

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



**Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
12 June 2023**

Overview

- A weak RMM-based MJO signal has propagated across the Western Hemisphere and into the Indian Ocean at the end of May and into early June.
- While RMM-based forecasts generally depict a weakening of the signal back into the unit circle, upper-level velocity potential based MJO forecasts are more robust, depicting the MJO propagating across the Pacific, possibly enhanced by the low frequency El Niño state.
- Tropical cyclogenesis is most favored across the Western Pacific during the next two weeks as the enhanced convective envelope shifts eastward, and this increased potential may spread into the Eastern Pacific by week-2.
- Relatively quieter conditions are forecast across the Indian Ocean due to the suppressed phase of the MJO.

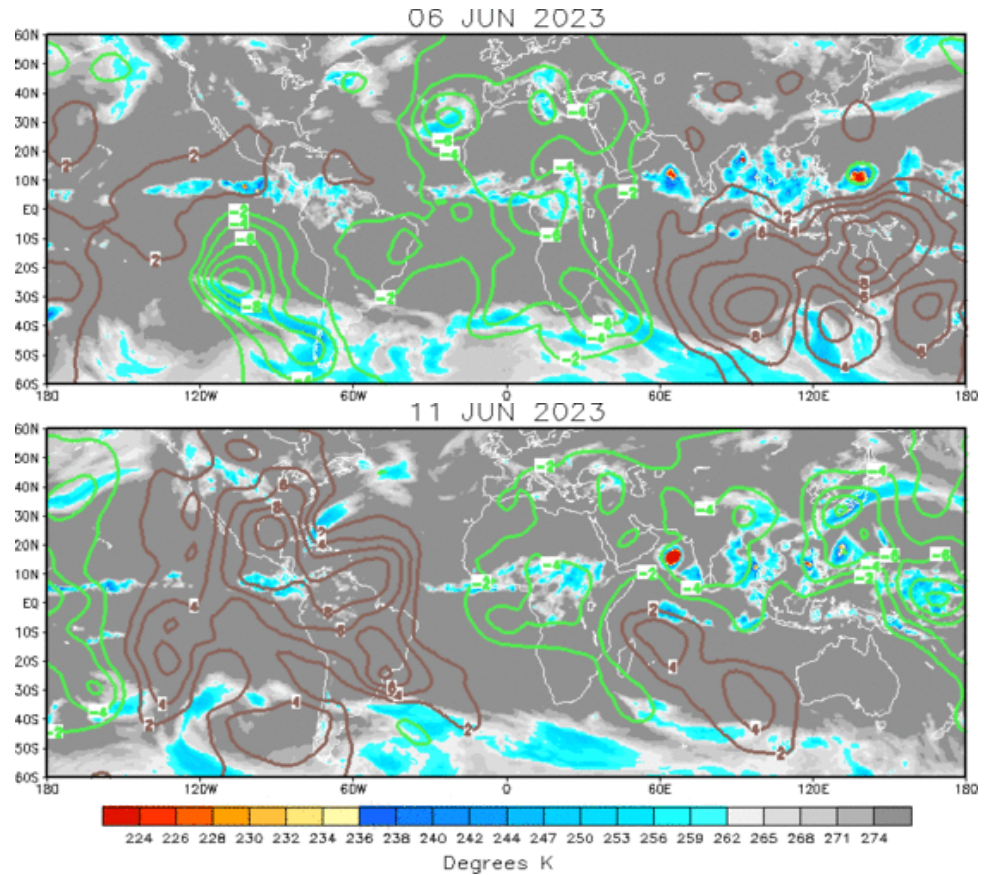
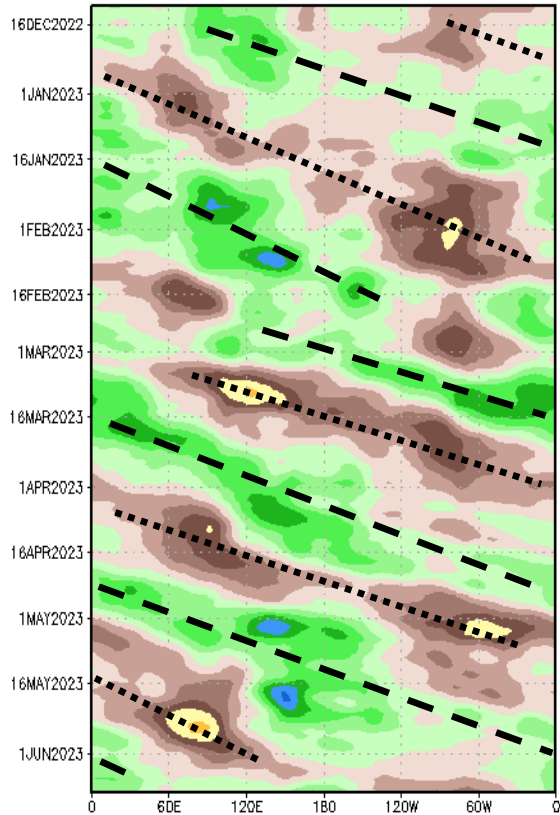
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

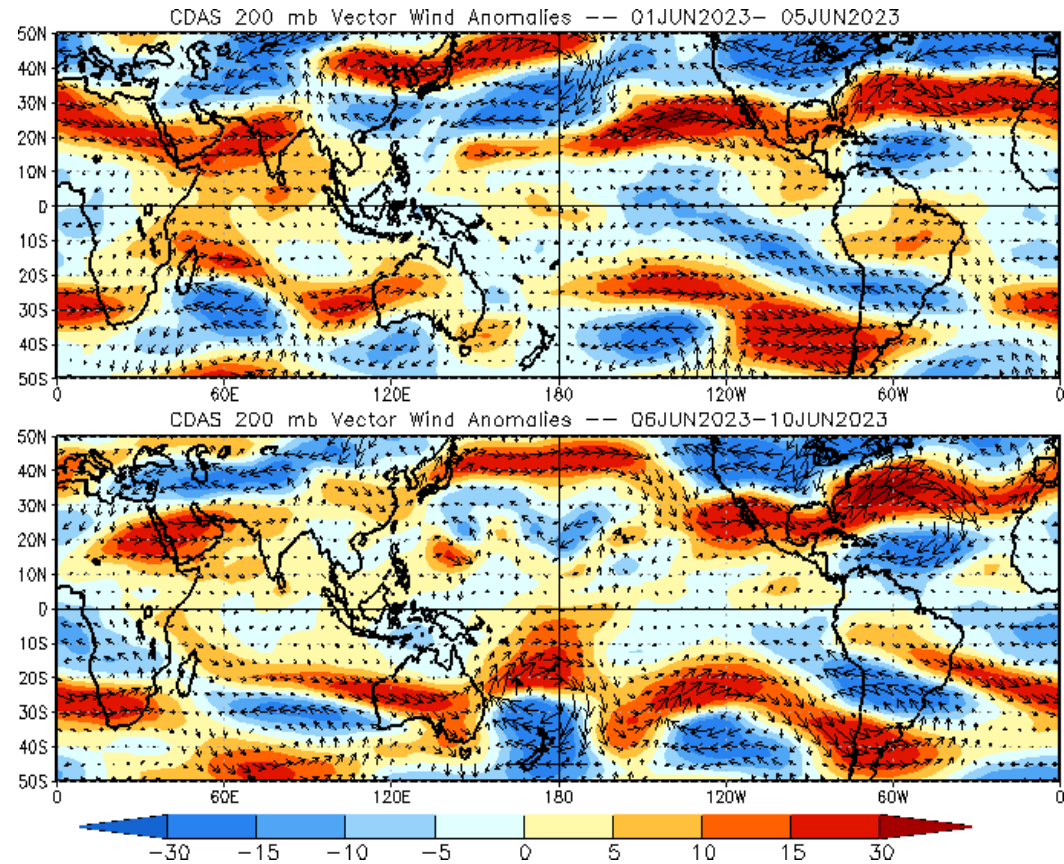
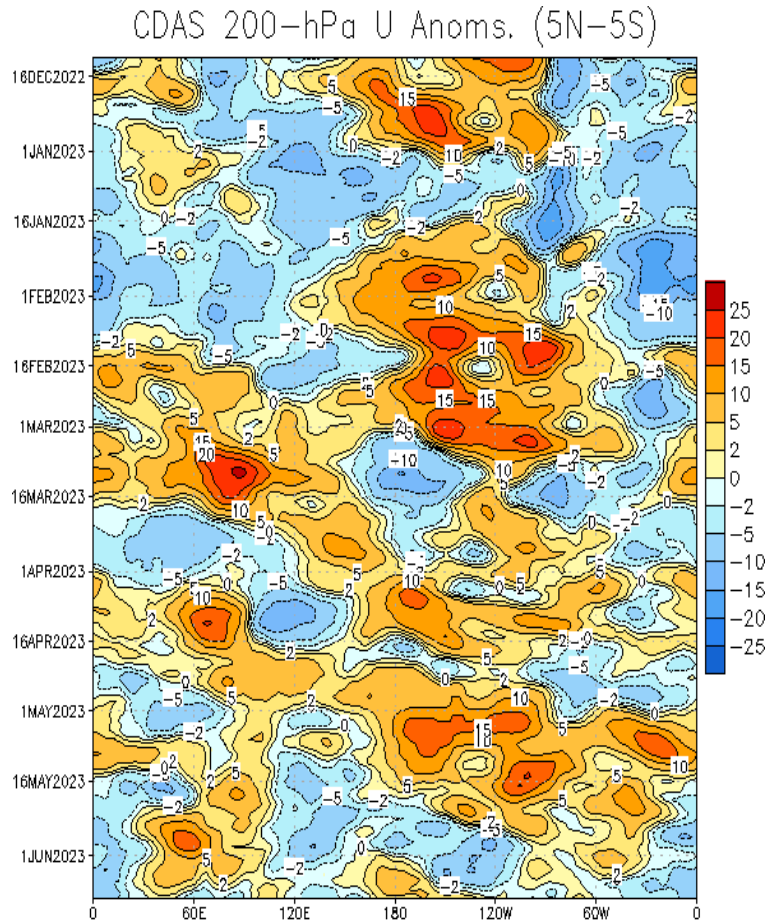
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- Enhanced upper-level divergence shifted across Asia and the Western Pacific due to influence from the MJO as well as El Niño, with anomalous upper-level convergence remaining across the southern Indian Ocean.
- Anomalous upper-level convergence expanded across the Americas, Western Atlantic, and Eastern Pacific during the past week in the wake of the departing MJO.

200-hPa Wind Anomalies

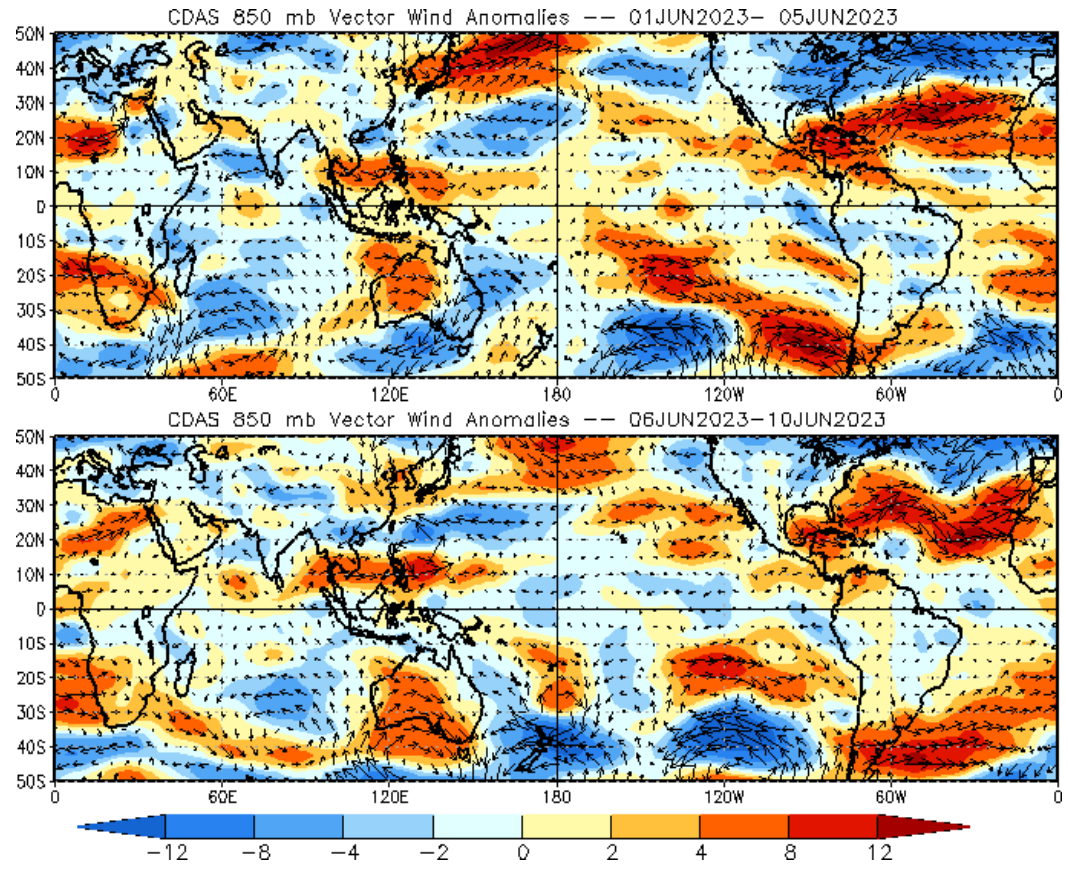
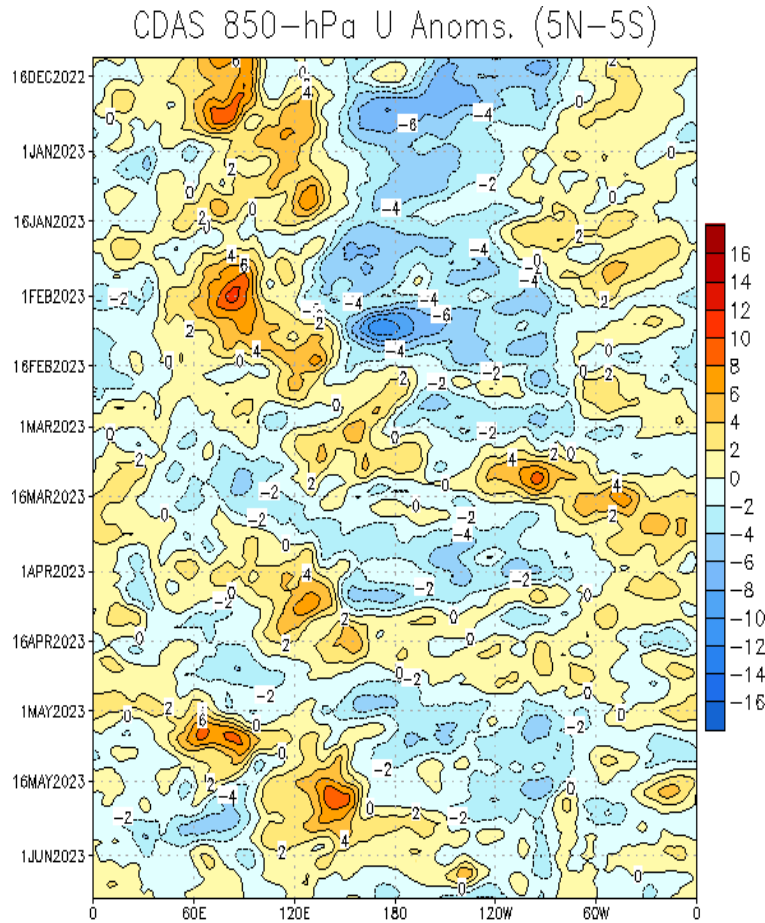
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Across the tropics, the upper-level wind anomalies are largely incoherent, although some expansion of anomalous upper-level westerlies is noted across the Western Pacific.
- An enhanced subtropical jet continues to be present across the eastern Pacific, extending across Mexico and into the Atlantic, likely resulting in diminished tropical cyclone activity across both basins.

850-hPa Wind Anomalies

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

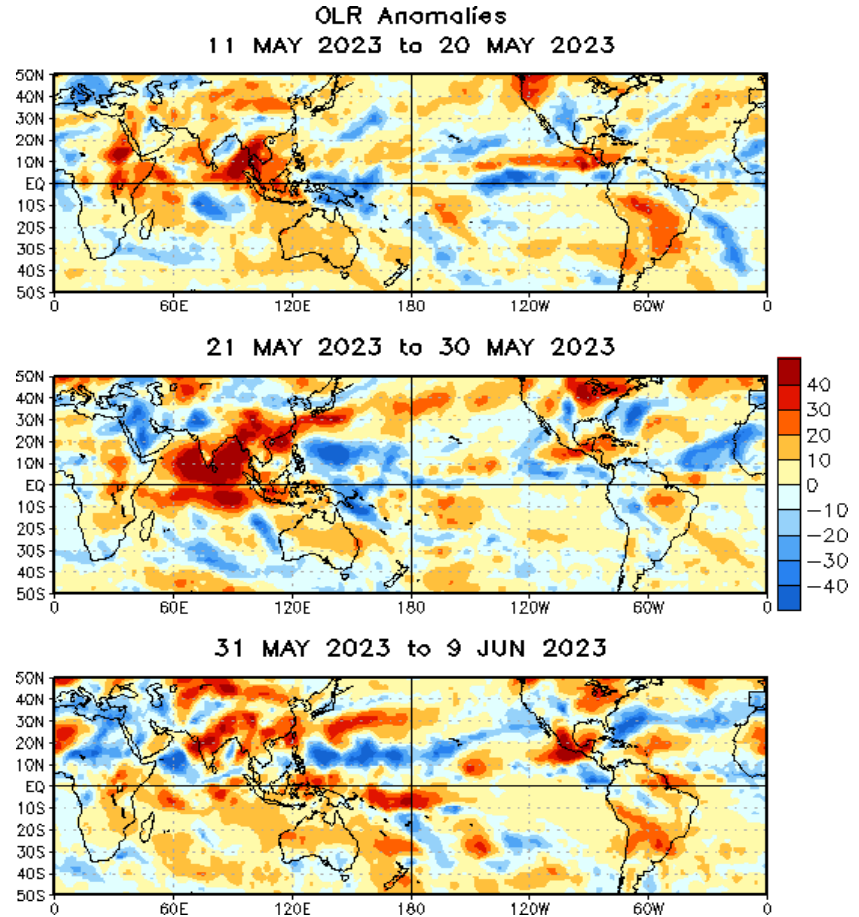
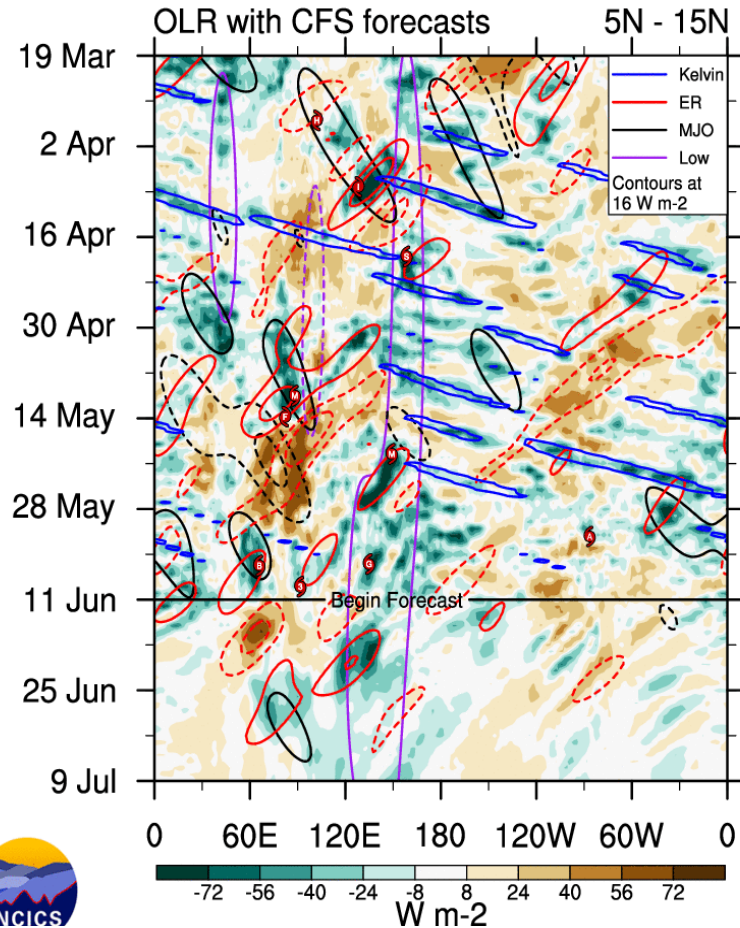


- Anomalous low-level westerlies persist across portions of southeastern Asia and the western-north Pacific.
- Cyclonic circulations are noted near the Philippines associated with Typhoon Guchol, and across southwestern Australia leading to increased onshore flow and enhanced rainfall.
- Surface low pressure over the North Atlantic resulted in anomalous northerly flow across the eastern United States leading to below-normal temperatures.

Outgoing Longwave Radiation (OLR) Anomalies

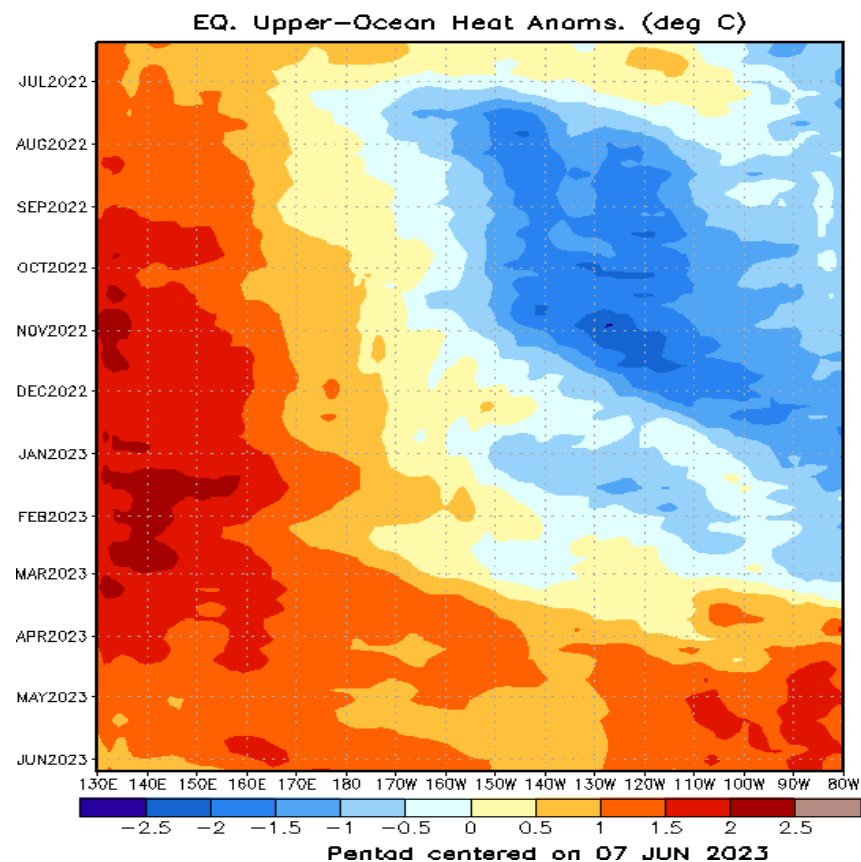
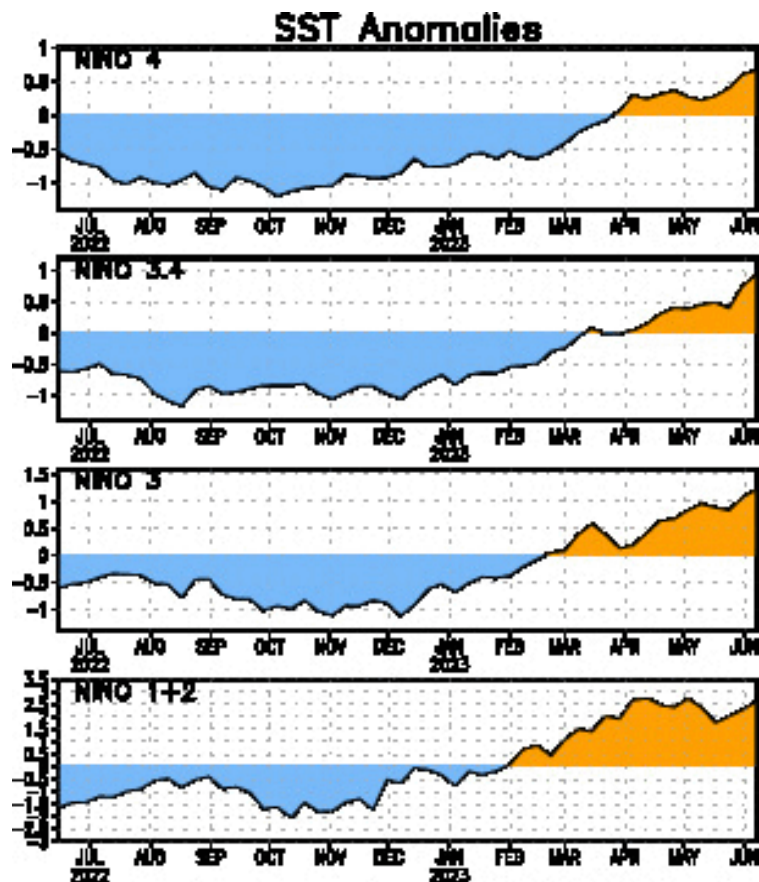
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- Positive OLR anomalies have weakened across the North Indian Ocean in early June, tied to the MJO and the development of Cyclone Biparjoy (Arabian Sea) and Tropical Cyclone 03B (Bay of Bengal).
- Enhanced Rossby Wave activity and the low frequency El Niño state are expected to result in negative OLR anomalies persisting across the western-north Pacific through early July.

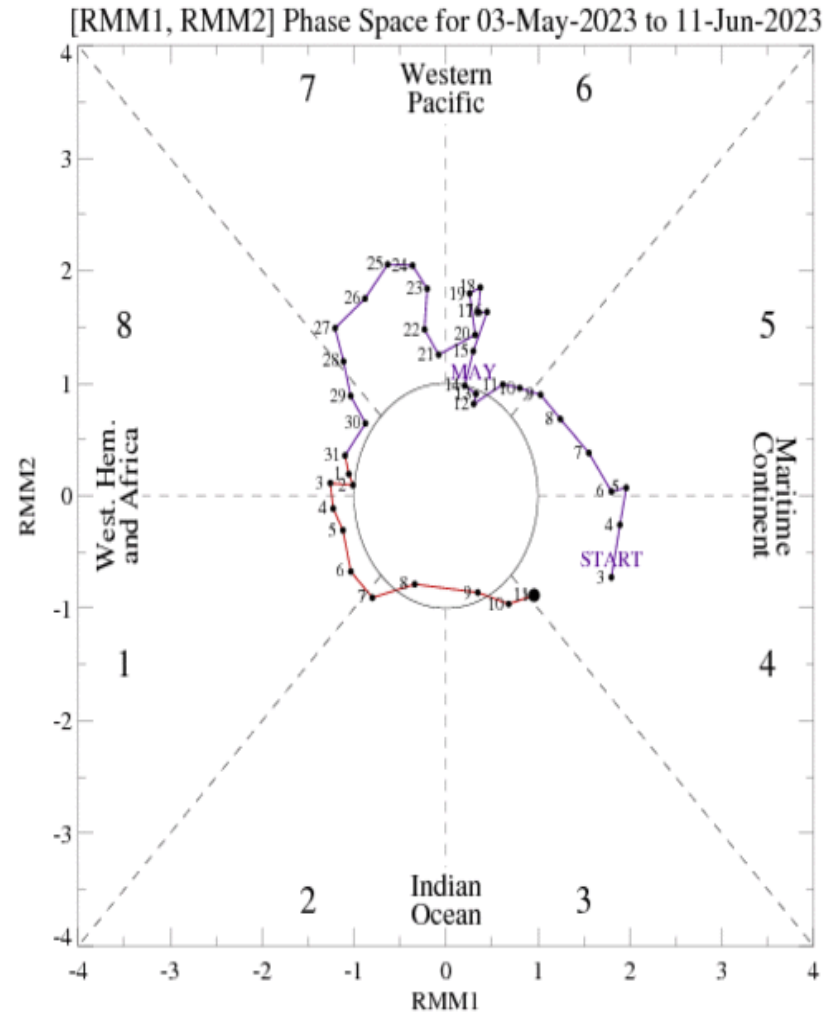
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- 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.
- SSTs in all of the Niño basins continue to trend upward.

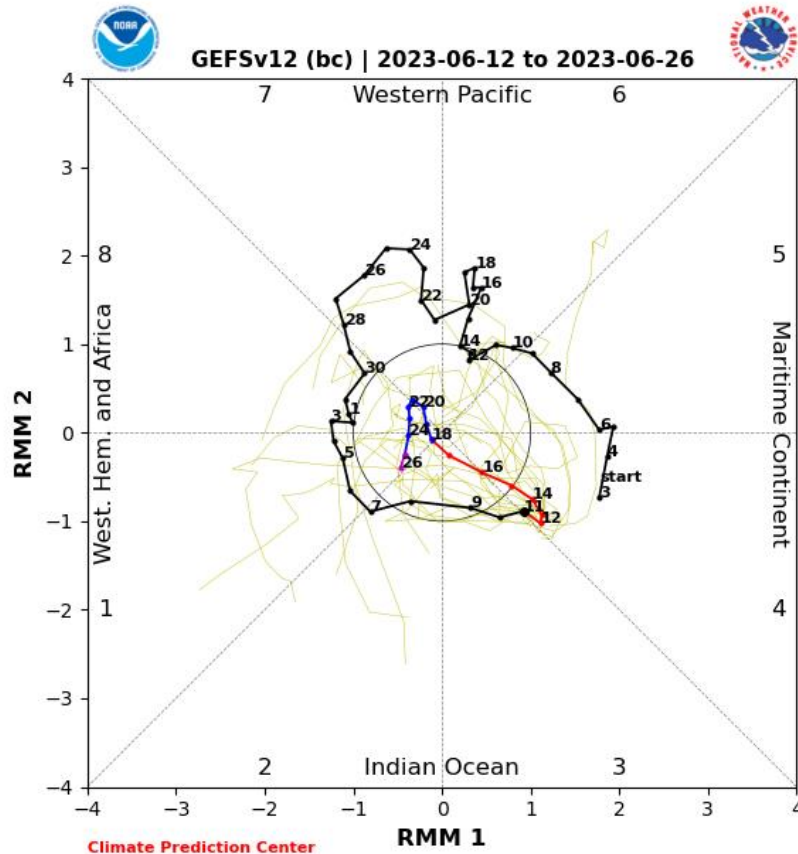
MJO Index: Recent Evolution

- The RMM-based index depicts a weak MJO signal propagating eastward across the Western Hemisphere and Indian Ocean at the end of May and into early June.

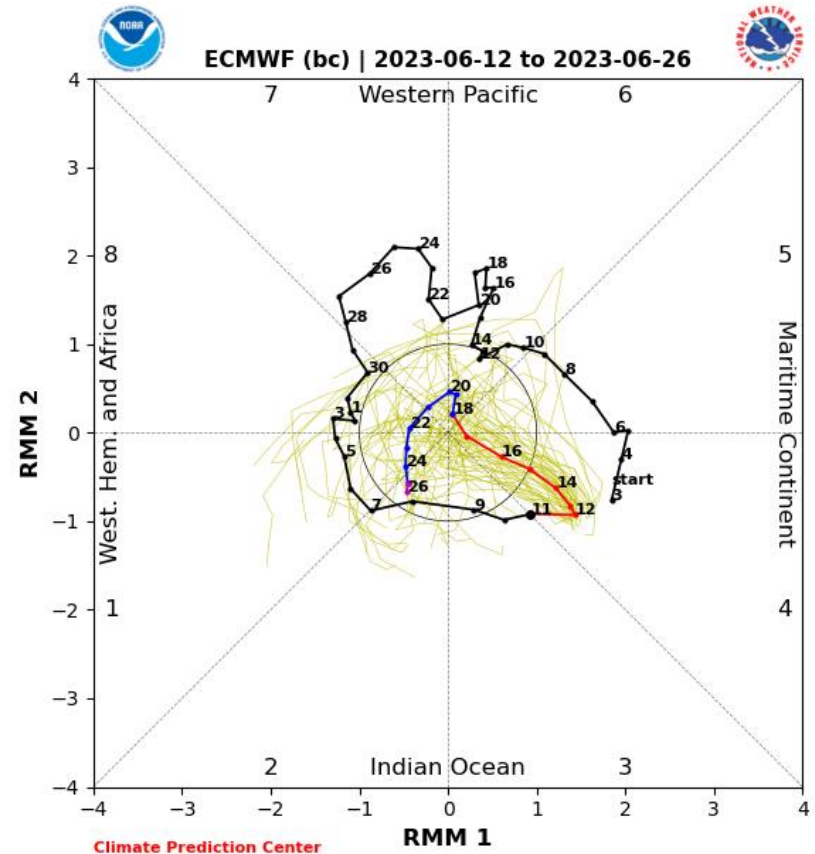


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



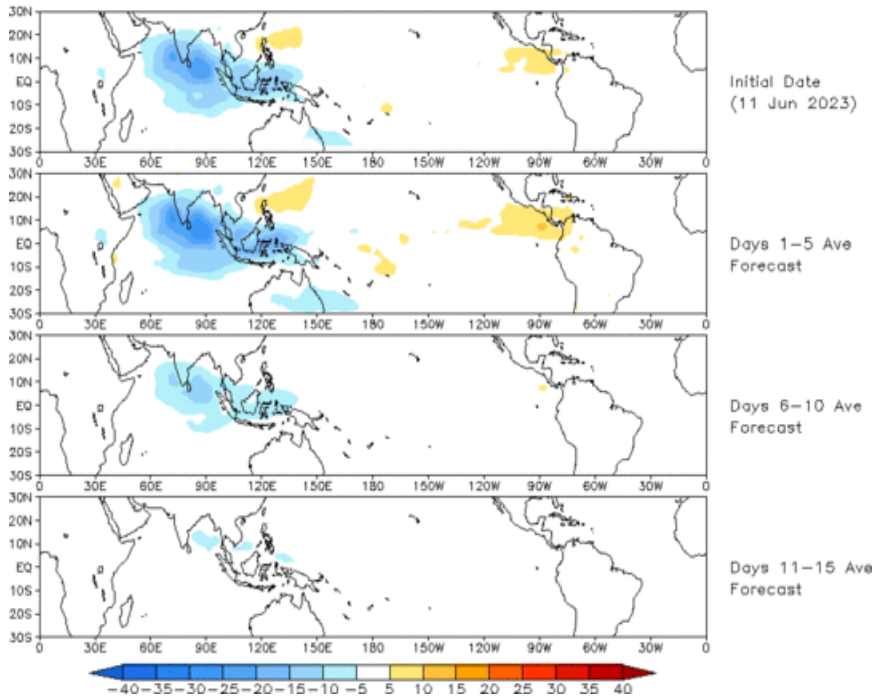
ECMWF Forecast

- Both the GEFS and ECMWF ensembles depict a weakening of the RMM-based MJO signal during the next week.
- However, a stronger MJO signal comes through the upper-level velocity potential filtering across the Maritime Continent and Western Pacific, perhaps aided by the low frequency El Niño state.
- Some individual GEFS and ECMWF ensemble members depict a renewed emergence of the RMM-based MJO index across the Western Hemisphere during week-2.

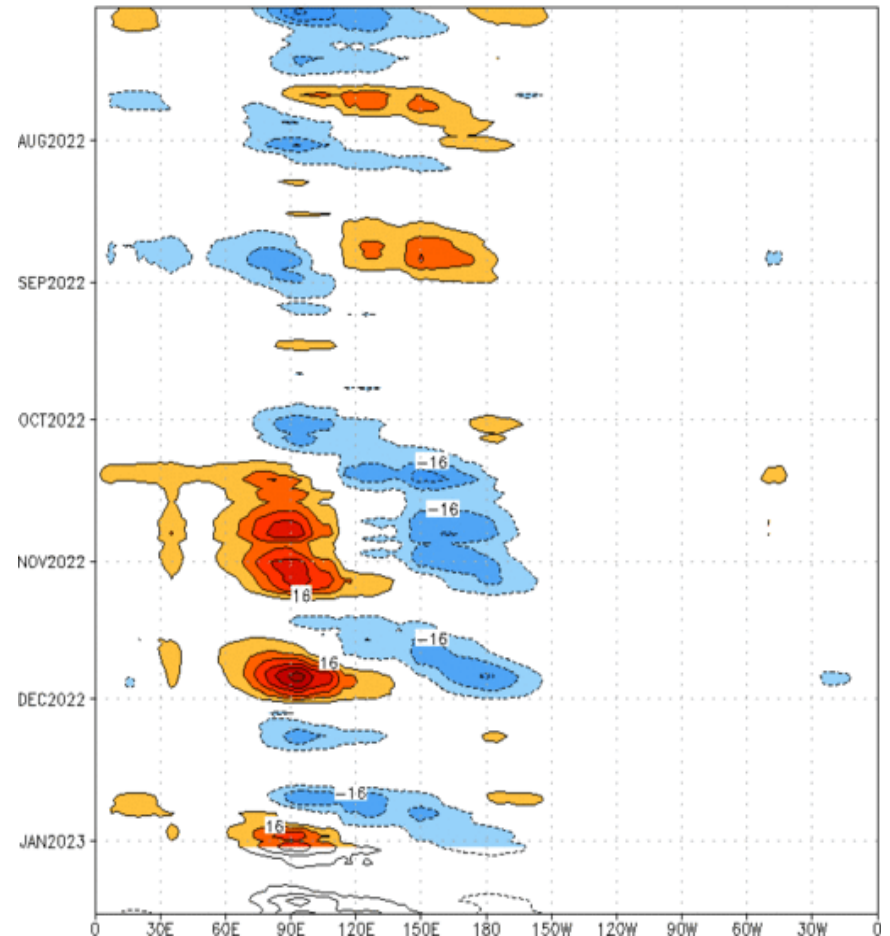
MJO: GEFS Forecast Evolution

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: 11 Jun 2023
OLR



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

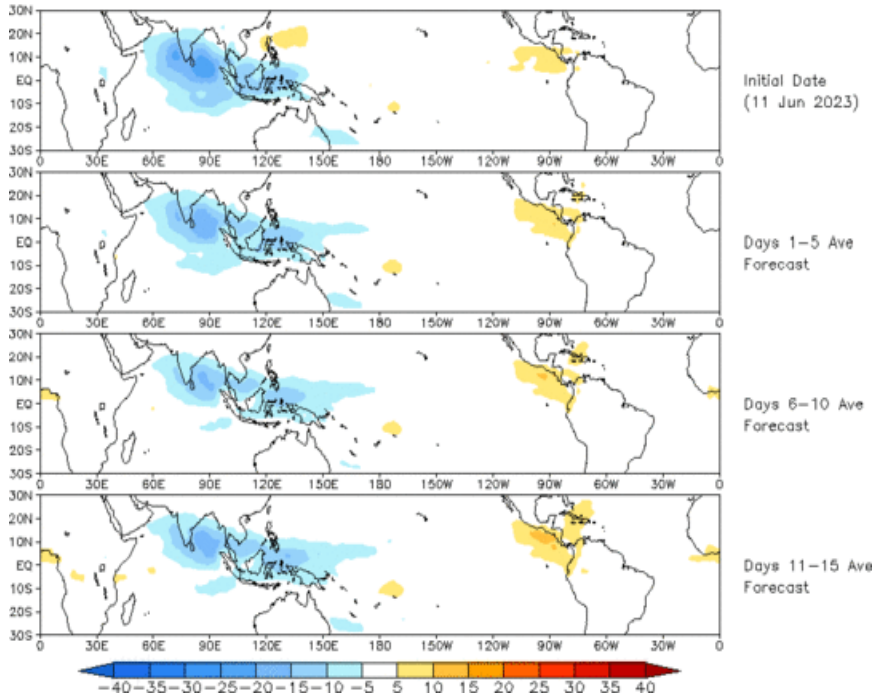


- The GEFS RMM-based OLR forecast depicts a gradual weakening of negative OLR anomalies (enhanced convection) across the Indian Ocean and Western Pacific.
- Positive OLR anomalies (suppressed convection) are noted across Central America and the eastern Pacific during week-1.

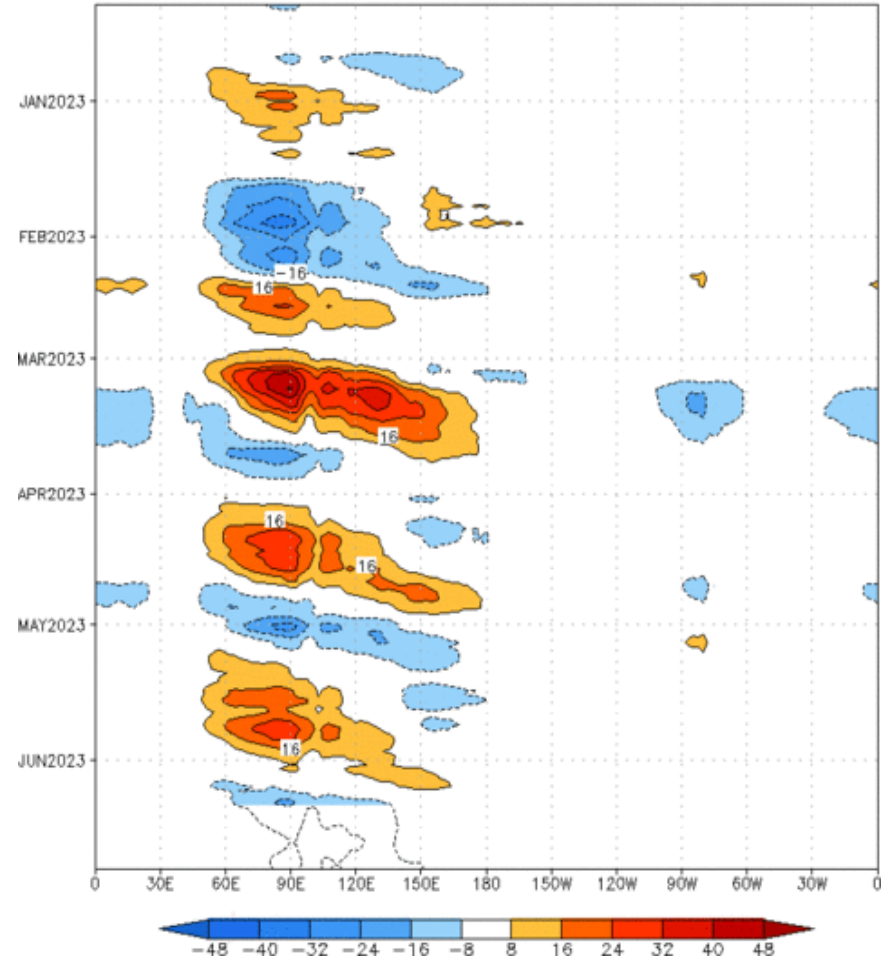
MJO: Constructed Analog Forecast Evolution

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 (11 Jun 2023)



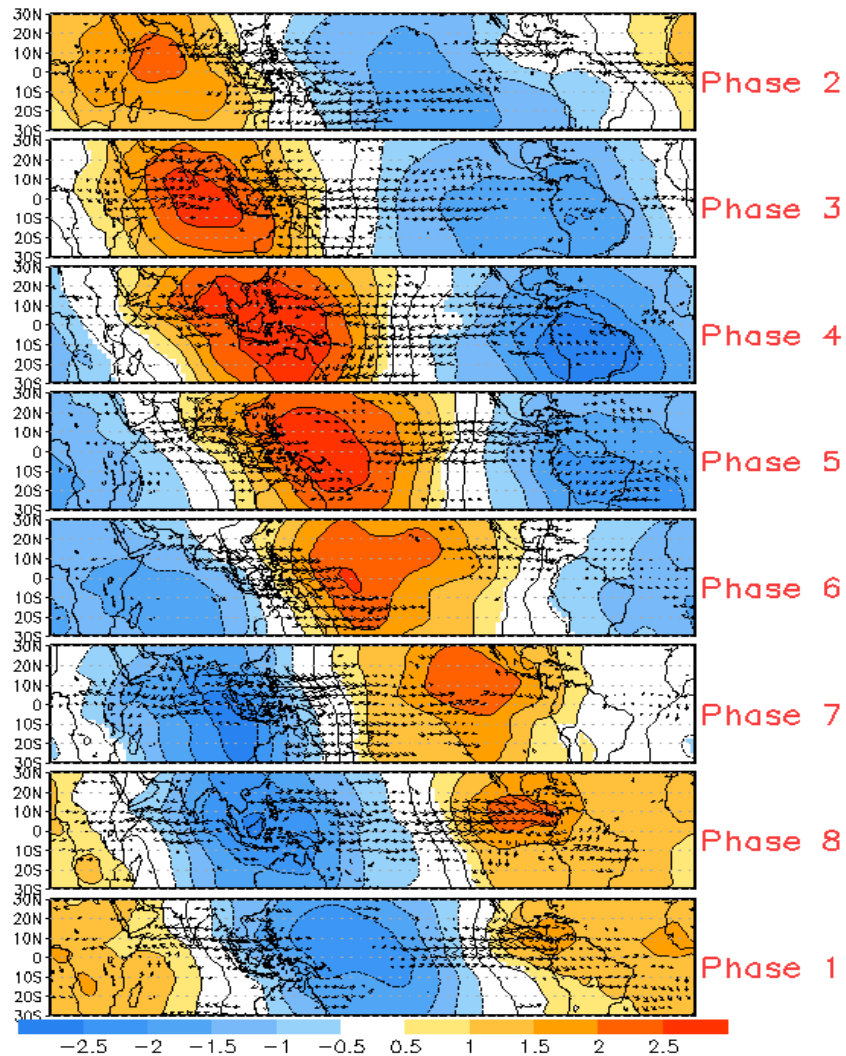
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:10-Dec-2022 to 11-Jun-2023
The unfilled contours are CA forecast reconstructed anomaly for 15 days



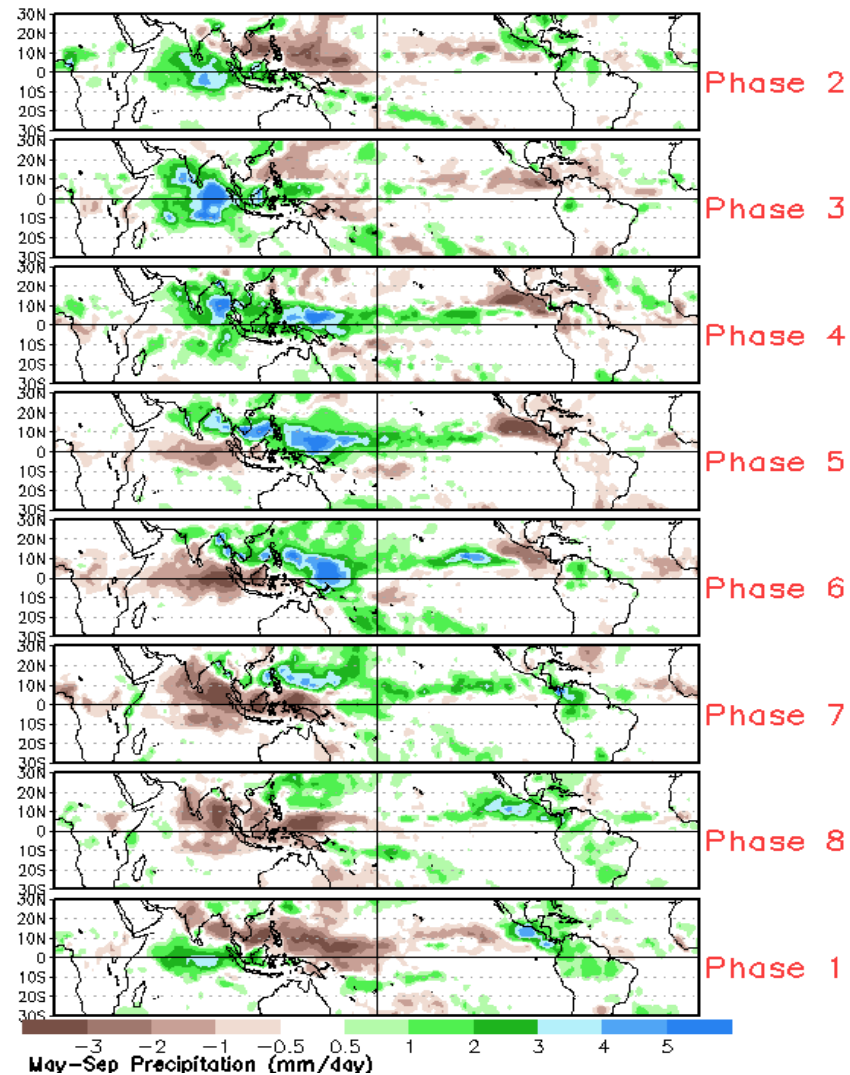
- The constructed analog RMM-based forecast persists the negative (positive) OLR anomalies across the Indian Ocean and Western Pacific (Eastern Pacific and Central America) into week-2, in contrast to the weakening signals in the GEFS forecast.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



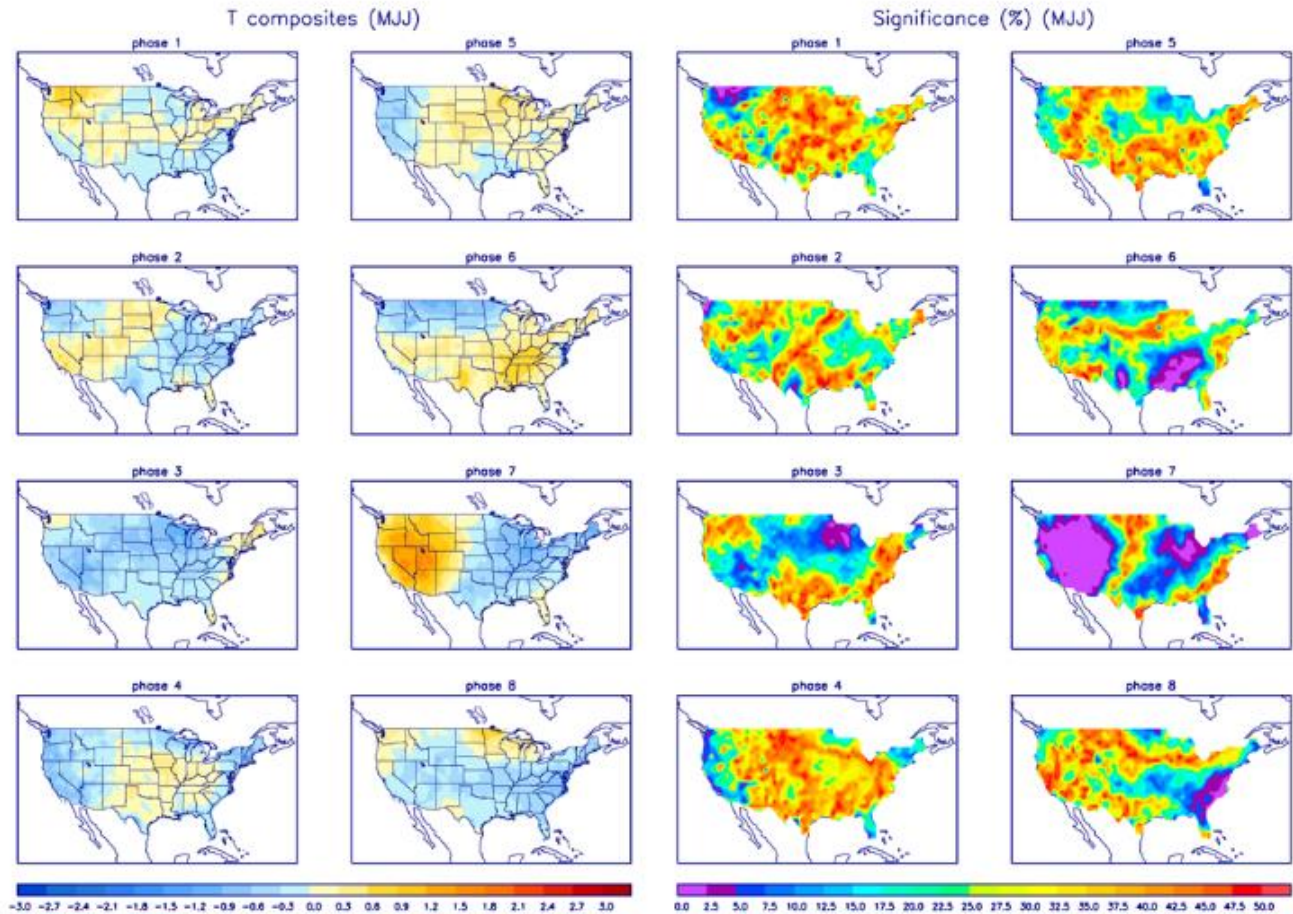
Precipitation Anomalies



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.

