



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

**Update prepared by
Climate Prediction Center / NCEP
November 5, 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 across the eastern Indian Ocean.**
- **There is considerable spread among the dynamical model MJO index forecasts with some continuing to indicate forecasts for a weakening signal that has yet to occur. Some models indicate continued eastward propagation. MJO index forecasts are likely struggling with the representation of other subseasonal tropical variability and we favor a continuation of MJO activity.**
- **Based on the latest observations and some model MJO index forecasts, the MJO is forecast to remain active during the next 1-2 weeks with the enhanced phase shifting east across the Maritime Continent to the west Pacific.**
- **The MJO is expected to contribute to enhanced rainfall across the Maritime continent (Weeks 1-2) and west Pacific (Week-2). Suppressed rainfall is expected across northern South America during the next 2 weeks. The MJO favors tropical cyclone activity in the south Indian Ocean during Week-1.**
- **Warmer than average temperatures for portions of the eastern and central U.S. forecast during Week-2 are consistent with upcoming MJO phases.**

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

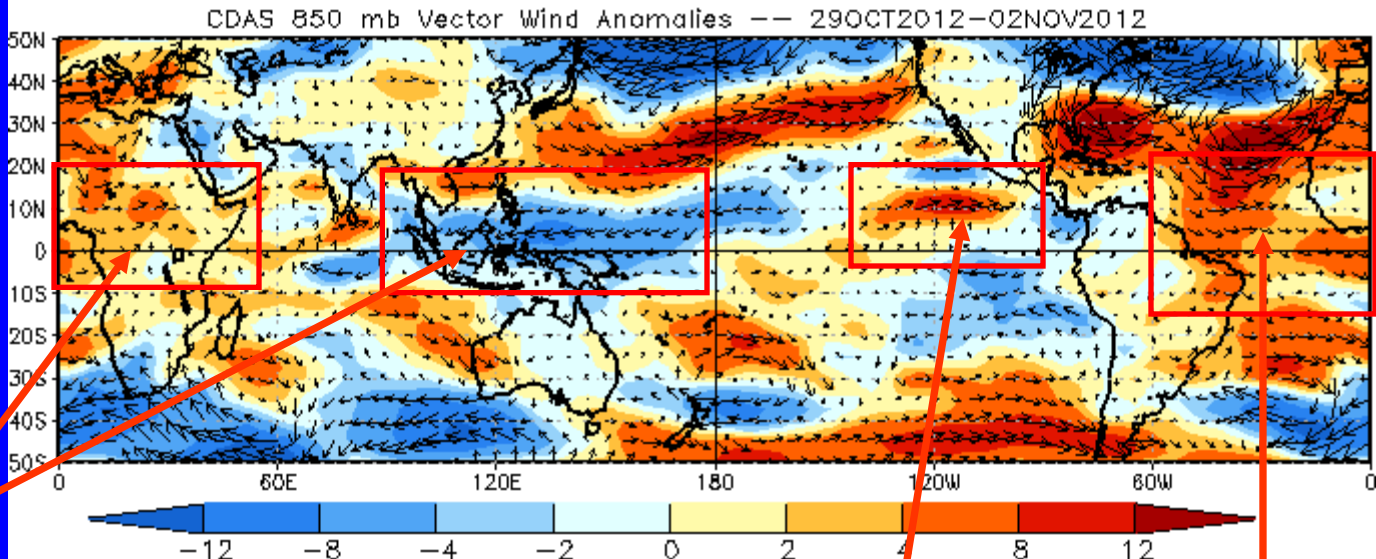
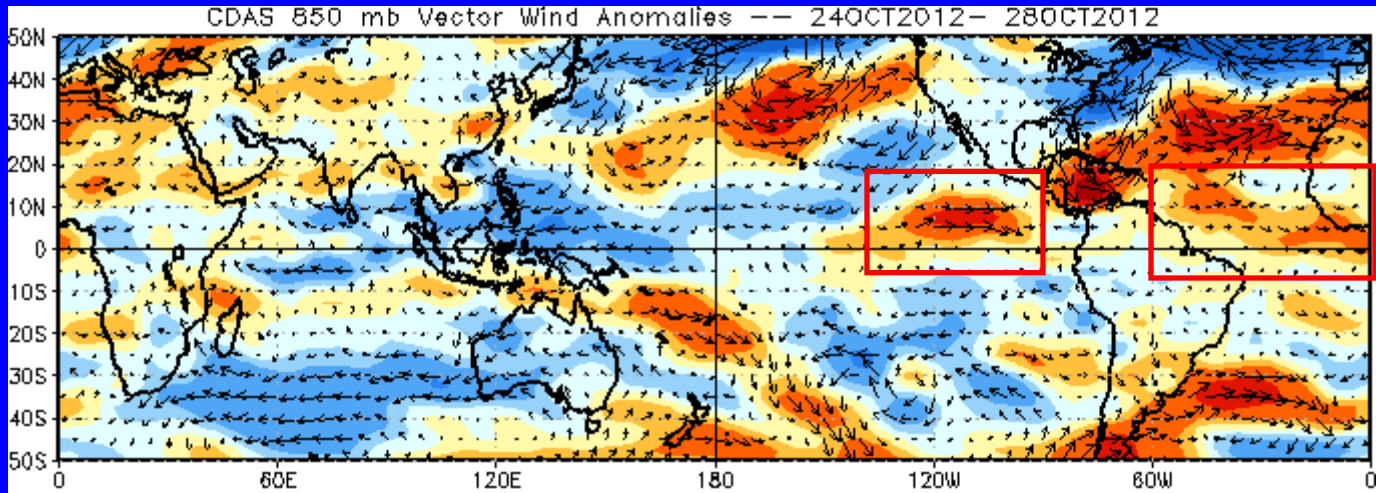


850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly anomalies developed across equatorial Africa, while easterly anomalies persisted across the Maritime during the past five days.

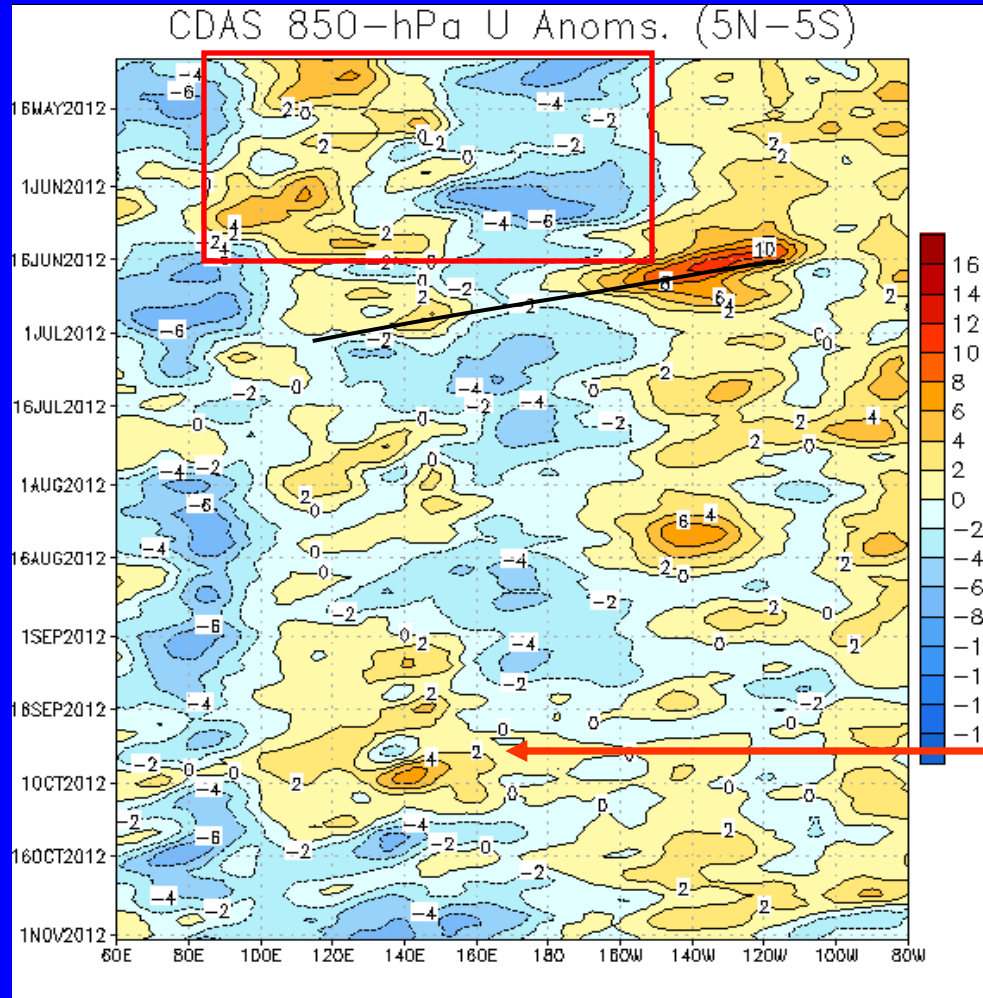
Westerly anomalies persisted over the east Pacific and tropical Atlantic during the past ten days.



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



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.

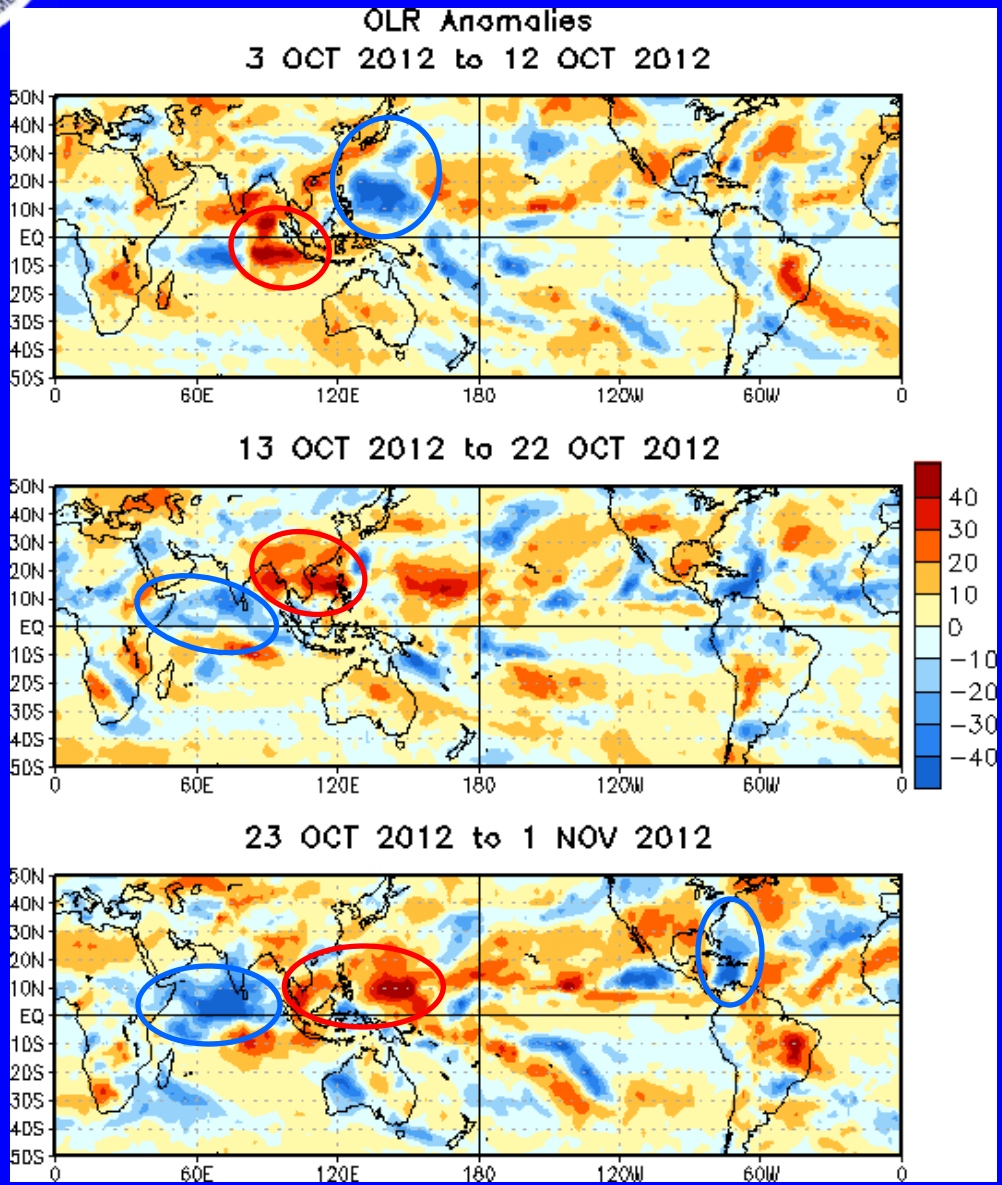
Easterly anomalies persisted near 80E for much of August and September.

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.



OLR Anomalies – Past 30 days

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



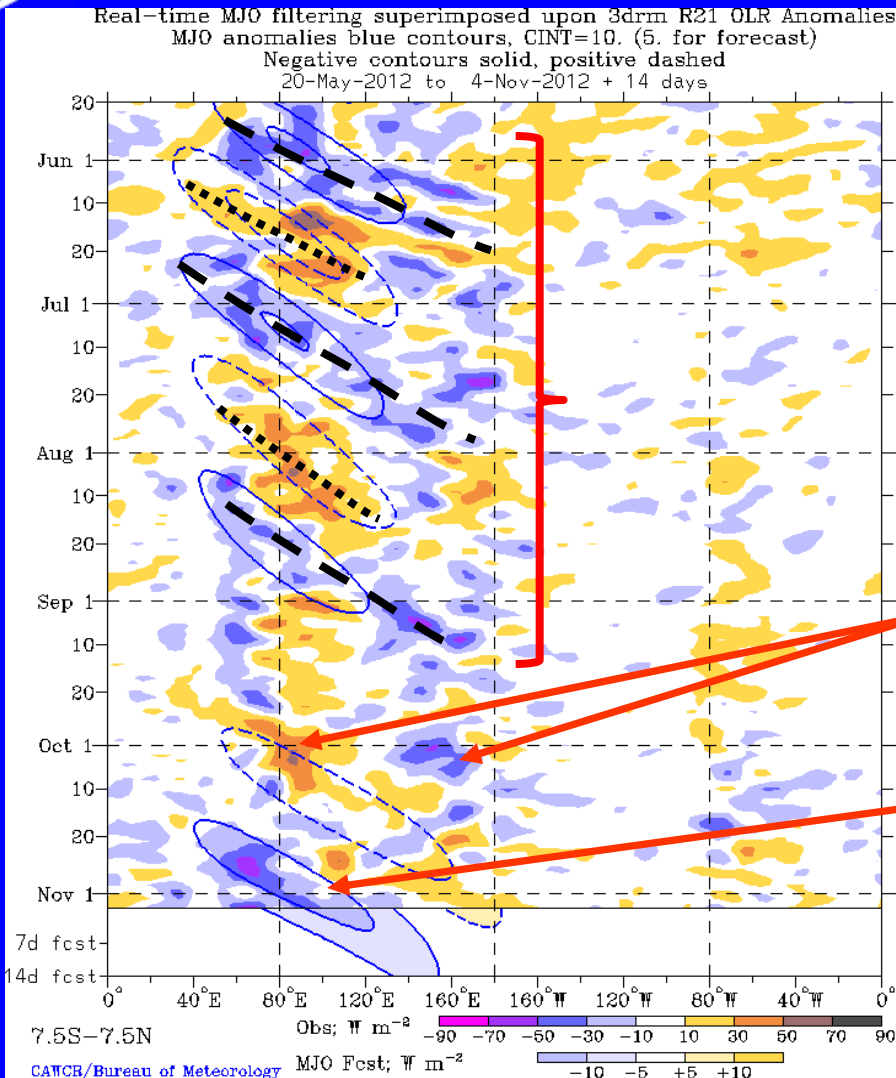
Enhanced convection continued across the western Pacific during early October, mainly associated with tropical cyclone activity. Suppressed convection continued across the eastern equatorial Indian Ocean.

During mid October, drier-than-average conditions shifted northeast from the Indian Ocean with wetter conditions developing in this region.

During late October, suppressed convection expanded across the western Pacific with enhanced convection observed across the Indian Ocean. The track of Hurricane Sandy is evident from the Caribbean Sea north to western Atlantic.



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)

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, a couplet of suppressed (enhanced) convection was observed in the Indian Ocean (western Pacific).

Most recently during mid-to-late October, enhanced convection initially developed across the Americas and Africa before shifting east across Africa and the Indian Ocean.

Longitude

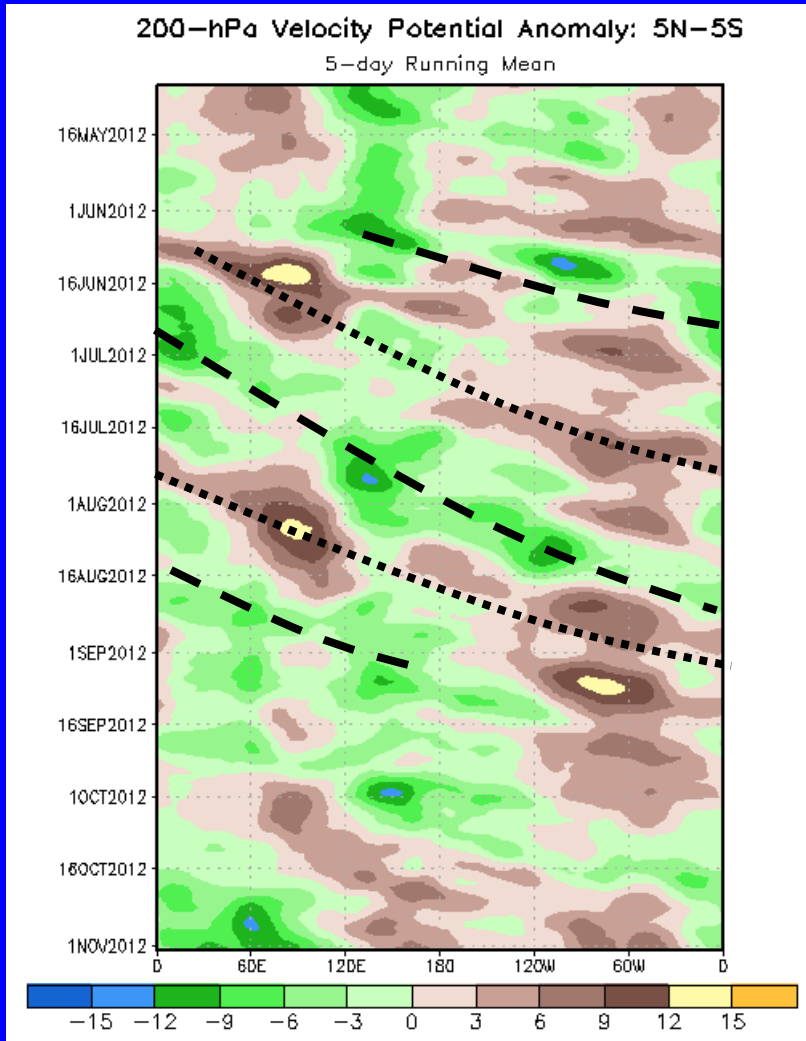


200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time
↓



Longitude

During May, anomalies were generally weak and not coherent as compared to earlier in the year.

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.

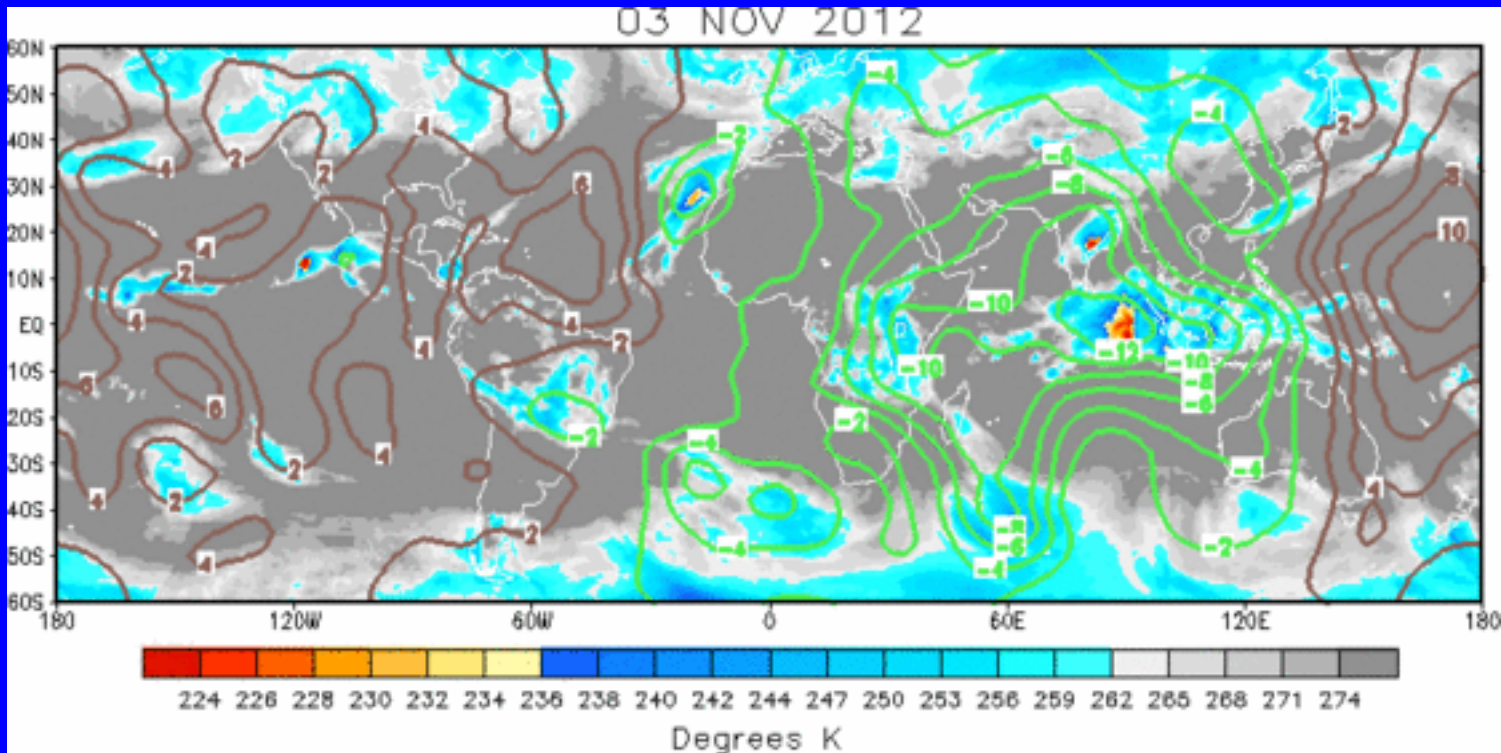
In early October, upper-level divergence (convergence) increased over the western Pacific (Indian Ocean) and has shifted eastward over the course of October.



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 remains reasonably coherent and shows anomalous upper-level divergence stretching from Africa to the Maritime Continent while anomalous upper-level convergence is evident across the central/eastern Pacific and western Atlantic.

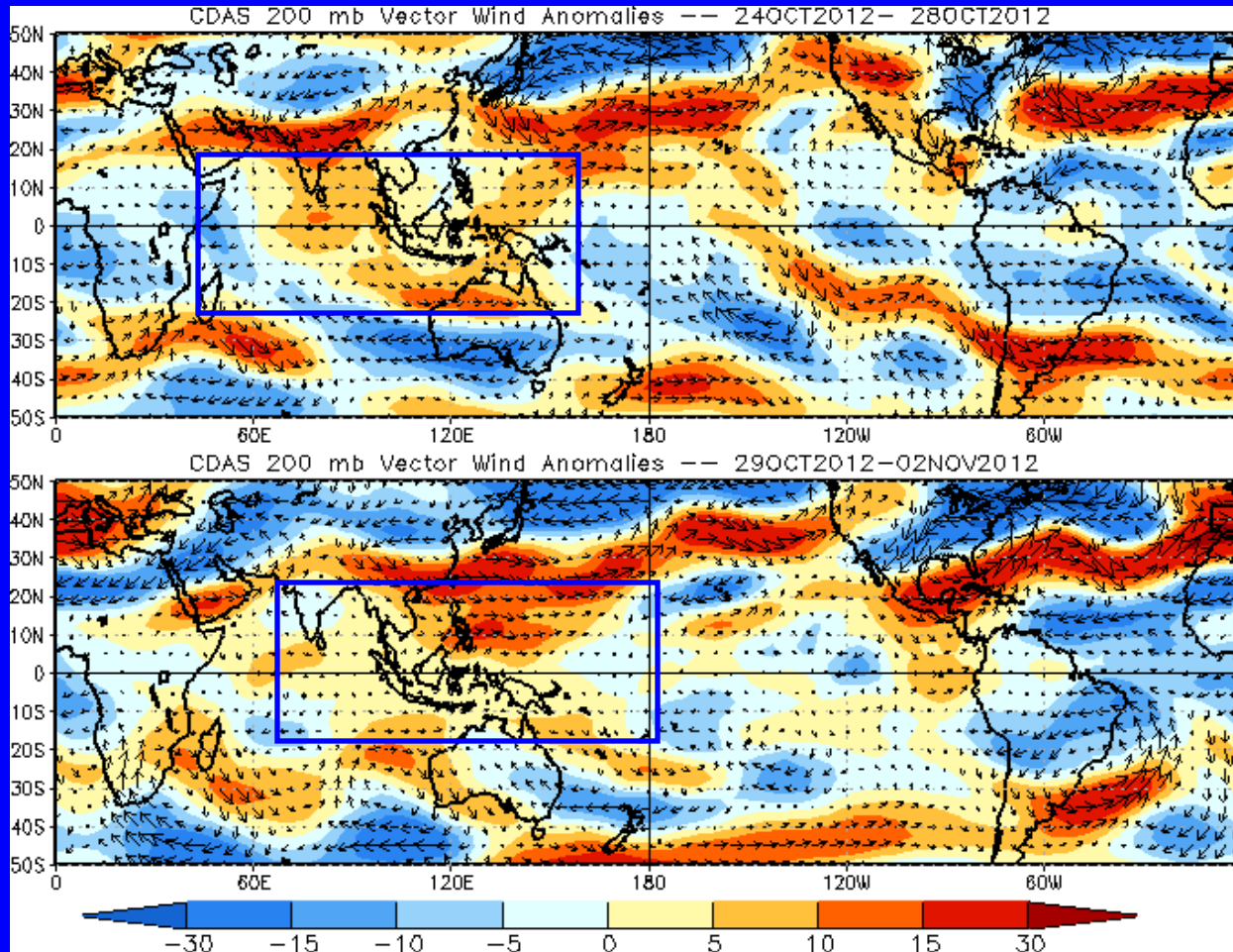


200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



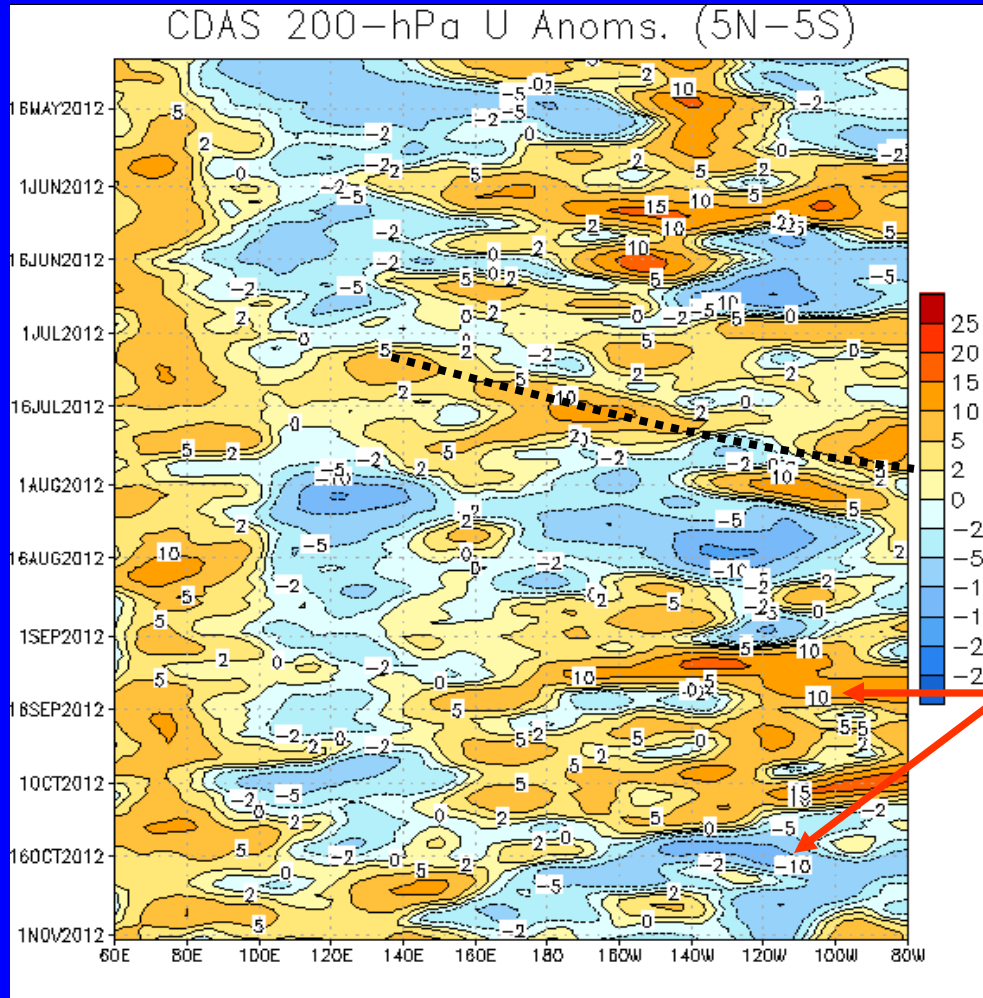
Westerly anomalies (blue boxes) have shifted slightly eastward during the last five days and are now centered across the Maritime continent.



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

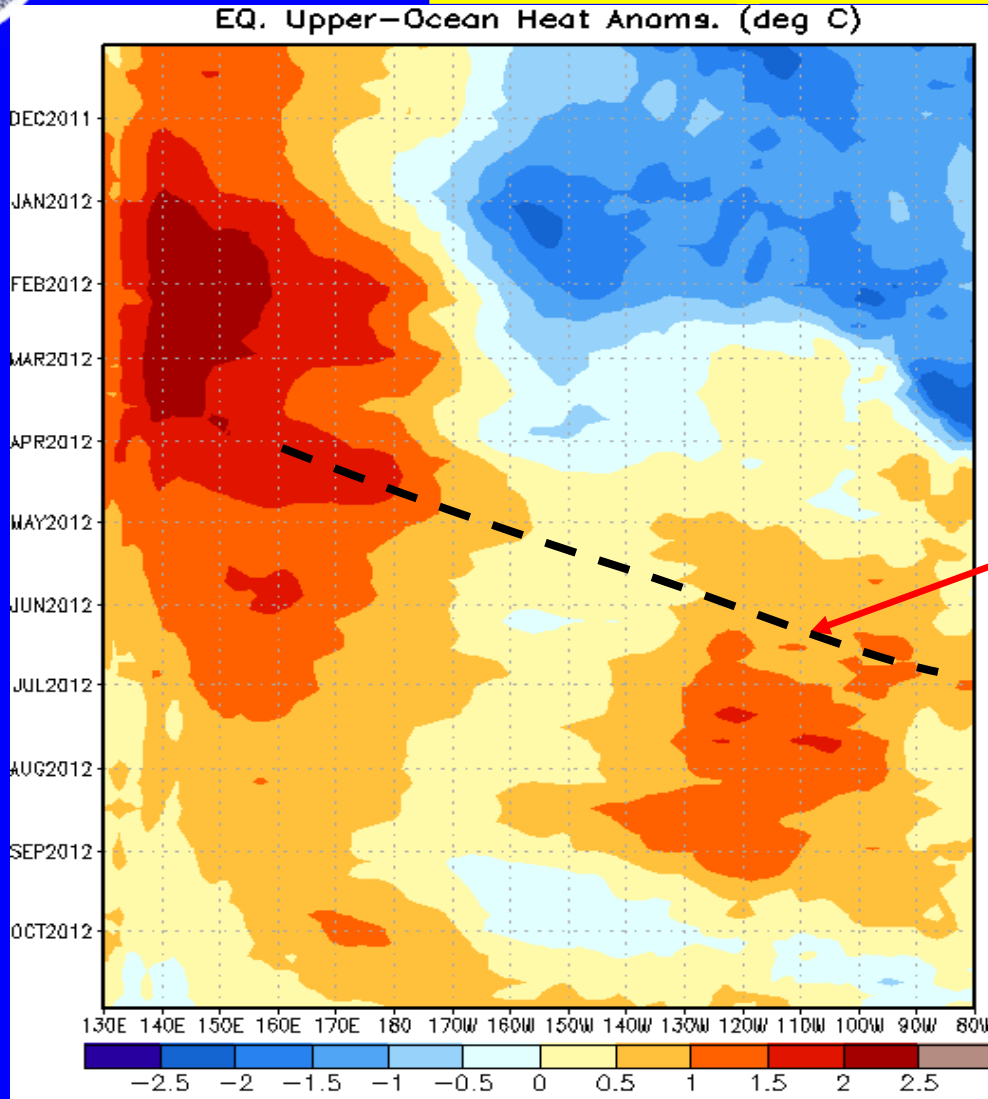
Anomalies were not very coherent during late May and June.

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 have since been replaced by easterly anomalies during mid-October.



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.



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.

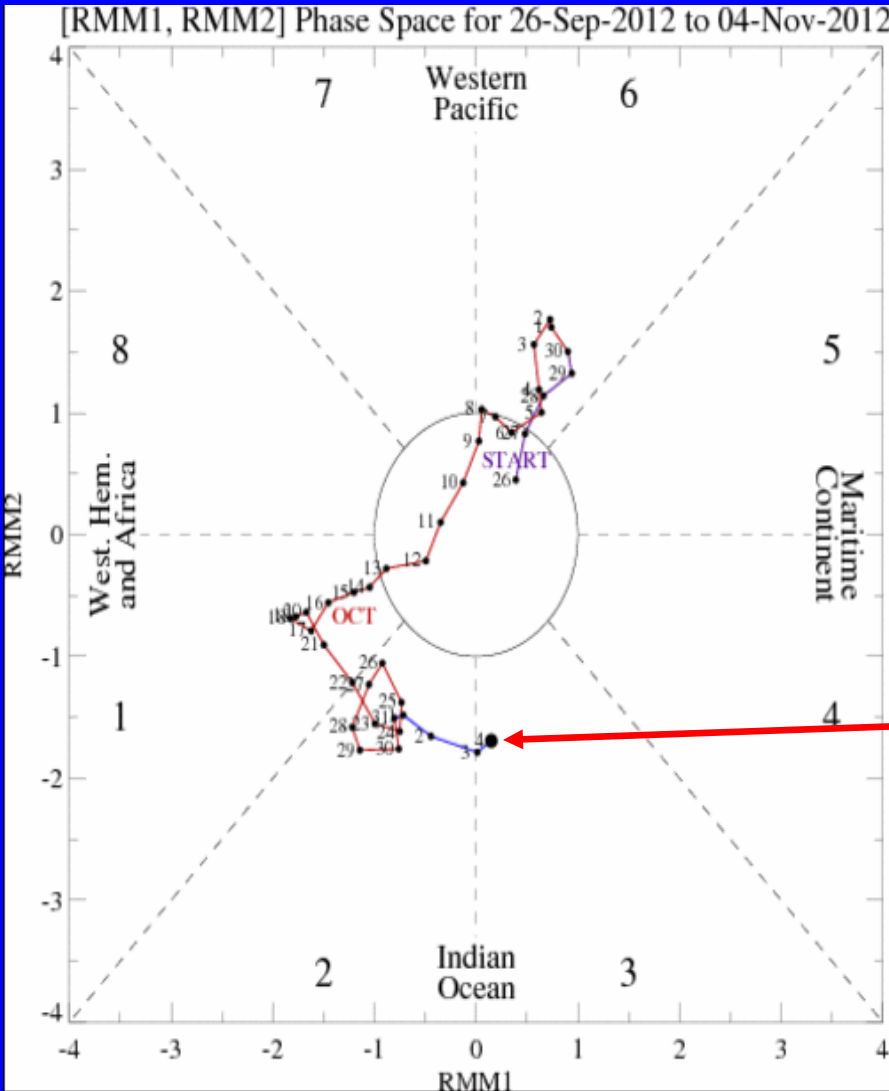
- The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.

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

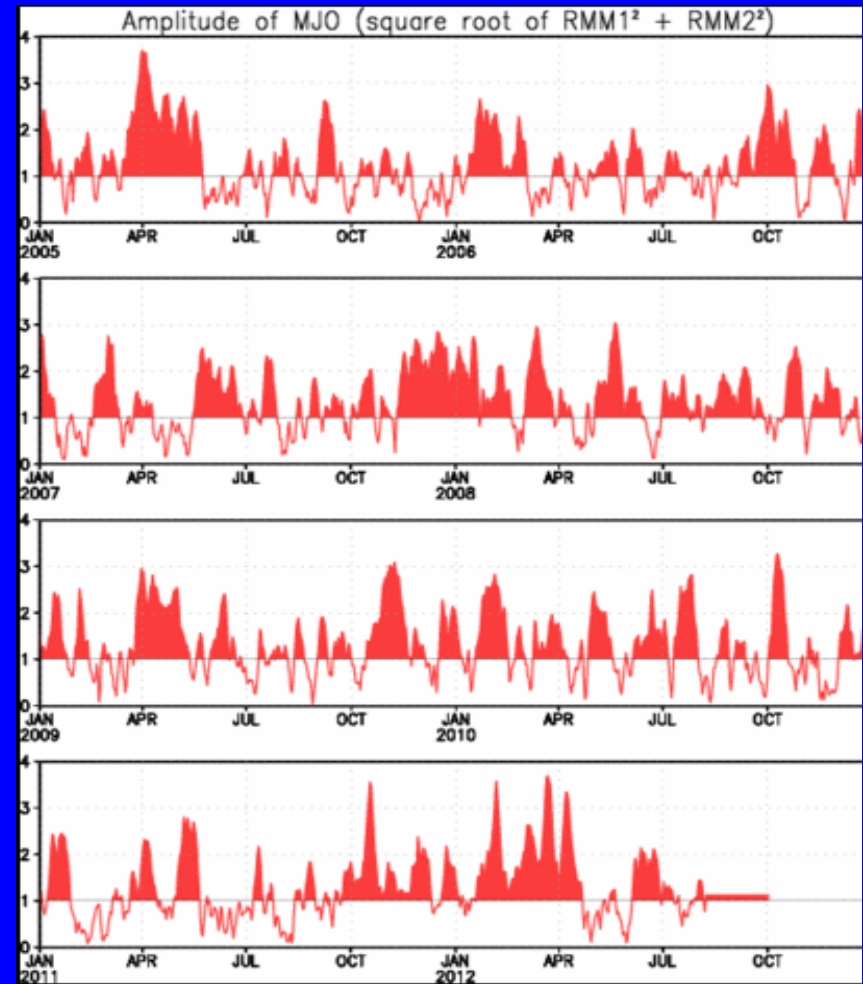
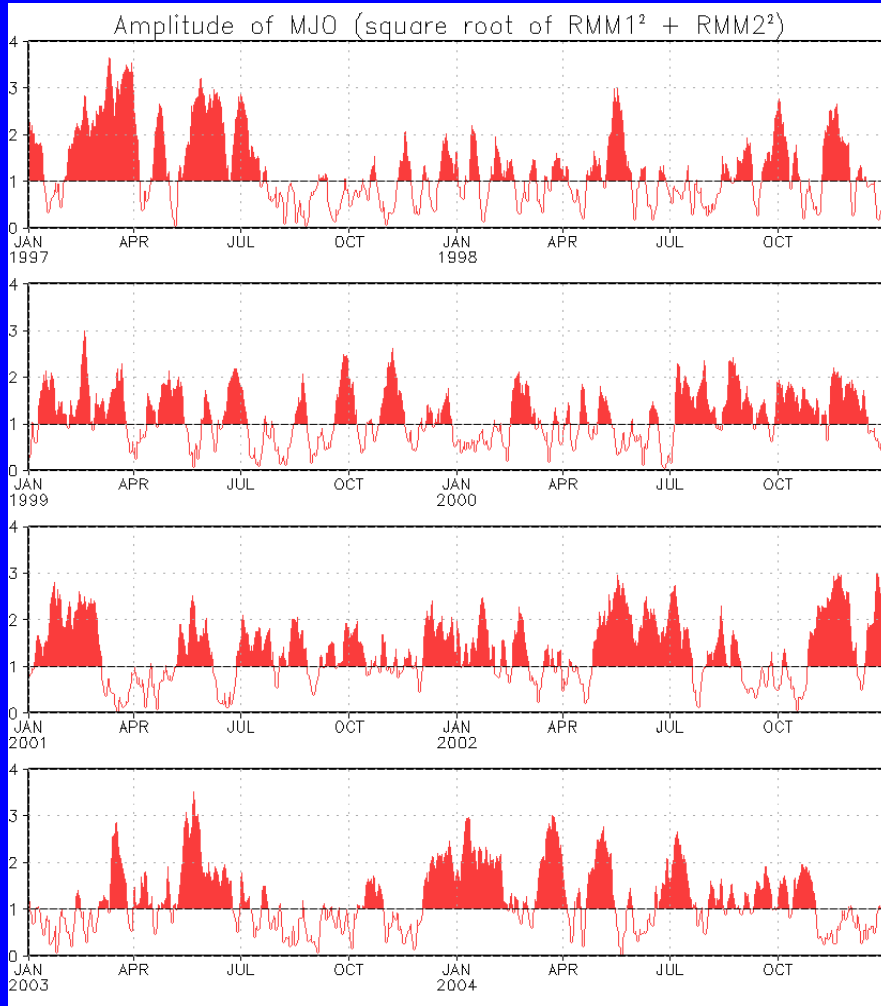


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index maintained its amplitude during the past week with renewed eastward propagation evident at the beginning of November.



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.



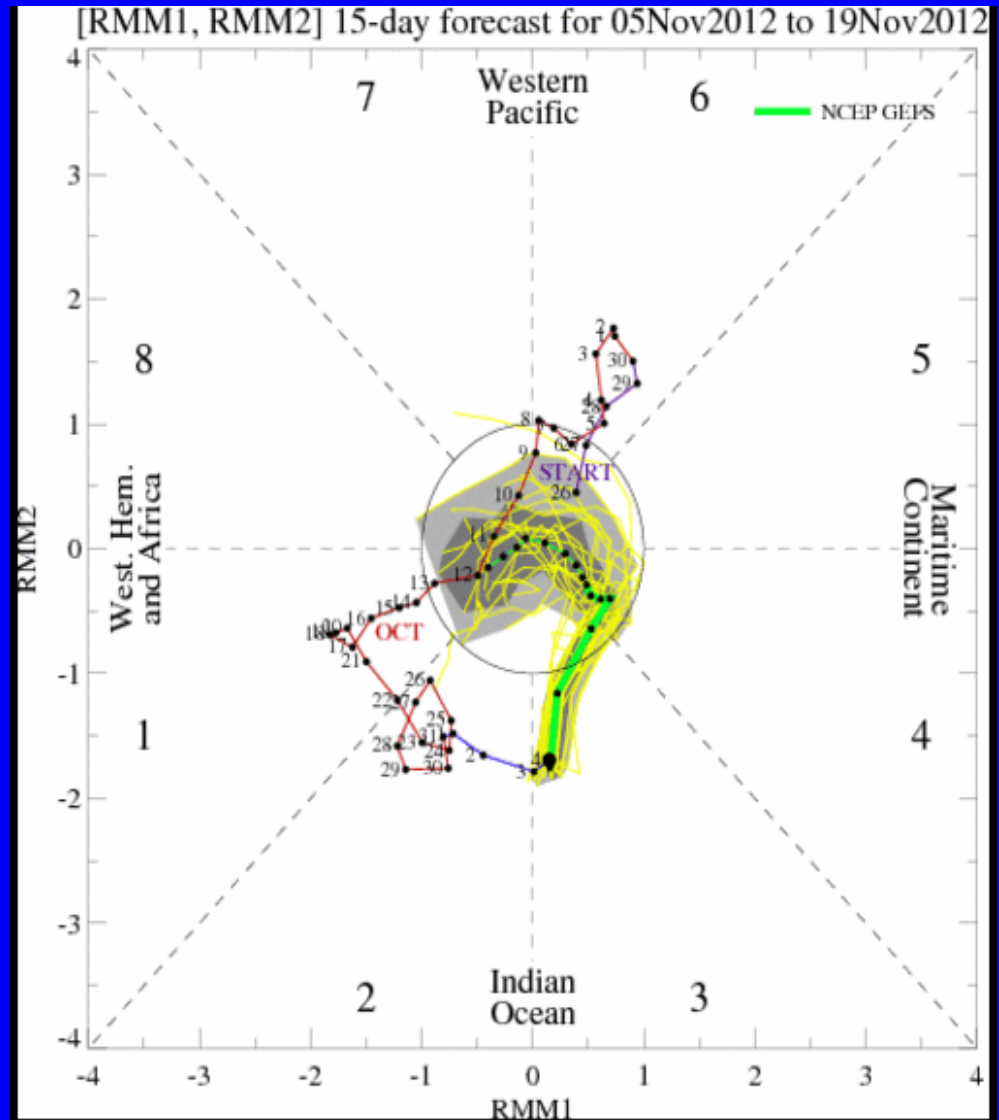
Ensemble GFS (GEFS) MJO Forecast

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 weakening signal during the period.



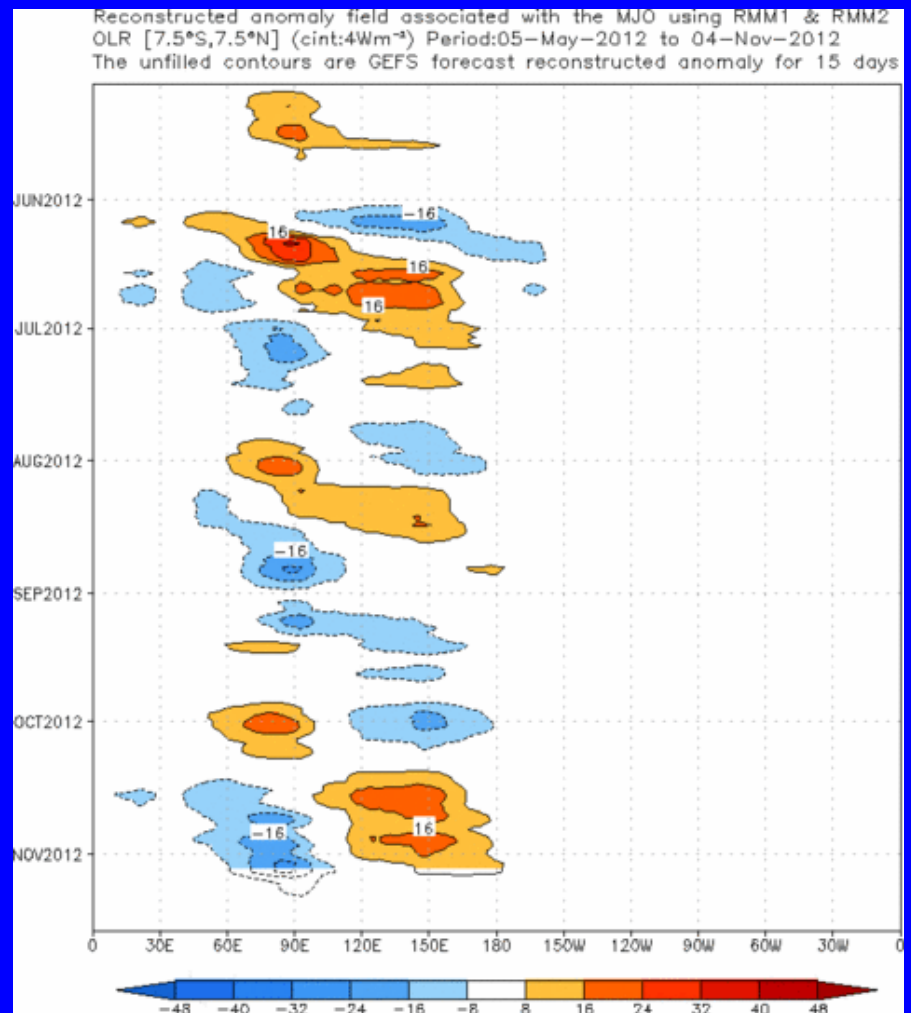
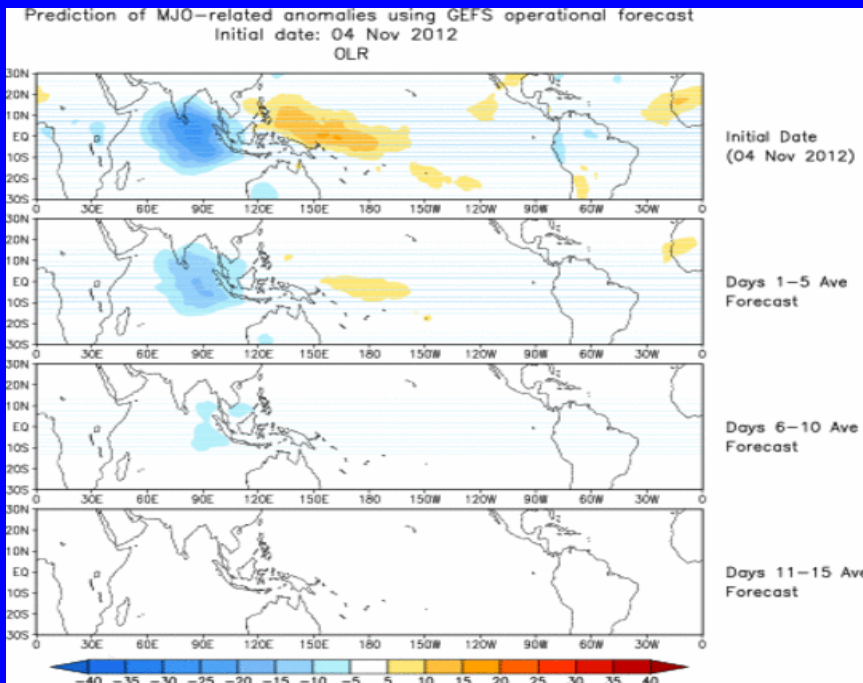


Ensemble Mean GFS MJO Forecast

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 enhanced convection gradually weakening across the Indian Ocean and western Maritime Continent, while suppressed convection diminishes across the west Pacific.

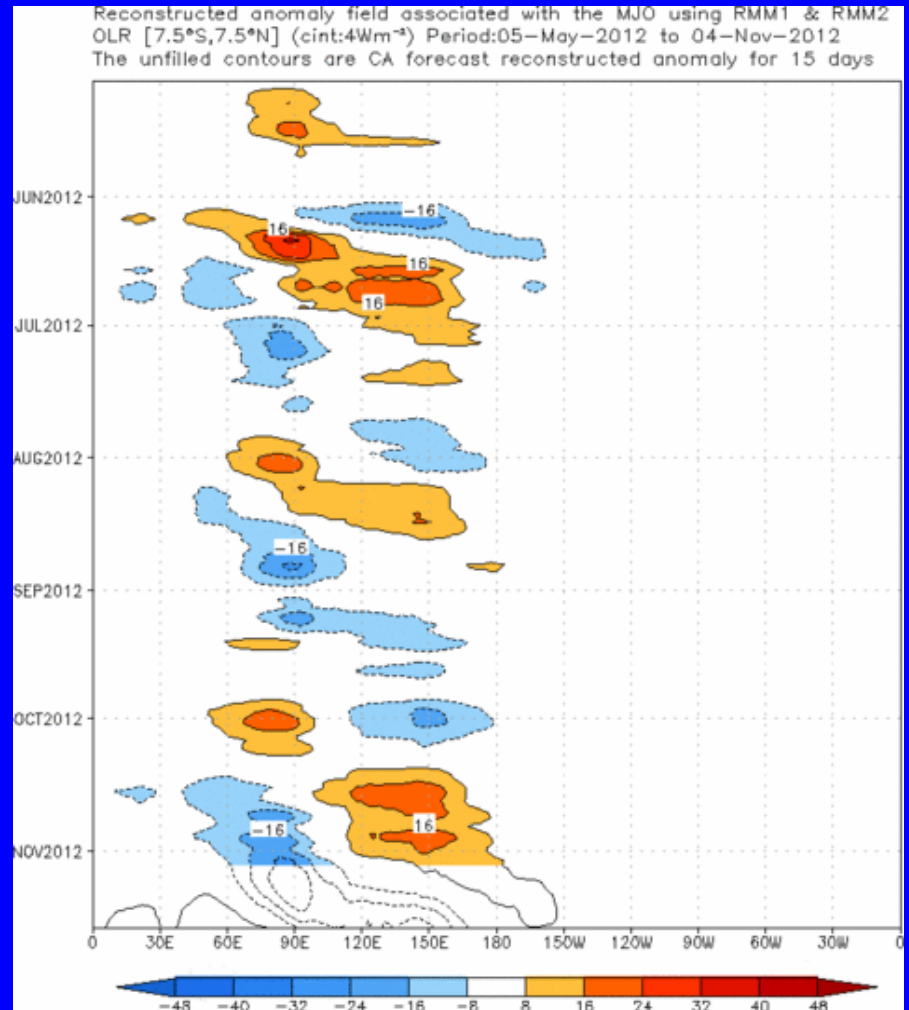
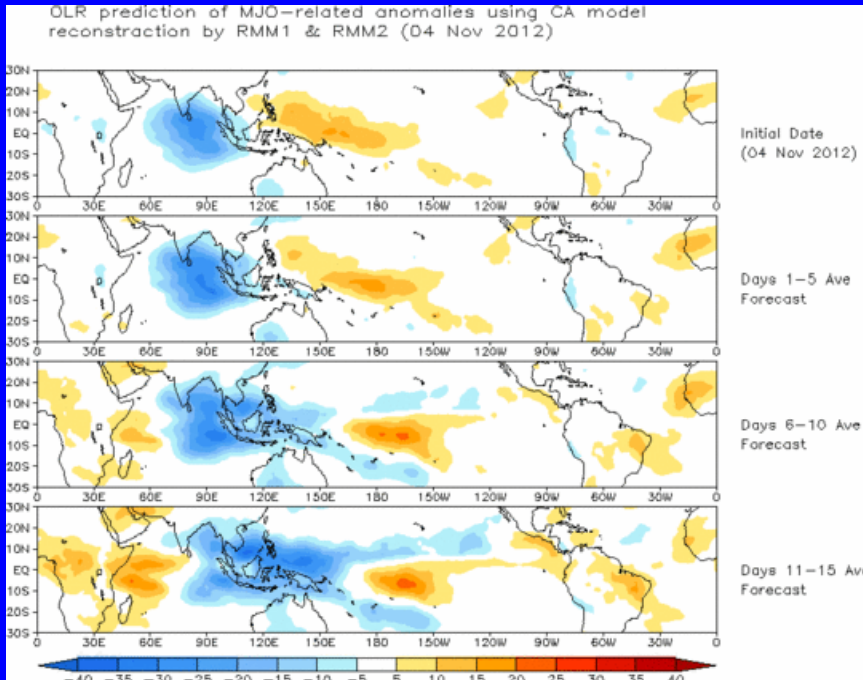


Constructed Analog (CA) MJO Forecast

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



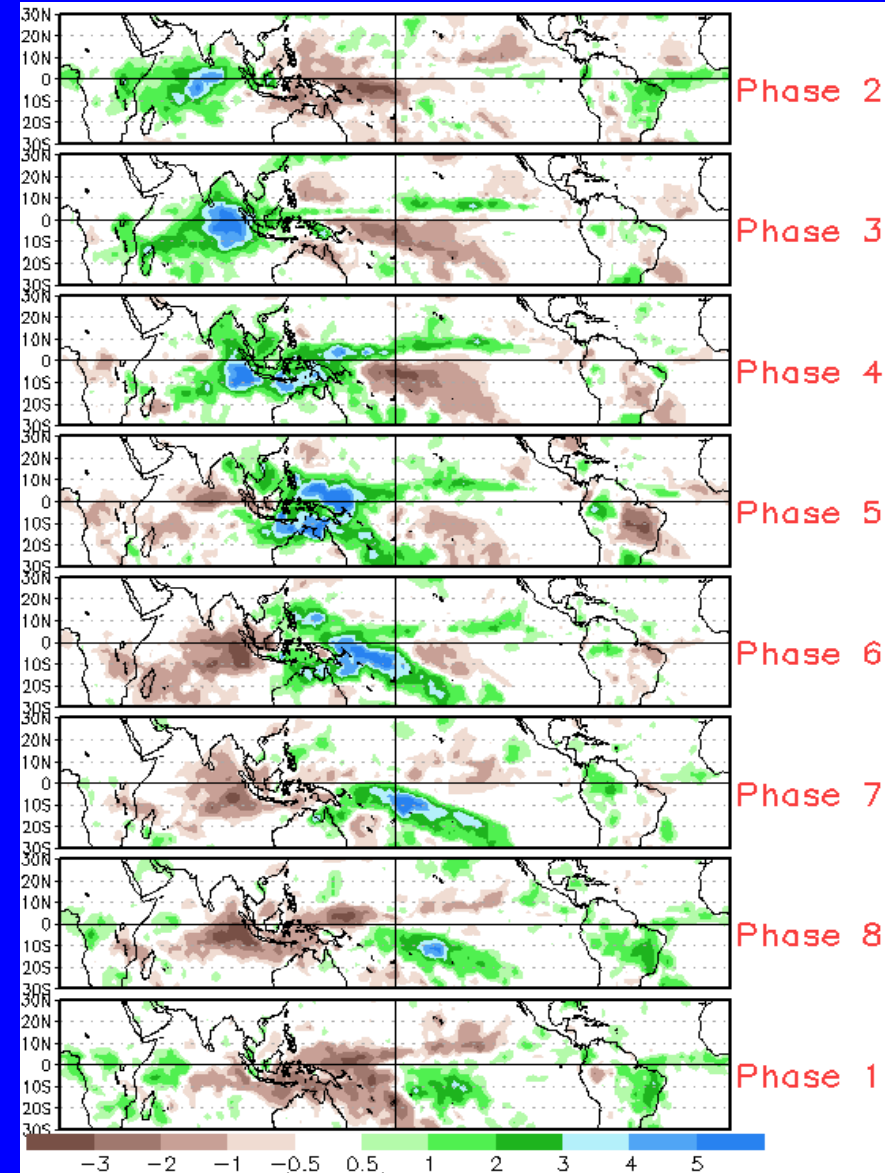
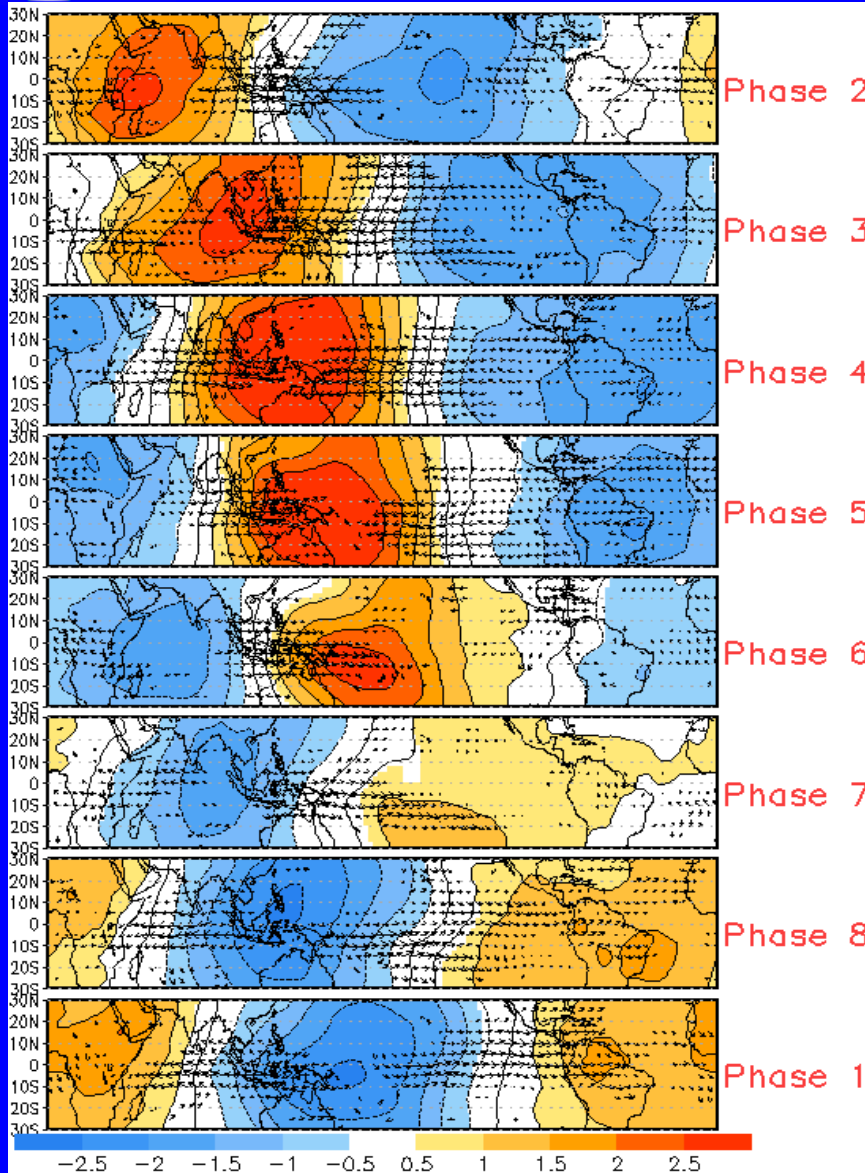
This forecast indicates enhanced convection shifting east across the Maritime Continent and west Pacific. Suppressed convection is forecast to strengthen across the western Hemisphere.



MJO Composites – Global Tropics

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

Precipitation Anomalies (Nov-Mar)

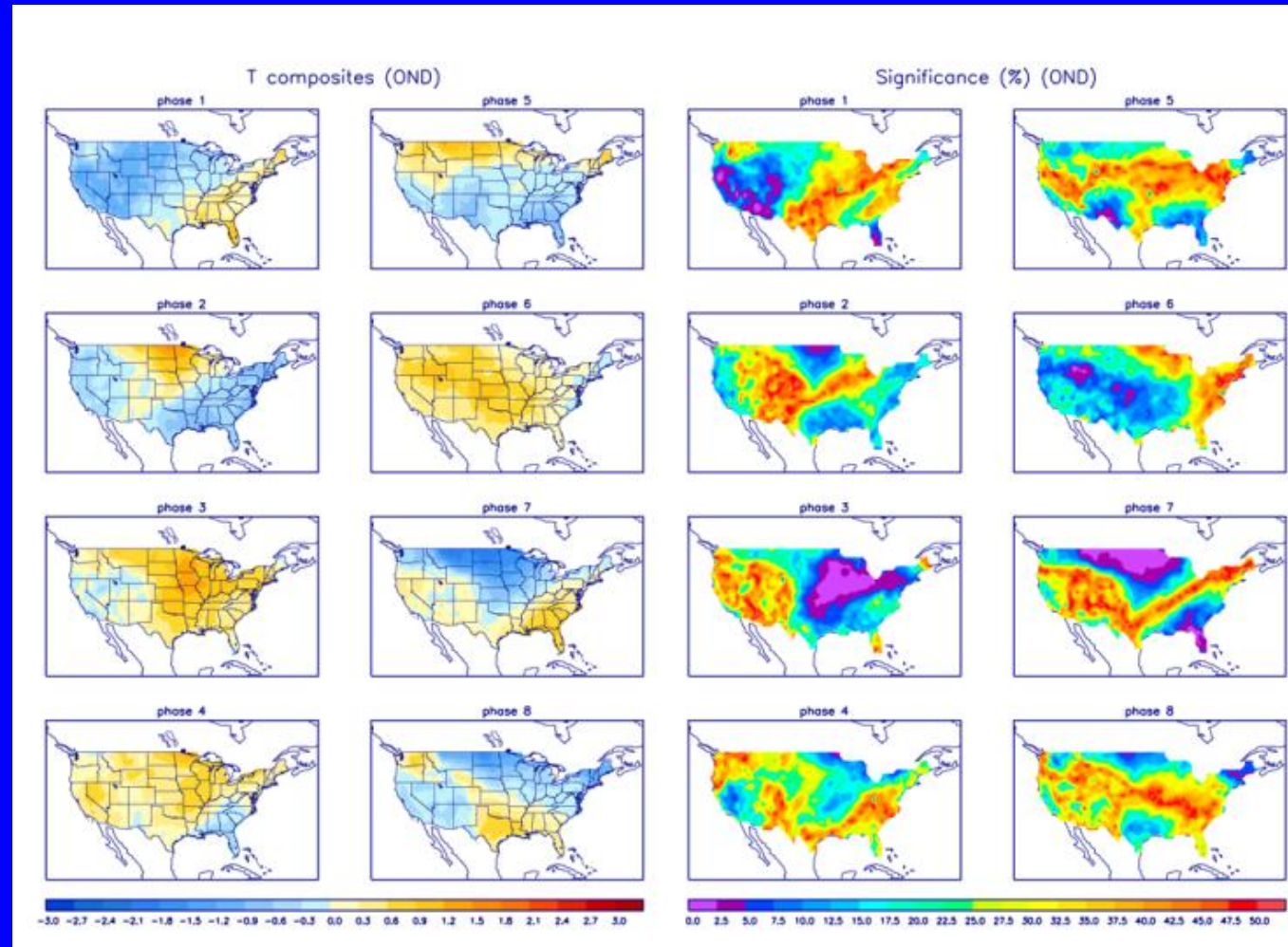




U.S. MJO Composites – Temperature

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.



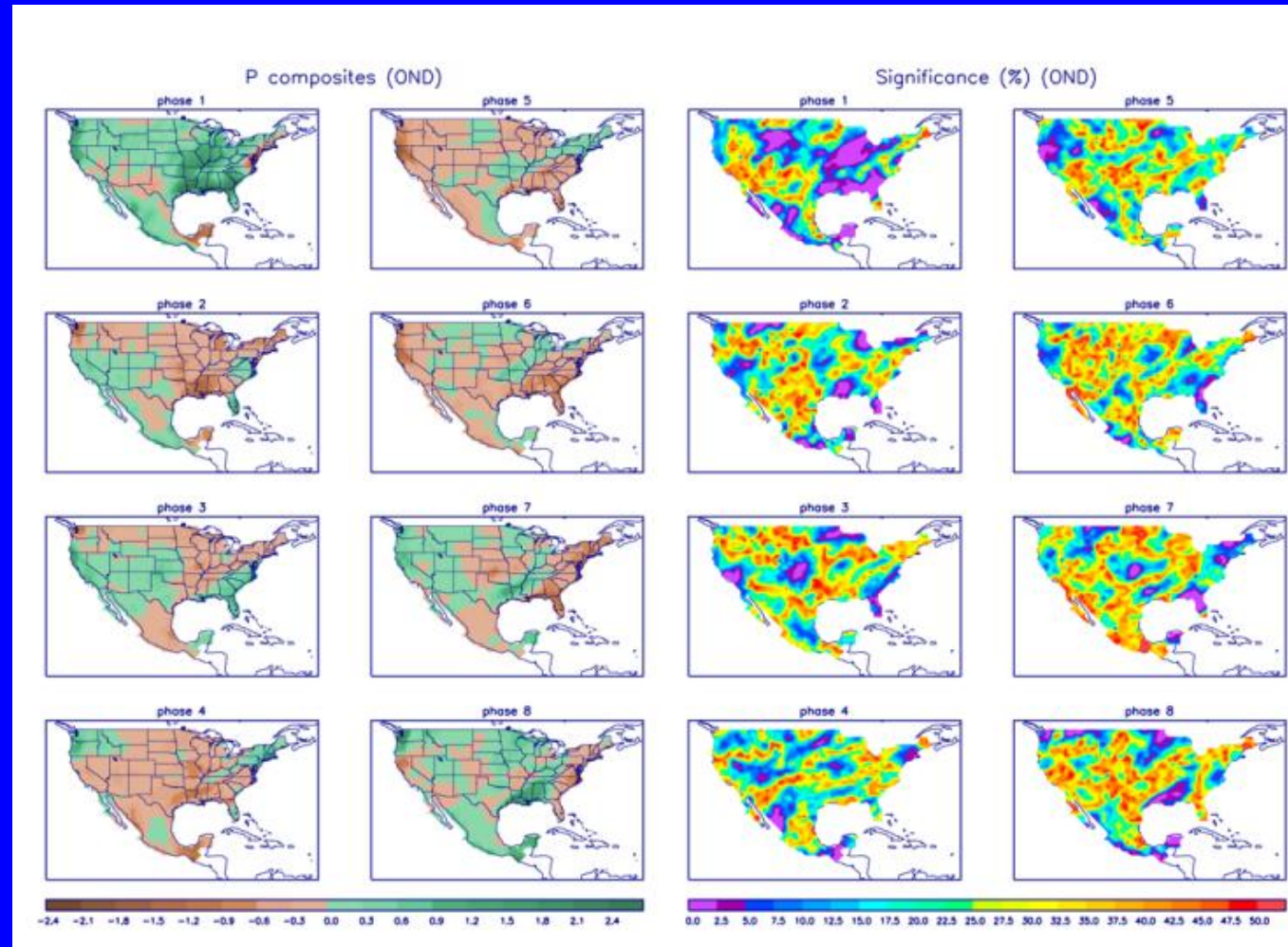
Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

<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

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