



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

**Update prepared by
Climate Prediction Center / NCEP
November 15, 2010**



Outline

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



Overview

- **The MJO remained weak during the past week. The MJO index has propagated eastward in recent days but this is primarily due to factors other than the MJO.**
- **In fact, most dynamical model MJO forecasts indicate a rapid weakening of this signal during Week-1.**
- **Confidence in this scenario is high given background La Nina conditions.**
- **Based on the above considerations, the MJO is expected to remain weak during the next 1-2 weeks.**

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

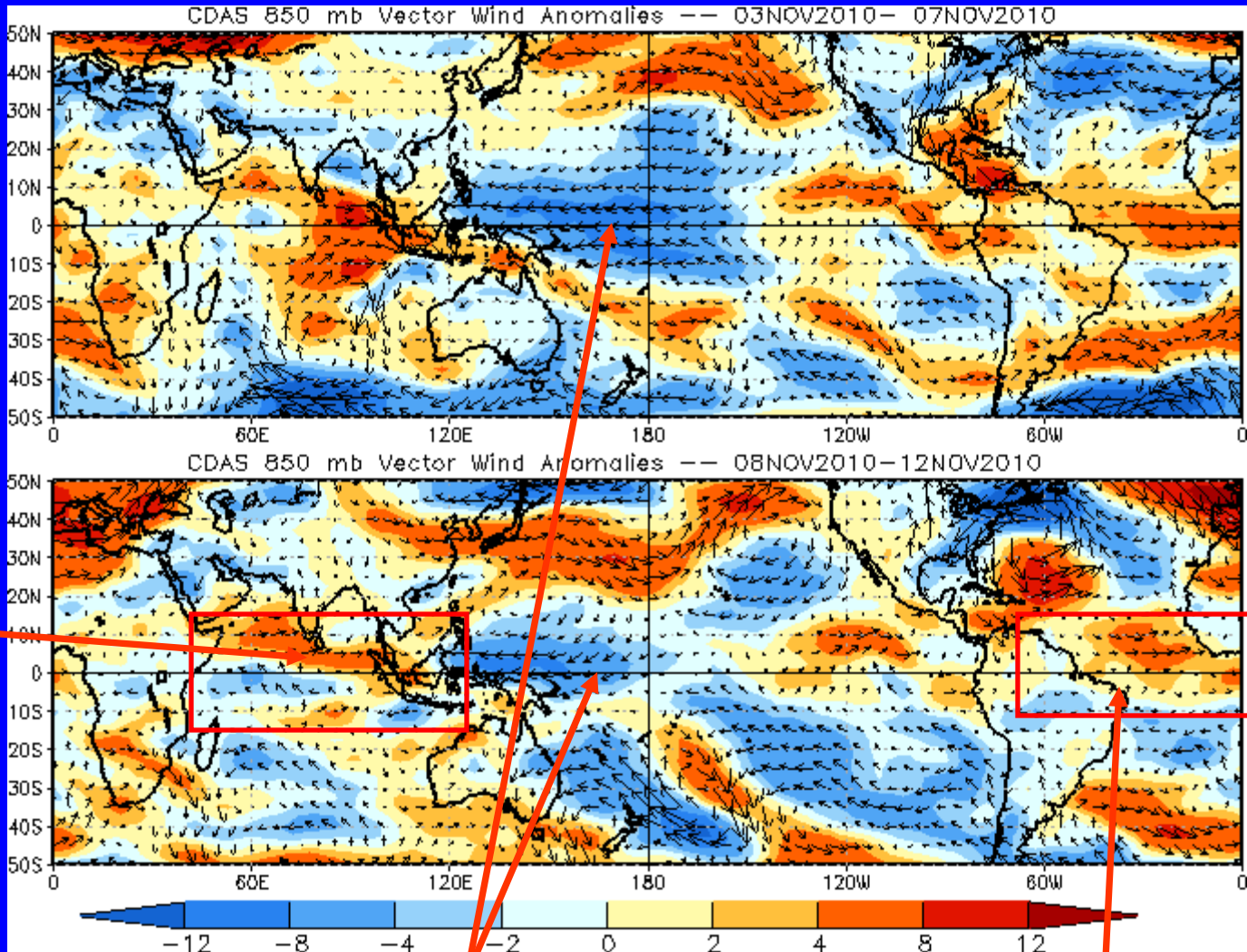


850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly anomalies weakened across the eastern Indian Ocean and western Maritime continent during the last five days.

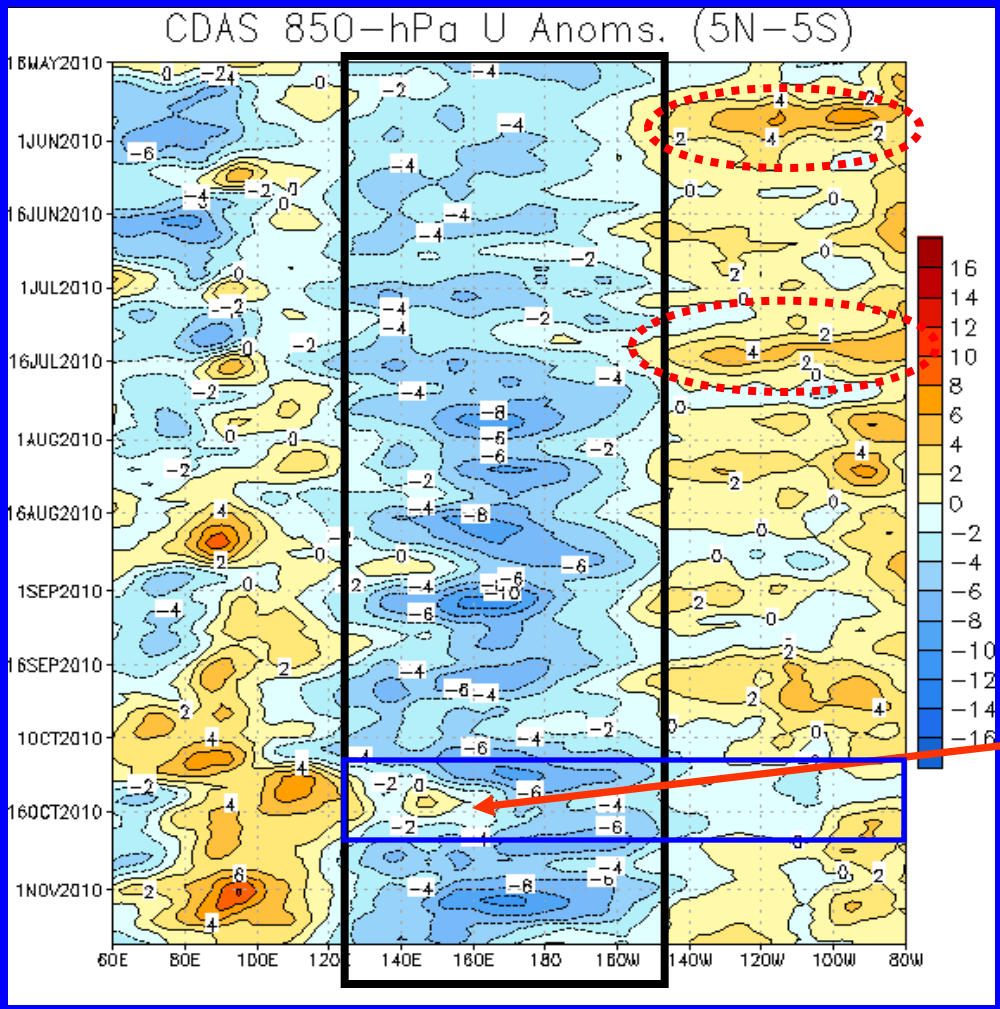
Easterly anomalies shifted slightly west and weakened across the western Pacific during the last five to ten days.

Westerly anomalies continued across the 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

Easterly anomalies have persisted in the west-central Pacific since April (black box) consistent with the development of La Nina conditions.

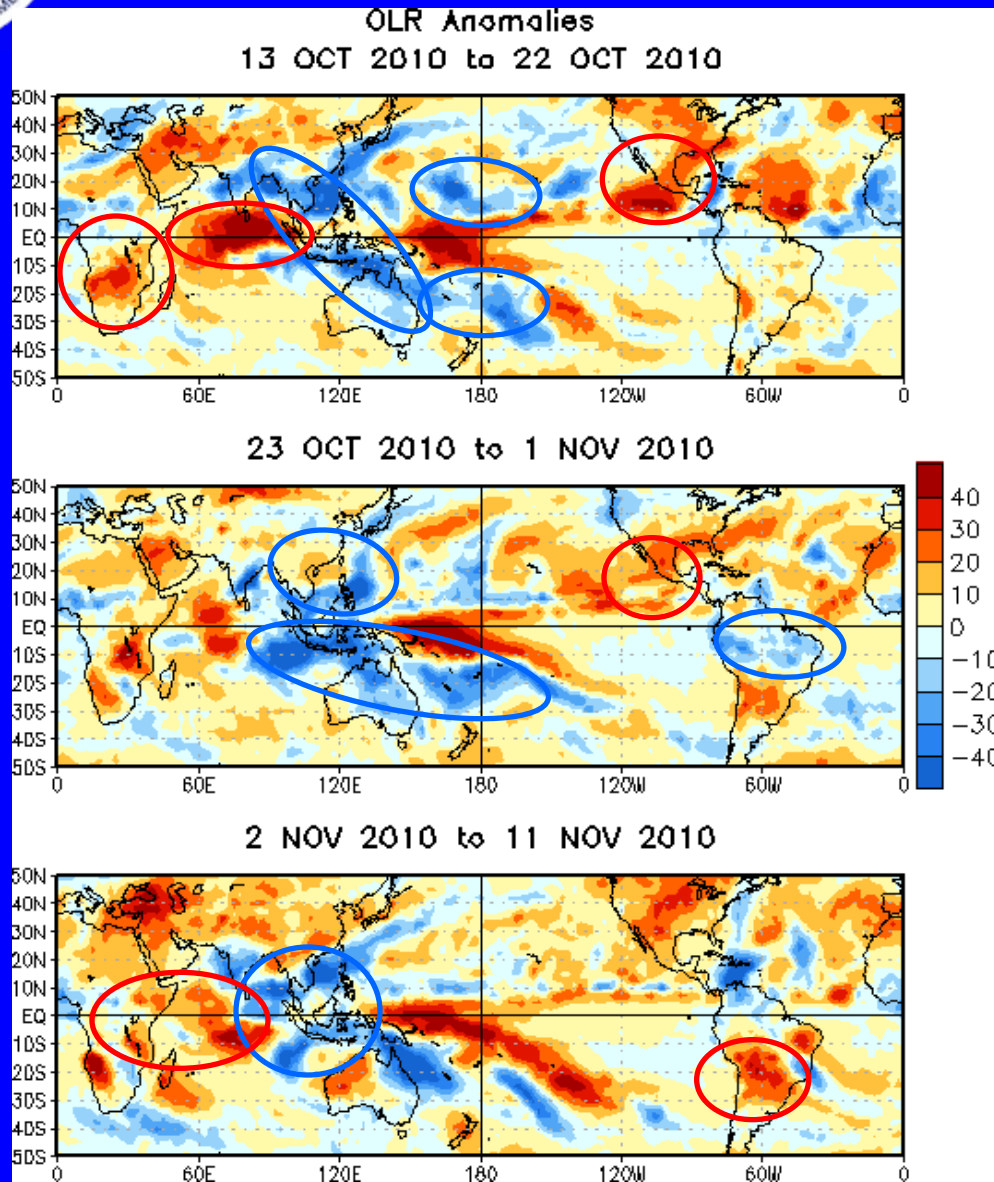
Enhanced westerly anomalies (red dotted ovals) occurred across the eastern Pacific on separate occasions during late April, late May and early-to-mid July and these were in part associated with MJO activity.

The MJO strengthened in October as evidenced by weak westerly anomalies and a weakening of the easterlies across the central Pacific during mid-October. Also, westerly anomalies weakened across the eastern Pacific at the same time (blue box).



OLR Anomalies – Past 30 days

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



Drier-than-average conditions continued over Mexico and the eastern Pacific in mid-October while enhanced convection shifted east to parts of the western Pacific and east of Australia. Suppressed convection developed across the equatorial Indian Ocean and continued over Africa.

In late October, suppressed convection continued over Mexico. Enhanced convection continued over parts of the western Pacific and the Maritime continent and developed over South America.

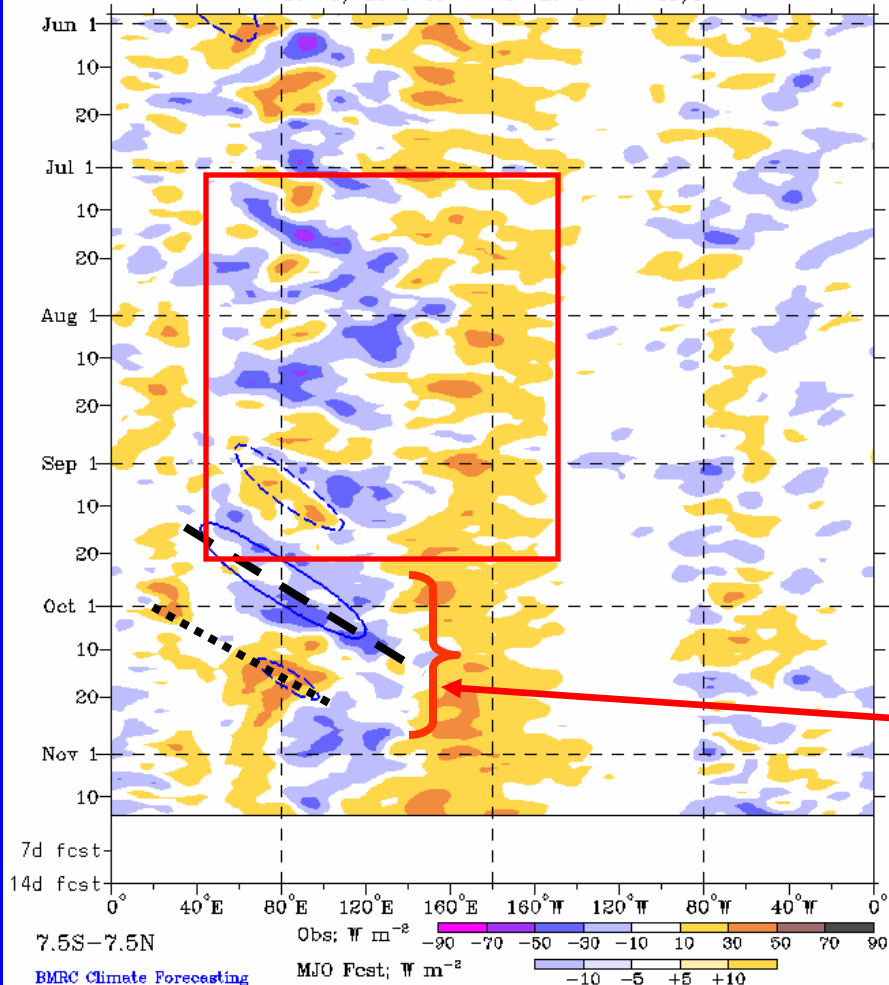
Enhanced convection continued over the Maritime continent and Australia into early November while suppressed convection is evident across parts of Africa, the Indian Ocean and central South America.



Outgoing Longwave Radiation (OLR) Anomalies (7.5°S-7.5°N)

Real-time MJO filtering superimposed upon 3drm R21 OLR Anomalies
MJO anomalies blue contours, CINT=10. (5. for forecast)
Negative contours solid, positive dashed
30-May-2010 to 14-Nov-2010 + 14 days

Time
↓



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-July into September, generally enhanced (suppressed) convection prevailed across the western Maritime continent (Date Line) (red box). Considerable intraseasonal variability is evident during the period as enhanced convection has shifted both eastward and westward in this area during the period but this has not been related to the MJO.

As the MJO strengthened in late September into October, stronger enhanced convection developed near 60E and shifted eastward followed by suppressed convection near 20E during early-mid October.

Longitude

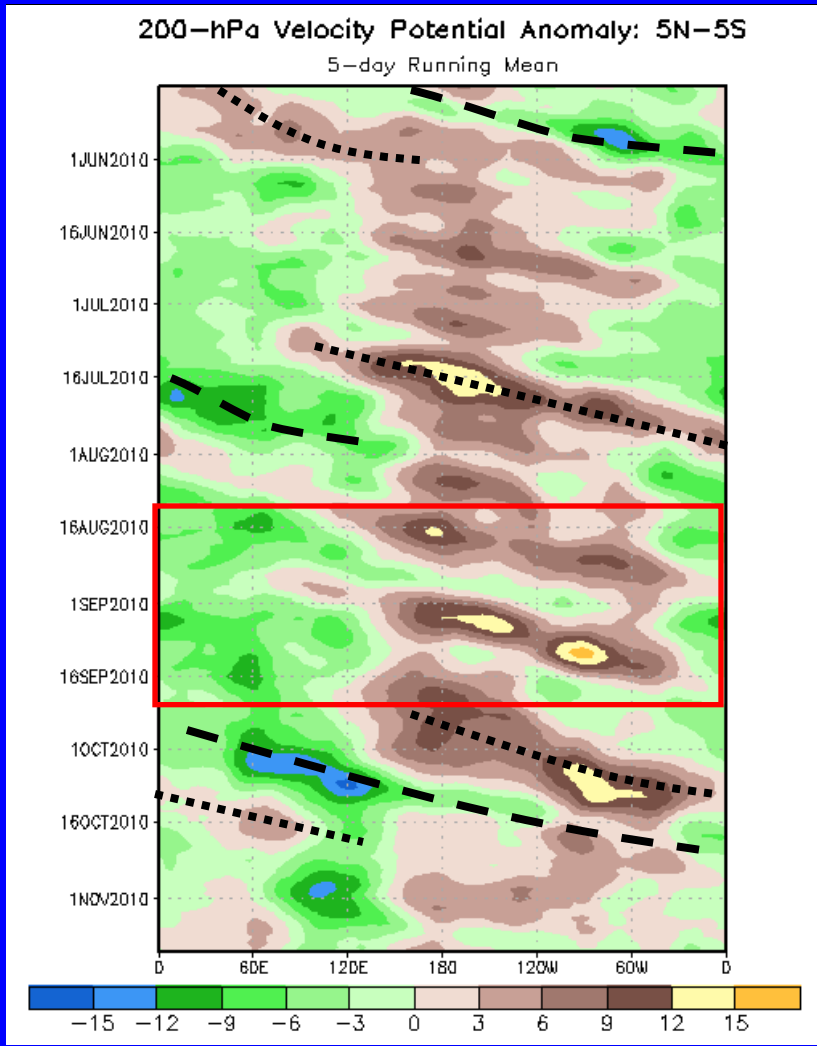


200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time
↓



During late April into May, anomalies increased and eastward propagation was evident, coincident with the MJO.

Eastward propagation was evident during mid-July associated with the MJO.

Eastward propagation in August and September was mainly associated with higher frequency coherent tropical variability rather than the MJO (red box).

The MJO strengthened during late September as anomalies increased and eastward propagation was seen through mid-October.

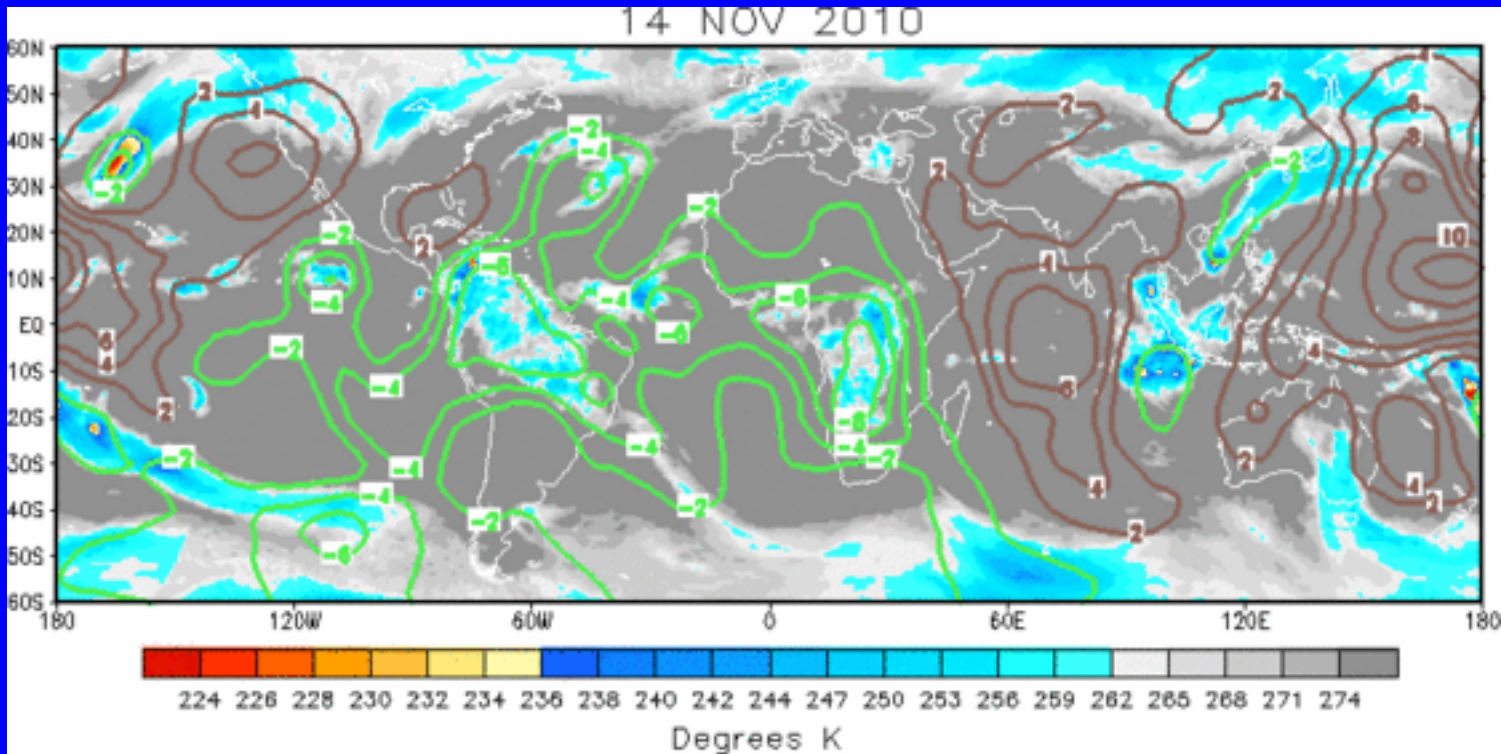
Longitude



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 large scale velocity potential pattern shows anomalous upper-level divergence mainly across South America and Africa with areas of upper-level convergence across parts of the Pacific and Indian Ocean.

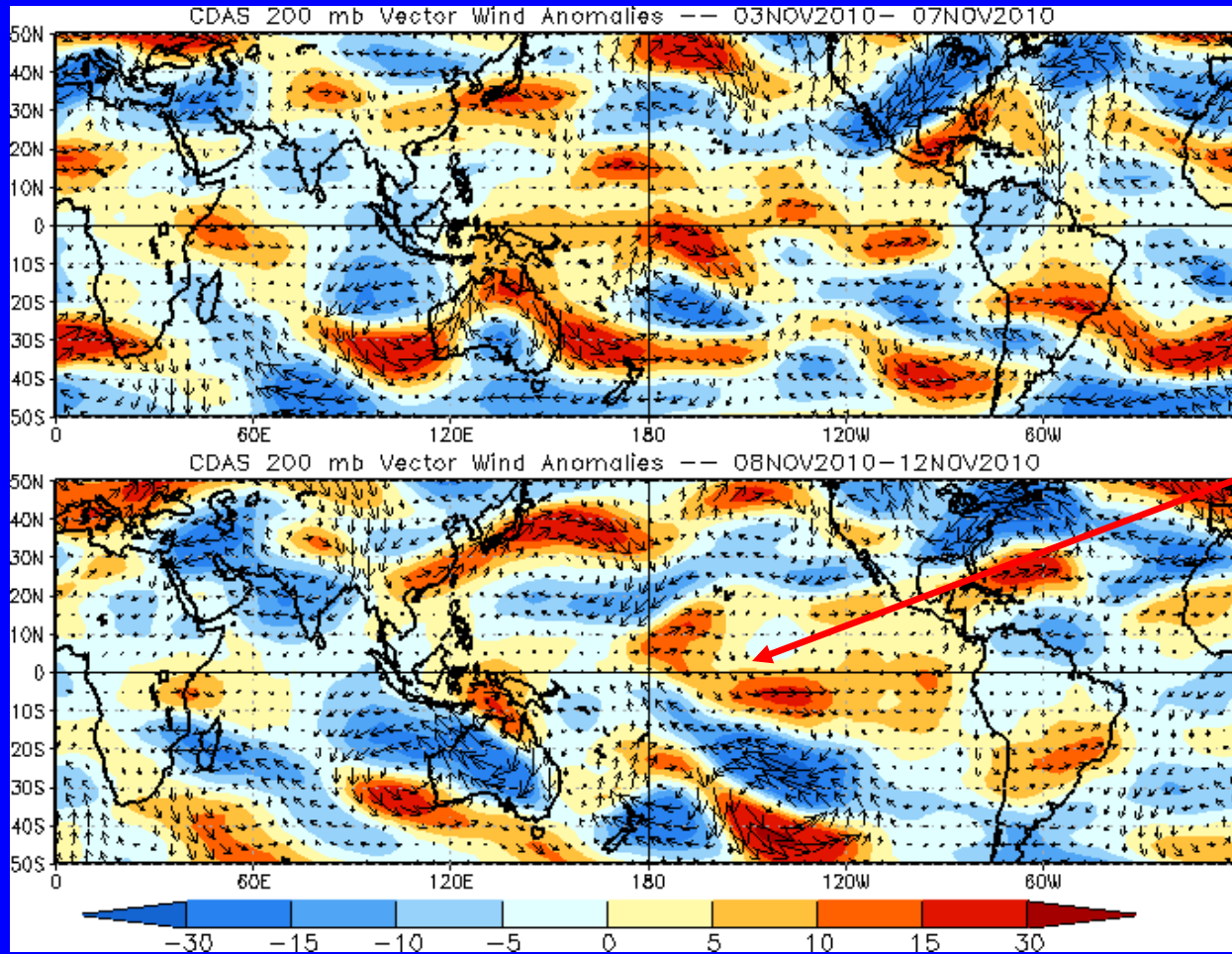


200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



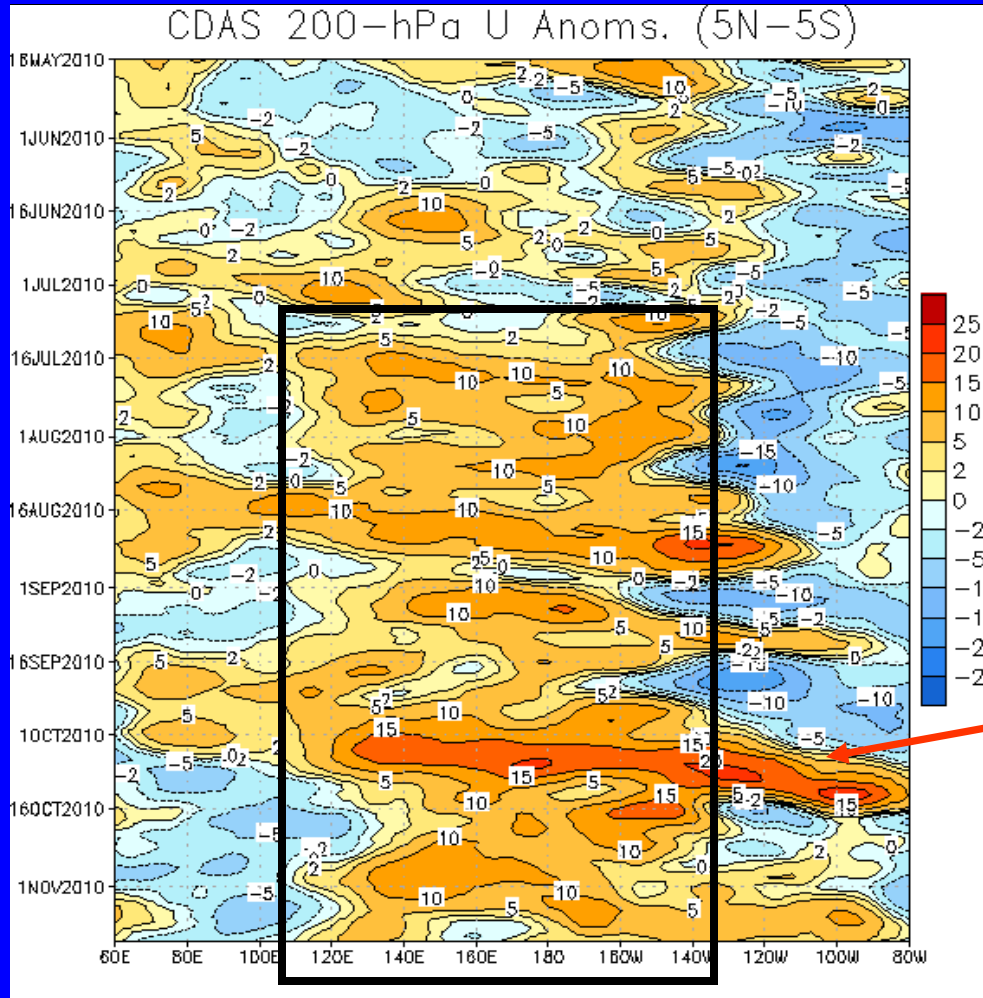
Westerly anomalies continued across the central Pacific during the last five to ten days.



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

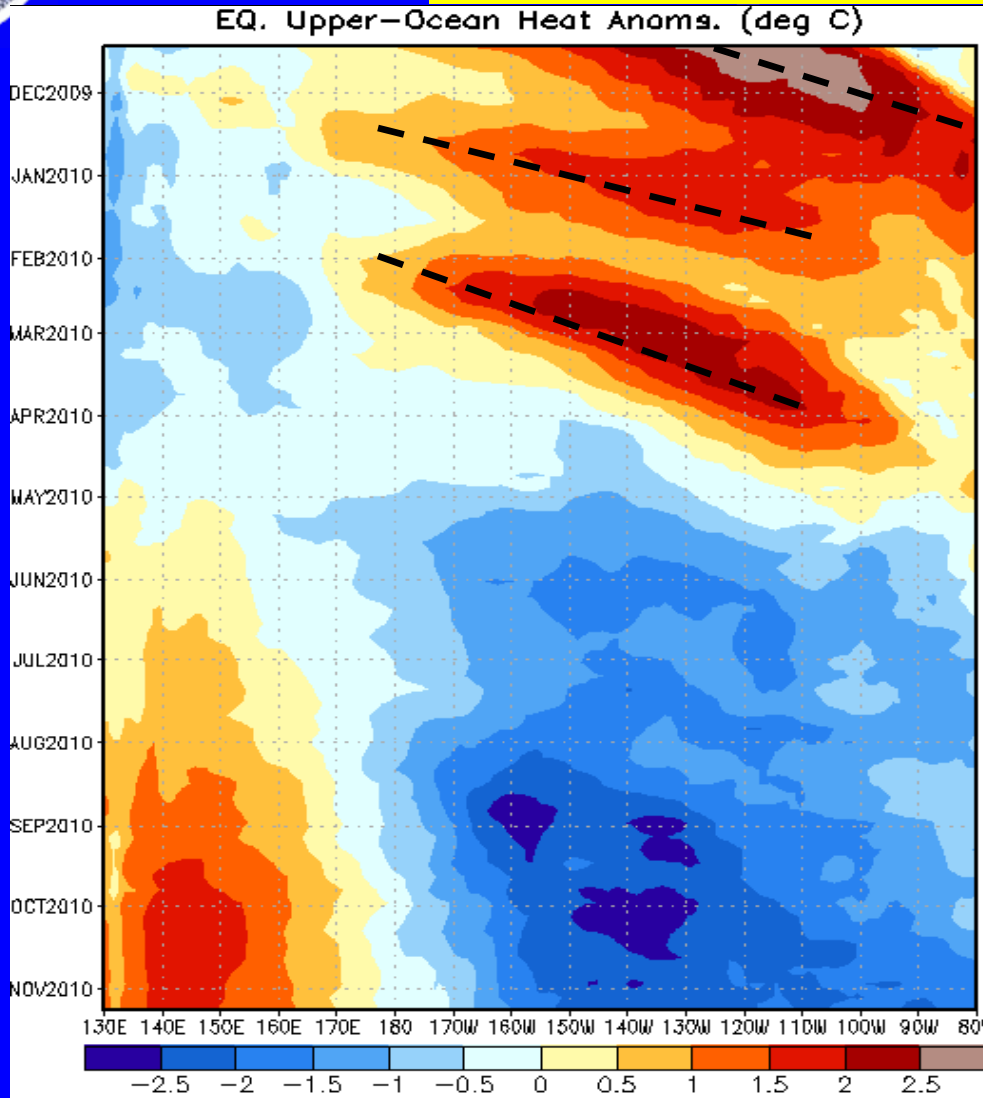
Westerly anomalies persisted across a large area from the Maritime Continent to the central Pacific (black solid box) since early July. Eastward propagation of westerly anomalies in August and September were not associated with the MJO.

In early October, westerly anomalies strengthened considerably and an eastward extension of these anomalies is evident associated with MJO activity.

Most recently, in early November, westerly anomalies increased once again from 140W to 80W.



Weekly Heat Content Evolution in the Equatorial Pacific



From November 2009 through March 2010, heat content anomalies remained above-average for much of the period.

From November 2009 – February 2010 three ocean Kelvin waves contributed to the change in heat content across the eastern Pacific (last three dashed black lines).

During April 2010 heat content anomalies decreased across the Pacific in association with the upwelling phase of a Kelvin wave and later during the early summer due to the development of La Nina.

Currently, negative heat content anomalies extend across the central and eastern Pacific with positive anomalies in the western Pacific.



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.

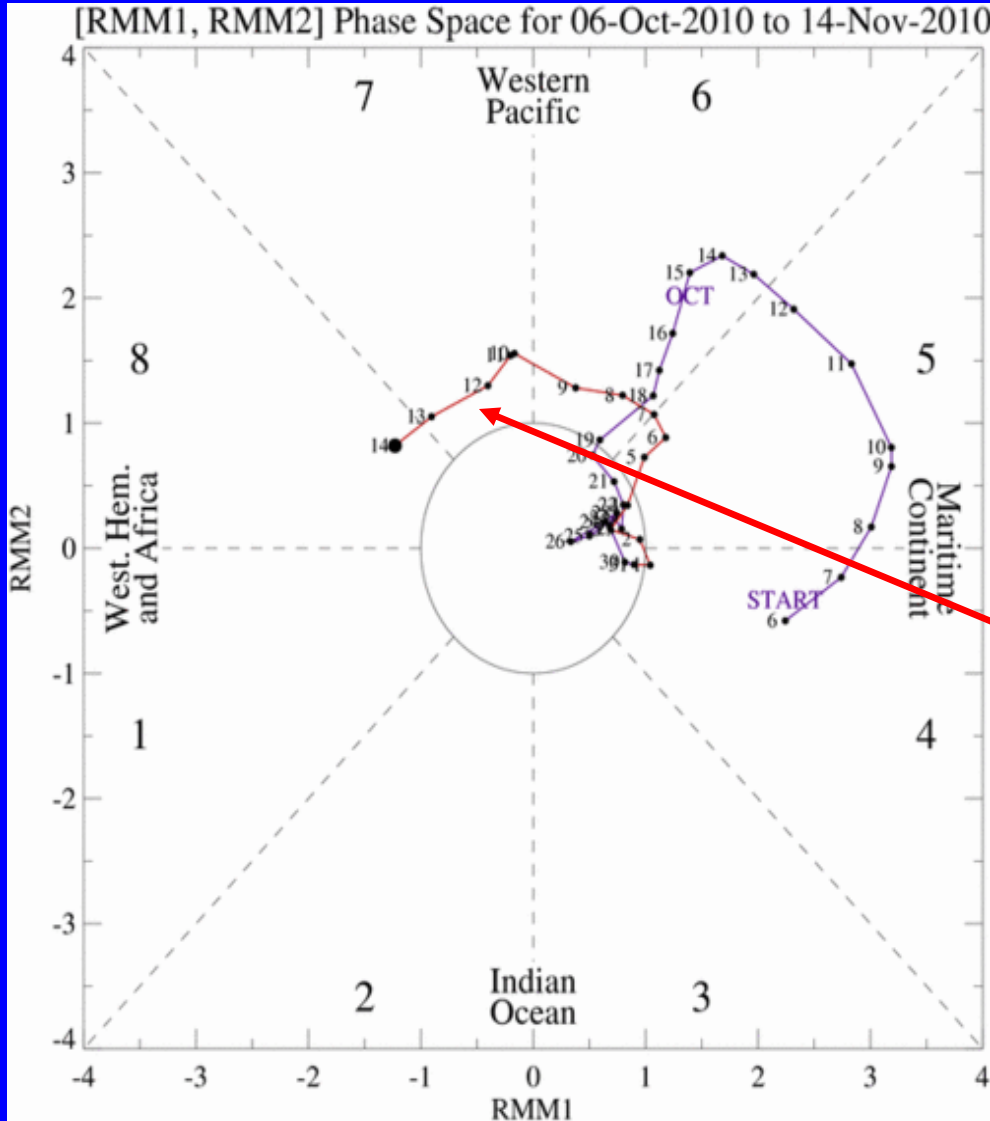
- The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.

Gottschalck et al. 2010: A Framework for Assessing Operational Madden-Julian Oscillation Forecasts: A CLIVAR MJO Working Group Project, *Bull. Amer. Met. Soc.*, 91, 1247-1258.

- 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

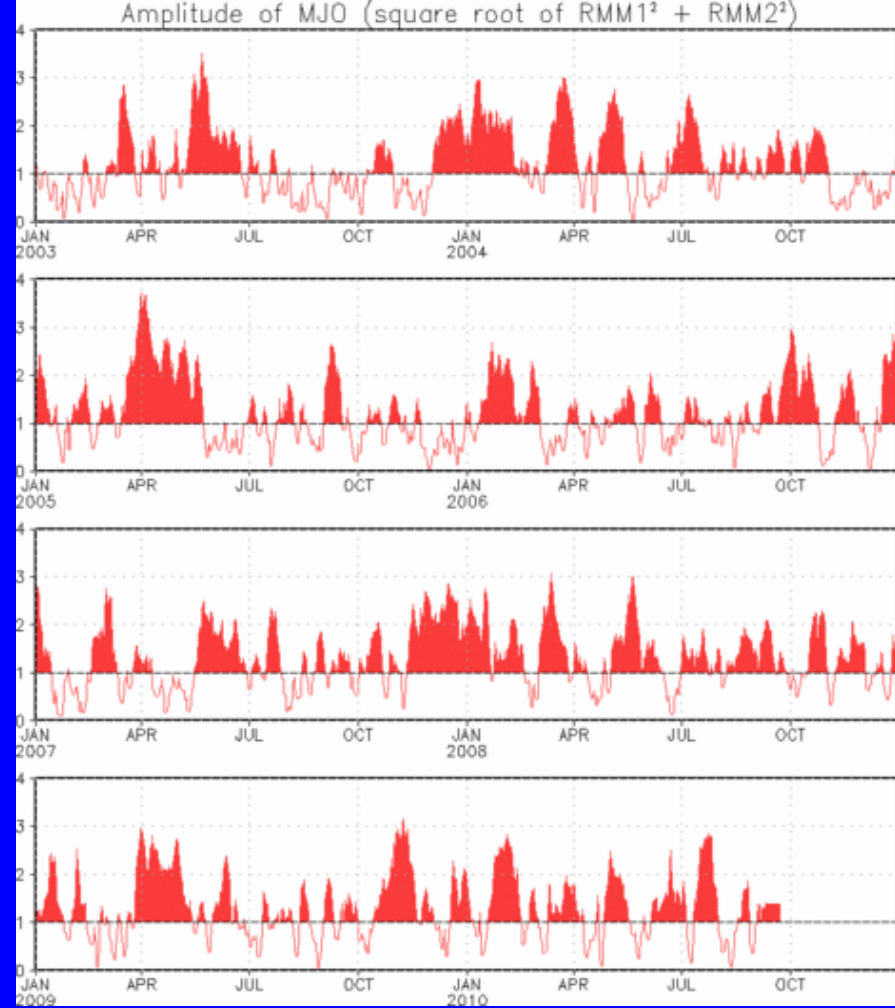
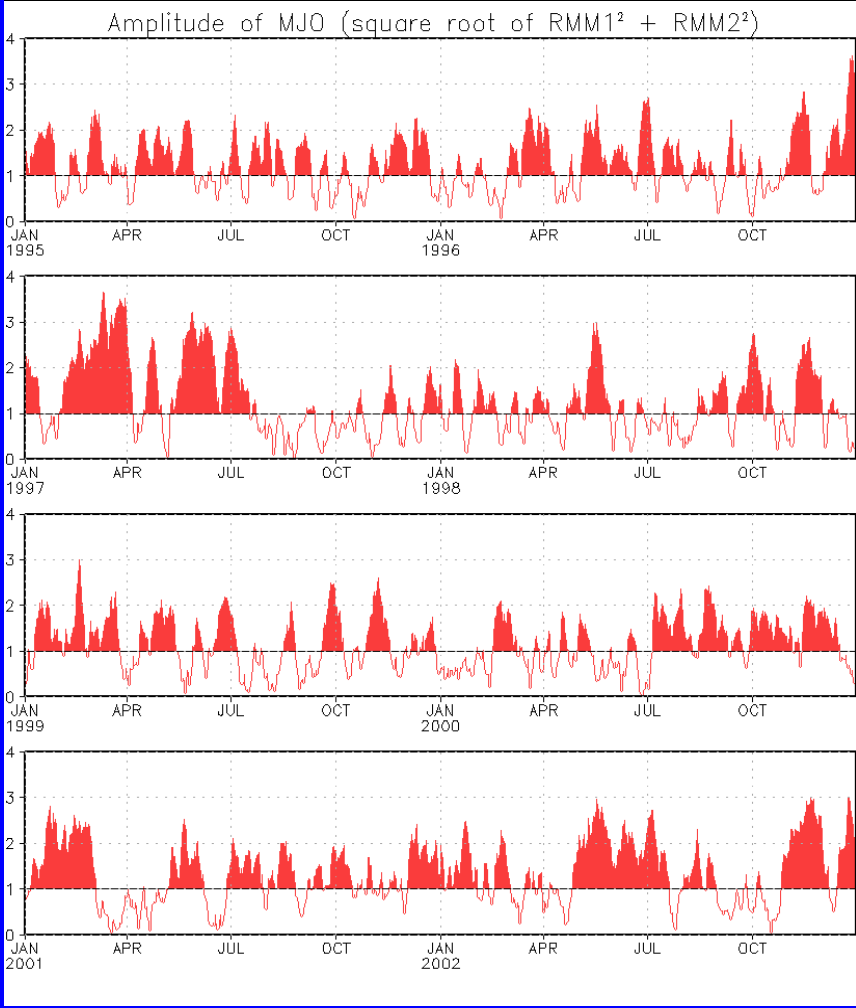


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index shows eastward propagation in recent days but other factors are contributing to the current index projection.



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.



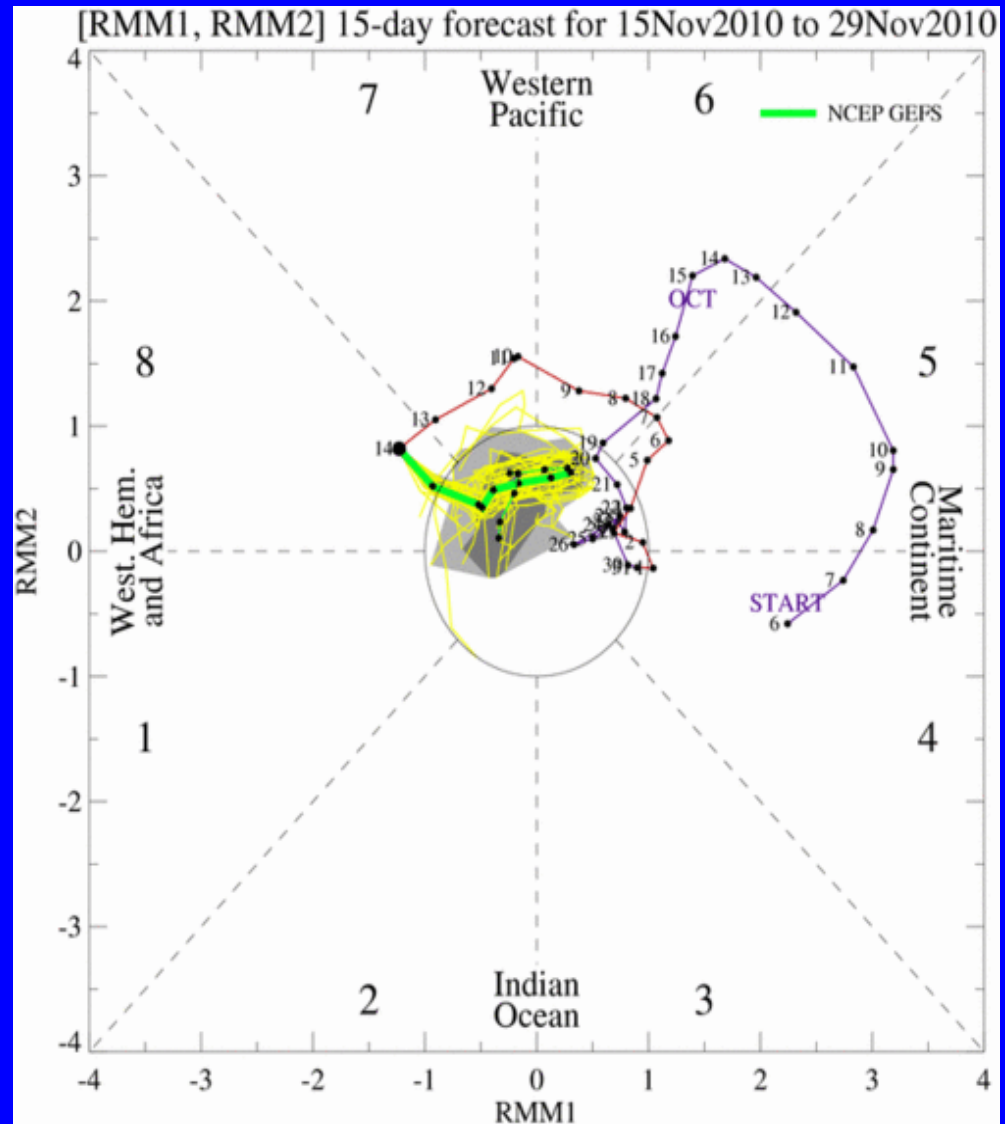
Ensemble GFS (GEFS) MJO Forecast

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 forecasts indicate a weakening of the signal during Week-1 with an incoherent signal during Week-2.

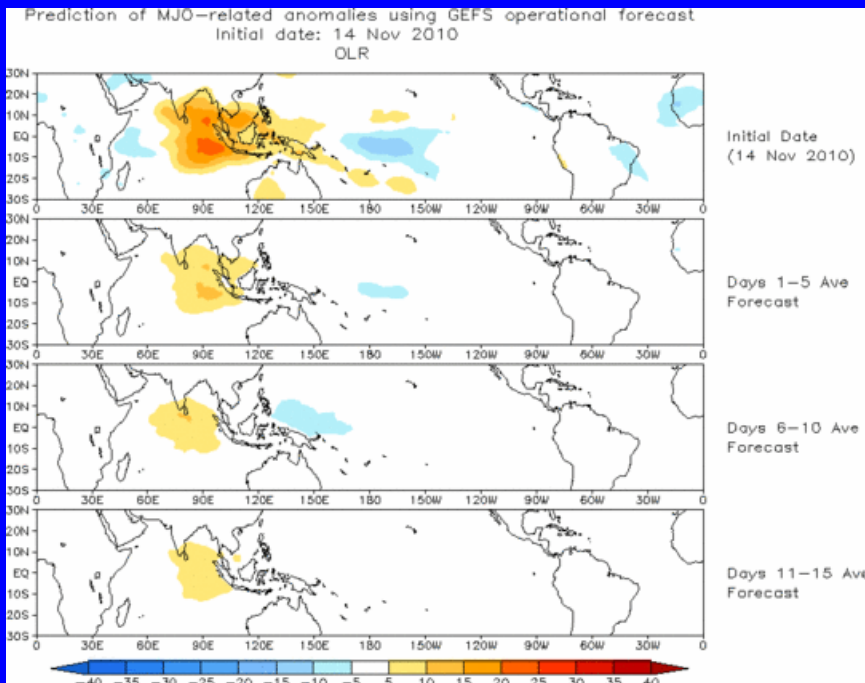




Ensemble Mean GFS MJO Forecast

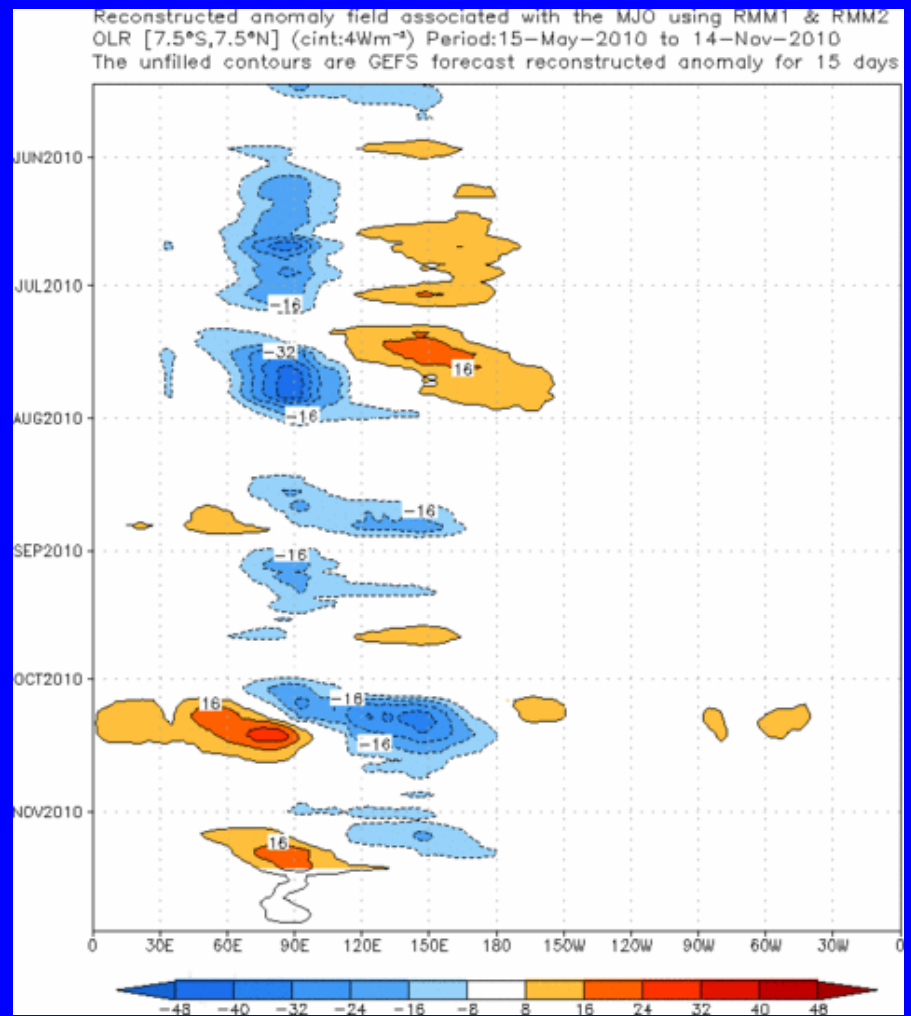
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecast indicates enhanced convection over parts of the western Pacific early in the period with suppressed convection forecast over the Indian Ocean.

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





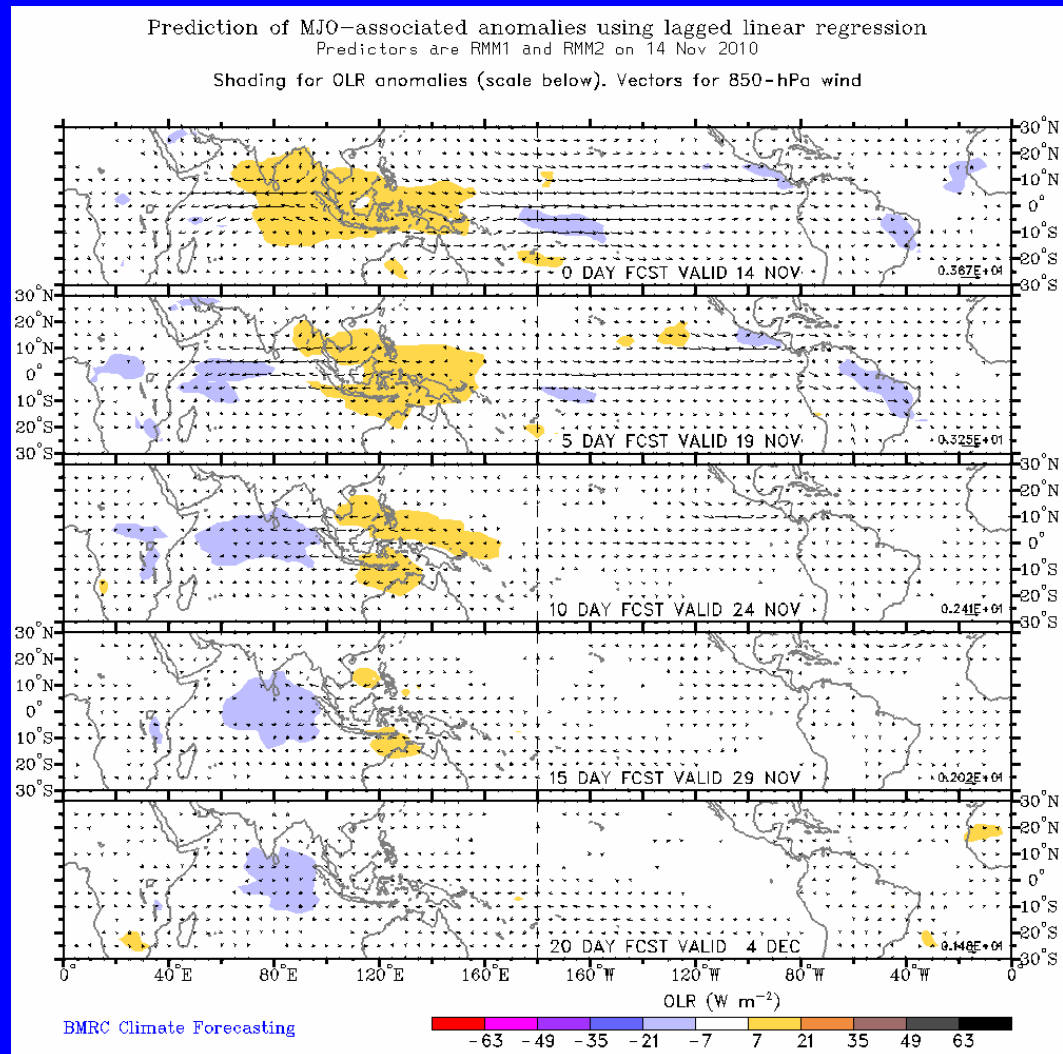
Statistical MJO Forecast

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)

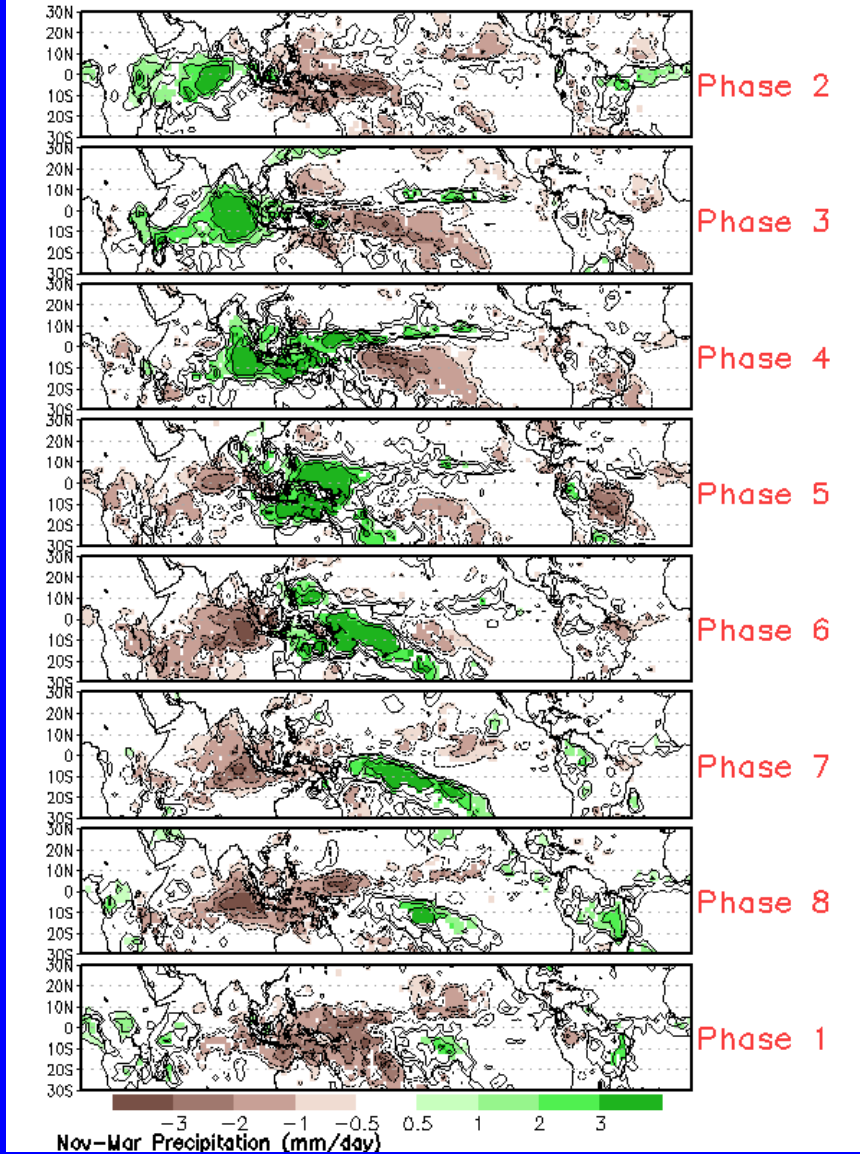
Weak-to-moderate MJO activity is forecast over the period with suppressed convection indicated over the Maritime continent in Week-1 with the development of negative OLR anomalies across the Indian Ocean in Week-2.





MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)

