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

Update prepared by
Climate Prediction Center / NCEP
March 1, 2010

Outline

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

Overview

- The MJO remains weak as anomalous convection across the Maritime continent and Pacific remains consistent with El Nino conditions.

- Based on the latest observations and forecasts of weak MJO activity by MJO index model forecasts, the MJO is expected to remain weak during the next 1-2 weeks.

- Impacts across the Tropics and U.S. are more likely to be consistent with El Nino.

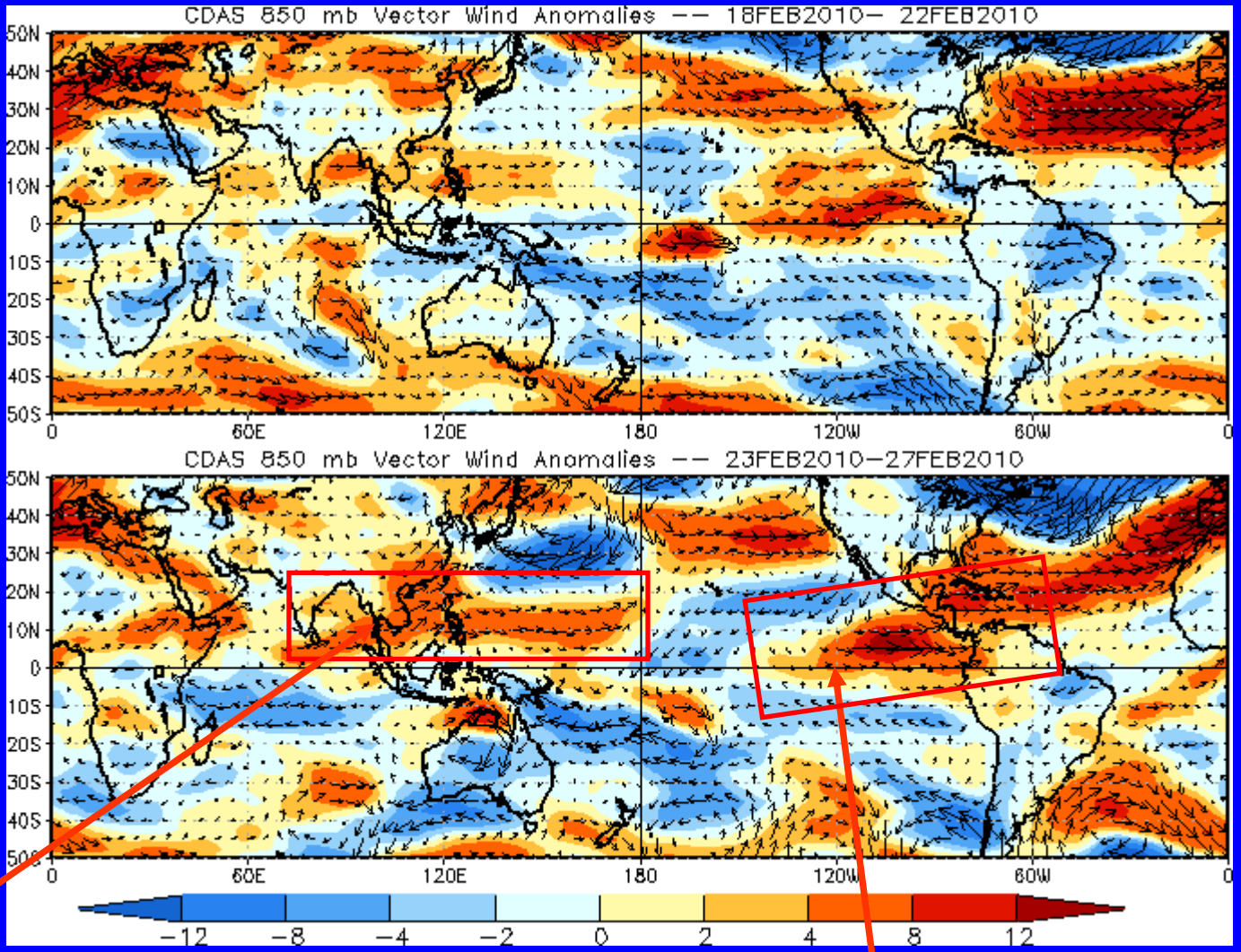
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



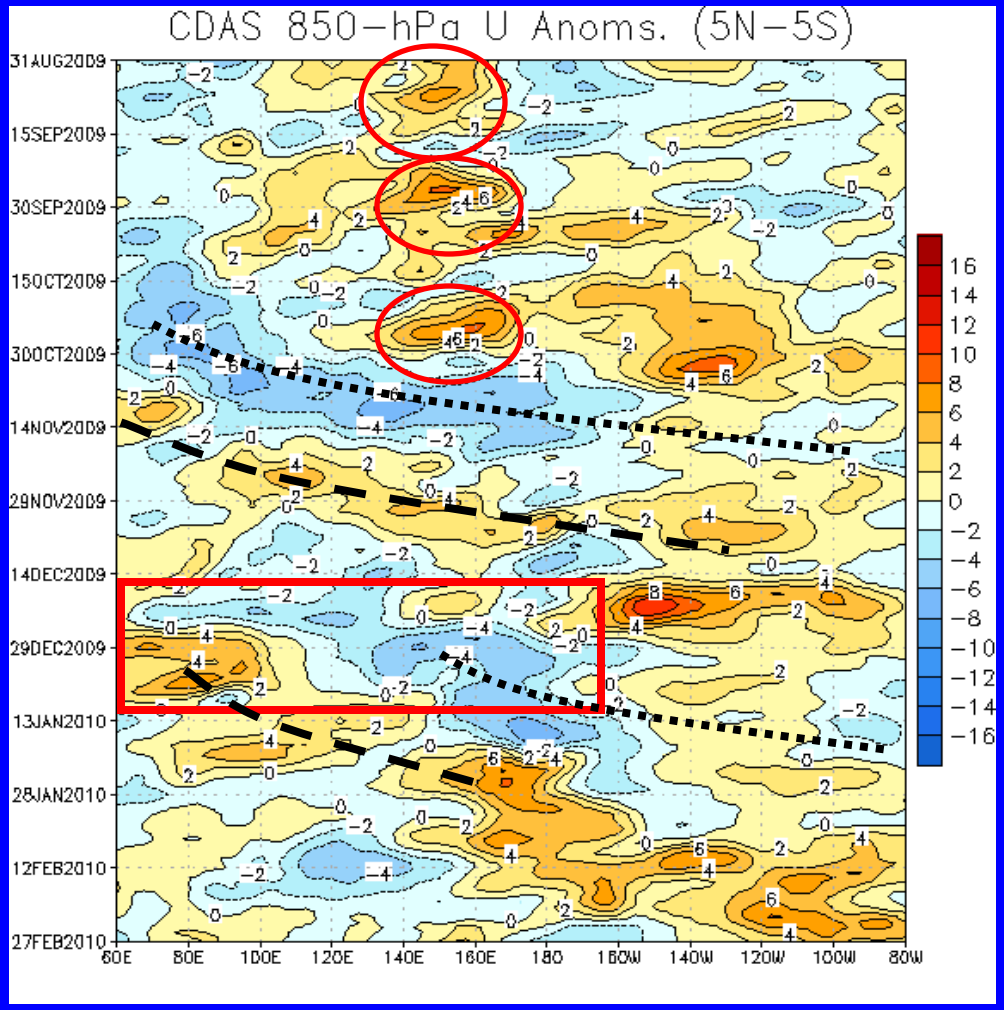
Westerly anomalies have developed from Southeast Asia into the western Pacific during the last five to ten days.

Westerly anomalies continued across the eastern Pacific and now include Central America and the Caribbean.

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

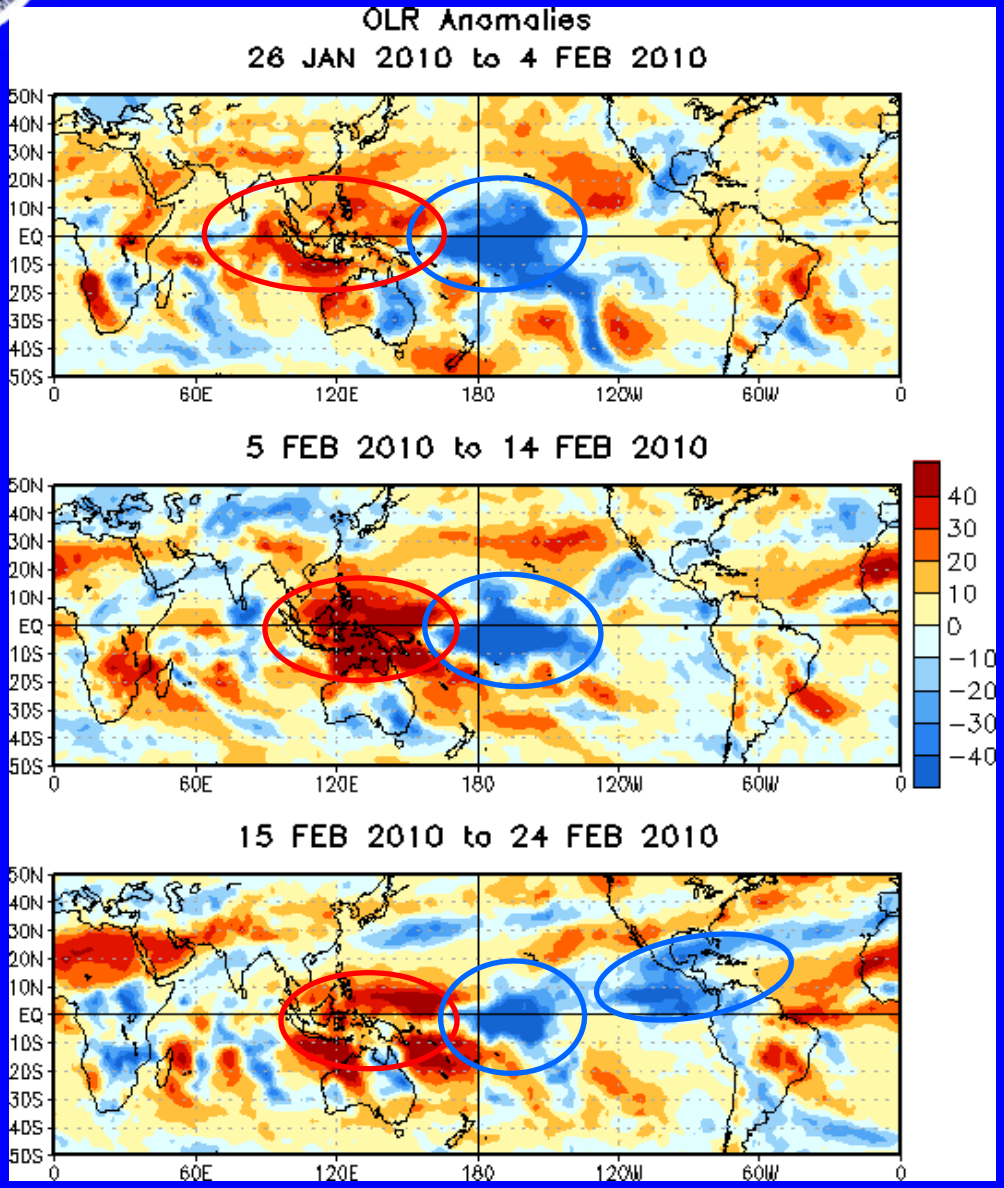
Longitude

Several westerly wind bursts (red circles) occurred during the July to October period. The westerly wind bursts became more frequent and stronger during September and October.

Easterly (dotted line) and westerly (dashed line) anomalies developed across the Indian Ocean and shifted eastward across the Date Line during late October and November associated with the MJO.

The westerly (easterly) anomalies (red box) evident in the Indian (western Pacific) Ocean during late December and early January shifted eastward during January.

OLR Anomalies: Last 30 days



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

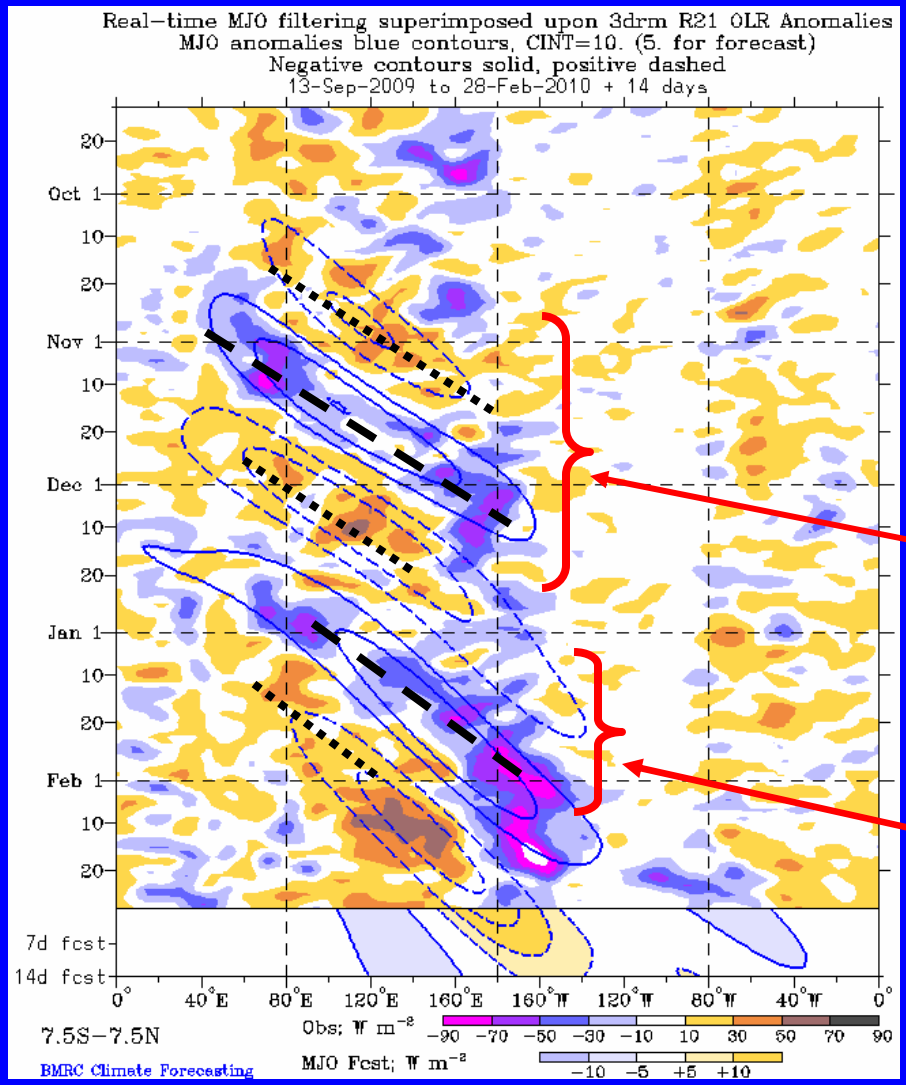
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

In late January and early February, enhanced convection (blue oval) continued near the Date Line with an eastward shifted South Pacific Convergence Zone (SPCZ). Suppressed convection (red oval) is evident across the Maritime continent.

Enhanced (suppressed) convection continued across the central Pacific (Maritime continent) regions during early-to-mid February. Also, wetter-than-average conditions developed across parts of the eastern Pacific.

During the second half of February, wetter-than-average conditions developed on a large scale from the eastern Pacific to the Caribbean. Suppressed convection across the Maritime continent and parts of the western 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 active for much of the October 2009 to January 2010 period.

The October to early December 2009 period saw two periods of suppressed convection shift eastward from the Indian Ocean into the western Pacific (dotted lines) and one episode of enhanced convection (dashed line).

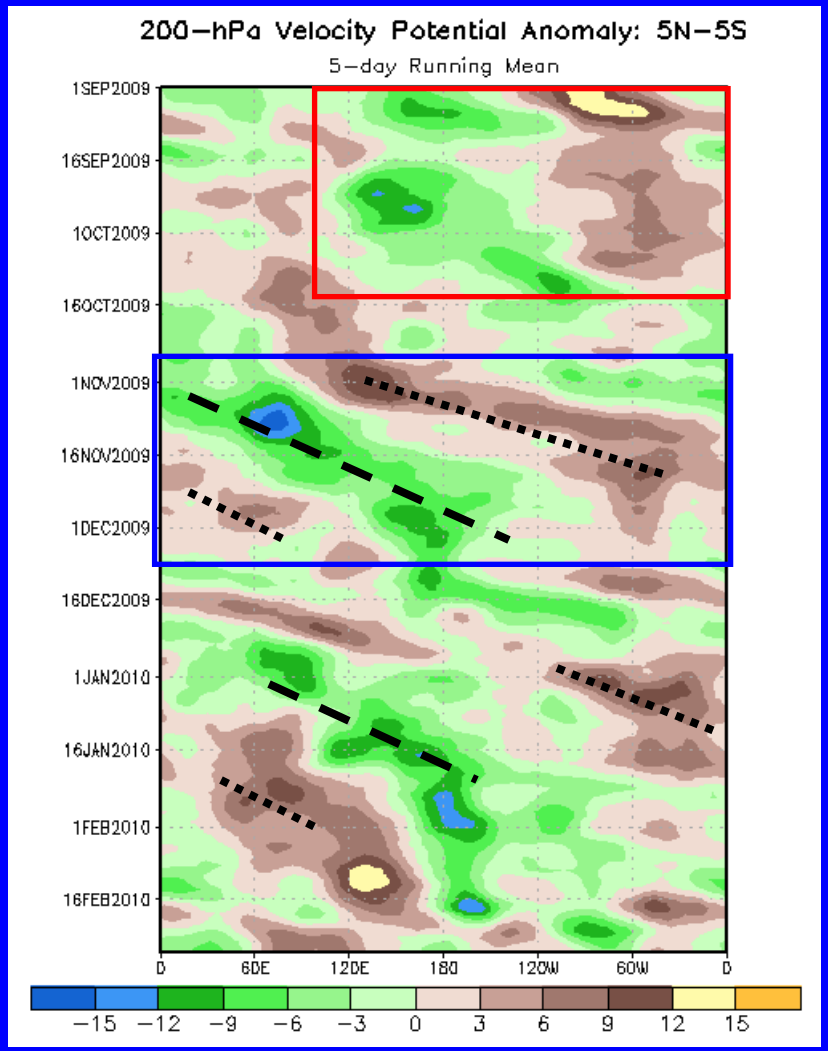
After a brief break during mid-late December, enhanced convection developed in the Indian Ocean and shifted eastward to the western and central Pacific during mid to late January. An area of suppressed convection across the Indian Ocean and Maritime Continent followed.

During February these anomalous areas have become more stationary.

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

Anomaly intensity varied during September and early October but the overall pattern remained generally persistent with upper-level divergence (convergence) across the western Pacific (parts of Western Hemisphere) (red box).

In late October and November, anomalies increased and eastward propagation was evident associated with MJO activity (blue box).

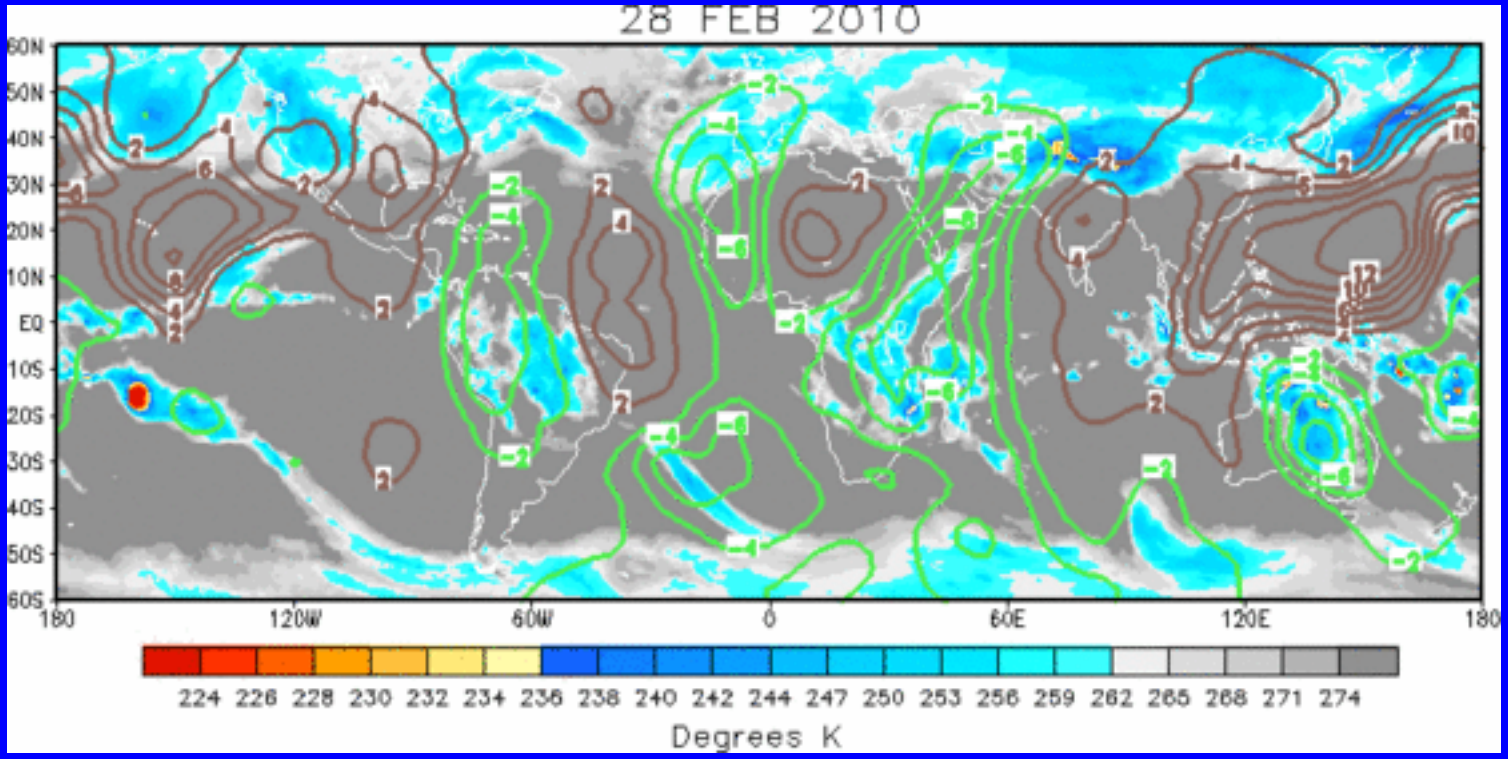
During early-to-mid December, the coherent MJO pattern weakened.

Eastward propagation associated with the MJO was again evident during early-mid January. During February, the MJO became much less coherent and anomalies became more stationary in nature.

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

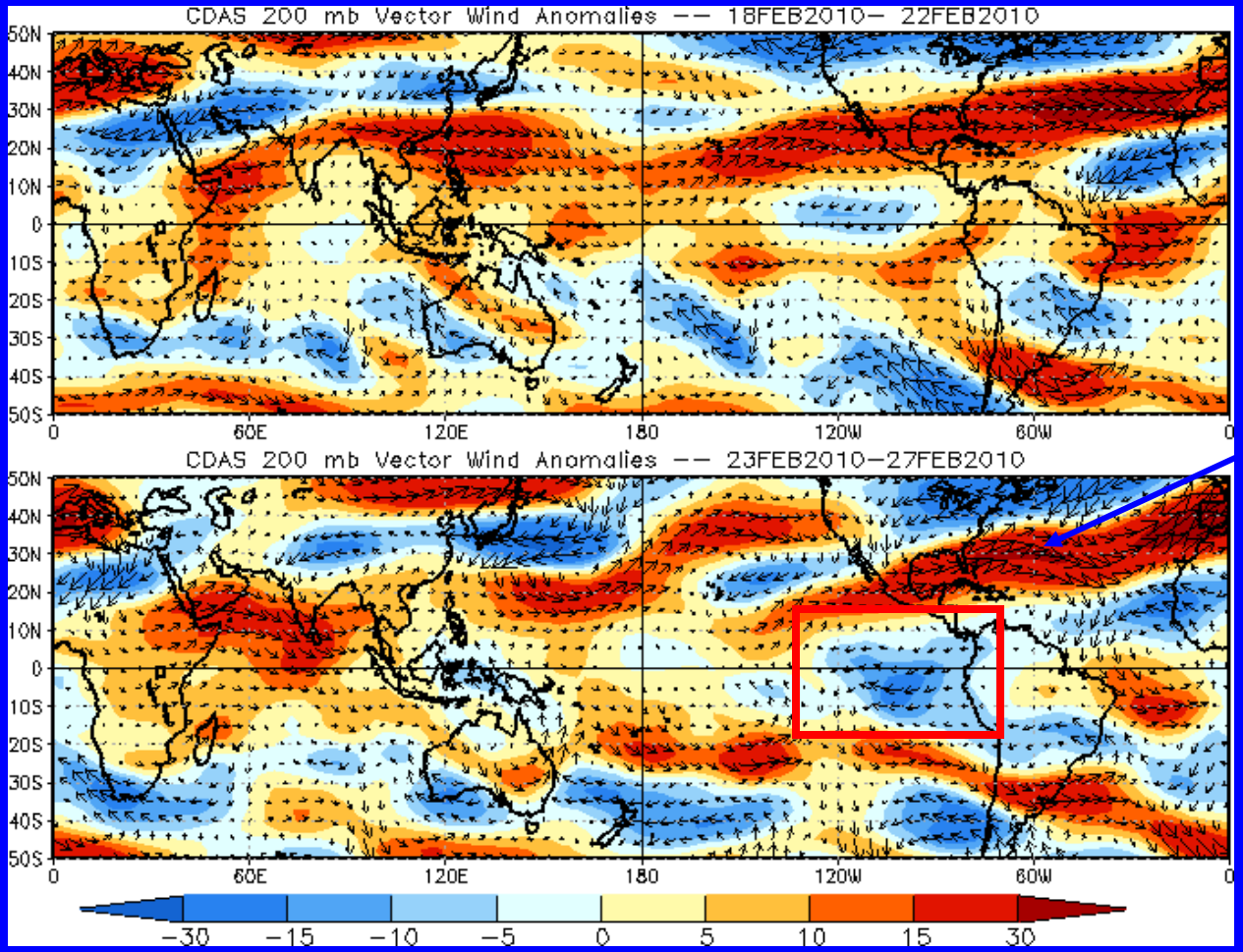
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The anomalous velocity potential pattern is not coherent. Upper-level divergence is indicated over parts of South America, Africa and the western Pacific while upper-level convergence is focused near the Philippines.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

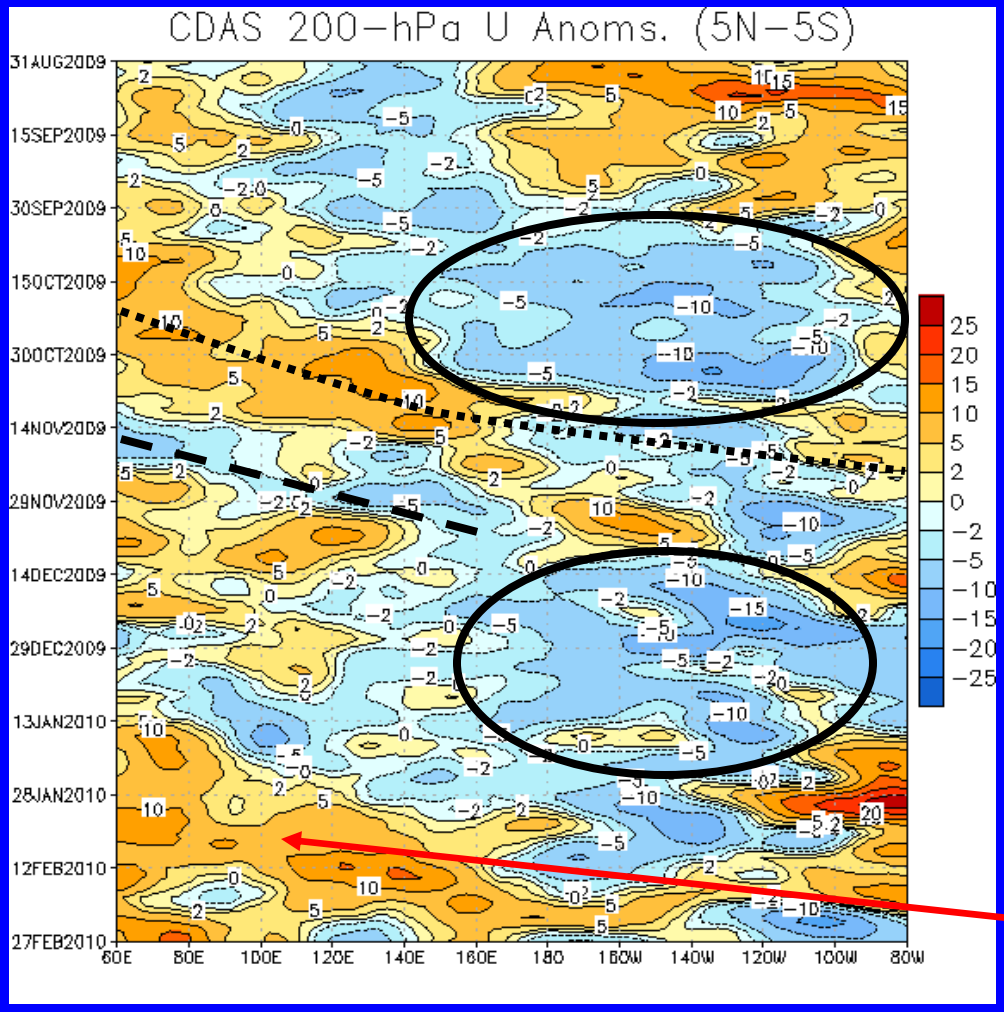
Red shades: Westerly anomalies

During the last five to ten days easterly anomalies have returned to parts of the eastern Pacific (red box) while strong subtropical jets continue especially across the western Hemisphere north of the equator.

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

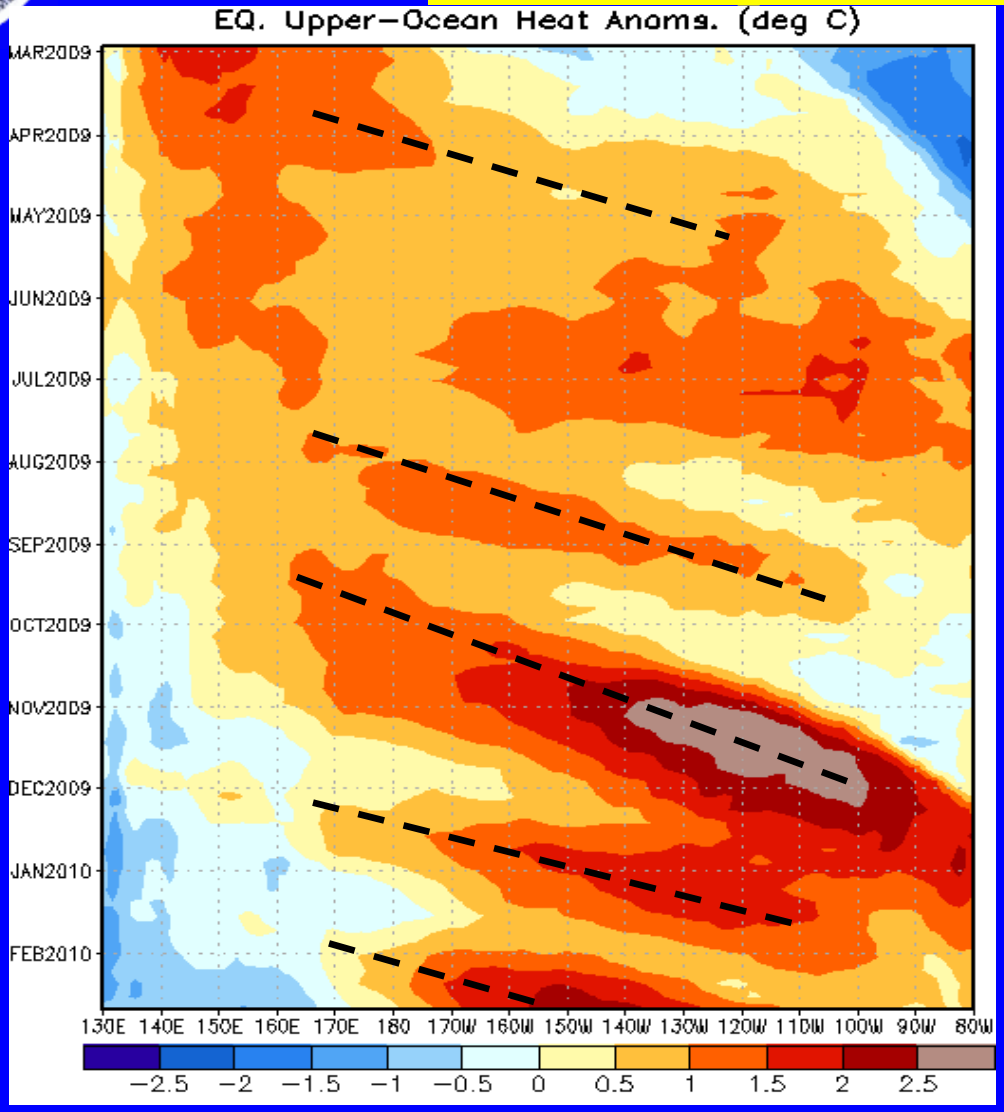
In early October, easterly anomalies rapidly replaced westerly anomalies across much of the Pacific (black solid oval).

Westerly (easterly) anomalies (dotted and dashed lines) shifted eastward across the Maritime Continent during late October and November associated with the MJO.

Easterly anomalies dominated much of the central and eastern Pacific during the second half of December and January.

During late January and February westerly anomalies over the Indian Ocean and Maritime continent have slowly shifted eastward.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

The negative anomalies associated with La Nina weakened during January-March 2009, with anomalies becoming positive since late March.

In April 2009, the combined effects of an oceanic Kelvin wave and weaker easterly trade winds contributed to an increase in the upper-ocean heat content anomalies across the Pacific Ocean.

Since April 2009, heat content anomalies have remained above-average (blue box).

Multiple Kelvin waves shifted eastward between August and February 2010 (last four dashed black lines).

West of the Date Line, some below-average anomalies are present in the upwelling phases of the most recent Kelvin waves.

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).**

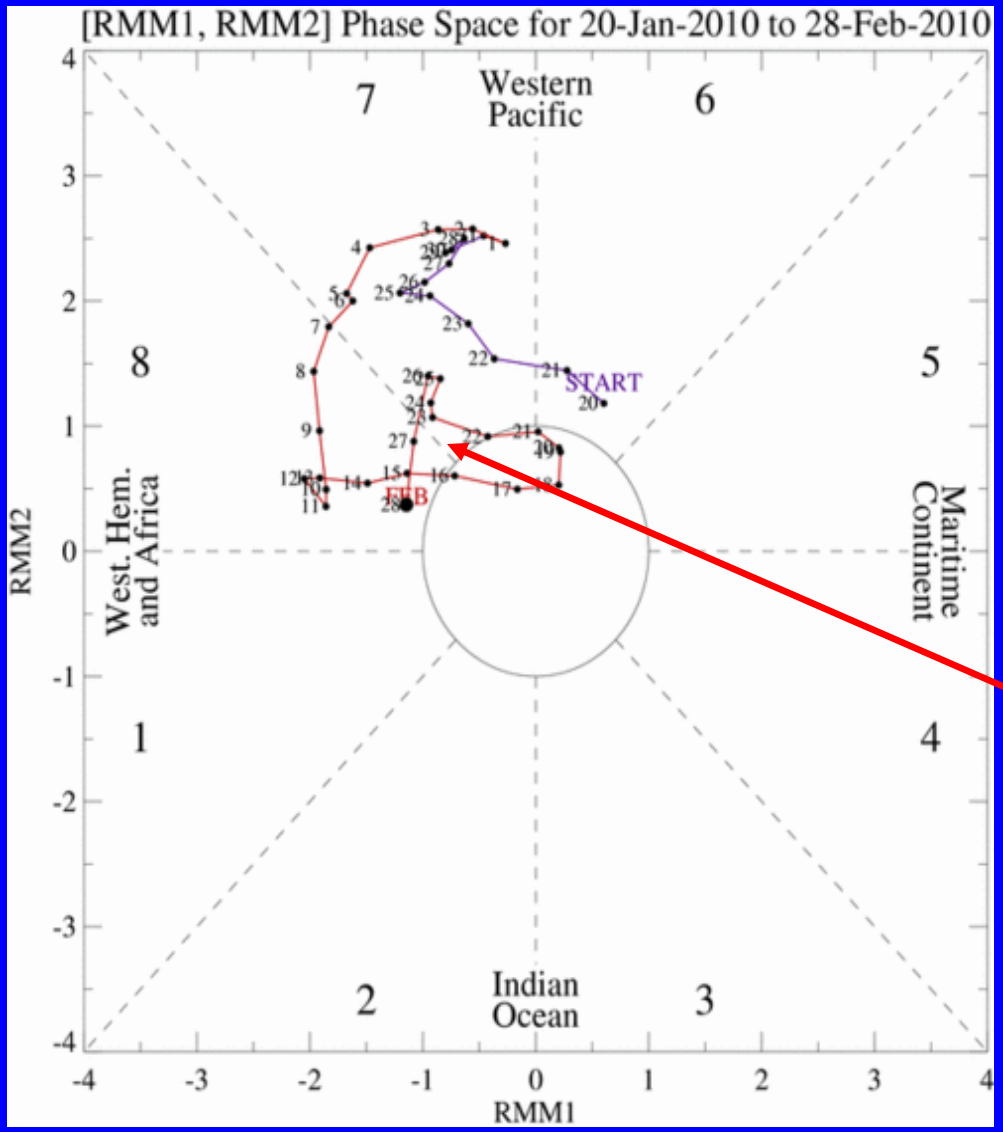
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review*, 132, 1917-1932.

- **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.*, Submitted.

- **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

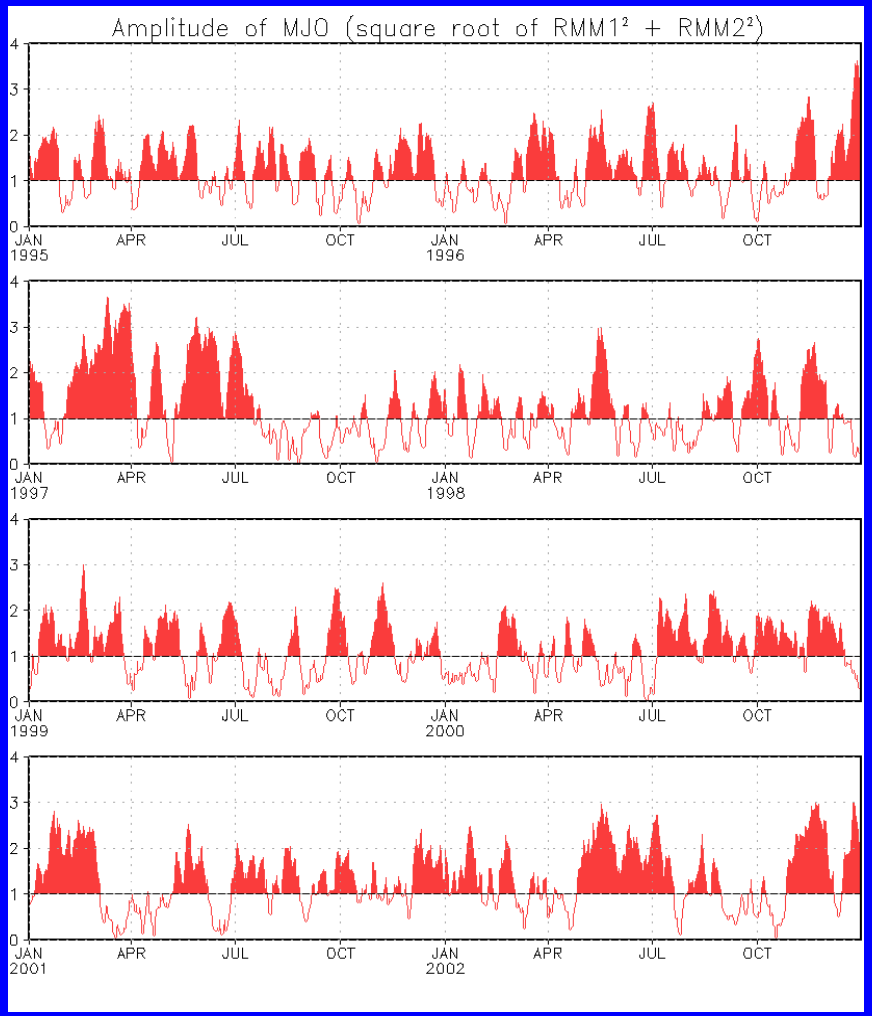


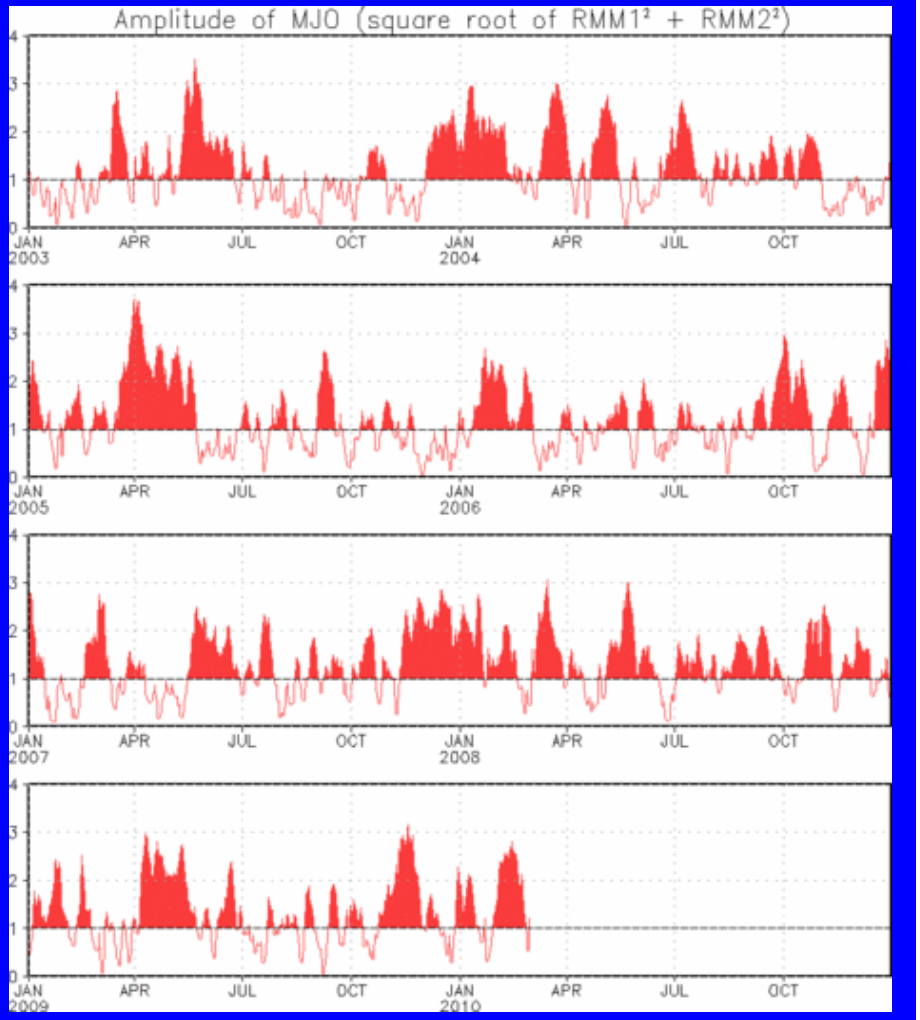
- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

During late January and February, the signal for the enhanced phase of the MJO remained across phases 7 and 8 indicating weak MJO activity.

El Nino conditions are contributing to some of the signal during this period.

MJO Index – Historical Daily Time Series





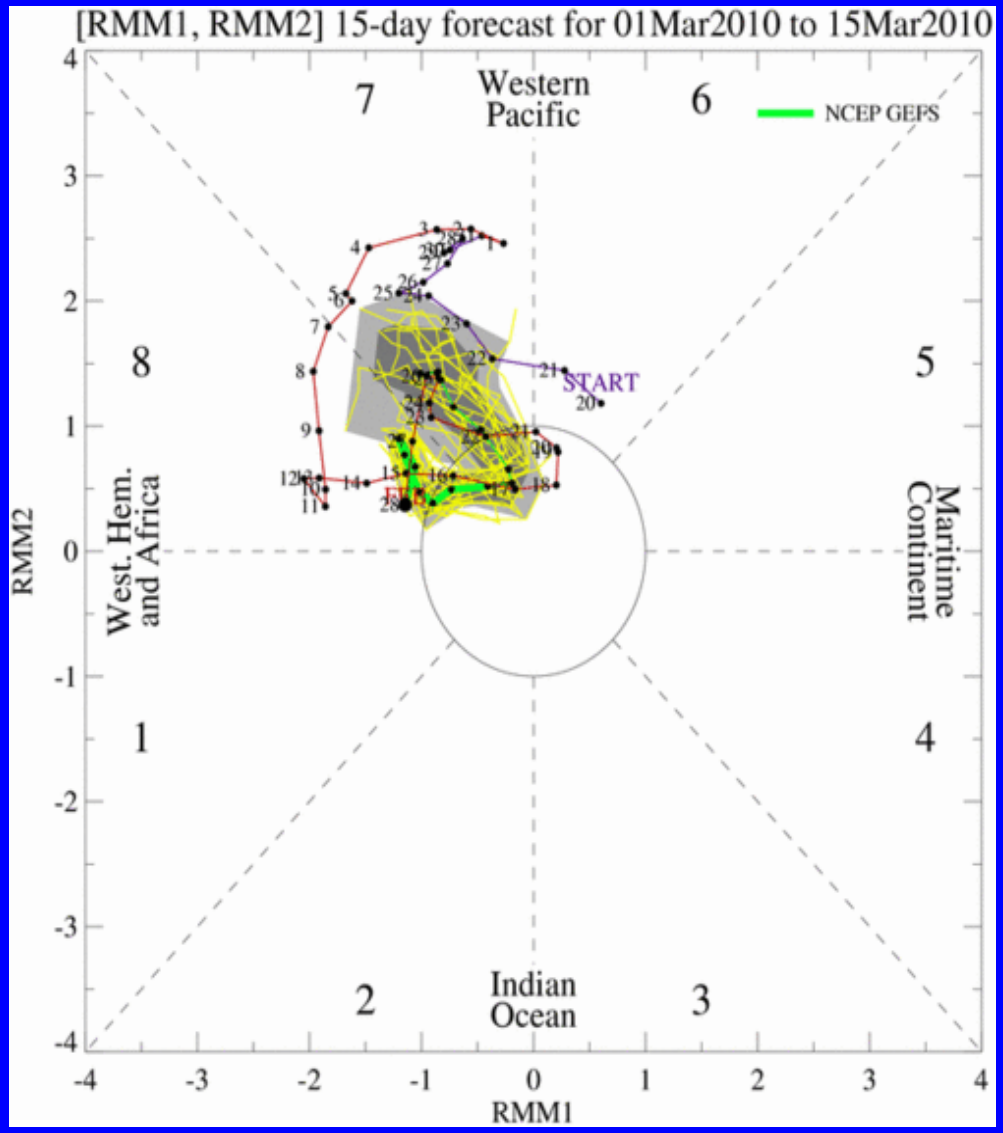
Time series of daily MJO index amplitude from 1995 to present.
Plots put current MJO activity in historical context.

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



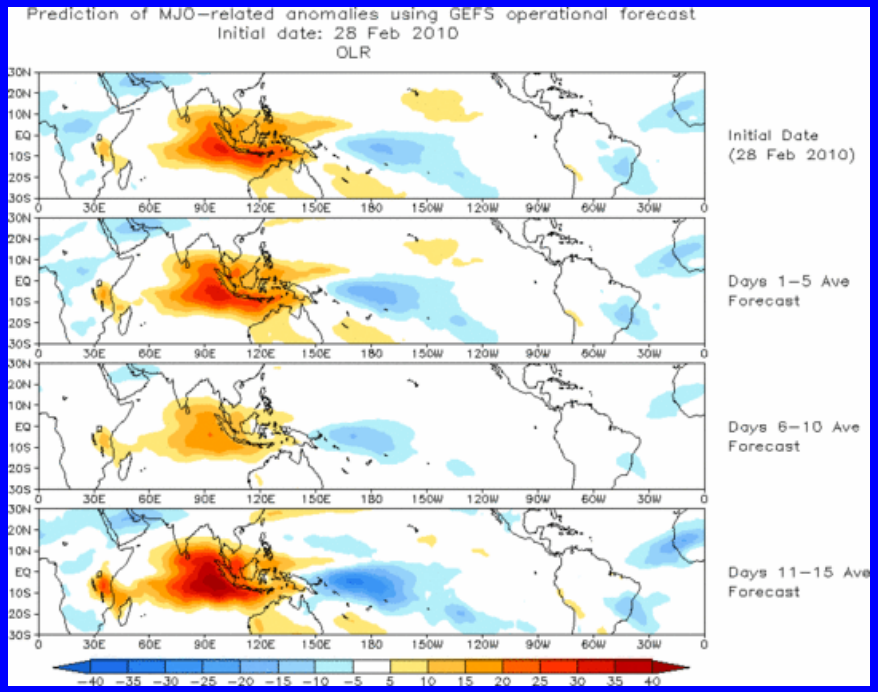
The GFS MJO index forecasts indicate a generally weak signal remaining in phases 7 and 8 with no eastward propagation.

El Nino conditions continue to contribute to the amplitude and non-steady behavior of the MJO index forecast.

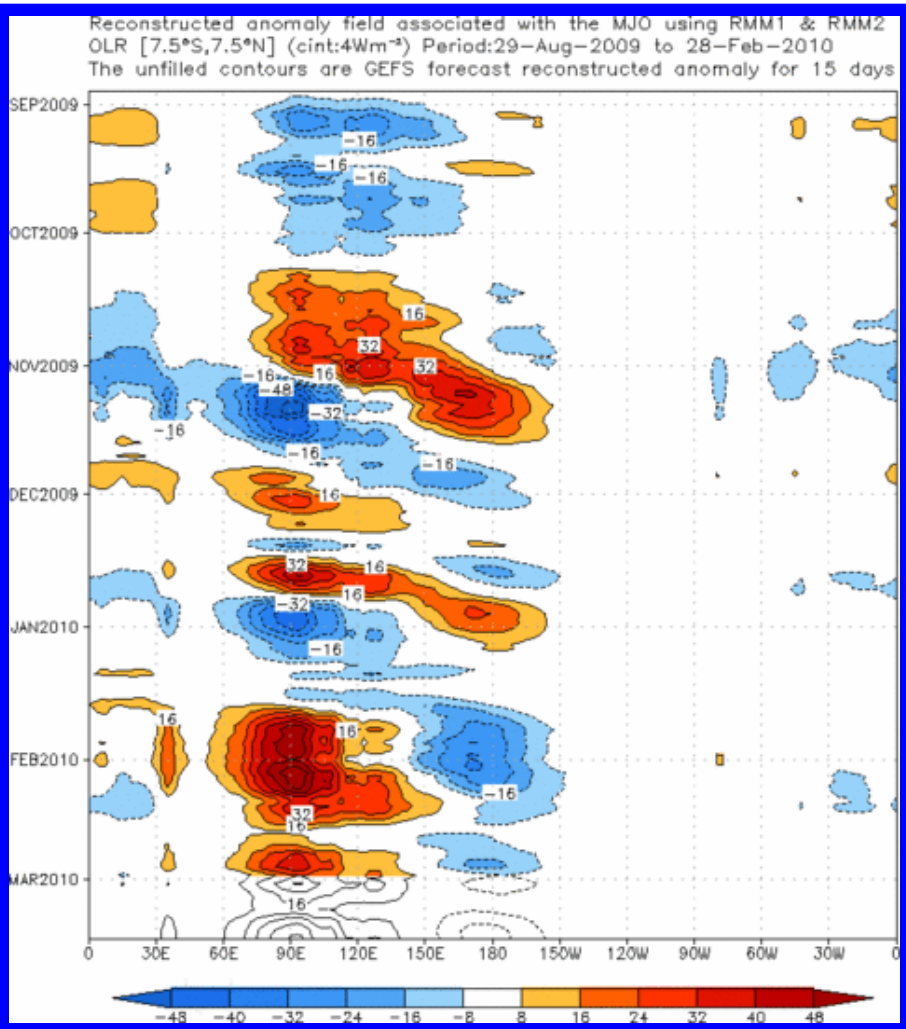
Ensemble Mean GFS MJO Forecast

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 little change in position of anomalies over the period, consistent with the MJO index plot on the previous slide.

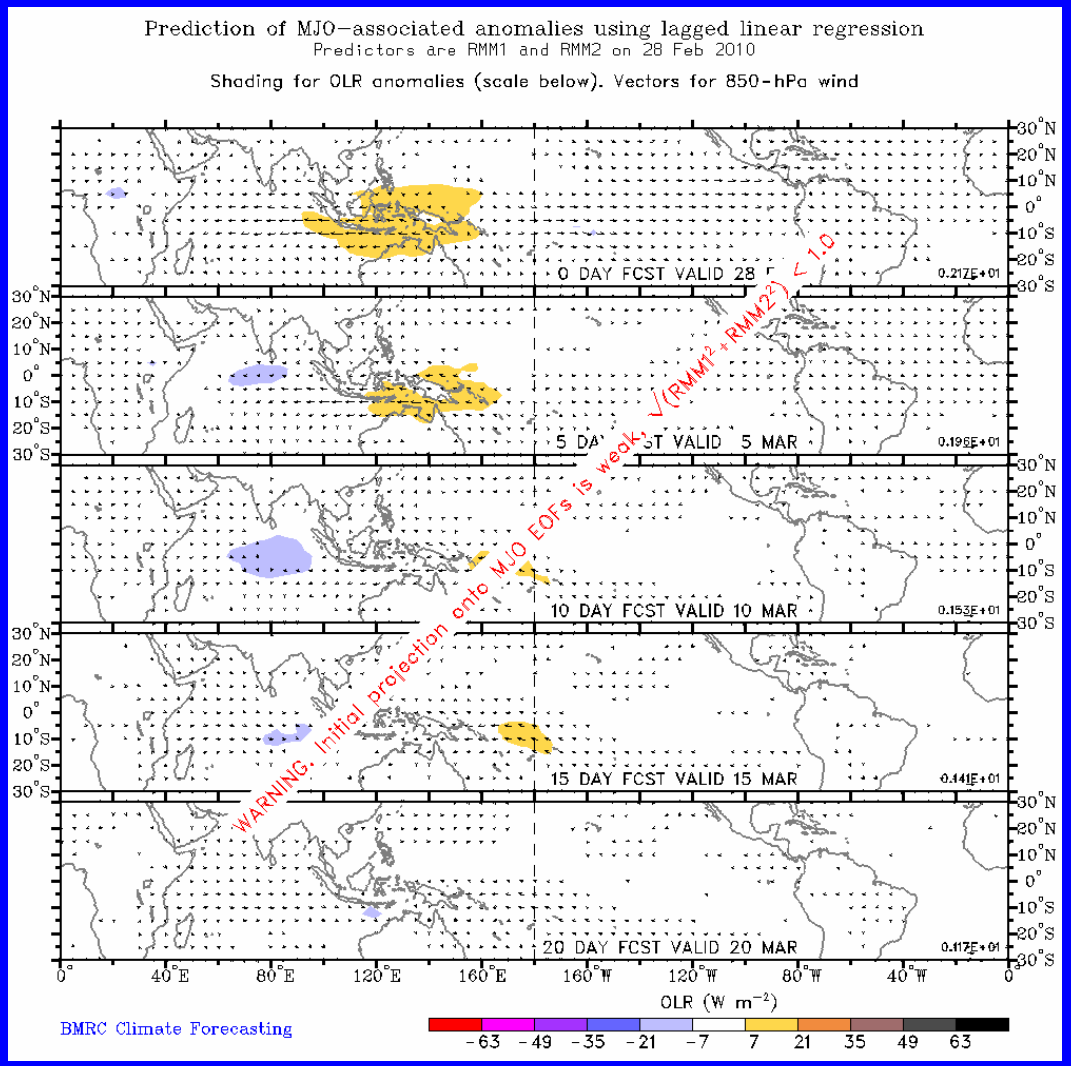
Statistical MJO Forecast

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

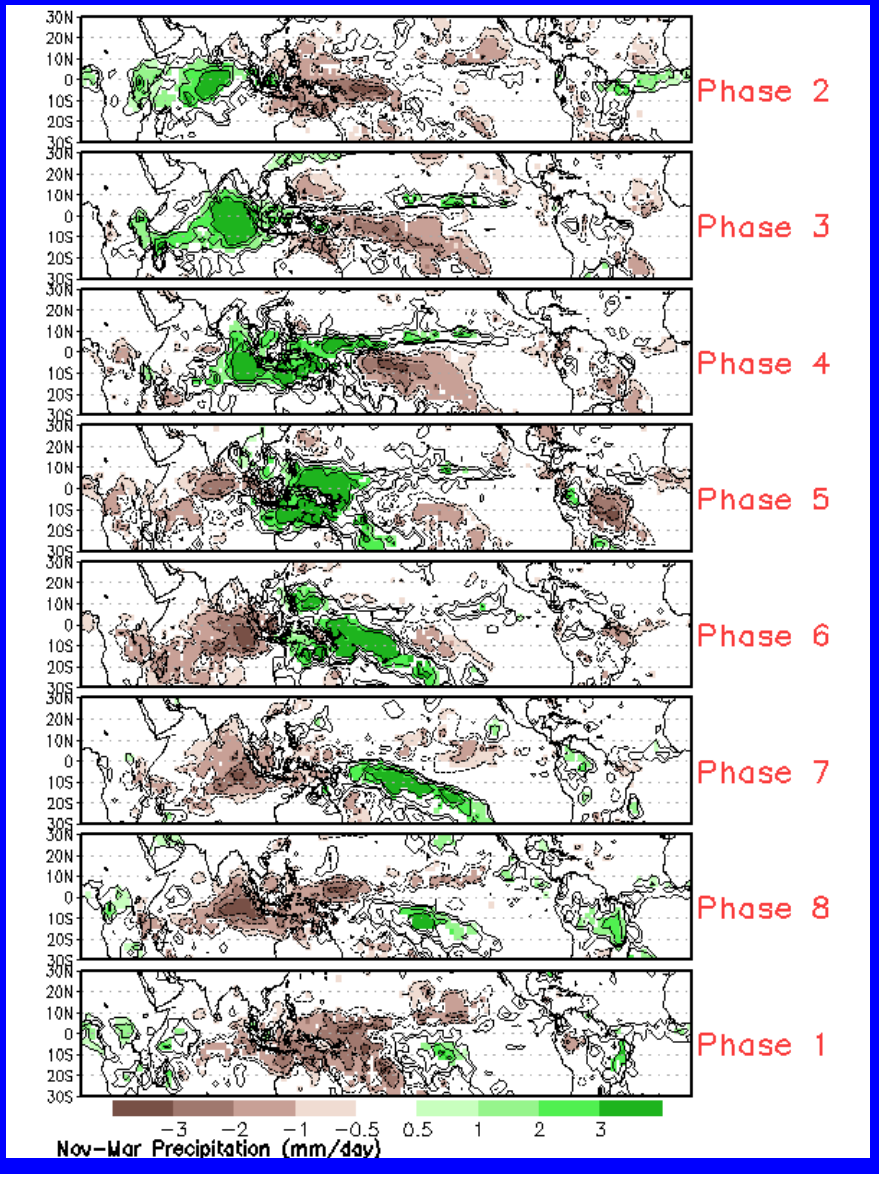
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical forecast indicates a weak MJO signal.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)