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

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

Overview

- Although there is a weak RMM-based MJO signal across the Western Hemisphere, it is more likely the signal is a result of competing modes of tropical variability rather than a true MJO.

- 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 an emerging positive phase of the Indian Ocean Dipole (IOD).

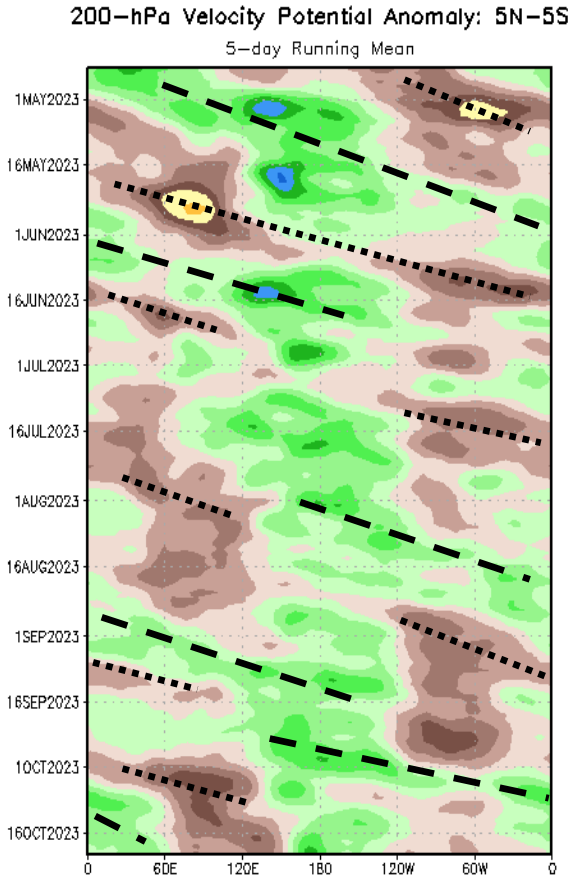
- The development of the Central American Gyre (CAG) favors enhanced chances for tropical cyclone (TC) development across the Eastern Pacific and Caribbean during early November, with decreasing climatology becoming a factor by week-3.

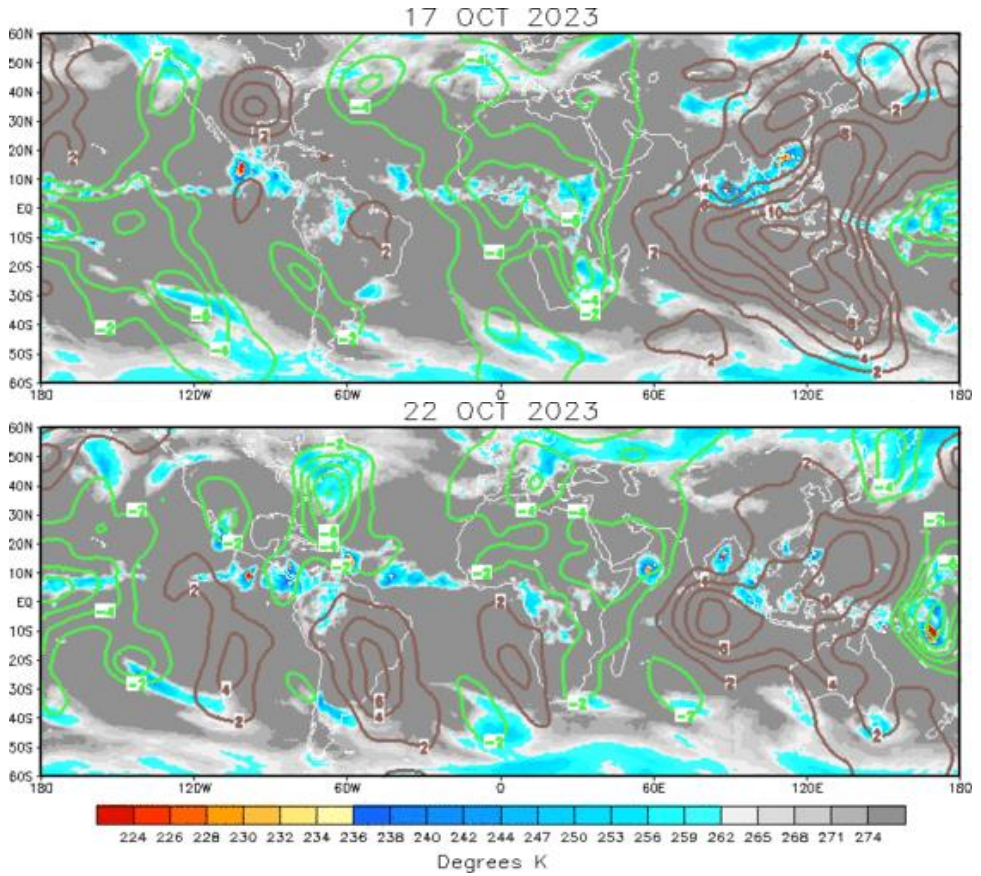
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

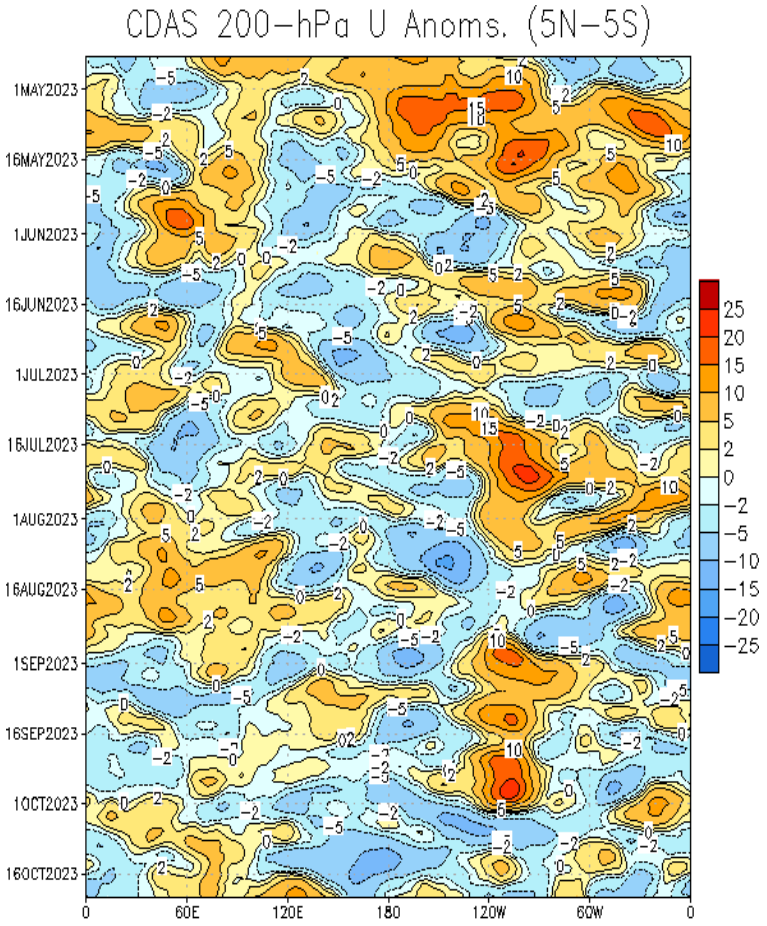


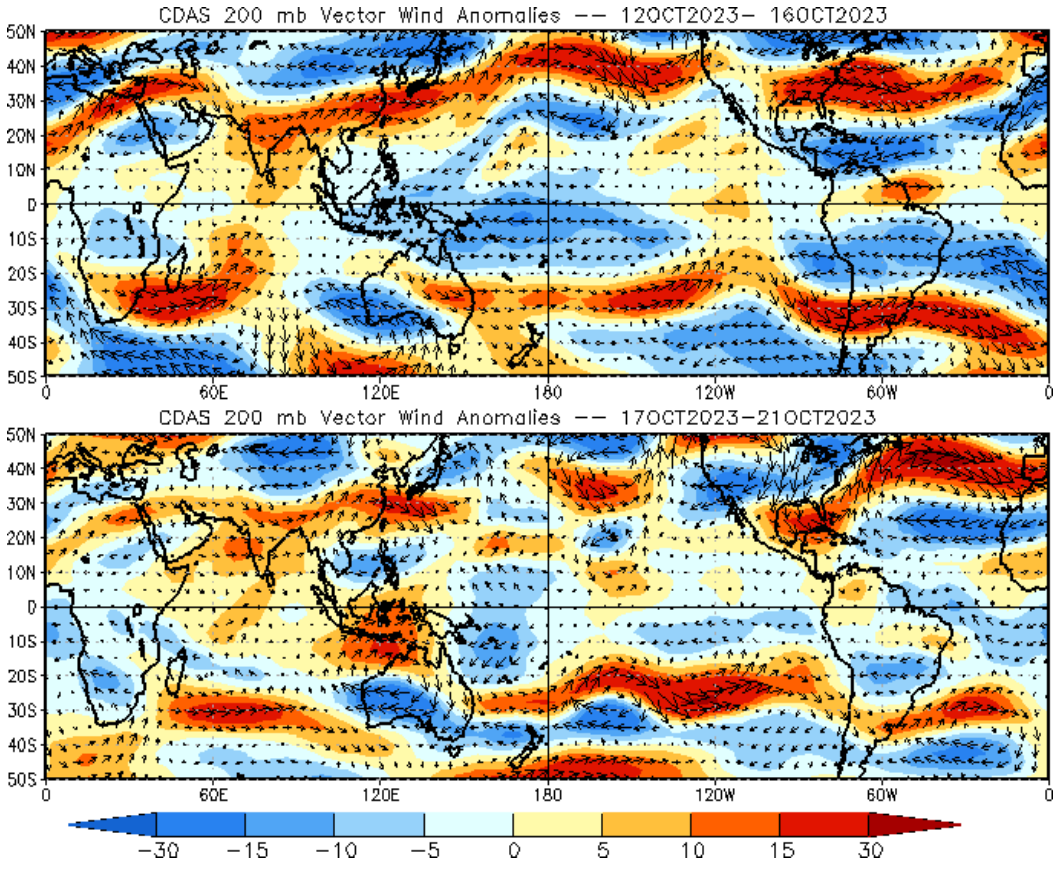


- Across the Eastern Hemisphere, the upper-level velocity potential pattern is consistent with the background El Niño state, with anomalous convergence across the much of the Indian Ocean and Western Pacific, and anomalous divergence over Africa and the far western Indian Ocean.
- The upper-level velocity potential pattern is less coherent across the Western Hemisphere given competing modes of tropical and extra-tropical variability in the transition season.

200-hPa Wind Anomalies

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

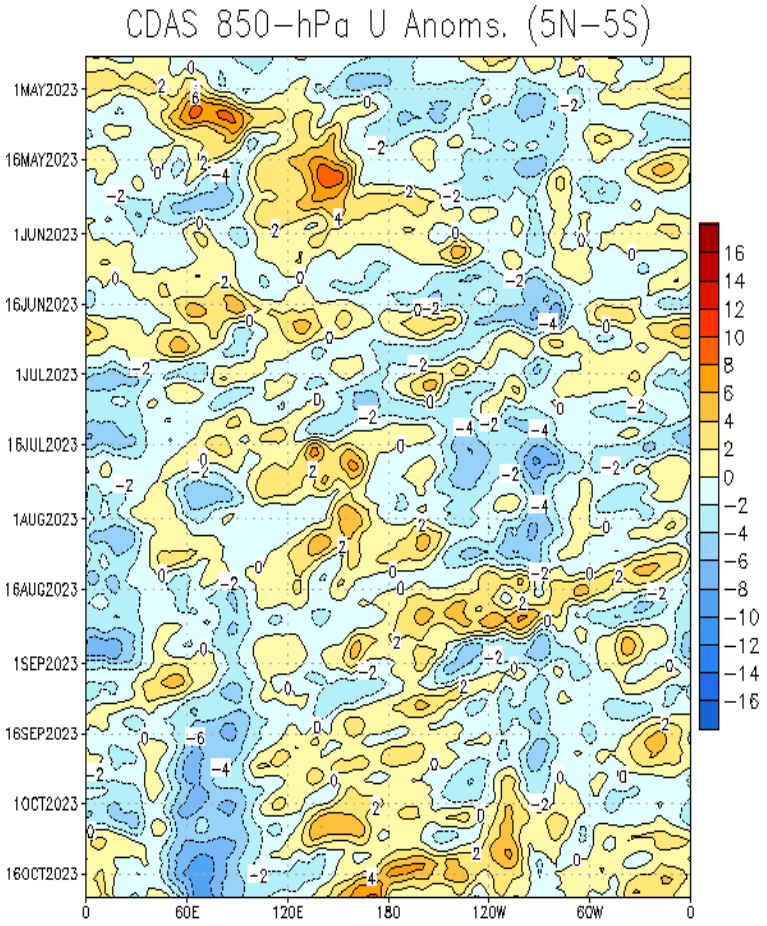


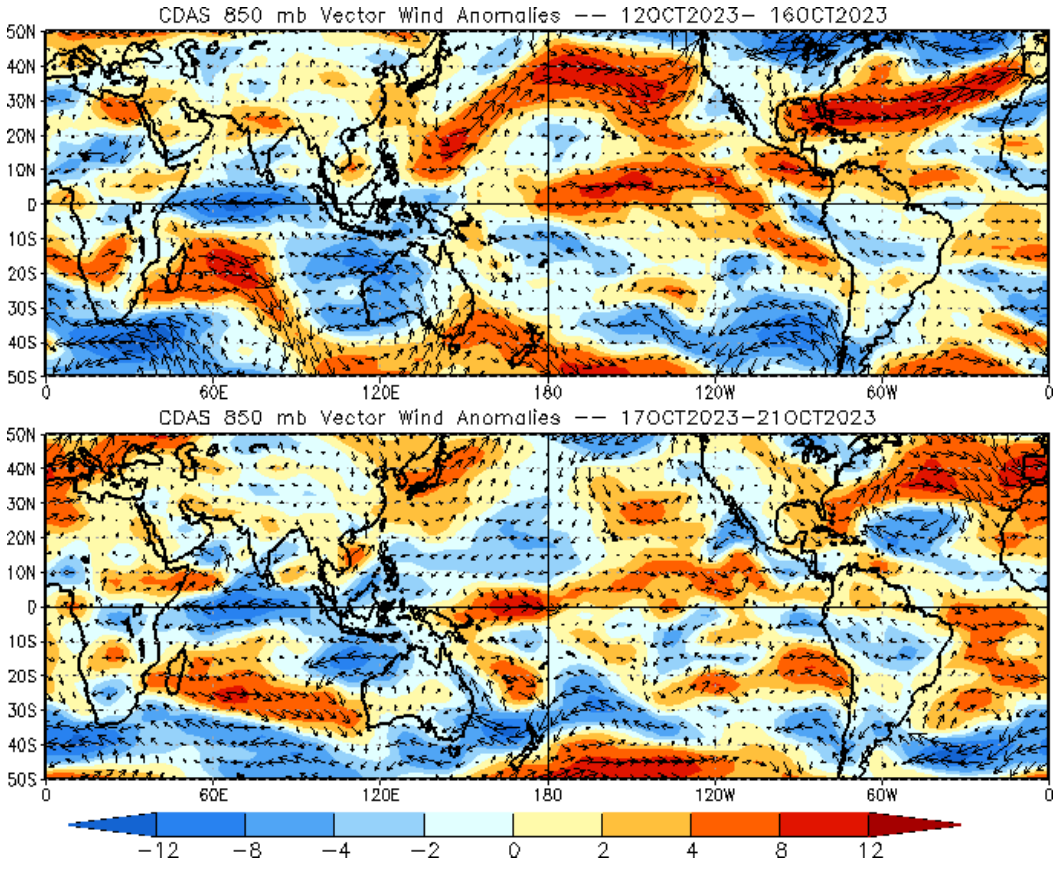


- An enhanced jet stream is seen across the southeastern CONUS extending into the western and north-Atlantic.
- Anomalous upper-level westerlies continued to expand across the northern Indian Ocean, consistent with the emergence of a positive phase of the IOD.

850-hPa Wind Anomalies

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

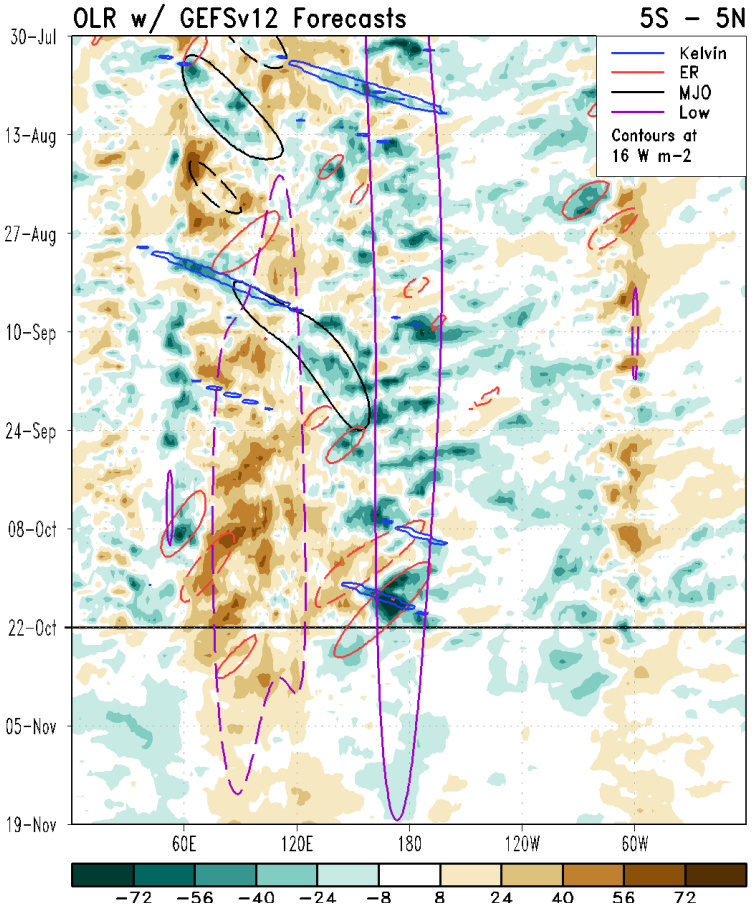


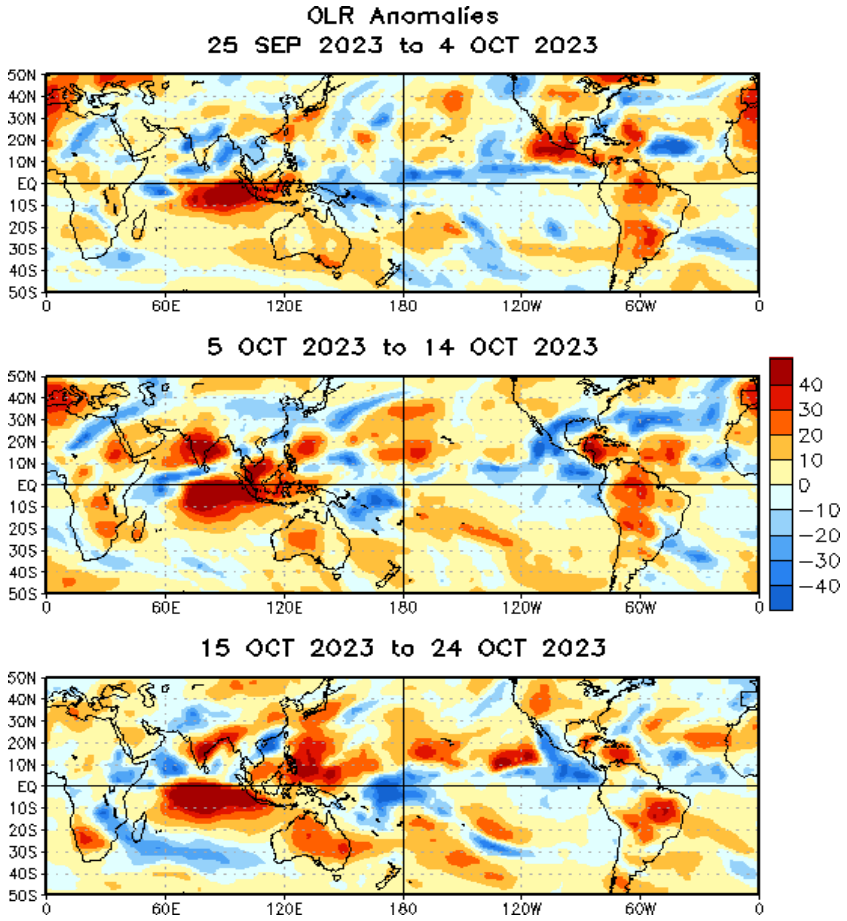


- Strong low-level easterlies remain established over the equatorial Indian Ocean due to the +IOD, with anomalous westerlies (decreased trades) across the Pacific north of the Equator.
- Anti-cyclonic flow present across much of the North Atlantic, with the Main Development Region continuing to be active in terms of TC activity into late-October (Hurricane Tammy).

Outgoing Longwave Radiation (OLR) Anomalies

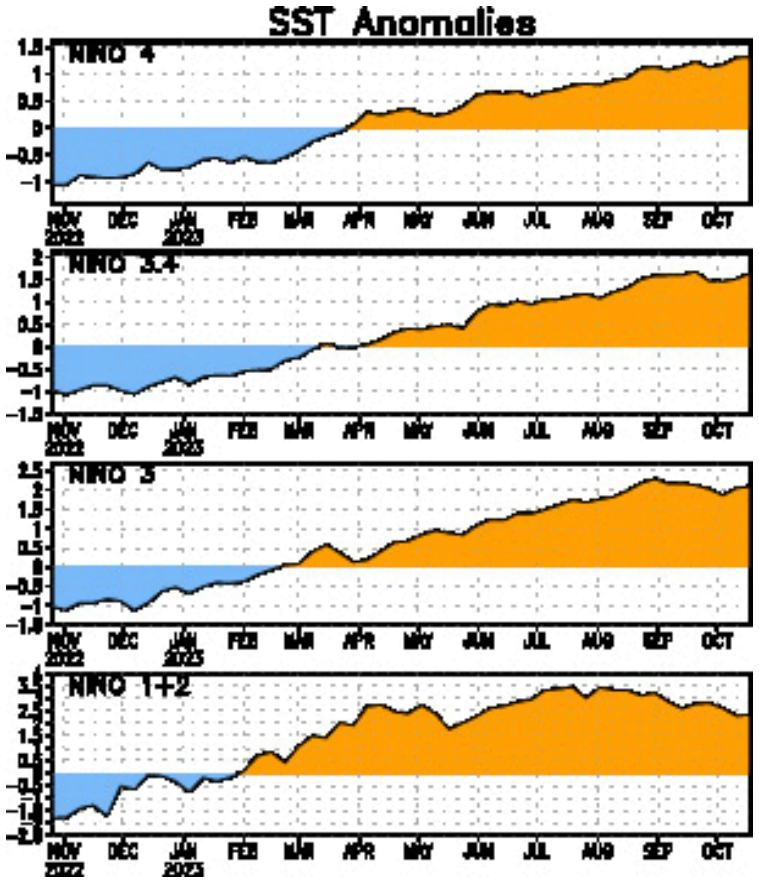
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

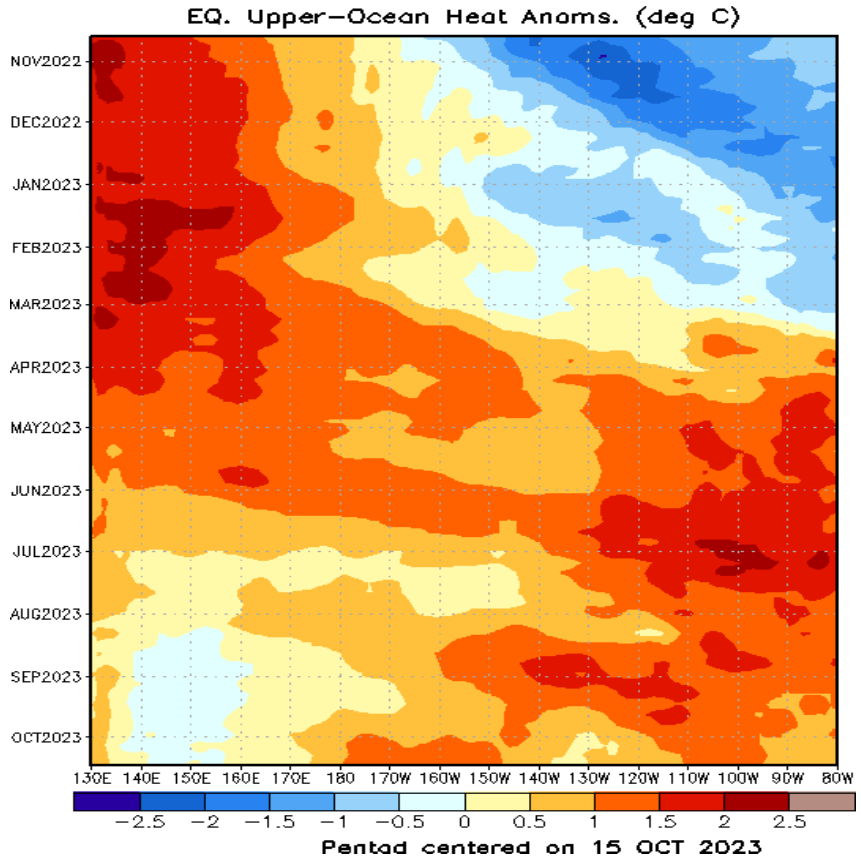




- El Niño continues to dominate tropical variability when applying filtering though OLR anomalies, with some constructive interference with enhanced Rossby Wave activity over the Western Pacific.
- OLR anomaly maps depict strong positive OLR anomalies across the Indian Ocean and far western Pacific, along with the Caribbean. Negative OLR anomalies have emerged across Central America and surrounding regions associated with an increase in anomalous low-level westerlies.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

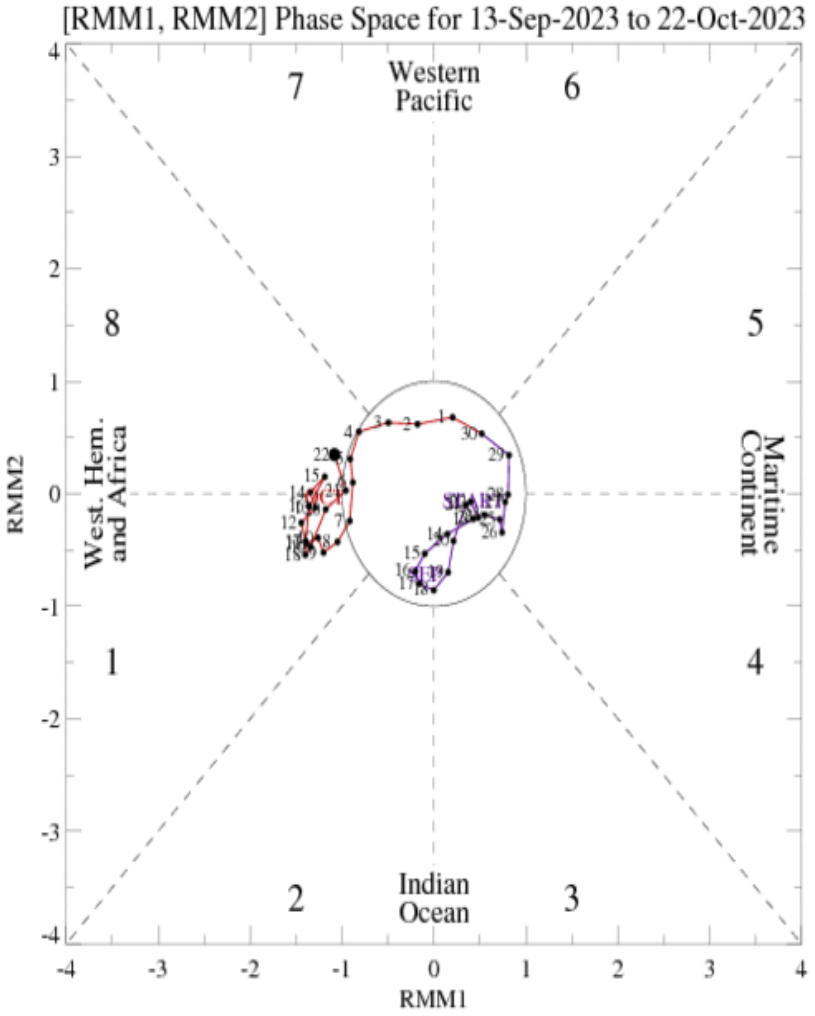




- El Niño conditions are present across the equatorial Pacific with SST anomalies remaining strongly positive in all of the Niño basins.
- An area of slightly negative upper-ocean heat content anomalies is noted across the Western Pacific given increased upwelling and anomalous low-level easterlies developing over the region.

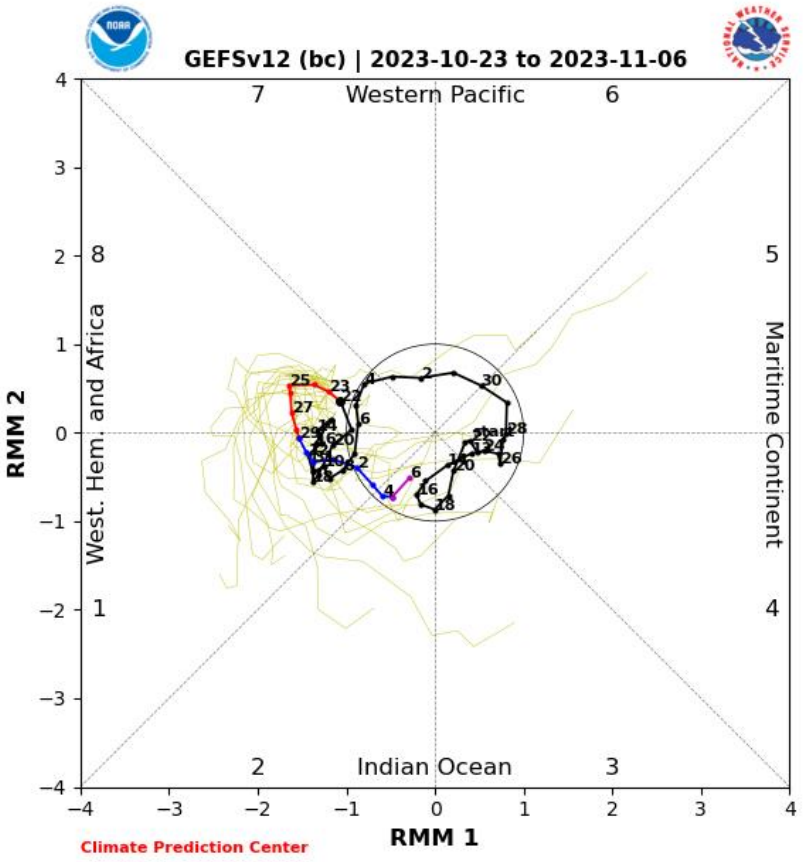
MJO Index: Recent Evolution

- The RMM-based MJO index has been meandering across the Western Hemisphere (phases 8 and 1) during the past week. However, this is more likely a result of competing modes of tropical variability rather than a true MJO signal.

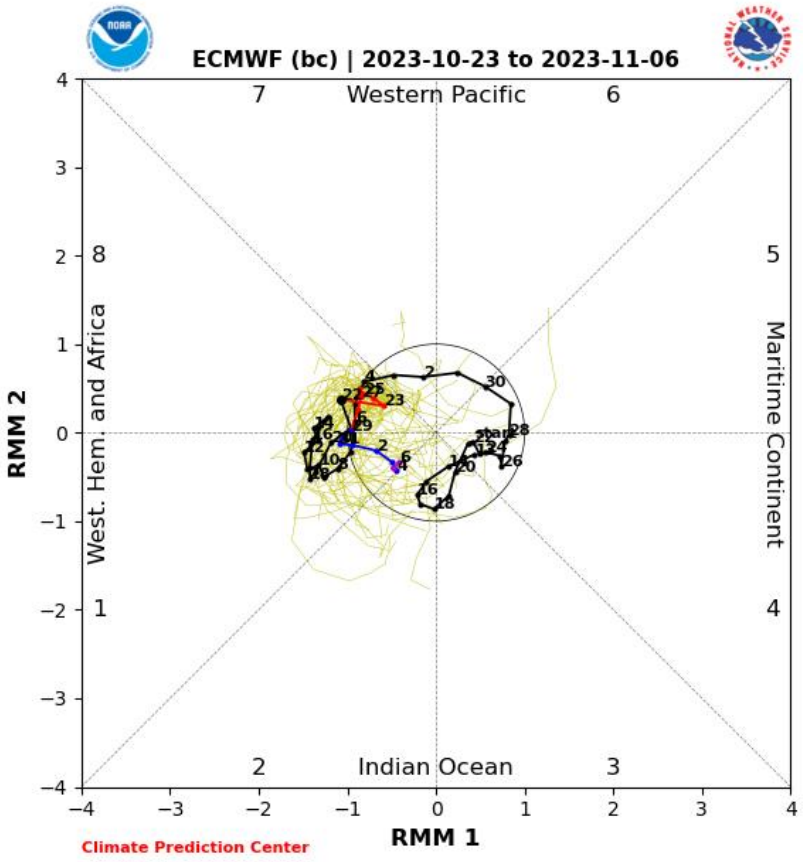


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

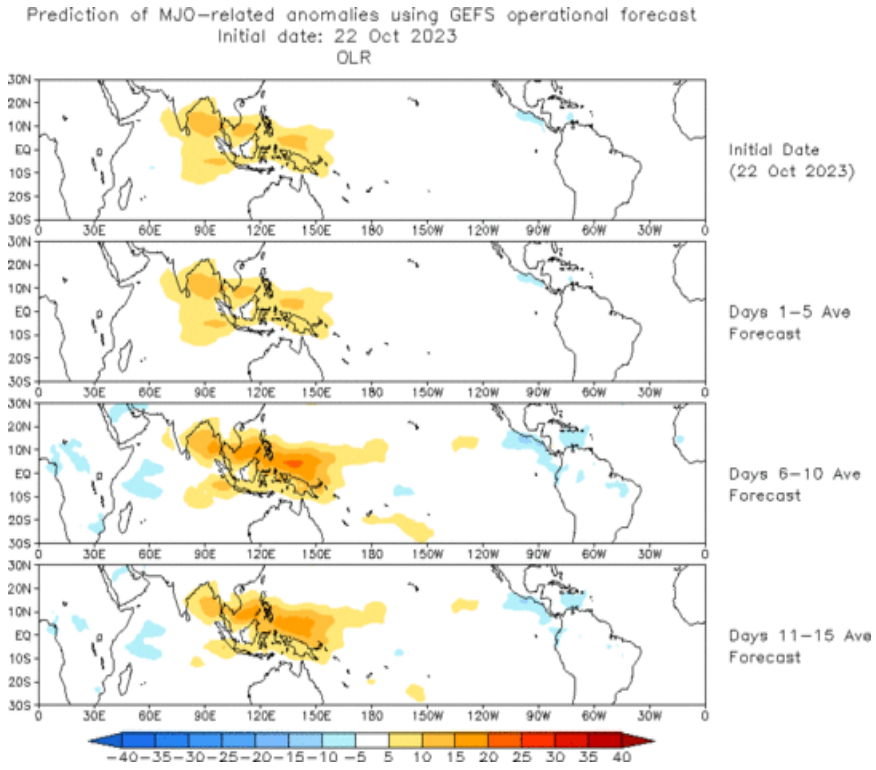


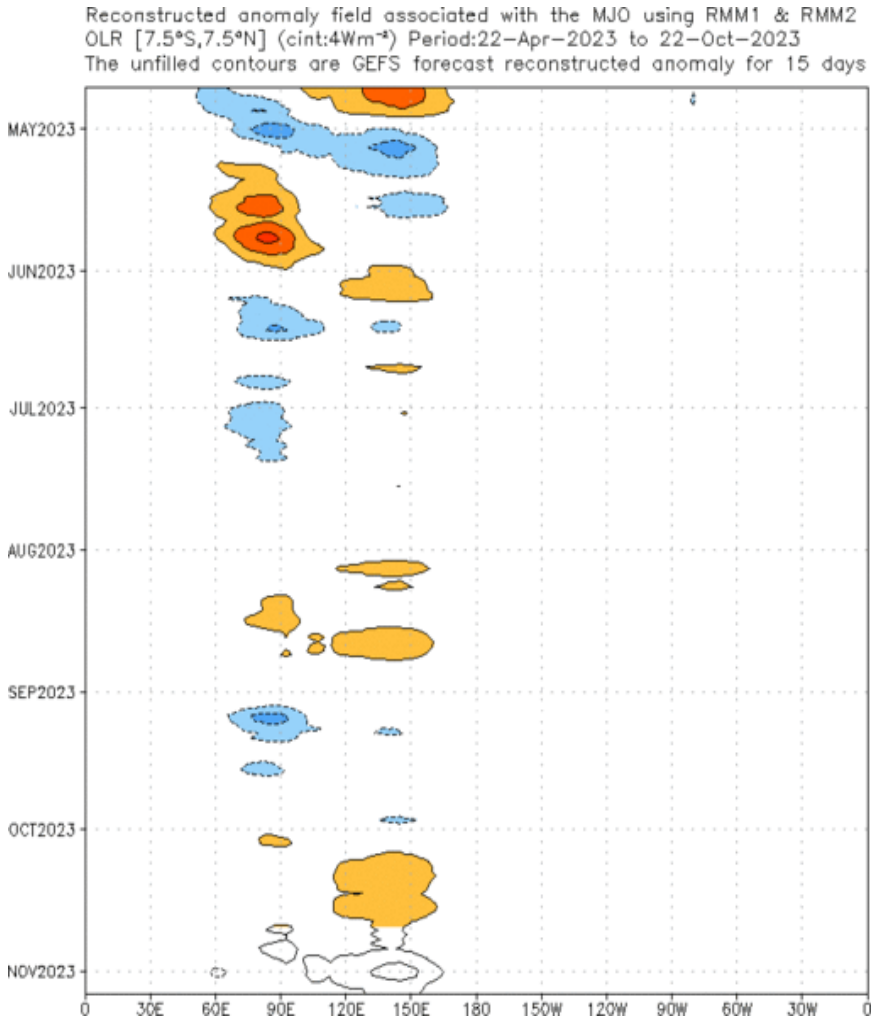
ECMWF Forecast

- Both the GEFS and ECMWF dynamical model ensembles are in good agreement regarding an eastward propagation of the RMM-based MJO index into the Indian Ocean by week-2.
- However, the ongoing El Niño and positive phase of the IOD are likely driving this enhanced convective signal rather than the MJO.

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.)

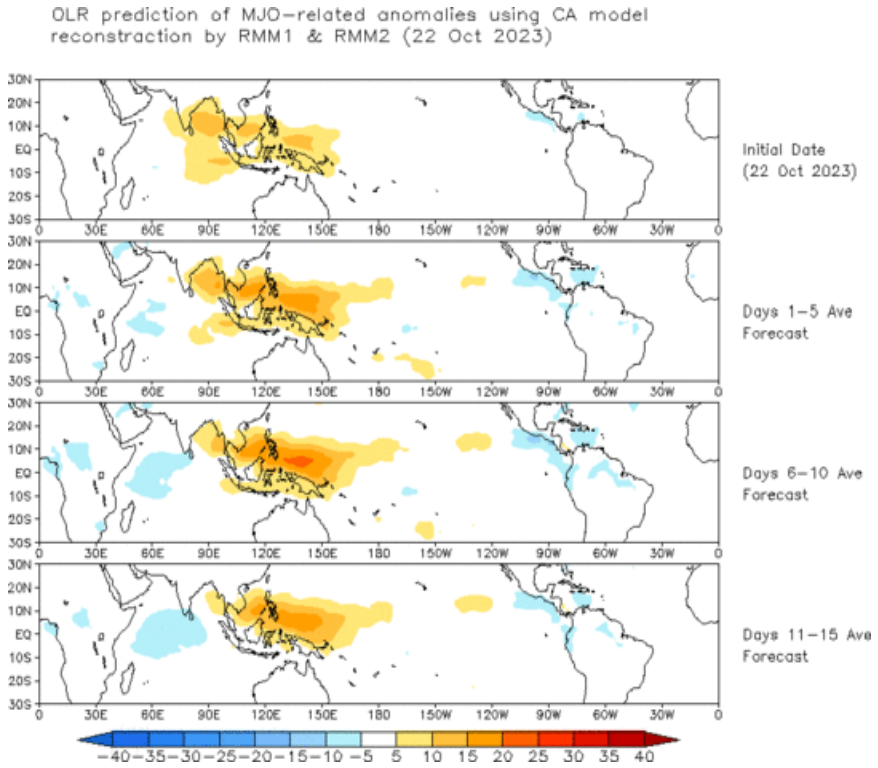


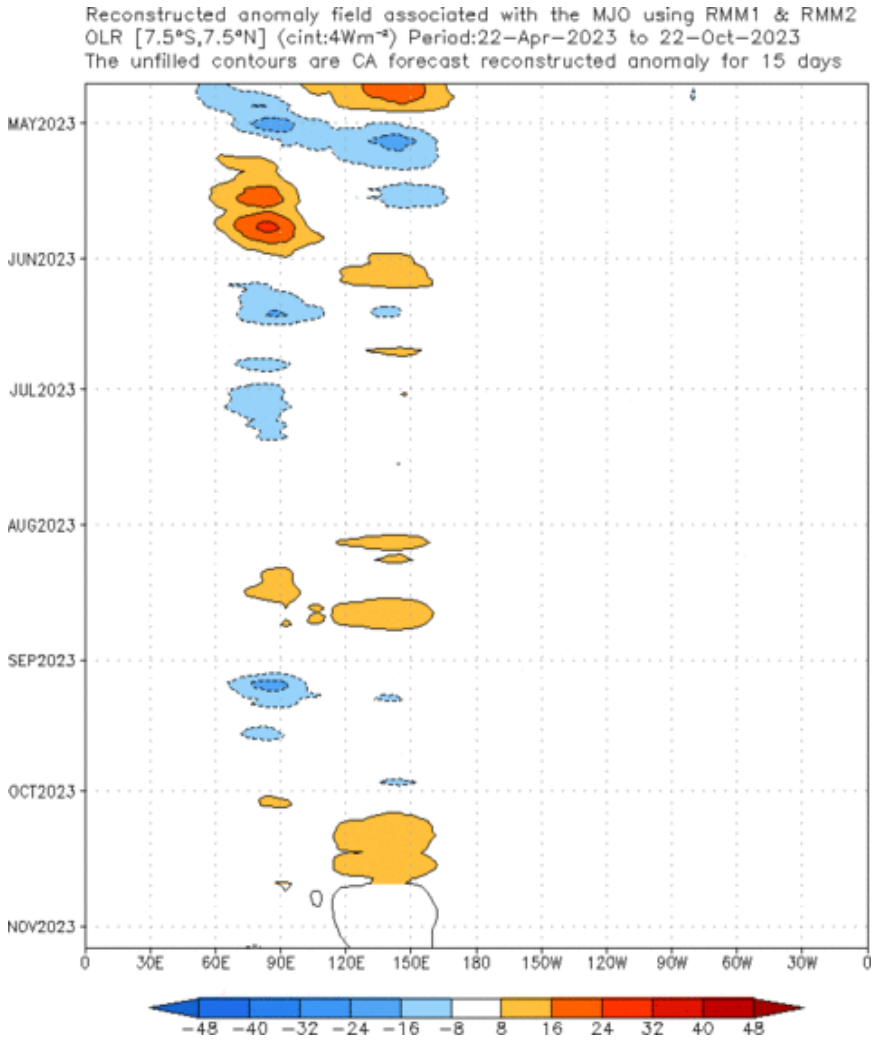


- The GEFS RMM-based OLR forecast depicts a persistent area of positive OLR anomalies across the eastern Indian Ocean and Western Pacific.
- Conversely, negative OLR anomalies are noted across Africa and the western Indian Ocean, along with Central America and the Caribbean.

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.)

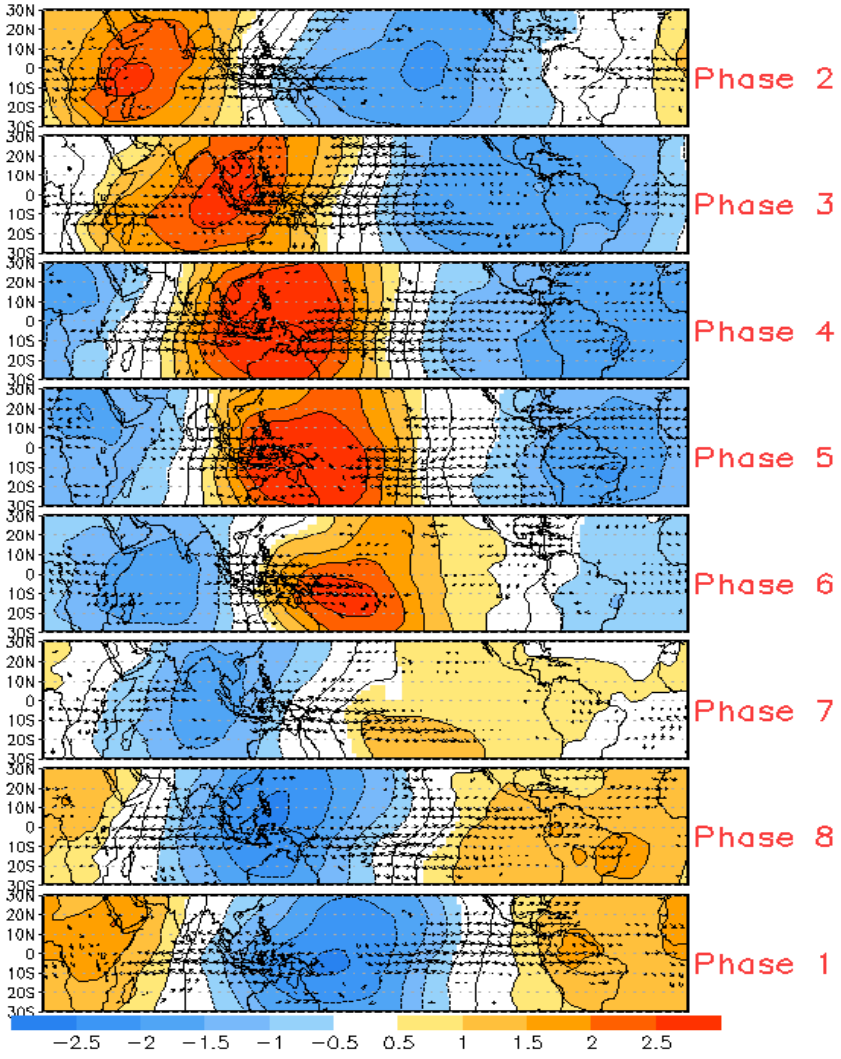




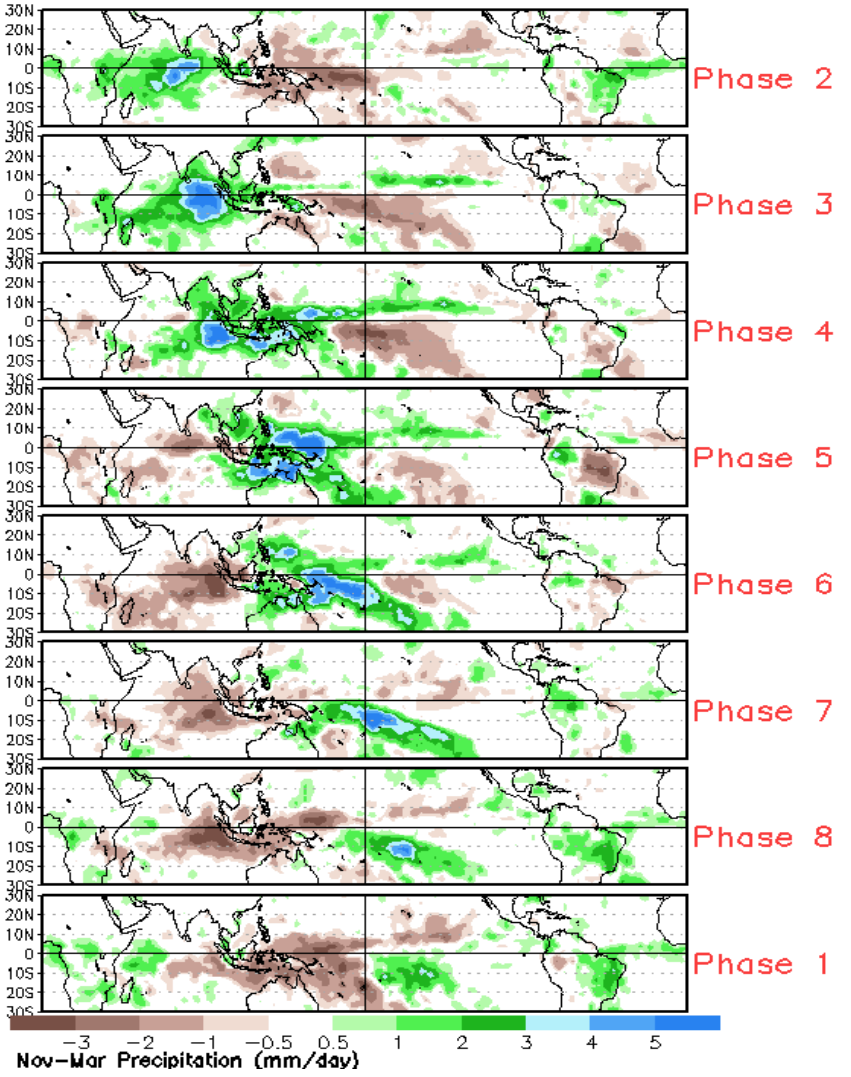
- The constructed analog RMM-based forecast is in good agreement with the GEFS, with a slightly greater expansion of negative OLR anomalies over the Indian Ocean.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



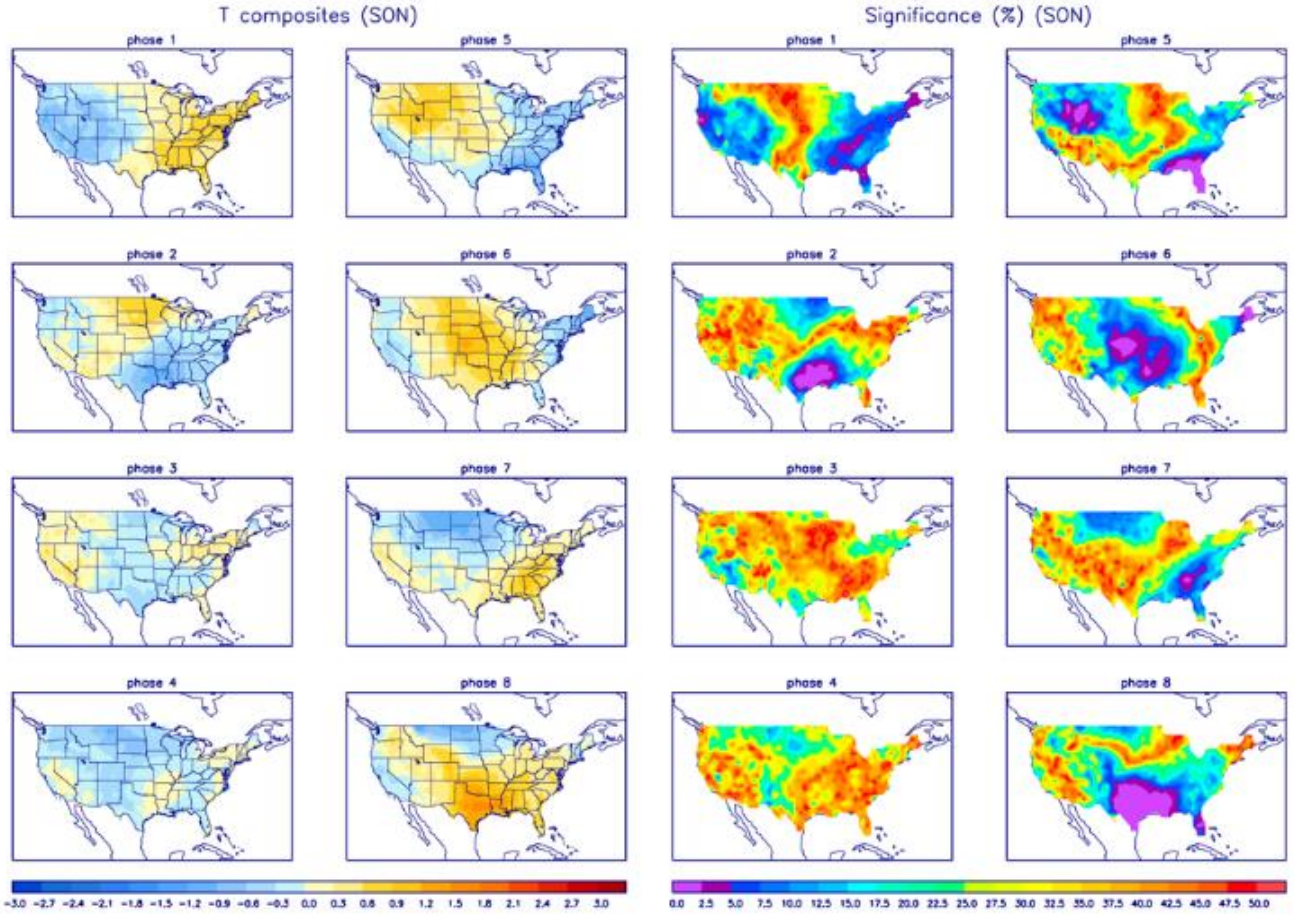
Precipitation Anomalies



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.

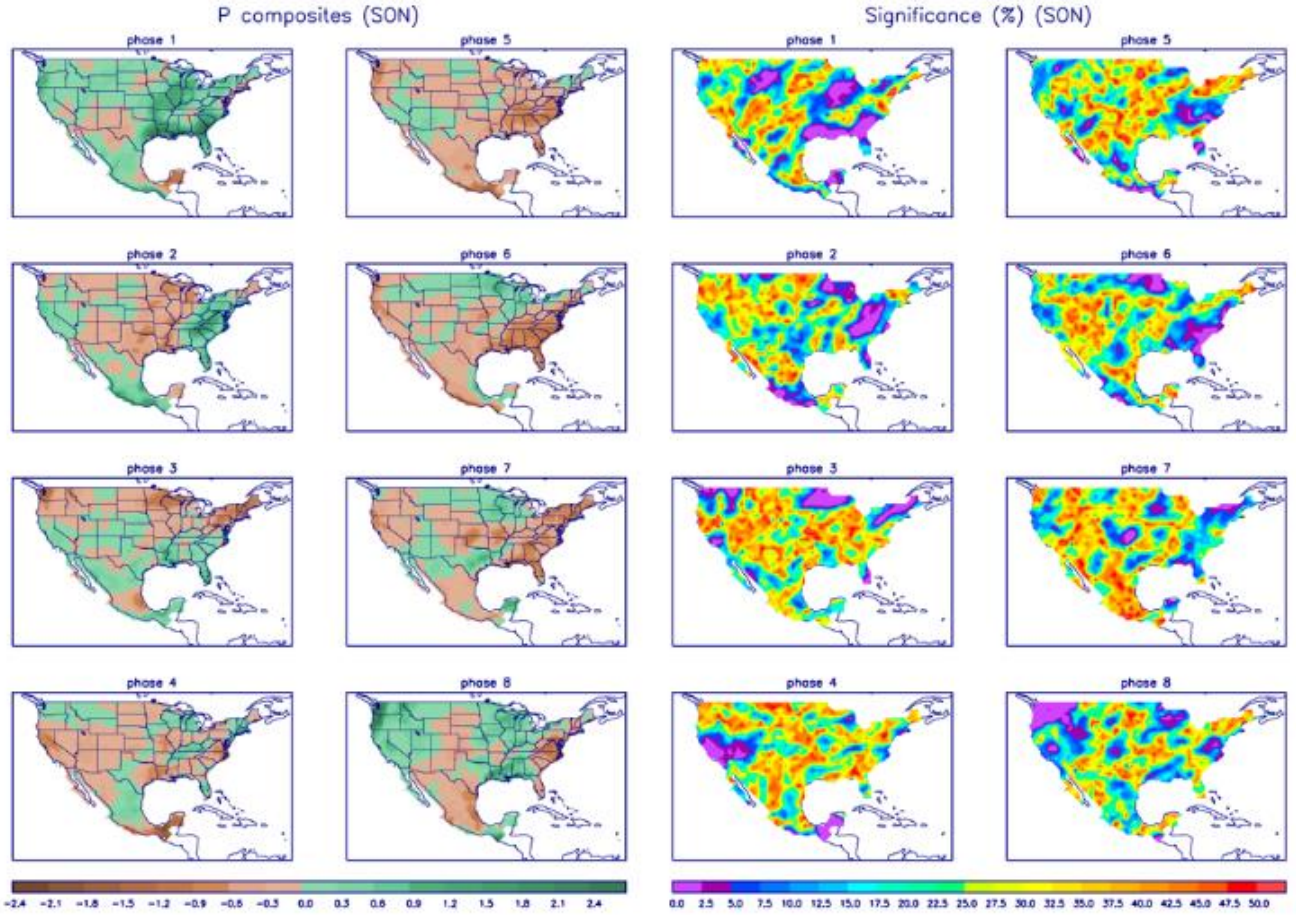


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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.



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