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

Update prepared by
Climate Prediction Center / NCEP
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Outline

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

Overview

- The MJO has strengthened during the past week with the enhanced convective phase located in the Western Hemisphere.

- The MJO is expected to continue during the next 1-2 weeks with the enhanced convective phase shifting to the Indian Ocean by the end of the period.

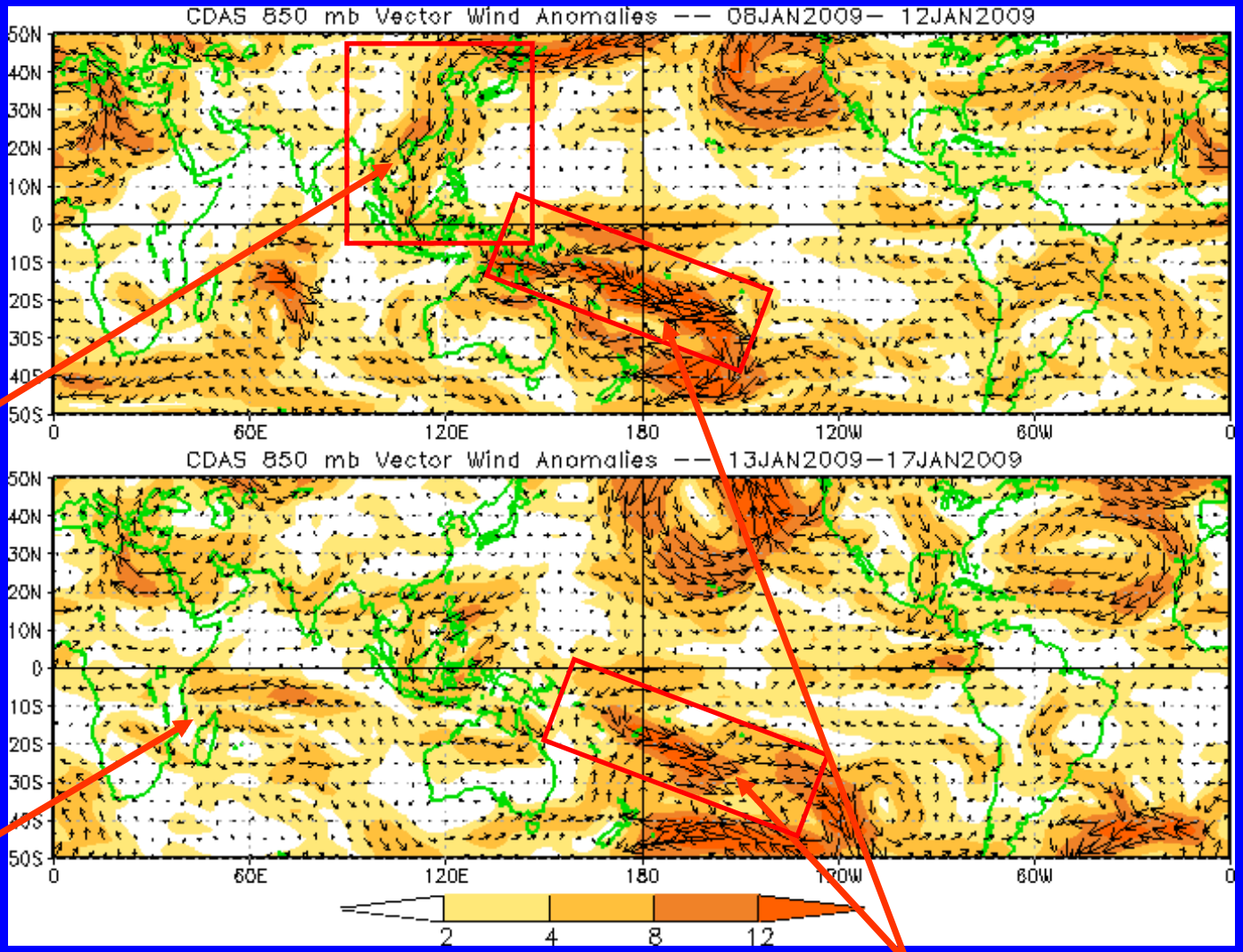
- The MJO is expected to decrease rainfall seen in recent weeks associated with La Nina across portions of Indonesia and increase rainfall for parts of South America and Africa during the period.

- Across the US, the southern branch of the jet stream will be more active and result in air of more Pacific origin affecting the southern tier of the US increasing chances for precipitation in California and moderating temperatures for parts of the south.

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



A strong northerly surge is evident from East Asia to the equator and extending eastward.

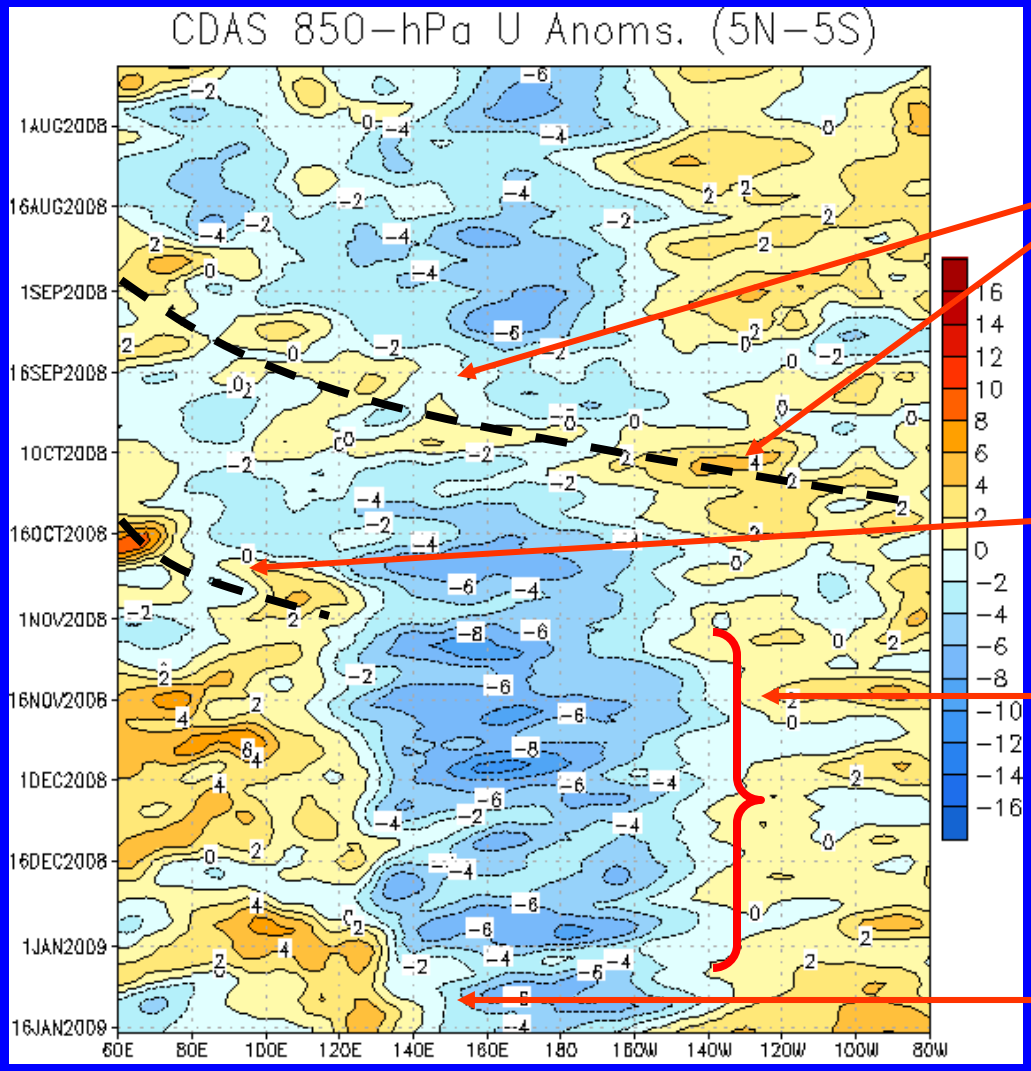
Easterly anomalies have developed across parts of Africa and the Indian Ocean during the last five days.

Strong westerly anomalies developed across the southwest tropical Pacific during the last five to ten 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

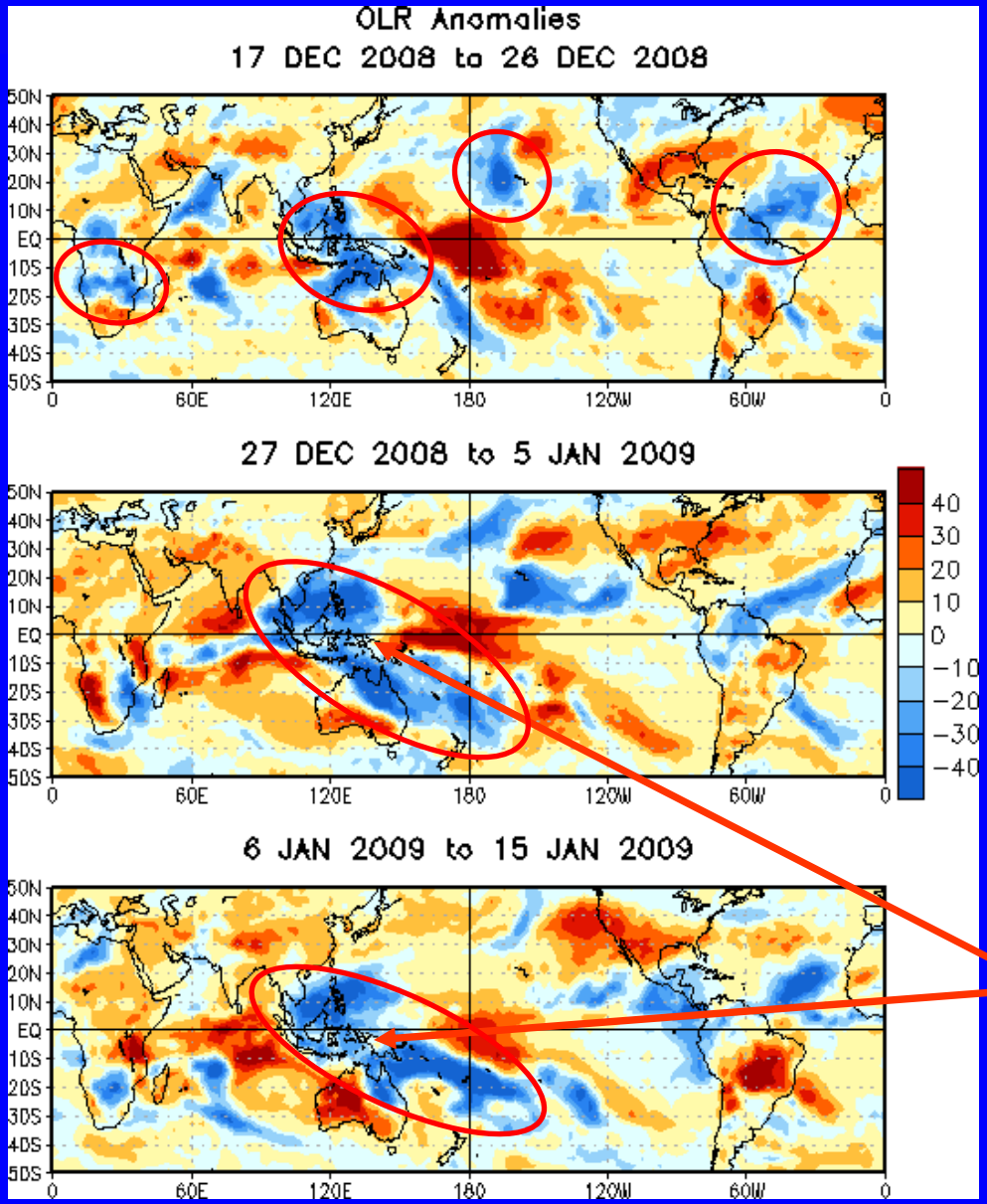
Beginning in September, anomalous westerlies associated with the MJO shifted from the Indian Ocean across the Pacific.

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.

A slight eastward shift in westerly anomalies is evident during January but the eastward movement is more evident south of the equator (not shown).

OLR Anomalies: Last 30 days



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

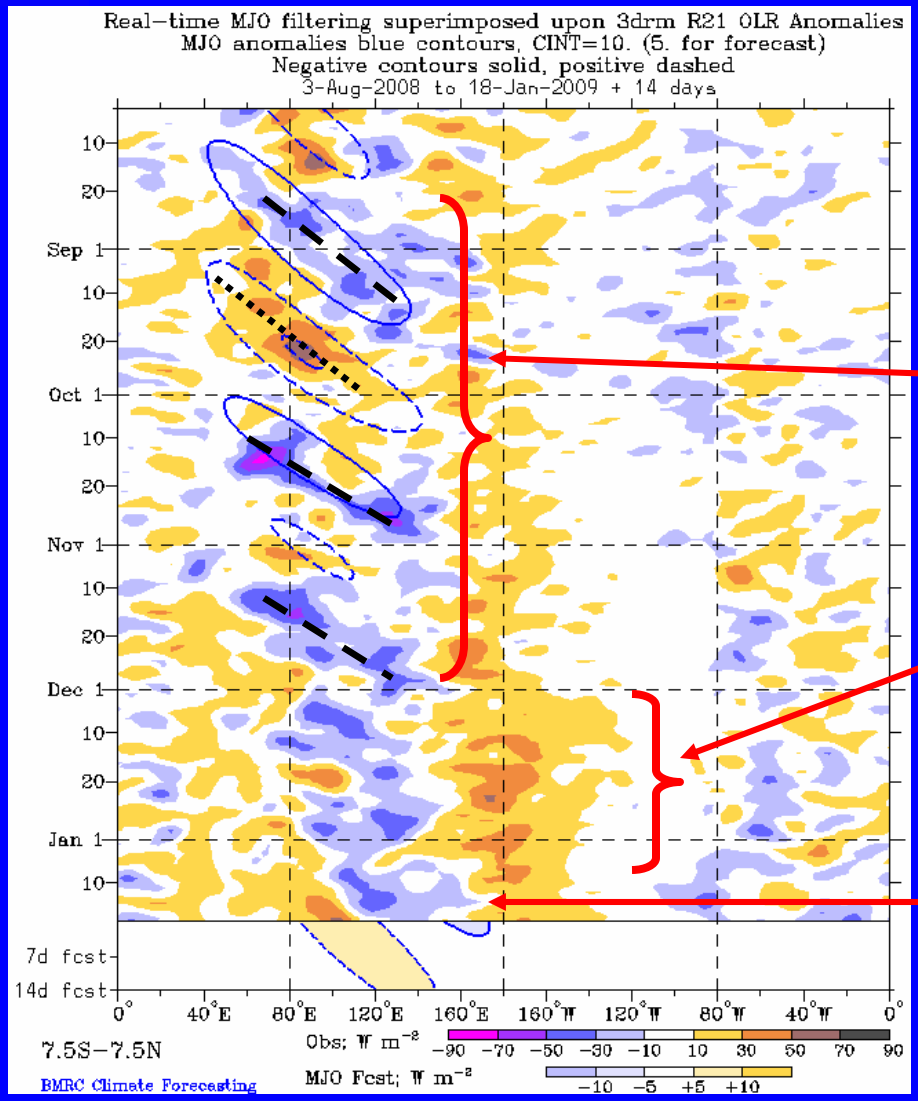
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

During mid-late December, areas of enhanced convection were located in several areas typical of La Nina - Indonesia, northern Australia, Hawaii, southern Africa and parts of northern South America.

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

Convection intensified during late December and early January across the western Pacific and the South Pacific Convergence Zone (SPCZ) while dry conditions have developed across the Indian Ocean and northeast Brazil.

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 mid-November as enhanced (suppressed) convection developed across the Indian Ocean and shifted eastward during the period.

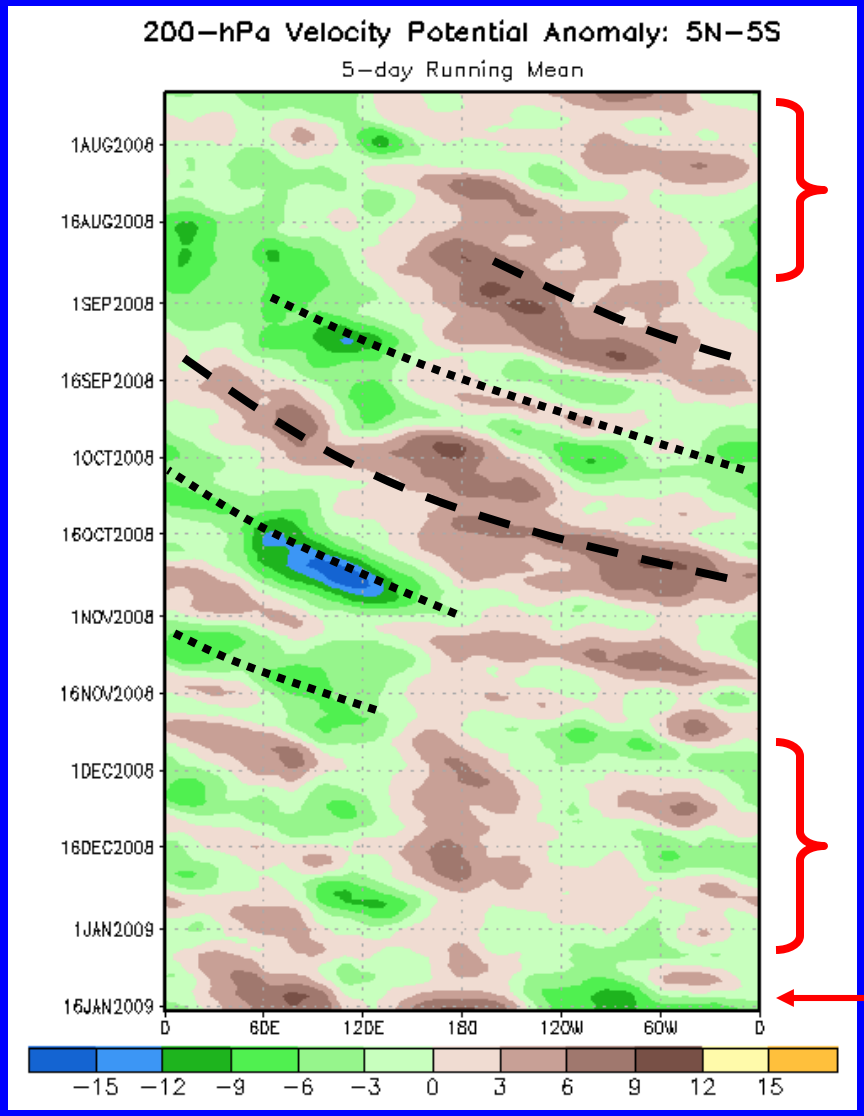
In December and January, anomalous convection was generally stationary and consistent with La Nina conditions.

During the past week, there has been some eastward movement of enhanced convection with suppressed convection developing in the Indian Ocean. The eastward movement is more defined south of the equator (not shown).

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.

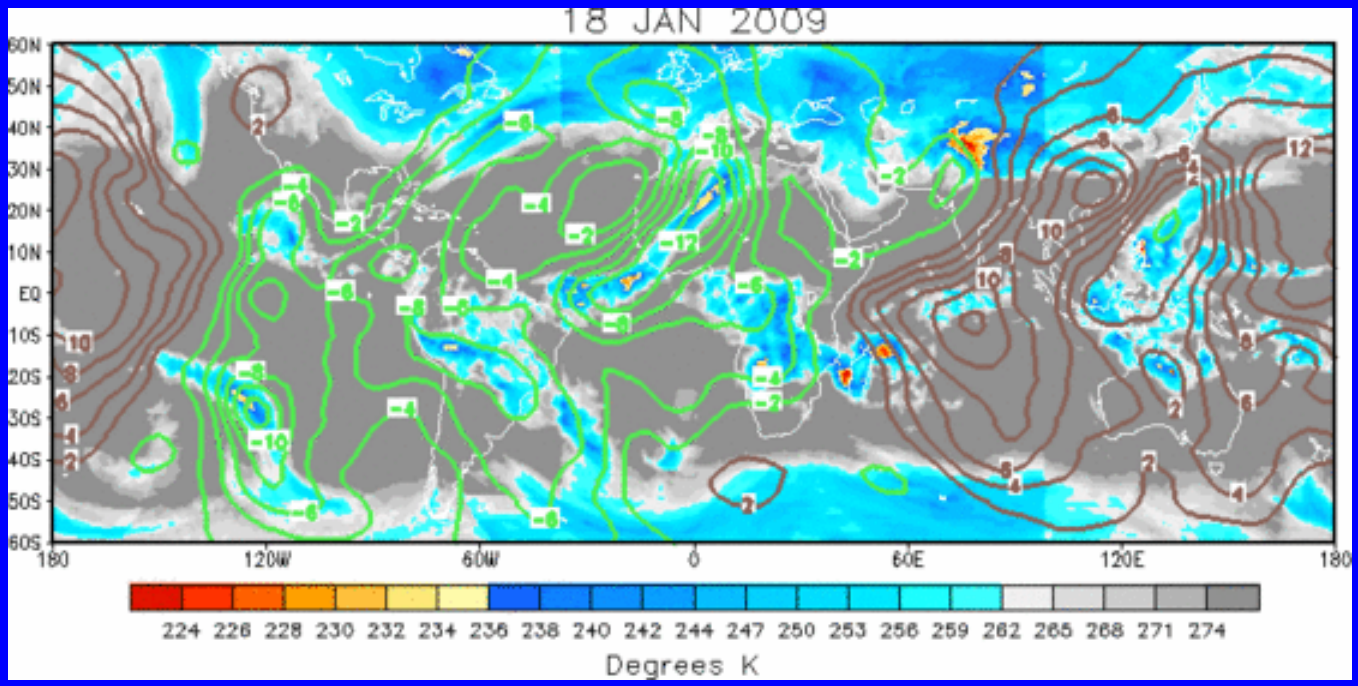
Since mid-November, the subseasonal activity has been organizing on a faster time scale and the MJO has been weak or incoherent.

Velocity potential anomalies have increased during the past week indicating the MJO is strengthening.

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

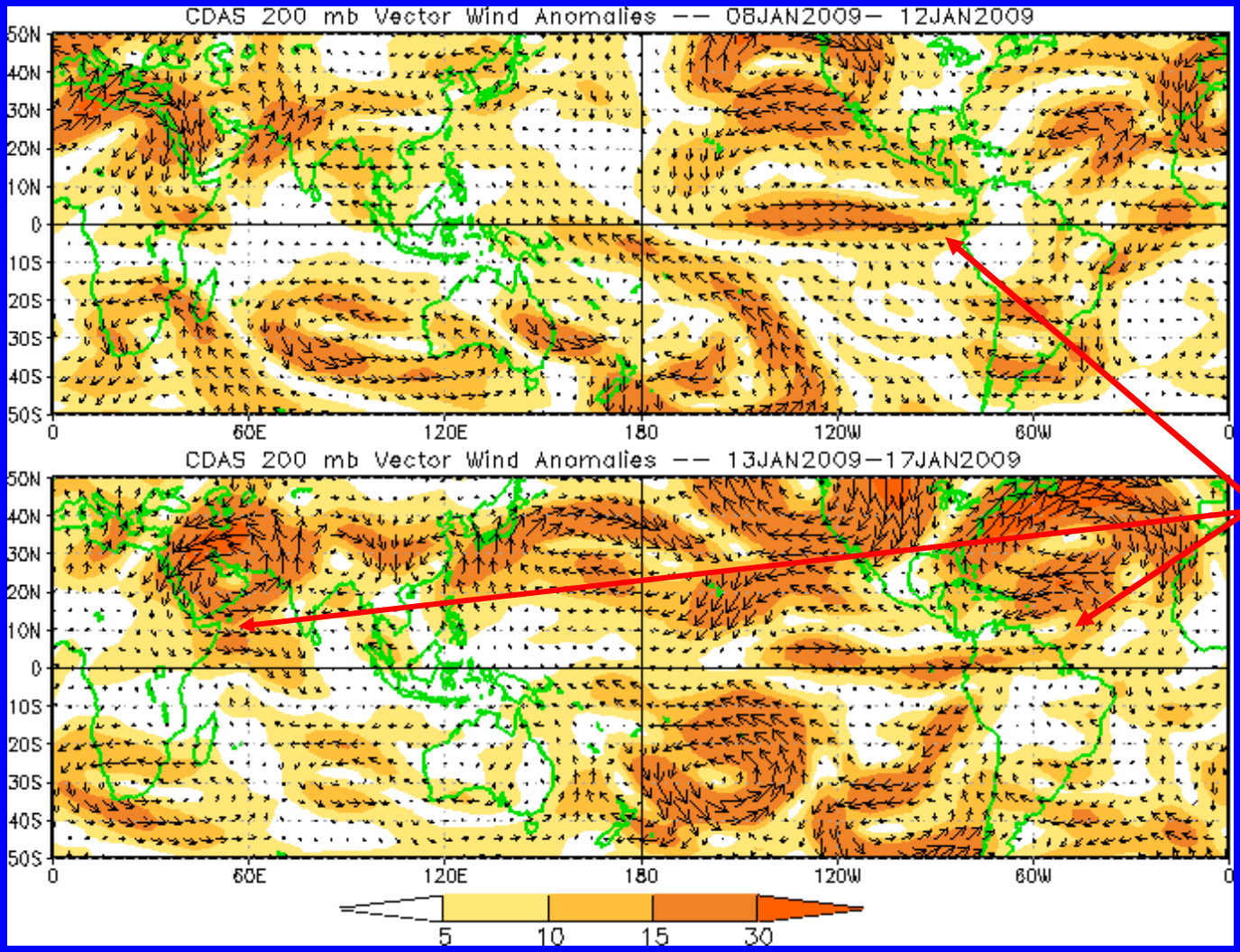


The velocity potential pattern has become much more organized during the past week with the pattern shifting eastward.

The strongest upper-level divergence is located over the Western Hemisphere while upper-level convergence has increased over the Indian Ocean, Indonesia and the western Pacific.

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

Note that shading denotes the magnitude of anomalous wind vectors

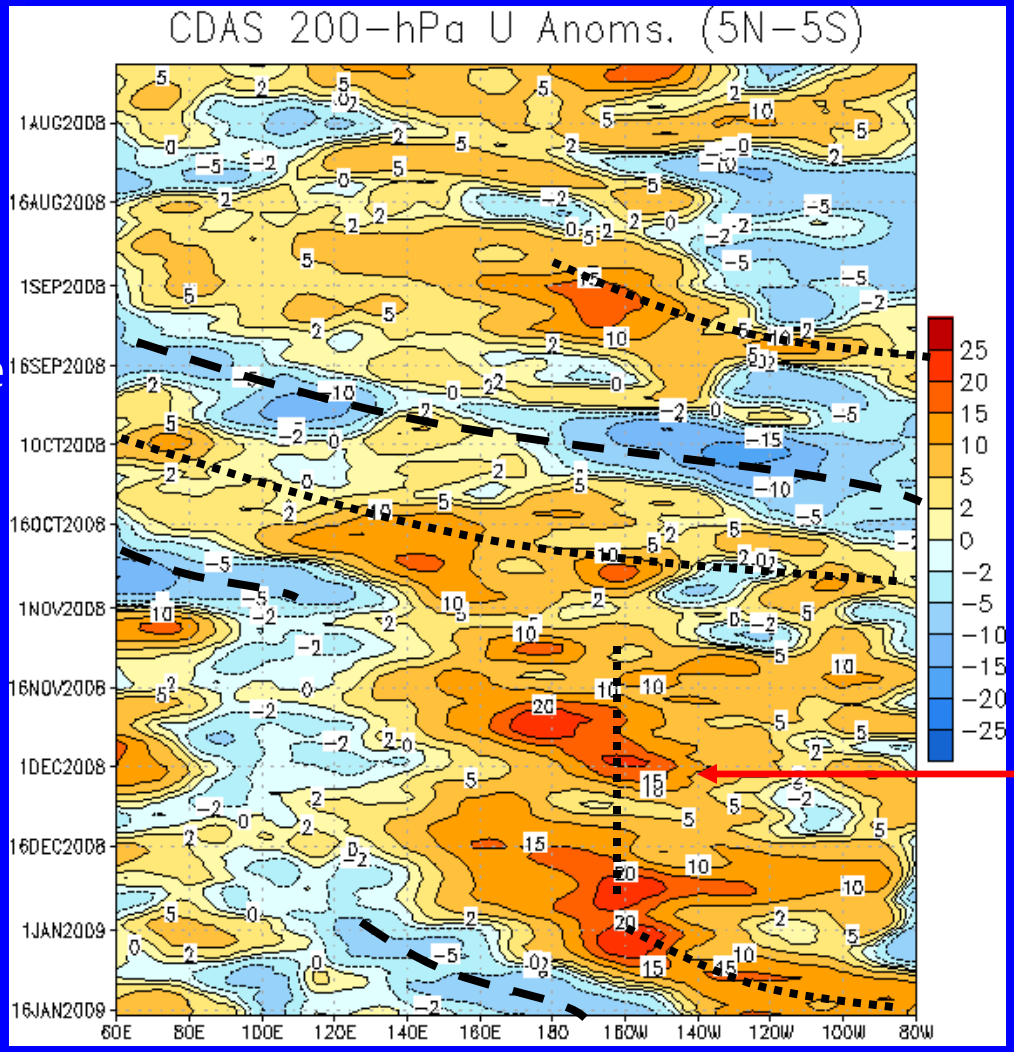


Westerly anomalies along the equator have shifted eastward during the last five to ten days across South America and Africa to the Indian Ocean.

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

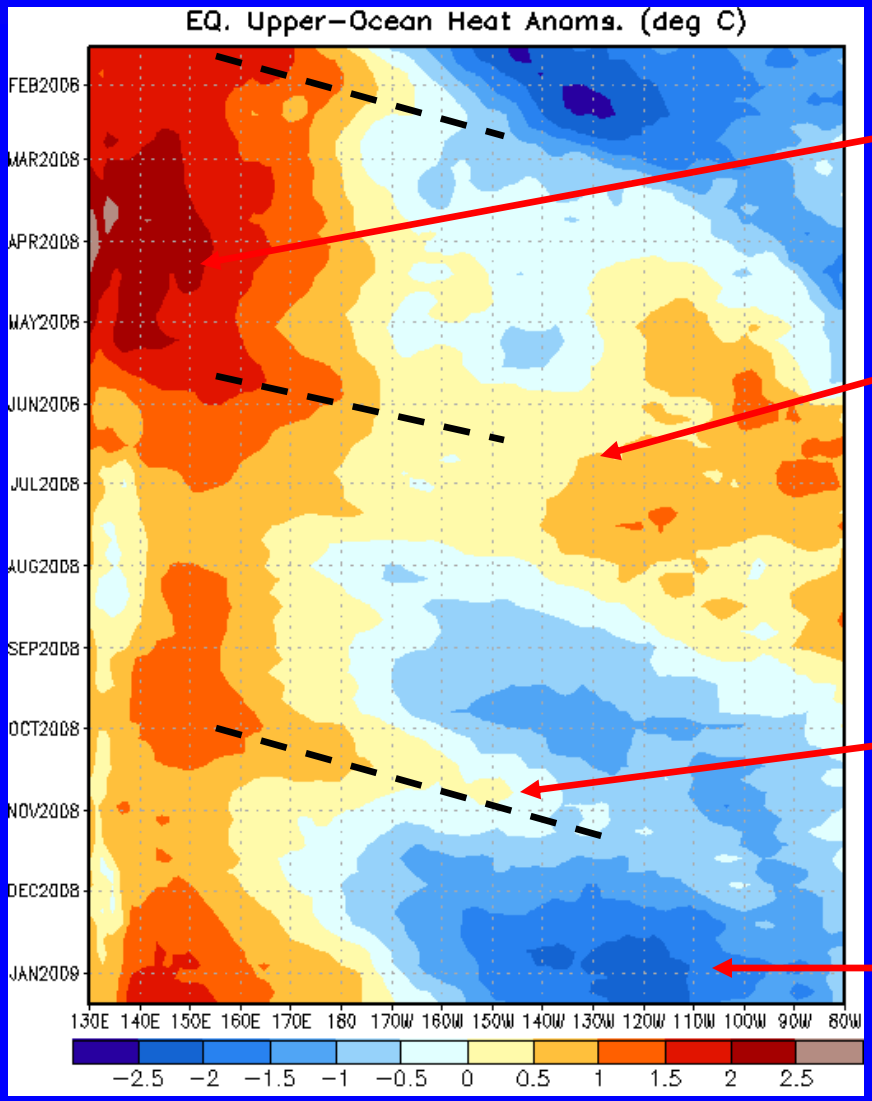
Longitude

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.

Eastward propagation is evident during January associated with the recent MJO activity.

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, December and January negative anomalies increased across the Pacific.

MJO Index -- Information

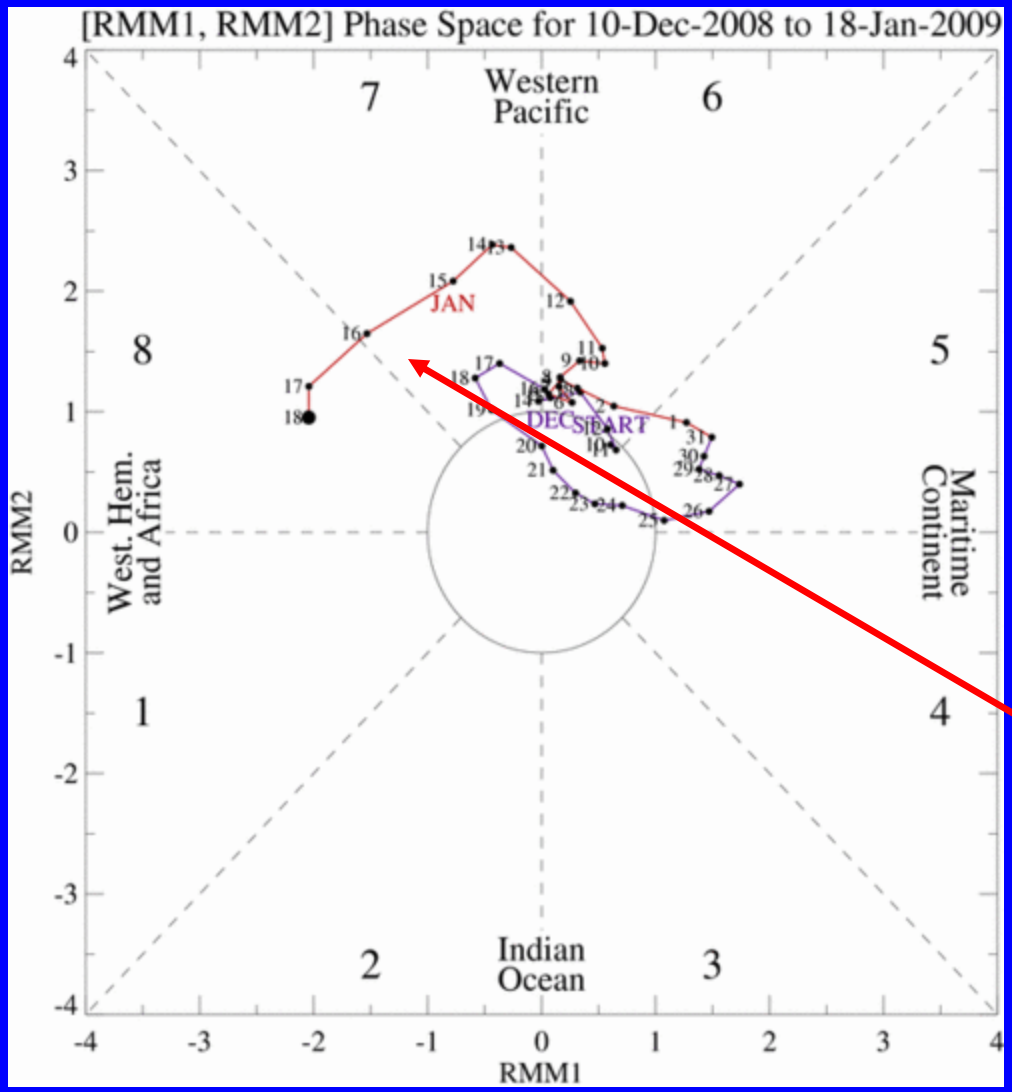
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

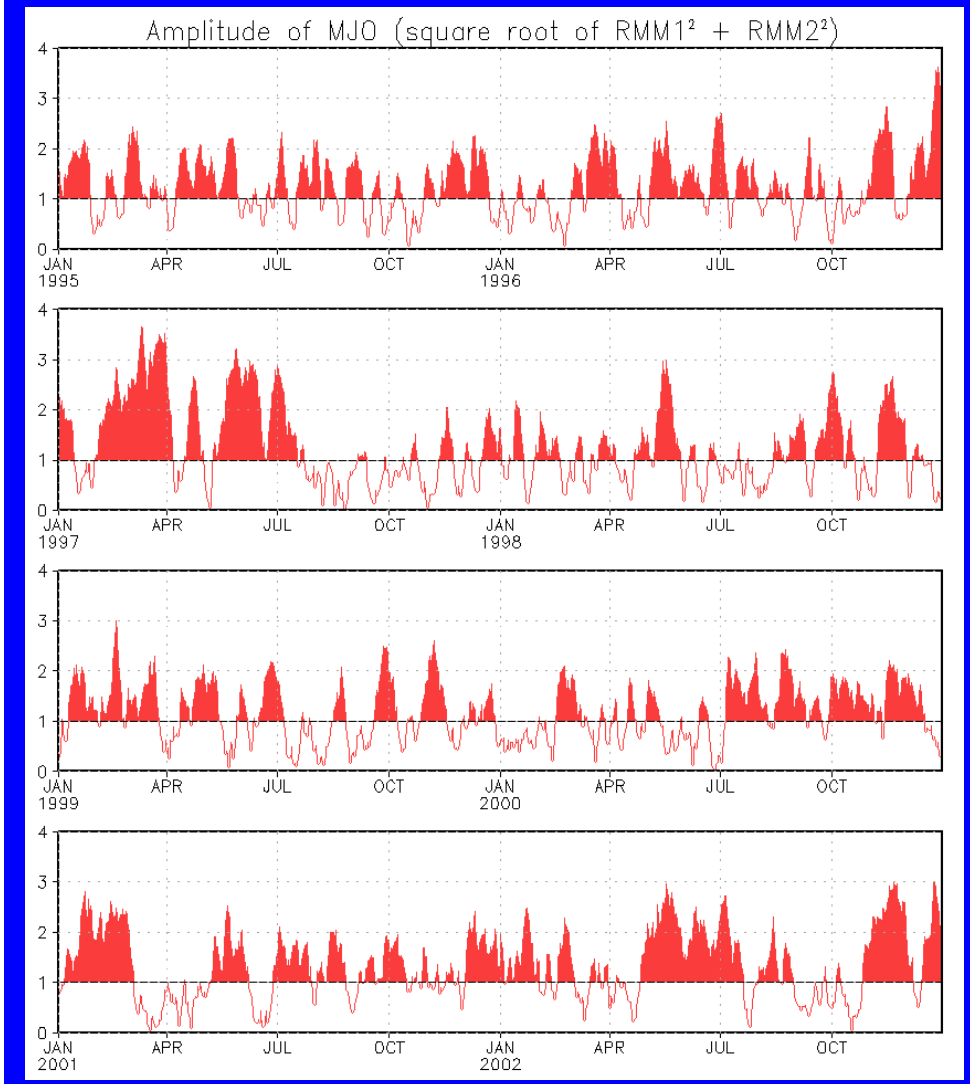
MJO Index -- Recent Evolution

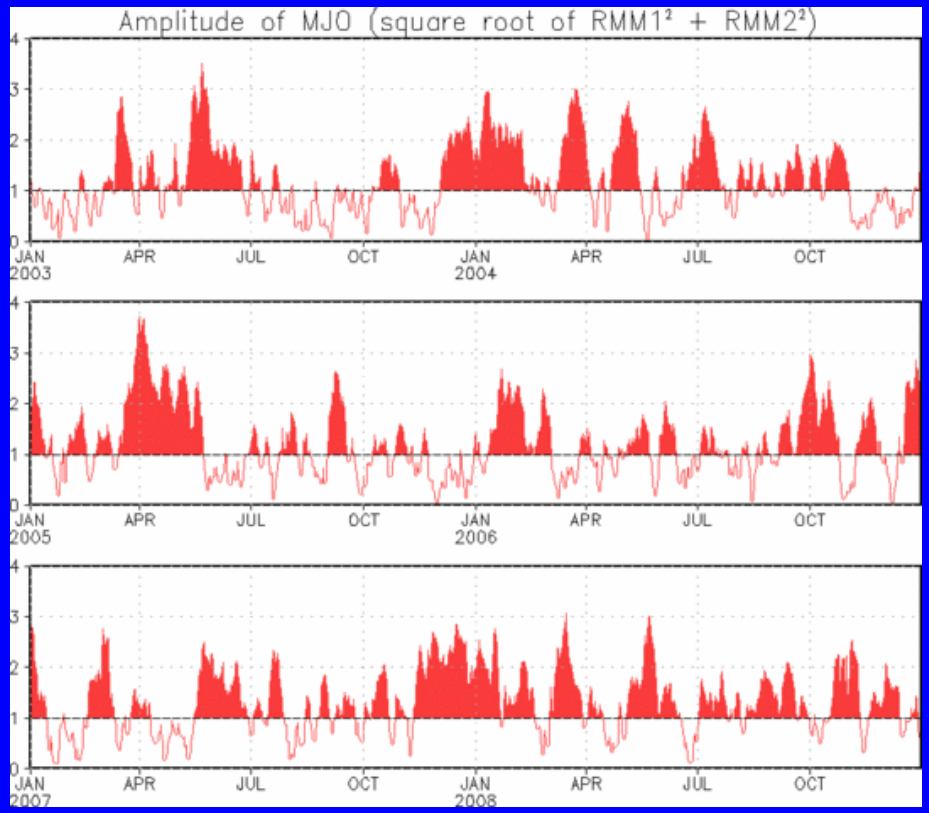


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index has increased considerably in amplitude during the past week with an increase in eastward propagation.

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

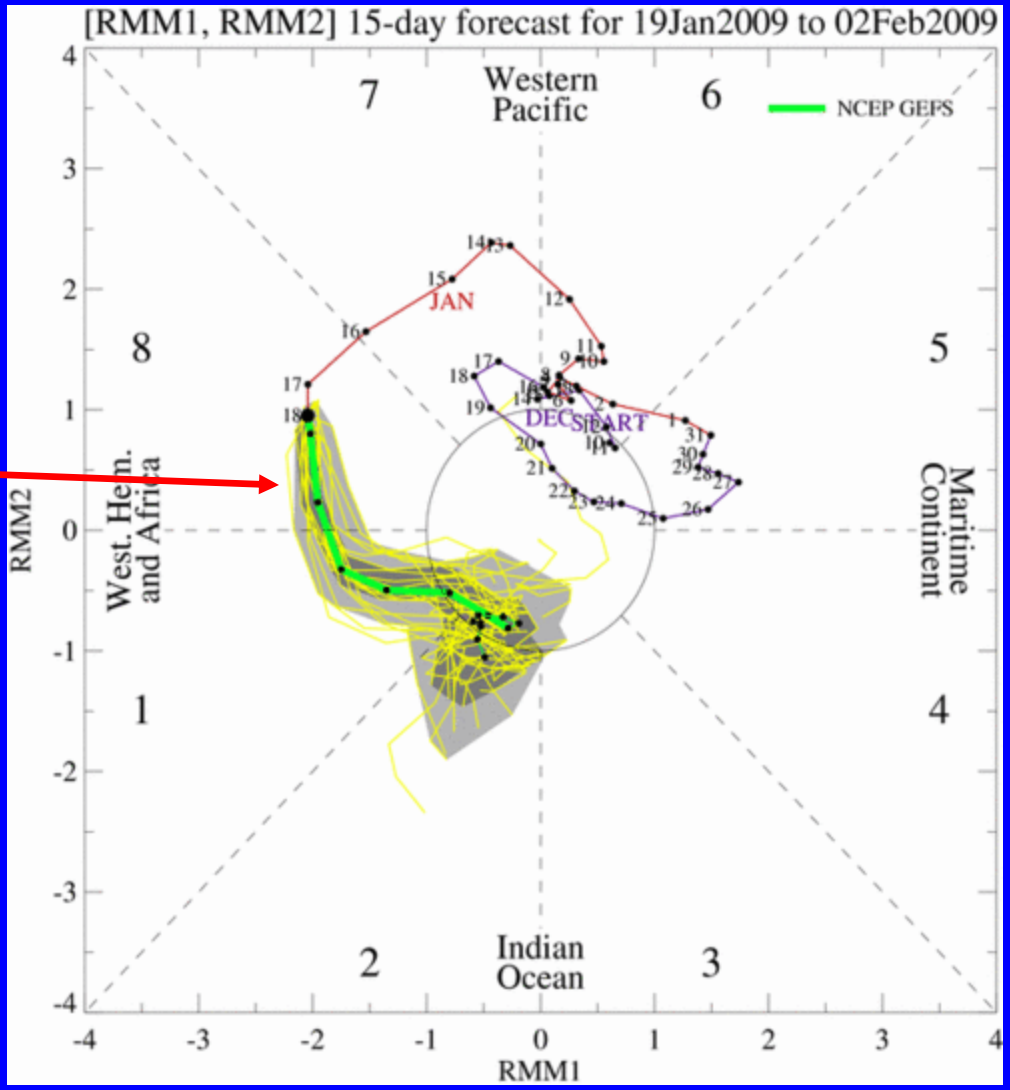
Ensemble GFS (GEFS) MJO Forecast

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

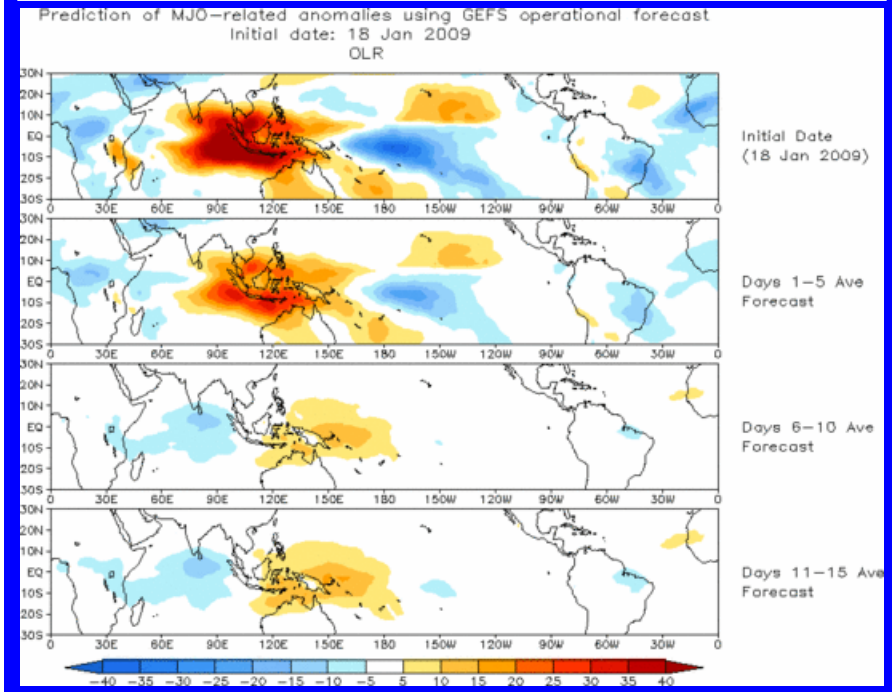
The GEFS forecasts predict eastward propagation of a moderate MJO during Week 1 with a decrease in eastward propagation during Week 2.



Ensemble Mean GFS MJO Forecast

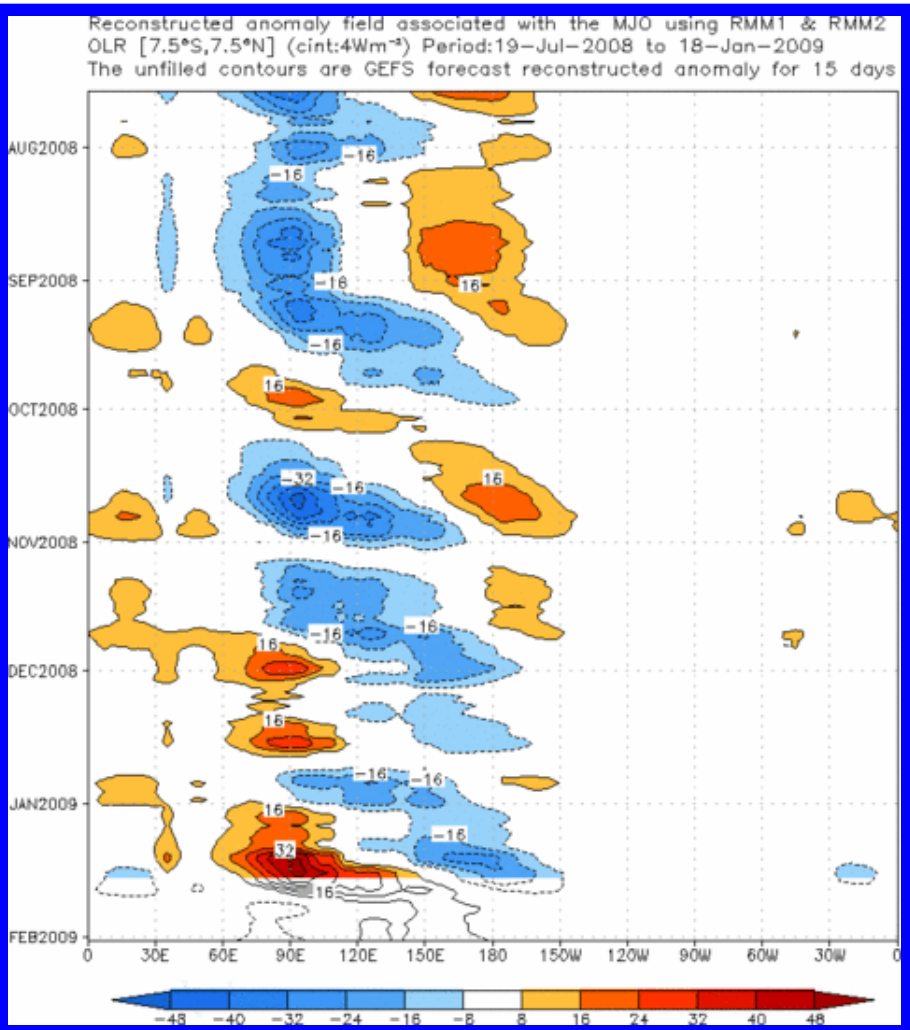
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

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 evident across parts of South America, Africa and later the Indian Ocean.

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



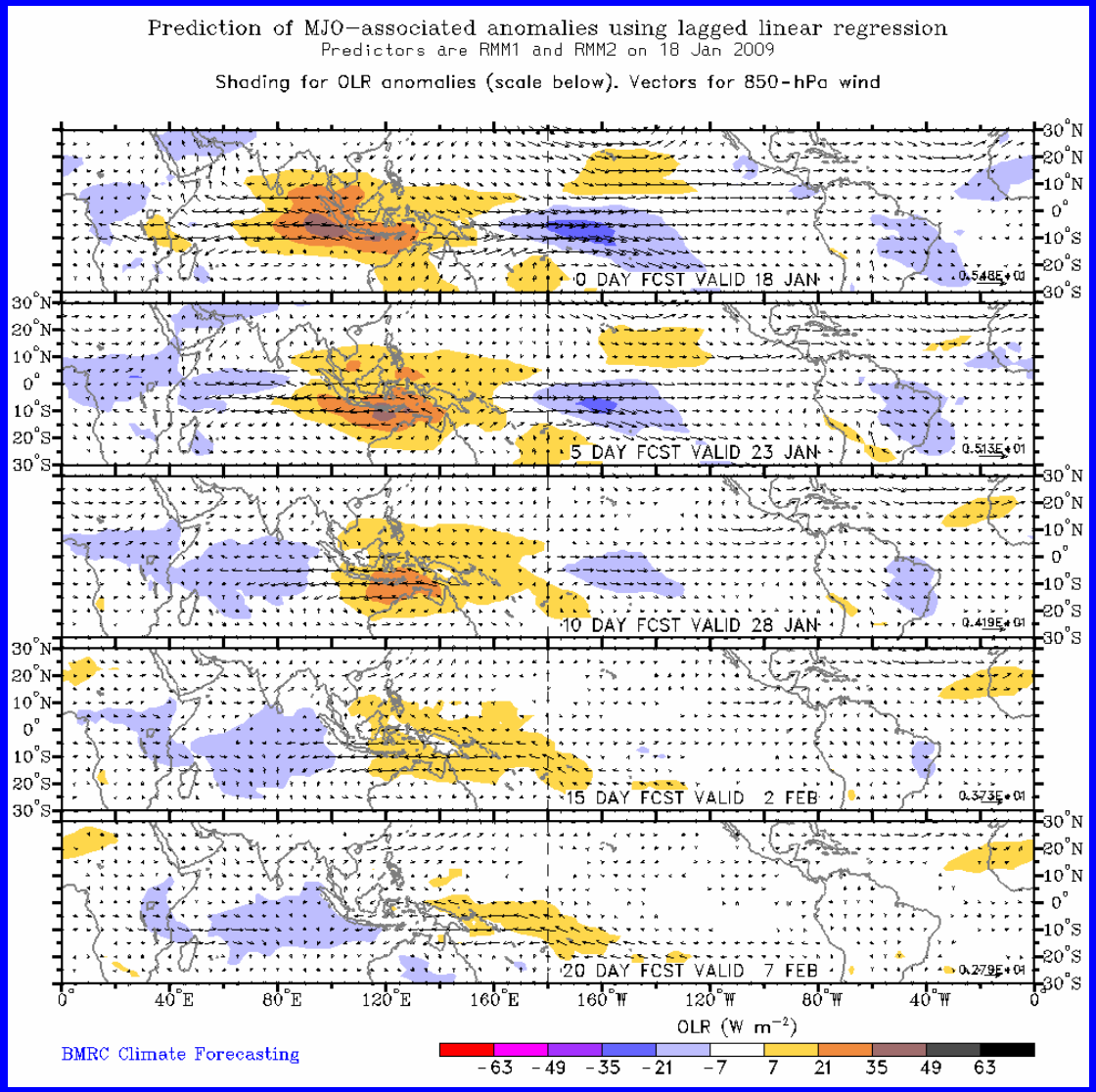
Statistical MJO Forecast

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

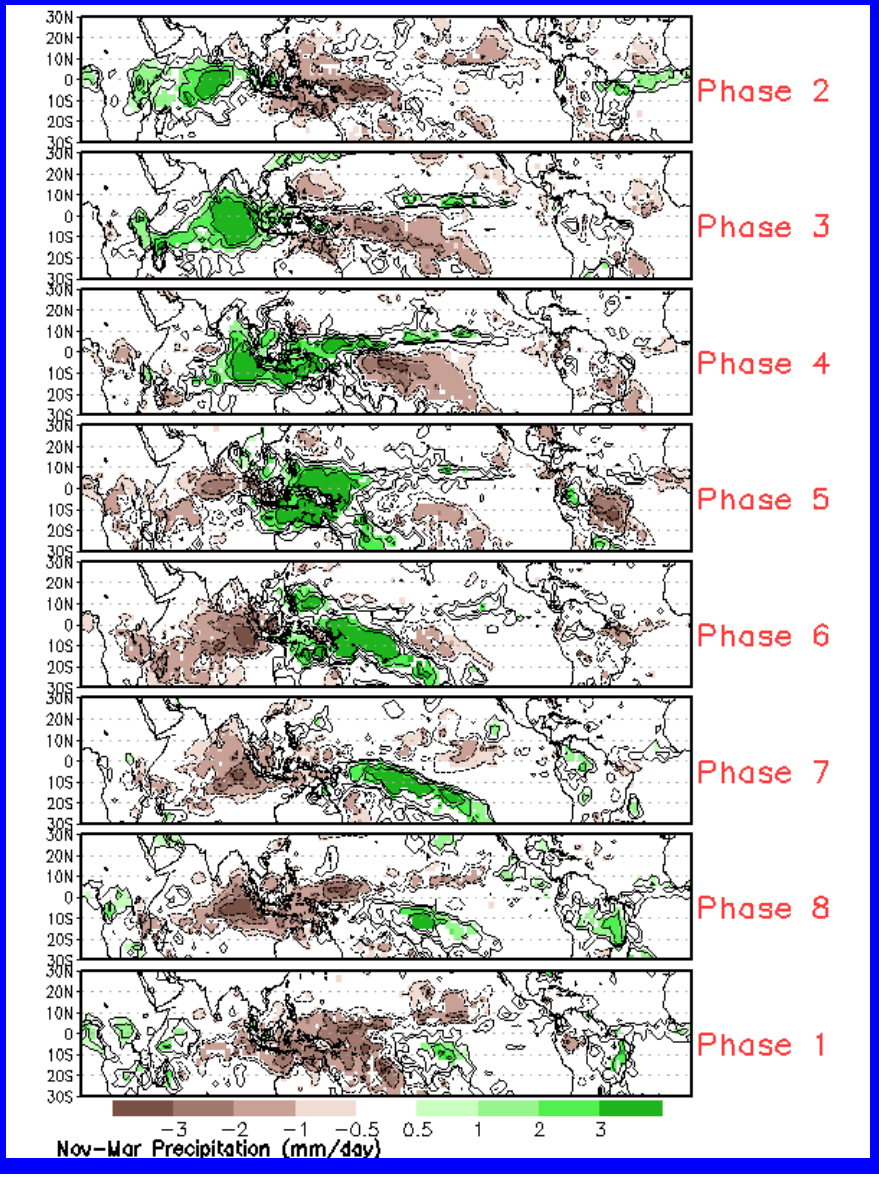
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

A strong MJO signal is forecast with suppressed convection predicted to shift eastward from the Indian Ocean across the Maritime Continent during the period while enhanced convection enters the Indian Ocean during Week 2.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)