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

Update prepared by
Climate Prediction Center / NCEP
September 8, 2009

Outline

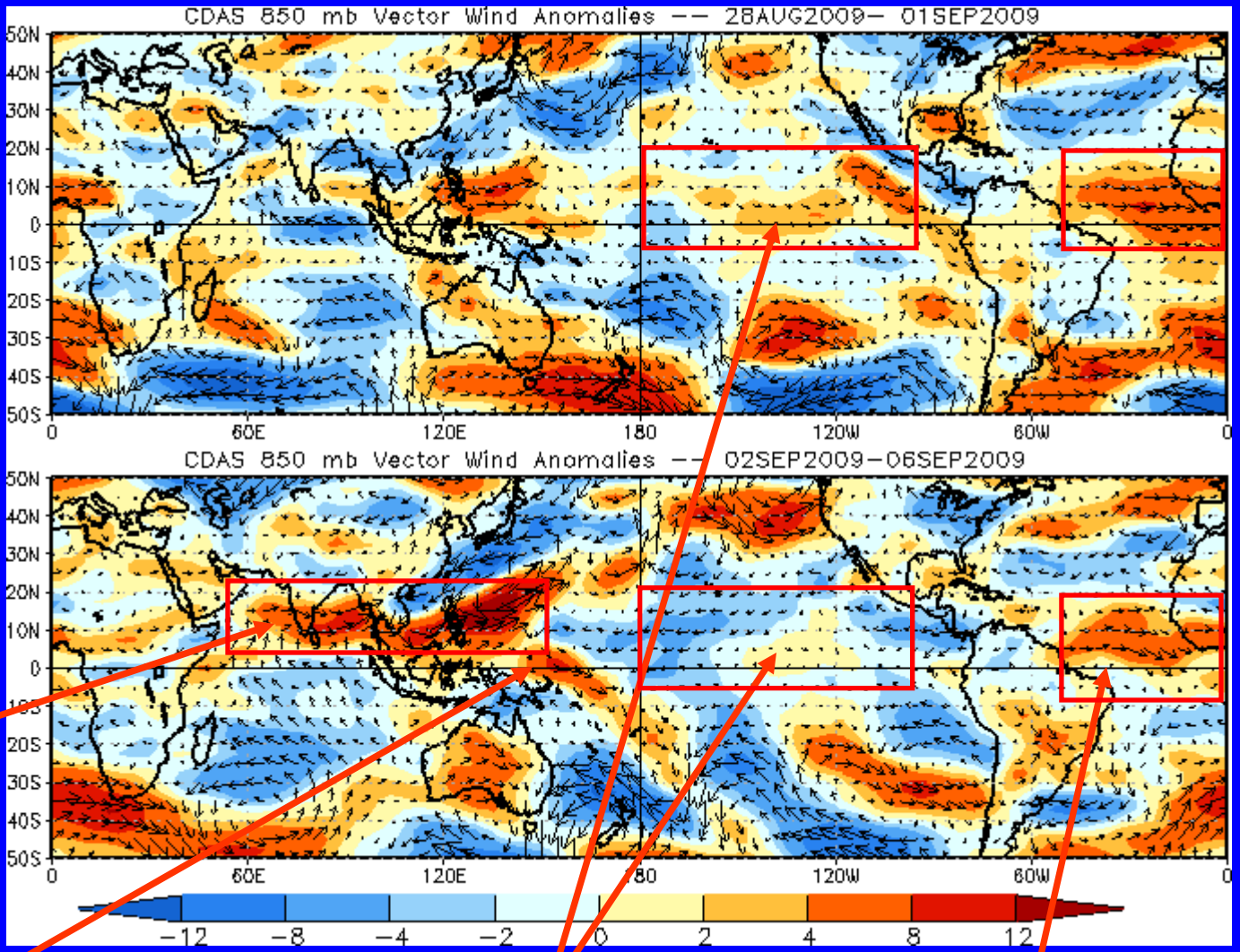
- Overview
- Recent Evolution and Current Conditions
- MJO Index Information
- MJO Index Forecasts
- MJO Composites

Overview

- During the past week, the patterns of anomalous convection and wind indicate a more coherent MJO signal with the enhanced phase located across the Maritime continent.
- The majority of dynamical model MJO forecasts, however, indicate only minor eastward propagation of coherent MJO activity over the next two weeks.
- Based on these MJO model forecasts and review of the most recent observations, considerable uncertainty remains for the strength of the MJO during the Week-2 period.
- The MJO is expected to contribute to suppressed (enhanced) rainfall for Central America (southern Asia, western Pacific) during Week-1. Impacts during Week-2 are more uncertain.

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 zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

Westerly anomalies expanded during the last five days and now stretch from India to the western Pacific east of the Philippines.

Also, westerly anomalies continue along the equator northeast of Papua-New Guinea.

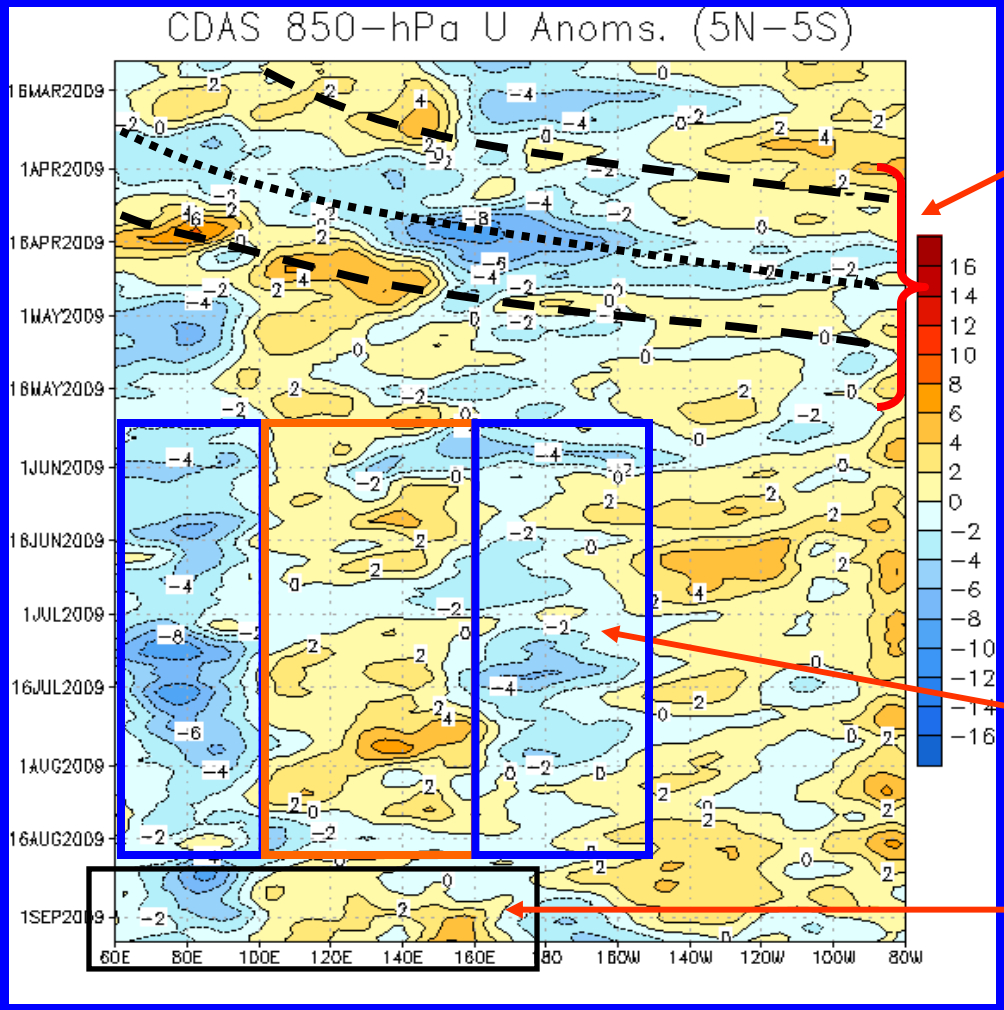
Westerly anomalies have ended across most areas in the east-central Pacific during the last five days.

Westerly anomalies weakened across 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

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.

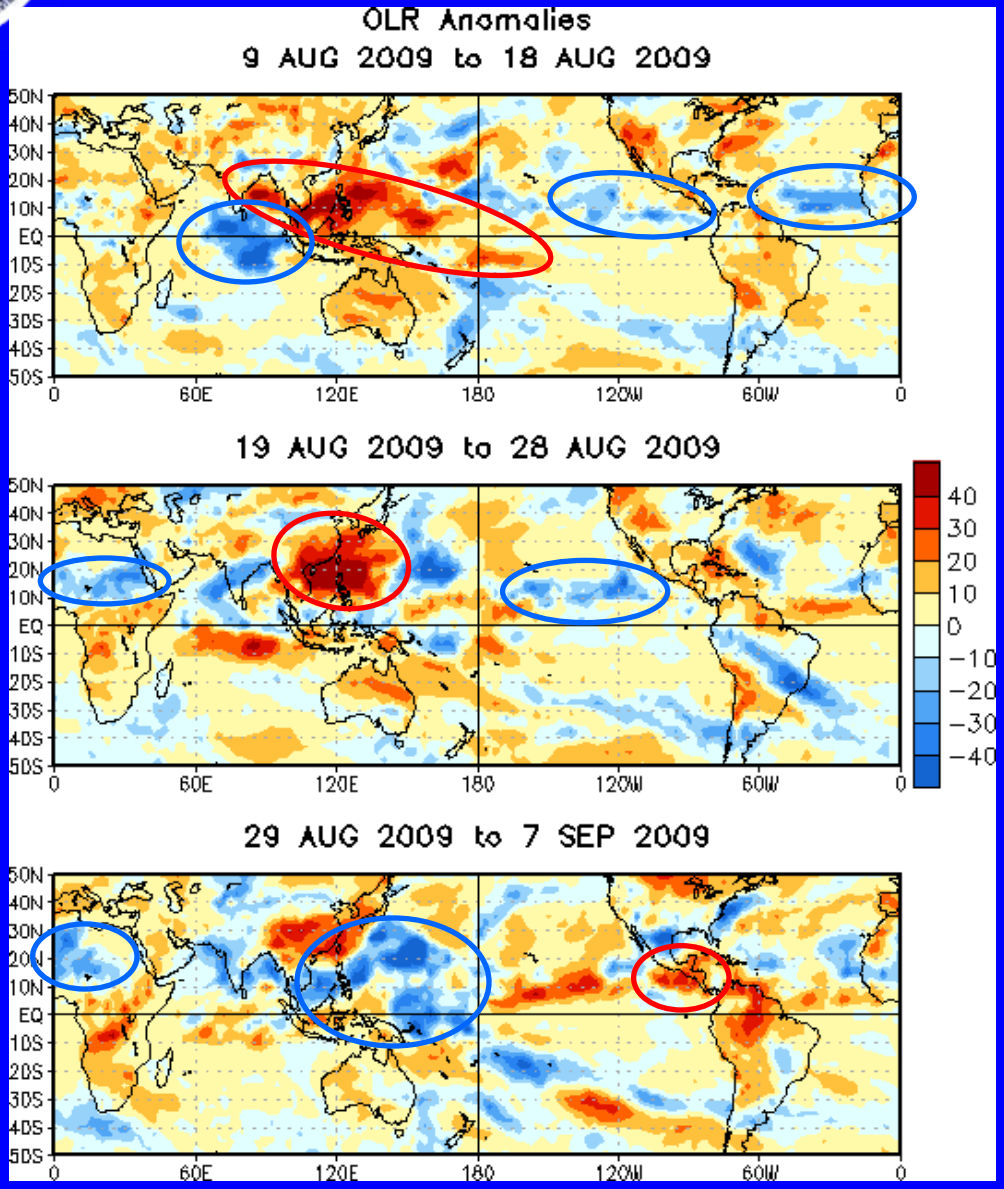
During much of the period from May-early August, a persistent pattern of easterly (westerly) anomalies was present across the Indian Ocean and central Pacific (Indonesia). NOTE: This pattern is partly due to NH summertime biases in the CDAS 850-hPa winds.

There is evidence of a westerly wind burst during the past ten days between 140-160° E in the western Pacific. Easterly anomalies are also once again evident across 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)

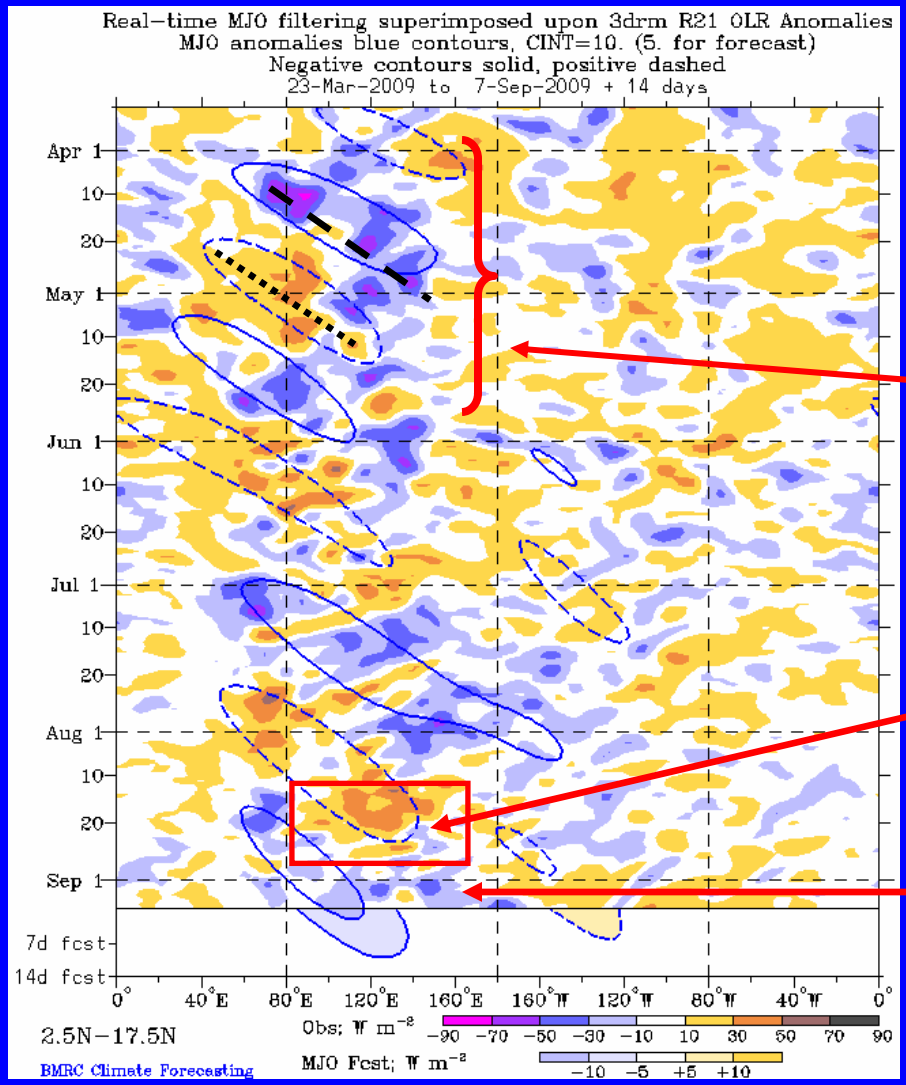


During mid-August, suppressed convection (red oval) shifted eastward and stretched from the Bay of Bengal to the western Pacific while enhanced convection developed across the equatorial Indian Ocean (blue oval). There also was enhanced convection across the eastern Pacific and Atlantic Oceans.

In late August, strong suppressed convection focused north of the Philippines while convection increased markedly over Africa.

Convection increased across the western Pacific, southern India and the Philippines in early September. Suppressed convection strengthened across Central America while enhanced convection continued across parts of Africa.

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).

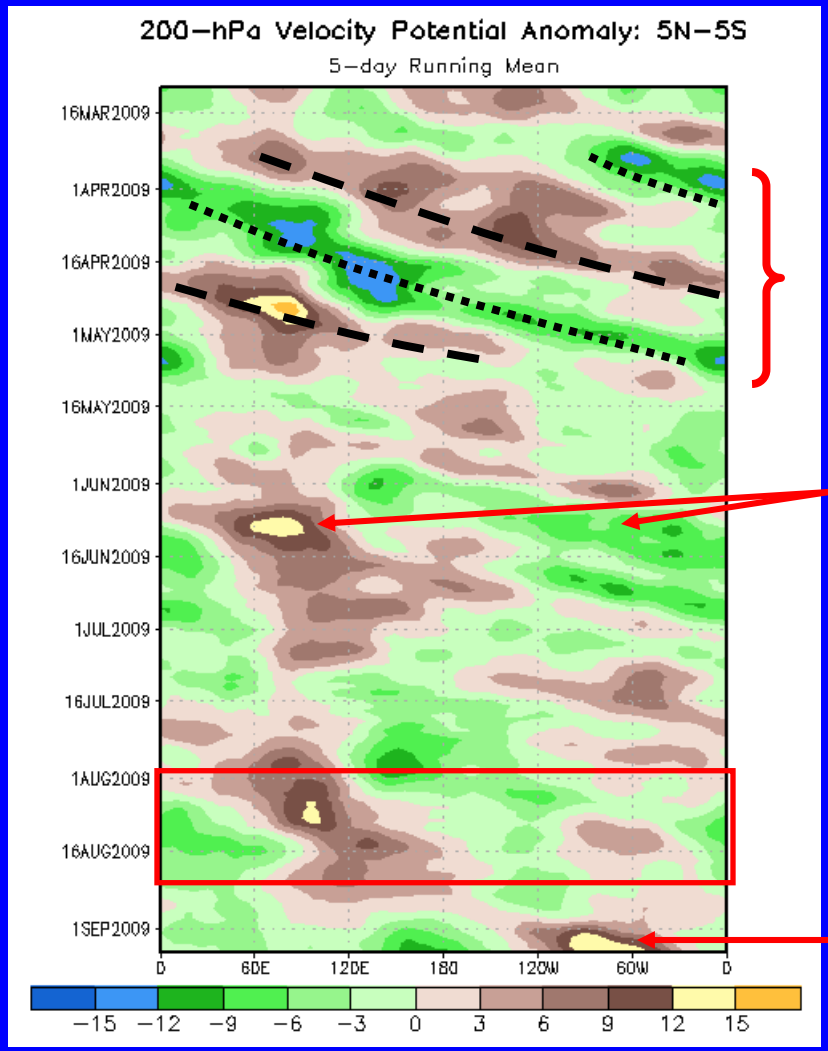
During mid-August, anomalous suppressed convection was evident across the Maritime continent and the western Pacific Ocean.

Convection has increased across the Maritime continent and western Pacific during the past week.

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

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.

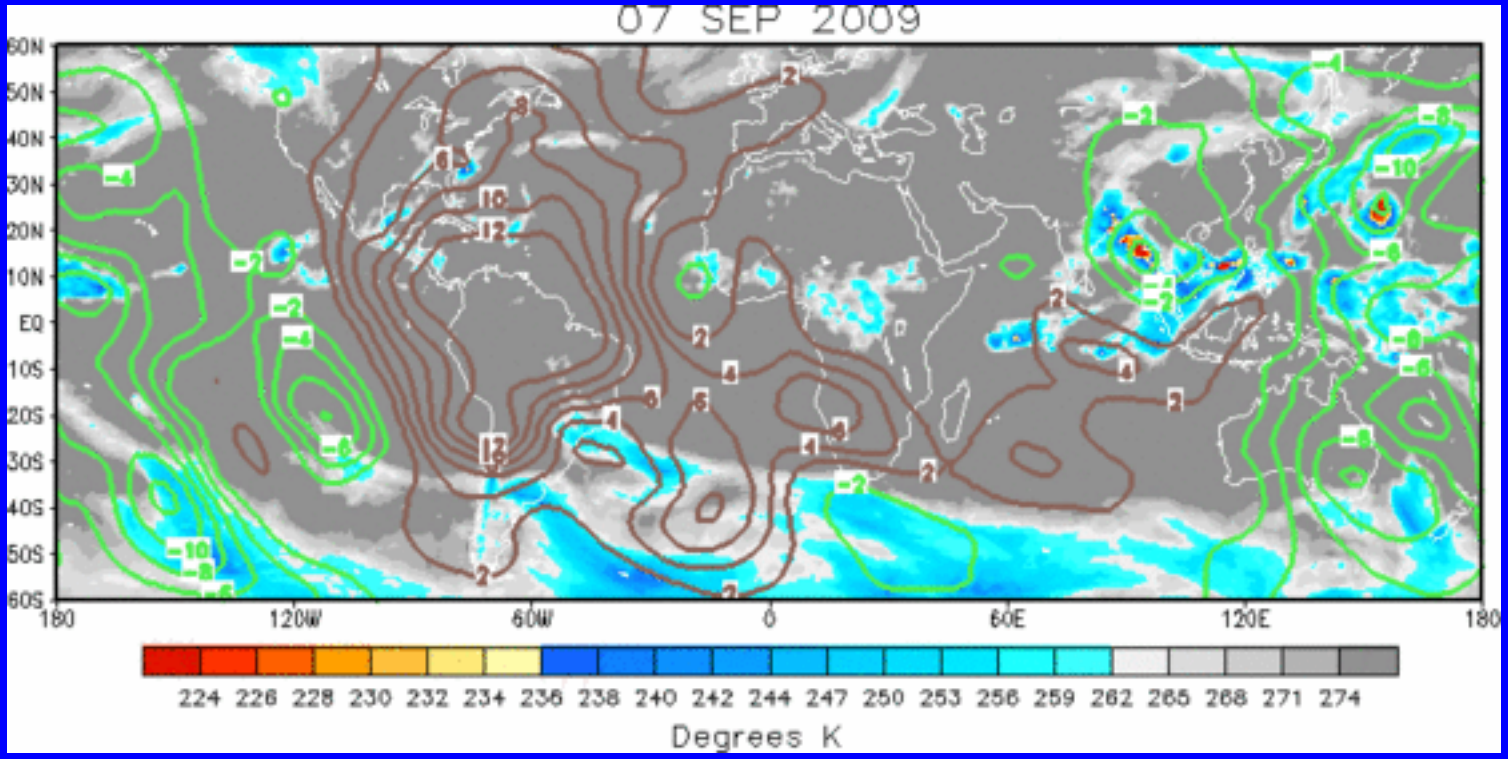
During early-mid August, anomalies increased with some eastward propagation due in part to considerable subseasonal variations (red box).

Anomalies have increased during the last several days with strong upper-level convergence evident across the Americas during early September.

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

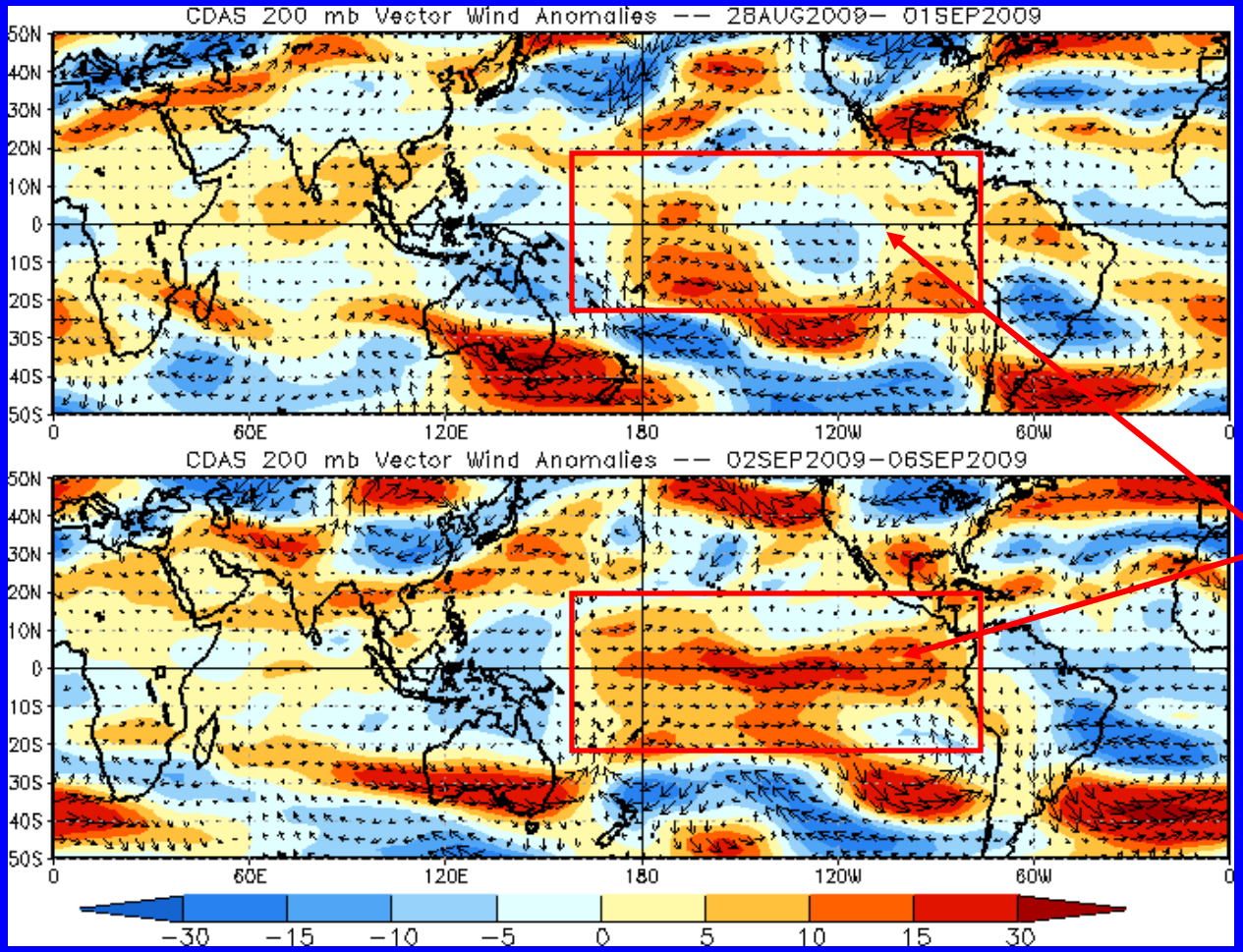
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The latest velocity potential pattern indicates strong enhanced upper-level convergence across much of the Western Hemisphere and upper-level divergence across southern Asia and the western Pacific.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

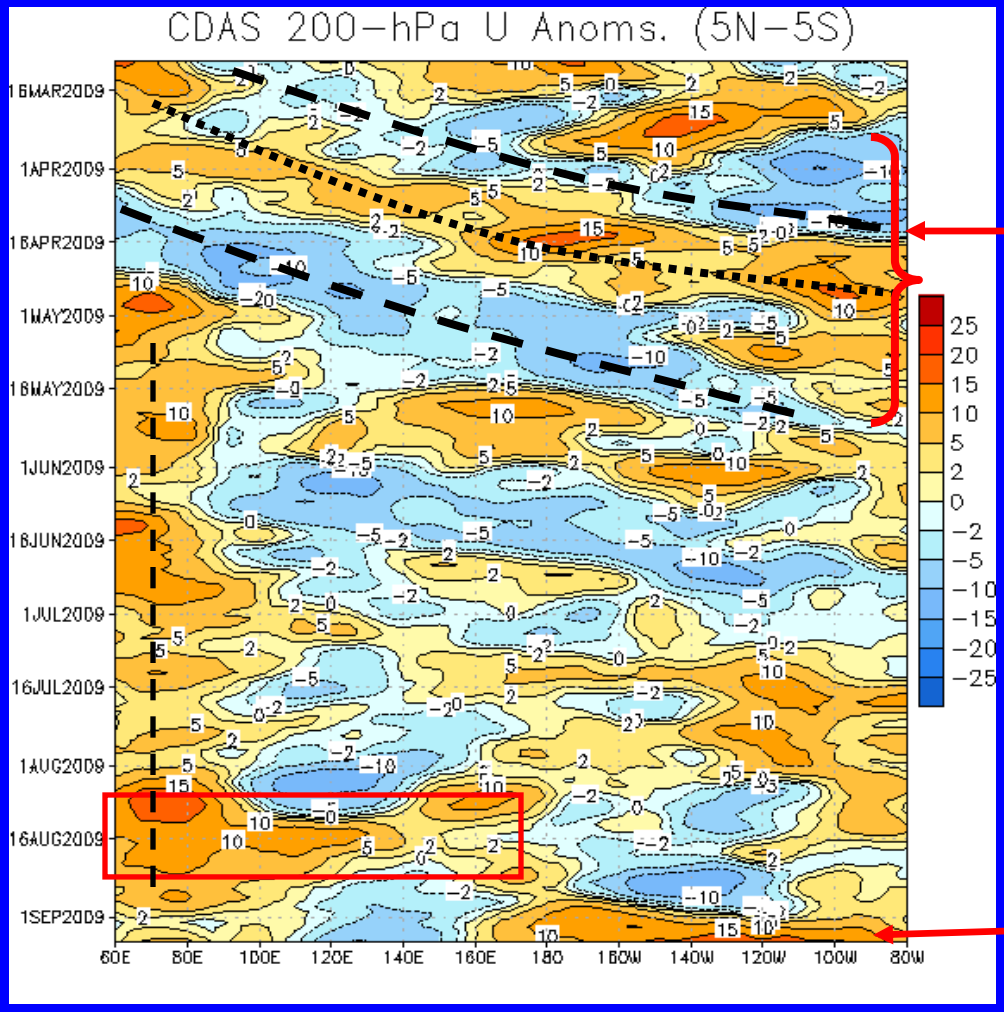
Red shades: Westerly anomalies

Westerly anomalies have strengthened and expanded across much of the equatorial central and eastern Pacific during the last five 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

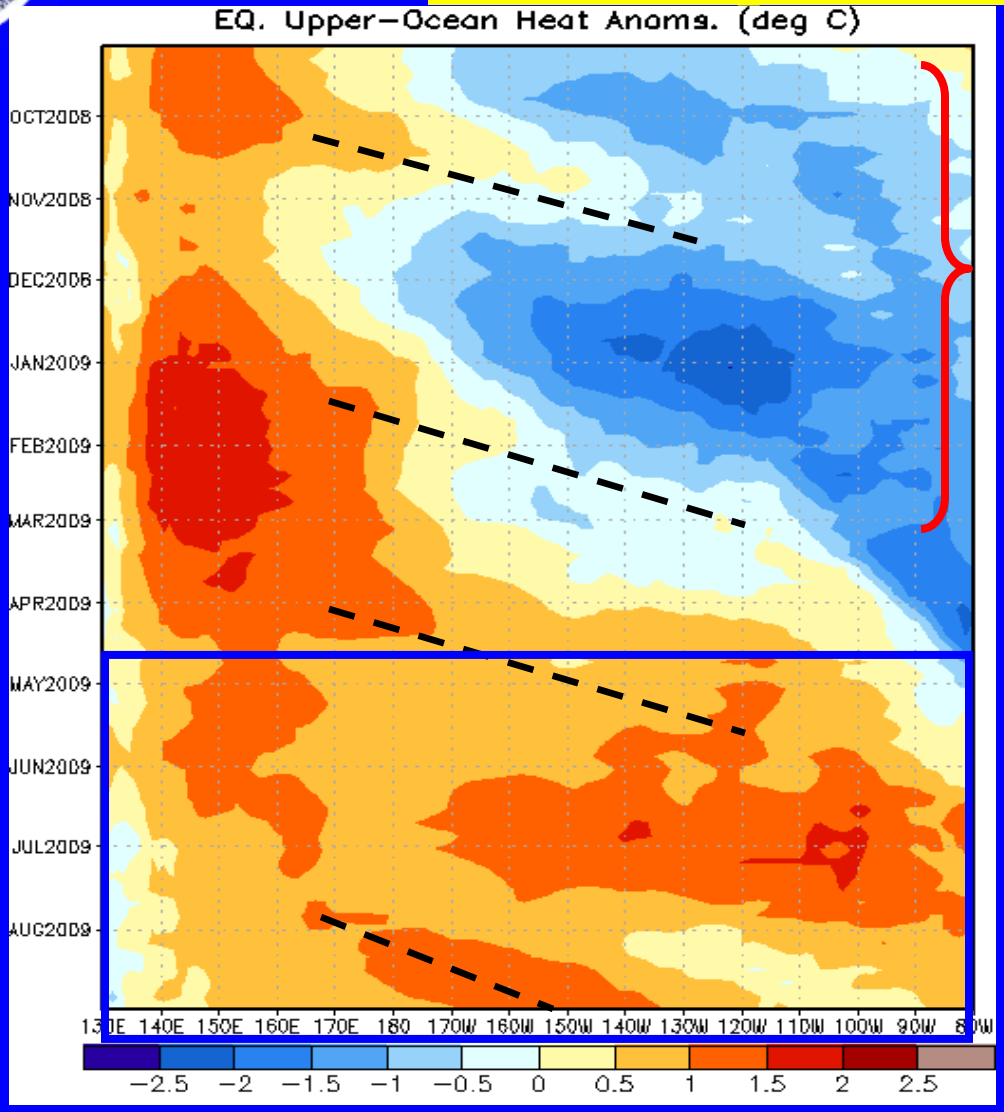
Longitude

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

Westerly anomalies across the Indian Ocean and Maritime continent have persisted since May 2009. During mid-August, these anomalies extended eastward into the western Pacific (red box).

Most recently, westerly anomalies are strong between the Date Line and 80W.

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 April 2009, heat content anomalies have remained above-average.
- Recently, the downwelling phase of a Kelvin wave has shifted eastward.

MJO Index -- Information

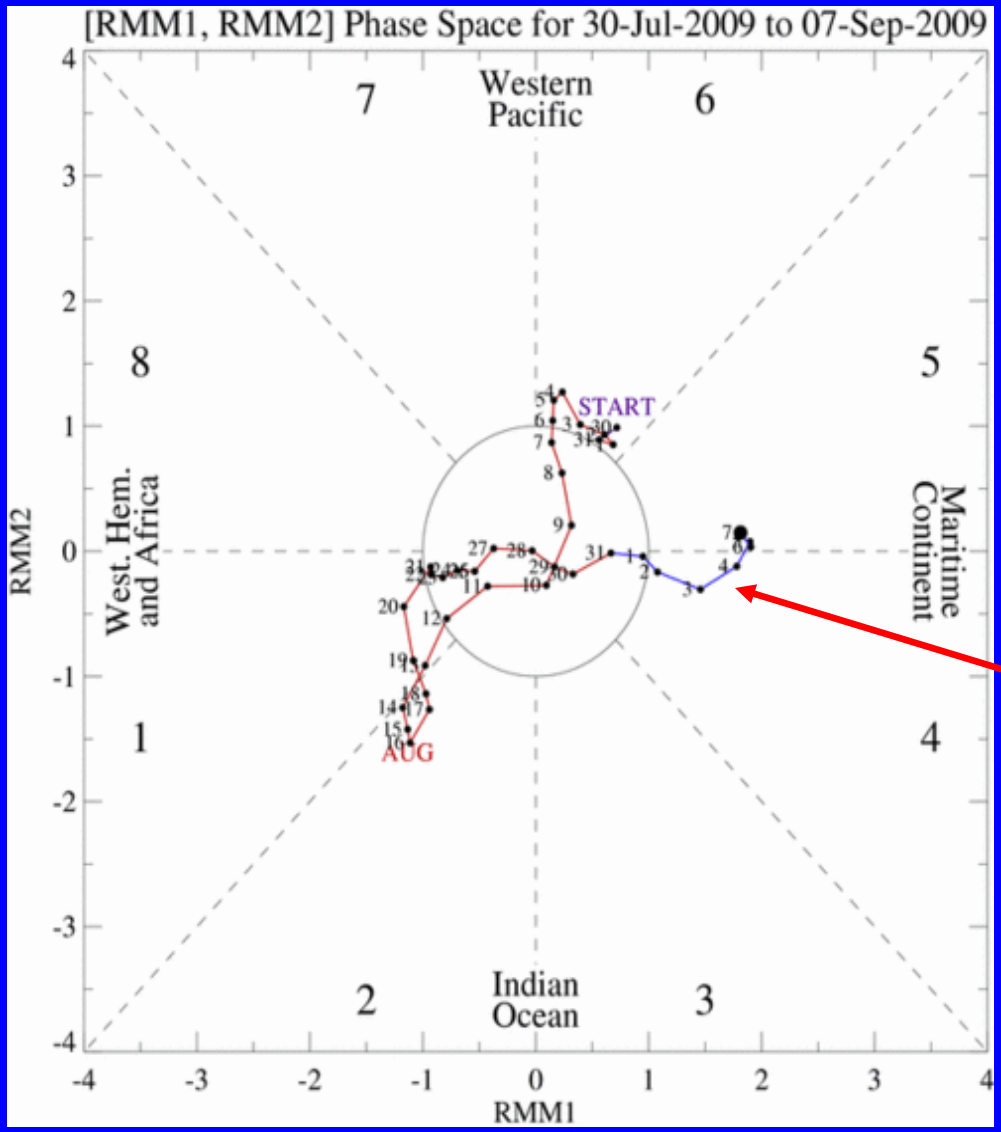
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

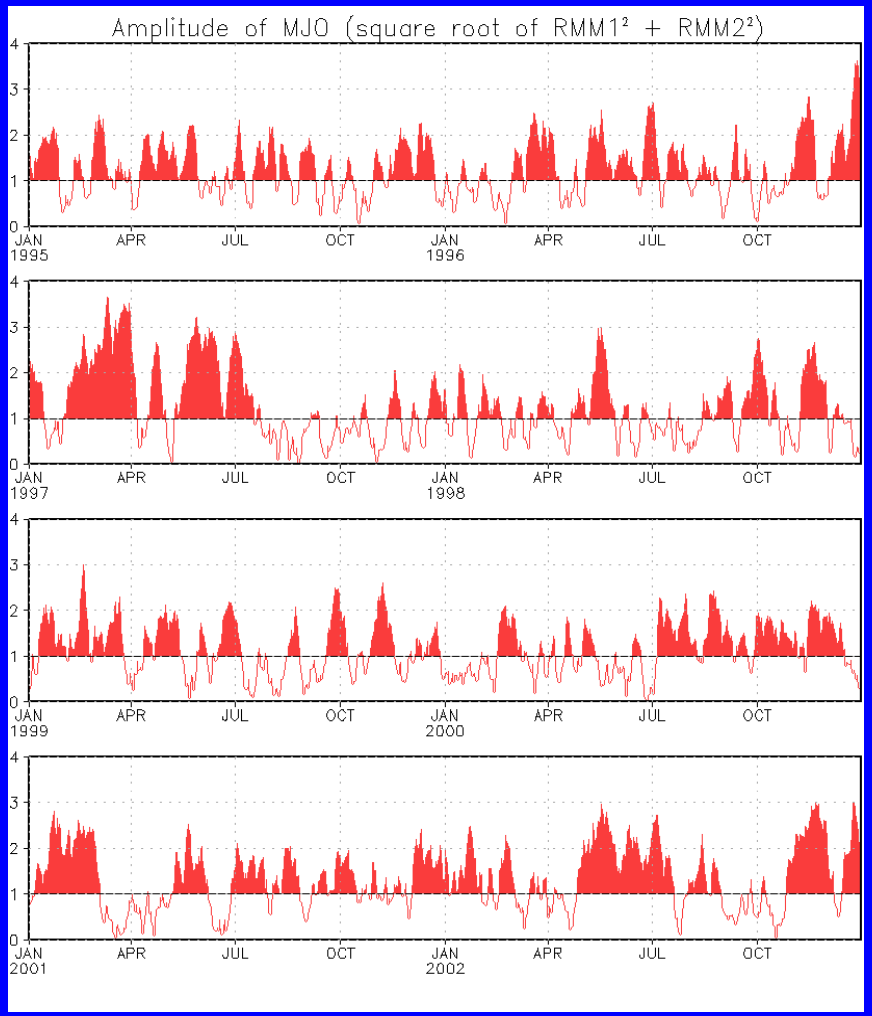
MJO Index -- Recent Evolution

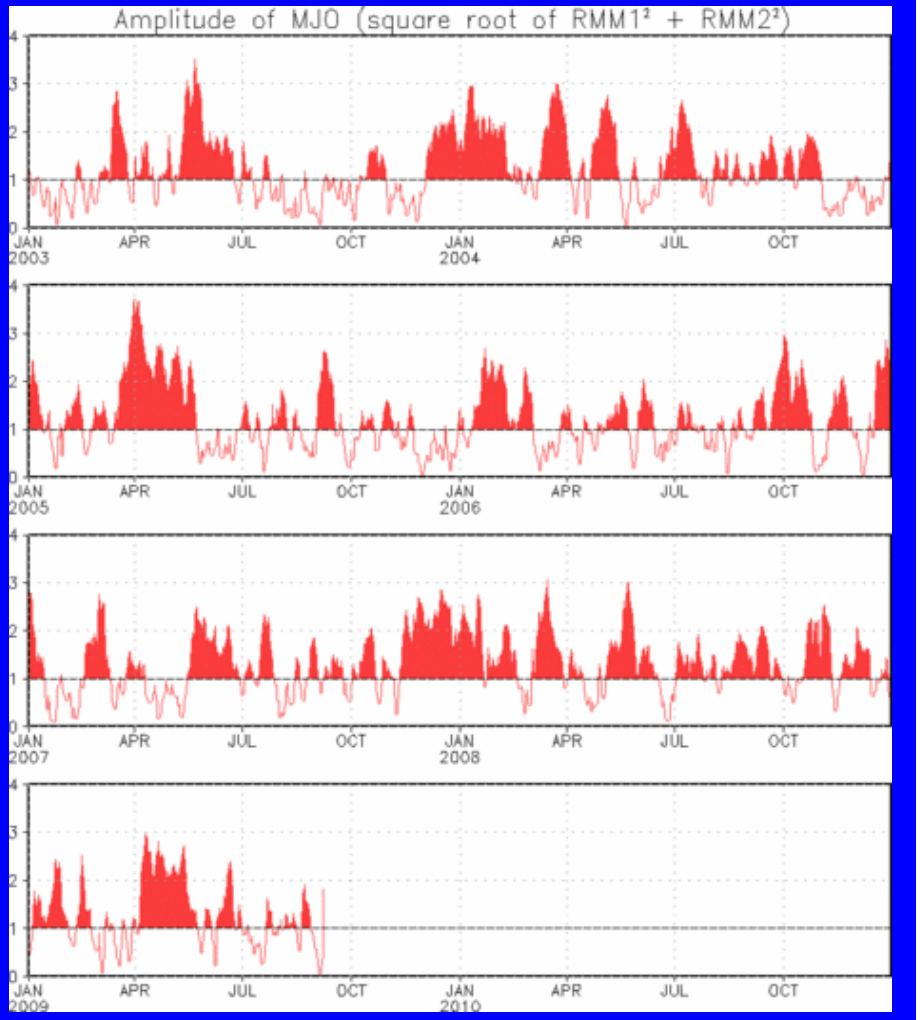


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index has increased in amplitude during the past week but has shown little eastward propagation during the last several days.

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.

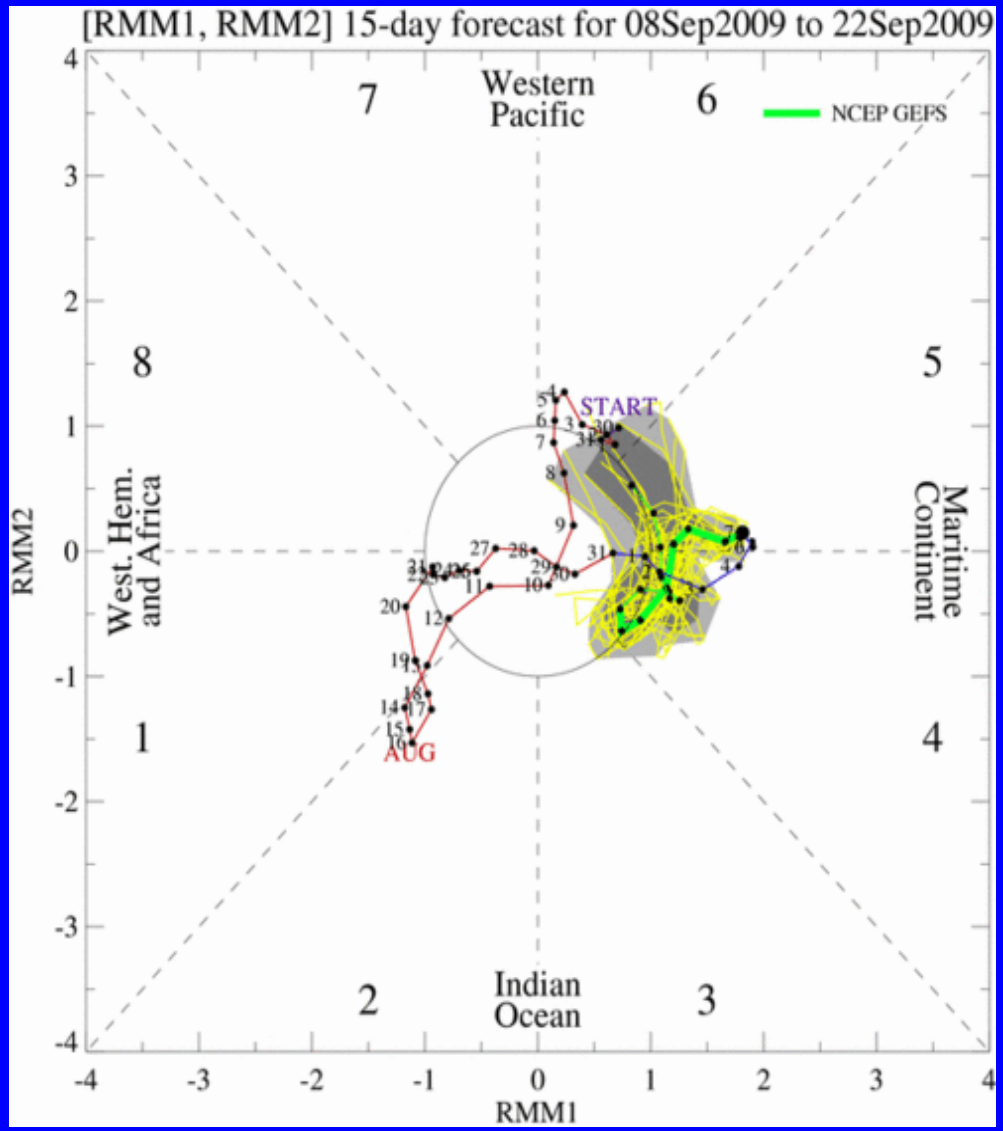
Ensemble GFS (GEFS) MJO Forecast

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

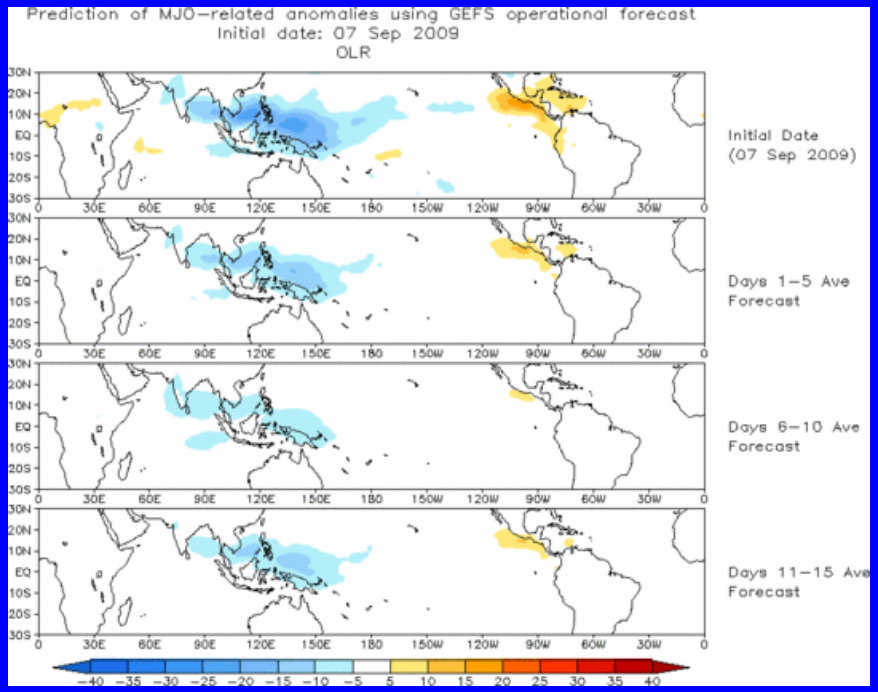
The GEFS forecasts a decrease in amplitude of the MJO index during Week-1 but some later in the Week-2 period.



Ensemble Mean GFS MJO Forecast

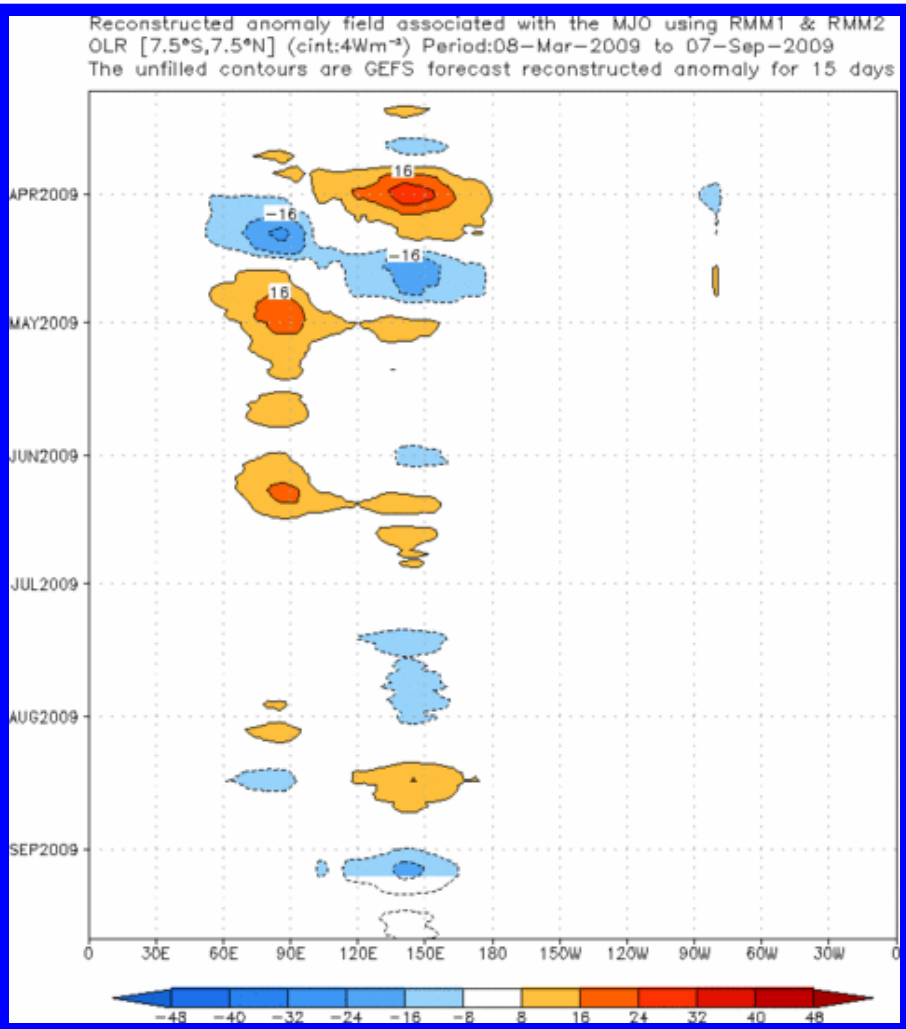
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecasts enhanced convection for India, the Maritime continent and the western Pacific during the entire period. Weak suppressed convection is indicated across Central America.

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

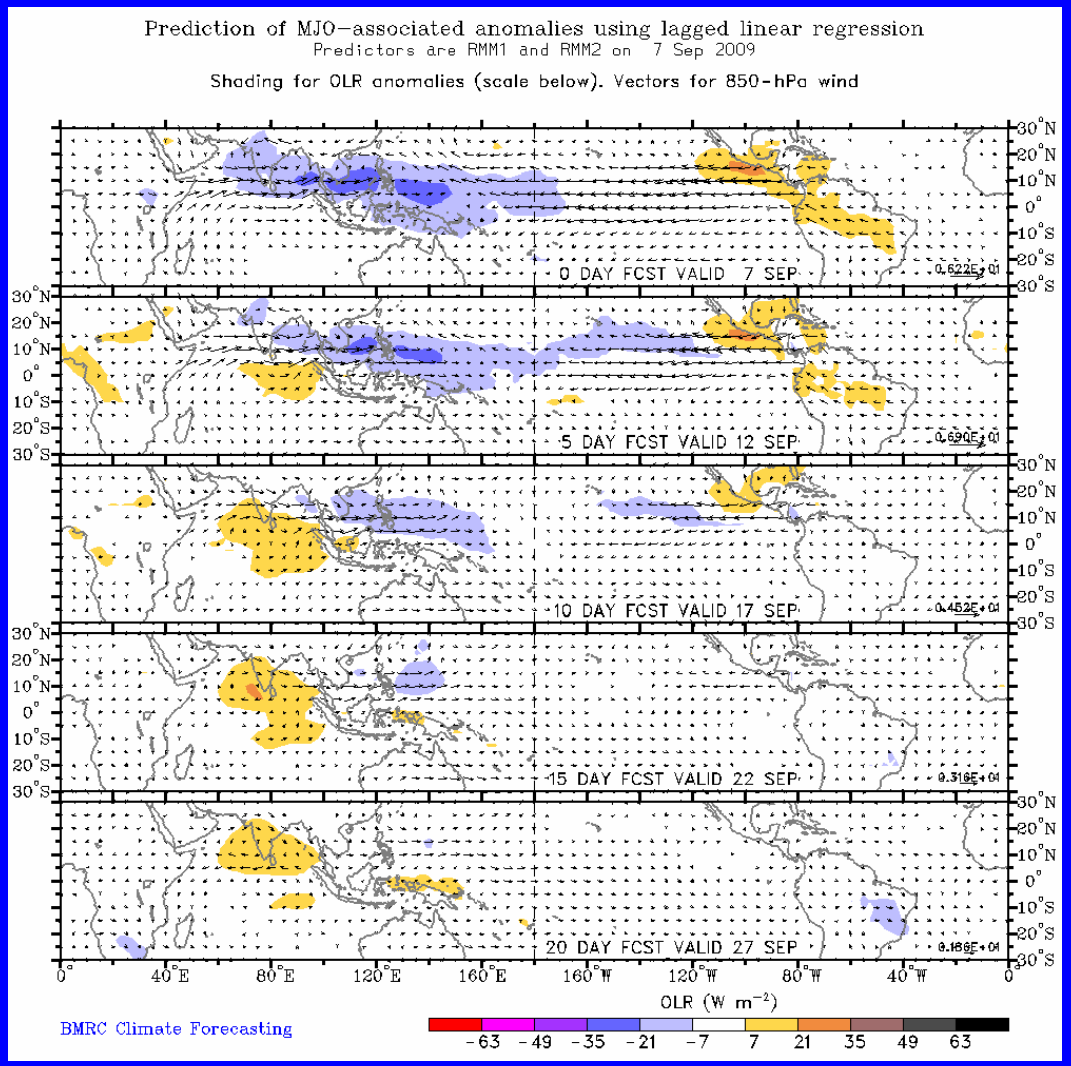
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

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

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

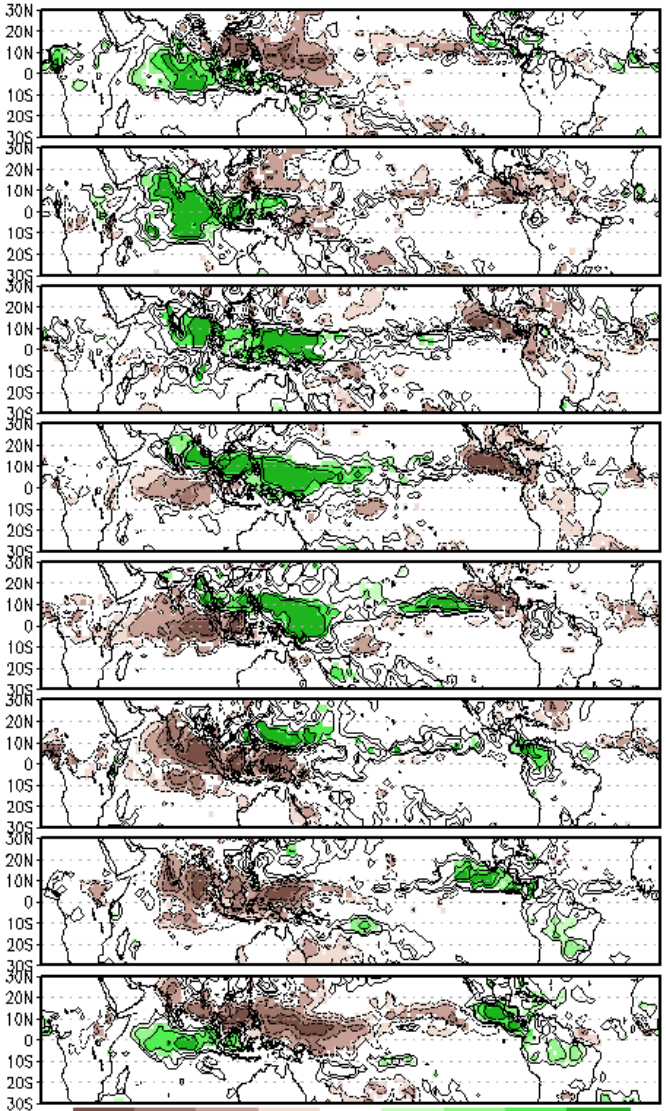
A statistical model forecasts weak-to-moderate MJO activity during the next 1-2 weeks.

Enhanced convection is indicated from India to the western Pacific during Week-1 with suppressed convection developing across the equatorial Indian Ocean by Week-2.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)