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

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Climate Prediction Center / NCEP
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Outline

Overview

Recent Evolution and Current Conditions

MJO Index Information

MJO Index Forecasts

MJO Composites

Overview

- The MJO remained weak during the past 7 days, with any remaining signal spanning Africa, from the Atlantic to the Indian Oceans. Suppressed convection developed of the western North Pacific while across the equatorial Americas enhanced convection developed. Those two areas of variability are likely related to higher frequency modes of variability (Equatorial Rossby Waves and Kelvin Waves).

- Statistical model guidance depicts little to no MJO signal during the next 2 weeks. Some dynamical models depict a signal emerging over the Atlantic Ocean and Africa during later Week-1 before moving east and weakening during Week-2.

- The MJO is anticipated to have a minor influence the global tropical convective pattern during the next two weeks.

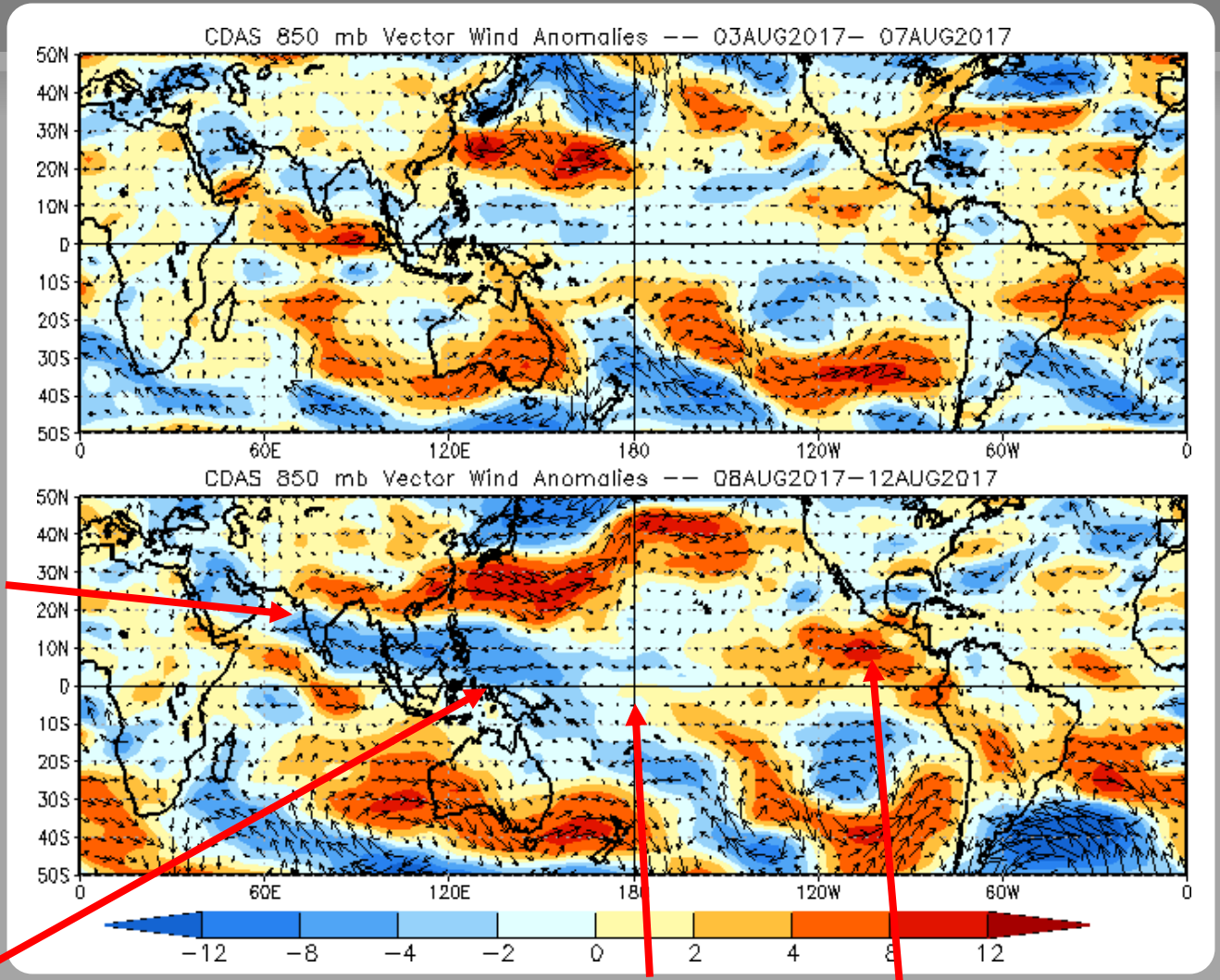
Additional potential impacts across the global tropics and a discussion for the U.S. are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



A weak monsoon inflow is still evident, with higher amplitude easterly anomalies over India.

Broad easterly anomalies built in over the equatorial western Pacific, while off equator, westerly anomalies remained.

Weak anomalies were present near the Date Line, while western anomalies remained over the East Pacific and Atlantic basins.

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

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

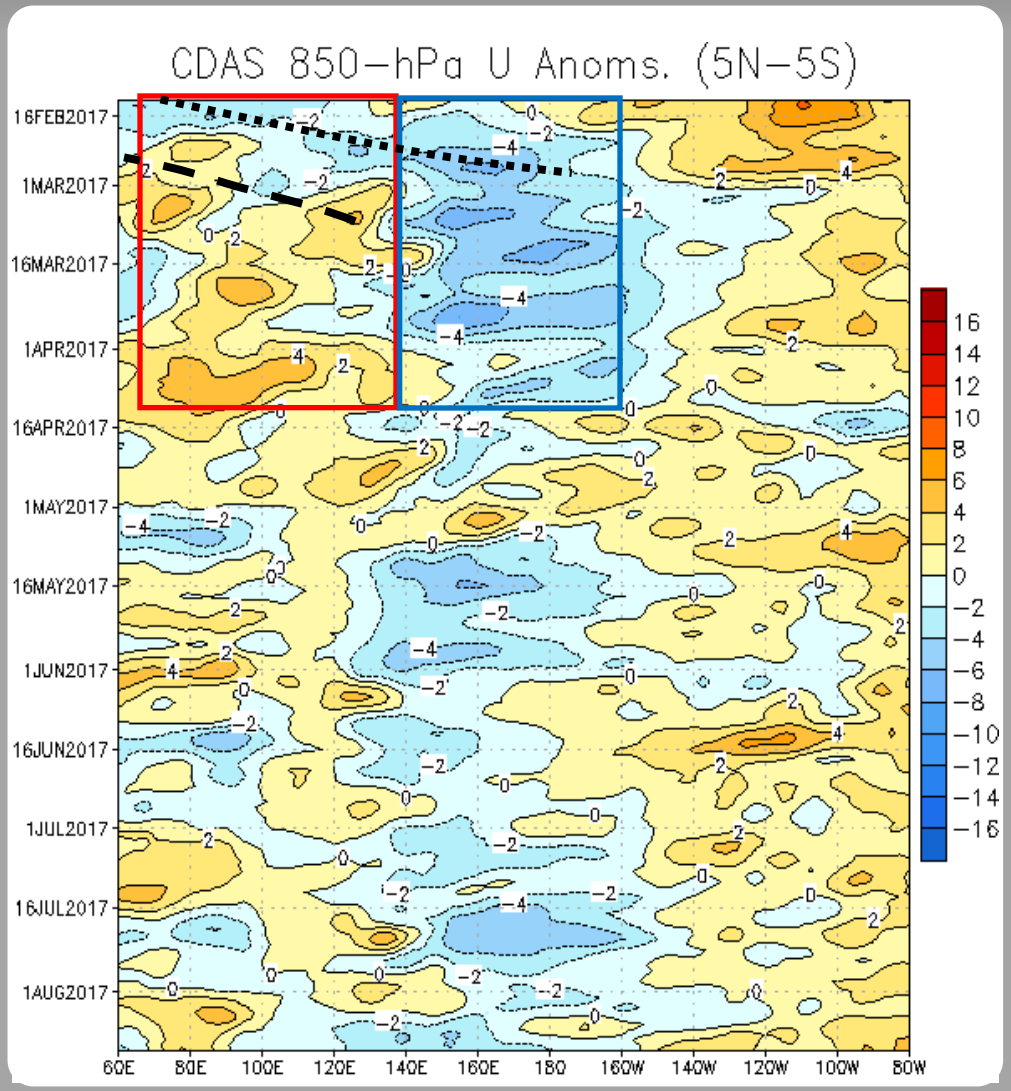
Easterly anomalies (blue shading) represent anomalous east-to-west flow

Persistent westerly (easterly) anomalies, shown by the red (blue) box at right, were associated with the negative phase of the Indian Ocean Dipole (IOD), and La Niña.

In February, MJO activity destructively interfered with the base state. During mid-March and early April, the low frequency state reemerged, with some intraseasonal variability evident in late March.

Equatorial flow was fairly close to climatology during June. During July, the low-frequency pattern shifted eastward, with easterly anomalies over the central Pacific. Intraseasonal variability shifted the pattern in late July.

Recently, easterly anomalies have developed over the Maritime Continent, with westerly anomalies over the East Pacific and Atlantic.



OLR Anomalies – Past 30 days

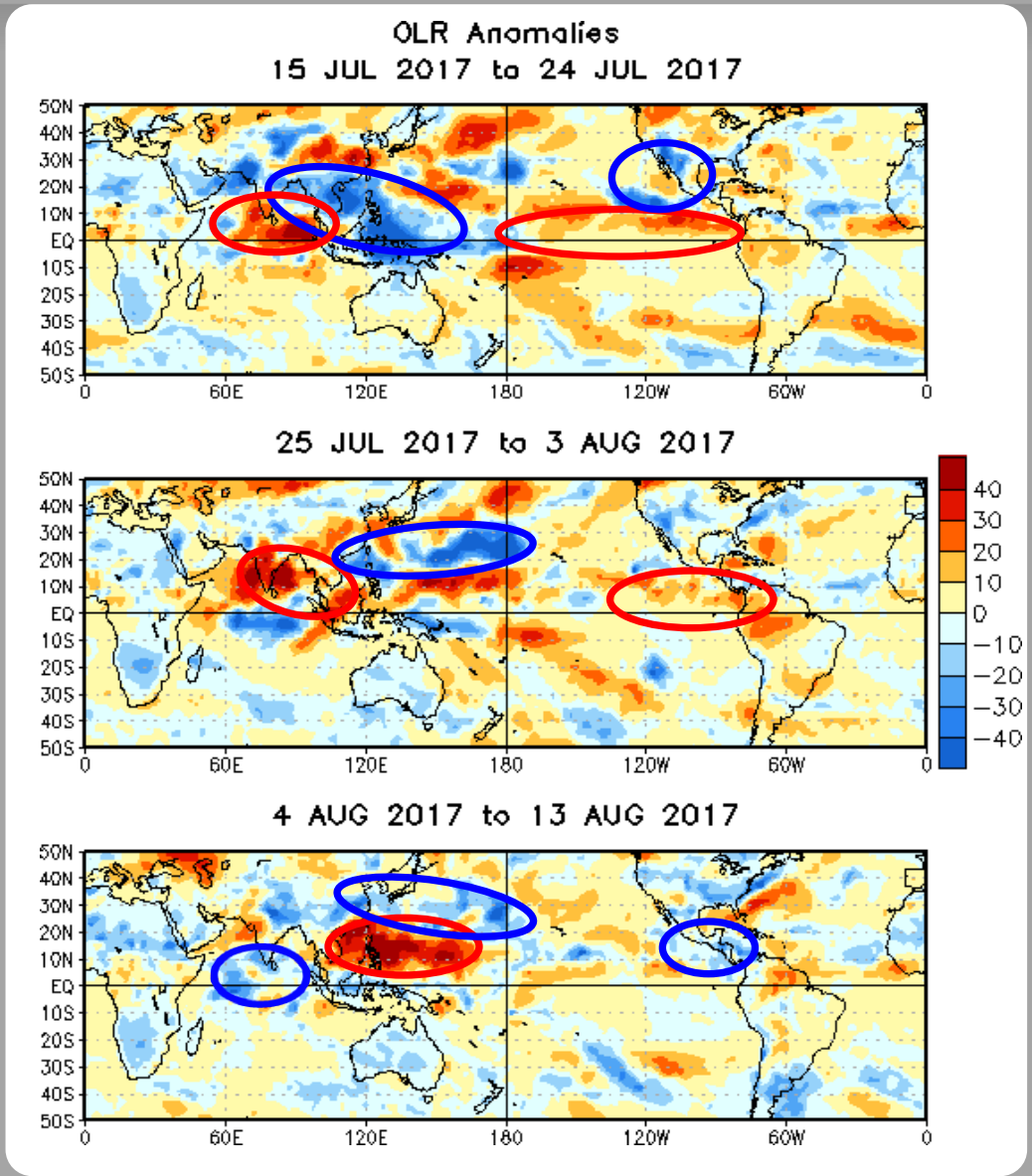
Drier-than-normal conditions, positive OLR anomalies (yellow/red shading)

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

During mid to late July convection built over Southeast Asia, while dryer than normal conditions developed over the Indian Ocean. Tropical cyclone activity is evident over the East Pacific.

During late July and early August, some of the dry signal from the Indian Ocean moved northward and the wet signal over the Maritime Continent waned. Weak drying built in over the East Pacific.

Some enhanced convection returned to southern India as the South Asian Monsoon vacillated. The dry signal consolidated to the West Pacific. Enhanced convection covered most of Central America and surrounding waters.



Outgoing Longwave Radiation (OLR) Anomalies (2.5°N - 17.5°N)

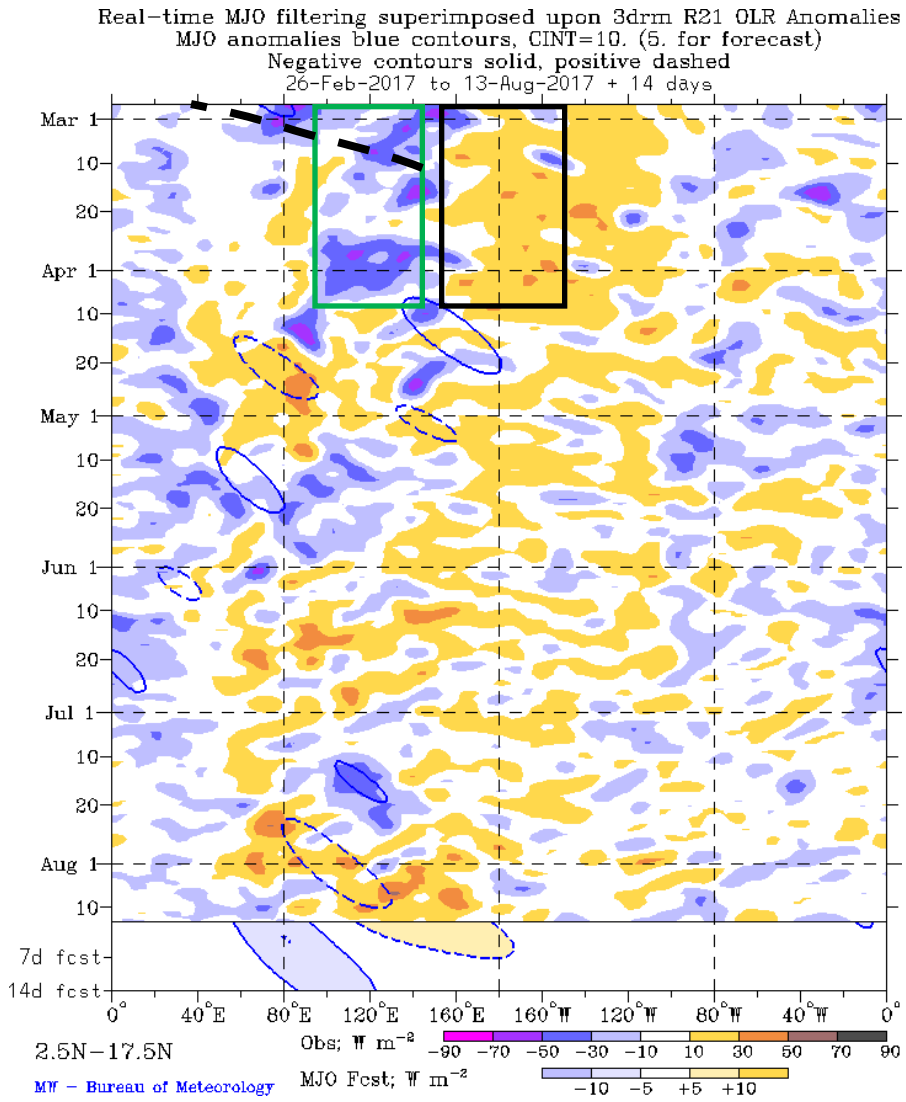
Drier-than-normal conditions, positive OLR anomalies (yellow/red shading)

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

A low frequency state favoring enhanced convection over the eastern IO and the Maritime Continent was evident from July 2016 through early April 2017 (green box), with suppressed convection near the Date Line (right black box).

From mid-April through present, convective anomalies were generally weak. In mid-May, enhanced convection was noted over the Indian Ocean with some eastward propagation.

During mid-July, there was a burst of enhanced convection over the Maritime Continent, due to interactions between a potential intraseasonal signal and the low-frequency state. More recently, suppressed convection was noted over much of South and Southeast Asia, with some activity over Africa and the western Caribbean.



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

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

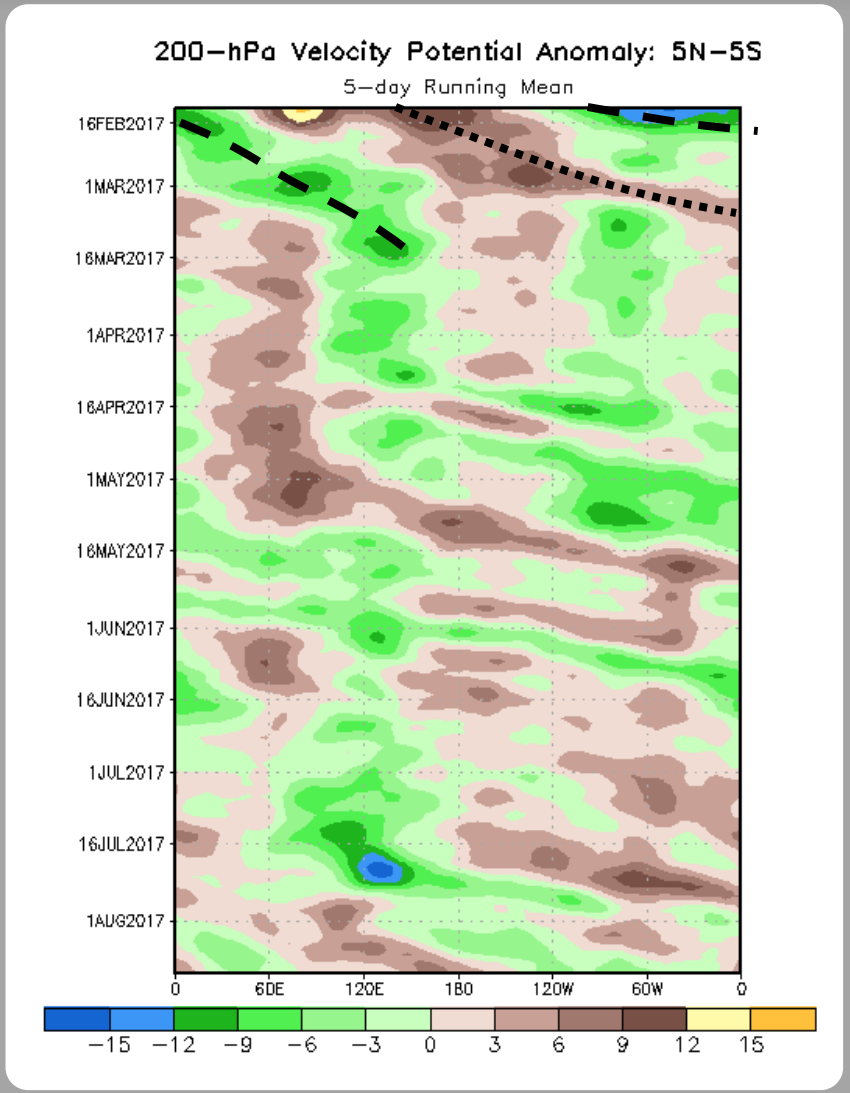
Negative anomalies (green shading) indicate favorable conditions for precipitation

A signal emerged over the Maritime Continent and continued propagating through early March, creating alternating periods of constructive and destructive interference with the base state.

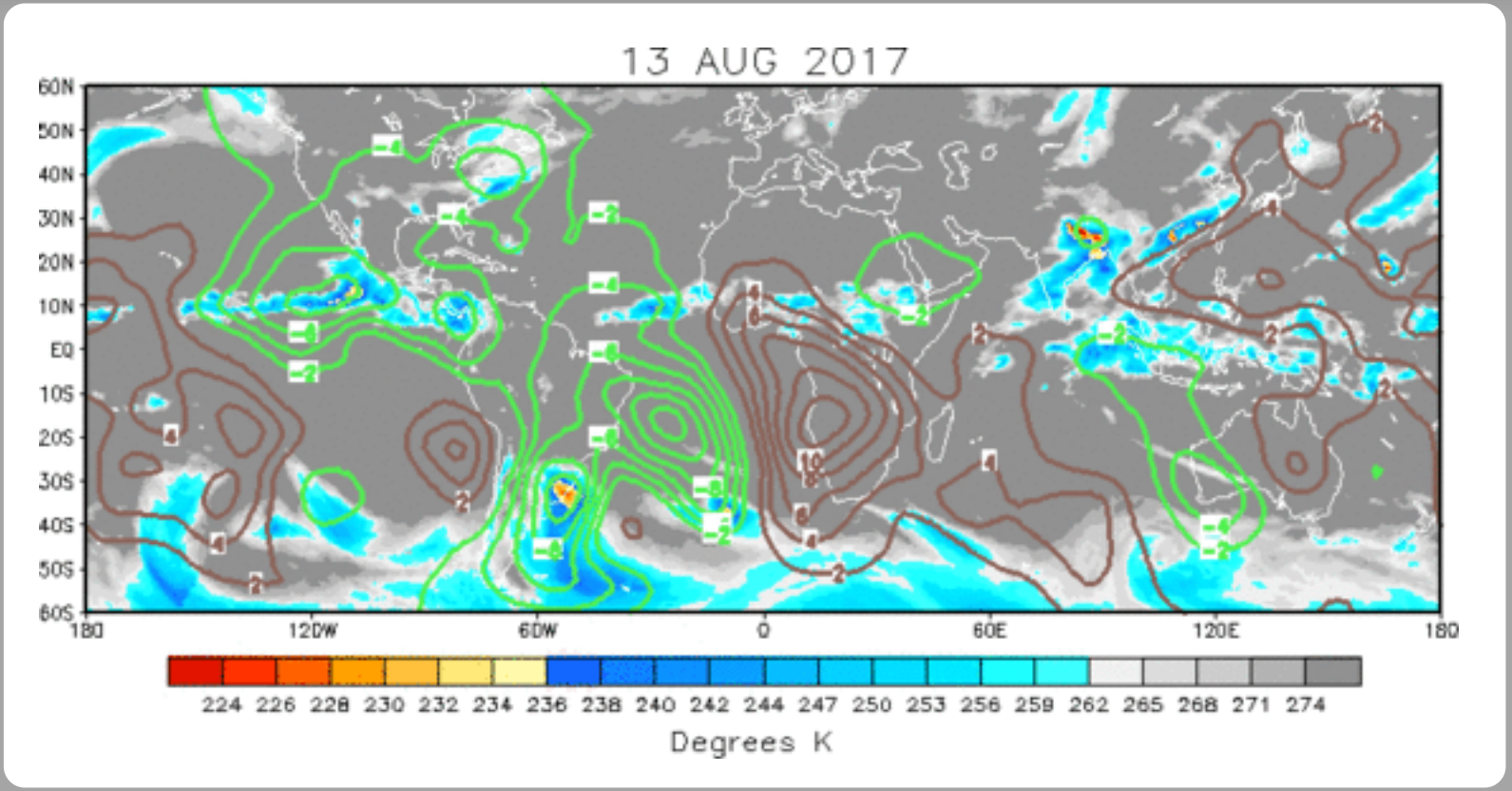
During March, a low frequency signal favoring enhanced (suppressed) convection over the Maritime Continent (Indian Ocean) became the primary component of the anomaly field.

Kelvin wave activity was apparent from April through early June, as seen in the rapidly propagating eastward signals. During July, enhanced convection strengthened over the Maritime Continent as the low-frequency signal constructively interfered with an easterly propagating signal.

Recently, suppressed convection overspread the West Pacific, with weakly enhanced convection (Kelvin wave-related) now over the Atlantic and Indian Oceans.



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



A Wave-2 pattern is evident, with an enhanced (suppressed) signal from the eastern Pacific the central Atlantic (Africa), and a second, weaker couplet over the Maritime Continent and western Pacific.

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

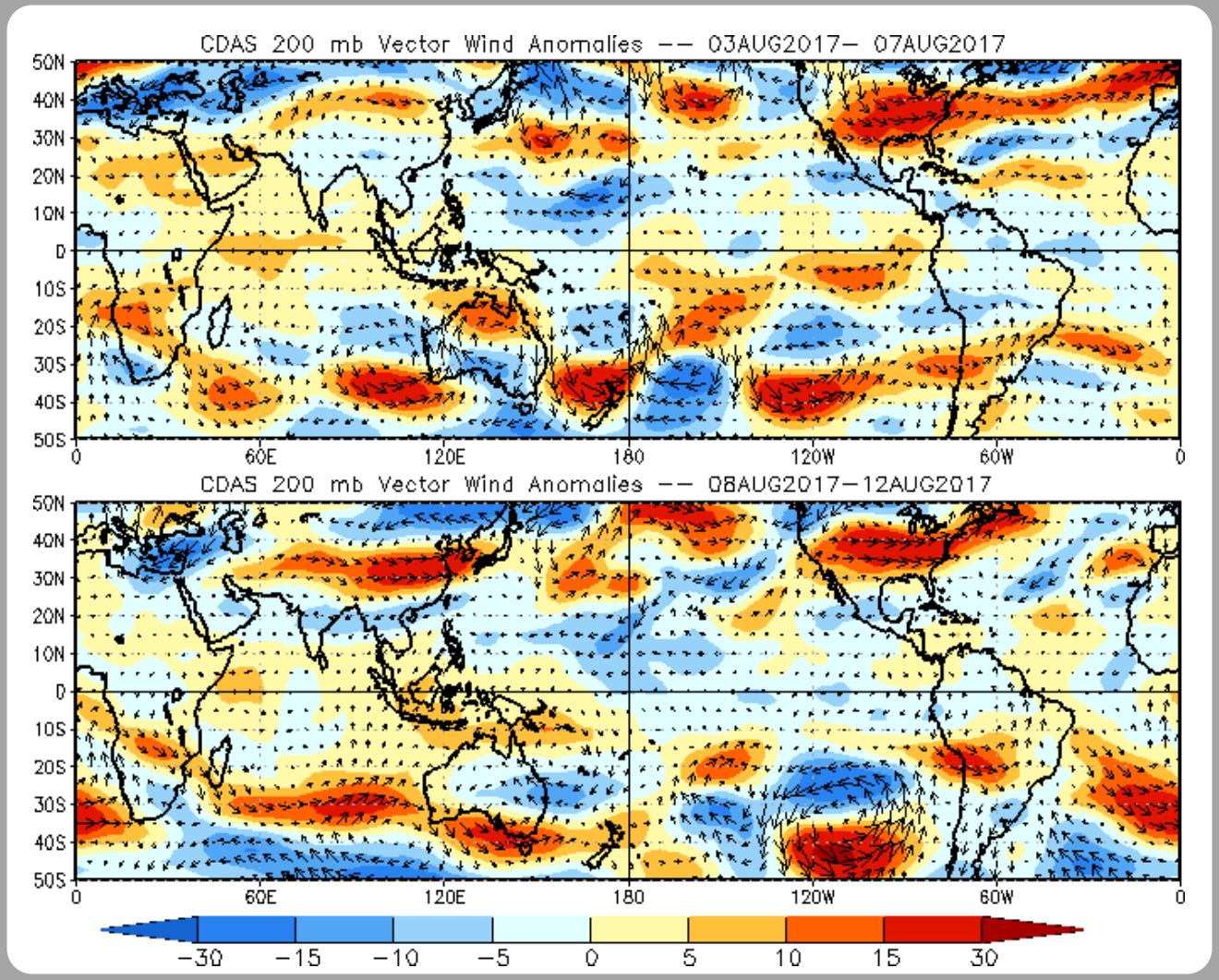
Negative anomalies (green contours) indicate favorable conditions for precipitation

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Upper-level convergence is evident over the Maritime Continent and West Pacific.

Zonal anomalies are evident in the Eastern Hemisphere, while more amplified pattern is evident near South America and near the Date Line.

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

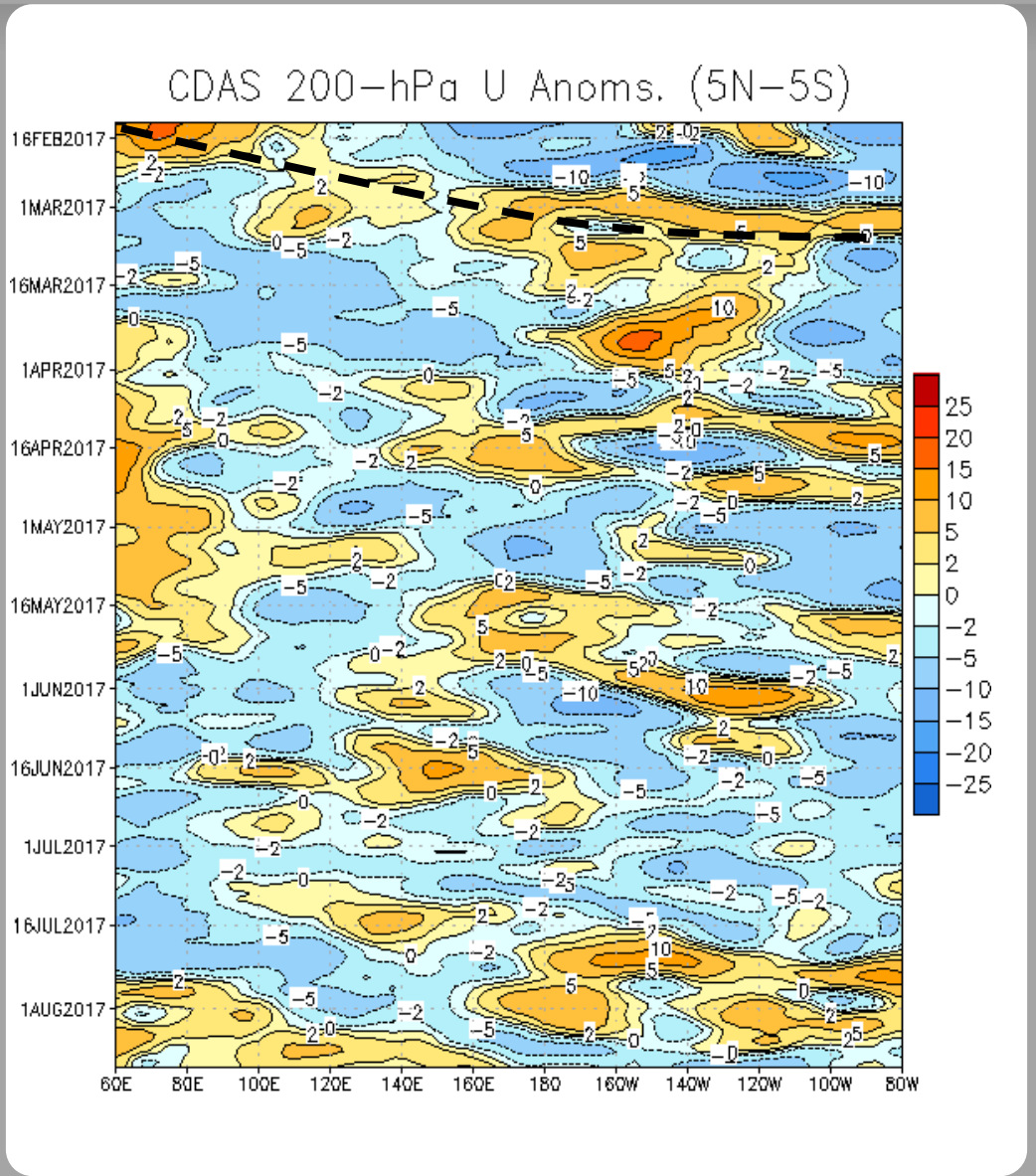
Westerly anomalies (orange/red shading) represent anomalous west-to-east flow

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

Easterly anomalies returned to the East Pacific during late April and persisted with some period of high-frequency interference.

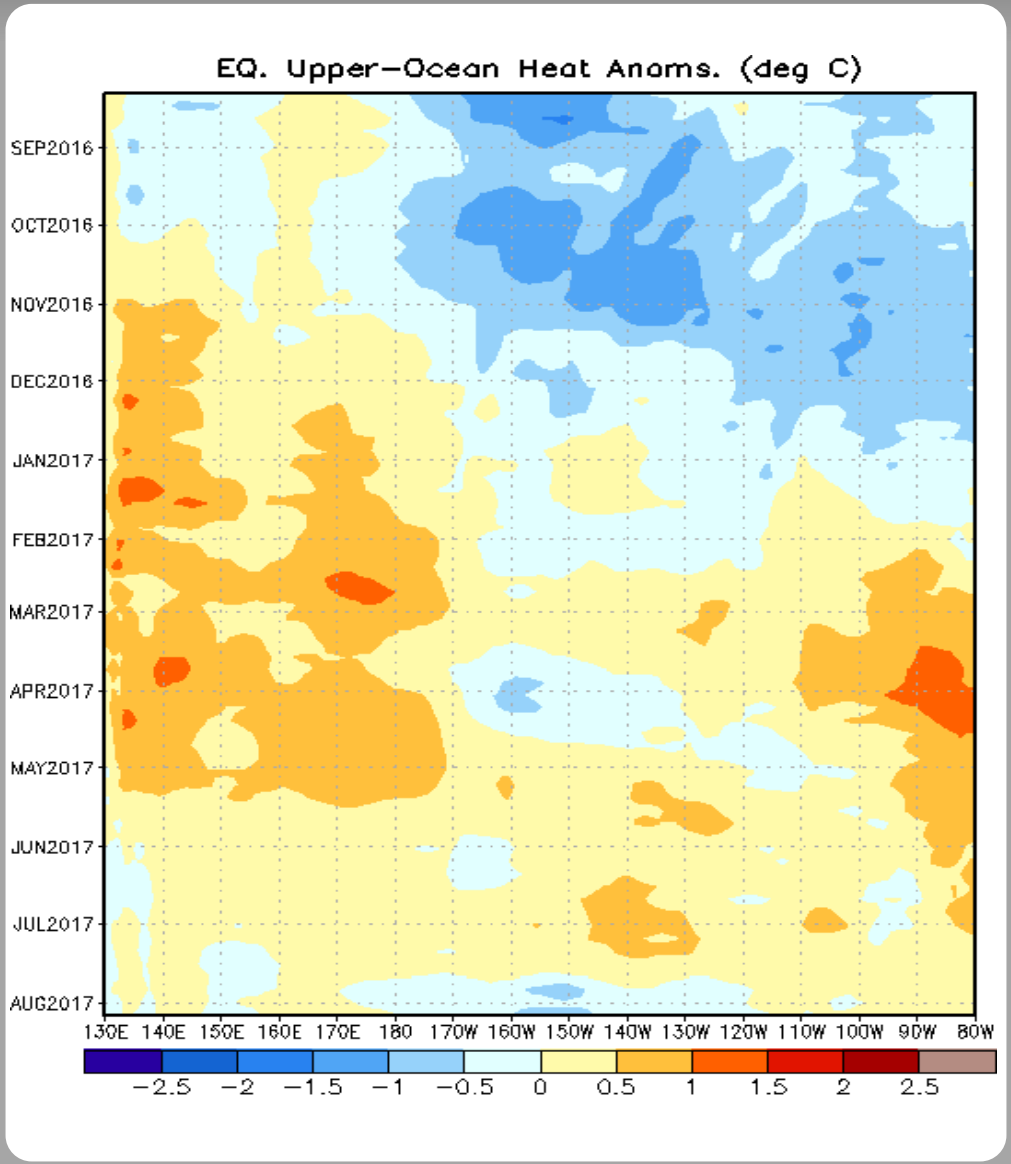
During early to mid-June, easterly anomalies were most prominent across the global tropics, in part due to mid-latitude influences.

Starting in July, the anomaly patterns have been continually moving eastward. Now westerly (easterly) anomalies are over the Maritime Continent (Central Pacific). Smaller spatial scale anomalies (associated with higher-frequency variability) are also evident.



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.



Upper-ocean heat content values continued to drop in the central Pacific as trade winds were near to above average during early August.

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

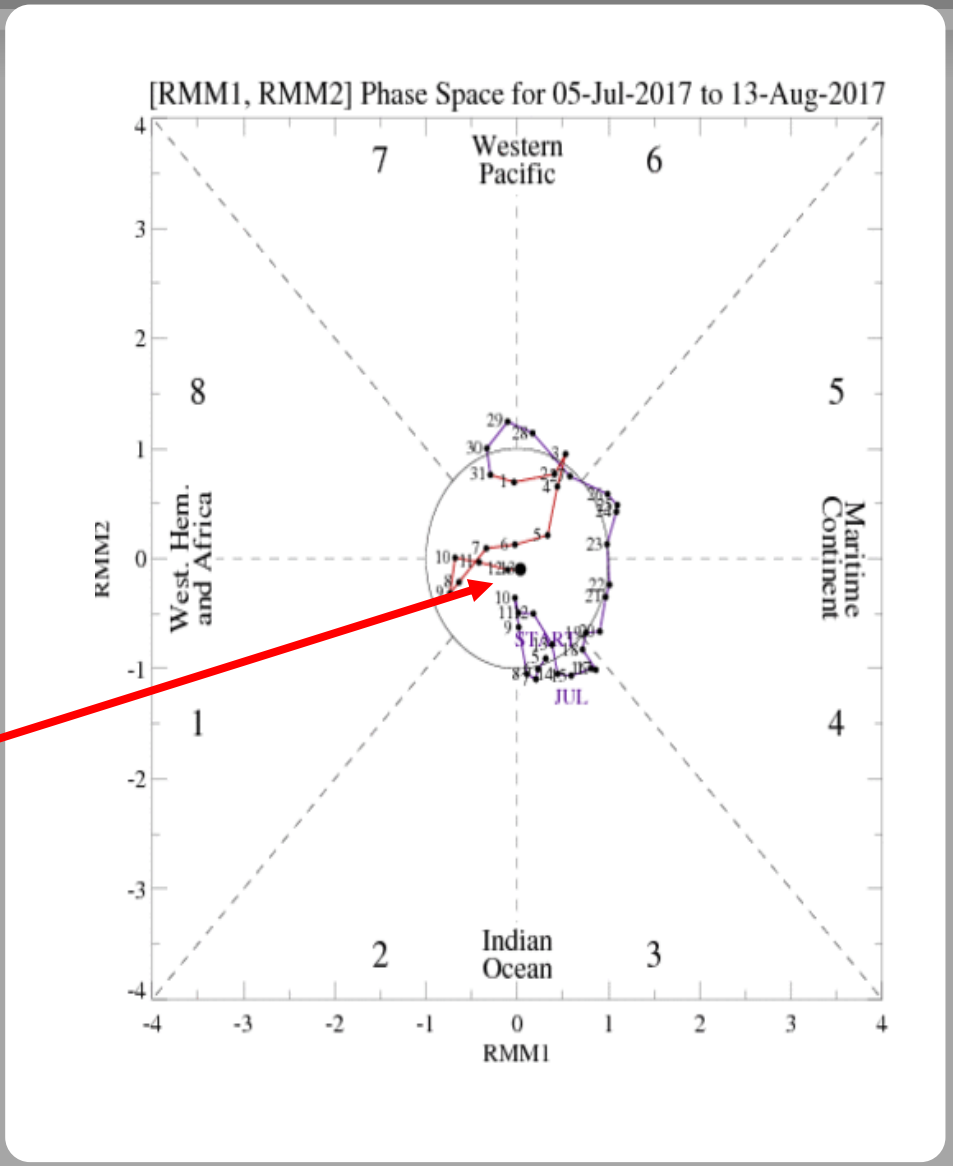
The triangular areas indicate the location of the enhanced phase of the MJO

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

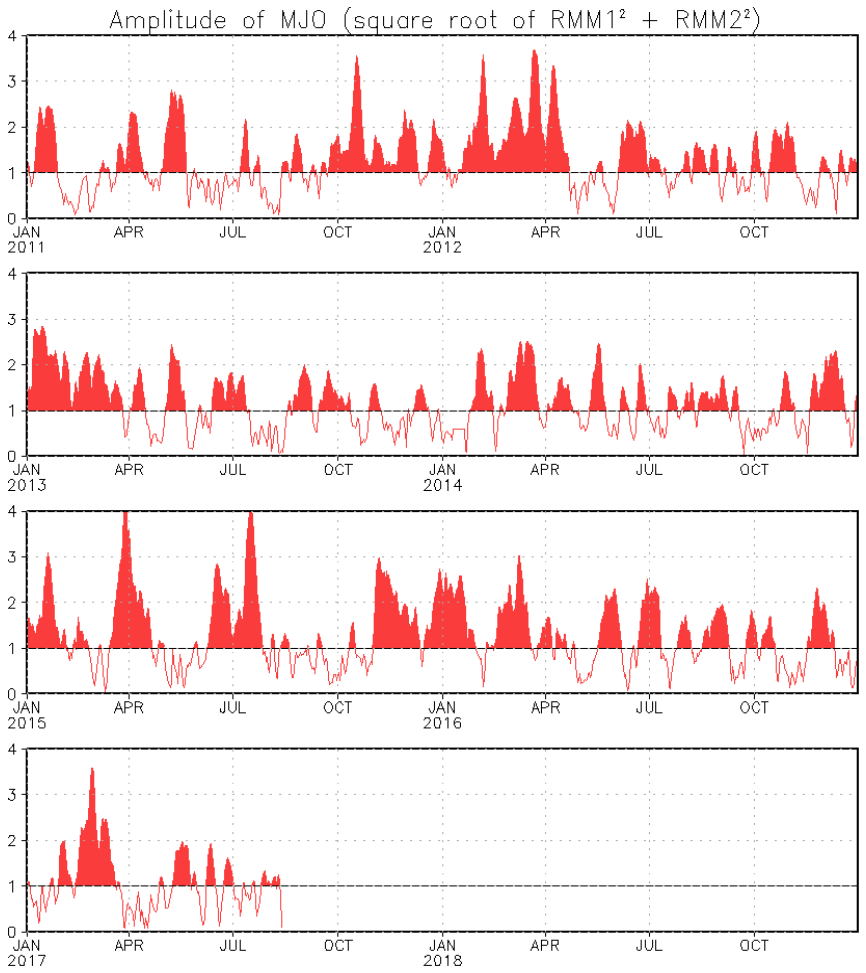
The MJO signal remained weak during the past 7 days, with other modes of variability contributing to the pattern.



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.



GFS Ensemble (GEFS) MJO Forecast

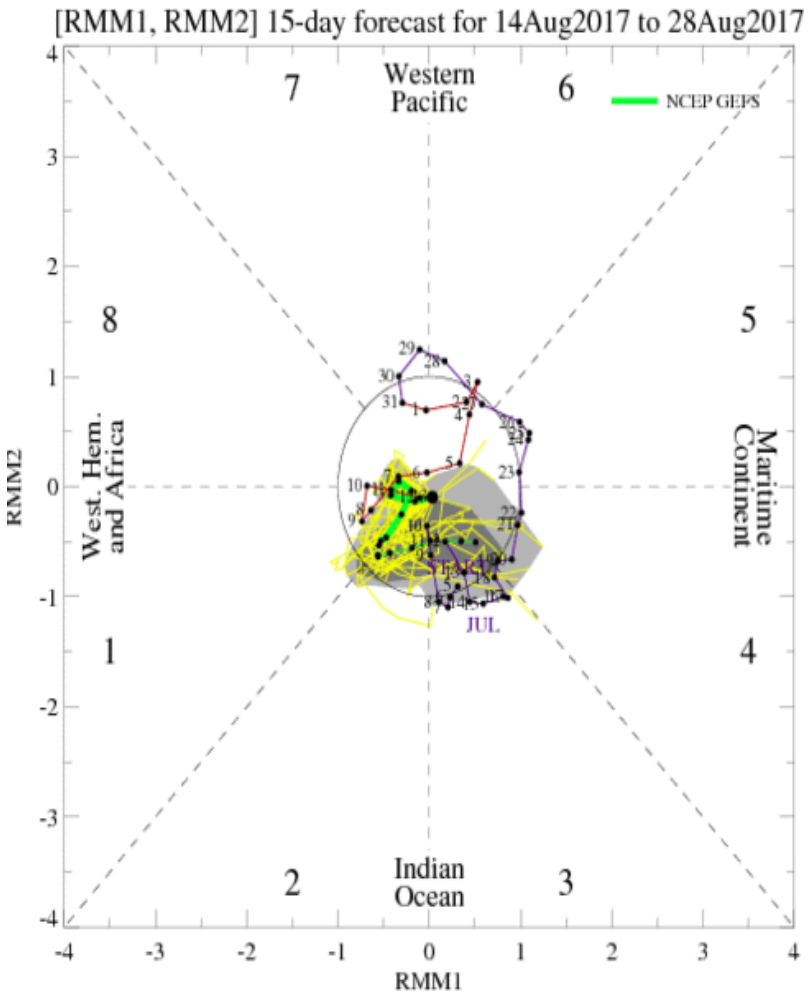
Yellow Lines - 20 Individual Members
Green Line - Ensemble Mean

RMM1 and RMM2 values for the most recent 40 days and forecasts from the GFS ensemble system (GEFS) for the next 15 days

light gray shading: 90% of forecasts

dark gray shading: 50% of forecasts

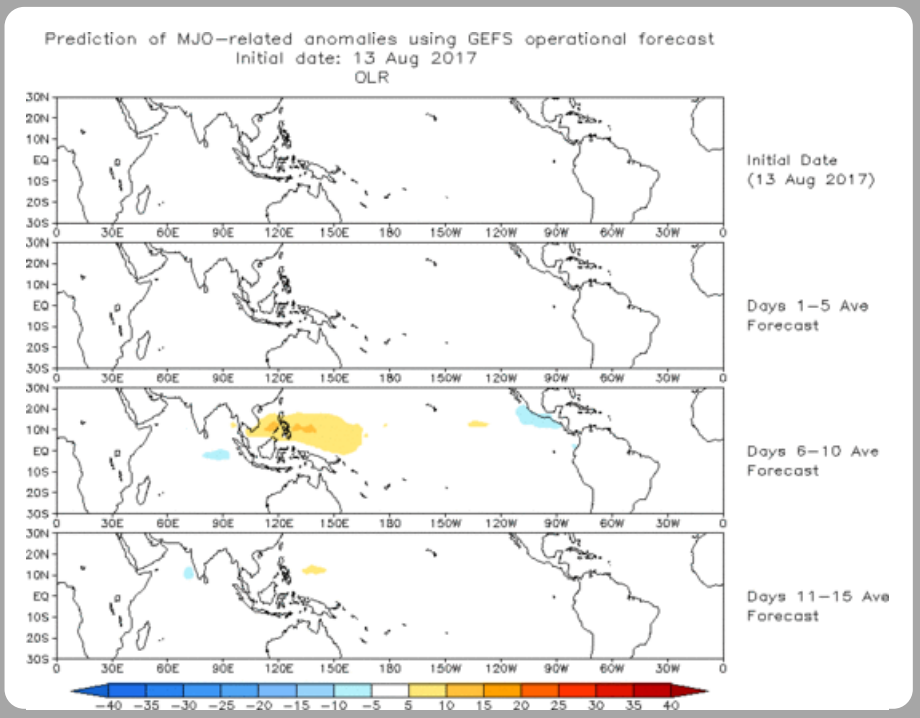
The GEFS ensembles generally depict a weak MJO signal over the next two weeks. Any predicted signal is likely to be over Africa or the Atlantic.



Ensemble GFS (GEFS) MJO Forecast

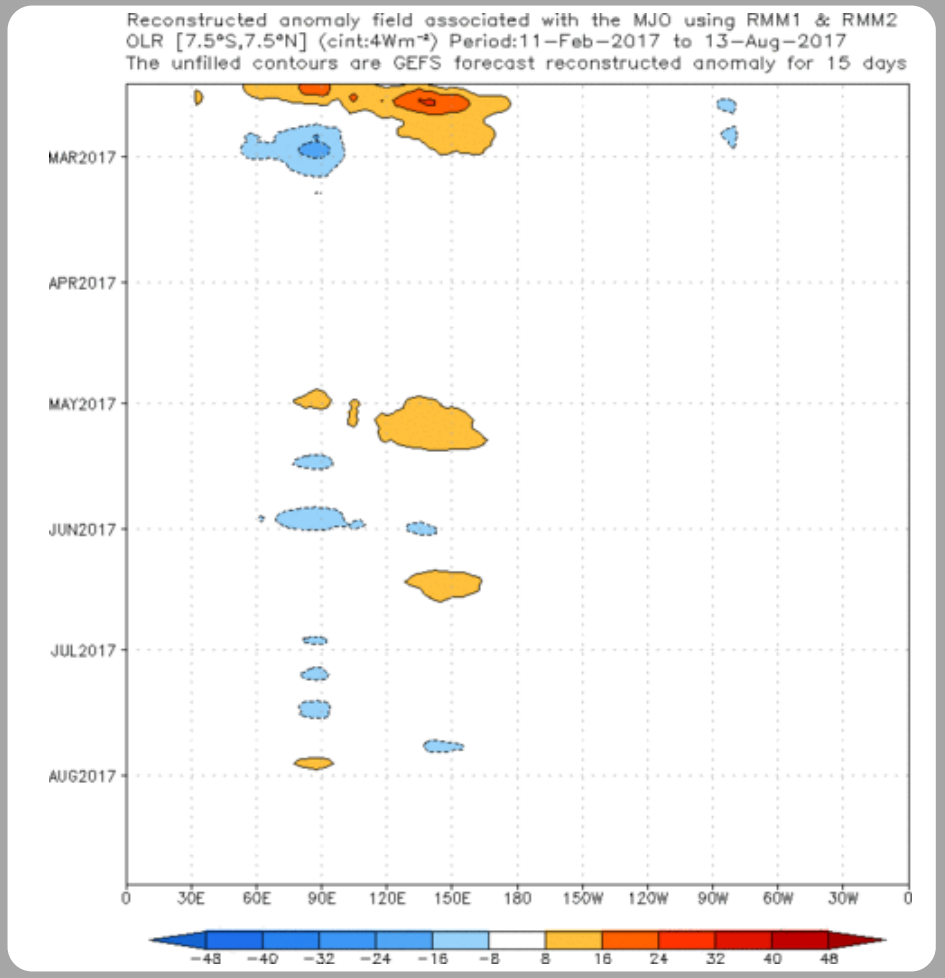
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Spatial map of OLR anomalies for the next 15 days



The GEFS RMM-based OLR anomaly forecast shows a weak signal emerging in Week-2, with little eastward propagation.

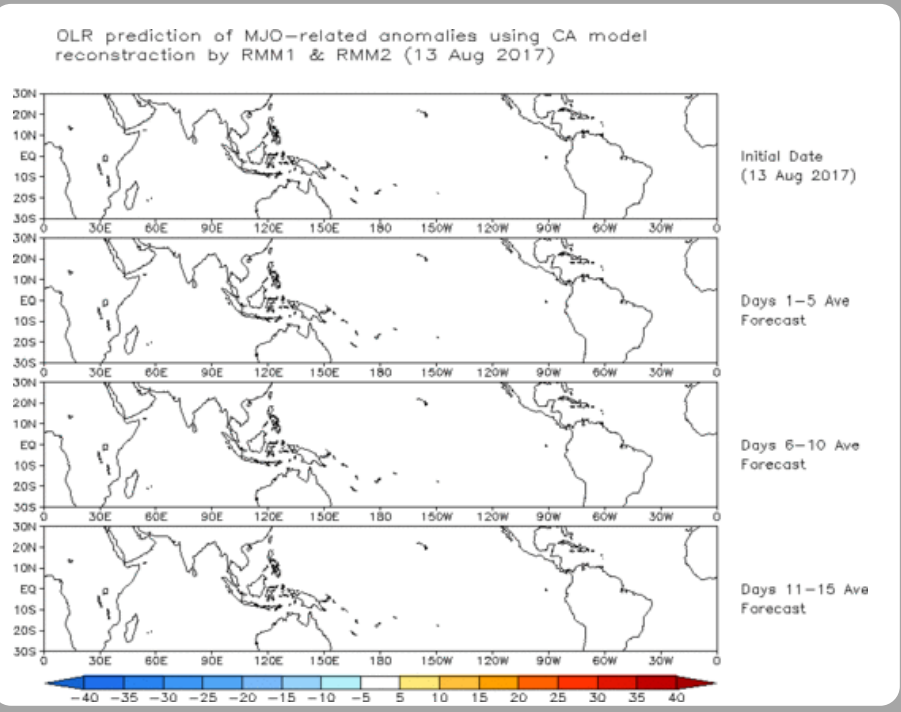
Time-longitude section of (7.5° S-7.5° N) OLR anomalies - last 180 days and for the next 15 days



Constructed Analog (CA) MJO Forecast

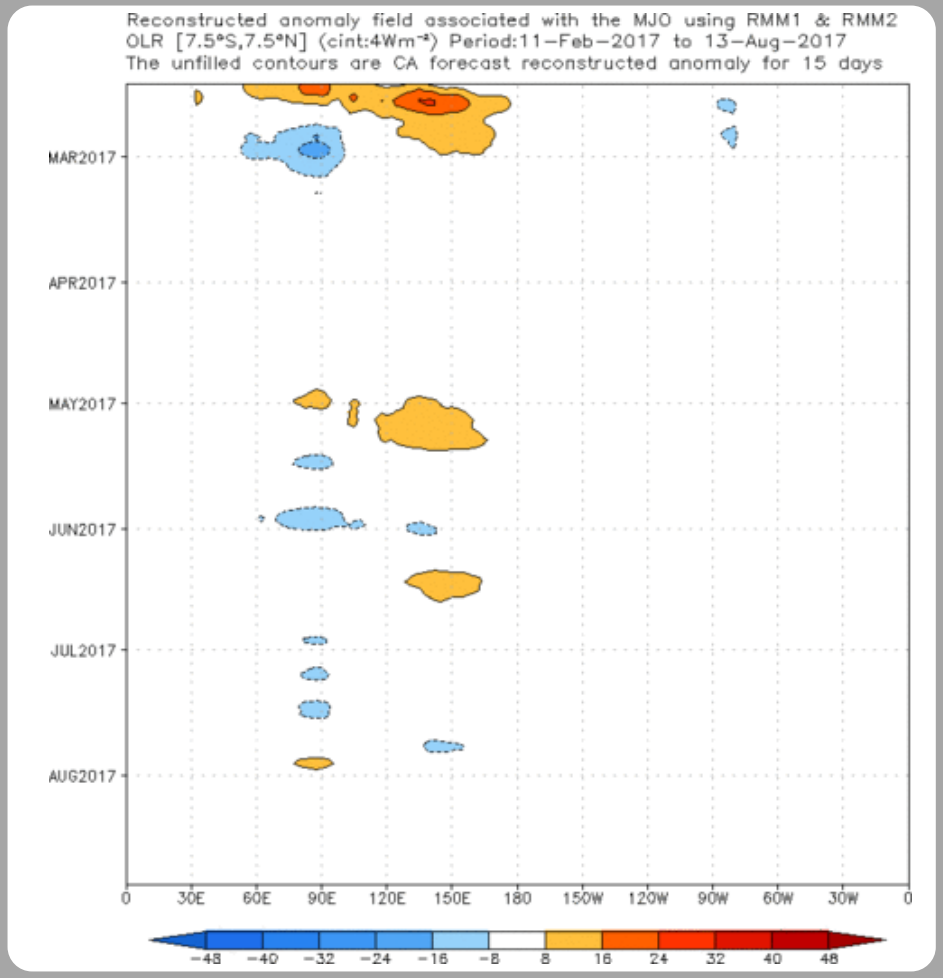
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Spatial map of OLR anomalies for the next 15 days



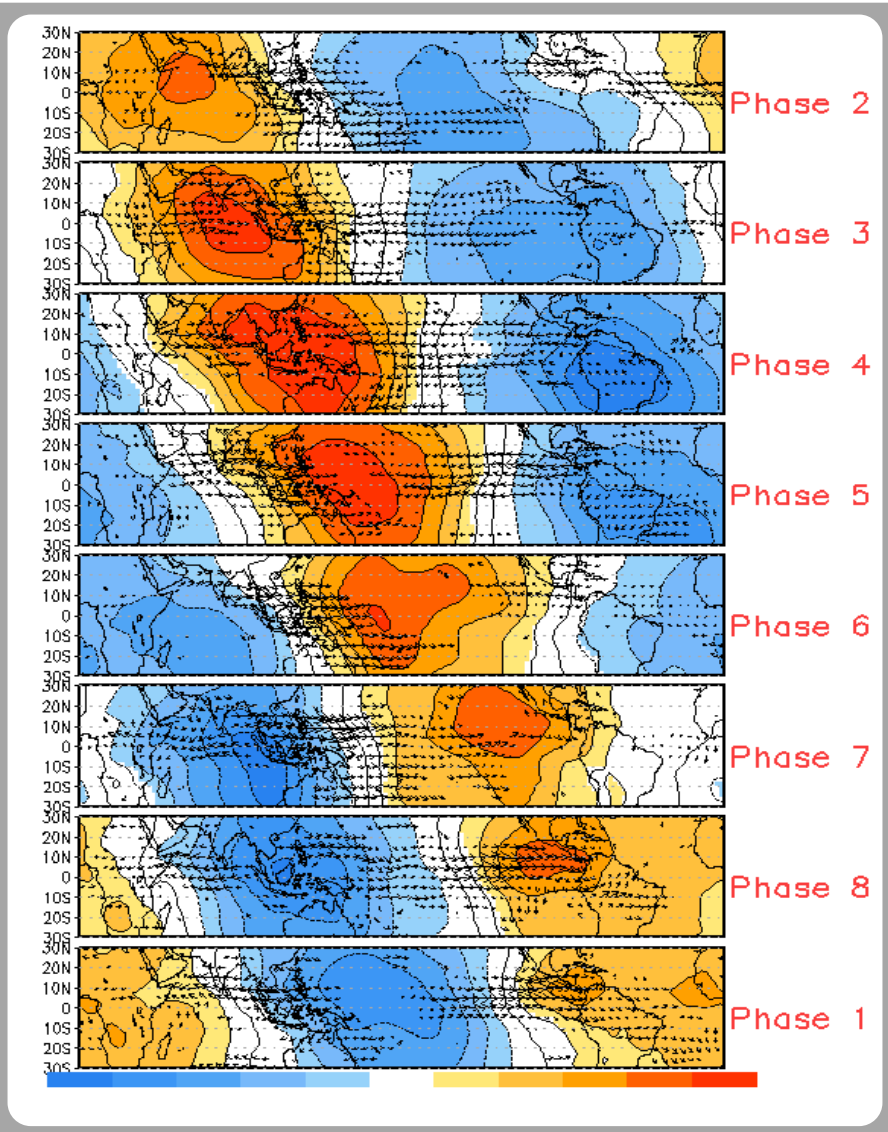
The constructed analog RMM-based forecast also depicts a weak signal.

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

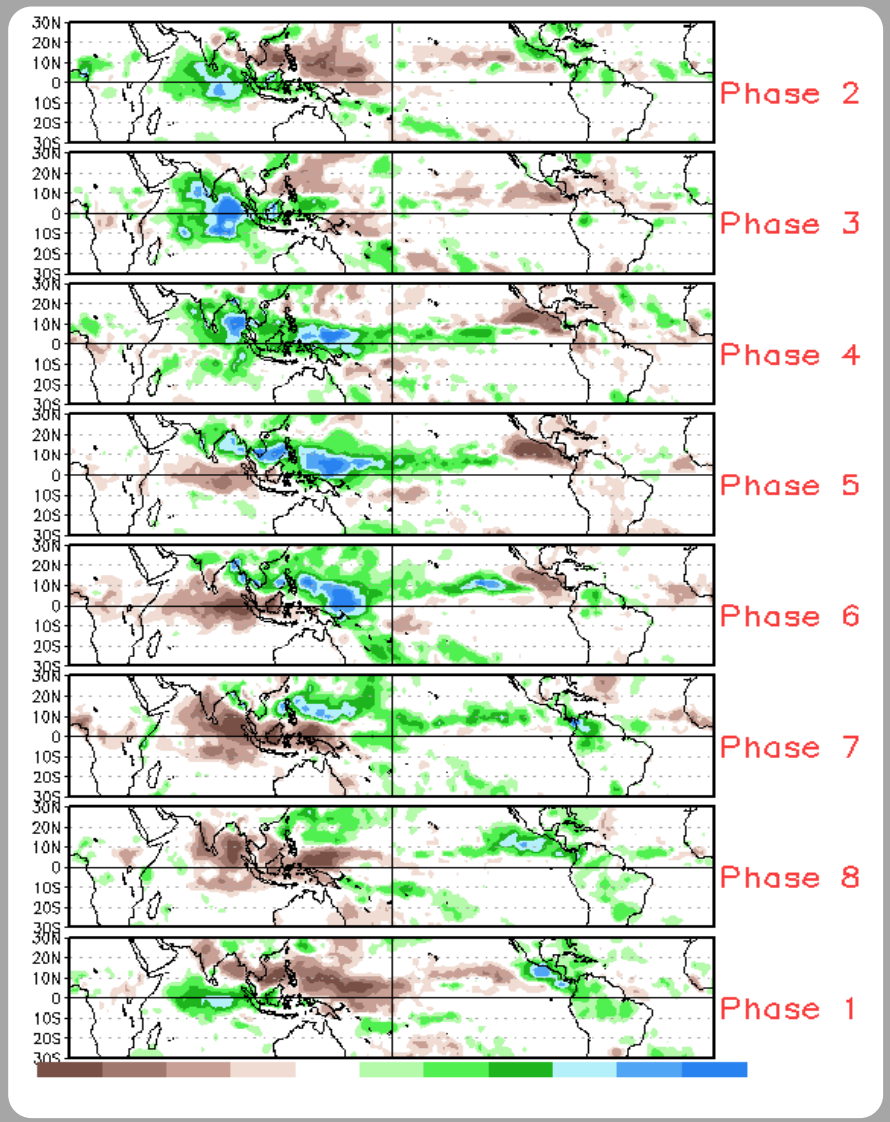


MJO Composites - Global Tropics

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



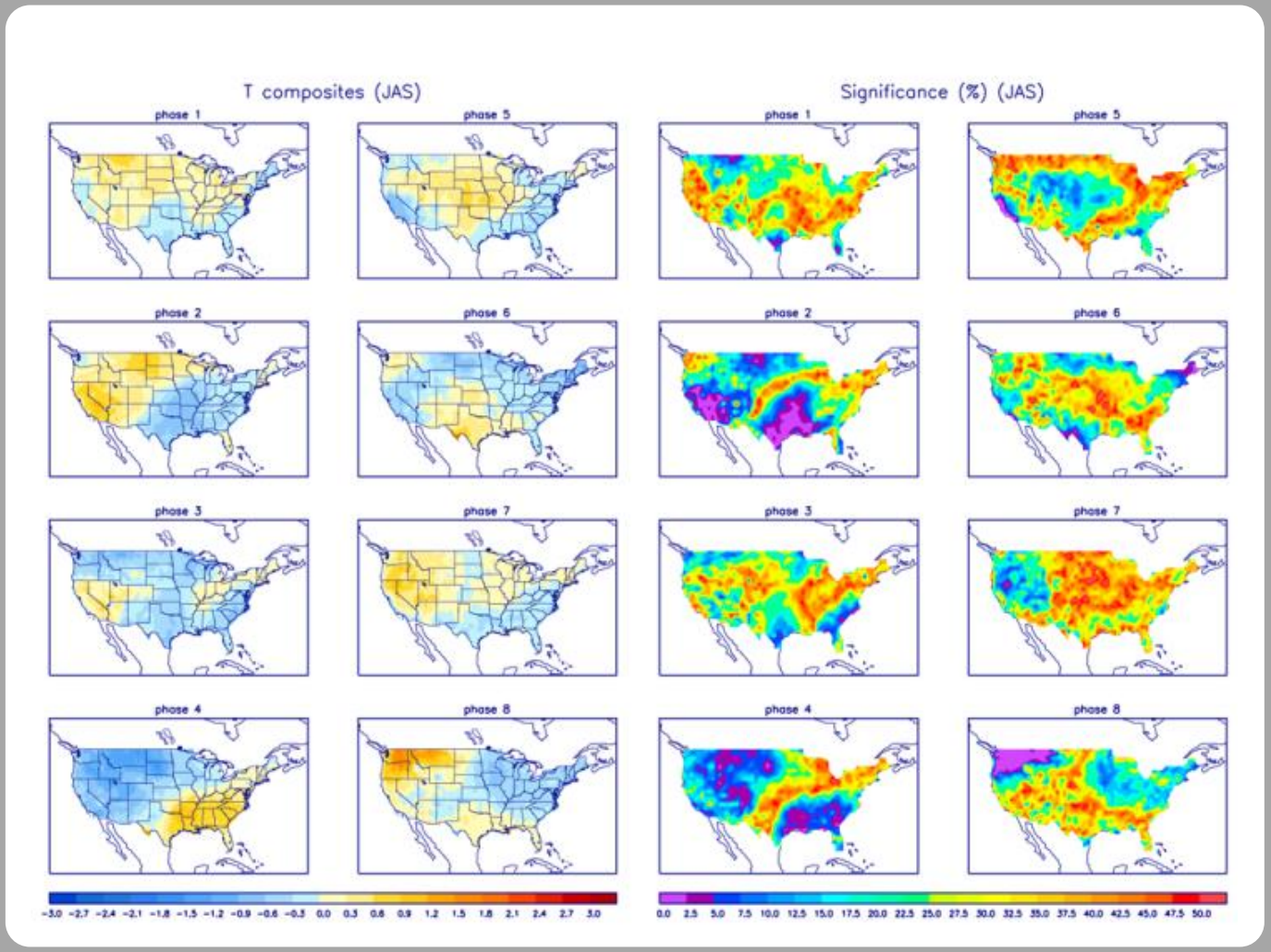
Precipitation Anomalies (May - Sep)



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.



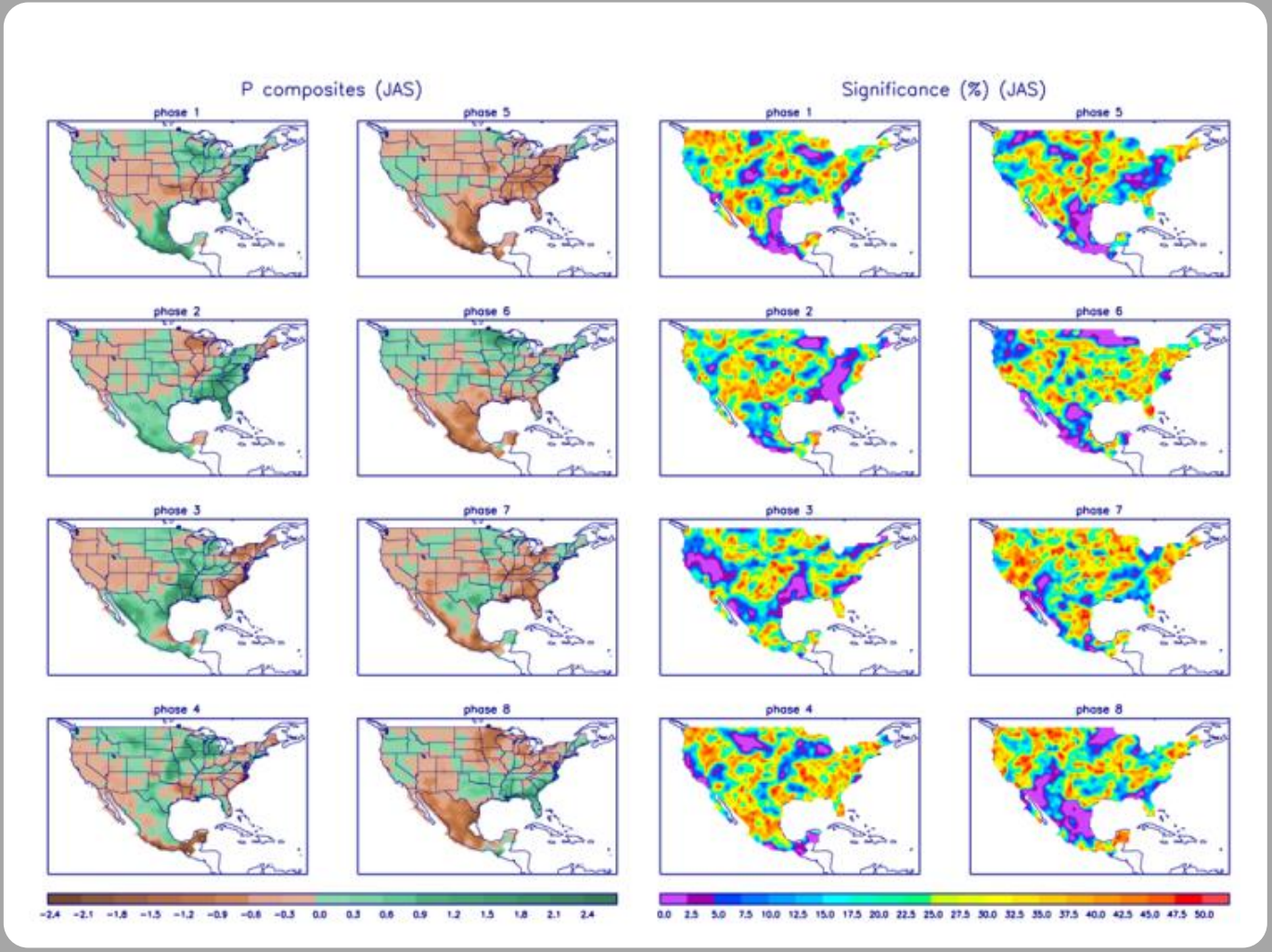
Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

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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