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

Update prepared by
Climate Prediction Center / NCEP
April 14, 2008

Outline

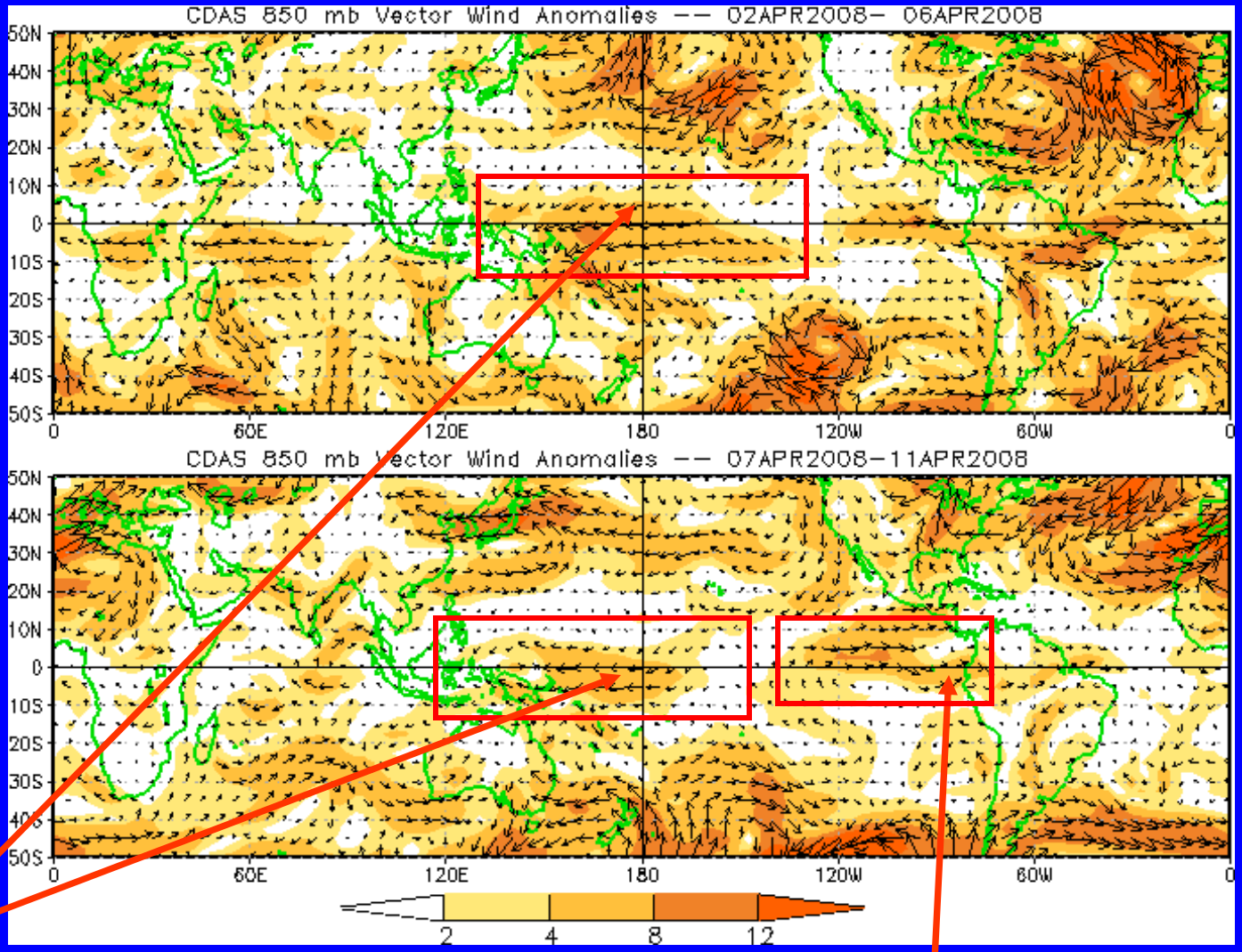
- Overview
- Recent Evolution and Current Conditions
- MJO Index Information
- MJO Index Forecasts
- MJO Composites

Overview

- The MJO has further weakened with the convectively enhanced phase located across Africa and the western Indian Ocean.
- Weak MJO activity is expected to continue during the next 1-2 weeks.
- Although weak, the MJO in part may contribute to enhanced tropical rainfall across eastern equatorial Africa and the western Indian Ocean during week 1 and later the eastern Indian Ocean during week 2.

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

Note that shading denotes the magnitude of anomalous wind vectors



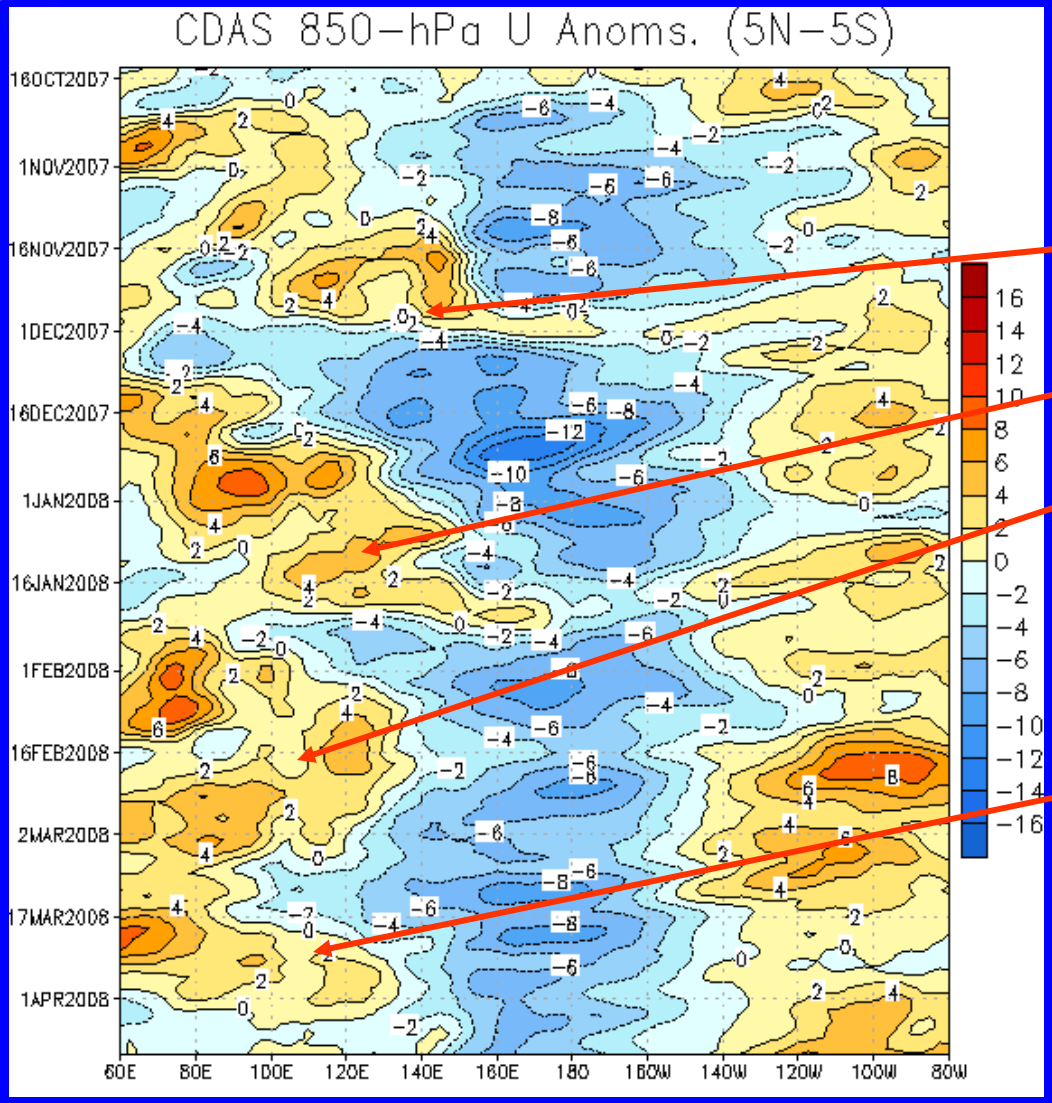
Easterly anomalies remain across the western Pacific but have decreased in extent and are slightly weaker during the last five days.

Westerly anomalies continue across parts of 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

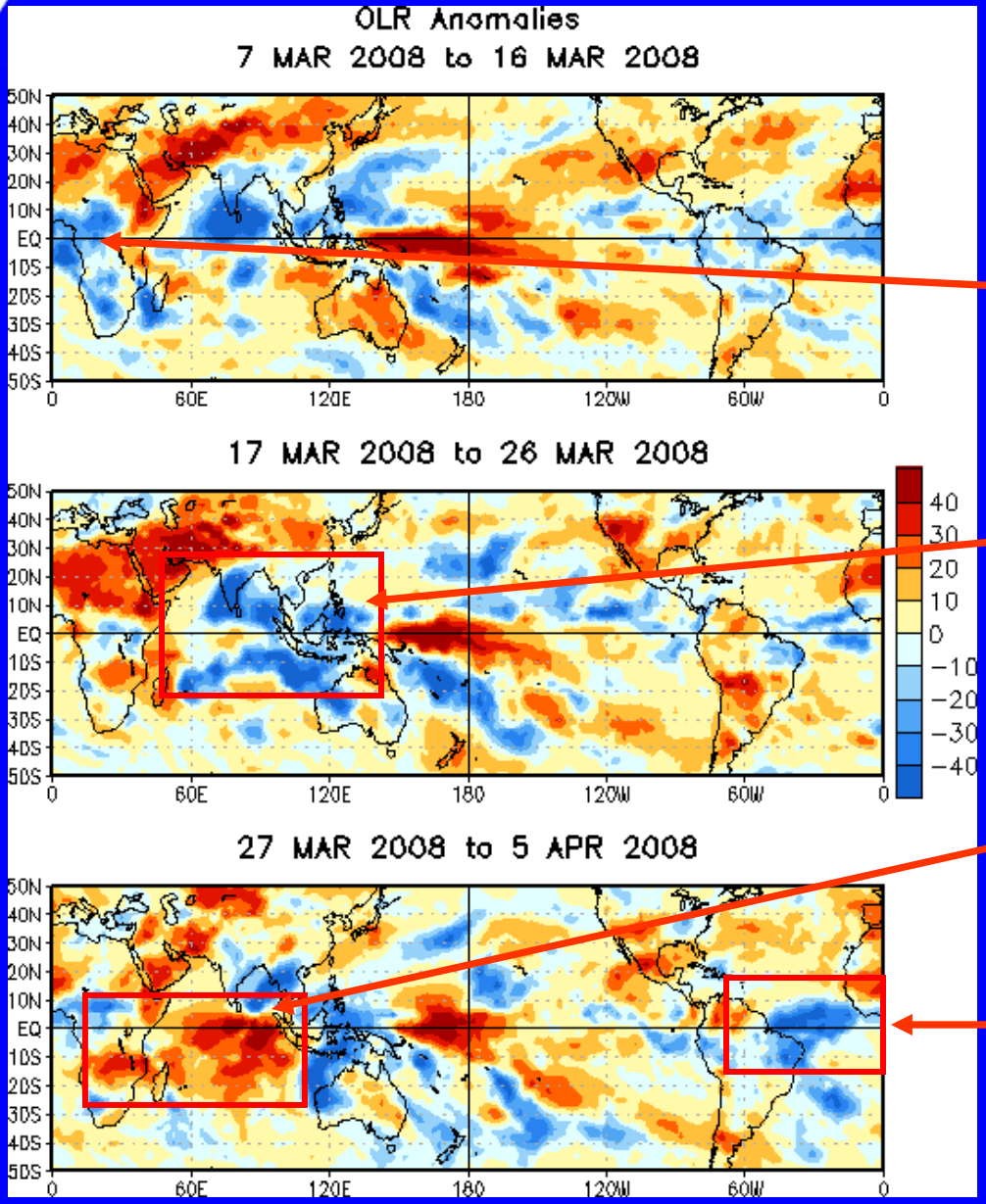
Longitude

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.

In late March, westerly anomalies shifted eastward to Indonesia but recently winds are near average in this region.

In early April, westerly anomalies in the far eastern Pacific increased while easterly anomalies continue near the Date Line.

OLR Anomalies: Last 30 days



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

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

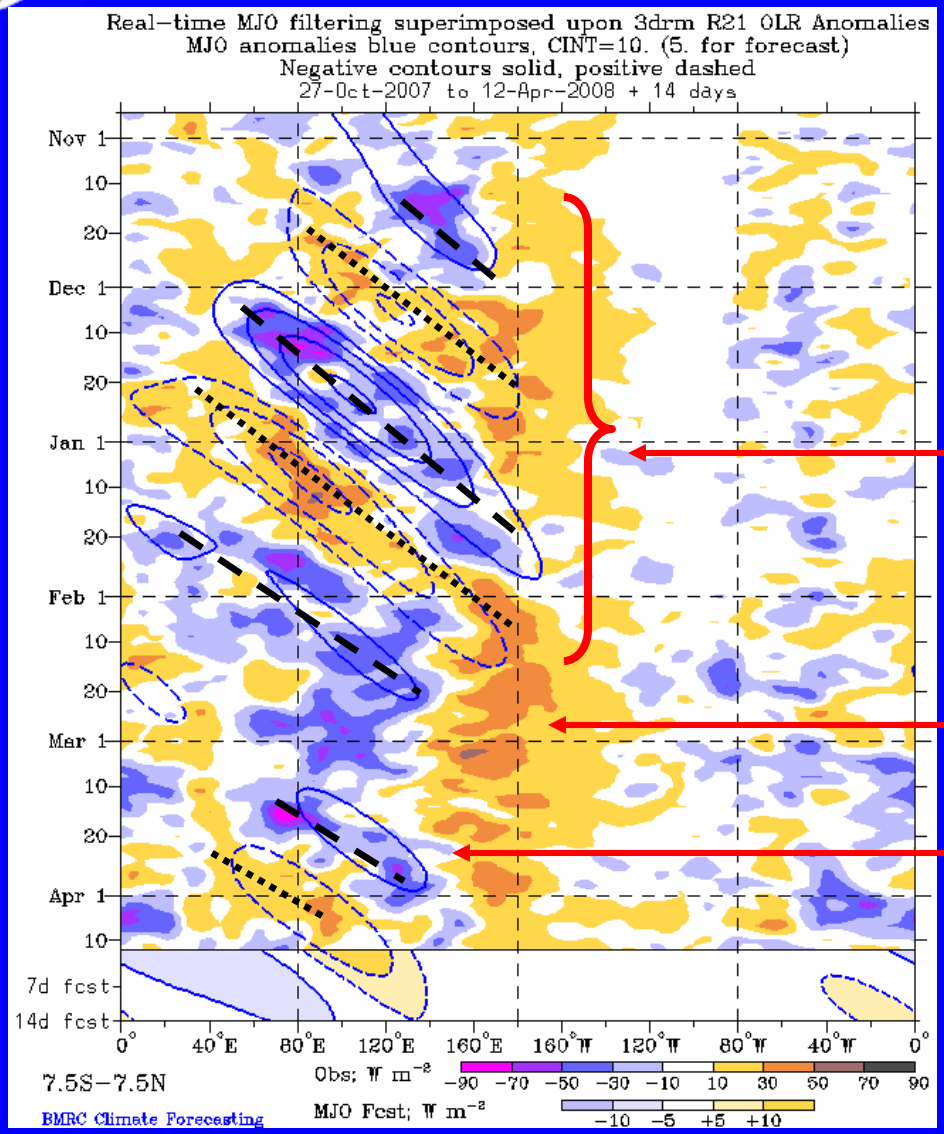
Enhanced convection was evident across the equatorial Atlantic and Africa during early-mid April.

In part associated with the MJO, enhanced convection rapidly shifted eastward to the Maritime continent.

Dry conditions were observed across parts of the Indian Ocean during late March and early April.

Wet conditions continue across portions of the Atlantic Ocean, South America, and Africa.

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



Time

Longitude

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.

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

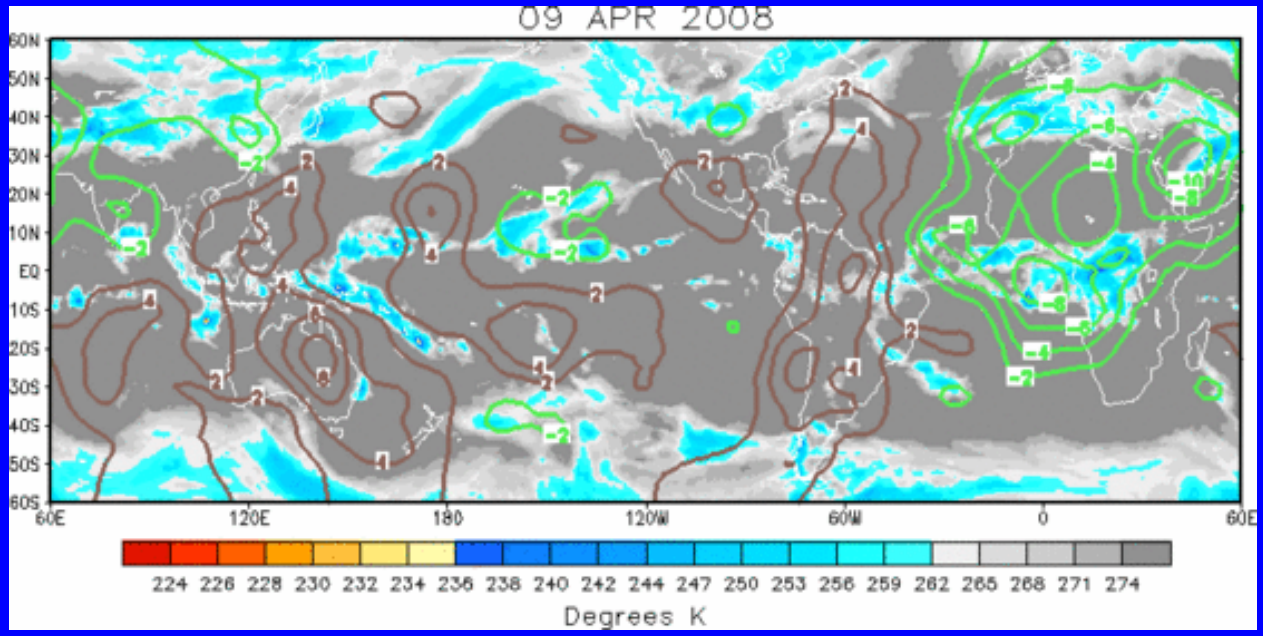
Weak MJO activity was evident during mid-late March as enhanced convection shifted east across the Indian Ocean.

Anomalous convection is small during the past several days.

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



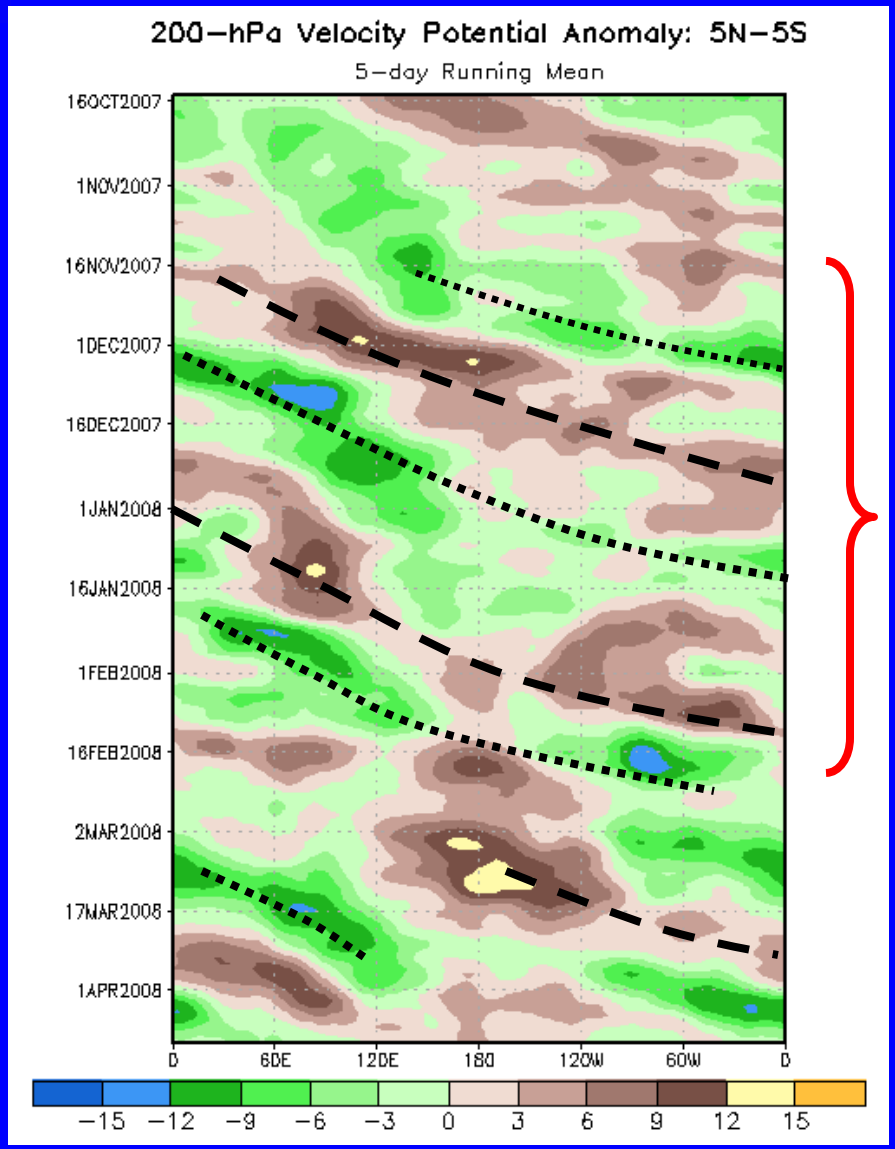
The velocity potential anomaly pattern has become less coherent during the past week.

As of April 09th, upper-level divergence (convergence) mainly remains across Africa (Indonesia).

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

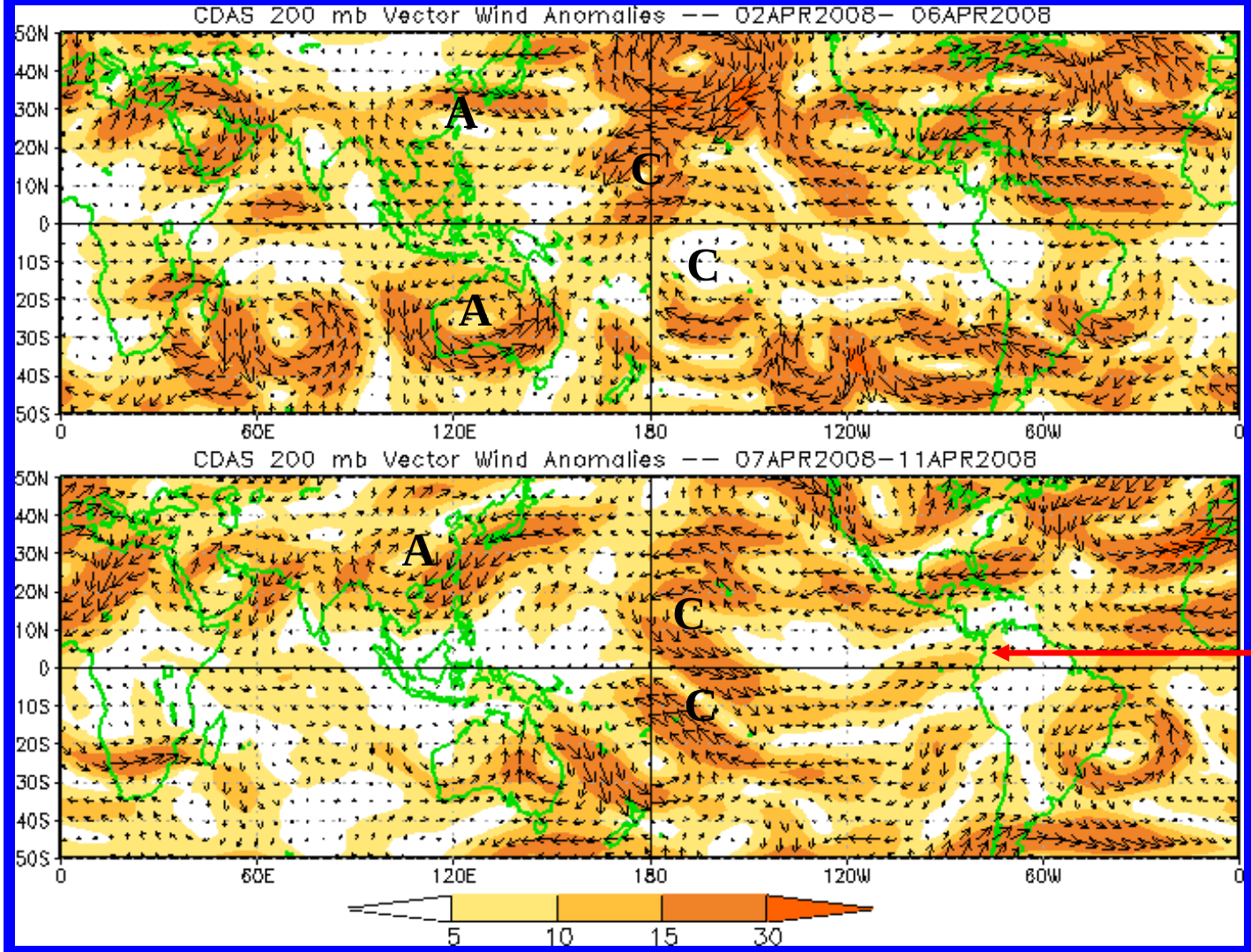


Moderate-to-strong MJO activity developed in mid-November and continued into mid-February.

The MJO weakened during the second half of February.

During March, velocity potential anomalies increased and some eastward propagation was evident but recently the MJO has again weakened.

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



Note that shading denotes the magnitude of anomalous wind vectors

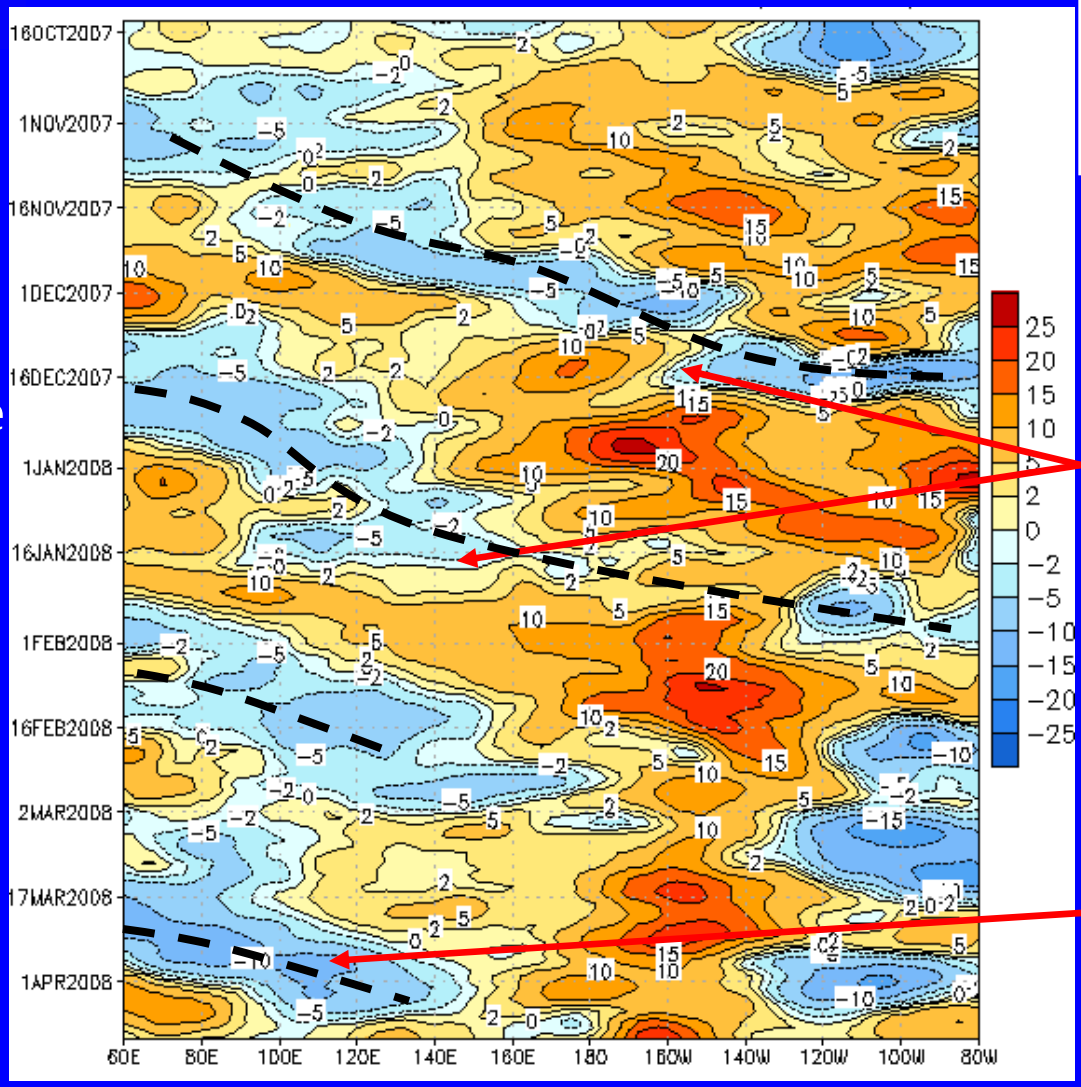
Well defined cyclonic circulations (C) and anti-cyclonic (A) circulations are evident early in April near the Date Line and in the eastern hemisphere.

Westerly anomalies are more clear across the central and eastern Pacific 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



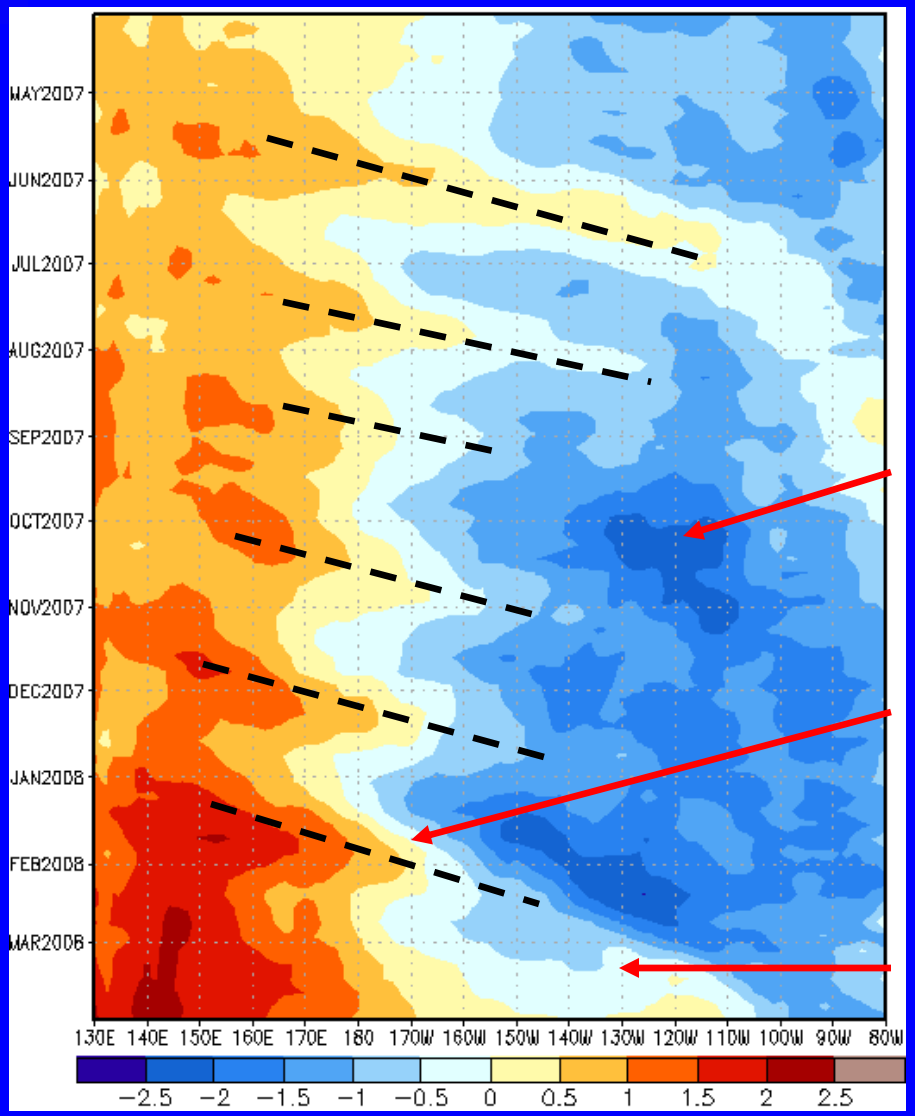
Time

Longitude

MJO activity is evident in the upper-levels by eastward propagation of easterly anomalies (dashed lines) globally from early November to mid-February.

During March, easterly anomalies propagated quickly eastward from the western hemisphere to the Maritime continent region.

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.

Negative anomalies have decreased during the last few weeks across the central Pacific.

MJO Index -- Information

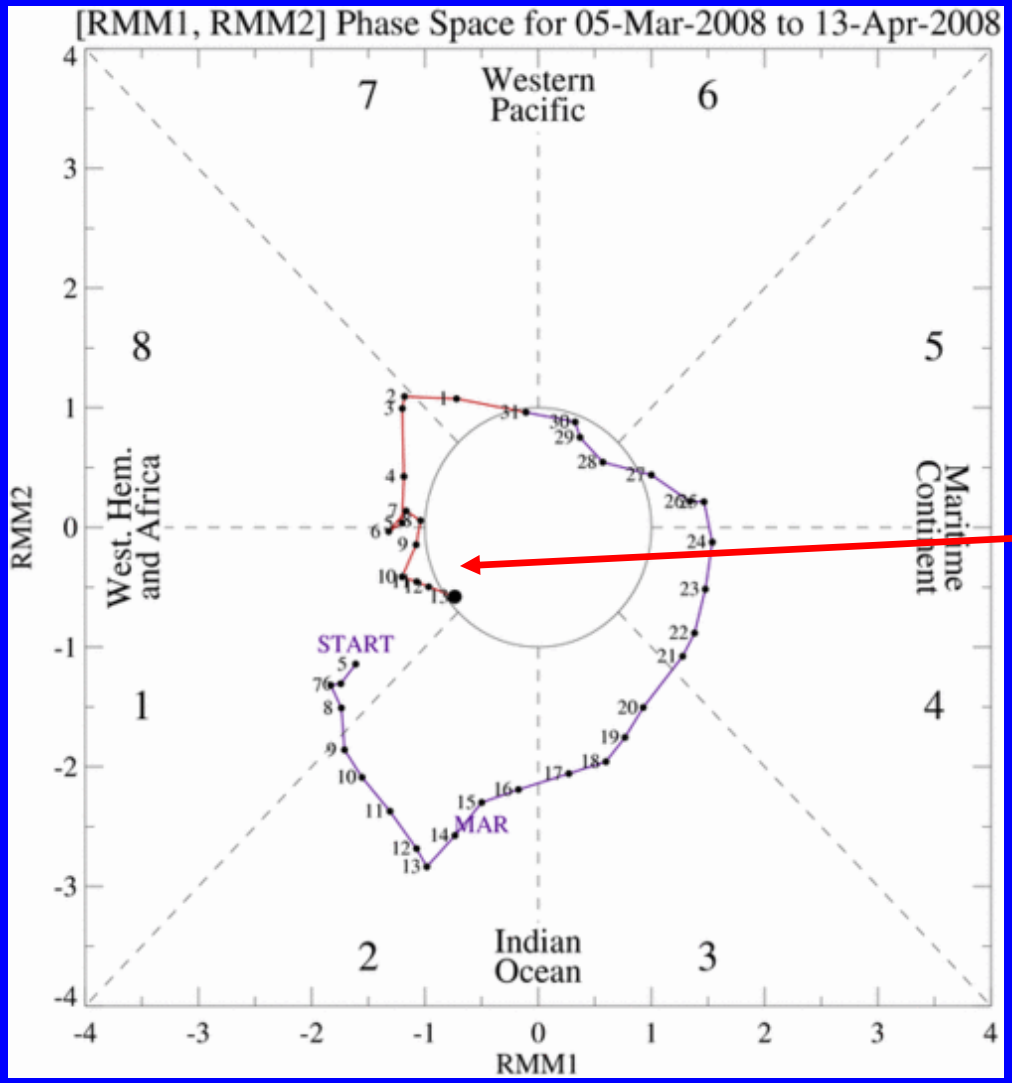
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

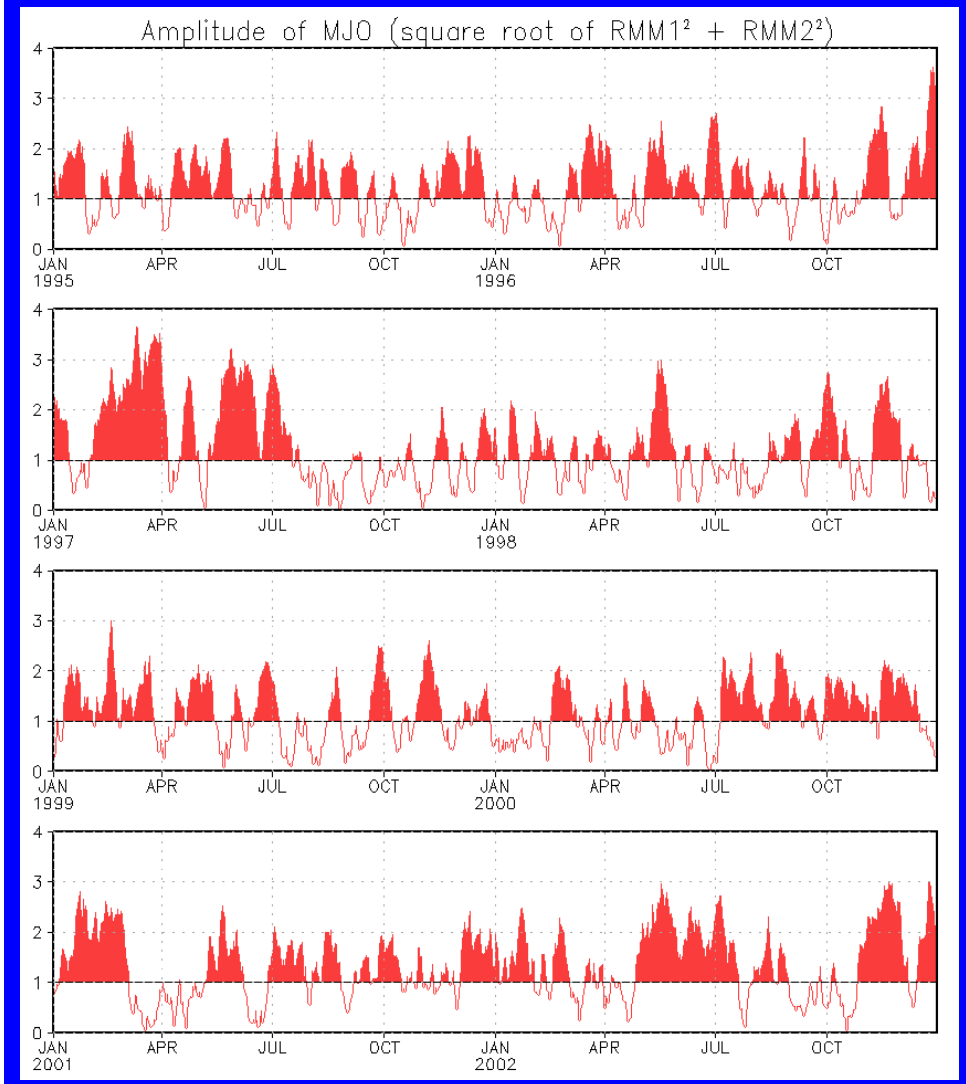
MJO Index -- Recent Evolution

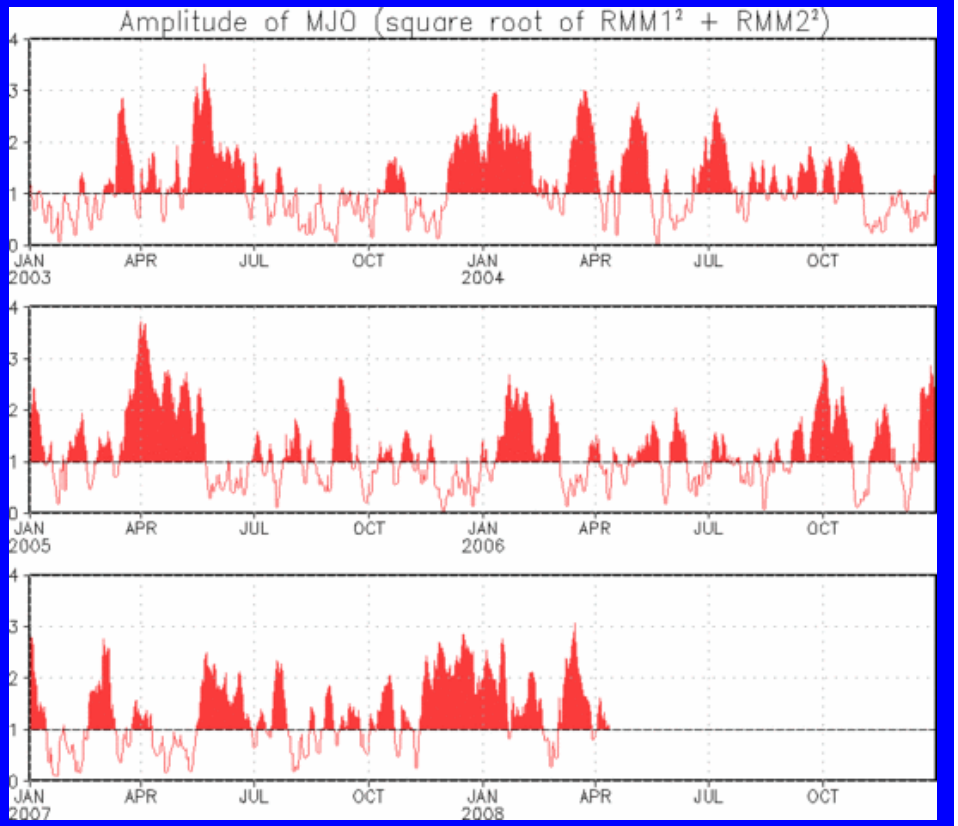


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation**
- **Distance from the origin is proportional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

The MJO signal has remained generally weak during the past week with a slight 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 MJO Forecasts

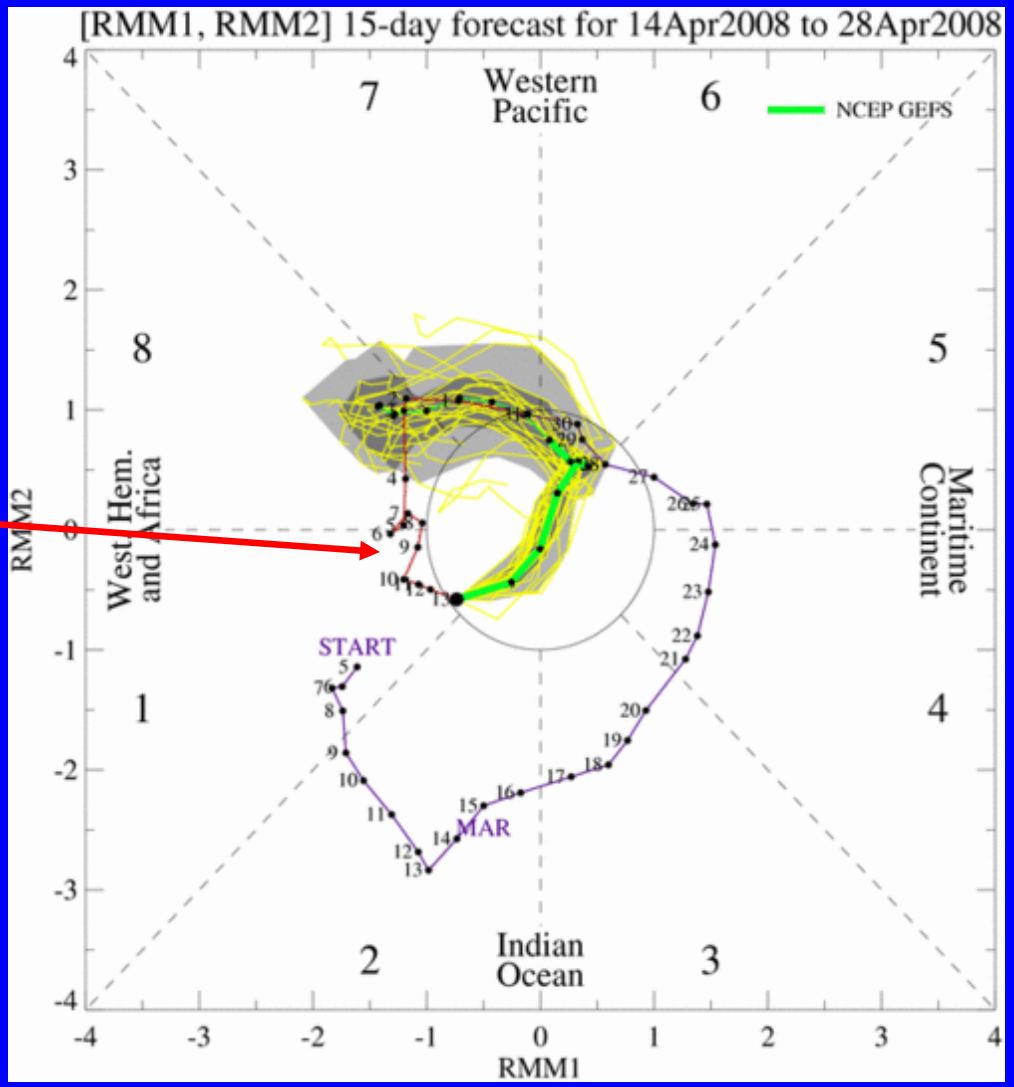
Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

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 predicts further weakening of the MJO signal during the week 1.

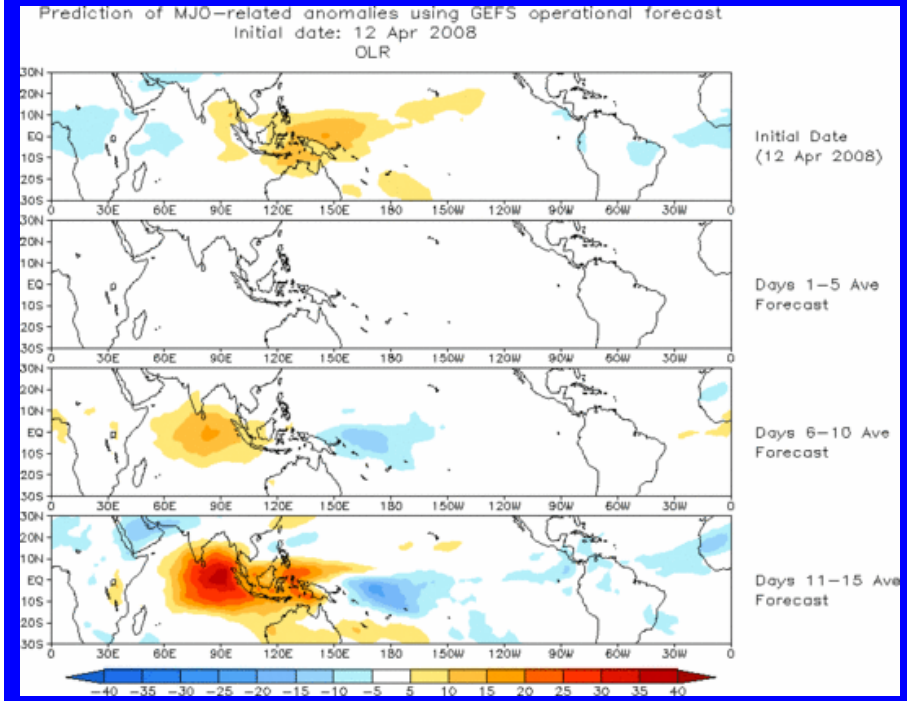
Considerable uncertainty exists for the future evolution of the MJO during the next 1-2 weeks.



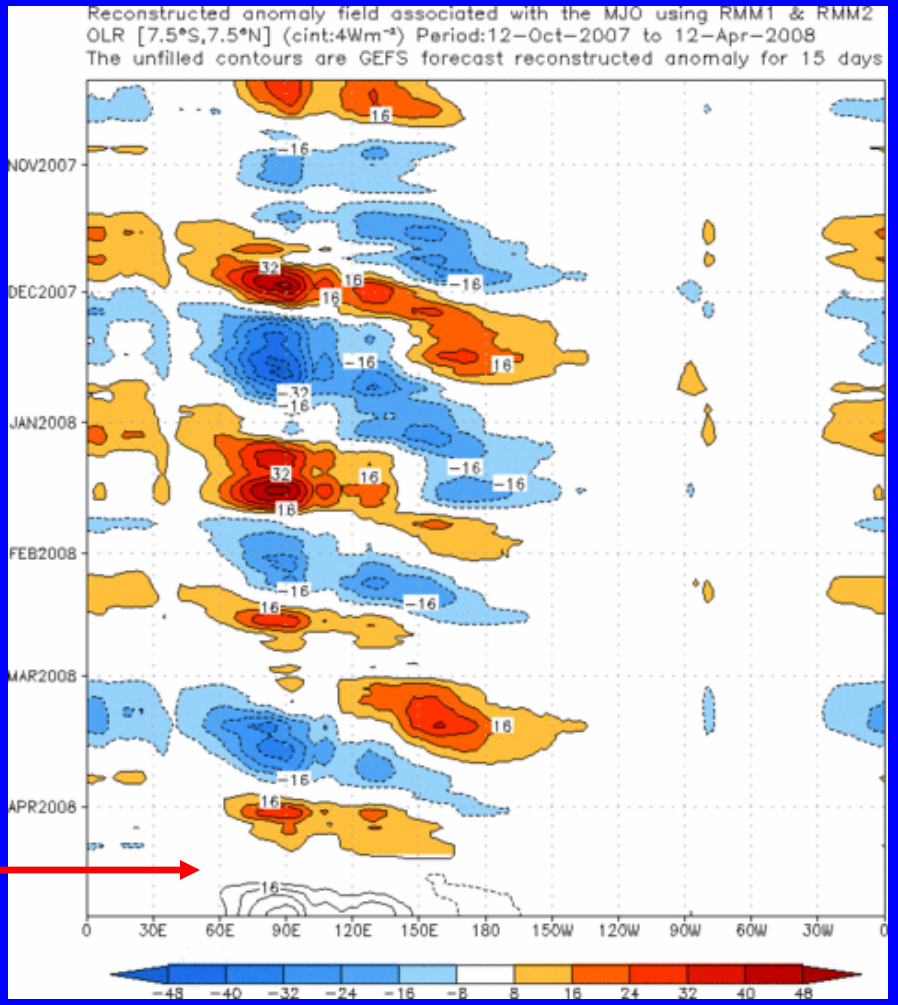
Ensemble Mean GFS MJO Forecast

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



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



MJO-related suppressed convection is forecast over portions of the Indian Ocean and Maritime continent later during the period.

Little propagation is evident.

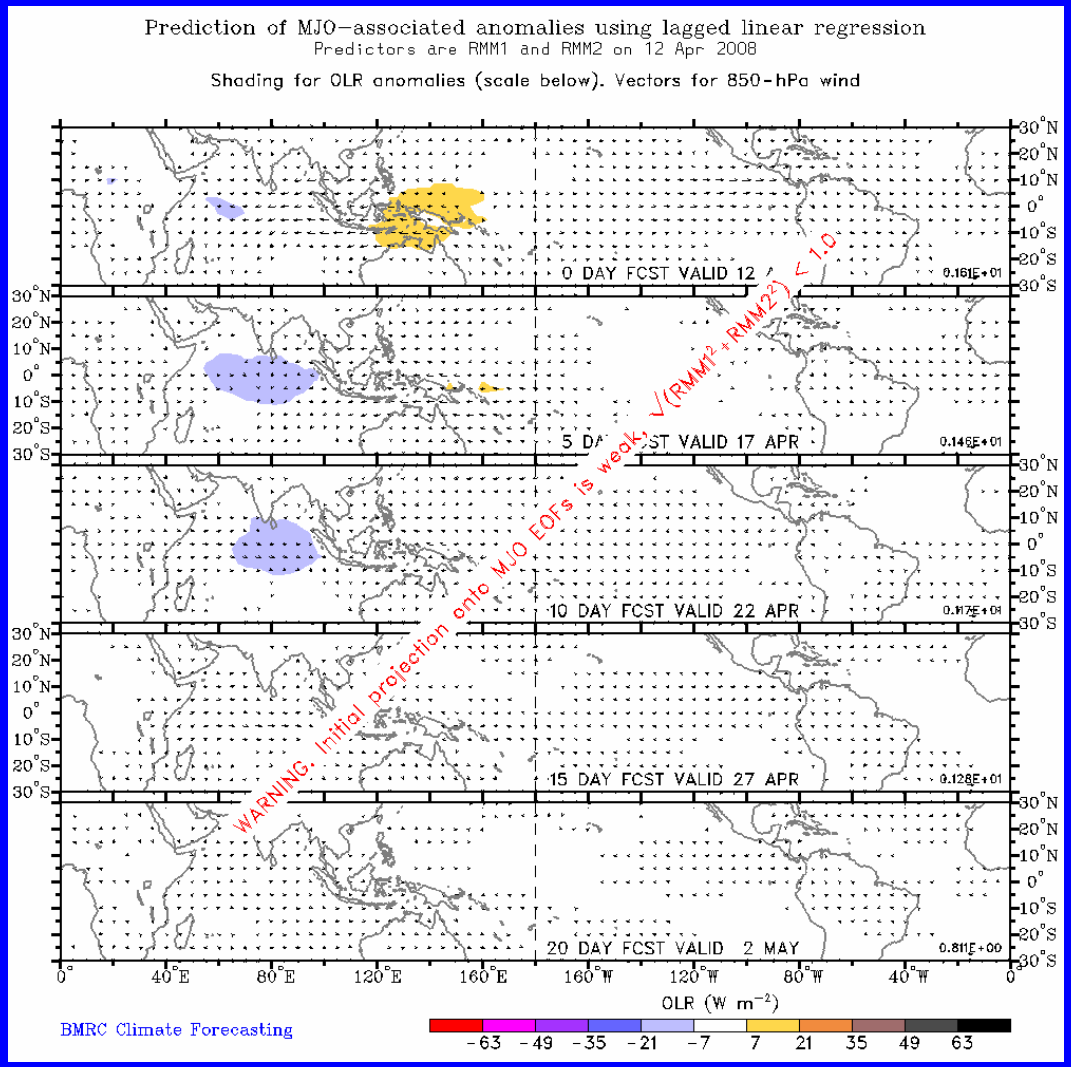
Statistical MJO Forecast

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

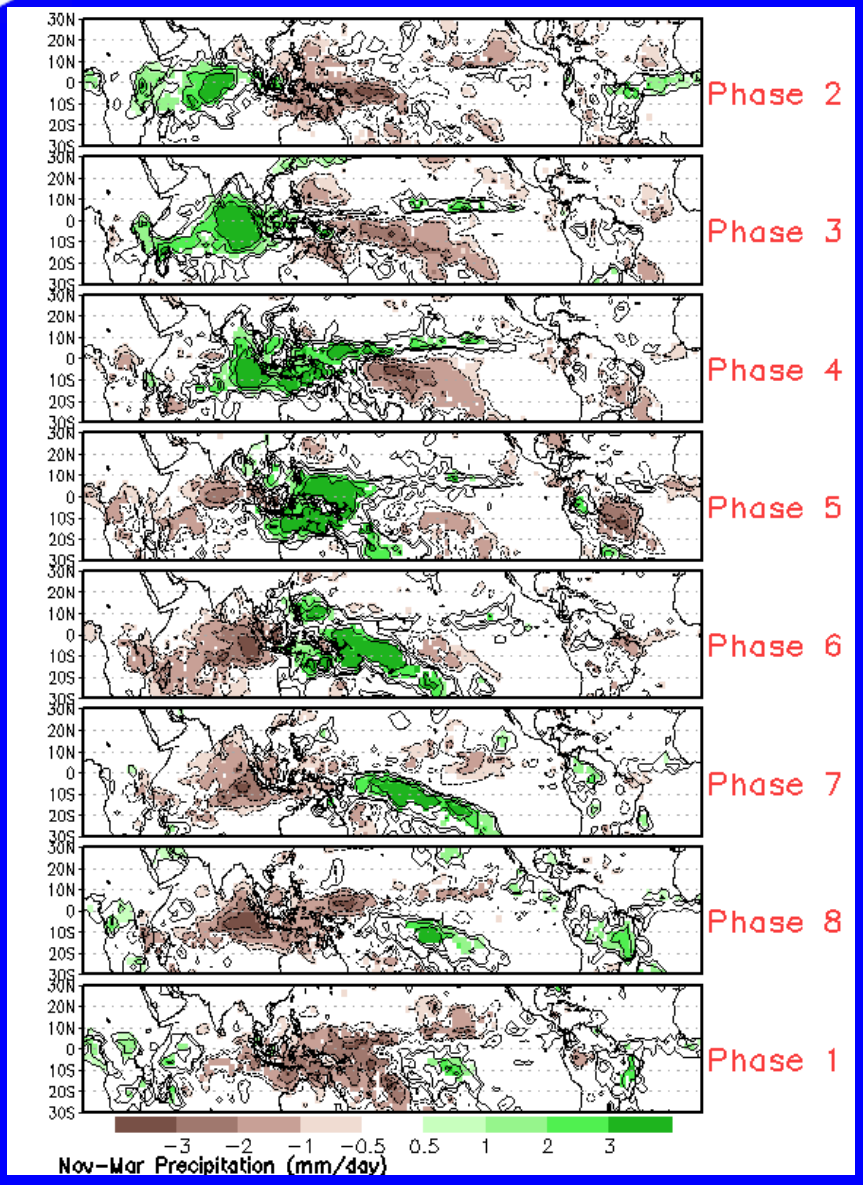
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical method forecasts weak enhanced convection across the Indian Ocean during the next week.



MJO Composites – Global Tropics

Precipitation Anomalies



850-hPa Wind Anomalies