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

Update prepared by
Climate Prediction Center / NCEP
August 17, 2009

Outline

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

Overview

- The patterns of tropical rainfall and winds continue to reflect considerable subseasonal variations including that consistent with weak MJO activity.

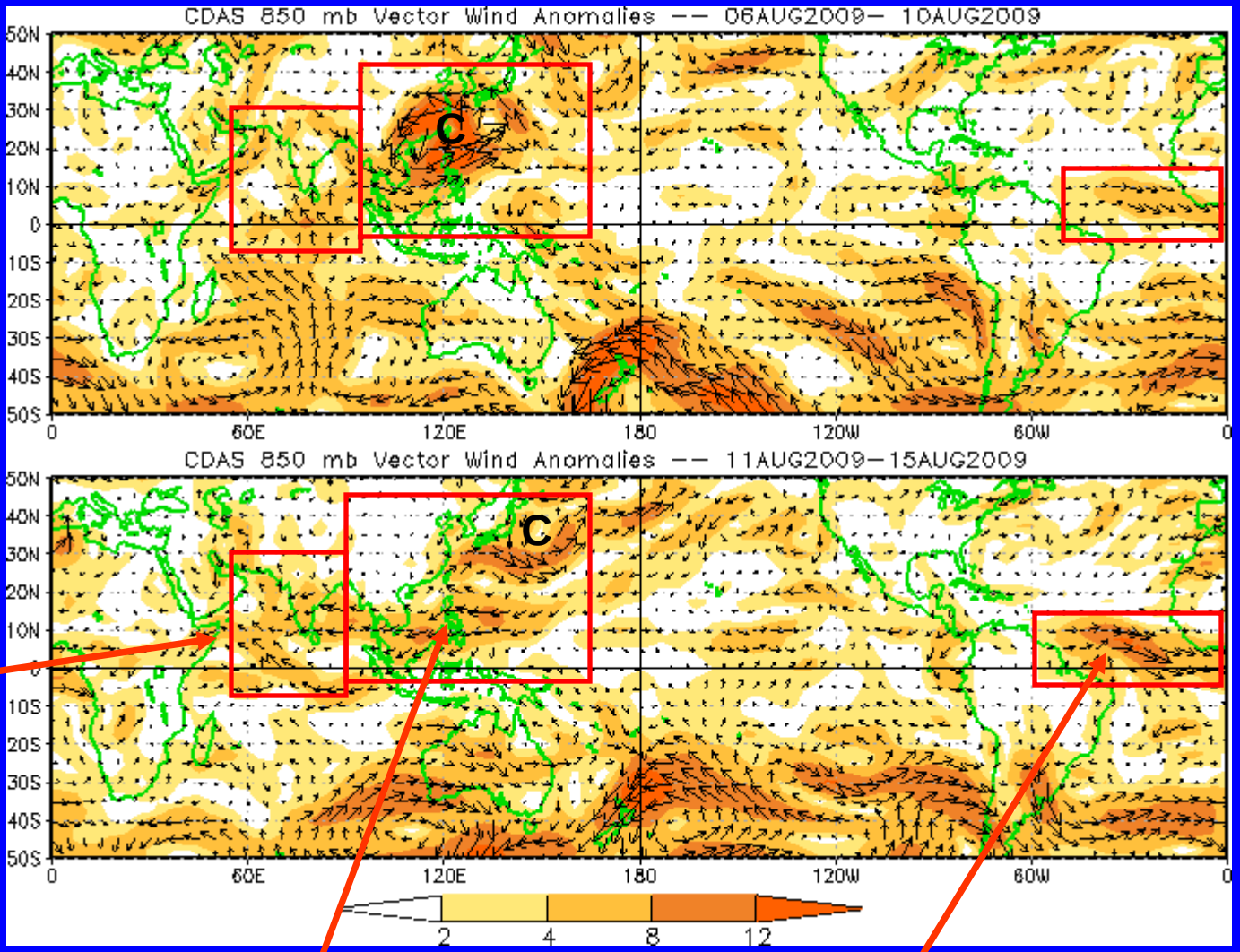
- Dynamical model forecasts of the MJO are contradictory and most do not forecast coherent MJO activity during the next 1-2 weeks.

- The MJO signal may contribute to enhanced rainfall across southern India and portions of western Indonesia and suppressed rainfall for parts of Southeast Asia, the Philippines and the western Pacific Ocean during the period.

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



Cross-equatorial flow over the central Indian Ocean continues to persist but flow into southern Asia remains weak.

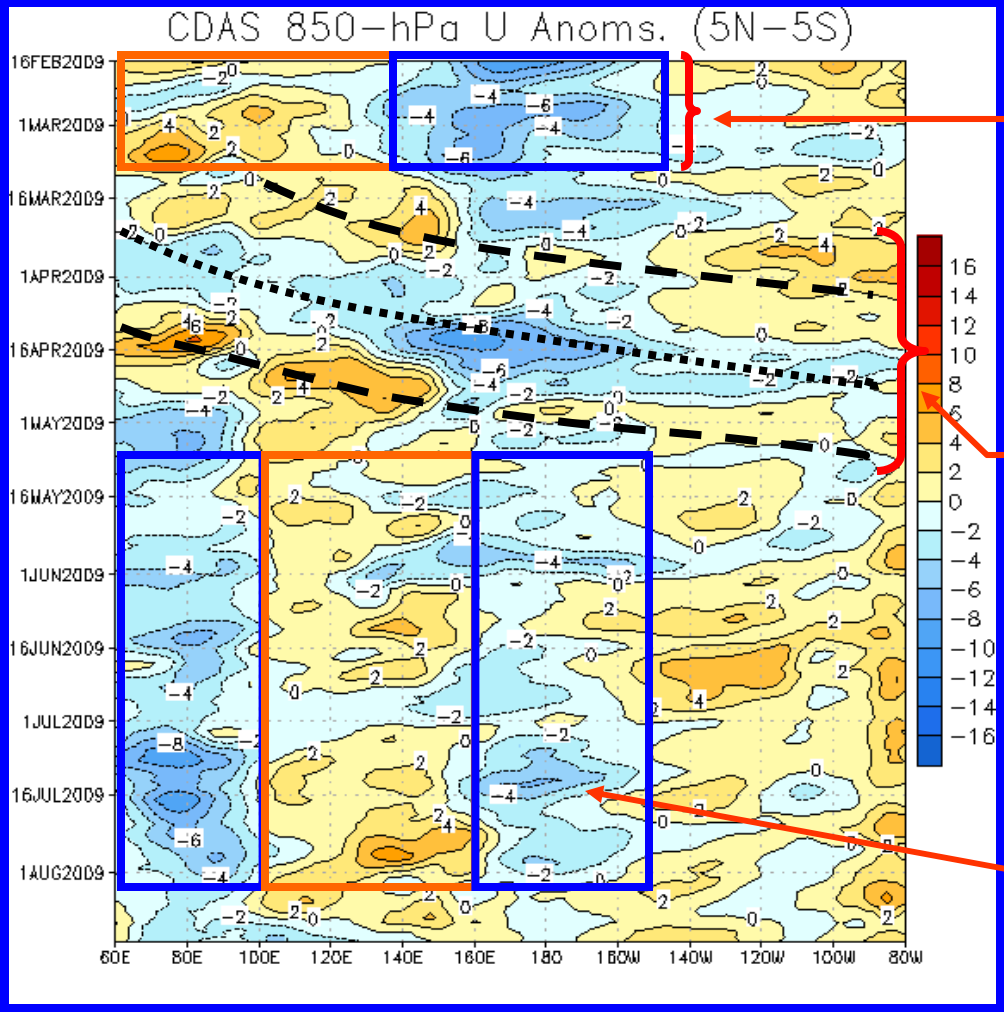
Low-level cyclonic anomalies in the western Pacific associated with tropical cyclone activity shifted northeastward and easterly anomalies developed over this region during the last five days.

Westerly anomalies strengthened slightly over the tropical Atlantic 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

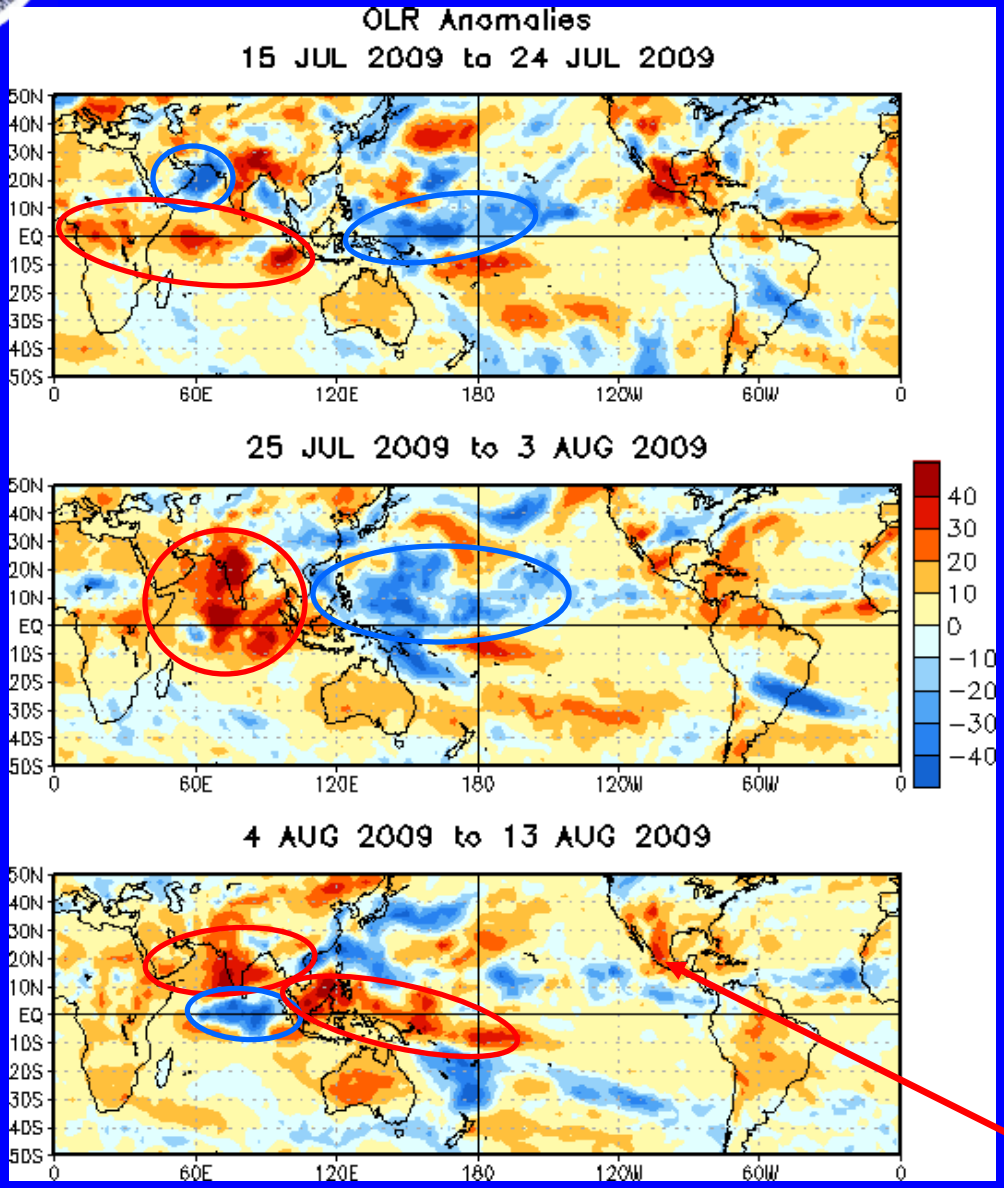
Longitude

A persistent pattern of westerly (easterly) anomalies over the Indian Ocean (central Pacific Ocean) were in place from mid-January to mid-March, consistent with La Nina conditions.

From mid-March to early May, a pattern of alternating eastward-propagating low-level westerly, easterly and again westerly anomalies, associated with the MJO, was evident over the Indian Ocean and equatorial Pacific.

During much of the period from May-early August, a persistent pattern of easterly (westerly) anomalies is evident across the Indian Ocean and central Pacific (Indonesia). NOTE: This pattern is partly due to NH summertime biases in the CDAS 850-hPa winds.

OLR Anomalies: Last 30 days



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

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

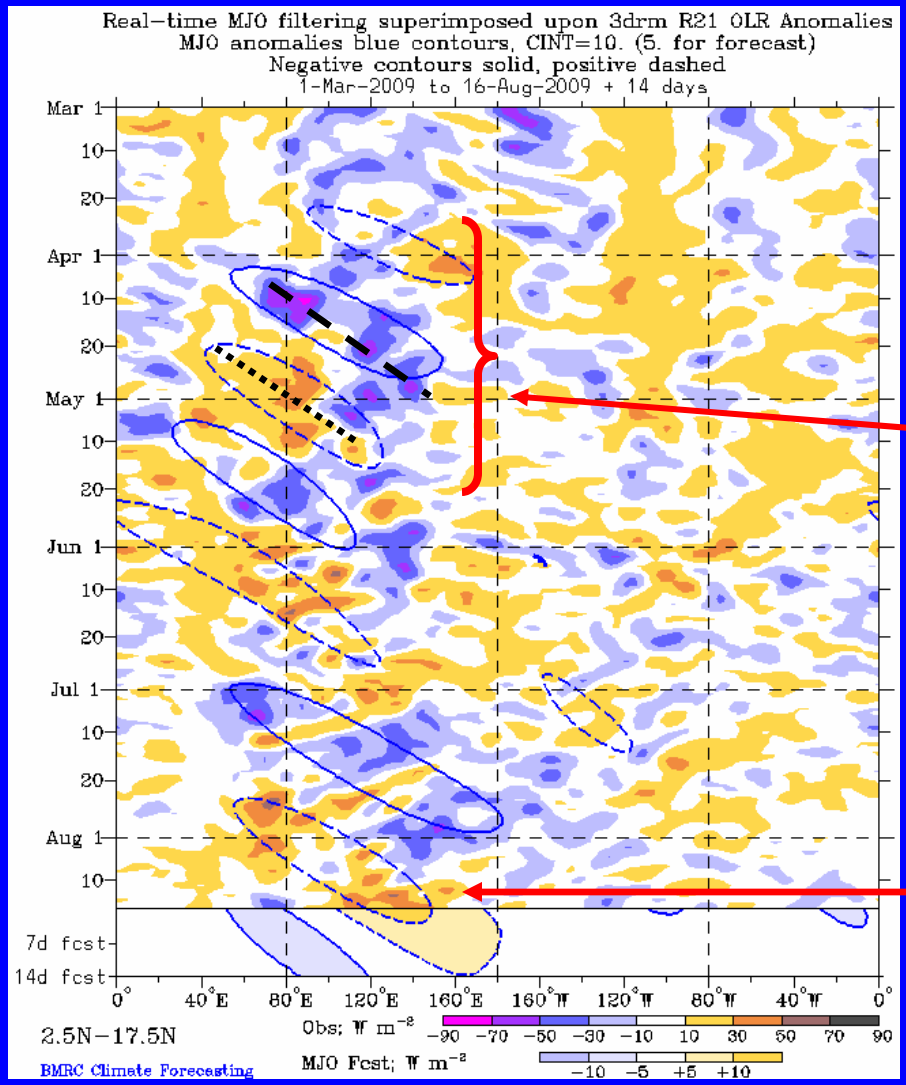
In mid-to-late July, areas of enhanced convection were evident across the Arabian Sea and the western and central tropical Pacific (blue ovals), while suppressed convection was evident over the Indian Ocean and Africa (red oval).

During late July-to-early August, enhanced convection extended eastward from the Philippines to east of the Date Line, while suppressed convection dominated the Arabian Sea, India and the Indian Ocean.

In early-to-mid August, suppressed convection shifted northward and eastward from the Indian Ocean, while enhanced convection developed over the central Indian Ocean.

Suppressed convection is evident over Central America and Mexico through the period.

Outgoing Longwave Radiation (OLR) Anomalies (2.5°N-17.5°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 (BOM) - Australia)

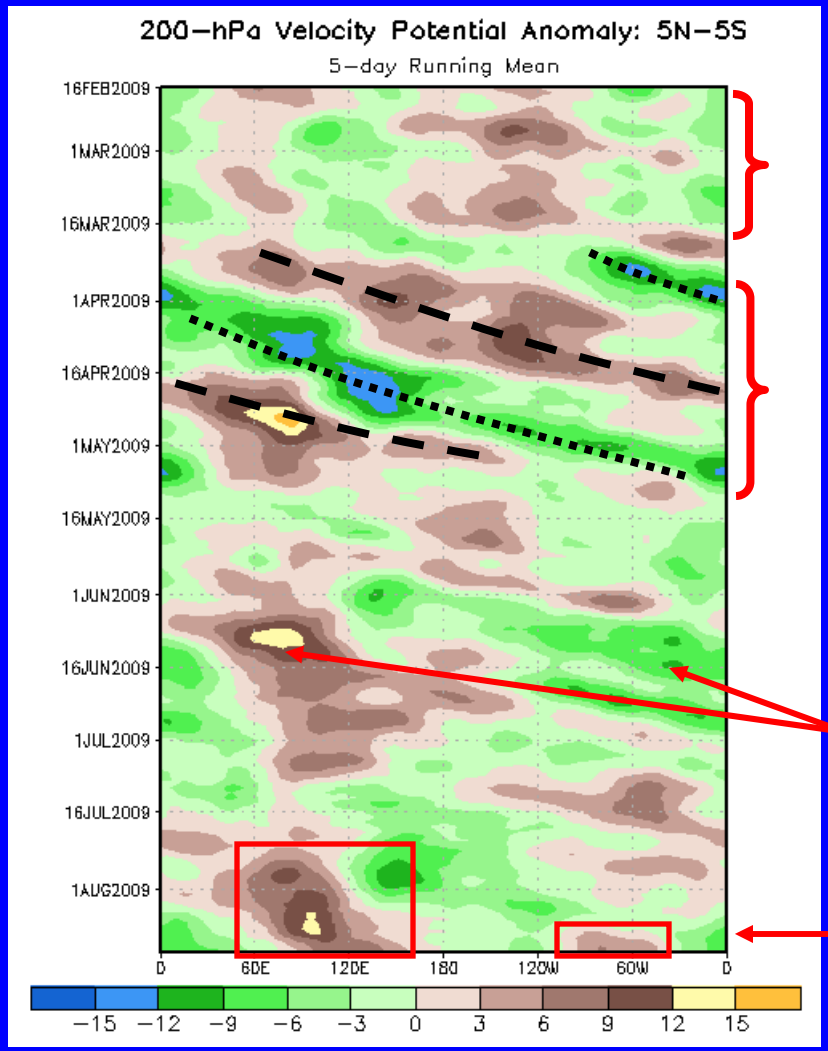
From mid-March into early May, areas of suppressed and enhanced convection shifted eastward in association with the MJO (also see equatorial version of this diagram at BOM as it is more suitable for the boreal Spring).

During the last week, anomalous suppressed convection has developed across the Maritime continent and the Philippines.

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

No coherent eastward-propagating pattern was evident from mid-February through early March.

From mid-March to early May, eastward propagating velocity potential anomalies indicated moderate-to-strong MJO activity.

The MJO weakened in May.

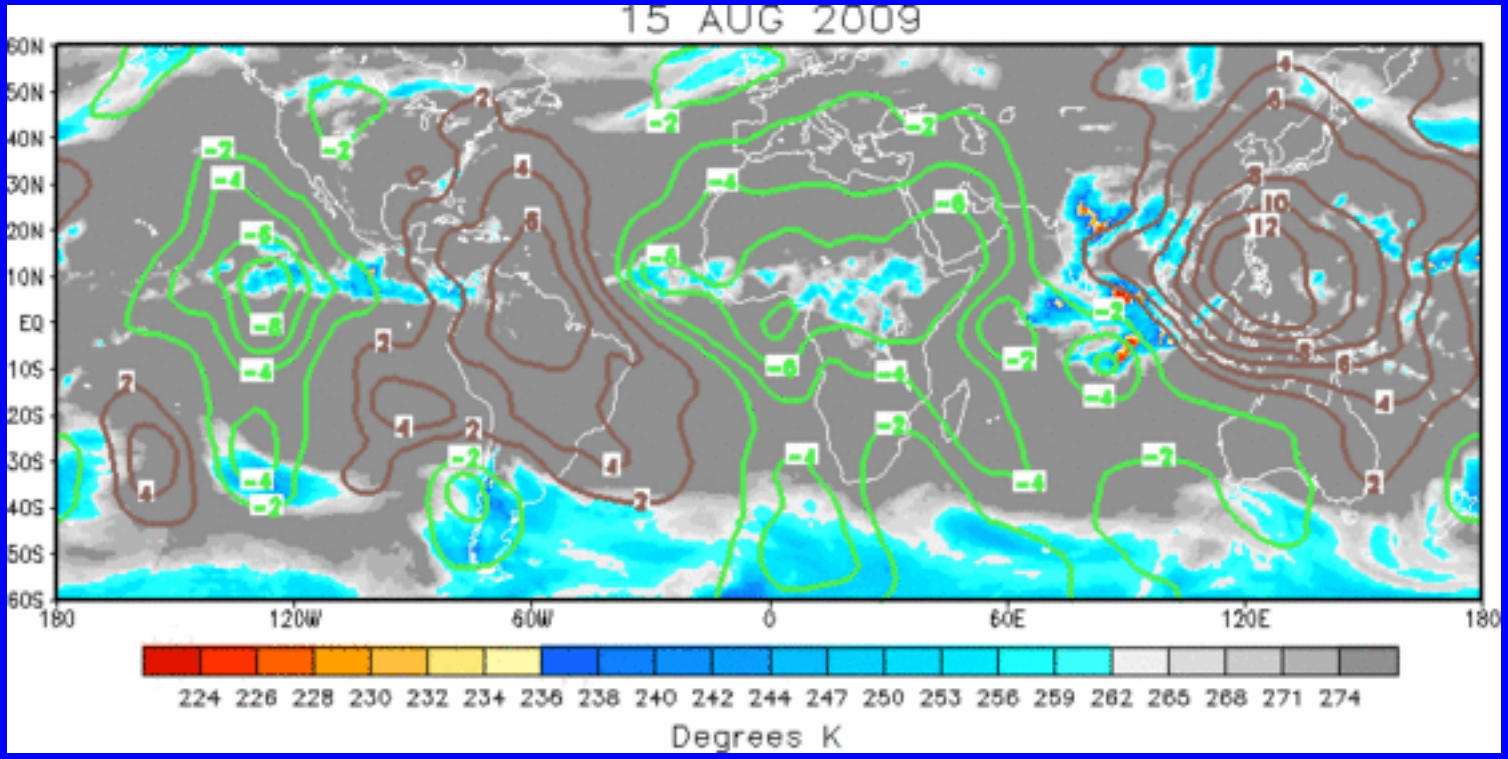
Velocity potential anomalies increased in early June with some eastward propagation evident.

Recently, positive anomalies have again strengthened over the Indian Ocean and Indonesia, negative anomalies expanded eastward over the central Pacific, and positive anomalies have developed over the eastern Pacific and South America.

IR Temperatures (K) / 200-hPa Velocity Potential Anomalies

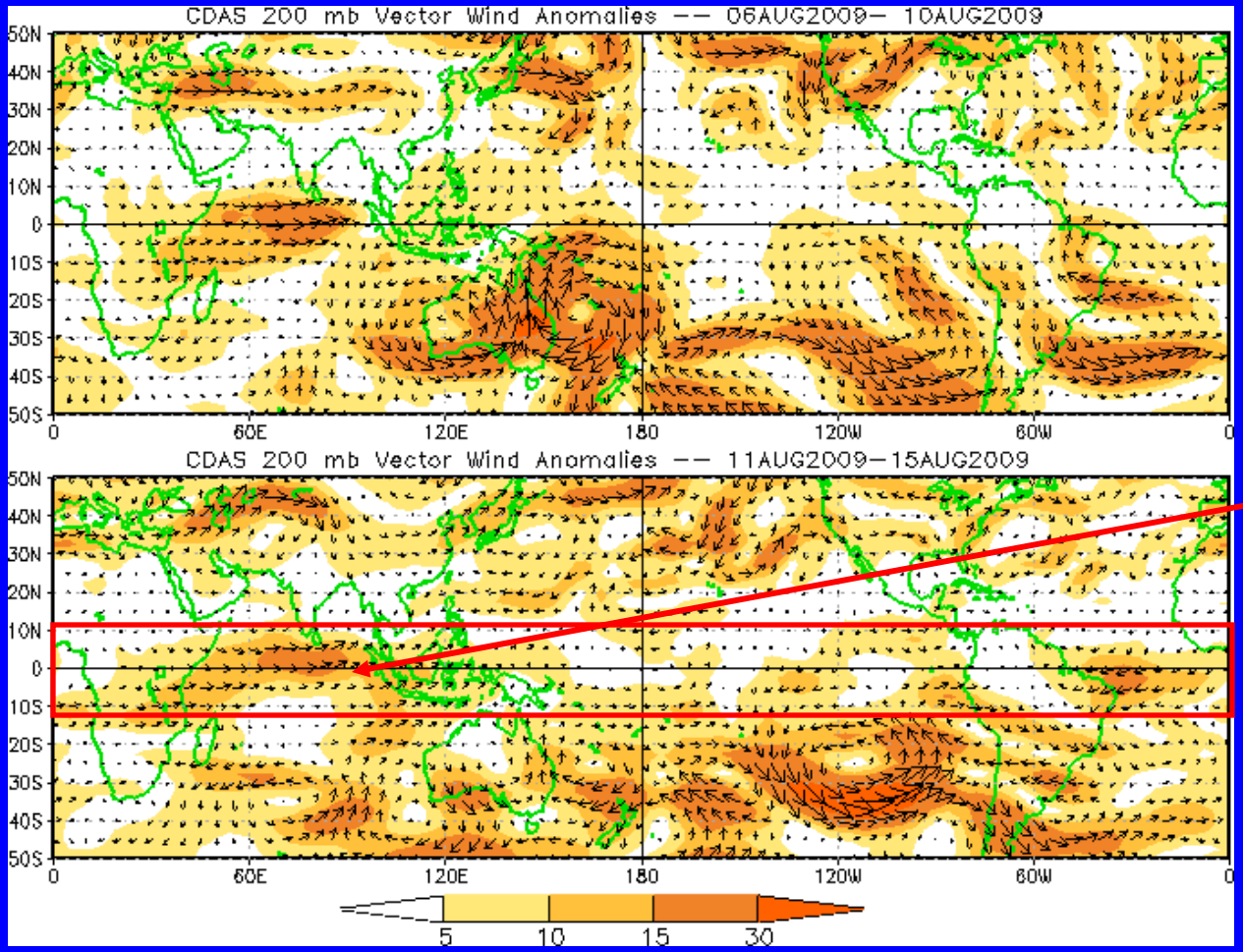
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The latest velocity potential anomalies indicate upper-level convergence over the Maritime Continent, the western Pacific Ocean and South America while upper-level divergence is indicated over the central Pacific and Africa.

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



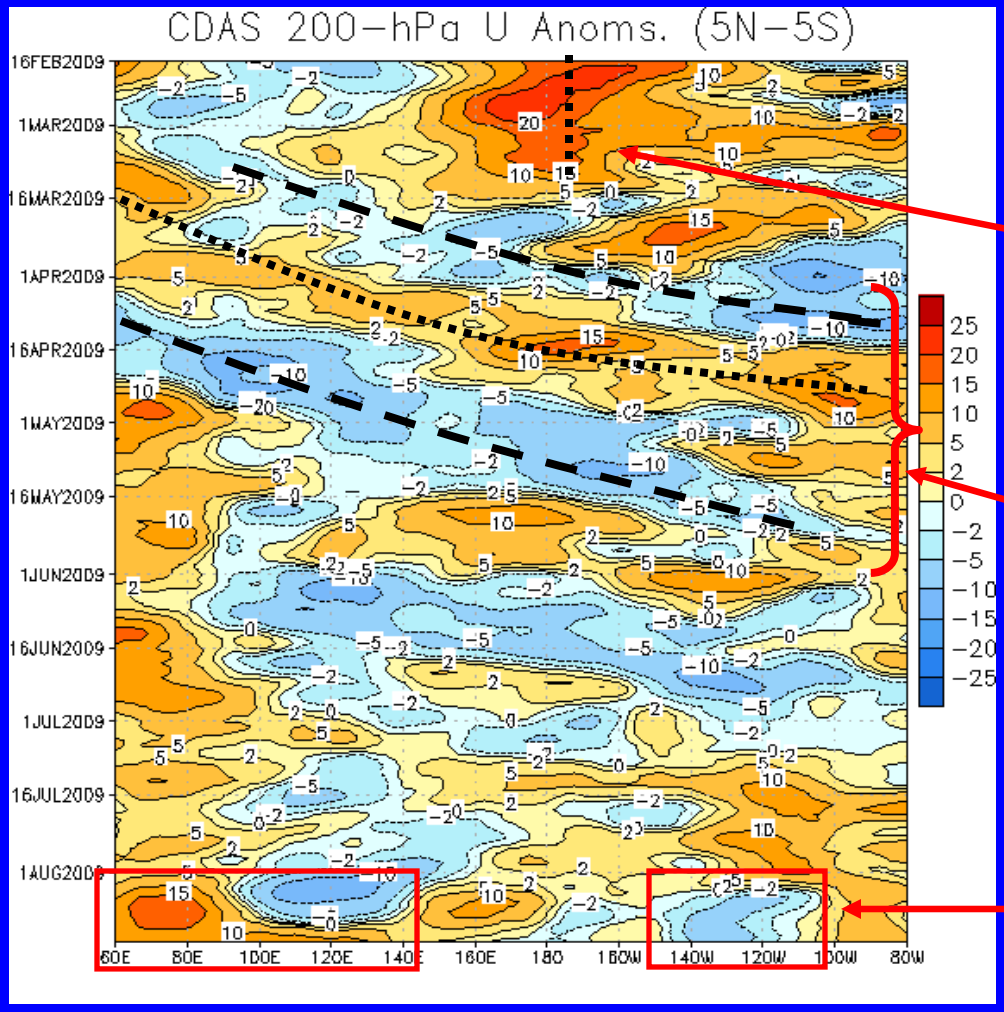
Note that shading denotes the magnitude of anomalous wind vectors

Weak upper-level wind anomalies are seen across most of global tropics (10N-10S) although westerly anomalies strengthened across the Indian Ocean.

200-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

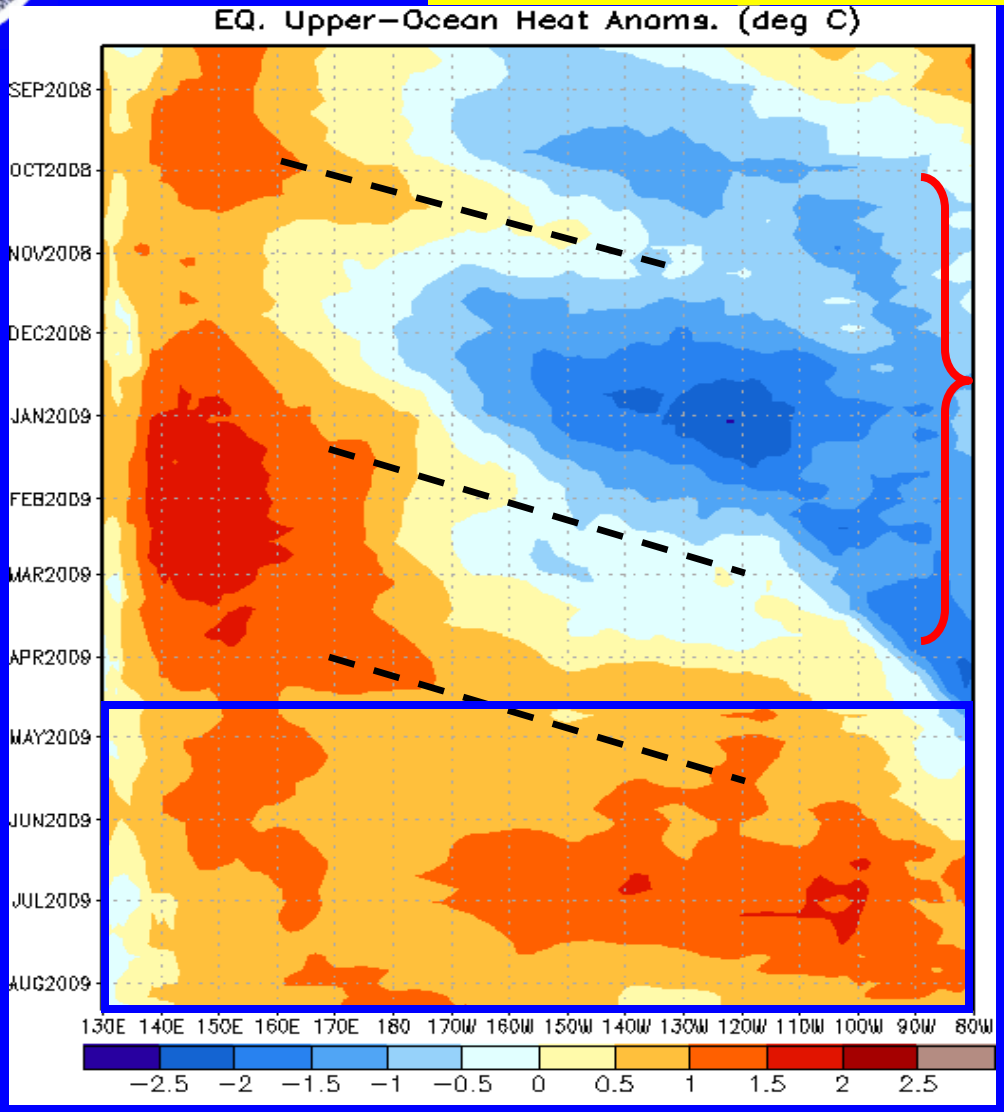
Longitude

Persistent westerly anomalies were observed near the Date Line into March 2009. These anomalies are consistent with La Niña conditions.

Alternating eastward-propagating easterly and westerly anomalies, consistent with MJO activity, were evident from mid-March to mid-May.

During the past week, westerly anomalies persisted across the Indian Ocean but also expanded eastward to Indonesia.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

- During September 2008 – January 2009, negative heat content anomalies returned and then strengthened in the central and eastern equatorial Pacific as La Niña conditions redeveloped.
- The negative anomalies weakened during January-March 2009, with anomalies becoming positive since late March.
- In April 2009, the combined effects of an oceanic Kelvin wave and weaker easterly trade winds contributed to an increase in the upper-ocean heat content anomalies across the Pacific Ocean.
- Since then, heat content anomalies have remained above-average.

MJO Index -- Information

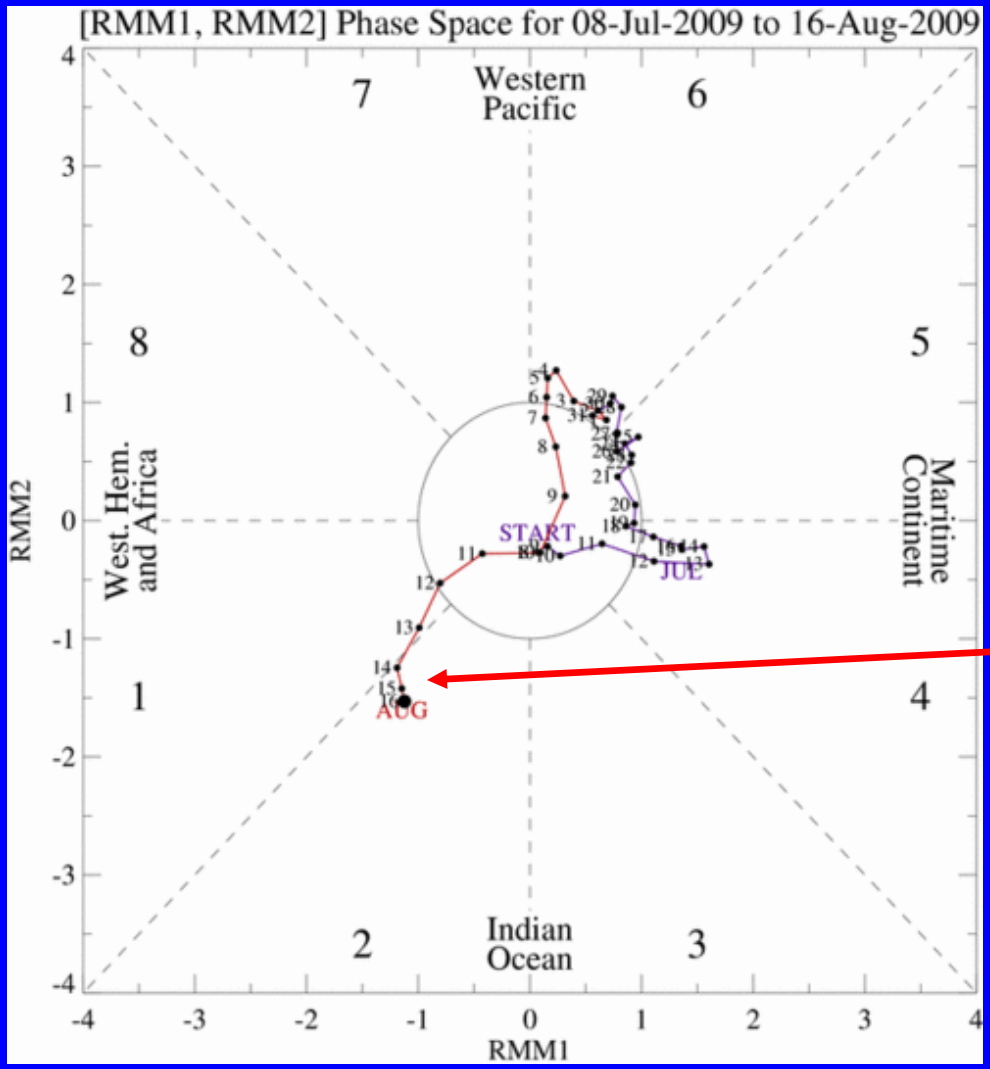
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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 or when the ENSO signal is large.**

- **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).**

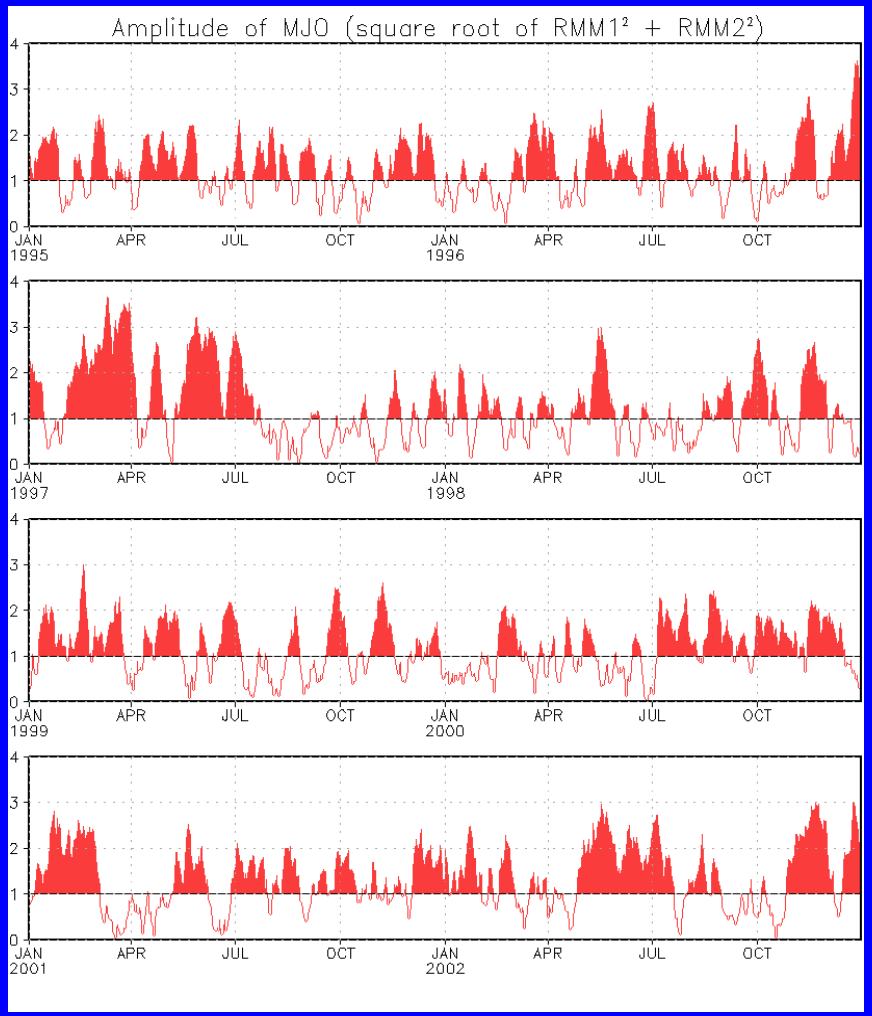
MJO Index -- Recent Evolution

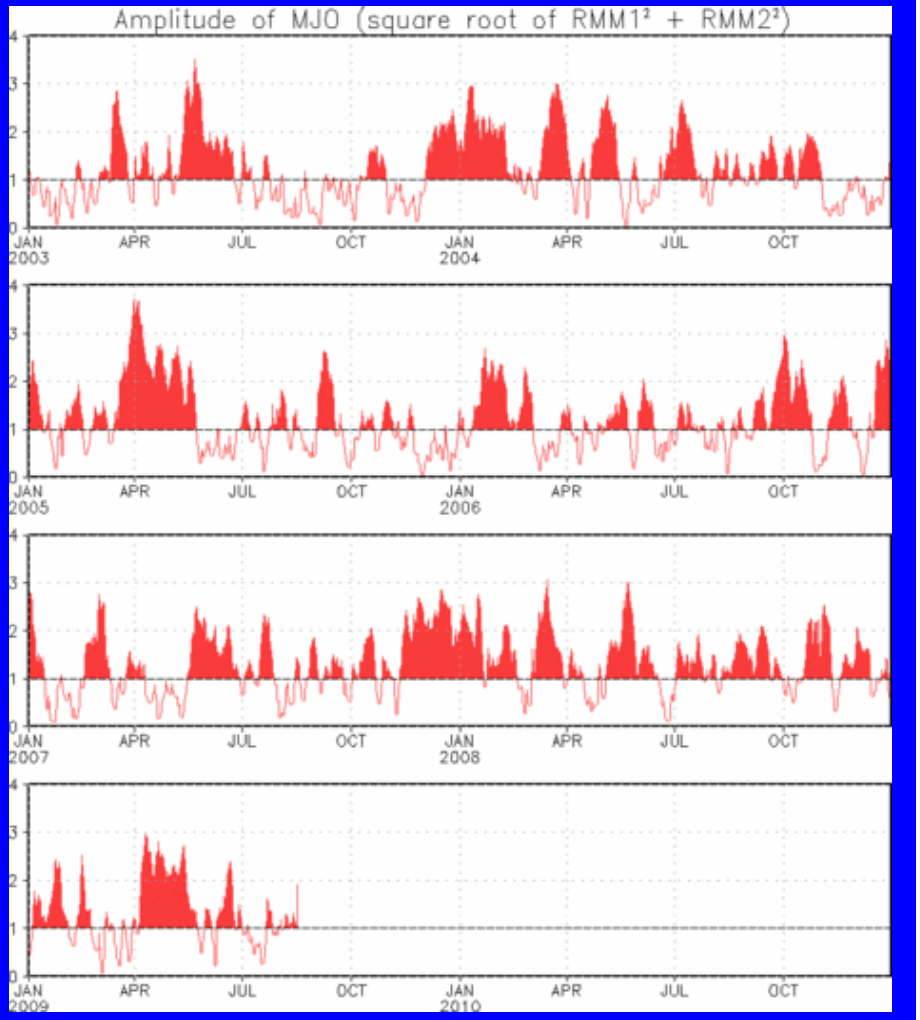


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

During the past week, the MJO index indicates an increase in amplitude but little 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.

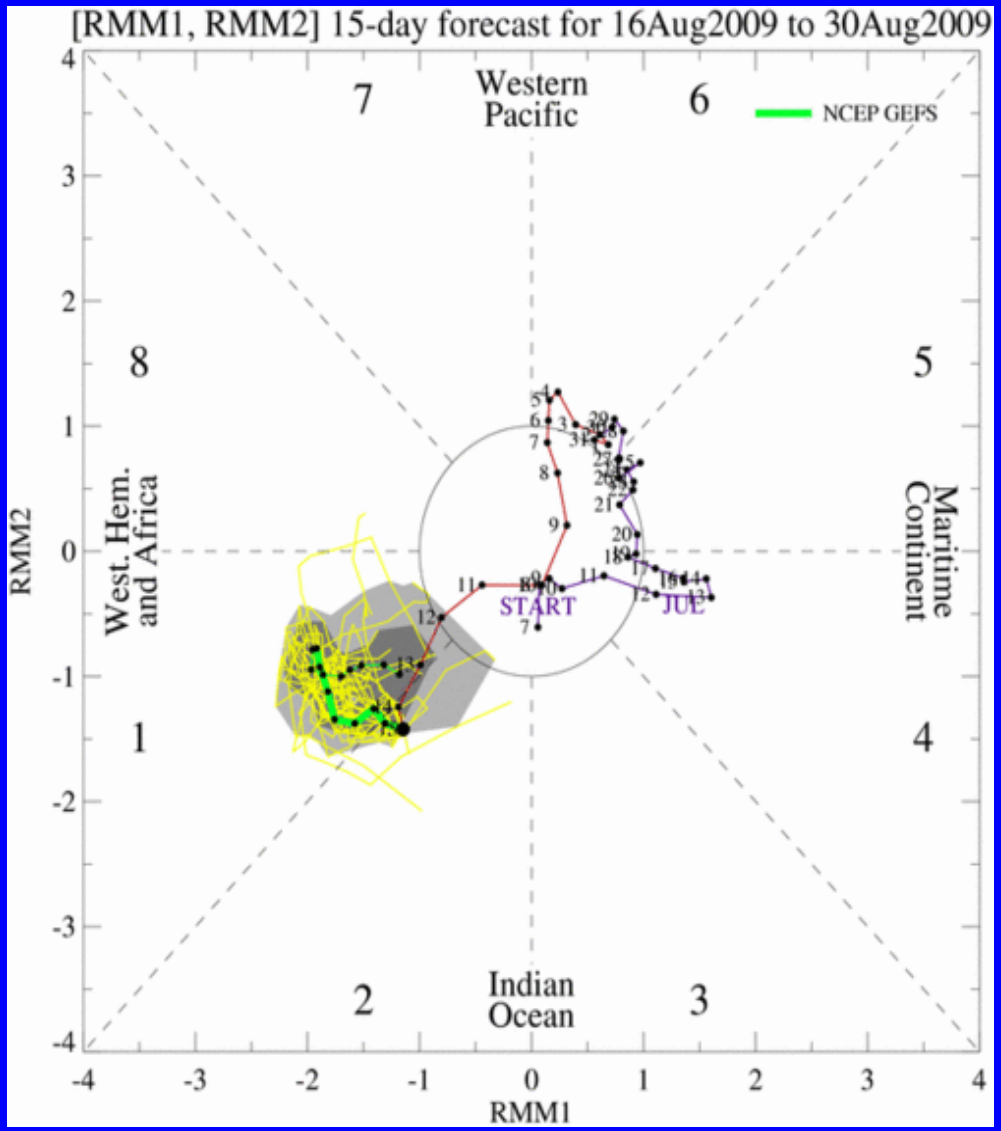
Ensemble GFS (GEFS) MJO Forecast

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

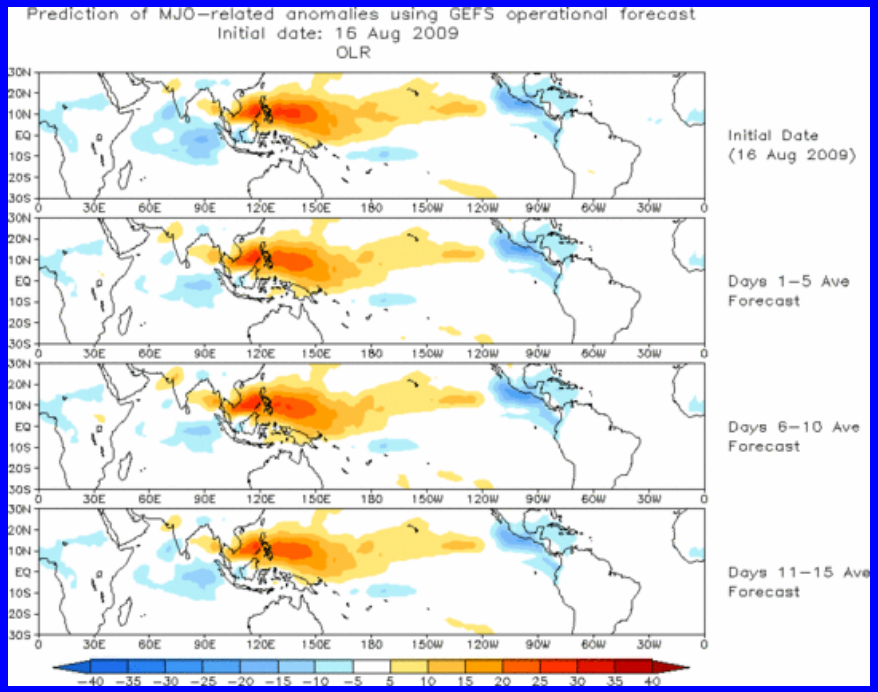
The GEFS forecasts a slight increase in the amplitude of the MJO index but little eastward propagation during the period.



Ensemble Mean GFS MJO Forecast

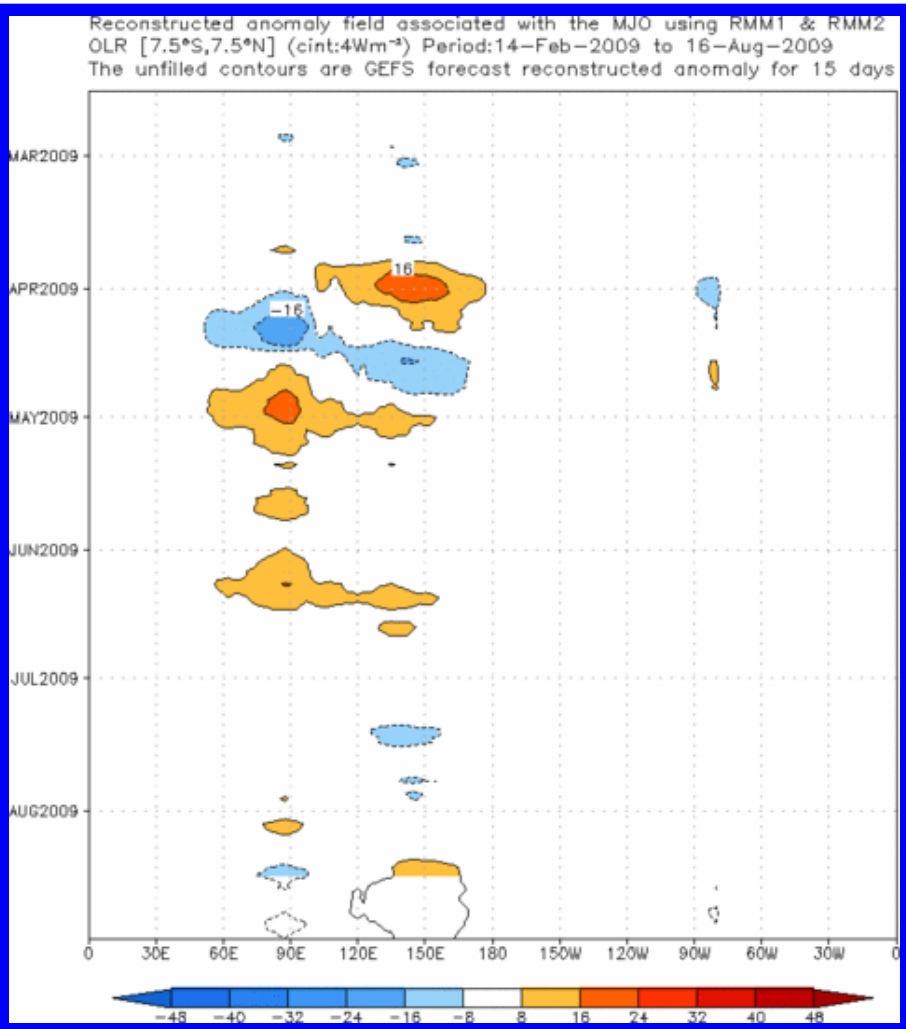
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecasts enhanced convection over the Indian Ocean, and strong suppressed convection over the western Pacific Ocean during Week-1 and 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

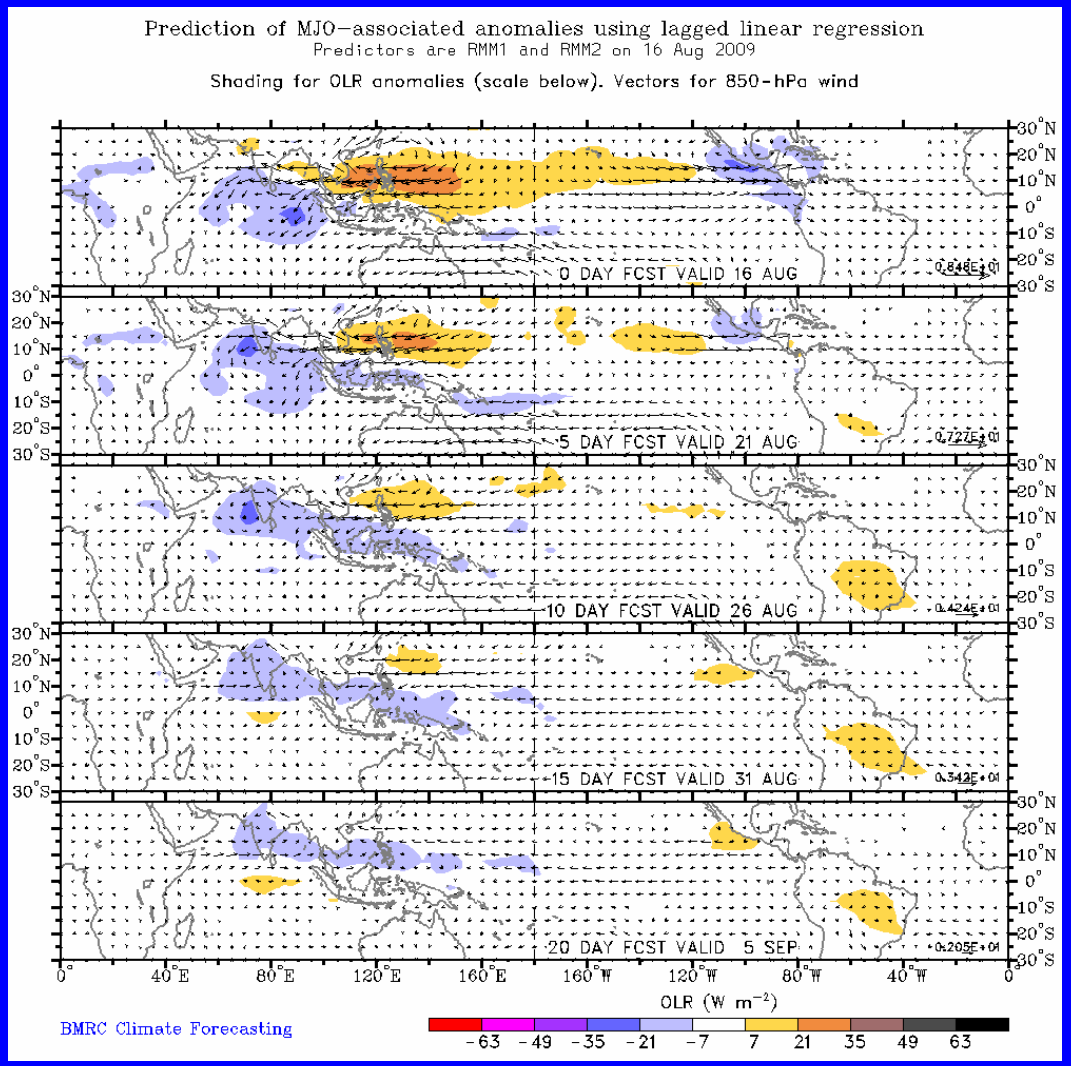
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

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

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

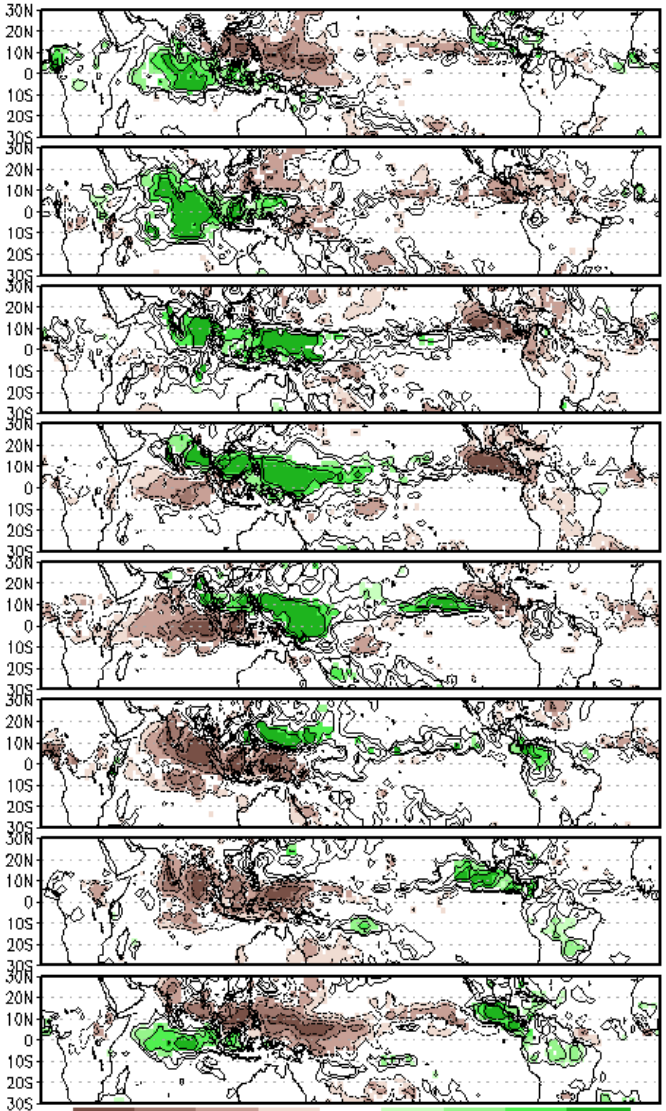
A statistical model forecasts moderate MJO activity during the next 1-2 weeks.

Enhanced convection shifting northeastward from the Indian Ocean to India and the Maritime continent. Suppressed convection near the Philippines is forecast to decrease.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)