



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

**Update prepared by  
Climate Prediction Center / NCEP  
June 20, 2011**



# Outline

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



# Overview

- **The MJO signal remained weak during the past seven days.**
- **The dynamical model MJO index forecasts indicate a continuation of generally weak, unorganized activity over the next two weeks with large differences among models.**
- **The MJO is not expected to contribute substantially to anomalous rainfall across the global Tropics.**

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



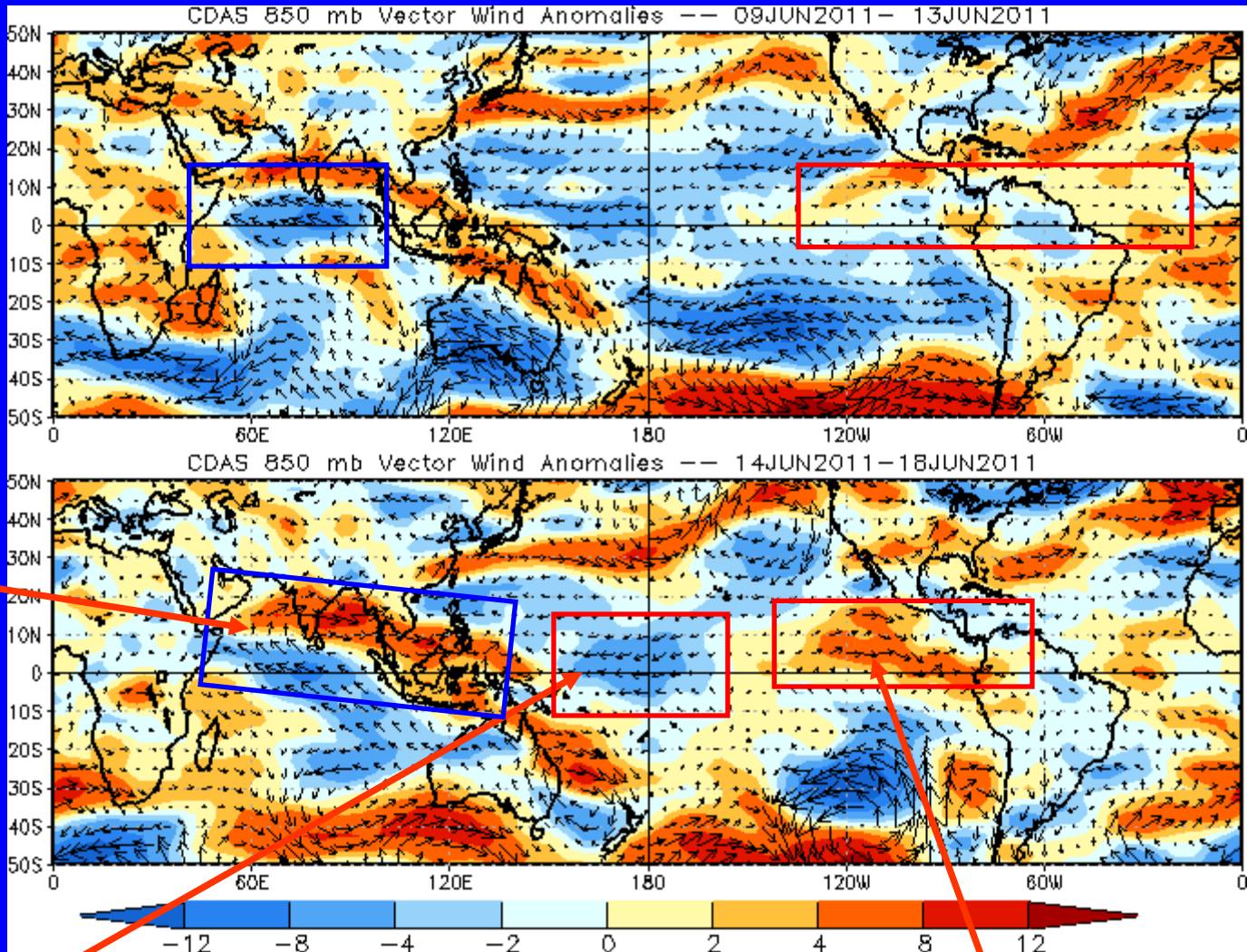
# 850-hPa Vector Wind Anomalies ( $\text{m s}^{-1}$ )

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

Enhanced flow monsoon flow is evident from the Indian Ocean to India and towards the Philippines.



Easterly anomalies continue near the Date Line.

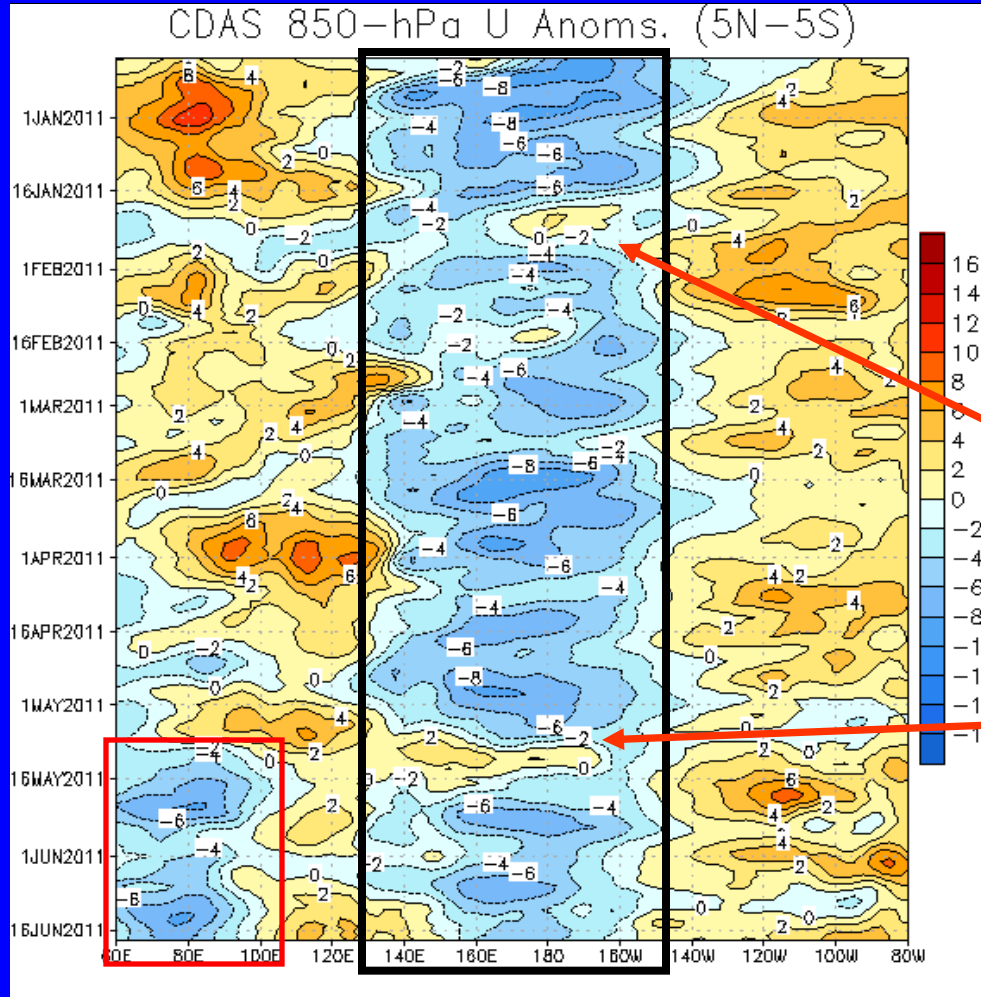
Westerly anomalies increased across the eastern Pacific Ocean during the last five days.



# 850-hPa Zonal Wind Anomalies ( $\text{m s}^{-1}$ )

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 November (black box) consistent with La Nina conditions. The magnitude of these anomalies, however, has gradually weakened over the period.

In late January, easterly winds weakened and westerly anomalies developed near the Date Line due to MJO activity.

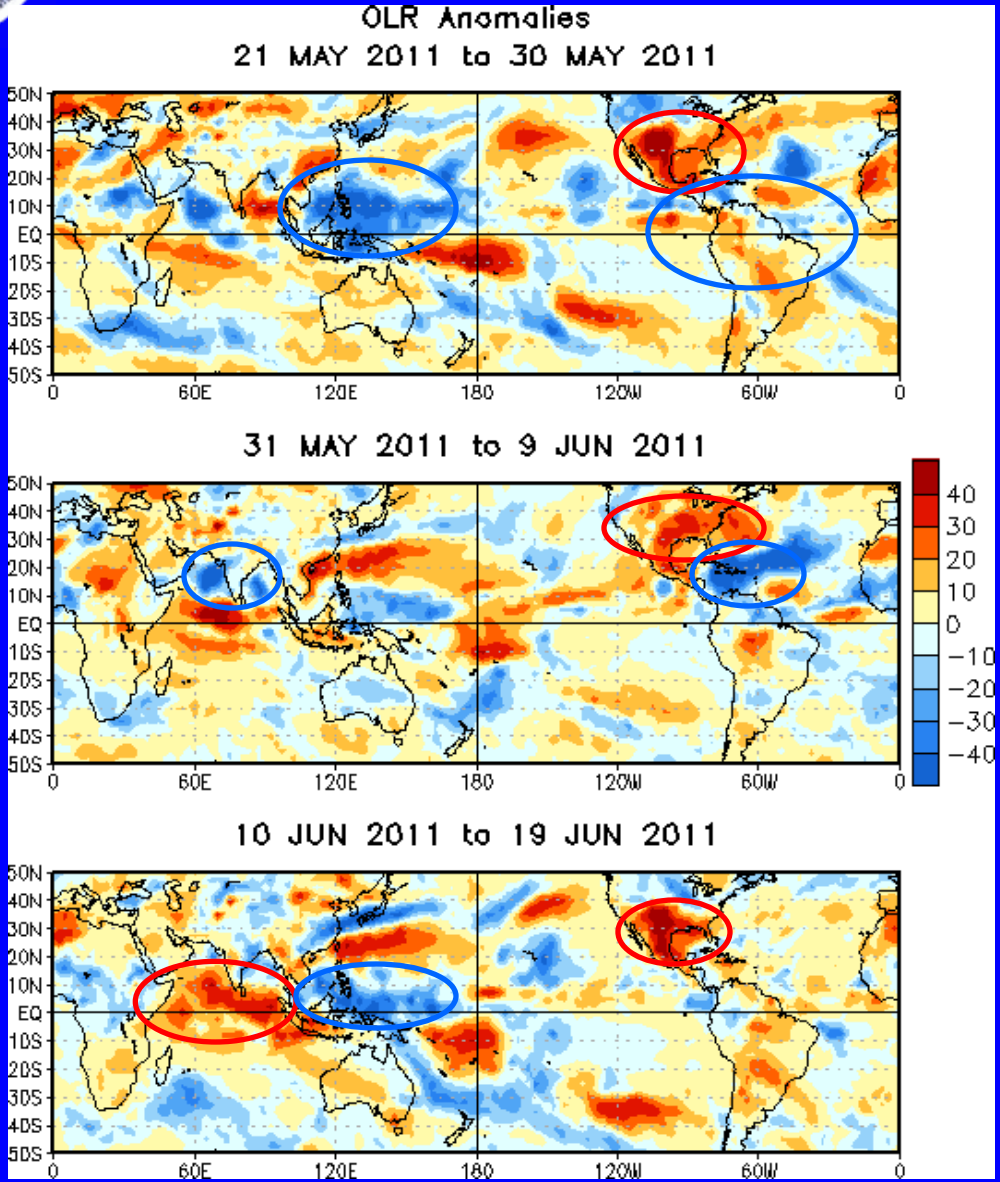
A burst of westerly wind anomalies associated with the MJO moved across the Pacific in early-to-mid May.

Since mid-May, easterly anomalies have replaced prevailing westerly anomalies across the western Indian (red 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)**



During late May, enhanced convection (blue circle) was evident across the far western Pacific while suppressed convection (red circle) continued across the southern CONUS, Gulf of Mexico and Mexico.

In early June, enhanced convection was evident across parts of the Arabian Sea, India, the Bay of Bengal and the Caribbean with suppressed convection continuing across the southern CONUS, Gulf of Mexico and Mexico.

Suppressed convection developed across the Indian Ocean during mid-June while enhanced convection intensified near the Philippines. Drier-than-average conditions continued over the southern CONUS and Mexico.





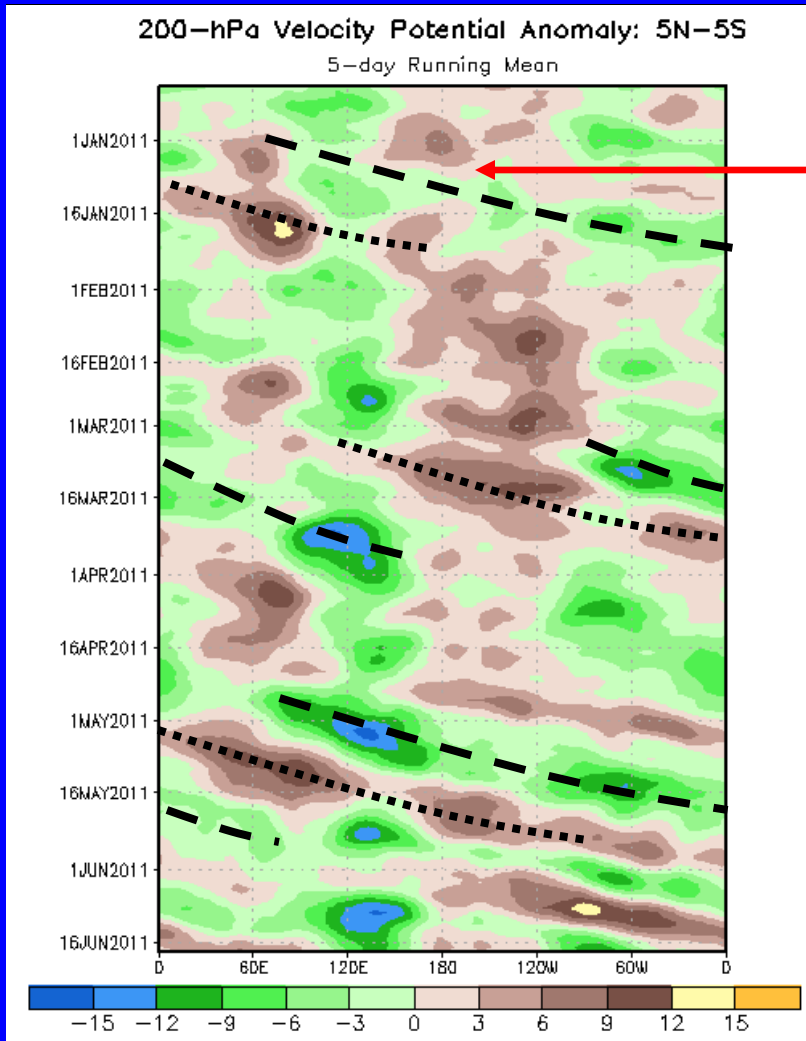


# 200-hPa Velocity Potential Anomalies (5 S-5 N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time  
↓



Longitude

During mid-to-late January, the MJO strengthened and upper-level divergence shifted eastward from 120E and upper-level convergence shifted from Africa to near the Date Line.

Eastward propagation of anomalies was observed during March associated with weak MJO activity.

Robust MJO activity was observed during late April into May as upper-level divergence (green shades) shifted eastward from the Indian Ocean beginning in early May followed by upper-level divergence (brown shades).

During June, very fast eastward propagation is evident and mainly associated with higher frequency subseasonal coherent tropical variability.

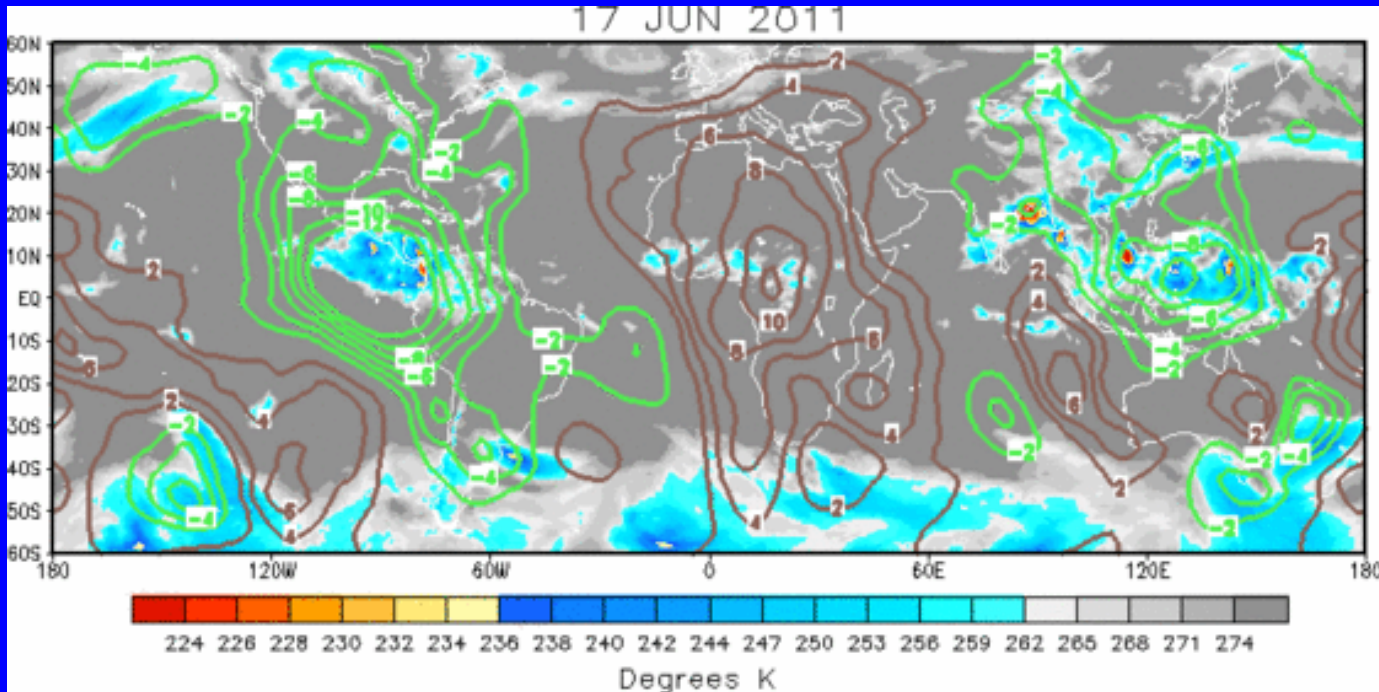




# IR Temperatures (K) / 200-hPa Velocity Potential Anomalies

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 strong anomalous upper-level divergence over Central America and near the Philippines, while anomalous upper-level convergence is observed over Africa.

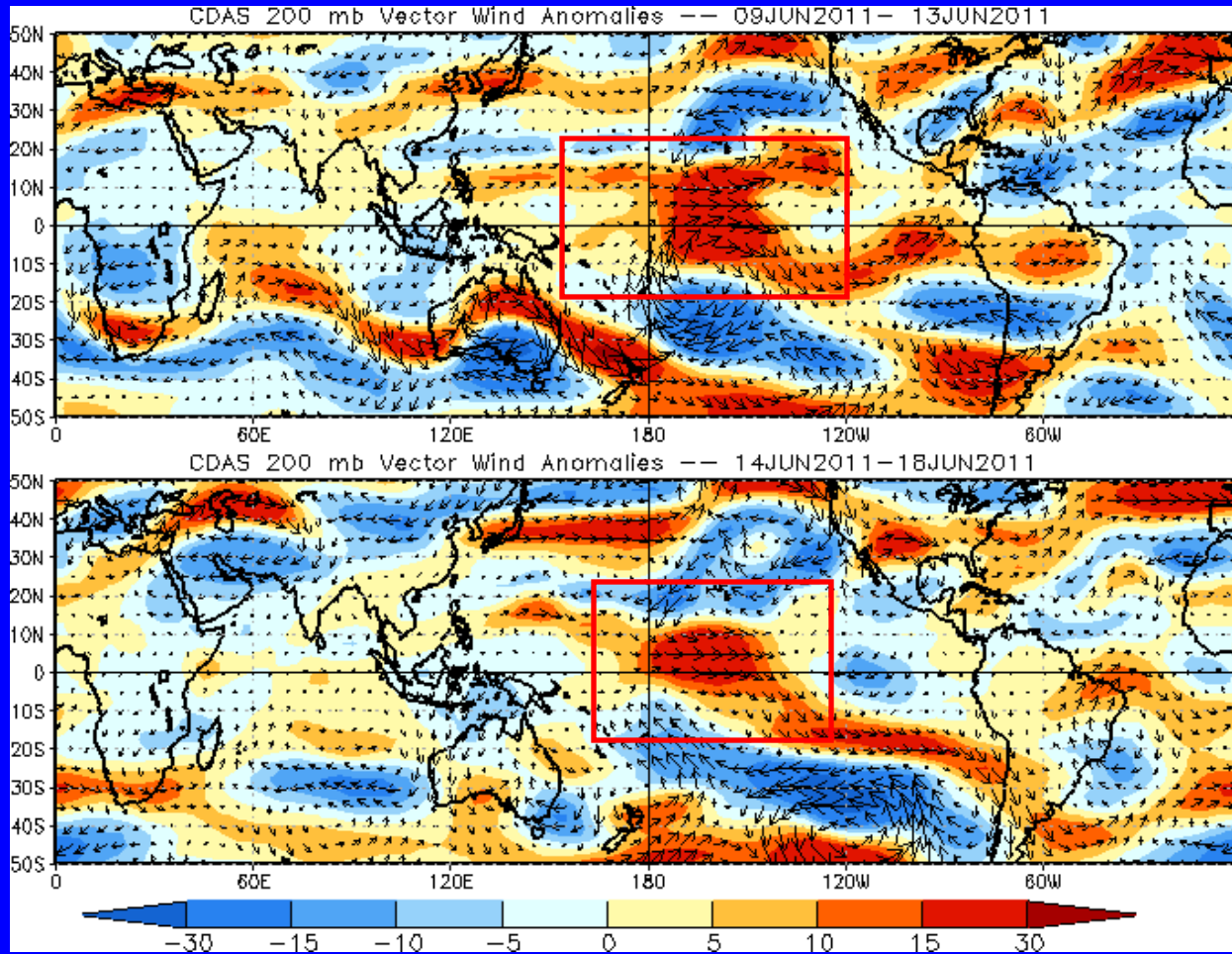


# 200-hPa Vector Wind Anomalies ( $\text{m s}^{-1}$ )

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



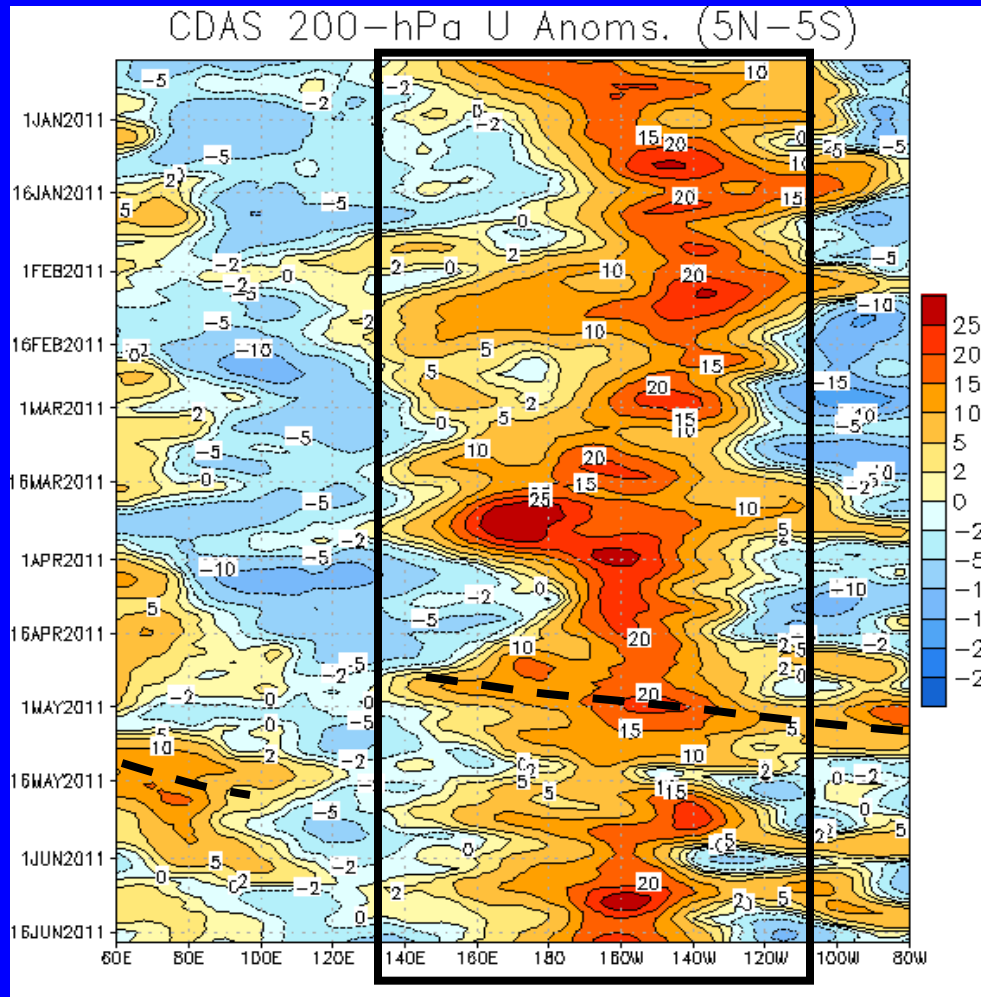
Westerly anomalies continue across the central Pacific Ocean (red boxes).



# 200-hPa Zonal Wind Anomalies ( $\text{m s}^{-1}$ )

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

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

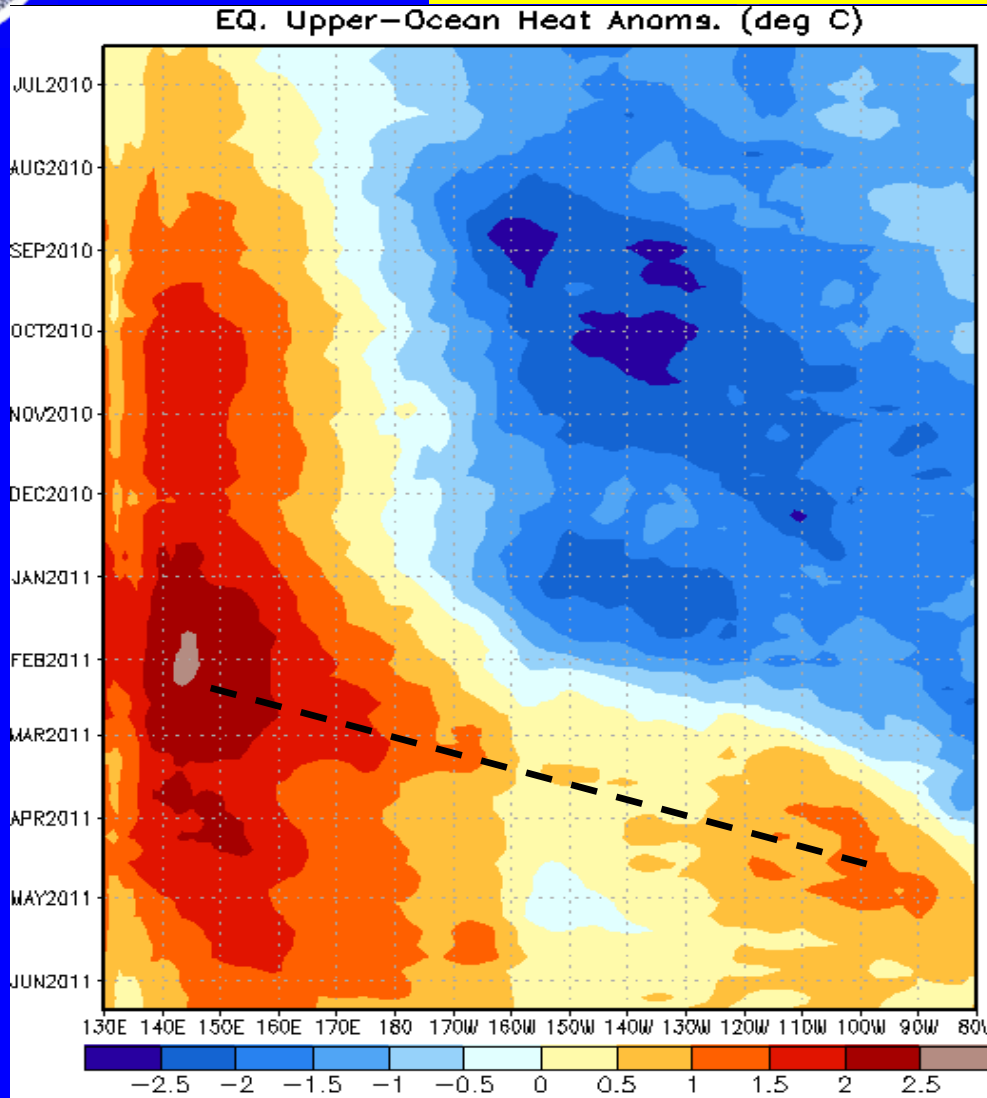


Westerly anomalies persisted across a large area from the Maritime Continent to the central Pacific (black solid box) since November.

Significant eastward propagation of westerly anomalies was evident in late April and May (dashed line) associated with the MJO.



# Weekly Heat Content Evolution in the Equatorial Pacific



Beginning in 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.

Since the beginning of January 2011, positive heat content anomalies have shifted eastward, while negative heat content anomalies weakened and then became positive across much of the Pacific basin.

An oceanic Kelvin wave (dashed line) shifted eastward during February and March 2011.





# 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.

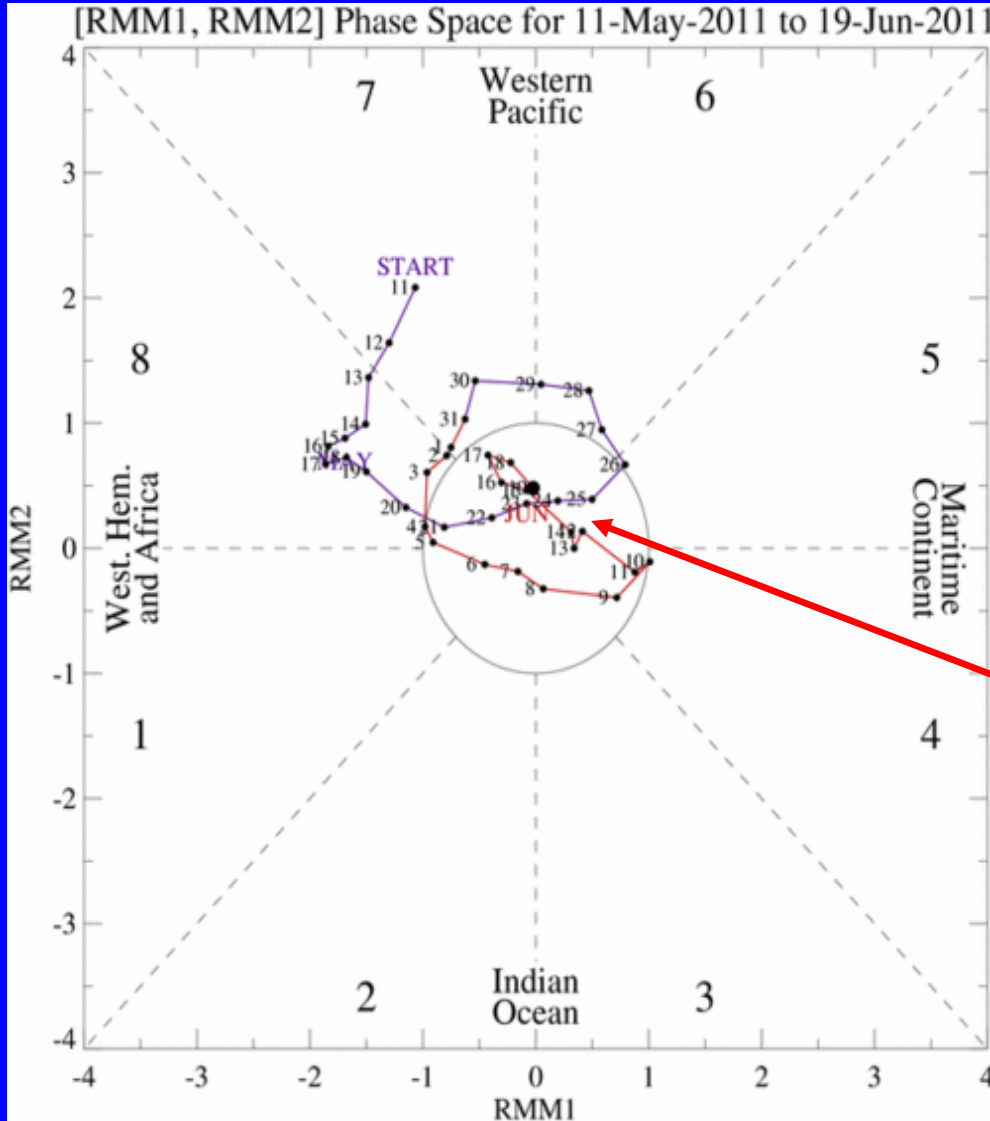
**Gottschalck et al. 2010: A Framework for Assessing Operational Madden-Julian Oscillation Forecasts: A CLIVAR MJO Working Group Project, *Bull. Amer. Met. Soc.*, 91, 1247-1258.**

- 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

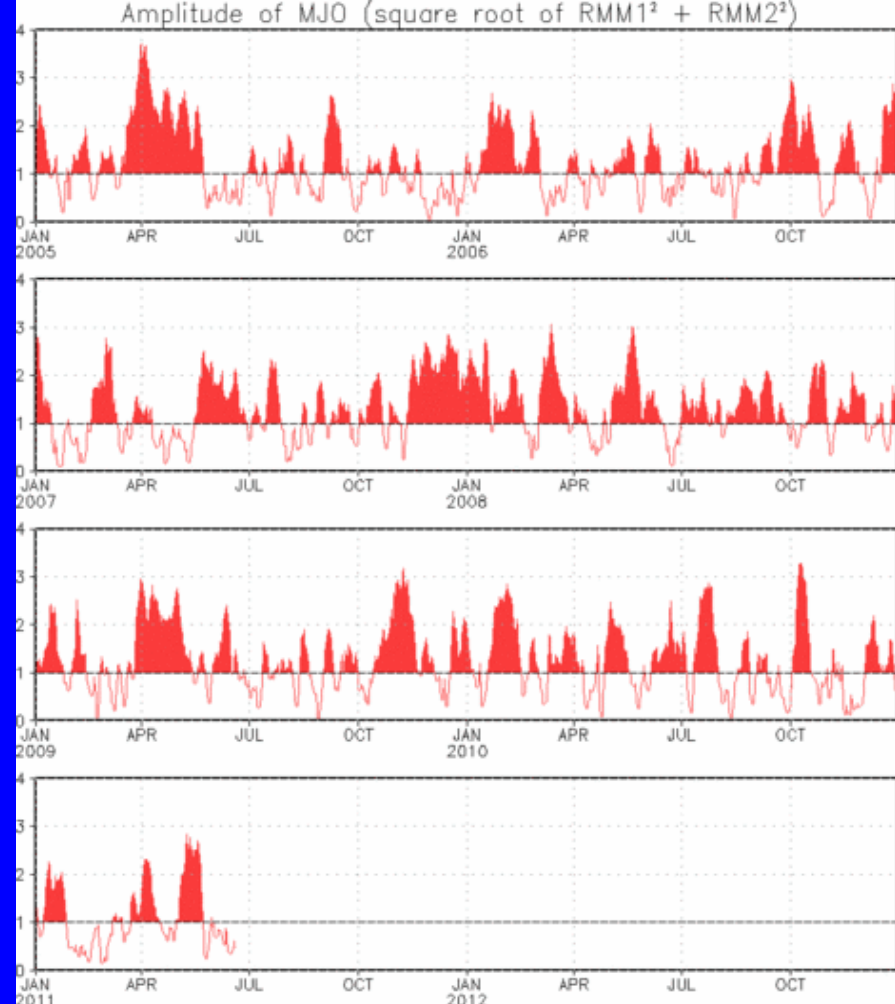
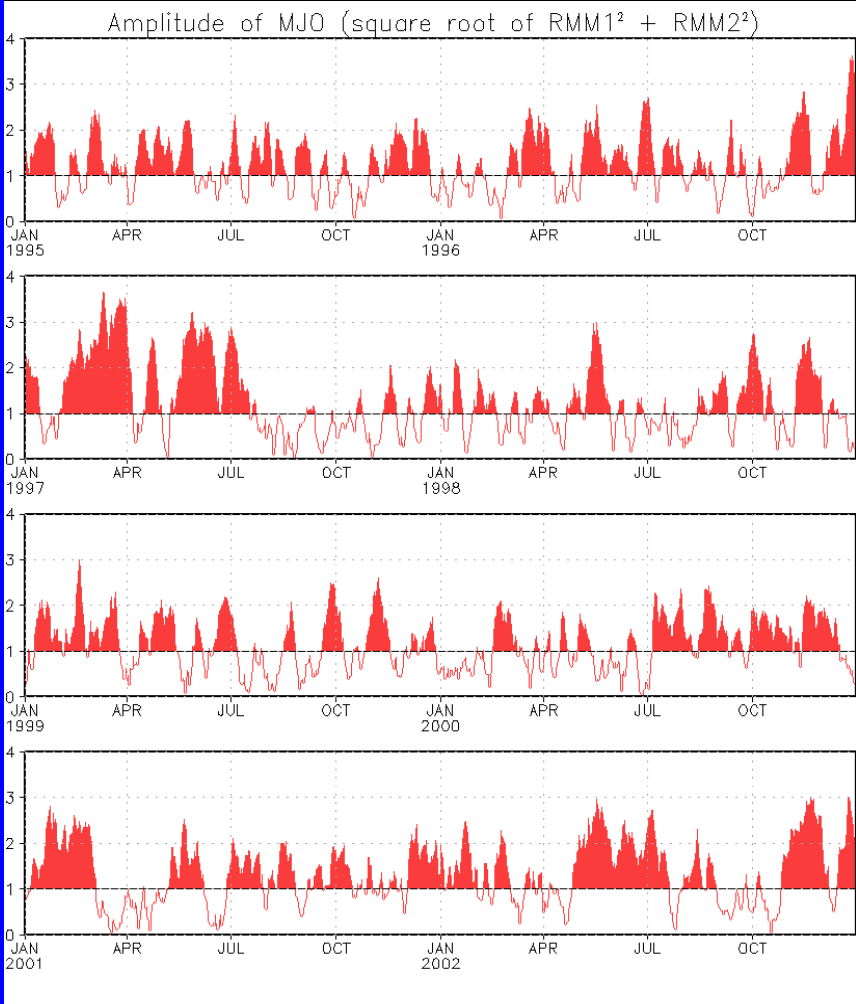


The MJO index indicates continued weak activity during the past week.





# 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.



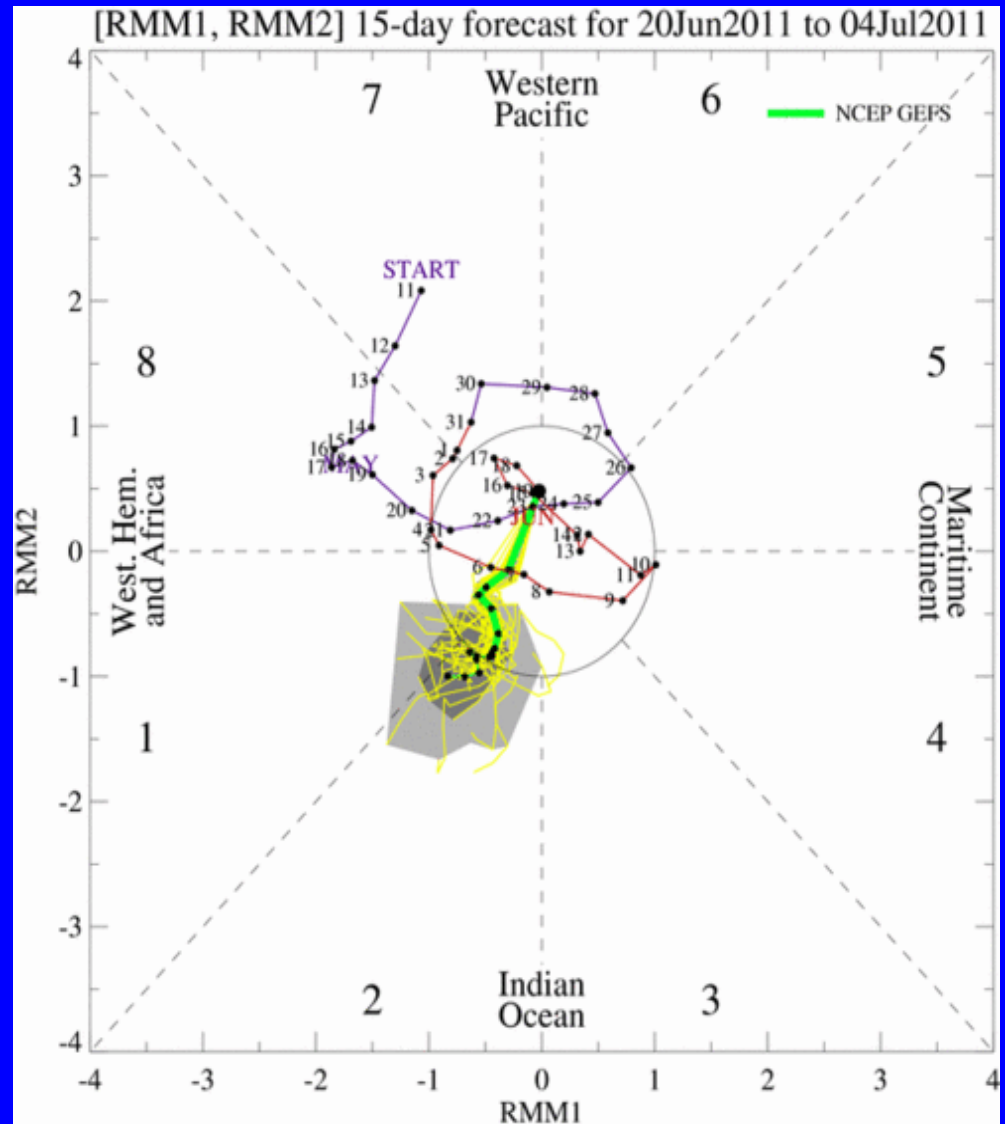
# Ensemble GFS (GEFS) MJO Forecast

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 ensemble GFS forecasts generally indicate continued weak activity during the next two weeks.



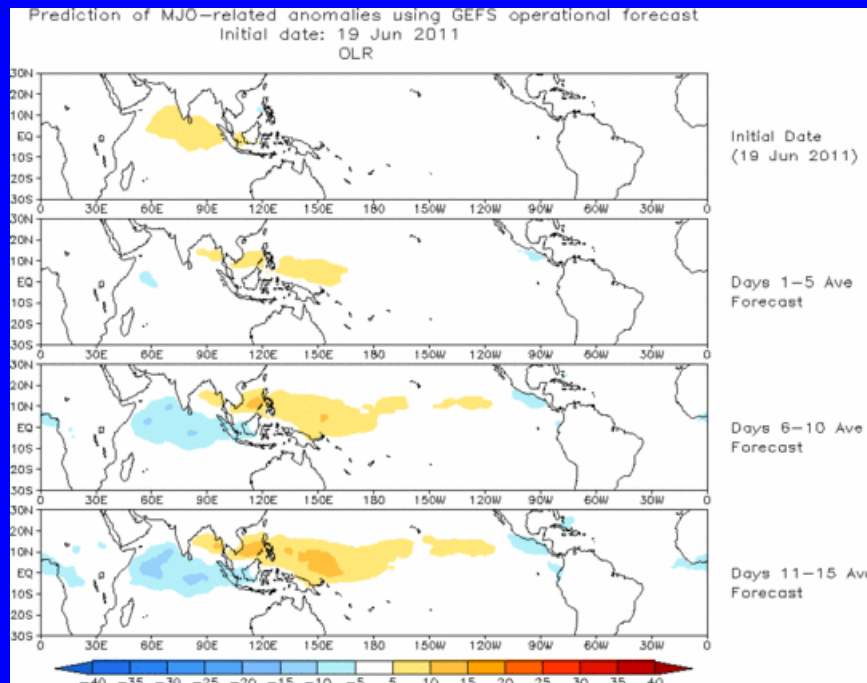


# Ensemble Mean GFS MJO Forecast

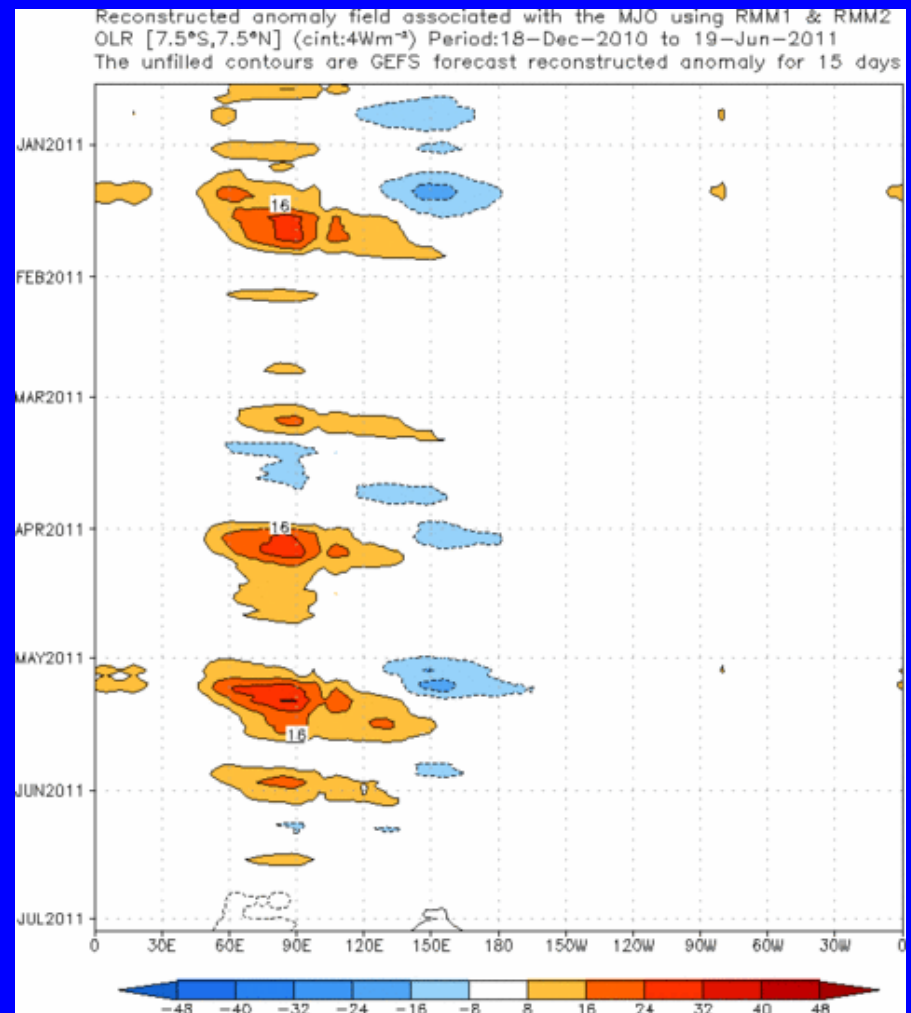
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

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 a very weak signal with only minor enhanced (suppressed) convection for the Indian Ocean (western Pacific) during Week-2.





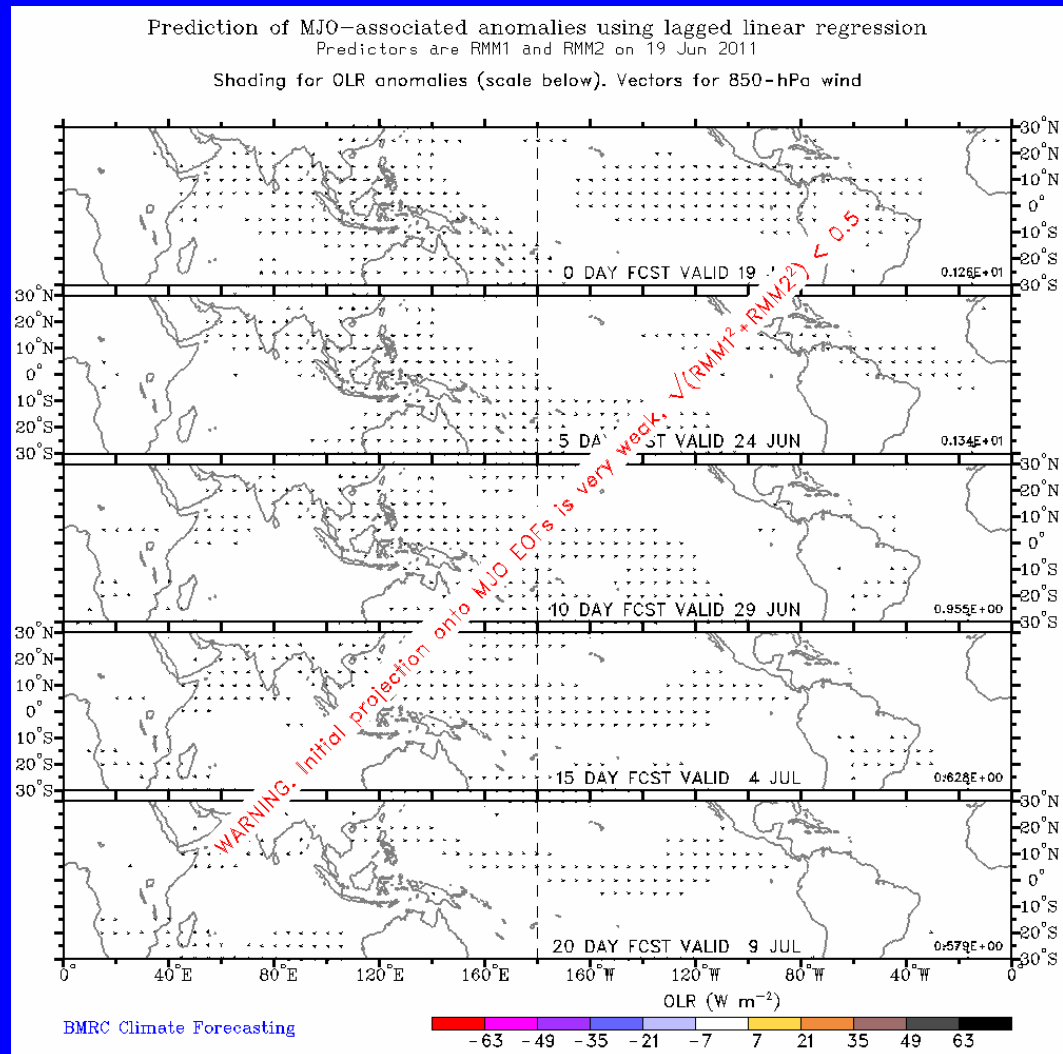
# Statistical MJO Forecast

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 forecast calls for little MJO activity during the period.



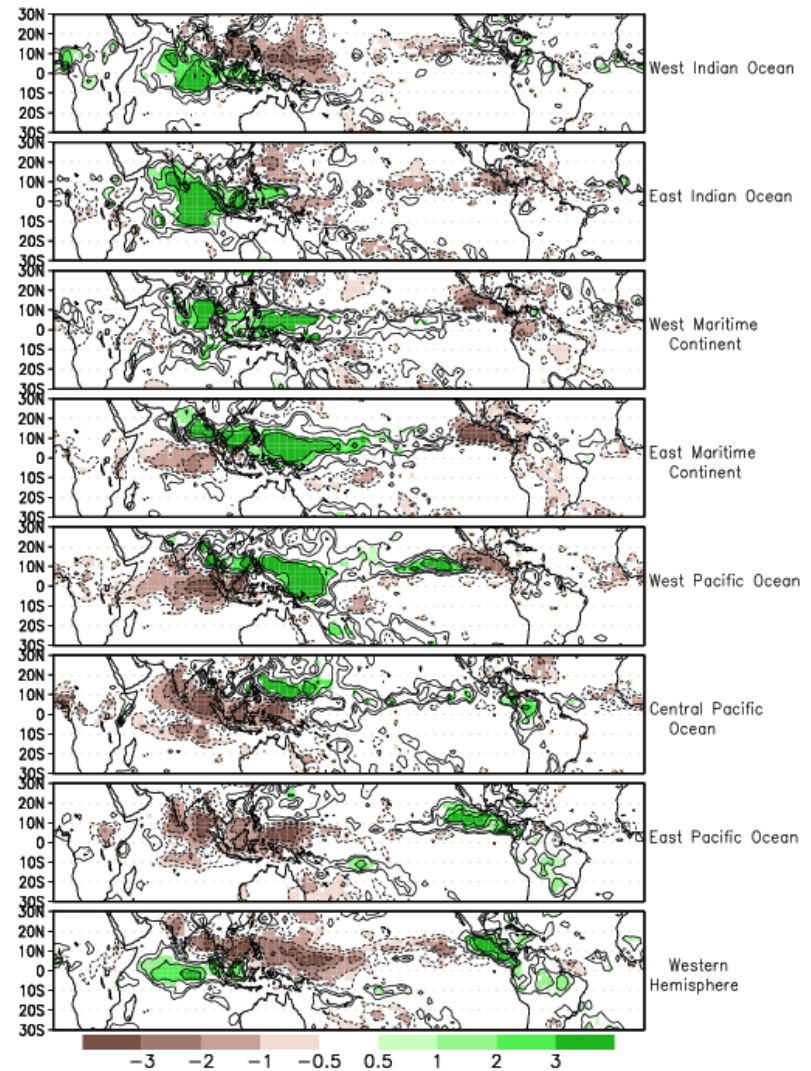
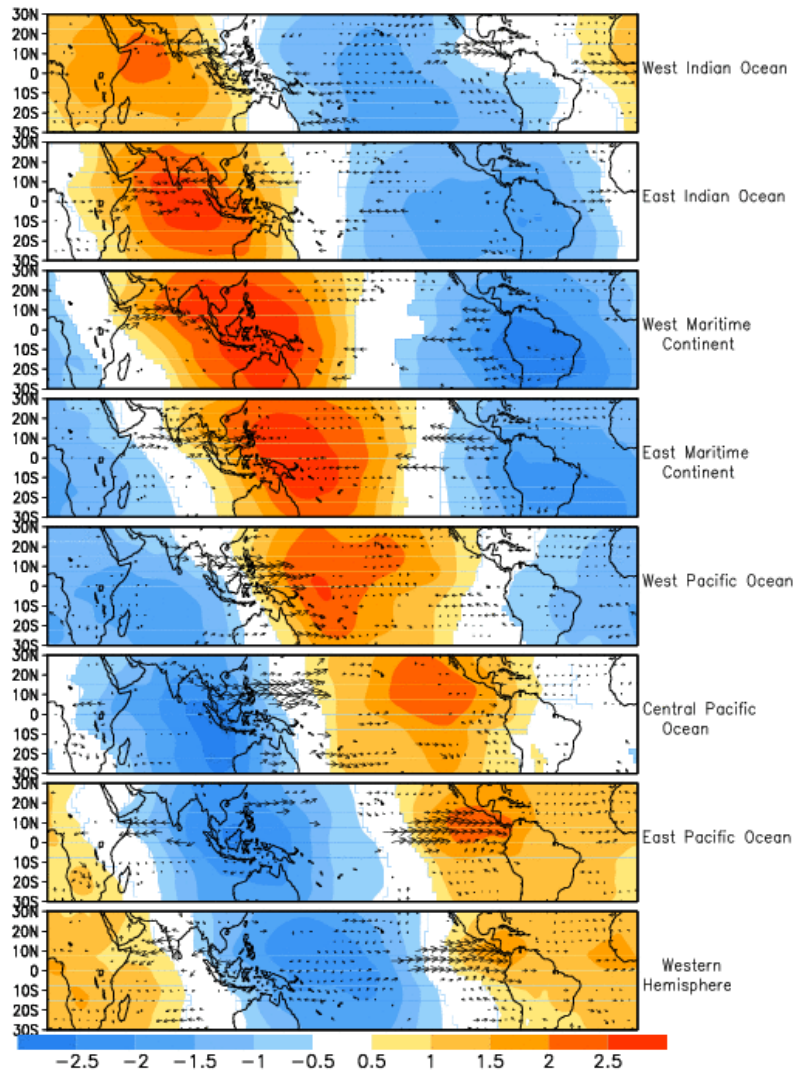




# MJO Composites – Global Tropics

## 850-hPa Wind Anomalies (May-Sep)

## Precipitation Anomalies (May-Sep)

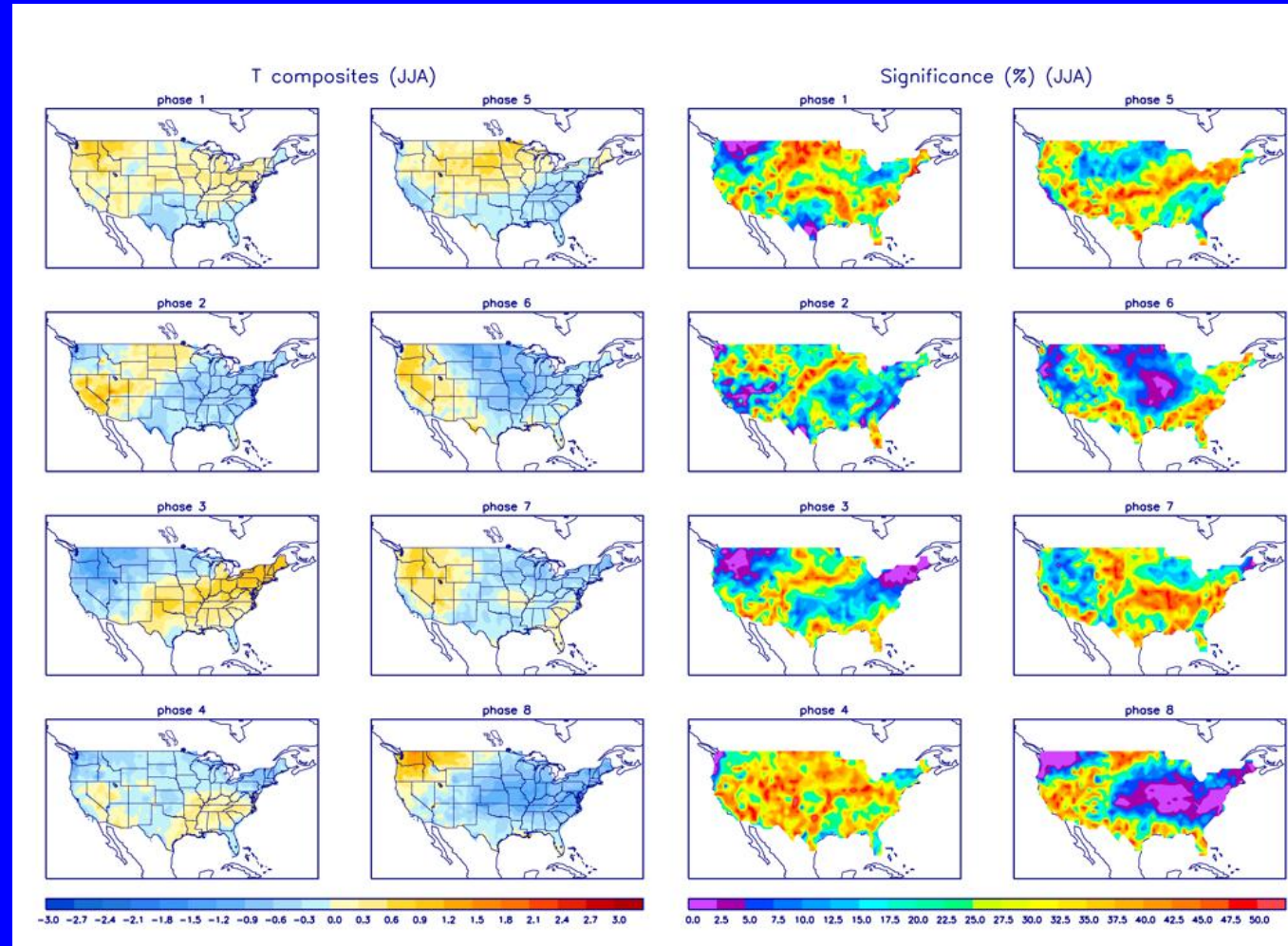




# U.S. MJO Composites – Temperature

Left hand side plots show temperature anomalies by MJO phase for MJO events that have occurred over the three month period in the historical record. Blue (orange) shades show negative (positive) anomalies respectively.

Right hand side plots show a measure of significance for the left hand side anomalies. Dark blue and purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.



Zhou et al. (2010): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, Submitted.

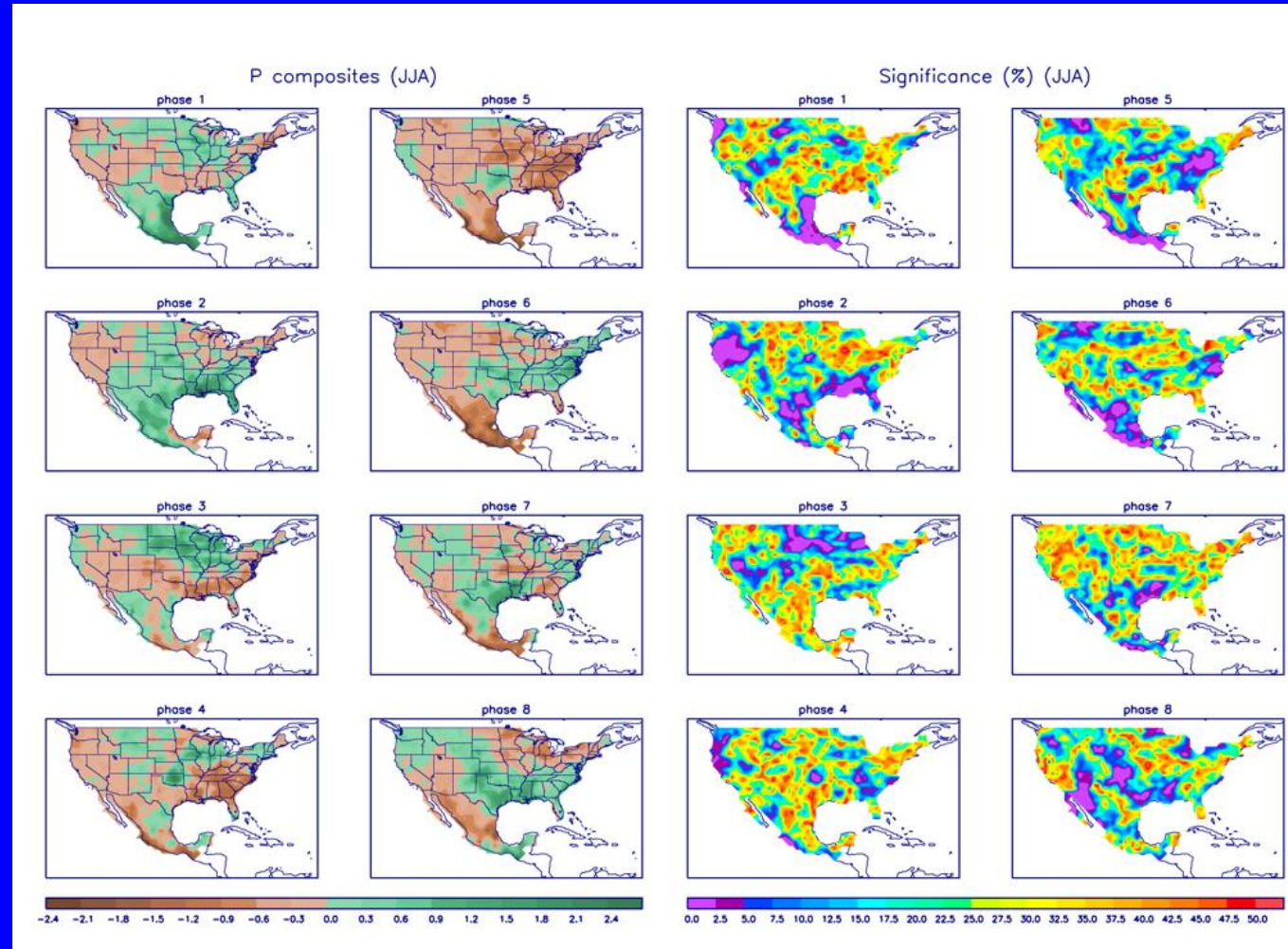
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml>





# U.S. MJO Composites – Precipitation

- Left hand side plots show precipitation anomalies by MJO phase for MJO events that have occurred over the three month period in the historical record. Brown (green) shades show negative (positive) anomalies respectively.
- Right hand side plots show a measure of significance for the left hand side anomalies. Dark blue and purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.



Zhou et al. (2010): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, Submitted.

<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml>