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

Update prepared by
Climate Prediction Center / NCEP
July 7, 2008

Outline

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

Overview

- The MJO remains incoherent. Most forecast tools indicate the MJO signal will remain incoherent during the next 1-2 weeks.

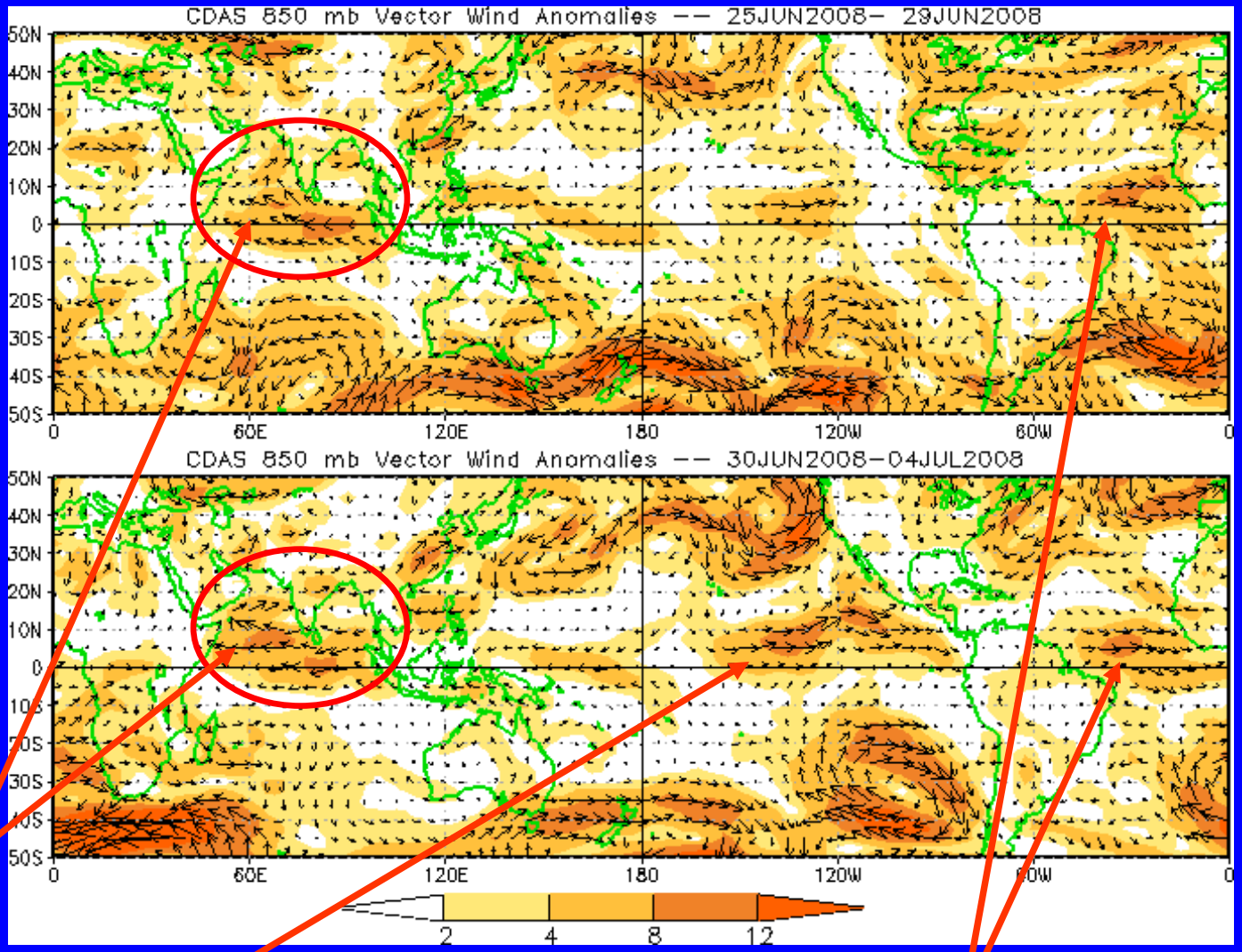
- Some data indicate a large-scale pattern consistent with the MJO, however, there has been little eastward propagation to date. This pattern is likely the combination of several factors.

- The pattern needs to closely monitored as propagation of this signal, if any, may indicate strengthening of the MJO.

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



An enhanced Indian monsoon flow is evident during the last ten days.

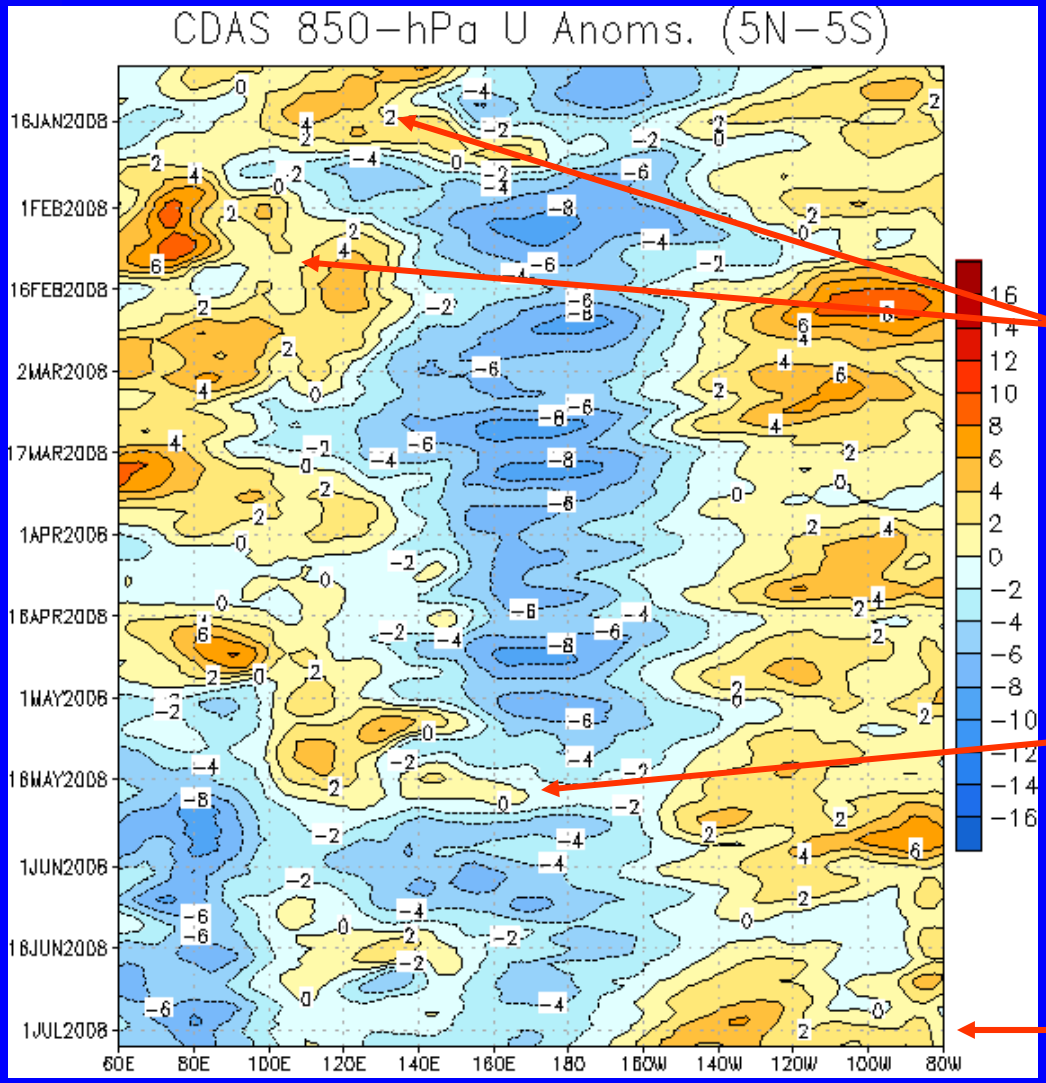
Westerly anomalies have expanded and increased across the eastern Pacific during the last five days.

Equatorial westerly anomalies in the Atlantic continued 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

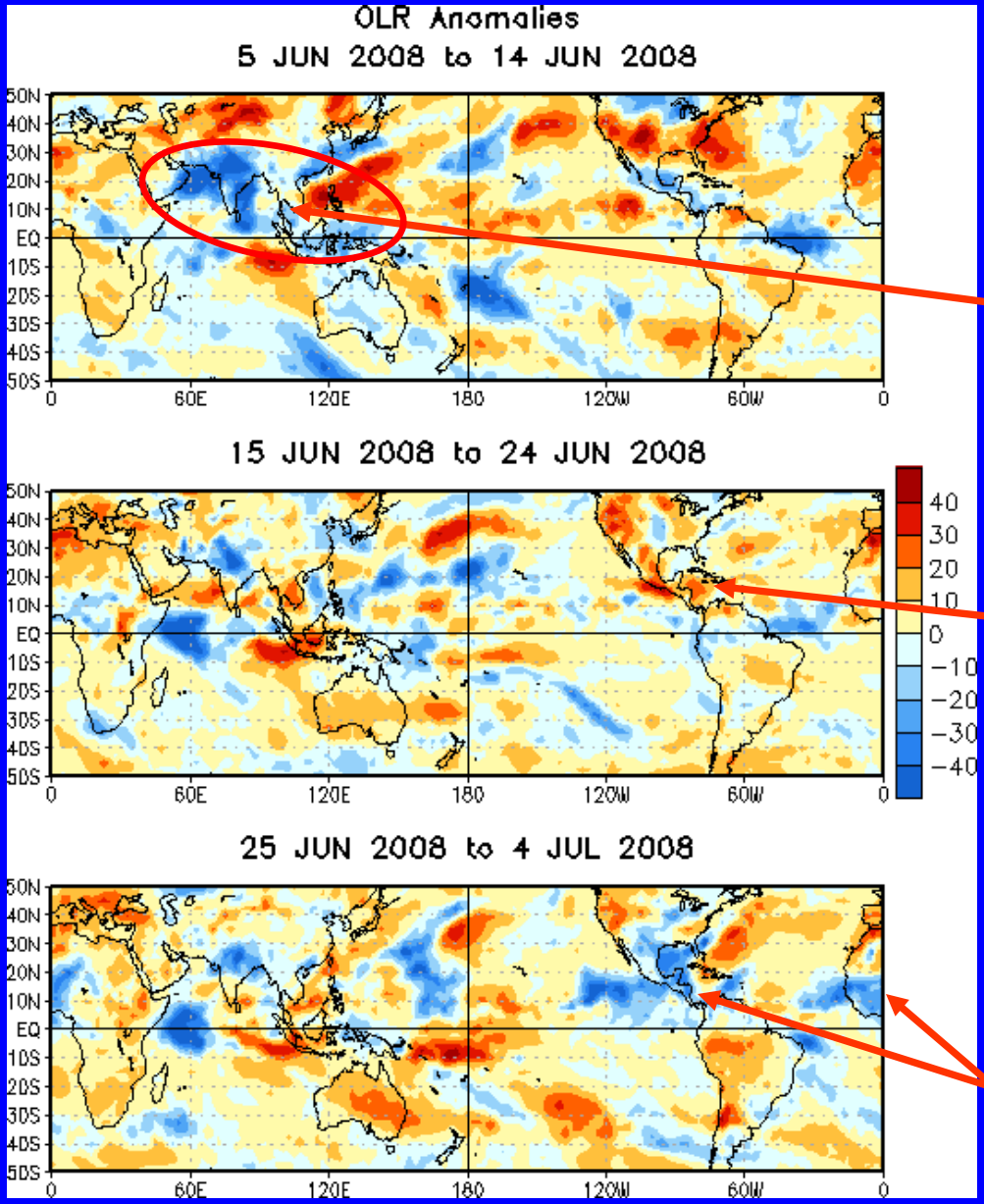
Moderate-to-strong MJO activity is evident during January to mid-late February as shown by westerly anomalies shifting eastward from the Indian Ocean across Indonesia and a weakening of the easterlies at the Date Line during mid-January.

MJO activity was weaker during much of March and April.

During mid-May, easterlies weakened near the Date Line associated with moderate MJO activity.

Easterly anomalies have prevailed across much of the eastern hemisphere during late May and all of June. Westerly anomalies have again strengthened in the eastern Pacific.

OLR Anomalies: Last 30 days



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

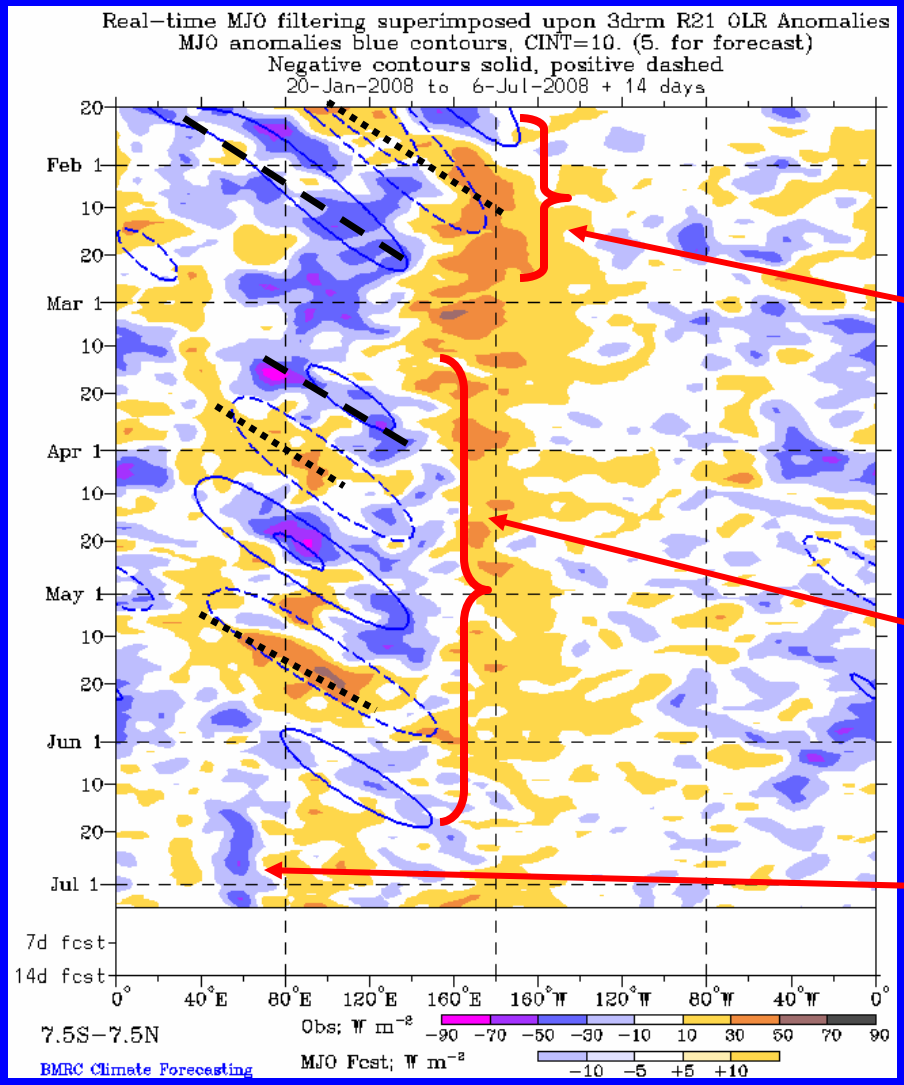
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

During early June, wet conditions were evident across the Arabian Sea, India and parts of the Maritime Continent.

Suppressed convection replaced the wet conditions across the eastern Pacific and Central America during mid-June.

During late-June and early July, convection was very active across the eastern Pacific, Central America, Mexico and western Africa.

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)

Moderate-to-strong MJO activity was evident during January and into mid-February with coherent eastward propagation of enhanced (suppressed) convection indicated by the dashed (dotted) lines.

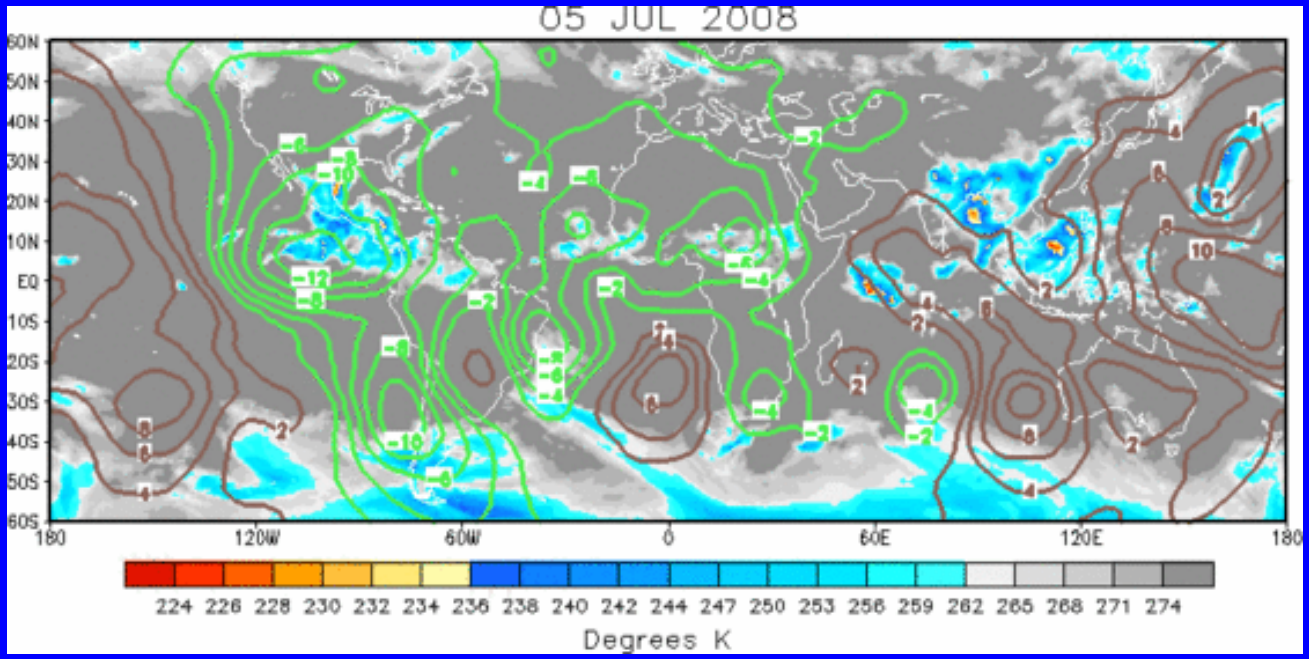
MJO activity was evident from mid-March into early June at varying levels of intensity. The strongest MJO activity occurred as strong suppressed convection organized across the Indian Ocean and shifted eastward during mid-to-late May.

Convection has generally been near-average across much of the equatorial tropics during the past few weeks. Persistent enhanced convection, however, has been evident across the western Indian Ocean.

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

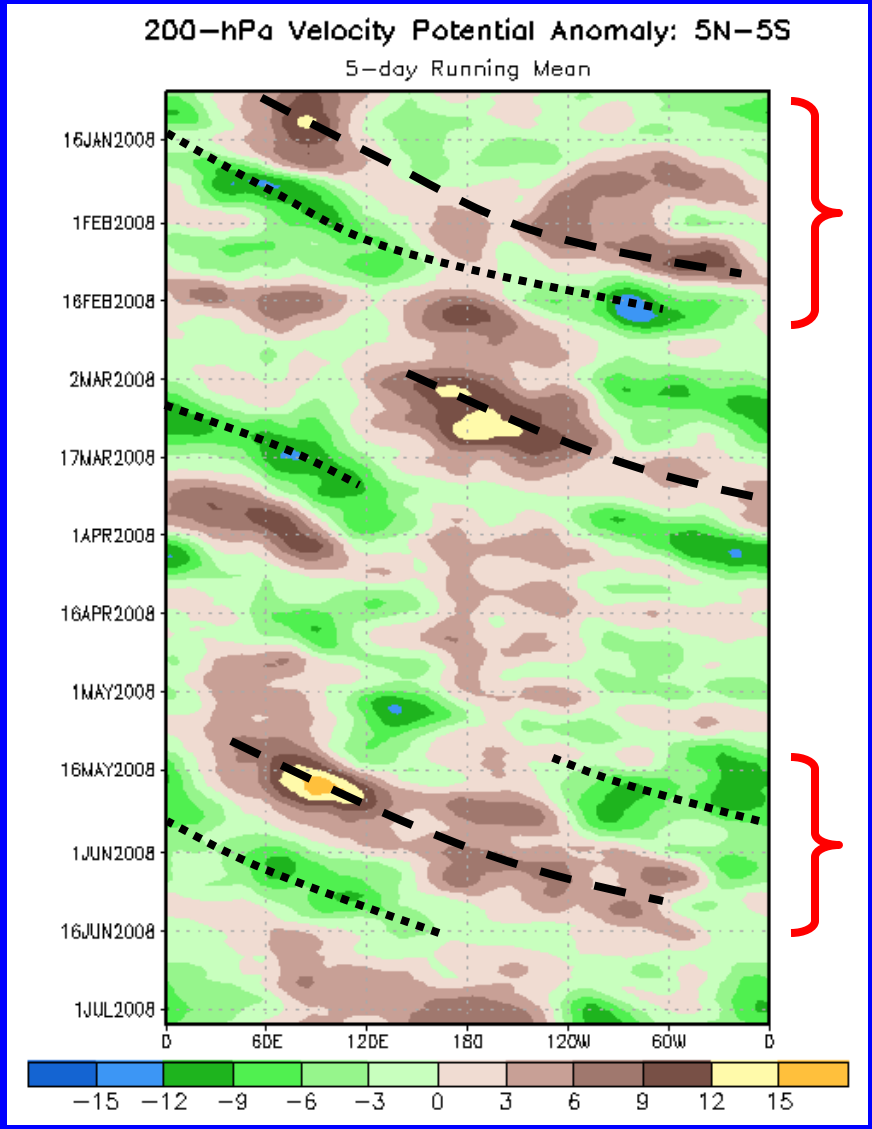


Strong and persistent upper-level divergence is evident across the eastern Pacific Ocean, Central America, and Mexico. An extensive area of upper-level convergence continues across parts of the Indian Ocean, Maritime Continent and western Pacific.

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

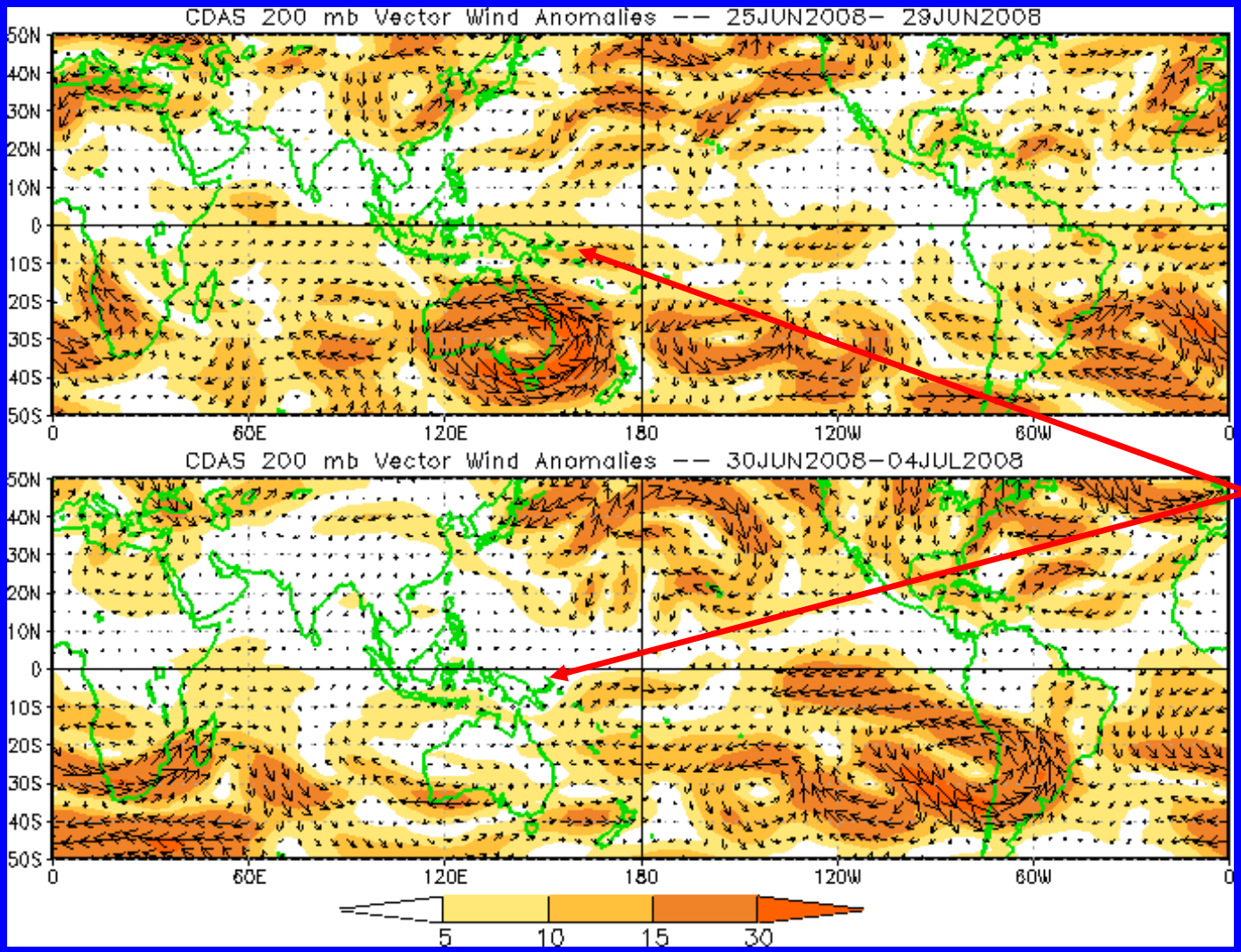
Moderate-to-strong MJO activity was evident during January to mid-February.

Weak MJO activity was evident during parts of March.

The MJO was largely incoherent during the month of April.

A moderate-to-strong MJO was observed from mid-May through mid-June.

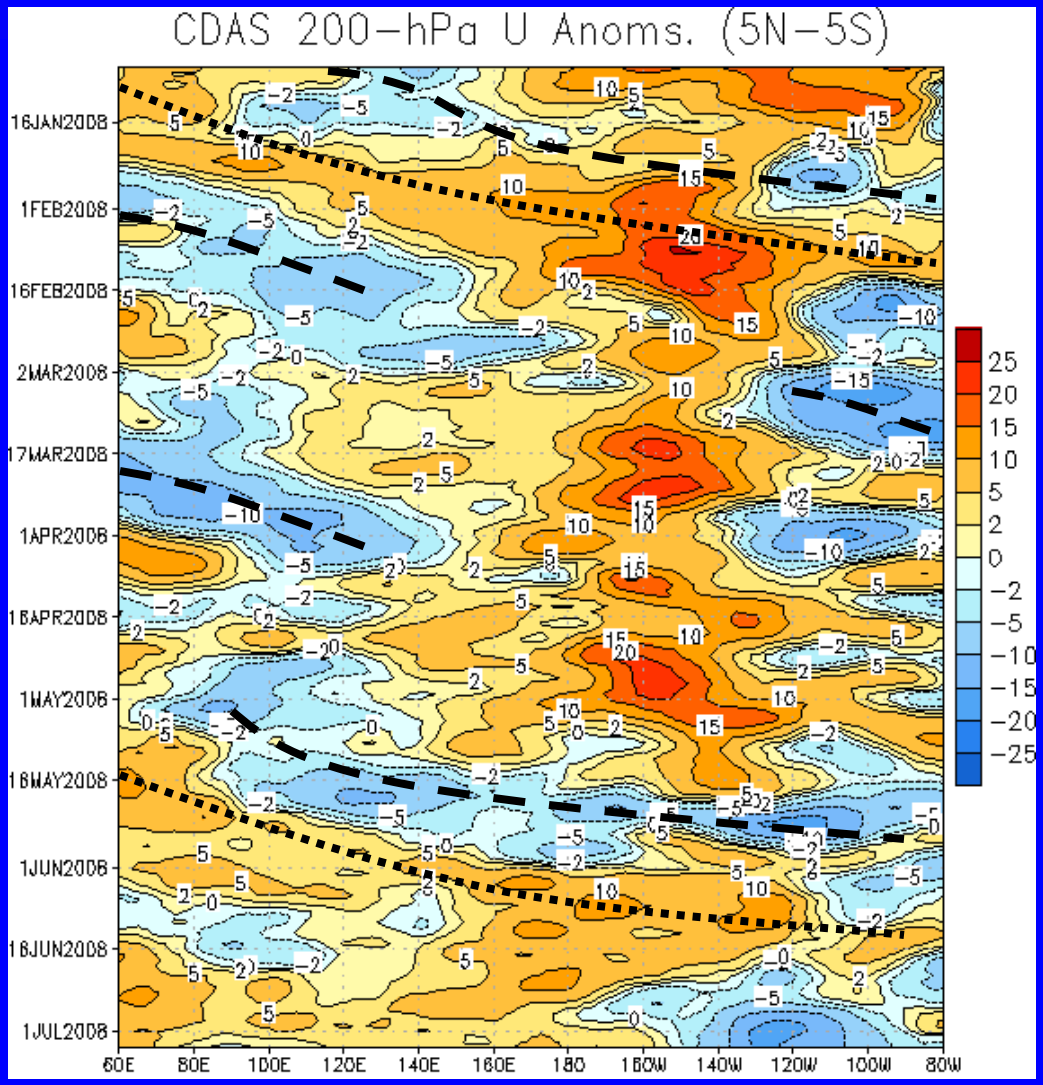
200-hPa Vector Wind Anomalies (m s^{-1})



Note that shading denotes the magnitude of anomalous wind vectors

Equatorial westerly anomalies have decreased during the last five days across the Indian Ocean, Maritime Continent and western Pacific.

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



Time

Longitude

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

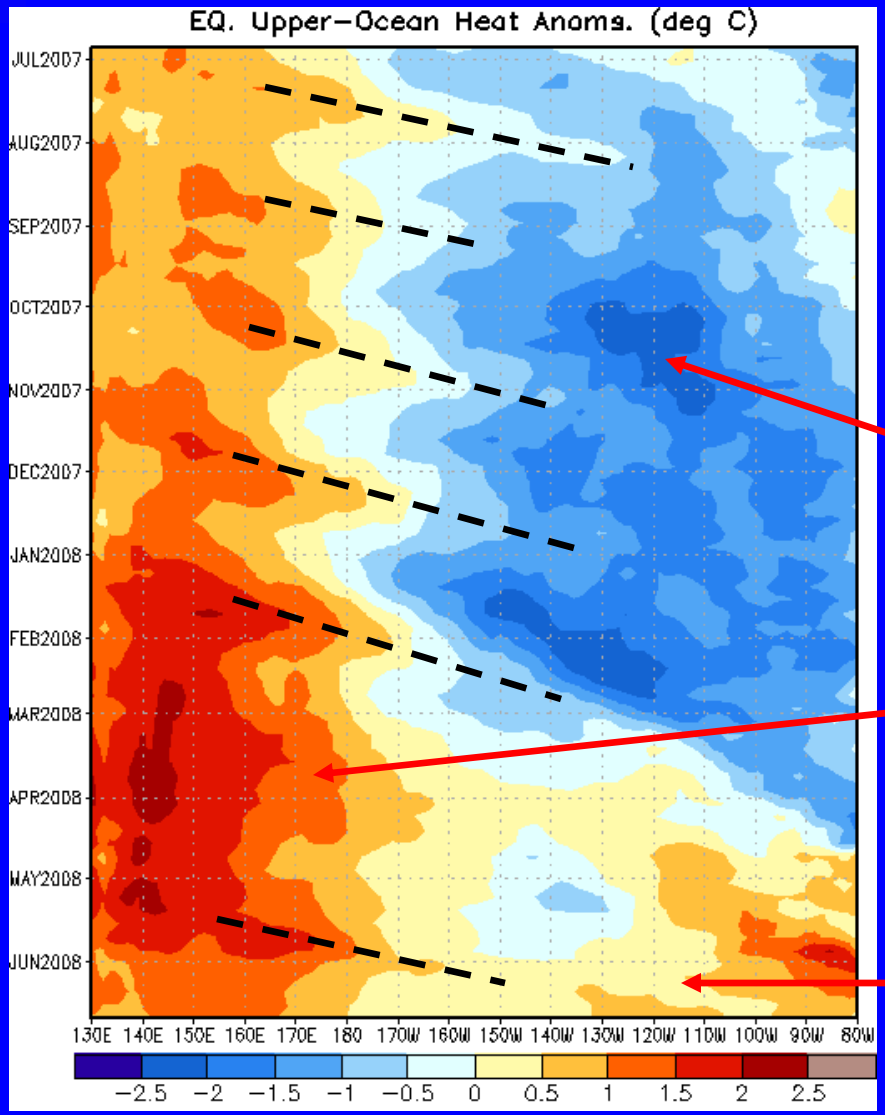
Easterly anomalies (blue shading) represent anomalous east-to-west flow

MJO activity is evident in the upper-levels by eastward propagation of easterly (westerly) anomalies by dashed (dotted) lines during January to mid-February.

During May and early June, eastward propagation was evident in the upper-level wind field and was associated with the MJO.

Recently, easterly anomalies are observed across the eastern Pacific Ocean while westerly anomalies have persisted across the Eastern Hemisphere.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

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

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.

Positive heat content anomalies now encompass the entire Pacific basin.

MJO Index -- Information

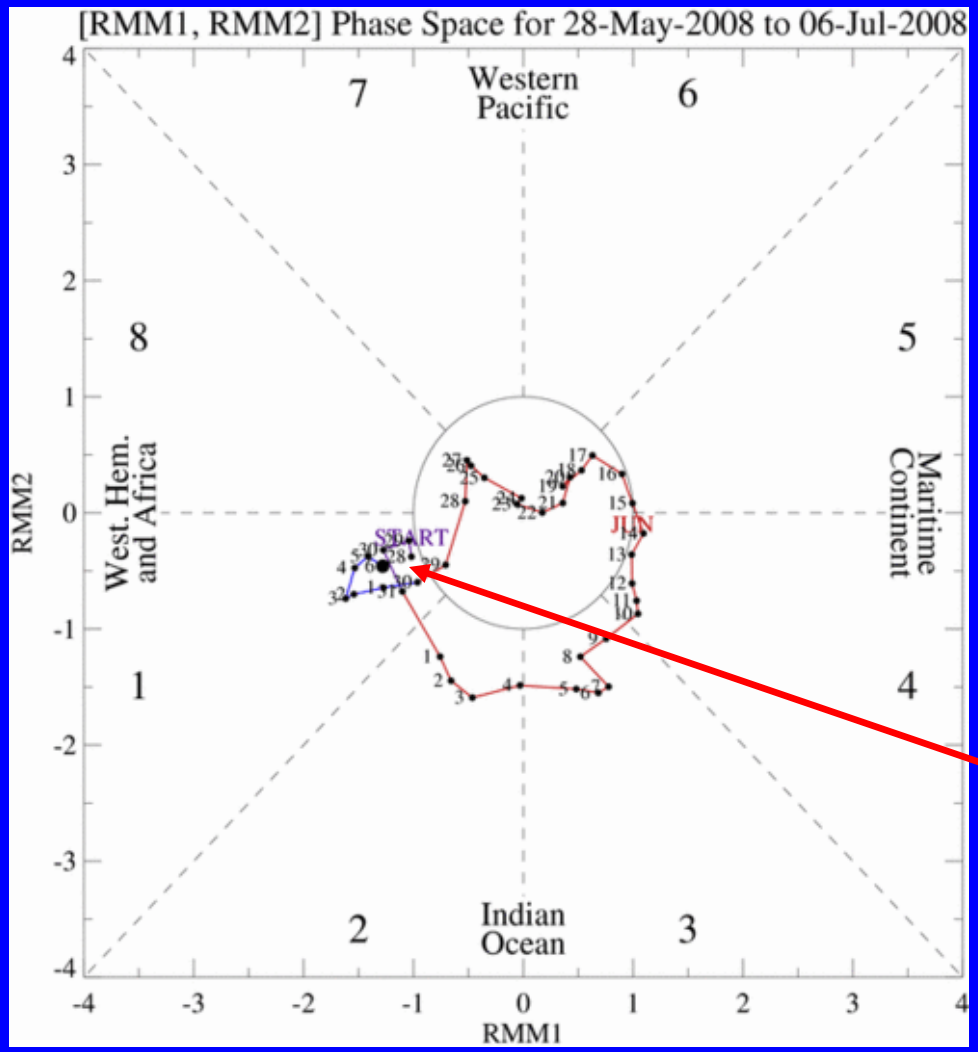
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

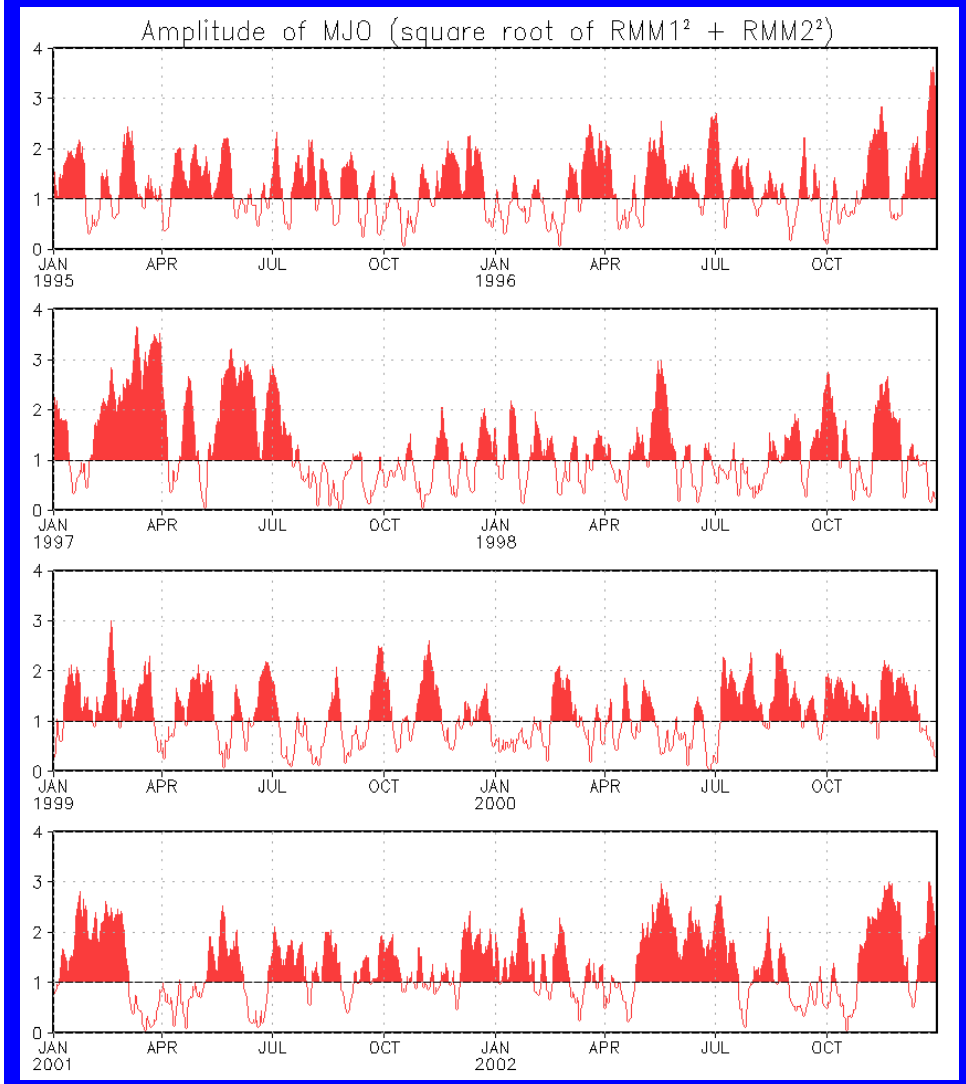
MJO Index -- Recent Evolution

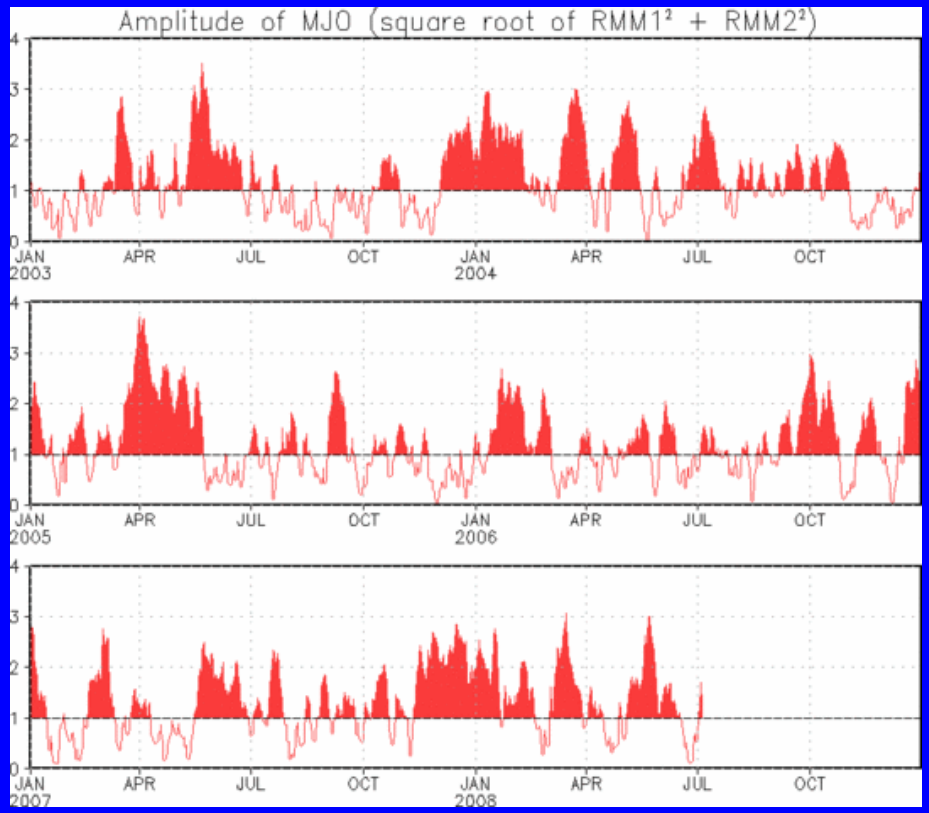


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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

Although the MJO index has increased in amplitude during the last week, no eastward propagation is evident indicating little MJO activity.

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

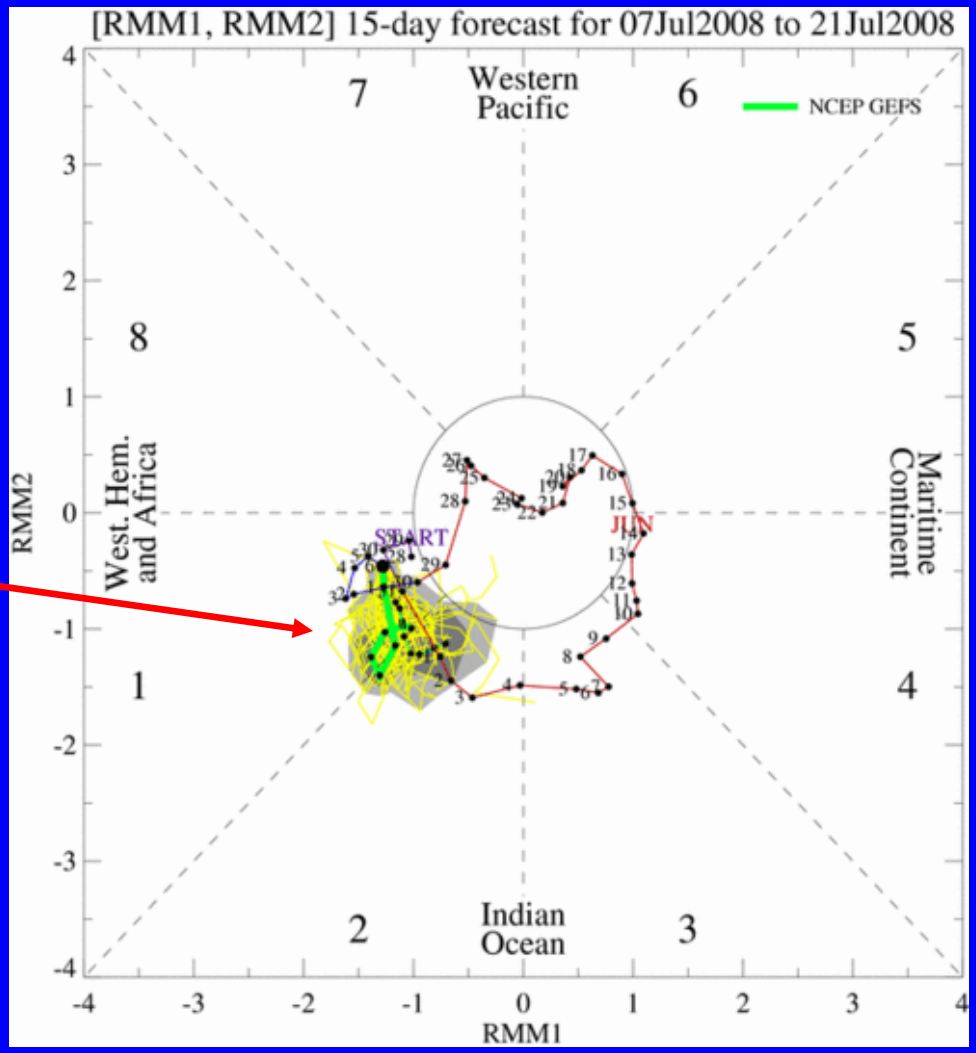
Ensemble GFS MJO Forecasts

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

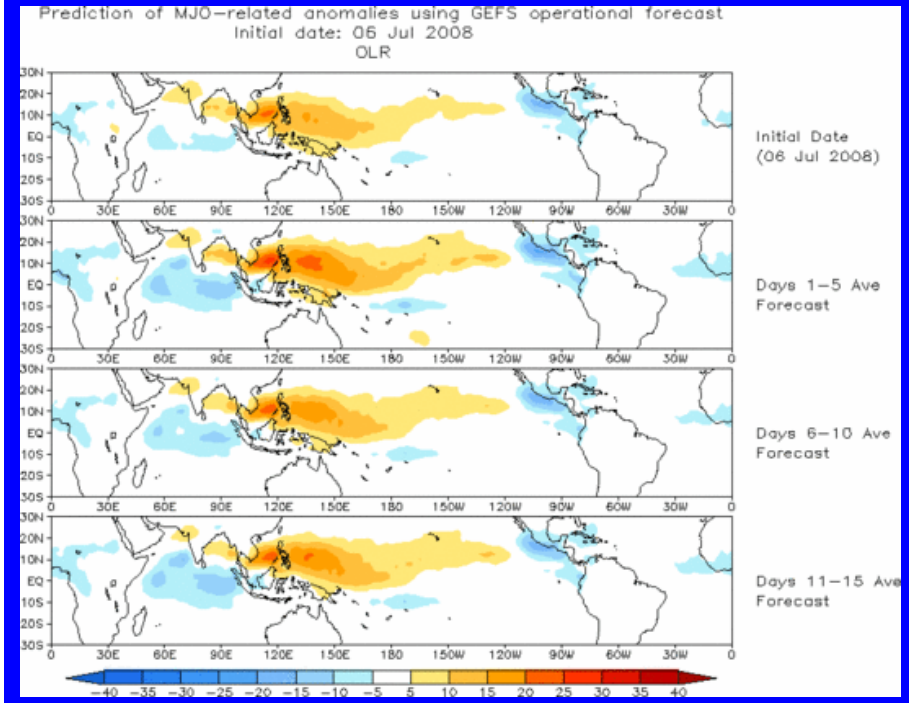
The GEFS ensemble mean predicts the MJO signal to generally continue at its current amplitude with some minor eastward propagation.



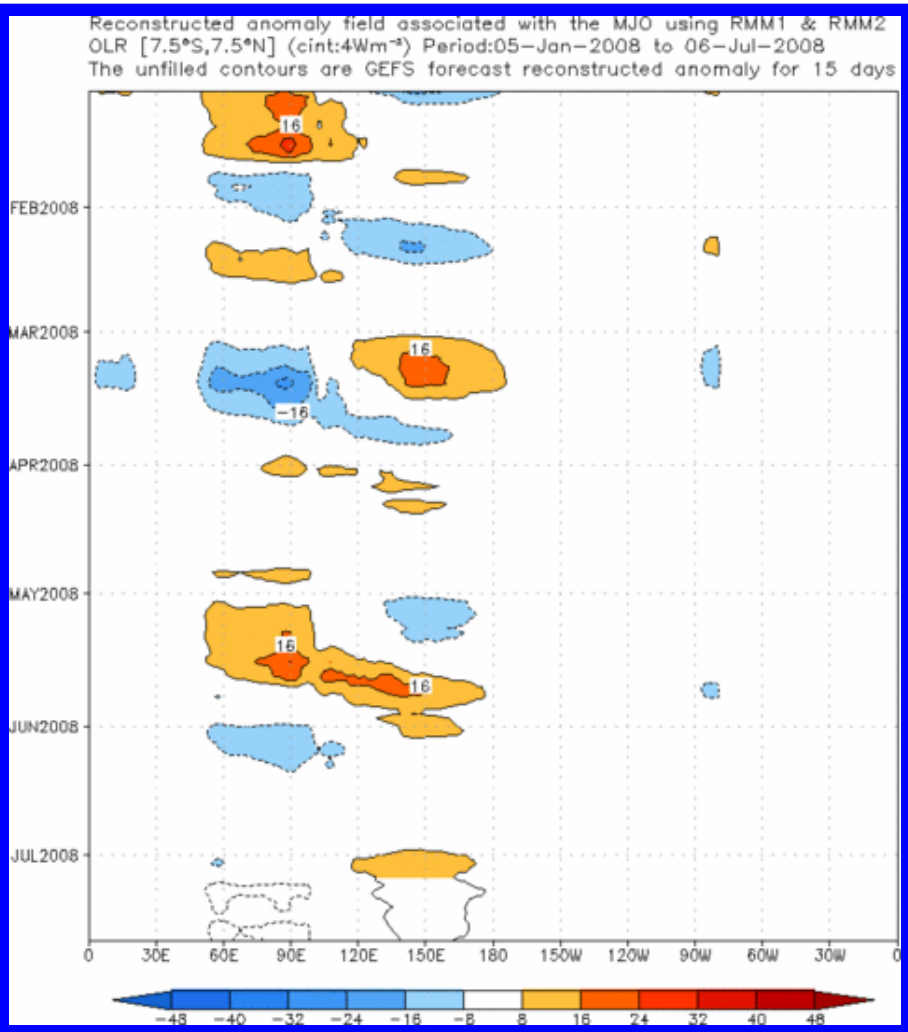
Ensemble Mean GFS MJO Forecast

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 GEFS indicates suppressed convection across the western Pacific with enhanced convection across Central America, Africa and the western Indian Ocean.

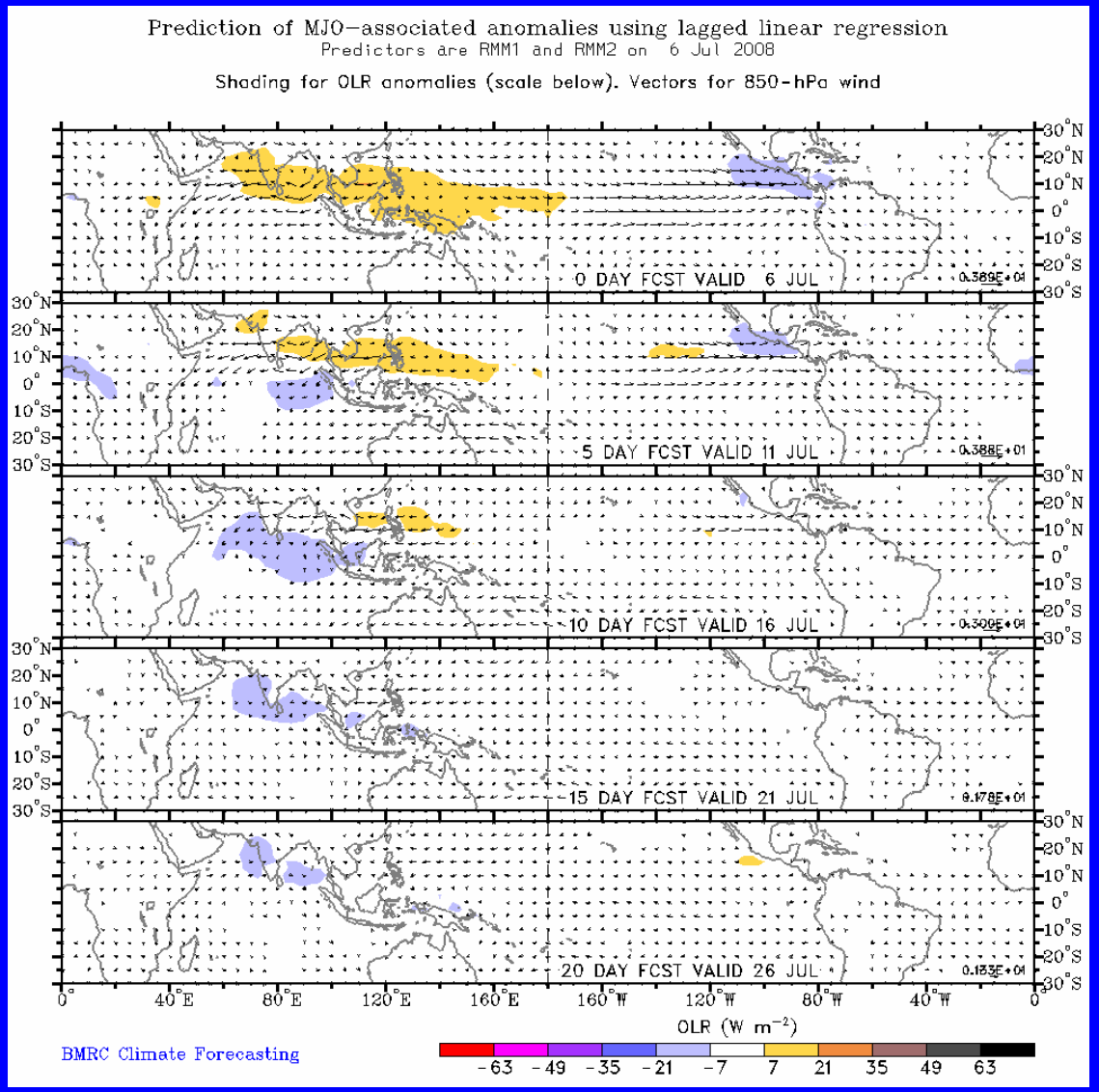
Statistical MJO Forecast

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

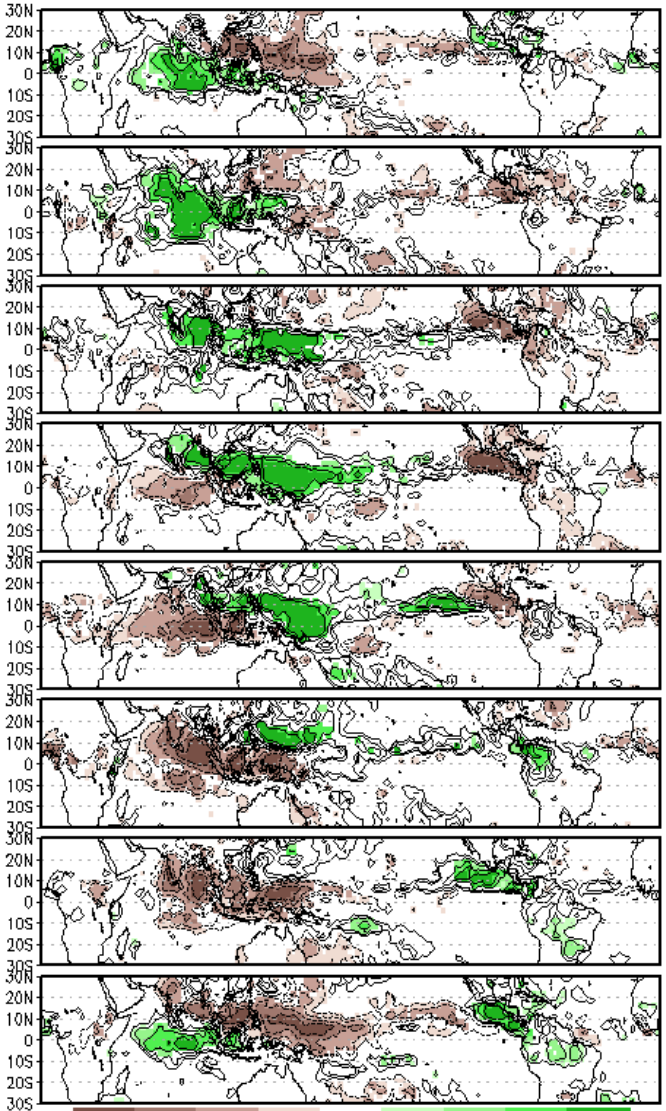
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

Weak MJO activity is forecast with wet conditions developing across the Indian Ocean during the period.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)