



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

**Update prepared by
Climate Prediction Center / NCEP
December 7, 2009**



Outline

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



Overview

- **The MJO signal continued to shift eastward during the past week but has weakened. The enhanced convective phase is centered over the central Pacific Ocean.**
- **The majority of MJO forecast tools indicate a weak signal during the upcoming 1-2 week period.**
- **The MJO is not expected to contribute substantially to anomalous tropical rainfall during the period.**
- **The MJO activity during the past few weeks has contributed in part to the pattern change across the Pacific that is expected to lead to stormy conditions along the US West Coast throughout Week-1.**

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

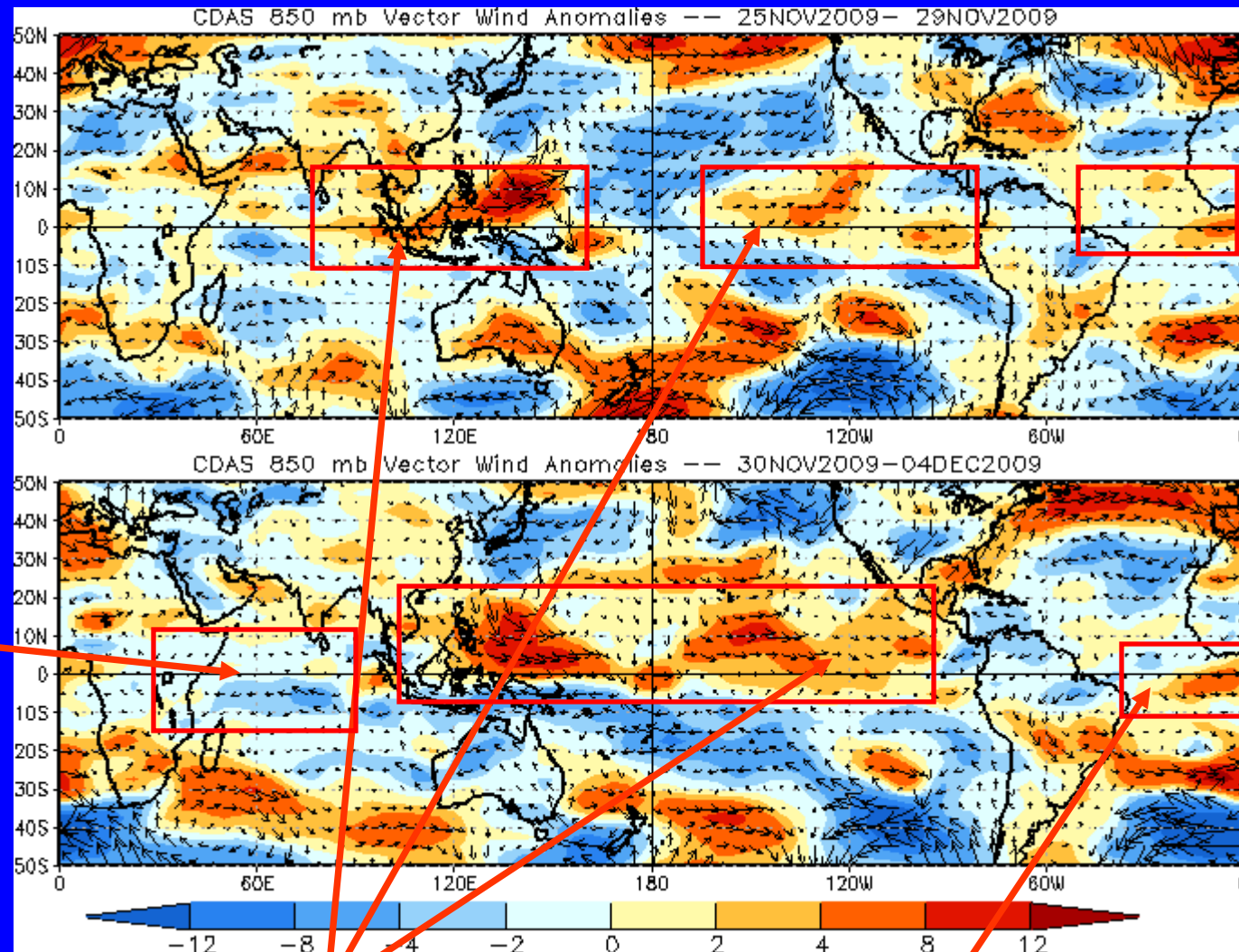


850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades:
Easterly anomalies

Red shades:
Westerly anomalies



Easterly anomalies have increased across most of the Indian Ocean.

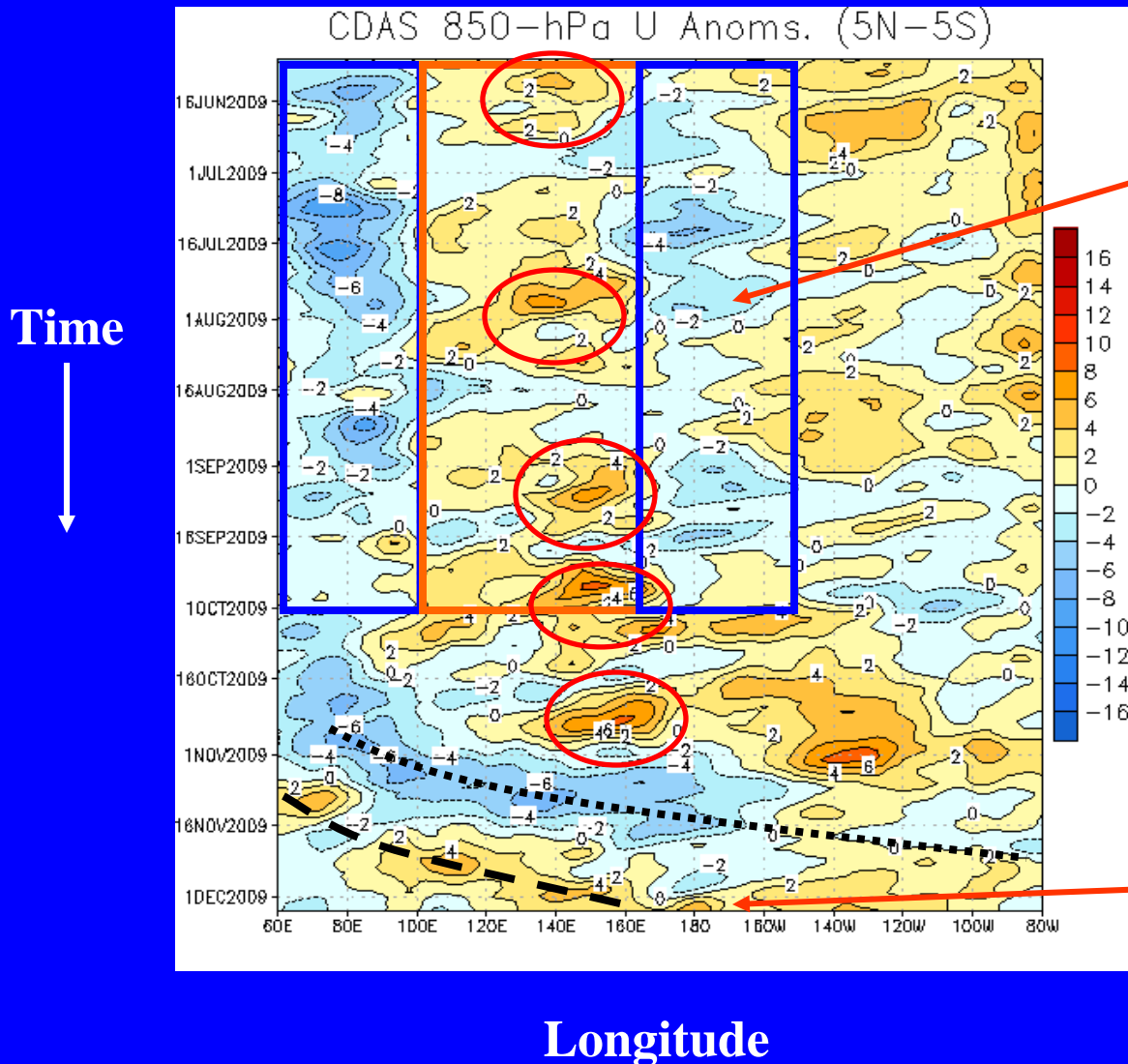
Westerly anomalies have spread across the entire Pacific Basin along and north of the equator.

Westerly anomalies across the Gulf of Guinea have strengthened during the past 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



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

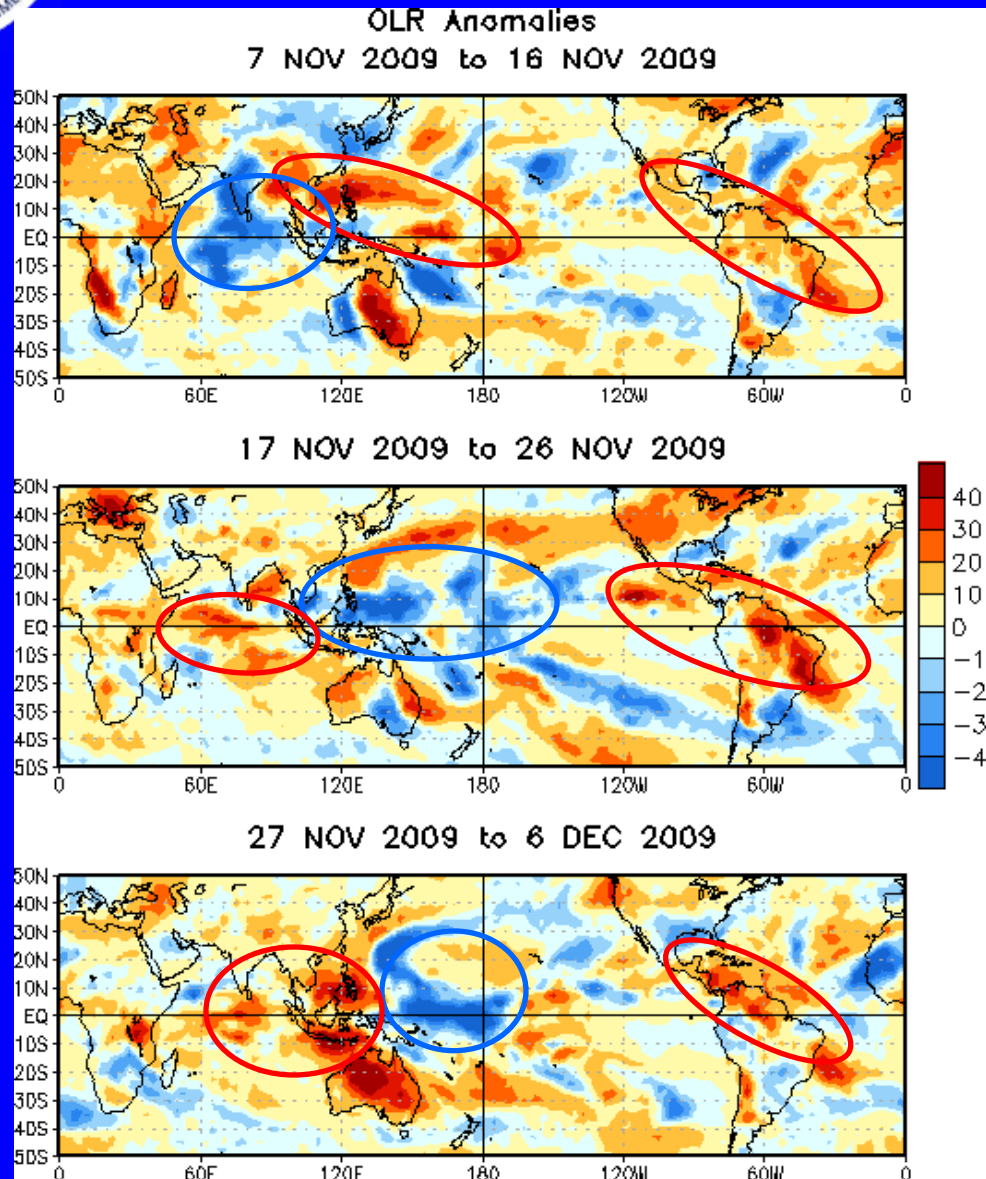
Several westerly wind bursts (red circles) occurred during this period. The westerly wind bursts became more frequent and stronger during September and October.

Easterly anomalies developed across the Indian Ocean in late October and shifted eastward across the Date Line during November (dotted line).

Most recently, the westerly anomalies have spread across the entire Pacific basin, with the strongest anomalies near 140E and the Date Line.



OLR Anomalies: Last 30 days



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

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

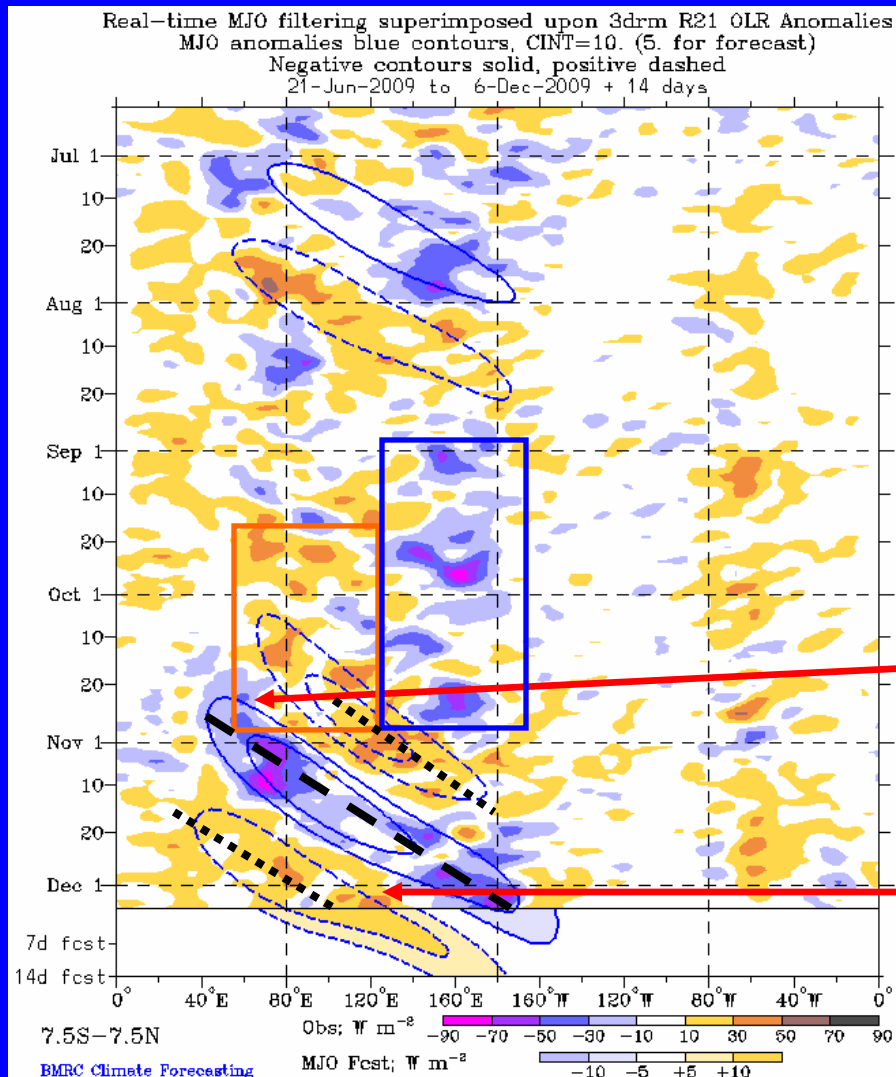
During early-to-mid November, suppressed convection (red ovals) was evident over parts of southeastern Asia and the western Pacific while enhanced convection (blue oval) developed across the Indian Ocean and portions of the Maritime Continent.

During mid-to-late November, suppressed convection developed across the Indian Ocean and continued in parts of the Americas. Enhanced convection associated with the MJO was noted across the Western and Central Pacific.

During late November and early December, enhanced convection intensified over the western Pacific while suppressed convection prevailed across Indian Ocean and parts of the western Maritime continent.



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)

During most of September and October, generally enhanced (suppressed) convection has been evident across the western Pacific (eastern Indian Ocean) (blue and orange boxes).

Beginning in late October, enhanced convection developed across Africa, shifted eastward across the Maritime Continent, and spread into the Pacific.

Behind that area of enhanced convection, suppressed convection once again has developed across the Indian Ocean and is now moving eastward to the Maritime Continent.

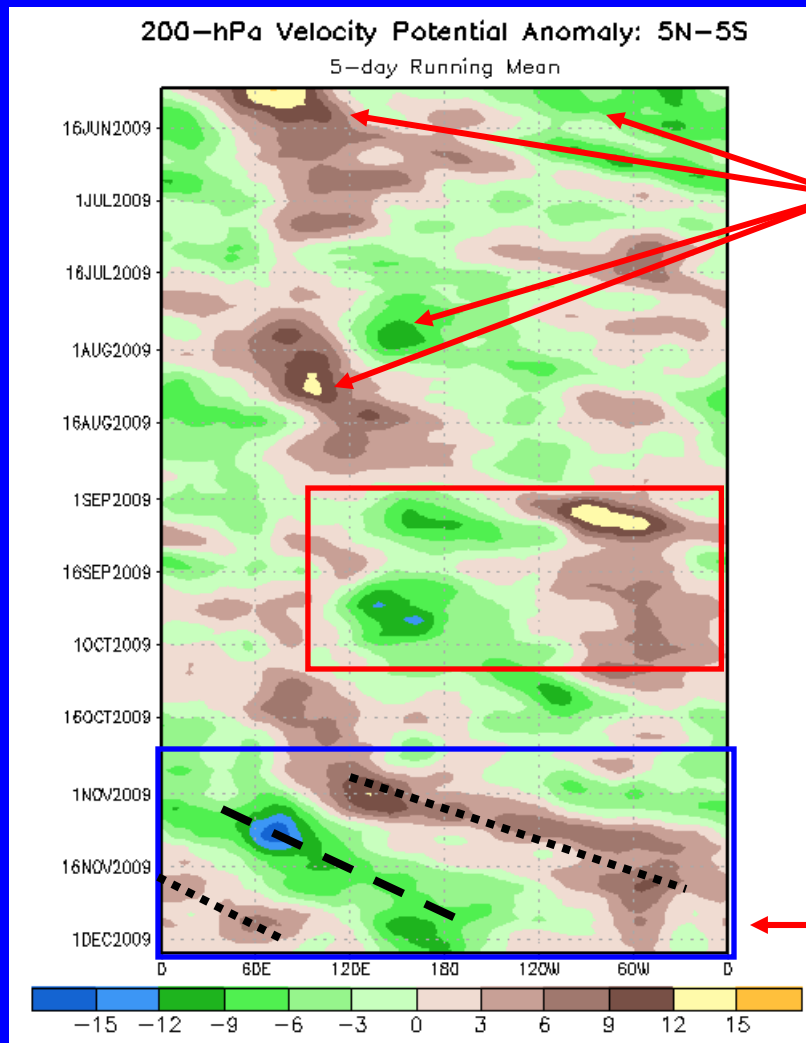


200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time
↓



Velocity potential anomalies increased in mid June and late July-early August due to several types of subseasonal variability with some eastward propagation evident.

Anomalies increased during September but the overall pattern remained generally persistent with upper-level divergence (convergence) across the western Pacific (parts of Western Hemisphere) (red box).

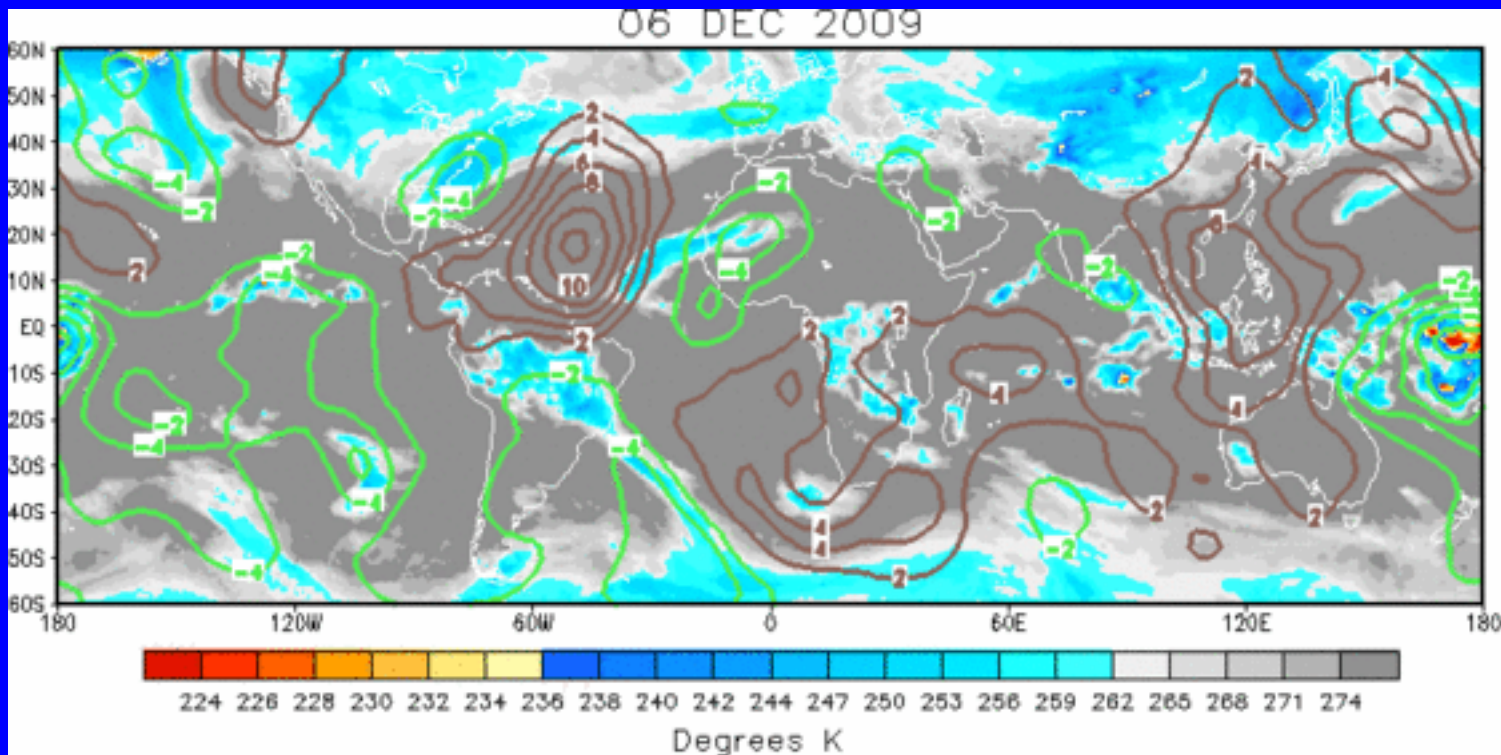
In late October and November, anomalies increased and eastward propagation has been evident associated with MJO activity (blue box). Most recently, the pattern has become somewhat stationary.



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



Recently, the velocity potential anomalies indicate an incoherent pattern with upper-level divergence mainly across the Pacific Ocean region.

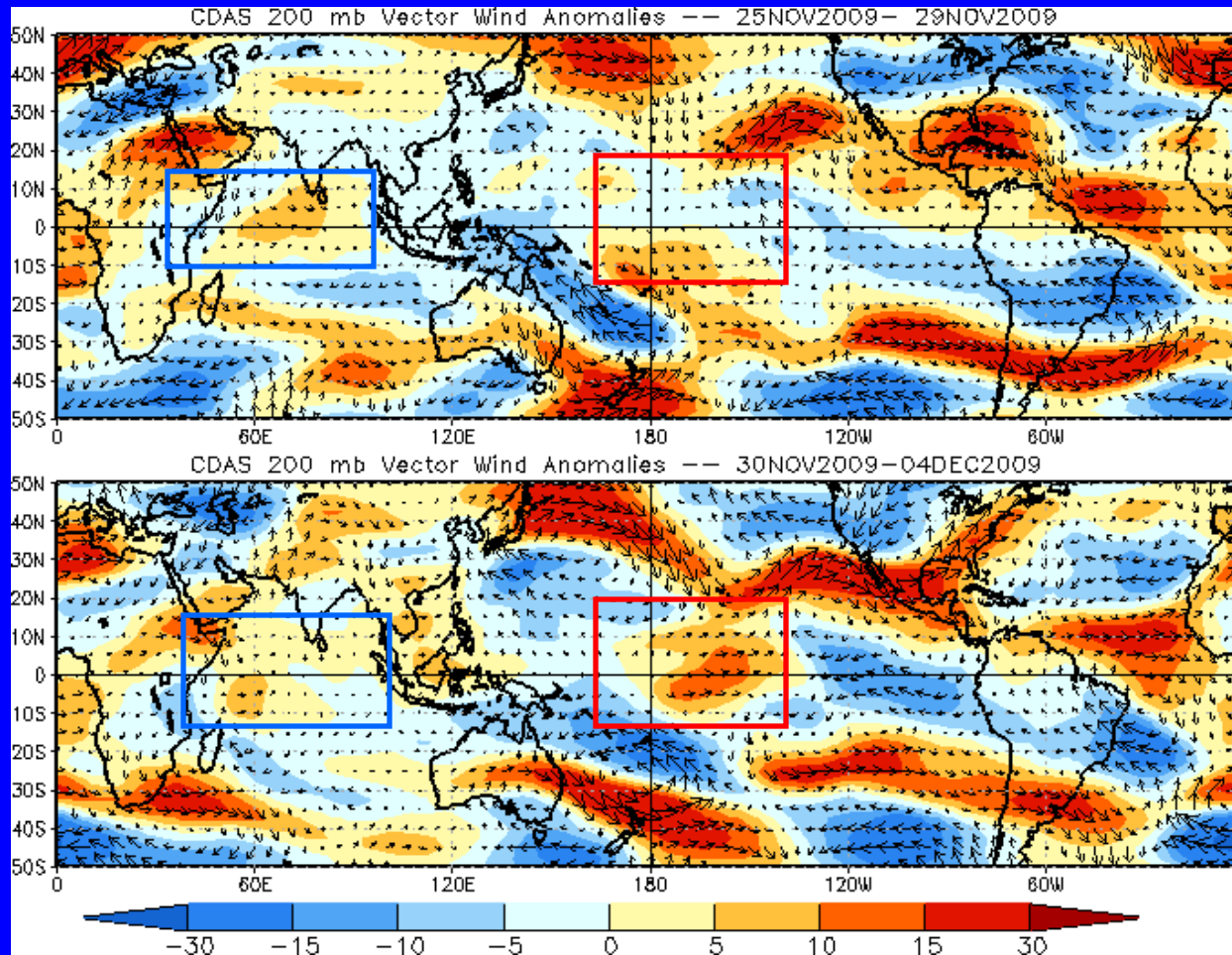


200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly anomalies (red boxes) across the west Pacific during the previous five days have moved eastward and strengthened across the central Pacific.

Westerly anomalies across the Indian Ocean remained weak (blue boxes).

There remains some inter-hemispheric symmetry during the past five days.

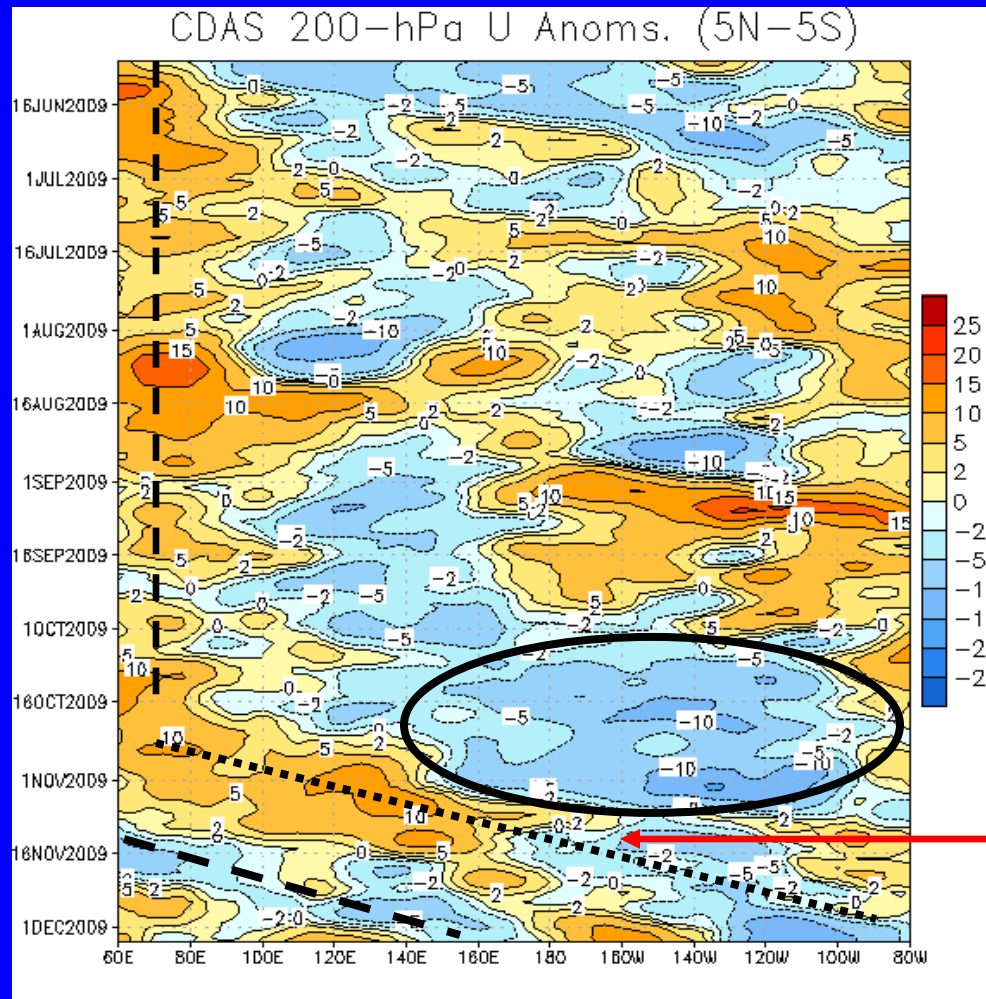


200-hPa Zonal Wind Anomalies (m s^{-1})

Westerly anomalies (orange/red shading) represent anomalous west-to-east flow

Easterly anomalies (blue shading) represent anomalous east-to-west flow

Time
↓



Longitude

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

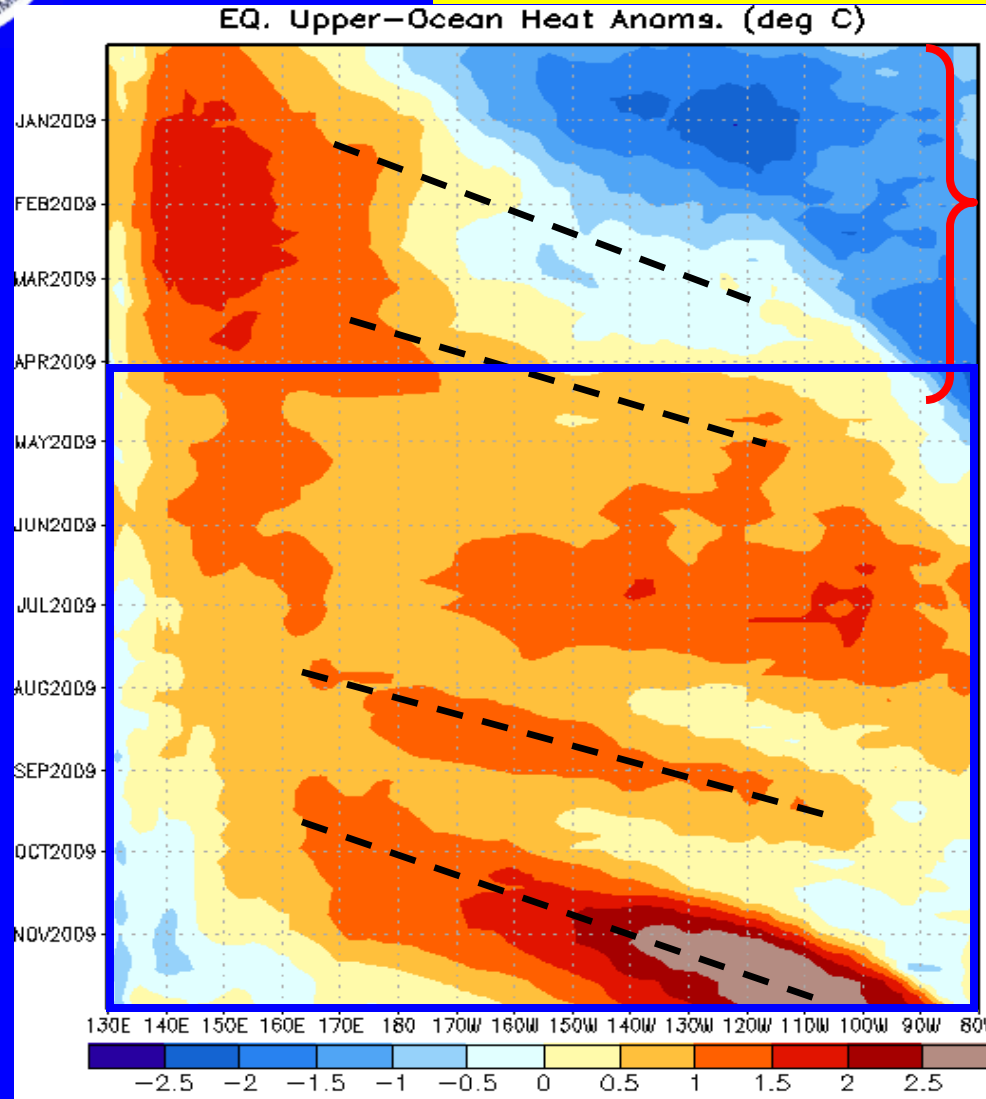
In early October, easterly anomalies rapidly replaced westerly anomalies across much of the Pacific (black solid oval).

Westerly anomalies (dotted line) shifted eastward across the Maritime Continent during late October and early November and have recently reappeared in the Indian Ocean.



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).

The downwelling phases of two Kelvin waves shifted eastward during August-September and late September-early November (last two dashed black lines).



MJO Index -- Information

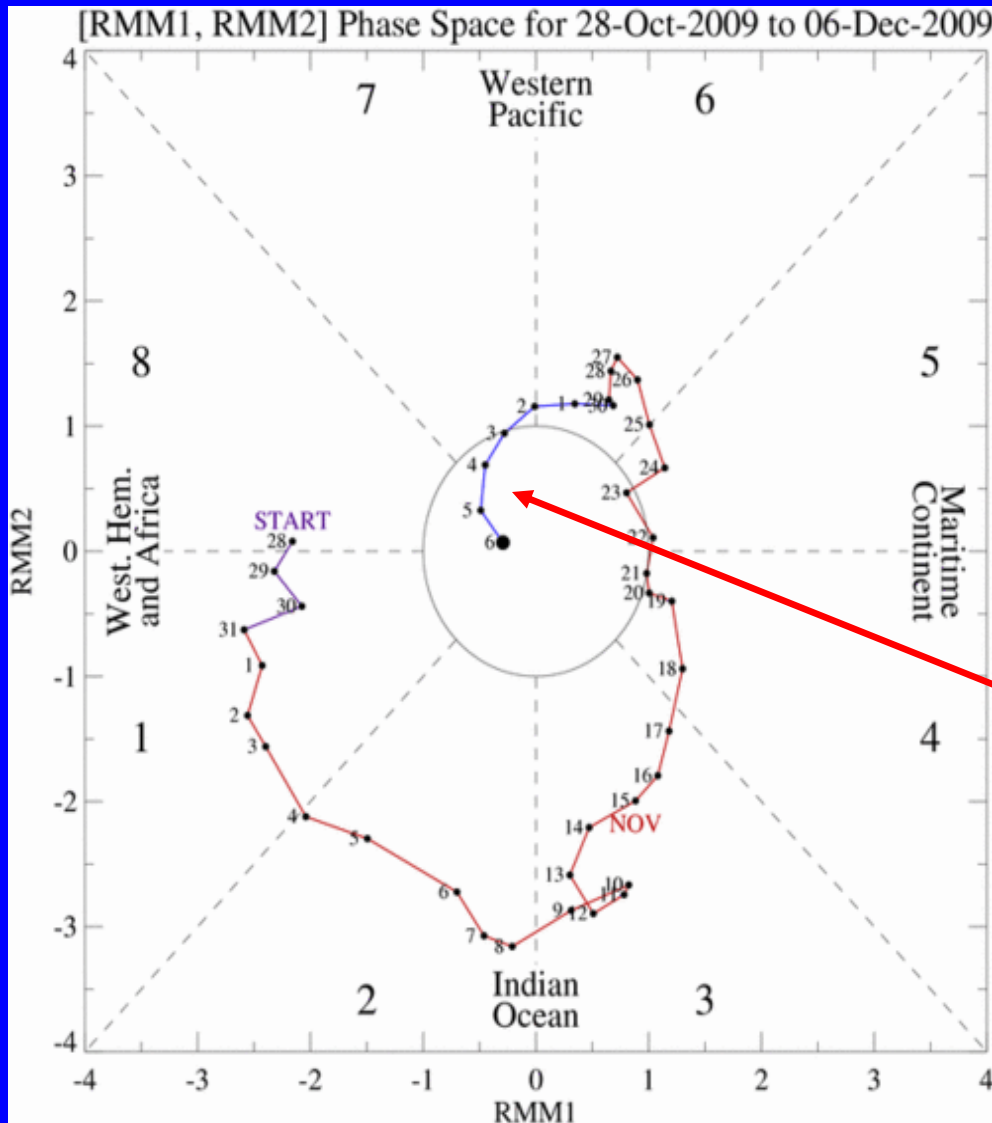
- The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).

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

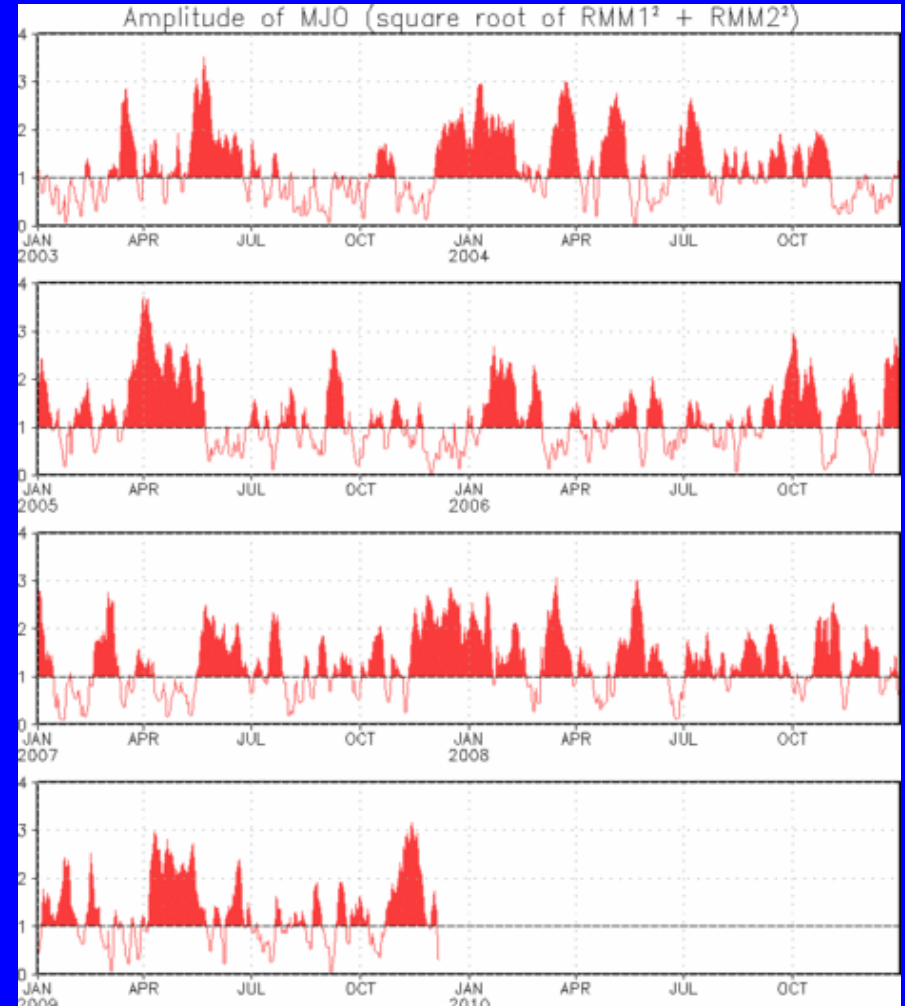
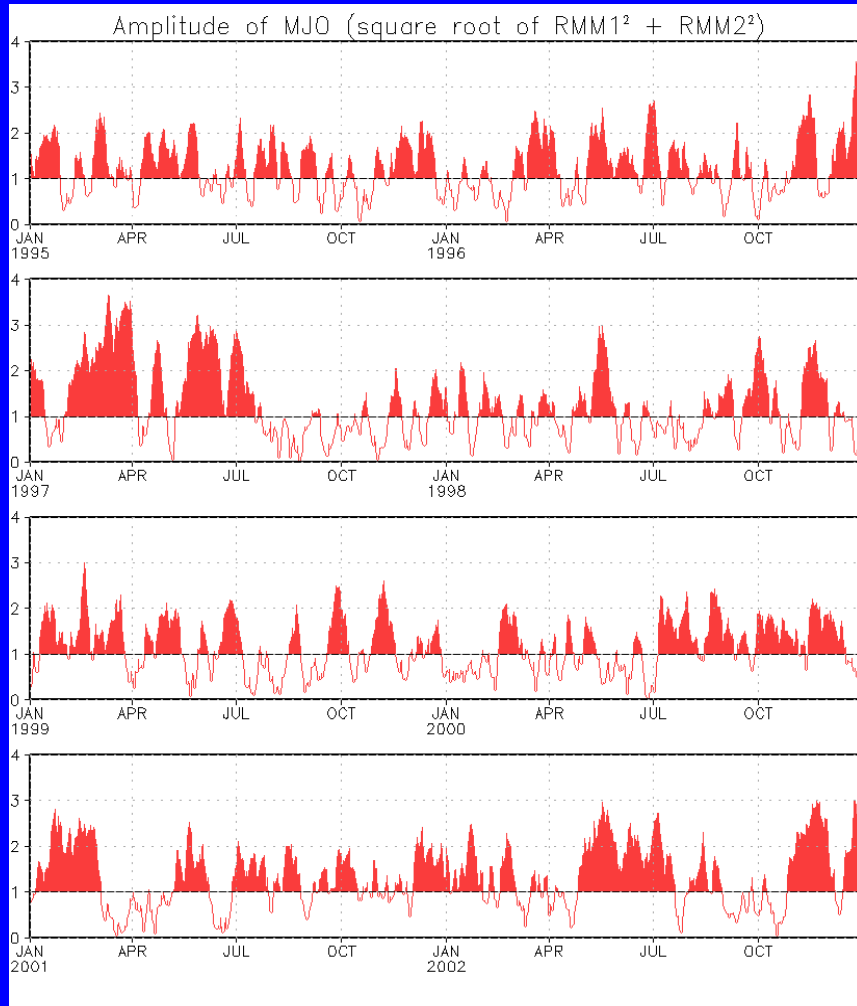


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index indicates a significant weakening of the signal during 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

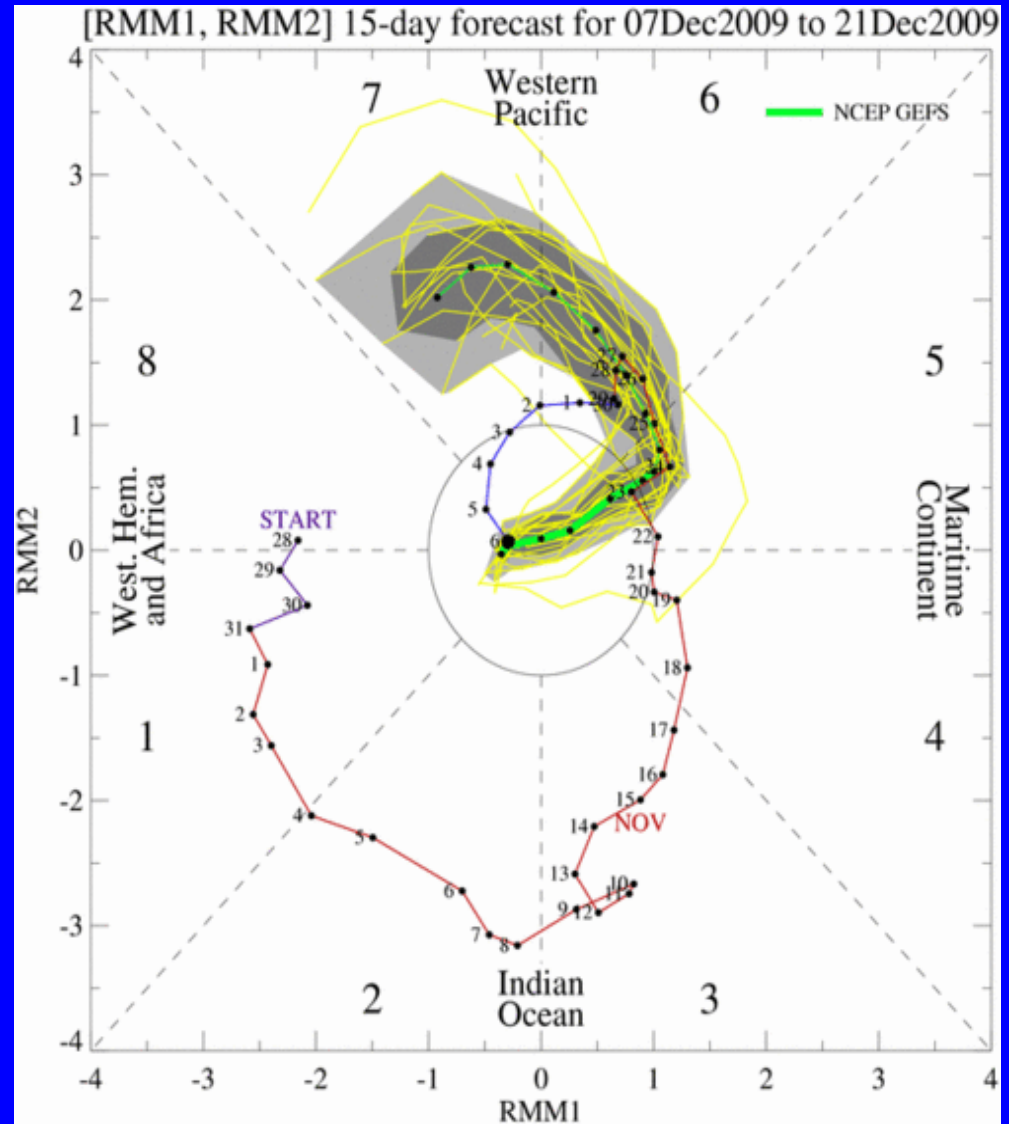
Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

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 a weak signal during Week-1 but strengthening during Week-2.

The strengthening of the signal in this forecast may be related to El Nino conditions and not indicative of a coherent MJO signal.

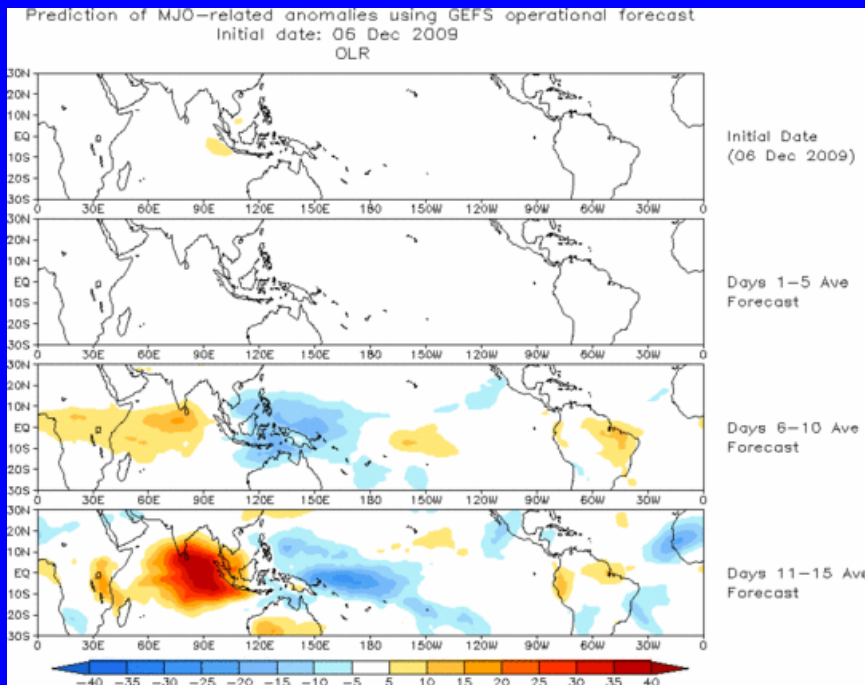




Ensemble Mean GFS MJO Forecast

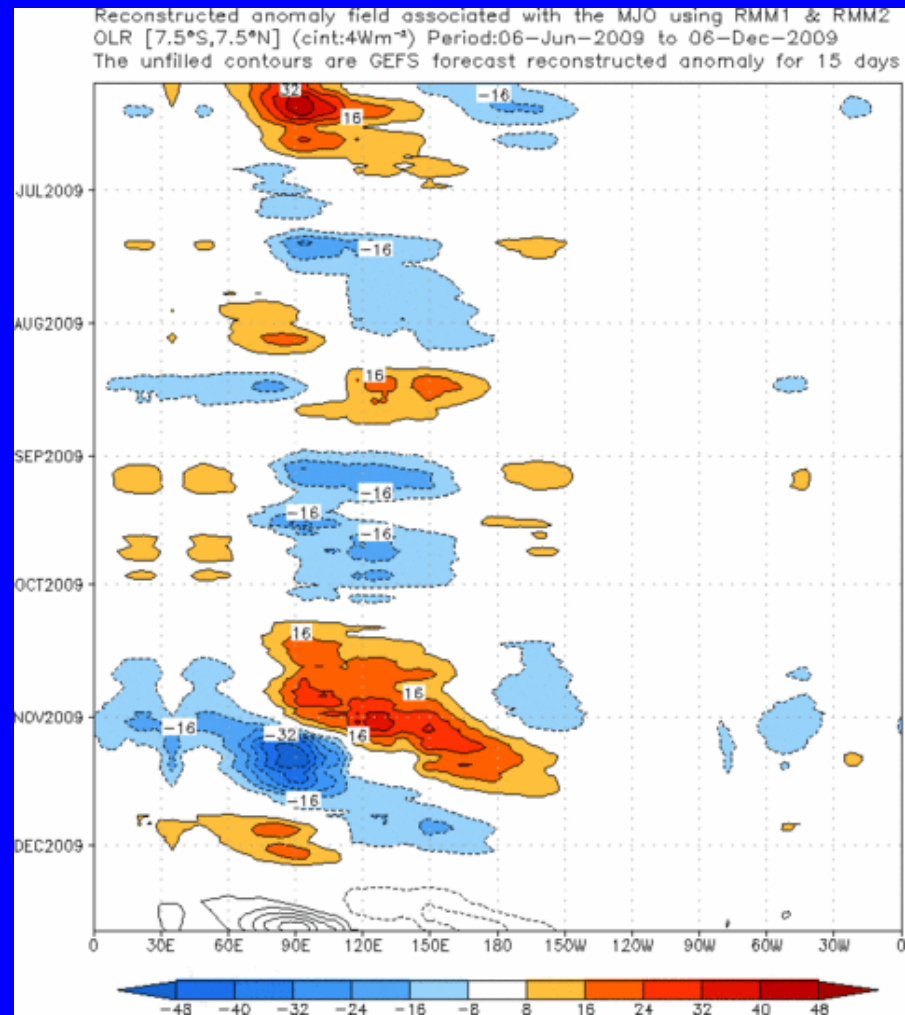
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



With diminished amplitude of the MJO index, the GEFS ensemble mean forecasts show little signal during Week-1. Enhanced (suppressed) convection in the western Pacific (Indian Ocean) develops again during Week-2.

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





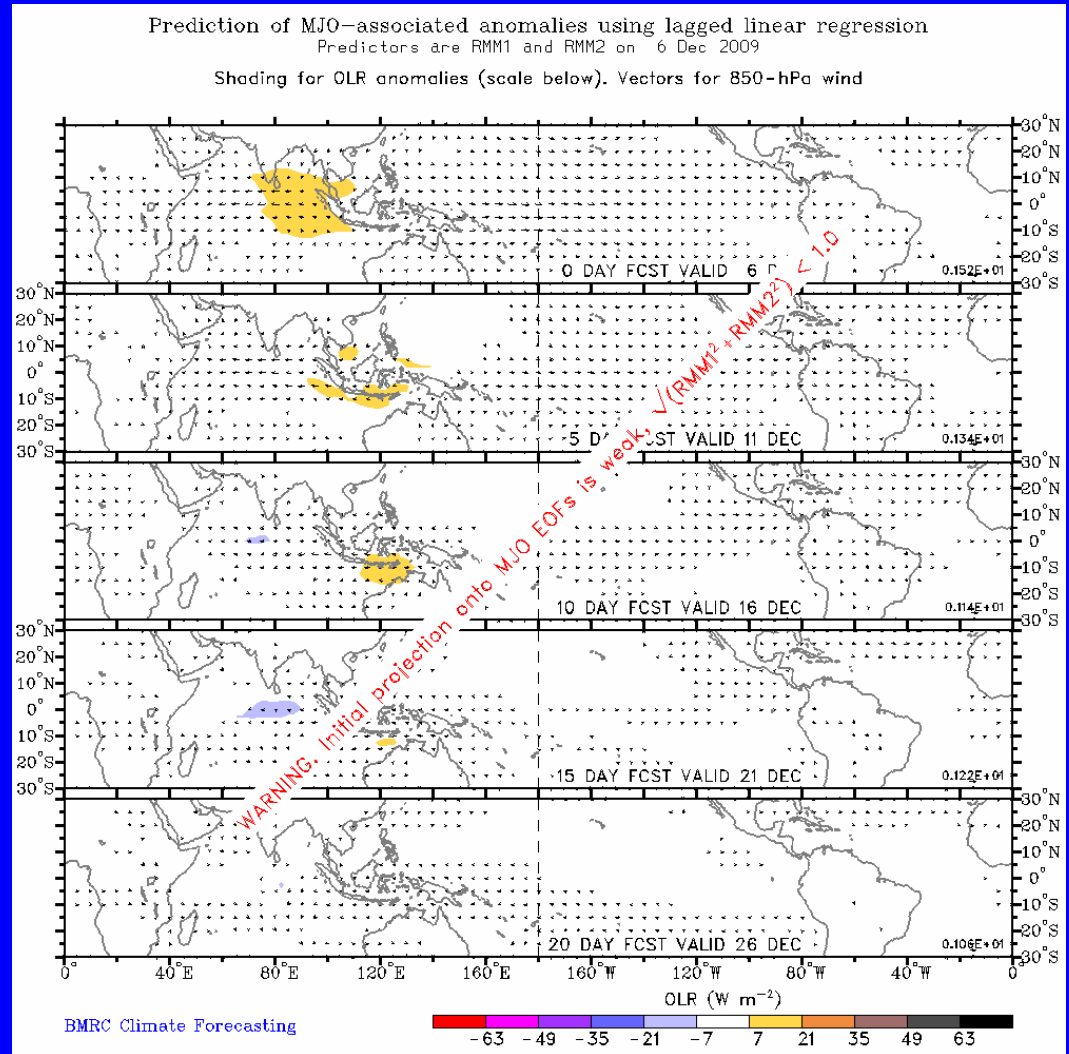
Statistical MJO Forecast

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)

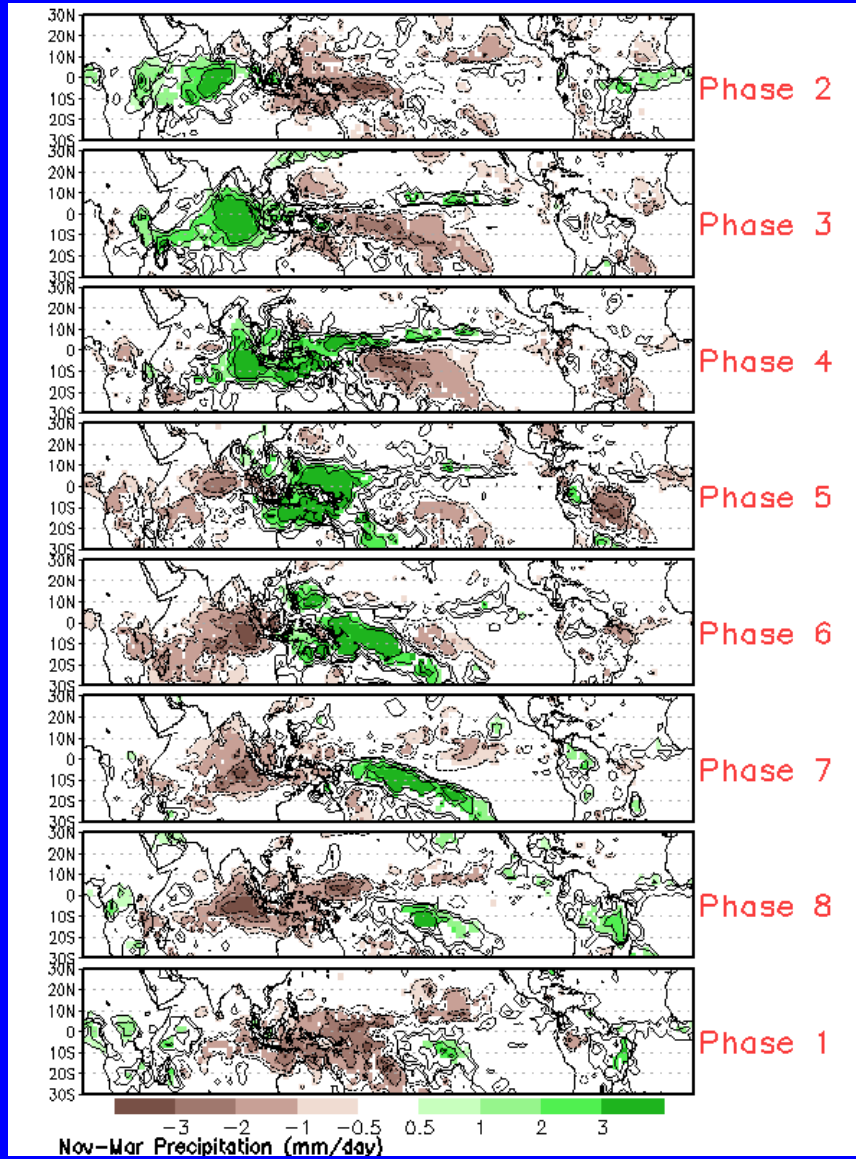
With the currently weak signal, the statistical forecasts do not indicate the development of any significant anomalies associated with the MJO.





MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)

