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

Update prepared by
Climate Prediction Center / NCEP
September 15, 2008

Outline

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

Overview

- Moderate MJO activity continued during the past week with the enhanced phase now centered across eastern Indonesia.

- Based on the latest observations and some forecast tools, moderate MJO activity is expected during the next 1-2 weeks.

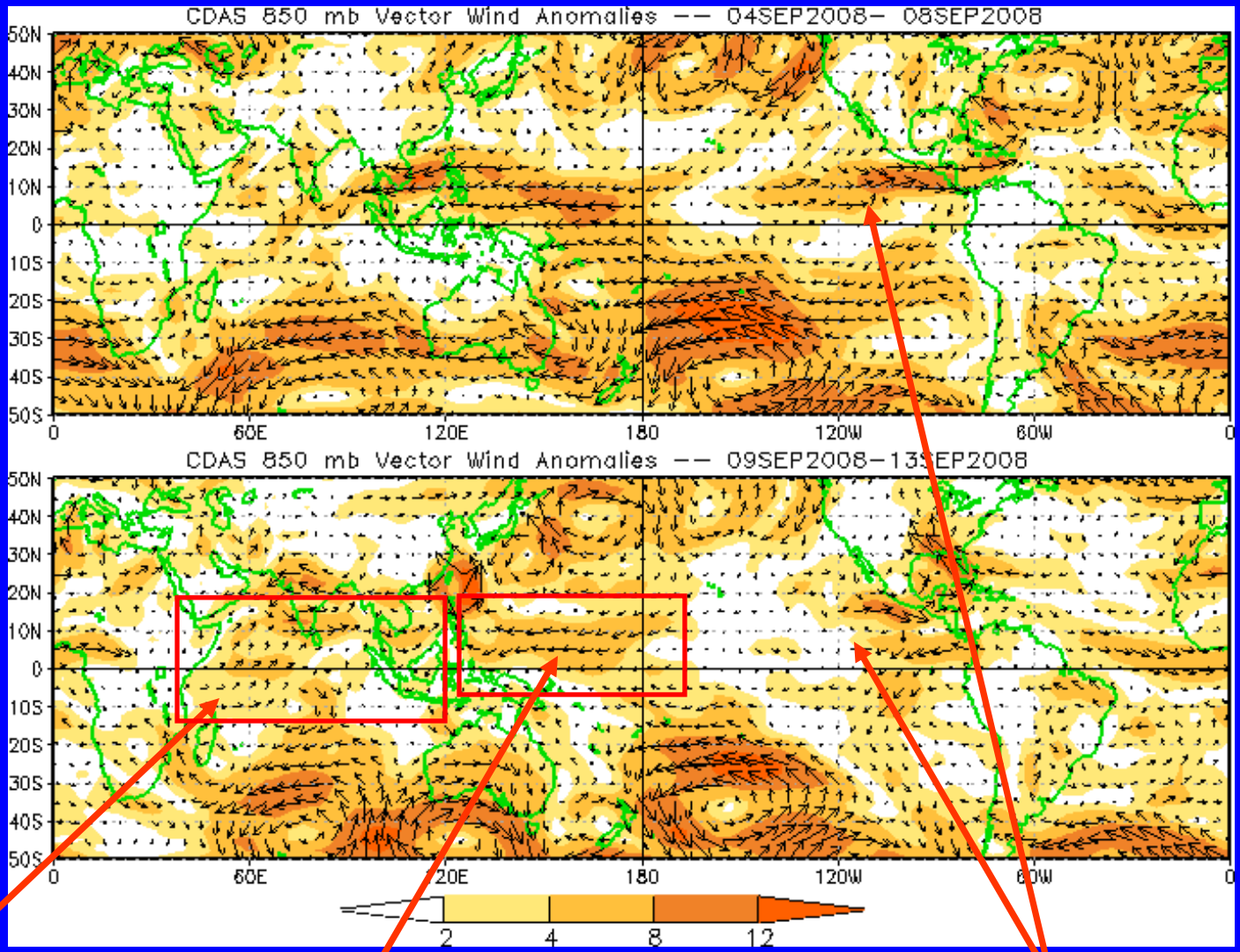
- During Week 1, the MJO is expected to contribute to enhanced rainfall across southern Asia and the western Pacific with drier-than-average conditions across the equatorial Indian Ocean. Week 2 likely will see wet conditions across the eastern Pacific, Central America and Mexico while dry conditions impact parts of India and Indonesia.

- The current MJO will likely suppress tropical cyclone development across the deep tropical Atlantic early during the period. Continued MJO propagation, however, is expected to increase the chances for development across the eastern Pacific Ocean and the western Gulf of Mexico and Caribbean Sea during Week 2.

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



Westerly anomalies have increased across parts of India, the Indian Ocean and Indonesia during the last five days.

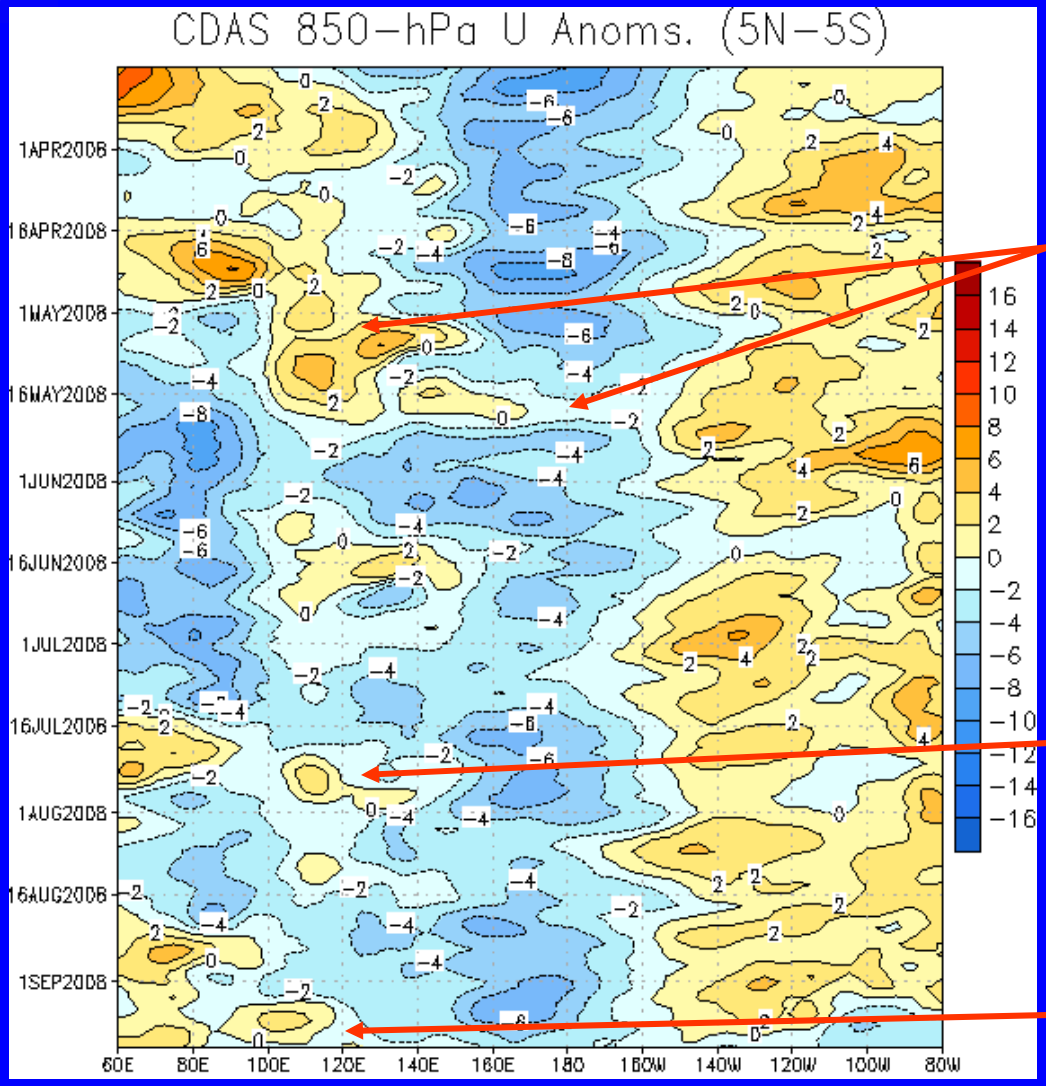
Easterly anomalies are now limited to the western Pacific.

Westerly anomalies decreased across the eastern Pacific 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

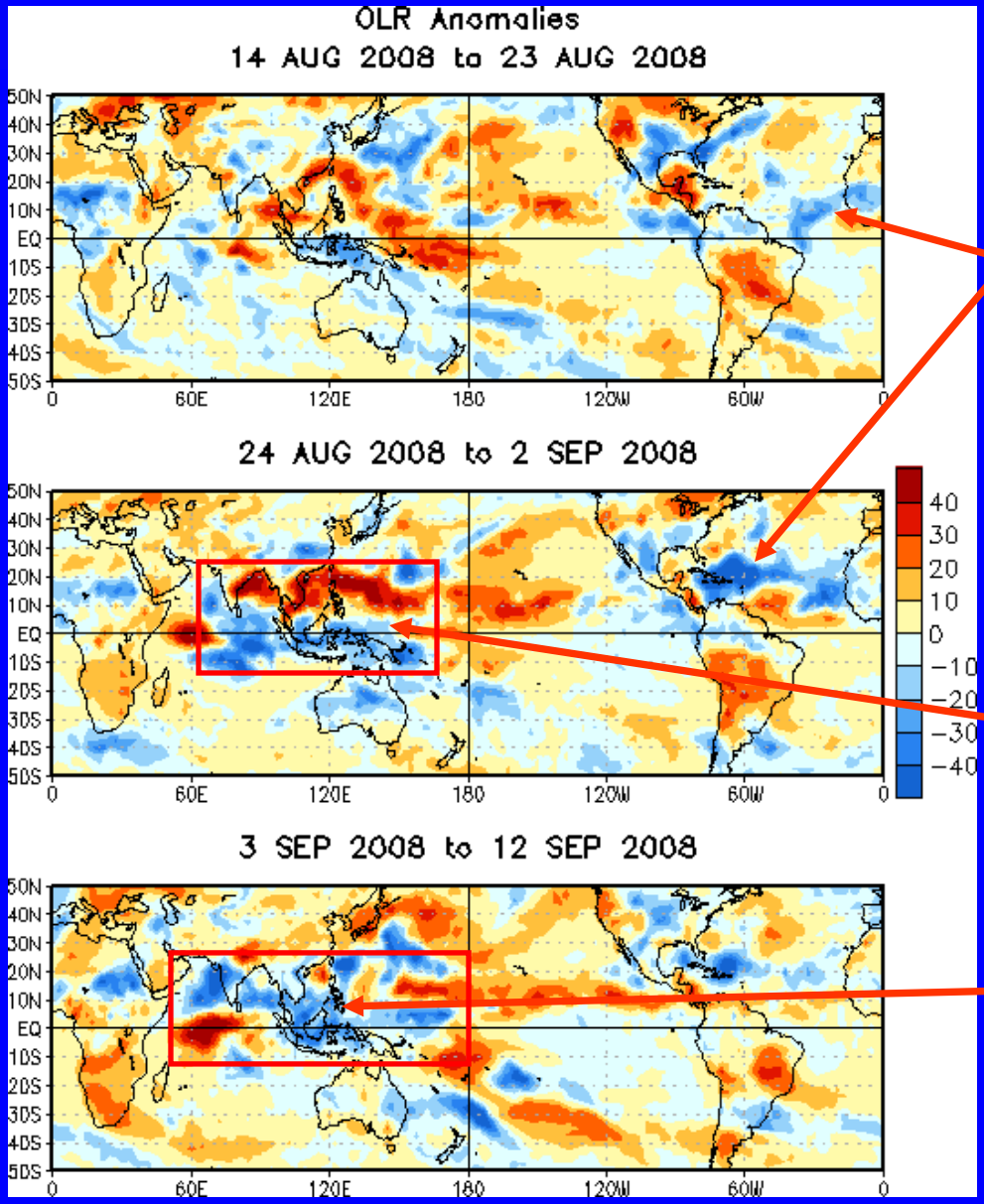
During mid-May, easterlies weakened across the western Pacific associated with moderate MJO activity.

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 weak MJO activity.

Westerly anomalies associated with the current MJO activity have propagated eastward to the Maritime continent from the Indian Ocean.

OLR Anomalies: Last 30 days



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

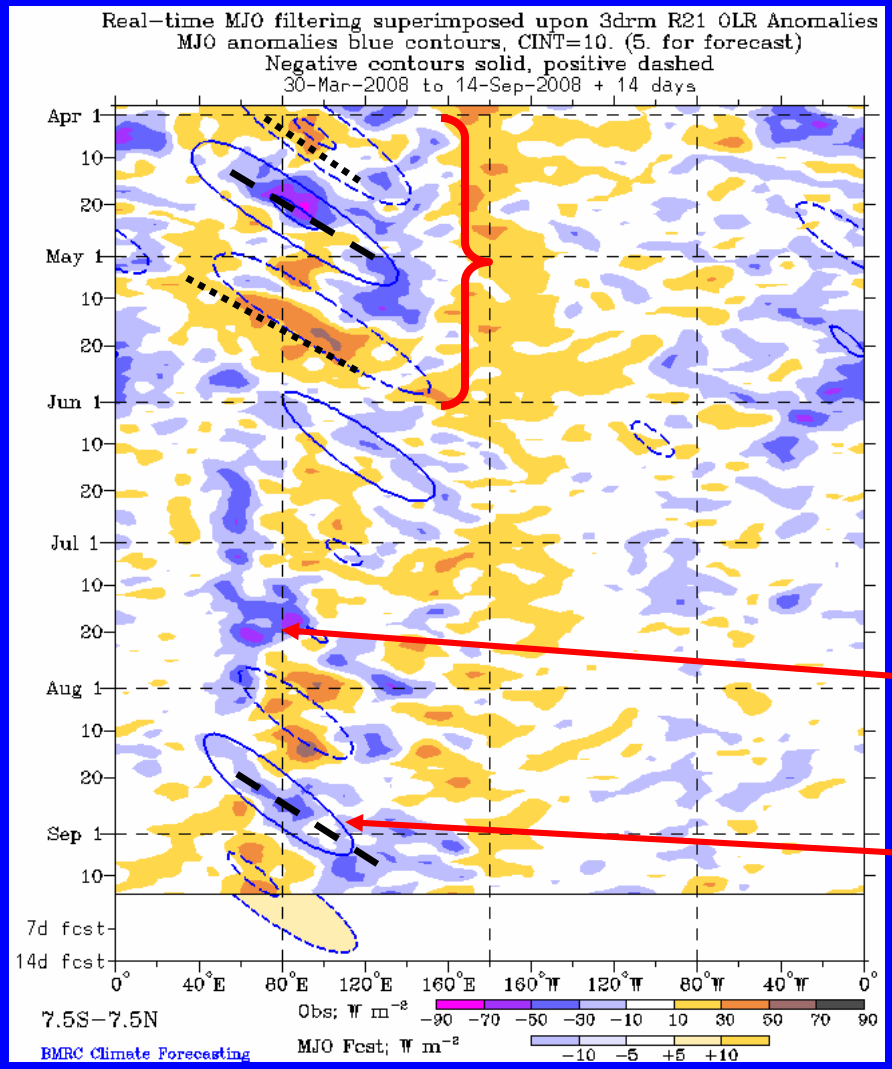
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

Enhanced convection was evident across the Atlantic and western Africa during mid-late August while drier-than-average conditions were indicated across much of the western Pacific.

In late August and early September, dry conditions propagated north while enhanced convection developed across the equatorial Indian Ocean and parts of Indonesia.

During early September, enhanced convection began to shift northeastwards into southern Asia and the western Pacific Ocean. Dry conditions are now evident across the equatorial Indian Ocean as well.

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 late-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.

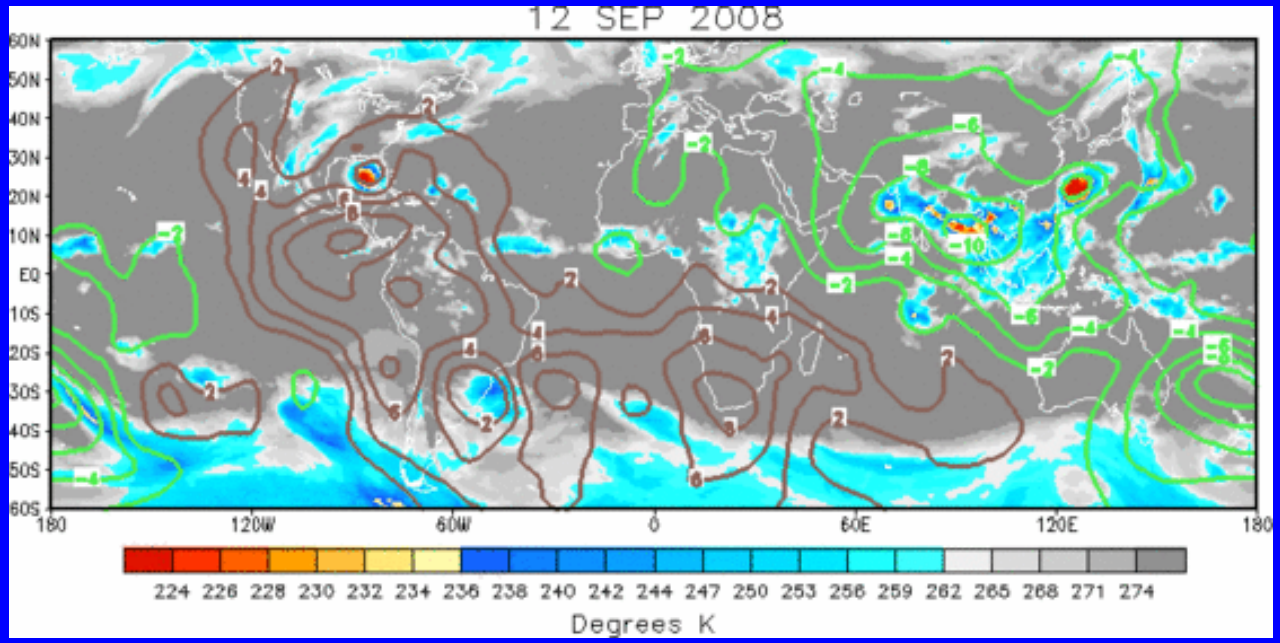
Persistent enhanced convection was evident across the western Indian Ocean from mid-June to early August.

Enhanced convection developed across the Indian Ocean during late August and has propagated eastward. Dry conditions have developed along the equator in the 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

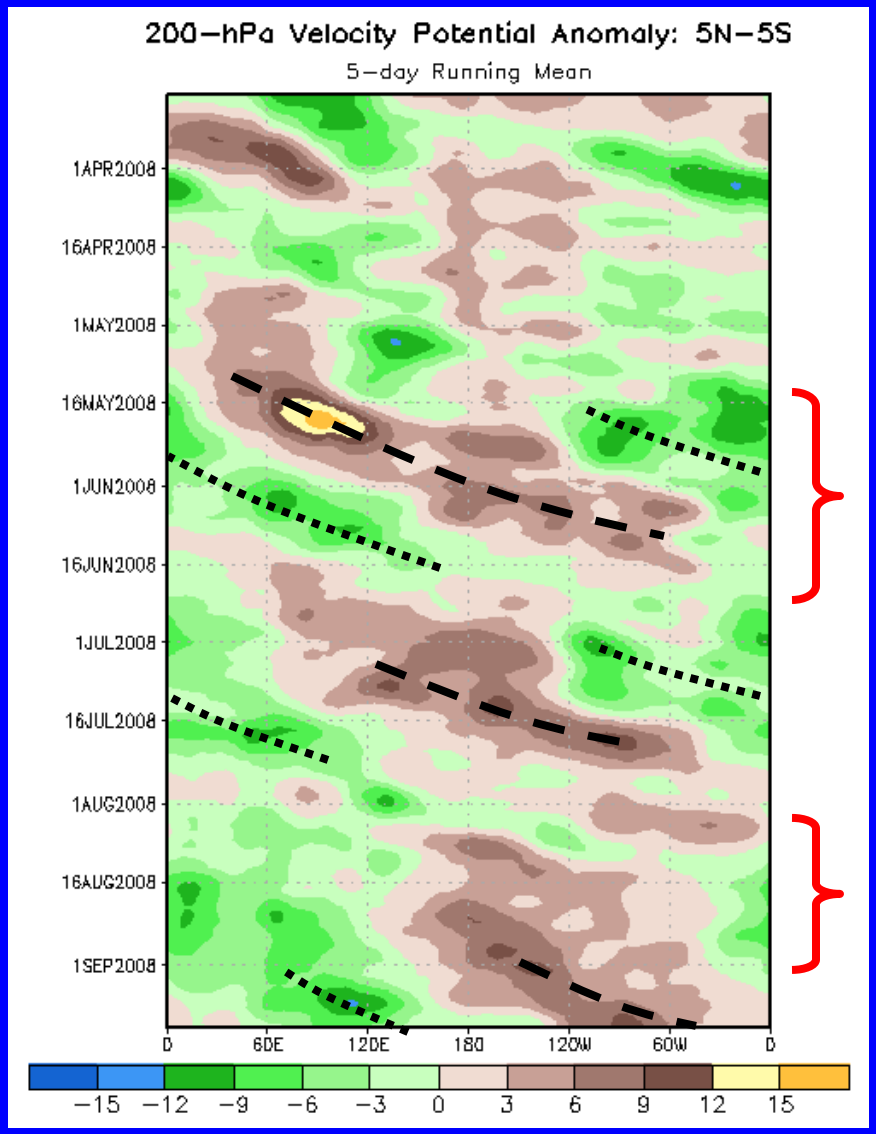


Upper-level divergence strengthened across southern Asia and the western Pacific Ocean while upper-level convergence has shifted eastward to include the Atlantic Ocean and parts of Africa.

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 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.

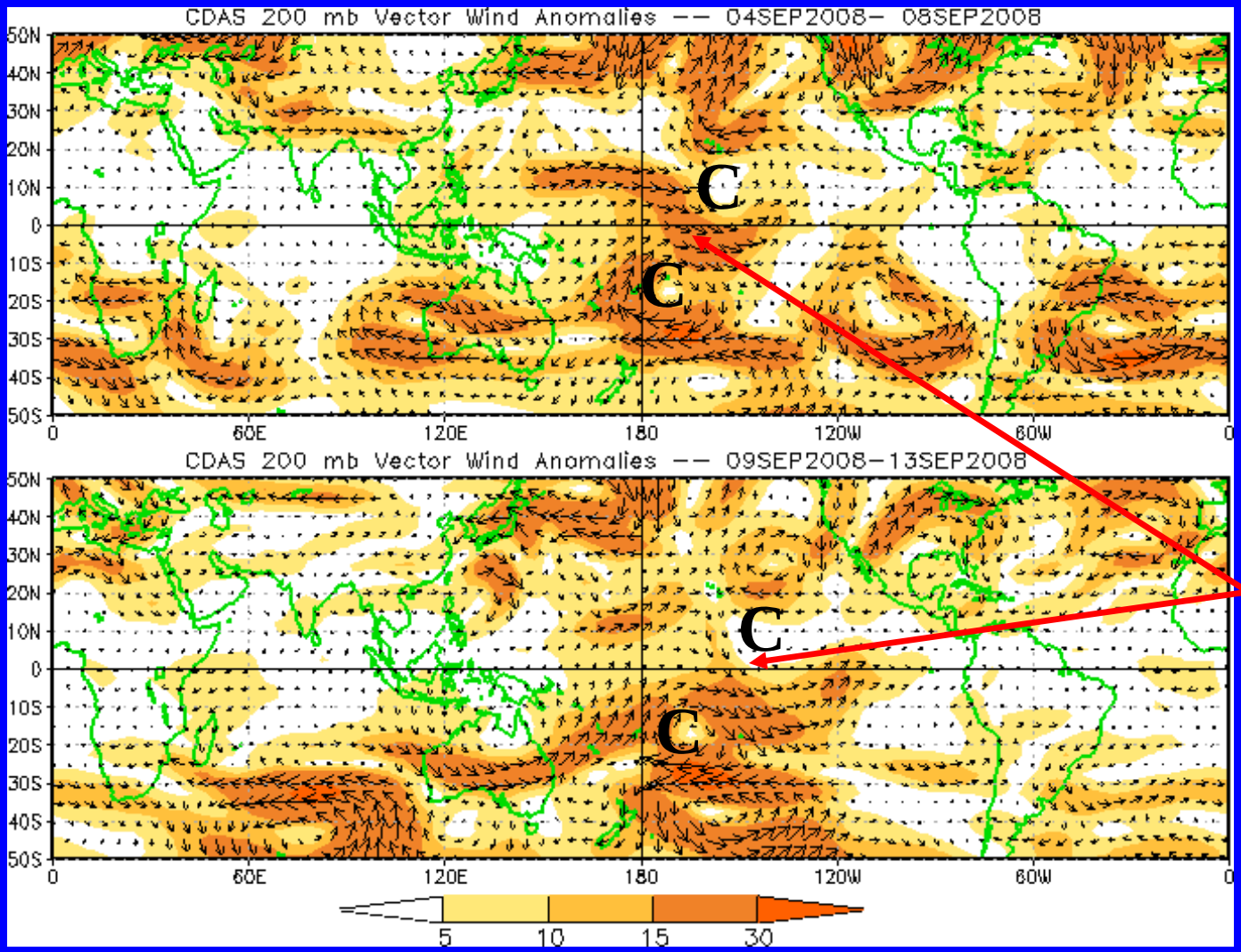
After weakening in late June, the MJO strengthened during mid-July.

From early-mid August into early September, the MJO was weak as a more stationary pattern was evident.

The MJO has strengthened and eastward propagation has been observed during the past 7-10 days.

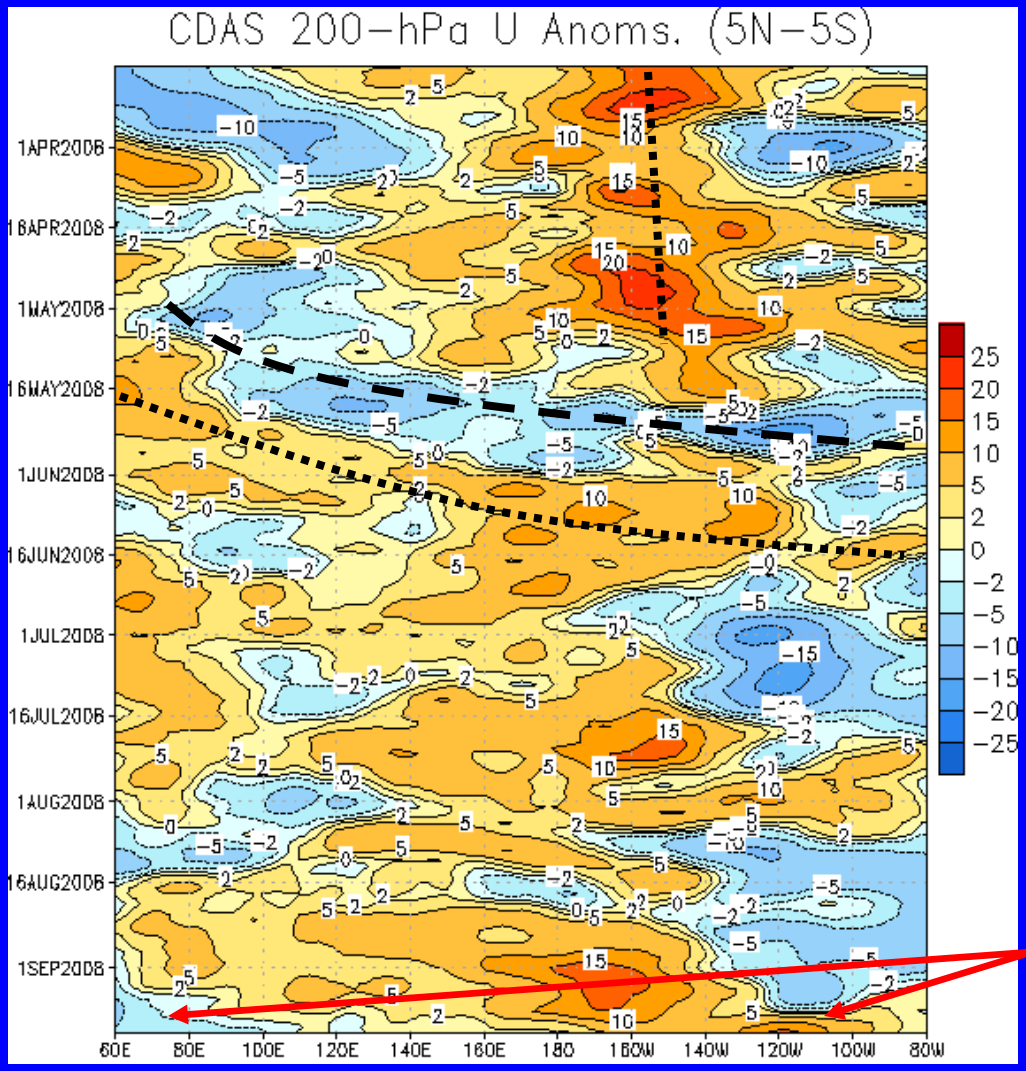
200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the magnitude of anomalous wind vectors



Upper-level westerly anomalies continue across the equatorial Pacific Ocean. Cyclones (C) are evident north and south of the equator during the last ten days.

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



Time

Longitude

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

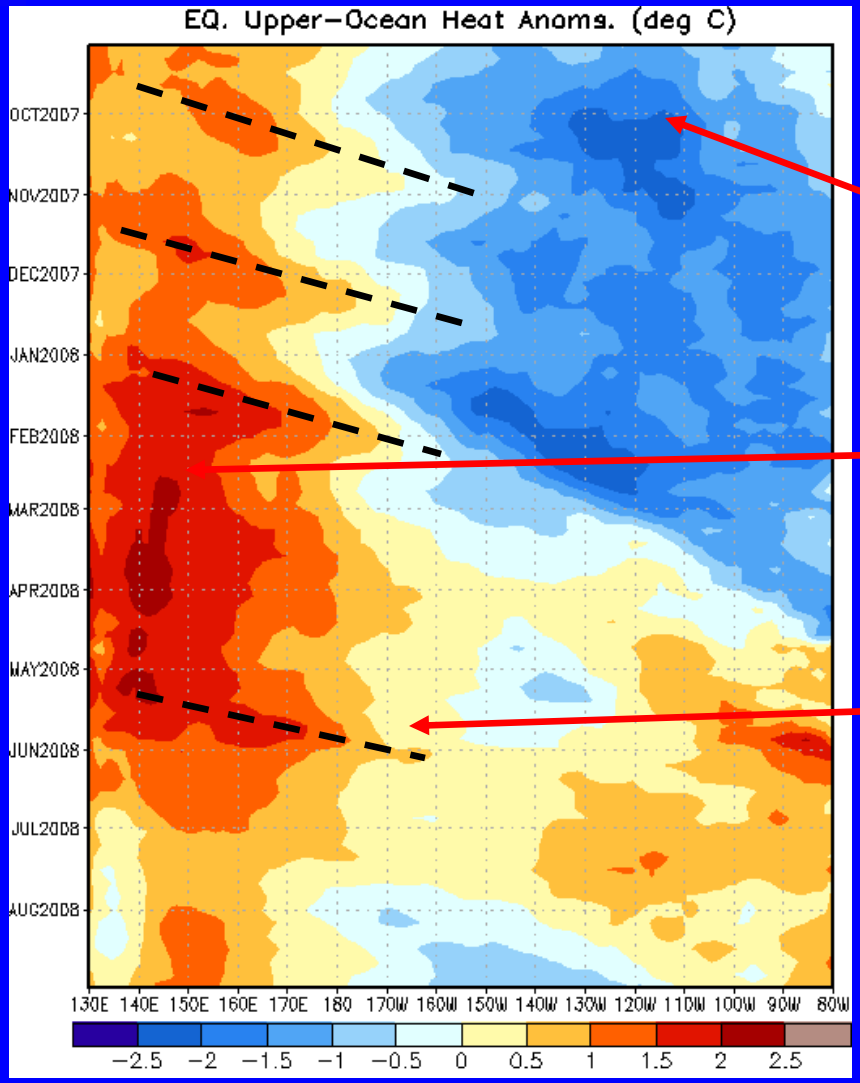
Easterly anomalies (blue shading) represent anomalous east-to-west flow

The MJO was weak or incoherent for much of the period from March 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.

Westerly anomalies have shifted eastward to the eastern Pacific during the past week while easterly anomalies are now present across the Indian Ocean.

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 encompassed much of the Pacific basin in part associated with a Kelvin wave initiated during May 2008.

During August 2008, negative anomalies started to develop near and east of the Date Line in response to enhanced easterly surface winds.

MJO Index -- Information

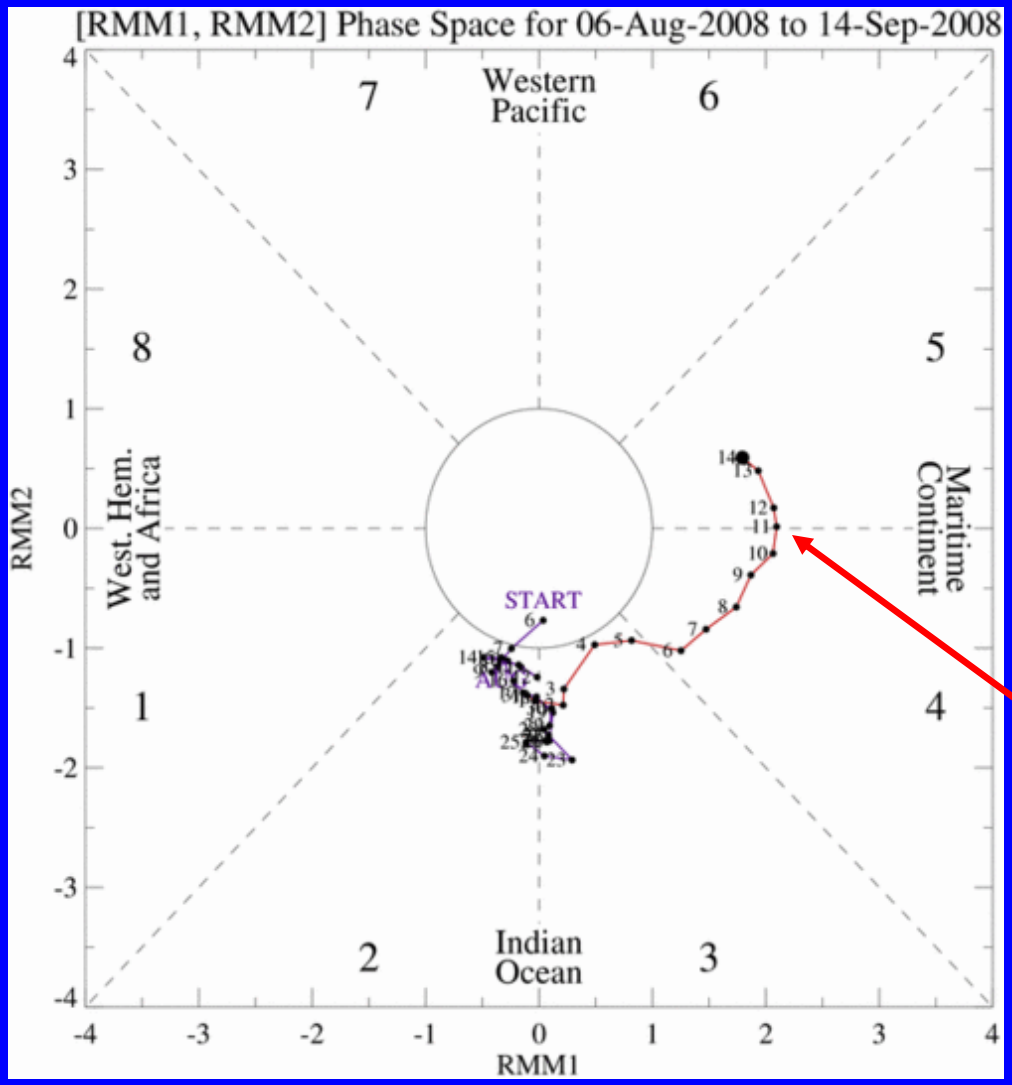
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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

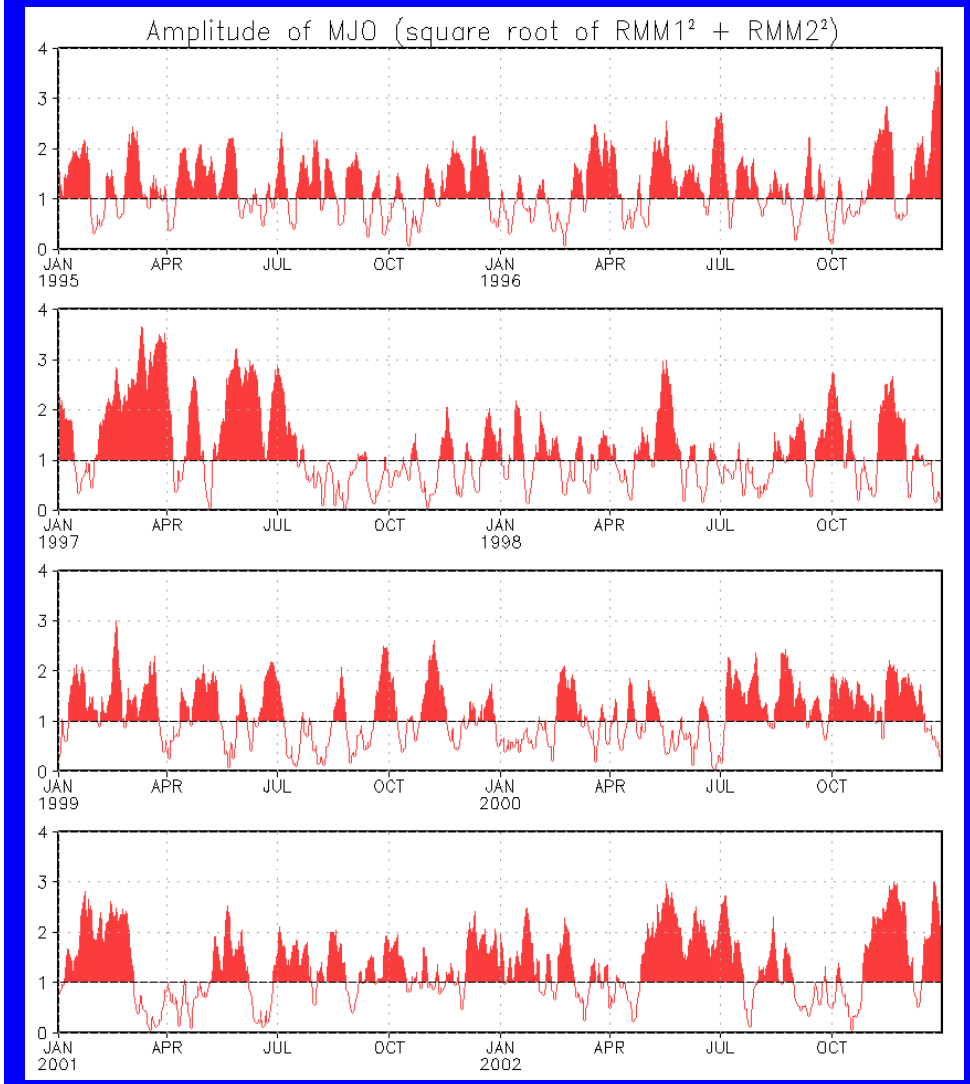


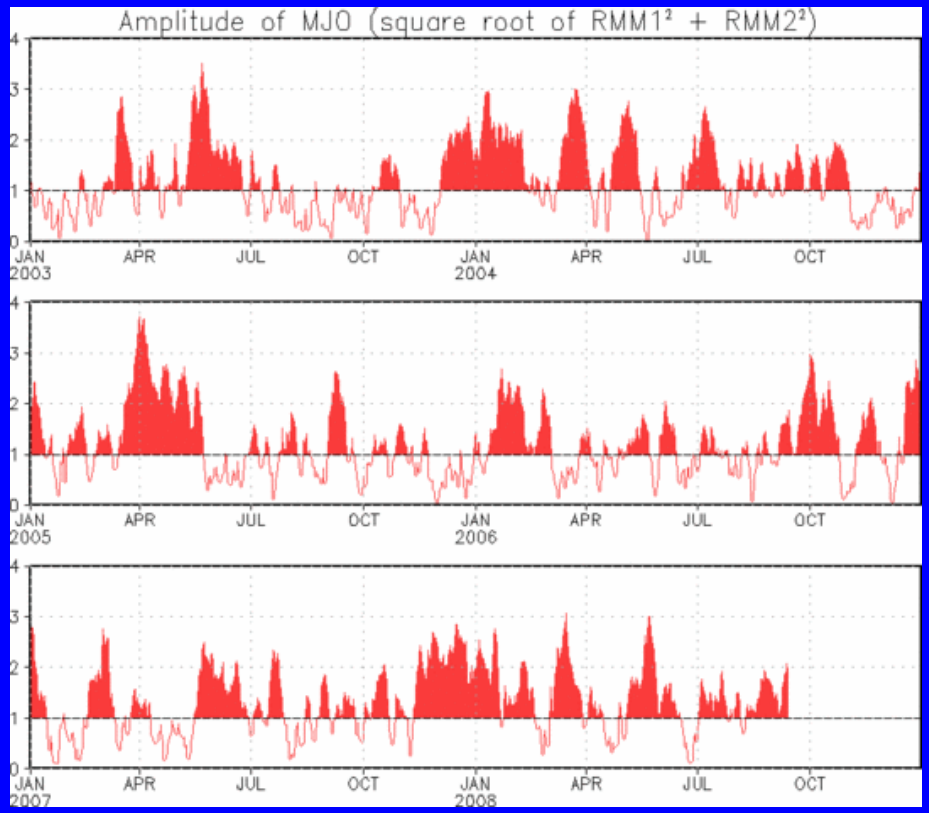
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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

The MJO has strengthened during the past week as the amplitude of the index has increased and eastward propagation continued.

The enhanced phase is now centered across the eastern Maritime continent.

MJO Index – Historical Daily Time Series





Time series of daily MJO index amplitude from 1995 to present

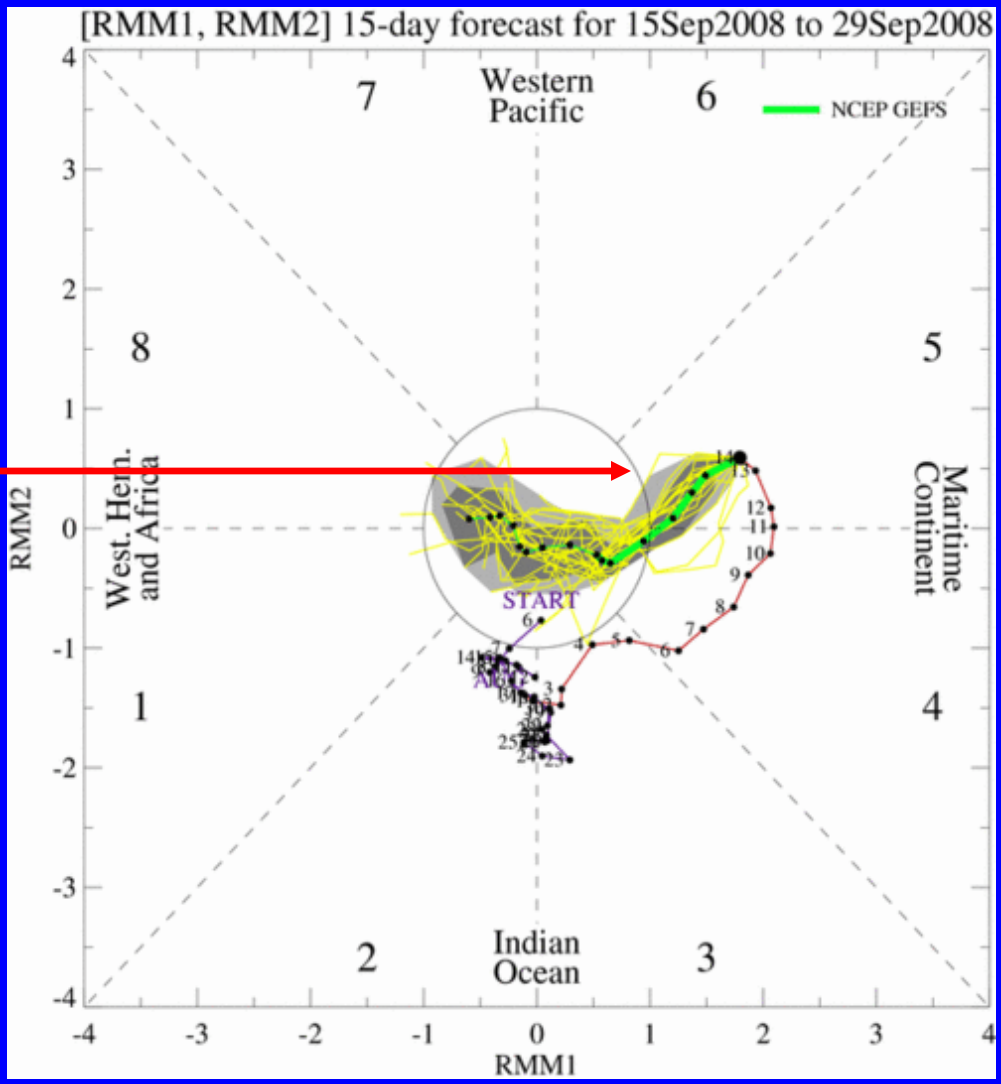
Plots put current MJO activity in historical context

Ensemble GFS (GEFS) MJO Forecast

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



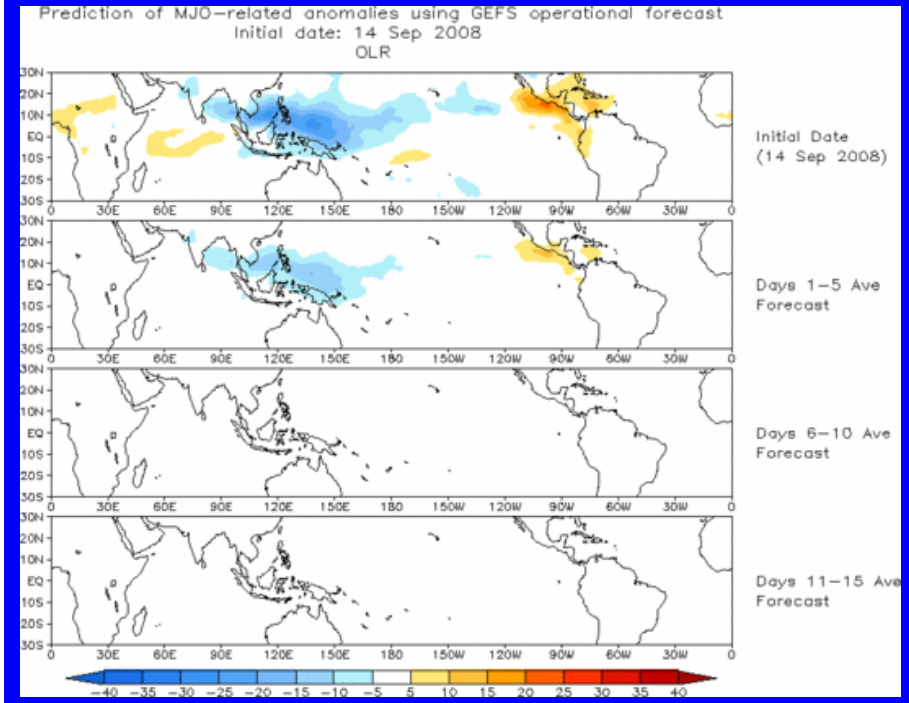
The GEFS does not predict further eastward propagation of the current MJO during the period.

Dynamical model forecasts often have difficulty maintaining the MJO signal across the Maritime continent.

Ensemble Mean GFS MJO Forecast

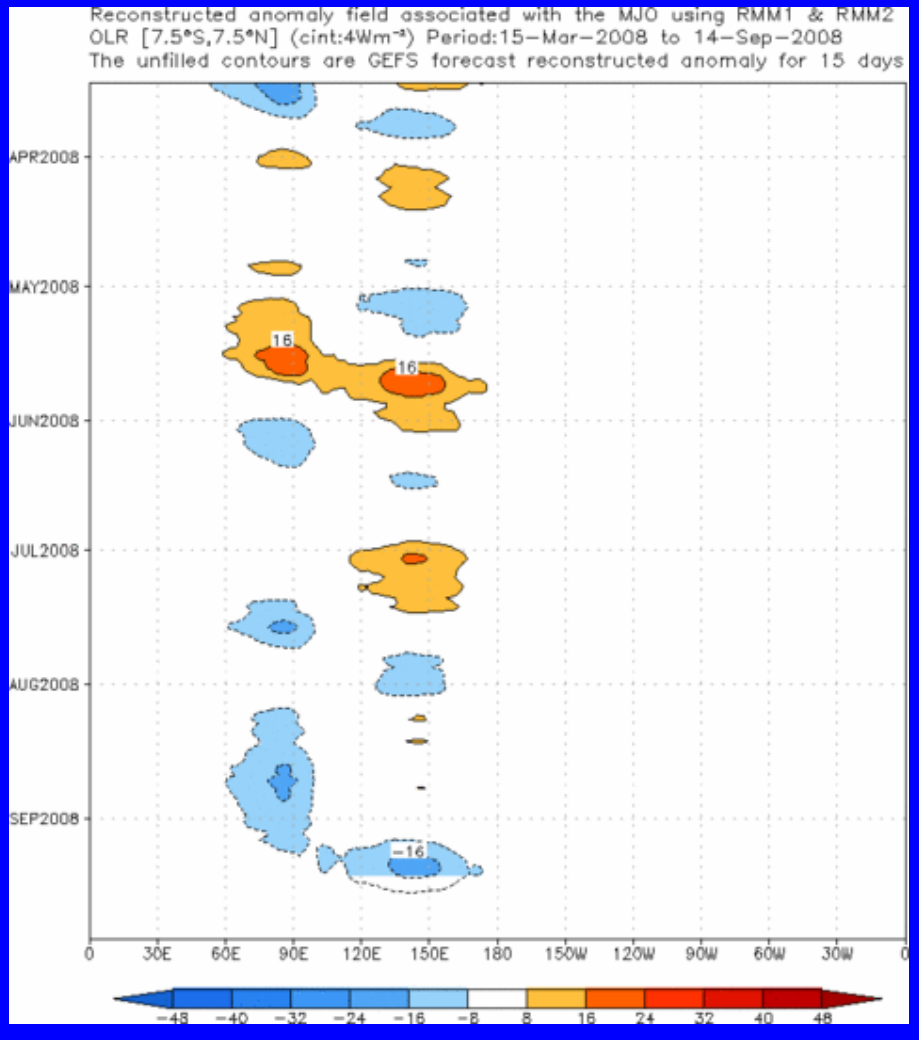
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The forecast indicates MJO-associated enhanced convection persisting across the western Pacific early during the period. The MJO signal becomes weak thereafter.

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)

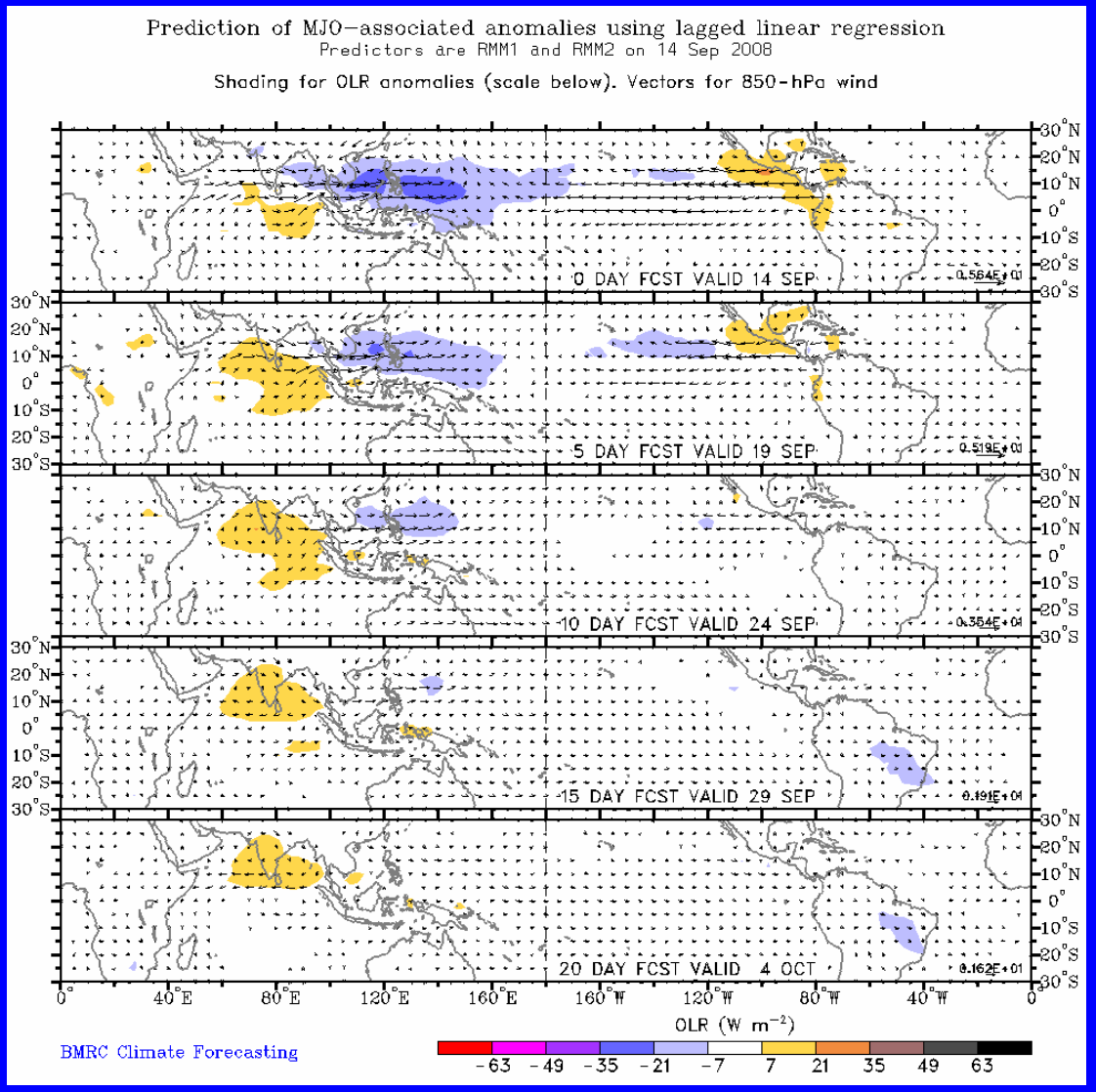
Spatial map of OLR anomalies and 850-hPa wind vectors for the next 20 days

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

Moderate MJO activity is forecast during the next two weeks.

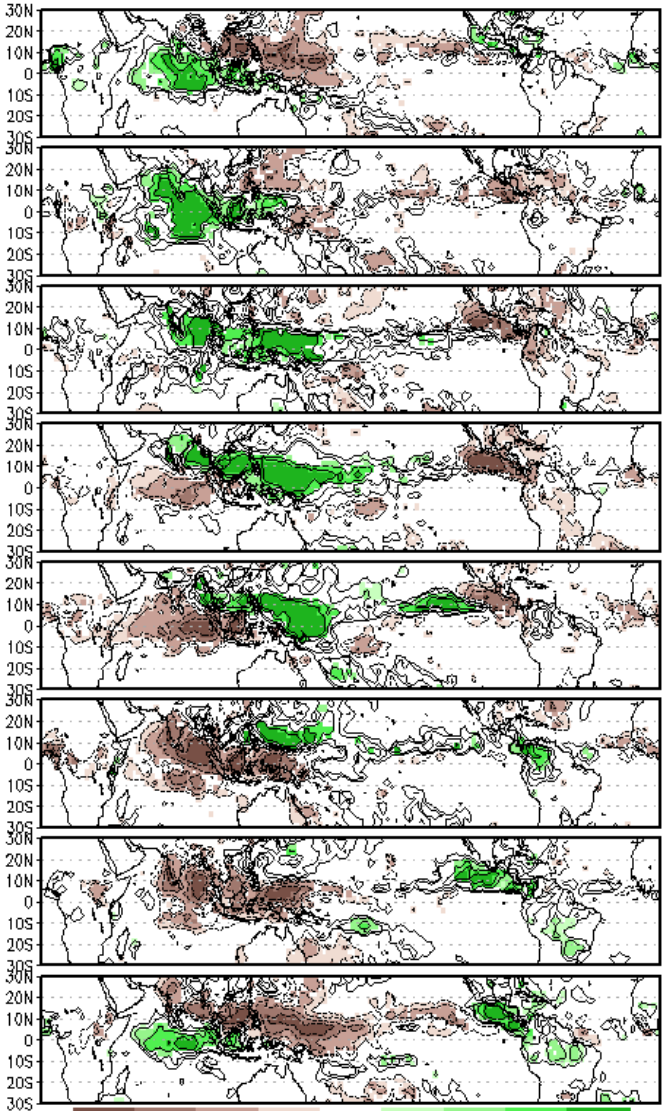
Enhanced convection is expected to slowly shift northeastwards from the Indian Ocean to the western and central Pacific.

Suppressed convection across the equatorial Indian Ocean is expected to slowly shift north and east to India and much of Indonesia.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)