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

Update prepared by
Climate Prediction Center / NCEP
January 12, 2009

Outline

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

Overview

- The MJO is showing signs of strengthening with the enhanced phase centered across the western Pacific.

- Based on MJO model forecasts, the MJO is expected to strengthen during the next 1-2 weeks with the enhanced phase shifting eastward from the western Pacific to near Africa by the end of the period.

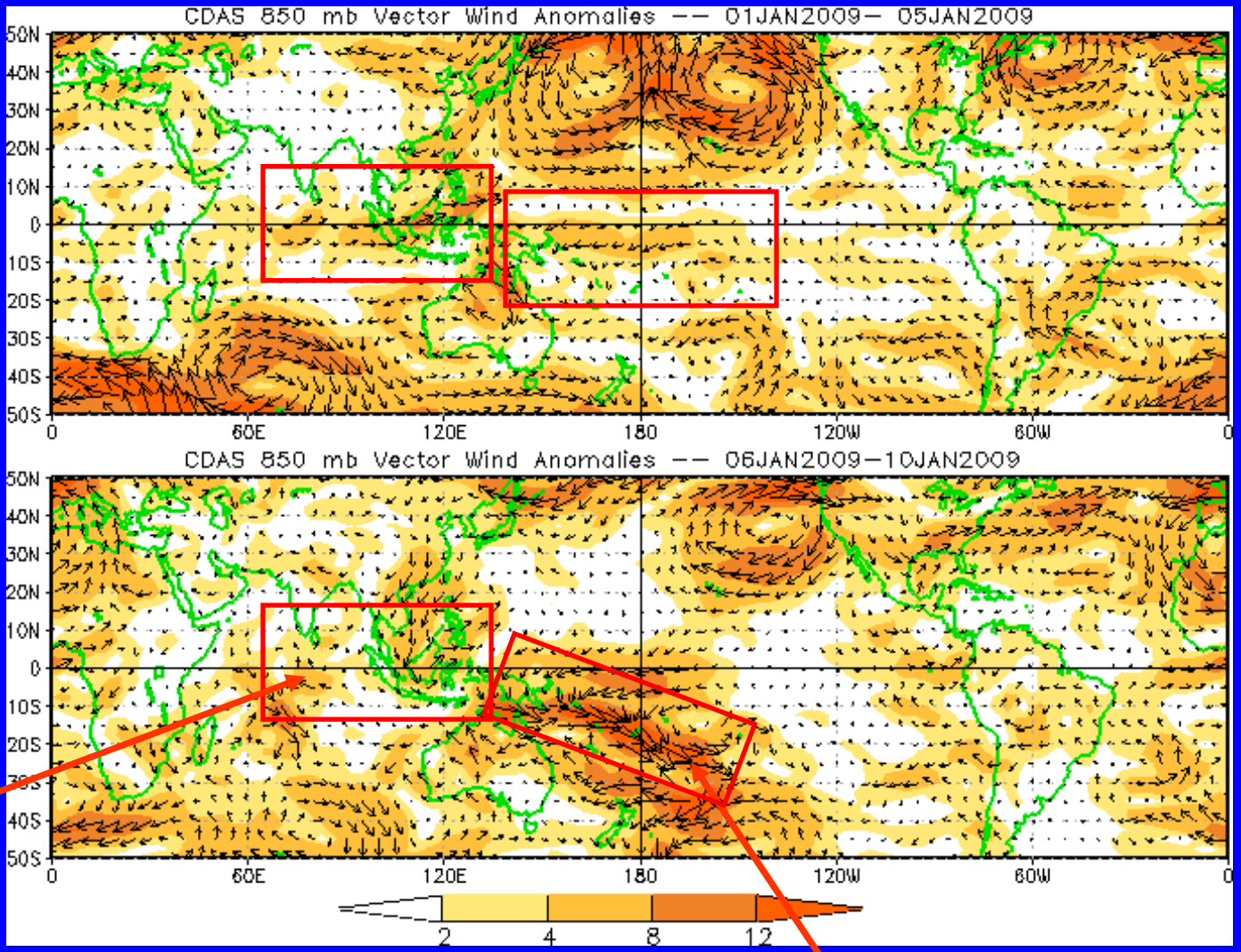
- The MJO is expected to contribute to dry conditions for northeast Brazil and decrease rainfall seen in recent weeks associated with La Nina across portions of Indonesia. Above-average rainfall is also expected in vicinity of the South Pacific Islands along with an increased threat for tropical cyclogenesis in the Southwest Pacific.

- The MJO may contribute to an extension of the Pacific Jet during late Week 2 leading to heightened chances for precipitation along portions of US West coast.

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 magnitude of anomalous wind vectors



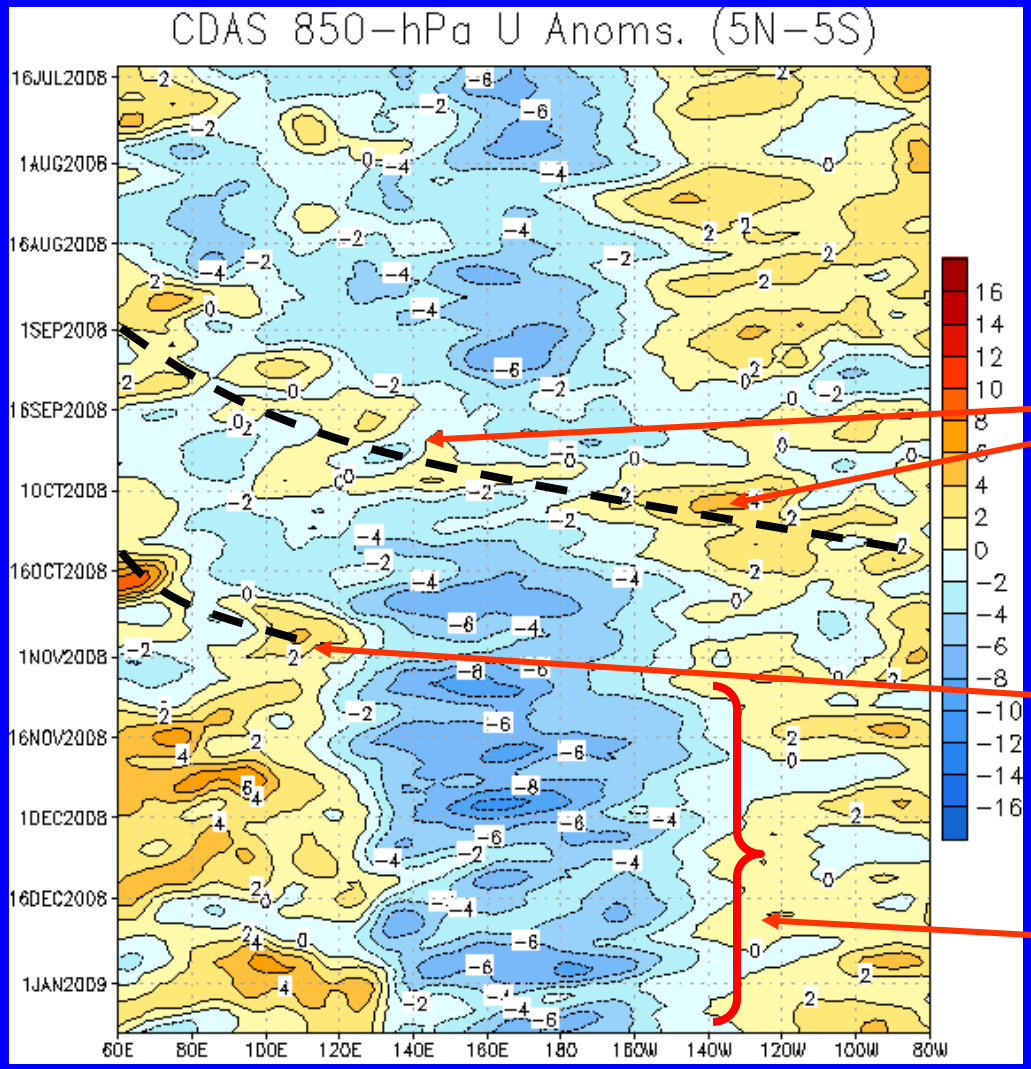
Westerly anomalies decreased across the eastern Indian Ocean and western Maritime continent during the last five days.

Westerly anomalies developed across the southwest tropical Pacific during the last five days leading to strong low-level convergence.

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

Easterly anomalies prevailed across much of the Eastern Hemisphere from late June into August.

Beginning in September, anomalous westerlies associated with the MJO shifted from the Indian Ocean across the Pacific.

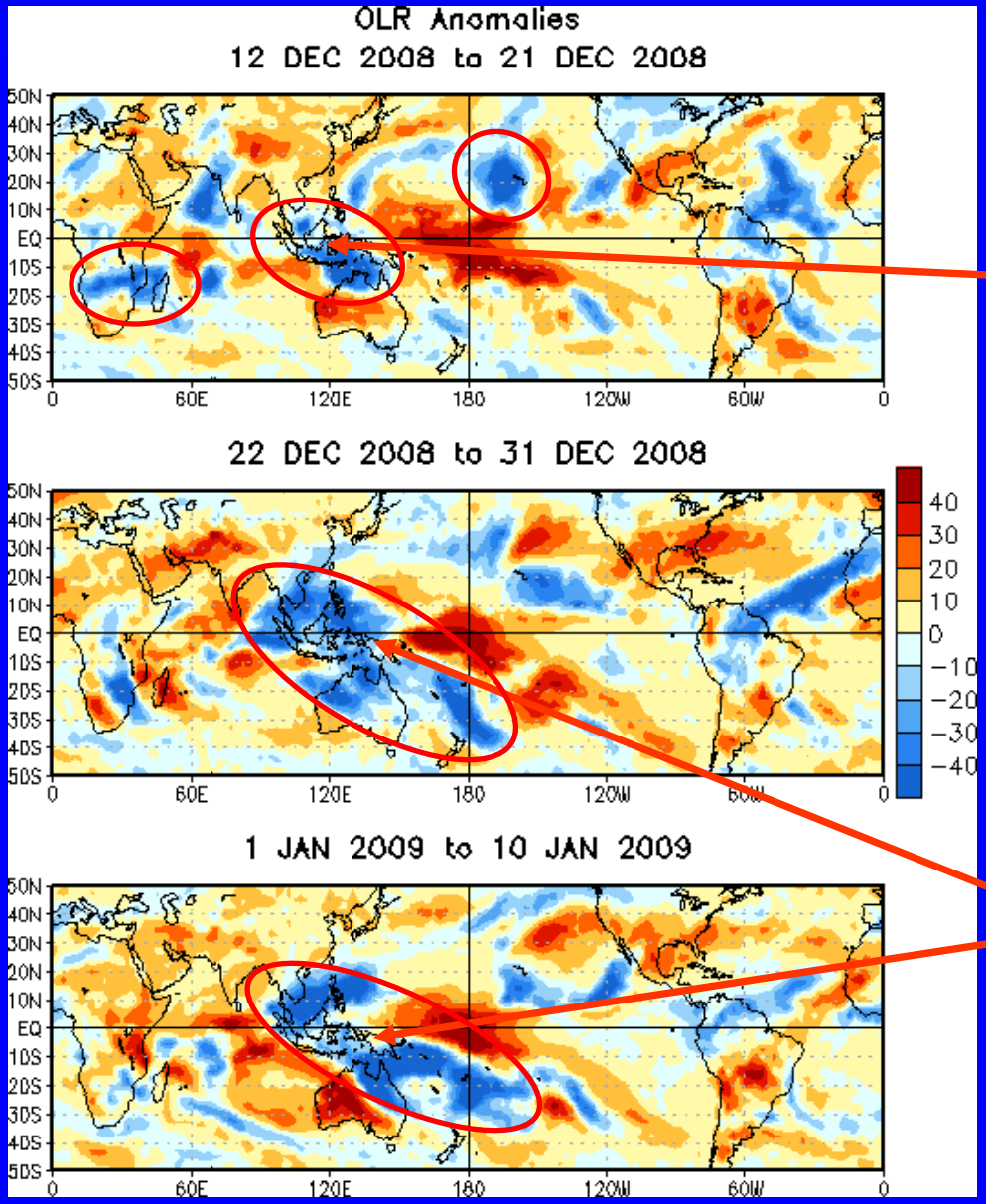
These westerly anomalies reentered the Maritime Continent during late October but eastward progress stalled.

A persistent pattern of westerly (easterly) anomalies stretching from the Indian Ocean to the central Pacific Ocean has been in place since November.

OLR Anomalies: Last 30 days

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

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

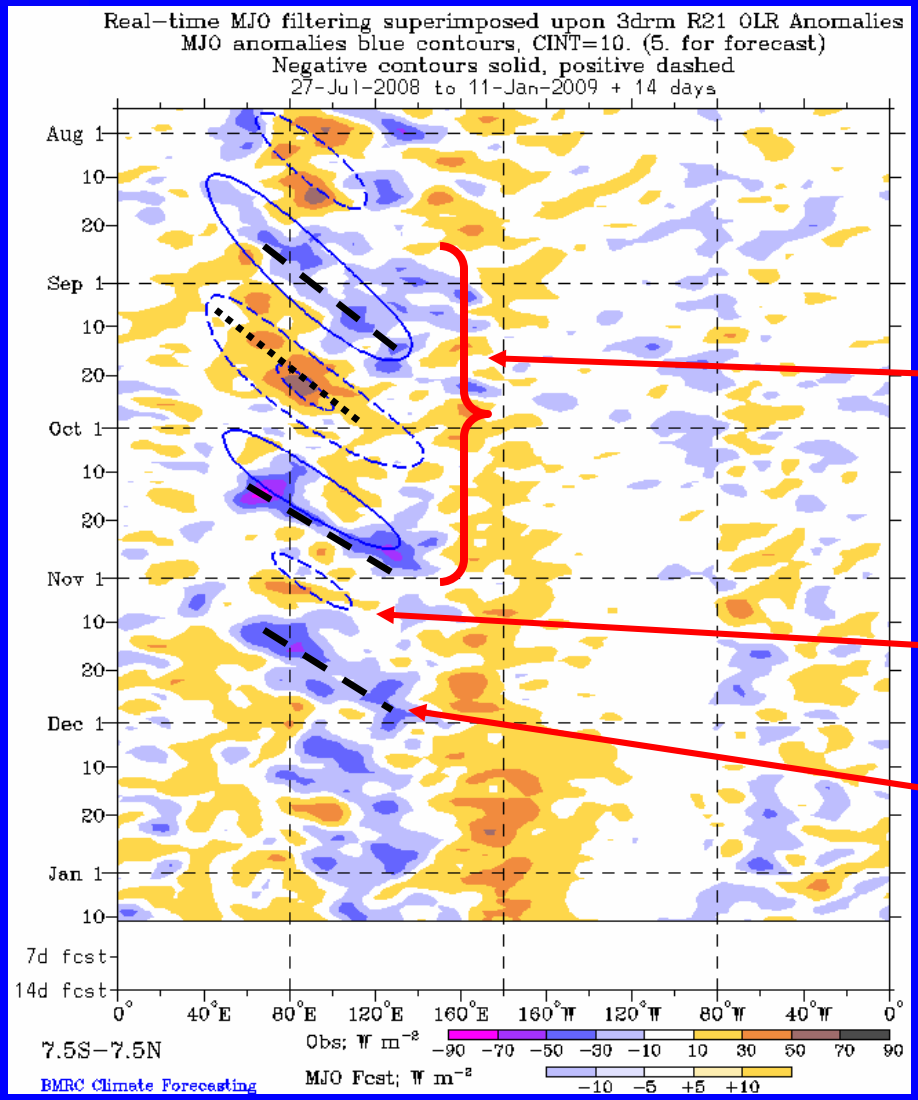


During the middle of December, enhanced convection was mainly confined to portions of Indonesia, Australia, Hawaii, and southern Africa.

Dry conditions have prevailed near the Date Line during the entire period.

Convection intensified during late December and early January across Indonesia, northern Australia, the western Pacific and the South Pacific Convergence Zone (SPCZ).

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 - Australia)

Moderate MJO activity was most evident from late August to early November as enhanced (suppressed) convection developed across the Indian Ocean and shifted eastward during the period.

The suppressed phase of the second MJO cycle in late October and early November was not as strong.

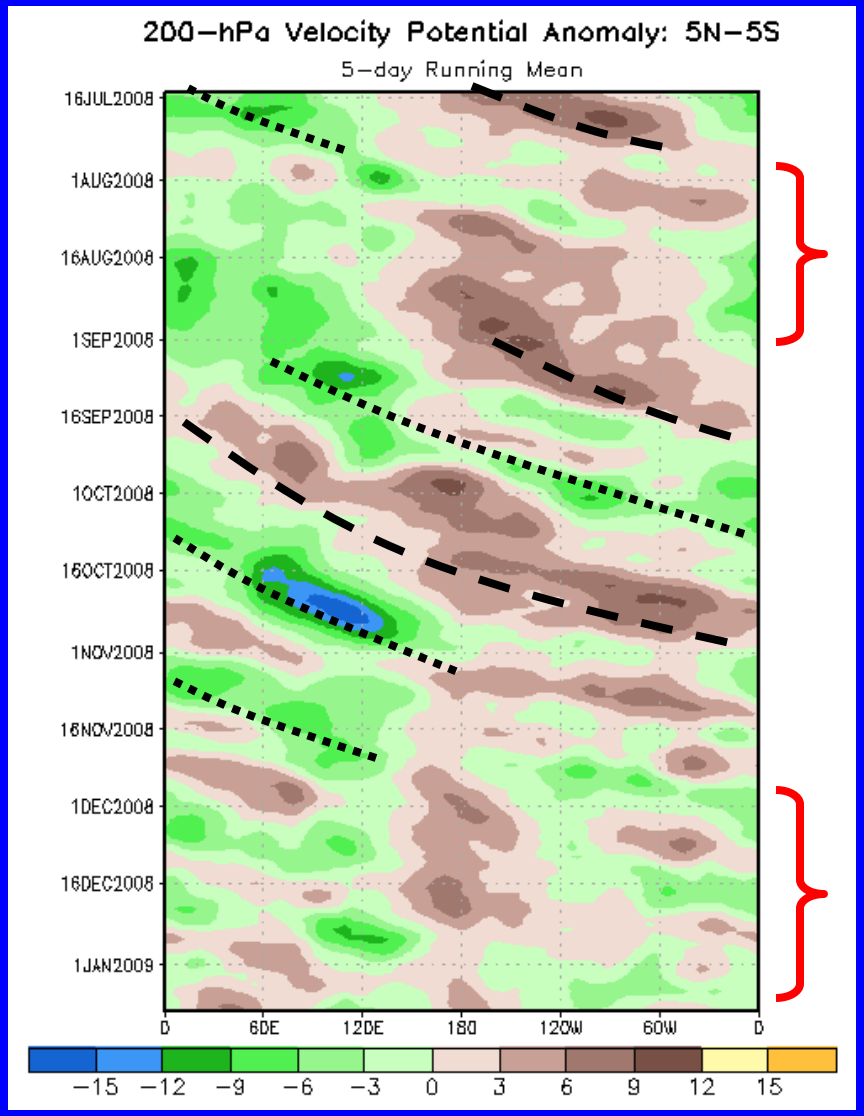
During late-November, enhanced convection shifted across the Maritime Continent before the MJO further weakened.

In December and January, anomalous convection has been generally stationary and consistent with La Nina conditions.

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

After MJO activity in July, the MJO was weak during August as a more stationary pattern of anomalous velocity potential was evident.

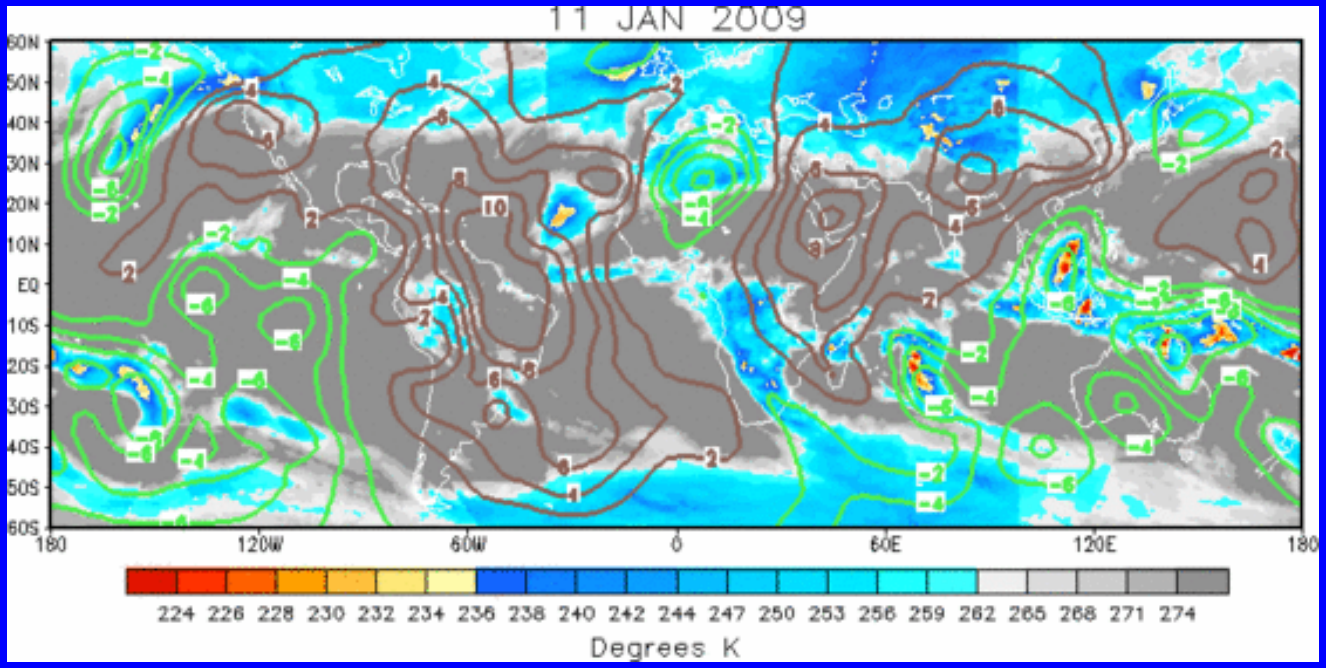
The MJO strengthened in early September and eastward propagation was observed from September through October.

Since mid-November, the subseasonal activity has been organizing on a faster time scale and the MJO has been weak or incoherent.

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

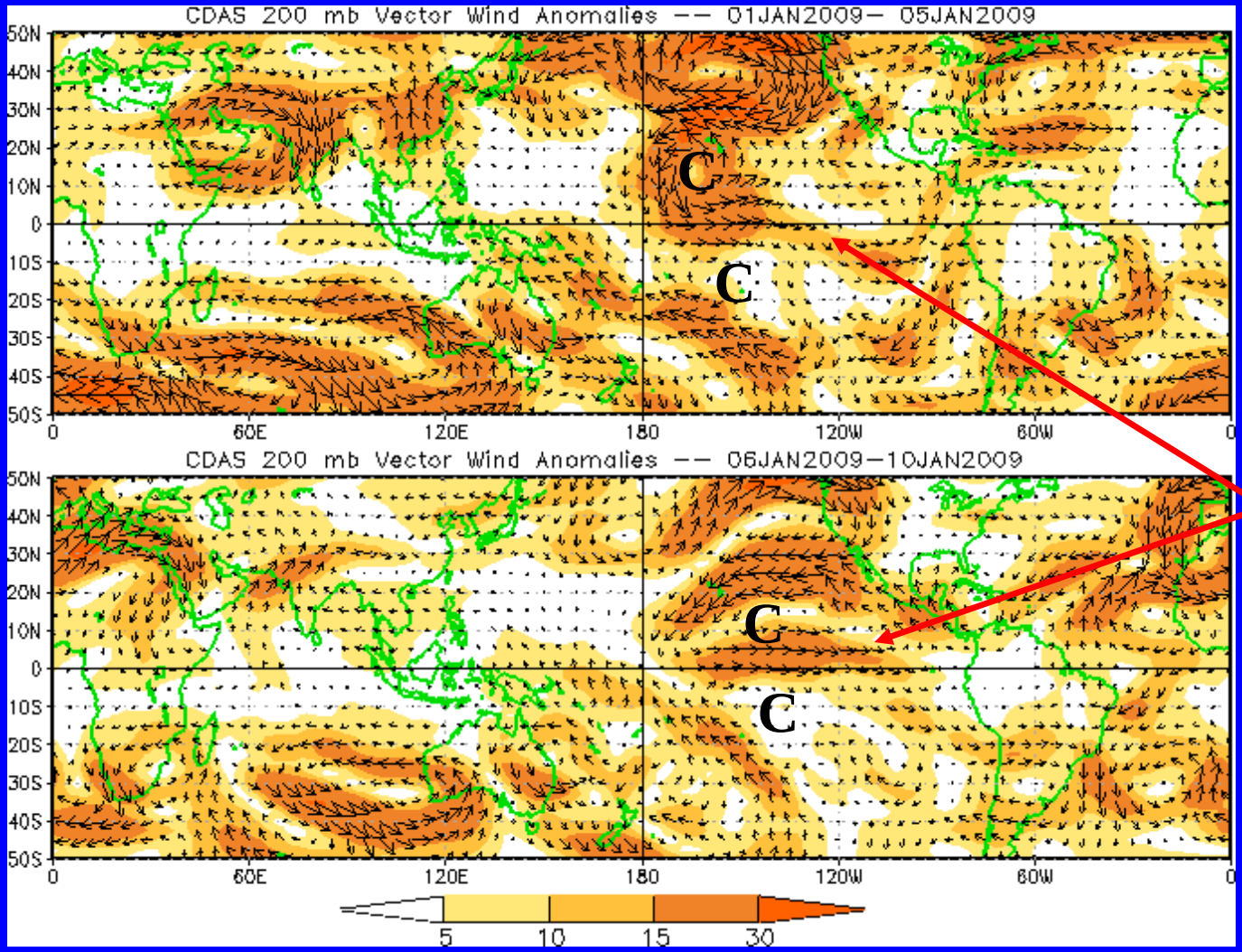


The velocity potential pattern has become a little more organized in recent days.

The strongest upper-level divergence remains located over the SPCZ region while upper-level convergence has increased over parts of the Western Hemisphere and Africa.

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

Note that shading denotes the magnitude of anomalous wind vectors



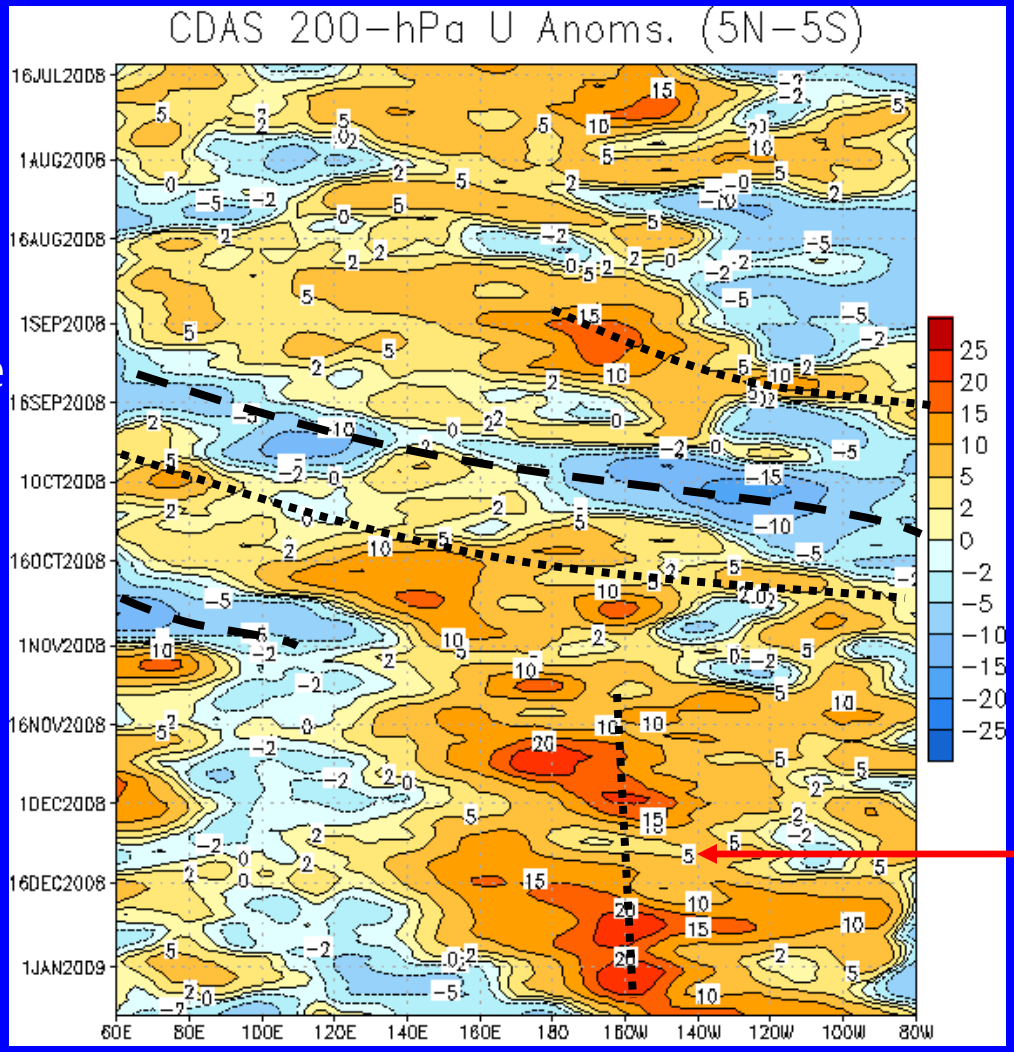
Westerly anomalies remain over the central Pacific Ocean during the period with cyclonic circulations straddling the equator.

There is an eastward displacement of these circulations during the last 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



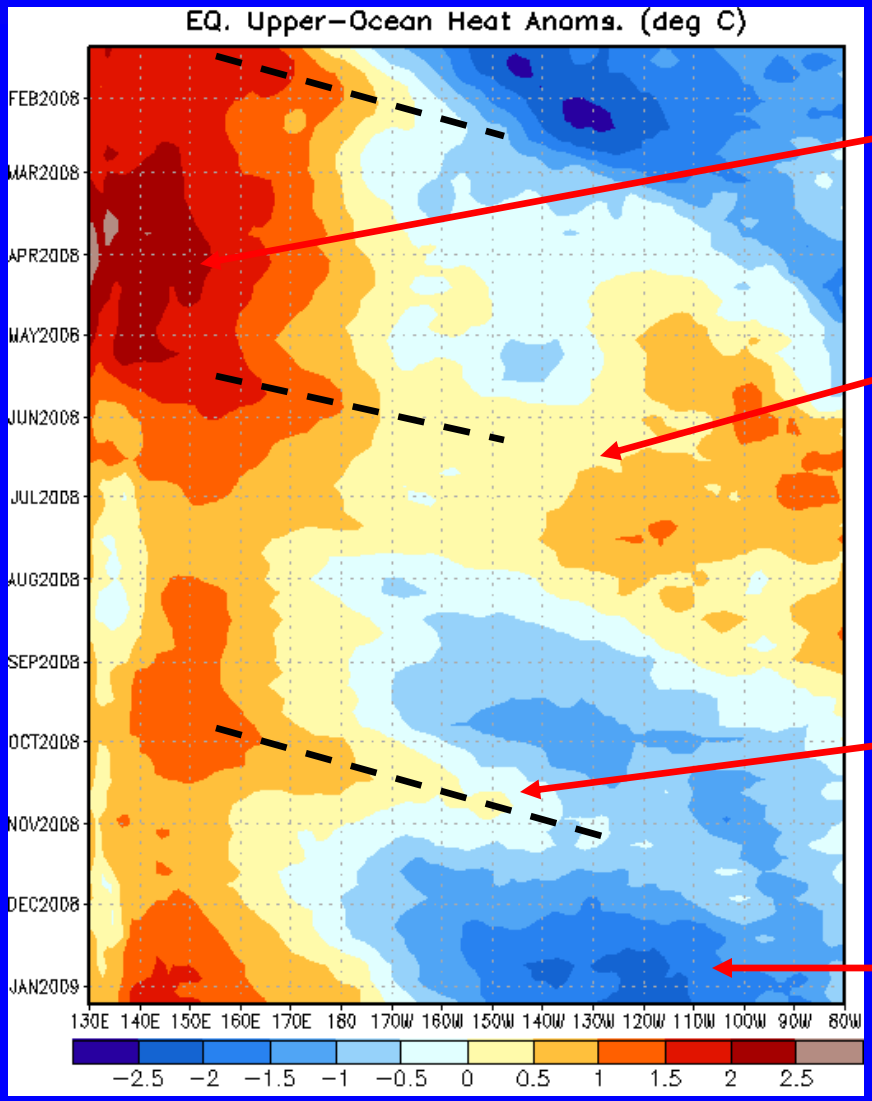
Time

Longitude

Westerly and easterly anomalies associated with the MJO activity shifted eastward during September and October.

Westerly anomalies strengthened markedly in mid-November near the Date Line and have persisted through December. These anomalies are consistent with La Nina conditions.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

Beginning in February, increasingly positive anomalies developed across parts of the western and central Pacific but have since decreased.

During June and July 2008, positive heat content anomalies encompassed much of the Pacific basin.

During August 2008, negative anomalies started to develop east of the Date Line and have increased and expanded eastward. There was a pause in this increase during October as a Kelvin wave shifted eastward.

During November and December, negative anomalies increased across the Pacific.

MJO Index -- Information

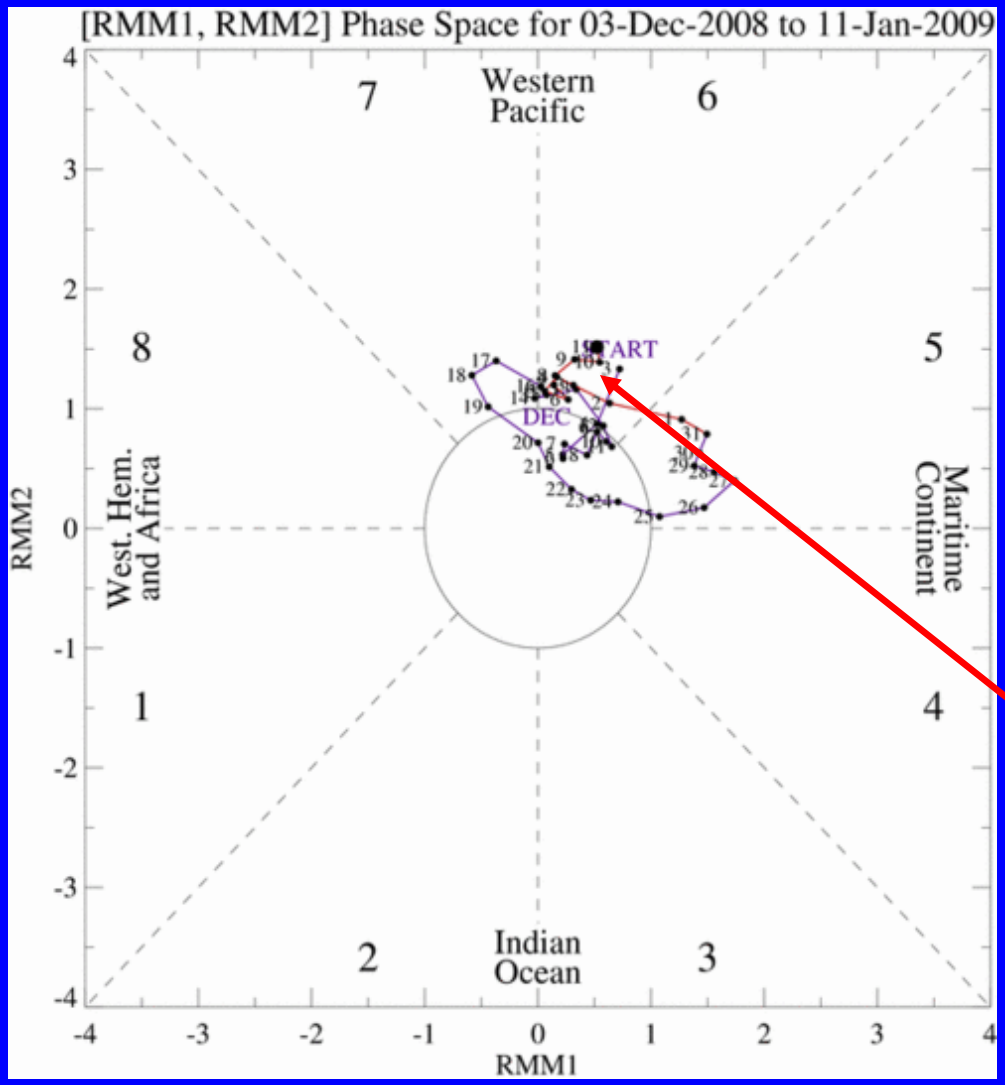
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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 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.**

- **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).**

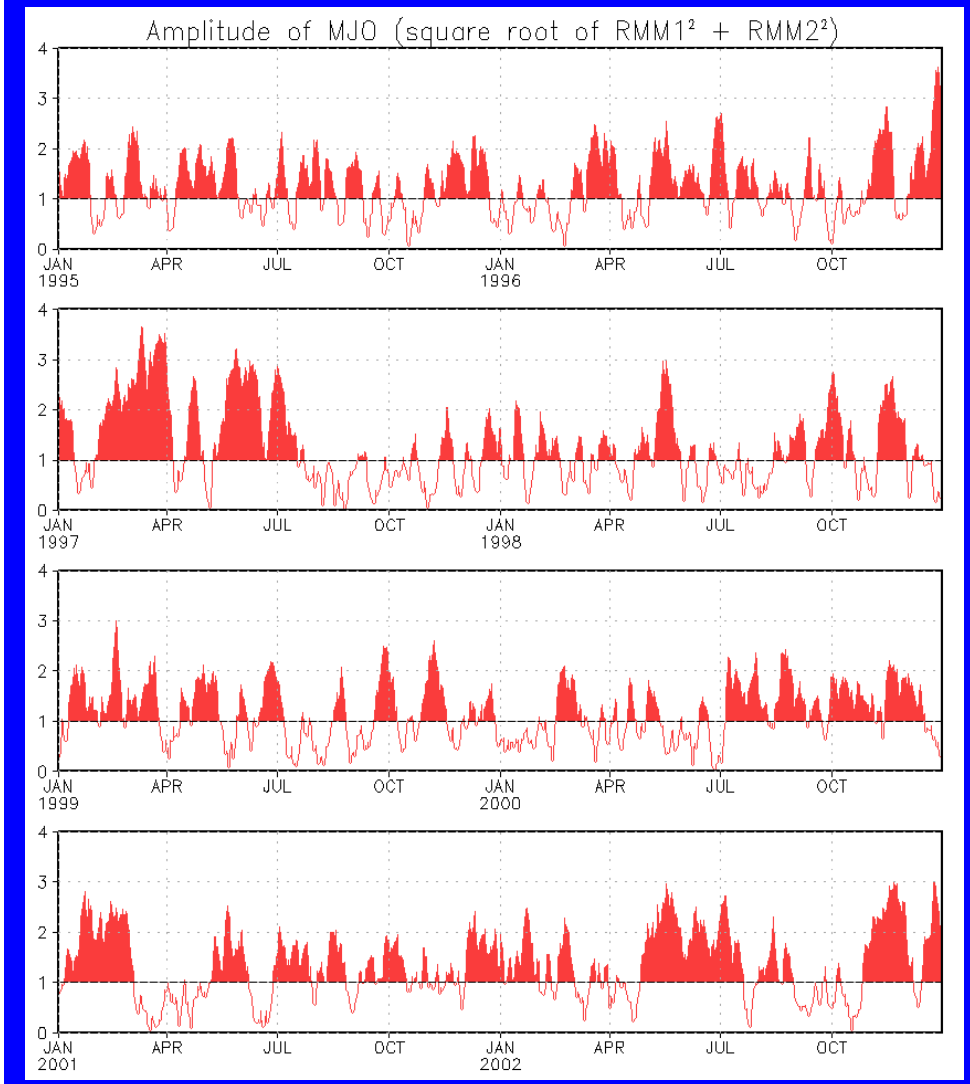
MJO Index -- Recent Evolution

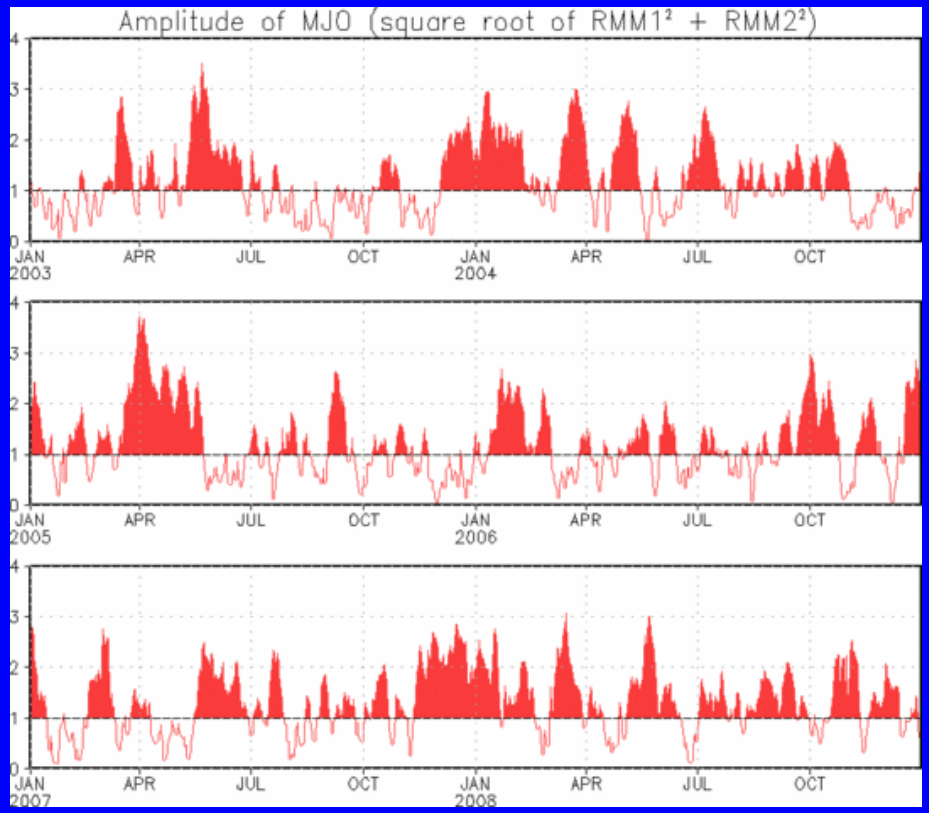


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index indicates generally weak or incoherent MJO activity 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

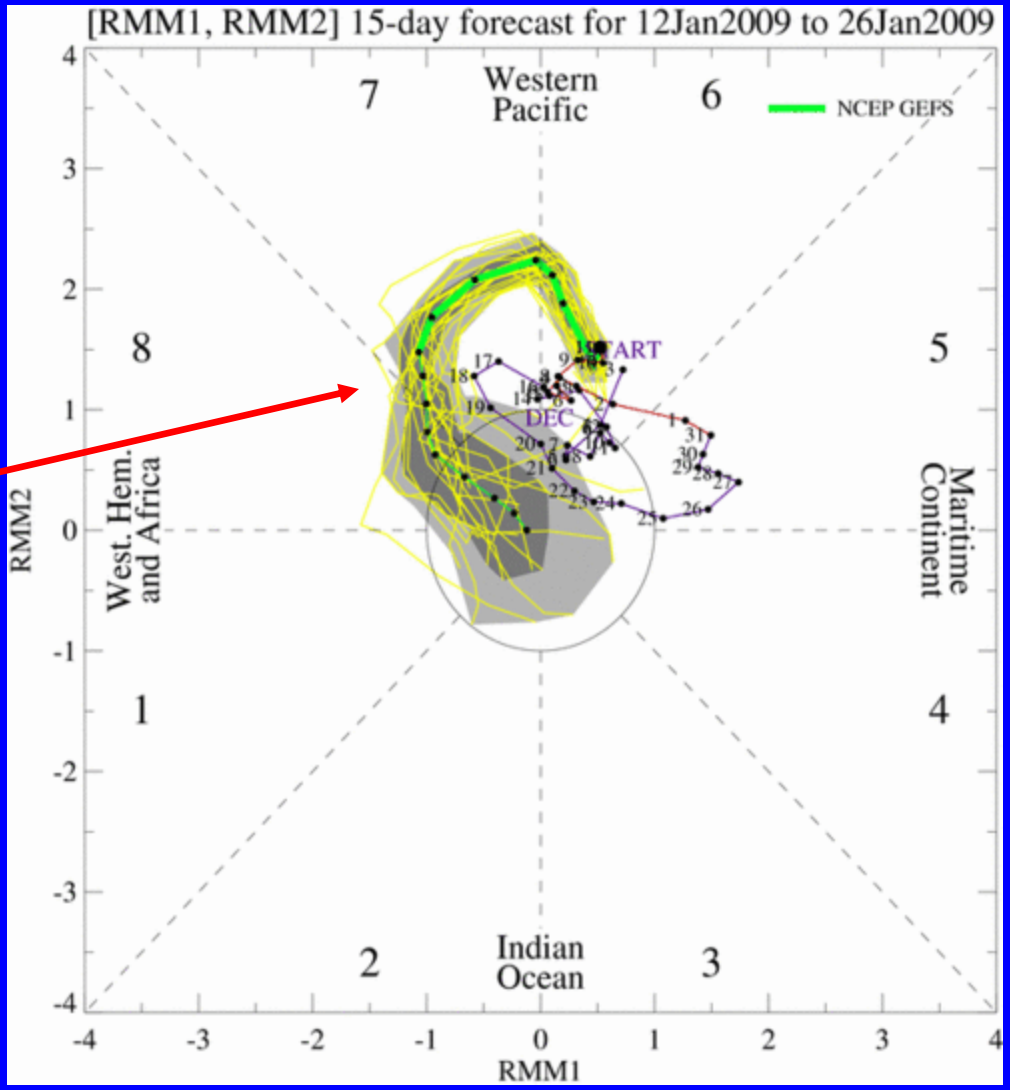
Ensemble GFS (GEFS) MJO Forecast

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

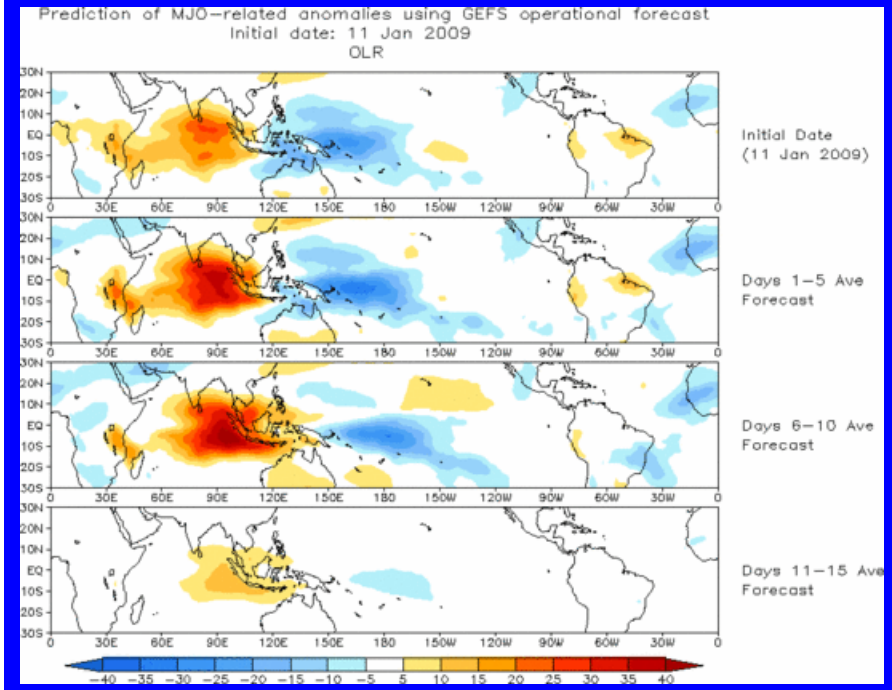
The GEFS forecasts predict an increasing MJO index amplitude during Week 1 with eastward propagation during the entire period.



Ensemble Mean GFS MJO Forecast

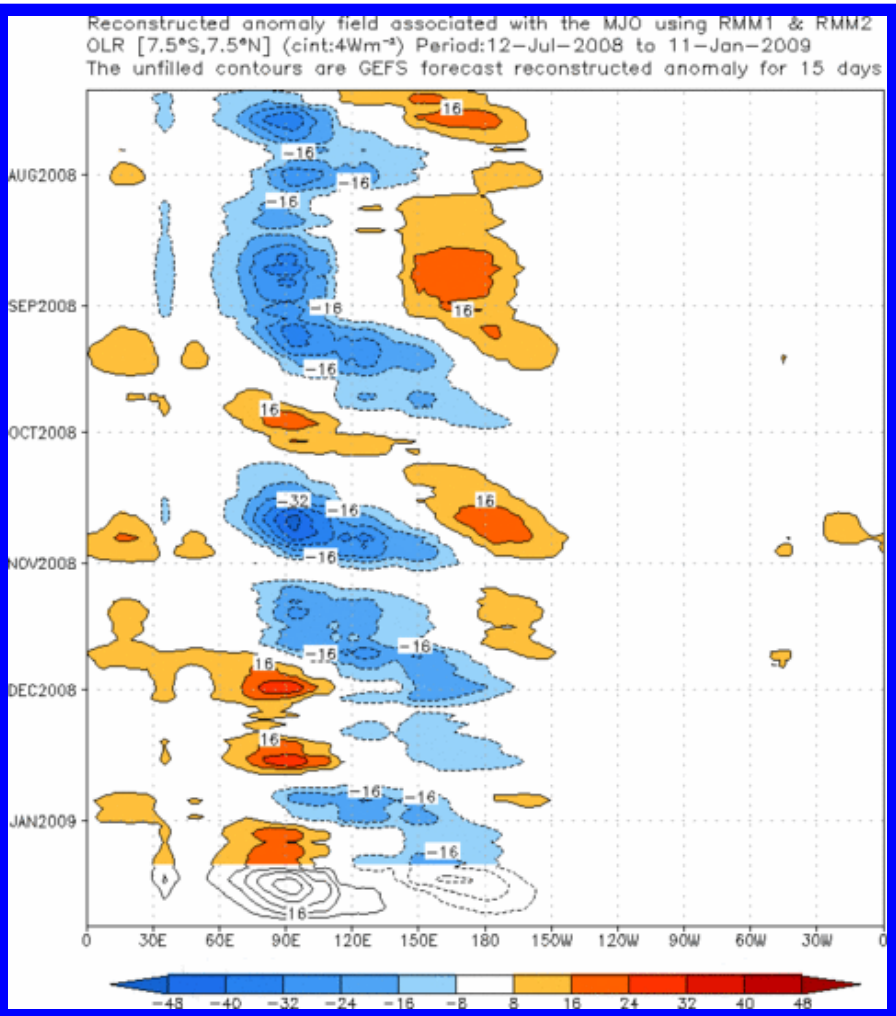
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



Suppressed convection is forecast to shift eastward from the Indian Ocean across Indonesia during the period with enhanced convection across portions of the southwest Pacific.

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



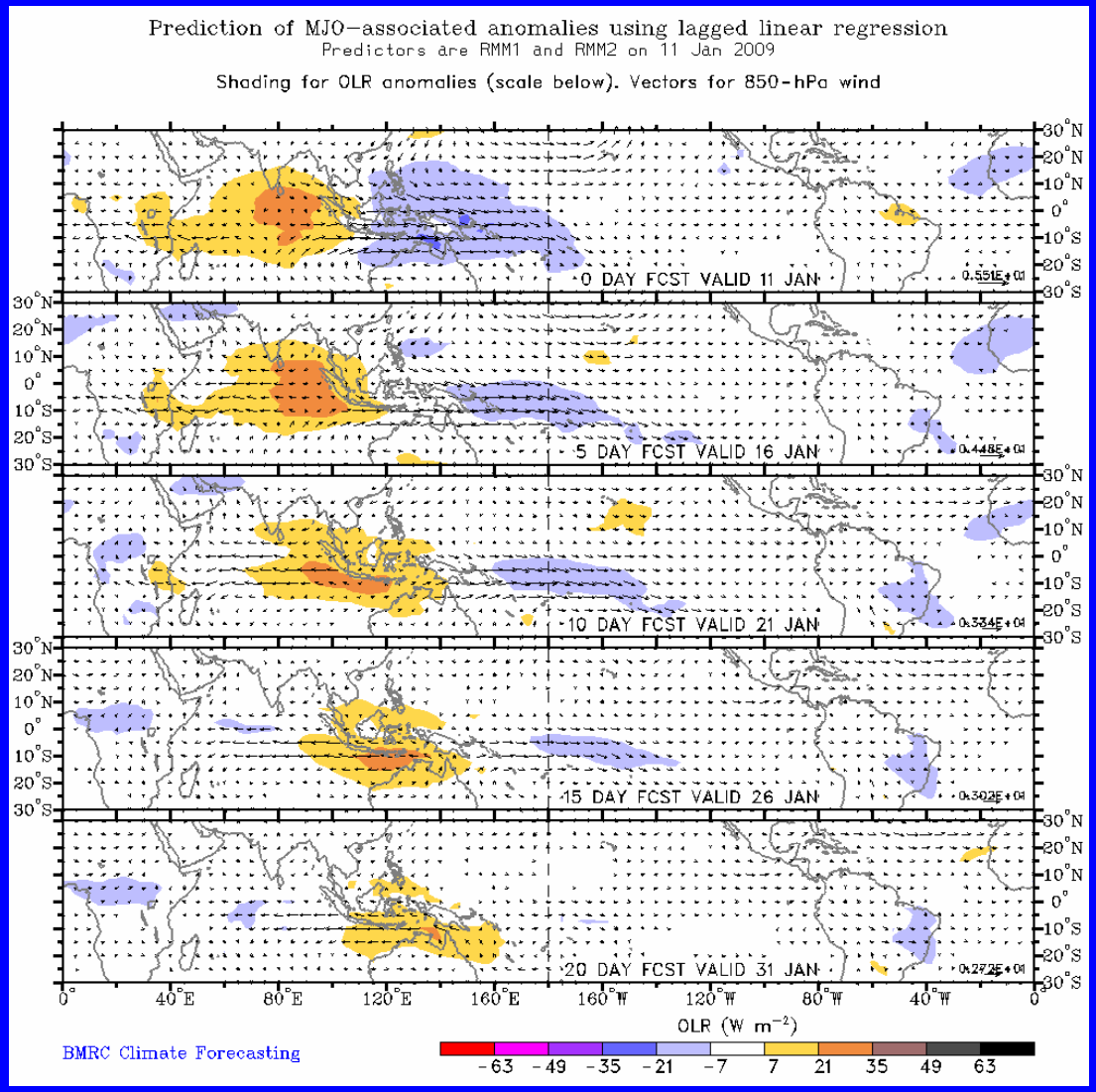
Statistical MJO Forecast

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 wind vectors for the next 20 days

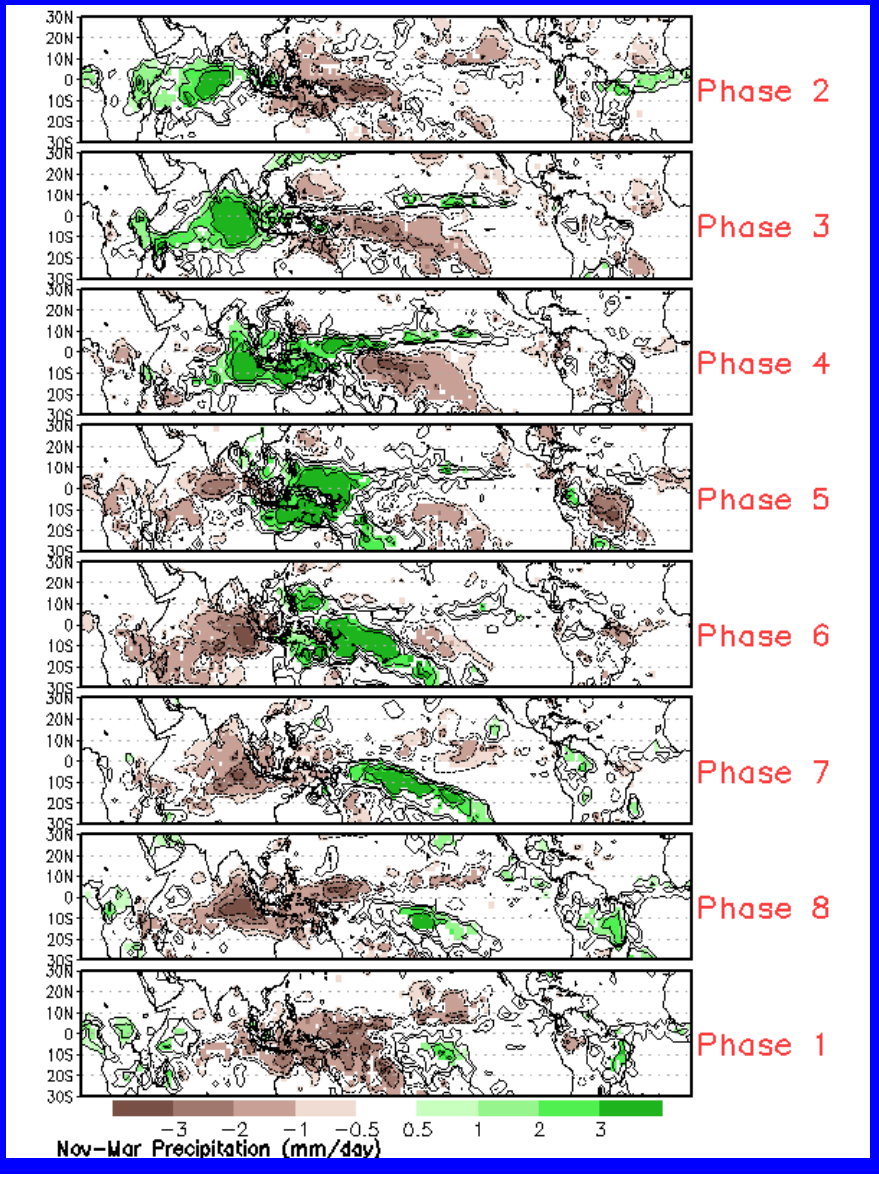
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

Suppressed convection associated with the MJO is predicted to shift eastward from the Indian Ocean across the Maritime Continent during the period.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)