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

Update prepared by
Climate Prediction Center / NCEP
August 2, 2010

Outline

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

Overview

- MJO activity continued during the past week and has shown signs of weakening. The enhanced convective phase is now centered over the western Maritime Continent.

- The majority of dynamical model MJO index forecasts indicate further weakening of the MJO signal over the next week.

- Based on recent observations, statistical MJO forecasts, and MJO dynamical forecast tools, the MJO is expected to further weaken during the Week-1 period.

- There remains enhanced chances for elevated tropical rainfall for portions of Southeast Asia, the Maritime Continent and the western North Pacific during the next 1-2 weeks.

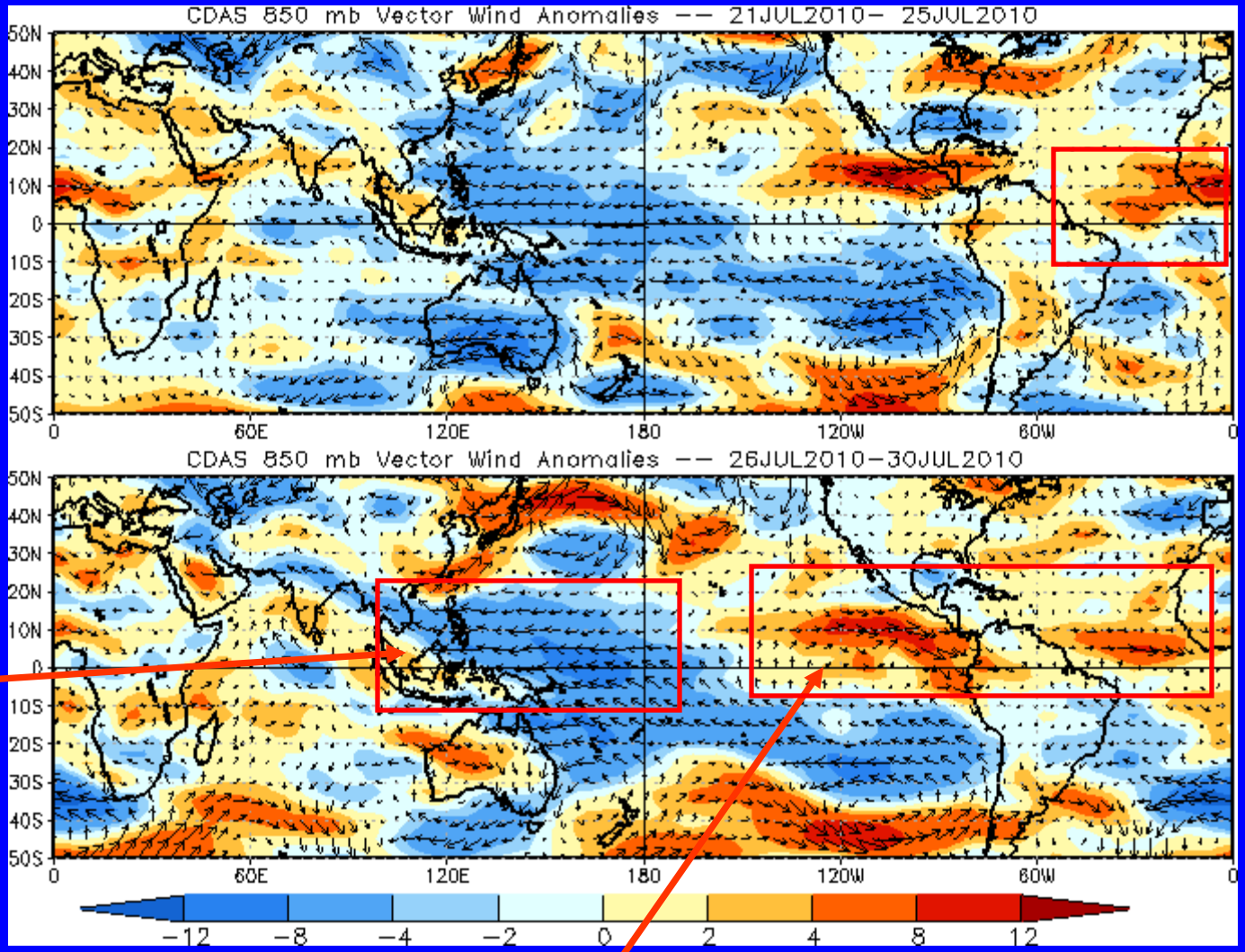
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



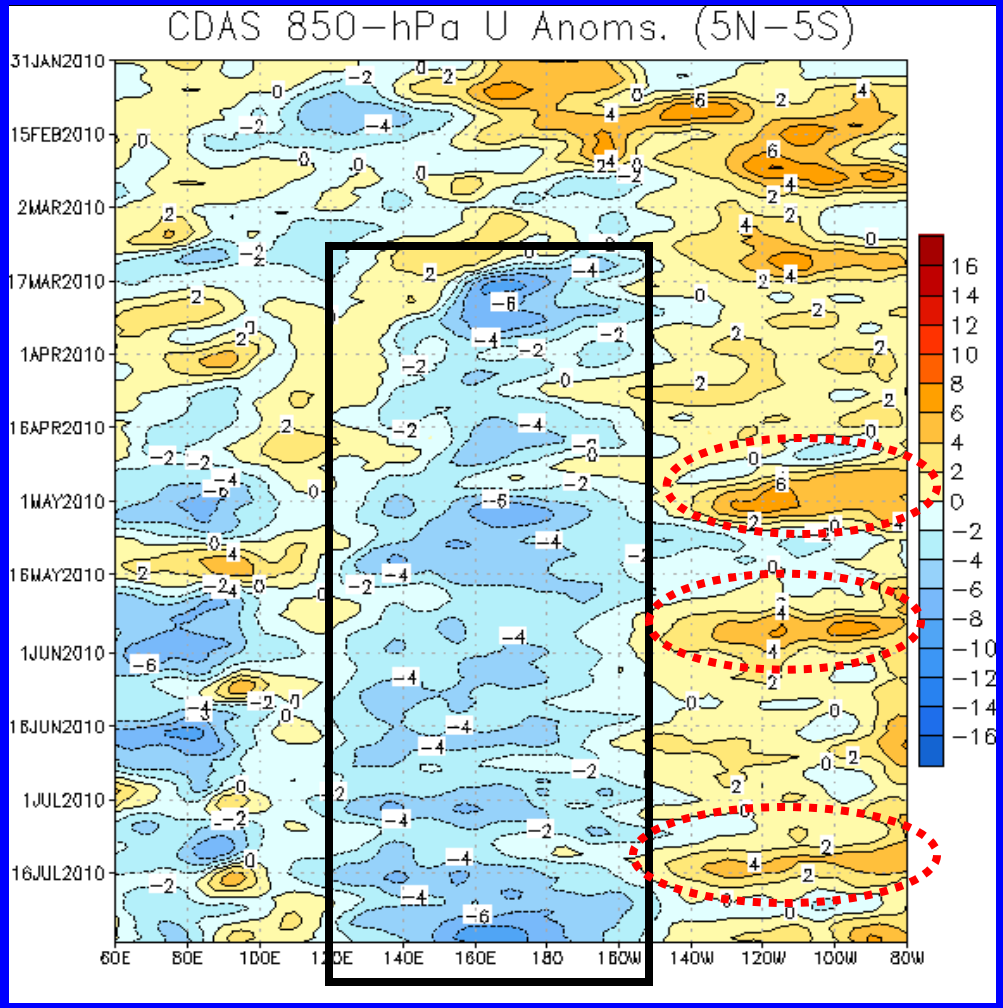
Easterly anomalies are evident from Southeast Asia to the central Pacific. Anomalies increased across the western Pacific along the equator during the last five days.

Strong westerly anomalies expanded in coverage over the eastern Pacific while the westerly anomalies in the Atlantic spread westward. Anomalies across Africa weakened.

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

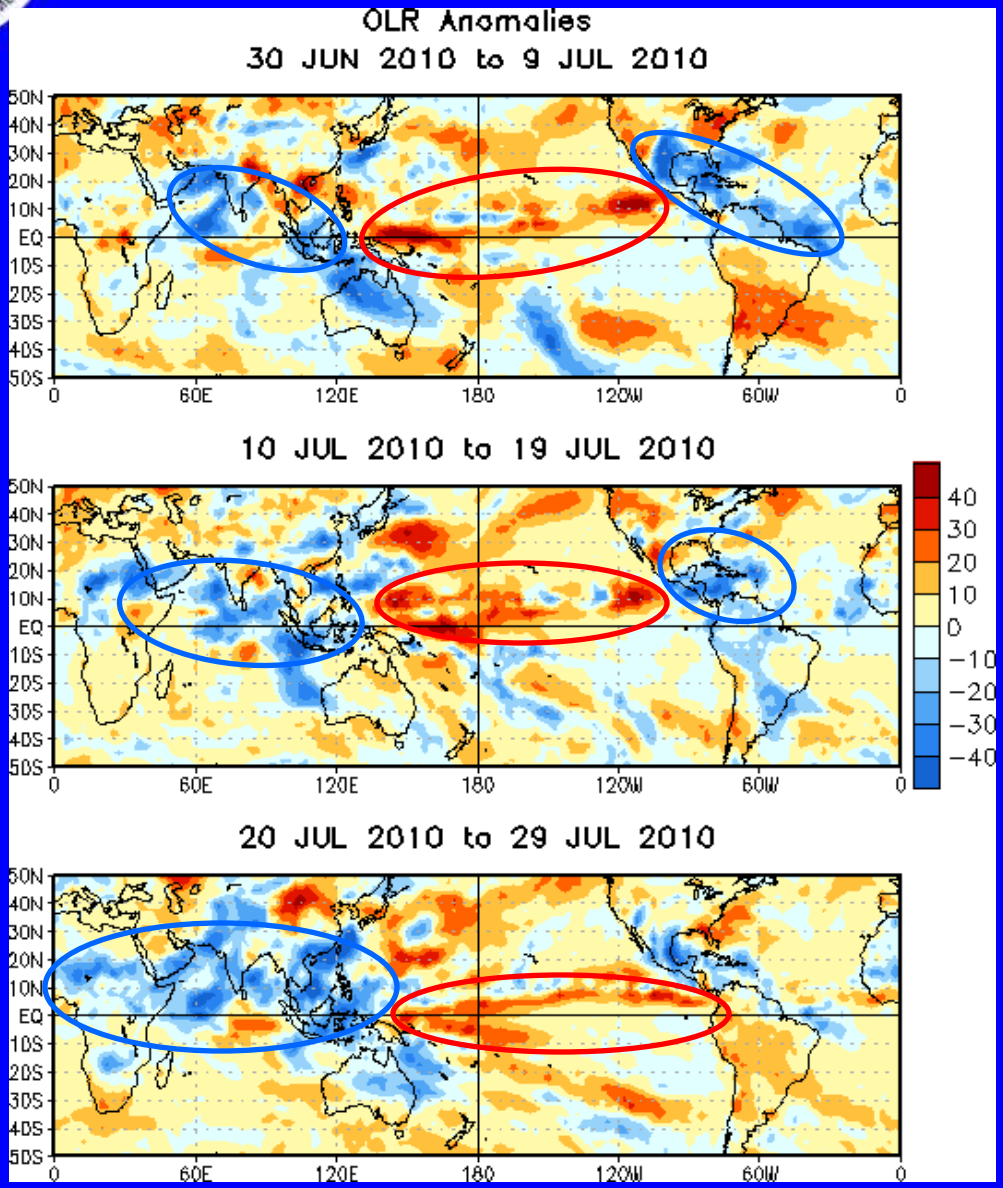
Longitude

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

Enhanced westerly anomalies (red dotted ovals) occurred across the eastern Pacific on separate occasions during late April, late May and early-to-mid July.

These were in part associated with MJO activity.

OLR Anomalies – Past 30 days



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

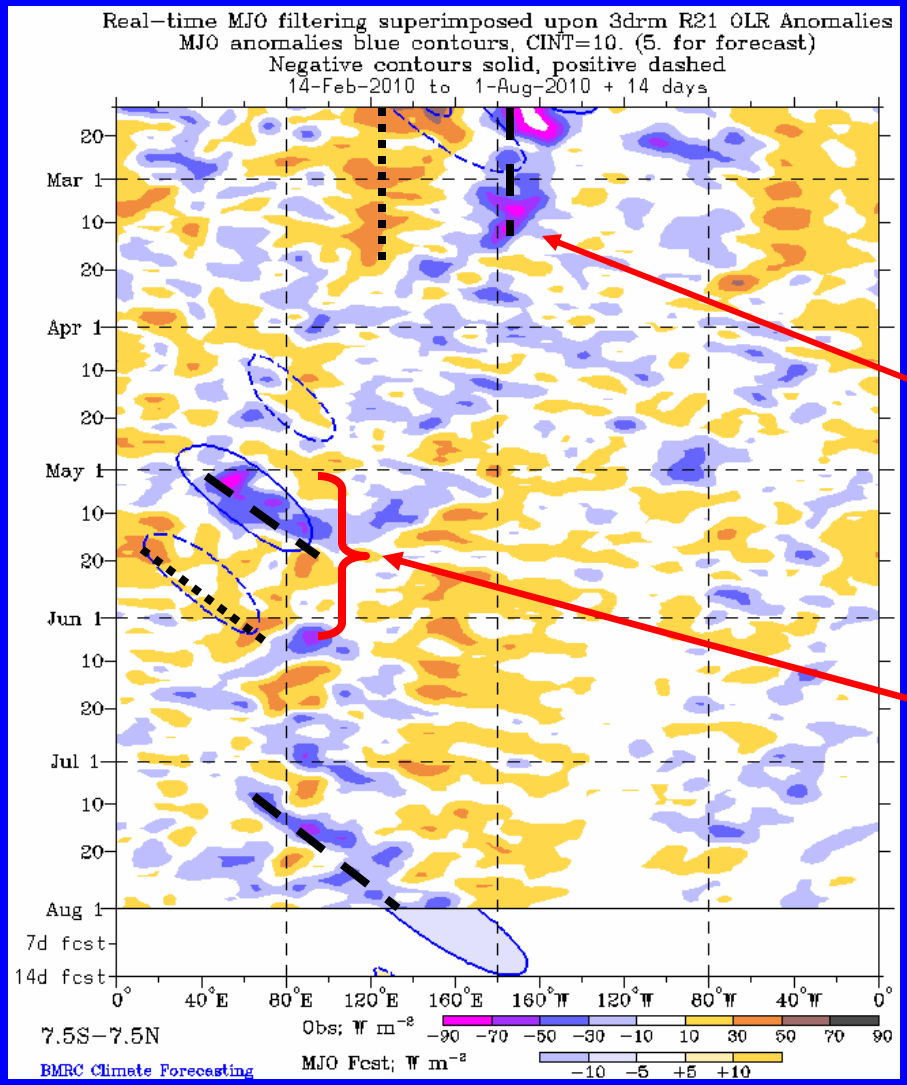
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

Suppressed convection persisted across much of the Pacific basin during late June and early July (red oval) while enhanced convection was evident from the southern US to northern South America and across parts of the Indian Ocean and western Maritime continent (blue ovals).

In mid-July, suppressed convection persisted across the Pacific while enhanced convection continued across the Indian Ocean and the Caribbean.

In late July, wetter-than-average conditions stretched from Africa, across south Asia to the western Pacific. Suppressed convection expanded slightly further east in the 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)

The MJO was not active during late 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.

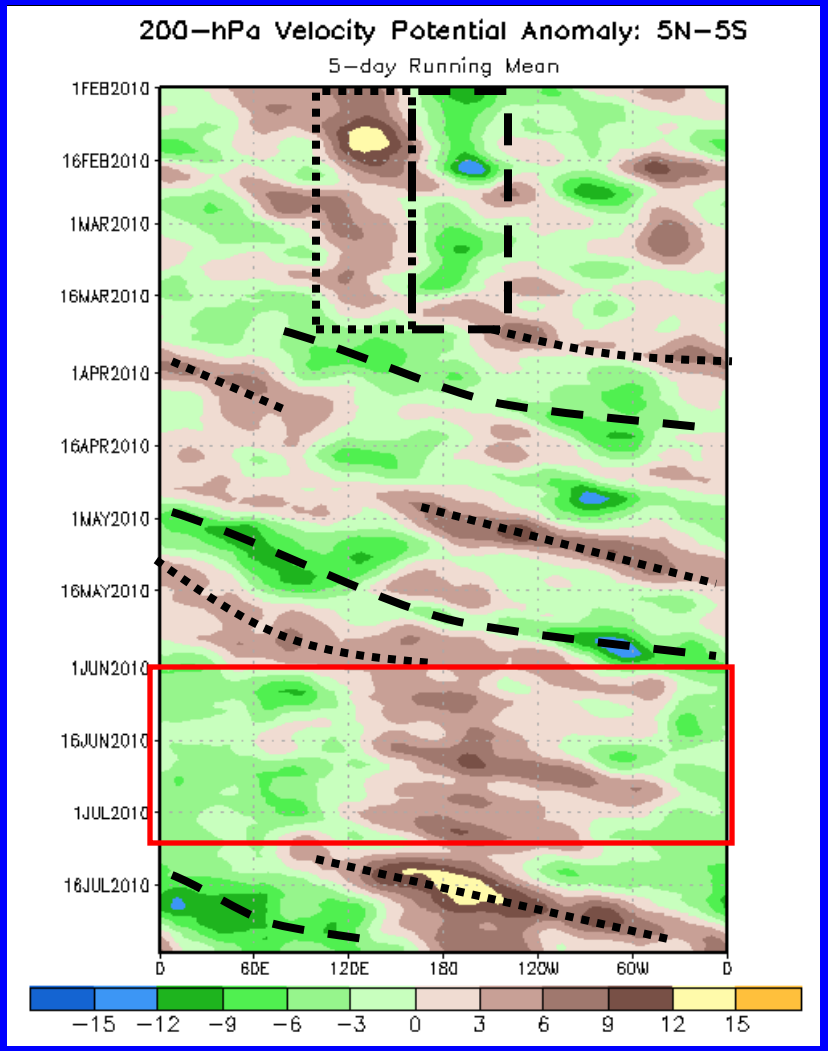
Enhanced convection, in part associated with MJO activity, developed across the Indian Ocean in early May and shifted slightly eastward. Suppressed convection developed across much of Africa.

In mid July, enhanced convection developed and shifted east from Africa to the Maritime continent region.

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.

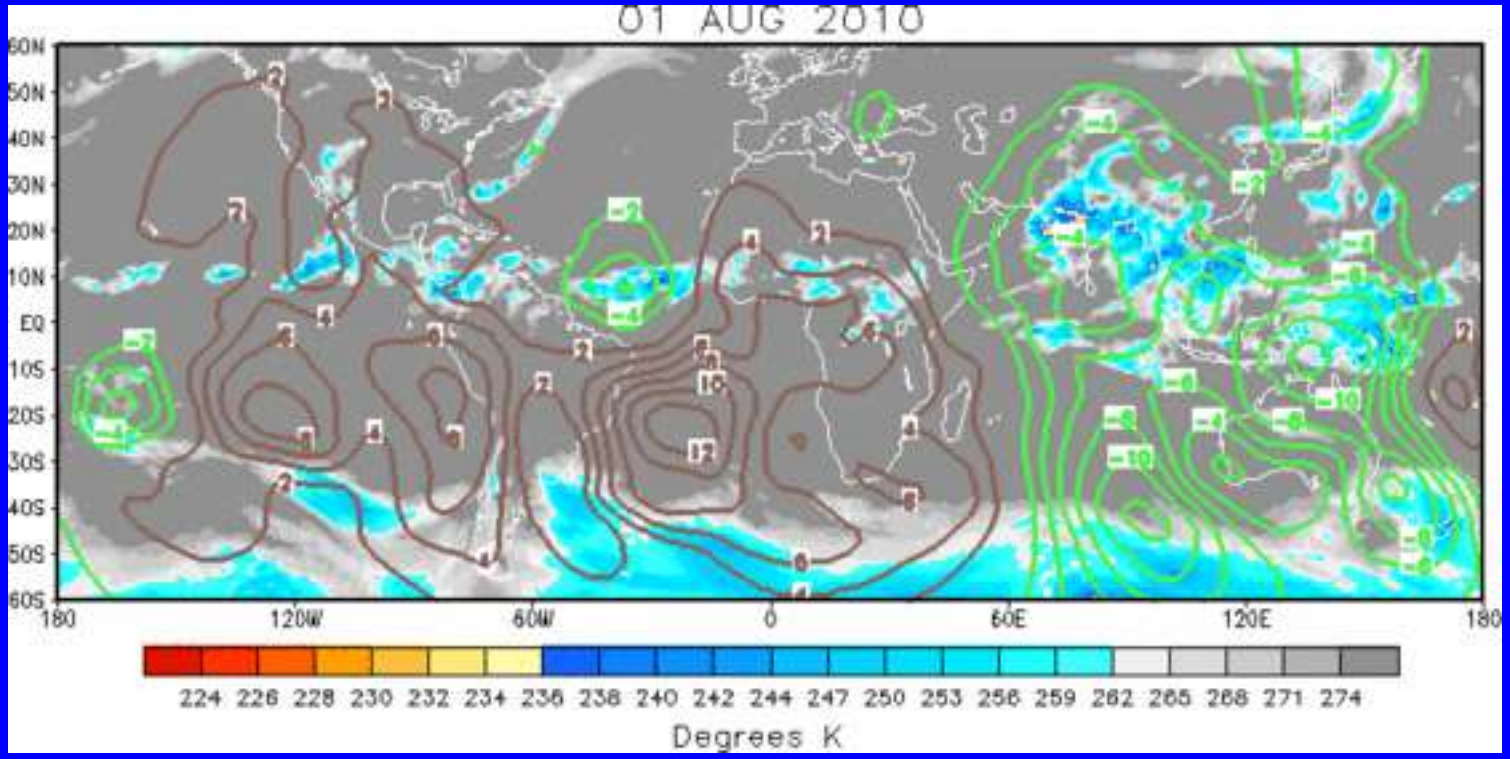
From early June to early July, anomalies became more stationary in nature (red box) with upper-level convergence primarily located across the central Pacific and divergence stretching from the Atlantic to the Indian Ocean.

Eastward propagation again developed during mid-July.

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

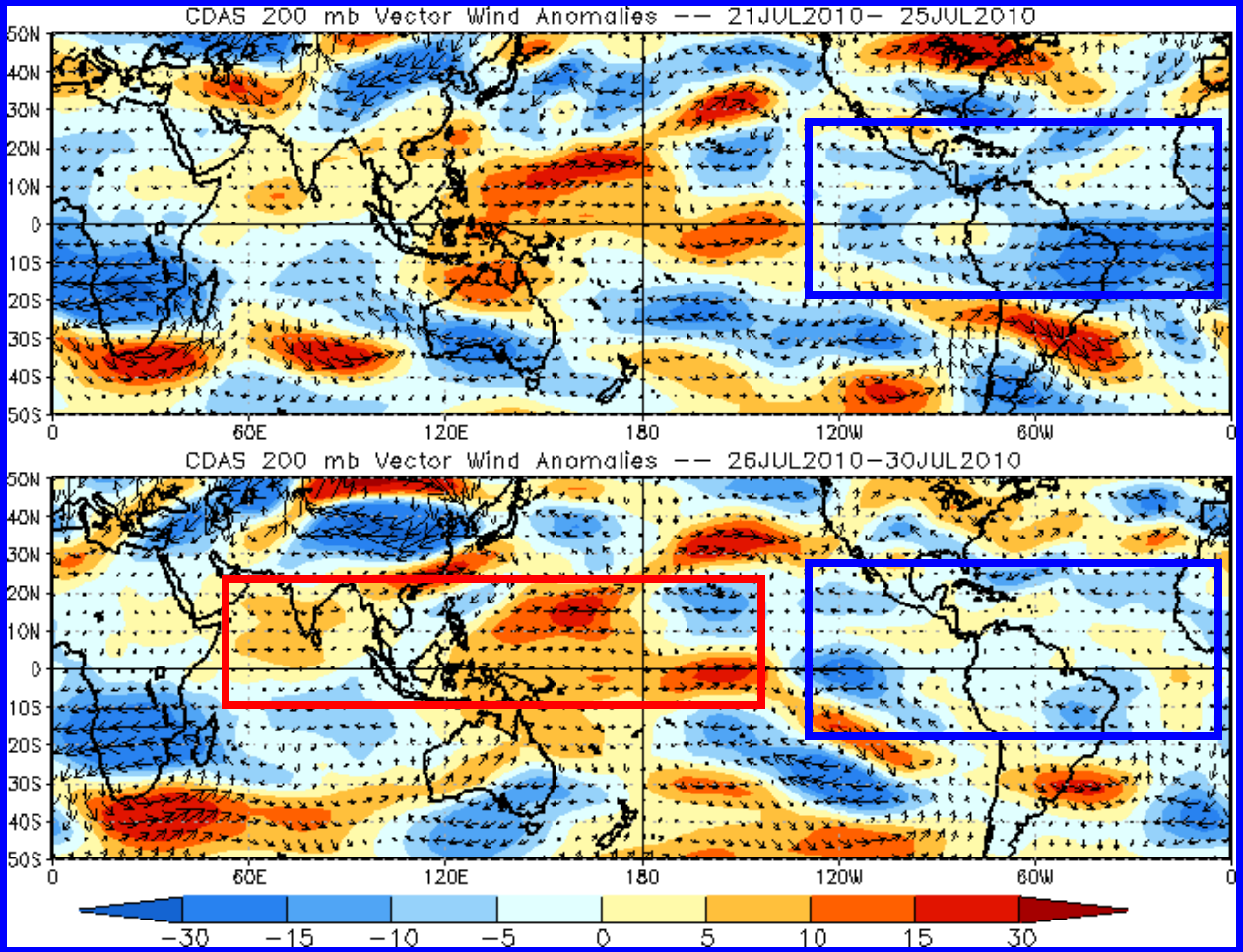
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The anomalous velocity potential pattern indicates the large scale structure has become less coherent than last week with some higher-frequency variability evident. Upper-level convergence is mainly evident south of the equator from the eastern Pacific to Africa with upper-level divergence stretching from the Indian Ocean to the western Pacific.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

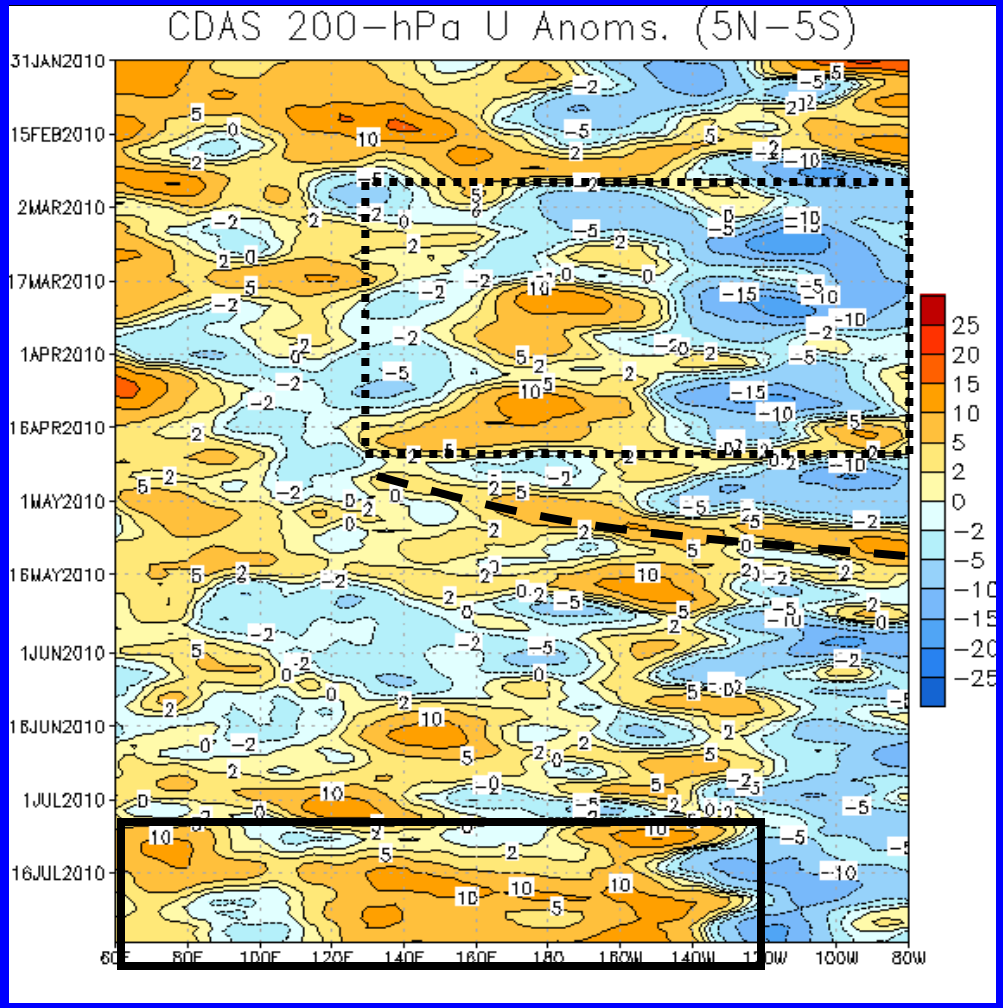
Easterly anomalies weakened dramatically across the equatorial Atlantic and South America during the last five days (blue boxes).

Westerly anomalies continued from the Maritime continent to near the Date Line (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

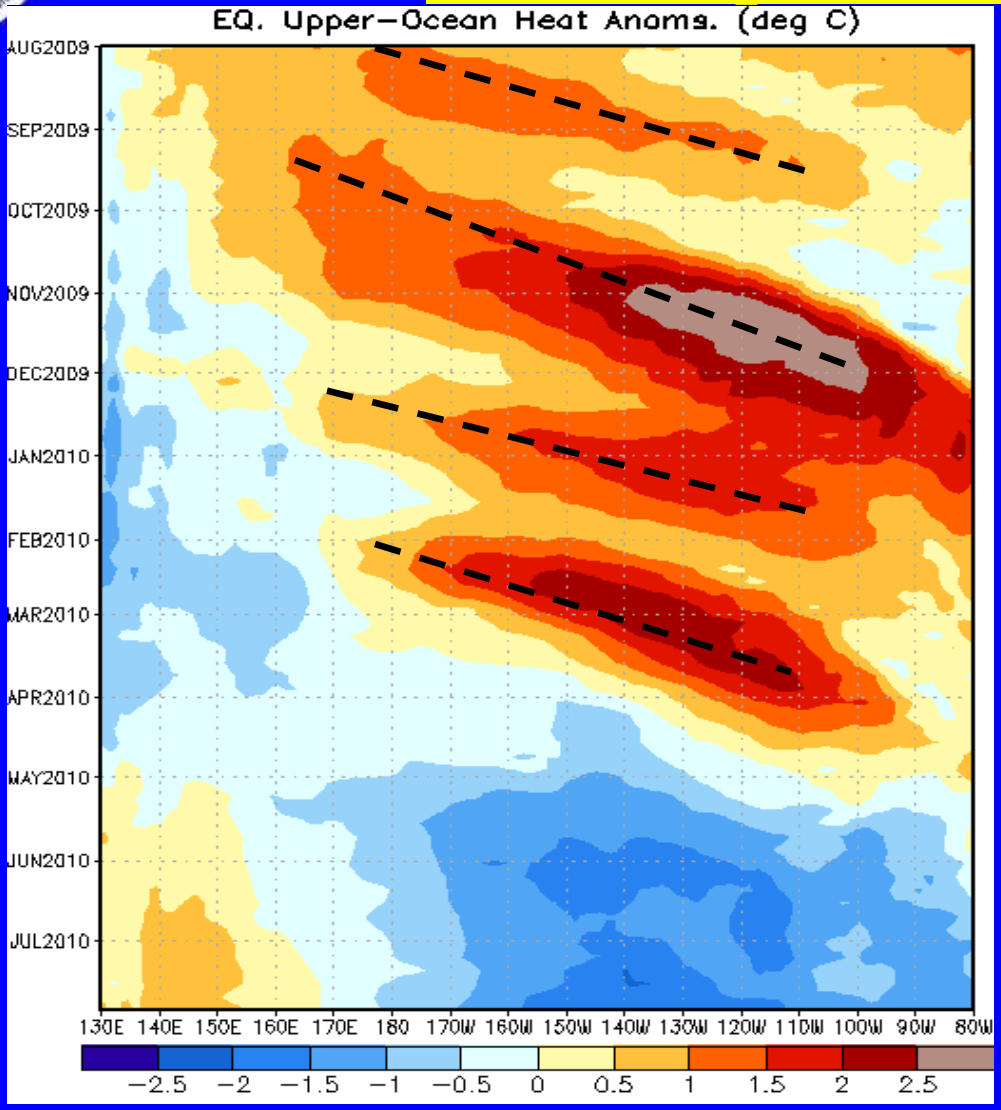
Longitude

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 across a large area from the Indian Ocean to the east-central Pacific (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 with positive anomalies in the western 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).

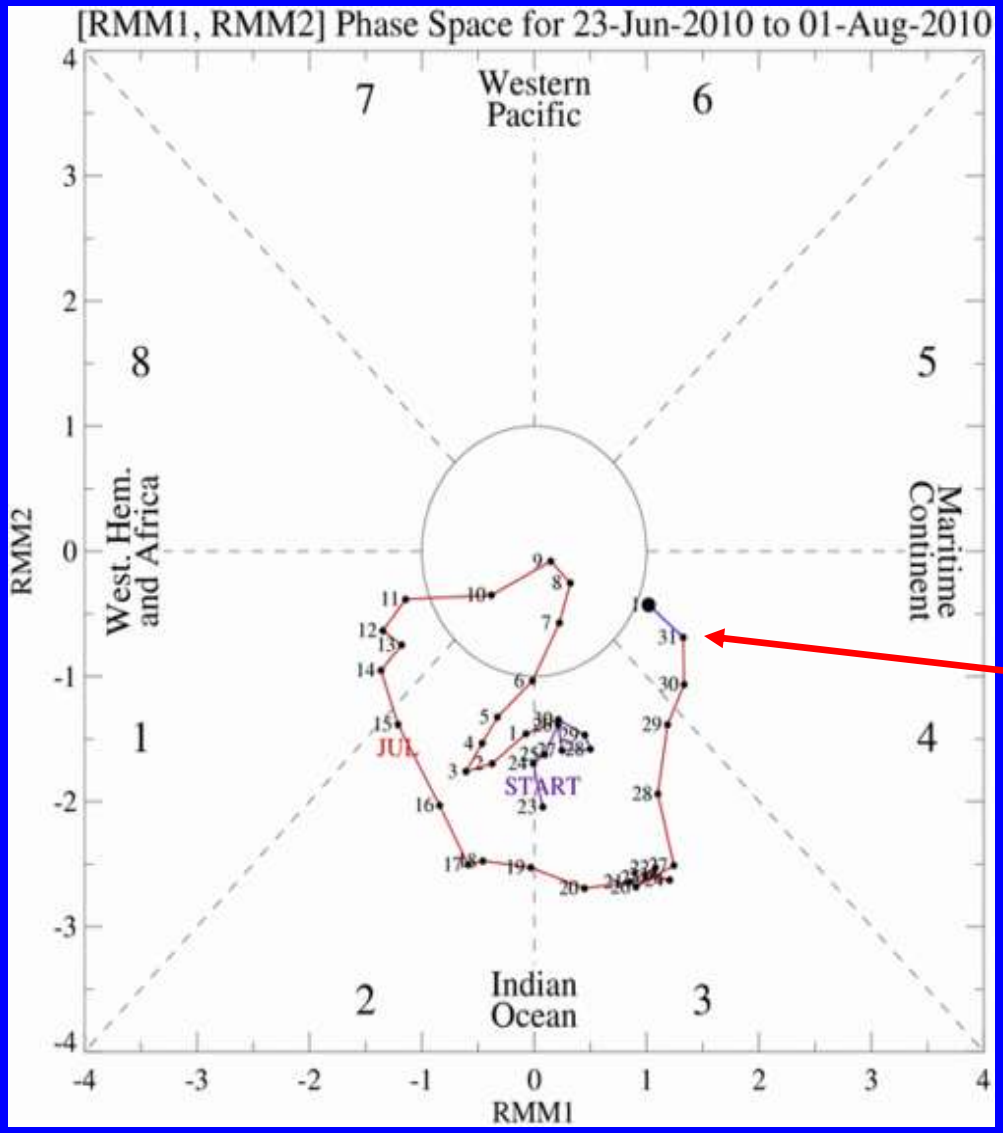
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review,* 132, 1917-1932.

• 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).

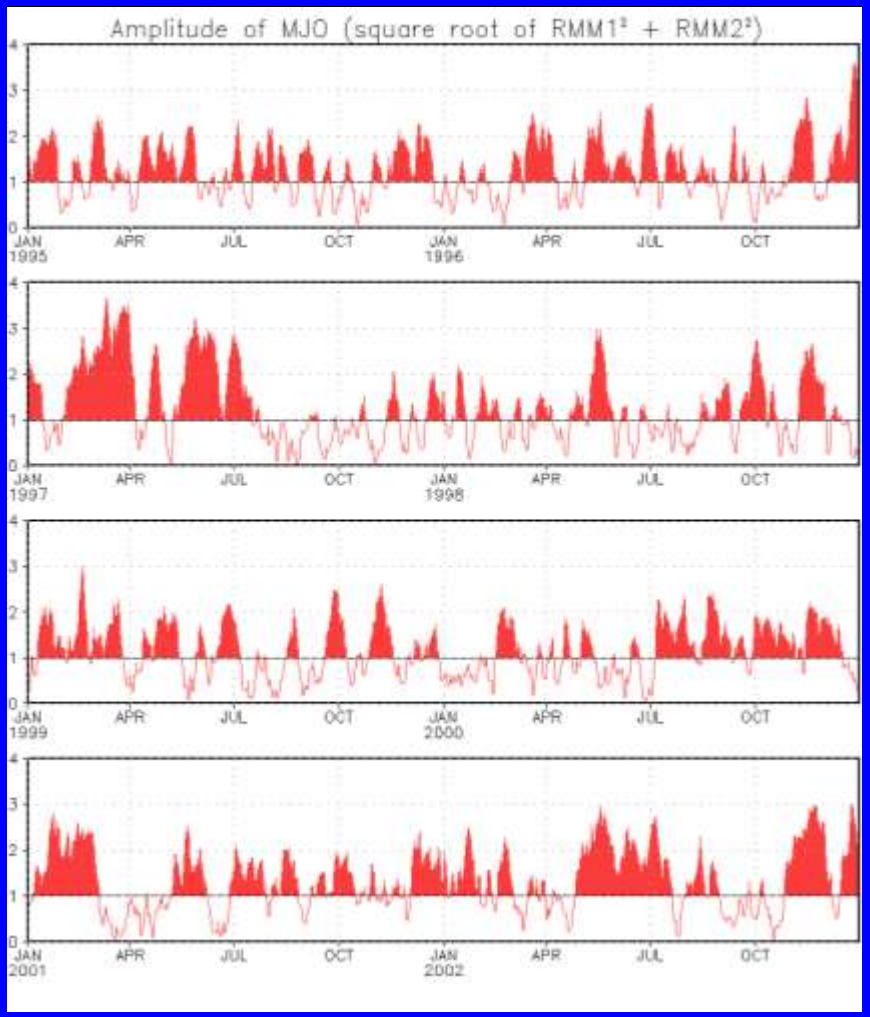
MJO Index -- Recent Evolution

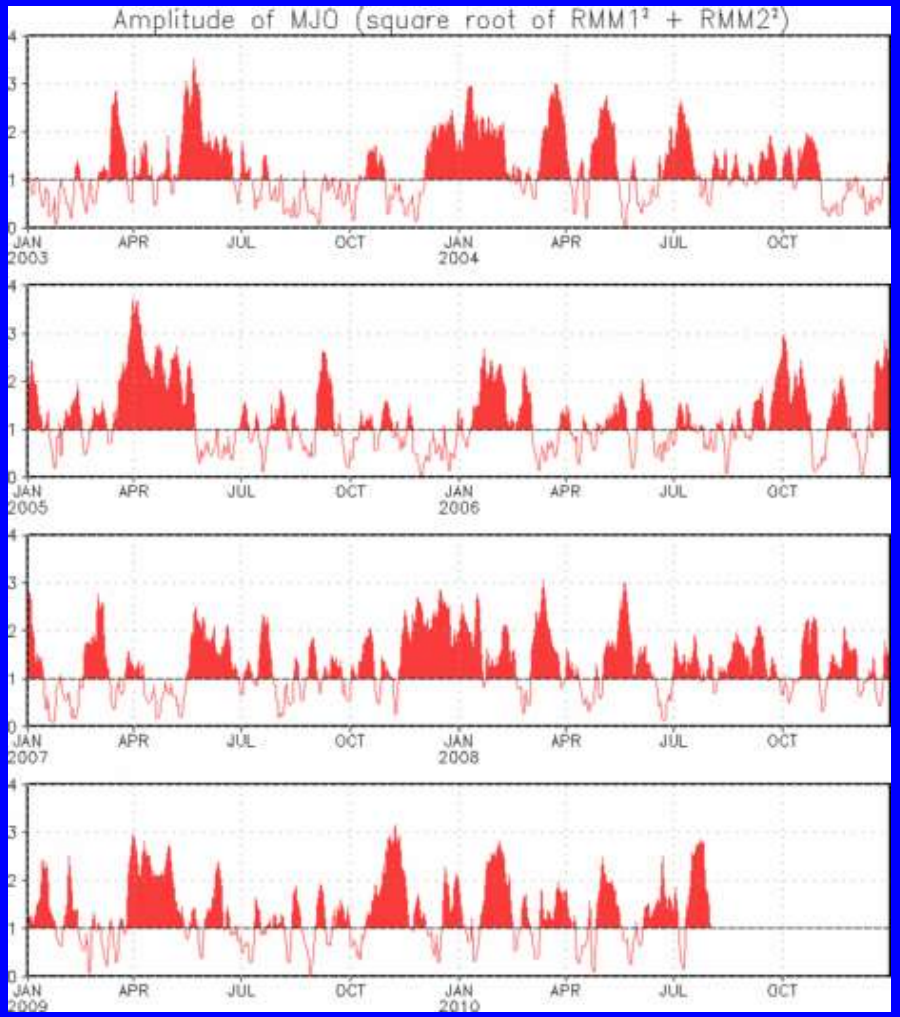


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index indicates the signal shifted eastward during the past week but has weakened. The signal is centered across the western Maritime Continent.

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.

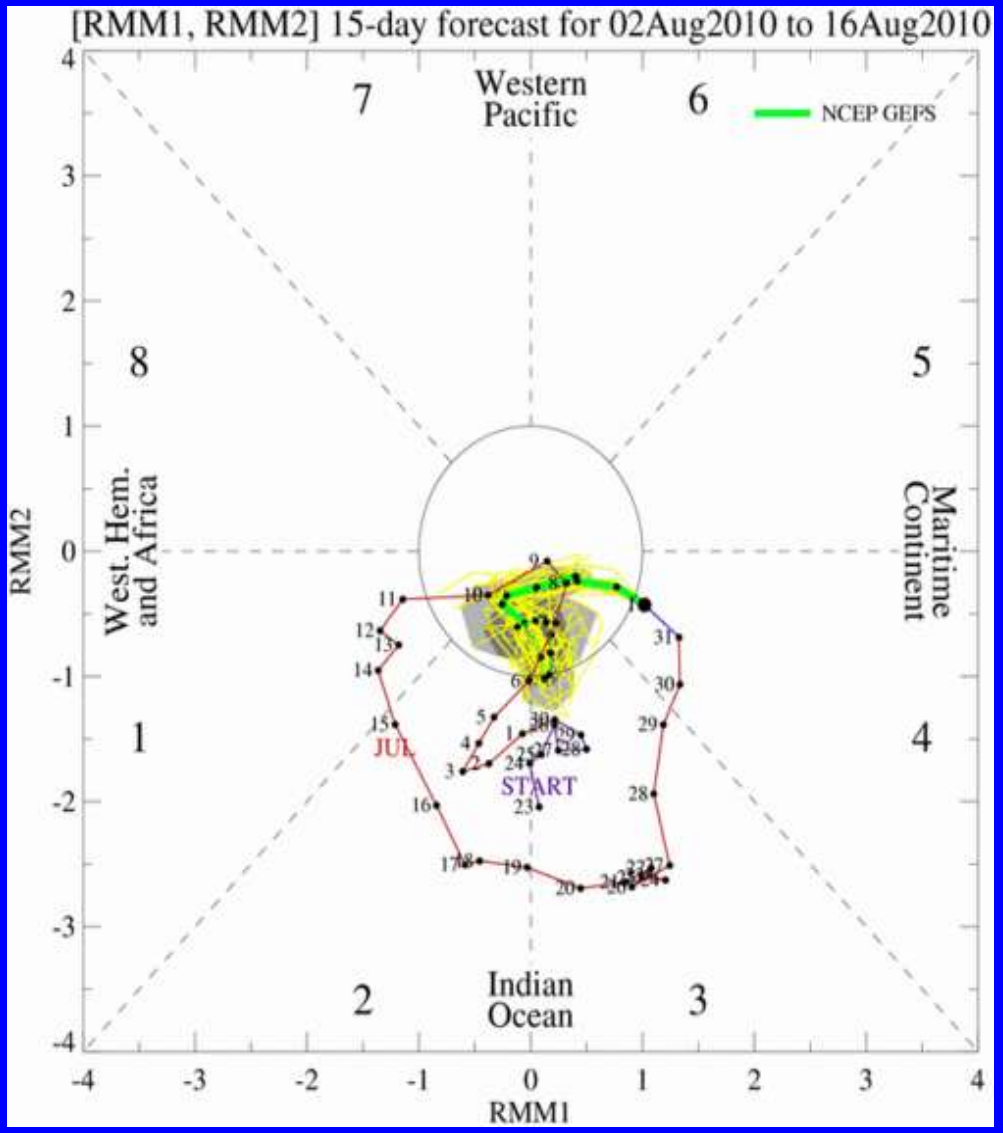
Ensemble GFS (GEFS) MJO Forecast

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

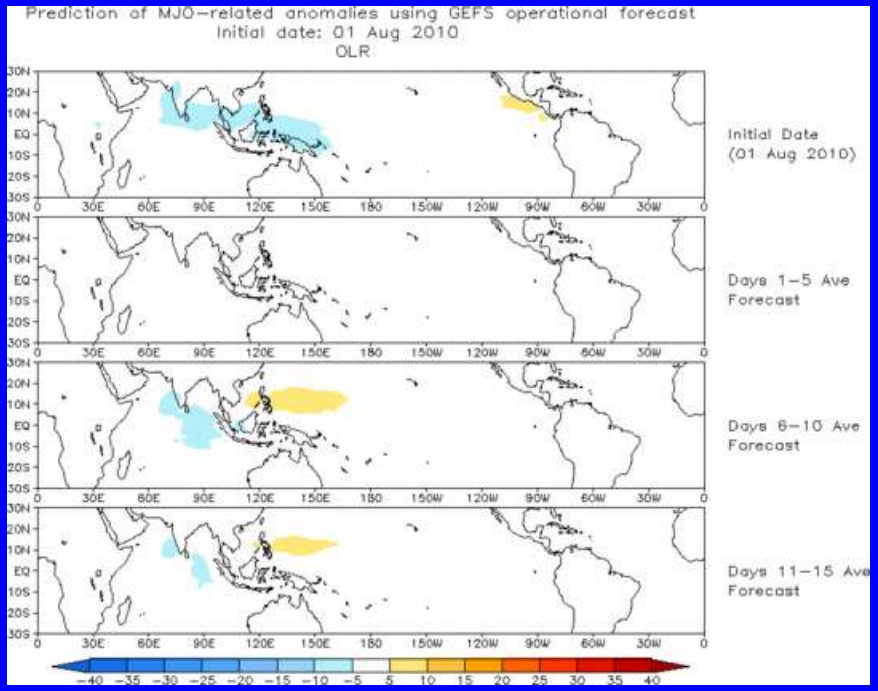
The GFS forecasts indicate a continuation of a weakening MJO signal. The spread is small during the Week-1 period with an increase in uncertainty during Week-2.



Ensemble Mean GFS MJO Forecast

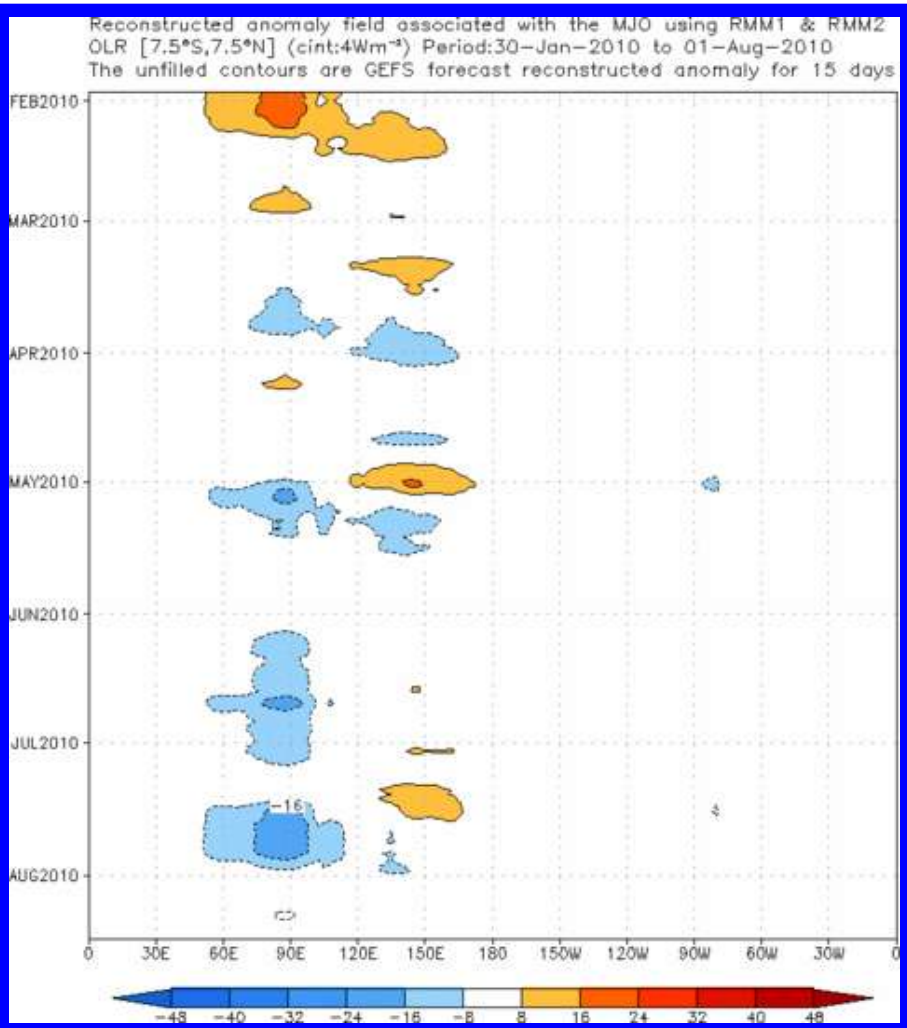
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecast indicates only weak convective anomalies during 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



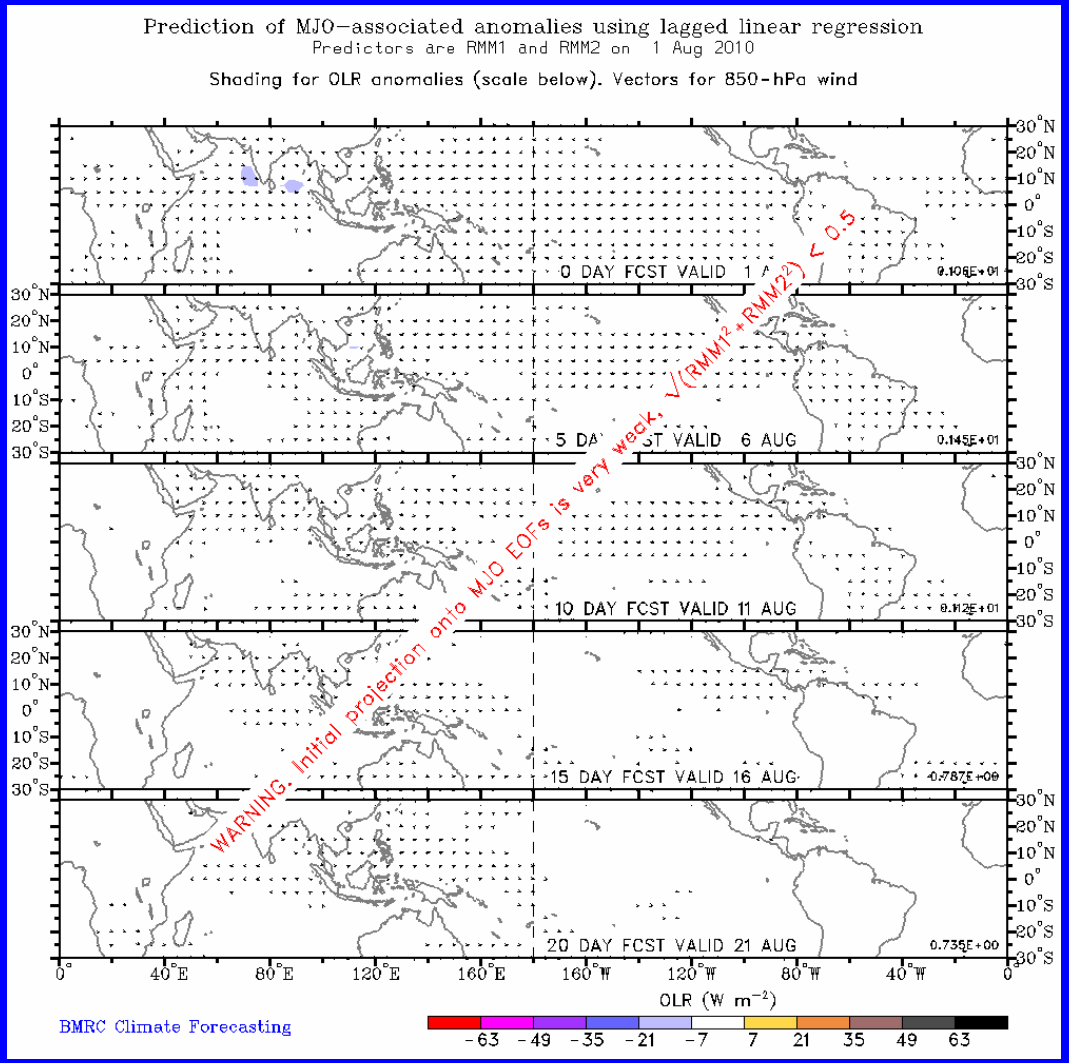
Statistical MJO Forecast

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

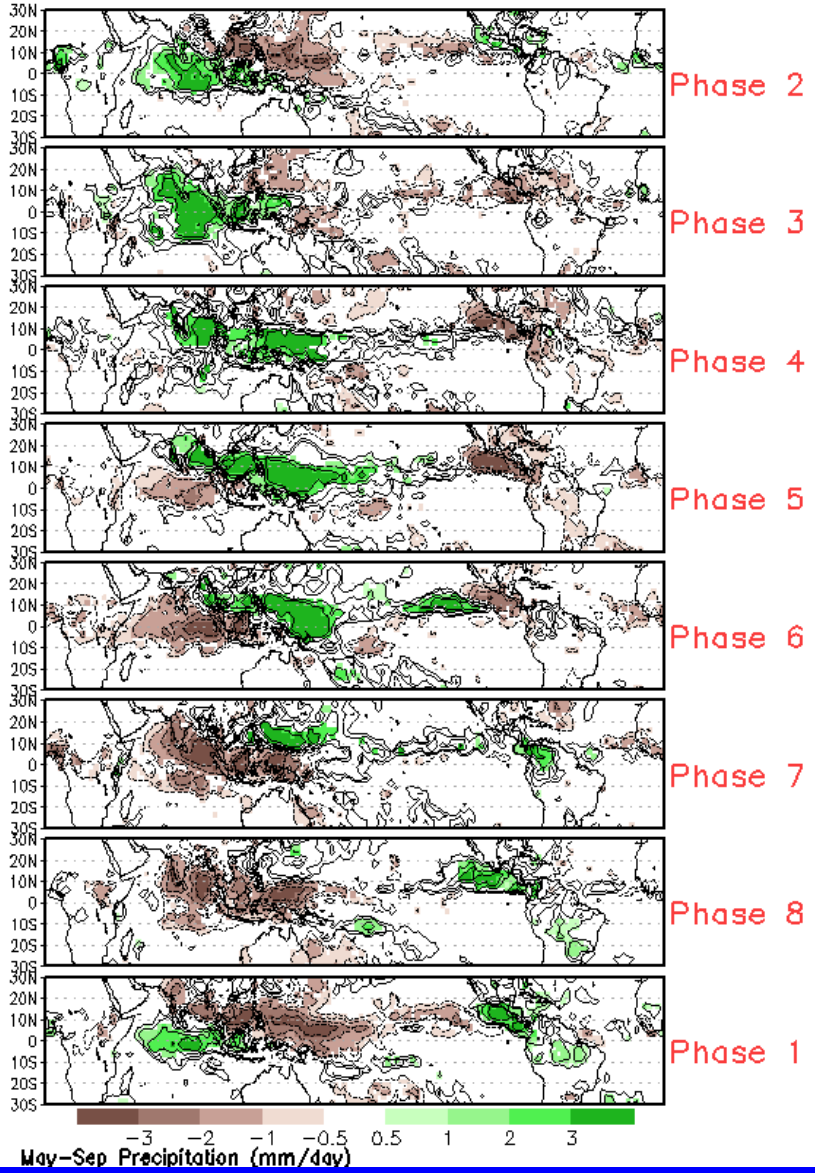
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

Weak MJO activity is forecast during the period.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)