



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

**Update prepared by
Climate Prediction Center / NCEP
April 9, 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 the enhanced phase centered over the western hemisphere.**
- **Dynamical model MJO index forecasts indicate the MJO signal continuing during most of the upcoming two week period. There is a tendency for a decrease in amplitude and eastward propagation late during Week-2 by most models.**
- **Based on the latest observations and model forecasts, the MJO is forecast to remain active and shift across the western hemisphere over the next 1-2 weeks, however, there is considerable uncertainty during Week-2.**
- **The MJO is forecast to contribute to enhanced convection across parts of the Americas (Week-1), Africa (Week 1 and 2) and the western Indian Ocean (Week-2). Suppressed convection is favored for the Maritime Continent and parts of the western Pacific throughout most of the period.**
- **The upcoming phase of the MJO (Phase 1) continues enhanced chances for colder air entering the central and eastern continental U.S. during the first portion of the period as MJO composites favor below-normal temperatures for parts of the central and southeast U.S. as well as above-average precipitation for parts of the southeast U.S.**

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

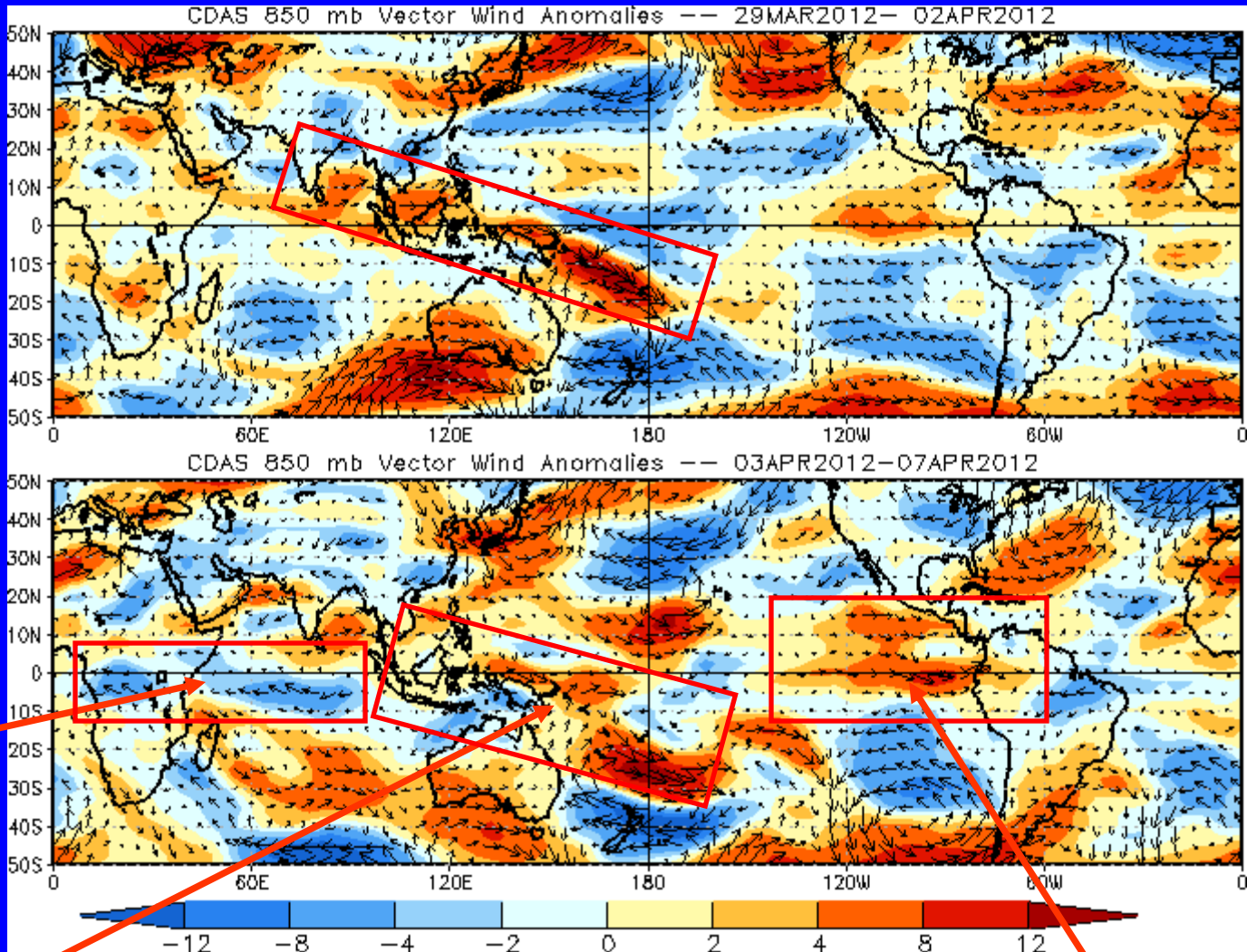


850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Easterly anomalies developed over portions of central Africa and the equatorial Indian Ocean during the past five days.

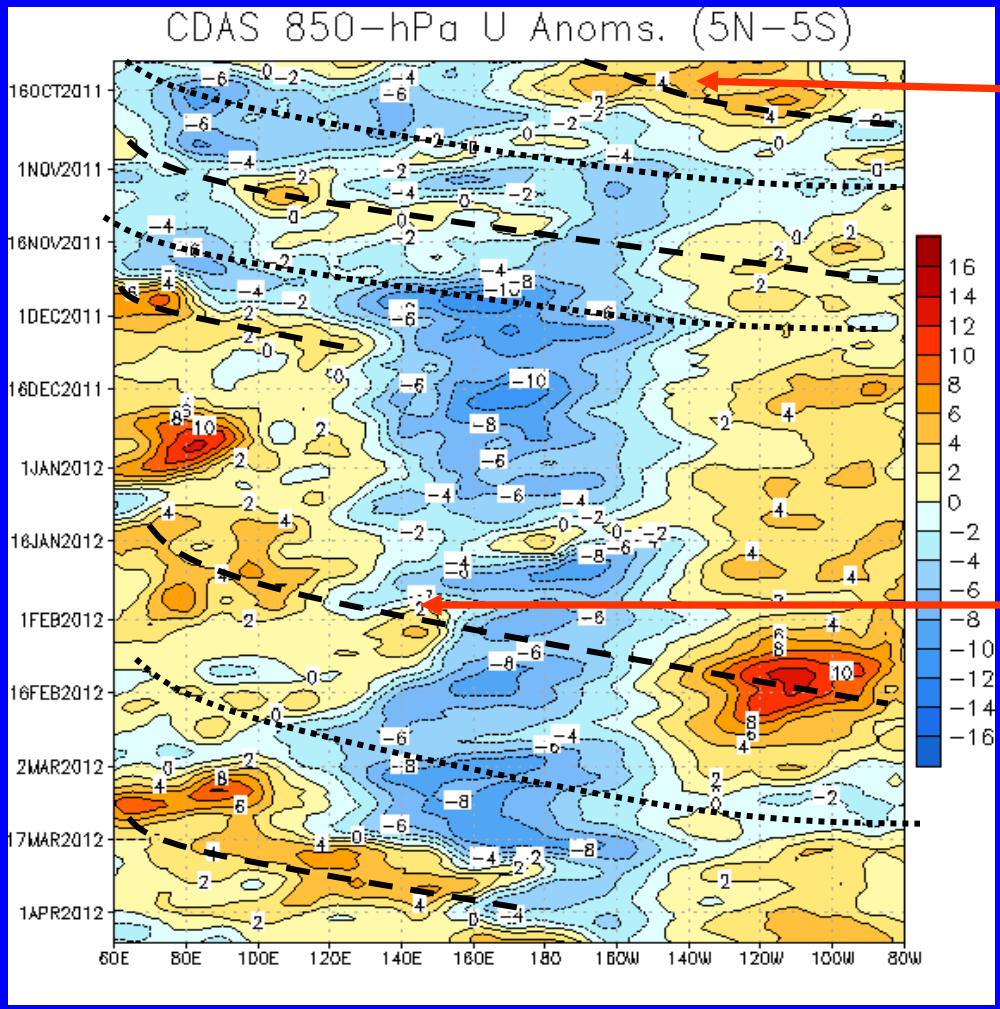
Westerly anomalies shifted eastward over parts of the western Pacific while weakening some across the Maritime continent.

Westerly anomalies increased in magnitude over the eastern Pacific 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

In October, MJO activity weakened the persistent easterly anomalies across the central Pacific and increased westerly anomalies in the eastern 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.

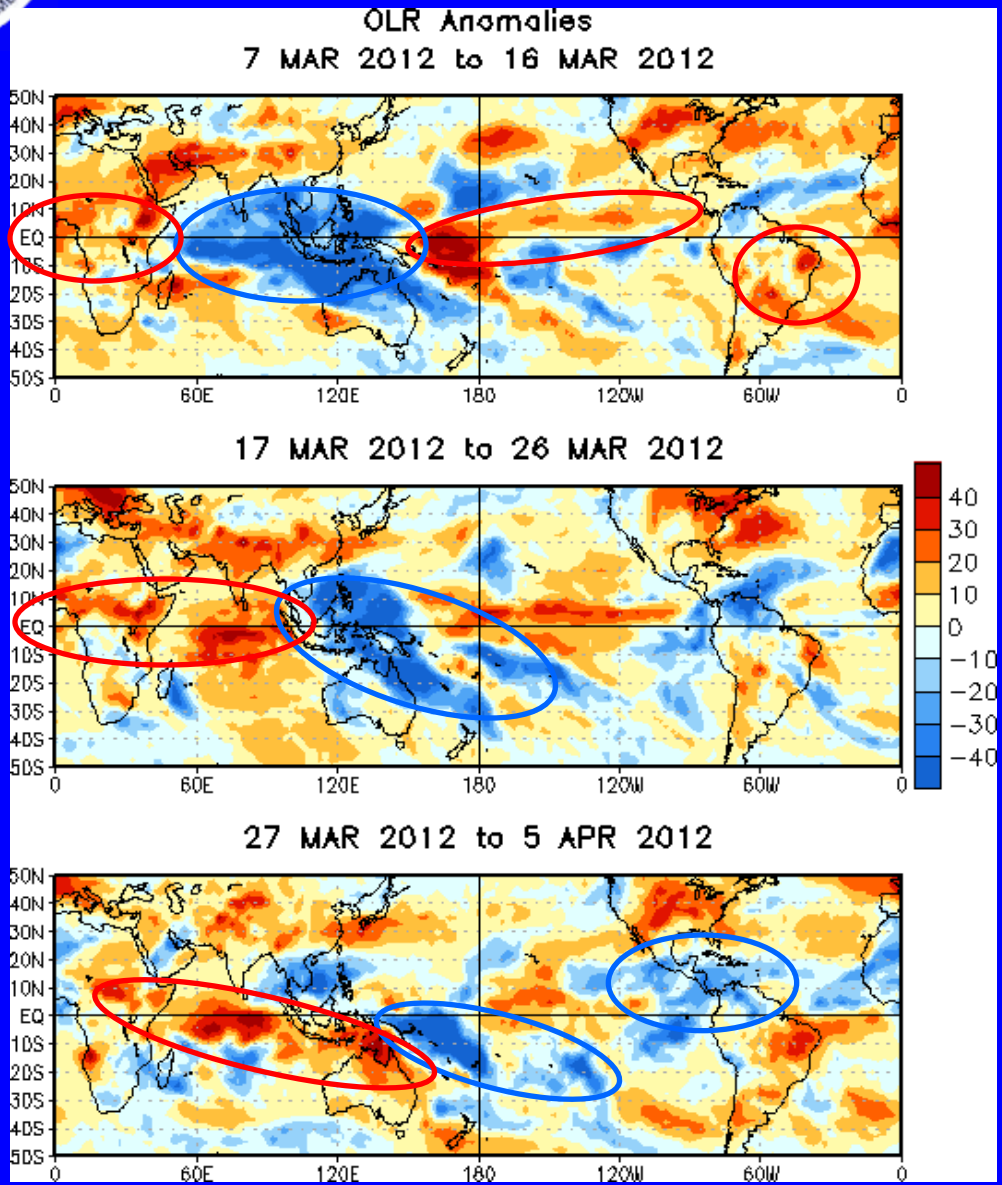
During first half of February, the MJO contributed to increased westerly anomalies near 140E and across the eastern Pacific while decreasing easterly anomalies in the central Pacific.

MJO activity has continued into April, with westerly anomalies associated with the MJO located near the Date Line and western hemisphere.



OLR Anomalies – Past 30 days

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



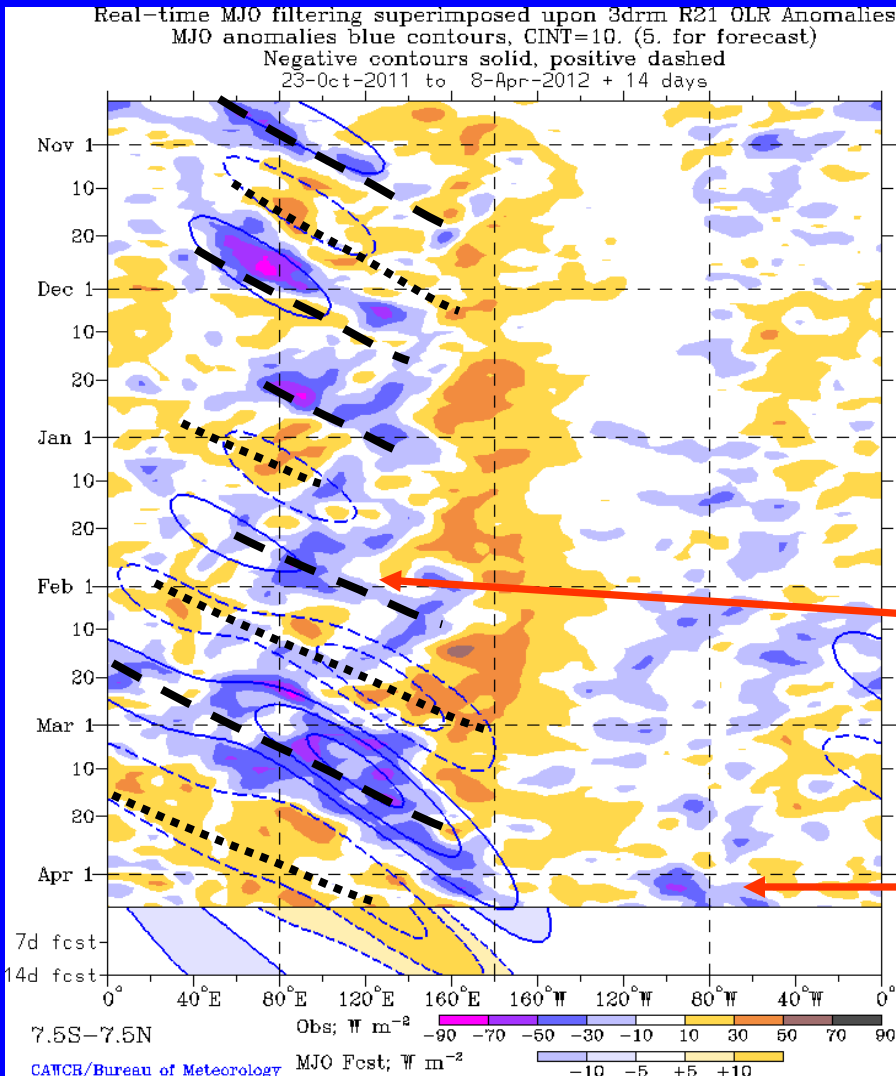
During early to mid-March, the MJO contributed to enhanced convection (blue circle) across the eastern Indian Ocean and Maritime Continent and suppressed convection (red circles) over the central Pacific, South America and Africa.

Late in March, enhanced convection shifted eastward into the western Pacific and suppressed convection continued over Africa and developed across the Indian Ocean.

Entering early April, enhanced convection remained evident over portions of the Pacific and Americas with suppressed convection shifting eastward to include parts of the Maritime continent and Australia.



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)

MJO activity was evident during October, November and early December as alternating areas of enhanced (dashed lines) and suppressed (dotted lines) convection shifted eastward.

Strong MJO activity once again developed during late January as enhanced convection shifted eastward across the Maritime continent.

The MJO has continued into April, with enhanced convection now located across the western hemisphere and suppressed convection shifting eastward from the Indian Ocean across the Maritime continent.



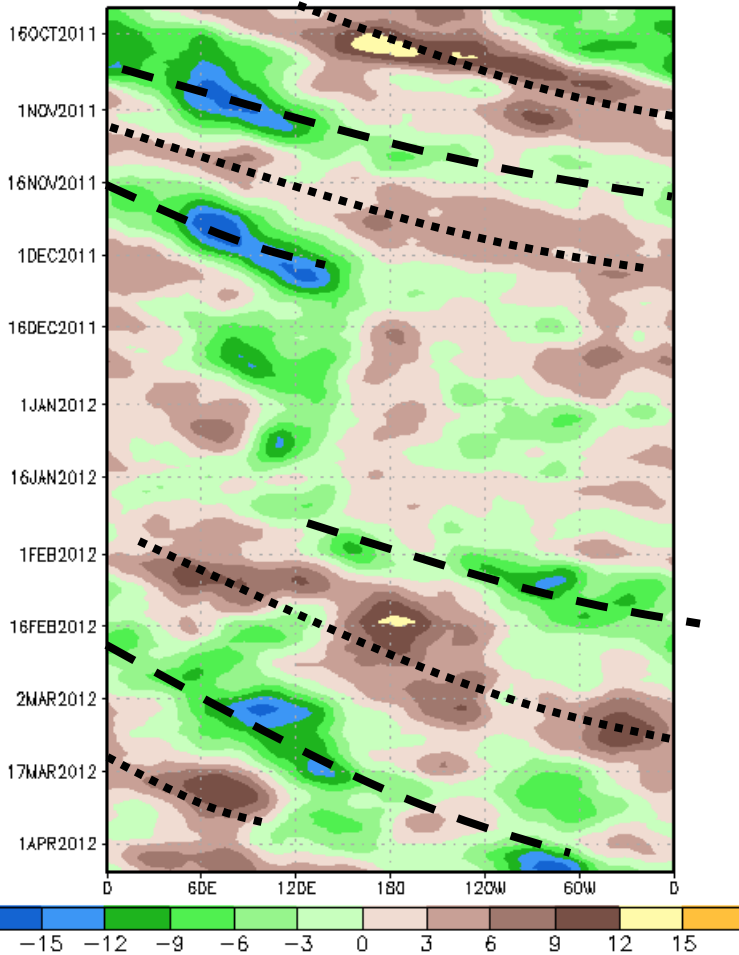
200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

200-hPa Velocity Potential Anomaly: 5N-5S

5-day Running Mean



Beginning in the second half of September and lasting until 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.

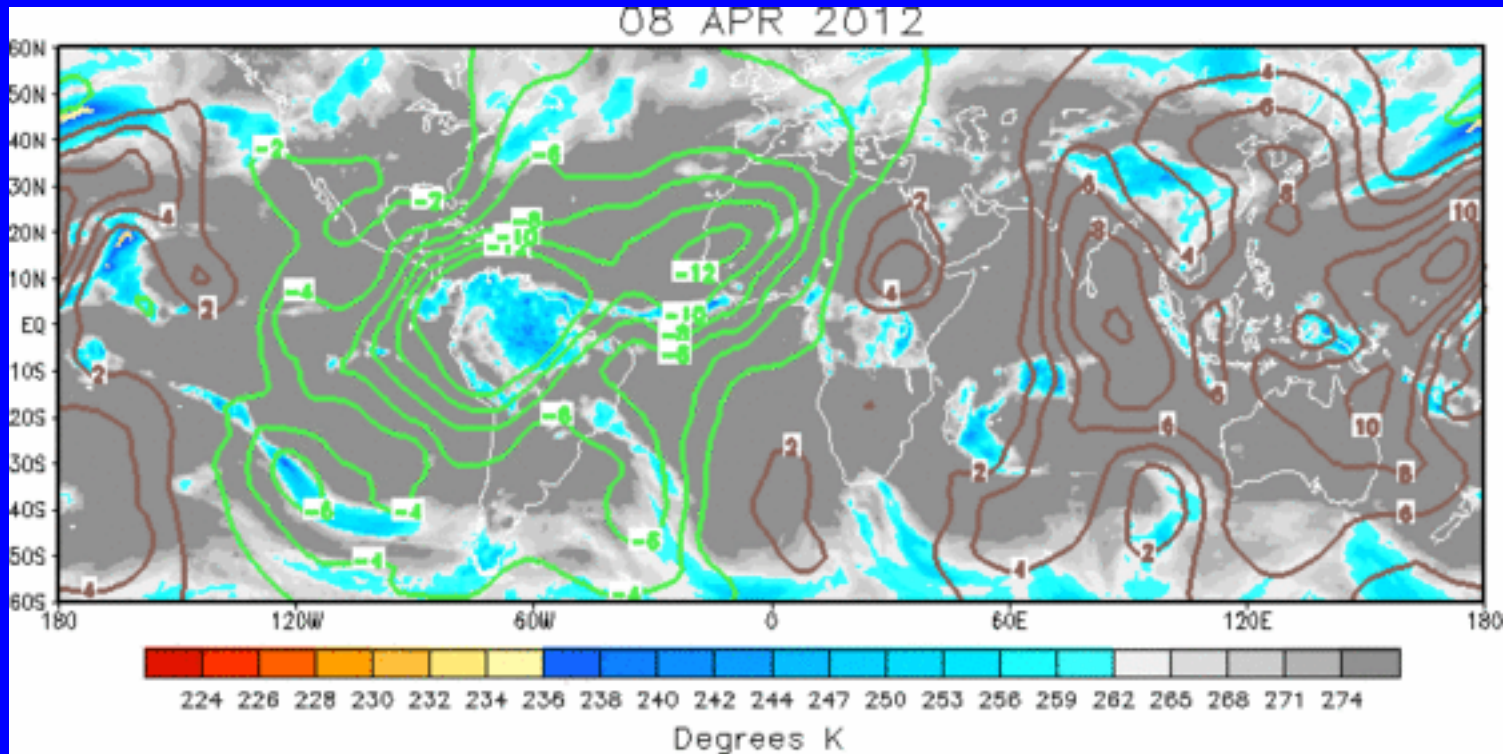
The MJO strengthened in late January and eastward propagation has been evident through late March.



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 shows a coherent signal with enhanced divergence centered across the western hemisphere and enhanced convergence centered across the Indian Ocean, Maritime continent and western Pacific.

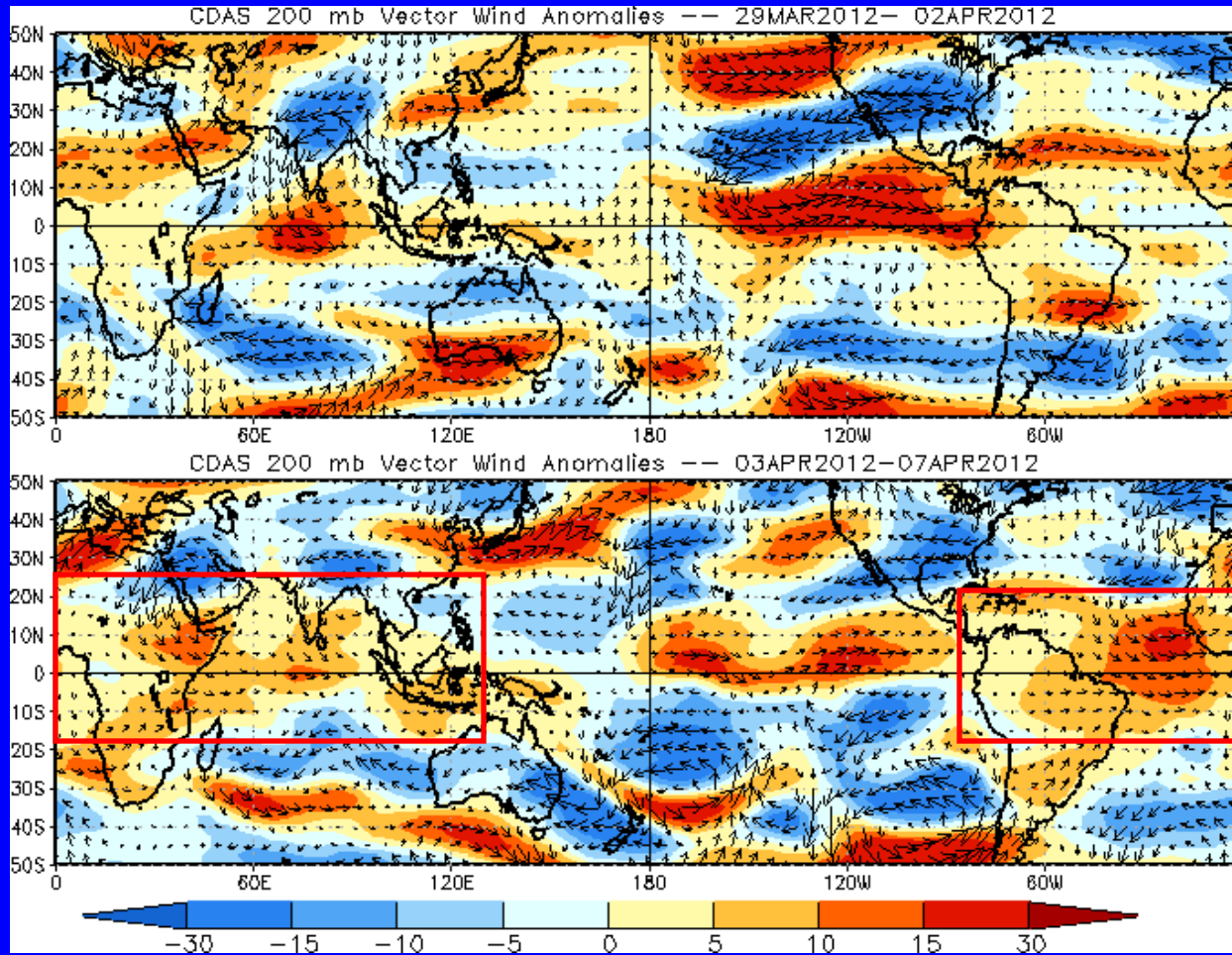


200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



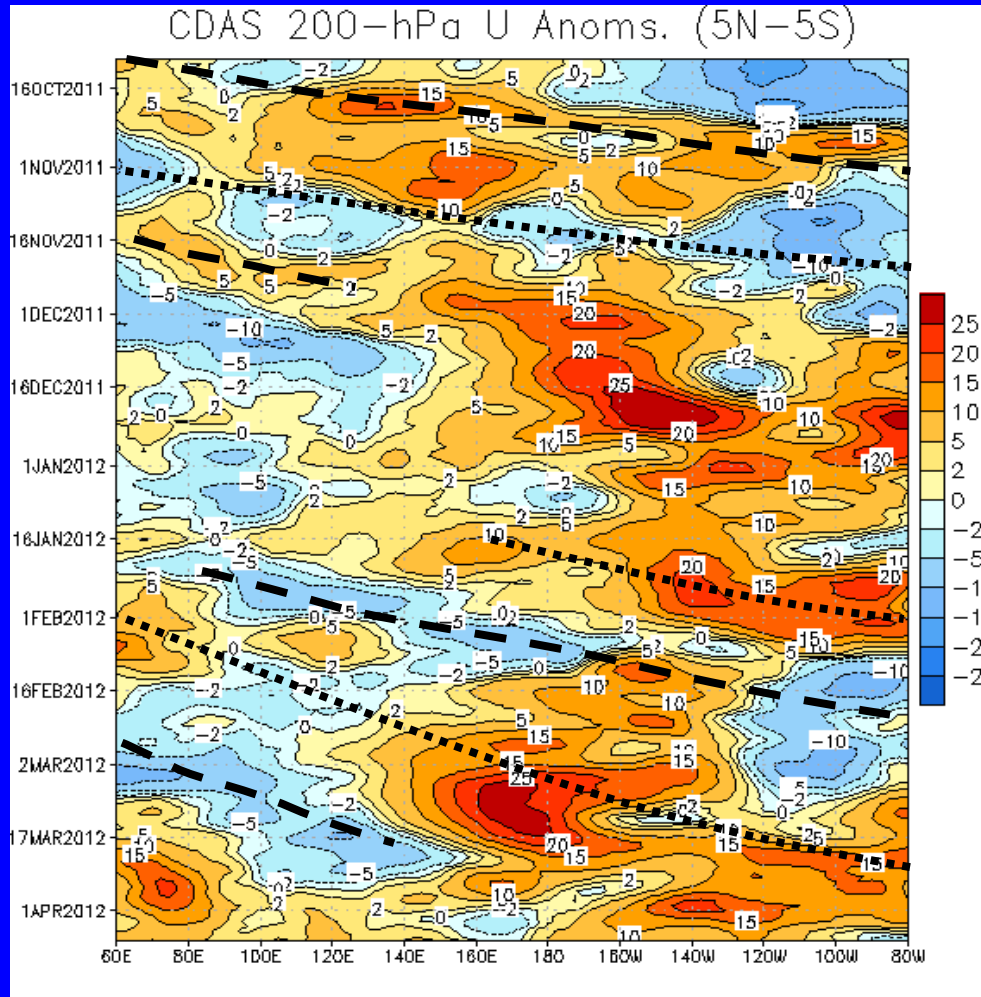
Westerly anomalies increased in coverage across portions of South America, the Atlantic, Africa and across the Indian Ocean during the past five days.



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



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.

Eastward propagation was again more clearly evident during late January and February, continuing until mid-to-late March when easterly anomalies were evident near 140E and westerly anomalies shifted eastward, over the Americas, Africa and the western Indian Ocean.

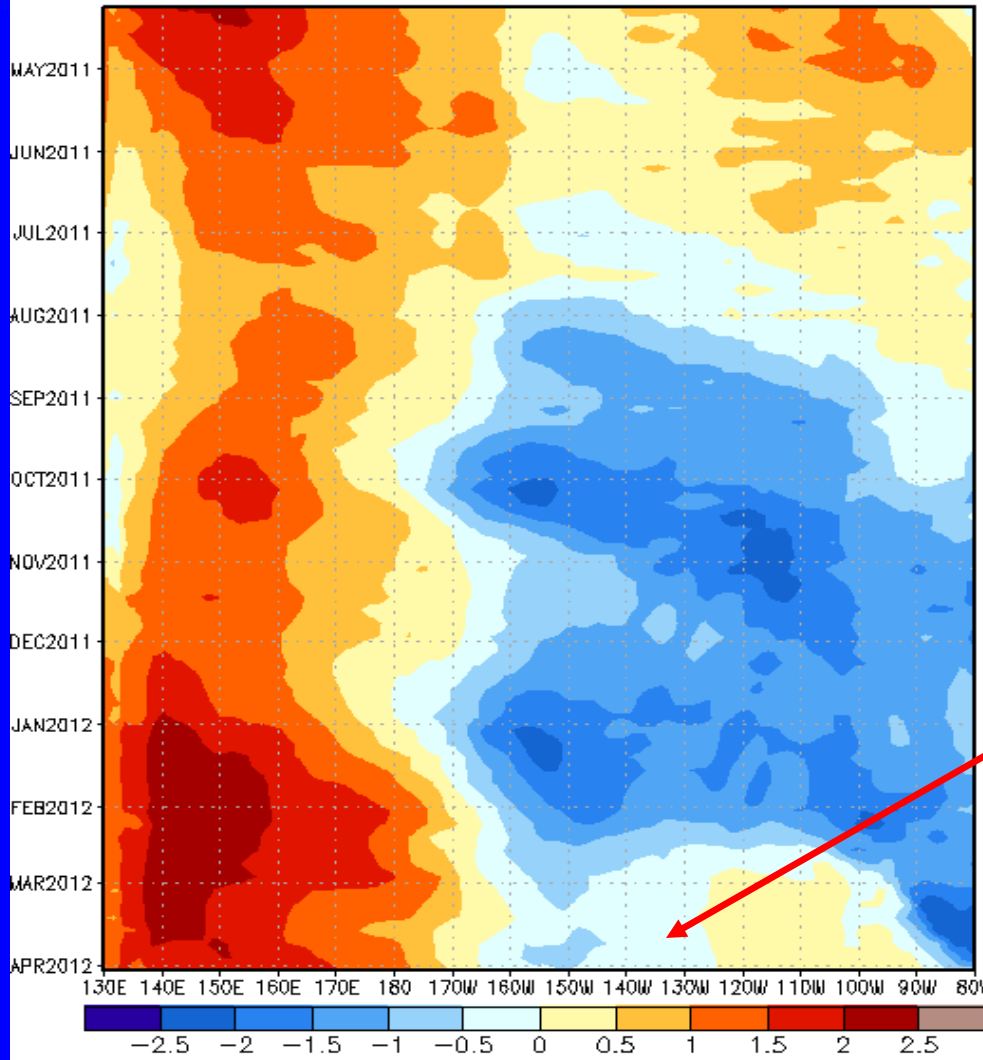


Weekly Heat Content Evolution in the Equatorial Pacific

Time



EQ. Upper-Ocean Heat Anoms. (deg C)



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

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.

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.

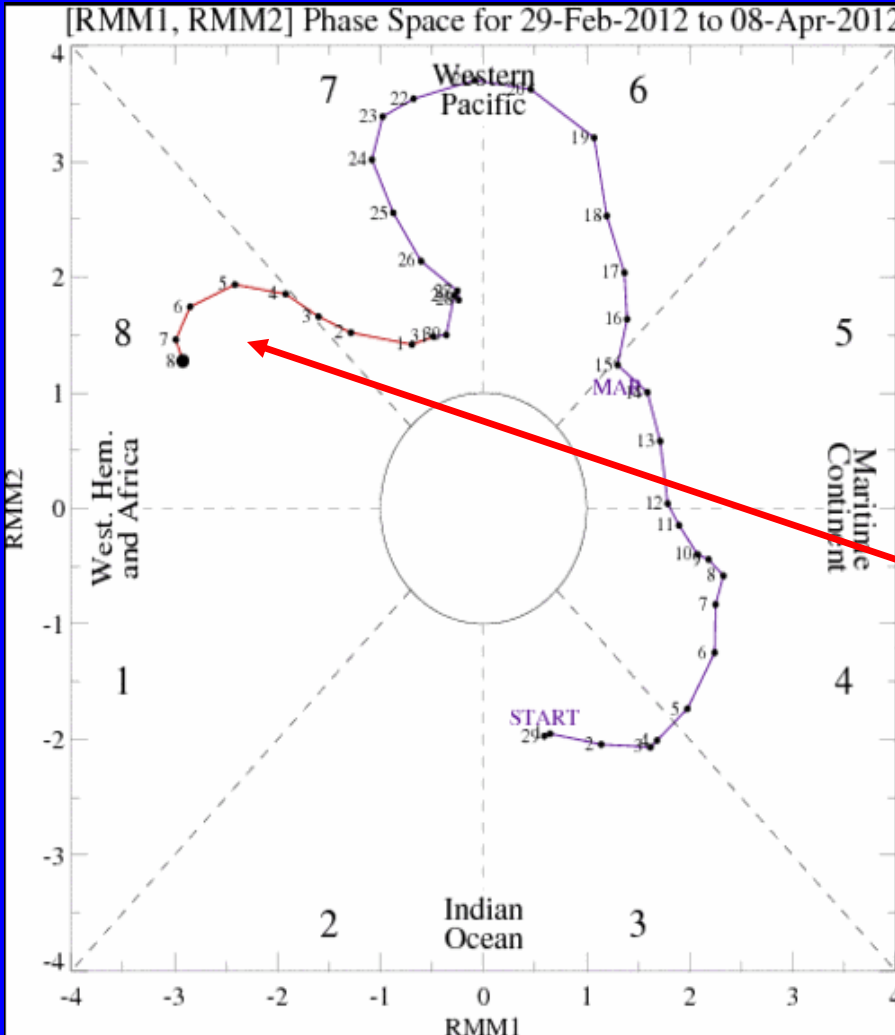
- The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.

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

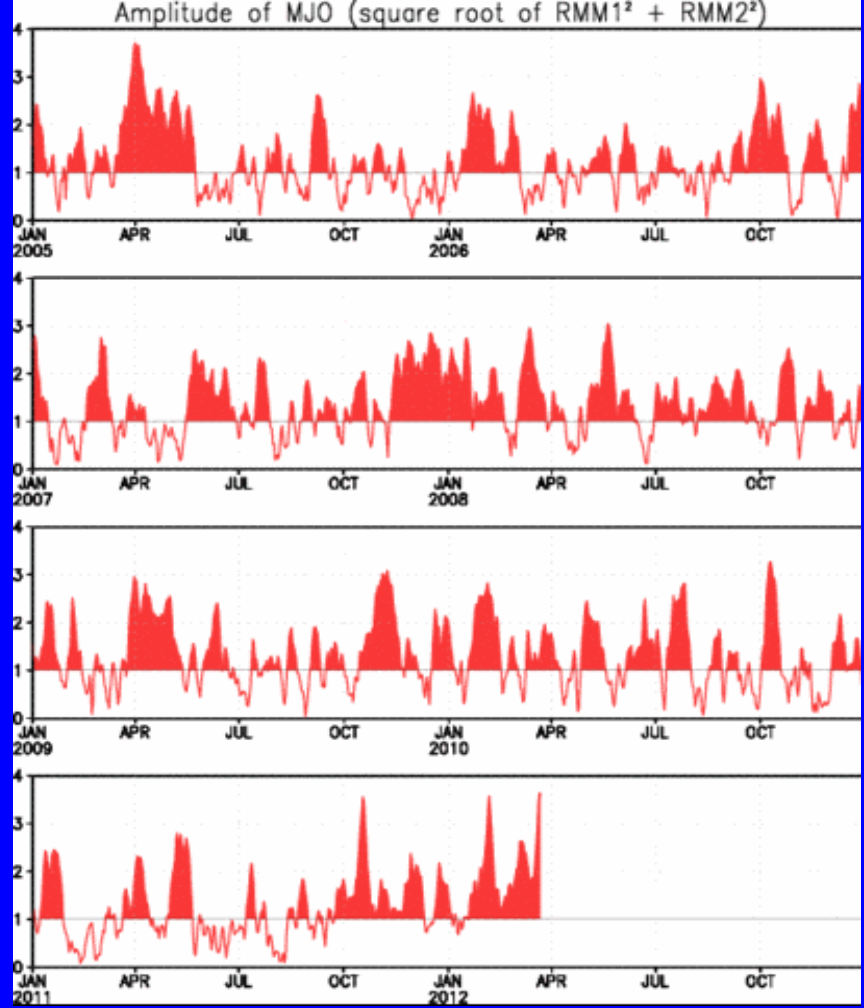
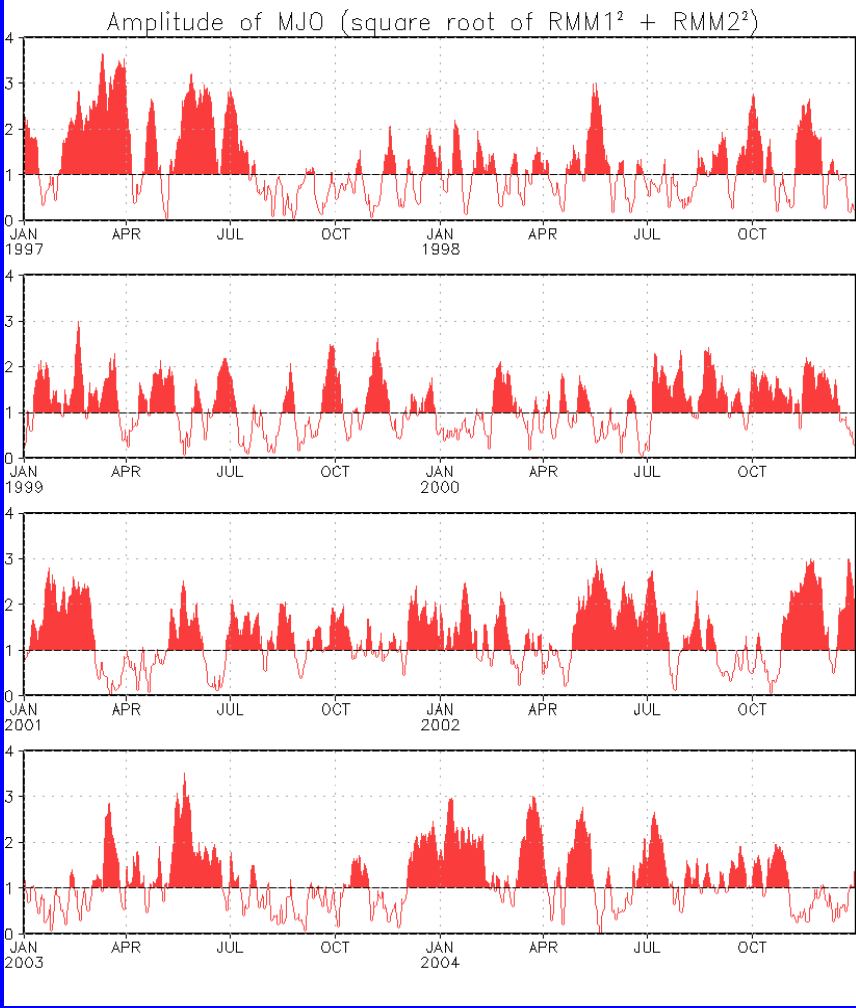


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index amplitude increased and eastward propagation resumed during the past week, indicating a continuation of MJO activity.



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.



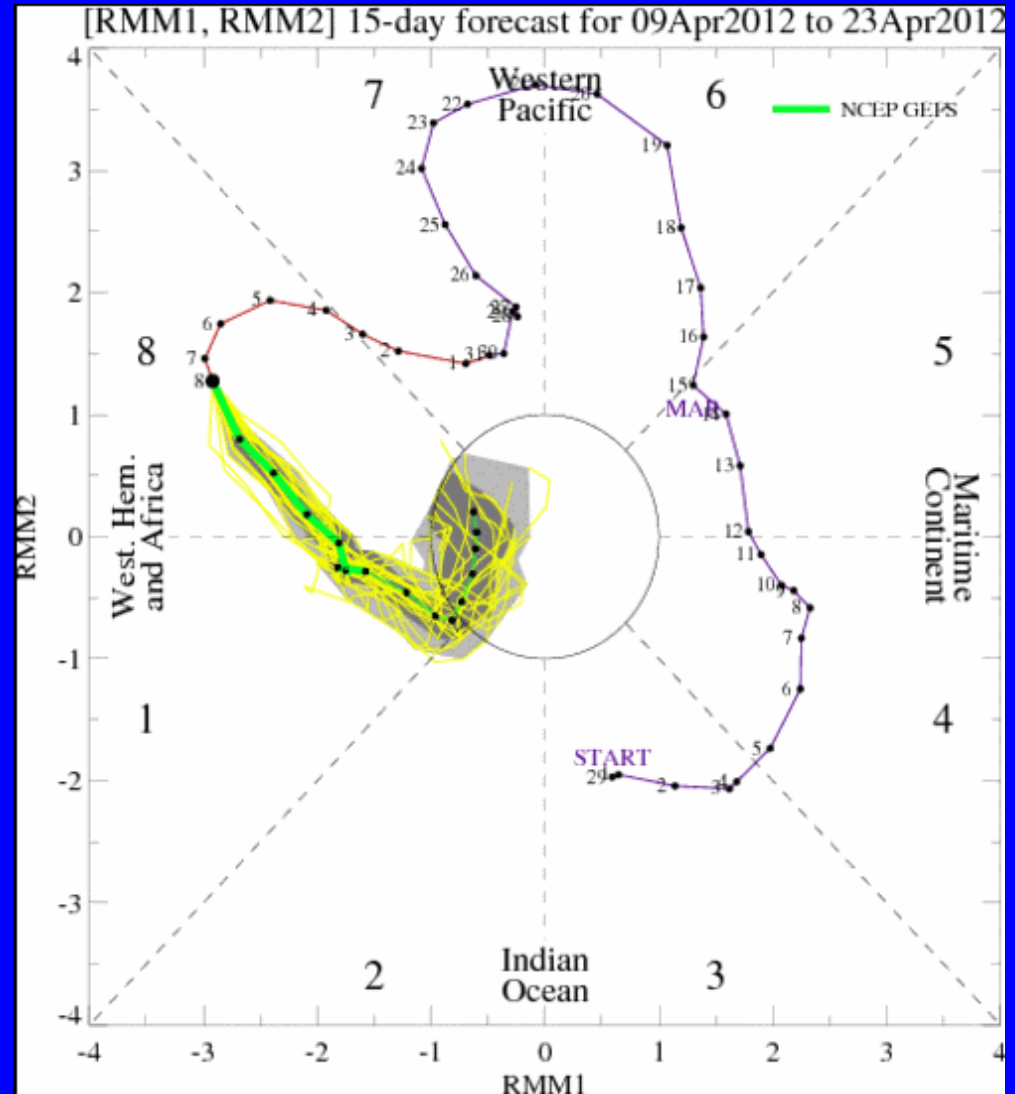
Ensemble GFS (GEFS) MJO Forecast

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 MJO activity to continue during most of the two week forecast period, although eastward propagation and amplitude decrease late during Week-2.



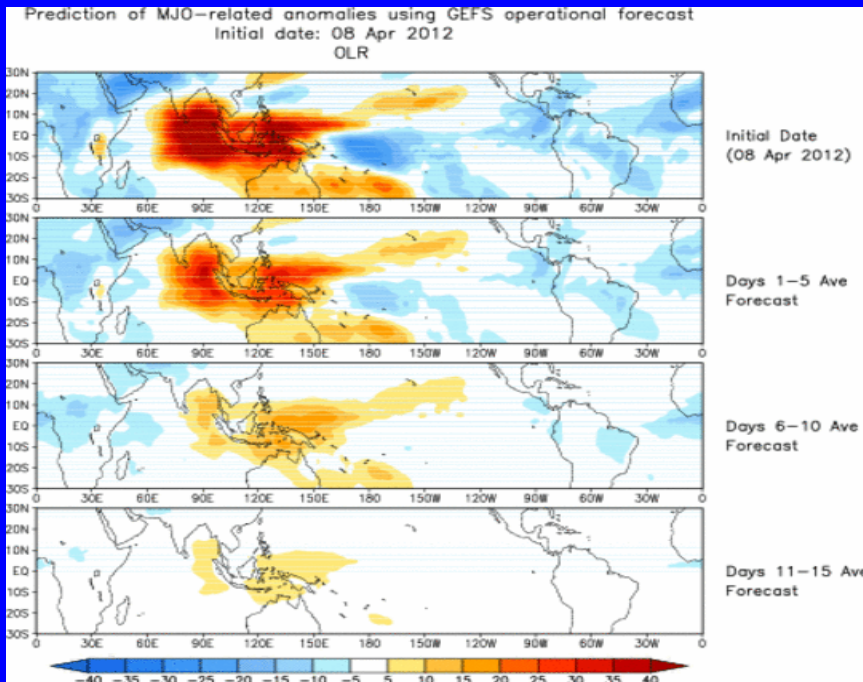


Ensemble Mean GFS MJO Forecast

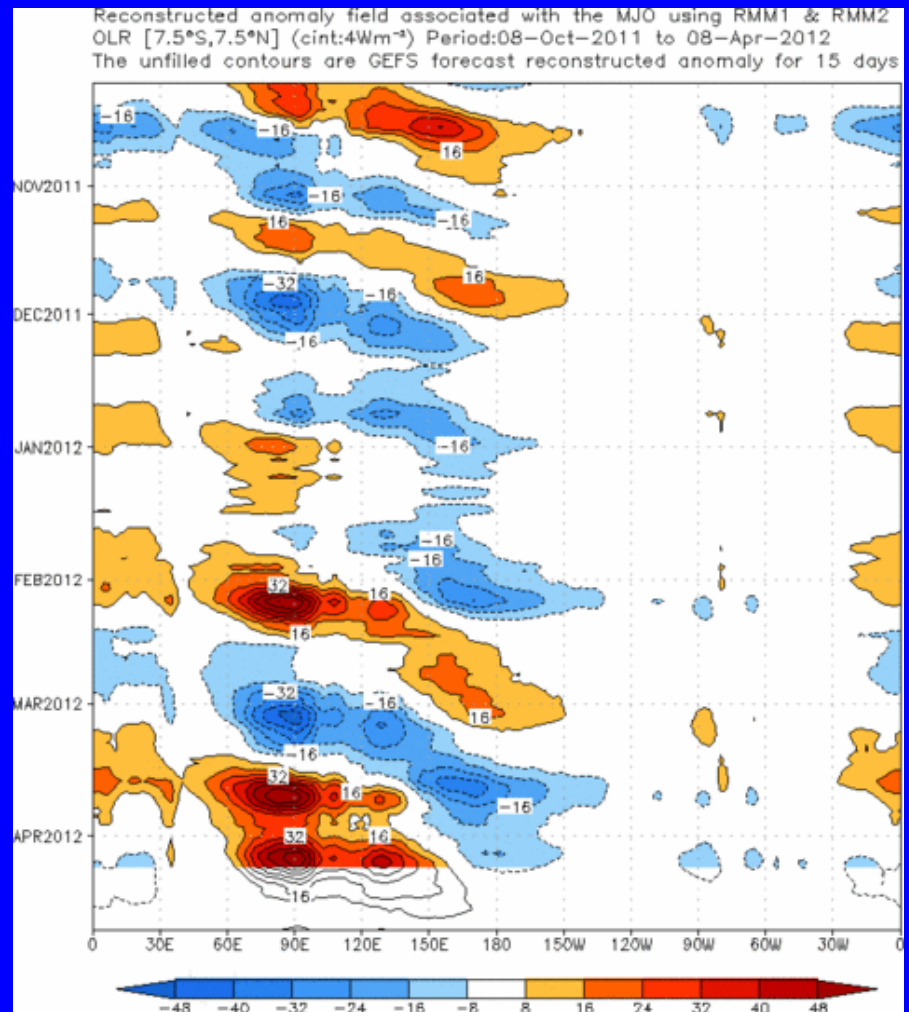
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

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 parts of the Americas and Africa during much of the period, with suppressed convection for the Maritime continent and parts of the western Pacific. Weak signals are indicated late during Week-2.



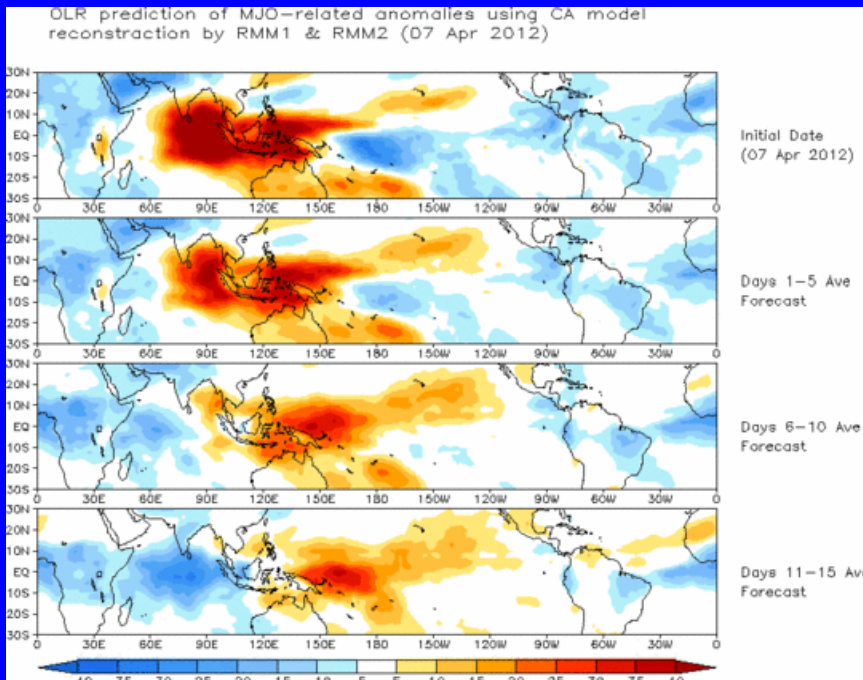


Constructed Analog (CA) MJO Forecast

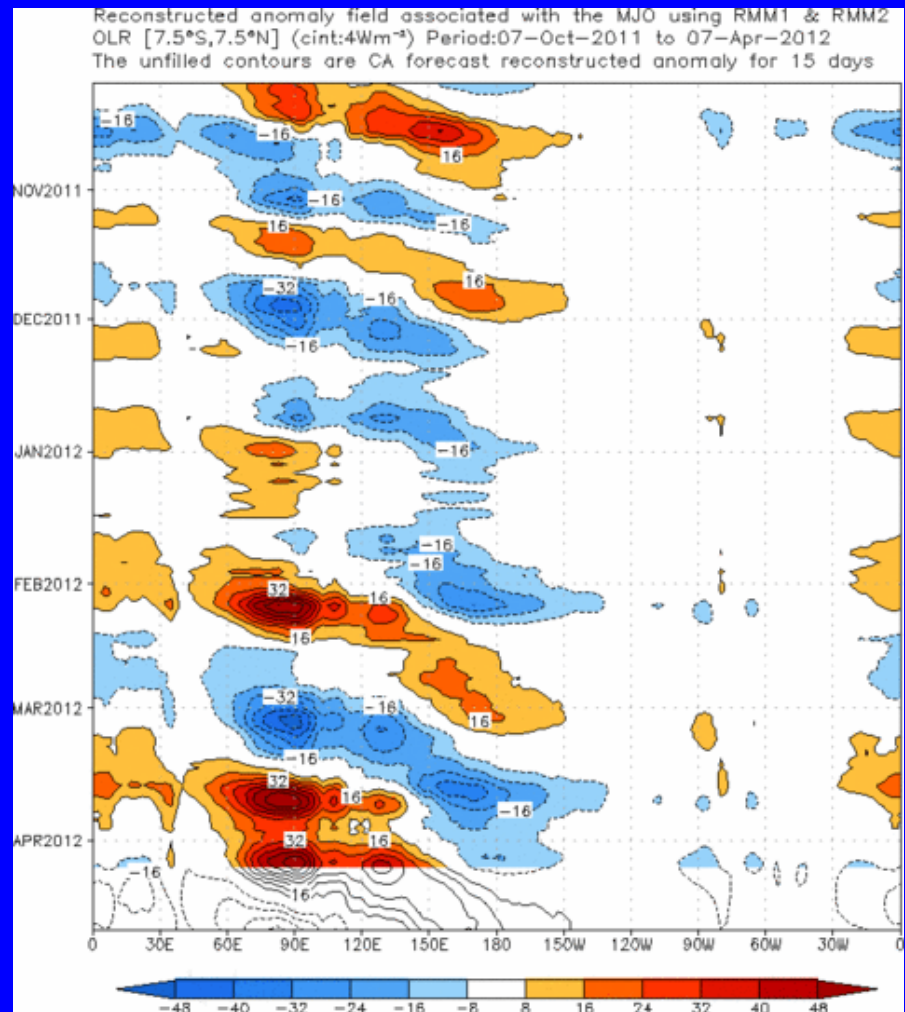
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

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 suppressed convection shifting across the Maritime Continent to the western and central Pacific during the period with enhanced convection impacting the Americas and Africa during Week-1 and developing in the Indian Ocean during Week-2.

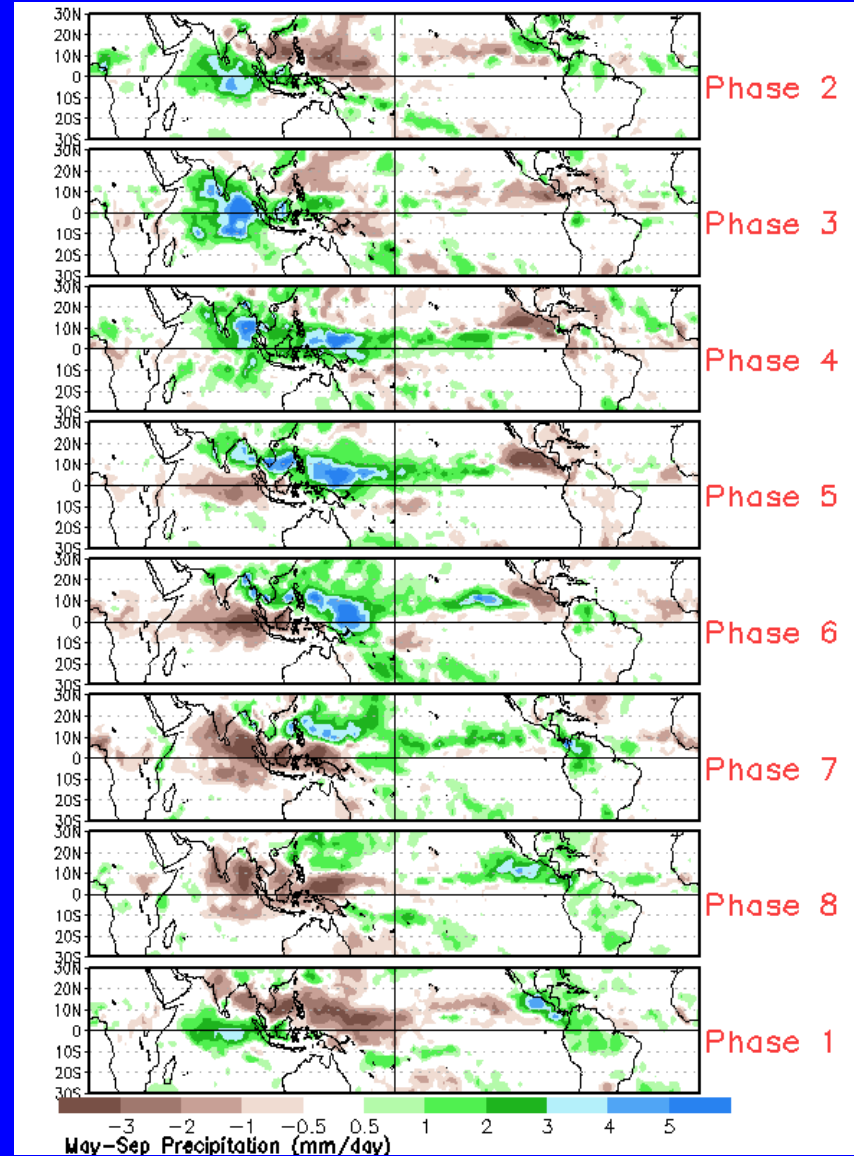
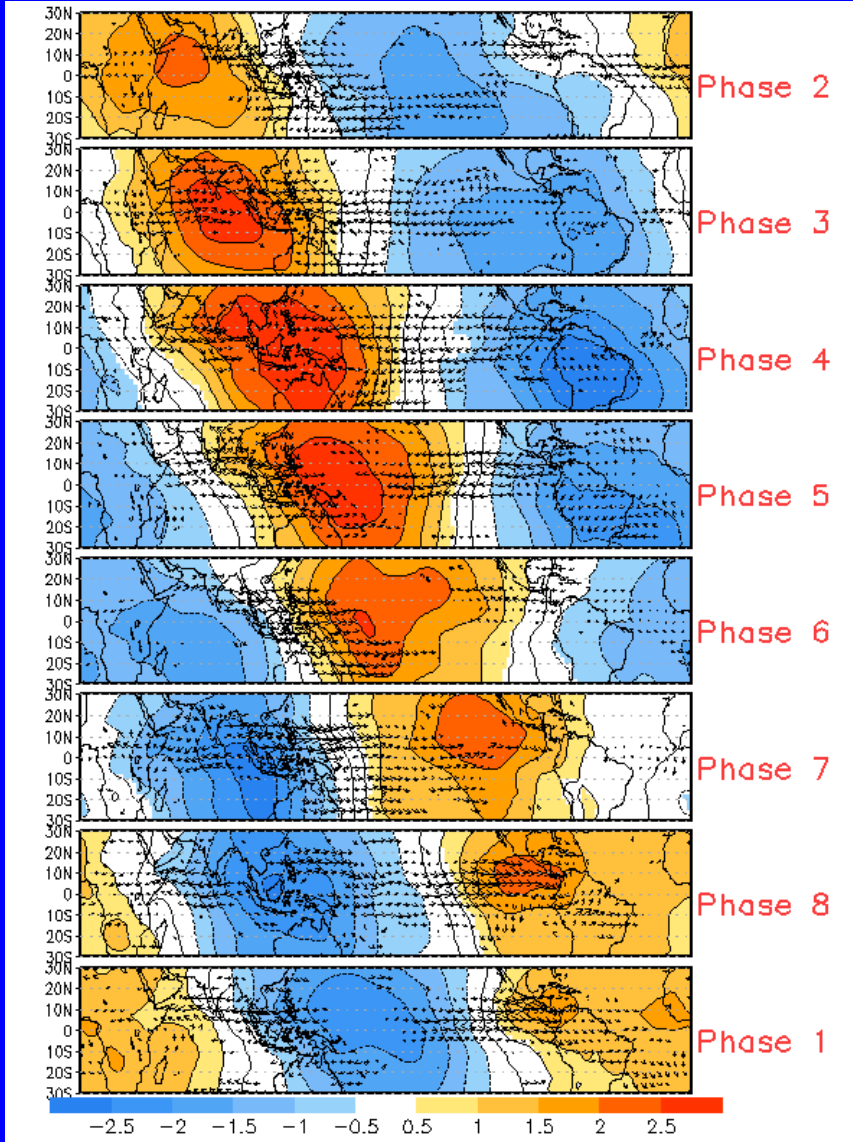




MJO Composites – Global Tropics

850-hPa Wind Anomalies (May-Sep)

Precipitation Anomalies (May-Sep)

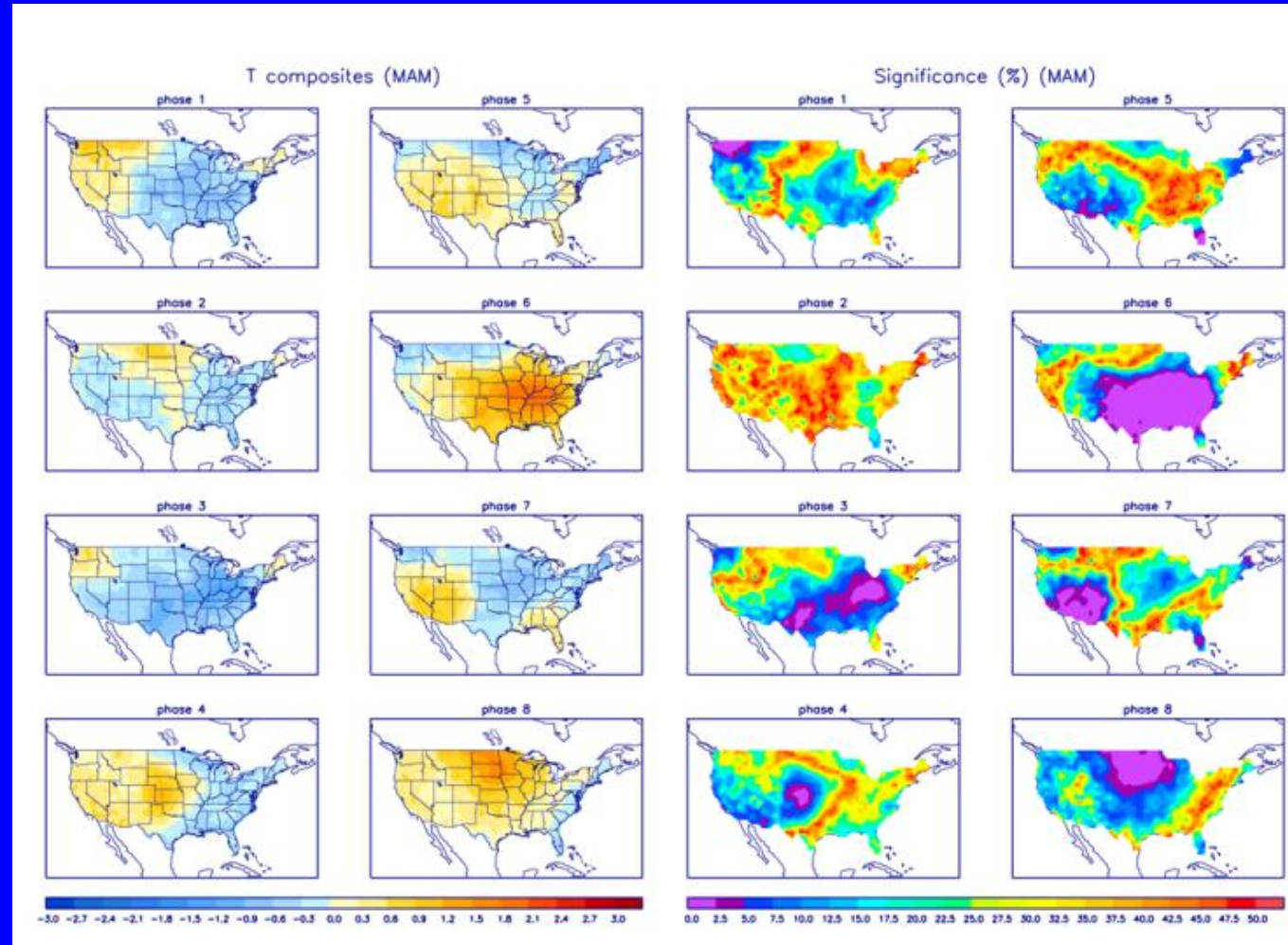




U.S. MJO Composites – Temperature

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.



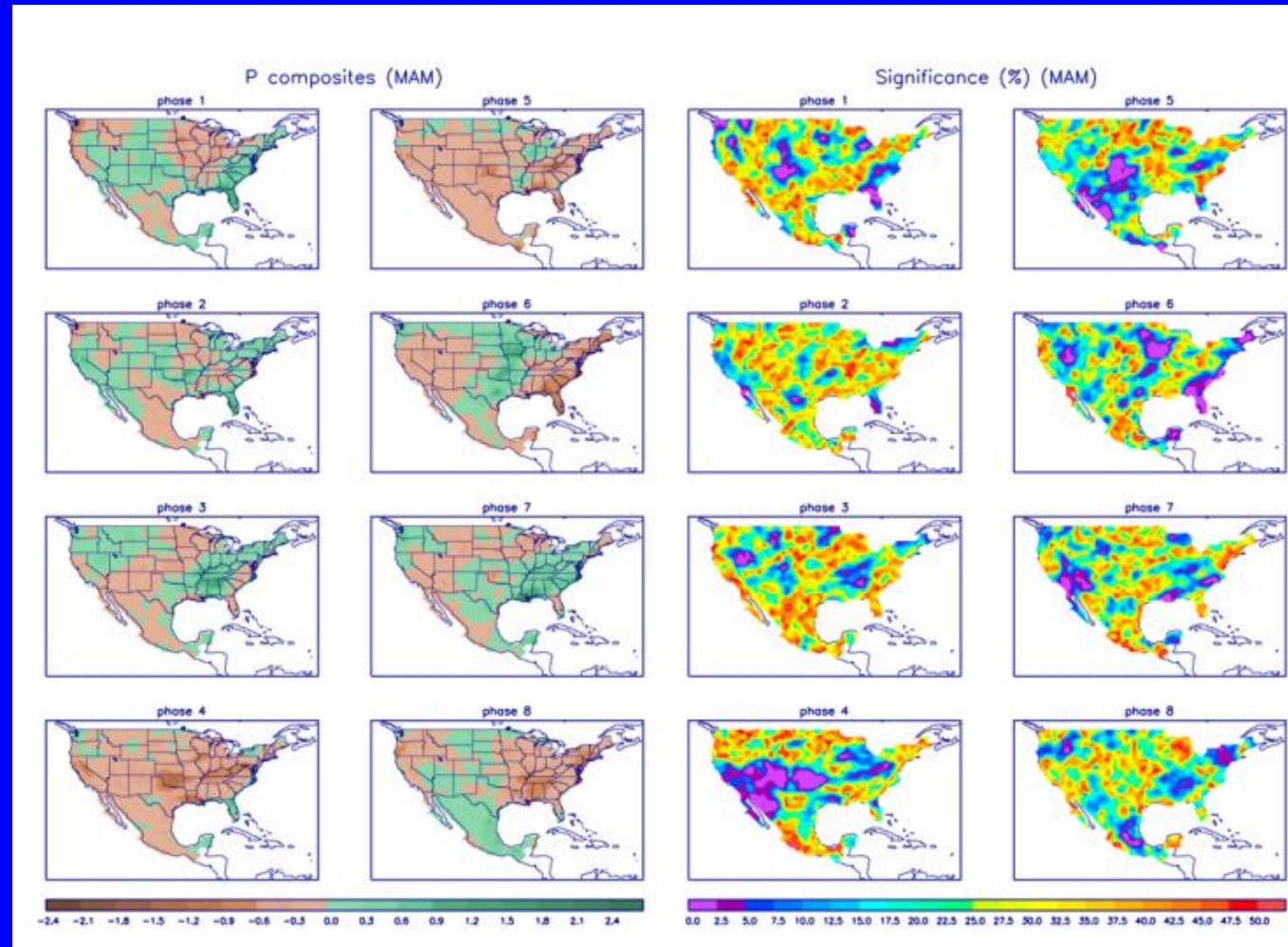
Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

<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.



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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