



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

**Update prepared by
Climate Prediction Center / NCEP
December 06, 2010**



Outline

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



Overview

- The MJO remained weak during much of the past week, however, recently the signal has strengthened.
- The majority of dynamical model MJO forecasts indicate continued activity during Week-1, with eastward propagation of an MJO signal for Week-2.
- Despite some model forecasts for a continued MJO signal, it is possible that this signal is a combination of other factors, including background La Nina conditions especially given the co-location with the core La Nina region, rather than coherent MJO development.
- Nevertheless, the potential for a propagating MJO signal needs to be closely monitored in the upcoming 1-2 week period and rainfall likely will increase across the Maritime continent over the period.

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



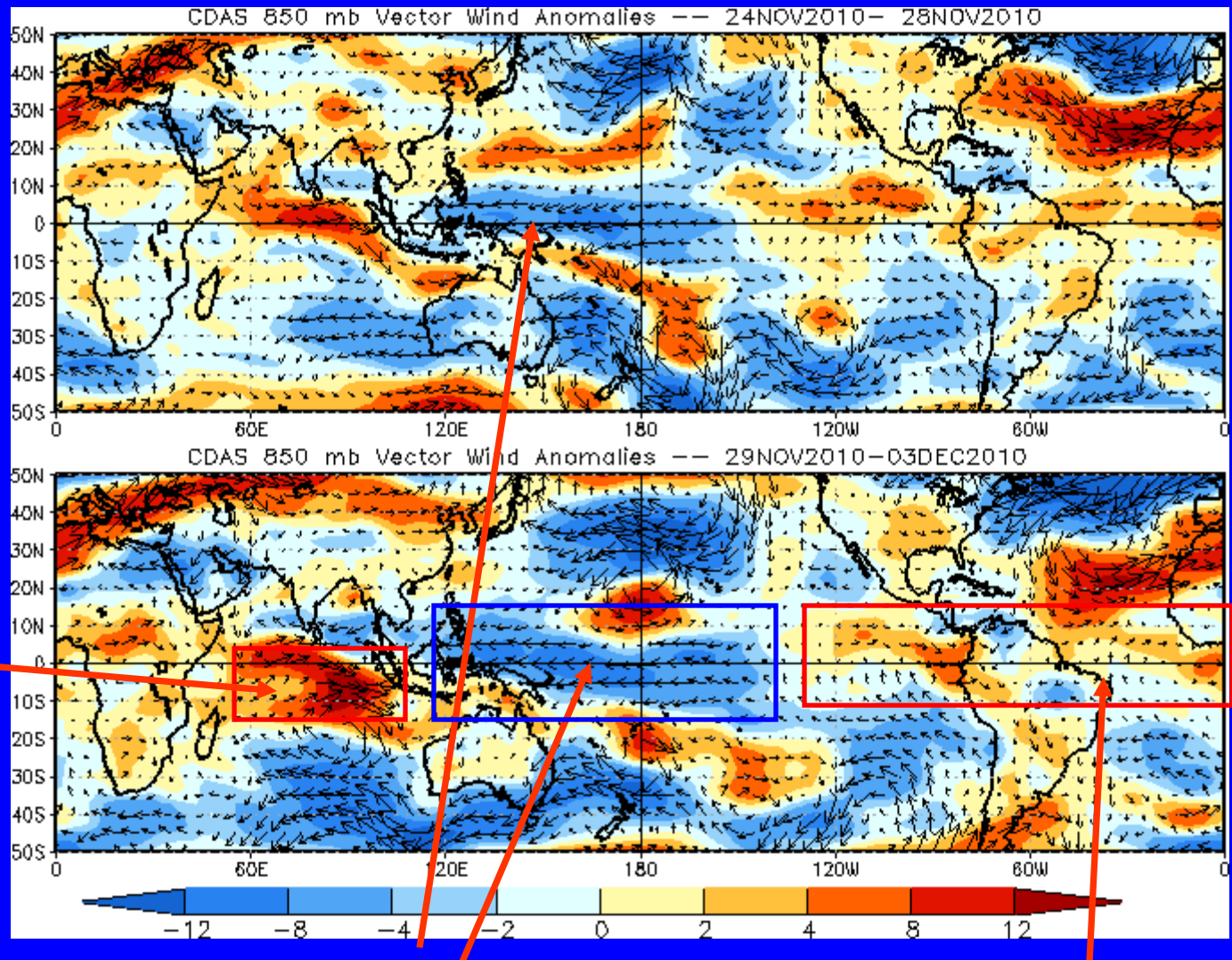
850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

Westerly anomalies continued across parts of the Indian Ocean during the last five days.



Easterly anomalies continued across the western Pacific during the last five days.

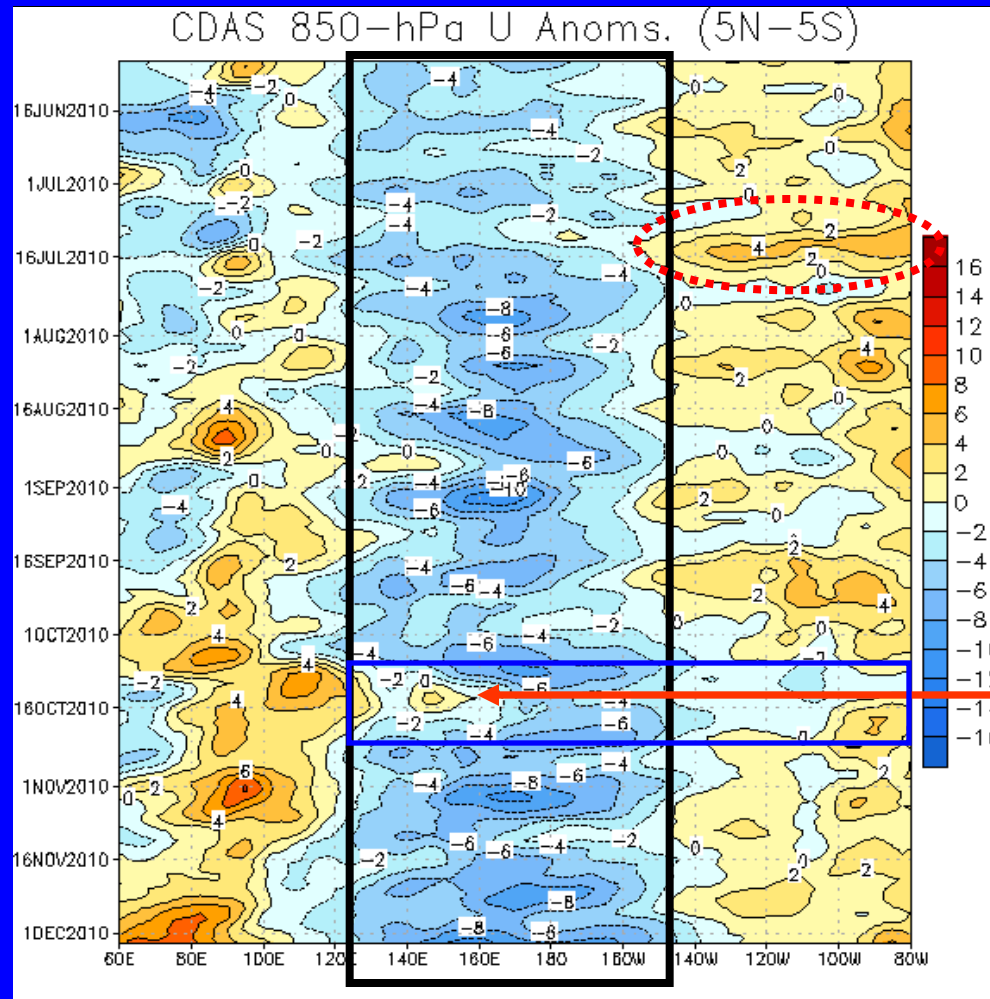
Westerly anomalies weakened across the eastern Pacific and Atlantic during the last five days.



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



Easterly anomalies have persisted in the west-central Pacific since June (black box) consistent with the development of La Nina conditions.

Enhanced westerly anomalies (red dotted oval) occurred across the eastern Pacific during early-to-mid July and these were in part associated with MJO activity.

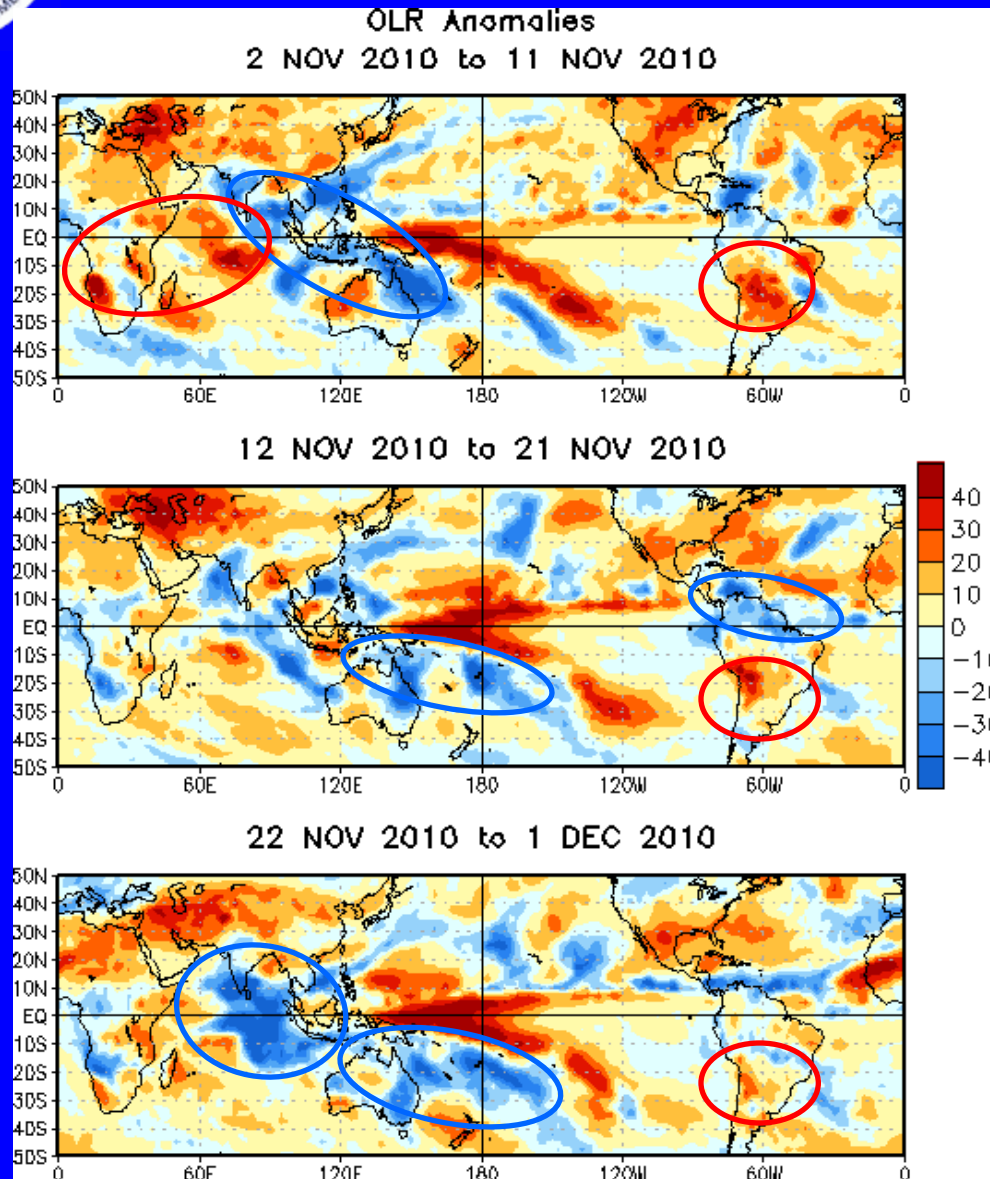
The MJO strengthened in October as evidenced by weak westerly anomalies and a weakening of the easterlies across the central Pacific during mid-October. Also, westerly anomalies weakened across the eastern Pacific at the same time (blue box).



OLR Anomalies – Past 30 days

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

Wetter-than-normal conditions, negative OLR anomalies (blue shading)



Drier-than-average conditions (red circle) continued across central South America in early November, while enhanced convection (blue circle) remained over the Maritime continent and eastern Australia. Suppressed convection developed across the western equatorial Indian Ocean and continued over Africa.

In mid-November, enhanced convection continued over parts of the western Pacific and the Maritime continent, while wetter-than-average conditions developed over northern South America.

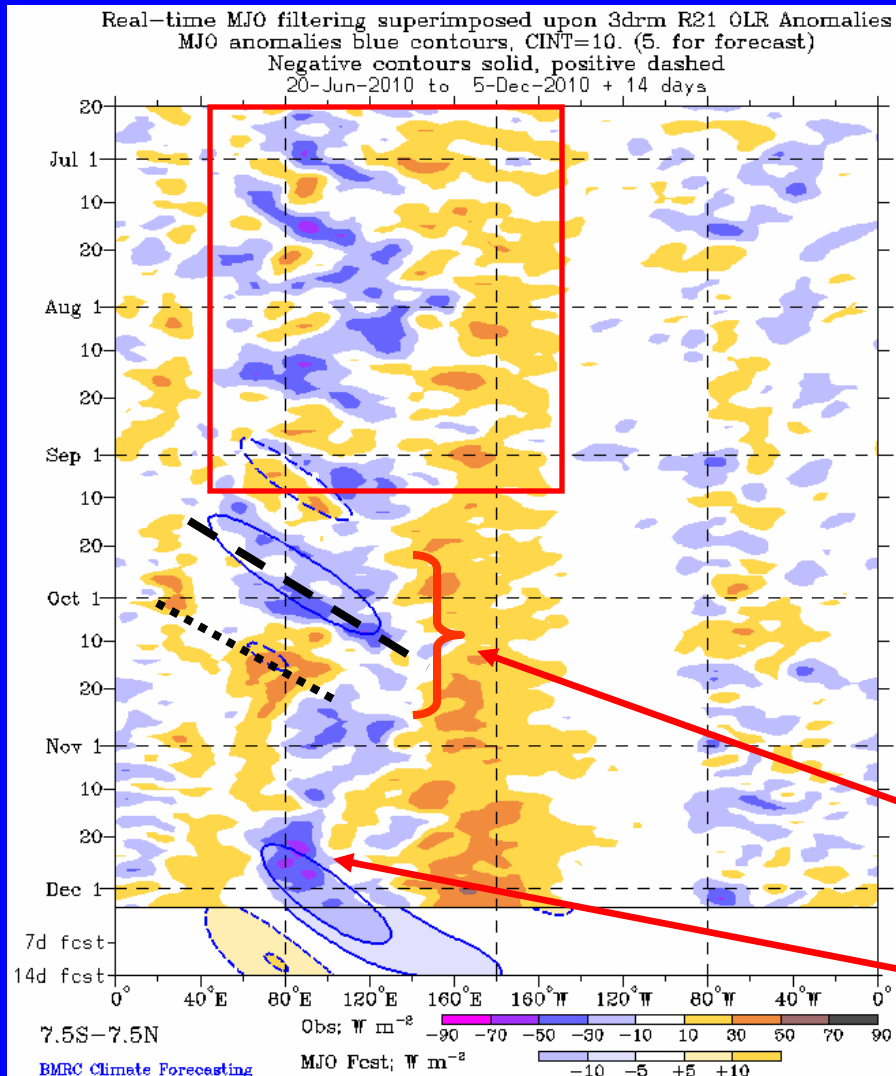
Enhanced convection developed over the Indian Ocean and continued over the southwest Pacific and Australia, while the suppressed convection over central South America began eased in mid-to-late November.



Outgoing Longwave Radiation (OLR)

Anomalies (7.5°S-7.5°N)

Time



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

Wetter-than-normal conditions, negative OLR anomalies (blue shading)

(Courtesy of the Bureau of Meteorology (BOM) - Australia)

From late-July into September, generally enhanced (suppressed) convection prevailed across the western Maritime continent (Date Line) (red box). Considerable intraseasonal variability is evident during the period as enhanced convection has shifted both eastward and westward in this area during the period but this has not been related to the MJO.

As the MJO strengthened in late September into October, enhanced convection developed near 60°E and shifted eastward followed by suppressed convection near 20°E during early-mid October.

Most recently, enhanced convection has developed near 80°E and is showing signs of eastward propagation.

Longitude

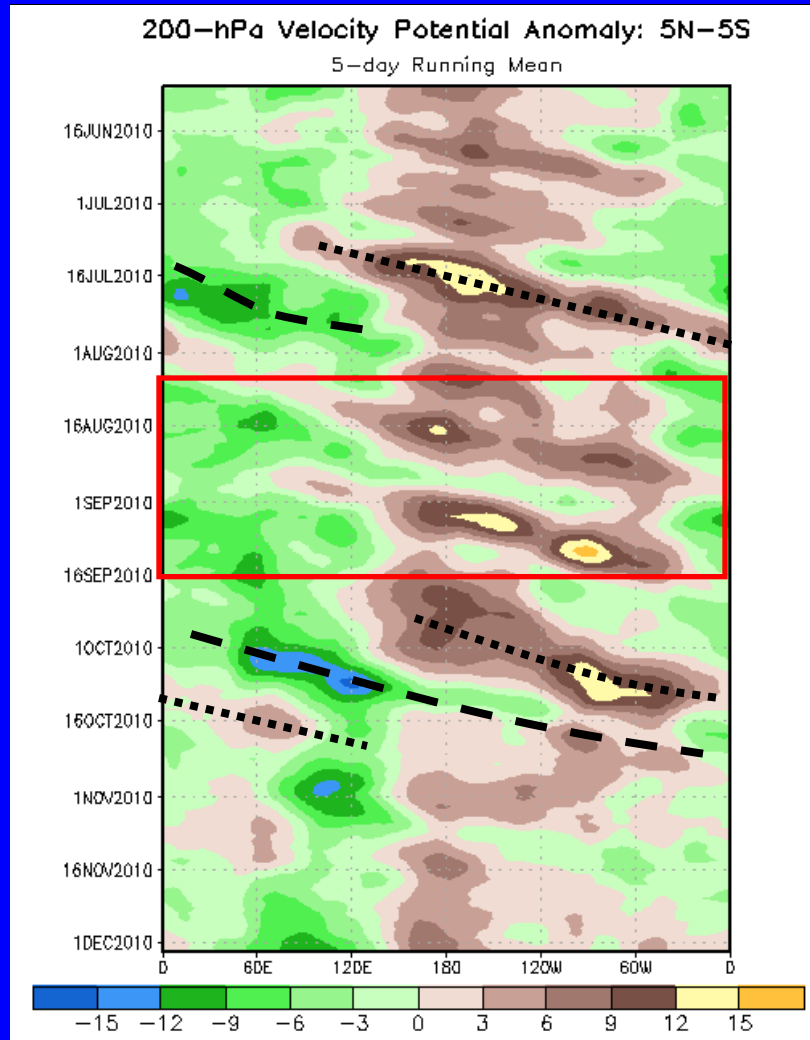


200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time



Longitude

Eastward propagation was evident during mid-July associated with the MJO.

Eastward propagation in August and September was mainly associated with higher frequency coherent tropical variability rather than the MJO (red box).

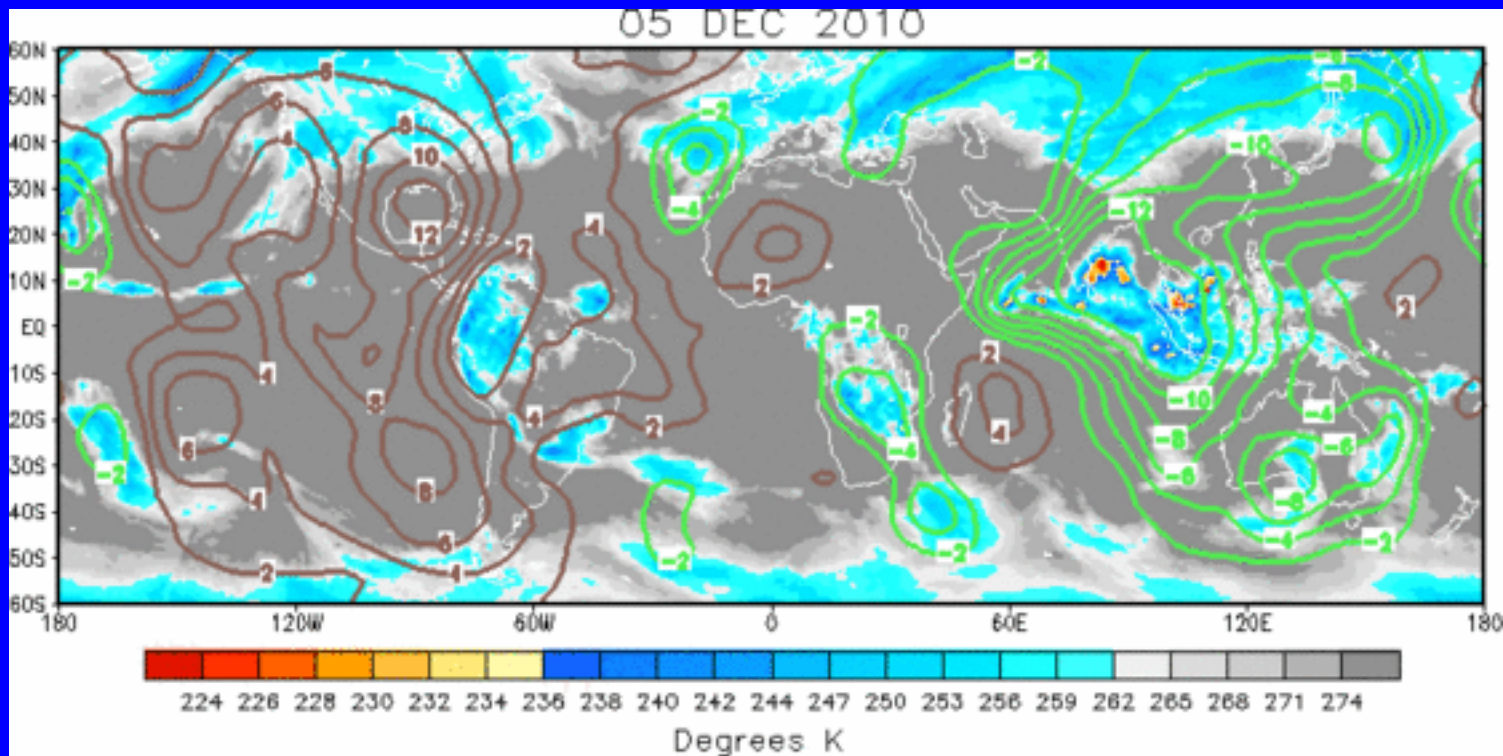
The MJO strengthened during late September as anomalies increased and eastward propagation was seen through mid-October.



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 shows anomalous upper-level divergence mainly across portions of Africa, the Indian Ocean, and Maritime continent with areas of upper-level convergence across the eastern Pacific and the Americas.

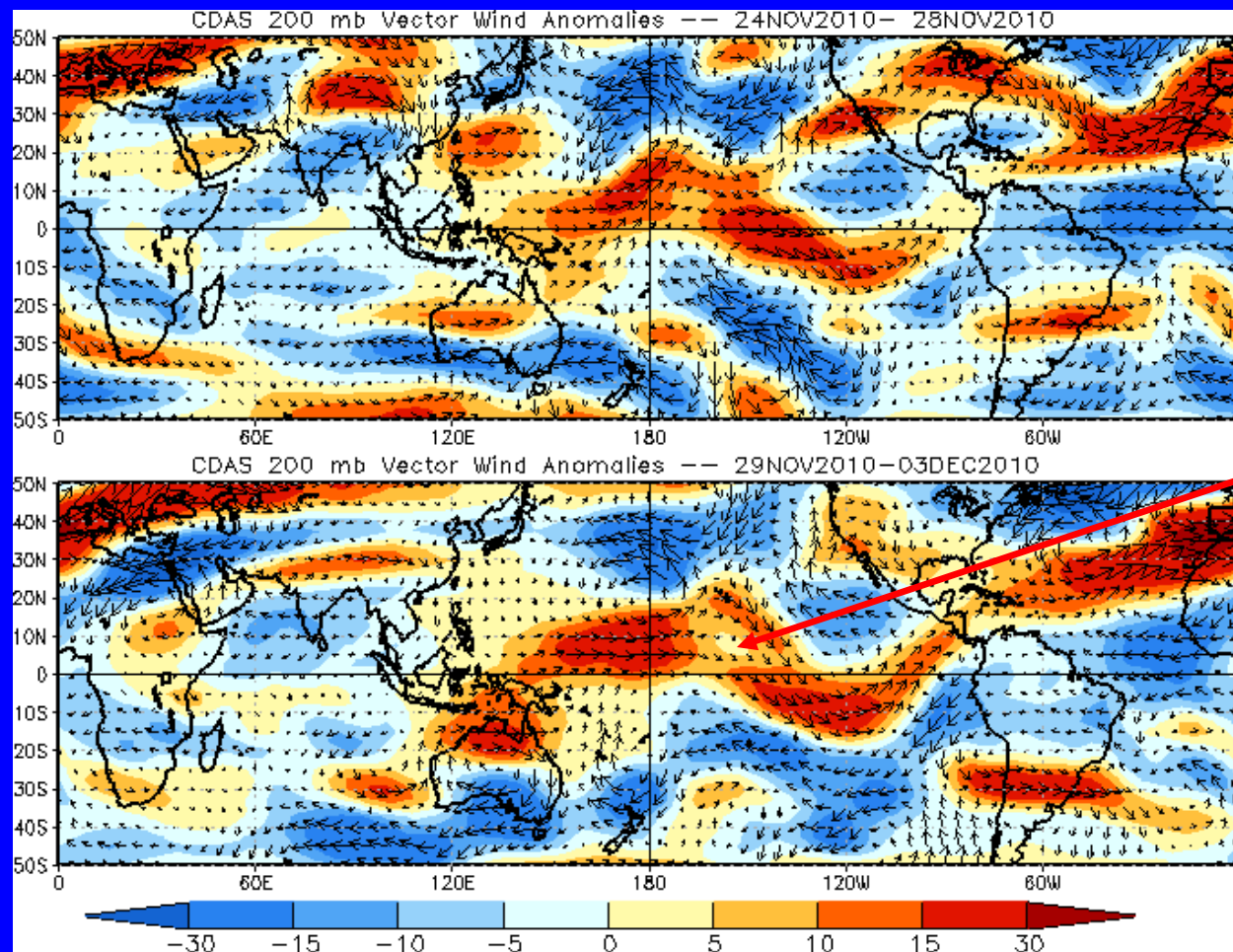


200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



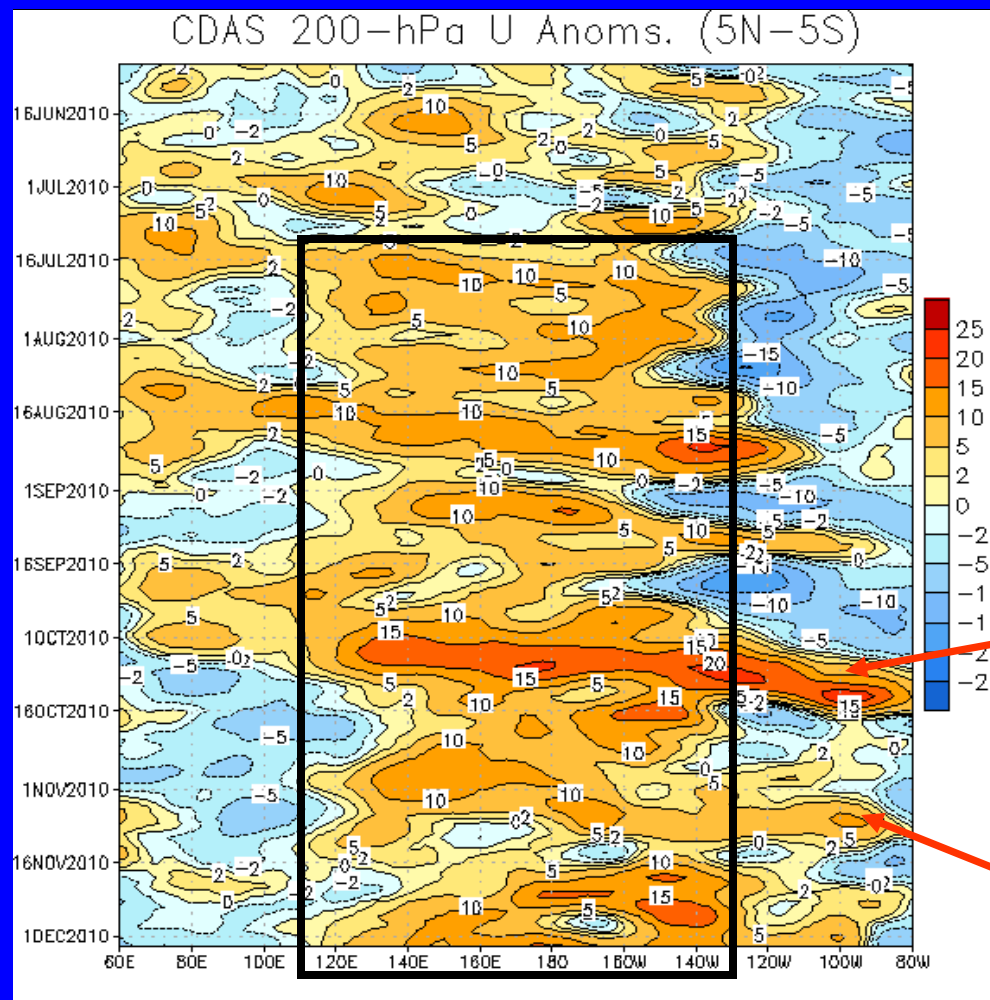
Westerly anomalies continued across the central Pacific during the last five to ten days.



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



Time



Longitude

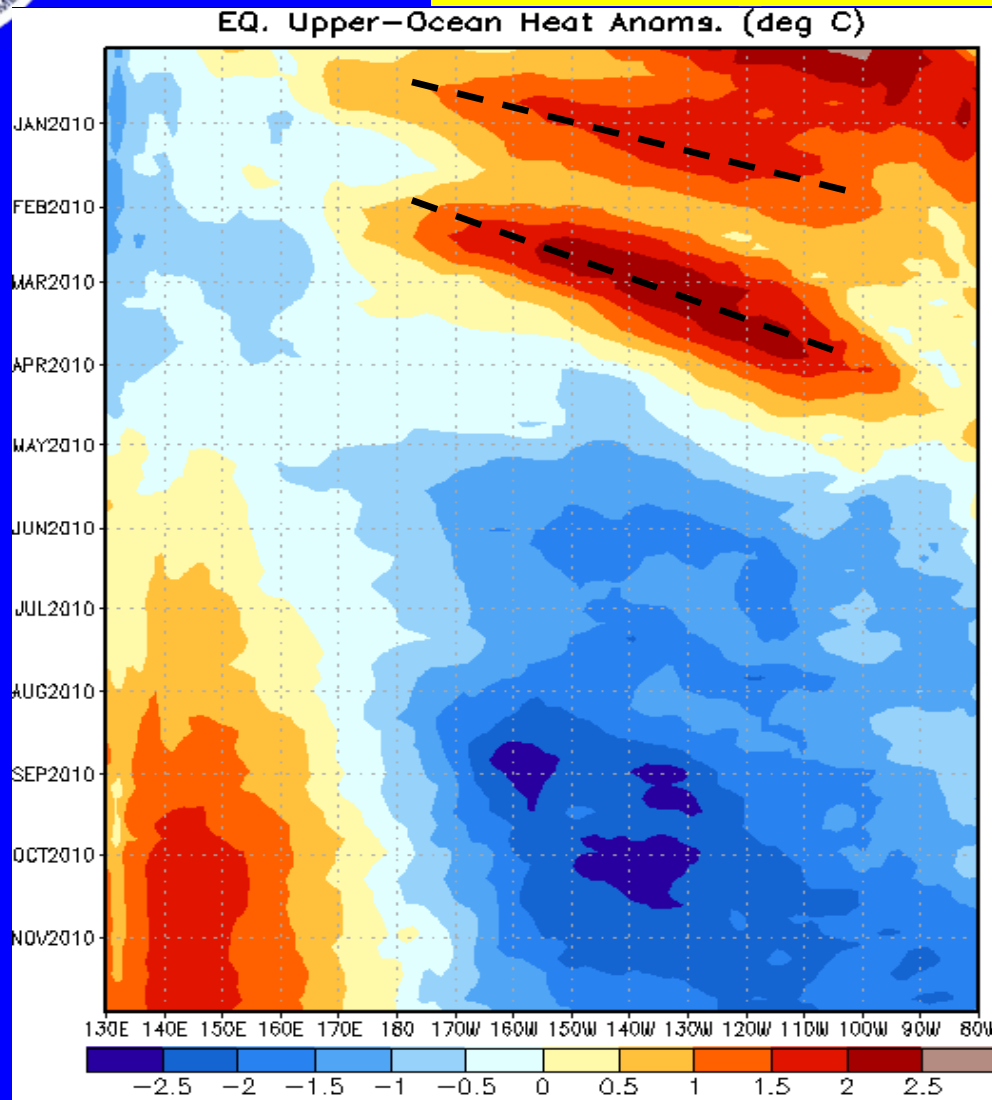
Westerly anomalies persisted across a large area from the Maritime Continent to the central Pacific (black solid box) since early July. Eastward propagation of westerly anomalies in August and September were not associated with the MJO.

In early October, westerly anomalies strengthened considerably and an eastward extension of these anomalies is evident associated with MJO activity.

Most recently, in early November, westerly anomalies increased once again from 140W to 80W.



Weekly Heat Content Evolution in the Equatorial Pacific



From November 2009 through March 2010, heat content anomalies remained above-average for much of the period.

From November 2009 – February 2010 three ocean Kelvin waves contributed to the change in heat content across the eastern Pacific (last three dashed black lines).

During April 2010 heat content anomalies decreased across the Pacific in association with the upwelling phase of a Kelvin wave and later during the early summer due to the development of La Nina.

Currently, negative heat content anomalies extend across the central and eastern Pacific with positive anomalies in the western Pacific.



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.

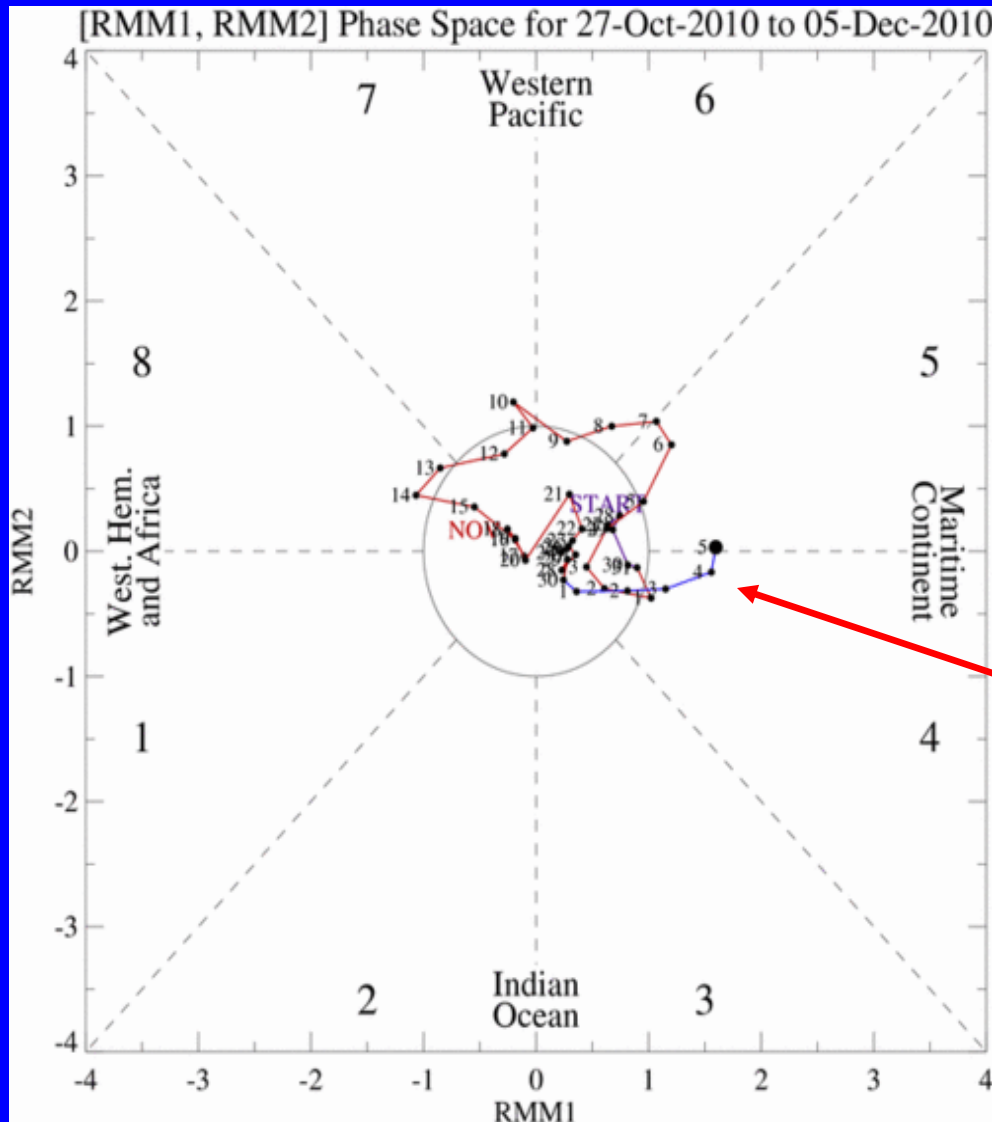
- The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.

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

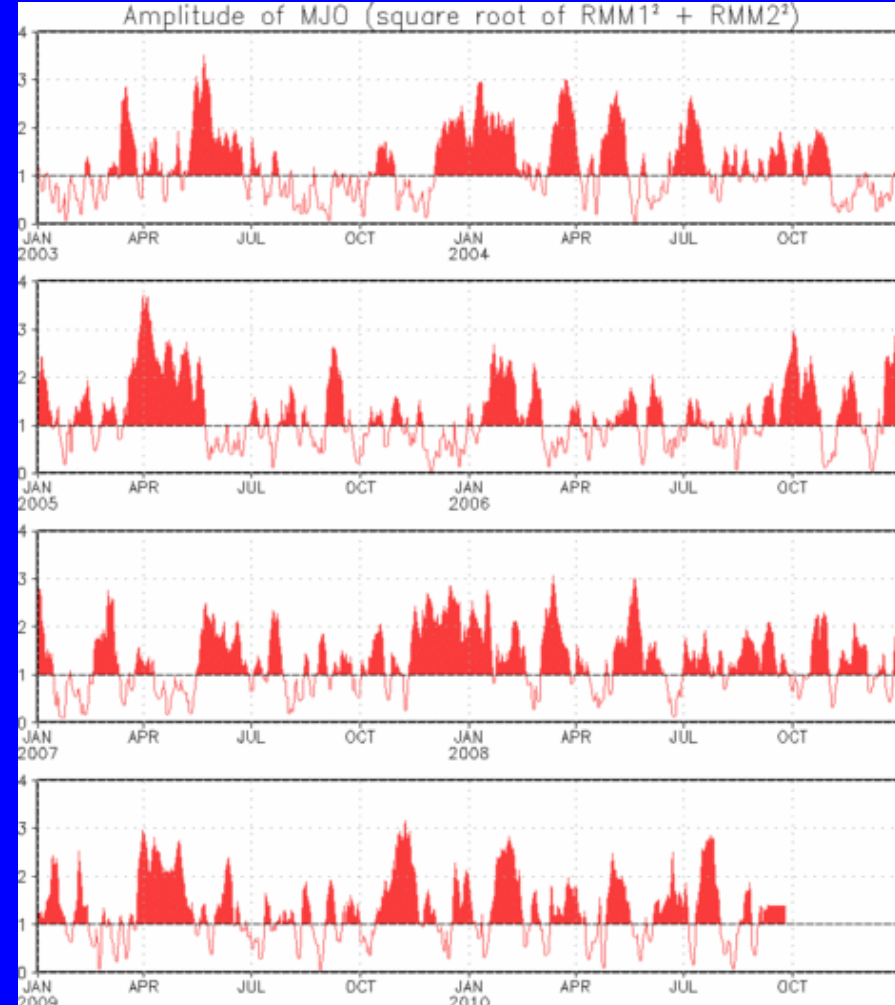
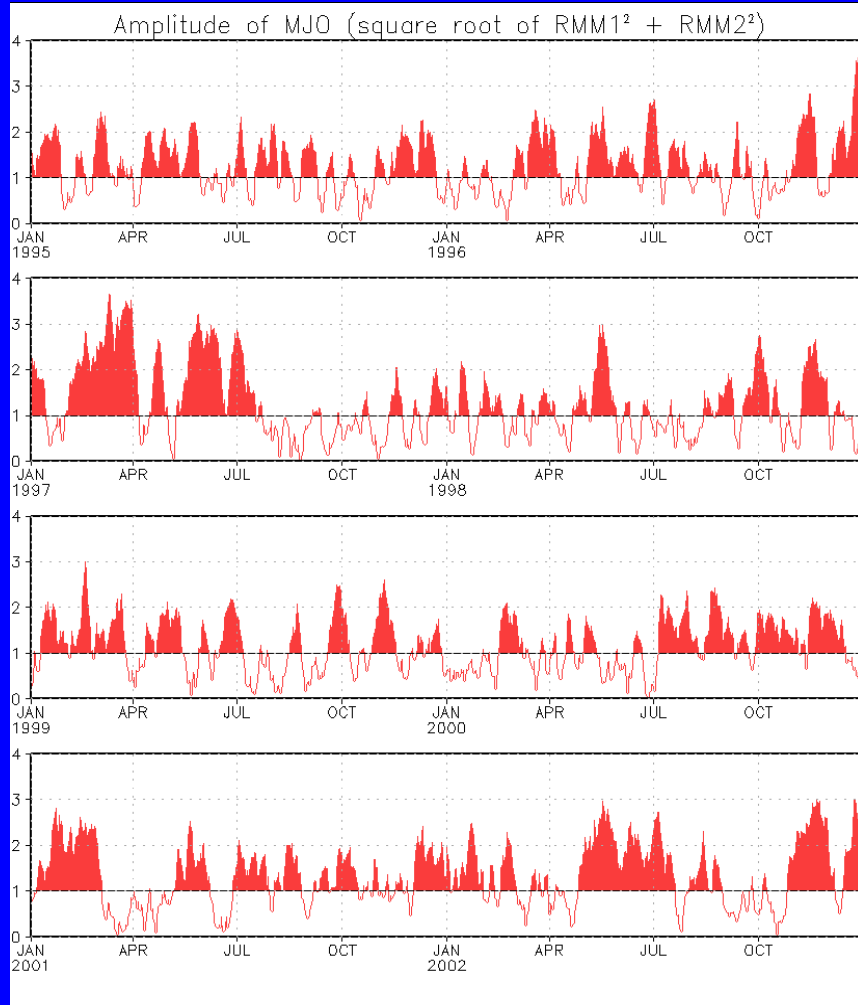


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index currently indicates a strengthening signal.



MJO Index – Historical Daily Time Series



Time series of daily MJO index amplitude from 1995 to present.
Plots put current MJO activity in historical context.



Ensemble GFS (GEFS) MJO Forecast

Yellow Lines – 20 Individual Members

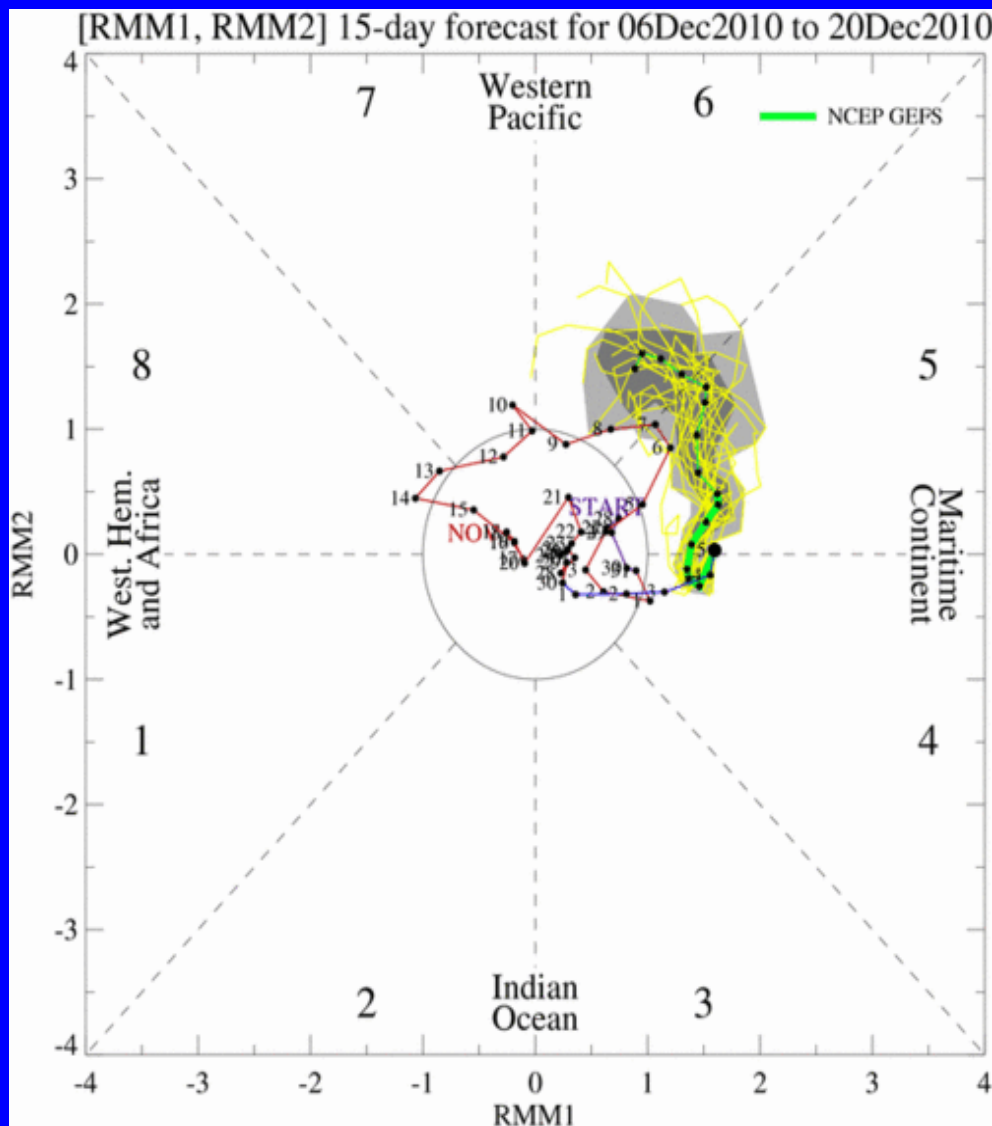
Green Line – Ensemble Mean

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 GFS forecasts indicate an eastward propagating signal primarily during Week-2.

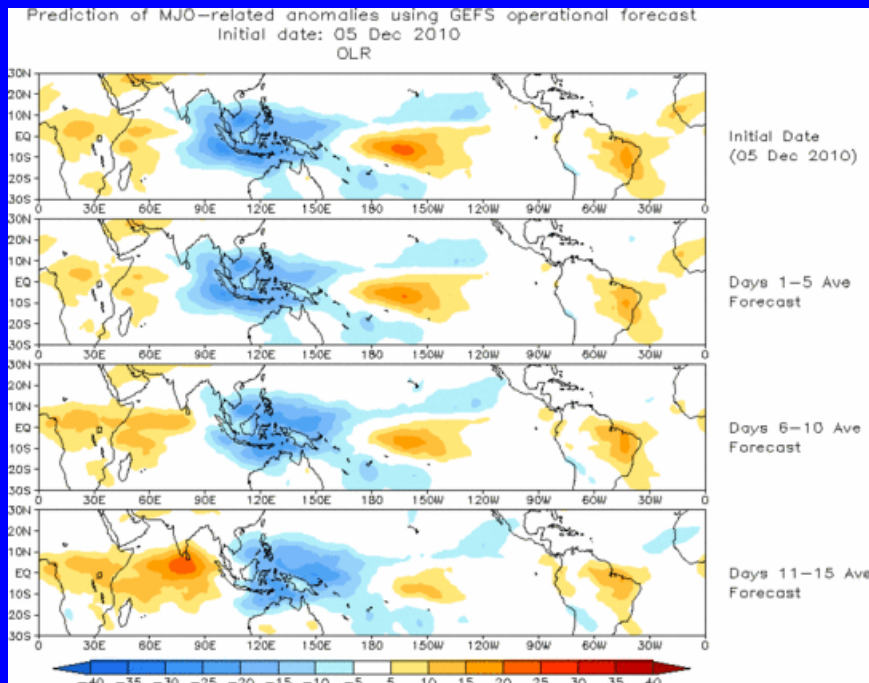




Ensemble Mean GFS MJO Forecast

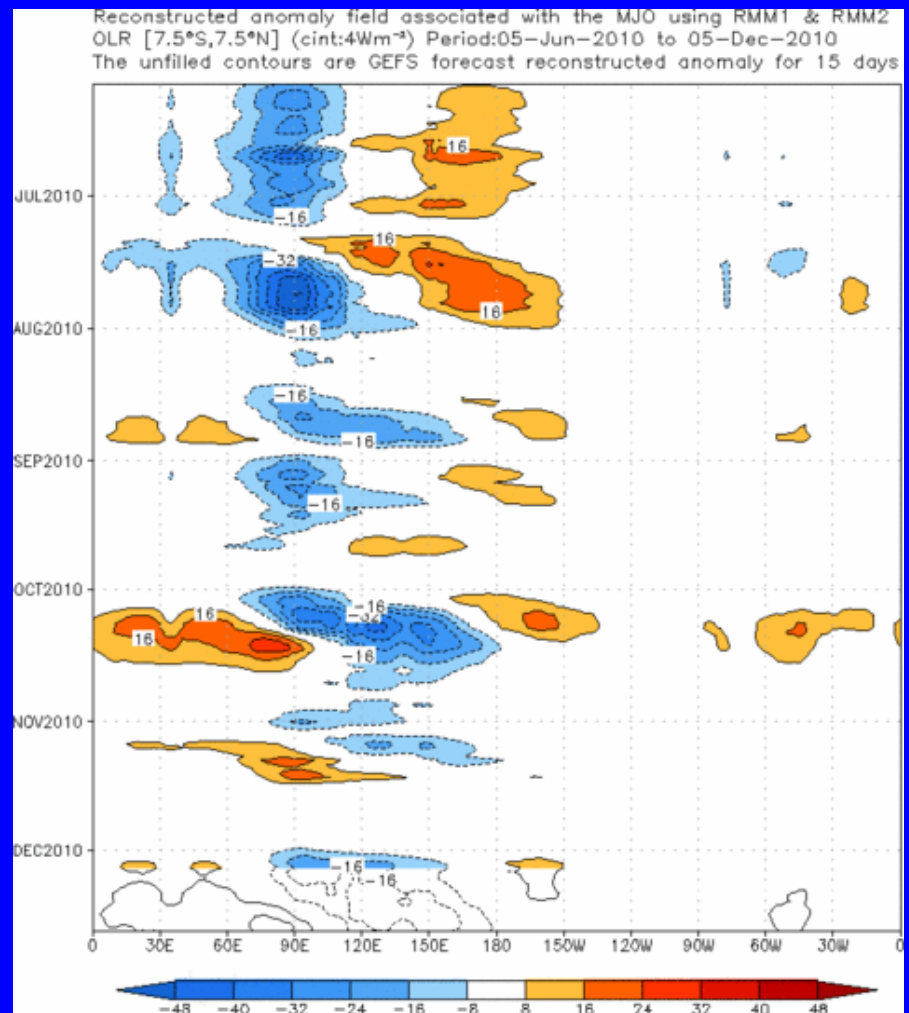
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



The GEFS ensemble mean forecast indicates strong anomalies in Week-1 with eastward propagation during Week-2.

Time-longitude section of (7.5°S–7.5°N) OLR anomalies for the last 180 days and for the next 15 days





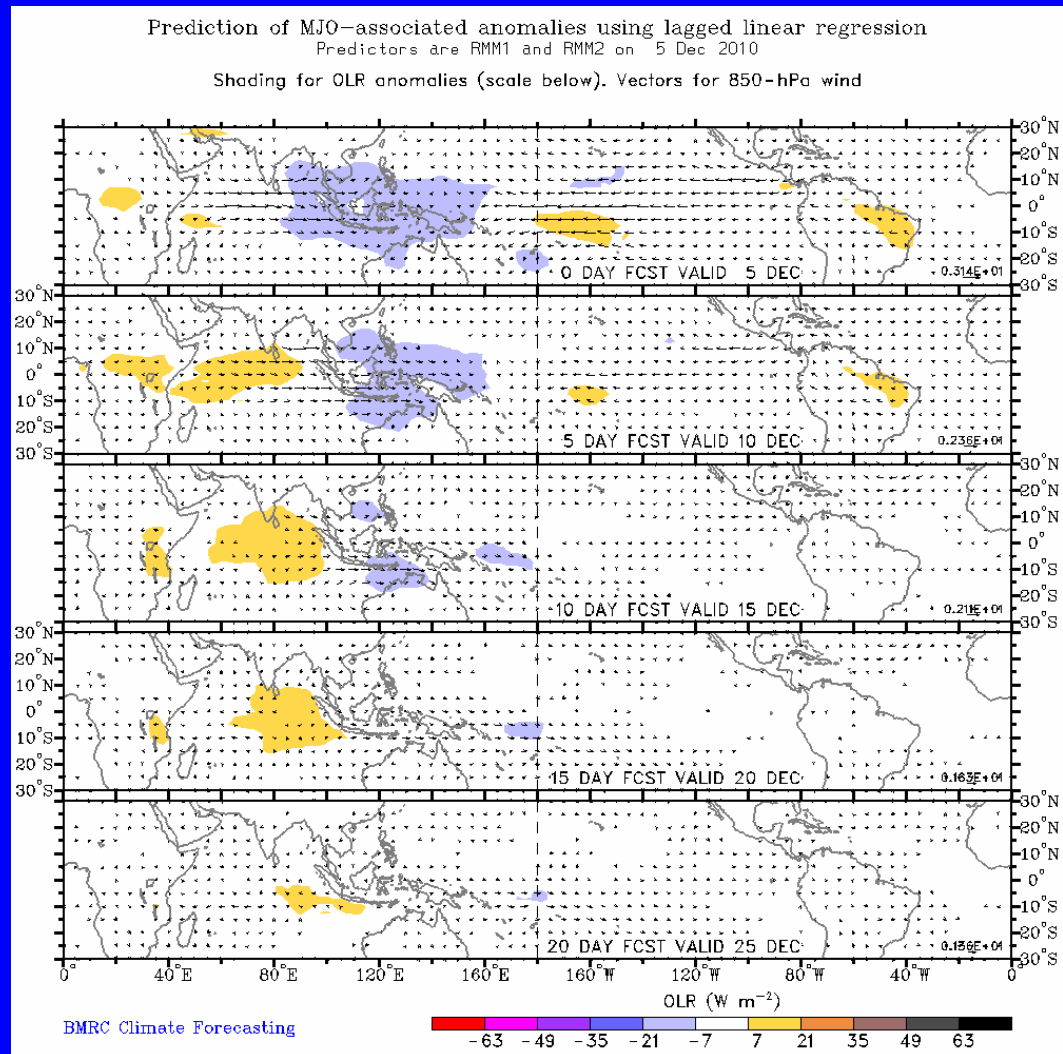
Statistical MJO Forecast

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)

**Spatial map of OLR anomalies and
850-hPa vectors for the next 20 days**

**(Courtesy of the Bureau of Meteorology
Research Centre - Australia)**

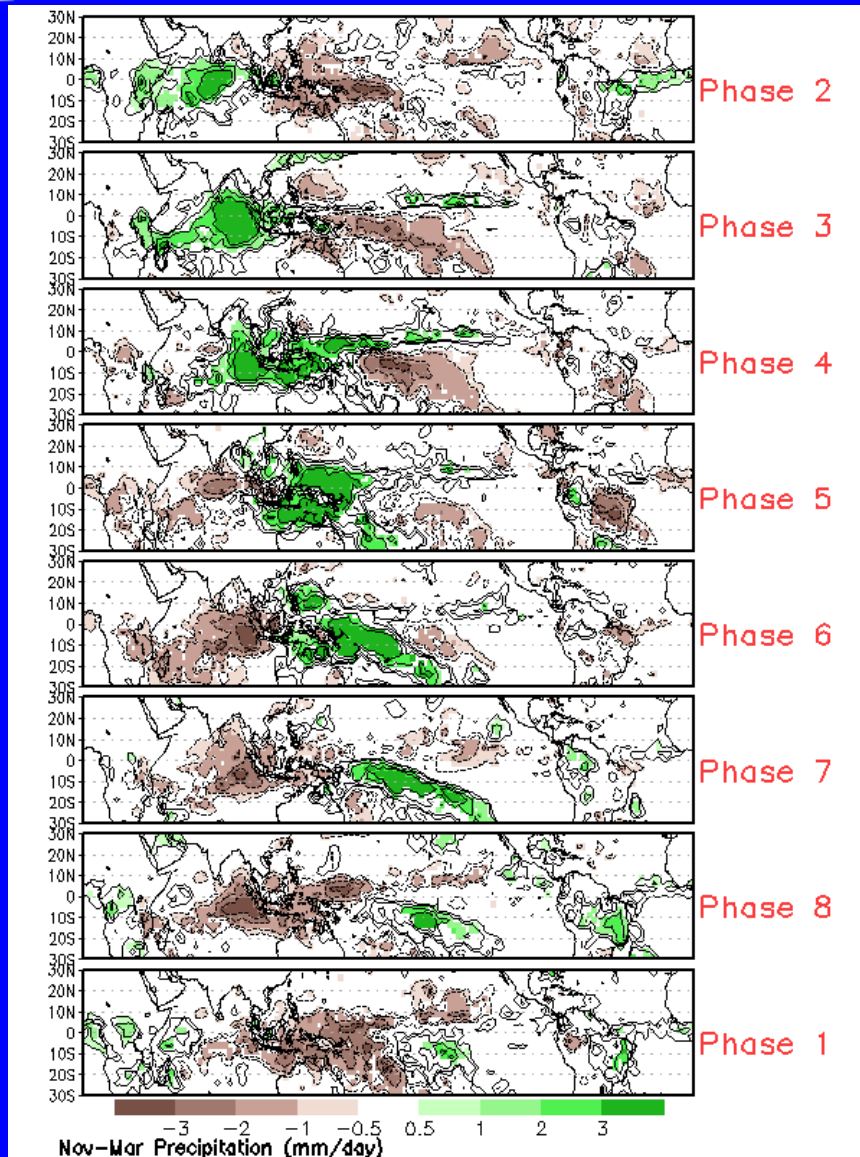
MJO activity is forecast over the period
with enhanced convection across the
Maritime continent and suppressed
convection developing over the Indian
Ocean.



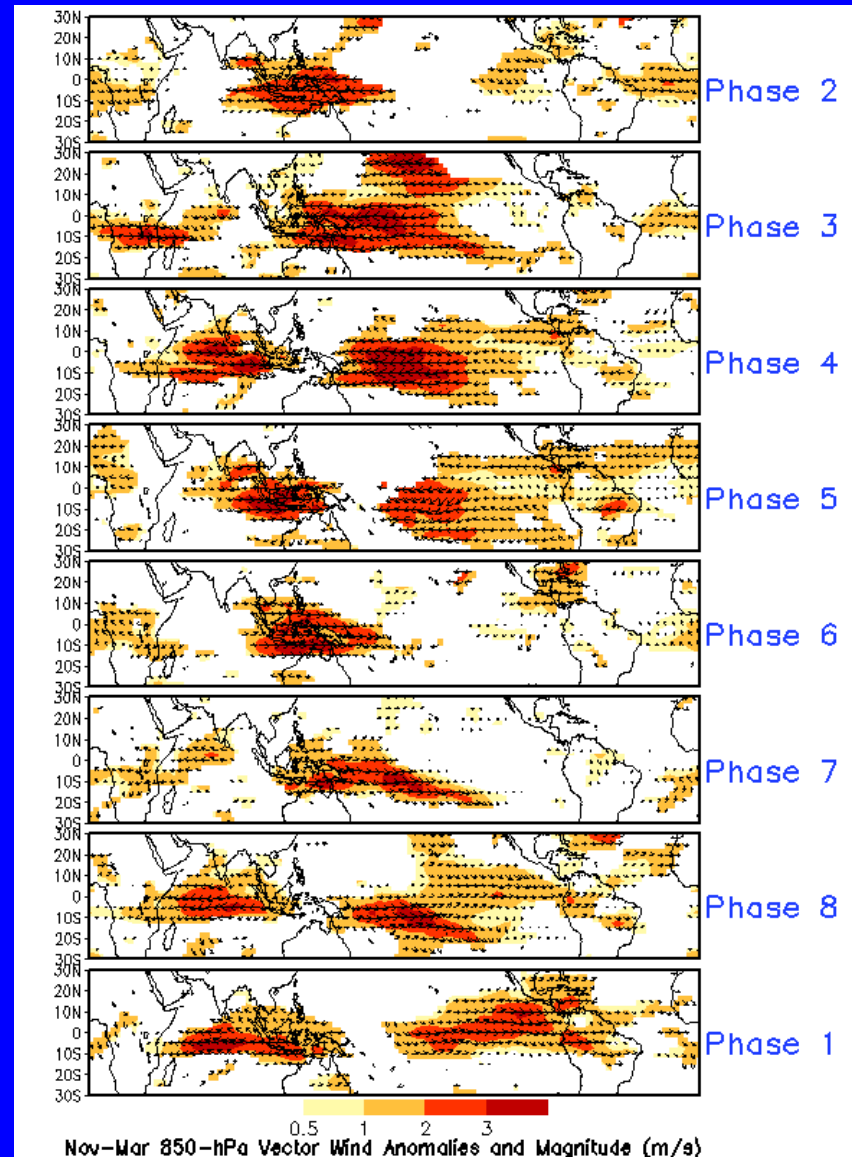


MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)

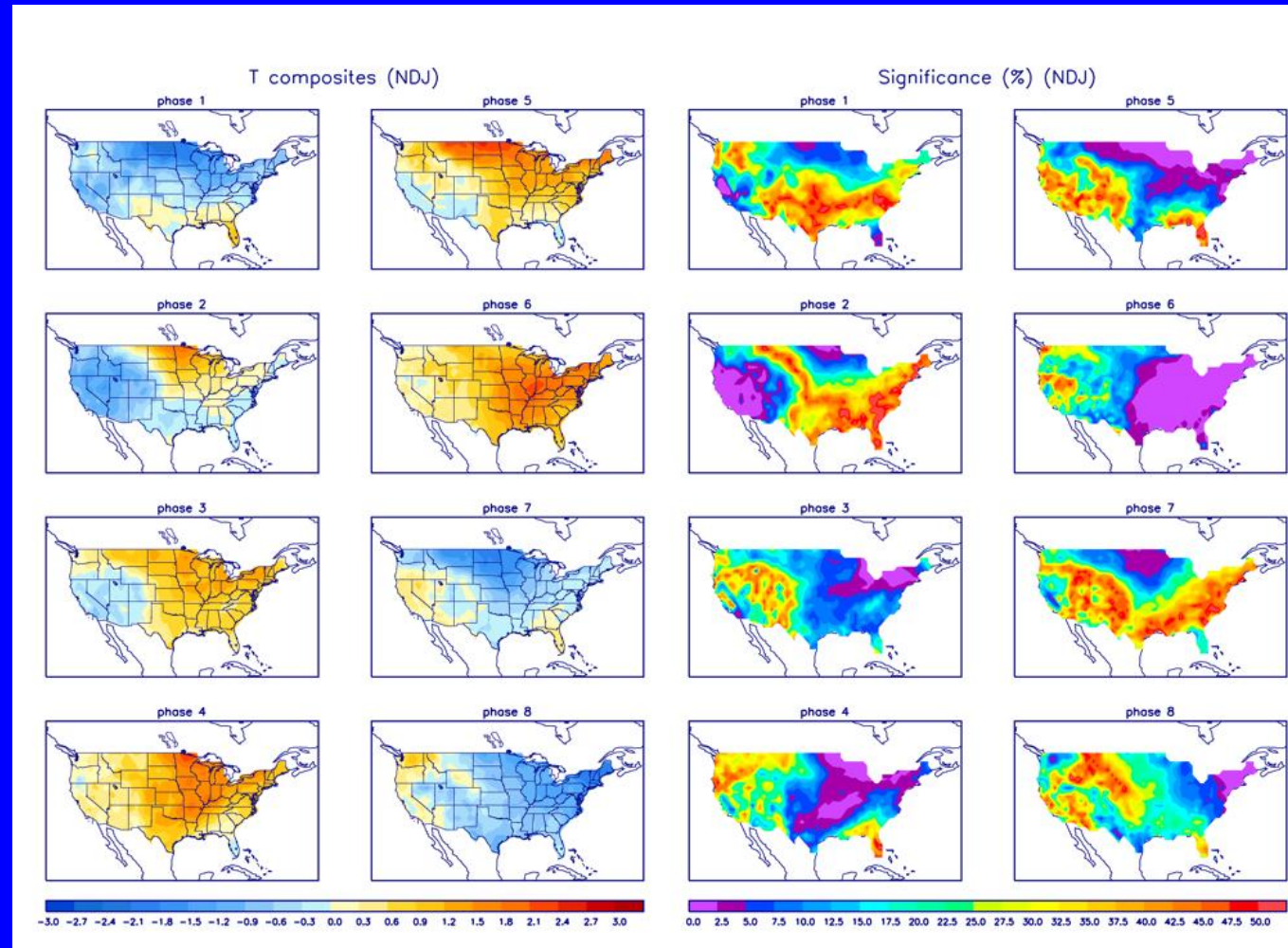




U.S. MJO Composites – Temperature

- 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. Dark blue and purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.



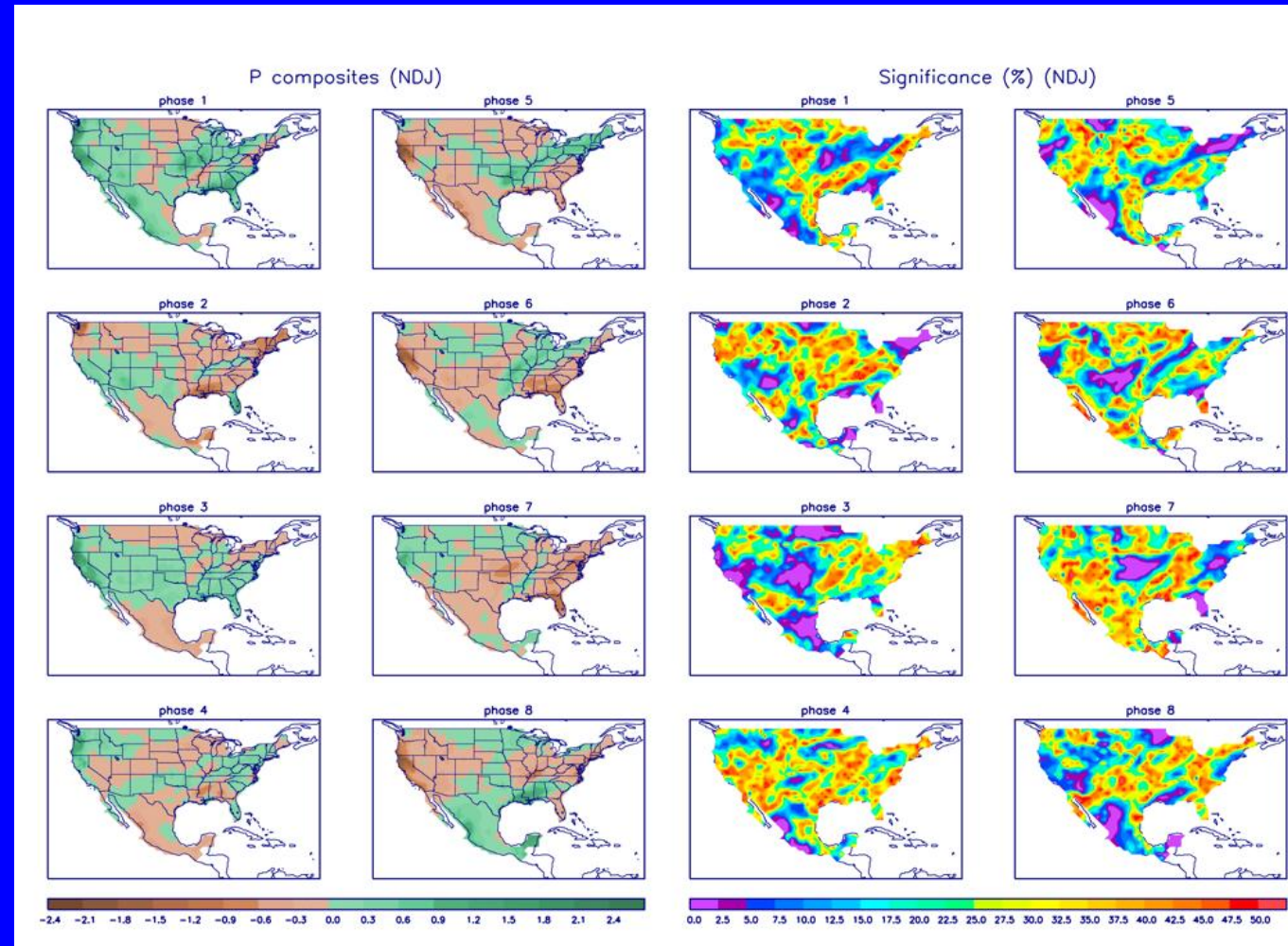
Zhou et al. (2010): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, Submitted.

<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. Dark blue and purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.



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