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

**Update prepared by**
**Climate Prediction Center / NCEP**
**February 27, 2012**

# Outline

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

# Overview

- The MJO remained active during the past week with a decrease in eastward propagation. The enhanced phase is centered over the Indian Ocean.

- Dynamical model MJO index forecasts forecast the MJO signal to continue through the period. There is some spread amongst the models for the magnitude and eventual phase by the end of Week-2, but most favor the enhanced phase moving across the Indian Ocean to the Maritime Continent during the period. Based on the latest observations and model forecasts, the MJO is forecast to remain active during the upcoming 1-2 weeks.

- The MJO is forecast to contribute to enhanced convection across the Indian Ocean and the Maritime Continent during the next two weeks. Suppressed convection is favored for the central Pacific and Brazil during the assessment period.

- The current and upcoming phases of the MJO favor a tendency for a negative PNA and later MJO enhanced convection will constructively interfere with La Nina over the Maritime continent.

- Above-average temperatures are favored for the eastern U.S. as the MJO enhanced phase shifts to the Maritime continent. The MJO and La Nina favor enhanced moisture across parts of the Pacific Northwest, the northern tier of the contiguous U.S, Great Lakes and Ohio Valley.

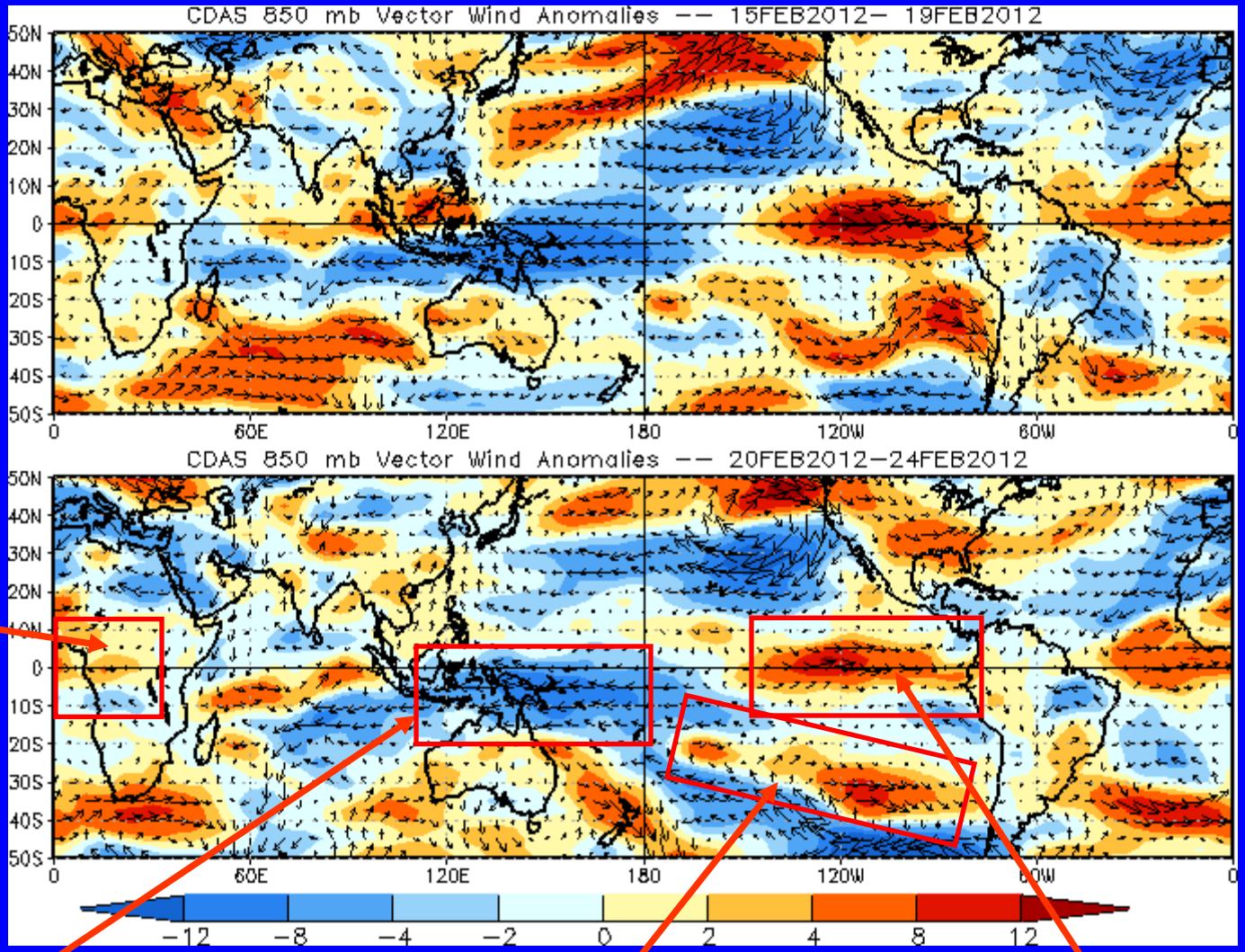
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

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

Note that shading denotes the zonal wind anomaly

**Blue shades**: Easterly anomalies

**Red shades**: Westerly anomalies




Westerly anomalies persisted over the Atlantic Ocean and Africa during the past five days.

Easterly anomalies expanded slightly over the Maritime Continent during the past five days.

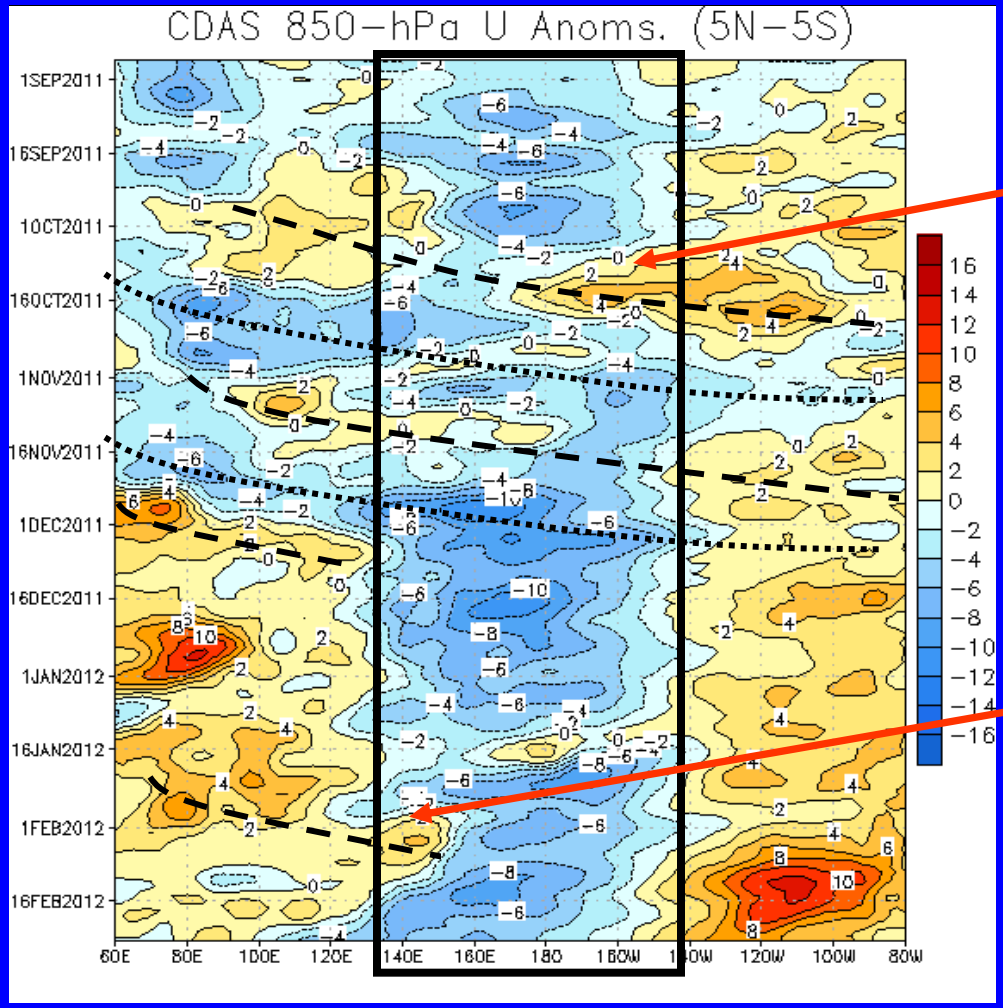
Westerly anomalies persisted across the southern Pacific.

Westerly wind anomalies over the eastern Pacific Ocean weakened some during the last five days.

# 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

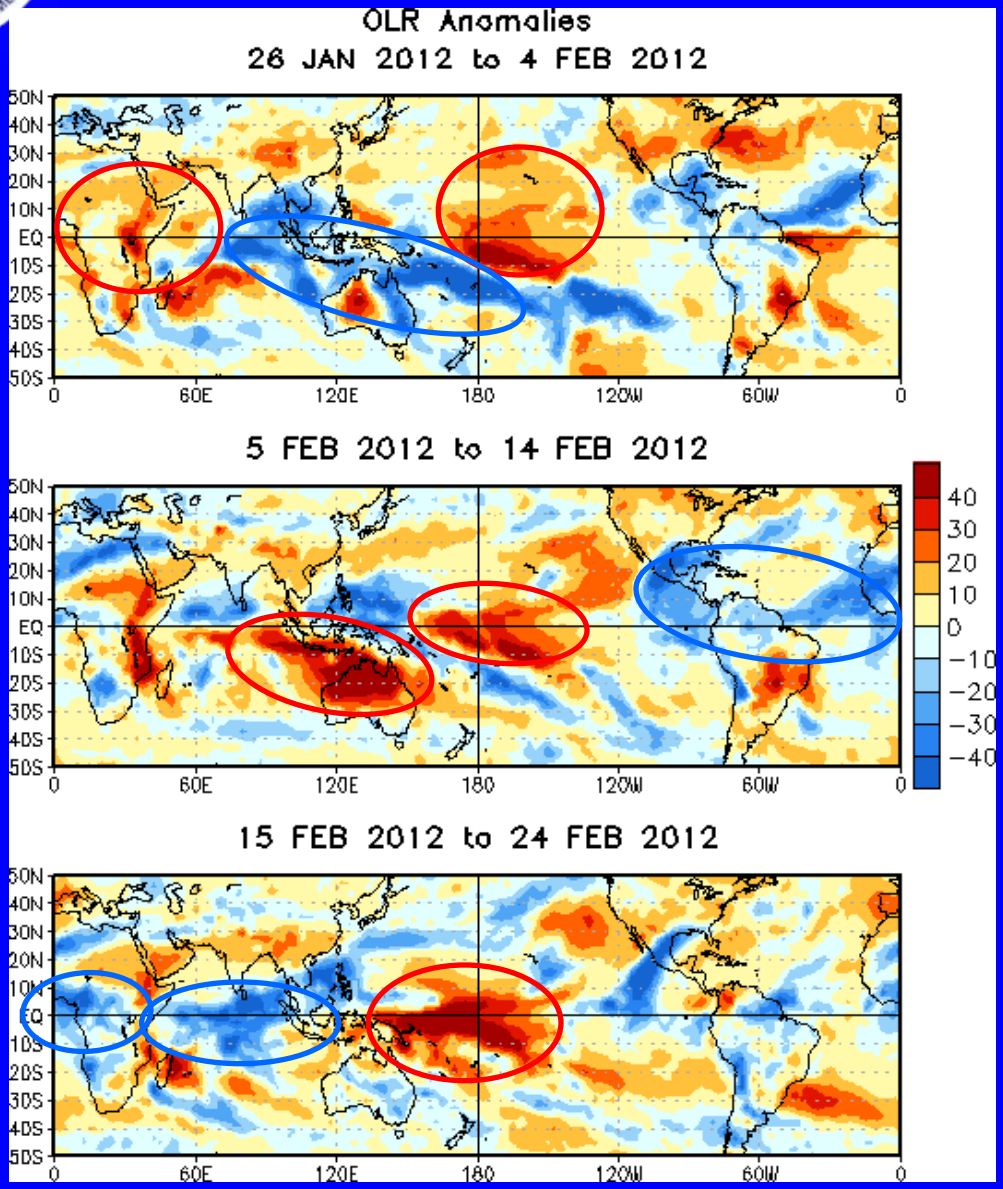
**In early October, MJO activity weakened the persistent easterly anomalies across the central Pacific (first dashed line).**

**MJO activity continued into December (altering dashed and dotted lines), but then westerly (easterly) wind anomalies across the Indian Ocean (western Pacific) became more stationary.**

**In early February, westerly anomalies extended to 140E and were associated with the current MJO activity.**

**Recently, easterly anomalies expanded westward over the Maritime Continent and westerly anomalies persisted over the eastern Pacific.**

# OLR Anomalies – Past 30 days




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

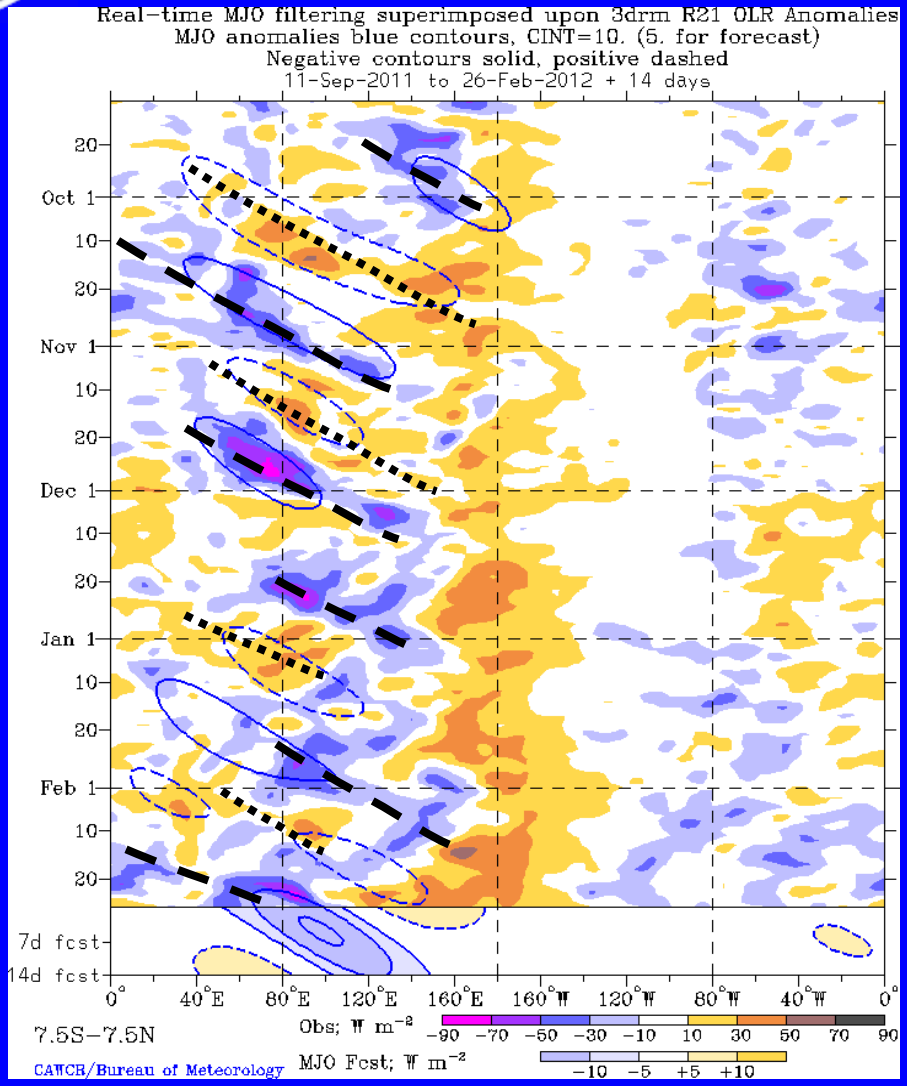
**Wetter-than-normal conditions, negative OLR anomalies (blue shading)**

**During late January and early February, suppressed convection was observed in the central Pacific, Africa and the western Indian Ocean. Enhanced convection covered the area from the eastern Indian Ocean to the southwest Pacific.**

**The MJO contributed to enhanced convection across the SPCZ, the Americas and the Atlantic during early-to-mid February. Suppressed convection was observed from the eastern Indian Ocean to Australia.**

**During mid-to-late February, the MJO contributed to enhanced (suppressed) convection across Africa and the Indian Ocean (western Pacific).**

# 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 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.**

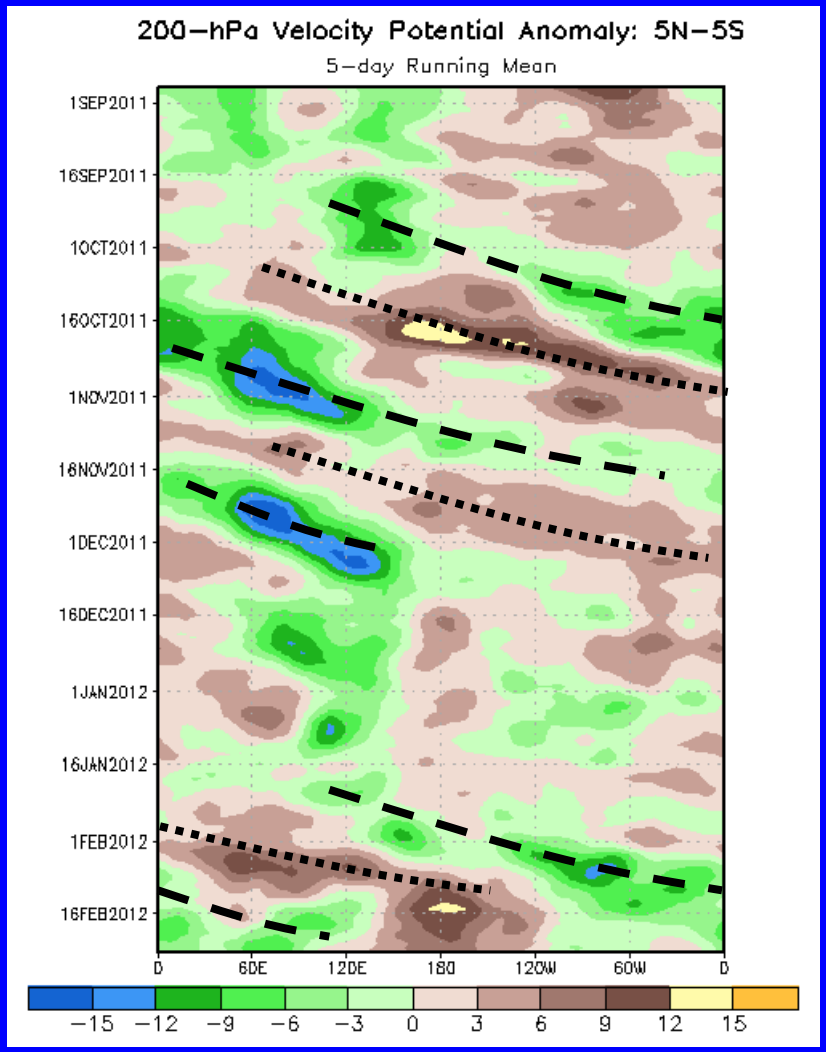
**MJO activity continued into early December, then OLR anomalies decreased and eastward propagation was not clear. However, during late December, eastward propagation of OLR anomalies was again observed.**

**Strong enhanced convection propagated eastward across the Indian Ocean and Maritime Continent during January. Recently, enhanced (suppressed) convection is evident across the Indian Ocean (Maritime Continent). Some evidence of other modes of tropical variability (Equatorial Rossby Waves) is also evident.**

# 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

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.

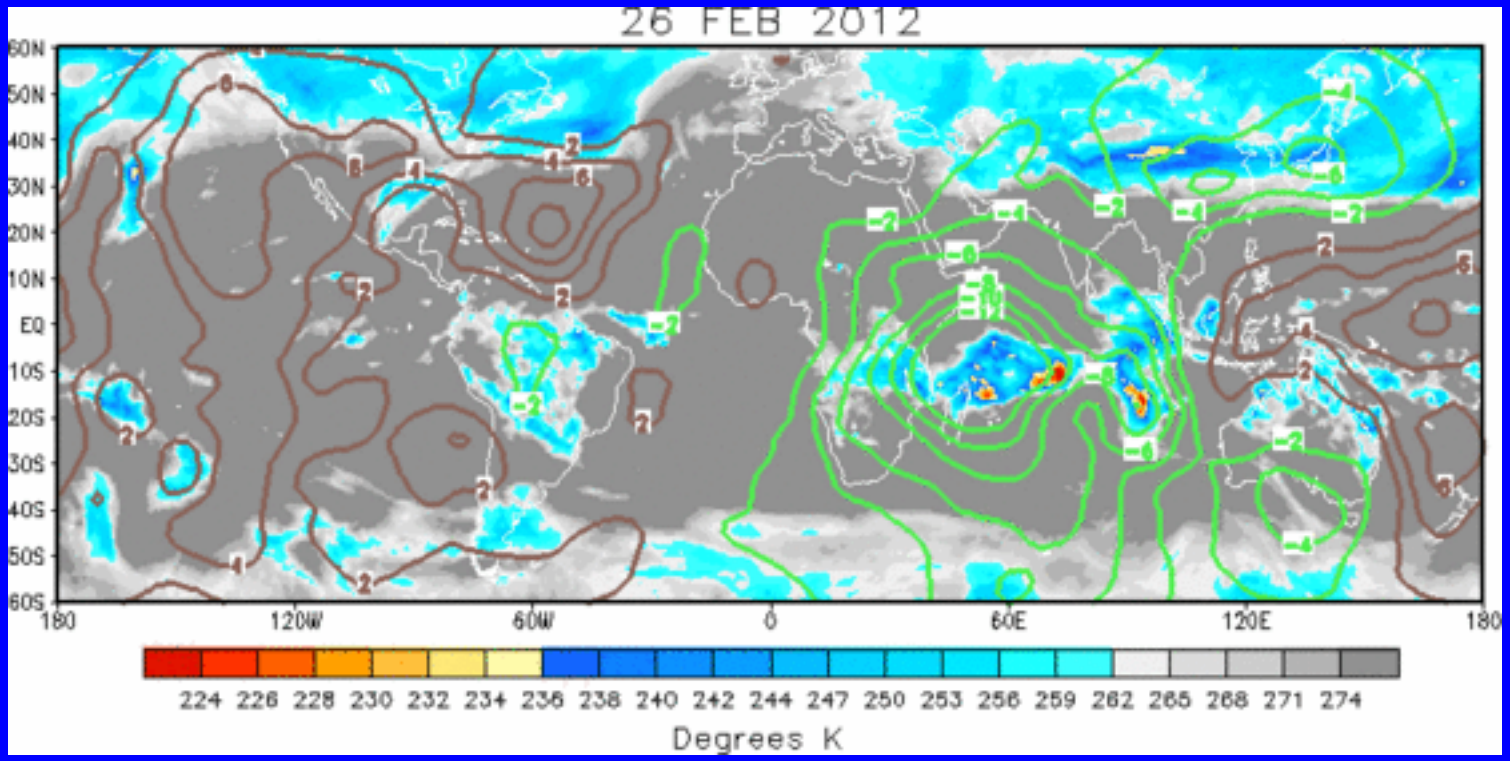
Eastward propagation of anomalies became less coherent during late December and early January and anomalies weakened.

Eastward propagation again became evident in late January and continued to mid February. Most recently, anomalies have become more stationary.

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

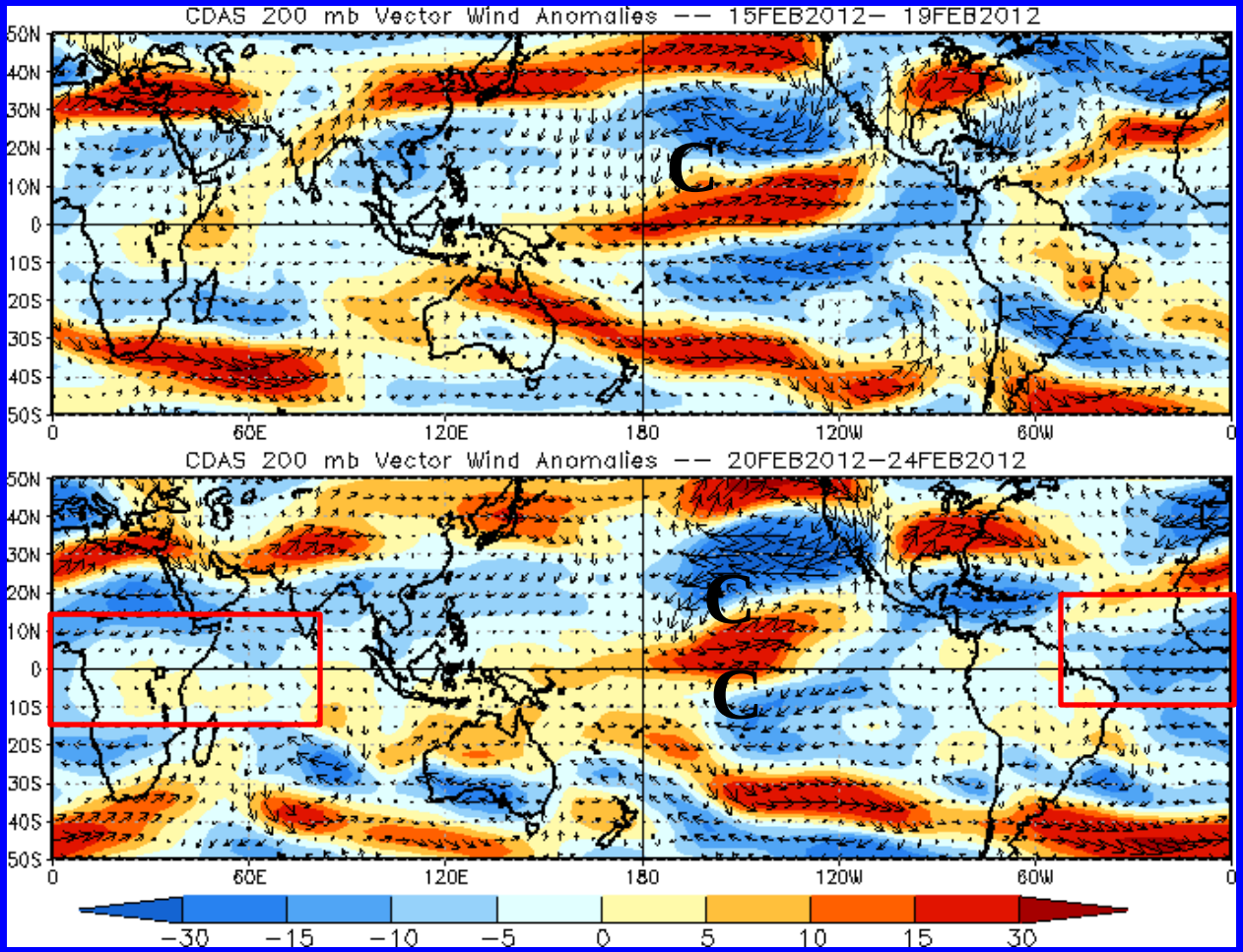
**Positive** anomalies (brown contours) indicate unfavorable conditions for precipitation

**Negative** anomalies (green contours) indicate favorable conditions for precipitation




**The large scale velocity potential pattern generally exhibits a wave-1 structure with upper-level divergence across Africa and the Indian Ocean and upper-level convergence across the Pacific. Other modes of subseasonal tropical variability and mid-latitude influences are also affecting the pattern.**

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




**Note that shading denotes the zonal wind anomaly**

**Blue shades: Easterly anomalies**

**Red shades: Westerly anomalies**

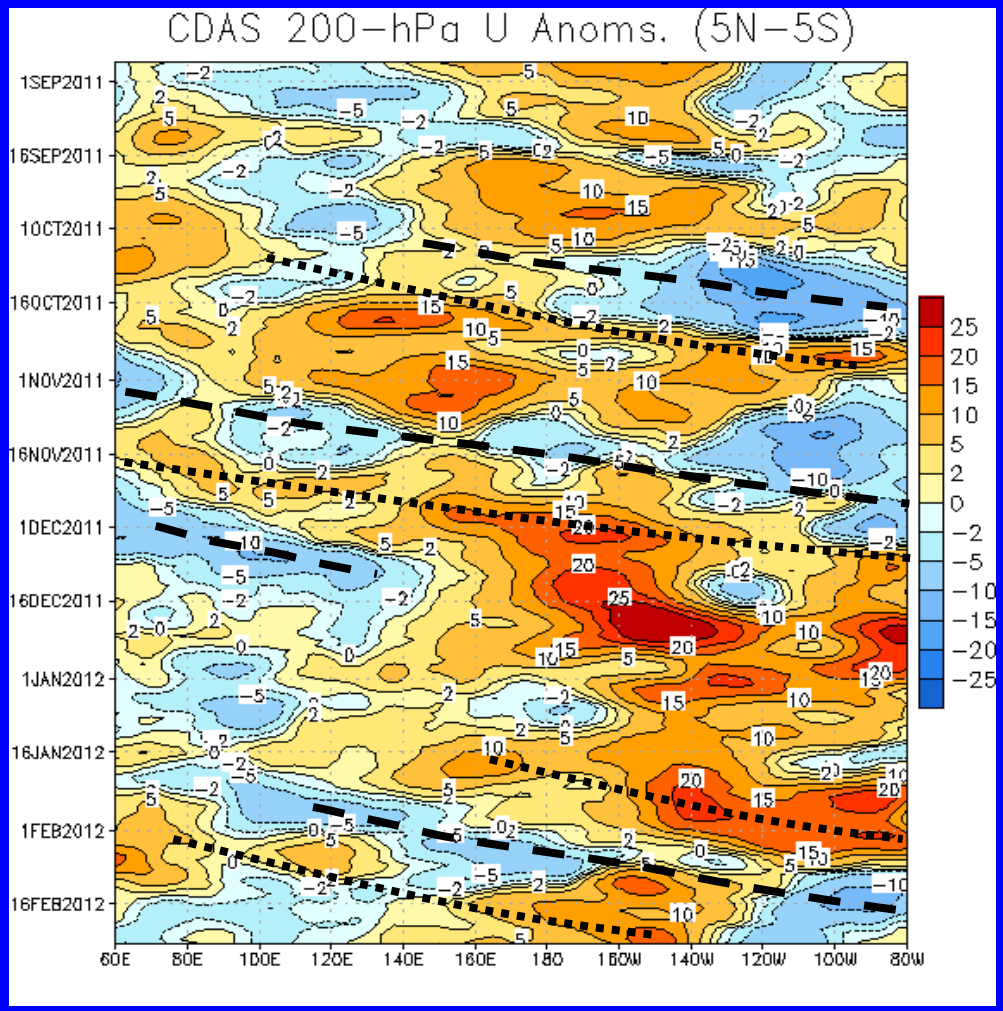
**A large scale cyclonic circulation is evident north of the equator east of the Date Line with a more elongated trough south of the equator.**

**During the past five days, westerly anomalies over the Atlantic, Africa, and the eastern tropical Pacific have waned. Anomalies near the central Pacific reflect a slight strengthening of the anomalous cyclonic circulations.**

# 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**



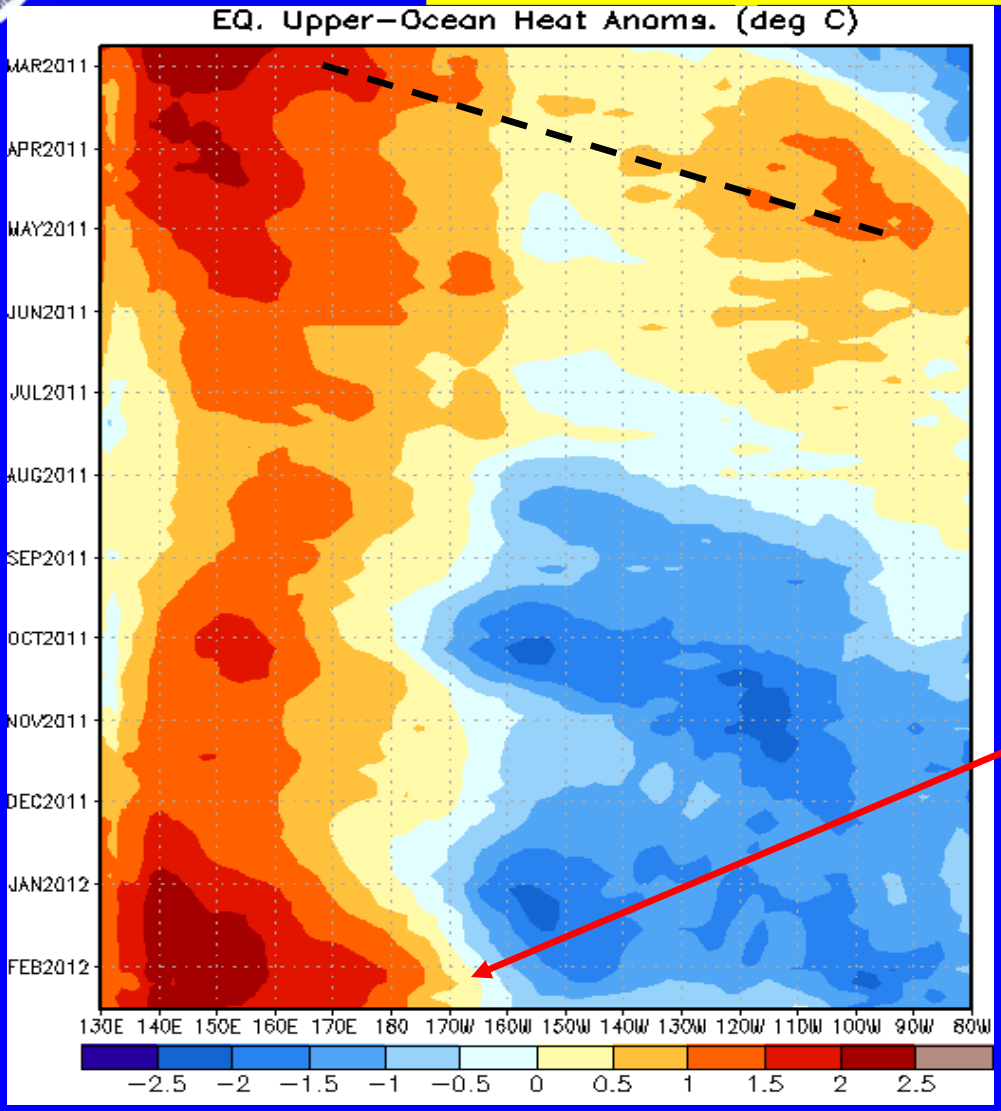

Time

Longitude

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

In December, westerly anomalies strengthened over the Pacific. In January these westerly anomalies have shown some eastward propagation and easterly anomalies have also shifted eastward into the Pacific.

# Weekly Heat Content Evolution in the Equatorial Pacific




Time

Longitude

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

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

In January and February 2012, negative heat content anomalies have weakened in the central equatorial Pacific.

# 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).

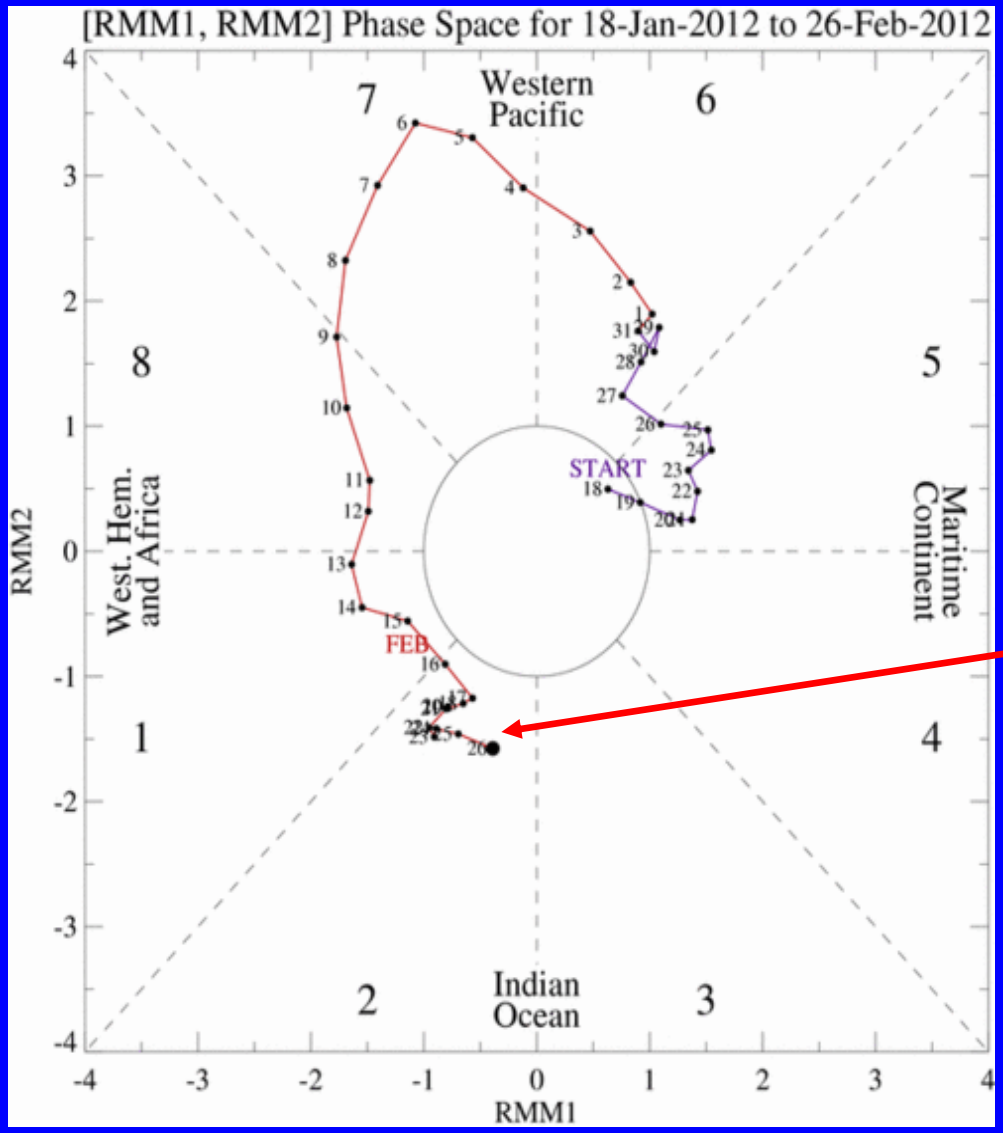
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review,* 132, 1917-1932.

• 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).

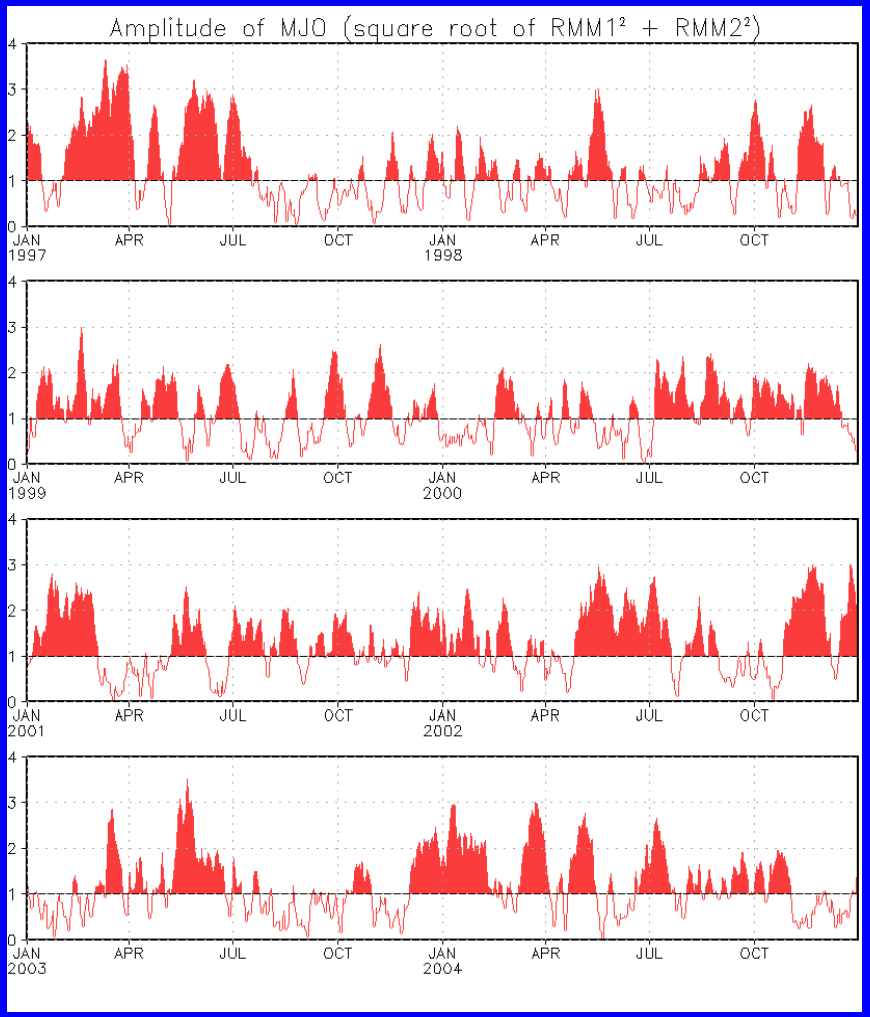
# MJO Index -- Recent Evolution

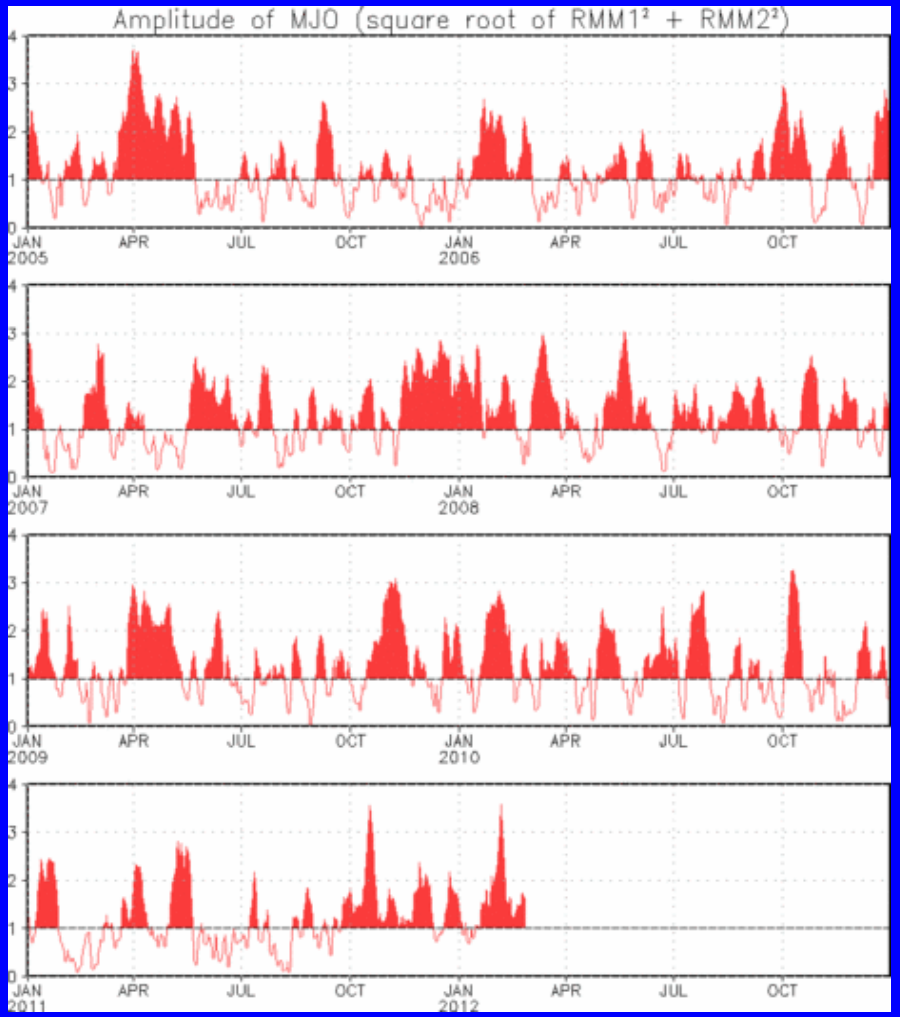



- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index shows continued MJO activity during the past week. The eastward propagation has slowed as the index is most likely being influenced by other modes of subseasonal tropical variability.

# MJO Index – Historical Daily Time Series



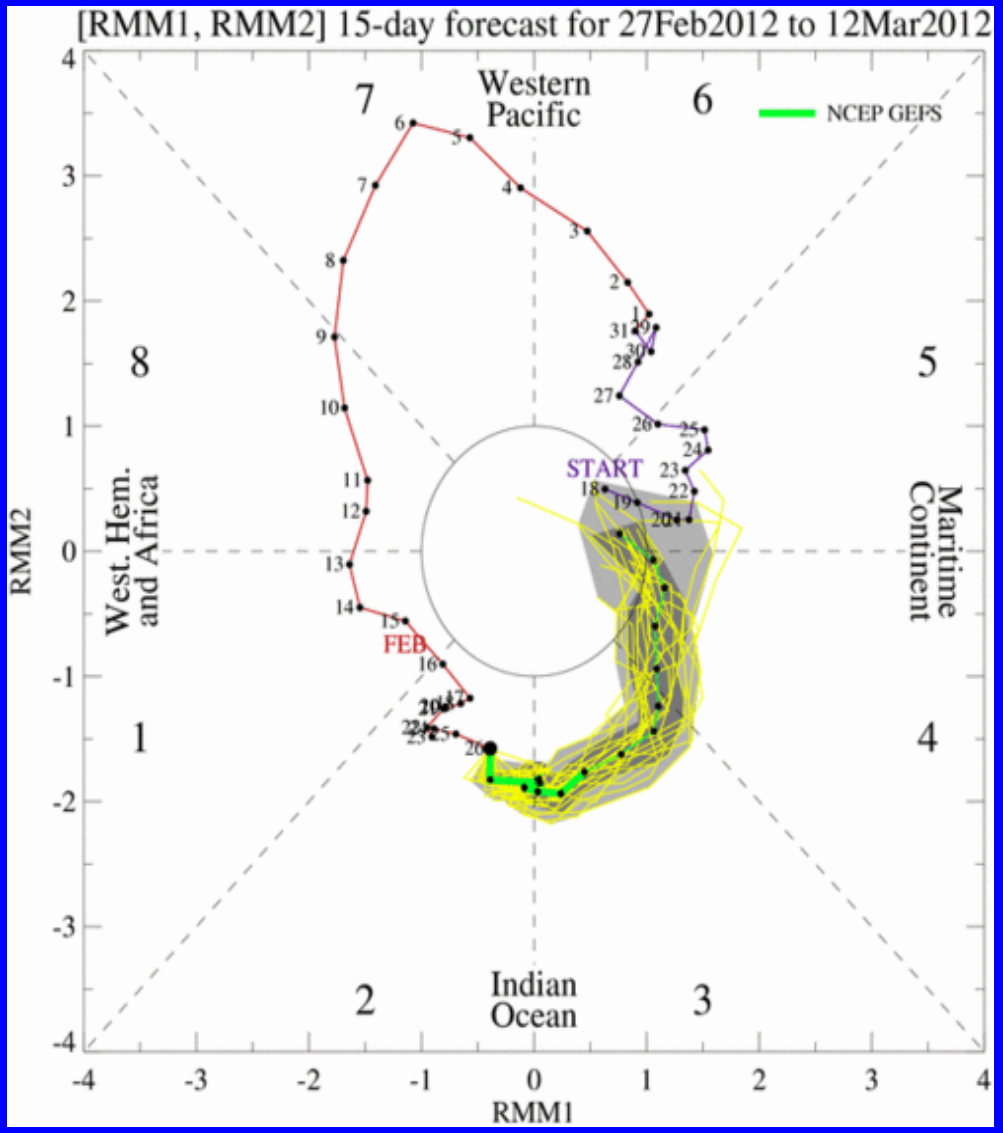

Time series of daily MJO index amplitude from 1997 to present.
Plots put current MJO activity in historical context.

# 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**

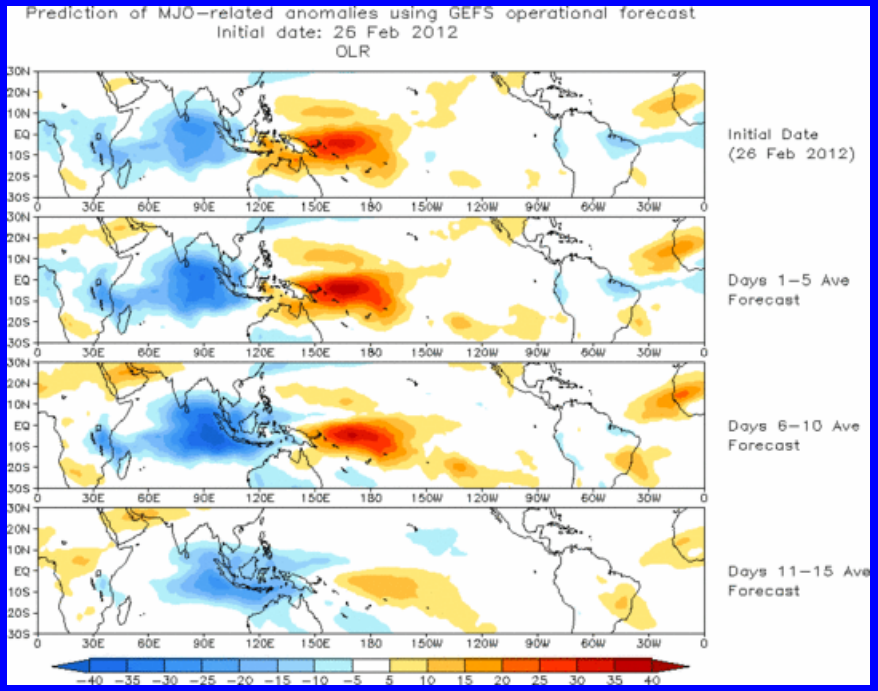



**The ensemble GFS forecasts the MJO signal to continue propagating eastward over the next week with the enhanced phase over the Indian Ocean during Week-1. By the end of Week-2, the MJO signal is forecast to be centered over the Maritime Continent.**

# Ensemble Mean GFS MJO Forecast

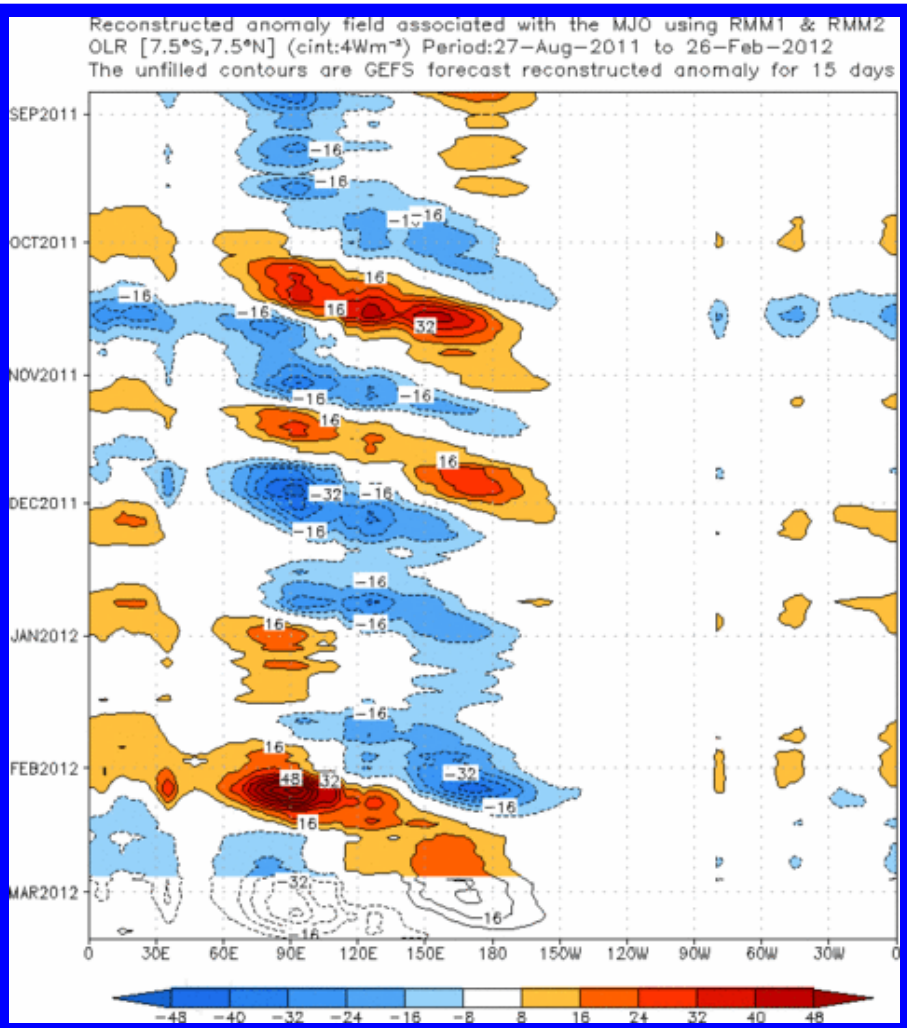
**Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)**

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




**The ensemble mean GFS forecast indicates enhanced convection across the Indian Ocean and eastern Africa during week-1. Suppressed convection is forecast across the central equatorial Pacific during the entire period.**

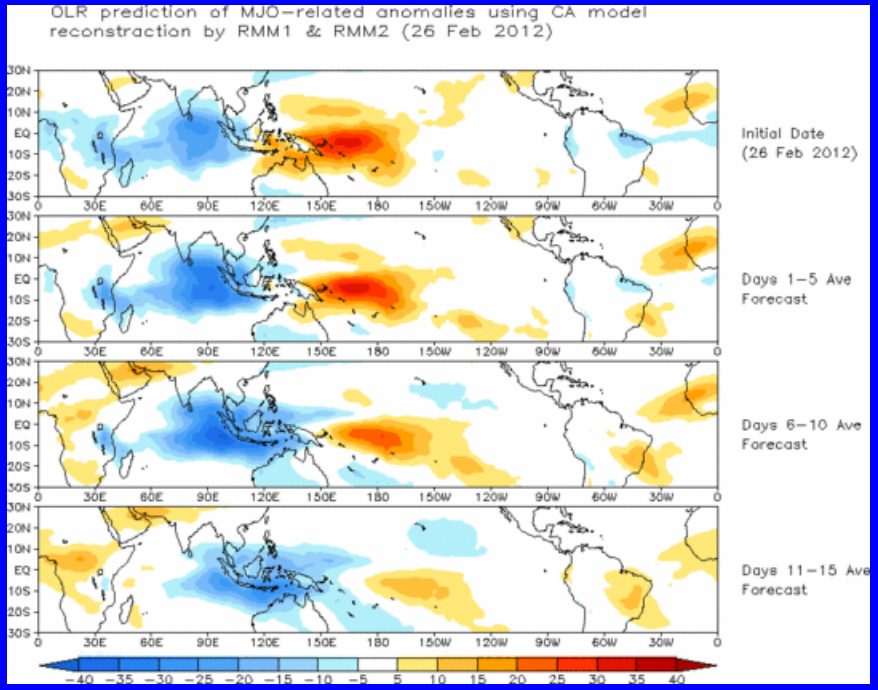
**Time-longitude section of (7.5°S-7.5°N) OLR anomalies for the last 180 days and for the next 15 days**



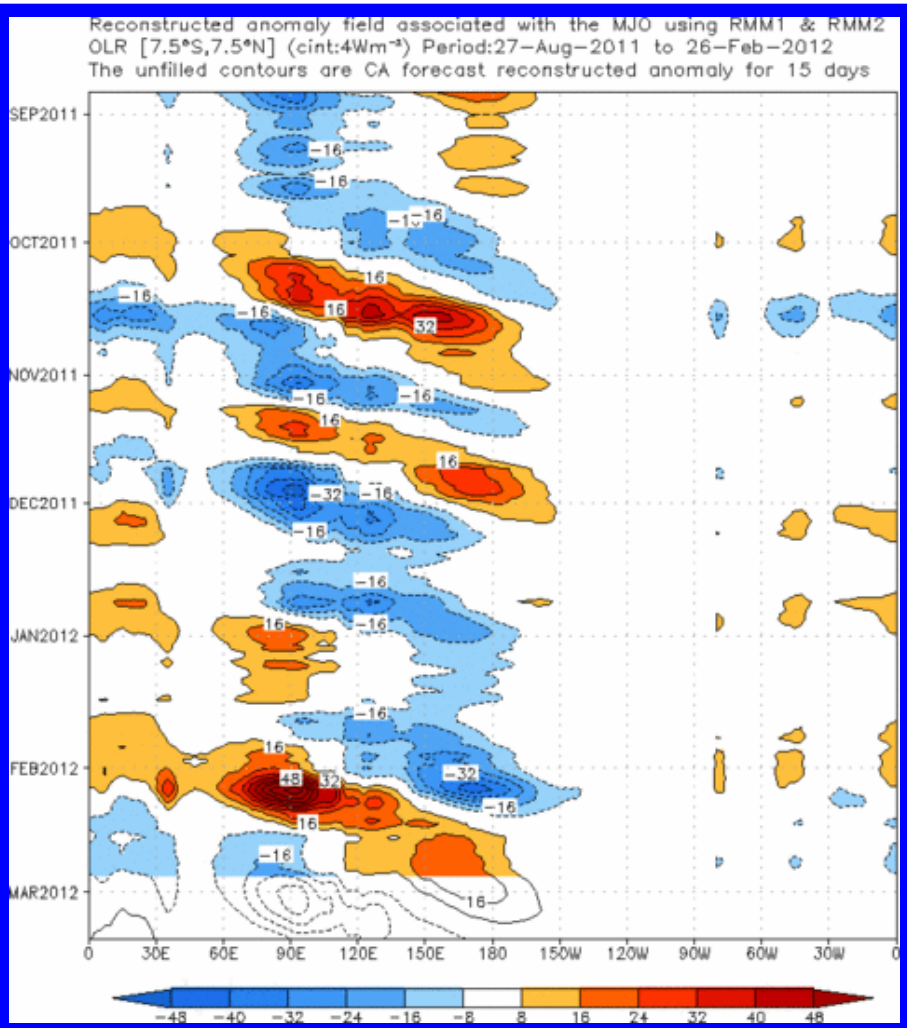
# Constructed Analog (CA) MJO Forecast

**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**



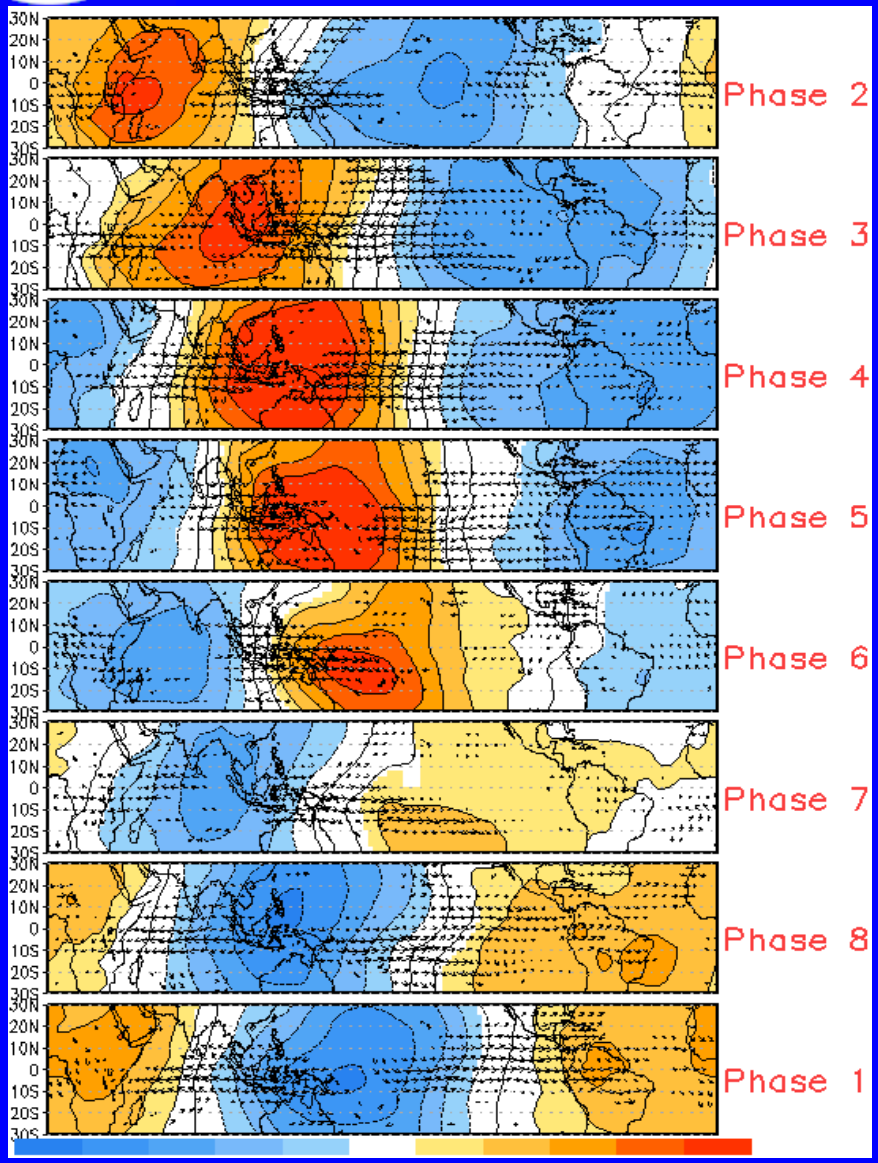

**Time-longitude section of (7.5°S-7.5°N) OLR anomalies for the last 180 days and for the next 15 days**



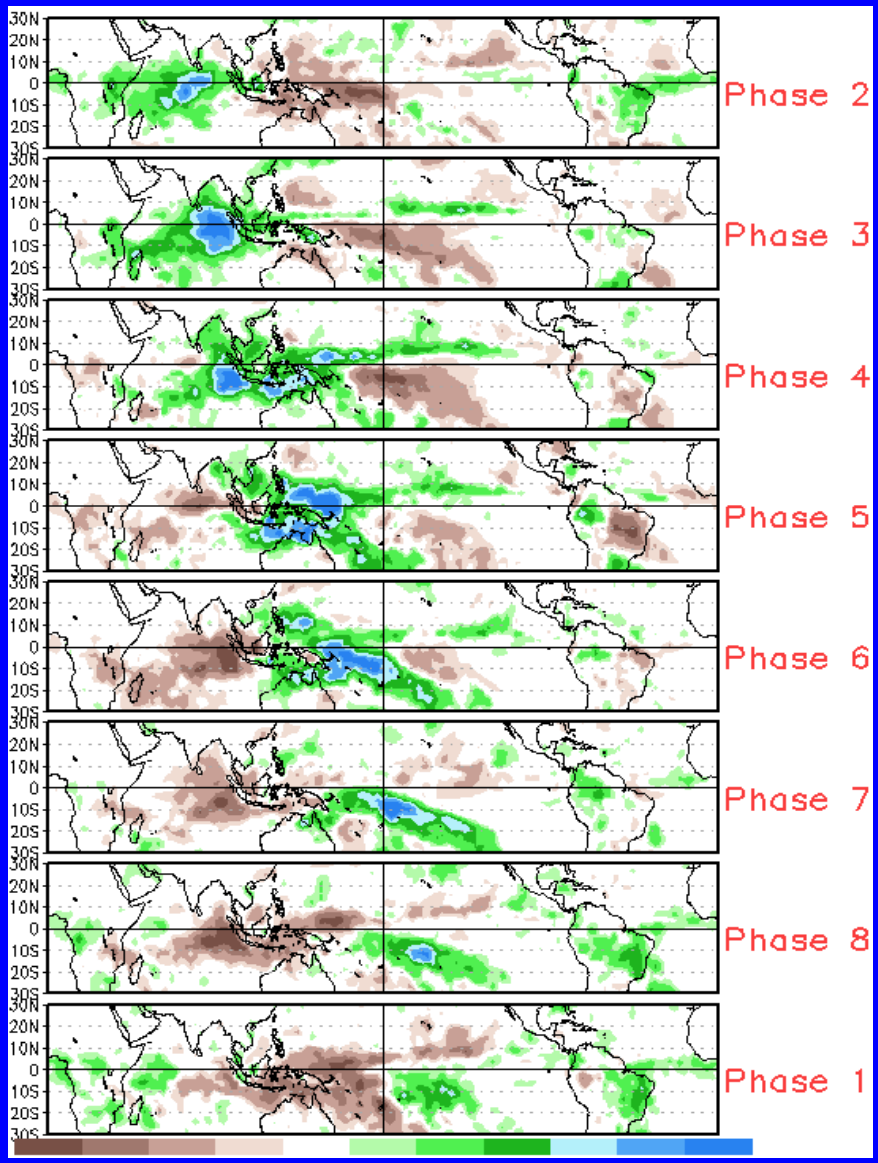

**The CA forecast shows enhanced convection stretching from eastern Africa to the Maritime Continent during week-1, with some eastward propagation during week-2. A return to drier than normal conditions across western Africa and the Americas is forecast during week-2.**

# MJO Composites – Global Tropics

850-hPa Wind Anomalies (Nov-Mar)

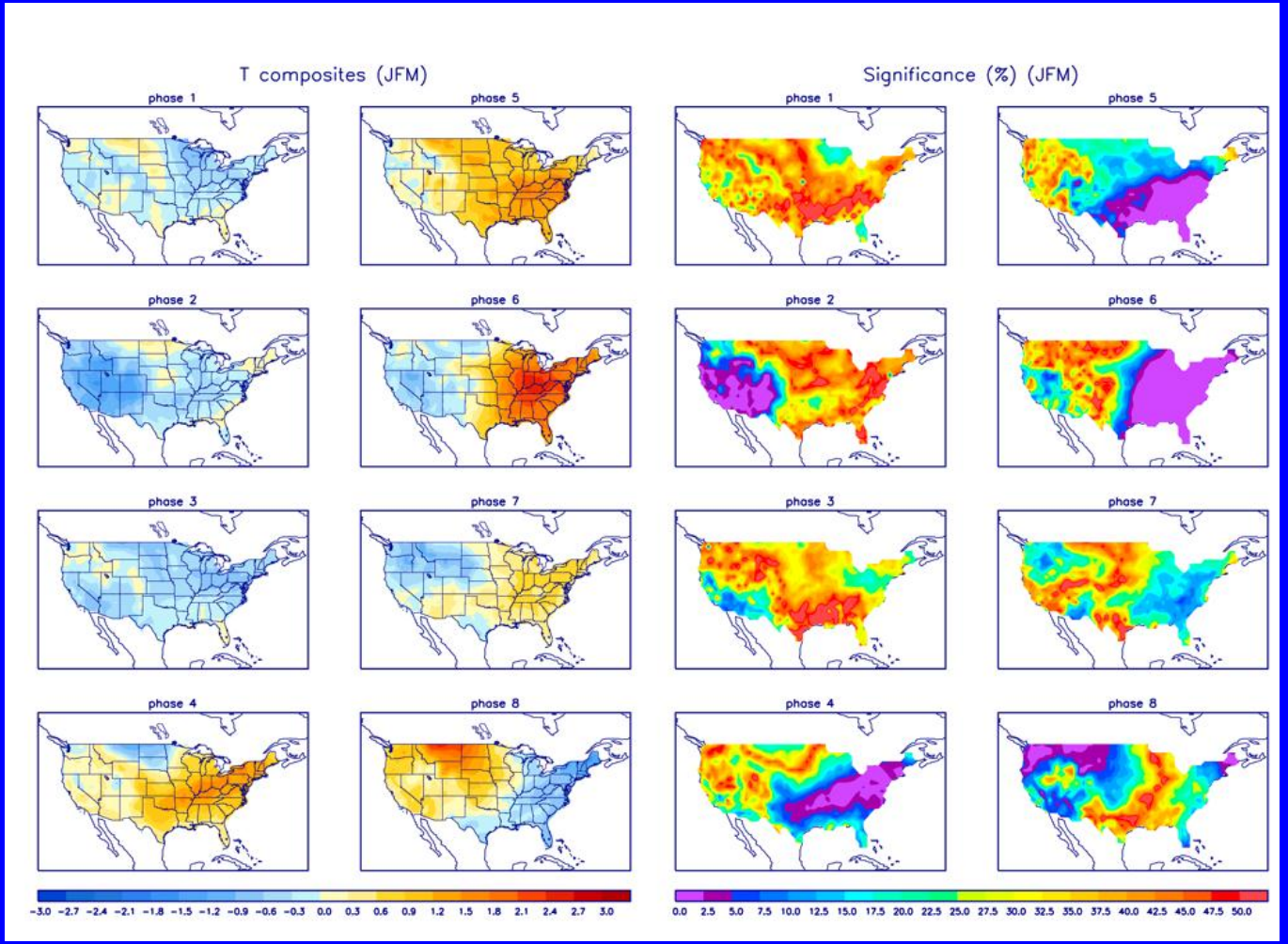



Precipitation Anomalies (Nov-Mar)



# 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.**

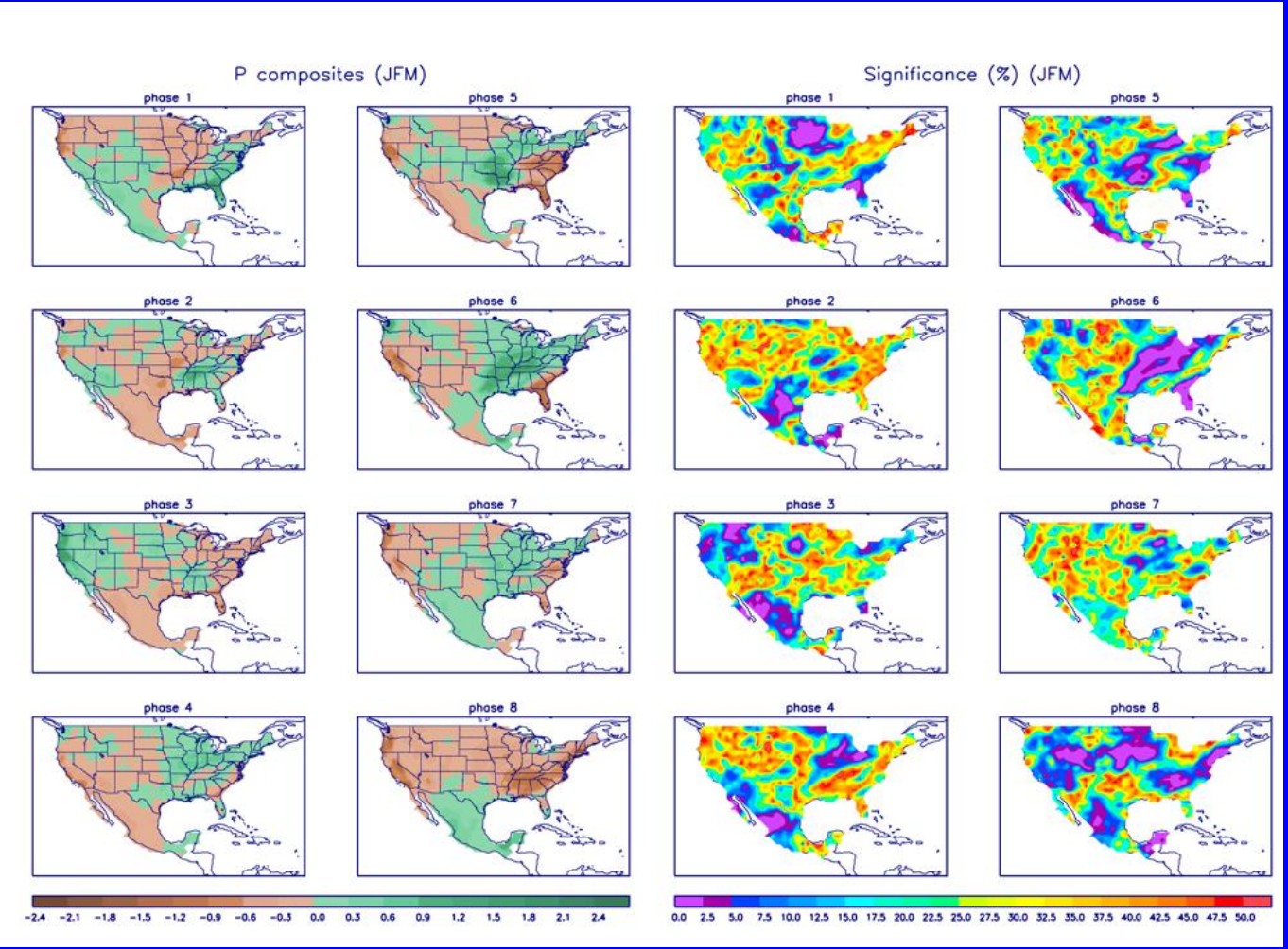



Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

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.**

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