



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

**Update prepared by
Climate Prediction Center / NCEP
June 21, 2010**



Outline

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



Overview

- **The MJO is currently incoherent.**
- **Dynamical model MJO index forecasts are generally consistent in showing a highly variable incoherent signal across the Indian Ocean continuing during the period.**
- **Based on a combination of the latest observations and MJO dynamical forecast tools, the MJO is expected to remain incoherent or 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>

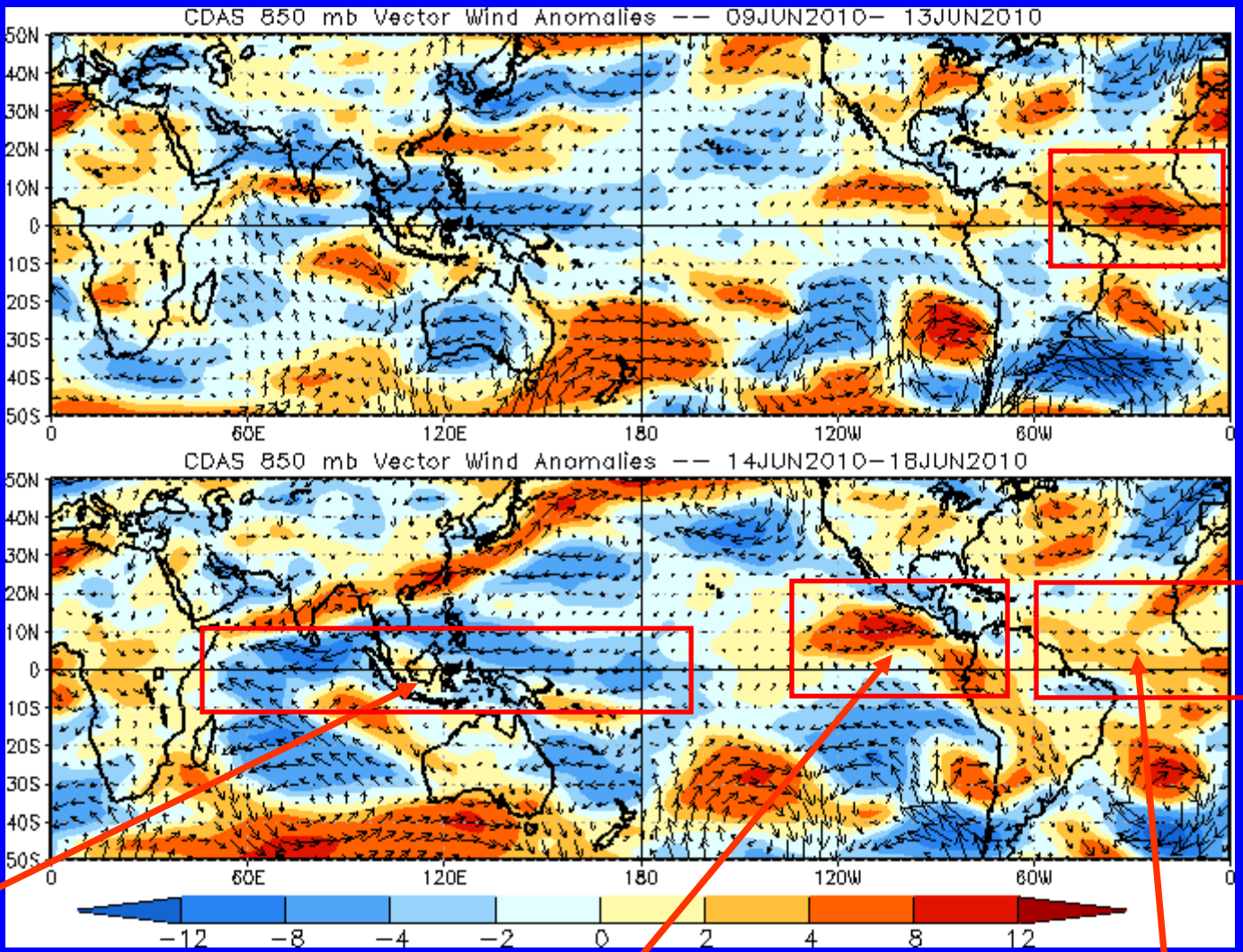


850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



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

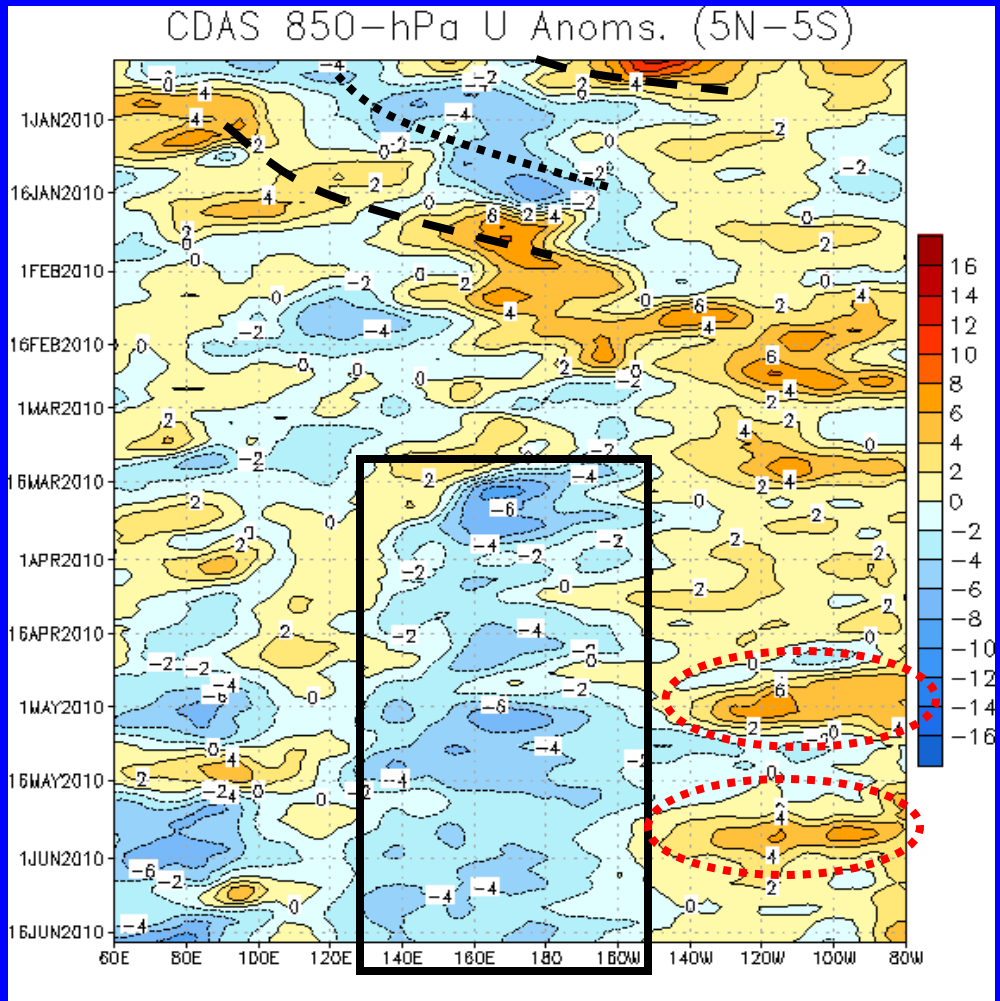
Westerly anomalies have strengthened across the eastern Pacific during the latest five days.

Westerly anomalies have weakened 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 late December and were associated with the MJO.

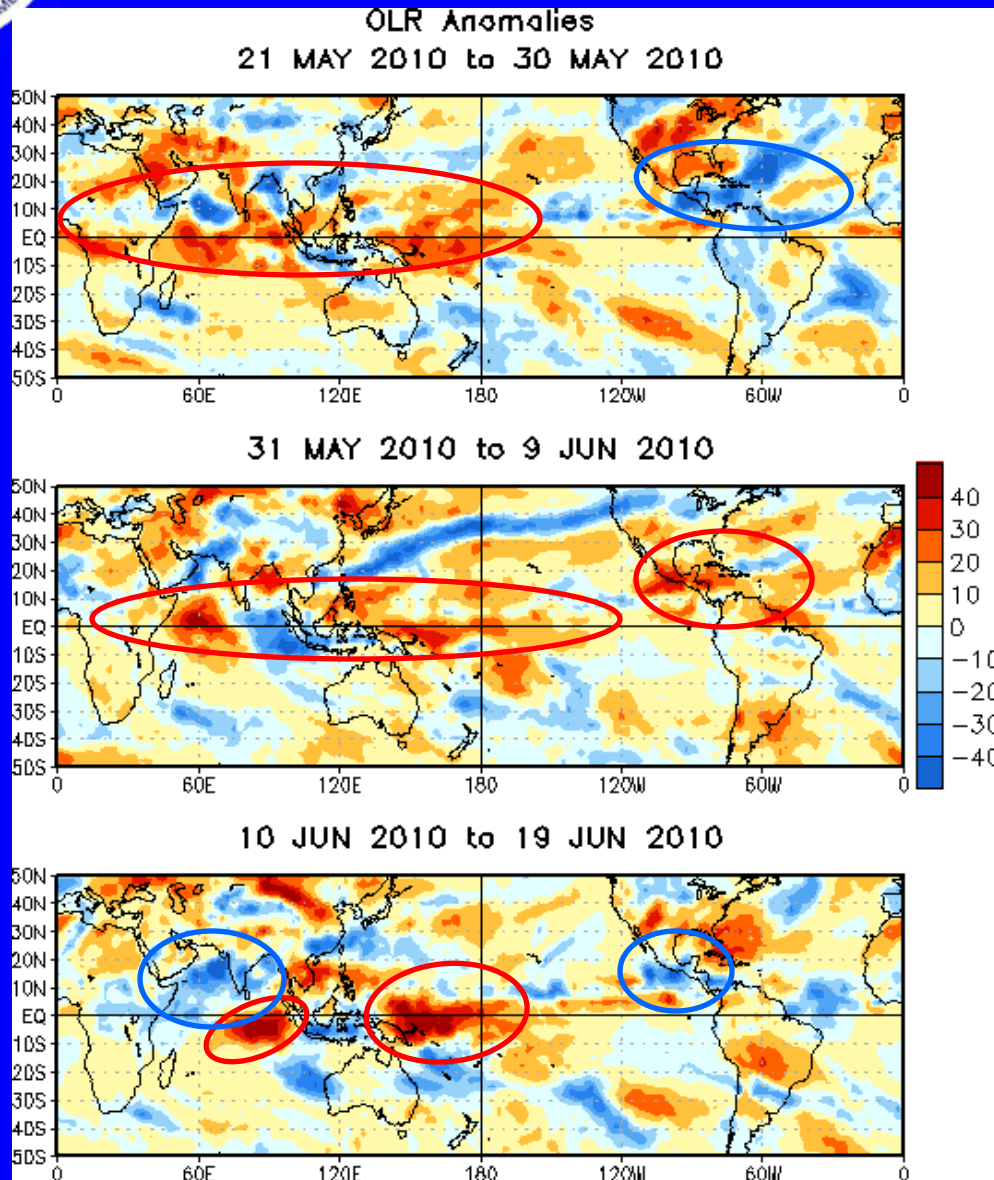
Weaker and shorter-lived MJO activity was evident during January (dotted and dashed line).

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 and again in late May. These were in part associated with the MJO.



OLR Anomalies: Last 30 days

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



Suppressed convection persisted across much of the Eastern Hemisphere tropics during late May (red oval). Enhanced convection (blue oval) was evident over Central and South America during this period.

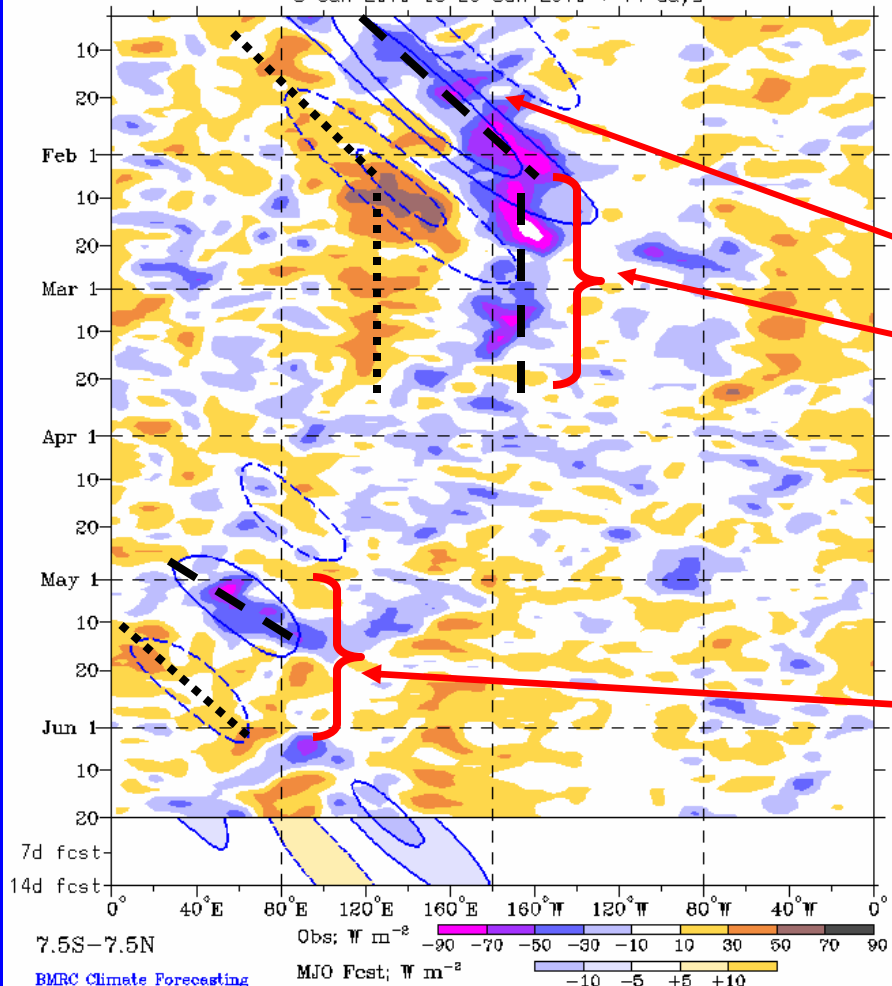
In early June, suppressed convection began to replace enhanced convection across Central America. Suppressed convection persisted over the Eastern Hemisphere except for the eastern Indian Ocean.

Suppressed convection was evident over the western Pacific while enhanced convection appeared over Central America and the adjacent Pacific Ocean during mid June. A dipole pattern in convection can be seen across portions of the Indian Ocean.



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

Real-time MJO filtering superimposed upon 3drn R21 OLR Anomalies
MJO anomalies blue contours, CINT=10. (5. for forecast)
Negative contours solid, positive dashed
3-Jan-2010 to 20-Jun-2010 + 14 days



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

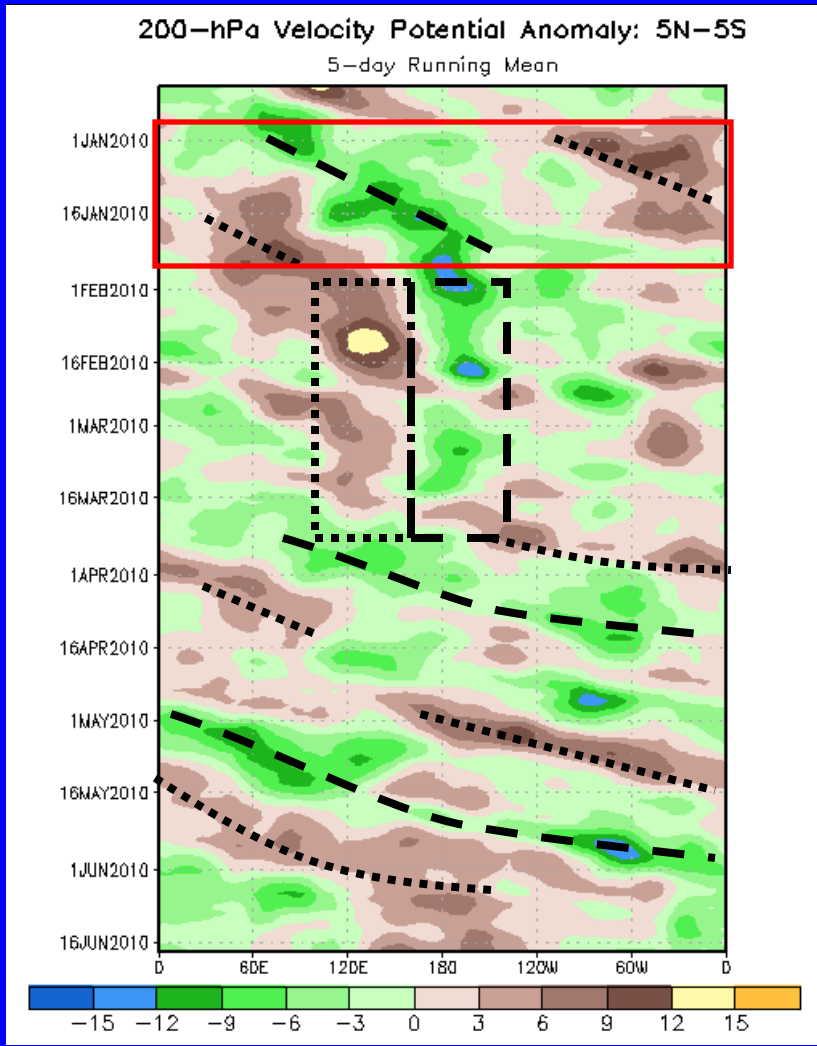


200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time
↓



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 May, anomalies increased and eastward propagation was evident coincident with the MJO.

Most recently, anomalies have become more stationary.

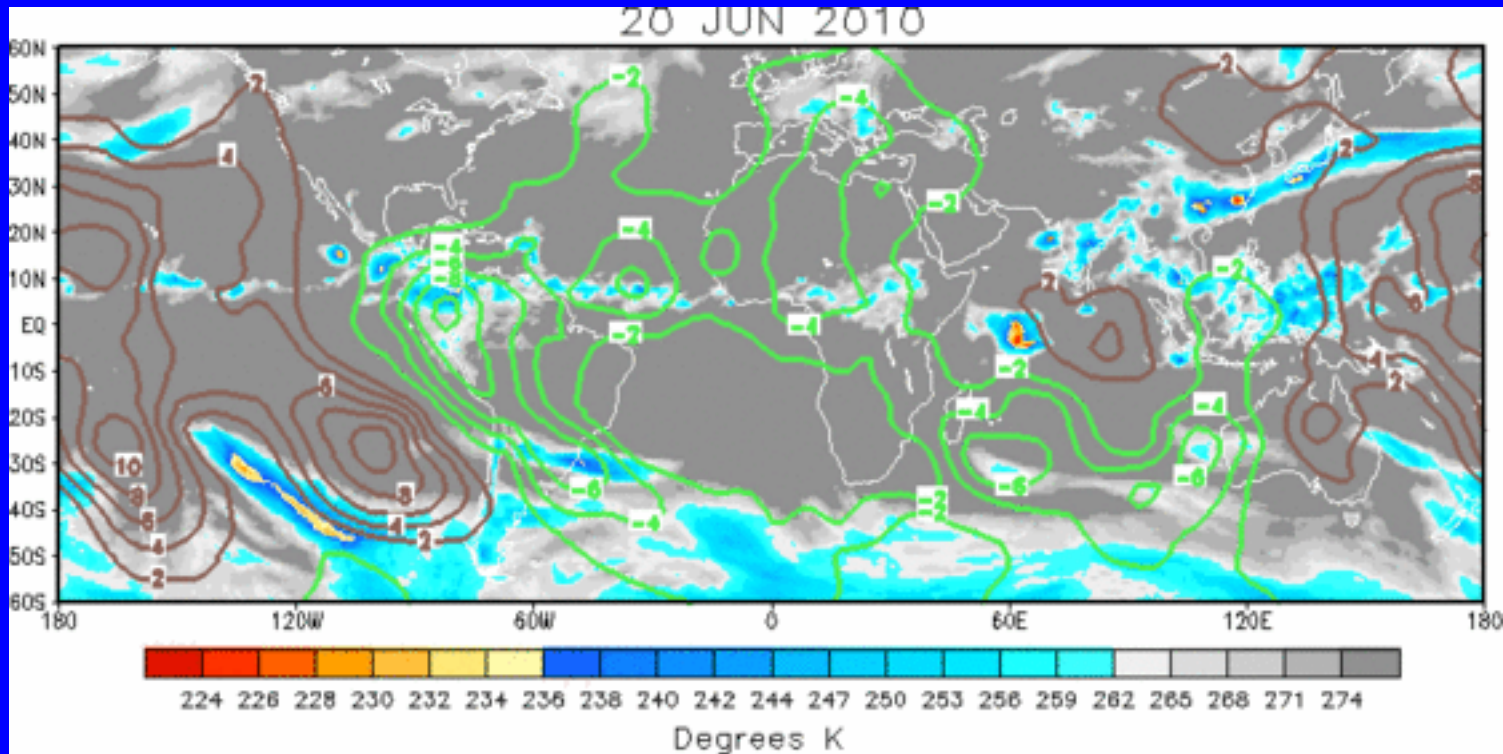
Longitude



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 current anomalous velocity potential pattern indicates upper-level divergence over Central America and Africa with upper-level convergence evident over much of the Pacific Ocean.

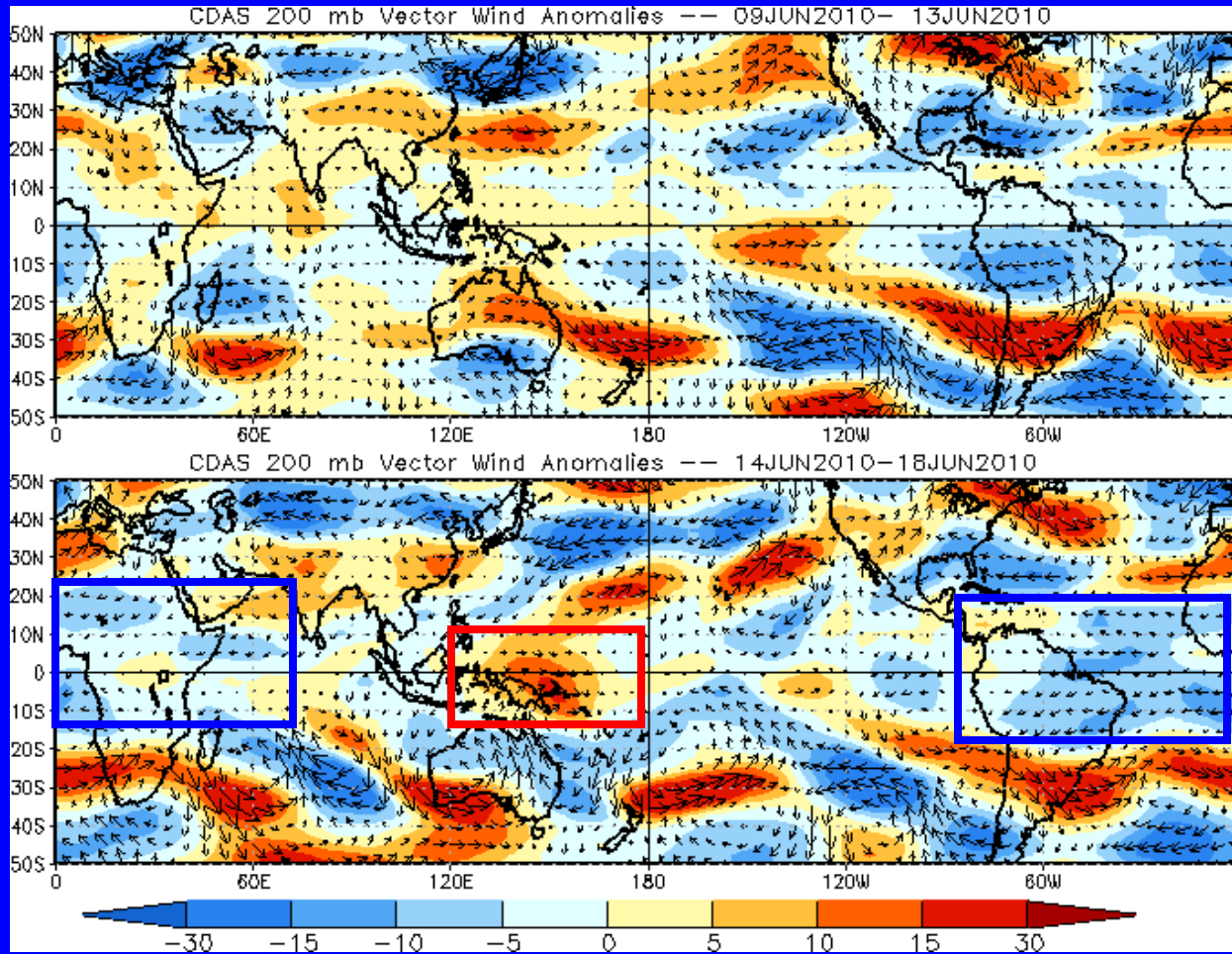


200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Easterly anomalies are evident across northern South America, the tropical Atlantic ocean, and Africa during the last five days (blue box).

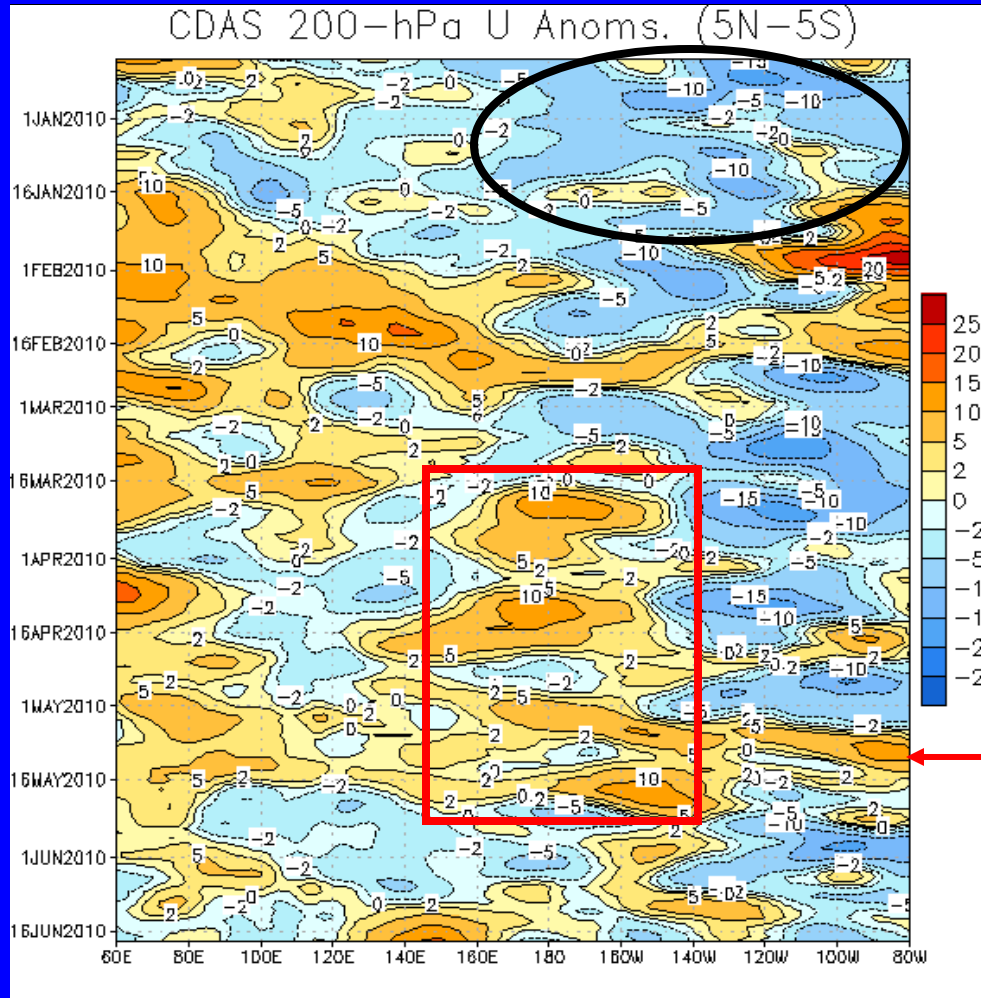
Westerly anomalies are evident across the far western Pacific Ocean (red box).



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



Time
↓

Longitude

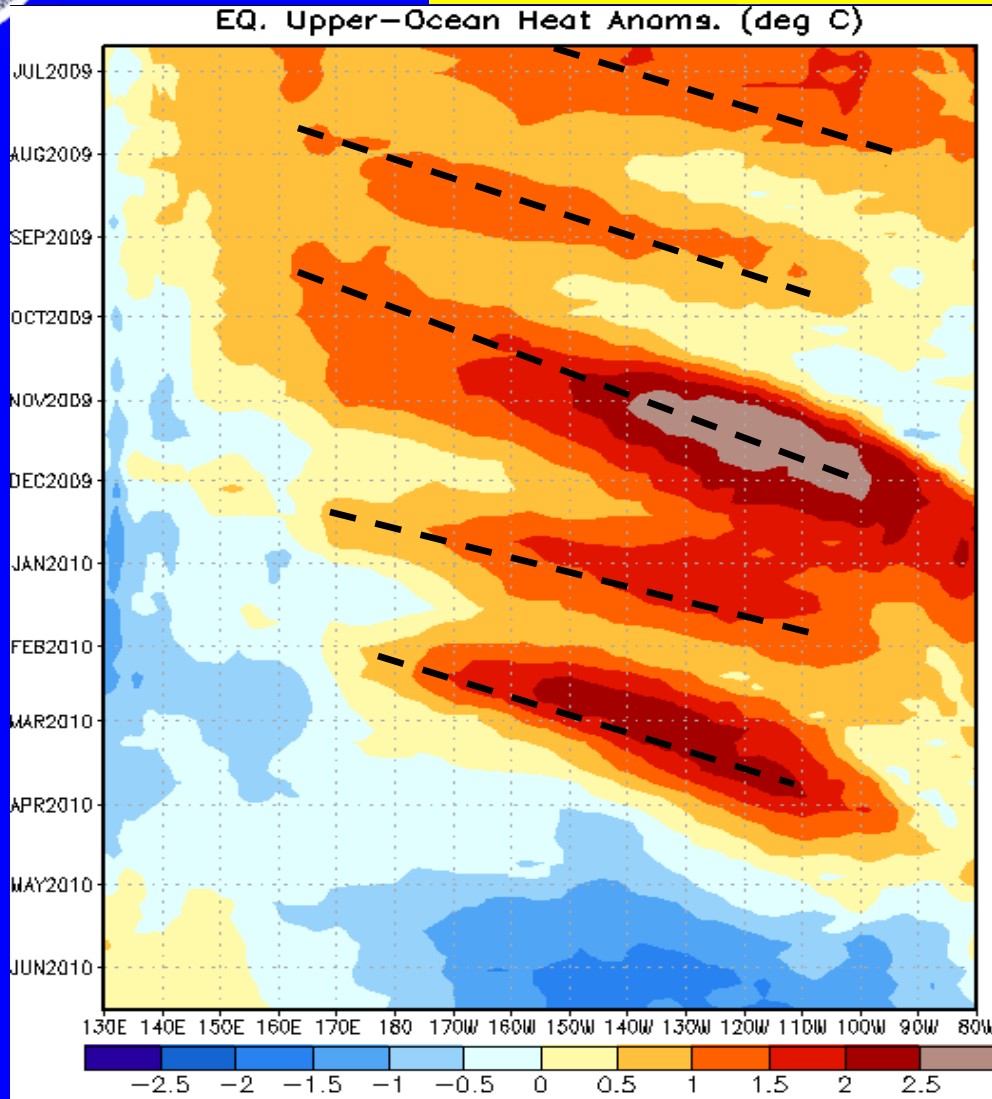
Easterly anomalies dominated much of the central and eastern Pacific during the second half of December and most of January (black oval).

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



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.



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.

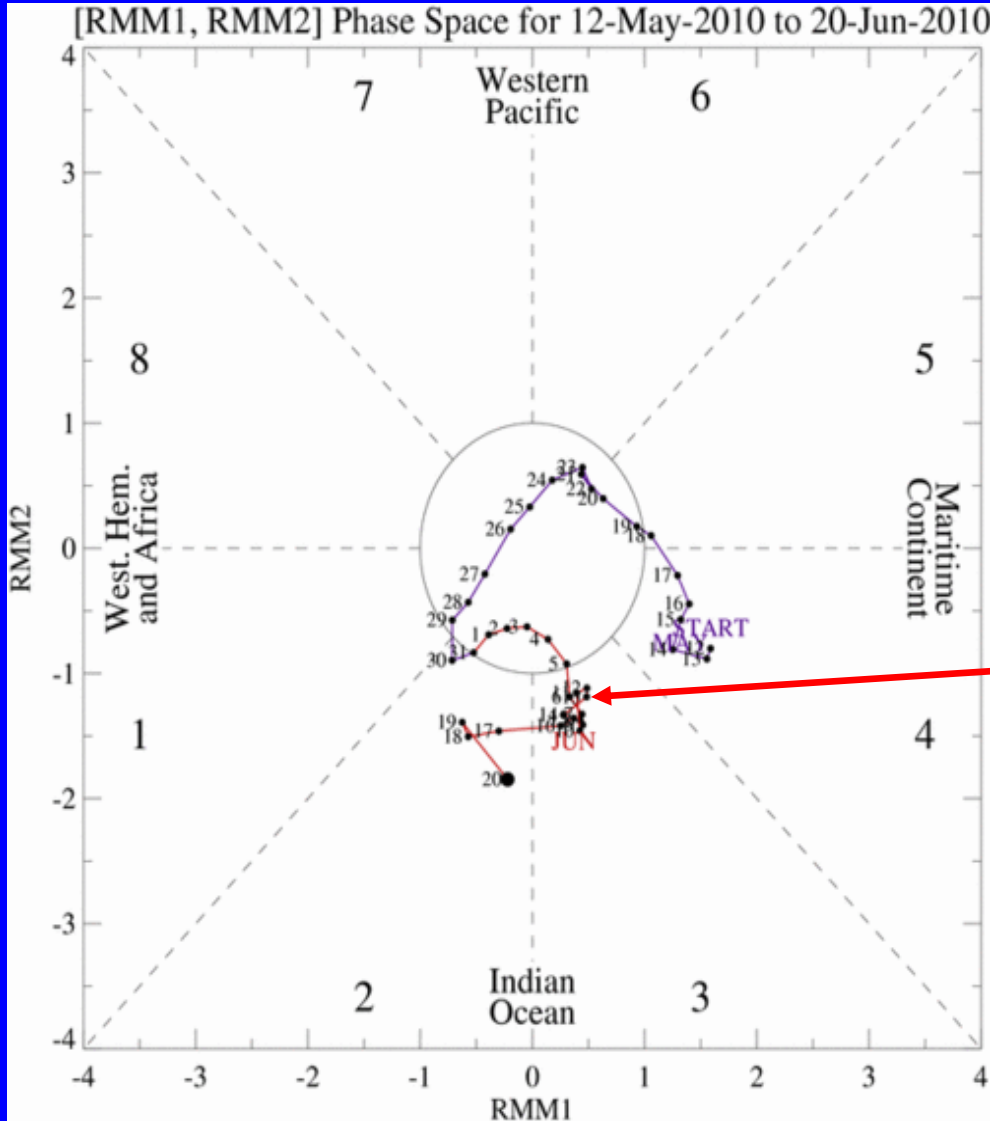
Gottschalck et al. 2010: A Framework for Assessing Operational Model MJO Forecasts: A Project of the CLIVAR Madden-Julian Oscillation Working Group, *Bull. Amer. Met. Soc.*, In Press.

- 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

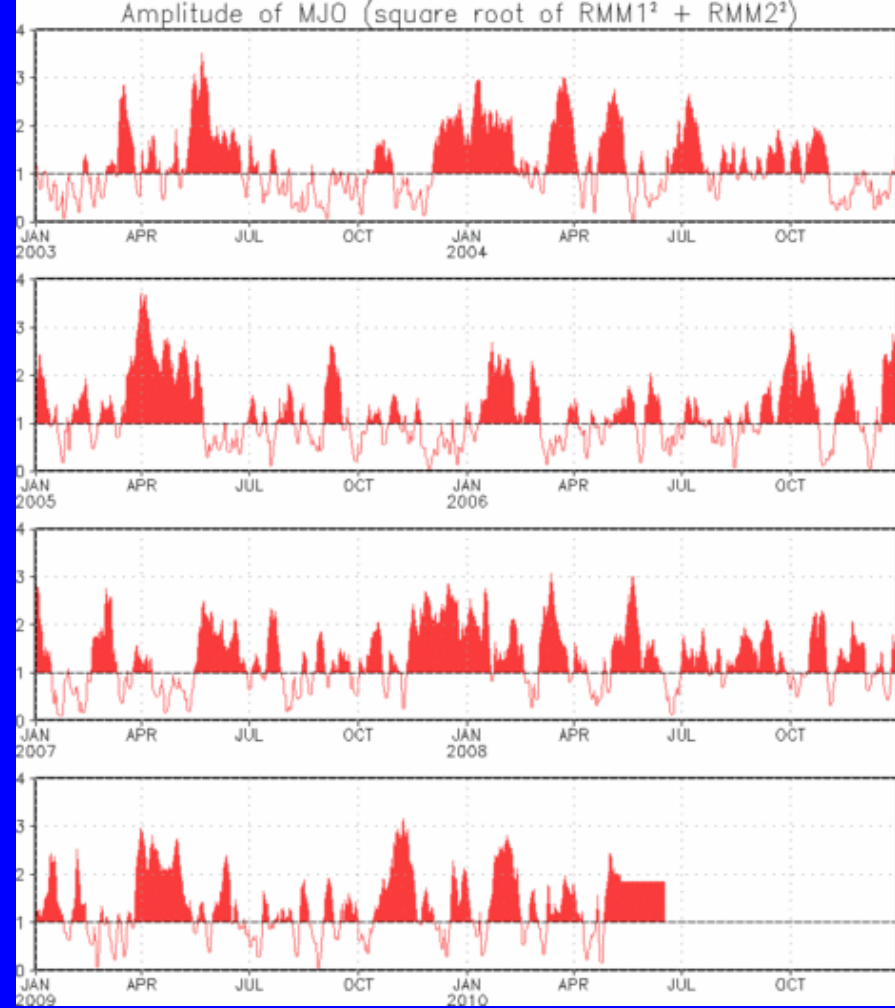
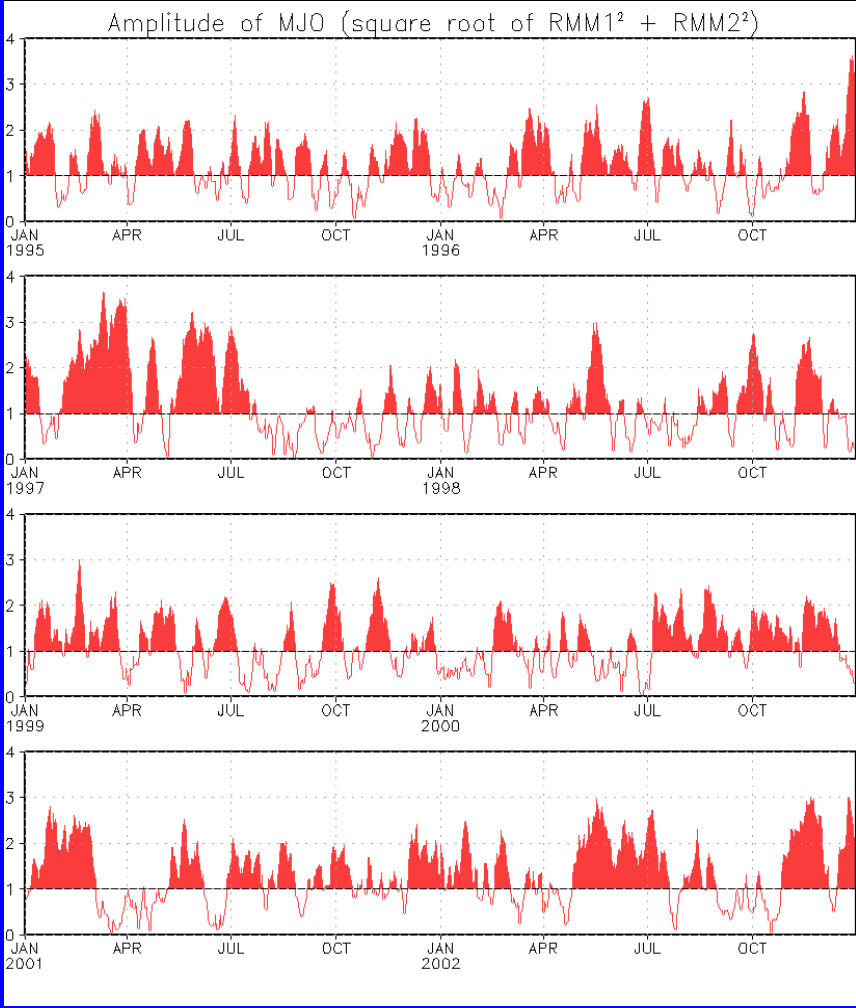
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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



During the past week, the MJO index indicates incoherent 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

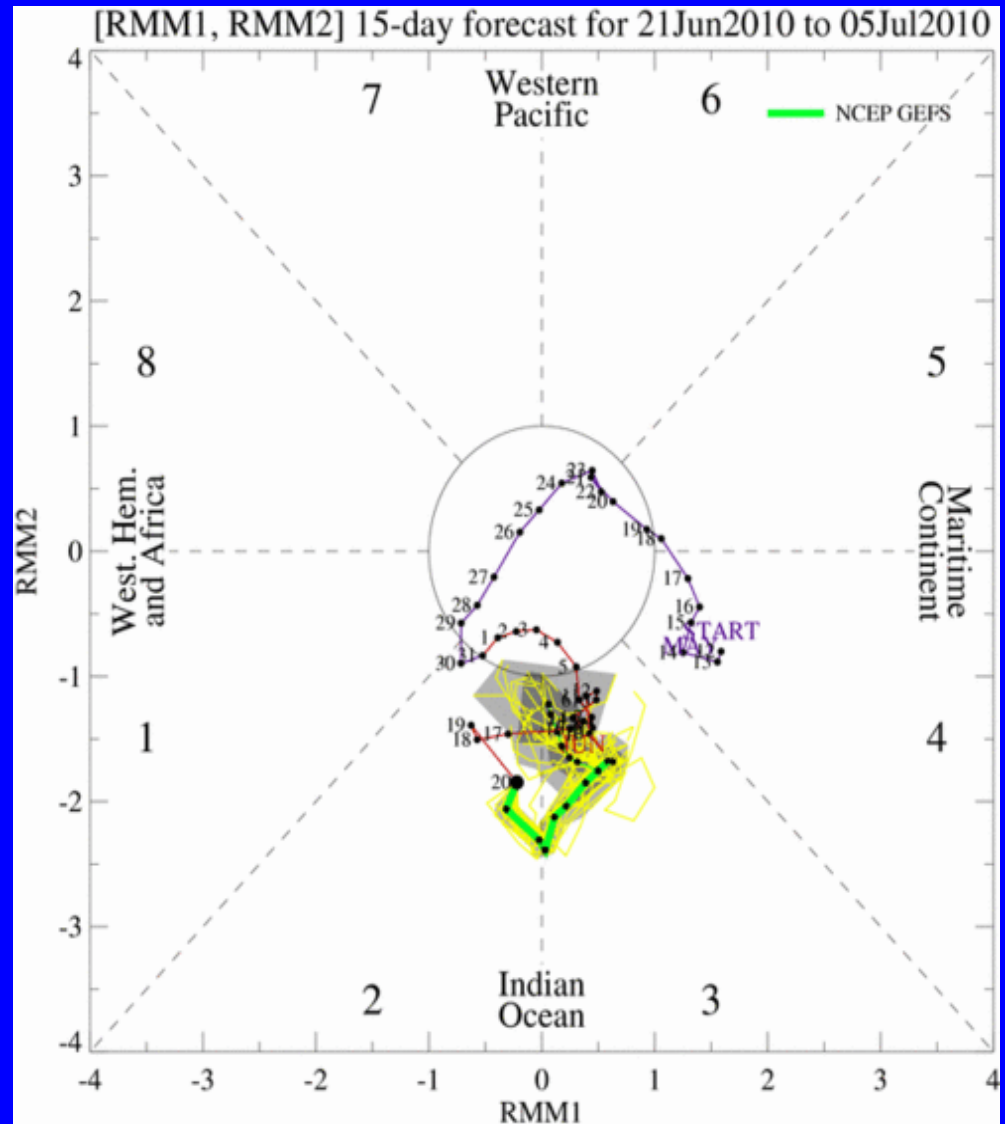
Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

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 an increase in amplitude during Week-1 with little eastward propagation.

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.



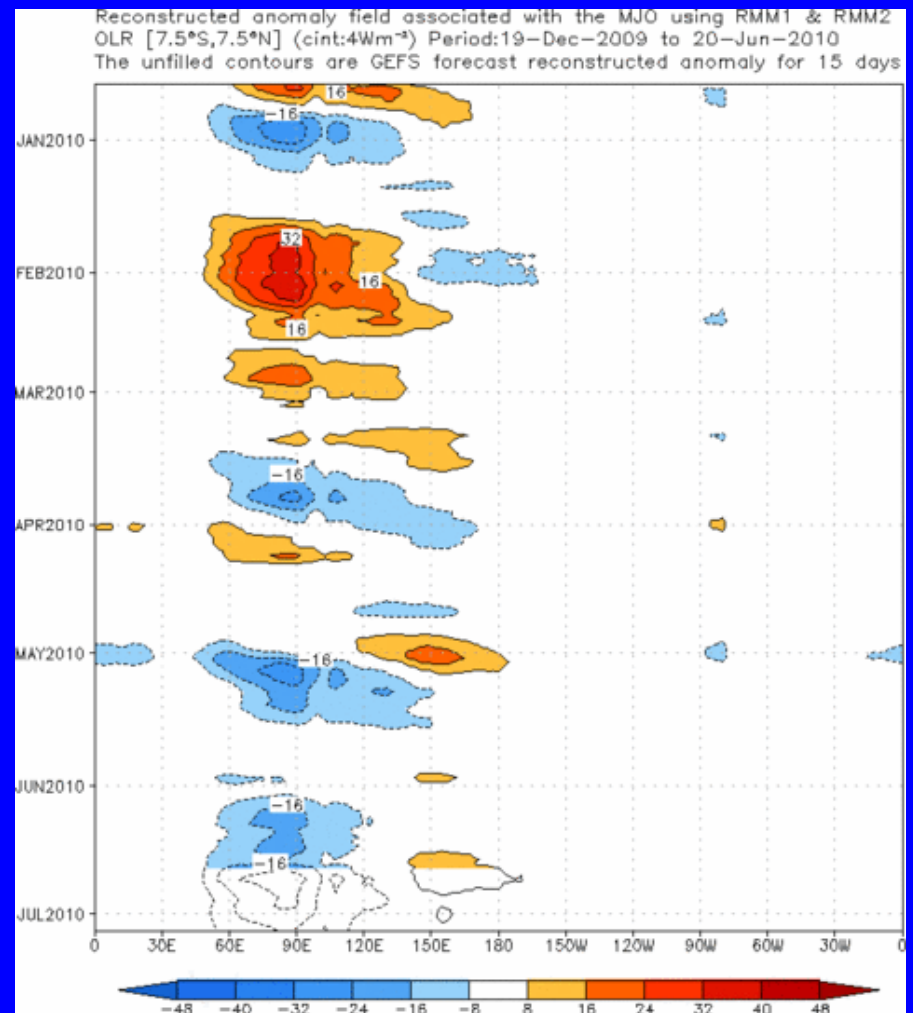
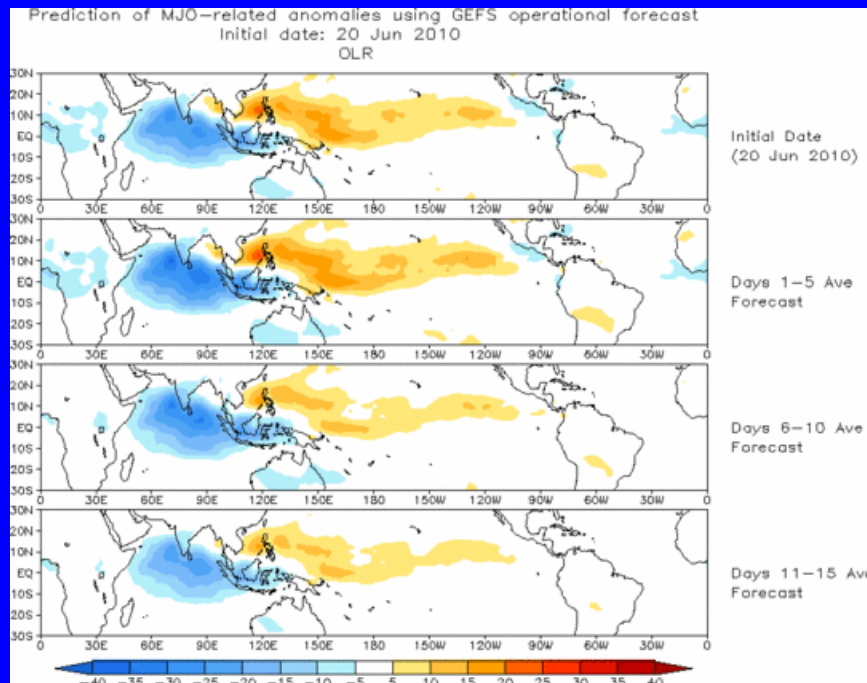


Ensemble Mean GFS MJO Forecast

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 across the Indian Ocean and western Maritime Continent persisting through the end of the period. Suppressed convection is forecast across the western and central Pacific Ocean during the period.



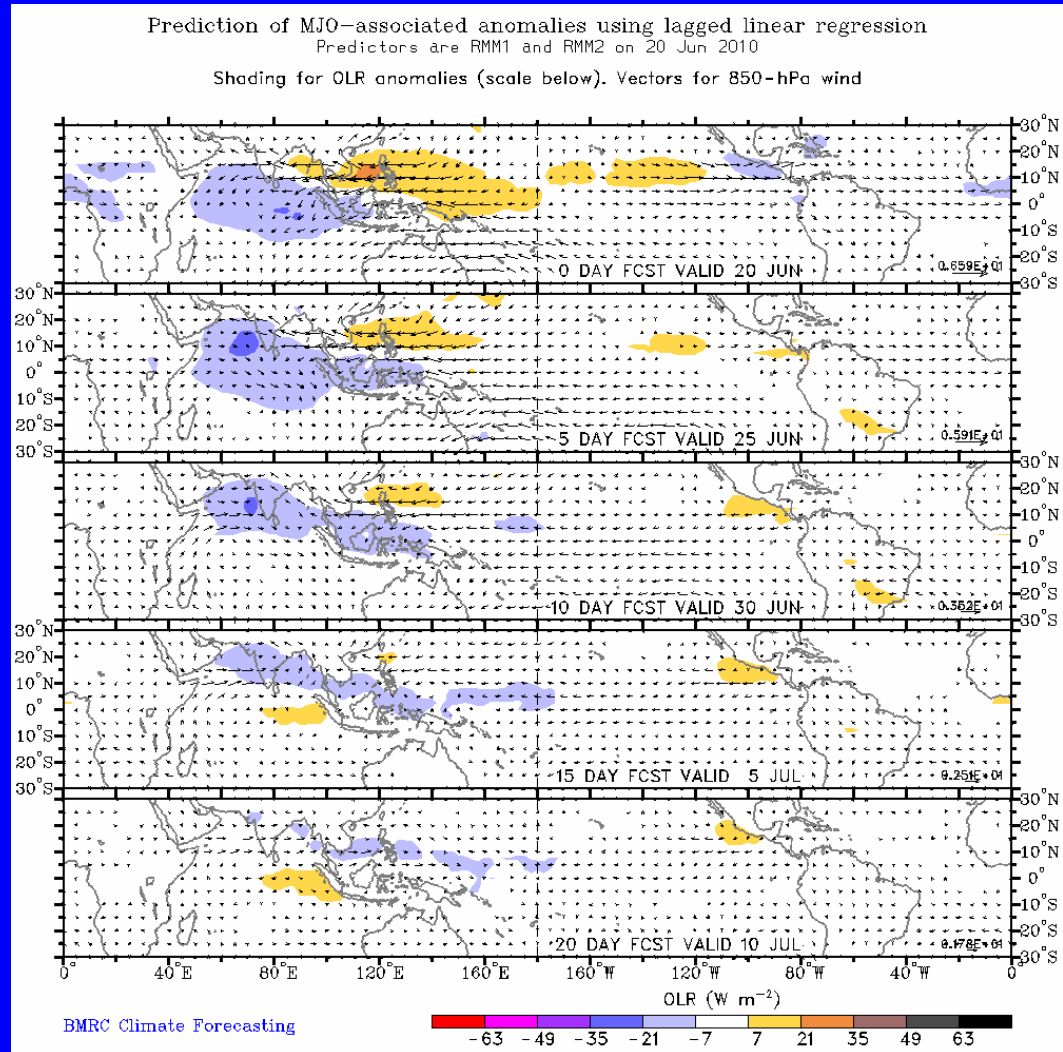
Statistical MJO Forecast

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 with enhanced convection across the Indian Ocean during Week-1 shifting northeastward during Week-2.





MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)

850-hPa Wind Anomalies (May-Sep)

