

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



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
8 May 2023

Overview

- Robust MJO activity continues and has largely supplanted ENSO as the dominant mode of variability in the Tropics.
- Dynamical models depict continued MJO activity, with enhanced convective envelope moving from the Maritime Continent into the Western Pacific during the coming two weeks and suppressed convection emerging over the Indian Ocean by week-2.
- The enhanced MJO phase moving into phase 6 favors increased probabilities of tropical cyclone (TC) formation over the Western Pacific coinciding with a climatological uptick in TC activity over the basin.

A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

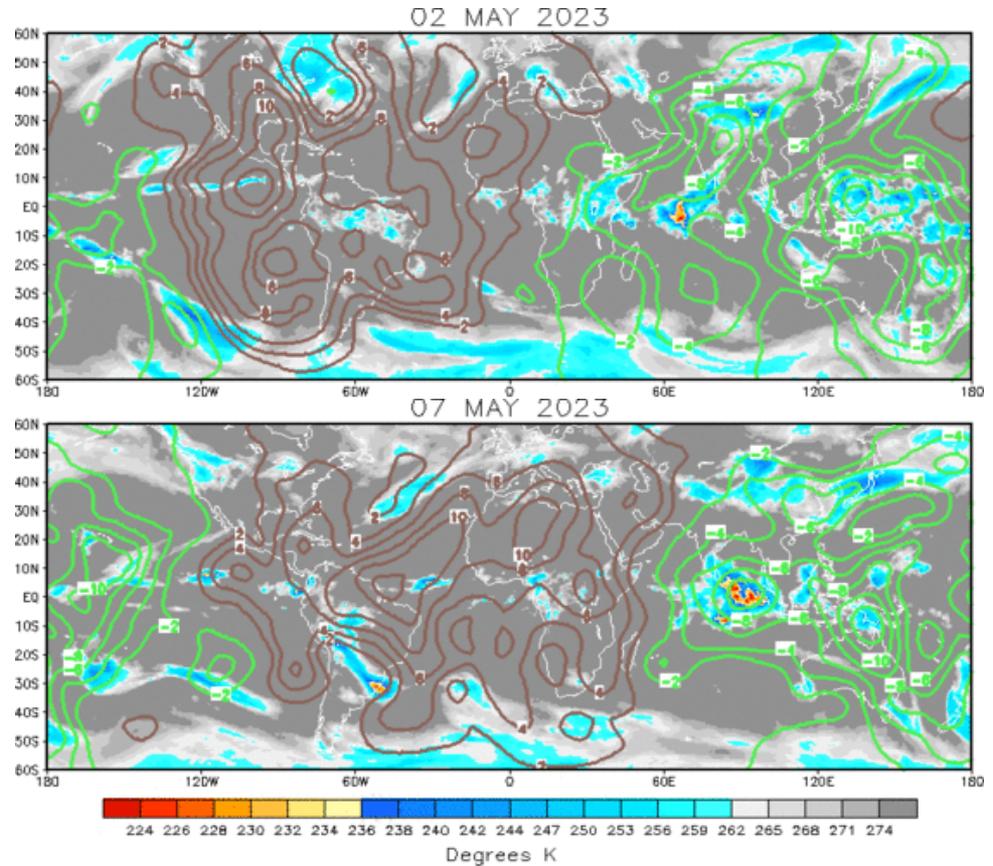
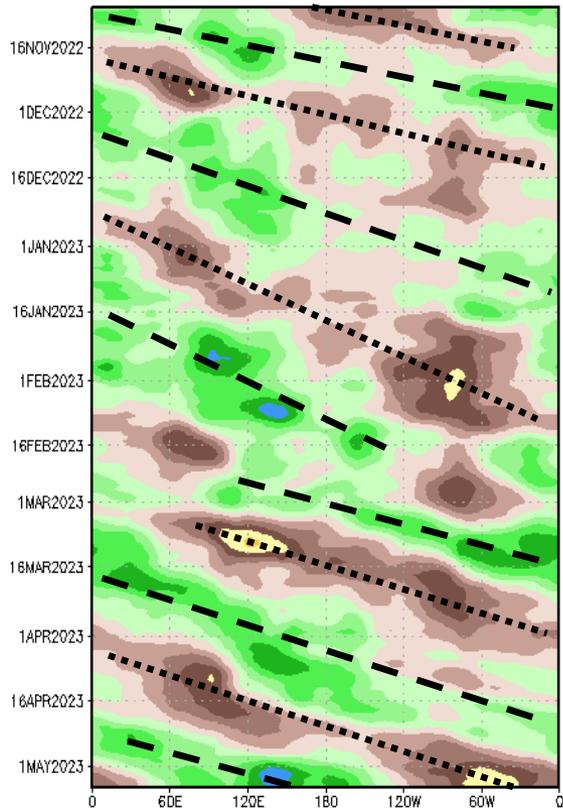
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

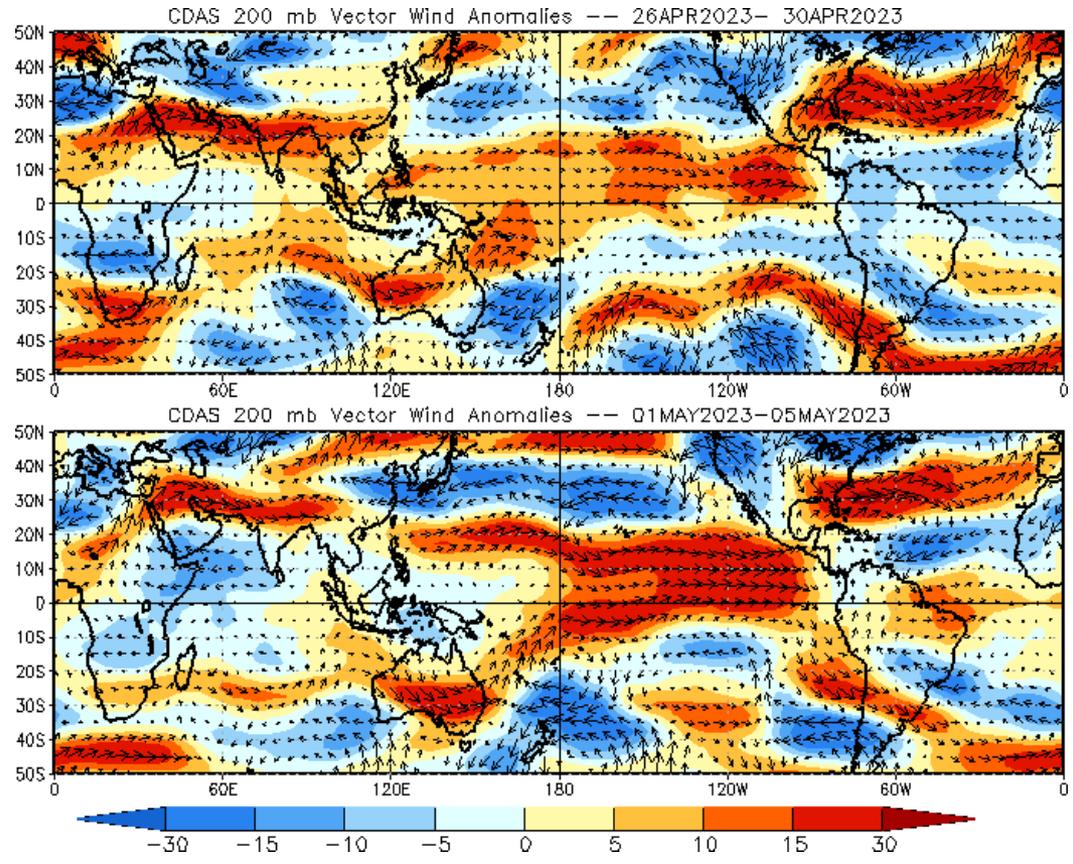
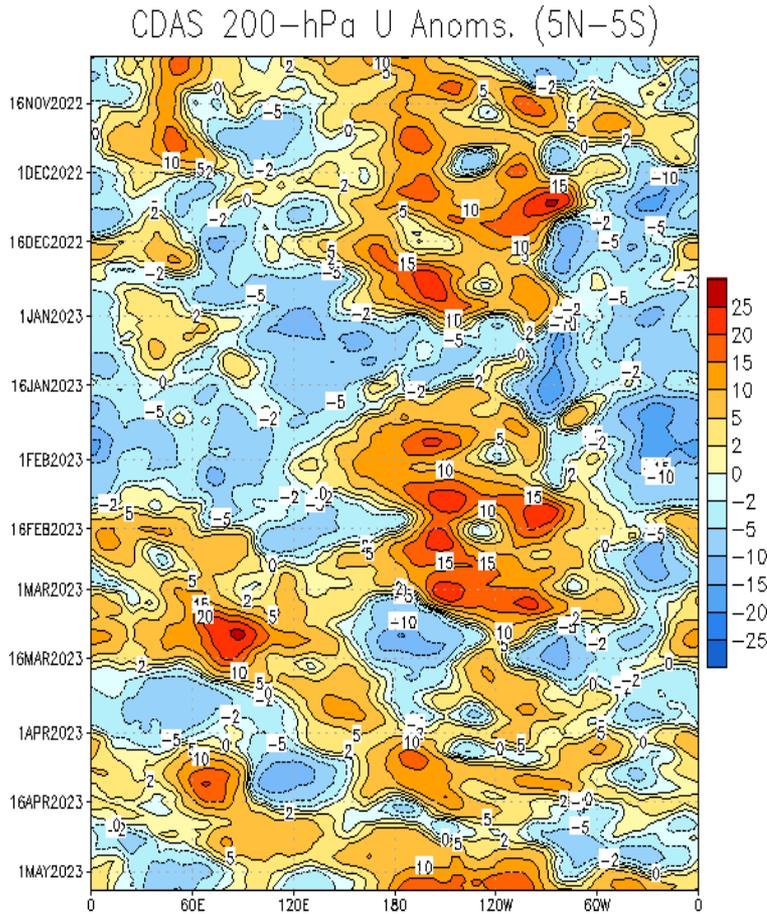
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- A wave-1 pattern is apparent in the spatial upper-level velocity potential field with anomalous divergence (convergence) aloft over the Indian Ocean and Maritime Continent (the Americas, the Atlantic, and Africa).
- Alternating periods of anomalous divergence and convergence propagated around the globe during the past few months, suggestive of the MJO superceding ENSO as the dominant mode of variability in the tropics.

200-hPa Wind Anomalies

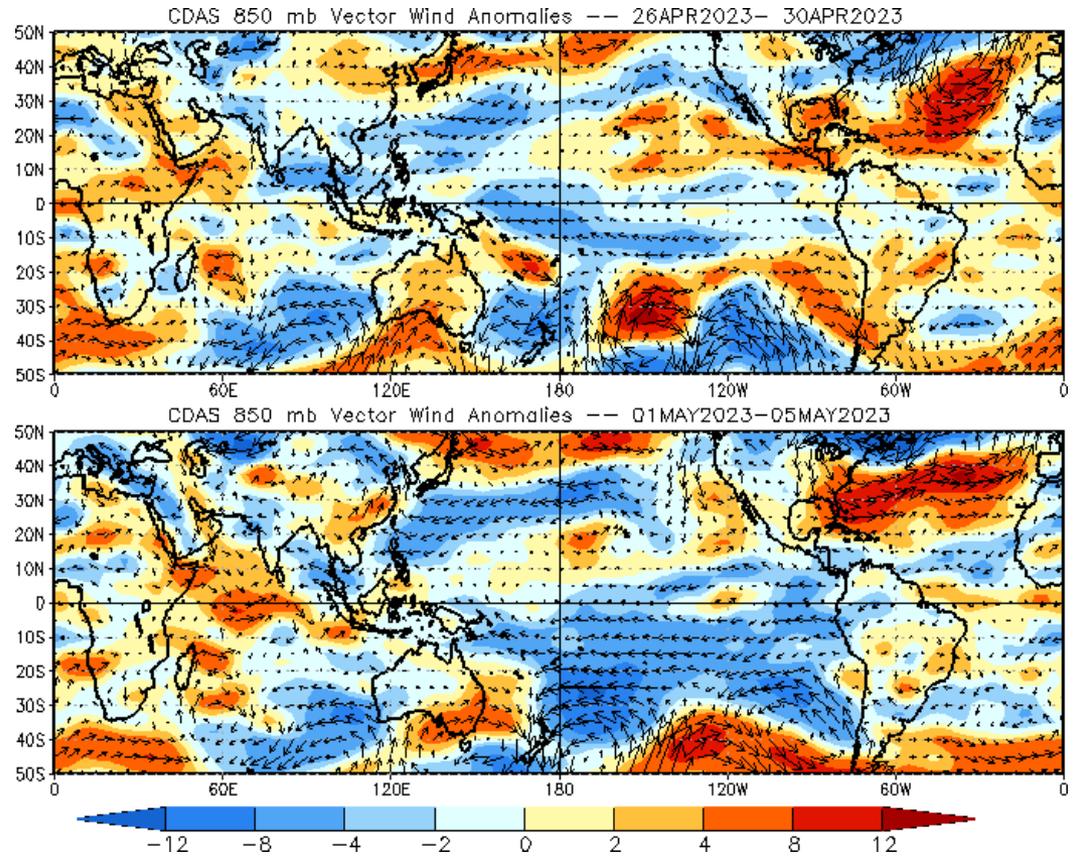
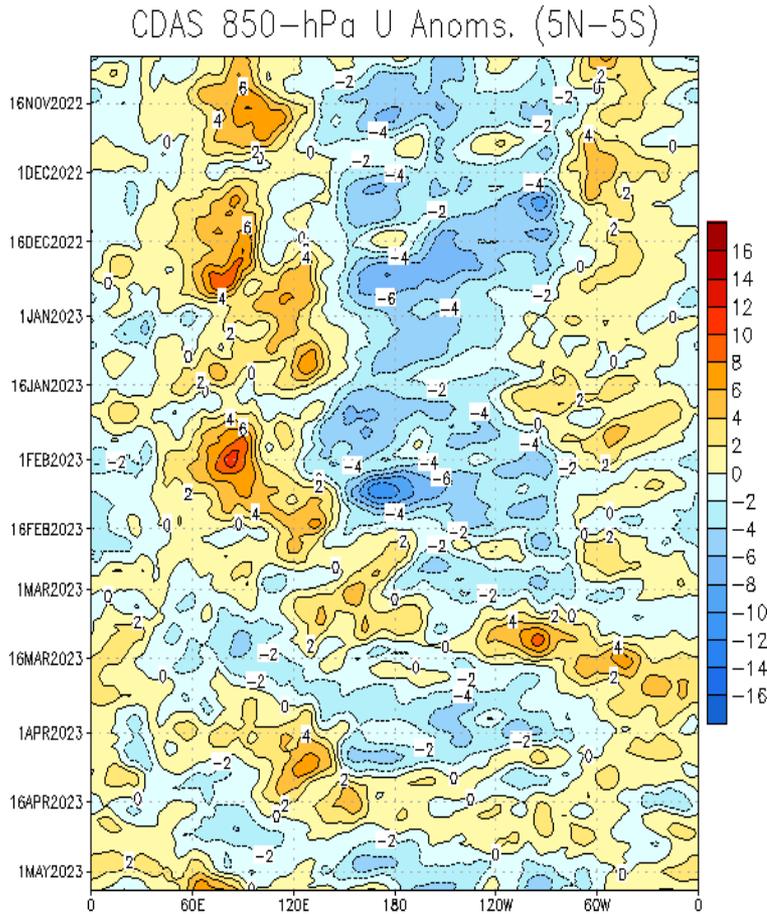
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous upper-level westerlies have shifted eastward and strengthened over the Pacific during the past week
- Anomalous easterlies developing along the east coast of Africa.
- Eastward propagation of anomalous features evident in Hovmoller plot indicating increased MJO influence in tropical upper-level winds.

850-hPa Wind Anomalies

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

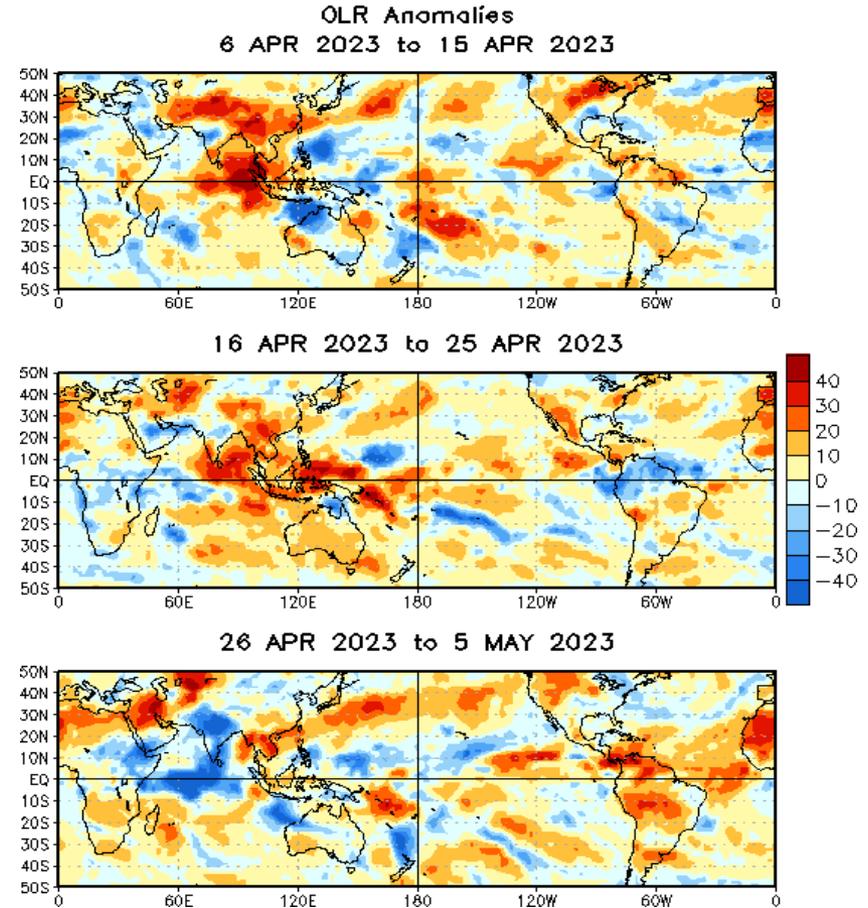
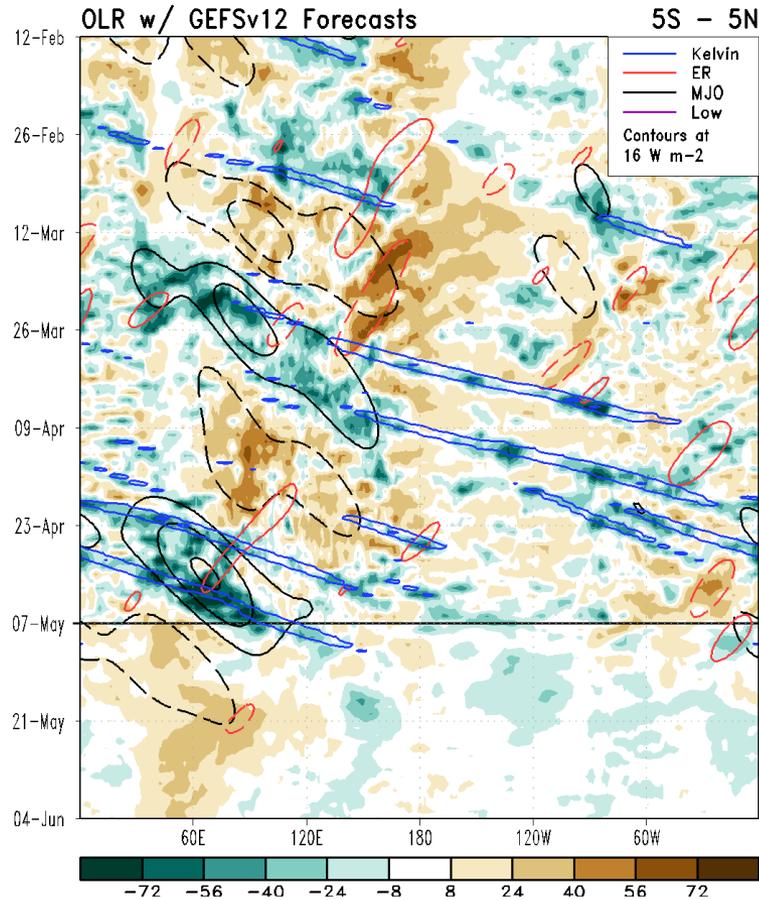


- Anomalous easterlies have been propagating eastward from the Maritime Continent to the Eastern Pacific over the last two weeks.
- As the anomalous easterlies have moved east, anomalous westerlies emerged over Africa and moved into the Indian Ocean.
- MJO influence in low-level tropical winds is even more evident compared to upper-level winds.

Outgoing Longwave Radiation (OLR) Anomalies

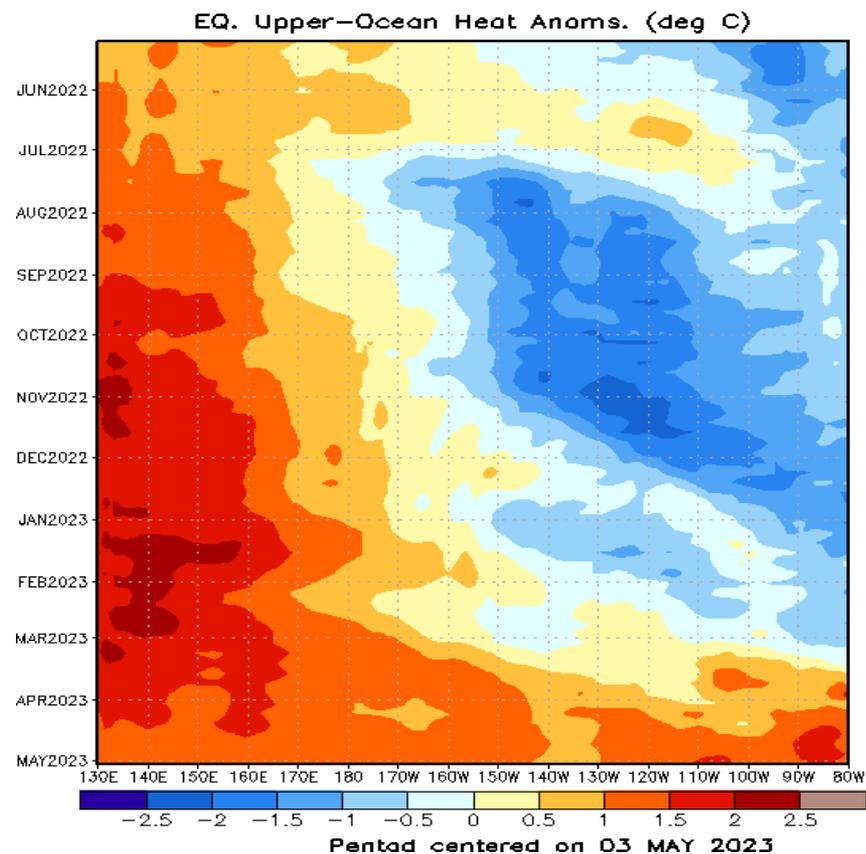
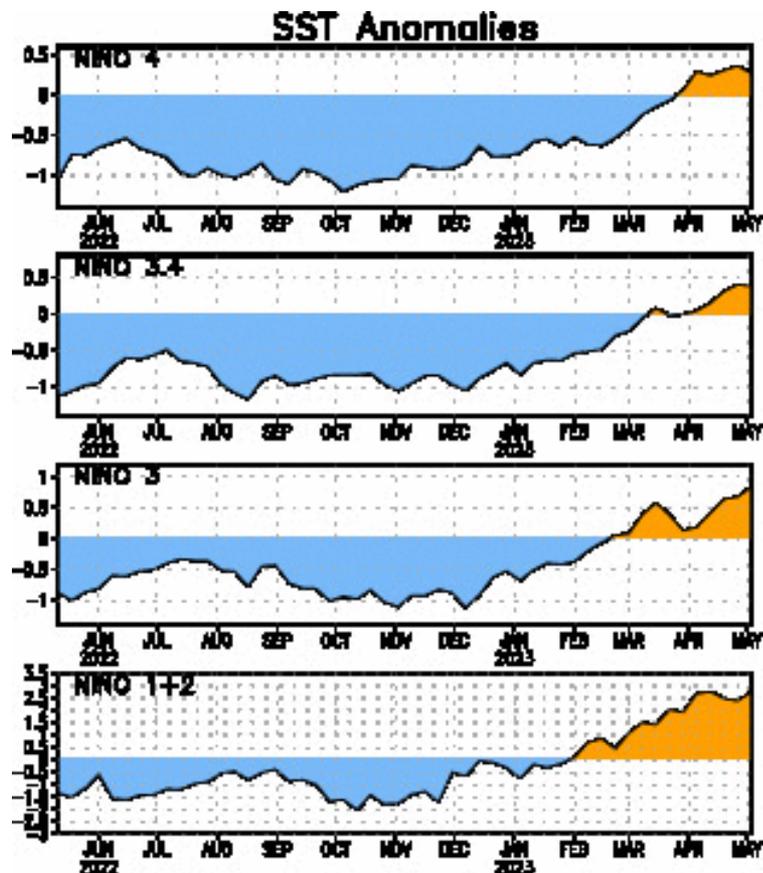
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- MJO activity is clear in OLR Hovmoller with alternating bands of enhanced and suppressed convection propagating from Africa to the Date Line, with occasional Kelvin wave activity continuing into the Americas.
- GEFS solution favors a continuation of MJO activity with next suppressed phase emerging over Africa and continued propagation of enhanced phase into Western Hemisphere.

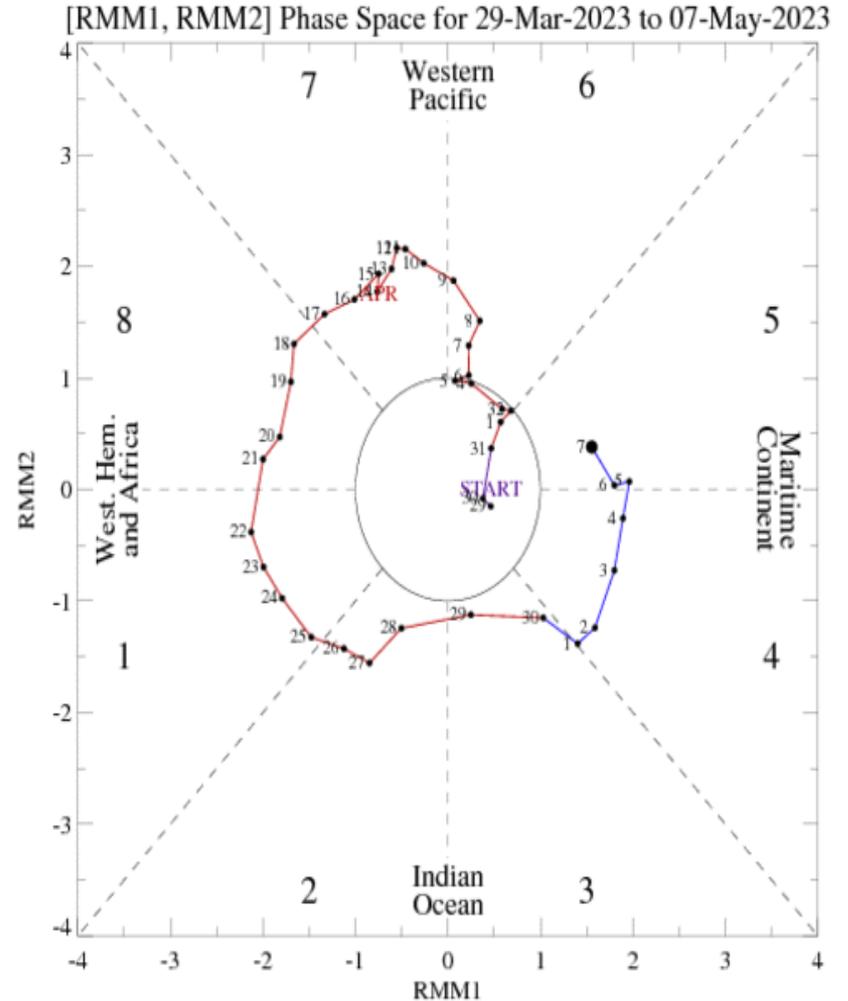
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Positive subsurface temperature anomalies continue to increase across the entire Pacific, driven by multiple MJO events and subsequent oceanic downwelling Kelvin Waves beginning in March.
- SSTs in all of the Niño basins are now above normal and continuing to trend upward across the Central Pacific reflecting the transition from La Niña to ENSO-neutral conditions.

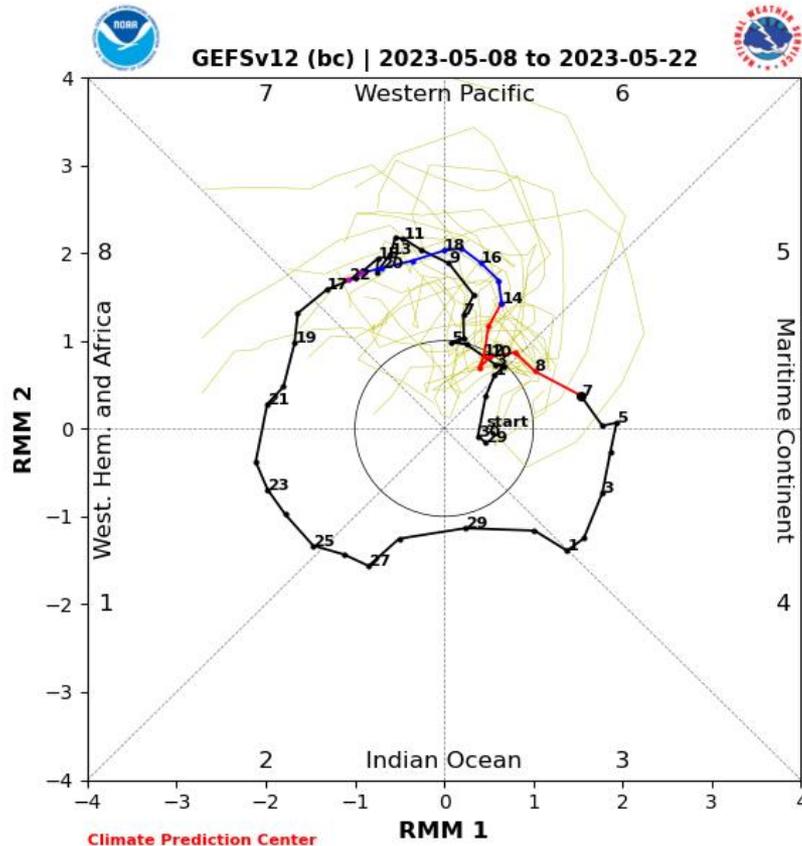
MJO Index: Recent Evolution

- An active MJO continued during the past month, with the RMM-based index completing another full global circumnavigation.
- The RMM index shows a continued robust MJO moving through the Maritime Continent.

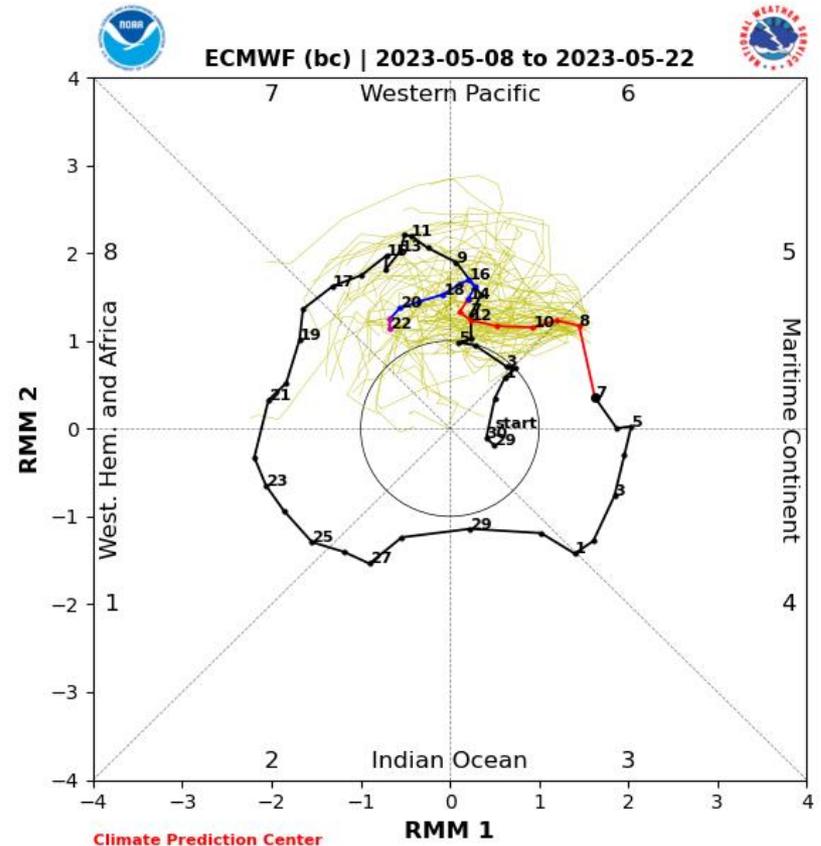


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



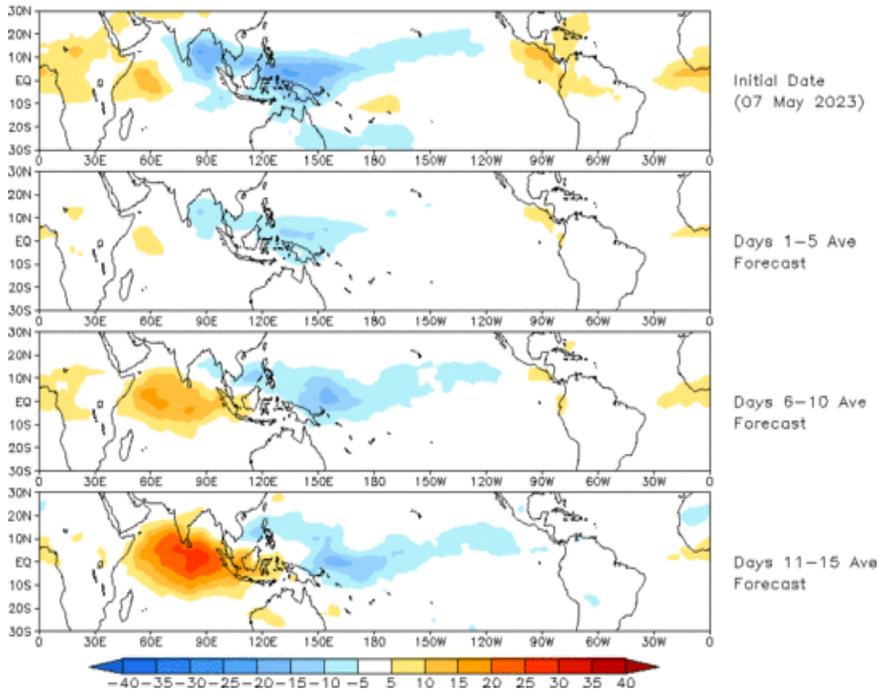
ECMWF Forecast

- Both the GEFS and ECMWF ensembles depict continued propagation of the MJO signal into week-3. The GEFS increases signal strength in week-2 after being initially weaker than the ECMWF, which favors a more consistent amplitude.
- The ECMWF ensemble spread is much lower than the GEFS, which has solutions ranging from very low MJO activity to extreme MJO events.

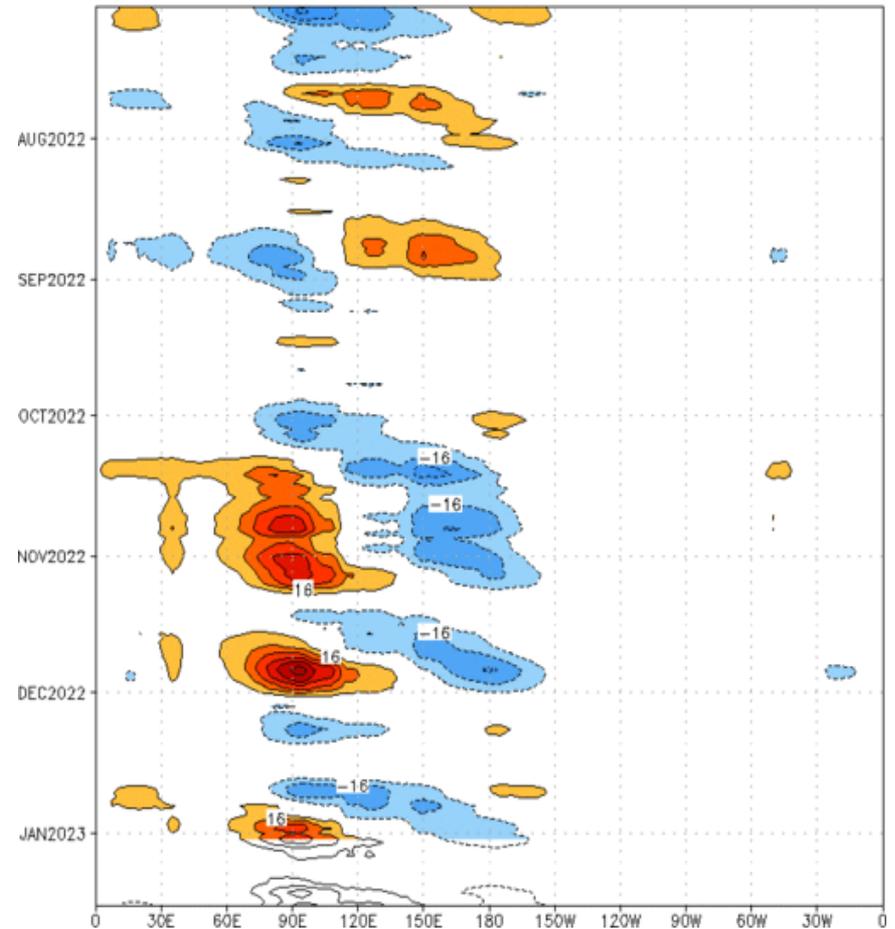
MJO: GEFS Forecast Evolution

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: 07 May 2023
OLR



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

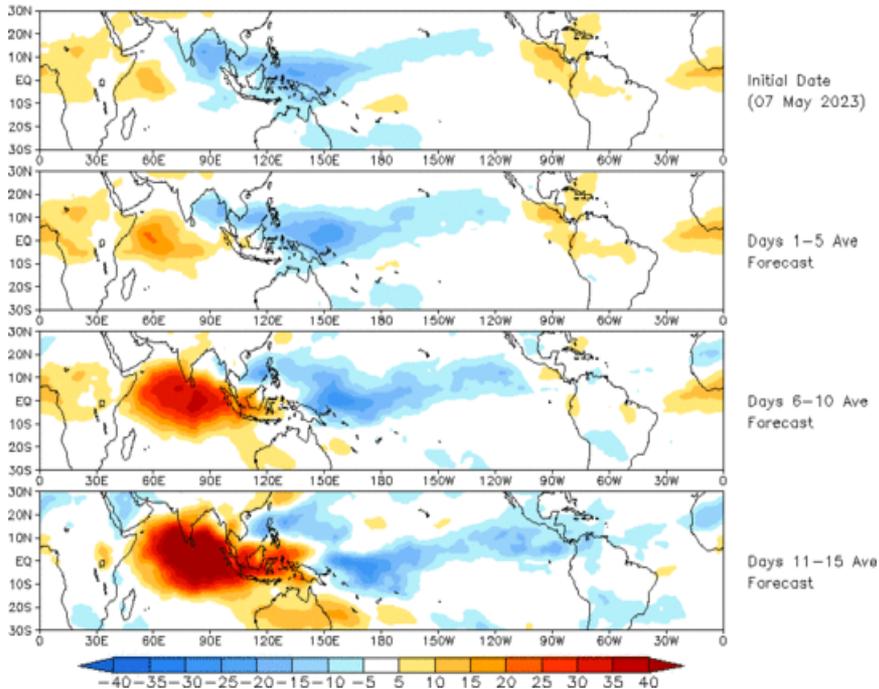


- The GEFS RMM-based forecast depicts continued regular and strong MJO activity, with initially strong enhanced convection over the Maritime Continent moving eastward and weakening as a strong suppressed convection signal emerges over the Indian Ocean during week-2.

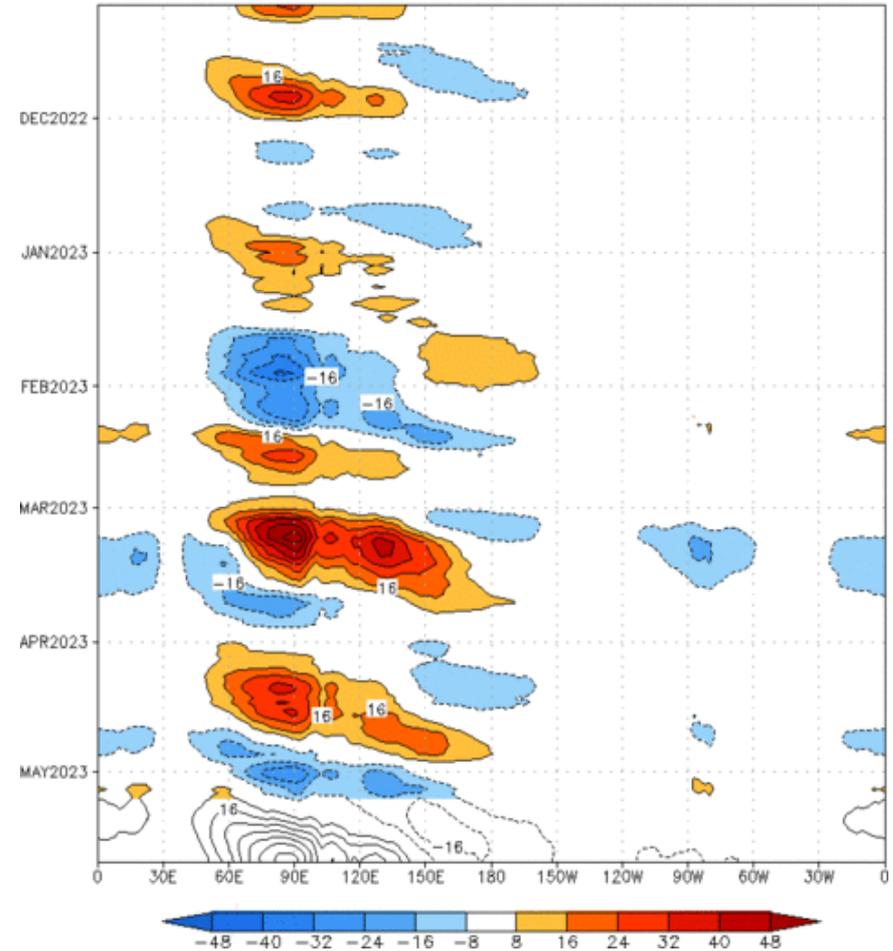
MJO: Constructed Analog Forecast Evolution

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 (07 May 2023)



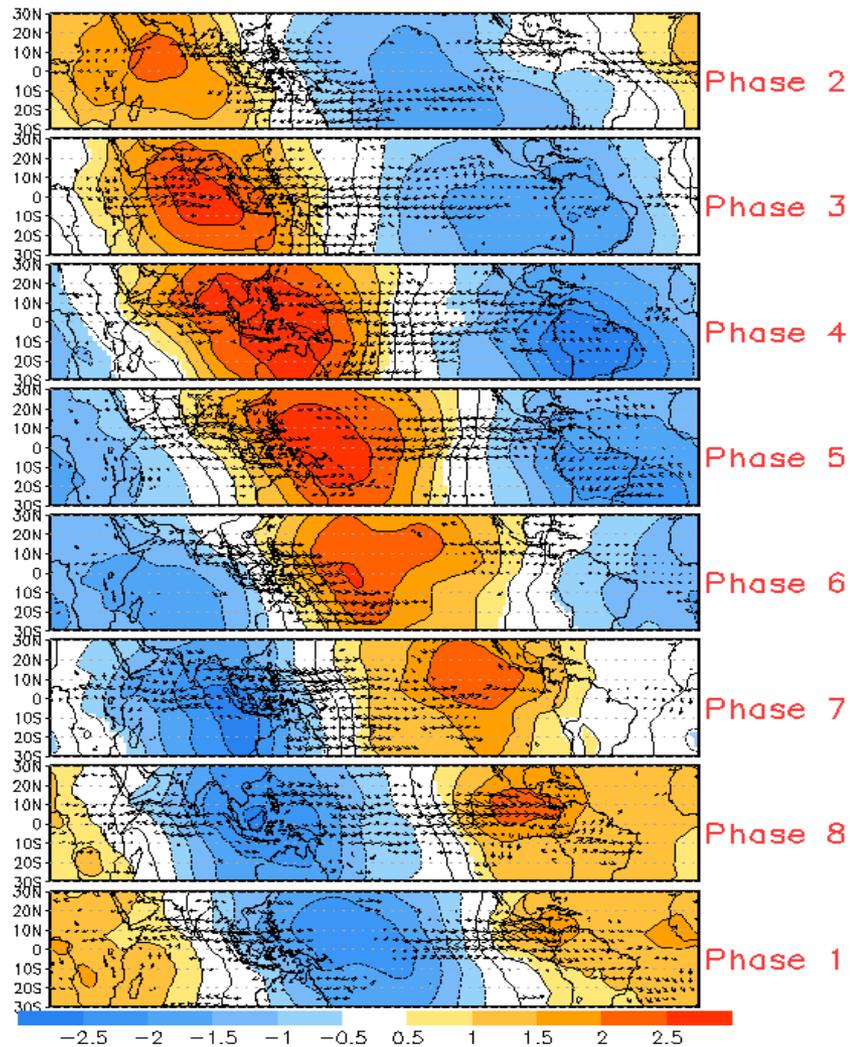
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:05-Nov-2022 to 07-May-2023
The unfilled contours are CA forecast reconstructed anomaly for 15 days



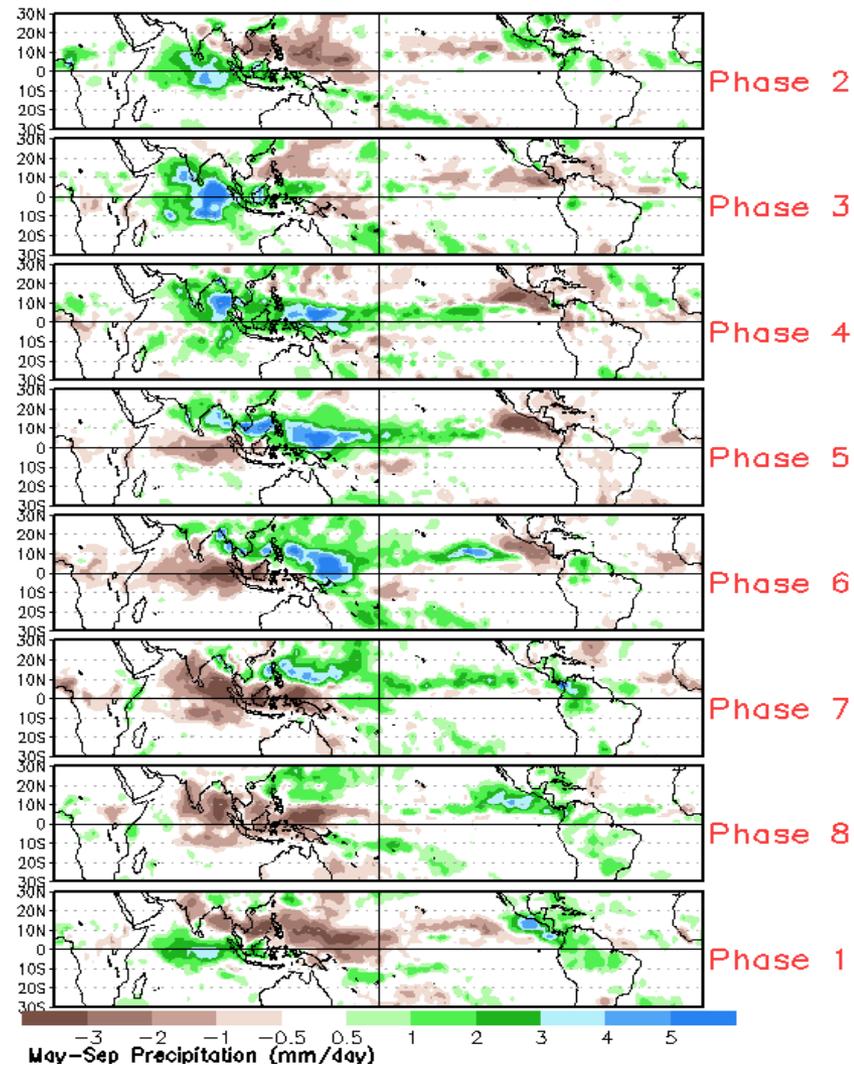
- The constructed analog RMM-based forecast is in agreement with the GEFS forecast with respect to continued eastward propagation, while favoring a stronger MJO signal.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



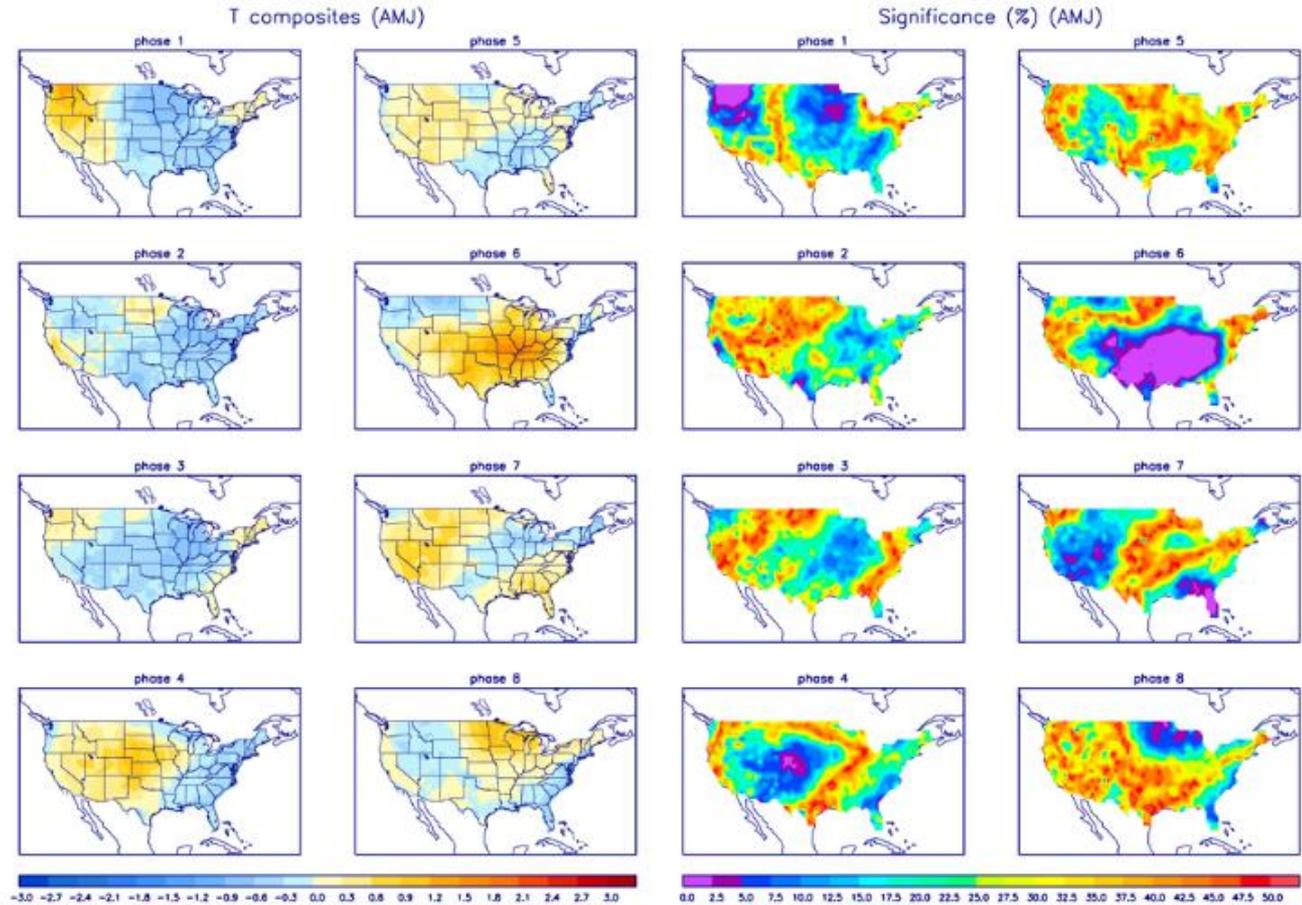
Precipitation Anomalies



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.

