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

**Update prepared by**
**Climate Prediction Center / NCEP**
**January 11, 2010**

# Outline

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

# Overview

- The MJO showed signs of strengthening during the past week with the enhanced convective phase centered over the Maritime continent.

- Although the majority of MJO index model forecasts indicate little forecast MJO signal, recent observations show that enhanced convection has shifted from the Indian Ocean and across the Maritime continent.

- MJO activity is expected to continue during the next 1-2 weeks with enhanced convection intensifying in the western Pacific.

- The MJO is expected to contribute to enhanced rainfall across the Maritime continent (Week-1) and the western Pacific (Week-2) and suppressed rainfall across the Maritime continent during Week-2.

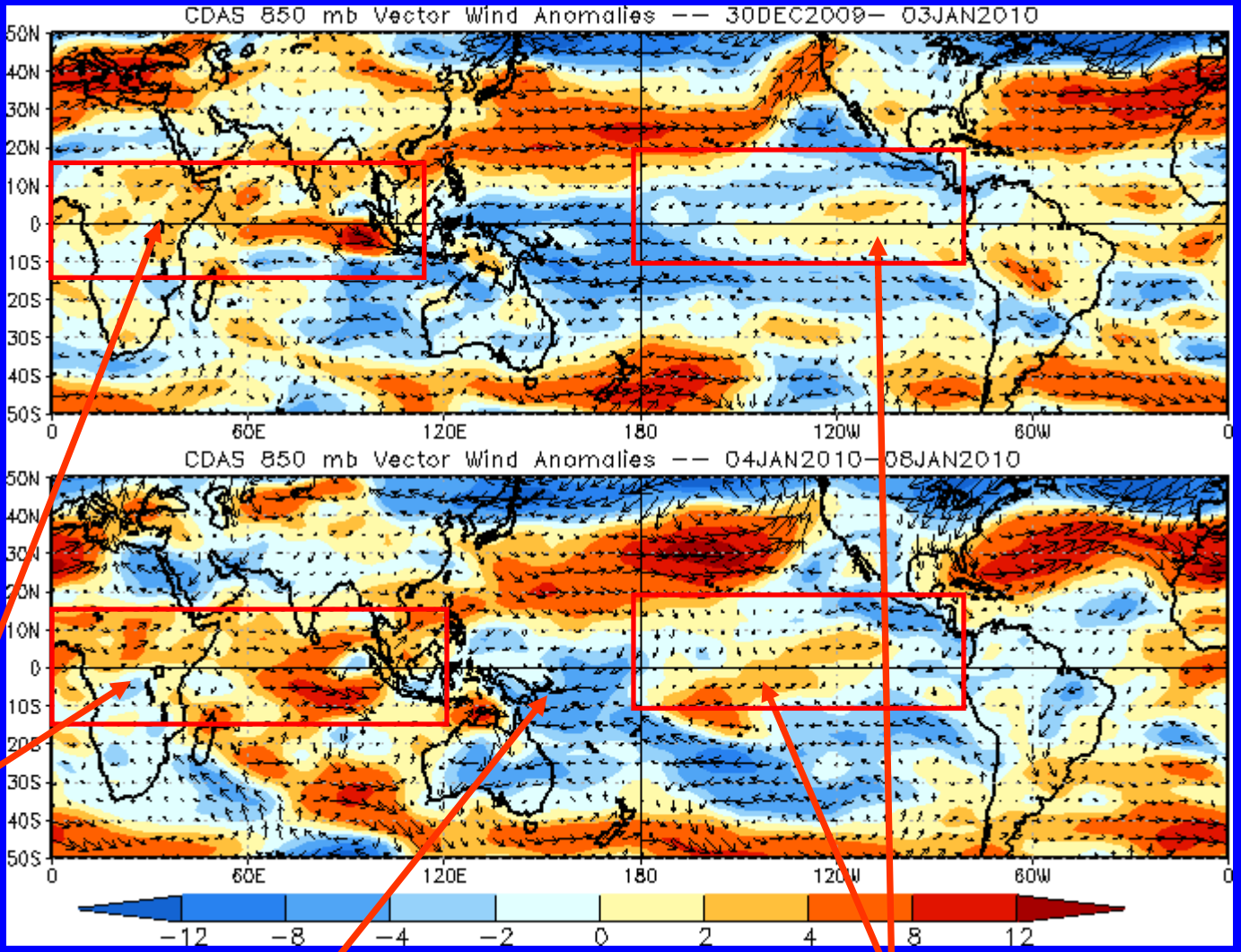
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

# 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 continued and increased in coverage during the last five days across the Indian Ocean and Africa.**

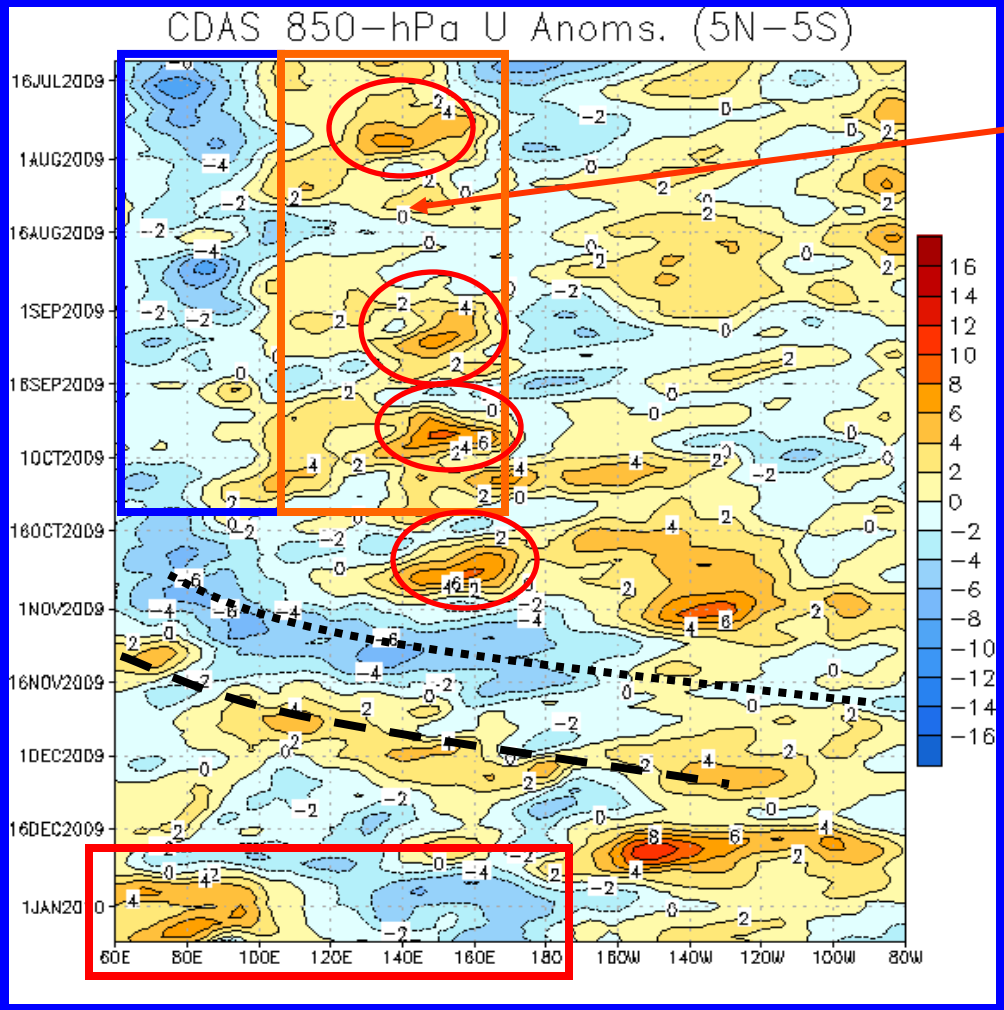
**Easterly wind anomalies decreased some across the western Pacific during the last five days.**

**Westerly wind anomalies increased slightly across the central and 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

From July into October, easterly (westerly) anomalies prevailed across the Indian Ocean (Indonesia) (blue and orange boxes).

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

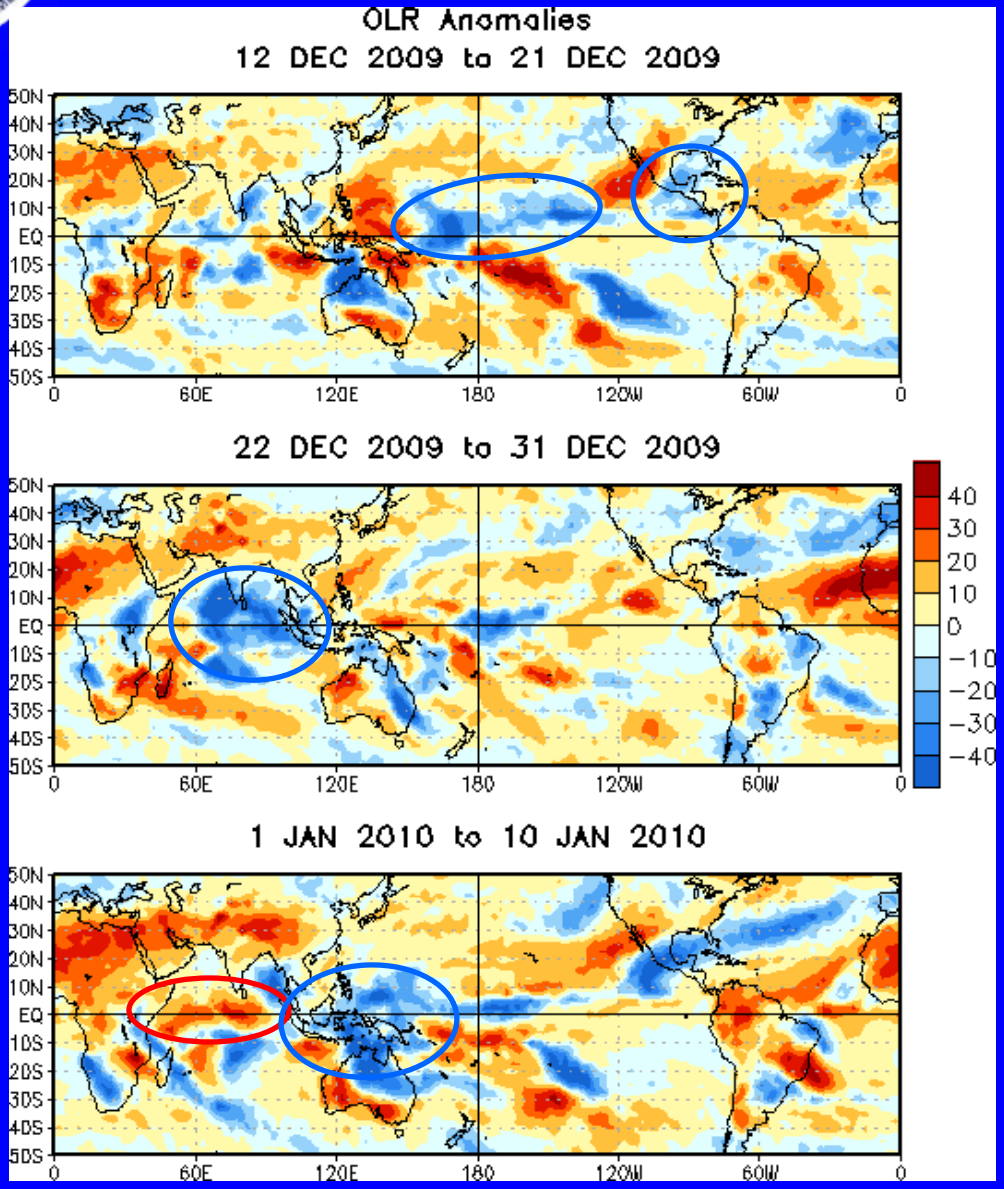
Easterly (dotted line) and westerly (dashed line) anomalies developed across the Indian Ocean and shifted eastward across the Date Line during late October and November associated with the MJO.

Beginning in late December, westerly (easterly) anomalies (red box) are evident in the Indian (western Pacific) Ocean.

# OLR Anomalies: Last 30 days

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

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

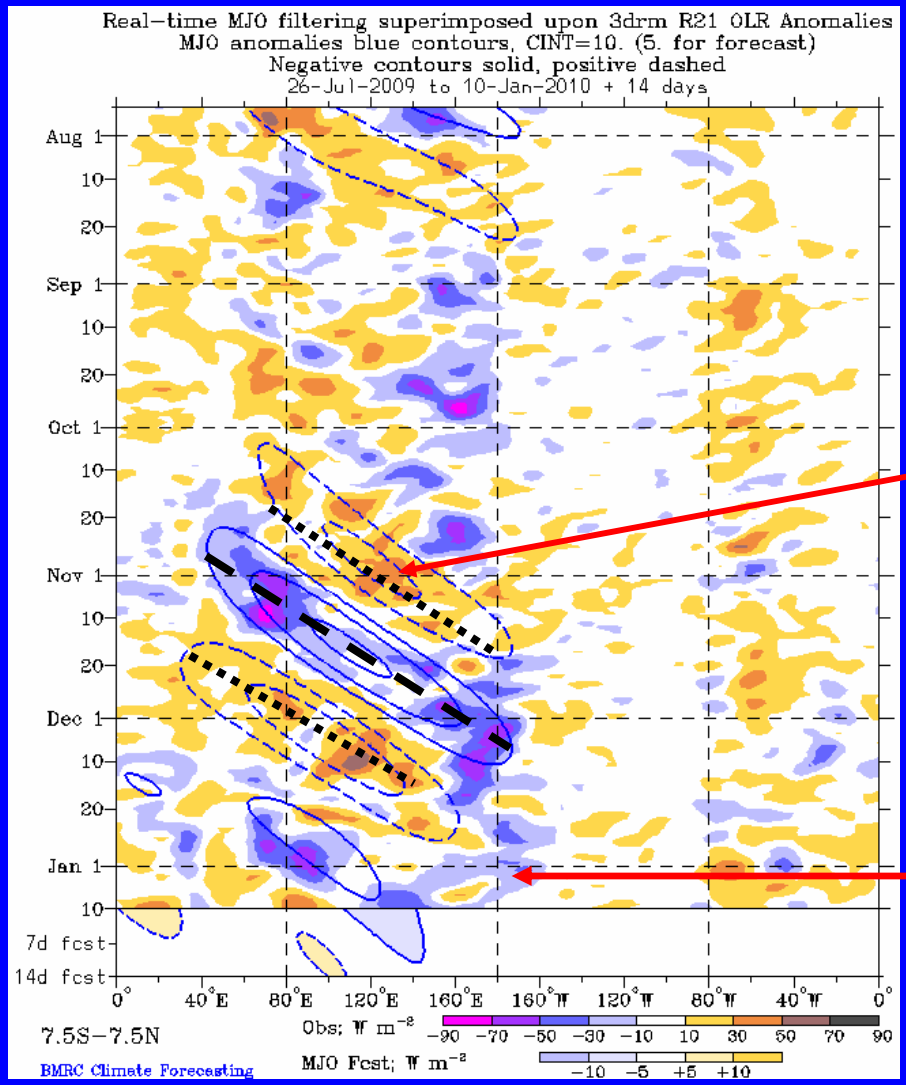



During mid-to-late December, convection became more mixed across the Maritime continent with enhanced convection in the western and central equatorial Pacific (blue oval). Enhanced convection was also evident across the Caribbean and Central America (blue oval).

During late December, enhanced convection rapidly developed across the Indian Ocean.

In early January, enhanced convection shifted eastward to the Maritime continent and the western Pacific while suppressed convection developed across the equatorial Indian Ocean.

# 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)**

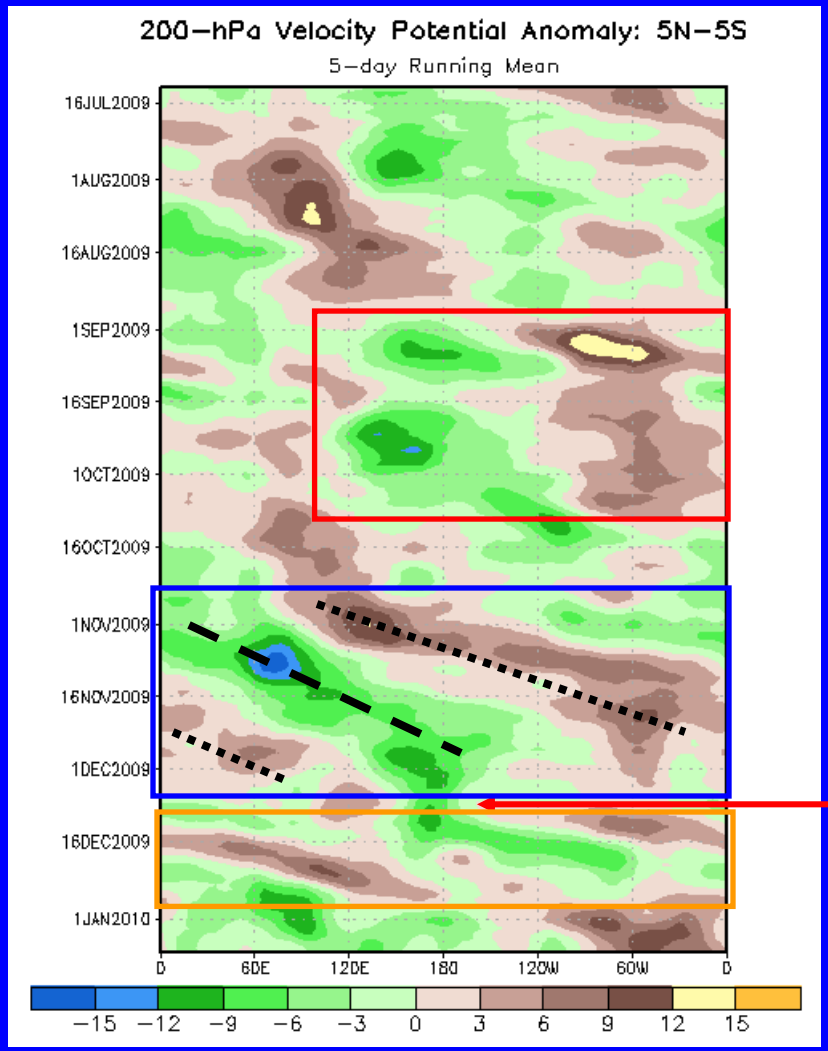
**Beginning in late October, suppressed (enhanced) convection (dotted and dashed lines) developed across the Maritime continent (Indian Ocean) and shifted eastward into the Pacific. Later, suppressed convection once again developed across the Indian Ocean and spread eastward during late November and early December.**

**During the second half of December and early January, enhanced convection weakened near the Date Line while strong enhanced convection developed in the Indian Ocean (60E – 100E) and has shifted eastward in recent days.**

# 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).**

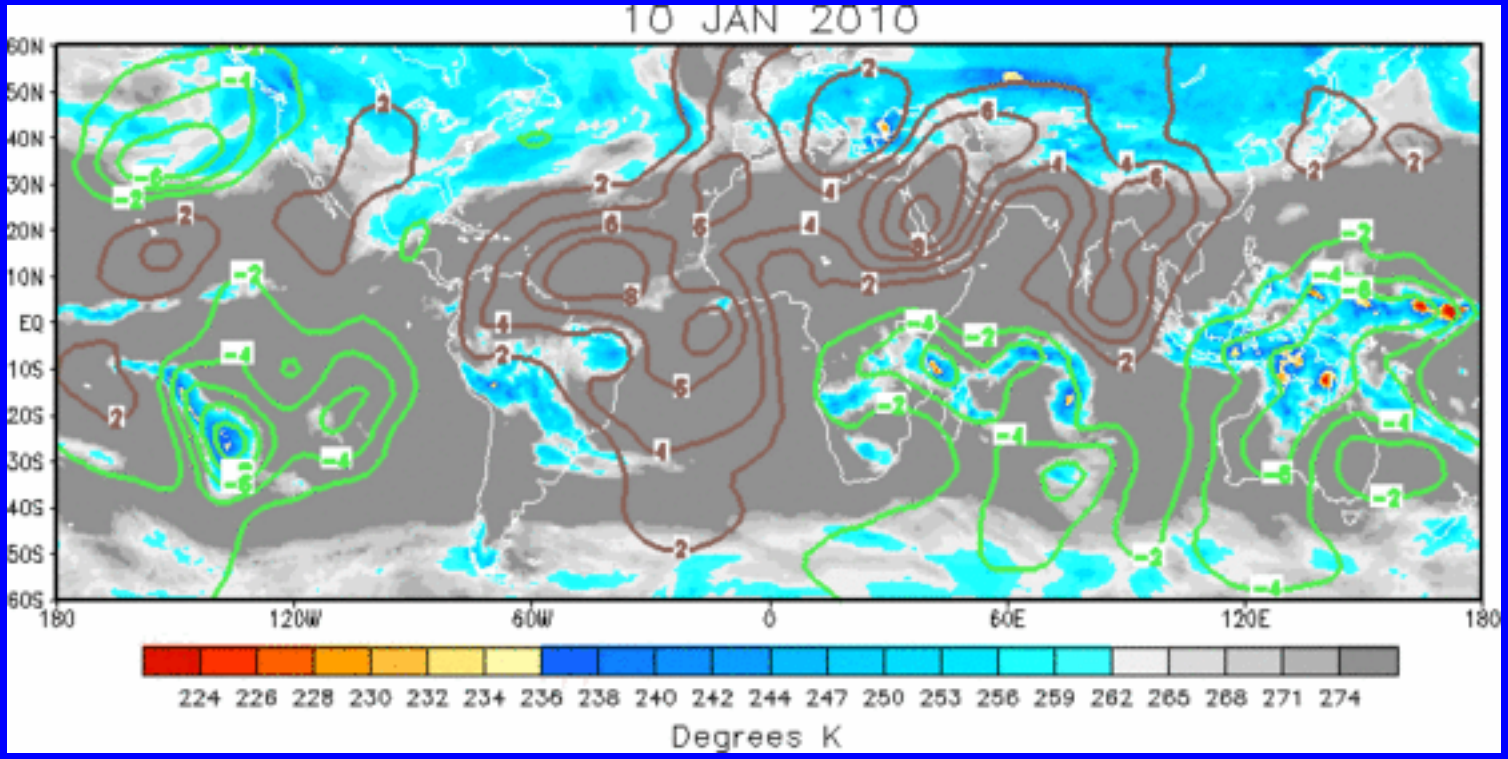
**In late October and November, anomalies increased and eastward propagation was evident associated with MJO activity (blue box).**

**During early-mid December, the coherent MJO pattern weakened. Eastward propagation evident during the second half of December was related to higher frequency tropical variability and not large-scale coherent MJO activity (orange box).**

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

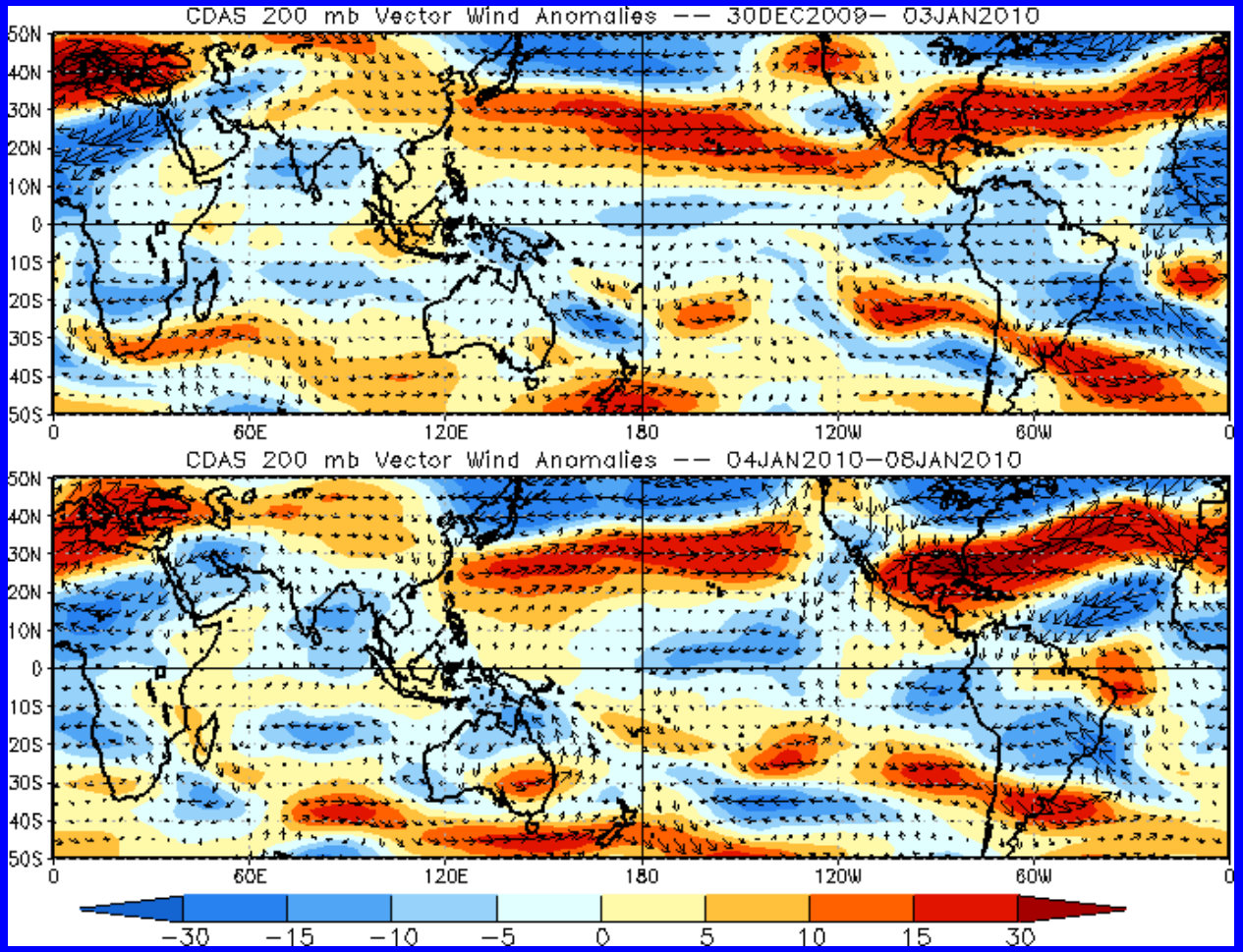
**Positive anomalies (brown contours) indicate unfavorable conditions for precipitation**

**Negative anomalies (green contours) indicate favorable conditions for precipitation**




**The anomalous velocity potential pattern indicates upper-level convergence over South America, the Atlantic and parts of Africa while areas of upper-level divergence are evident in the South Pacific, southern Africa and the Maritime continent.**

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




**Note that shading denotes the zonal wind anomaly**

**Blue shades: Easterly anomalies**

**Red shades: Westerly anomalies**

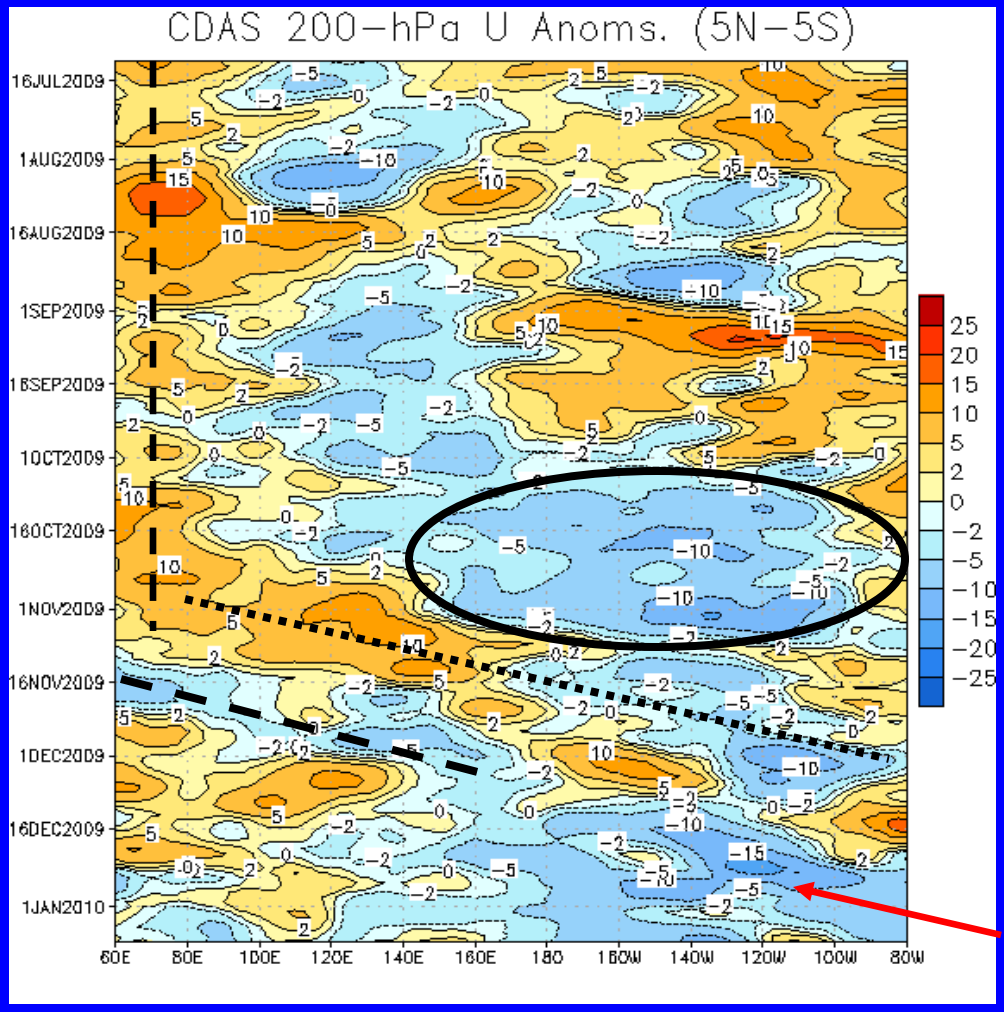
**During the last five to ten days, there has been little change in the tropical wind anomalies.**

**Strong westerly winds (red shades) continue across much of the subtropics of the Northern Hemisphere.**

# 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

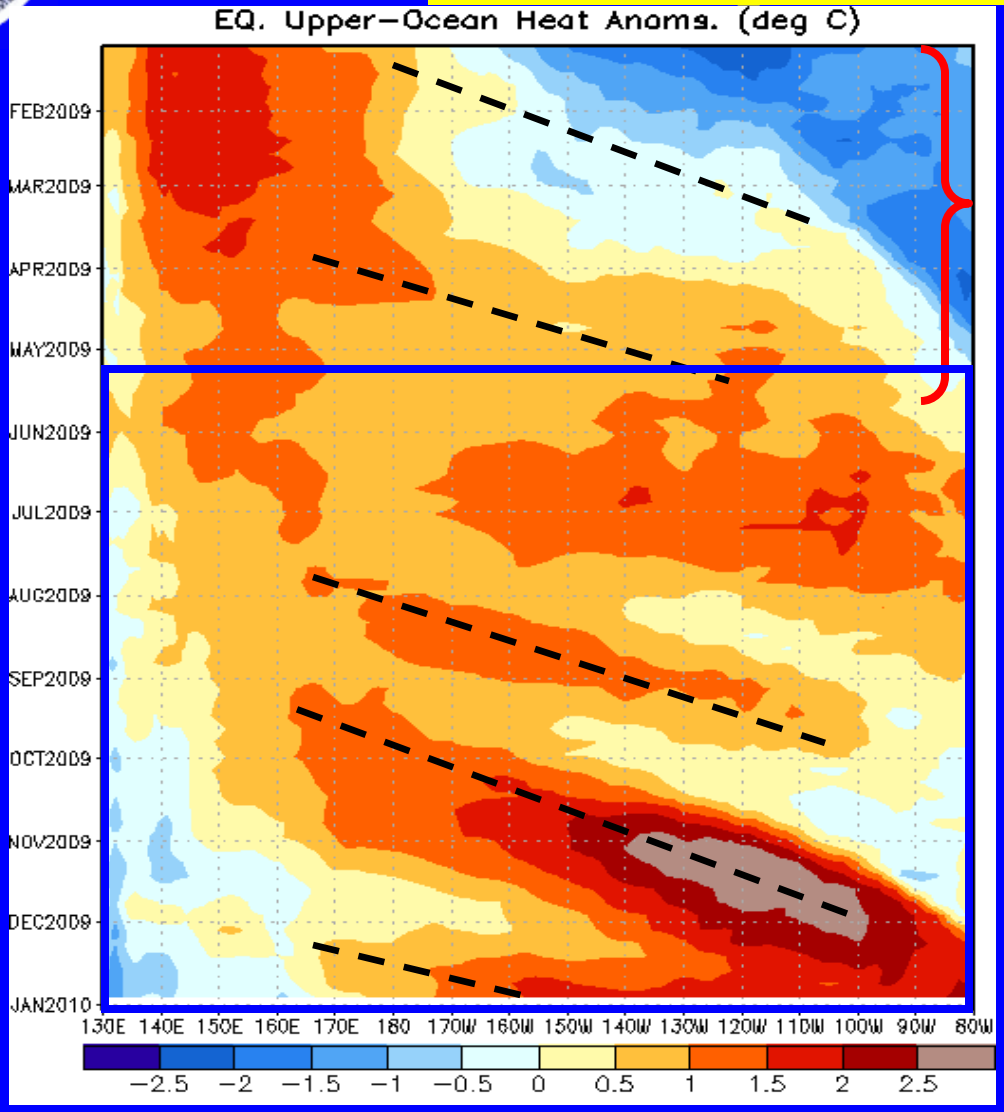
**Westerly anomalies across the Indian Ocean had persisted for much of the period since July 2009 (vertical dashed black line).**

**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 were reestablished across much of the Pacific during the second half of December.**

# Weekly Heat Content Evolution in the Equatorial Pacific




Time

Longitude

During December 2008 – January 2009, negative heat content anomalies returned and then strengthened in the central and eastern equatorial Pacific as La Niña conditions redeveloped.

The negative anomalies 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 December (last three dashed black lines).

# MJO Index -- Information

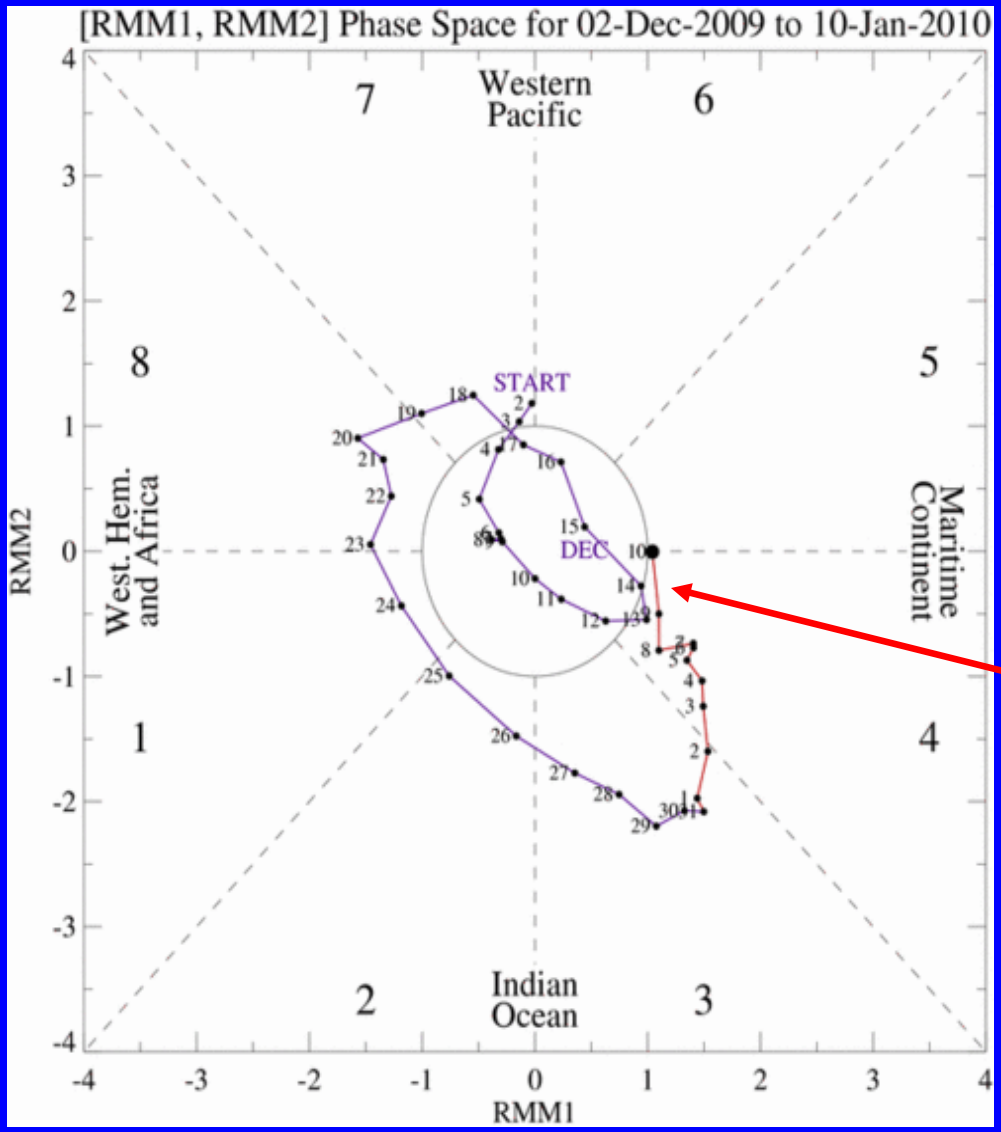
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

**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 nearly identical to that described in WH2004 but small deviations from the BMRC figure are possible at times due to differences in input data and methodology. These typically occur during weak MJO periods or when the ENSO signal is large.**

- **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).**

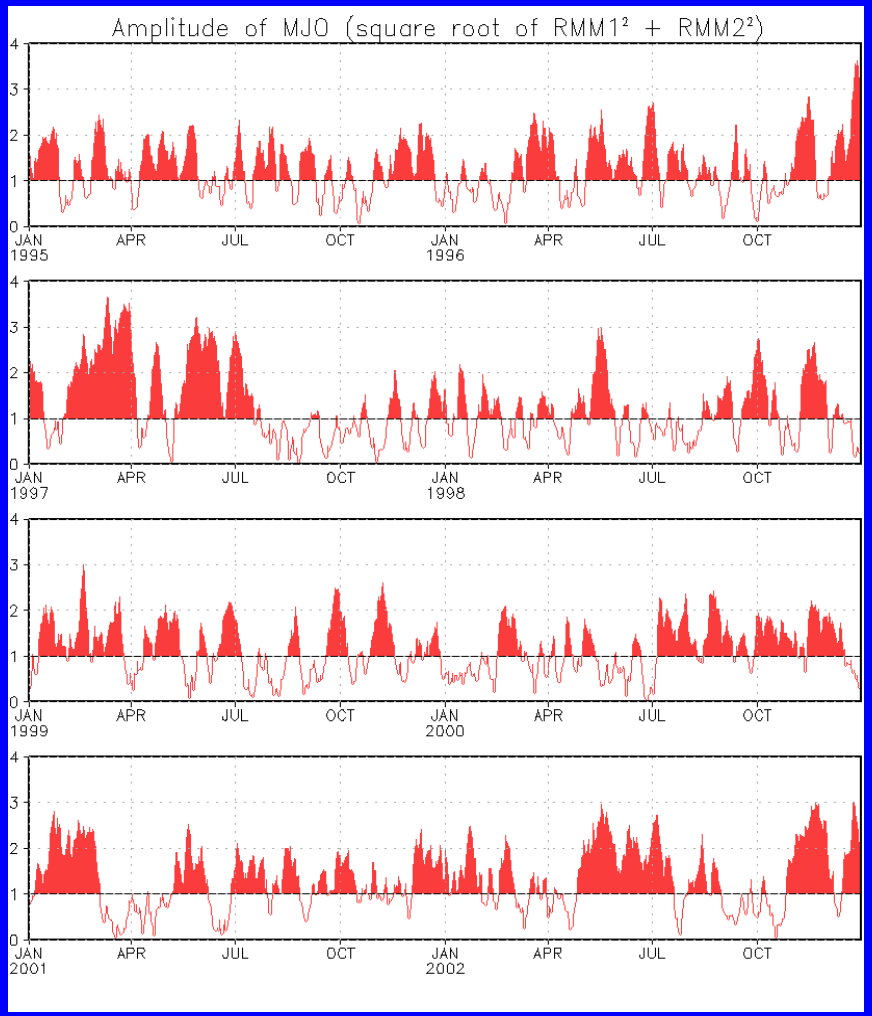
# MJO Index -- Recent Evolution

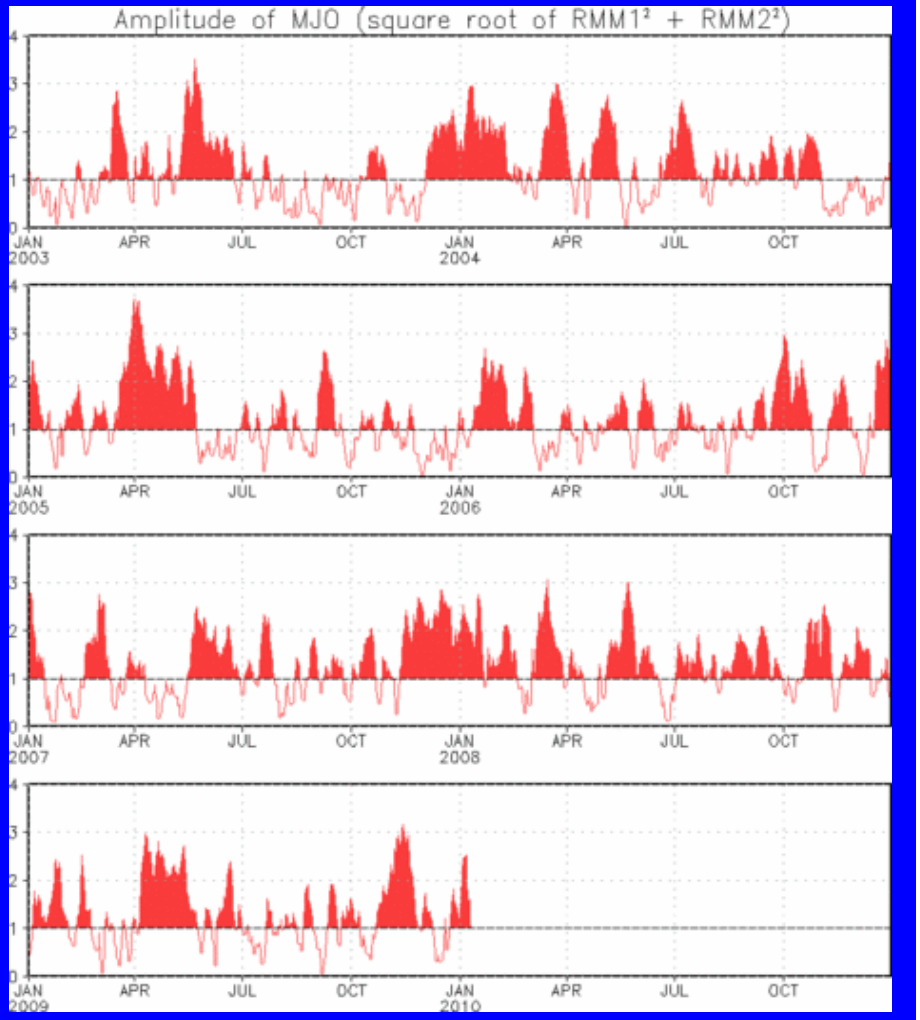



- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

During the past week, the MJO index indicates eastward propagation more consistent with the MJO time scale. The amplitude has decreased over the past week.

# MJO Index – Historical Daily Time Series



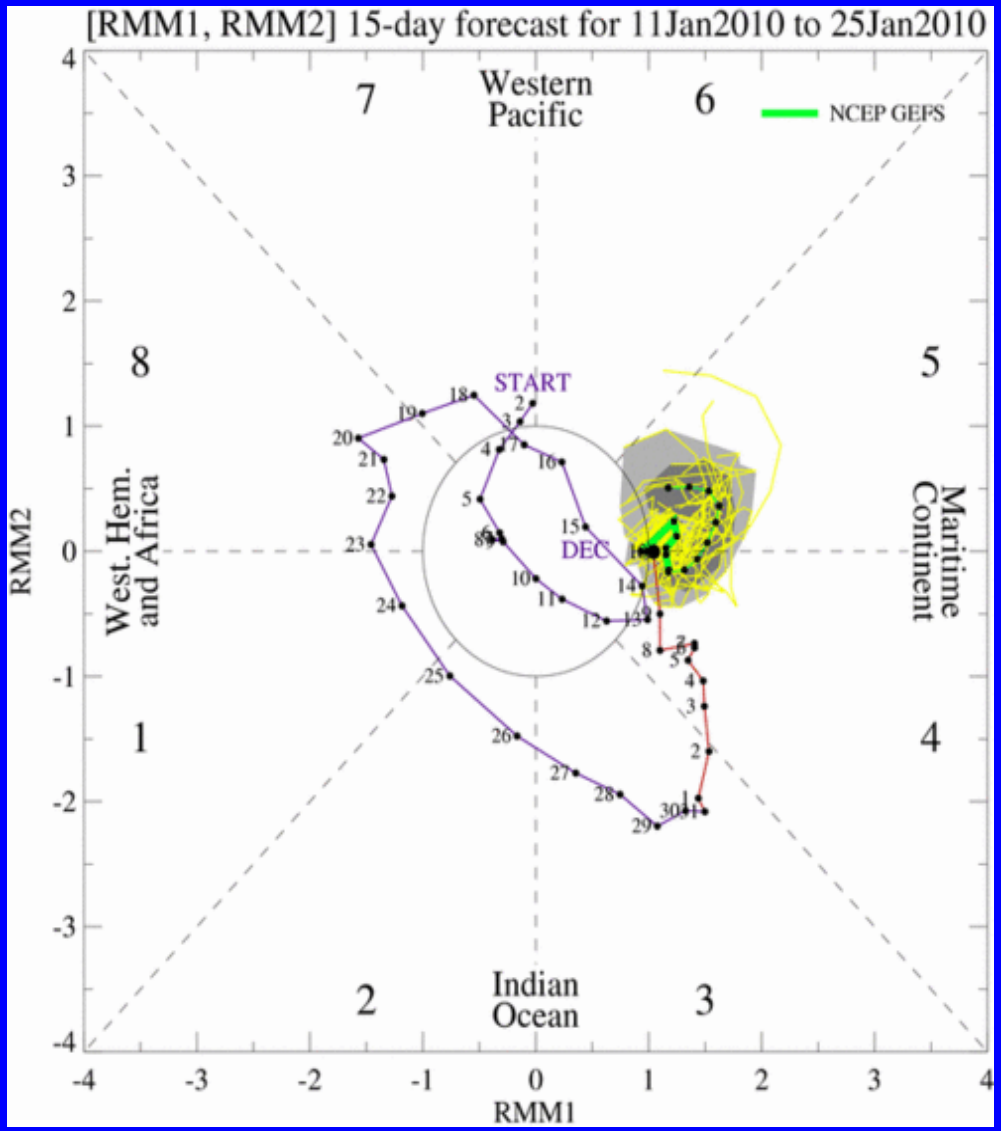

**Time series of daily MJO index amplitude from 1995 to present.**
**Plots put current MJO activity in historical context.**

# 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**



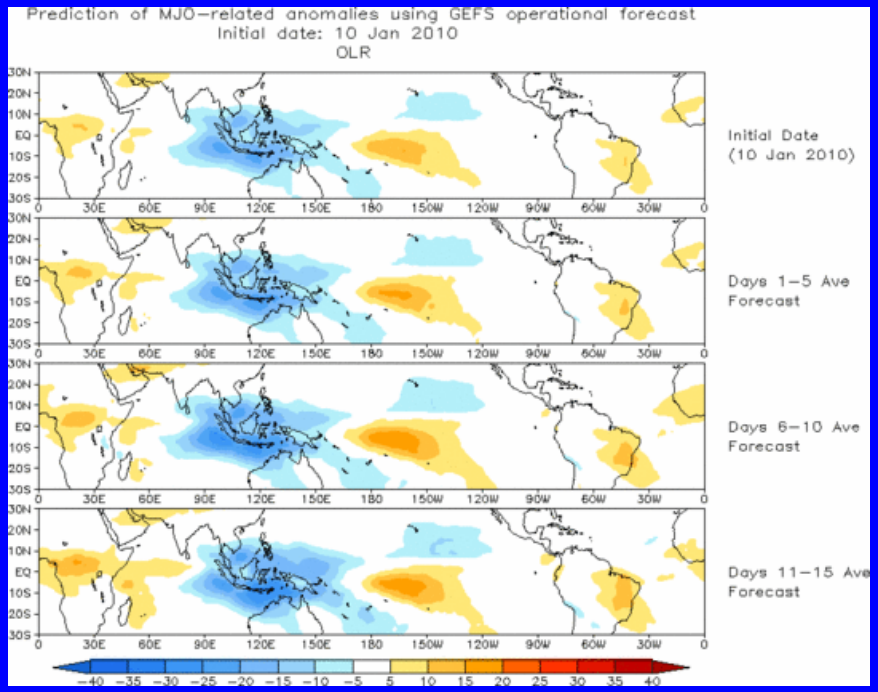

**The GFS MJO index forecasts indicate only little eastward propagation during the next two weeks. The signal is generally focused across the Maritime Continent over the period.**

**There is considerable ensemble spread during the period.**

# Ensemble Mean GFS MJO Forecast

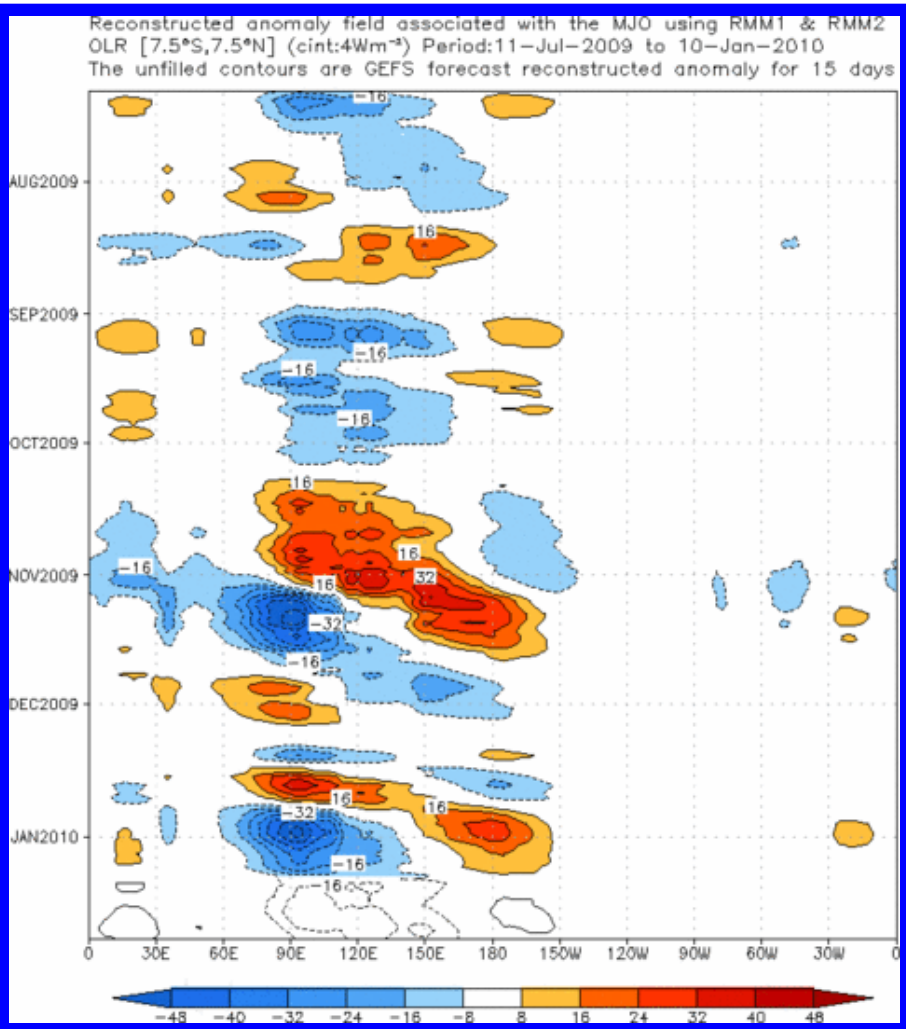
**Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)**

**Spatial map of OLR anomalies for the next 15 days**




**The GEFS ensemble mean forecast indicates enhanced convection (blue shades) across the Maritime continent persisting over the period. Areas of suppressed convection are forecast for parts of South America, Africa and the south Pacific.**

**Time-longitude section of (7.5°S-7.5°N) OLR anomalies for the last 180 days and for the next 15 days**



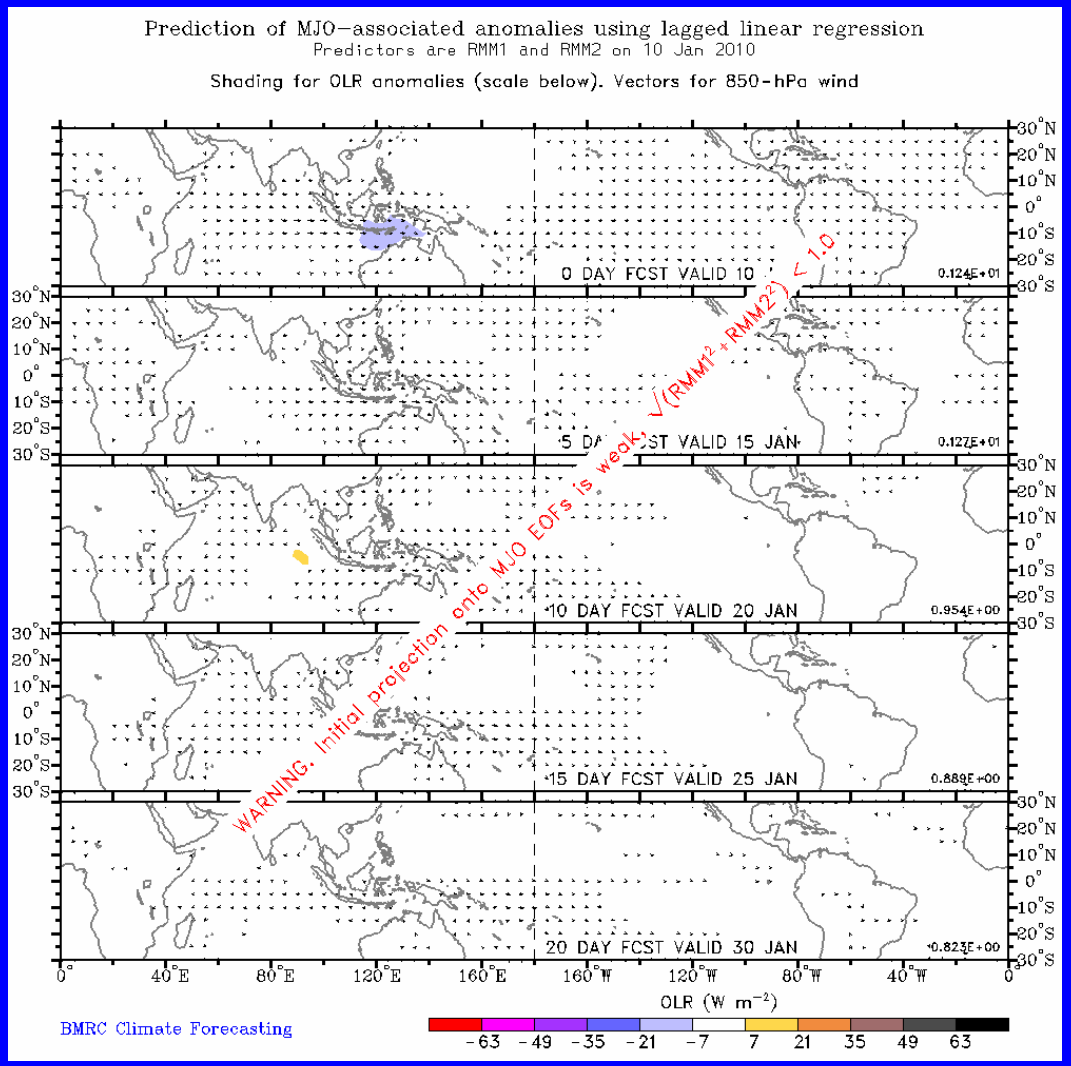
# Statistical MJO Forecast

**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**

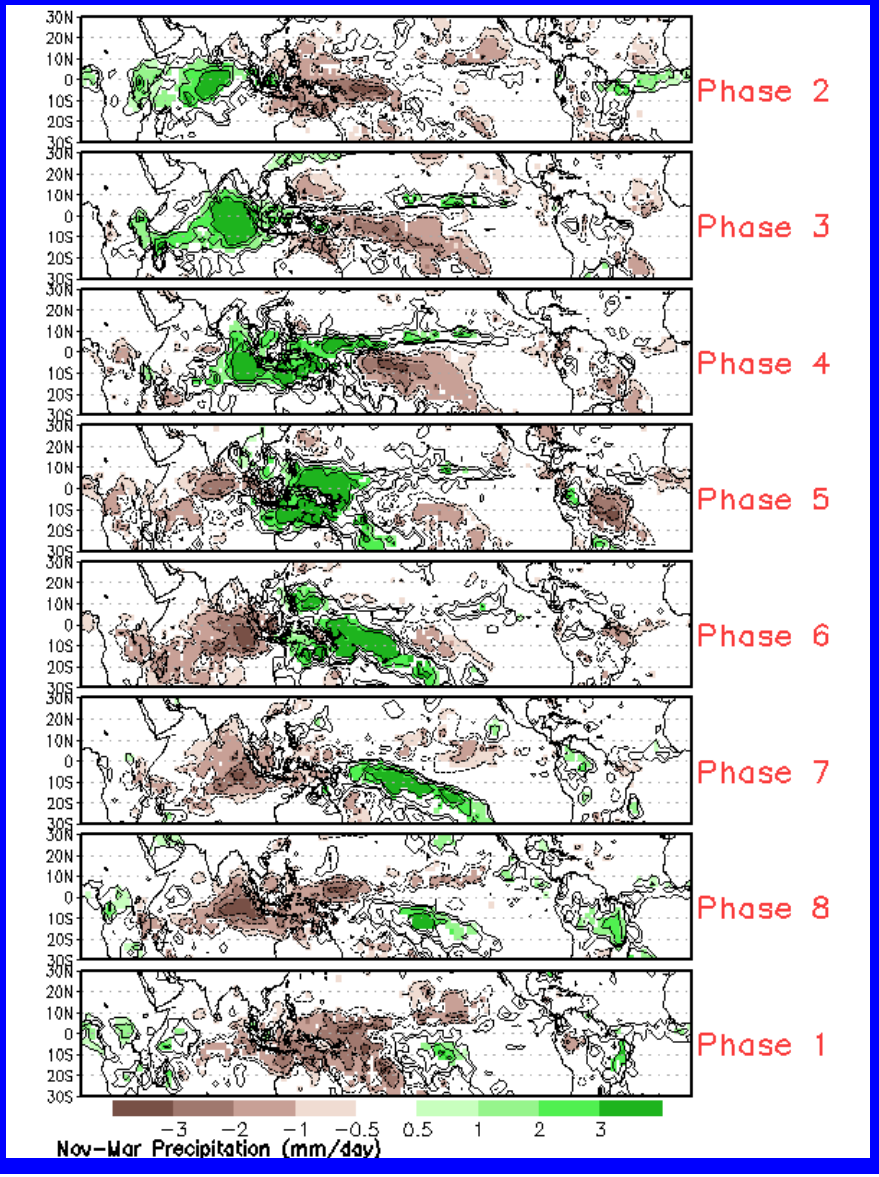
**(Courtesy of the Bureau of Meteorology Research Centre - Australia)**

**The statistical forecast indicates a weak signal during the period.**



# MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)




850-hPa Wind Anomalies (Nov-Mar)