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

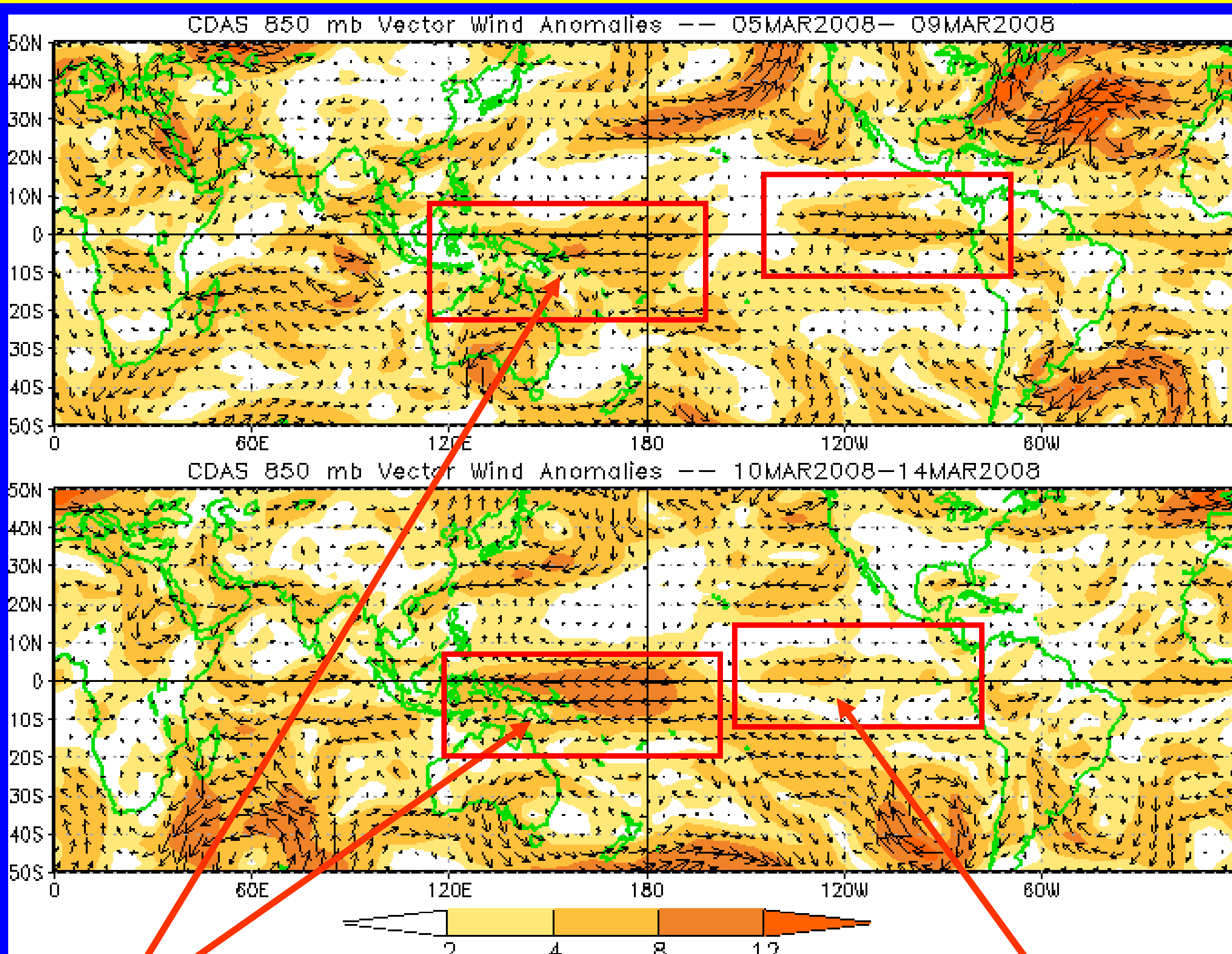
- The MJO signal has decreased during the past week. Recent observations (tropical rainfall and wind) have not been entirely consistent with the MJO in its current phase.

- Based on dynamical model forecast tools, along with these recent observations, it is expected that the MJO will continue to weaken during the next 1-2 weeks. Considerable uncertainty, however, still remains for the future evolution of the MJO during weeks 2-3.

- Enhanced tropical rainfall is expected to mainly focus across the eastern Indian Ocean and Indonesia over the next 1-2 weeks. Tropical cyclone activity is favored for the southern Indian Ocean.

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

Note that shading denotes the magnitude of anomalous wind vectors



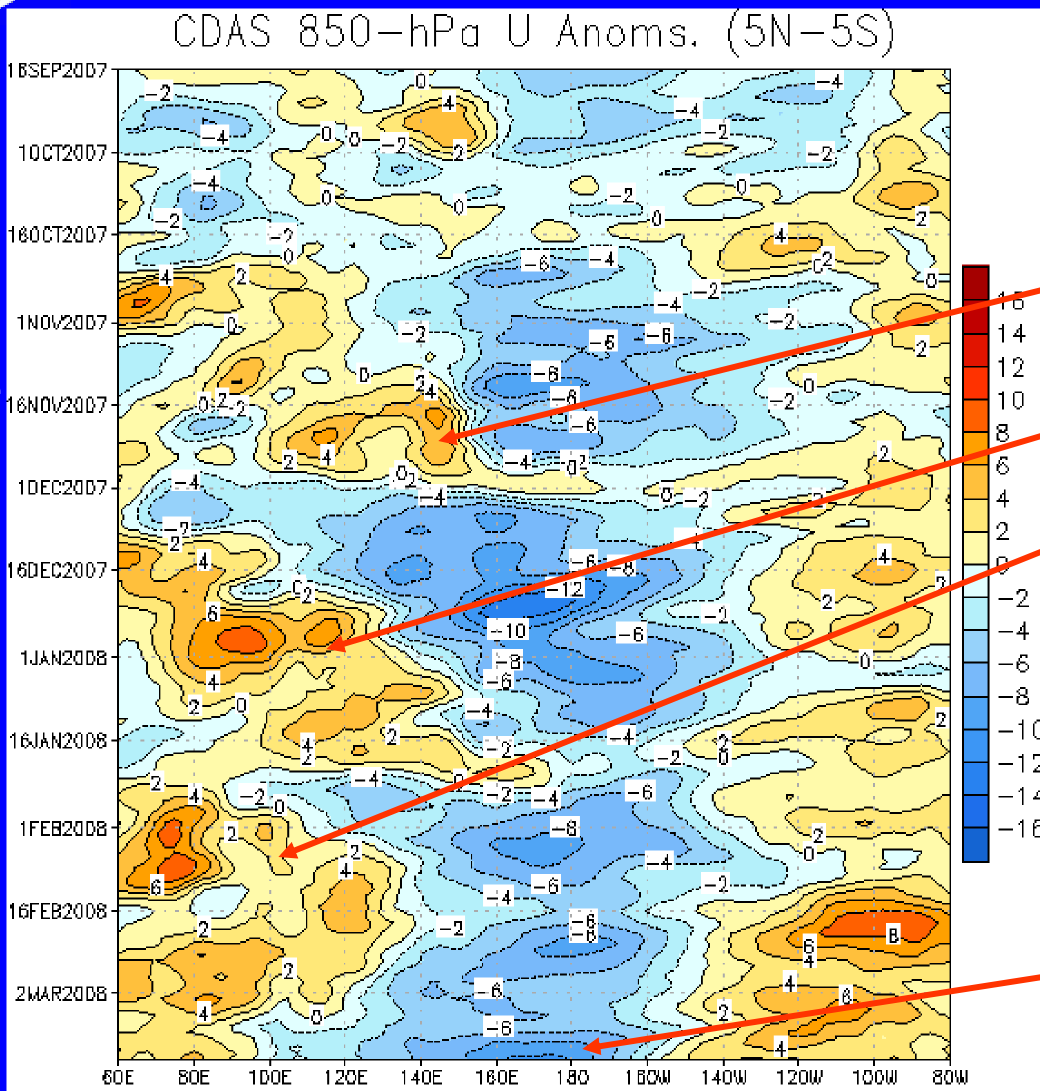
Easterly anomalies have increased across the western Pacific.

Westerly anomalies continue across the eastern Pacific.

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



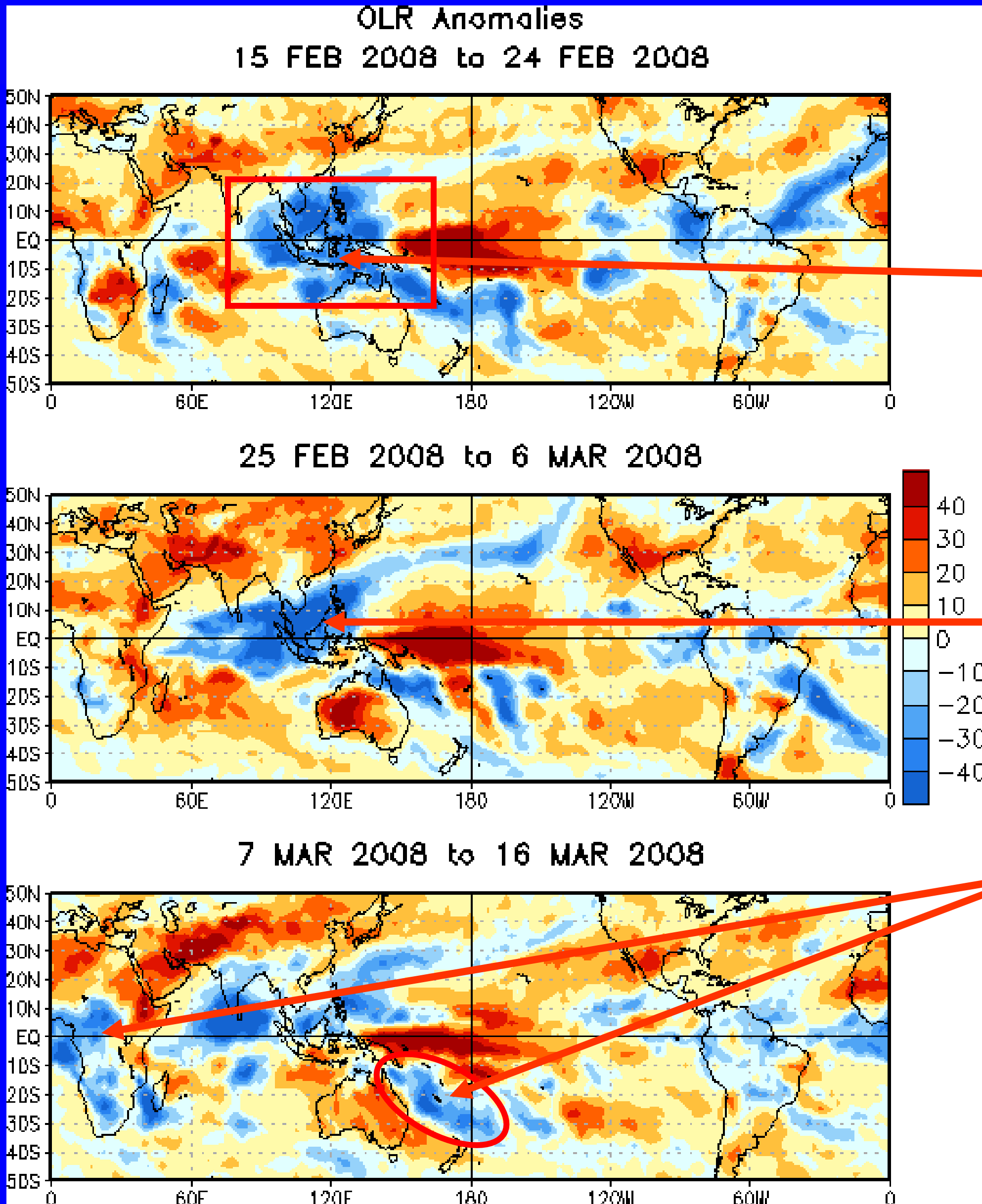
Time

Longitude

Moderate-to-strong MJO activity was evident from late October to mid-late February as shown by westerly anomalies shifting eastward from the Indian Ocean across Indonesia and a weakening of the easterlies at the Date Line during early December, mid-January and mid-February.

Low-level easterlies have strengthened and expanded to include most of the Maritime continent.

OLR Anomalies: Last 30 days



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

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

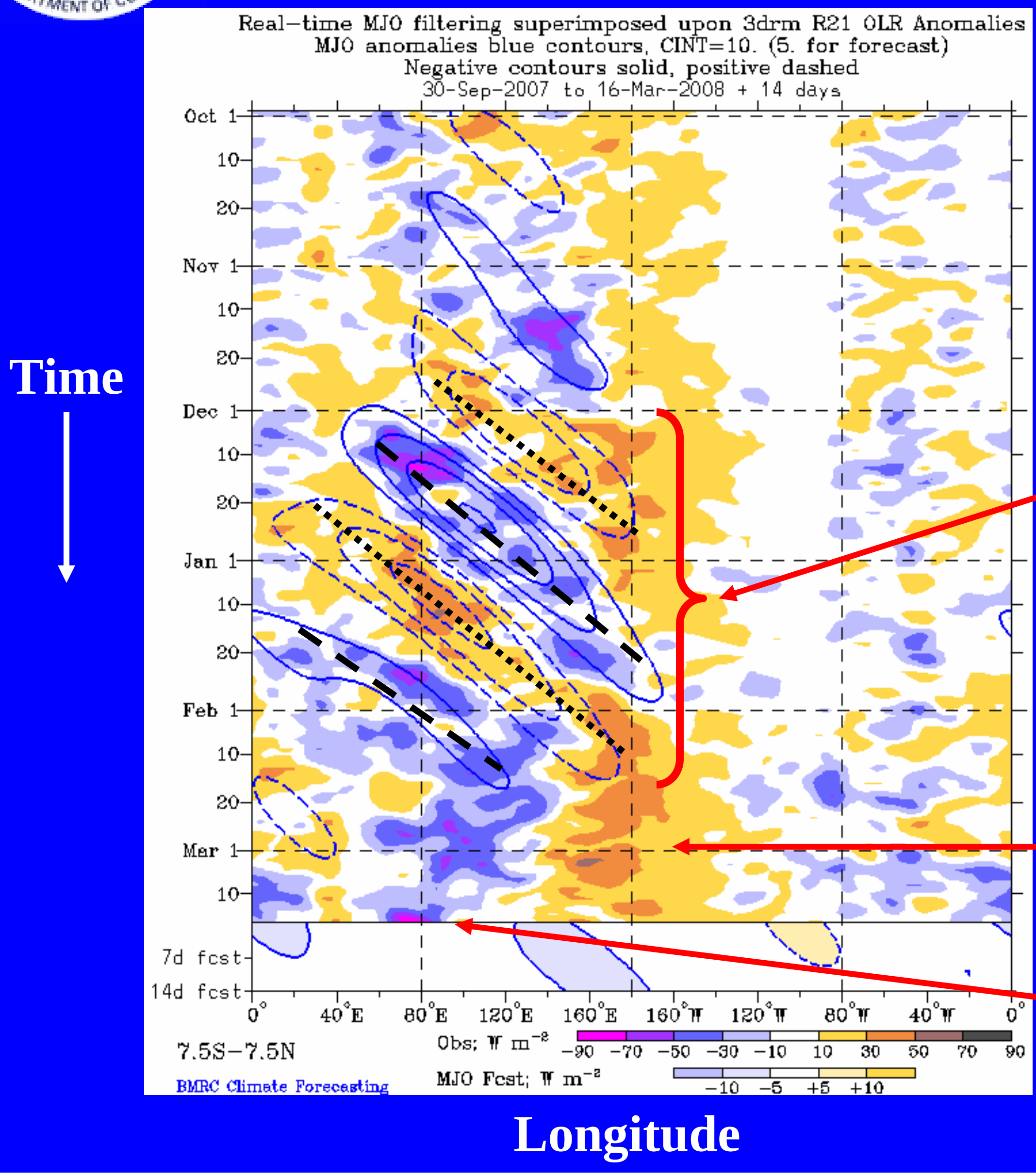
Wet conditions were observed across the Indian Ocean, Maritime Continent, and northern Australia during mid-late February.

From late-February into early March, enhanced rainfall shifted slightly westward to include more of the Indian Ocean.

Rainfall increased markedly across Africa and the Atlantic Ocean during early-mid March. The South Pacific Convergence Zone (SPCZ) also was convectively active.

Suppressed convection associated with La Nina is indicated throughout the period.

Outgoing Longwave Radiation (OLR) Anomalies (7.5°S-7.5°N)



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

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

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

Moderate-to-strong MJO activity was evident from mid-November to mid-February with coherent eastward propagation of enhanced (suppressed) convection indicated by the dashed (dotted) lines.

Considerable subseasonal variability is also evident across the western hemisphere during this period.

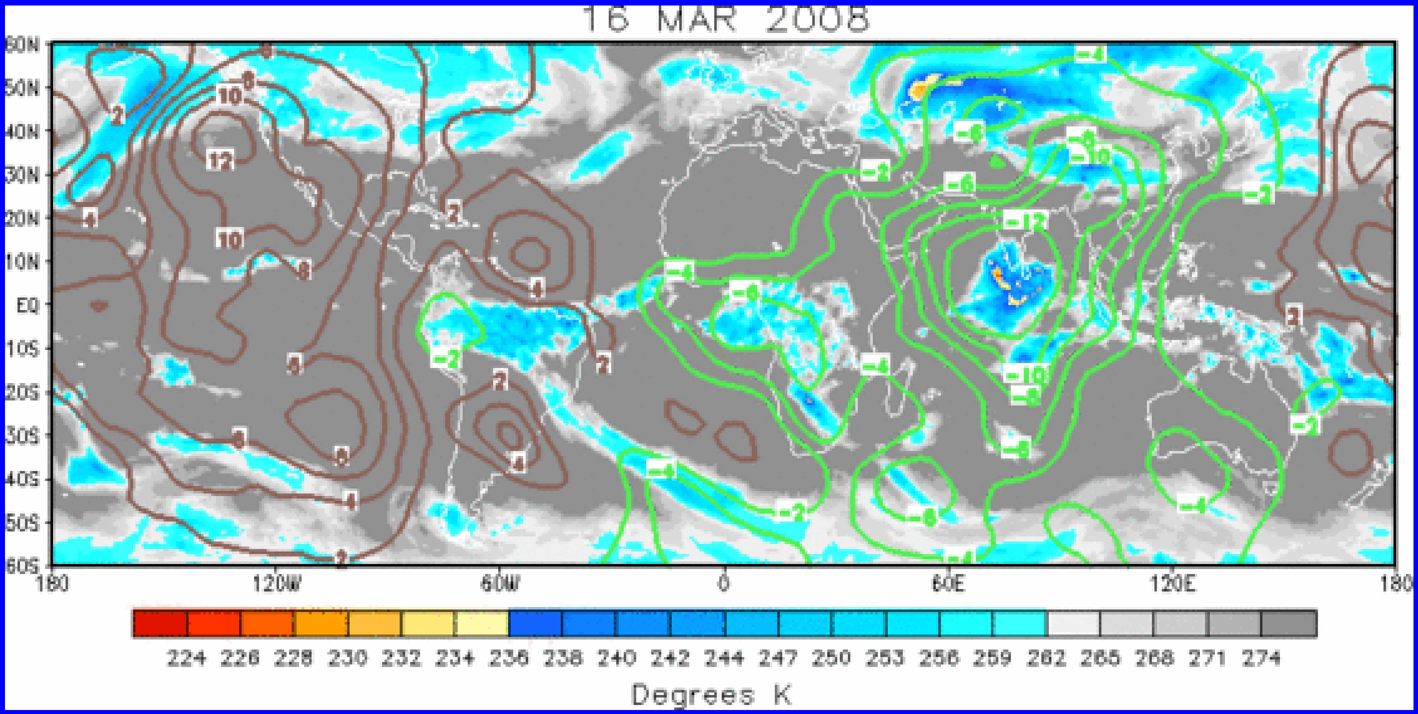
From mid-February into early March, a more stationary pattern of anomalous convection was evident.

In recent days, strong enhanced convection has developed across the Indian Ocean.

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



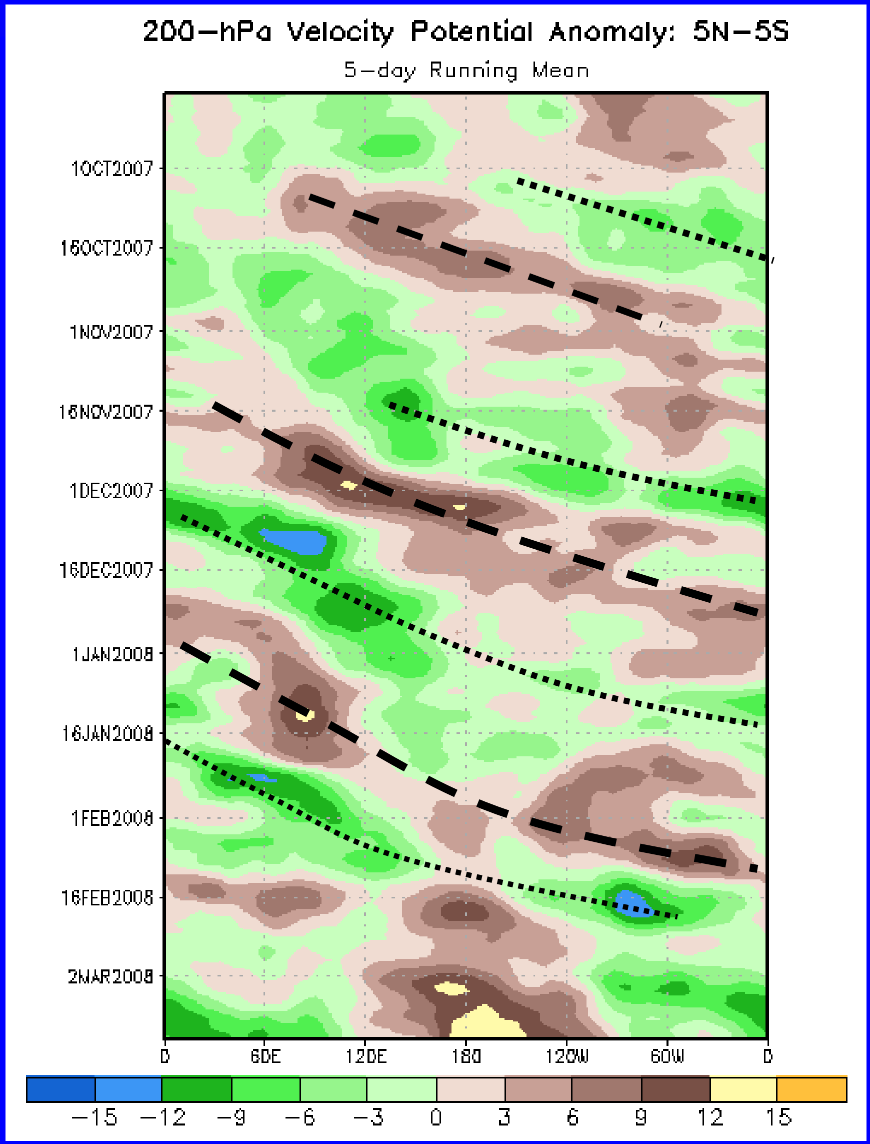
The current global velocity potential anomalies indicate a coherent pattern featuring: upper-level divergence over parts of Africa and the Indian Ocean and upper-level convergence over the central and eastern Pacific Ocean.

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

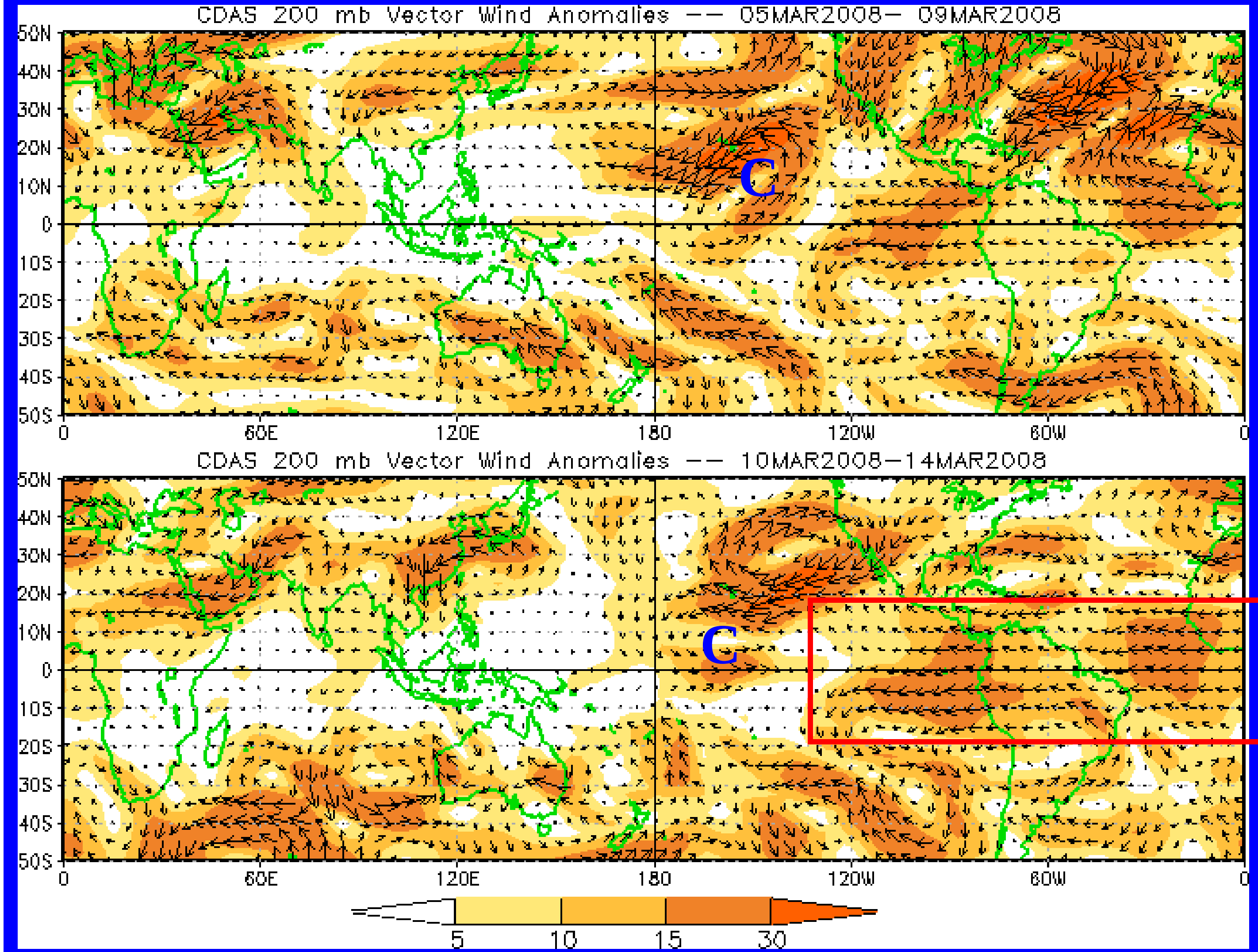
The MJO strengthened during October but coherent propagation was short-lived.

Moderate-to-strong MJO activity developed in mid-November and continued into mid-February.

At the beginning of March, velocity potential anomalies have increased markedly especially the upper-level convergence across the Pacific Ocean.

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

Note that shading denotes the magnitude of anomalous wind vectors



The cyclonic (C) circulation mainly associated with La Nina persists near Hawaii.

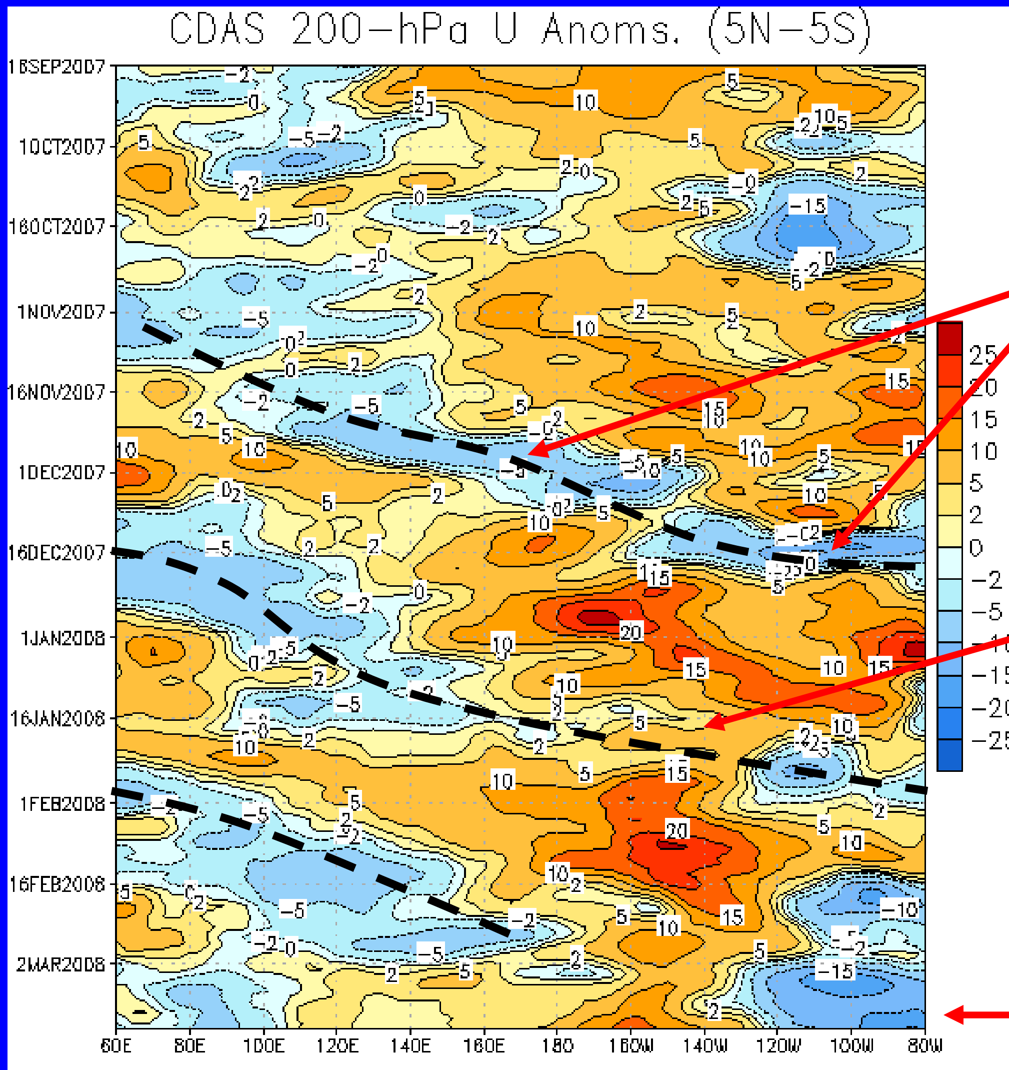
Easterly anomalies continue across much of the Western Hemisphere but have showed only minor eastward movement.

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

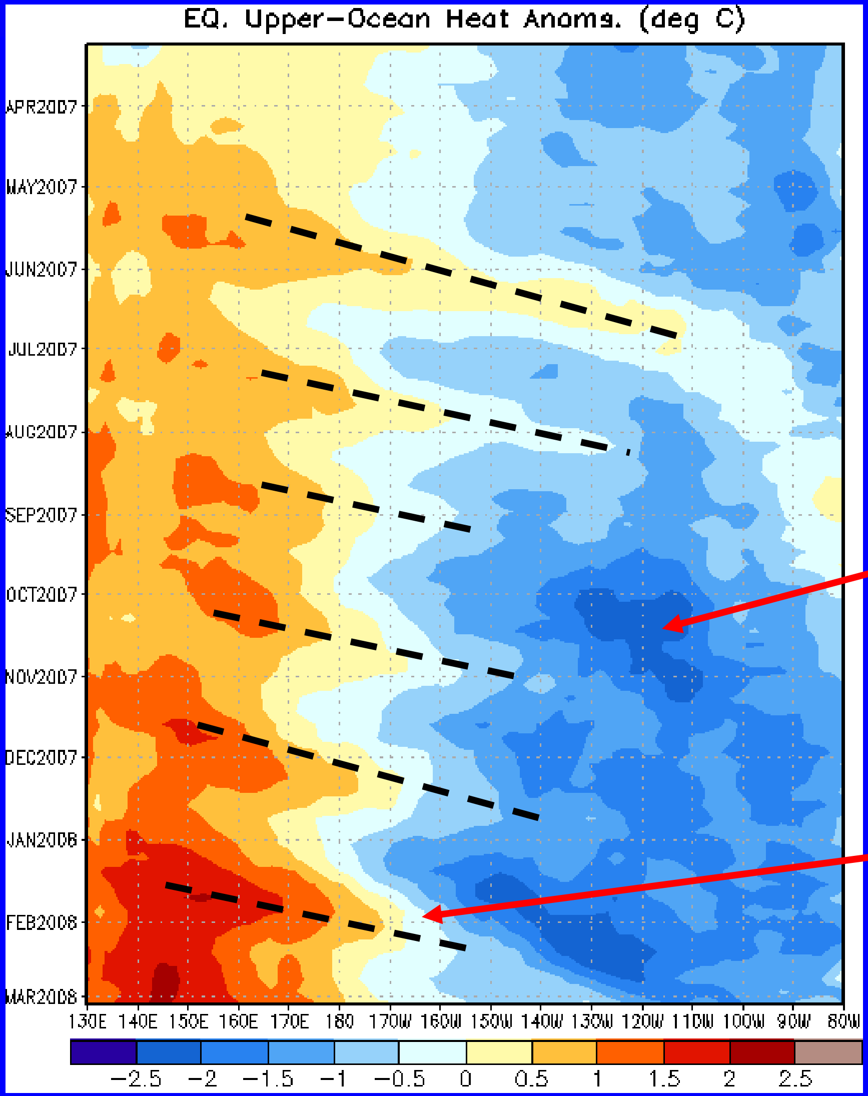
Cycle 1 of the MJO activity is evident in the upper-levels by eastward propagation of easterly anomalies globally from early November to mid-December.

MJO cycle 2 signal was somewhat weaker especially as it shifted across the central Pacific Ocean due to the strong La Nina.

Most recently, westerly anomalies have increased and remained generally stationary. Large easterly anomalies are also evident from 120W to 80W.

Weekly Heat Content Evolution in the Equatorial Pacific

Time



Longitude

Kelvin wave activity (downwelling phases indicated by dashed lines) has been observed since May and has affected the sub-surface temperature departures at varying degrees across the Pacific Ocean. The strongest wave occurred during May and June.

During September and October, negative heat content anomalies increased markedly across the eastern Pacific Ocean.

From late January into early February, increasingly positive anomalies developed across the western Pacific and shifted eastward associated with the latest downwelling Kelvin wave.

MJO Index -- Information

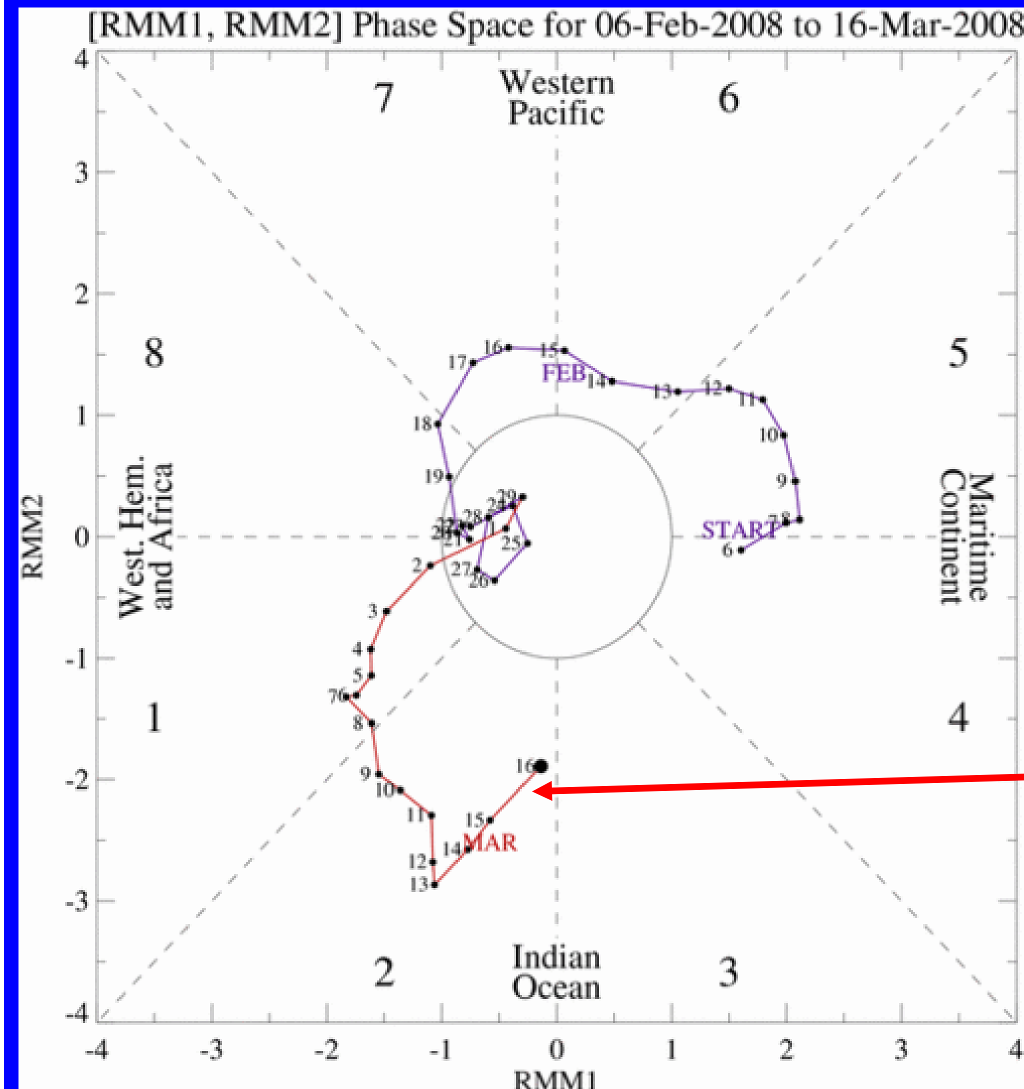
- The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).

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).

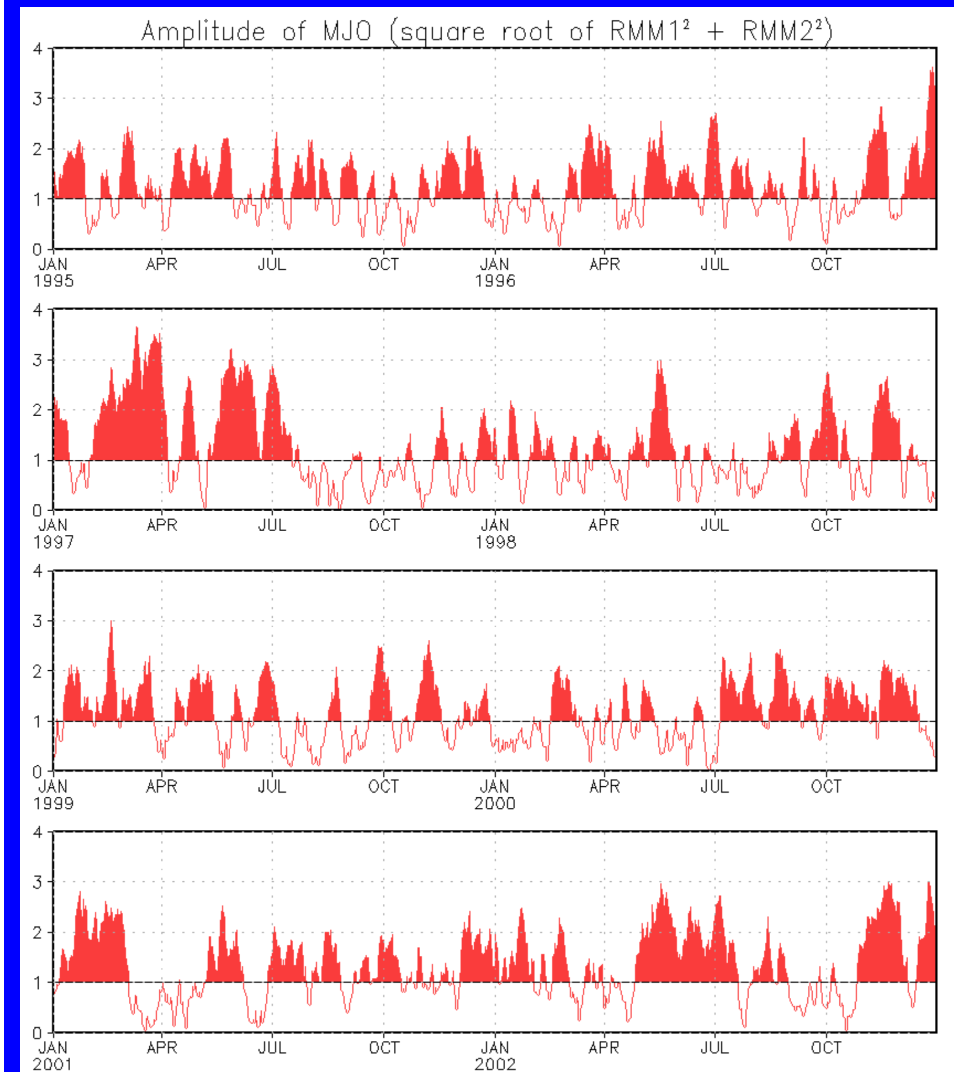
MJO Index -- Recent Evolution

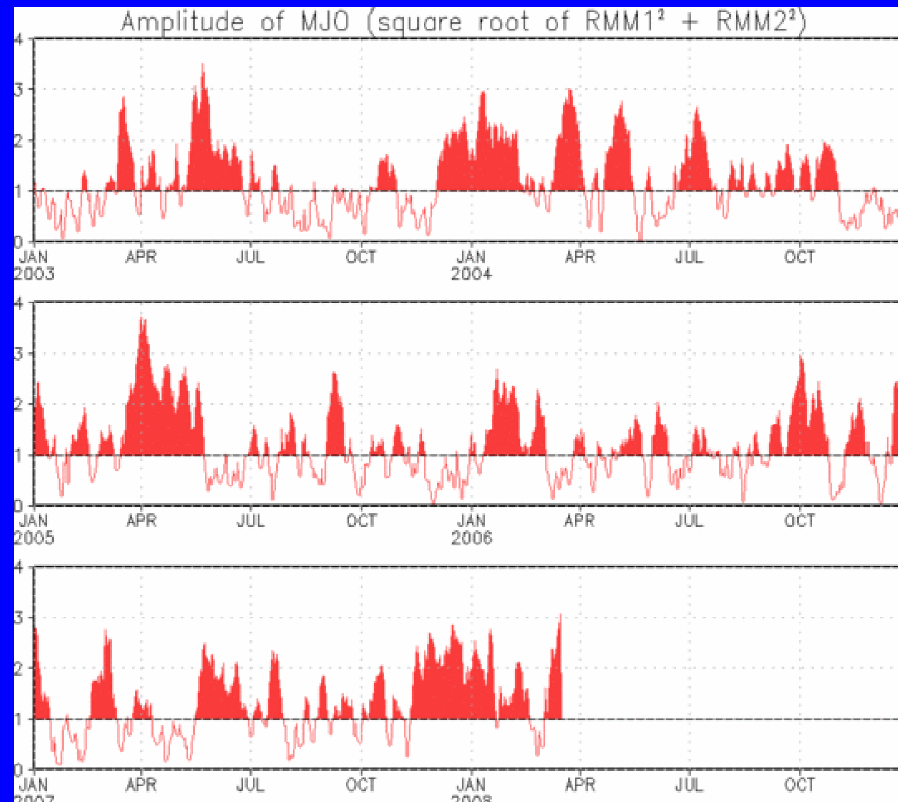


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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

According to the MJO index, the MJO signal has weakened during the past few days.

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 MJO Forecasts

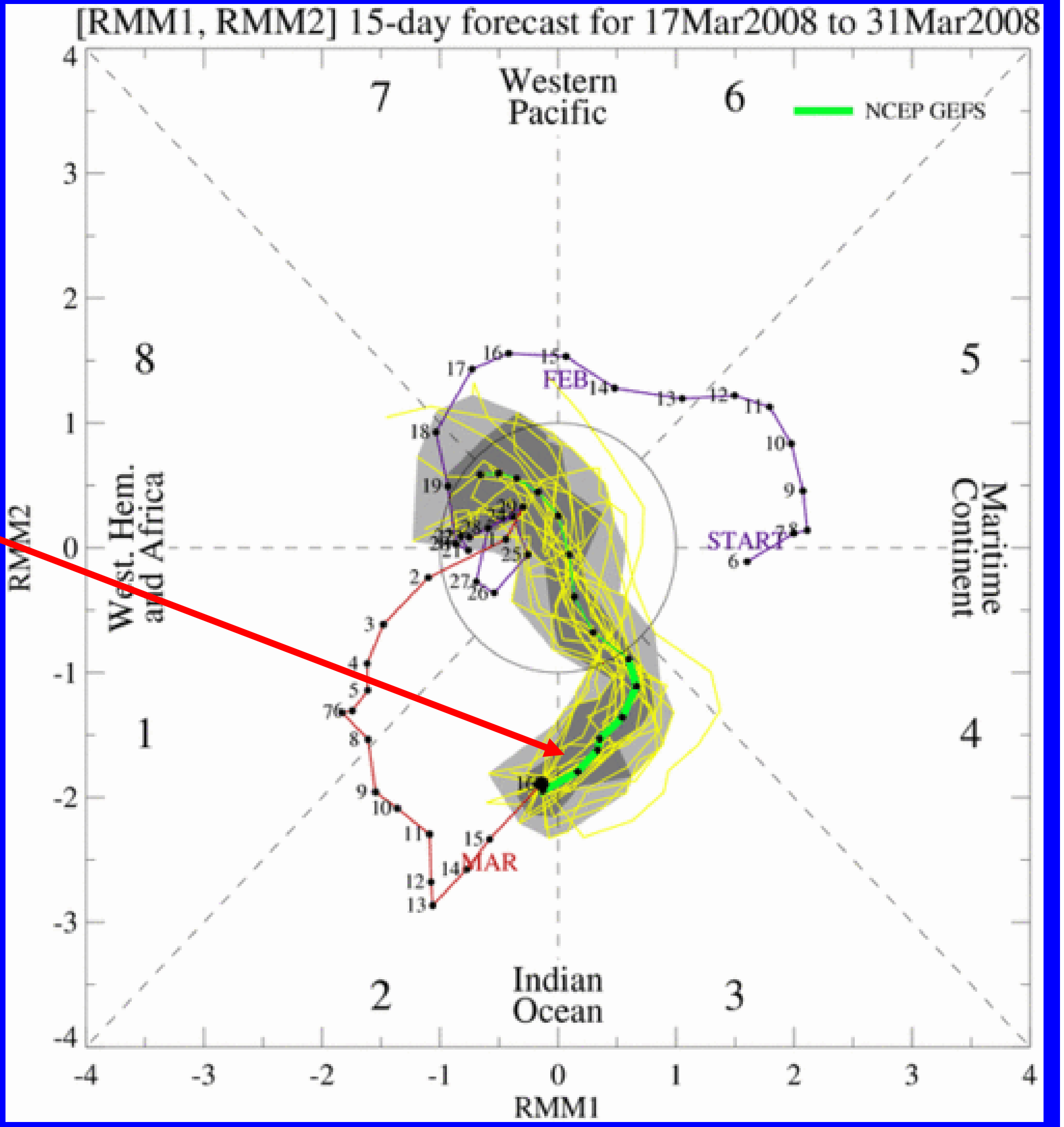
Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

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 ensemble mean predicts a weakening MJO signal as it approaches the western Maritime Continent.

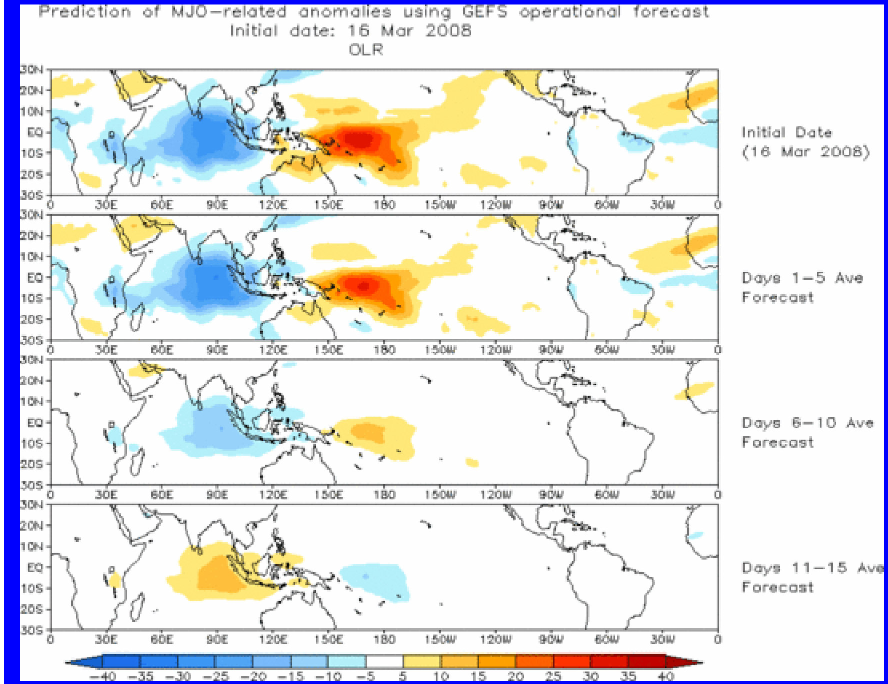
Uncertainty of the future evolution of the MJO is greater than in previous weeks.



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)

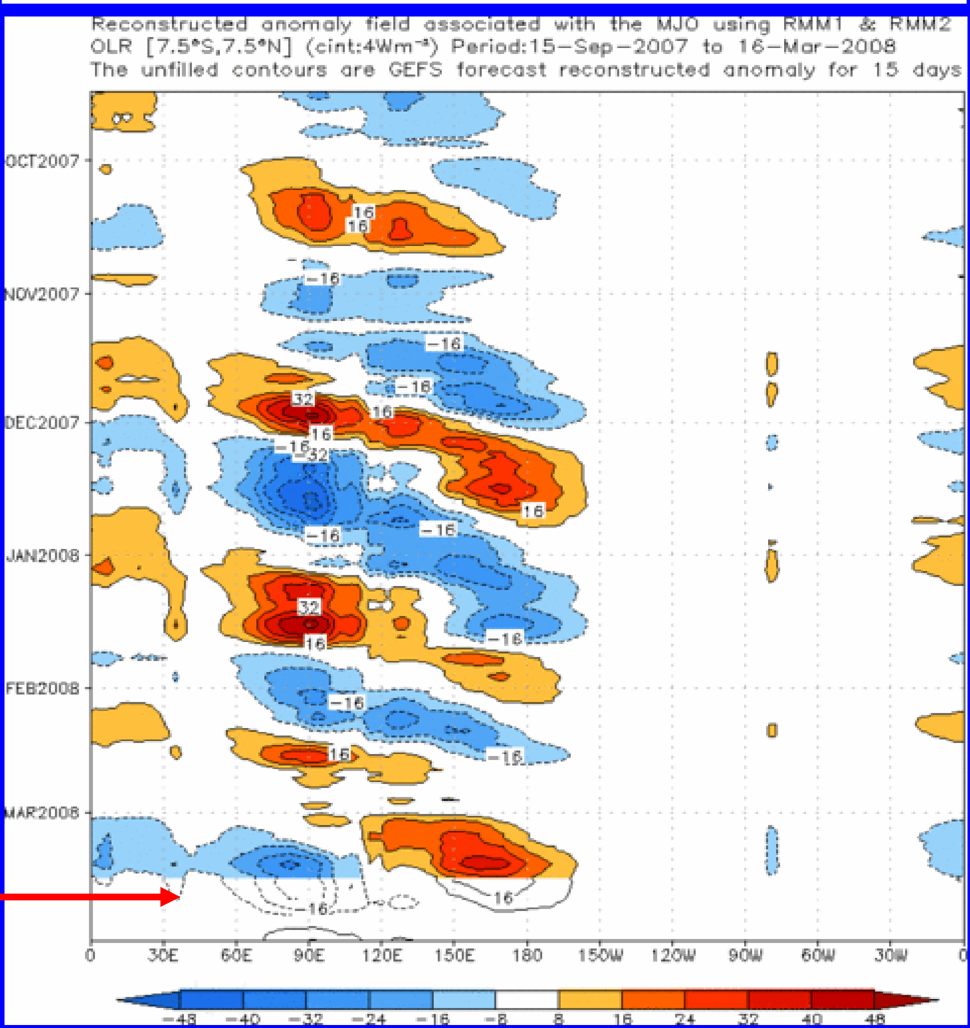
Spatial map of OLR anomalies for the next 15 days



Based on the GEFS forecast, enhanced convection will persist across the eastern Indian Ocean and western Maritime Continent before weakening.

Little or no eastward propagation is expected during week 1.

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



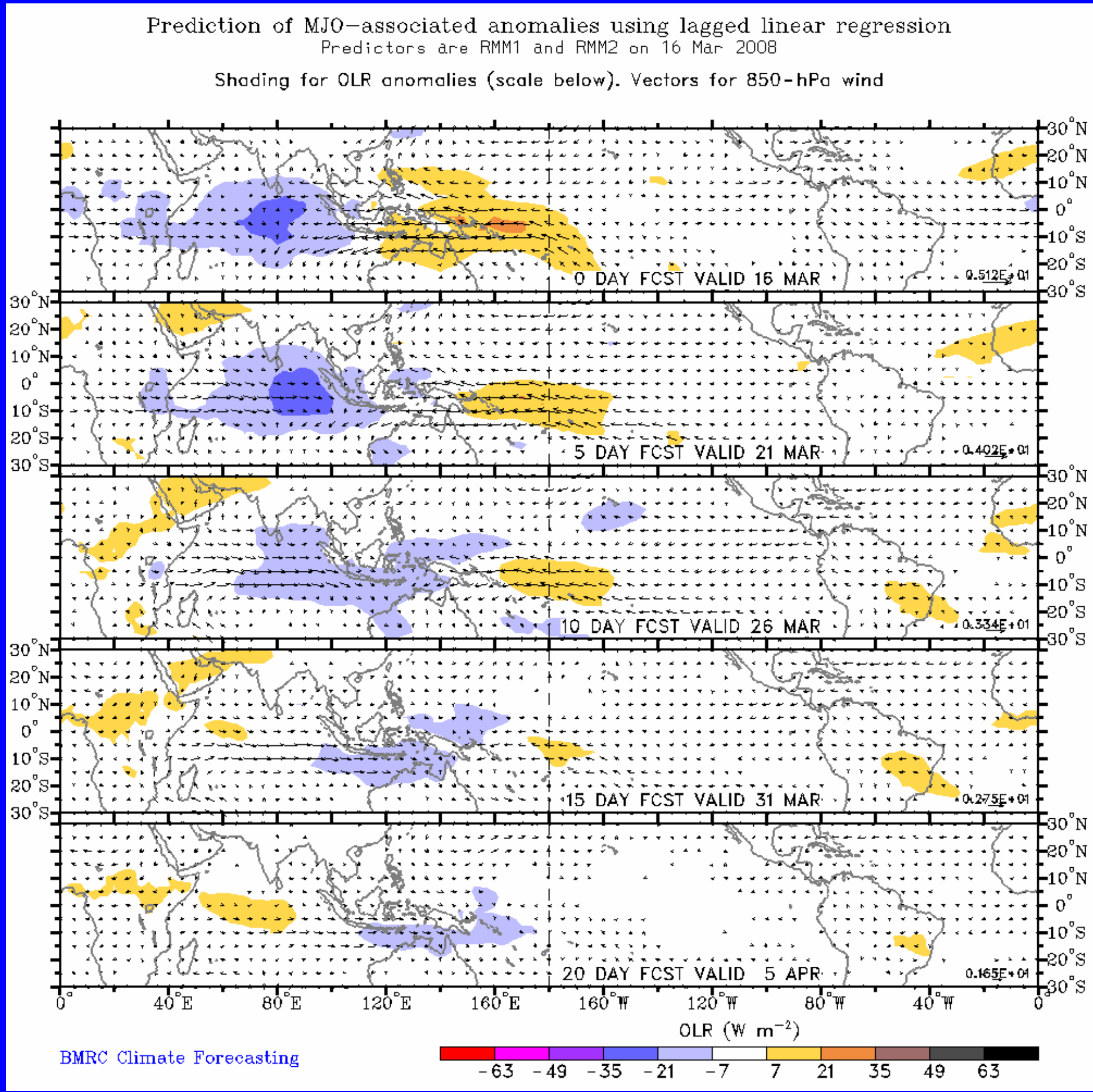
Statistical MJO Forecast

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

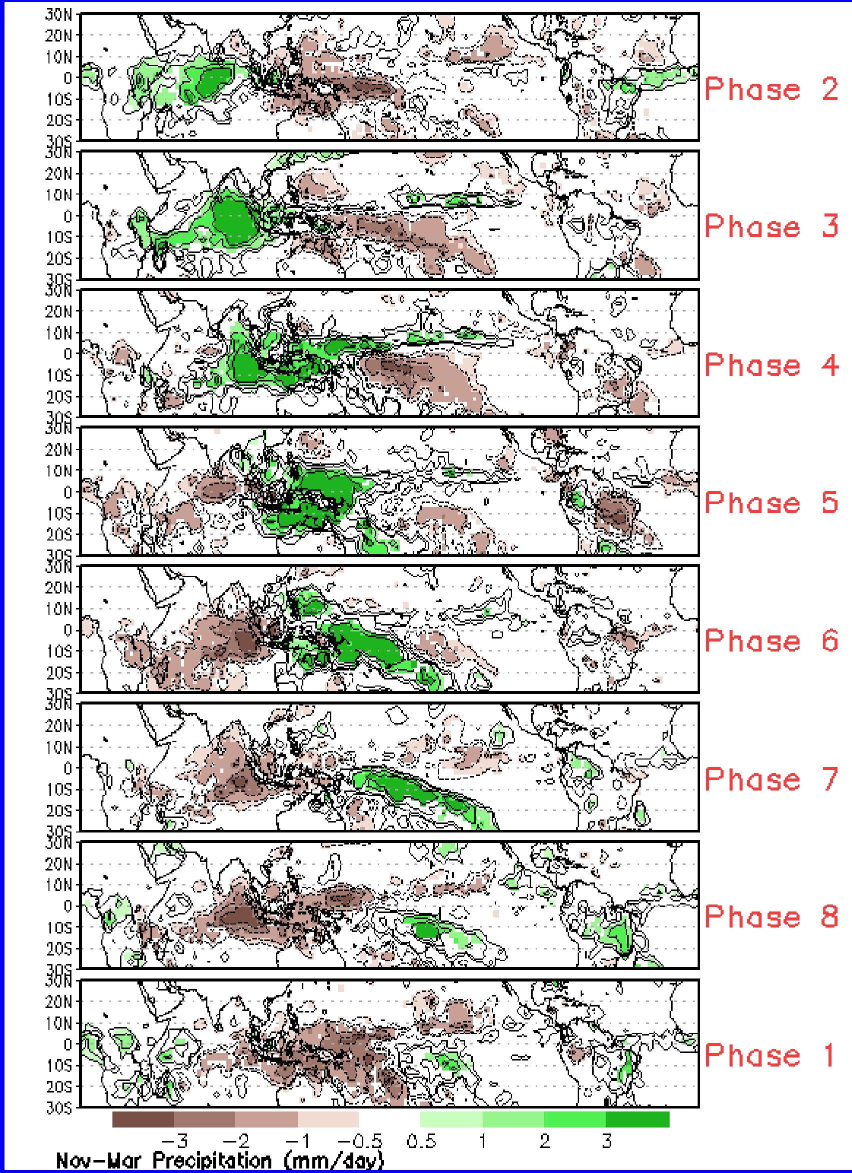
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical method forecasts a weak-moderate MJO signal with enhanced convection shifting from the Indian Ocean to the Maritime continent.



MJO Composites – Global Tropics

Precipitation Anomalies



850-hPa Wind Anomalies