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

Update prepared by
Climate Prediction Center / NCEP
May 31, 2010

Outline

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

Overview

- The MJO remained weak during the past week as indicated by recent observations.

- There is considerable spread in solutions from dynamical model MJO index forecasts for the coming two weeks. Some models indicate a weak signal across the Indian Ocean during the period.

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

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

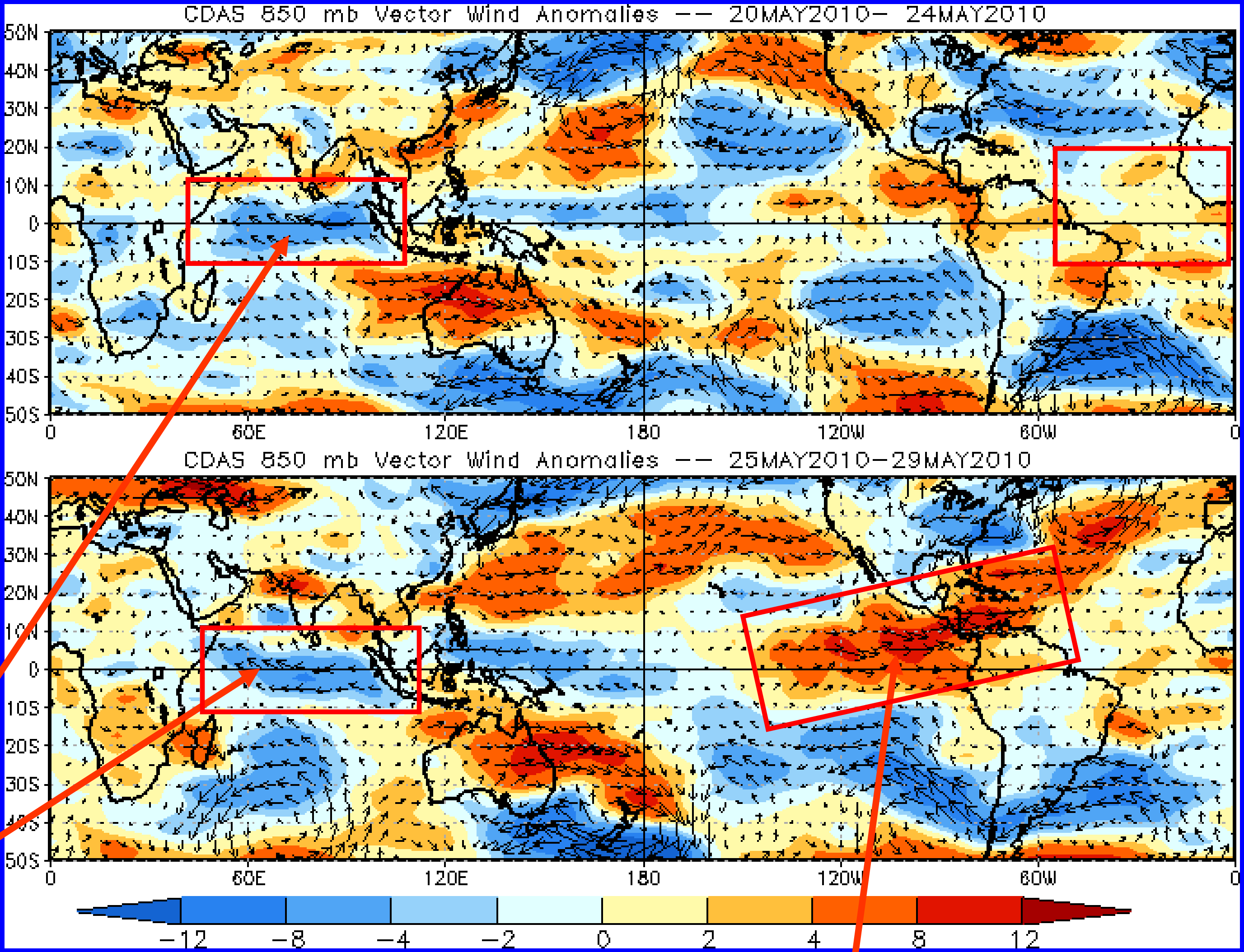
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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 have been evident during the past five to ten days across the equatorial Indian Ocean.

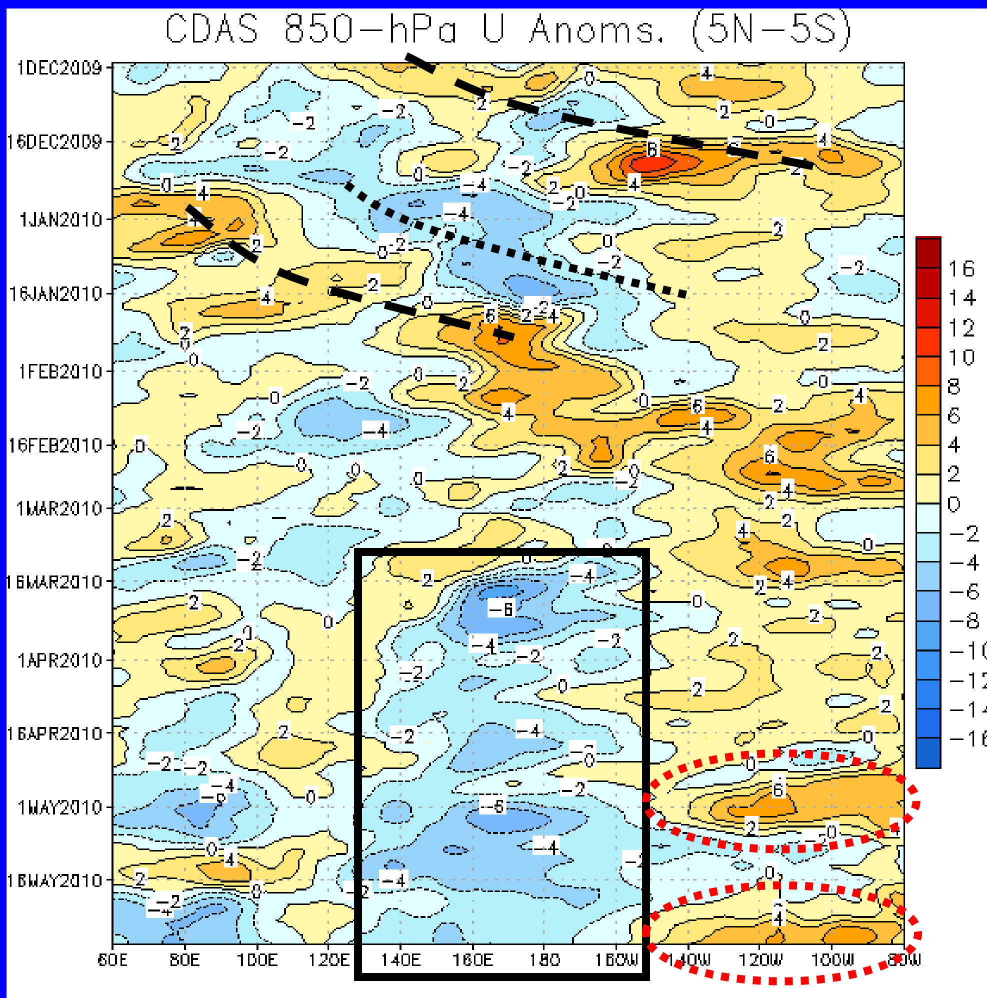
Strong westerly anomalies developed during the last five days across a large region from the eastern Pacific to the western Atlantic.

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



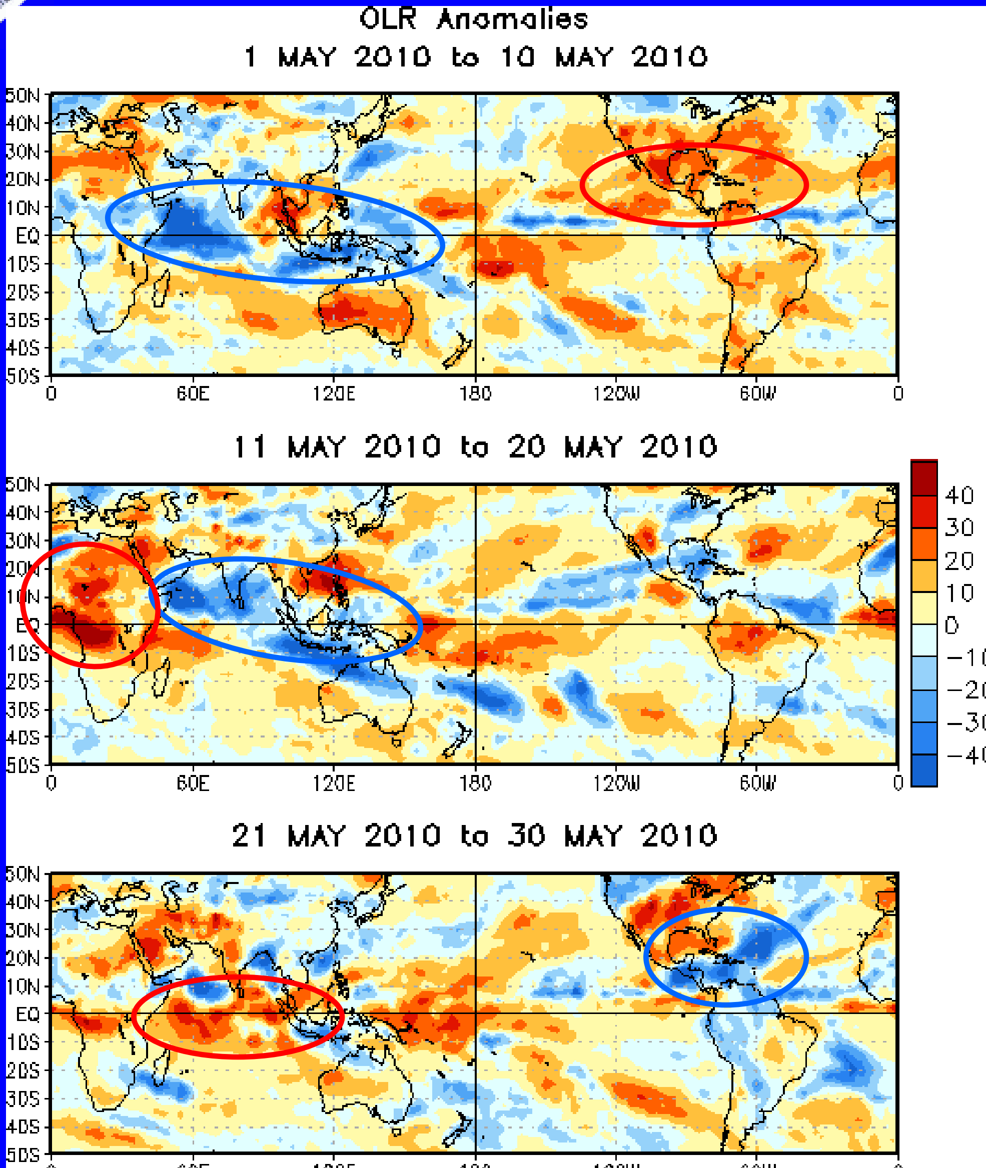
Longitude

Westerly (dashed line) anomalies developed across the Indian Ocean and shifted eastward across the Date Line during November and early December associated with the MJO.

Weaker and shorter-lived MJO activity was evident during January.

Easterly anomalies have persisted in the west-central Pacific since mid-March (black box). Strong westerly anomalies (red dotted ovals) have occurred across the eastern Pacific on separate occasions during late April and early May associated with the MJO and again in late May.

OLR Anomalies: Last 30 days



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

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

In early May, enhanced convection shifted east to the Indian Ocean and parts of the Maritime continent. Suppressed convection developed across parts of the eastern Pacific, Central America and the Caribbean.

Enhanced convection persisted across the Indian Ocean and parts of the Maritime continent during the middle of May. Suppressed convection developed across much of Africa during this period.

In late May, suppressed convection began to replace enhanced convection across the Indian Ocean. Enhanced convection developed over Central America and the Caribbean.

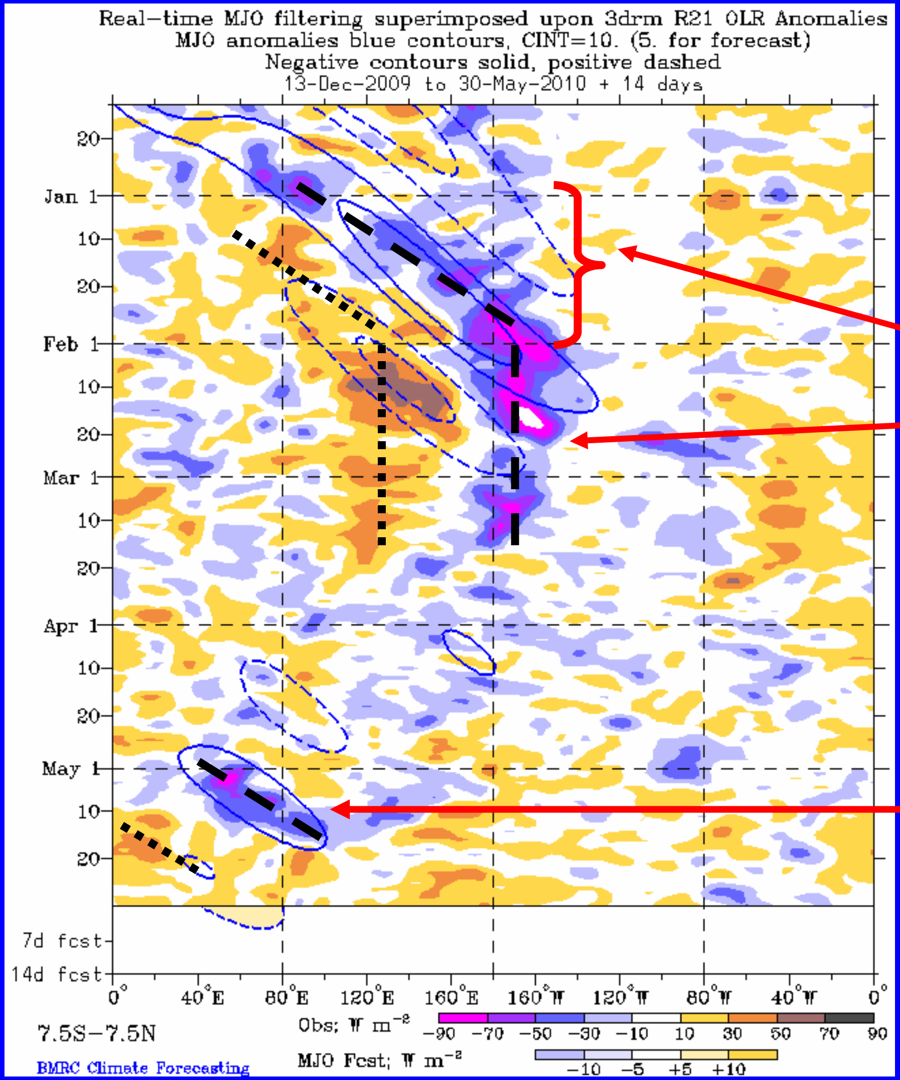
Outgoing Longwave Radiation (OLR) Anomalies (7.5°S-7.5°N)

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)

Time



Longitude

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.

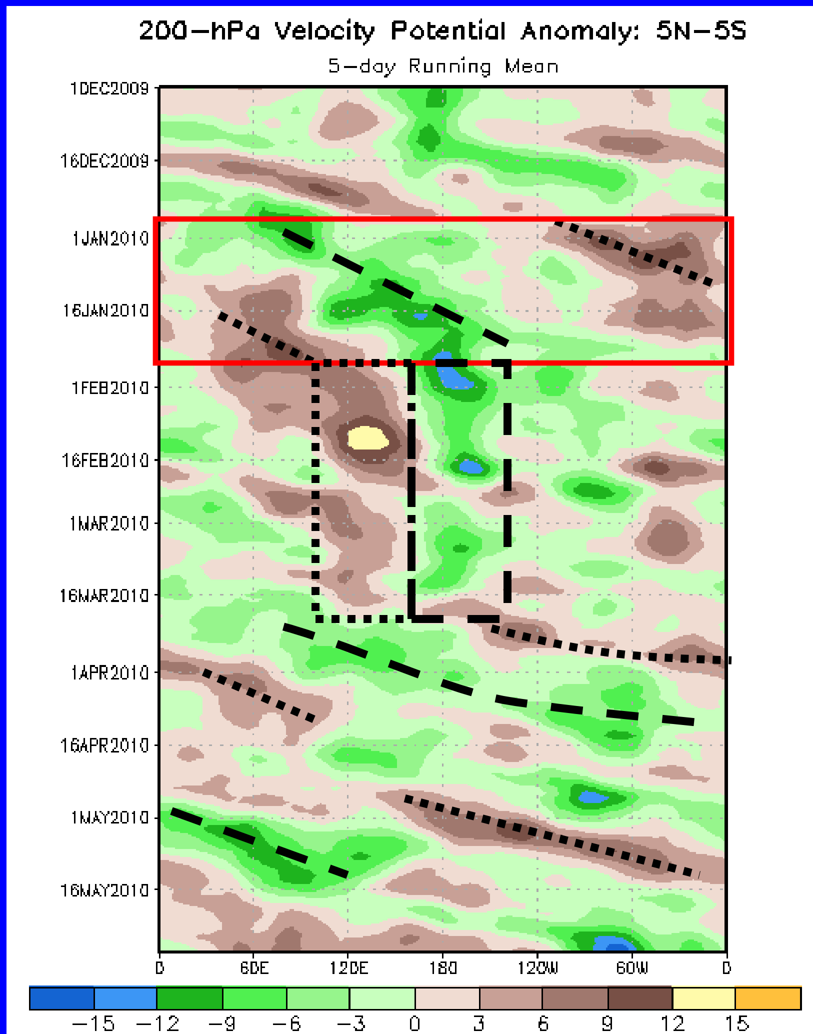
Enhanced convection in part associated with MJO activity developed across the Indian Ocean in early May and shifted slightly eastward. Suppressed convection developed after this across much of Africa.

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

Eastward propagation associated with the MJO was evident during early-mid January (red box).

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).

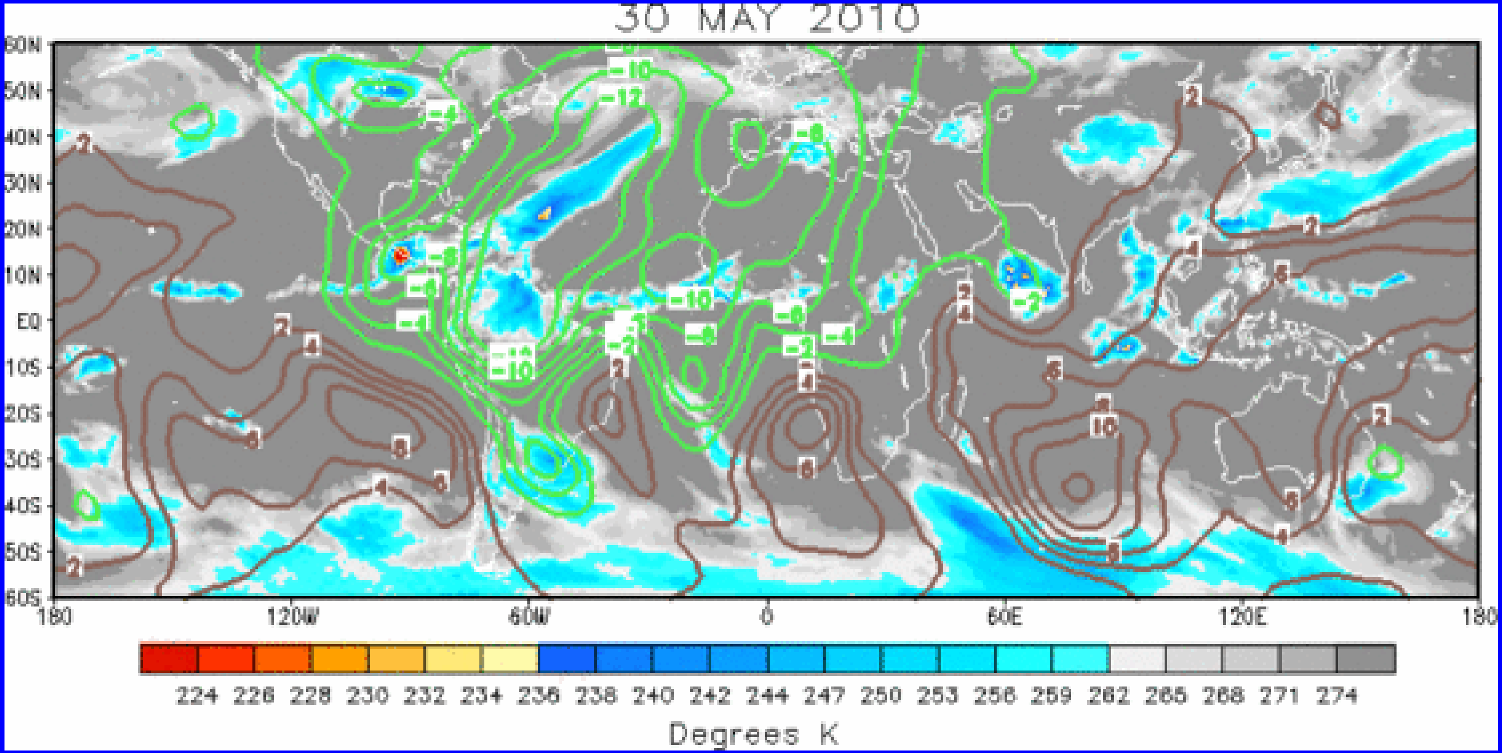
In mid-March, weak upper-level divergence (convergence) developed over Africa and the Indian Ocean (Maritime continent) and these anomalies propagated eastward.

In late April and early May, anomalies increased and eastward propagation was evident. Most recently in late May, strong upper-level divergence is evident near 60W.

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



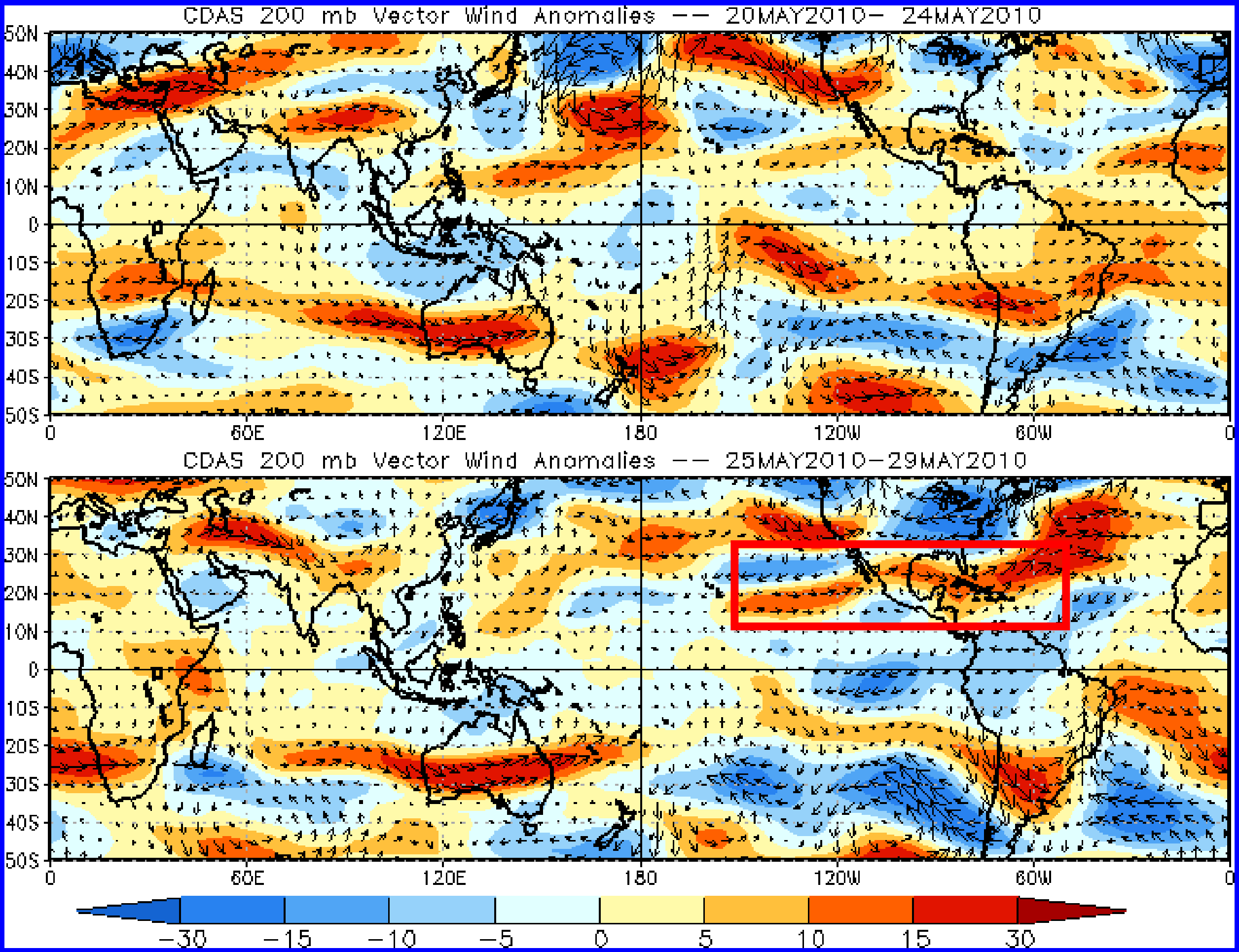
The current anomalous velocity potential pattern indicates upper-level divergence from Central America to west-central Africa with weak upper-level convergence evident over parts of the Maritime continent and western Pacific.

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



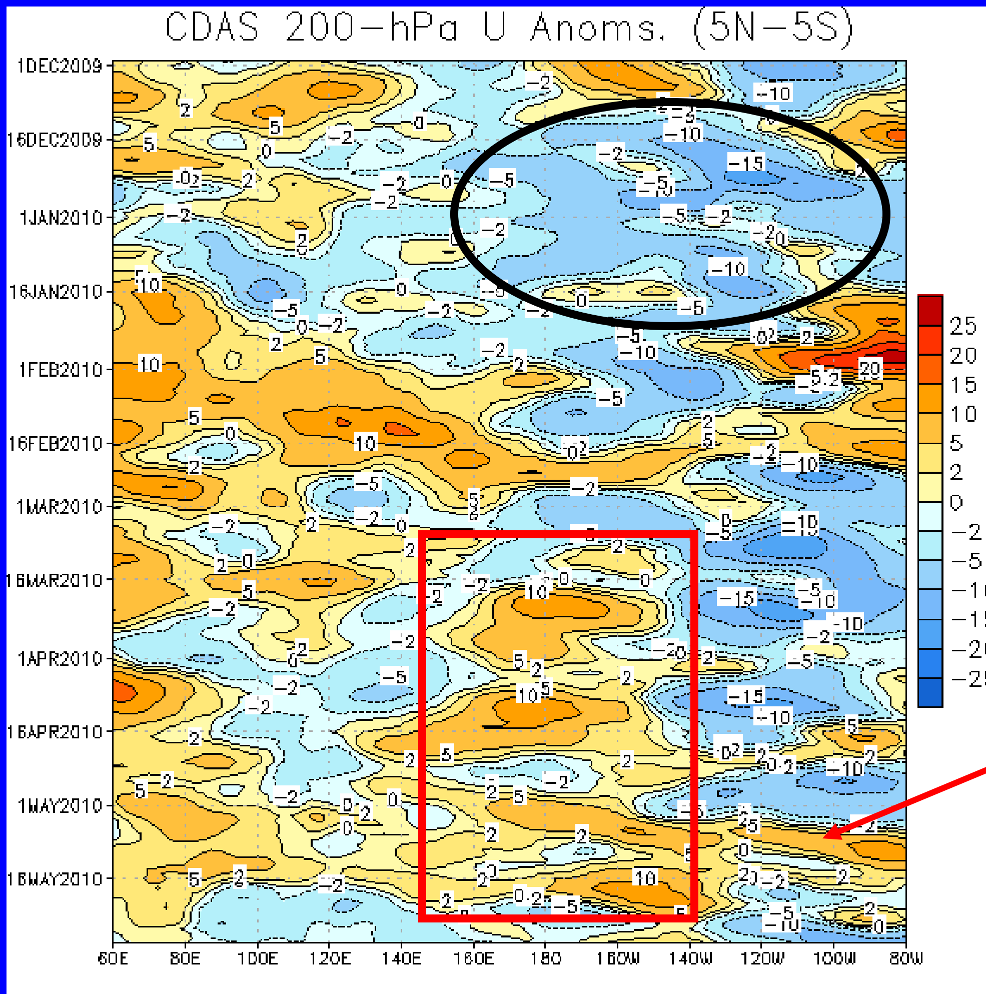
A band of westerly anomalies continued across portions of the eastern Pacific and Caribbean islands during the last five days (red box).

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



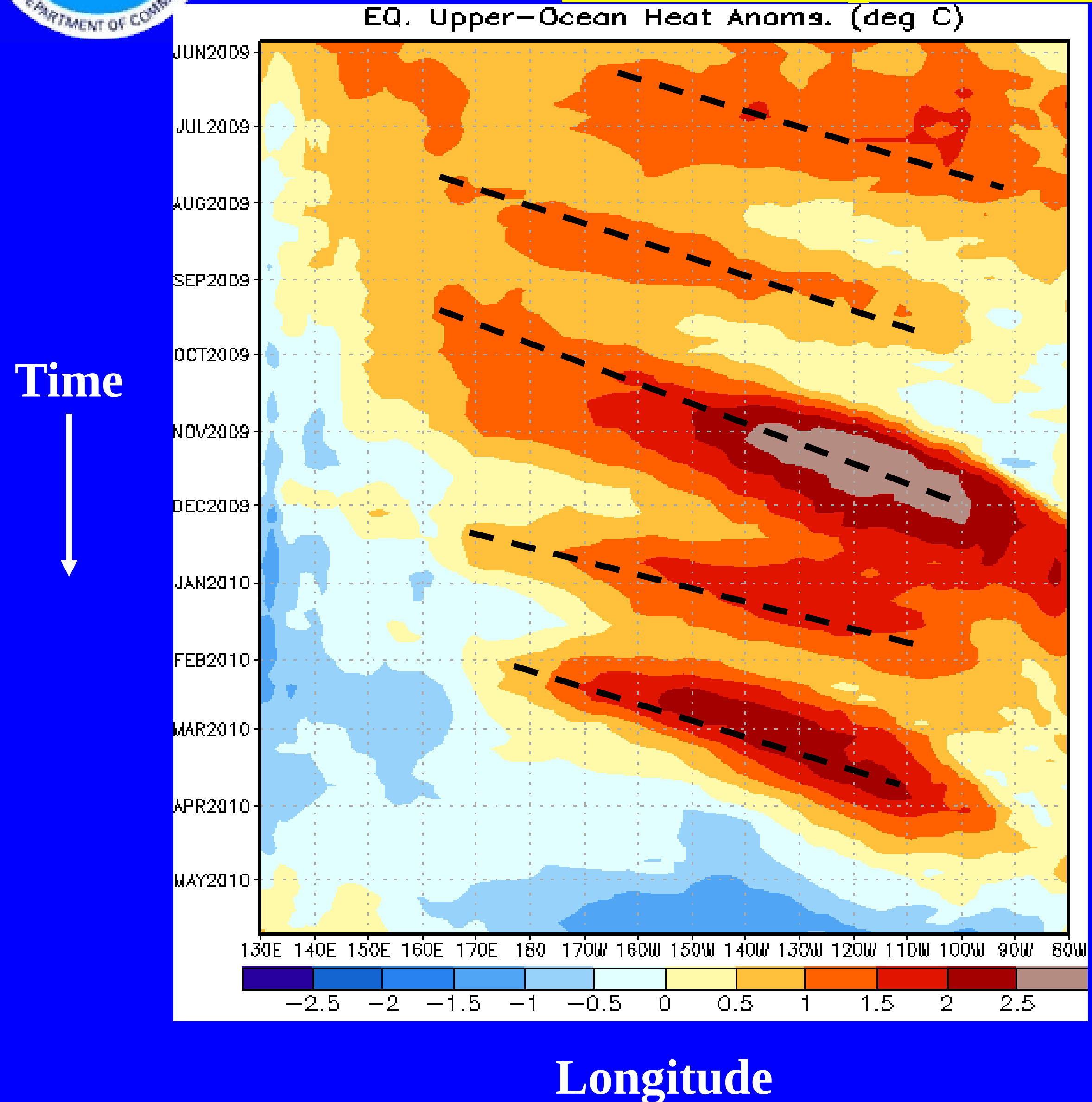
Longitude

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

Westerly anomalies prevailed across the central 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 May 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).

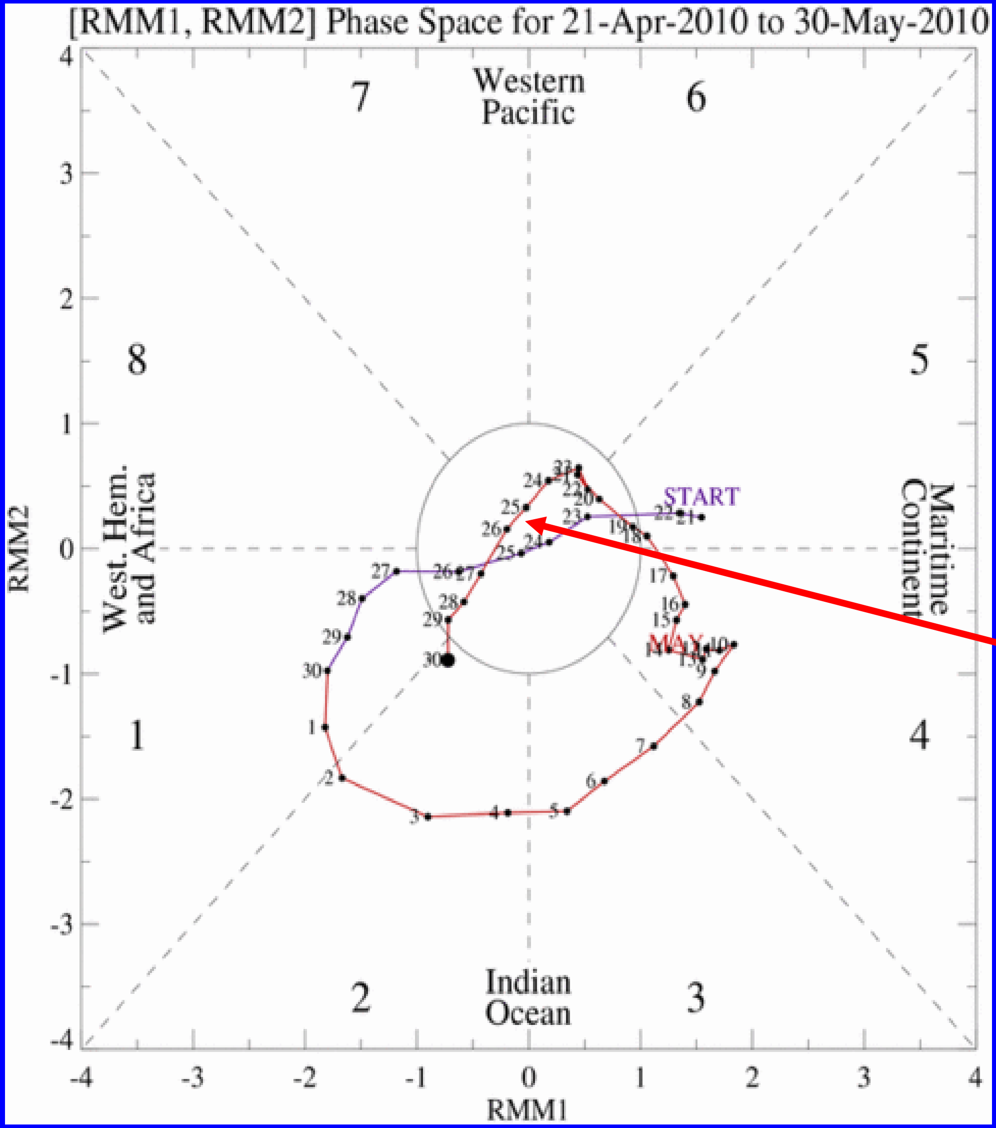
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review,* 132, 1917-1932.

• 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*., Accepted.

• 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).

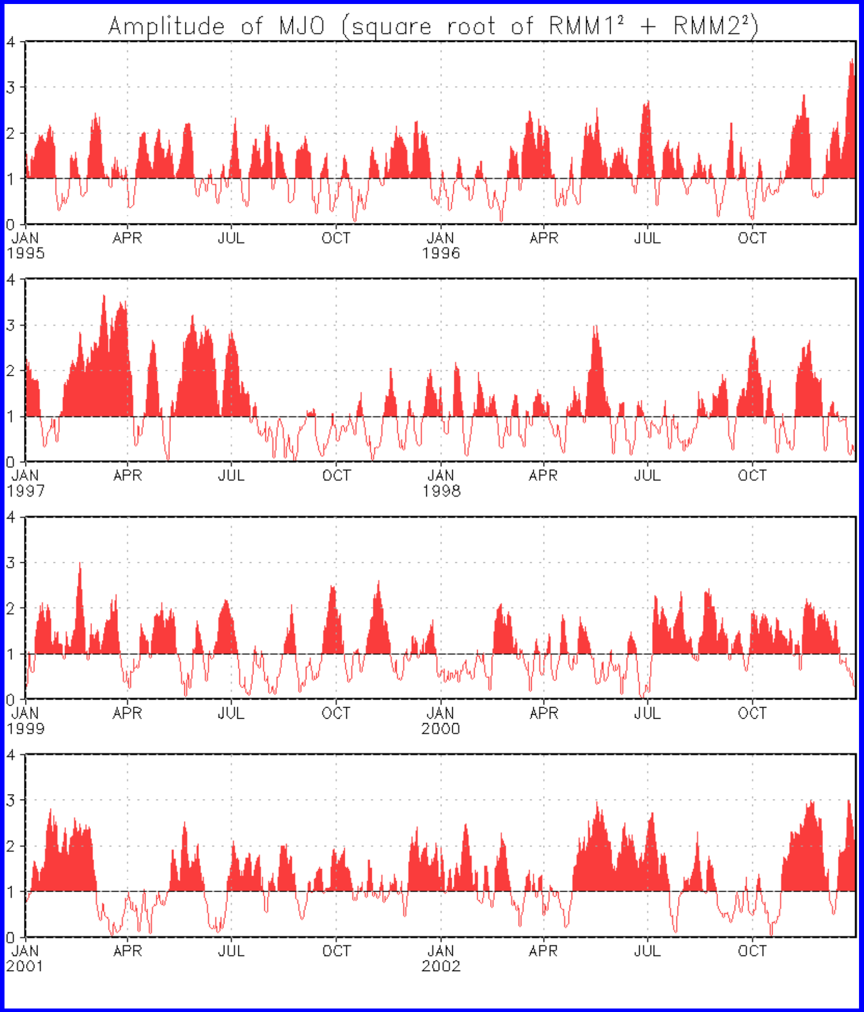
MJO Index -- Recent Evolution

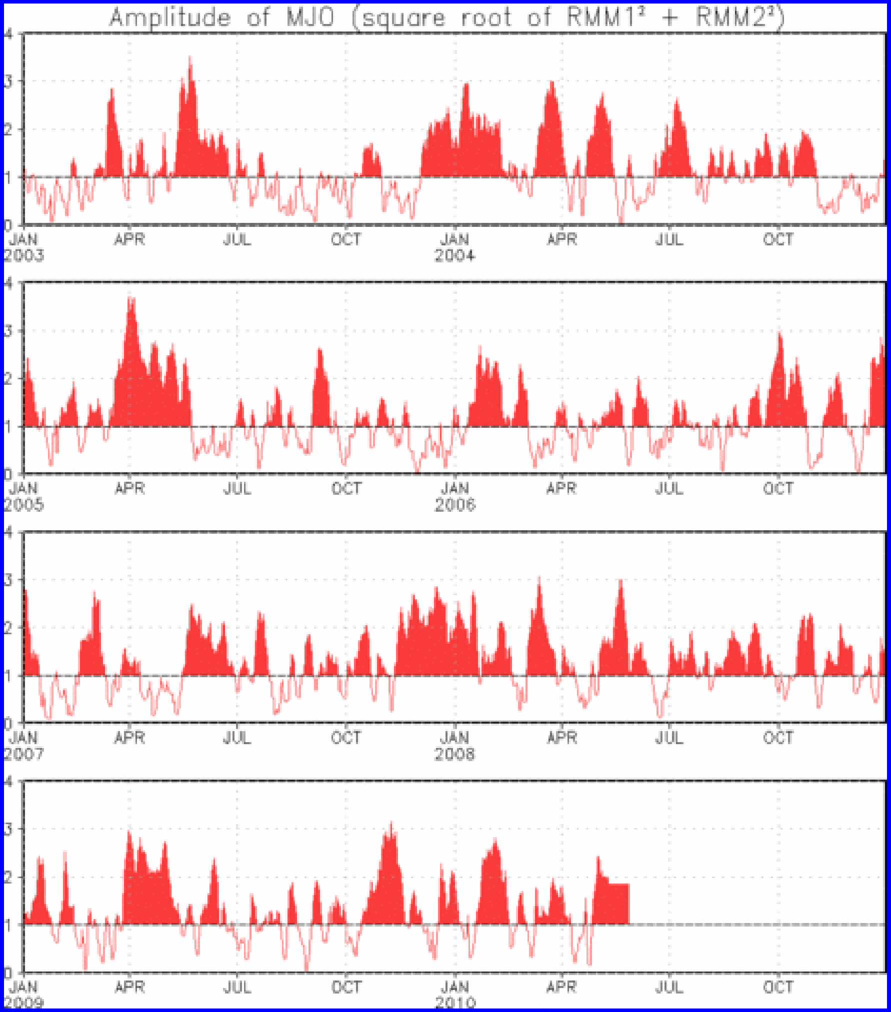


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

During the majority of the past week, the MJO index showed a weak amplitude although in recent days it has increased in vicinity of the western Indian Ocean.

MJO Index – Historical Daily Time Series





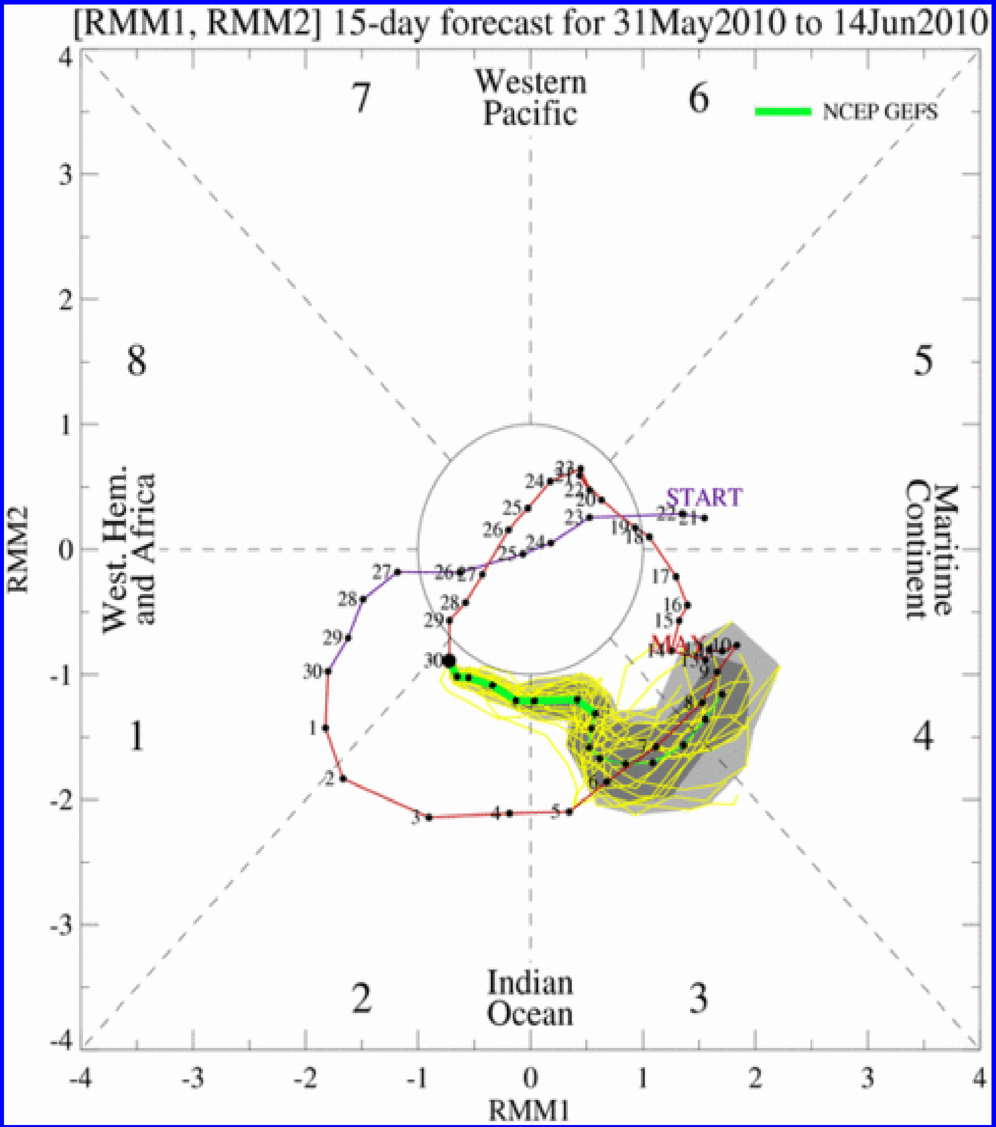
Time series of daily MJO index amplitude from 1995 to present. Plots put current MJO activity in historical context.

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 an eastward propagating MJO signal during the next two weeks. Uncertainty during the Week-2 period increases significantly.

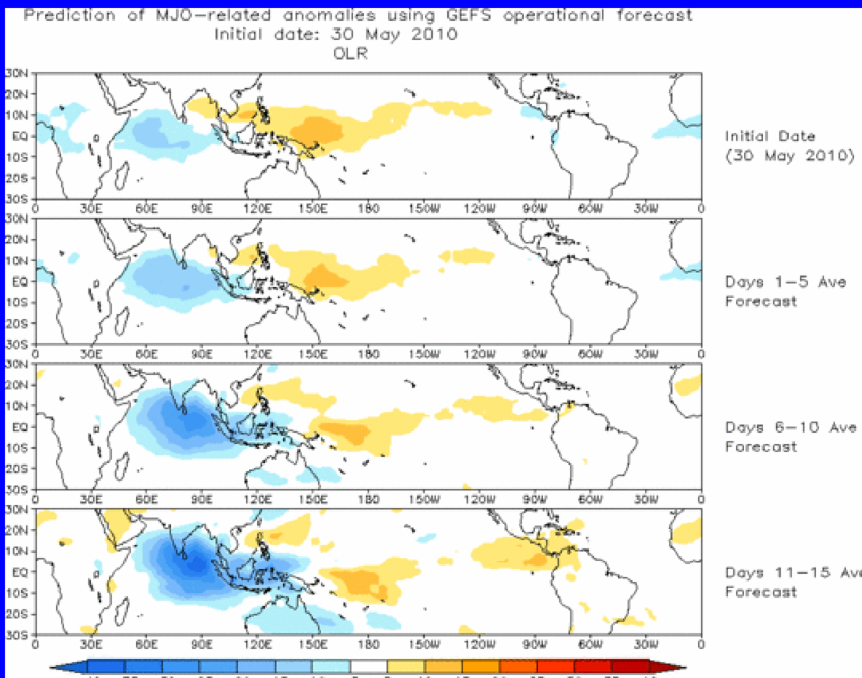
The latter signal is most likely related to a combination of subseasonal variability rather than a coherent MJO signal emerging.

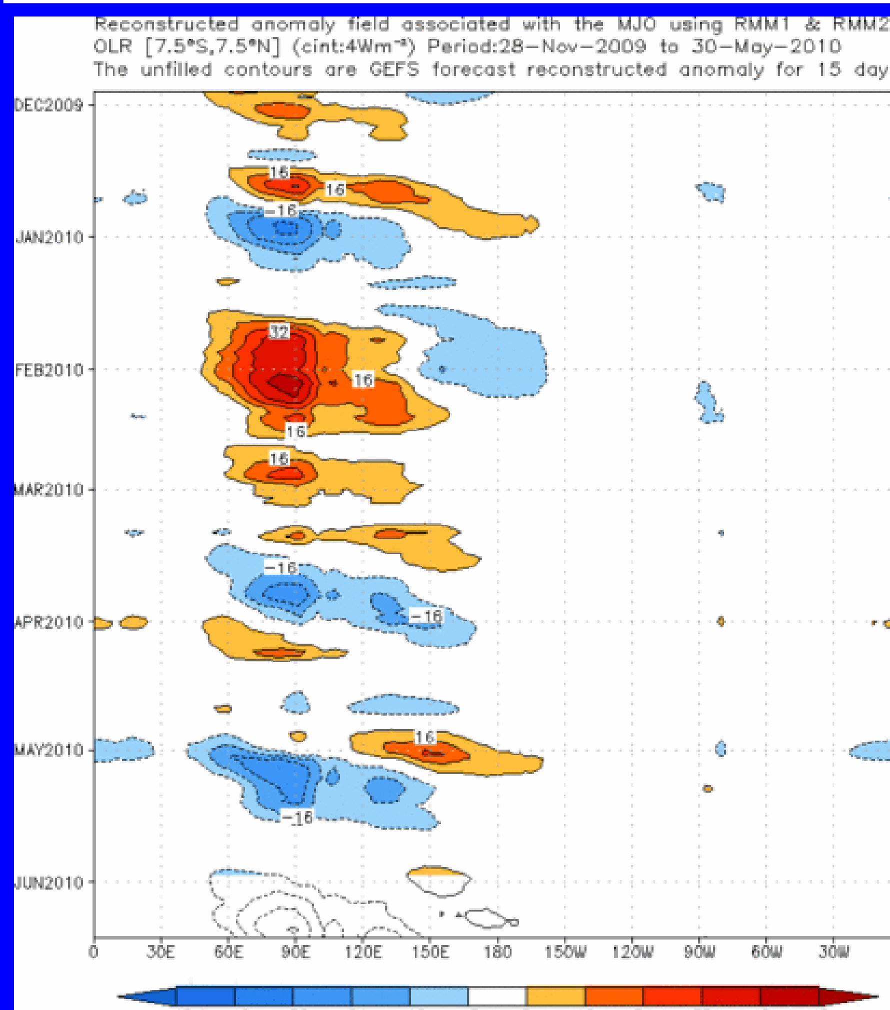
Ensemble Mean GFS MJO Forecast

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 (suppressed) convection across the Indian Ocean/western Maritime continent (western Pacific) during much of the period.

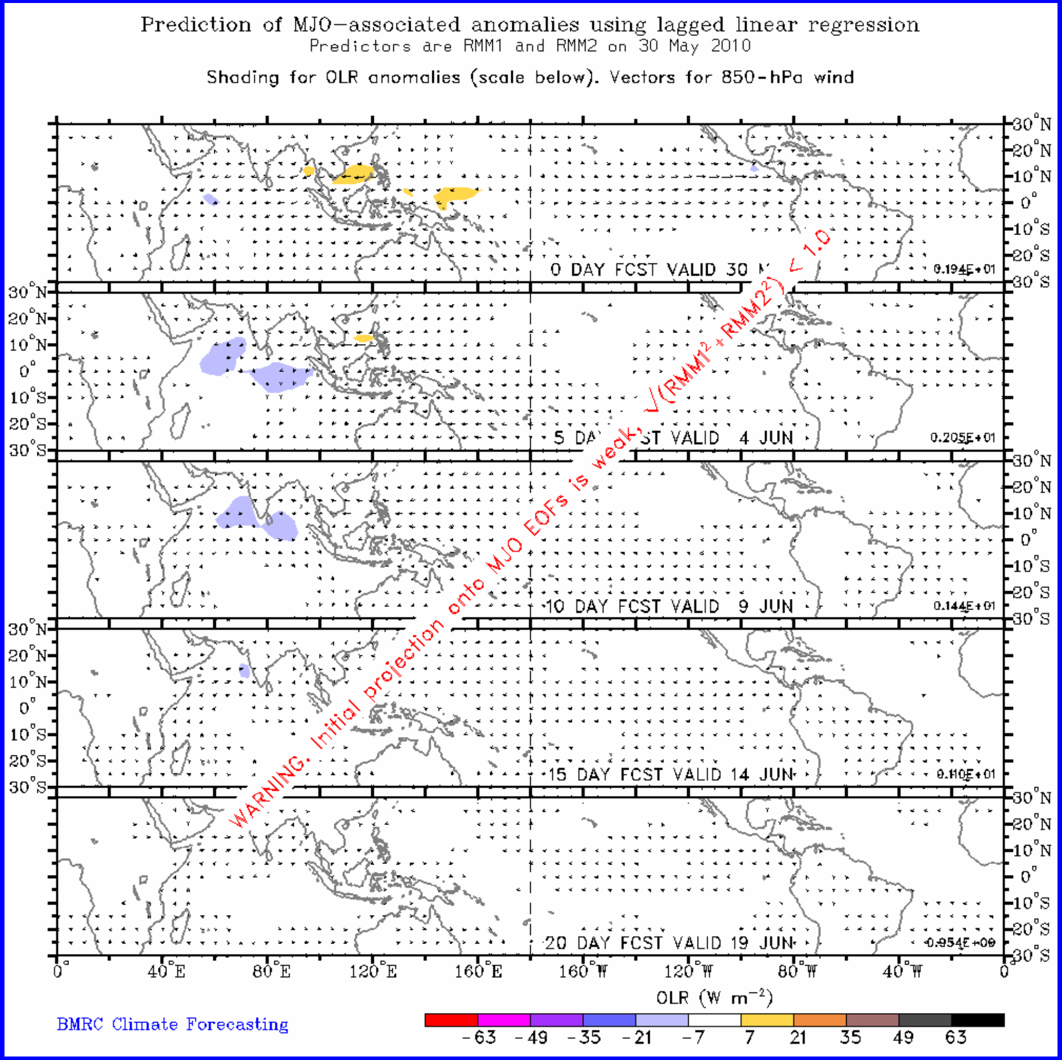
Statistical MJO Forecast

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)

The statistical forecast indicates weak MJO activity during the next two weeks.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)

850-hPa Wind Anomalies (May-Sep)