



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

**Update prepared by
Climate Prediction Center / NCEP
November 26, 2012**



Outline

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



Overview

- **The MJO remained weak during the past week as many observational indicators remain largely incoherent. The enhanced phase of any signal is most likely located across the Pacific.**
- **Most of the dynamical model MJO index forecasts continue to indicate little, if any, coherent MJO signal during the next two weeks.**
- **Based on the latest observations and model MJO index forecasts, the MJO is forecast to remain generally weak during the next 1-2 weeks. An equatorial Rossby wave currently in the western Pacific is likely to continue to impact anomalous tropical convection in the eastern hemisphere during much of the period.**
- **The MJO may contribute to suppressed (enhanced) convection in the eastern Indian Ocean and Maritime Continent (parts of the western and central Pacific) during parts of the period.**

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

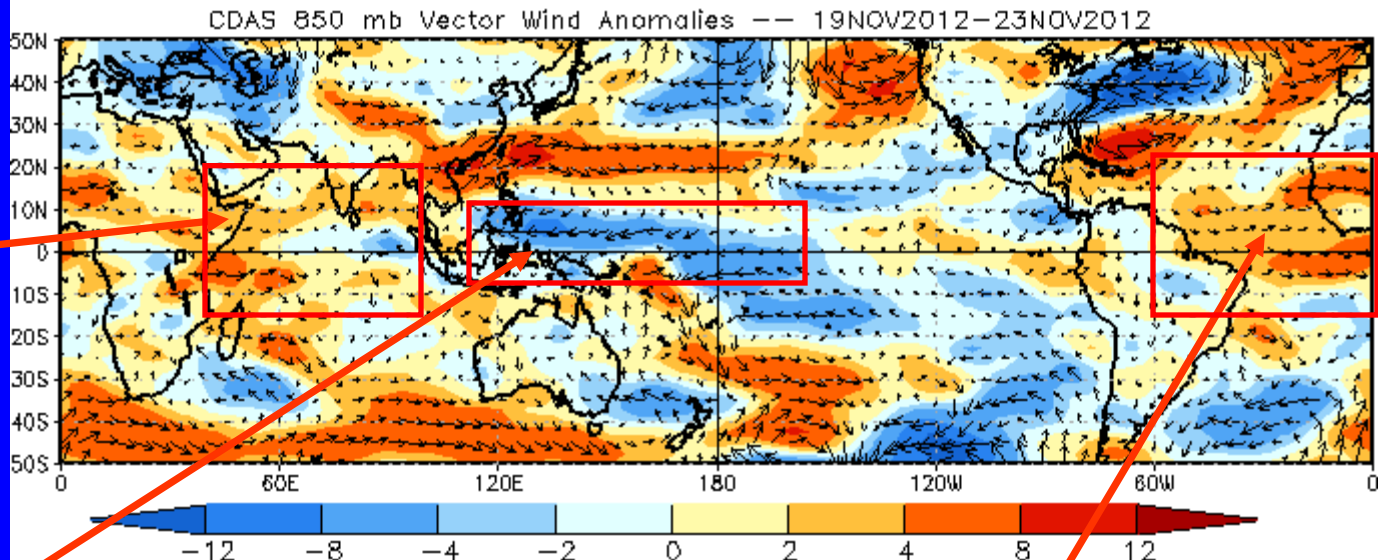
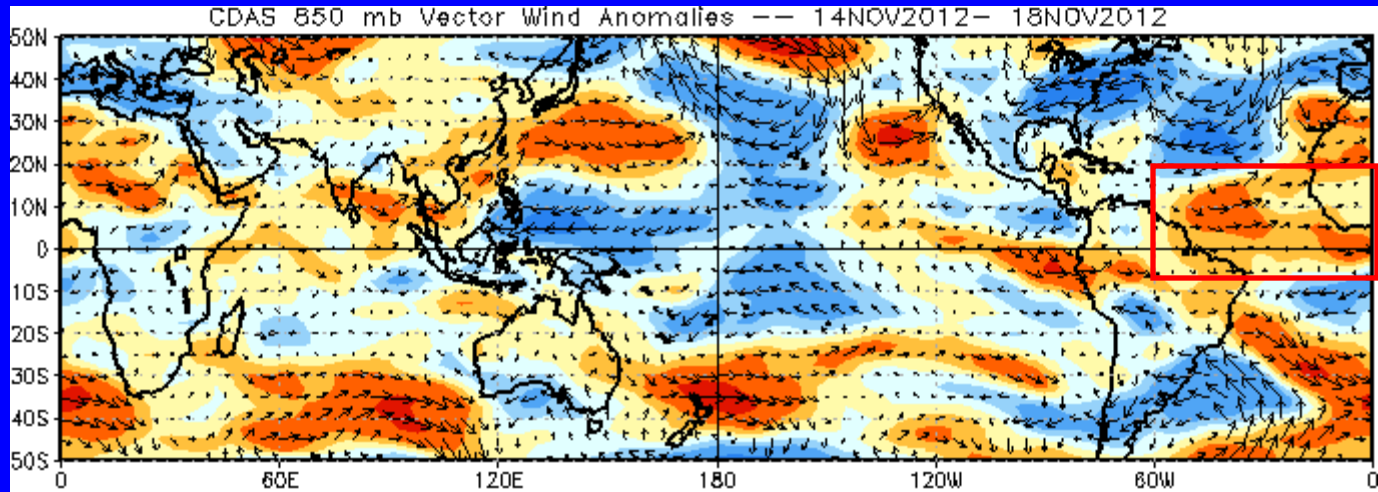


850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly anomalies have persisted over the Indian Ocean during the past five days.

Coverage of easterly anomalies remains similar to the previous five day period over the western Pacific.

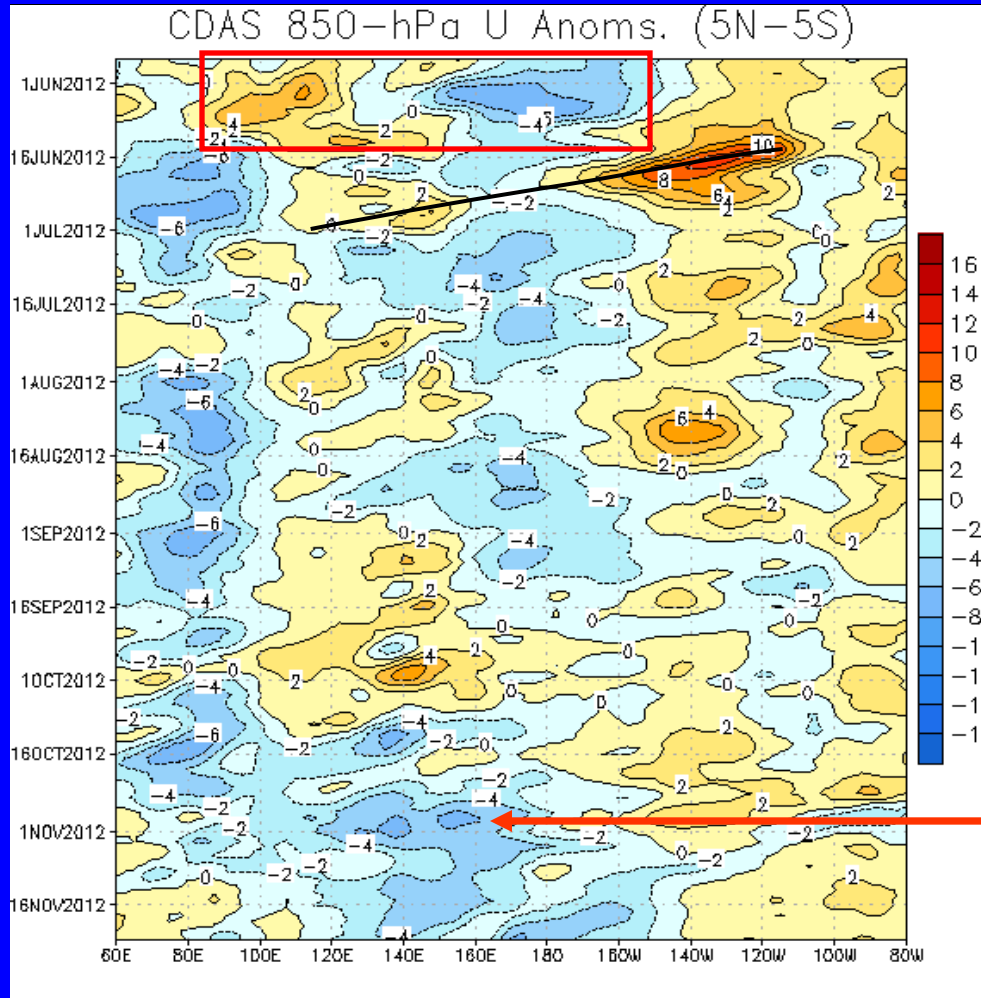
Westerly anomalies continued over the tropical Atlantic during the past five days.



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

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.

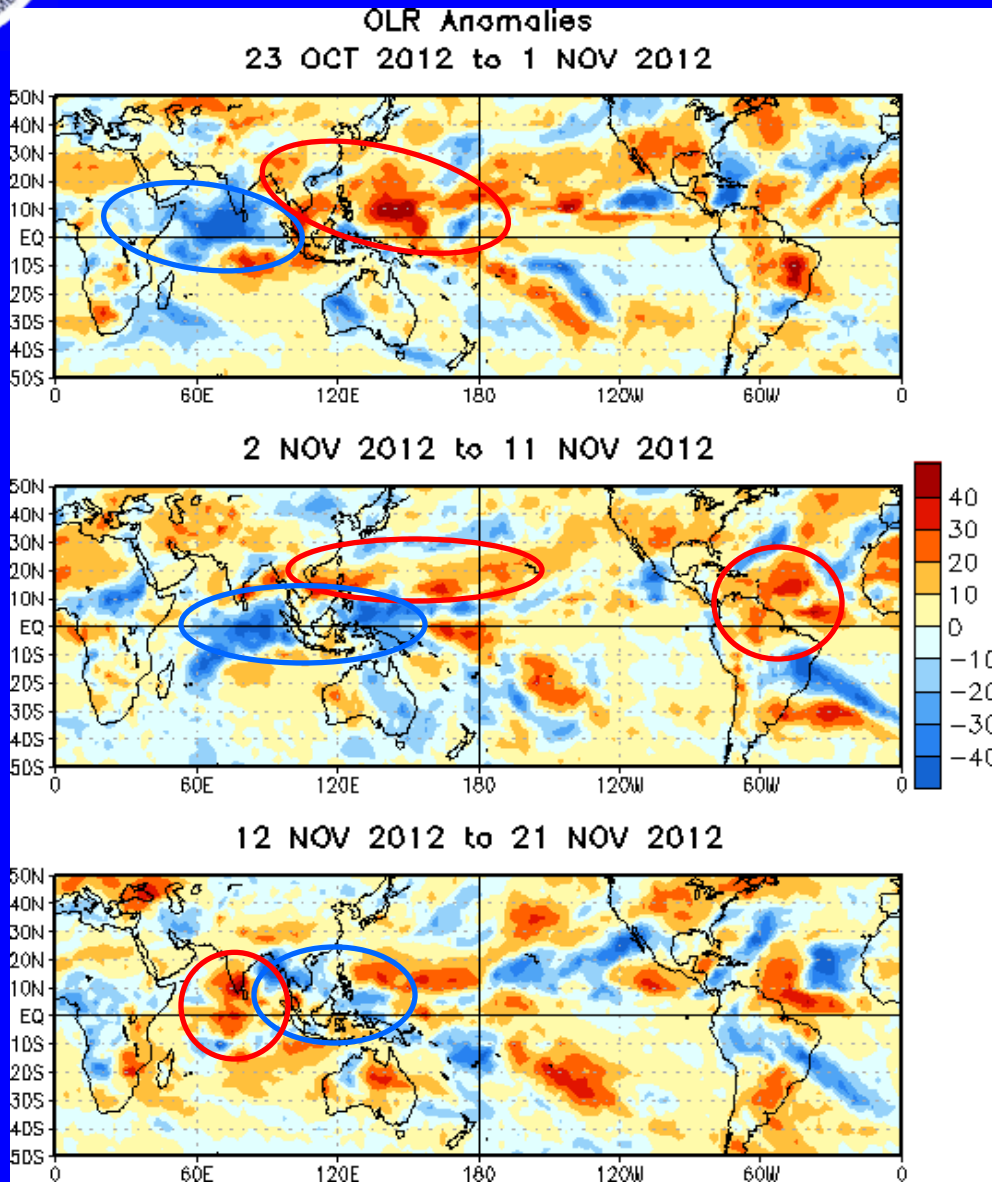
During September, westerly anomalies developed near 140E and persisted into October.

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 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.

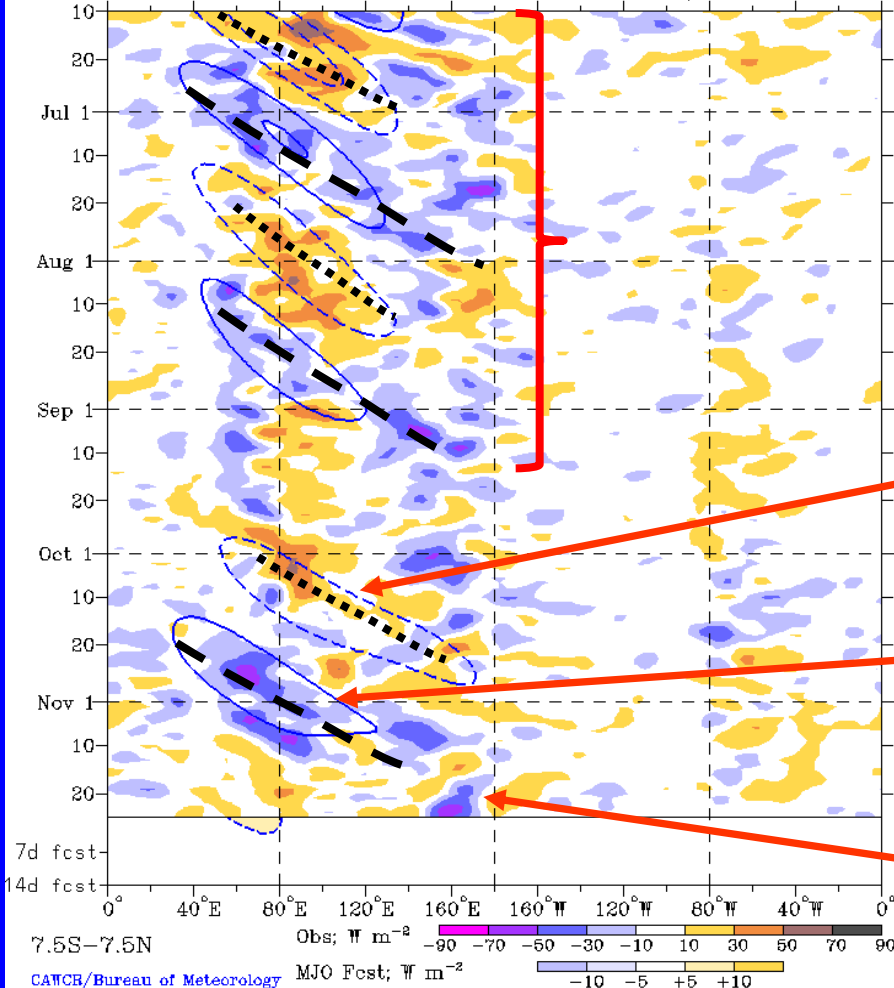
Entering early- to mid-November, suppressed convection shifted north across the western Pacific and strengthened over northern South America. Enhanced convection shifted east into the western Pacific.

In mid-November, some weakly enhanced convection remained over the Maritime continent and western Pacific, while suppressed convection developed in the central 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
10-Jun-2012 to 25-Nov-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)

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.

A weak suppressed phase moved into the Indian Ocean, but convection decreased as it crossed the Maritime Continent. The recent convection near 160°E is due, at least in part, to a strong equatorial Rossby wave.

Time
↓

Longitude



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

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

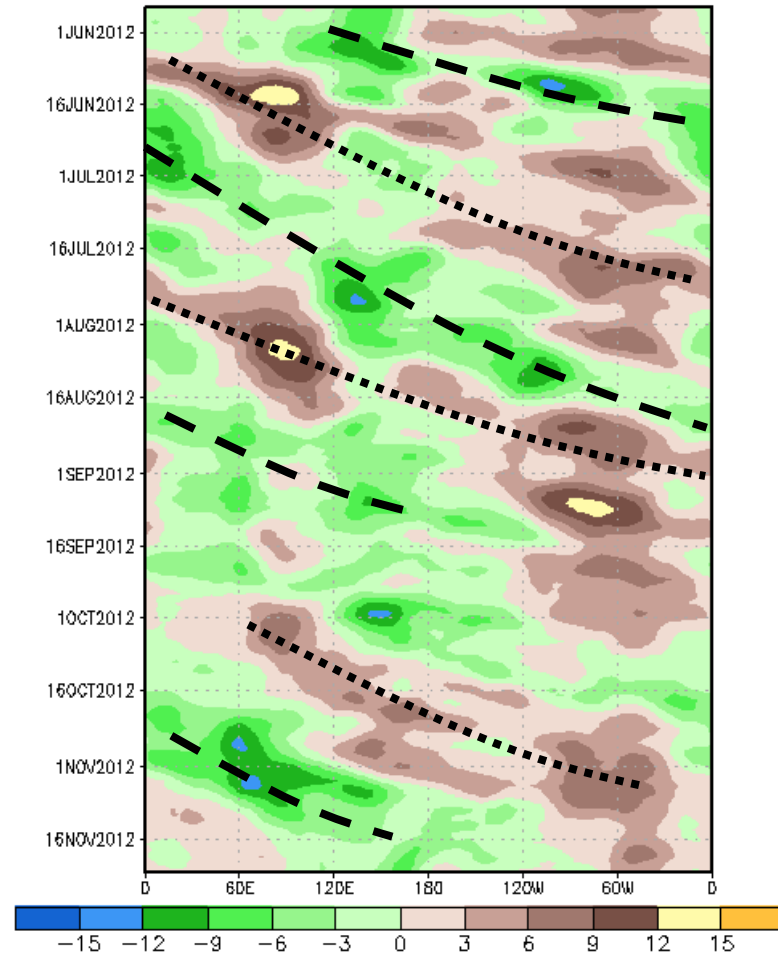
Negative anomalies (green shading) indicate favorable conditions for precipitation

Time



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

5-day Running Mean



Longitude

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.

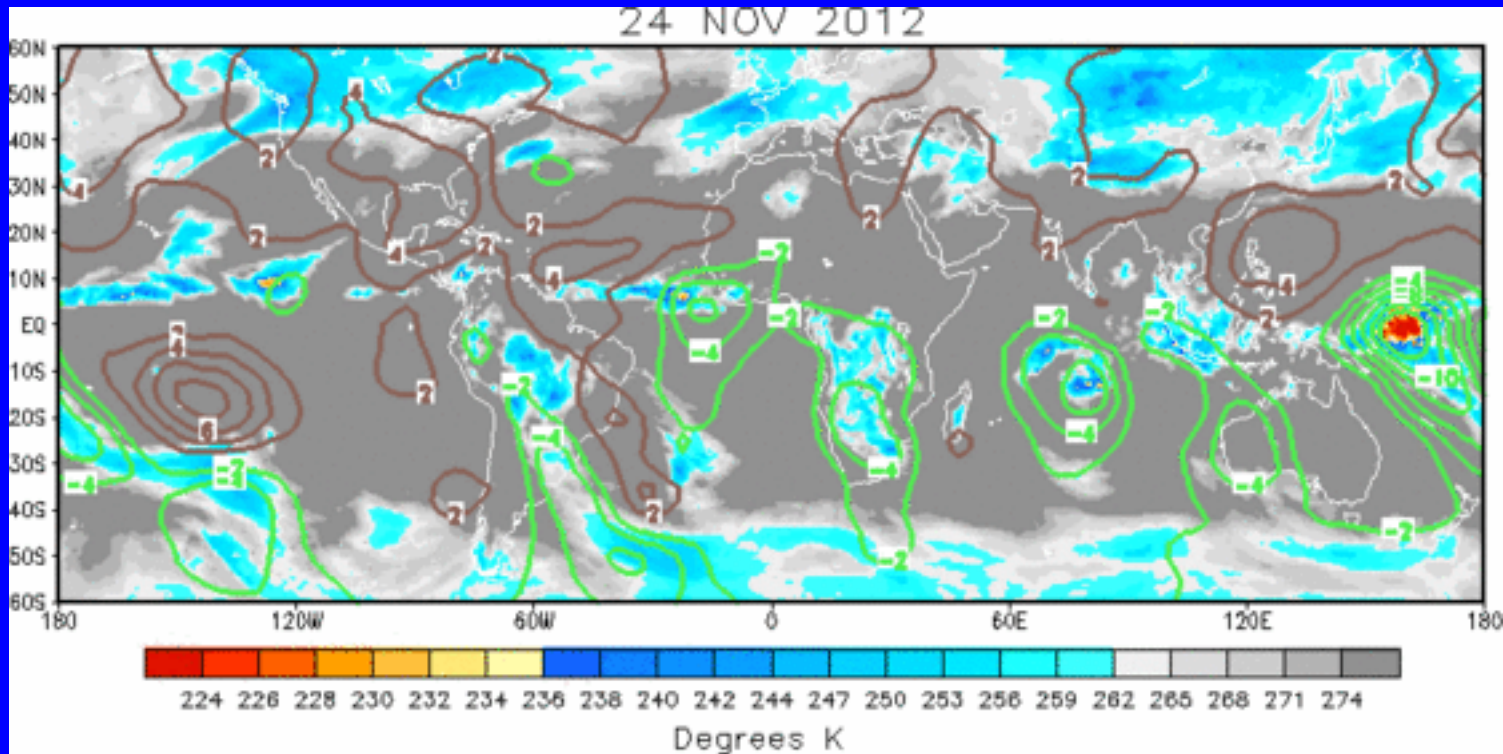
In early October, upper-level divergence (convergence) increased over the Pacific (Indian Ocean) and has shifted eastward throughout October and early November. Anomalies have decreased in recent days.



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, showing strong upper-level divergence across the western equatorial Pacific largely associated with an equatorial Rossby wave and weak anomalous upper-level convergence over parts of the Americas and the Atlantic.

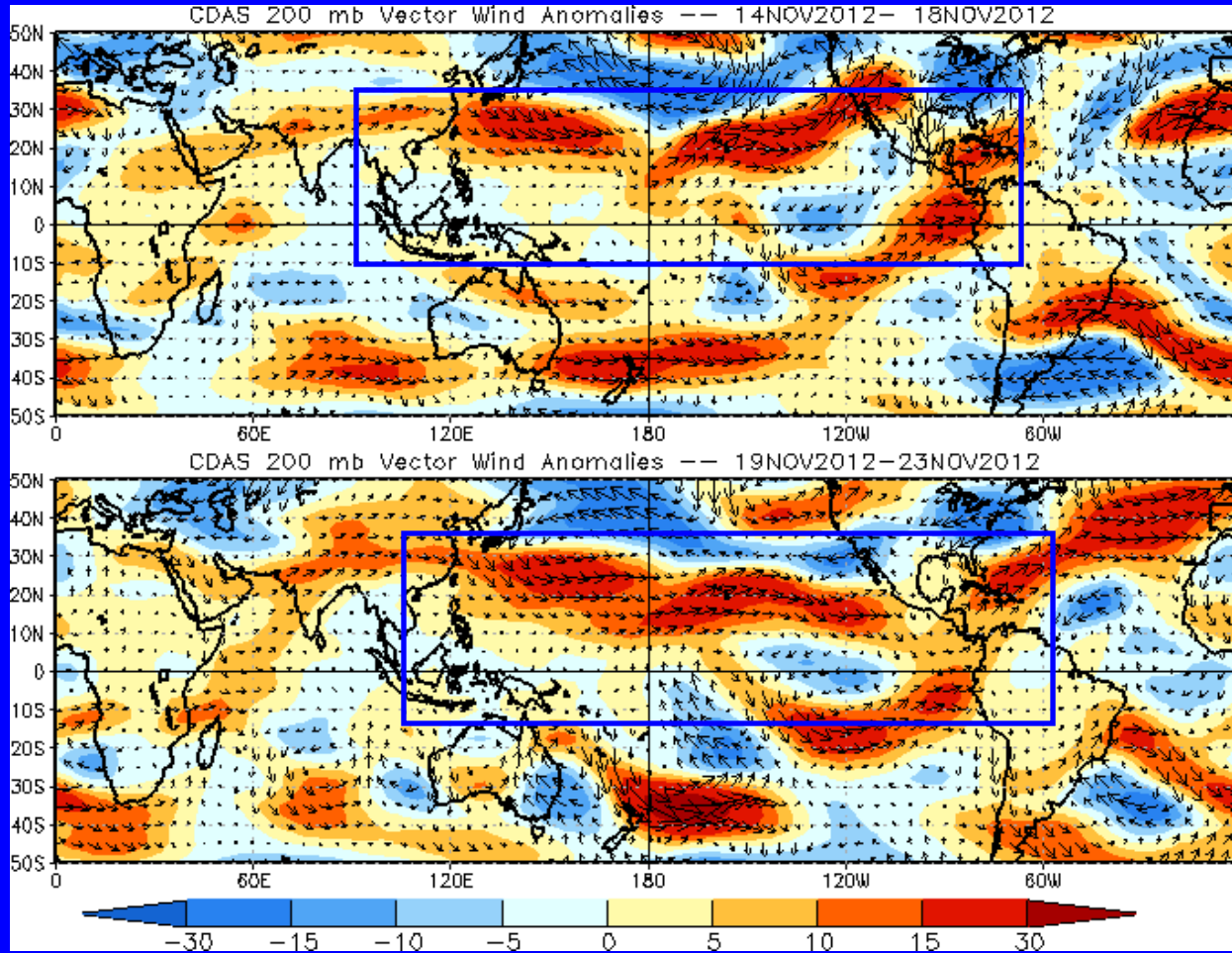


200-hPa Vector Wind Anomalies ($m s^{-1}$)

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



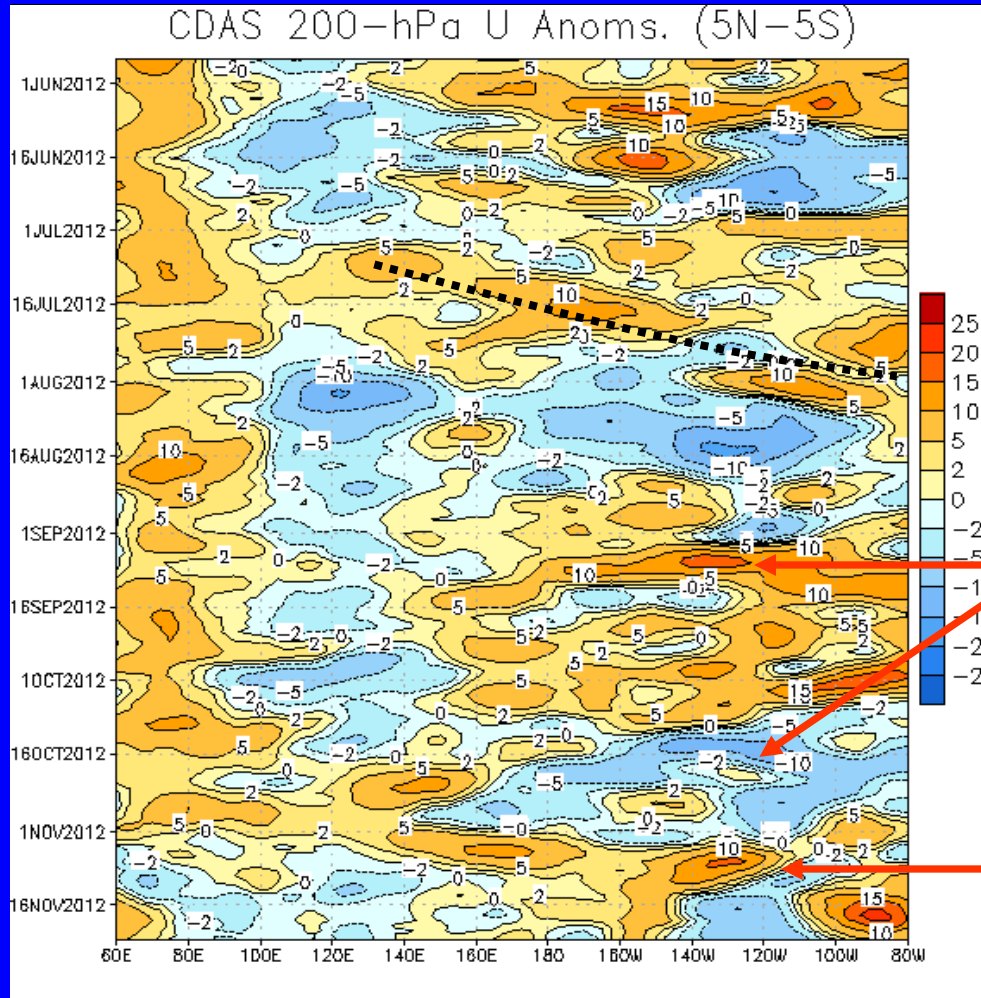
Westerly anomalies (blue boxes) have been generally persistent over the tropical and sub-tropical Pacific into the Americas during the last five to ten days.



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



Anomalies were not very coherent during late May and June.

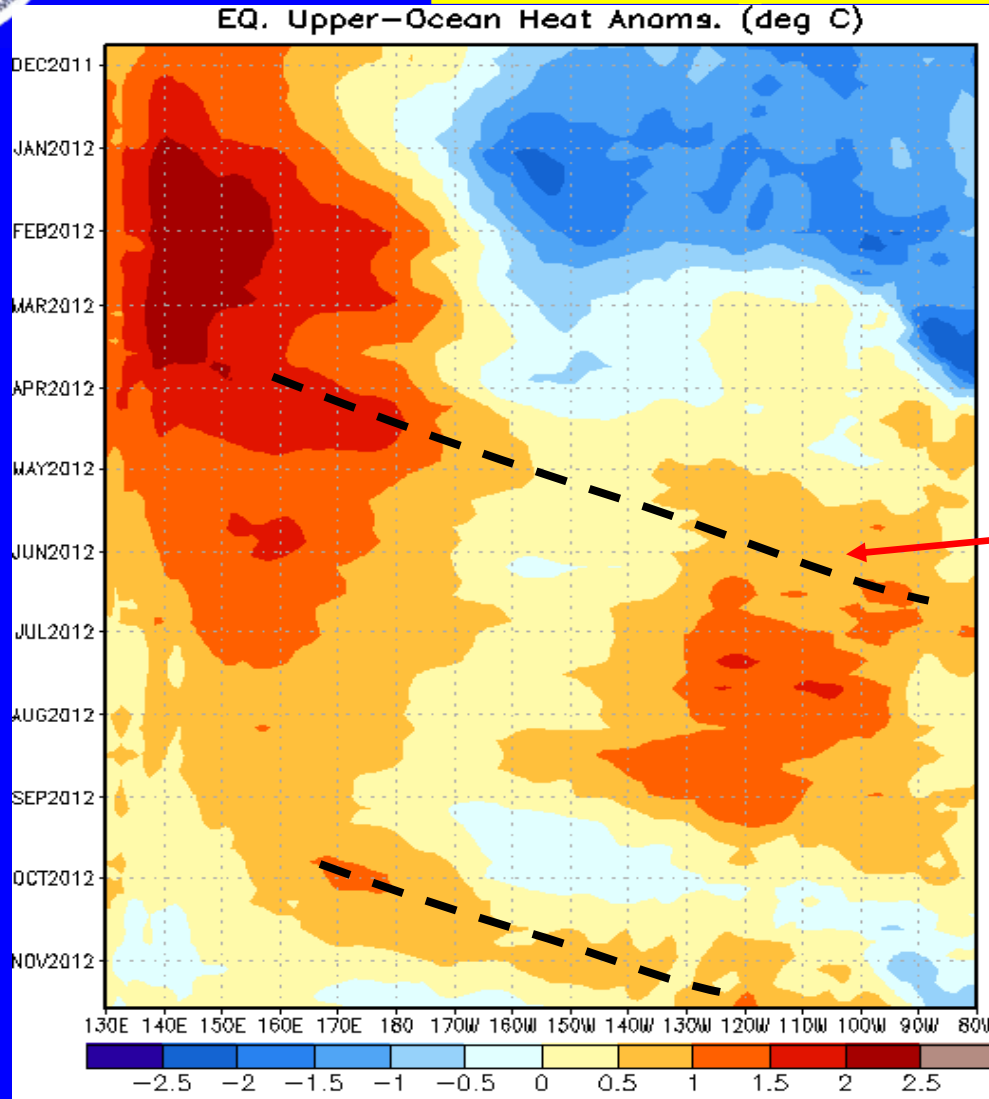
Westerly anomalies shifted eastward across the Pacific during July and early August.

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 shifted east to the eastern Pacific in early November, but have recently weakened and, in some places, been replaced by easterly anomalies.



Weekly Heat Content Evolution in the Equatorial Pacific



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.

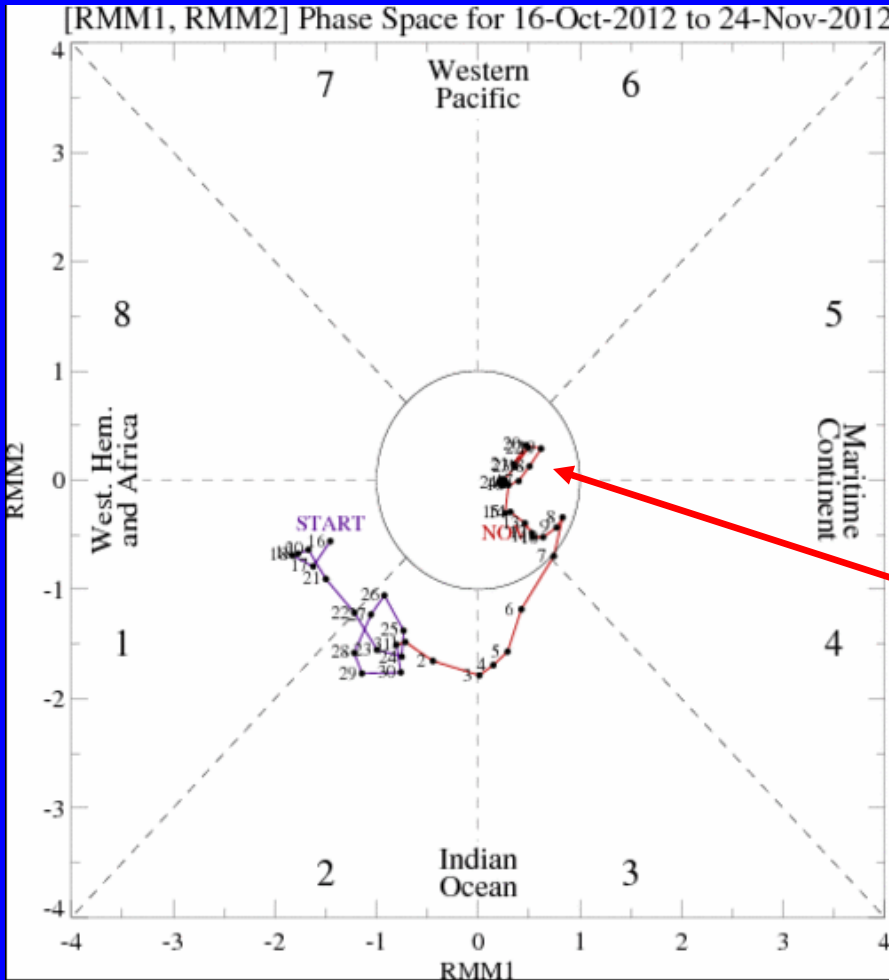
- The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.

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

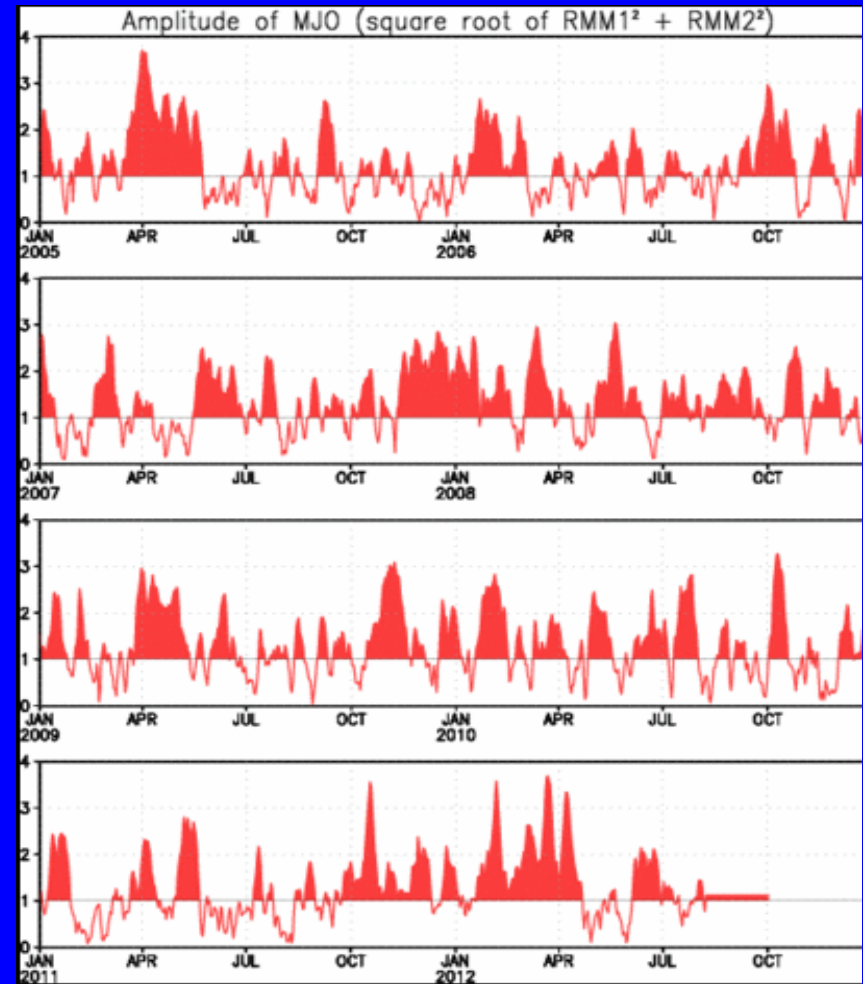
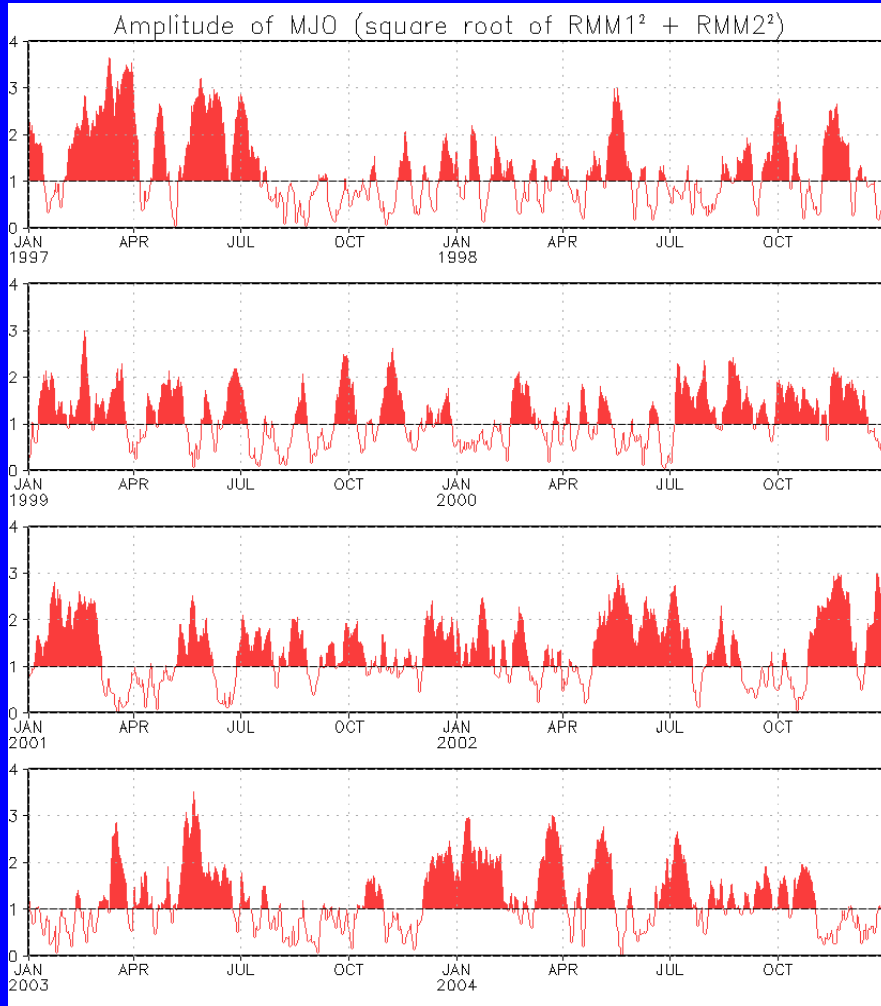


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The amplitude of the MJO index remains weak 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.



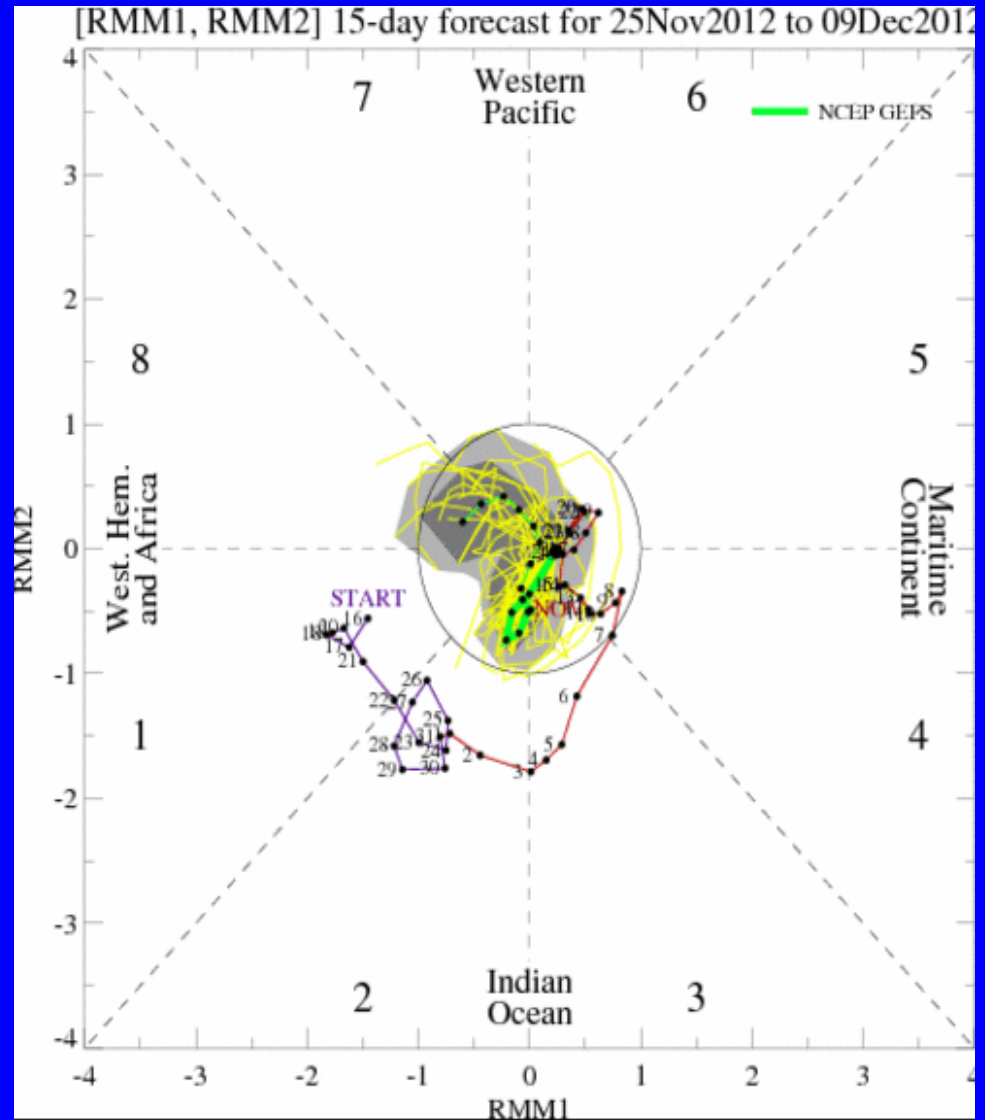
Ensemble GFS (GEFS) MJO Forecast

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 bias-corrected ensemble GFS continues to forecast a weak signal during the period.



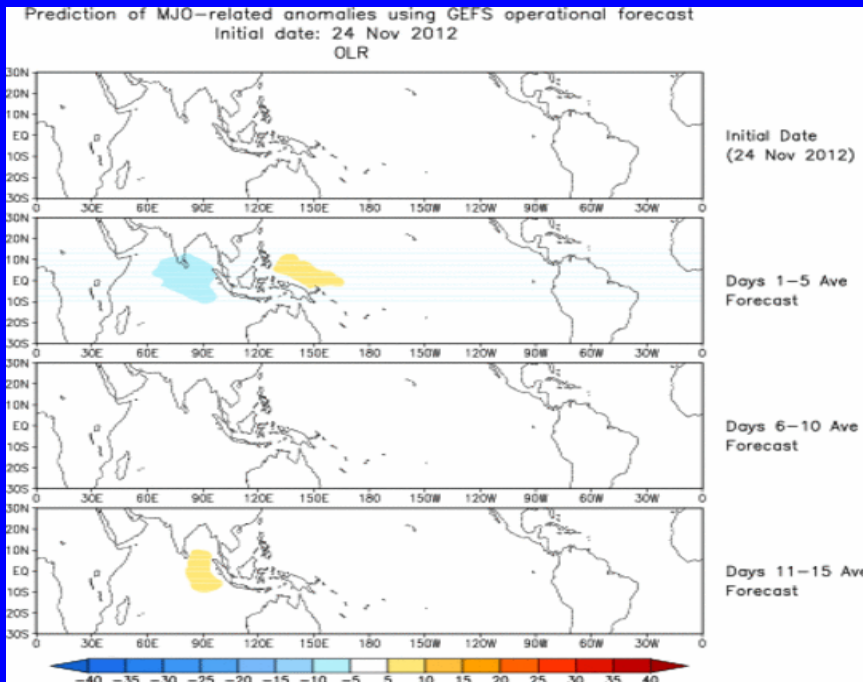


Ensemble Mean GFS MJO Forecast

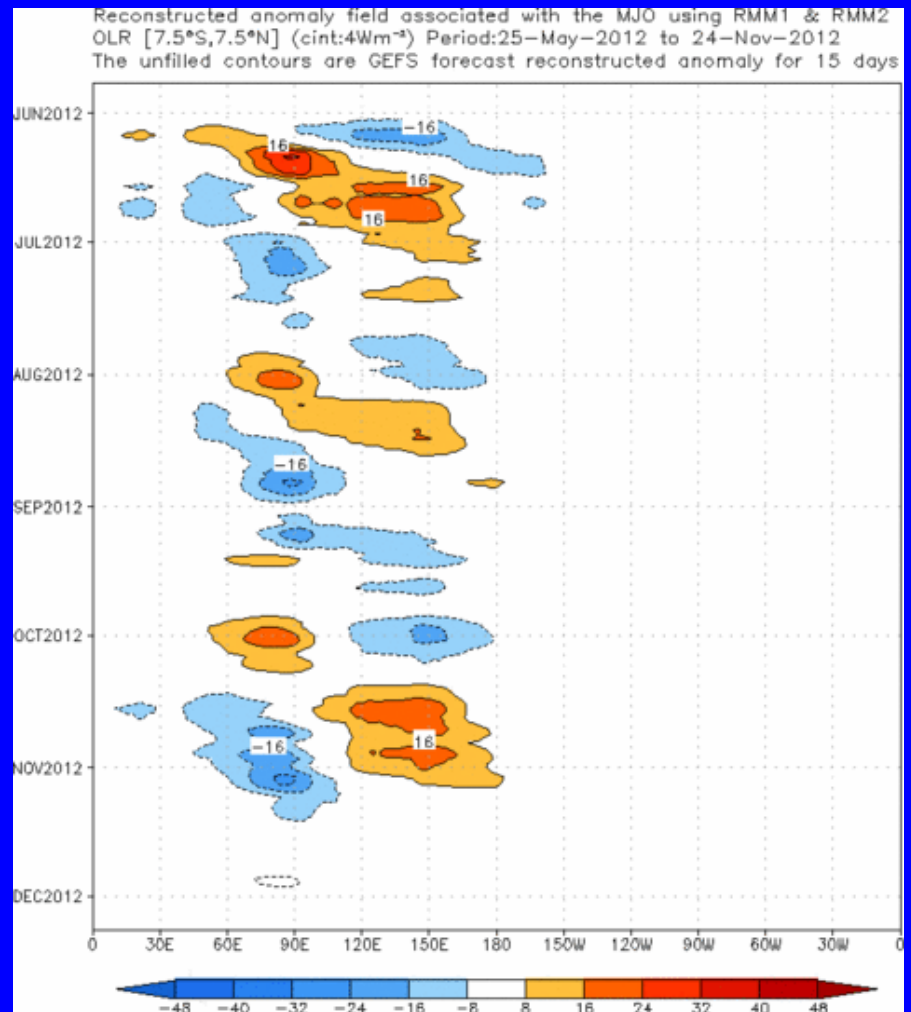
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Spatial map of OLR anomalies for the next 15 days

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 little or no anomalous convection during the next two weeks.



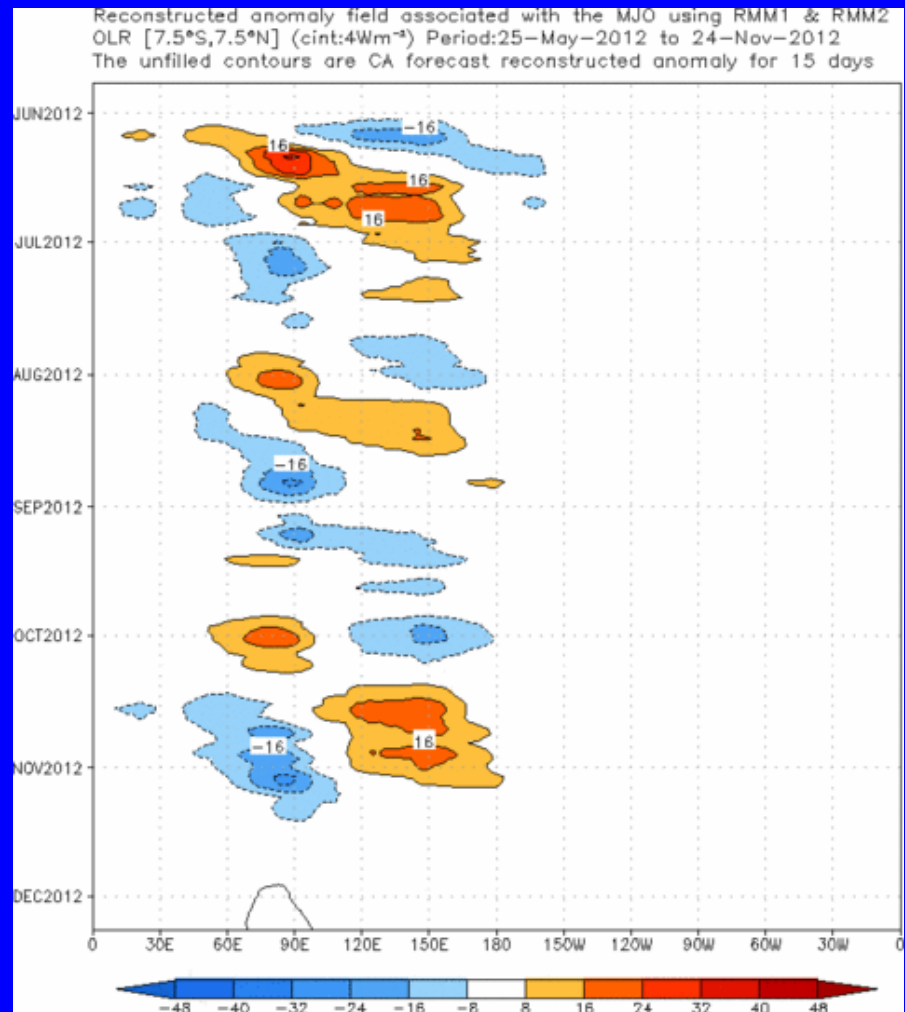
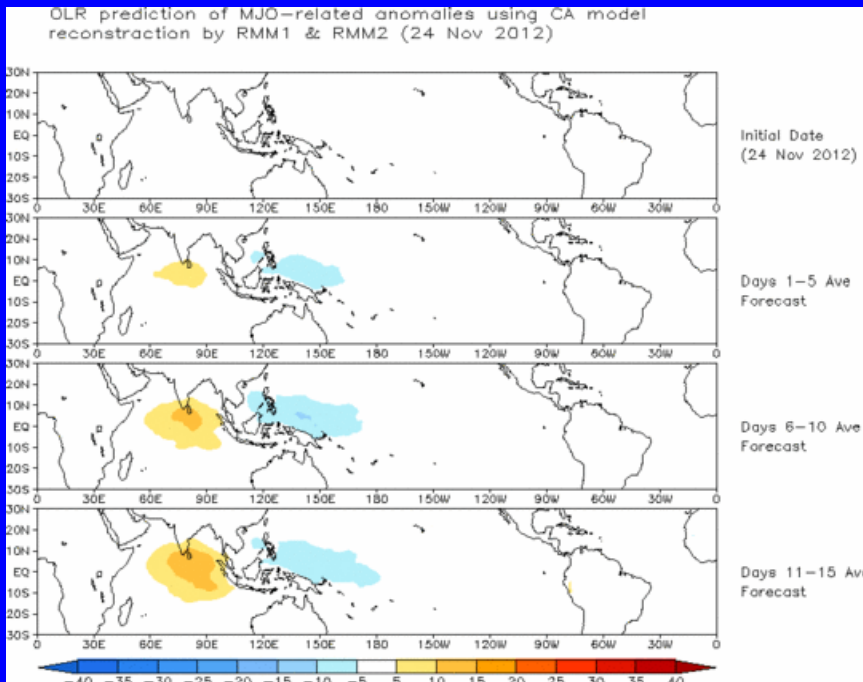


Constructed Analog (CA) MJO Forecast

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



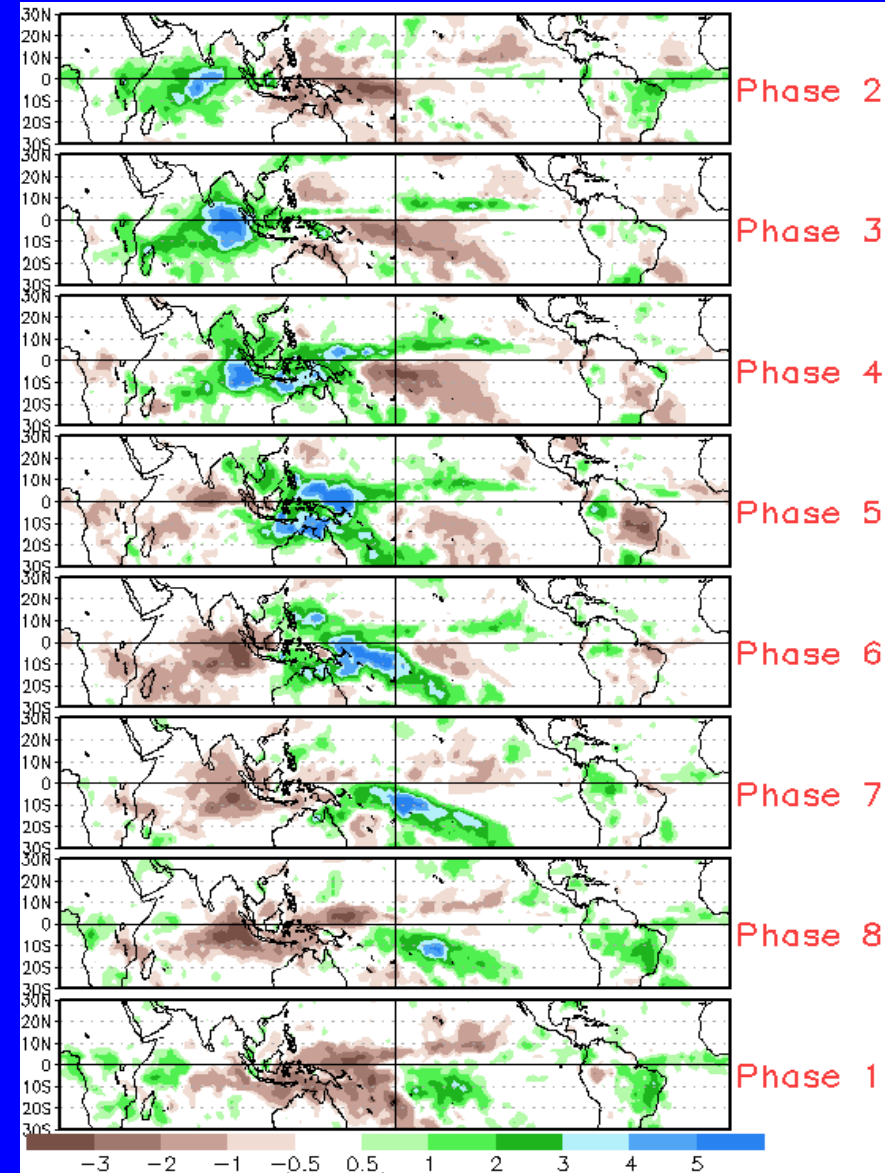
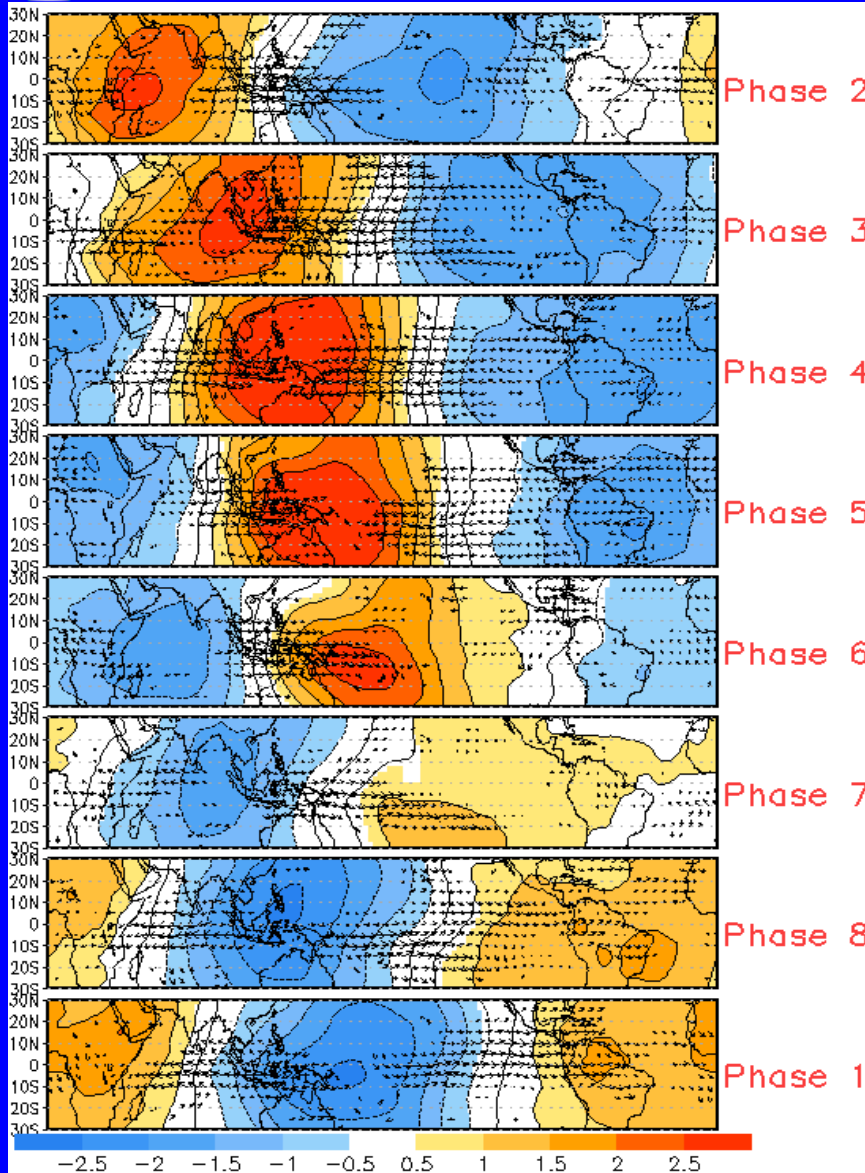
This forecast also indicates on minor anomalous convection during Week-1, but some enhanced (suppressed) convection across the Maritime Continent and western Pacific (Indian Ocean) during Week-2.



MJO Composites – Global Tropics

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

Precipitation Anomalies (Nov-Mar)

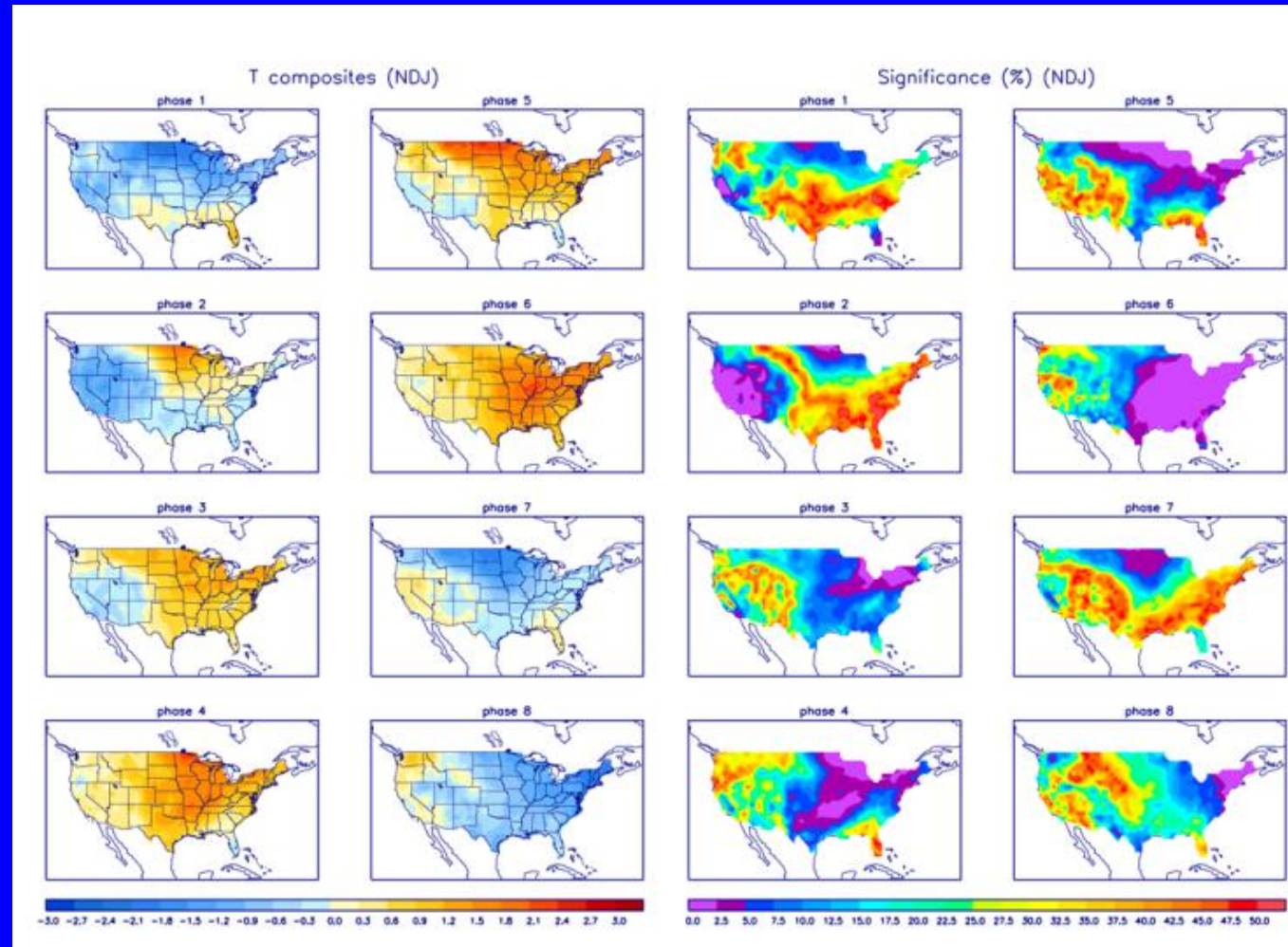




U.S. MJO Composites – Temperature

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.



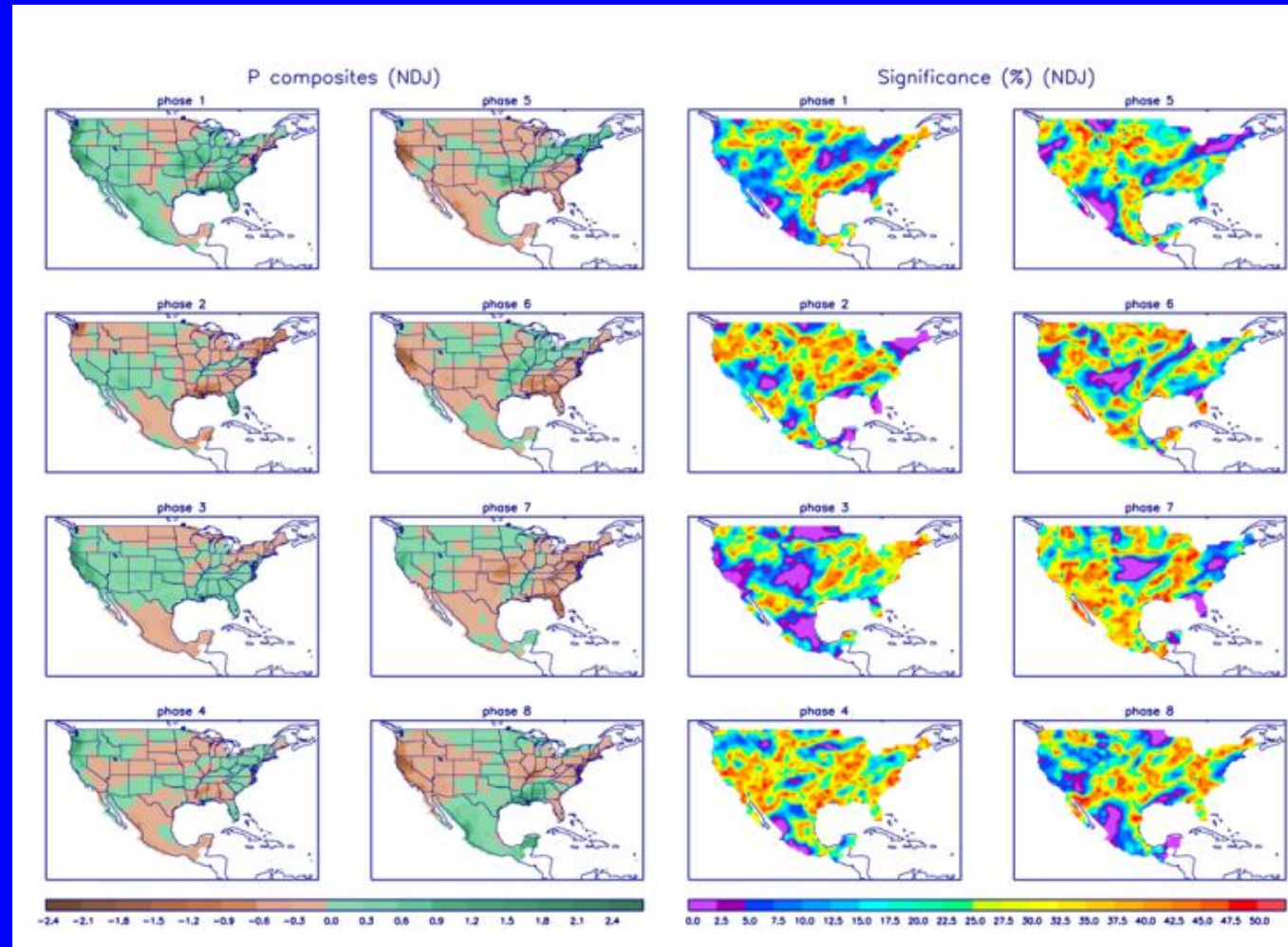
Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

<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.



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>