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

Update prepared by
Climate Prediction Center / NCEP
November 9, 2009

Outline

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

Overview

- A strong MJO signal has emerged during the past week with the enhanced convective phase centered across the Indian Ocean.

- Based on recent observations, statistical MJO tools and some dynamical MJO index forecasts, the MJO is expected to remain active during the next 1-2 weeks.

- During Week-1, the MJO is expected to contribute to enhanced (suppressed) rainfall across the equatorial Indian Ocean (portions of the western Pacific) and elevated chances for tropical cyclogenesis in Indian Ocean both north and south of the equator. The MJO is expected to contribute to enhanced rainfall across the western Pacific during Week-2.

- For the US, the expected phase of the MJO favors troughs near the US West coast and increased chances for potentially heavy rain events especially during late Week-1 and Week-2. Warmer than normal temperatures are favored across much of the central and eastern US.

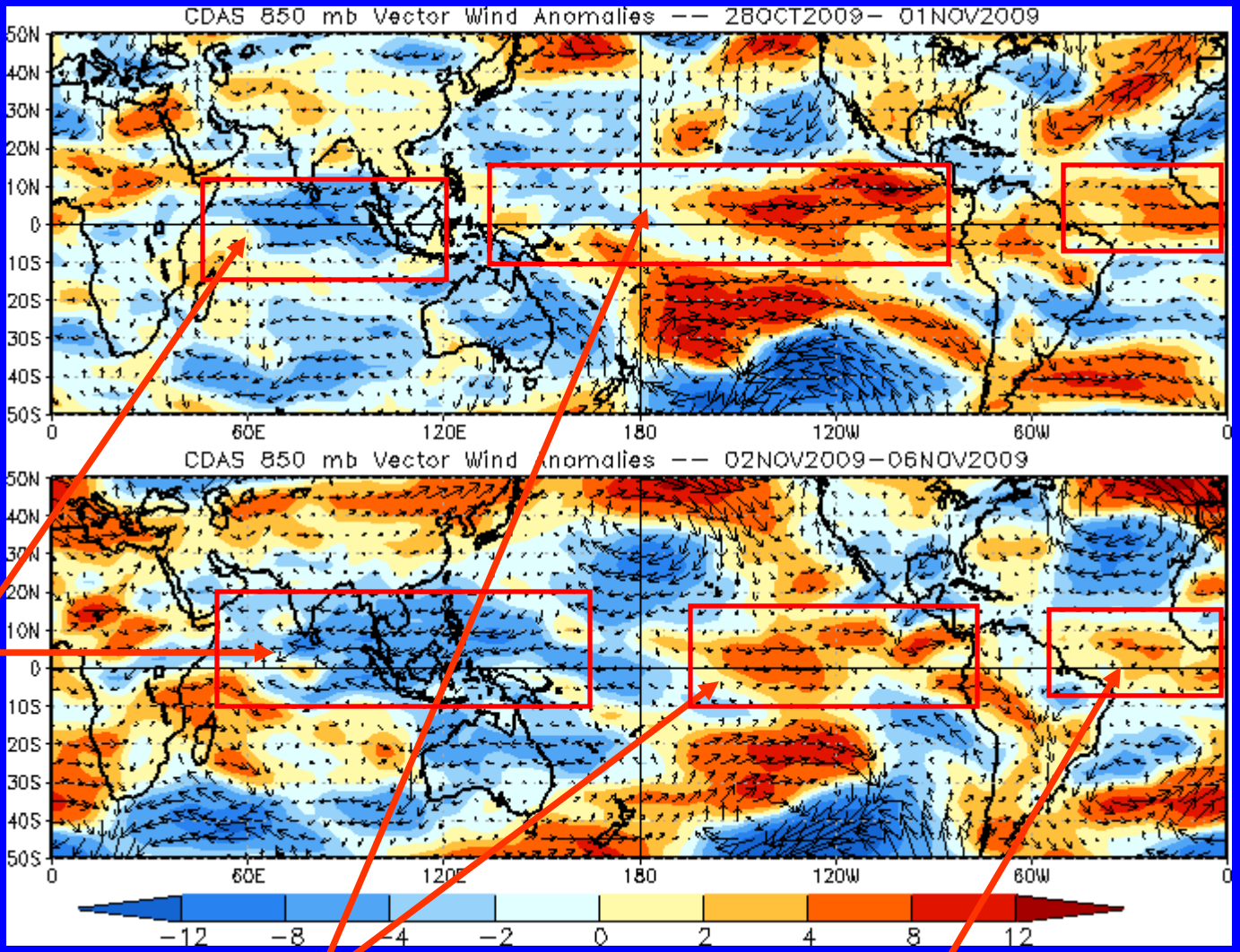
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Easterly anomalies have expanded across the Maritime continent during the last five days.

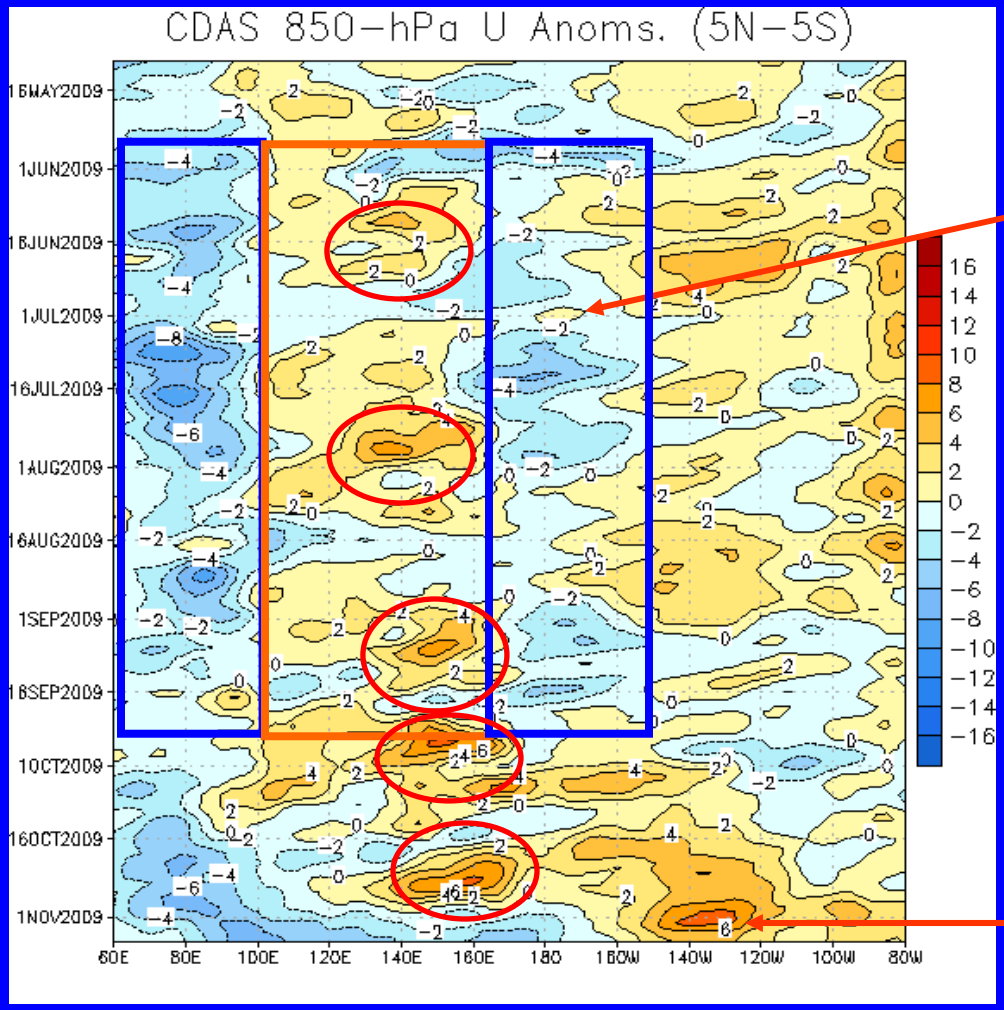
Westerly anomalies have diminished over the western Pacific during the last five days but remain across much of the east-central Pacific.

Westerly anomalies have decreased across the Atlantic and Africa 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 May into September, easterly (westerly) anomalies prevailed across the Indian Ocean (Indonesia) (blue and orange boxes).

Several westerly wind bursts (red circles) occurred during this period and are evident in mid-June, late July, and early September.

There has also been a slow gradual shift eastward of the westerly anomalies over the entire period.

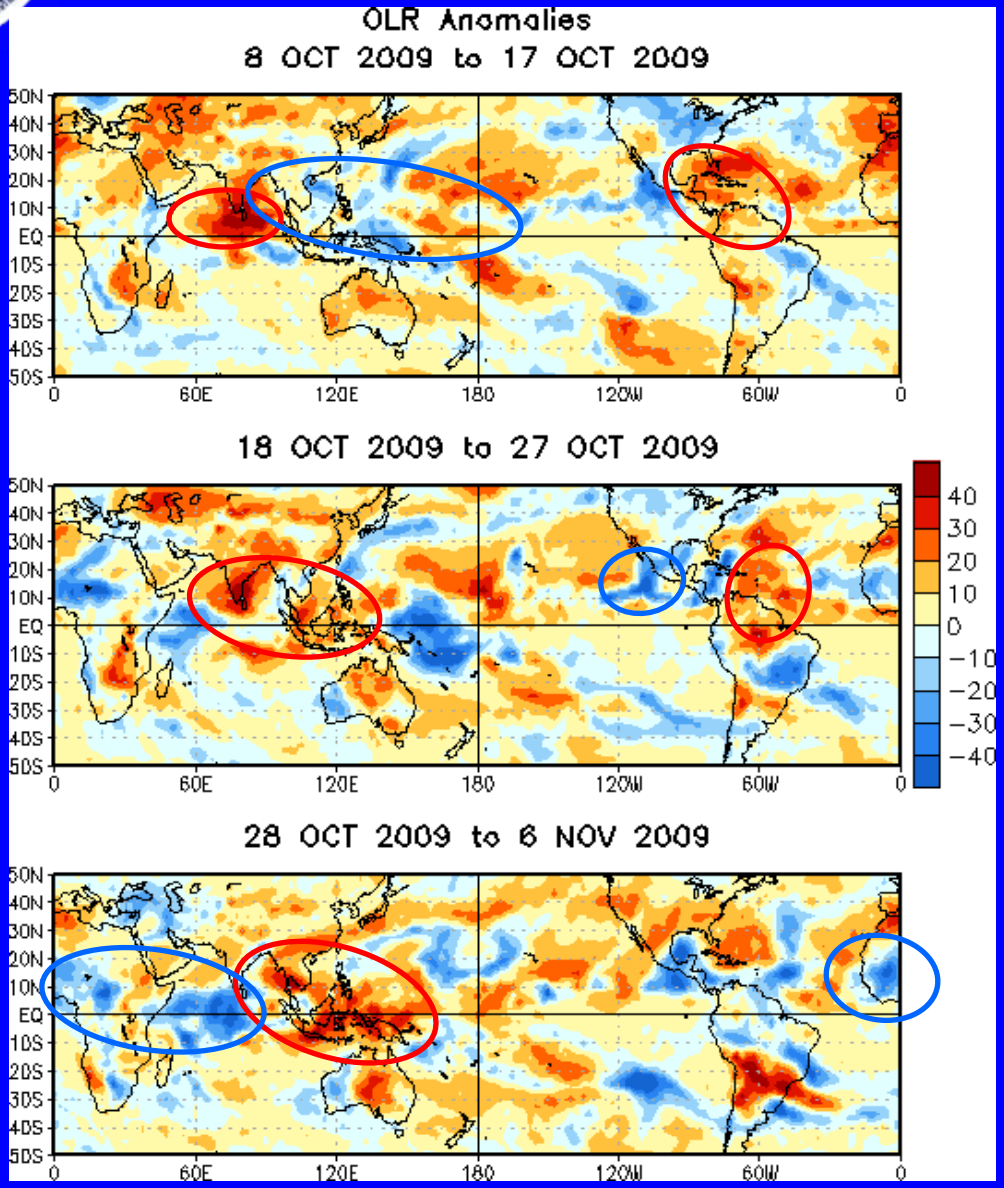
The westerly wind bursts became more frequent and stronger during September and October.

In recent days, easterly anomalies have expanded eastward to the Date Line while westerly anomalies continued 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)

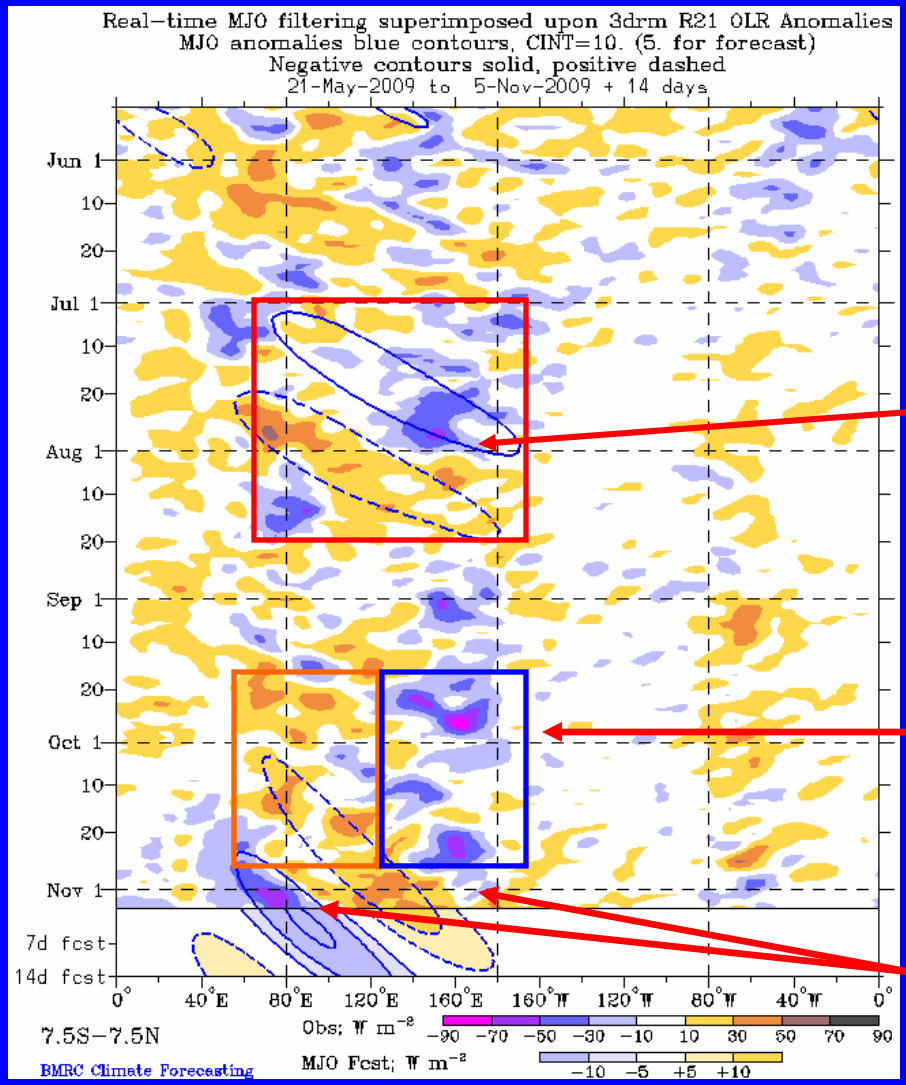


During mid October, enhanced convection (blue oval) diminished across much of the western Pacific. Areas of suppressed convection (red ovals) were evident over parts of the Indian Ocean, Americas and Caribbean Sea.

During mid-to-late October, suppressed convection developed over parts of southern Asia and the western Maritime continent while continuing across the western Atlantic. Enhanced convection was noted across parts of the eastern Pacific.

During late October and early November, suppressed convection continued to shift eastward across the Maritime continent while enhanced convection has developed across the western Indian Ocean and Africa.

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 (BOM) - Australia)

Several types of subseasonal variability – including weak MJO activity – combined to produce generally enhanced (suppressed) convection across the Maritime continent and western Pacific during July (August).

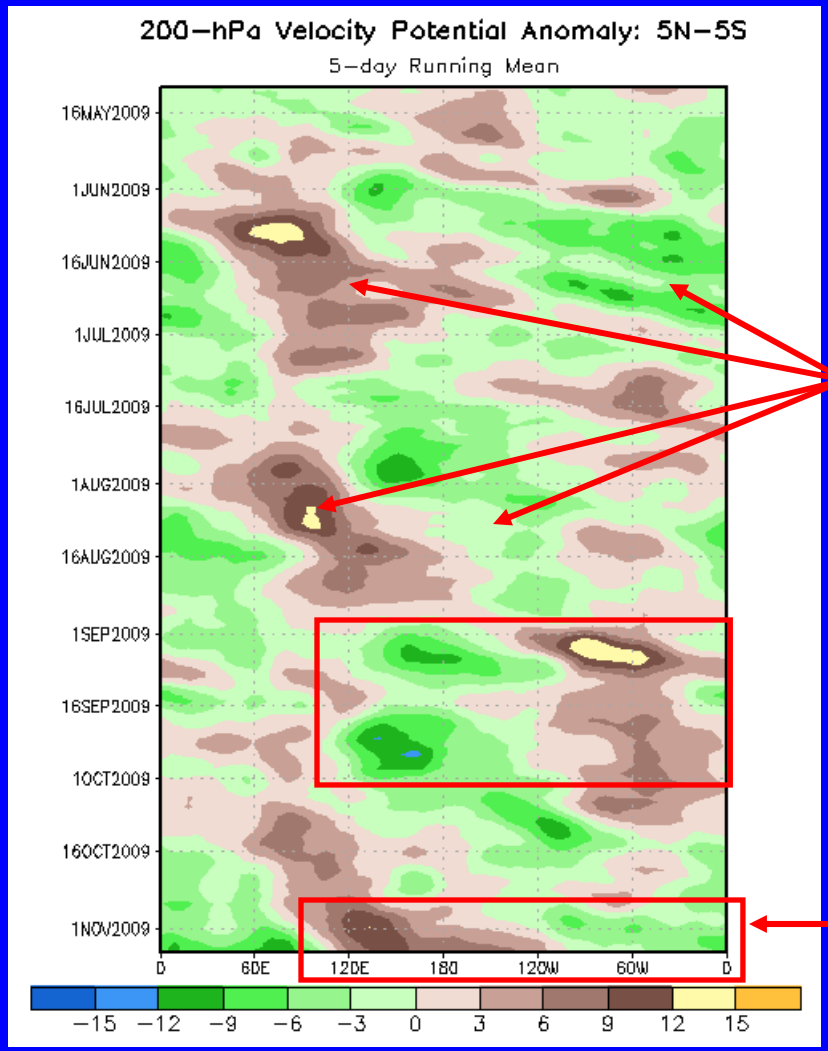
During most of September and October, generally enhanced (suppressed) convection has been evident across the western Pacific (eastern Indian Ocean) (blue and orange boxes).

Beginning in late October, enhanced convection developed across Africa and has shifted eastward into the Indian Ocean while suppressed convection is moving across the Maritime continent.

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 weak during most of May.

Velocity potential anomalies increased in early June and late July due to several types of subseasonal variability with some eastward propagation evident.

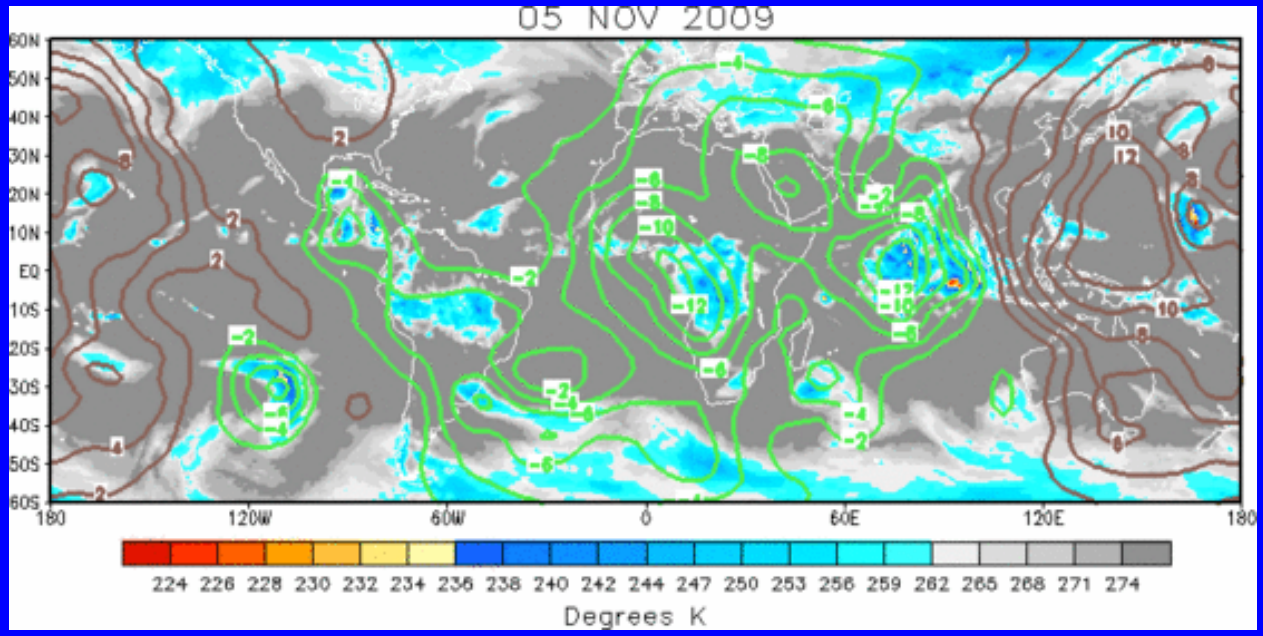
Anomalies increased during September but the overall pattern remained generally persistent with upper-level divergence (convergence) across the western Pacific (parts of Western Hemisphere) (red box).

In late October, anomalies increased and some eastward propagation has been evident.

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

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

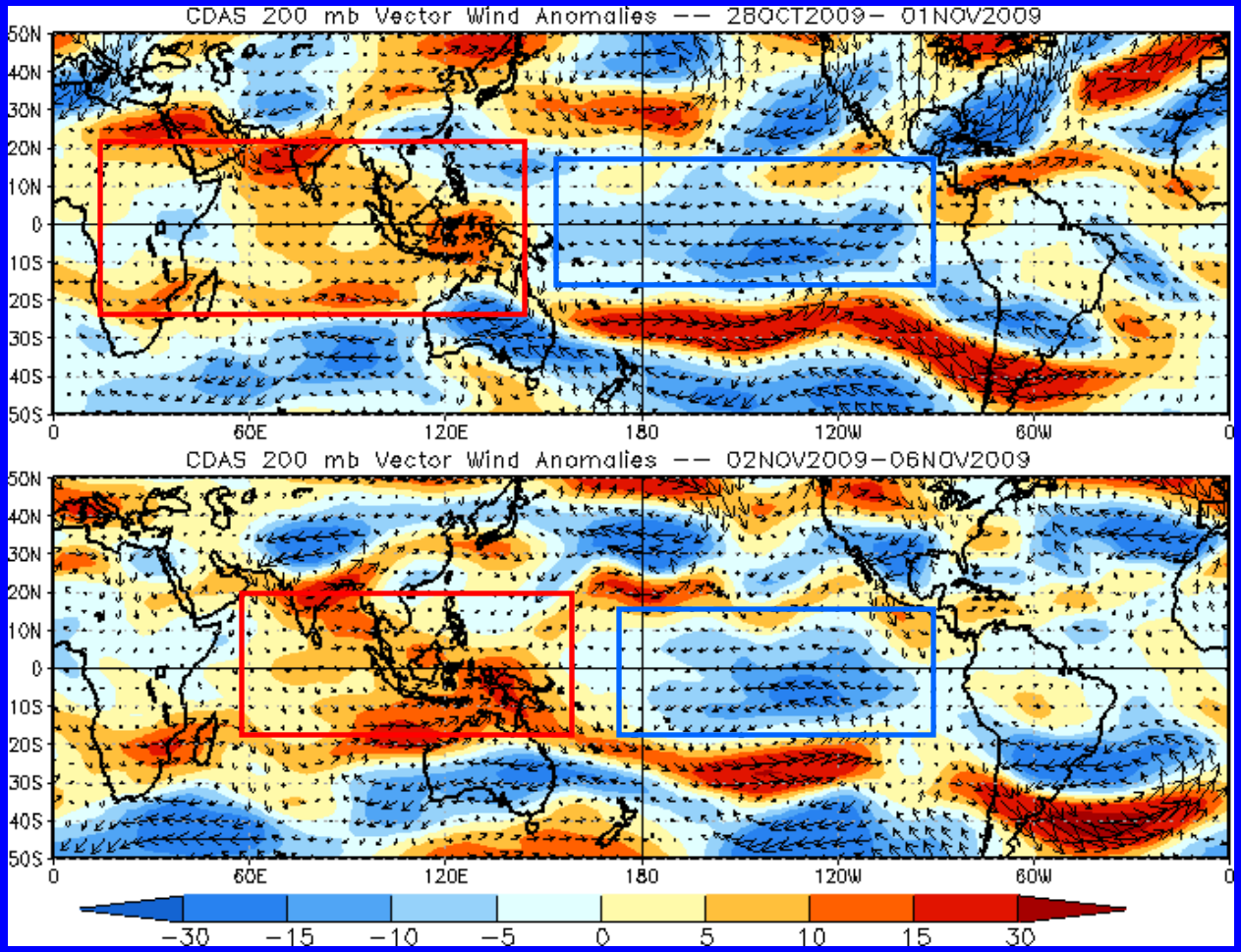
Negative anomalies (green contours) indicate favorable conditions for precipitation



Velocity potential anomalies indicate a coherent pattern with upper-level divergence mainly across Africa and the Indian Ocean with upper-level convergence is evident over the Pacific.

The pattern has been propagating eastward during the past week.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

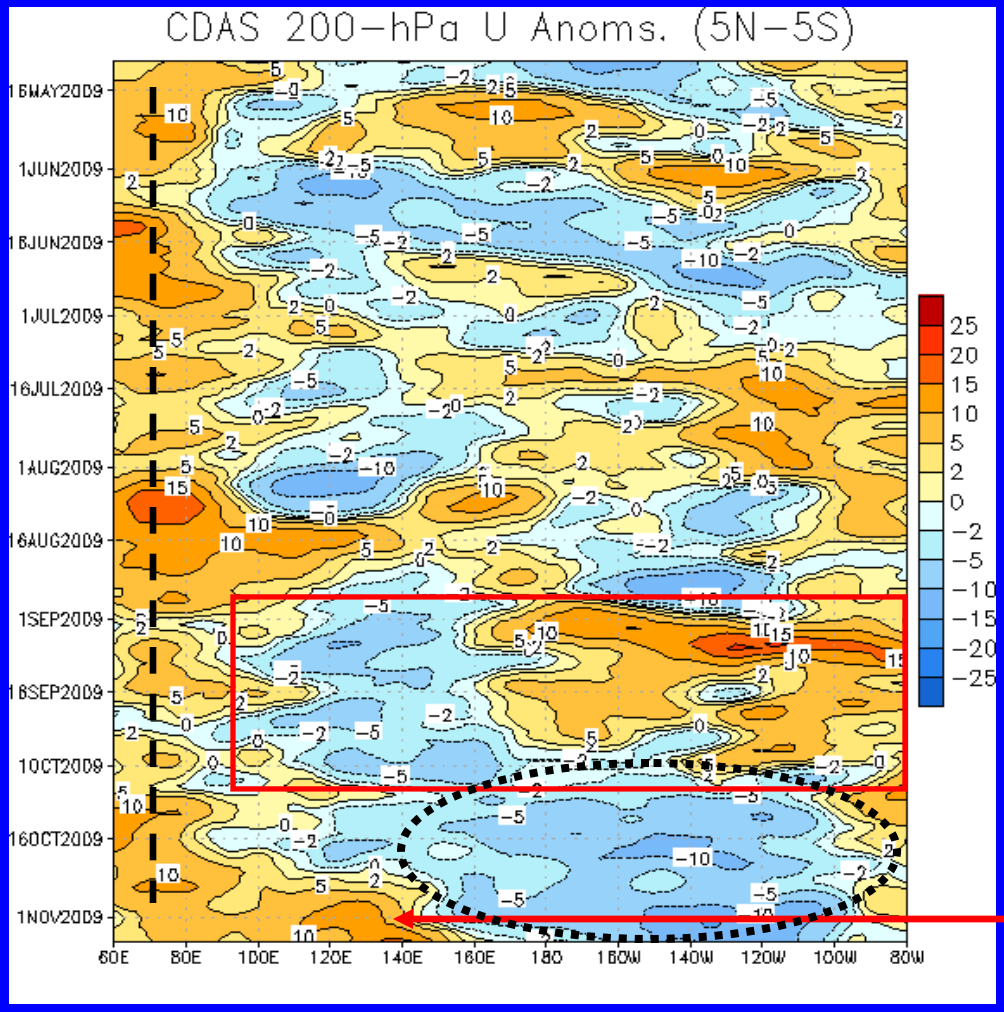
Westerly anomalies (red boxes) persisted across the Indian Ocean with a slight increase in strength across portions of the Maritime continent during the last five days.

Easterly anomalies continued across the Pacific during the last five to ten days (blue 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

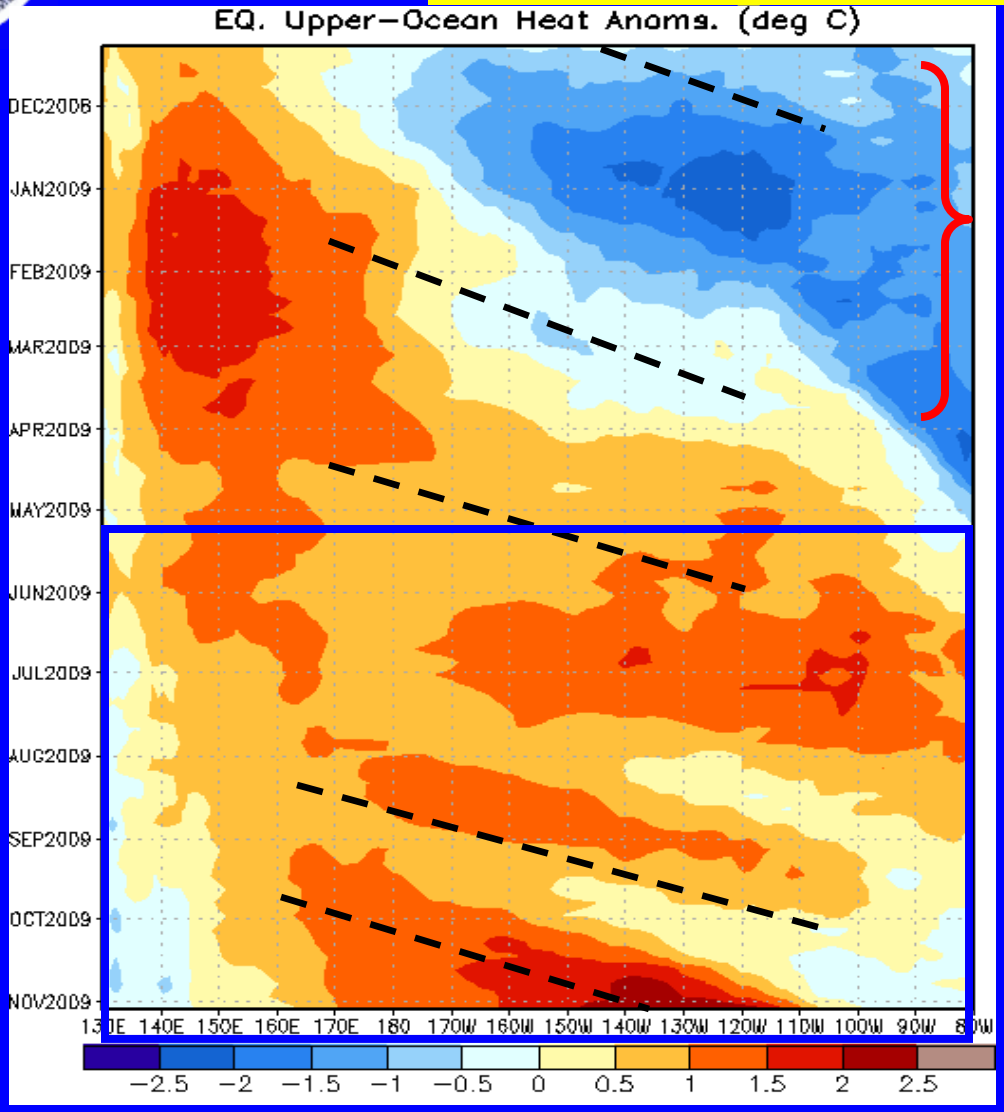
Westerly anomalies across the Indian Ocean have persisted since May 2009 (vertical dashed black line).

During September easterly (westerly) anomalies remained generally persistent across Indonesia and the western Pacific (Western Hemisphere) (red box).

In early October, easterly anomalies rapidly replaced westerly anomalies across much of the Pacific (black dotted oval).

Westerly anomalies expanded eastward during late October across the Maritime Continent.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

During November 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).

The downwelling phase of two Kelvin waves have shifted eastward during August/September and late September/mid October (last two dashed black lines).

MJO Index -- Information

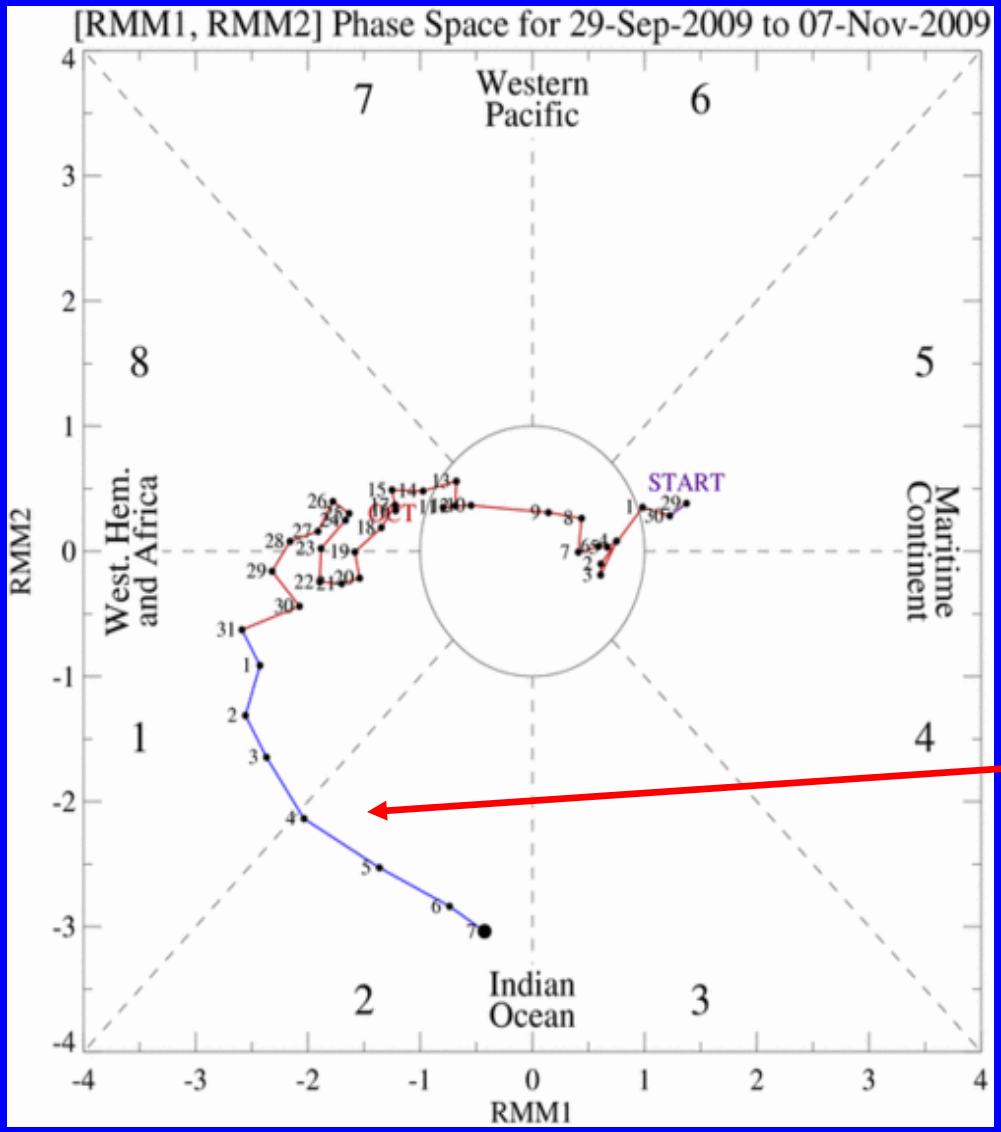
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

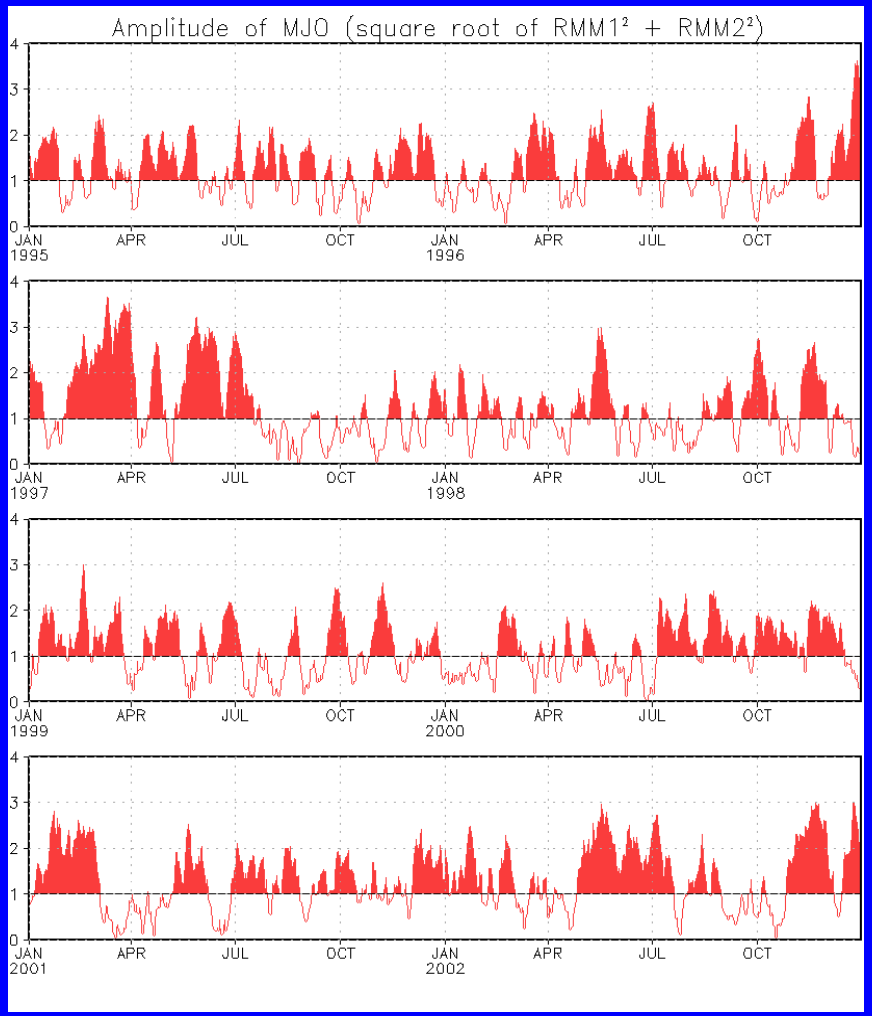
MJO Index -- Recent Evolution

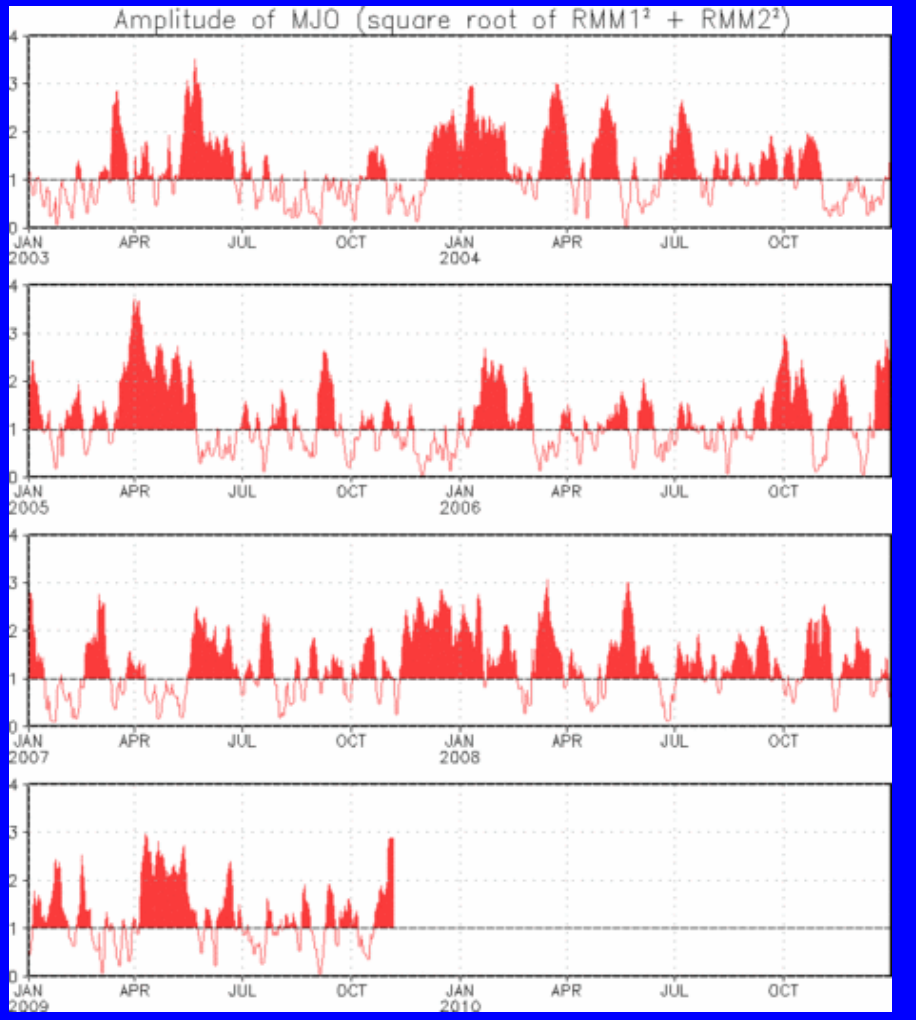


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.**
- **Distance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

The MJO index has maintained its amplitude and eastward propagation during the last week.

MJO Index – Historical Daily Time Series





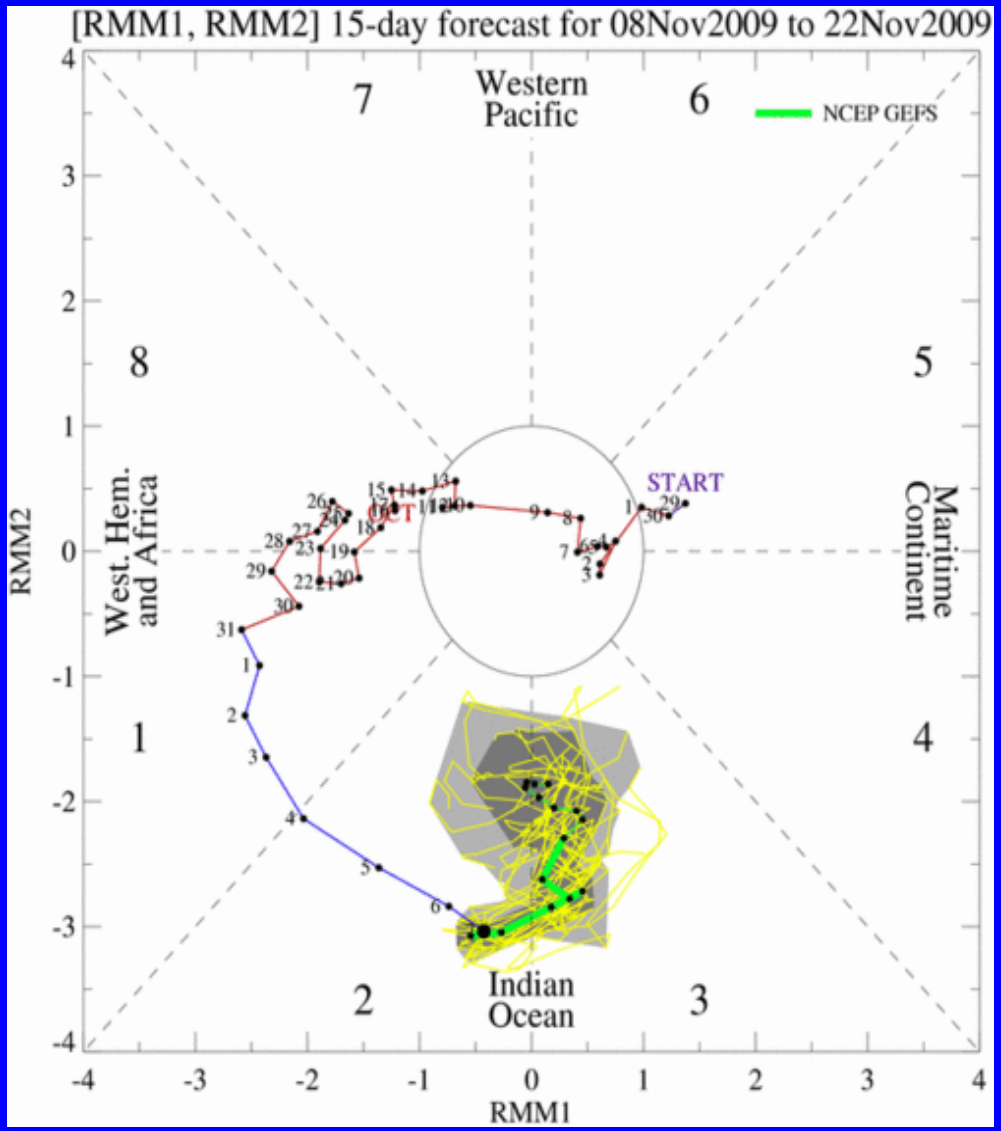
Time series of daily MJO index amplitude from 1995 to present. Plots put current MJO activity in historical context.

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



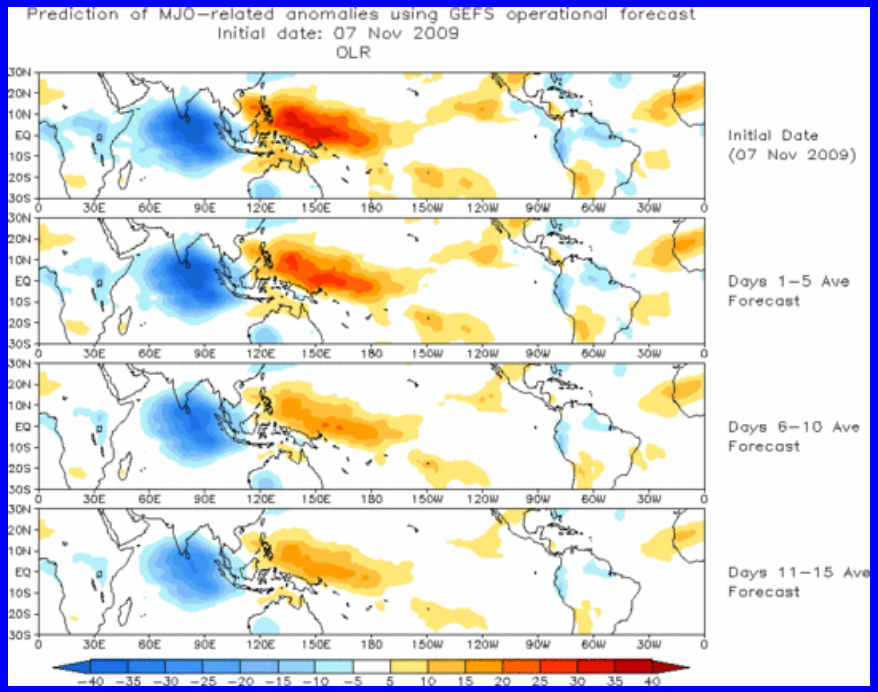
The GFS MJO index forecasts indicate continued eastward propagation during Week-1 before a weakening of the MJO signal and decrease in eastward movement.

Uncertainty becomes high during the Week-2.

Ensemble Mean GFS MJO Forecast

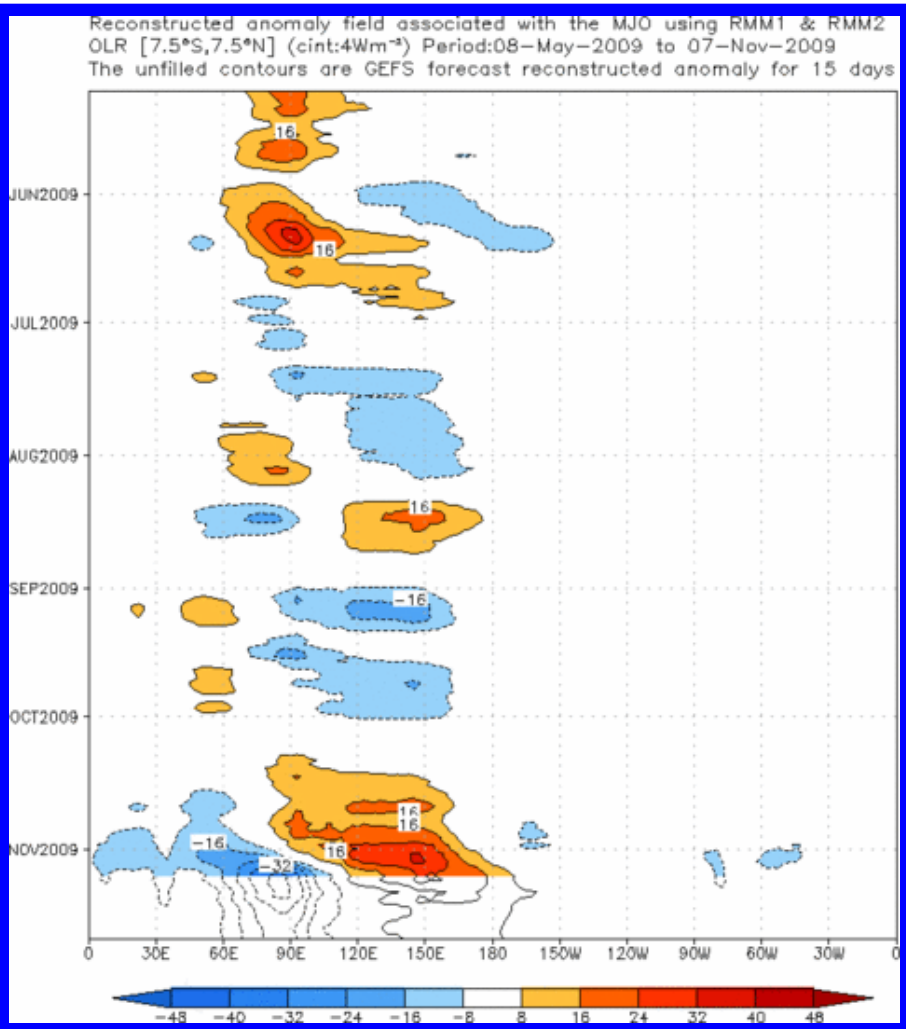
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



With decreasing eastward propagation, the GEFS ensemble mean forecasts persist enhanced convection over Indian Ocean and suppressed convection across the western Pacific throughout the period.

Time-longitude section of (7.5°S-7.5°N) OLR anomalies for the last 180 days and for the next 15 days



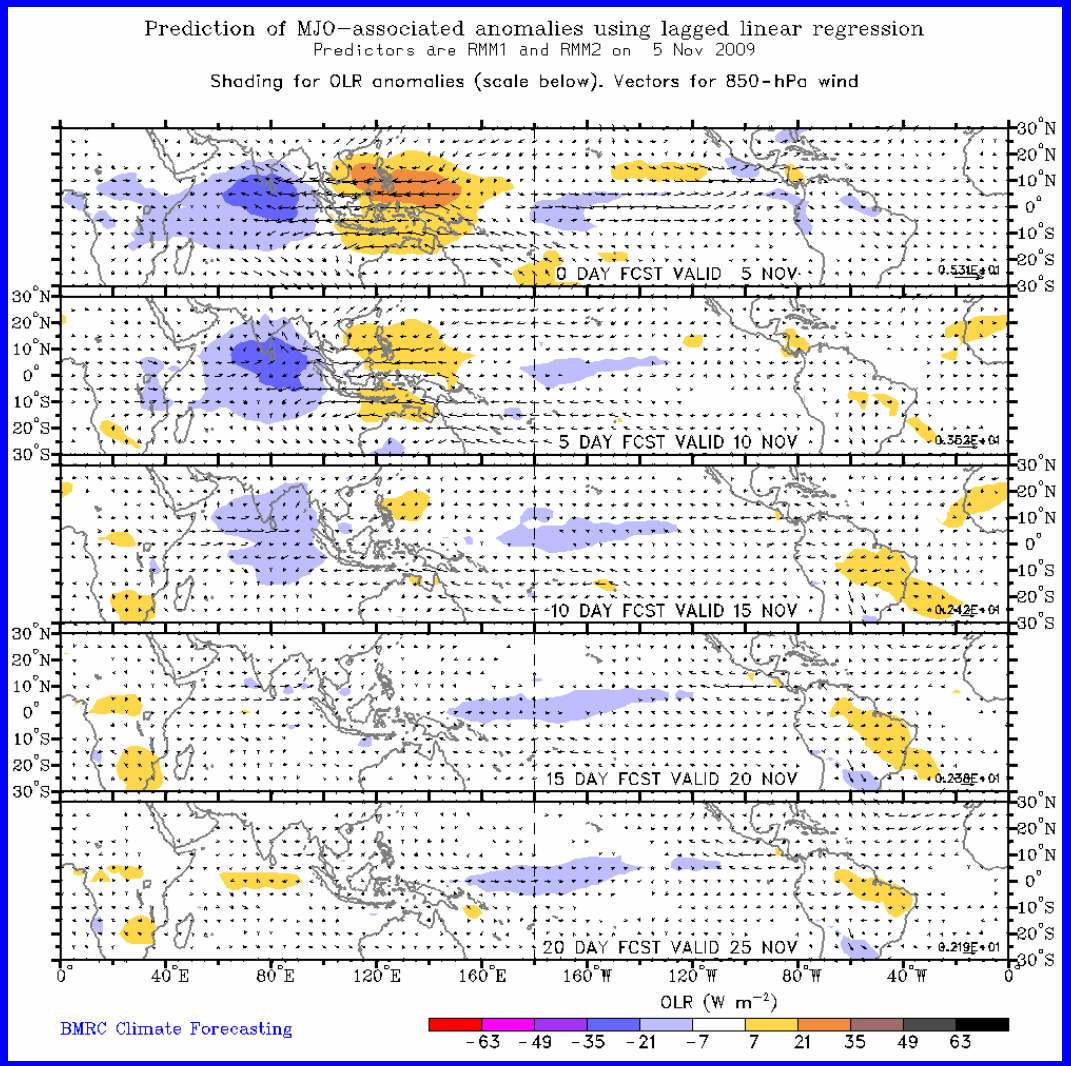
Statistical MJO Forecast

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

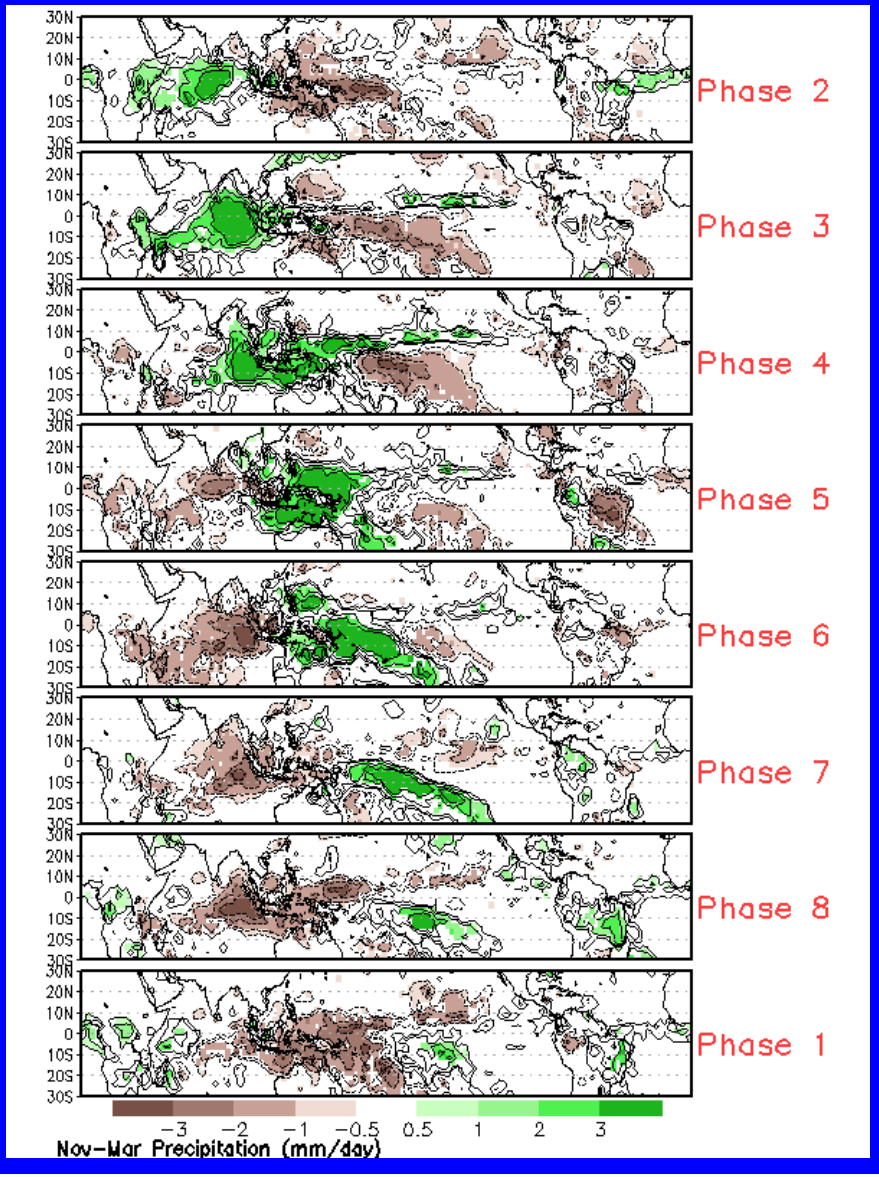
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical model forecast is more progressive than the dynamical model forecast. A weak-to-moderate signal is evident and shows enhanced convection across the Indian Ocean and suppressed convection decreasing across the western Pacific during Week-1.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)