



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

**Update prepared by
Climate Prediction Center / NCEP
September 3, 2012**



Outline

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



Overview

- **The MJO continued to show signs of weakening during the past week.**
- **Most dynamical model MJO index forecasts indicate a weak, incoherent signal. There is large spread and therefore high uncertainty in these forecasts.**
- **Based on the latest observations and most model forecasts, the MJO is forecast to be weak.**
- **The MJO is not expected to contribute substantially to areas of anomalous convection during the upcoming period. Uncertainty is high during the Week-2 period due to the expected weak MJO signal.**

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

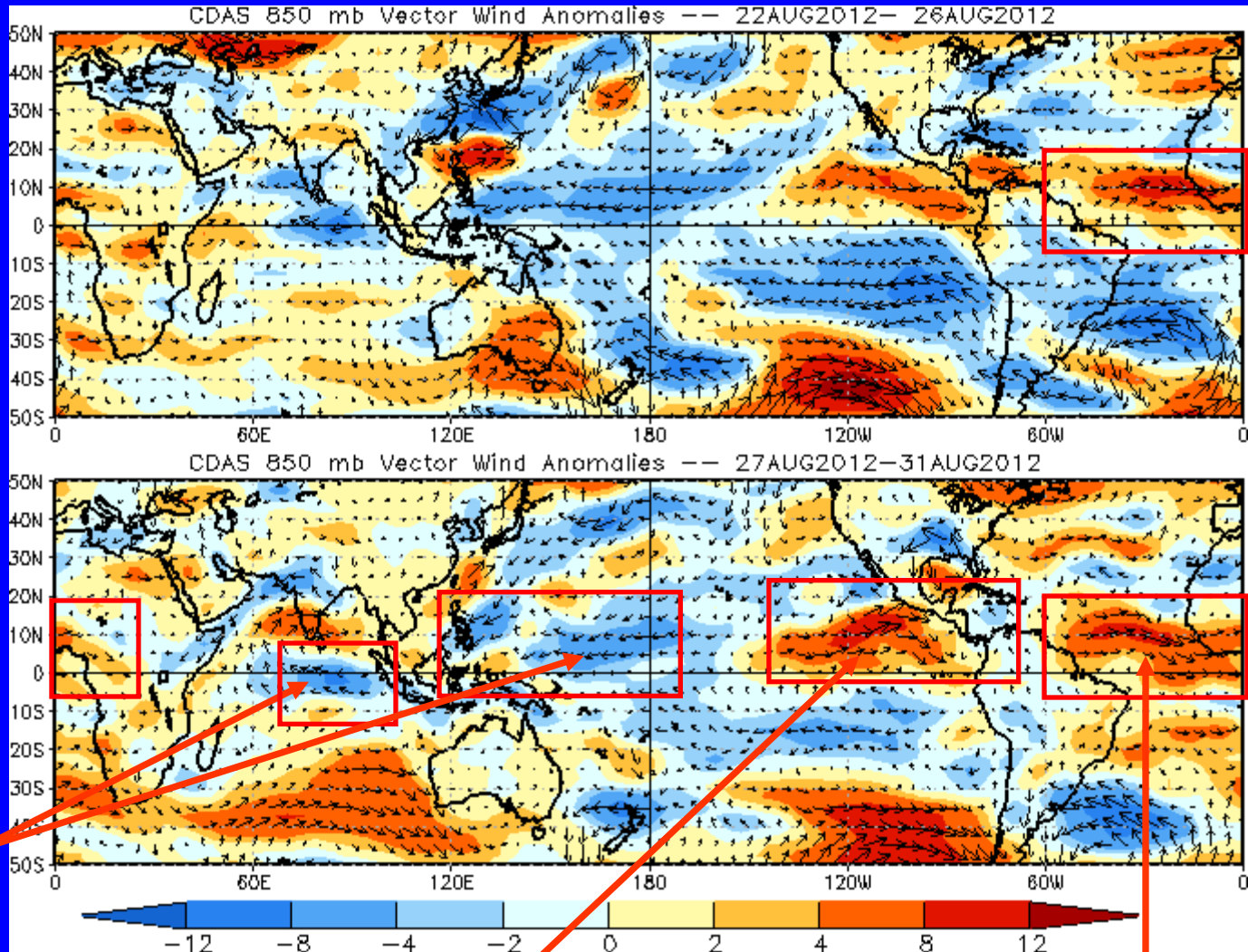


850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Easterly anomalies continued over the eastern Indian Ocean and the west-central Pacific during the past five days.

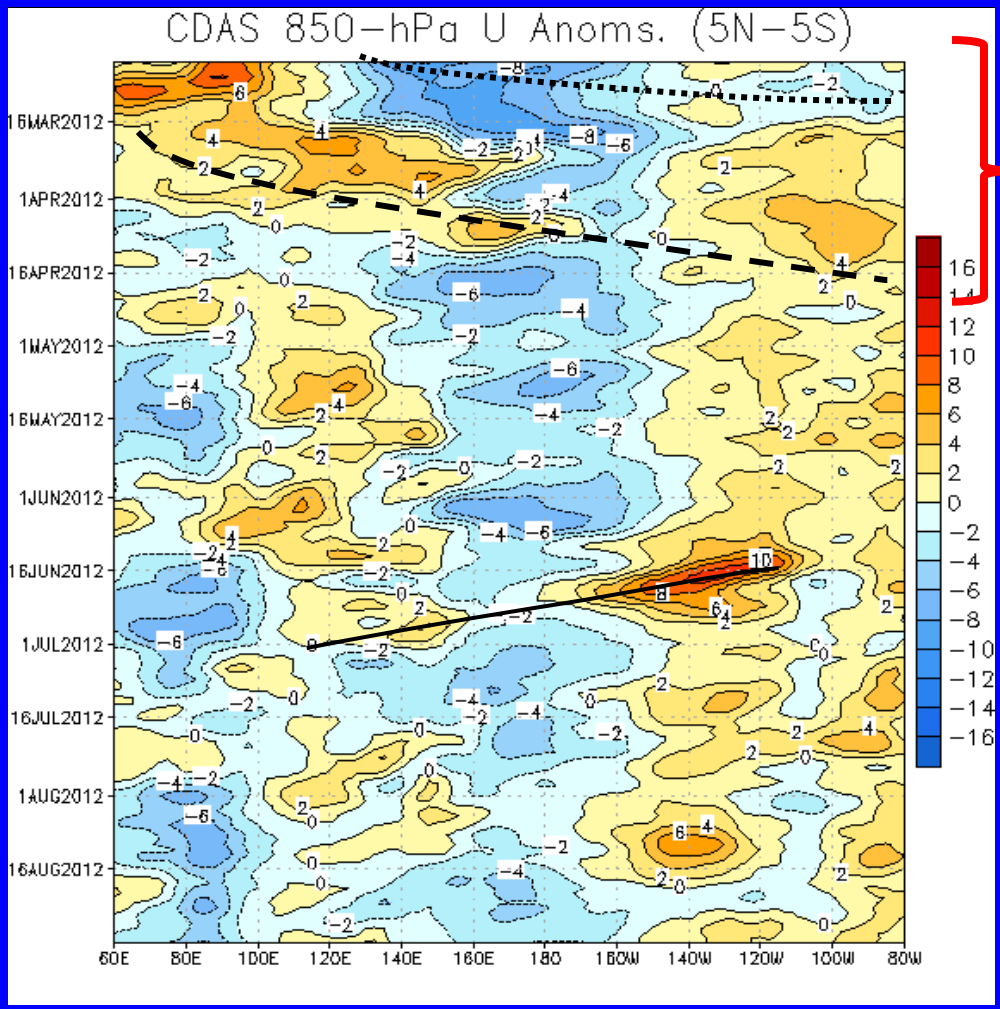
Westerly wind anomalies strengthened across the eastern Pacific during the past five days.

Westerly wind anomalies continued across the tropical Atlantic and western Africa.



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



During February and March, the MJO (alternating black dashed and dotted lines) 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.

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

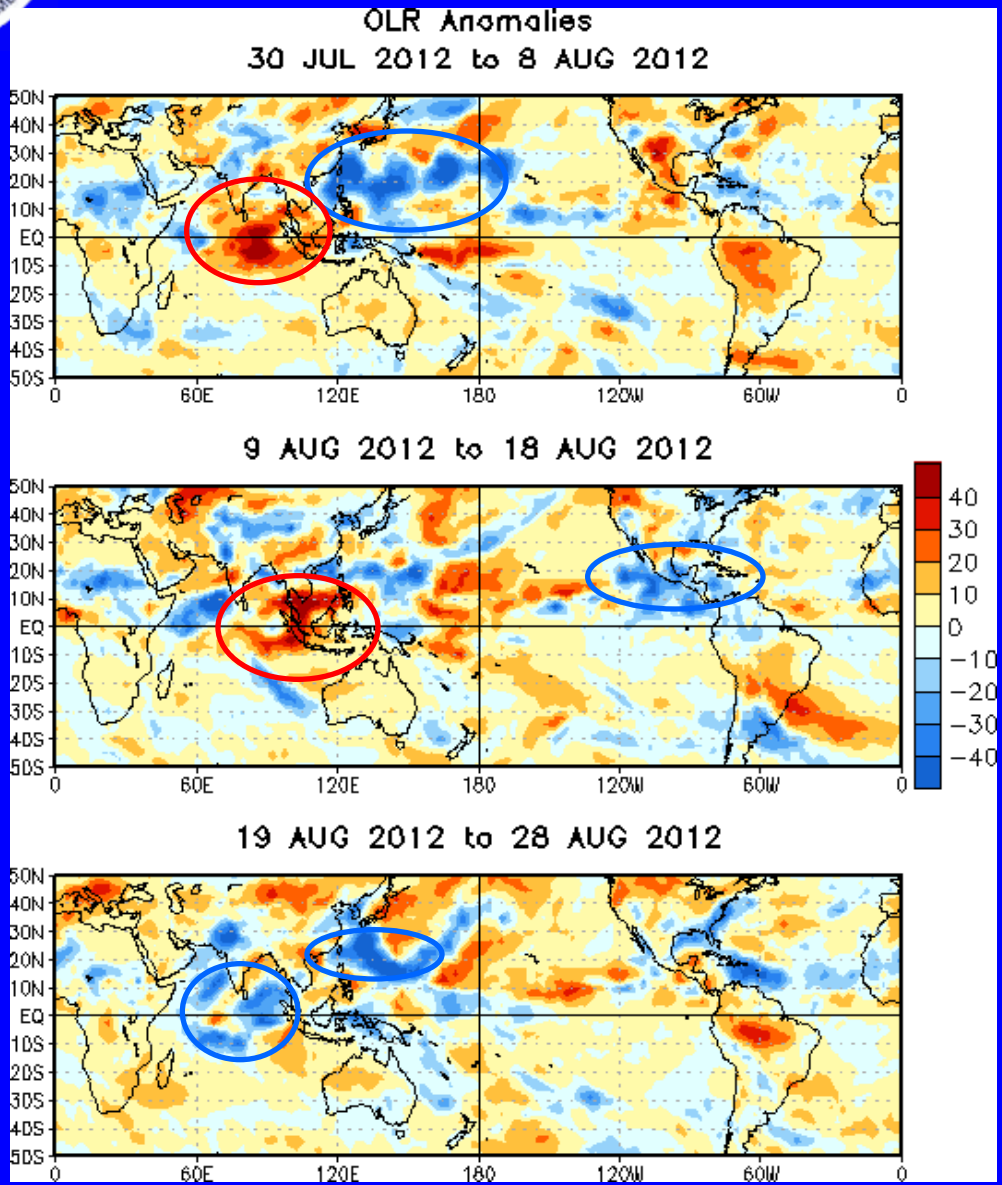
Easterly anomalies have persisted near 90E and the Date Line. Westerly anomalies have recently returned to the eastern Pacific.

Longitude



OLR Anomalies – Past 30 days

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



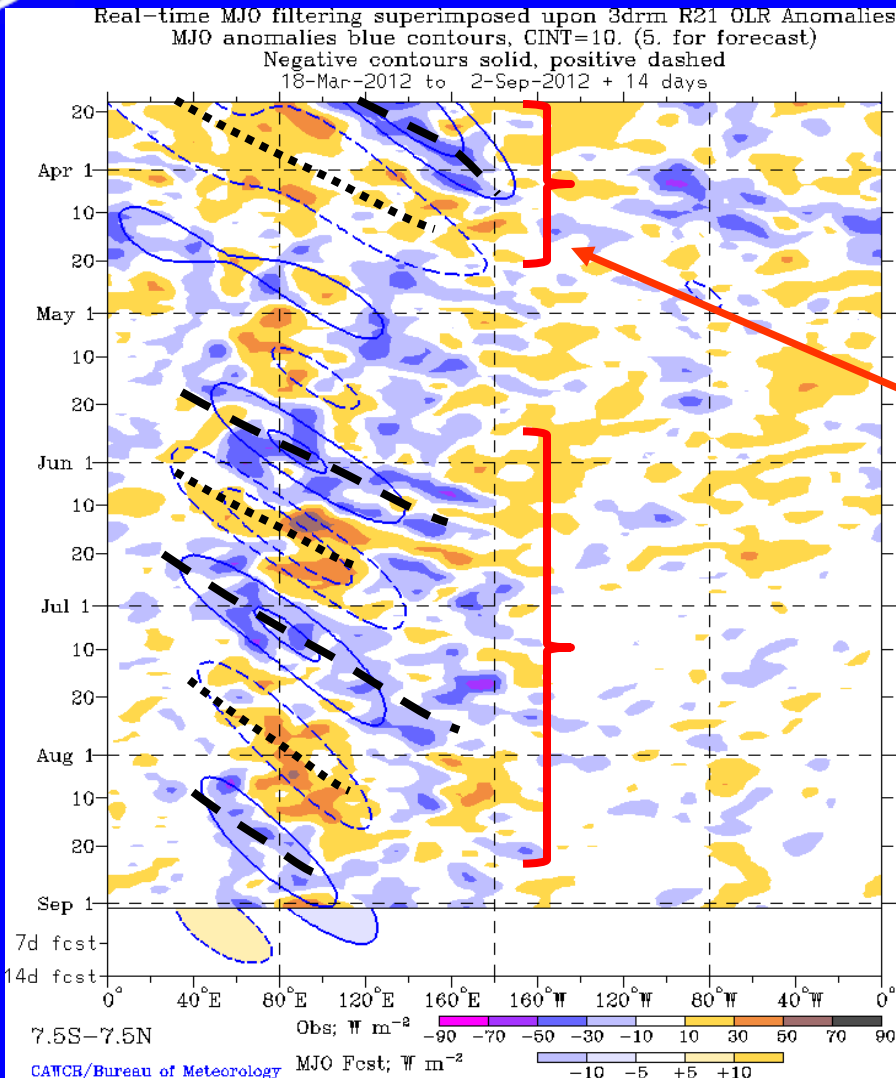
Enhanced convection was observed over the Western Pacific from late July into the beginning of August while suppressed convection developed across the Indian Ocean. Drier weather was observed for the North American monsoon region.

In mid August, anomalous convection developed across the eastern Pacific, central America, and the Caribbean Sea, while suppressed convection shifted slightly eastward, over the eastern Indian Ocean and Maritime Continent.

During mid to late August, enhanced convection was observed over the Indian Ocean. Enhanced convection was also observed in the northwest Pacific and from the Caribbean to the northern Gulf of Mexico, which was associated with tropical cyclone activity.



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)

Strong MJO activity (alternating dashed and dotted lines) was evident during February and continued into mid-April.

In late May into August, eastward propagation of both enhanced and suppressed convection is evident across the eastern hemisphere. Atmospheric Kelvin wave activity also played a large role in the pattern of anomalous convection across the Pacific and western Hemisphere during this period.

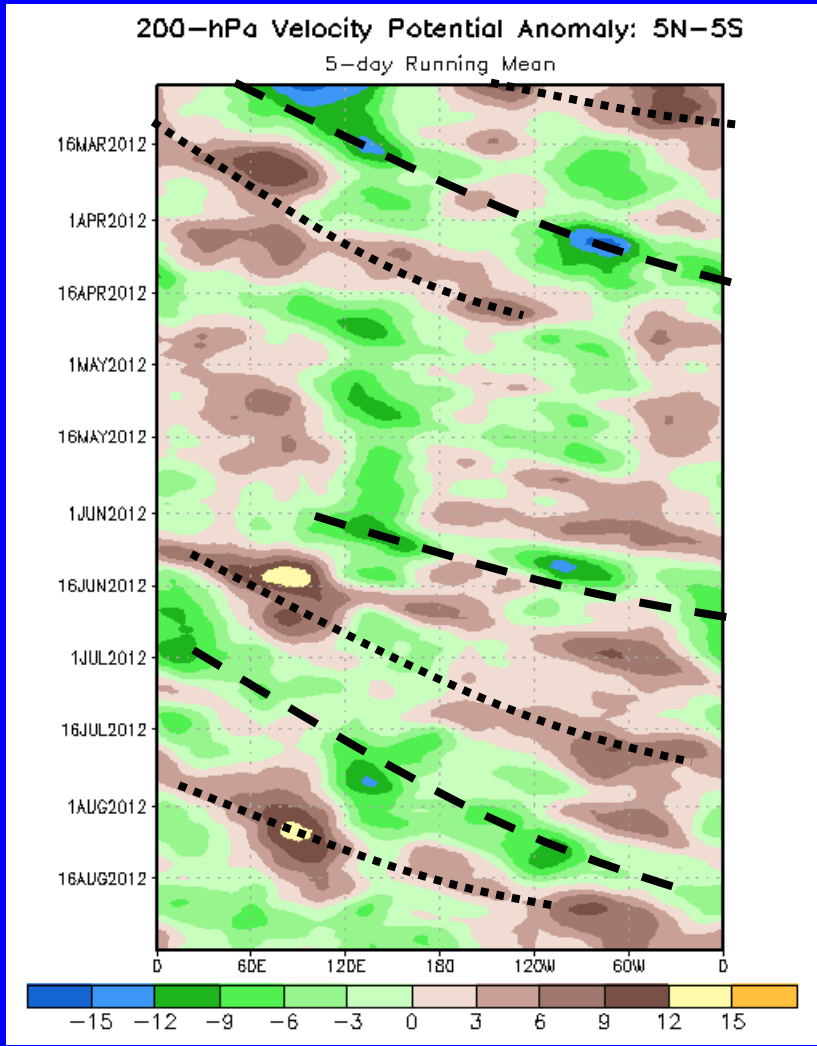


200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time
↓



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 August associated with the MJO, as well as atmospheric Kelvin wave activity, which at times resulted in fast eastward propagation of observed anomalies. Most recently, anomalies of upper-level convergence and divergence have decreased somewhat.

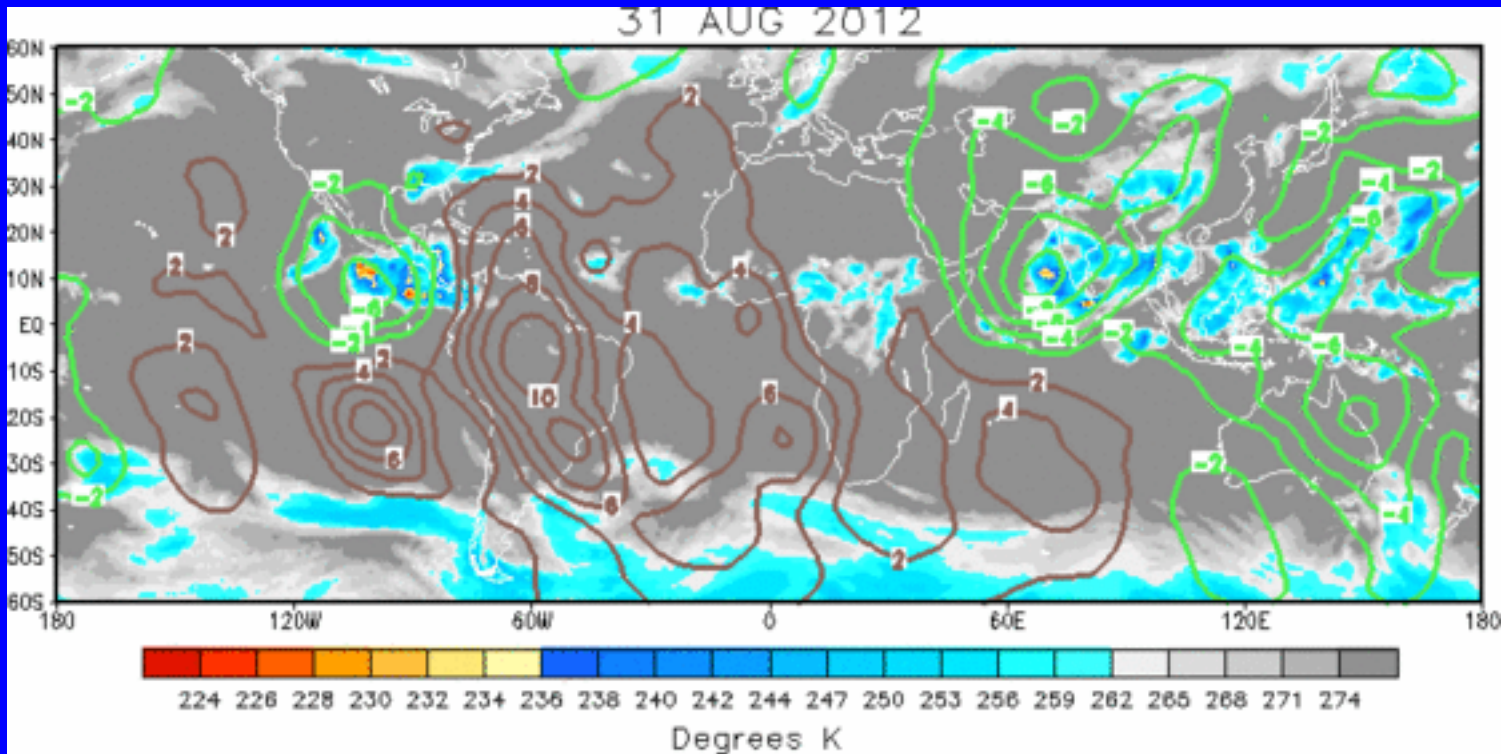
Longitude



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 reflects anomalous upper-level convergence across South America and the tropical Atlantic. Anomalous upper-level divergence is evident from the Indian Ocean eastward to the western Pacific Ocean.

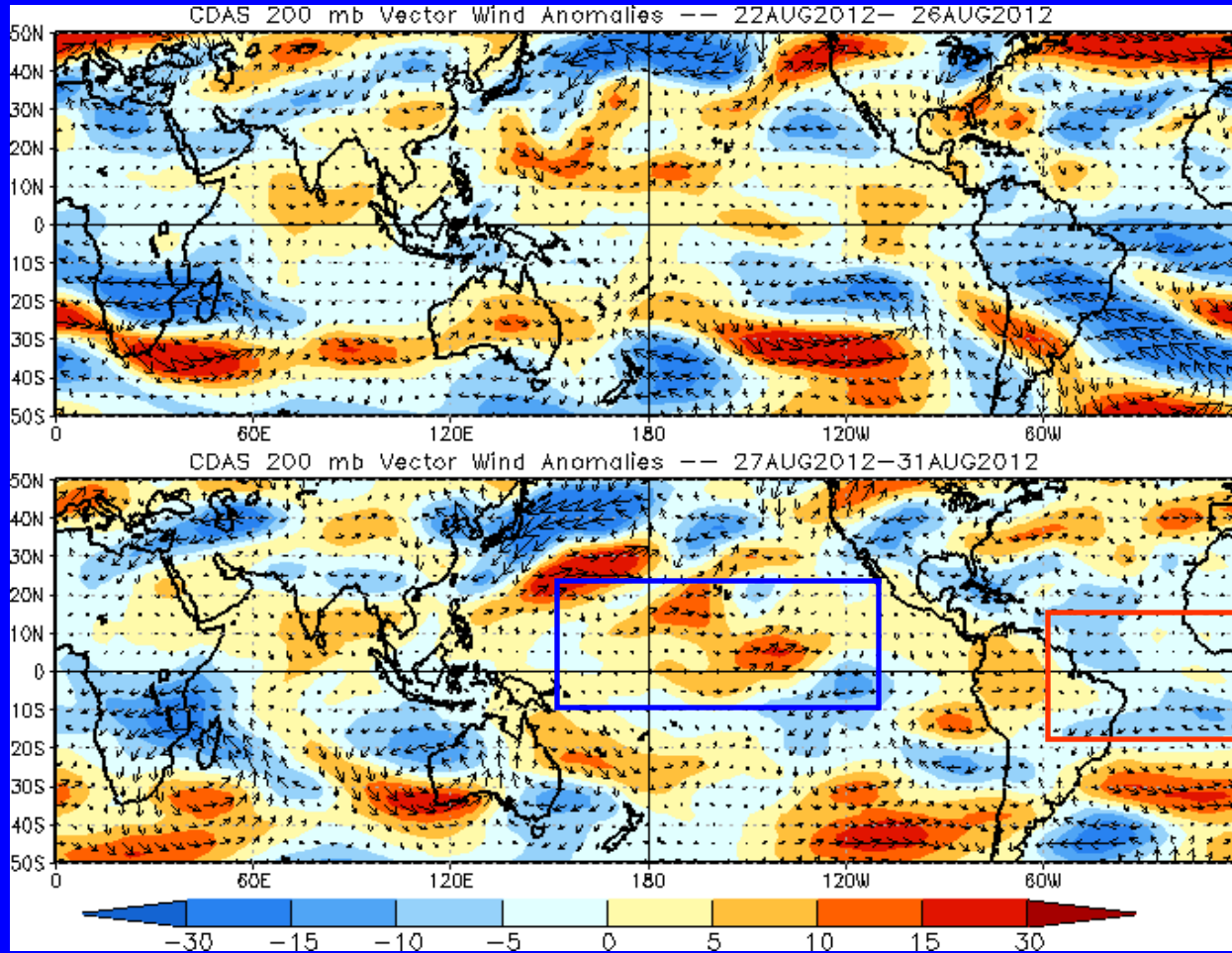


200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



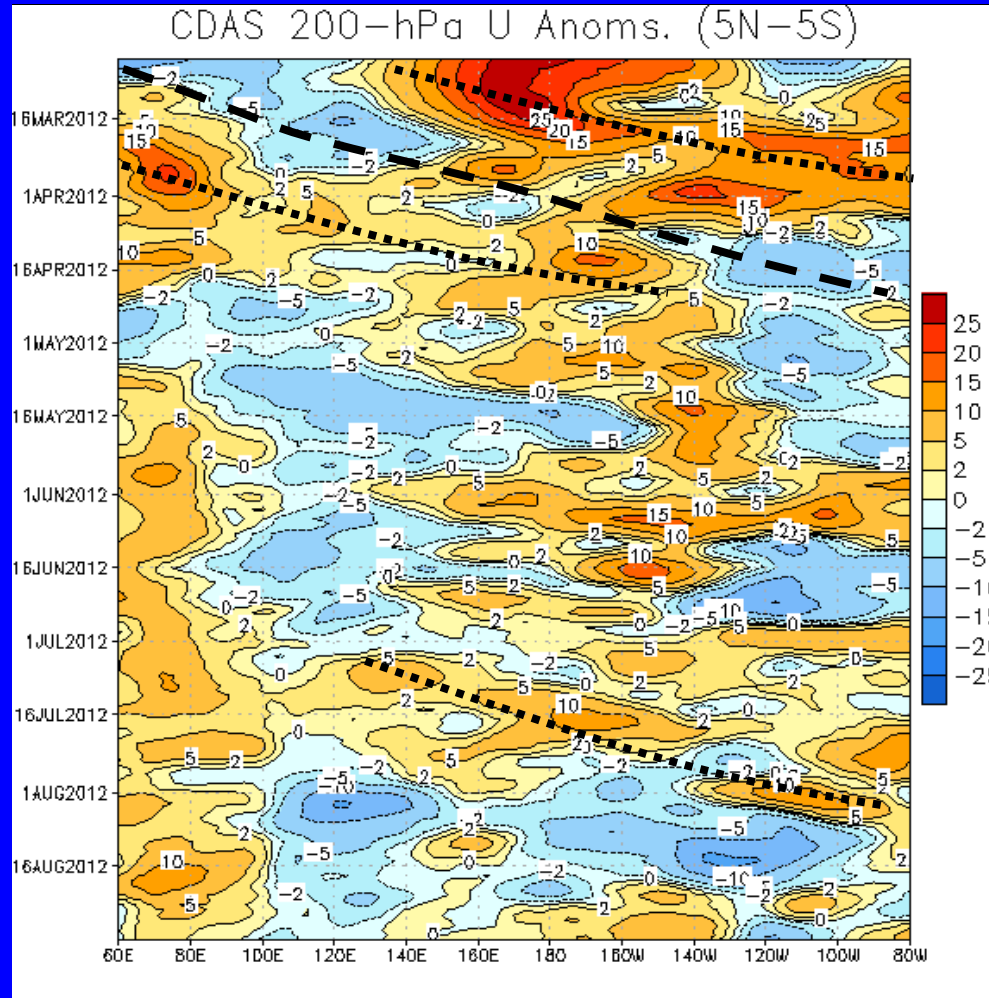
Westerly anomalies (blue box) increased across the central Pacific ocean and easterly anomalies decreased over the tropical Atlantic (red box) during the last five days.



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



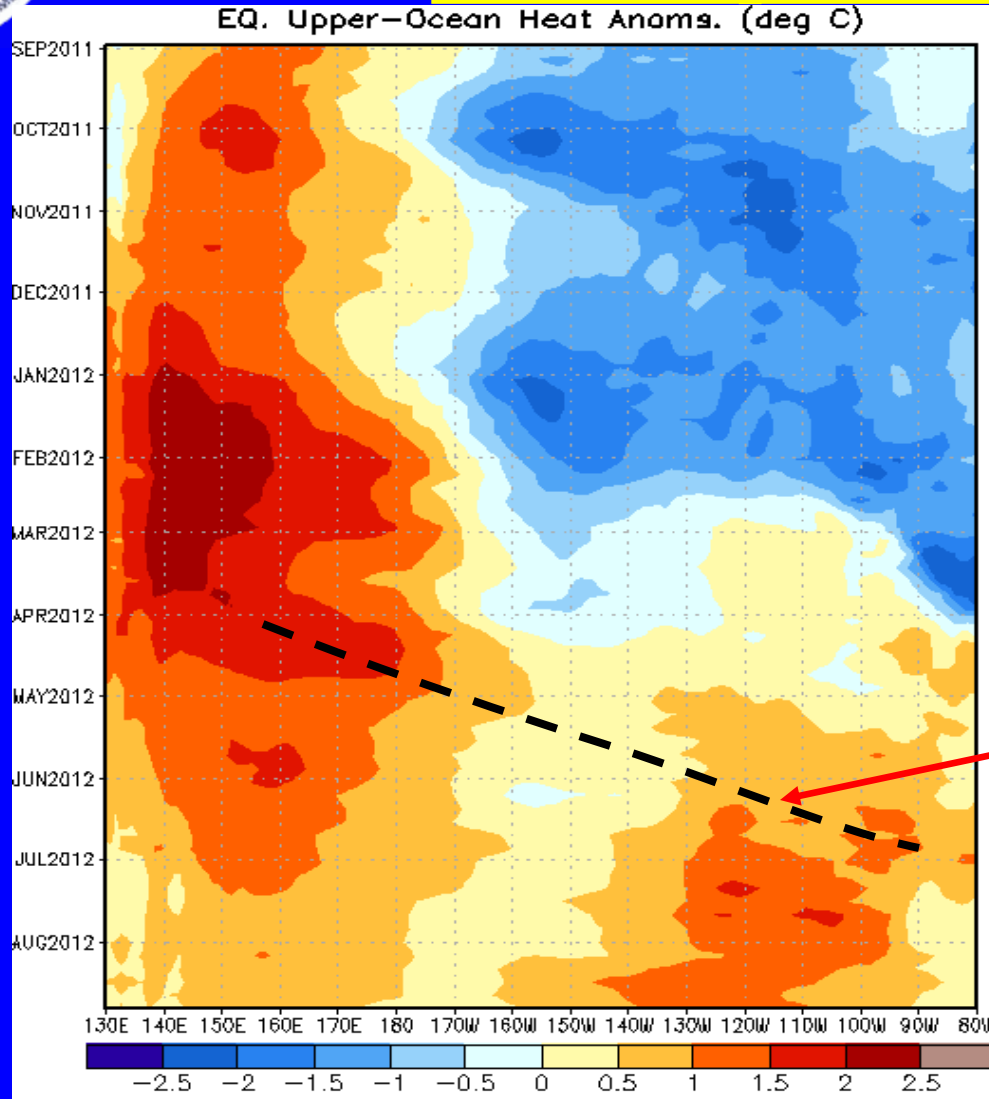
The MJO strengthened once again in late January as indicated by alternating westerly (dotted lines) and easterly (dashed lines) anomalies. This activity continued to mid-April.

Anomalies were less coherent during much of April and May.

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



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.



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.

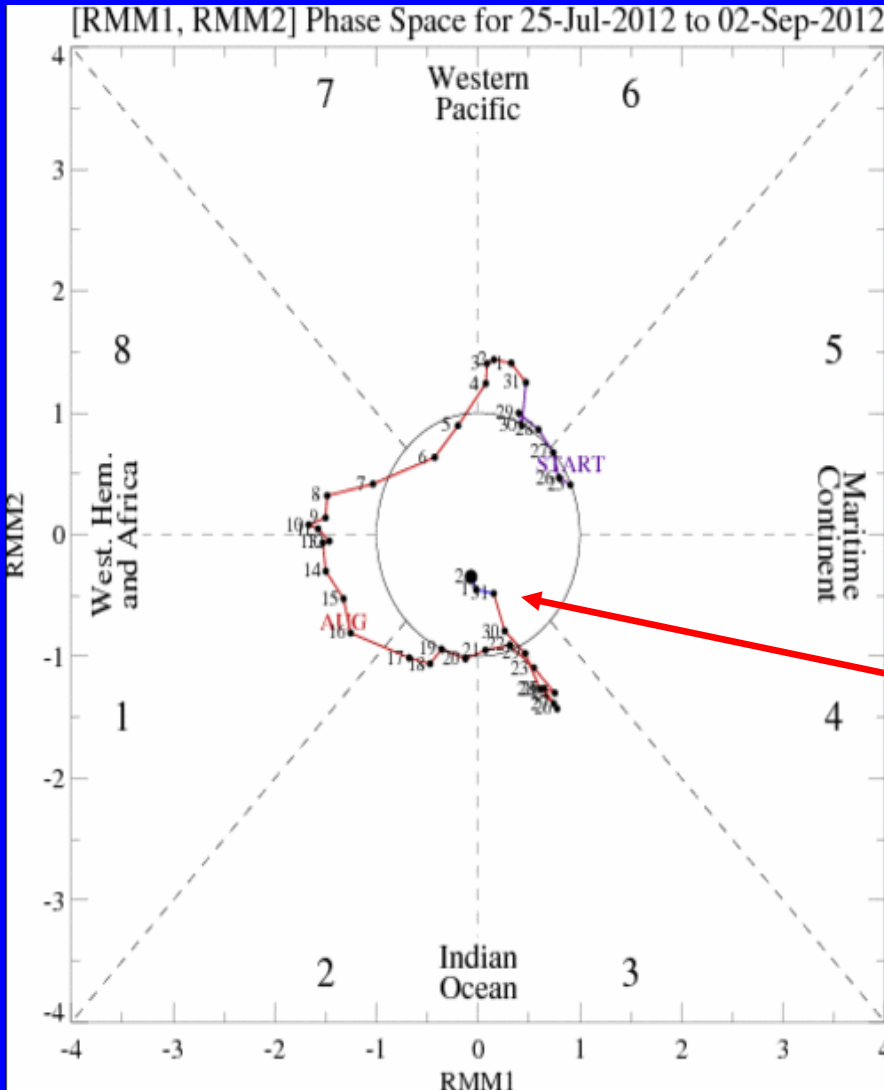
- The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.

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

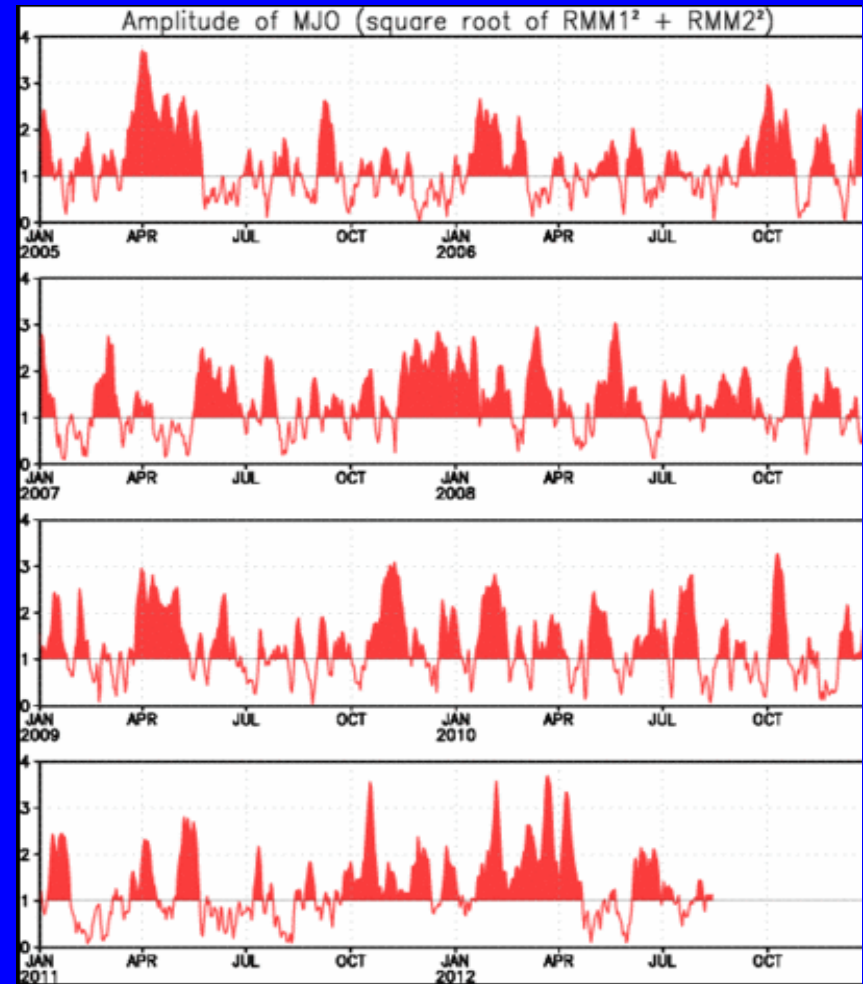
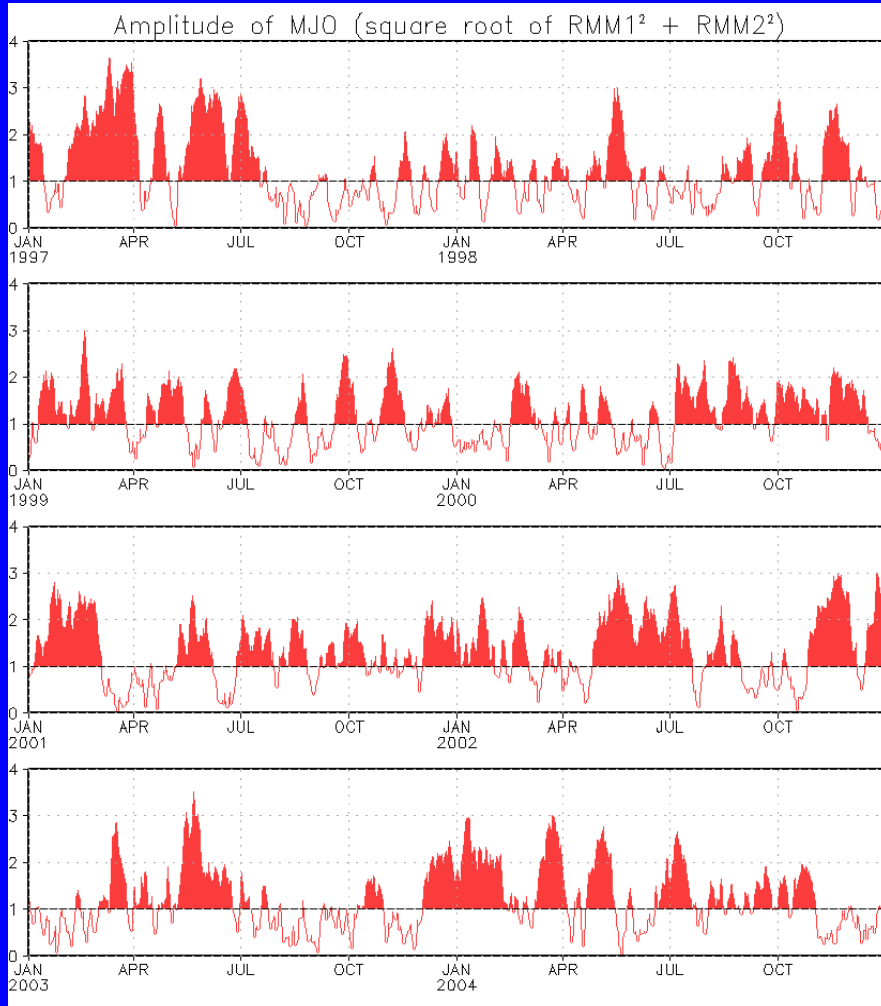


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO continued to show signs of weakening during the past week .



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.



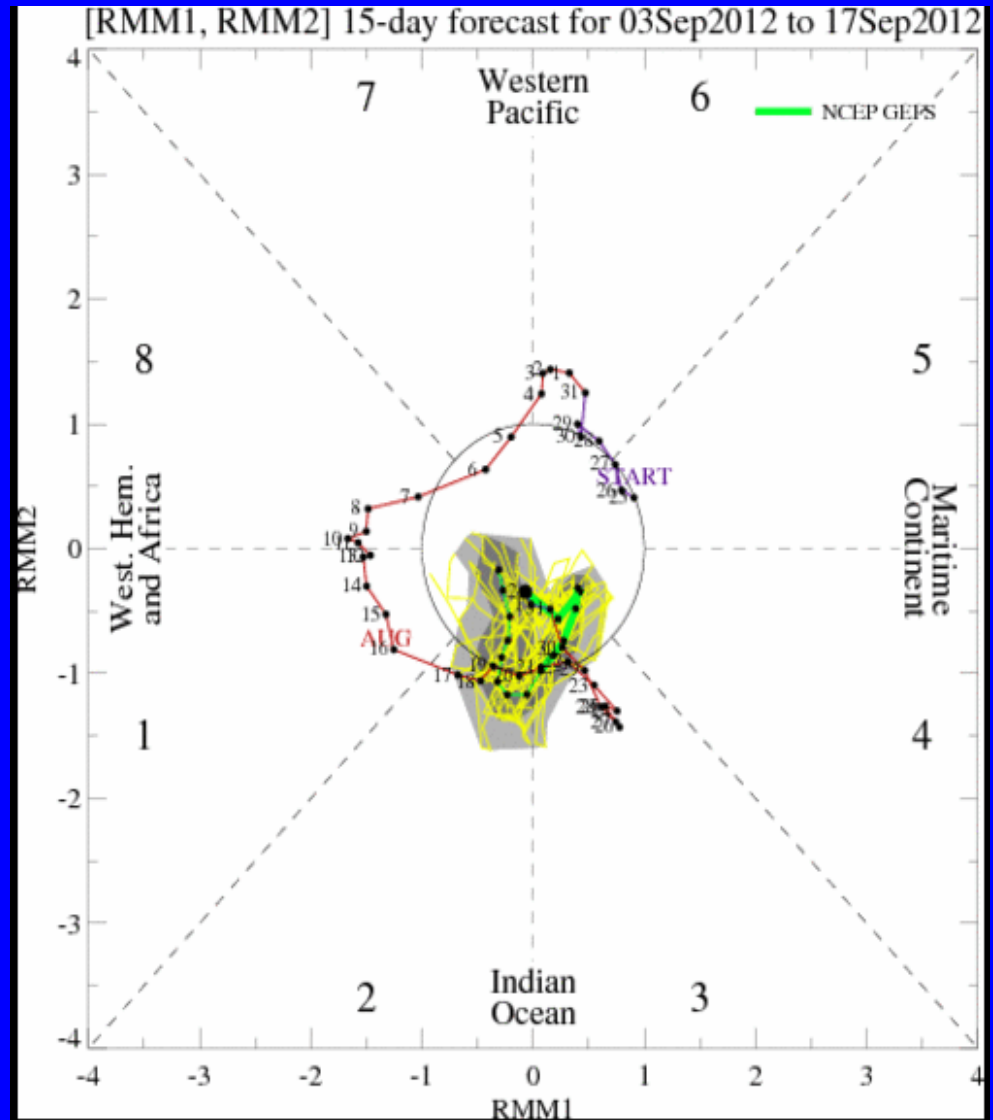
Ensemble GFS (GEFS) MJO Forecast

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 next two weeks.



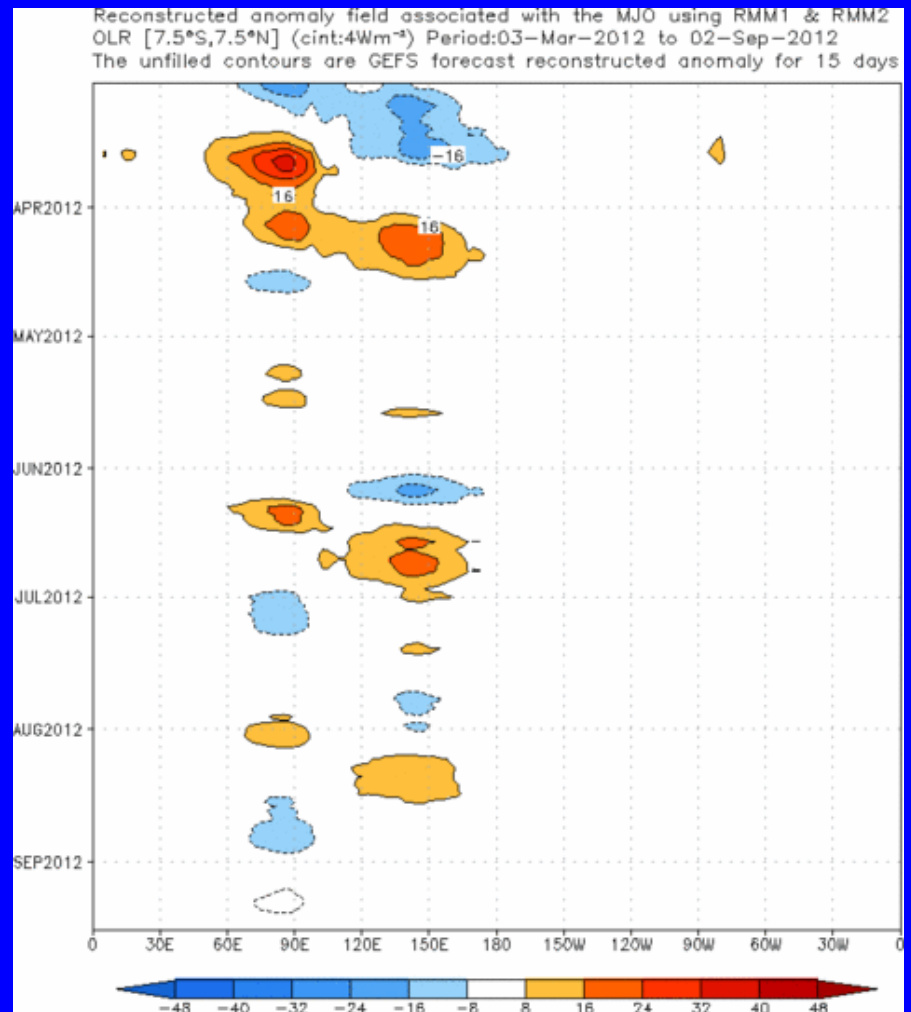
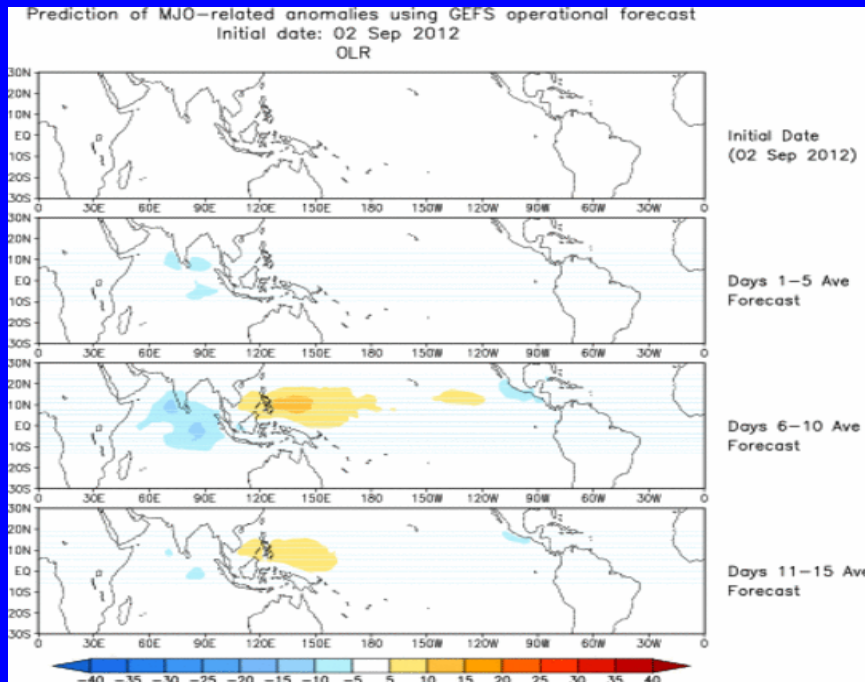


Ensemble Mean GFS MJO Forecast

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 generally weak anomalous convection during much of the forecast period.

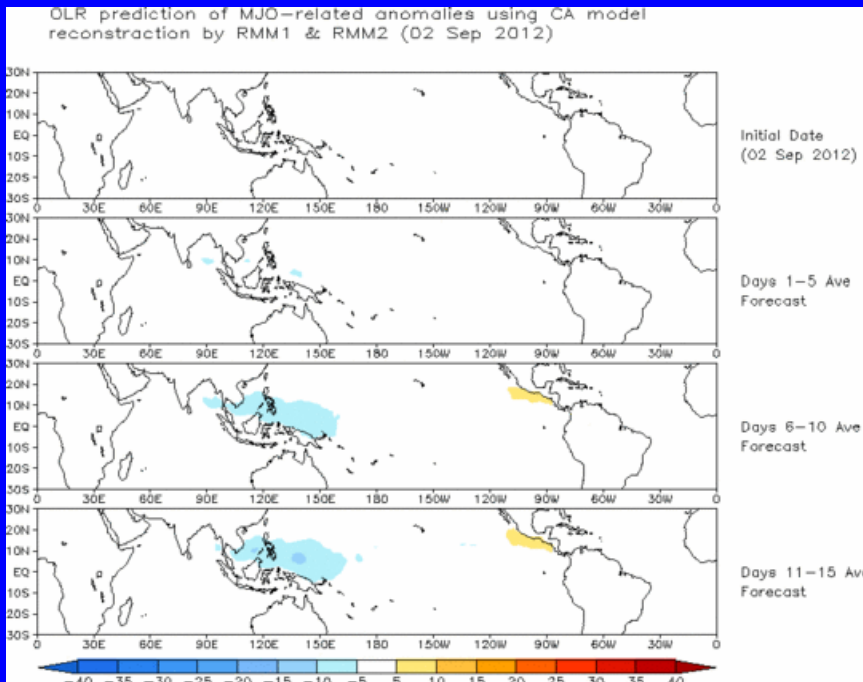


Constructed Analog (CA) MJO Forecast

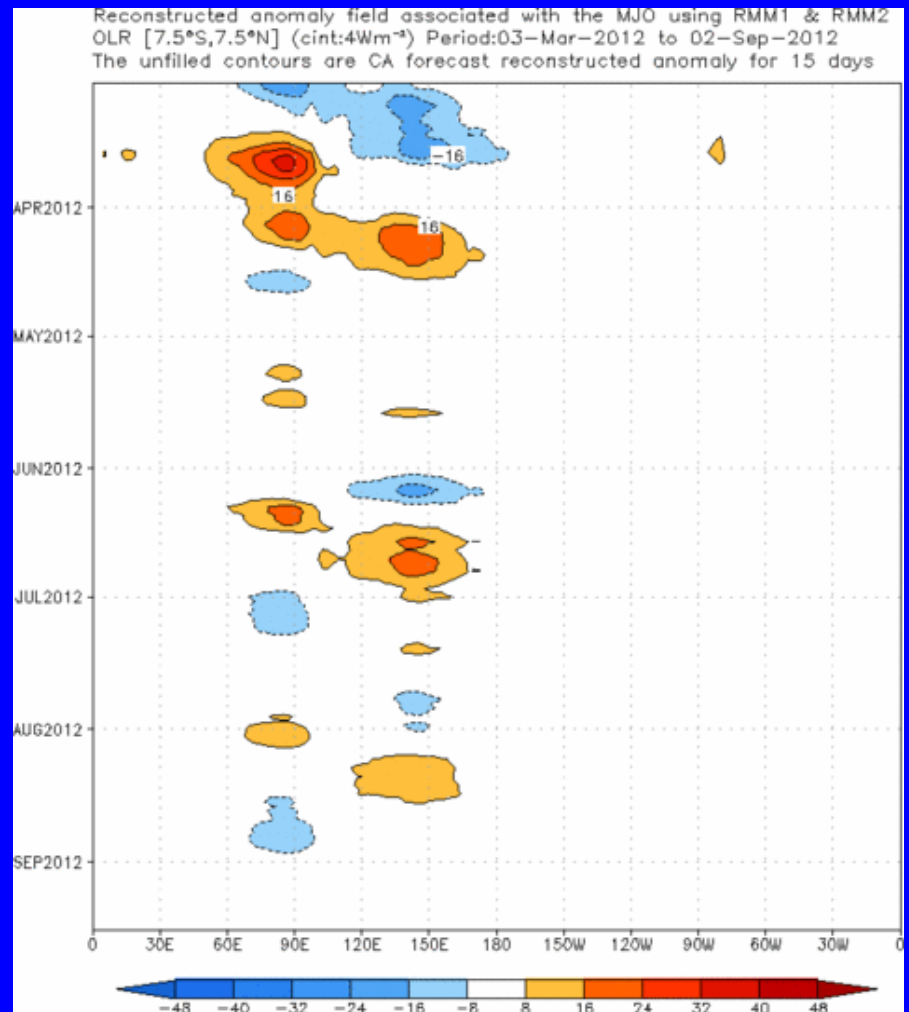
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

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 forecast indicates weakly enhanced convection over the Maritime Continent and western Pacific mainly during Week-2.

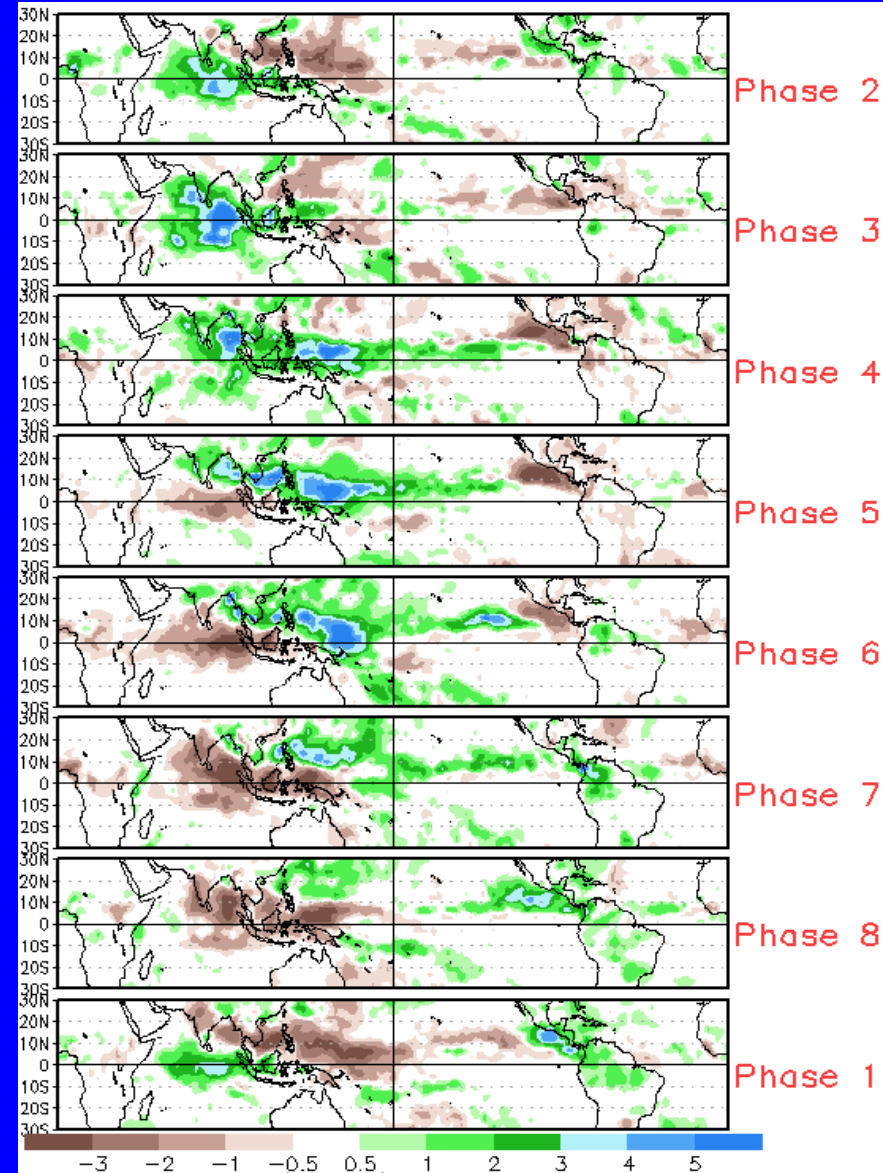
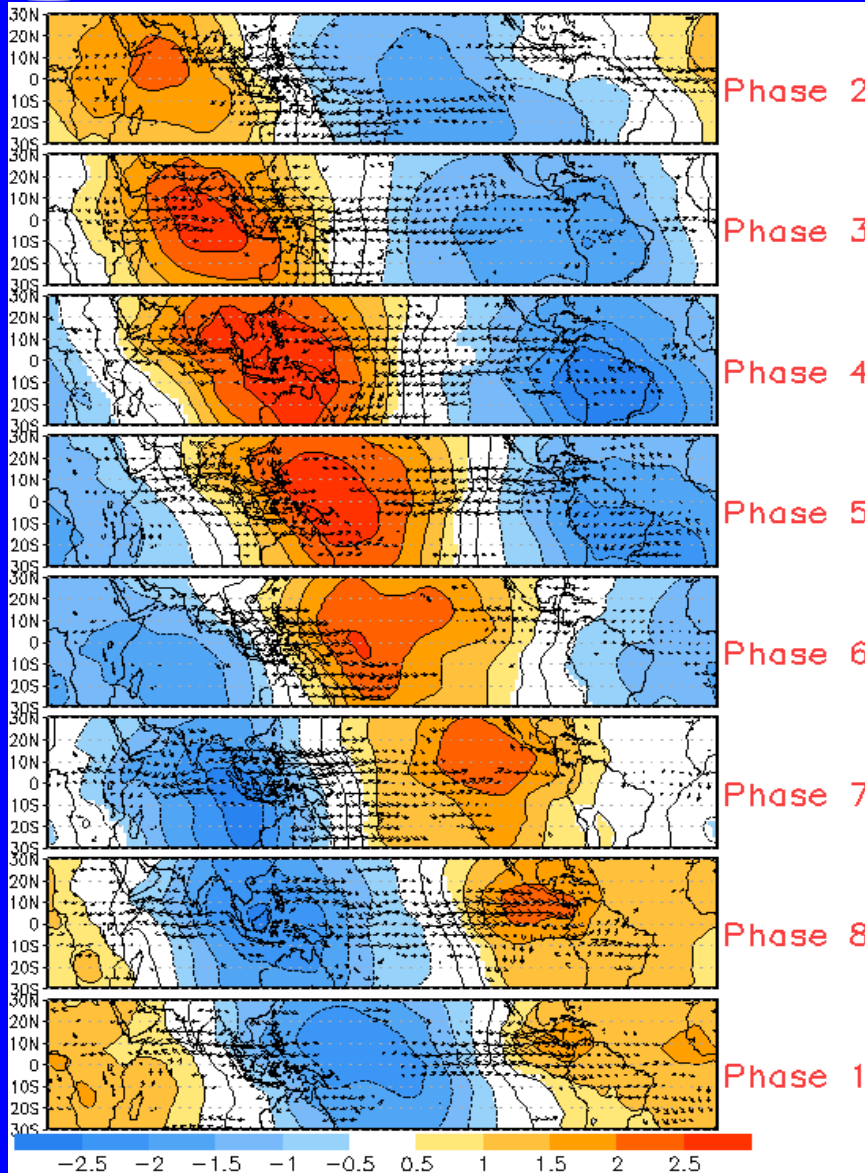




MJO Composites – Global Tropics

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

Precipitation Anomalies (May-Sep)

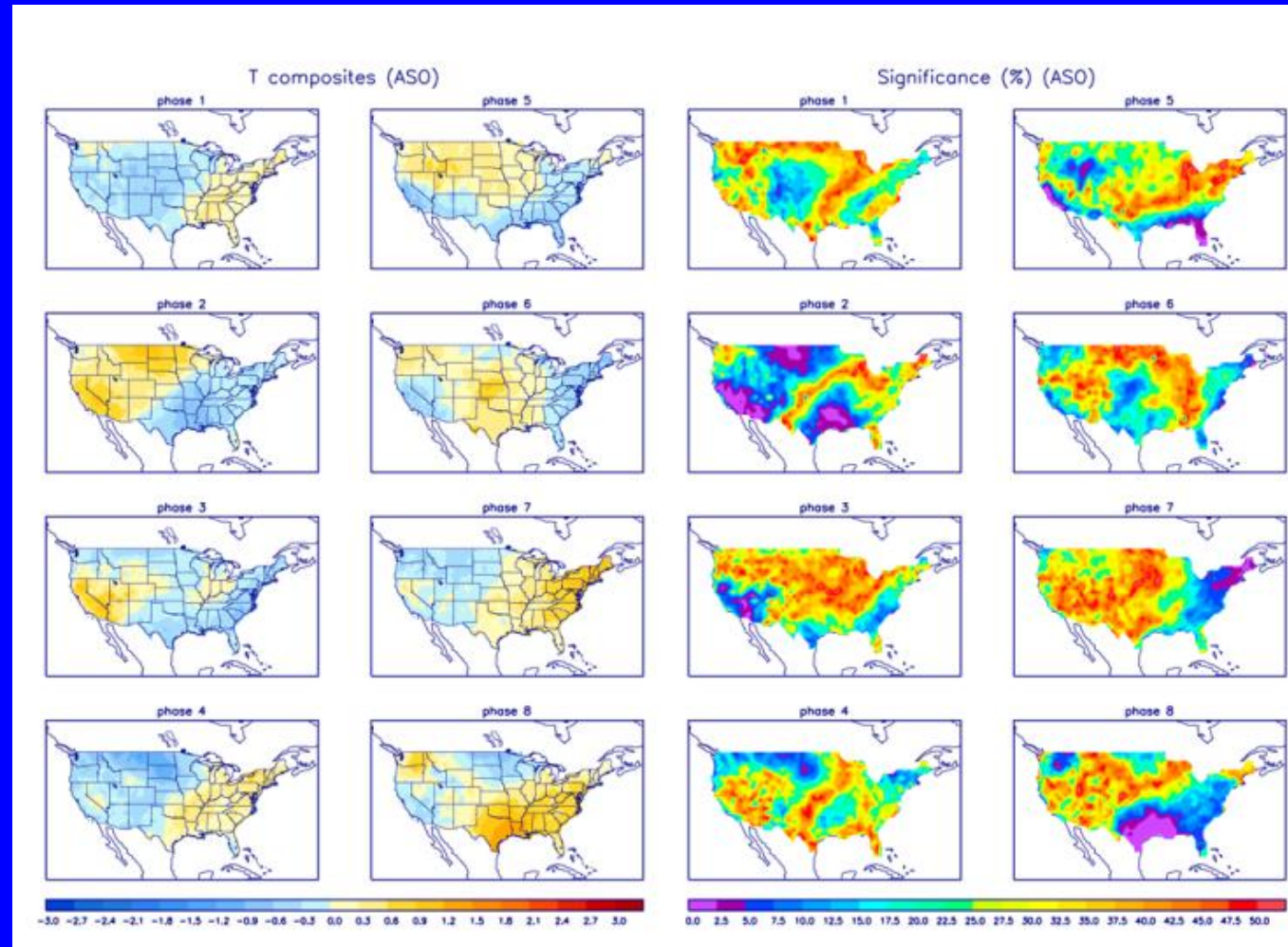




U.S. MJO Composites – Temperature

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.



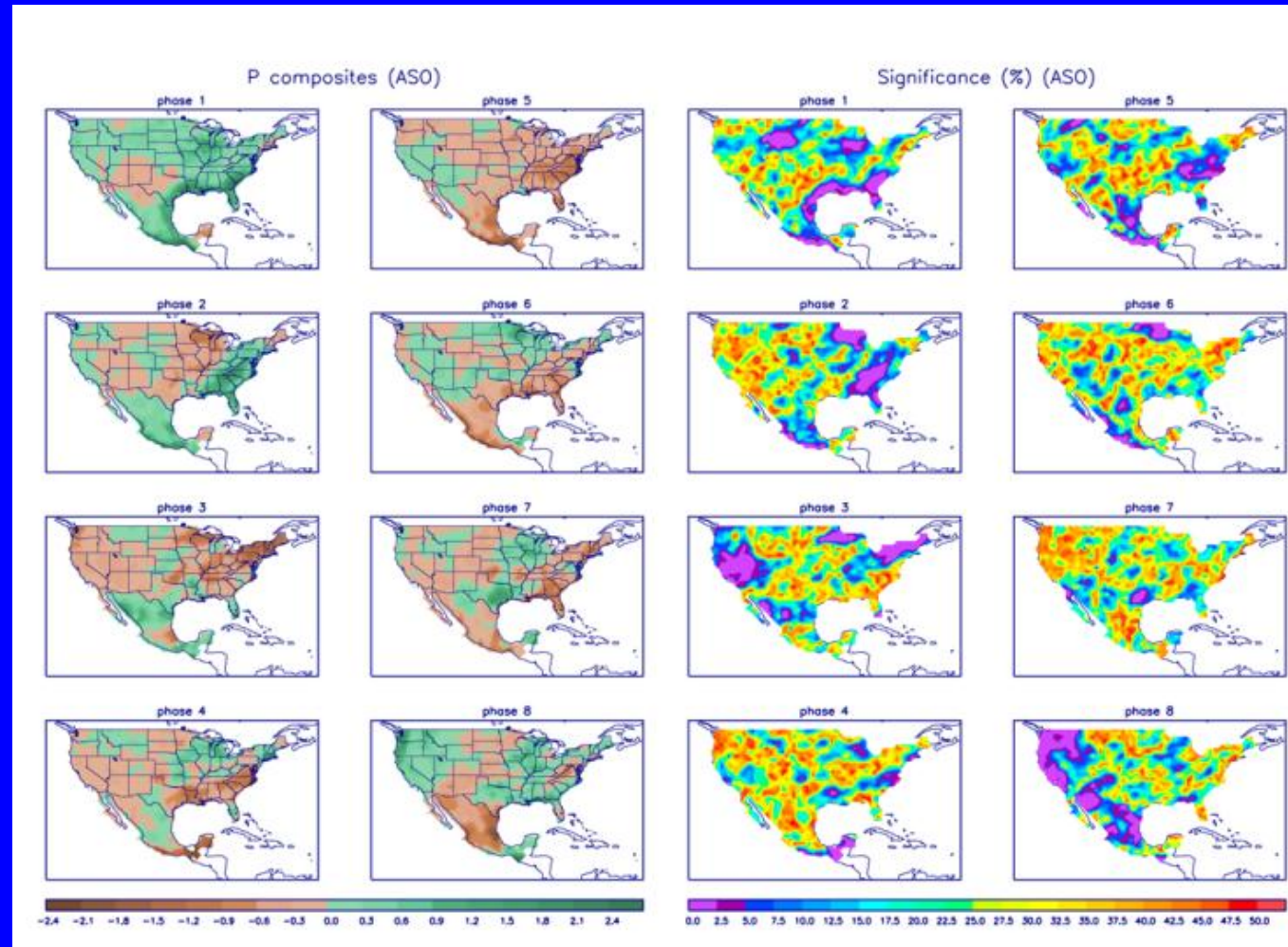
Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

<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

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