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

Update prepared by
Climate Prediction Center / NCEP
May 28, 2012

Outline

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

Overview

- The MJO remained weak over the past week with much of the pattern of anomalous tropical convection related to higher frequency variability.
- The latest forecasts of the MJO index from dynamical models indicate continued incoherent, weak MJO activity during the period. Several different areas of enhanced convection are likely to be active.
- Based on the latest observations and model forecasts, the MJO is forecast to remain weak during the next 1-2 weeks.
- At the current time, the MJO is not expected to contribute substantially to areas of anomalous tropical convection during the period.

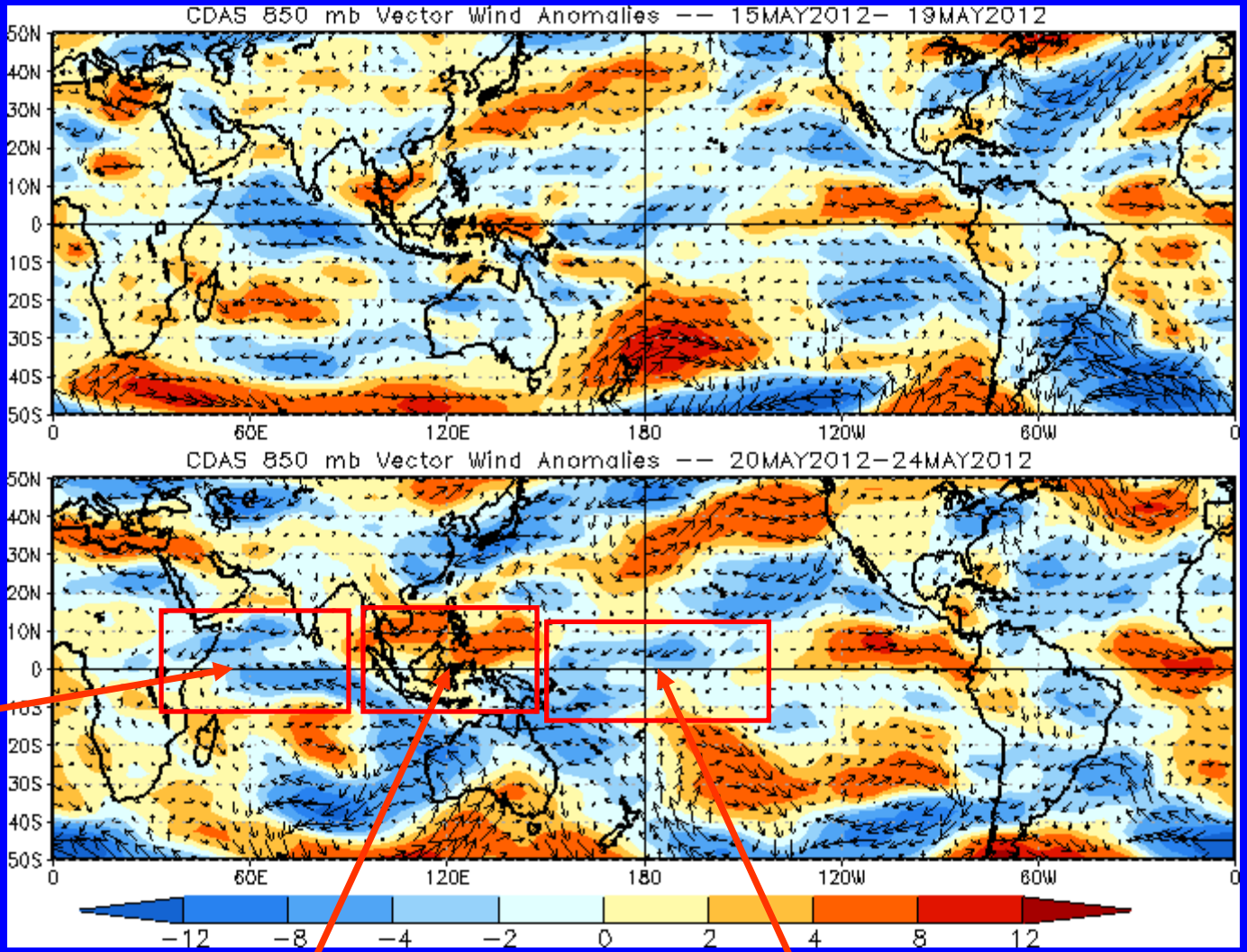
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

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 across the equatorial Indian Ocean during the last five days.

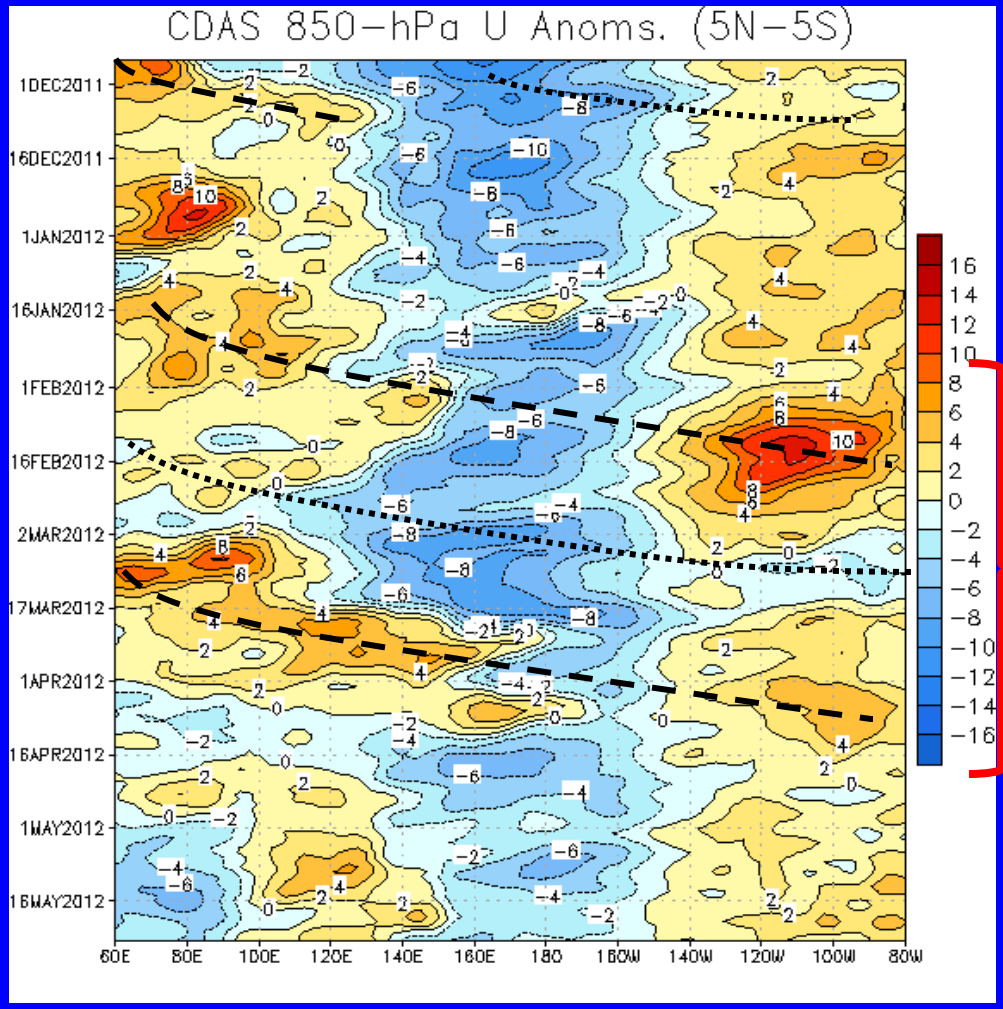
Westerly anomalies strengthened across areas over the Maritime continent and western Pacific during the last five days.

Small easterly anomalies remained in the central Pacific 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



Time

Longitude

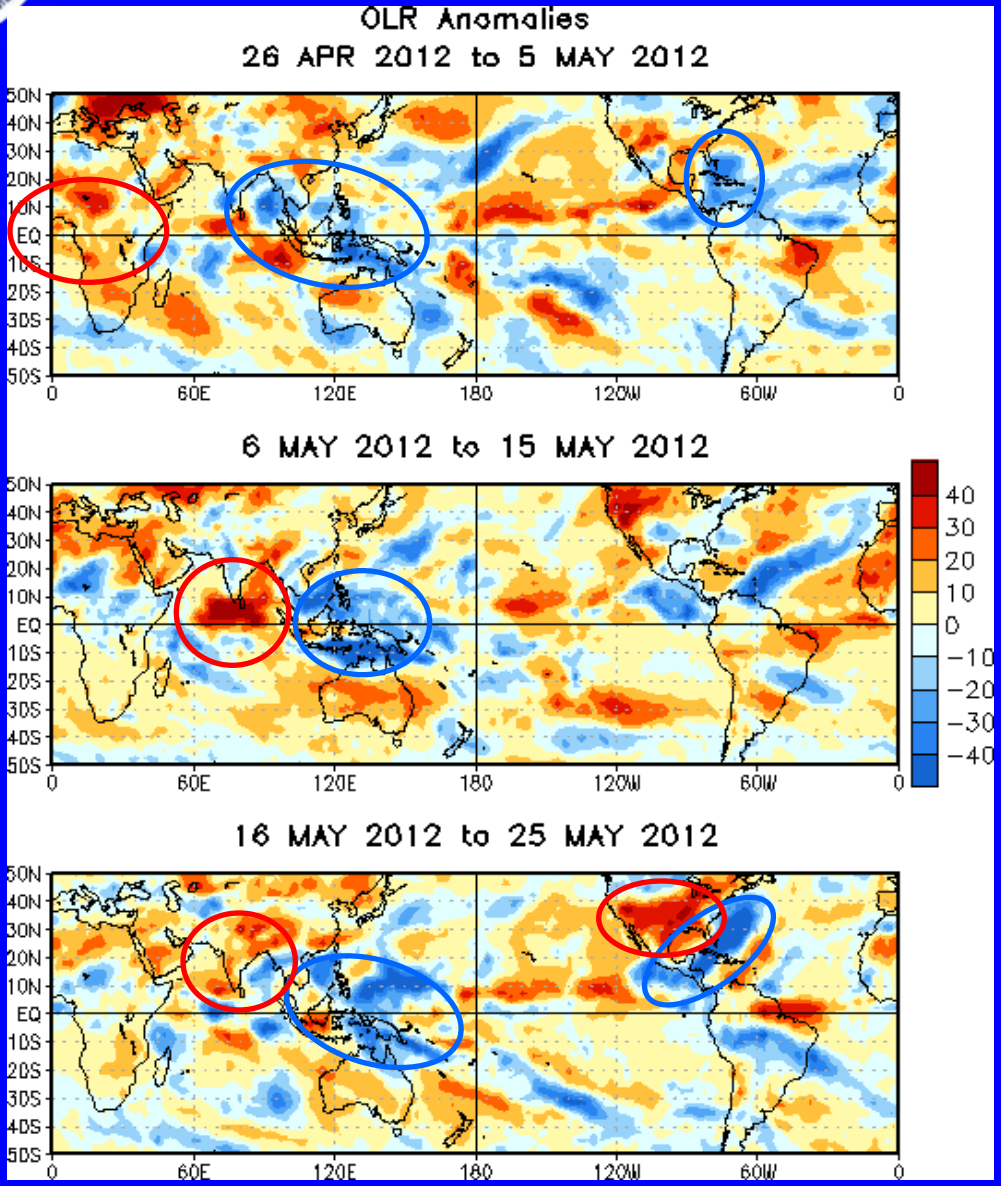
MJO activity continued into December as indicated by altering dashed and dotted lines. Later during other portions of December and January, westerly (easterly) wind anomalies across the Indian Ocean (western Pacific) became more stationary.

During the first half of February, the MJO 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.

On average, anomalies have been somewhat stationary across much of the global tropics since mid-April.

OLR Anomalies – Past 30 days



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

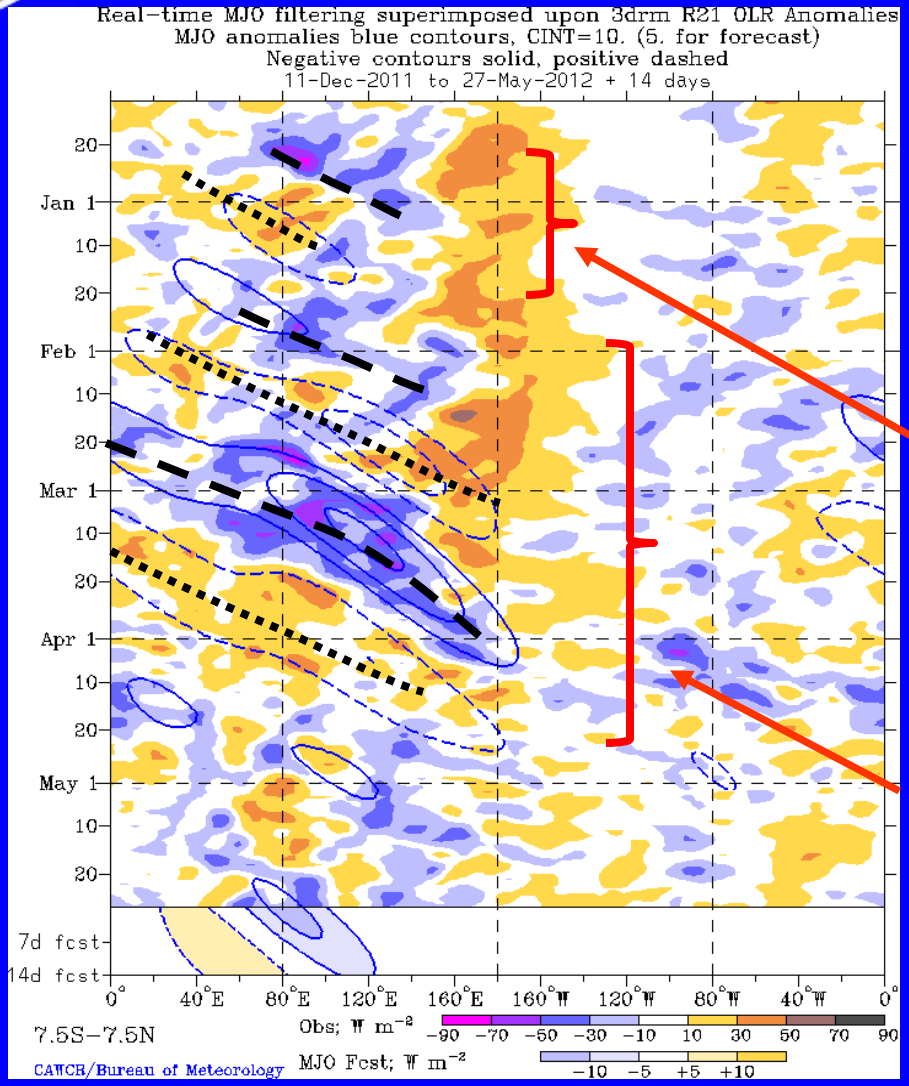
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

During late April into early May, enhanced convection was scattered over areas of the Indian Ocean, southern Asia and the Maritime Continent and also near the Caribbean (blue circles). Suppressed convection developed across Africa (red circle).

In early-to-mid May, suppressed convection developed across the equatorial Indian Ocean while wet conditions increased across the Maritime continent.

During mid-to-late May, suppressed convection was evident across India and the southern U.S. while enhanced convection was observed across the Maritime continent, western Pacific, Central America and the Caribbean.

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 CAWCR Australia Bureau of Meteorology)

Weak MJO activity was evident in late December and early January as alternating areas of enhanced (dashed lines) and suppressed (dotted lines) convection shifted eastward.

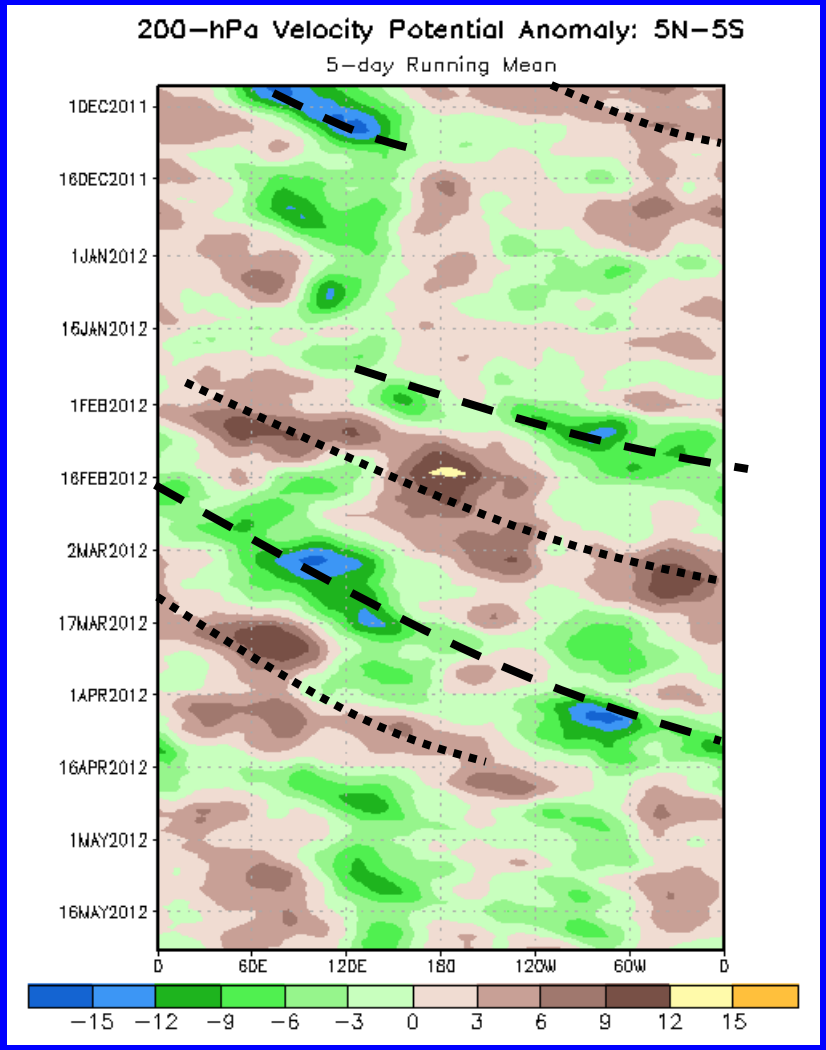
Strong MJO activity once again developed during late January and continued into early April. During this same period, other modes of subseasonal variability have also contributed to the observed pattern.

Anomalies have become generally small in many areas in May with the strongest enhanced convection currently observed near 90E.

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

Alternating negative (dashed lines) and positive (dotted lines) anomalies were evident and associated with MJO activity during the end of 2011.

Eastward propagation of anomalies became less coherent during late December and early January and anomalies weakened.

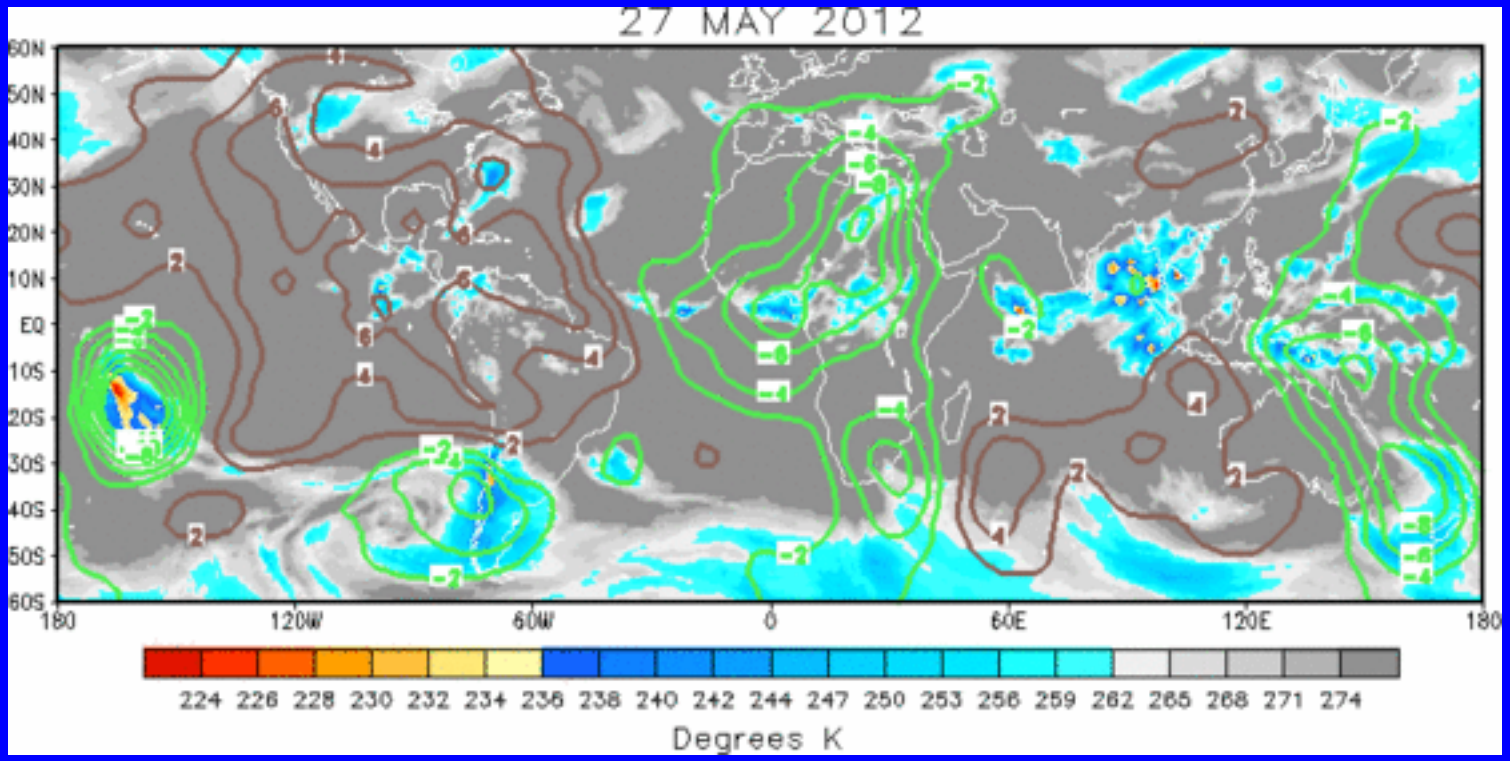
The MJO strengthened in late January and eastward propagation was evident through mid-April. Most recently, anomalies have decreased and the pattern is less coherent as the MJO has weakened.

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

IR Temperatures (K) / 200-hPa Velocity Potential Anomalies

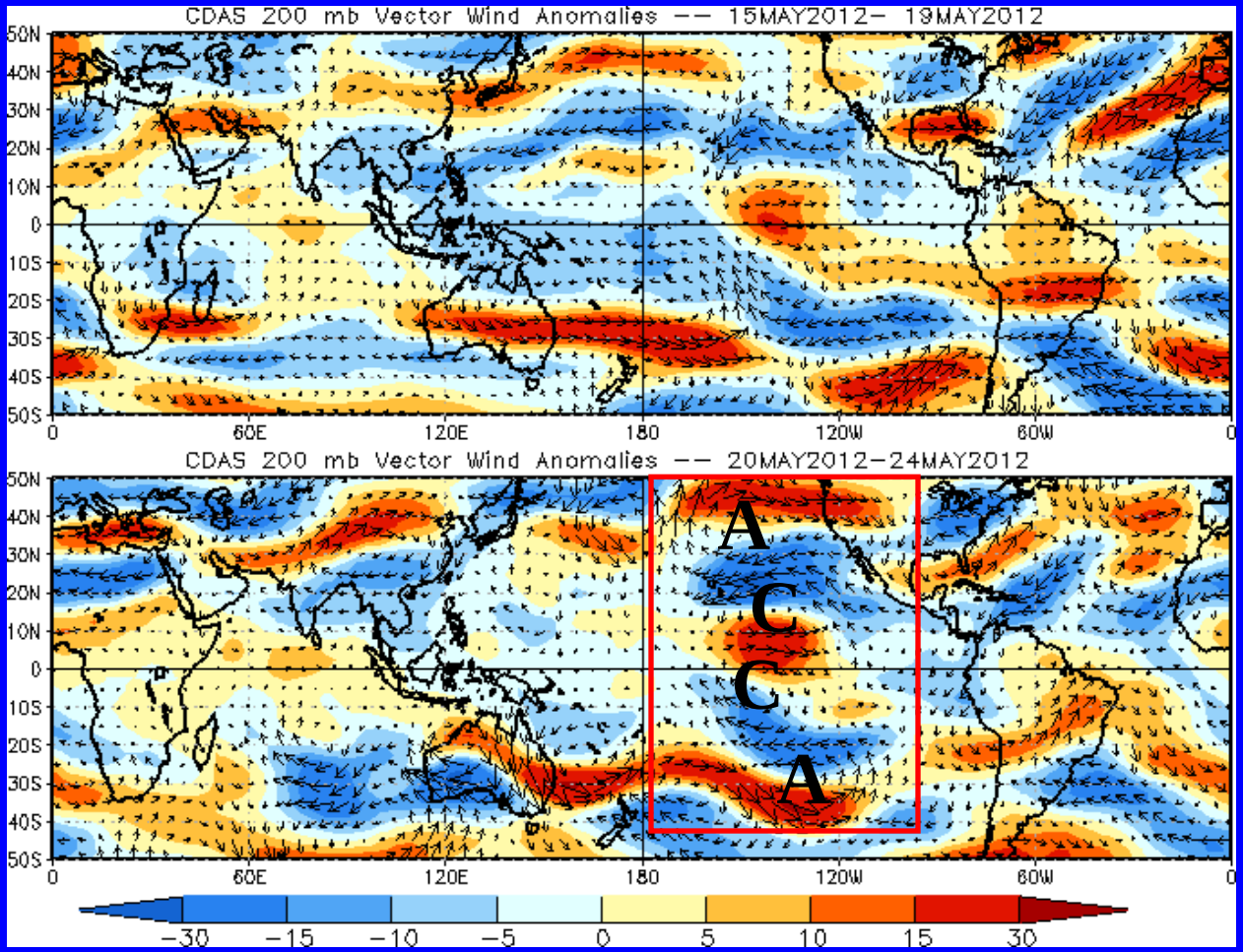
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



The large scale velocity potential pattern reflects upper-level divergence over Africa and also parts of the western Pacific with the strongest upper-level convergence now over the eastern Pacific and 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

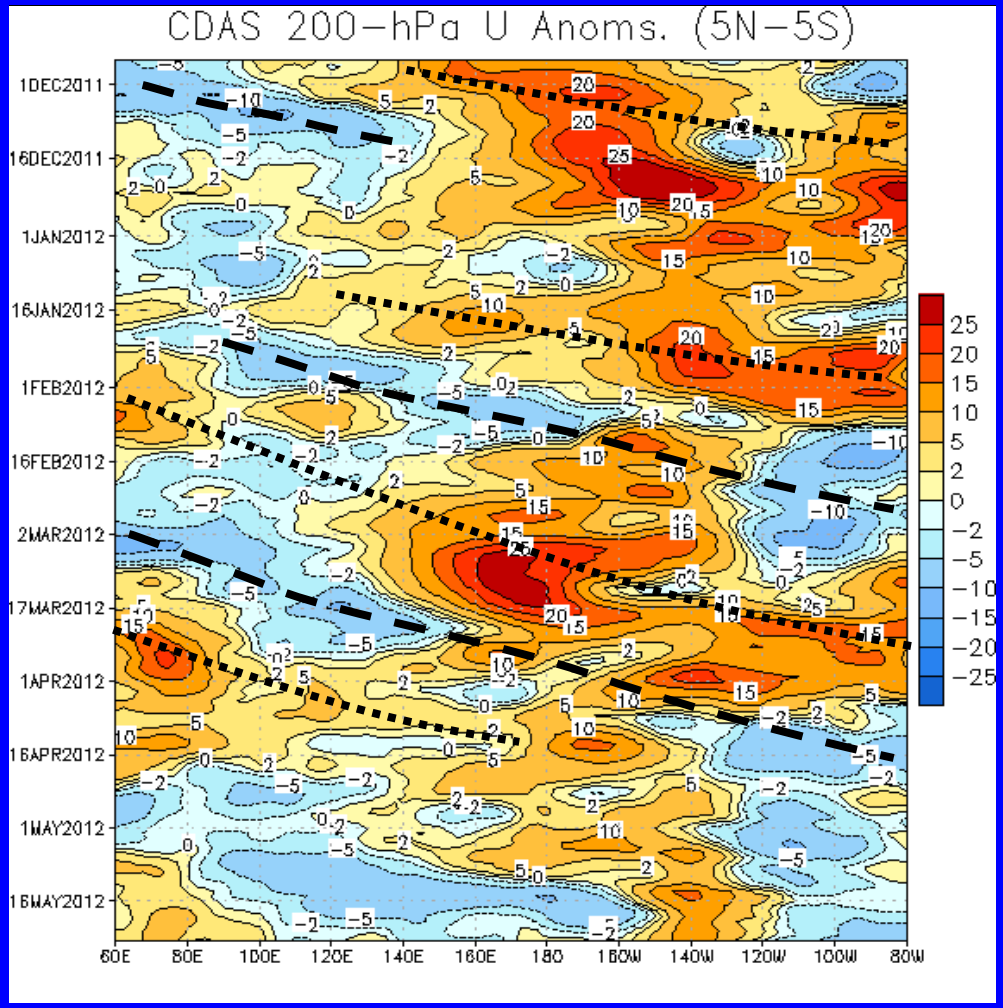
Symmetry about the equator is observed over the eastern Pacific during the last five days.

Westerly anomalies are located near the equator with a pair of cyclonic circulations north and south of the equator in the sub-tropics and a pair of anticyclonic circulations in the mid-latitudes also in both hemispheres.

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

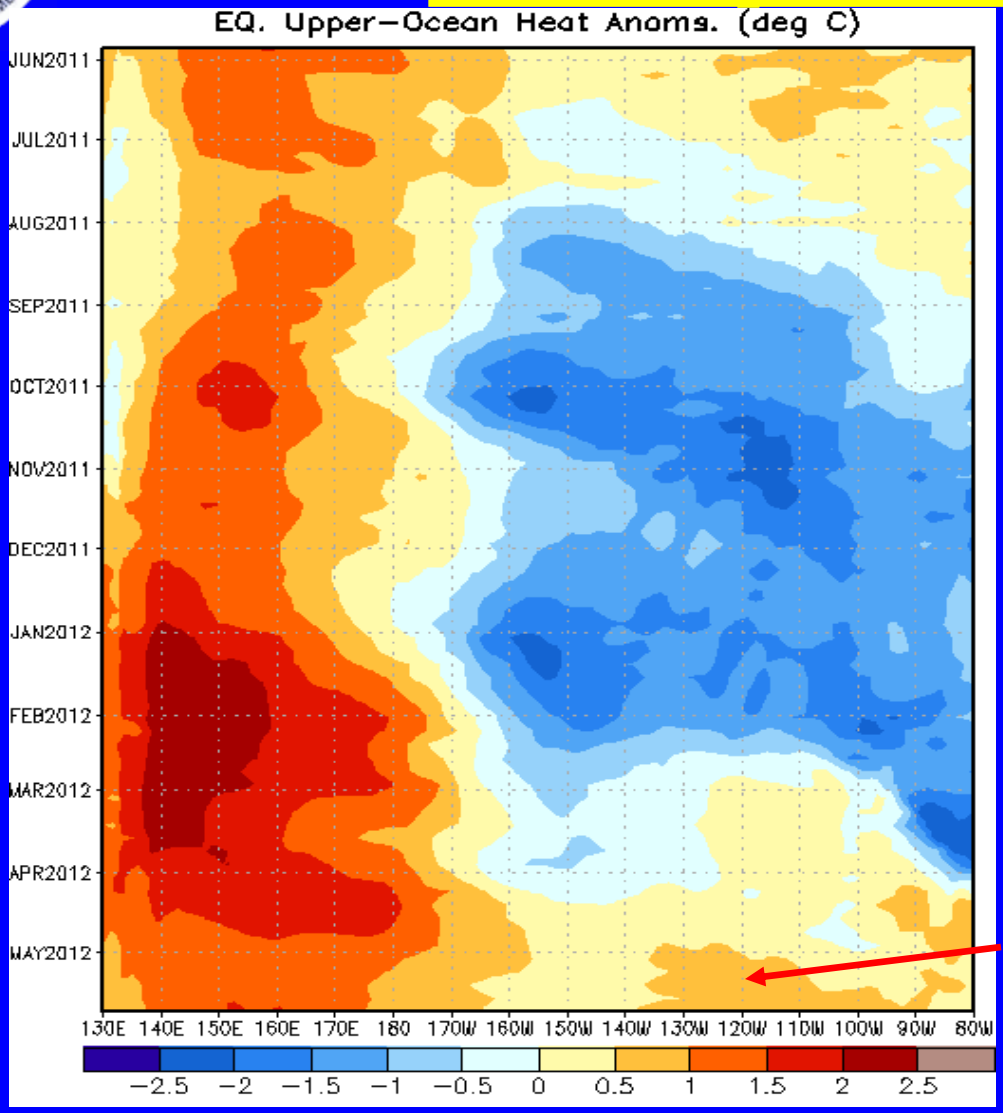
Longitude

Alternating westerly (dotted lines) and easterly (dashed lines) anomalies associated with the MJO are evident into December.

In December, westerly anomalies strengthened over the central Pacific.

Eastward propagation was again more clearly evident during late January and February, continuing into April when westerly anomalies shifted eastward, over the Americas, Africa and the Indian Ocean.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

From July 2011 through February 2012, heat content was below average in the central and eastern equatorial Pacific.

In April, heat content anomalies returned to near zero across much of the central and eastern Pacific.

Recently, heat content is now positive in the east-central 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).

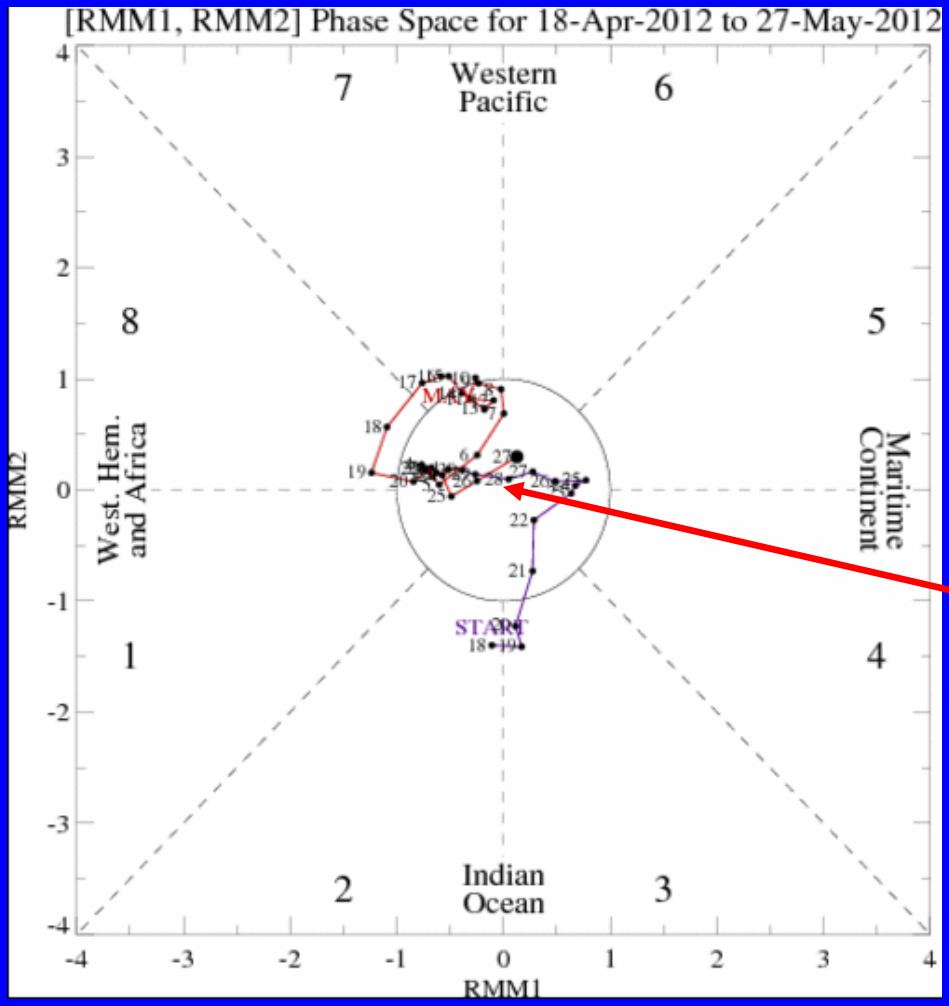
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review,* 132, 1917-1932.

• 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).

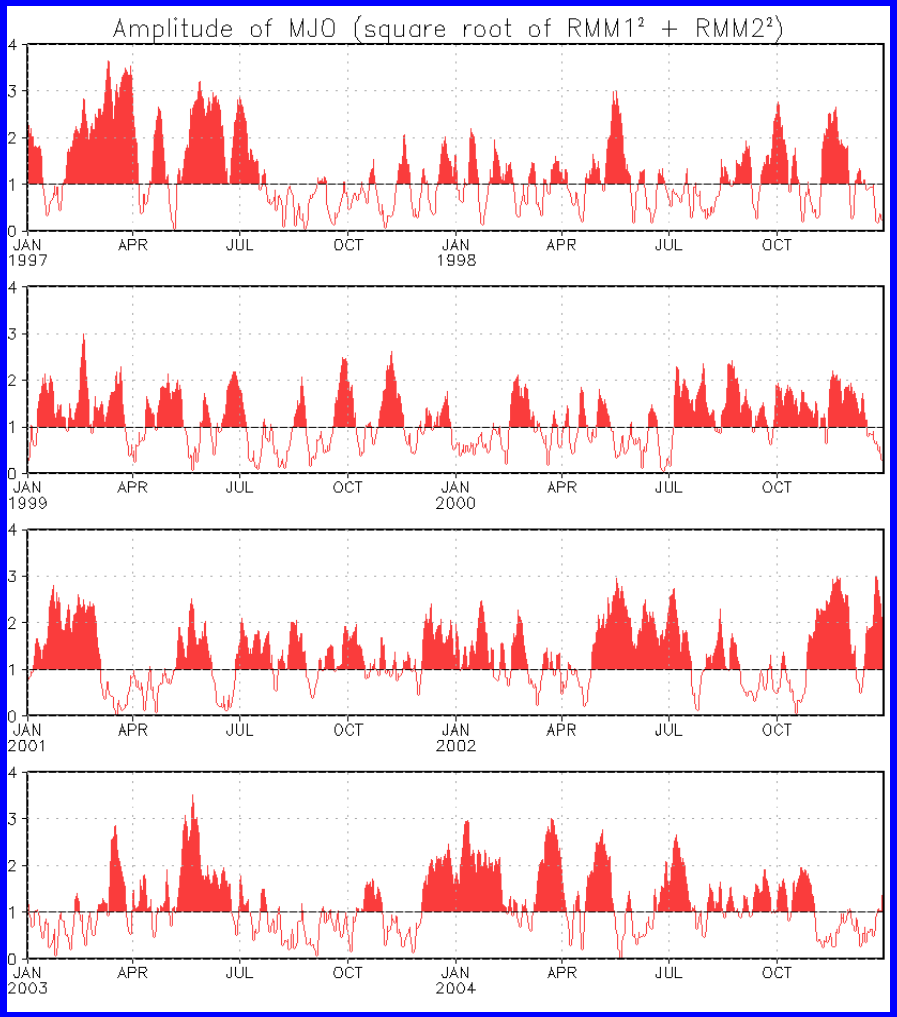
MJO Index -- Recent Evolution

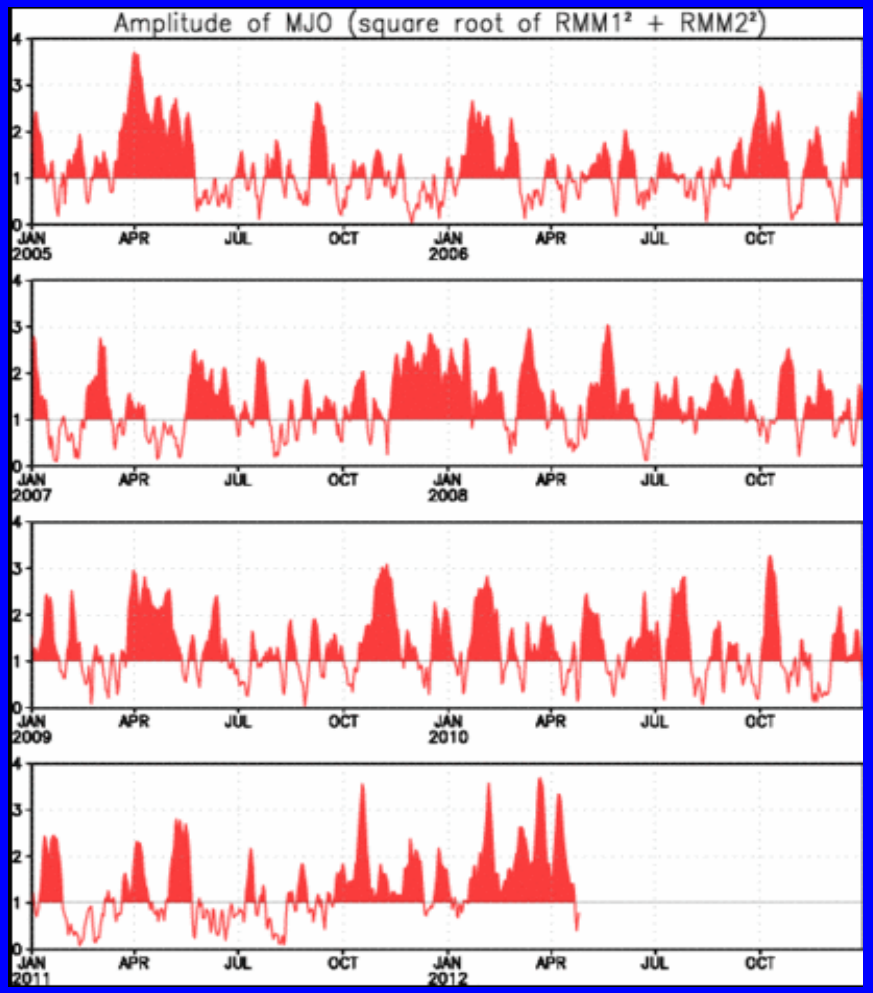


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

During the past week, the MJO index has indicated a continued weak signal.

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.

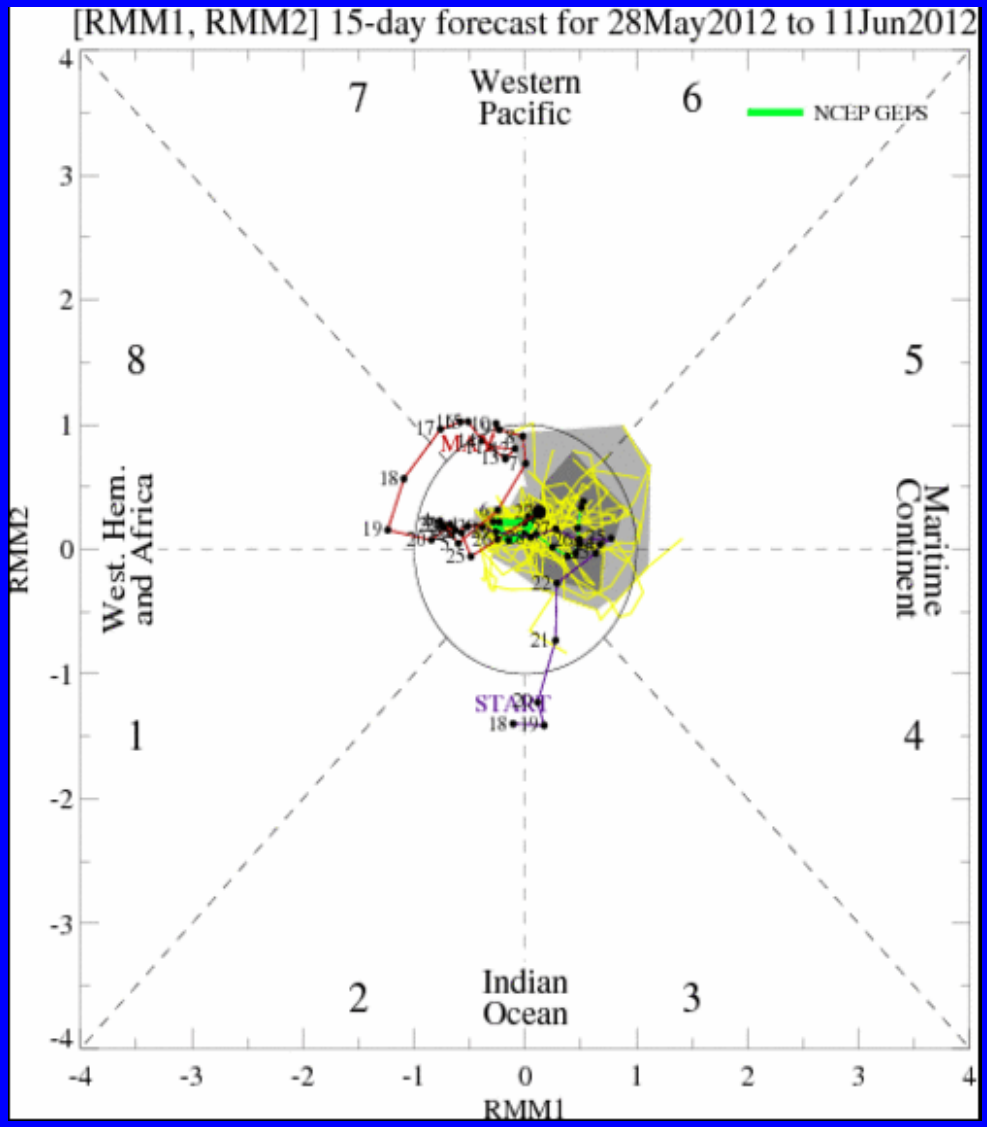
Ensemble GFS (GEFS) MJO Forecast

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

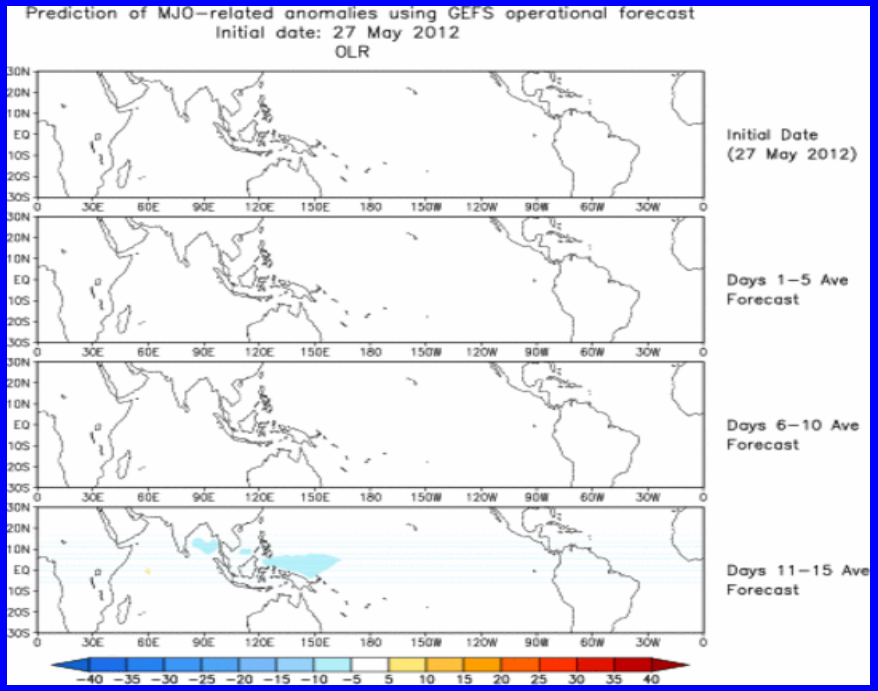
The ensemble GFS MJO index forecasts indicate a weak signal during the next two weeks.



Ensemble Mean GFS MJO Forecast

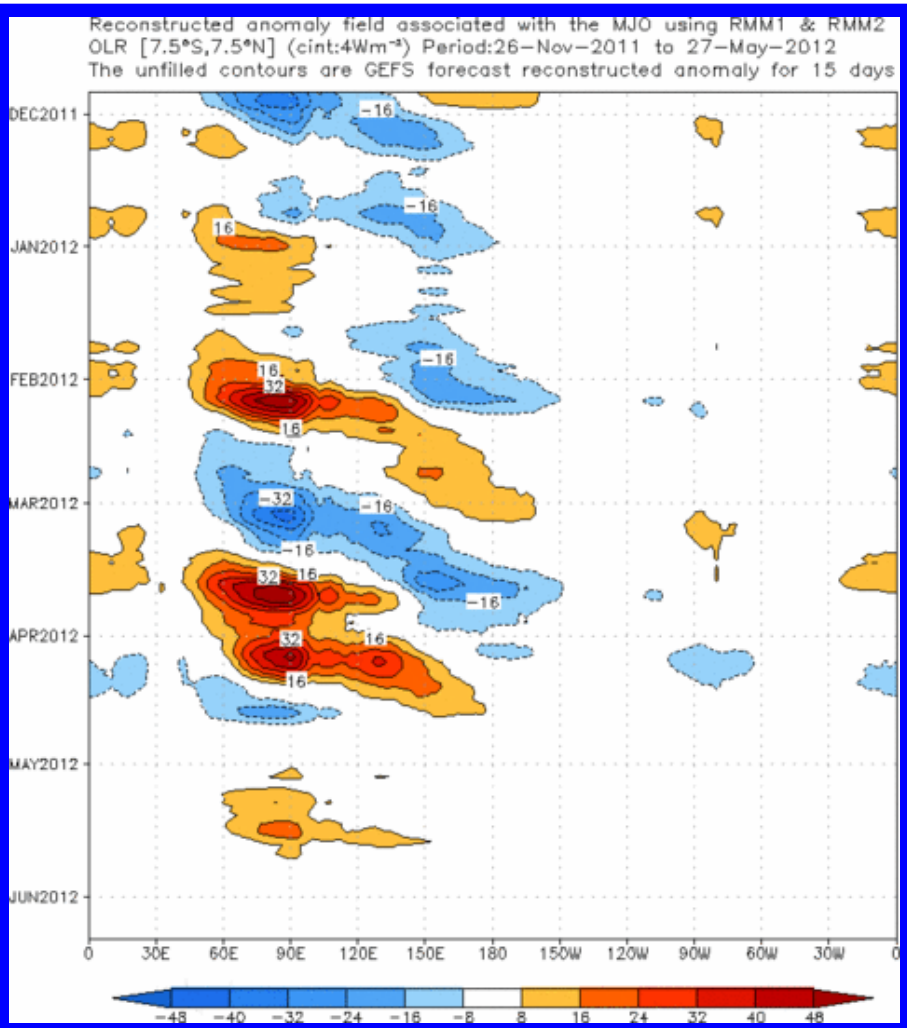
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Spatial map of OLR anomalies for the next 15 days



The ensemble mean GFS forecast indicates only very weak signals of anomalous convection associated with the MJO at the current time.

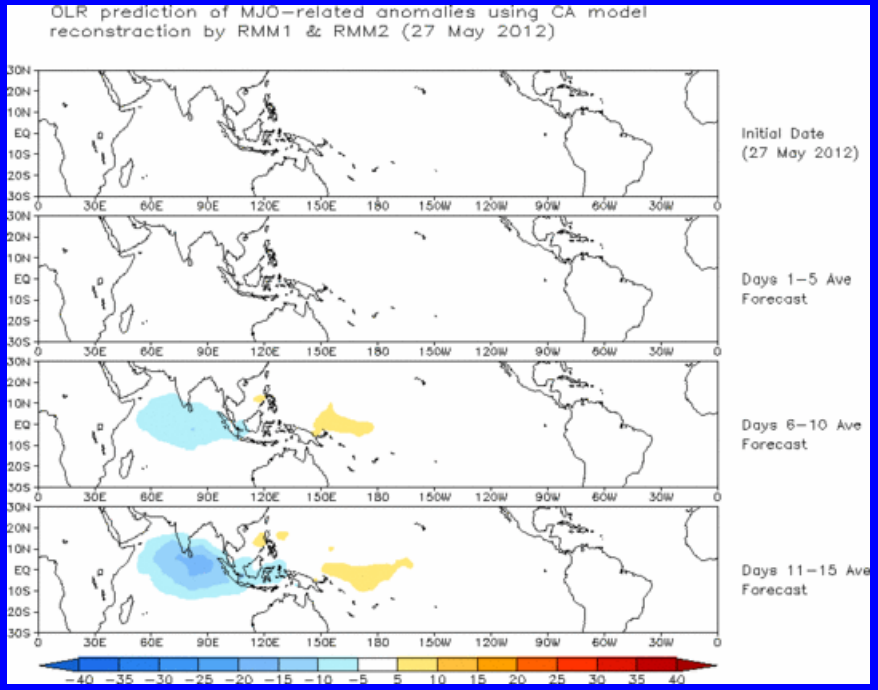
Time-longitude section of (7.5°S-7.5°N) OLR anomalies for the last 180 days and for the next 15 days



Constructed Analog (CA) MJO Forecast

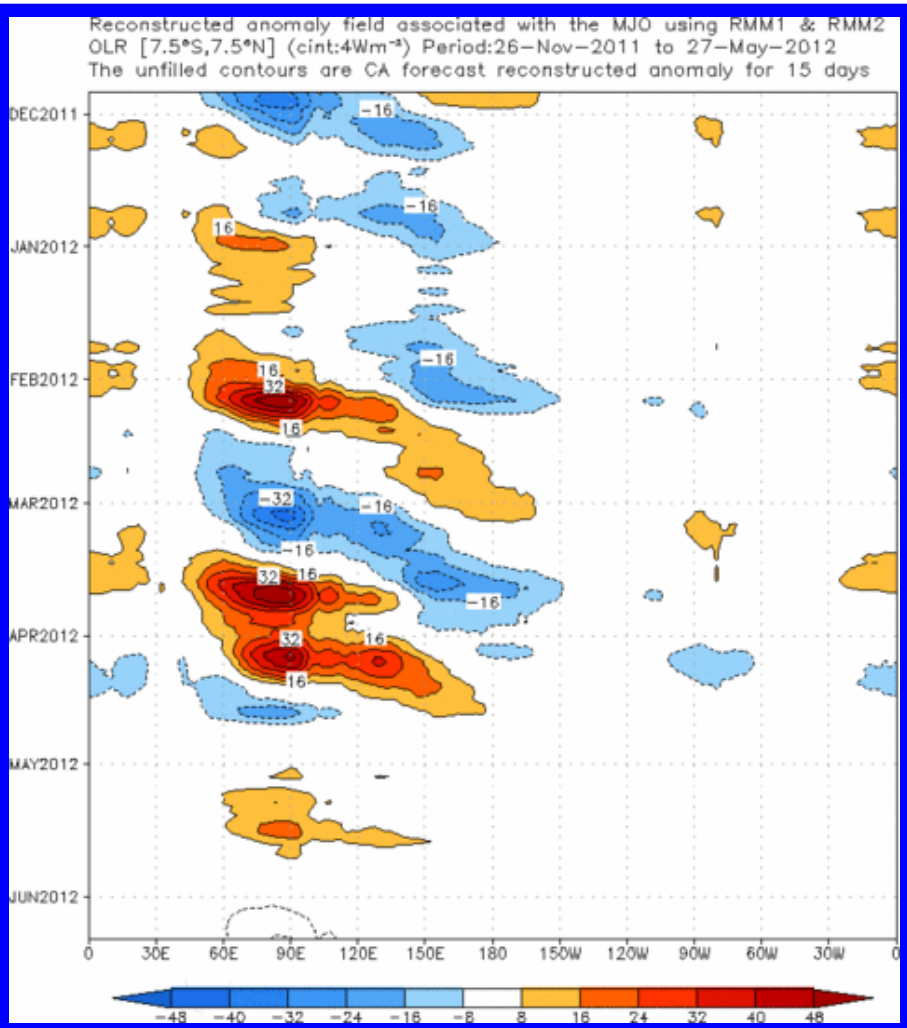
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Spatial map of OLR anomalies for the next 15 days



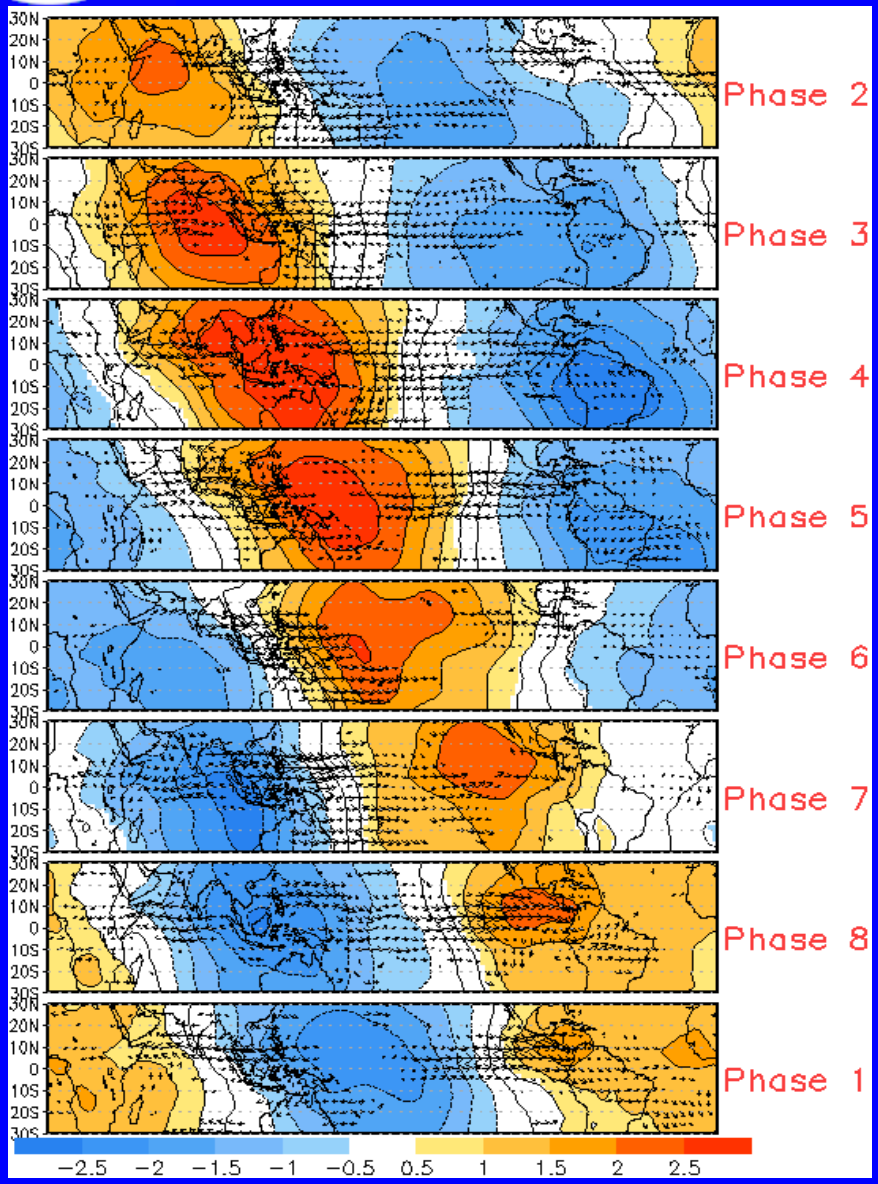
The forecast indicates weak signals for anomalous convection during much of the period. Weak enhanced convection is forecast to develop across the Indian Ocean entering Week-2.

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

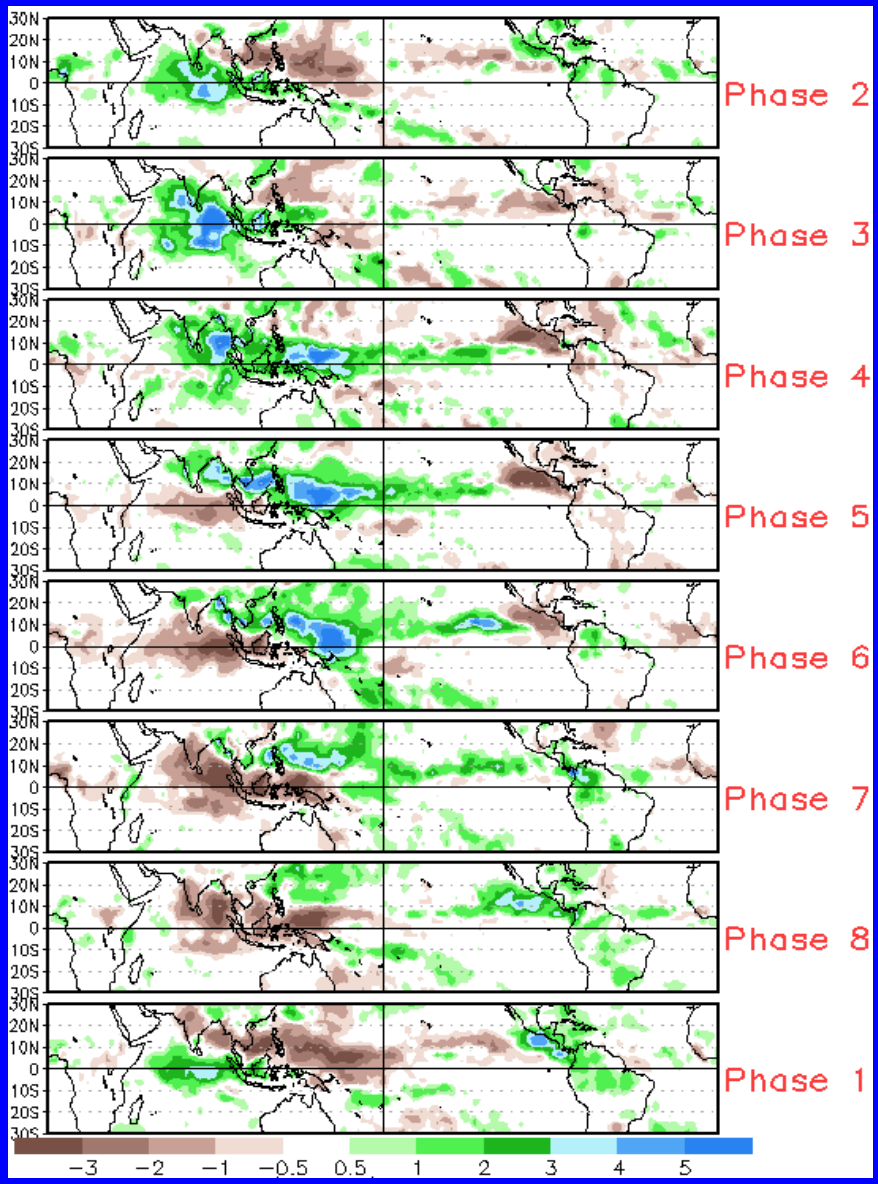


MJO Composites – Global Tropics

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

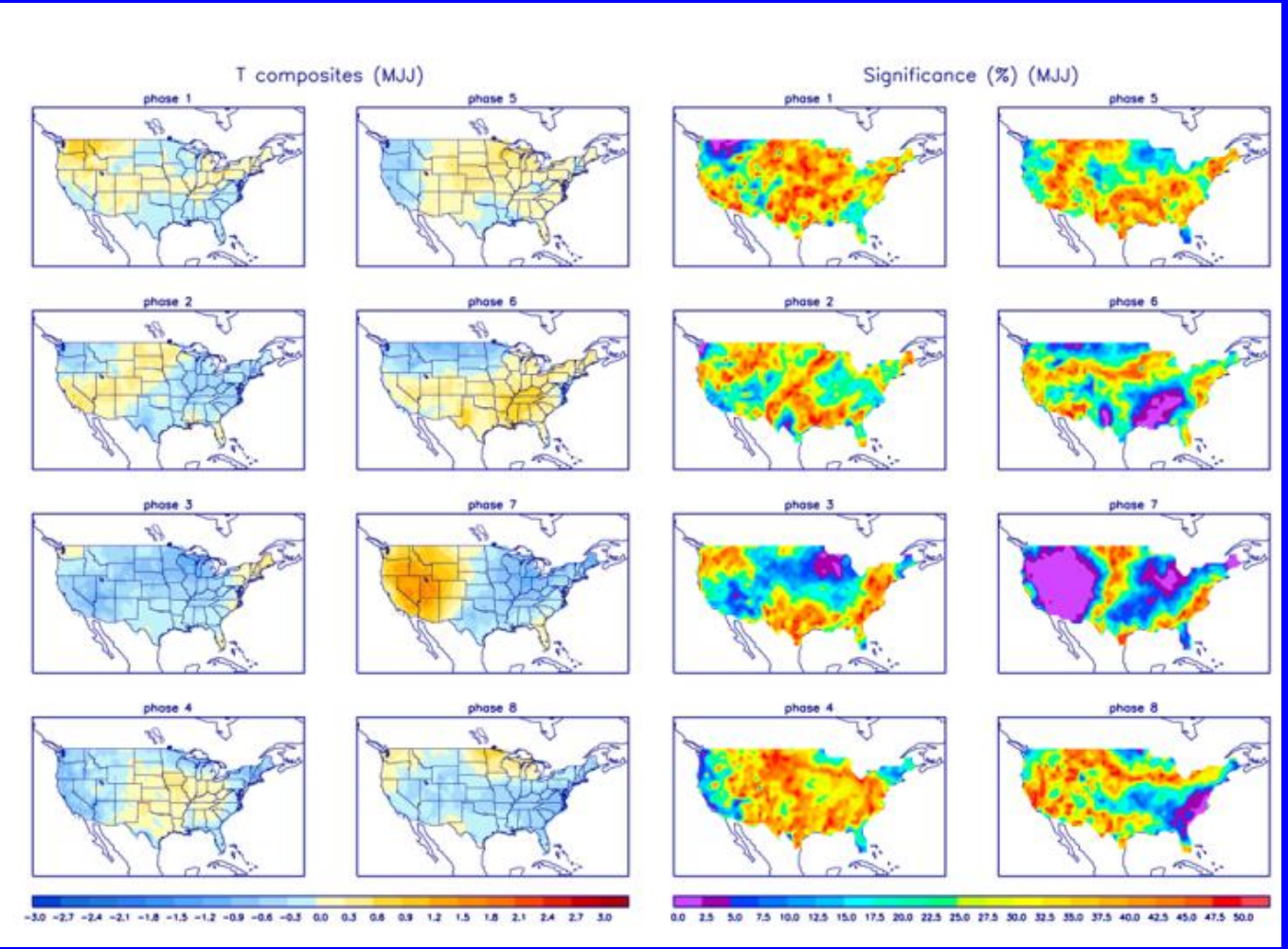


Precipitation Anomalies (May-Sep)



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.**

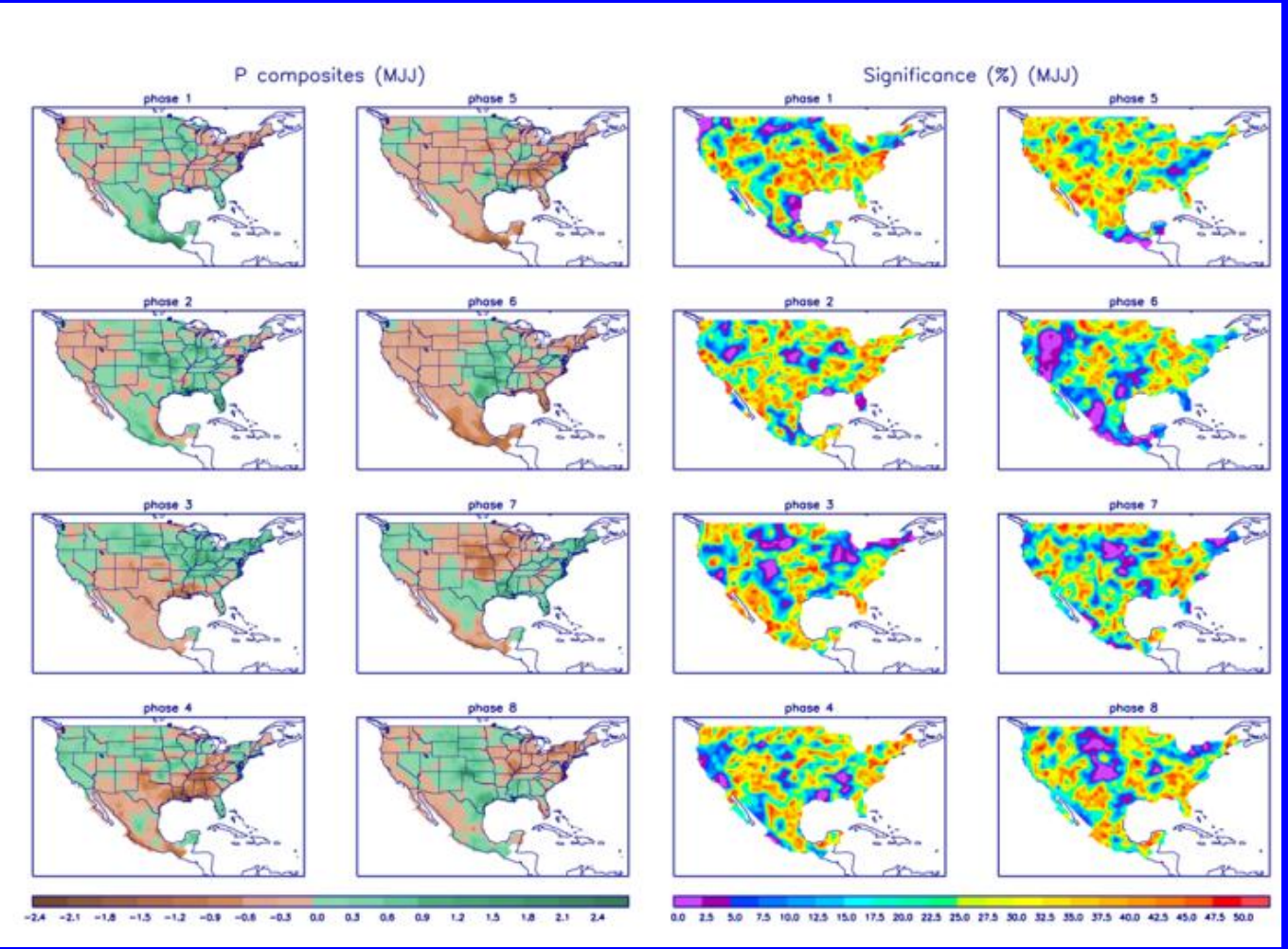


Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

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.**



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