

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



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

Overview

- The MJO remains weak, with other modes, particularly the evolving El Niño base state, influencing a pattern that remains largely incoherent.
- The zonal wind fields indicate some disruption to the atmospheric response to El Niño, with increased trade winds evident across the Pacific. OLR anomalies however show increased convection near the Date Line, which is consistent with ENSO conditions.
- Following the weakening of Tropical Storm Adrian over the East Pacific the tropics are currently quiet. The warm ENSO conditions favor renewed development over both the West and East Pacific basins.
- Dynamical model forecasts for Week-2 indicate TC formation potential over the East Pacific basin south of Mexico, and a broad region of favorability over the West Pacific.
- Continued weak SAL activity and enhanced convection over the Atlantic MDR may provide opportunities for continued early TC development, though climatology is still quite low during mid July.

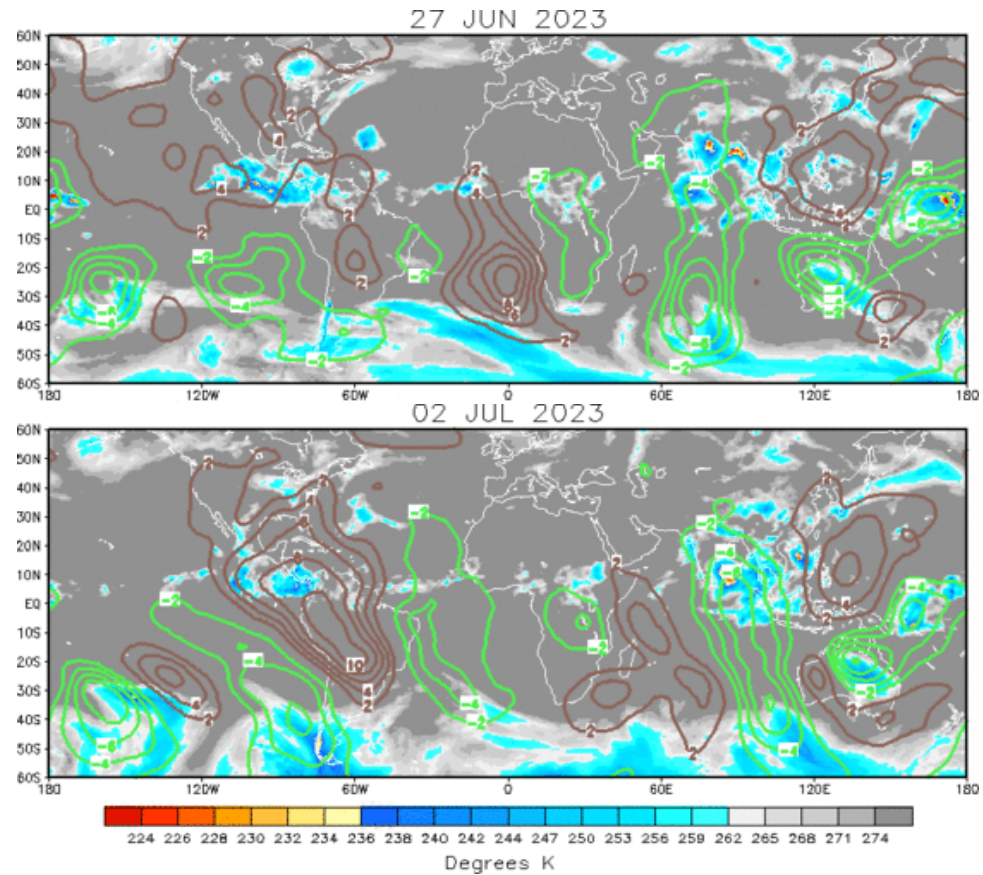
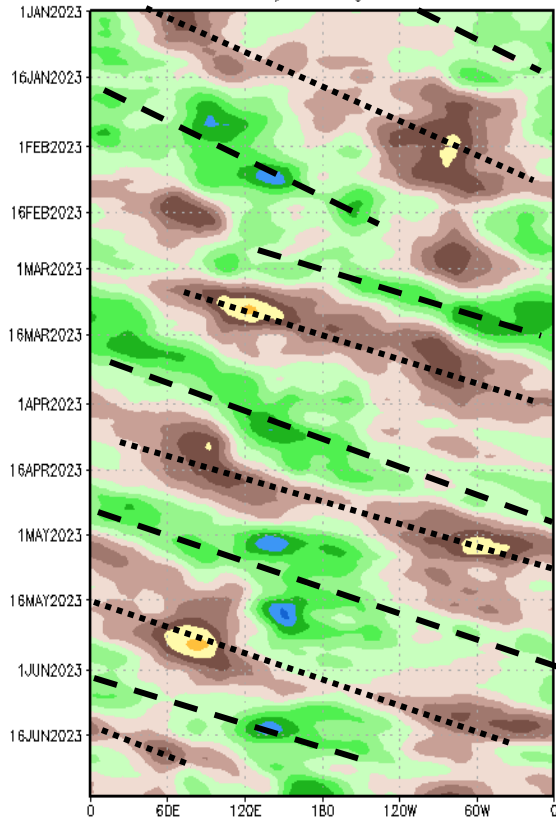
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

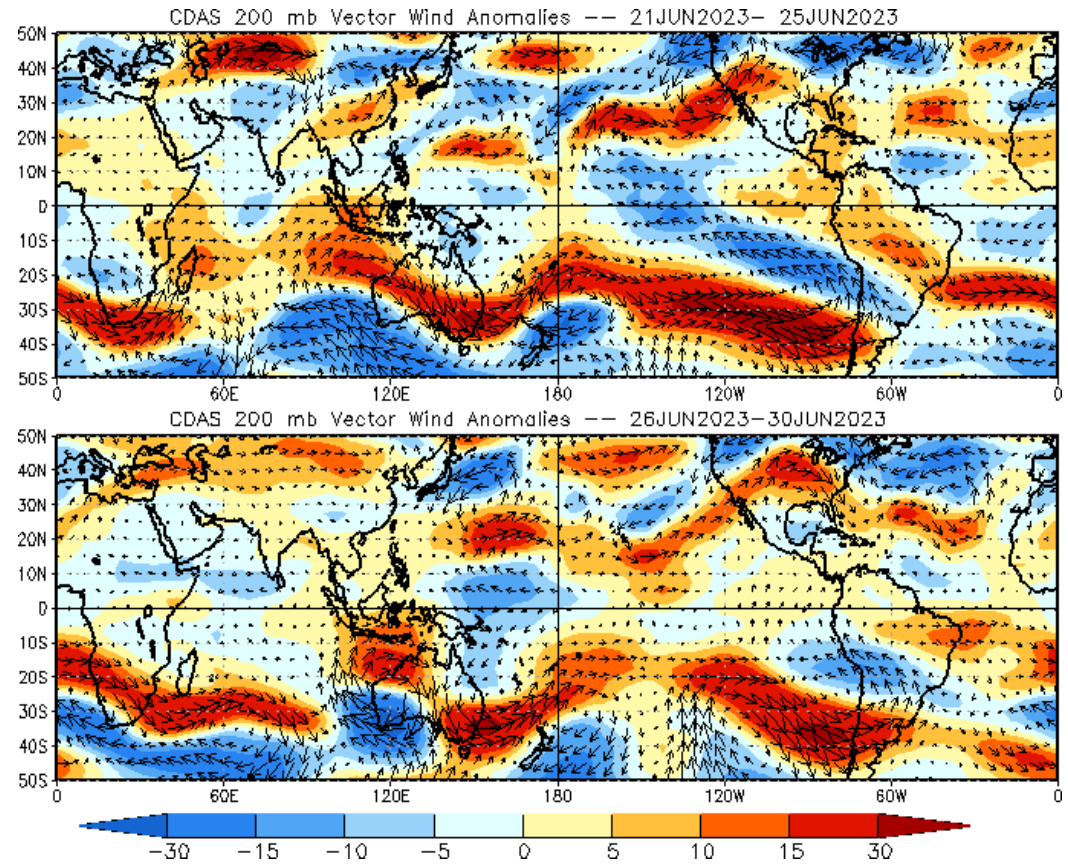
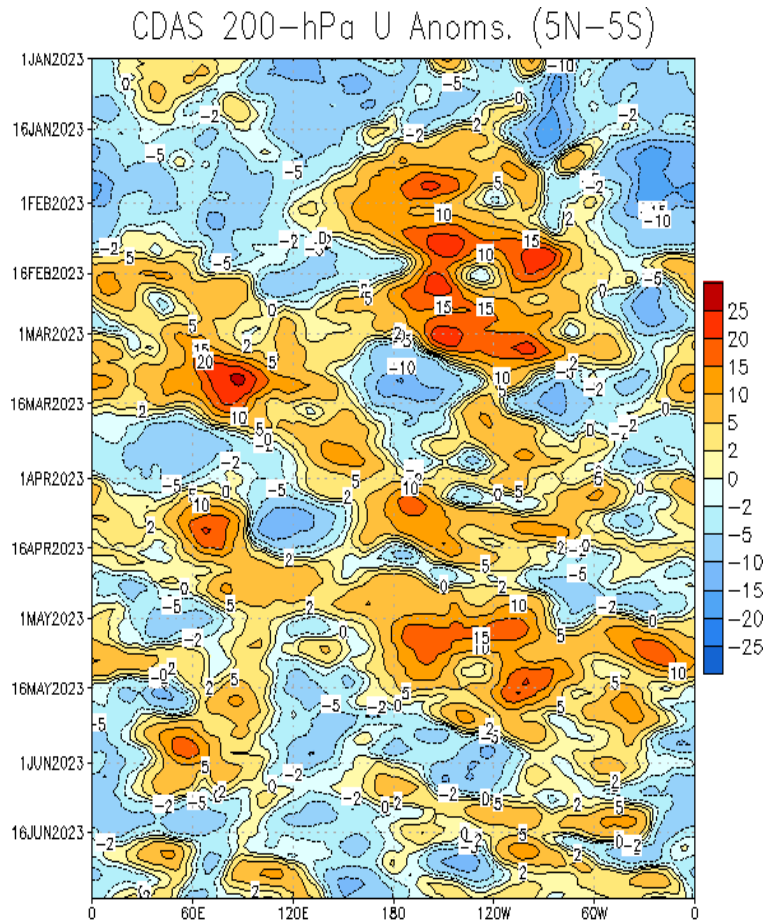
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- The upper-level velocity potential pattern remains largely incoherent, with a fairly stationary signal setting up over the Maritime Continent and West Pacific.
- Some easterly propagating modes (Kelvin waves or remnant MJO activity) are evident in the pattern, with enhanced convection developing over the eastern Indian Ocean.

200-hPa Wind Anomalies

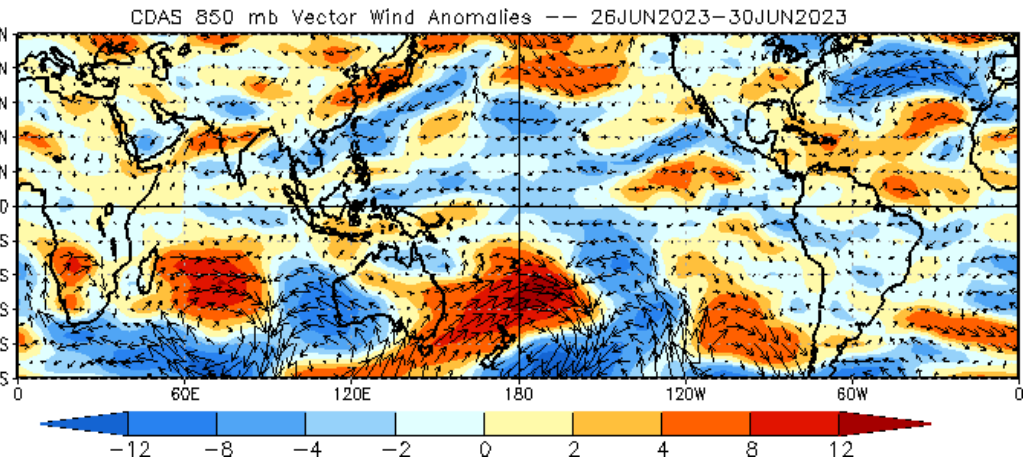
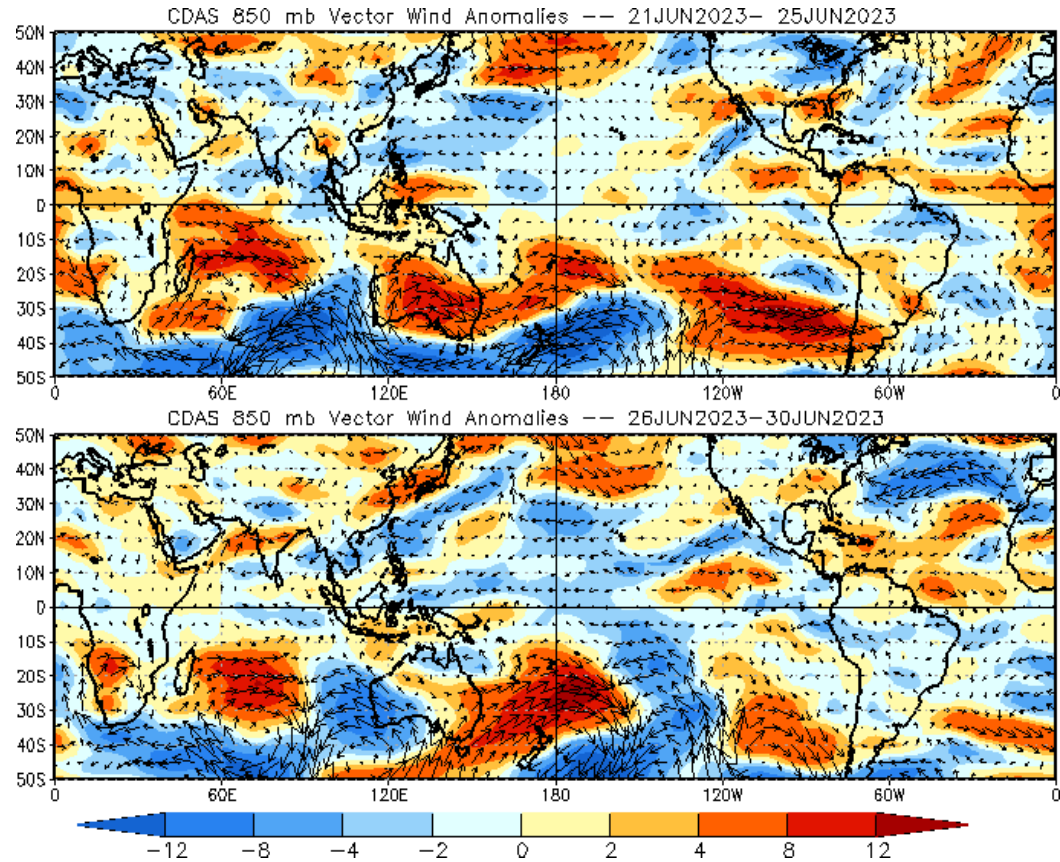
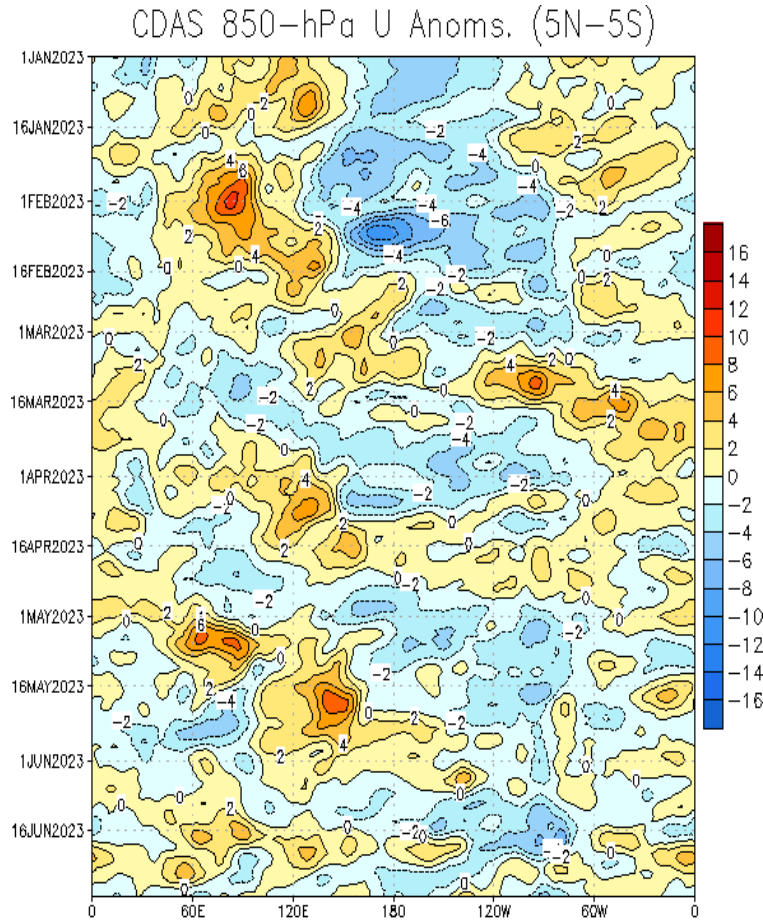
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Easterly anomalies diminished across the East Pacific.
- A pronounced subtropical jet is evident across the Pacific and western North America. Strong ridging remains in place over the central US and Gulf of Mexico.

850-hPa Wind Anomalies

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

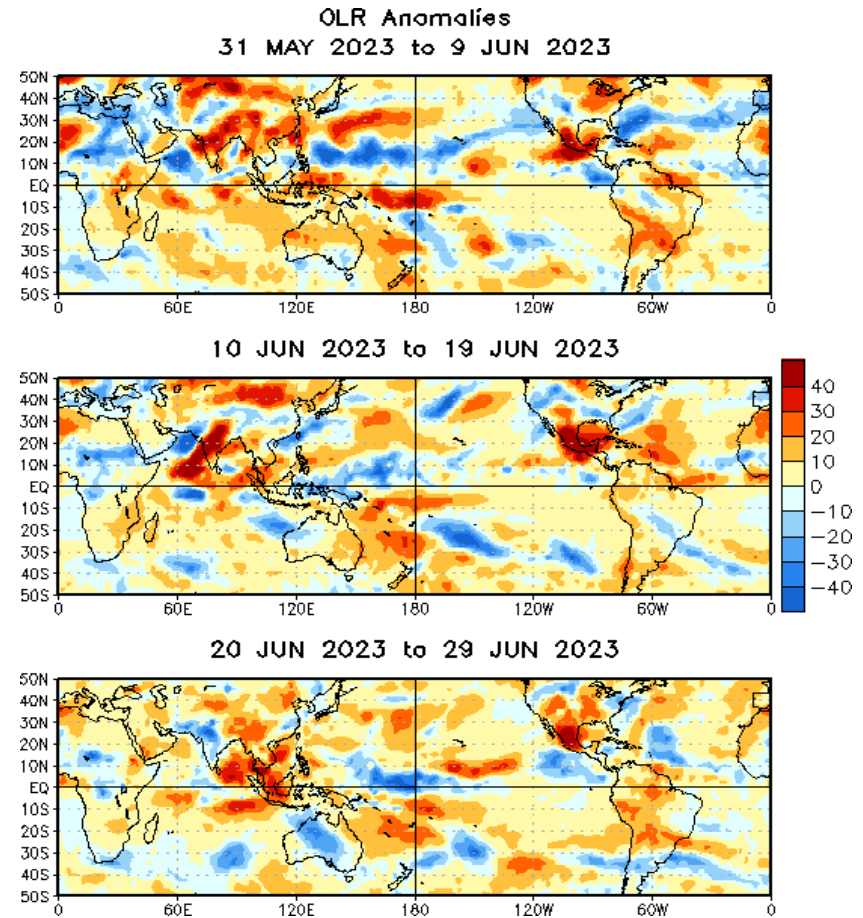
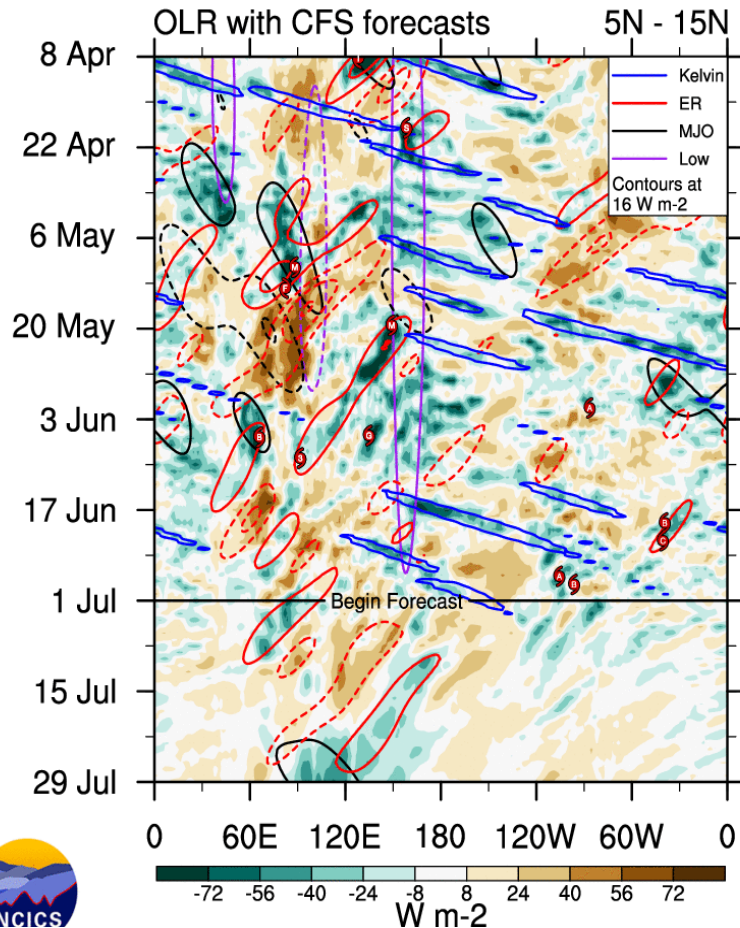


- An amplified pattern is present across much of the Southern Hemisphere.
- Increased trade winds across the central Pacific may indicate a brief interruption in the atmospheric response to El Niño.
- The overall low-level wind pattern is incoherent across the tropics.

Outgoing Longwave Radiation (OLR) Anomalies

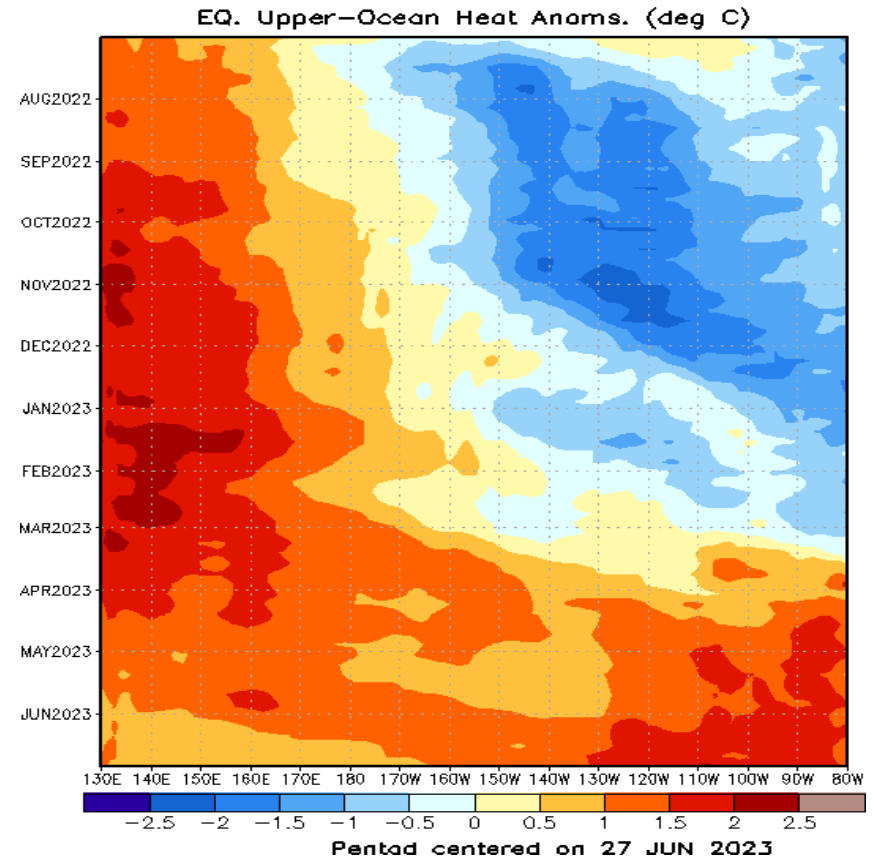
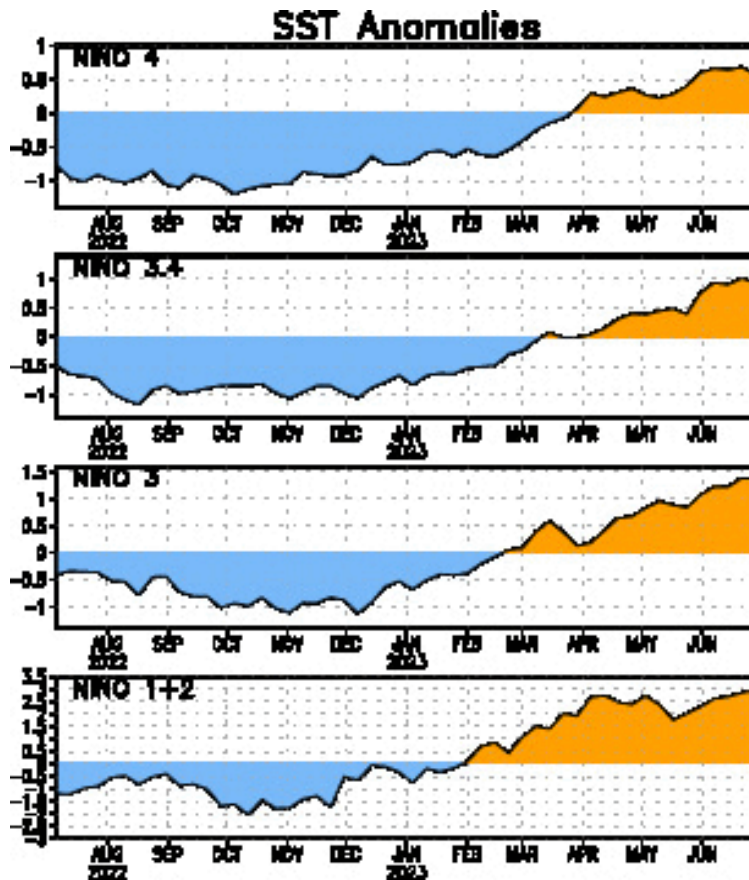
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- Increased convection towards the end of June near the Date Line may reflect a response to warm SSTs.
- Enhanced convection began to build across the East Pacific towards the end of June, with two new tropical cyclone formations.
- The CFS forecast is not indicative of MJO activity, though increased convection builds across the eastern Indian Ocean and Maritime Continent towards the end of July.

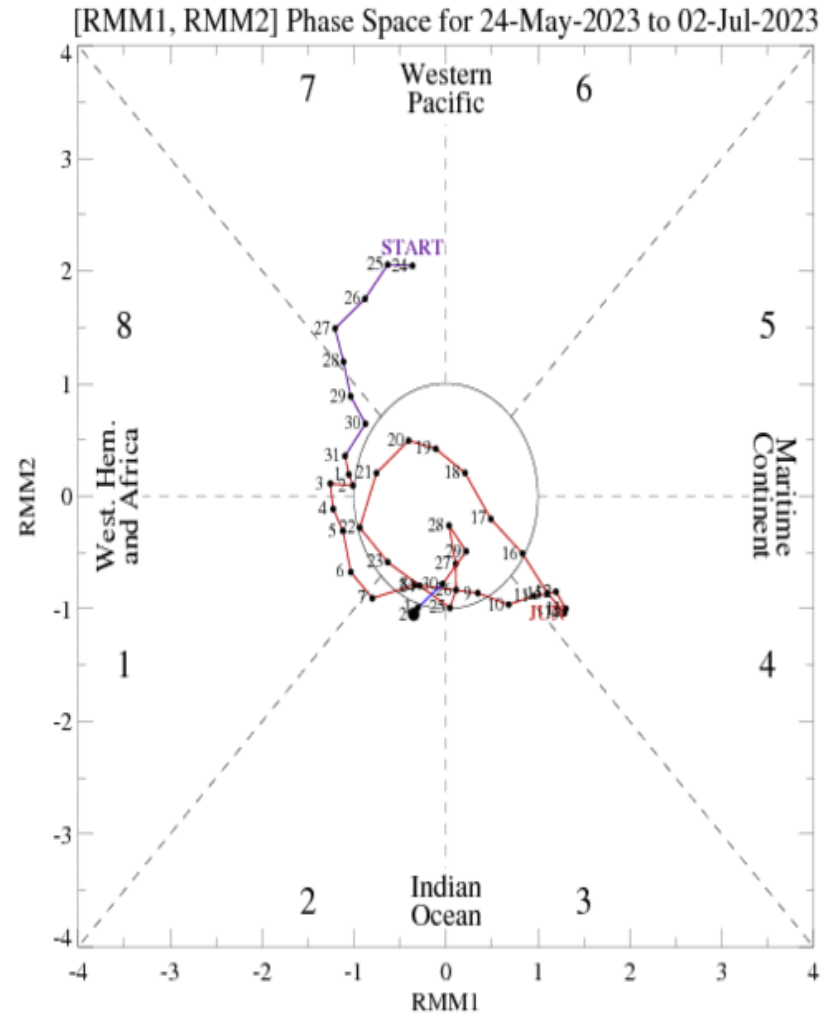
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Per the June 8, 2023 update, El Niño conditions are now present across the equatorial Pacific.
- Above-normal oceanic subsurface temperatures are present across the entire equatorial Pacific, with the largest positive anomalies over the eastern Pacific, representing a rapid transition since late 2022.
- Positive SST anomalies exist in all Niño regions.

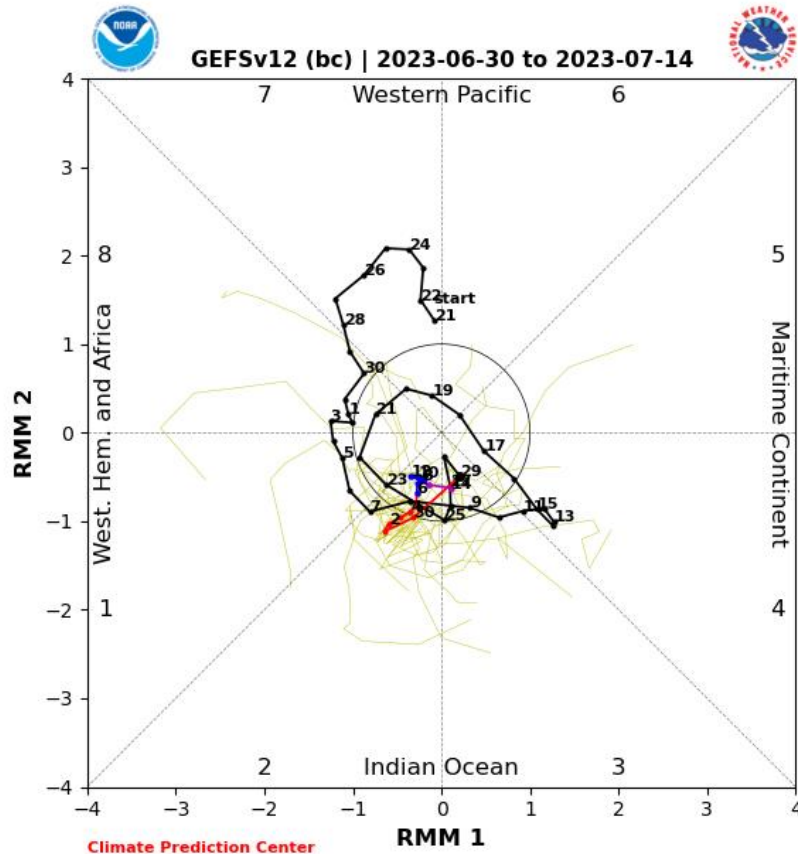
MJO Index: Recent Evolution

- The RMM-based MJO has remained largely weak, though amplitude over the Indian Ocean has increased in the last day or two in response to increased convection across the eastern Indian Ocean.

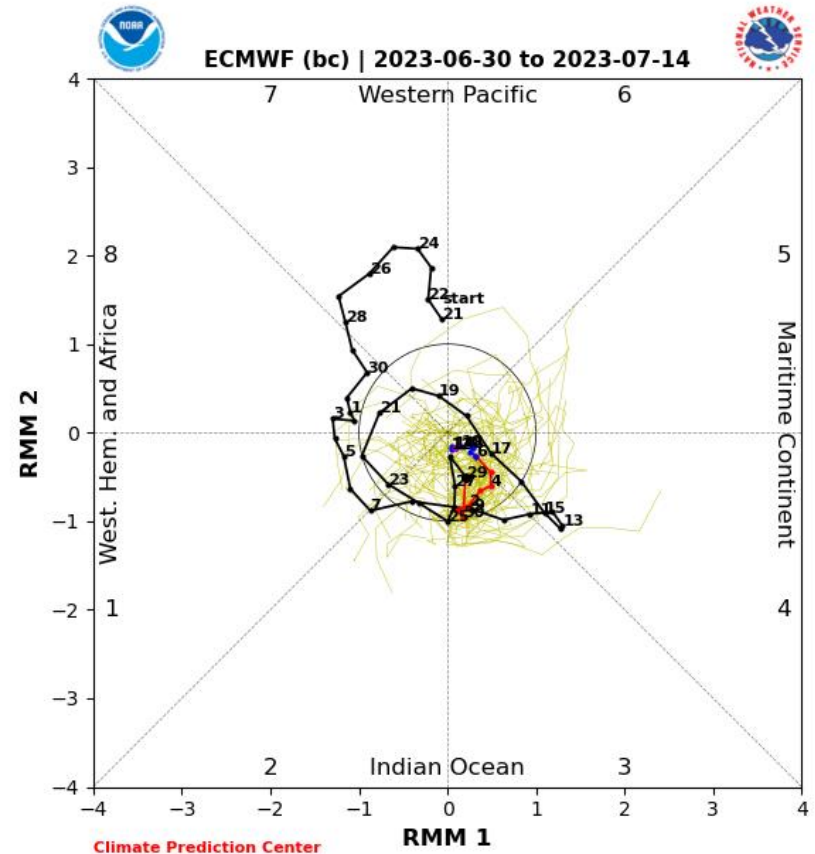


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



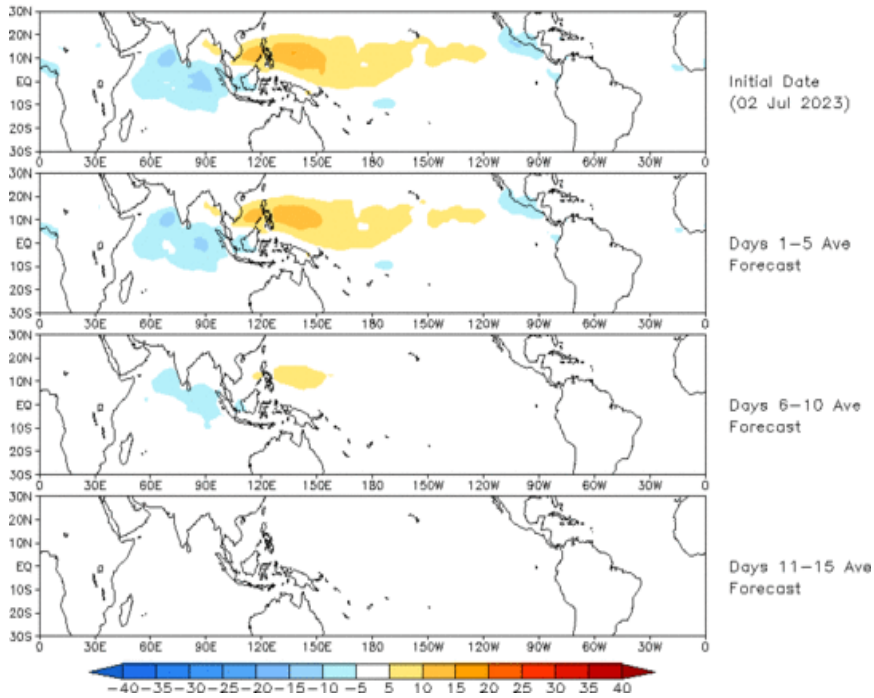
ECMWF Forecast

- Little eastward propagation is evident in the dynamical model MJO index forecasts, though some ECMWF ensemble members show propagation across the Maritime Continent during Week-2.
- Longer-range ECMWF forecasts show some indication of MJO activity crossing the West Pacific during Week-3.
- The GEFS generally reflects an enhanced signal over the Indian Ocean. The IOD signal is currently weak, but this enhancement could be related to the evolving ENSO base state.

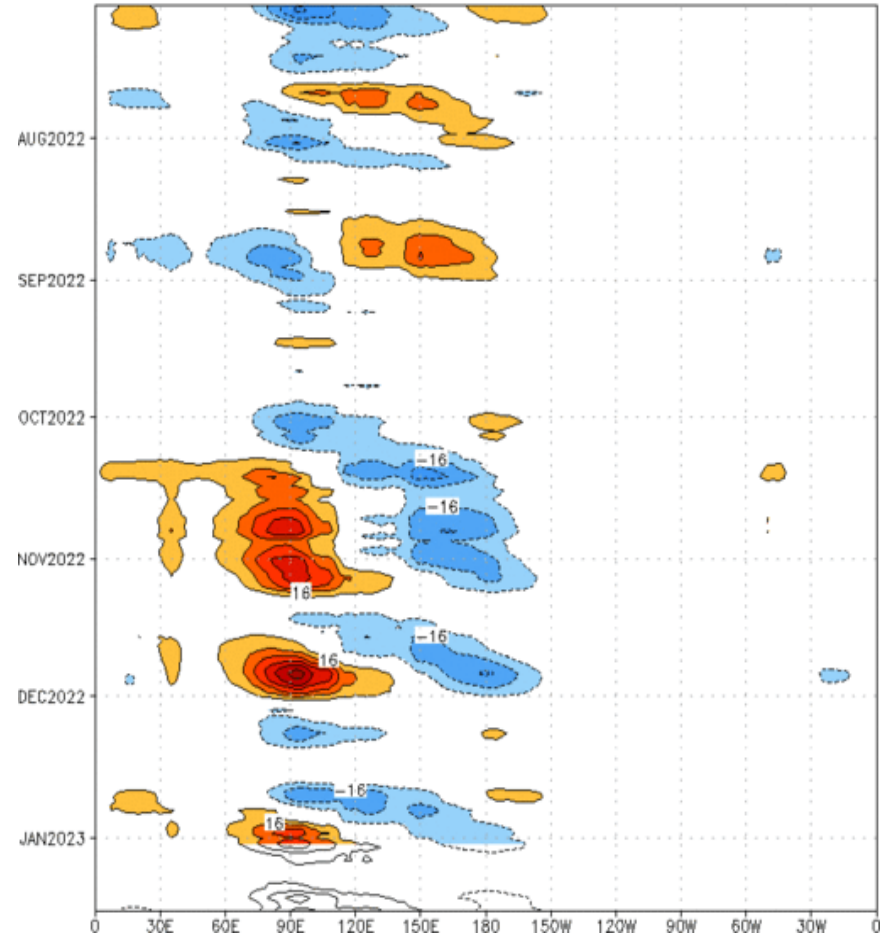
MJO: GEFS Forecast Evolution

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: 02 Jul 2023
OLR



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

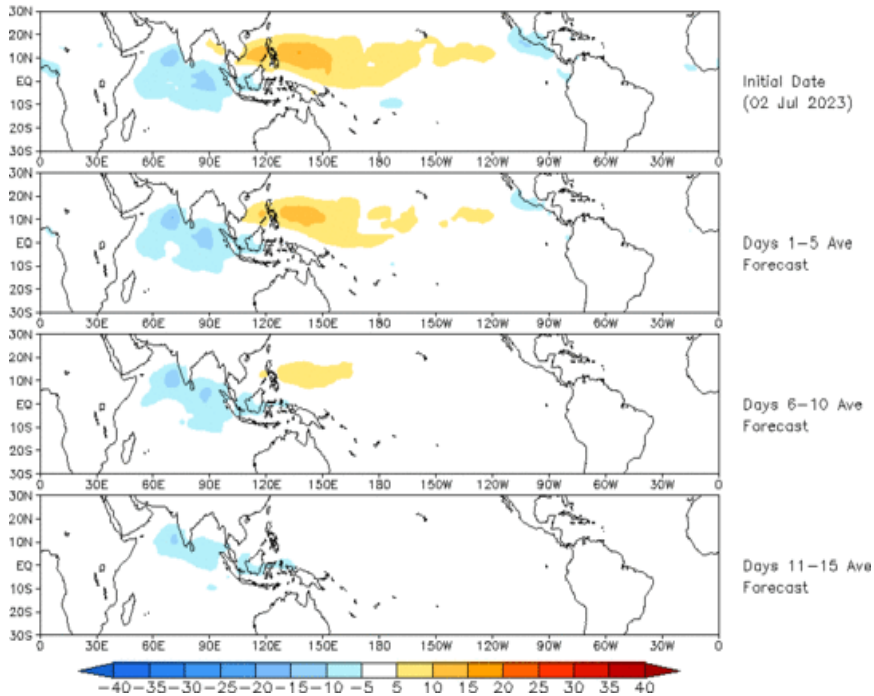


- The GEFS RMM-based OLR forecast depicts an Indian Ocean signal that remains largely stationary and weakens over the next two weeks.

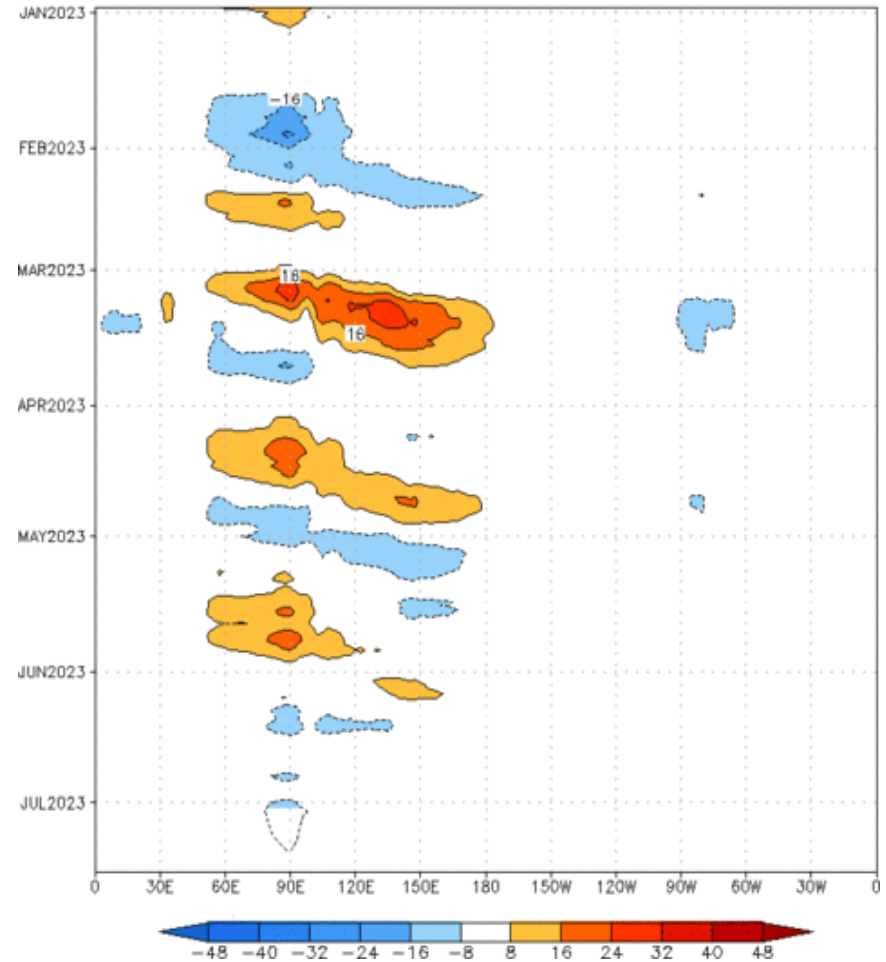
MJO: Constructed Analog Forecast Evolution

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 (02 Jul 2023)



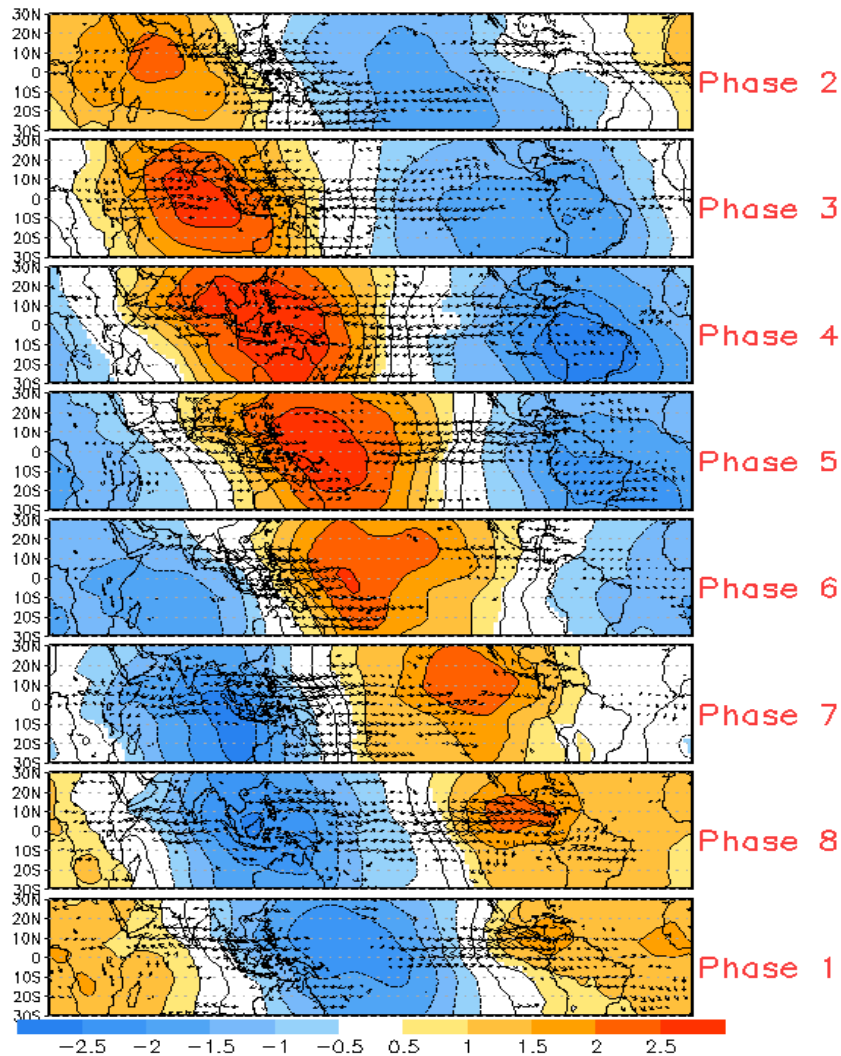
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:31-Dec-2022 to 02-Jul-2023
The unfilled contours are CA forecast reconstructed anomaly for 15 days



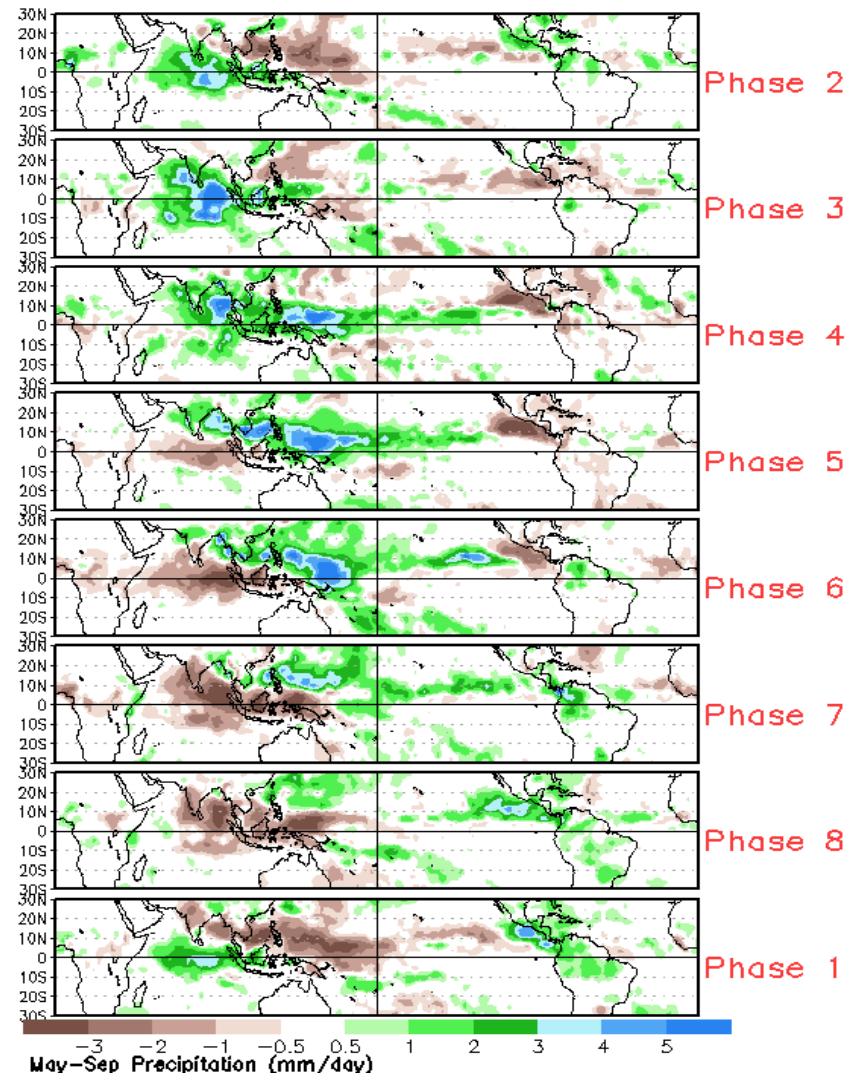
- The constructed analog RMM-based forecast is quite similar to the GEFS.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



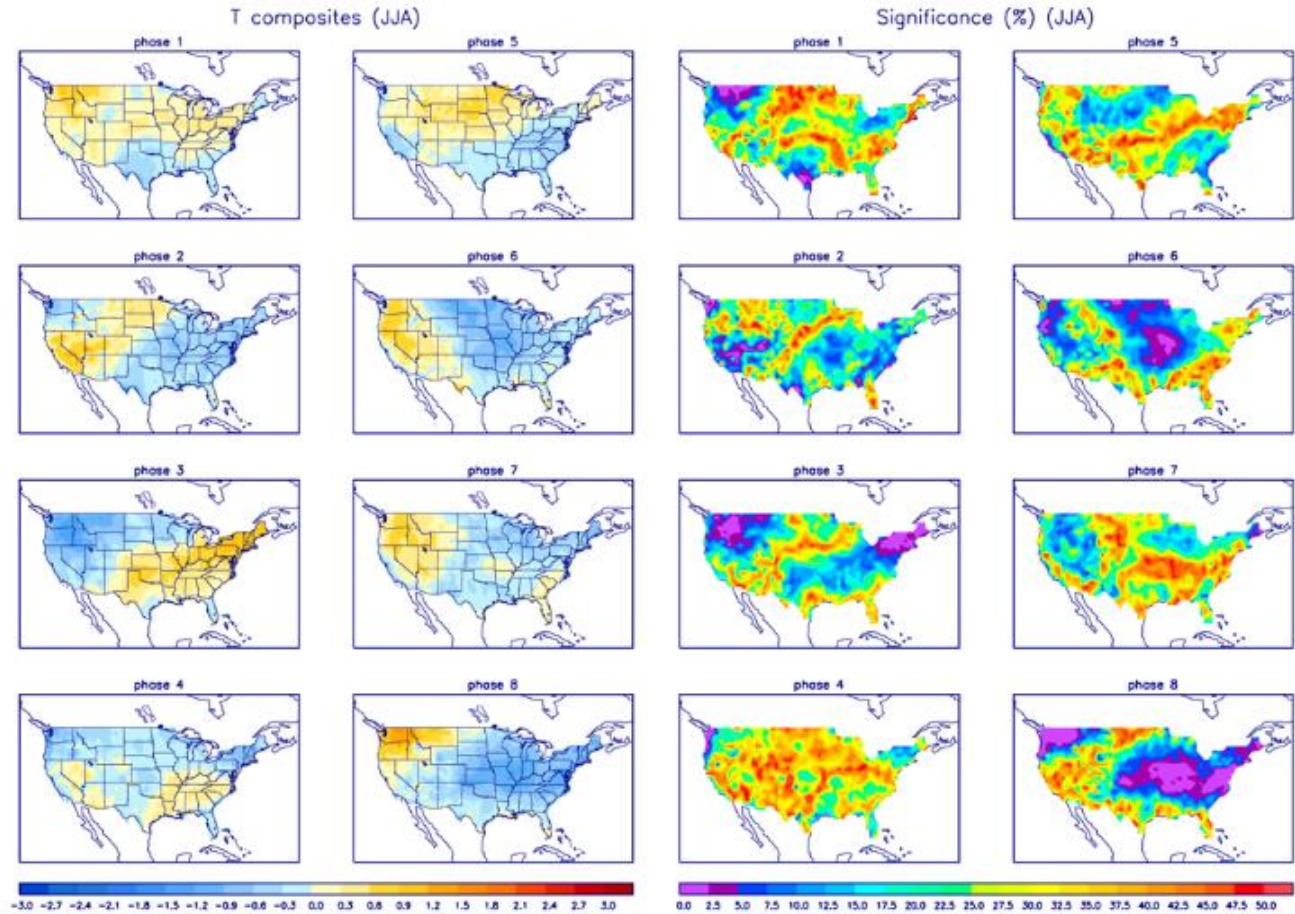
Precipitation Anomalies



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.

