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

Update prepared by
Climate Prediction Center / NCEP
September 13, 2010

Outline

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

Overview

- The MJO signal remained weak during the past week.

- The majority of dynamical model MJO index forecasts indicate a weak MJO index signal over the forecast period. Any eastward propagation is most likely a result of a combination of other higher-frequency coherent subseasonal tropical variability and background La Nina conditions.

- Based on recent observations, statistical MJO forecasts, and MJO dynamical forecast tools, the MJO is expected to remain weak during the next 1-2 weeks.

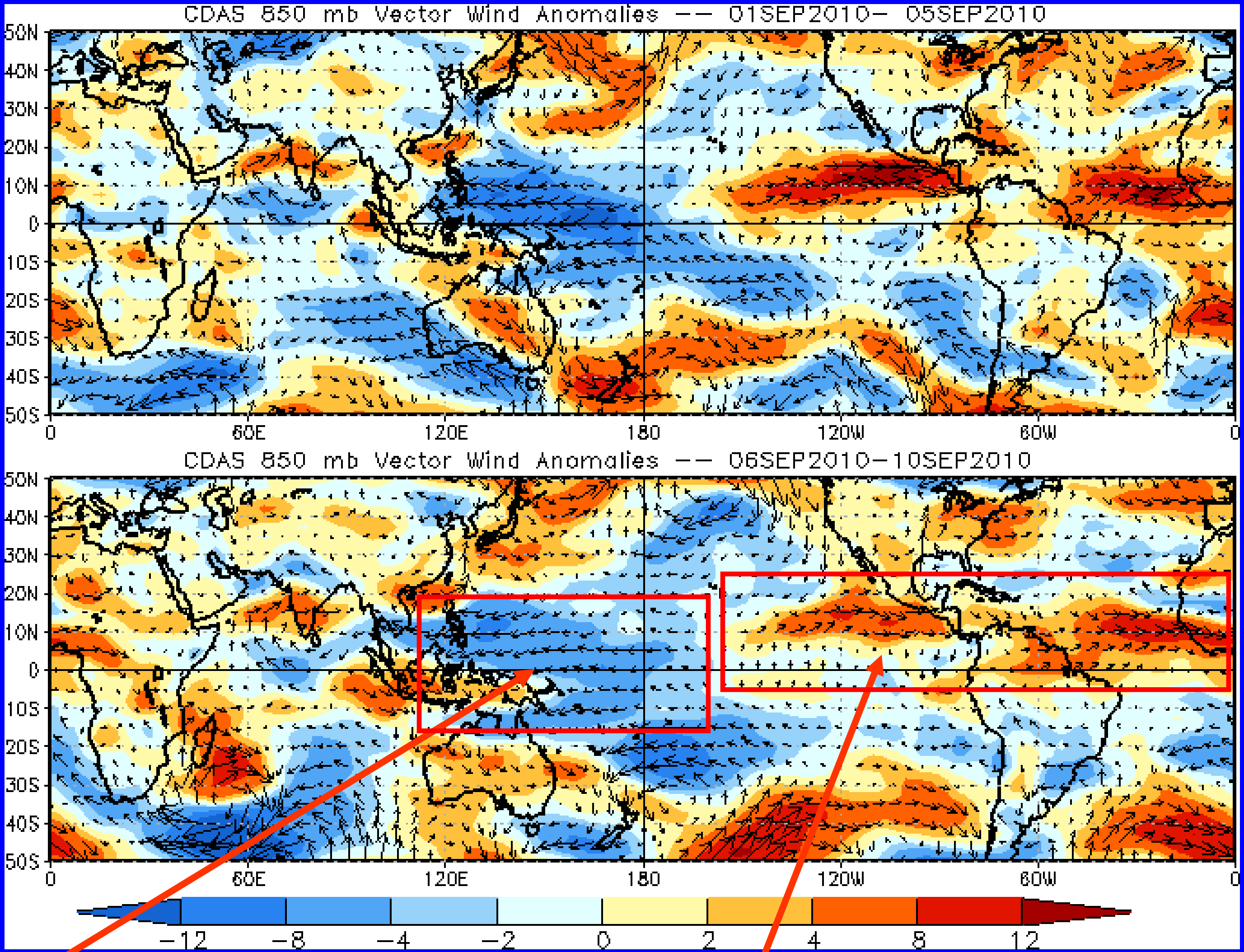
<u>**Additional potential impacts across the global tropics are available at:**</u>
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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 persist across the western Pacific.

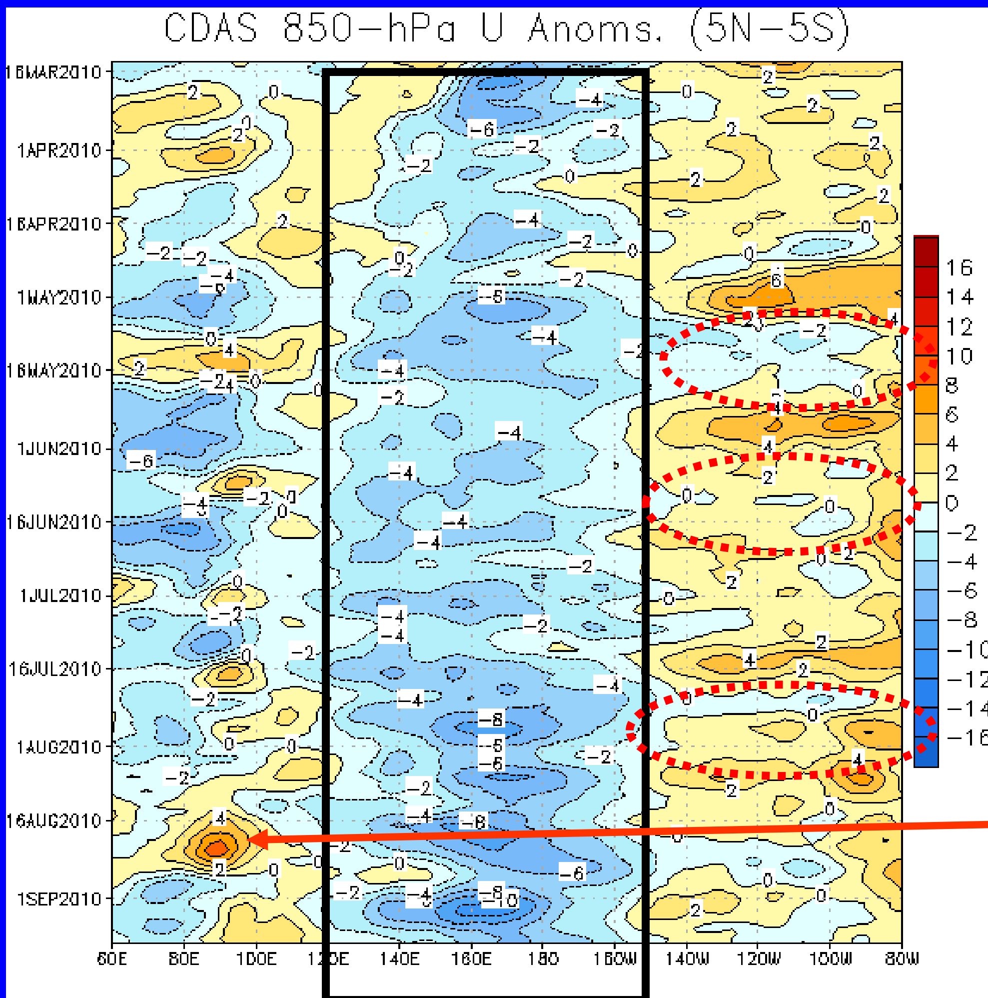
Westerly anomalies continued from the eastern Pacific across the Atlantic to west Africa.

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



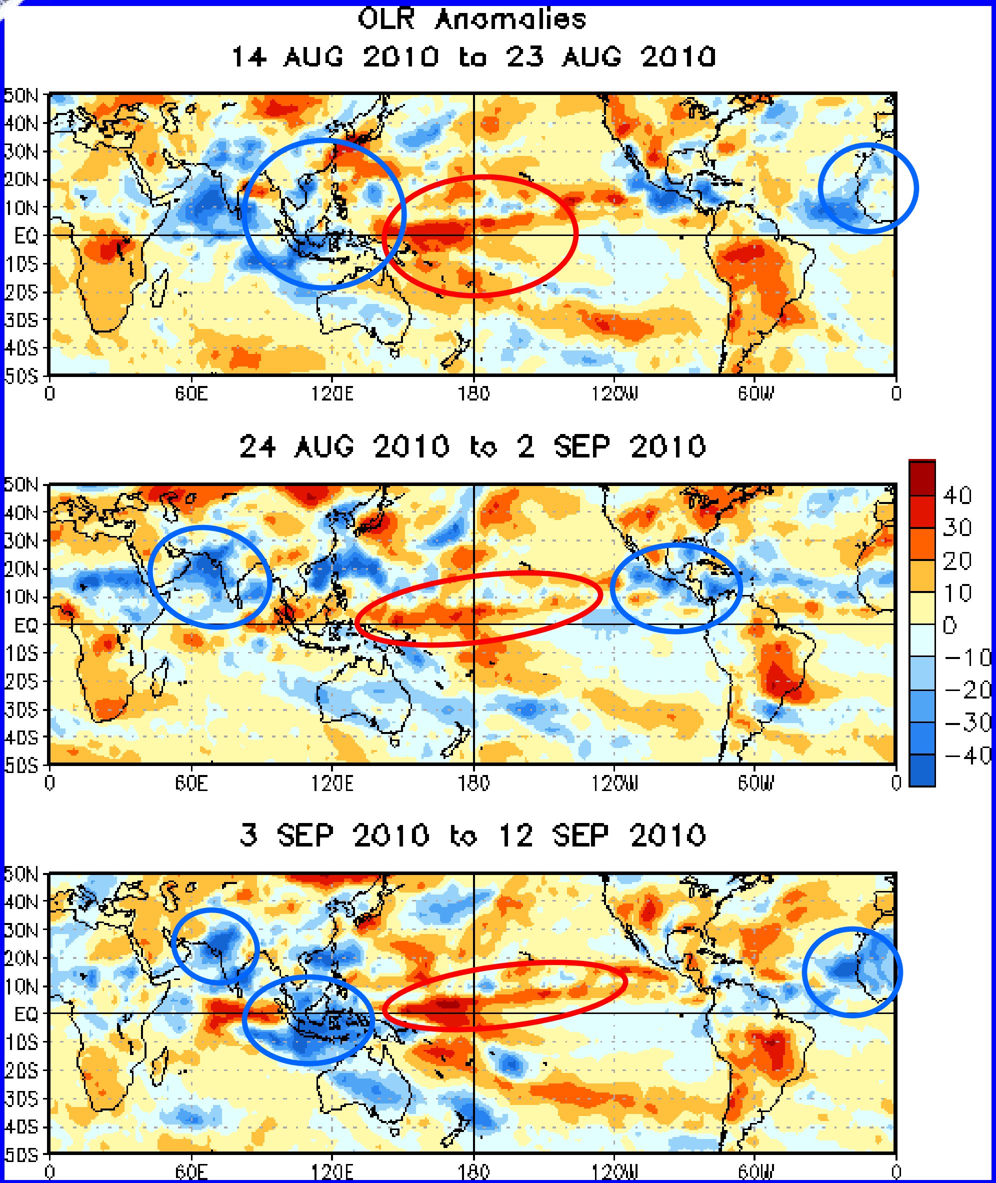
Longitude

Easterly anomalies have persisted in the west-central Pacific since mid-March (black box) consistent with the development of La Nina conditions.

Enhanced westerly anomalies (red dotted ovals) occurred across the eastern Pacific on separate occasions during late April, late May and early-to-mid July and these were in part associated with MJO activity.

During mid-August, westerly anomalies strengthened at 90E, enhancing low-level convergence over the western Maritime Continent.

OLR Anomalies – Past 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 August, suppressed convection (red oval) persisted near the Date Line while enhanced convection was evident across the far western Pacific, Indonesia, and west Africa (blue ovals).

In late August, wetter-than-average conditions developed across the Indian Ocean and continued over Central America while suppressed convection remained dominant across much of the Pacific.

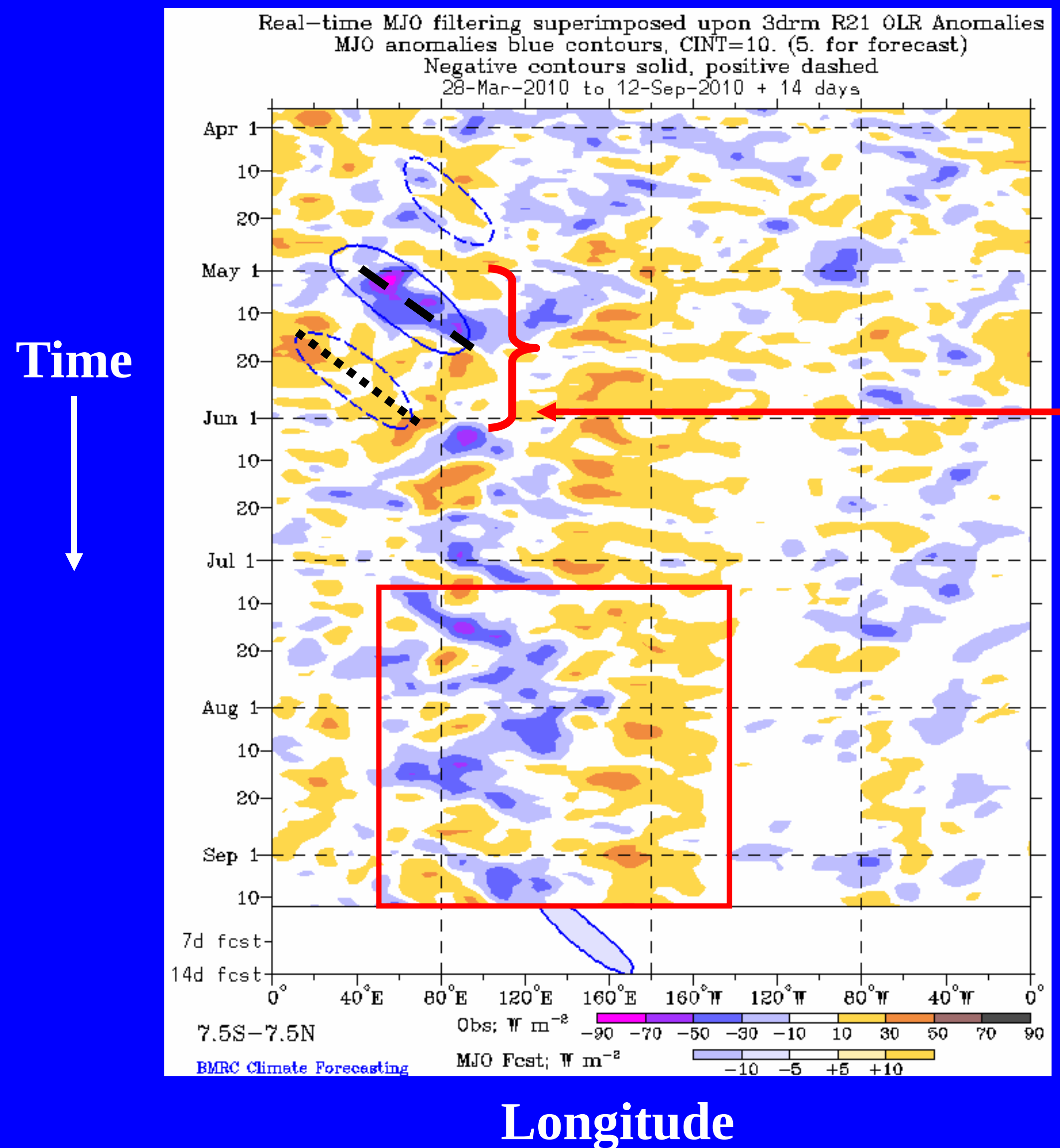
Enhanced convection strengthened over west Africa and the Maritime Continent during early September. Suppressed convection continued across the western and central Pacific.

Outgoing Longwave Radiation (OLR) Anomalies (7.5°S-7.5°N)

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)



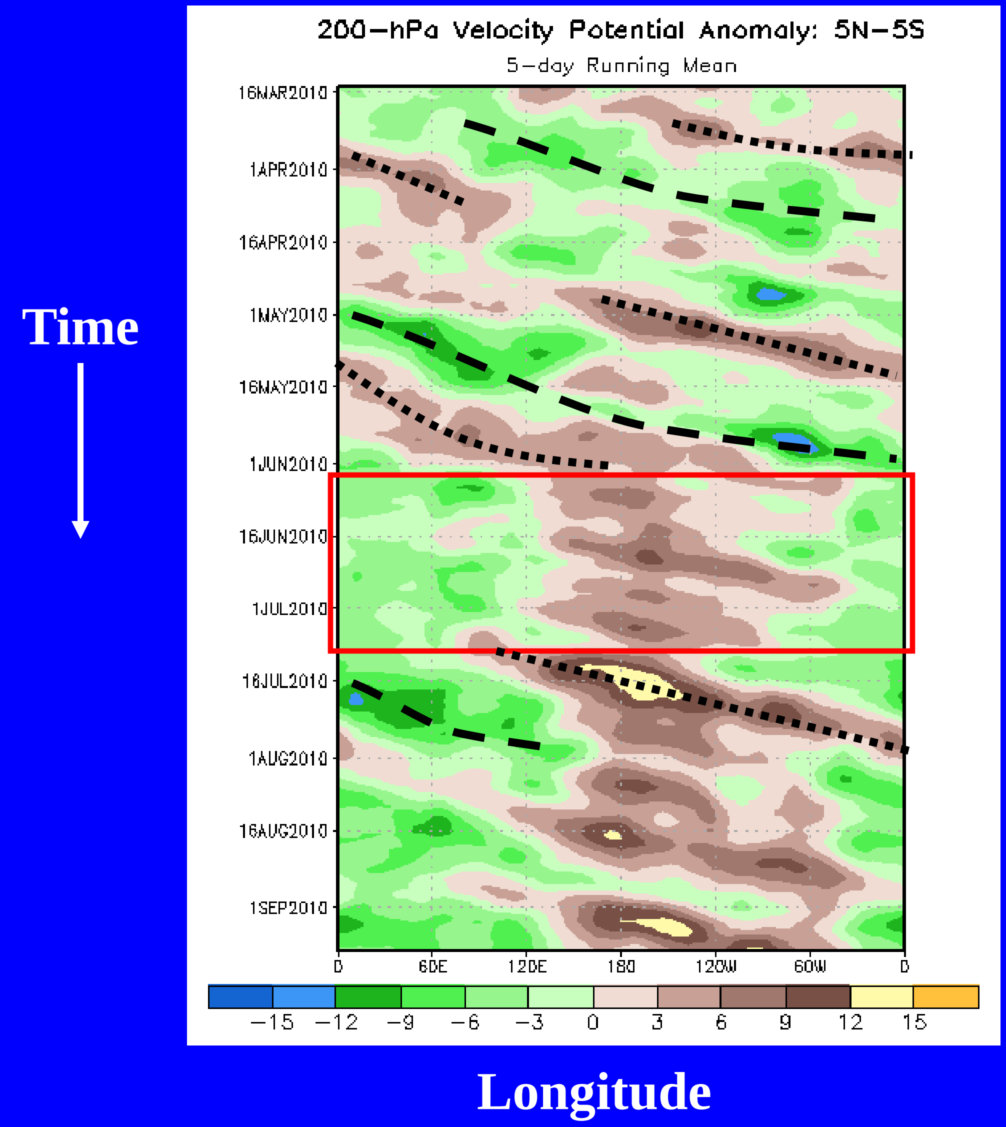
Enhanced convection, in part associated with the MJO, developed across the Indian Ocean in early May and shifted eastward. Suppressed convection developed across much of Africa in its wake.

Since mid-July, generally enhanced (suppressed) convection has prevailed across the western Maritime continent (Date Line) (red box). Considerable intraseasonal variability is evident during the period as enhanced convection has shifted both eastward and westward in this area during the period.

200-hPa Velocity Potential Anomalies (5°S-5°N)

<u>Positive</u> anomalies (brown shading) indicate unfavorable conditions for precipitation

<u>Negative</u> anomalies (green shading) indicate favorable conditions for precipitation



In mid-March, weak upper-level divergence (convergence) developed over the Maritime Continent (eastern Pacific) and these anomalies propagated eastward.

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

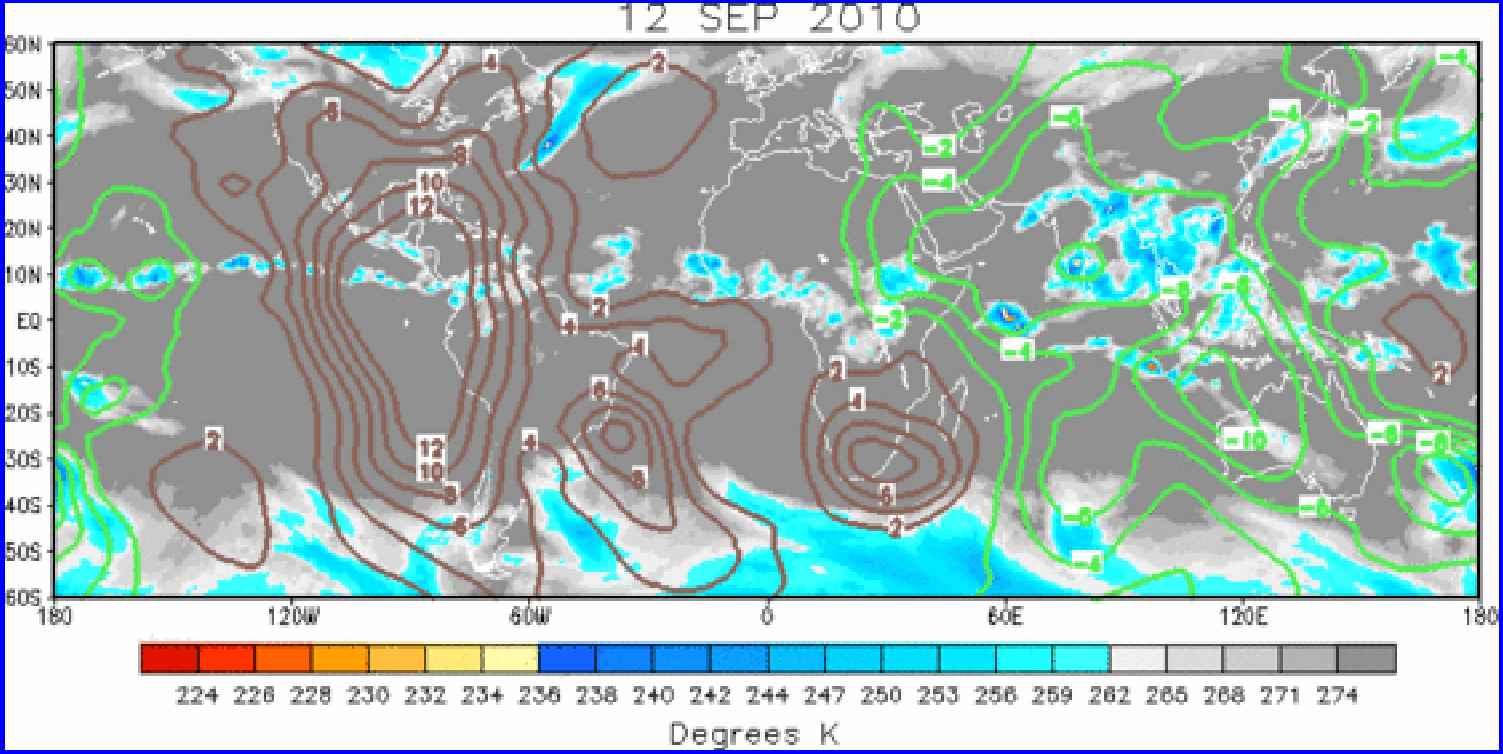
From early June to early July, anomalies became more stationary in nature (red box) with upper-level convergence primarily located across the central Pacific and divergence stretching from the Atlantic to the Indian Ocean.

Eastward propagation was evident during mid-July and mid-August.

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 shows large anomalies with upper-level convergence mainly evident across the eastern Pacific and upper-level divergence stretching from eastern Africa to the Maritime continent.

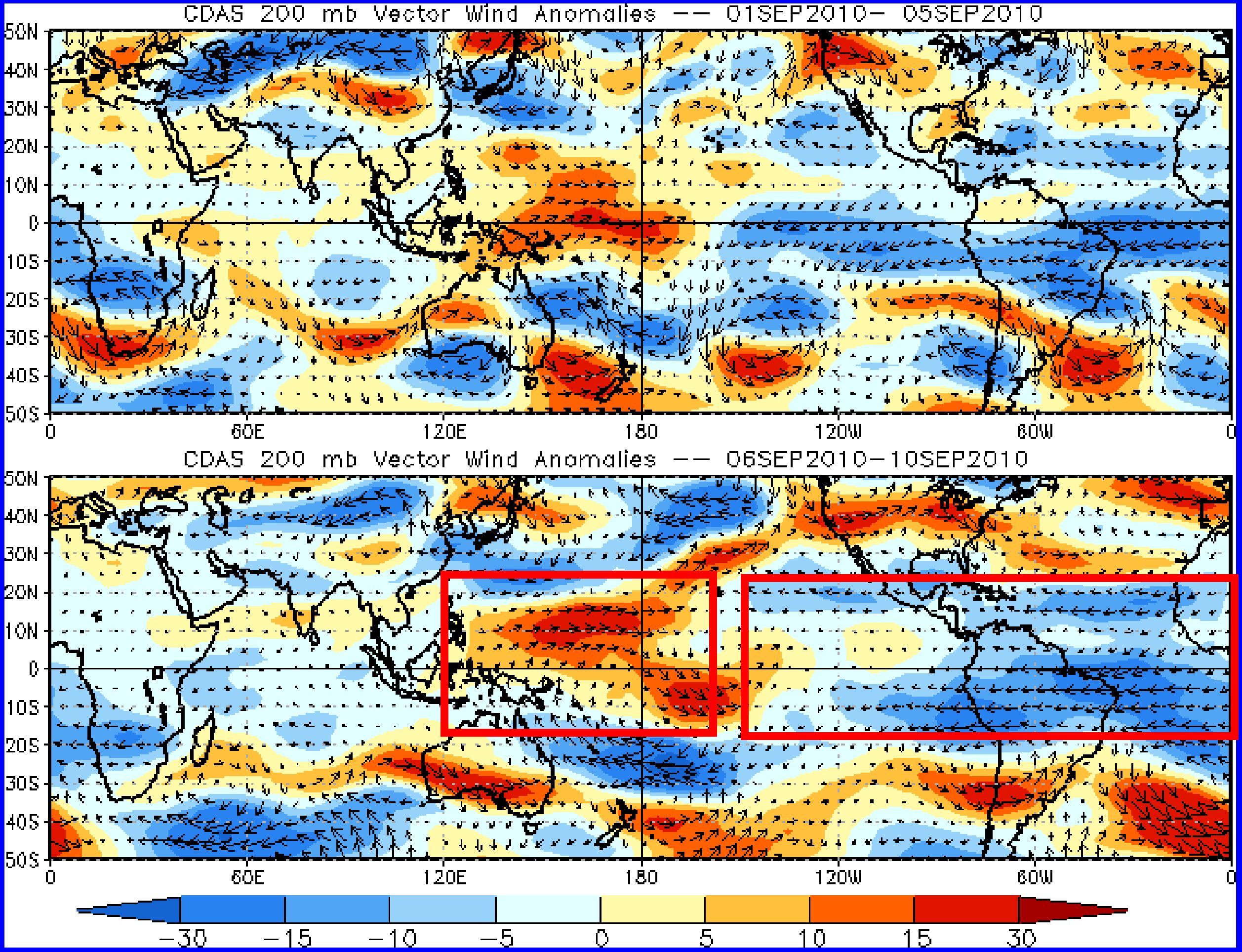
The pattern has recently shown a slight eastward shift during the last several days.

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



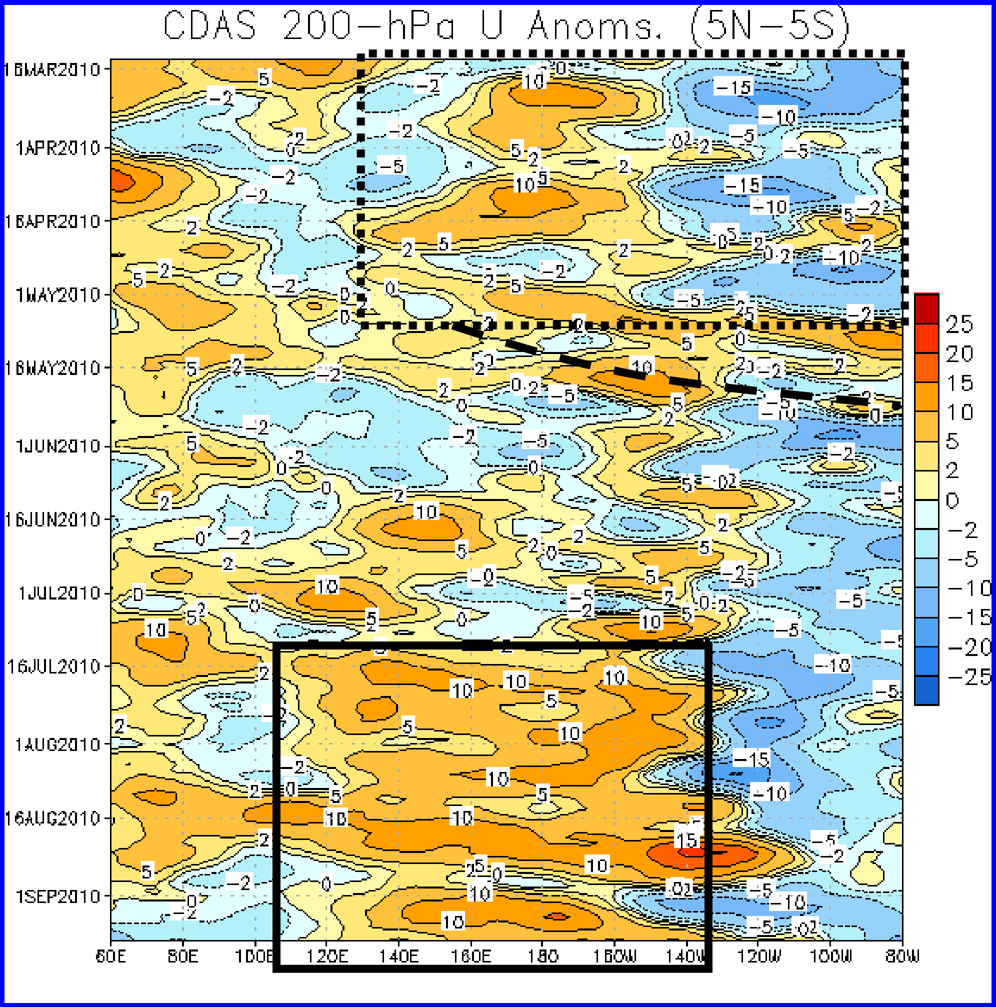
Westerly anomalies continued over the western Pacific with primarily easterly anomalies across much of tropical Western Hemisphere. southern Asia to east of the Date Line (red boxes).

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

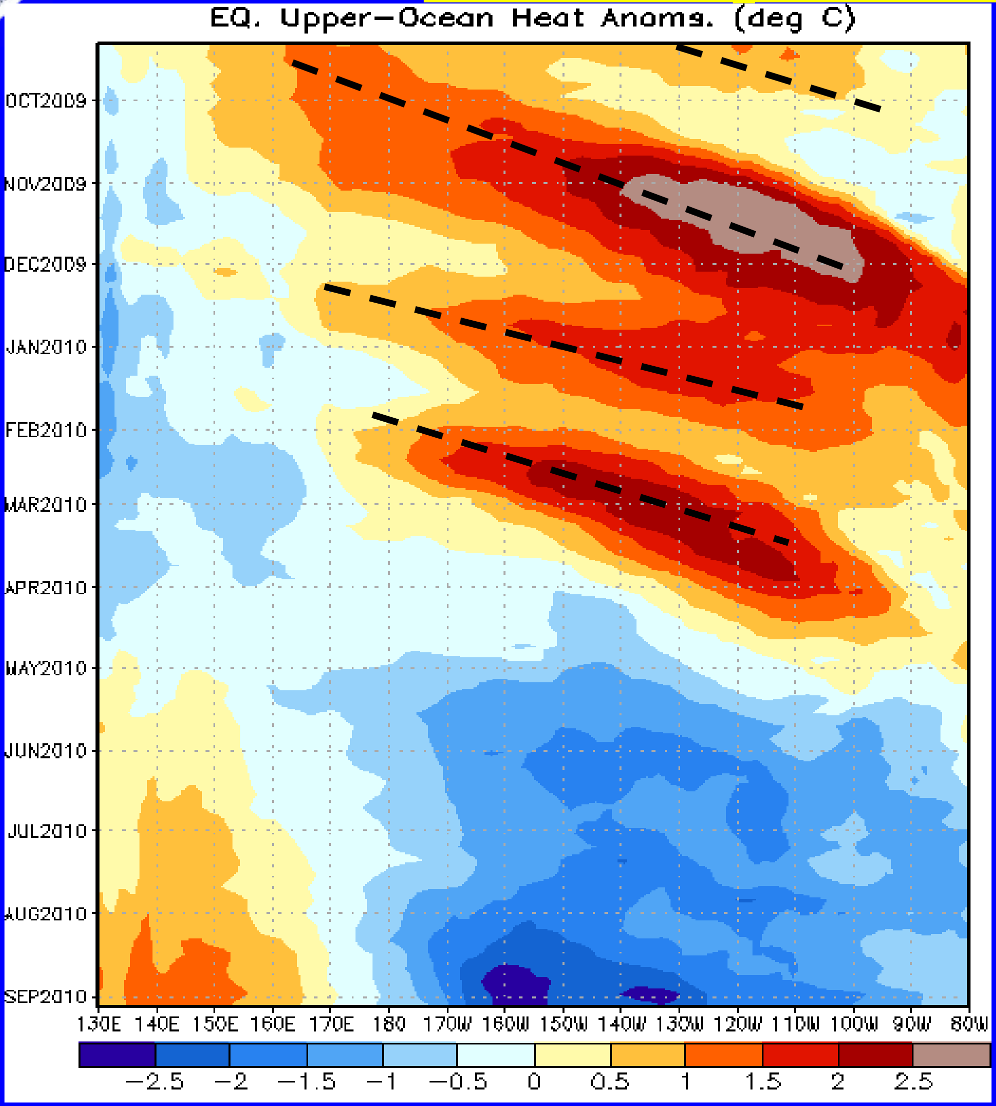
Westerly (easterly) anomalies prevailed across the central (eastern) Pacific (red box) for much of the period during March and April (black dotted box).

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 have persisted across a large area from the Maritime Continent to the central Pacific (black solid box) since early July.

Weekly Heat Content Evolution in the Equatorial Pacific

Time



Longitude

From Aug 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 and later during the early summer due to the development of La Nina.

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).

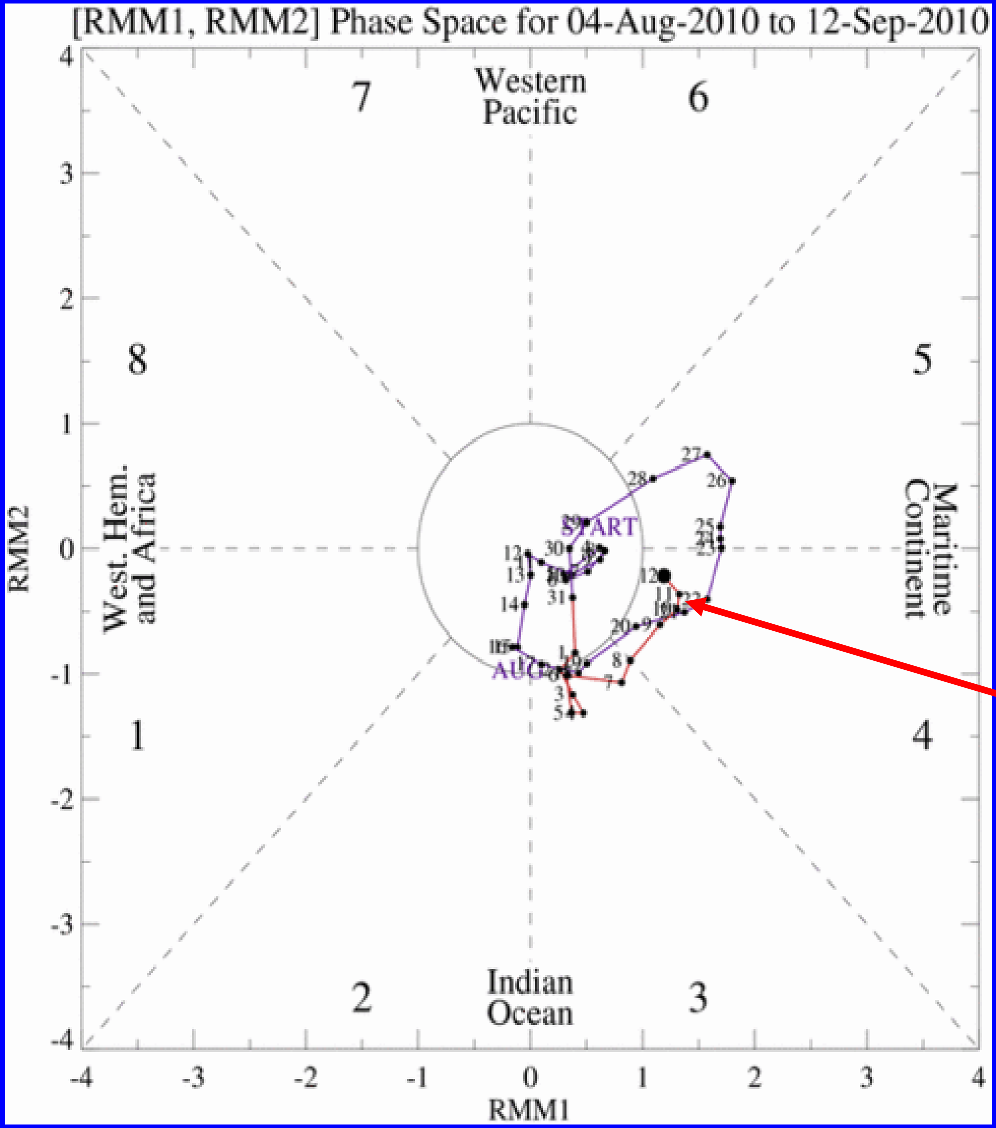
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review,* 132, 1917-1932.

• 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).

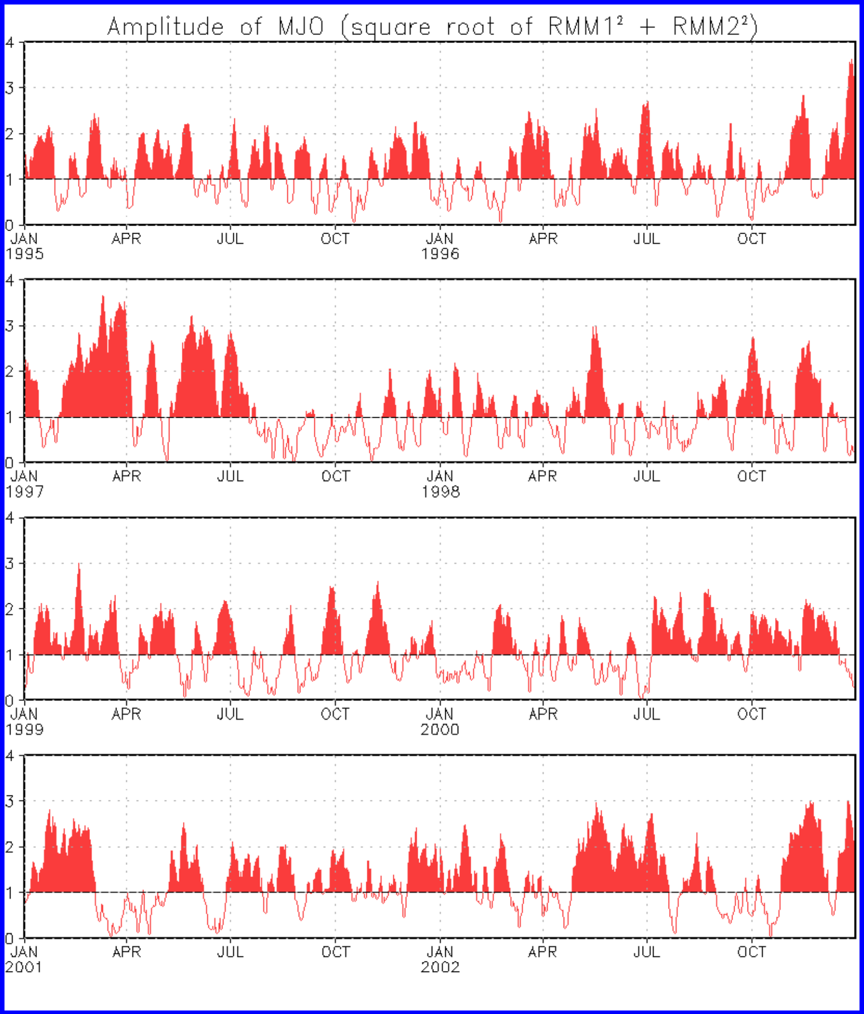
MJO Index -- Recent Evolution

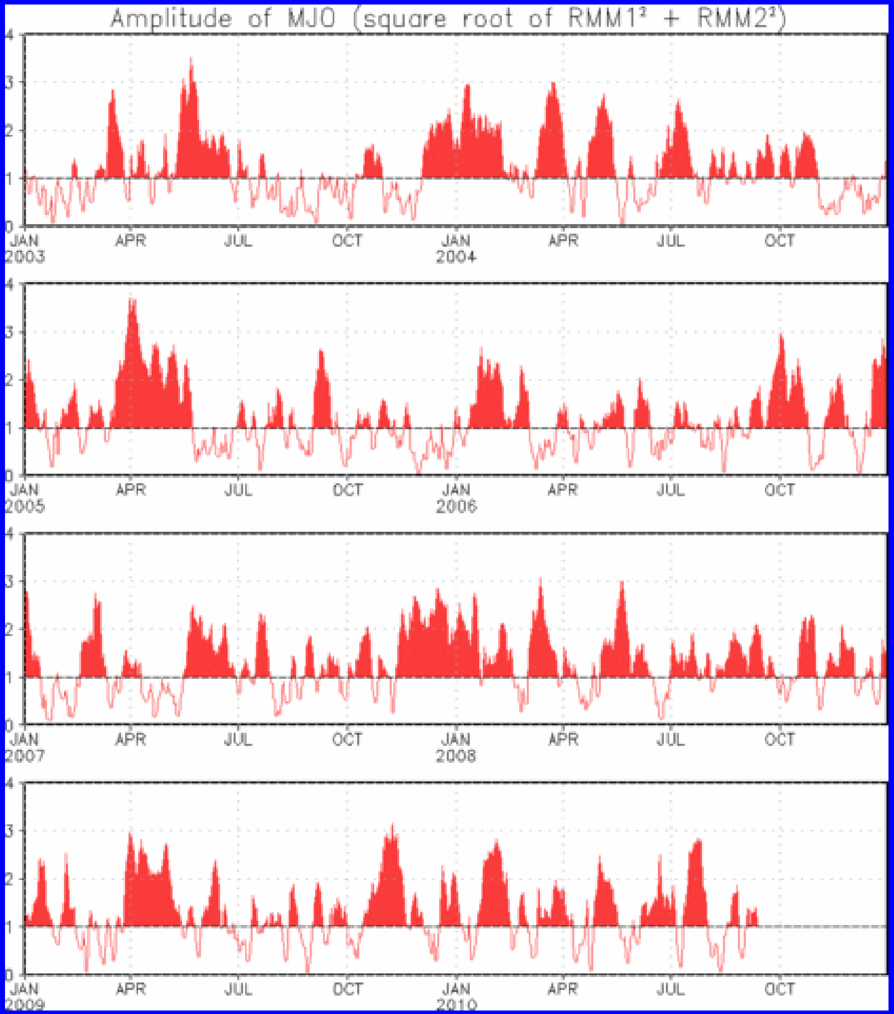


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

During the past week, the MJO index has indicated eastward propagation but it is likely short-term in duration.

MJO Index – Historical Daily Time Series





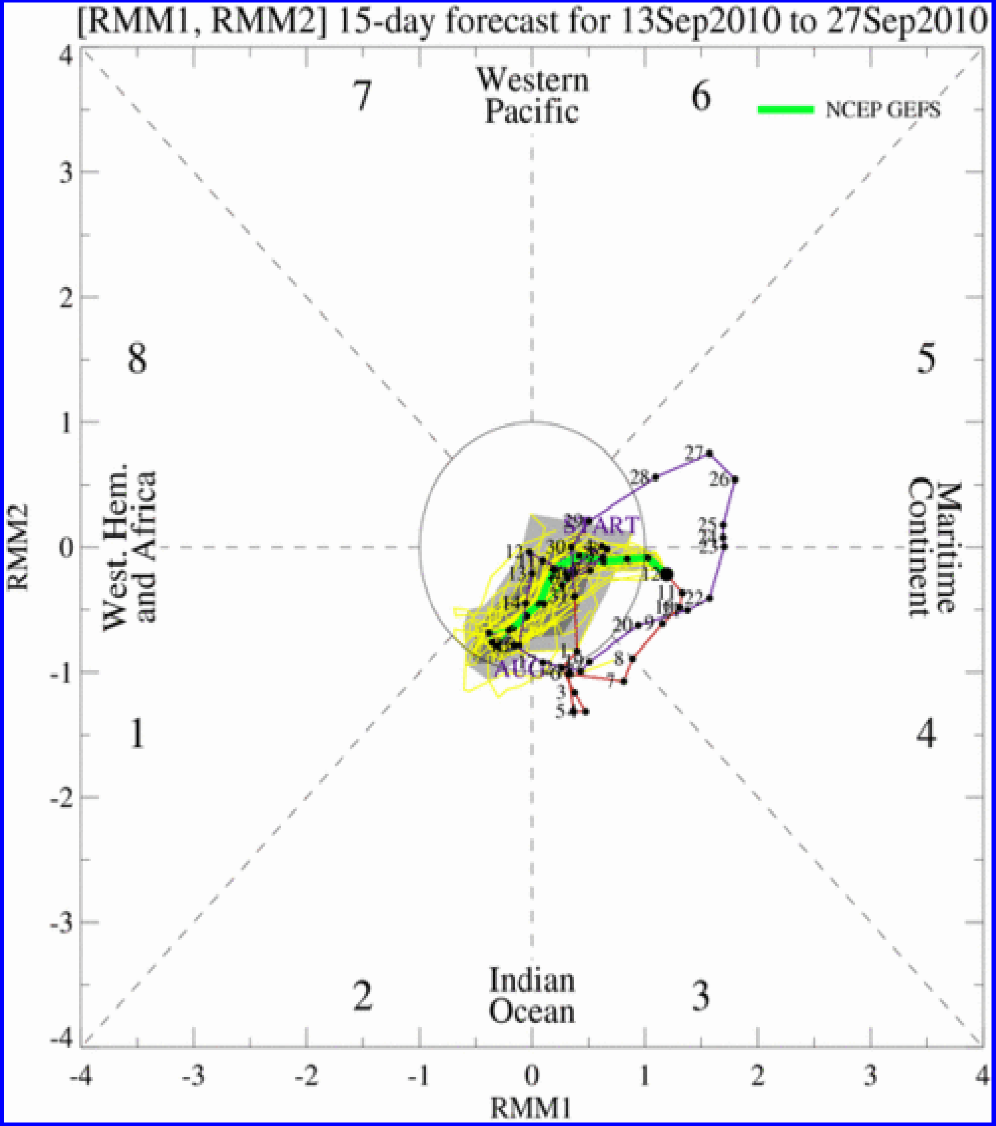
Time series of daily MJO index amplitude from 1995 to present.
Plots put current MJO activity in historical context.

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

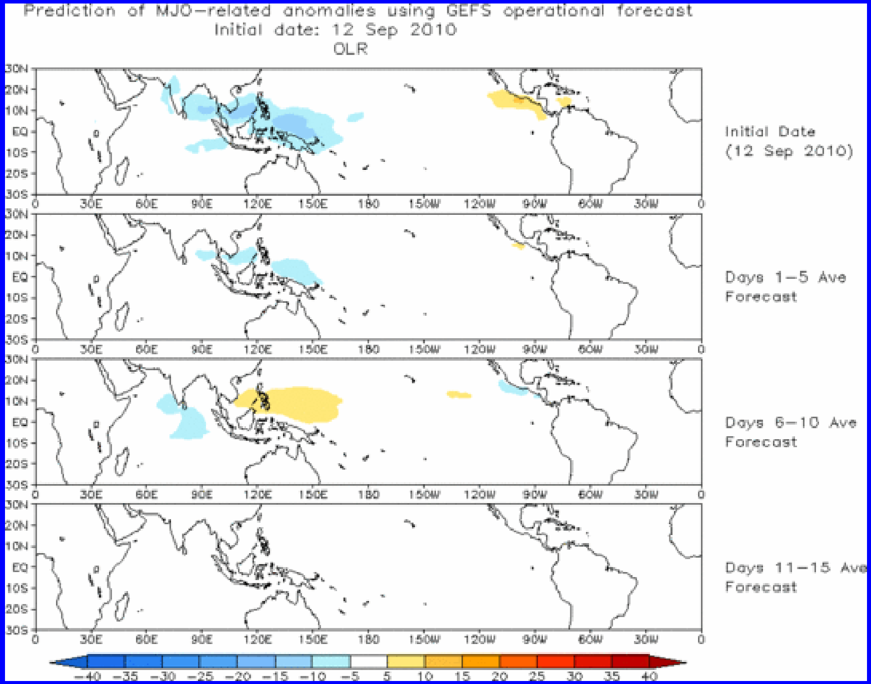


The GFS forecasts indicate weak MJO activity during the next two weeks.

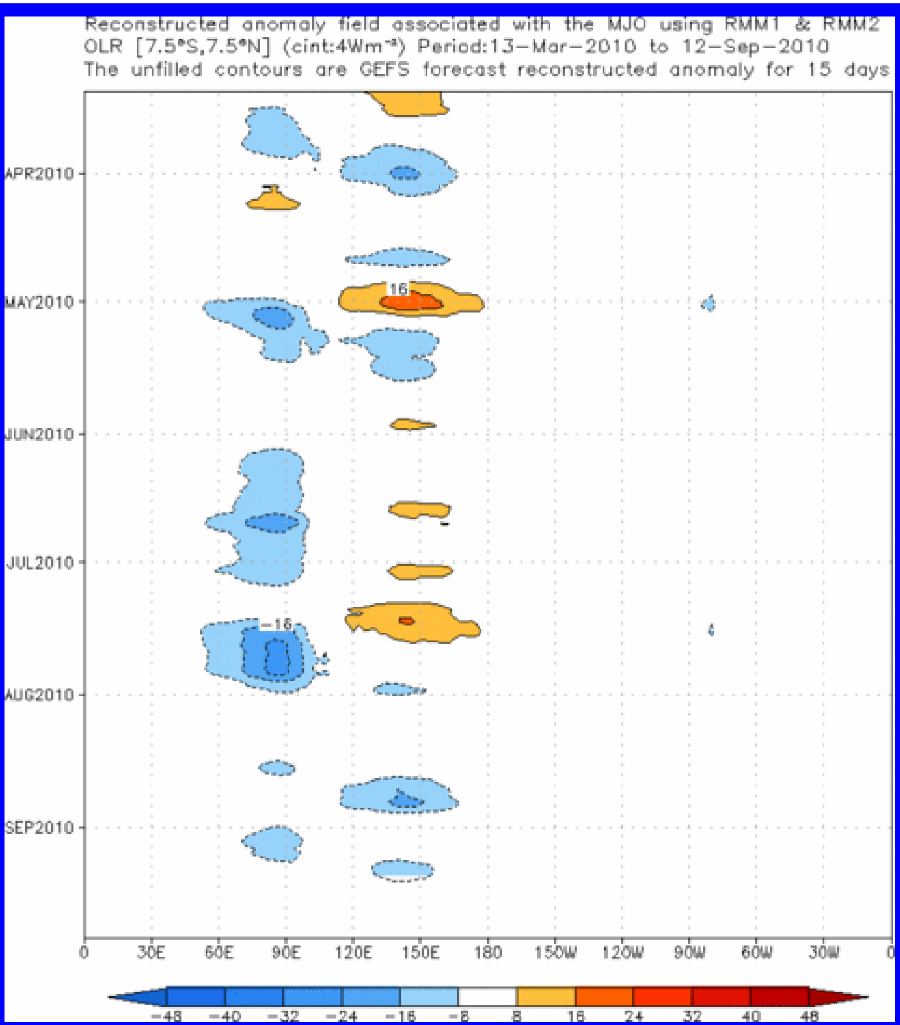
Ensemble Mean GFS MJO Forecast

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



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 generally weak convective anomalies during the period.

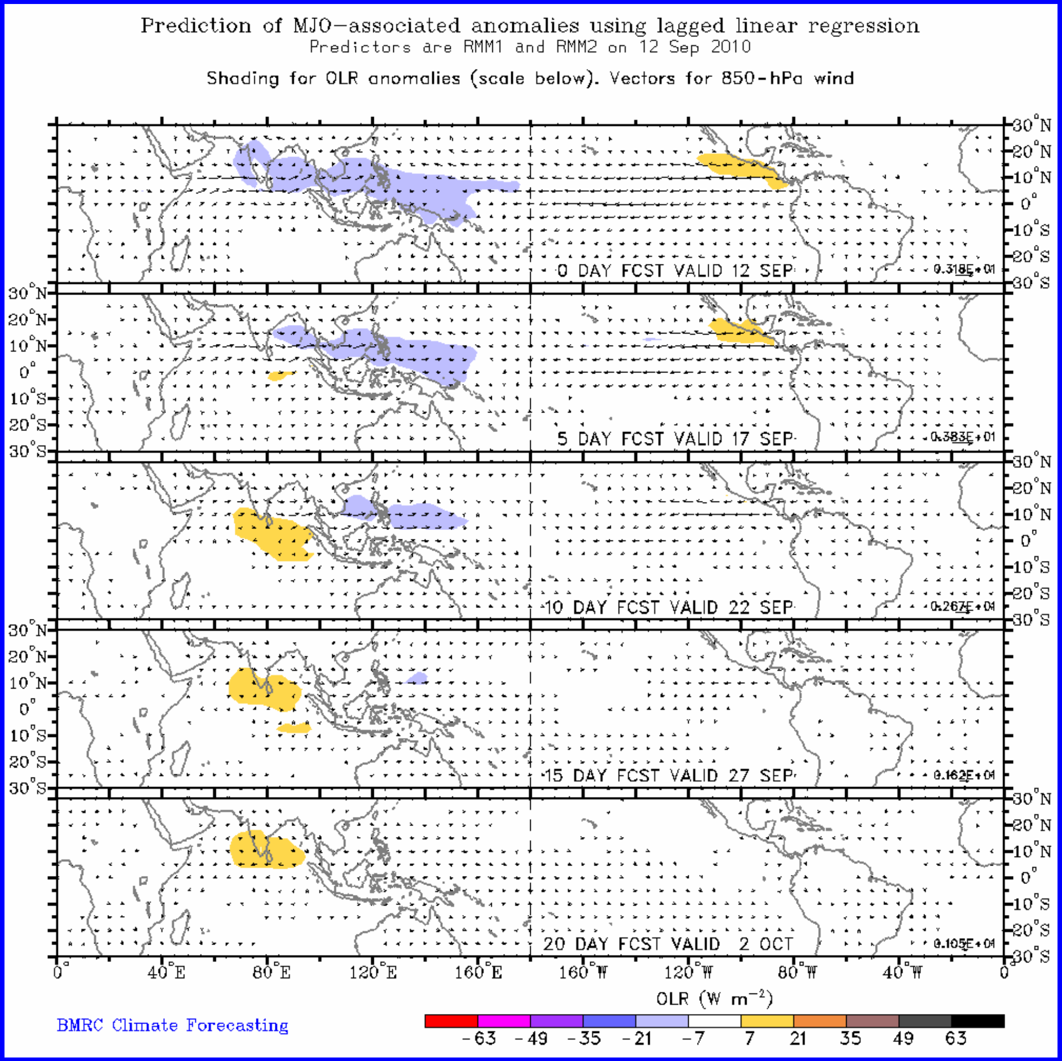
Statistical MJO Forecast

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

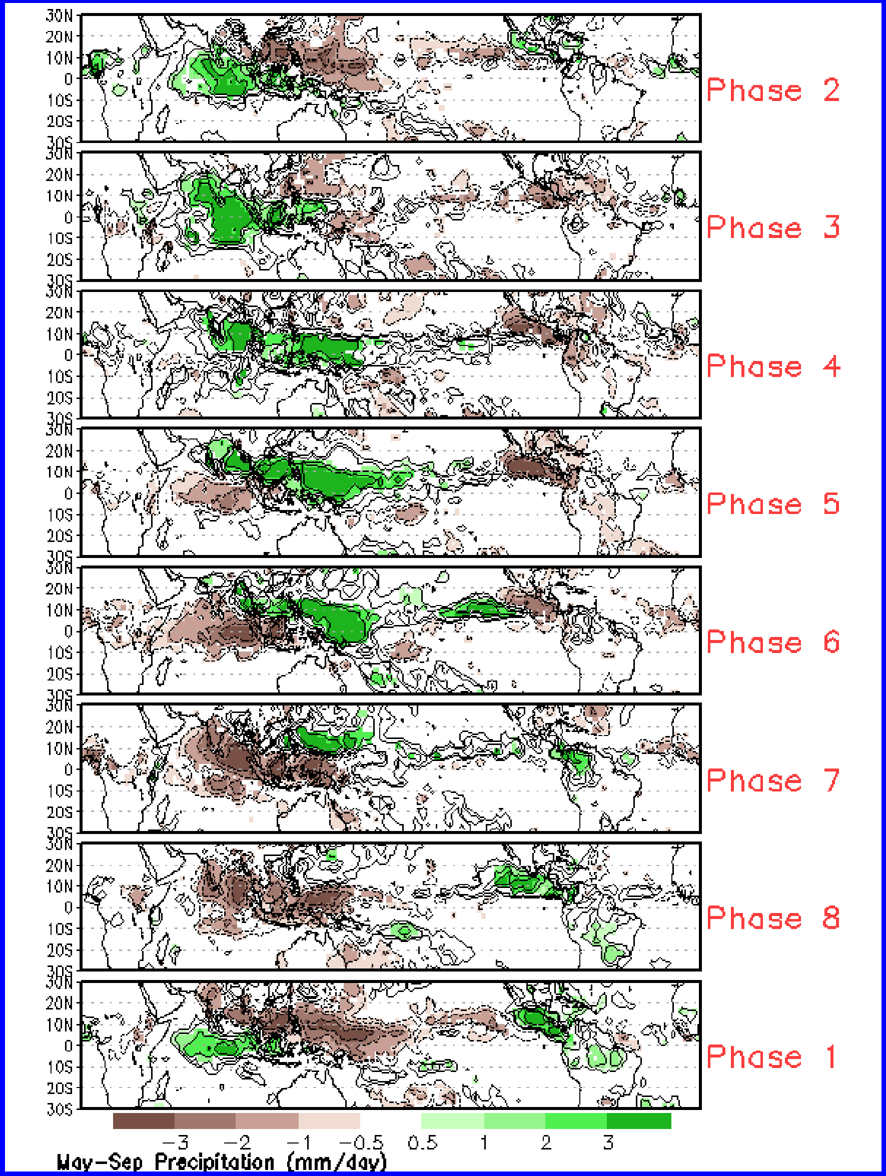
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

Weak MJO activity is forecast during the period.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)