



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

**Update prepared by
Climate Prediction Center / NCEP
June 7, 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 as indicated by recent observations.**
- **There is considerable spread in solutions from dynamical model MJO index forecasts for the coming two weeks. Some models indicate a signal across the Indian Ocean and western Maritime continent during the period but at this time it is likely that this signal is a combination of subseasonal variability rather than a coherent MJO emerging.**
- **Based on a combination of the latest observations and MJO statistical and dynamical forecast tools, the MJO is expected to remain weak over the period.**
- **The MJO is not expected to contribute substantially to anomalous tropical rainfall 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>

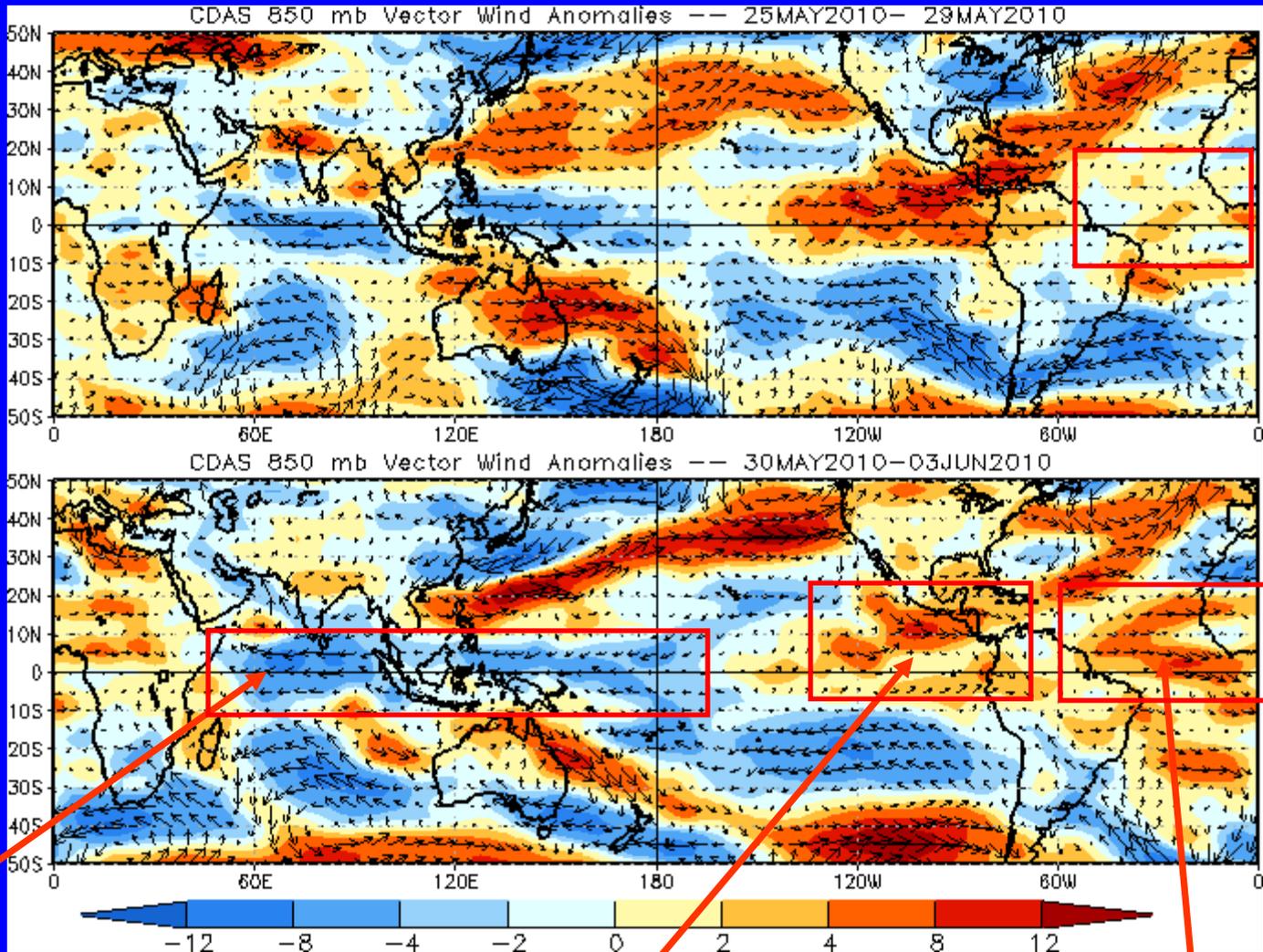


850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Easterly anomalies continued during the past five days across the equatorial Indian Ocean and western Pacific.

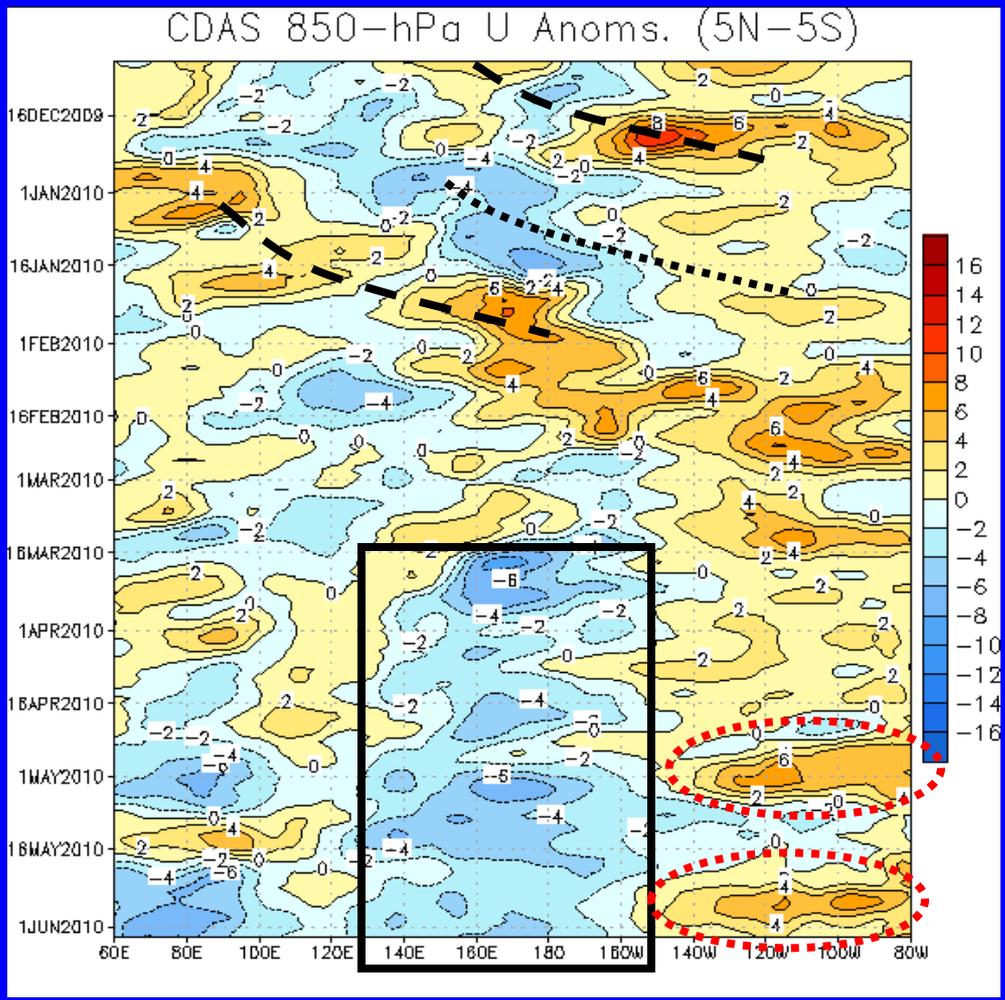
Westerly anomalies weakened across the eastern Pacific during the latest five days.

Westerly anomalies strengthened during the last five days over 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 anomalies (dashed line) developed across the Indian Ocean and shifted eastward across the Date Line during November and early December and were associated with the MJO.

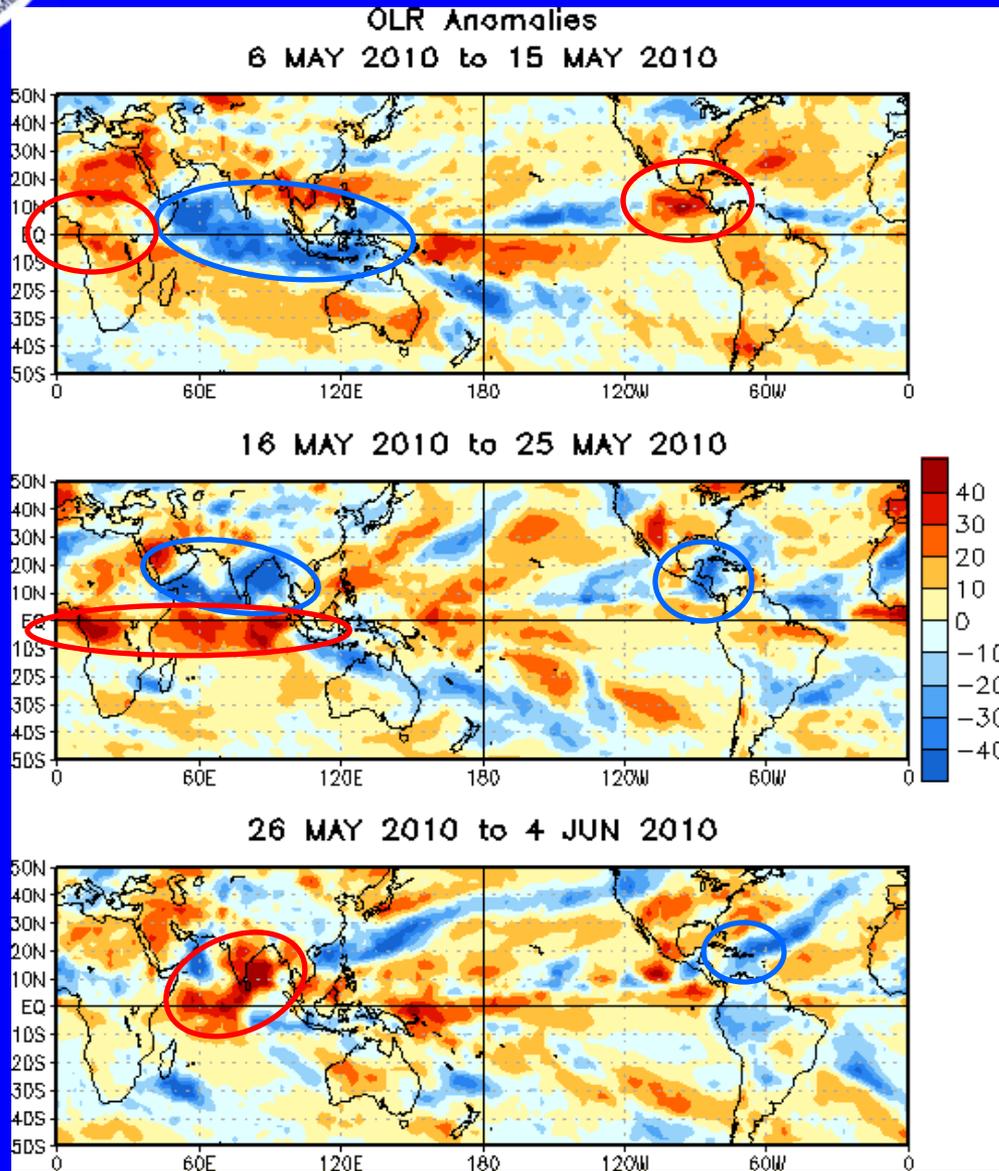
Weaker and shorter-lived MJO activity was evident during January (dotted and dashed line).

Easterly anomalies have persisted in the west-central Pacific since mid-March (black box). Strong westerly anomalies (red dotted ovals) have occurred across the eastern Pacific on separate occasions during late April/early May associated with the MJO and again in late May.



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 convection persisted across the Indian Ocean and parts of the Maritime continent during early-mid May. Suppressed convection was evident over Central America and much of Africa during this period.

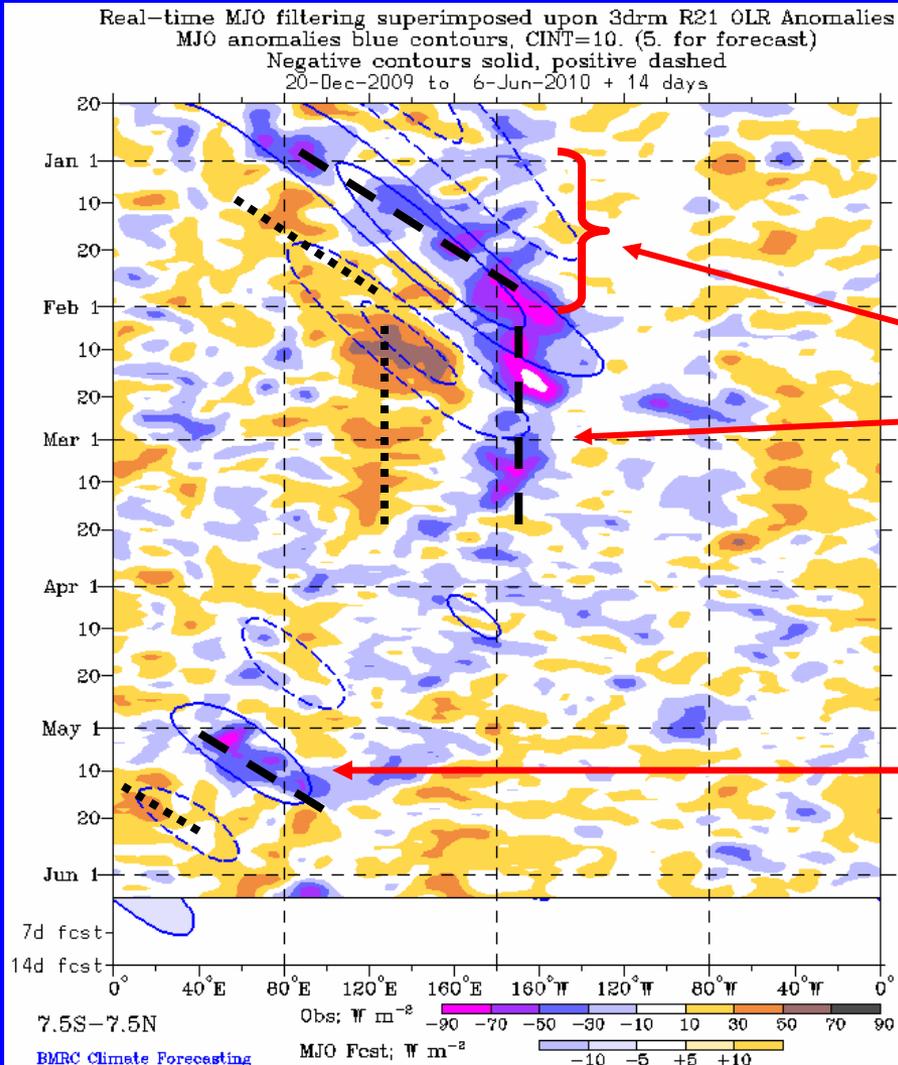
In mid-late May, suppressed convection began to replace enhanced convection across the equatorial Indian Ocean as enhanced convection moved north of the equator and impacted India. Enhanced convection developed over Central America and the Caribbean.

Suppressed convection was evident over southern India and western Indian Ocean during late May and early June. Enhanced convection continued across parts of the Caribbean.



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

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)

MJO activity was evident during January 2010.

The MJO was not active during February and March as anomalous convection was more persistent across the Maritime continent (suppressed) and west-central Pacific (enhanced).

Anomalies were small during the month of April.

Enhanced convection, in part associated with MJO activity, developed across the Indian Ocean in early May and shifted slightly eastward. Suppressed convection developed after this across much of Africa.

Longitude

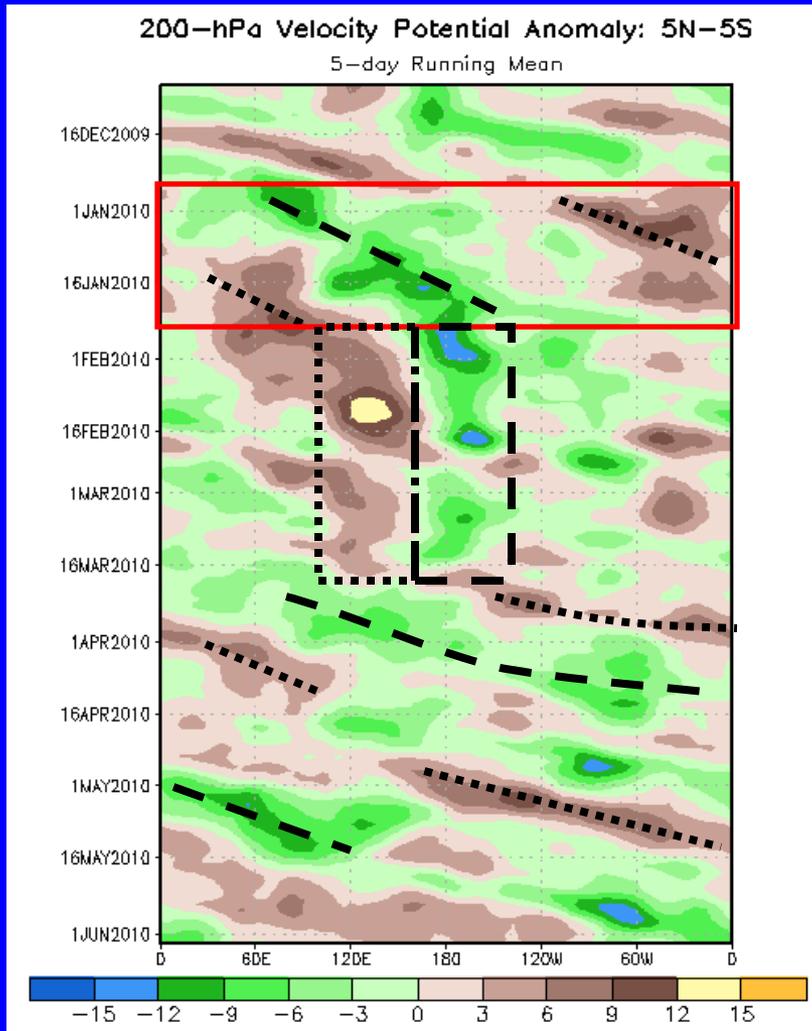


200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time
↓



Longitude

Eastward propagation associated with the MJO was evident during early-mid January (red box).

During February and the first half of March, the MJO weakened and anomalies became more stationary and incoherent on the intraseasonal time scale (black boxes).

In mid-March, weak upper-level divergence (convergence) developed over Africa and the Indian Ocean (Maritime continent) and these anomalies propagated eastward.

In late April and early May, anomalies increased and eastward propagation was evident and was associated with the MJO.

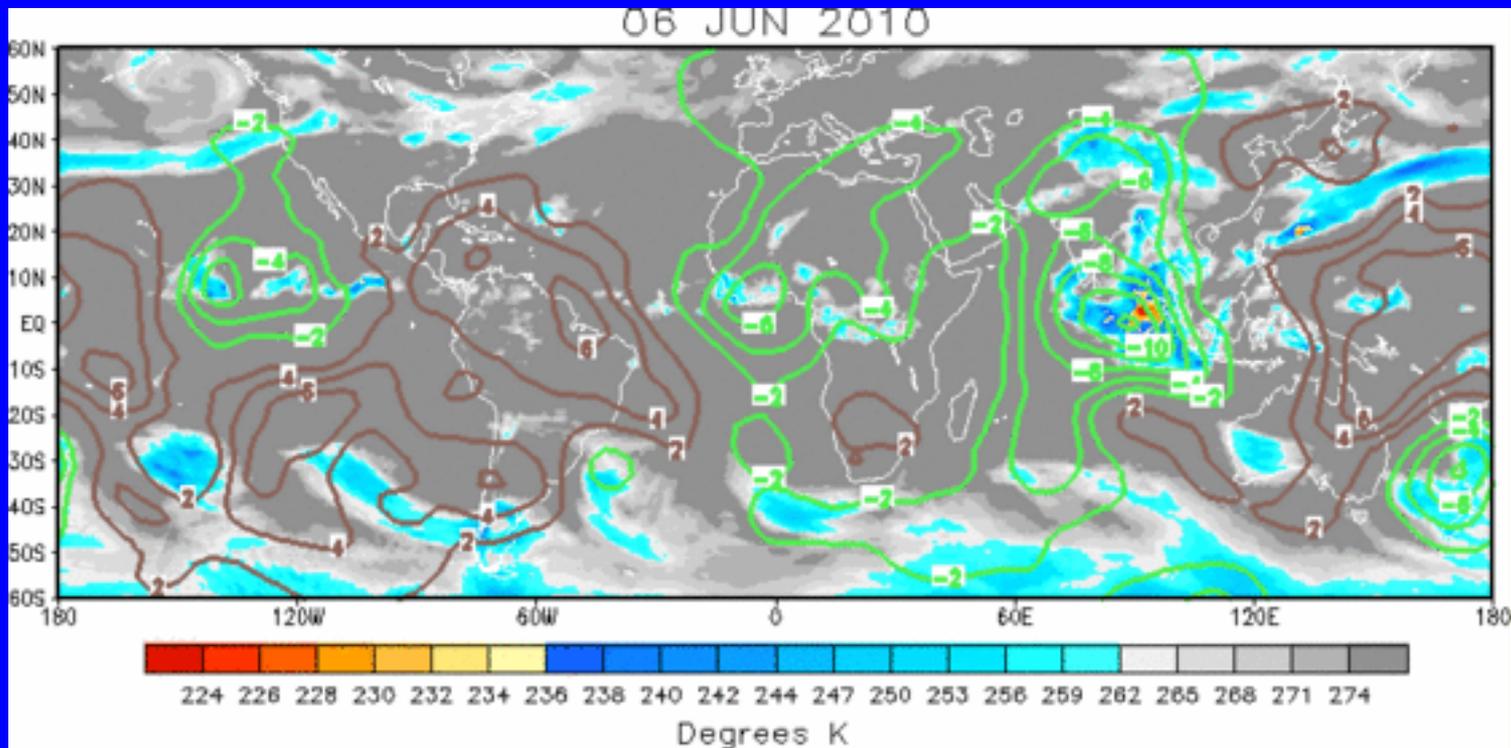
Most recently in late May and early June, upper-level divergence is evident from 80W to 30E.



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 current anomalous velocity potential pattern indicates upper-level divergence over Africa and the eastern Indian Ocean with upper-level convergence evident over the western Pacific and South America.

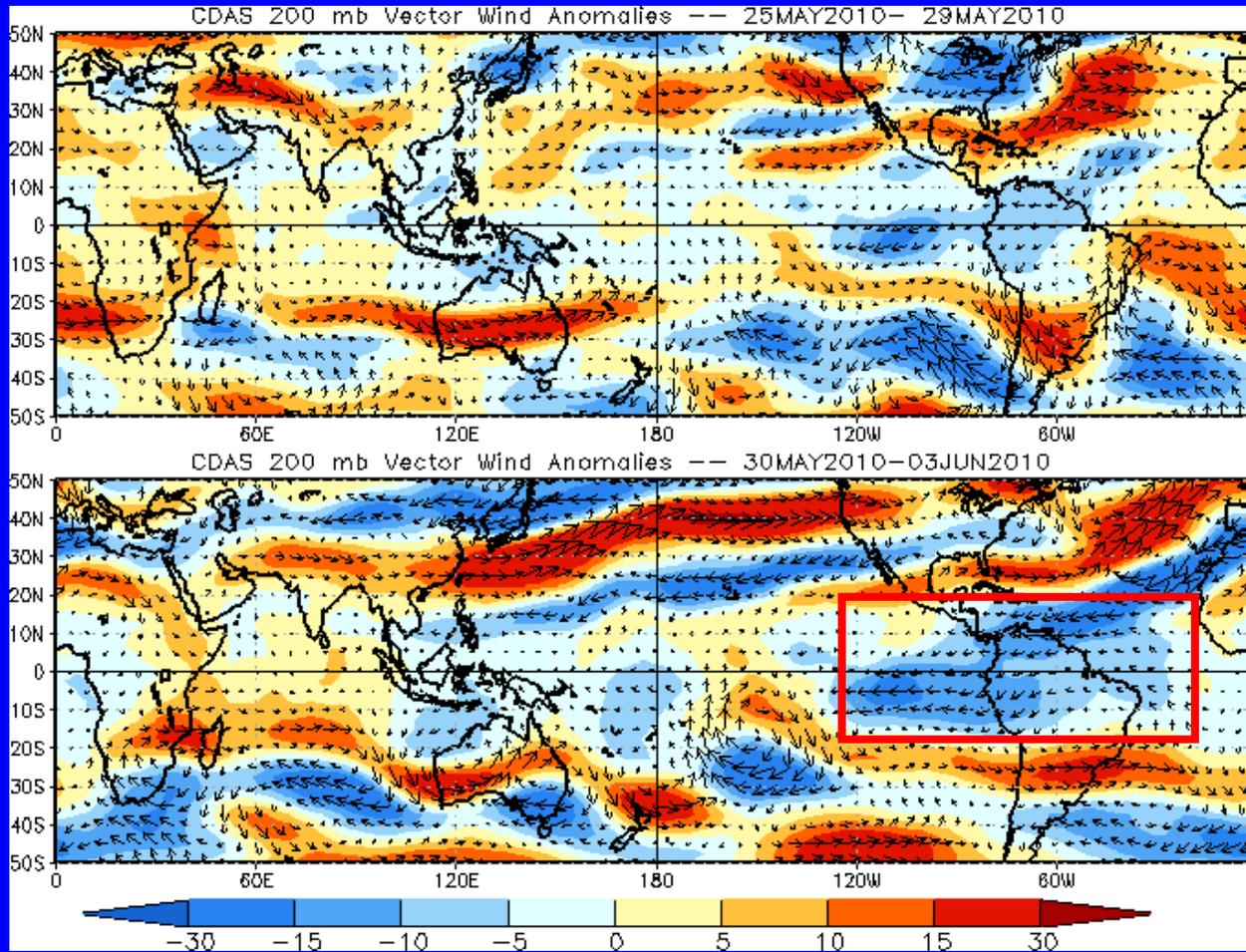


200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



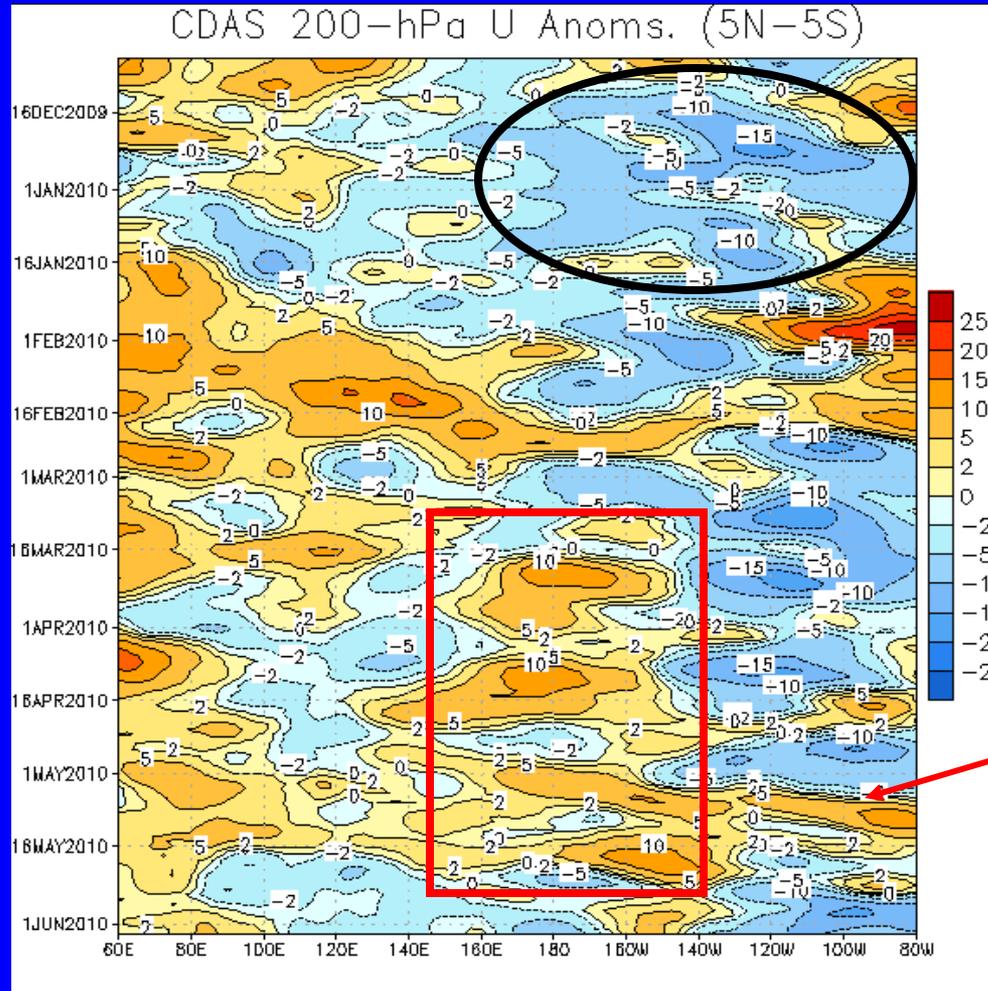
Easterly anomalies are evident across the equatorial eastern Pacific, northern South America and the western Atlantic during the last five days (red box).



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



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

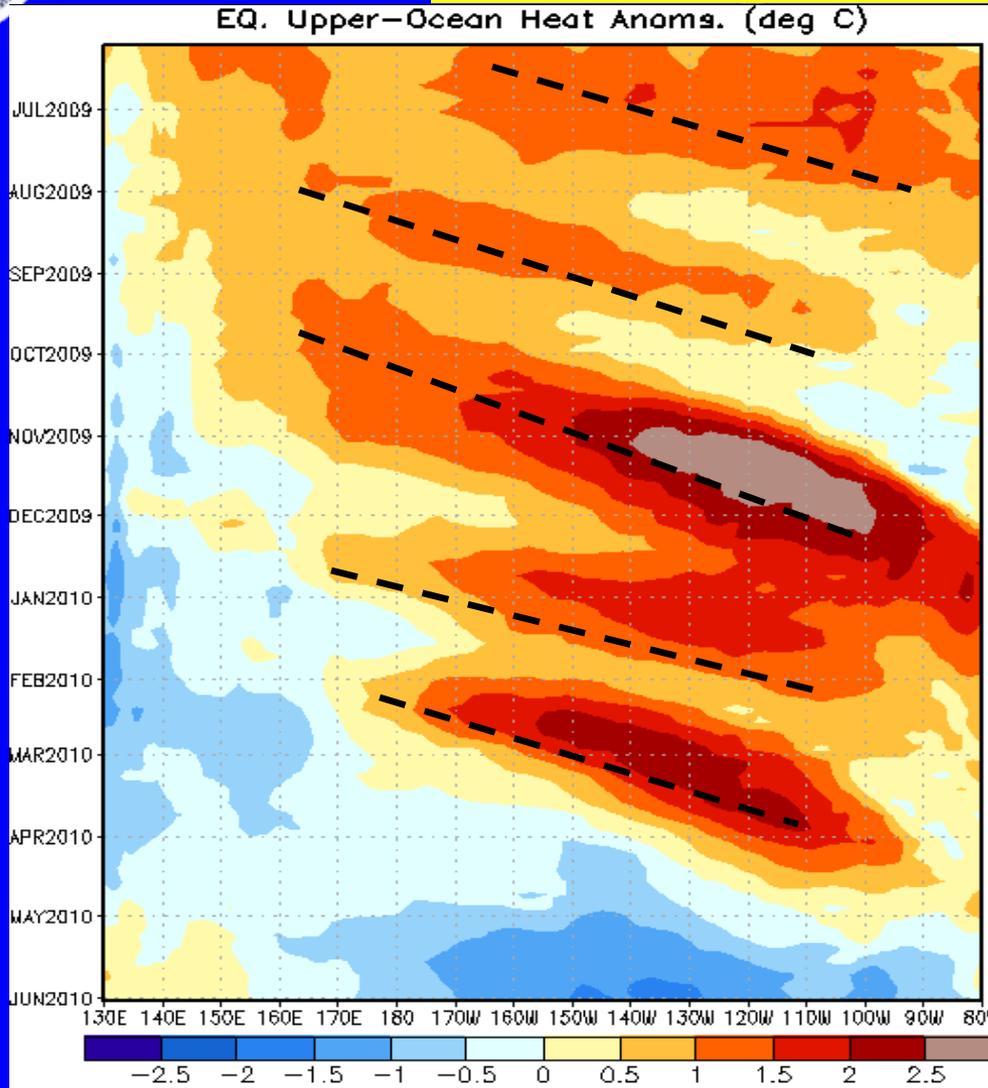
Westerly anomalies prevailed across the central Pacific (red box) for much of the period since mid-March to mid-May.

In early May, however, there was some eastward propagation of westerly anomalies across the Pacific in association with the MJO at that time.



Weekly Heat Content Evolution in the Equatorial Pacific

Time
↓



From June 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. Currently, negative heat content anomalies extend across the central and east-central Pacific.

Longitude



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.

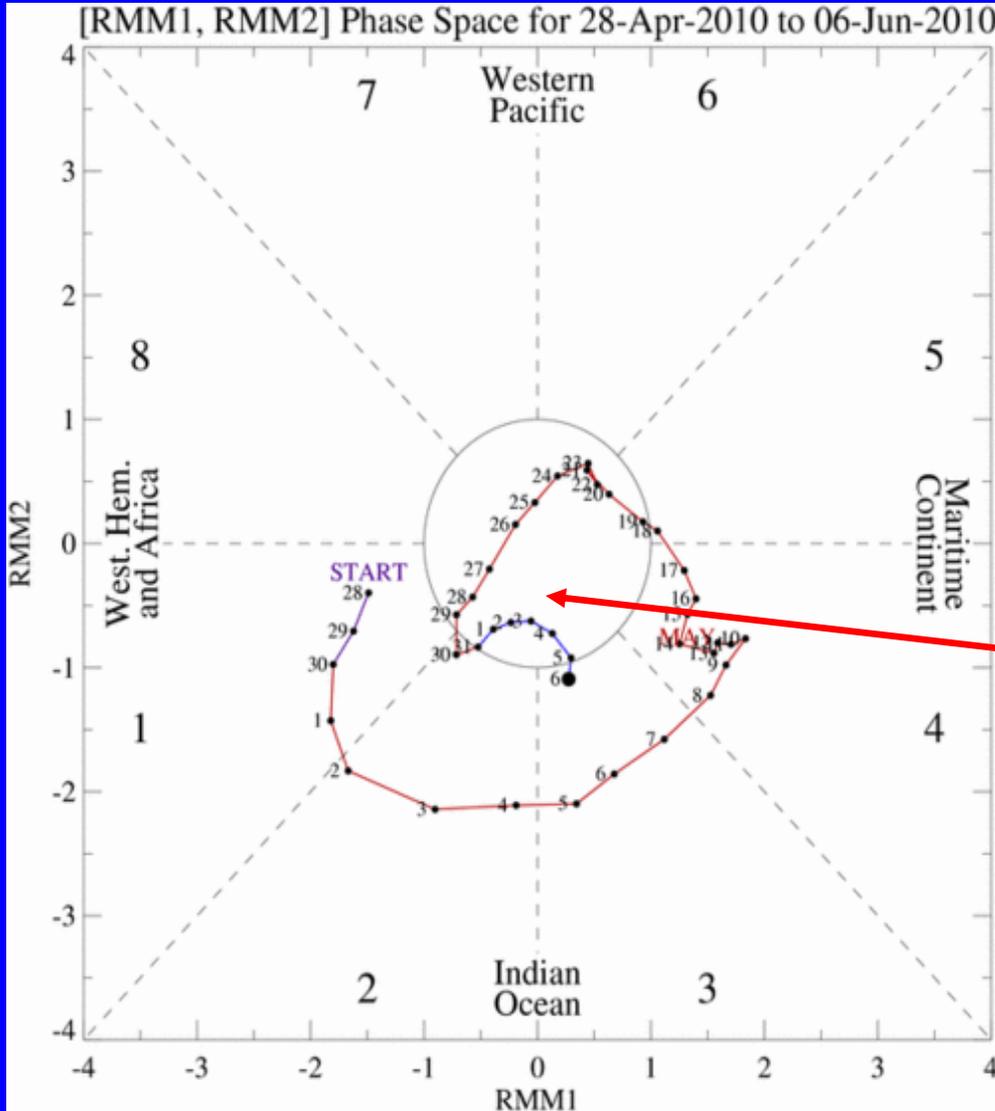
Gottschalck et al. 2010: A Framework for Assessing Operational Model MJO Forecasts: A Project of the CLIVAR Madden-Julian Oscillation Working Group, *Bull. Amer. Met. Soc.*, Accepted.

- 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

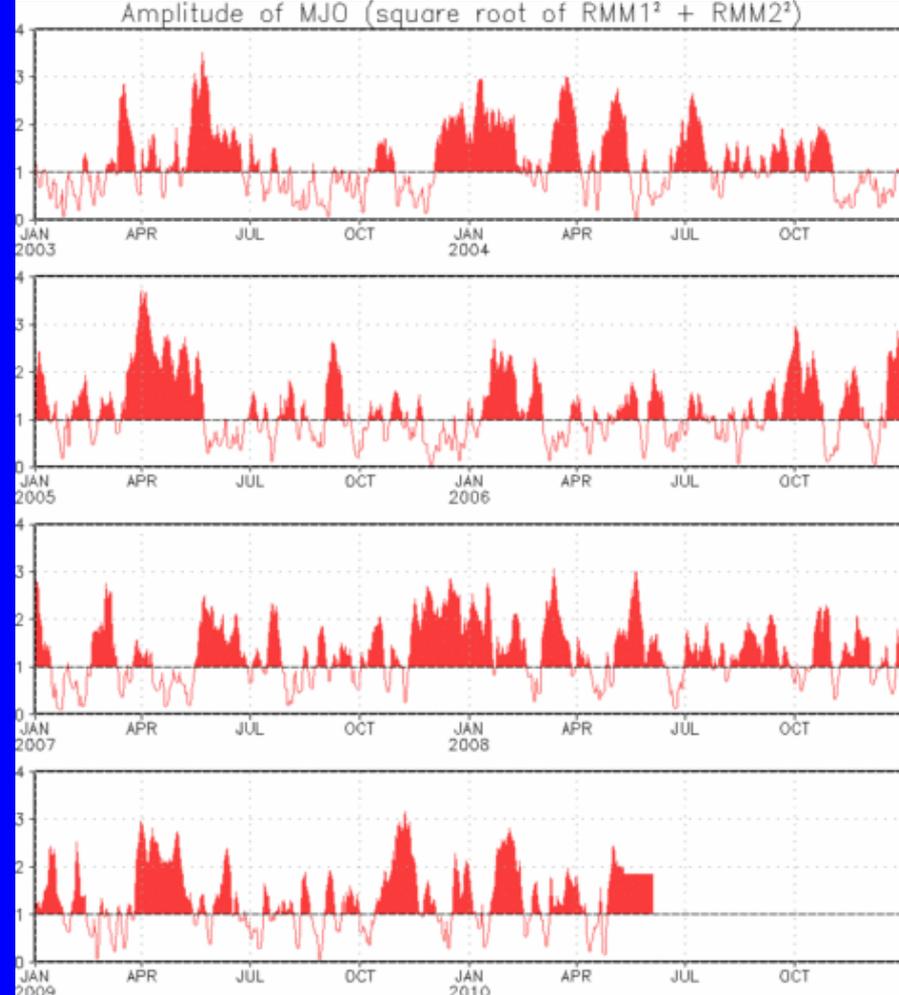
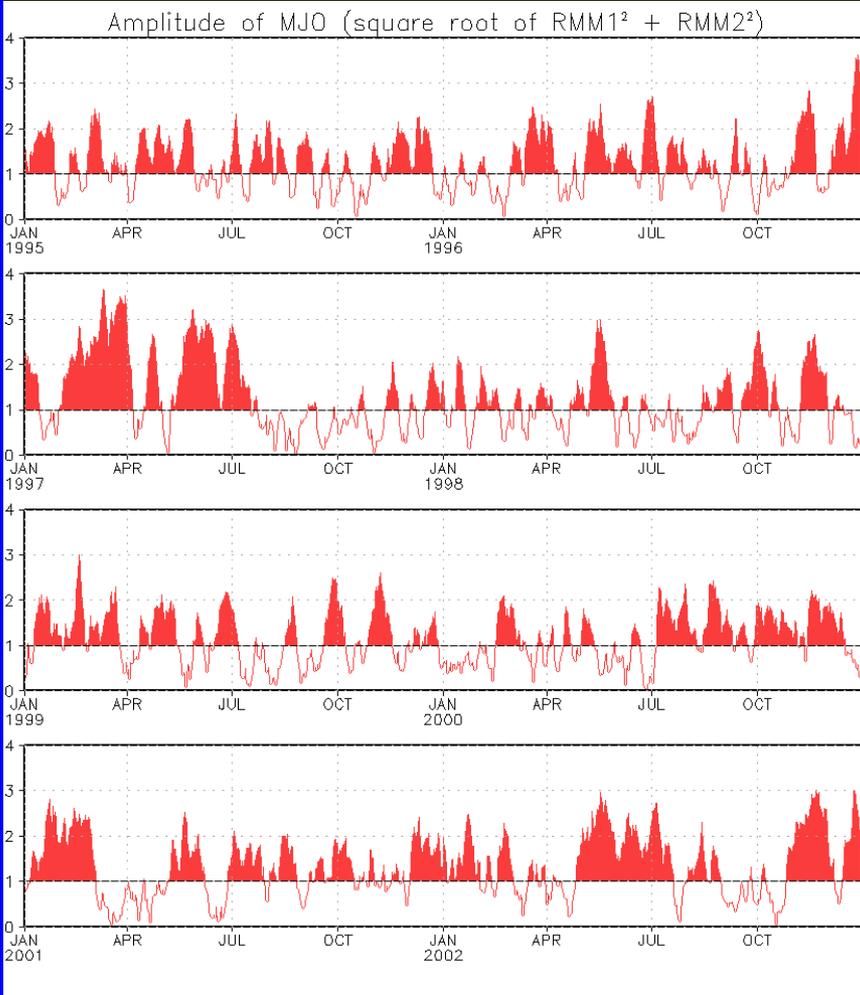
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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



During the past week, the MJO index showed weak MJO activity.



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

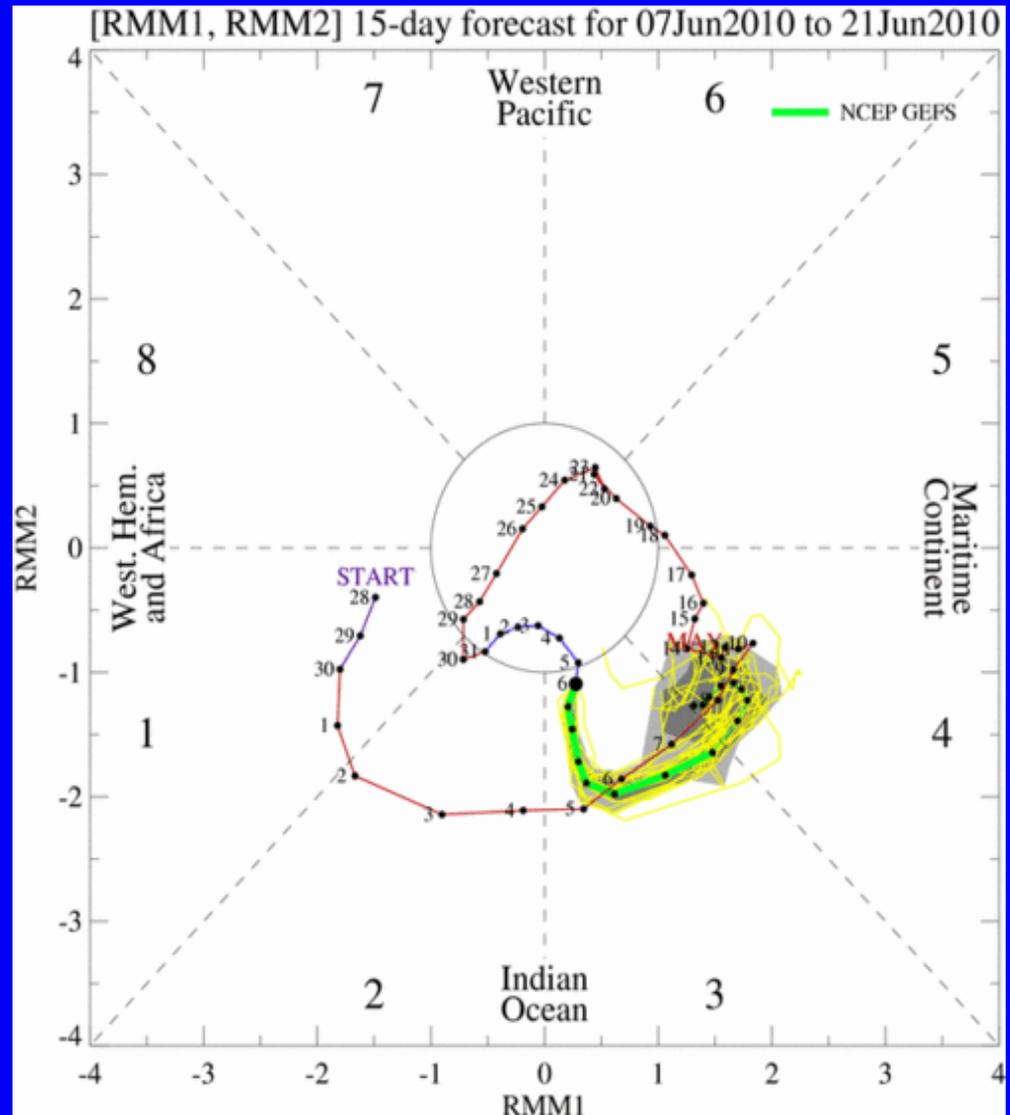
Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

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 strengthening MJO signal during Week-1 with some minor eastward propagation. Spread is small early in the forecast period but increases by Week-2.

At this time, it appears that the increase in signal is likely due to a combination of subseasonal variability as opposed to a more coherent MJO signal emerging.



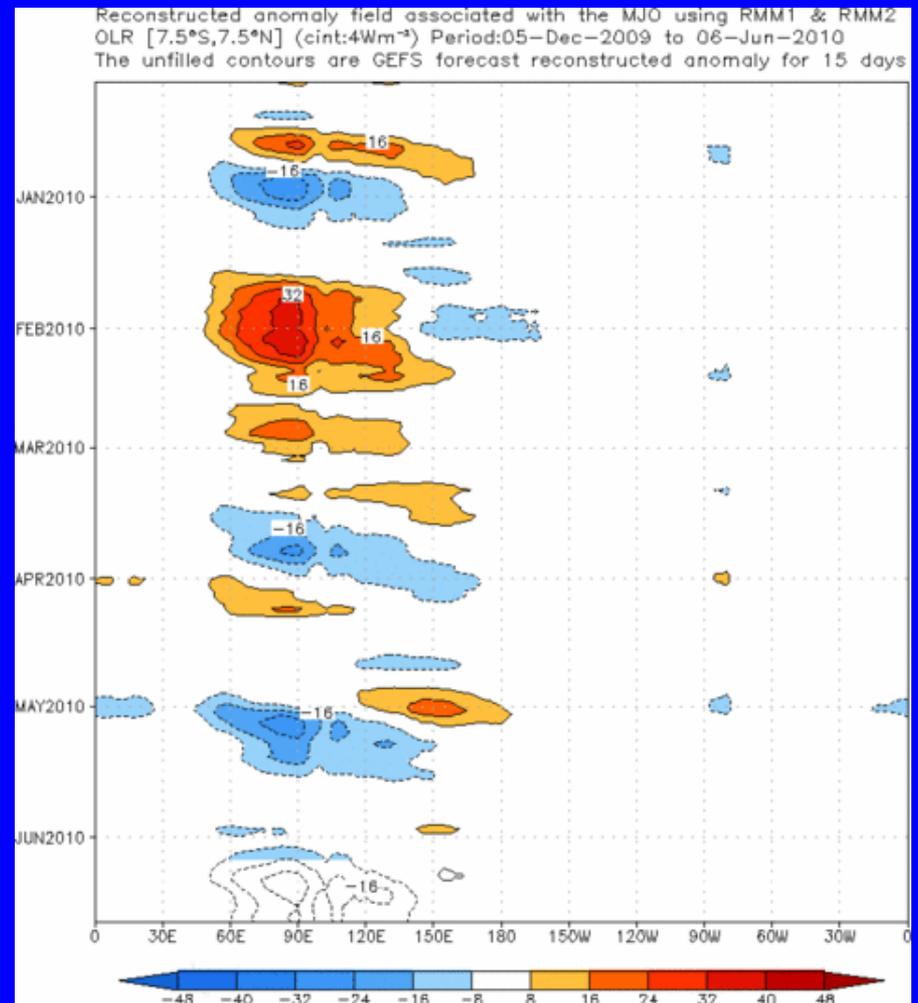
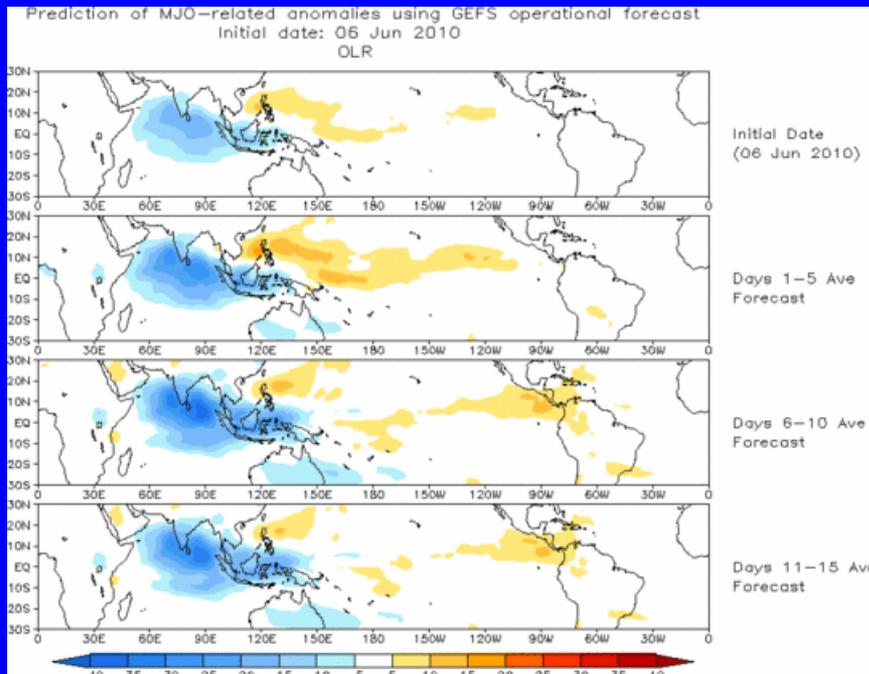


Ensemble Mean GFS MJO Forecast

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

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



The GEFS ensemble mean forecast indicates enhanced convection developing across the Indian Ocean and shifting slightly eastward by the end of the period. Suppressed convection is forecast across Central America during Week-2.



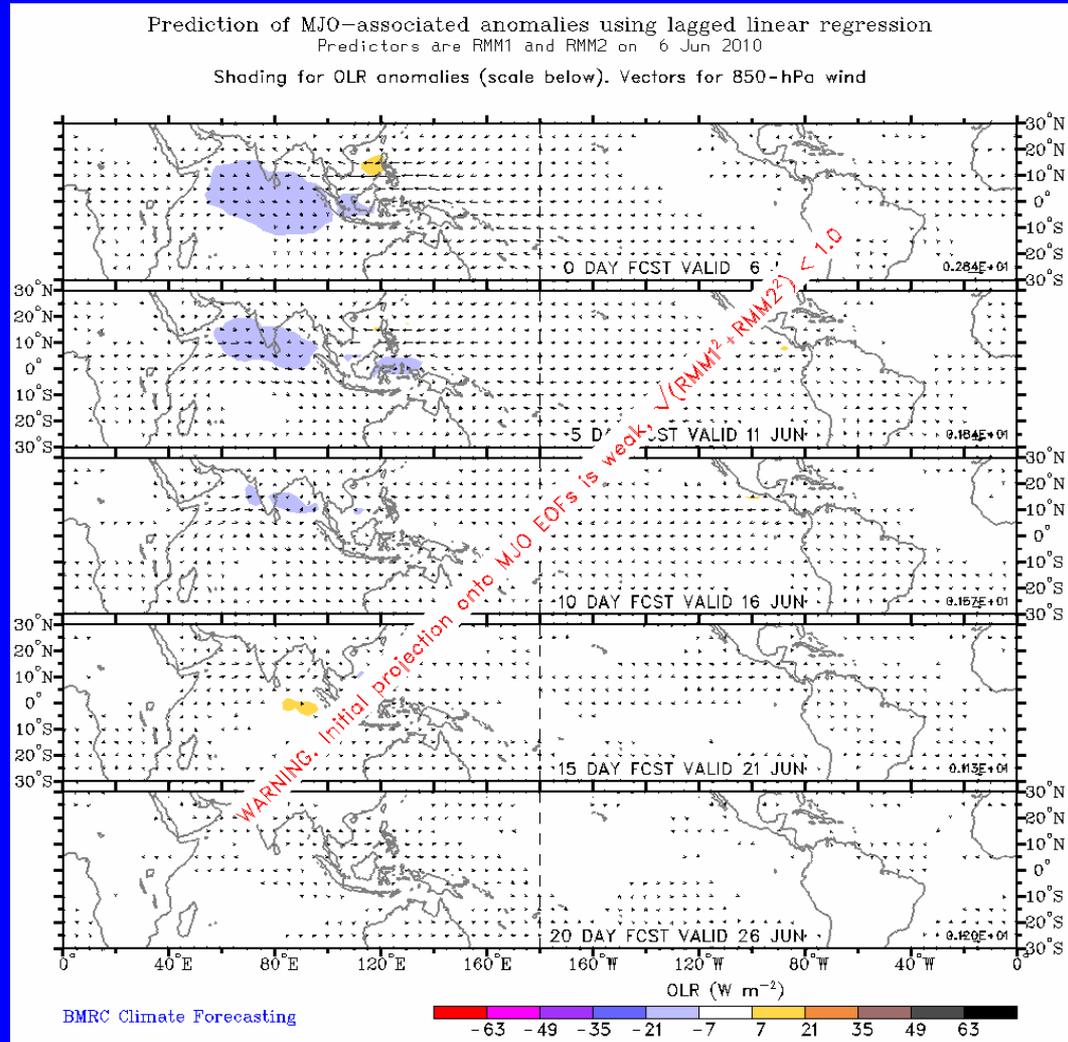
Statistical MJO Forecast

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 during the next two weeks.





MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)

850-hPa Wind Anomalies (May-Sep)

