

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
29 July 2019

Overview

- The MJO remains weak, with a strong Kelvin wave crossing the Western Hemisphere projecting as the strongest mode in both low-level and upper-level observational analyses.
- An area of weak enhancement is evident over the Maritime Continent. Dynamical model MJO index forecasts depict a strengthening signal in the Indian Ocean or Maritime Continent, possibly due to constructive interference with the Kelvin wave as it crosses these regions.
- Dynamical models depict little eastward propagation of the intraseasonal signal over the next two weeks. Tropical cyclone activity may play a role in the evolution of this pattern.
- Tropical cyclone activity is expected to continue impacting the East and Central Pacific regions. Additional tropical cyclogenesis is possible over the South China Sea, West Pacific, and the Atlantic basins.

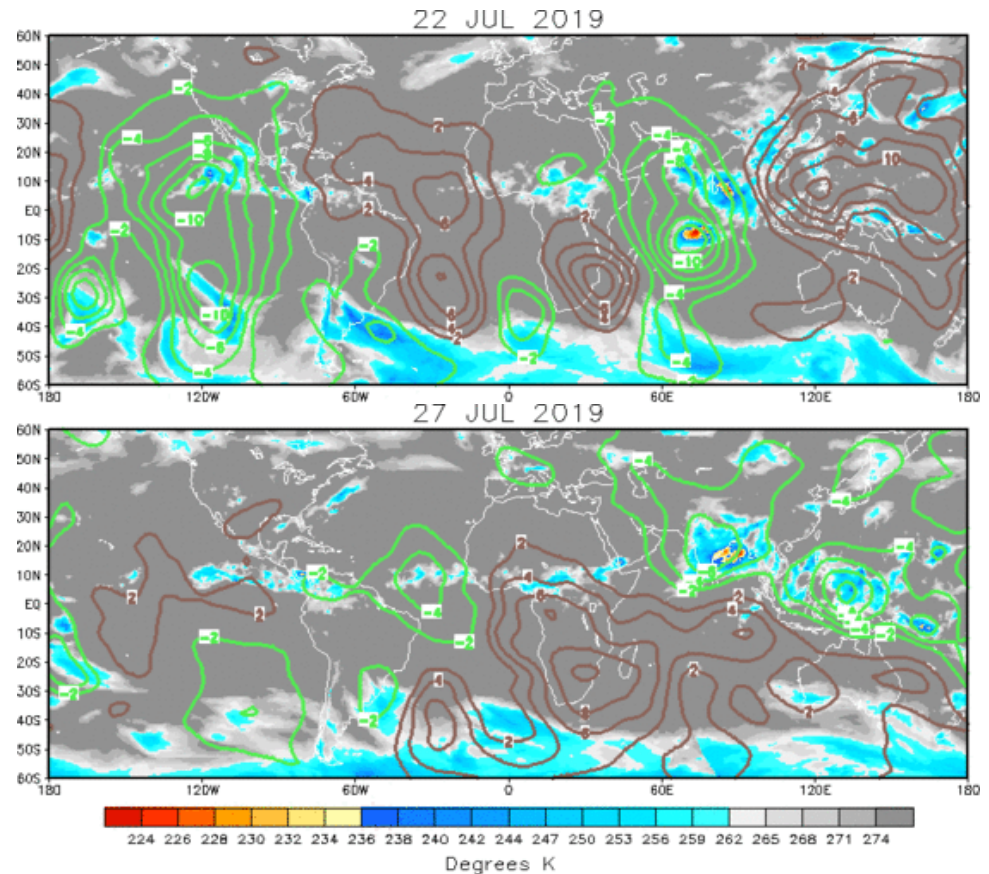
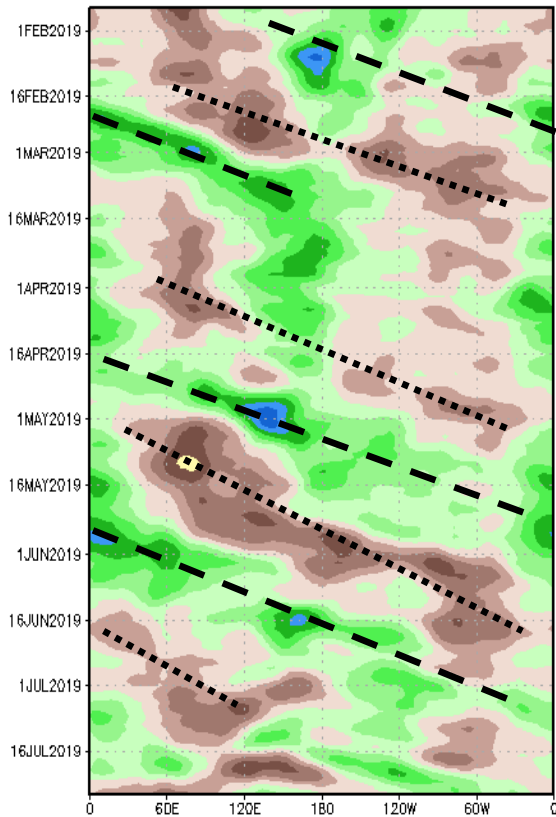
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

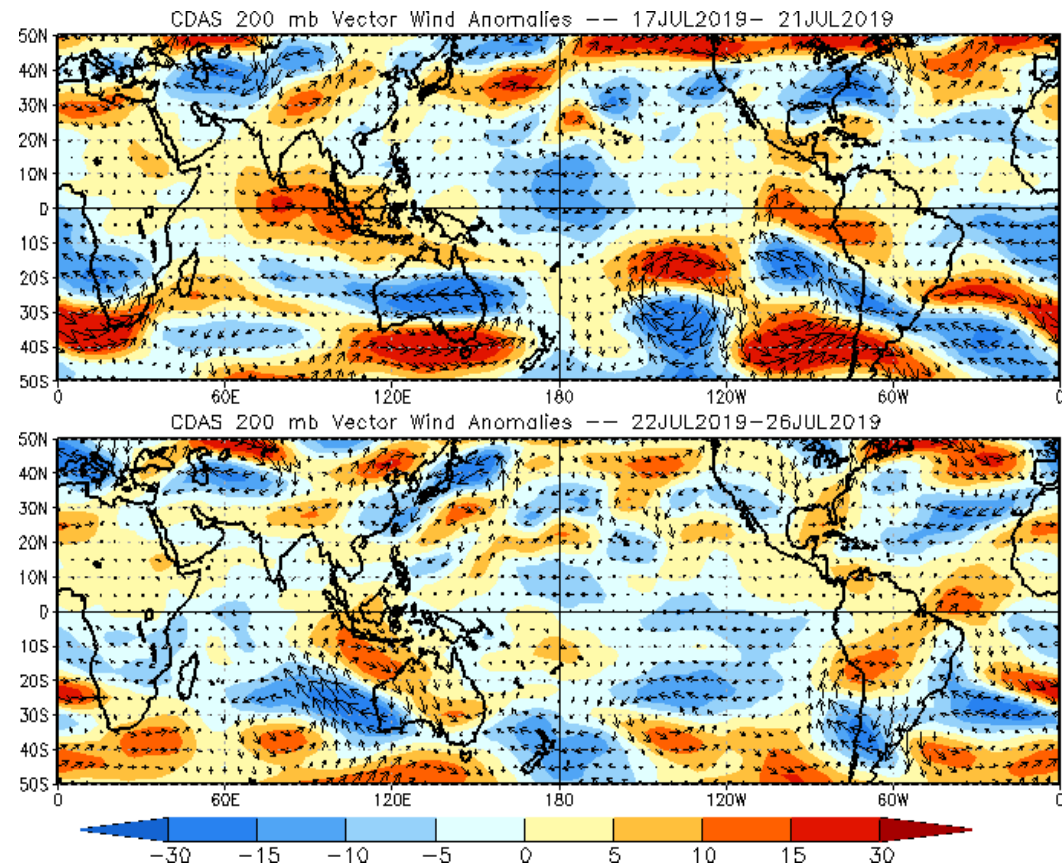
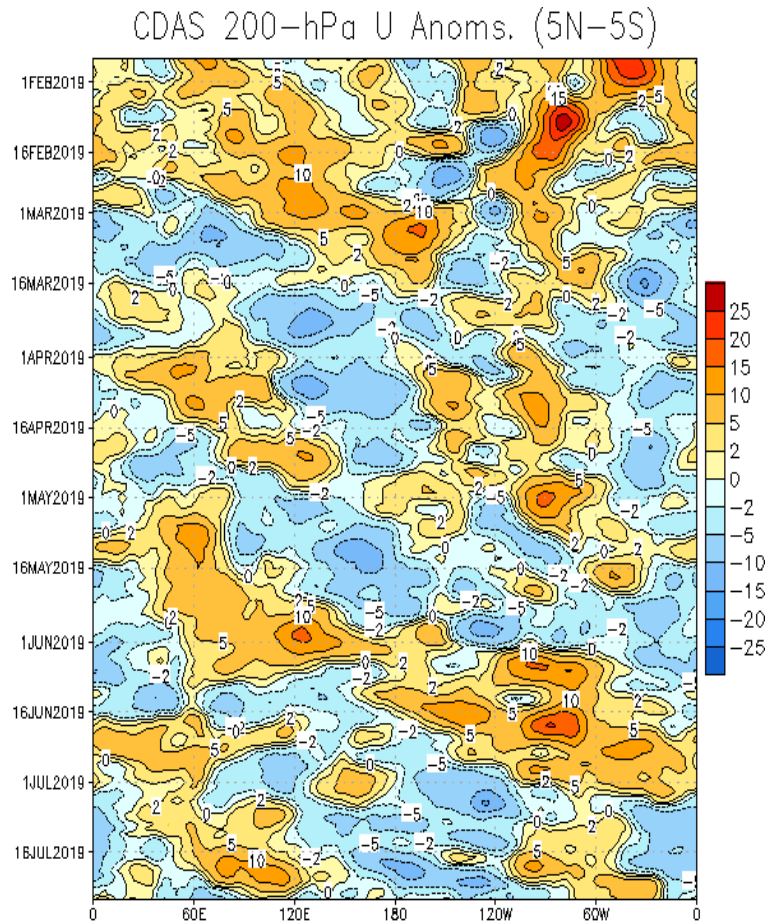
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- Following two months of robust MJO activity, the intraseasonal signal became less well defined in July due to strong Rossby wave interference.
- The overall upper level velocity potential spatial anomaly field deteriorated during the past week, with a weak Wave-2 pattern persisting.
- A strong Kelvin wave was recently over the tropical Atlantic. A second center of action over the Maritime Continent may evolve into renewed MJO activity.

200-hPa Wind Anomalies

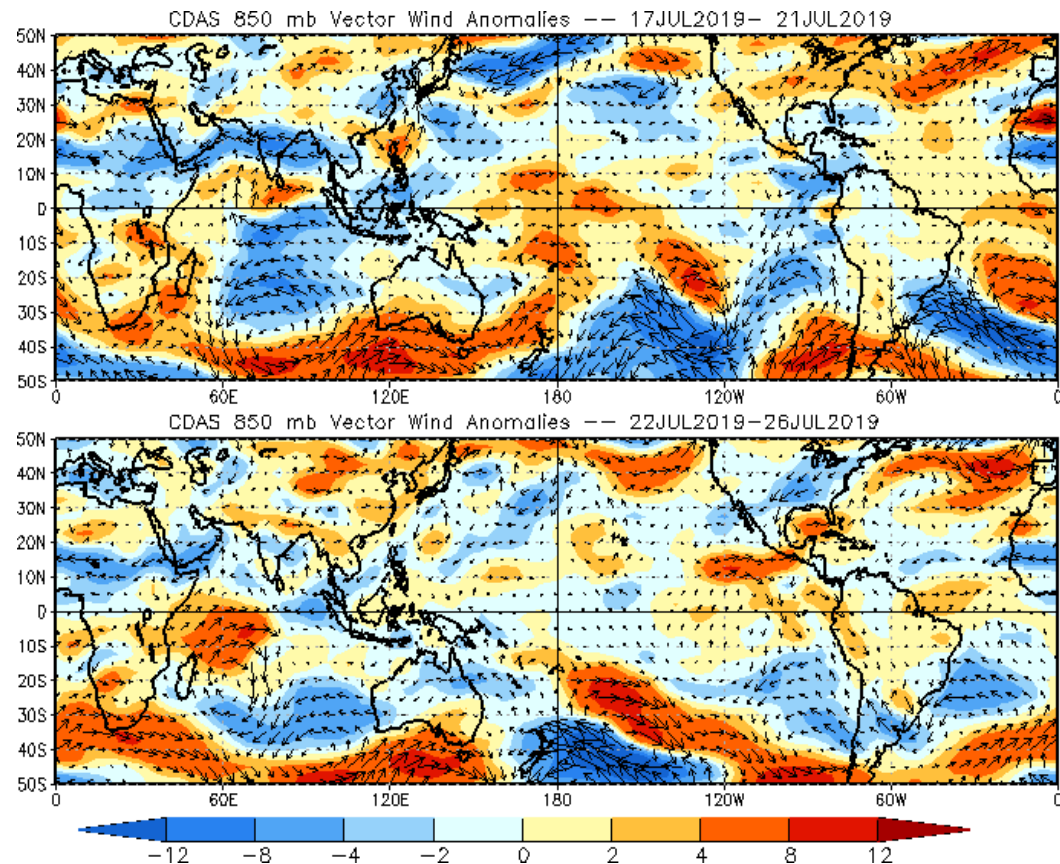
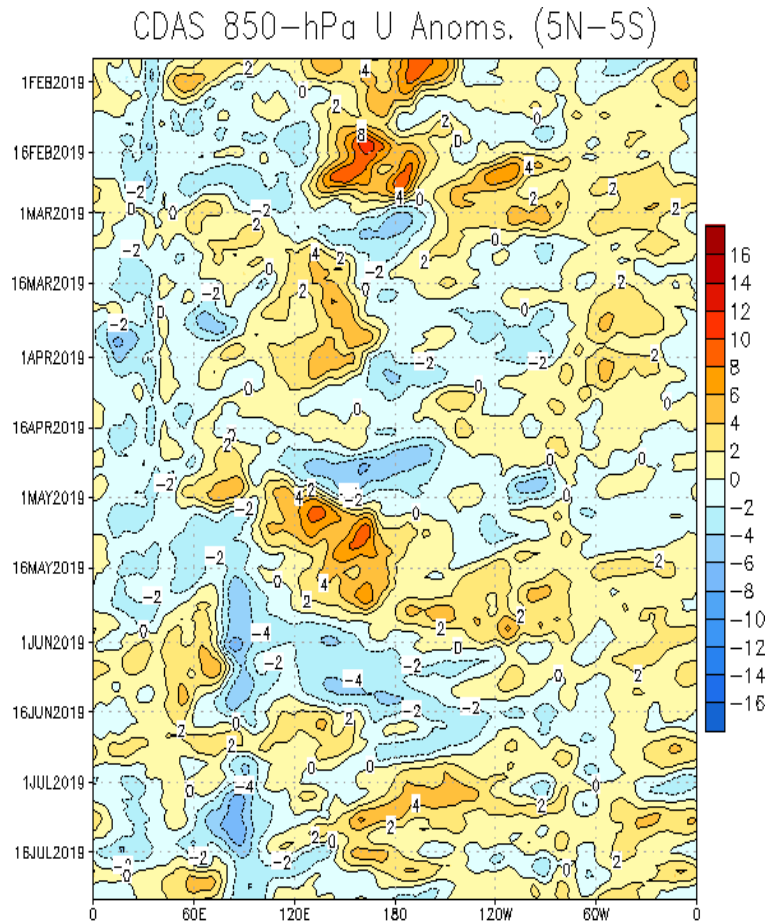
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Westerly anomalies over the Indian Ocean in mid-July shifted eastward to the Maritime Continent with reduced amplitude. Extratropical wave breaking increased upper-level convergence over the southern Indian Ocean.
- Kelvin wave activity over the Western Hemisphere is evident in the upper-level wind field.

850-hPa Wind Anomalies

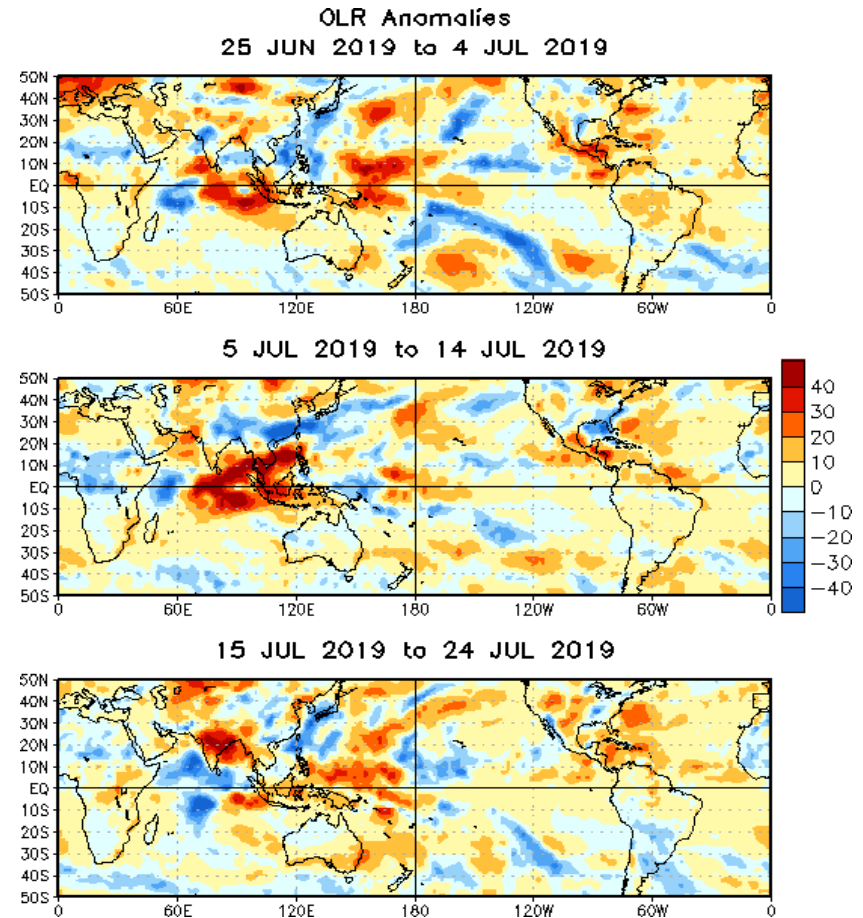
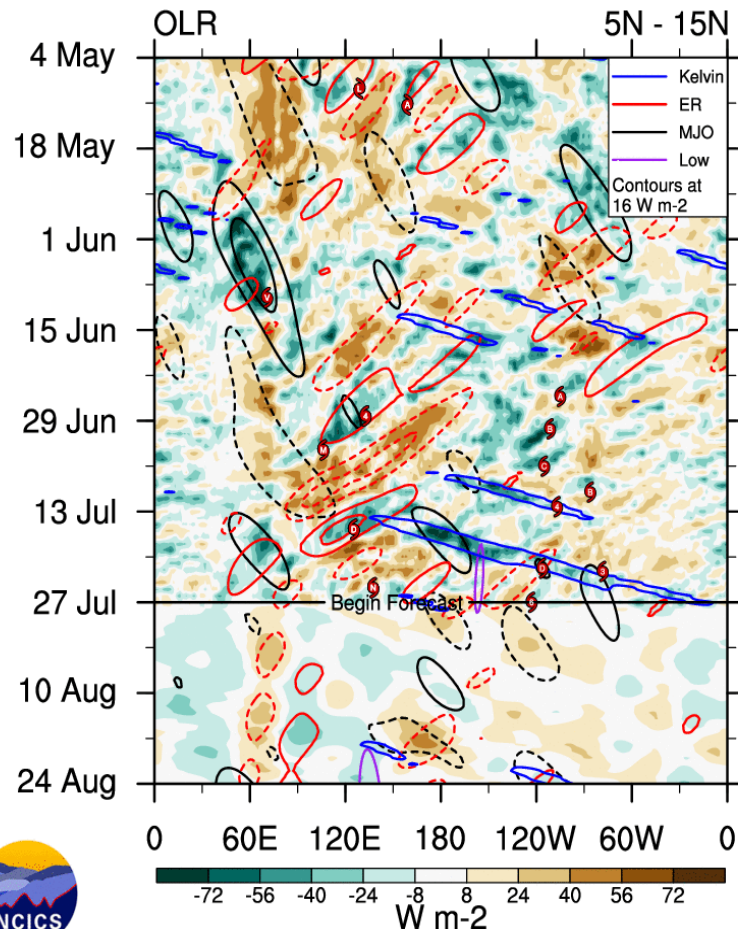
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- The overall low-level zonal wind field weakened during late July.
- Westerly anomalies shifted rapidly from the central Pacific to the Western Hemisphere from mid to late July in association with a strong Kelvin wave.
- A burst of westerly anomalies was observed over the western Indian Ocean from 22-26 July, but weakened later in the period.

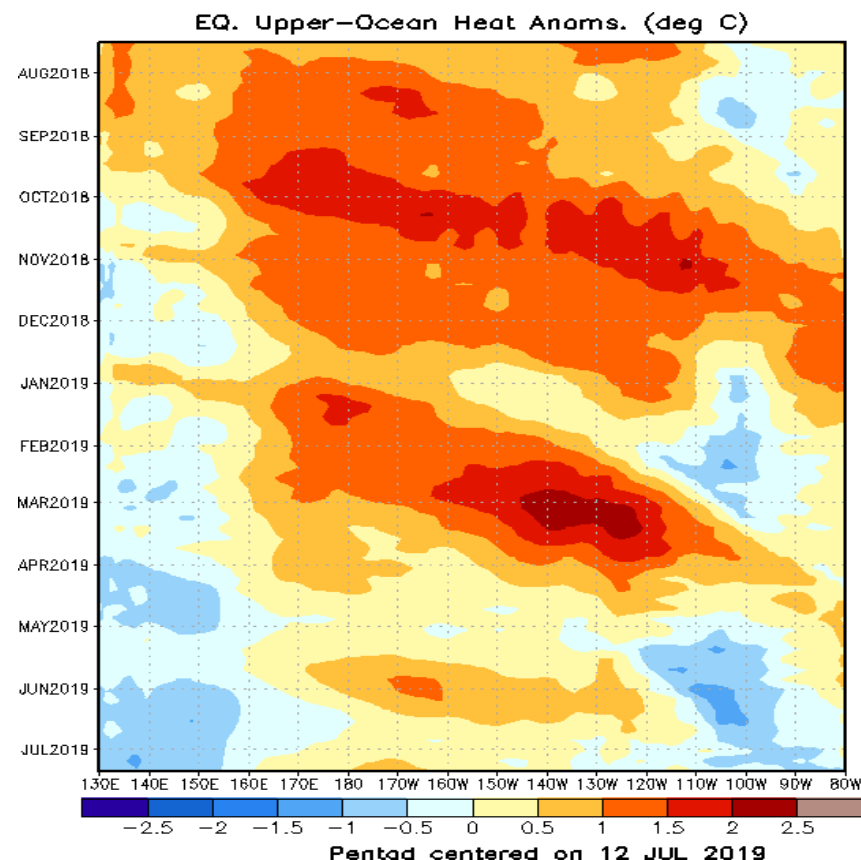
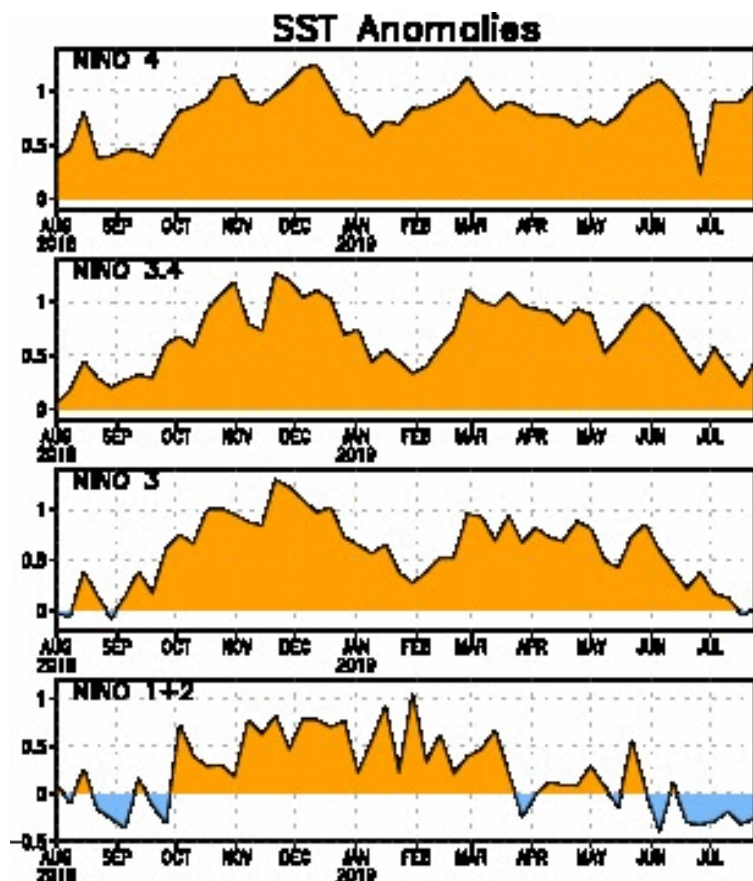
Outgoing Longwave Radiation (OLR) Anomalies

Blue shades: Anomalous convection (wetness). **Red shades:** Anomalous subsidence (dryness).



- A strong Kelvin wave crossing the Pacific and Western Hemisphere was the most coherent feature in the OLR field during the second half of July.
- Enhanced convection developed over the west-central Indian Ocean from 15-24 July, but weakened more recently, with a corresponding uptick in convection over the Maritime Continent.
- Tropical cyclone activity in the Gulf of Mexico was evident in mid-July. More recently, suppressed convection returned to the Caribbean and tropical Atlantic.

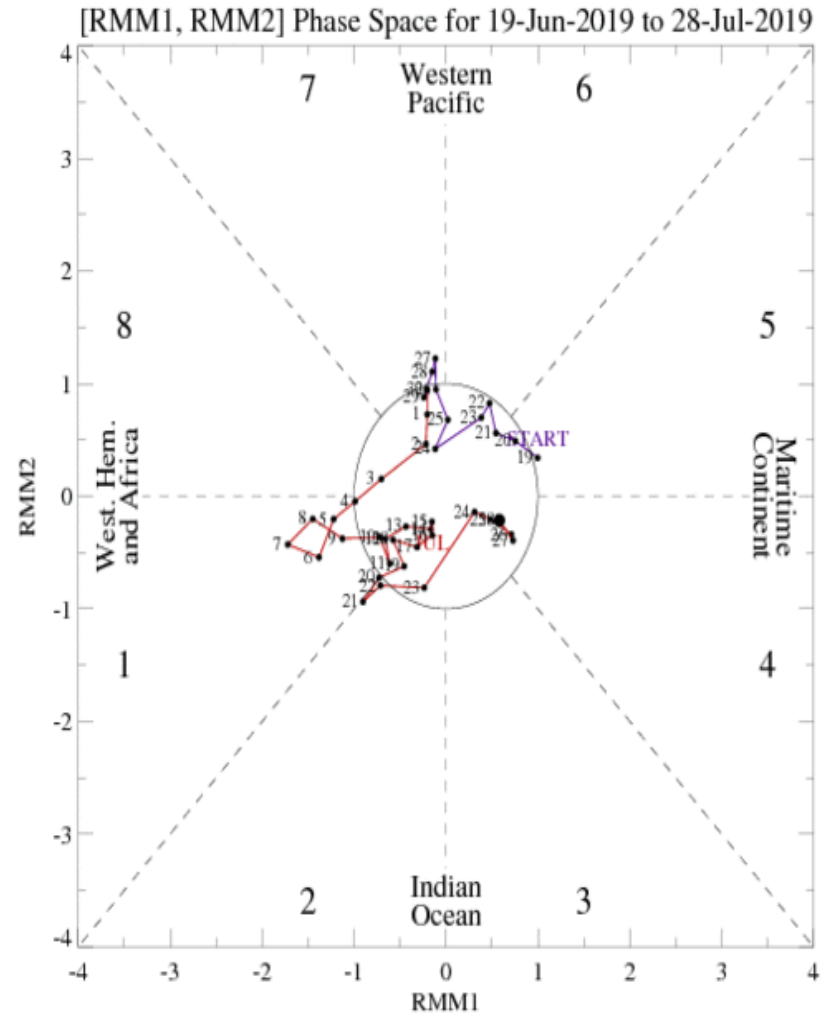
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Low amplitude SST anomalies remain above climatology across much of the equatorial Central and East Pacific, consistent with what remains of the ongoing El Niño event.
- A downwelling Kelvin wave event was evident over the central and eastern Pacific during mid-May through mid-June, but its amplitude was weaker than what was observed in previous events. Overall, upper-ocean heat content has continued to steadily decline over the past several months.
- Another weak downwelling wave has developed in response to recent period of anomalous westerlies over the central Pacific.

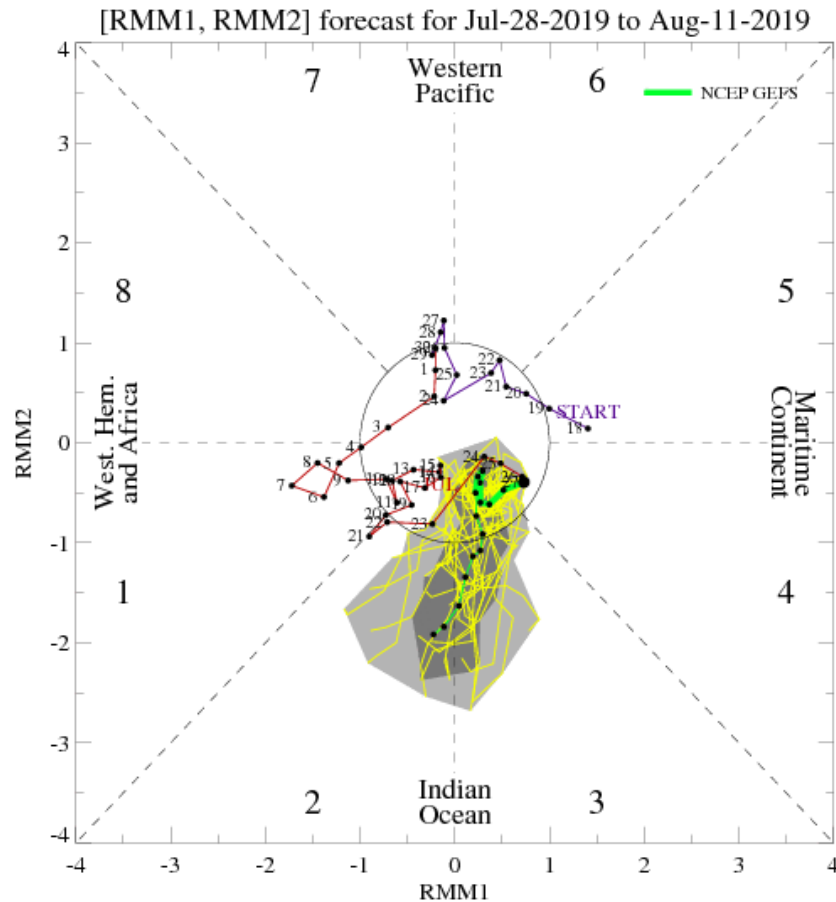
MJO Index: Recent Evolution

- The projection of the intraseasonal signal in RMM space remains weak, with a recent rapid shift towards the Maritime Continent.

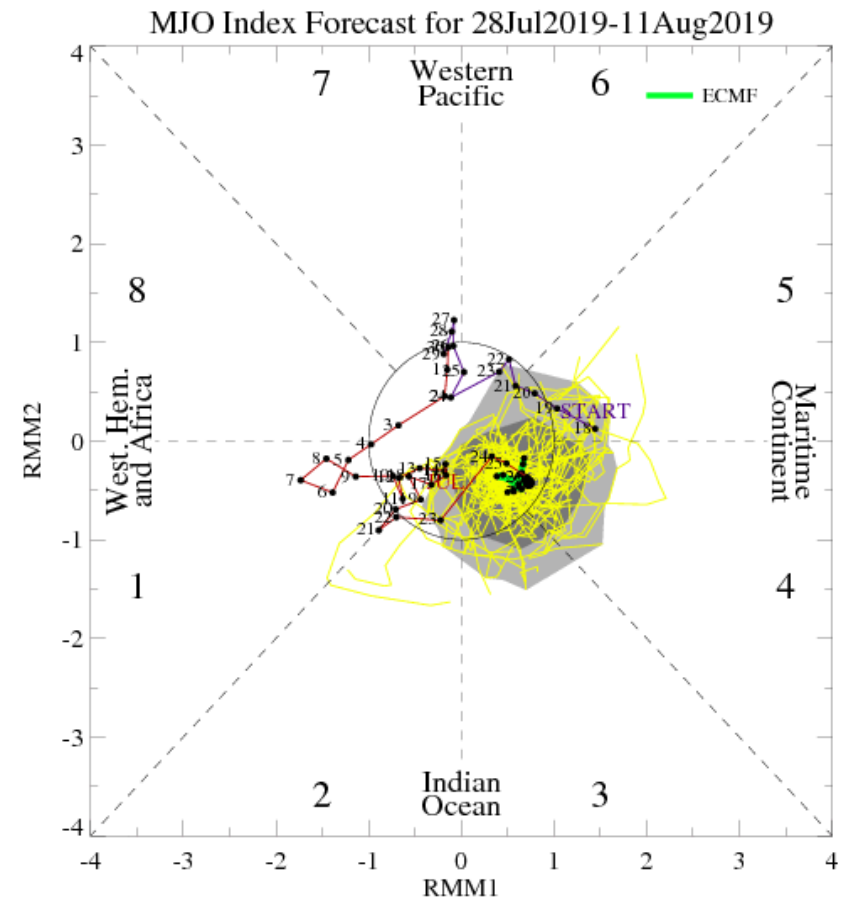


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



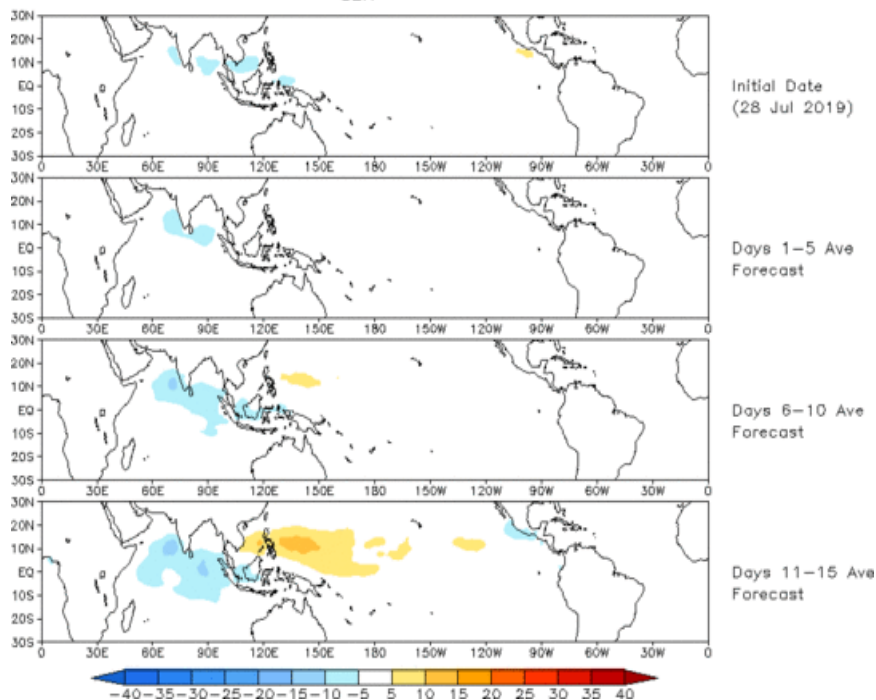
ECMWF Forecast

- The GEFS strongly amplifies the convective signal over the Indian Ocean, with little evident eastward propagation.
- The ECMWF forecast depicts greater variability among the ensemble members, but generally favors amplification over the eastern Indian Ocean and Maritime Continent. Few ensemble members show robust eastward propagation of the signal.

MJO: GEFS Forecast Evolution

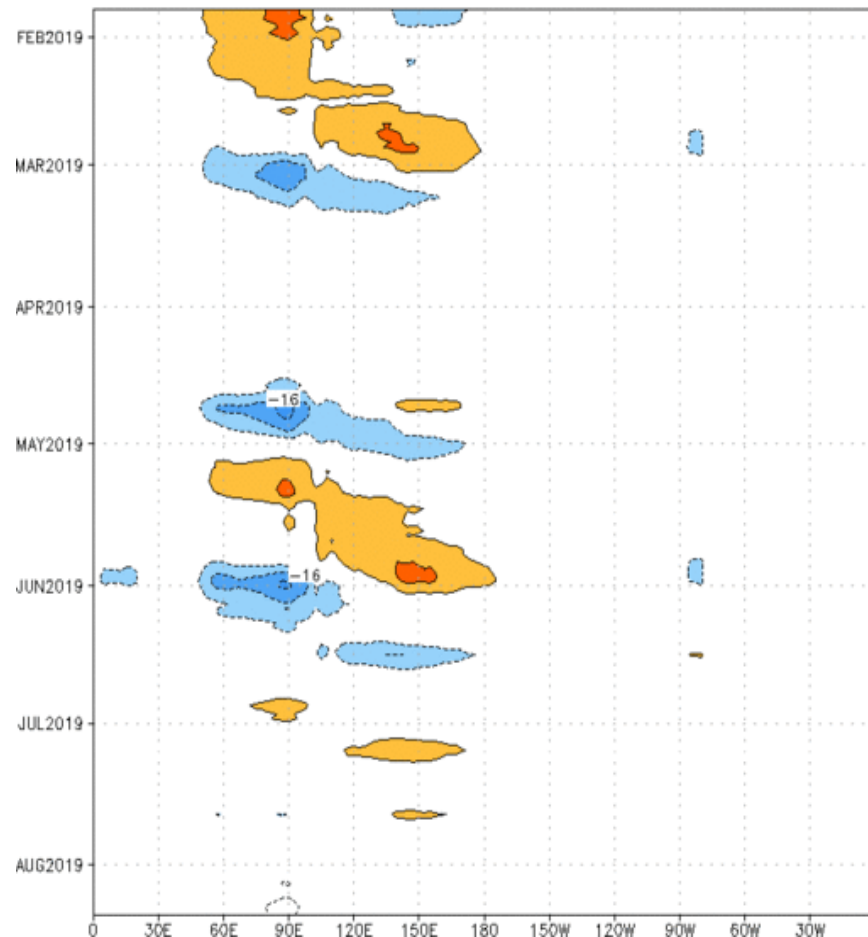
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Prediction of MJO-related anomalies using GEFS operational forecast
Initial date: 28 Jul 2019
OLR



- The spatial depiction of OLR anomalies based on the GEFS RMM index forecast shows an amplifying but stationary signal favoring enhanced (suppressed) convection over the Indian Ocean and western Maritime Continent (Northwest Pacific).

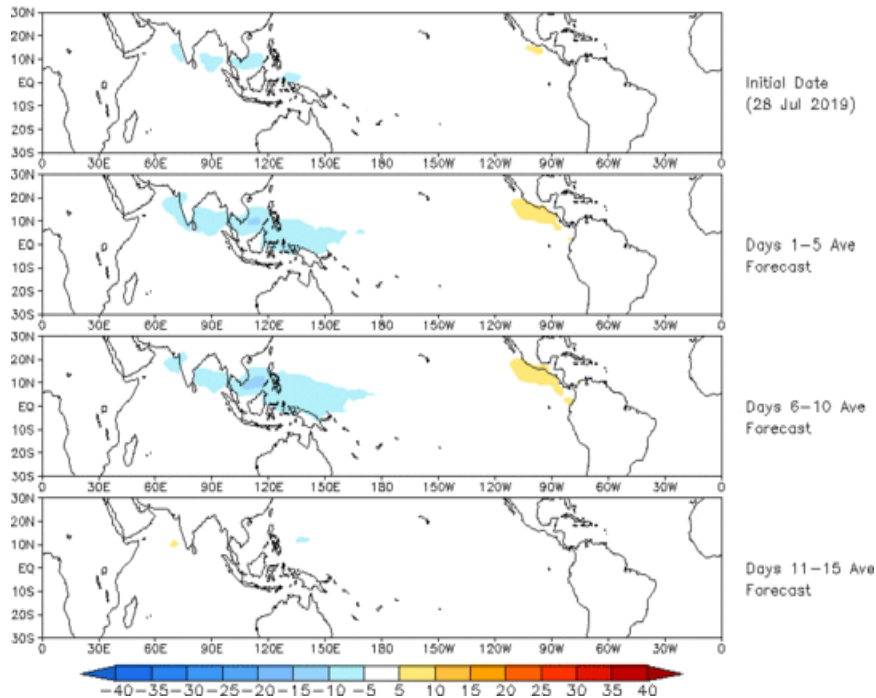
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$] ($\text{cont: } 4\text{Wm}^{-2}$) Period: 26-Jan-2019 to 28-Jul-2019
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days



MJO: Constructed Analog Forecast Evolution

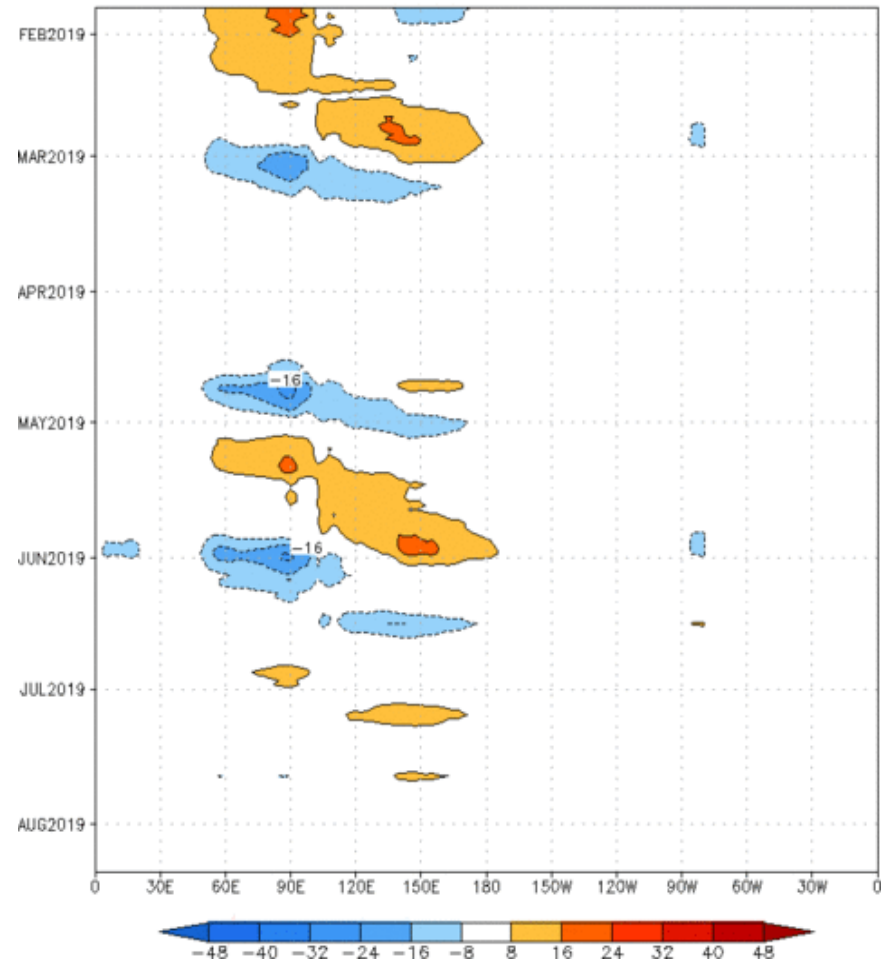
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (28 Jul 2019)



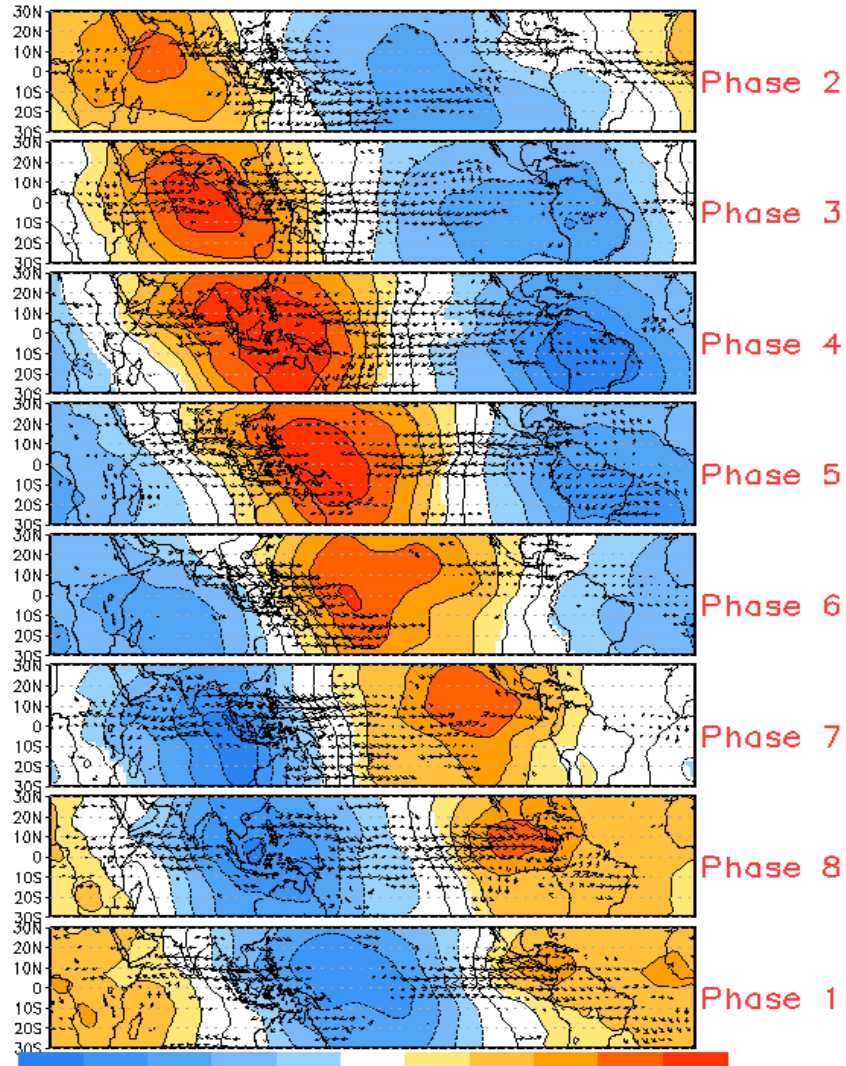
- The constructed analog MJO forecast also shows a slow-moving or stationary signal, with the enhanced convective phase over the Maritime Continent, which is east of the GEFS-favored solution.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:26-Jan-2019 to 28-Jul-2019
The unfilled contours are CA forecast reconstructed anomaly for 15 days

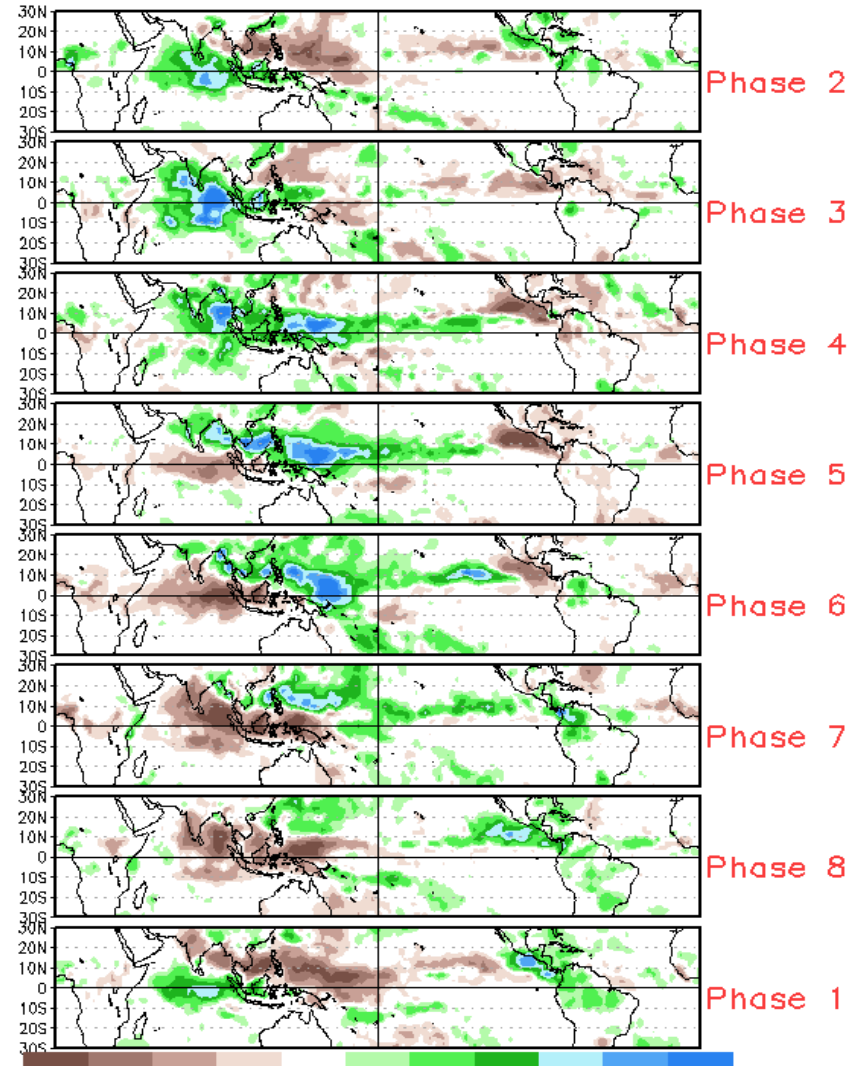


MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



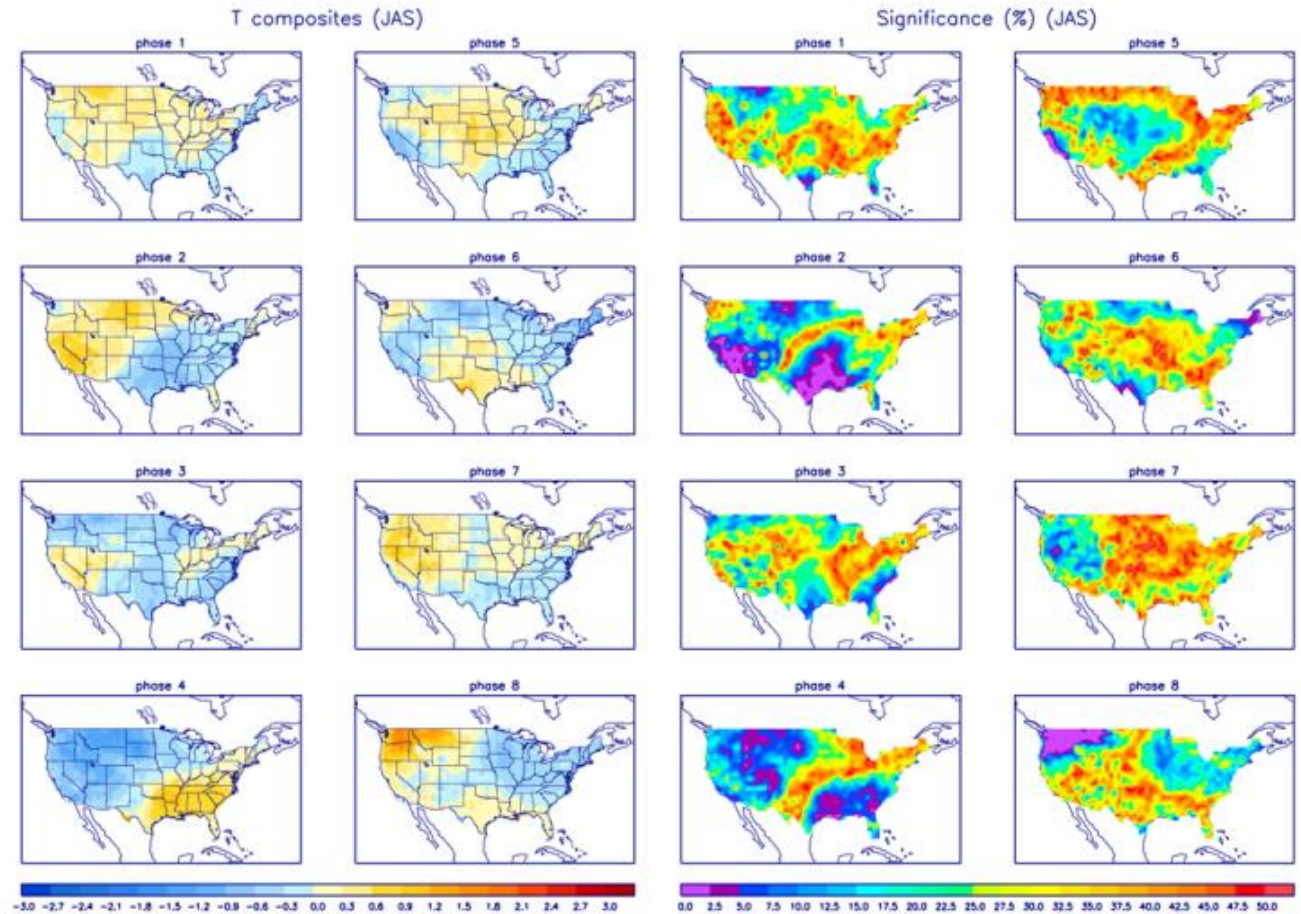
Precipitation Anomalies



MJO: CONUS Composite Maps by RMM Phase - 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 (red) 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.



MJO: CONUS Composite Maps by RMM Phase - Temperature

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.

