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

Update prepared by
Climate Prediction Center / NCEP
October 11, 2010

Outline

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

Overview

- The MJO index has strengthened dramatically during the past week with the enhanced phase centered across the eastern Maritime continent.

- Dynamical model MJO forecasts indicate continued eastward propagation of the current activity during Week-1 but reduced eastward propagation and a weakening signal during Week-2. Uncertainty remains high for whether this current activity will become a long-lived MJO event due to underlying La Nina background conditions.

- Based on the latest observations and dynamical forecasts, the MJO signal is expected to continue to shift eastward to the western Pacific over the next week.

- Enhanced rainfall is forecast for the Maritime continent and western Pacific with suppressed rainfall over Central America. Drier-than-average conditions are likely to develop across the equatorial Indian Ocean.

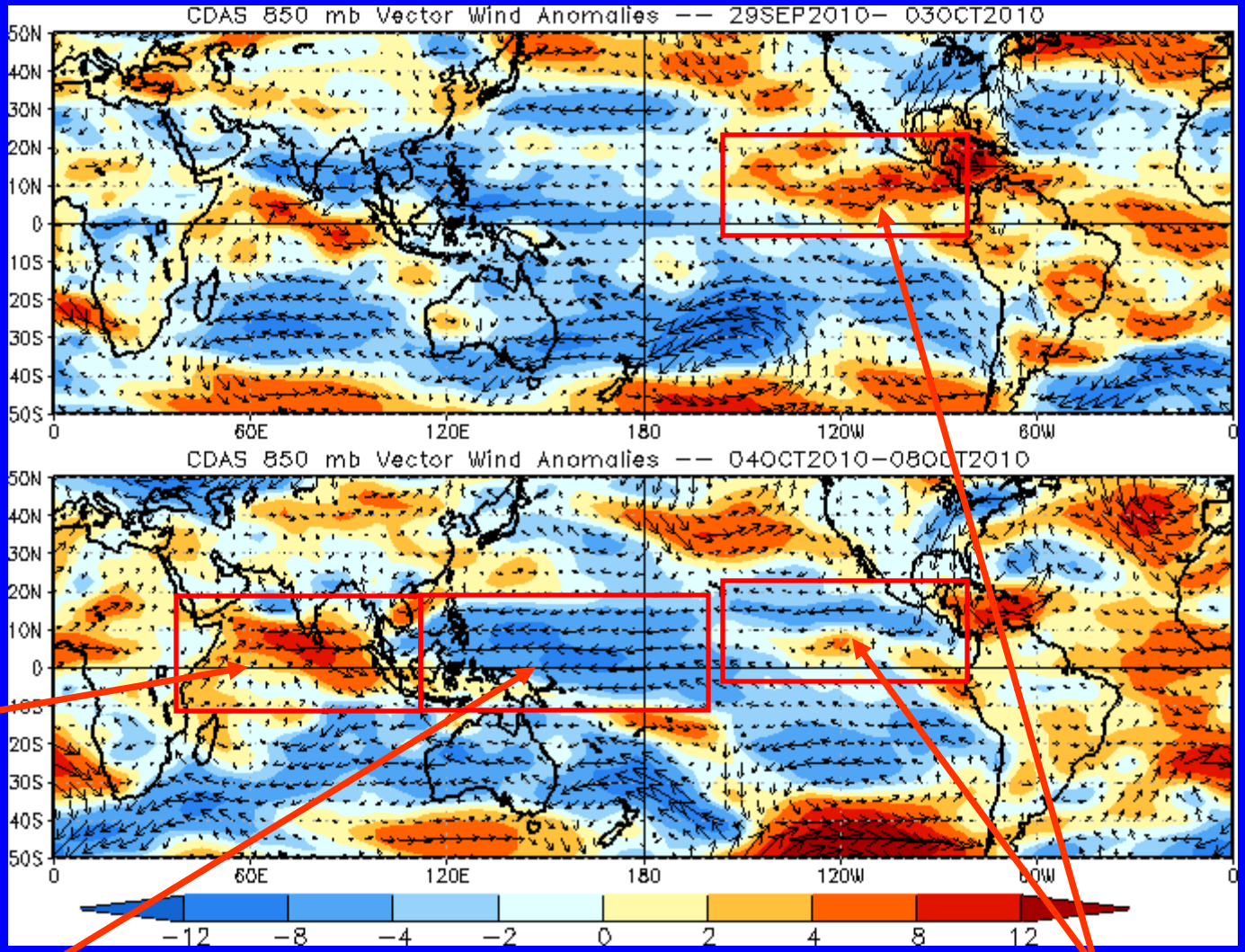
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly anomalies across the Indian Ocean have increased in coverage and strength during the last five days.

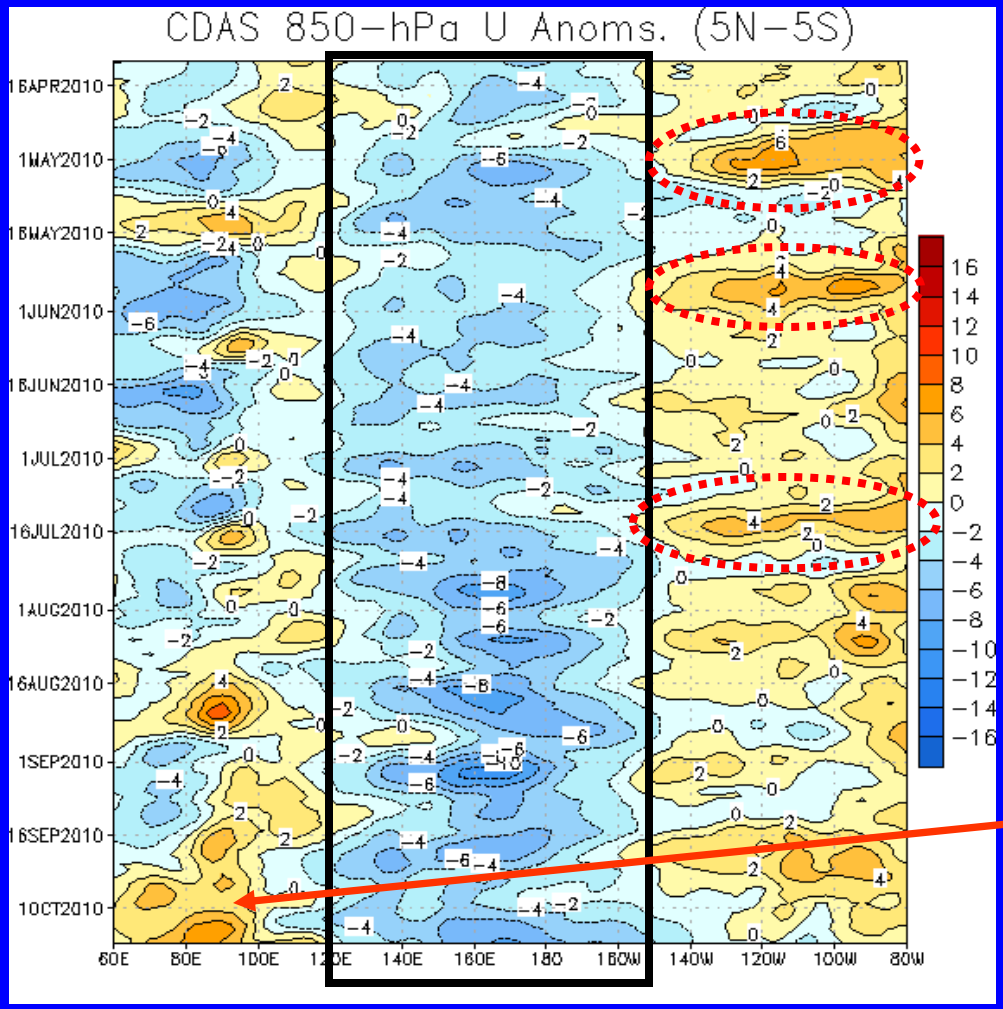
Easterly anomalies persisted across the western Pacific during the last five days.

Westerly anomalies weakened considerably across the eastern Pacific during the last five 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

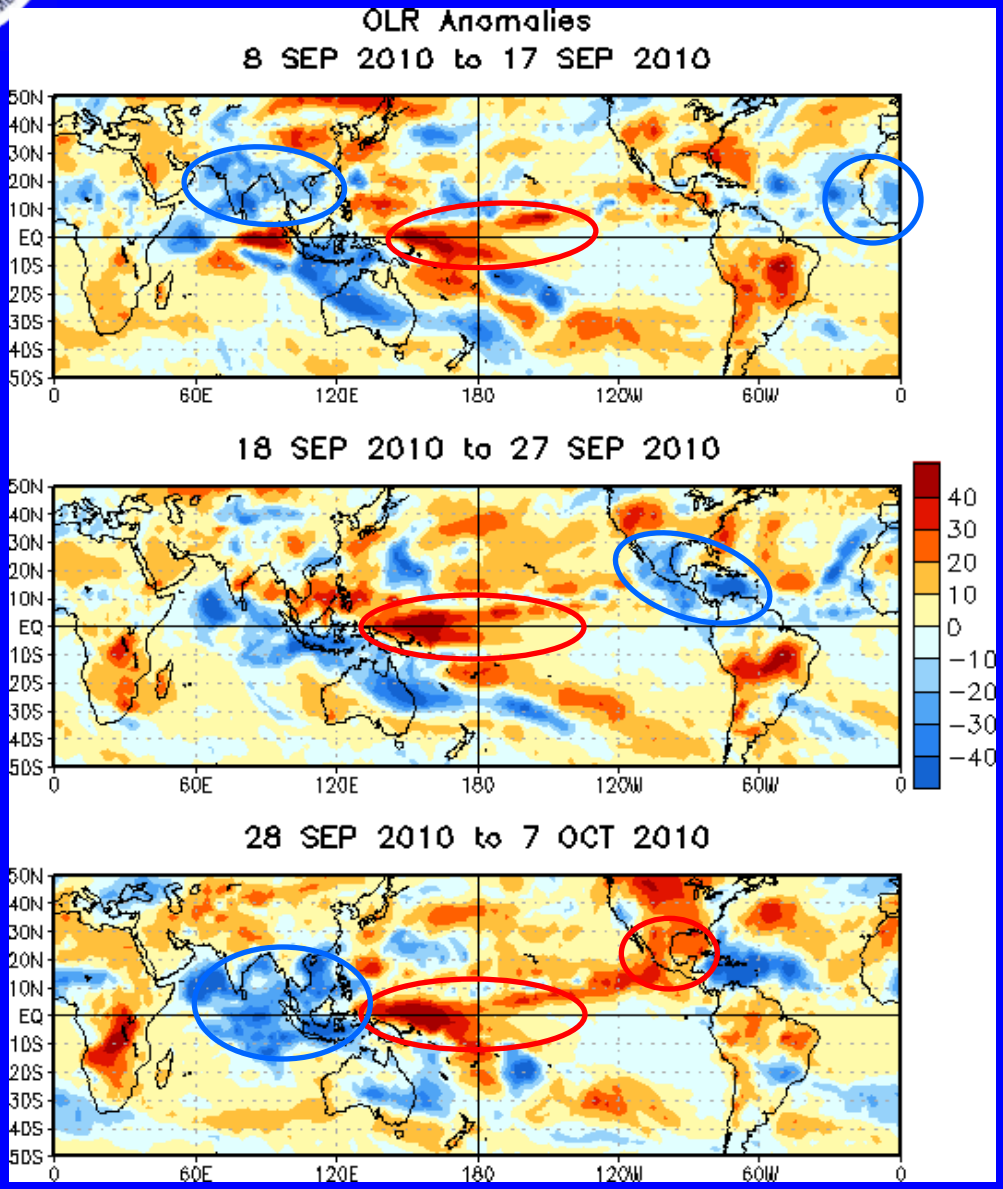
Longitude

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.

Westerly anomalies have become more pervasive across the equatorial Indian Ocean since mid-September.

OLR Anomalies – Past 30 days



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

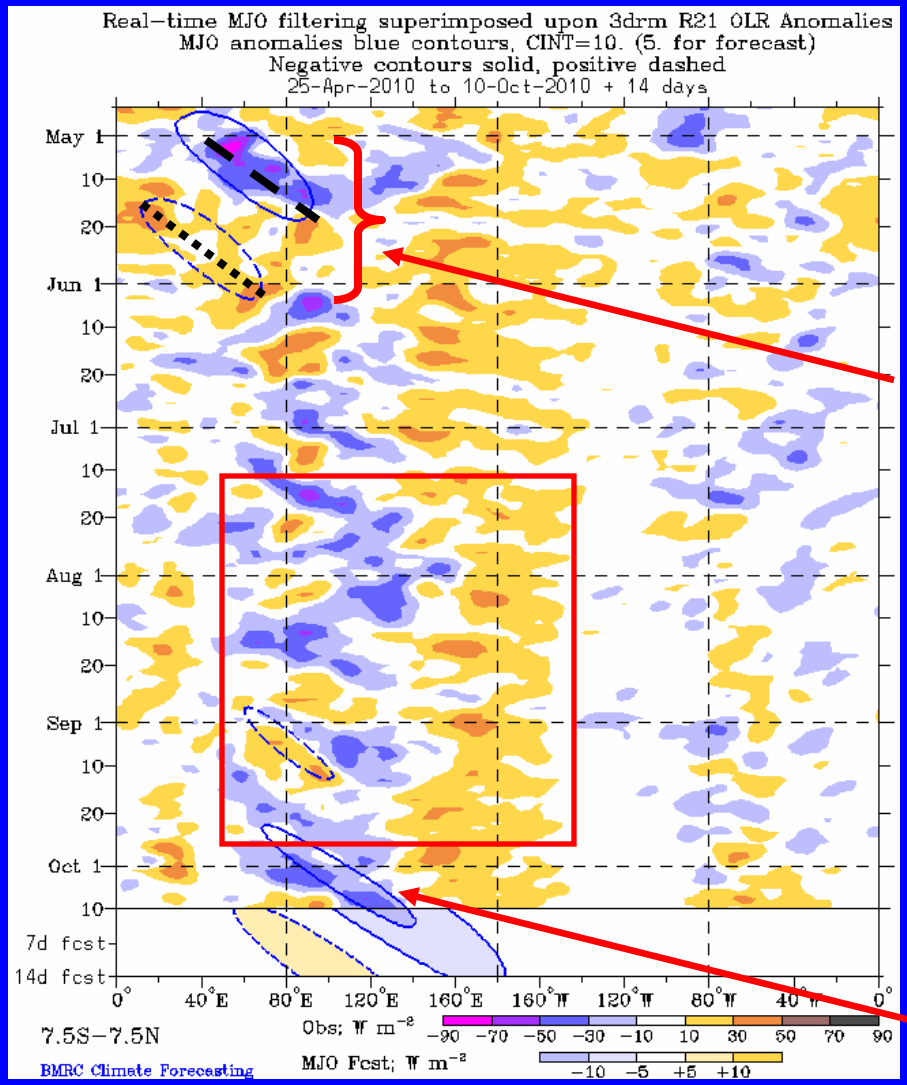
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

Enhanced convection (blue ovals) continued over west Africa and parts of southern Asia during mid September while suppressed convection (red ovals) continued across the west-central Pacific.

During mid-to-late September, enhanced convection was evident across Mexico, Central America and the Caribbean.

Drier-than-average conditions developed over Mexico and Central America in early October while enhanced convection developed across much of 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)

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

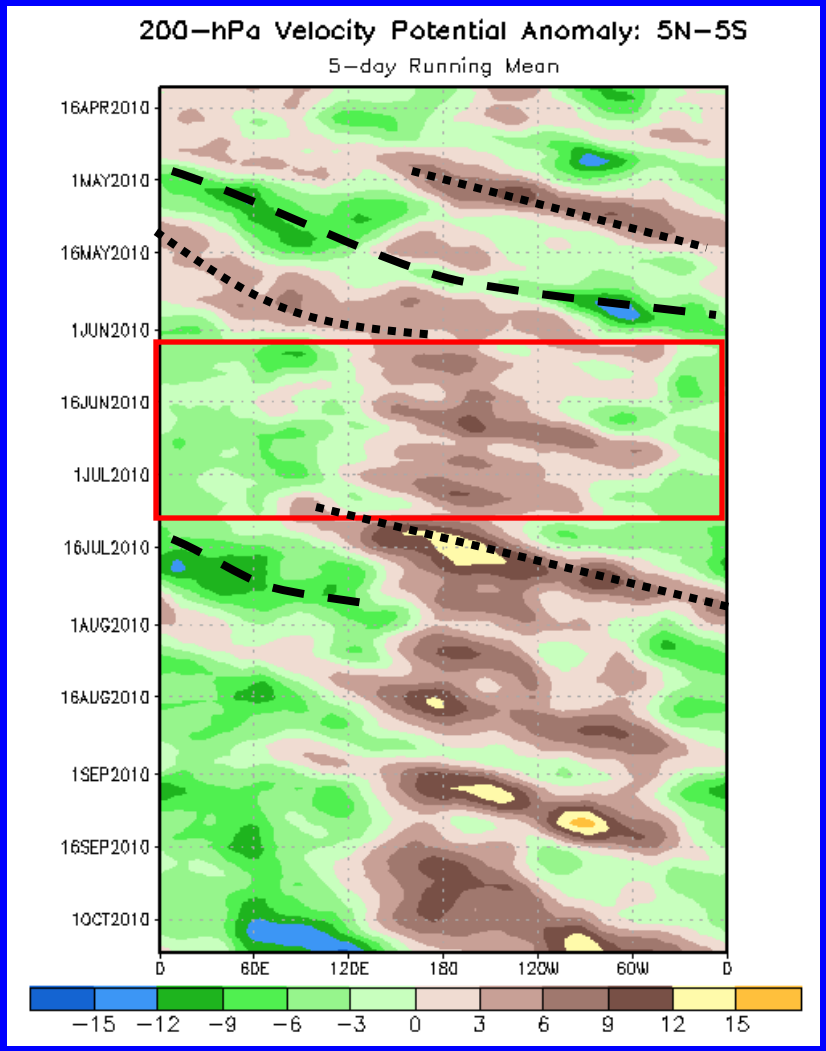
From mid-July into September, generally enhanced (suppressed) convection prevailed across the western Maritime continent (Date Line) (red box). Considerable intraseasonal variability is evident during the period as enhanced convection has shifted both eastward and westward in this area during the period.

In late September, stronger enhanced convection developed near 80E with eastward propagation evident.

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 late April into 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 associated with the MJO.

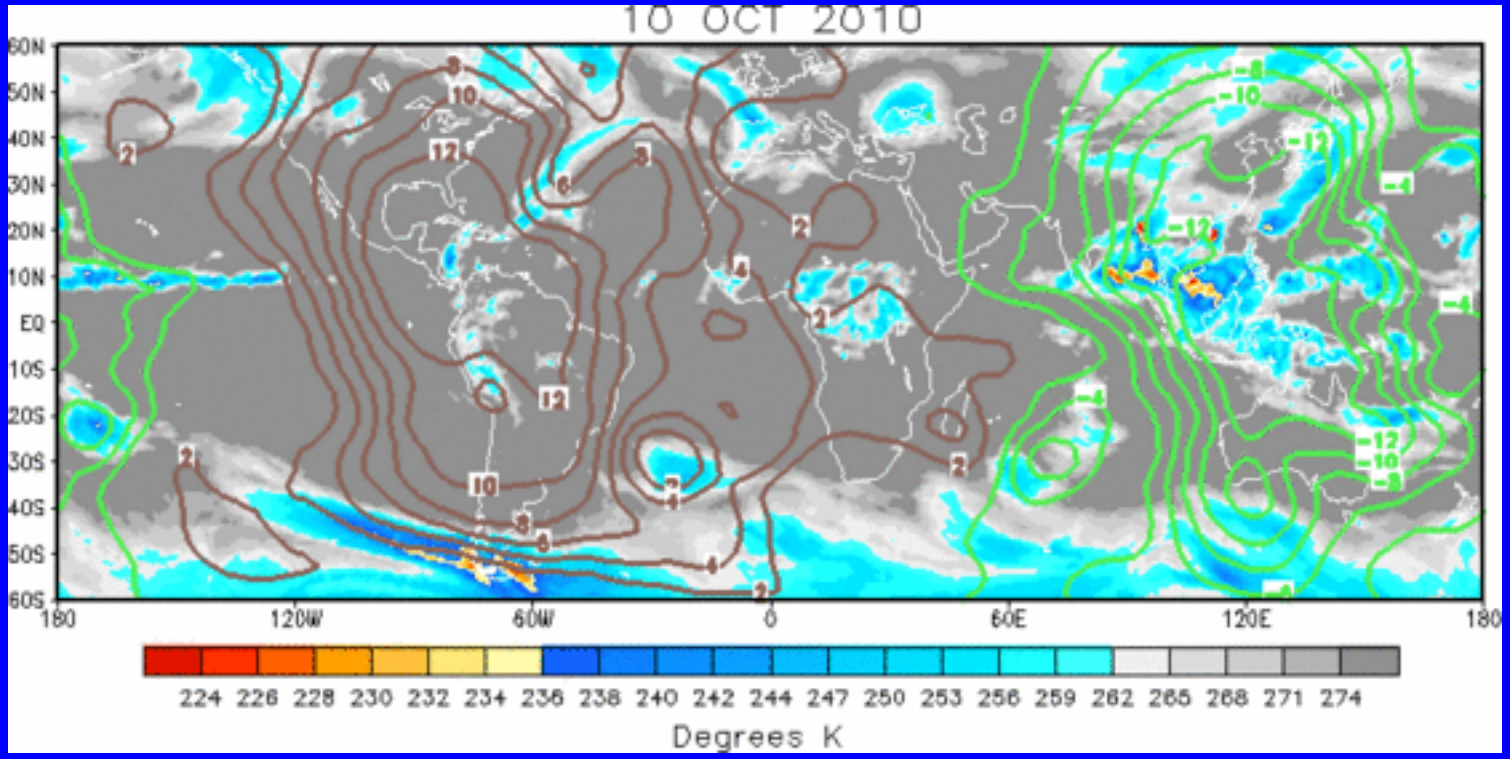
Eastward propagation in August and September has mainly been associated with higher frequency coherent tropical variability rather than the MJO.

Anomalies have increased markedly during October with strong enhanced upper-level divergence (convergence) evident from 60E-120E (120W – 60W). Some eastward propagation is evident.

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

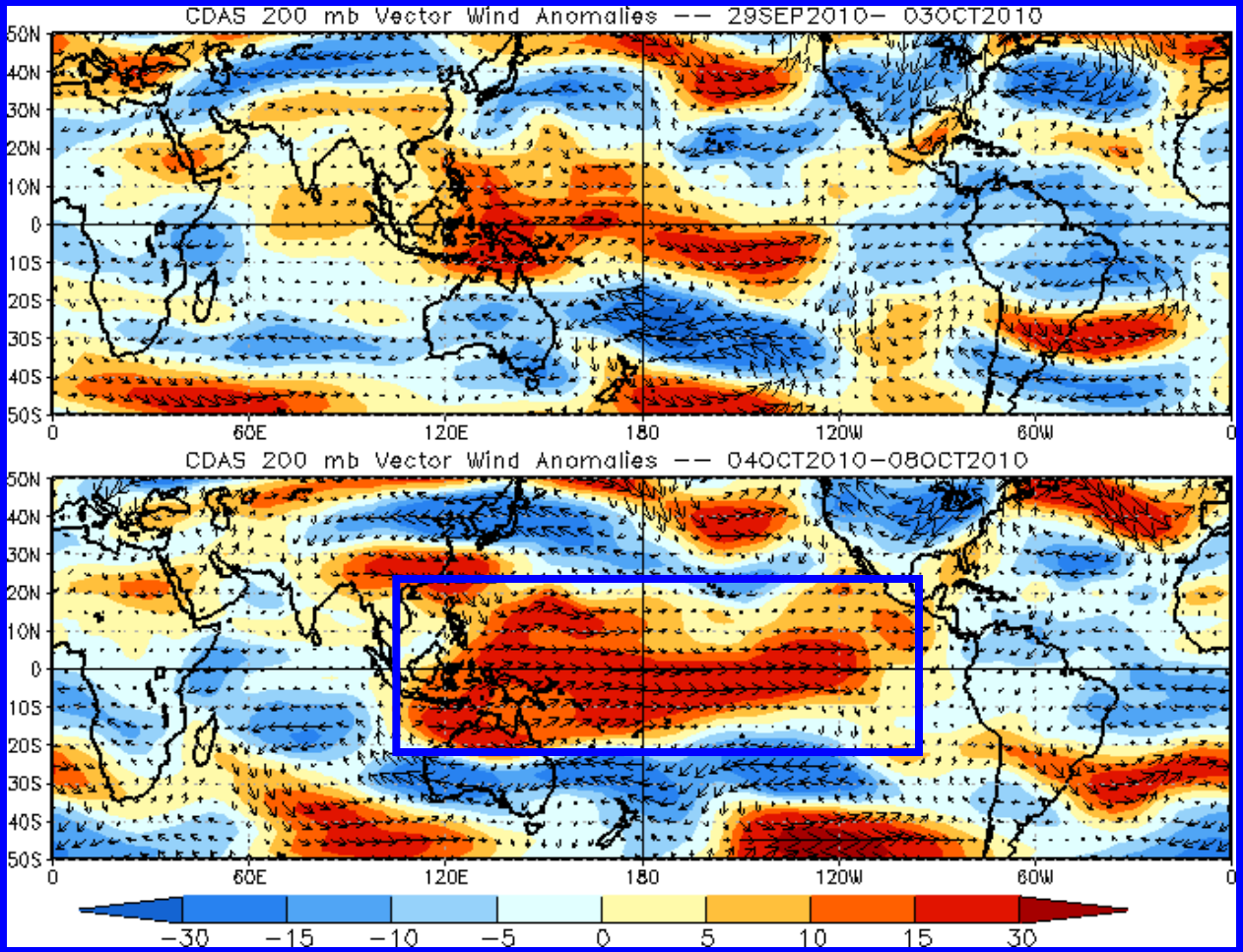
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



Anomalous velocity potential shows a large-scale coherent pattern with upper-level divergence centered over the Maritime continent and upper-level convergence centered over the Americas.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

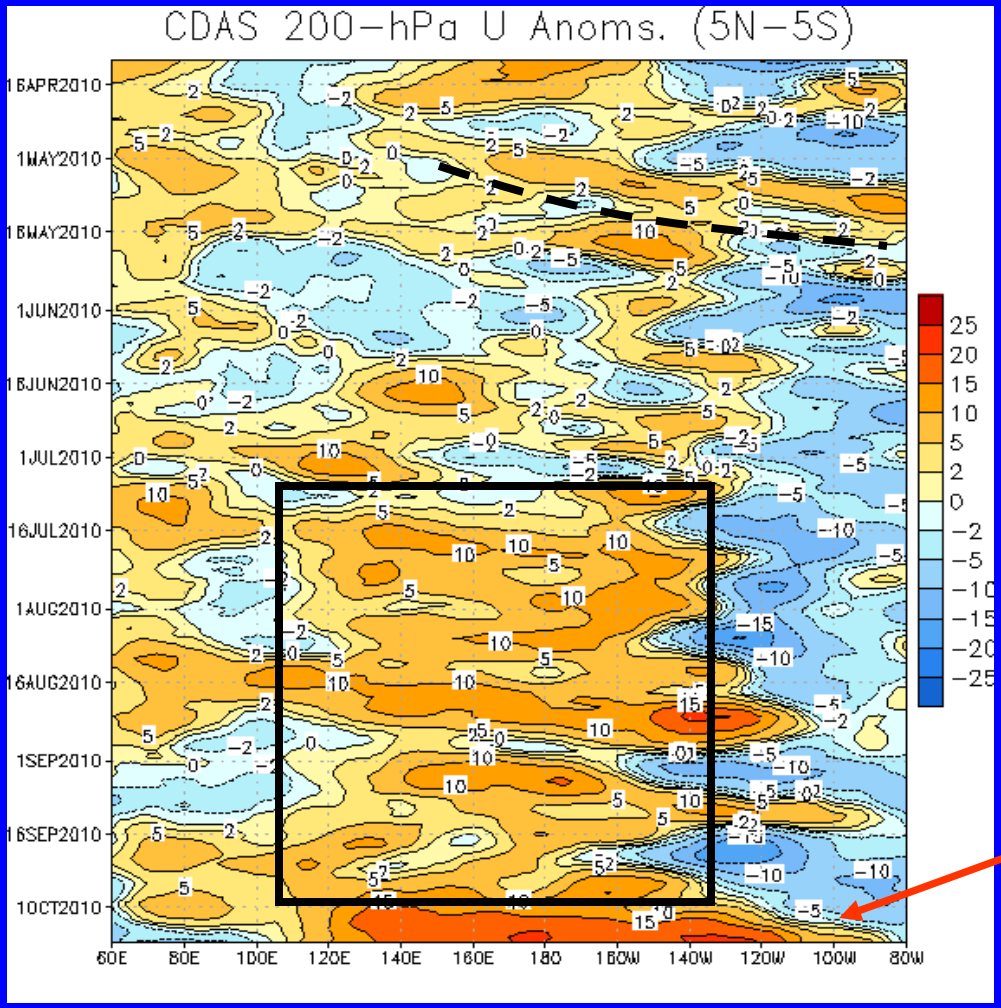
Red shades: Westerly anomalies

Westerly anomalies have strengthened over the Maritime continent and western Pacific (blue box) and have extended into the eastern Pacific during the last five days.

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

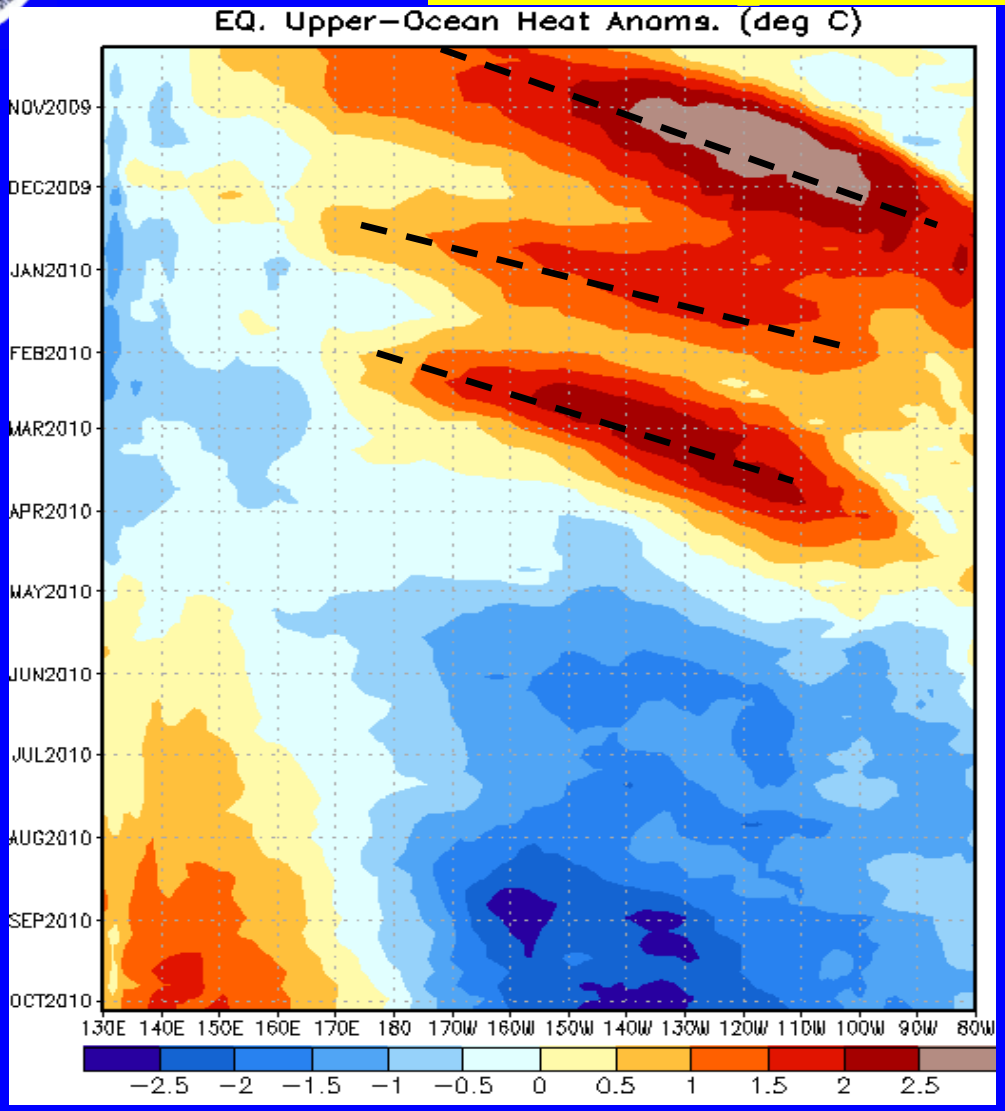
Longitude

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. Eastward propagation of westerly anomalies in August and September were not associated with the MJO.

In early October, westerly anomalies have strengthened considerably and an eastward extension of these anomalies is evident to near 80W.

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).

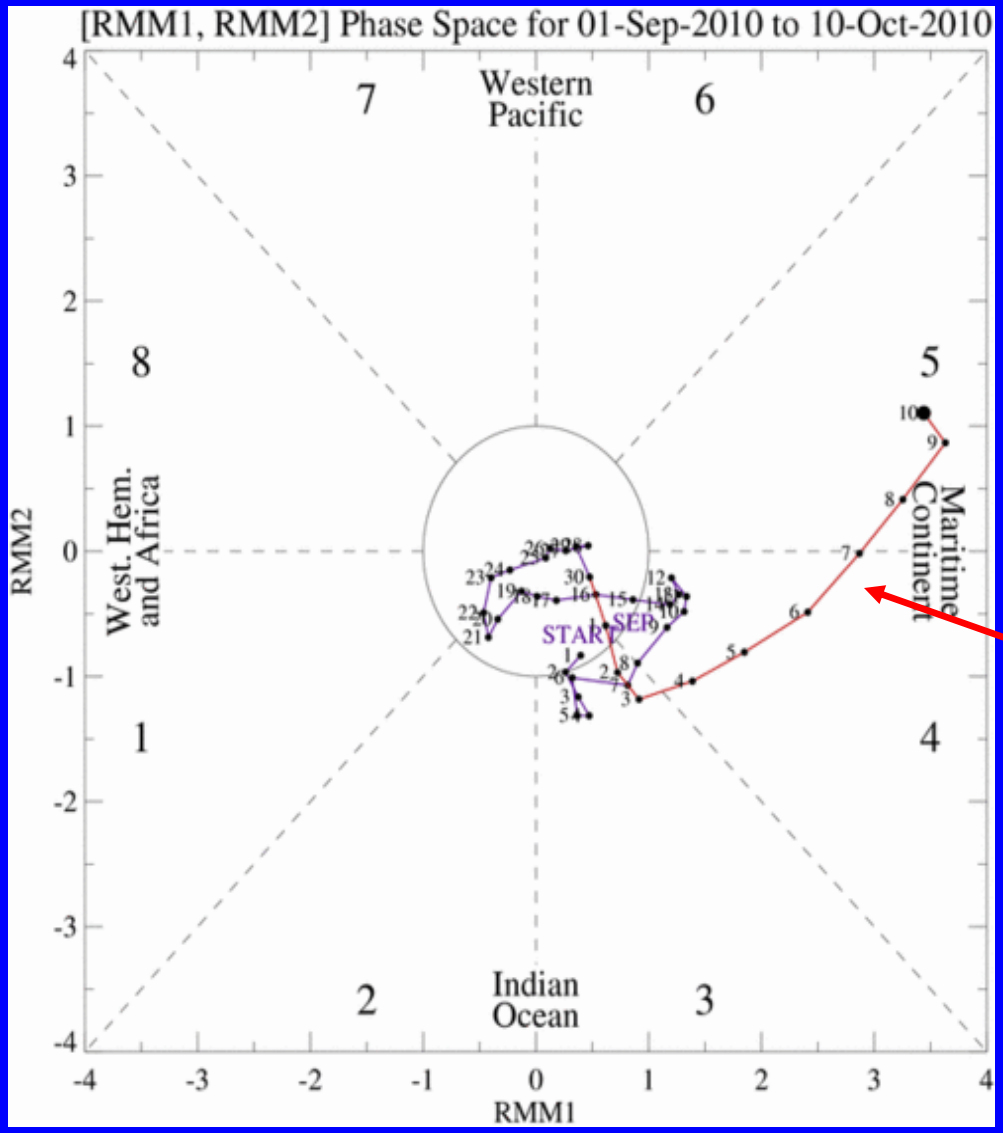
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review,* 132, 1917-1932.

• 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 Madden-Julian Oscillation Forecasts: A CLIVAR MJO Working Group Project, *Bull. Amer. Met. Soc.*, 91, 1247-1258.

• 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).

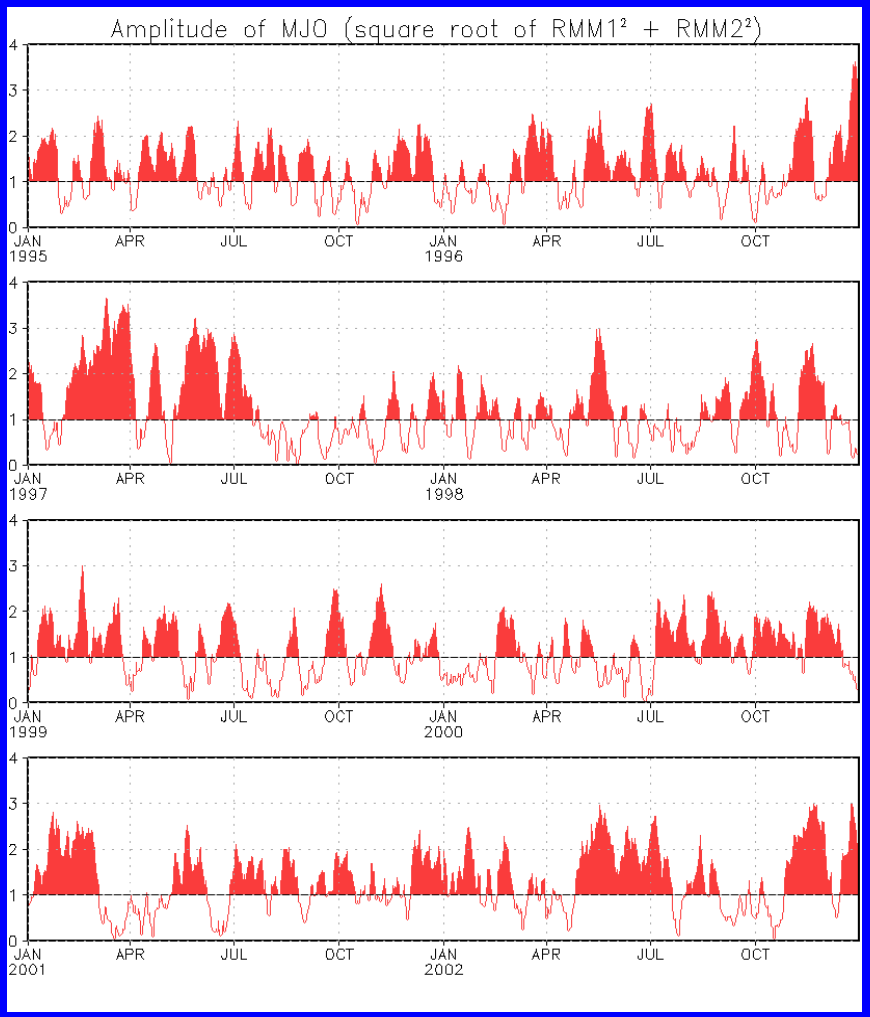
MJO Index -- Recent Evolution

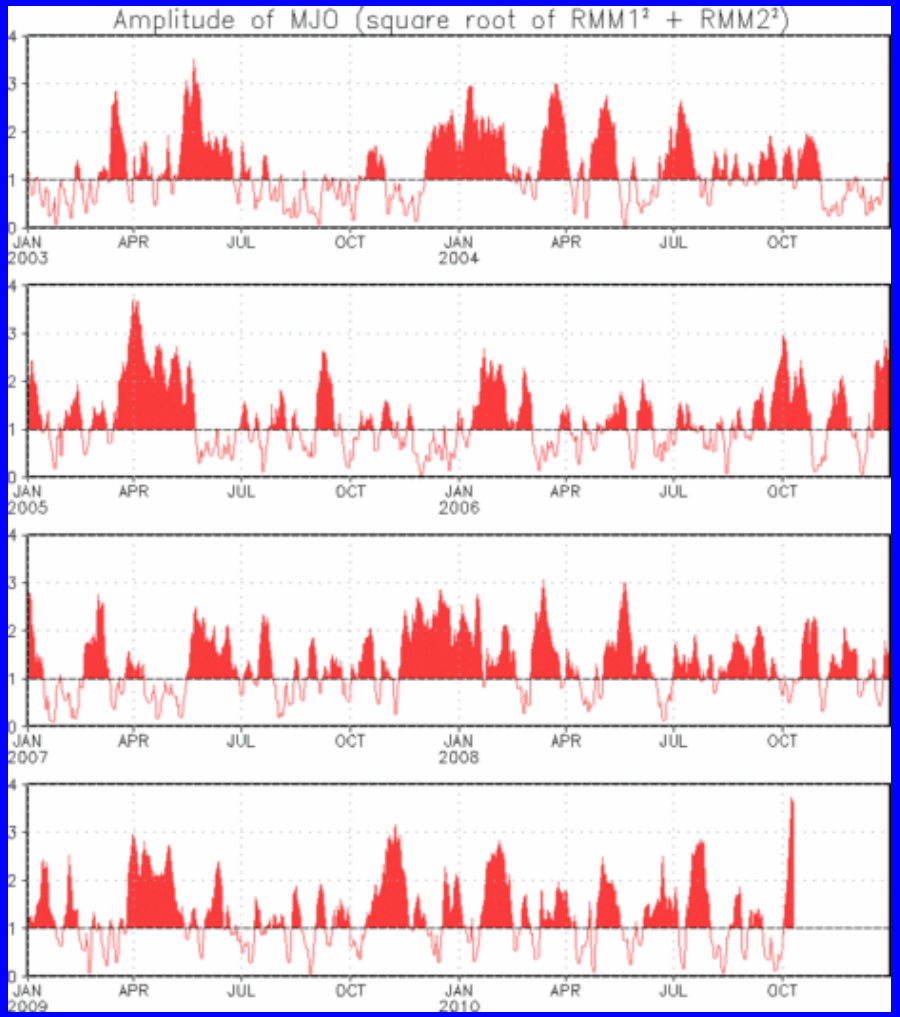


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index strengthened strongly during the past week and the signal is now centered across the eastern Maritime continent.

MJO Index – Historical Daily Time Series





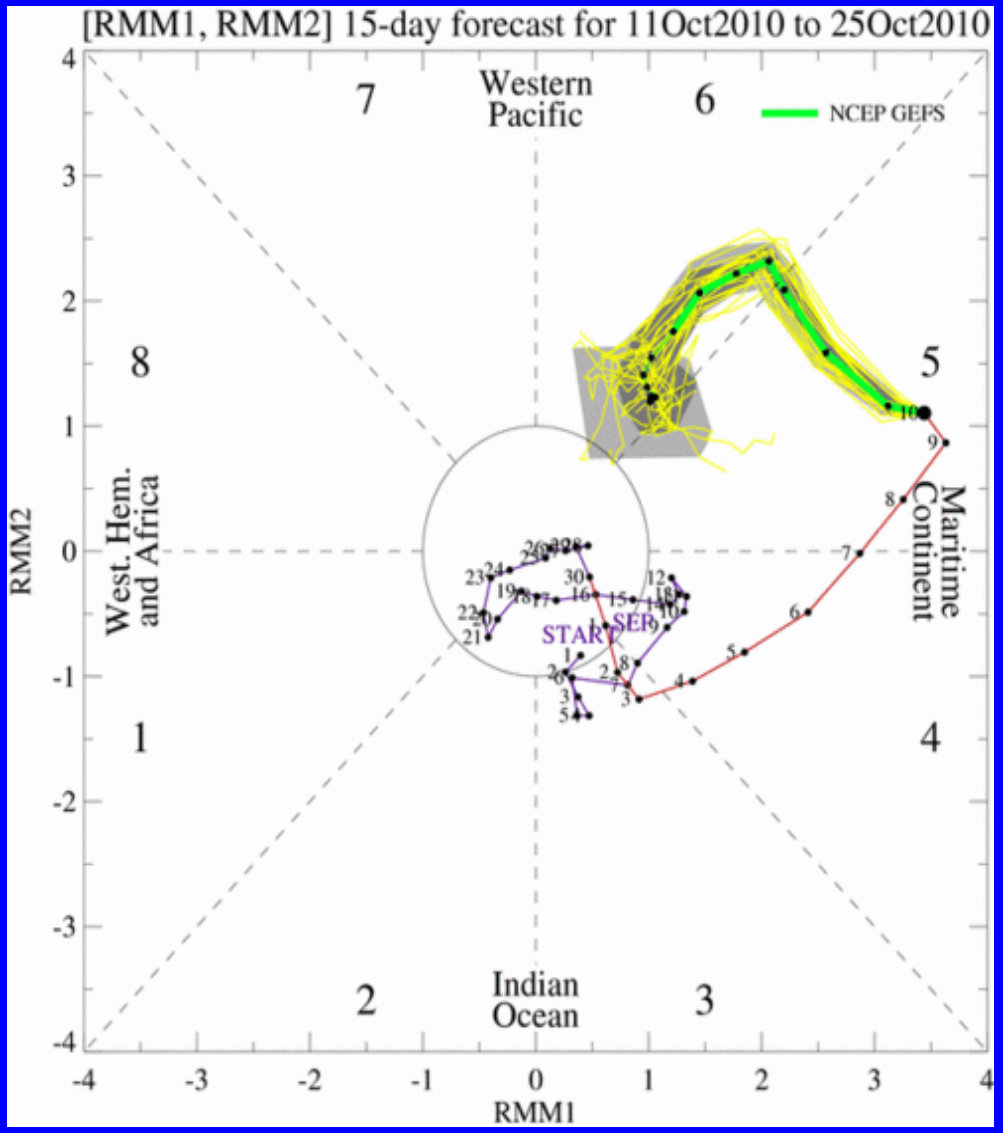
Time series of daily MJO index amplitude from 1995 to present.
Plots put current MJO activity in historical context.

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



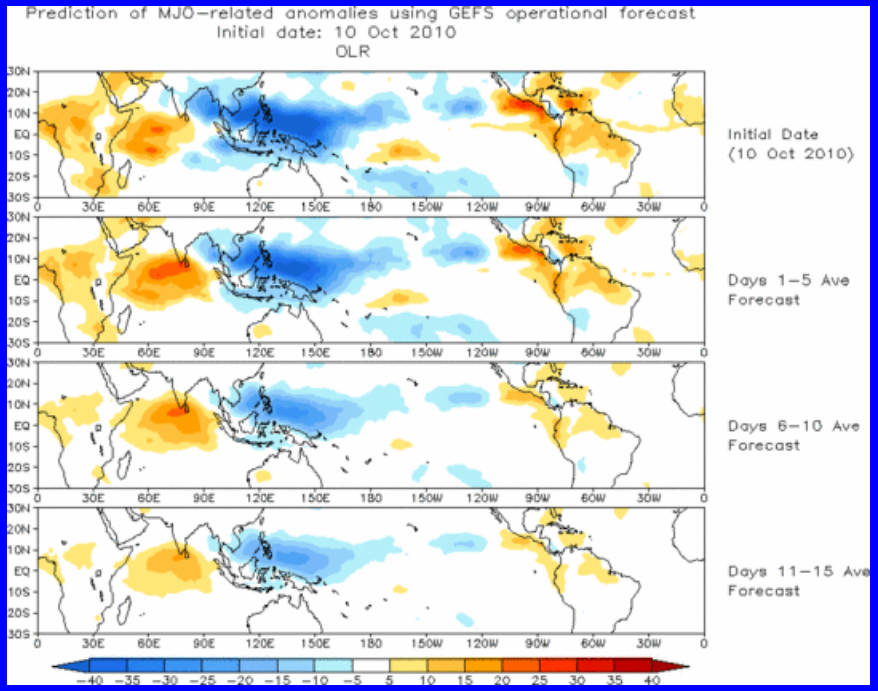
The GFS forecasts indicate continued eastward propagation for most of Week-1 with a decrease in amplitude.

The forecasts indicate a cessation of propagation and a continued weakening of the signal during Week-2. Ensemble spread also increases during this period.

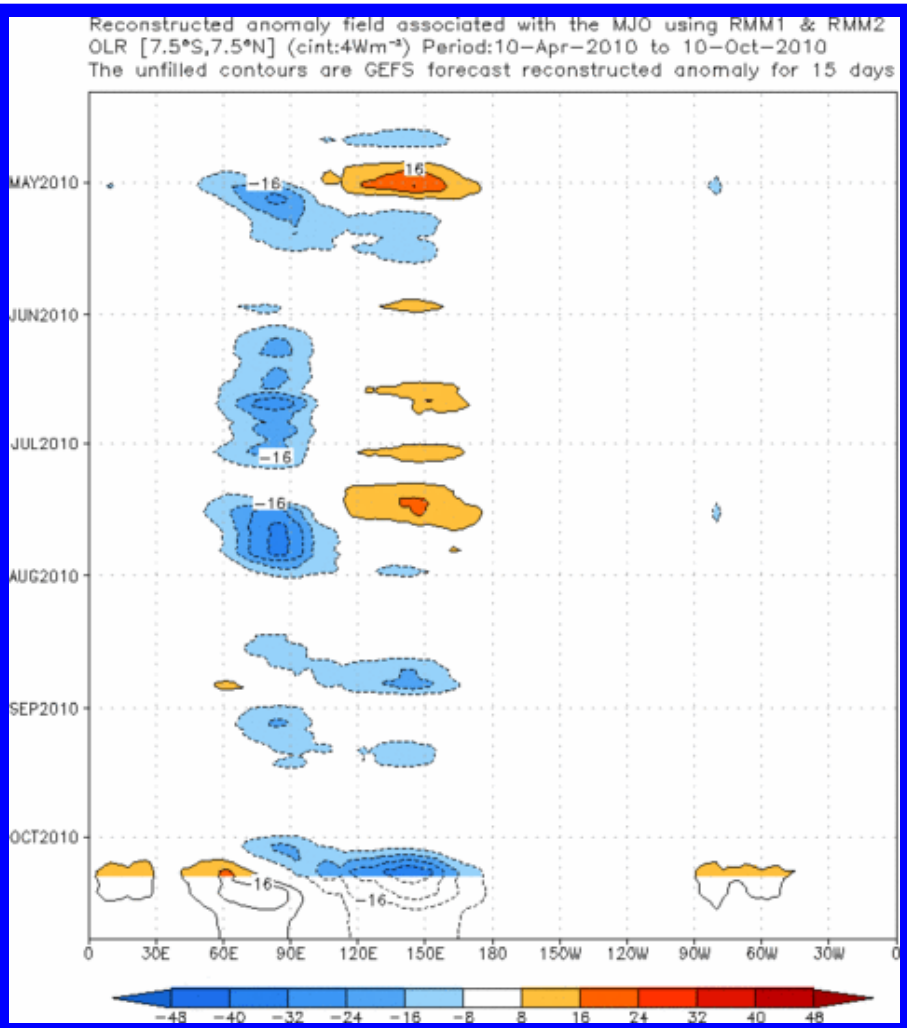
Ensemble Mean GFS MJO Forecast

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 over the Maritime Continent and western Pacific during Week 1 with only very minor eastward propagation over the entire period. Suppressed convection is forecast over Central America and Africa.

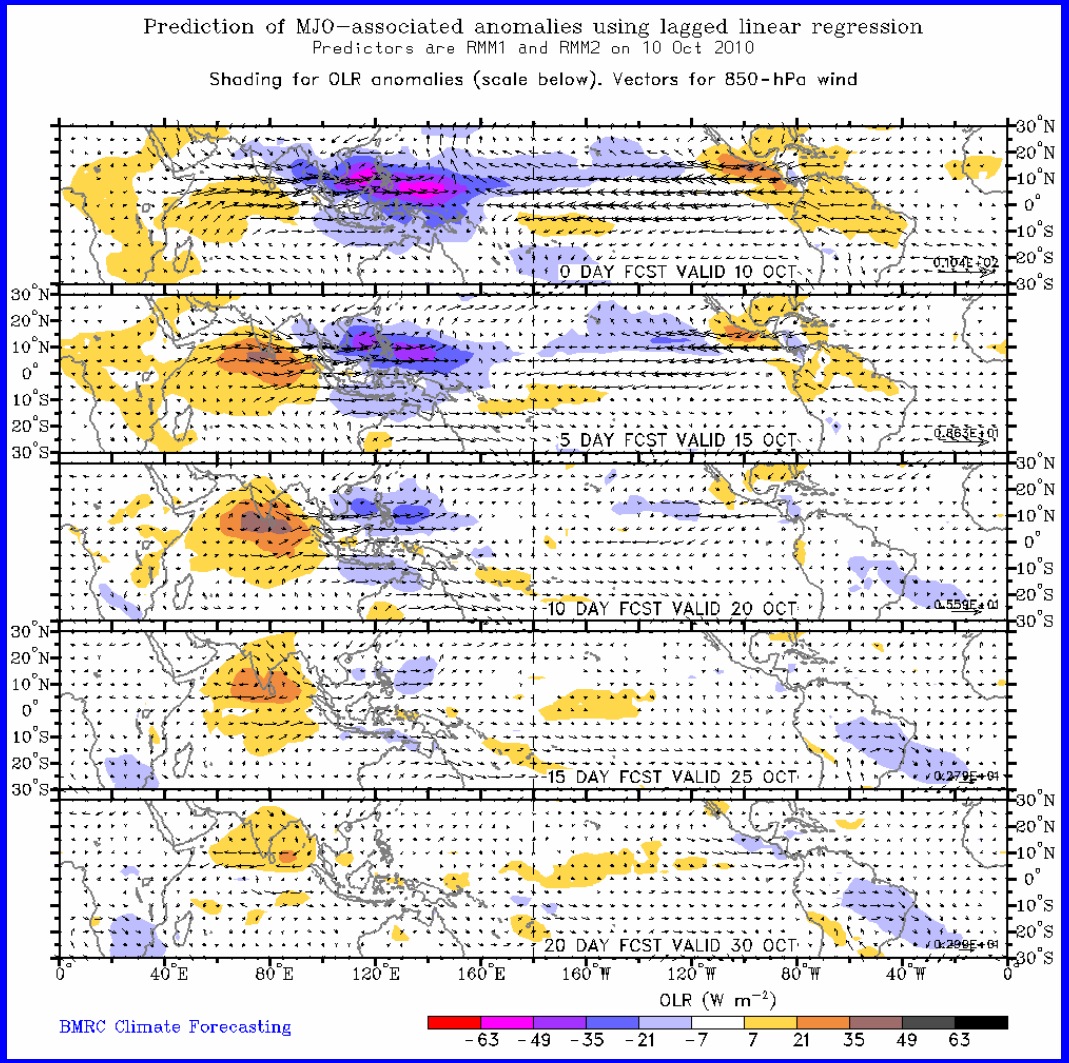
Statistical MJO Forecast

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

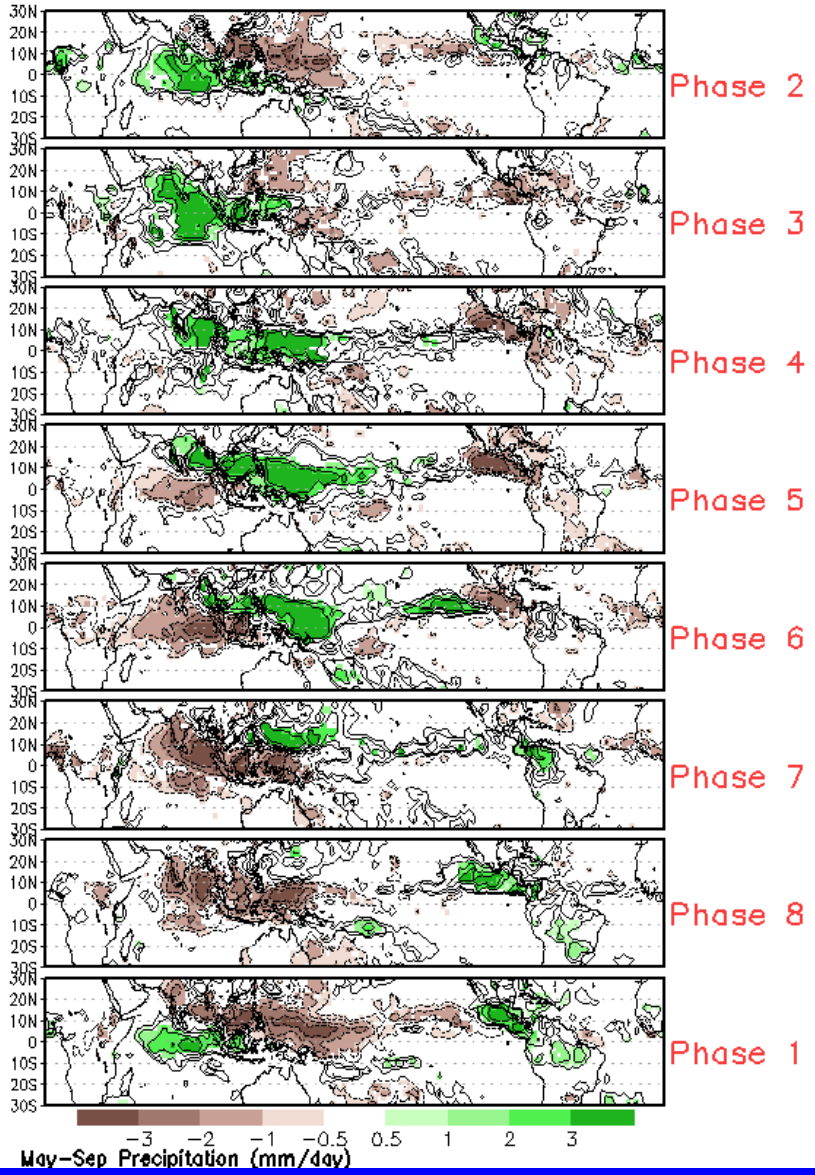
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

Strong MJO activity is forecast during the period with enhanced convection over the eastern Maritime continent and western Pacific especially early in the period. Suppressed convection strengthens over the period across the Indian Ocean.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)