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

Update prepared by
Climate Prediction Center / NCEP
March 10, 2008

Outline

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

Overview

- The MJO signal has strengthened.

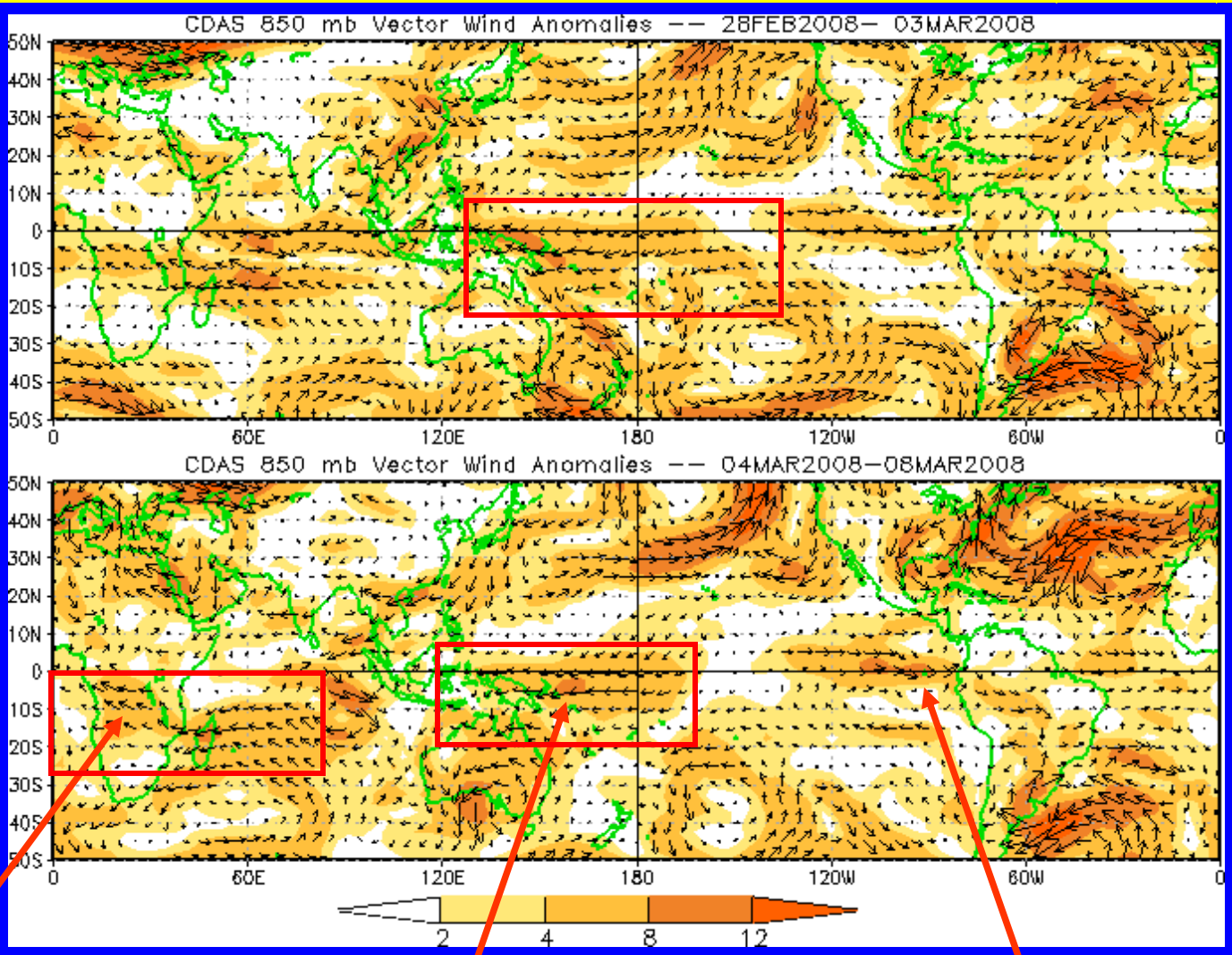
- Dynamical model forecast tools indicate MJO activity during the next week with eastward propagation into the Indian Ocean over the next 1-2 weeks.

- Enhanced rainfall is expected across northern South America, parts of Africa, and the western Indian Ocean during week 1. The region of enhanced rainfall is expected to shift eastward and focus across much of the Indian Ocean. Tropical cyclogenesis is favored across much of the southern Indian Ocean during the period.

- For the US, a trough is expected to become established across the western US over the period and interests across the Plains and Midwest should monitor the potential for an active storm track during the next two weeks.

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

Note that shading denotes the magnitude of anomalous wind vectors



Easterly anomalies extend from the southwest Indian Ocean into Africa.

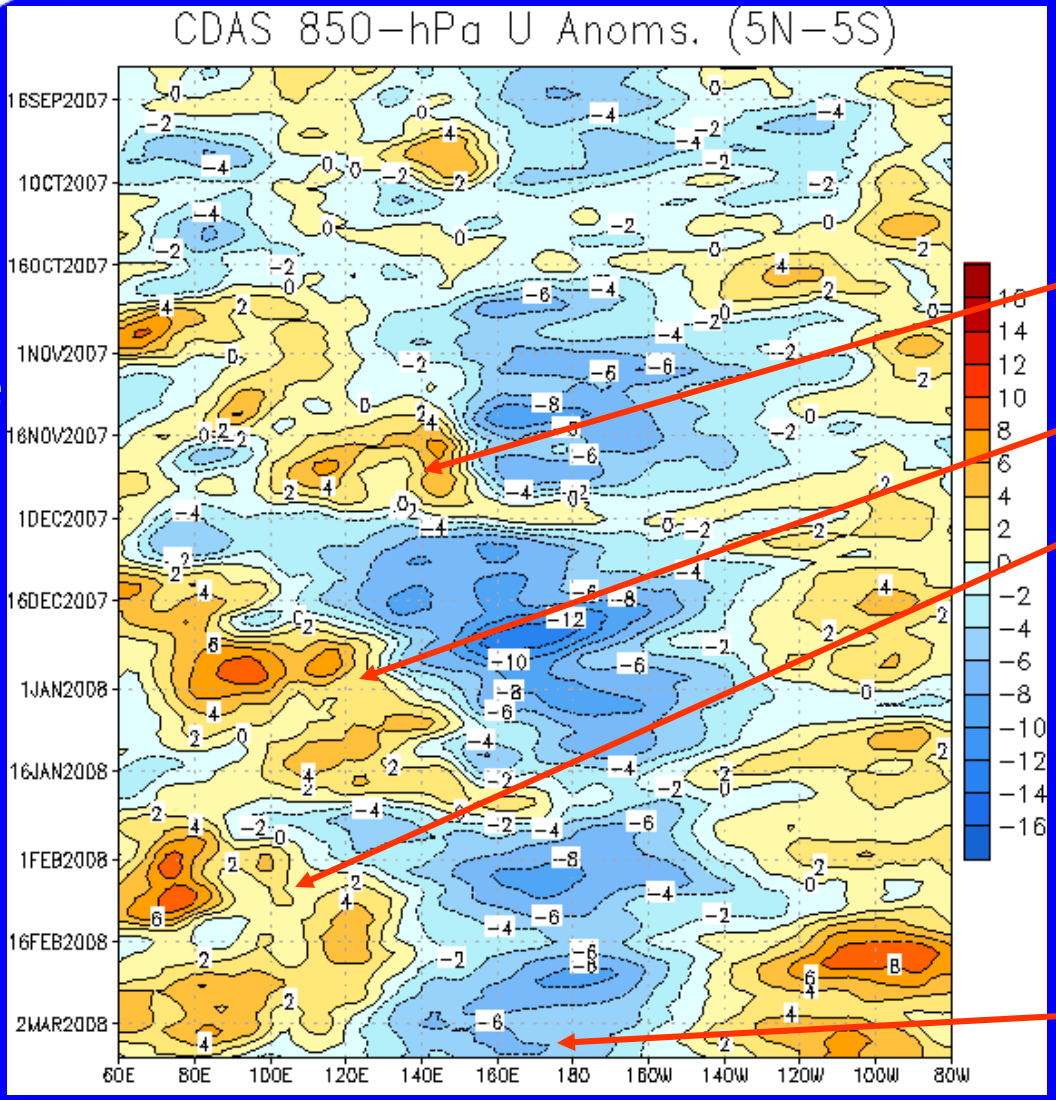
Easterly anomalies continue across the western Pacific.

Weak 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



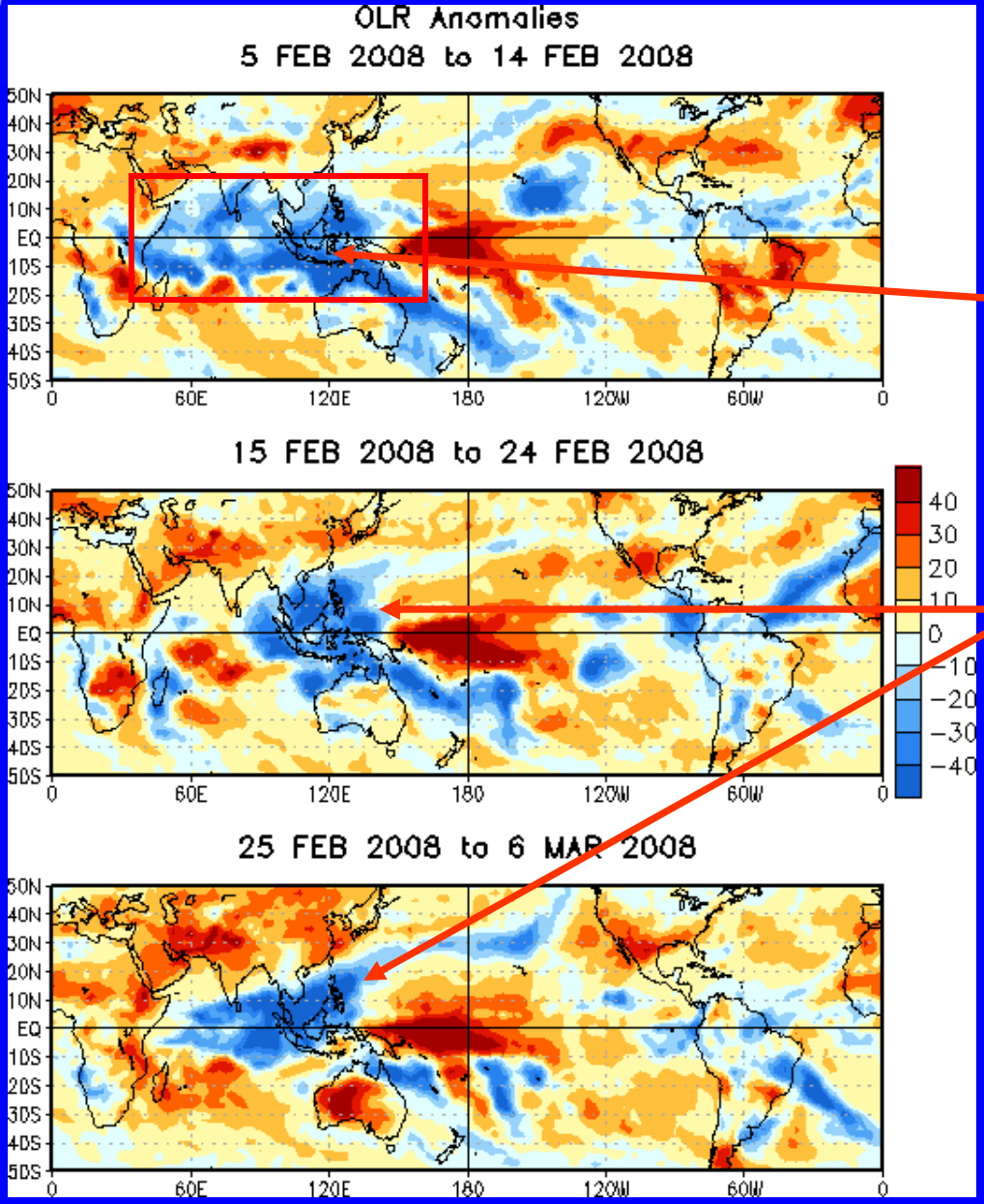
Time

Longitude

Moderate-to-strong MJO activity has been evident since late October 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 shifted west since mid-February and also now span parts of Indonesia .

OLR Anomalies: Last 30 days



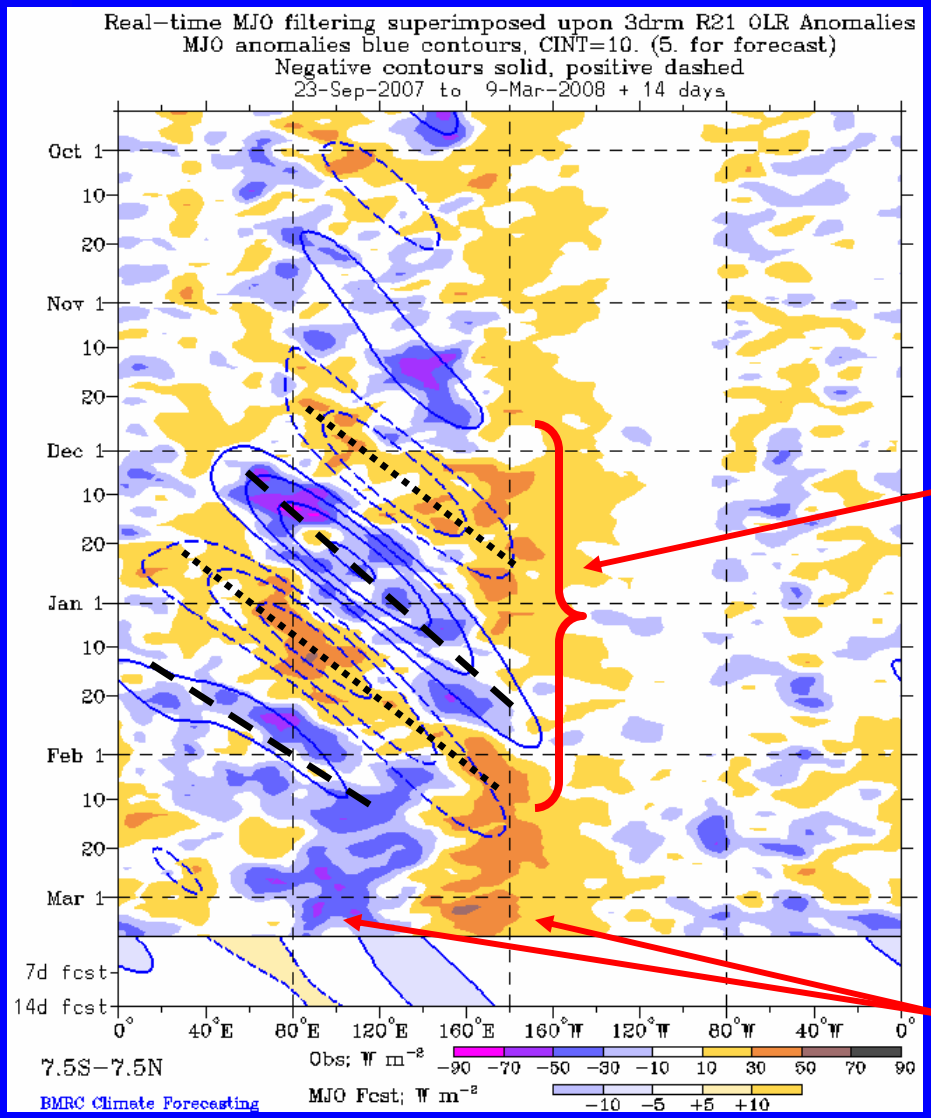
Drier-than-normal conditions, positive OLR anomalies (red shading)

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

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

From mid-Feb into early March, enhanced rainfall persisted across the Maritime Continent, northern Australia, and parts of the South Pacific Convergence Zone (SPCZ). Suppressed convection persisted across the central equatorial Pacific Ocean.

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.

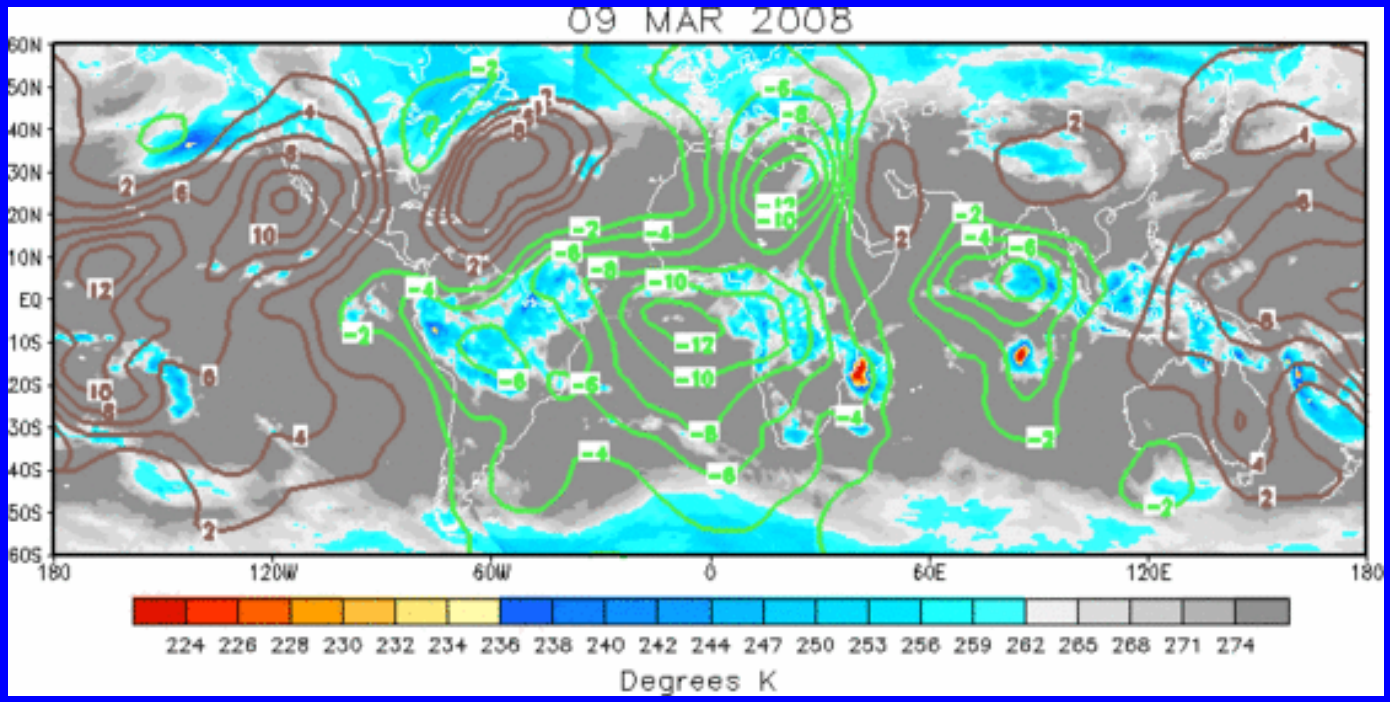
Considerable subseasonal variability is also evident across the western hemisphere during this period.

Equatorial anomalous convection across Indonesia and the western Pacific persisted into the beginning of March.

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

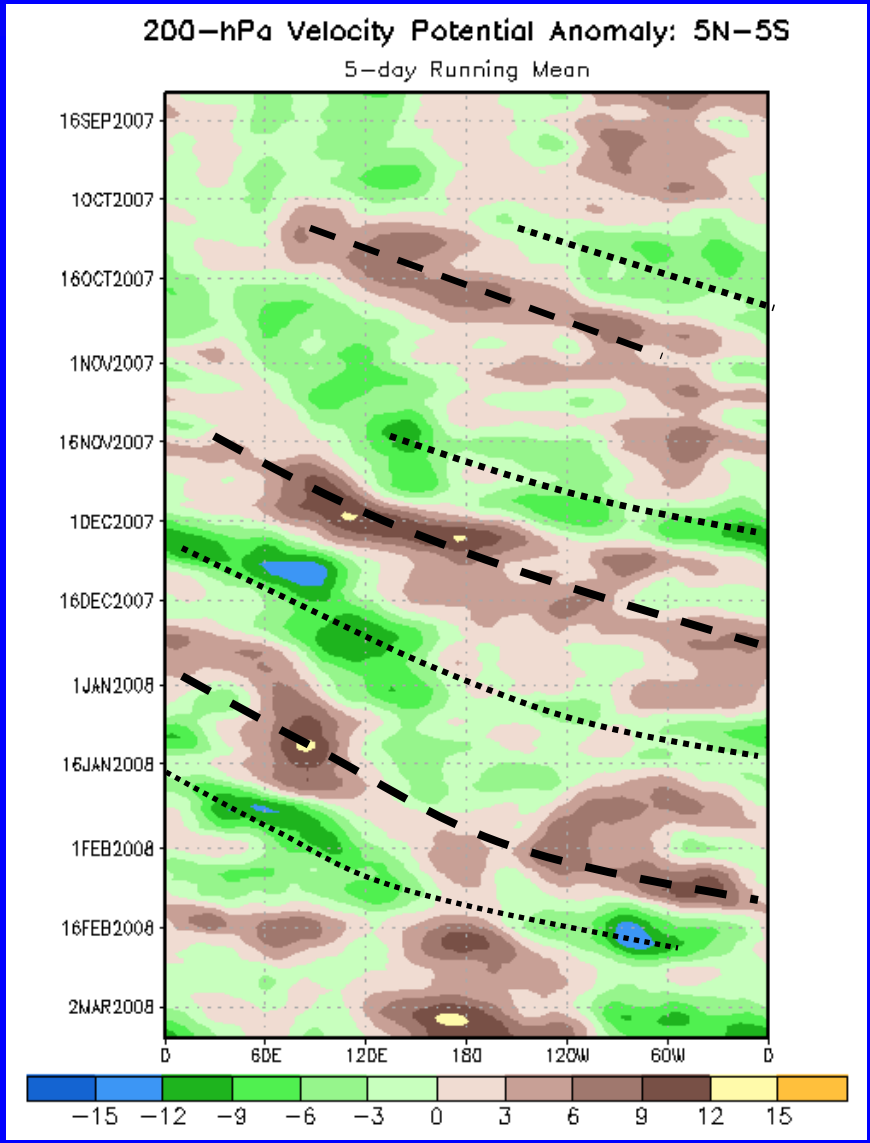


The current global velocity potential anomalies have increased and a more coherent pattern has developed during the past week. Strong upper-level divergence is noted over parts of South America, Africa, and the Indian Ocean while upper-level convergence is evident across much of the Pacific Ocean.

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

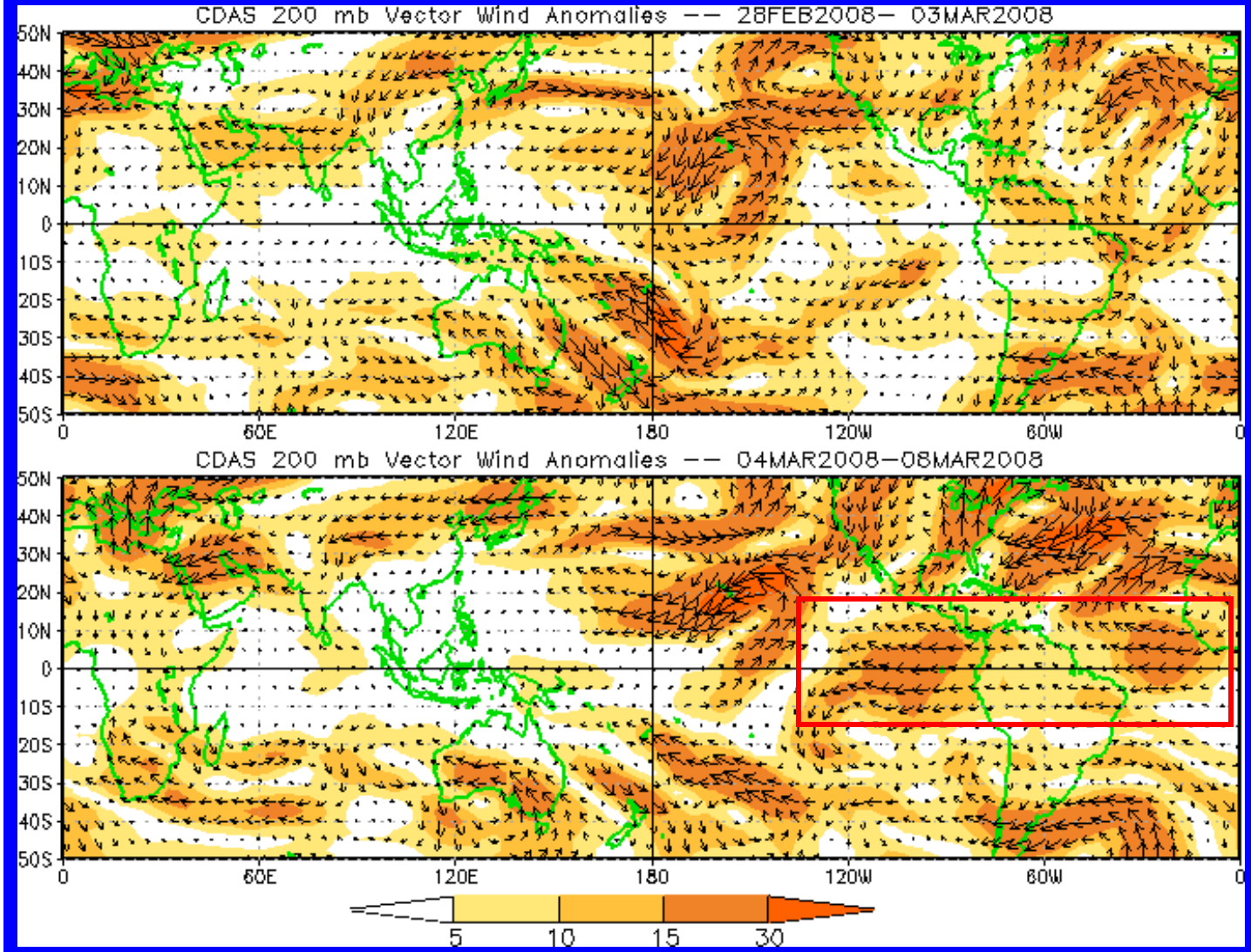
The MJO strengthened during October but coherent propagation was short-lived.

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

At the beginning of March, velocity potential anomalies have increased in some equatorial regions to date only minor eastward propagation is evident.

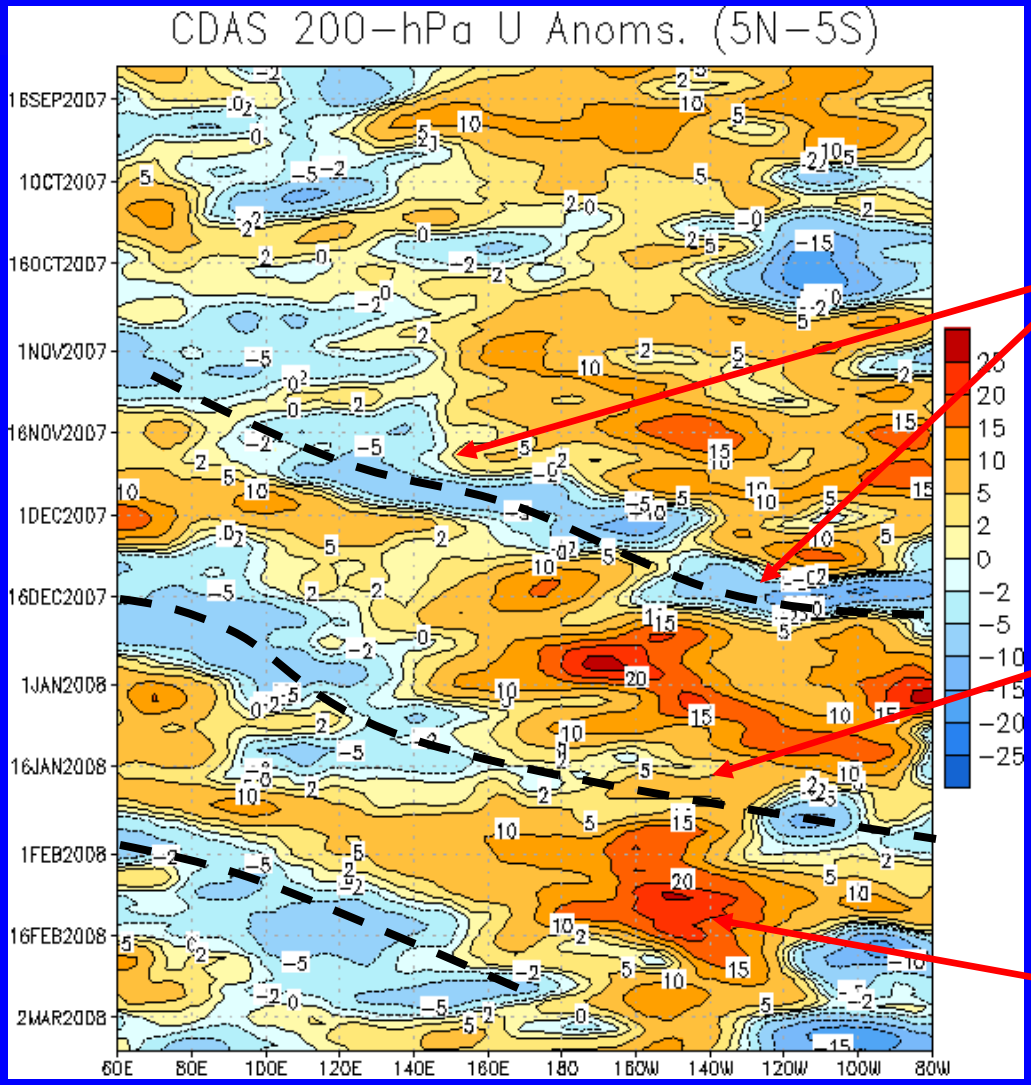
200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the magnitude of anomalous wind vectors



Widespread easterly anomalies are evident across the equatorial east Pacific, South America, and the Atlantic during the last five days.

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



Time

Longitude

Westerly anomalies (orange/red shading) represent anomalous west-to-east flow

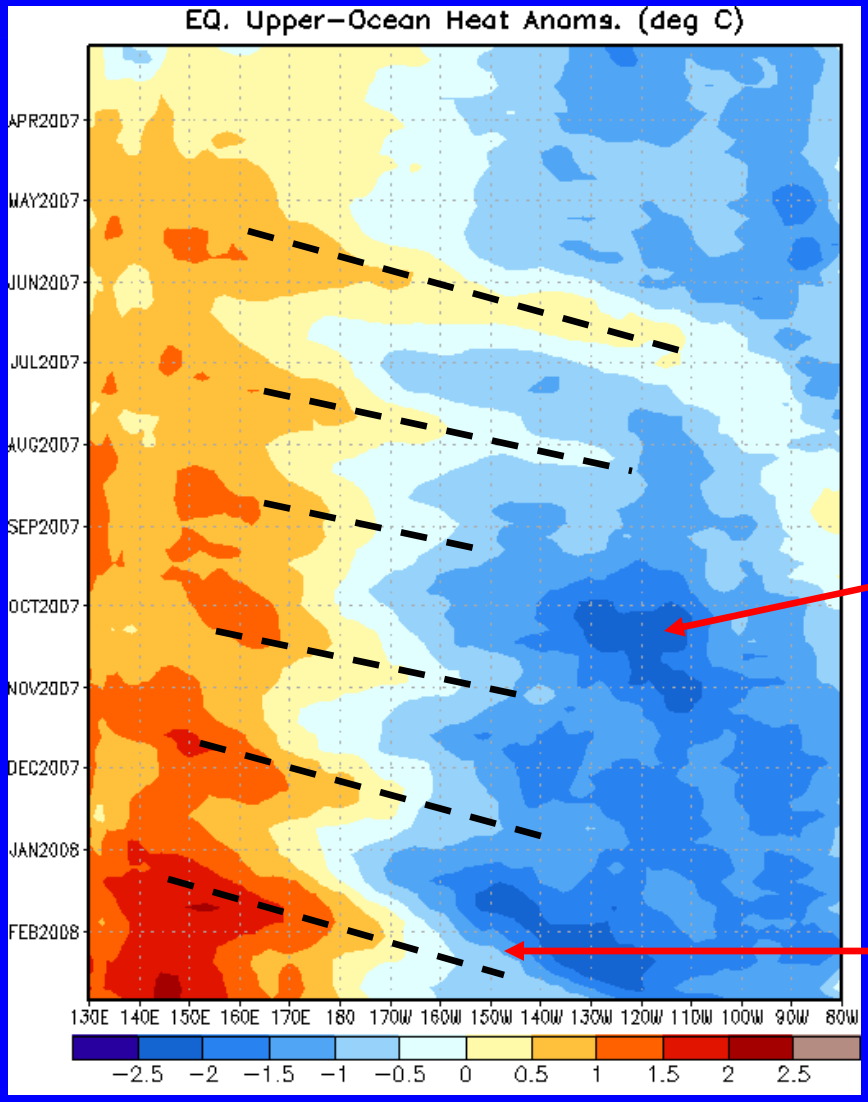
Easterly anomalies (blue shading) represent anomalous east-to-west flow

Cycle 1 of the ongoing 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 strengthening La Nina.

During early February, both the MJO and La Nina contributed to strong westerly anomalies between 160°W – 130°W.

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

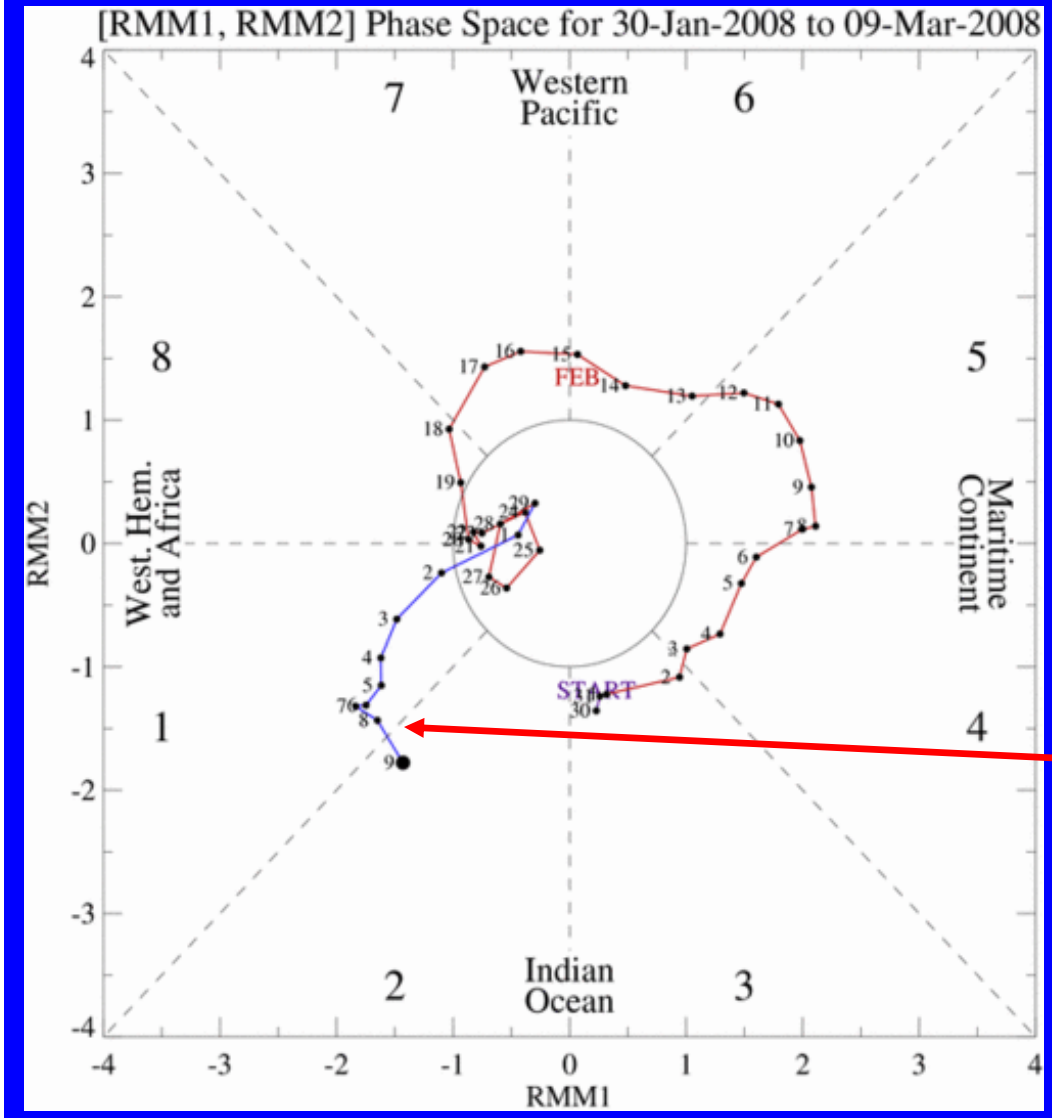
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

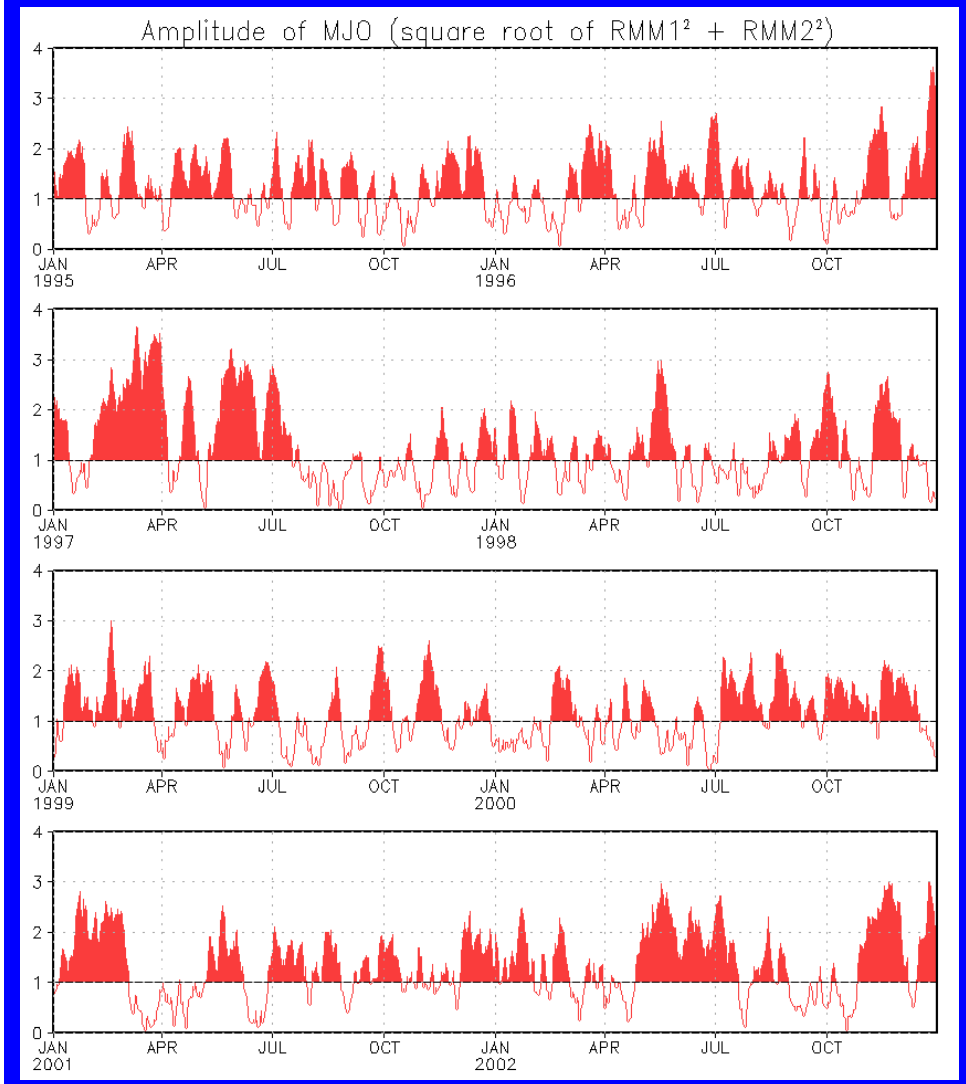
MJO Index -- Recent Evolution

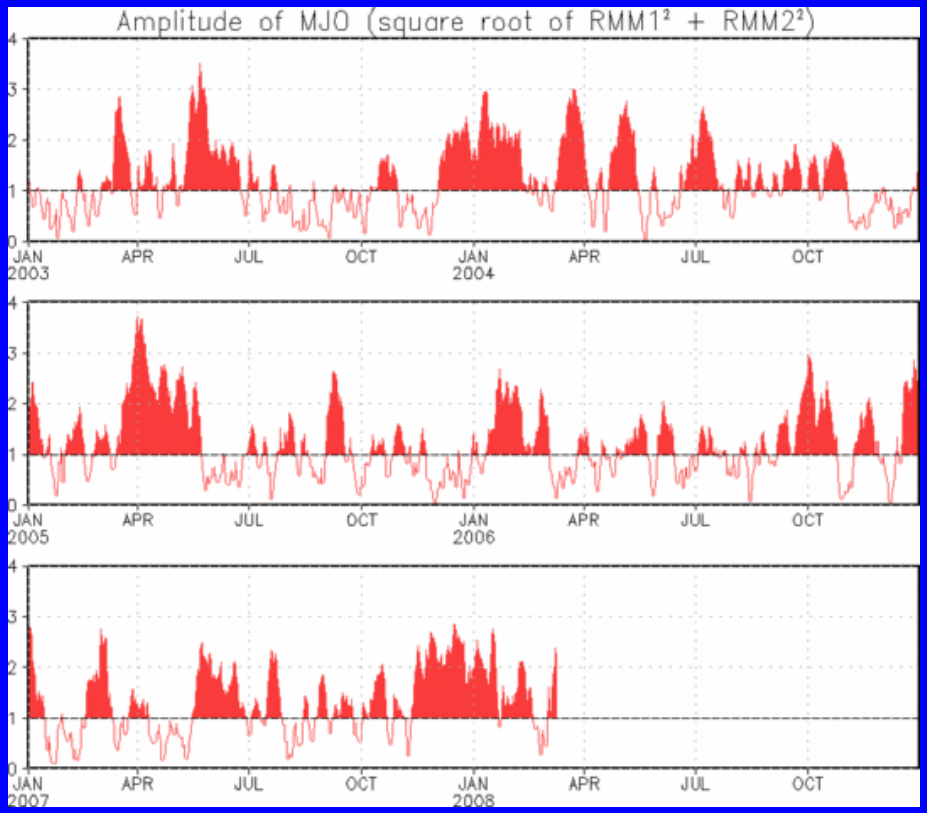


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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

According to the MJO index, the MJO signal has strengthened during early March.

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

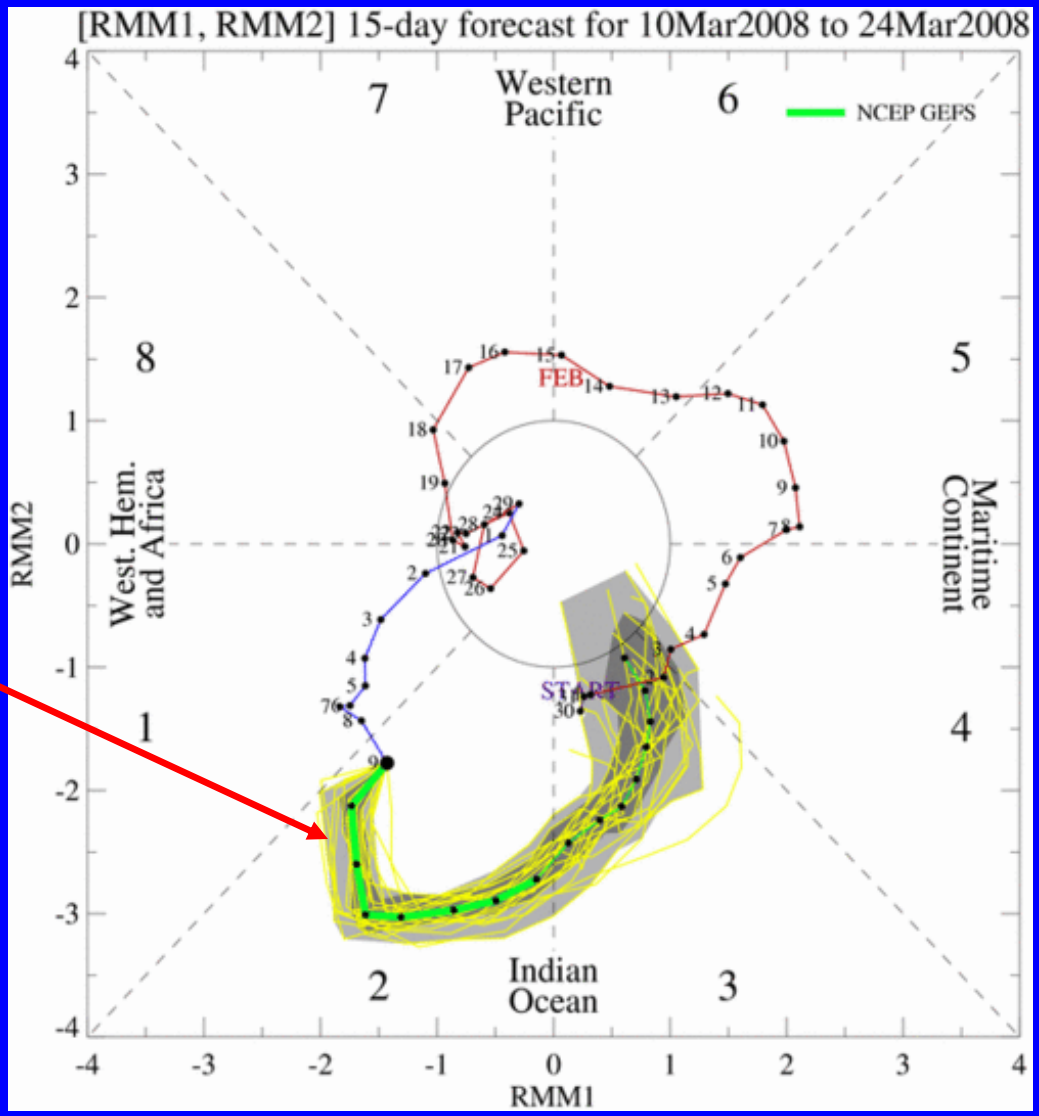
Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

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 strong MJO signal with eastward propagation across the Indian Ocean.

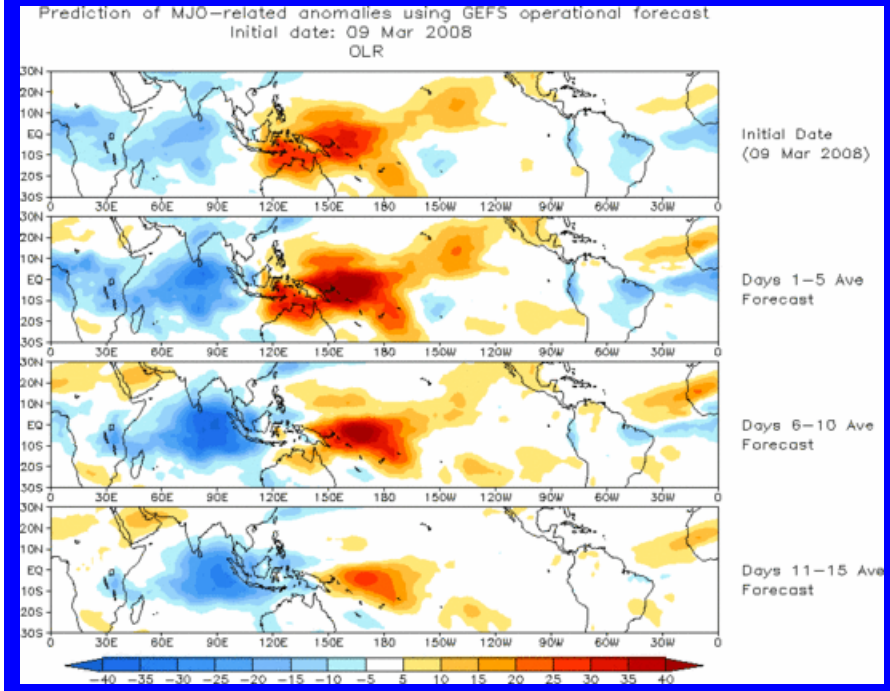
Confidence is reasonably high as the majority of members show a similar evolution over the period. Also, it should be noted that last week's forecast indicated this renewed cycle.



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)

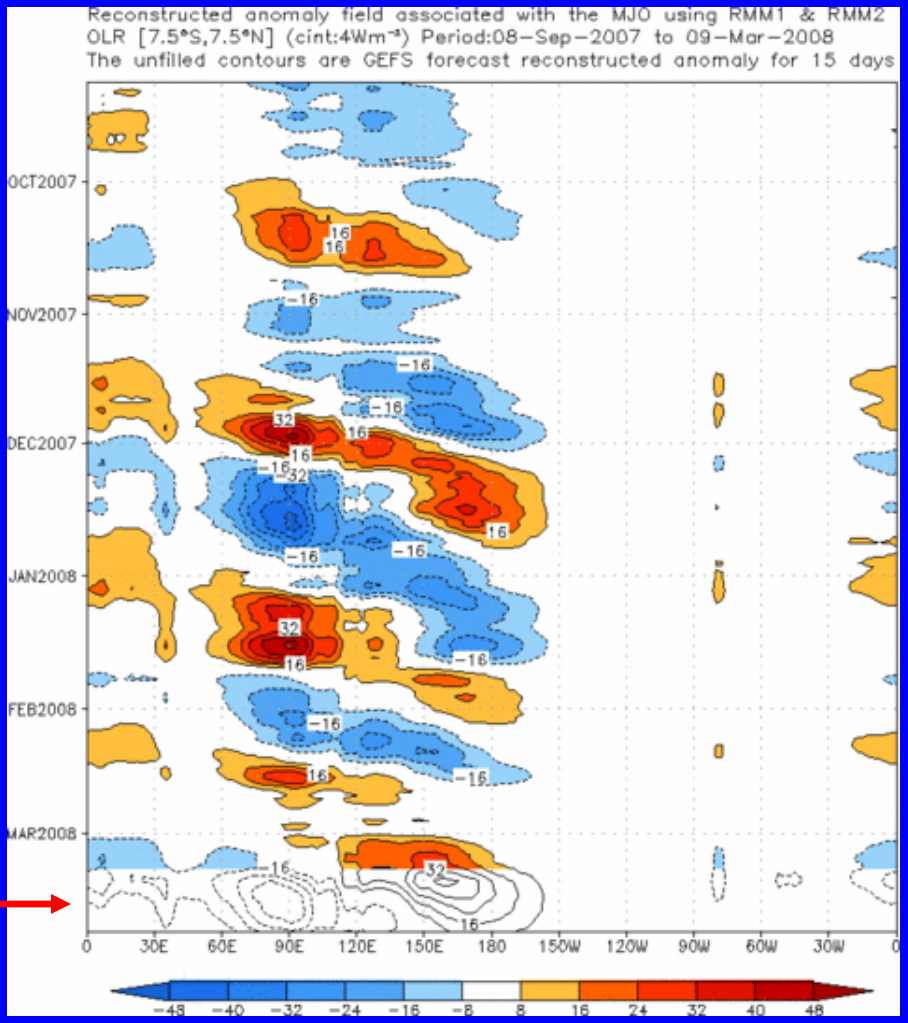
Spatial map of OLR anomalies for the next 15 days



Based on the GEFS forecast, enhanced convection will spread across Africa and the Indian Ocean while suppressed convection affects the eastern Maritime Continent and western Pacific.

Eastward propagation is expected during the next two weeks.

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



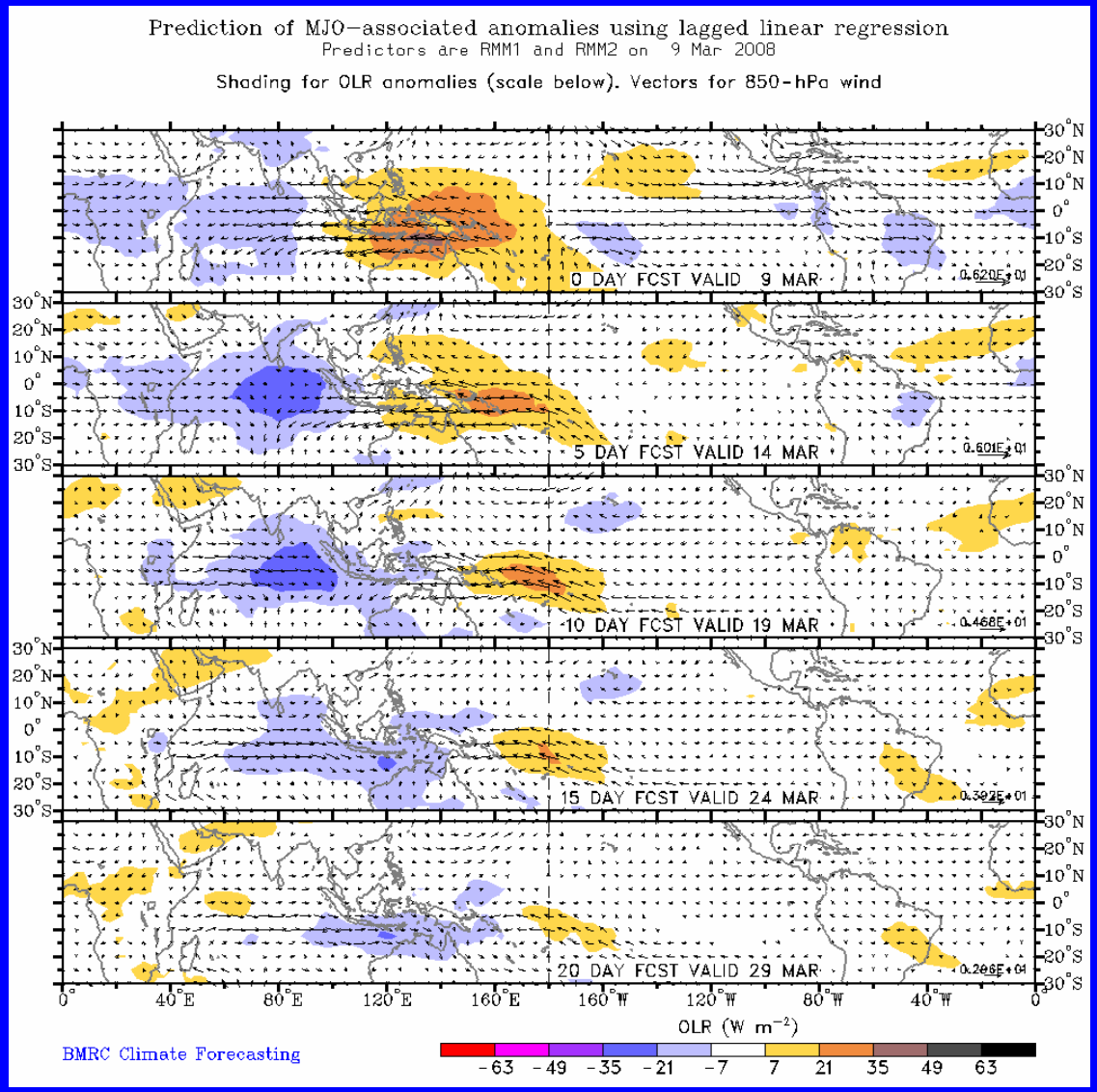
Statistical MJO Forecast

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

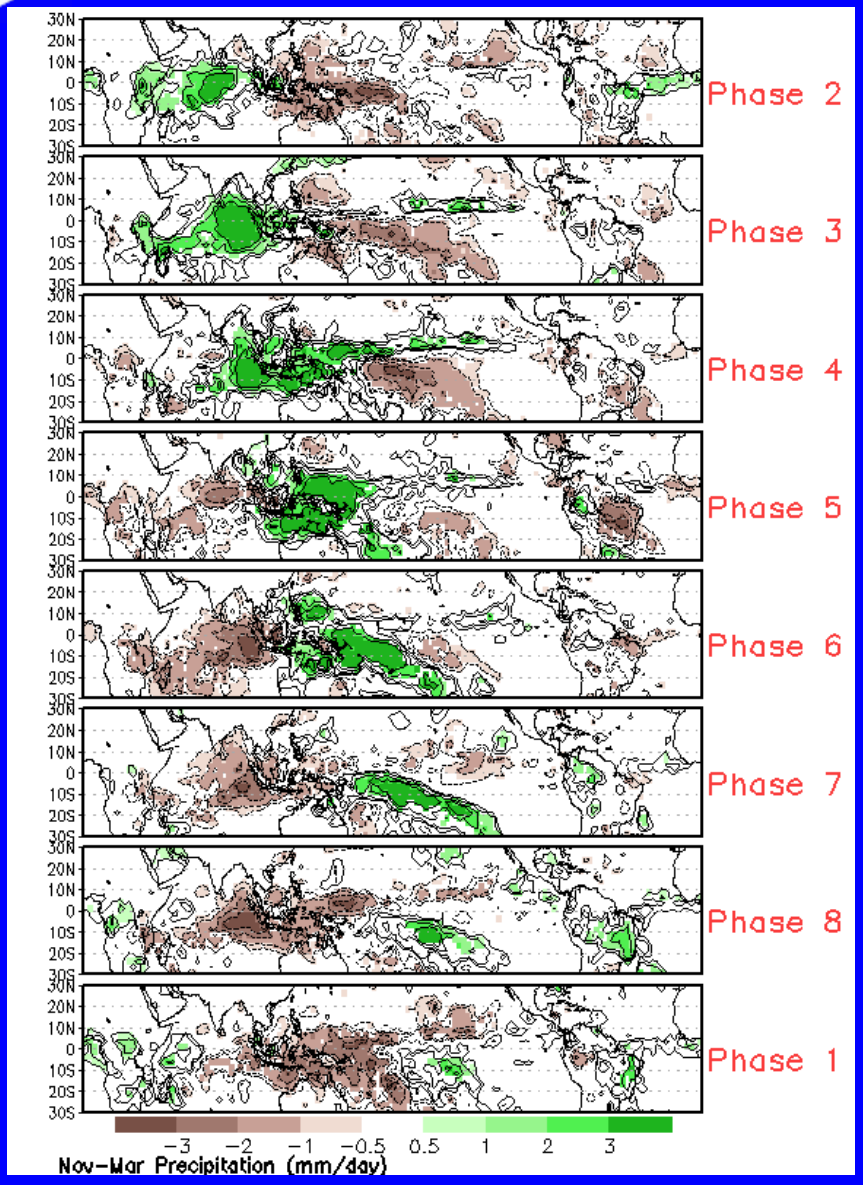
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical forecast indicates strong and coherent MJO activity during the upcoming 1-2 weeks.



MJO Composites – Global Tropics

Precipitation Anomalies



850-hPa Wind Anomalies