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

Update prepared by
Climate Prediction Center / NCEP
April 28, 2008

Outline

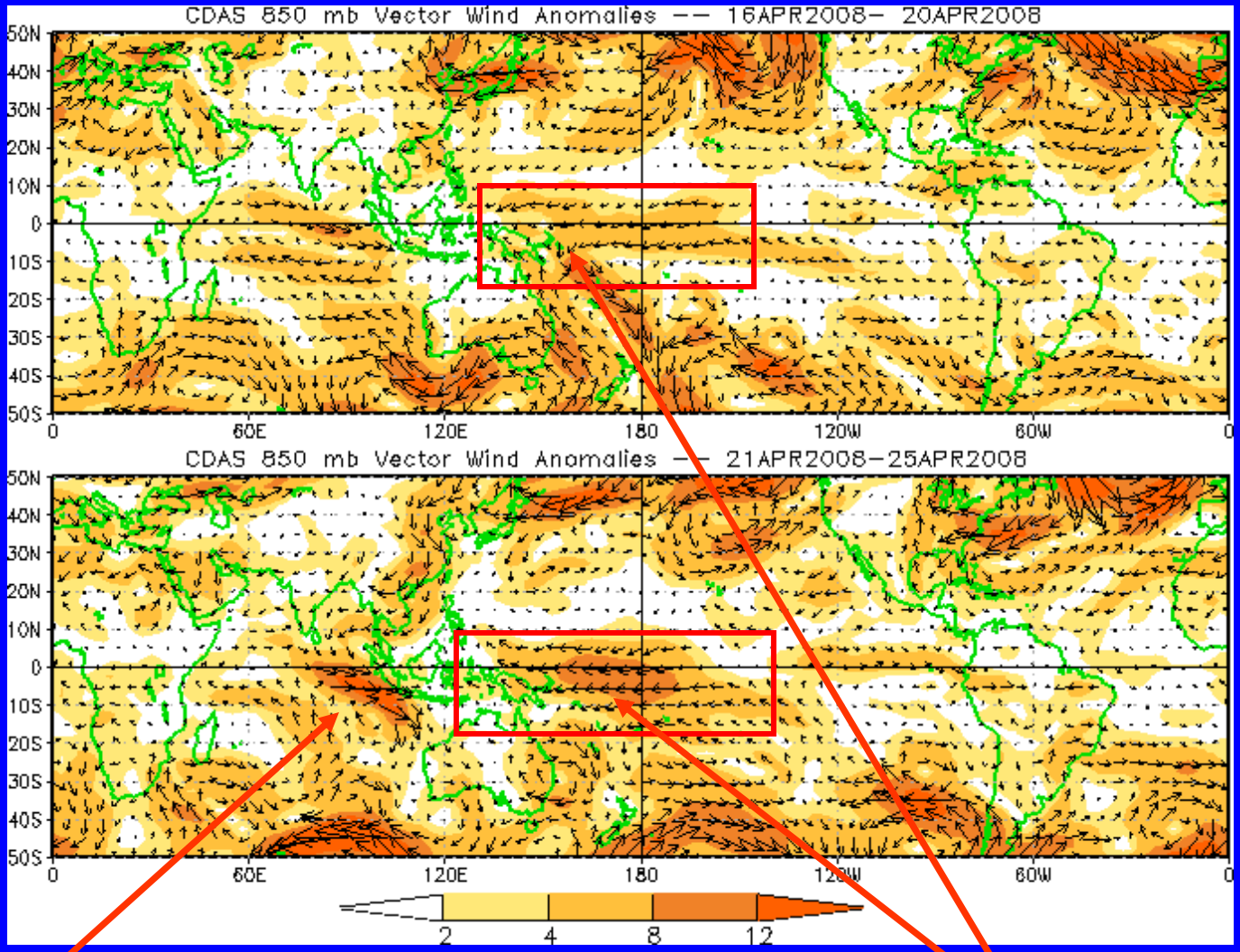
- Overview
- Recent Evolution and Current Conditions
- MJO Index Information
- MJO Index Forecasts
- MJO Composites

Overview

- **The MJO signal has become generally incoherent over the last few weeks.**
- **Continued incoherent or weak MJO activity is expected during the next 1-2 weeks.**
- **At this time, it is not expected that the MJO will contribute largely to the patterns of tropical rainfall during the period.**

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

Note that shading denotes the magnitude of anomalous wind vectors



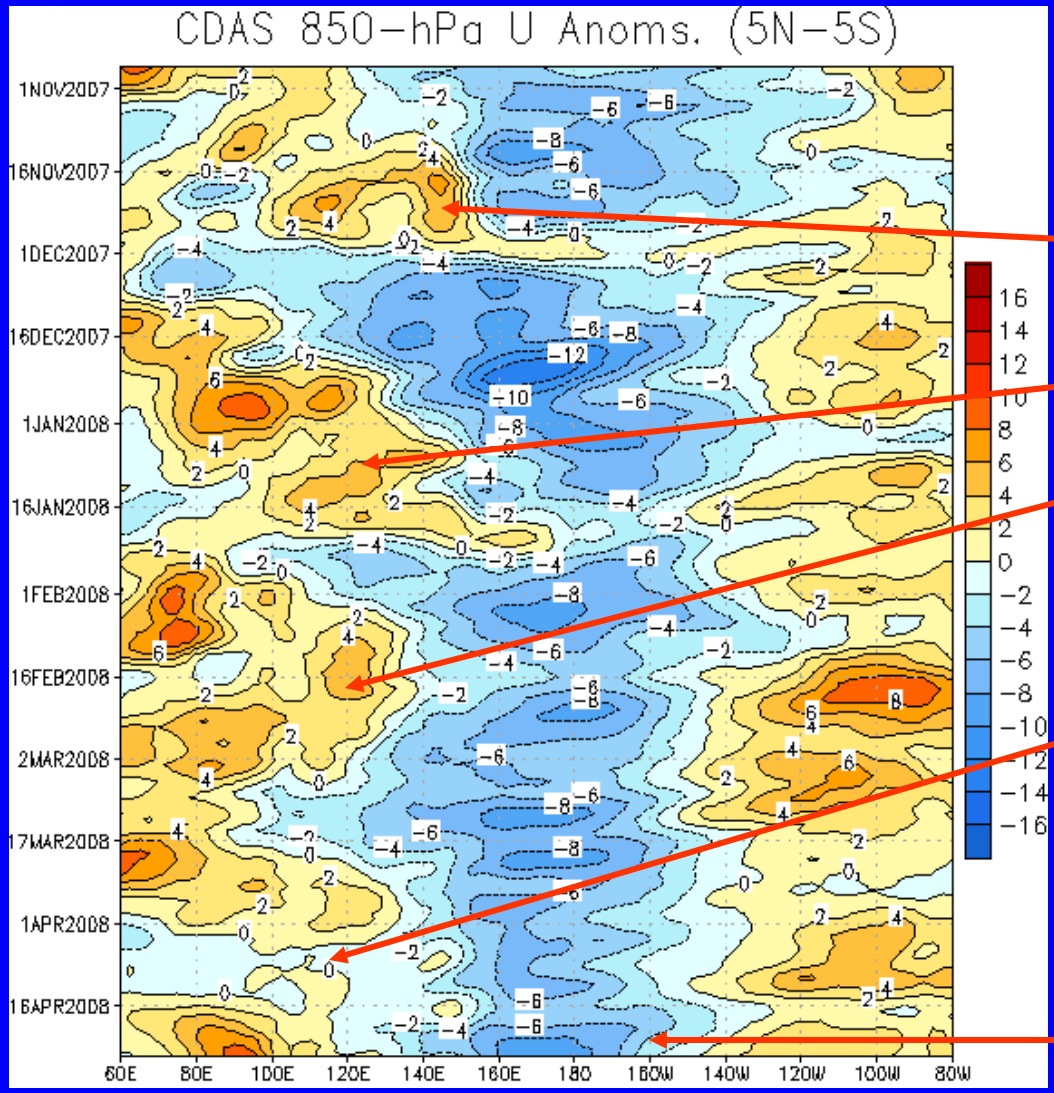
Westerly anomalies across the eastern Indian Ocean have developed during the last 5-10 days.

Easterly anomalies continue across the western 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

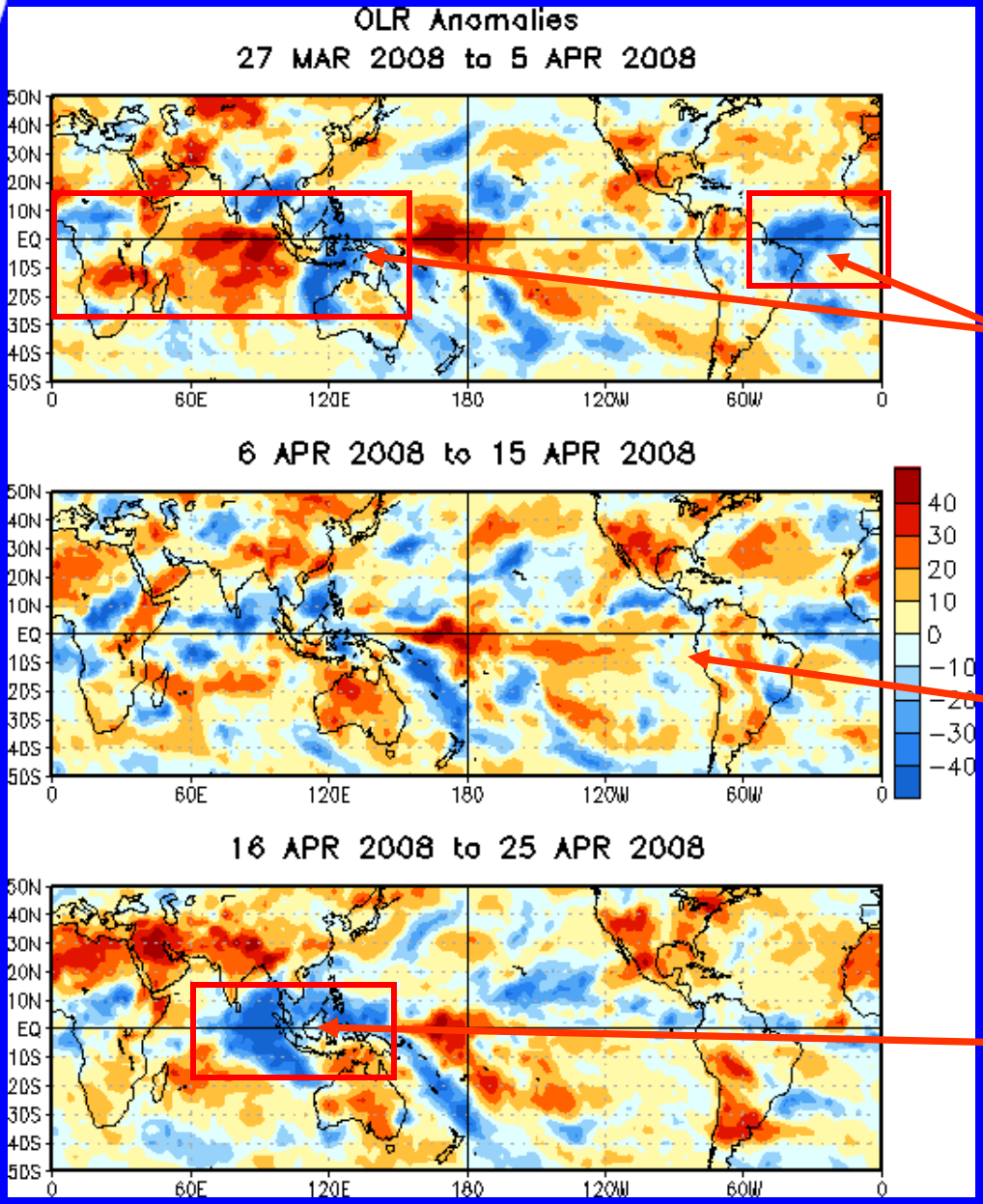
Longitude

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.

During early April, winds across the Indian Ocean and Indonesia were near average.

Recently, westerly anomalies have developed in the Indian Ocean but have shown little propagation. Easterly anomalies in the Pacific continue and have extended westward.

OLR Anomalies: Last 30 days



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

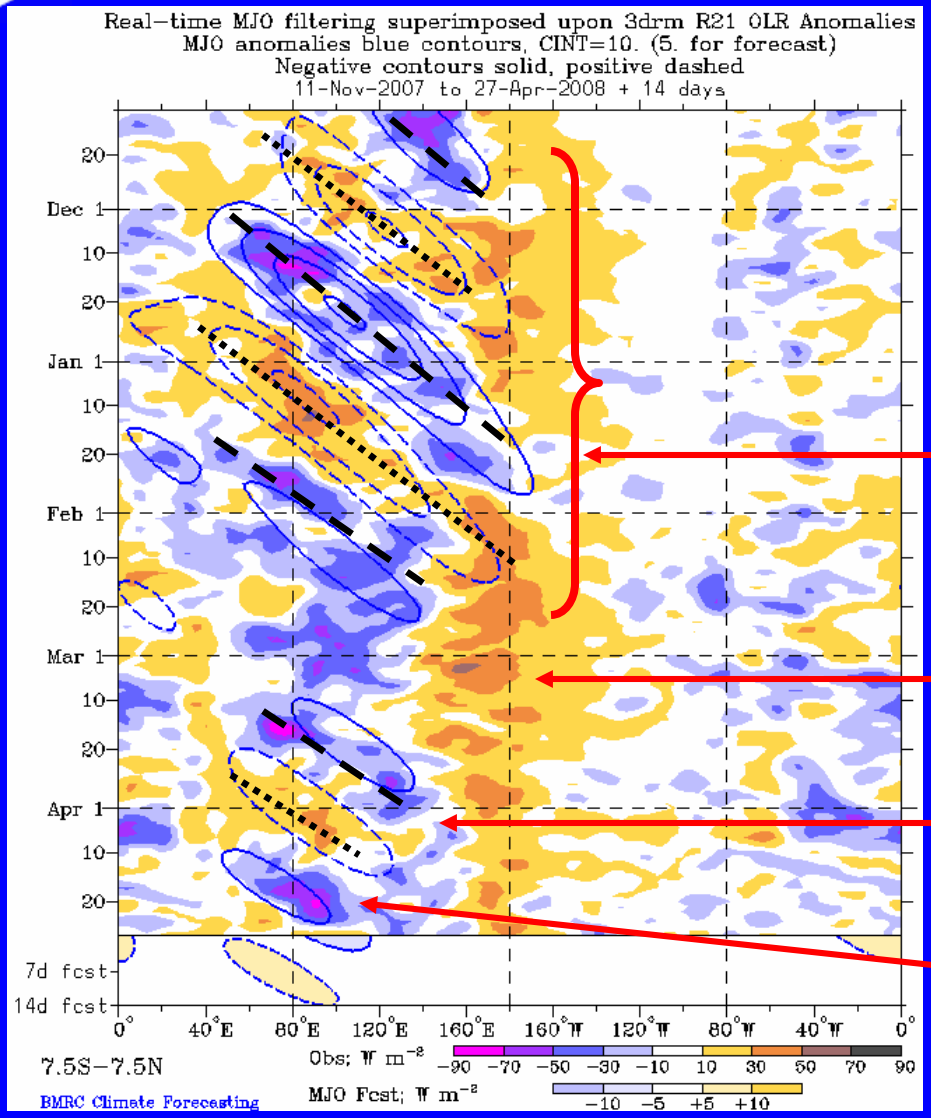
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

During late March and early April, dry conditions were observed across parts of eastern Africa and the Indian Ocean while wet conditions were evident across portions of the Atlantic Ocean, South America, Africa and Indonesia.

Tropical convection became less organized during early-mid April.

More widespread enhanced convection developed across the eastern Indian Ocean and Indonesia regions.

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.

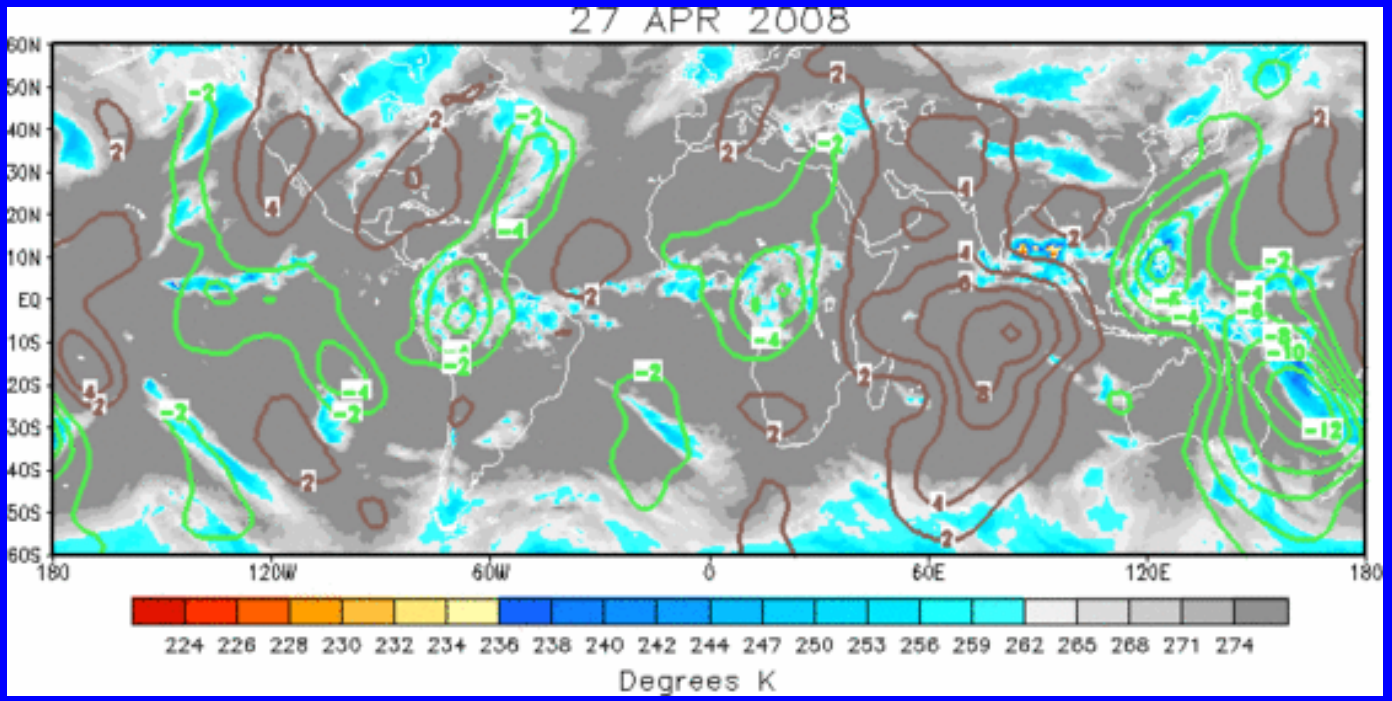
Weak MJO activity was evident during mid-late March as enhanced convection shifted east across the Indian Ocean.

Convection across the Indian Ocean during the last ten days has shifted only slightly eastward for the most part.

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

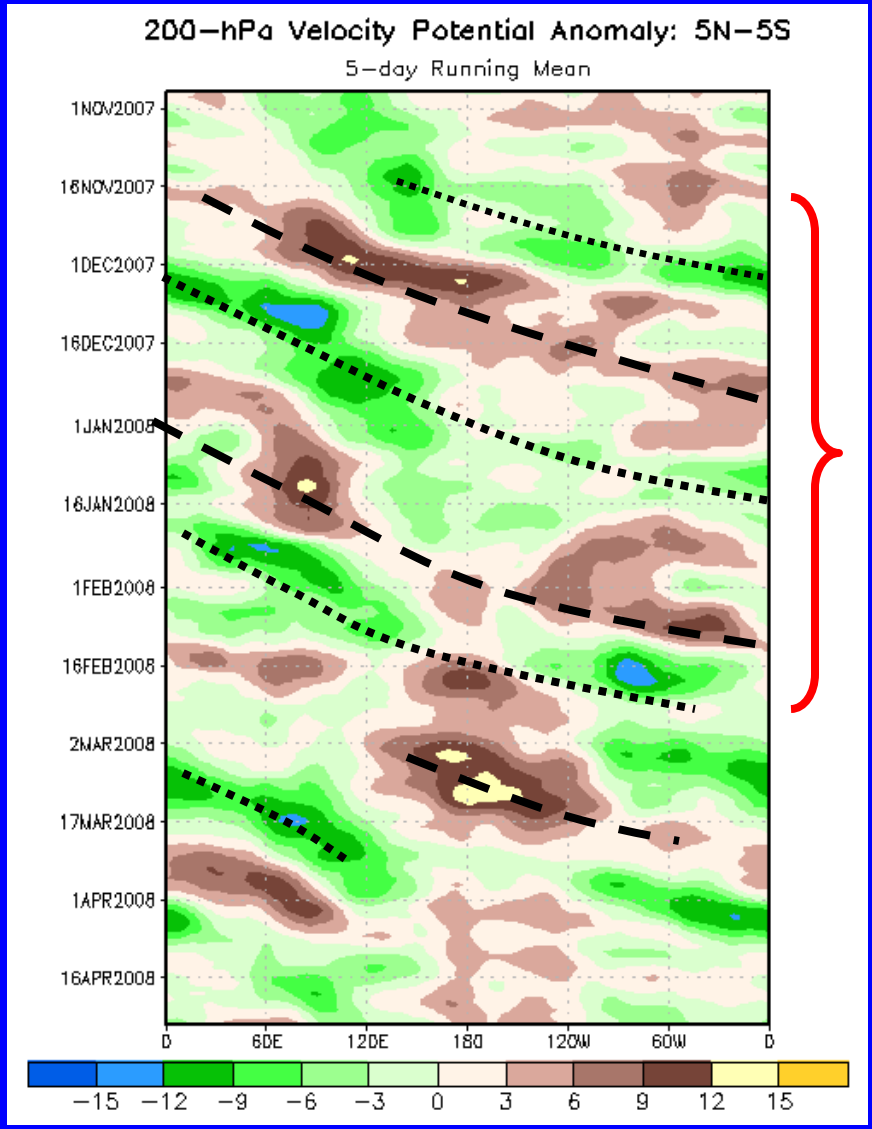


The current velocity potential anomalies show a mainly regionally varying pattern with large-scale divergence over parts of Africa, South America, and the Maritime Continent.

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

Longitude

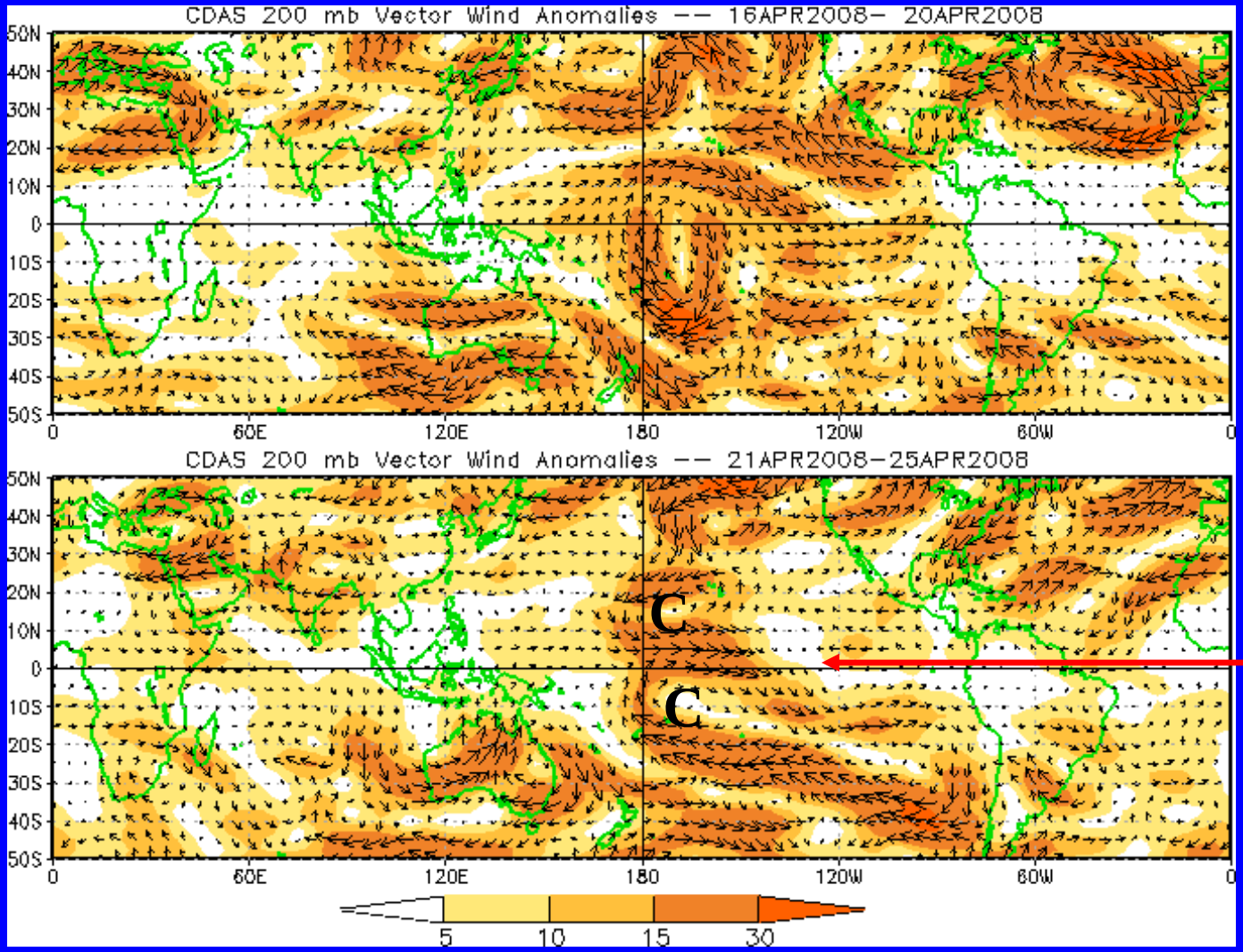
Moderate-to-strong MJO activity developed in mid-November and continued into mid-February.

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

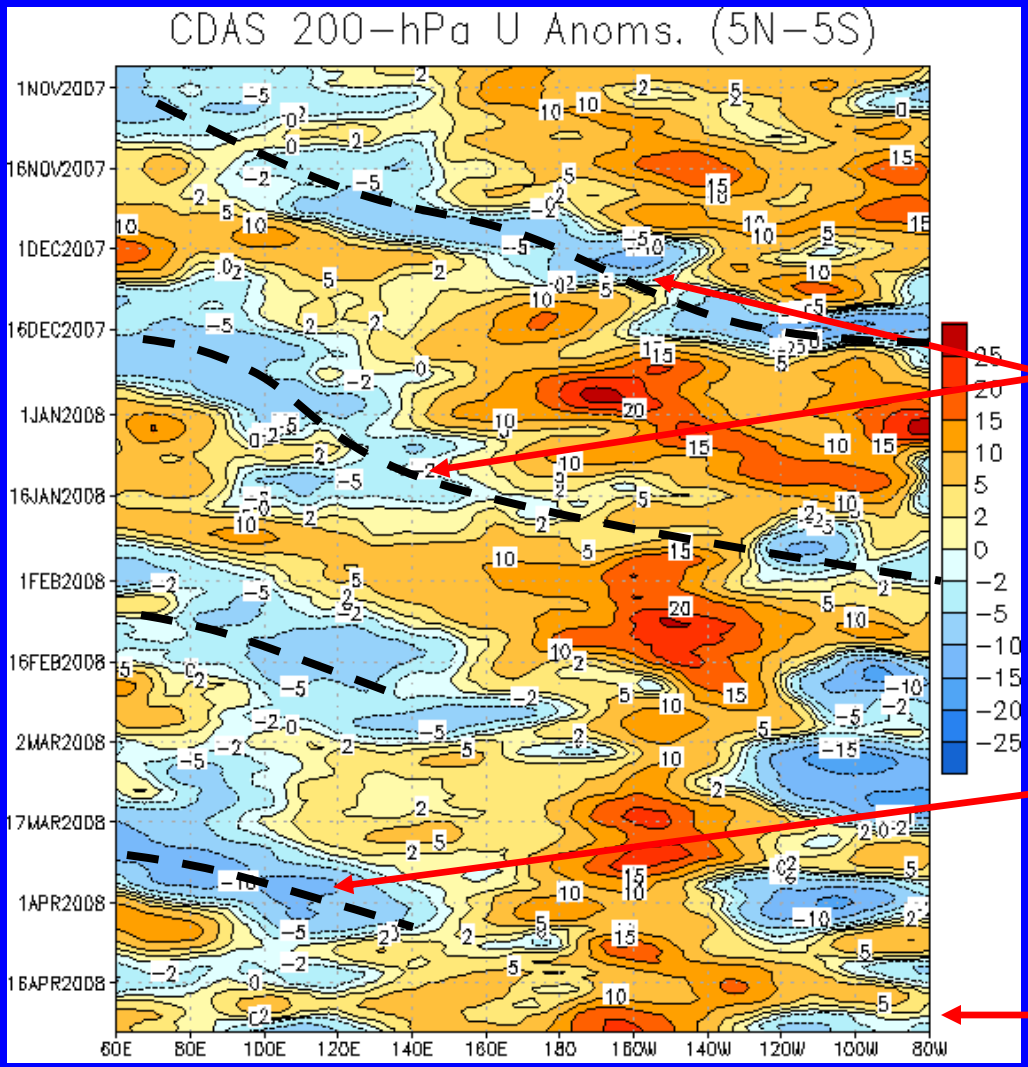


Cyclonic circulations (C) and equatorial westerly anomalies continue across the central Pacific Ocean during the last ten days and are consistent with continuing La Nina conditions.

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

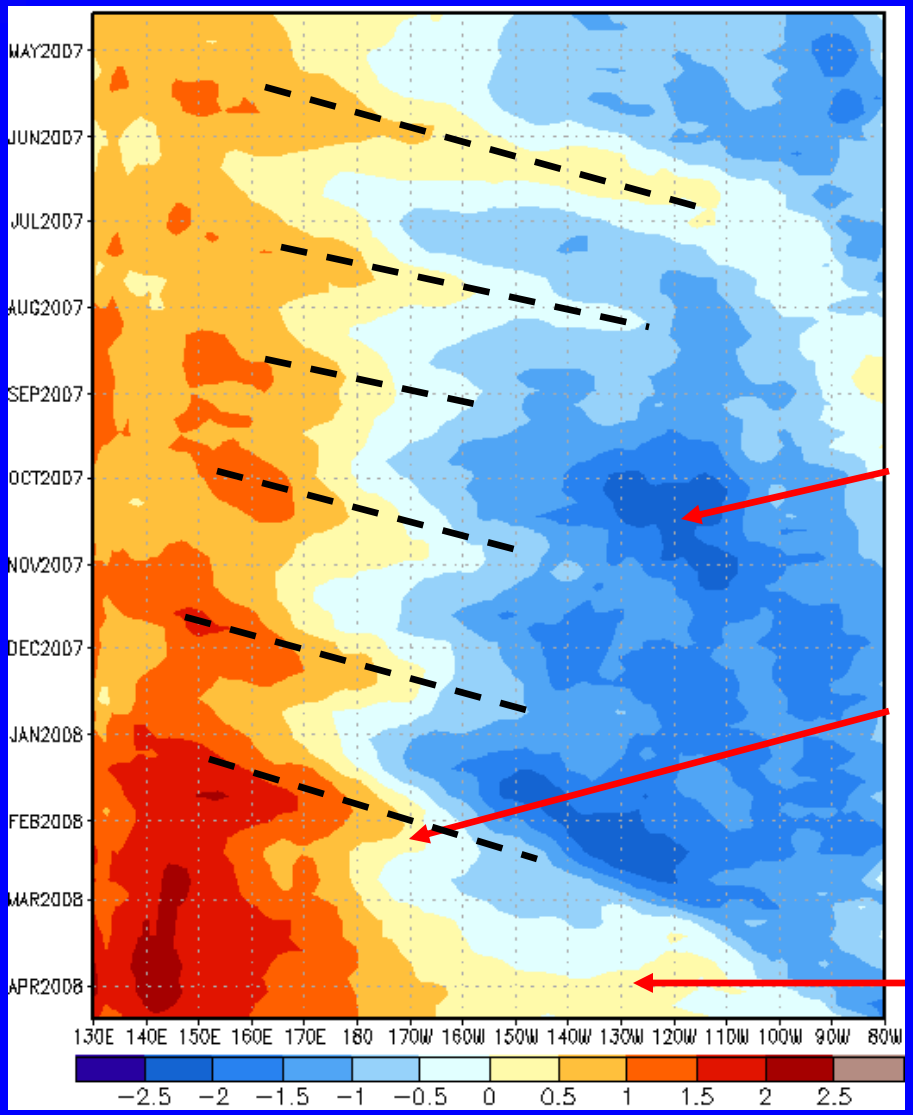
Longitude

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.

Currently, westerly anomalies stretch across much of the global tropics.

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.

Positive anomalies have developed during late March and early April across parts of the central and eastern Pacific.

MJO Index -- Information

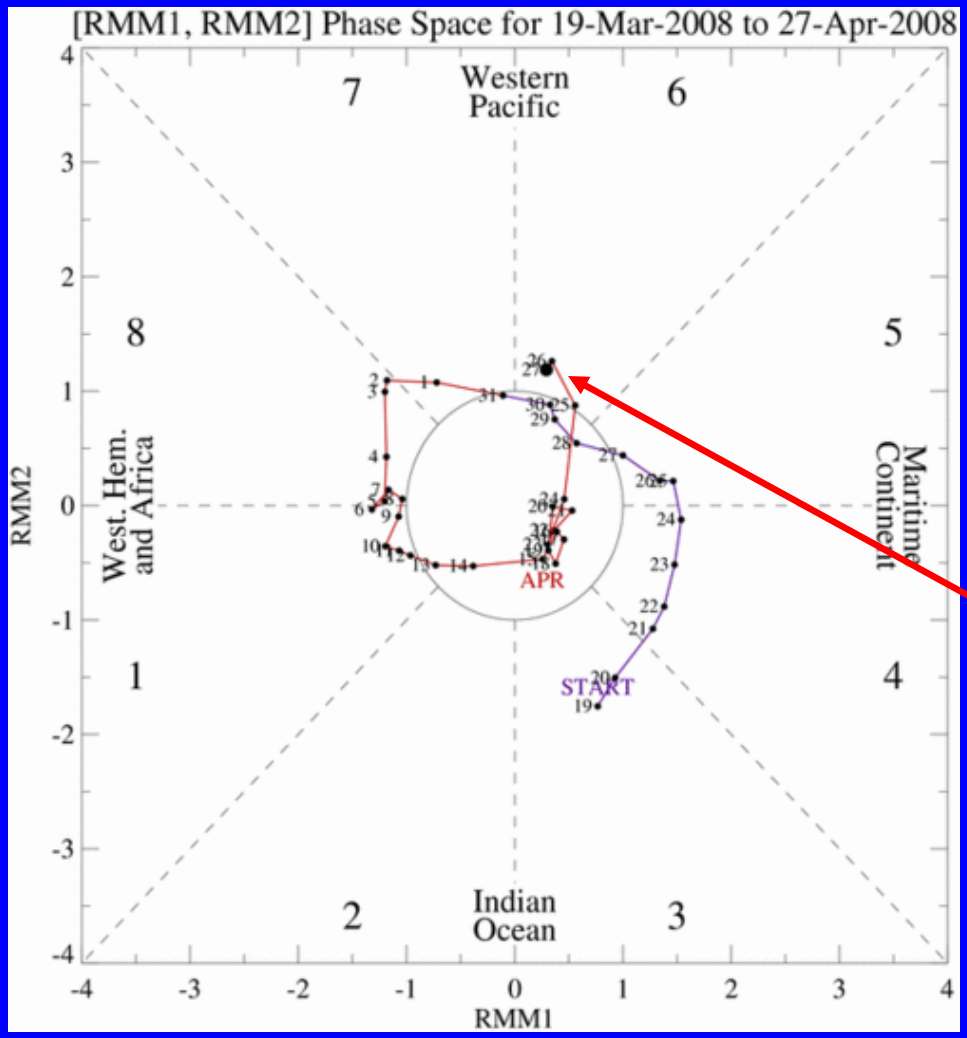
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

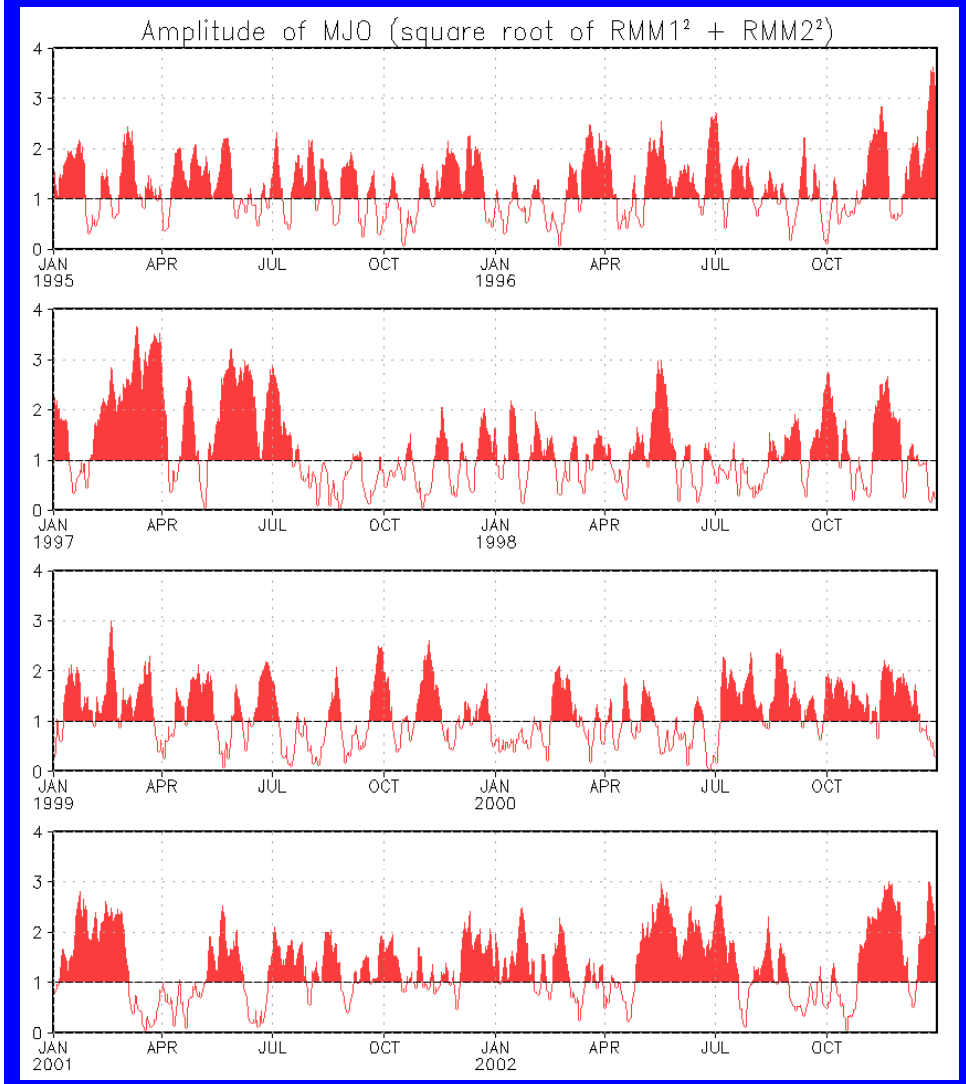
MJO Index -- Recent Evolution

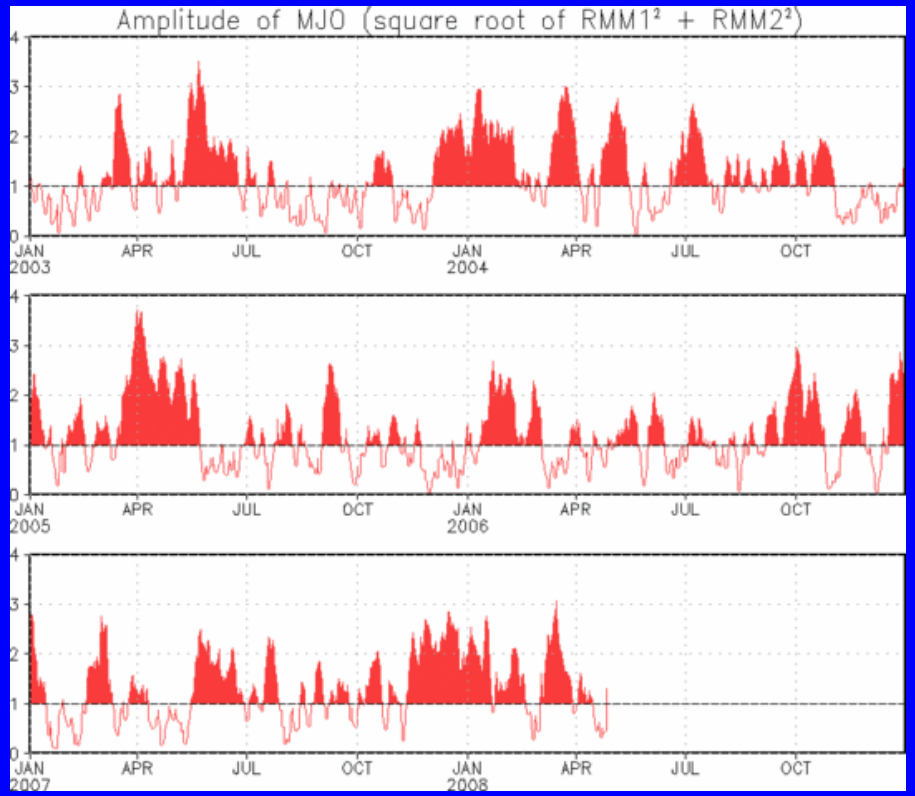


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation**
- **Distance from the origin is proportional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

The MJO signal has increased in amplitude in recent days but remains weak.

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

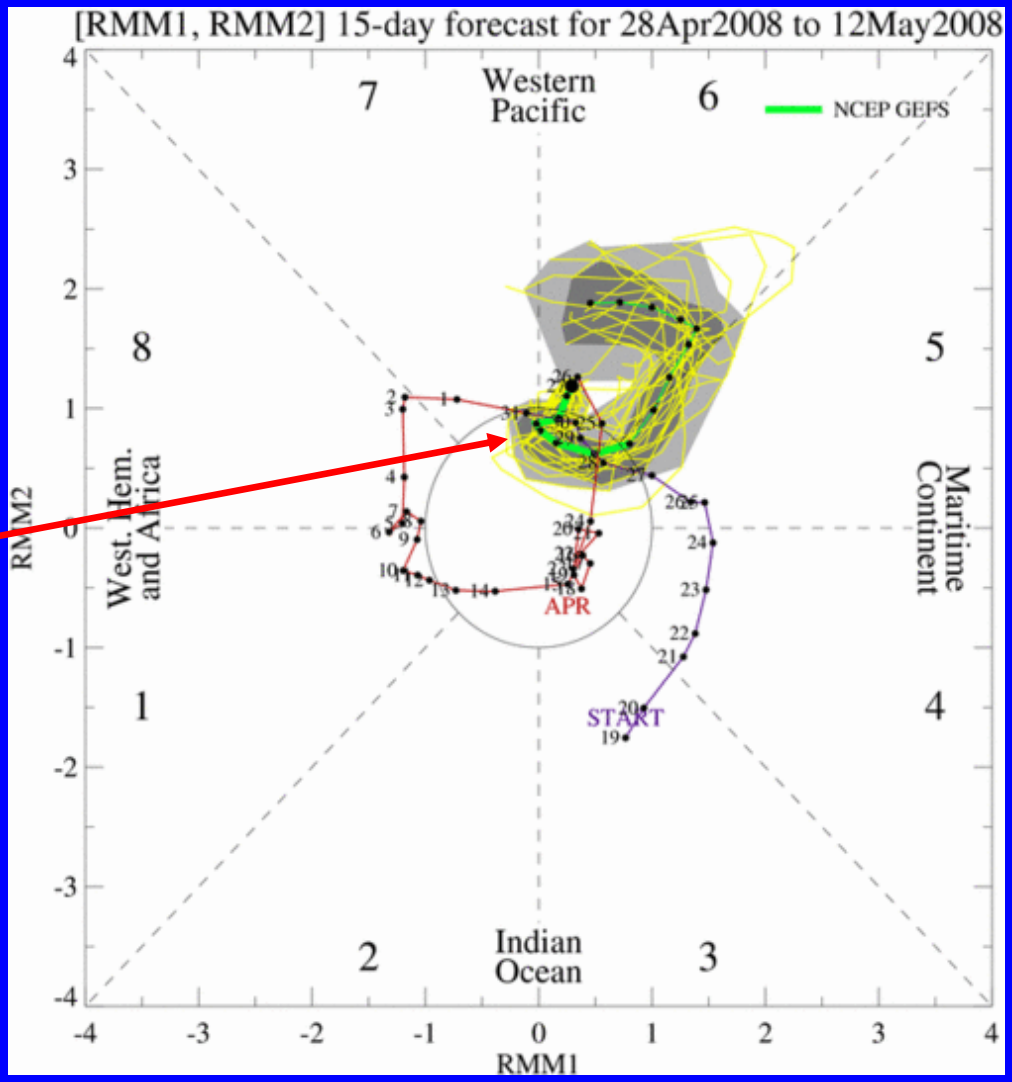
Ensemble GFS MJO Forecasts

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

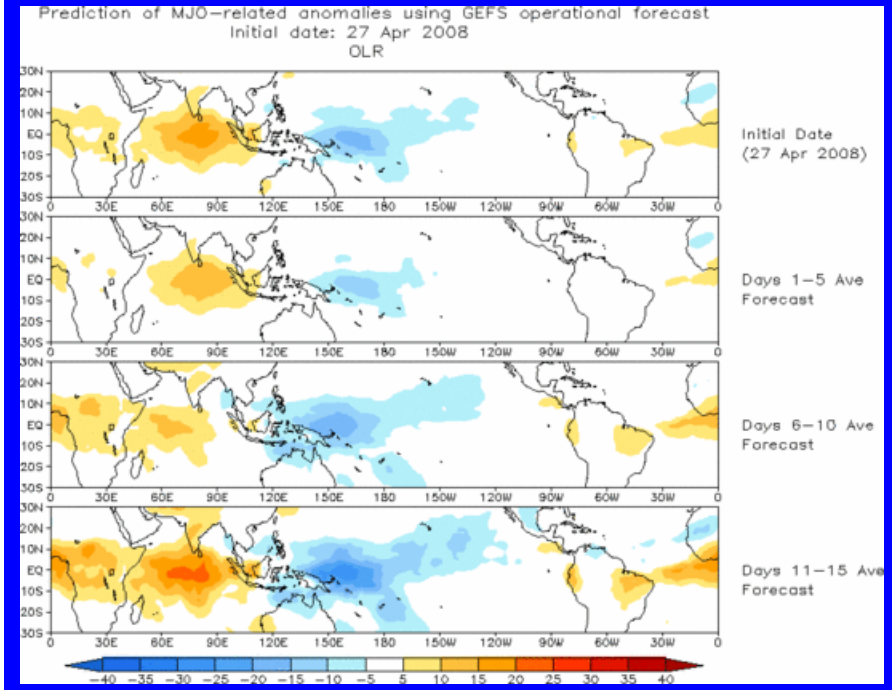
The GEFS predicts a weak MJO signal during the upcoming week with considerable uncertainty thereafter.



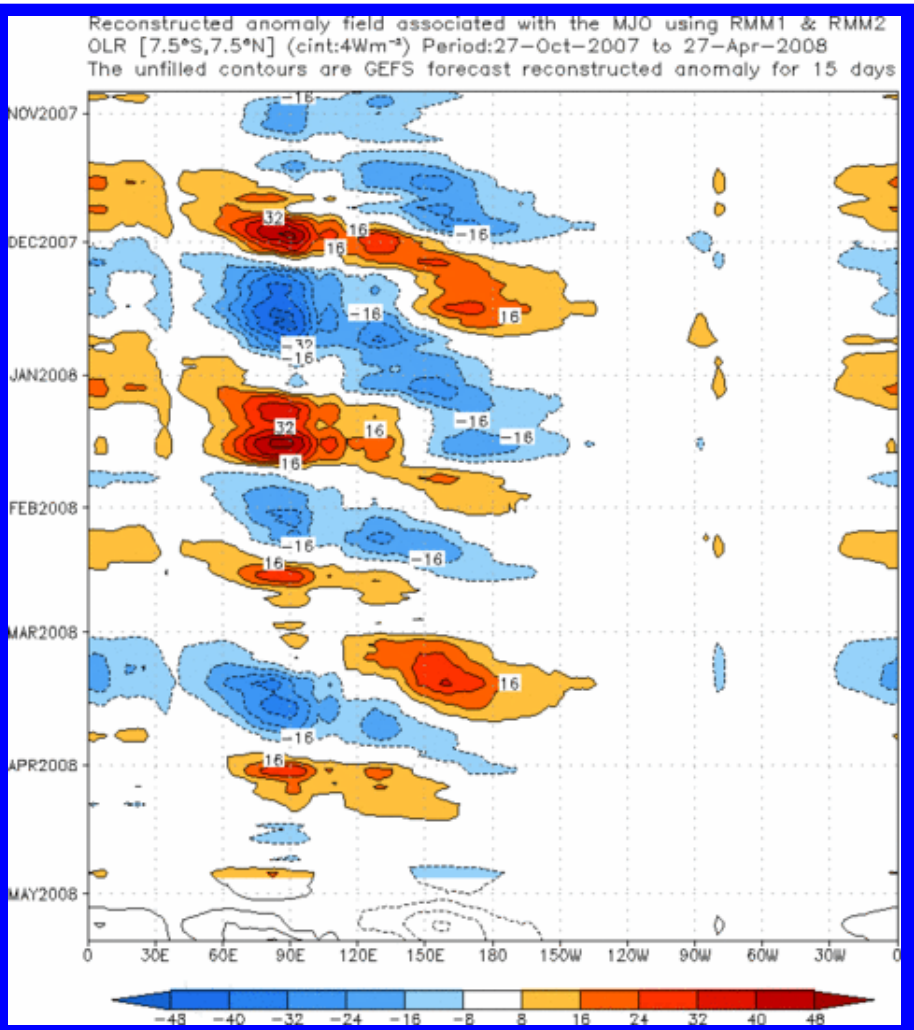
Ensemble Mean GFS MJO Forecast

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



Due to a somewhat stronger MJO signal (previous slide) forecast by the GEFS, suppressed (enhanced) MJO-associated convection is indicated for the Indian Ocean (western Pacific).

It is unlikely that the MJO will largely contribute to the tropical rainfall during the period.

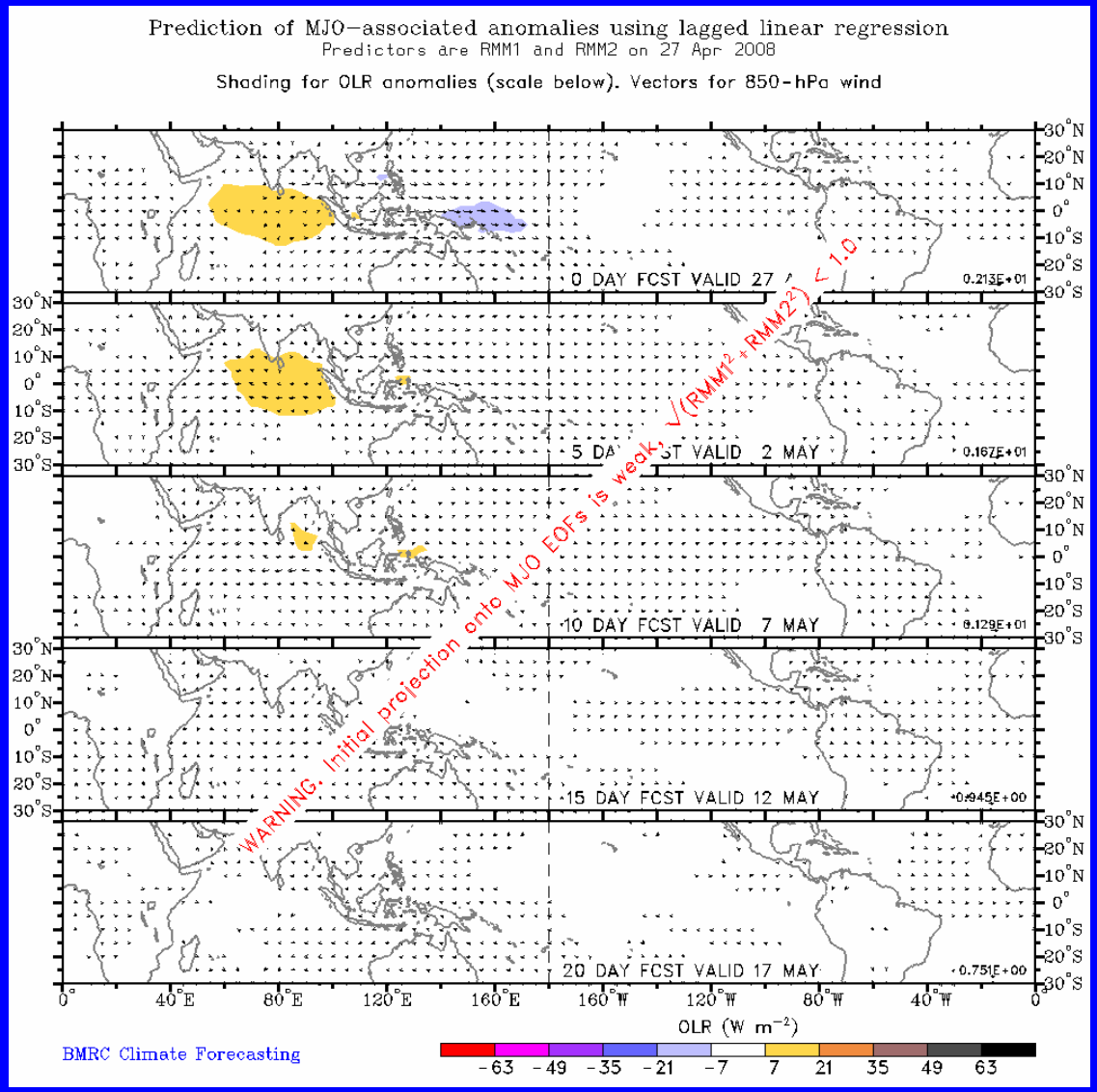
Statistical MJO Forecast

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

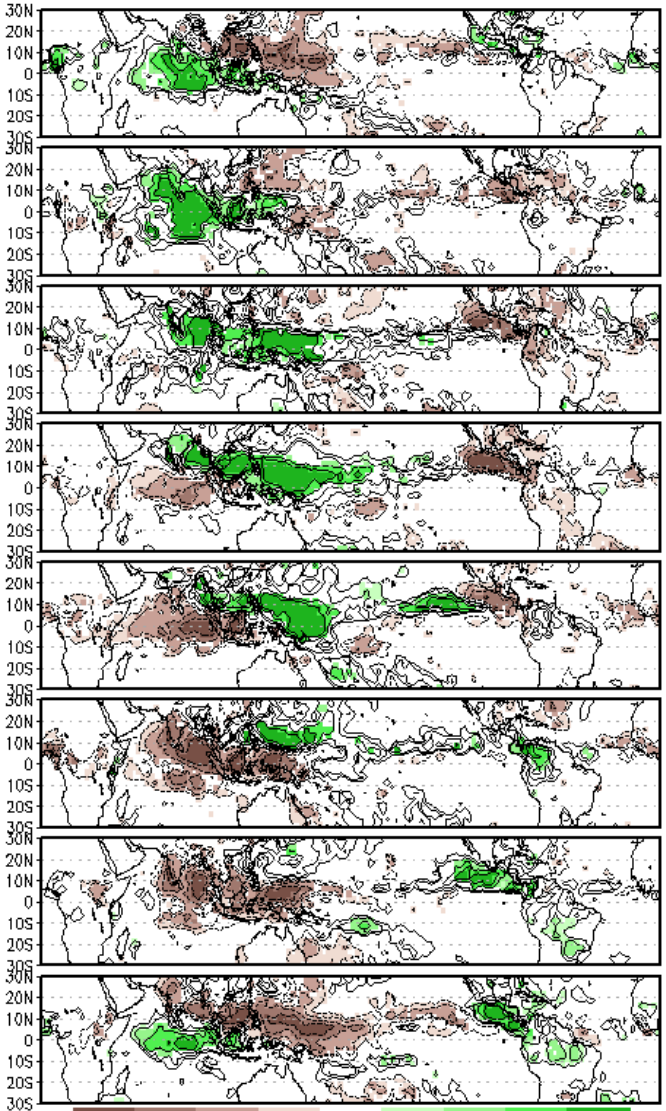
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

Weak MJO activity is forecast



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)