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

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Climate Prediction Center / NCEP
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Outline

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Recent Evolution and Current Conditions

MJO Index Information

MJO Index Forecasts

MJO Composites

Overview

- Some measures (velocity potential and 200-hPa winds) of the MJO depict a more robust signal, while low-level winds and OLR depict a weak signal. An area of enhanced convection shifted east to the Maritime Continent from the Indian Ocean. Overall the MJO is considered weak.

- Dynamical model guidance predicts a continued weak MJO signal during the next week, then some models have a signal emerging over the central Pacific while other models maintain a weak signal for 2 weeks. An equatorial Rossby wave is moving across the Maritime Continent and interacting with the remaining MJO signal.

- The equatorial Rossby wave, a weak MJO signal, and mid-latitude interactions are likely to play large roles in the distribution of tropical convection. Tropical cyclone formations are likely to be relatively slowed, compared to the last month.

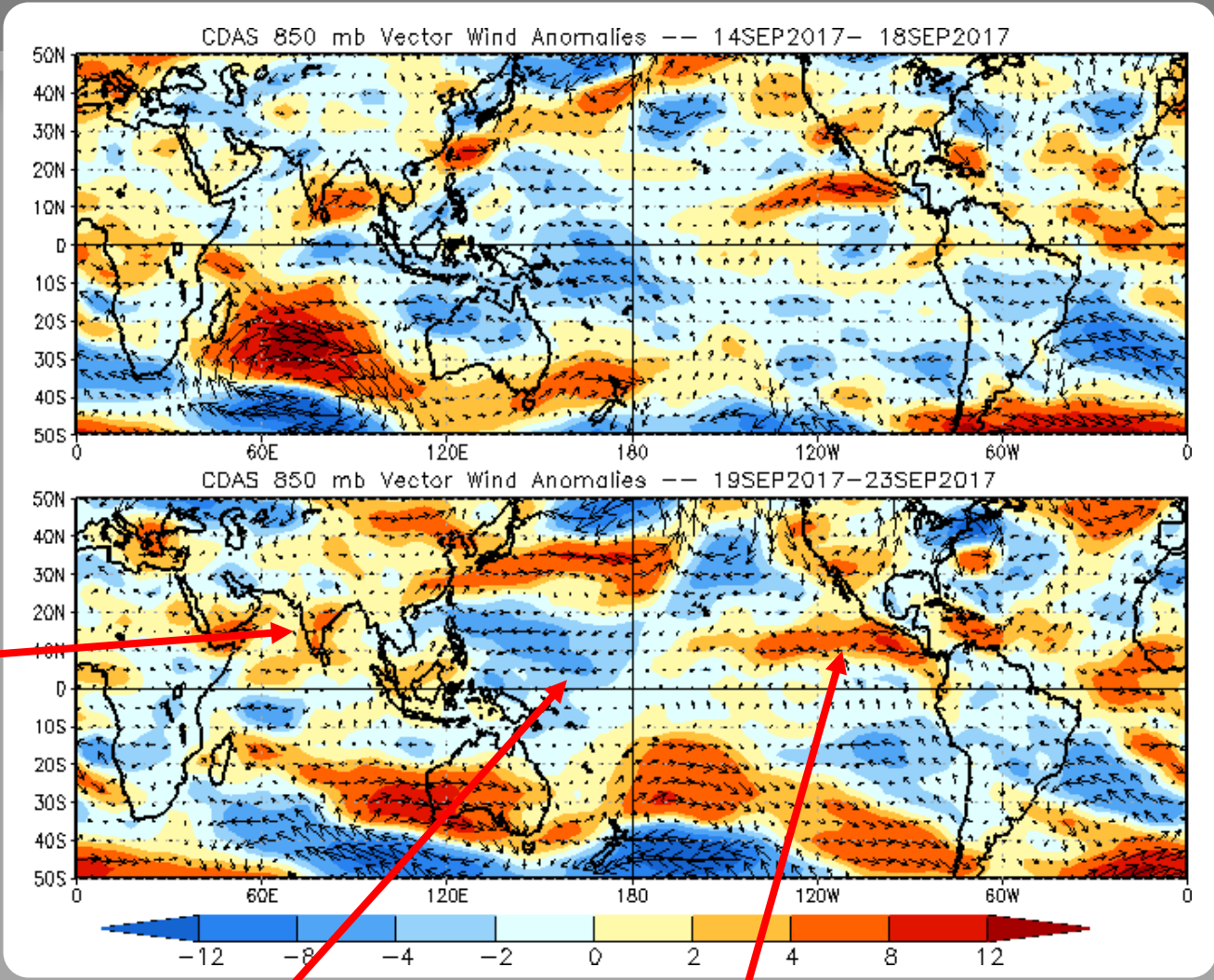
Additional potential impacts across the global tropics and a discussion for the U.S. are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly anomalies moved northward into India, while also replacing easterly anomalies over the Maritime Continent.

Enhanced trade winds persisted near and west of the Date Line.

Westerly anomalies persisted over the eastern Pacific and southwest Atlantic.

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

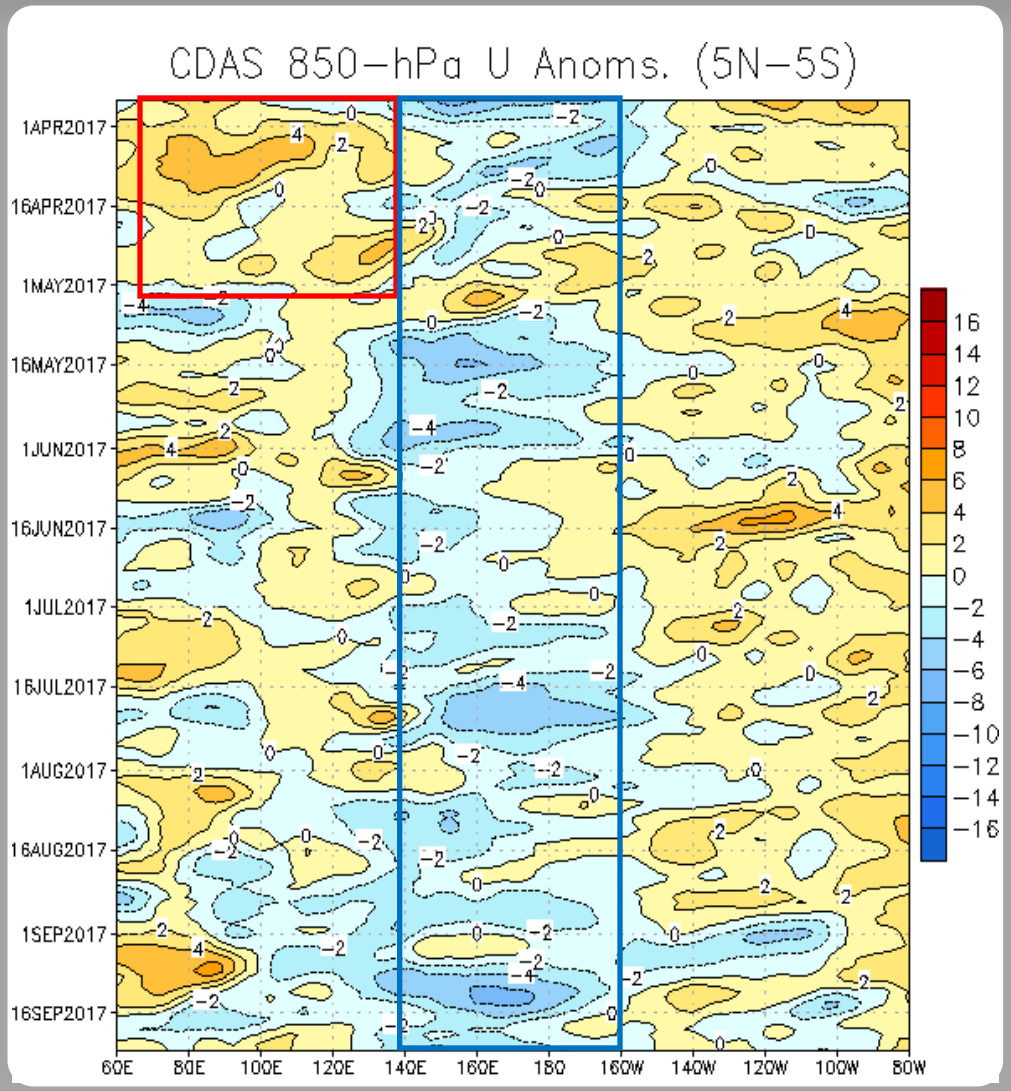
Westerly anomalies (orange/red shading) represent anomalous west-to-east flow

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

In March and April, 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 a weakening La Niña. Low-frequency easterly anomalies have largely persisted over the west-central Pacific throughout the summer.

Equatorial zonal wind anomalies were notably of low amplitude in June. During July, a slight eastward shift in the low-frequency pattern is noted, related to short-lived MJO activity.

During September, easterly anomalies persisted along and to the west of the Date Line. Some intraseasonal variability is evident, but no MJO related variability is evident.



OLR Anomalies – Past 30 days

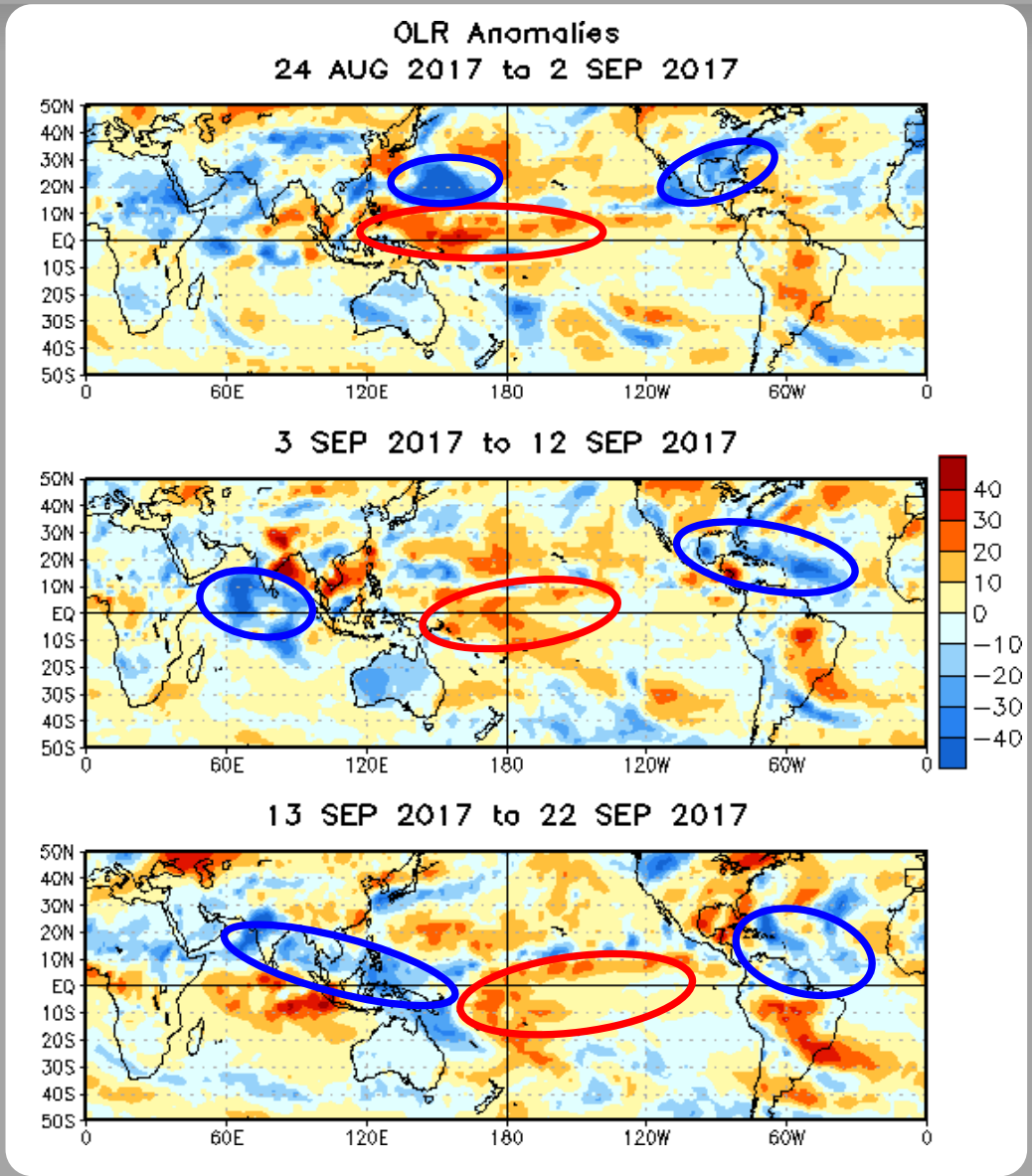
Drier-than-normal conditions, positive OLR anomalies (yellow/red shading)

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

Enhanced convection across North America , the Caribbean, and tropical areas of the East Pacific was related to multiple tropical cyclones since late August.

The persistent area of suppressed convection near the Date Line across the equatorial Pacific is associated with the low frequency state.

Anomalous convection is more variable across the Indian Ocean, Maritime Continent, and West Pacific during the past month. The variability is not consistent with robust MJO activity



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

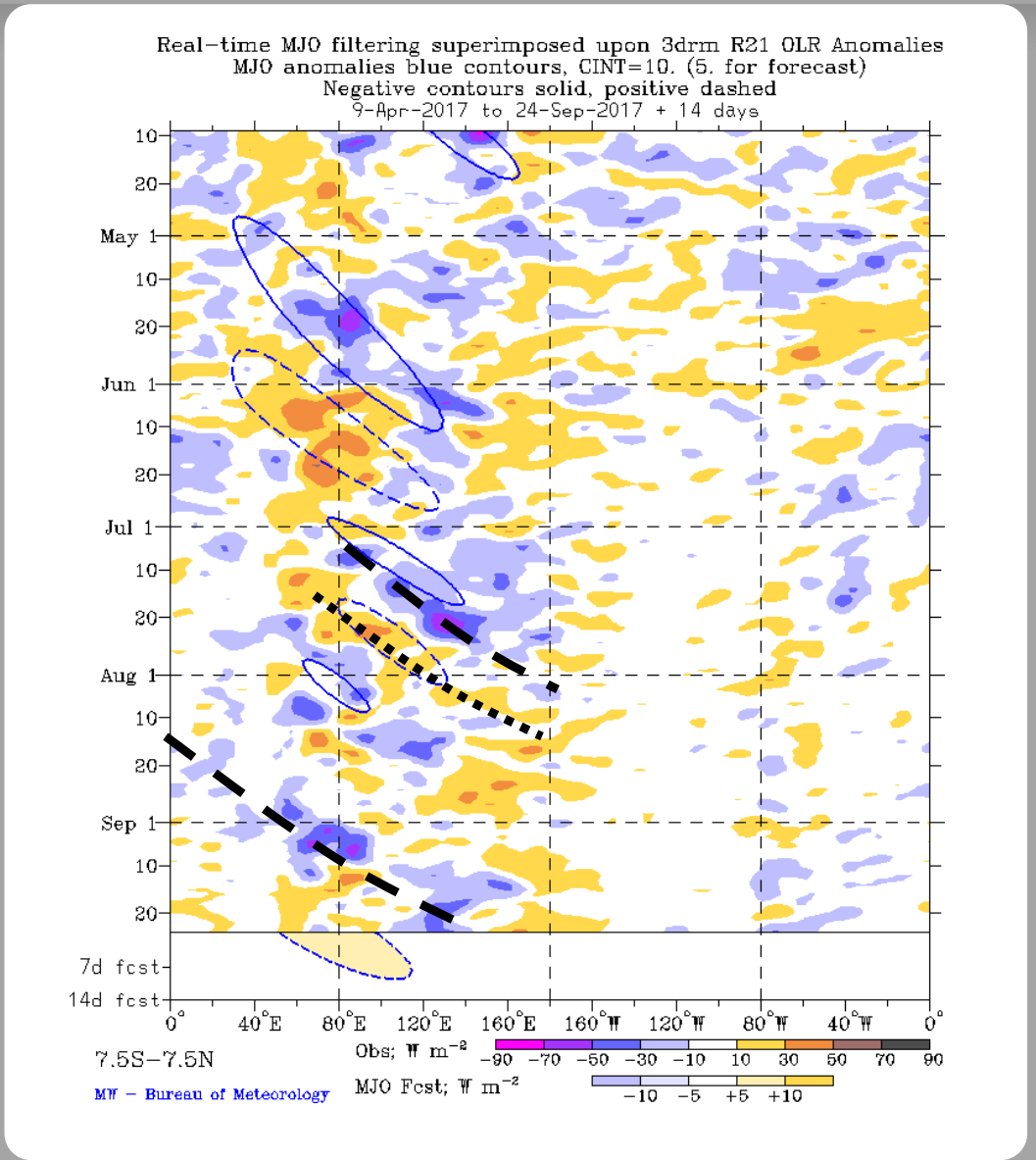
Drier-than-normal conditions, positive OLR anomalies (yellow/red shading)

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

Starting in mid-April, 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 short-lived intraseasonal signal and the low-frequency state.

Multiple modes of variability including tropical cyclones contributed to the pattern of anomalous convection during the past month. Suppressed convection continues near and just west of the Date Line, though multiple modes are contributing to enhanced convection over the Maritime Continent.



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

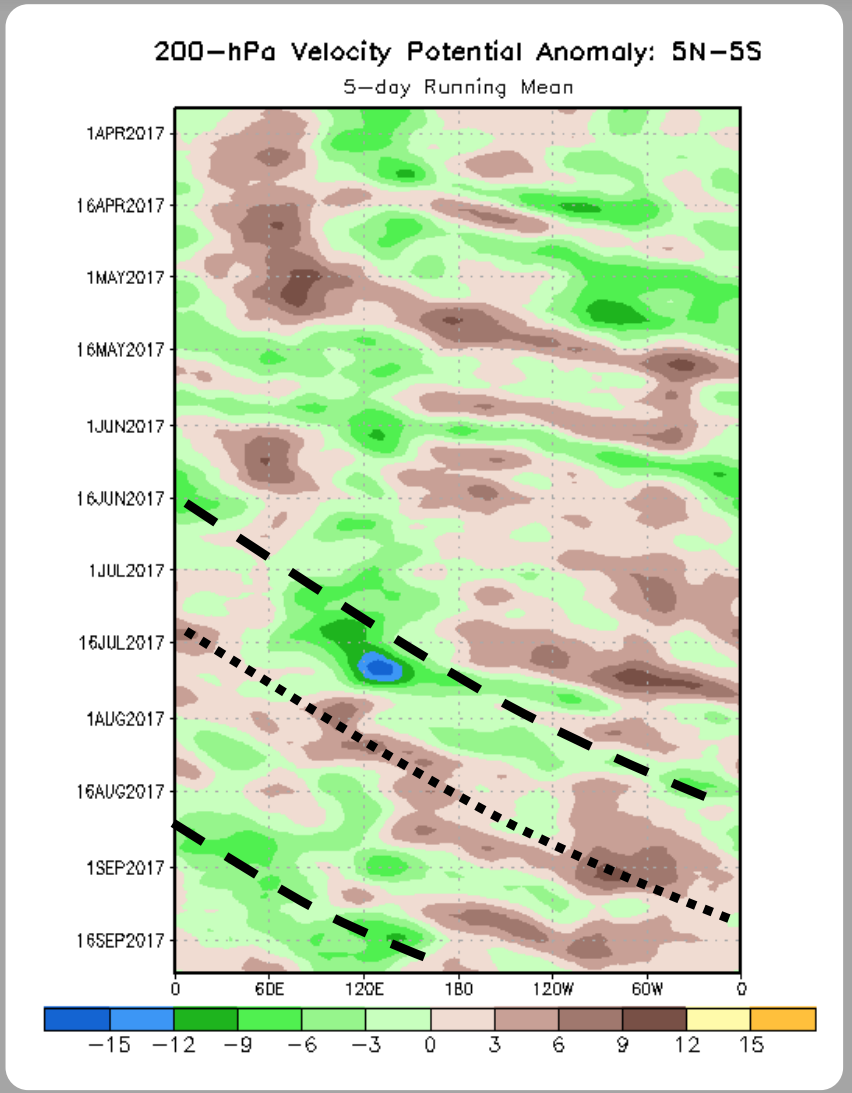
Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

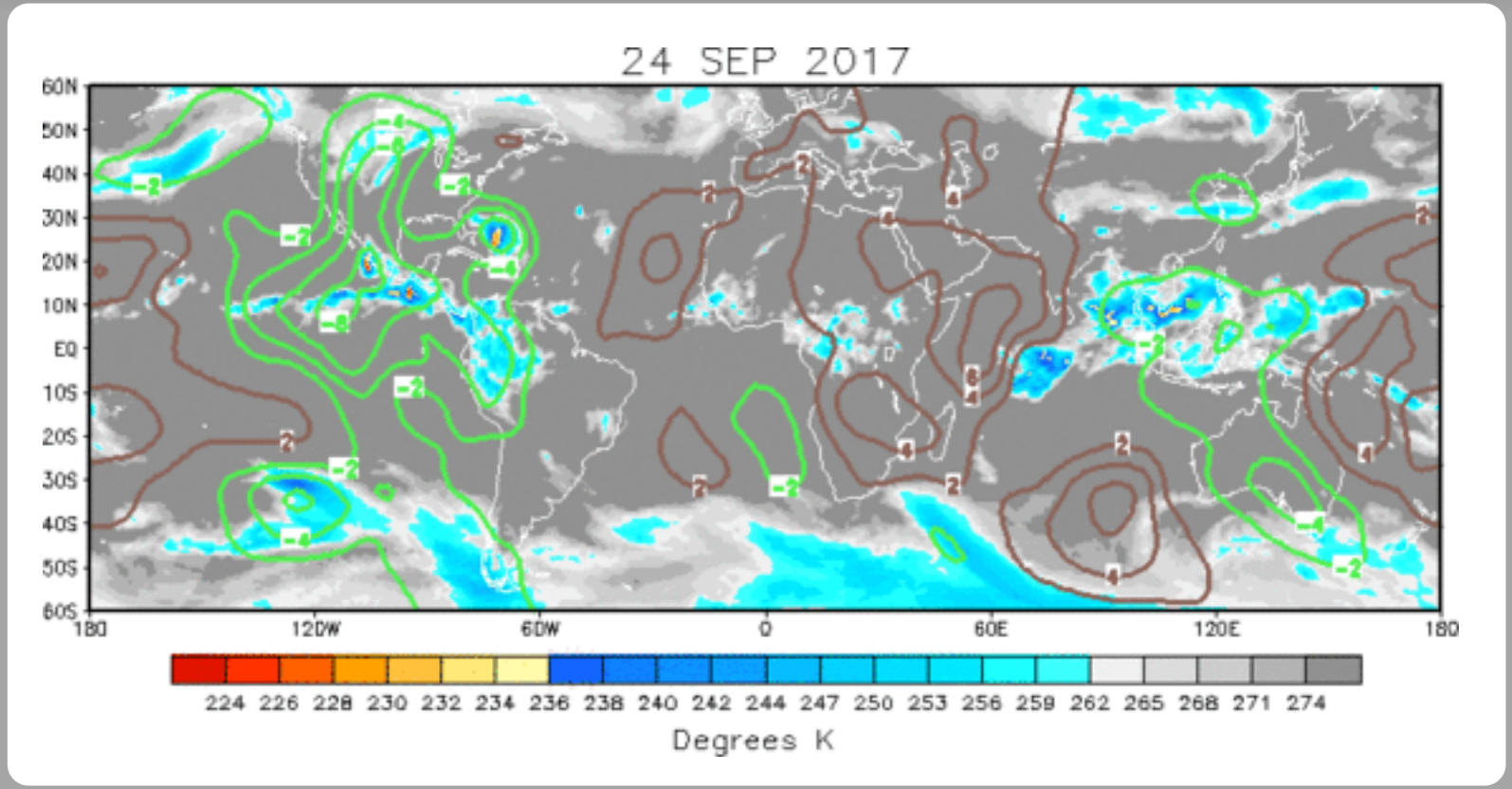
Kelvin wave activity was apparent from April through early June, as seen in the rapidly propagating eastward signals.

During July, enhanced convection strengthened over the Maritime Continent as the low-frequency signal constructively interfered with an easterly propagating signal. This eastward propagating signal appears more or less intact with a period in line with canonical MJO phase speeds.

An signal on the MJO timescale is evident in this field, currently centered over the Maritime Continent. The signal is not evident in wind fields (850 and 200-hPa) but is evident in OLR.



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



The pattern of anomalous Velocity Potential anomalies became more Wave-2 recently, with enhanced upper-level divergence over the Indian Ocean and Maritime Continent, as well as the Americas, with enhanced subsidence over Africa and Central Pacific.

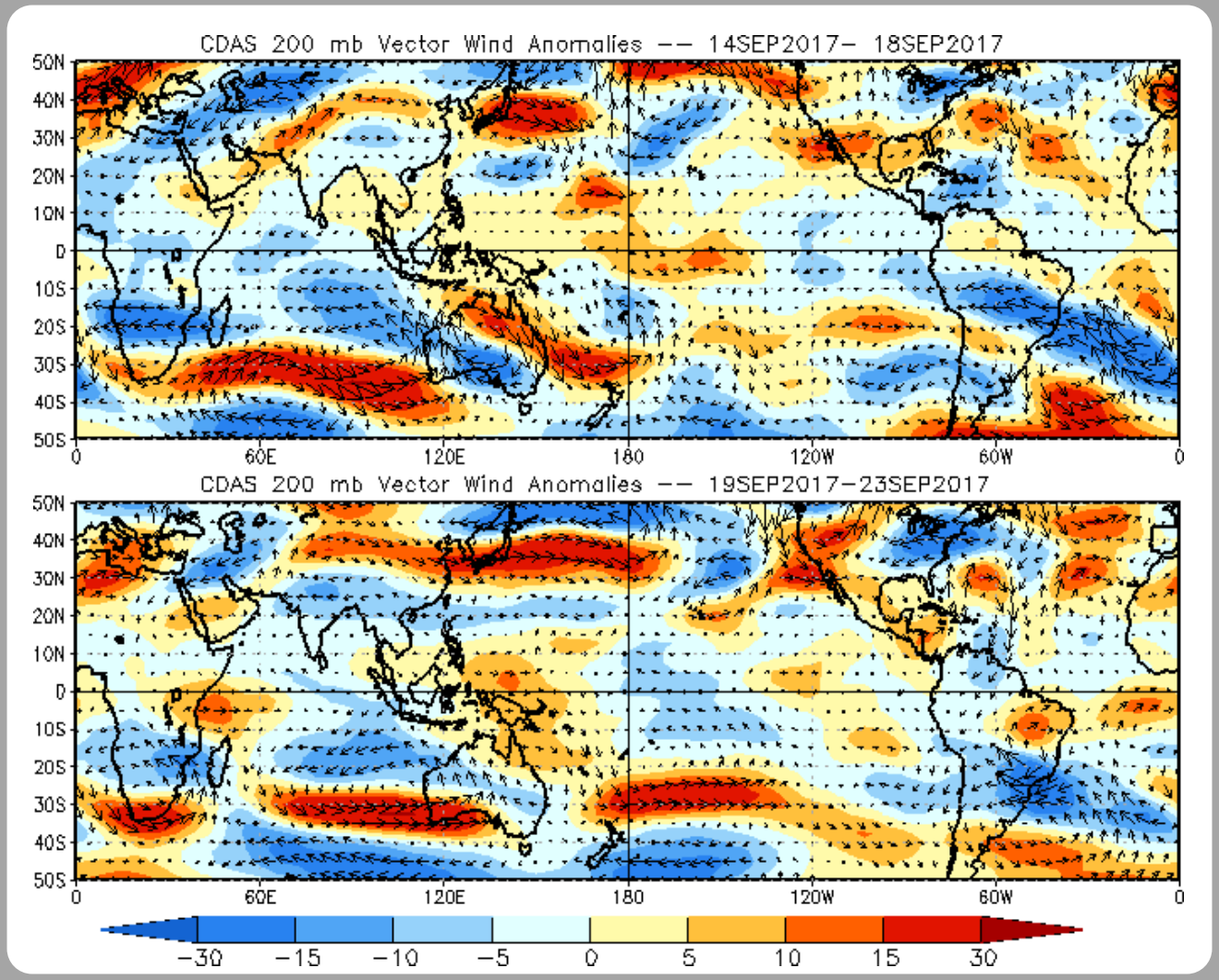
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation
Negative anomalies (green contours) indicate favorable conditions for precipitation

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly (easterly) anomalies are evident over the Maritime Continent (central Pacific).

Some mid-latitude influence is evident over the eastern Pacific.

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

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

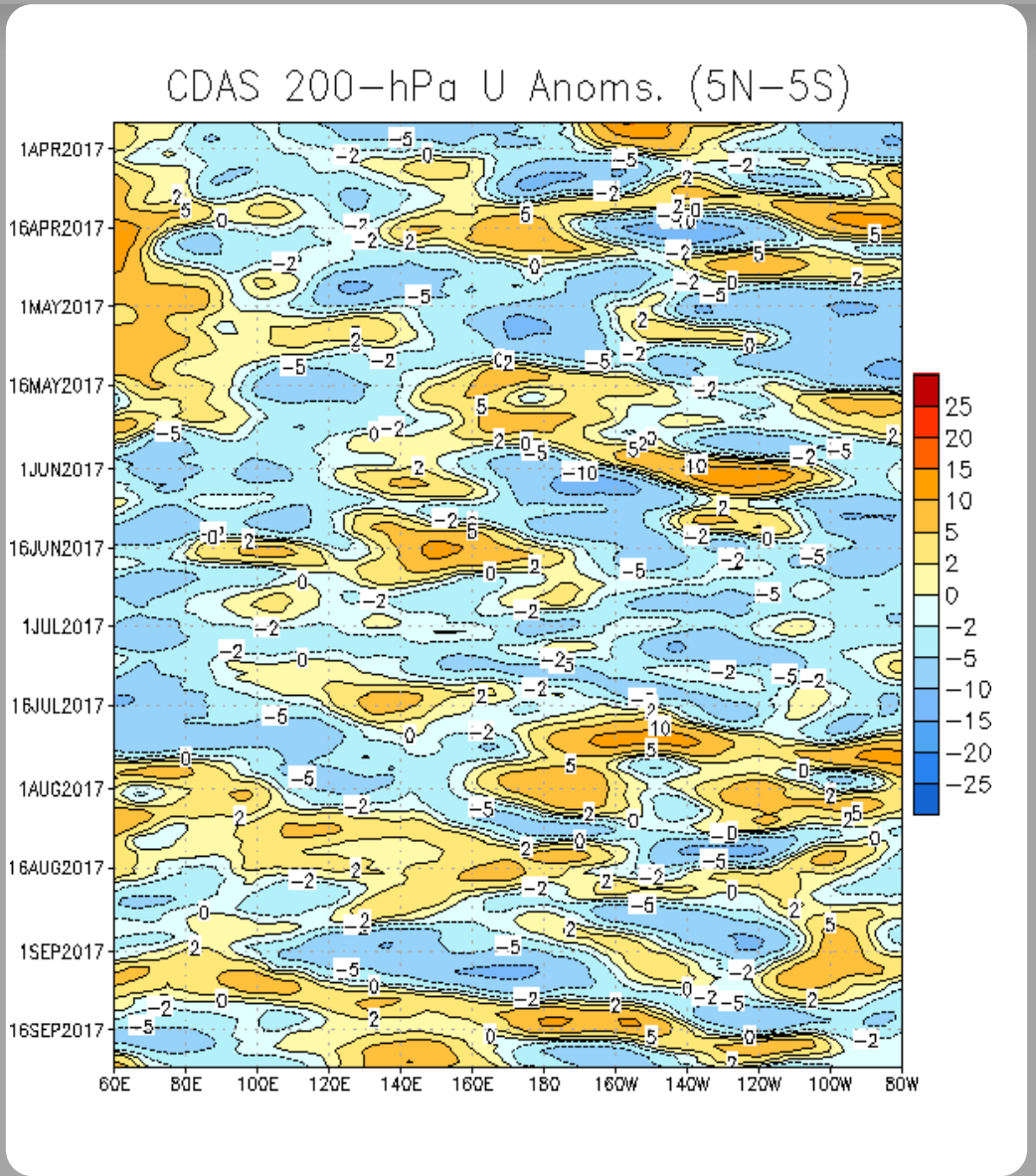
Easterly anomalies (blue shading) represent anomalous east-to-west flow

Easterly anomalies returned to the East Pacific during late April and persisted with some periods 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 associated with weak MJO activity and atmospheric Kelvin waves.

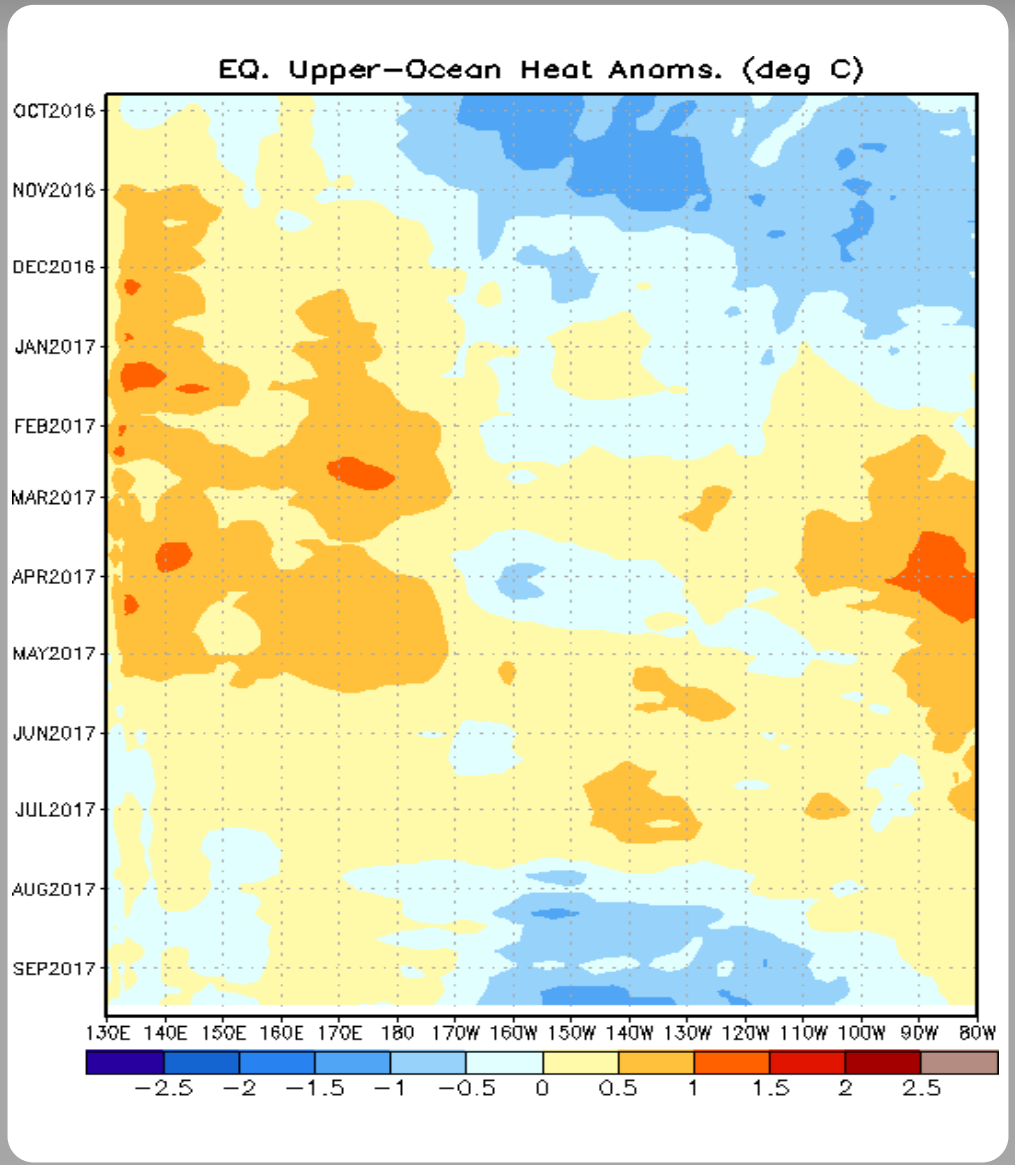
During September, fast-moving eastward propagation of anomalies continued, consistent with additional atmospheric Kelvin Waves. A slower signal is evident over the eastern Maritime Continent.



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 decrease in the central Pacific as trade winds were near to above average from late July and early August, while temperature anomalies 50-200 meters below the surface continued to cool.



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

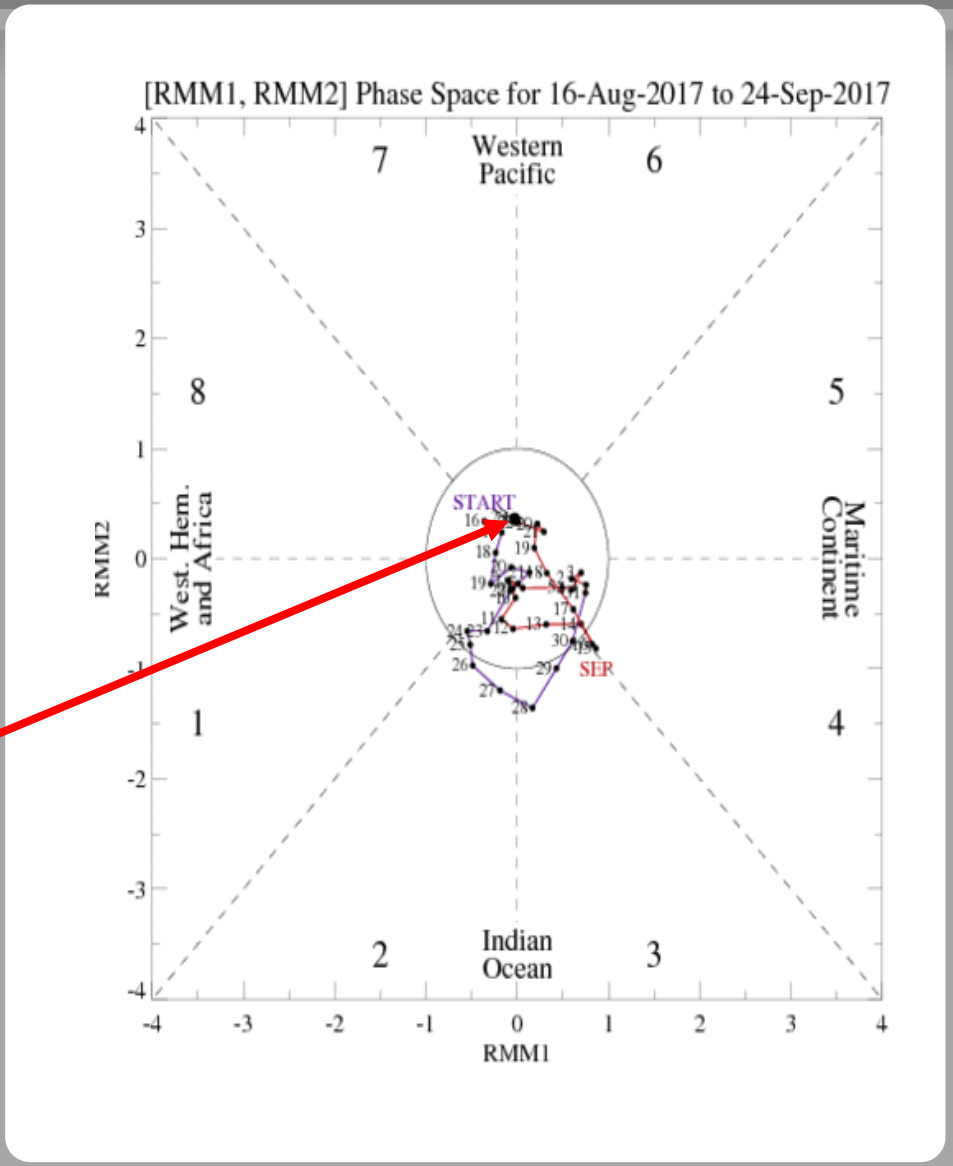
The triangular areas indicate the location of the enhanced phase of the MJO

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

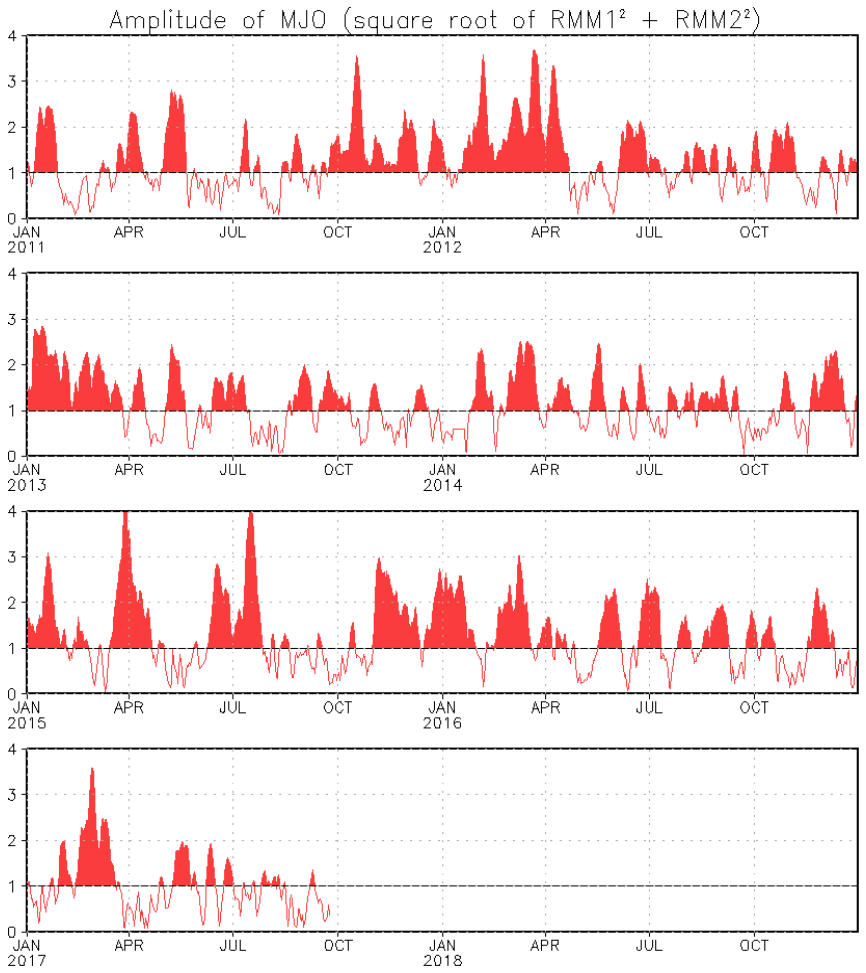
The MJO signal as monitored by the RMM index has been weak since the beginning of September.



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

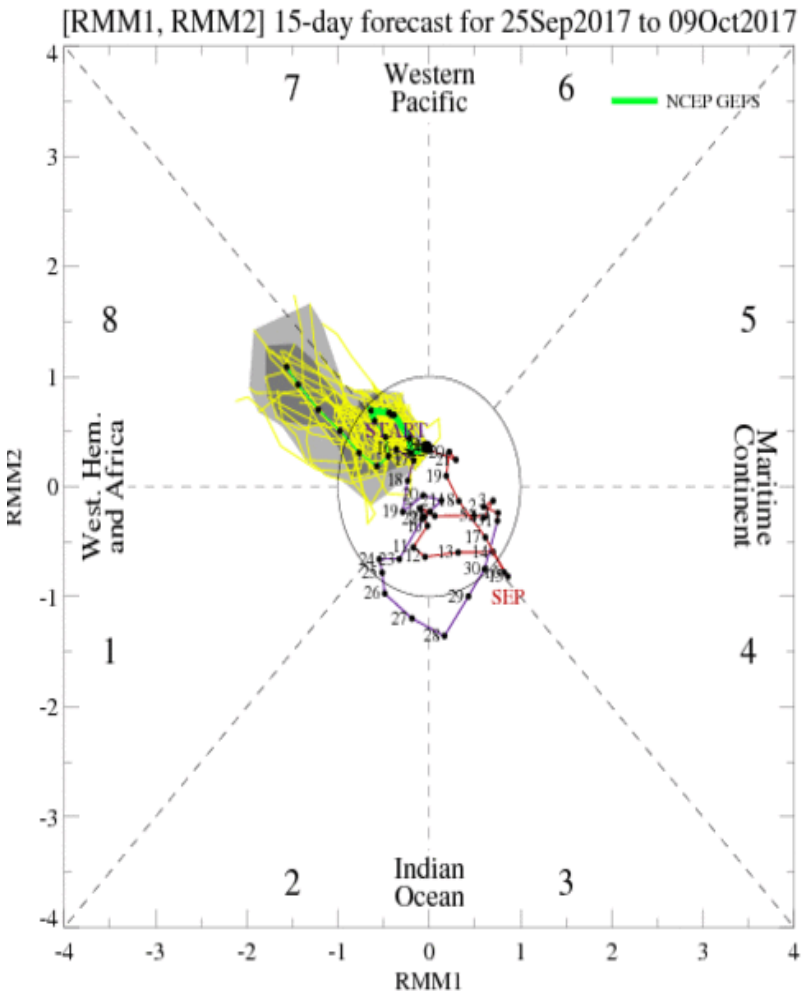
Yellow Lines - 20 Individual Members
Green Line - Ensemble Mean

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

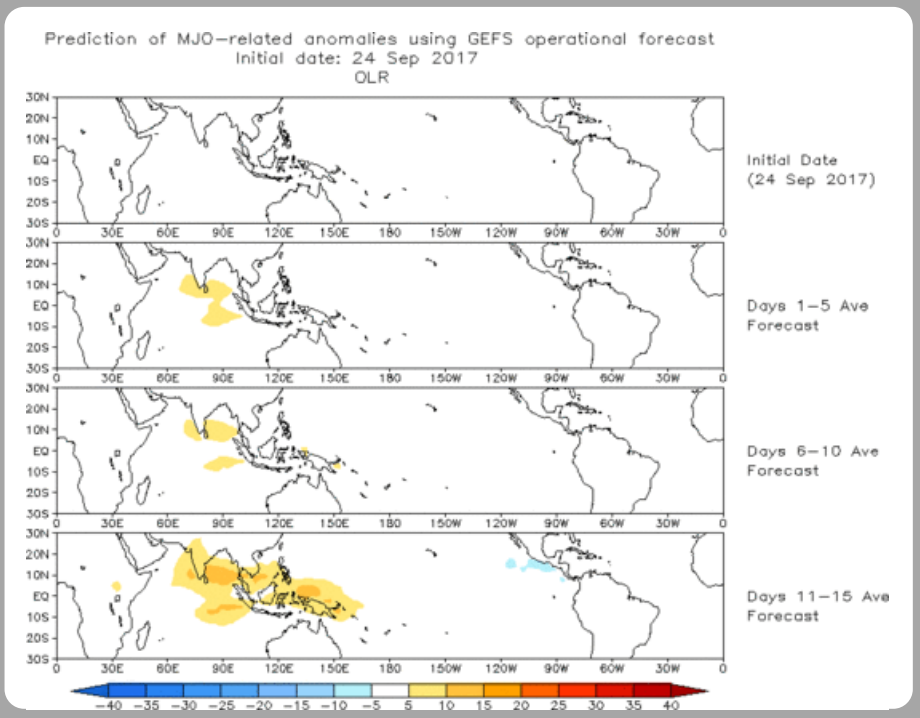
The GEFS depicts a signal emerging over the Central Pacific during Week-2.



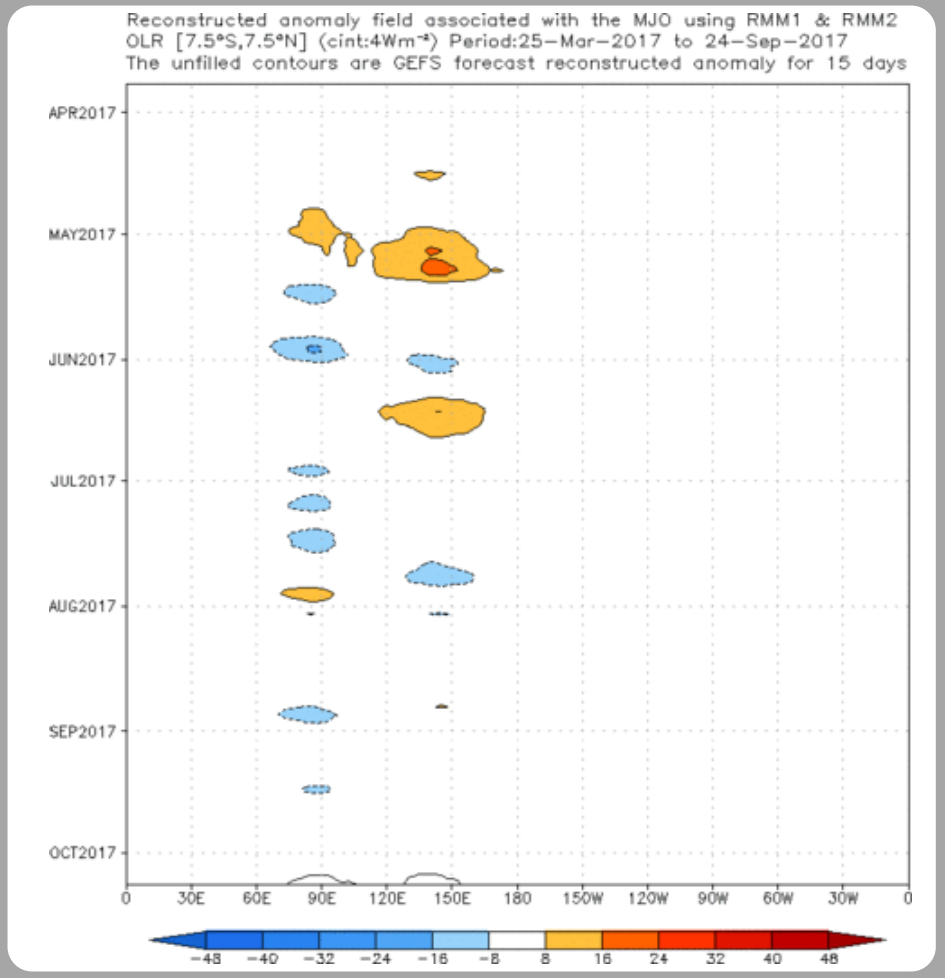
Ensemble GFS (GEFS) MJO Forecast

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

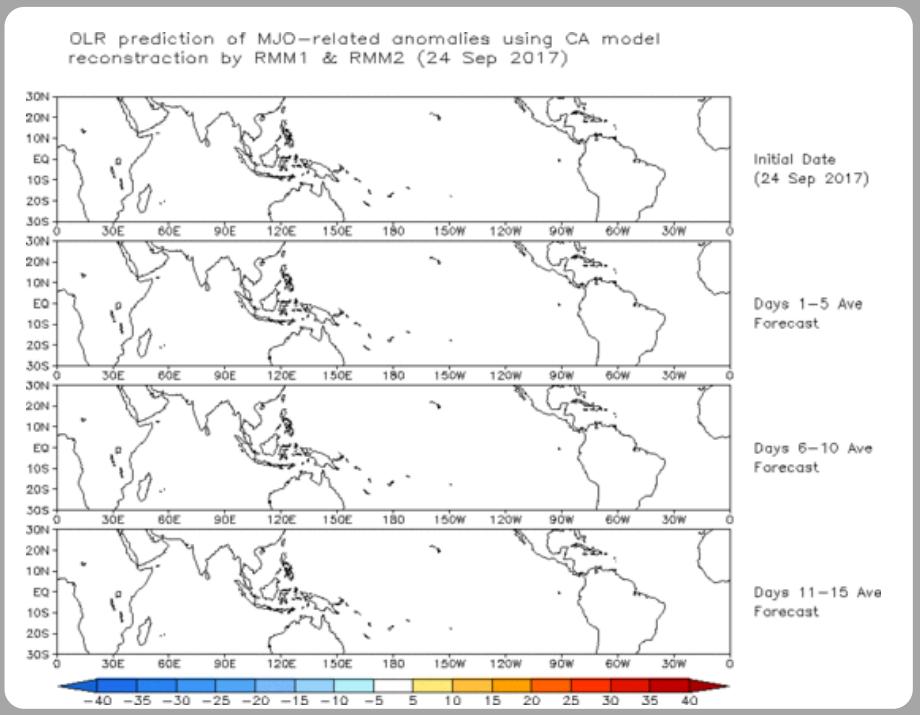


The GEFS RMM-based OLR anomaly forecast indicates little to no signal in Week-1, with an emerging signal in Week-2 over the central and eastern Pacific.

Constructed Analog (CA) MJO Forecast

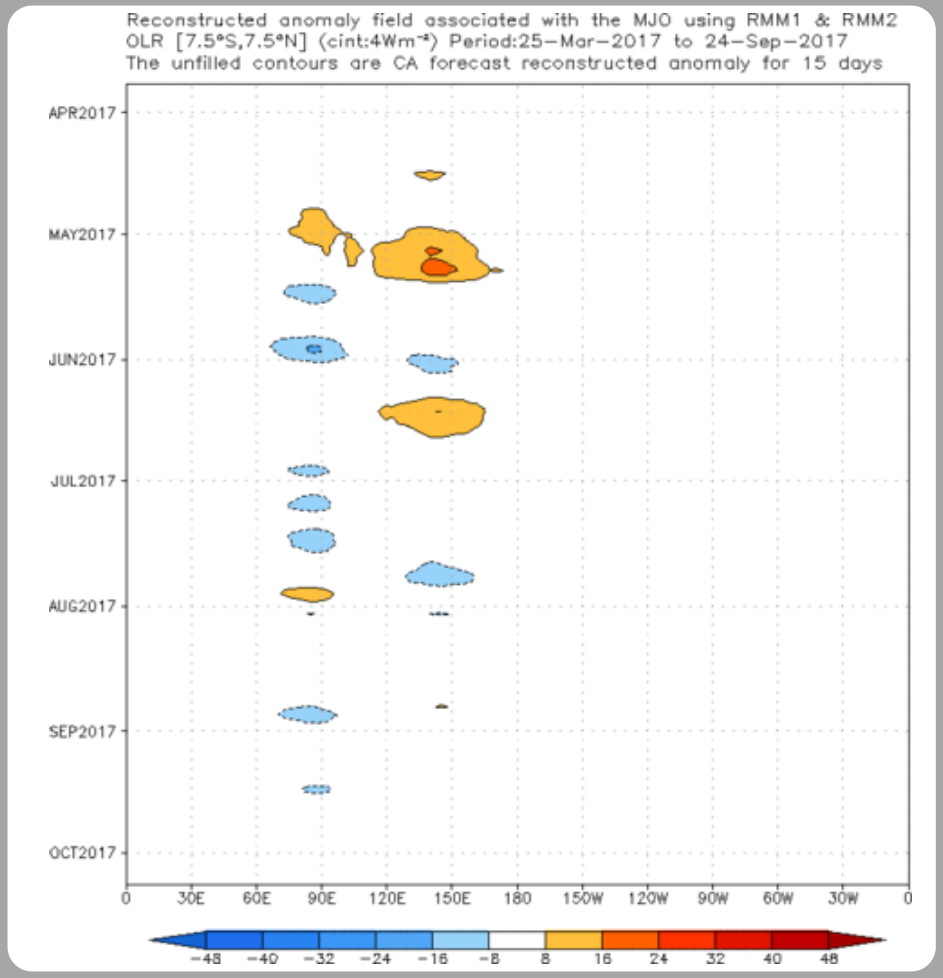
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Spatial map of OLR anomalies for the next 15 days



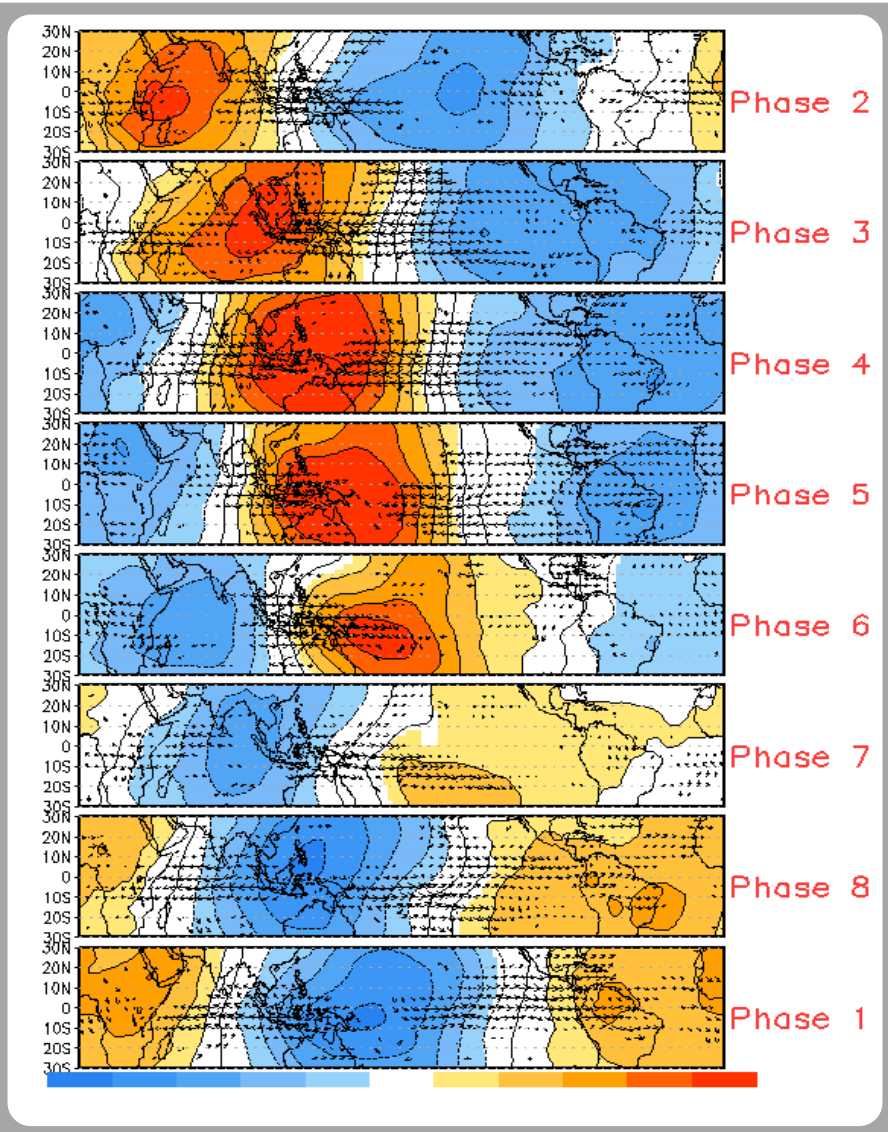
The constructed analog depicts little to no signal throughout the period.

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

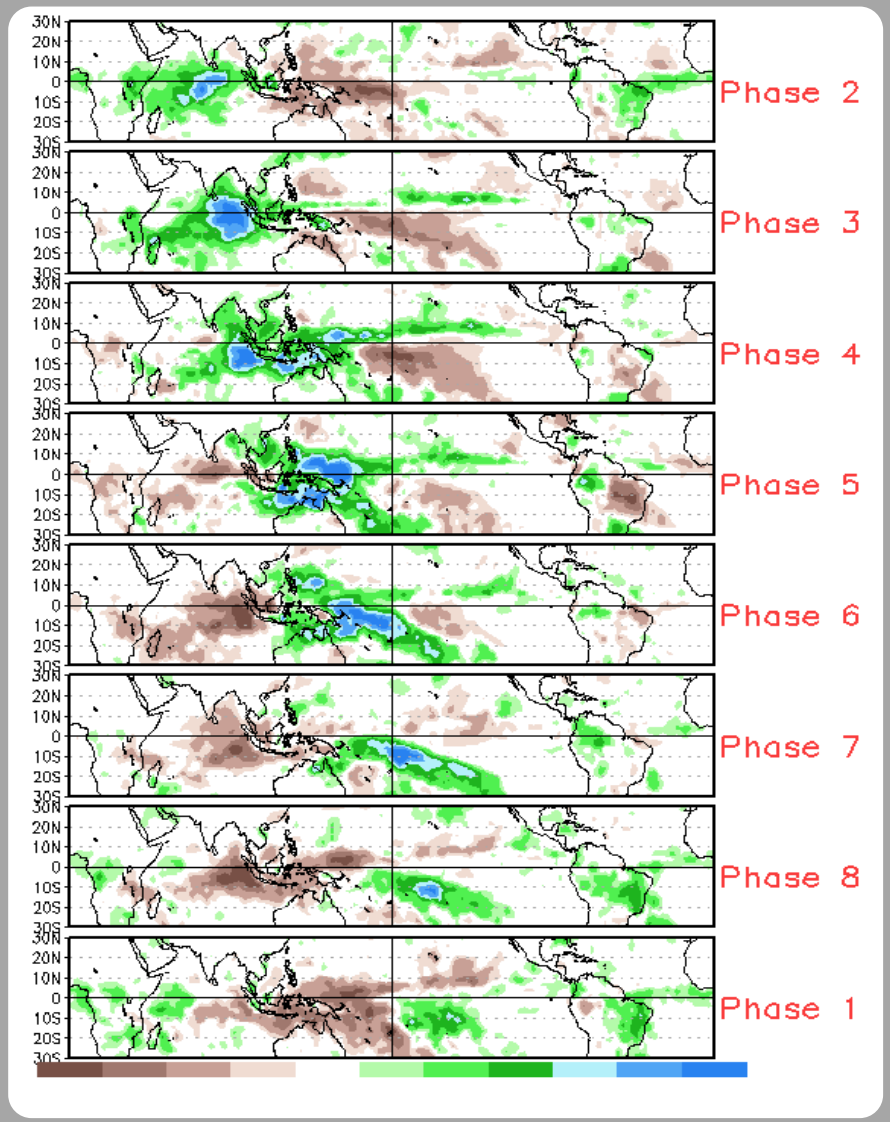


MJO Composites - Global Tropics

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



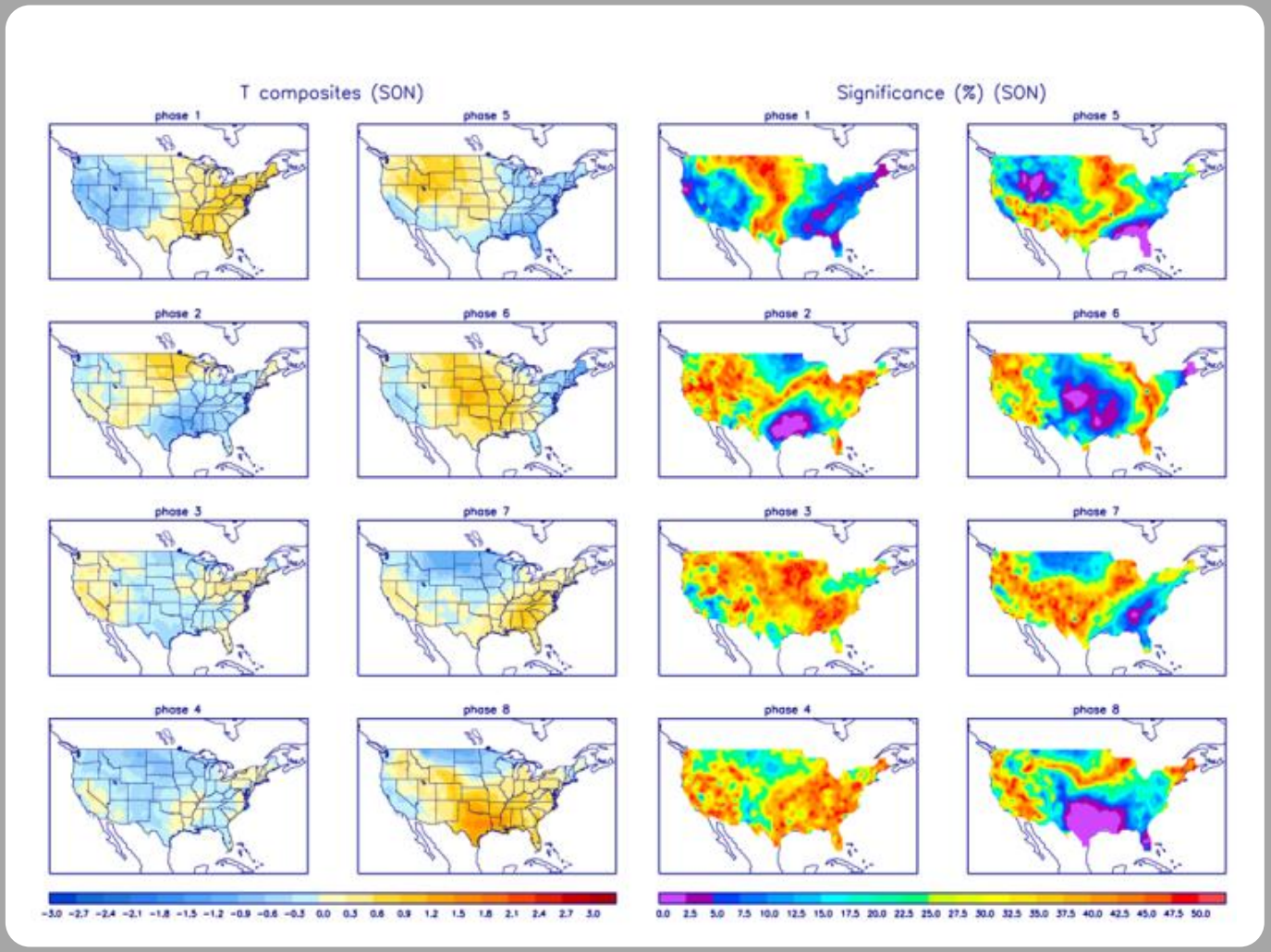
Precipitation Anomalies (Nov - Mar)



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.

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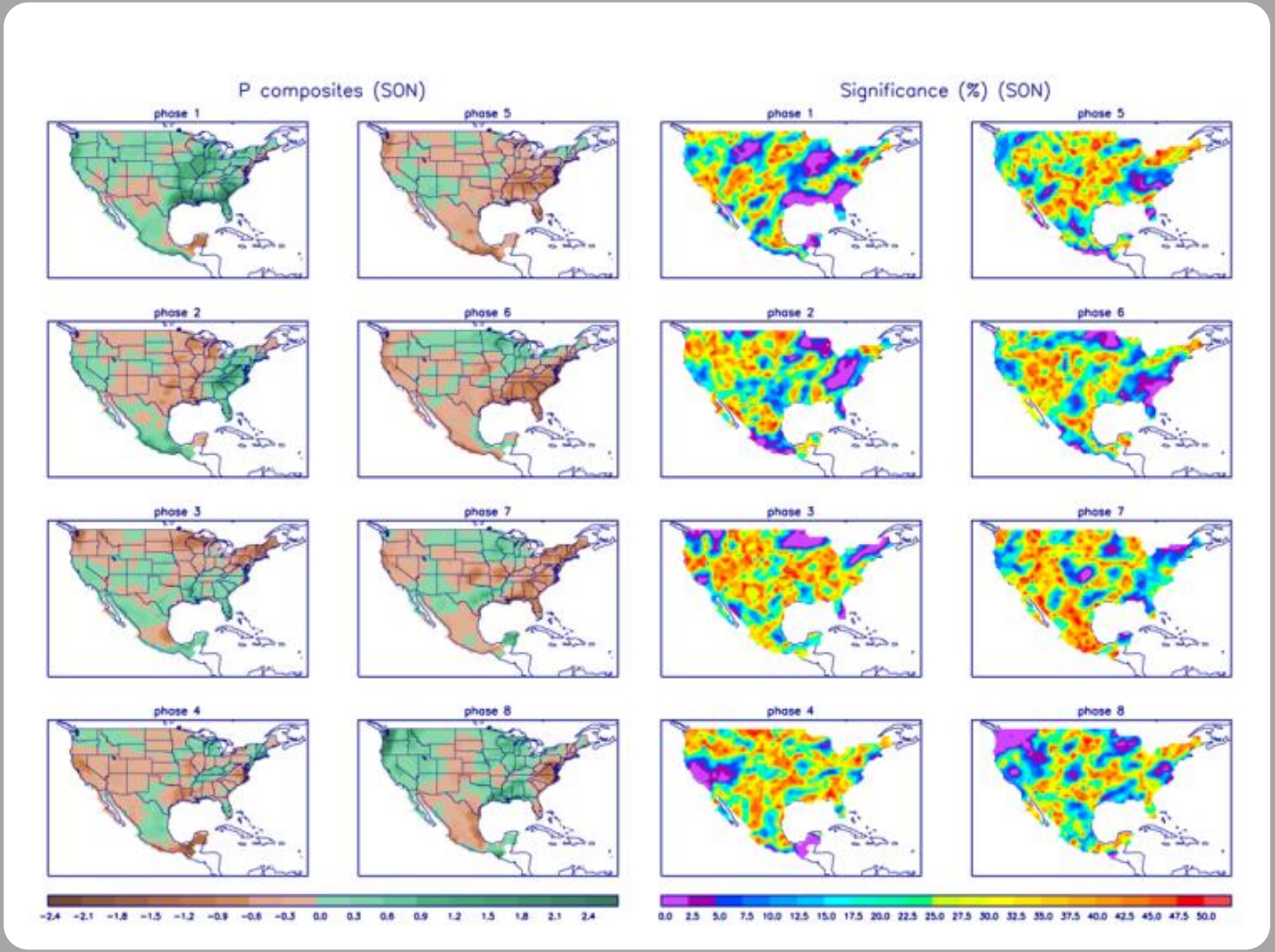

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