

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



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
30 October 2023

Overview

- Low-frequency modes of variability (i.e. ENSO, SOI) continue to dominate weather in the Tropics. RMM index indicates a fairly strong MJO signal currently in phase 1 (W. Hem. and Africa) but low-frequency interference makes interpretation of RMM index and diagnosis of MJO difficult.
- Dynamical models favor the strongest convective signal over Africa and the far western Indian Ocean during the next 2-3 weeks, consistent with the low frequency El Niño state as well as a positive phase of the Indian Ocean Dipole (IOD).
- The Central American Gyre (CAG) favors enhanced chances for tropical cyclone (TC) development across the Eastern Pacific and Caribbean continuing into mid-November, despite decreasing climatology becoming a factor.

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

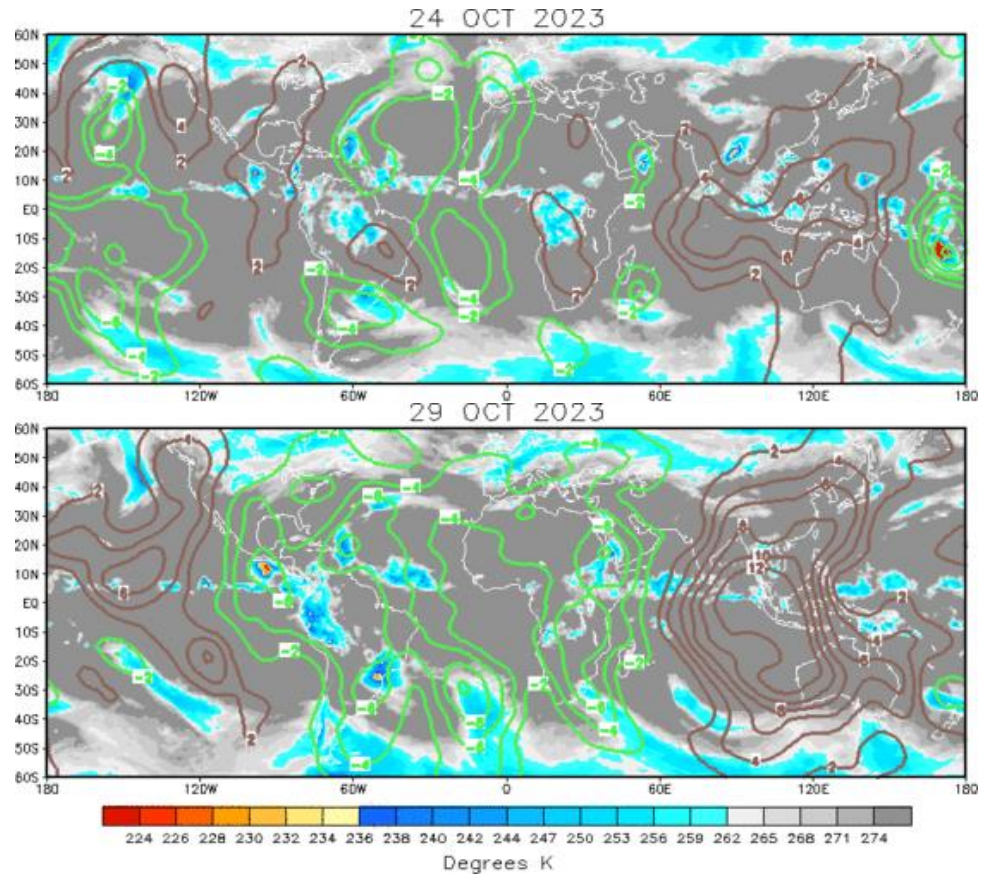
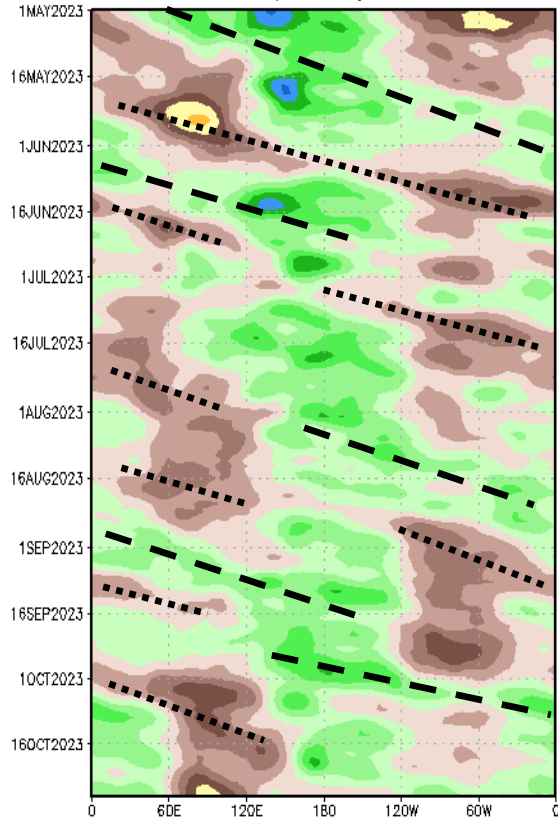
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

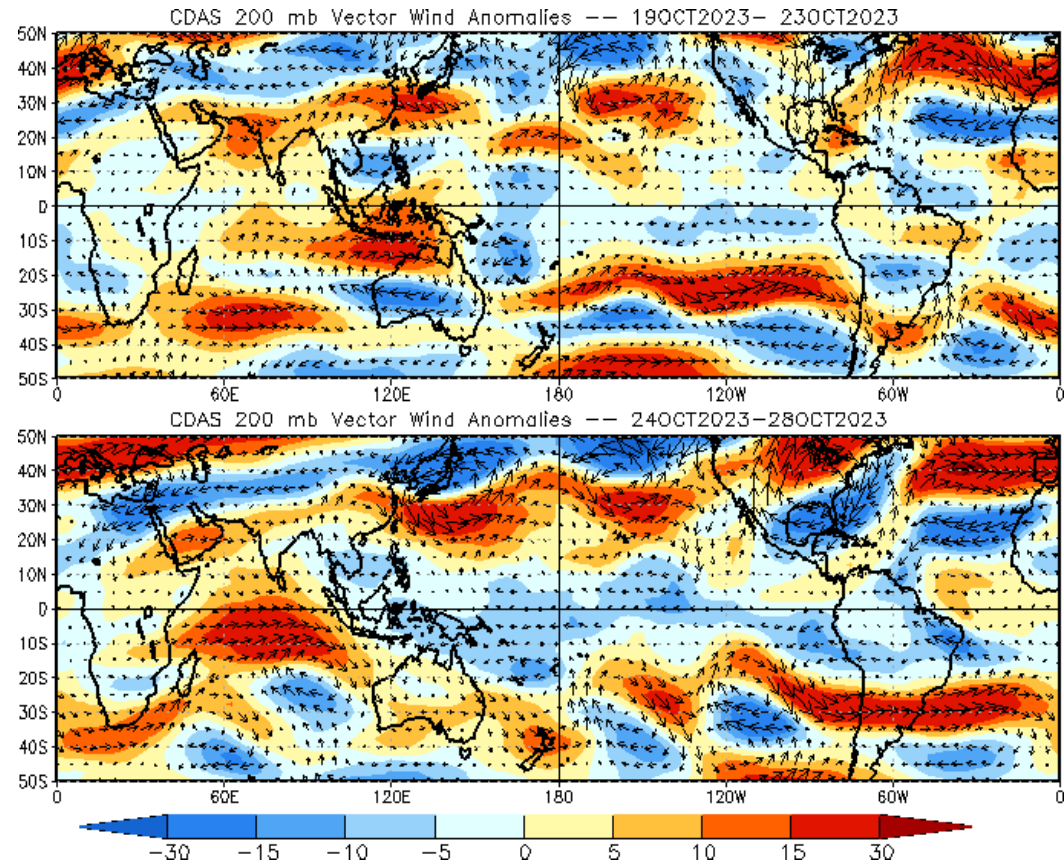
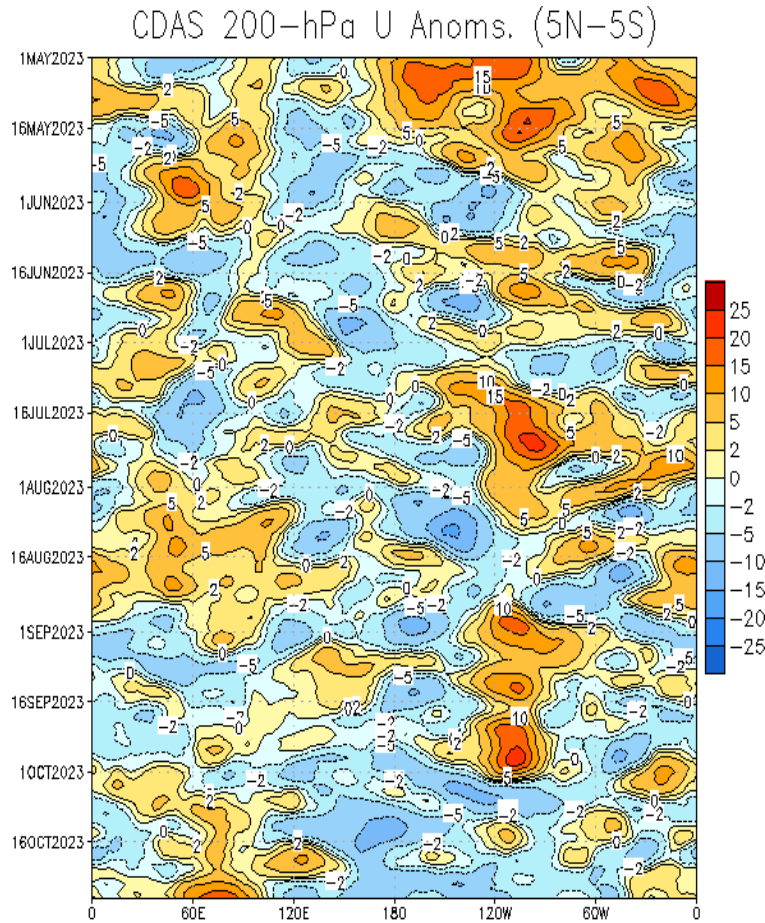
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- Large-scale tropical convection has had difficulty maintaining organized structure. Transient features suggestive of Kelvin wave or MJO activity are quickly overwhelmed by strong interference from low-frequency variability.
- Global tropical convection has become more coherent recently; the upper-level velocity potential pattern is consistent with the background El Niño state, with anomalous convergence across much of the Indian Ocean and Western Pacific, and anomalous divergence over Africa and the far western Indian Ocean.

200-hPa Wind Anomalies

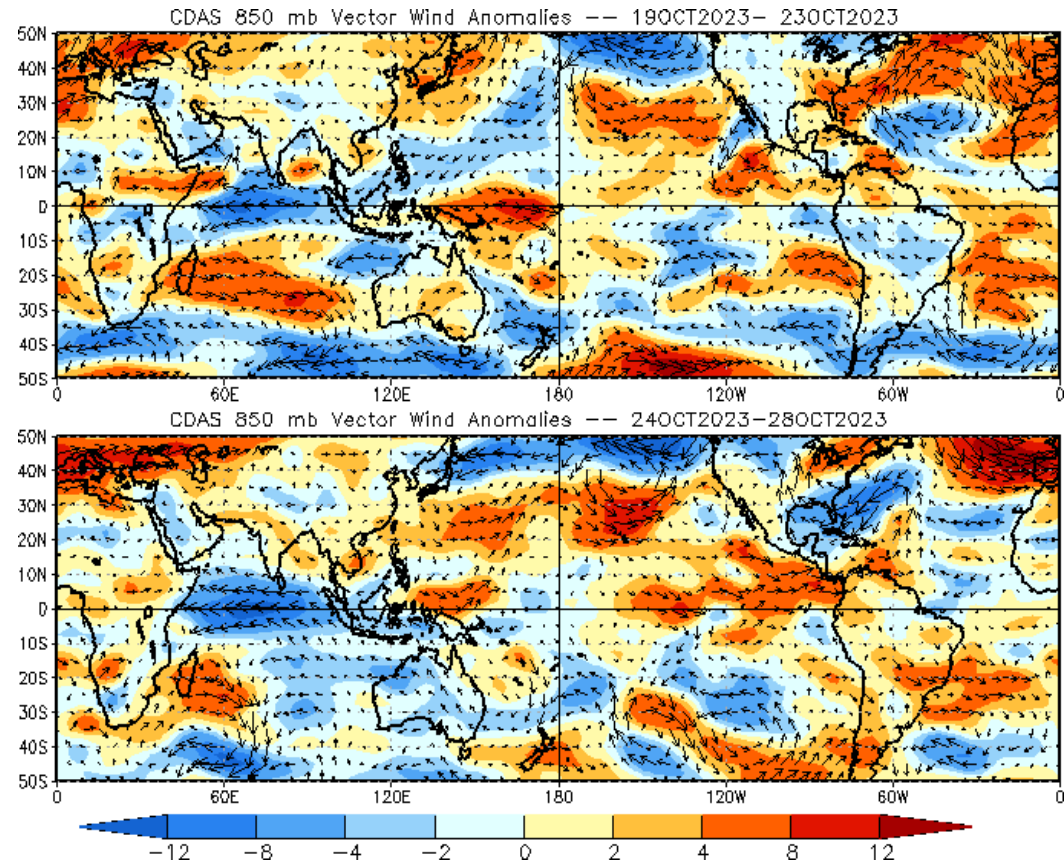
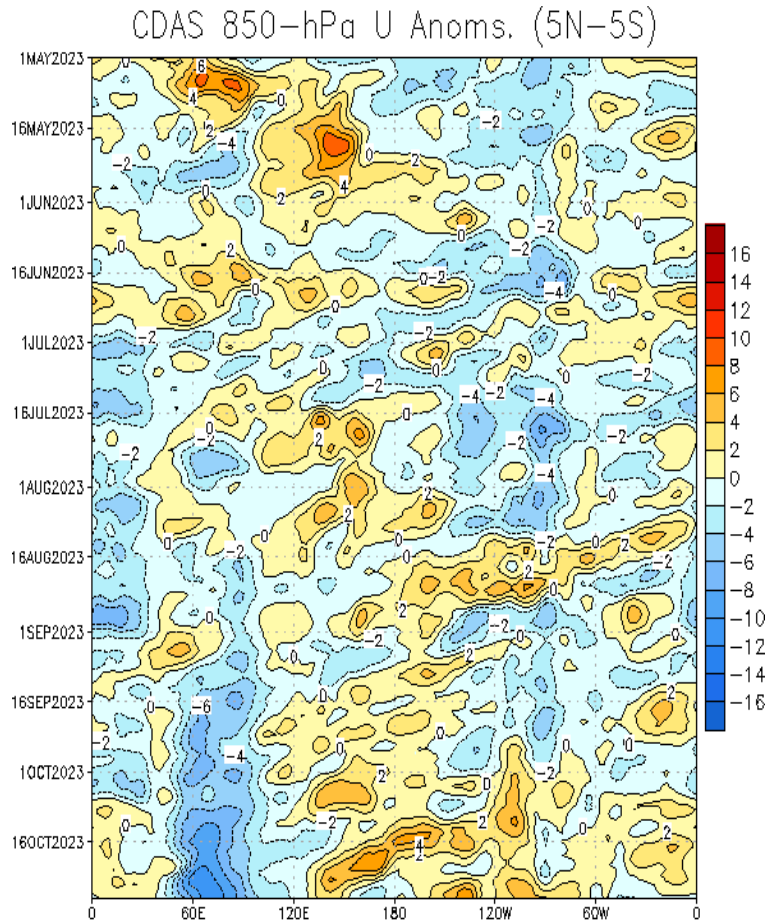
Shading denotes the zonal wind anomaly. **Blue shades: Anomalous easterlies.** **Red shades: Anomalous westerlies.**



- Anomalous easterlies are becoming widespread and more temporally persistent over the Central Pacific.
- The N. Hem. storm track is becoming more active, with several cyclonic centers over the North Pacific.
- Anomalous upper-level westerlies continued to expand across the northern Indian Ocean, consistent with the emergence of a positive phase of the IOD.

850-hPa Wind Anomalies

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

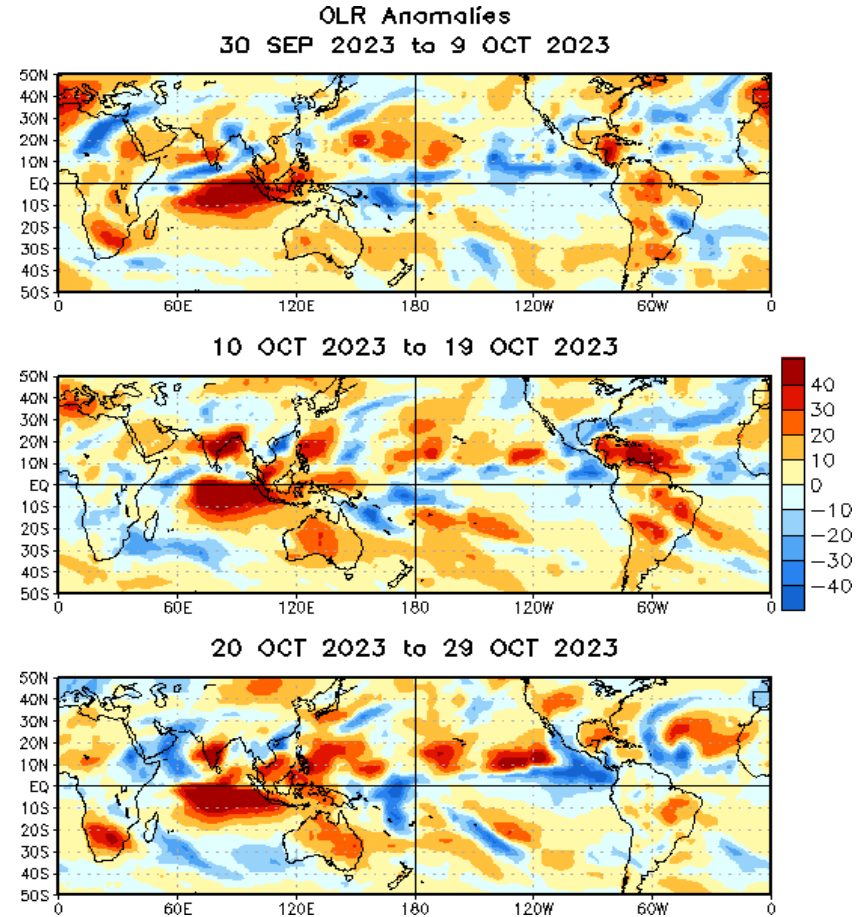
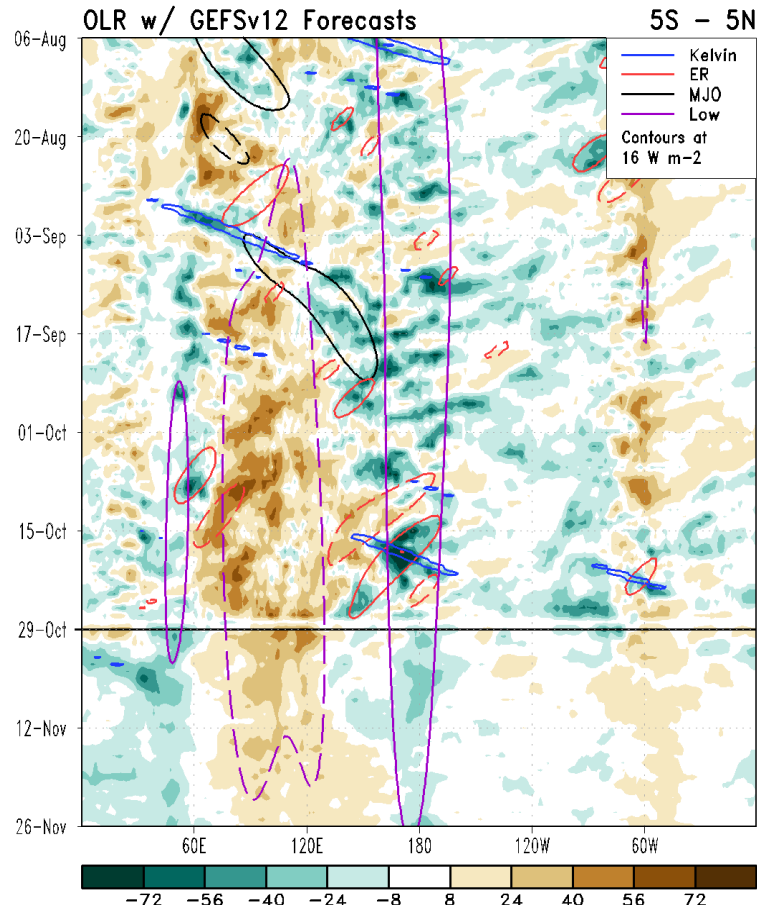


- Strong low-level easterlies strengthen over the equatorial Indian Ocean due to the +IOD, with anomalous westerlies (decreased trades) spreading across the Pacific north of the Equator.
- Anti-cyclonic flow has subsided across much of the North Atlantic, while the emerging CAG becomes more evident in the latest observations.

Outgoing Longwave Radiation (OLR) Anomalies

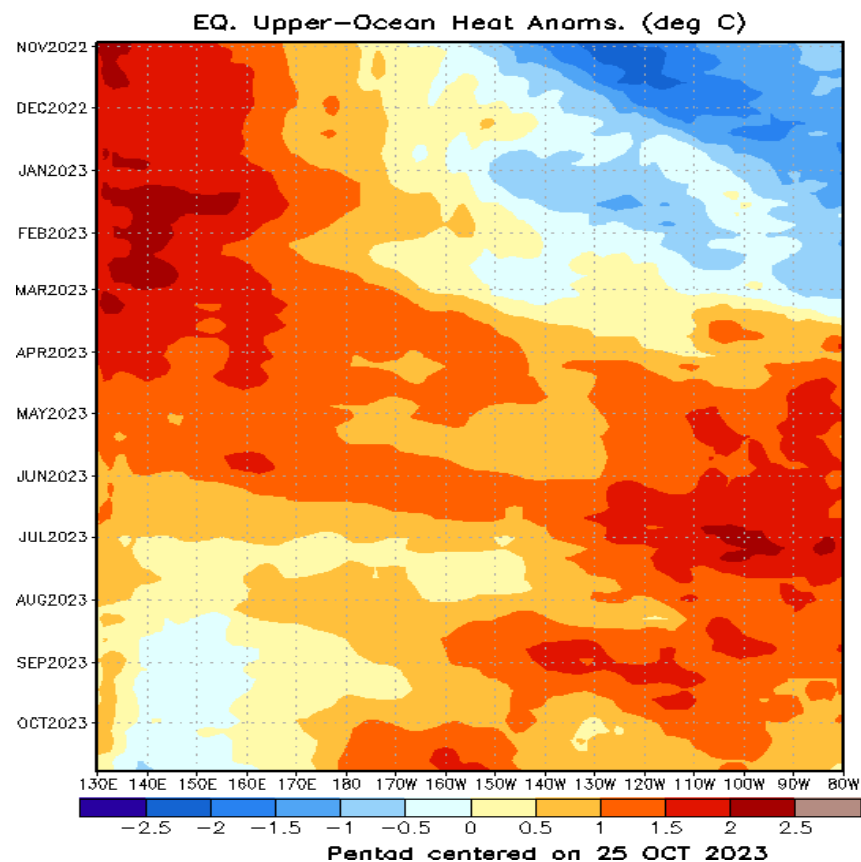
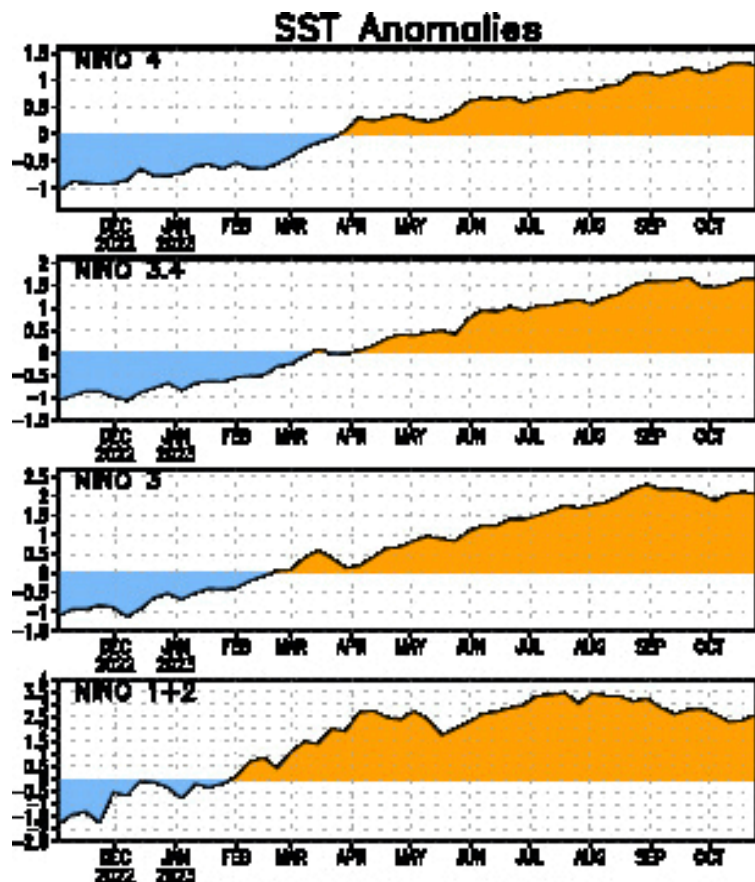
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- El Niño continues to dominate tropical variability when applying filtering though OLR anomalies, with some constructive interference with enhanced Rossby Wave activity over the Western Pacific.
- OLR anomaly maps depict strong positive OLR anomalies across the Indian Ocean and far western Pacific. Negative OLR anomalies persist over the Eastern Pacific, while positive anomalies ease over the Caribbean as the CAG becomes established.

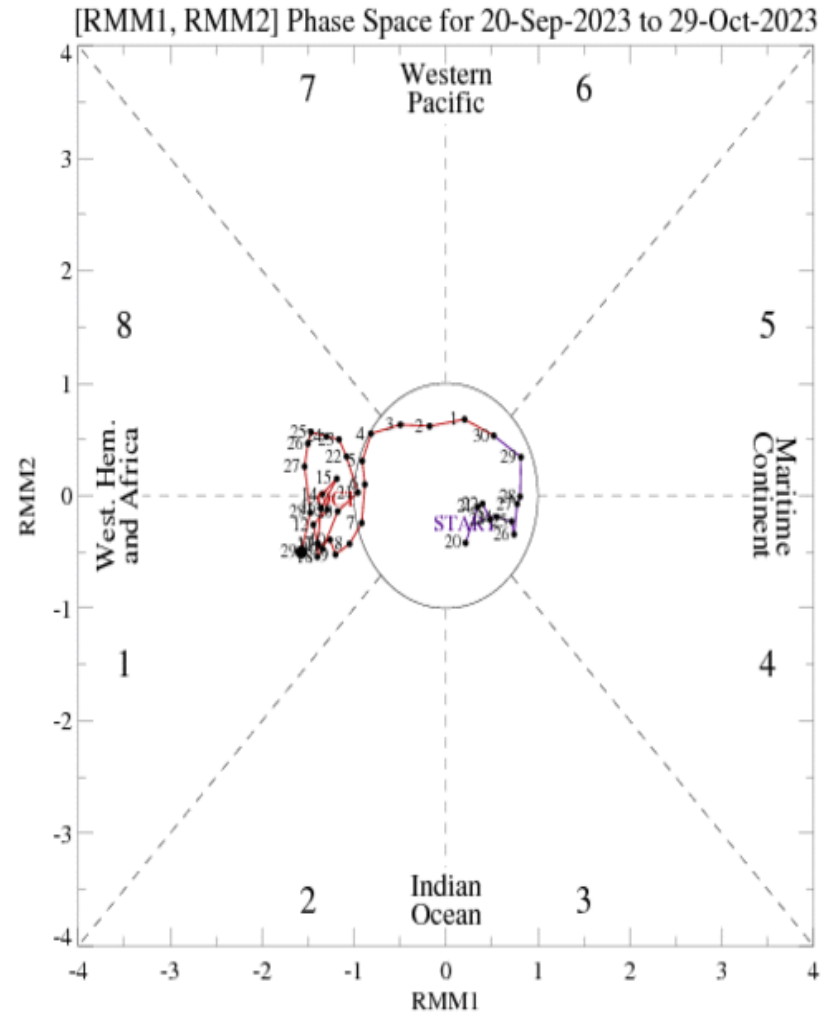
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- El Niño conditions are present across the equatorial Pacific with SST anomalies remaining strongly positive in all of the Niño basins.
- An area of slightly negative upper-ocean heat content anomalies continues across the Western Pacific and appears to have expanded slightly in recent observations.

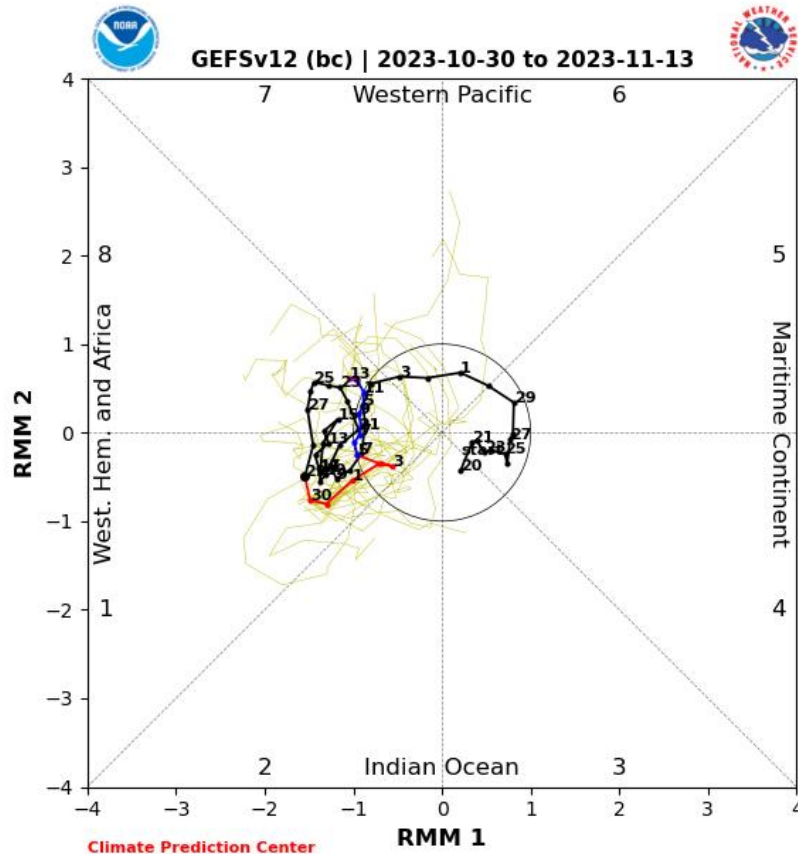
MJO Index: Recent Evolution

- The RMM-based MJO index has been meandering across the Western Hemisphere (phases 8 and 1) for much of the last month. The index is likely being overwhelmed by ENSO and SOI signal.

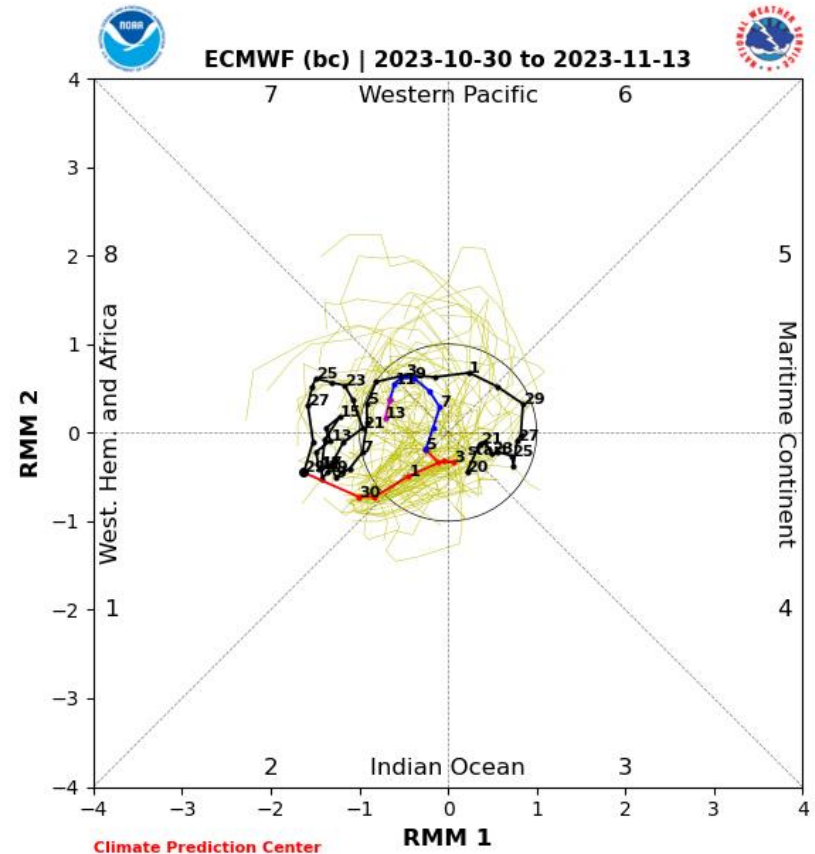


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



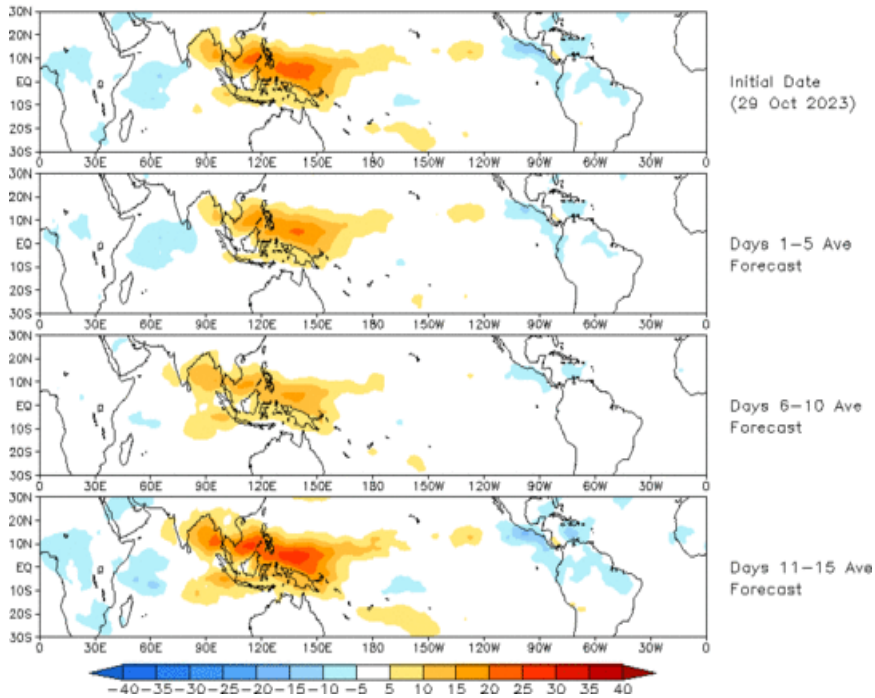
ECMWF Forecast

- Model guidance regarding the RMM index generally continues the trend we have seen in the last month, with the signal remaining mostly confined to the left side of the diagram. The ECMWF suggests a more coherent eastward propagation in the week 1-2 timeframe, but also shows a very weak amplitude as it does so.

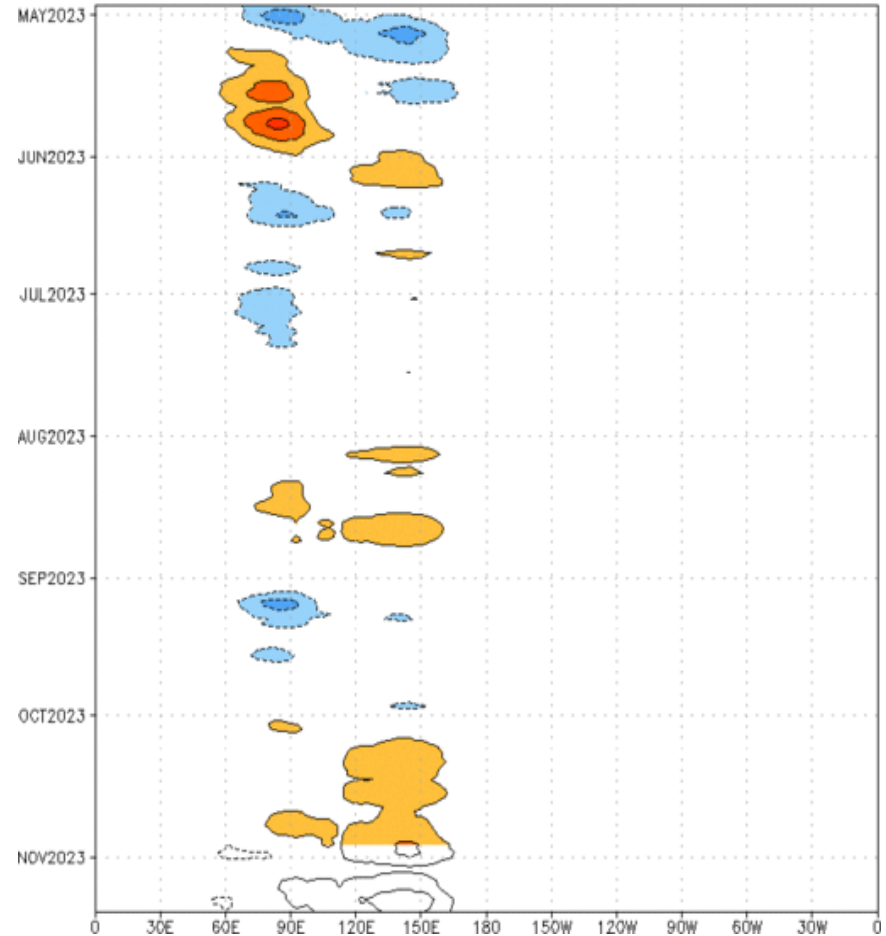
MJO: GEFS Forecast Evolution

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: 29 Oct 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: 29-Apr-2023 to 29-Oct-2023
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

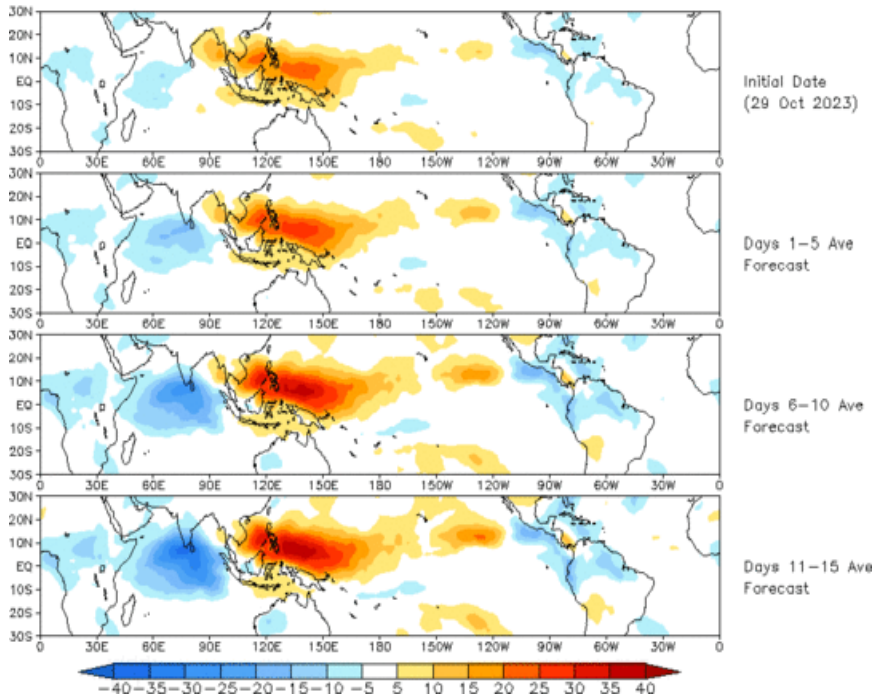


- The GEFS RMM-based OLR forecast depicts a persistent area of positive OLR anomalies across the eastern Indian Ocean and Western Pacific.
- Conversely, negative OLR anomalies are noted across Africa and the western Indian Ocean, along with Central America and the Caribbean.

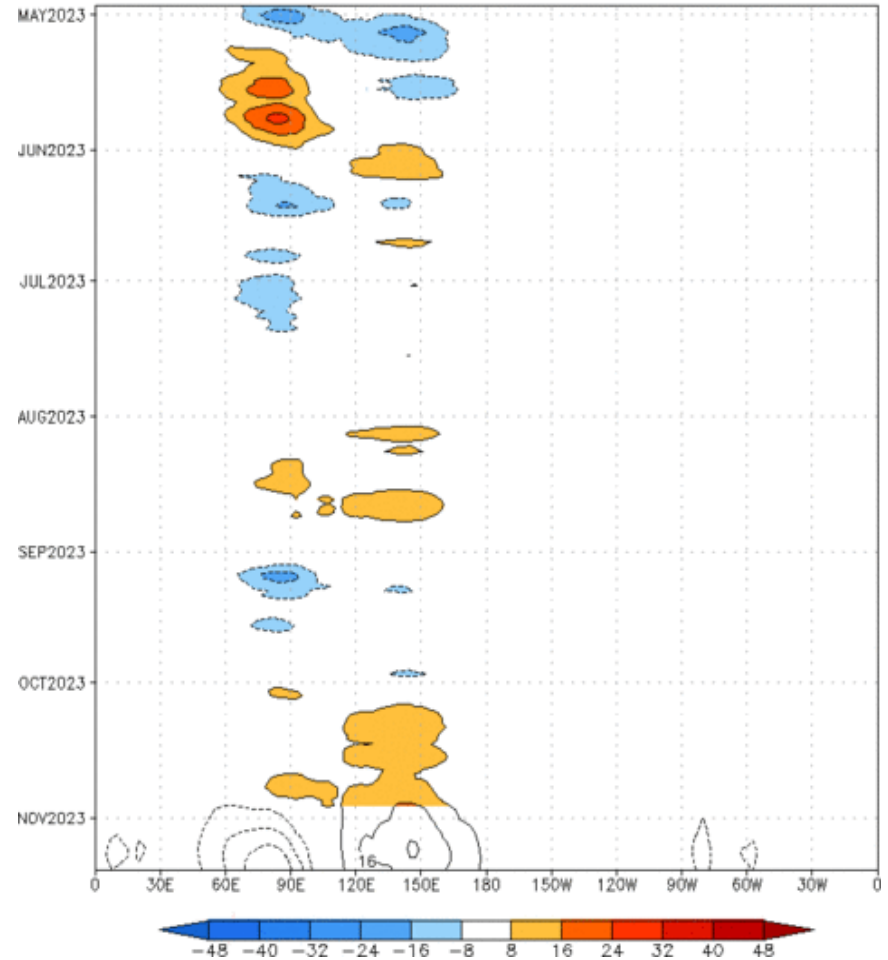
MJO: Constructed Analog Forecast Evolution

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 (29 Oct 2023)



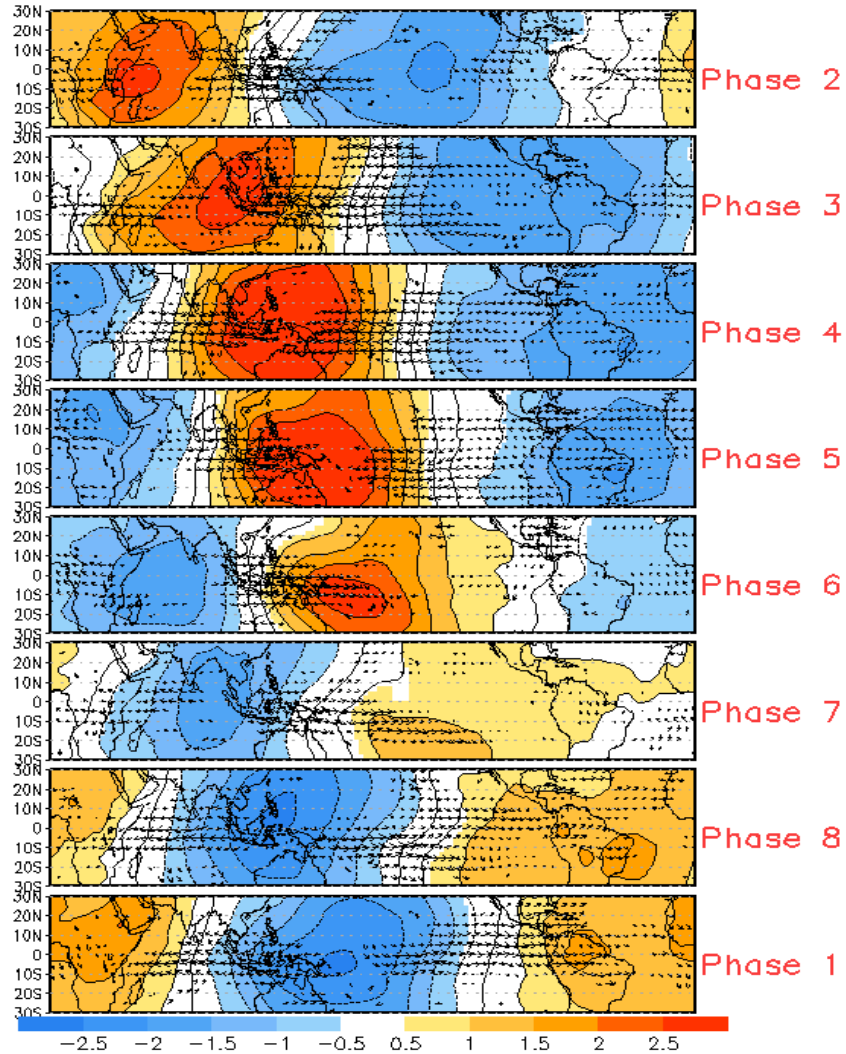
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:29-Apr-2023 to 29-Oct-2023
The unfilled contours are CA forecast reconstructed anomaly for 15 days



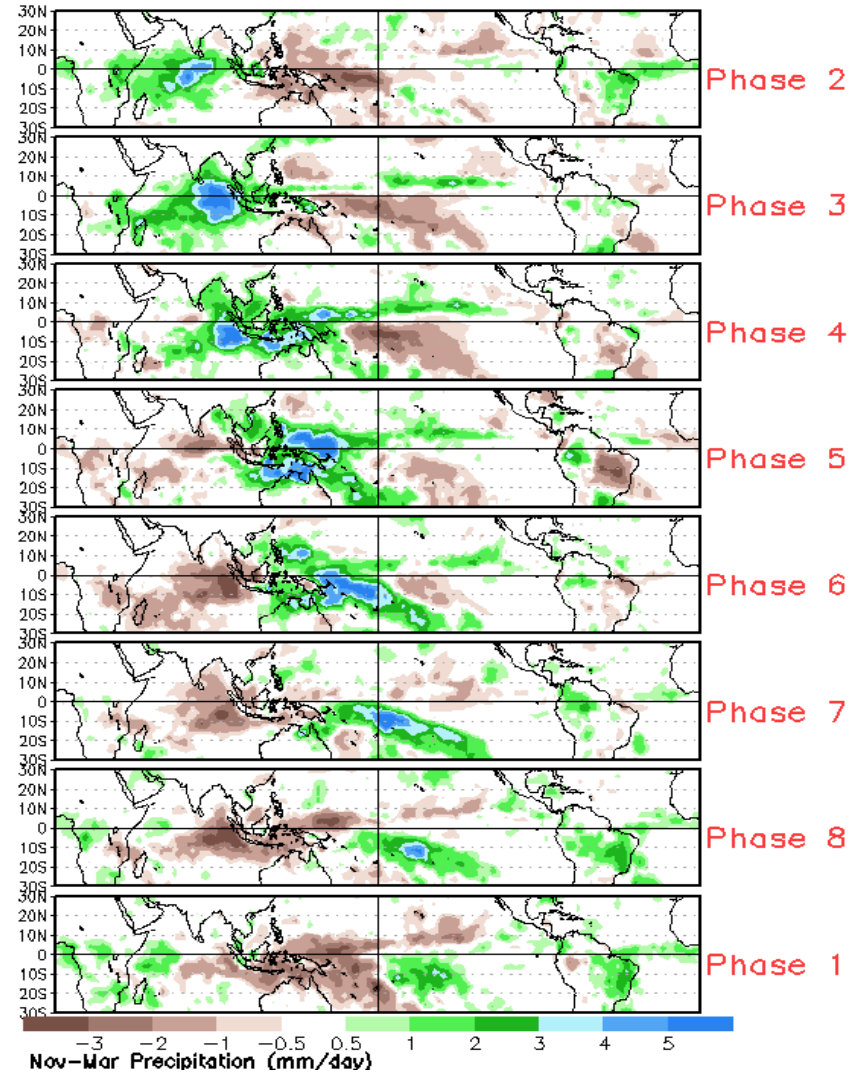
- The constructed analog RMM-based forecast is in good agreement with the GEFS, with a slightly greater expansion of negative OLR anomalies over the Indian Ocean and a stronger signal overall.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



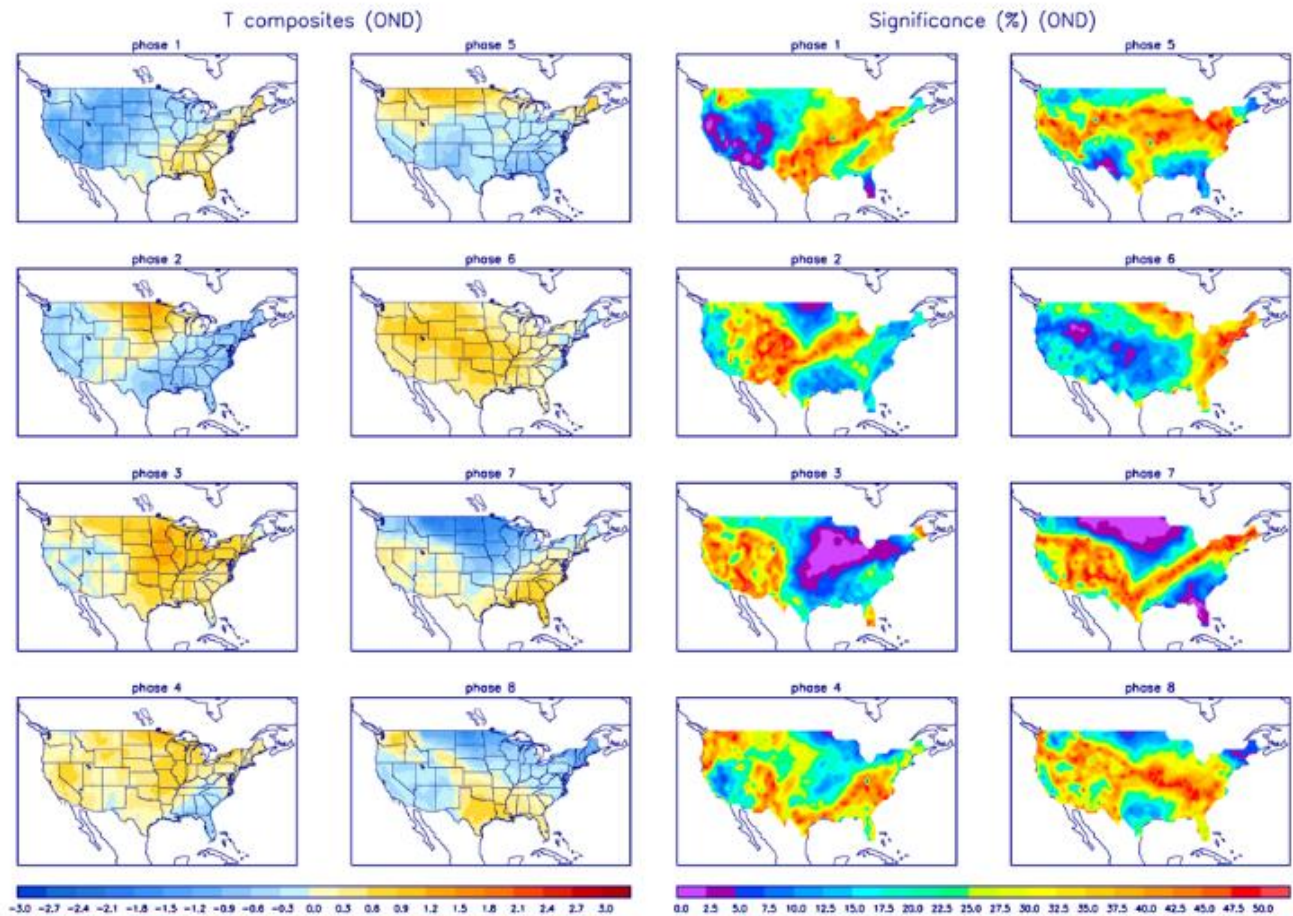
Precipitation Anomalies



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.

