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

Update prepared by
Climate Prediction Center / NCEP
August 11, 2008

Outline

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

Overview

- The MJO has become generally incoherent during the past week with the large-scale signal shifting westward.

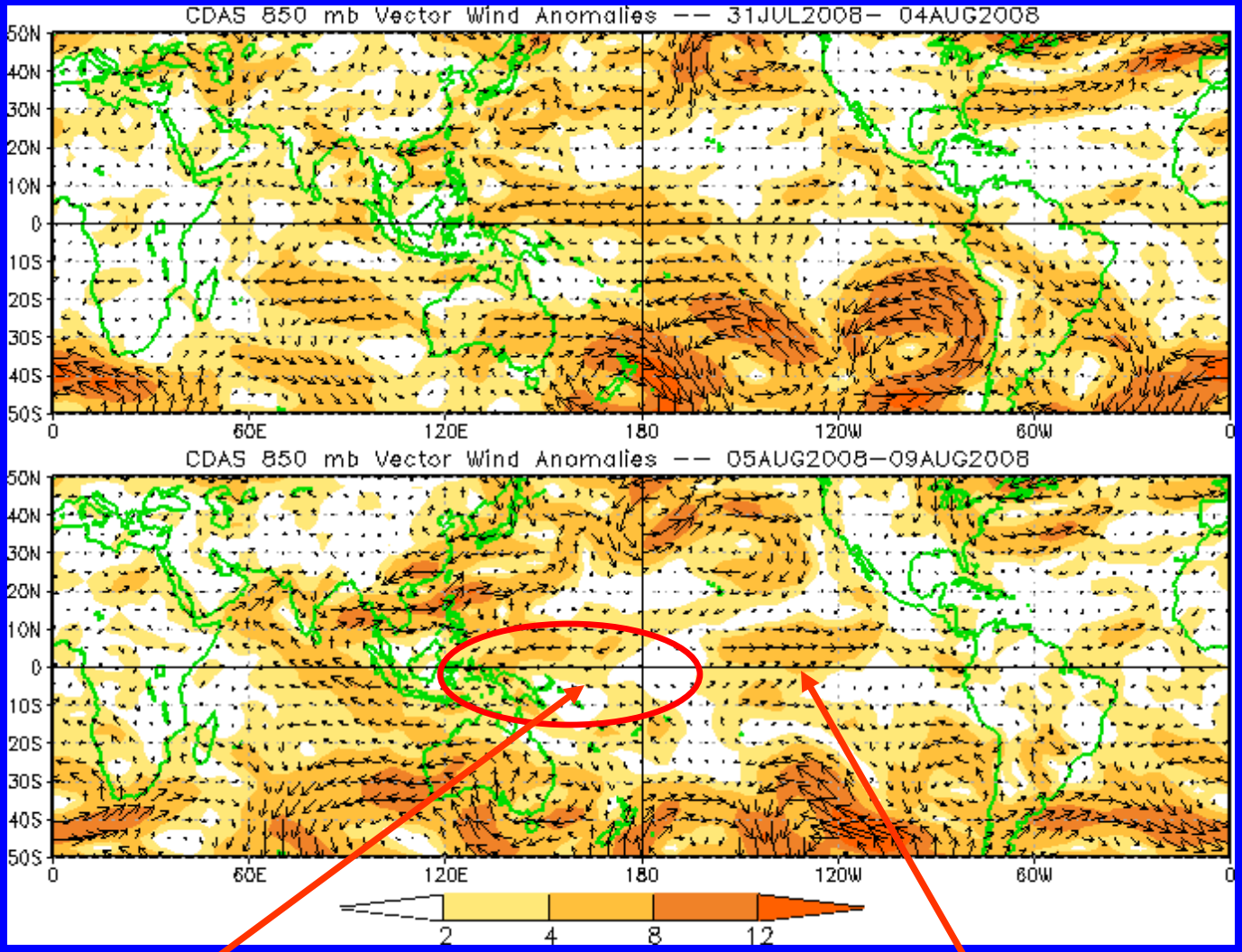
- Considerable spread exists in model forecasts for the upcoming MJO signal. Although a few tools indicate the possibility of a weak eastward propagating signal, the majority do not.

- Based on the above guidance and the most recent observations, the MJO is expected to remain weak or incoherent during the next 1-2 weeks.

Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the magnitude of anomalous wind vectors



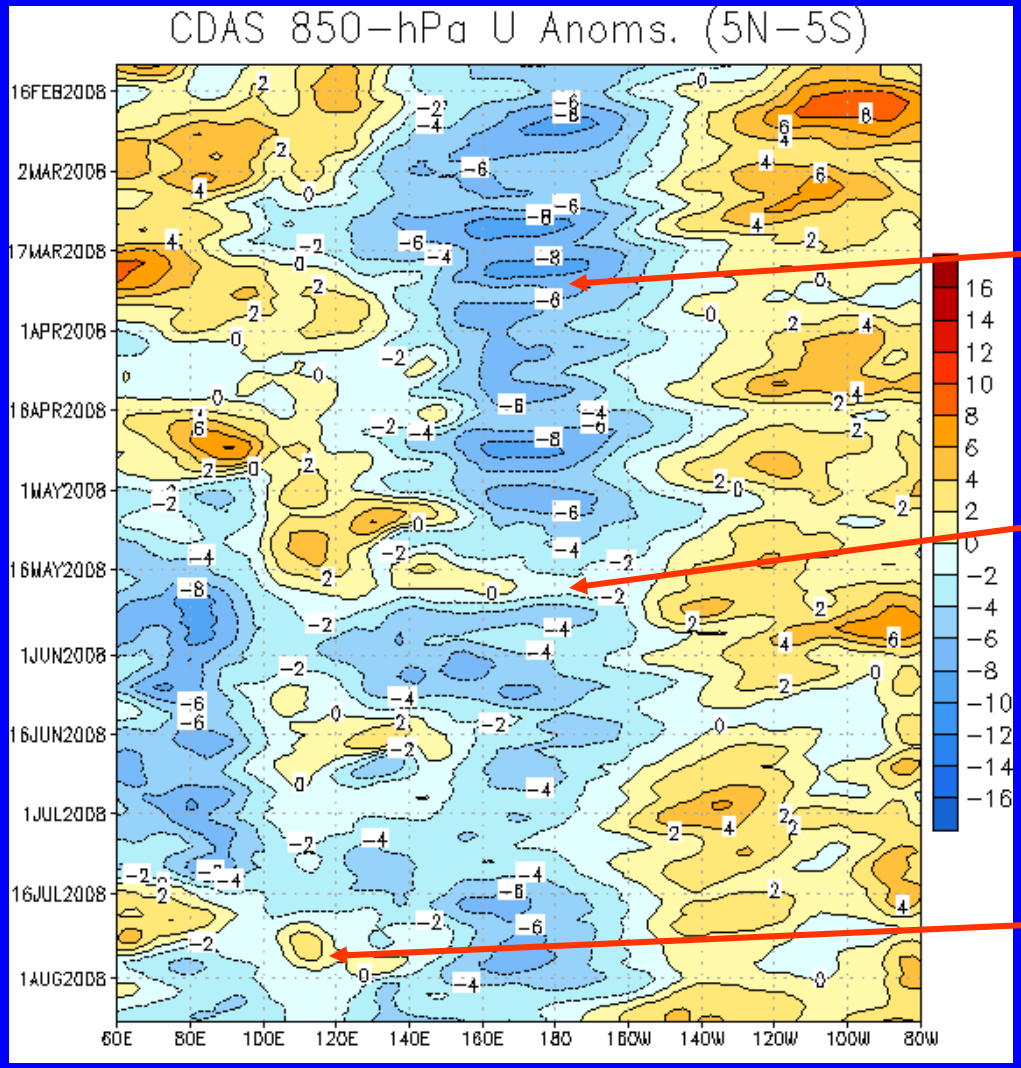
Low-level easterly anomalies have decreased across the western Pacific during the last five days.

Equatorial westerly anomalies have developed 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

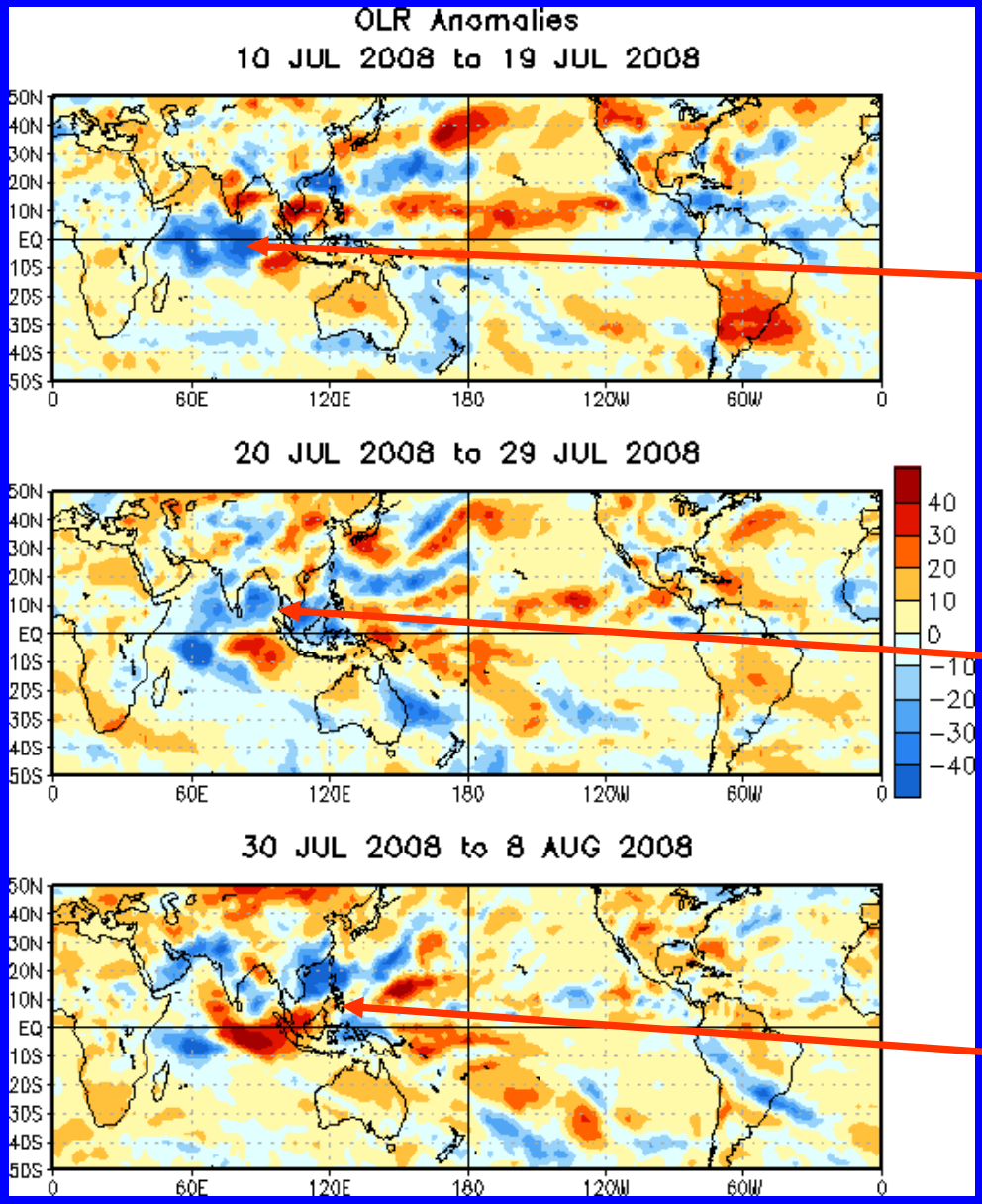
MJO activity was weak during much of March and April with strong anomalous easterlies continuing near the Date Line.

During mid-May, easterlies weakened across the western Pacific associated with moderate MJO activity.

Easterly anomalies have prevailed across much of the eastern hemisphere since late May.

Westerly anomalies were evident across parts of the Indian Ocean and Indonesia during the second half of July associated with the most recent MJO activity.

OLR Anomalies: Last 30 days



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

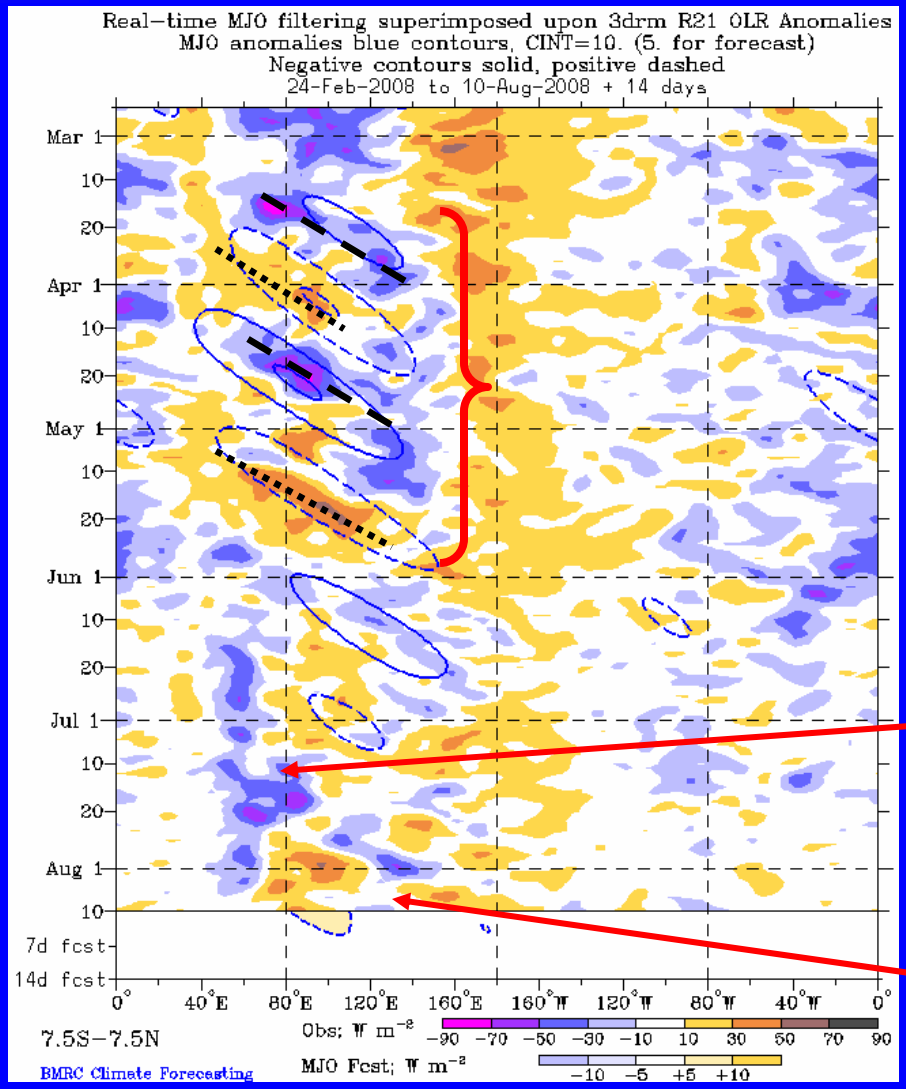
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

Enhanced convection developed across the entire equatorial Indian Ocean during mid-July.

Northeast propagation of enhanced convection is evident during late-July. These are indicative of the most recent MJO activity.

During early August, dry conditions are developed over central-eastern Indian Ocean.

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



Time

Longitude

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

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

(Courtesy of the Bureau of Meteorology - Australia)

MJO activity was evident from mid-March into early June at varying levels of intensity. The strongest MJO activity occurred as strong suppressed convection organized across the Indian Ocean and shifted eastward during mid-to-late May.

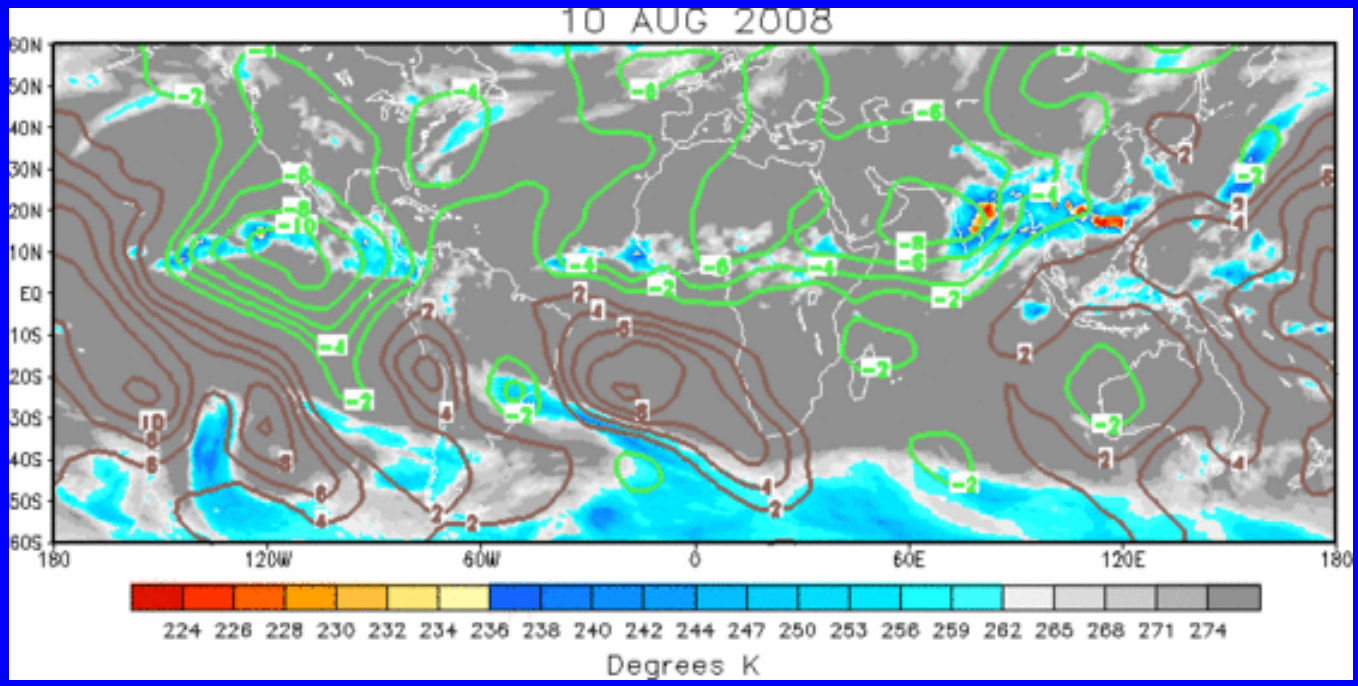
Persistent enhanced convection has been evident across the western Indian Ocean since mid-June.

During the past ten days, suppressed convection is evident across the equatorial Indian Ocean and western Indonesia.

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

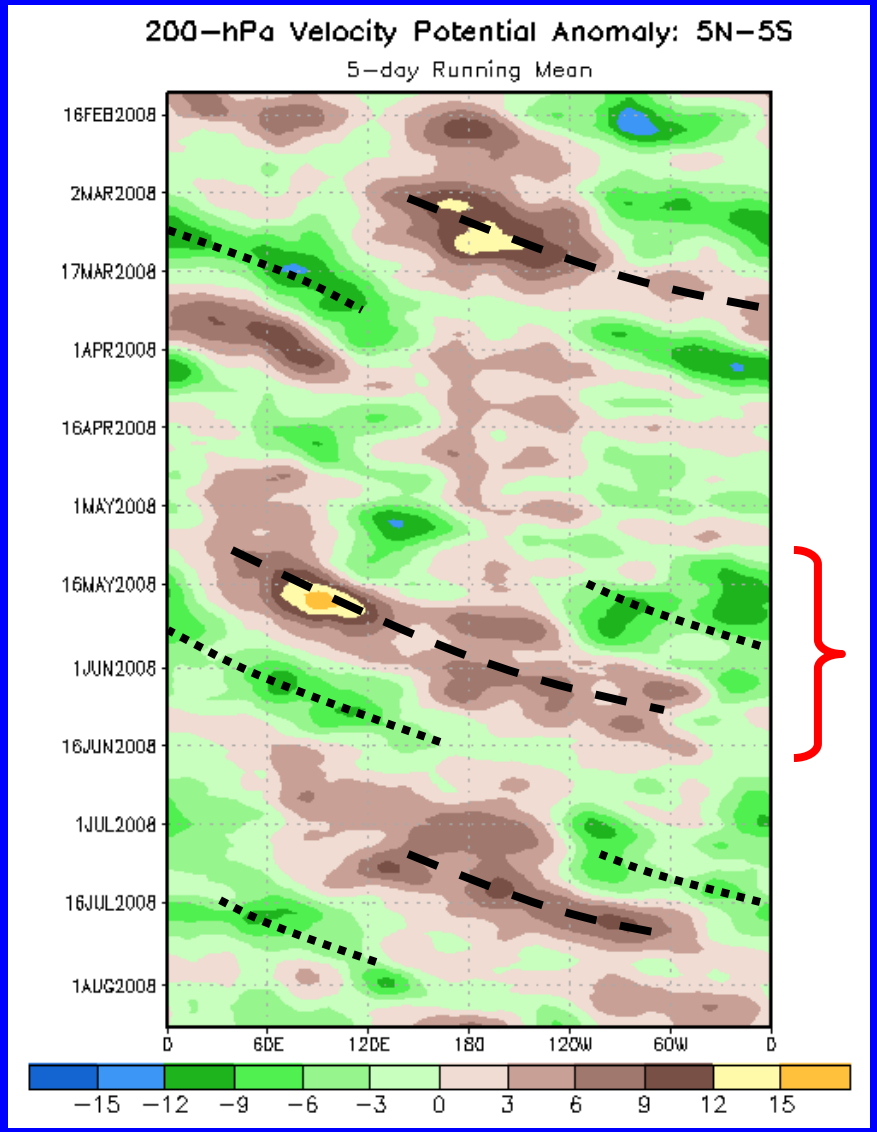


Upper-level divergence is evident across the eastern Pacific, Africa and southern Asia. Upper-level convergence along the equator is focused across Indonesia and the western Pacific.

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

Weak-to-moderate MJO activity was evident during March.

The MJO was largely incoherent during the month of April.

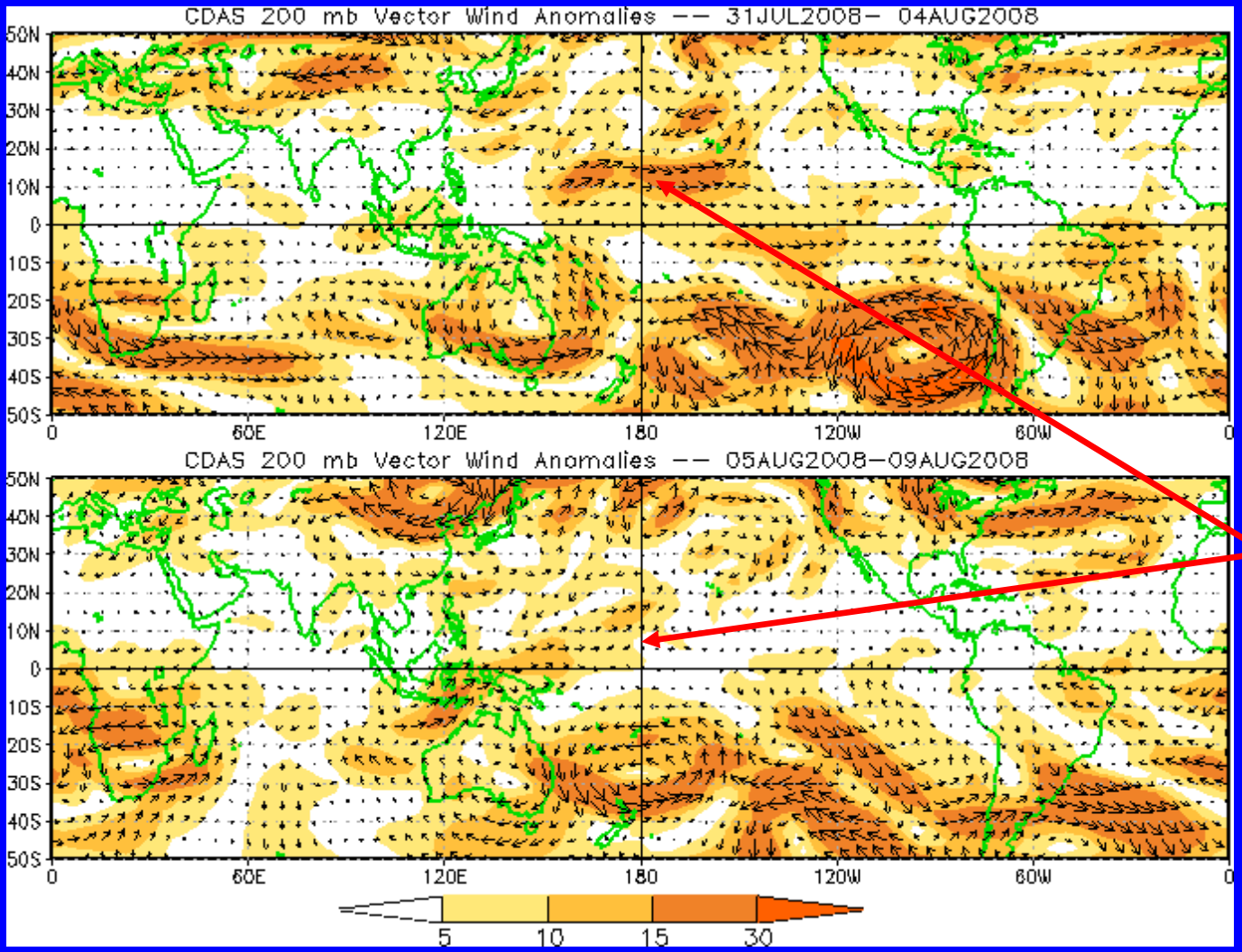
A moderate-to-strong MJO was observed from mid-May through mid-June as eastward propagation was more coherent and longer-lived.

After weakening in late June, the MJO strengthened during mid-July.

Recently, the MJO has once again become less coherent.

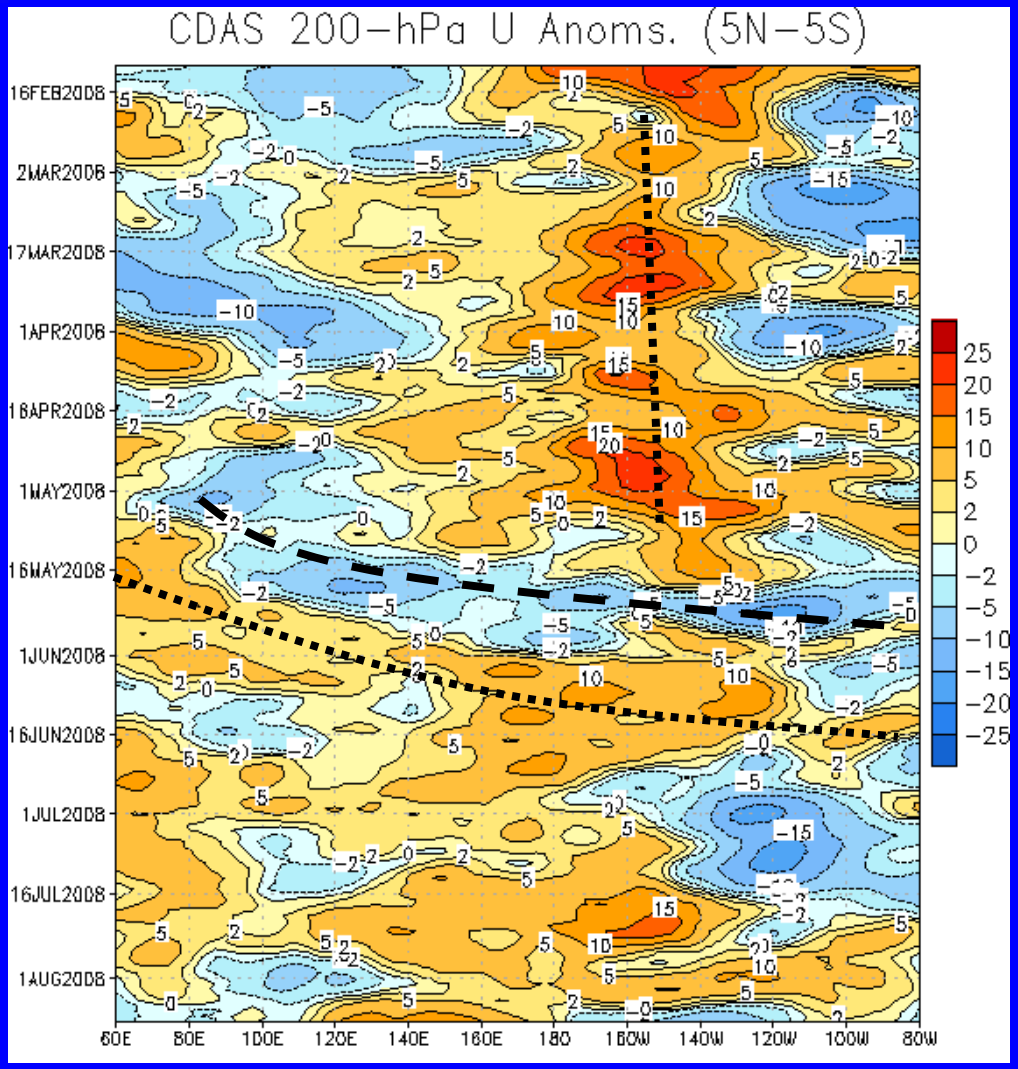
200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the magnitude of anomalous wind vectors



Upper-level westerly anomalies north of the Equator across the central Pacific Ocean have decreased 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

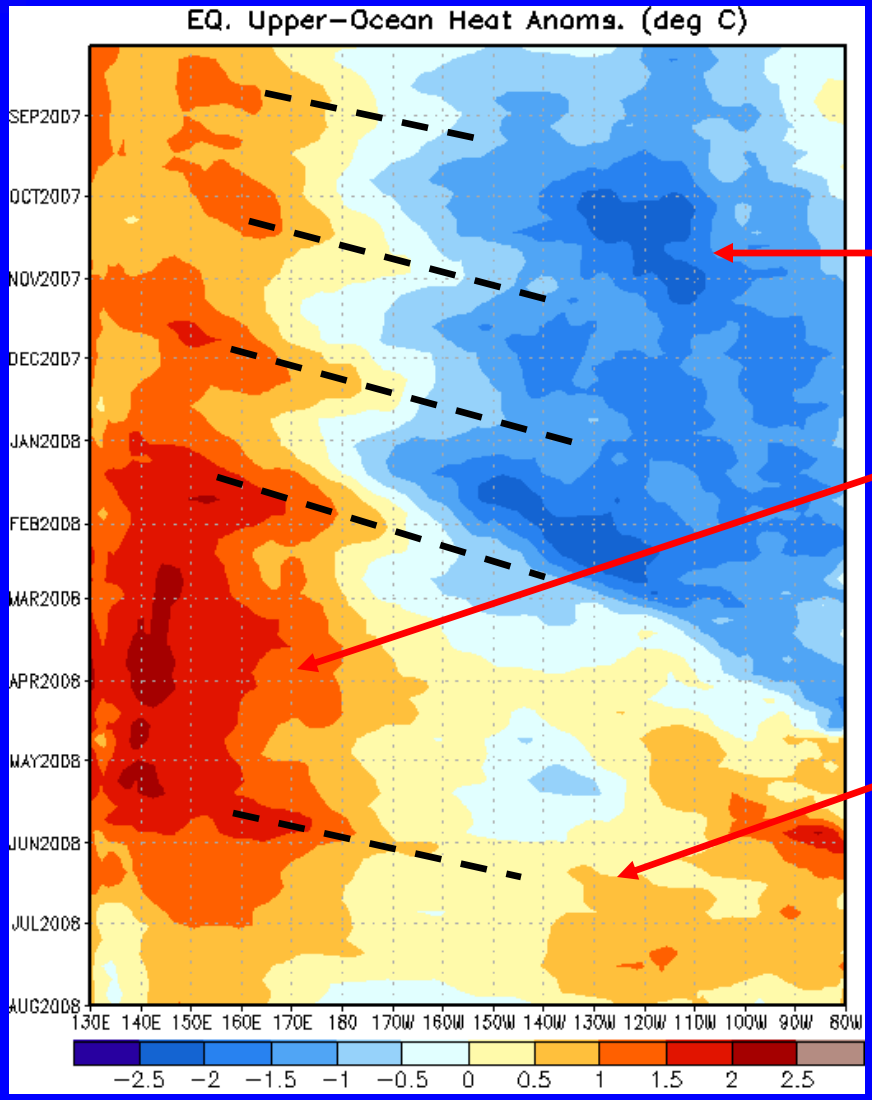
Easterly anomalies (blue shading) represent anomalous east-to-west flow

The MJO was weak or incoherent for much of the period from mid-February through April and upper-level winds indicate generally strong and persistent westerly anomalies near and east of the Date Line.

During May and early June, eastward propagation was evident in the upper-level wind field and was associated with the moderate-to-strong MJO activity during this time.

During late July, westerly anomalies extend across much of the global tropics.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

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

Beginning in February, increasingly positive anomalies developed across parts of the western and central Pacific but have since decreased.

During June and July 2008, positive heat content anomalies encompass much of the Pacific basin in part associated with a Kelvin wave initiated during May 2008.

During early August 2008, negative anomalies stated to develop in response to enhanced easterly surface wind.

MJO Index -- Information

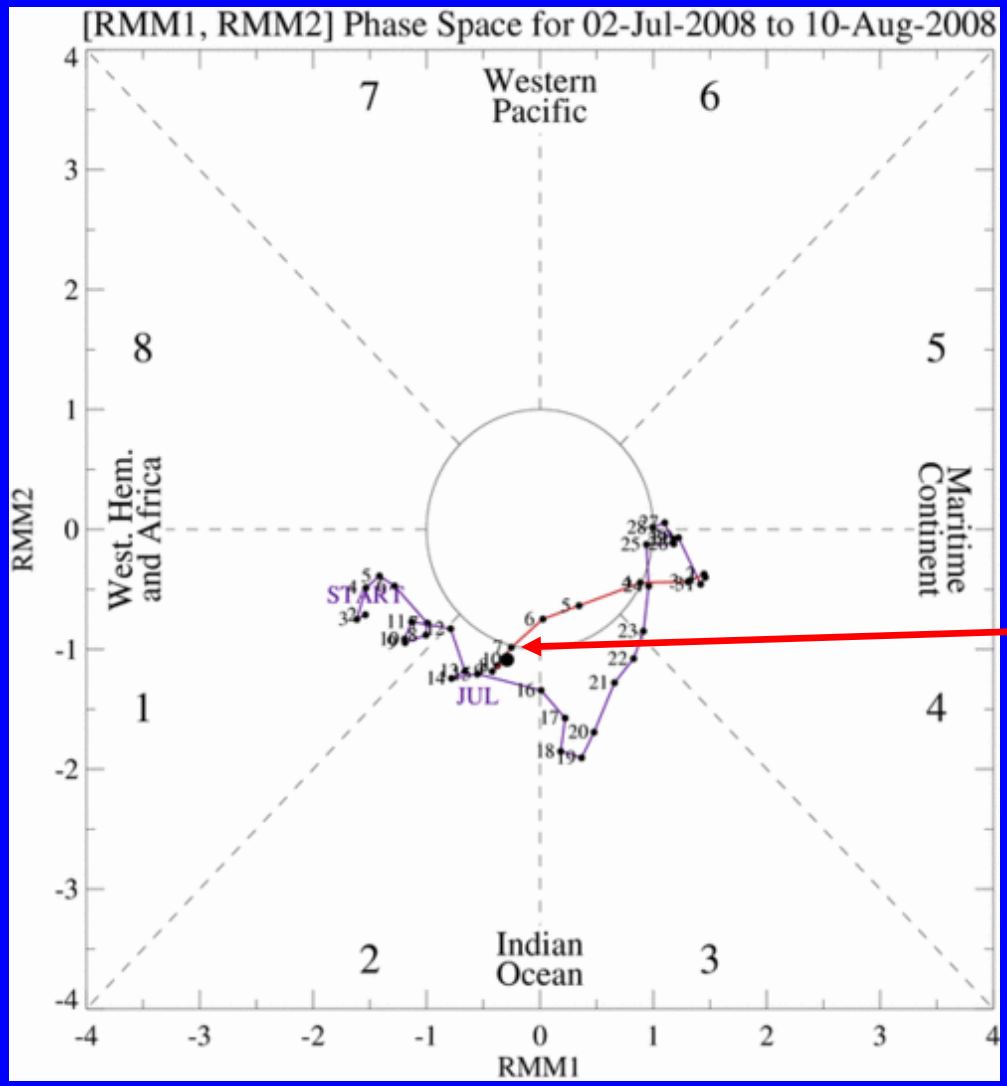
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

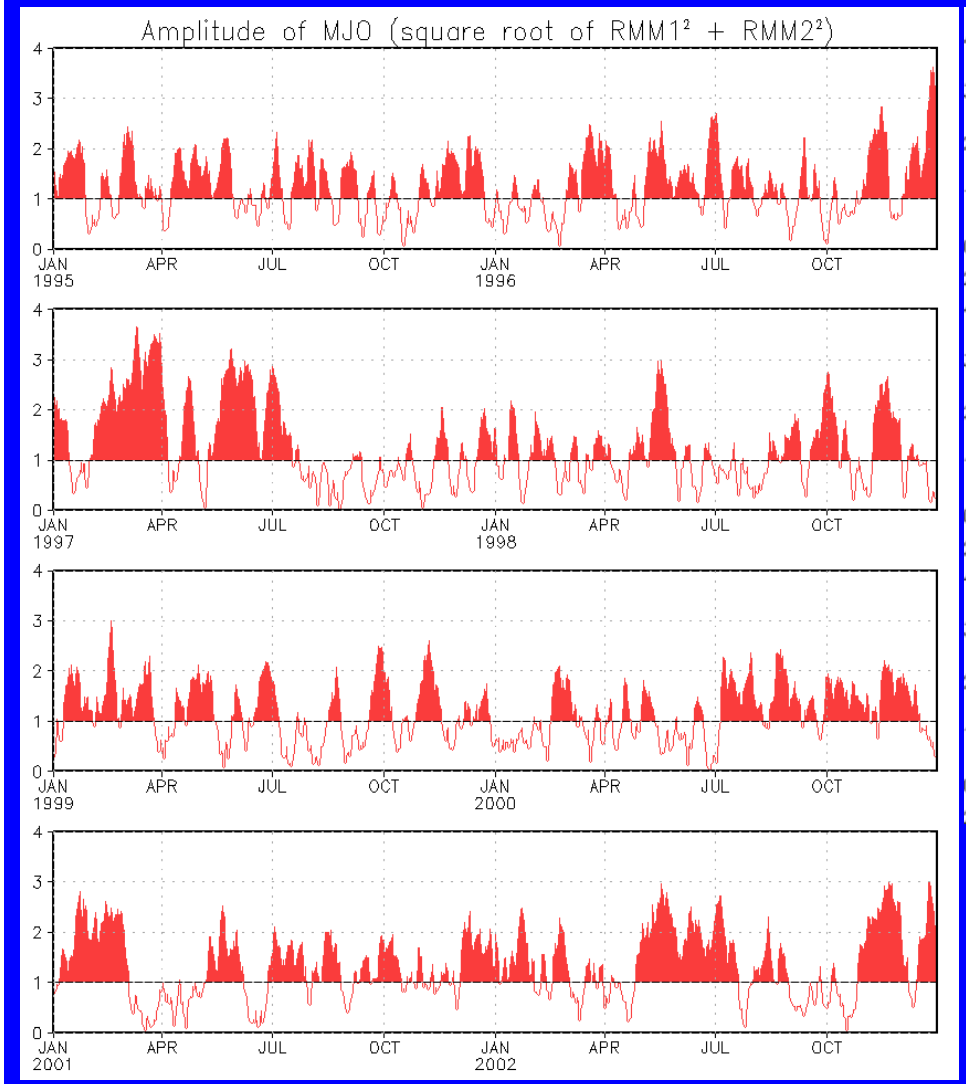
MJO Index -- Recent Evolution

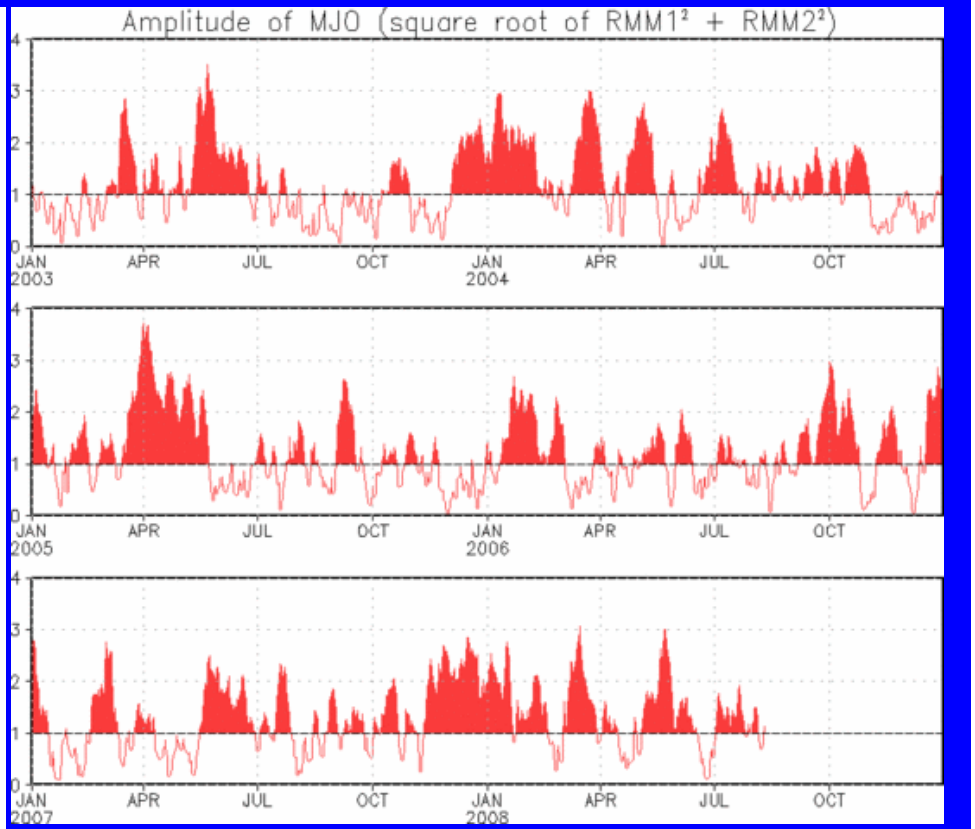


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation**
- **Distance from the origin is proportional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

The MJO index indicates incoherent activity with a shift in the large-scale MJO signal back to the west during the past week.

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

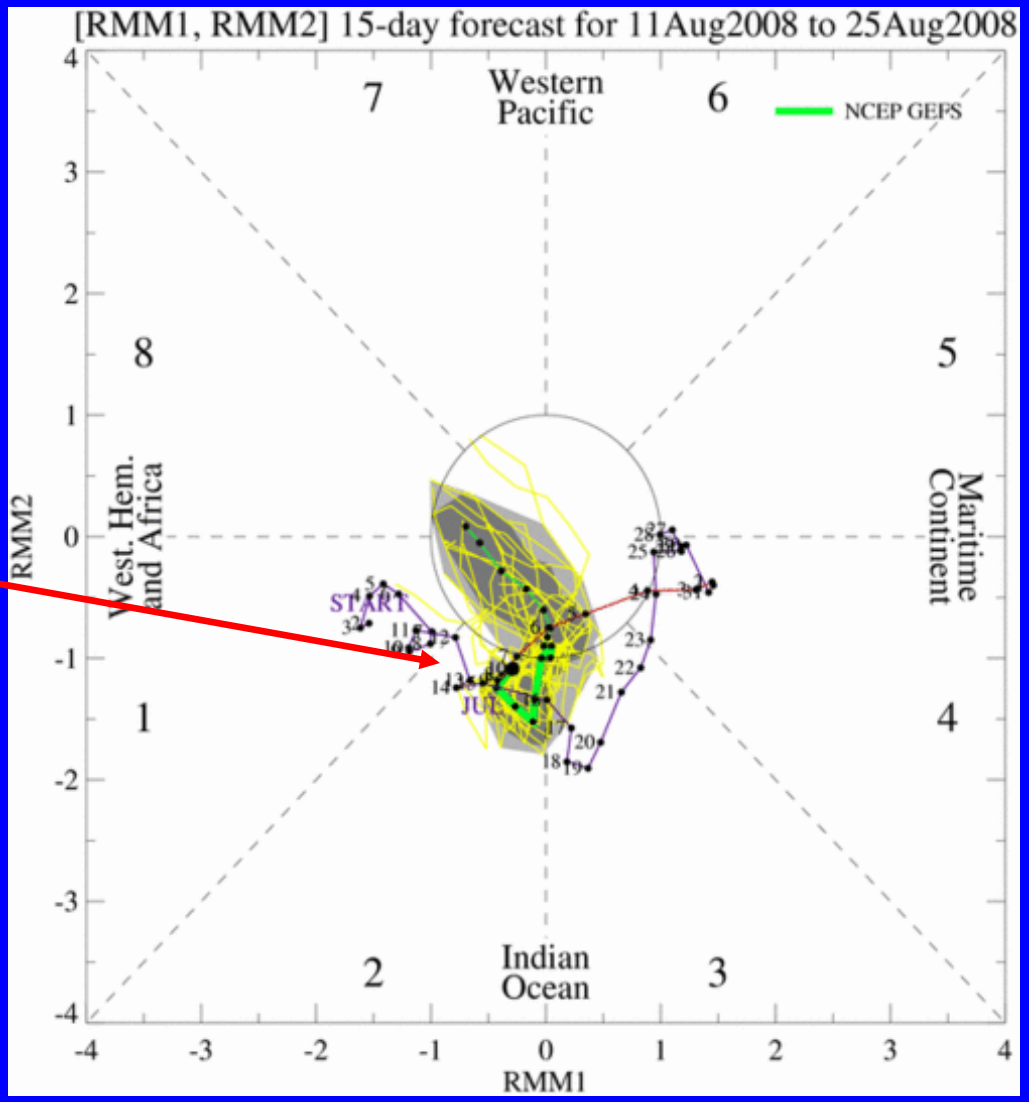
Ensemble GFS MJO Forecasts

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

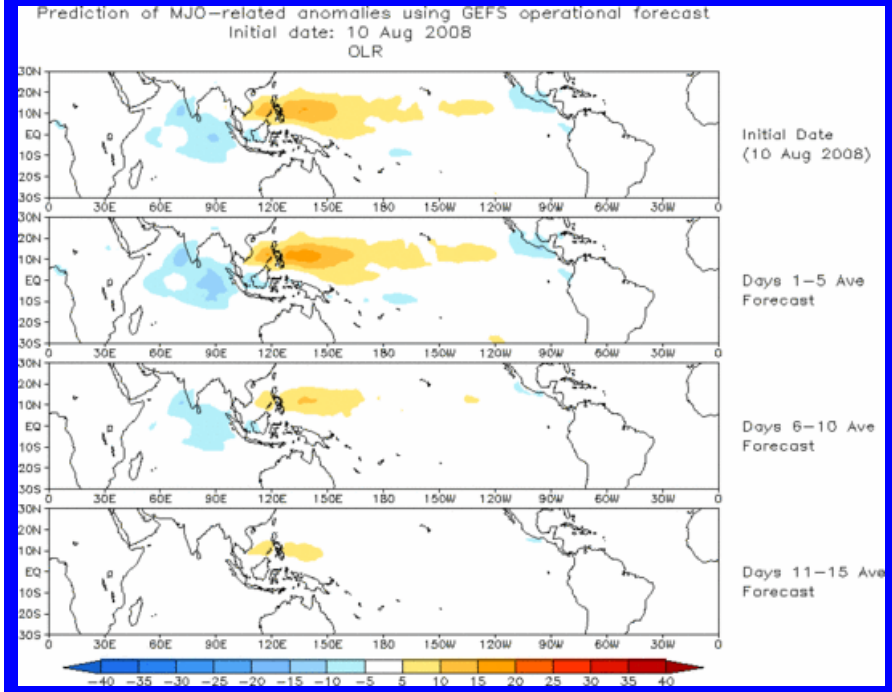
The GEFS predicts a week MJO signal for most of the period.



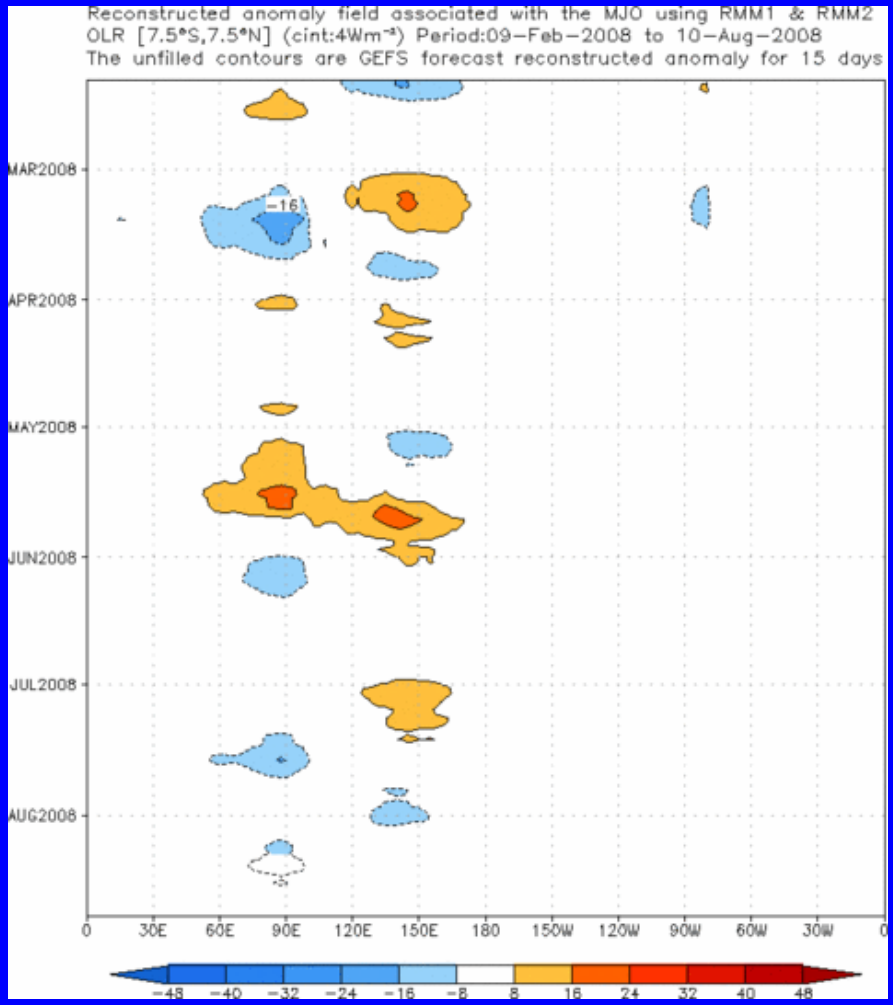
Ensemble Mean GFS MJO Forecast

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



The forecast from the ensemble mean GEFS indicates mainly weak enhanced (suppressed) convection across the Indian (western Pacific) Ocean throughout the period.

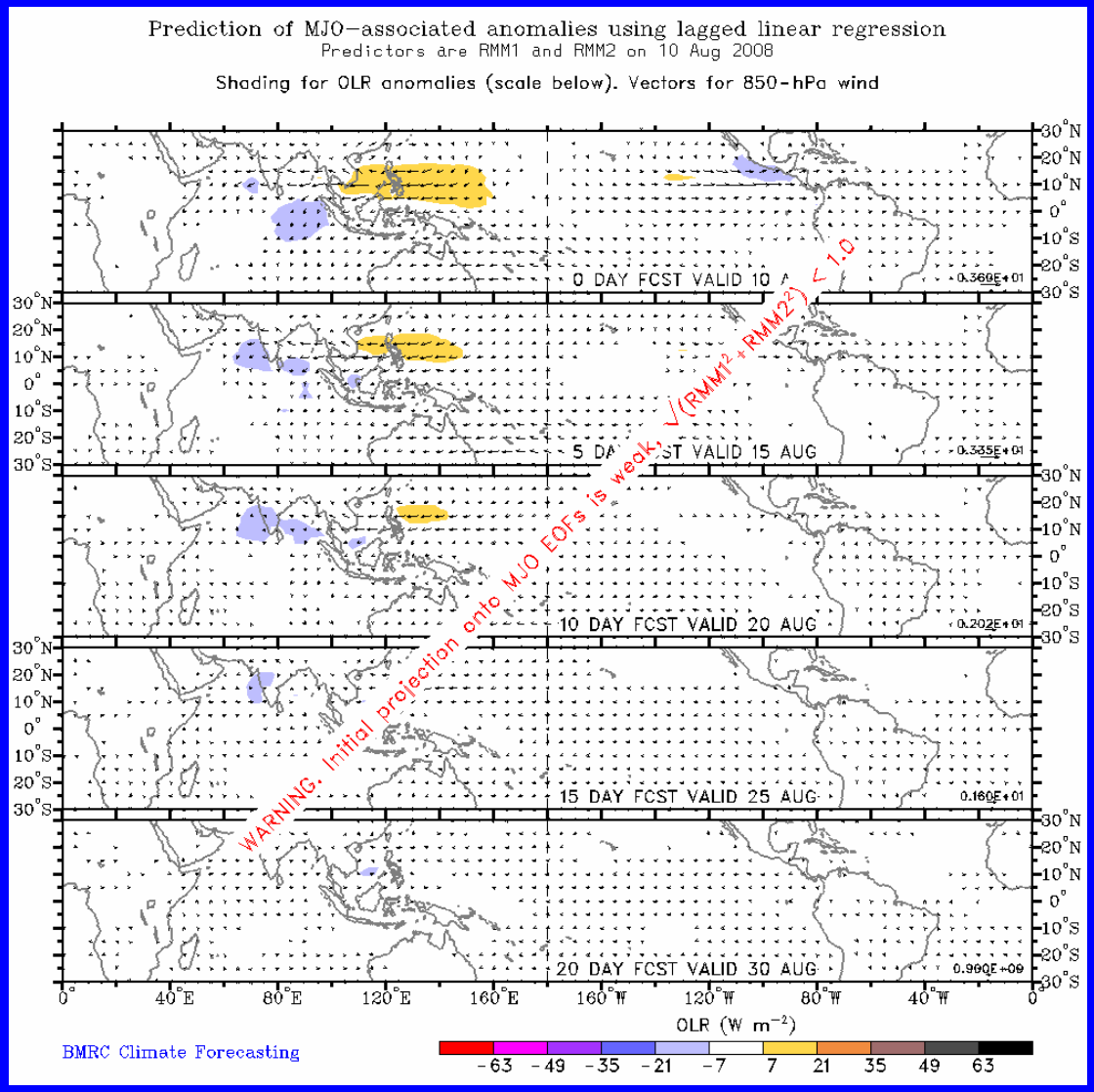
Statistical MJO Forecast

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

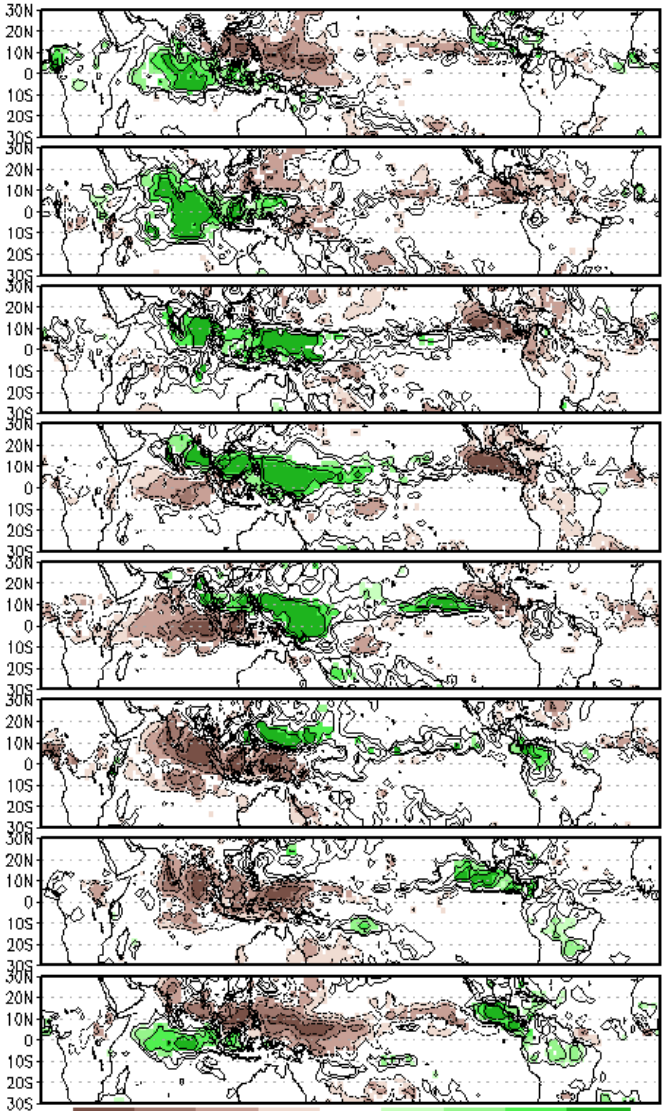
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

Weak MJO activity is forecast during the next two weeks.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)