



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

**Update prepared by
Climate Prediction Center / NCEP
October 8, 2012**



Outline

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



Overview

- **The latest observations indicate that the MJO remains weak.**
- **The majority of dynamical model MJO index forecasts indicate a continuation of a weak signal during Week-1. There is some agreement for a stronger signal in the index to emerge during Week-2 across the western Hemisphere. It is most likely, however, that this increase in amplitude is a combination of other subseasonal tropical variability initiating more broad scale convection that persists through the period in this area.**
- **Based on the latest observations and model forecasts, the MJO is forecast to remain weak during the outlook period.**
- **The MJO is not expected to contribute substantially to anomalous tropical convection during the next 1-2 weeks.**

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

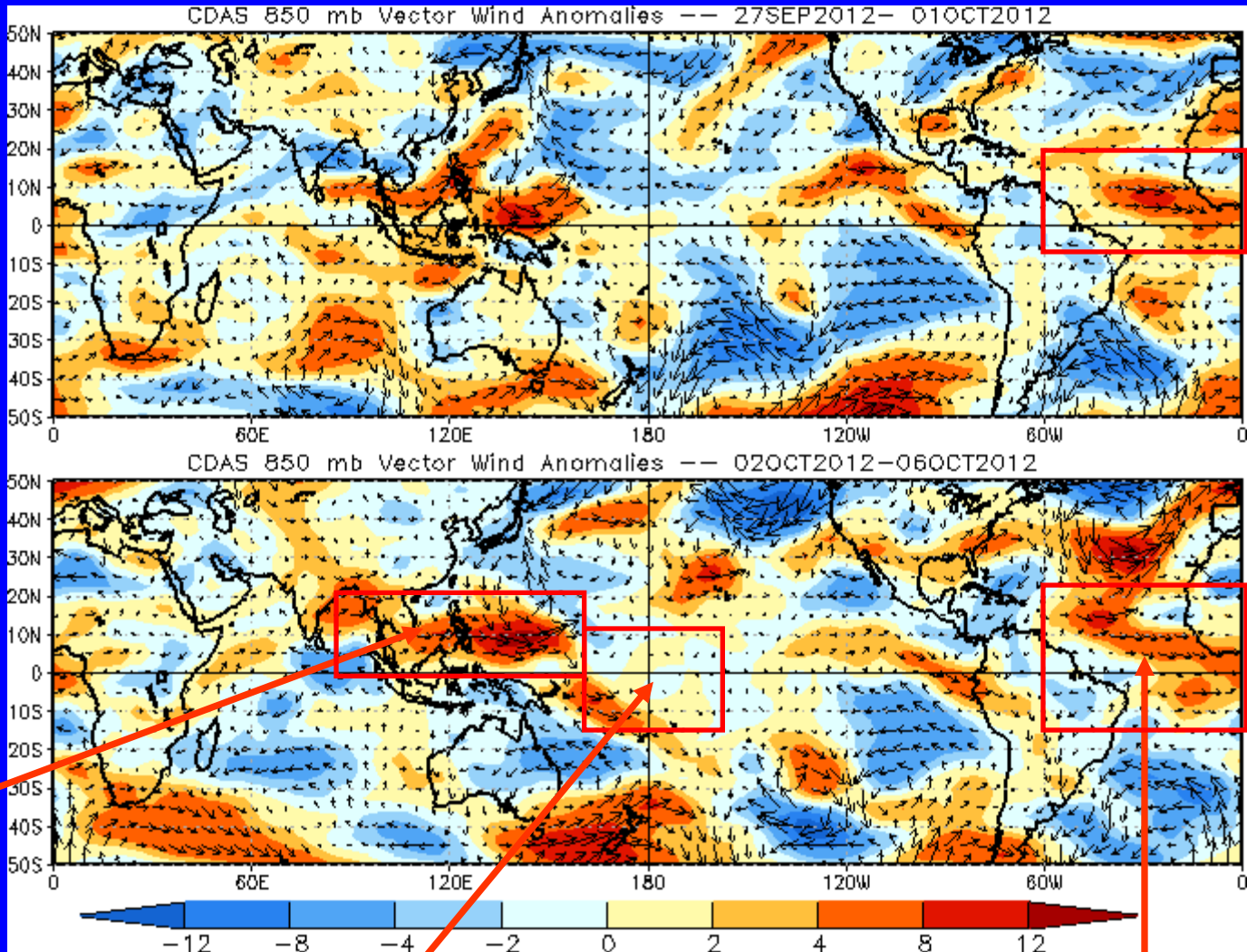


850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly anomalies increased but shifted north of the equator during the last five days.

Westerly anomalies decreased slightly near the Date Line on the equator during the past five days.

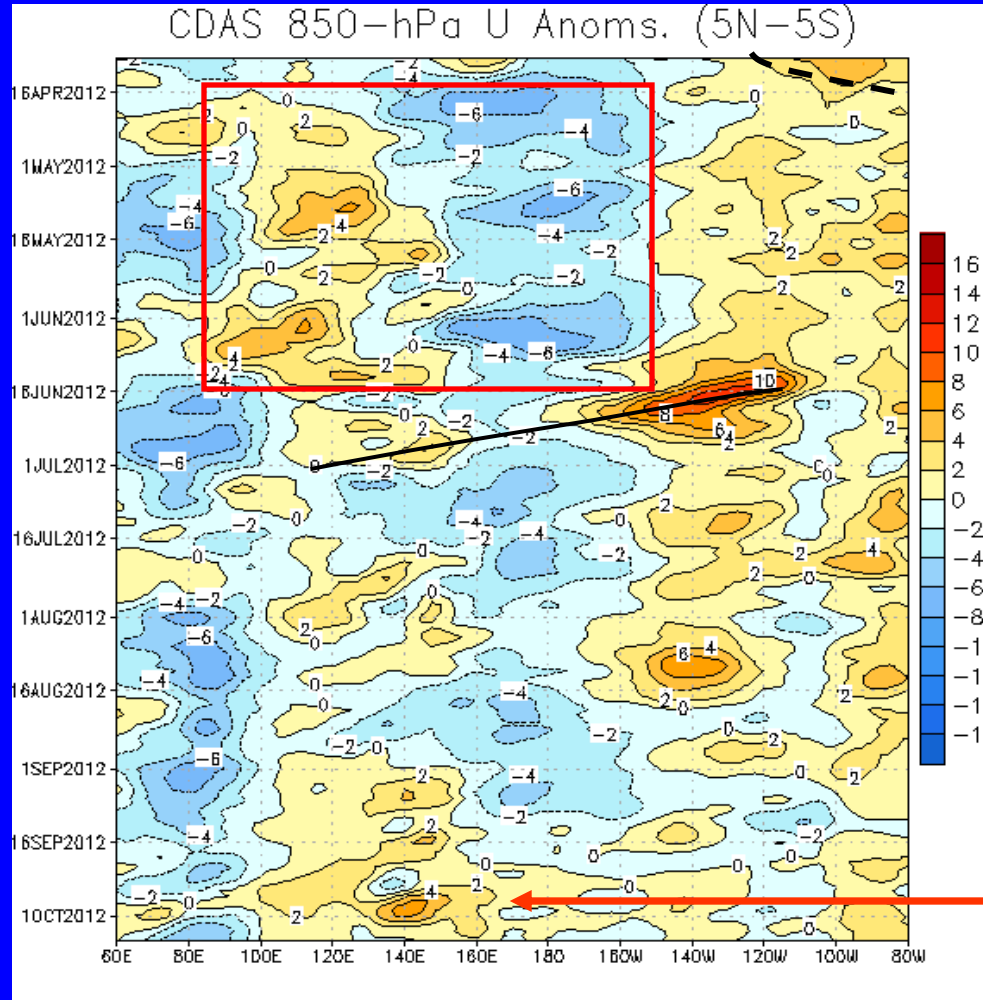
Westerly anomalies persisted over the tropical Atlantic and western Africa during the last five days.



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



The MJO (dashed line) contributed to westerly anomalies near the Date Line and across the western hemisphere during late April. Anomalies became more persistent in most areas during the remainder of April and May (red box).

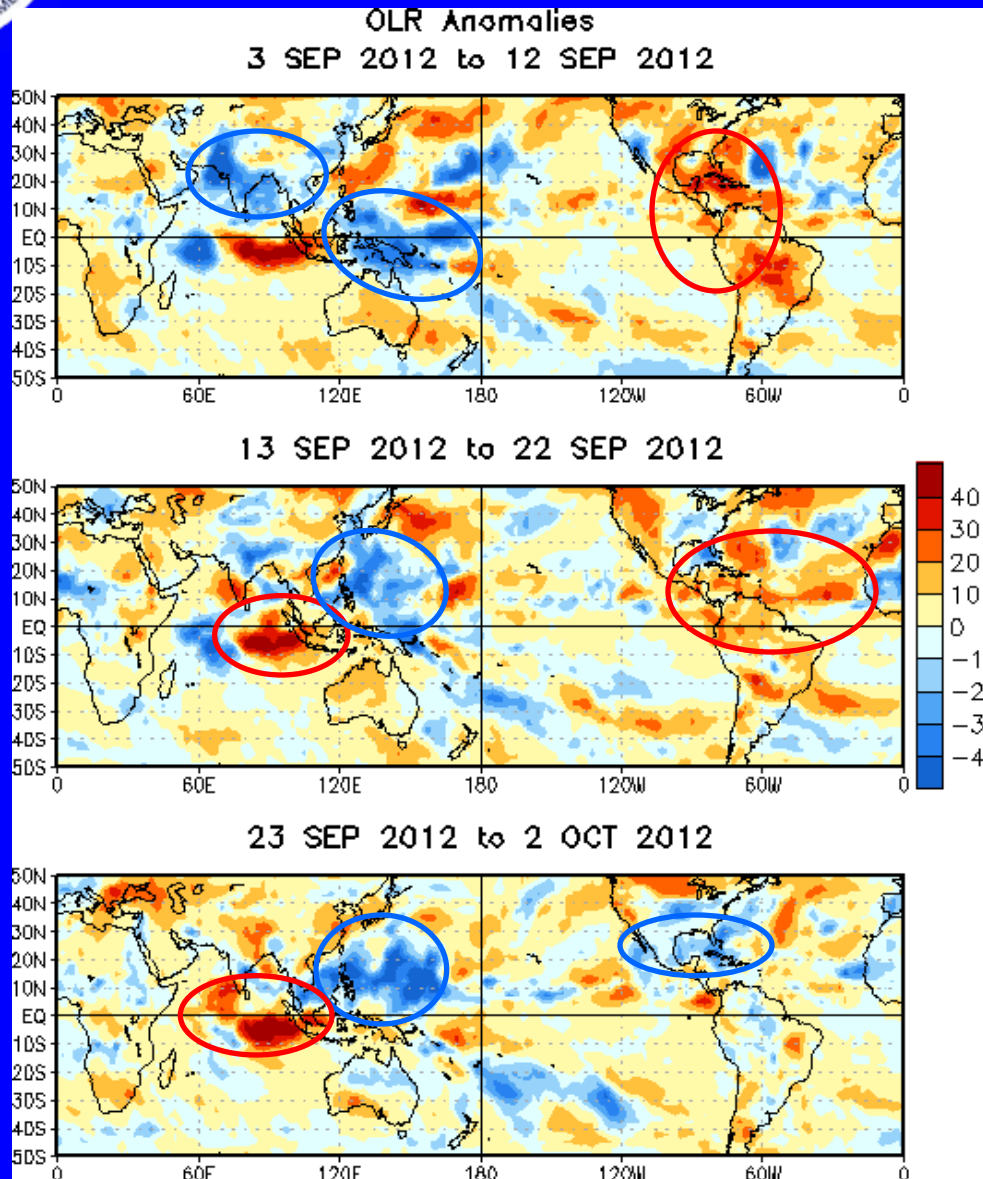
Strong westerly anomalies developed across the eastern Pacific in mid-June and shifted westward (black solid line) and contributed to weakening the trade winds.

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

During September, westerly anomalies developed near 140E and the easterlies have decreased near the Date Line.



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 September, enhanced convection continued for southern Asia and parts of the western Pacific while strong suppressed convection continued across the eastern equatorial Indian Ocean and Americas.

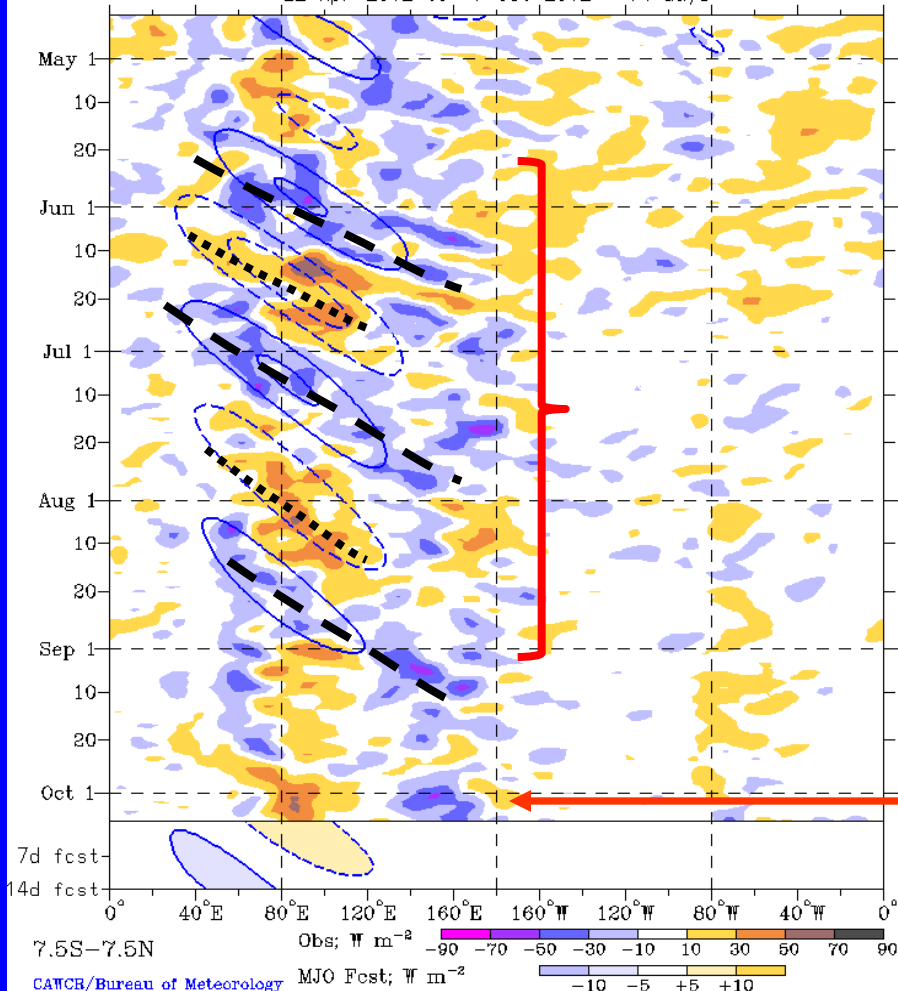
Enhanced convection continued across the western Pacific during mid-September mainly associated with tropical cyclone activity. Suppressed convection continued across the eastern equatorial Indian Ocean and increased over the Atlantic.

Enhanced convection continued east of the Philippines while convection became closer to average across the Americas and Atlantic by early October. Wetter-than-average conditions were observed in proximity to the Gulf of Mexico.



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
22-Apr-2012 to 7-Oct-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).

Atmospheric Kelvin wave activity also played a large role in the pattern of anomalous convection across the Pacific and western Hemisphere during much of this period, especially June and July.

During September into October, the primary area of enhanced convection has been located in the western Pacific, just west of Date Line. Strong suppressed convection has developed over the Indian Ocean.

Longitude

Time

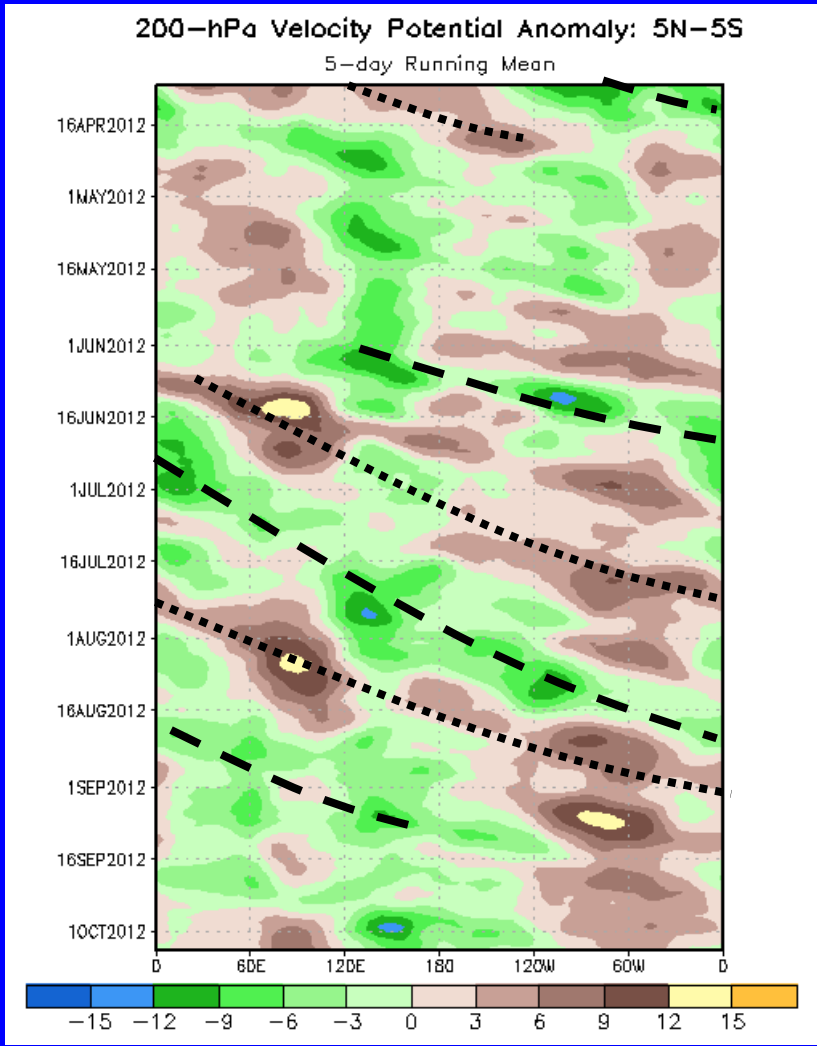




200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation



Time
↓

Longitude

The MJO strengthened in late January and continued into mid-April as indicated by alternating negative (dashed lines) and positive (dotted lines) anomalies with eastward propagation.

Beginning in late April, anomalies became weaker and less coherent than earlier in the year.

Eastward propagation was once again evident from late May into September associated with the MJO, as well as atmospheric Kelvin wave activity, which at times resulted in fast eastward propagation of observed anomalies.

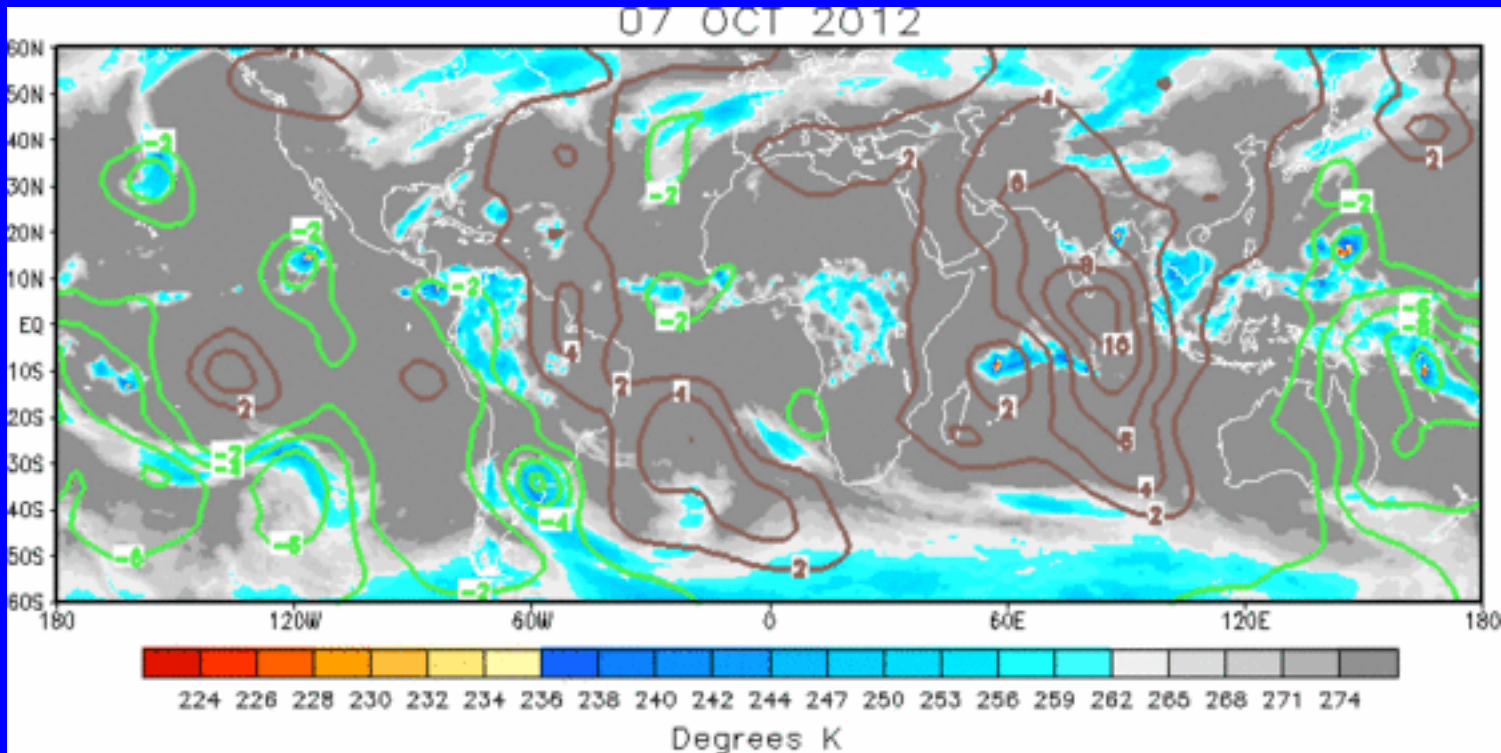
In mid-September, anomalies decreased and eastward propagation less clear. Most recently, upper-level divergence increased over the western Pacific in early October.



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 is not very coherent and shows anomalous upper-level divergence mainly over the southwest Pacific. Strong anomalous upper-level convergence is evident across the Indian Ocean.

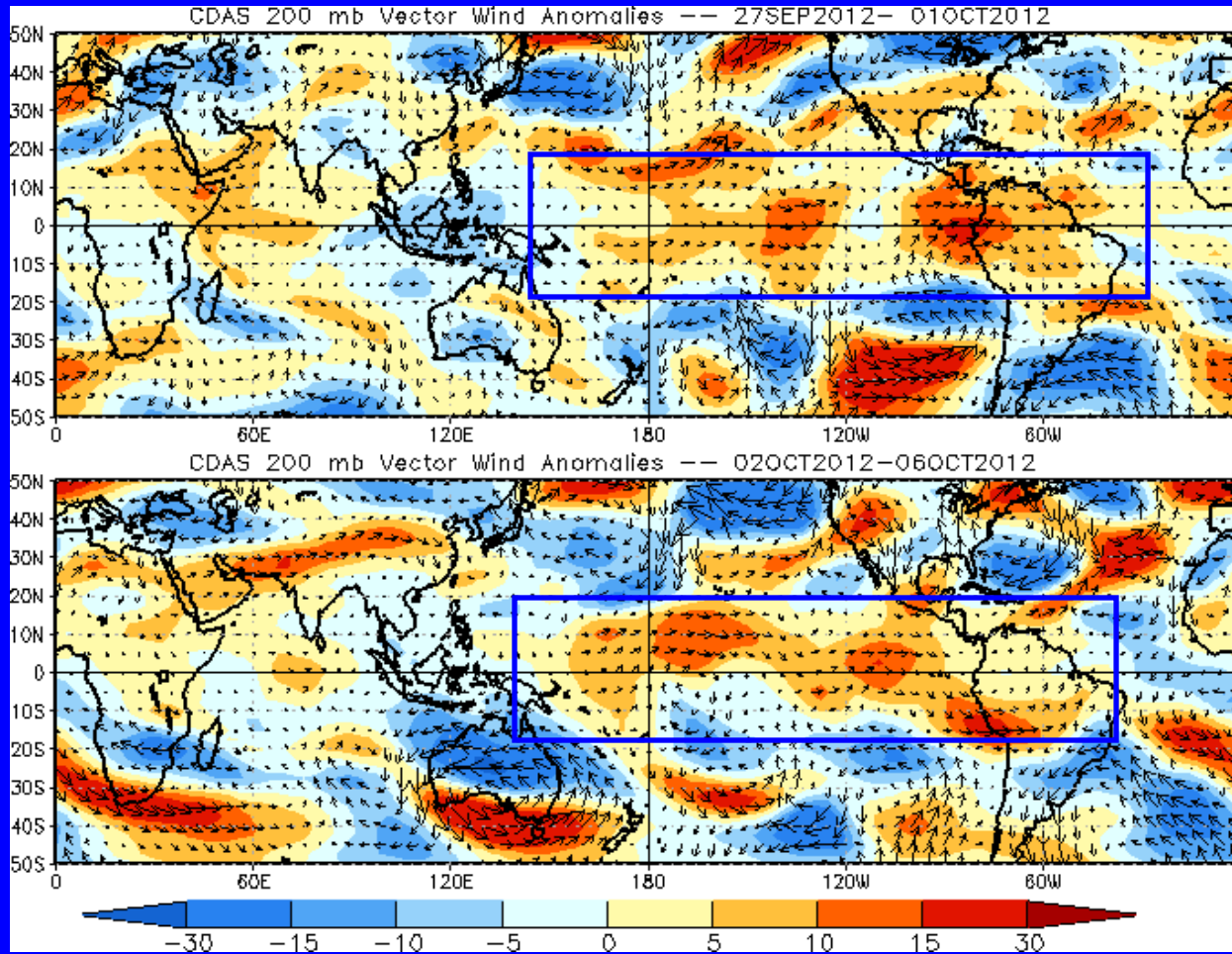


200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



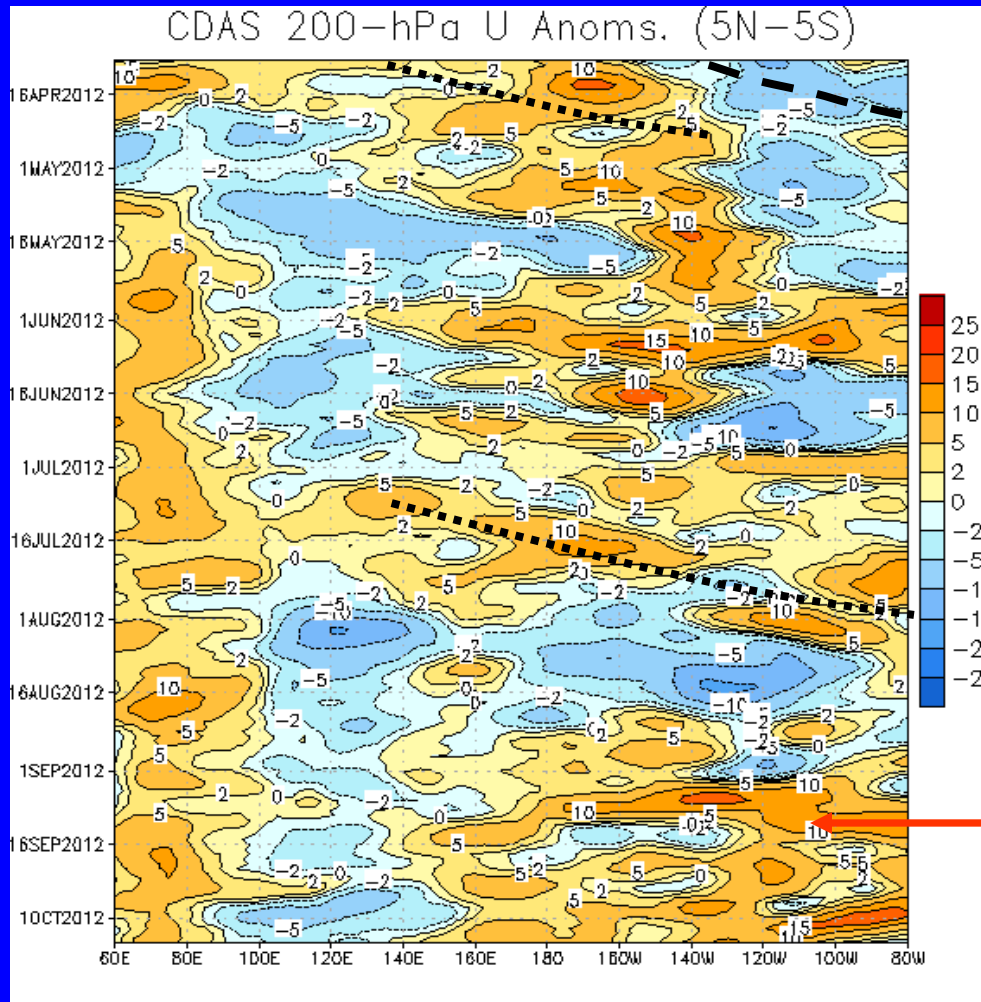
There has not been much change in wind anomalies over the past 10 days. Westerly anomalies (blue boxes) persisted over the entire tropical Pacific and the Americas.



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



The MJO contributed to alternating westerly (dotted lines) and easterly (dashed lines) anomalies into mid-April.

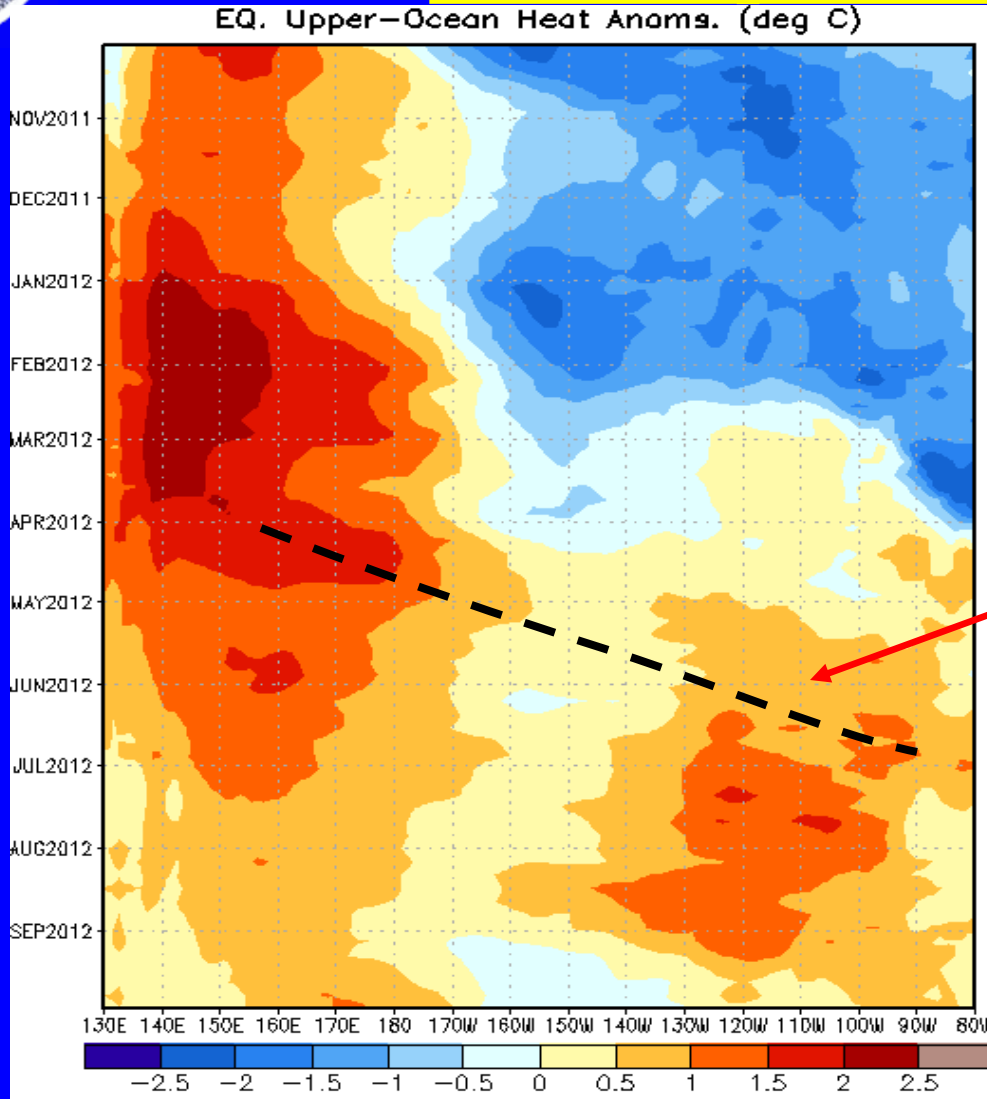
Anomalies were less coherent during much of April and May as the MJO was weak.

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

Westerly anomalies increased markedly across the eastern Pacific in early September and have persisted.



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.



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.

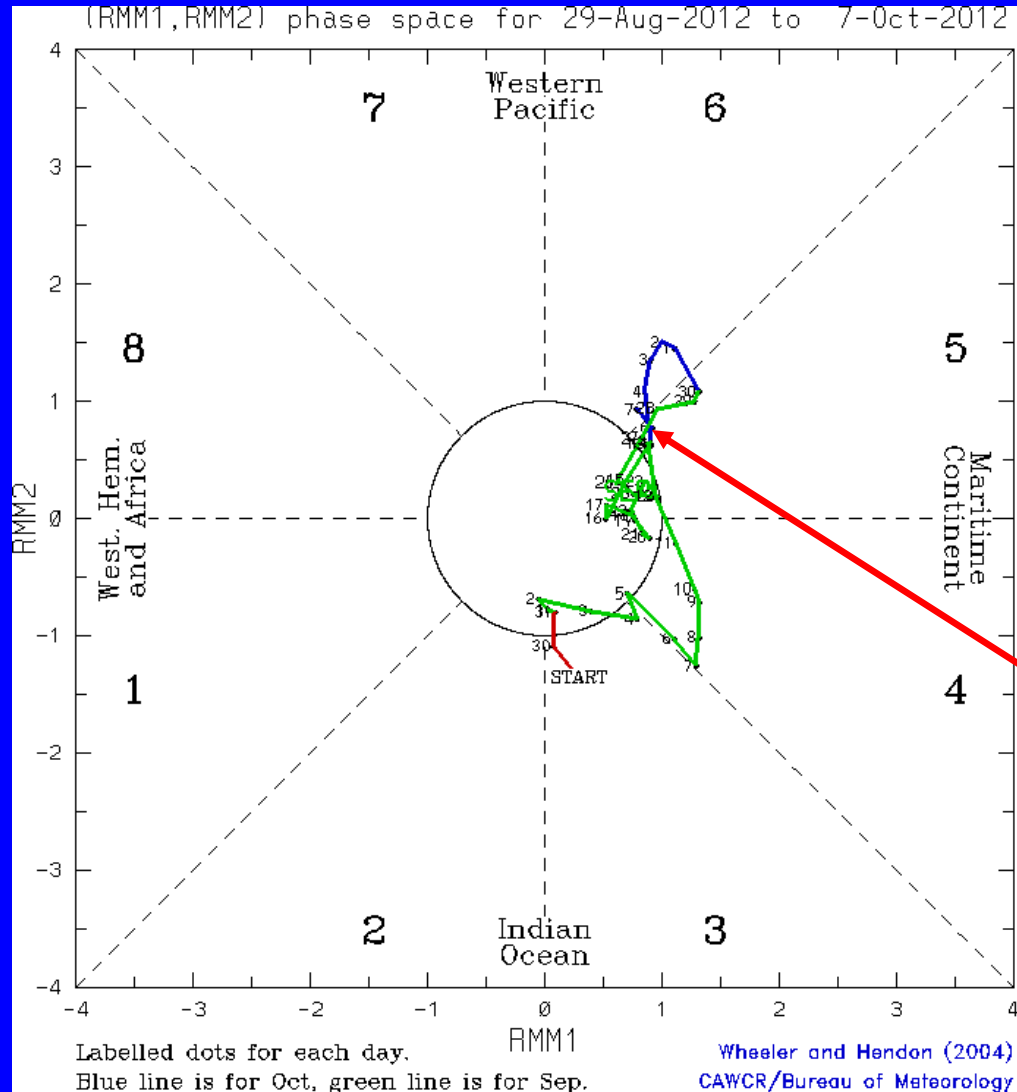
- The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.

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

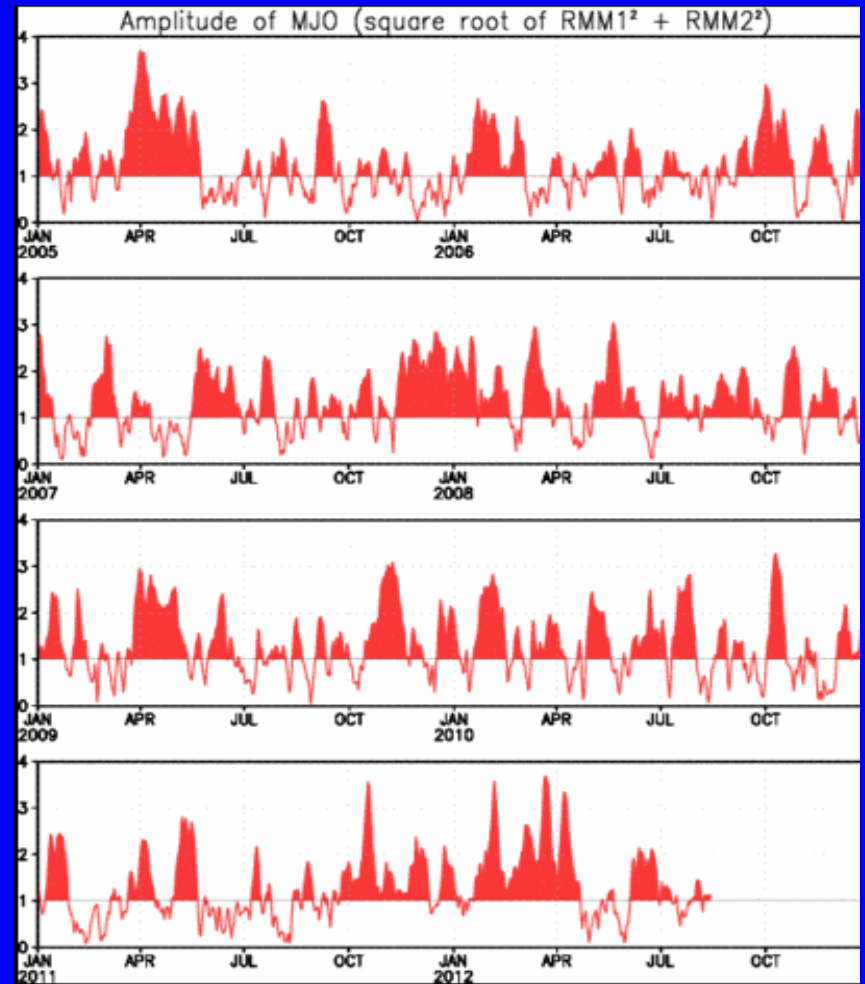
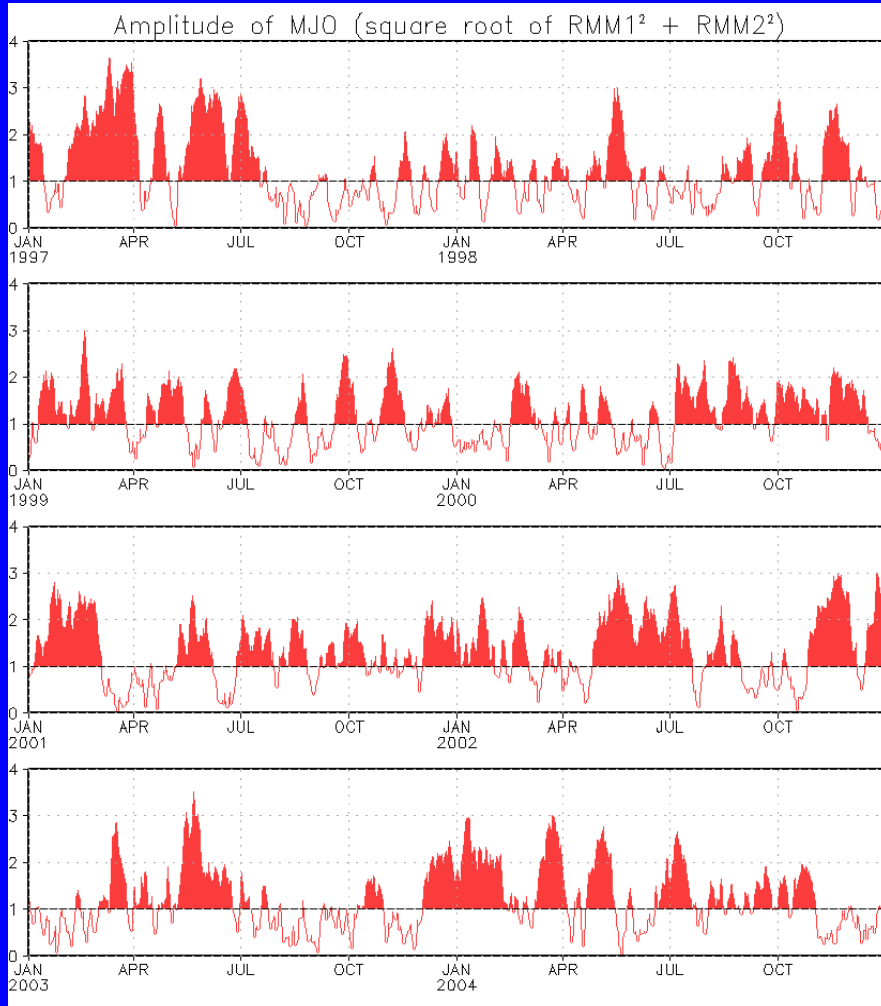


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index increased in amplitude during the past week but there has been 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.



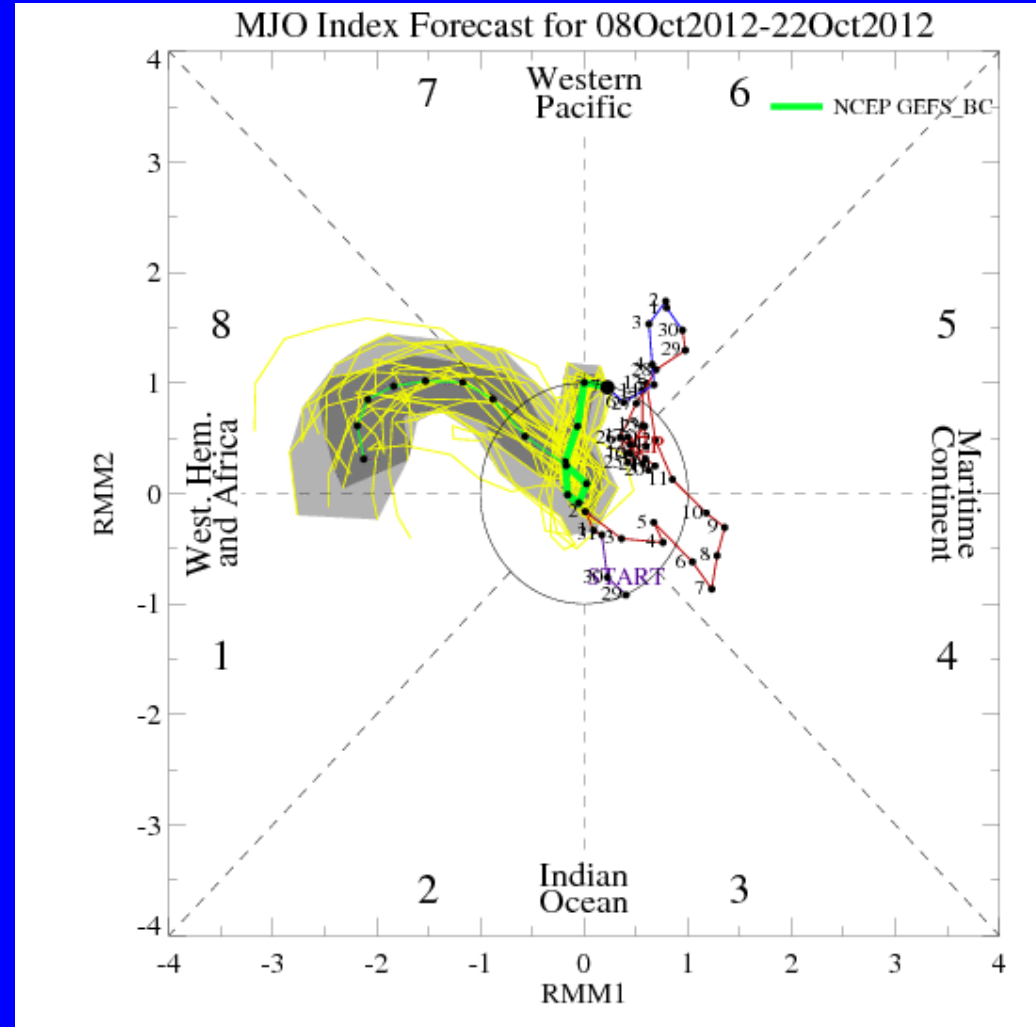
Ensemble GFS (GEFS) MJO Forecast

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 ensemble GFS forecasts a weak signal during the Week-1 period but increase in amplitude and eastward propagation later in Week-2.

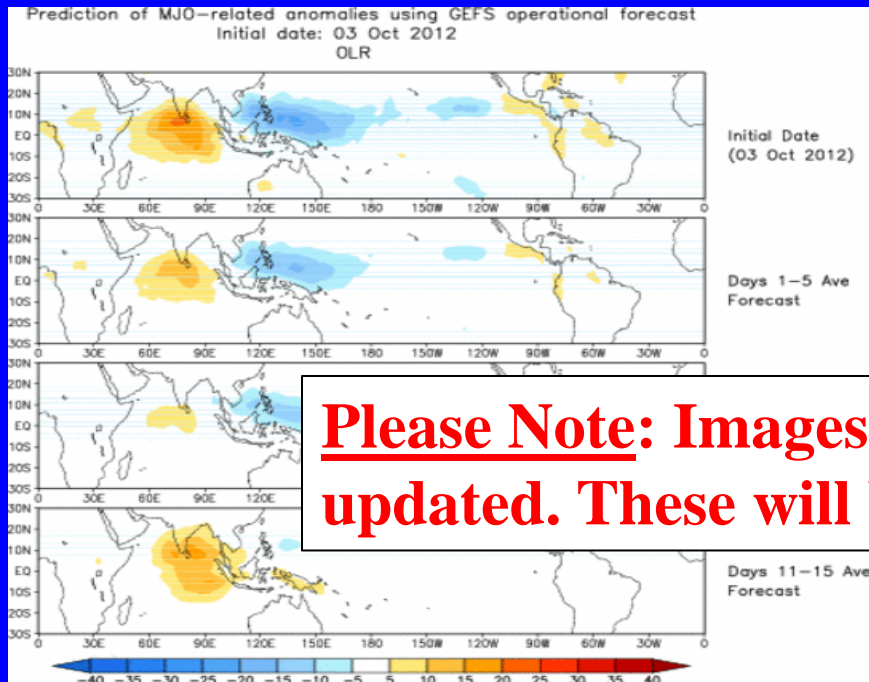




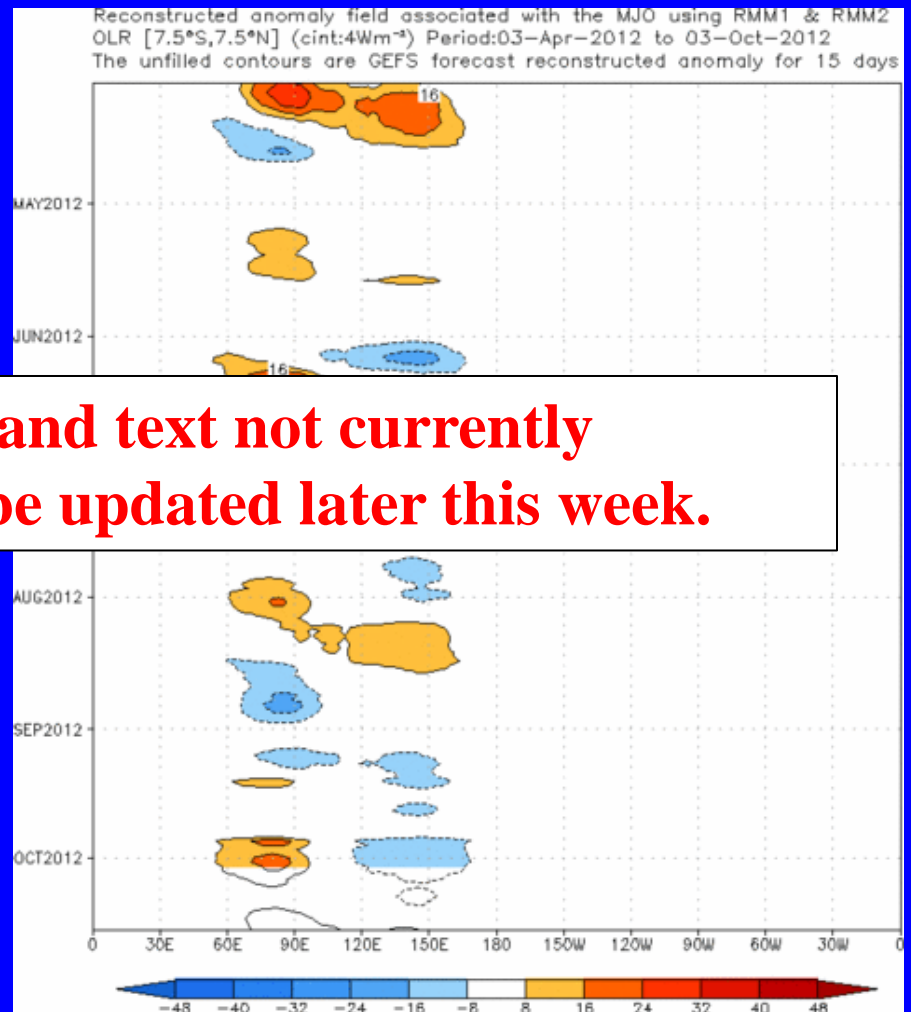
Ensemble Mean GFS MJO Forecast

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



Please Note: Images and text not currently updated. These will be updated later this week.

The ensemble mean GFS forecast indicates enhanced (suppressed) convection persisting across the western Pacific (Indian Ocean/Americas) during the forecast period with some weakening during Week-2.

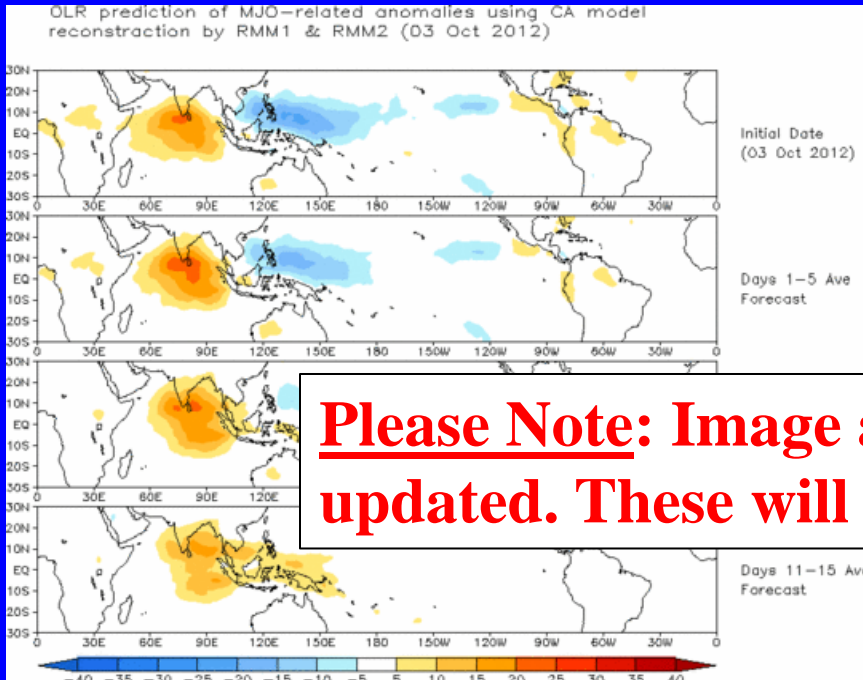


Constructed Analog (CA) MJO Forecast

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



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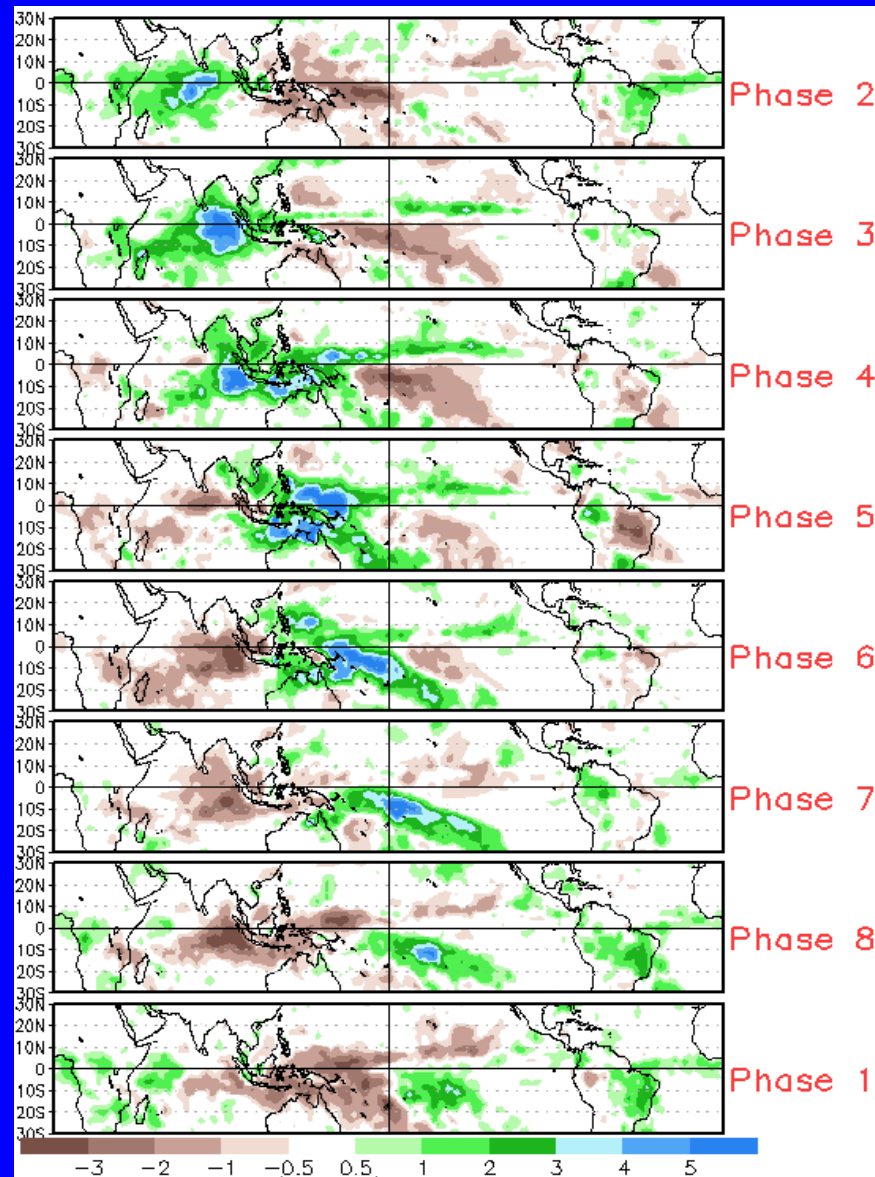
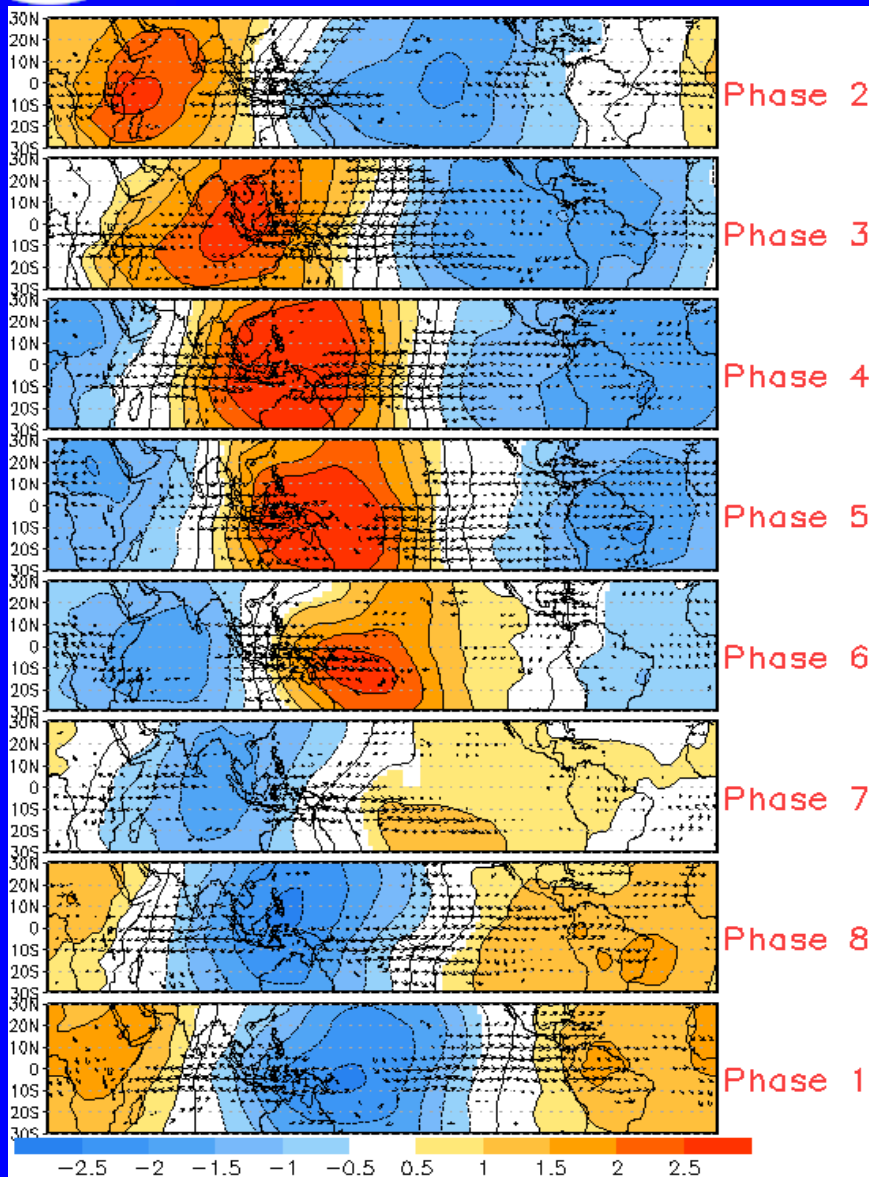
This forecast also indicates general persistence of anomalous enhanced (suppressed) convection across the western Pacific (Indian Ocean/Americas) during the next two weeks as well.



MJO Composites – Global Tropics

850-hPa Velocity Potential and
Wind Anomalies (May-Sep)

Precipitation Anomalies (May-Sep)

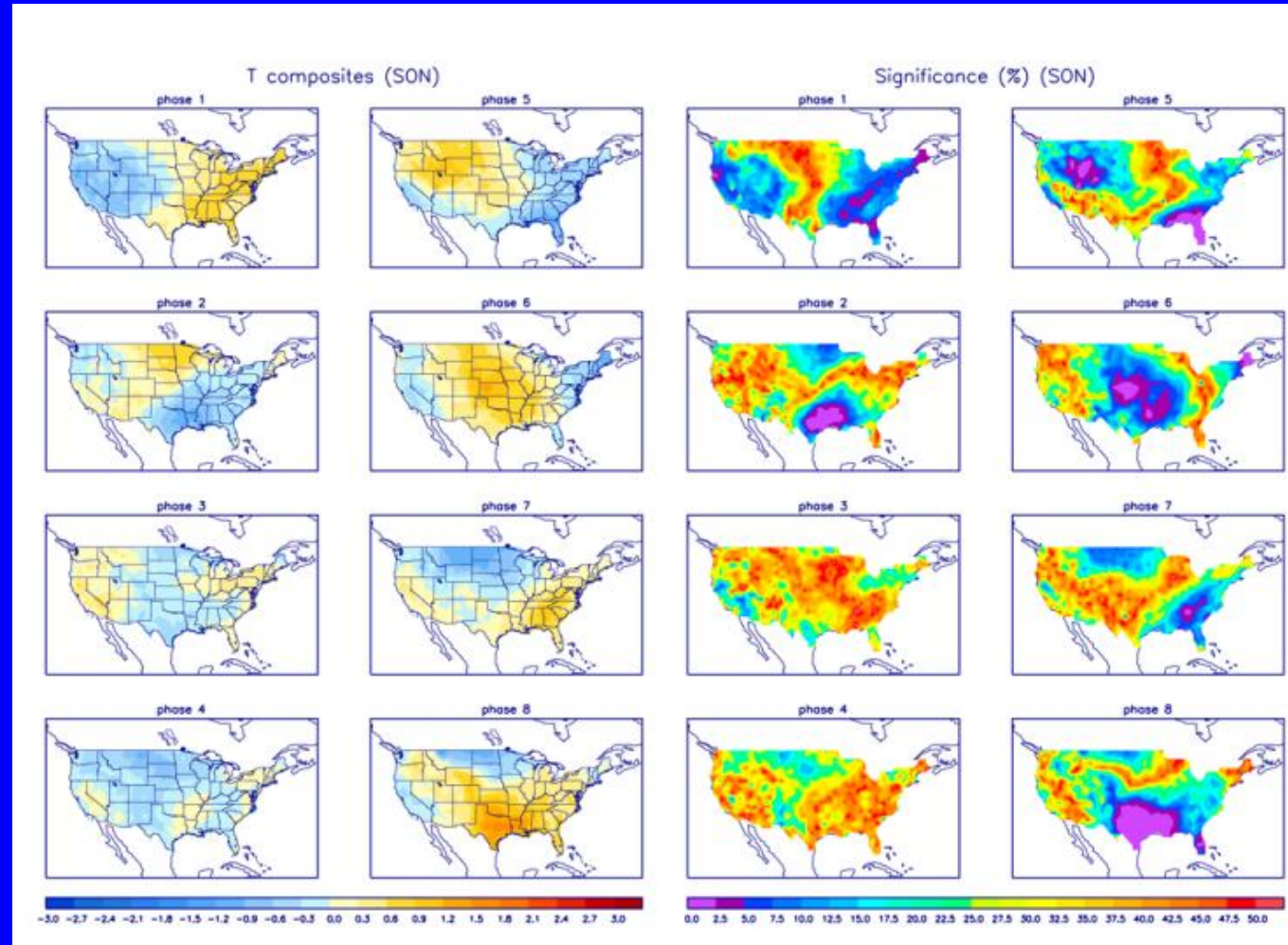




U.S. MJO Composites – Temperature

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.



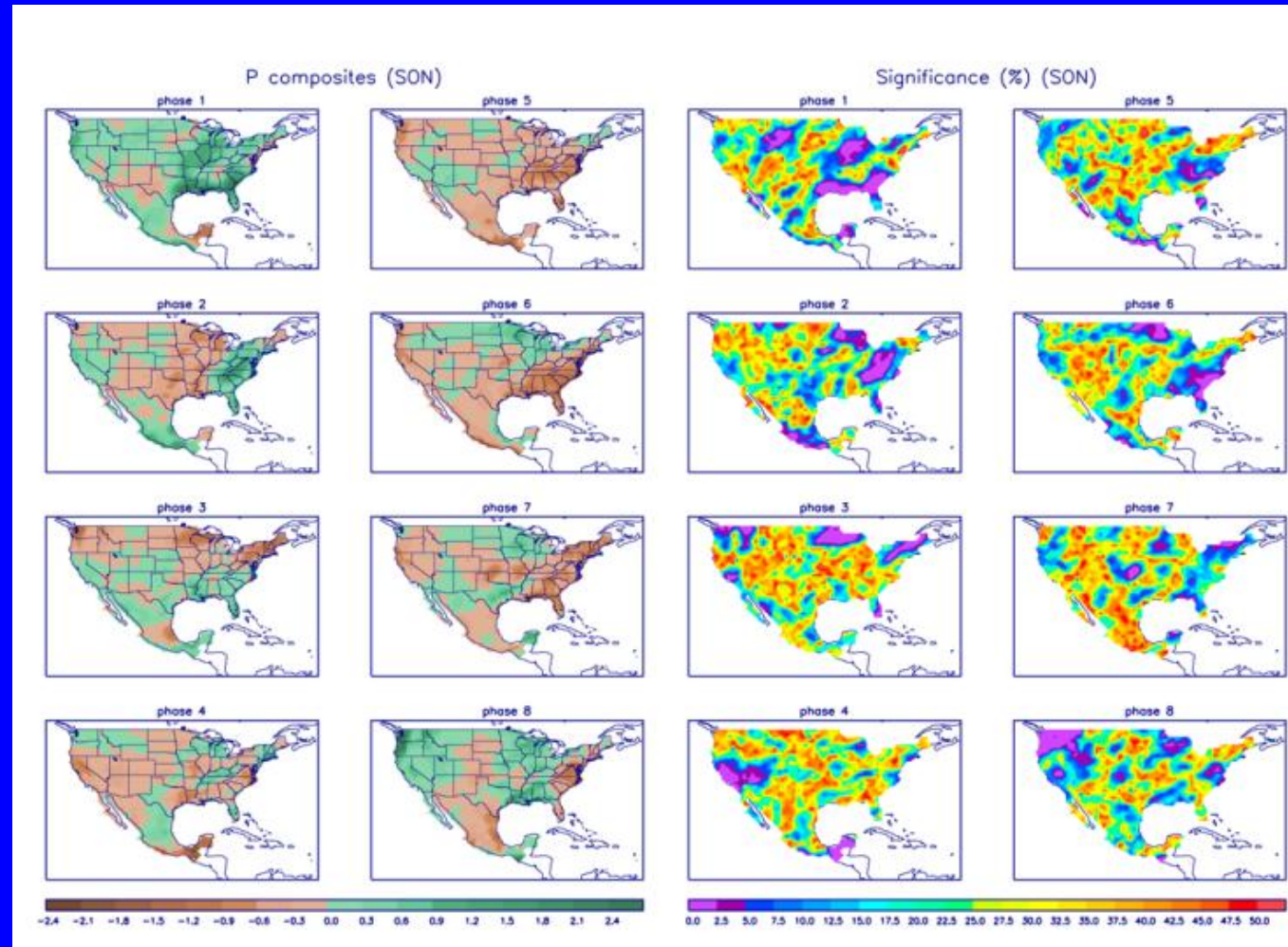
Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

<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

<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml>