



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

**Update prepared by
Climate Prediction Center / NCEP
April 5, 2010**



Outline

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



Overview

- **MJO activity continues with the enhanced convective phase located across the western Pacific.**
- **Most dynamical model MJO index forecasts indicate a weakening signal over the western and central Pacific during the next two weeks, but statistical forecasts do show an eastward propagating signal.**
- **Based on the latest observations and statistical forecasts, the MJO is forecast to remain active during the next 1-2 weeks.**
- **The MJO is expected to contribute to suppressed rainfall across parts of east-central Africa, the Indian Ocean and the western Maritime continent and enhanced rainfall across the central Pacific.**

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

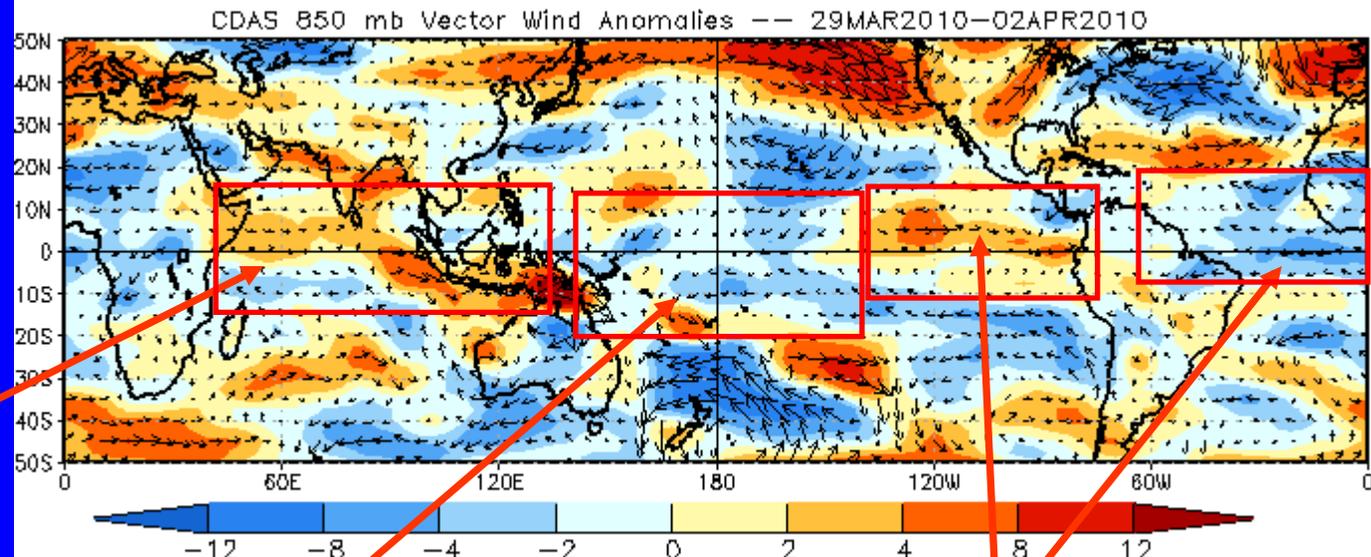
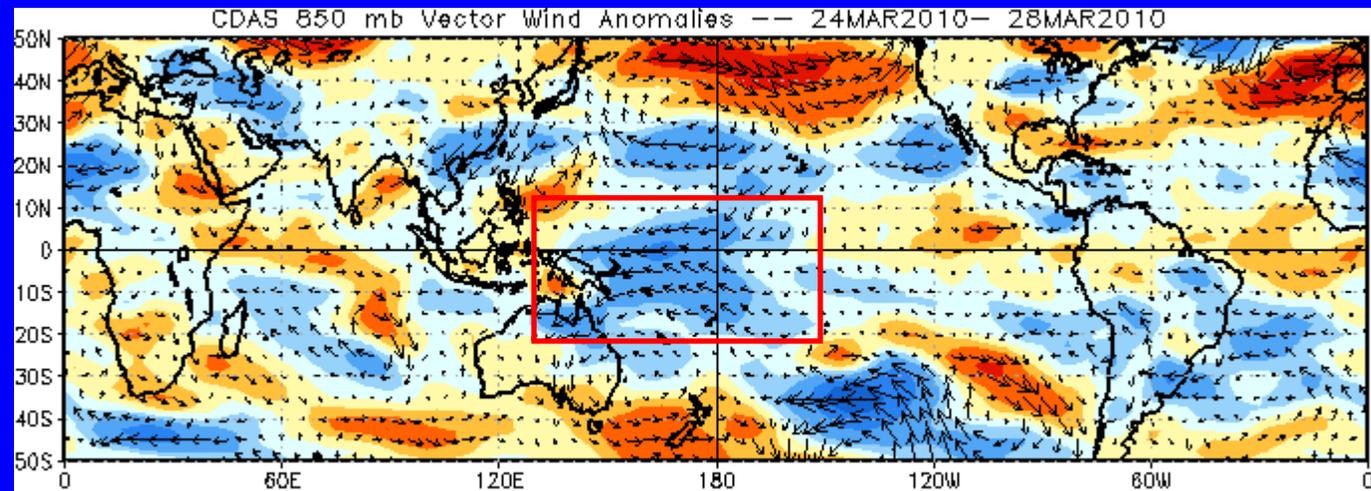


850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades:
Easterly anomalies

Red shades:
Westerly anomalies



Westerly anomalies expanded over the Indian Ocean and parts of the Maritime Continent during the last five days.

Easterly anomalies have weakened but continued in parts of the central Pacific.

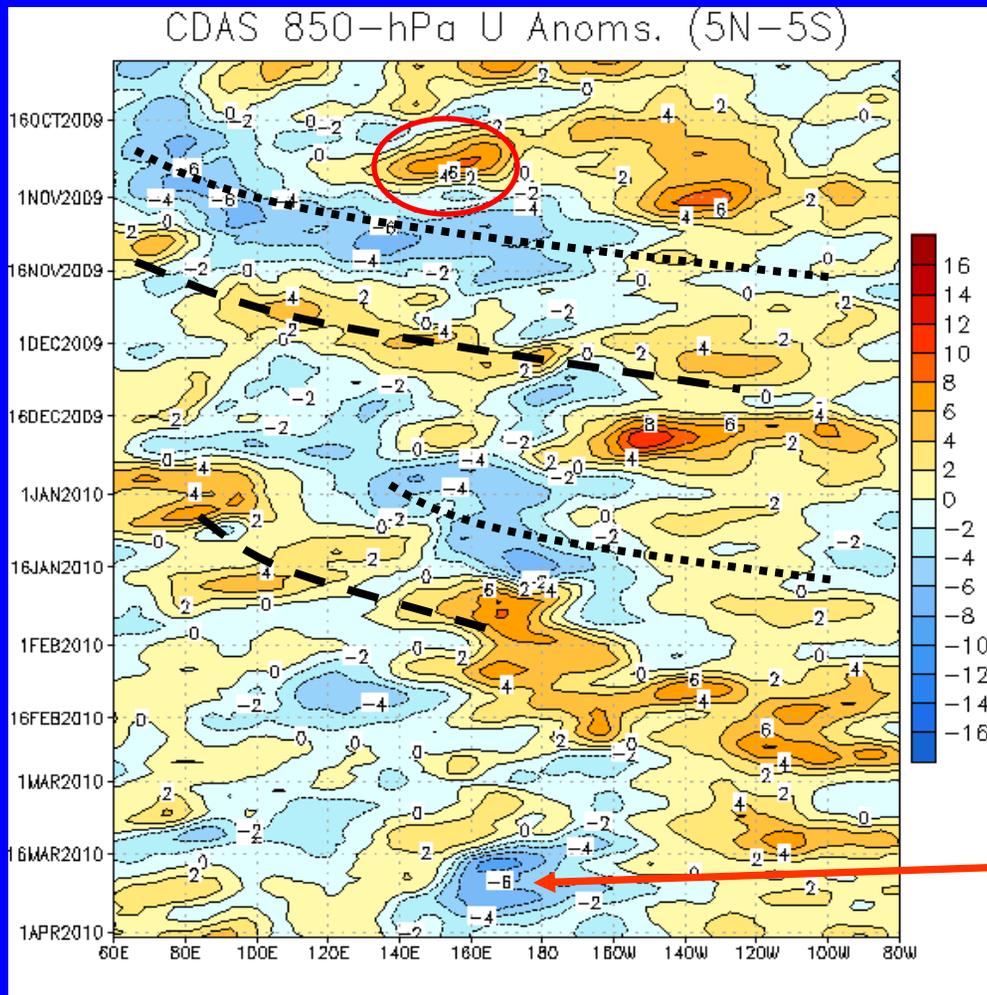
During the last five days, westerly anomalies continued across the eastern Pacific while easterly anomalies developed in the Atlantic.



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

Westerly wind bursts (red circle) occurred during October.

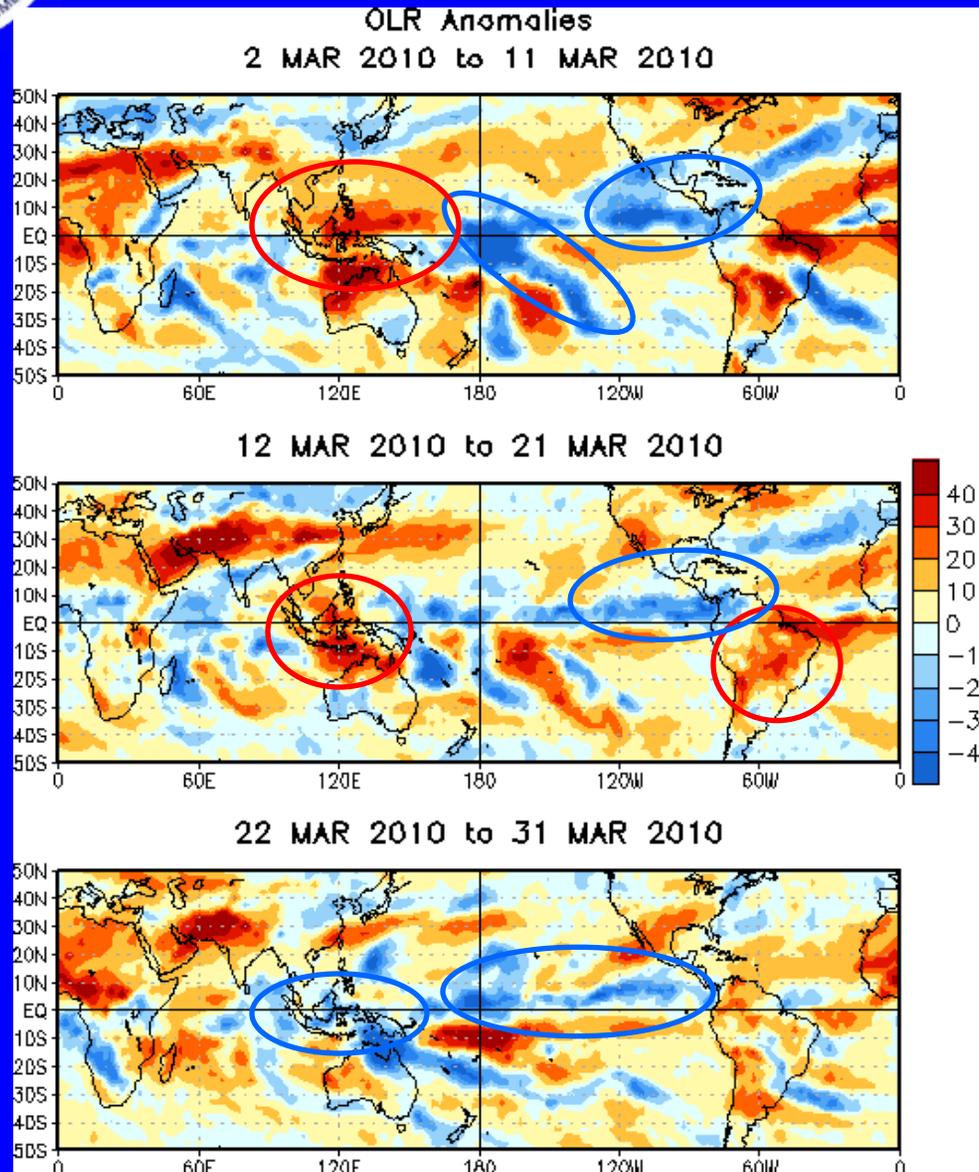
Easterly (dotted line) and westerly (dashed line) anomalies developed across the Indian Ocean and shifted eastward across the Date Line during late October and November associated with the MJO.

Weaker and shorter-lived MJO activity was evident during January.

During mid-to-late March, easterly anomalies were evident in the west-central 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)

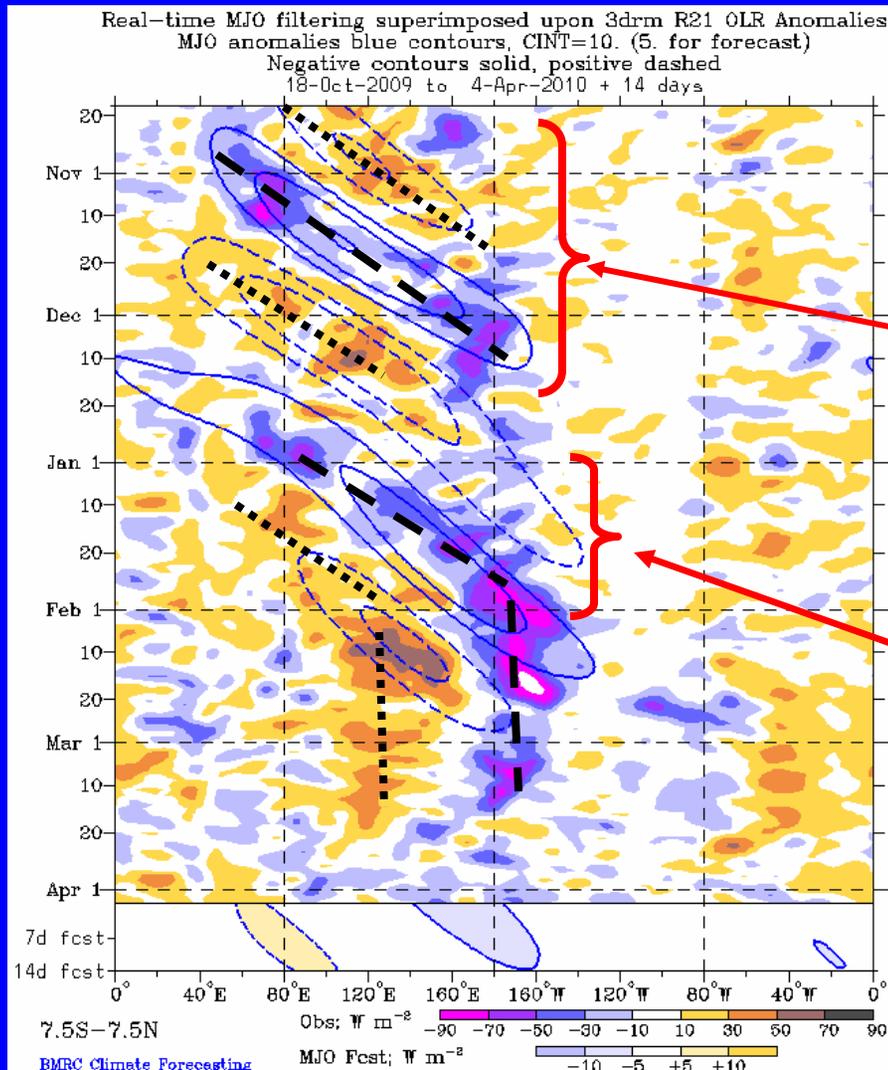
Enhanced (suppressed) convection (blue/red ovals) continued across the central Pacific (Maritime continent) regions during early March. Wet conditions were also evident from the eastern Pacific to the Caribbean.

During mid-March, enhanced convection continued across parts of the central and the eastern Pacific with a less expansive area of suppressed convection over Indonesia. Dry conditions were evident across much of South America.

In late March, anomalous convection was more variable than in recent weeks but enhanced convection was evident over the Maritime Continent and parts of the central and eastern Pacific.



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



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)

During October to early December 2009, two periods of suppressed convection shifted eastward from the Indian Ocean into the western Pacific (dotted lines) and one episode of enhanced convection (dashed line).

After a brief break during mid-late December, enhanced convection developed in the Indian Ocean and shifted eastward to the western and central Pacific during mid to late January. An area of suppressed convection across the Indian Ocean and Maritime Continent followed.

During February and March these anomalous areas became stationary and more recently have weakened.

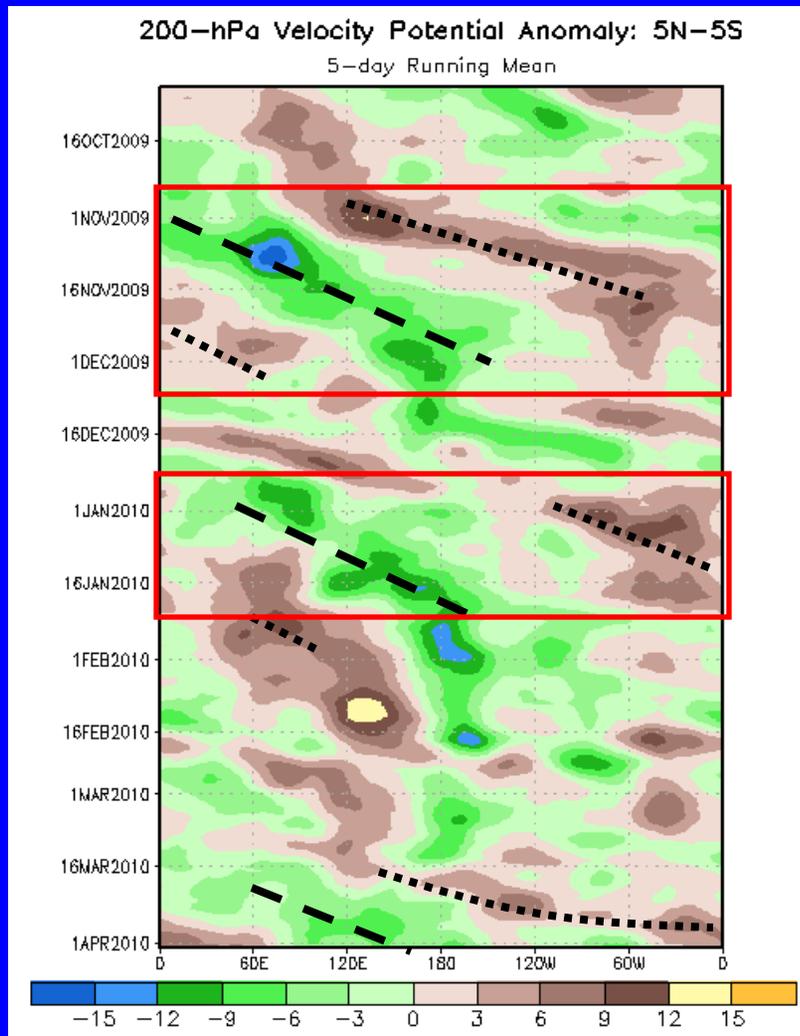


200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time
↓



Longitude

In late October and November, anomalies increased and eastward propagation was evident associated with MJO activity (red box).

Eastward propagation associated with the MJO was again evident during early-mid January.

During February and early March, the MJO weakened and anomalies became more stationary and incoherent on the intraseasonal time scale.

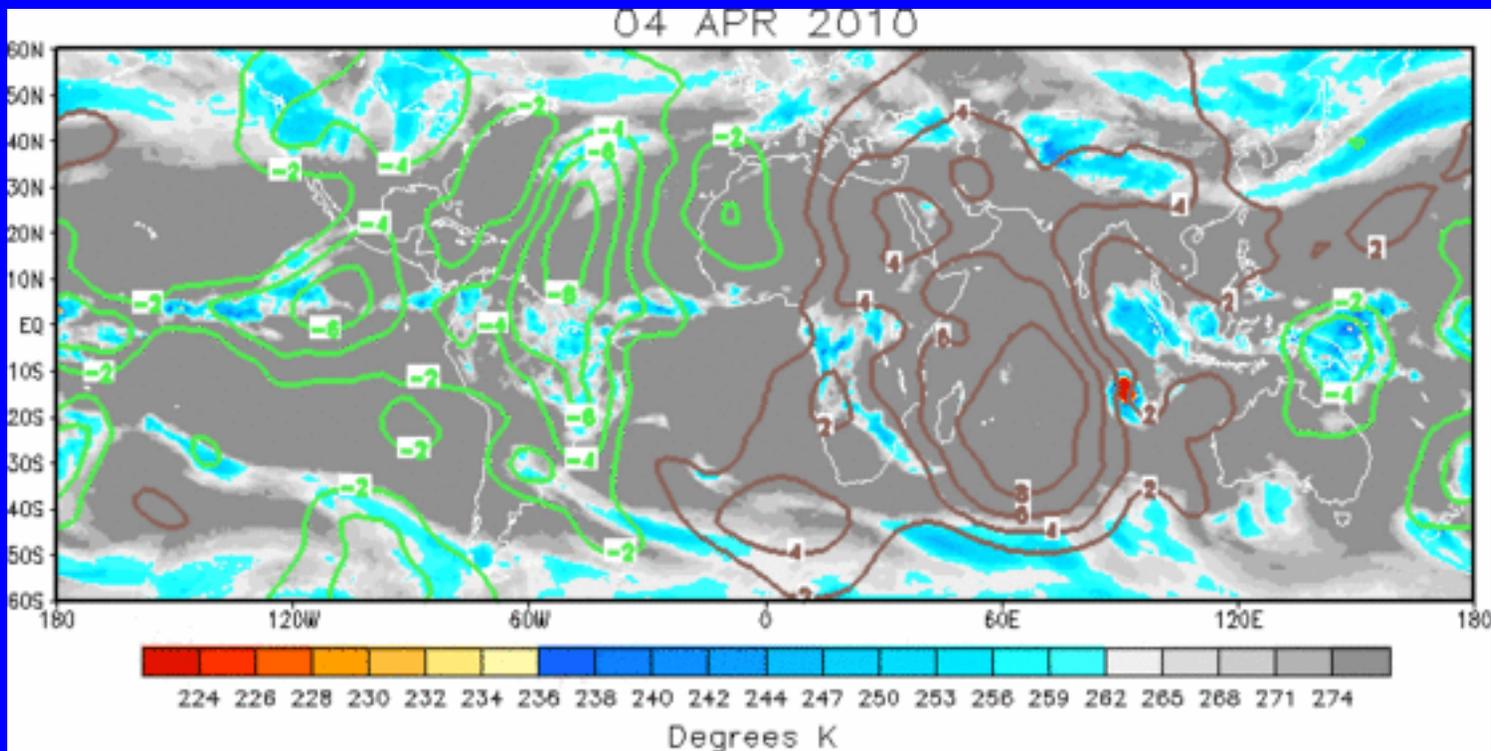
Recently, weak upper-level divergence developed over most of the eastern hemisphere where some areas have experienced upper-level convergence. These anomalies have propagated eastward.



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 anomalous velocity potential pattern is coherent and has propagated eastward in recent weeks. Upper-level divergence is indicated across the western hemisphere while upper-level convergence is indicated over parts of the eastern hemisphere.

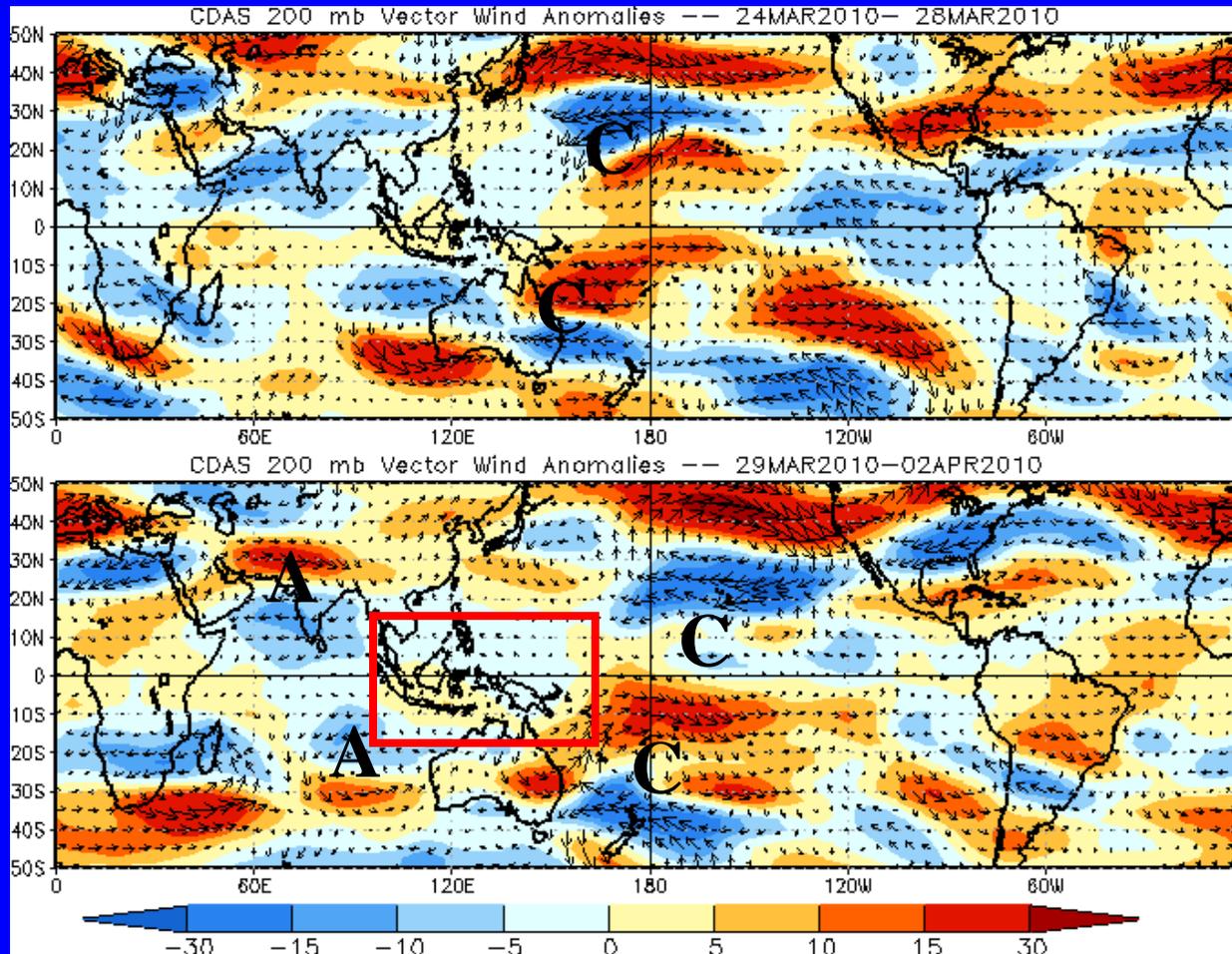


200-hPa Vector Wind Anomalies ($m s^{-1}$)

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



During the last five days easterly anomalies have developed in the Indian Ocean and upper level diffluence is apparent over the Maritime Continent (red box).

Cyclonic couplets downstream of the upper level divergence have shifted eastward during the last 5 days.

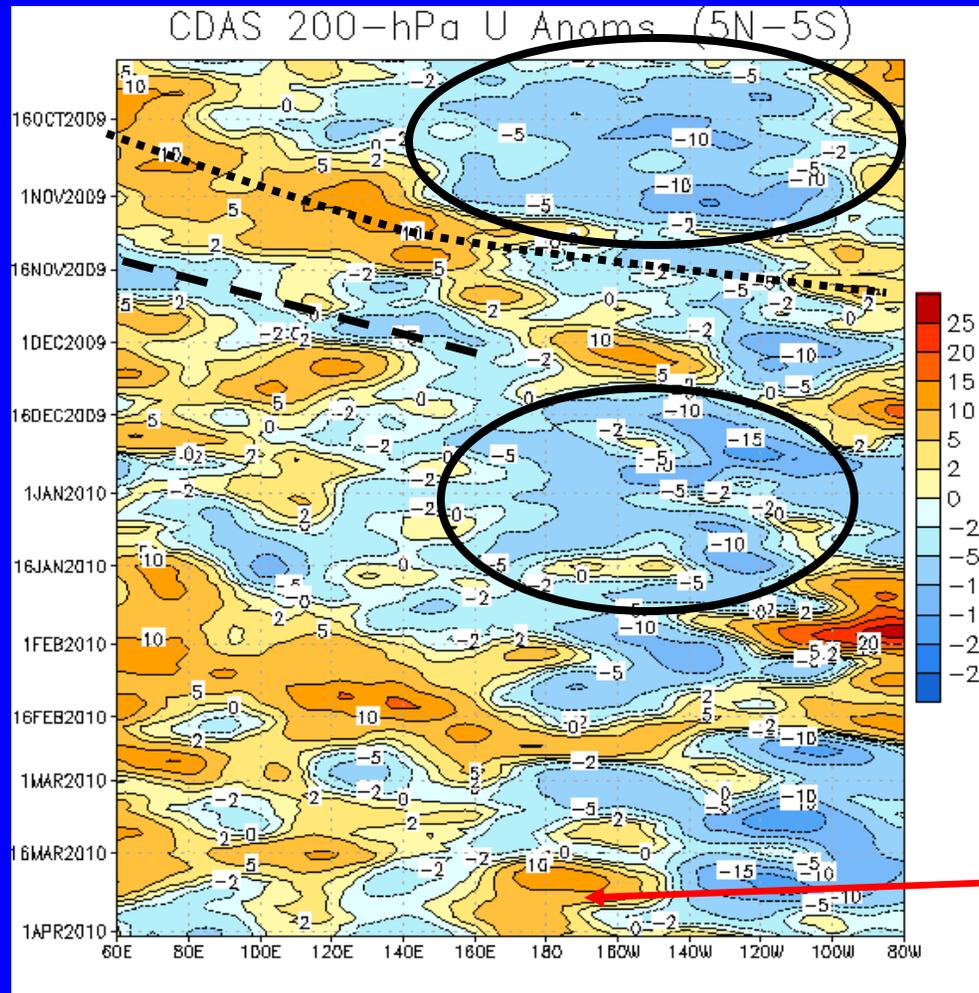


200-hPa Zonal Wind Anomalies (m s^{-1})

Westerly anomalies (orange/red shading) represent anomalous west-to-east flow

Easterly anomalies (blue shading) represent anomalous east-to-west flow

Time
↓



Longitude

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

Westerly (easterly) anomalies (dotted and dashed lines) shifted eastward across the Maritime Continent during late October and November associated with the MJO.

Easterly anomalies dominated much of the central and eastern Pacific during the second half of December and most of January.

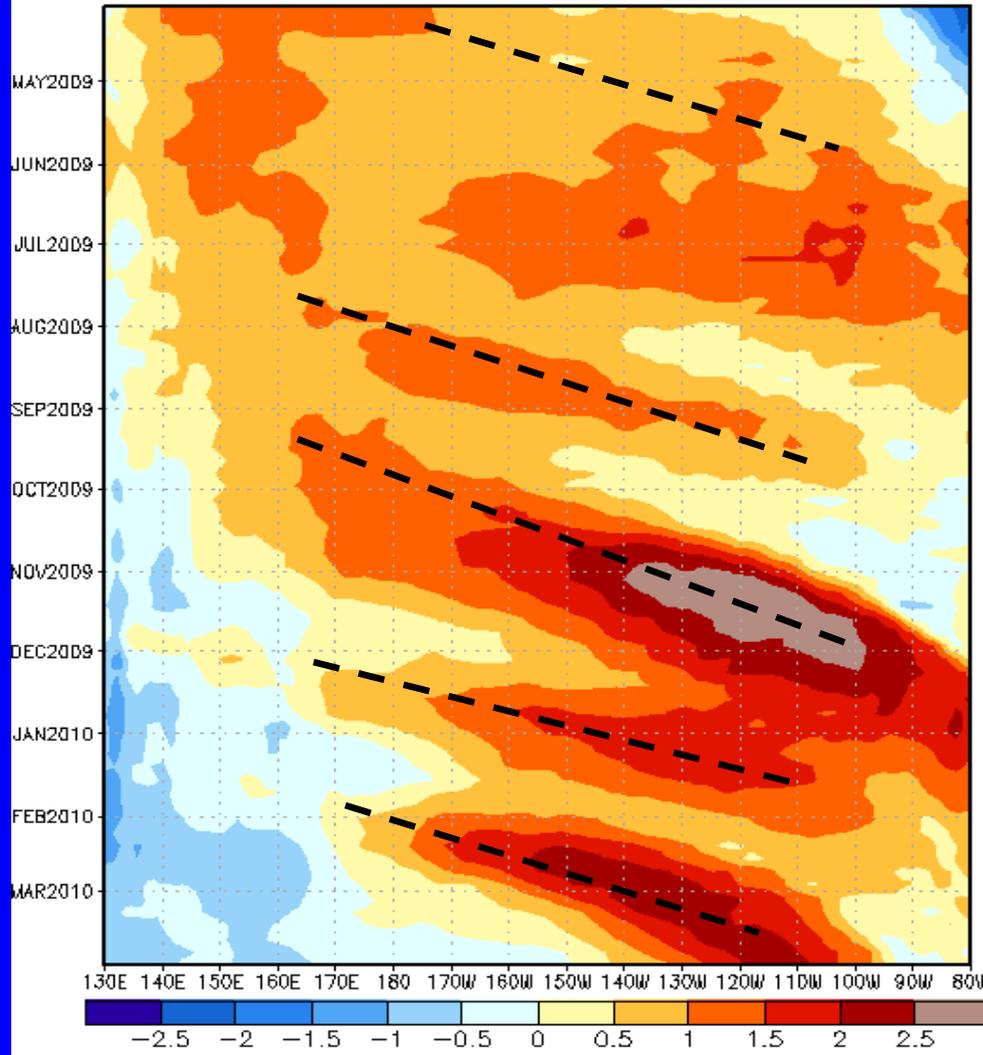
Recently westerly anomalies have developed in the central Pacific.



Weekly Heat Content Evolution in the Equatorial Pacific

EQ. Upper-Ocean Heat Anoms. (deg C)

Time
↓



Longitude

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.

Multiple Kelvin waves shifted eastward between August and March 2010 (last four dashed black lines).

West of the Date Line, some below-average anomalies are now present.



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.

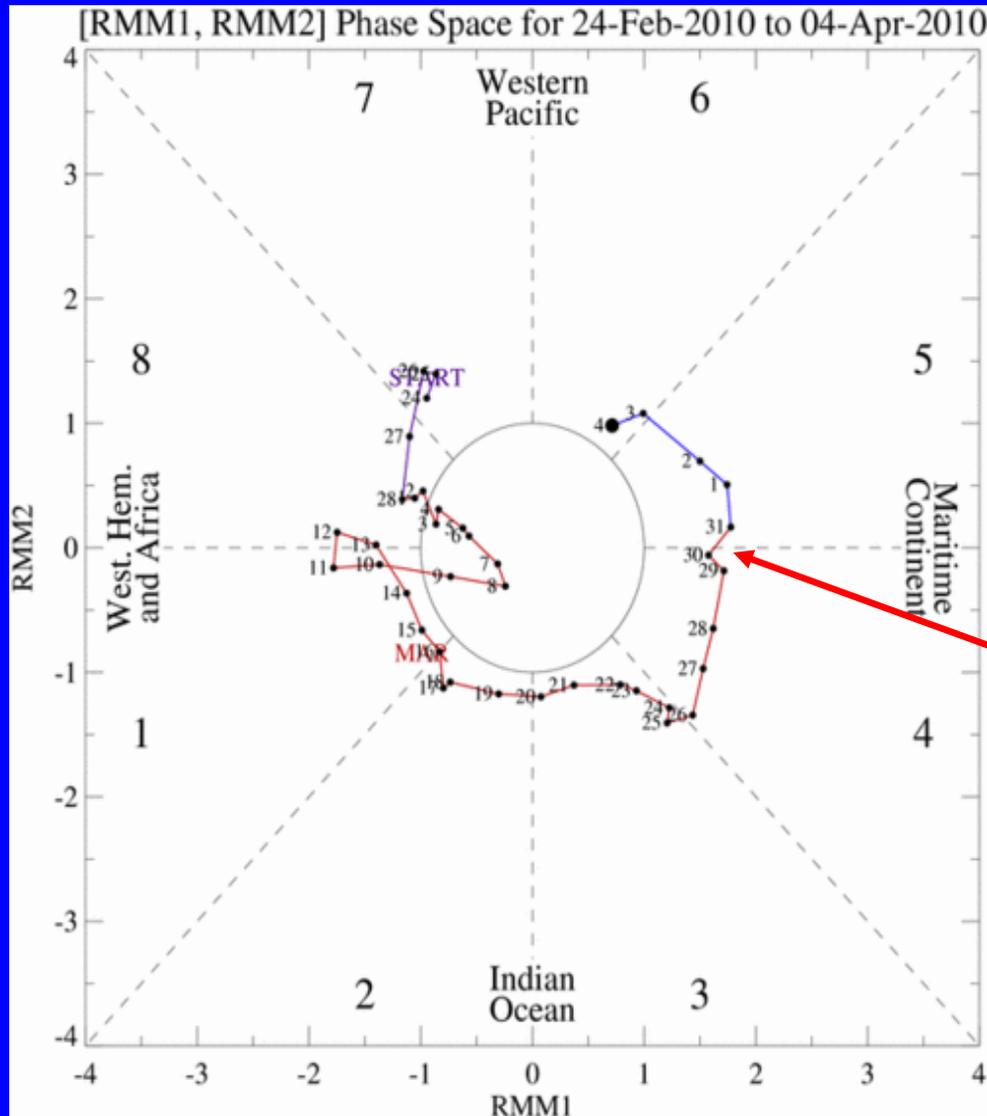
- The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.

Gottschalck et al. 2010: A Framework for Assessing Operational Model MJO Forecasts: A Project of the CLIVAR Madden-Julian Oscillation Working Group, *Bull. Amer. Met. Soc.*, Accepted.

- 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

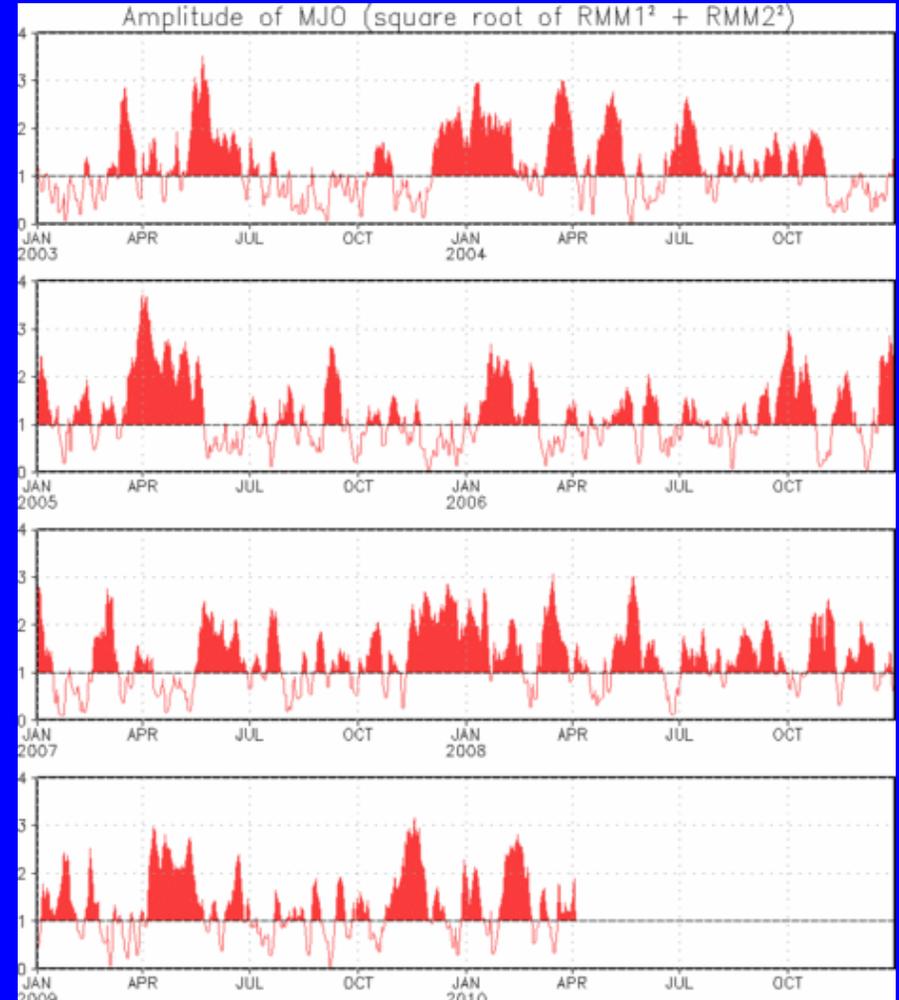
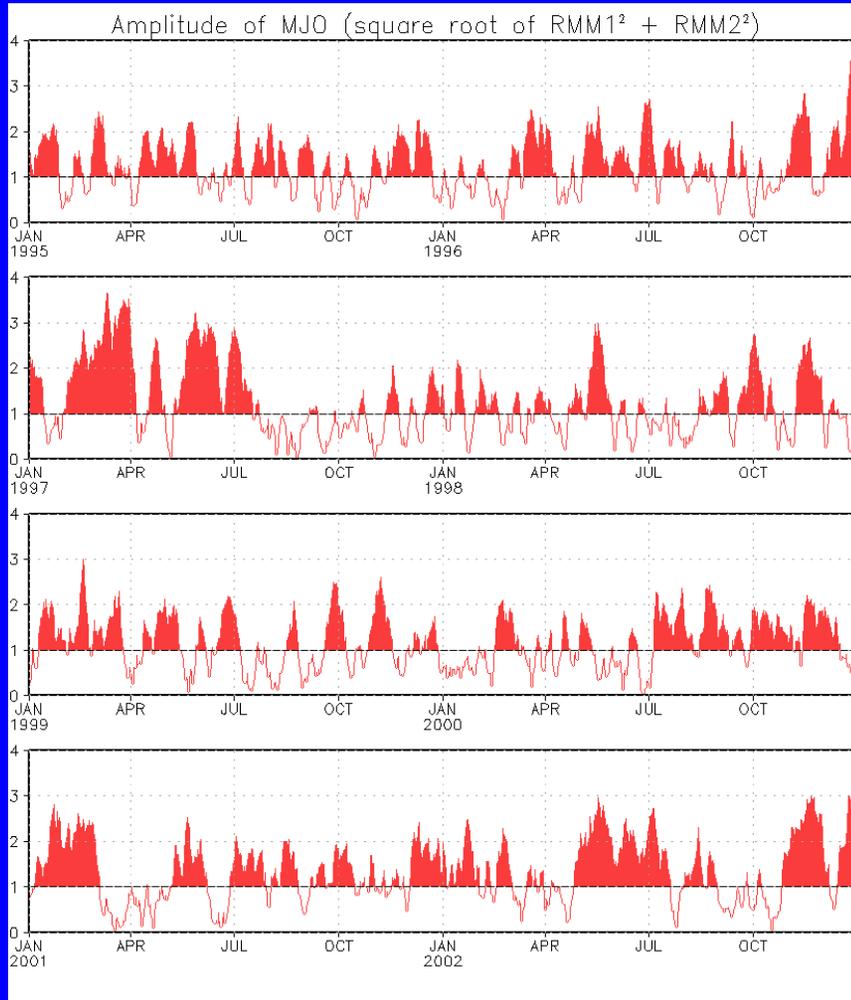


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The index continues to indicate MJO activity with the enhanced convective phase located across the western Pacific.



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.**



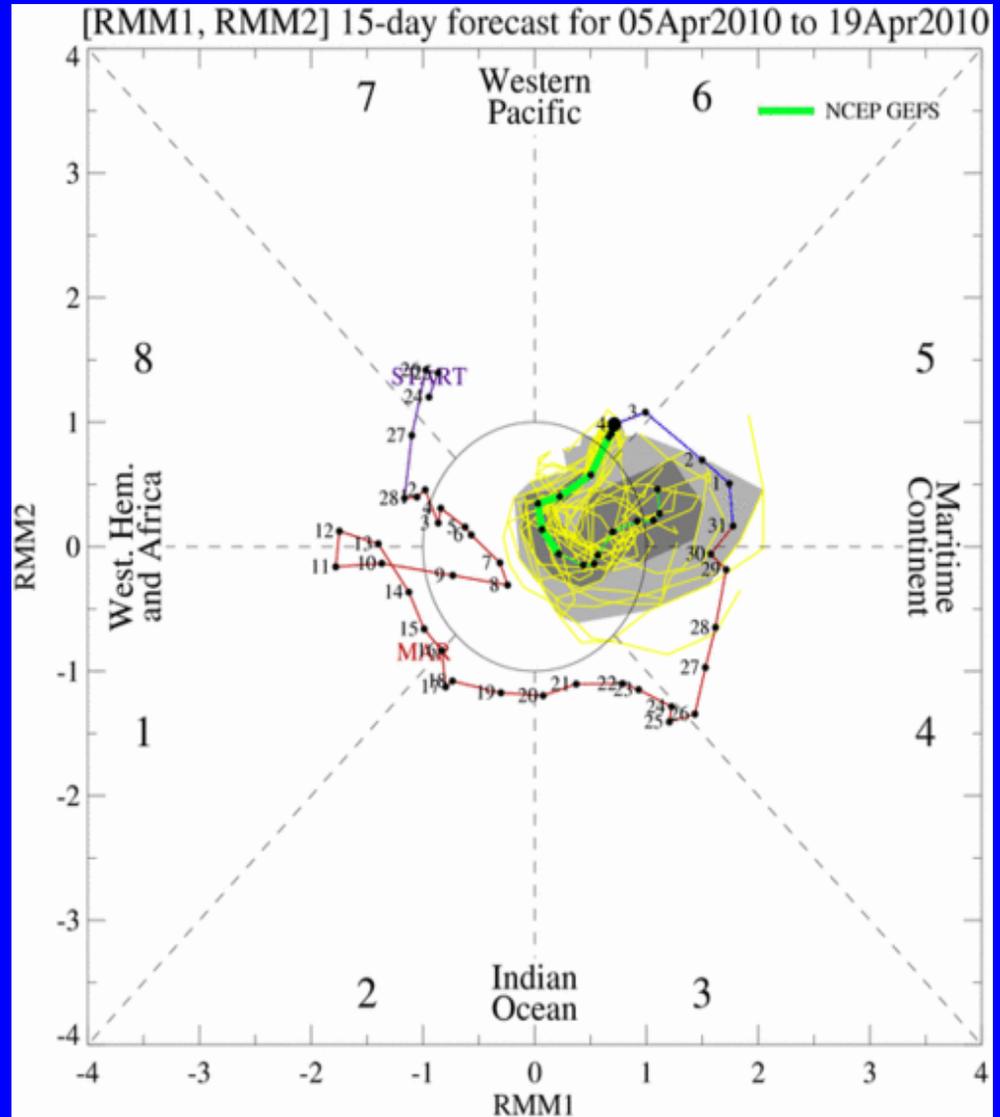
Ensemble GFS (GEFS) MJO Forecast

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 signal with little propagation during the next 1-2 weeks. This forecast is not consistent with current observations and statistical forecasts which show a propagating signal.

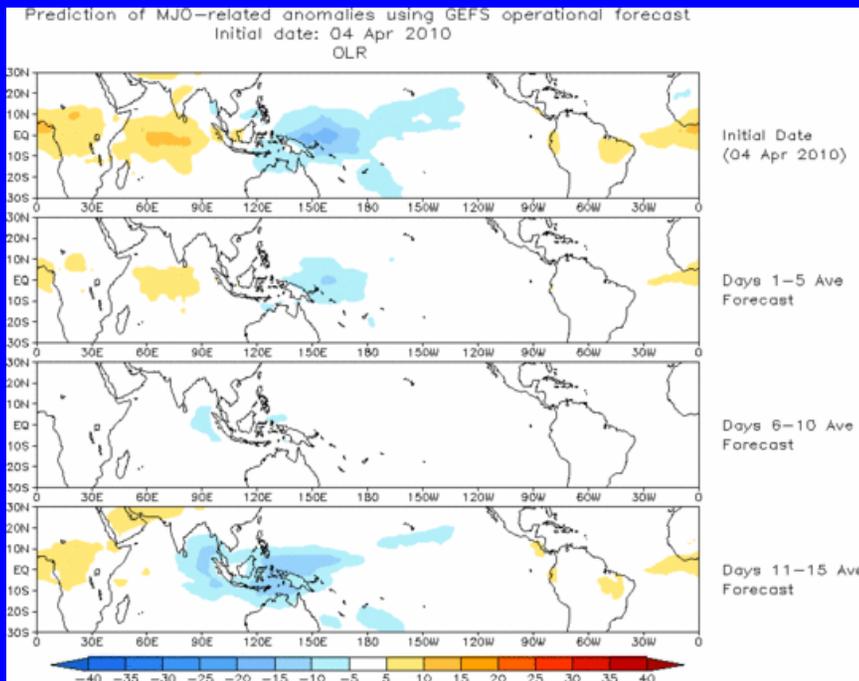




Ensemble Mean GFS MJO Forecast

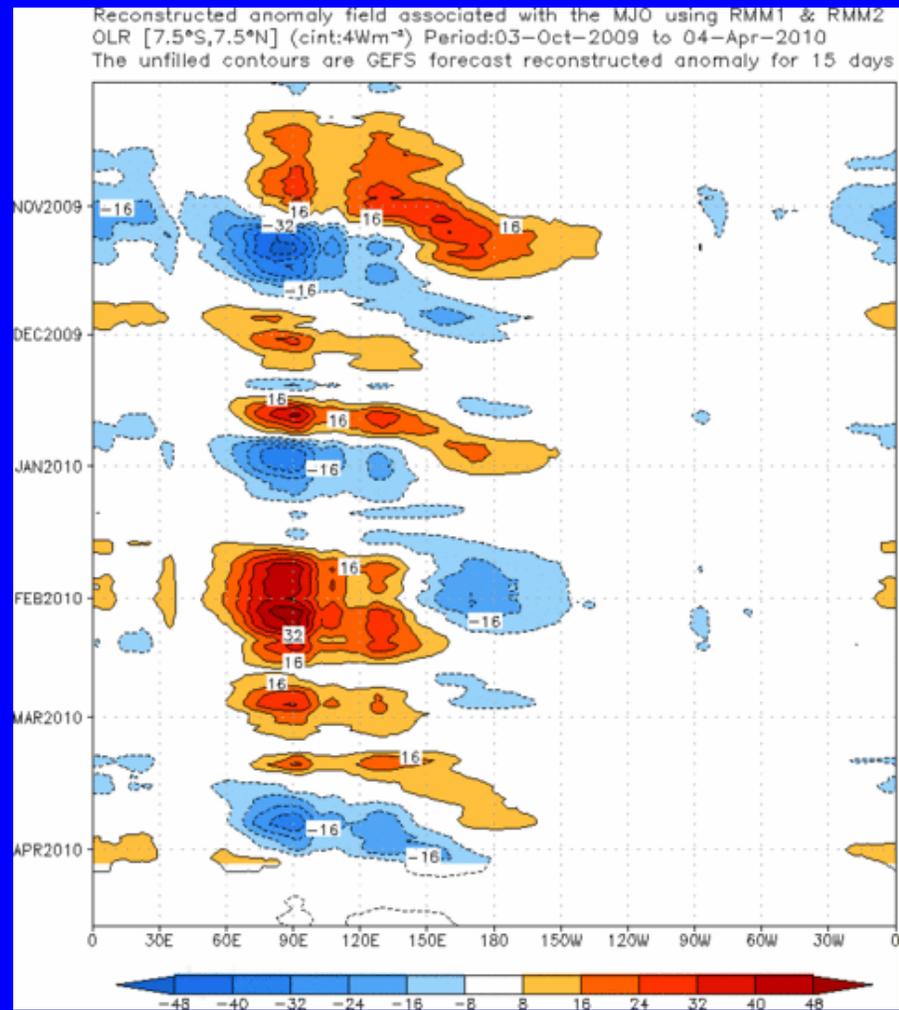
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecast indicates weak enhanced convection (blue shades) over the western Pacific during the next 5 days. This forecast is not consistent with current observations and statistical forecasts which show a propagating signal.

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





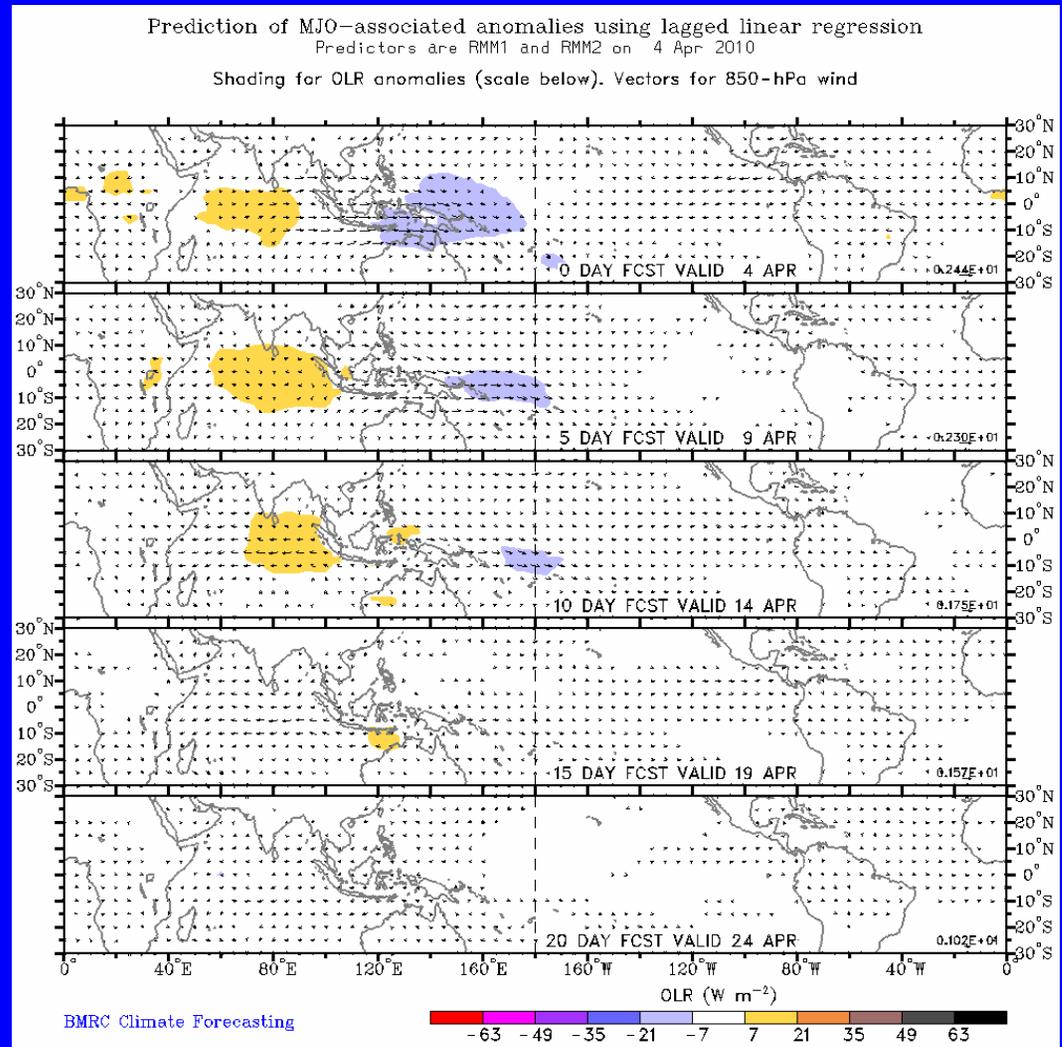
Statistical MJO Forecast

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 forecast indicates weak MJO activity with enhanced convection shifting from the western Pacific to the central Pacific over the next two weeks. Suppressed convection is forecast across the Indian Ocean during the period.





MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)

850-hPa Wind Anomalies (Nov-Mar)

