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

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Climate Prediction Center / NCEP
9 May 2016

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Recent Evolution and Current Conditions

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Overview

The MJO signal remained weak overall during the past week, though there are currently signs of a strengthening MJO event over the Indian Ocean.

Most dynamical models suggest that a coherent MJO signal will strengthen over the Indian Ocean during the next two weeks.

The MJO is not expected to have a significant impact on United States temperature and precipitation patterns during the next two weeks.

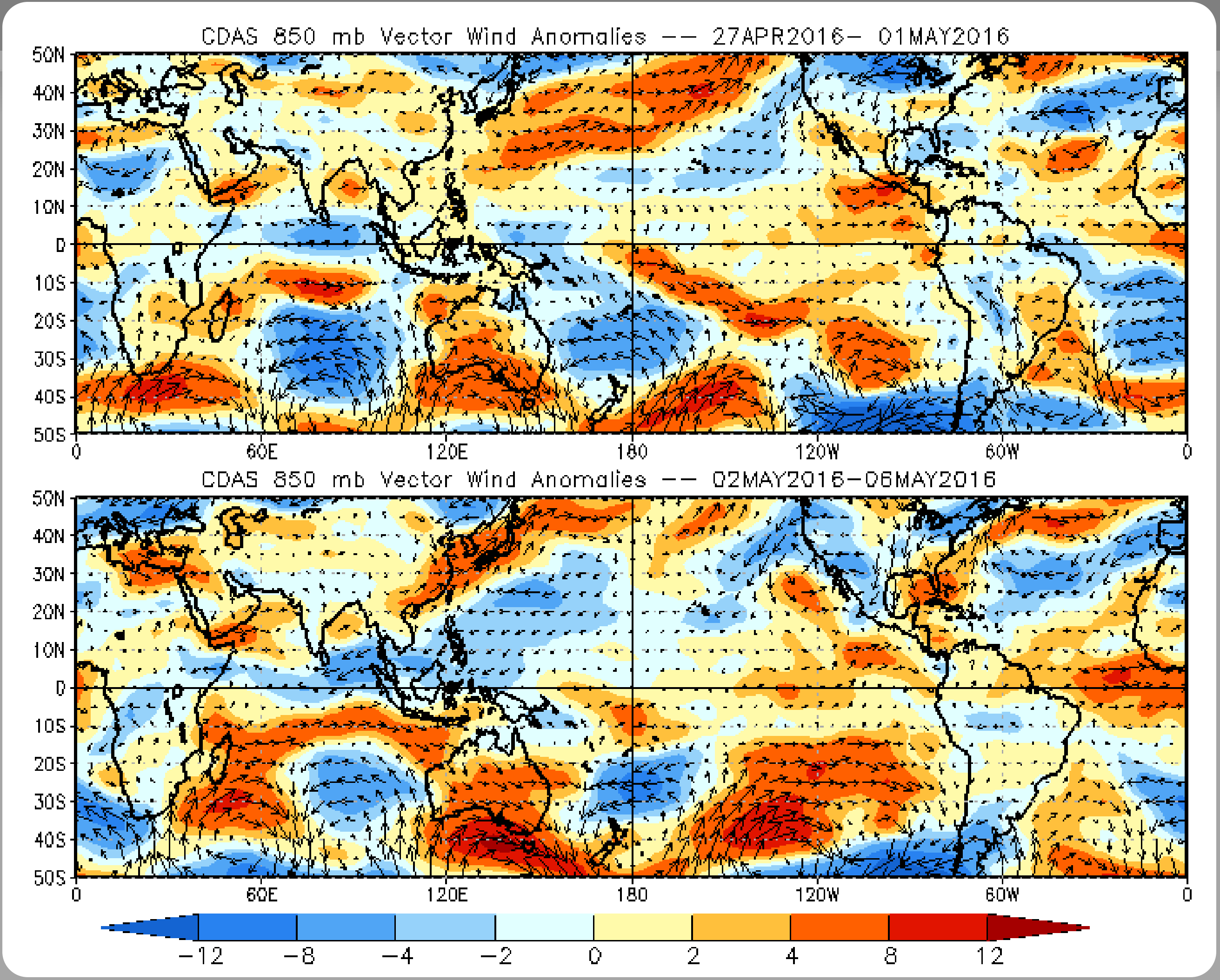
Additional potential impacts across the global tropics and a discussion for the U.S. are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

850-hPa Vector Wind Anomalies (m s-1)

Note that shading denotes the zonal wind anomaly

<u>Blue shades</u>: Easterly anomalies

<u>Red shades</u>: Westerly anomalies



Weak westerly anomalies are evident near the Equator from the Date Line to the South American coast.

850-hPa Zonal Wind Anomalies (m s-1)

Westerly anomalies (orange/red shading) represent anomalous west-to-east flow

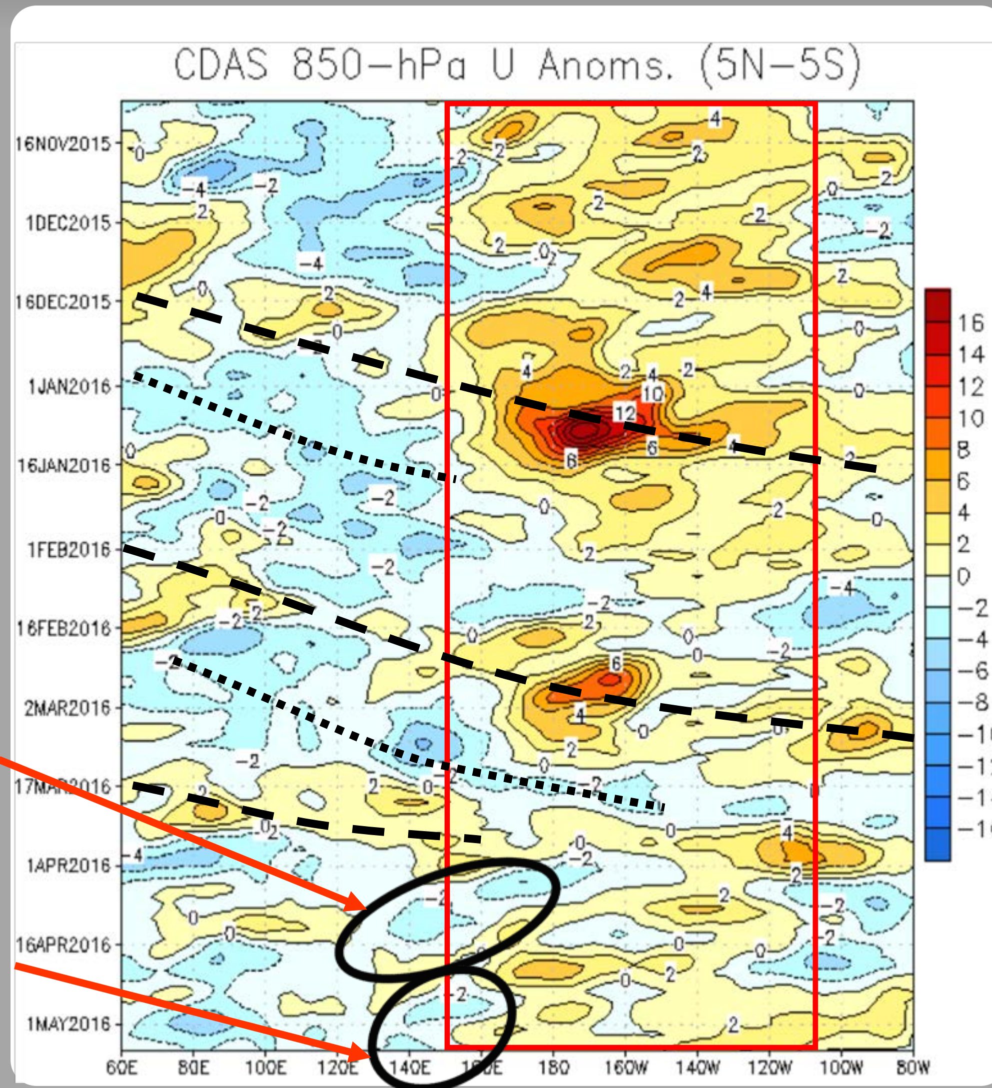
Easterly anomalies (blue shading) represent anomalous east-to-west flow

The red box highlights the persistent low-frequency westerly wind anomalies associated with ENSO.

The MJO was most coherent and robust during December 2015 and this past February.

During March, a fast eastward propagating intraseasonal signal crossed the Pacific.

During April, the pattern included more high frequency variability including an equatorial Rossby Wave (ERW) that shifted westward from near the Date Line to 130 E. During the last 1-2 weeks, easterlies prevailed over the Indian Ocean and Maritime Continent. A possible ERW is depicted from about 130E to 160E.



OLR Anomalies - Past 30 days

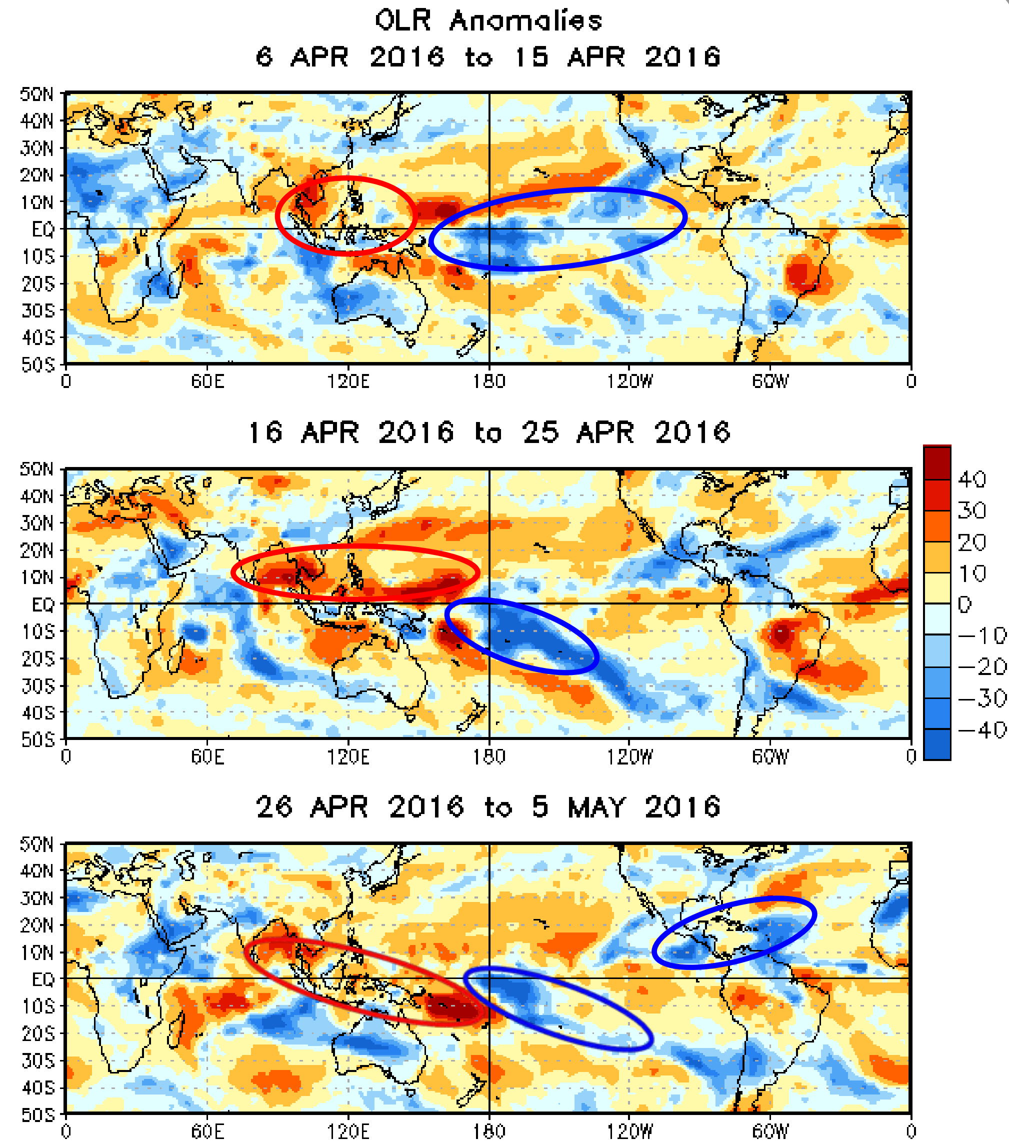
Drier-than-normal conditions, positive OLR anomalies (yellow/red shading)

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

During early April, enhanced convection returned to the southeastern Indian Ocean. Enhanced convection shifted expanded east of the Date Line across the Pacific, while suppressed convection prevailed across much of the Maritime Continent.

An enhanced SPCZ is clearly indicated during the middle portion of April. Suppressed convection is noted from the Bay of Bengal eastward across the Maritime Continent to near the Date Line. An anomalous convective couplet is evident over South America.

During the last 1-2 weeks, enhanced (suppressed) convection persisted along the SPCZ (Bay of Bengal to Vanuatu/Fiji). Enhanced convection persists over Central America and from the far eastern Caribbean Sea to about 40W in the North Atlantic.



Outgoing Longwave Radiation (OLR) Anomalies (7.5ºS - 7.5ºN)

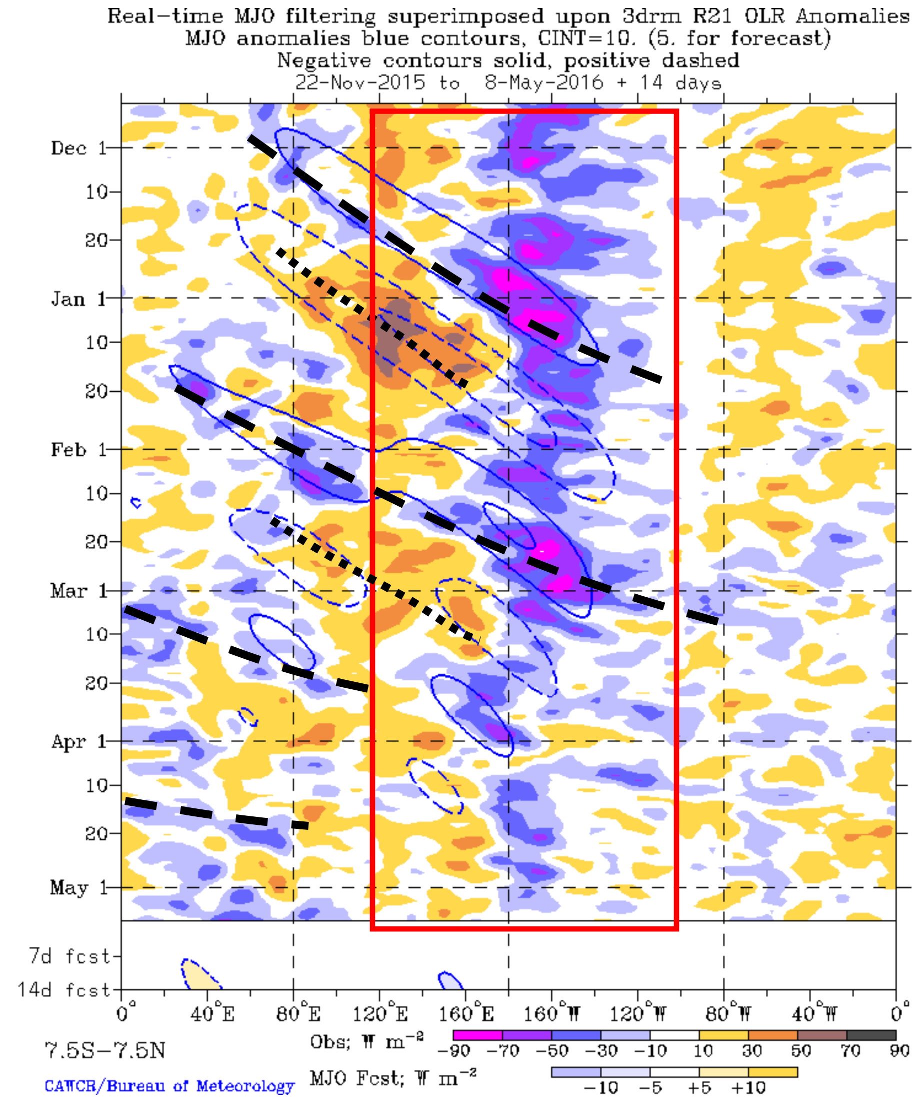
Drier-than-normal conditions, positive OLR anomalies (yellow/red shading)

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

The ongoing El Niño is observed (red box) as a dipole of anomalous convection extending from the Maritime Continent to the East Pacific.

Alternating periods of constructive/destructive interference with ENSO is evident. A fast eastward propagating signal raced across the Pacific during mid-March.

A mostly incoherent pattern continues across the Indian Ocean and Pacific since late March which is related to the dispersion of intra-seasonal modes. Within the last 1-2 weeks, enhanced convection is evident over the Indian Ocean, and many dynamical and statistical models suggest that this could be the beginning of a coherent MJO event.



200-hPa Velocity Potential Anomalies (5ºS - 5ºN)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

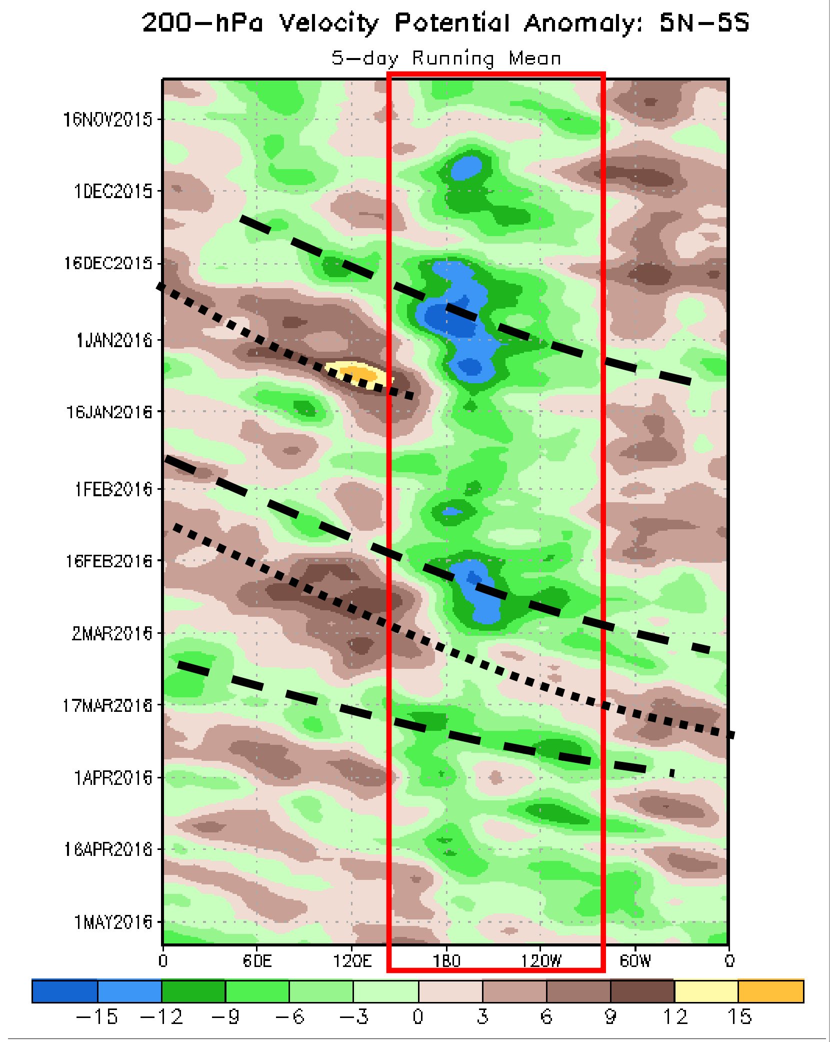
Negative anomalies (green shading) indicate favorable conditions for precipitation

The ongoing ENSO state is highlighted by the red box, showing anomalous divergence over the central and eastern Pacific.

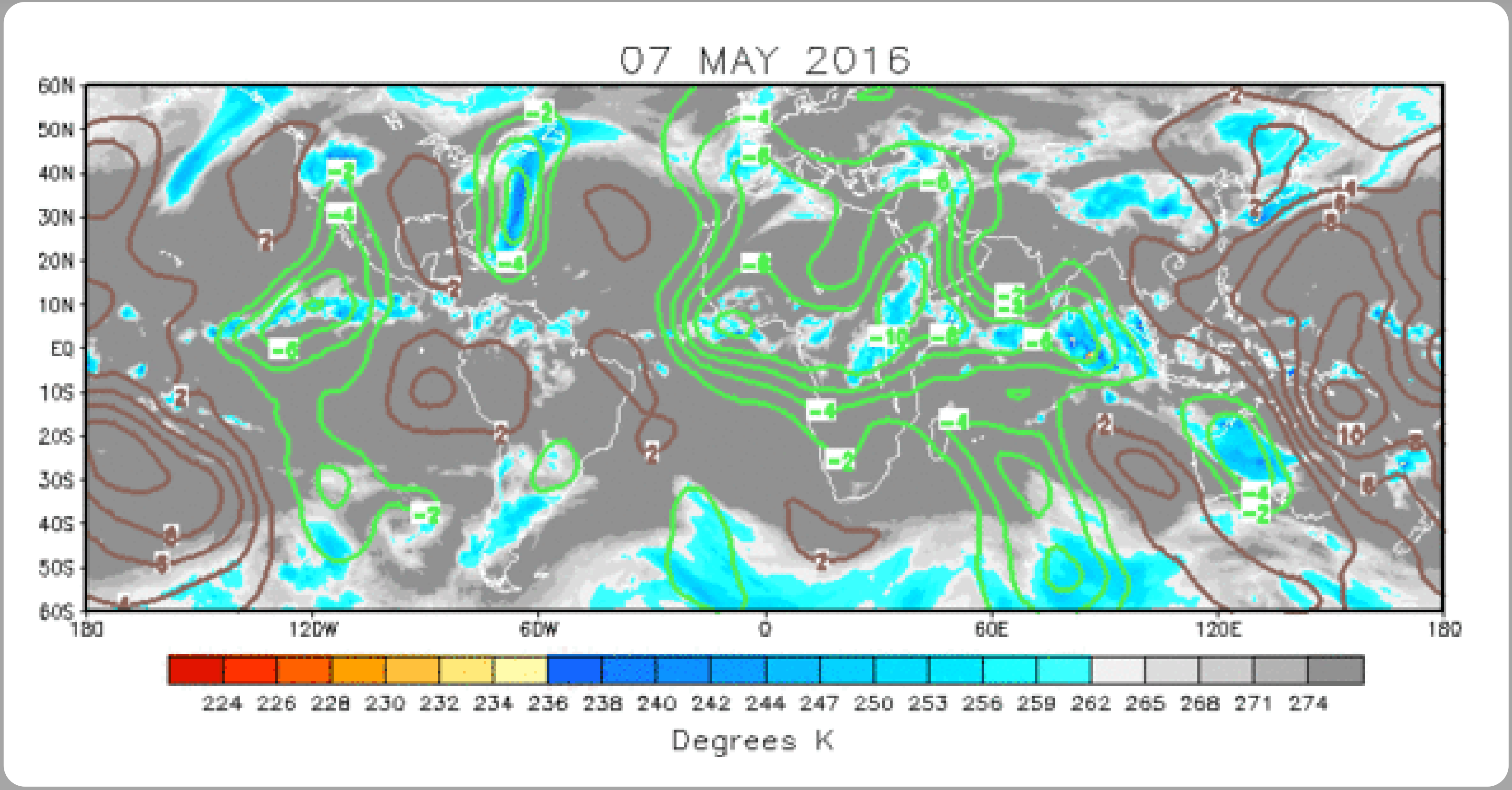
During late February, intraseasonal variability constructively interfered with the ongoing El Nino. During mid-March, the intraseasonal variability destructively interfered with the ENSO signal.

In April, the pattern in upper-level velocity potential anomalies is incoherent with respect to MJO activity, and more reflective of other modes of tropical variability.

During the past 1-2 weeks, an area of upper-level divergence has moved into the region between the Prime Meridian and 60E. Upper-level convergence is noted between 120E and the Date Line.



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



With the exception of the Americas, the large scale upper-level velocity potential anomaly pattern indicates a coherent wave-1 structure, with upper-level divergence (convergence) eastward from about 30W to 100E (120E to 120W).

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation

200-hPa Vector Wind Anomalies (m s-1)

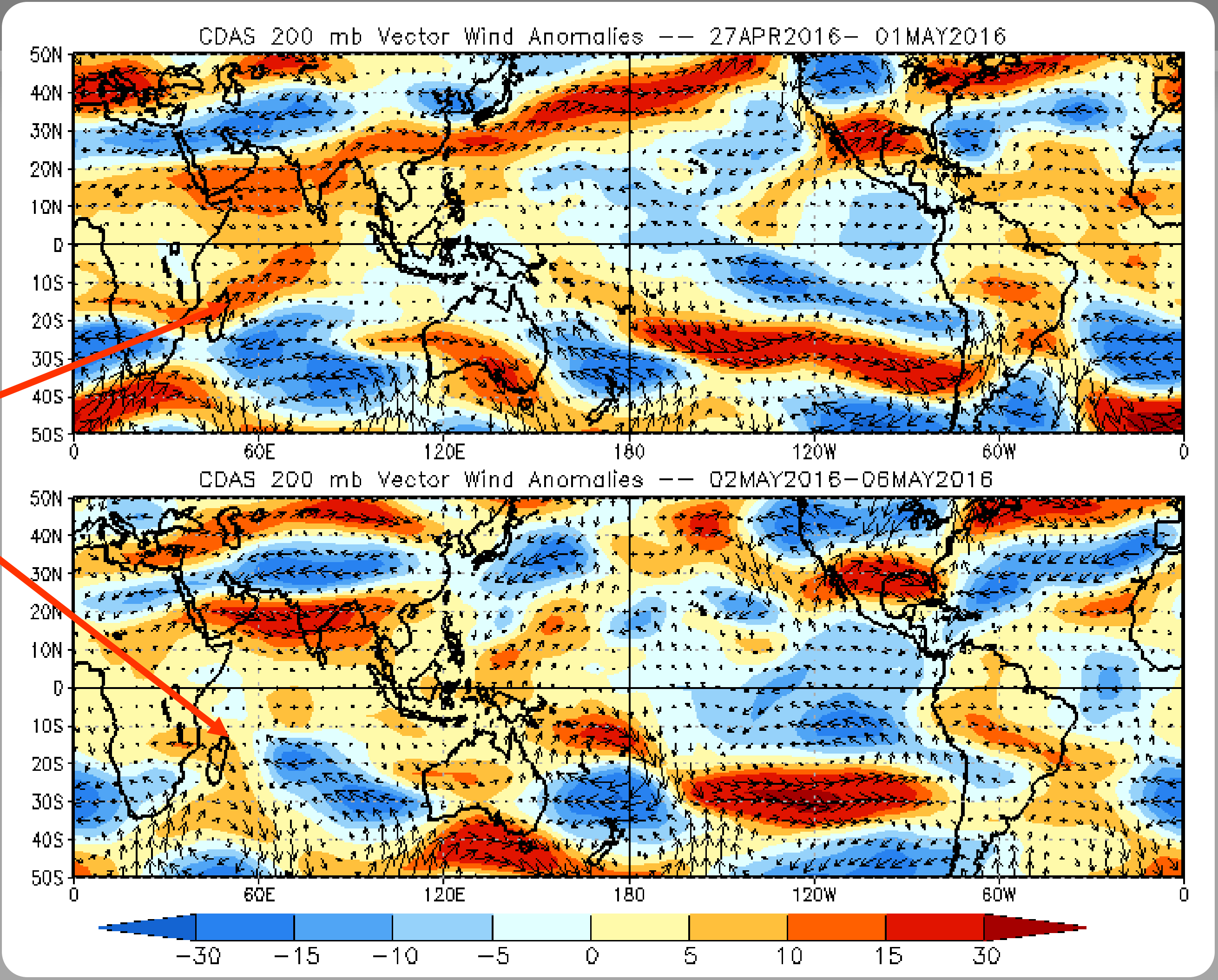
Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

The westerly anomalies extending from Mozambique & Madagascar northeastward have weakened significantly during the second 5-day period.

The mid-latitude westerly jet that had persisted over the North Pacific has fallen apart in the past week. Easterly anomalies have also expanded in areal coverage across the eastern tropical Pacific.



200-hPa Zonal Wind Anomalies (m s-1)

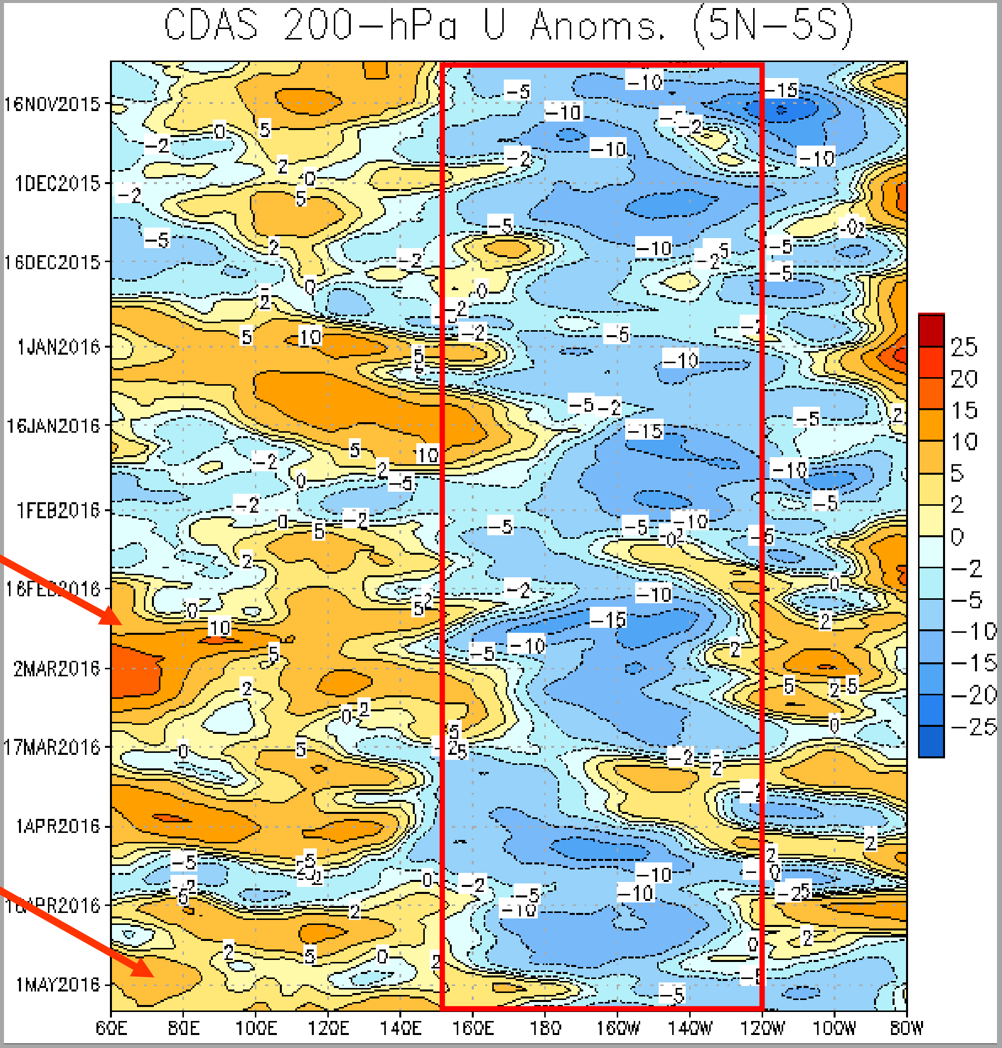
Westerly anomalies (orange/red shading) represent anomalous west-to-east flow

Easterly anomalies (blue shading) represent anomalous east-to-west flow

Easterly anomalies have persisted over the central and eastern Pacific since June 2015 associated with El Niño (red box).

During early March, westerly anomalies returned to the Indian Ocean and Maritime Continent, with easterly anomalies between about 170E – 120W.

Recently, westerly anomalies weakened and then re-strengthened over the Indian Ocean & Maritime Continent. Easterly anomalies remain anchored near and east of the Date Line.



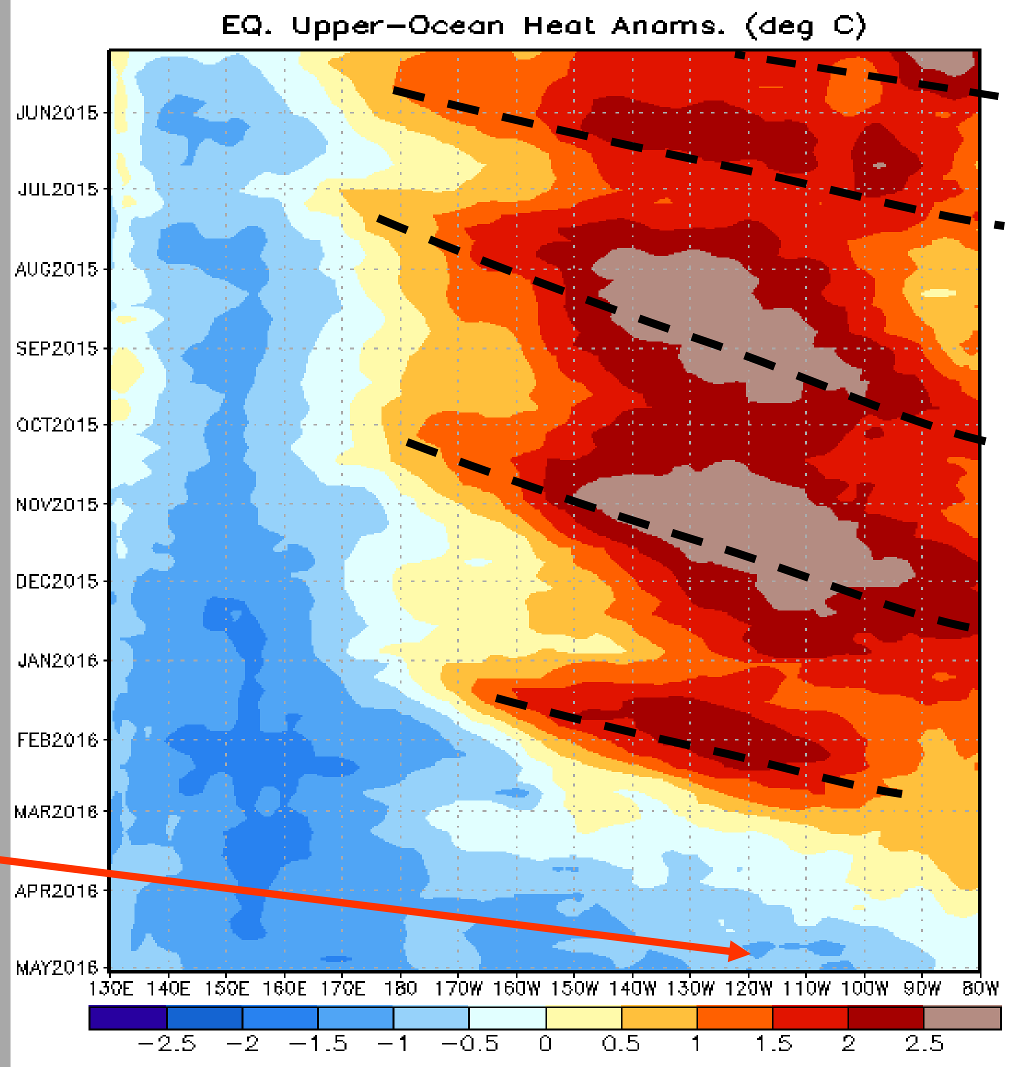
Weekly Heat Content Evolution in the Equatorial Pacific

Oceanic Kelvin waves have alternating warm and cold phases. The warm phase is indicated by dashed lines. Downwelling and warming occur in the leading portion of a Kelvin wave, and upwelling and cooling occur in the trailing portion.

Reinforcing downwelling events were observed during the second half of 2015, resulting in persistently above-normal heat content from the Date Line to 80W throughout the period.

An eastward expansion of below average heat content over the western Pacific is evident since January, and negative anomalies spread east of the Date Line during February 2016.

In the last two months, there has been a rapid eastward expansion of below-average oceanic heat content across the central and eastern 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

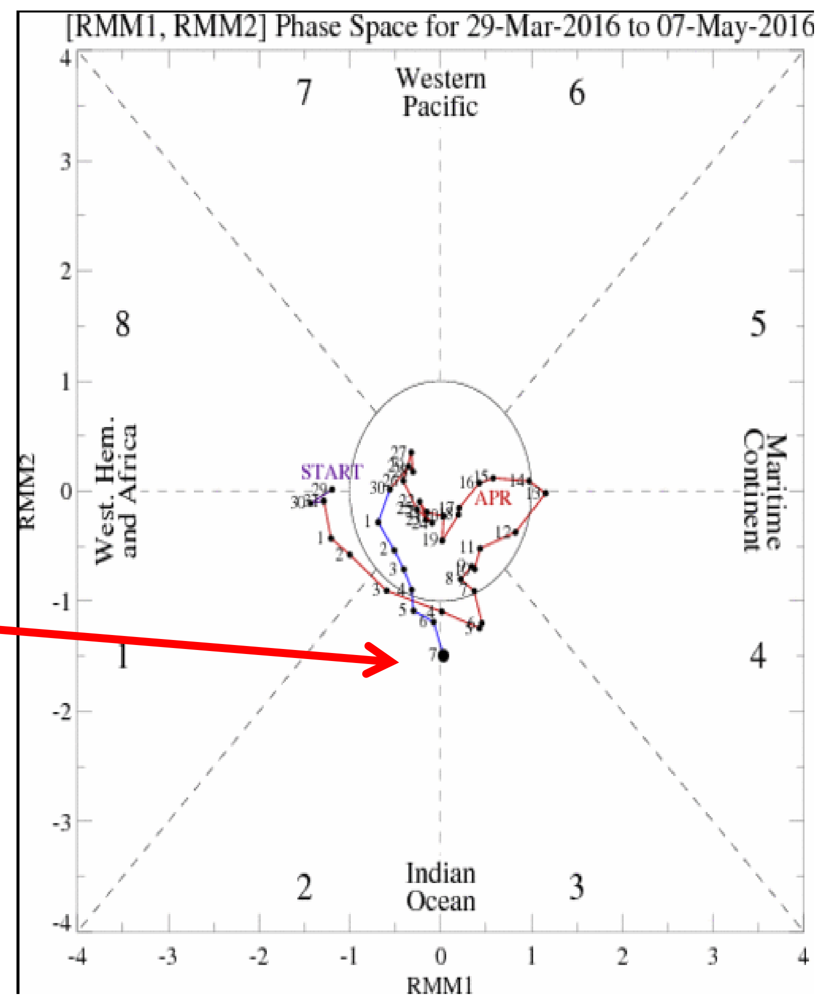
The triangular areas indicate the location of the enhanced phase of the MJO

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

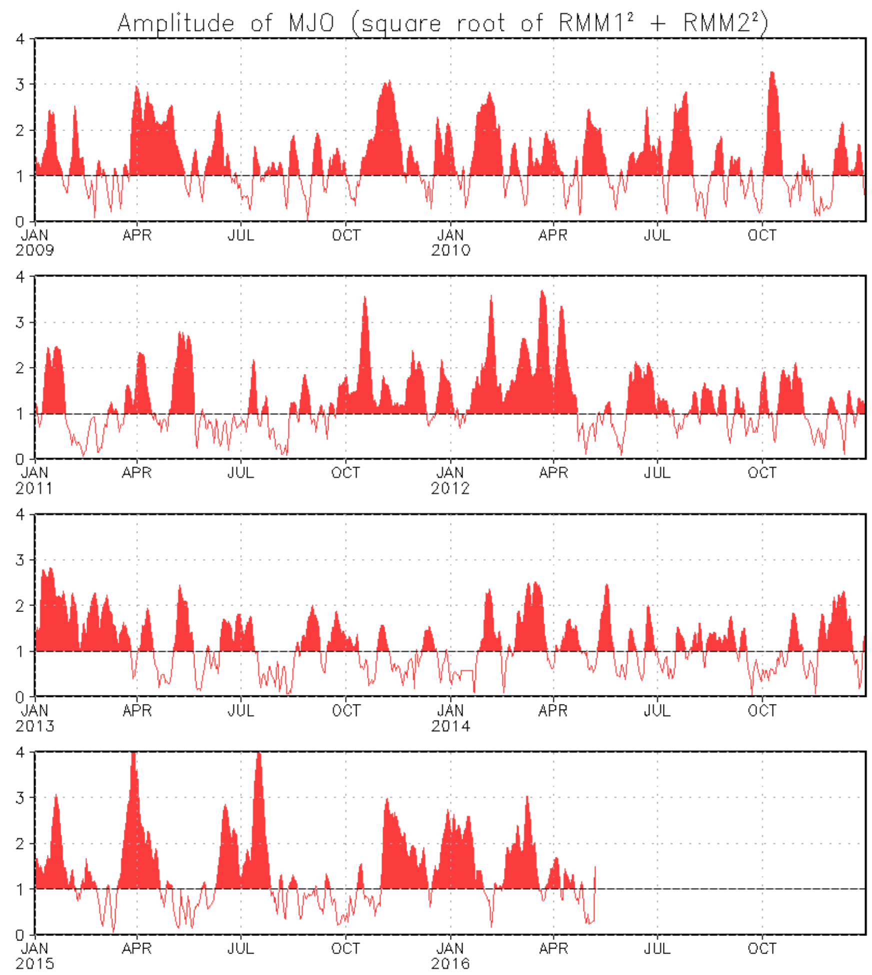
The RMM MJO index indicates the emergence of a significant MJO signal in the Indian Ocean.



MJO Index - Historical Daily Time Series

Time series of daily MJO index amplitude for the last few years.

Plot puts current MJO activity in recent historical context.



Ensemble GFS (GEFS) MJO Forecast

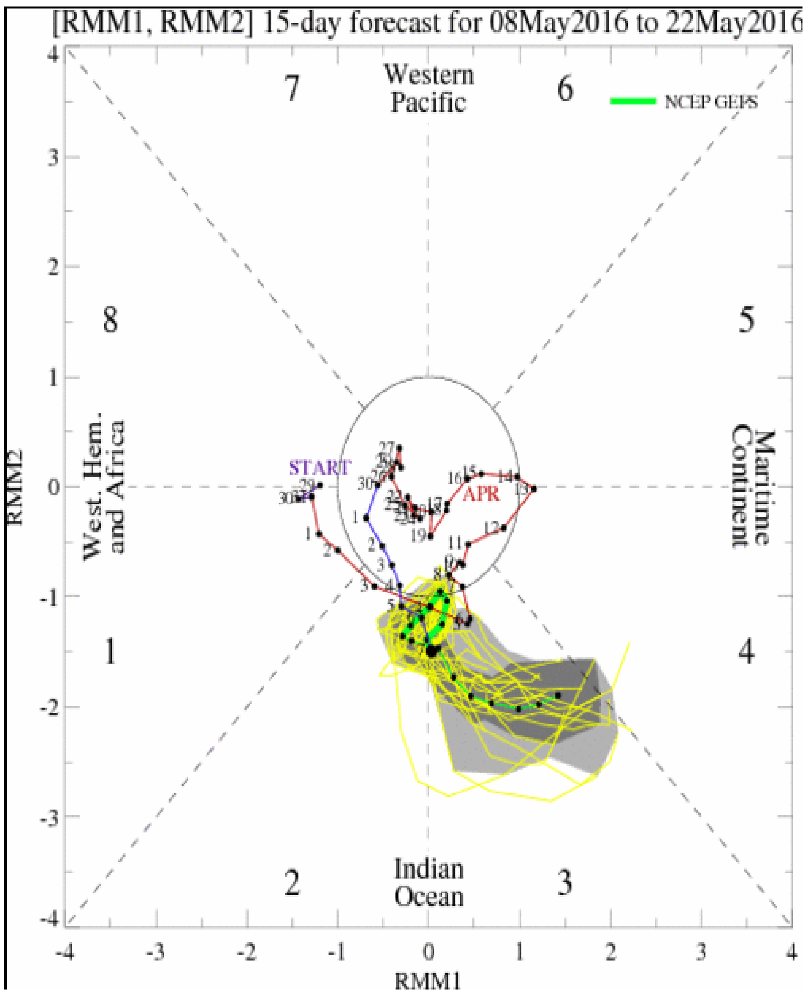
Yellow Lines - 20 Individual Members
Green Line - Ensemble Mean

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

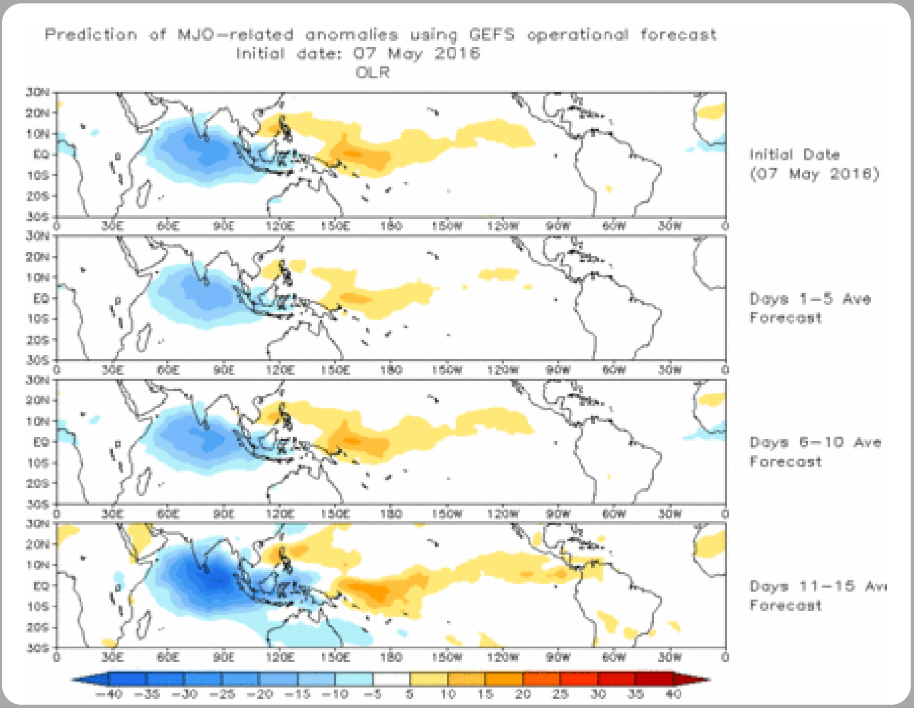
During the next two weeks, the GFS ensemble MJO index forecast depicts the eventual eastward propagation of a robust MJO signal.



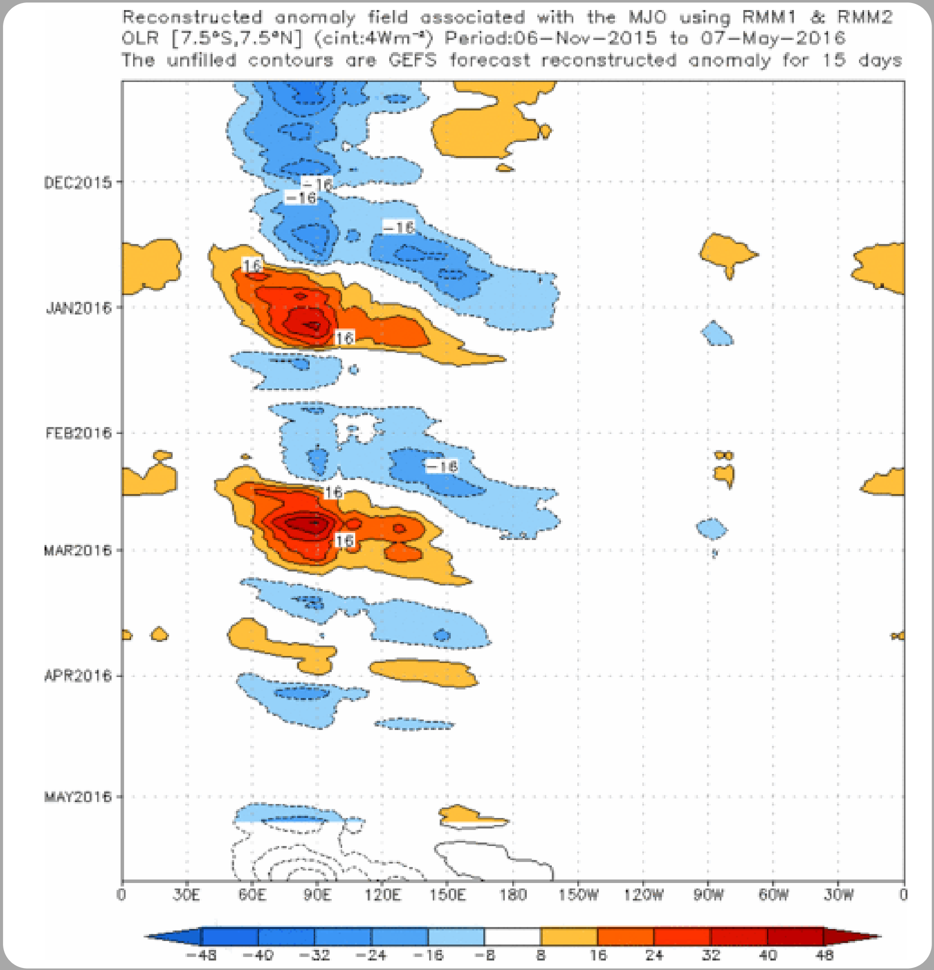
Ensemble GFS (GEFS) MJO Forecast

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 - last 180 days and for the next 15 days



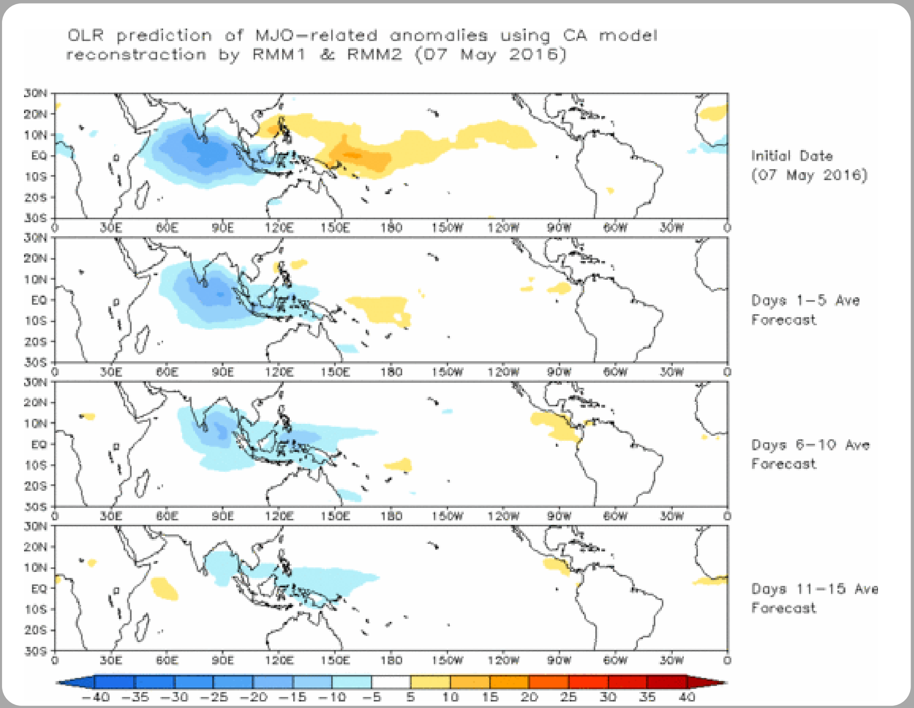
The GEFS OLR forecast based on the RMM Index depicts a stationary pattern over the next two weeks with the enhanced (suppressed) phase over the Indian Ocean (western Pacific).

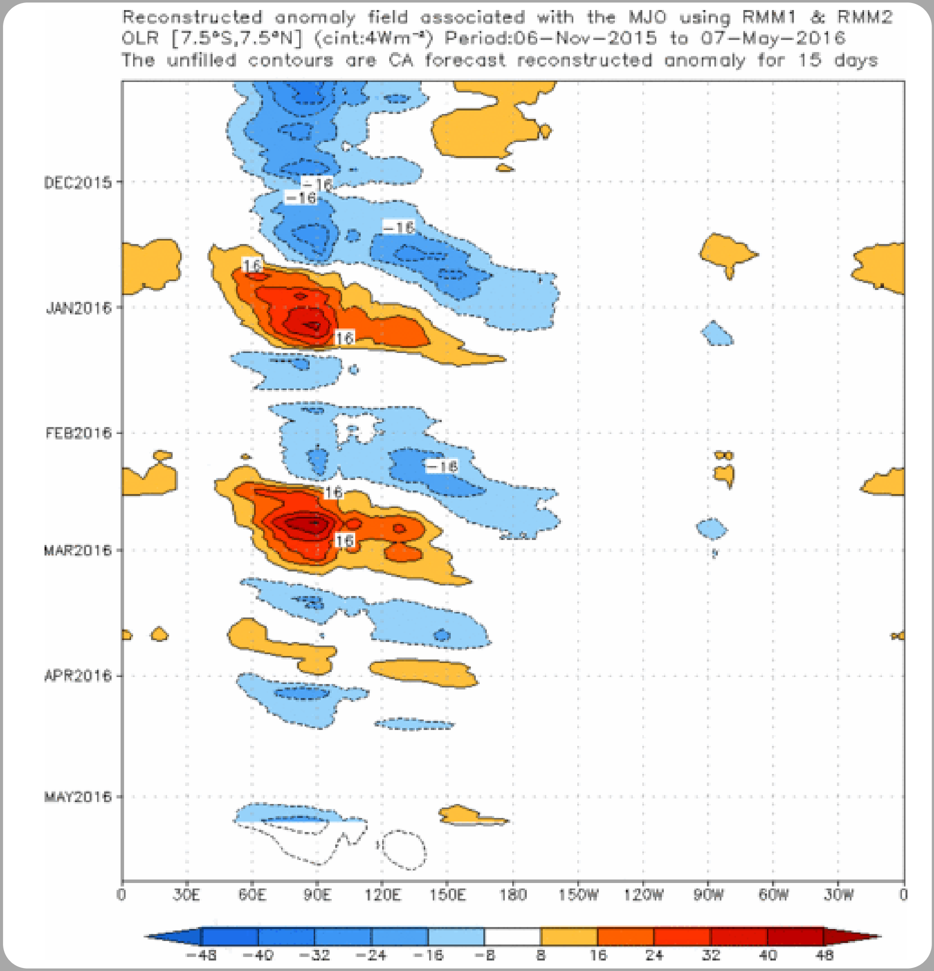
Constructed Analog (CA) MJO Forecast

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 - last 180 days and for the next 15 days

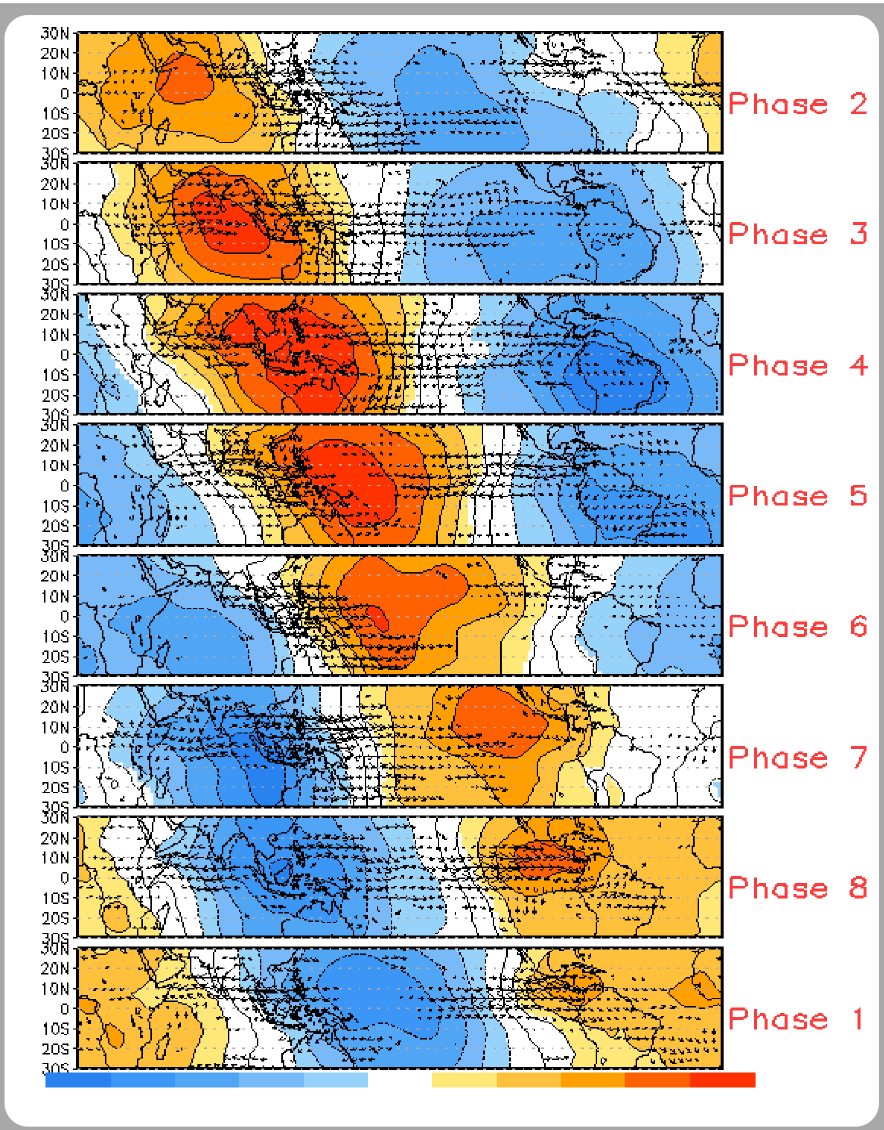




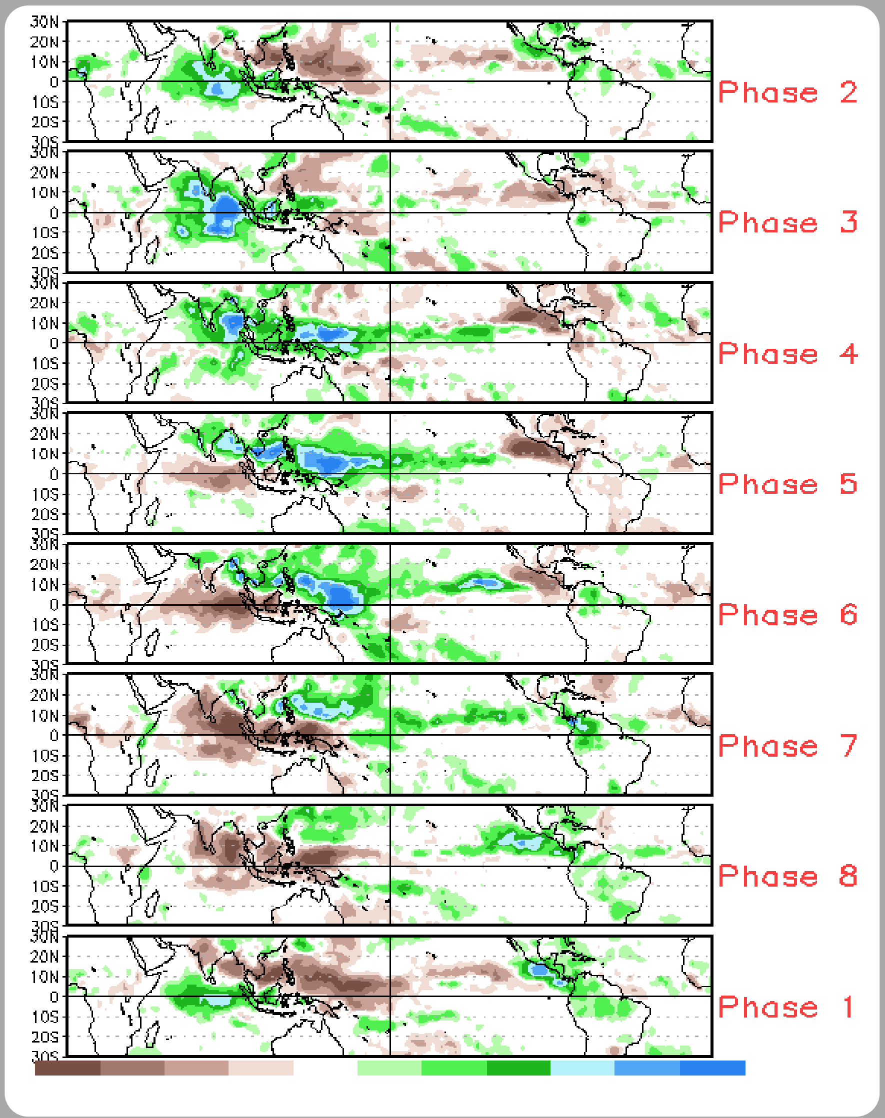
The Constructed Analog (CA) model predicts a weakening and eastward propagating intraseasonal signal during the next two weeks.

MJO Composites - Global Tropics

850-hPa Velocity Potential and Wind Anomalies (Nov-Mar)



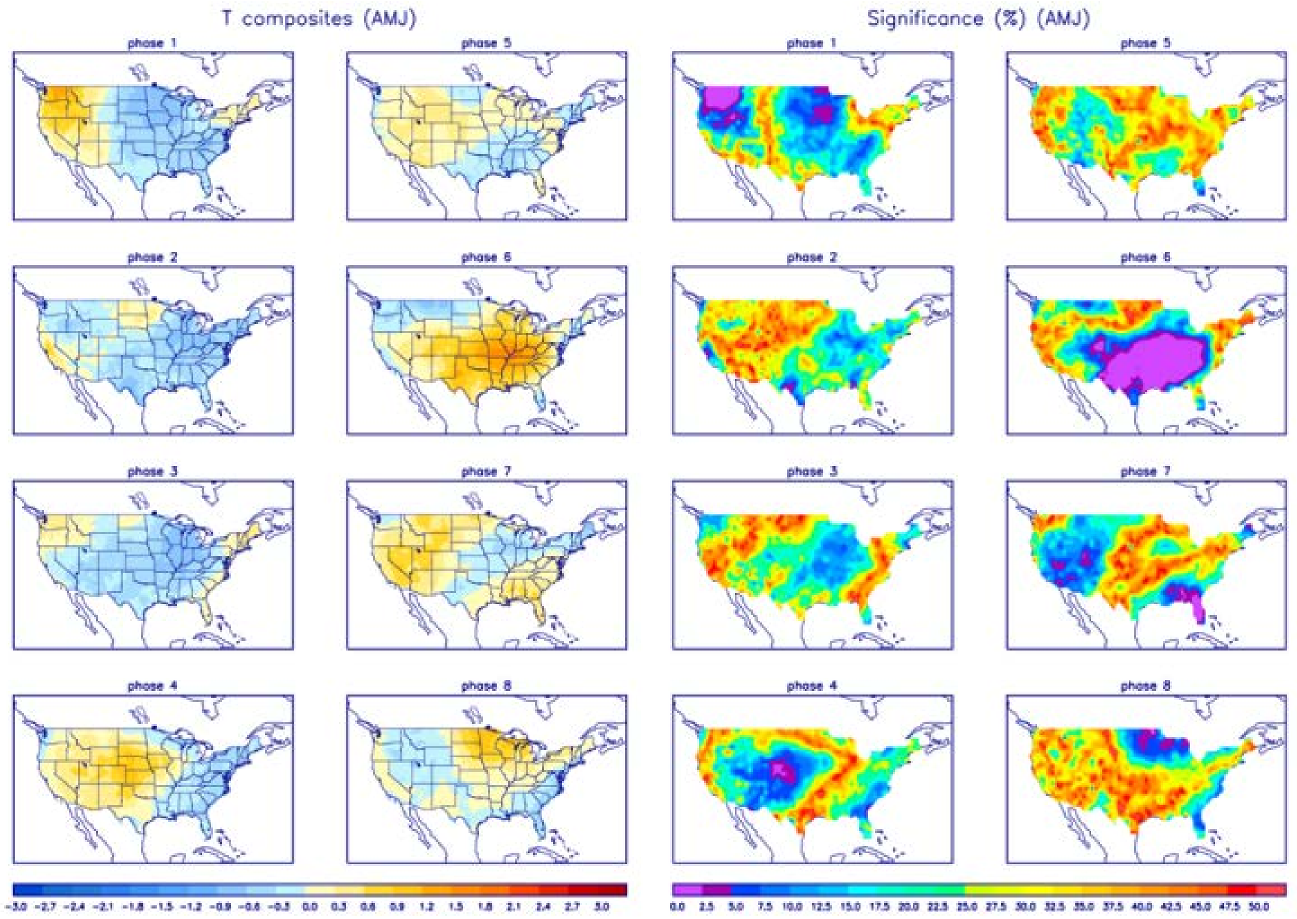
Precipitation Anomalies (Nov-Mar)



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. Purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.



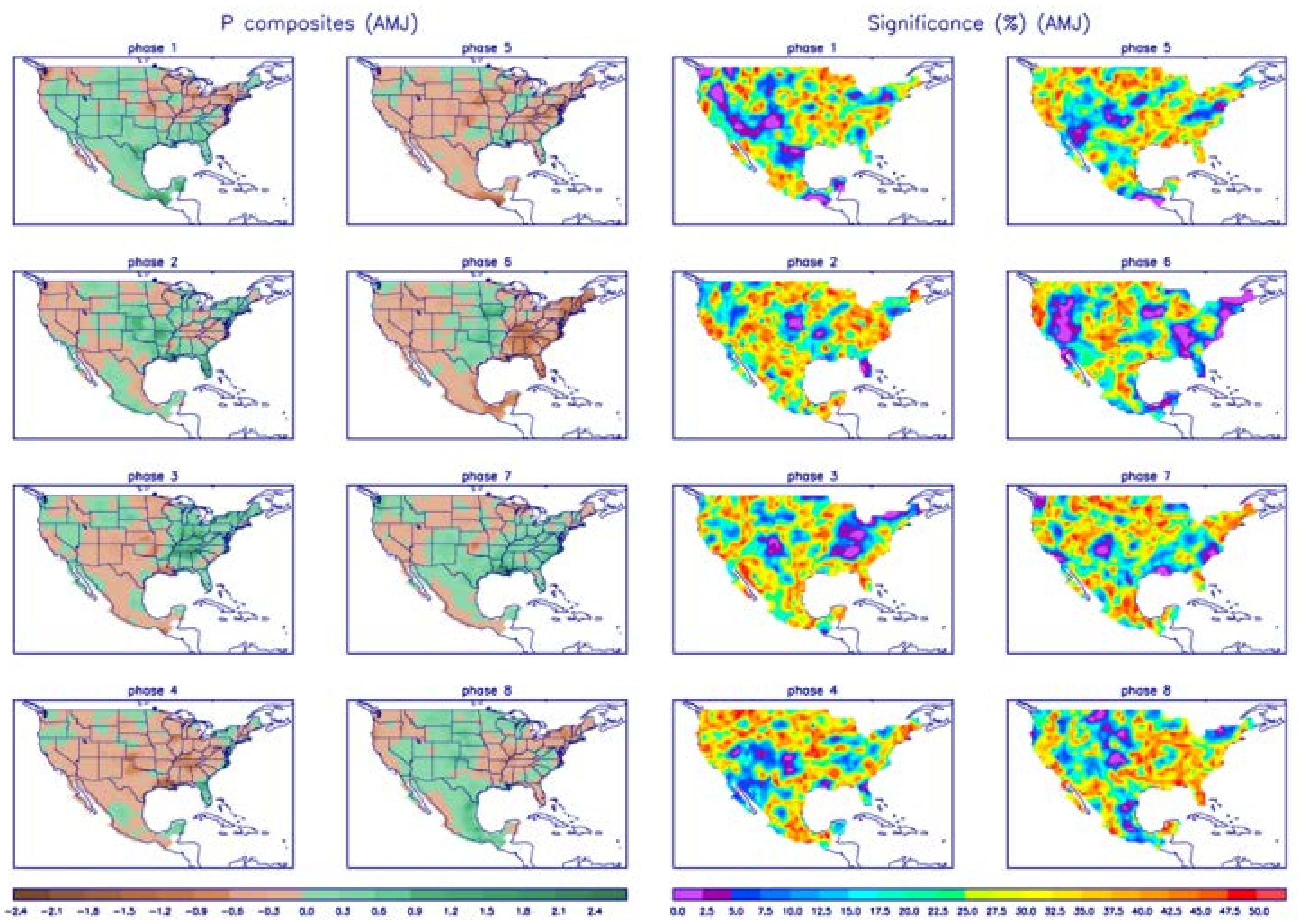
Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

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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