



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

**Update prepared by  
Climate Prediction Center / NCEP  
November 19, 2012**



# Outline

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



# Overview

- The MJO showed signs of weakening during the past week as several observational indicators became considerably less coherent.
- Most of the dynamical model MJO index forecasts currently indicate little, if any, coherent MJO signal during the next two weeks. Some models and a few statistical forecast tools, however, do indicate the potential for renewed enhanced convection in the western Pacific during the period.
- Based on the latest observations and model MJO index forecasts, the MJO is forecast to be weak during the next 1-2 weeks.
- The MJO may contribute to suppressed (enhanced) convection in the Indian Ocean (parts of the western Pacific) during the 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

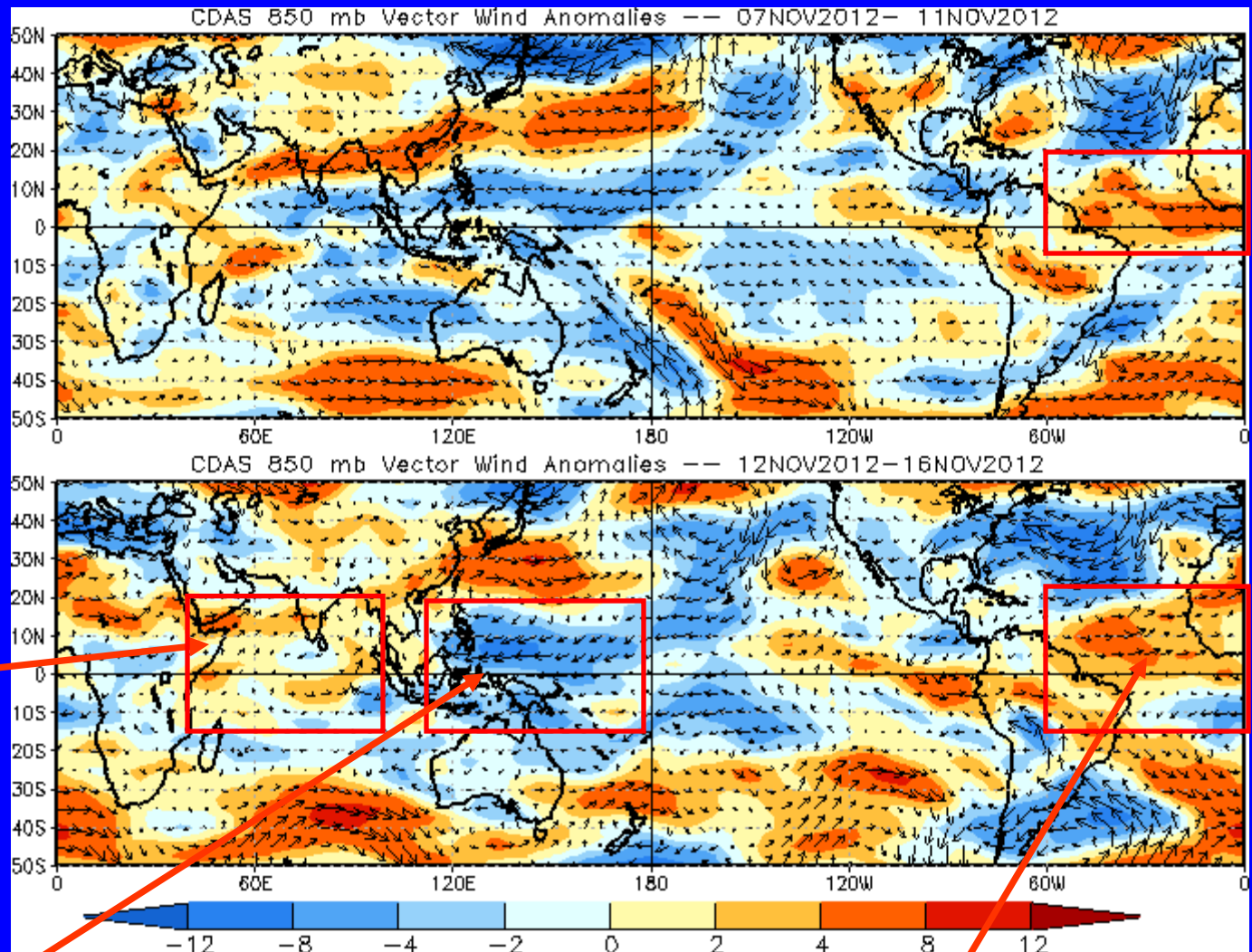
Blue shades: Easterly anomalies

Red shades: Westerly anomalies

There has been an increase in westerly anomalies over the Indian Ocean anomalies during the past five days.

Coverage of easterly anomalies has become more focused across the western Pacific and Maritime continent during the past five days.

Westerly anomalies continued over the tropical Atlantic during the past five days.



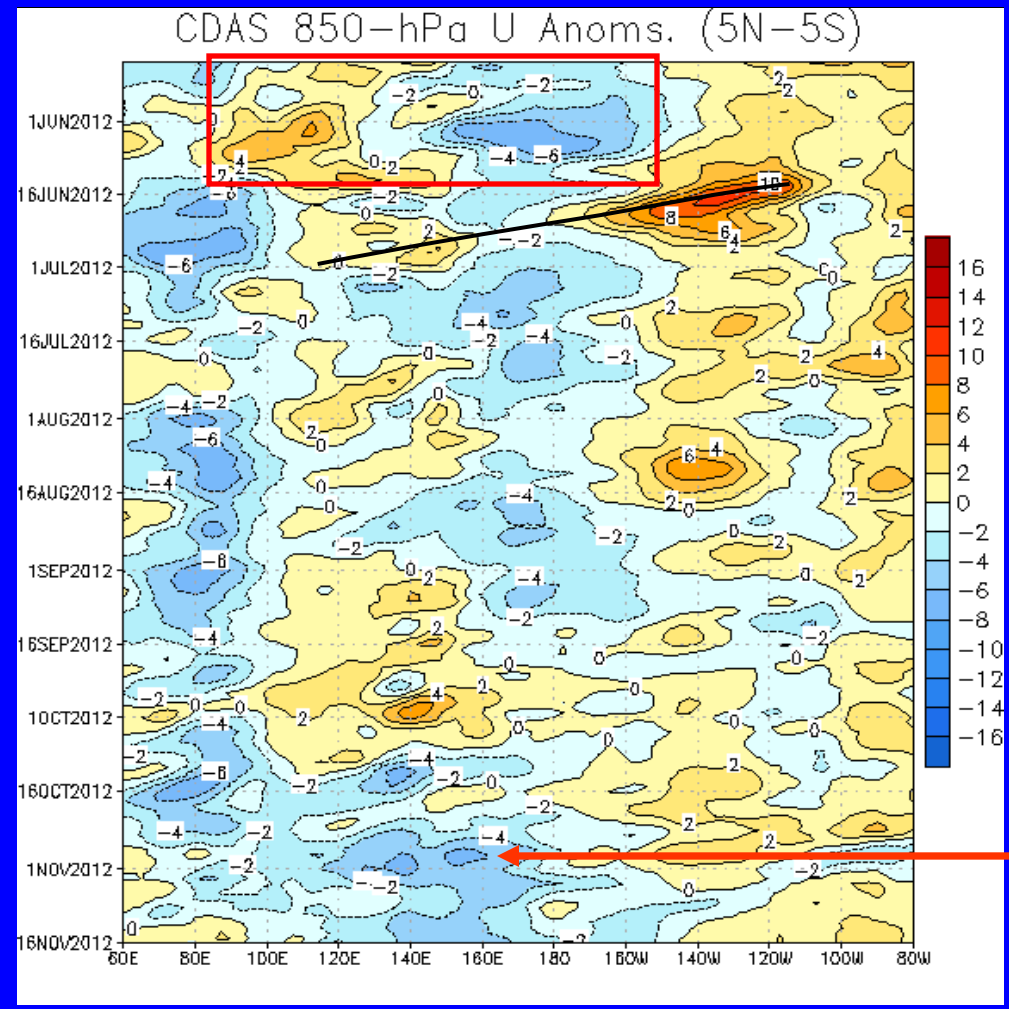


# 850-hPa Zonal Wind Anomalies ( $\text{m s}^{-1}$ )

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

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

Time  
↓



Longitude

Anomalies were generally persistent in most areas during May and early June (red box). Strong westerly anomalies developed across the eastern Pacific in mid-June and shifted westward (black solid line) and contributed to weakening the trade winds.

Easterly anomalies persisted near 80E for much of August and September.

During September, westerly anomalies developed near 140E and persisted into October.

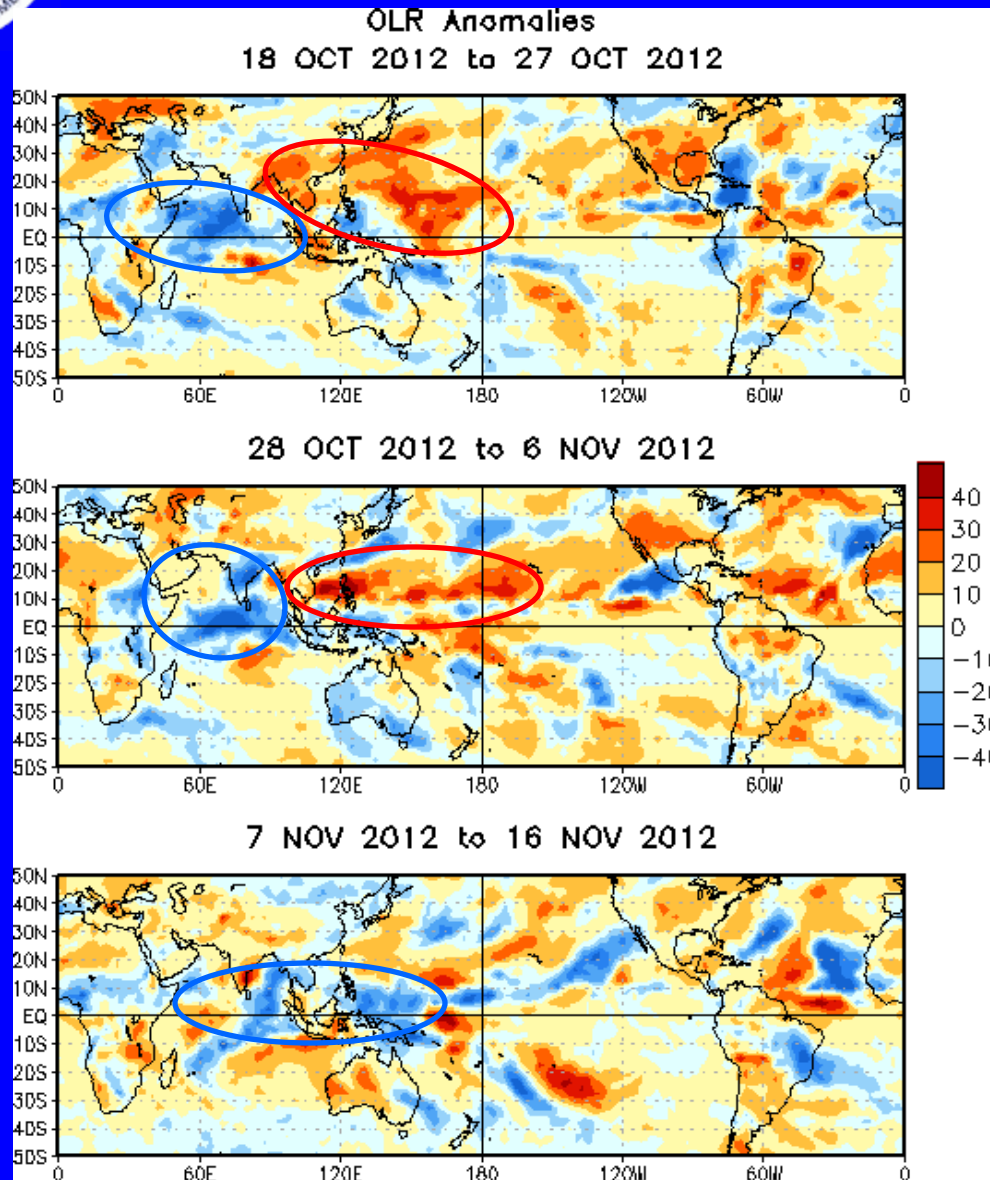
In mid-October, easterly anomalies developed west of the Date Line in the west Pacific and have persisted.



# 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 mid-to-late October, suppressed convection expanded across the western Pacific with enhanced convection developing across the Indian Ocean. The track of Hurricane Sandy is evident from the Caribbean Sea north to the western Atlantic.

Entering early November, suppressed continued across much of the Pacific Ocean as did enhanced convection in the Indian Ocean.

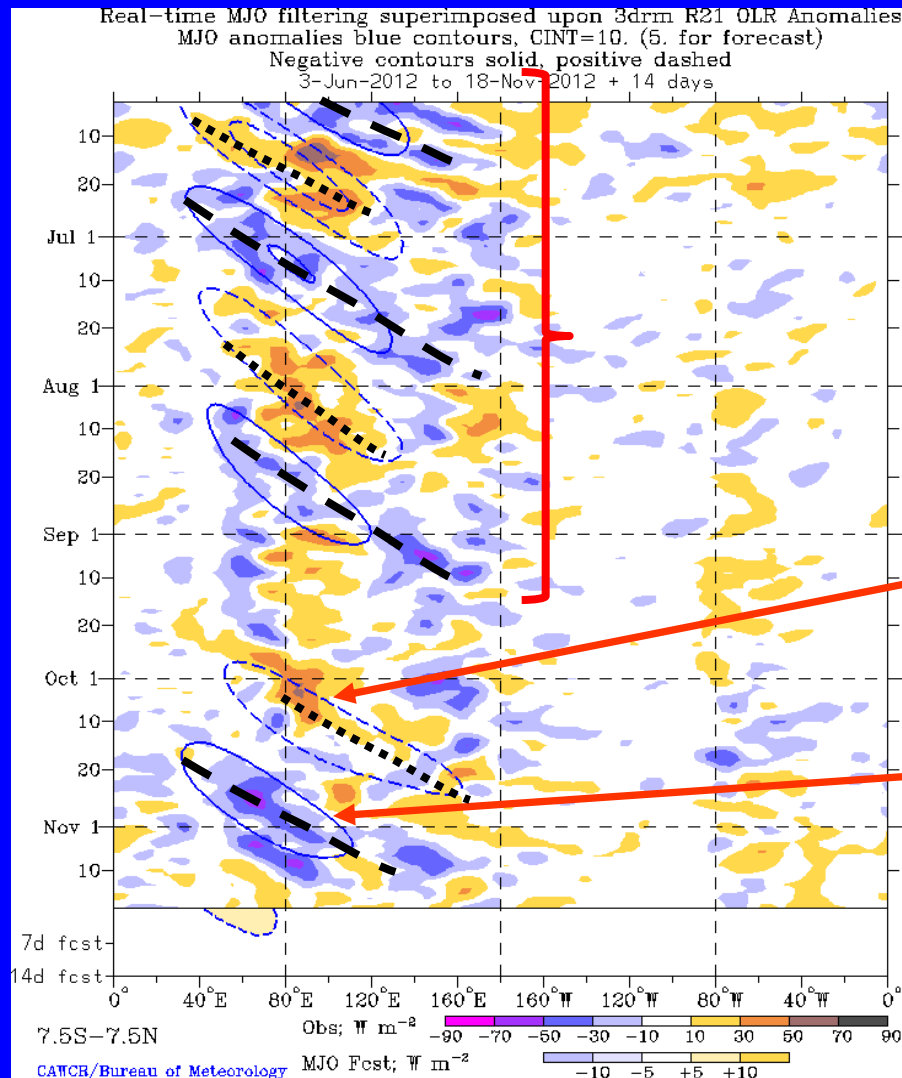
In early-to-mid-November, some enhanced convection shifted eastward to parts of the Maritime continent and western Pacific.





# Outgoing Longwave Radiation (OLR)

## Anomalies (7.5°S-7.5°N)



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

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

**(Courtesy of CAWCR Australia Bureau of Meteorology)**

From late May into September, eastward propagation of both enhanced and suppressed convection is evident across the eastern hemisphere (alternating dashed and dotted lines).

At the start of October, suppressed (enhanced) convection observed in the Indian Ocean (western Hemisphere) shifted eastward with time and by mid-to-late October, enhanced convection intensified across the Americas and Africa before shifting east across Africa and the Indian Ocean.

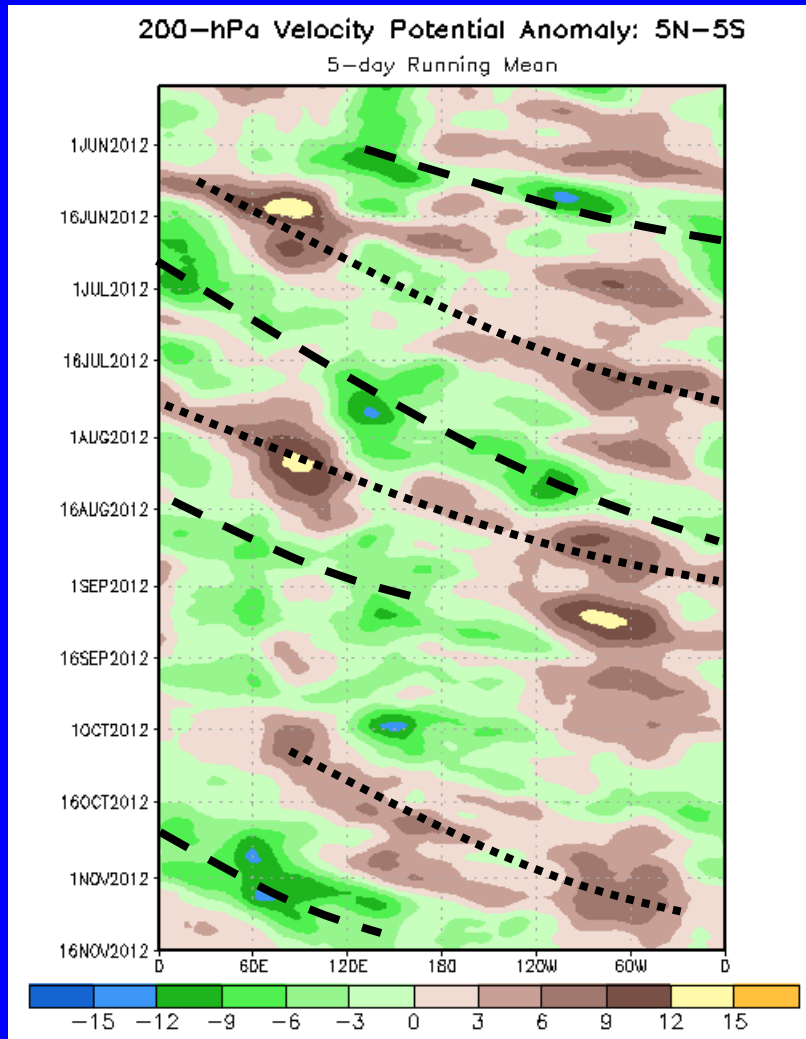


# 200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time



Eastward propagation was evident from late May into September associated with the MJO (alternating dashed and dotted lines), as well as atmospheric Kelvin wave activity, which at times resulted in fast eastward propagation of observed anomalies.

In mid-September, anomalies decreased and eastward propagation became less clear.

In early October, upper-level divergence (convergence) increased over the Pacific (Indian Ocean) and has shifted eastward throughout October and early November. Anomalies have decreased in recent days.

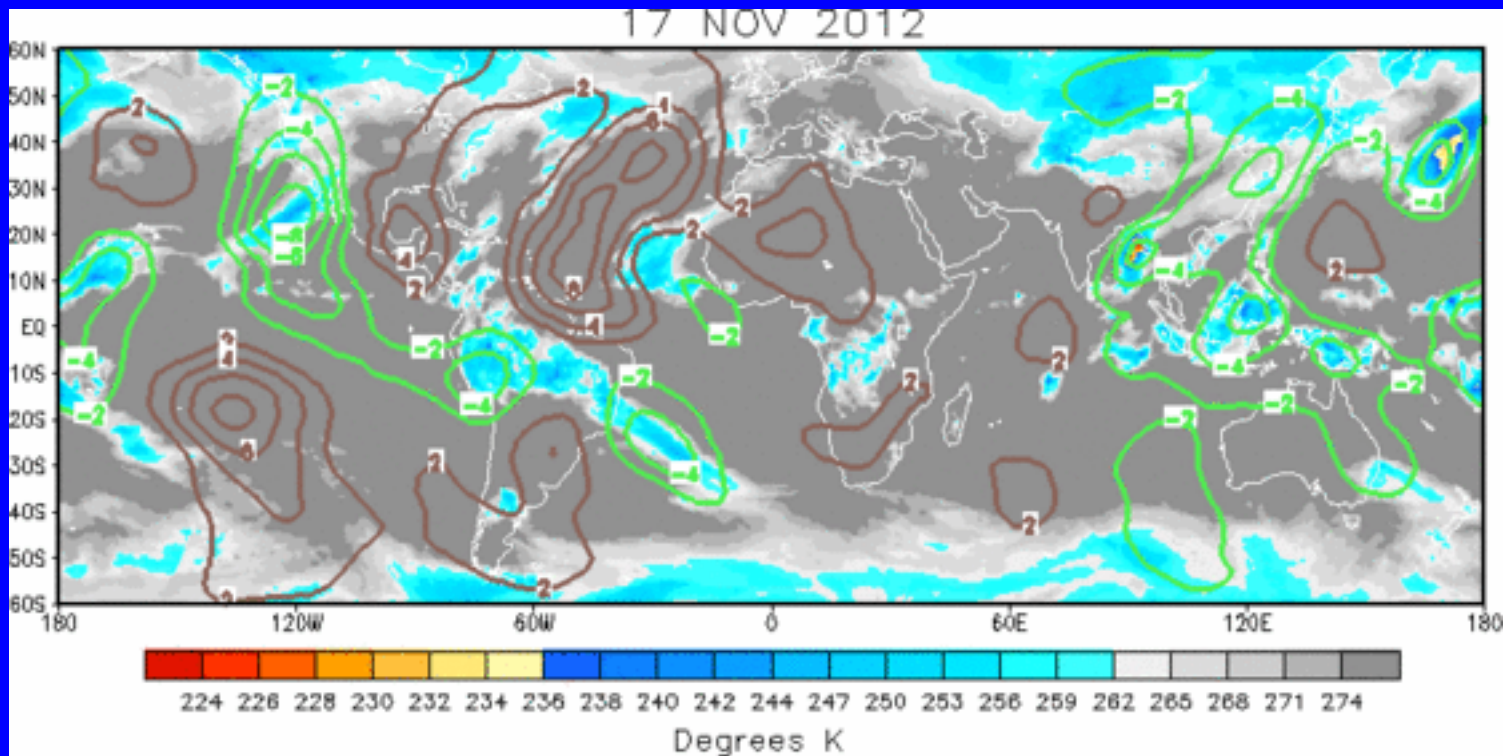




# IR Temperatures (K) / 200-hPa Velocity Potential Anomalies

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The large scale velocity potential pattern has continued to become less coherent and shows only weak anomalous upper-level divergence across the Maritime Continent and weak anomalous upper-level convergence over parts of the Americas, Atlantic, and Africa.

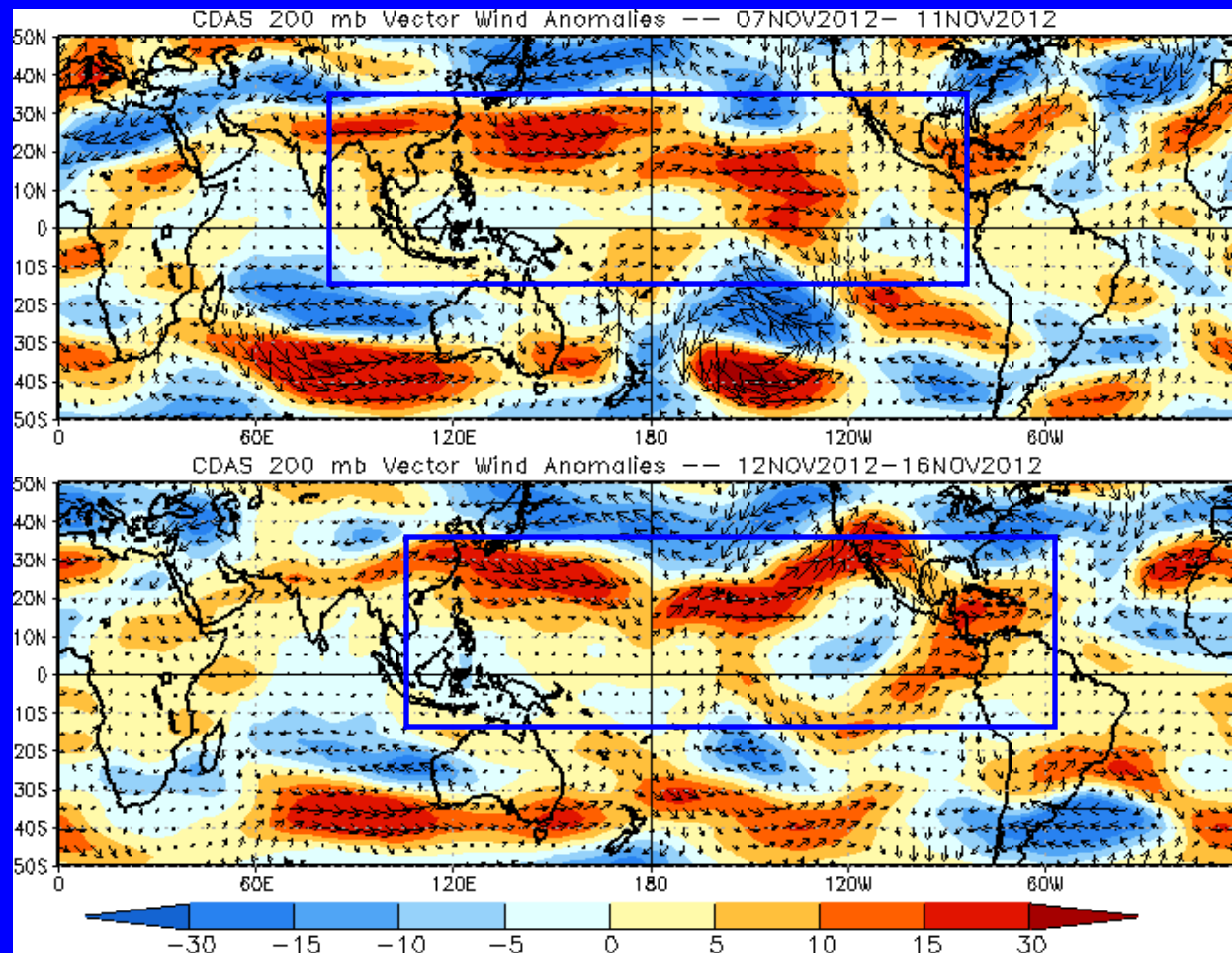


# 200-hPa Vector Wind Anomalies ( $\text{m s}^{-1}$ )

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



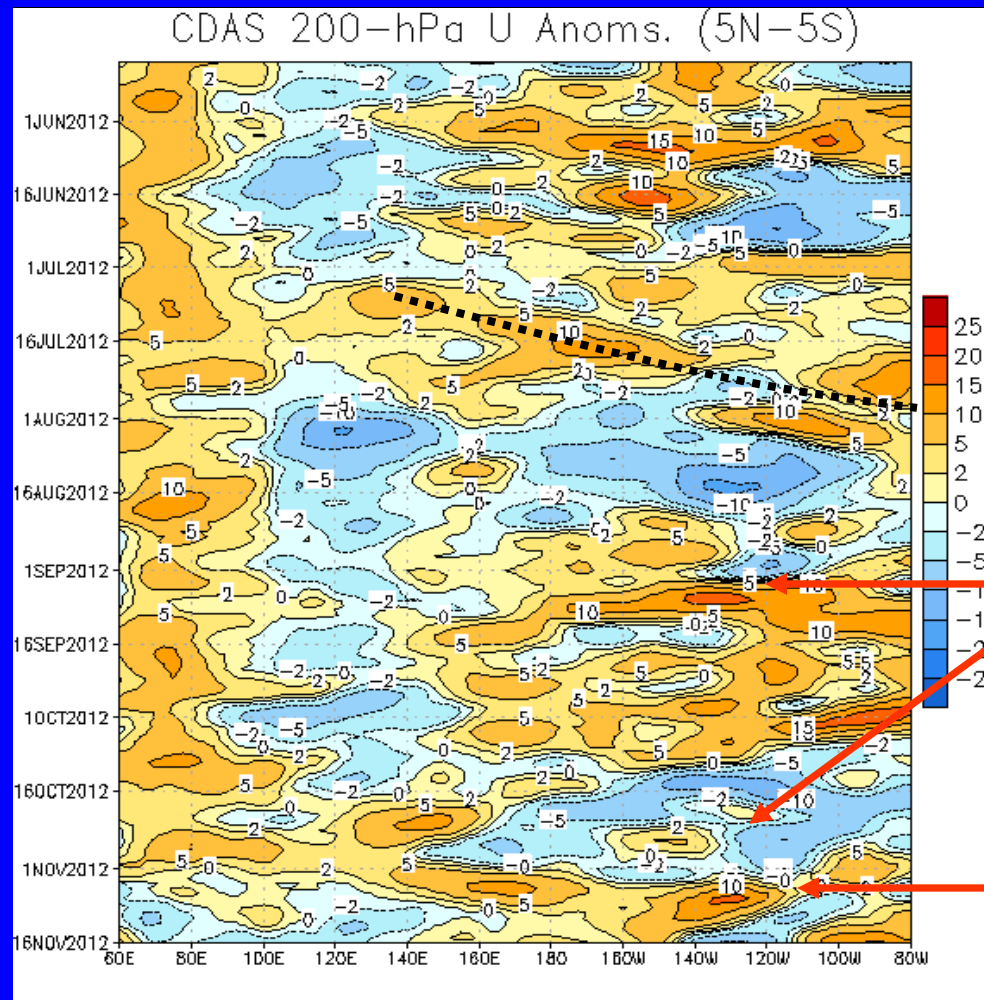
Westerly anomalies (blue boxes) have been generally persistent over the Pacific into the Americas during the last five to ten days.



# 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



Anomalies were not very coherent during late May and June.

Westerly anomalies shifted eastward across the Pacific during July and early August.

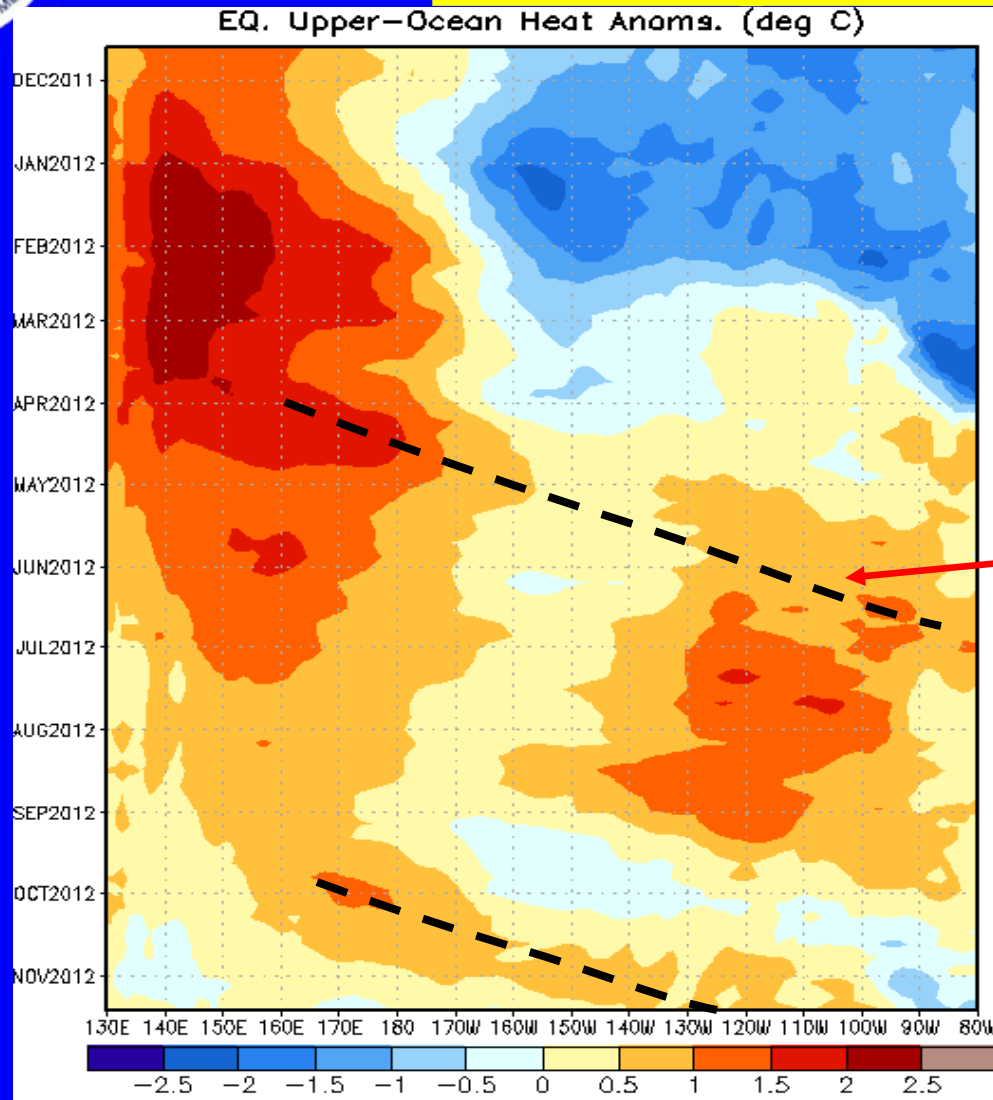
Westerly anomalies prevailed across the eastern Pacific and Americas for much of September and October, but were replaced by easterly anomalies during mid-October.

Westerly anomalies have recently shifted east to the central Pacific.



# Weekly Heat Content Evolution in the Equatorial Pacific

Time



Longitude

From July 2011 through February 2012, heat content was below average in the central and eastern equatorial Pacific.

From March into July 2012, heat content anomalies became positive and increased in magnitude across eastern equatorial Pacific, partly in association with a downwelling Kelvin wave.

Positive anomalies decreased across the eastern Pacific during late August and September.

An oceanic Kelvin wave was initiated at the end of September and has increased heat content across the central and eastern Pacific during October and November.





# **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.**

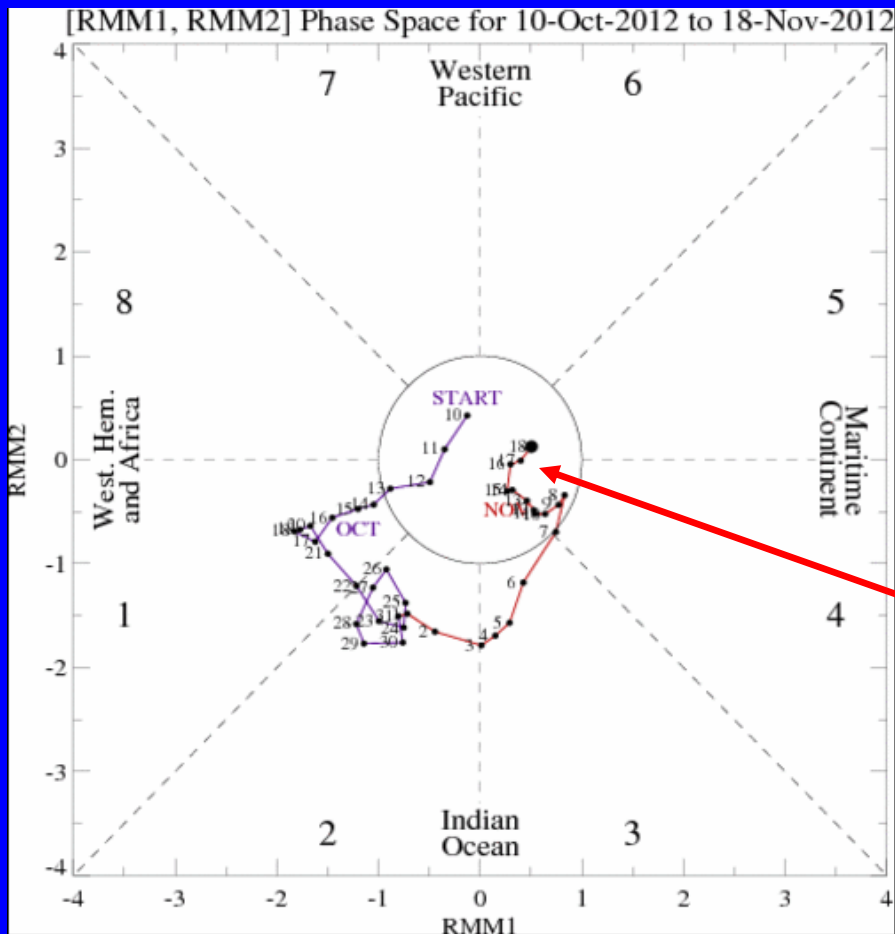
- The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.

**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



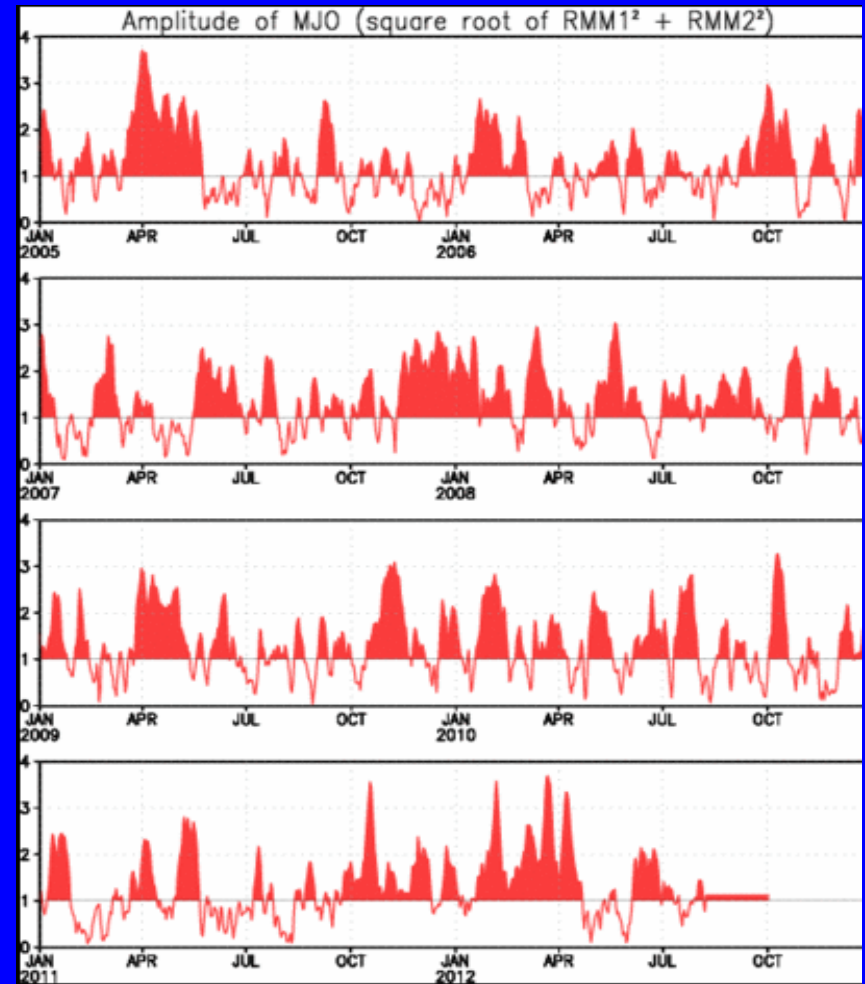
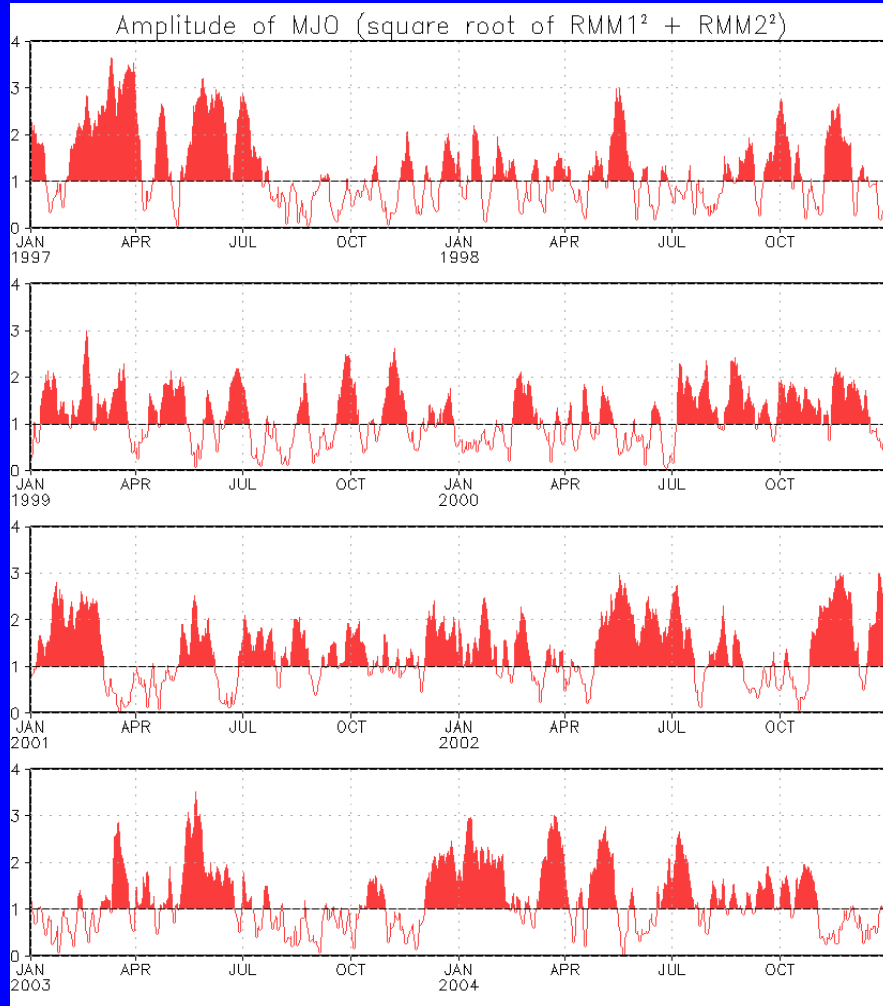
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The amplitude of the MJO index decreased during the past week with less eastward propagation.





# 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

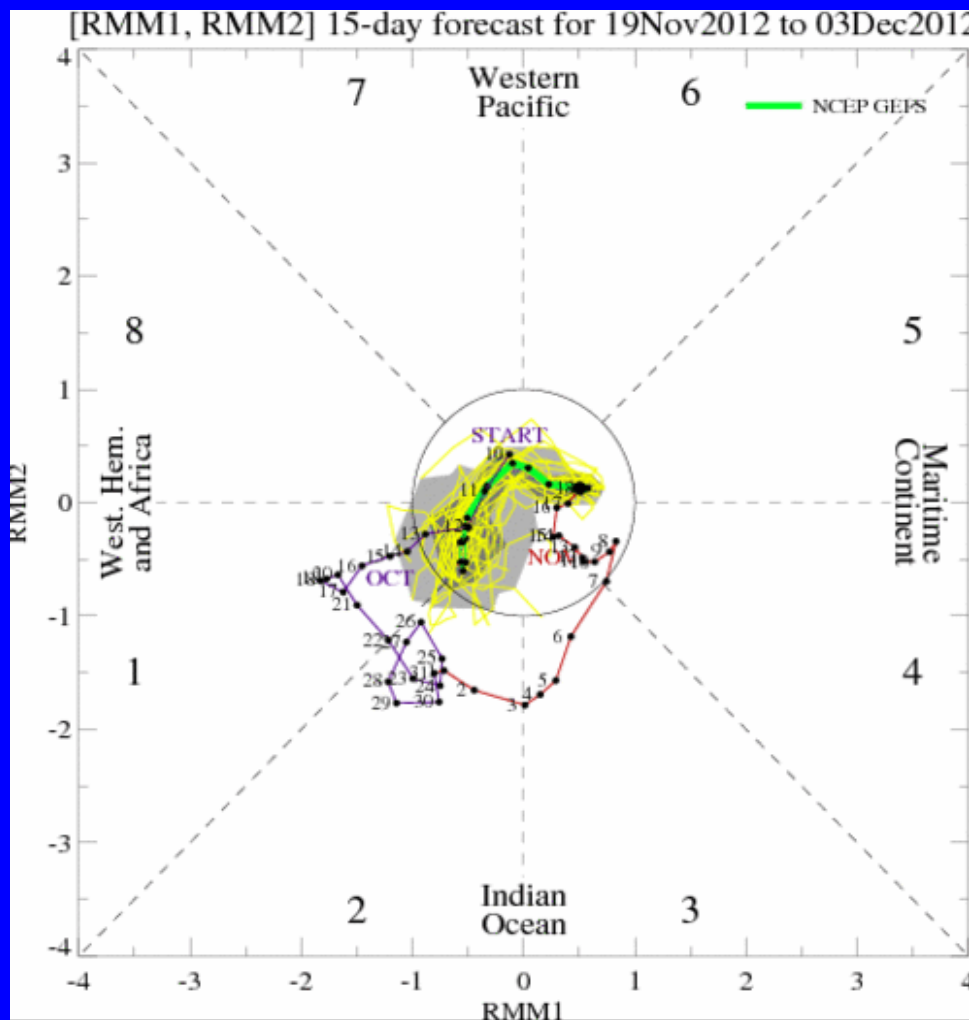
Green Line – Ensemble Mean

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 a weak signal during the period.

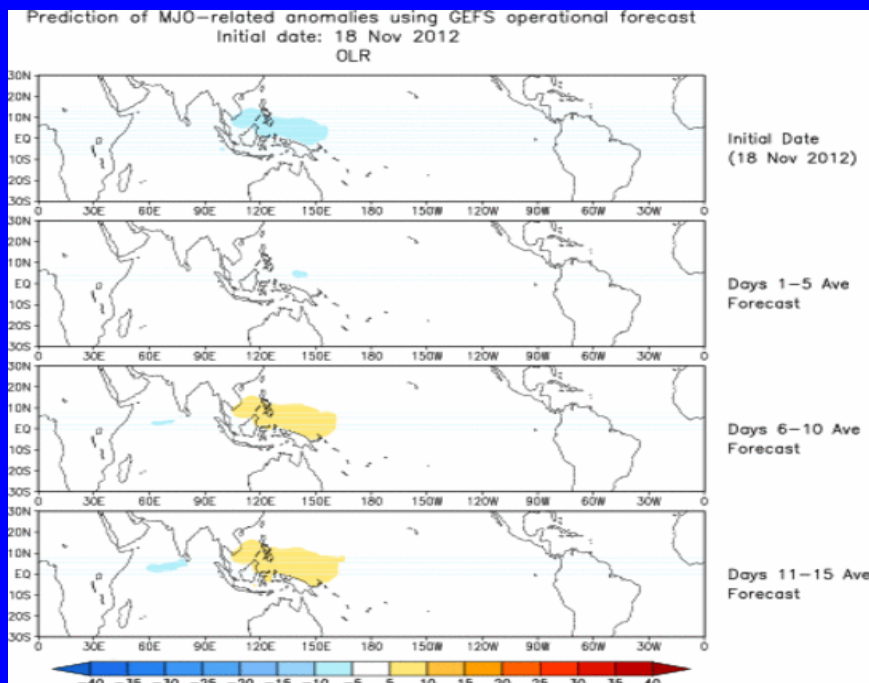




# Ensemble Mean GFS MJO Forecast

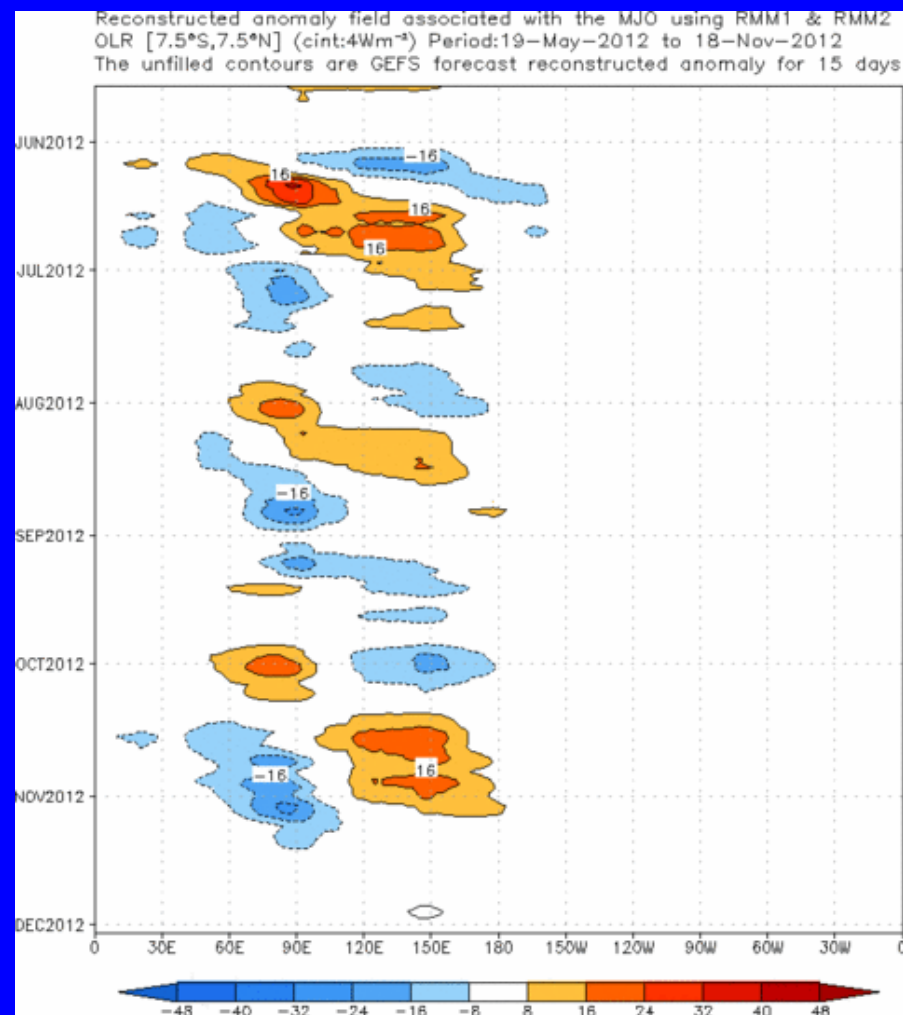
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

**Spatial map of OLR anomalies for the next 15 days**



The ensemble mean GFS forecast indicates little or no anomalous convection during the next two weeks.

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

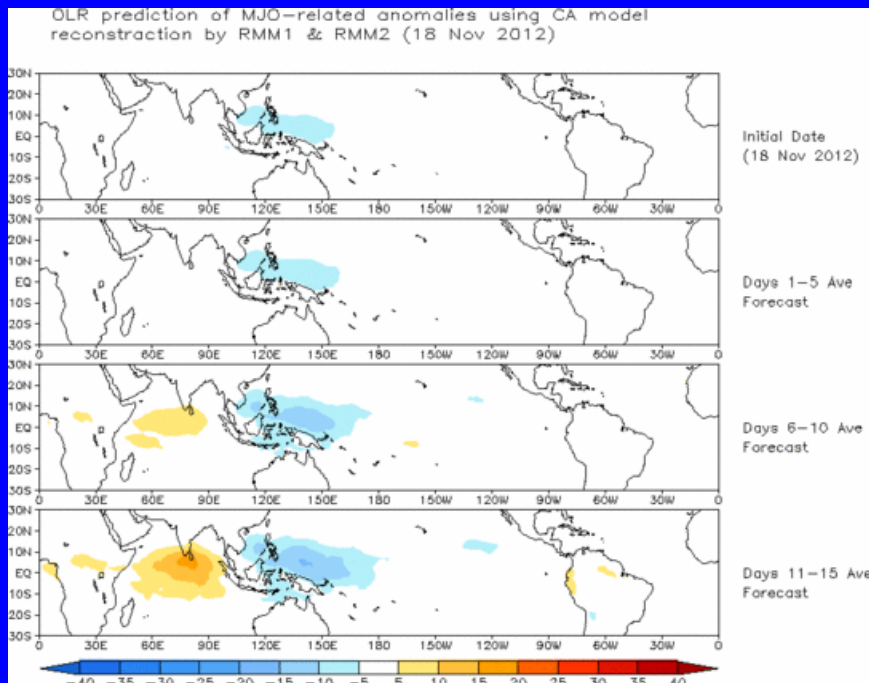




# Constructed Analog (CA) MJO Forecast

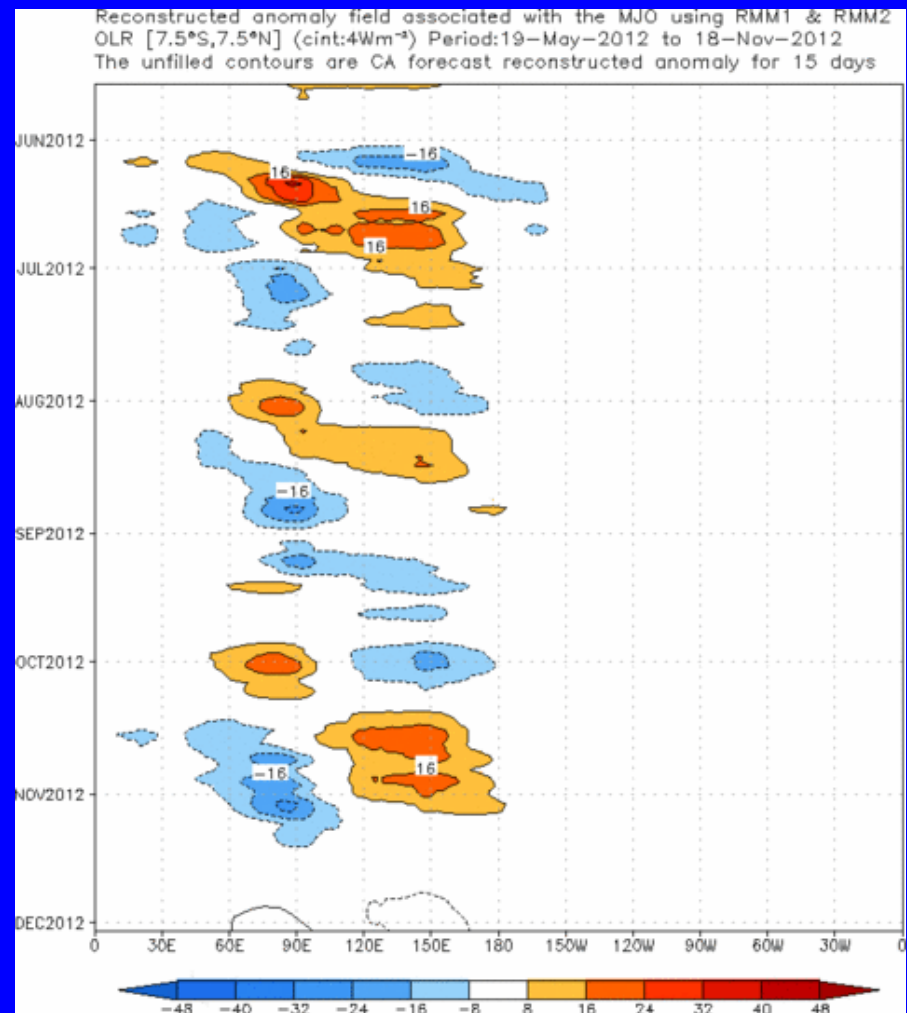
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

**Spatial map of OLR anomalies for the next 15 days**



This forecast also indicates little anomalous convection during Week-1 but some enhanced (suppressed) convection forecast across the Maritime Continent (Indian Ocean) during Week-2.

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

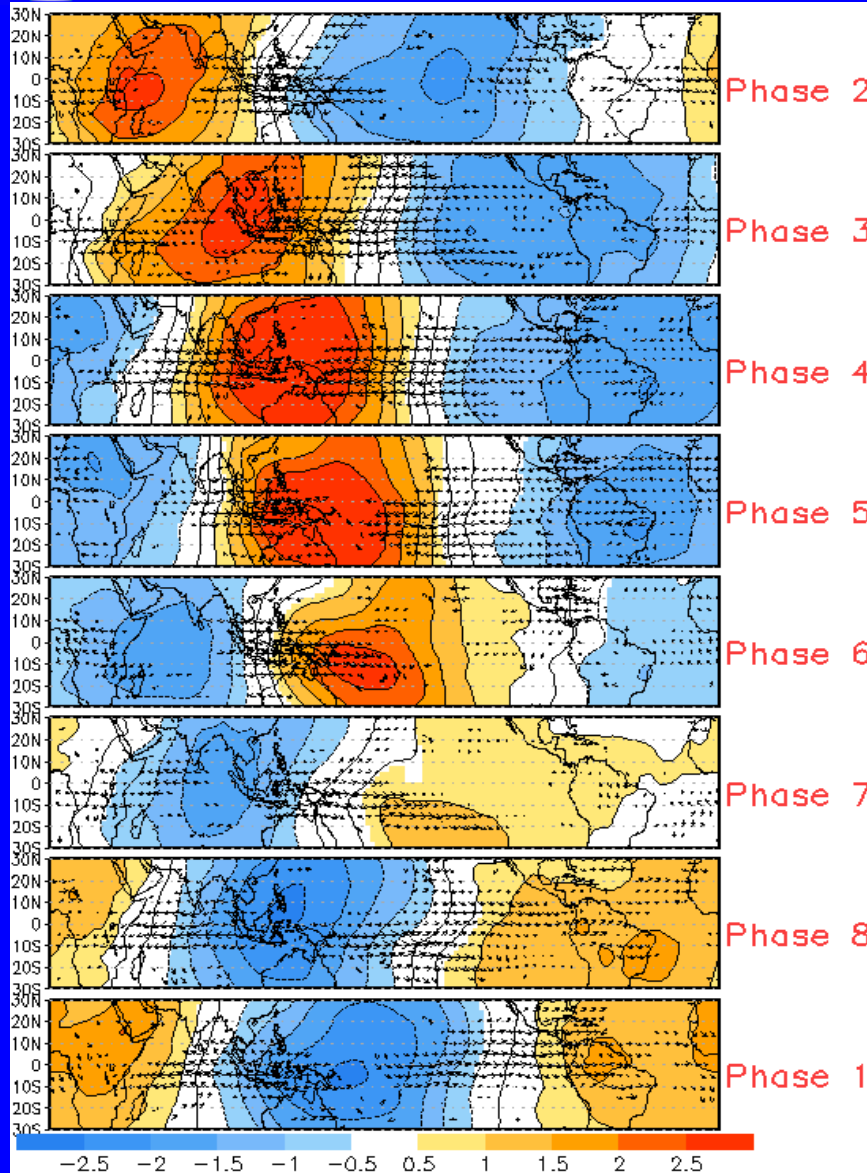




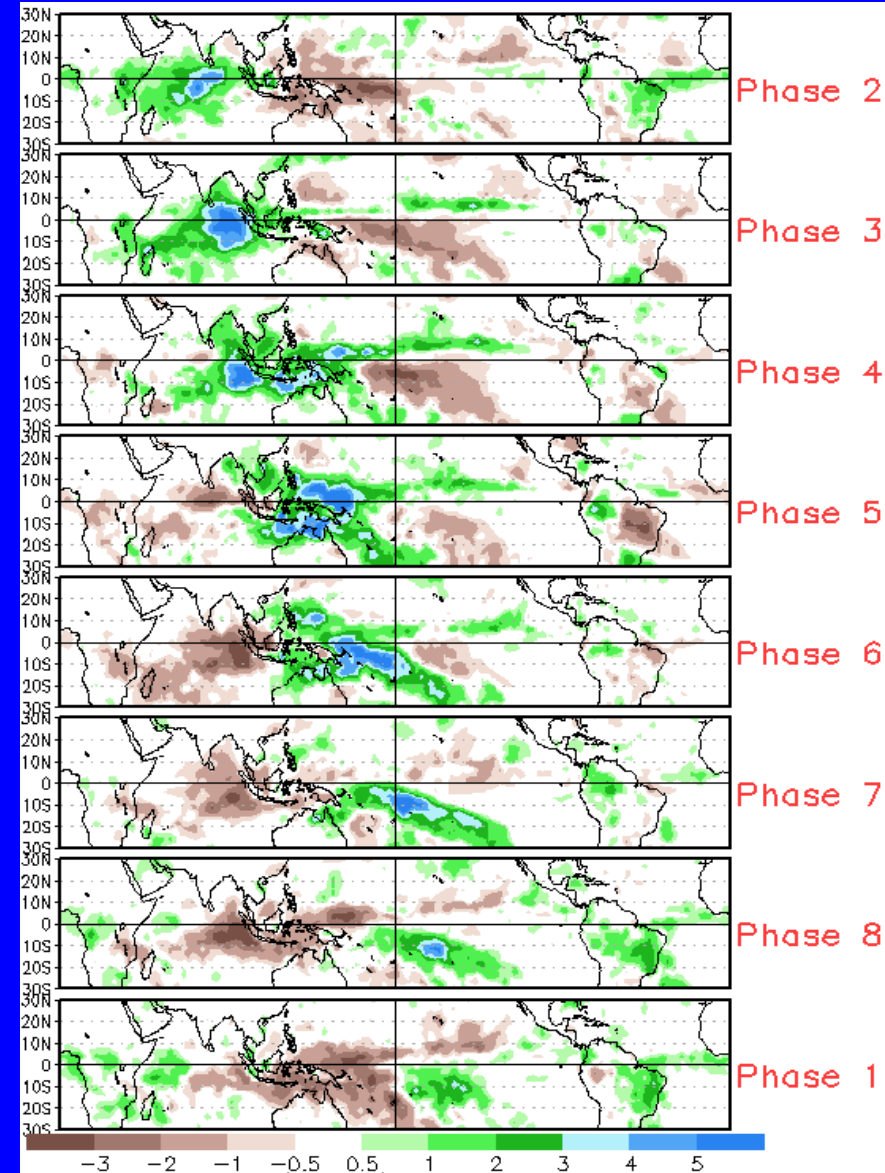


# MJO Composites – Global Tropics

850-hPa Velocity Potential and  
Wind Anomalies (Nov-Mar)



Precipitation Anomalies (Nov-Mar)

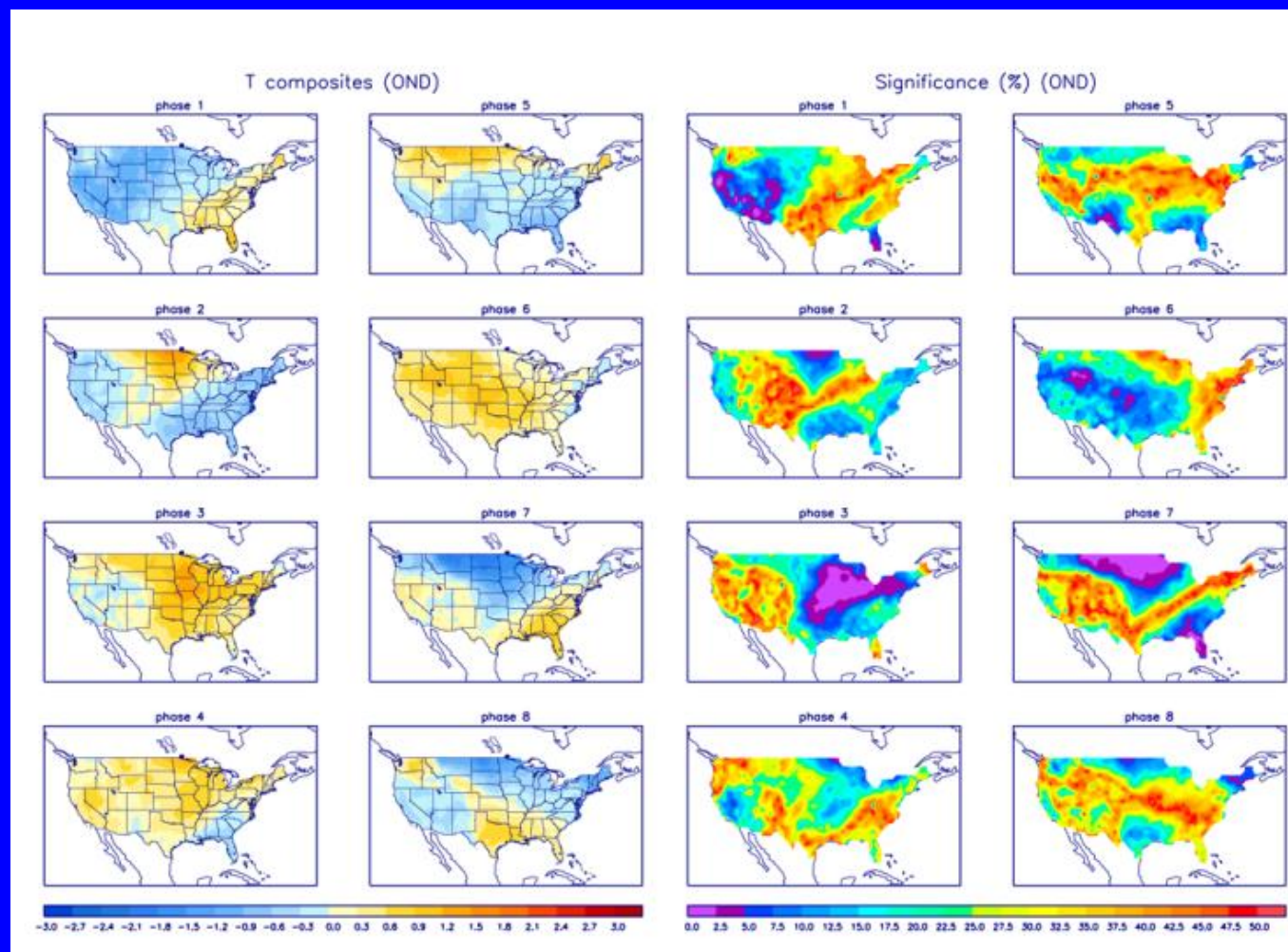




# U.S. MJO Composites – Temperature

- 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. 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

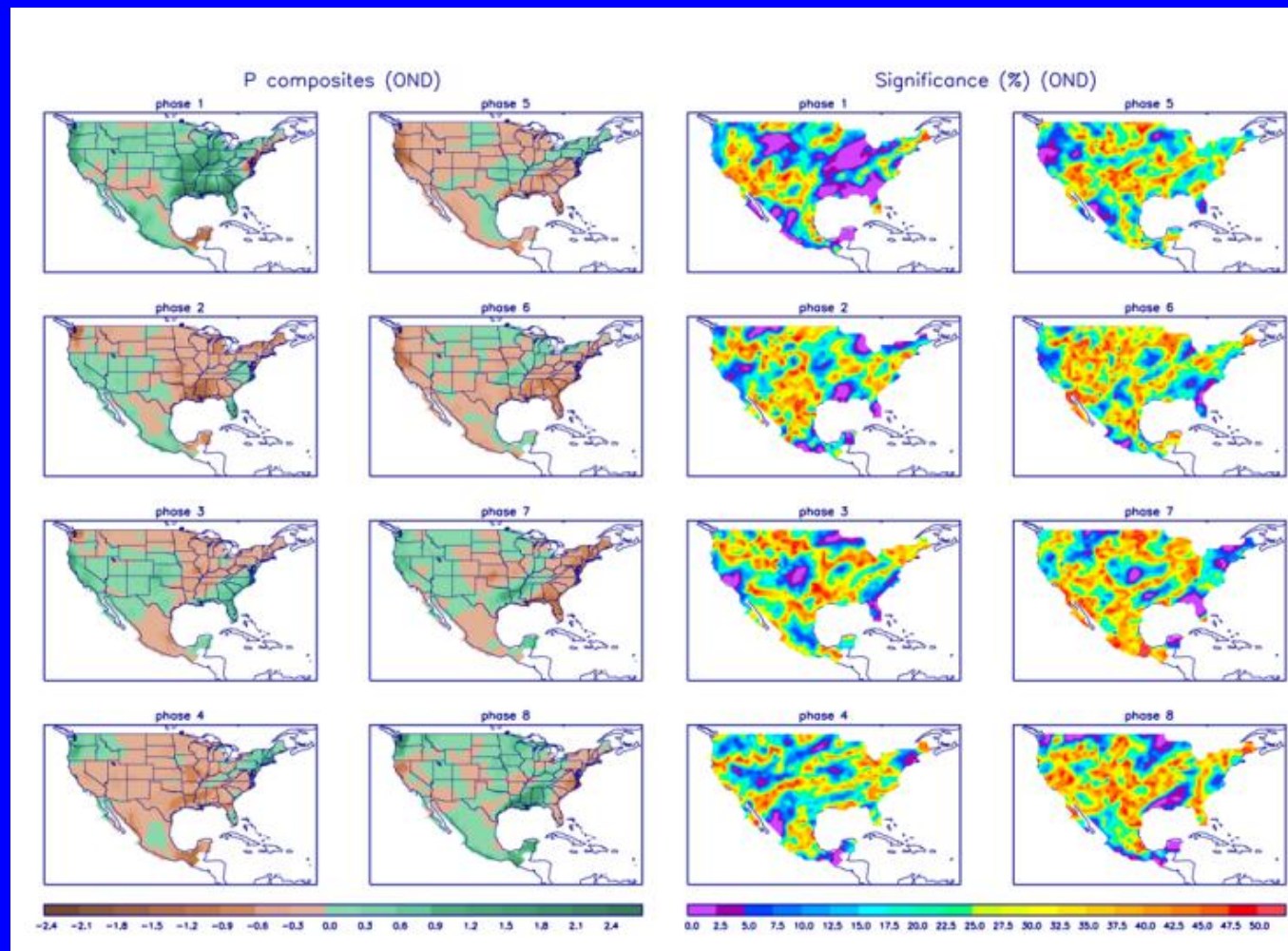
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml>





# 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. Purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.



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