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

Update prepared by
Climate Prediction Center / NCEP
September 14, 2009

Outline

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

Overview

- The MJO signal weakened during the past week.
- Based on the most recent observations, the MJO is expected to remain weak during Week-1 with some strengthening possible during Week-2.
- Suppressed (enhanced) rainfall for Africa/India (the western Pacific) is expected during Week-1. During Week-2, suppressed rainfall is expected for the eastern Indian Ocean with enhanced convection over the western Pacific.

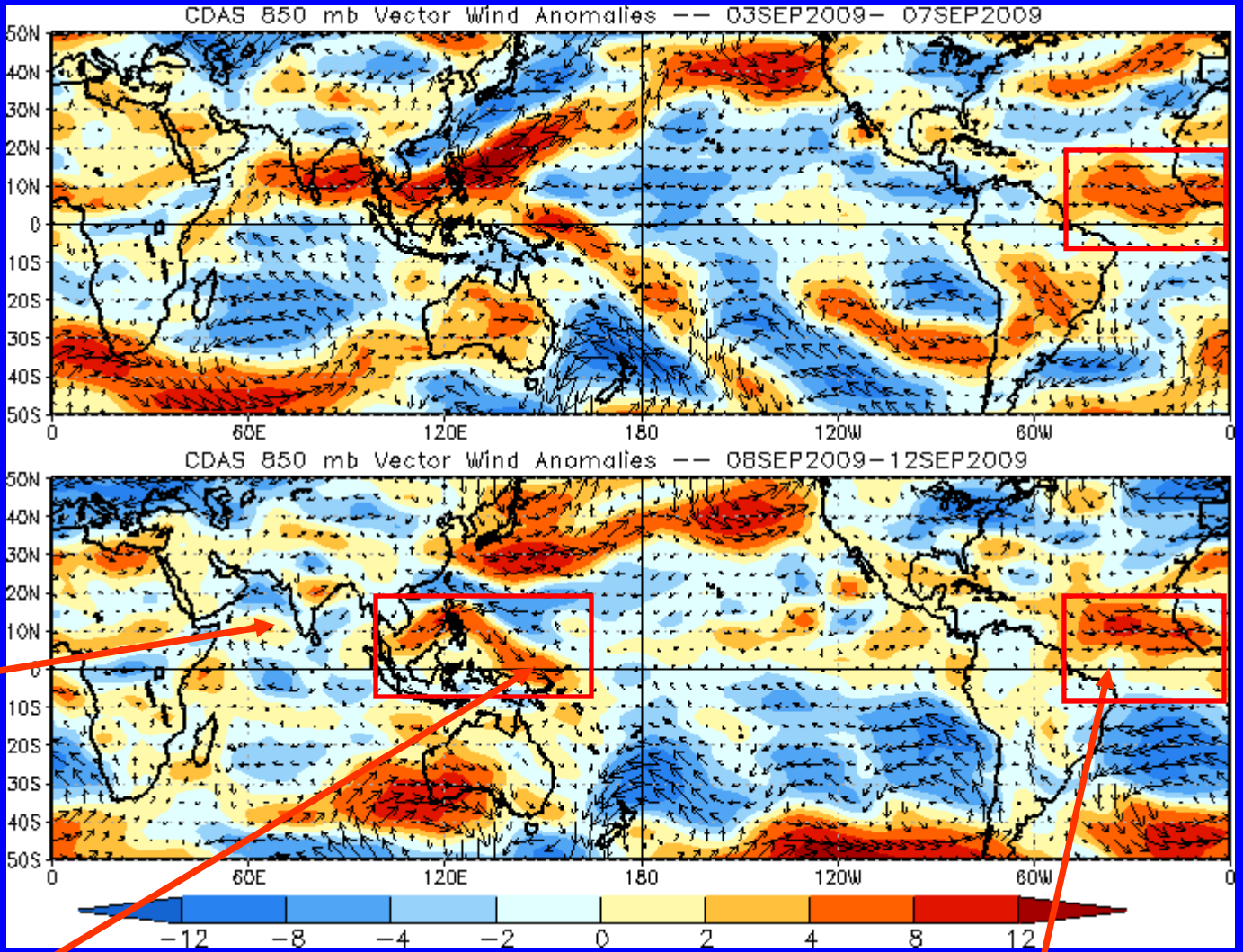
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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 diminished near India in the last five days.

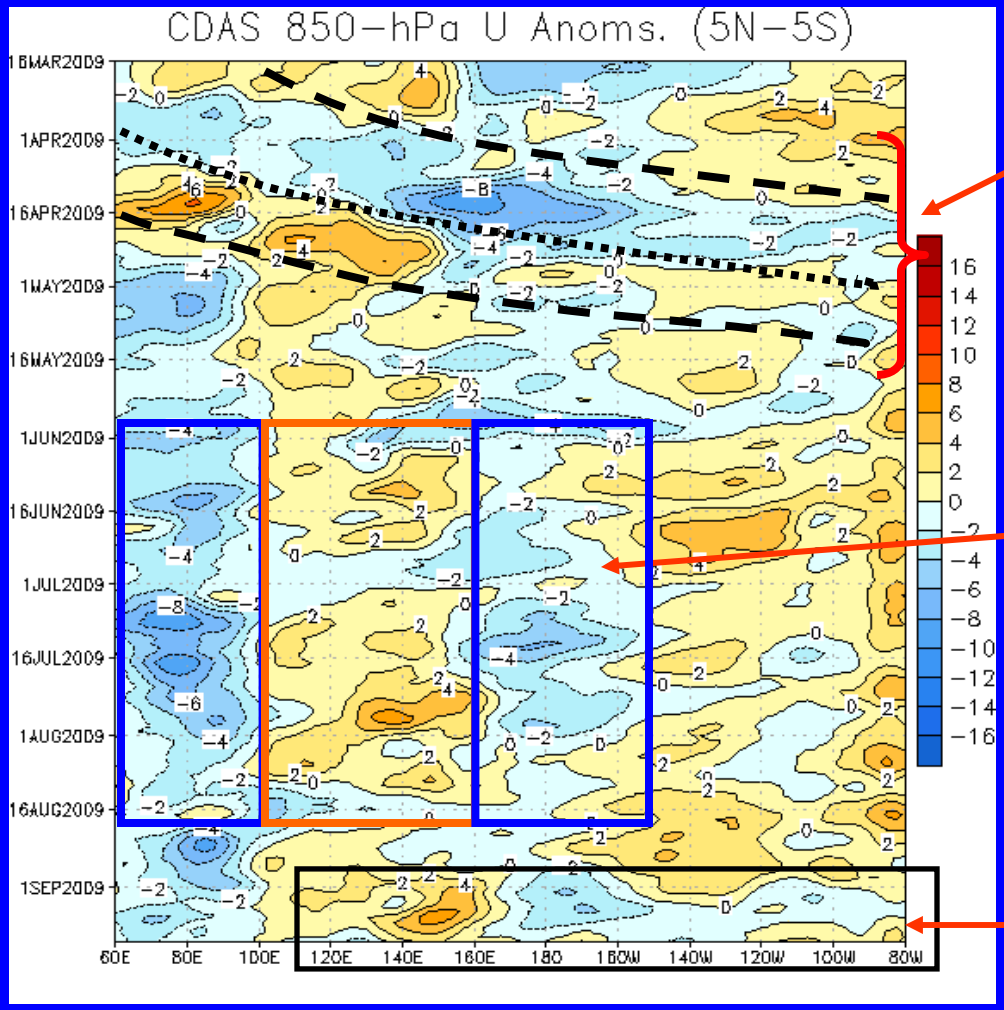
Westerly anomalies continued over the Maritime Continent and over the equatorial western Pacific.

Westerly anomalies persisted across the Atlantic north of the equator.

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.

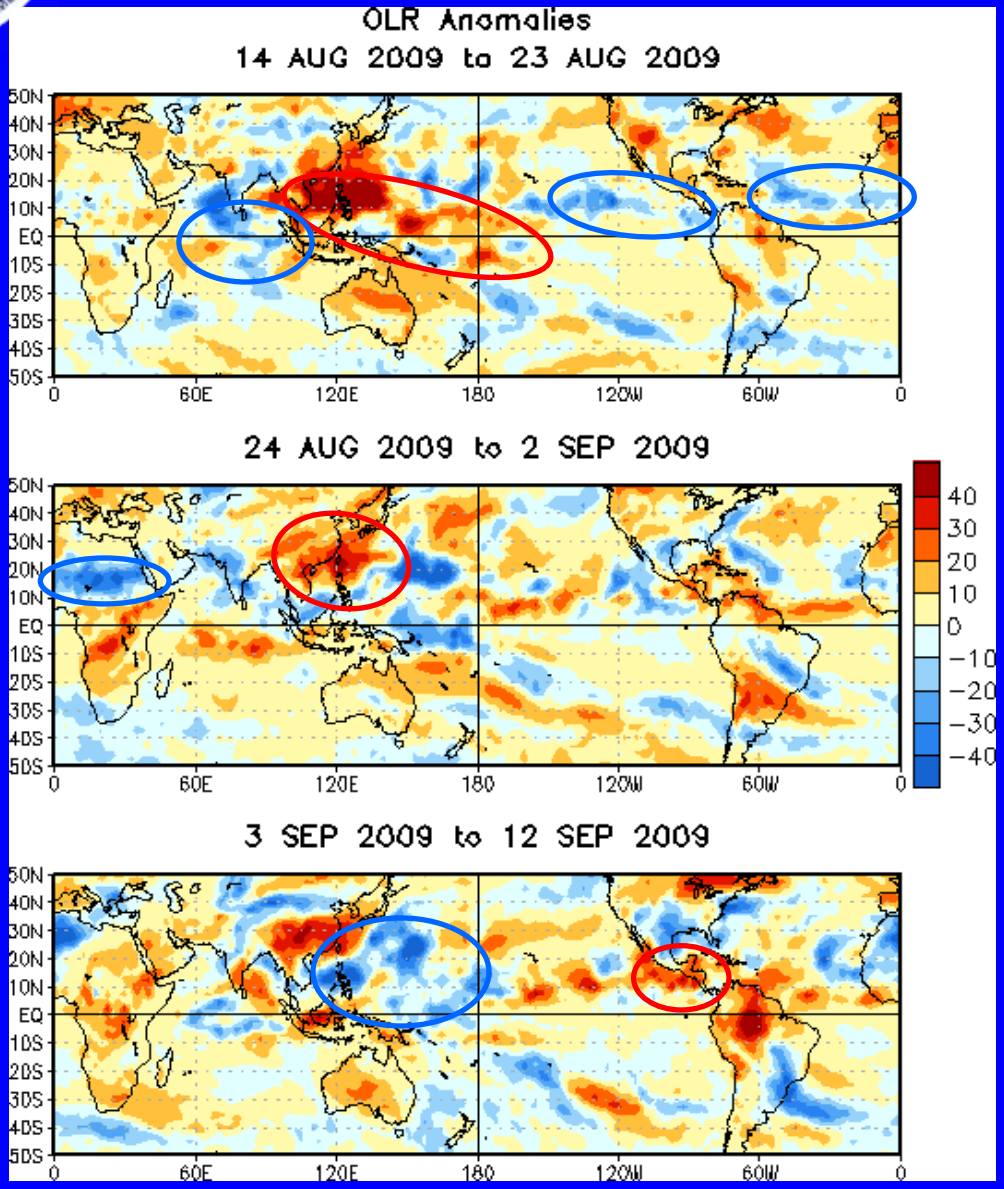
During much of the period from May-early August, a persistent pattern of easterly (westerly) anomalies was present across the Indian Ocean and central Pacific (Indonesia).

A westerly wind burst is evident over the western Pacific during recent days, while winds have become closer to average across 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)

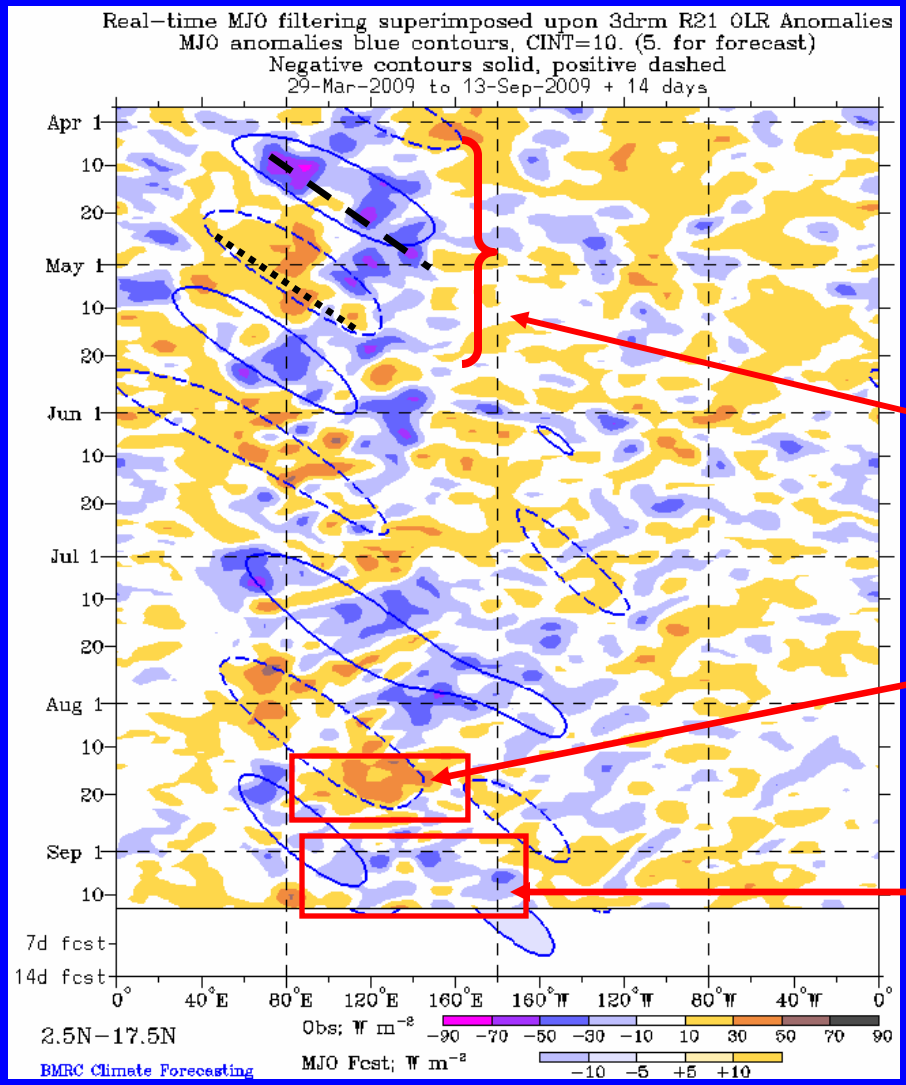


During mid-August, suppressed convection (red oval) shifted eastward and stretched from the Southeast Asia to the western Pacific while enhanced convection developed across the equatorial Indian Ocean (blue oval). There also was enhanced convection across the east-central/eastern Pacific and Atlantic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

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

Convection increased across the western Pacific and Philippines in early September. Suppressed convection strengthened across 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 (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).

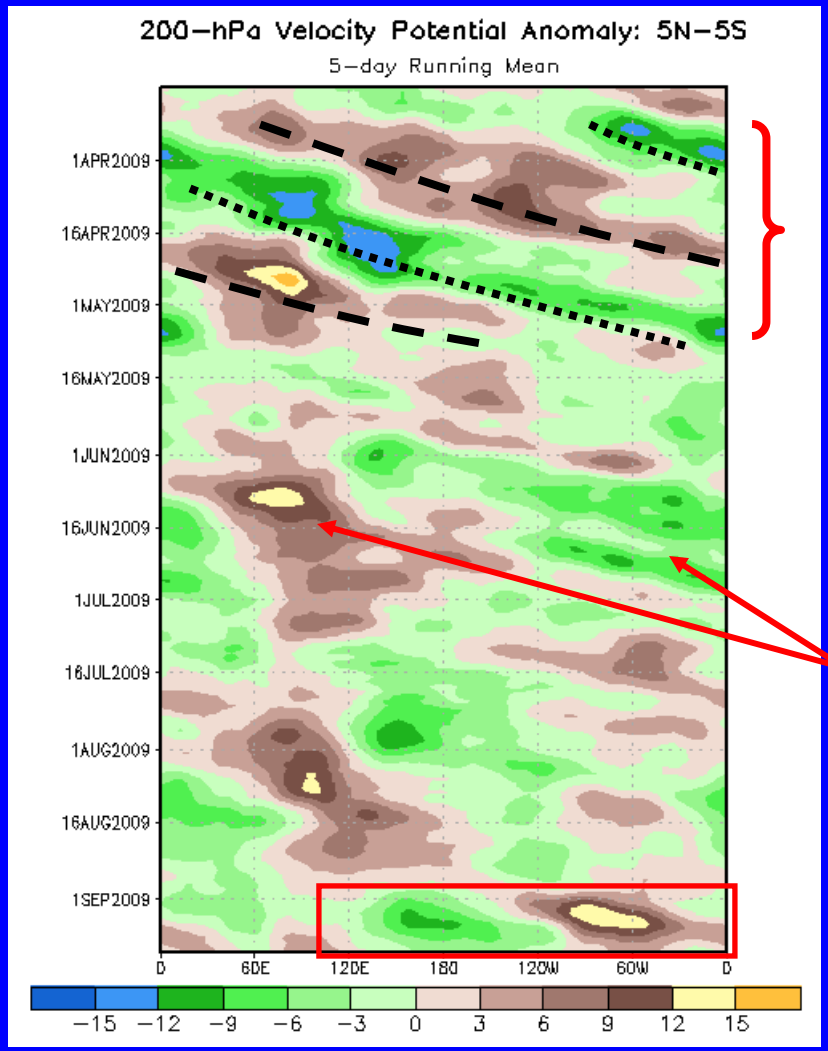
During mid-August, anomalous suppressed convection was evident across the Maritime continent and the western Pacific Ocean.

Recently, enhanced convection has become prevalent over the western and central Pacific, although anomalies remain weak.

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.

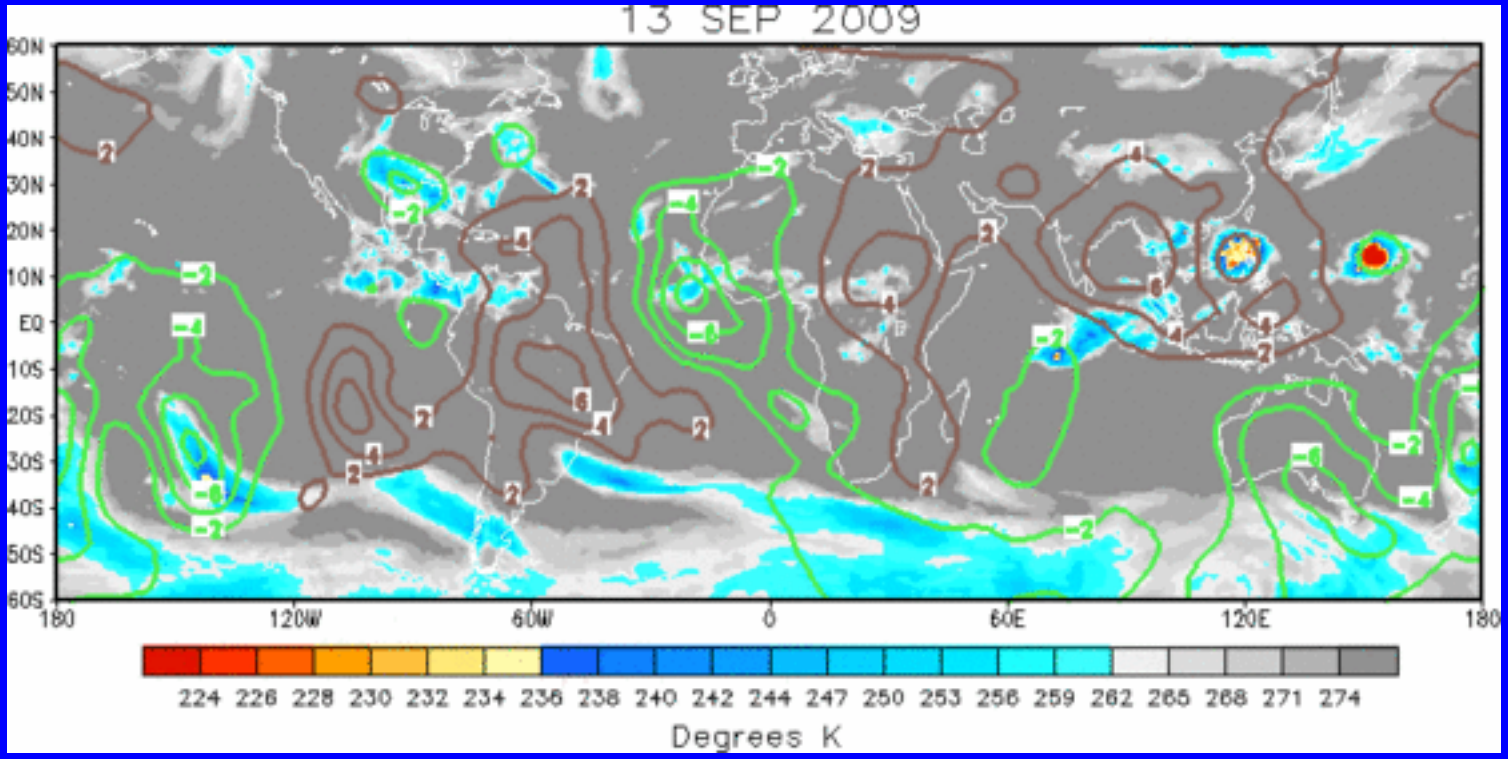
Velocity potential anomalies increased in early June with some eastward propagation evident due to considerable subseasonal variations.

Anomalies increased considerably during the last week with some eastward propagation evident (red box).

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

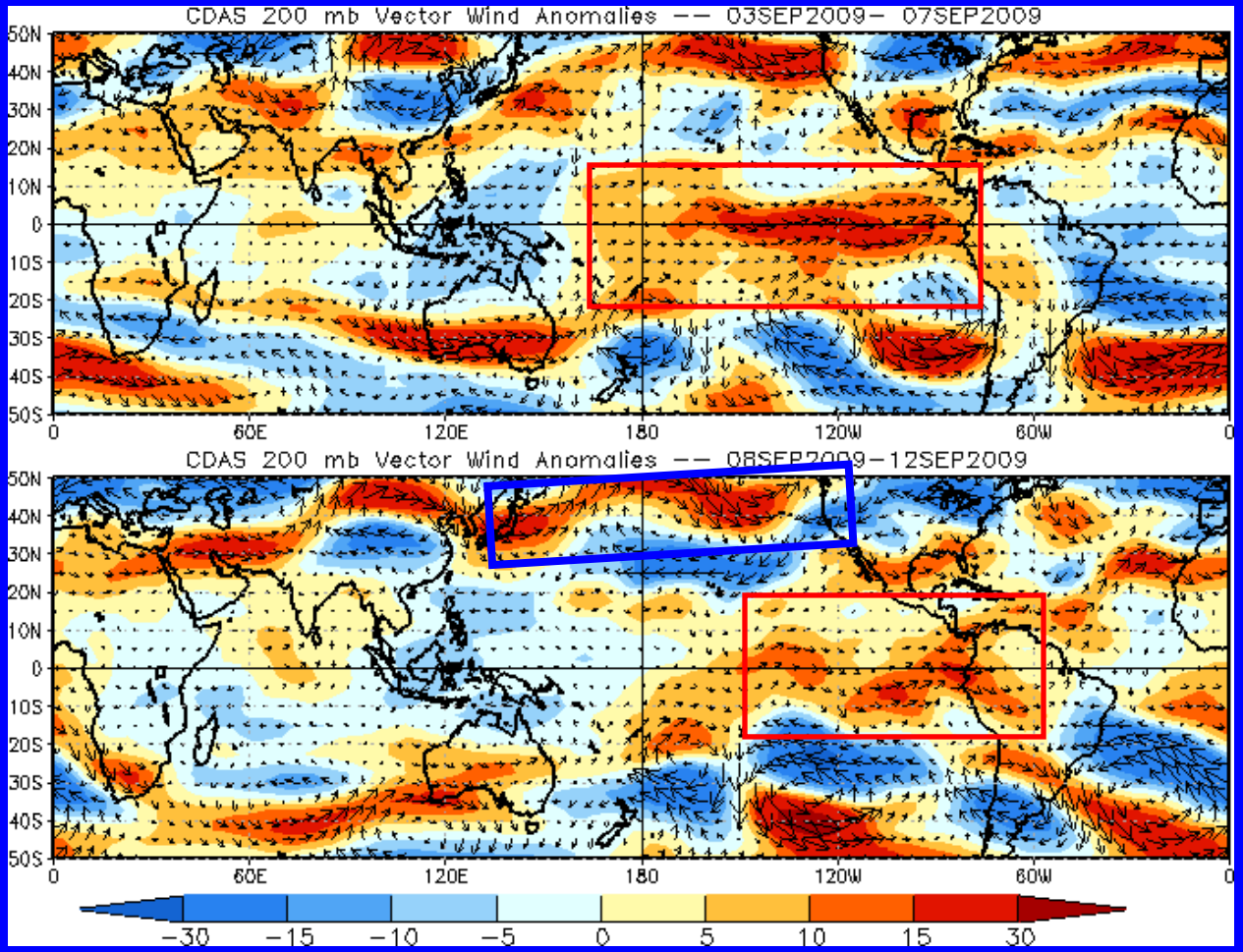
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The velocity potential pattern has weakened with enhanced upper-level convergence over Africa and the Bay of Bengal, while enhanced upper-level divergence is featured across the central and eastern Pacific ocean.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

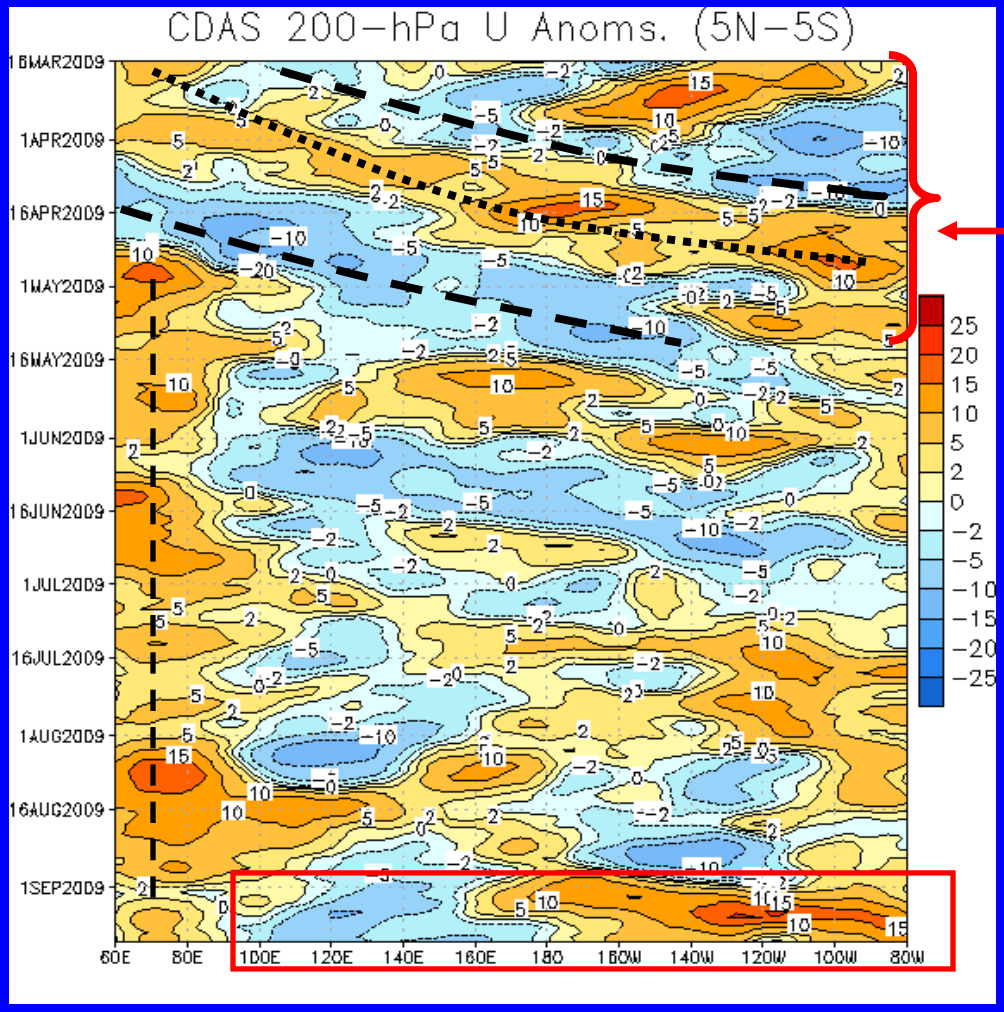
A strong Pacific Jet in the Northern hemisphere is indicated during the last five days (blue box).

The core of the westerly anomalies across the Pacific have shifted eastward and expanded to South America during the last five days (red boxes).

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

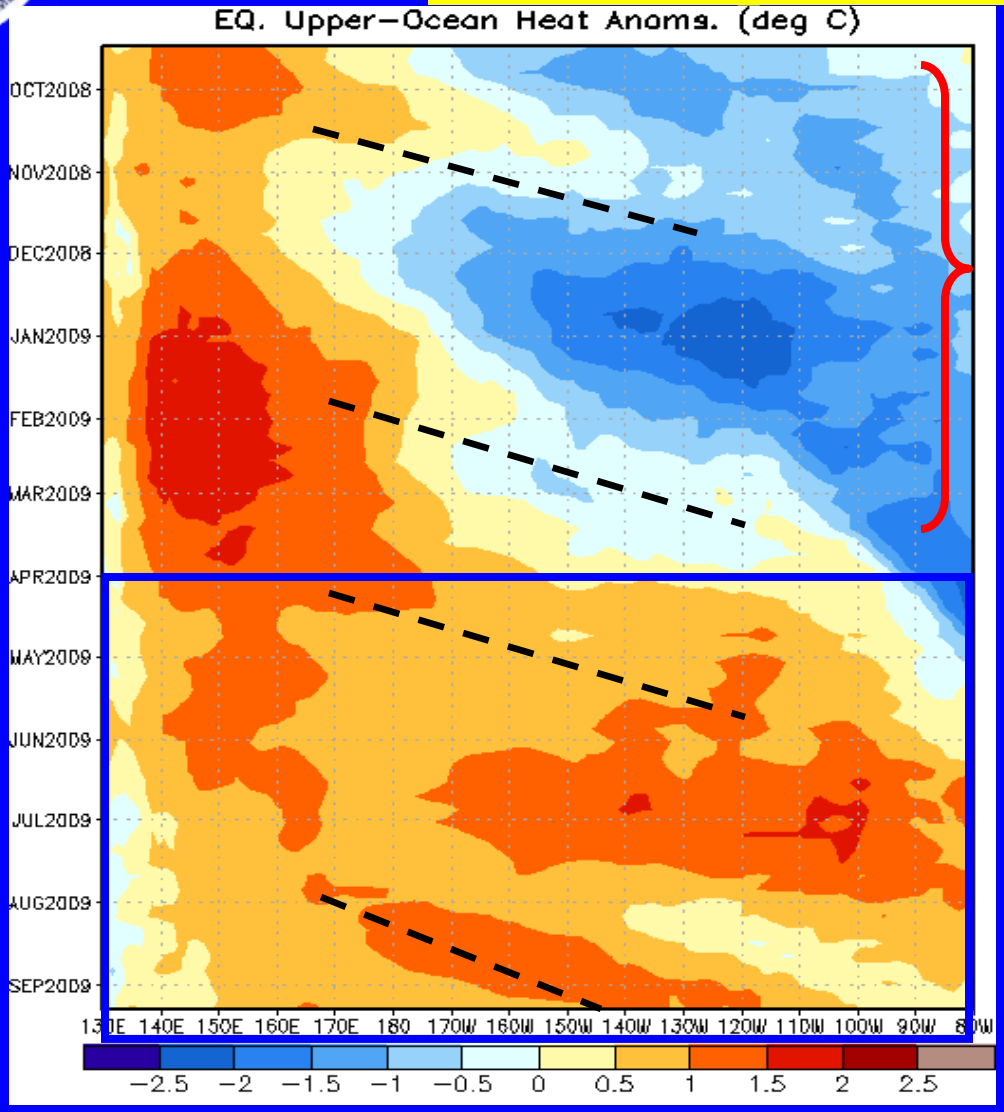
Longitude

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).

During the last week, westerly anomalies have become quite strong east of 140W, while easterly wind anomalies are evident near the Maritime Continent.

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 (blue box).
- Recently, the downwelling phase of a Kelvin wave has shifted eastward.

MJO Index -- Information

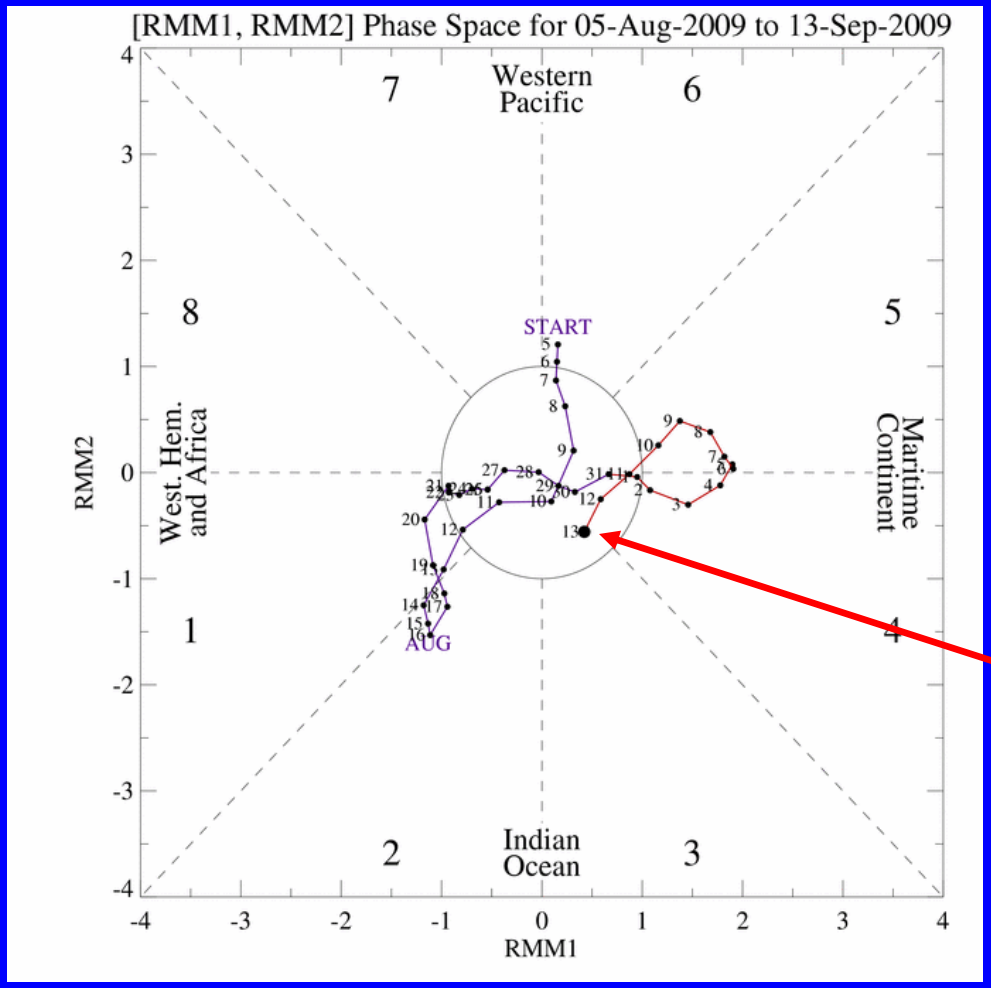
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

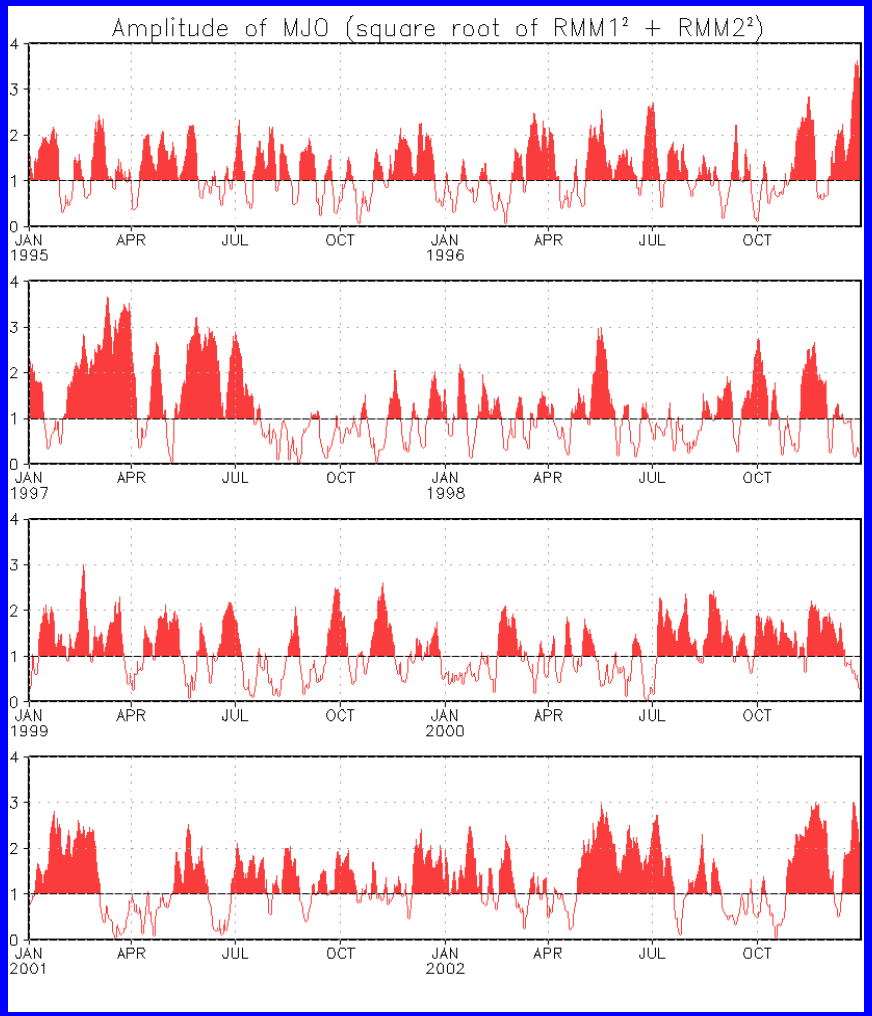
MJO Index -- Recent Evolution

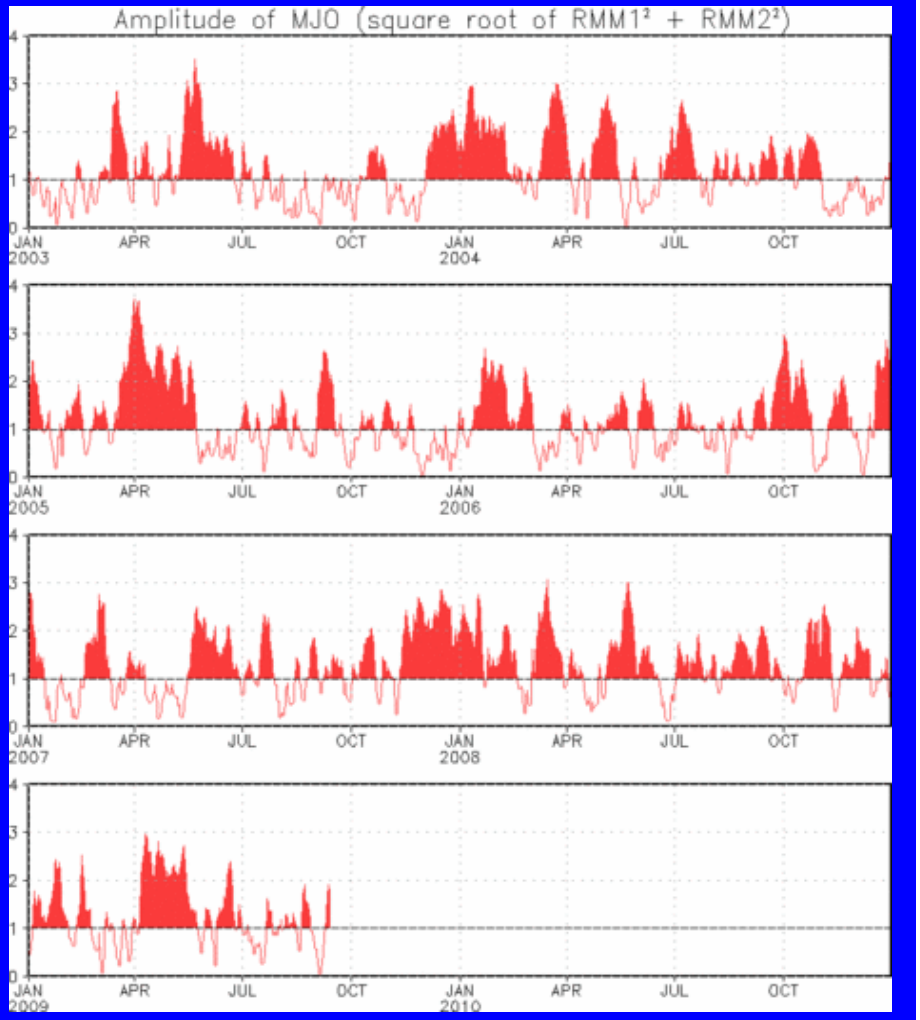


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

The MJO index decreased in amplitude during the past week.

MJO Index – Historical Daily Time Series





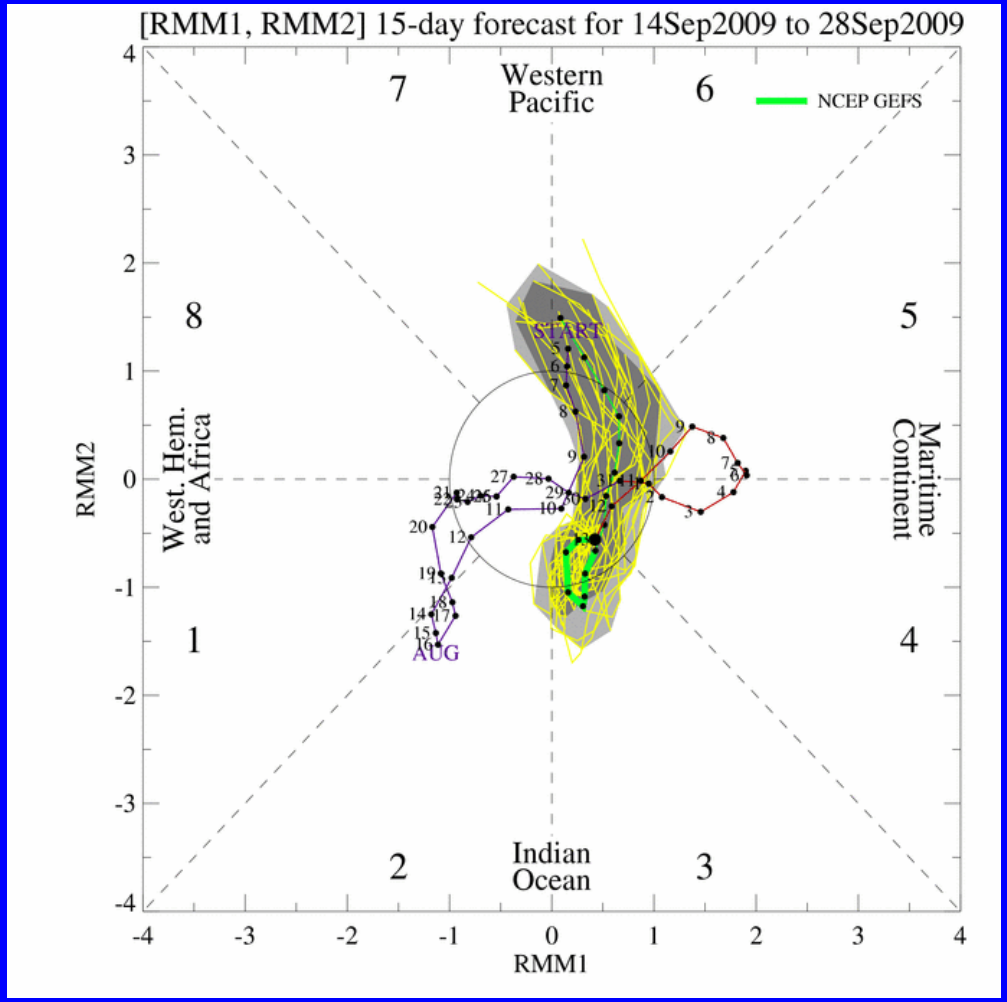
Time series of daily MJO index amplitude from 1995 to present. Plots put current MJO activity in historical context.

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



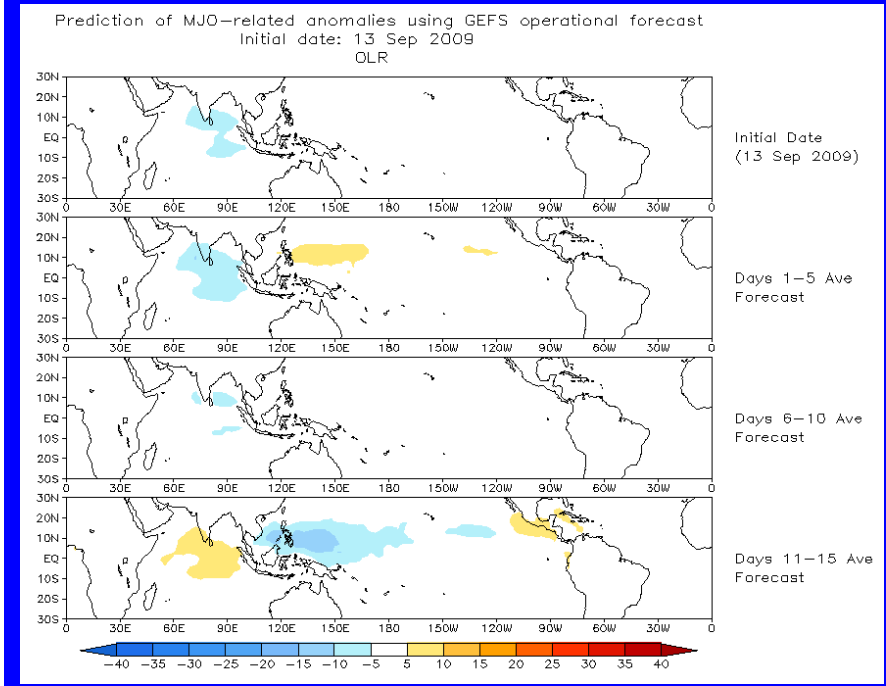
The GEFS forecasts a weak amplitude of the MJO index during Week-1.

During Week-2, the MJO index amplitude strengthens with eastward progression.

Ensemble Mean GFS MJO Forecast

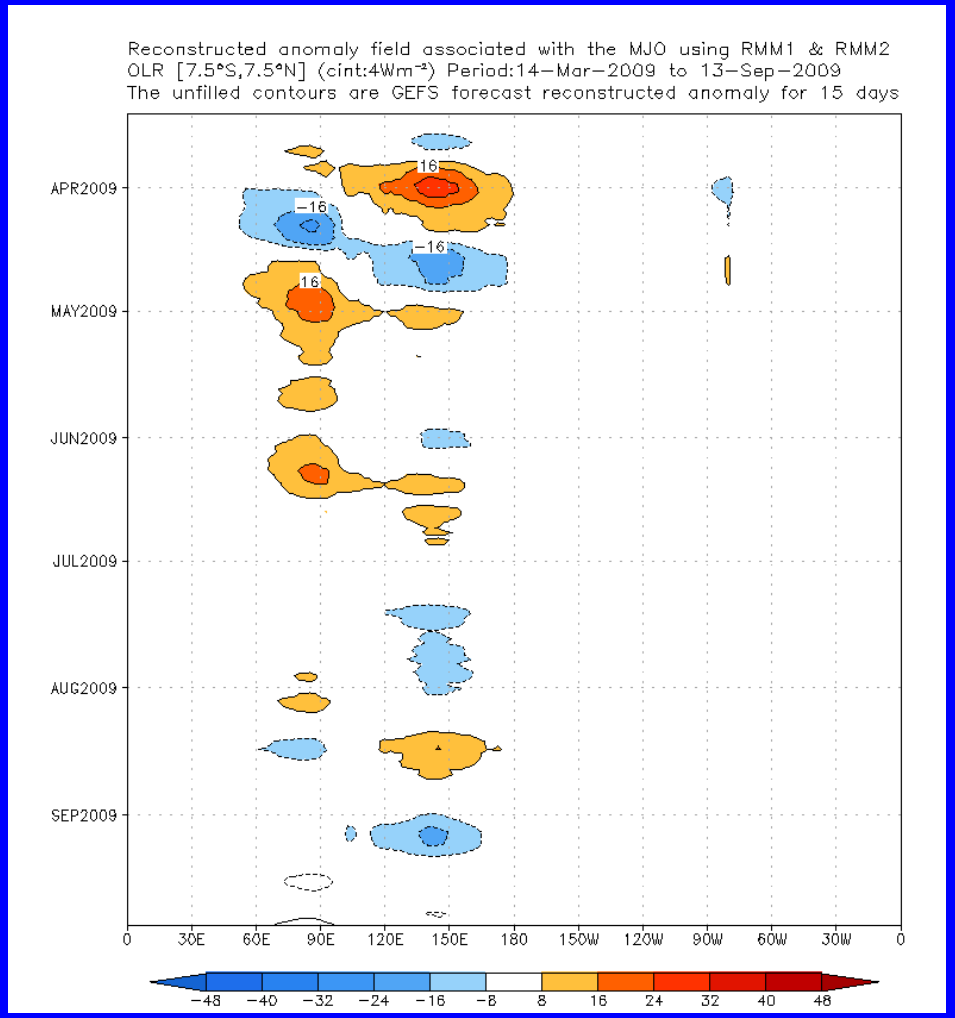
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecasts a weak convective signal during Week-1, but strengthens during 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



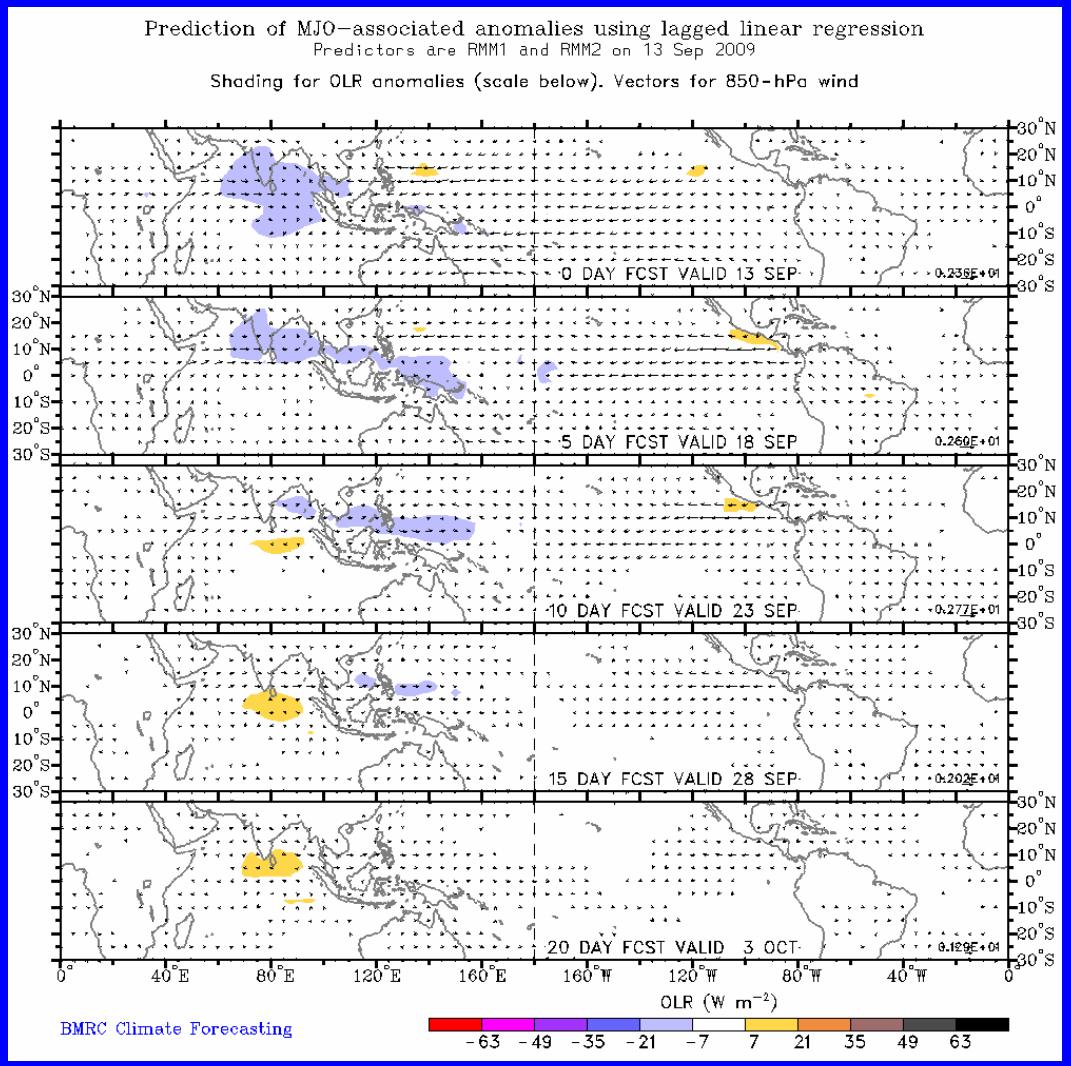
Statistical MJO Forecast

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

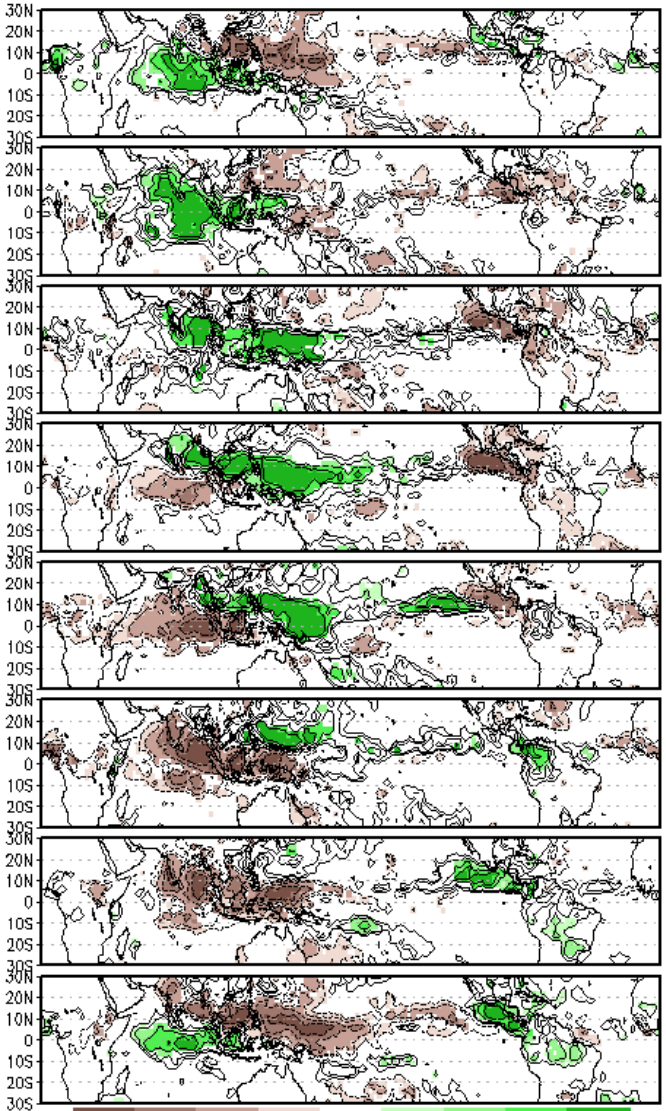
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

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



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)