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

Update prepared by
Climate Prediction Center / NCEP
May 12, 2008

Outline

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

Overview

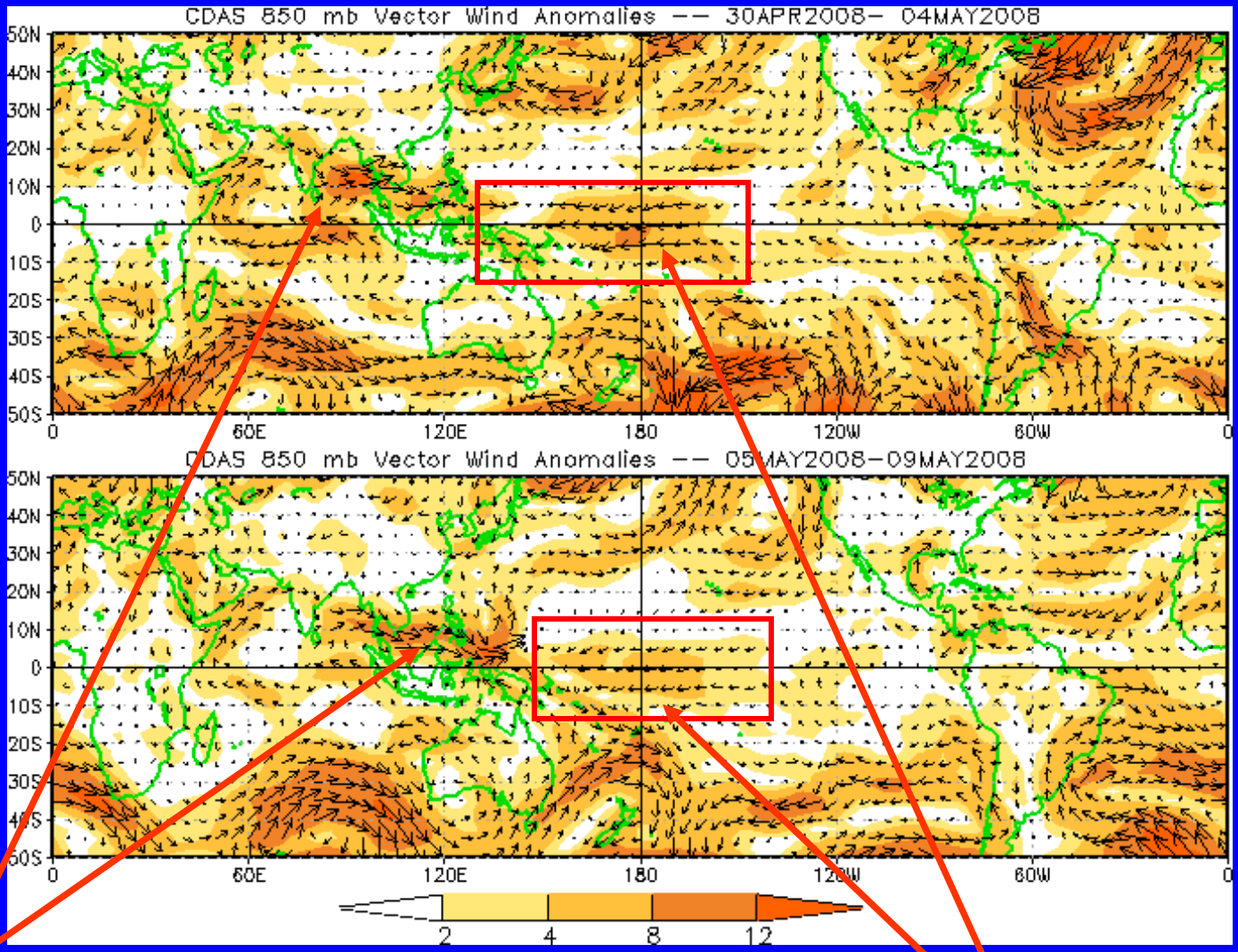
- The MJO has become better organized during the past week. The enhanced phase is located across the western Pacific Ocean.

- It is unclear how much the MJO will further strengthen but it is most likely the MJO will remain weak to moderate during the next 1-2 weeks.

- The MJO will contribute to dry conditions across the Indian Ocean during week 1 as well as continue wet conditions across Southeast Asia and the western Pacific during the period.

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

Note that shading denotes the magnitude of anomalous wind vectors



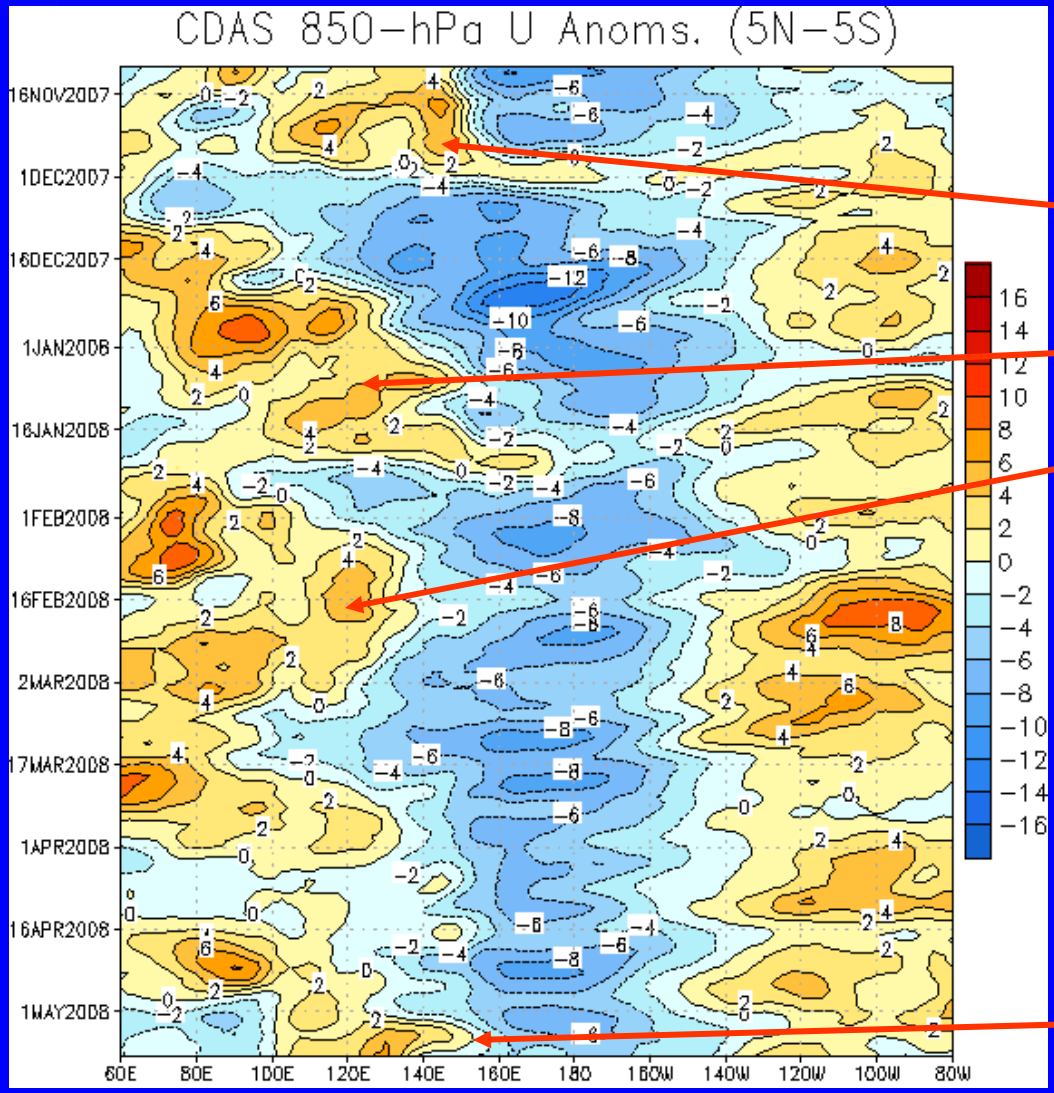
Westerly anomalies in the Indian Ocean have shifted eastward into the western Pacific Ocean in part due to tropical cyclone activity.

Easterly anomalies continue across the western Pacific but have decreased in magnitude during the last five 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

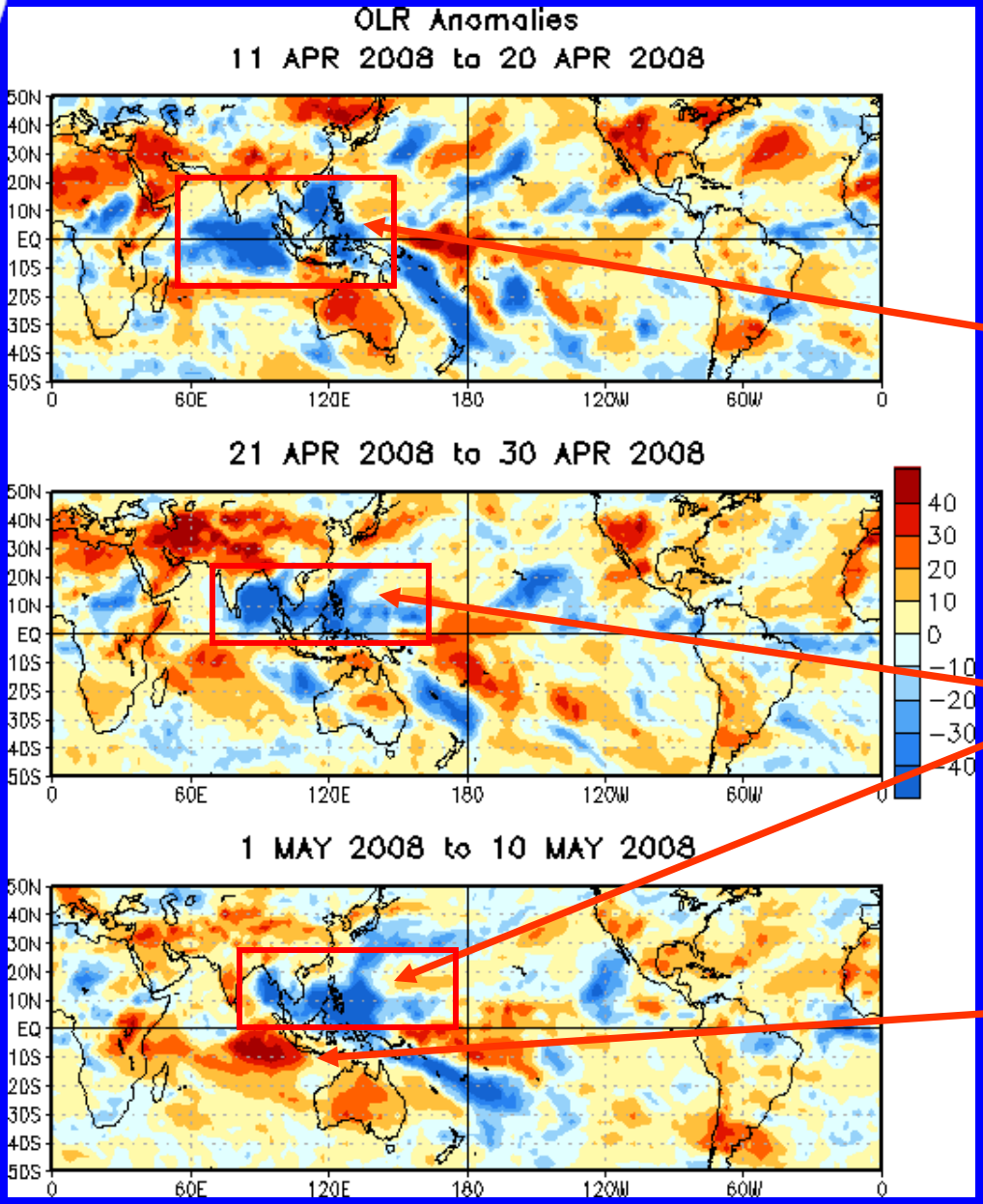
Longitude

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 much of March and April, the most important feature was the continuation of easterly (westerly) anomalies across the central (eastern) Pacific Ocean associated with La Nina conditions.

During the past week, westerly anomalies are evident across the western Pacific Ocean.

OLR Anomalies: Last 30 days



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

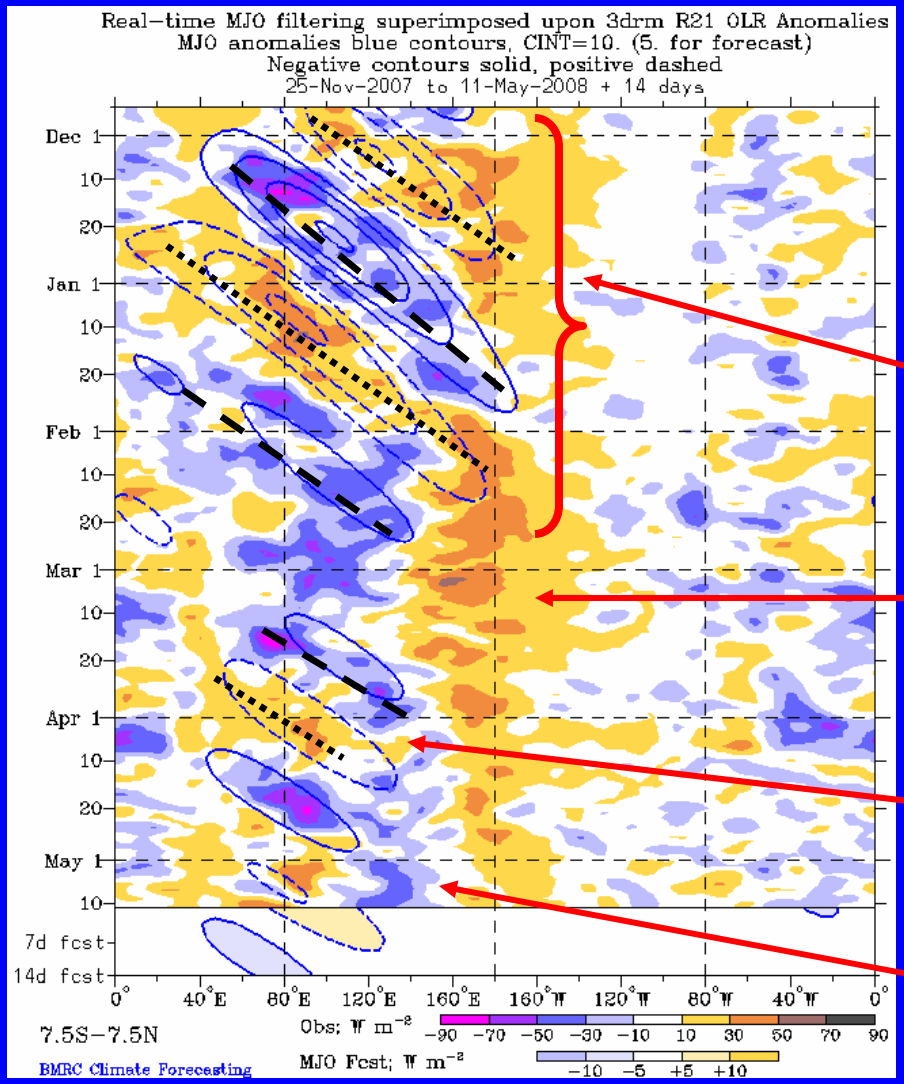
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

Tropical convection increased markedly across the Indian Ocean and Indonesia during mid-April.

Enhanced convection shifted northeastward to include more of the western Pacific during late April and early May.

At the same time, dry conditions have become established in the Indian Ocean south of the equator and across equatorial east Africa.

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



Time

Longitude

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

Wetter-than-normal conditions, negative OLR anomalies (yellow/red shading)

(Courtesy of the Bureau of Meteorology - 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.

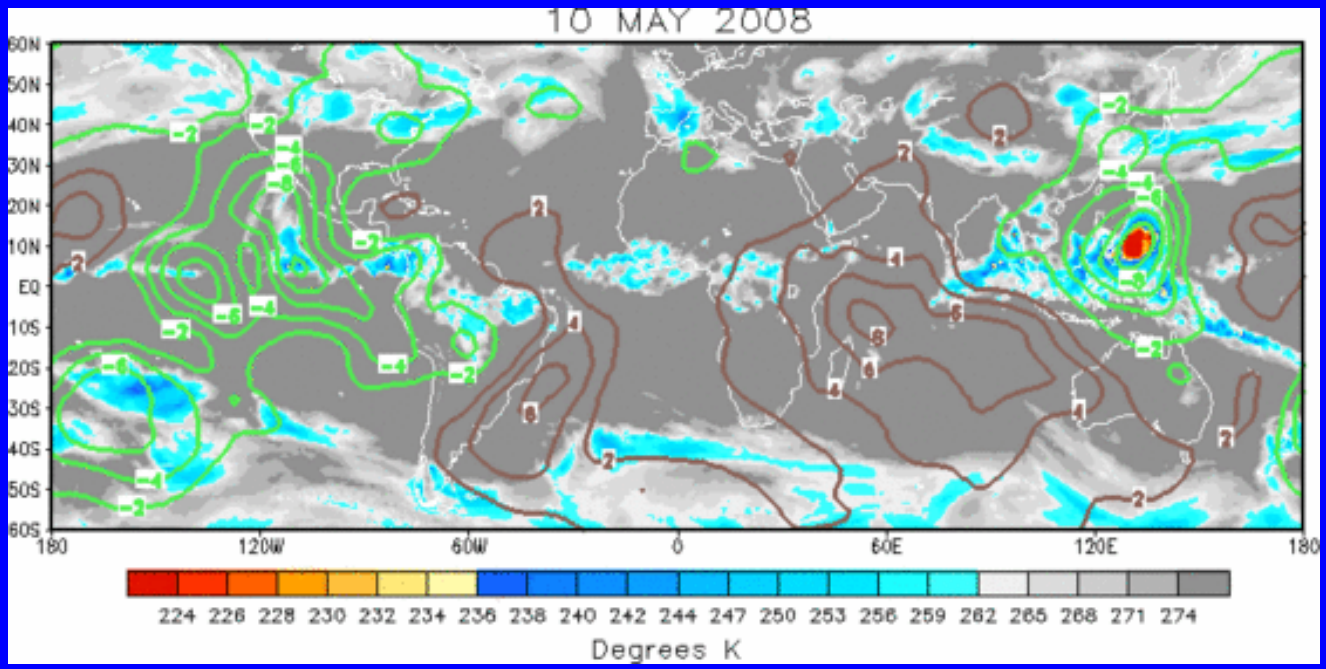
Weak MJO activity was evident during mid-late March.

Recently, convection has increased along the equator in the western Pacific.

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

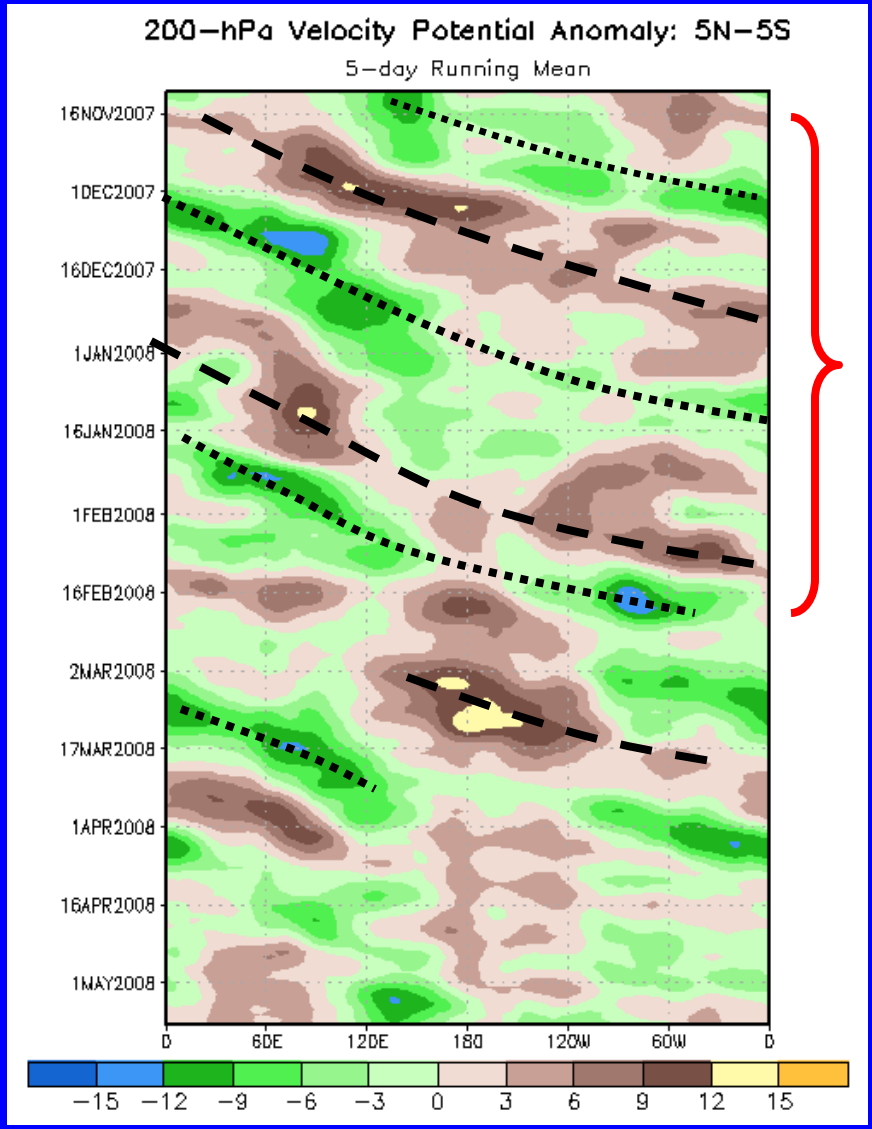


The current velocity potential anomalies show upper-level convergence stretching from the Atlantic to the Indian Ocean. Aside from Super Typhoon Rammasun, the main upper-level divergence has shifted eastward into the eastern Pacific Ocean.

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

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

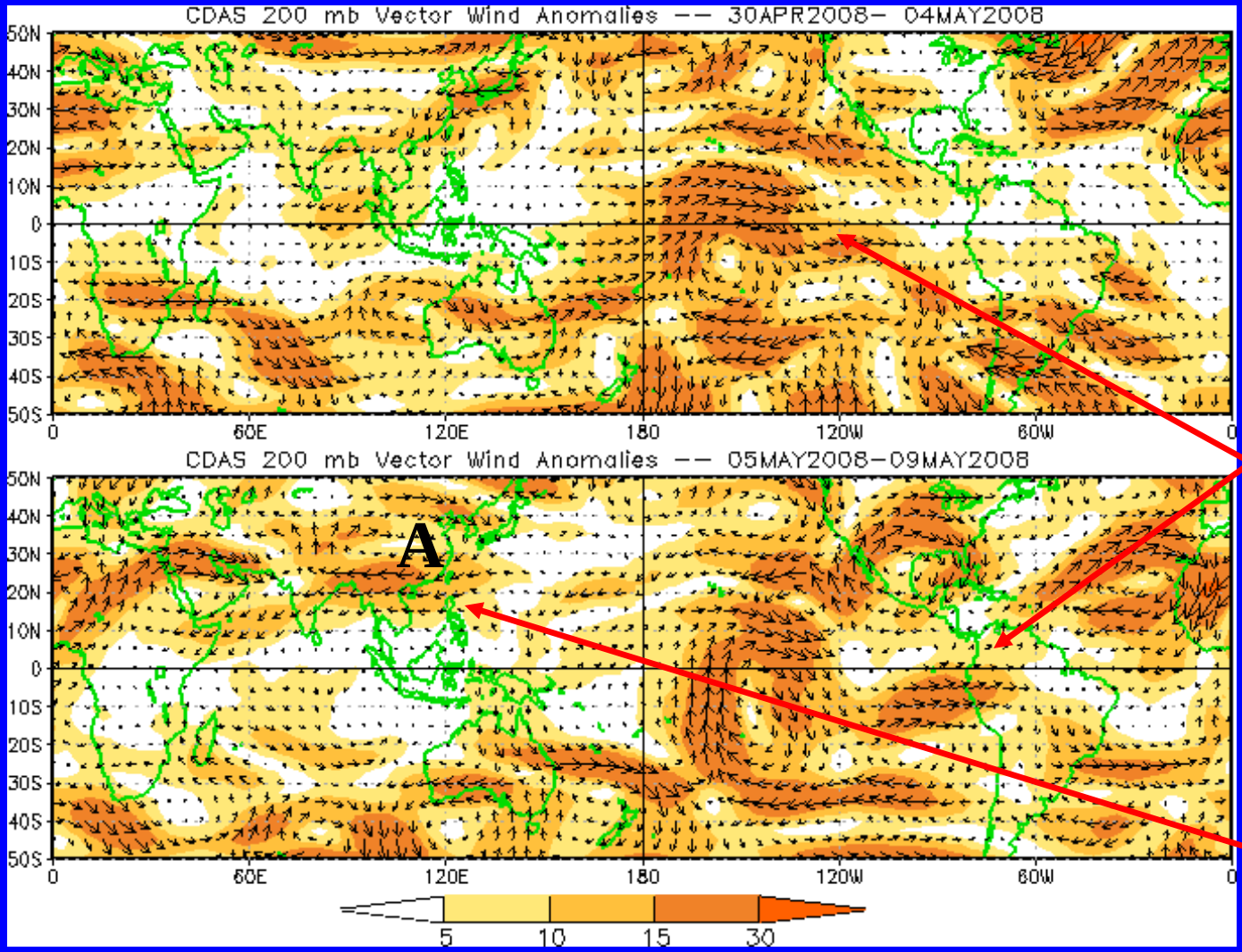
The MJO weakened during the second half of February but again strengthened during March.

The MJO was largely incoherent during the month of April.

During the past week, larger negative velocity potential anomalies have developed in the western Pacific.

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

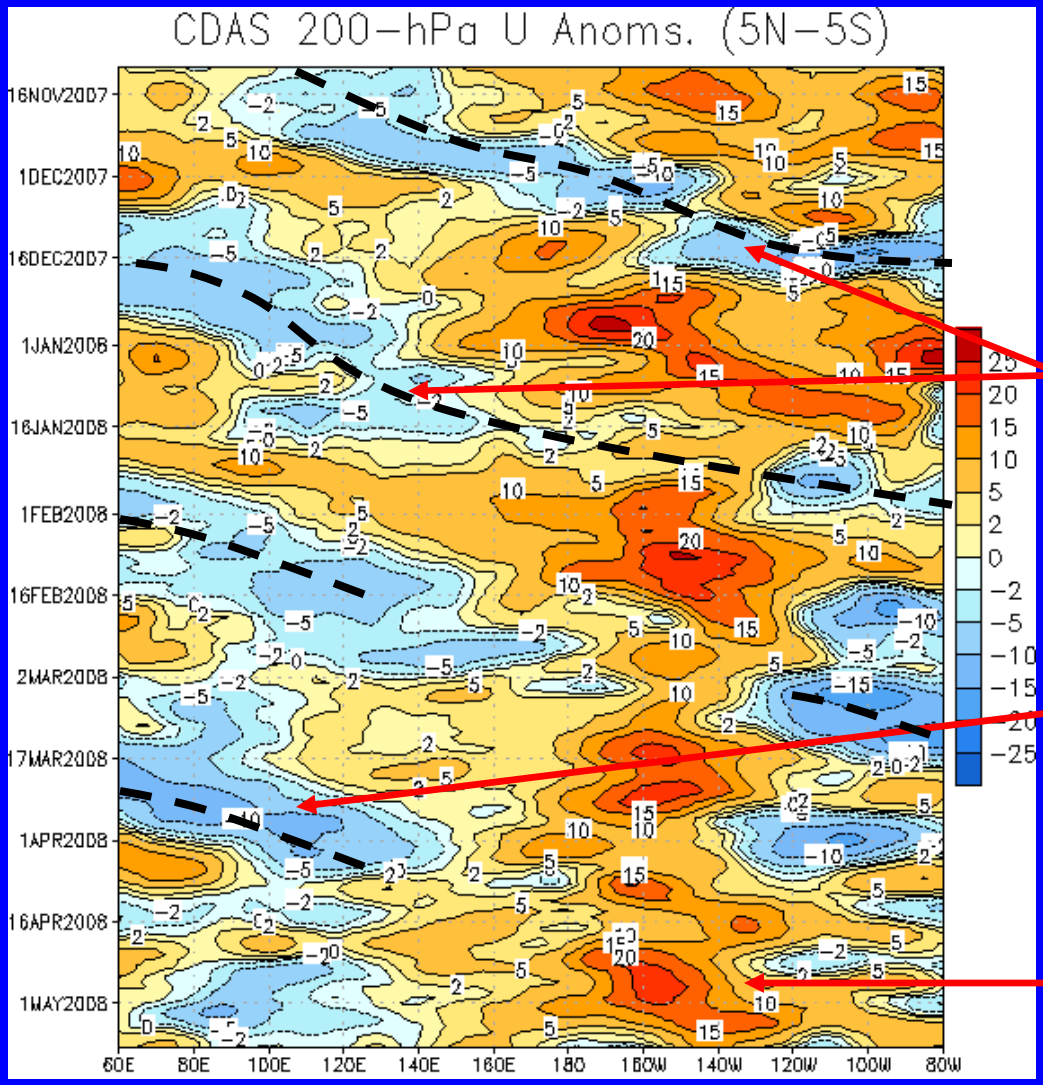
Note that shading denotes the magnitude of anomalous wind vectors



Westerly anomalies continue to impact a large area in the tropical Pacific and have shown some eastward movement during the last five days.

Anti-cyclonic circulation associated with enhanced convection over Southeast Asia and the Philippines 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

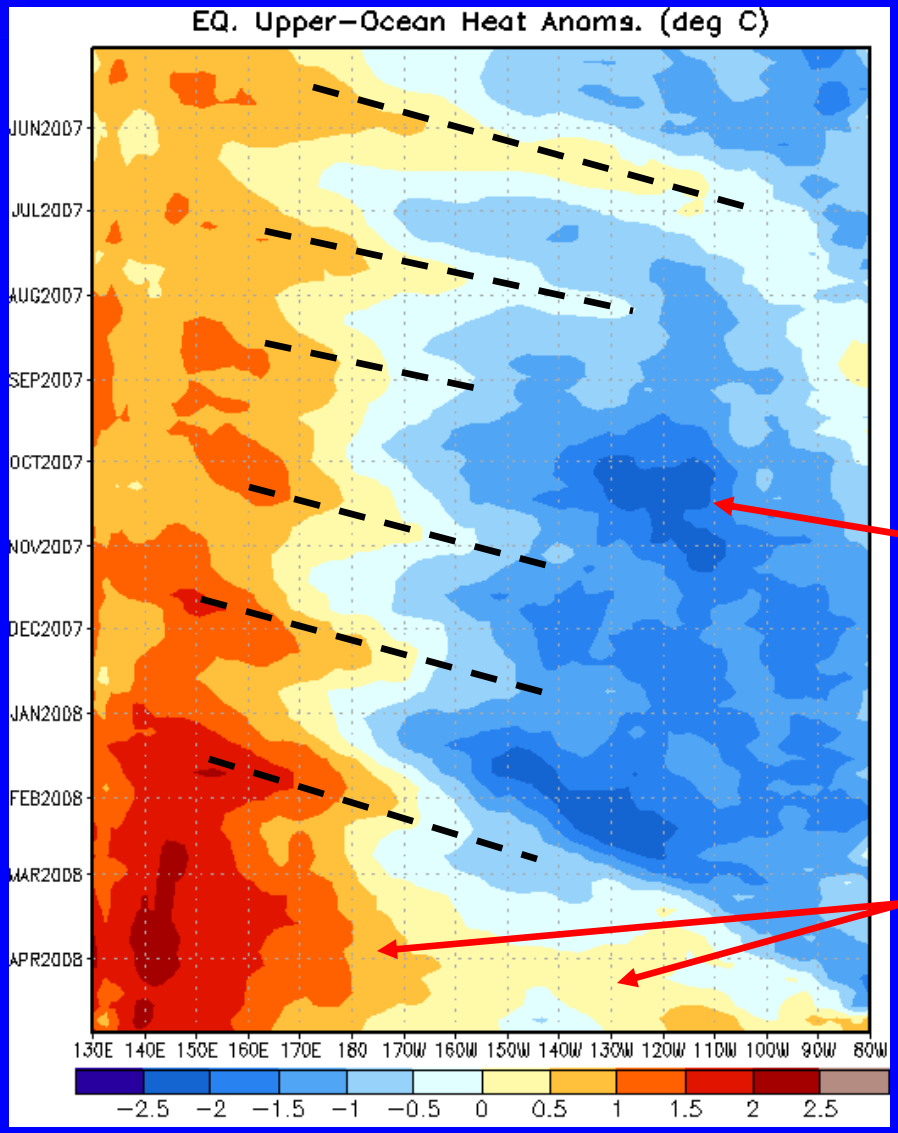
Easterly anomalies (blue shading) represent anomalous east-to-west flow

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

During March, easterly anomalies propagated quickly eastward from the western hemisphere to the Maritime continent region in part associated with weak MJO activity.

Westerly wind anomalies increased during late April across the central and eastern Pacific Ocean.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

Kelvin wave activity (downwelling phases indicated by dashed lines) was observed from May 2007 to February 2008 and affected sub-surface temperature departures at varying degrees across the Pacific Ocean. The strongest wave occurred during May and June 2007.

During September and October, negative heat content anomalies increased markedly across the eastern Pacific Ocean and continued until February 2008.

Beginning in March, increasingly positive anomalies have developed across parts of the western and central Pacific and have extended eastward into the eastern Pacific during April.

MJO Index -- Information

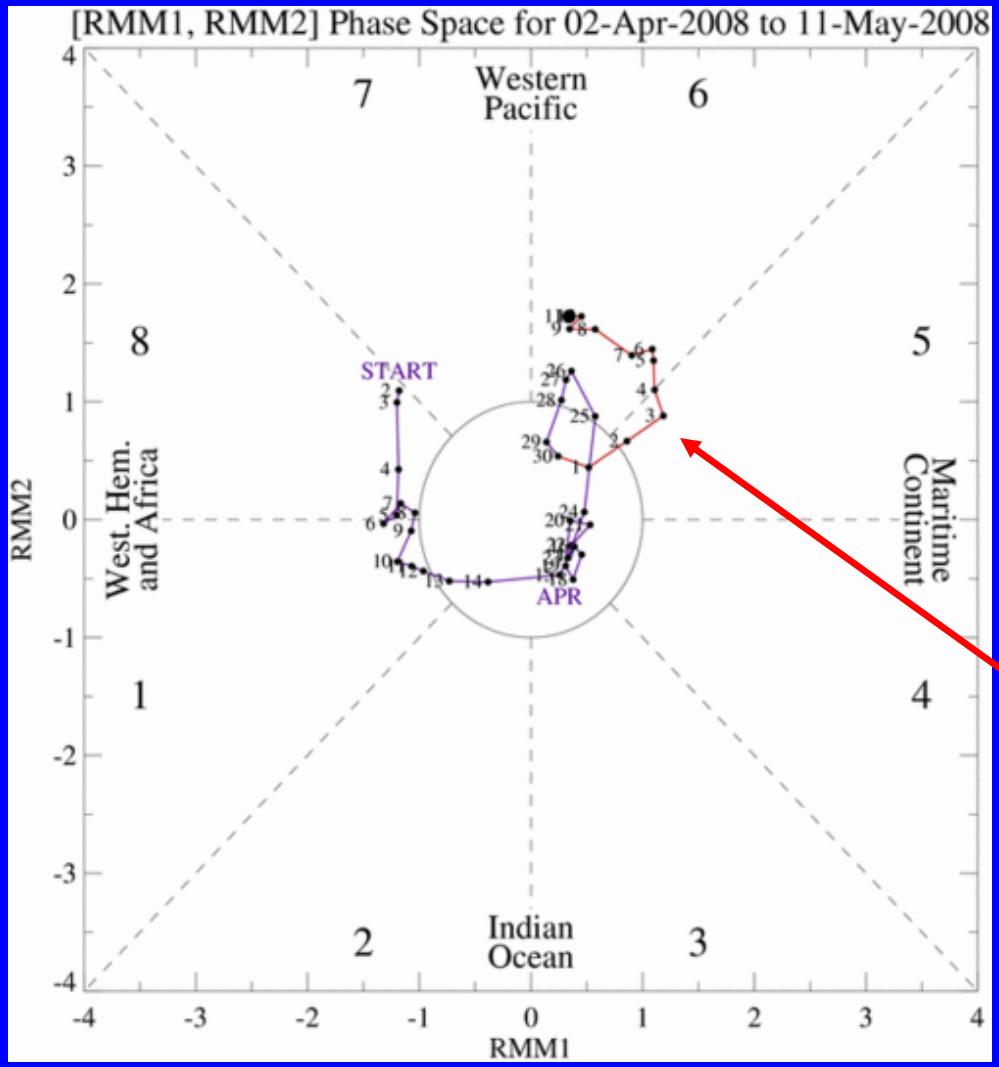
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

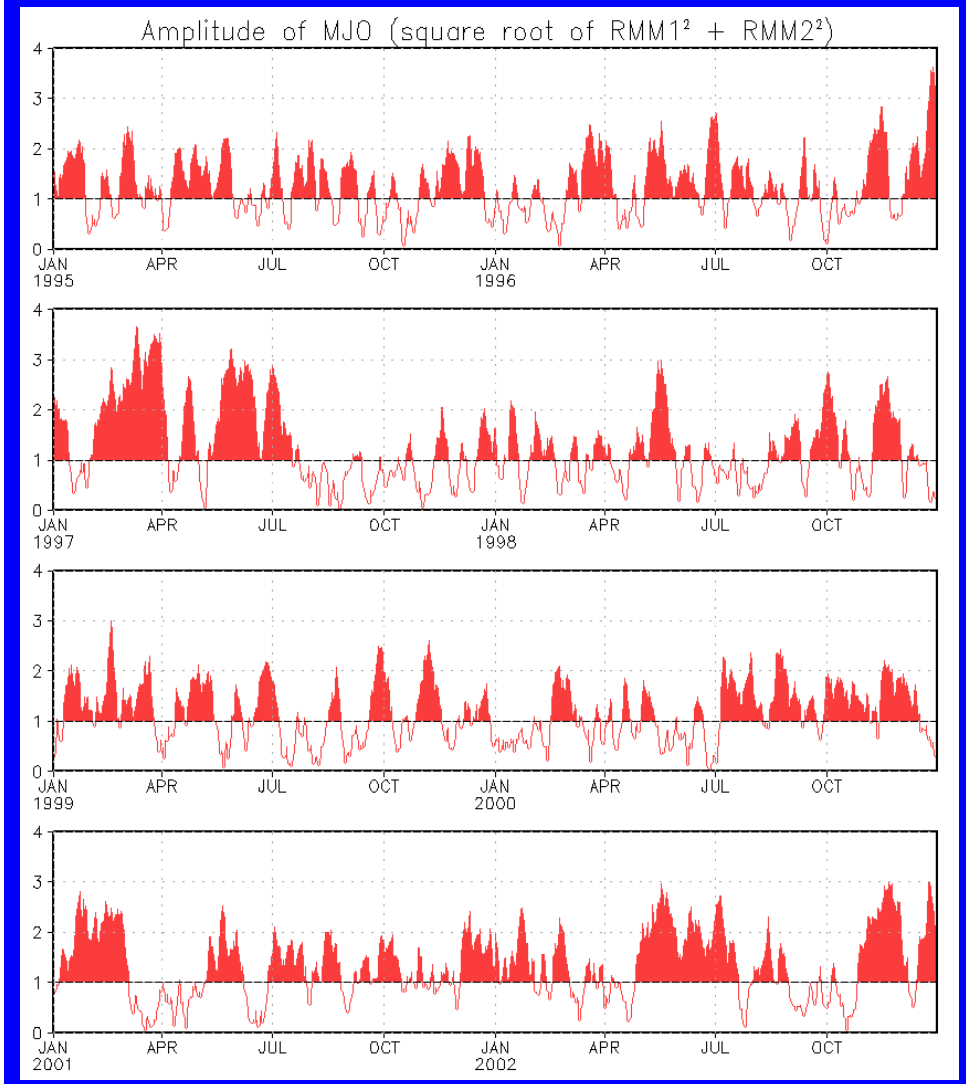
MJO Index -- Recent Evolution

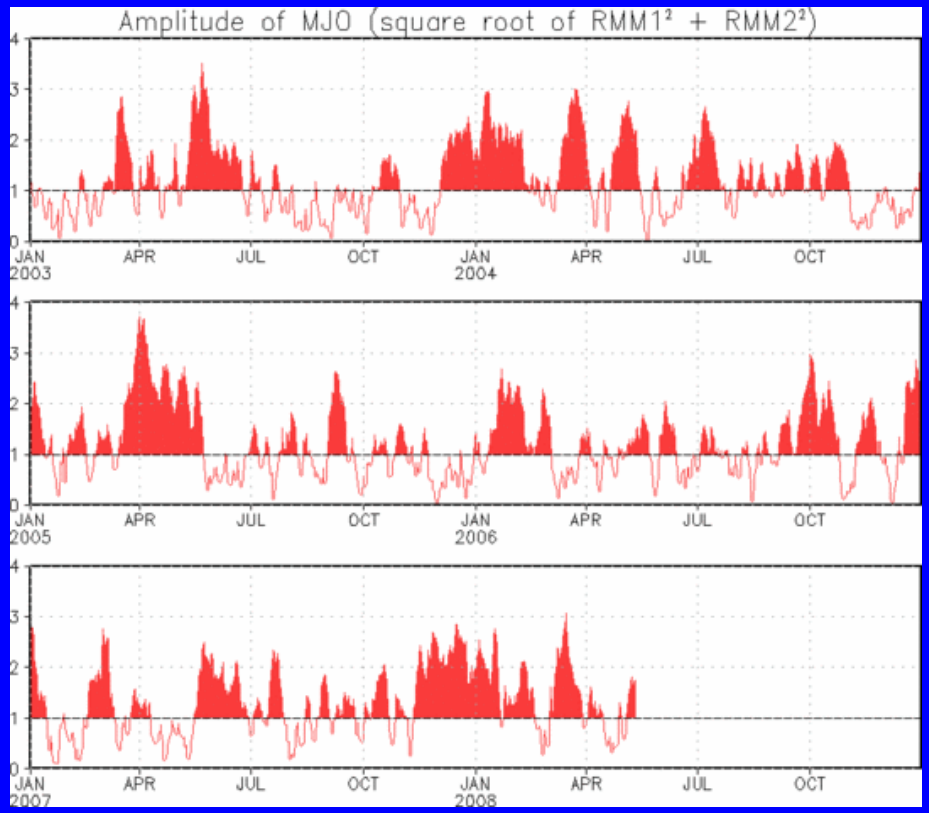


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation**
- **Distance from the origin is proportional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

The MJO index has increased in amplitude during the past week with some 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

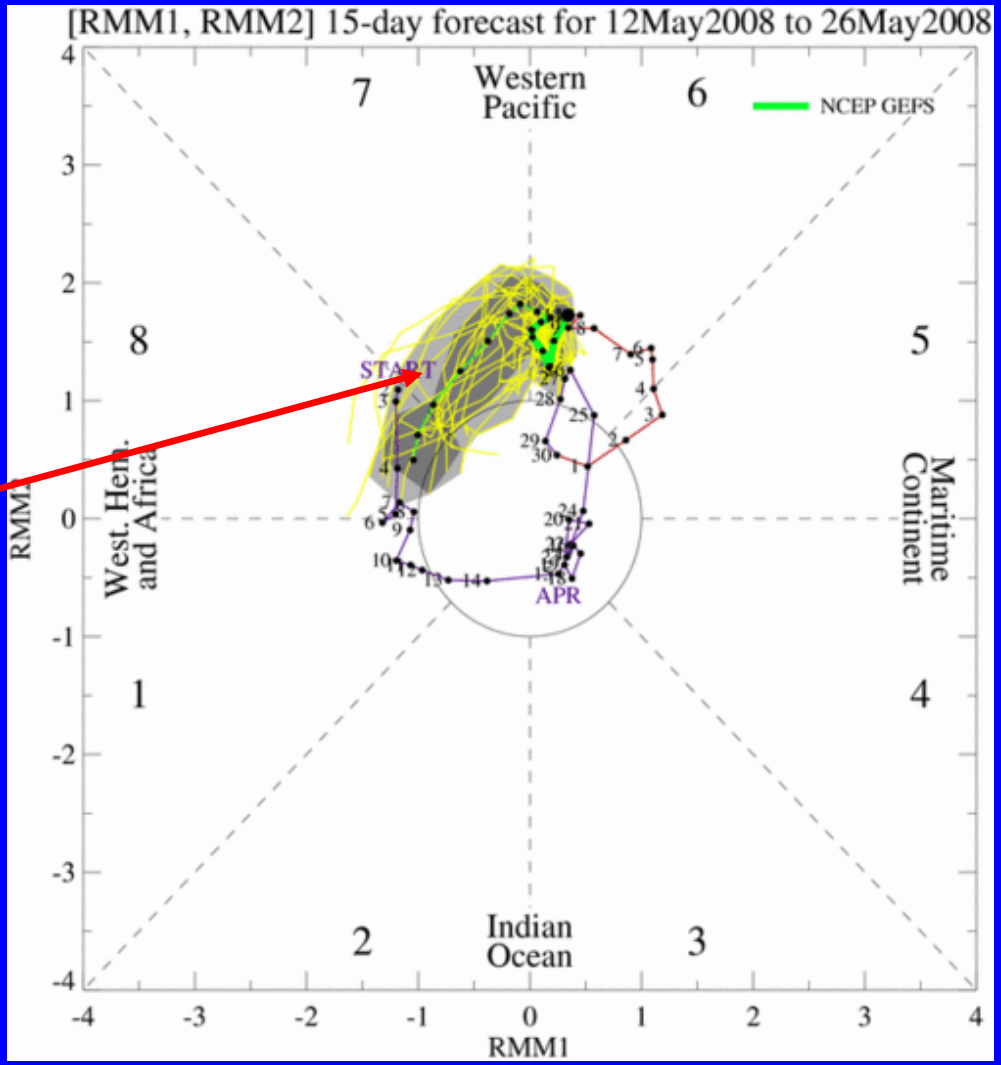
Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

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 generally weak MJO activity during the period with considerable uncertainty.

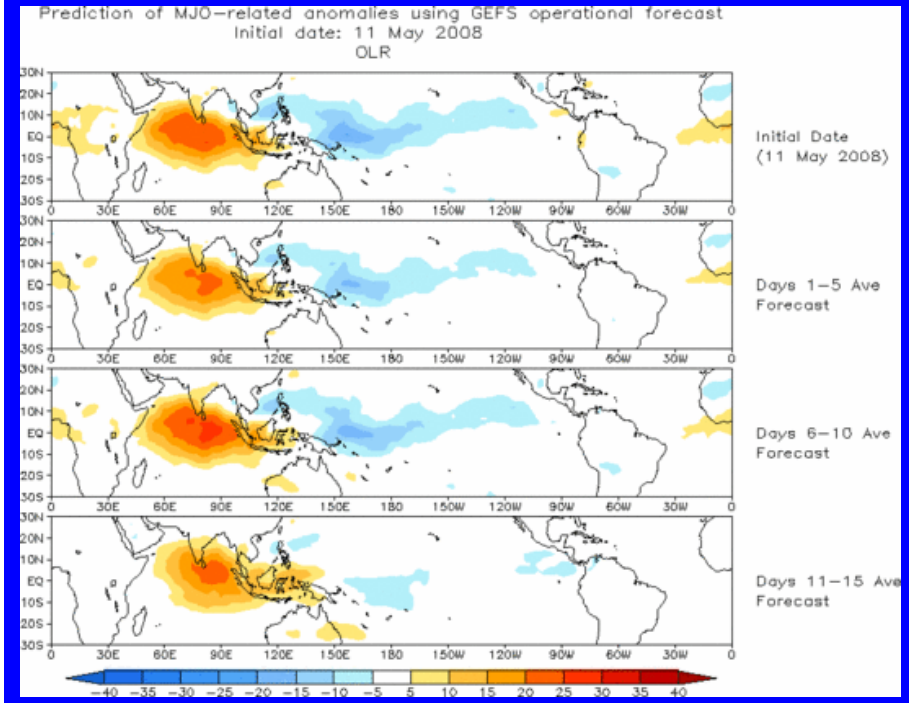
There is some propagation of the signal – mainly during week 2.



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)

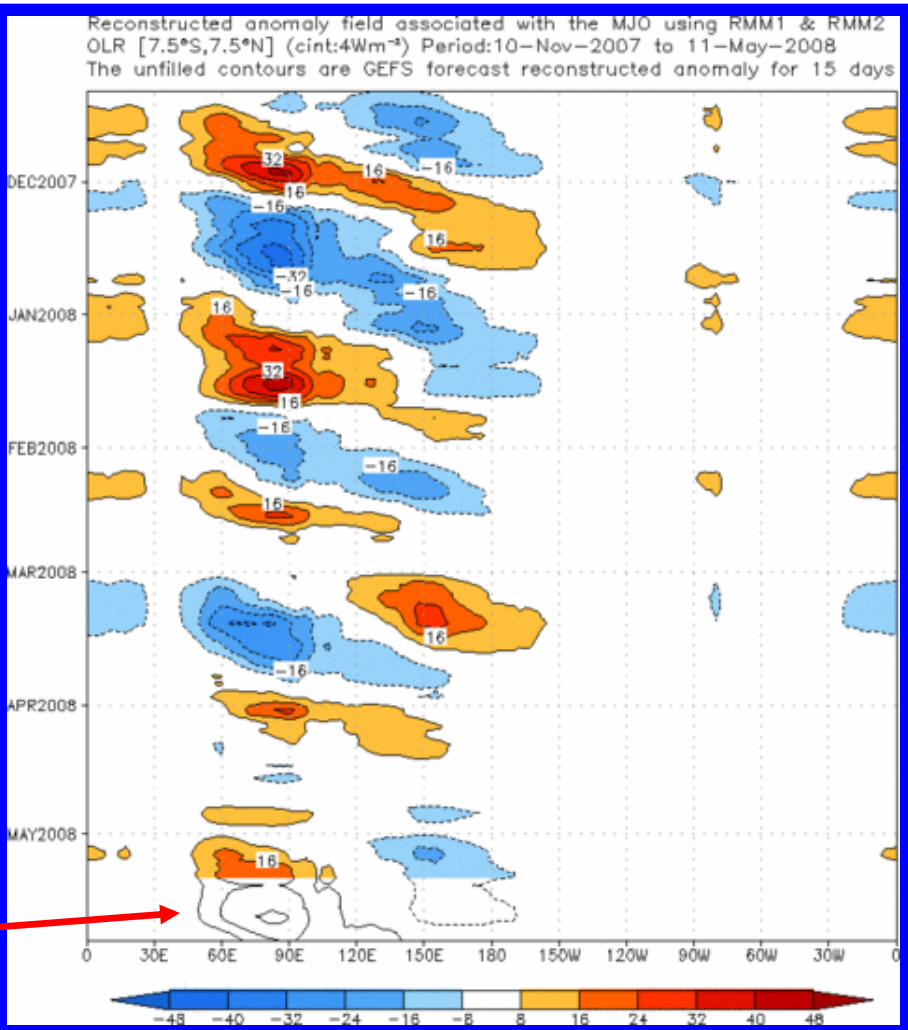
Spatial map of OLR anomalies for the next 15 days



The forecast from the GEFS for MJO-associated convection indicates suppressed (enhanced) convection for the Indian Ocean (western Pacific) especially early in the period.

Some eastward propagation is forecast during week 2.

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



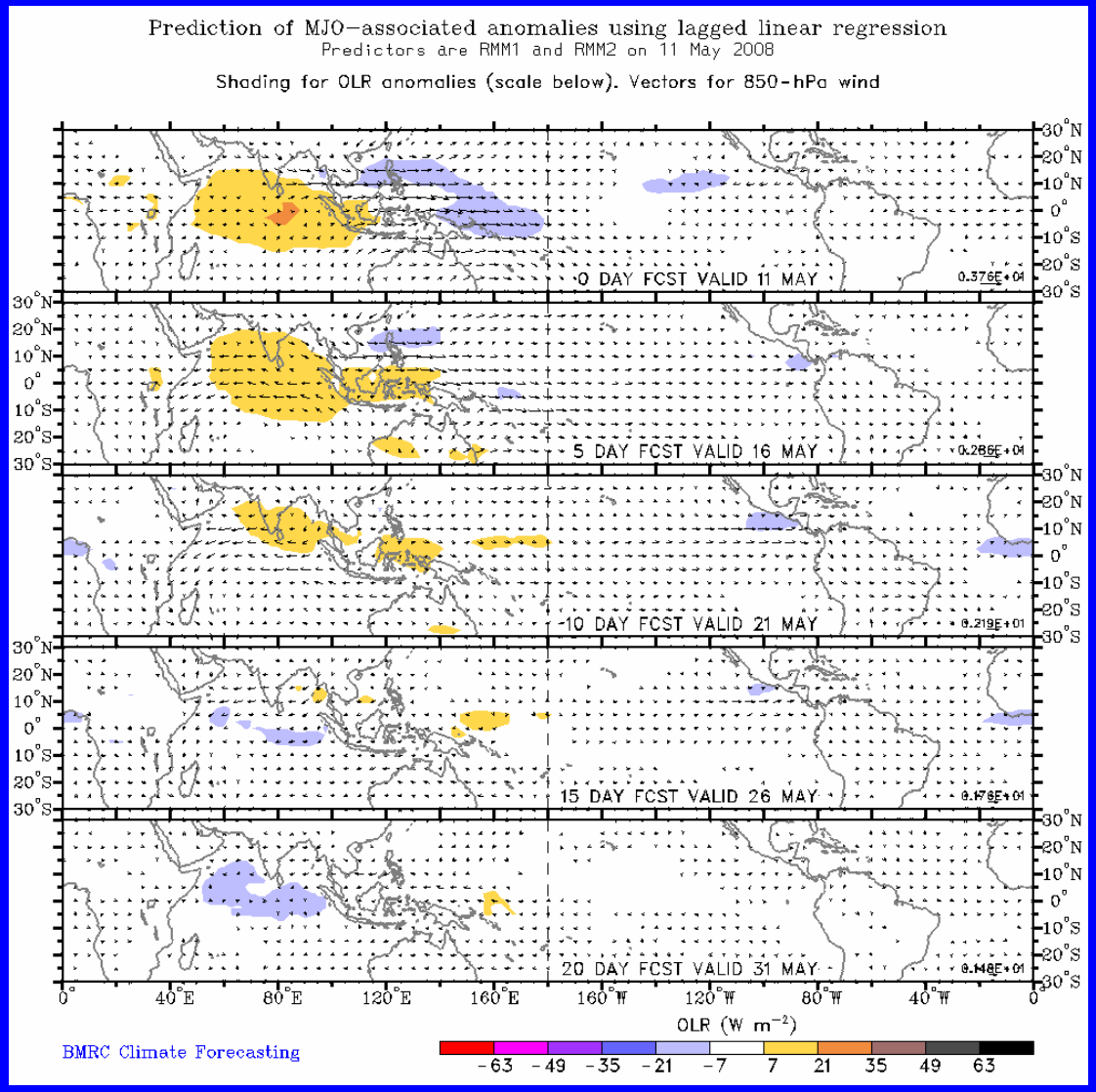
Statistical MJO Forecast

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

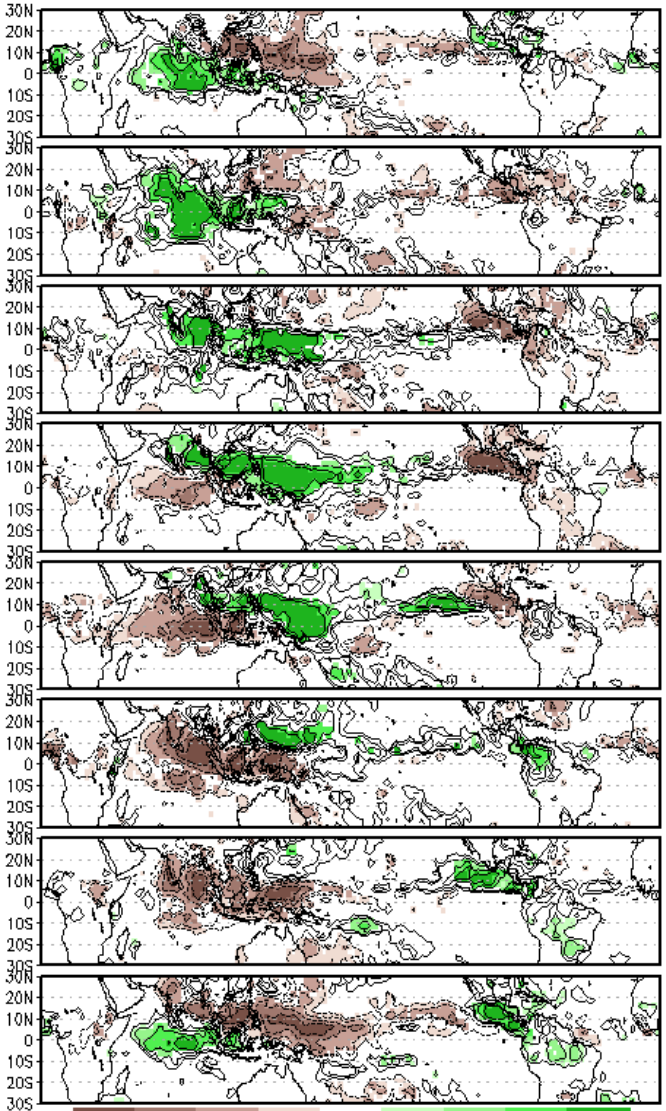
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

Weak MJO activity is forecast with suppressed convection across the Indian Ocean and western Indonesia during week 1.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)