



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

**Update prepared by
Climate Prediction Center / NCEP
November 29, 2010**



Outline

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



Overview

- **The MJO remained weak during the past week.**
- **The majority of dynamical model MJO forecasts indicate continued weak activity during Week-1, however, some models indicate potential strengthening of an MJO signal for Week-2.**
- **Despite some model forecasts for a strengthening MJO signal, it is most likely that this signal is a combination of other factors, including background La Nina conditions, rather than coherent MJO development.**
- **Nevertheless, the potential for MJO development needs to be closely monitored in the upcoming 1-2 week period.**

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



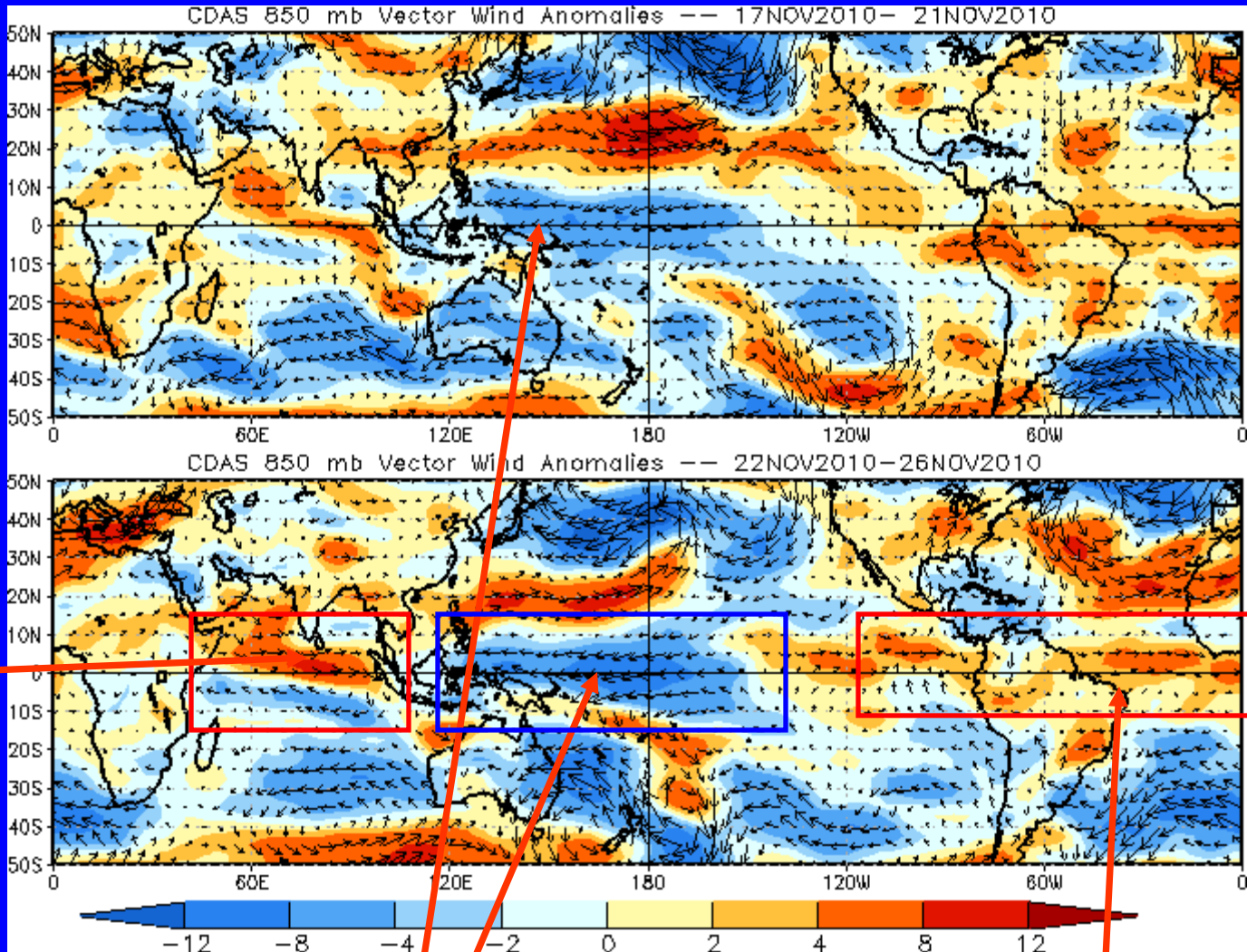
850-hPa Vector Wind Anomalies (m s^{-1})

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 strengthened across the western Pacific during the last five days.

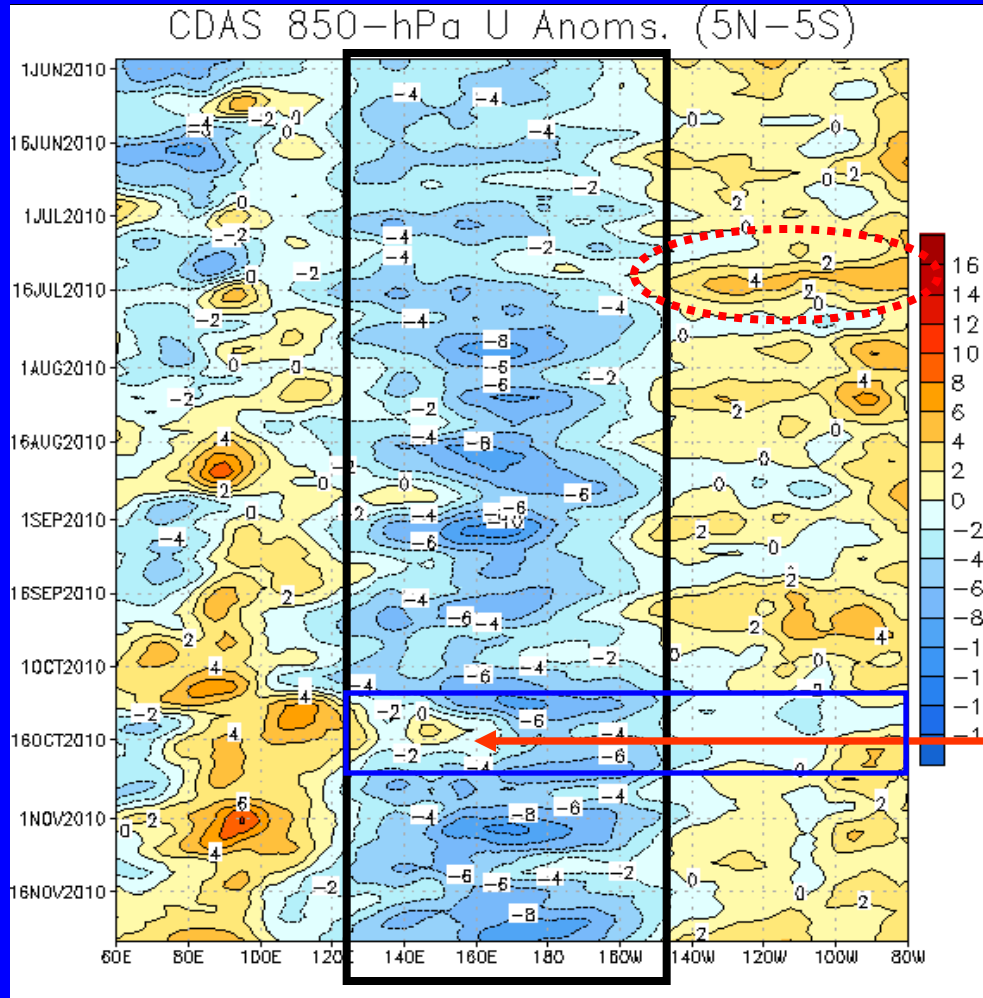
Westerly anomalies continued across the Atlantic during the last five days.



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 April (black box) consistent with the development of La Nina conditions.

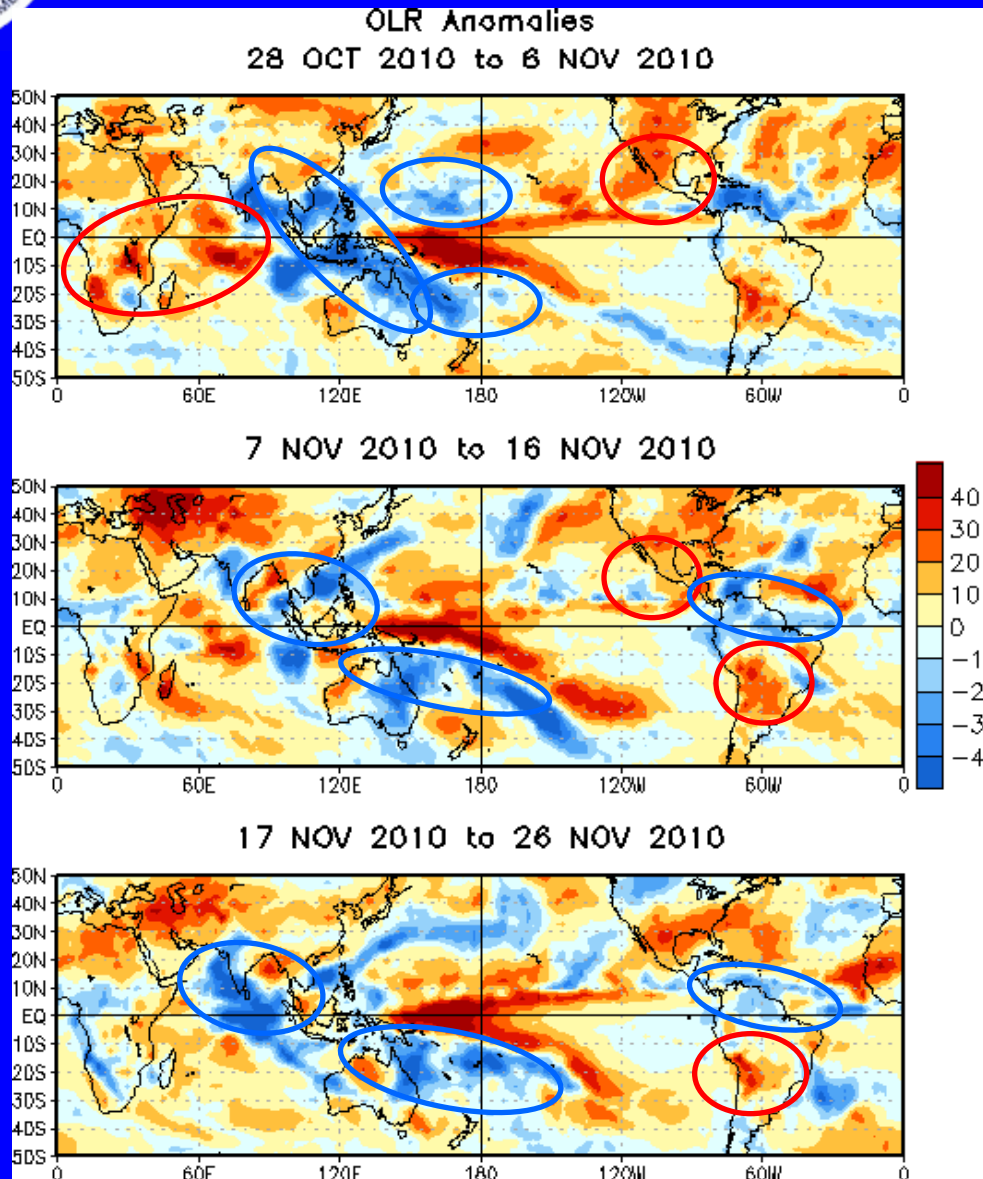
Enhanced westerly anomalies (red dotted ovals) occurred across the eastern Pacific during early-to-mid July and these were in part associated with MJO activity.

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).

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)

Drier-than-average conditions continued over Mexico and the eastern Pacific in late-October to early November, while enhanced convection shifted east to parts of the western Pacific east of Australia. Suppressed convection developed across the western equatorial Indian Ocean and continued over Africa.

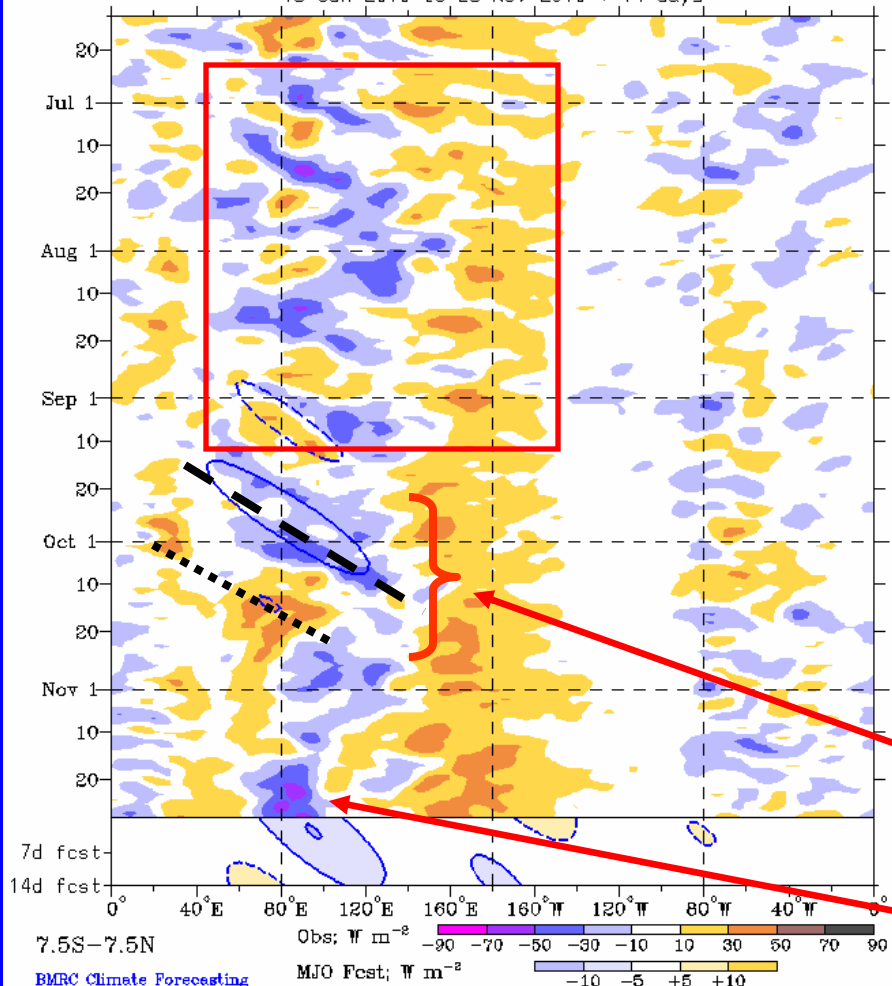
In mid-November, suppressed convection strengthened over central South America. Enhanced convection continued over parts of the western Pacific and the Maritime continent, while wetter-than-average conditions developed over northern South America.

Enhanced convection developed over the Indian Ocean and continued over the southwest Pacific and Australia in mid to late November.



Outgoing Longwave Radiation (OLR) Anomalies (7.5°S-7.5°N)

Real-time MJO filtering superimposed upon 3drn R21 OLR Anomalies
MJO anomalies blue contours, CINT=10. (5. for forecast)
Negative contours solid, positive dashed
13-Jun-2010 to 28-Nov-2010 + 14 days



Time
↓

Longitude

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 mid-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 60E and shifted eastward followed by suppressed convection near 20E during early-mid October.

Most recently, enhanced convection has developed near 80E but has remained stationary to date.

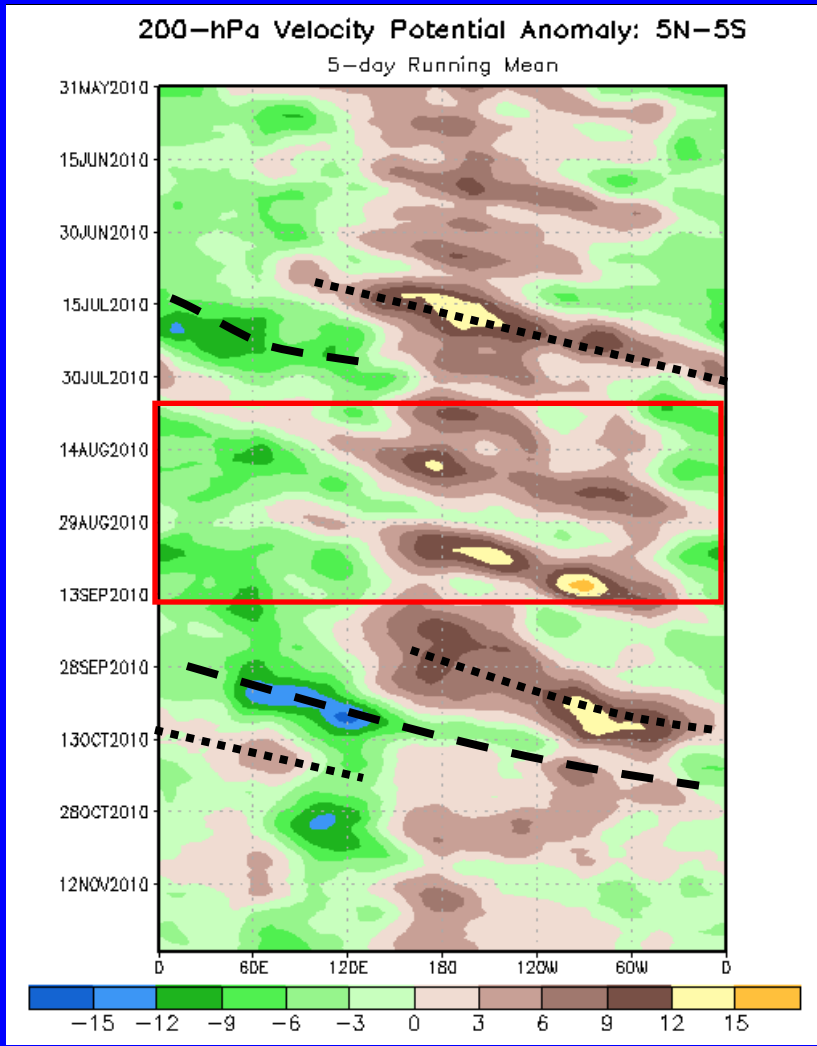


200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time
↓



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).

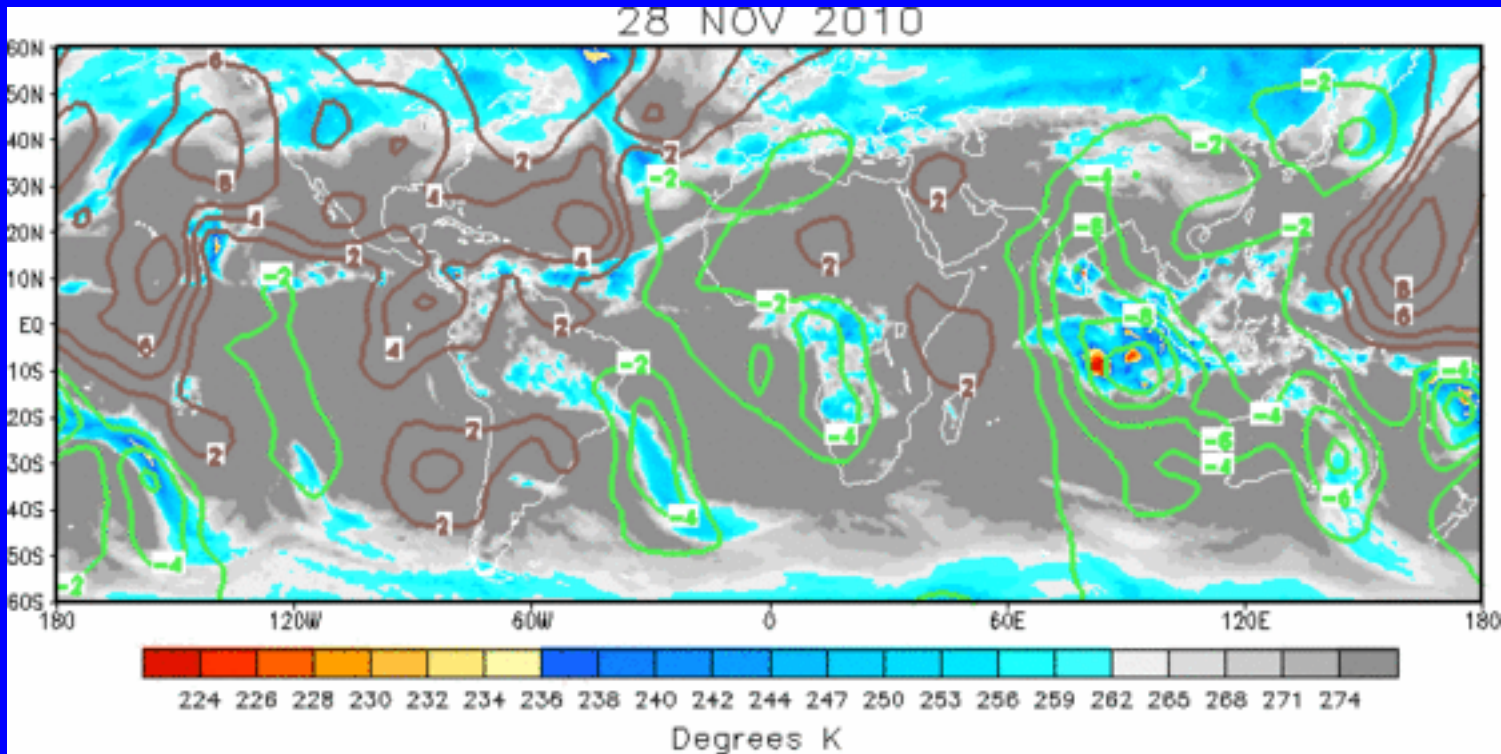
The MJO strengthened during late September as anomalies increased and eastward propagation was seen through mid-October.



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 parts of the Pacific and North America

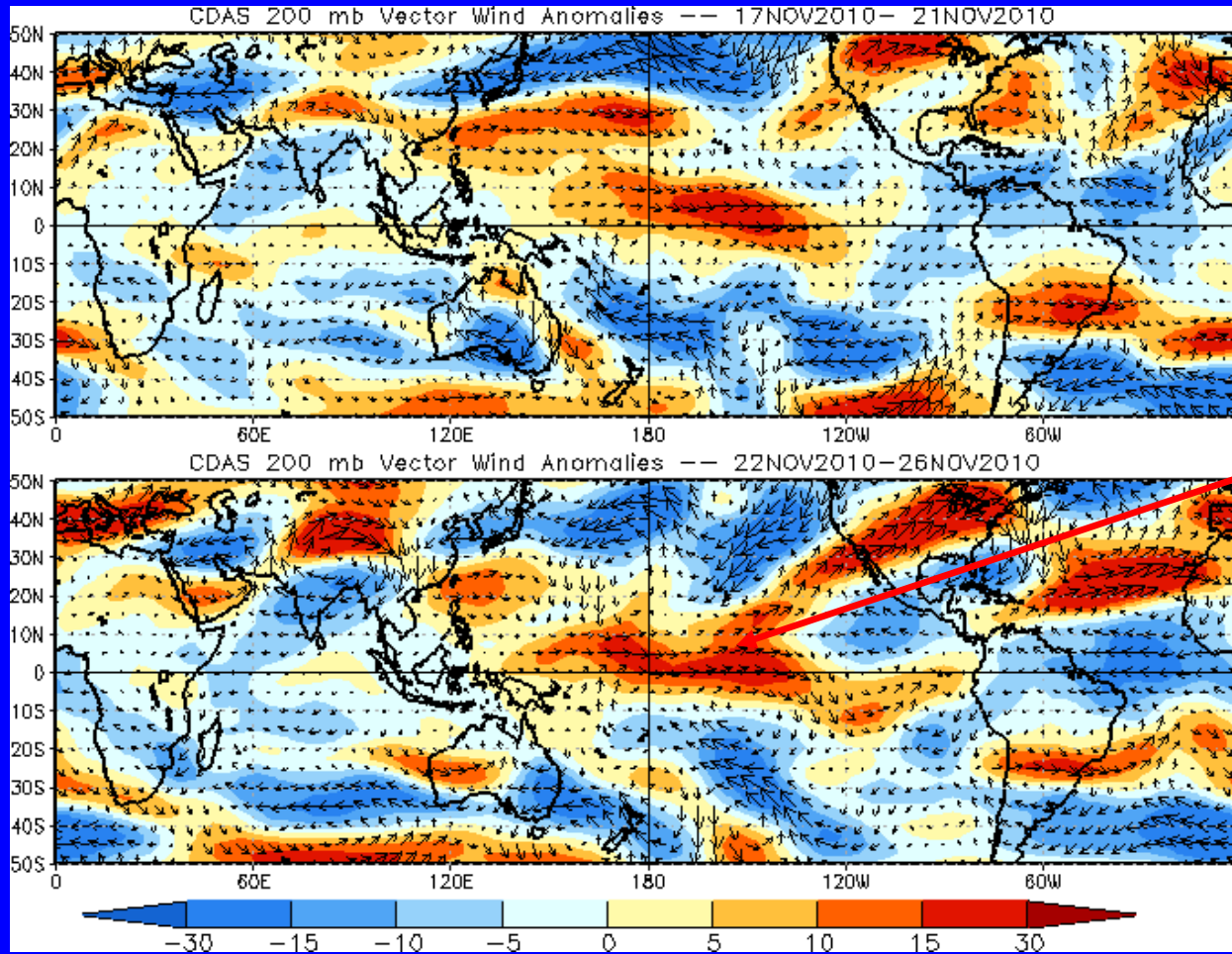


200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



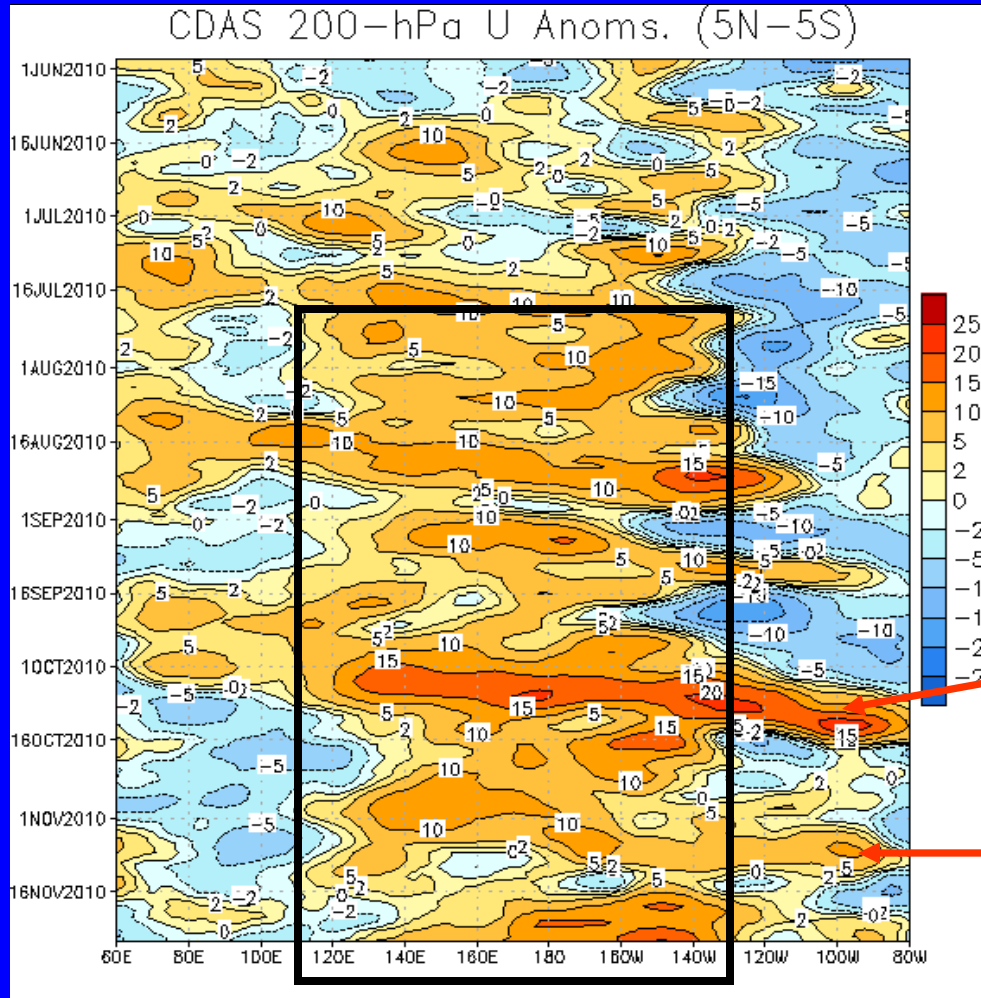
Westerly anomalies continued across the central Pacific during the last five to ten days.



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



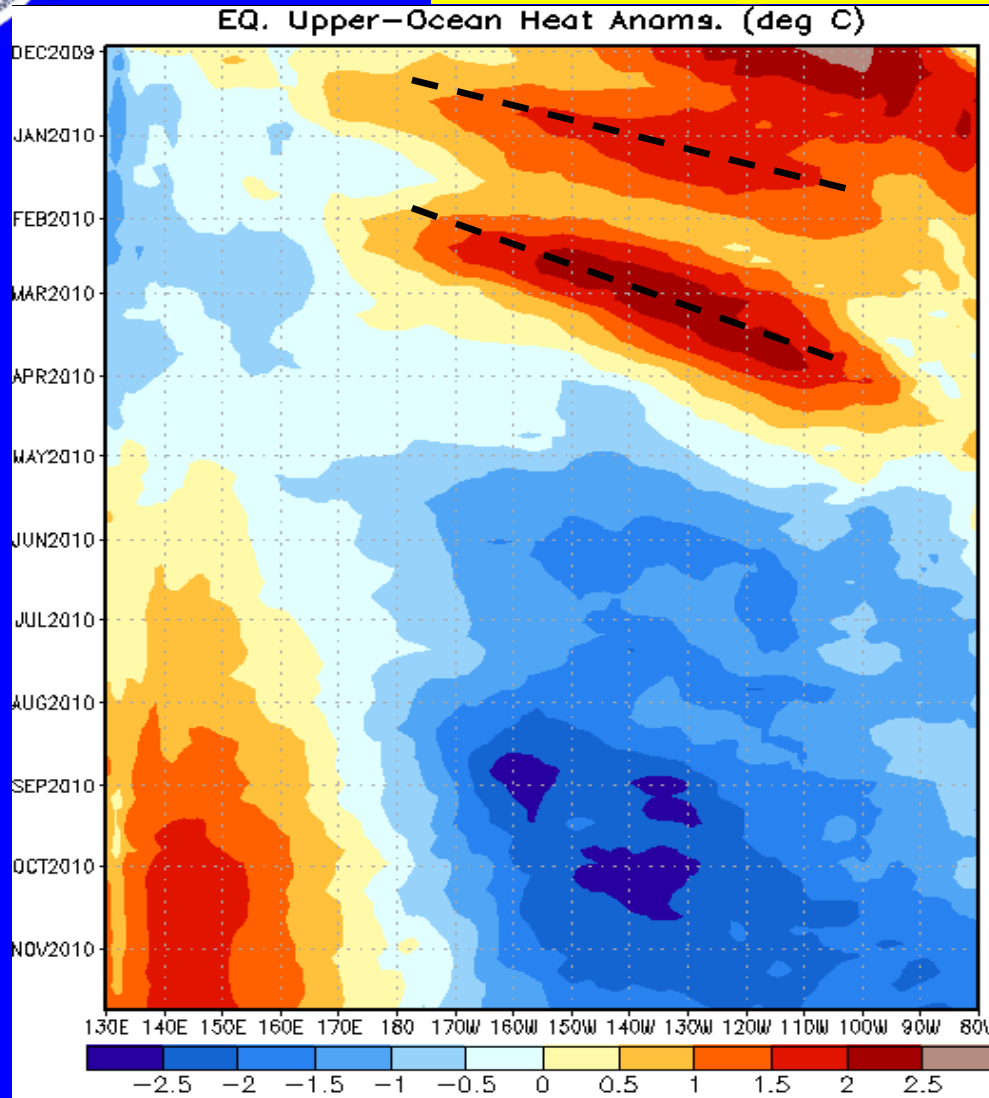
Westerly anomalies persisted across a large area from the Maritime Continent to the central Pacific (black solid box) since early July. Eastward propagation of westerly anomalies in August and September were not associated with the MJO.

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.

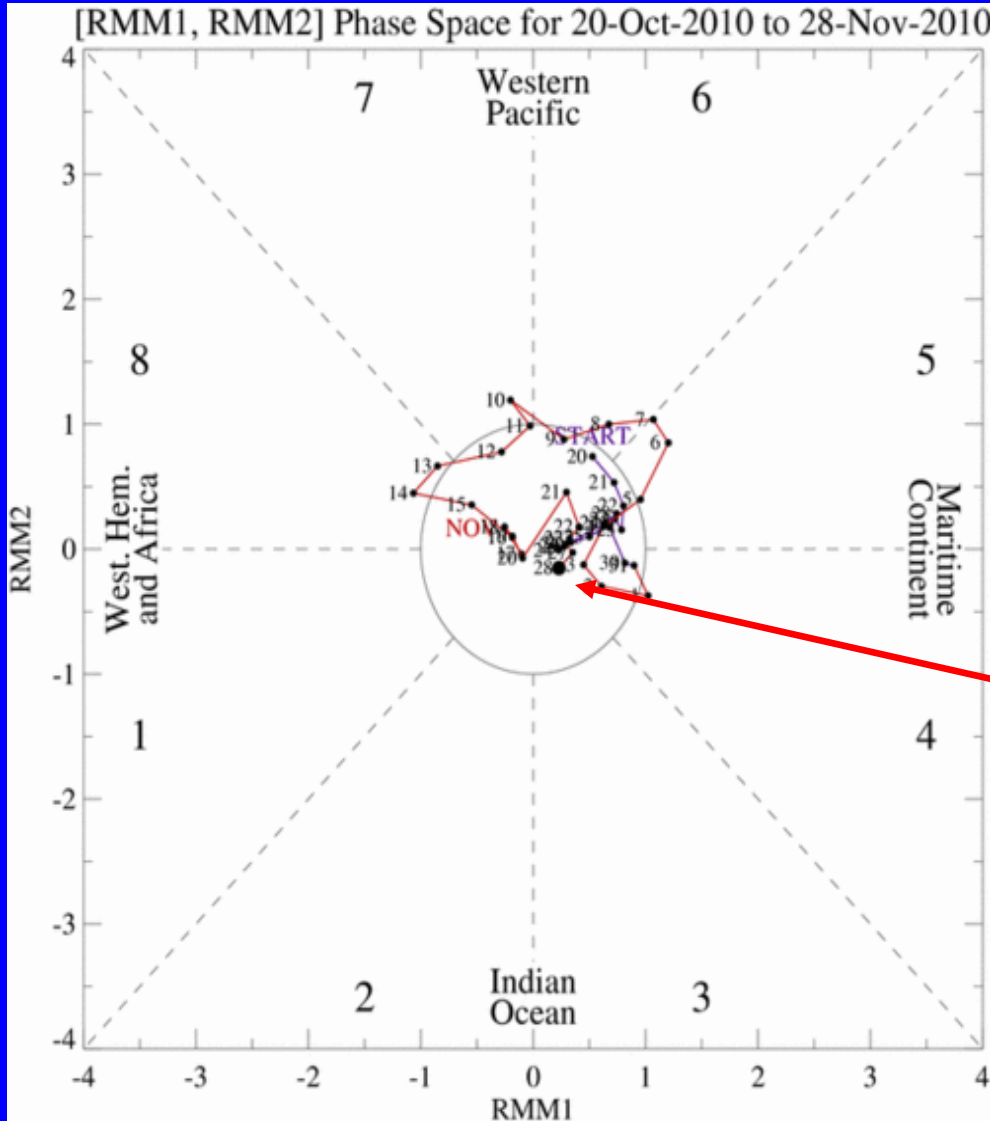
Gottschalck et al. 2010: A Framework for Assessing Operational Madden-Julian Oscillation Forecasts: A CLIVAR MJO Working Group Project, *Bull. Amer. Met. Soc.*, 91, 1247-1258.

- 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

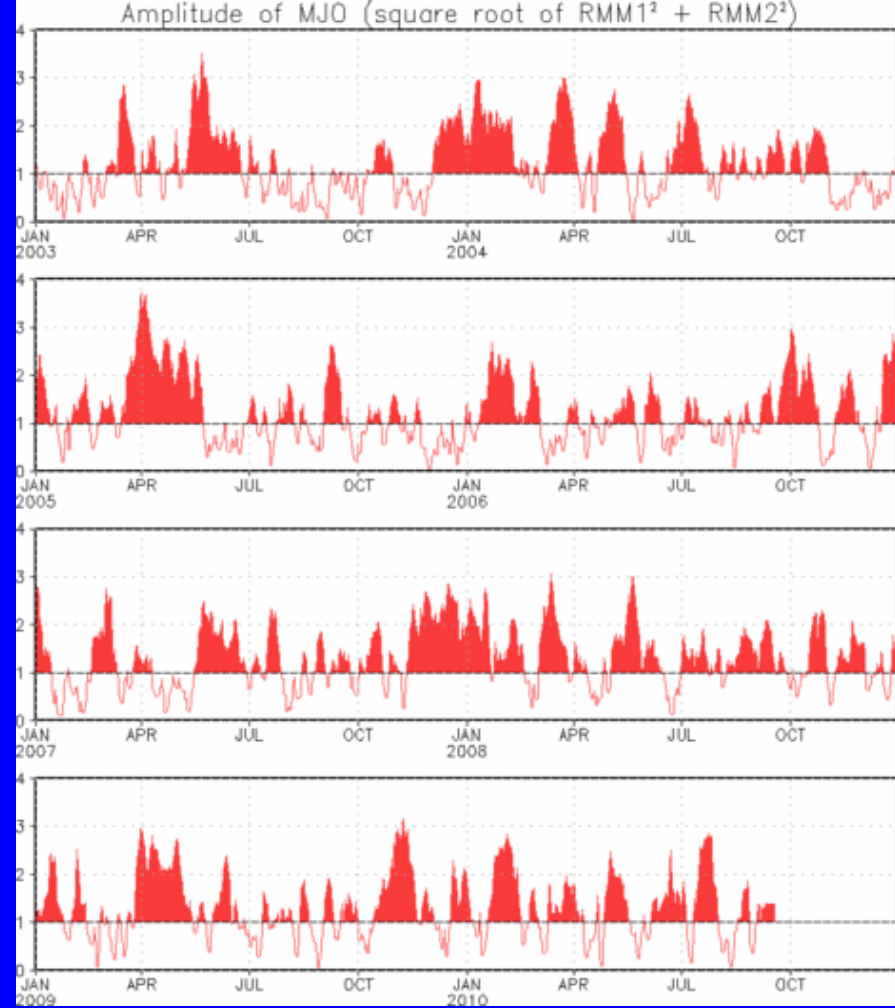
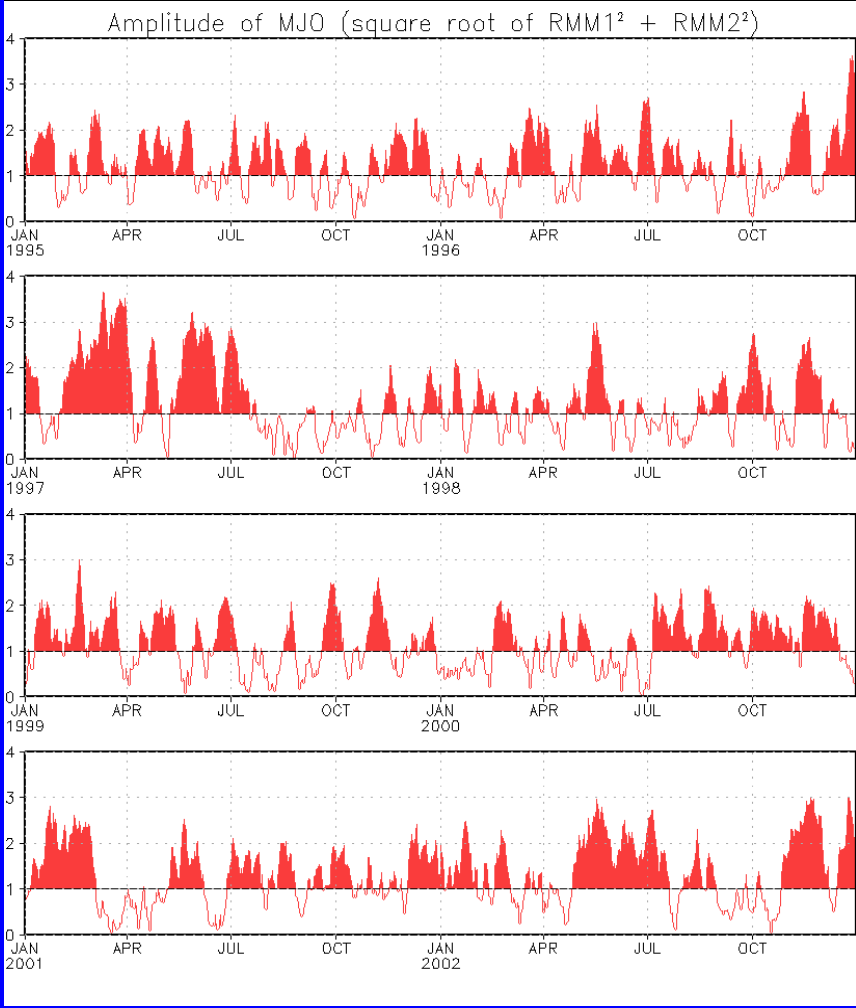
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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



The MJO index currently indicates weak activity.



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.



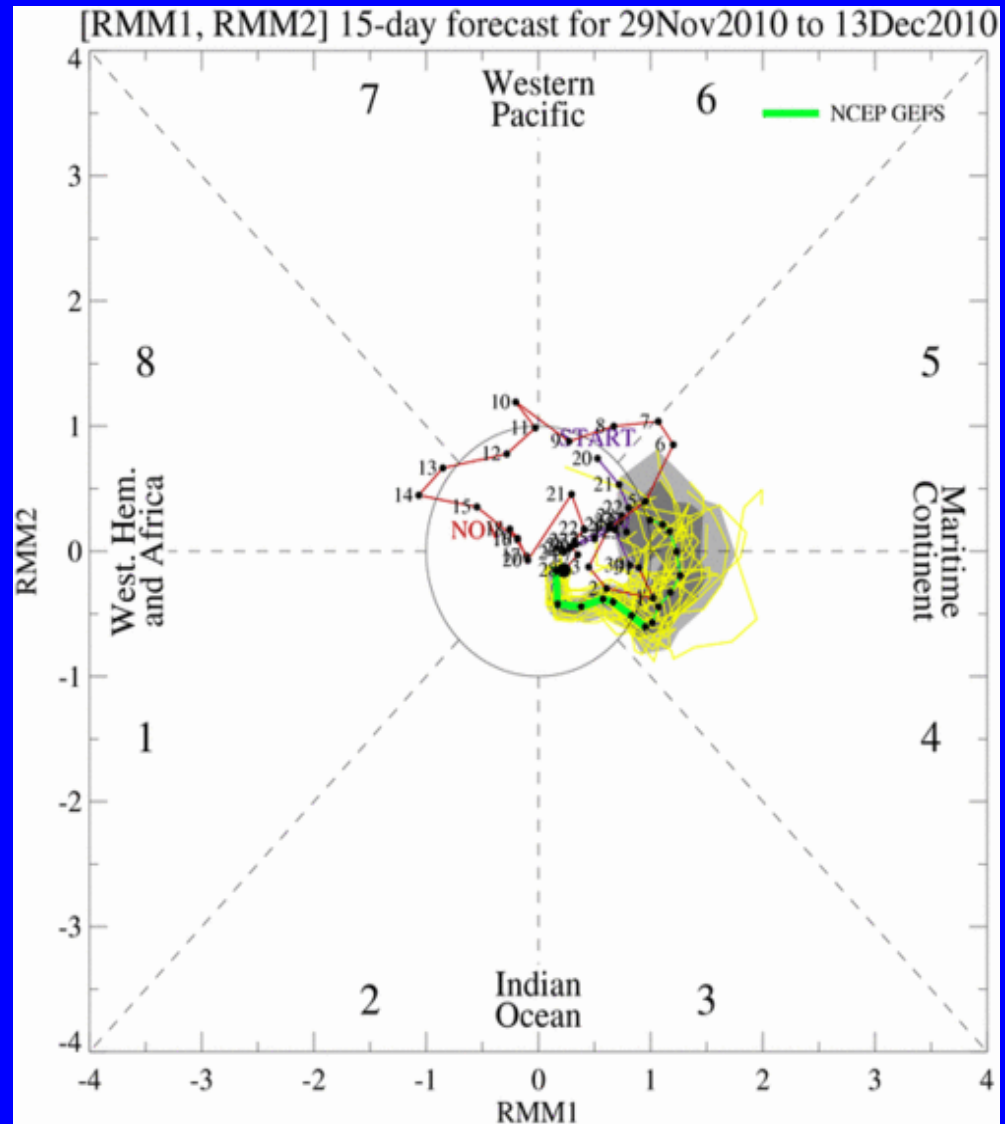
Ensemble GFS (GEFS) MJO Forecast

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 a weak signal during Week-1 with some strengthening during Week-2.



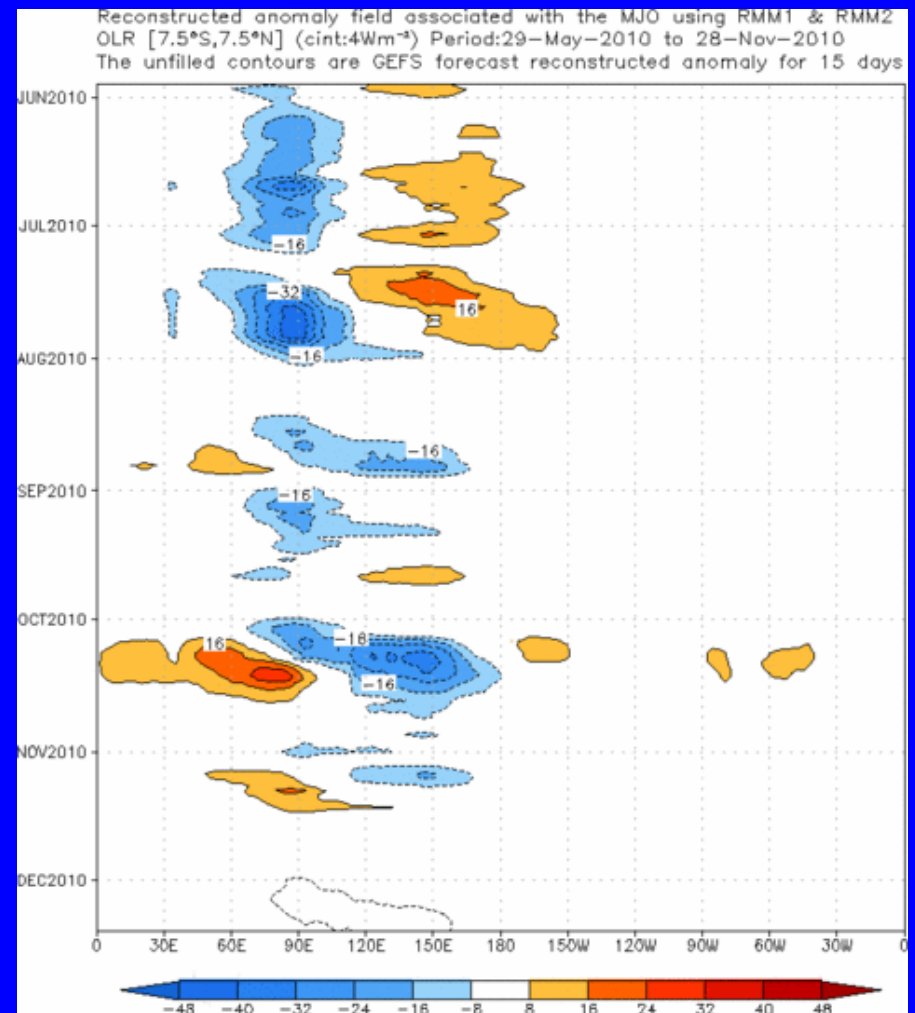
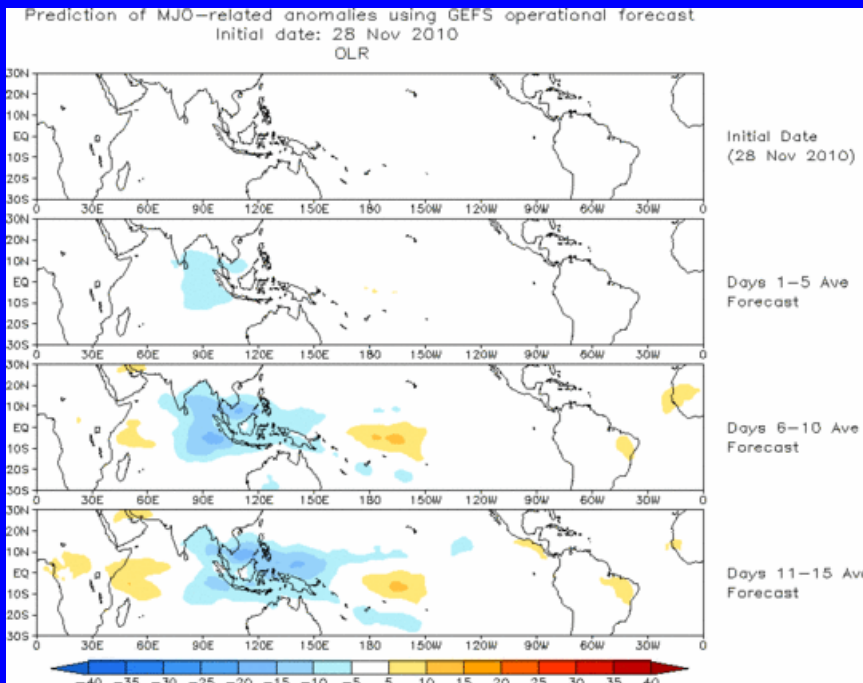


Ensemble Mean GFS MJO Forecast

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

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



The GEFS ensemble mean forecast indicates weak anomalies in Week-1 with some increase during Week-2, particularly with respect to enhanced convection over the Maritime continent.



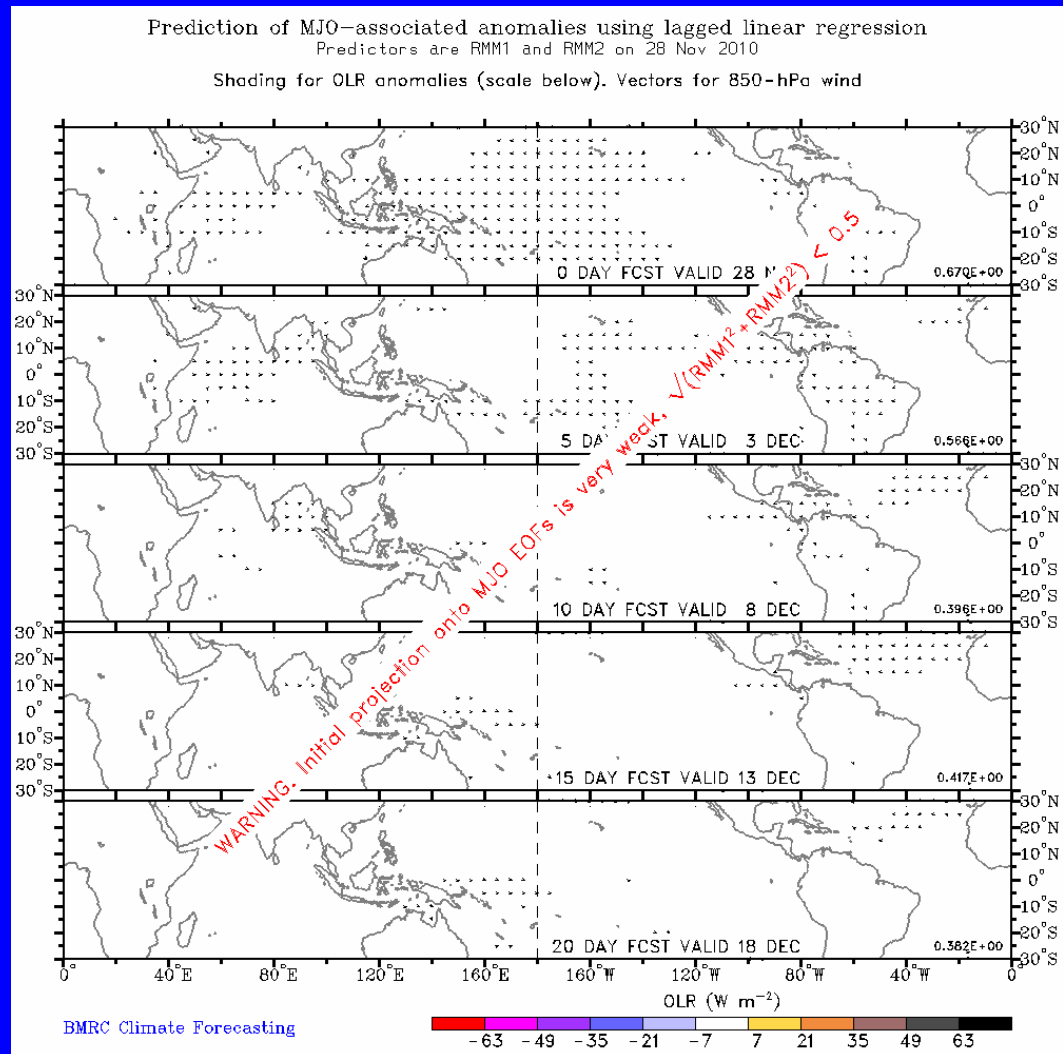
Statistical MJO Forecast

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)

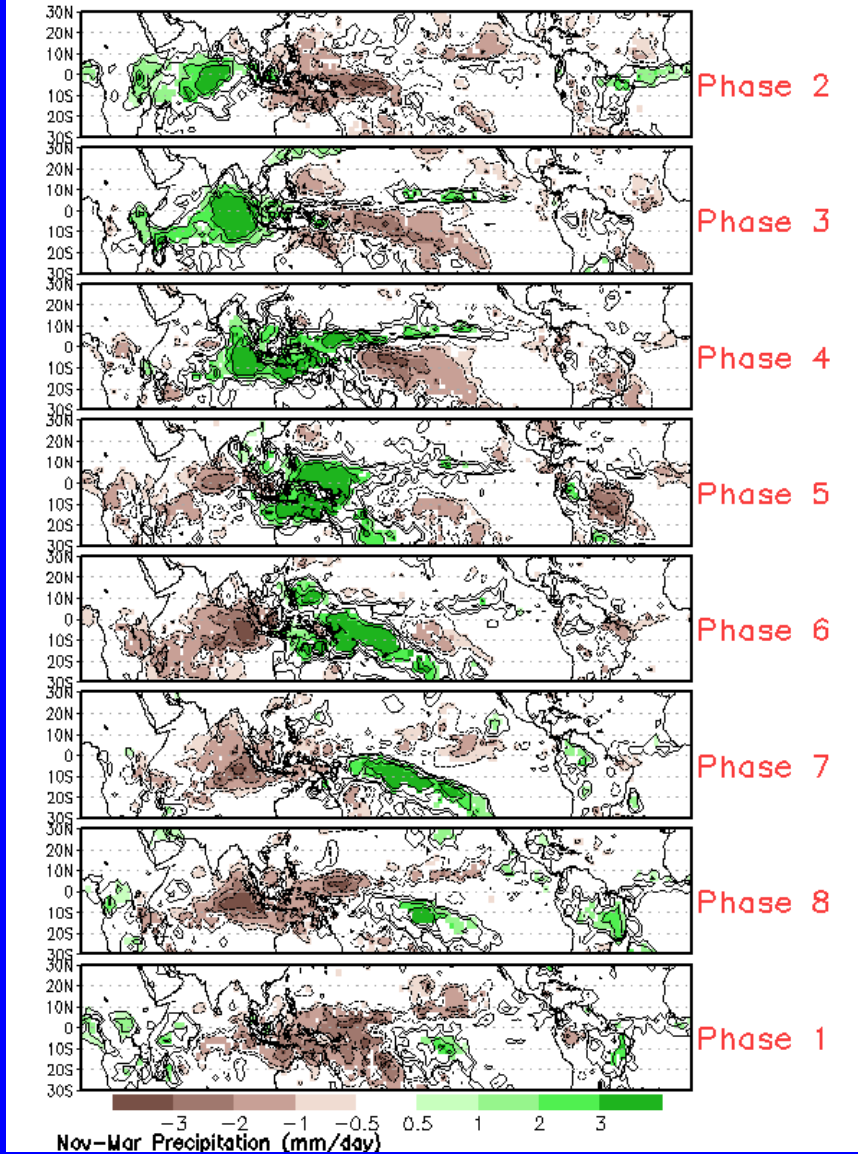
No MJO activity is forecast over the period.



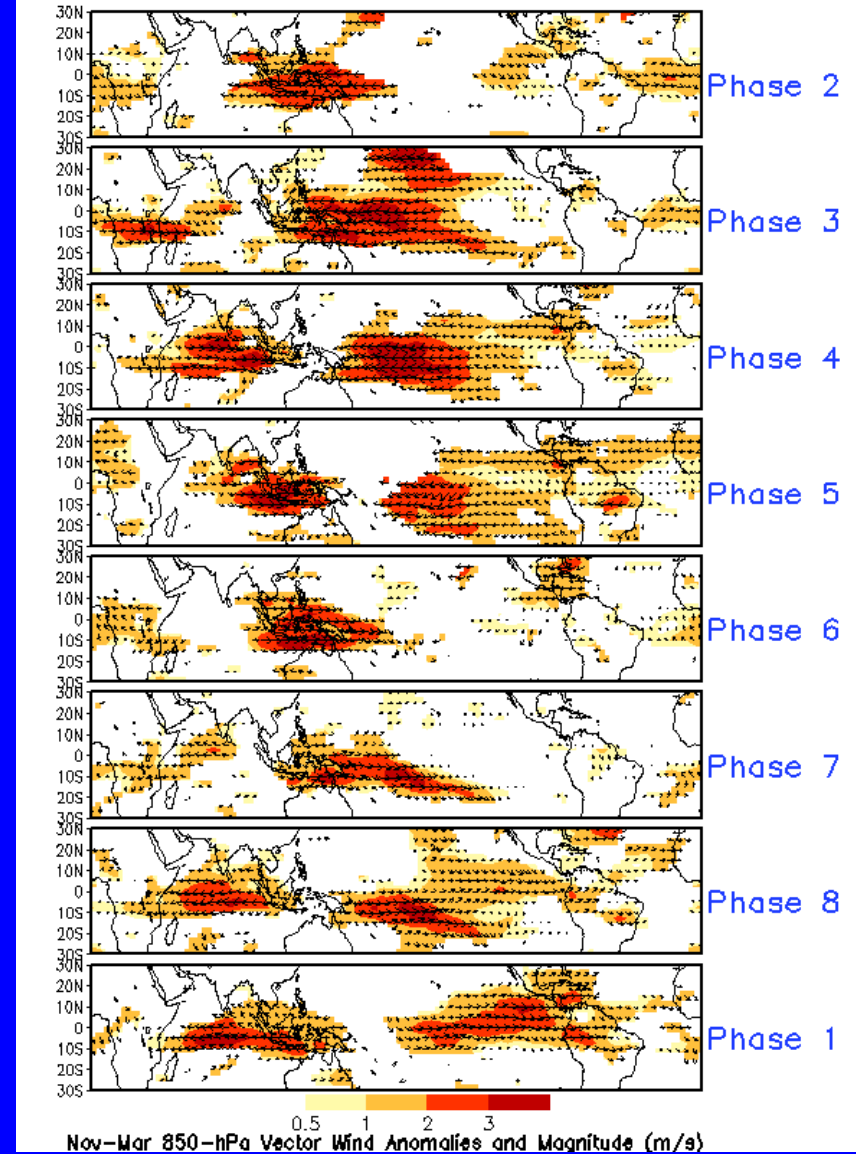


MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)

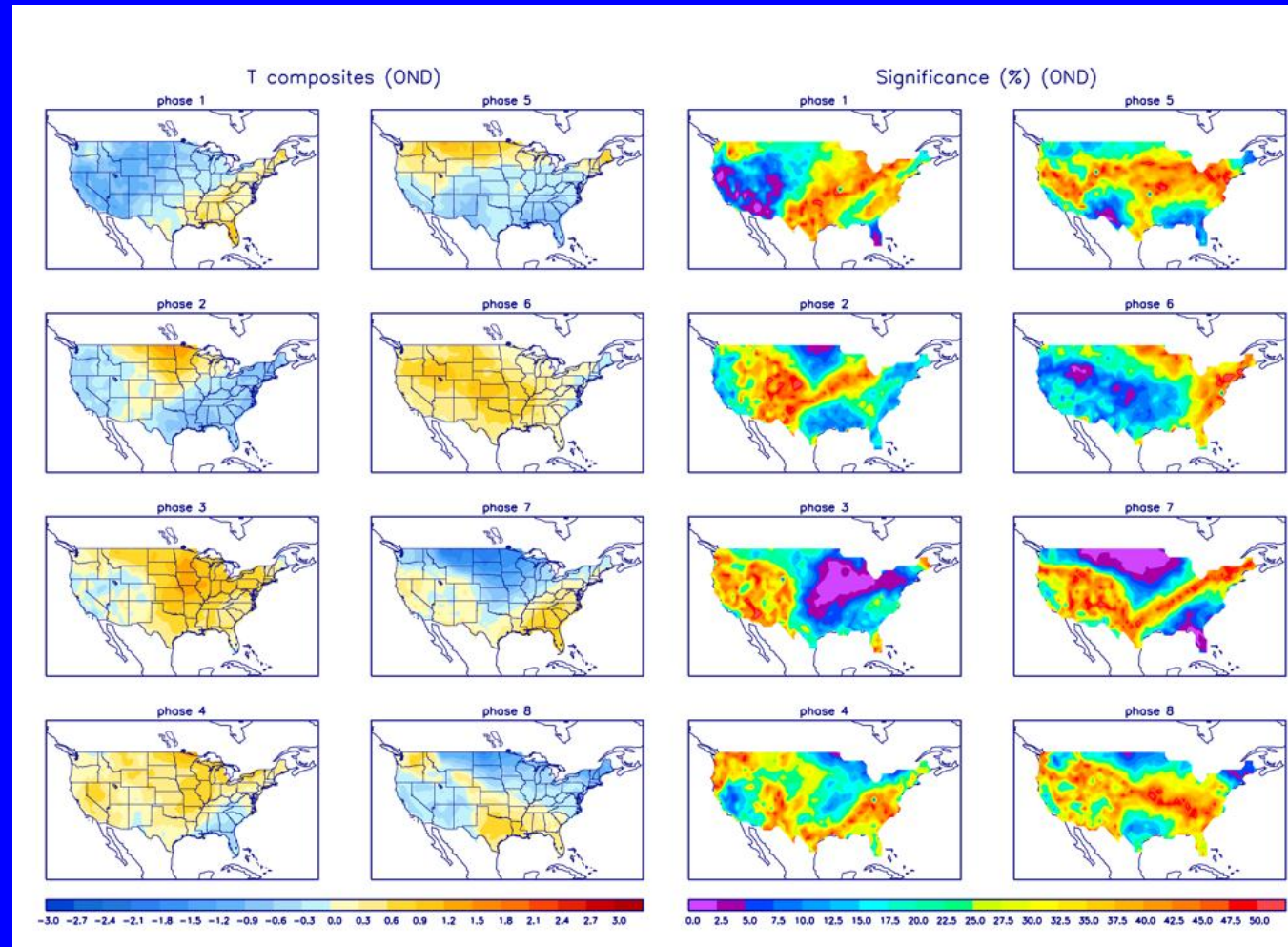




U.S. MJO Composites – Temperature

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.



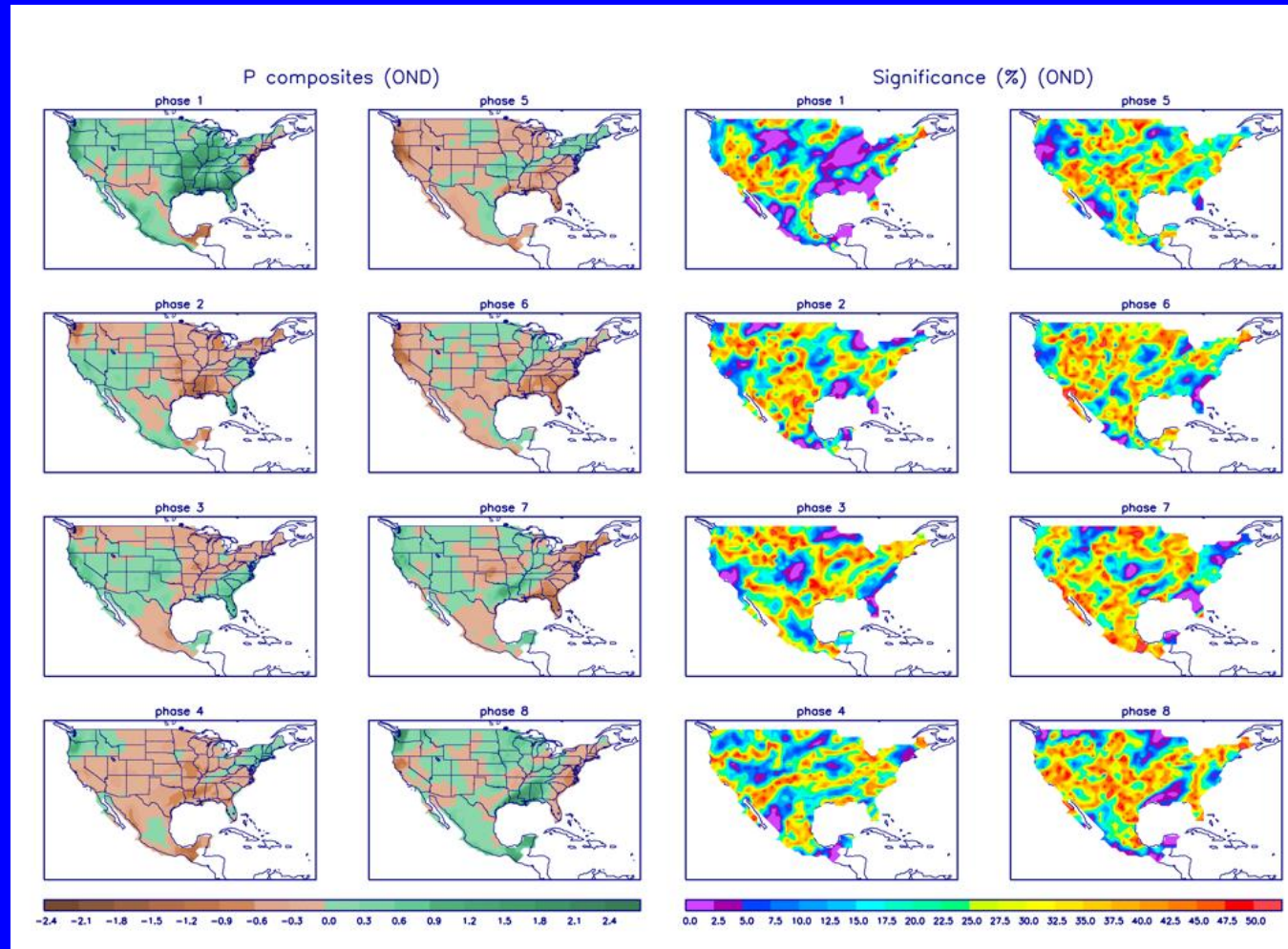
Zhou et al. (2010): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, Submitted.

<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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