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

Update prepared by
Climate Prediction Center / NCEP
July 19, 2010

Outline

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

Overview

- The MJO strengthened during the past week with the enhanced convective phase now centered over the Indian Ocean.

- Dynamical model MJO index forecasts are mixed on whether the MJO signal will continue to propagate across Indonesia over the next two weeks.

- Based on recent observations and both statistical and dynamical MJO forecasts, MJO activity is forecast to continue with the enhanced convective phase approaching the Maritime continent over the period.

- There are enhanced chances for elevated tropical rainfall across west-central Africa (Week-1) and parts of India, Southeast Asia, the Bay of Bengal, the western Maritime continent and far western Pacific (Weeks 1-2) during the period.

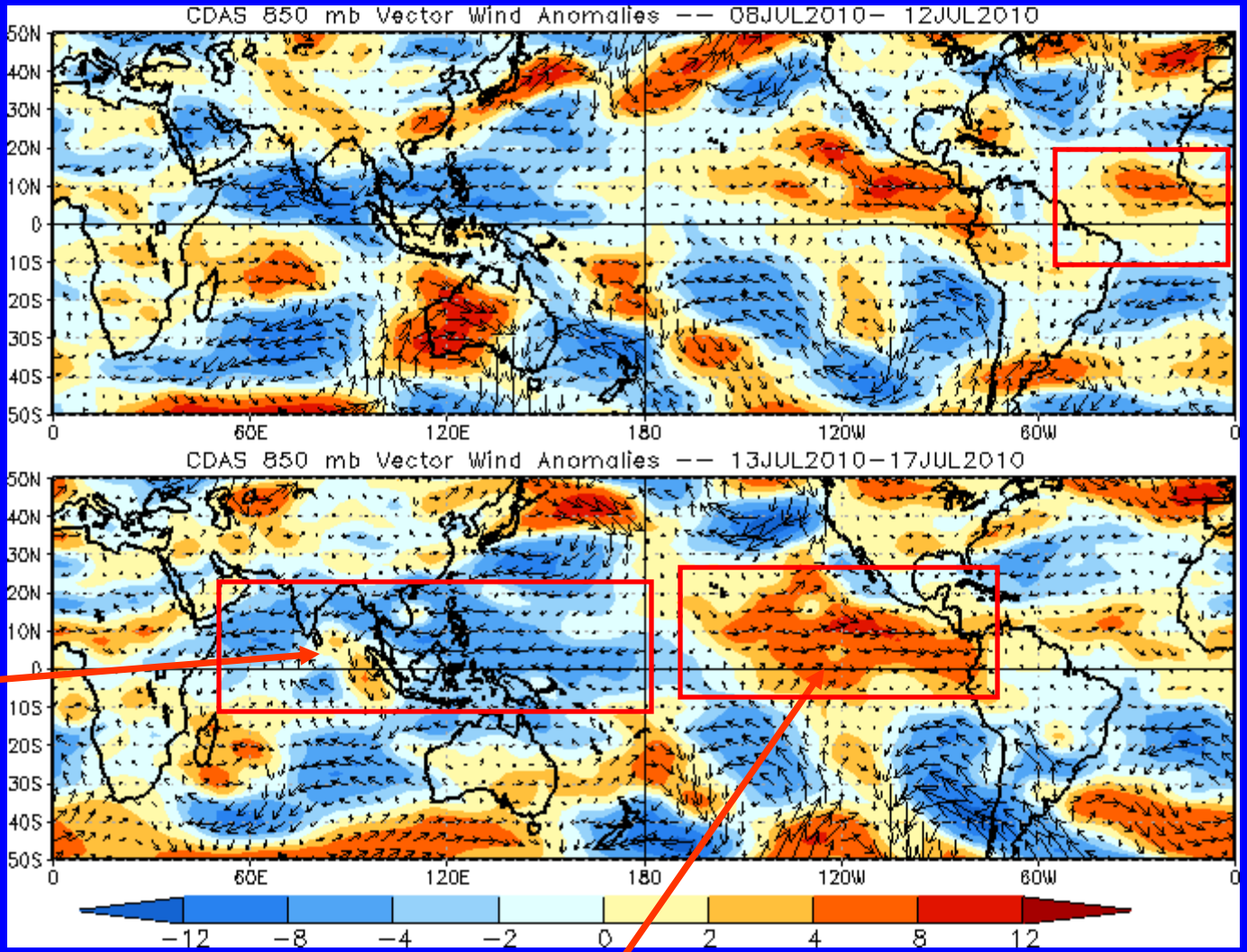
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



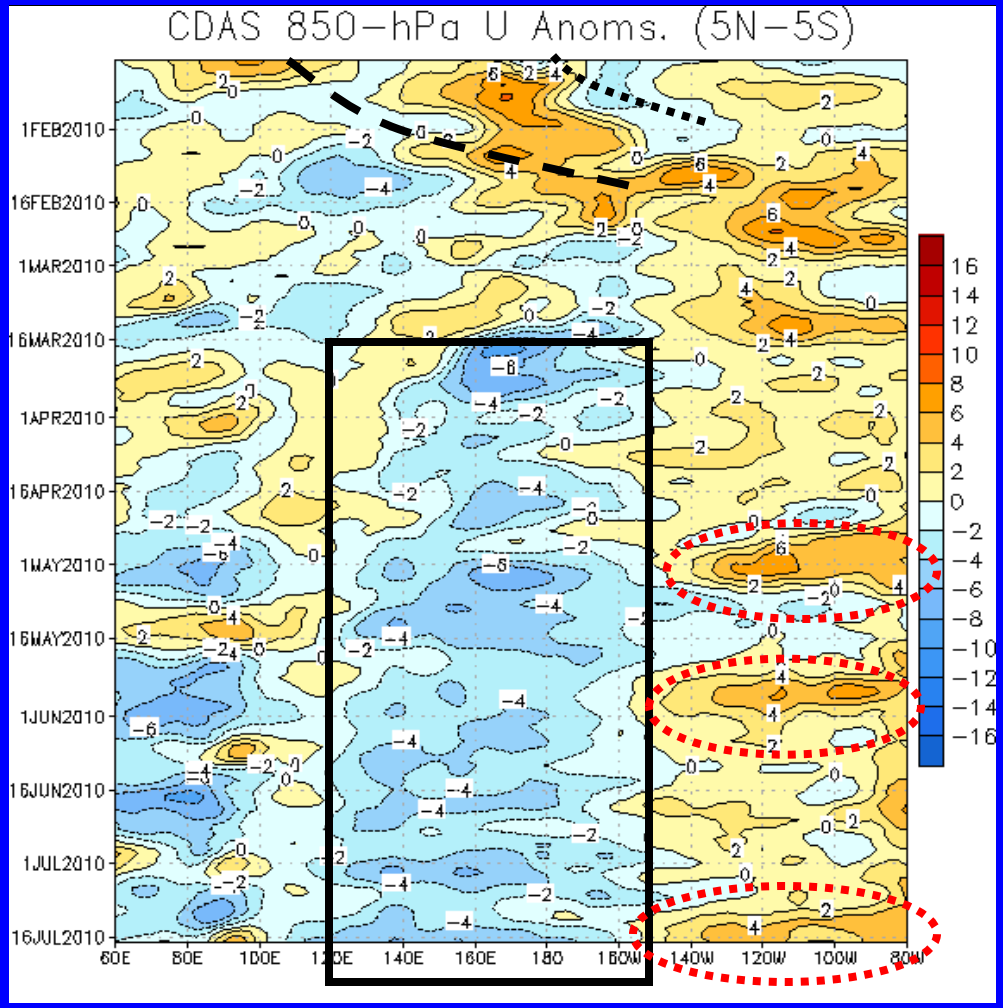
A large area of easterly anomalies are evident from the Indian Ocean to the western Pacific.

Strong westerly anomalies developed over a large area in the eastern Pacific during the last five to ten days.

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

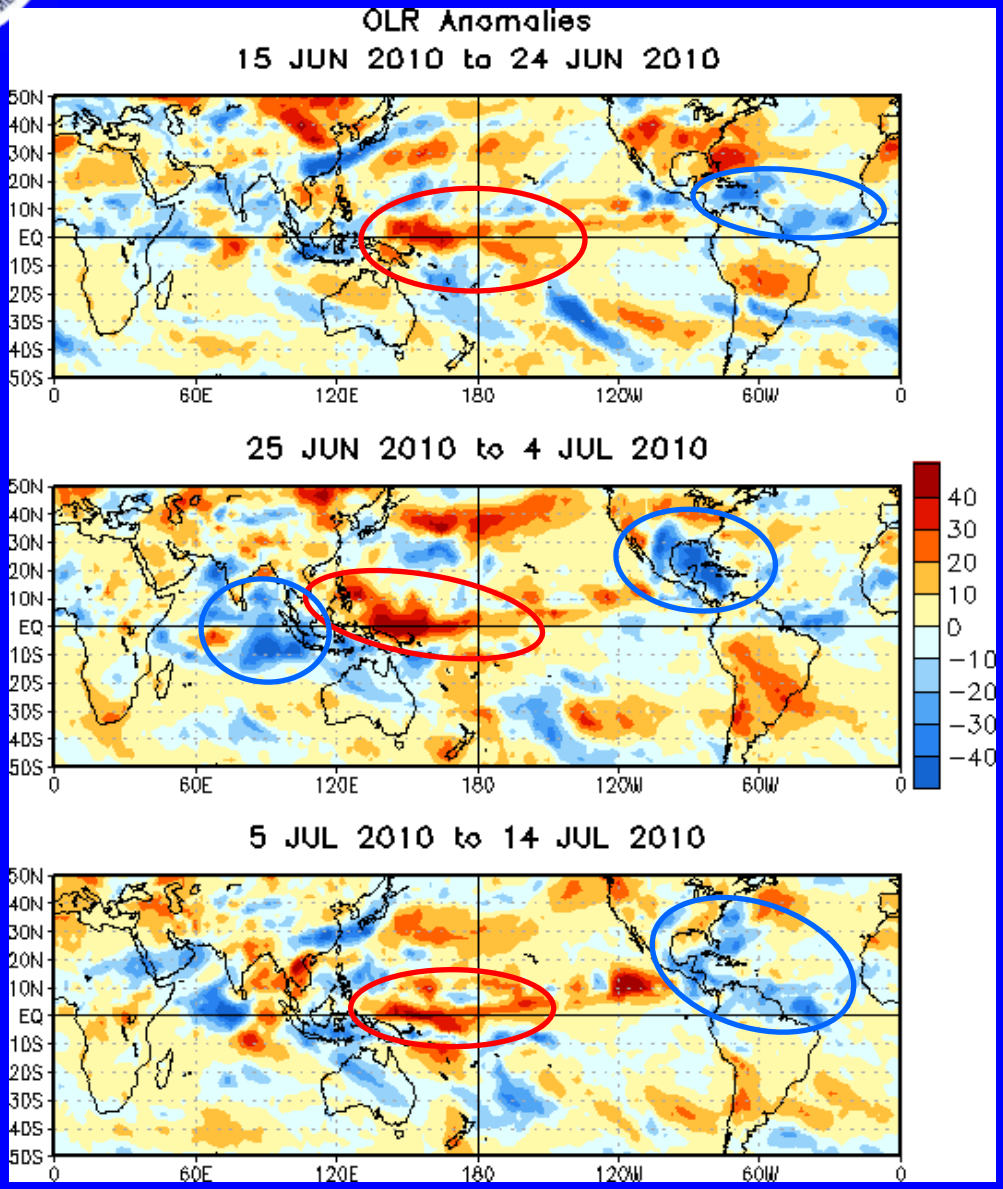
Weak and short-lived MJO activity was evident during January (dotted and dashed line).

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 and again in late May. These were in part associated with the MJO.

Westerly anomalies have again increased during mid-July.

OLR Anomalies – Past 30 days



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

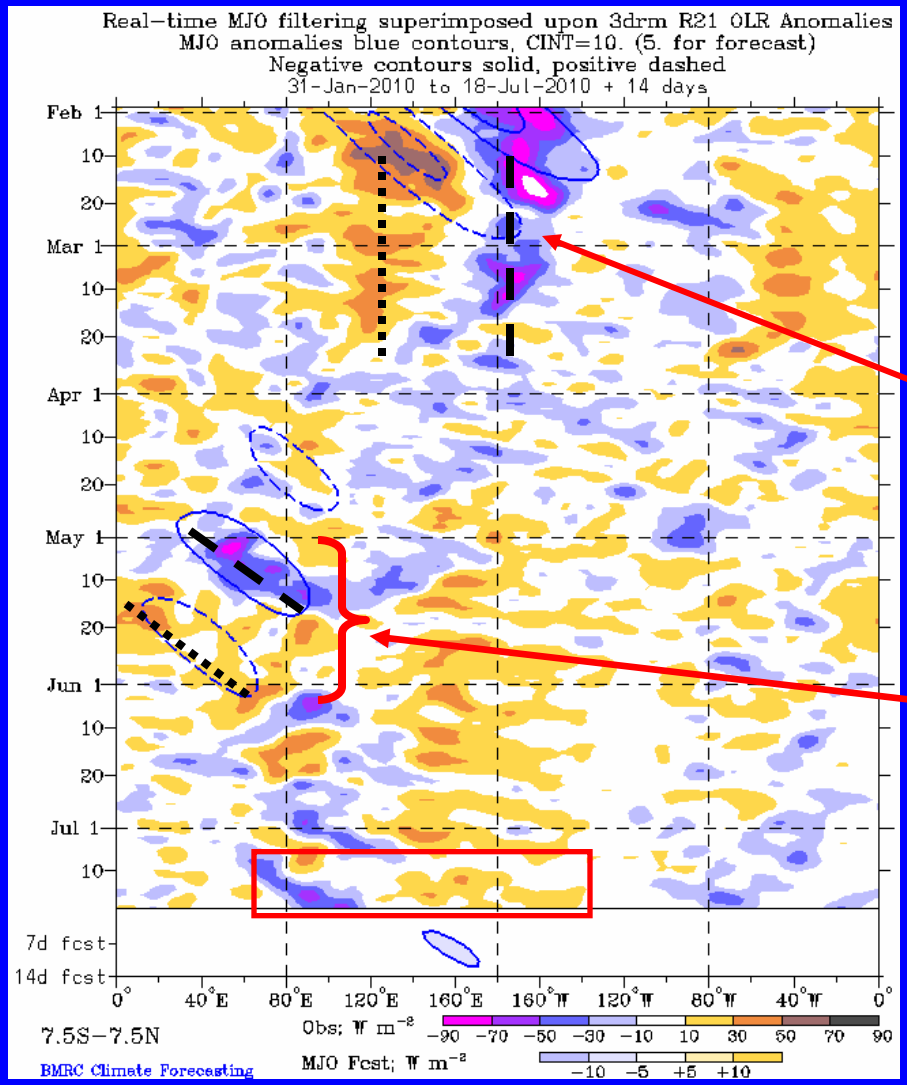
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

Suppressed convection persisted across parts of the equatorial western Pacific during mid-to-late June (red oval) while enhanced convection was evident over the Caribbean Sea and the Atlantic (blue oval).

In late June and early July, suppressed convection continued across the west central Pacific while enhanced convection developed across the eastern Indian Ocean. Wet conditions continued across the Caribbean and expanded to include Mexico and the southern US.

Suppressed convection continued over the western tropical Pacific during mid July while enhanced convection covered a large area of the Caribbean Sea, Central America, the Atlantic and northern South America.

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)

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).

Convection was close to average for the most part during April.

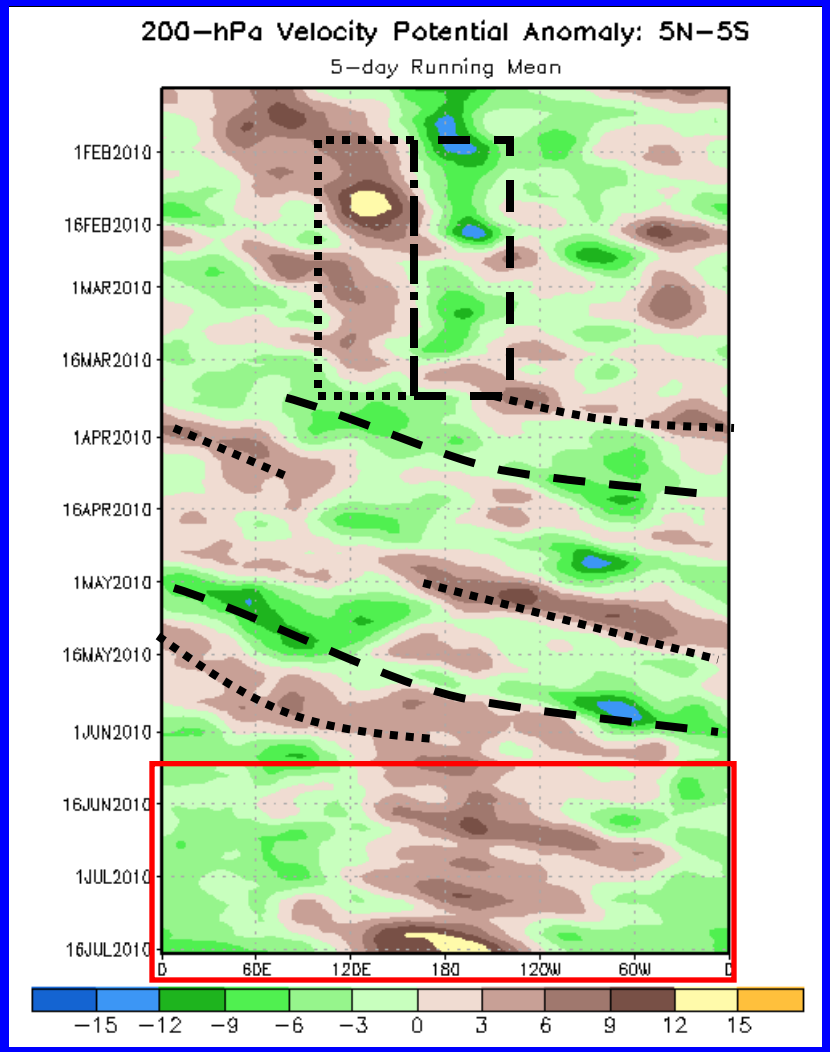
Enhanced convection, in part associated with MJO activity, developed across the Indian Ocean in early May and shifted slightly eastward. Suppressed convection subsequently developed across much of Africa.

In mid July, enhanced convection developed from 60E to 110E with suppressed convection continuing just 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



Time

Longitude

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.

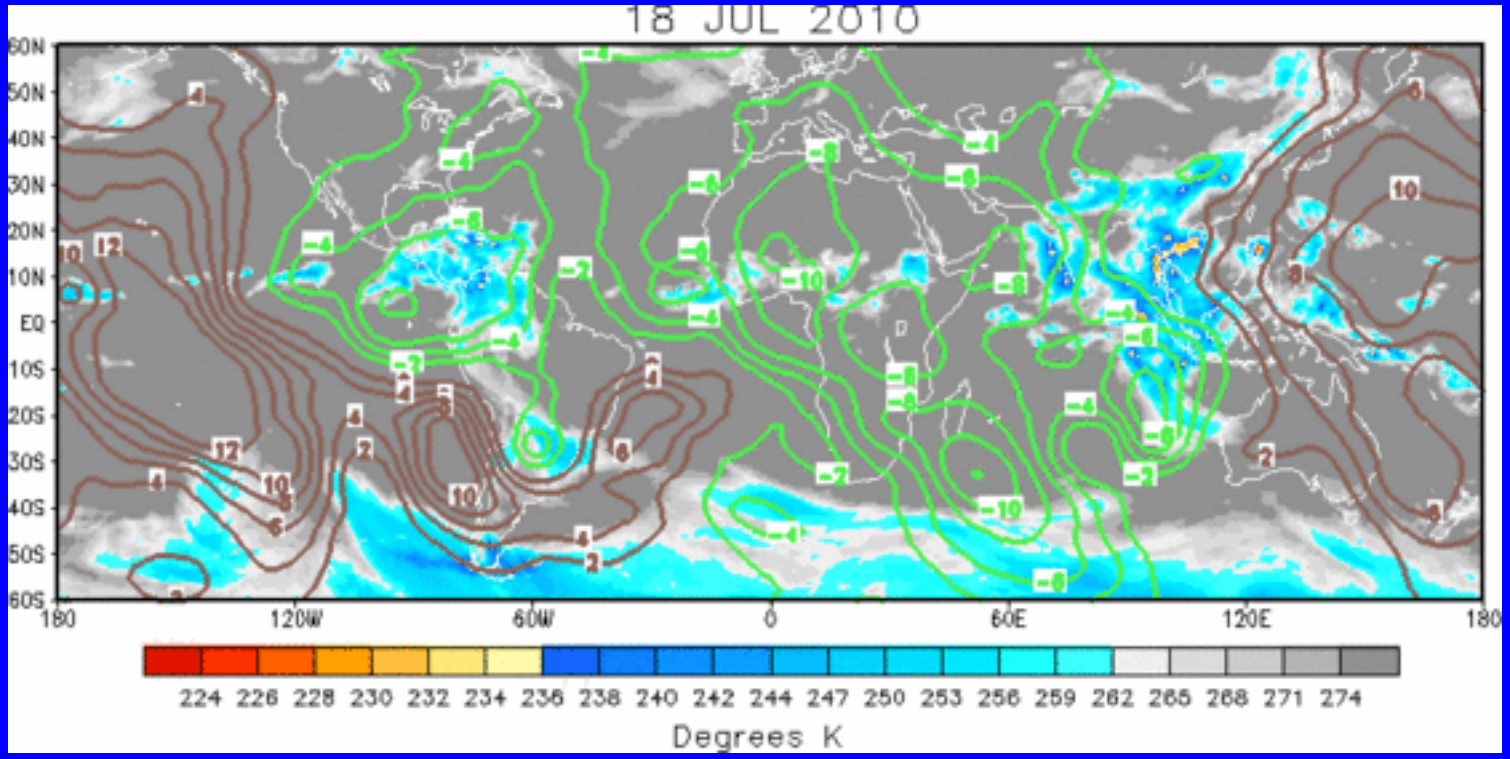
In late April and May, anomalies increased and eastward propagation was evident, coincident with the MJO.

Beginning in early June, anomalies became more stationary in nature (red box) with upper-level convergence primarily located across the west-central Pacific and divergence across much of the western hemisphere and Africa.

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

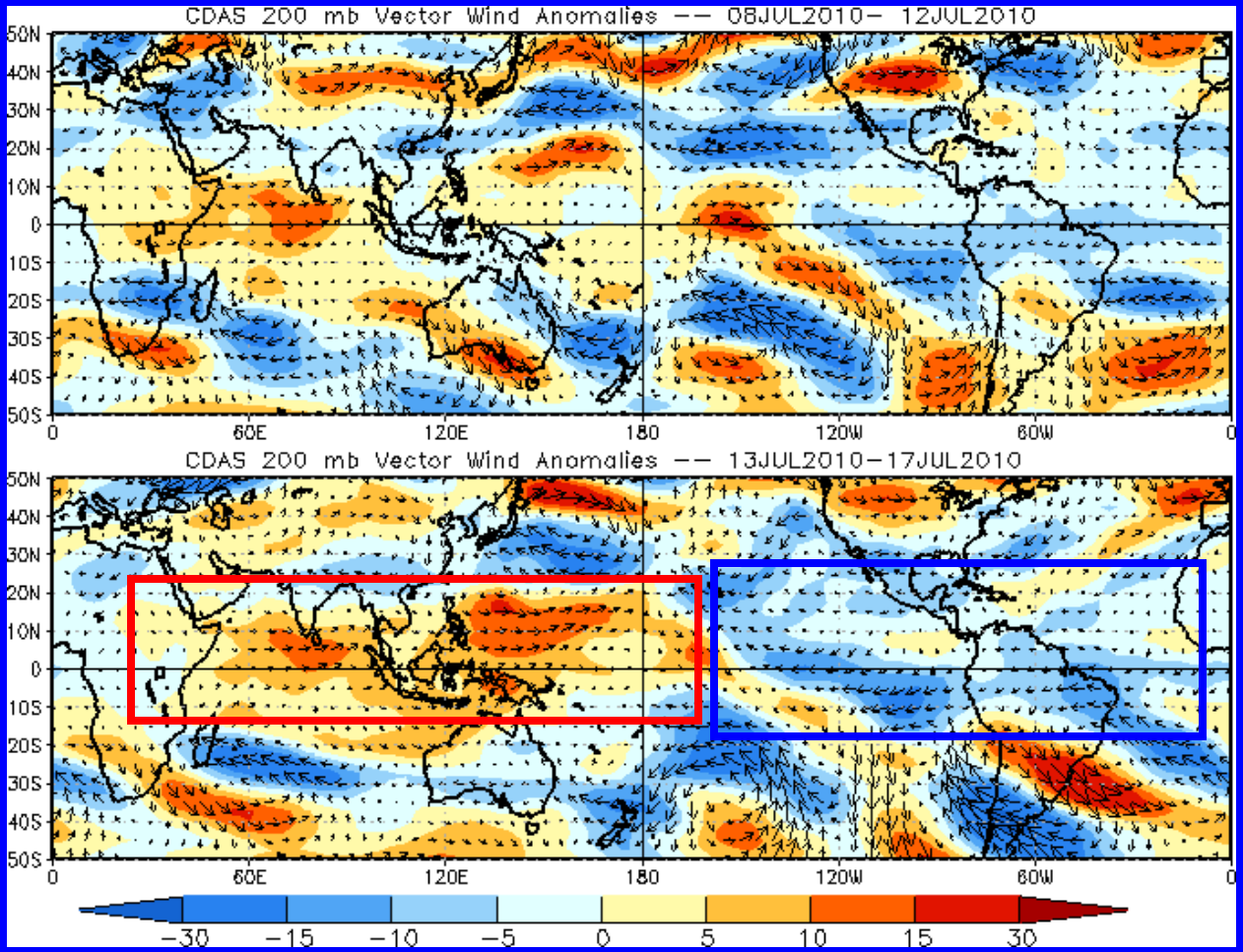
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The anomalous velocity potential pattern has become more coherent during the past week and exhibits closer resemblance to a "Wave 1" structure. Upper-level convergence is evident across the Pacific with upper-level divergence stretching from Central America to 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

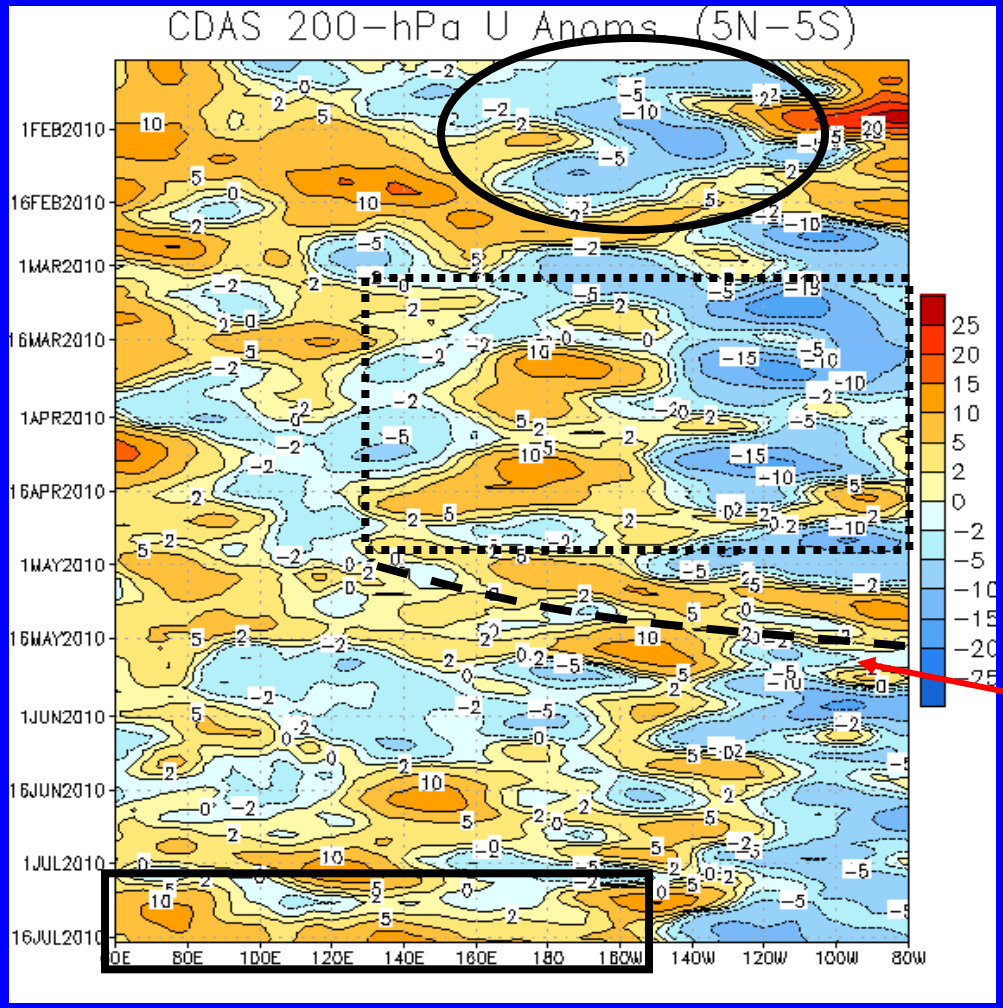
Easterly anomalies remain evident across the eastern Pacific, northern South America and the tropical Atlantic Ocean during the last five days (blue box).

Westerly anomalies are evident across the Indian Ocean and western Pacific (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

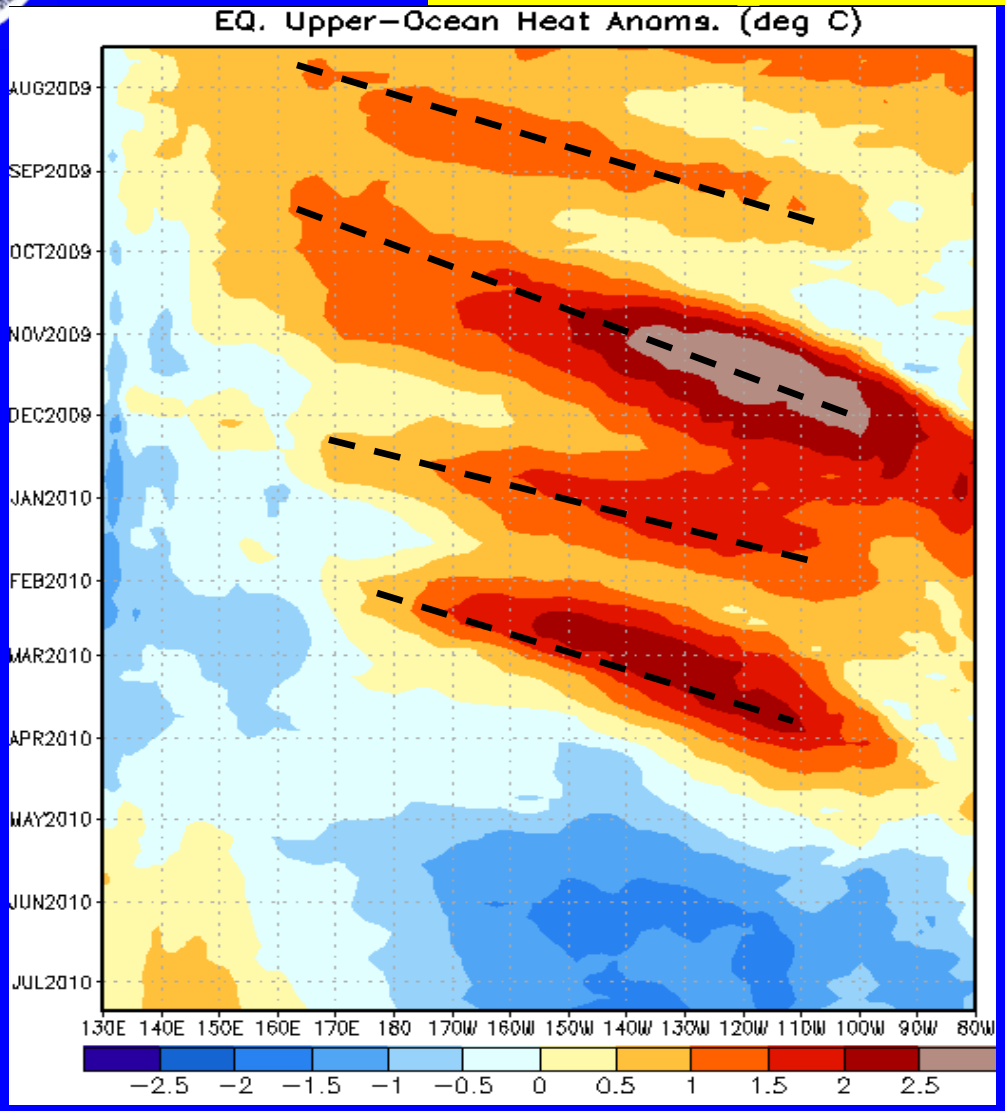
Easterly anomalies dominated much of the central and eastern Pacific during most of January (black oval).

Westerly (easterlies) anomalies prevailed across the central (eastern) Pacific (red box) for much of the period during March and April (black dotted box).

In early May, there was some eastward propagation of westerly anomalies across the Pacific in association with the MJO at that time (dashed black line).

Westerly anomalies are evident during the past week across a large area from the Indian Ocean to the Date Line (black box).

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

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 eastern 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).

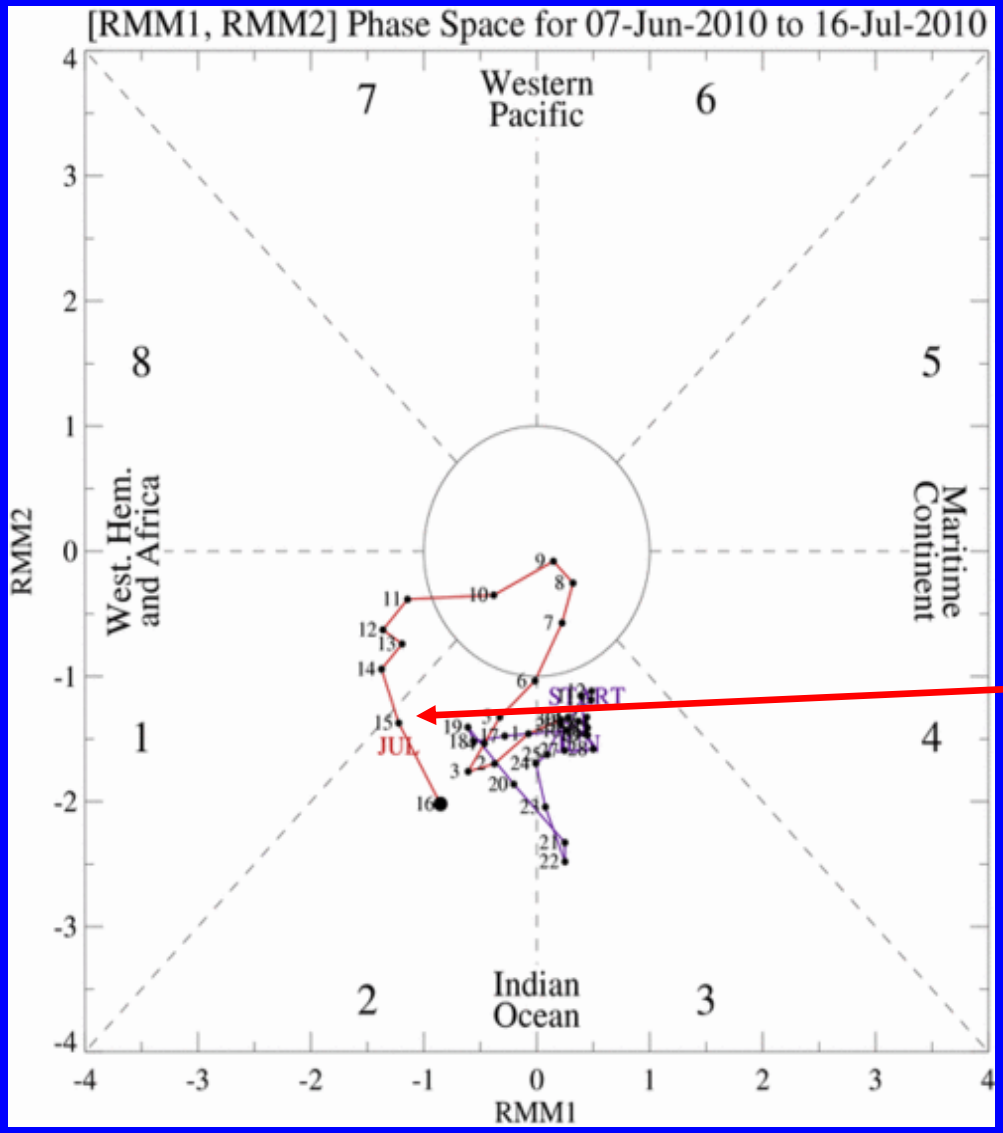
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review*, 132, 1917-1932.

- 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).

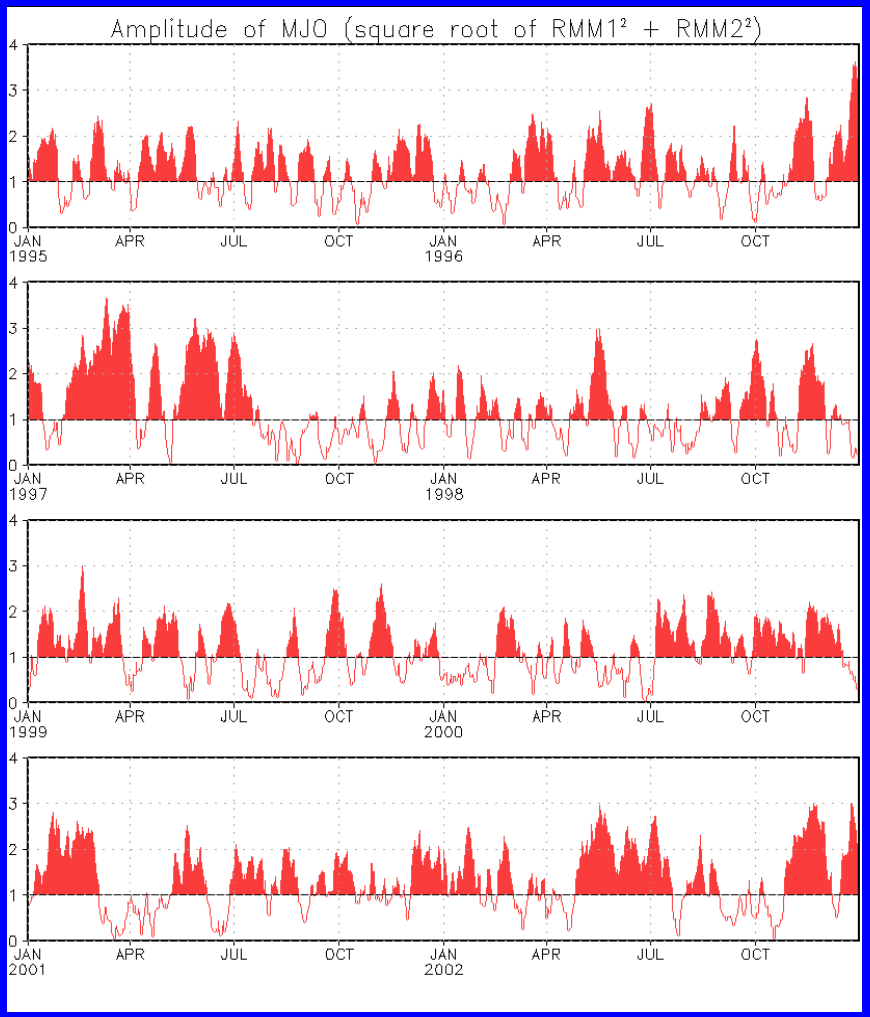
MJO Index -- Recent Evolution

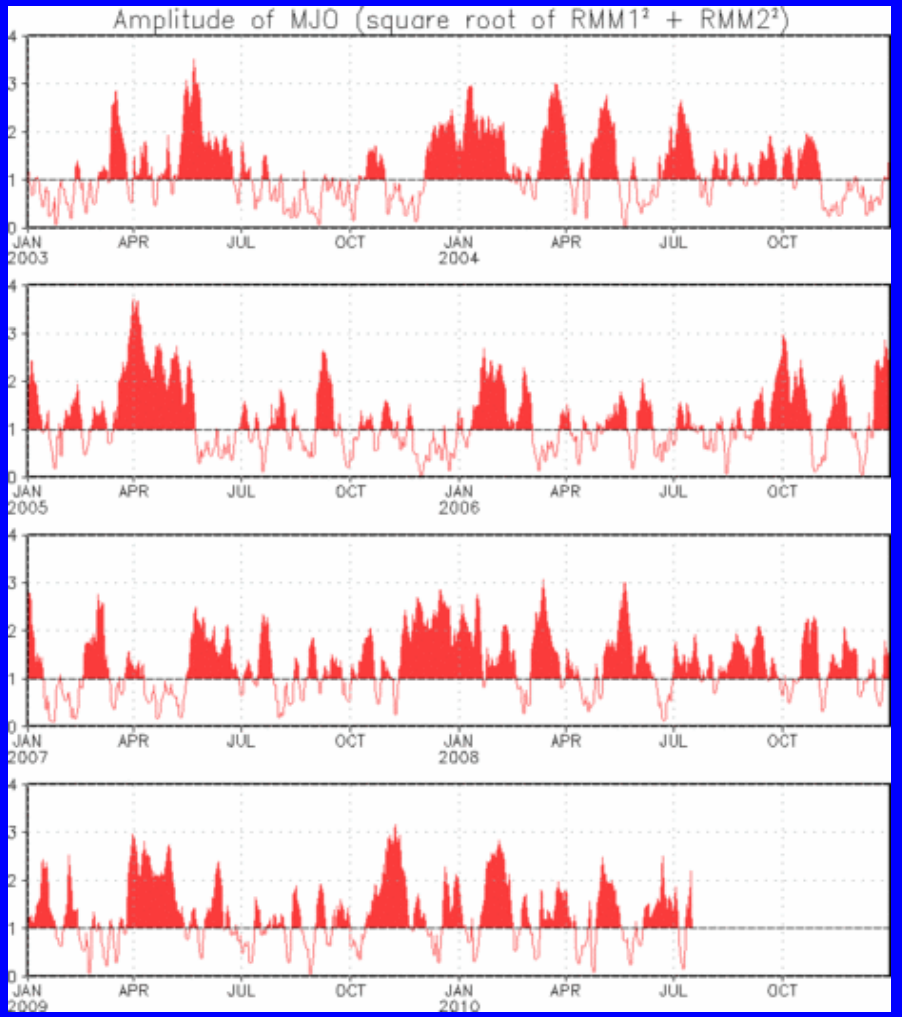


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index indicates the MJO has strengthened during the past week. The signal is centered in the western Indian Ocean with an increasing amplitude.

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.

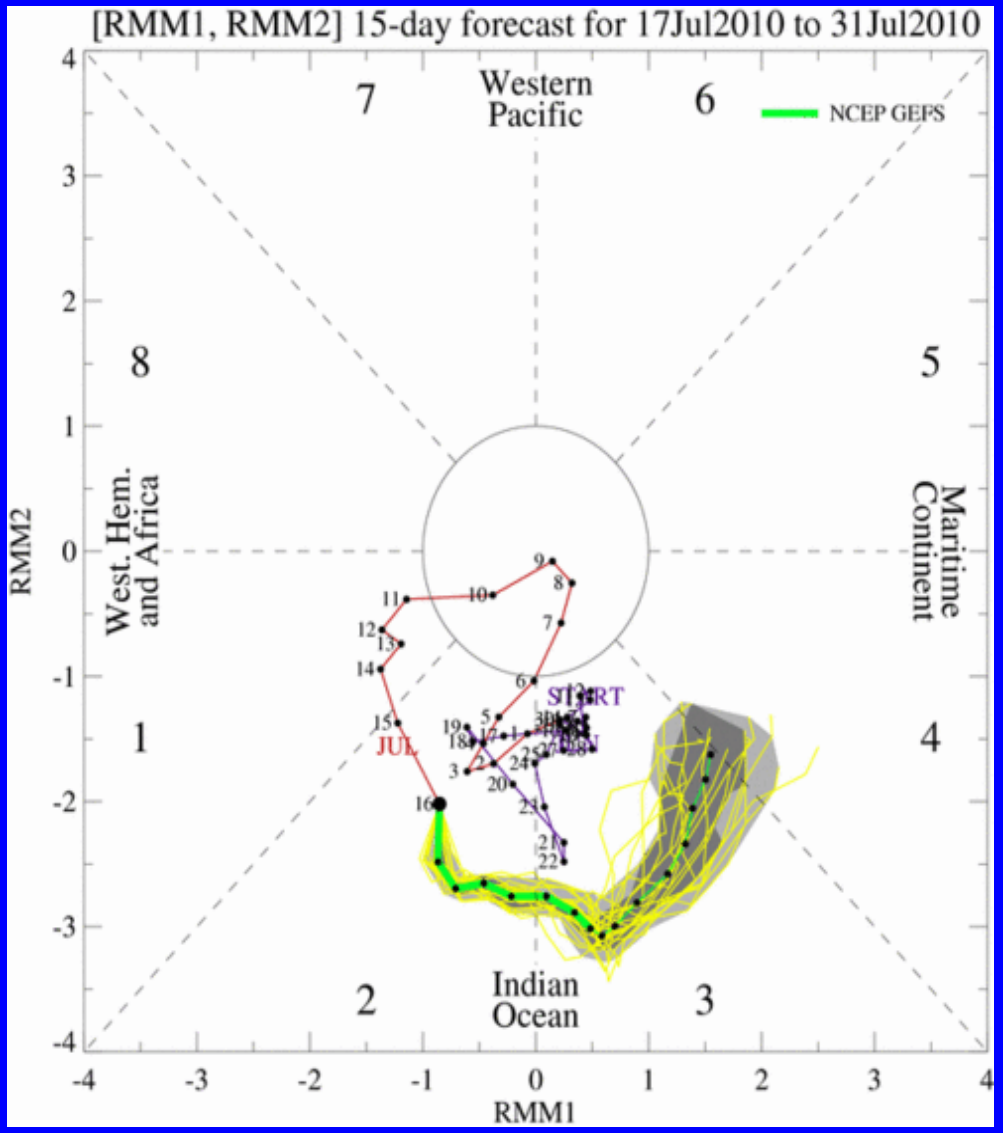
Ensemble GFS (GEFS) MJO Forecast

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

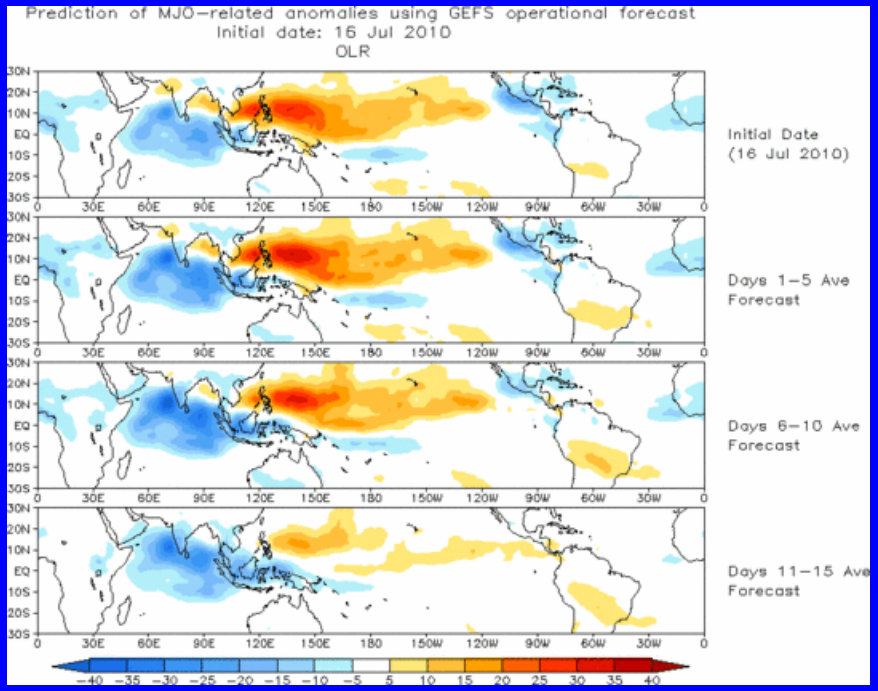
The GFS forecasts indicate continued MJO activity. The spread is very small during the Week-1 period.



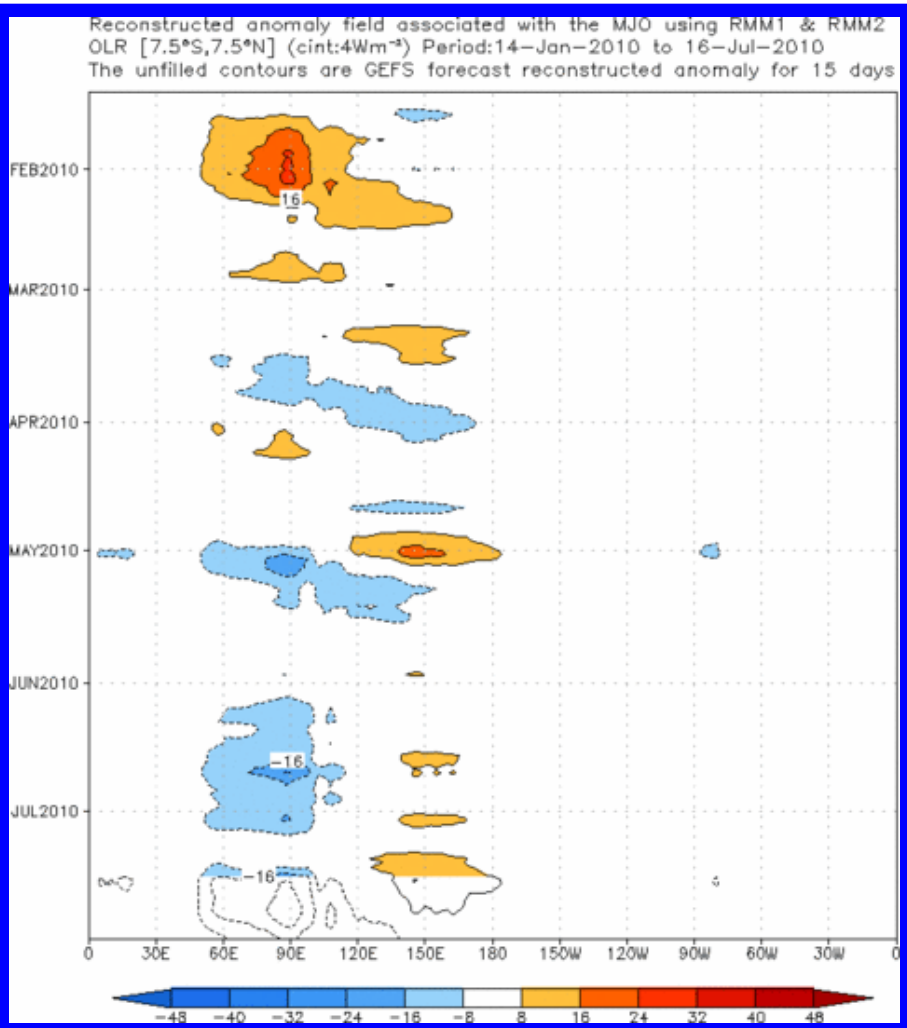
Ensemble Mean GFS MJO Forecast

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



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



The GEFS ensemble mean forecast indicates enhanced convection shifting from Africa and the Indian Ocean to the western Maritime continent by the end of the period. Suppressed convection slowly wanes across the west-central Pacific.

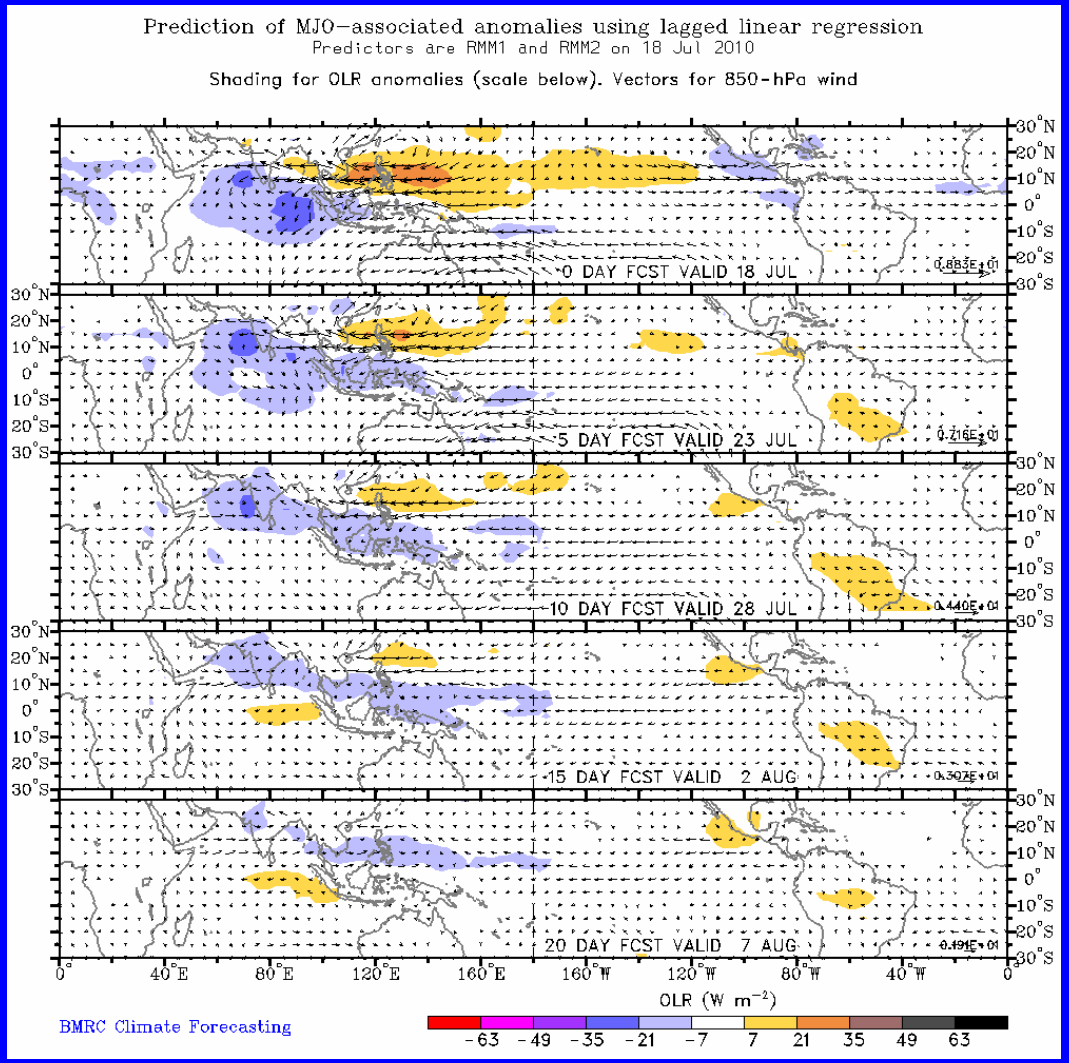
Statistical MJO Forecast

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

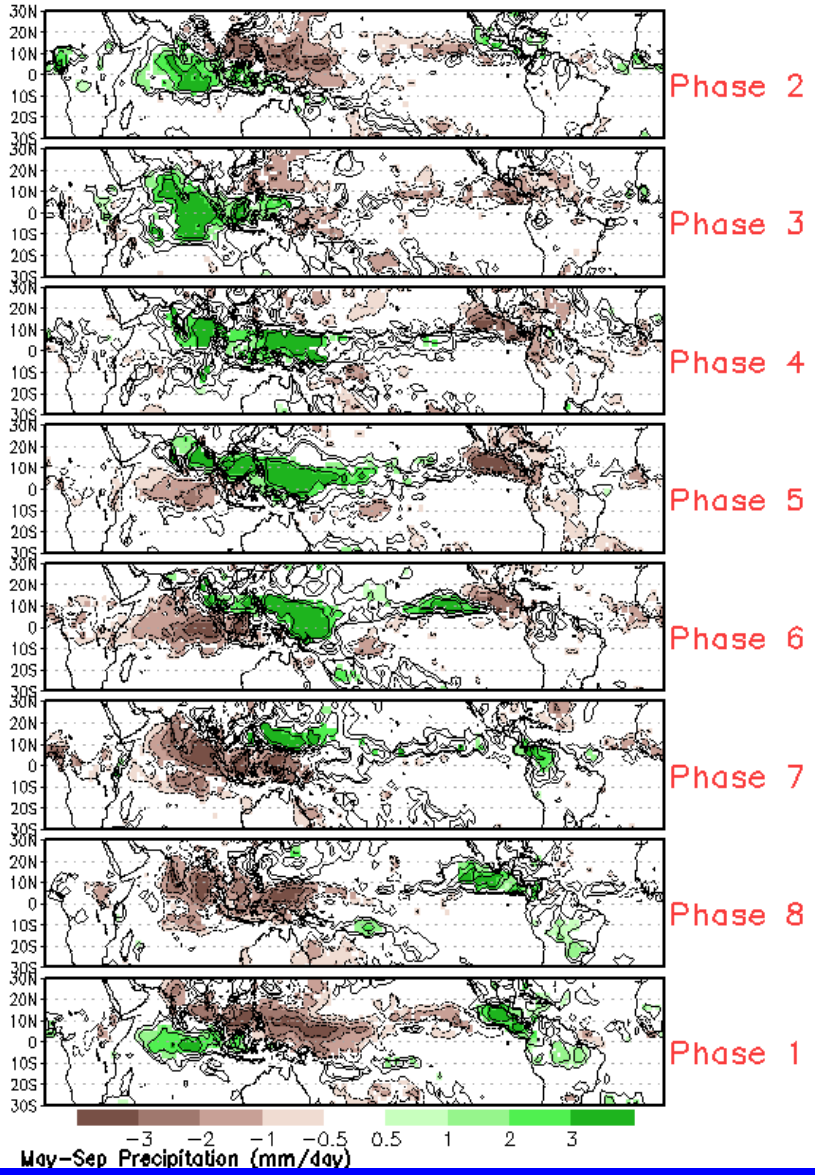
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical forecast indicates moderate-to-strong MJO activity during the next two weeks with enhanced convection propagating eastward from Africa and the Indian ocean to the western Pacific by the end of Week-2.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)