



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

**Update prepared by  
Climate Prediction Center / NCEP  
August 15, 2011**



# Outline

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



# Overview

- **The MJO remained weak during the last seven days.**
- **Some dynamical model MJO index forecasts indicate greater amplitude of the MJO index during the period with no eastward propagation. This signal is most likely related to an expected increase in tropical convection across Africa and the east Pacific.**
- **Based on the latest observations and model forecasts, the MJO is forecast to remain weak during the period.**
- **The MJO is not forecast to contribute substantially to the patterns of tropical rainfall during the forecast period.**

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

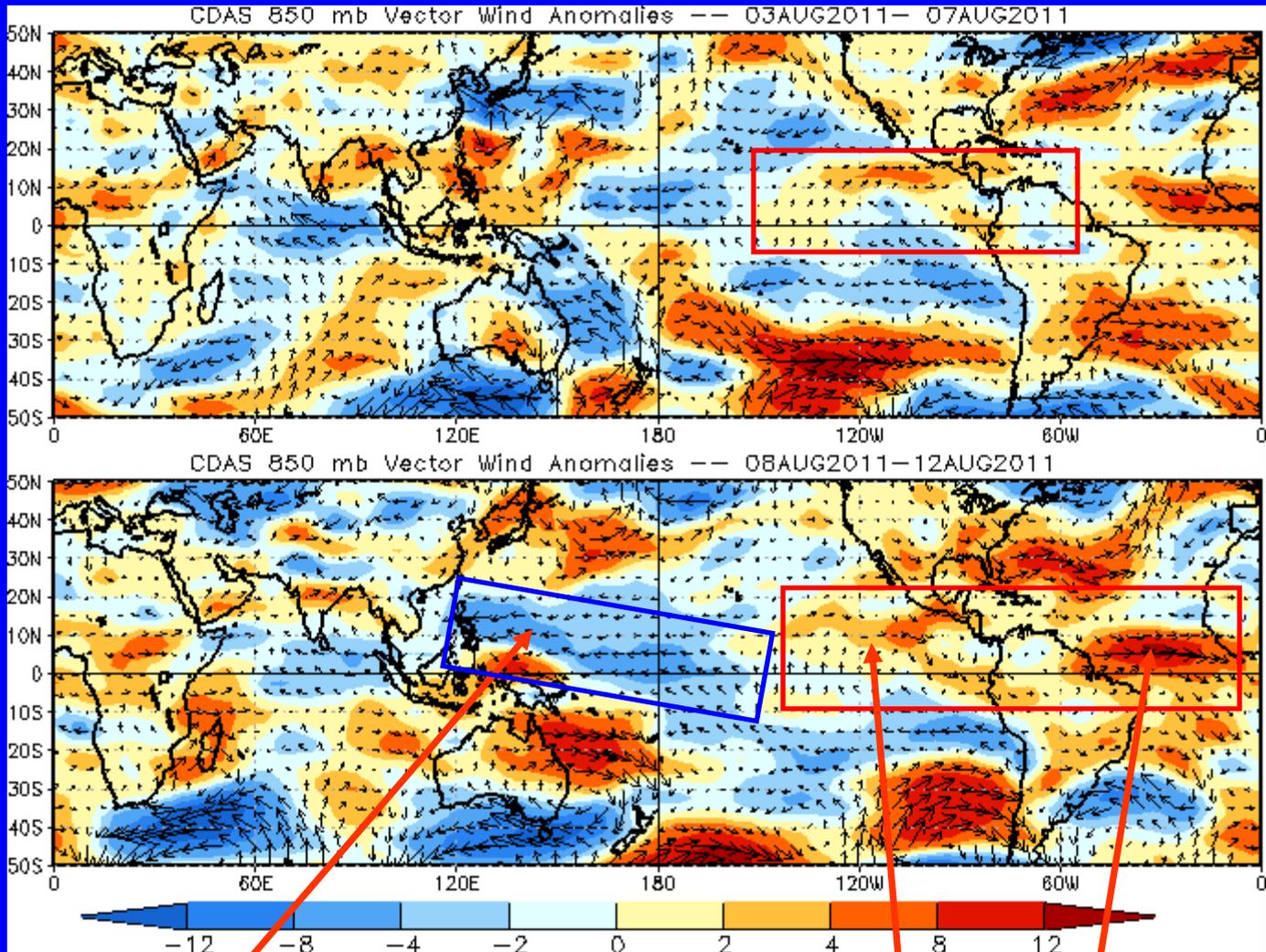


# 850-hPa Vector Wind Anomalies ( $\text{m s}^{-1}$ )

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



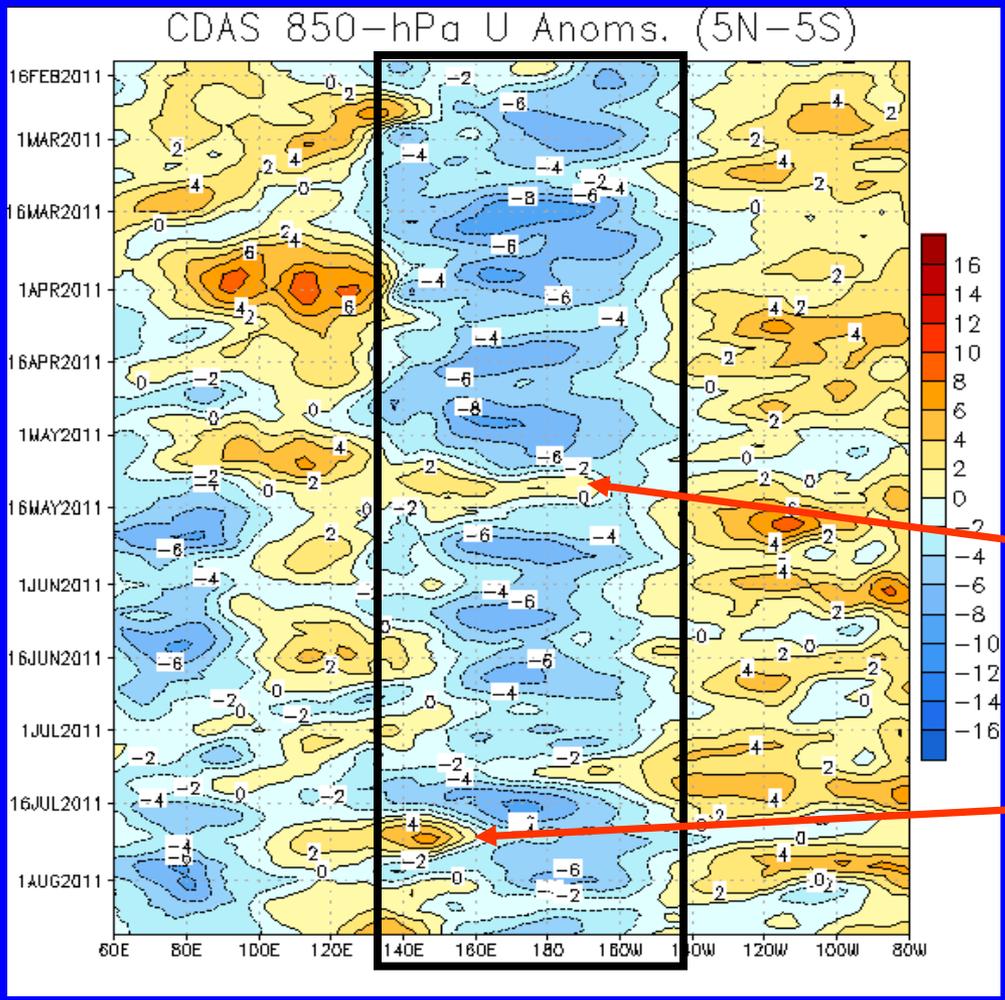
Easterly wind anomalies remain evident near the Date Line and have expanded across the west Pacific.

Westerly anomalies continued across parts of the east Pacific during the last five days. Westerly anomalies strengthened across the east 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

Easterly anomalies have persisted in the west-central Pacific since January (black box) consistent with La Nina conditions. The magnitude of these anomalies, however, has gradually weakened over the period and shifted slightly eastward over time.

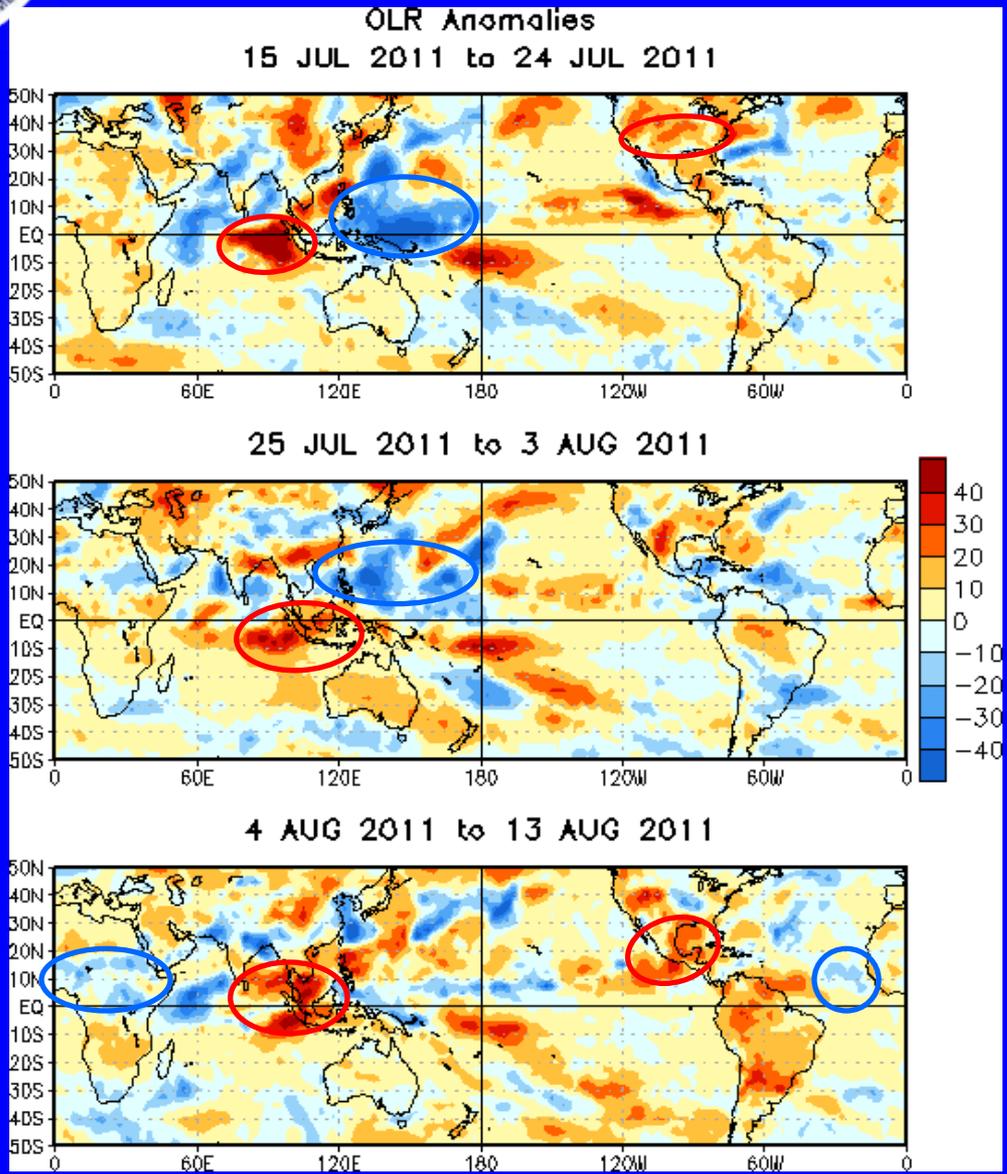
A burst of westerly wind anomalies associated with the MJO moved across the Pacific in early-to-mid May.

Westerly anomalies developed across the western Pacific centered near 150E during the second half of July and near 130E in recent days.



# OLR Anomalies – Past 30 days

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



In mid-July, enhanced convection (blue circle) was evident across the western Pacific, while suppressed convection (red circle) was present across the eastern Indian Ocean and southern CONUS.

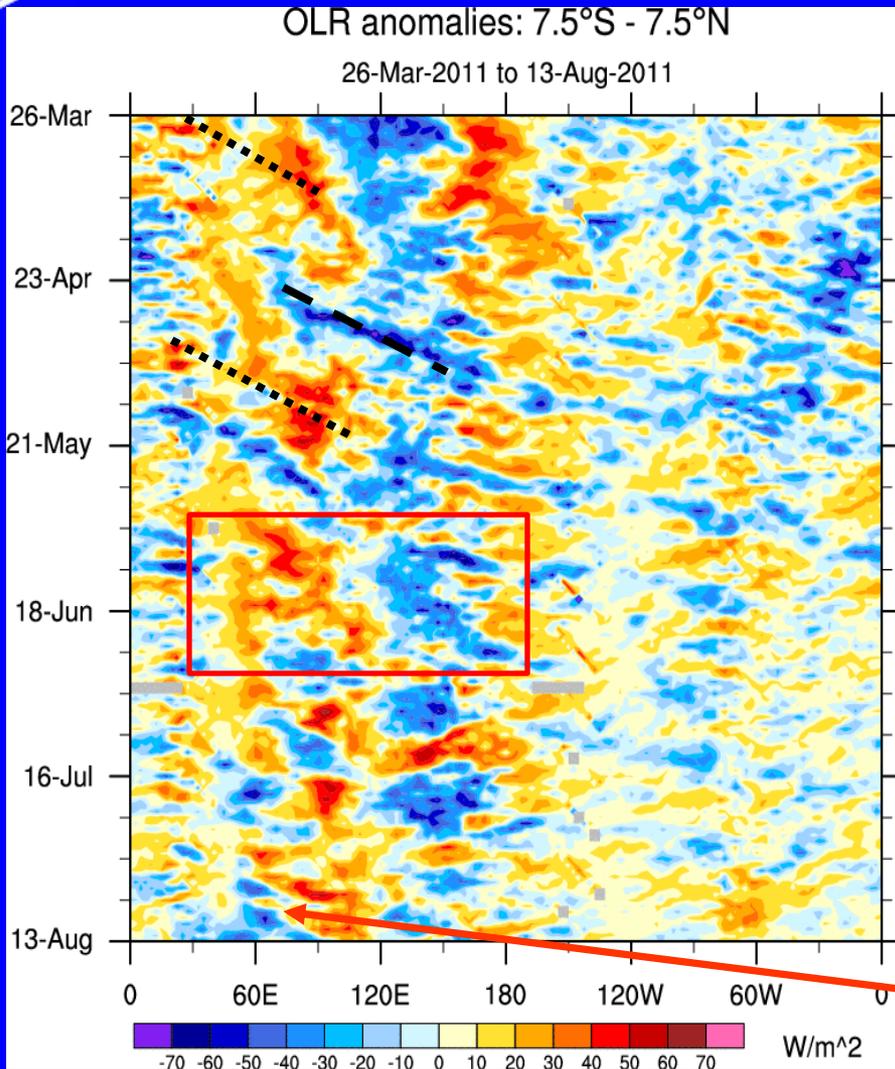
By the beginning of August, enhanced convection shifted north across the subtropical western Pacific, with suppressed convection spreading east across Indonesia.

During early August, suppressed convection continued across Indonesia and developed across the eastern Pacific, Mexico, and the Gulf of Mexico. Enhanced convection was evident across parts of Africa and the eastern Atlantic.



# 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 Cooperative Institute for Climate and Satellites (CICS-NC) and NCDC)**

**During March and in late April, areas of enhanced convection propagated eastward followed by suppressed convection thereafter. This activity was in part associated with MJO activity.**

**During mid-June, a couplet of suppressed (enhanced) convection was evident and centered near 80E (140E).**

**In early August, enhanced convection intensified and has persisted near 60E.**

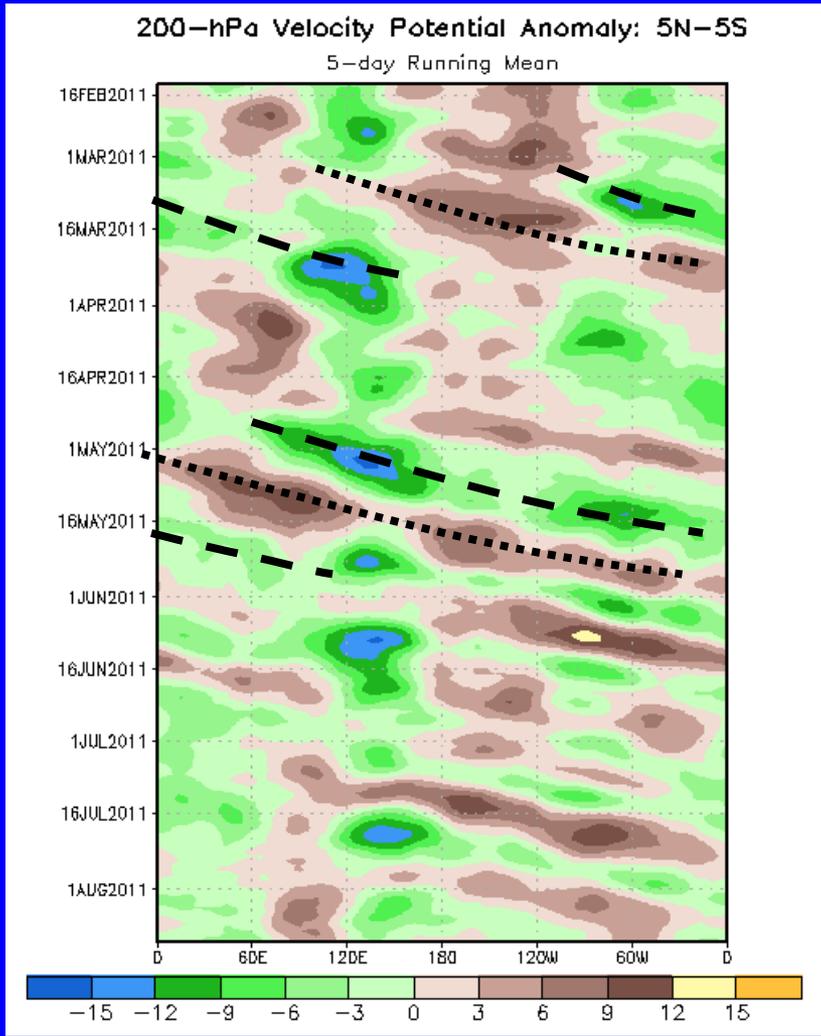


# 200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time  
↓



Eastward propagation 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 parts of June, July and August very fast eastward propagation was evident and mainly associated with higher frequency sub-seasonal coherent tropical variability.

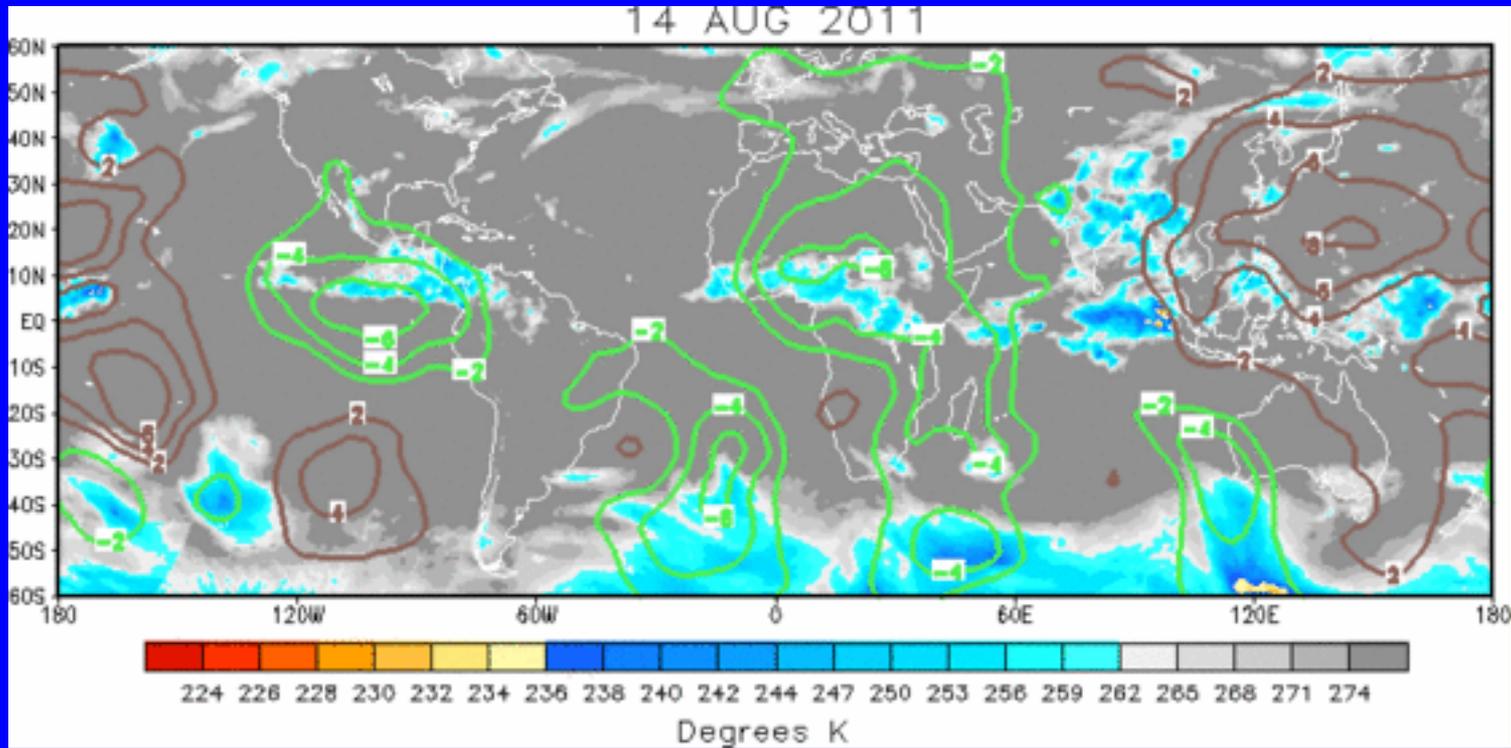
Longitude



# 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 large scale velocity potential indicates a nondescript pattern. Weak anomalous upper-level divergence is indicated over parts of Africa and the eastern Pacific, while anomalous upper-level convergence is observed across the western/central Pacific Ocean.

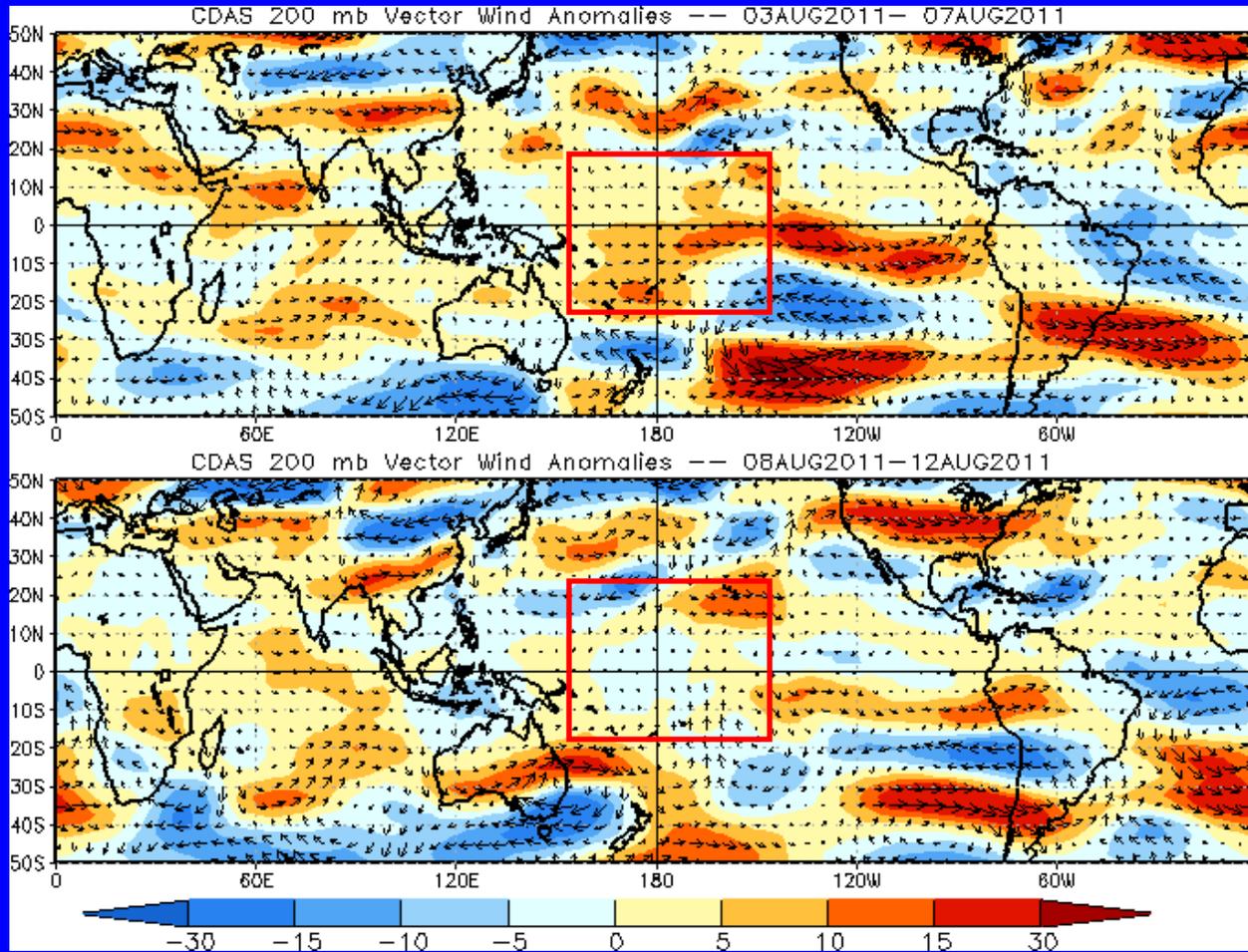


# 200-hPa Vector Wind Anomalies ( $\text{m s}^{-1}$ )

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



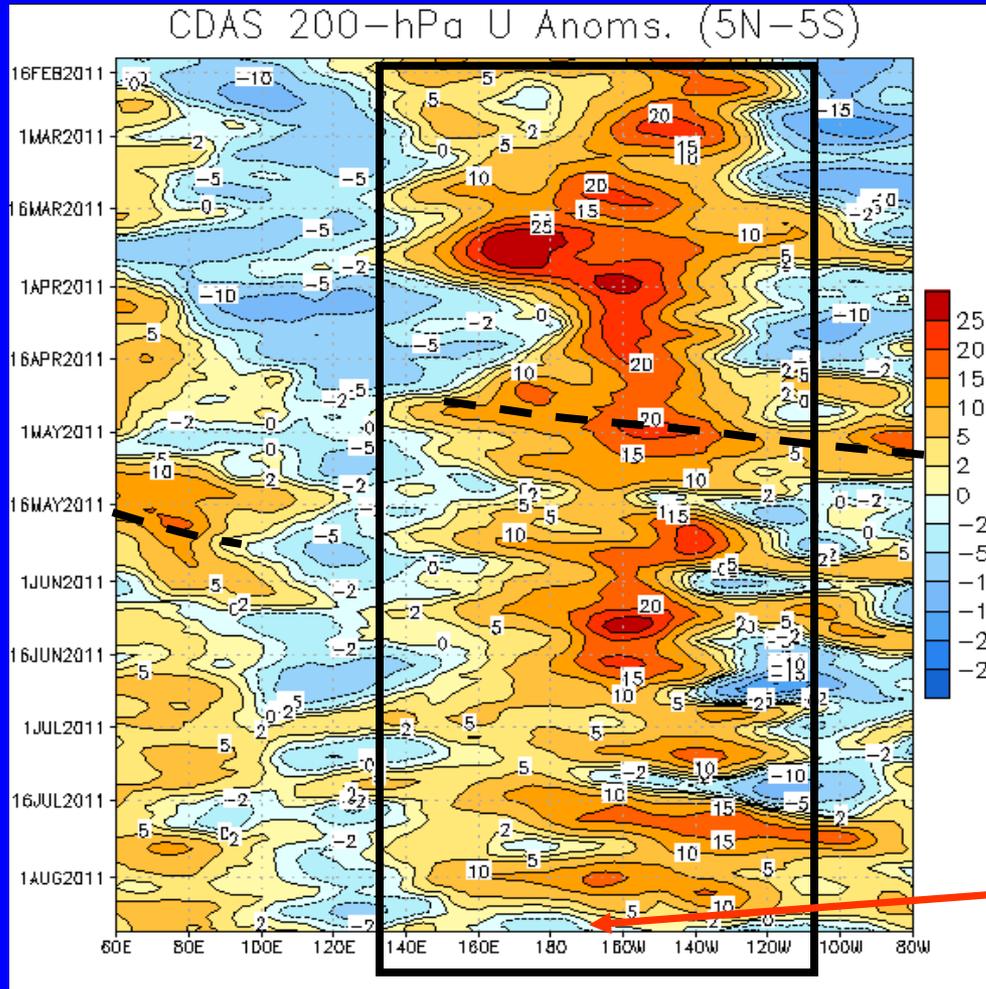
Westerly anomalies have recently diminished across the central Pacific Ocean (red boxes).



# 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



Time



Longitude

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

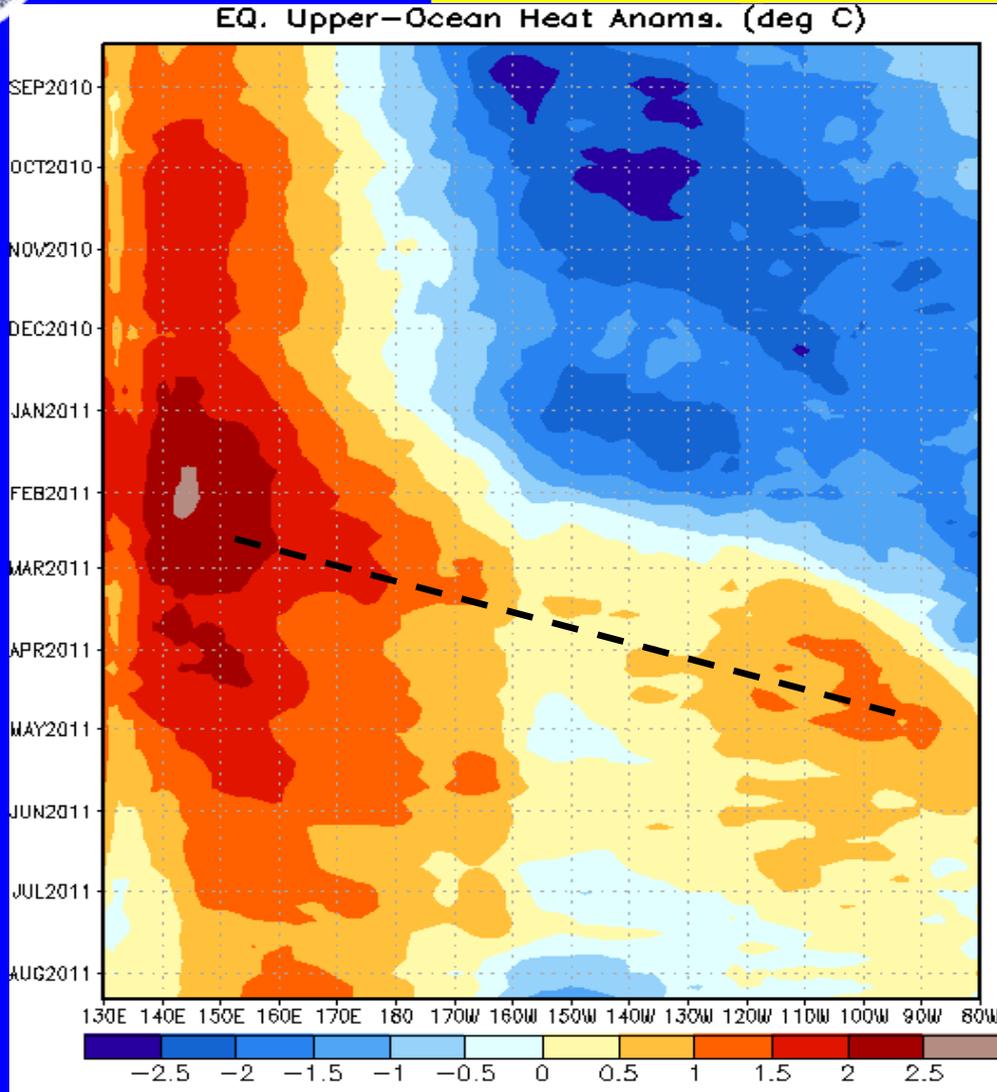
Significant eastward propagation of westerly anomalies was evident in late April and May (dashed line) associated with the MJO.

During mid-August, easterly anomalies developed near the Date Line.



# Weekly Heat Content Evolution in the Equatorial Pacific

Time  
↓



Longitude

Beginning in April 2010 positive 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 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. Much of the Pacific basin now indicates above- or near-normal integrated heat content.

Since the beginning of August, negative heat content anomalies increased near 150W.



# 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.

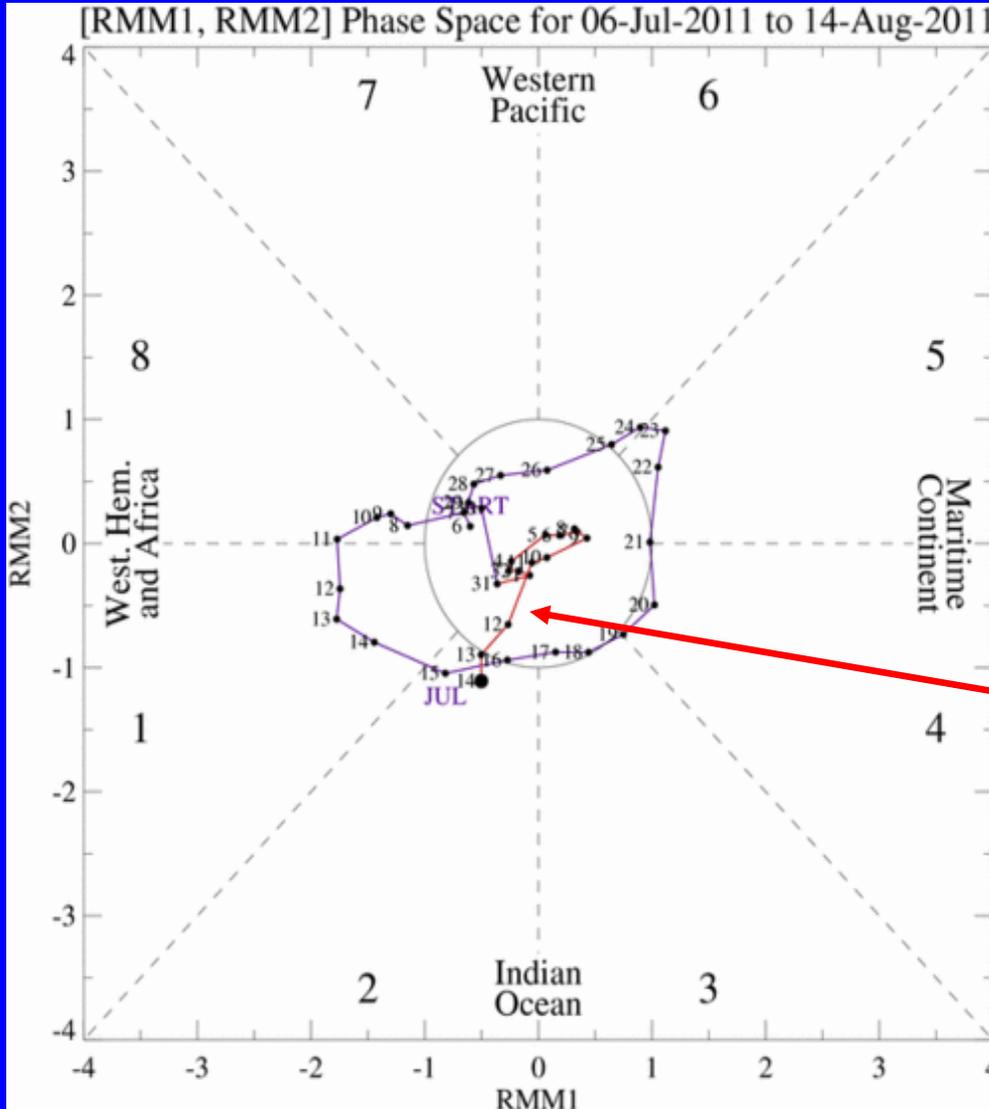
**Gottschalck et al. 2010: A Framework for Assessing Operational Madden-Julian Oscillation Forecasts: A CLIVAR MJO Working Group Project, *Bull. Amer. Met. Soc.*, 91, 1247-1258.**

- 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

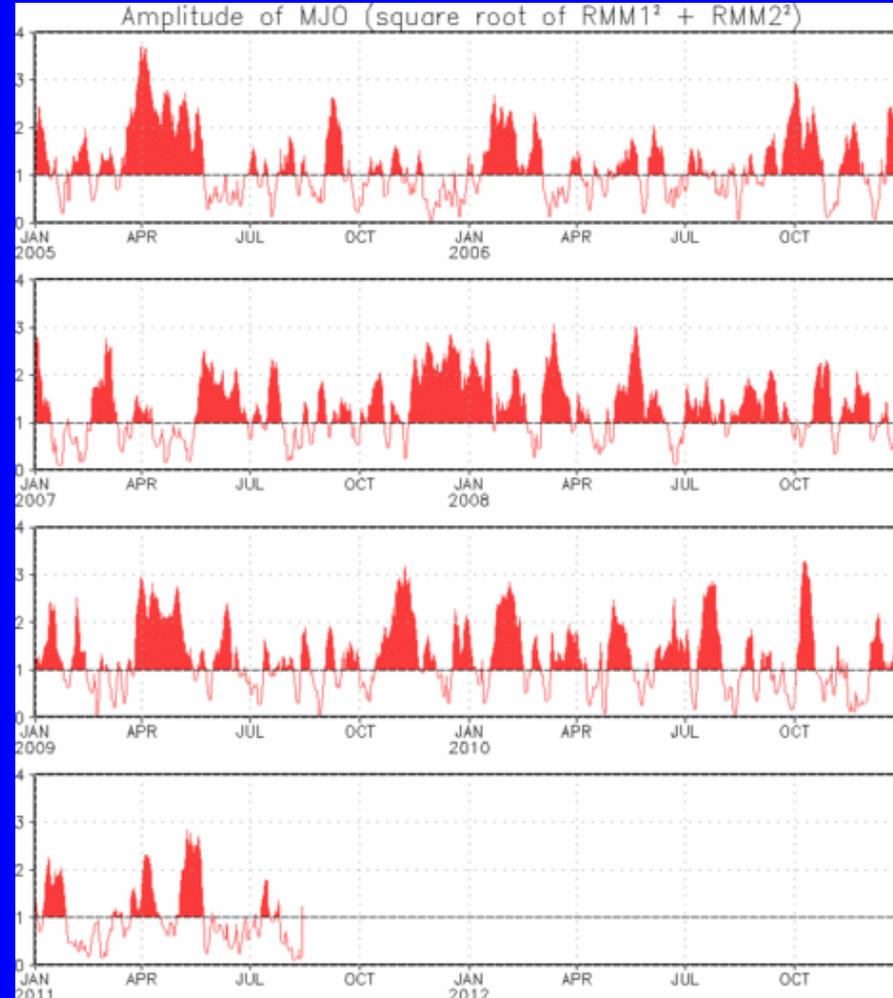
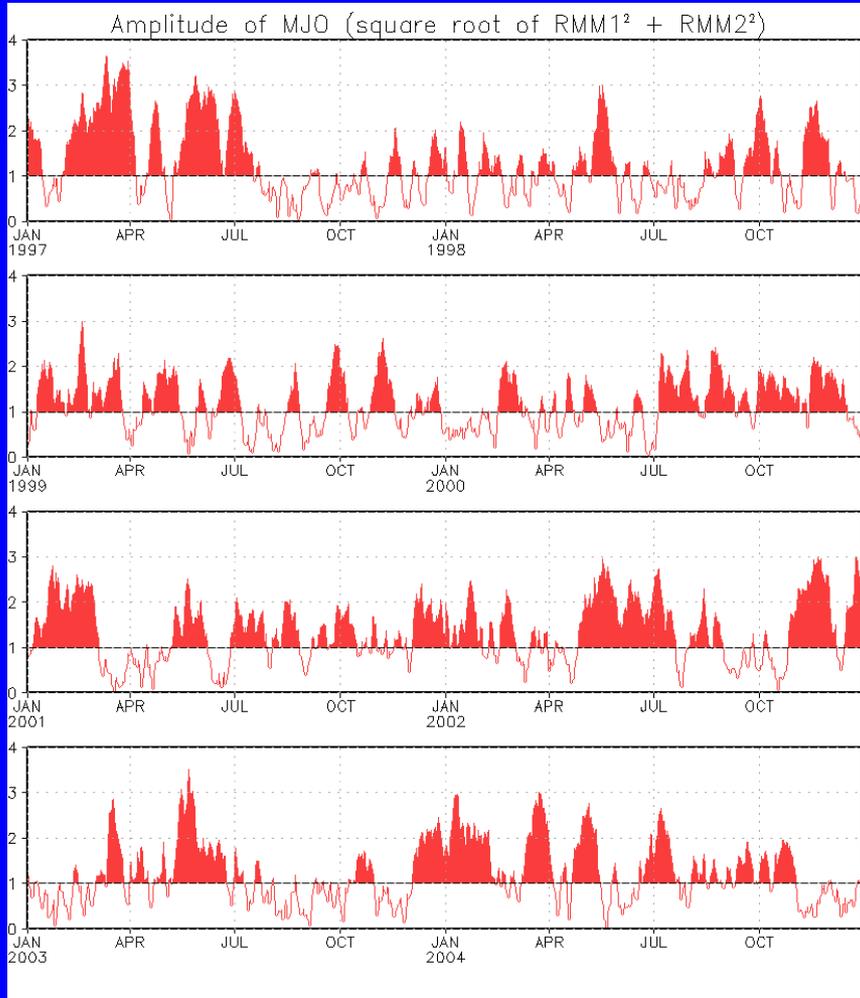
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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



The MJO index indicates a weak signal over most of the past week.



# MJO Index – Historical Daily Time Series



Time series of daily MJO index amplitude from 1997 to present.  
Plots put current MJO activity in historical context.



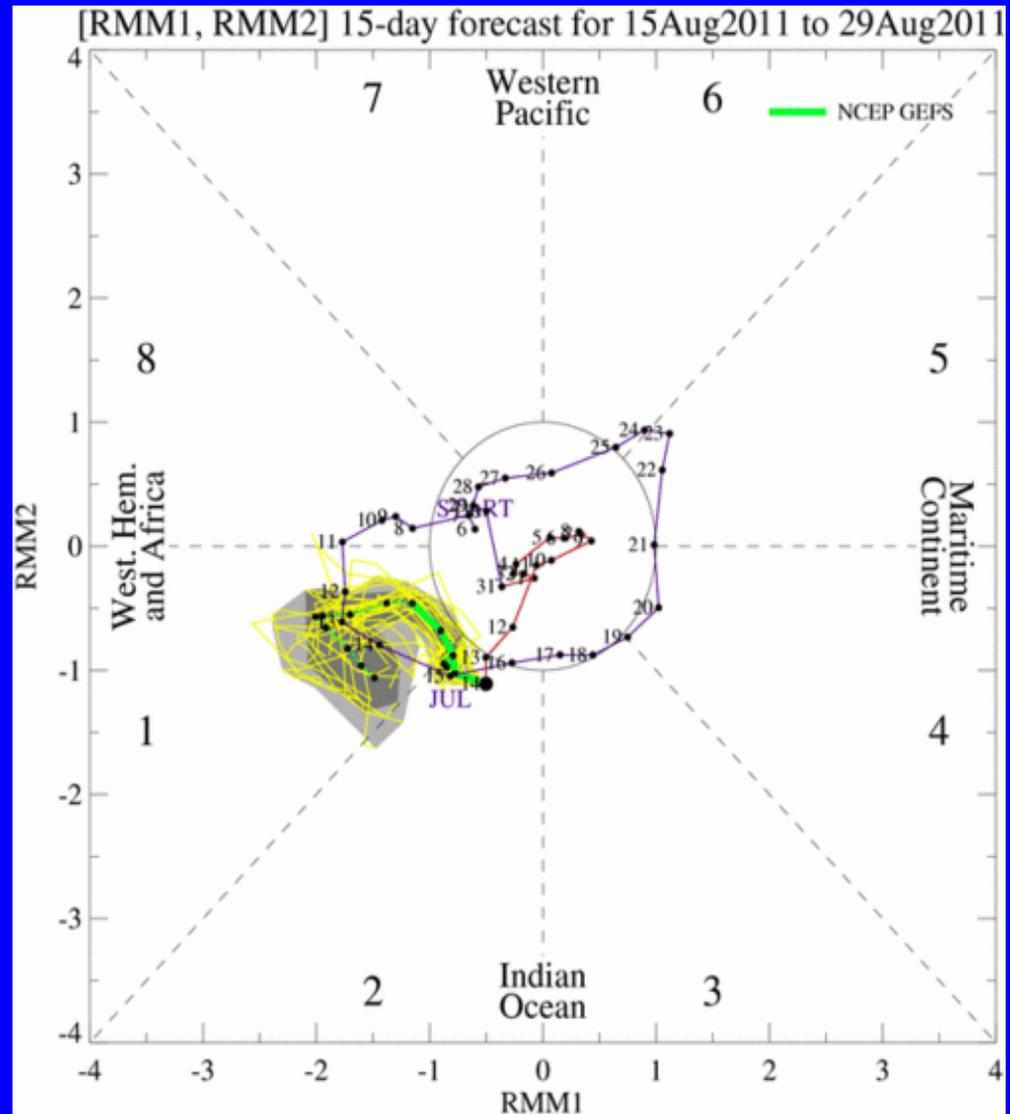
# Ensemble GFS (GEFS) MJO Forecast

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 indicate westward propagation of an increased signal. The projection is related to other forms of coherent subseasonal tropical variability and not the MJO.



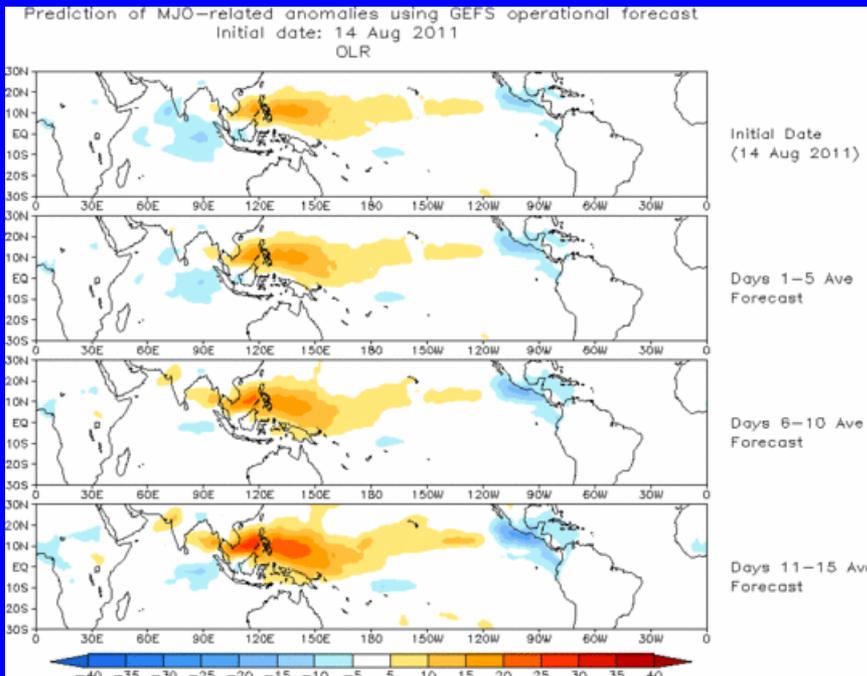


# Ensemble Mean GFS MJO Forecast

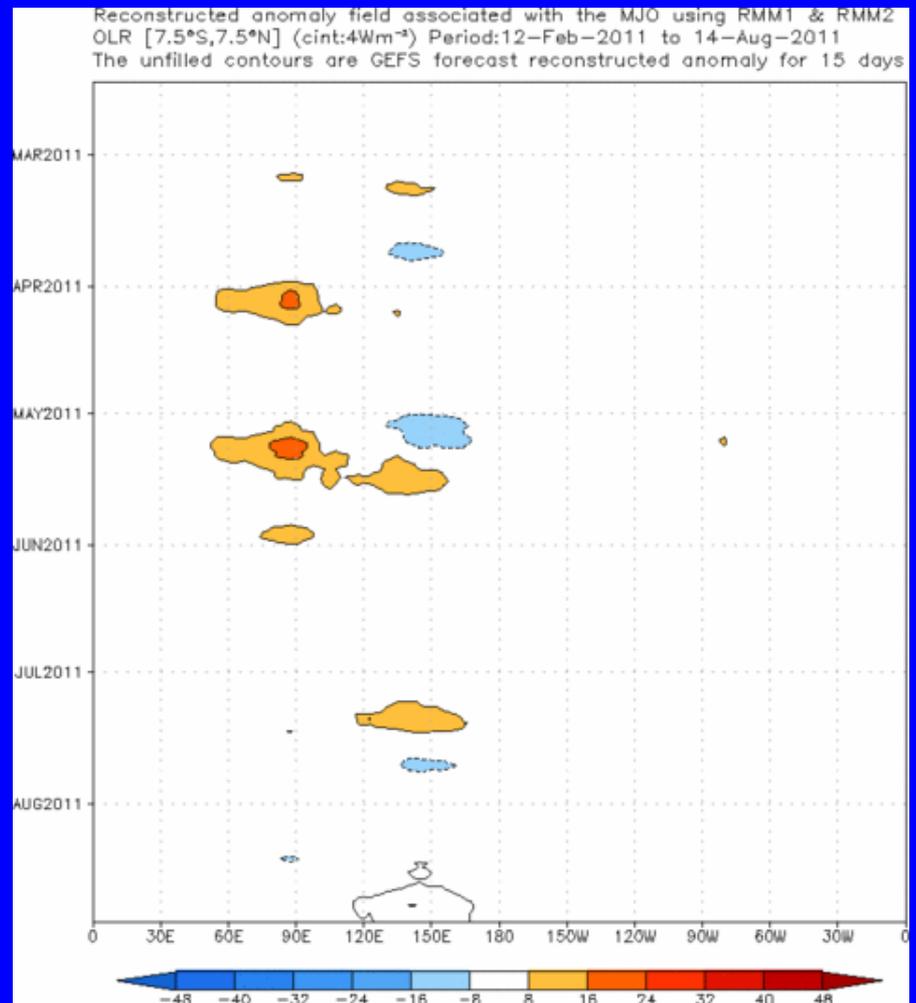
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

**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 suppressed (enhanced) convection in the western Pacific (eastern Pacific/Central America) area during the Week-1 and Week-2 period.



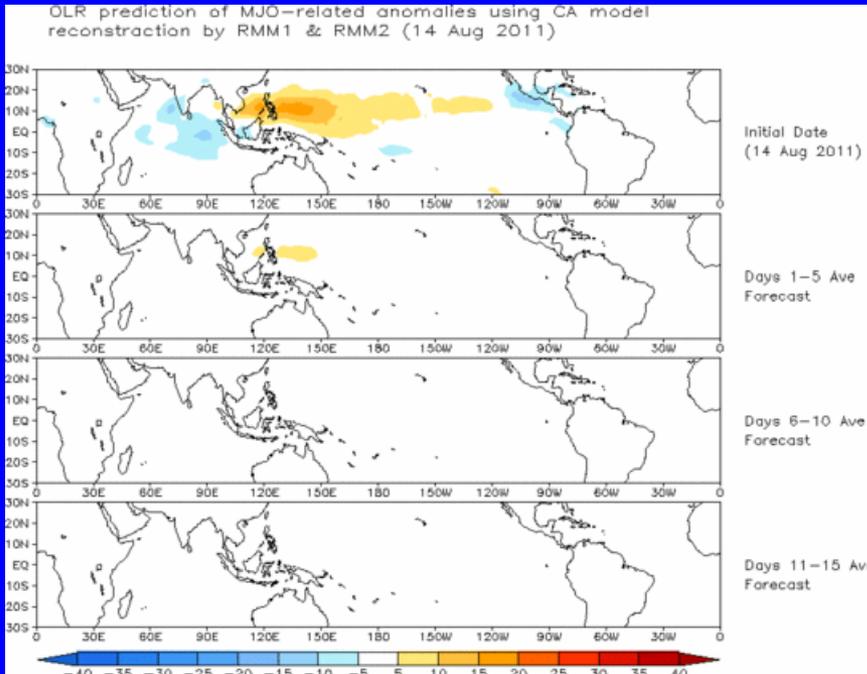


# Constructed Analog MJO Forecast

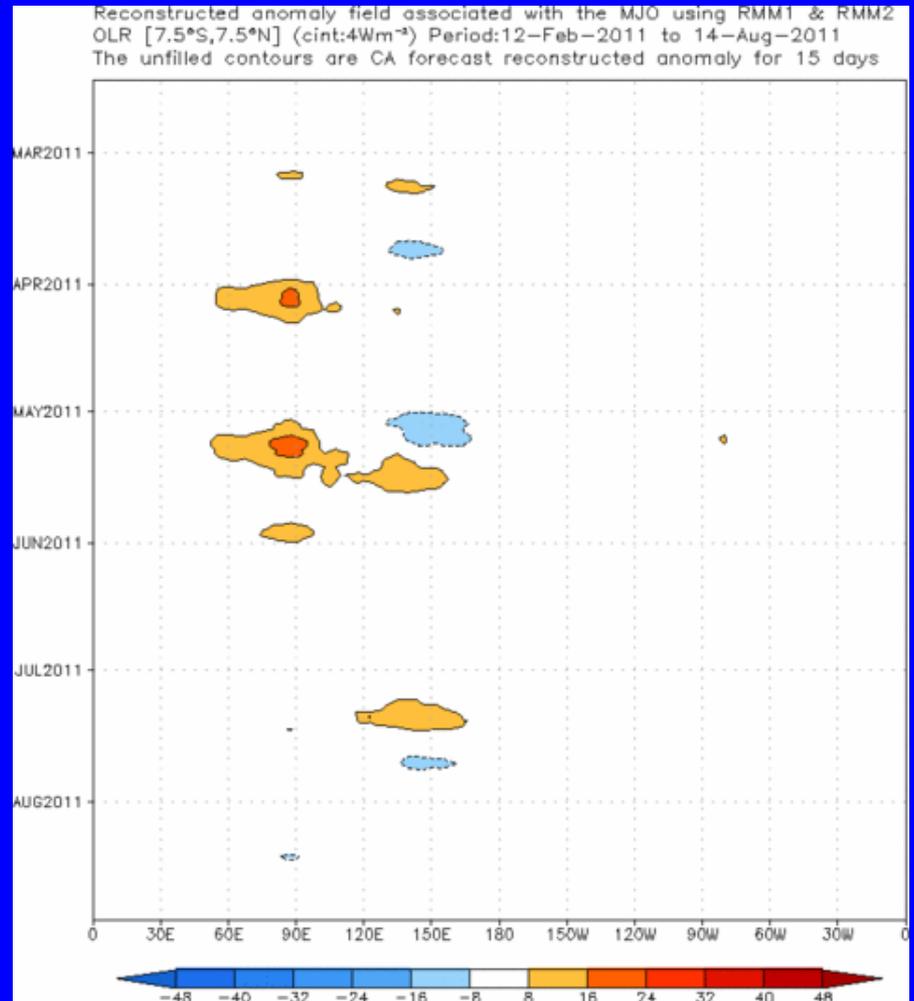
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies 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 CA forecast indicates little anomalous convection during the entire 2 week period.

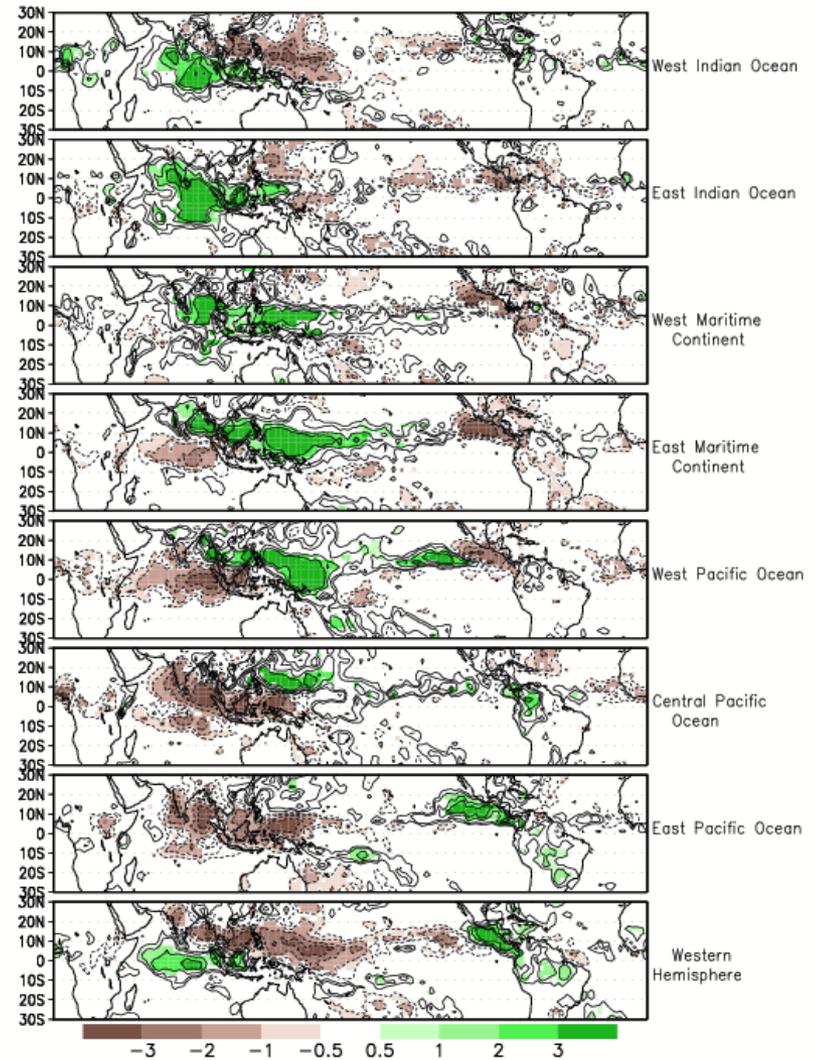
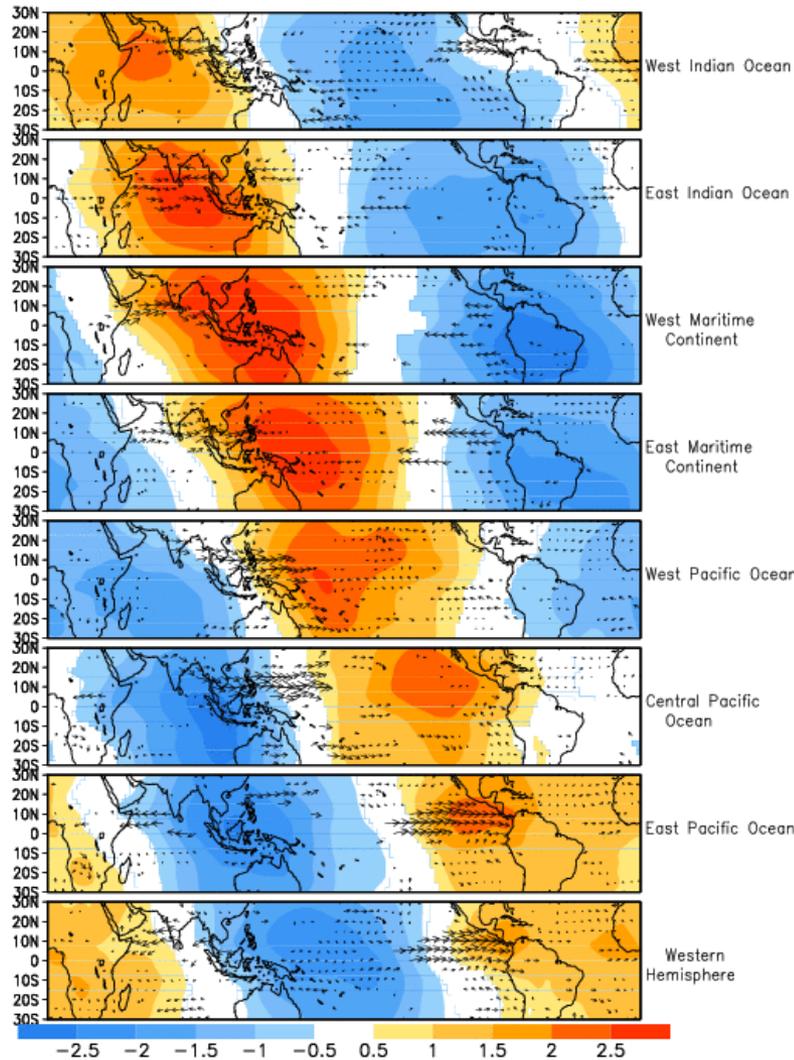




# MJO Composites – Global Tropics

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

## Precipitation Anomalies (May-Sep)

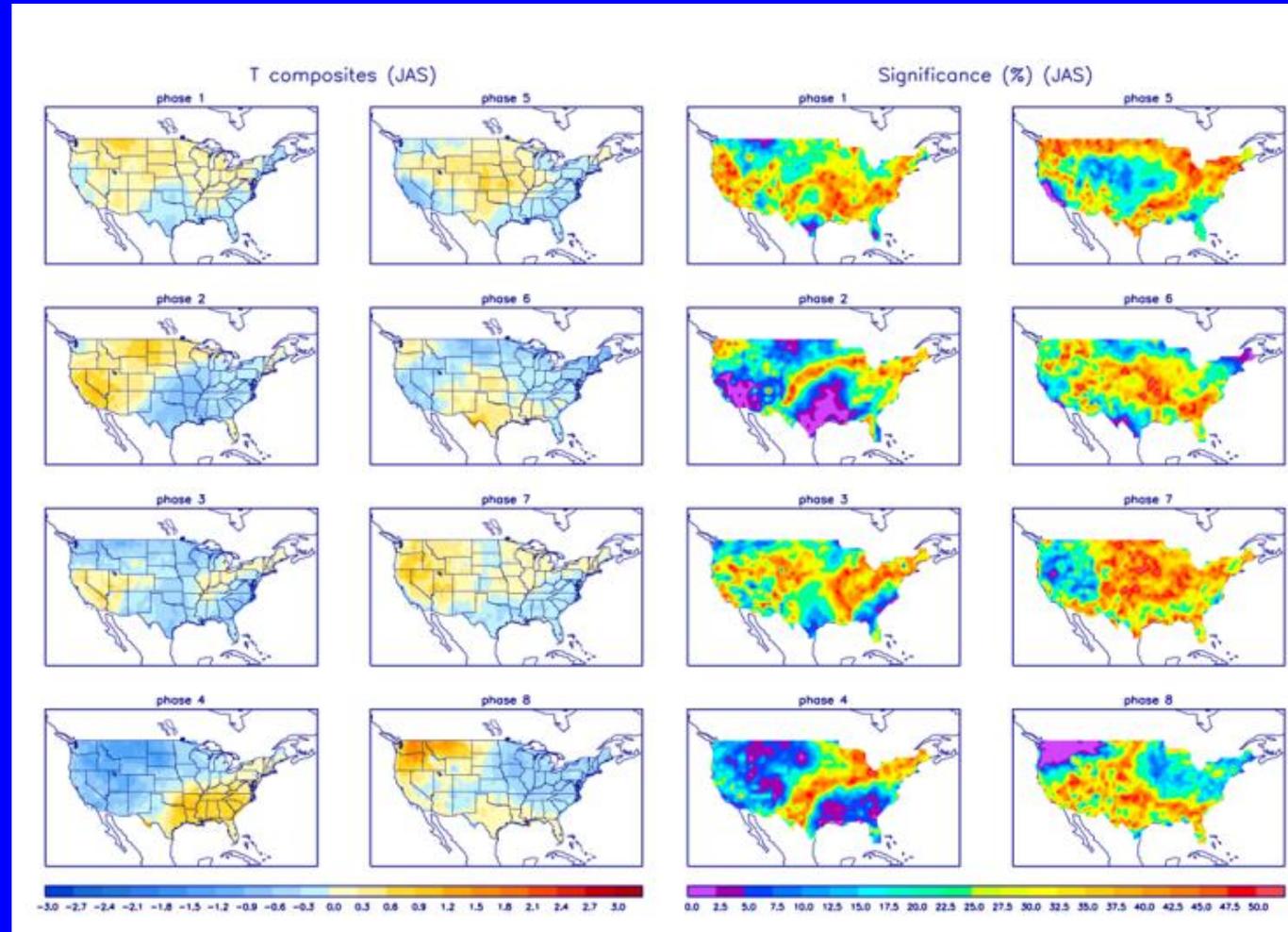




# U.S. MJO Composites – Temperature

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.



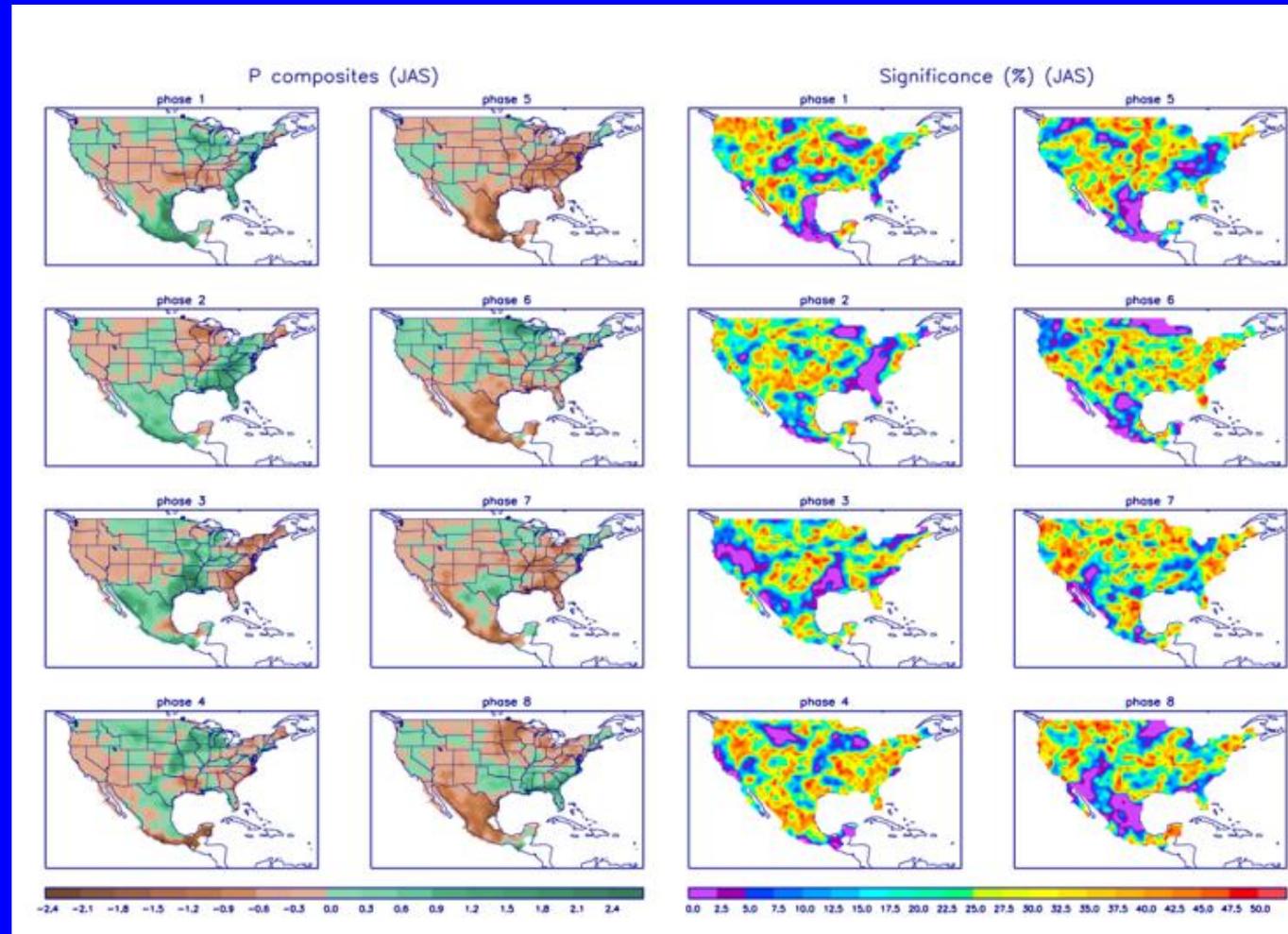
Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

<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. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

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