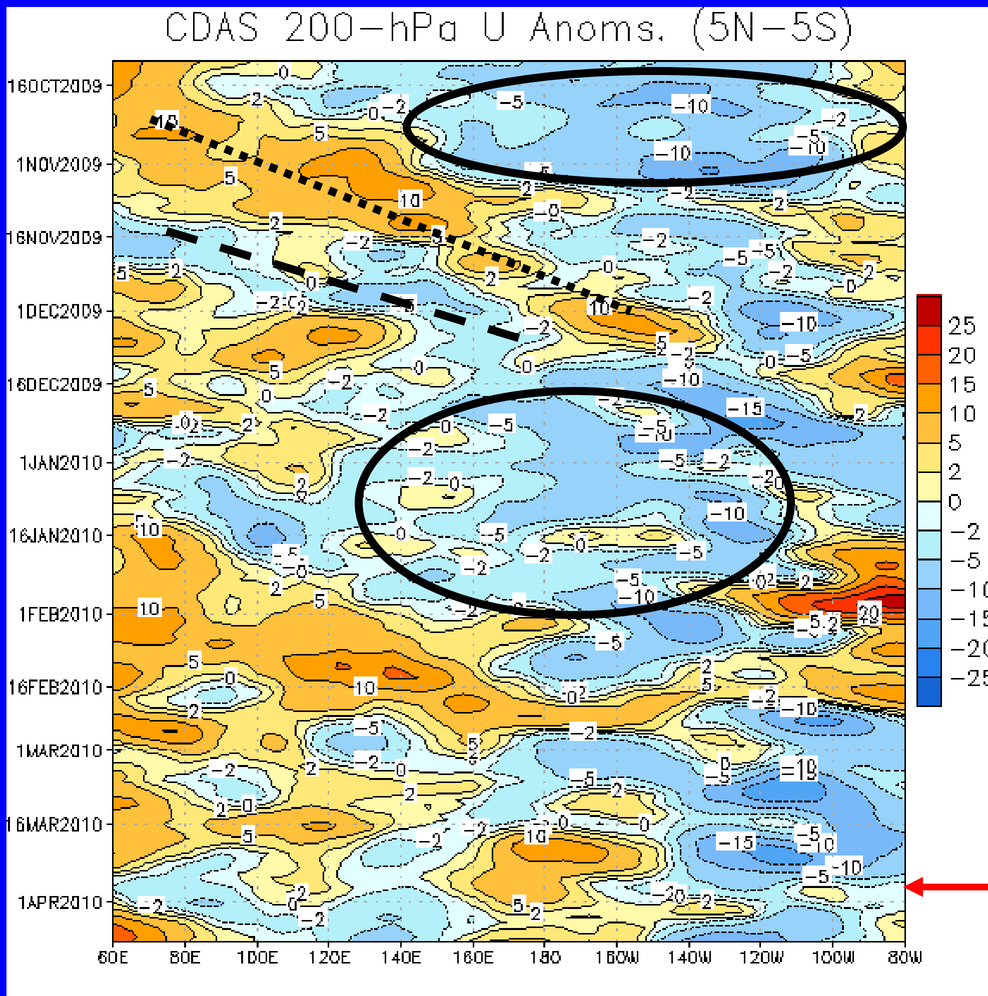
Easterly anomalies strengthened in the eastern Pacific.

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

In October, easterly anomalies rapidly replaced westerly anomalies across much of the Pacific (black solid oval).

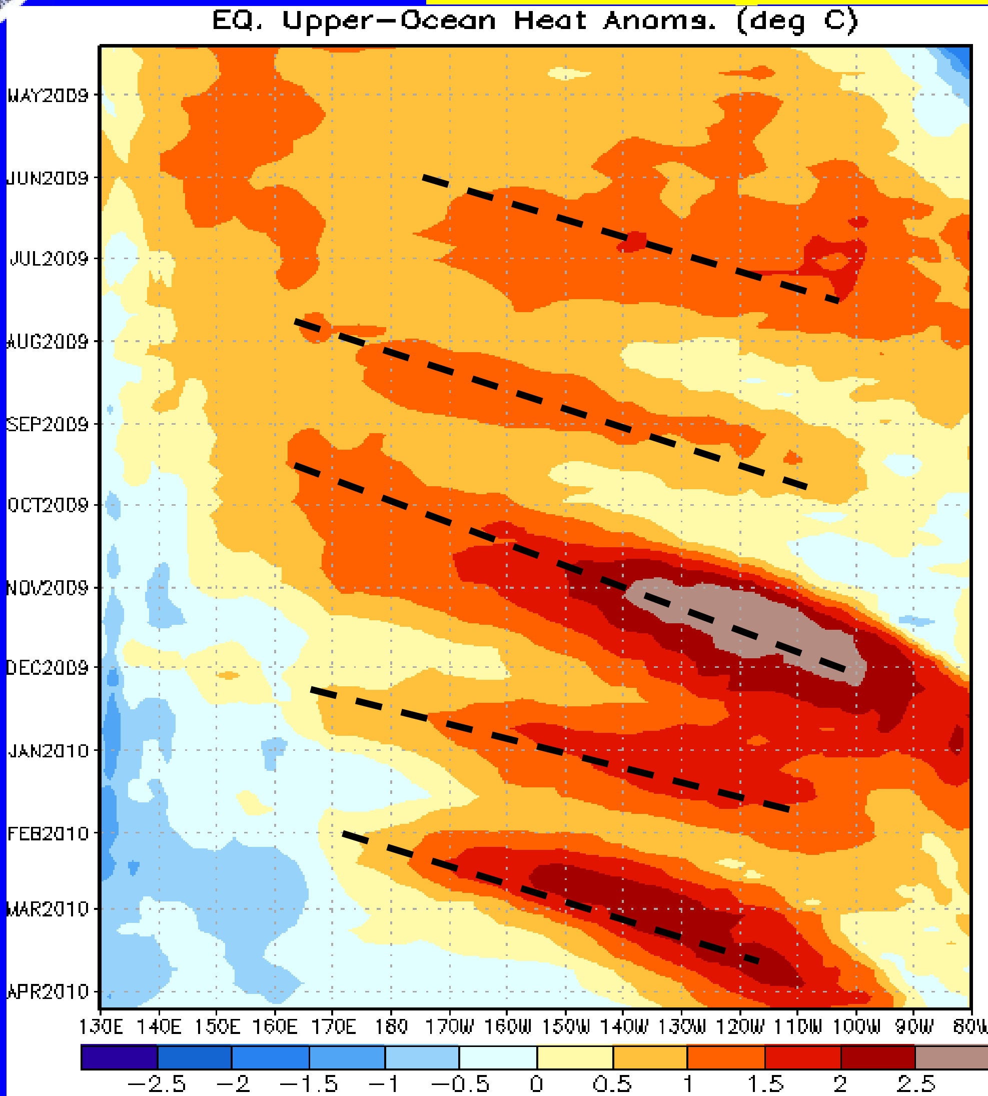
Westerly (easterly) anomalies (dotted and dashed lines) shifted eastward across the Maritime Continent during late October and November associated with the MJO.

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

For several weeks, westerly anomalies have been in place in the central Pacific while easterlies have dominated 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).

Some below-average anomalies are now present west of 150W.

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).**

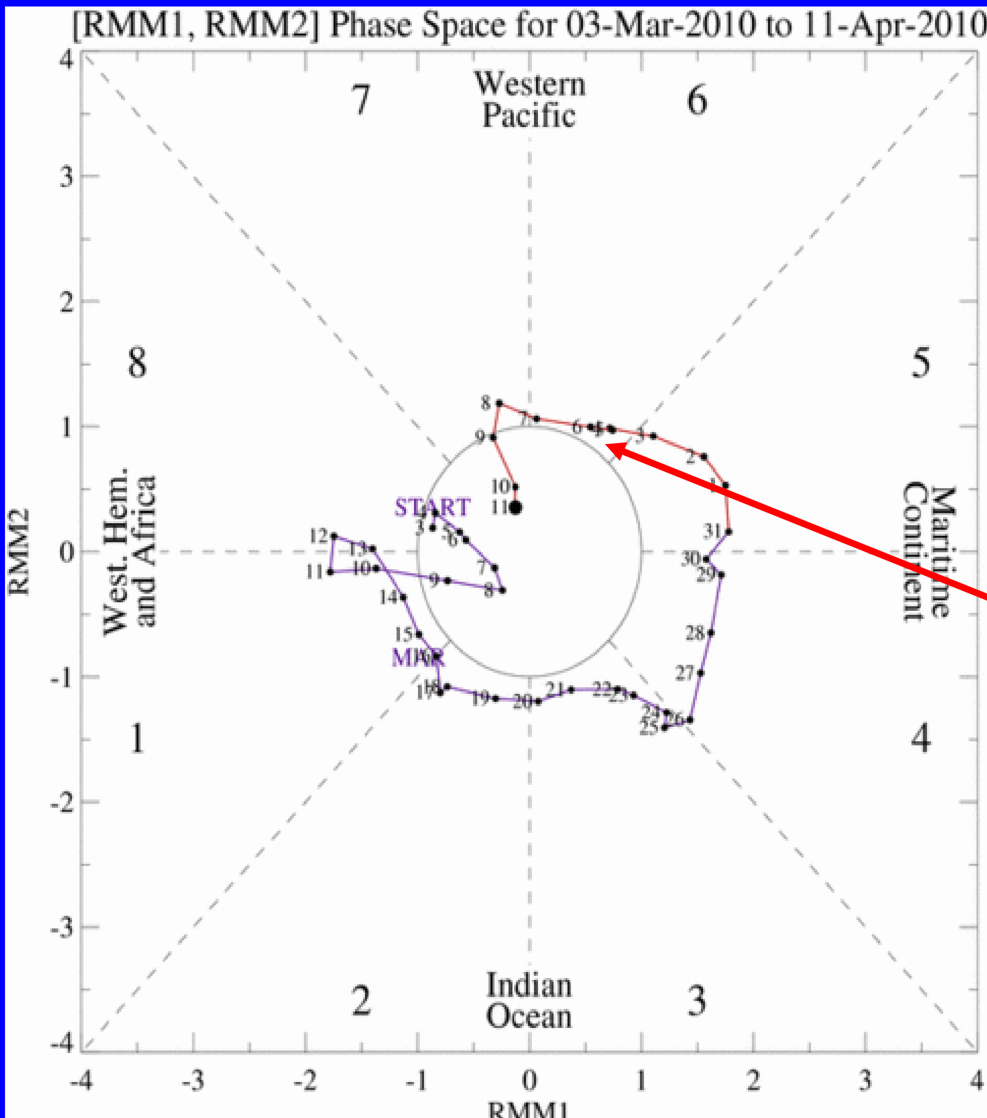
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review*, 132, 1917-1932.

• **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

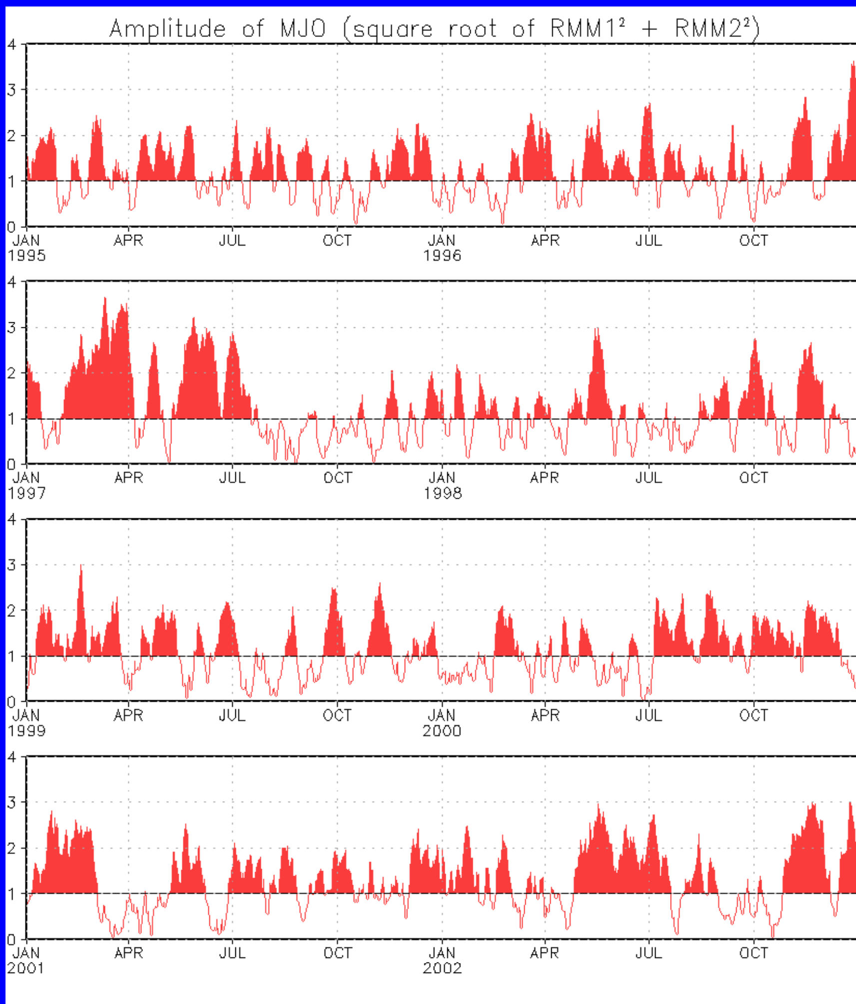


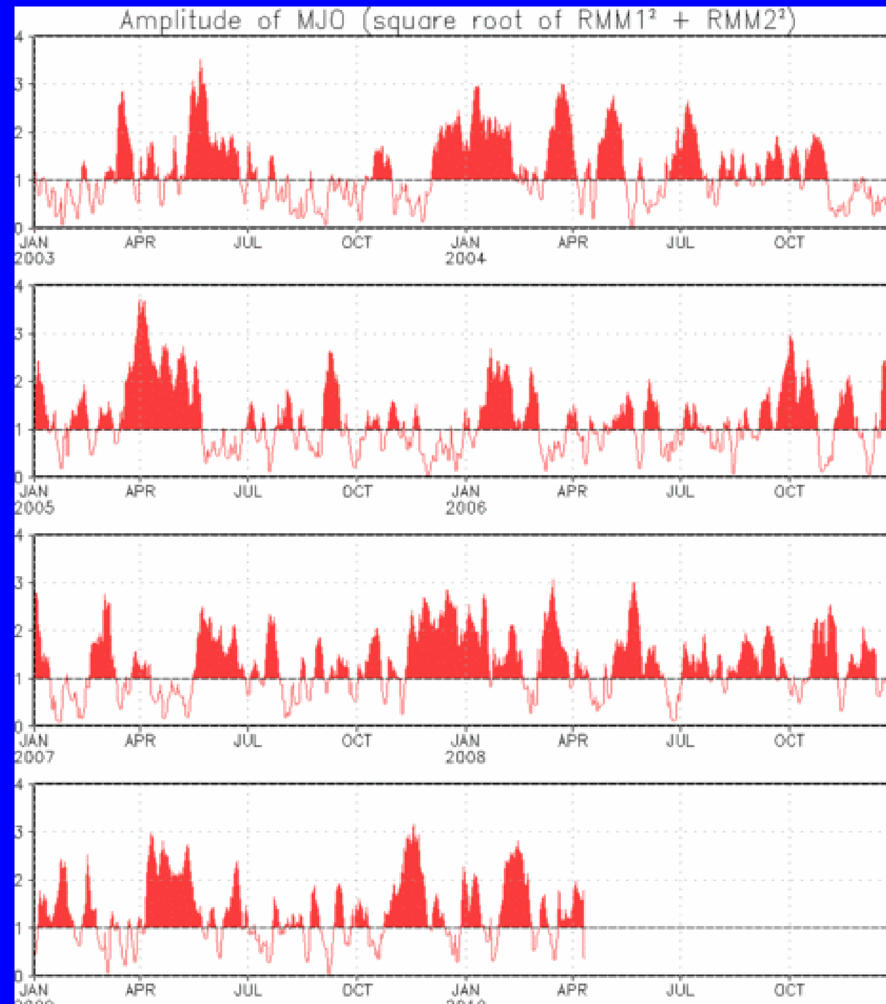
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

During the past week, the MJO index indicated eastward propagation of a weak MJO signal.

In recent days, the index has decreased its amplitude and eastward propagation.

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.

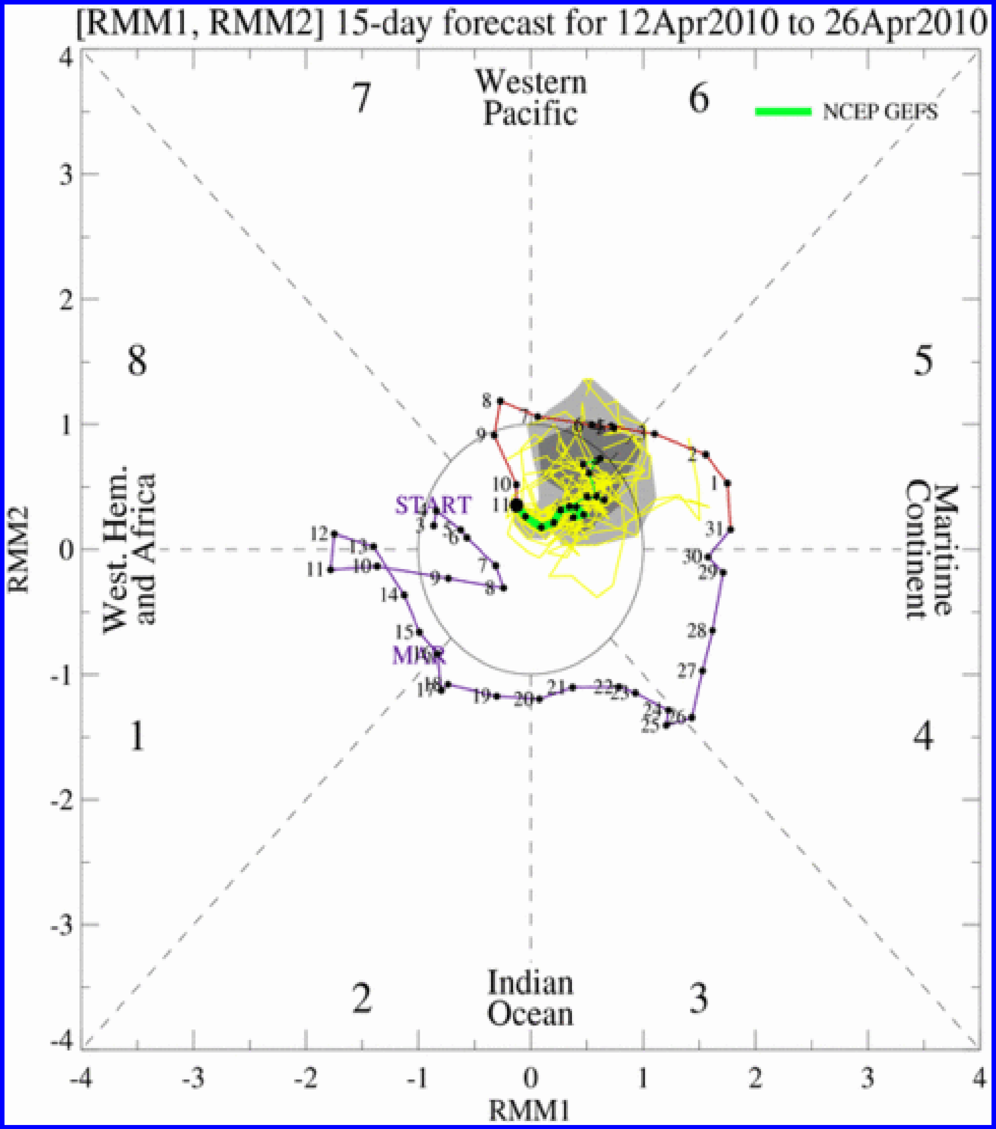
Ensemble GFS (GEFS) MJO Forecast

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

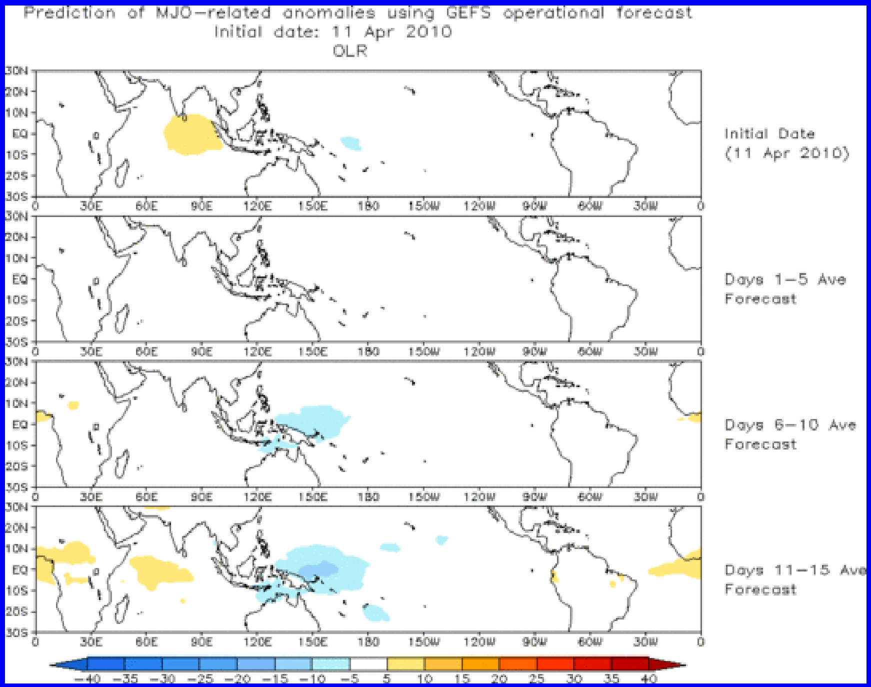
The GFS forecasts indicate a weak signal with no eastward propagation during the next the 1-2 weeks.



Ensemble Mean GFS MJO Forecast

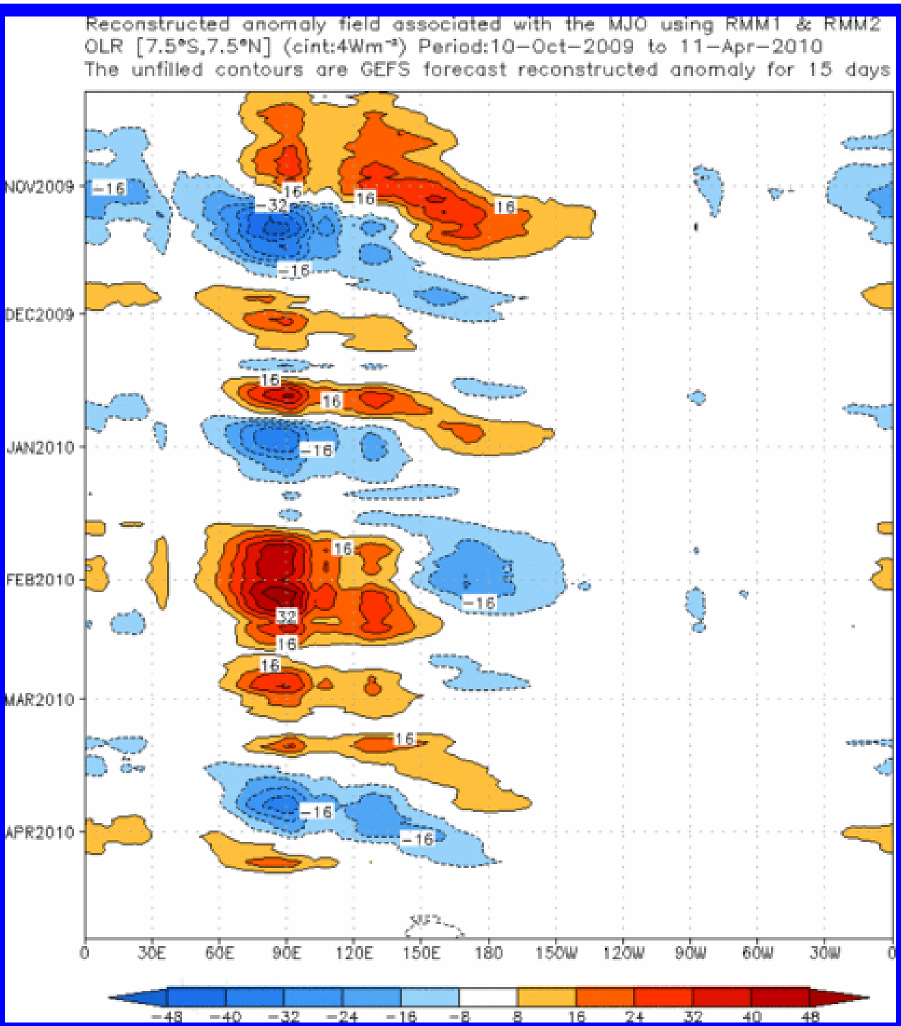
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecast indicates weak anomalies over the next two weeks.

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



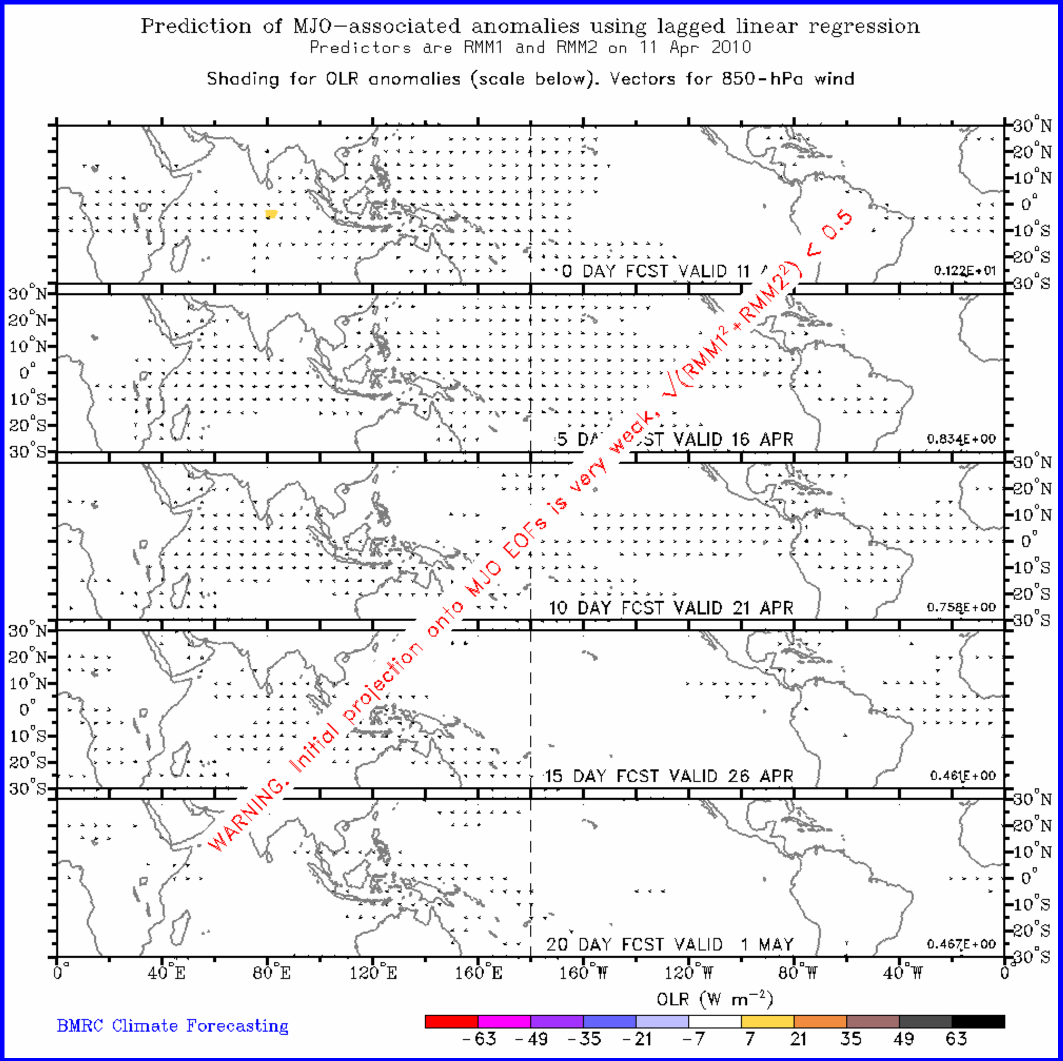
Statistical MJO Forecast

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

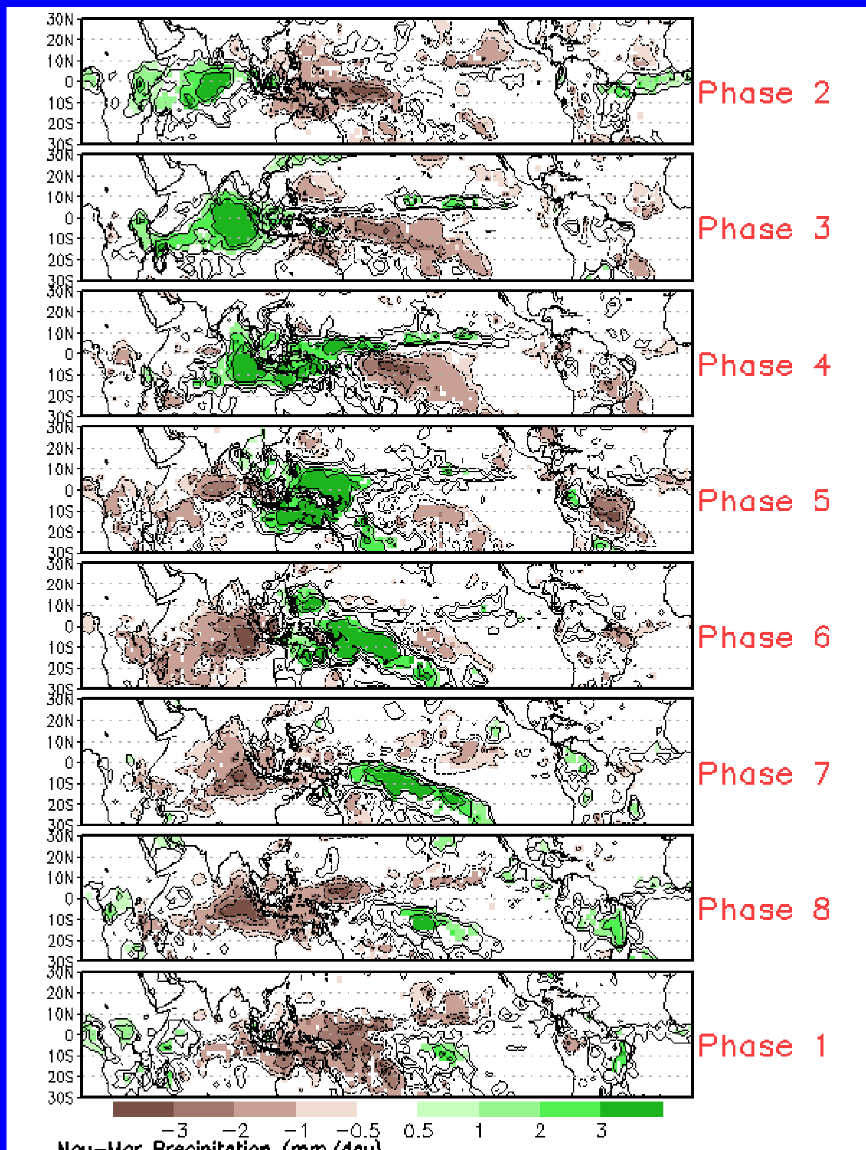
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical forecast indicates a very weak MJO signal over the next two weeks.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)