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

Update prepared by
Climate Prediction Center / NCEP
April 30, 2012

Outline

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

Overview

- The MJO weakened during the past week and the signal is currently incoherent.
- Dynamical model MJO index forecasts indicate weak MJO activity during the period, a stark contrast to the recent months of strong, coherent activity.
- Disruption of the signal is likely related to interference from other types of coherent subseasonal variability as well as a weakening of the MJO itself.
- At the current time, the MJO is not expected to contribute substantially to areas of anomalous tropical convection during the period.

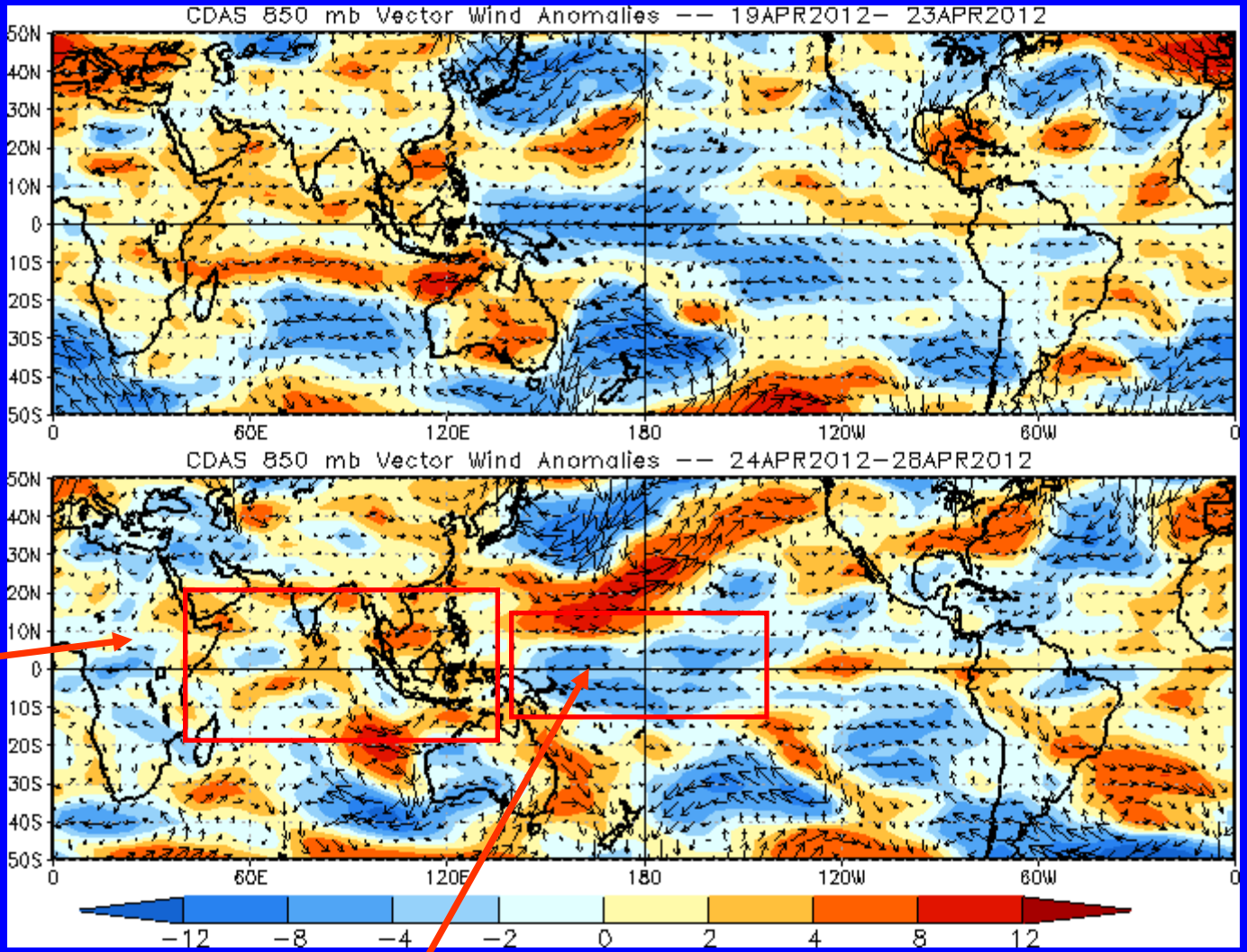
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



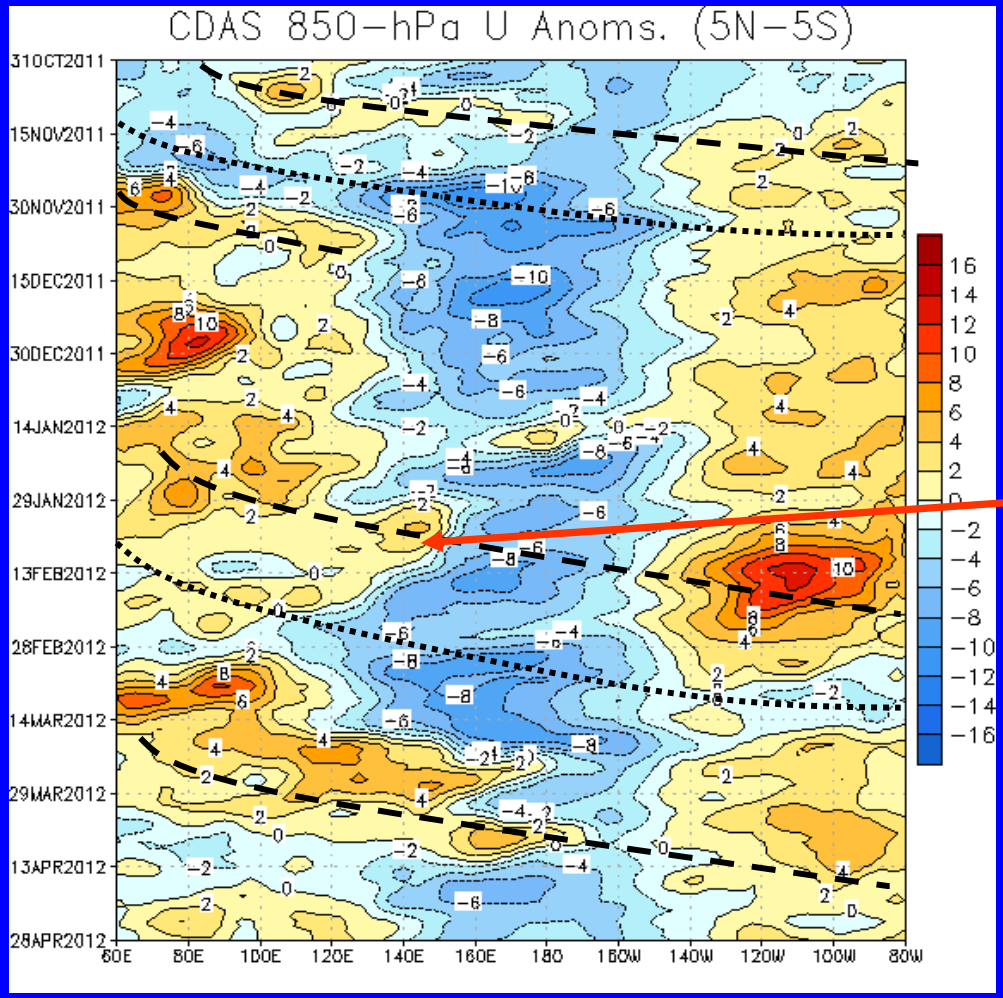
Westerly anomalies continued across the Indian Ocean and western Maritime Continent. They have shifted slightly eastward.

Easterly anomalies weakened across the west-central Pacific . They have shifted slightly eastward during the past 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

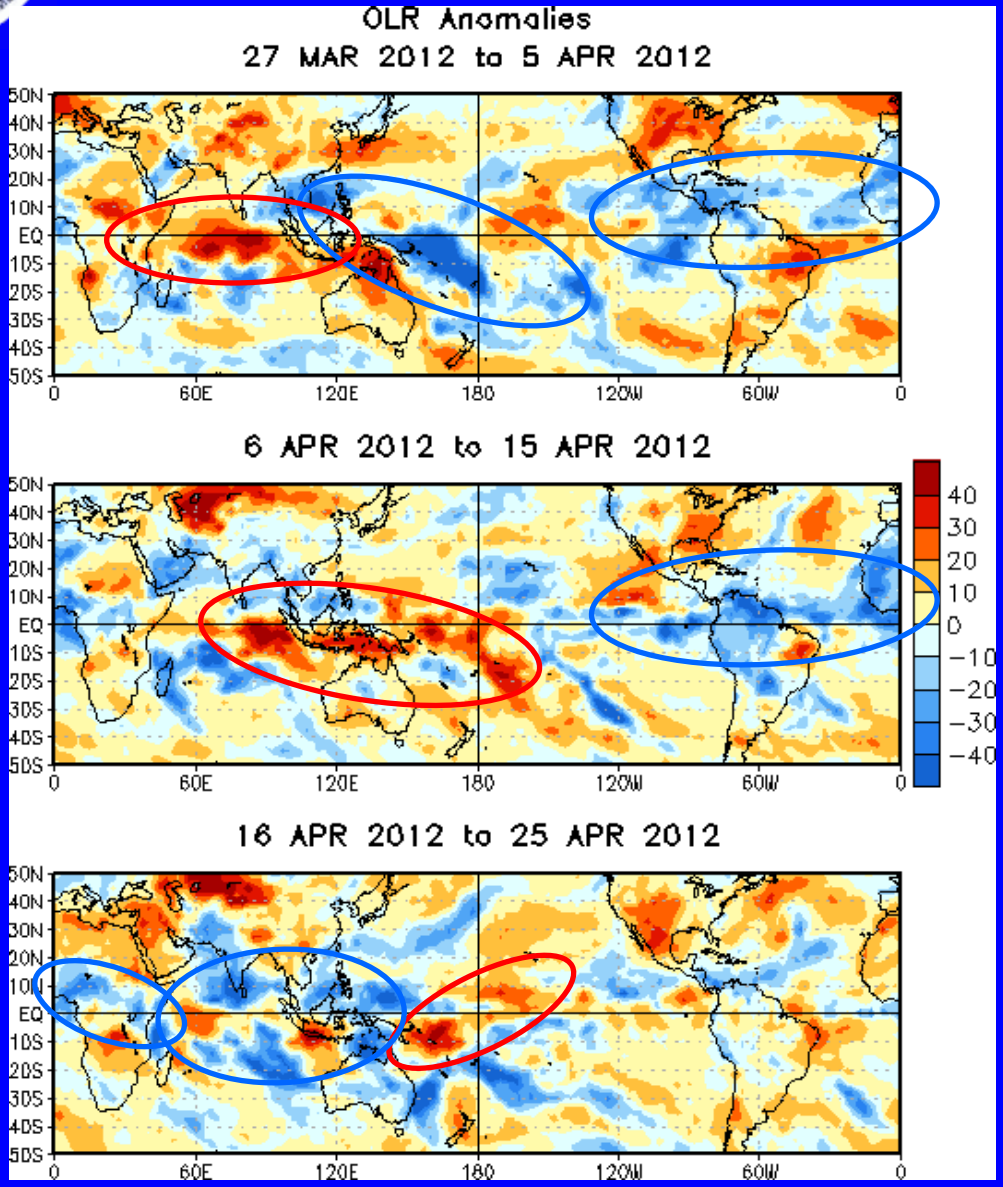
Longitude

MJO activity continued into December as indicated by altering dashed and dotted lines. Later during other portions of December and January, westerly (easterly) wind anomalies across the Indian Ocean (western Pacific) became more stationary.

During the first half of February, the MJO contributed to increased westerly anomalies near 140E and across the eastern Pacific while decreasing easterly anomalies in the central Pacific.

MJO activity continued into April, with westerly anomalies associated with the MJO located near the Date Line and western hemisphere early in the month. Most recently, easterly anomalies have returned to the Date Line during mid-April.

OLR Anomalies – Past 30 days



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

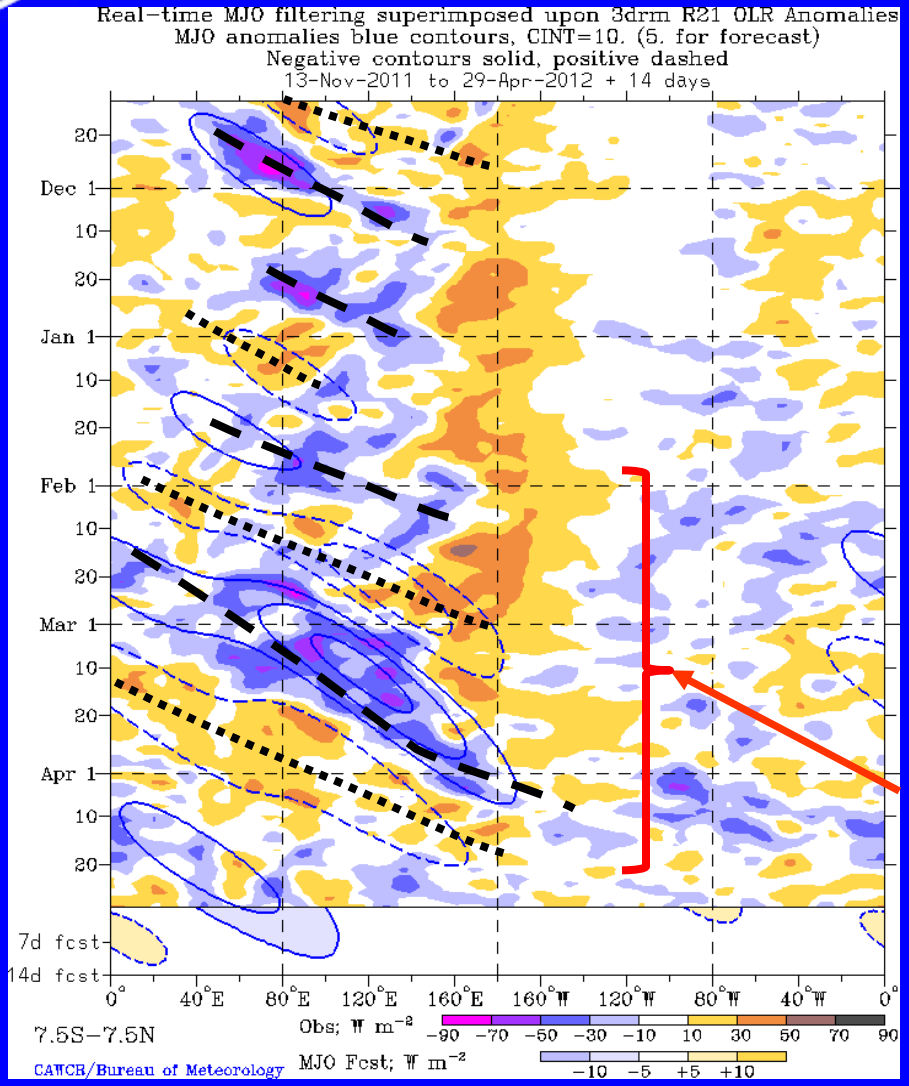
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

Late March into early April, enhanced convection shifted eastward into the western Pacific while suppressed convection continued over east Africa and developed across the Indian Ocean. Enhanced convection developed over the western hemisphere and western Africa.

During early to mid April, enhanced convection continued over the western hemisphere and Africa. Suppressed convection shifted eastward, over the Maritime continent and western Pacific.

During mid to late April, enhanced convection continued across portions of Africa. The newly developed area of enhanced convection over the Indian Ocean and Maritime Continent straddled the equators. Suppressed convection was evident near the Date Line.

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)

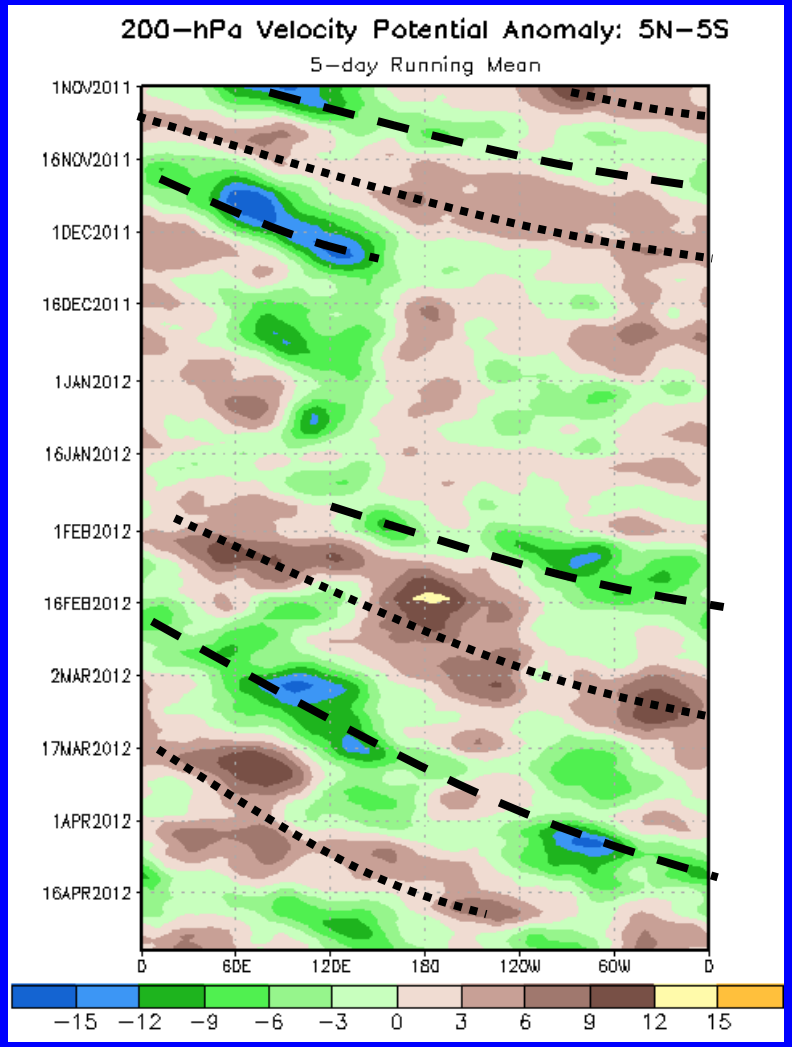
MJO activity was evident in November and early December and briefly again in late December and early January as alternating areas of enhanced (dashed lines) and suppressed (dotted lines) convection shifted eastward.

Strong MJO activity once again developed during late January and continued into early April. During this same period, other modes of subseasonal variability have also contributed to the observed pattern.

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

Alternating negative (dashed lines) and positive (dotted lines) anomalies were evident and associated with MJO activity during the end of 2011.

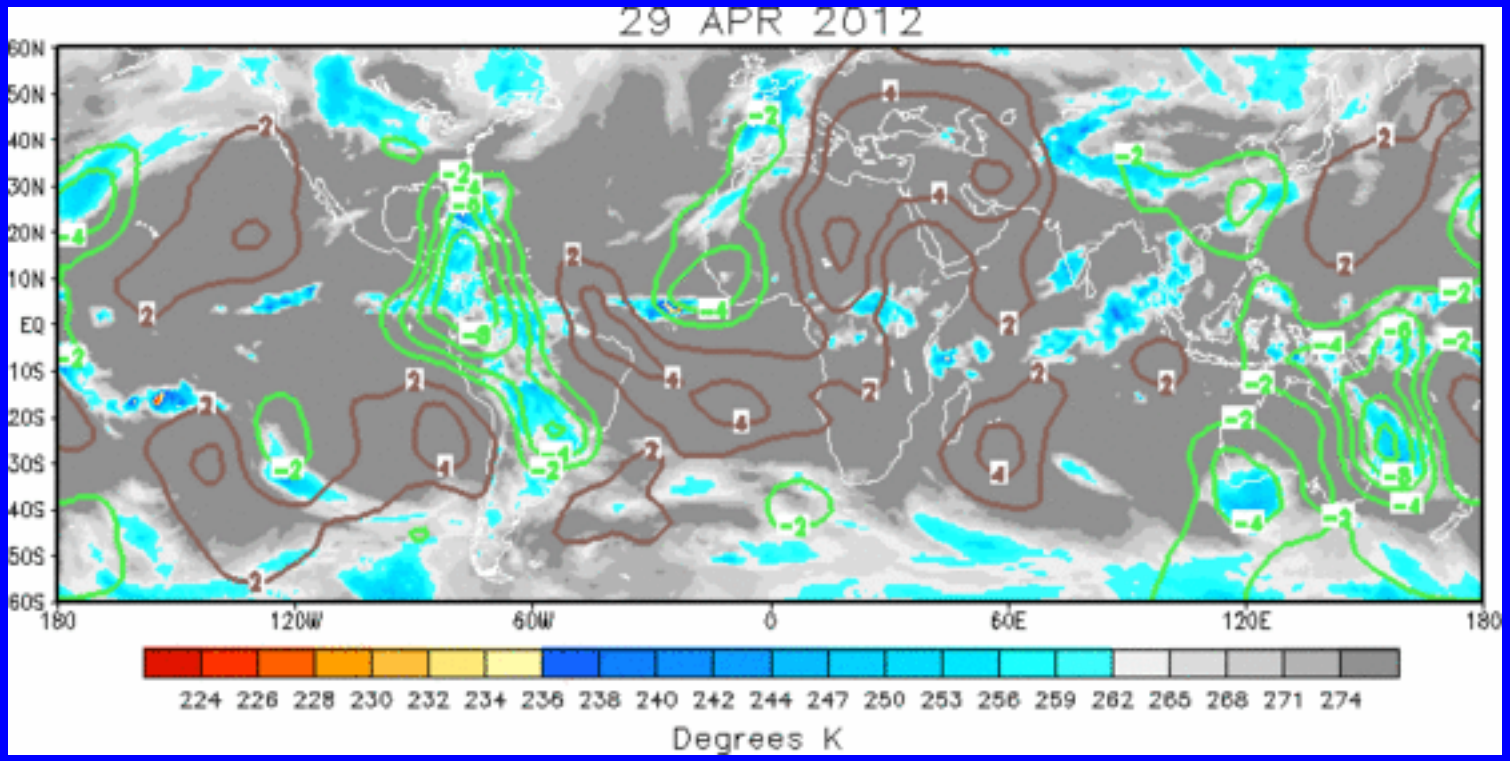
Eastward propagation of anomalies became less coherent during late December and early January and anomalies weakened.

The MJO strengthened in late January and eastward propagation has been evident through mid-April. The period of this MJO activity has been considerably longer lived than the activity observed during late 2011.

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

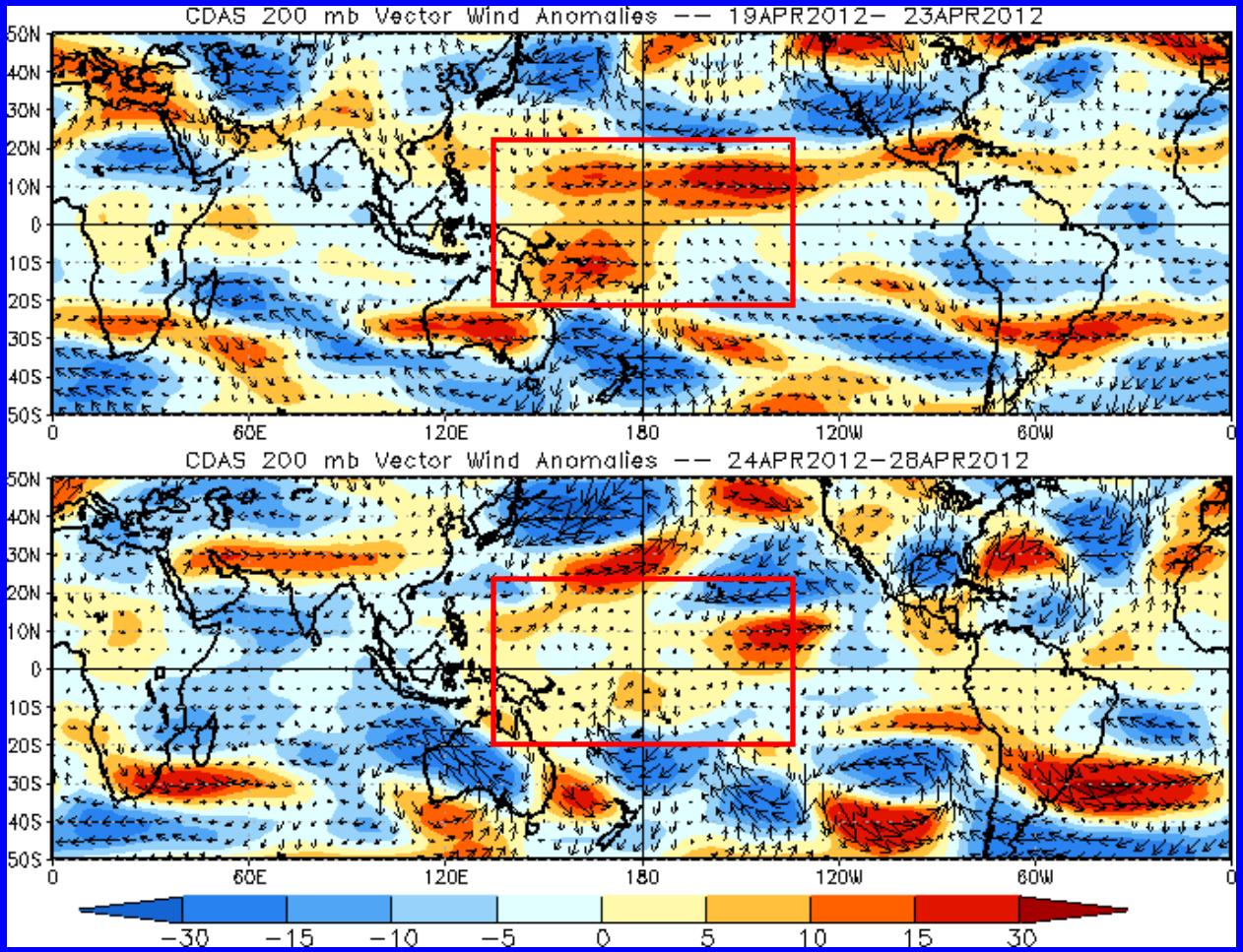
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The large scale velocity potential pattern does not reflect a wave-1 structure, which is typically associated with the MJO. Enhanced upper-level difluence is located over Central America, the Maritime Continent, and Australia. Anomalous confluence is located over most of the Atlantic Ocean, Africa, and the central Pacific.

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



Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

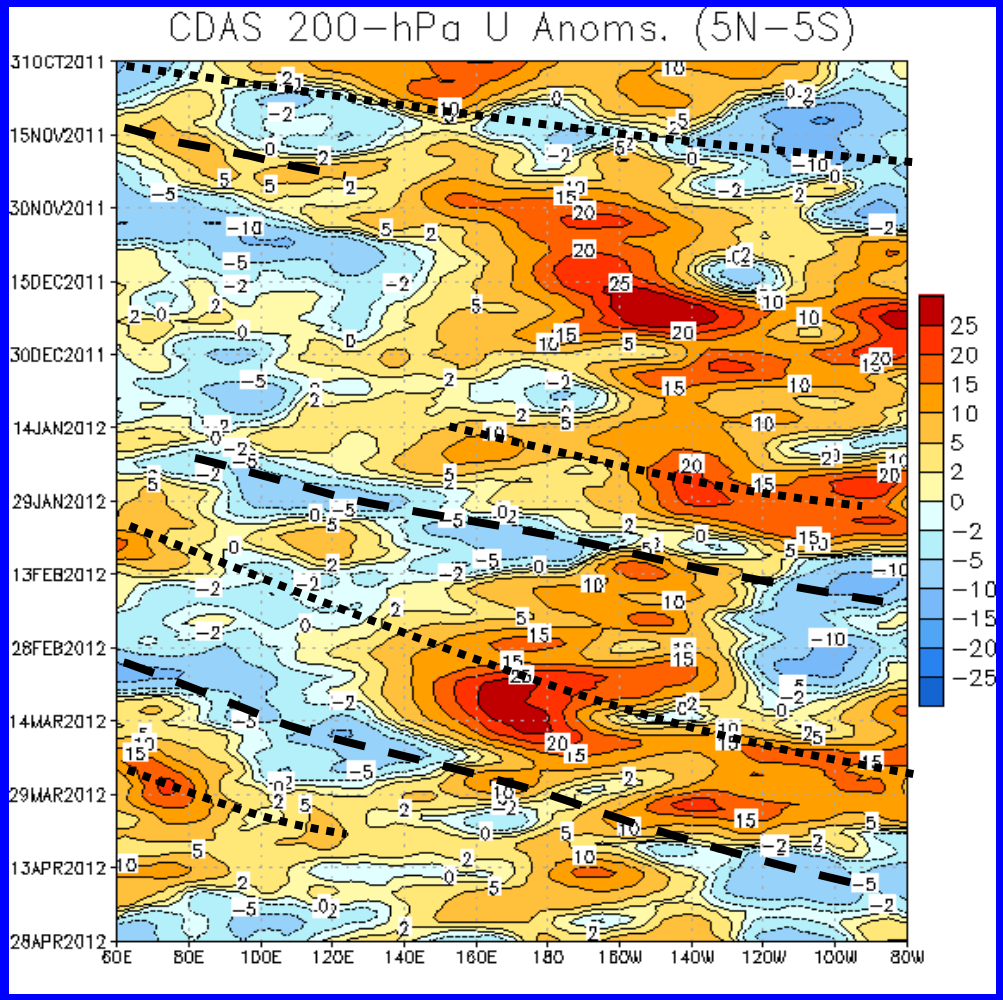
Red shades: Westerly anomalies

Westerly anomalies weakened across the central Pacific.

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

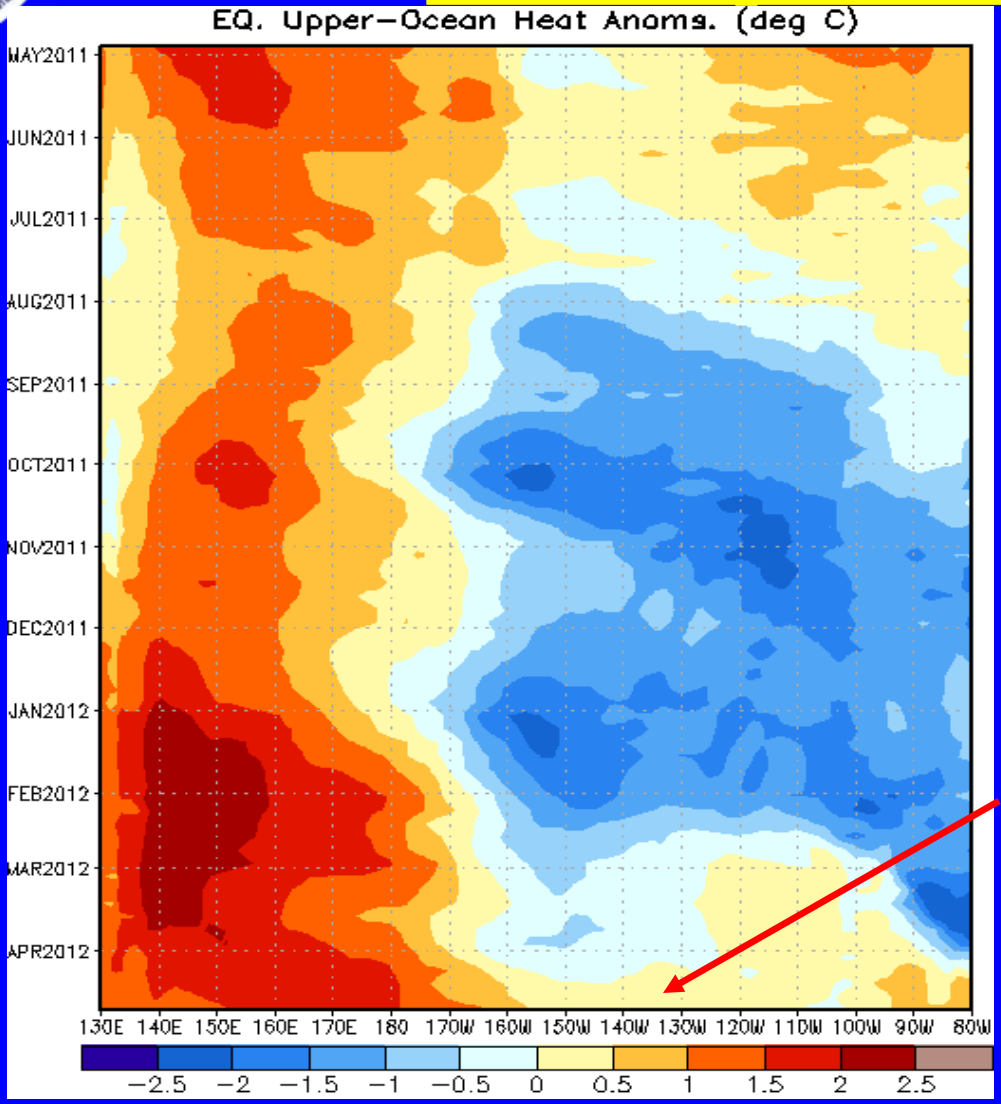
Longitude

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

In December, westerly anomalies strengthened over the central Pacific.

Eastward propagation was again more clearly evident during late January and February, continuing into April when westerly anomalies shifted eastward, over the Americas, Africa and the western Indian Ocean.

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.

Recent heat content anomalies have returned to near zero across much of the central and eastern 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).

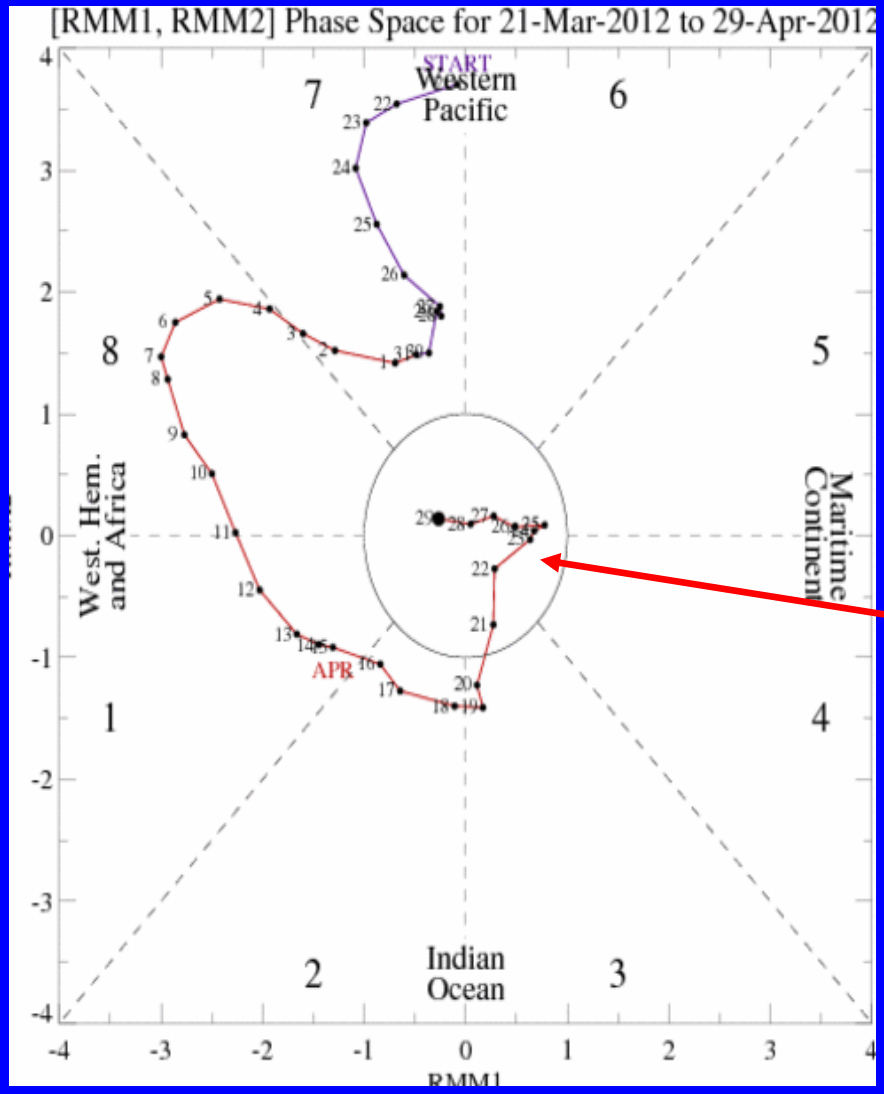
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review,* 132, 1917-1932.

• 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).

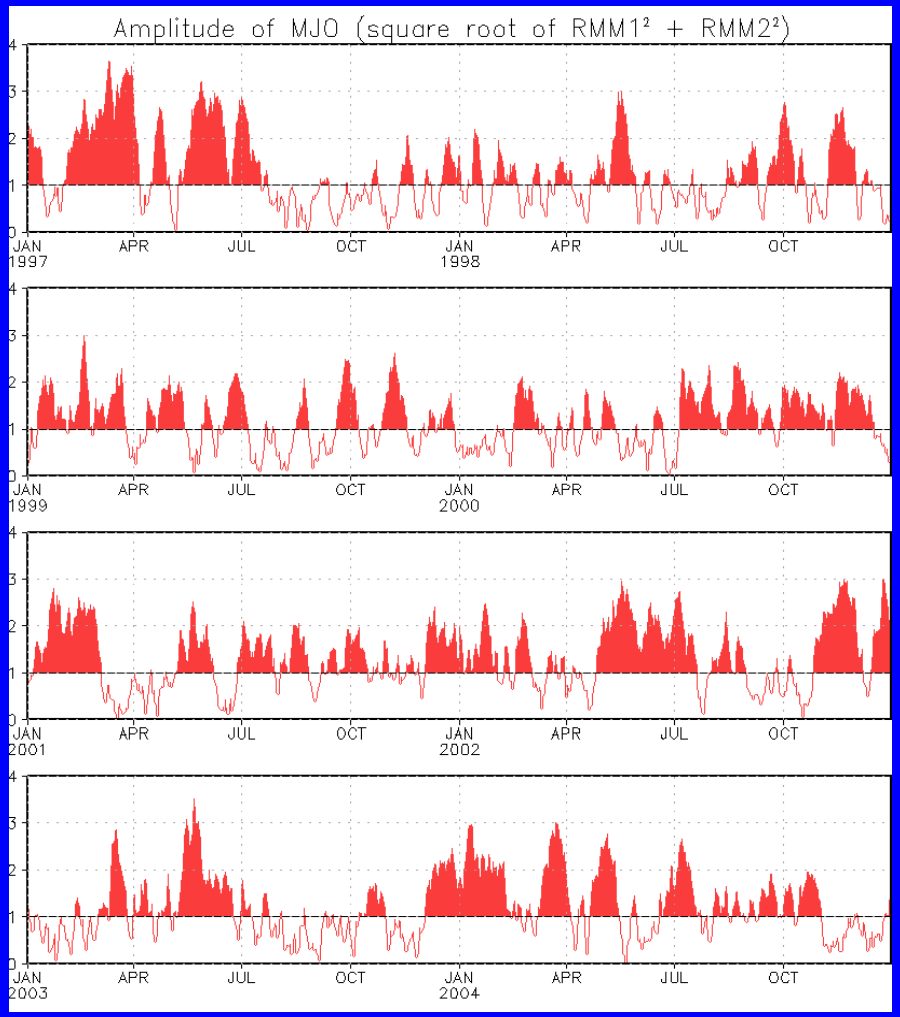
MJO Index -- Recent Evolution

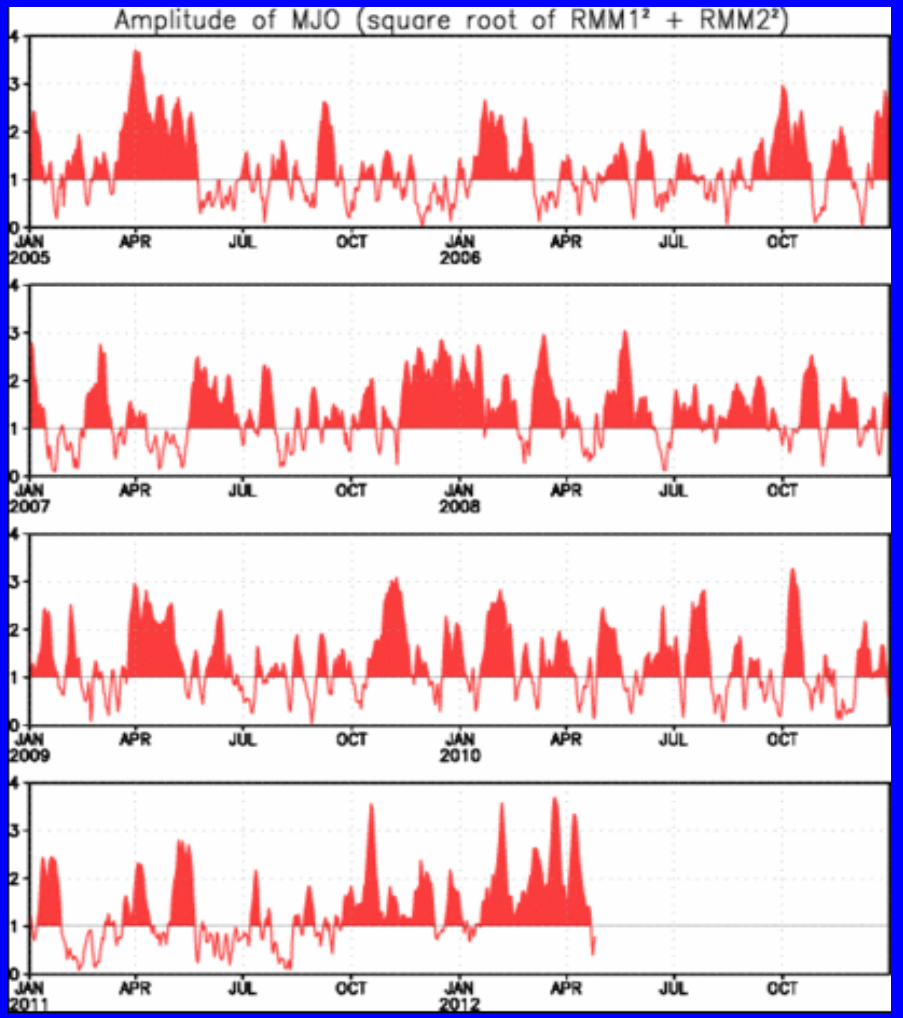


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index decreased in amplitude to near zero during the past week and currently indicates no coherent signal.

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.

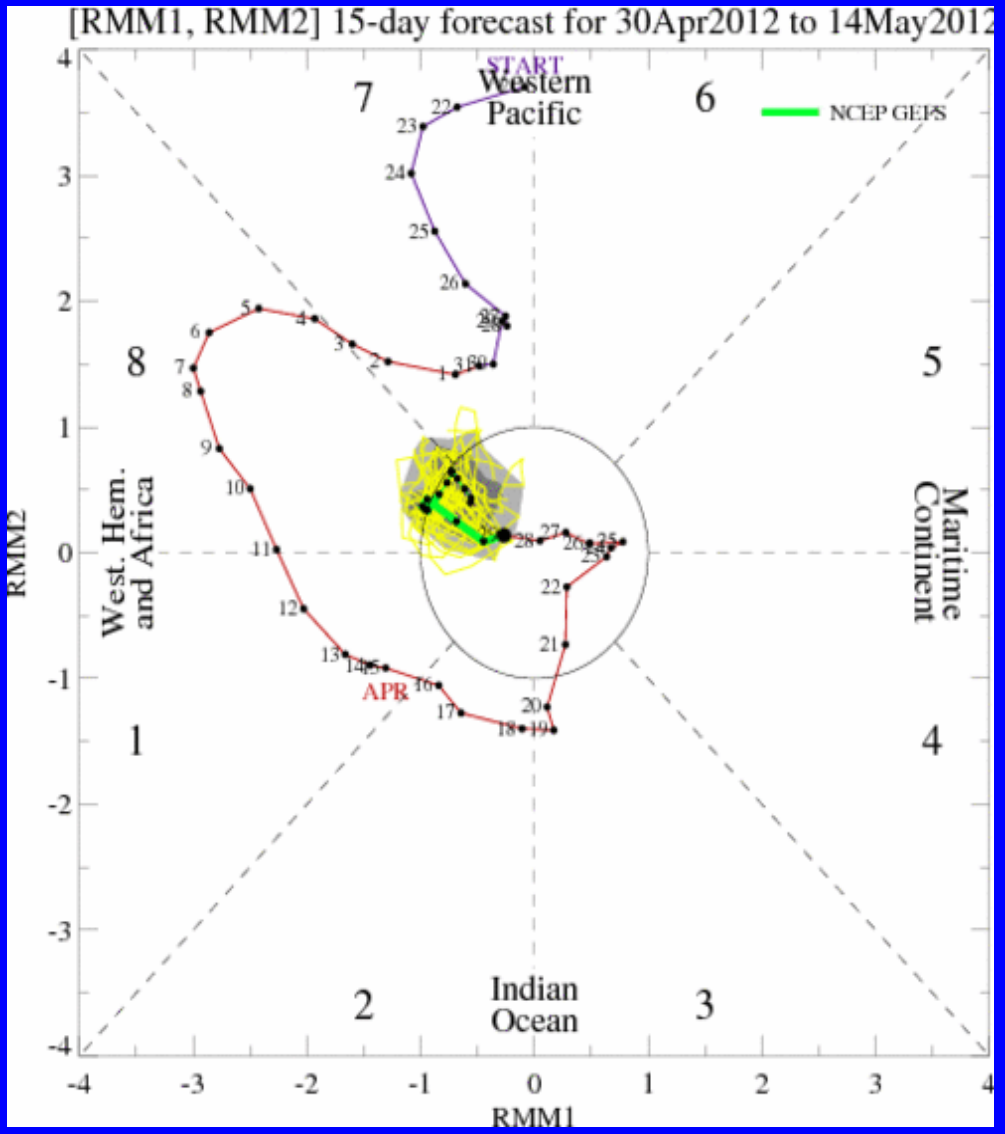
Ensemble GFS (GEFS) MJO Forecast

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

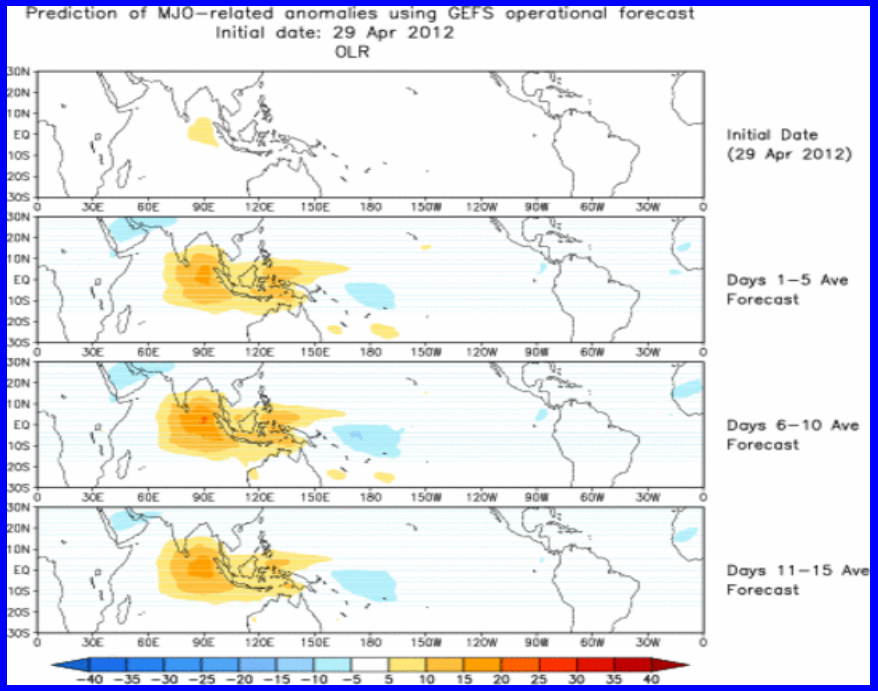
The ensemble GFS MJO index forecasts show weak MJO activity during the period.



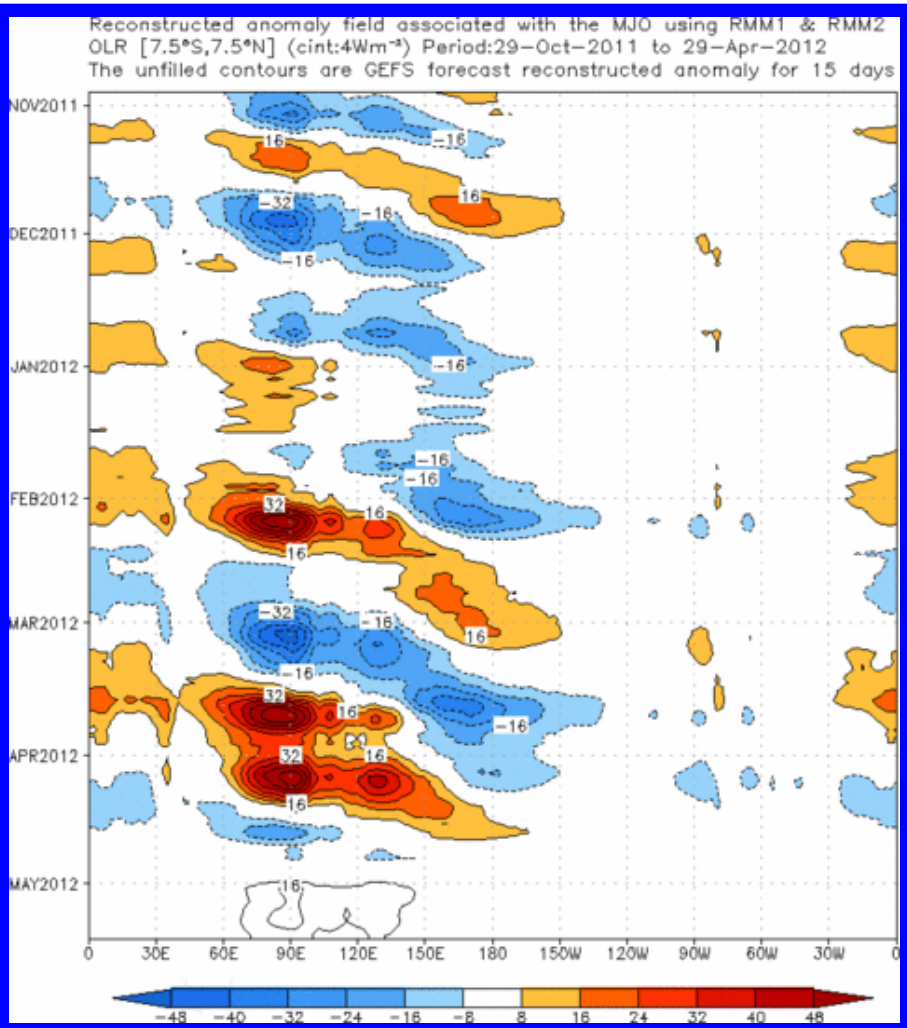
Ensemble Mean GFS MJO Forecast

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



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

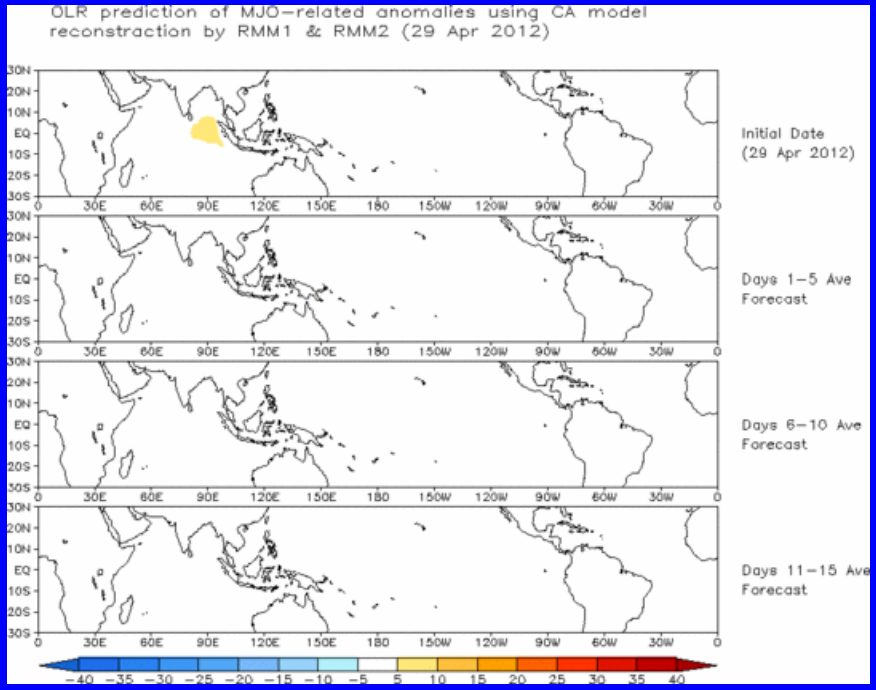


The ensemble mean GFS forecast indicates small anomalies during the next ten days with suppressed convection strengthening across the eastern Indian Ocean and Maritime Continent.

Constructed Analog (CA) MJO Forecast

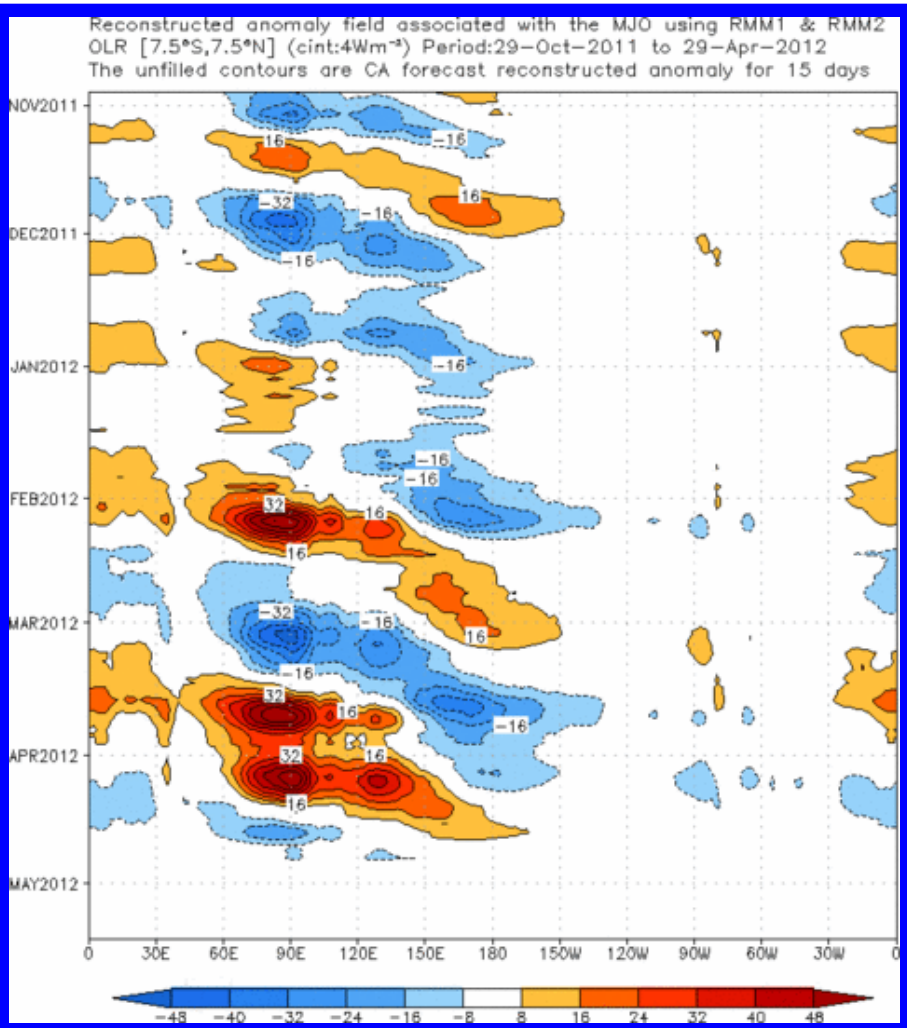
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Spatial map of OLR anomalies for the next 15 days



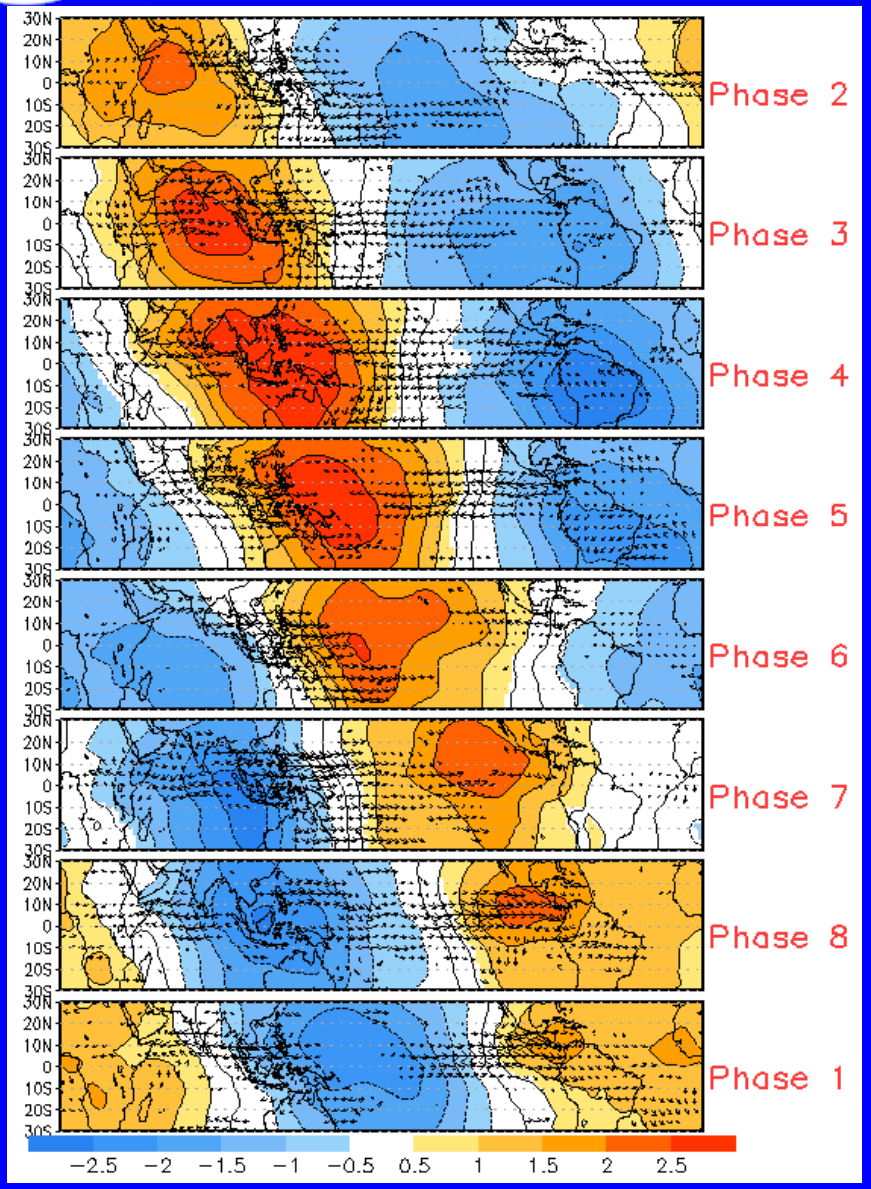
The Constructed Analog forecast calls for little to no MJO activity through week-2. This is due to a weak initial signal (near zero according to the Wheeler-Hendon MJO Index).

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

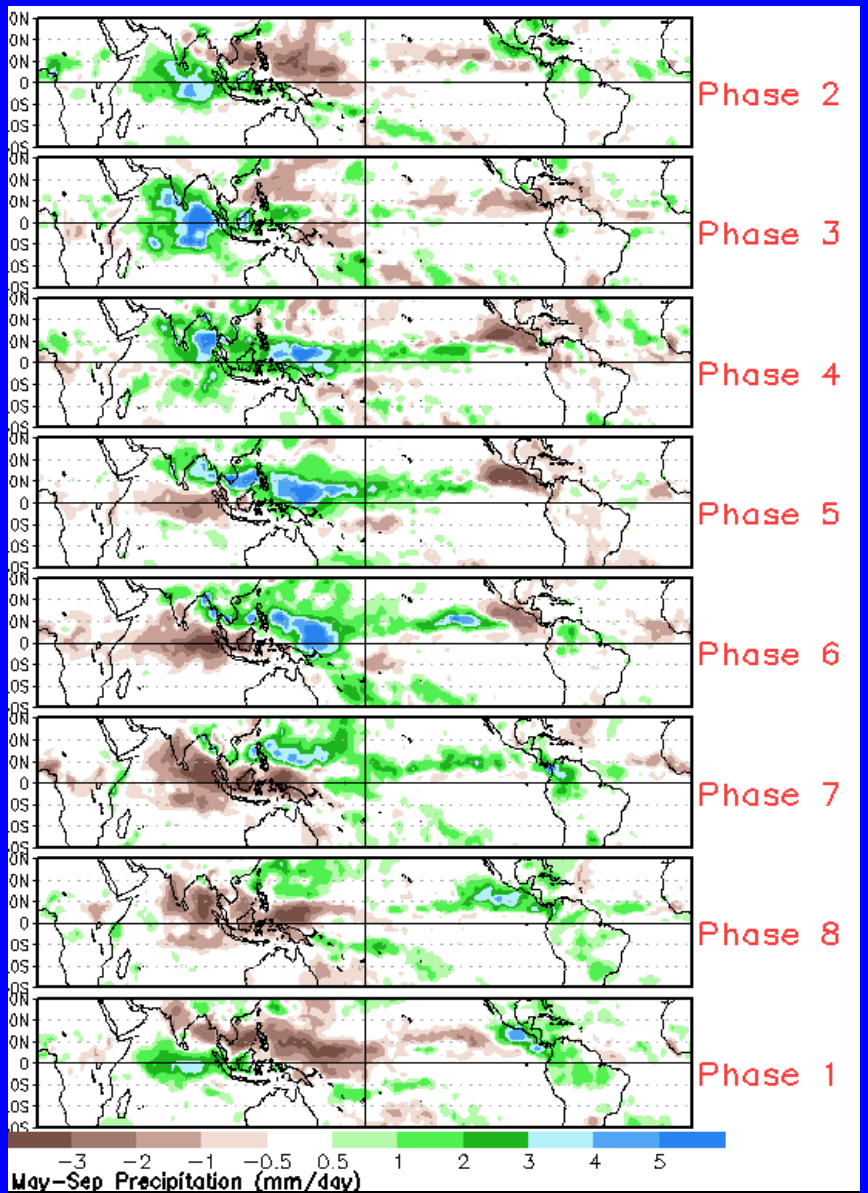


MJO Composites – Global Tropics

850-hPa Wind Anomalies (May-Sep)

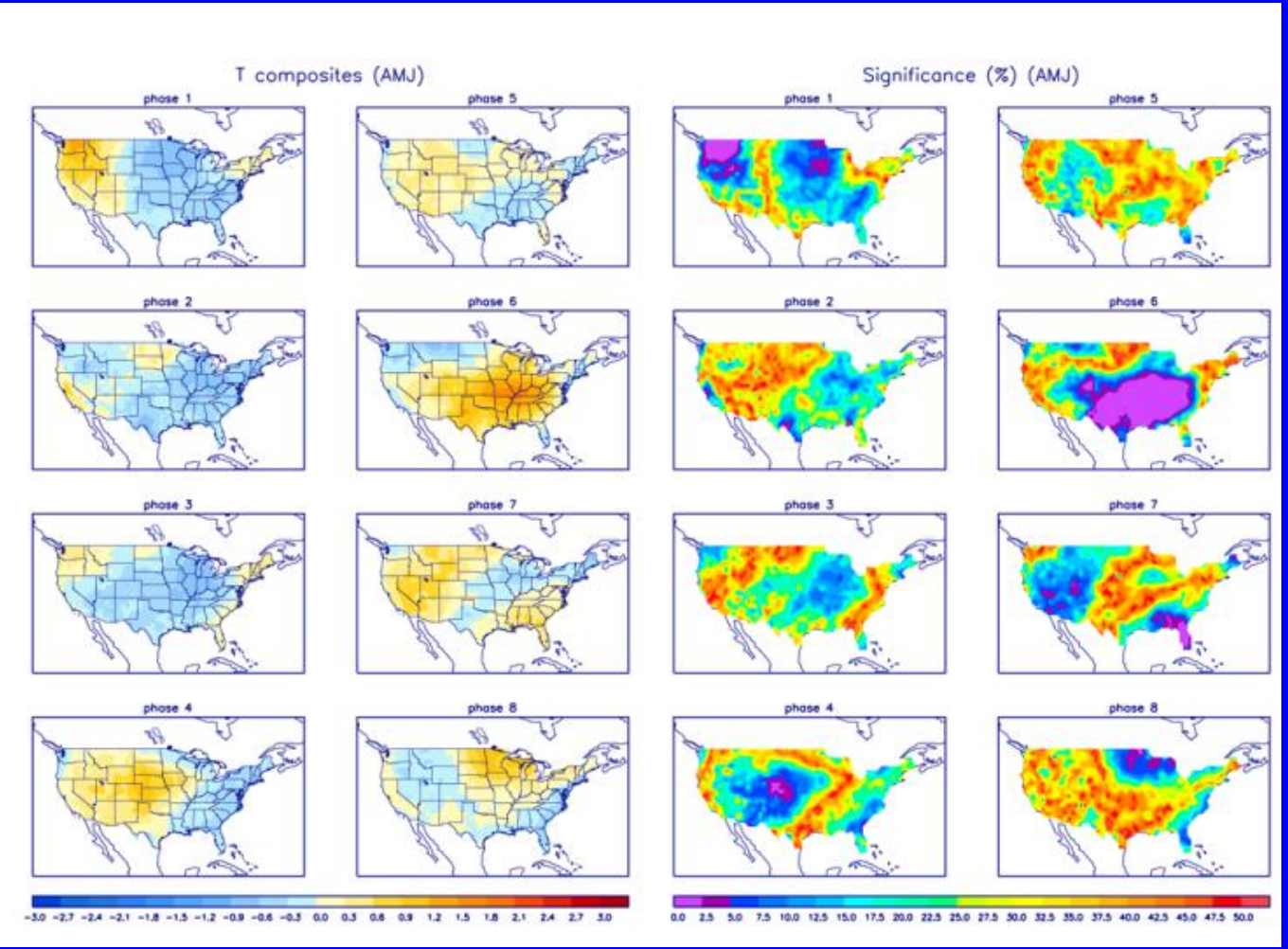


Precipitation Anomalies (May-Sep)



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

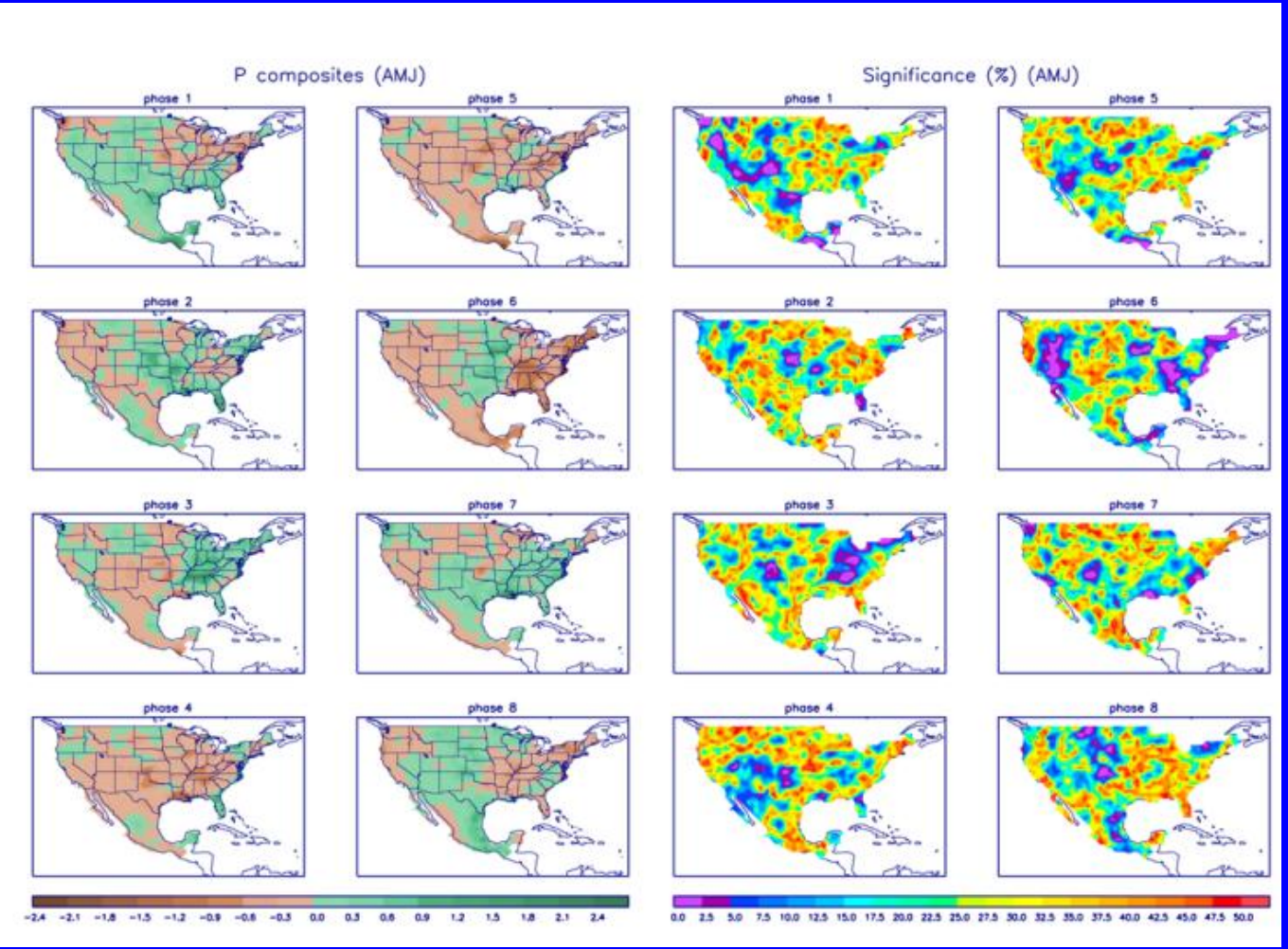


Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

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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