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

Update prepared by
Climate Prediction Center / NCEP
July 27, 2009

Outline

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

Overview

- Enhanced convection over the past week has intensified and rapidly shifted eastward to the west-central Pacific, which is indicative of some subseasonal variations. At the current time, it is too early to assign this change to a developing MJO.

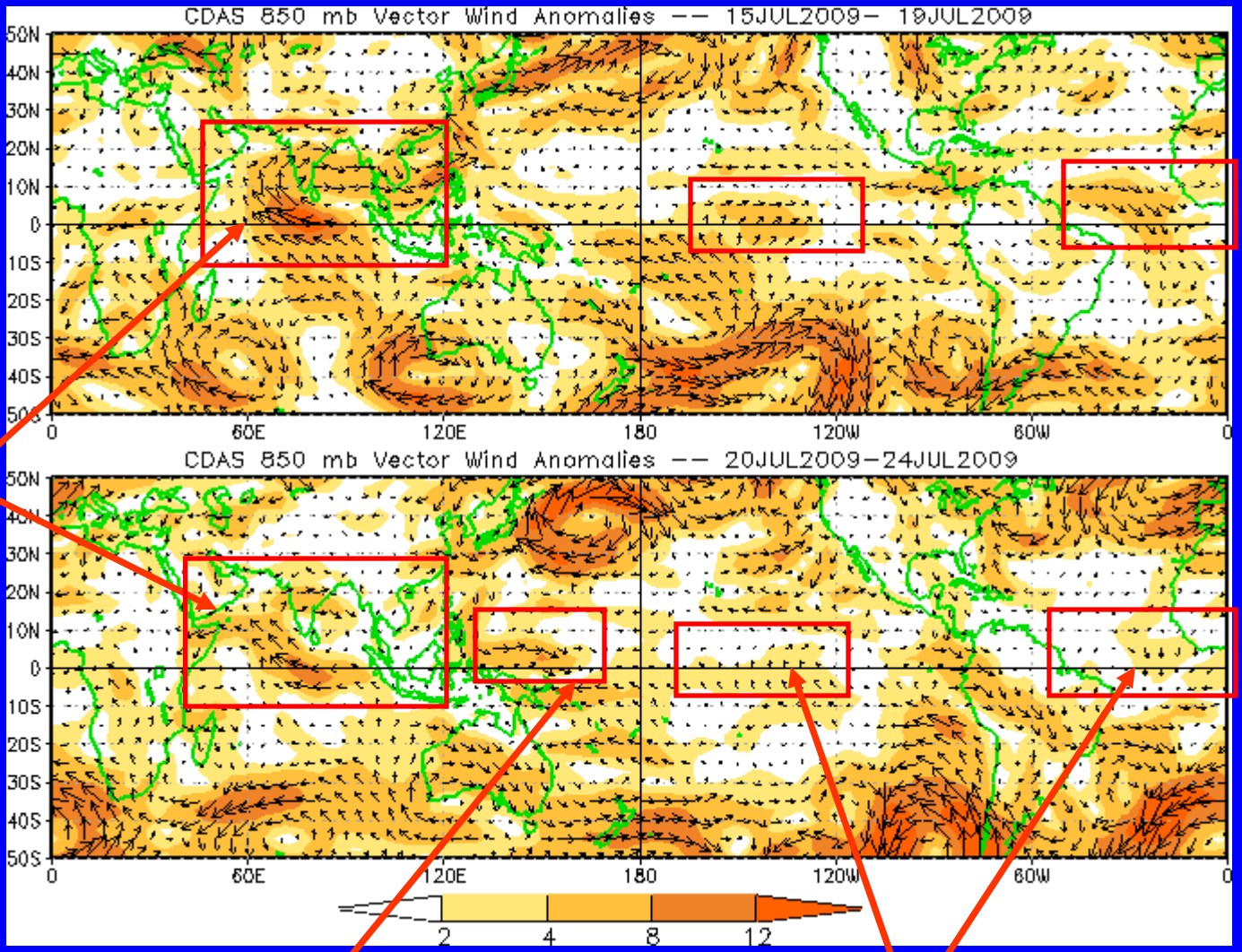
- The current El Niño conditions and other subseasonal variability make the forecast of MJO activity during the next 1-2 weeks very uncertain.

- The development of a MJO signal would contribute to enhanced rainfall across the western and central Pacific and suppressed rainfall across Mexico and Central America. Tropical cyclogenesis would also become more favored across the eastern Pacific during the Week-2 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



Anomalous Asian monsoonal flow weakened during the last five days.

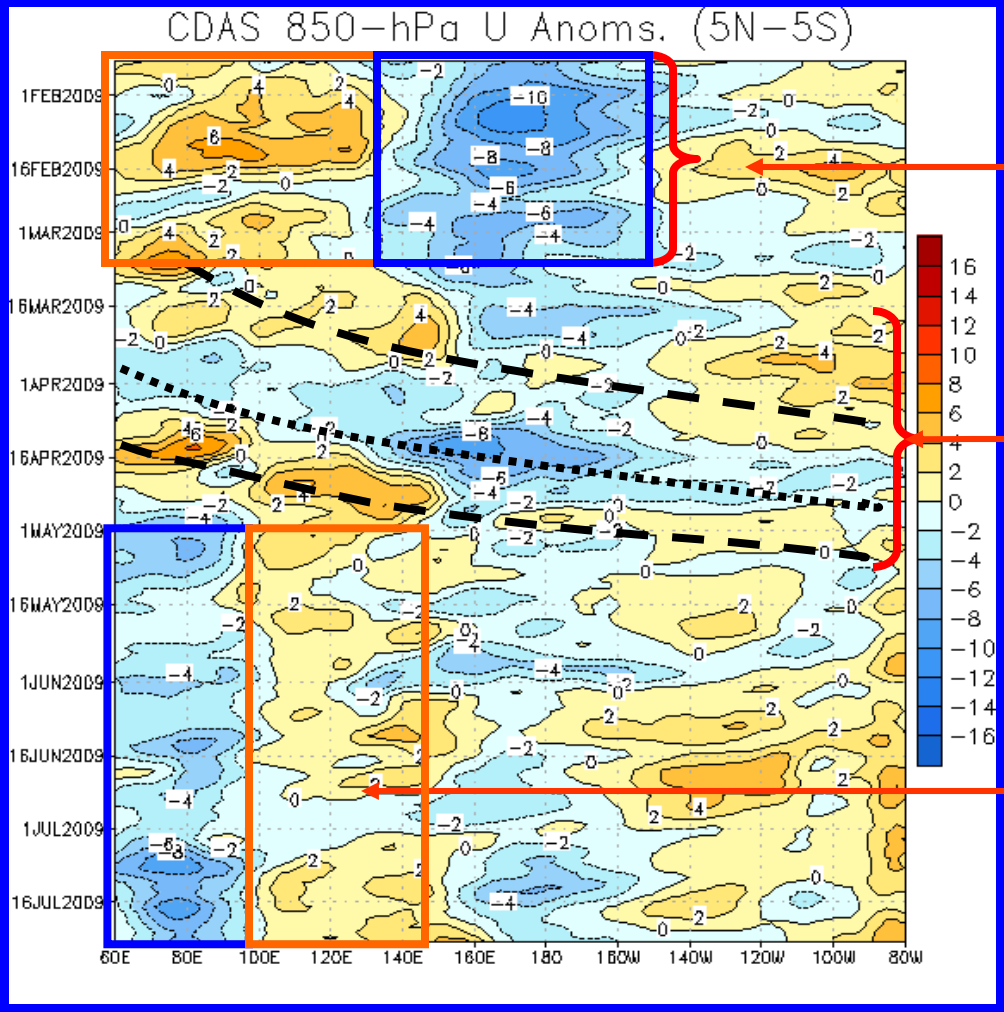
Low-level westerly wind anomalies have strengthened over the western Pacific Ocean.

Westerly anomalies weakened across the Atlantic and east-central 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

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

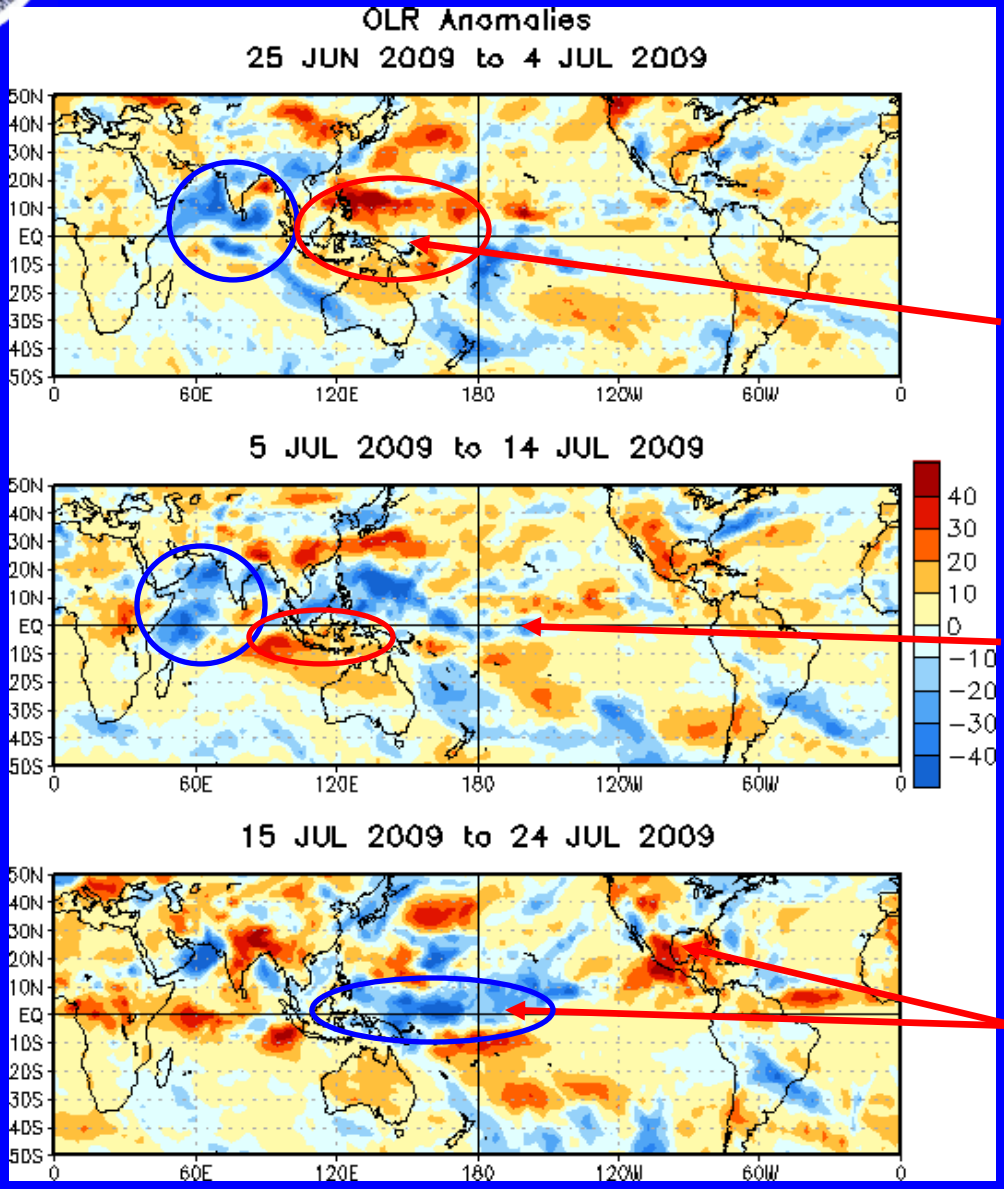
From mid-March to early May, a pattern of alternating low-level westerly, easterly and again westerly anomalies associated with the MJO shifted eastward from the Indian Ocean through the equatorial Pacific.

Since May 2009, a persistent pattern of easterly (westerly) anomalies is evident across the Indian Ocean (Indonesia) areas.

OLR Anomalies: Last 30 days

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

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

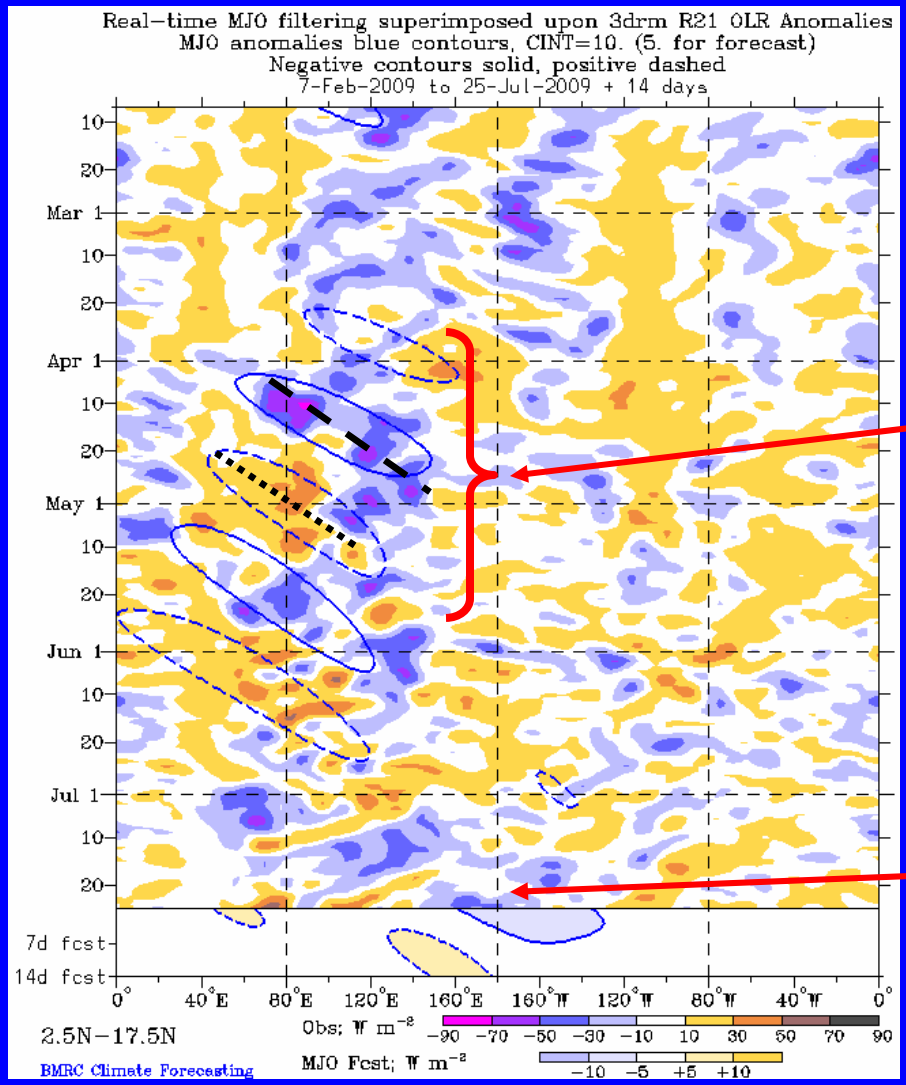


In late June and early July, enhanced convection was evident across portions of the Indian Ocean. Areas of suppressed convection were observed across the Maritime Continent and western Pacific.

During early July, enhanced convection increased across parts of the western Indian Ocean, Arabian Sea, India, and in the western Pacific (mainly north of the equator), while suppressed convection dominated the equatorial Maritime Continent.

In late July, enhanced convection was evident over the western and central Pacific, while suppressed convection continued across portions of Mexico and Central America.

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 - Australia)

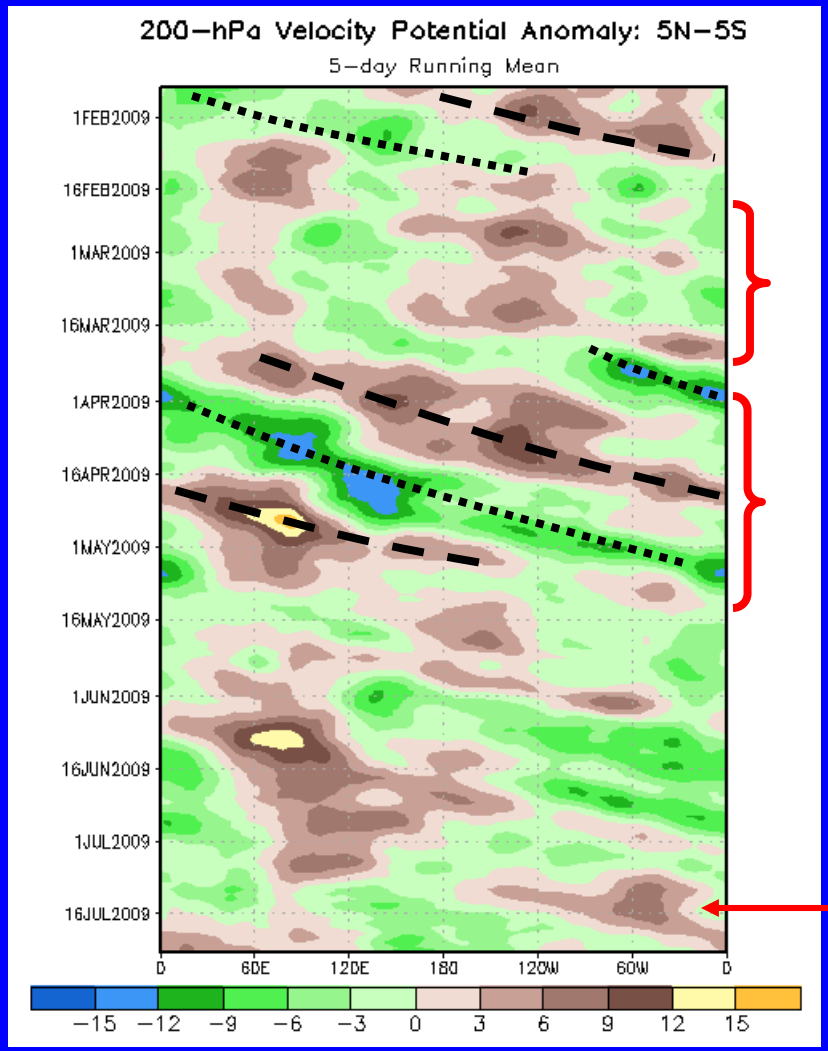
From mid-March into early May, areas of suppressed and enhanced convection shifted eastward in association with the MJO (also see equatorial version of this diagram at BOM as it is more suitable for the boreal Spring).

Recently, enhanced convection has developed near the Date Line 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

No coherent pattern was exhibited in the weak velocity potential anomalies from mid-February through early March.

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

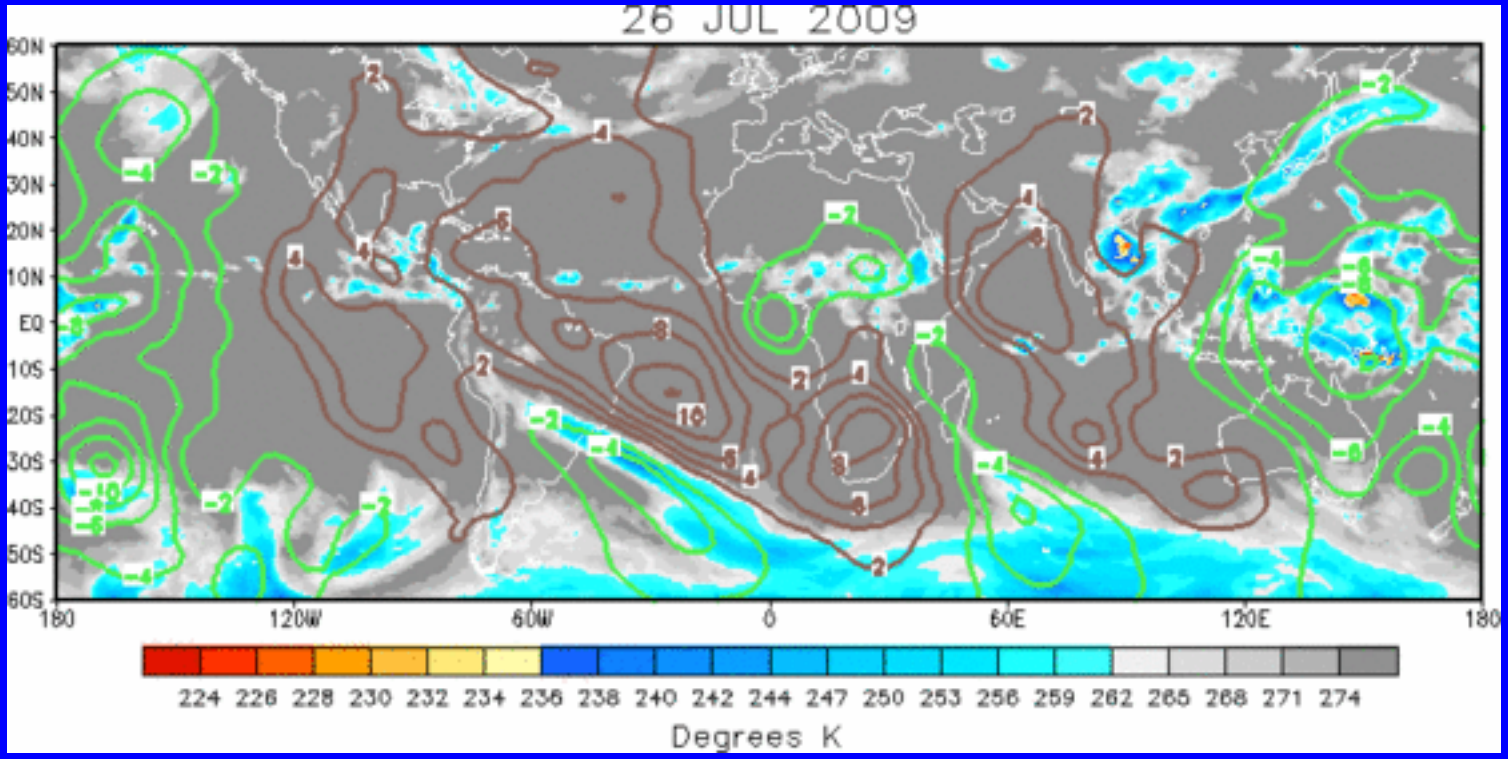
The MJO weakened in May and velocity potential anomalies were generally stationary throughout much of June.

Recently, some eastward propagation has been evident in the velocity potential anomalies.

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

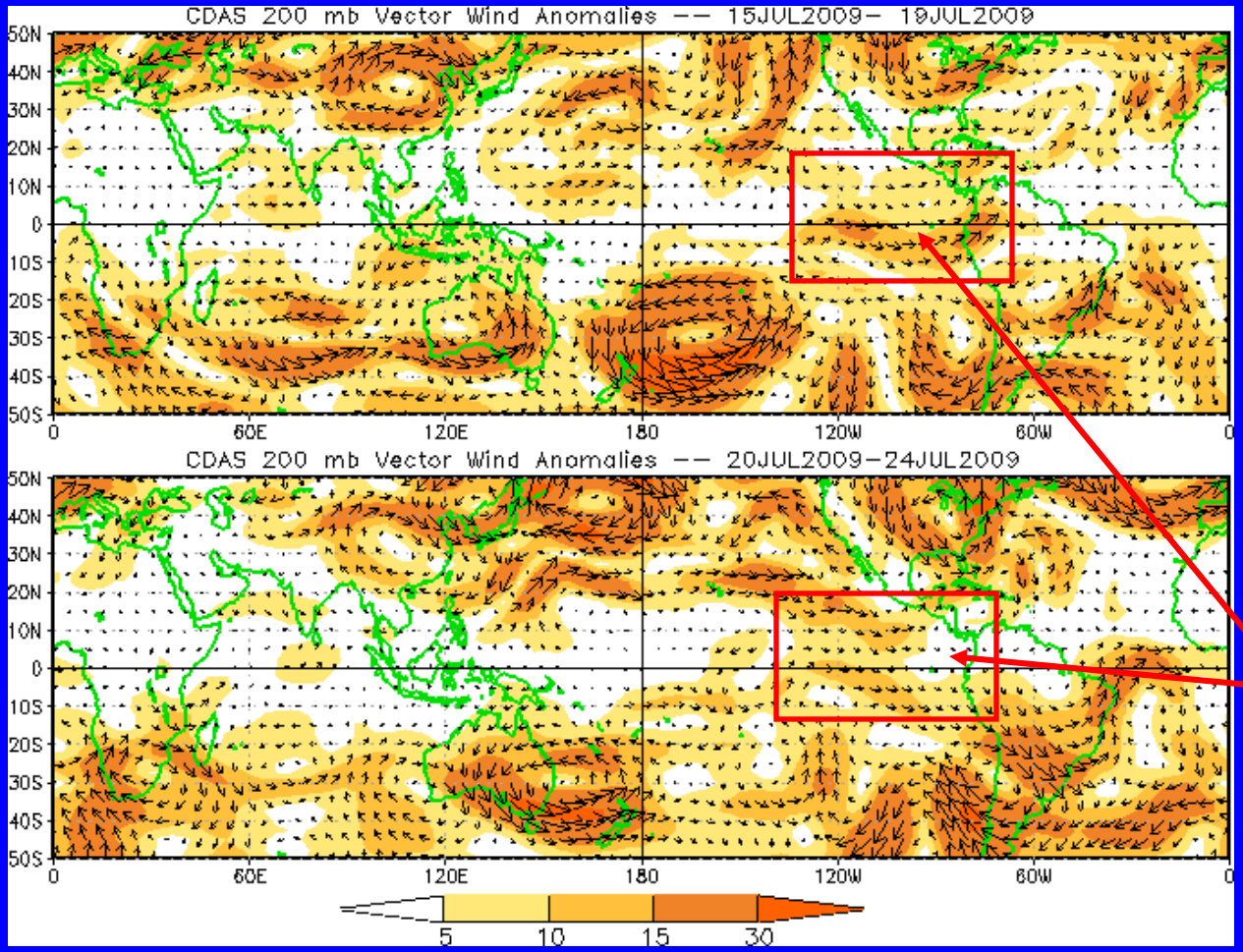
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The latest velocity potential anomalies indicate upper-level divergence across the western and central Pacific. Upper-level convergence is evident across the Americas, Atlantic Ocean Basin, and the Indian Ocean.

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



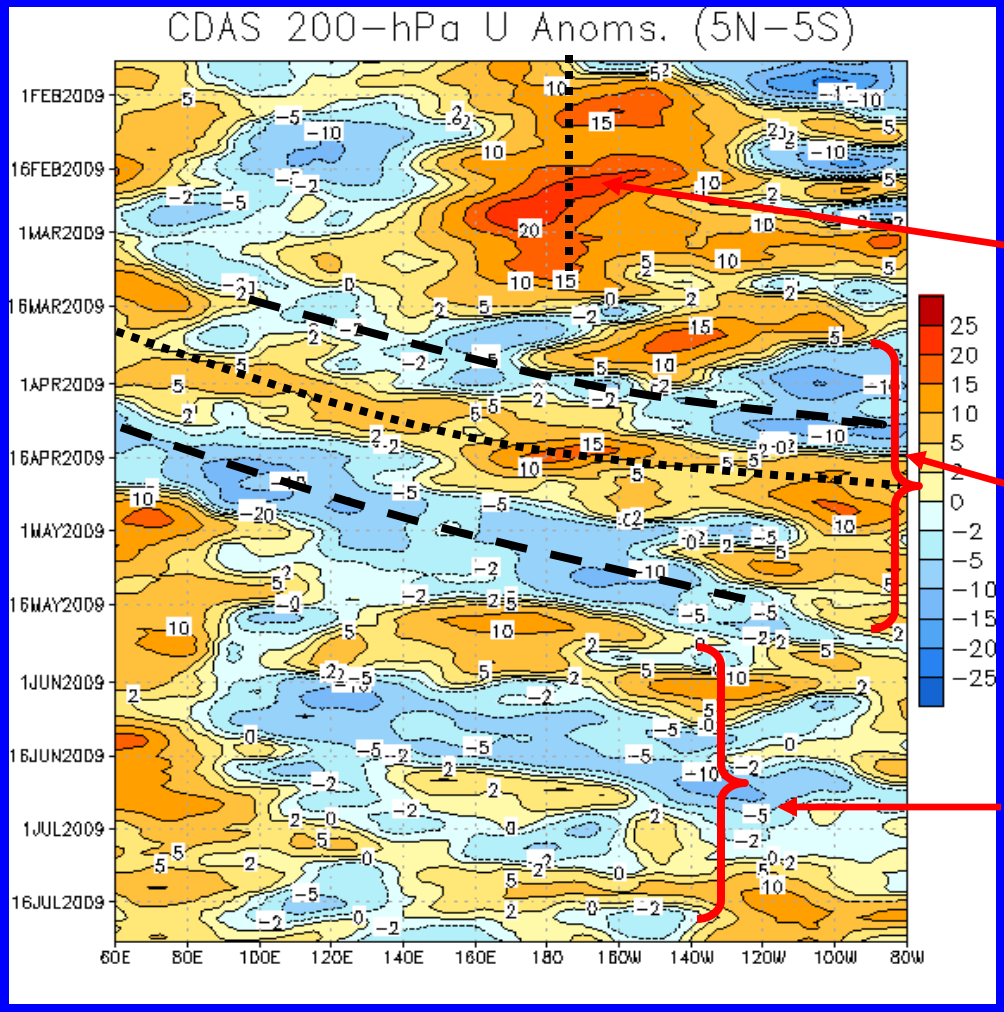
Note that shading denotes the magnitude of anomalous wind vectors

Westerly anomalies have persisted in the east-central Pacific during the last 5-10 days.

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

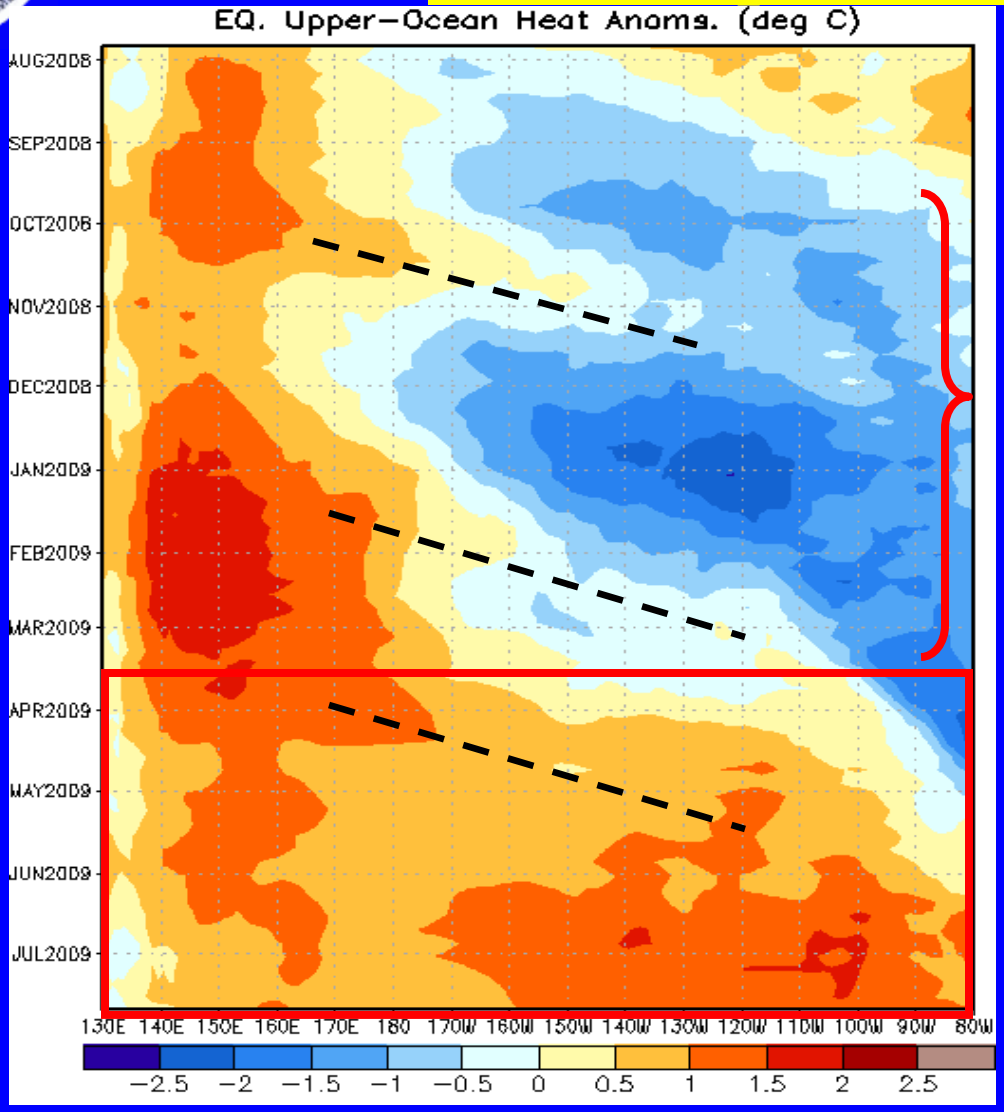
Longitude

Westerly anomalies continued near the Date Line into March 2009. These anomalies are consistent with La Nina conditions.

Easterly and westerly anomaly patterns consistent with MJO activity shifted eastward from mid-March to the beginning of May.

Some eastward propagating signals are evident during May and June, but compared to the February/March period, easterly anomalies are much more prevalent near the Date Line.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

During August 2008, negative anomalies started to develop east of the Date Line and increased/expanded eastward through early 2009. There was a pause in this increase during October as a Kelvin wave shifted eastward.

An eastward propagating Kelvin wave during April and May contributed to increased heat content in the eastern half of the Pacific.

Positive anomalies in the Pacific increased in magnitude and coverage (red box) since May 2009.

MJO Index -- Information

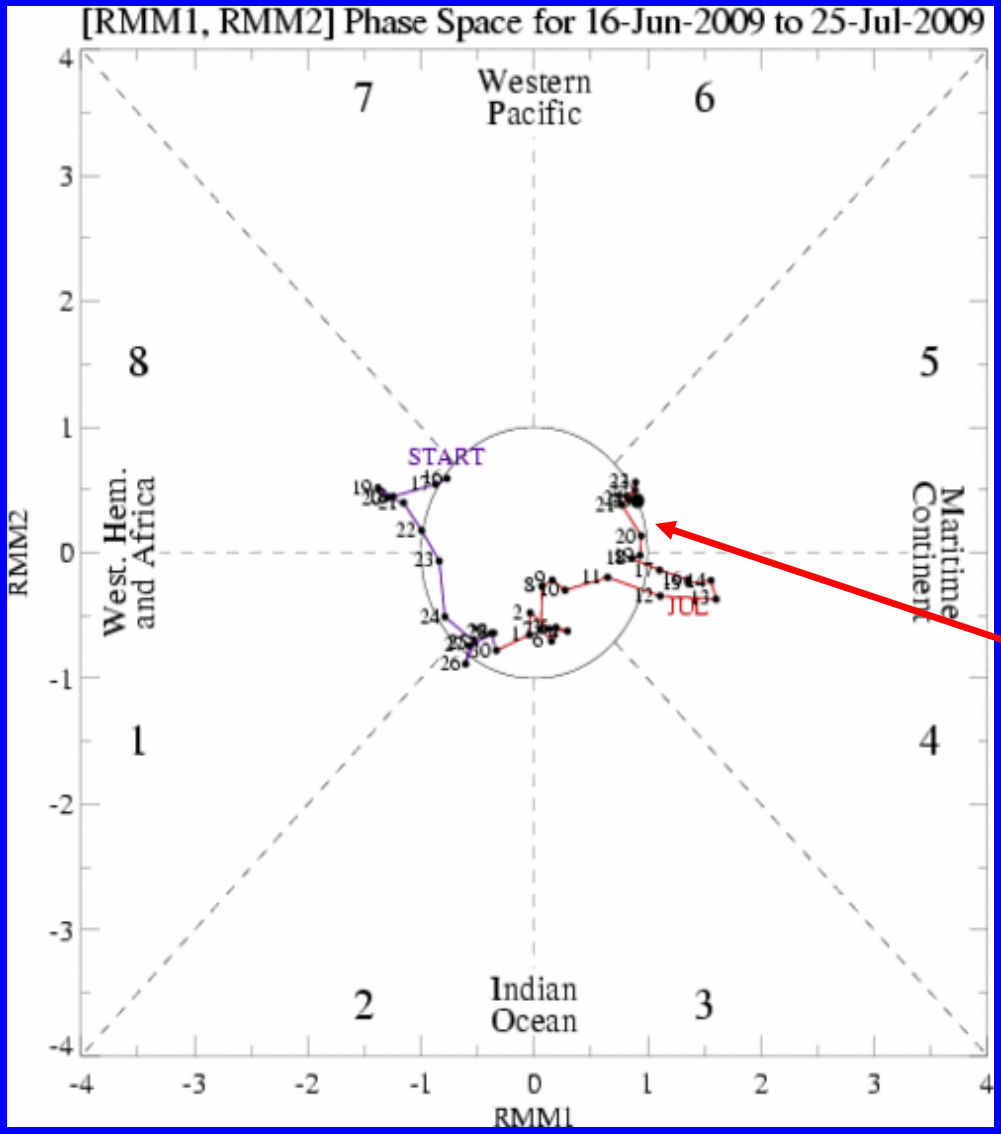
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

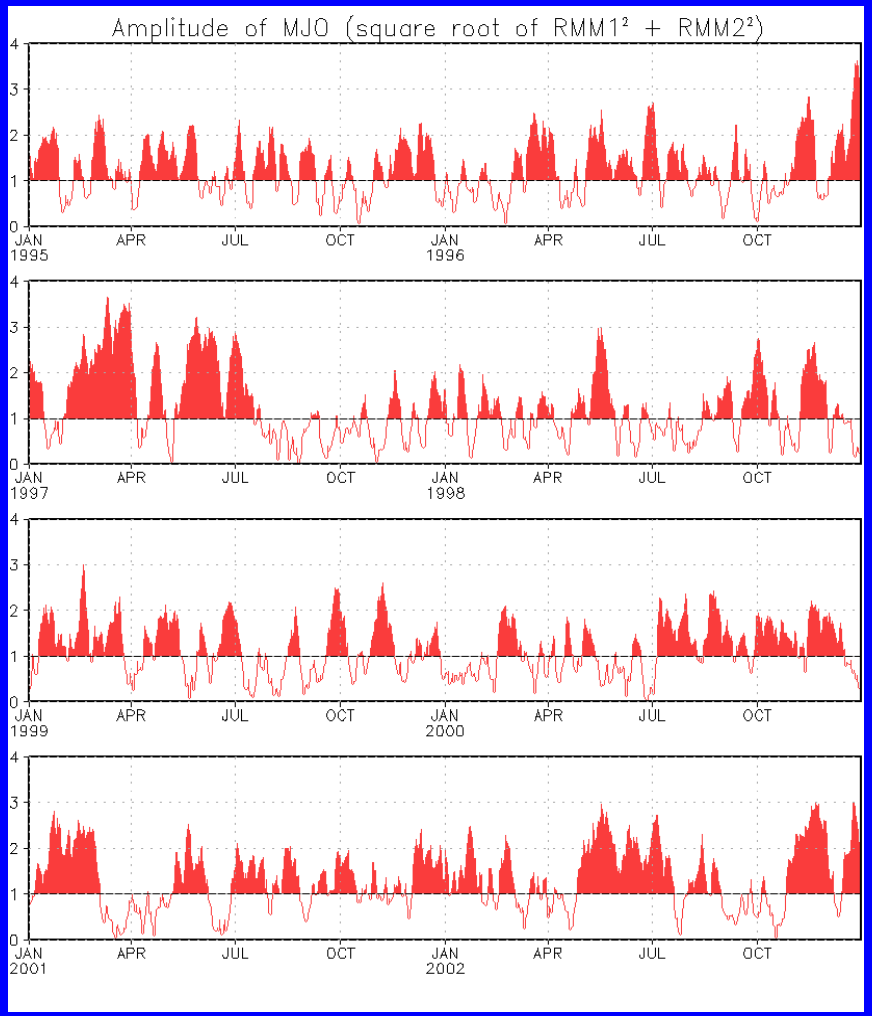
MJO Index -- Recent Evolution

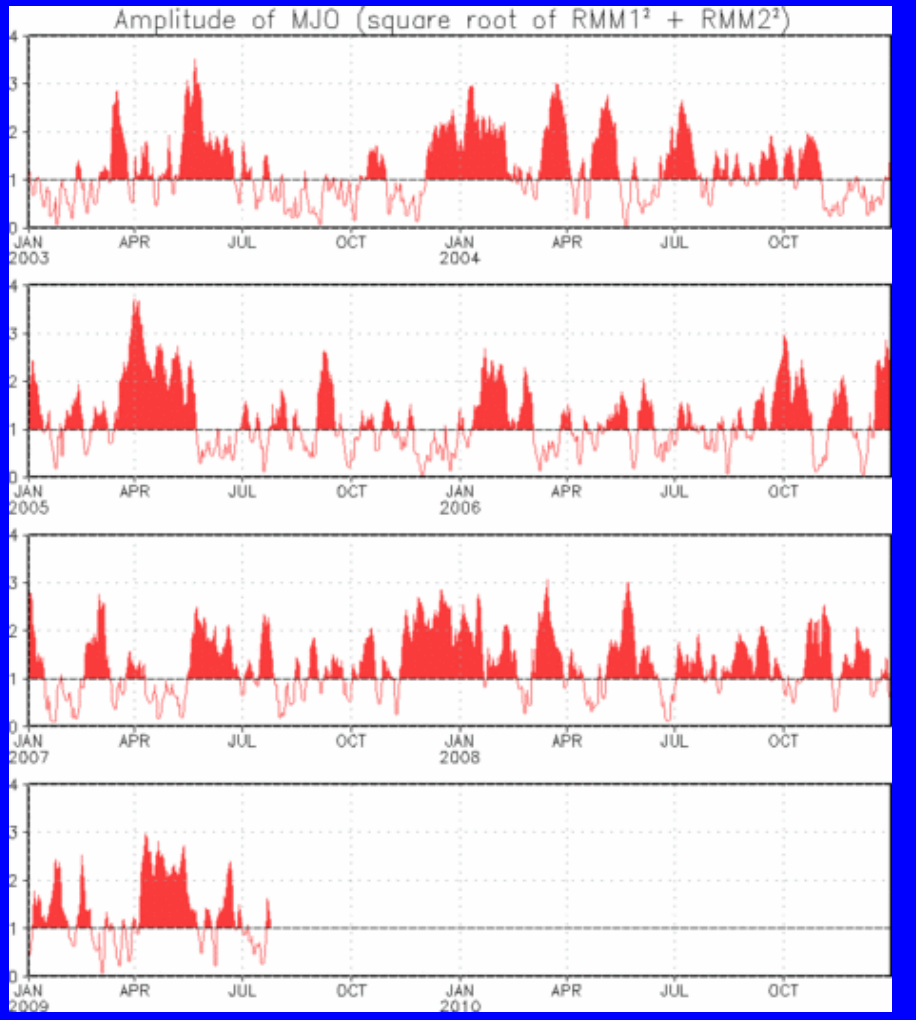


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

During the past week, the MJO index indicates weak 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.

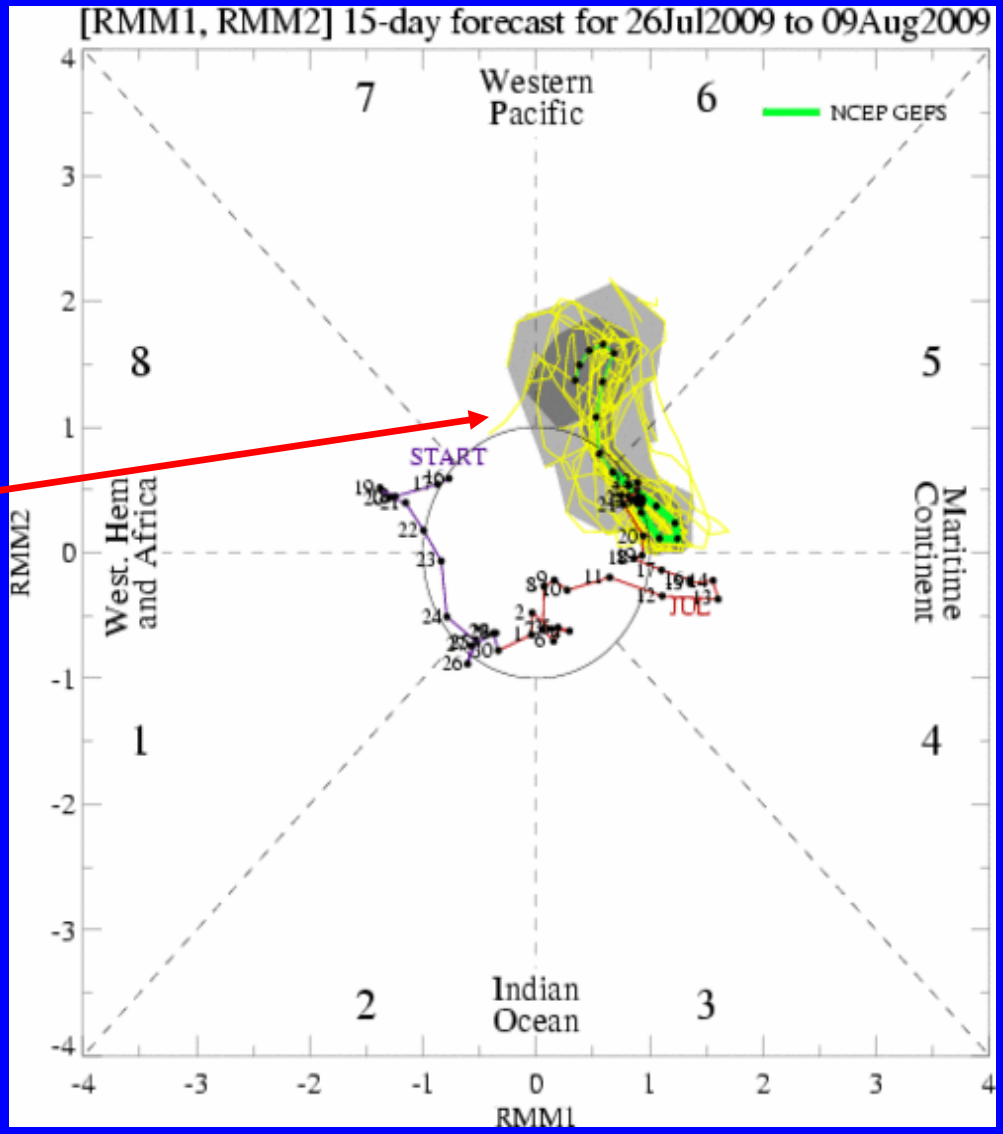
Ensemble GFS (GEFS) MJO Forecast

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

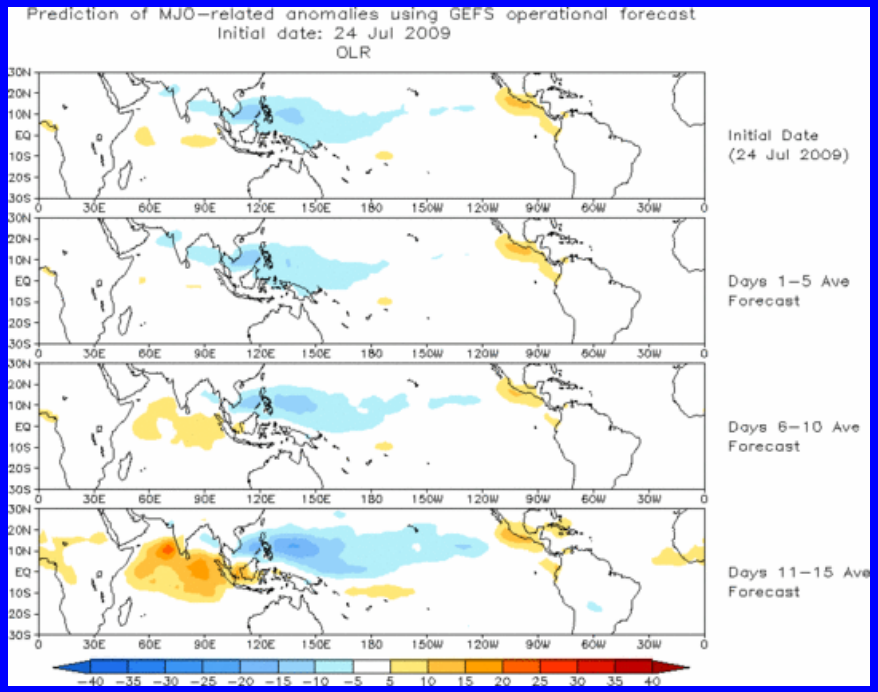
The GEFS forecasts indicates a stronger MJO signal during the period with some eastward propagation. Later in Week-2, the eastward propagation slows.



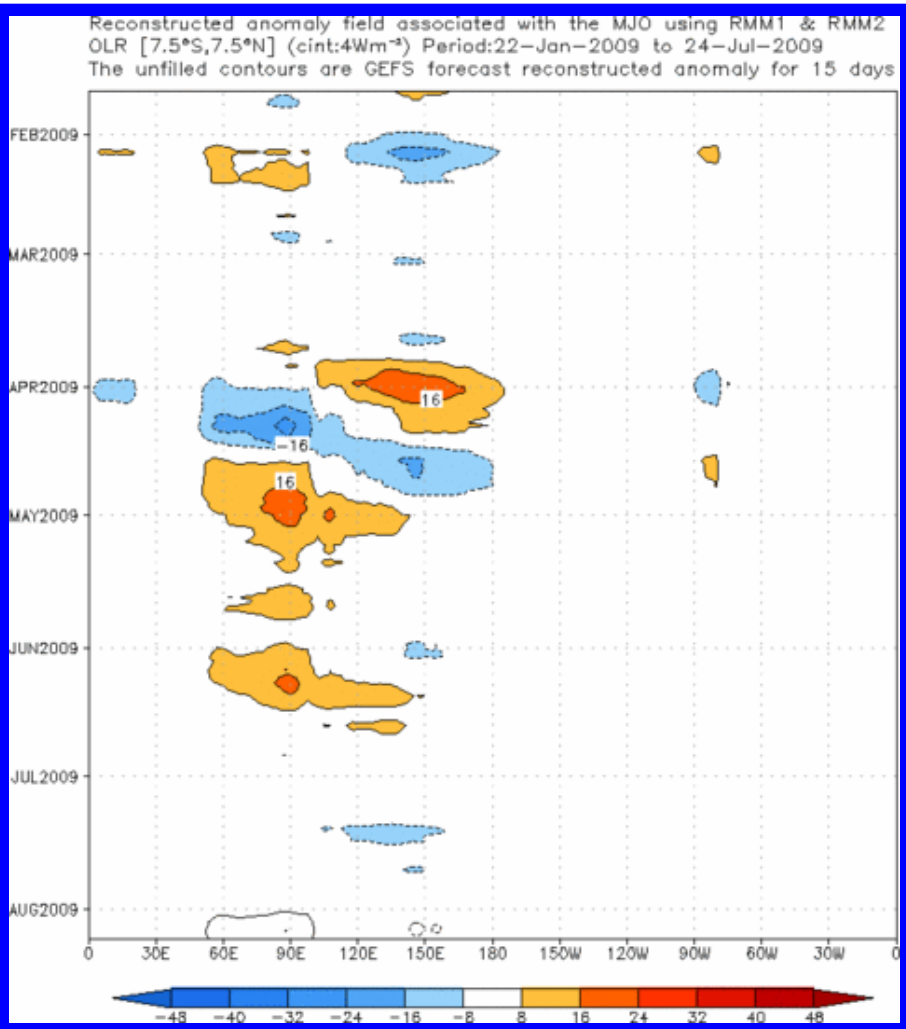
Ensemble Mean GFS MJO Forecast

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 GEFS ensemble mean forecasts suppressed convection over southern India through the western Maritime Continent by Week-2. Enhanced convection is forecast from the Philippines to the Date Line during the entire period.

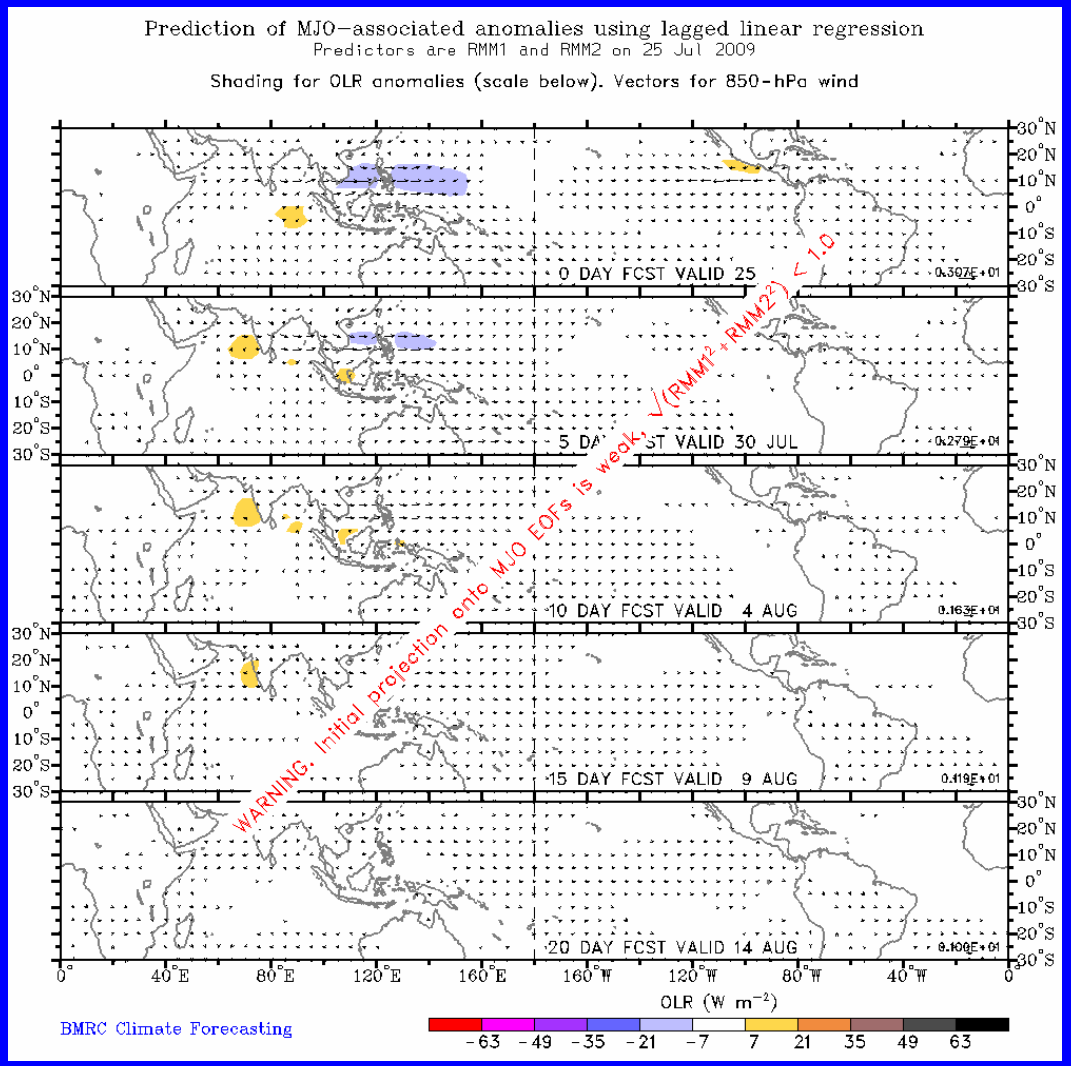
Statistical MJO Forecast

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 vectors for the next 20 days

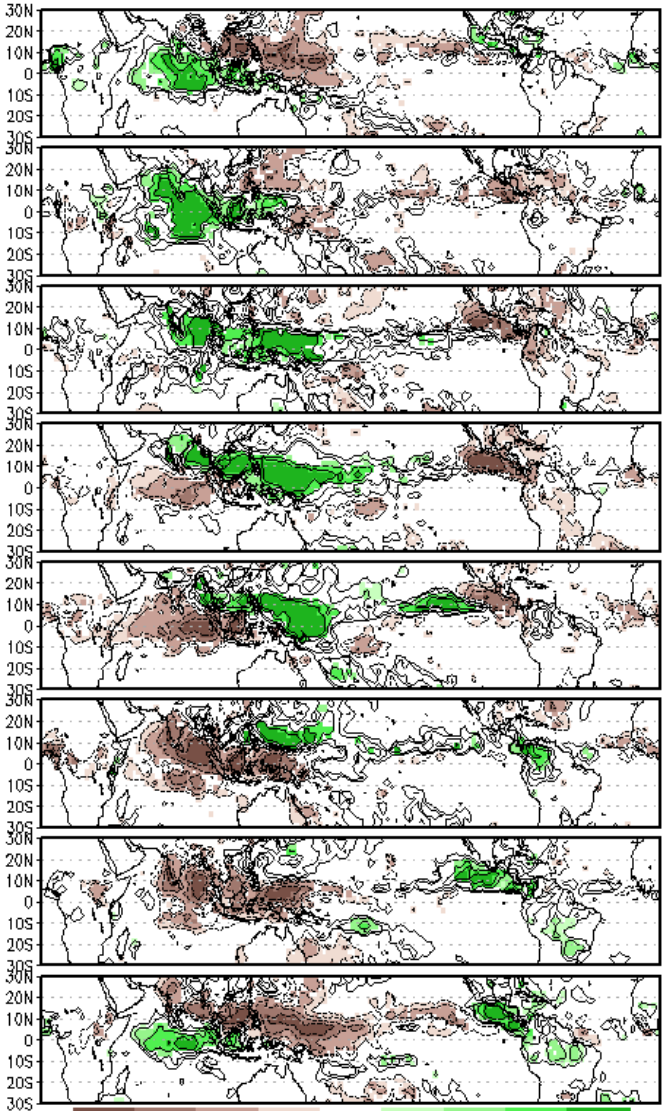
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

A statistical forecast indicates weak MJO activity during the next 1-2 weeks.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)