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

Update prepared by
Climate Prediction Center / NCEP
February 14, 2011

Outline

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

Overview

- The MJO signal remained weak during the past week.

- All dynamical MJO index models forecast little or no MJO activity during the upcoming 1-2 week period. Based on this and recent observational evidence, the MJO is expected to remain weak during the next two weeks.

- The MJO is not expected to contribute in any substantial way to impacts across the Tropics or U.S. during the next 1-2 weeks.

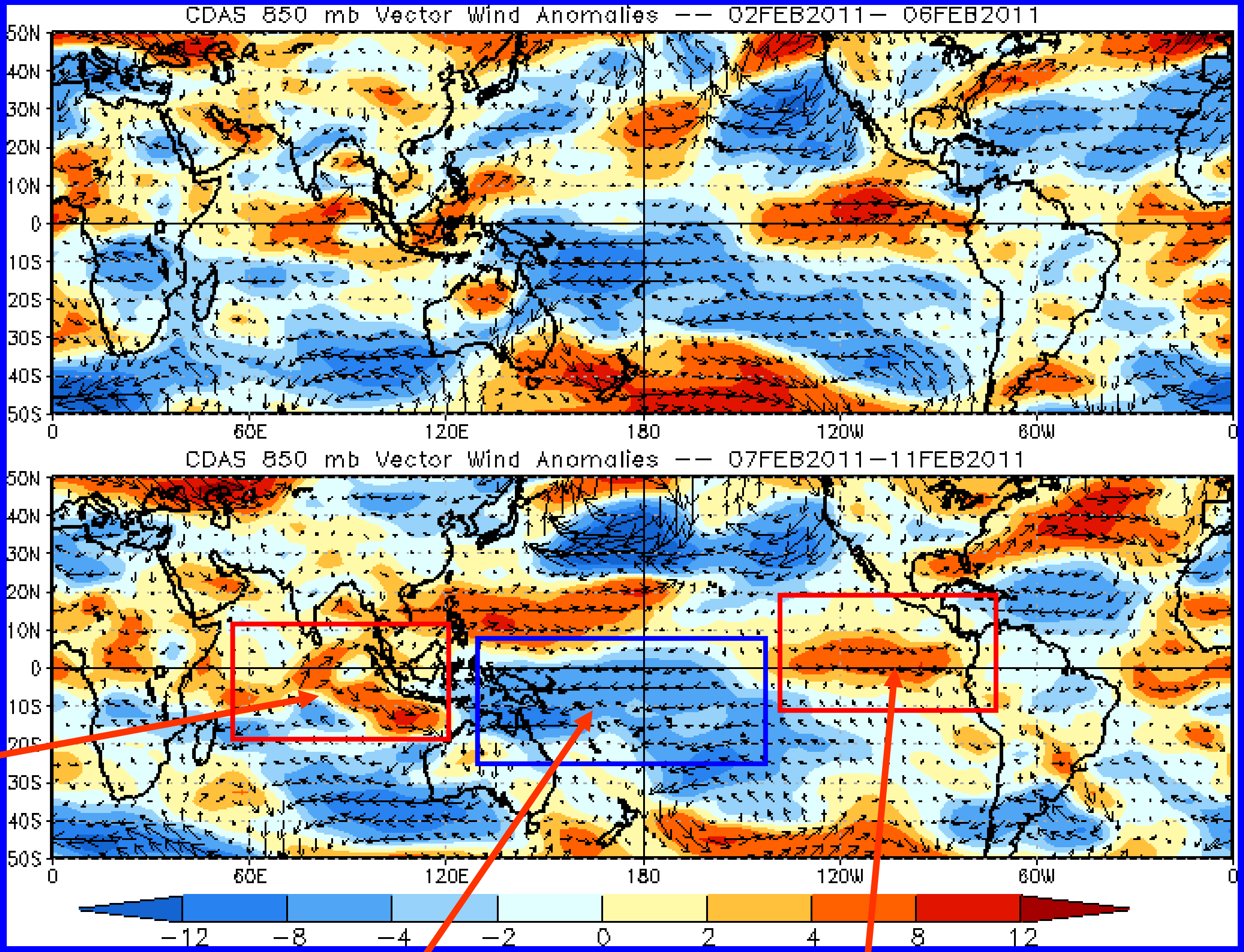
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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 the Indian Ocean during the last five days.

Easterly anomalies continued across the western and central equatorial Pacific mainly south of the equator.

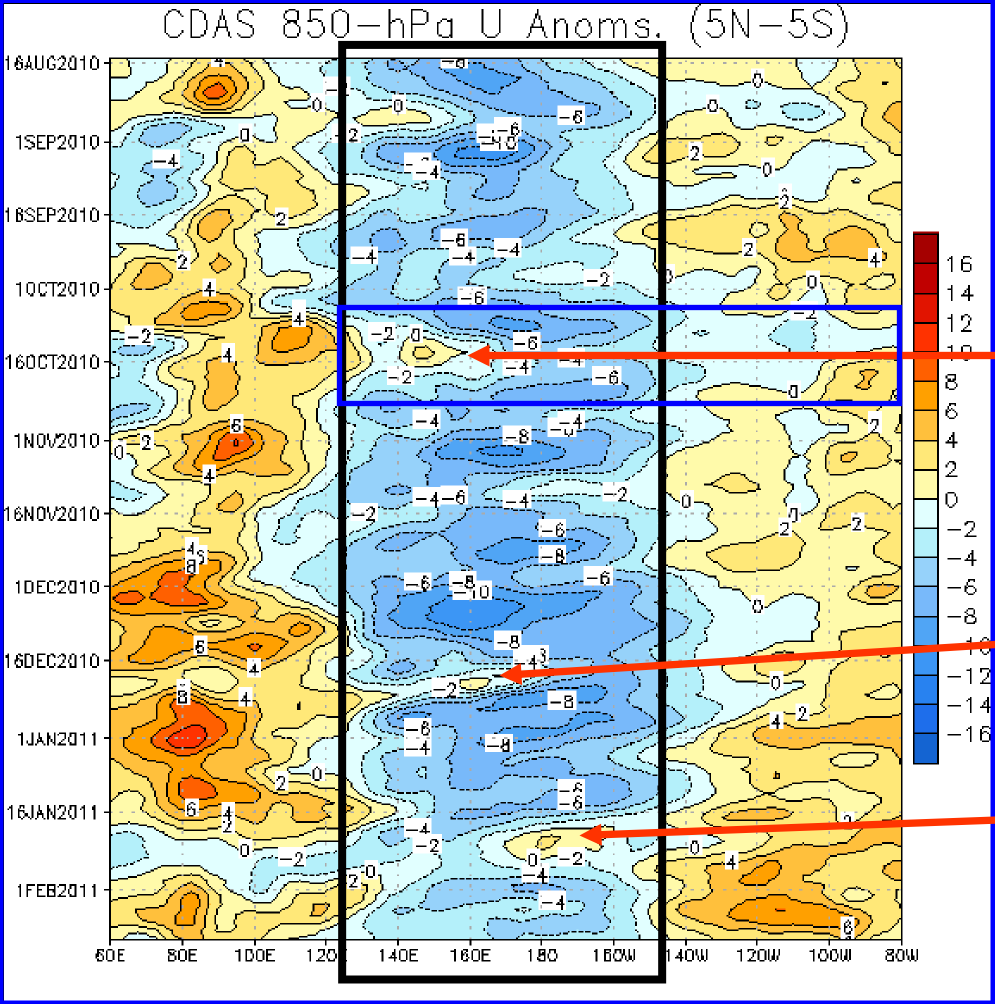
Westerly anomalies are somewhat weaker across the eastern equatorial Pacific.

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

Time



Longitude

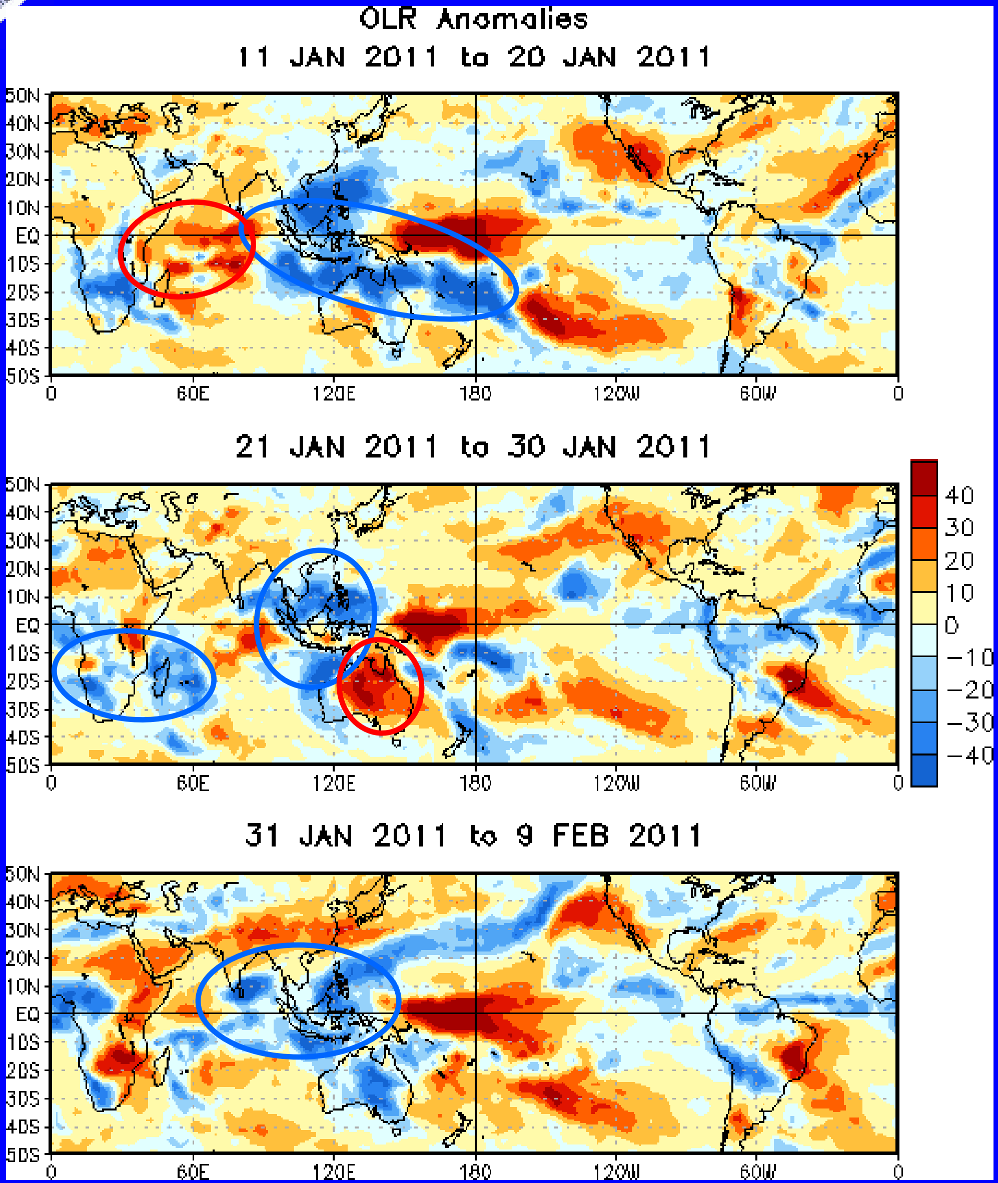
Easterly anomalies have persisted in the west-central Pacific since August (black box) consistent with the development of La Nina conditions.

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

In mid-December, easterly anomalies weakened just west of the Date Line due to a combination of weak MJO activity and extratropical interactions.

In late January, easterly winds weakened and westerly anomalies developed in some areas near the Date Line due to MJO activity.

OLR Anomalies – Past 30 days



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

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

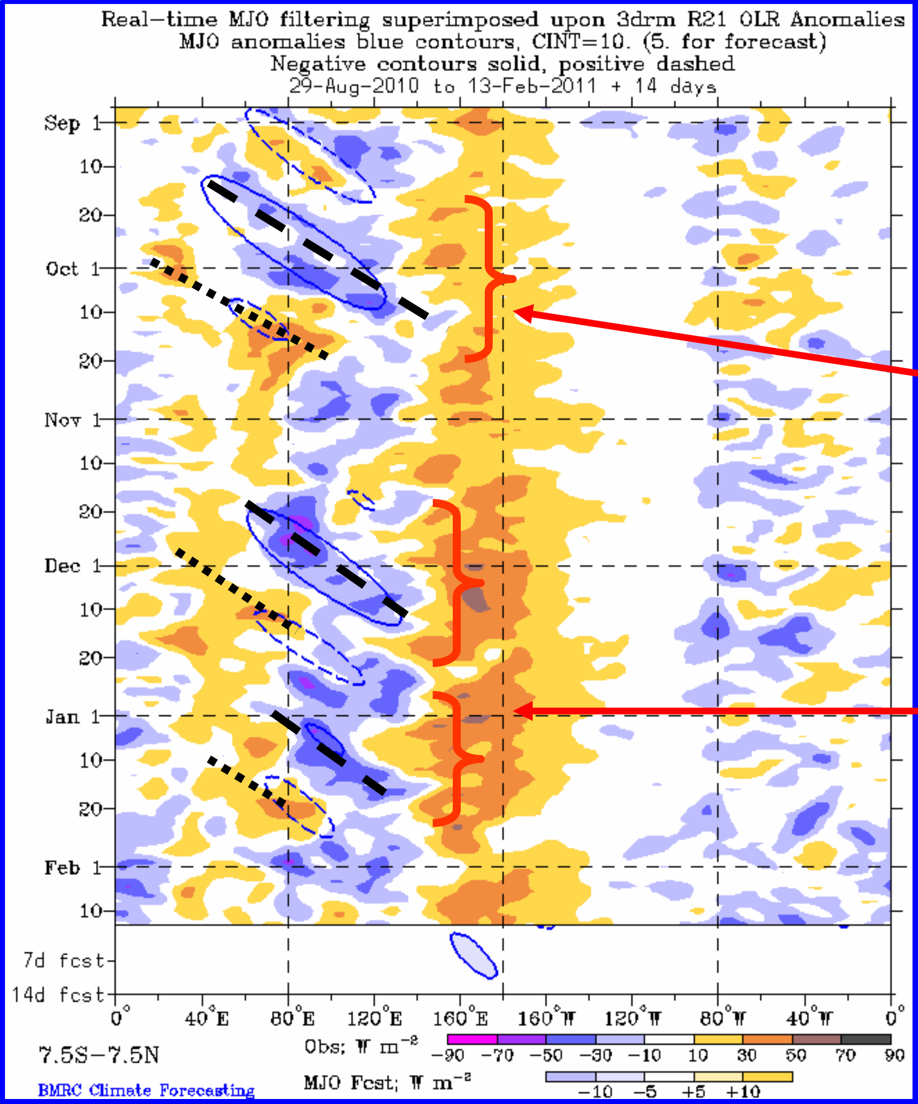
During mid-January, enhanced convection (blue circle) was observed over the Maritime Continent, Philippines, Australia and along the SPCZ, while suppressed convection (red circle) was evident across the western Indian Ocean and parts of eastern Africa.

Enhanced convection continued over parts of the Maritime continent while suppressed convection developed over parts of Australia. Enhanced convection also developed across southern Africa.

During early February, enhanced convection spread across the eastern Indian Ocean and Australia.

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

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)

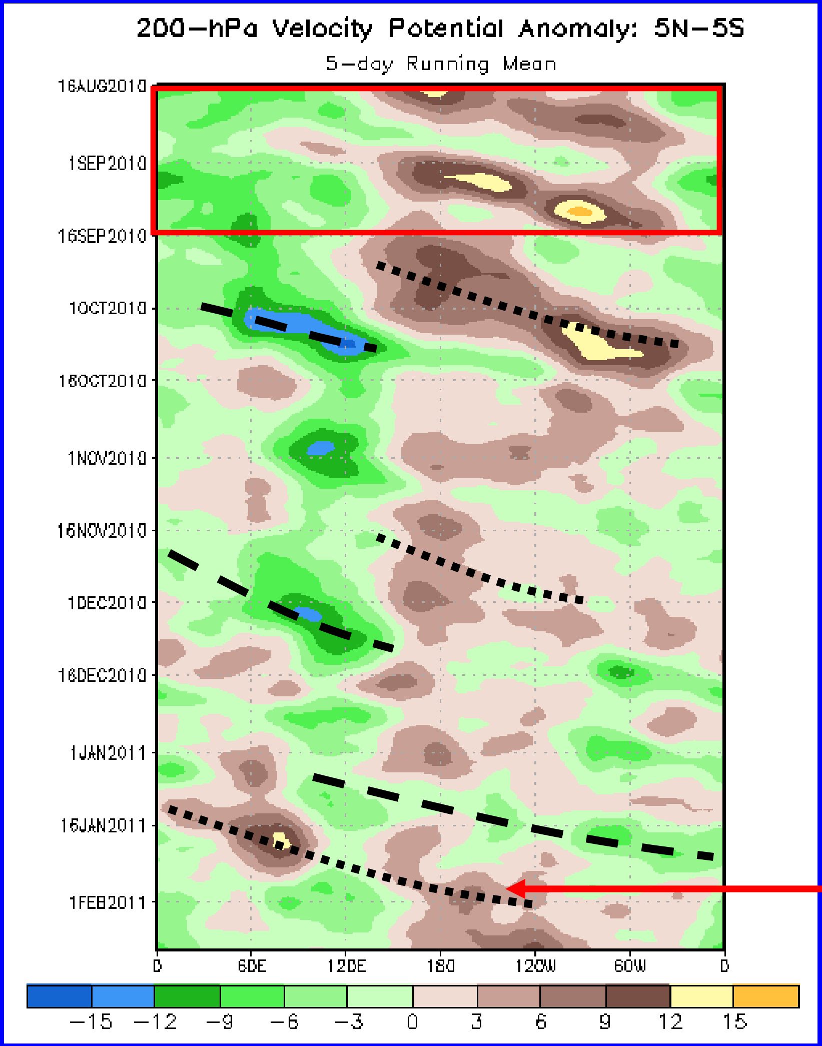
As the MJO strengthened in late September into October, enhanced convection developed near 60E and shifted eastward followed by suppressed convection near 20E during early-mid October.

MJO activity was experienced during late November into December and once again during January. During both periods, enhanced convection developed near 80E and shifted to the Maritime continent followed by an area of suppressed convection.

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 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.

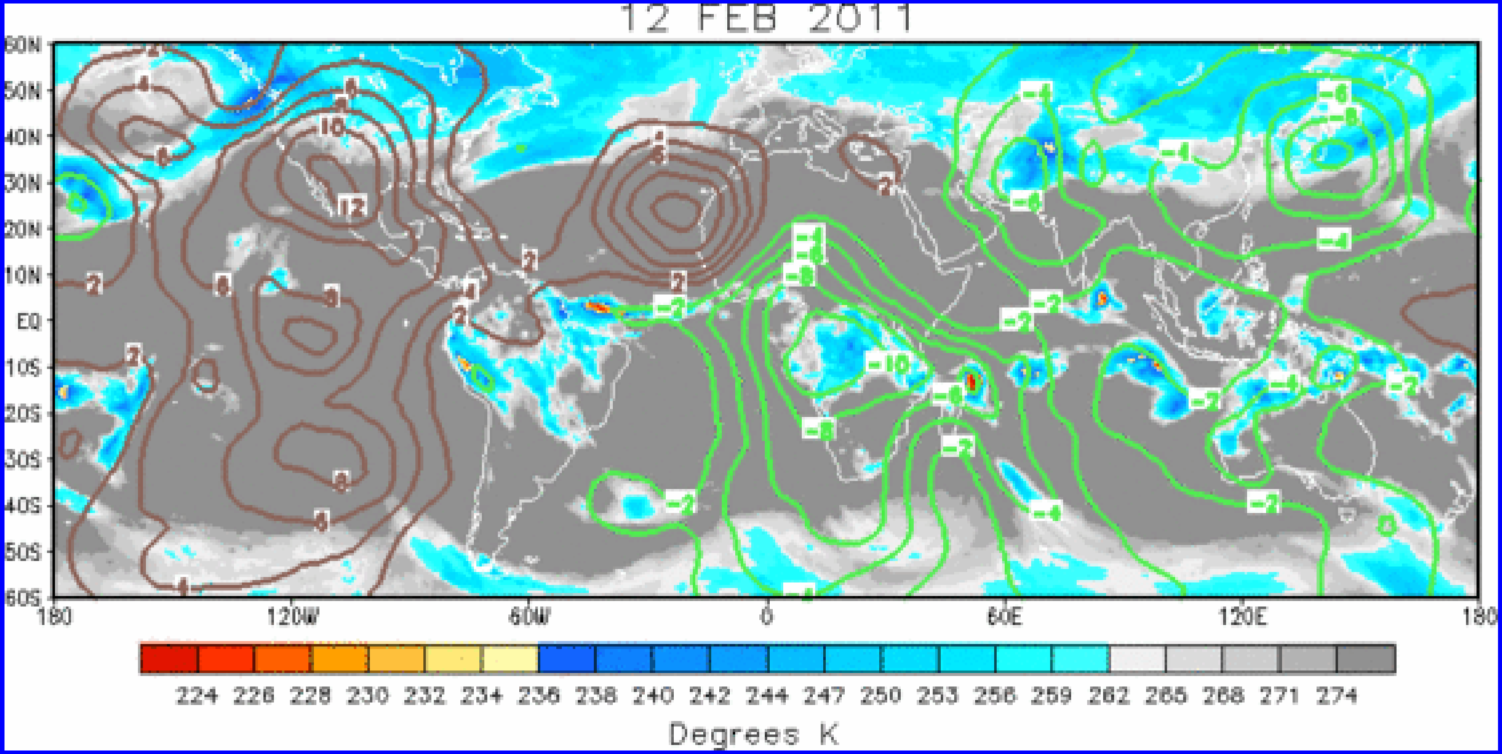
During late November and early December, some eastward propagation associated with the MJO is evident in velocity potential anomalies.

During mid-to-late January, the MJO strengthened as upper-level divergence shifted eastward from 120E and upper-level convergence shifted from Africa to near the Date Line.

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



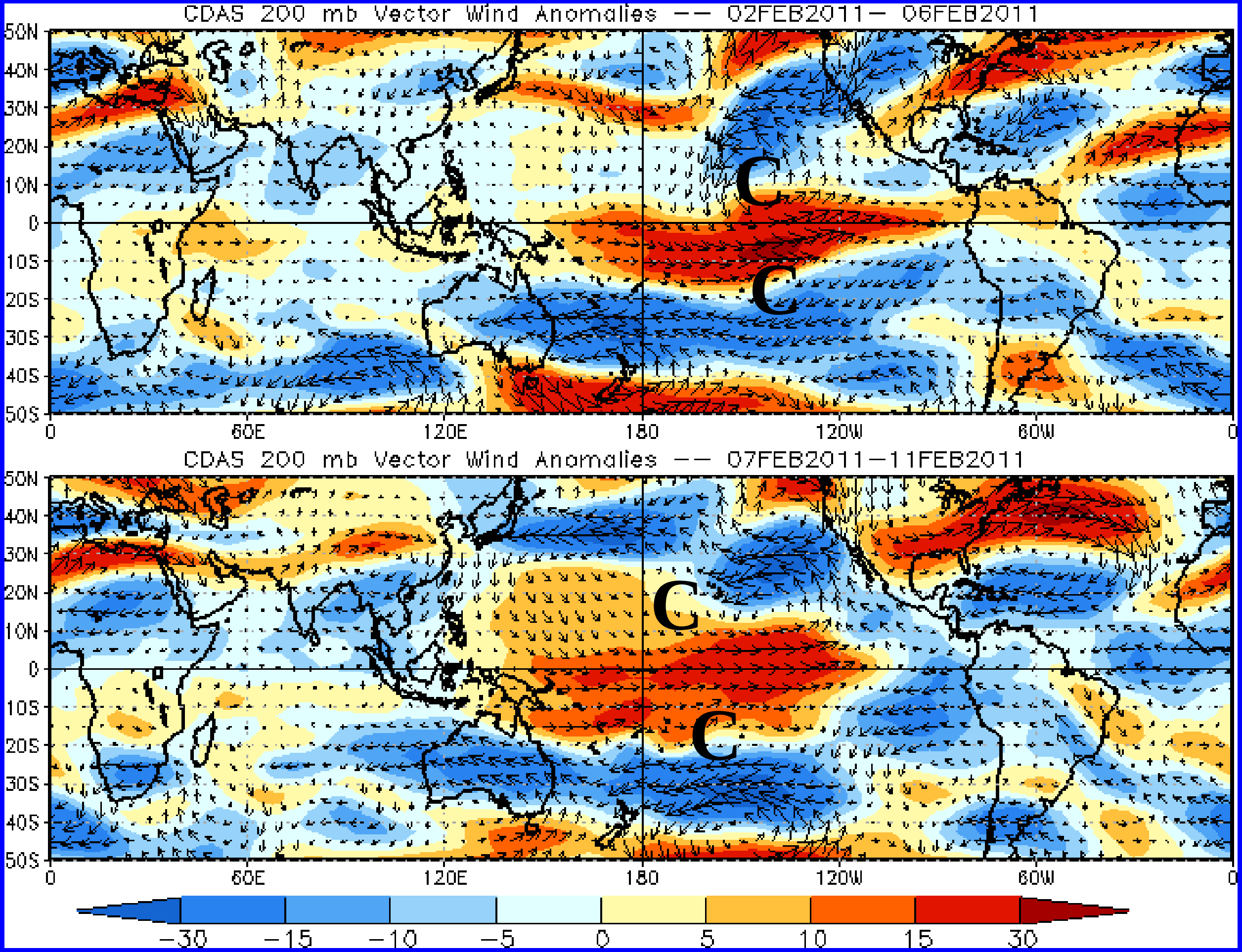
The large scale velocity potential pattern shows anomalous upper-level divergence over Africa to the Maritime continent and anomalous upper-level convergence across much of the Western Hemisphere.

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



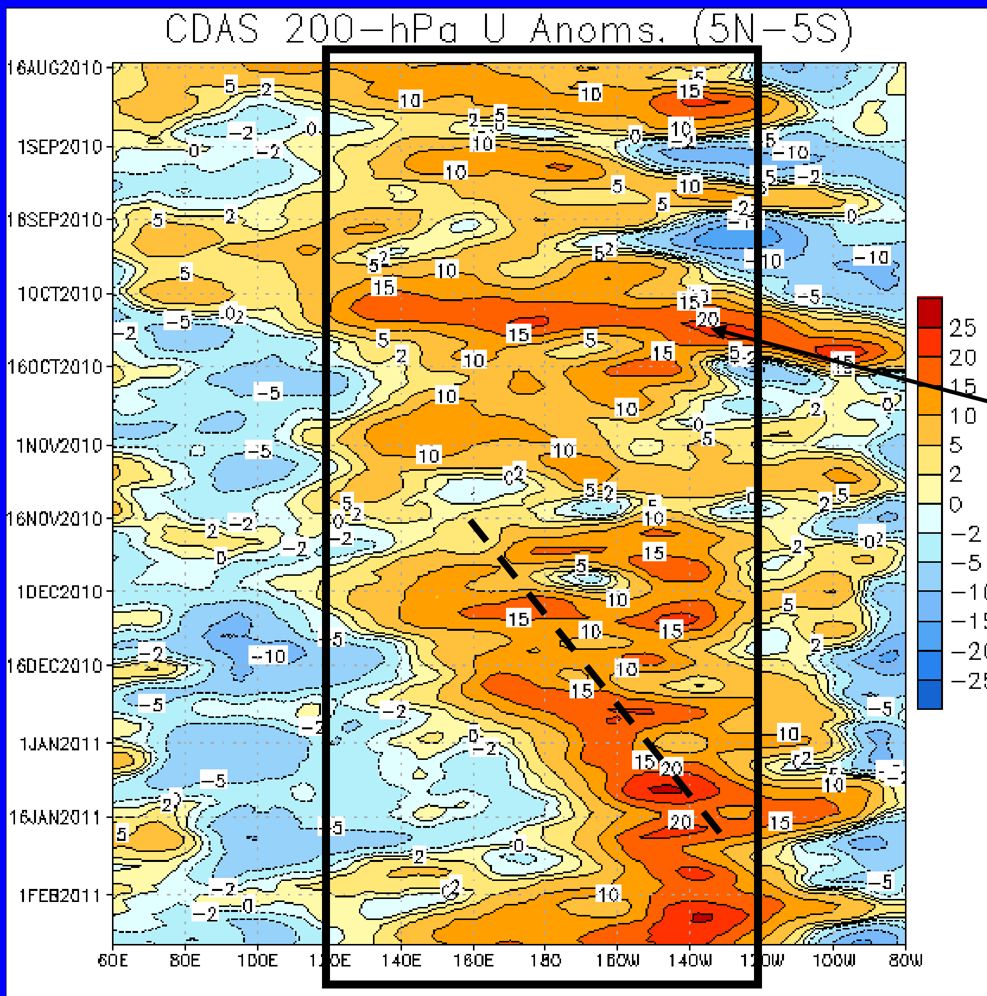
Cyclonic circulations (C) are evident north and south of the equator across the eastern Pacific.

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

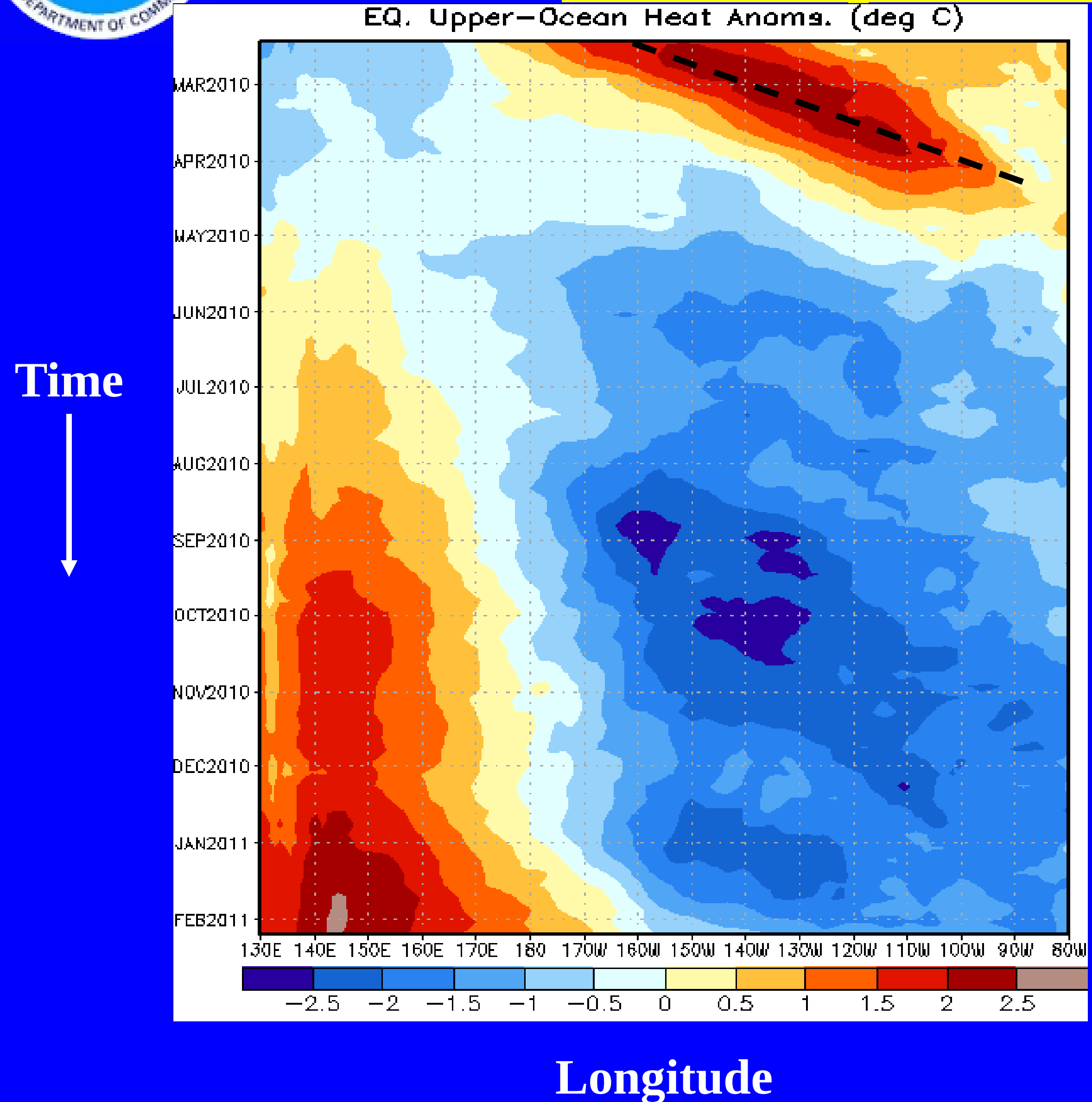
Westerly anomalies persisted across a large area from the Maritime Continent to the central Pacific (black solid box) since July.

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

There has been a slight eastward shift in the core of the westerly anomalies across the Pacific beginning in early December (dashed line).

Recently, westerly anomalies have expanded back to the west across the central Pacific.

Weekly Heat Content Evolution in the Equatorial Pacific



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

From December 2009 – February 2010 two ocean Kelvin waves contributed to the change in heat content across the eastern Pacific (last two 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.

Since the beginning of January 2011, positive heat content anomalies have shifted slightly eastward, while negative heat content anomalies have weakened across much of the Pacific basin.

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).**

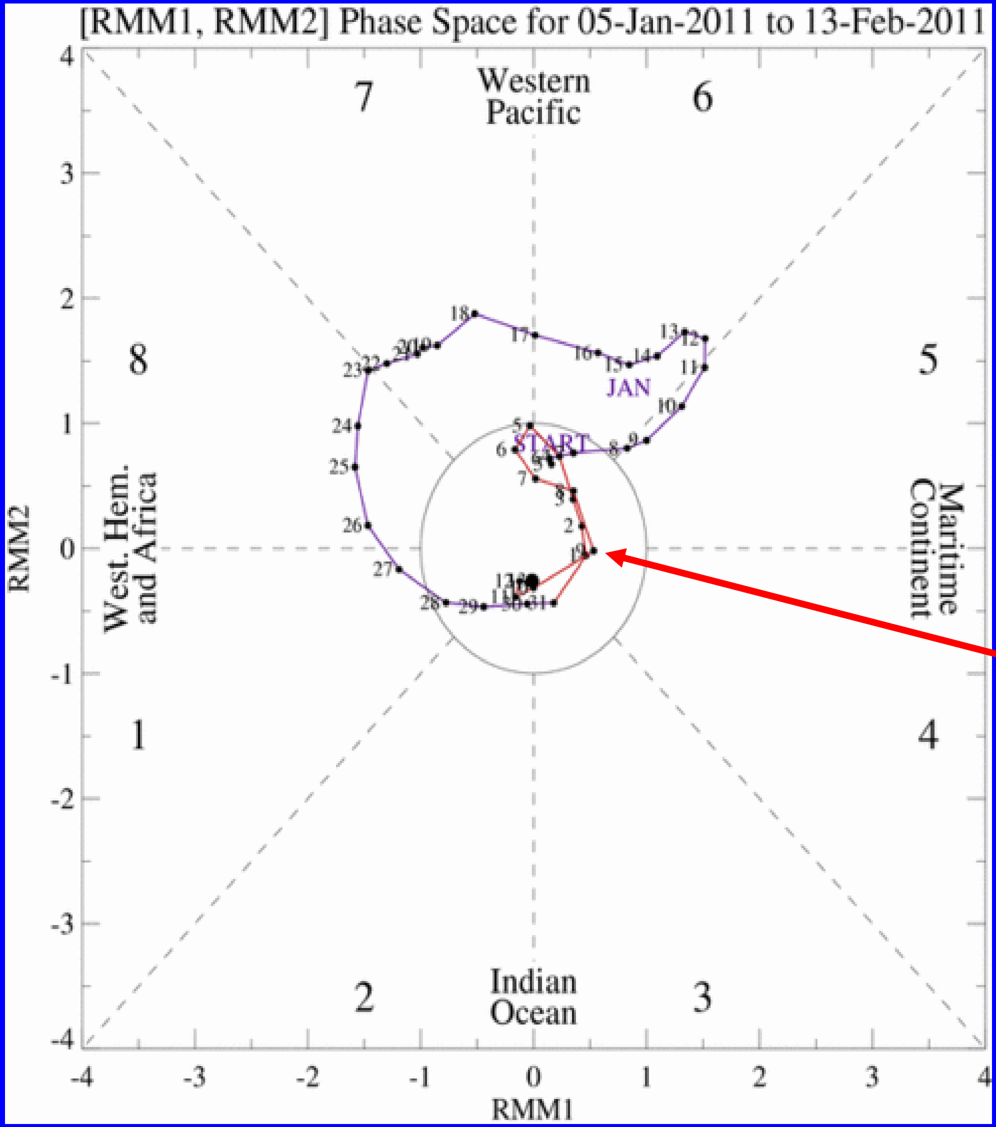
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review,* 132, 1917-1932.

• **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).**

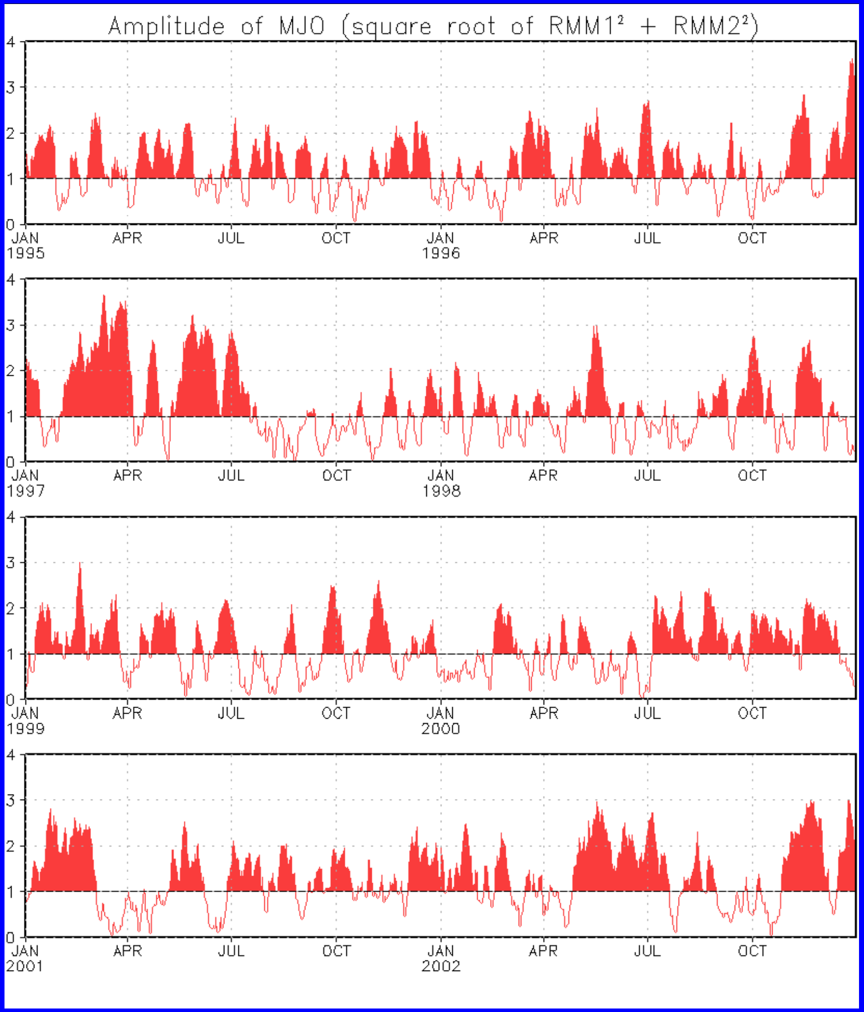
MJO Index -- Recent Evolution

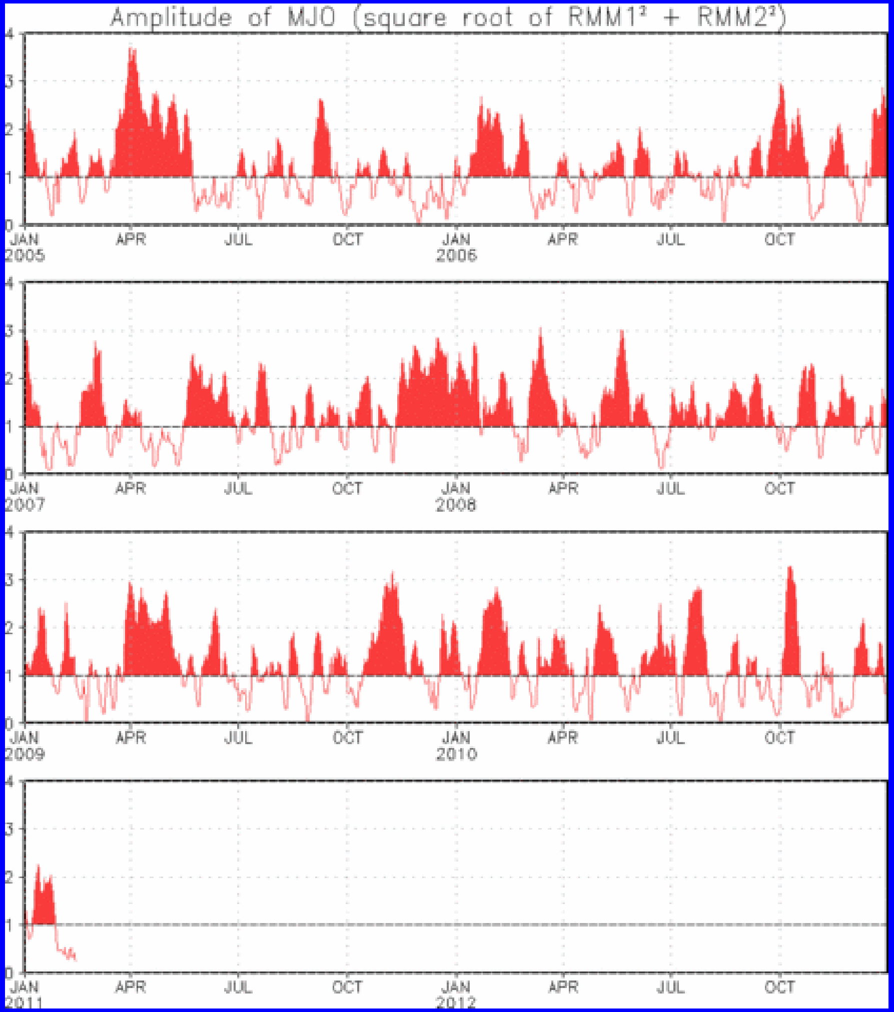


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO remained weak during the past week as indicated by the MJO index.

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.

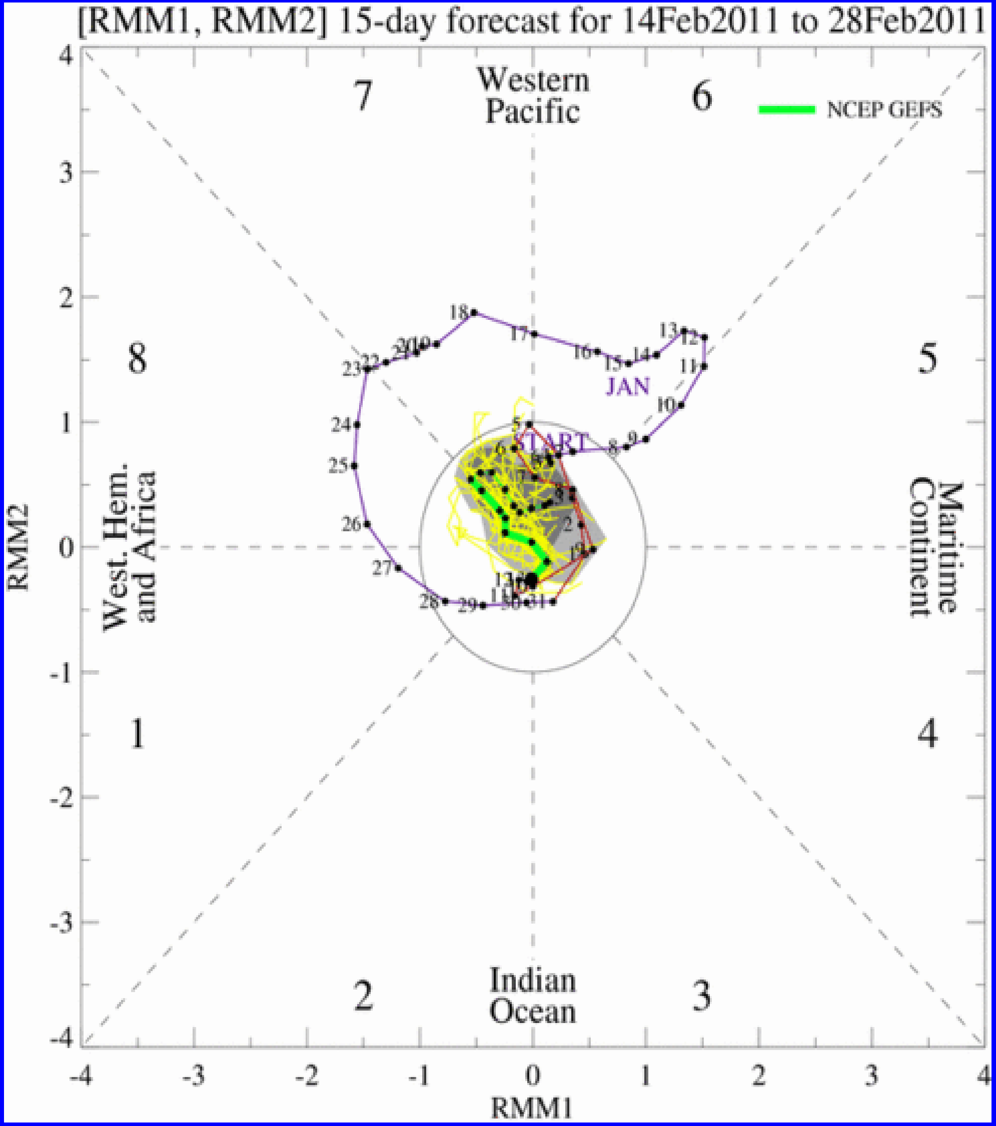
Ensemble GFS (GEFS) MJO Forecast

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

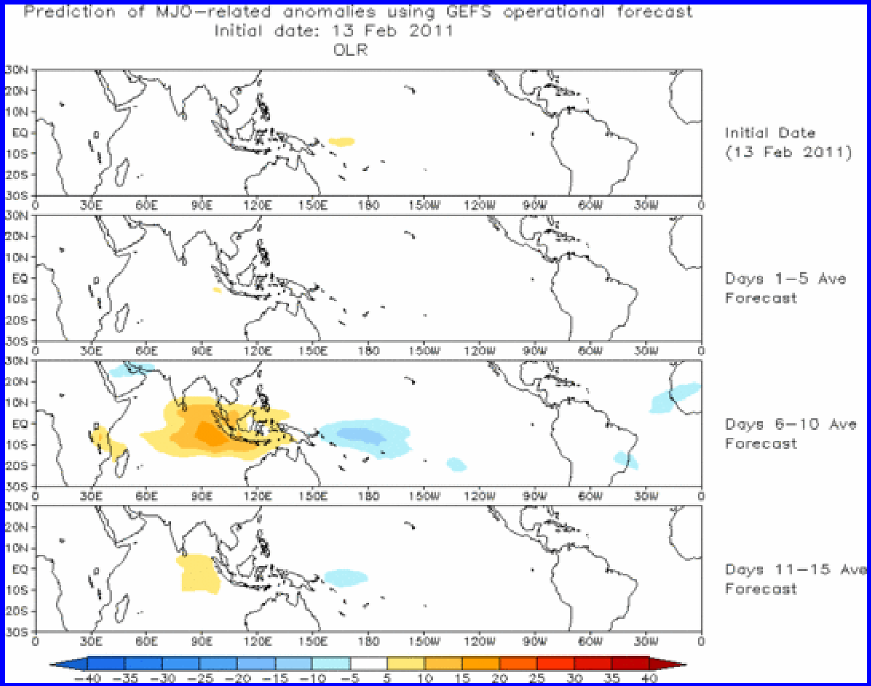
The ensemble GFS forecasts a weak signal during the period.



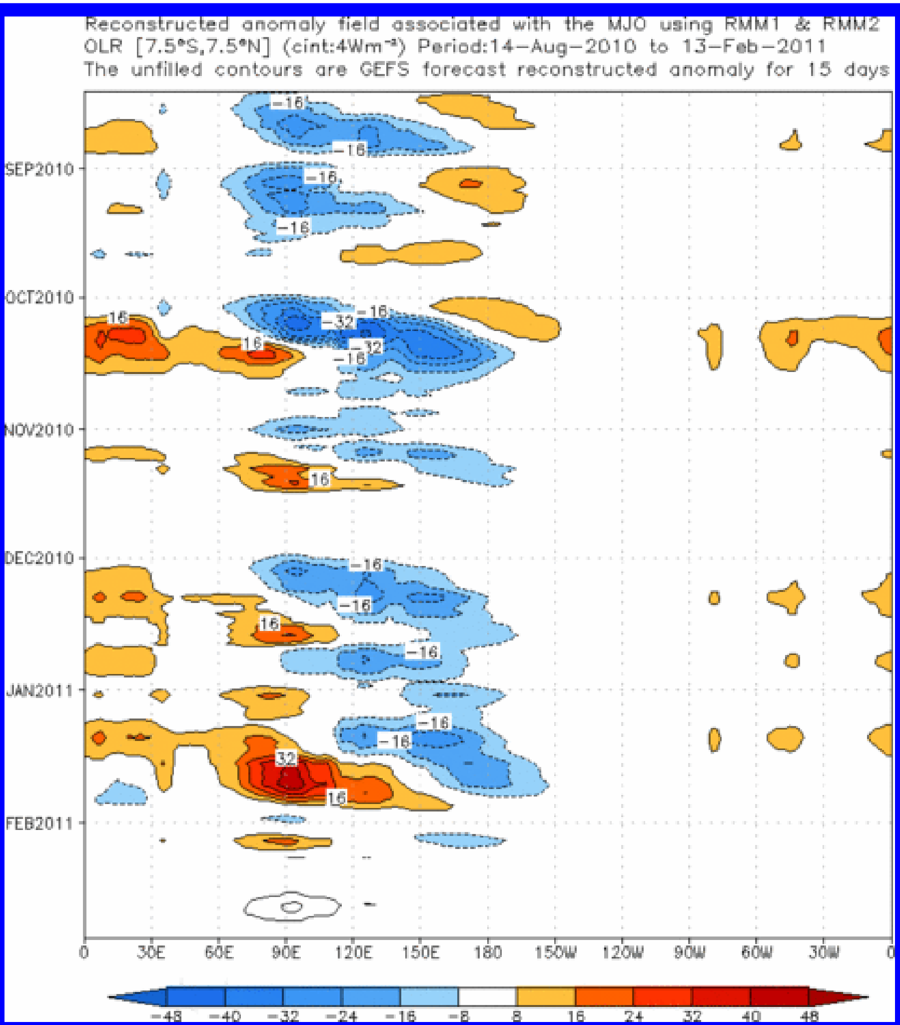
Ensemble Mean GFS MJO Forecast

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)

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 suppressed convection developing across the Indian Ocean and Maritime Continent during Week-2.

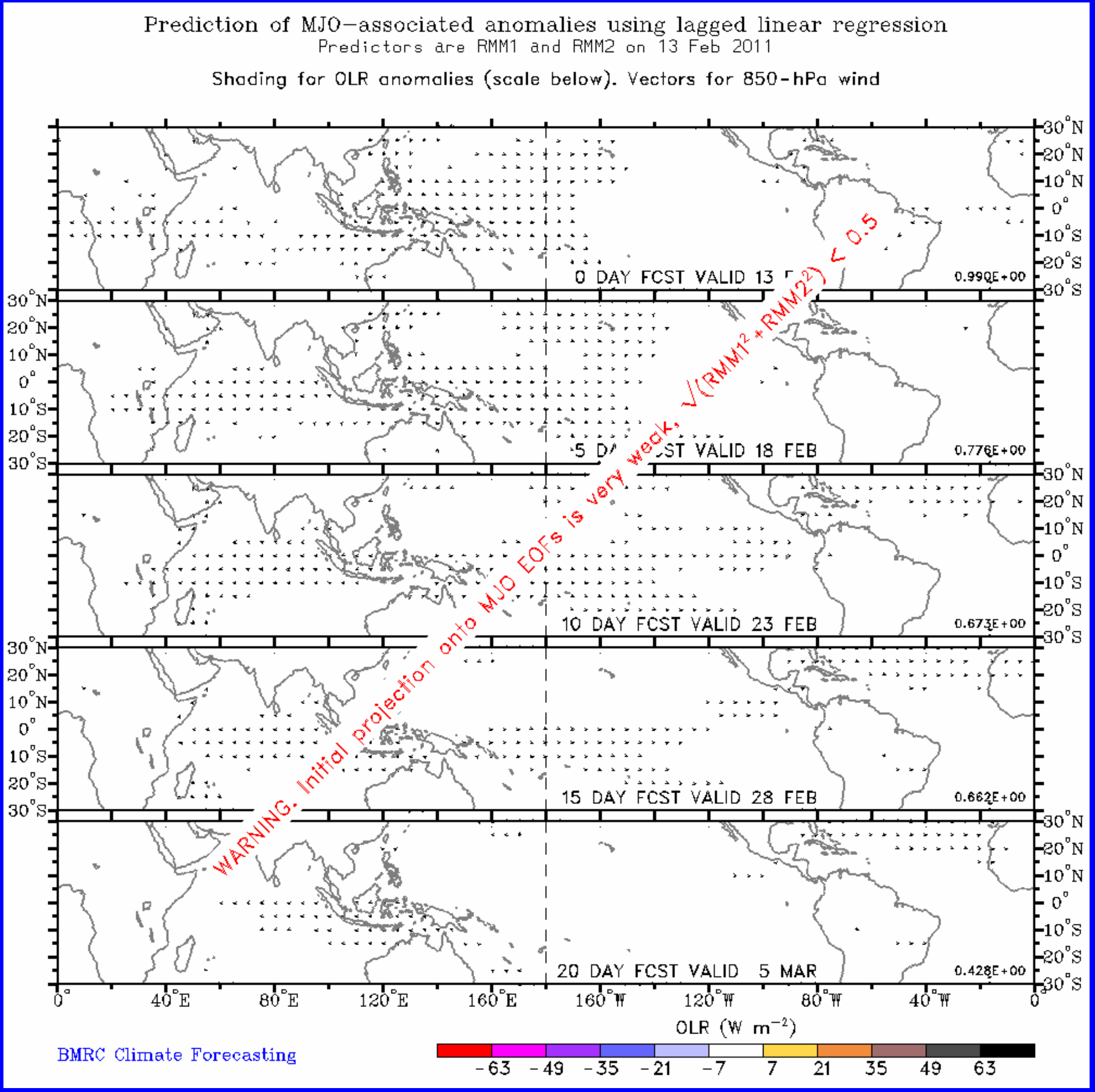
Statistical MJO Forecast

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

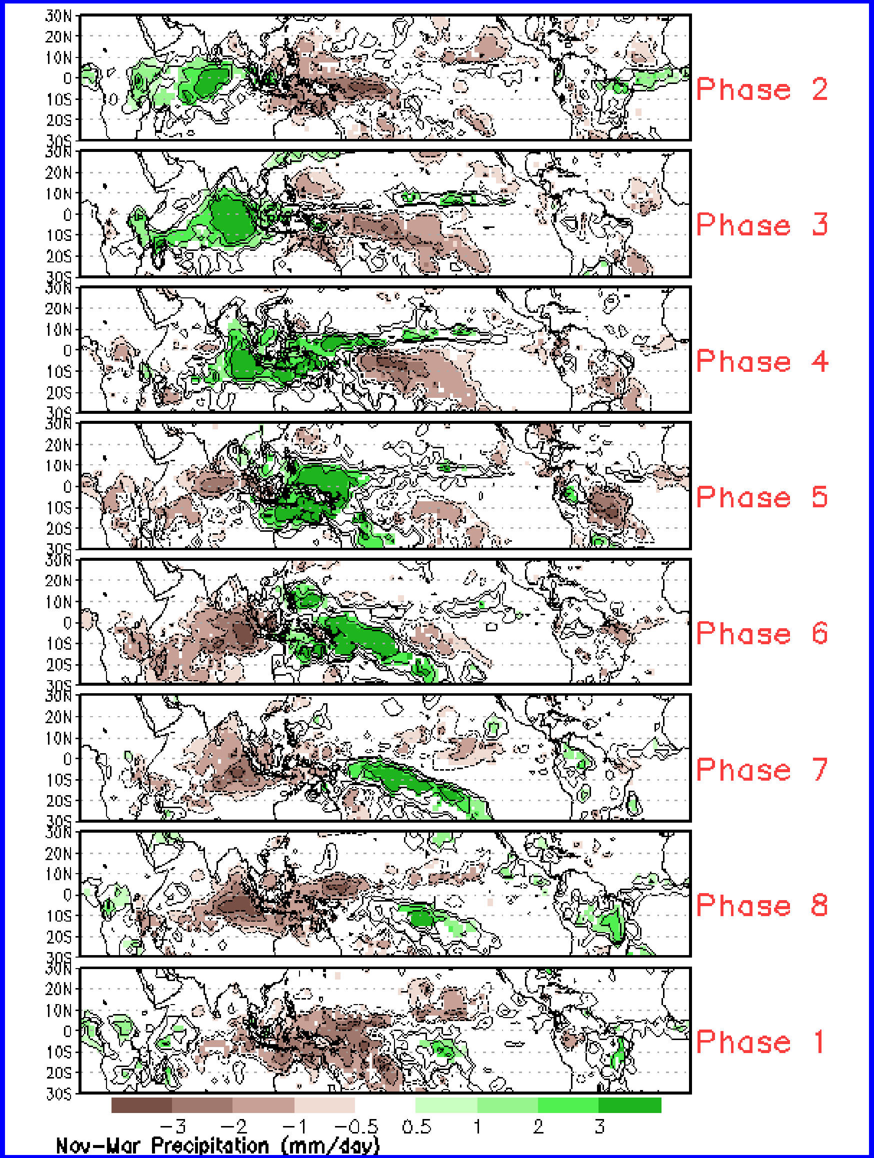
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

MJO activity is forecast to remain weak.

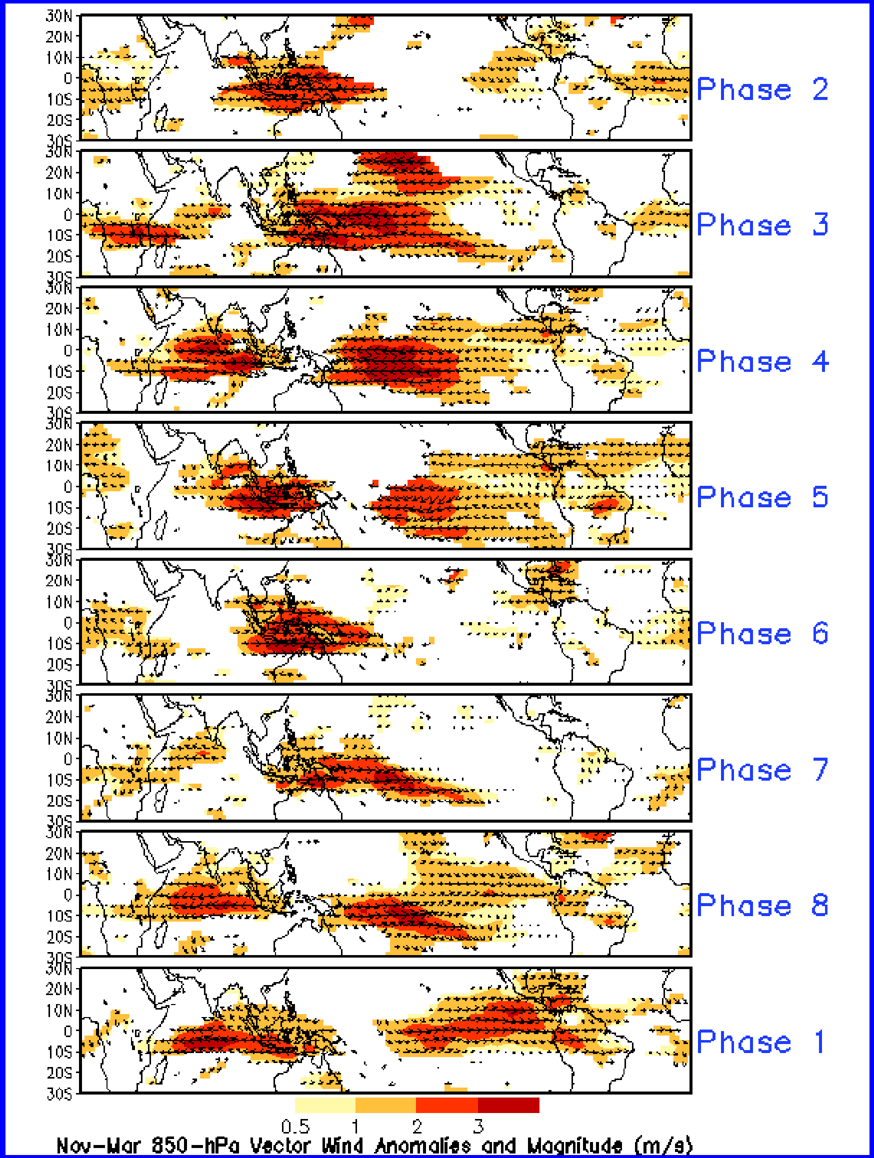


MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)

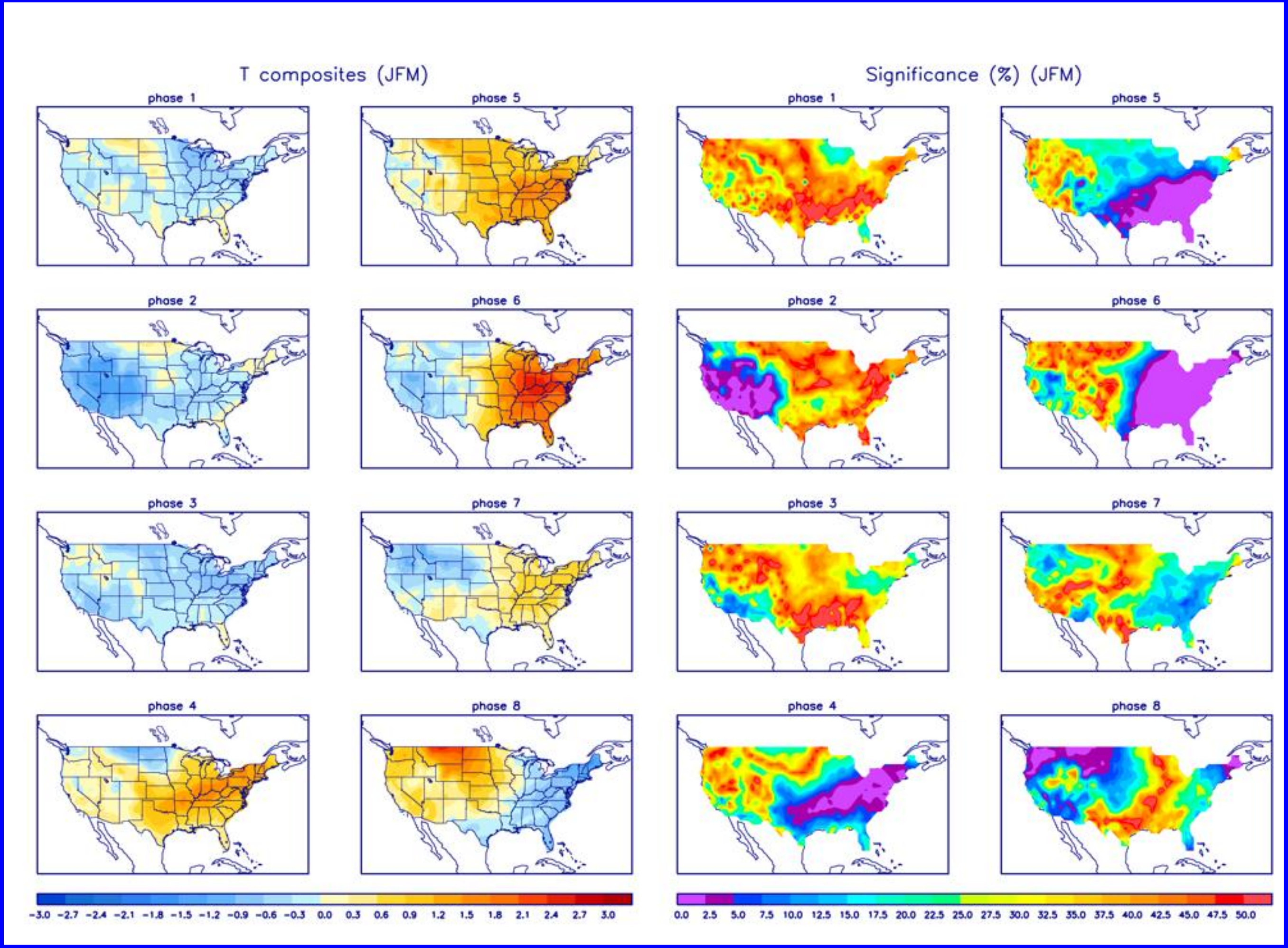


850-hPa Wind Anomalies (Nov-Mar)



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.**

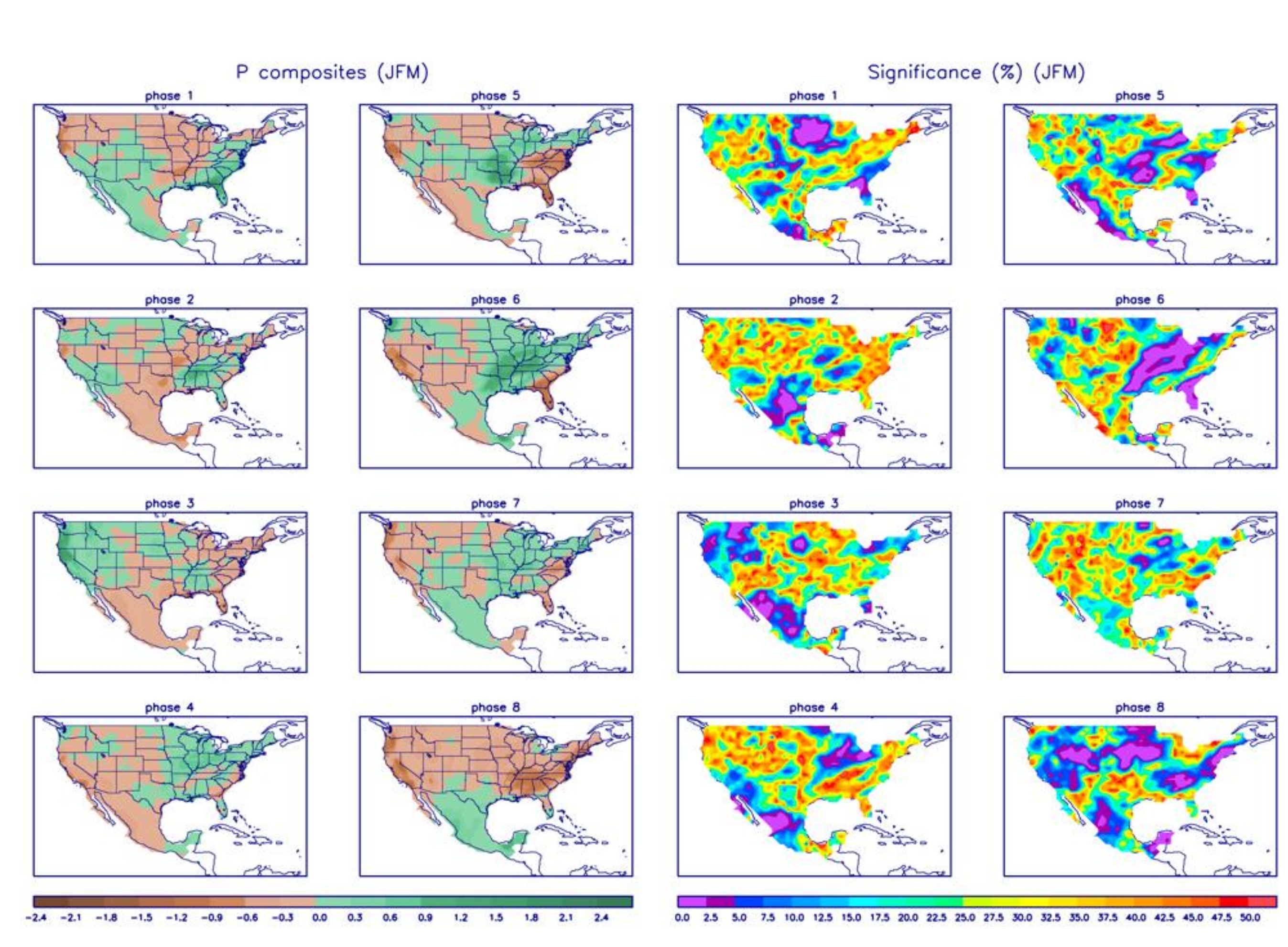


Zhou et al. (2010): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, Submitted.

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.**



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