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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
25 September 2023

Overview

- The RMM-based MJO index returned to the unit circle, with dynamical models depicting a largely incoherent propagation during the next 2 weeks.

- Despite the weak RMM-based MJO signals, the upper-level velocity potential filtering depicts a much more coherent eastward propagating MJO signal from the Indian Ocean/Maritime Continent to the Western Hemisphere by mid-October.

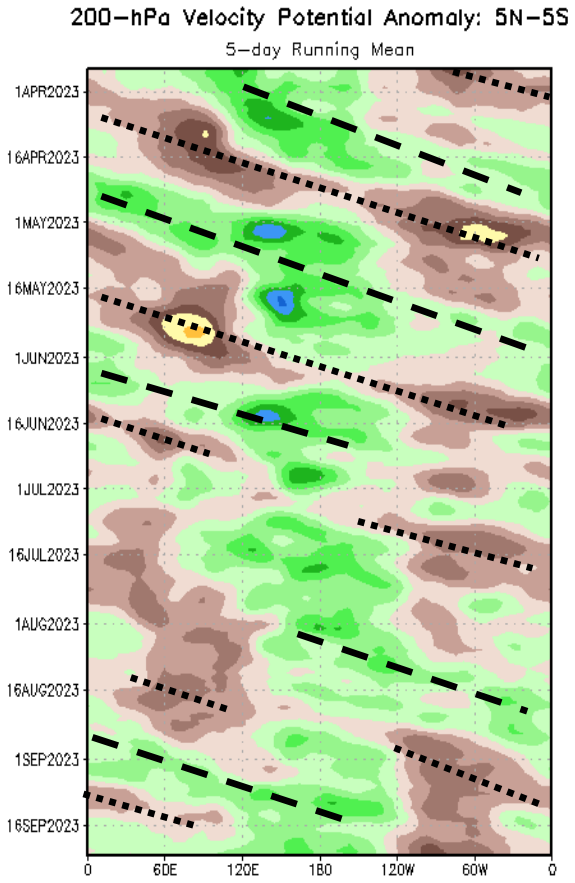
- As a result tropical cyclone activity is forecast to increase across the Eastern Pacific by week-2, possibly extending into the Western Caribbean. The Atlantic Main Development Region may also see a renewed burst of activity following a break in the near-term, although climatology favors this region to begin to quiet down during October.

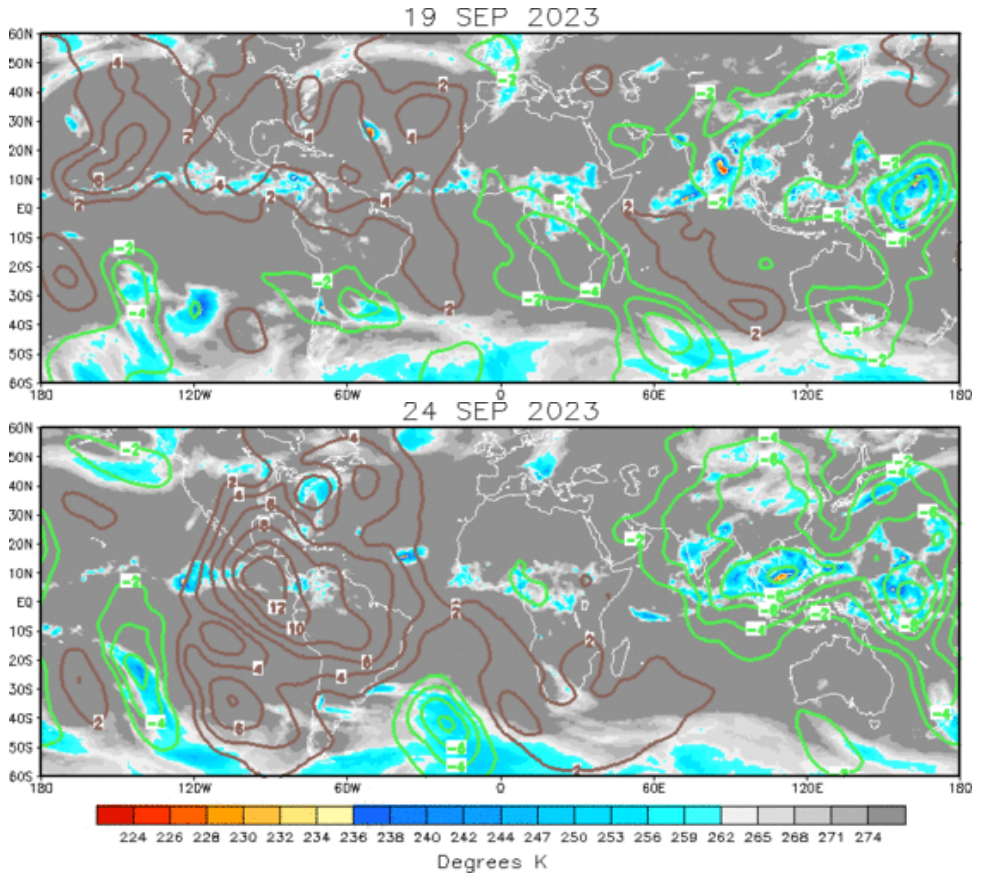
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)



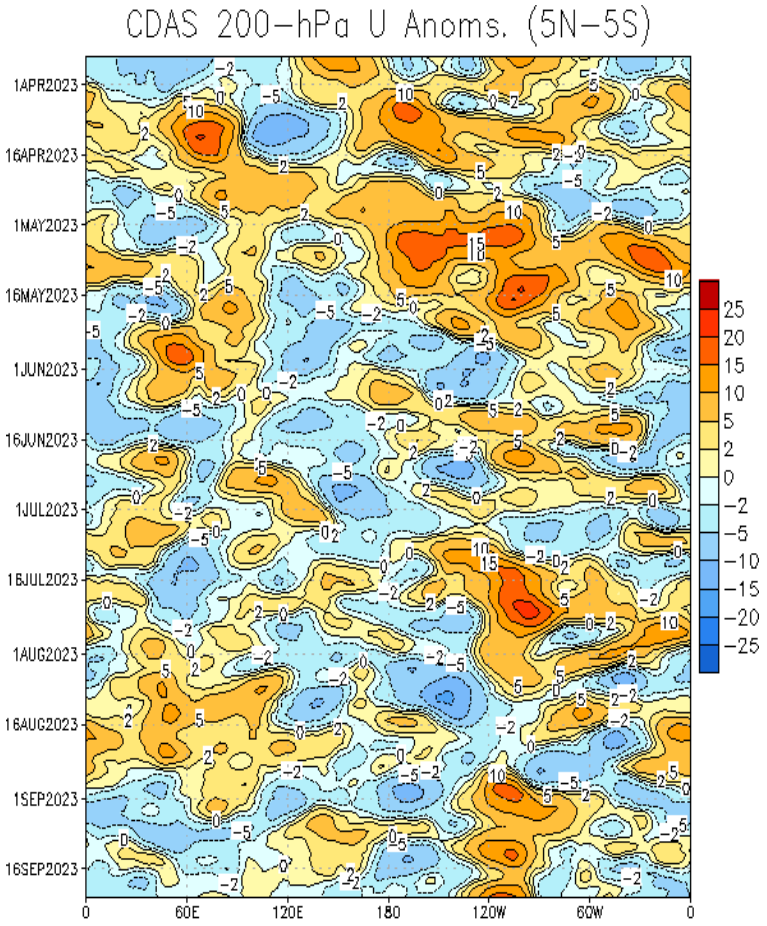


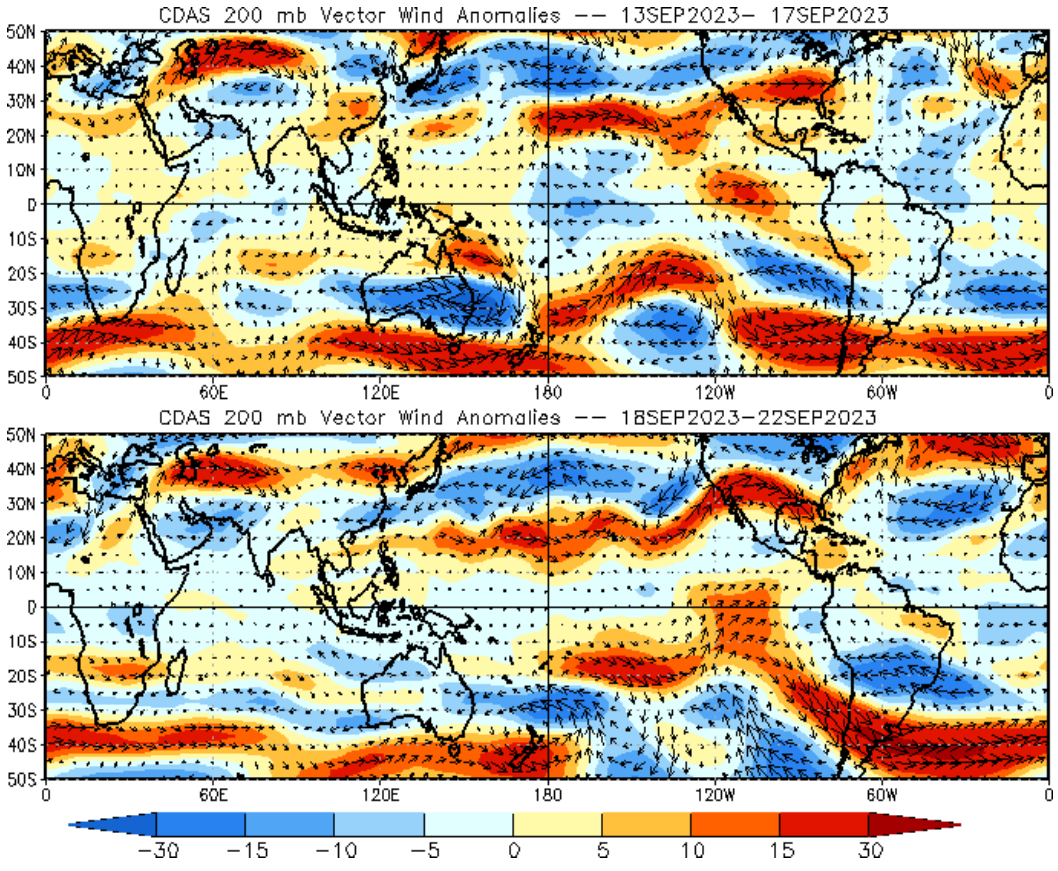
- The spatial upper-level velocity potential field has become more organized during the past week, with anomalous convergence across the Eastern Pacific, Americas, and Atlantic, and anomalous divergence across the Indian Ocean, Asia, and the Western Pacific.

- Reduced propagation of these features indicates a greater influence from the low frequency El Niño state rather than the MJO.

200-hPa Wind Anomalies

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

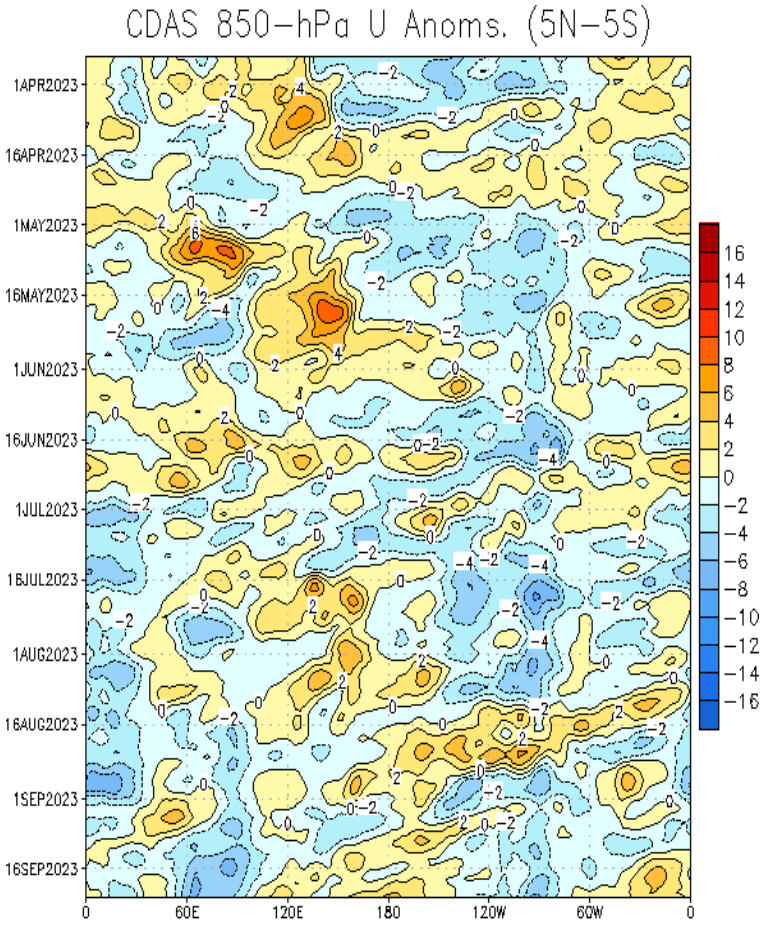


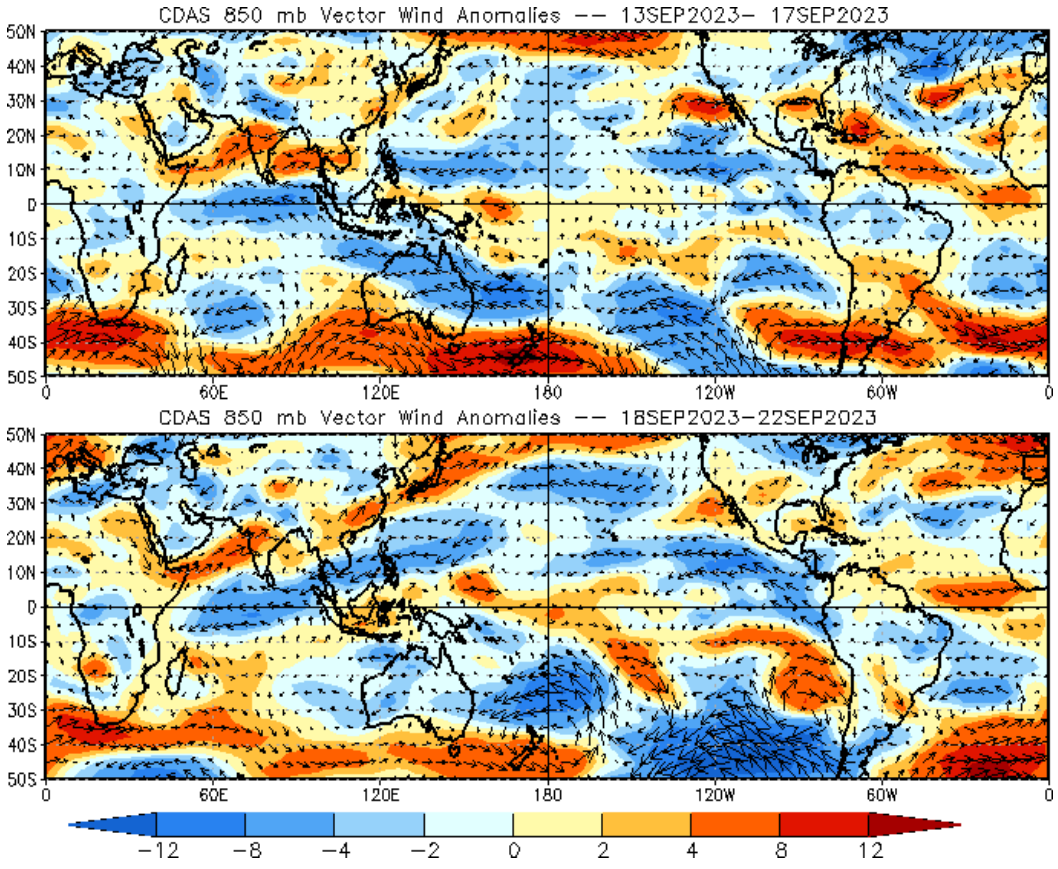


- Upper-level jet stream is displaced to the south relative to climatology across the North Pacific and North America
- Anti-cyclonic flow over the North Atlantic serves as the steering mechanism for tropical cyclones.
- More persistent anomalous upper-level westerlies are highlighted across the Eastern Pacific.

850-hPa Wind Anomalies

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

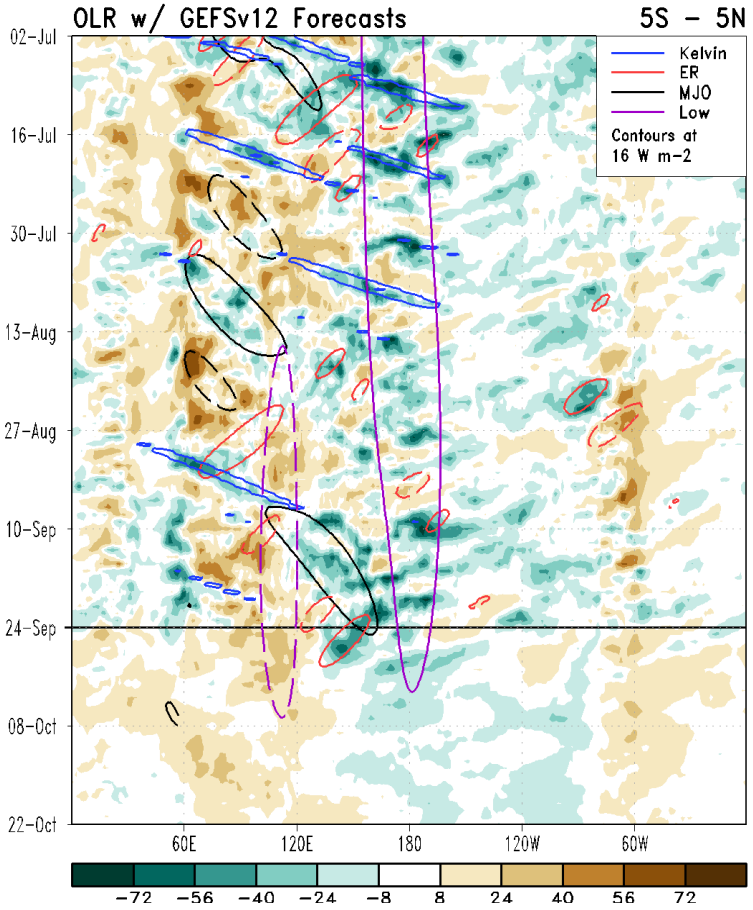


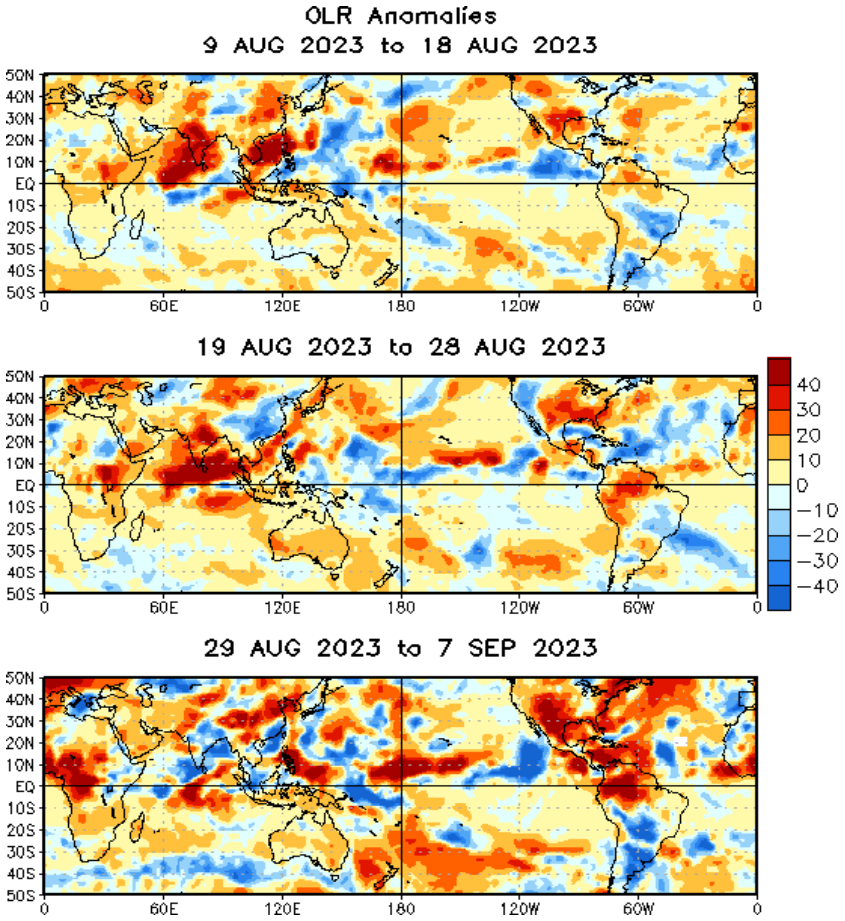


- Anomalous low-level westerlies are observed across much of the Atlantic coinciding with increased tropical cyclone activity in the basin.
- Anomalous low-level easterlies continue to persist across the Western and Eastern Pacific basins, inhibiting tropical cyclone activity, with an area of anomalous low-level westerlies near the Date Line.

Outgoing Longwave Radiation (OLR) Anomalies

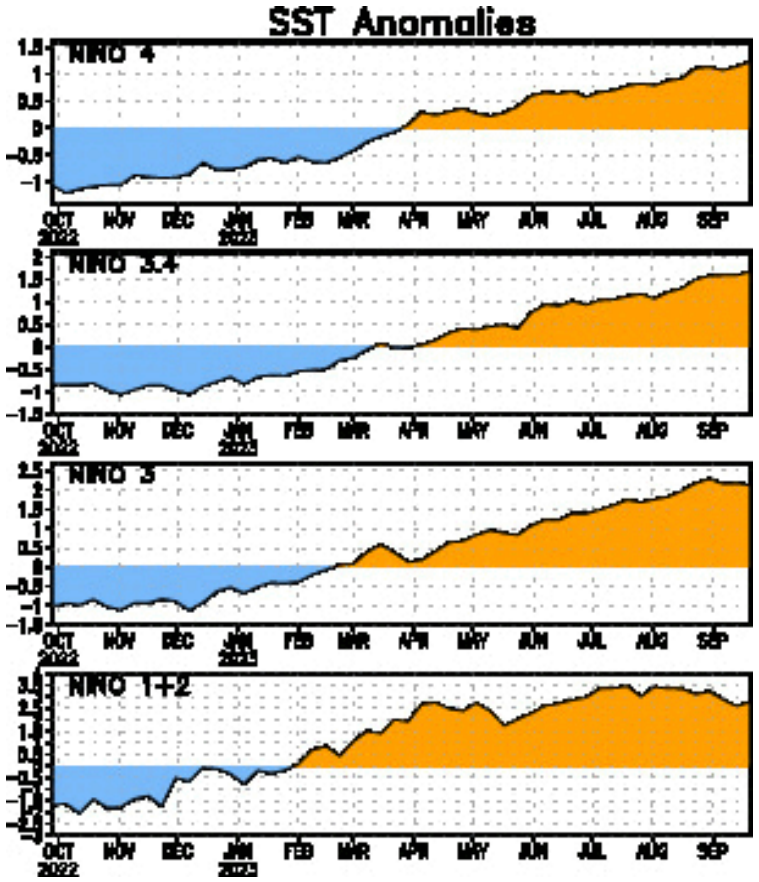
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

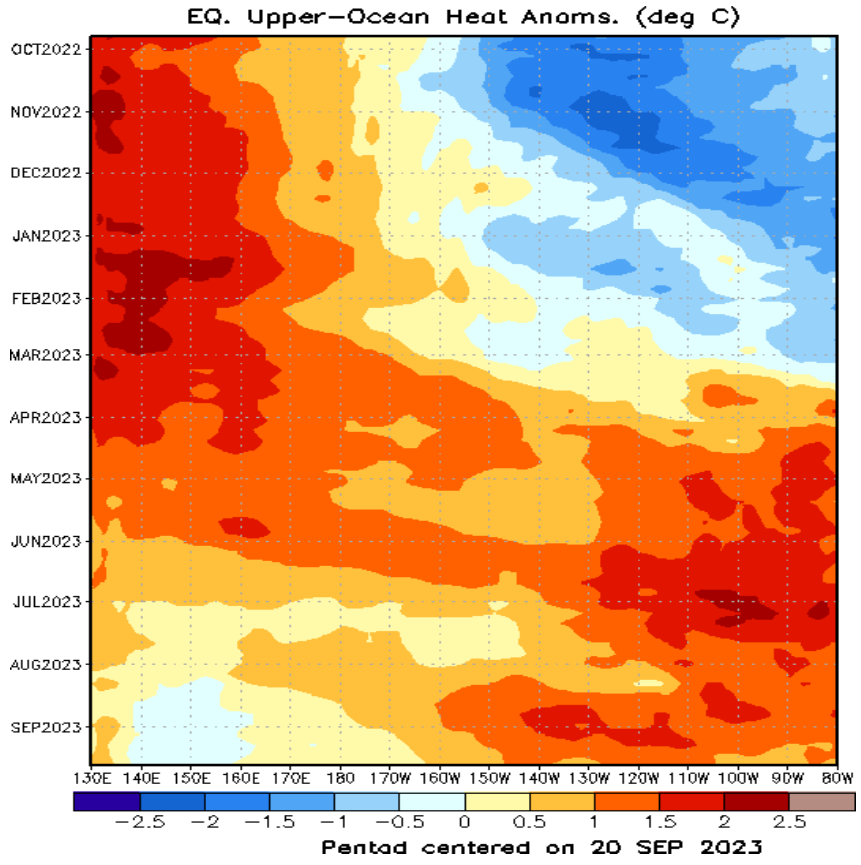




- In early September, positive OLR anomalies are noted across northern South America, extending through North America with several tropical cyclone tracks apparent over the Atlantic where the anomalies are sporadically negative.
- The low frequency El Niño state has remained dominant this past summer, although the MJO is seen coming through the OLR filtering across the Maritime Continent/Western Pacific during the past 2 weeks.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

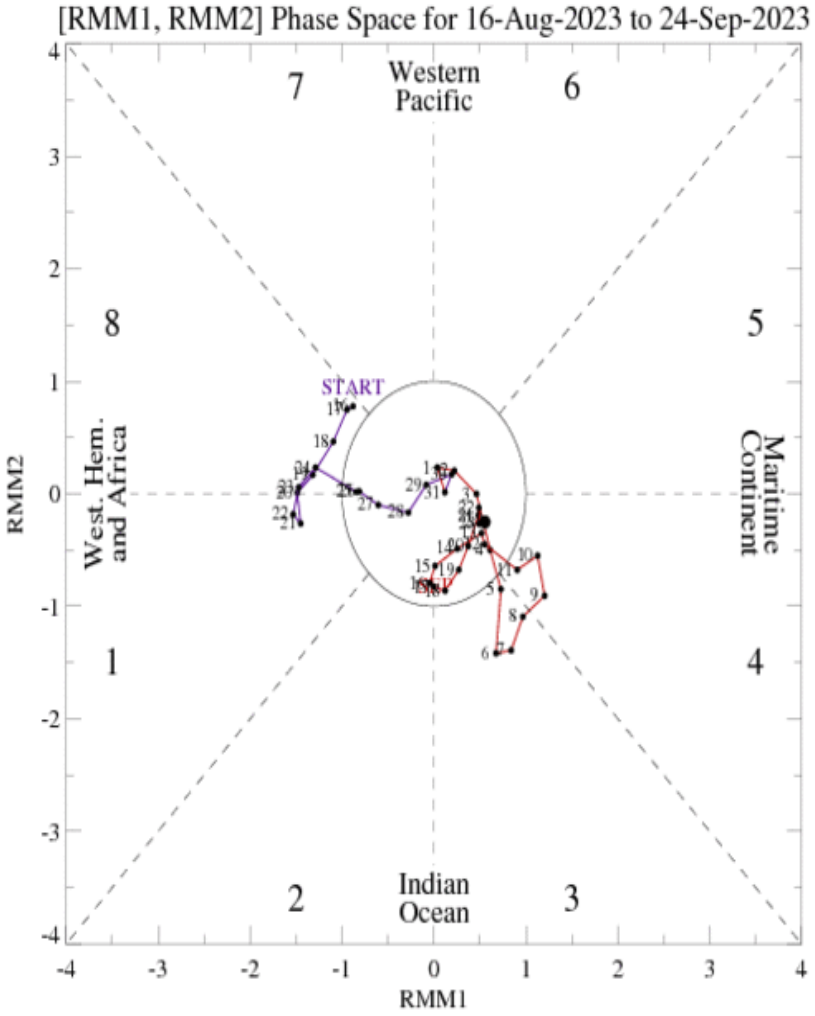




- El Niño conditions are present across the equatorial Pacific as SST anomalies remain strongly positive in all of the Niño basins, although the upward trend appears to have leveled off in the eastern-most regions.
- Tied to a westerly wind event over the western Pacific in August, another surge of warm subsurface ocean water extended eastward across the central Pacific. Negative heat content anomalies are observed in the West Pacific Warm Pool in the wake of this event.

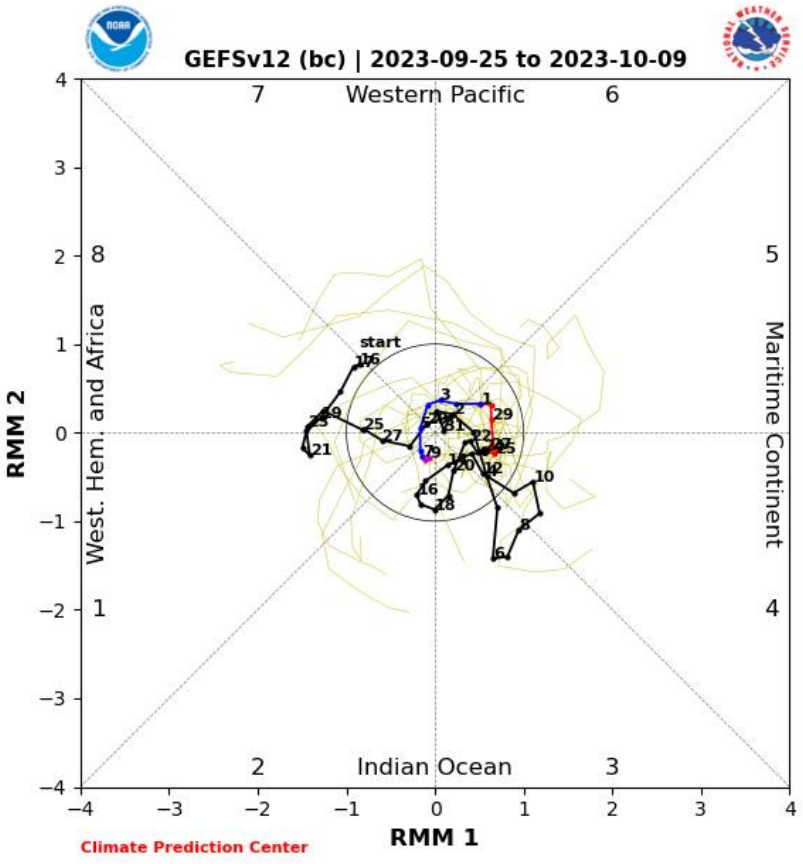
MJO Index: Recent Evolution

- The RMM-based MJO index has weakened and has moved back into the unit circle during the past week following a brief increase in amplitude over the Indian Ocean and Maritime Continent.

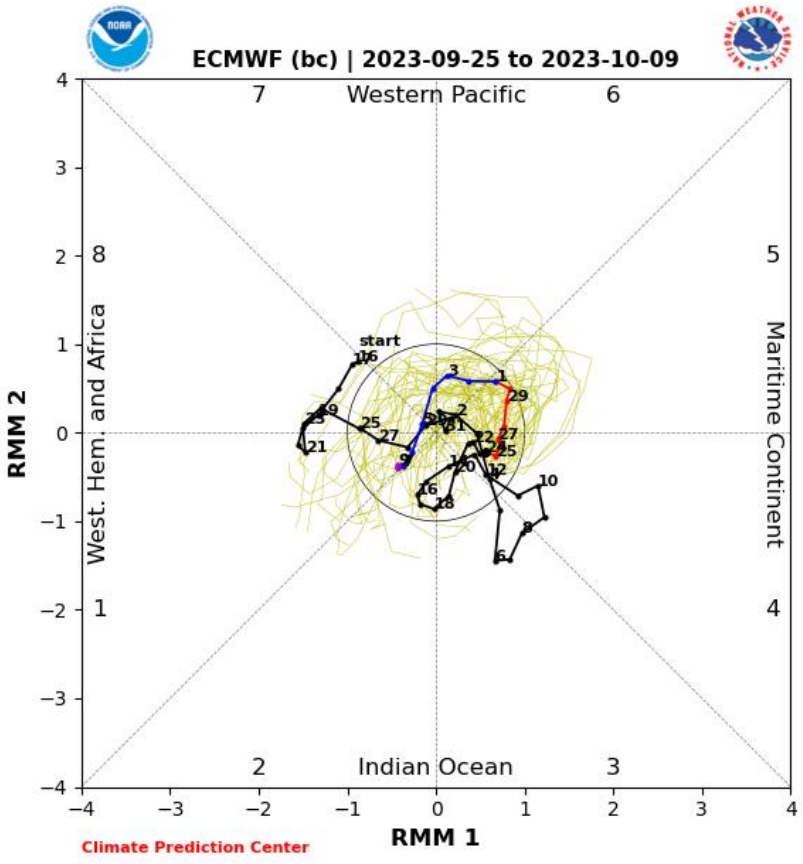


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

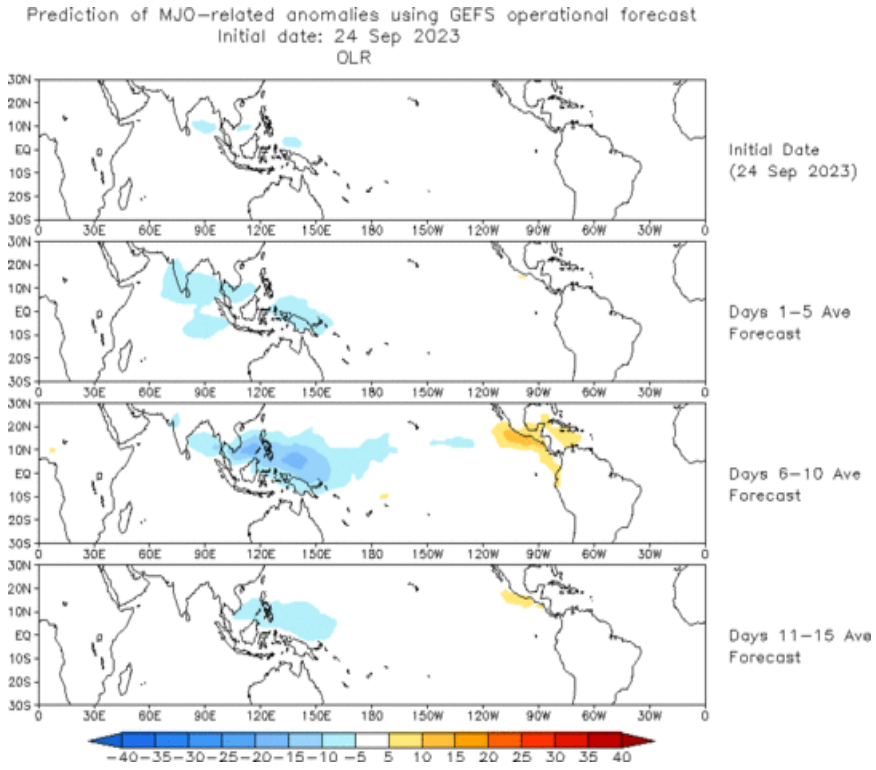


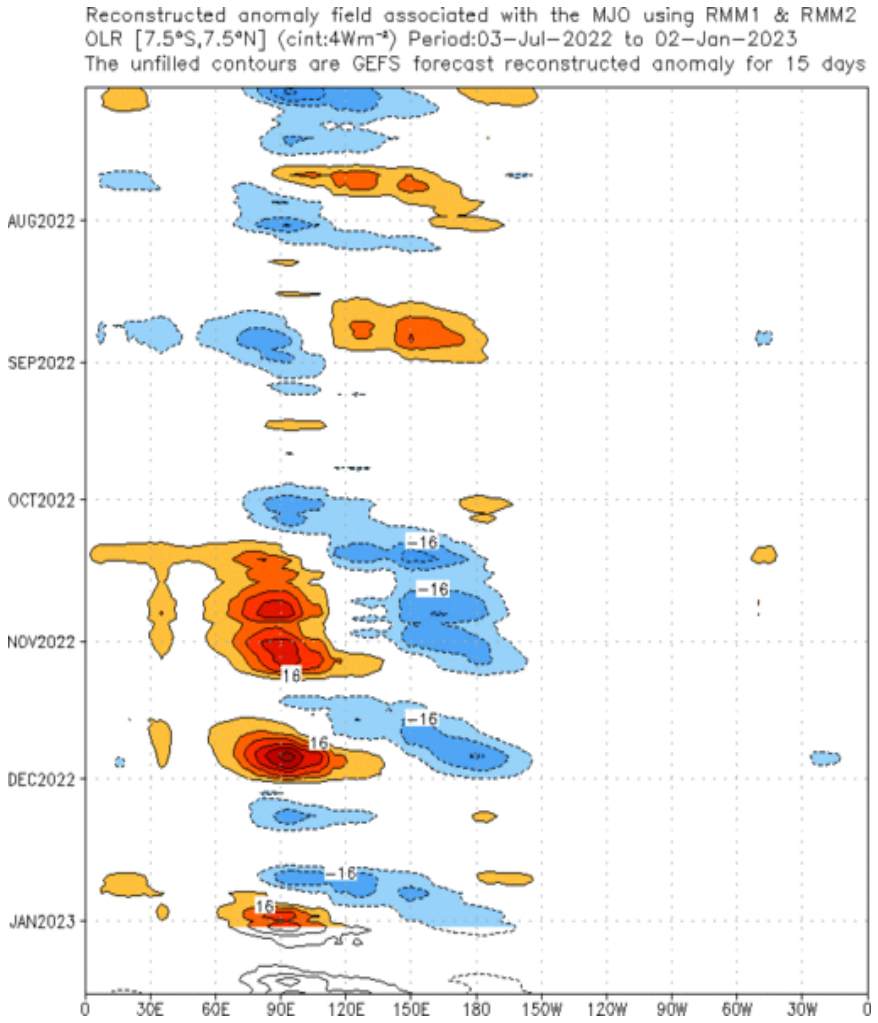
ECMWF Forecast

- Both the GEFS and ECMWF models generally depict an incoherent MJO signal during the next 2 weeks.
- Some individual ensemble members indicate a more pronounced eastward propagation from the Maritime Continent/Western Pacific into the Western Hemisphere.

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.)

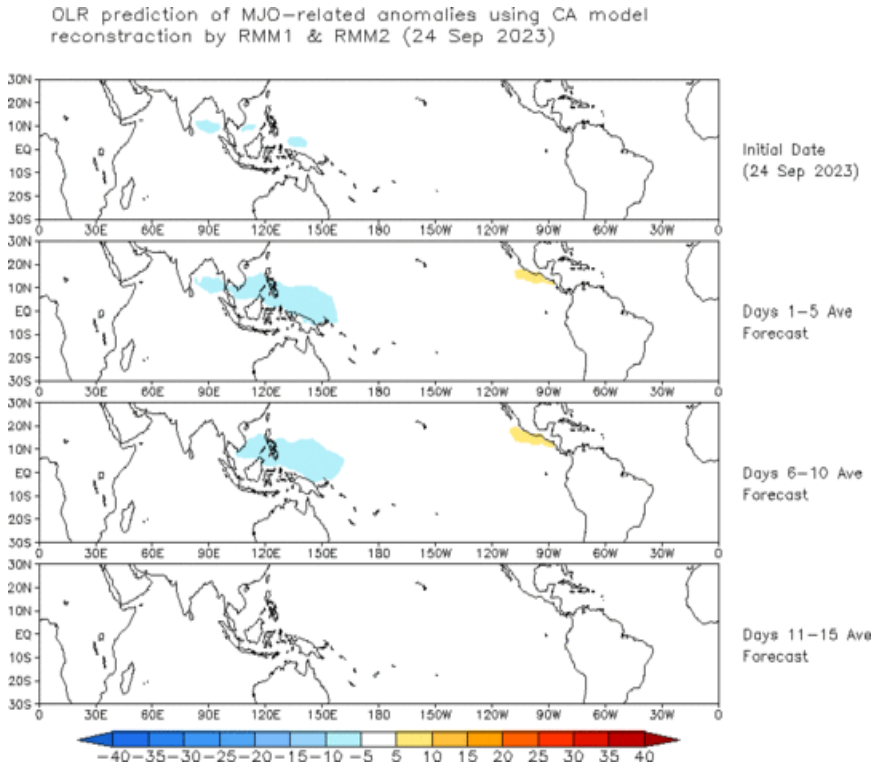


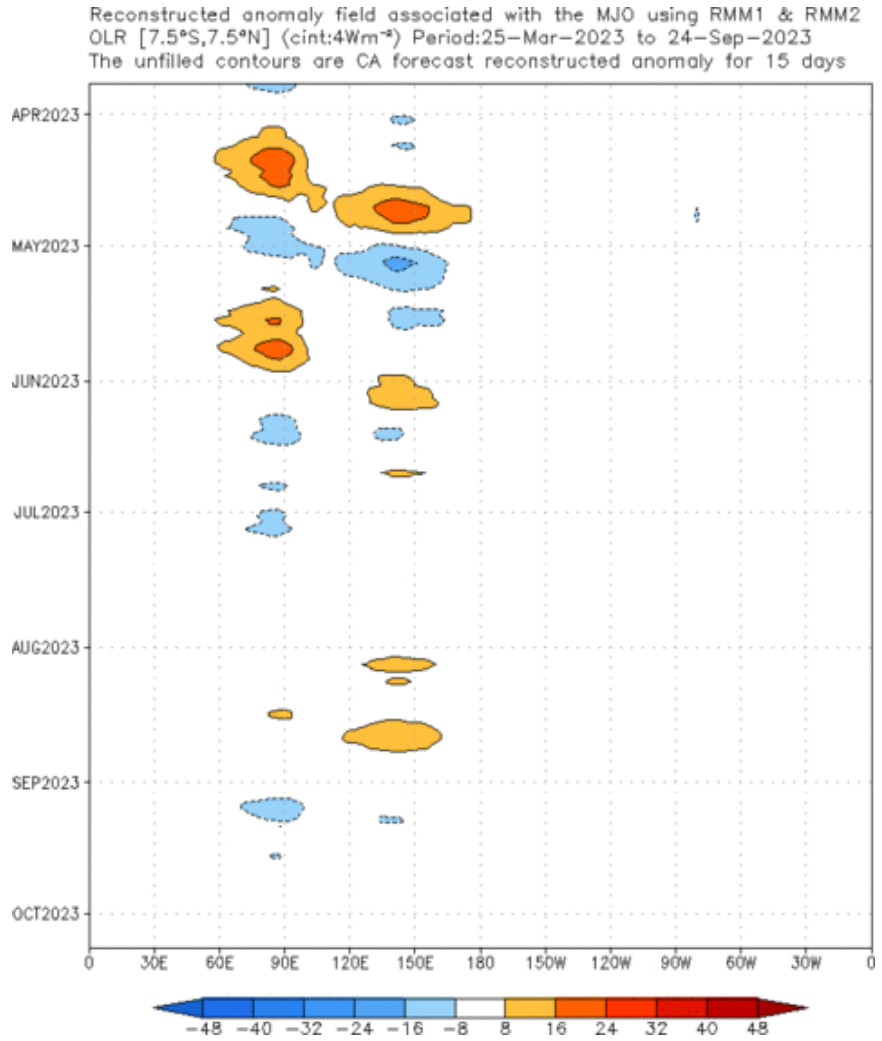


- The GEFS RMM-based OLR forecast depicts negative OLR anomalies (enhanced convection) across the Bay of Bengal and Western Pacific, weakening toward the end of week-2.
- Some positive OLR anomalies (suppressed convection) are noted across the Eastern Pacific and Caribbean.

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.)

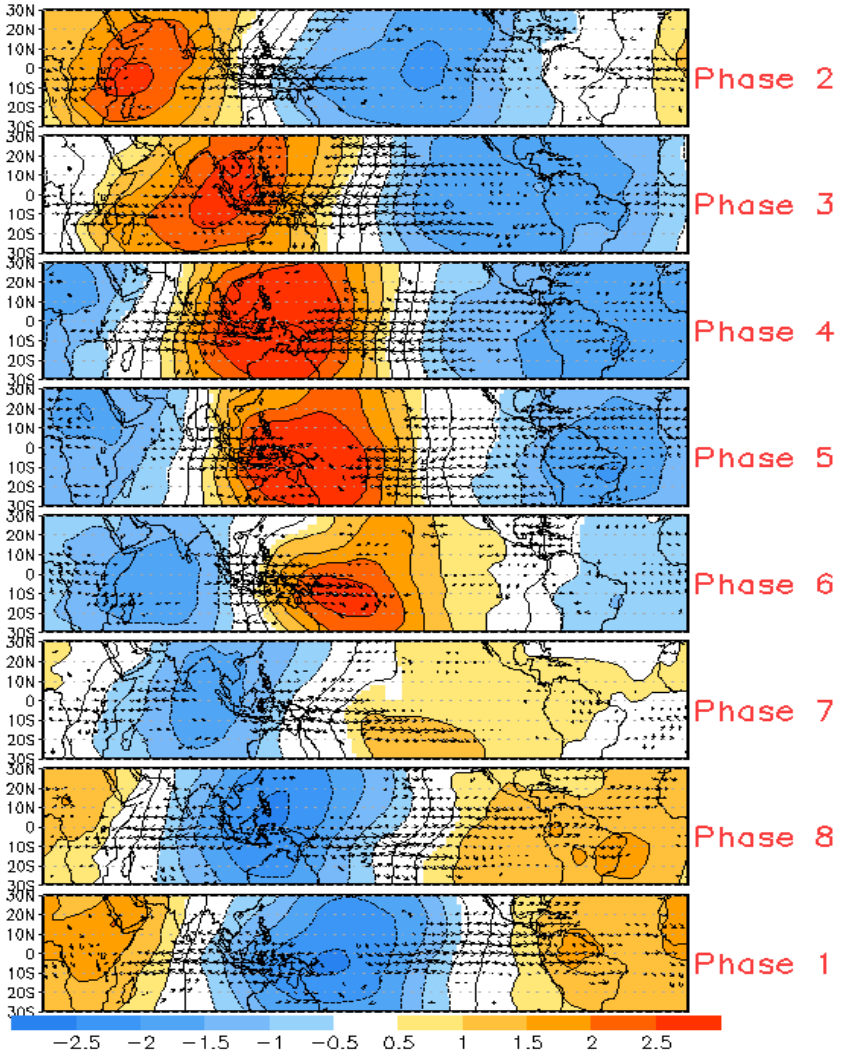




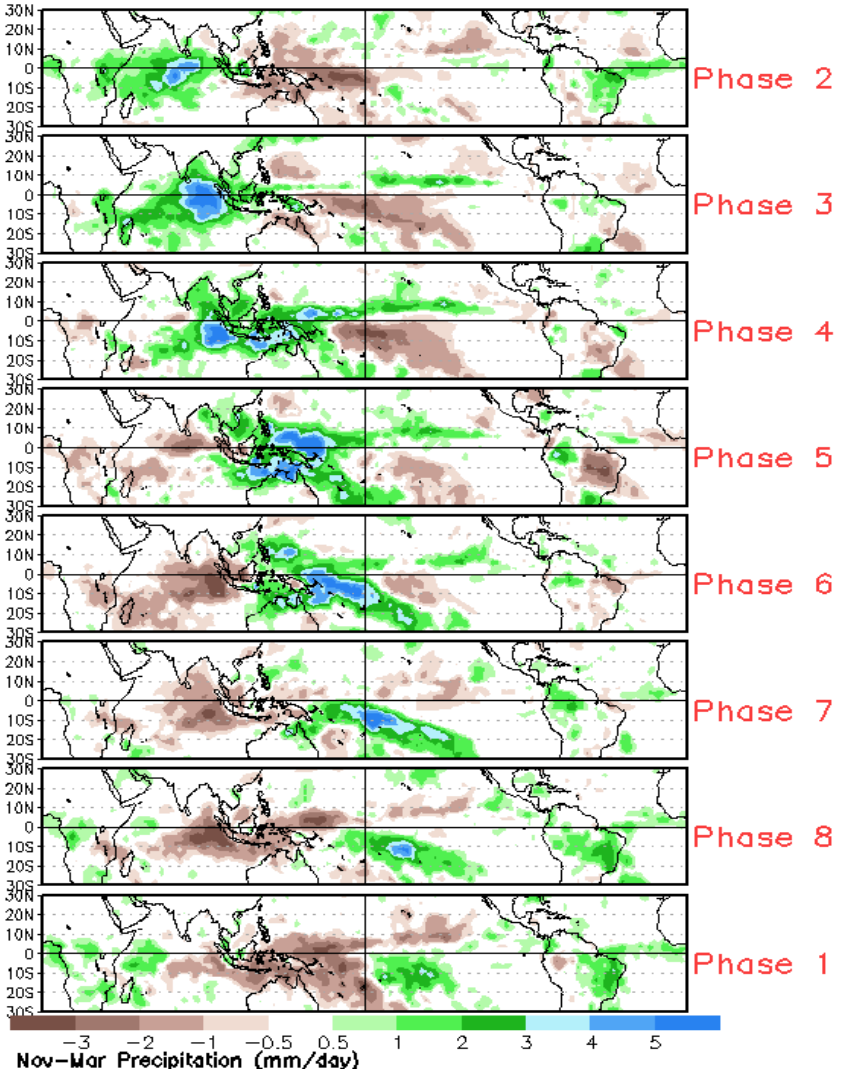
- The constructed analog RMM-based forecast indicates a similar pattern as the GEFS but with weaker OLR anomalies.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



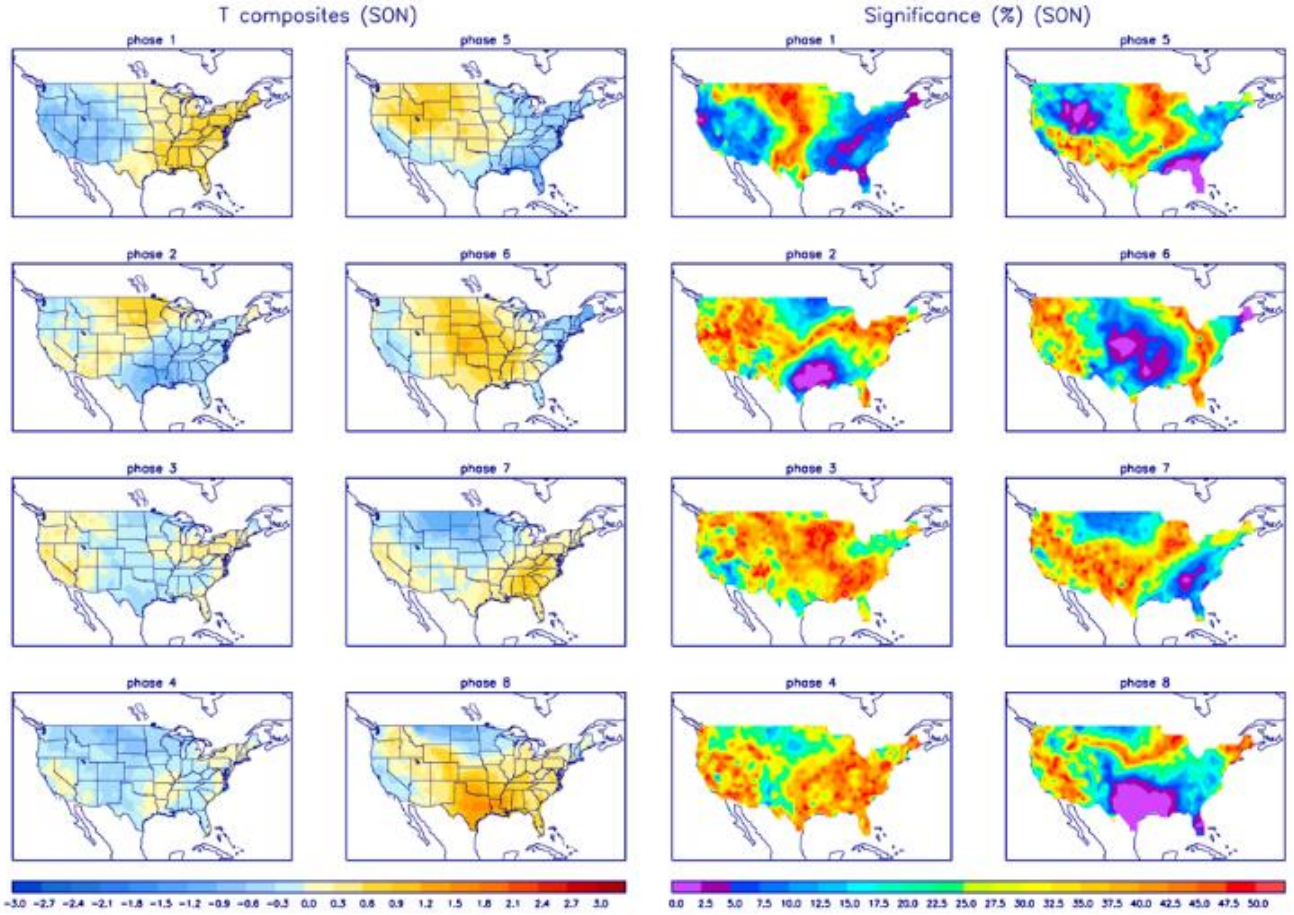
Precipitation Anomalies



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.

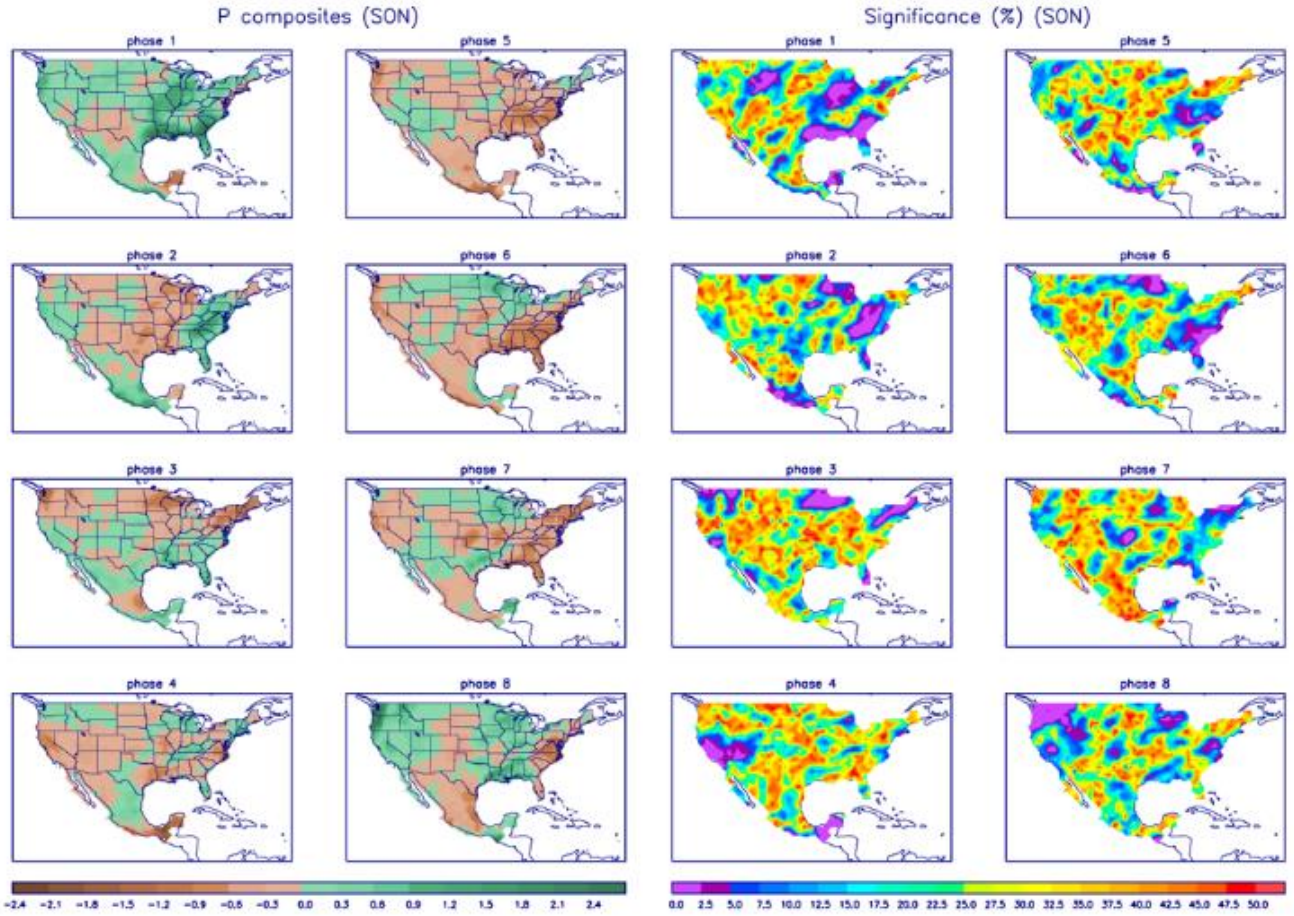


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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