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

Update prepared by
Climate Prediction Center / NCEP
May 30, 2011

Outline

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

Overview

- The MJO signal was generally 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, but show a tendency for an increase in signal in proximity to the Western Hemisphere / Africa in Week-2.
- Based on the latest observations and some MJO index model forecasts, the MJO is not expected to contribute significantly to rainfall anomalies across the Tropics.

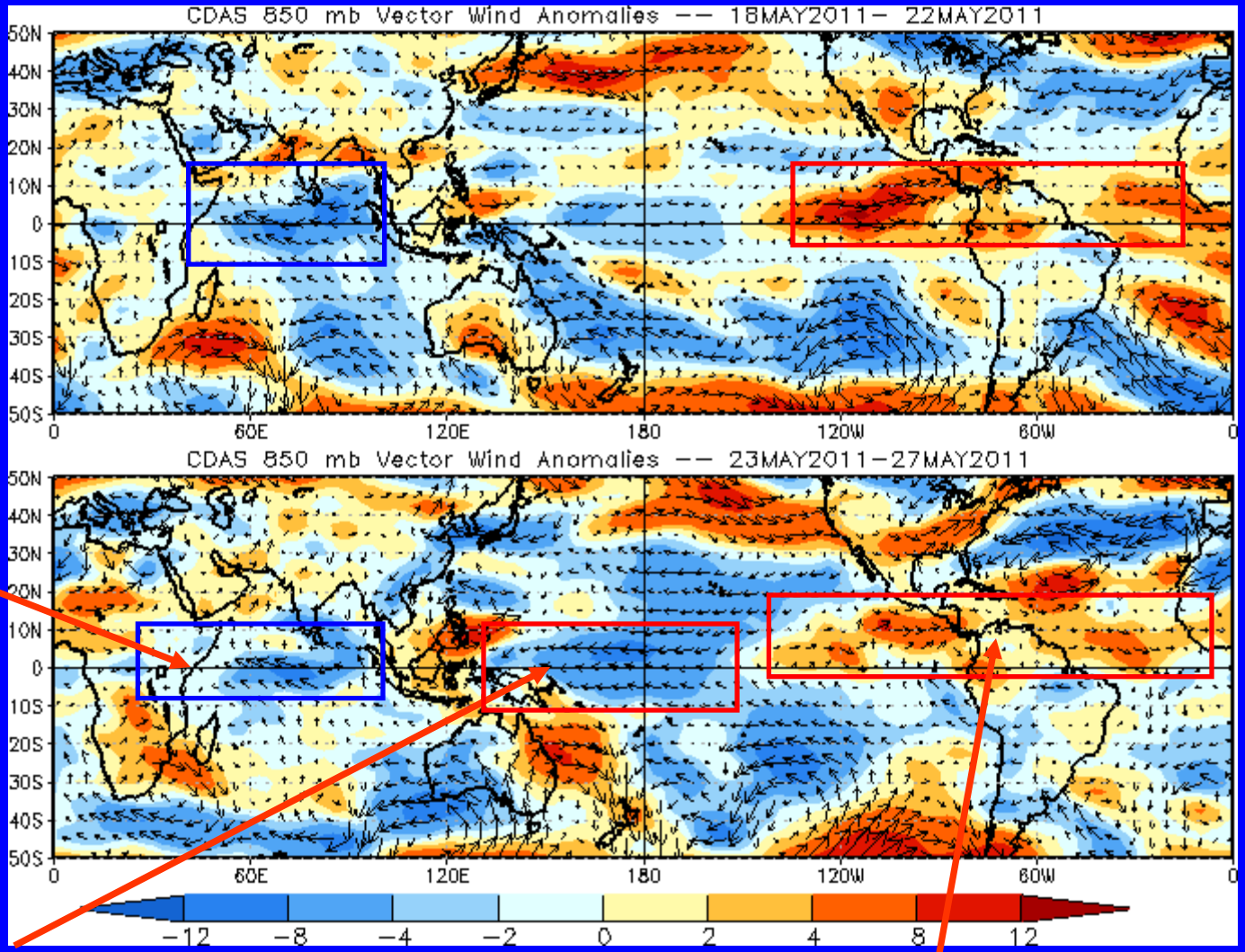
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Easterly anomalies persisted across the equatorial Indian Ocean during the last five days, but have weakened.

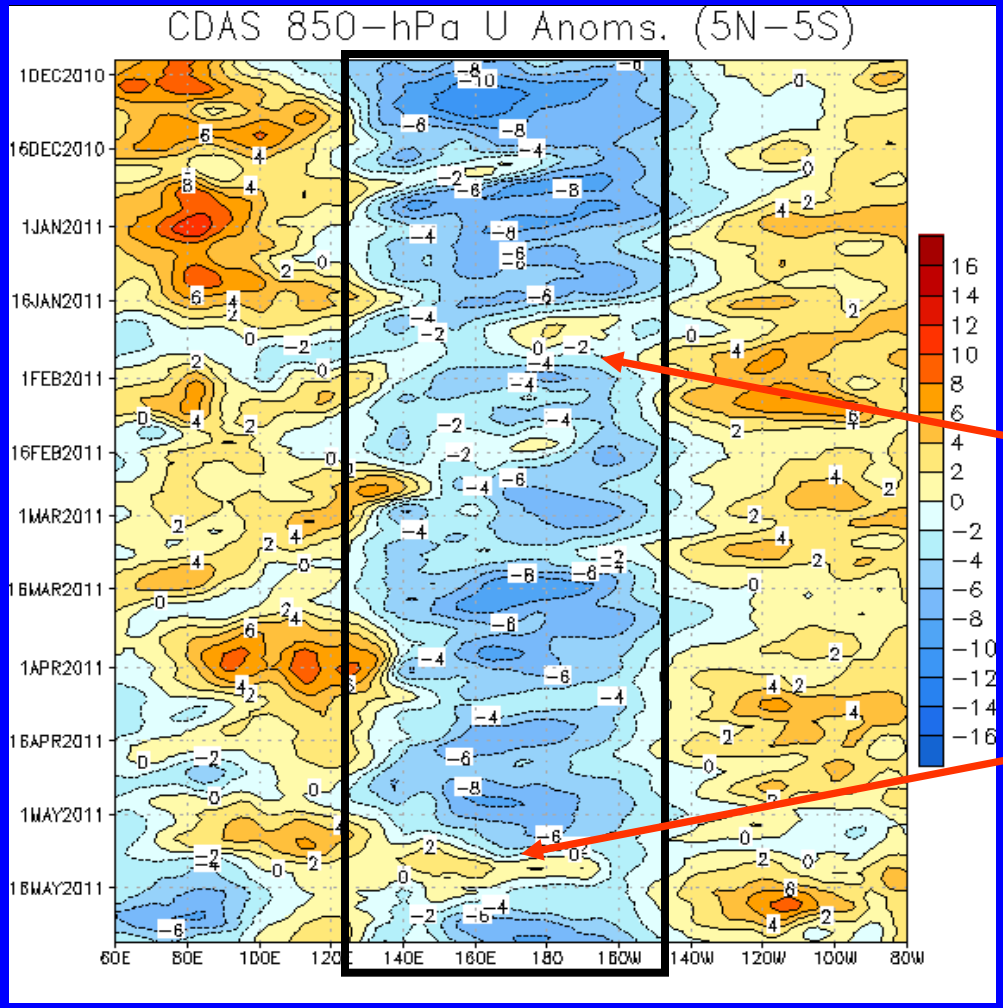
Easterly anomalies increased in coverage and magnitude during the last five days across the western Pacific.

Westerly anomalies persisted across the eastern Pacific Ocean and most of the tropical Atlantic Basin but with a decrease in magnitude.

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

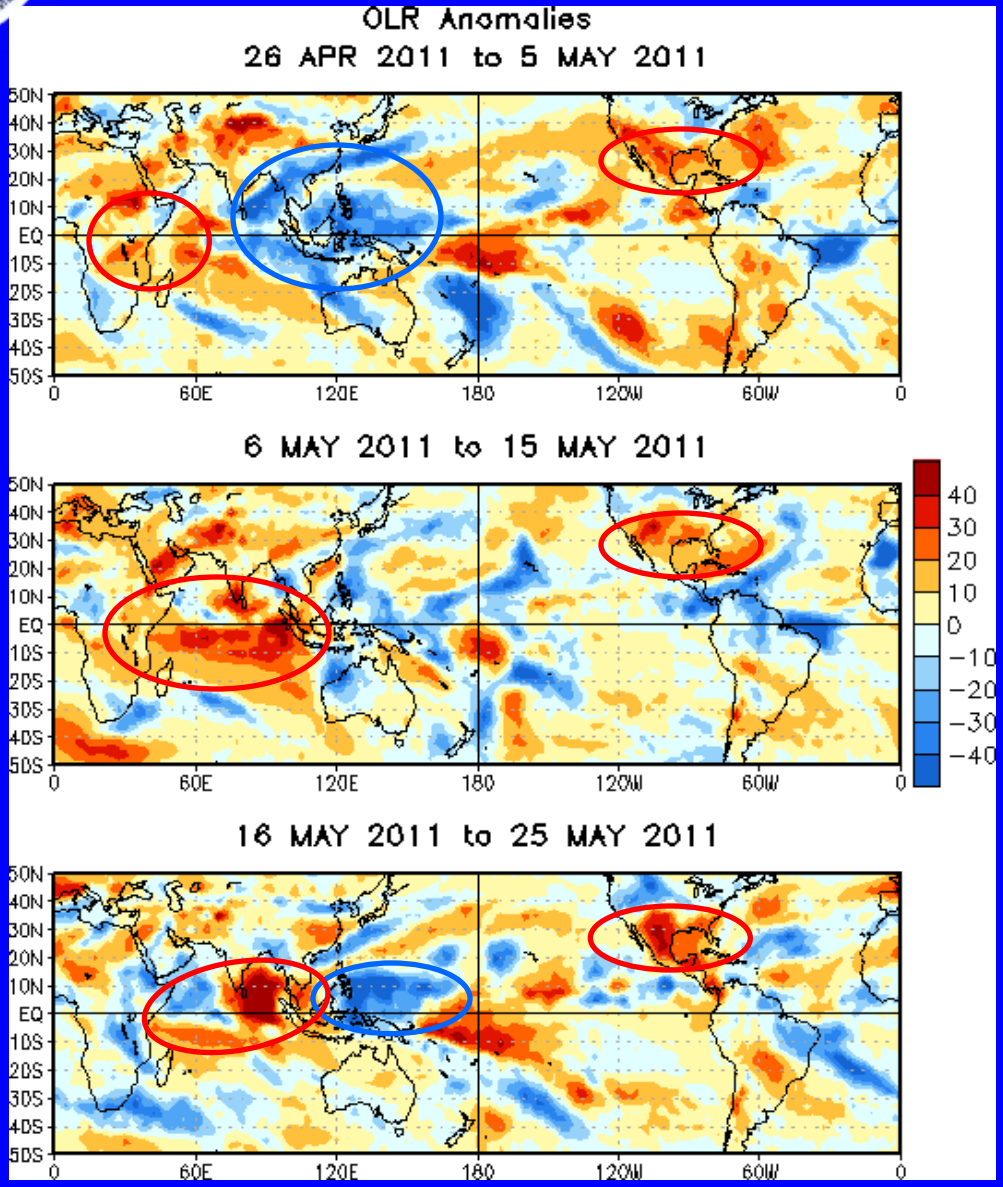
Longitude

Easterly anomalies have persisted in the west-central Pacific since October (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 recent burst of westerly winds associated with the MJO moved across the Pacific early-to-mid May. Most recently, easterly anomalies have returned to the western Pacific.

OLR Anomalies – Past 30 days



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

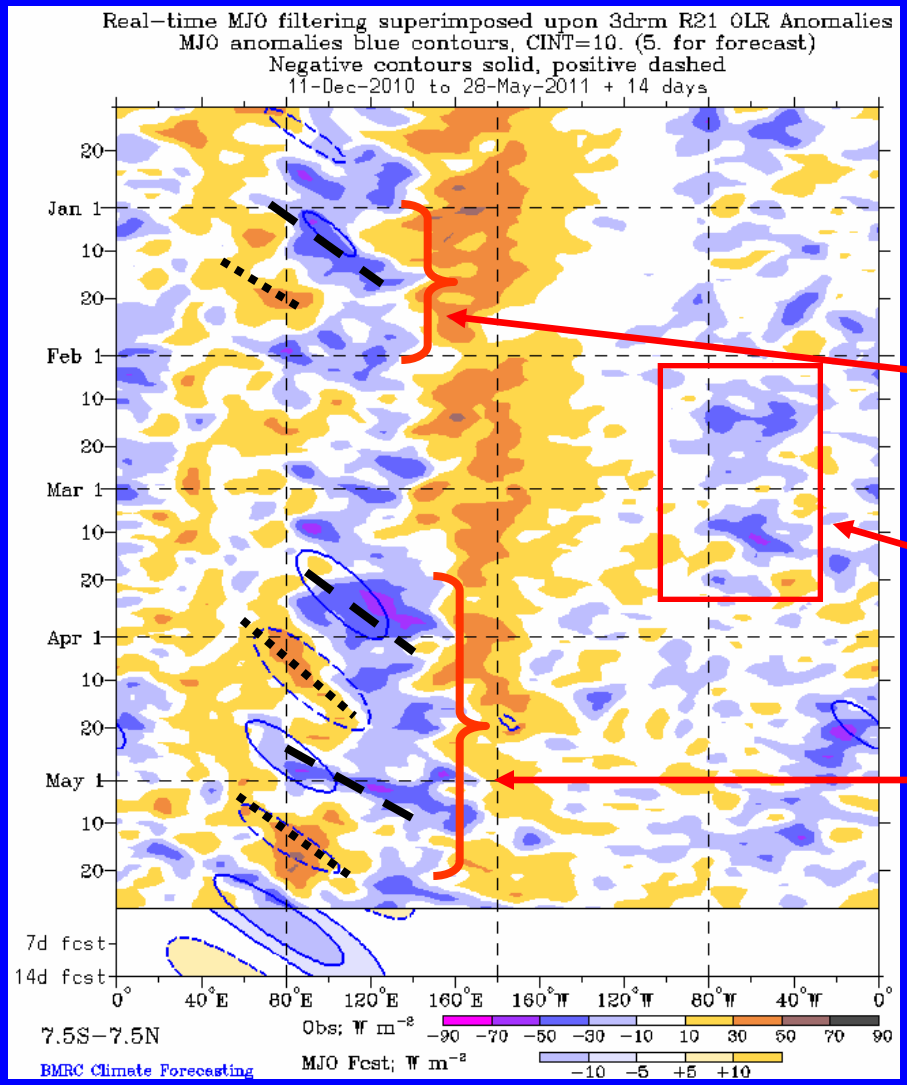
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

During late April into early May, enhanced convection continued from the eastern Indian Ocean to the Western Pacific while suppressed convection continued across parts of Africa and the southern CONUS.

Enhanced convection over the Eastern Hemisphere dramatically decreased during early-to-mid May. Suppressed convection developed across the Indian Ocean.

During mid-to-late May, some enhanced convection intensified across the far western Pacific. Residual suppressed convection continued across parts of the Indian Ocean.

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



Time

Longitude

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)

Weak MJO activity was experienced during January. Enhanced convection developed near 80E and shifted to the Maritime continent followed by an area of suppressed convection.

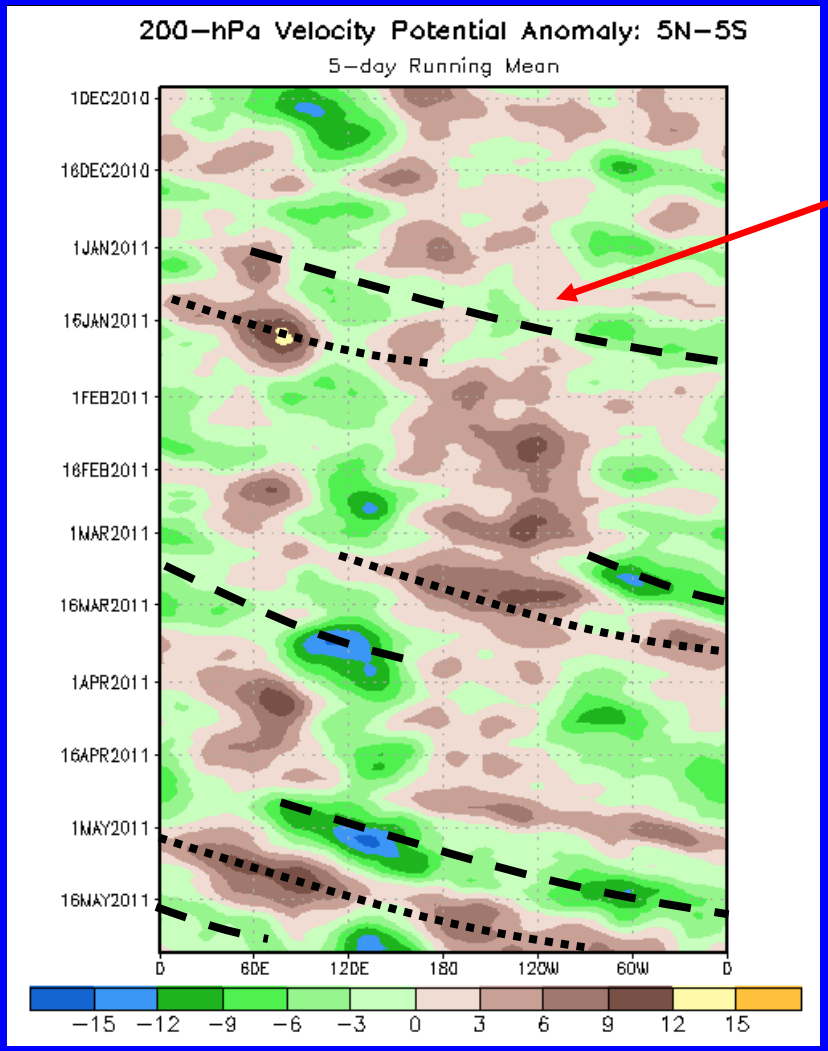
Enhanced convection was evident across northern South America during much of February and March.

During late March and again in late April, two periods of distinct eastward movement of enhanced convection are noted followed by suppressed convection associated with MJO activity.

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.

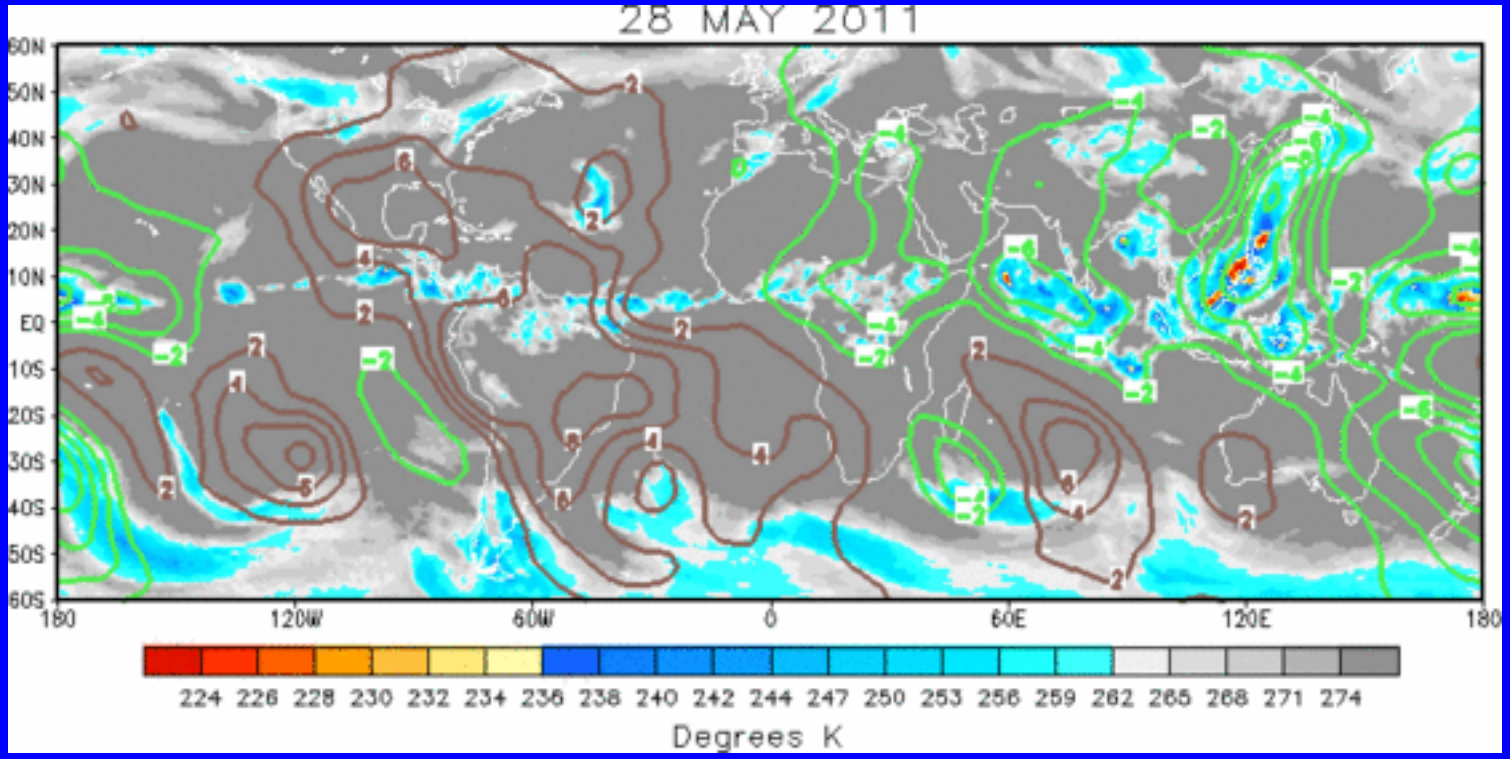
Eastward propagation of anomalies was observed during March associated with weak MJO activity.

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

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

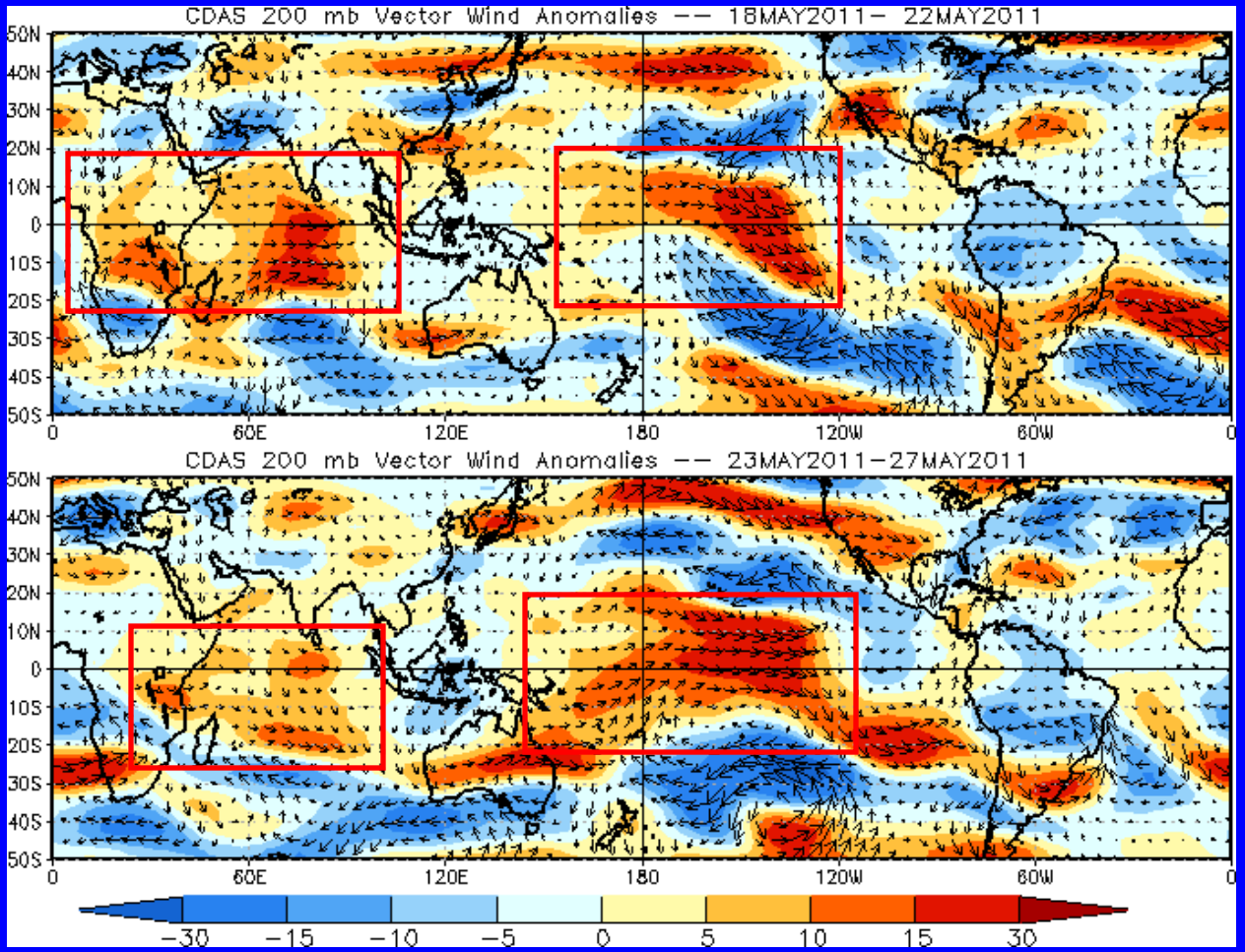
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The large scale velocity potential pattern shows anomalous upper-level divergence over portions of the Indian Ocean and western Pacific and anomalous upper-level convergence mainly over the Americas.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

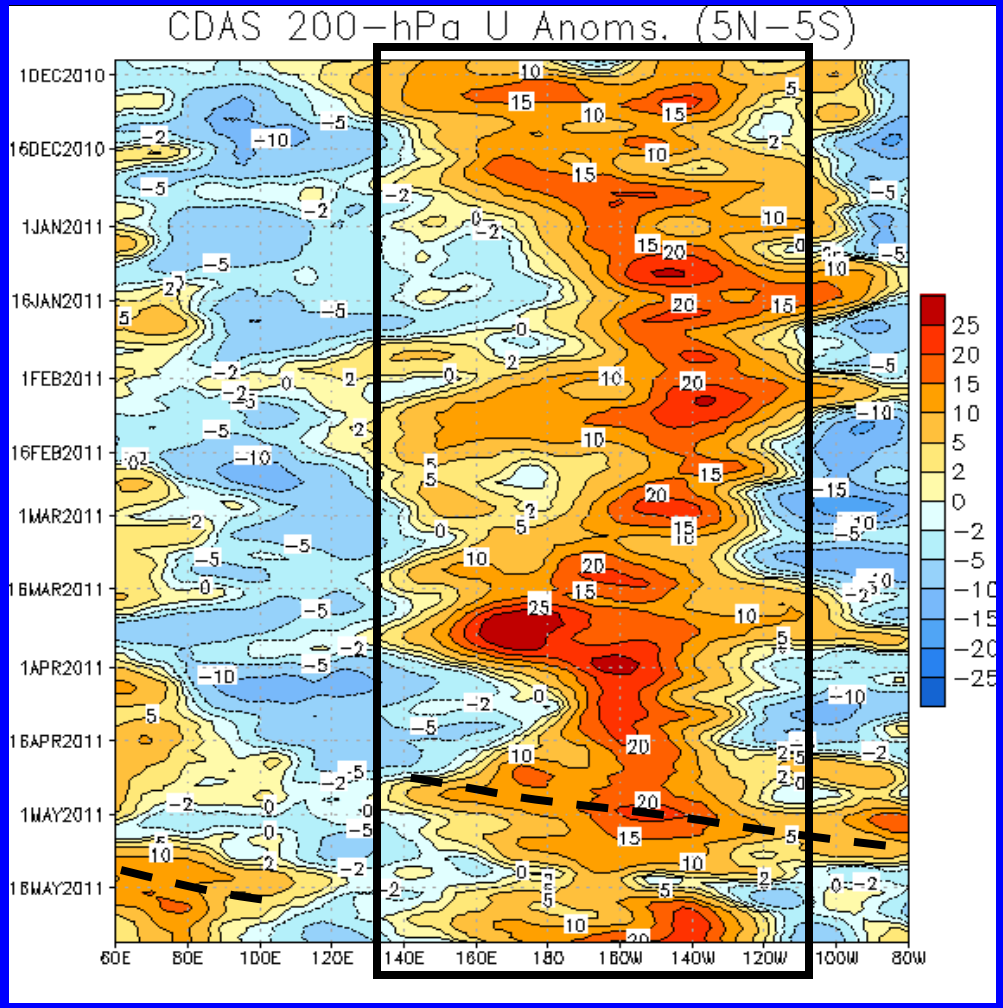
Red shades: Westerly anomalies

Westerly anomalies weakened across the Indian Ocean during the last five days while the westerly anomalies over the central Pacific increased in coverage (red boxes).

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



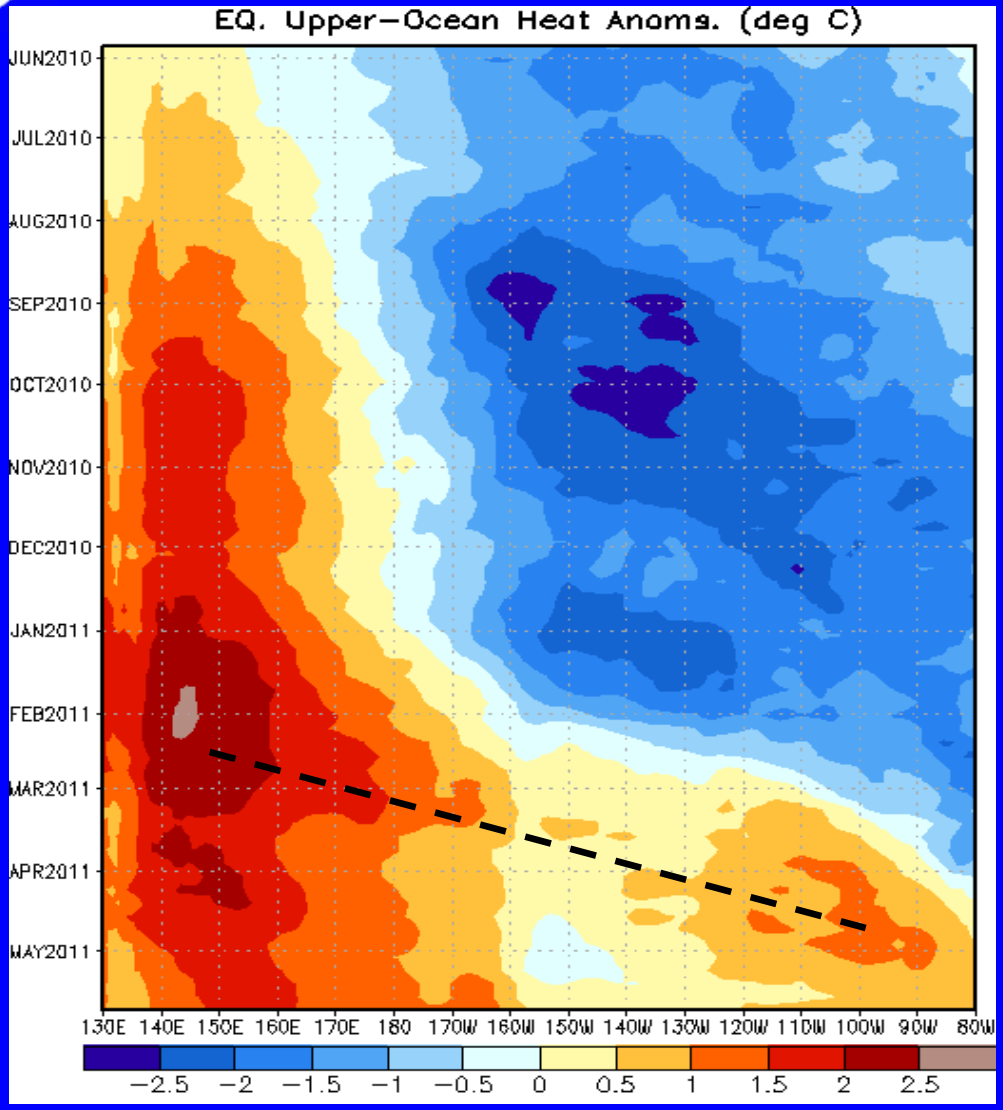
Time

Longitude

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



Time

Longitude

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).

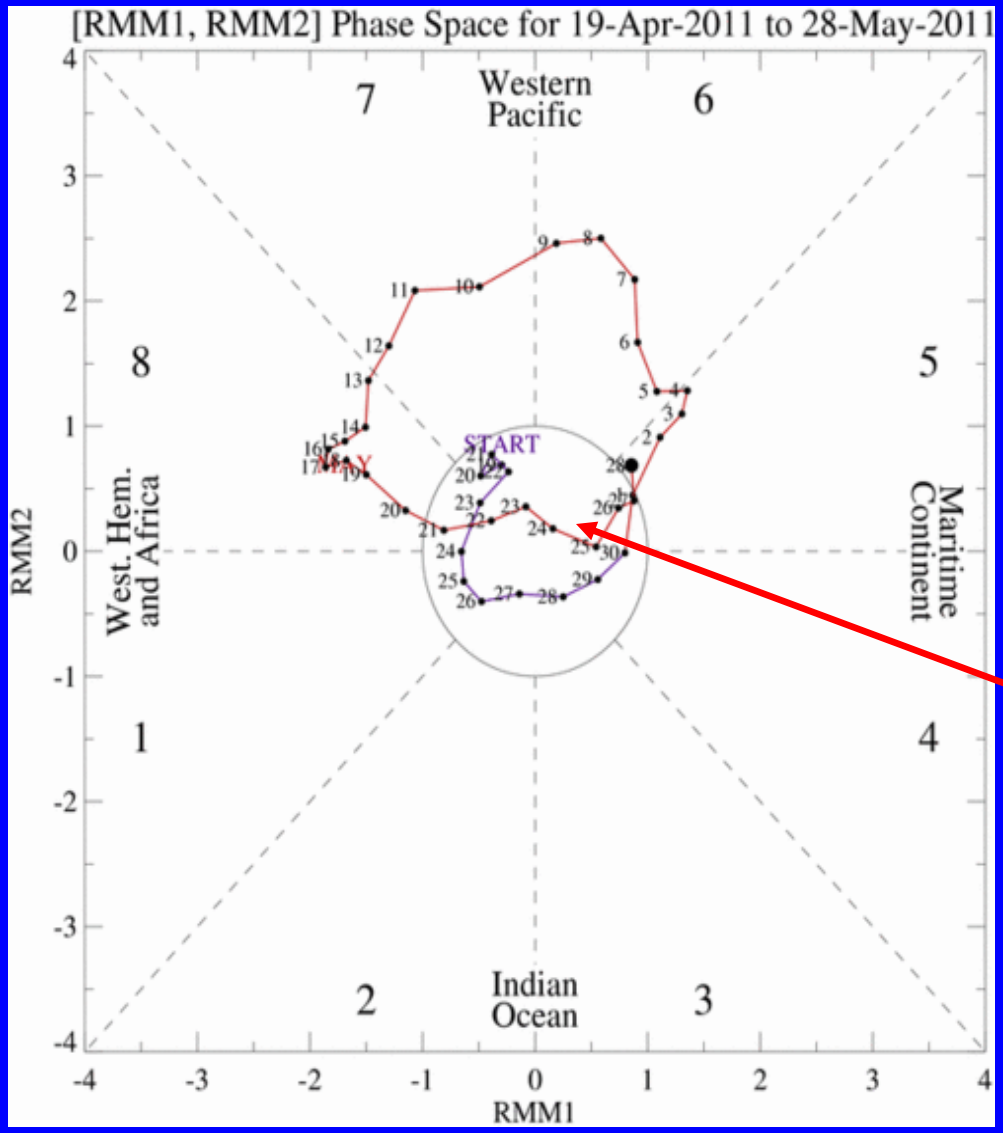
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review,* 132, 1917-1932.

• 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).

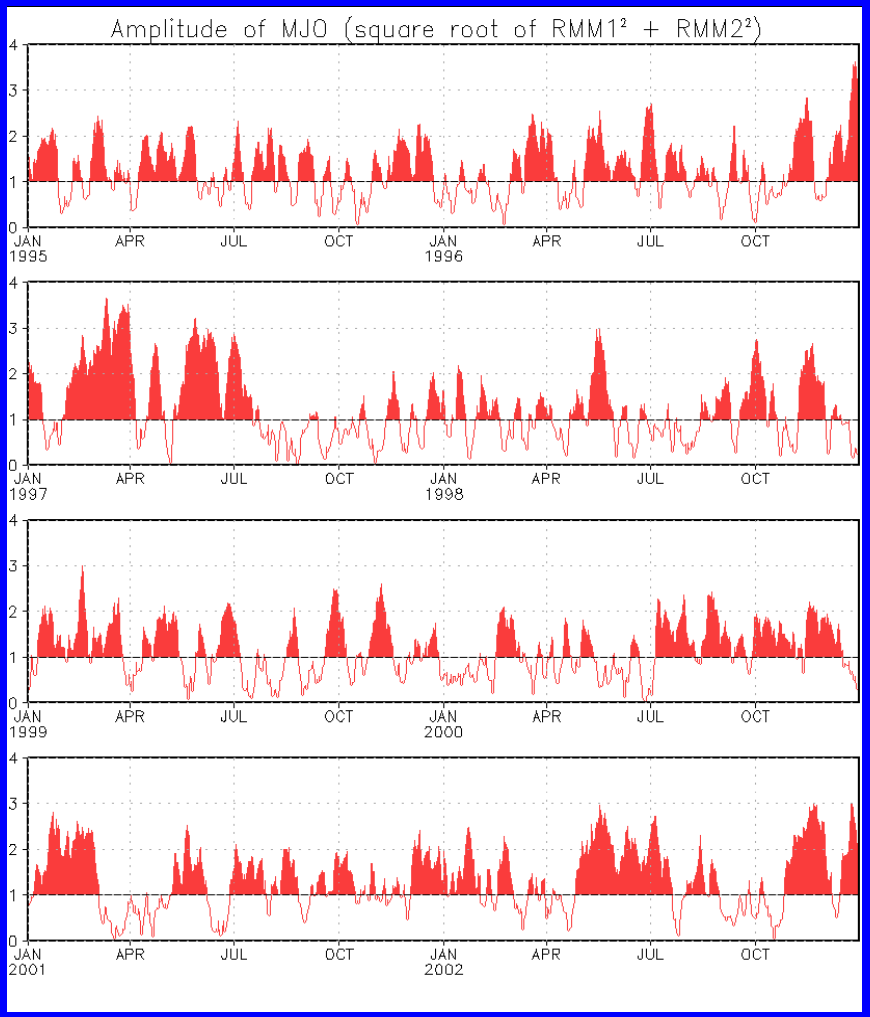
MJO Index -- Recent Evolution

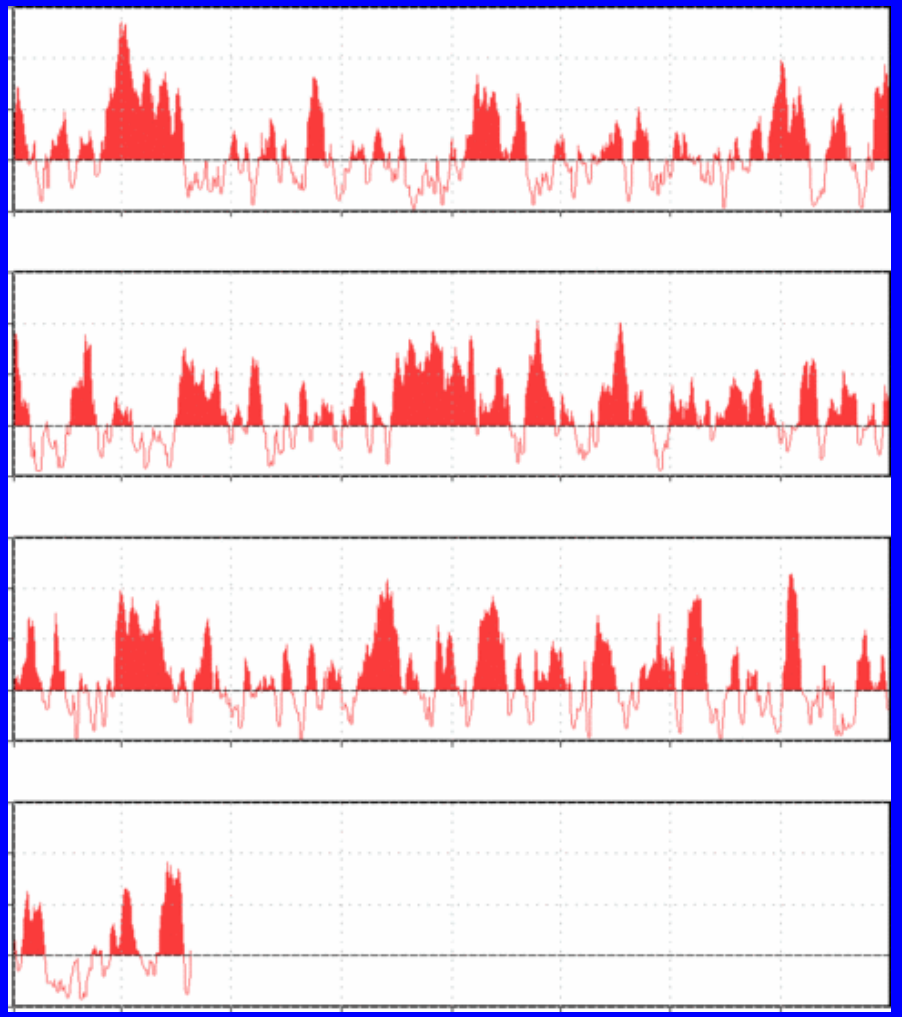


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index indicates weak activity during the past week with a slight increase in amplitude in recent days towards phases 5 and 6.

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.

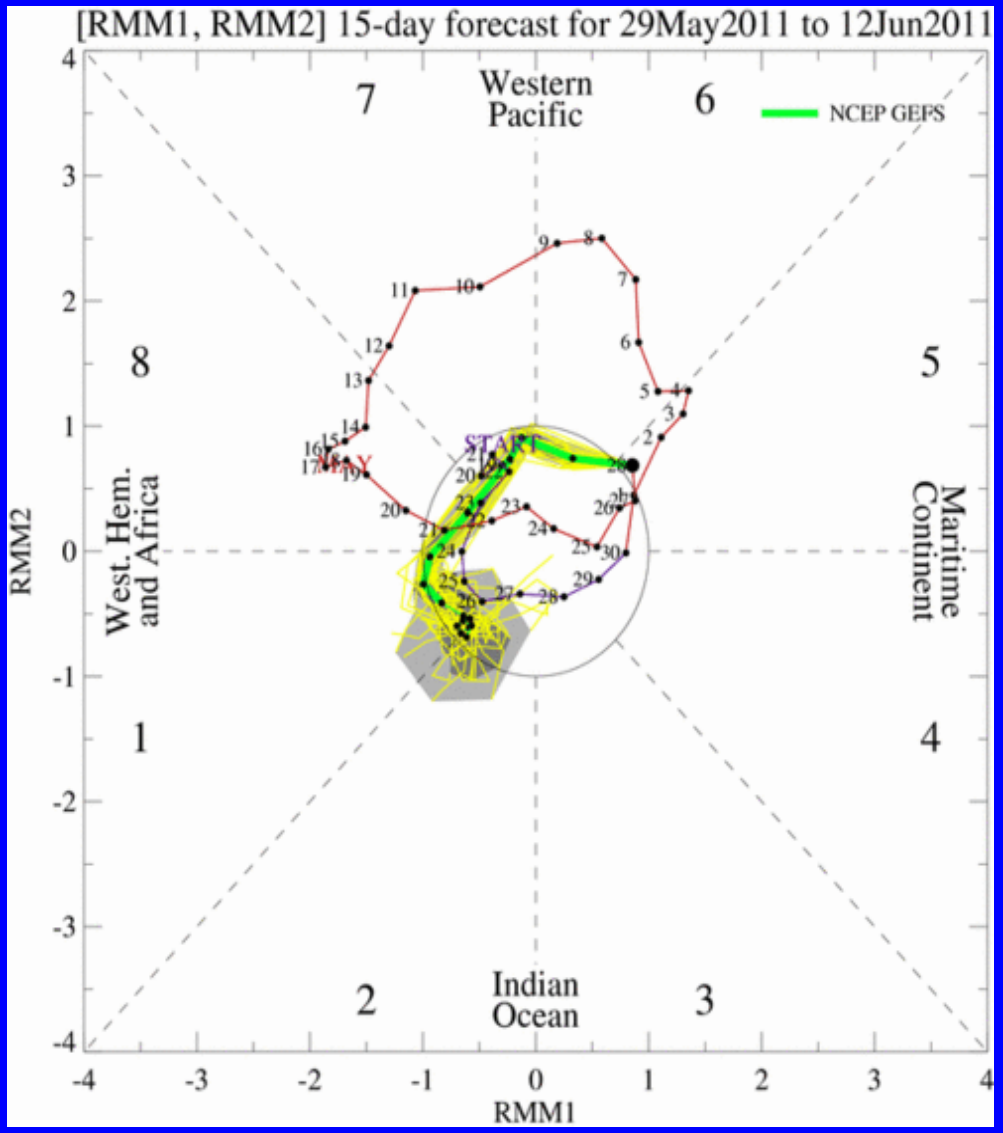
Ensemble GFS (GEFS) MJO Forecast

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 few weeks.



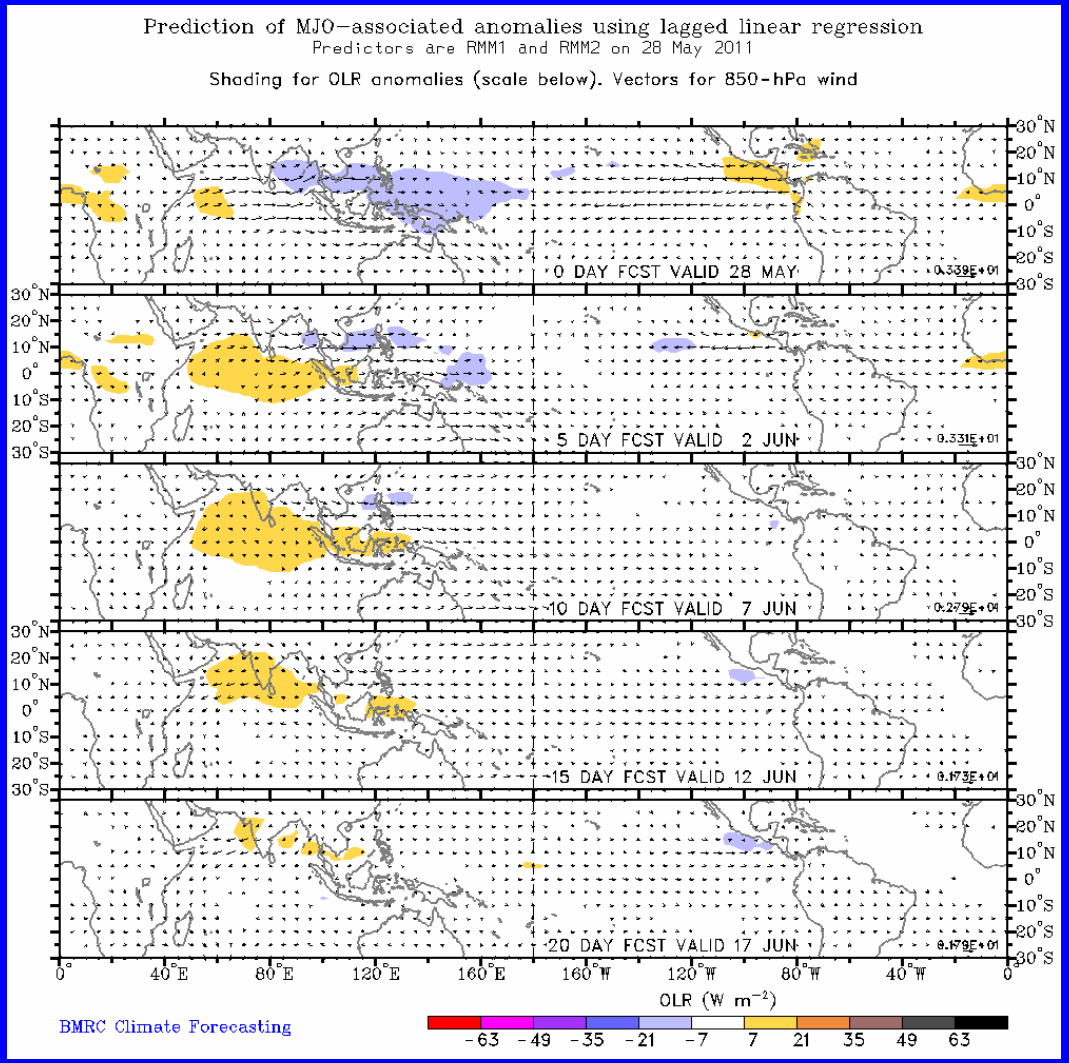
Statistical MJO Forecast

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

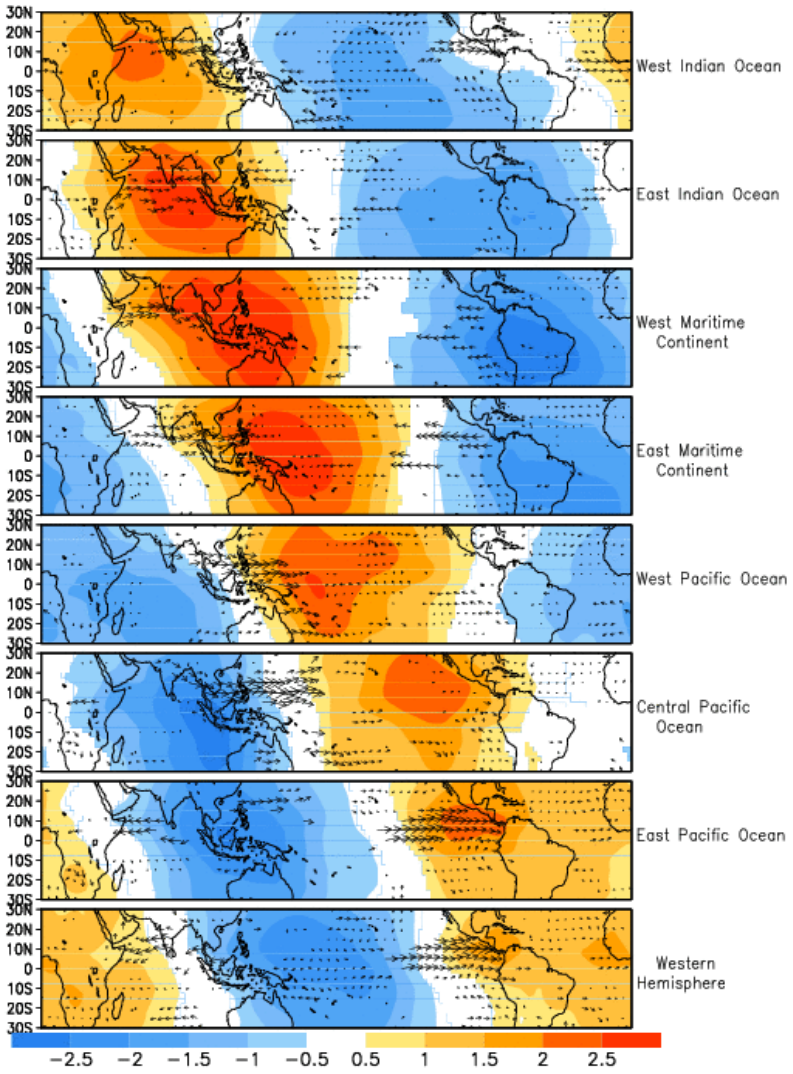
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The forecast calls for weak MJO activity during the period with suppressed convection developing across the Indian Ocean during the period.

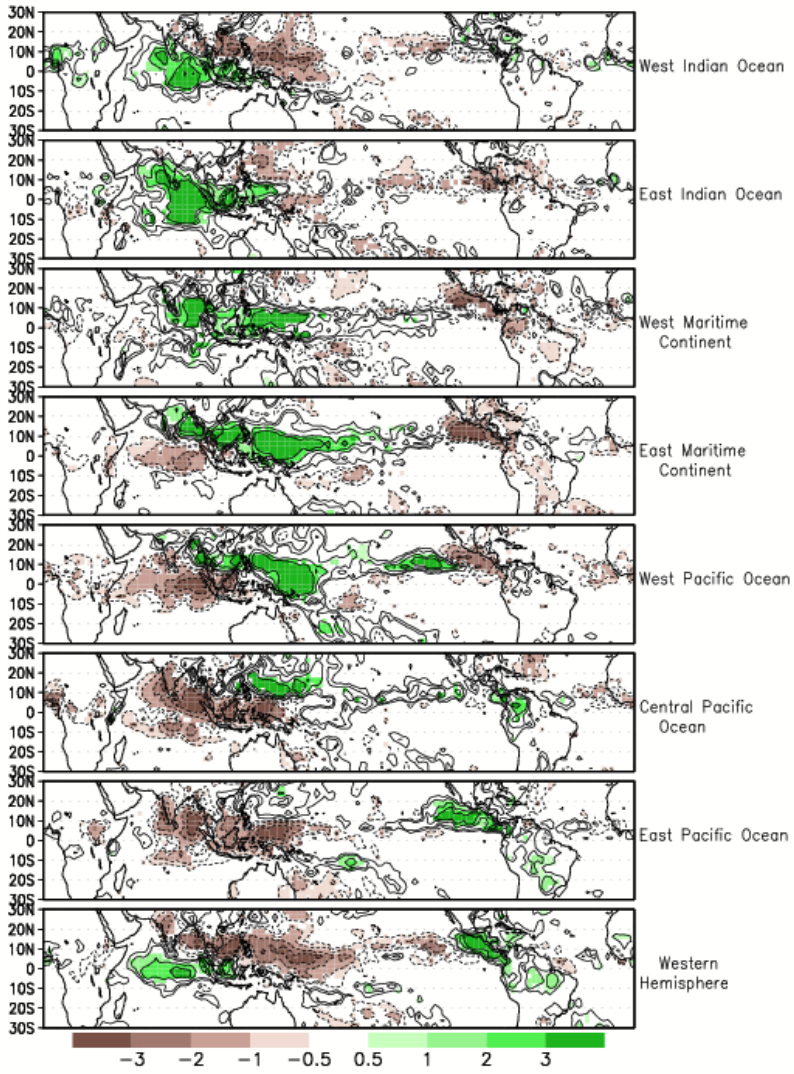


MJO Composites – Global Tropics

850-hPa Wind Anomalies (May-Sep)

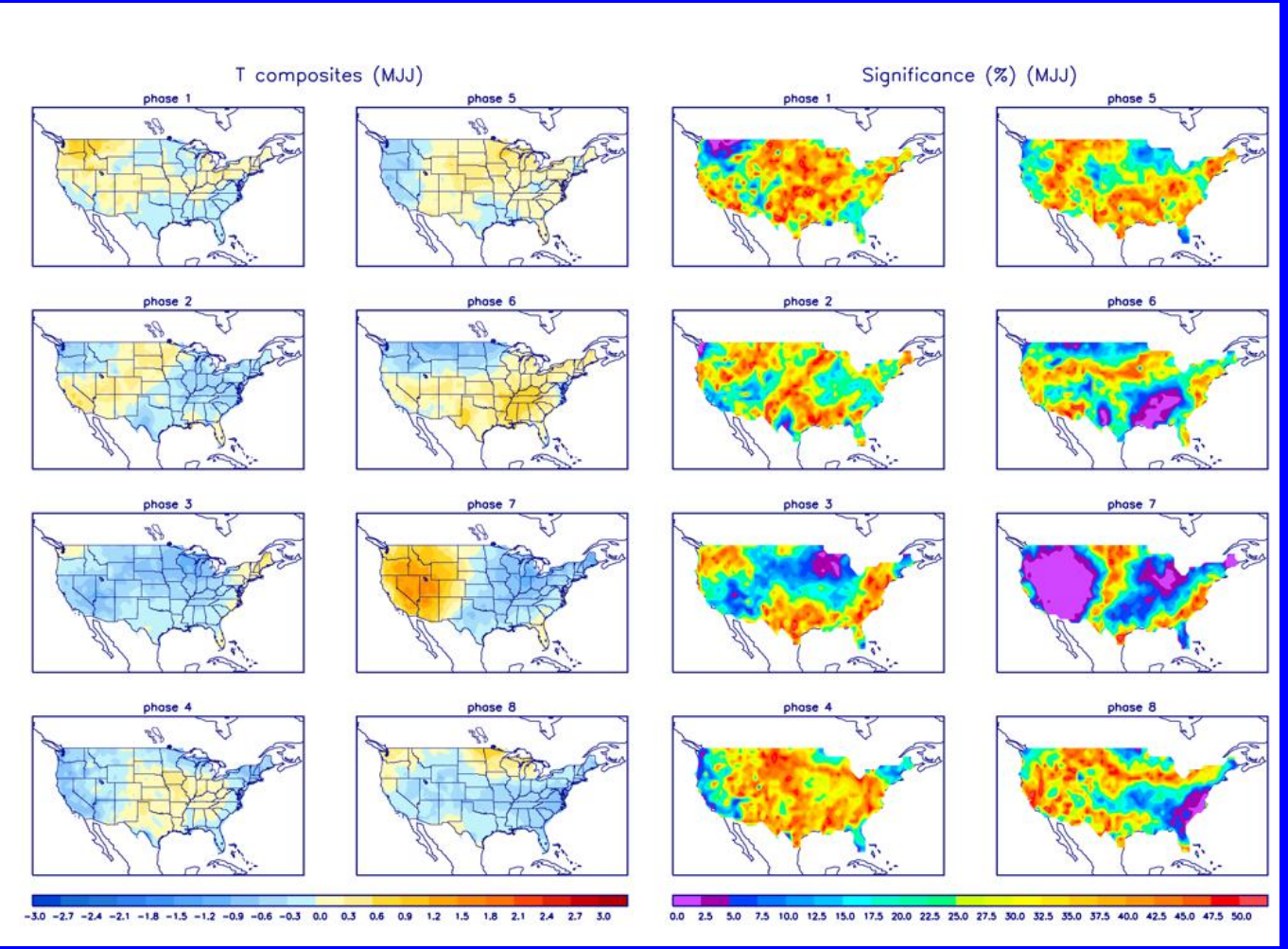


Precipitation Anomalies (May-Sep)



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.**

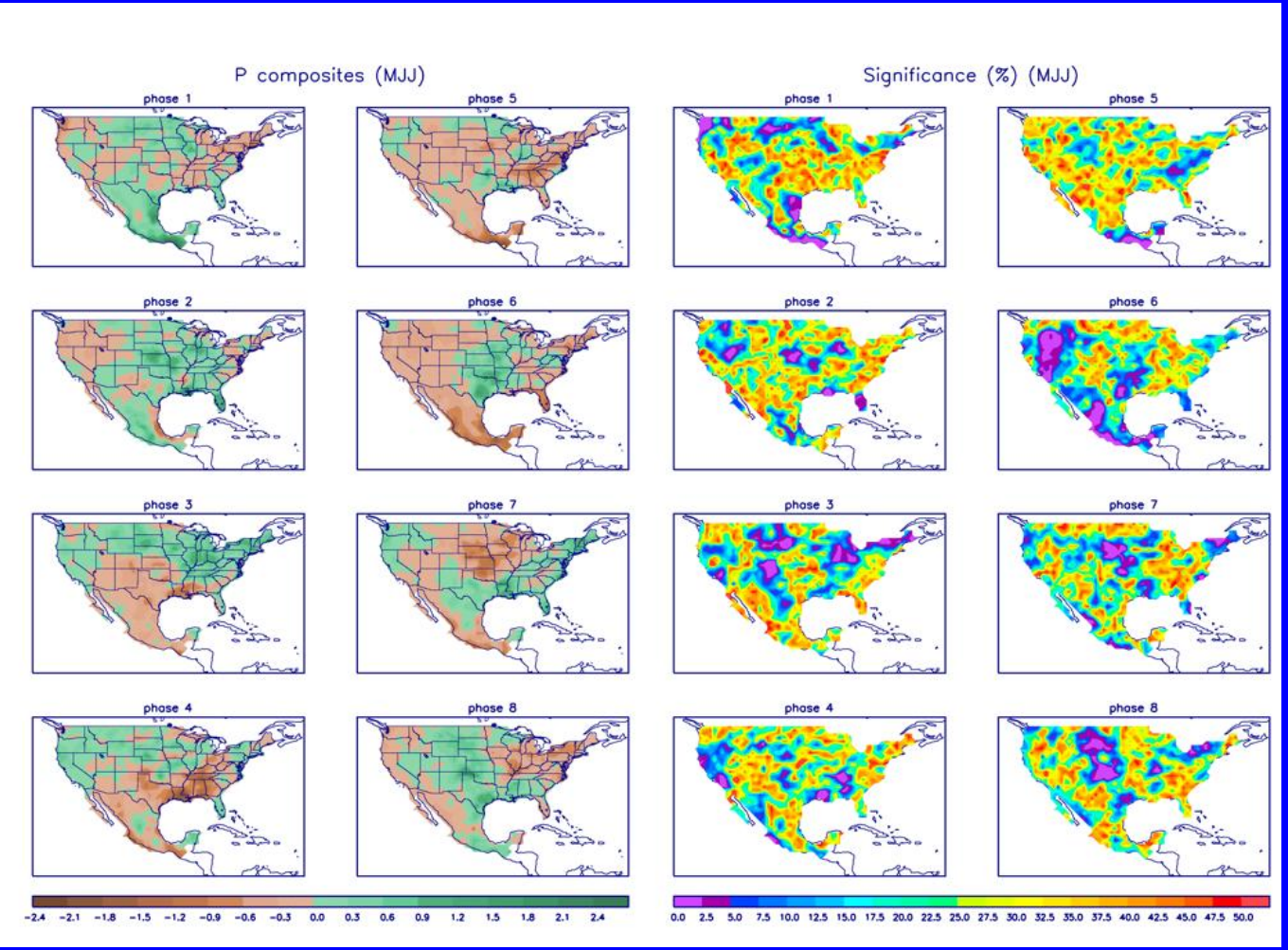


Zhou et al. (2010): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, Submitted.

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.**



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