

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



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
24 July 2023

Overview

- While the RMM-based MJO index continues to show a low-amplitude signal, a more robust intraseasonal envelope is apparent in the upper-level velocity potential field.
- Both the subseasonal signal and tropical cyclone activity contributed to a strong westerly wind burst centered over the equatorial West Pacific. This WWB should help to reinforce the ongoing El Niño event with a new downwelling oceanic Kelvin wave.
- Dynamical model MJO index forecasts reflect high uncertainty, with both the ECMWF and GEFS indicating a potential for renewed MJO activity over the Maritime Continent or West Pacific by the end of Week-2, which is inconsistent with current activity.
- Enhanced westerlies aloft may suppress East Pacific tropical cyclone activity during Week-1, with a potential for renewed activity during Weeks 2-3. The West Pacific is favored to remain active.
- Early tropical cyclone development over the Atlantic MDR remains possible due to abnormally warm ocean temperatures. Climatological activity begins to increase during August.

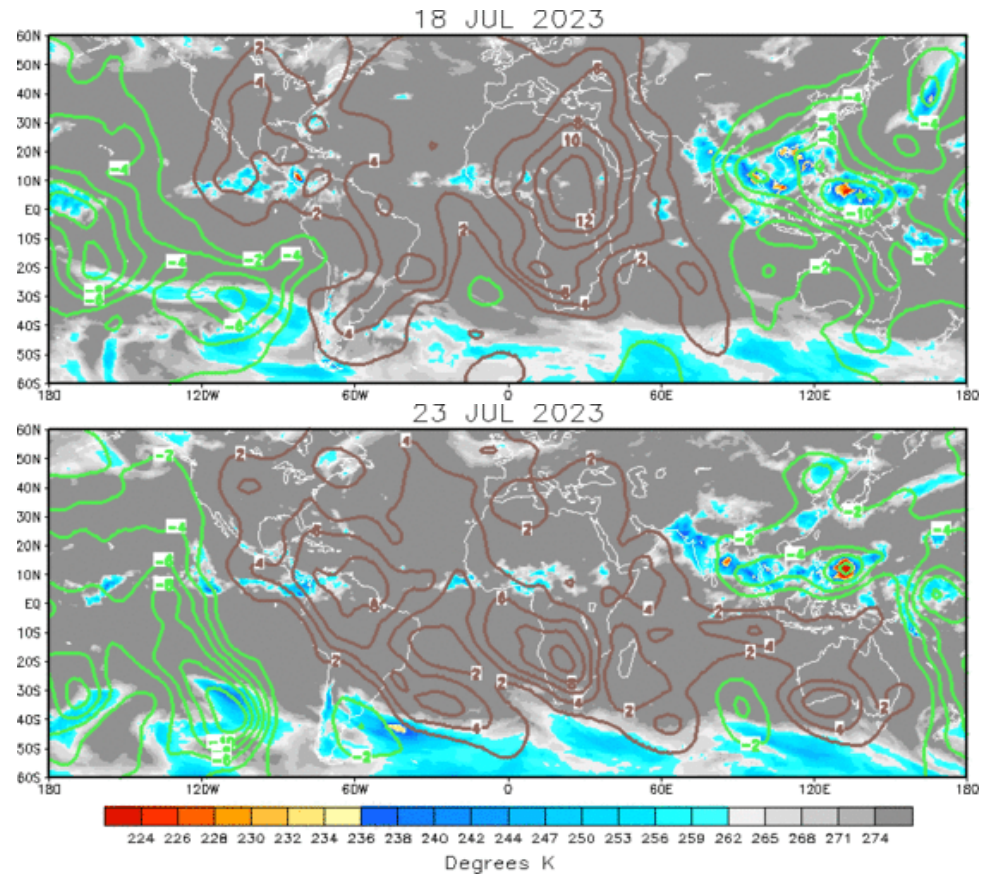
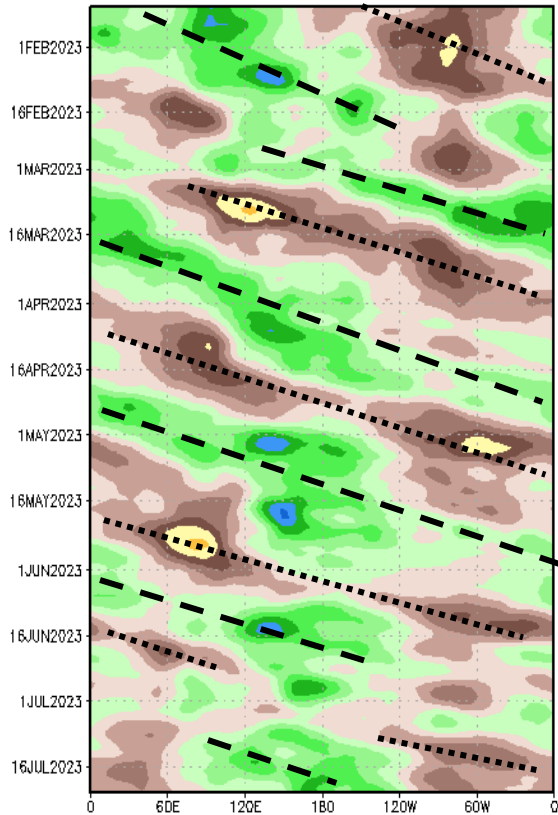
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

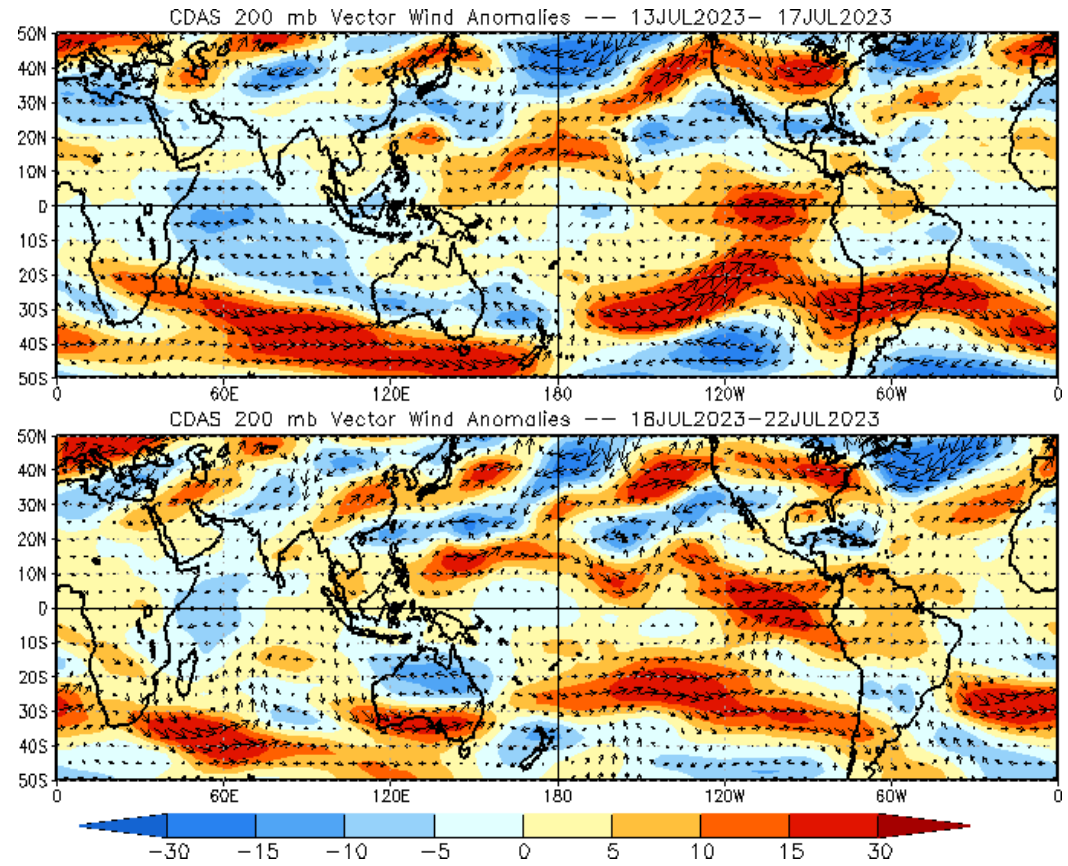
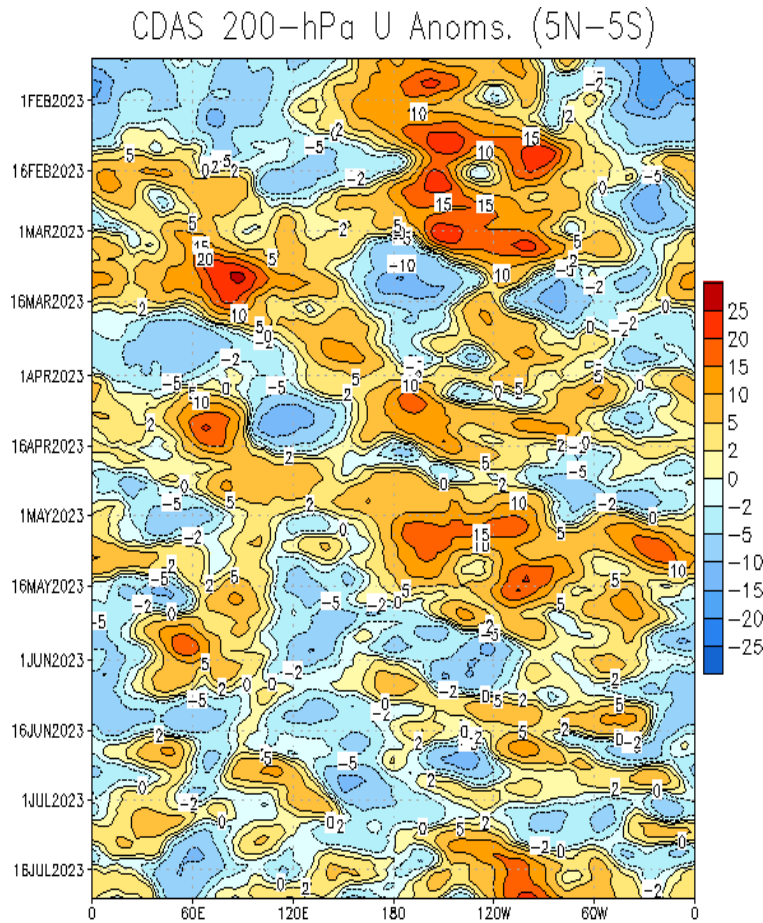
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- Since mid-June, the upper-level velocity potential pattern continues to be mostly incoherent, with enhanced convection remaining entrenched across the western Pacific tied to the low frequency footprint.
- In the last few days a more discernable wave-1 pattern has emerged with the enhanced convective envelope over the Maritime Continent, possibly indicating an increase in MJO strength and coherence.

200-hPa Wind Anomalies

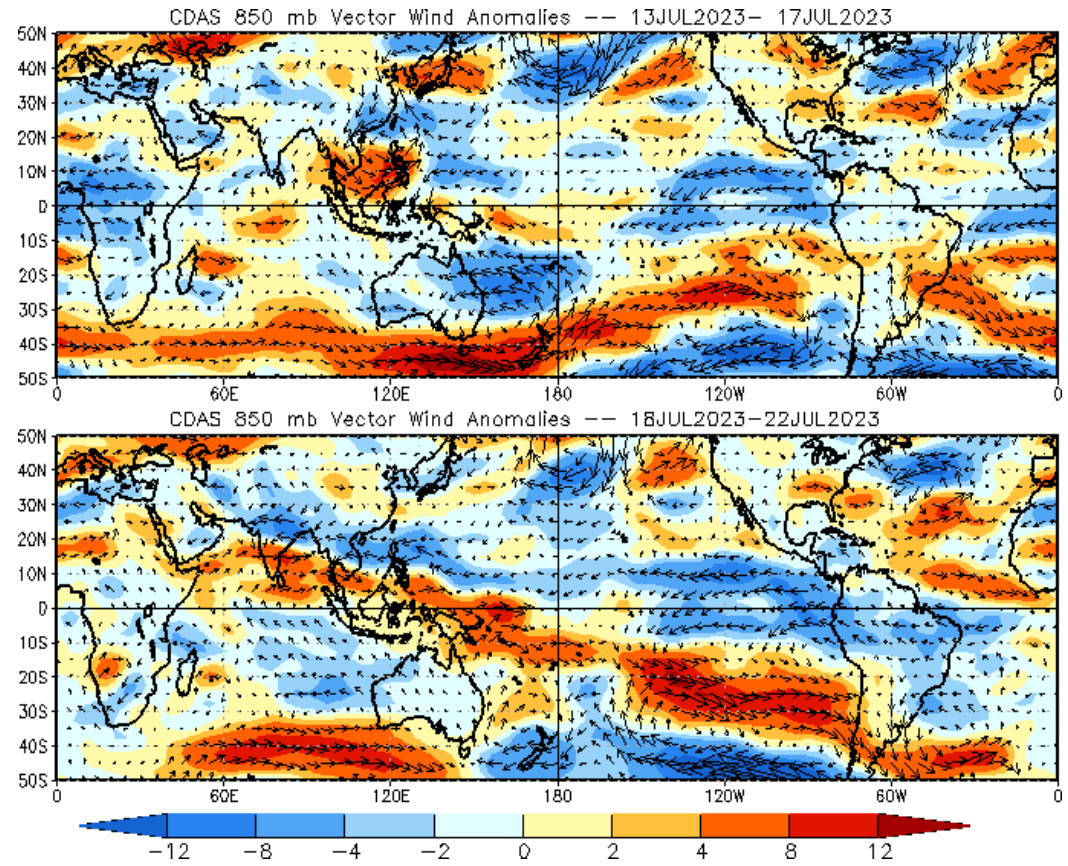
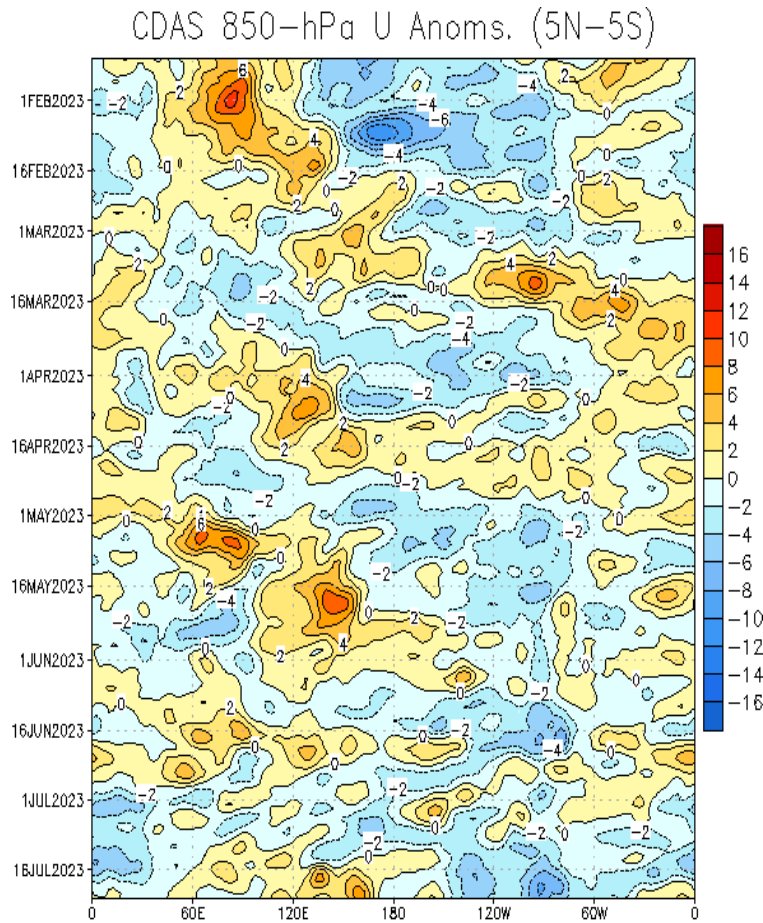
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Westerly anomalies persisted over the East Pacific basin, which is inconsistent with a typical response to El Niño conditions.
- The upper-level zonal wind field remains fairly incoherent across the remainder of the global tropics.
- An enhanced subtropical jet remains evident across the Pacific and western North America, where strong ridging persists and shifted westward over the southern tier of the CONUS.

850-hPa Wind Anomalies

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

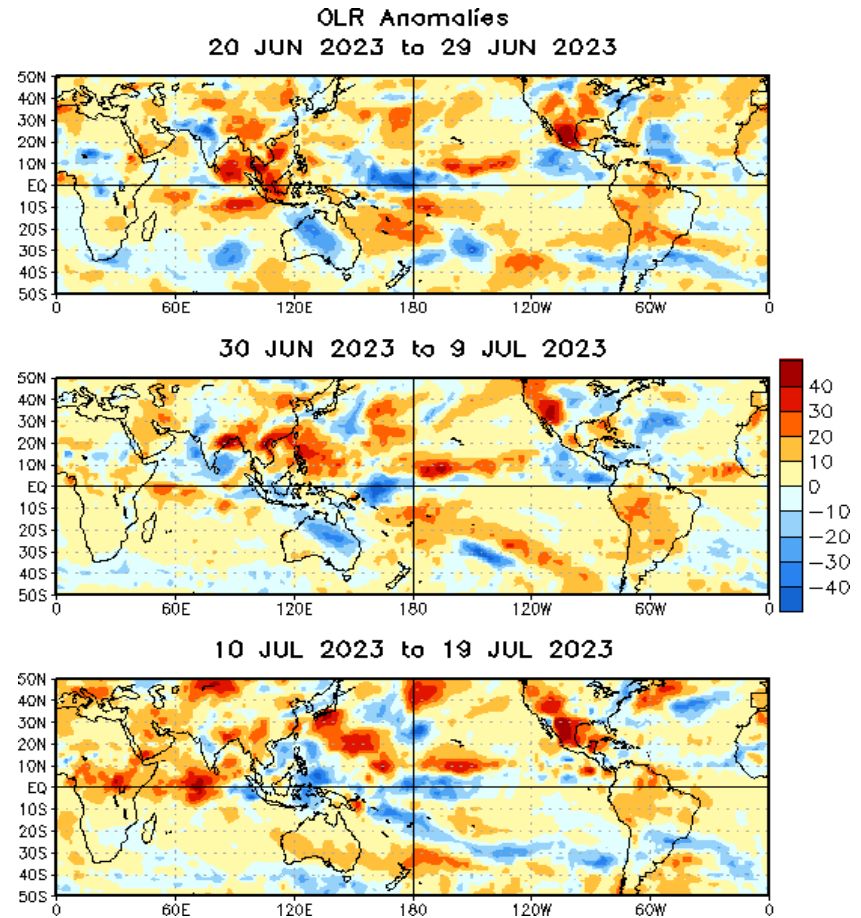
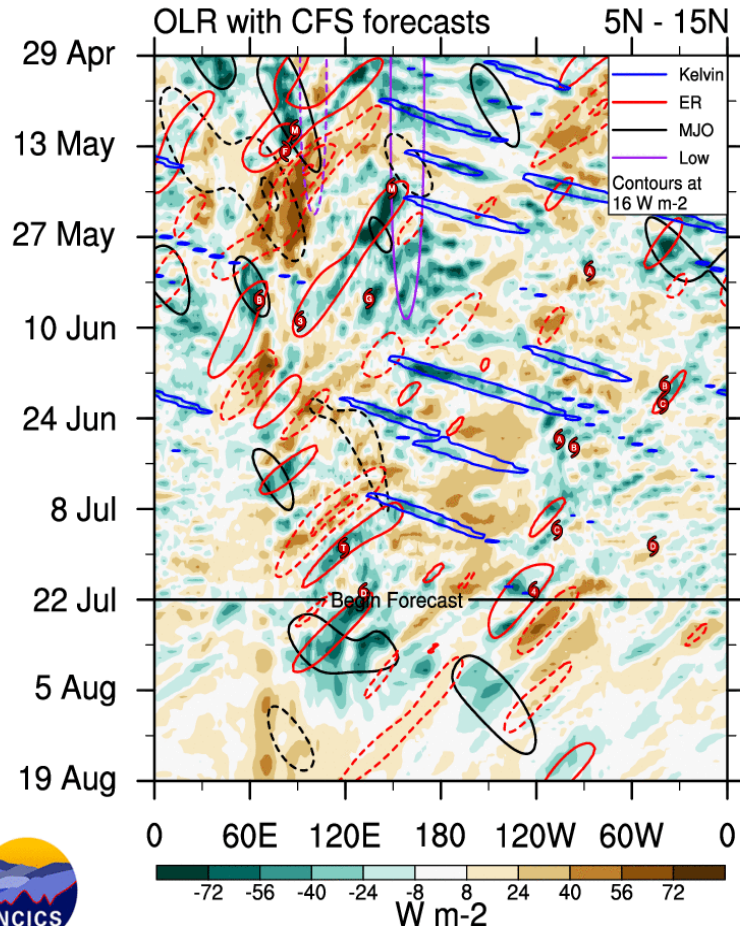


- A strong, equatorially centered westerly wind burst was observed recently northeast of New Guinea.
- Trade winds weakened across the central Pacific, but remained strongly enhanced across the East Pacific.
- A robust monsoon trough has become established with a northwest to southeast tilt extending from southern Asia through the Maritime Continent.

Outgoing Longwave Radiation (OLR) Anomalies

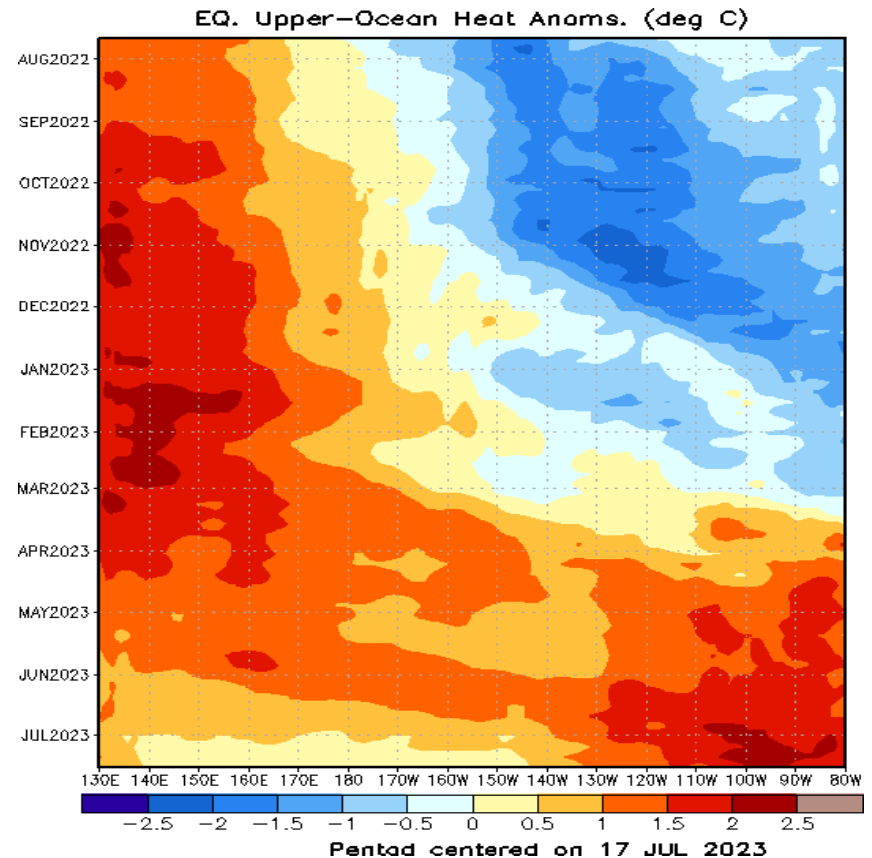
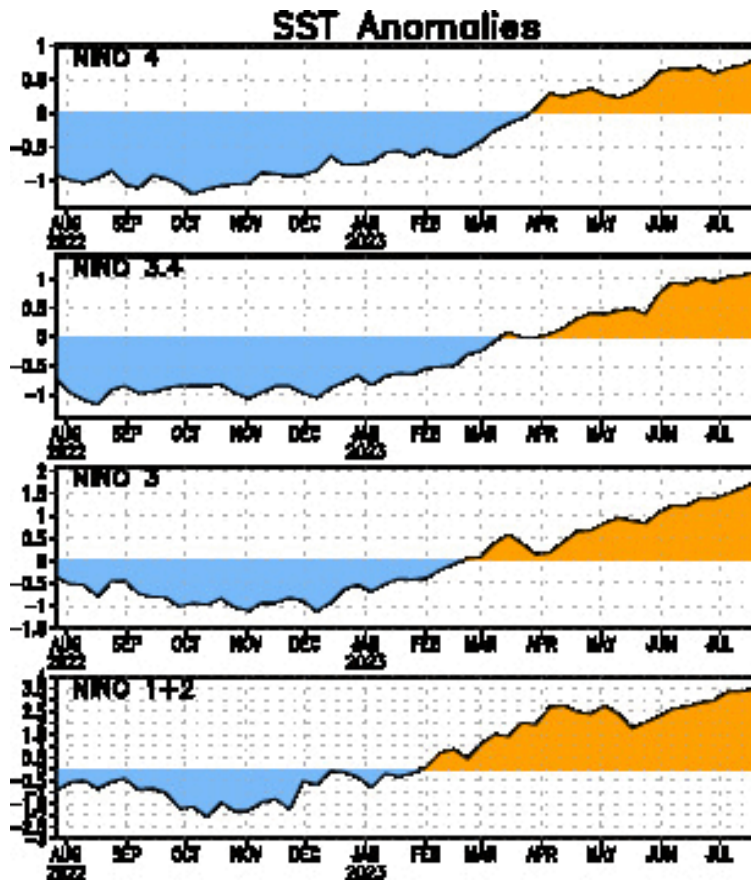
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- Following a few weeks of suppressed activity, enhanced convection (including tropical cyclone activity) has returned to portions of the West Pacific and South China Sea.
- An enhanced convective signal has returned to the Date Line region, consistent with the ENSO signal.
- Following a period of convection and tropical cyclone activity over the East Pacific basin, the enhanced signal has begun to wane.

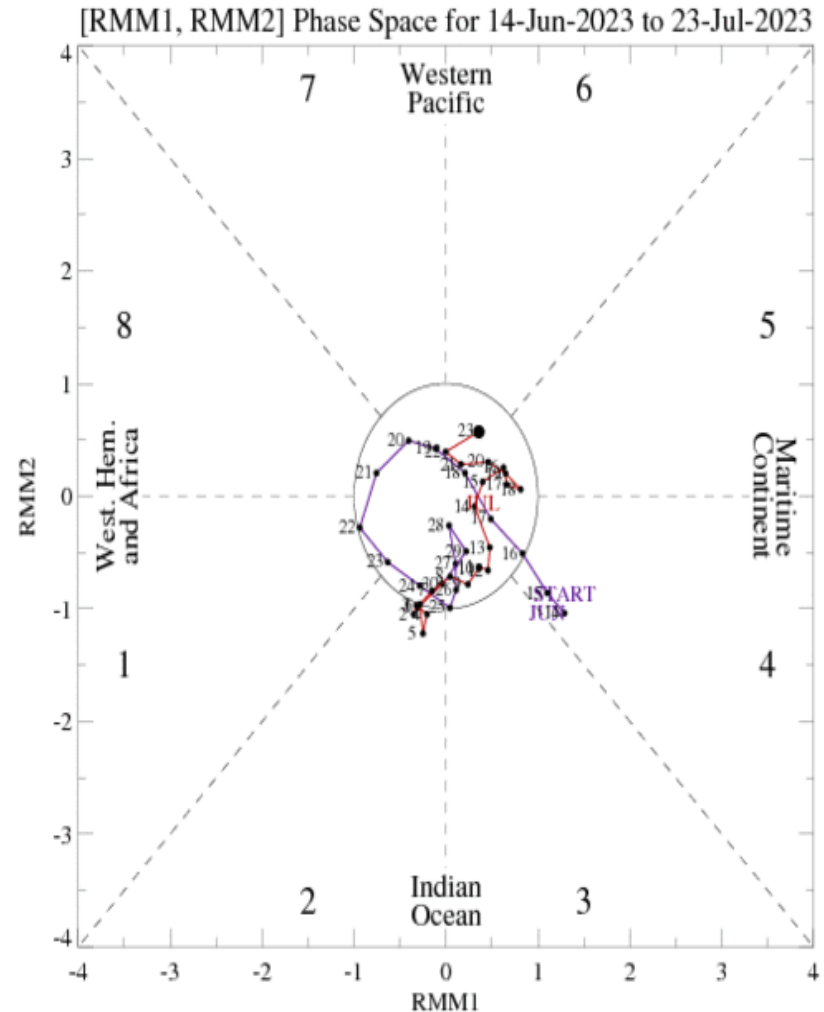
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- El Niño conditions are now present across the equatorial Pacific as SST anomalies continue to climb throughout the Niño regions.
- Above-normal oceanic subsurface temperatures are present across the entire equatorial Pacific, with the largest positive anomalies (>2 degrees C) between 110W and 100W.
- Upper-ocean heat content anomalies in the Pacific Warm Pool continue to decline, approaching zero west of the Date Line.

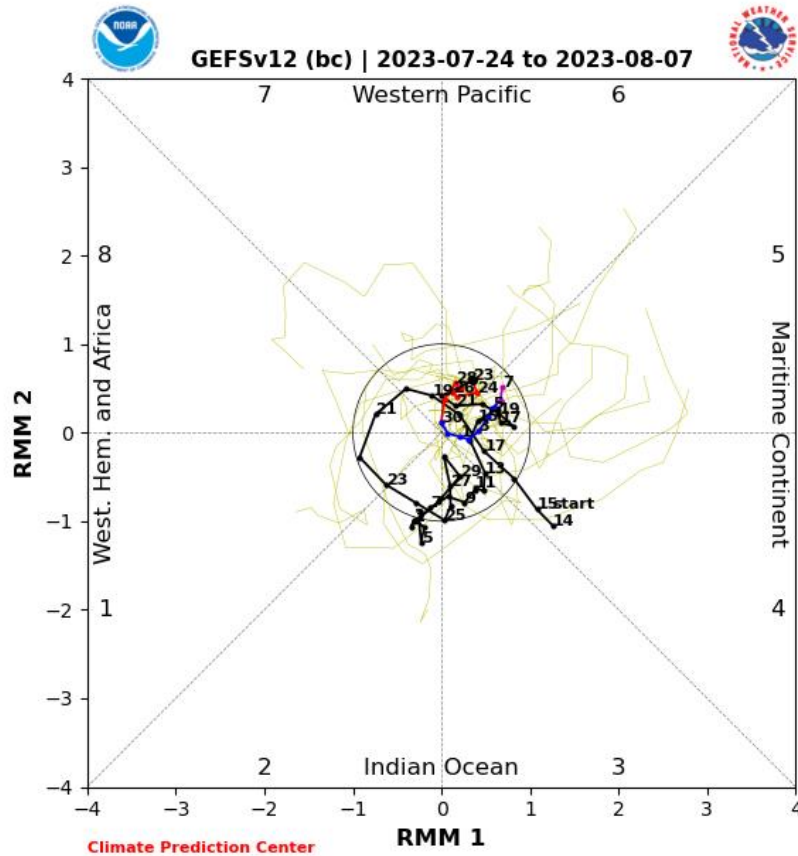
MJO Index: Recent Evolution

- The RMM index continues to reflect weak amplitude, though there have been some hints of an eastward propagating signal moving from the Maritime Continent to the West Pacific.

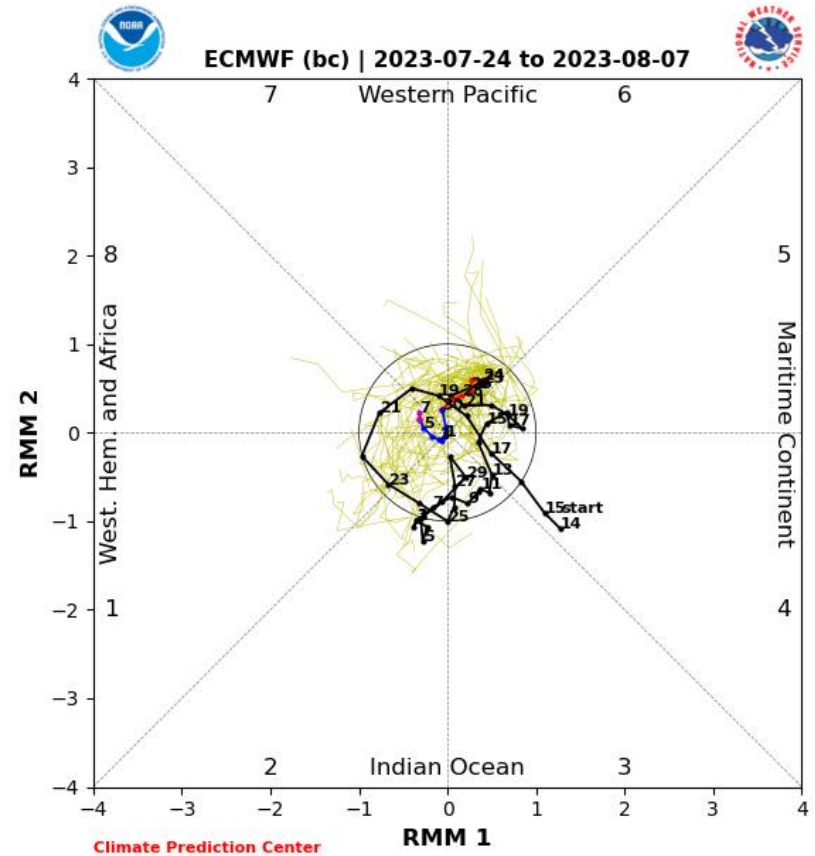


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



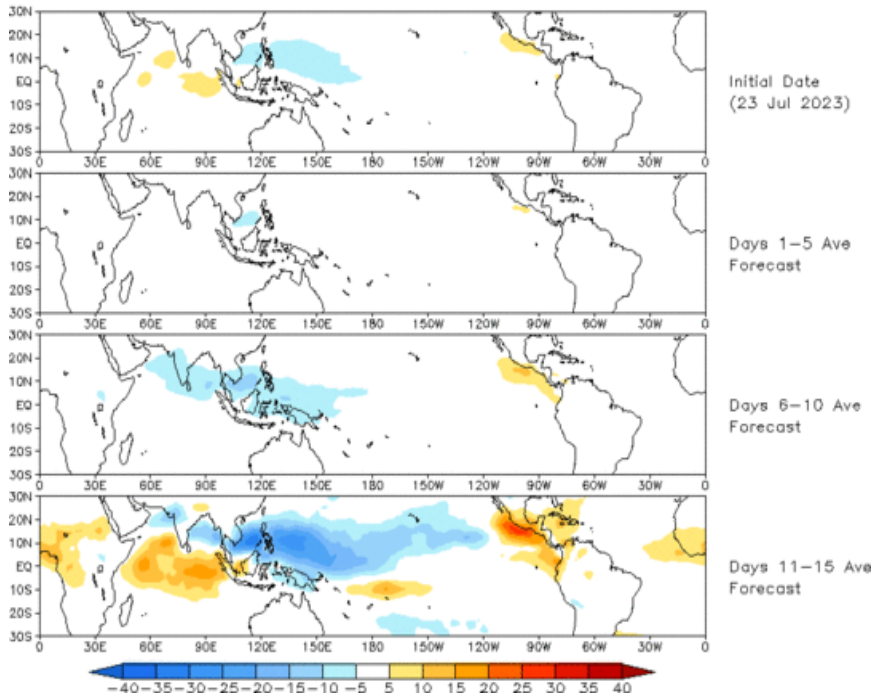
ECMWF Forecast

- Dynamical model MJO index forecasts reflect a continued low-amplitude signal.
- A few ensemble members from both the GEFS and ECMWF depict a stronger signal emerging towards the beginning of August.
- Longer-range RMM forecasts from the GEFS and ECMWF indicate a potential for renewed MJO activity during August, but uncertainty is high.

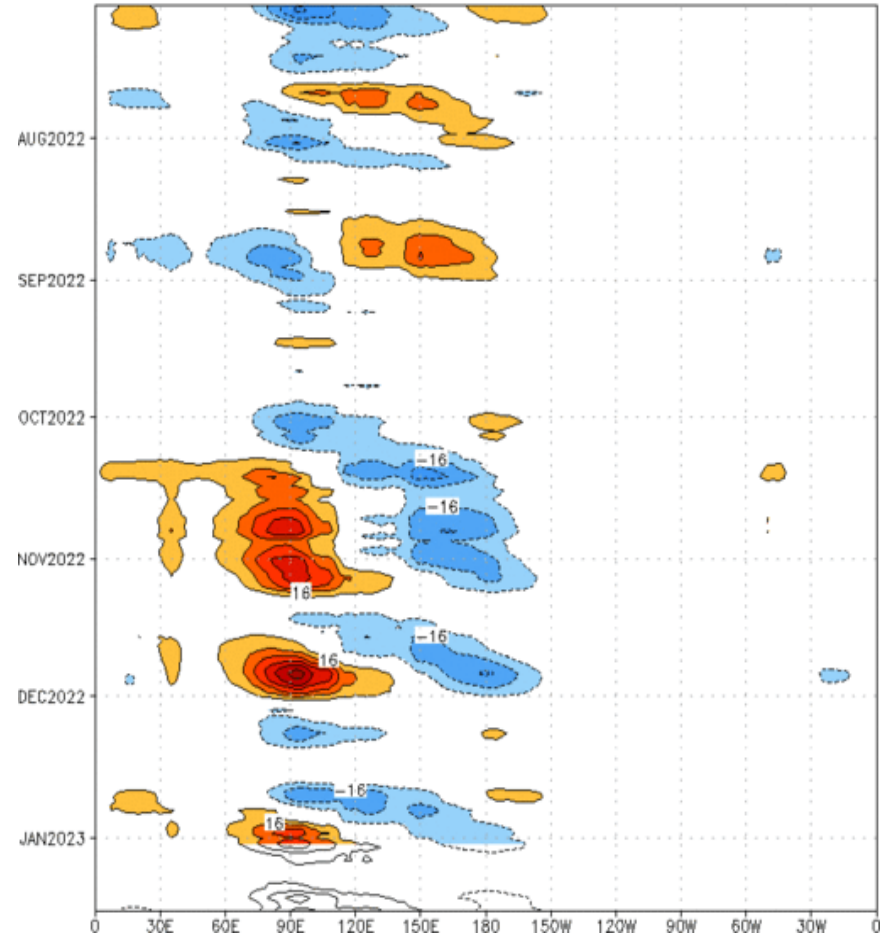
MJO: GEFS Forecast Evolution

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: 23 Jul 2023
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}S, 7.5^{\circ}N$] (cont: $4Wm^{-2}$) Period: 03-Jul-2022 to 02-Jan-2023
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

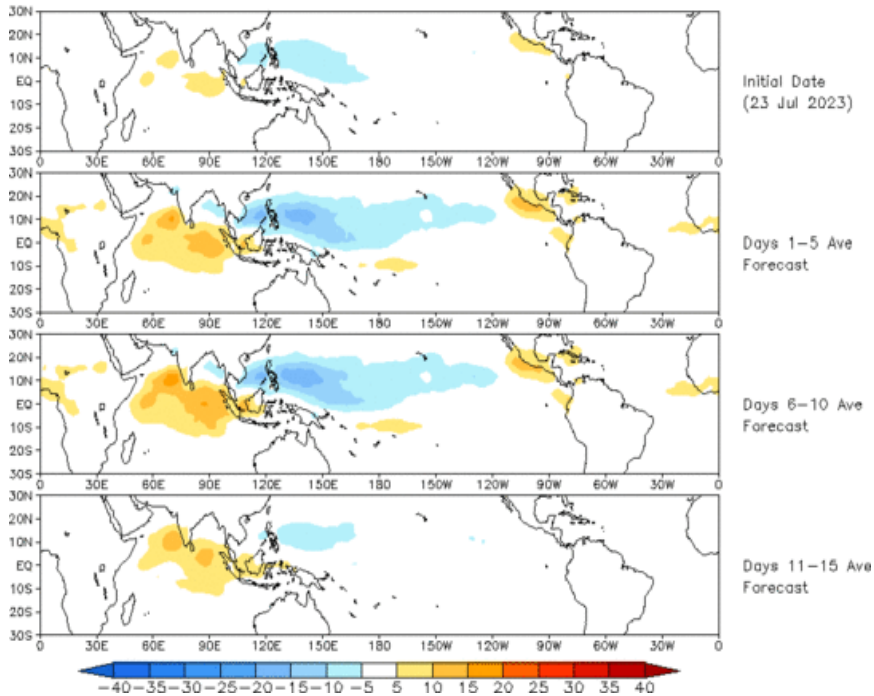


- The GEFS RMM-based OLR forecast shows an amplifying signal with convective anomalies consistent with an MJO event propagating from the Maritime Continent to the West Pacific.

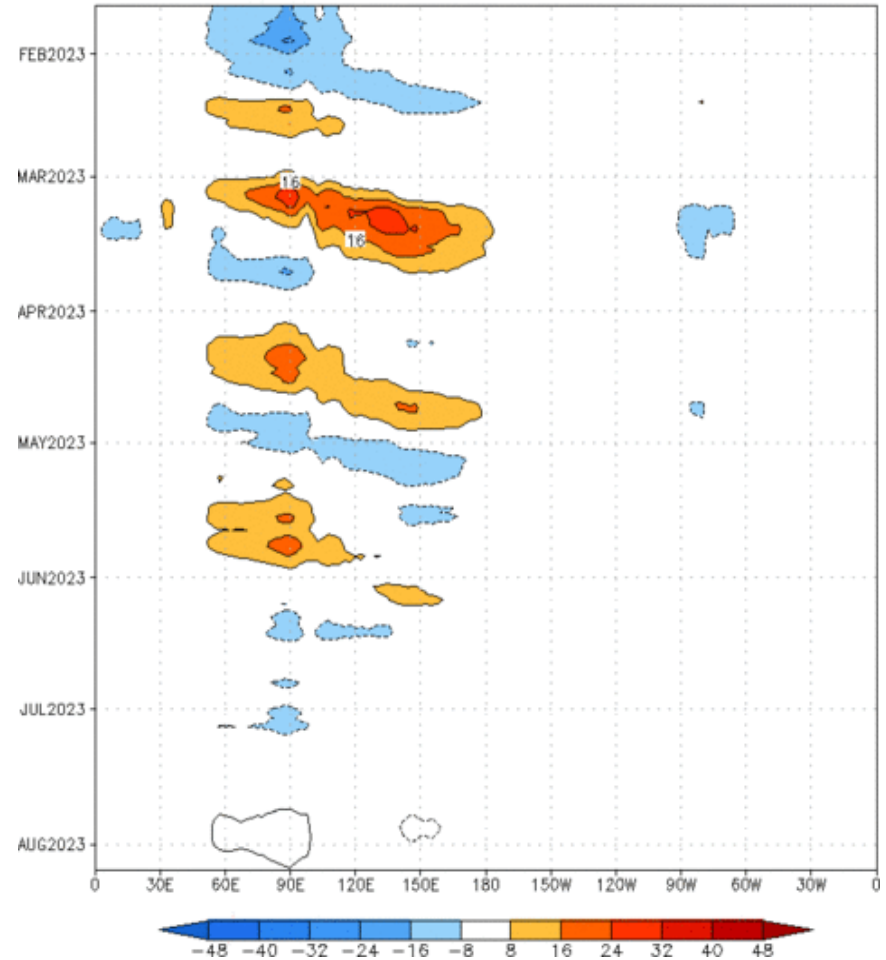
MJO: Constructed Analog Forecast Evolution

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 (23 Jul 2023)



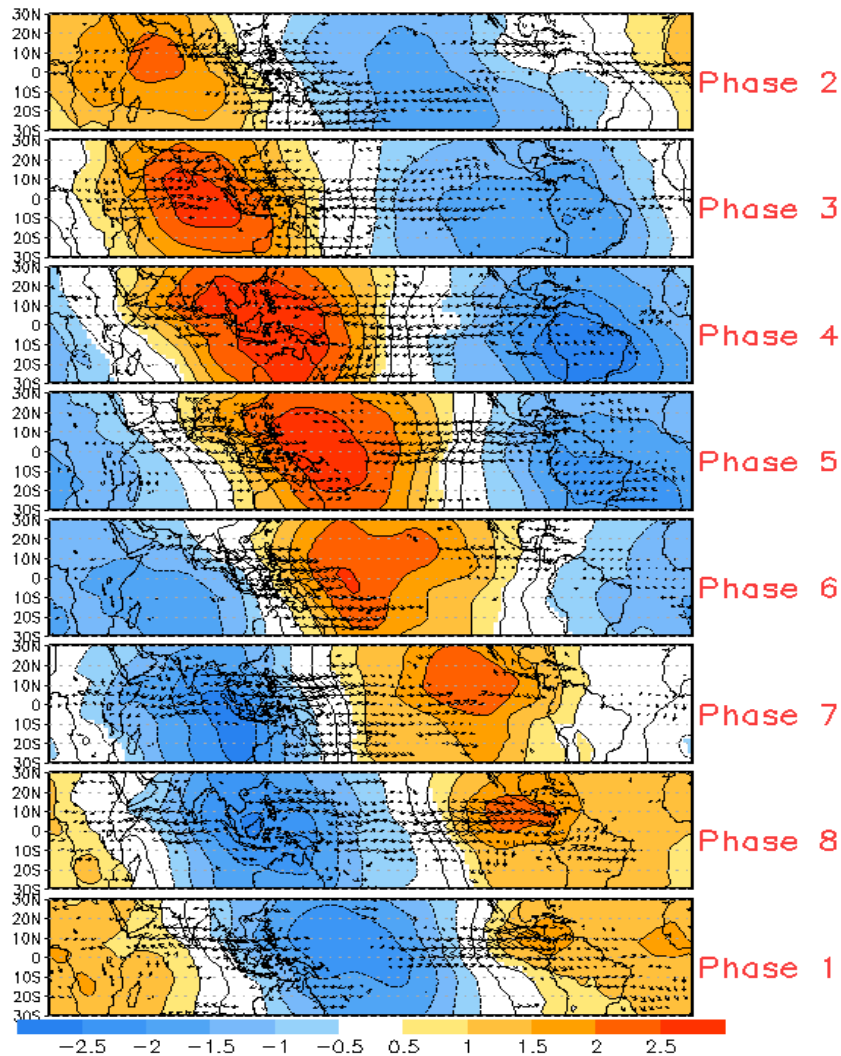
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:21-Jan-2023 to 23-Jul-2023
The unfilled contours are CA forecast reconstructed anomaly for 15 days



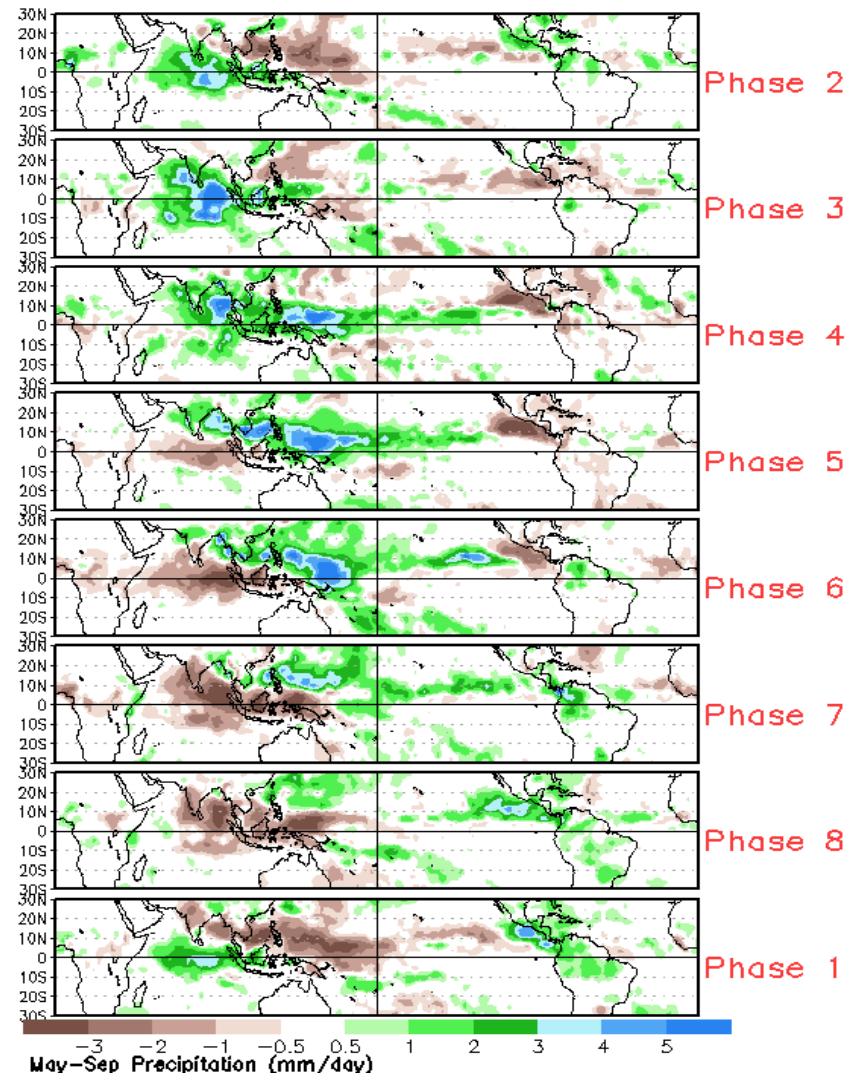
- The constructed analog RMM-based forecast reflects a more stationary signal with enhanced convection over the West Pacific that gradually weakens towards the end of Week-2.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



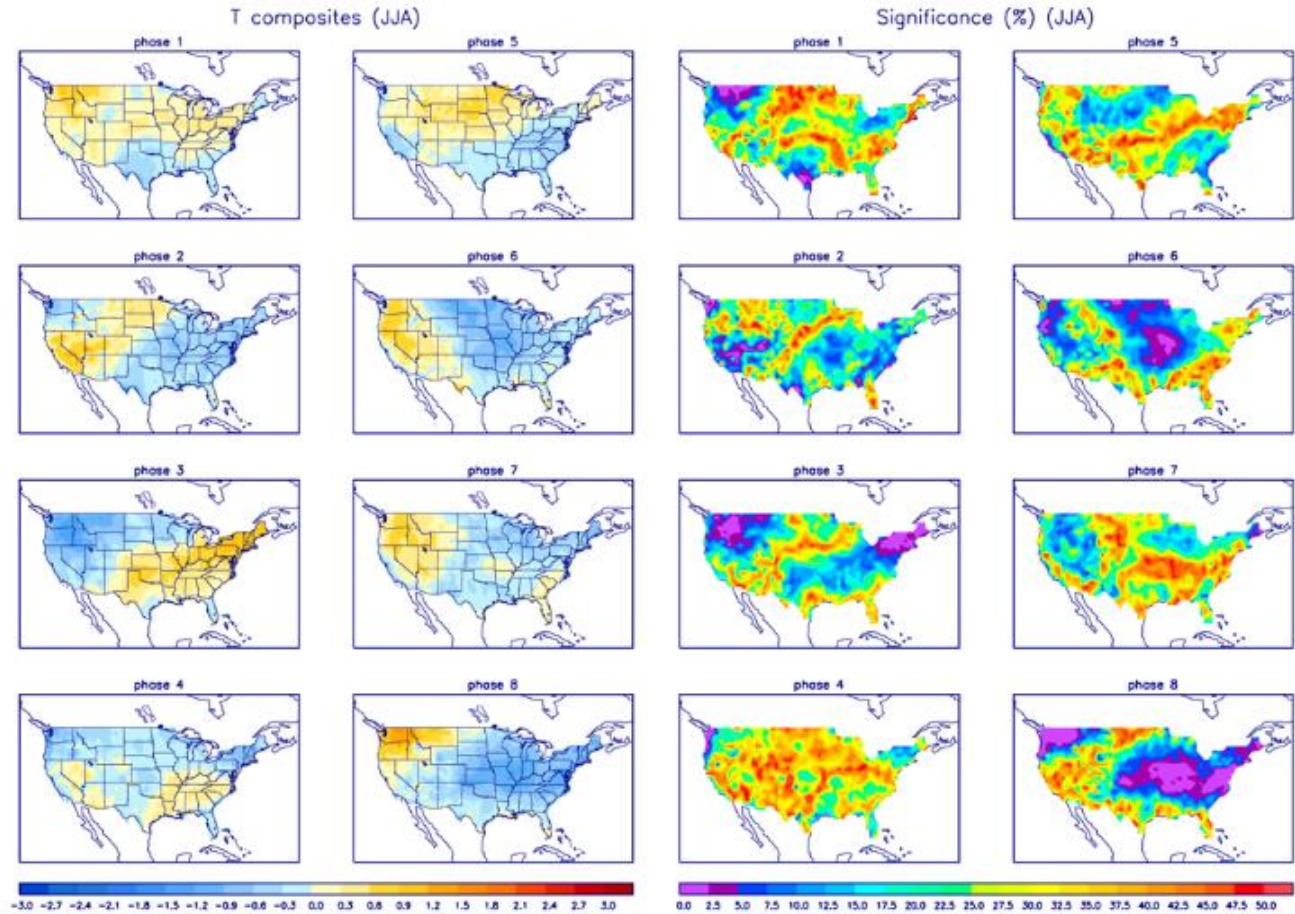
Precipitation Anomalies



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 - 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.

