



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

**Update prepared by  
Climate Prediction Center / NCEP  
January 16, 2012**



# Outline

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



# Overview

- **The MJO was weak during the past week as most observational indicators do not indicate any clear, coherent behavior.**
- **La Nina conditions and additional subseasonal tropical variability continue to contribute much to the patterns of anomalous convection in the global Tropics.**
- **At the current time, dynamical model MJO index forecasts indicate no coherent MJO signal during the next 1-2 weeks.**
- **Based on recent observations and model forecasts, the MJO is forecast to remain weak over the next 1-2 weeks and may not contribute much to anomalous tropical convection.**

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

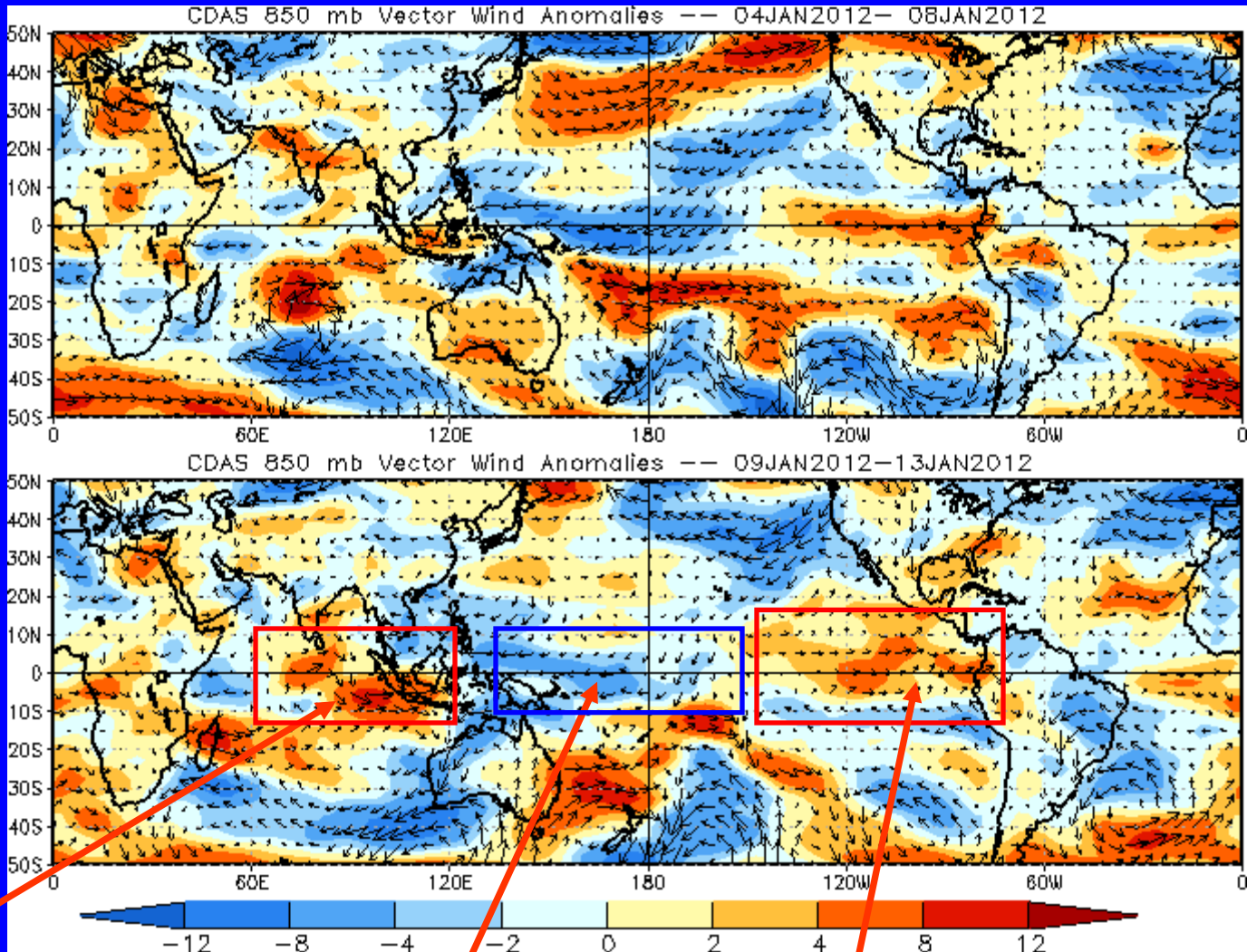


# 850-hPa Vector Wind Anomalies ( $\text{m s}^{-1}$ )

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly wind anomalies strengthened over the equatorial Indian Ocean during the past five days.

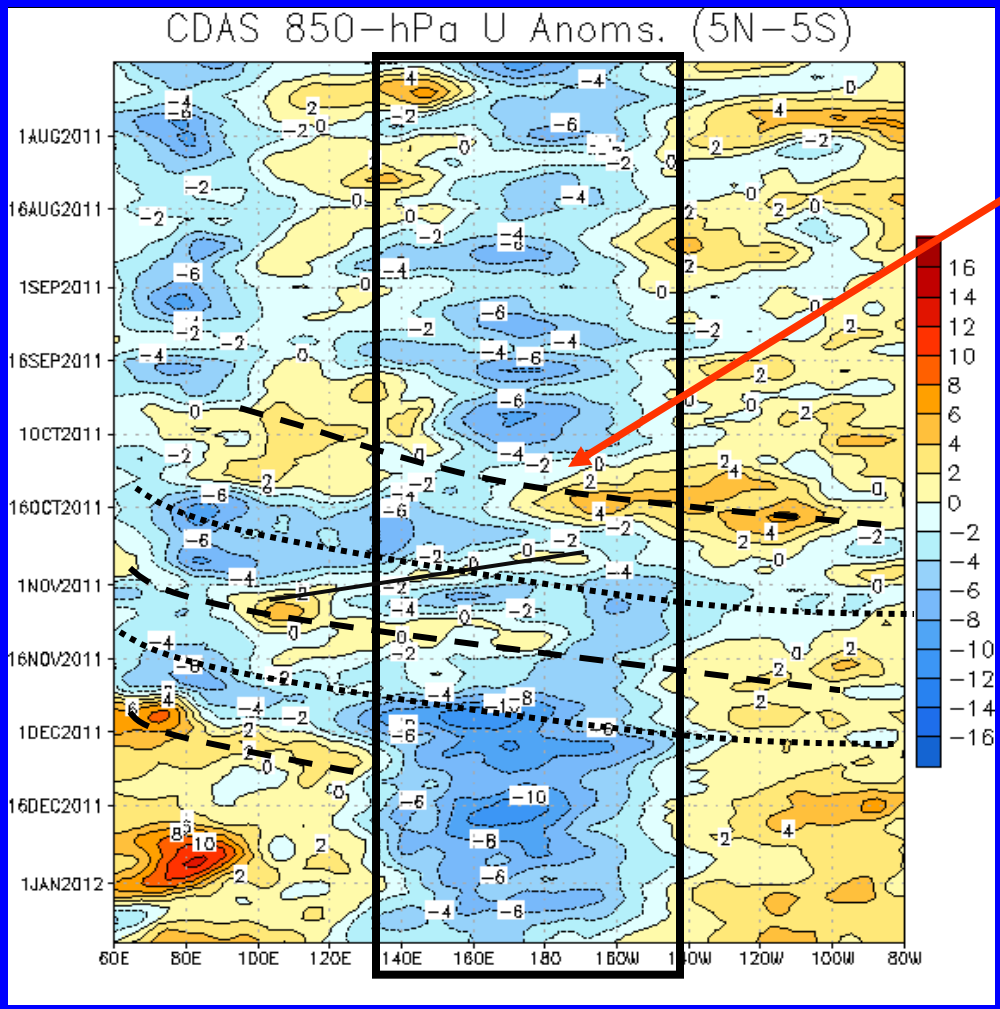
Easterly anomalies weakened over the equatorial Pacific.

Westerly wind anomalies continued over the east Pacific Ocean.



# 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

In early October, MJO activity weakened the persistent easterly anomalies across the central Pacific (first dashed line).

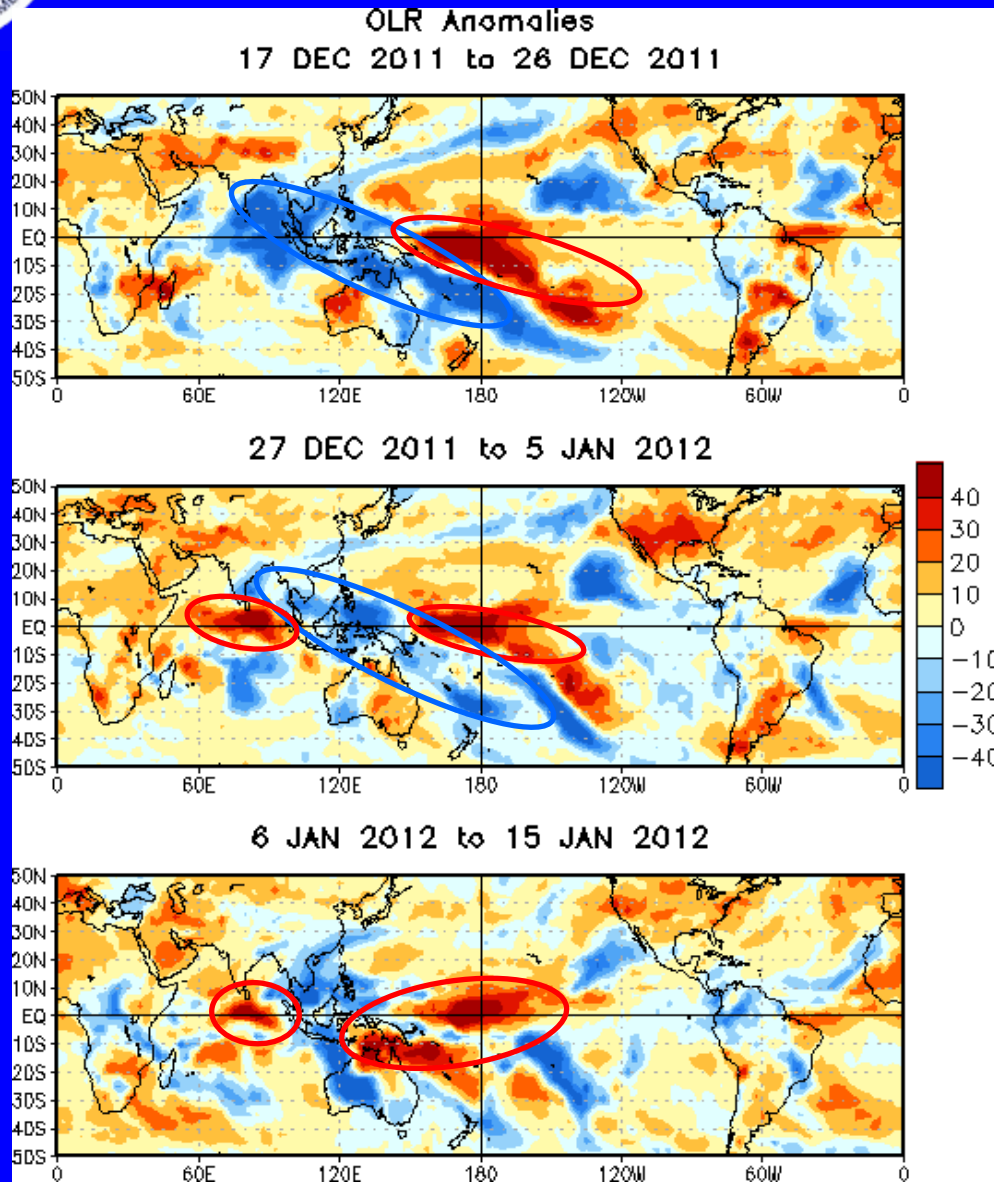
An equatorial Rossby wave imparted westerly anomalies across parts of the western Pacific and Maritime continent during late October and early November (thin solid line).

MJO activity continued into December (altering dashed and dotted lines), but most recently westerly (easterly) wind anomalies across the Indian Ocean (western Pacific) have become more stationary. There has been a slight shift westward in these anomalies most recently.



# 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-December, enhanced convection (blue circle) developed near the Philippines, the Maritime continent and the South Pacific Convergence Zone (SPCZ). Suppressed convection (red circle) continued near the Date Line and to the southeast.

Enhanced convection continued into the beginning of January from the Maritime Continent to the SPCZ, while suppressed convection developed over the equatorial Indian Ocean.

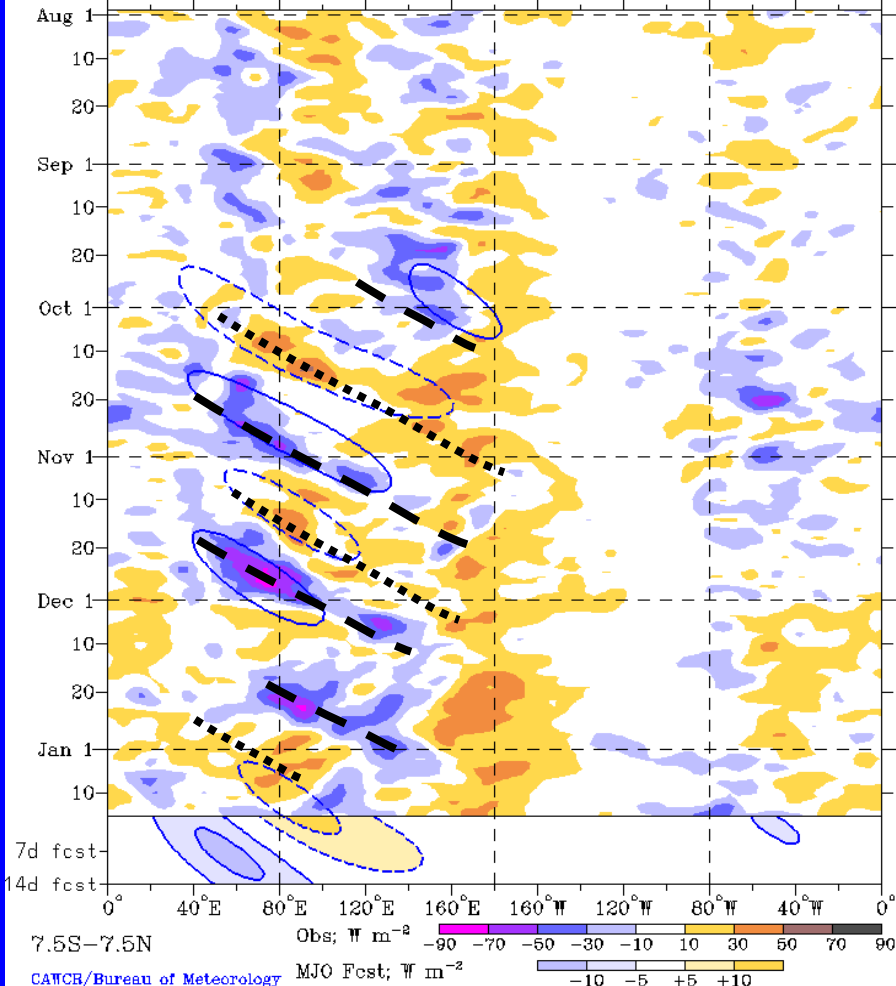
During early January, much drier conditions became evident to the north of Australia with suppressed convection persisting across the equatorial Indian Ocean.





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

Real-time MJO filtering superimposed upon 3drmm R21 OLR Anomalies  
MJO anomalies blue contours, CINT=10. (5. for forecast)  
Negative contours solid, positive dashed  
31-Jul-2011 to 15-Jan-2012 + 14 days



**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)**

Beginning in mid-September, enhanced convection shifted from southern Asia to the western Pacific while suppressed convection developed during late September across India and also shifted eastward to the western Pacific.

MJO activity continued into the first half of December when OLR anomalies decreased and eastward propagation was not clear.

During late December, eastward propagation of OLR anomalies is indicated once again with suppressed convection indicated across the Indian Ocean during the first week in January.

**Longitude**

**Time**  
↓

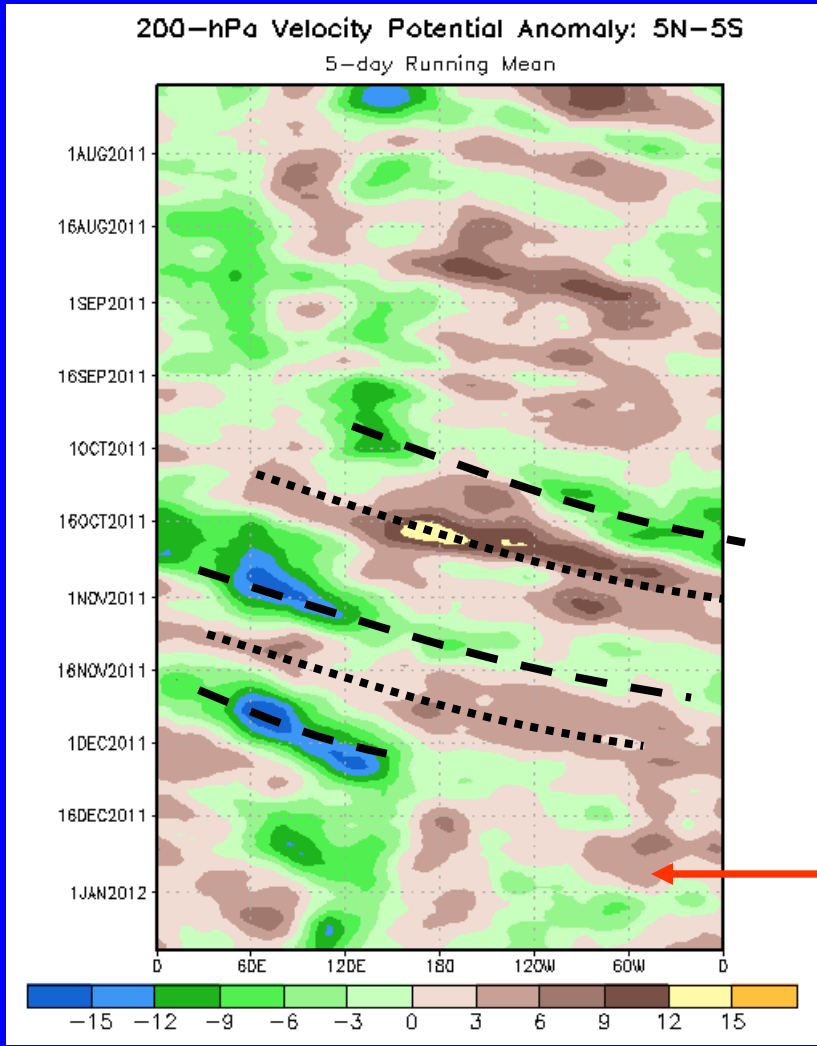


# 200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time  
↓



During July and August very fast eastward propagation was evident at times and mainly associated with higher frequency sub-seasonal coherent tropical variability not associated with MJO activity.

Beginning in the second half of September into December, alternating negative (dashed lines) and positive (dotted lines) anomalies were evident and associated with MJO activity during the period.

Eastward propagation of anomalies became less coherent during December as compared to the end of 2011.

Longitude

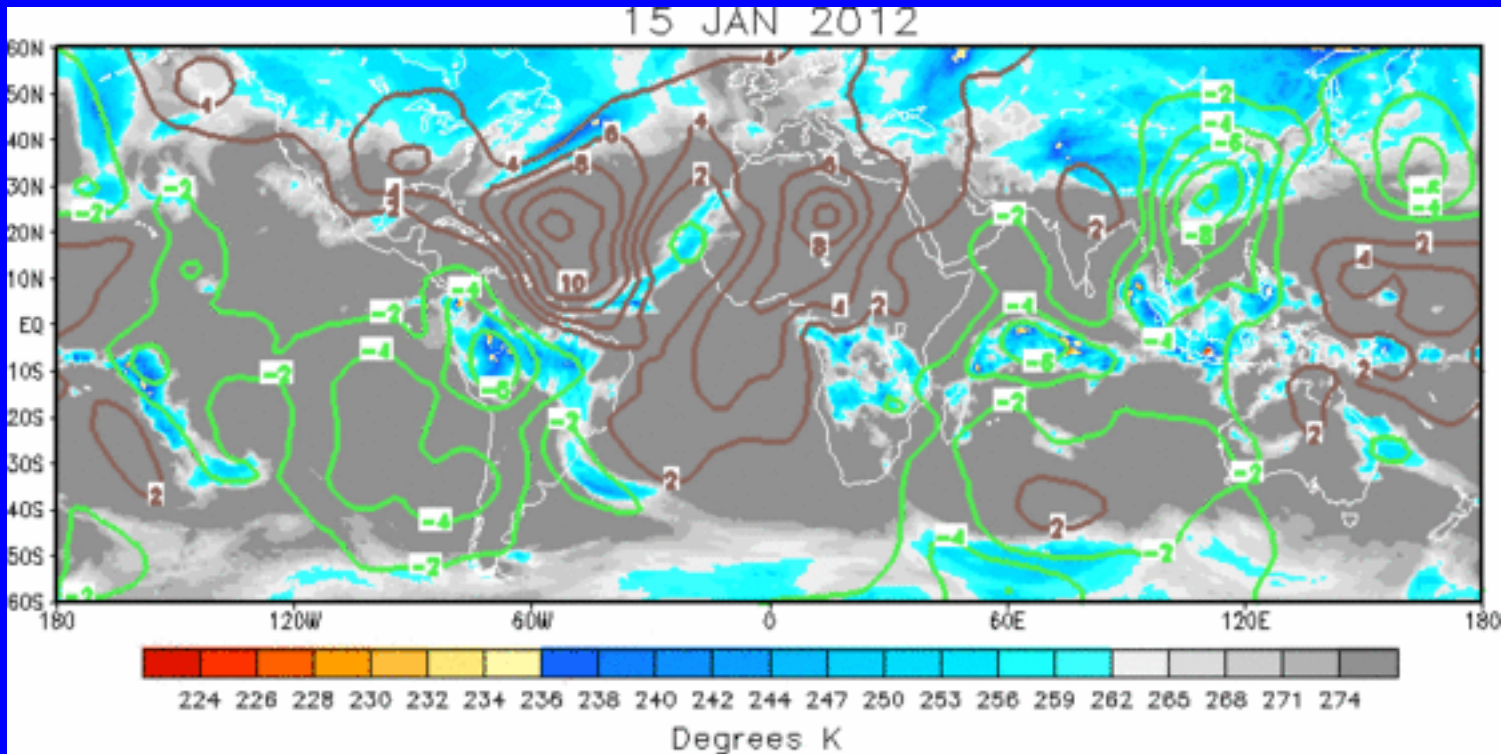




# IR Temperatures (K) / 200-hPa Velocity Potential Anomalies

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The latest large scale velocity potential pattern indicates a less coherent pattern than observed during December.

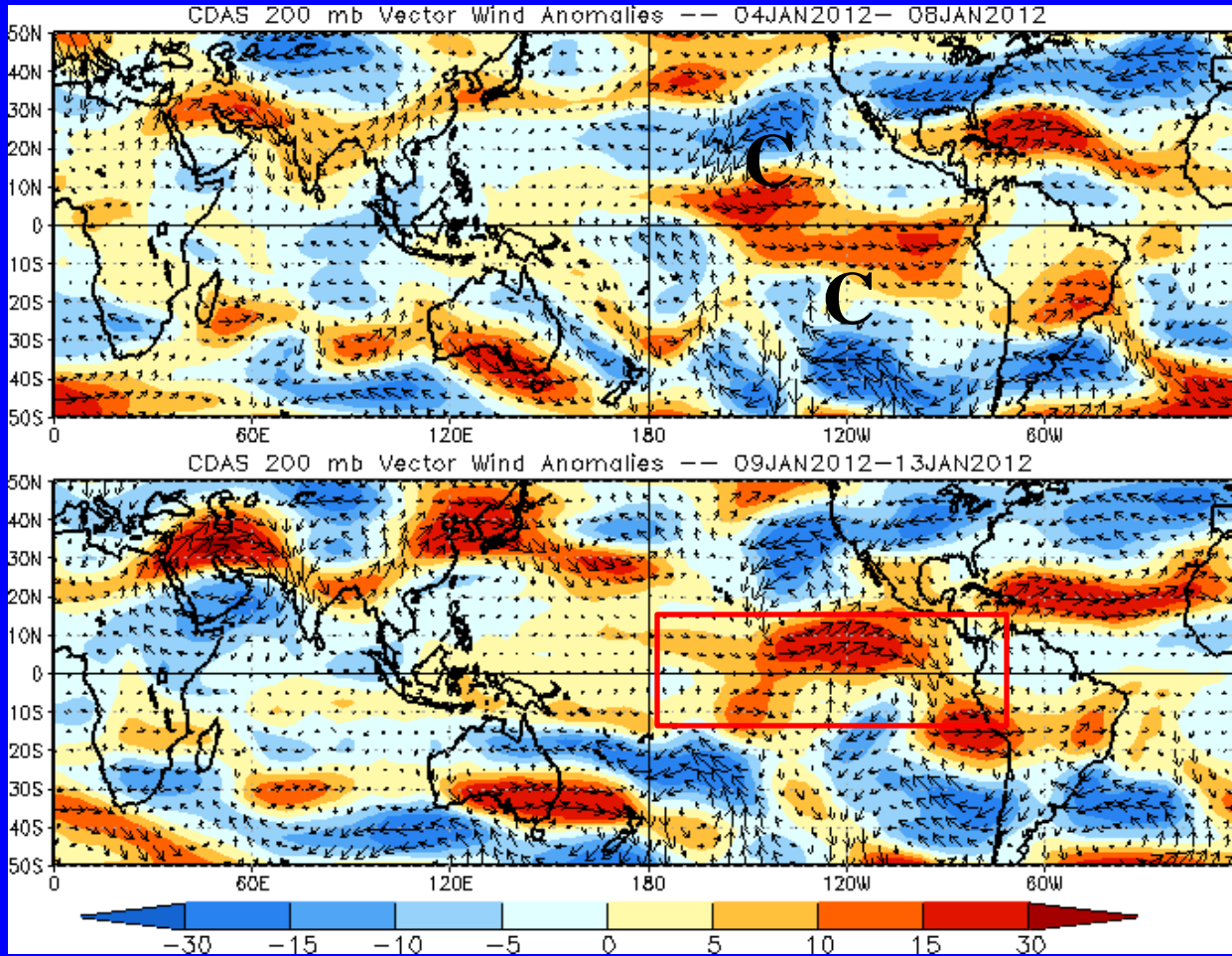


# 200-hPa Vector Wind Anomalies ( $\text{m s}^{-1}$ )

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Large scale cyclonic circulations are evident both north and south of the equator near the Date Line.

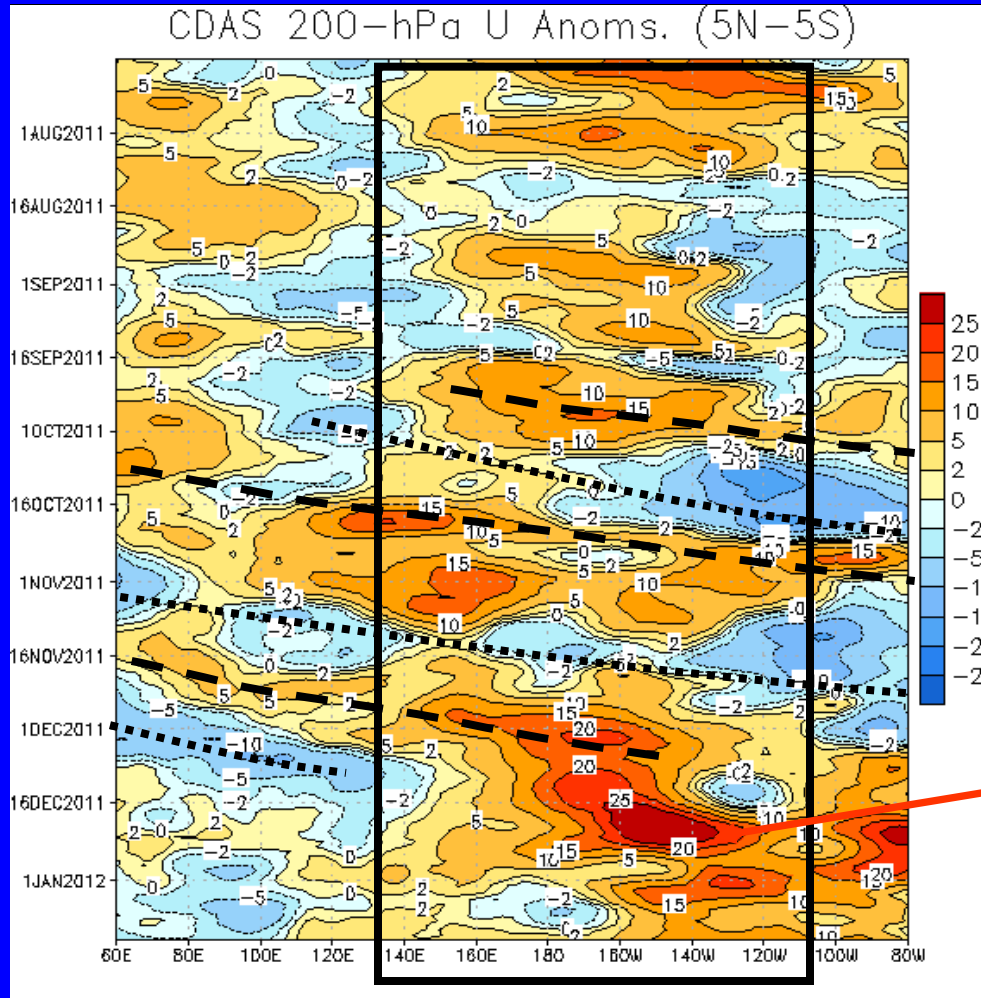
During the past five days, westerly anomalies persisted over the east Pacific.



# 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) during much of the period prior to mid-September.

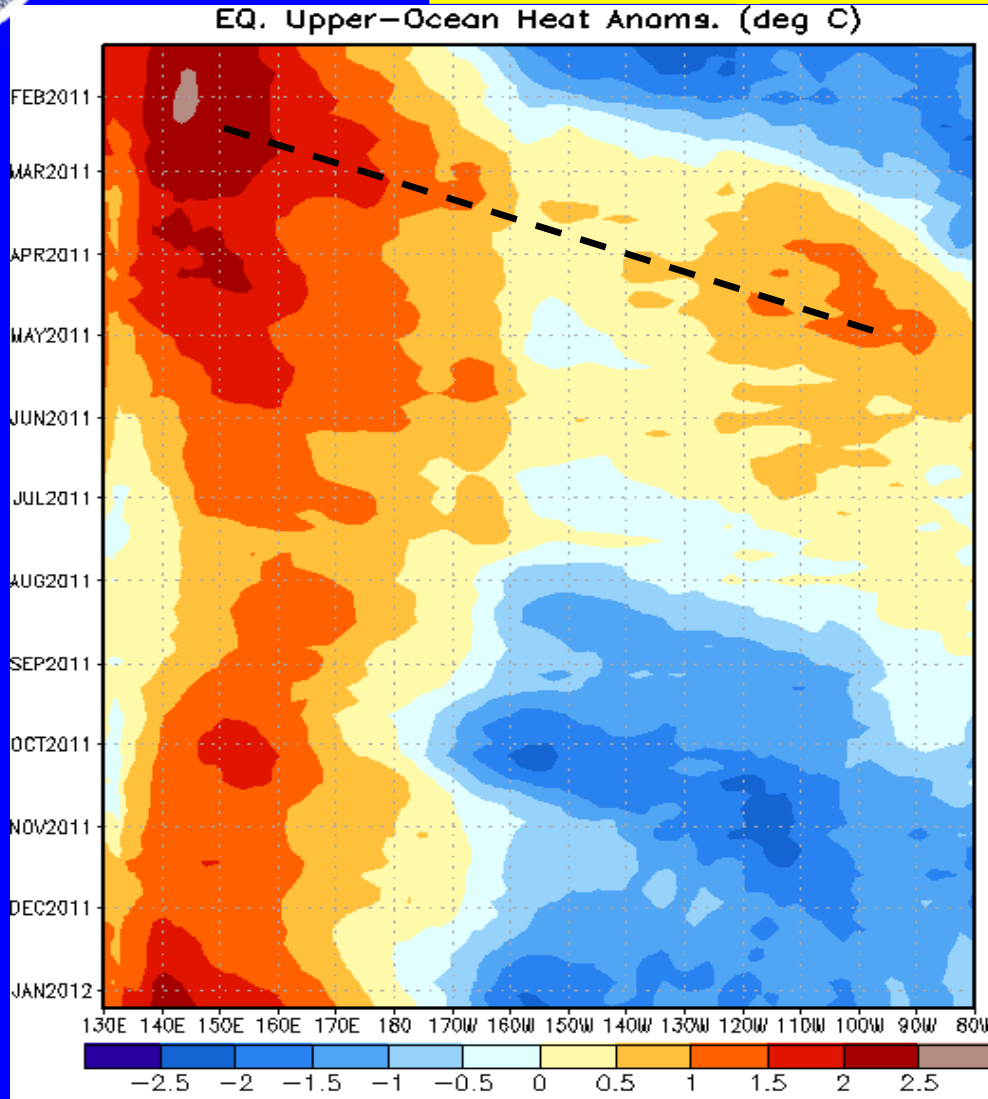
Alternating westerly (dashed lines) and easterly (dotted lines) anomalies are evident from mid-September into December associated with the MJO.

Westerly anomalies over the Pacific strengthened during early-to-mid December with some eastward propagation evident. Most recently, westerly anomalies have persisted over the primarily the western hemisphere.



# Weekly Heat Content Evolution in the Equatorial Pacific

Time  
↓



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 late July, negative heat content anomalies are evident across the equatorial central and eastern Pacific.

Longitude





# 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.

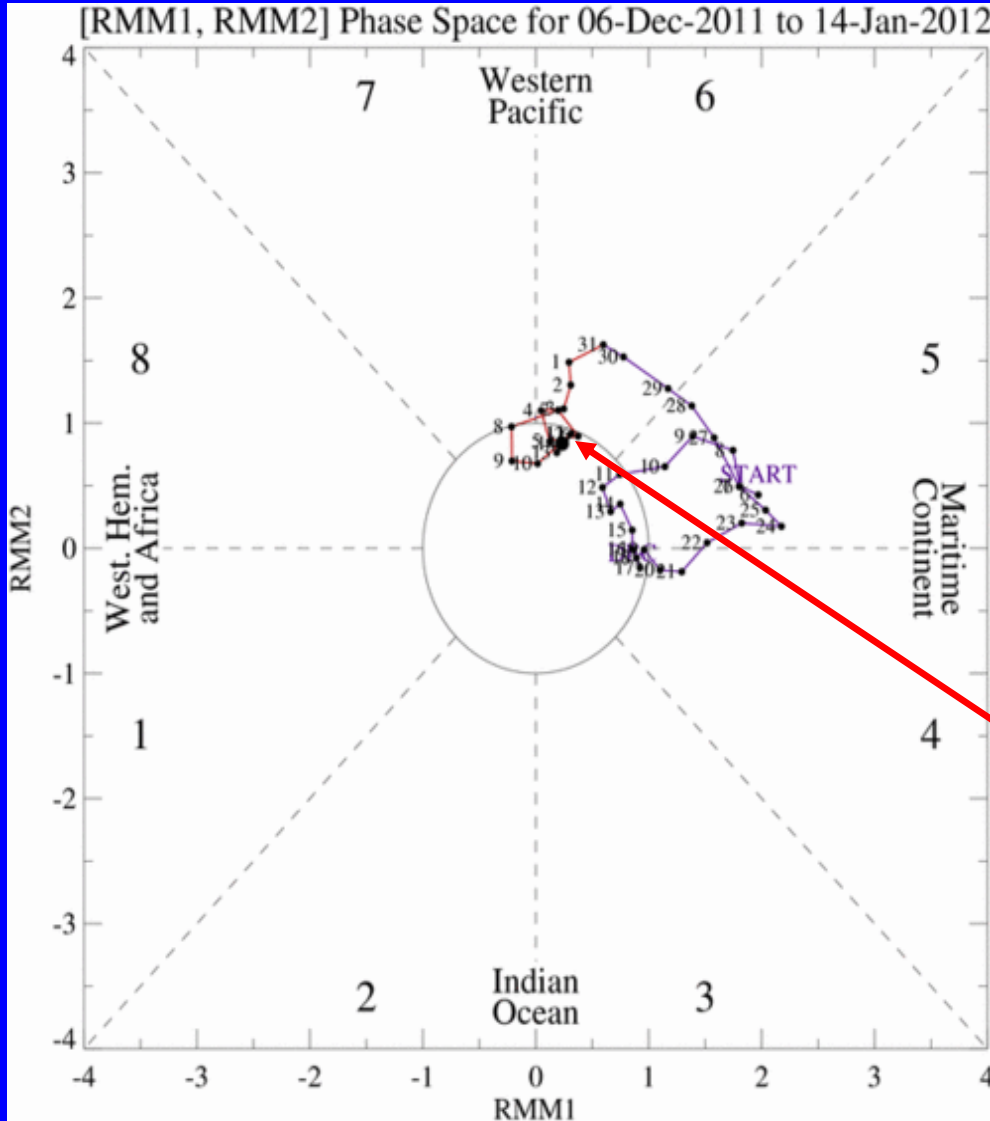
**Gottschalck et al. 2010: A Framework for Assessing Operational Madden-Julian Oscillation Forecasts: A CLIVAR MJO Working Group Project, *Bull. Amer. Met. Soc.*, 91, 1247-1258.**

- 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

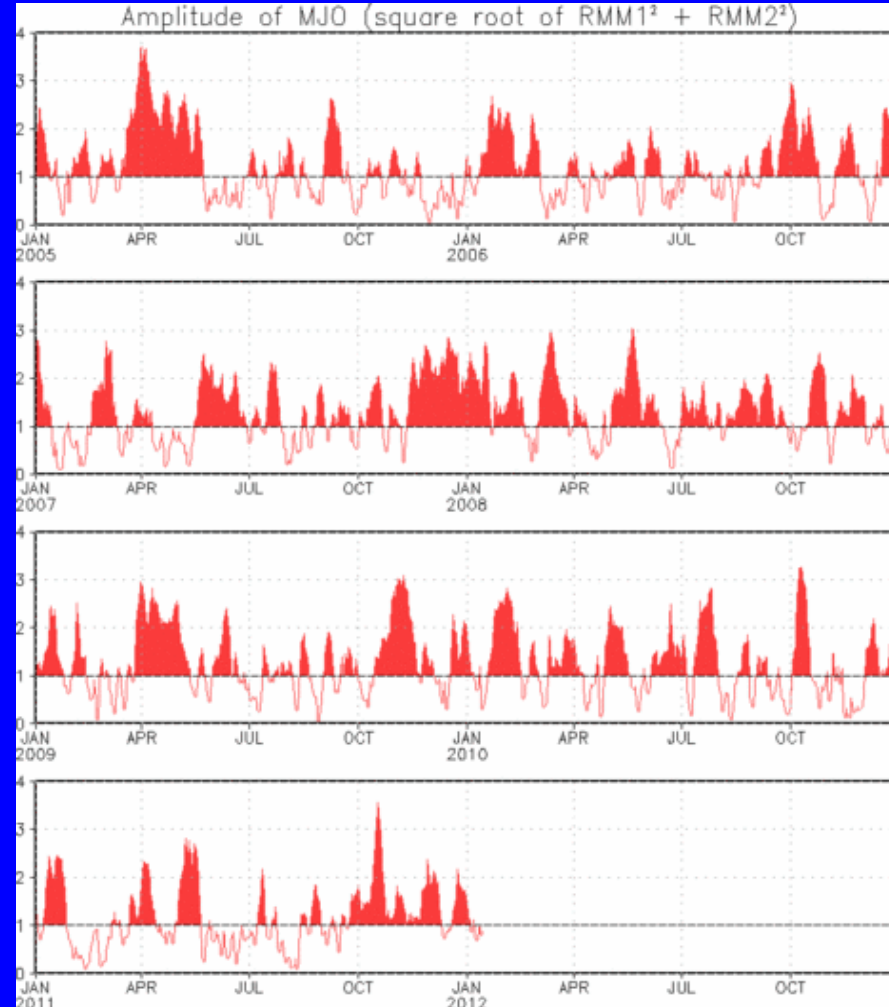
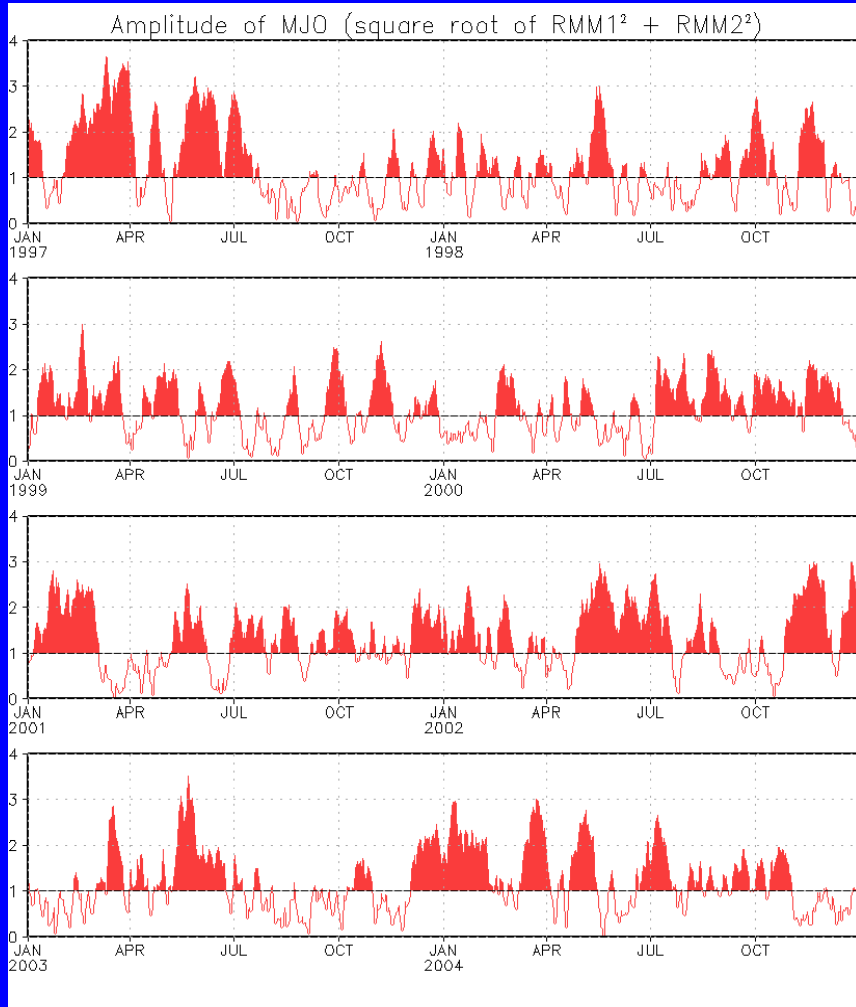


Since the beginning of January, the MJO index decreased in amplitude with no eastward propagation.





# 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.



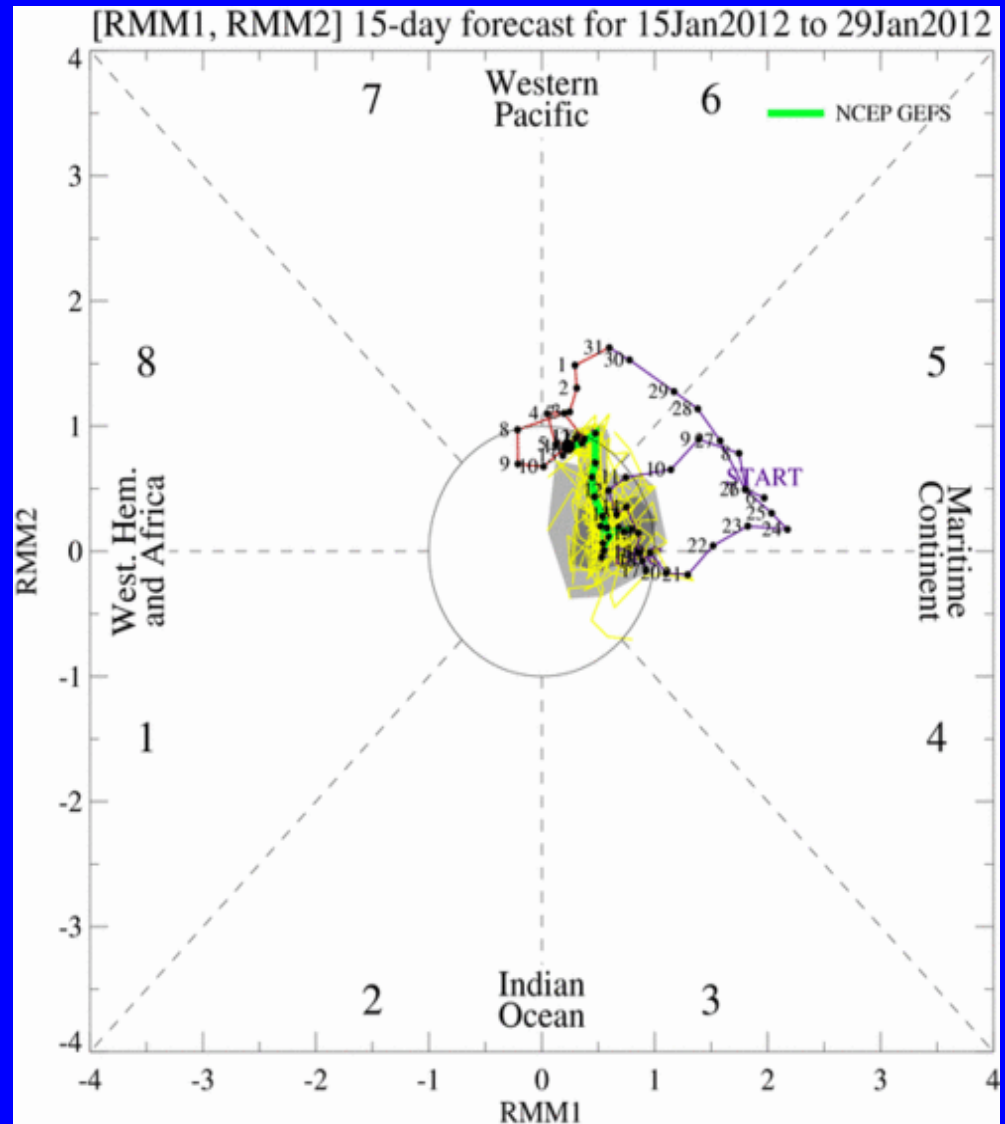
# Ensemble GFS (GEFS) MJO Forecast

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 generally stationary signal with the enhanced phase persisting across parts of Maritime Continent and western Pacific during the next two weeks.



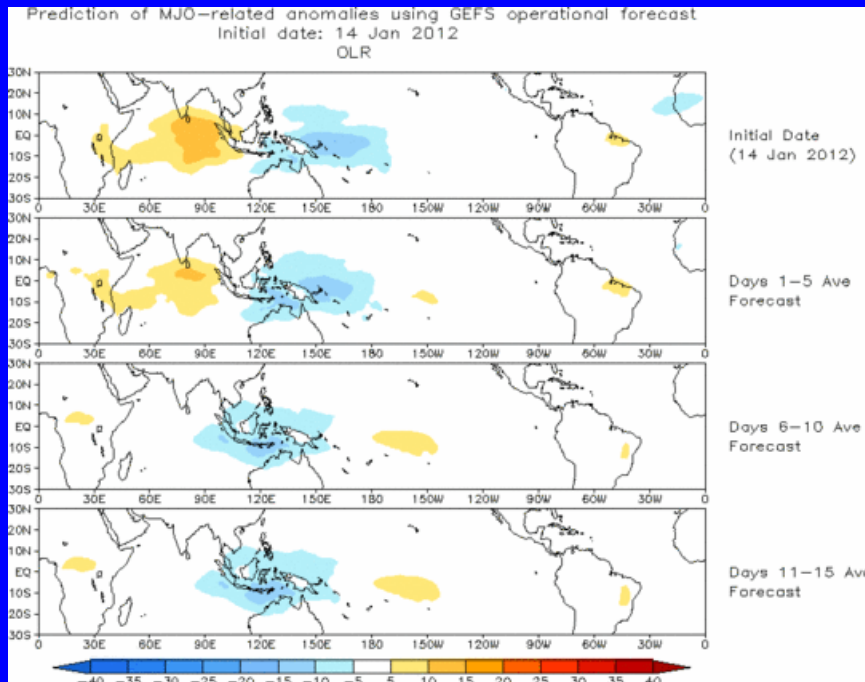


# Ensemble Mean GFS MJO Forecast

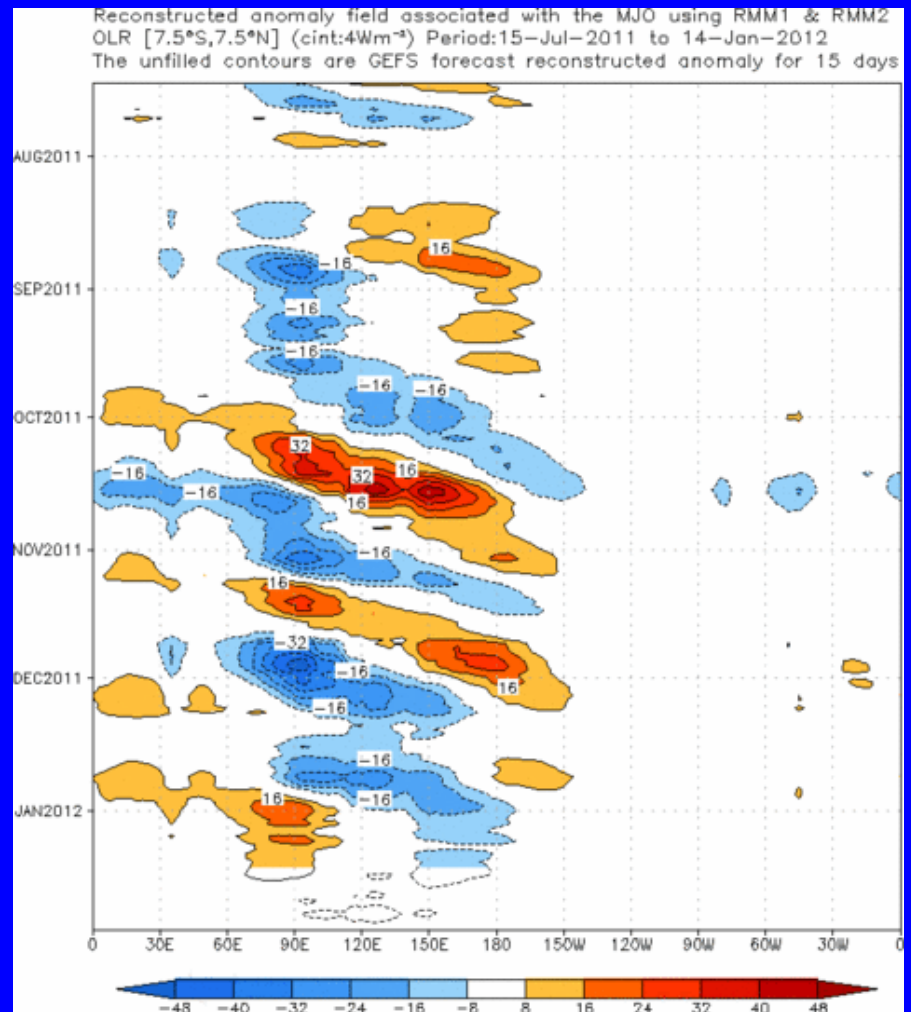
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

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 ensemble mean GFS forecast indicates enhanced convection across the western Pacific and Maritime Continent during the next two weeks.



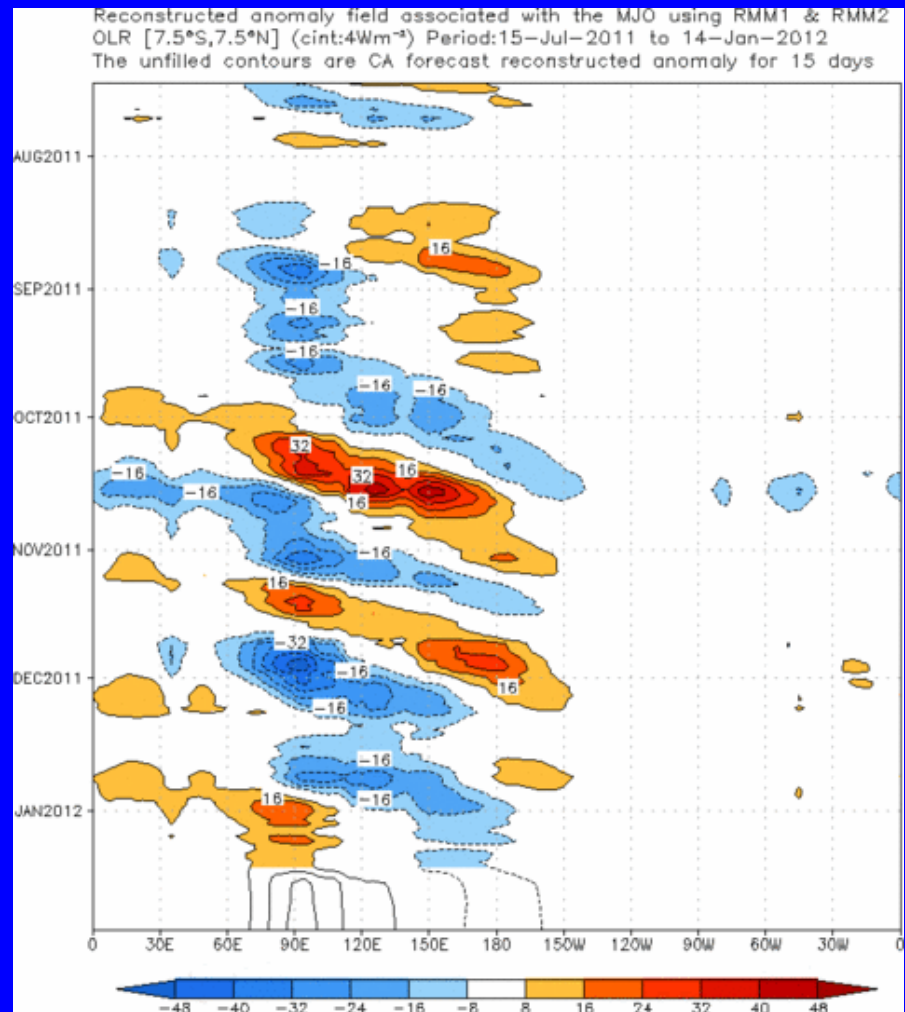
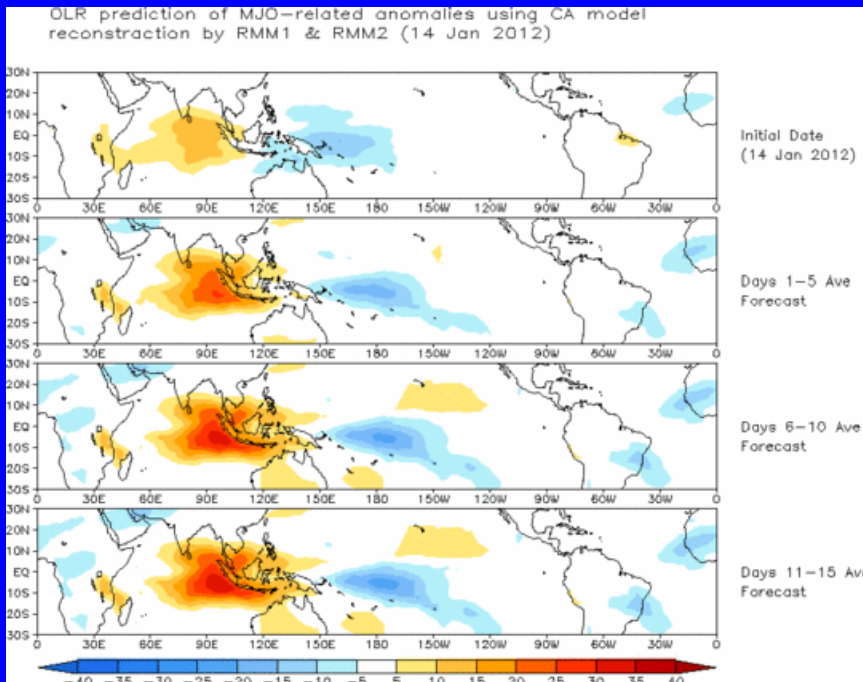


# Constructed Analog (CA) MJO Forecast

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

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



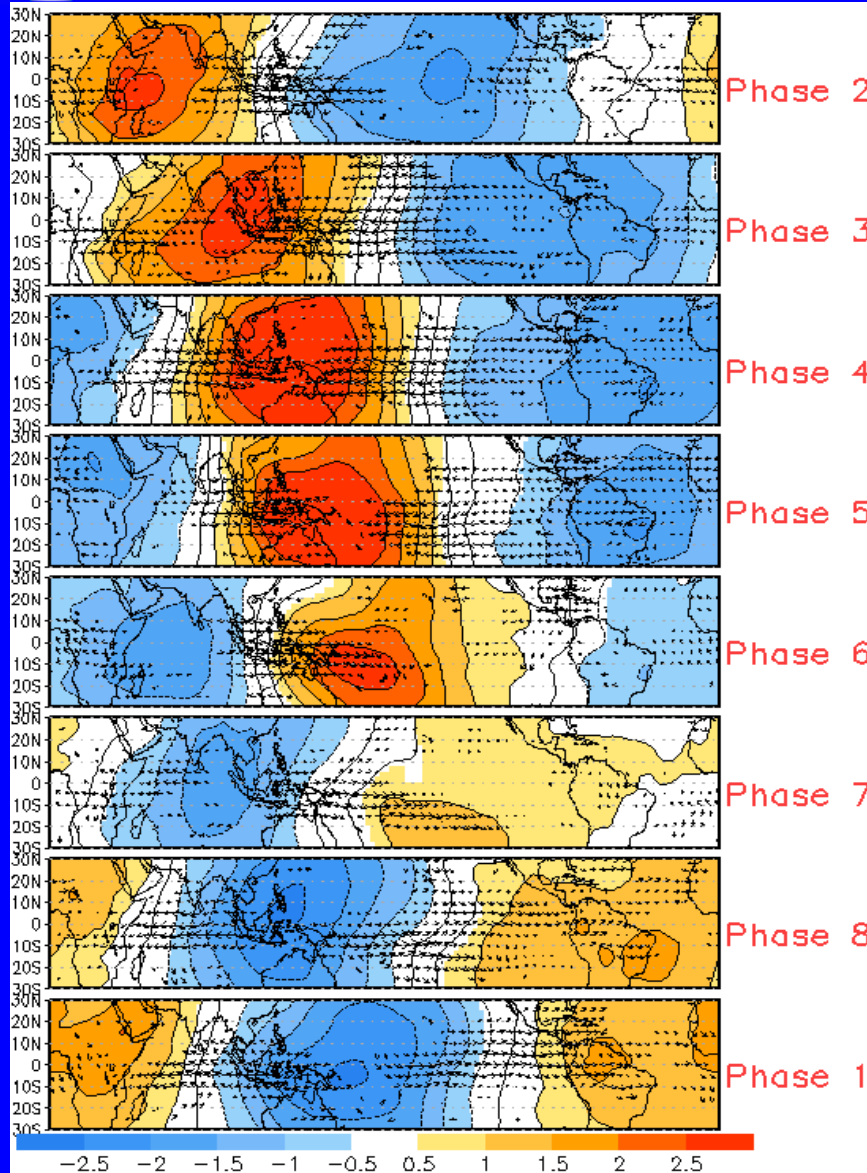
The CA forecast shows enhanced convection over parts of the western Pacific and Brazil while suppressed convection dominates the region from the central Indian Ocean to the Maritime Continent.



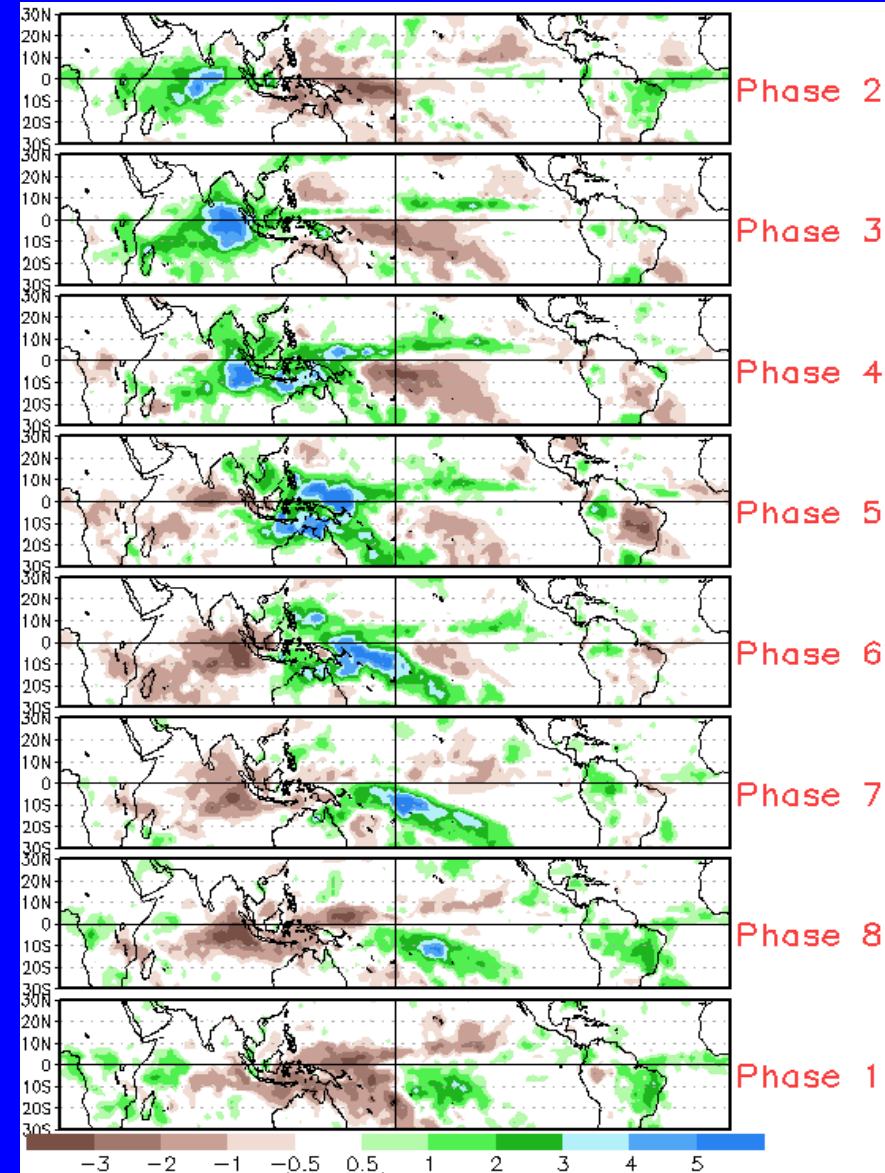


# MJO Composites – Global Tropics

## 850-hPa Wind Anomalies (Nov-Mar)



## Precipitation Anomalies (Nov-Mar)

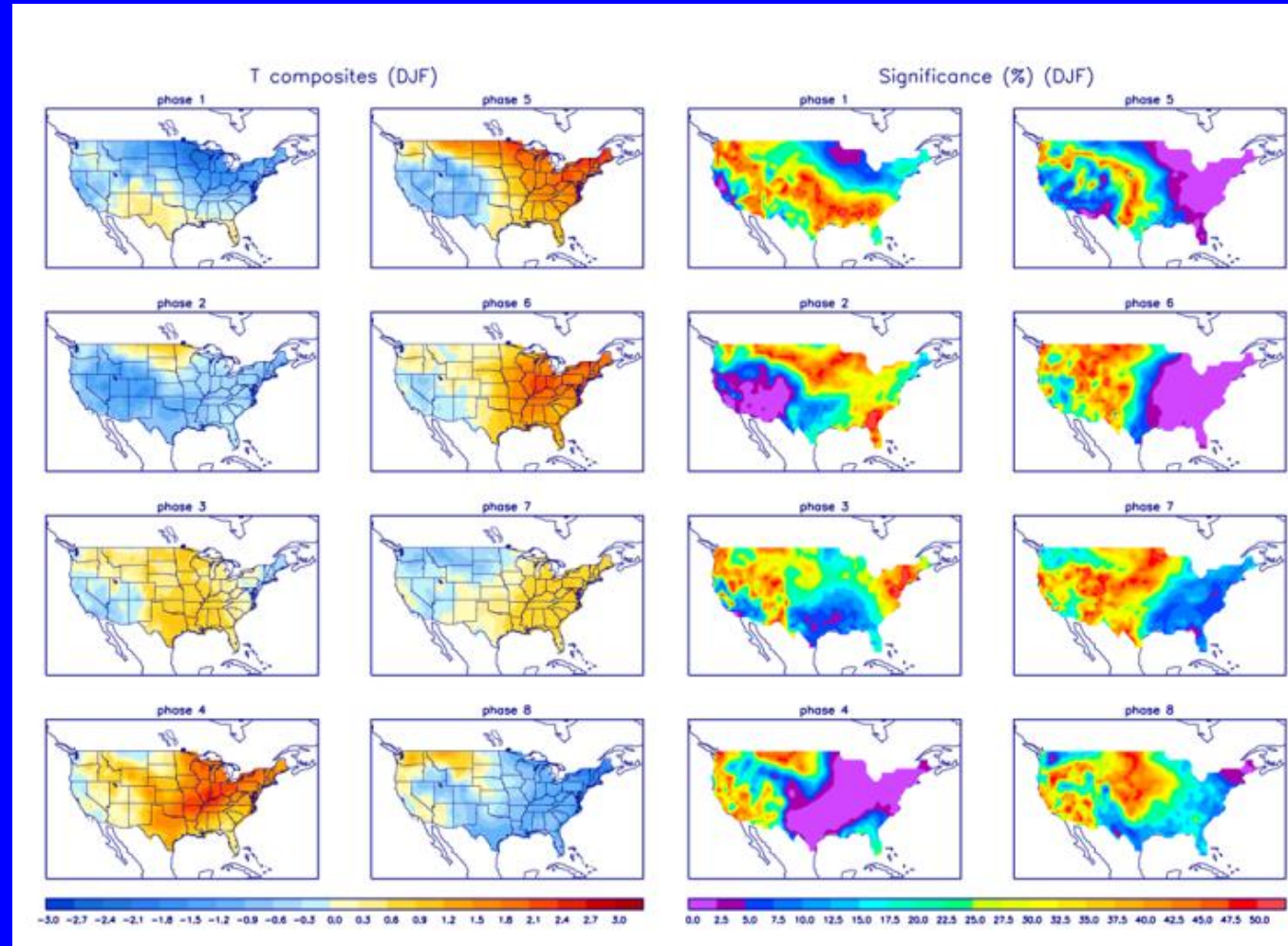




# U.S. MJO Composites – Temperature

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. 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

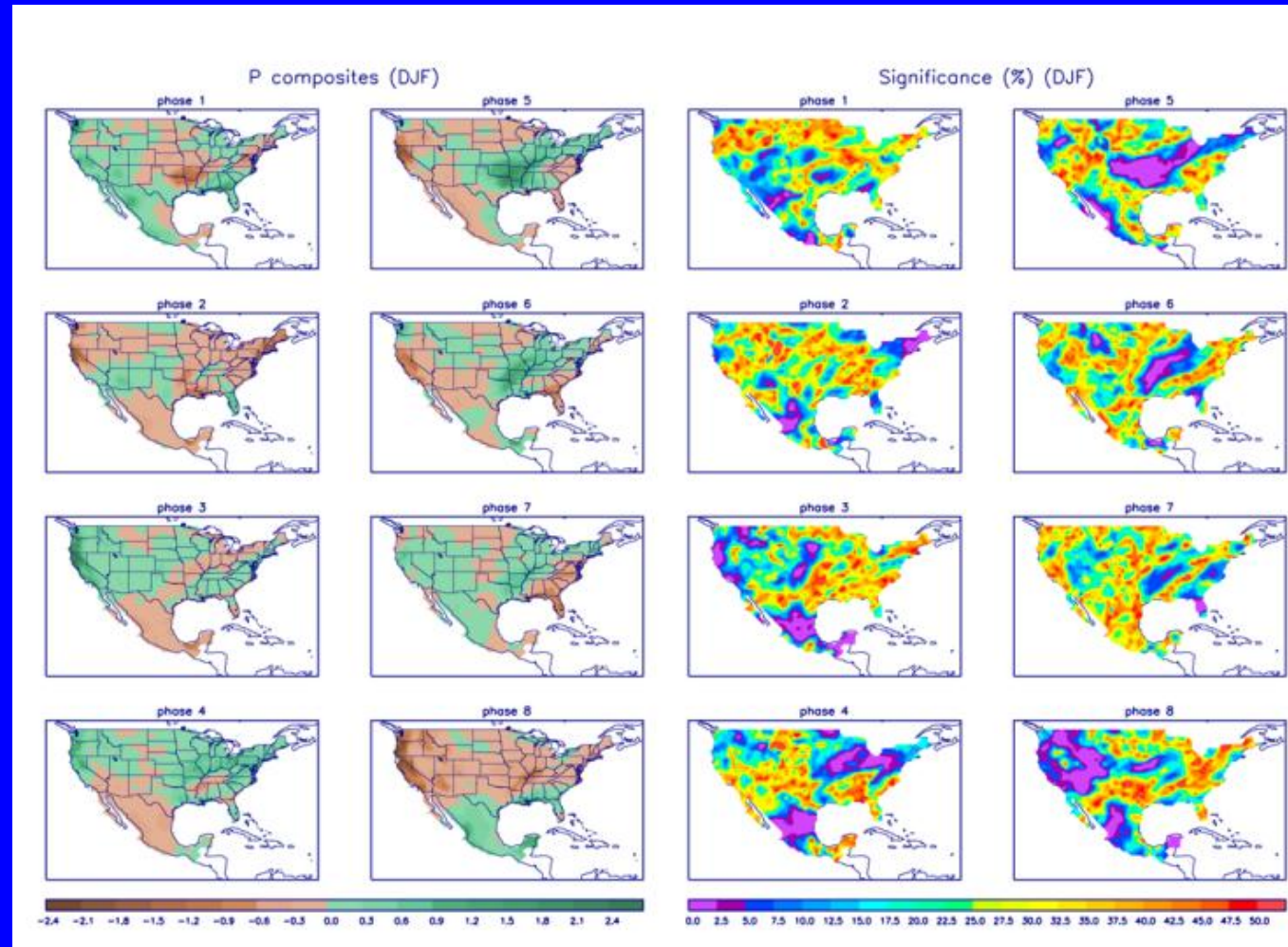
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml>





# 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

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