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

Update prepared by
Climate Prediction Center / NCEP
May 10, 2010

Outline

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

Overview

- The MJO remained active during the past week with the enhanced convective phase entering the Maritime continent region.

- The majority of dynamical model MJO index forecasts indicate a weakening MJO signal during Week-2.

- Based on the latest observations and statistical MJO forecasts, the MJO is expected to remain active during the next 1-2 weeks. Uncertainty is high for the Week-2 period due to differences in forecast tools.

- The MJO is expected to contribute to enhanced rainfall across the eastern Indian Ocean, Maritime Continent and far western Pacific over the coming two weeks. Drier-than-average conditions are favored across northwest South America (Week-1) and Africa (Week-1 and Week-2).

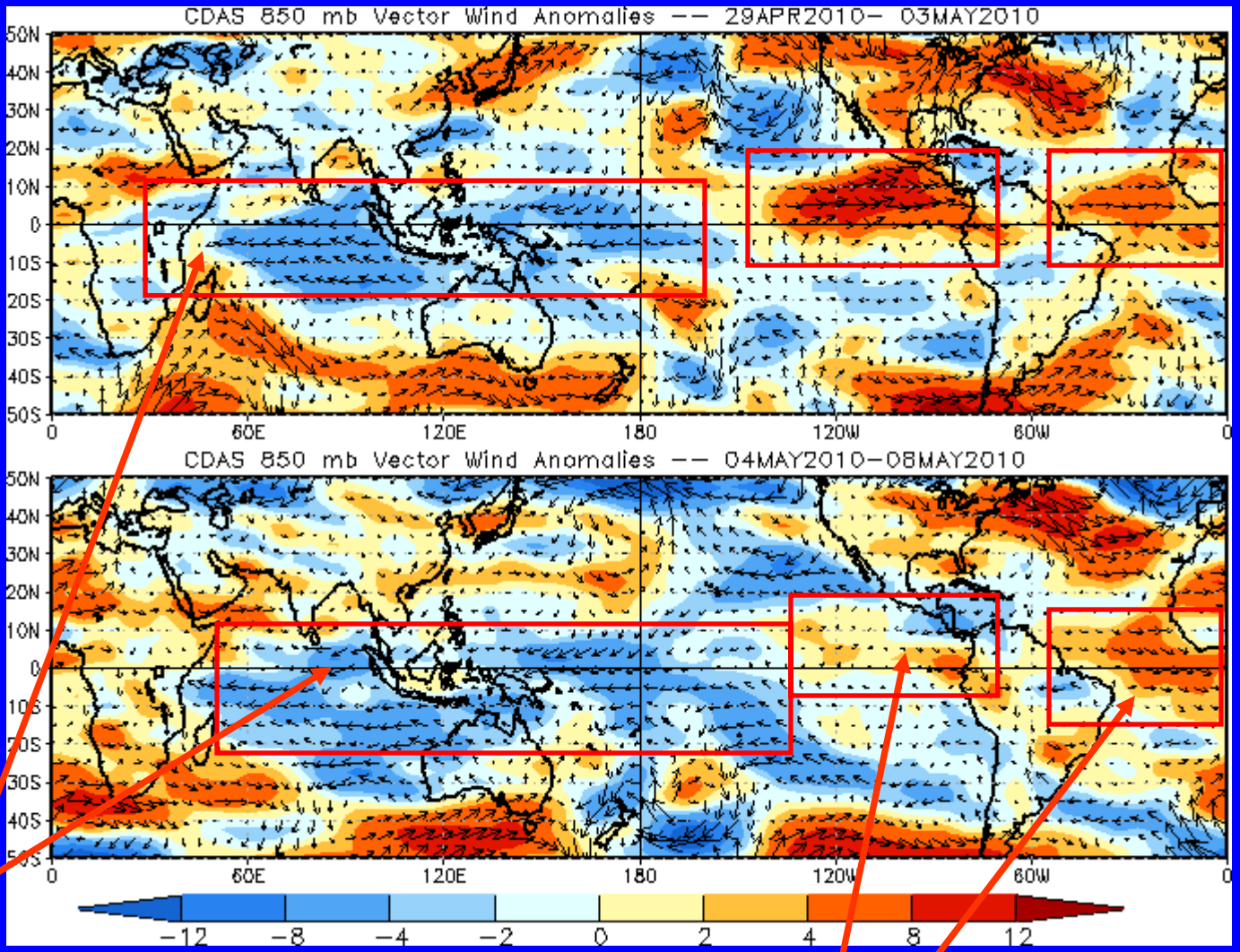
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



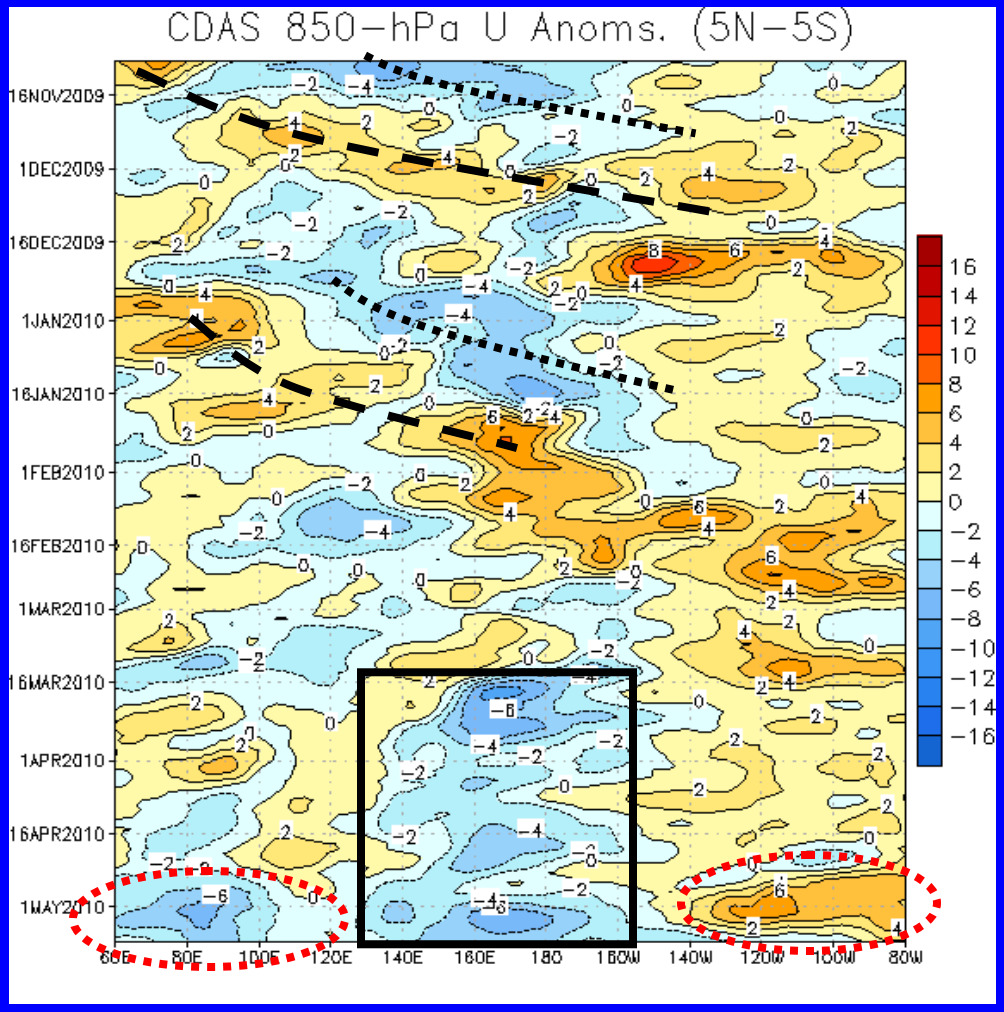
A large area of easterly anomalies is evident from the Indian Ocean to near the Date Line. There has been a slight eastward shift during the last five days.

Westerly anomalies weakened during the last five days across the eastern Pacific while they continued across the Atlantic and increased over Africa.

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 November associated with the MJO.

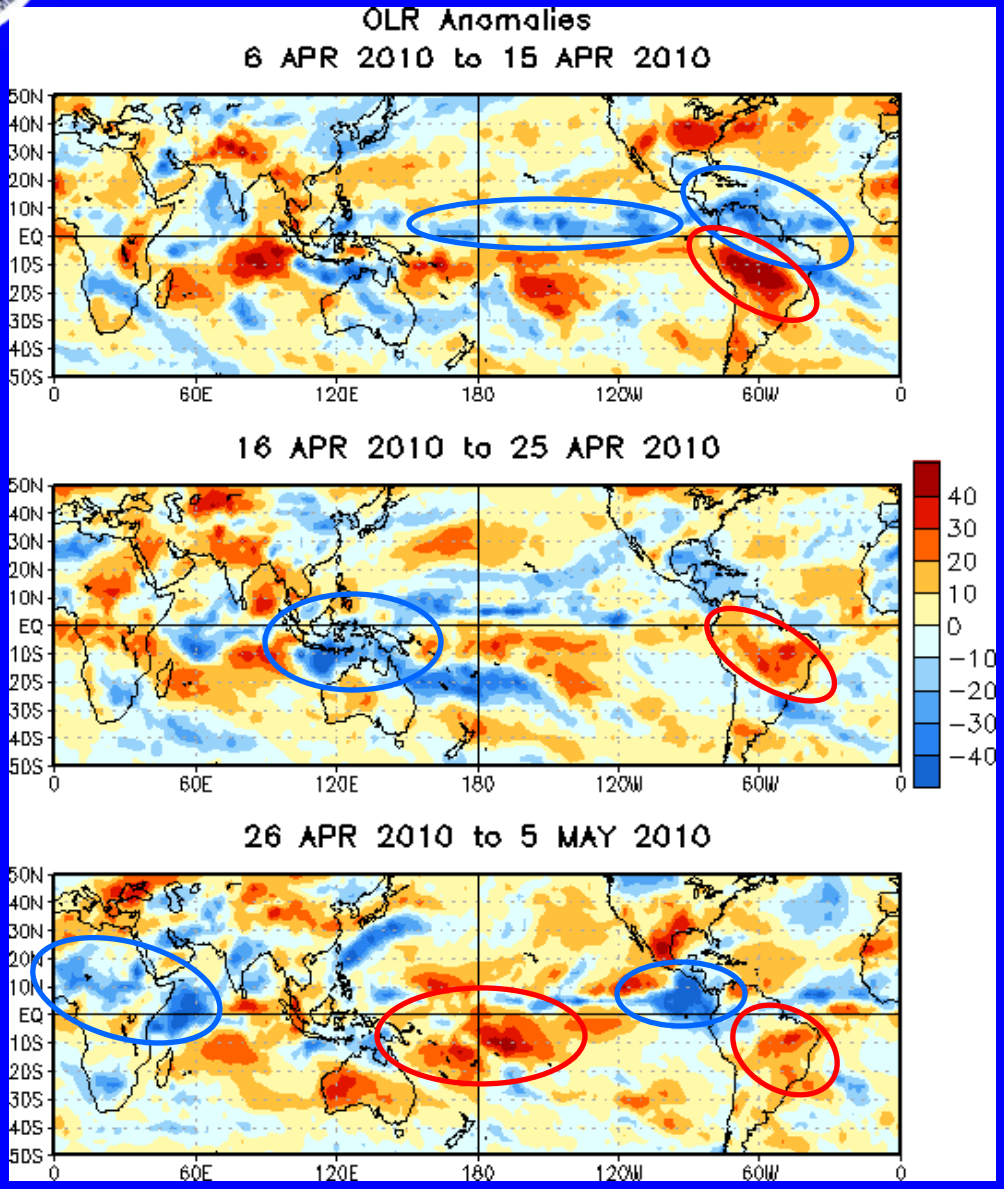
Weaker and shorter-lived MJO activity was evident during January.

Easterly anomalies have persisted in the west-central Pacific since mid-March (black box). Recently, easterly (westerly) anomalies have developed in the Indian Ocean (eastern Pacific) associated with the current MJO activity (red ovals).

OLR Anomalies: Last 30 days

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

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

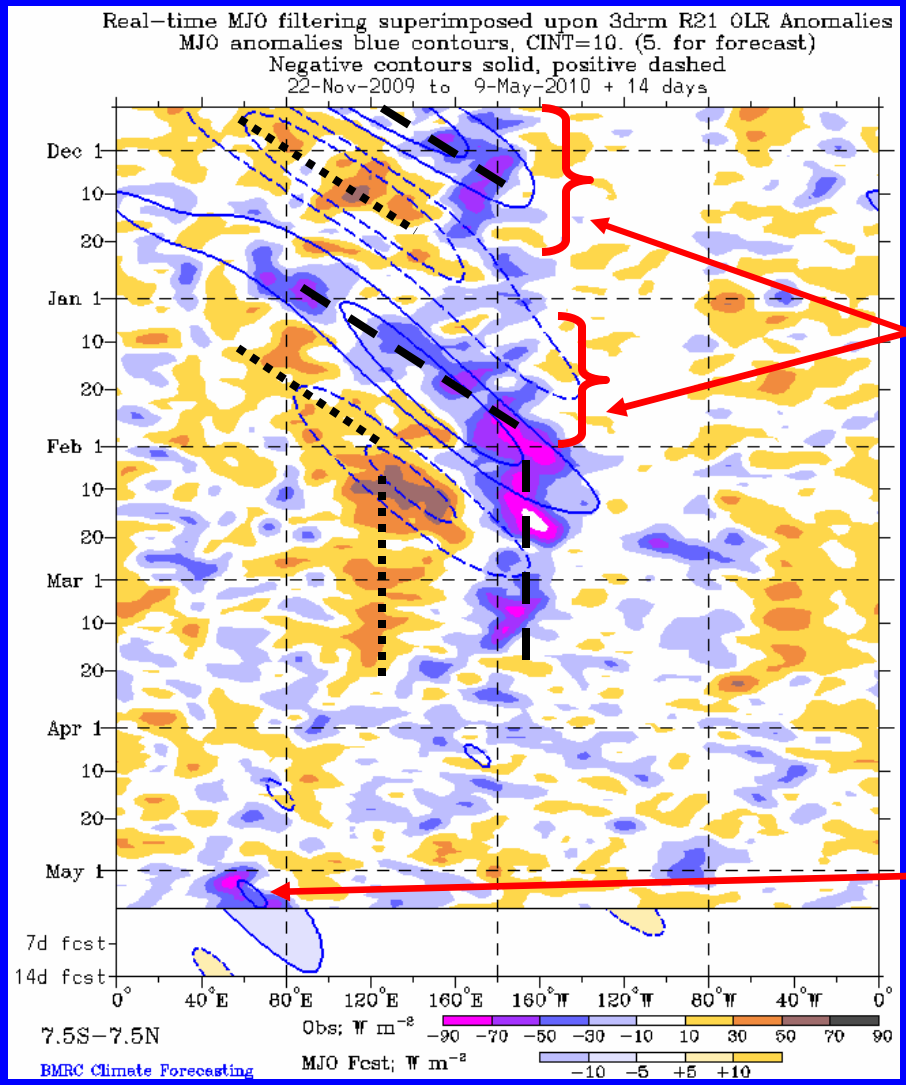


During early-to-mid April, enhanced convection was evident over much of the equatorial Pacific and northern South America with strong suppressed convection across parts of central South America.

In mid-to-late April enhanced convection developed over the Maritime Continent while suppressed convection continued in central South America.

During late April and early May, suppressed convection developed over the west-central Pacific and continued over parts of Brazil. Enhanced convection developed over the eastern Pacific, Central America, central Africa and the western Indian Ocean.

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)

MJO activity was evident during November to early December 2009 and again during January 2010.

The MJO was not active during February and March as anomalous convection was more persistent across the Maritime continent (suppressed) and west-central Pacific (enhanced).

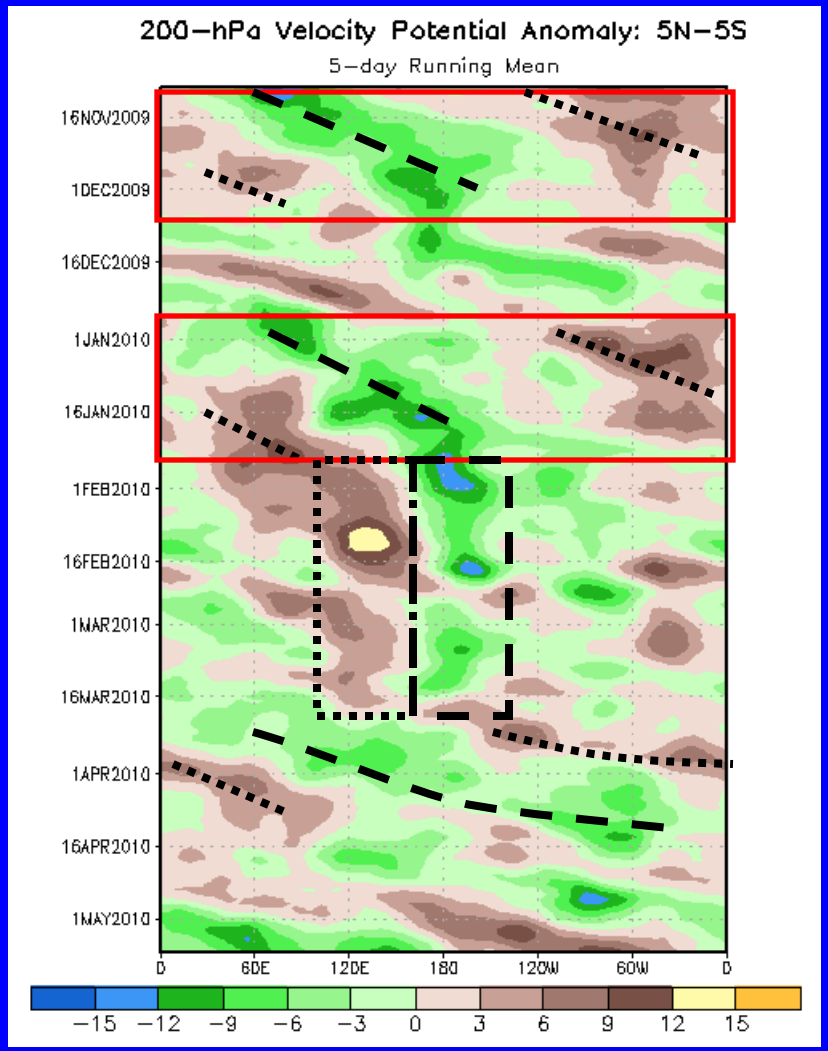
Anomalies were small during the month of April.

Enhanced convection developed across the Indian Ocean in early May.

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 again during early-mid January (red boxes).

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

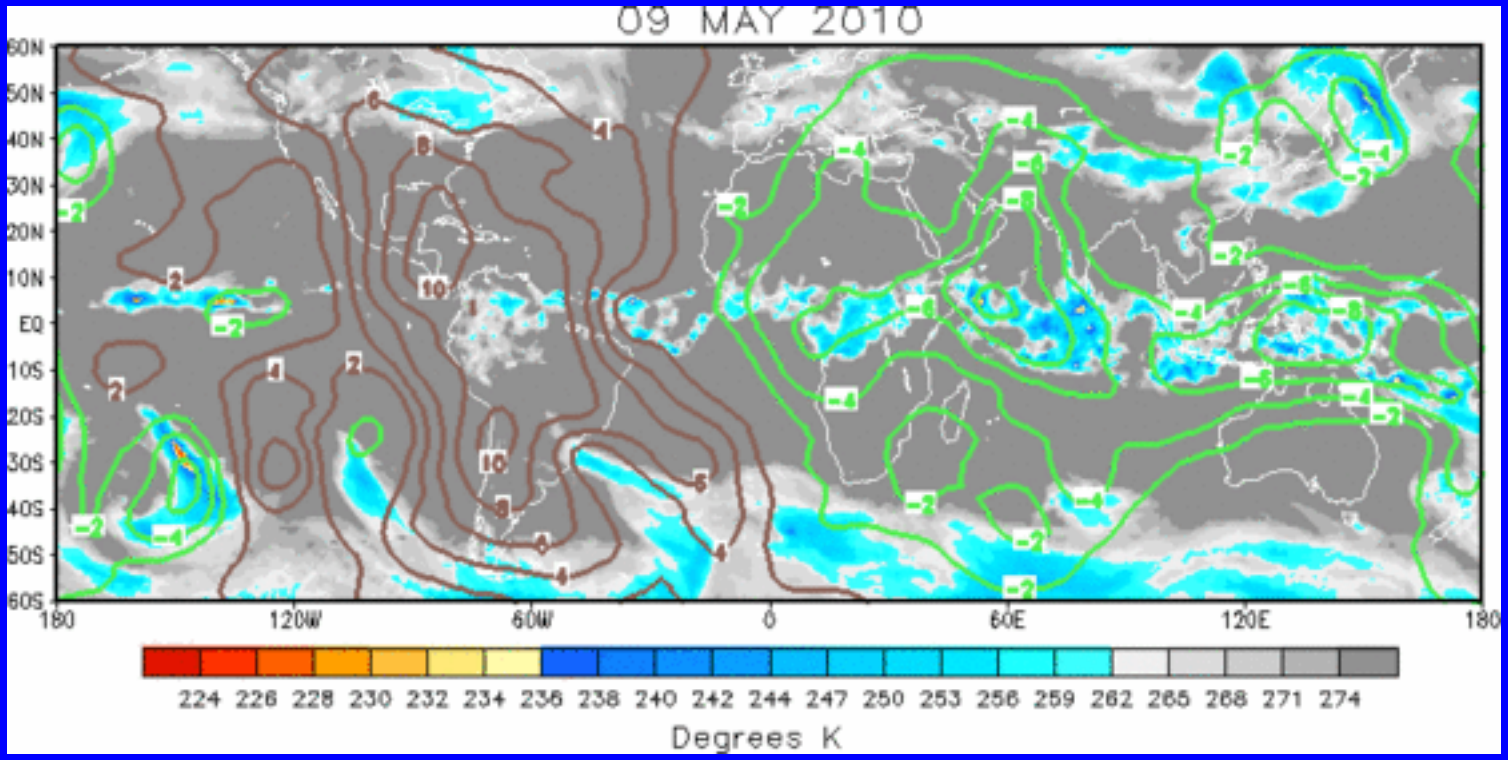
In mid-March, weak upper-level divergence (convergence) developed over Africa and the Indian Ocean (Maritime continent) and these anomalies propagated eastward.

In late April and early May, anomalies increased and fast eastward propagation is evident.

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



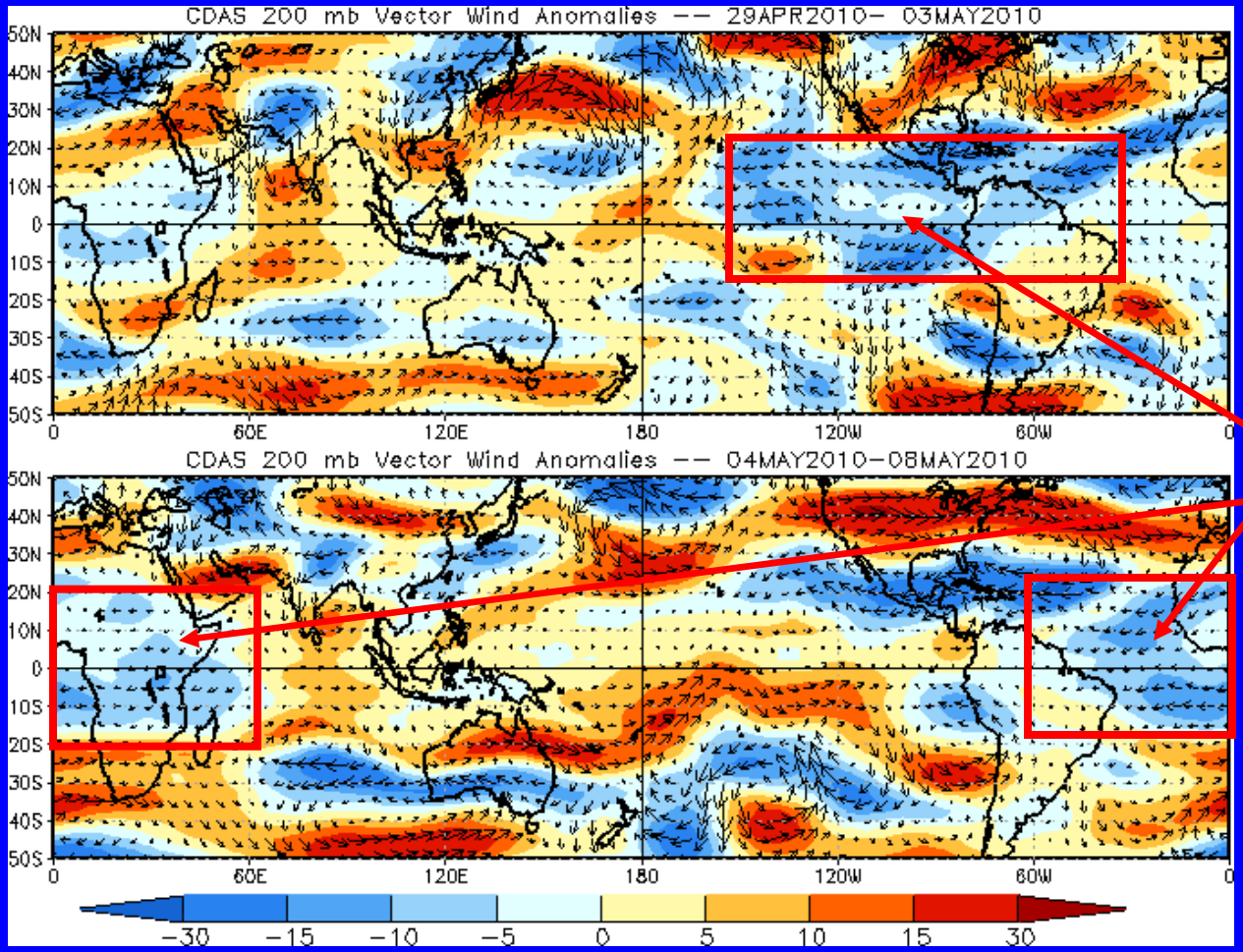
The current anomalous velocity potential pattern is coherent with large scale upper-level divergence stretching from Africa to the Maritime continent. Upper-level convergence is evident over the western hemisphere.

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

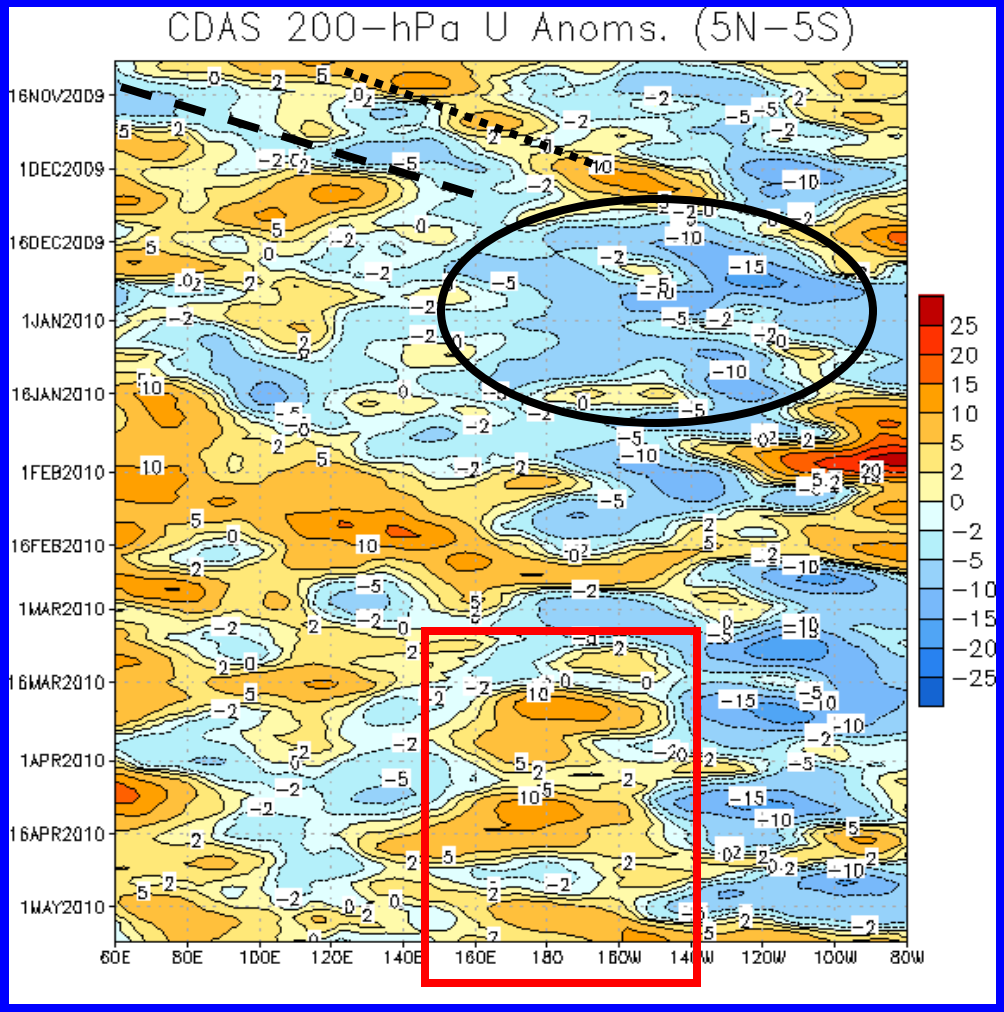


Easterly anomalies across the tropical eastern Pacific and the Americas have shifted eastward to the Atlantic and Africa during the last five days (red boxes).

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

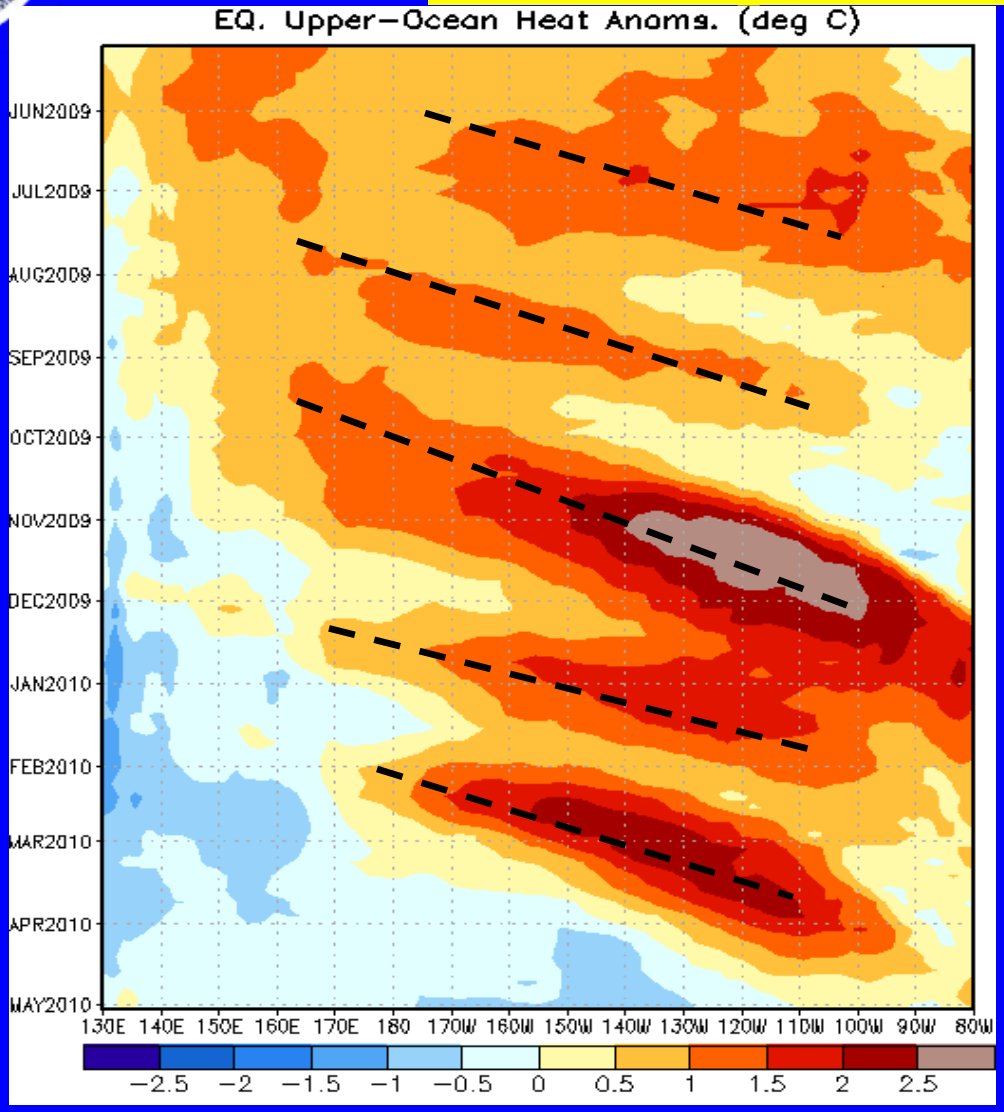
Longitude

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). During the past week, eastward propagation of westerly anomalies is evident.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

Since May 2009, heat content anomalies have remained above-average for much of the period.

From November 2009 – February 2010 three ocean Kelvin waves contributed to the change in heat content across the eastern Pacific (last three dashed black lines).

During April 2010 heat content anomalies have decreased across the Pacific in association with the upwelling phase of a Kelvin wave. Currently, negative heat content anomalies extend across 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).**

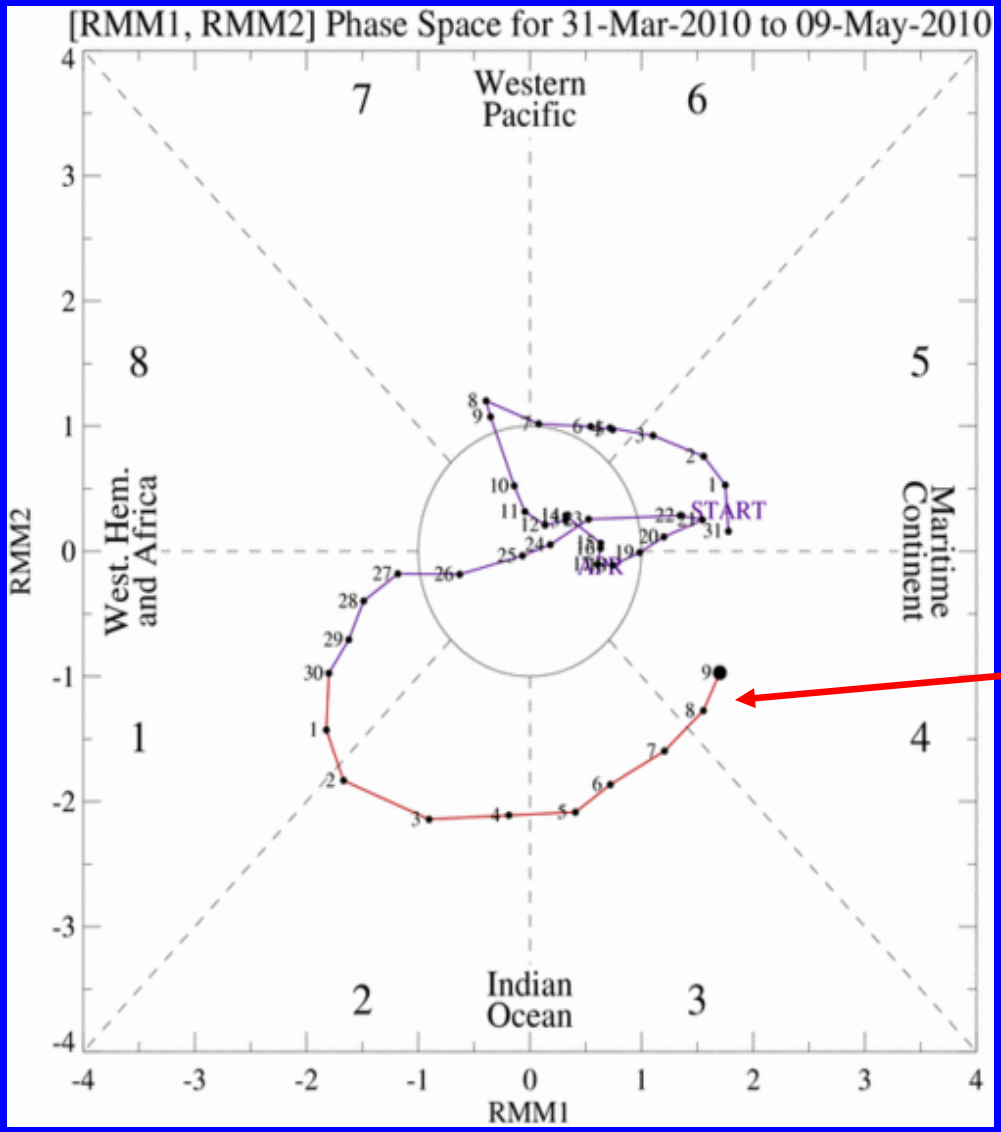
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review*, 132, 1917-1932.

- **The methodology is 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).**

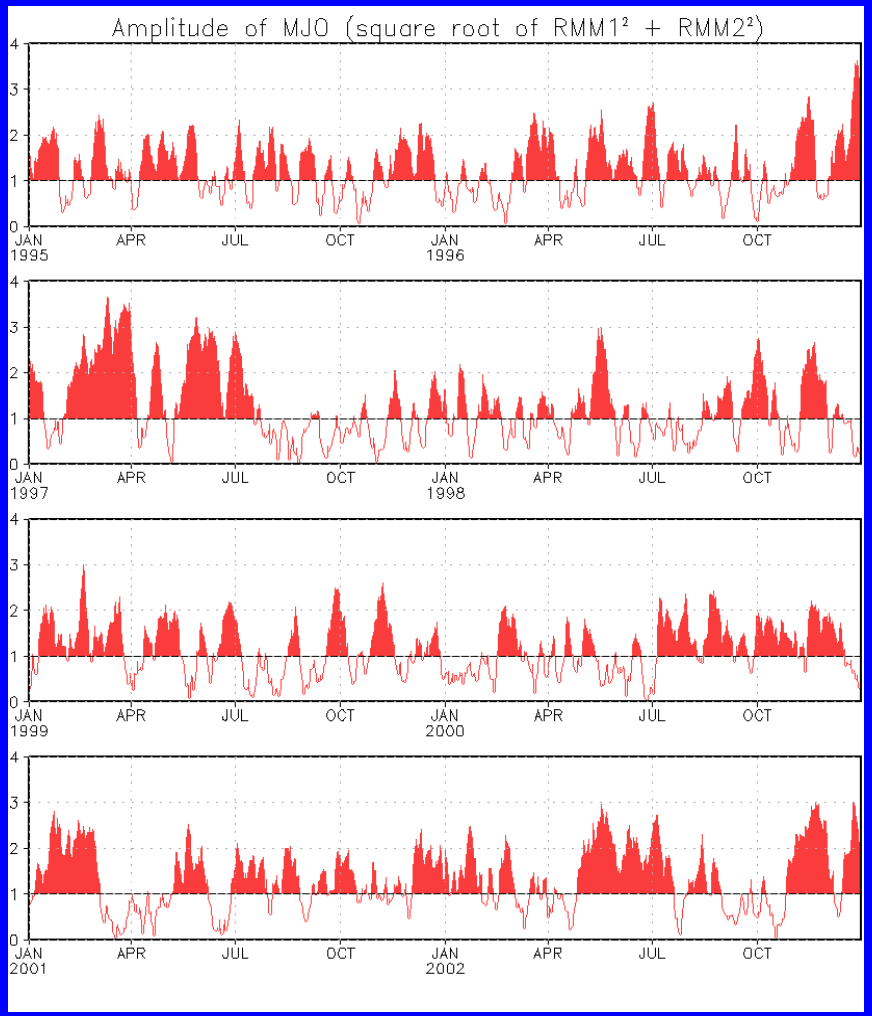
MJO Index -- Recent Evolution

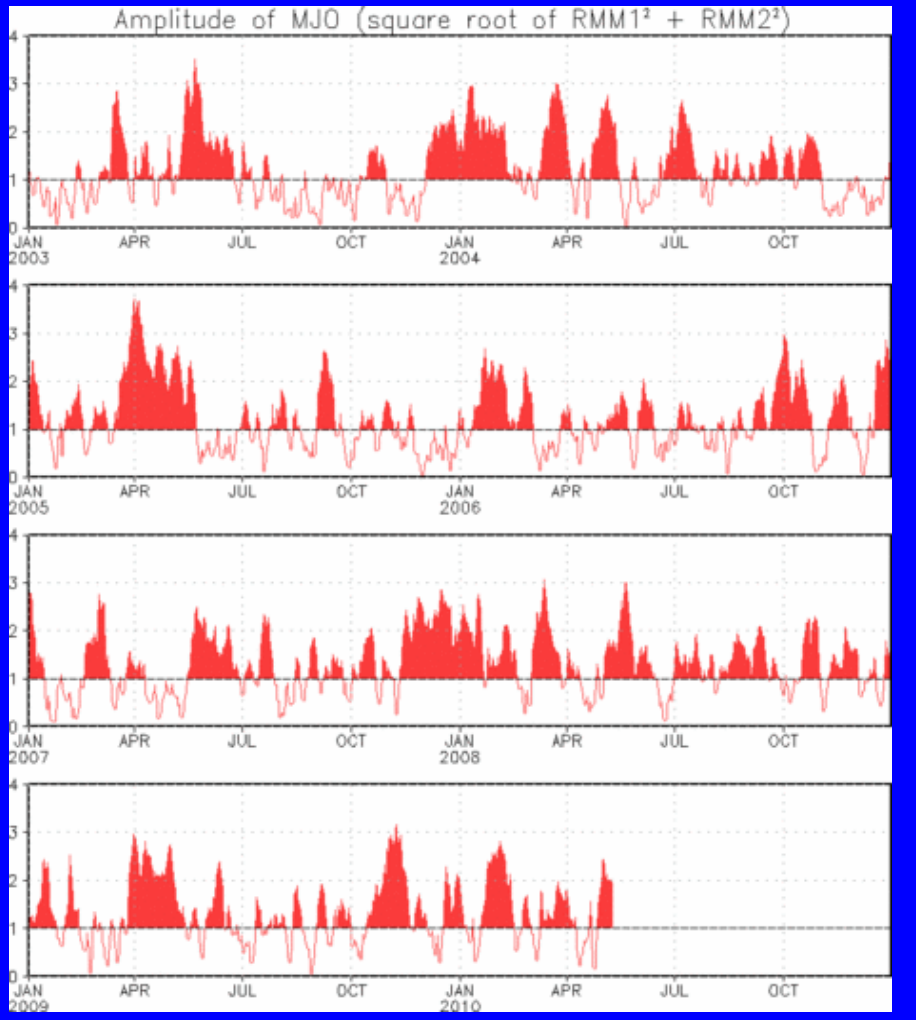


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

During the past week, the MJO index indicates a fast eastward propagating signal entering the Maritime continent region.

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.

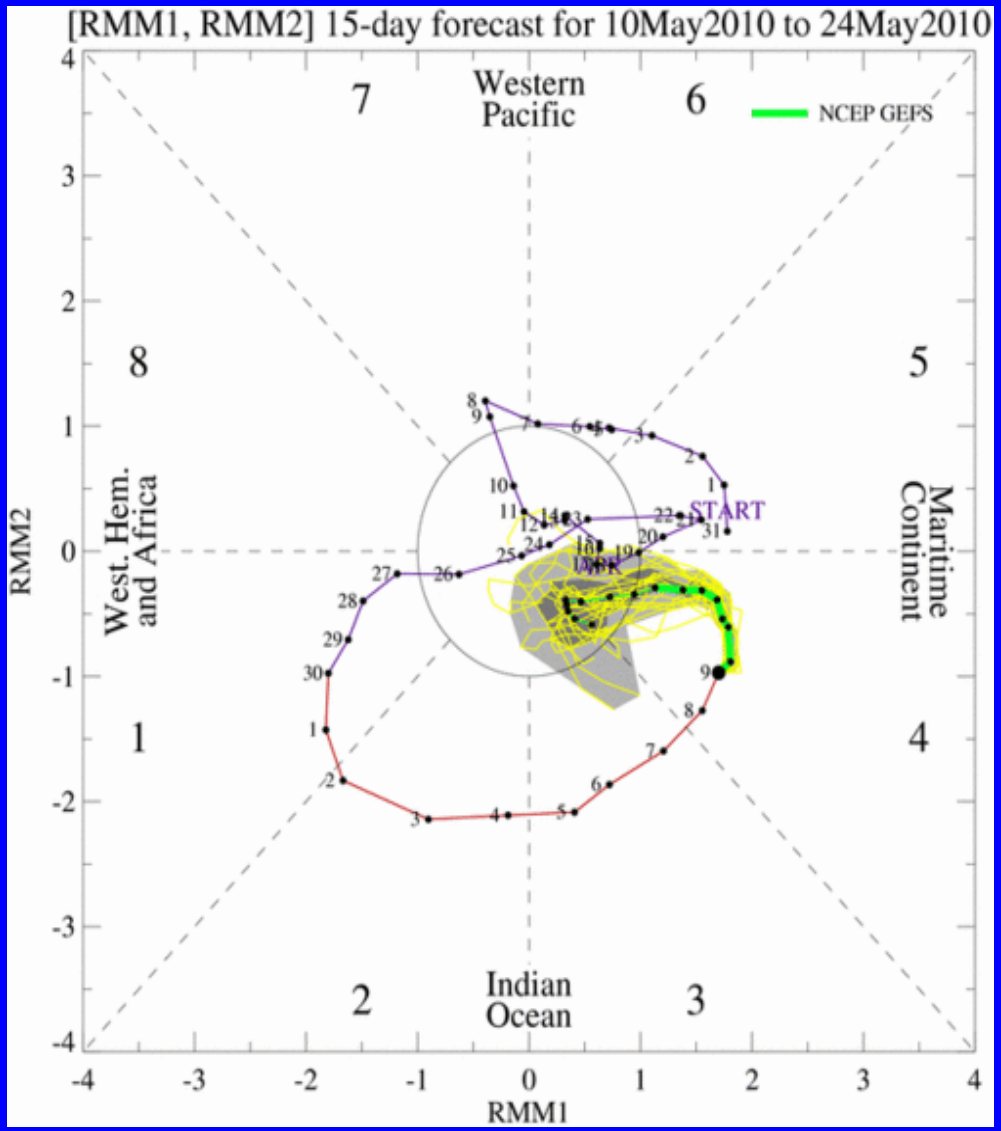
Ensemble GFS (GEFS) MJO Forecast

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

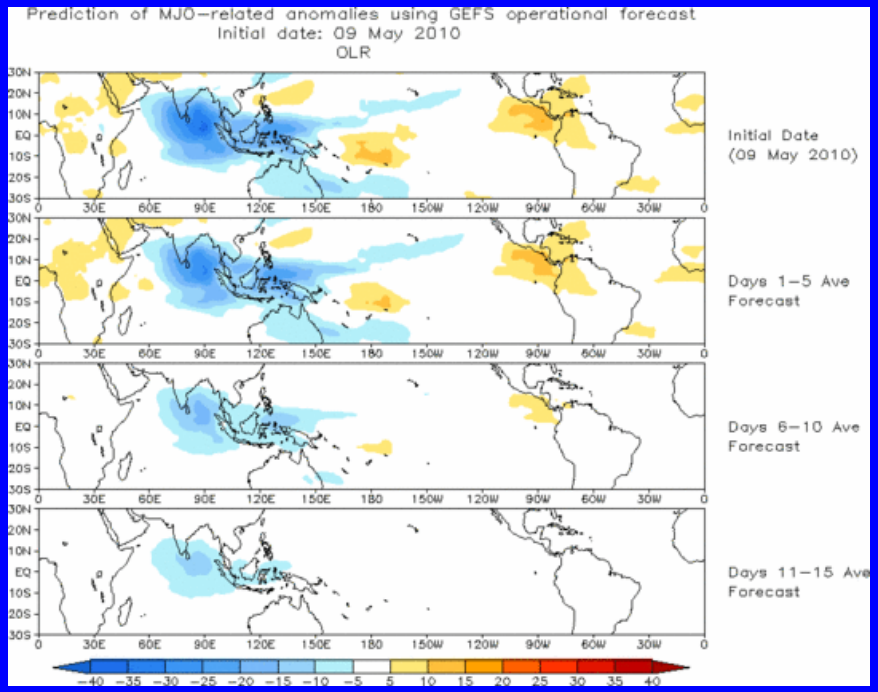
The GFS forecasts indicate a weakening signal late in Week-1 with little strength during Week-2. Spread increases considerably after the next few days.



Ensemble Mean GFS MJO Forecast

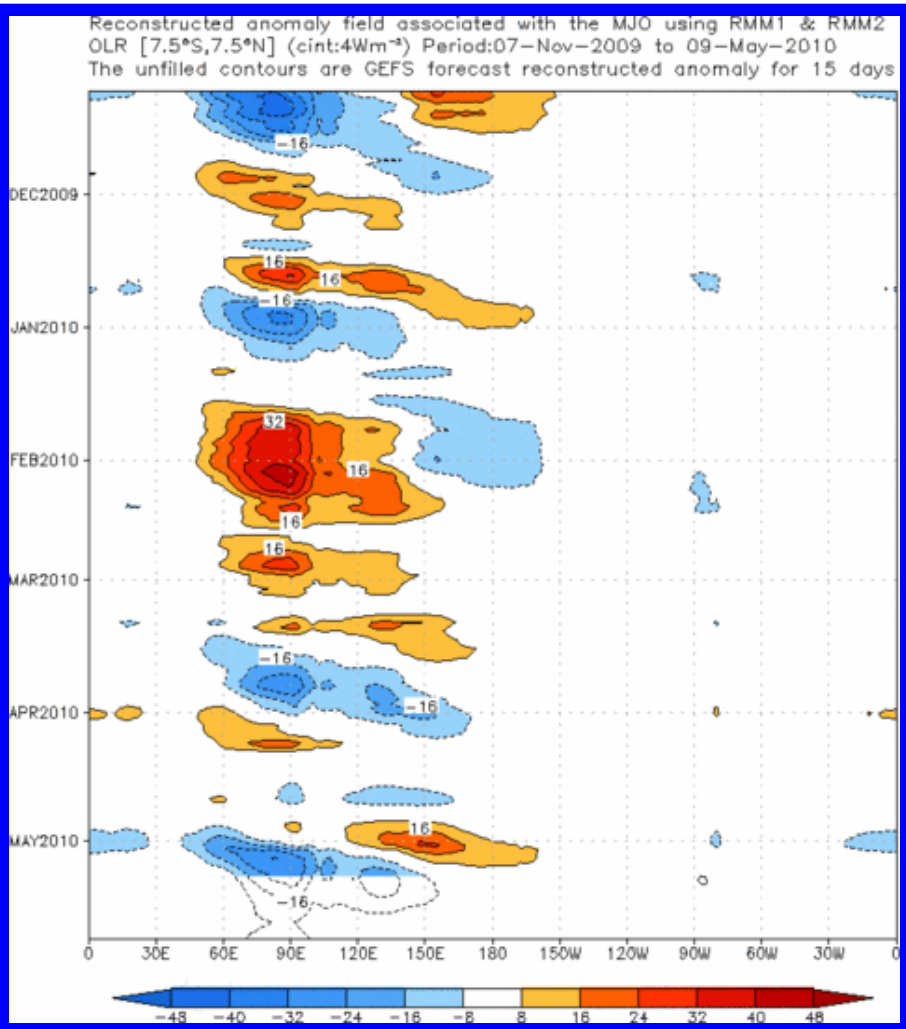
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecast indicates enhanced (suppressed) convection over the Indian Ocean and Maritime continent (Central America and Africa) over the period.

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

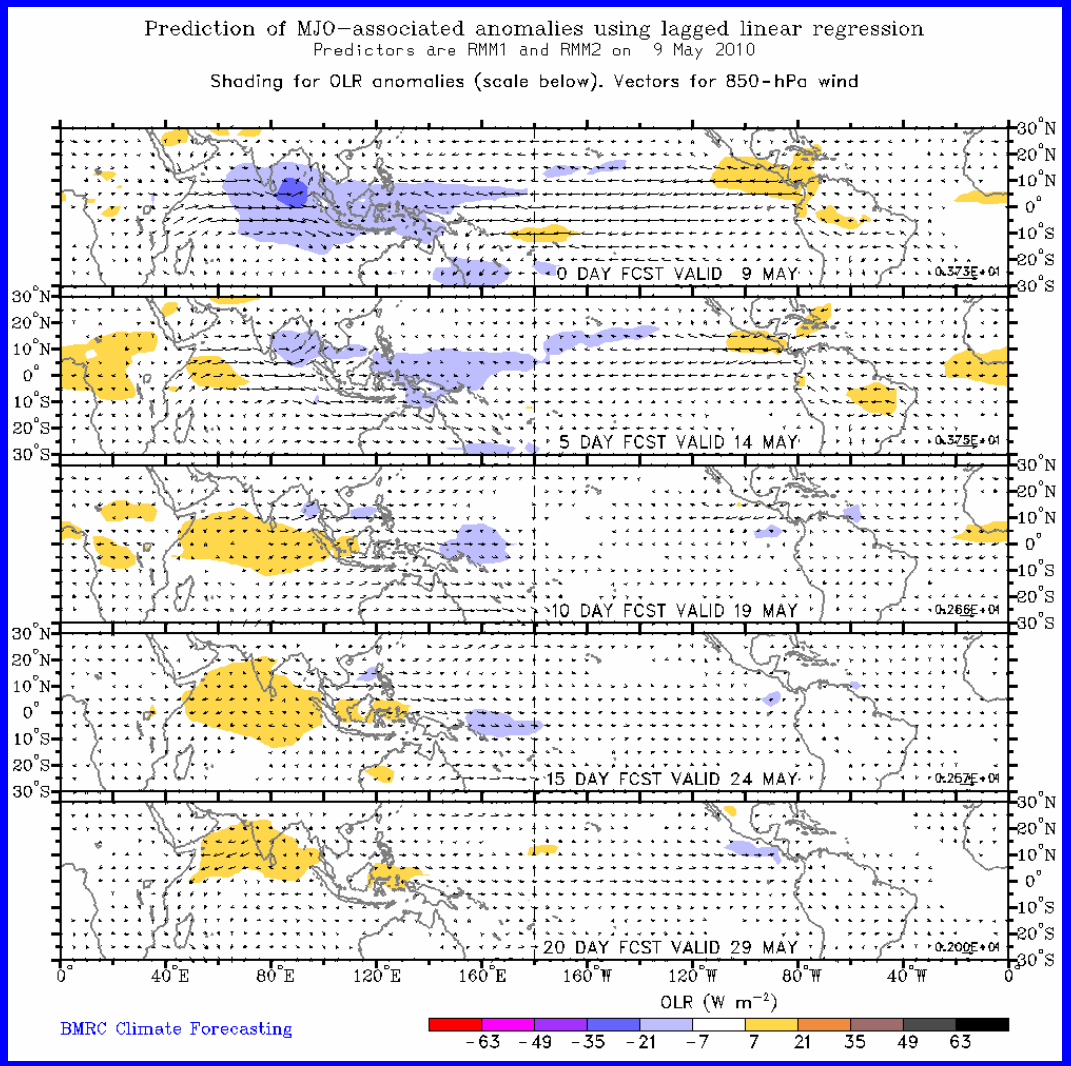
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

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

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

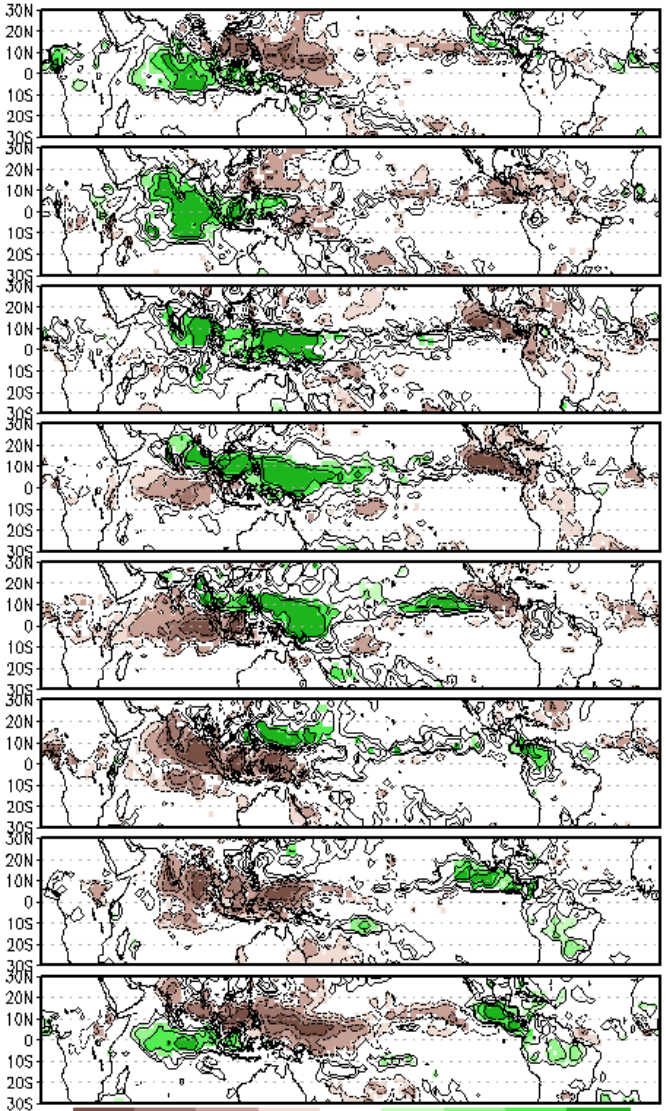
The statistical forecast is consistent with the GFS but indicates continued propagation during Week-2.

This forecast shows enhanced convection from the Indian Ocean to the western Pacific by Week-2. Suppressed convection is forecast to enter the Indian Ocean during Week-2.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)