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

Update prepared by
Climate Prediction Center / NCEP
January 4, 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.
- The MJO index signal indicated over the past two weeks is related to higher frequency coherent tropical variability rather than a large-scale, long-lived coherent MJO. Moreover, the majority of MJO index forecasts indicate a weakening of this signal.
- The MJO is expected to remain weak during the upcoming 1-2 week period.
- The MJO is not expected to contribute substantially to anomalous tropical rainfall during the period.

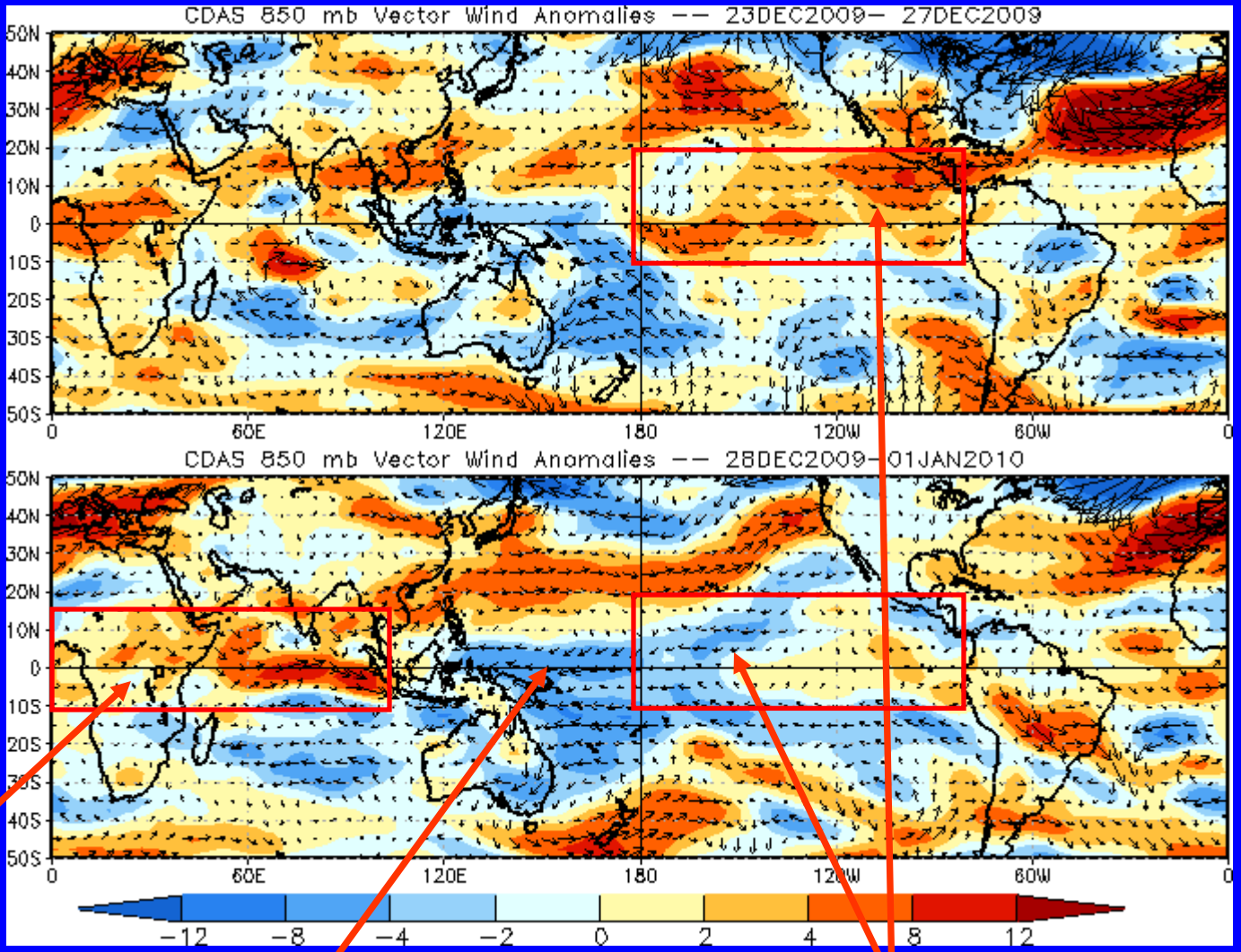
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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 shifted east to during the last five days to encompass the entire equatorial Indian Ocean.

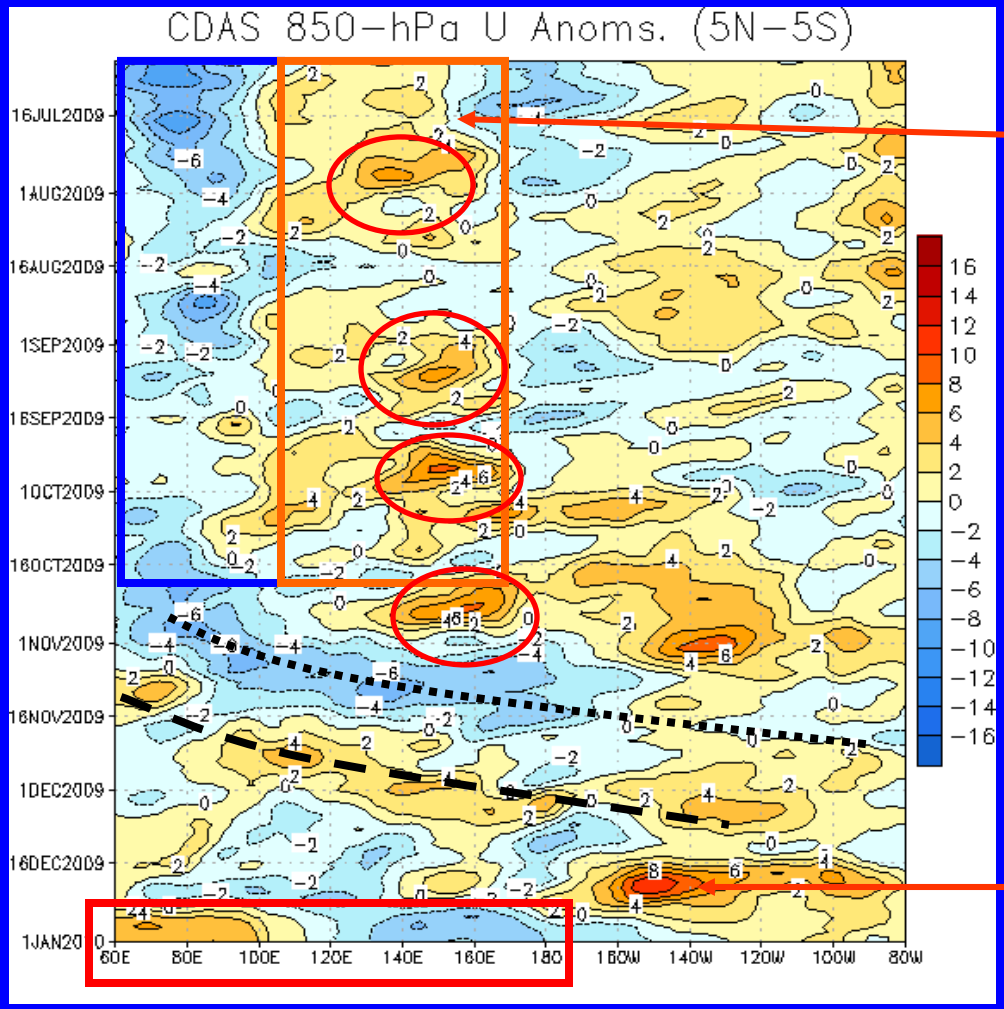
Easterly wind anomalies increased across the western Pacific Continent during the last five days.

Westerly wind anomalies decreased 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 September, 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.

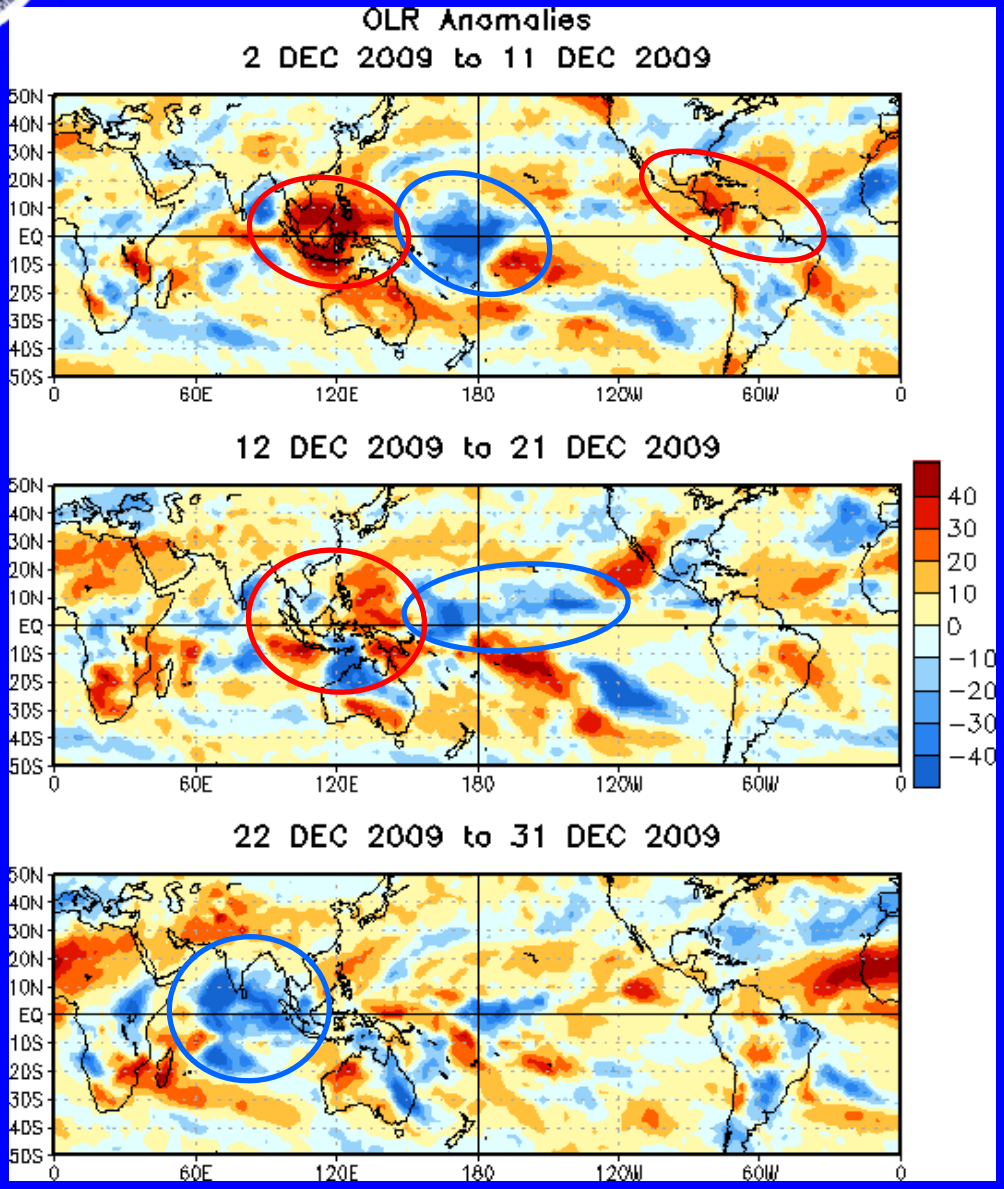
Easterly (dotted line) and westerly (dashed line) anomalies developed across the Indian Ocean and shifted eastward across the Date Line during late October and November associated with the MJO.

During mid December, westerly anomalies strengthened across much of the eastern Pacific Ocean. Most recently, 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)

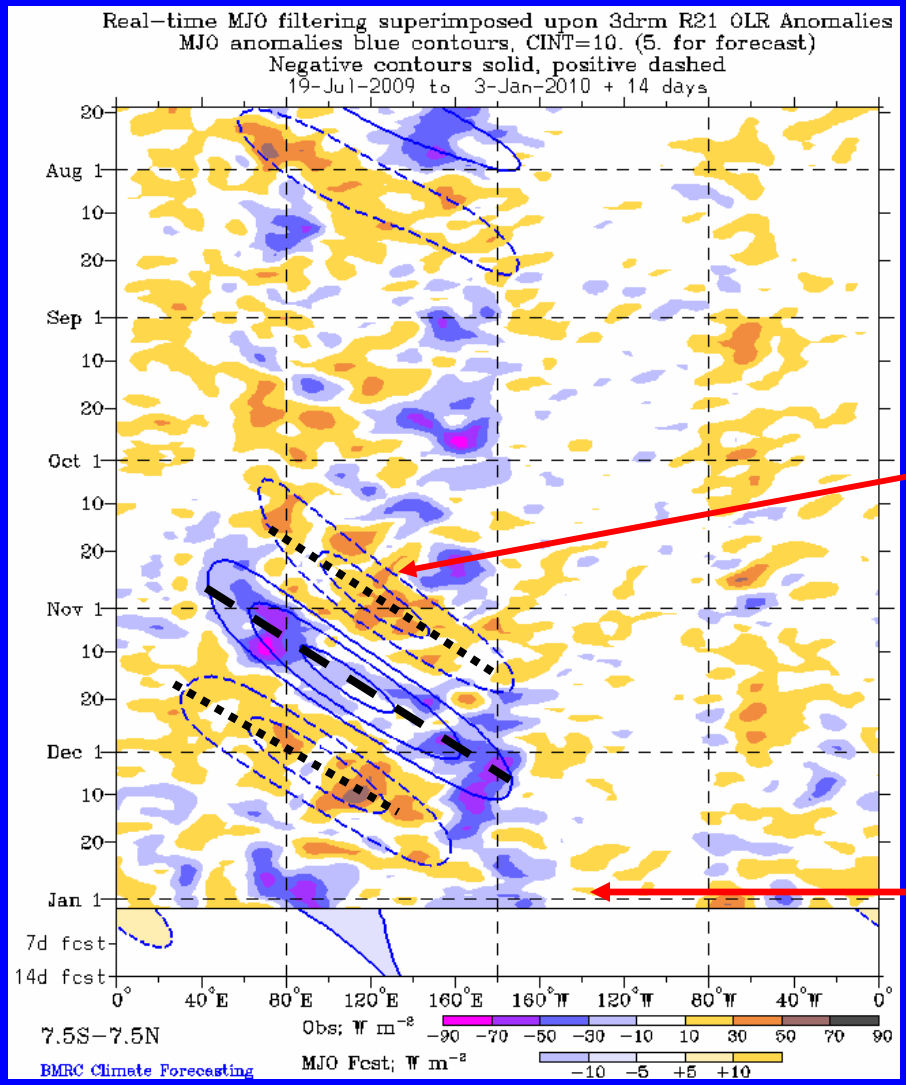


During early December, suppressed convection (red ovals) was evident over parts of the Americas, the Maritime Continent and Australia, while enhanced convection was evident near the Date Line.

During mid December, enhanced convection spread slightly eastward into the central Pacific while anomalous convection across the Maritime continent became mixed.

During late December, enhanced convection rapidly developed across the Indian Ocean. Anomalous convection remain mixed across the Maritime continent and the 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)

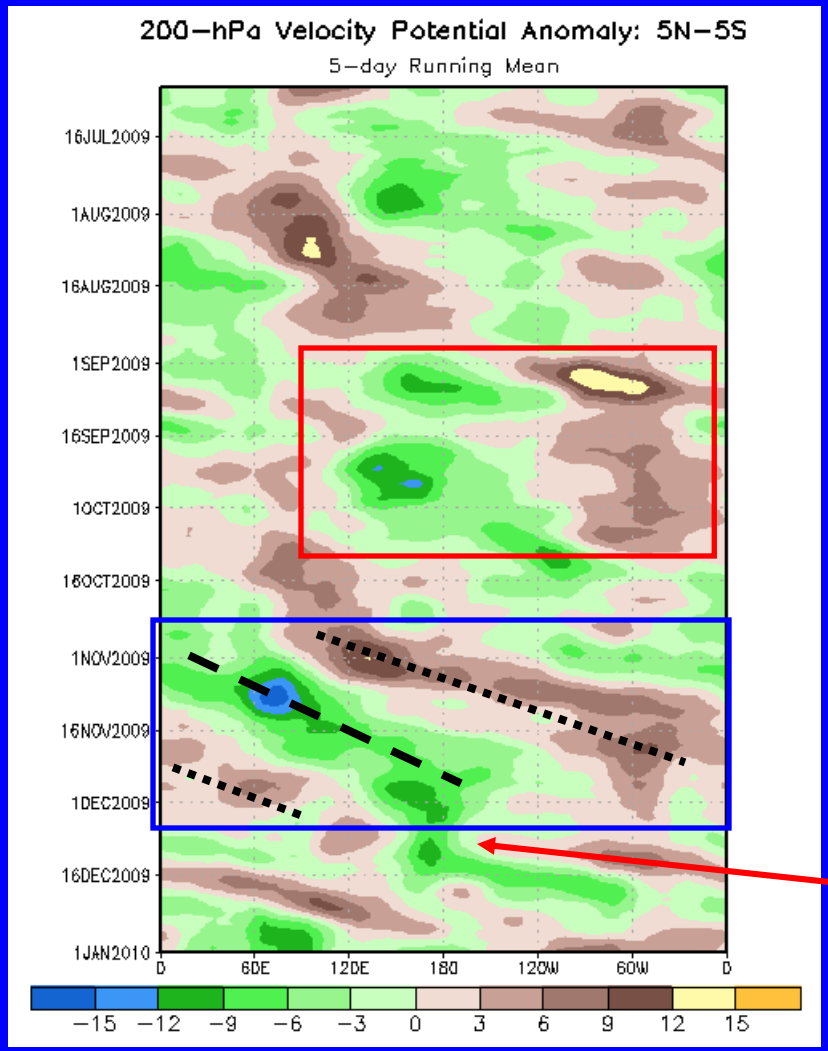
Beginning in late October, suppressed (enhanced) convection (dotted and dashed lines) developed across the Maritime continent (Indian Ocean) and shifted eastward into the Pacific. Later, suppressed convection once again developed across the Indian Ocean and spread eastward during late November and early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

During the second half of December, enhanced convection weakened near the Date Line while strong enhanced convection developed in the Indian Ocean (60E – 100E).

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).

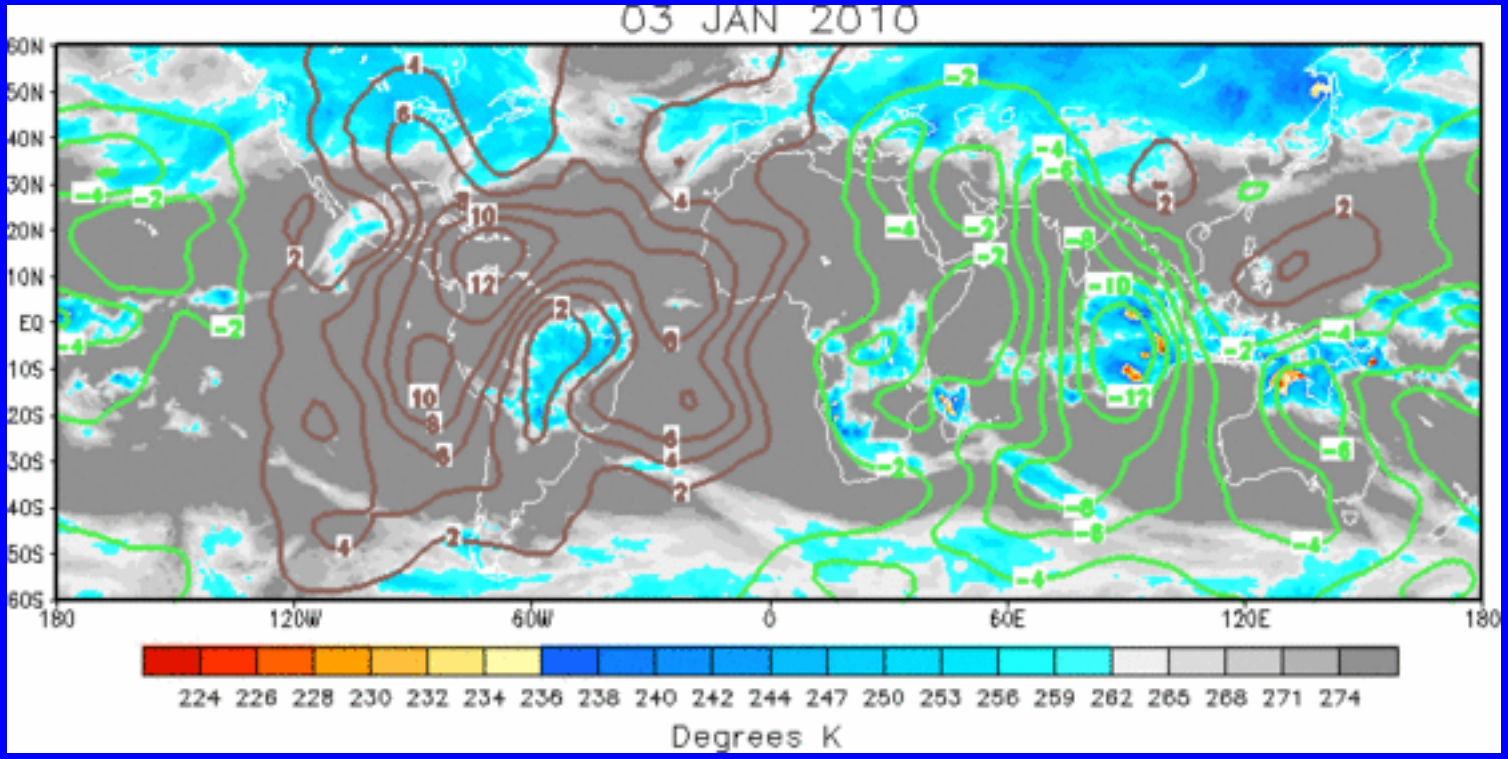
In late October and November, anomalies increased and eastward propagation was evident associated with MJO activity (blue box).

During early-mid December, the coherent MJO pattern weakened. Eastward propagation evident afterwards is related to higher frequency tropical variability and not large-scale coherent MJO activity.

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

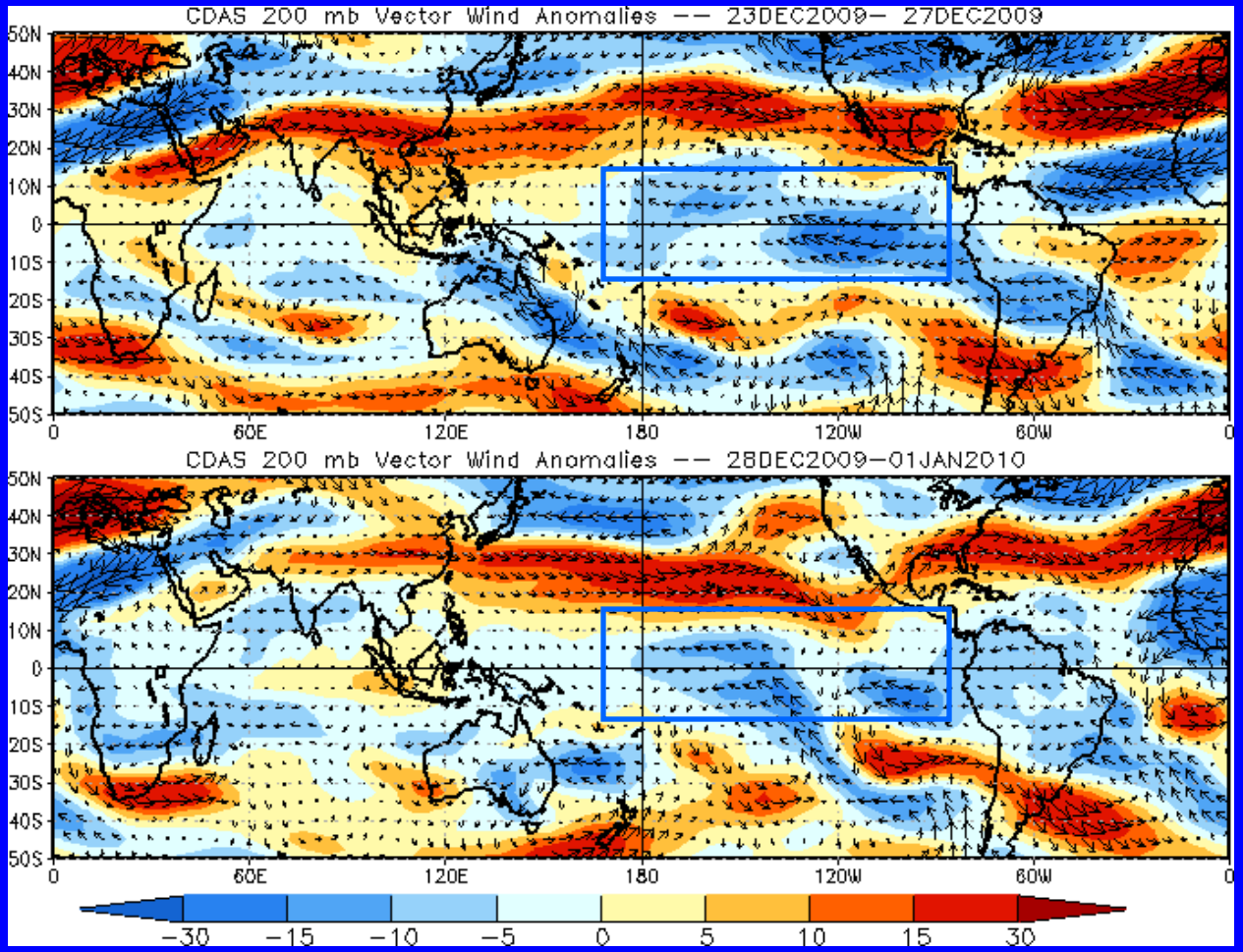
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The anomalous velocity potential pattern indicates upper-level convergence (divergence) over generally the western (eastern) Hemisphere.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

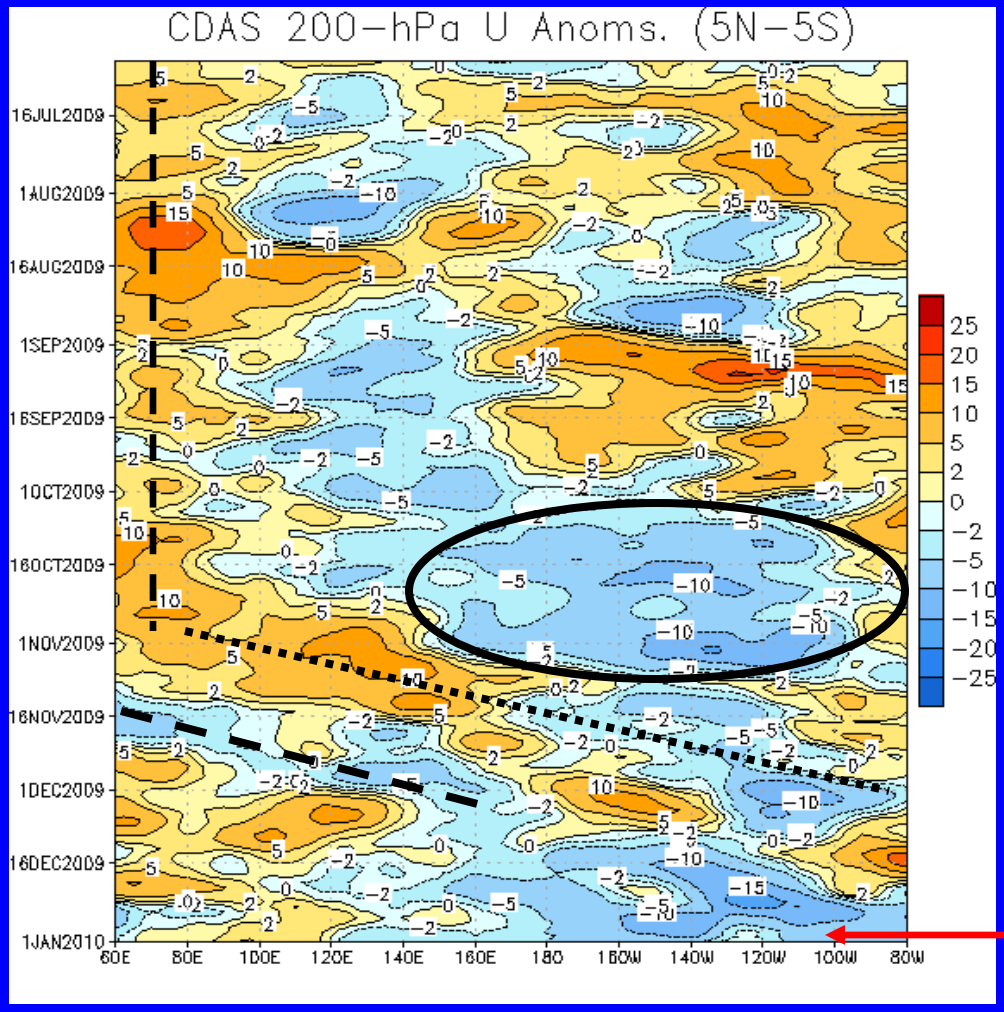
During the last five to ten days, easterly anomalies continued across the eastern and central Pacific (blue boxes).

Westerly anomalies (red shades) stretch across much of the globe in the northern Hemisphere sub-tropics.

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

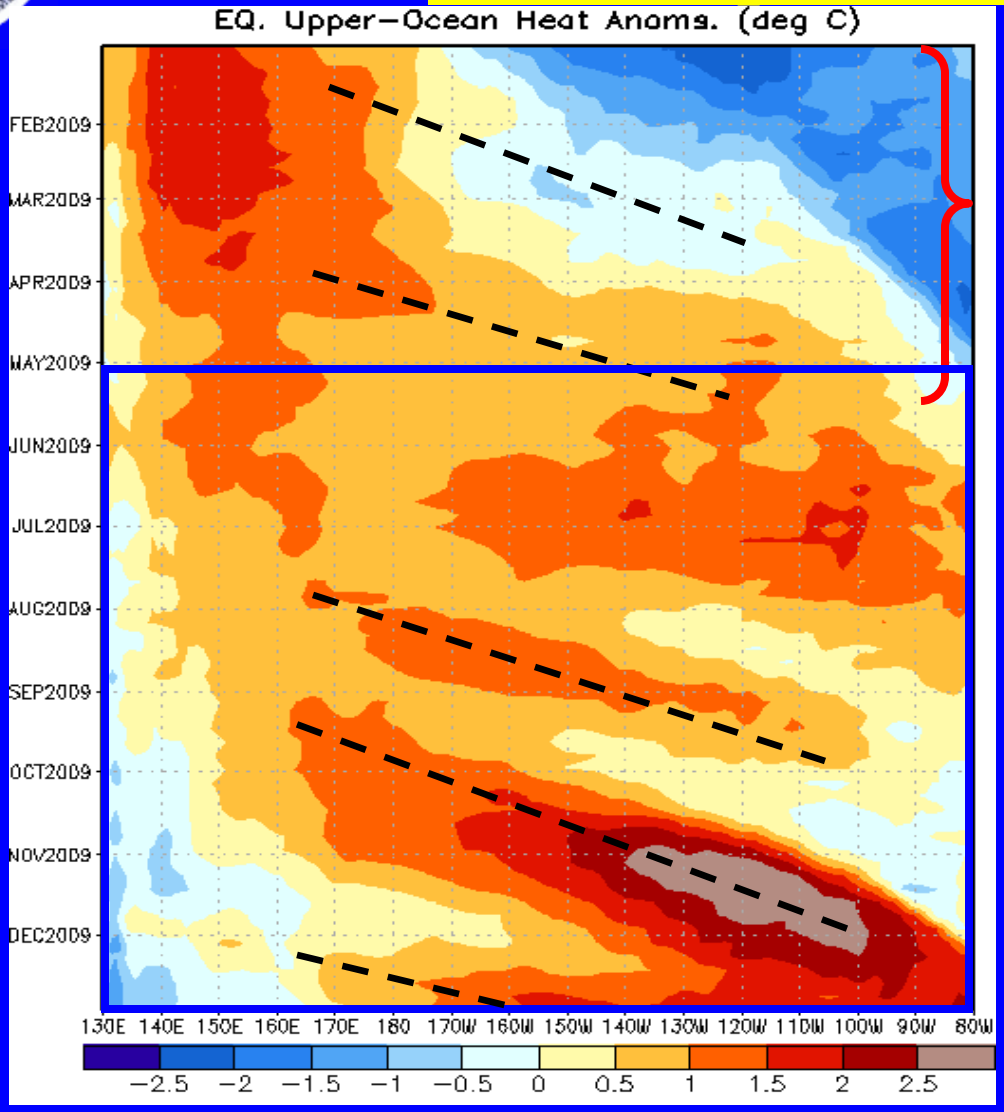
Westerly anomalies across the Indian Ocean had persisted for much of the period since July 2009 (vertical dashed black line).

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 have since been 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

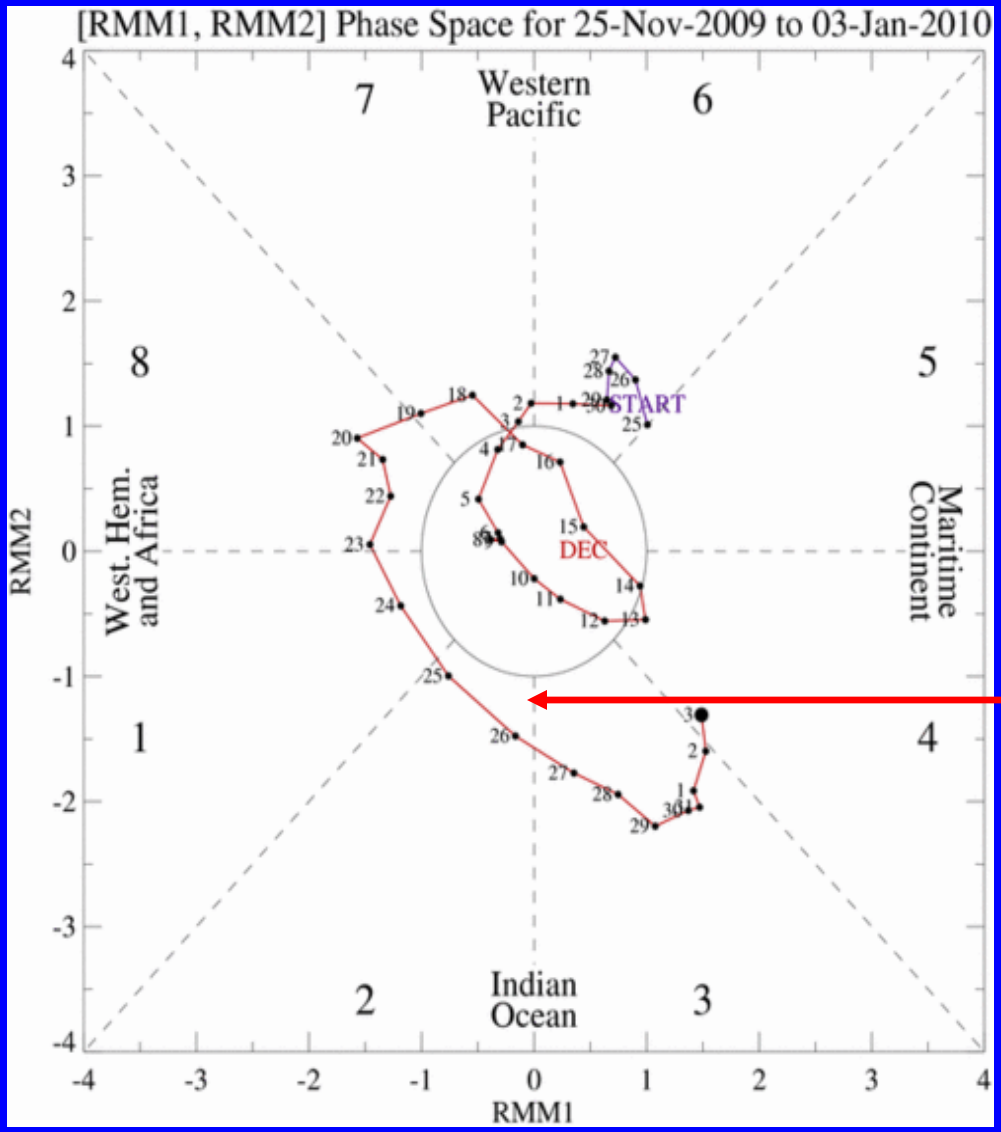
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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

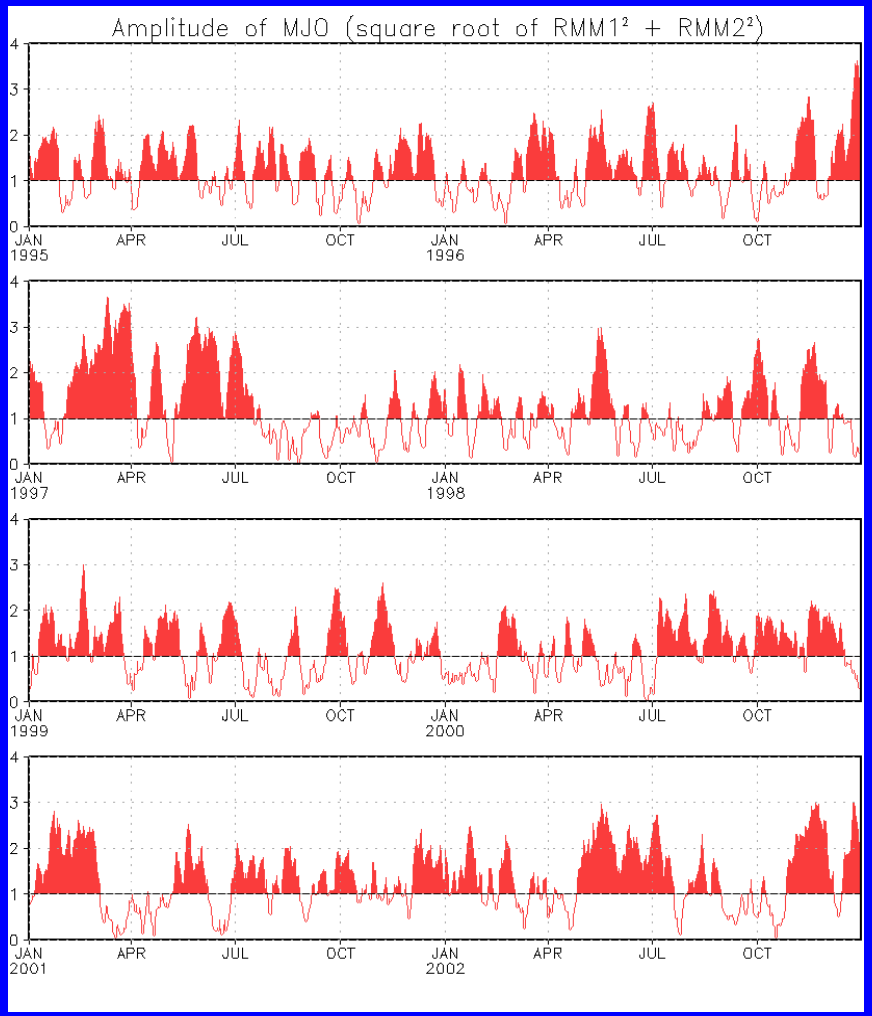


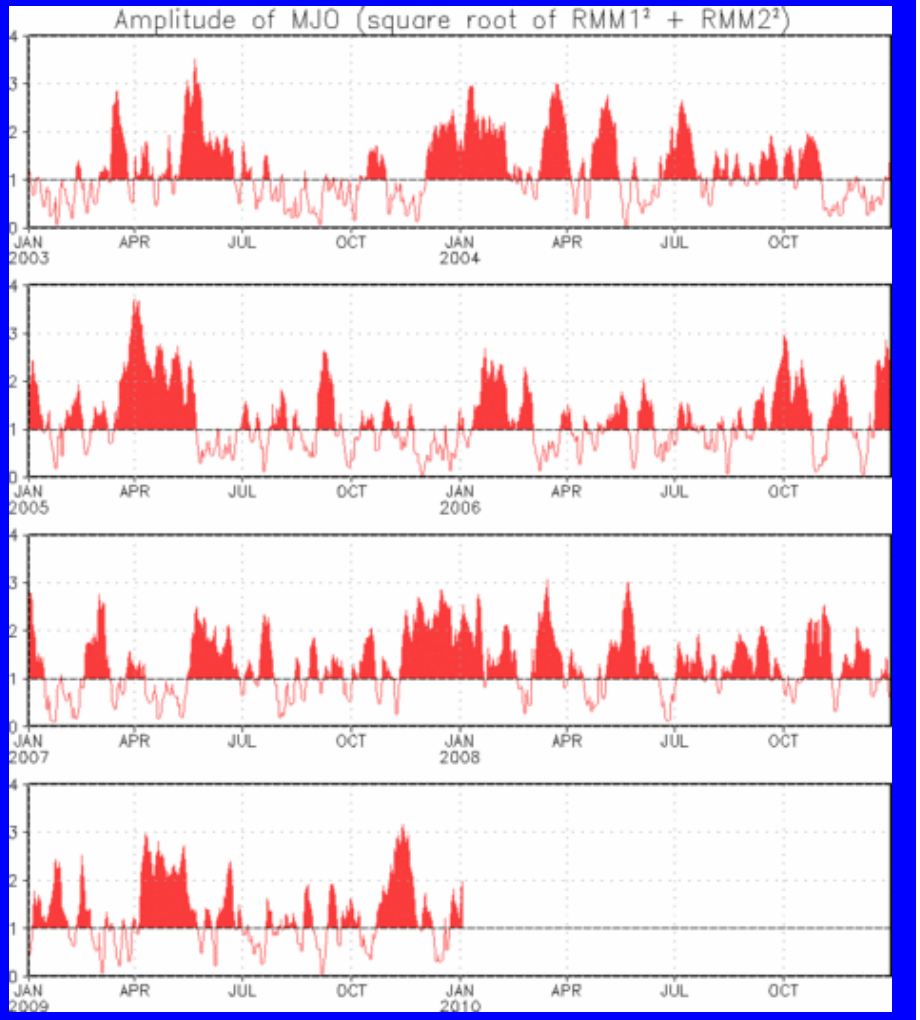
- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

The MJO index indicated an increase in amplitude and very fast eastward propagation during late December. This is consistent with higher frequency tropical variability and not a coherent MJO.

In recent days, the MJO index movement has slowed.

MJO Index – Historical Daily Time Series





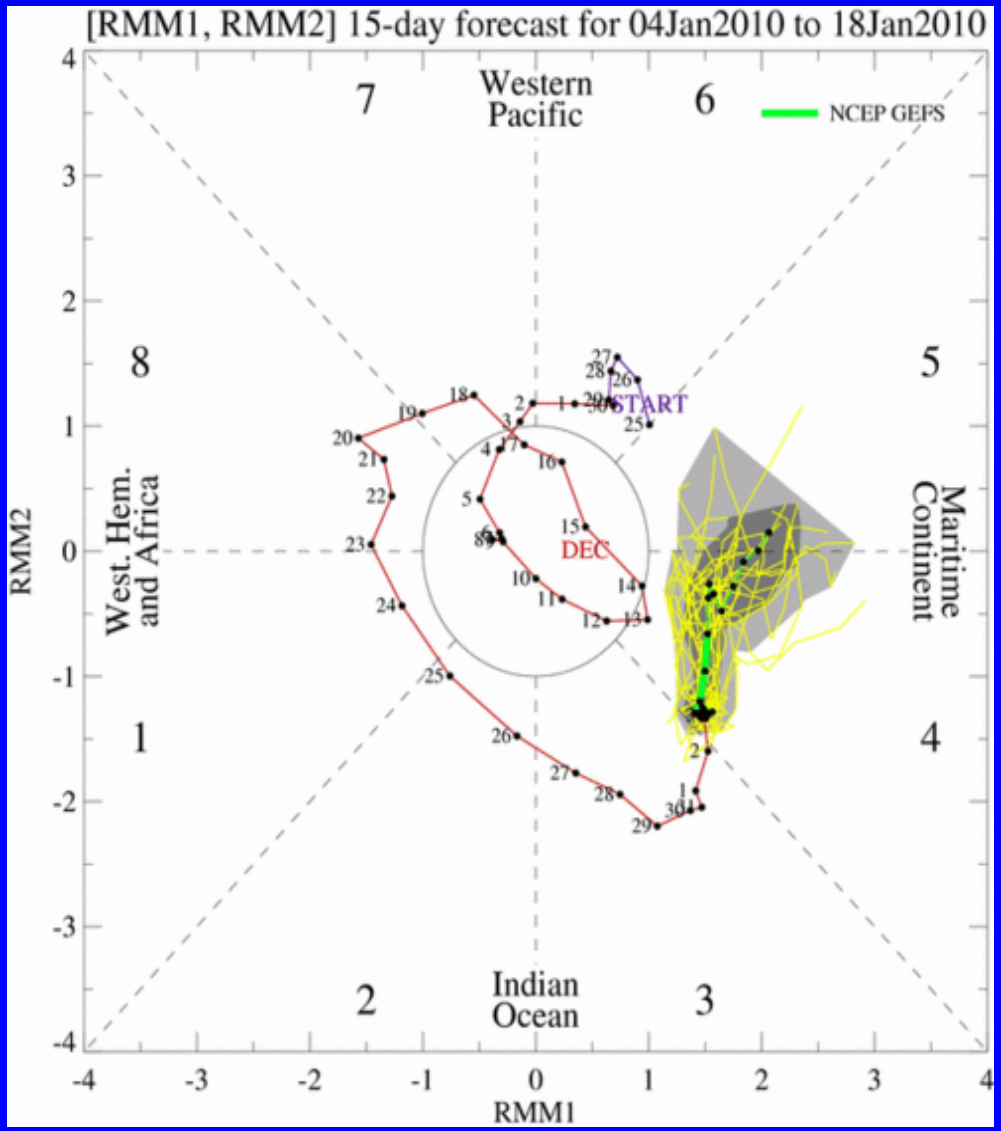
Time series of daily MJO index amplitude from 1995 to present.
Plots put current MJO activity in historical context.

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



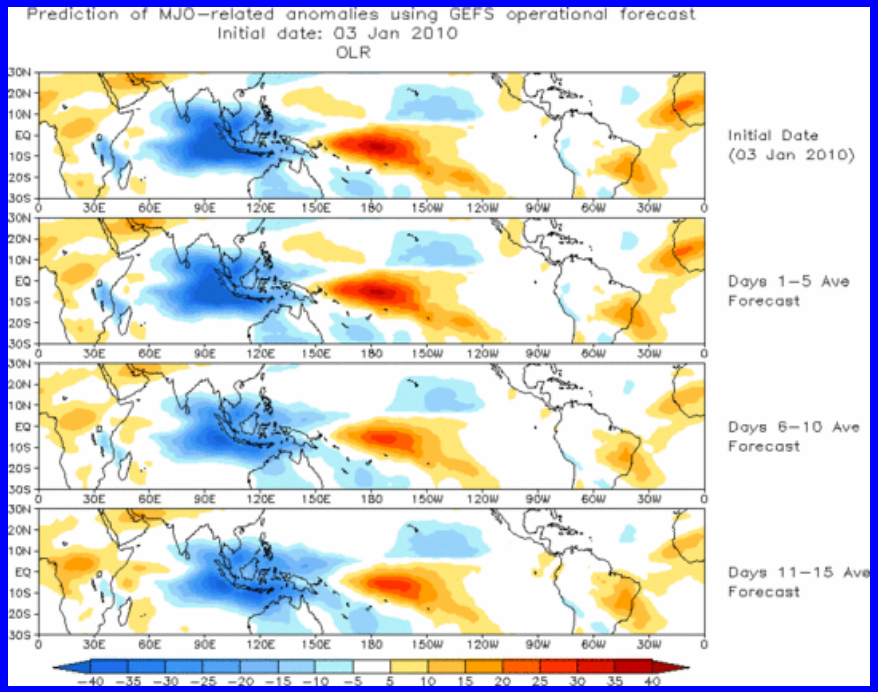
The GFS MJO index forecasts indicate only minor eastward propagation during the next two weeks. The signal is generally focused across the western Maritime Continent over the period.

There is considerable ensemble spread over the period.

Ensemble Mean GFS MJO Forecast

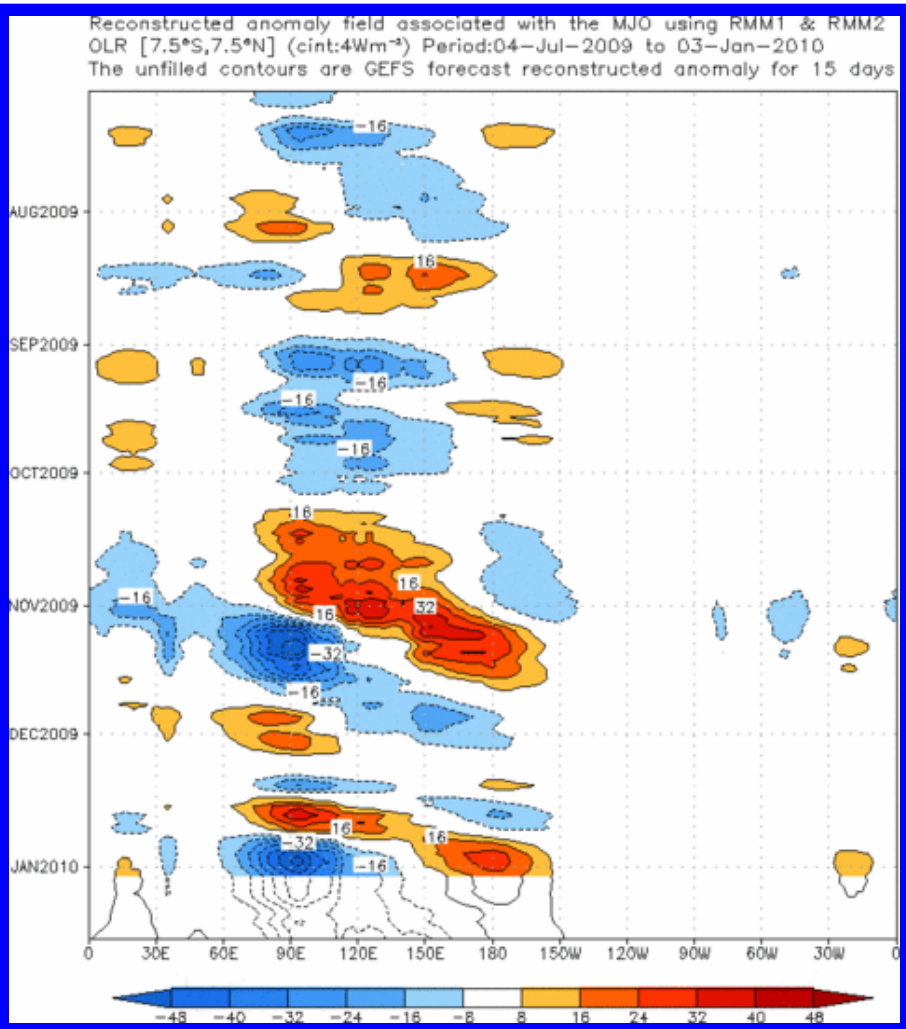
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecast shows enhanced convection (blue shades) in the Indian Ocean throughout the period with areas of suppressed convection forecast for parts of South America, Africa and the Pacific.

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



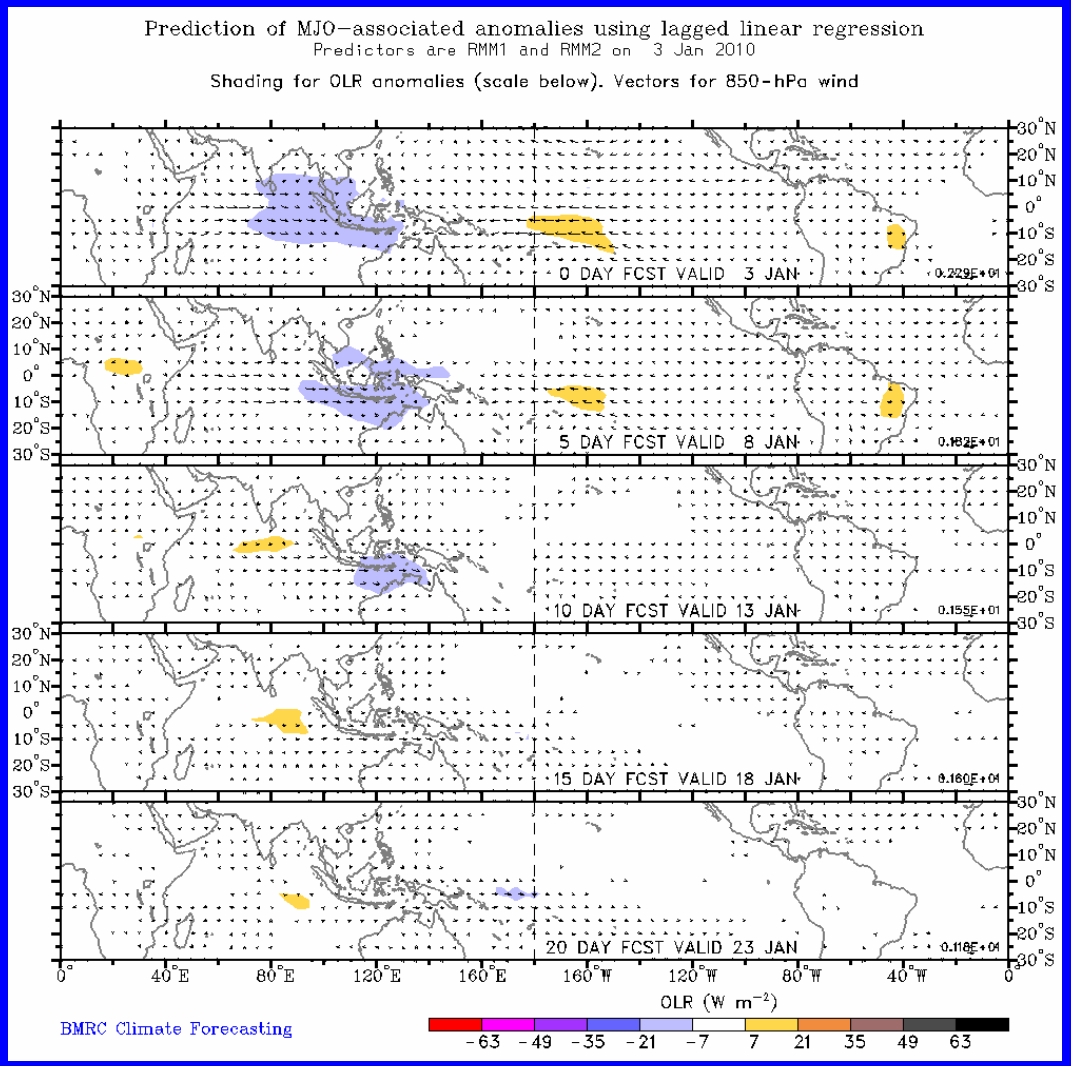
Statistical MJO Forecast

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

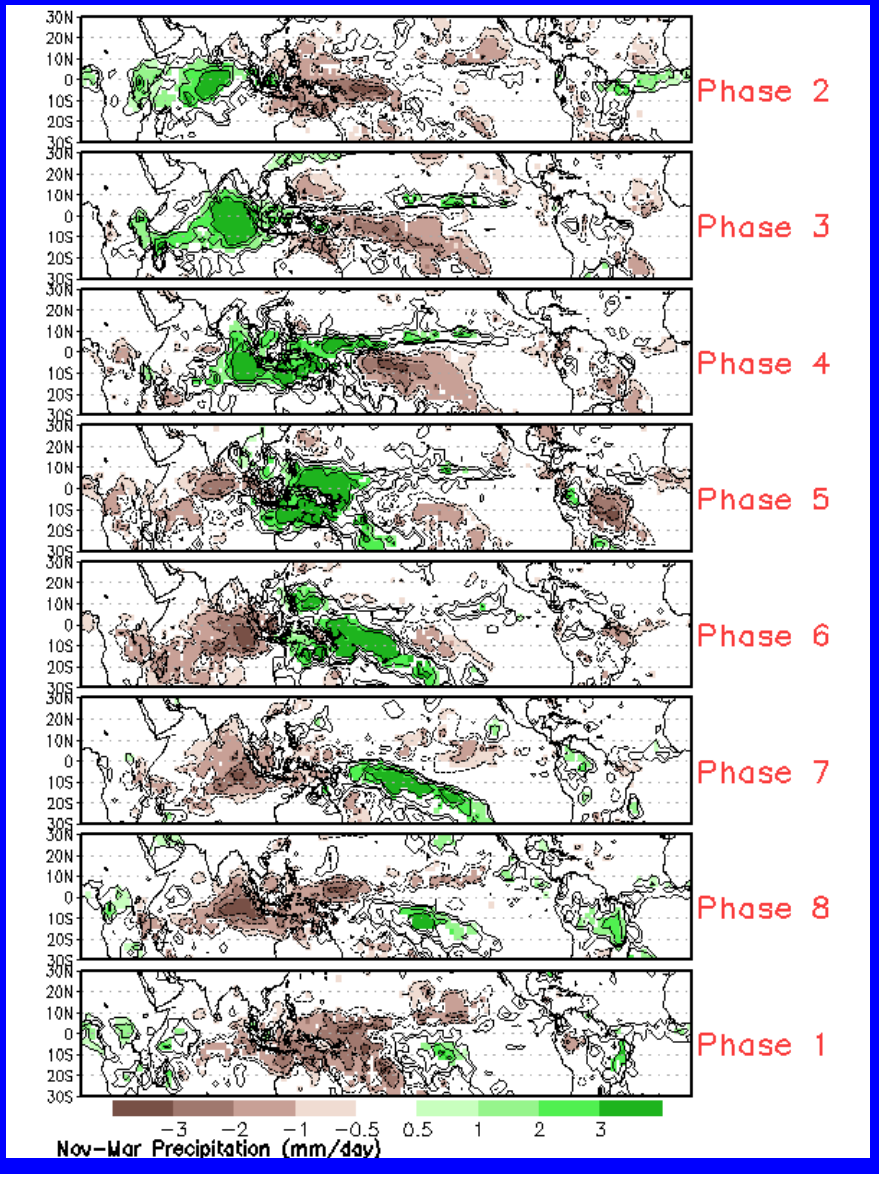
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical forecast indicates a weak-to-moderate signal of enhanced convection shifting from the Indian Ocean across the Maritime continent over the period.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)