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

Update prepared by
Climate Prediction Center / NCEP
July 5, 2010

Outline

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

Overview

- The MJO is currently incoherent.

- Dynamical model MJO index forecasts are generally consistent in showing a highly variable incoherent signal across the Indian Ocean continuing during the period.

- Based on a combination of the latest observations and MJO dynamical forecast tools, the MJO is expected to remain incoherent or weak over the period.

- The MJO is not expected to contribute substantially to anomalous tropical rainfall during the next 1-2 weeks.

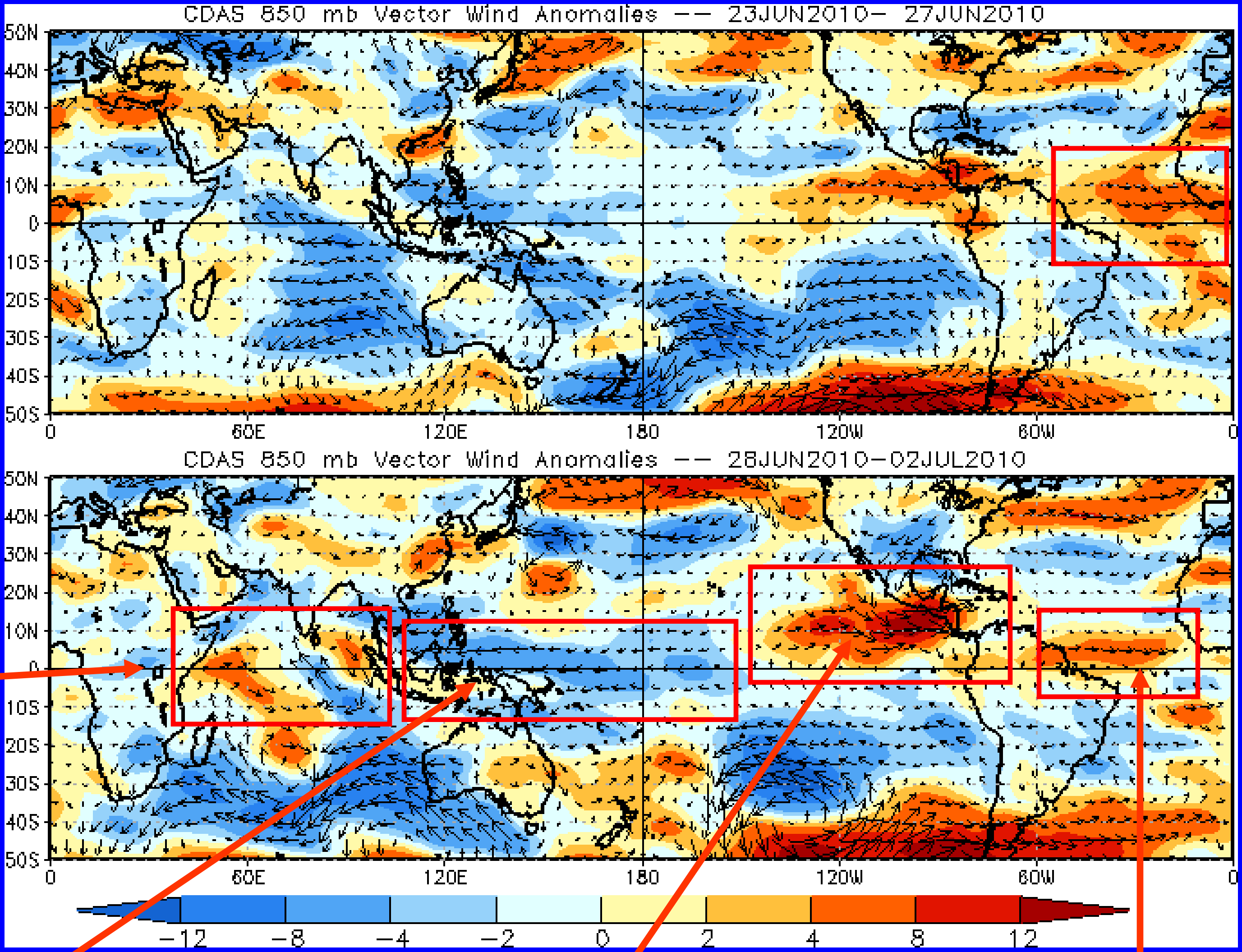
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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 weakened in many areas across the Indian Ocean during the past five days.

Easterly anomalies continued during the past five days across the western Pacific.

Strong westerly anomalies continue in the eastern Pacific.

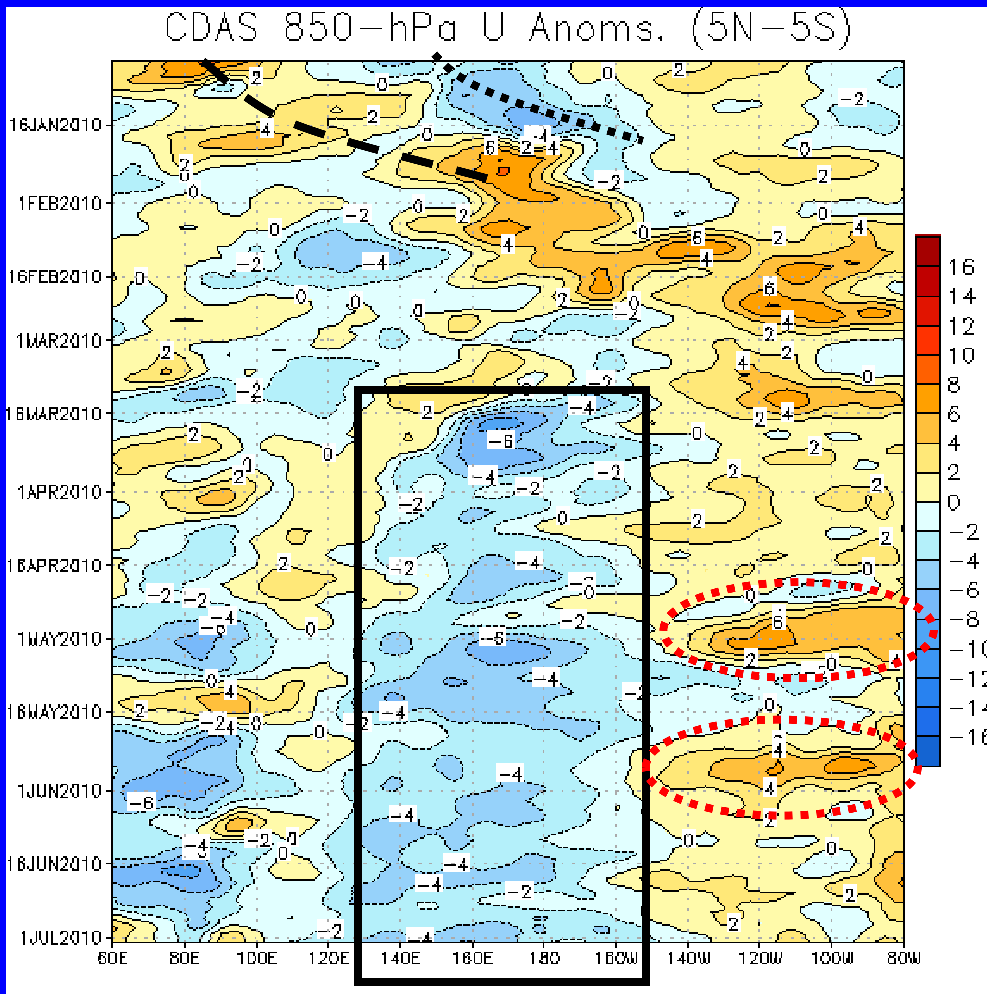
Westerly anomalies continued during the last five days over the Atlantic.

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

Time



Longitude

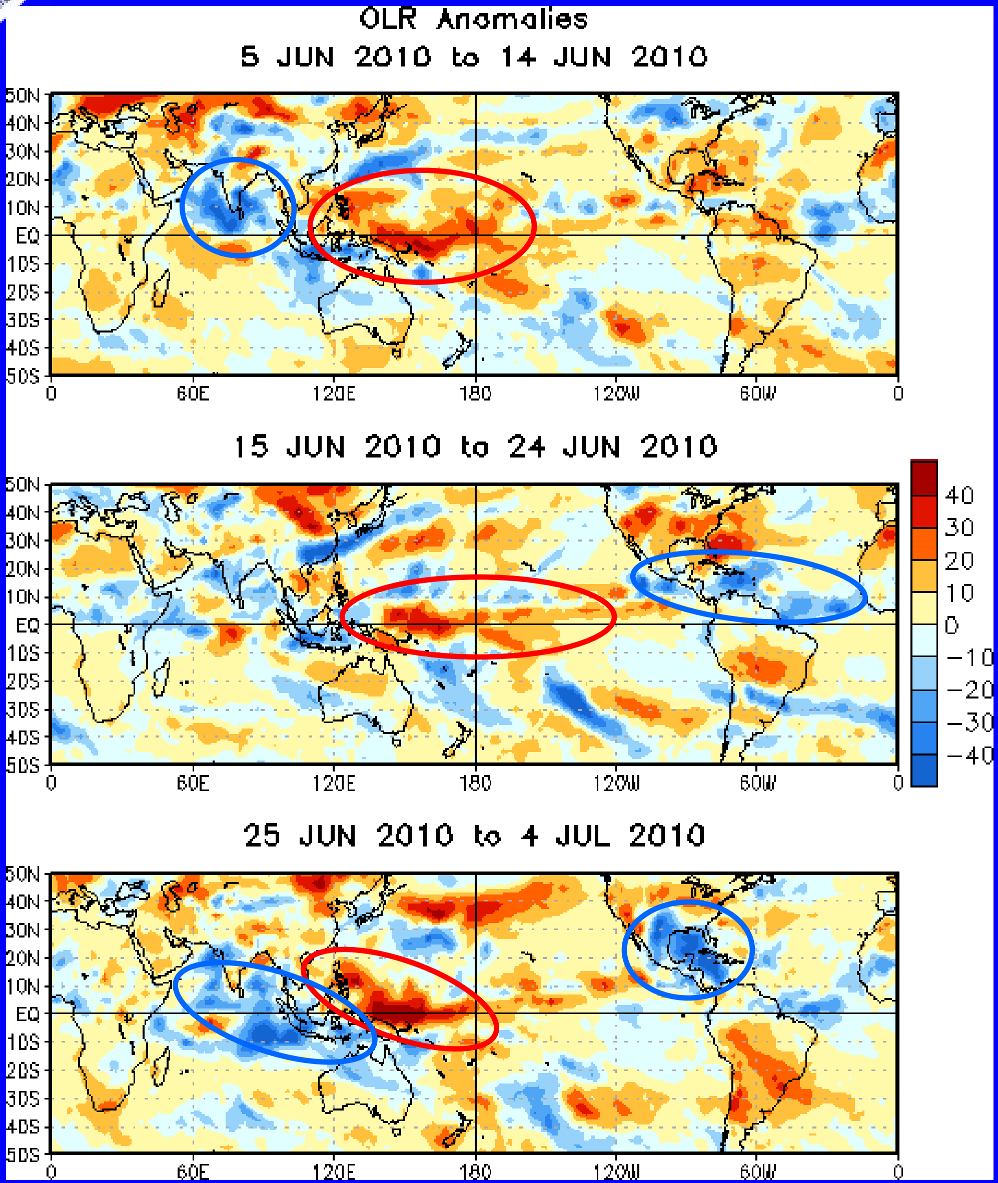
Weak and short-lived MJO activity was evident during January (dotted and dashed line).

Easterly anomalies have persisted in the west-central Pacific since mid-March (black box).

Strong westerly anomalies (red dotted ovals) occurred across the eastern Pacific on separate occasions during late April/early May and again in late May.

These were in part 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)

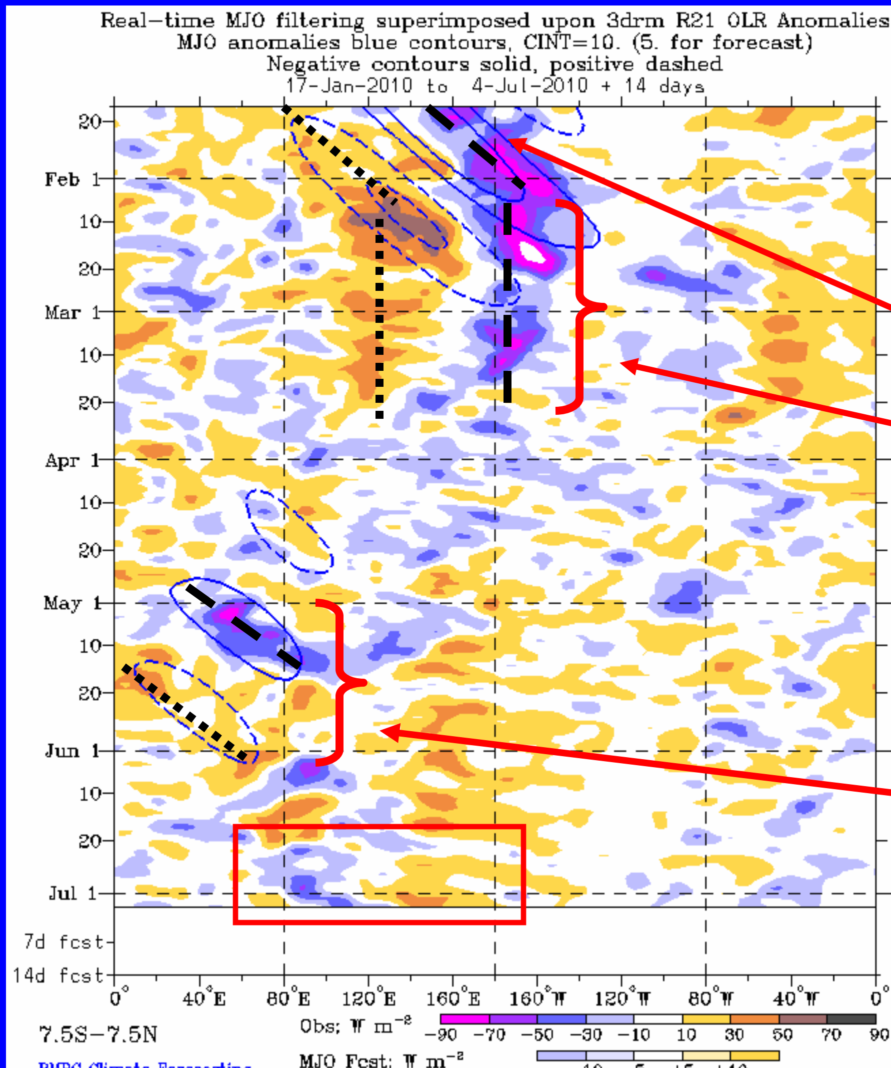
Suppressed convection persisted across the western Pacific during early-to-mid June (red oval). Enhanced convection was evident over southern India during this period (blue oval).

In mid June, suppressed convection continued across the west central Pacific while enhanced convection developed across the Caribbean, eastern Pacific and Atlantic.

Enhanced convection spread to Mexico, the southern U.S., Central America and the Caribbean during late June and early July. Suppressed convection continued over the western tropical Pacific while enhanced convection was evident across the Indian Ocean and western Maritime Continent.

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 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.

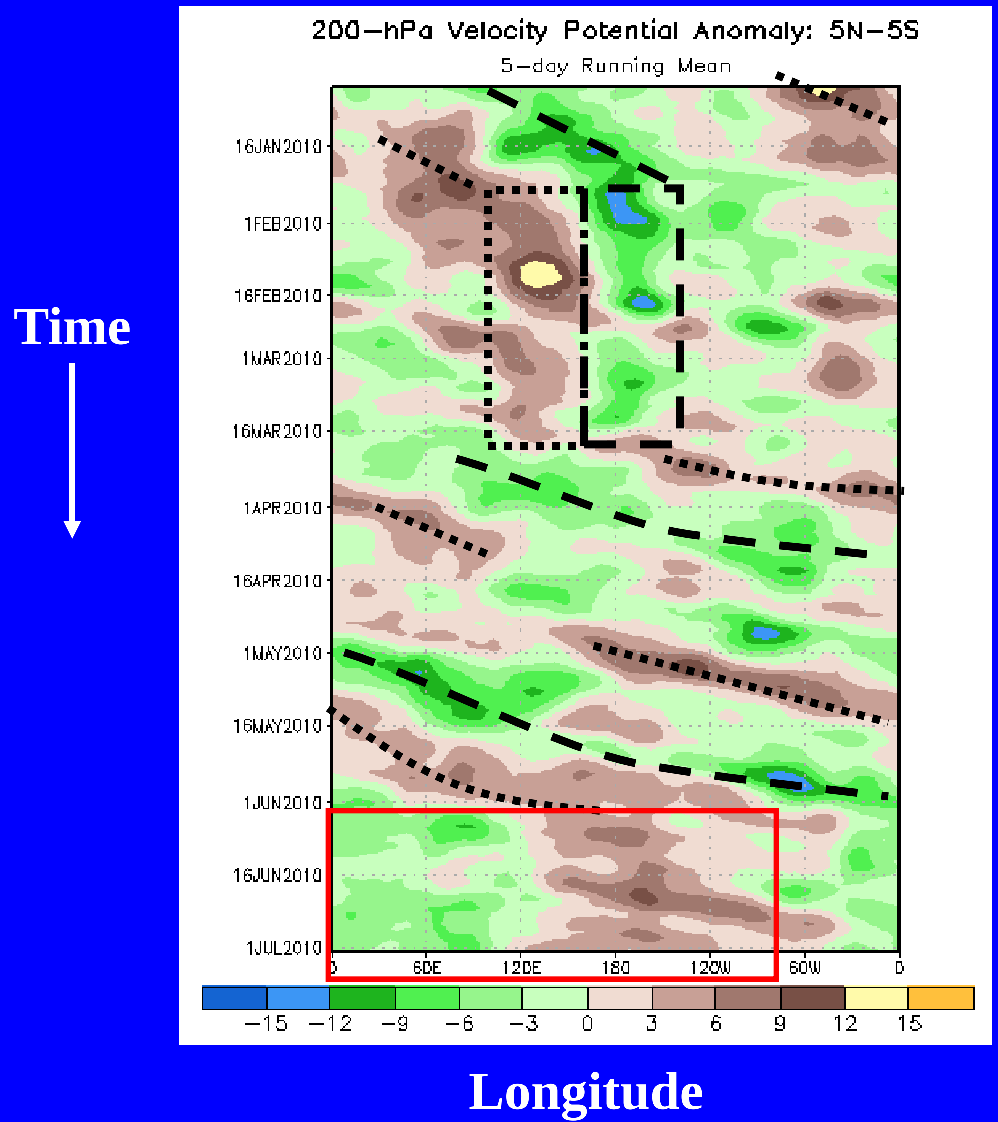
Enhanced convection, in part associated with MJO activity, developed across the Indian Ocean in early May and shifted slightly eastward. Suppressed convection developed after this across much of Africa.

In late June, enhanced convection developed from 80E to 110E with suppressed convection continuing west of the Date Line (red box).

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



Eastward propagation associated with the MJO was evident during early-mid January (dotted and dashed lines).

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.

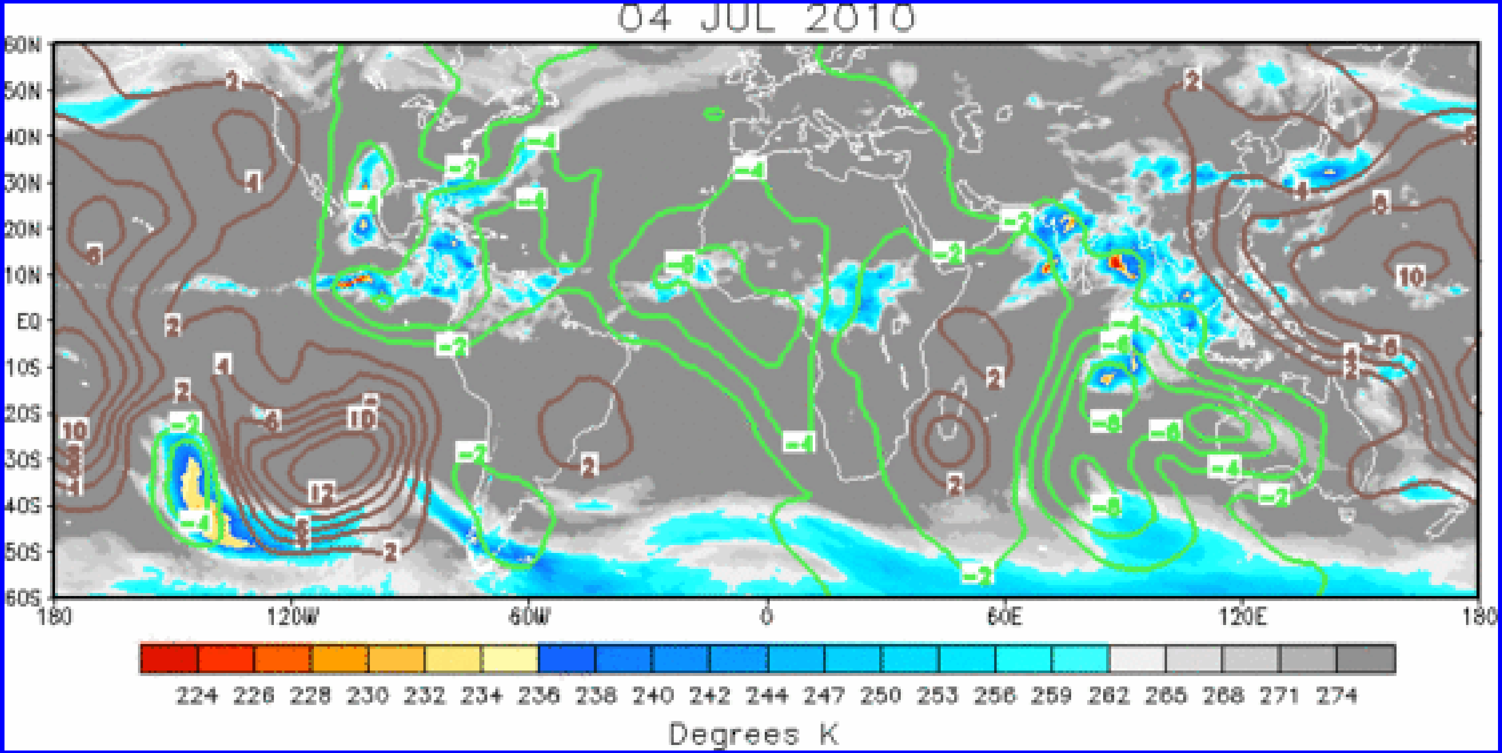
In late April and May, anomalies increased and eastward propagation was evident, coincident with the MJO.

Beginning in early June, anomalies became more stationary (red box) with upper-level divergence (convergence) located from 30W to 120E (140E to 90W).

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



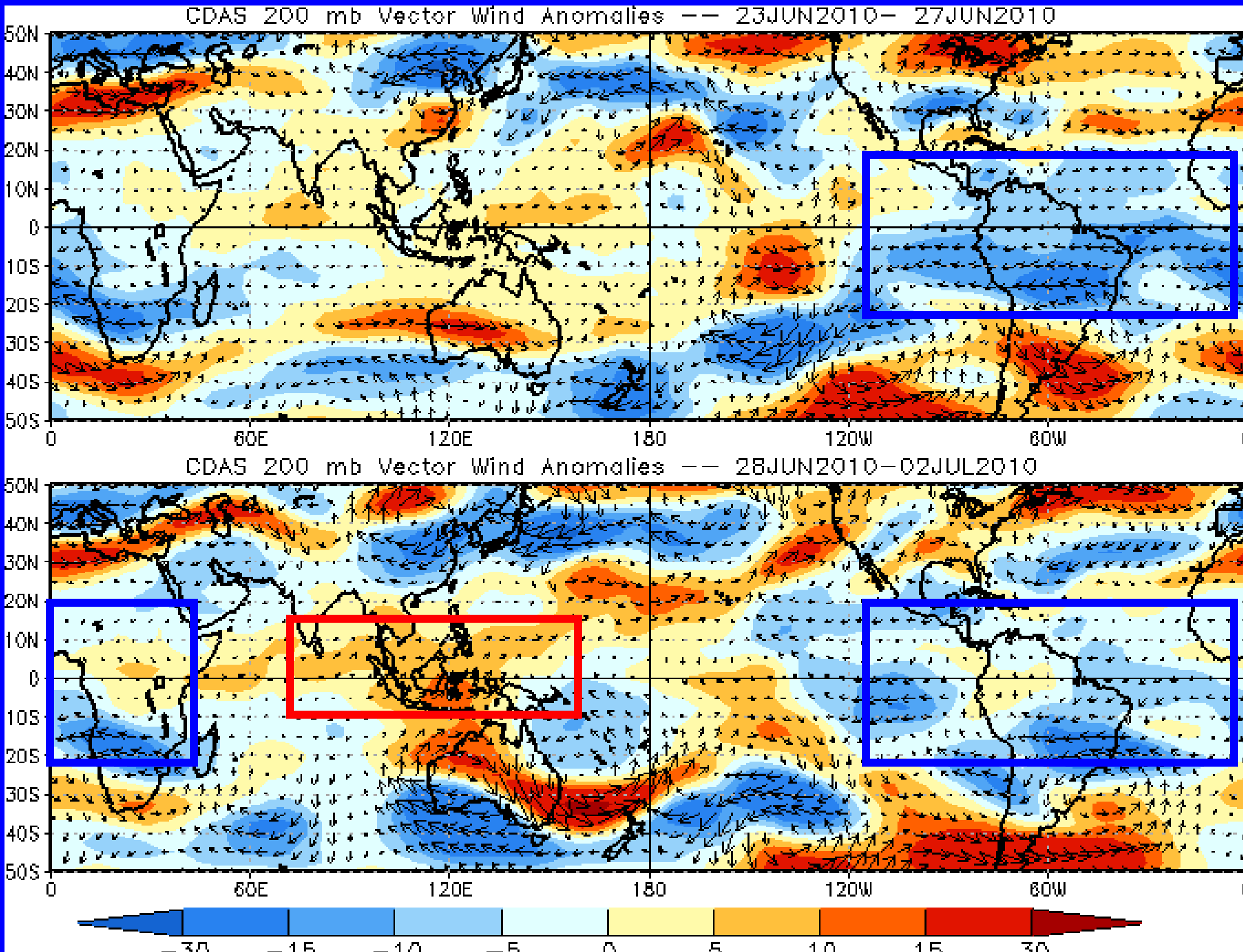
The current anomalous velocity potential pattern is not coherent and indicates upper-level convergence over the western and central Pacific with weak upper-level divergence evident over parts of Central America, Africa and the Indian Ocean.

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 weakened across northern South America, the tropical Atlantic Ocean, and Africa during the last five days (blue boxes).

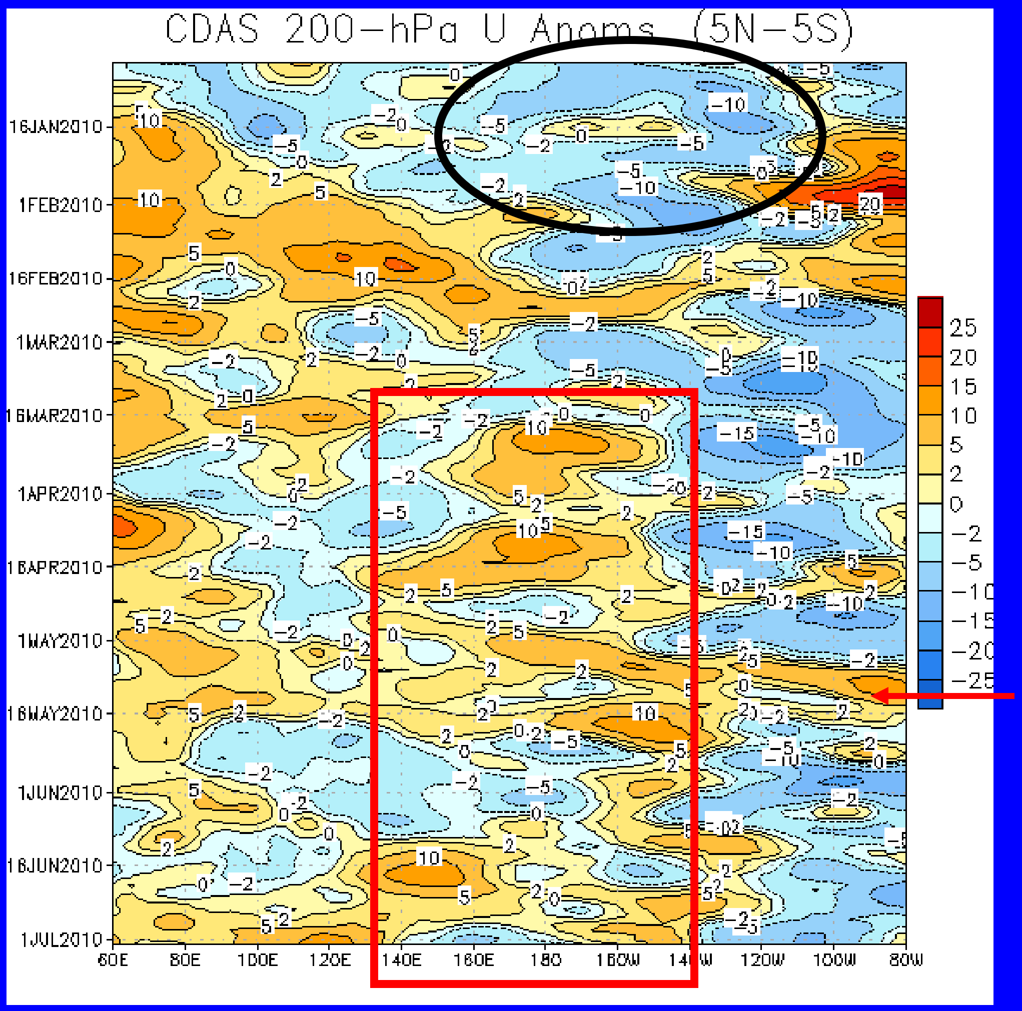
Westerly anomalies remain evident across the Maritime continent (red box).

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



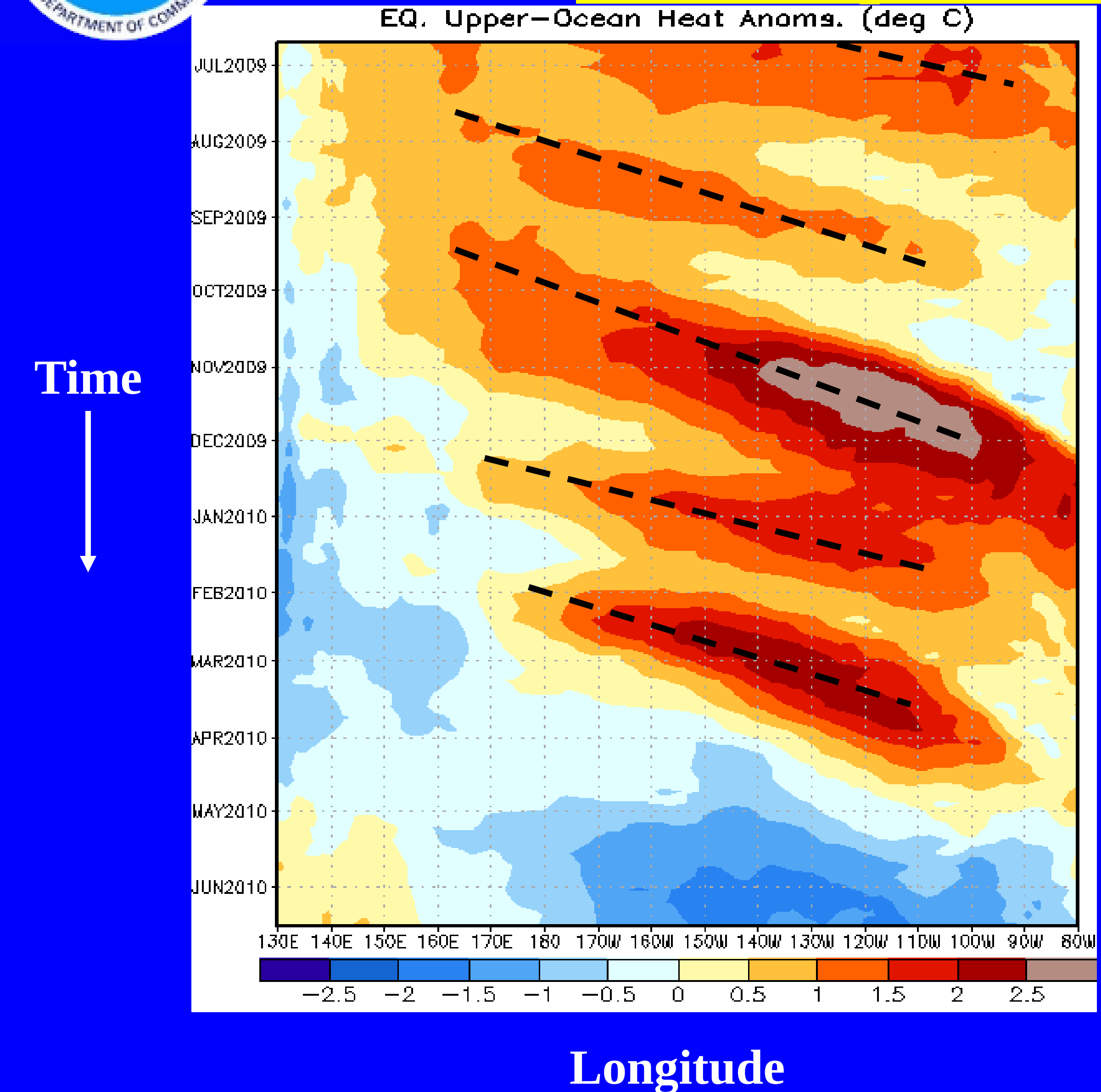
Longitude

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

Westerly (easterlies) anomalies prevailed across the central (eastern) Pacific (red box) for much of the period since mid-March.

In early May, however, there was some eastward propagation of westerly anomalies across the Pacific in association with the MJO at that time.

Weekly Heat Content Evolution in the Equatorial Pacific



From July 2009 through March 2010, heat content anomalies 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 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).

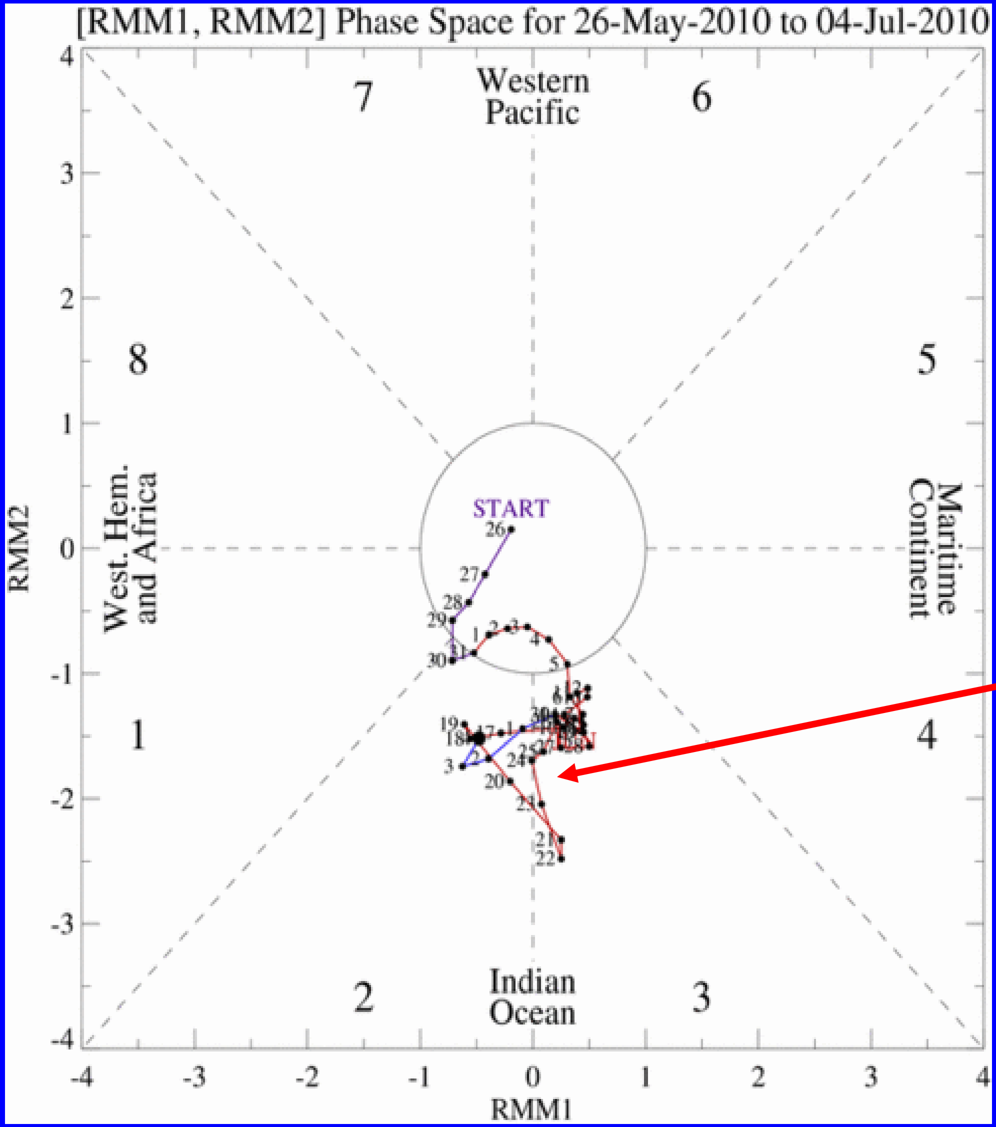
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review,* 132, 1917-1932.

• 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*., In Press.

• 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).

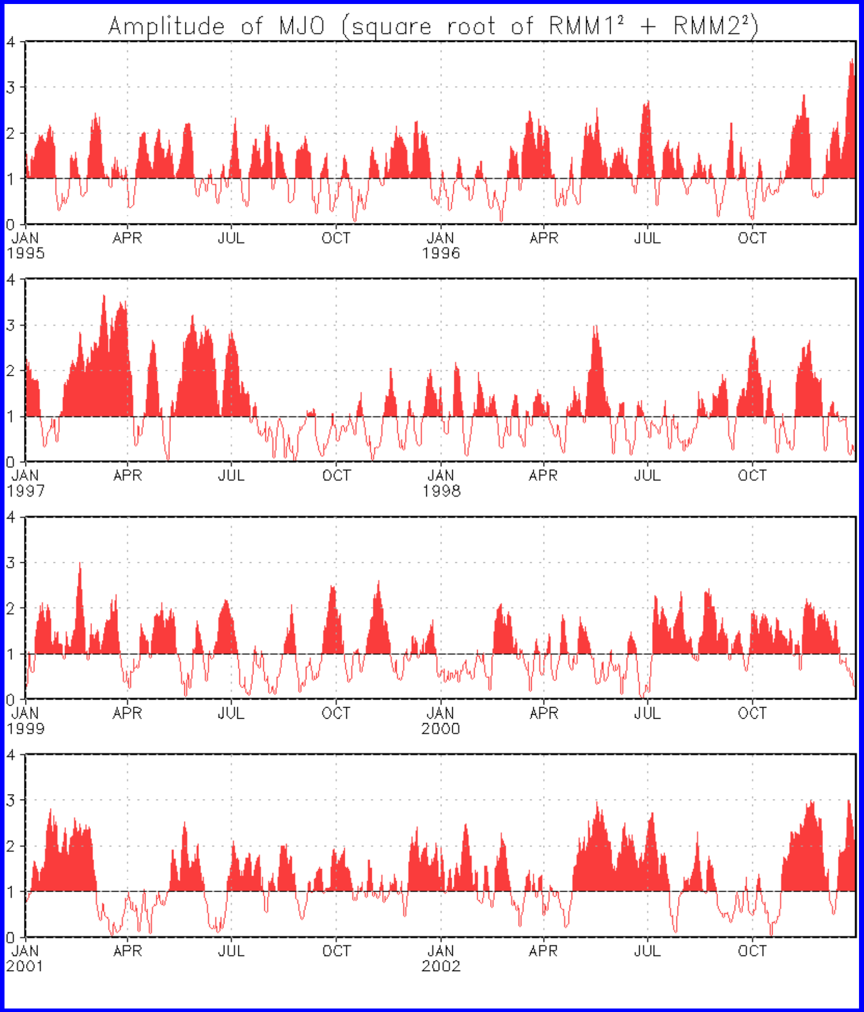
MJO Index -- Recent Evolution

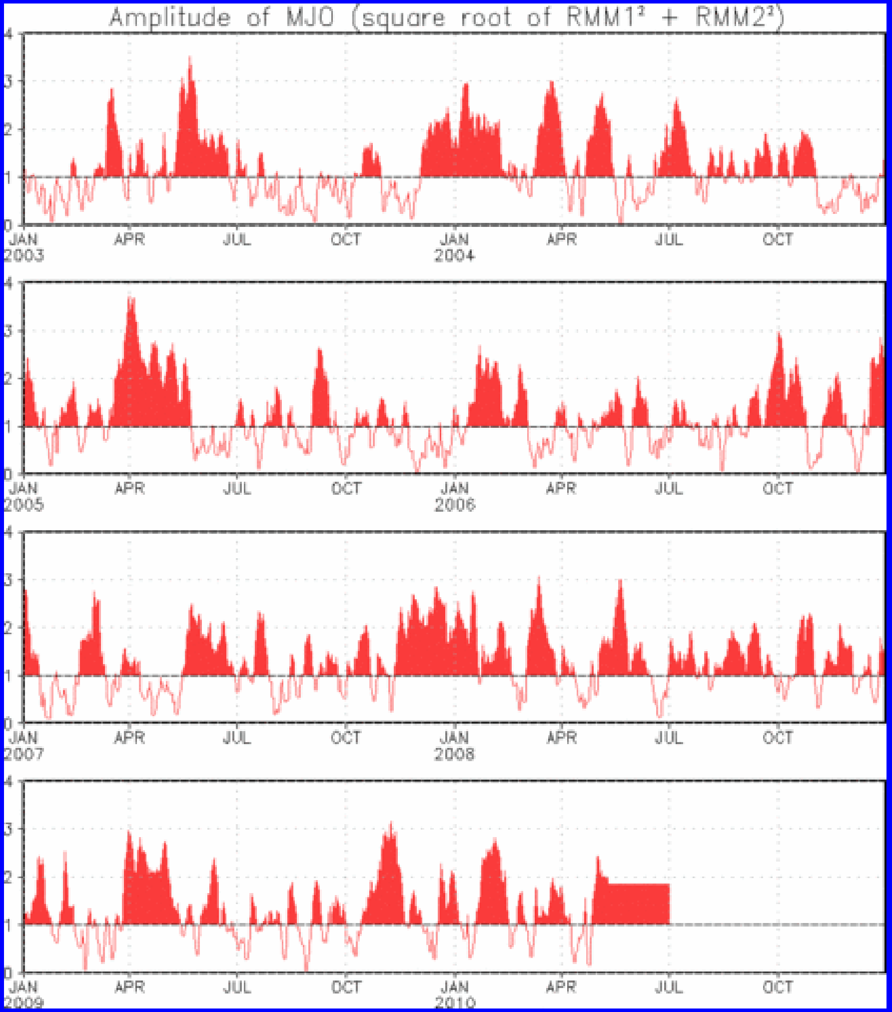


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index continues to indicate incoherent activity during the past few weeks.

MJO Index – Historical Daily Time Series





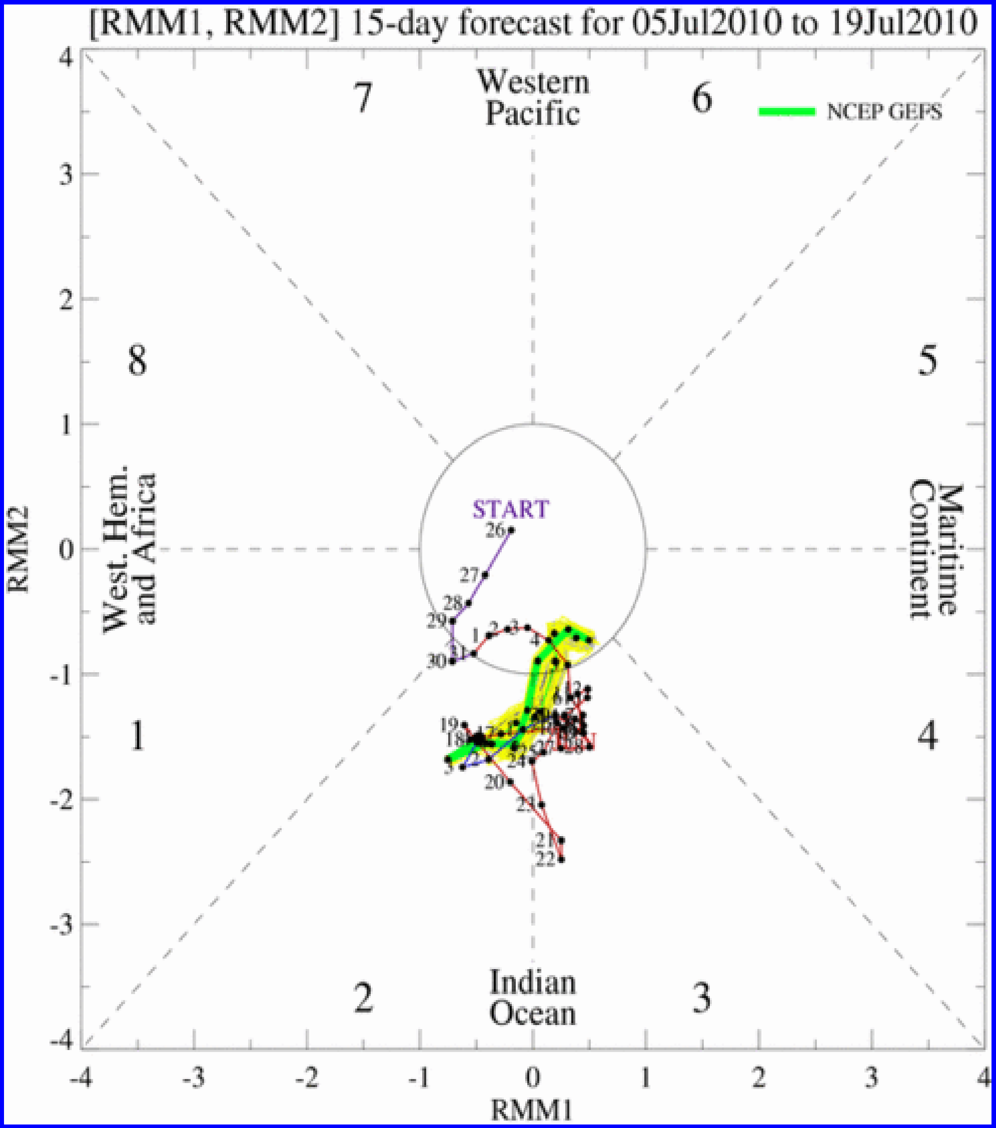
Time series of daily MJO index amplitude from 1995 to present. Plots put current MJO activity in historical context.

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

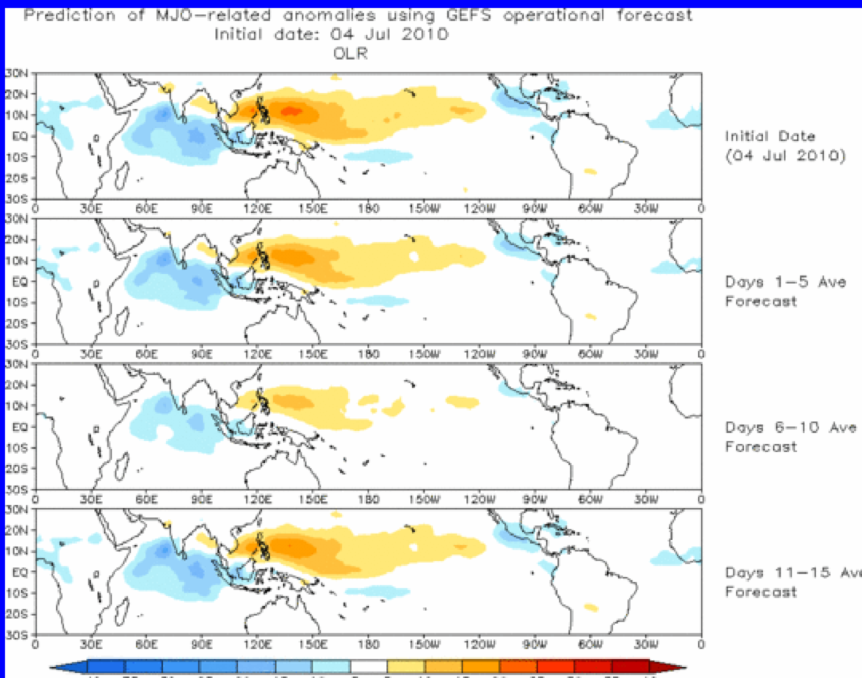


The GFS forecasts continue to indicate incoherent or weak MJO activity.

Ensemble Mean GFS MJO Forecast

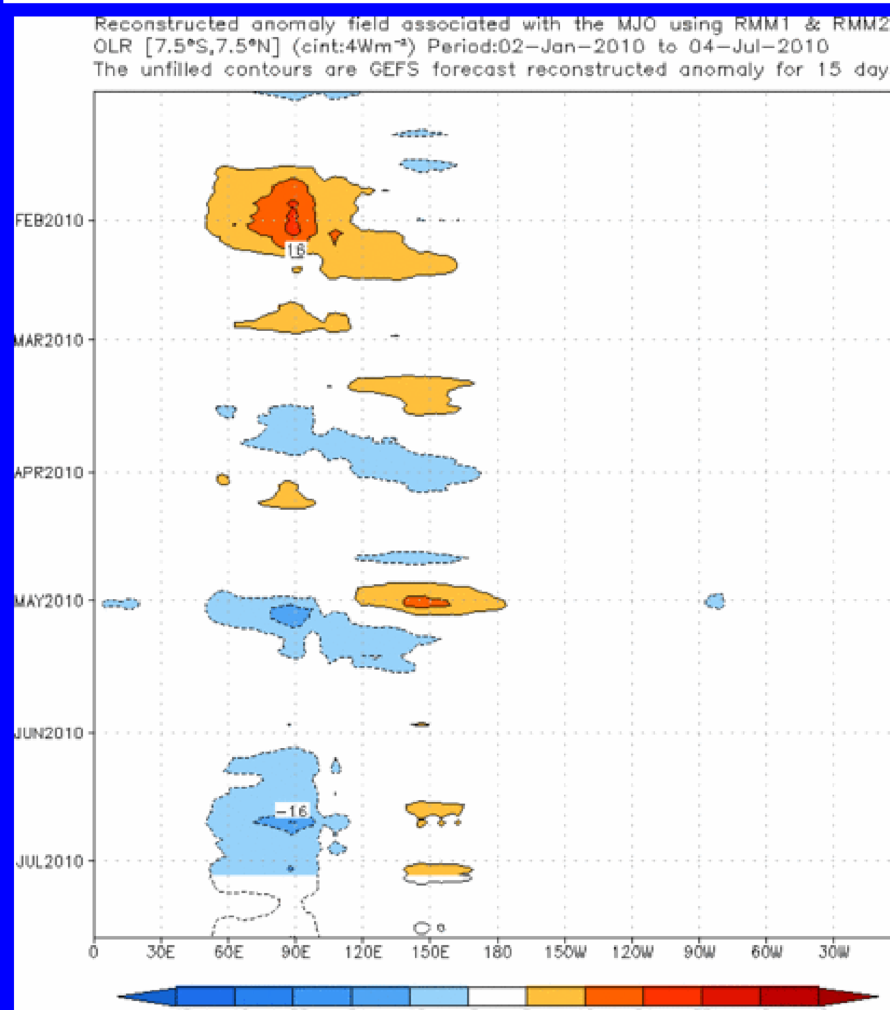
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecast indicates the continuation of a persistent pattern of enhanced (suppressed) convection across the Indian Ocean (west-central Pacific) through the end of 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



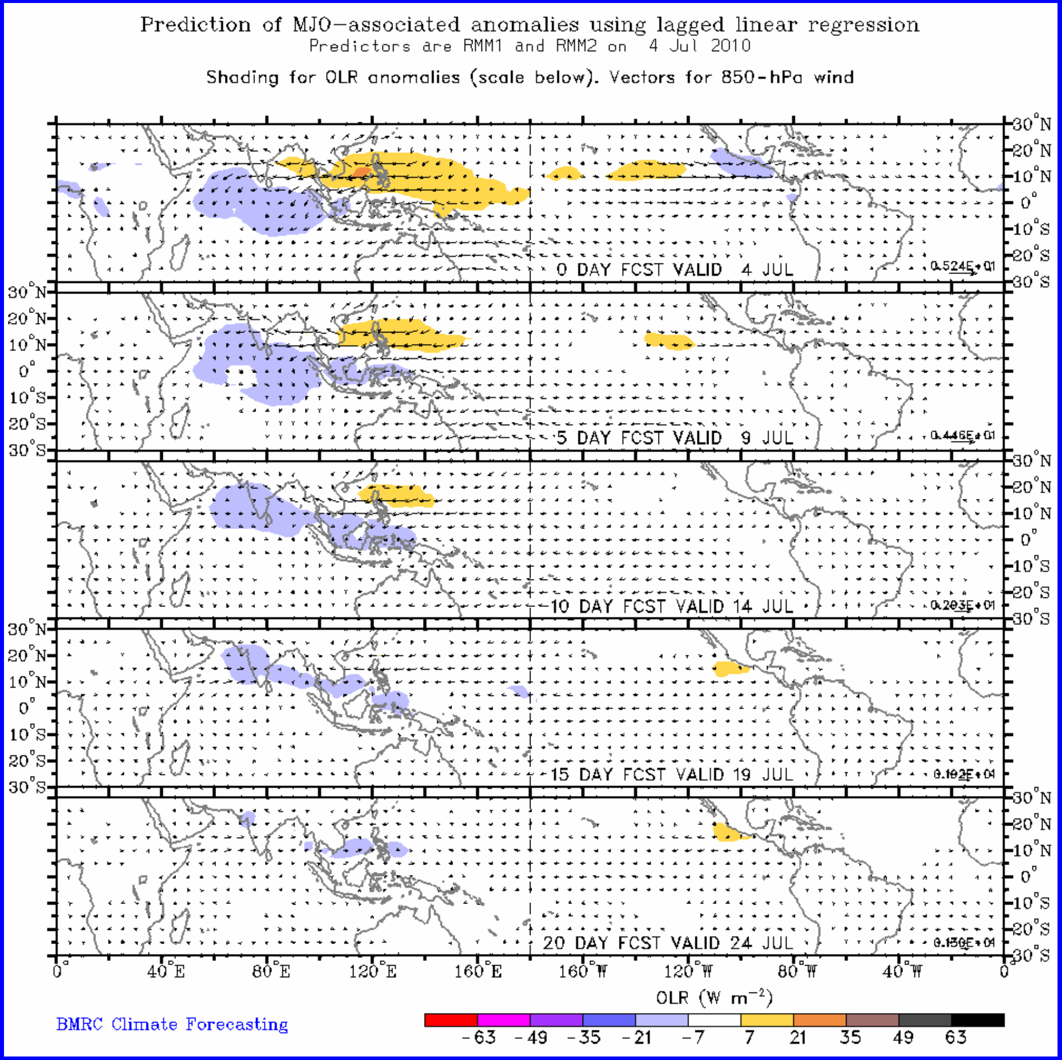
Statistical MJO Forecast

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

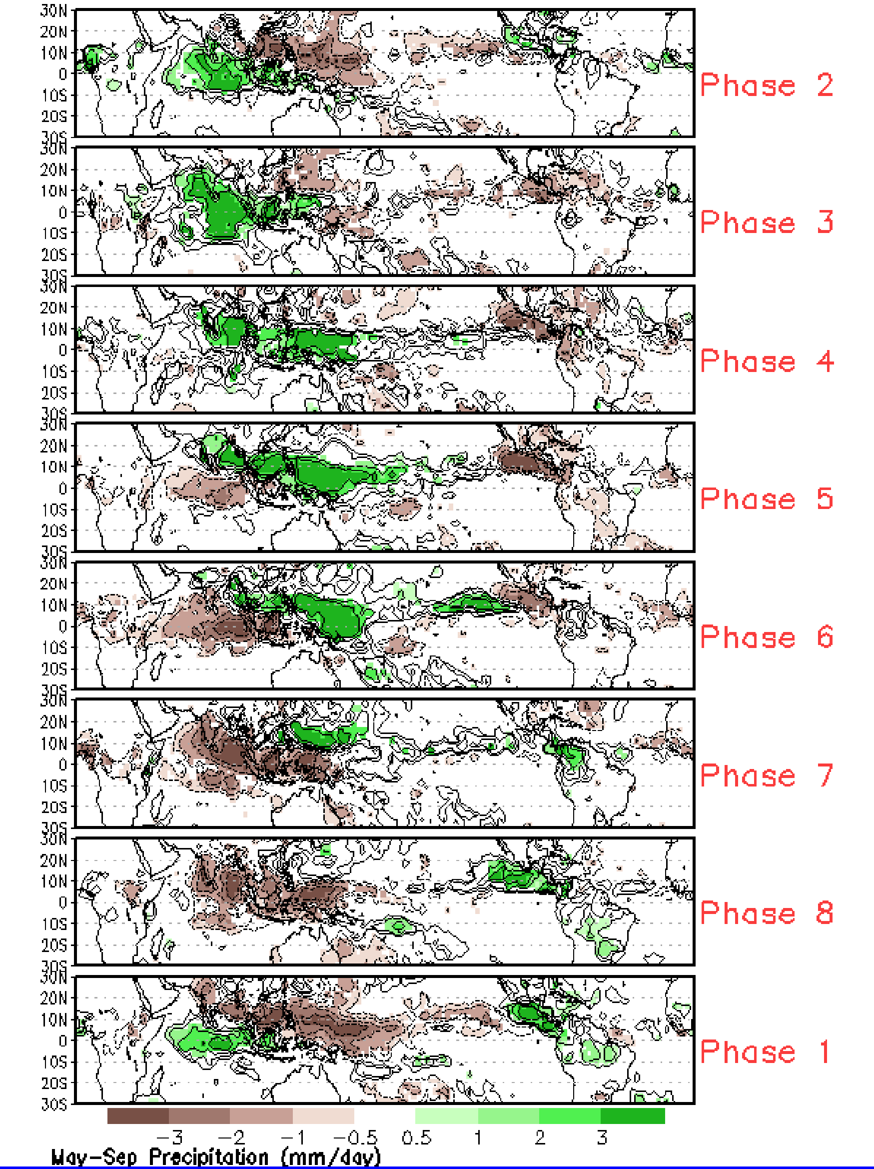
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical forecast indicates weak MJO activity during the next two weeks. Enhanced convection across the Indian Ocean slowly shifts northeast over the period while suppressed convection across the western Pacific weakens.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)