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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
20 November 2023

Overview

- While low frequency variability is predominately featured in the global tropics, the reemergence of a more coherent MJO signal is evident. The uptick of intraseasonal activity constructively interfered with El Nino and likely triggered an unusually strong westerly wind burst event over the equatorial Pacific during mid-November.

- Dynamical models remain in good agreement depicting continued eastward propagation of the MJO over the Indian Ocean and into the Maritime Continent during the next several weeks. Favored increases (decreases) in amplitude in RMM space appear to be tied to constructive (destructive) interference with the +IOD (El Nino and other modes of variability) in the forecast period.

- The large scale environment is expected to remain conducive for tropical cyclogenesis over the Indian Ocean through the end of November, with more favorable conditions for development shifting eastward into the Pacific later in the outlook period.

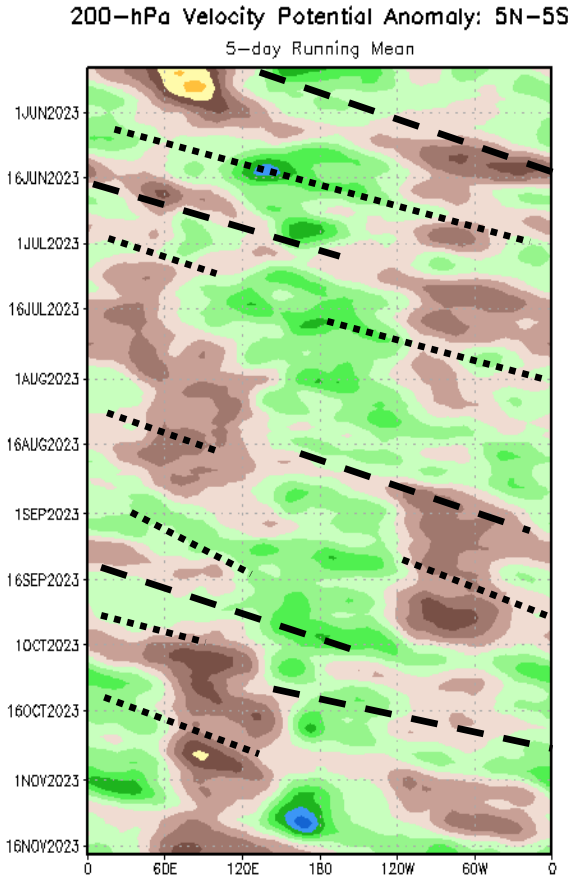
- The extratropical response associated with eastward propagating Indian Ocean MJO events during late autumn typically leads to the development mid-level ridging and above-normal temperatures over the central and eastern U.S.

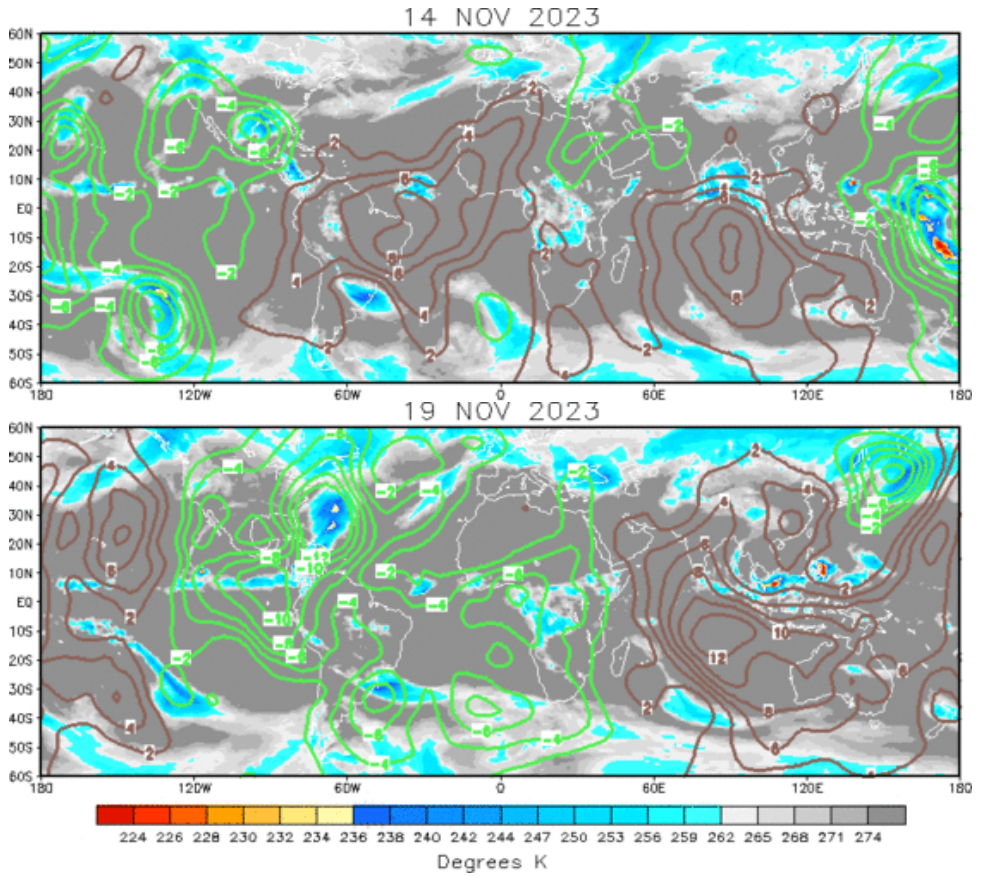
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

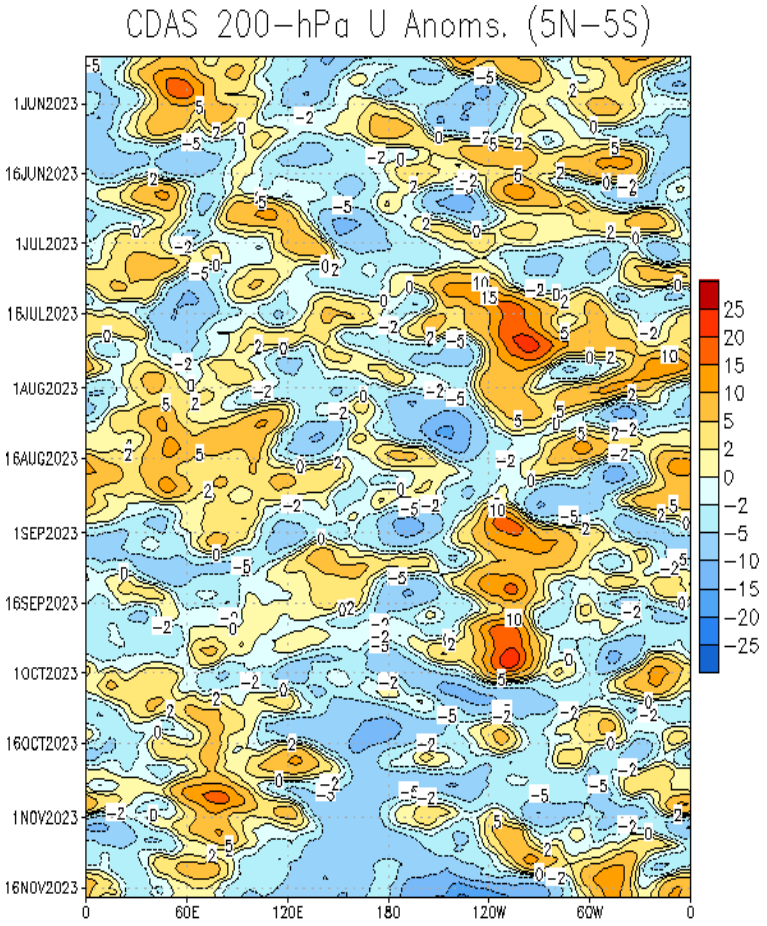


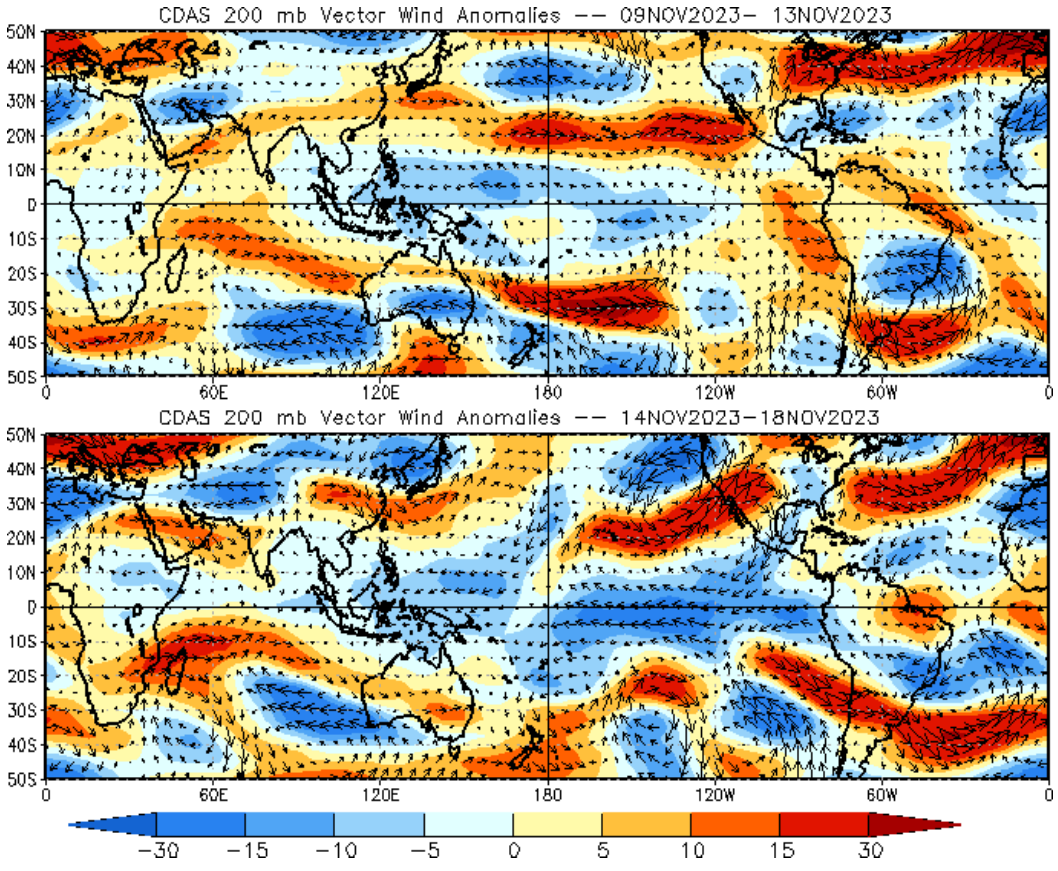


- While low frequency signals have dominated the global tropics, a more coherent wave-1 pattern has emerged in the upper-level velocity potential anomalies fields during mid-November.
- A broad envelope of enhanced divergence shifted eastward across the tropical Americas/Africa. Suppressed convection also shifted eastward across the Indian Ocean and Maritime Continent, and looks to destructively interfere with the stationary ENSO response to the west of the Date Line.

200-hPa Wind Anomalies

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

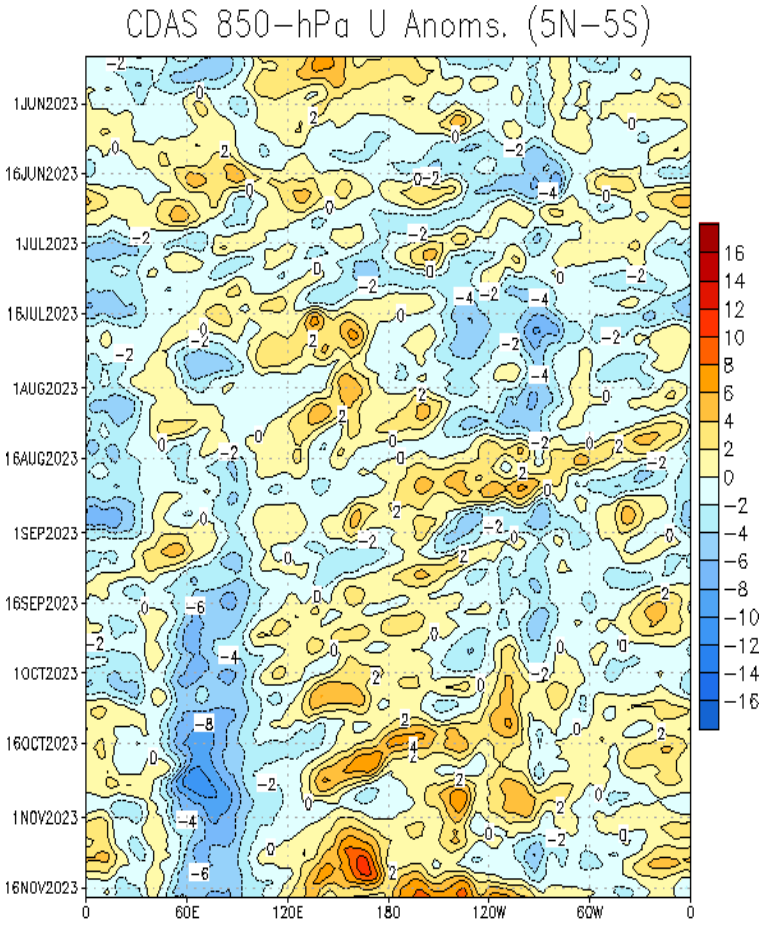


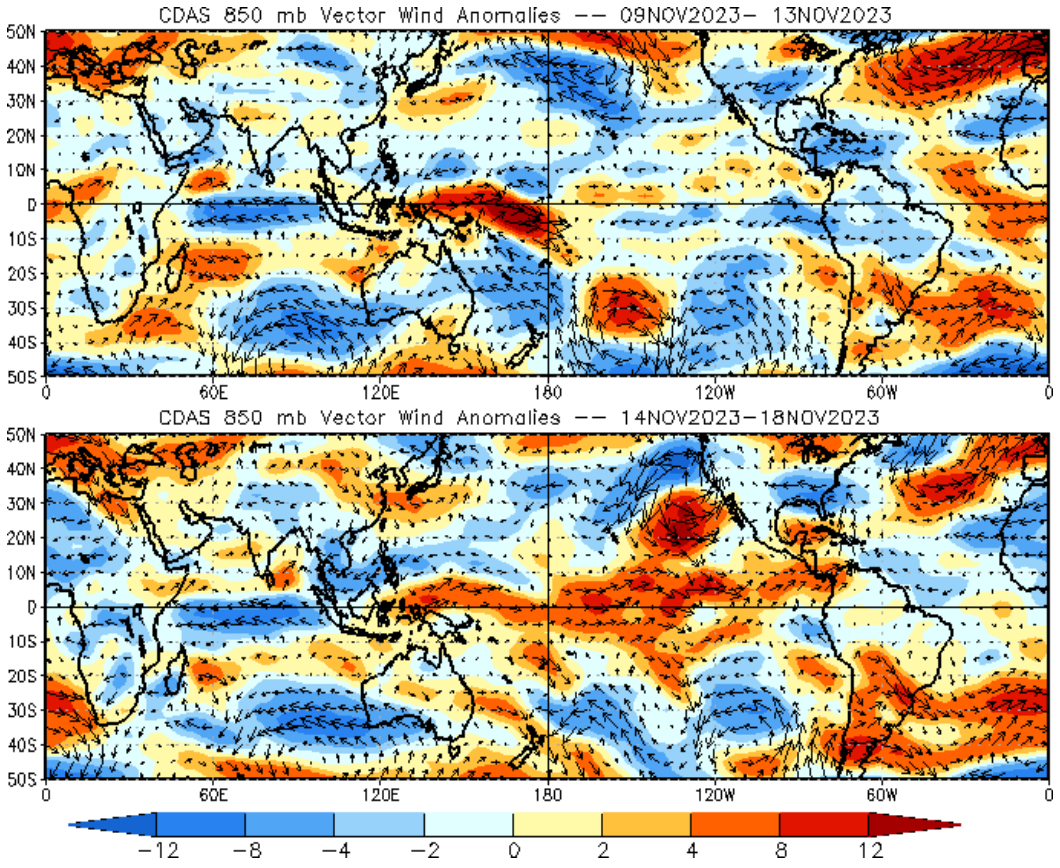


- Tied to a weakening positive Indian Ocean dipole (+IOD), anomalous westerlies have relaxed and become more easterly in the upper-levels across the equatorial Indian Ocean.
- An anomalous anti-cyclonic circulation shifted eastward into the eastern Pacific and led to a sharp reversal of the wind pattern loft along the equator to the west of South America.
- These developments have resulted in a zonally expanded region of enhanced easterlies aloft throughout much of global tropics.

850-hPa Wind Anomalies

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

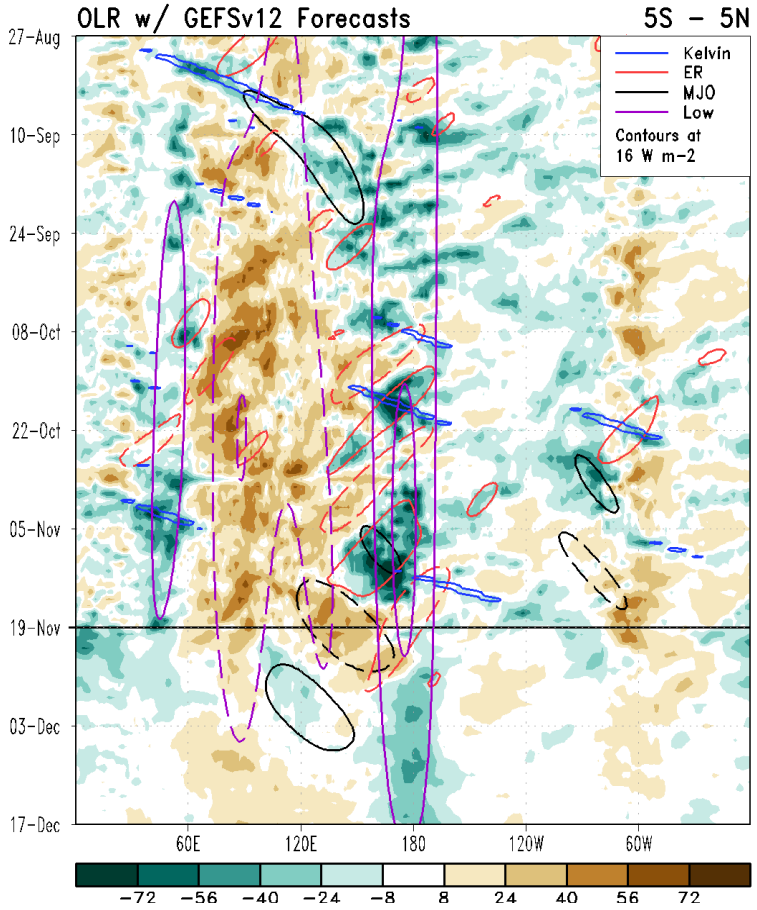


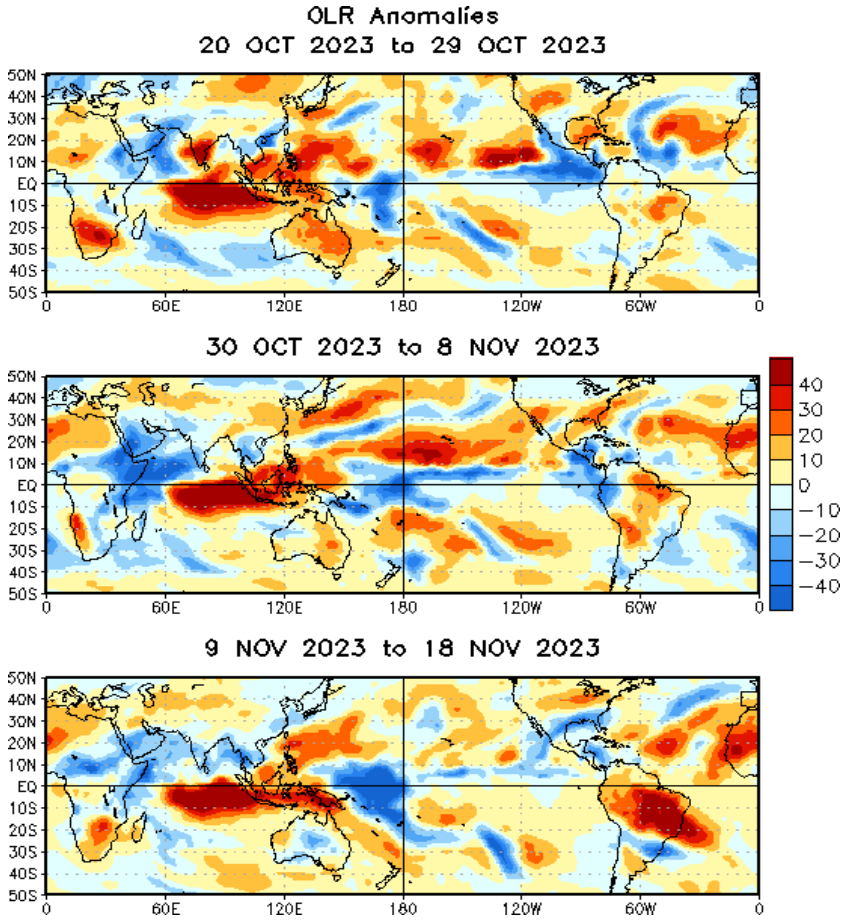


- A remarkably strong westerly wind burst event was recently observed to the west of the Date Line, with strengthening anomalous westerlies to the east, suggestive of reemerging intraseasonal activity.
- Enhanced lower-level easterlies have somewhat eased over the Indian Ocean, but remains fairly robust along and to the south of the equator.
- A potent trough is featured off the west coast of the U.S during mid-November.

Outgoing Longwave Radiation (OLR) Anomalies

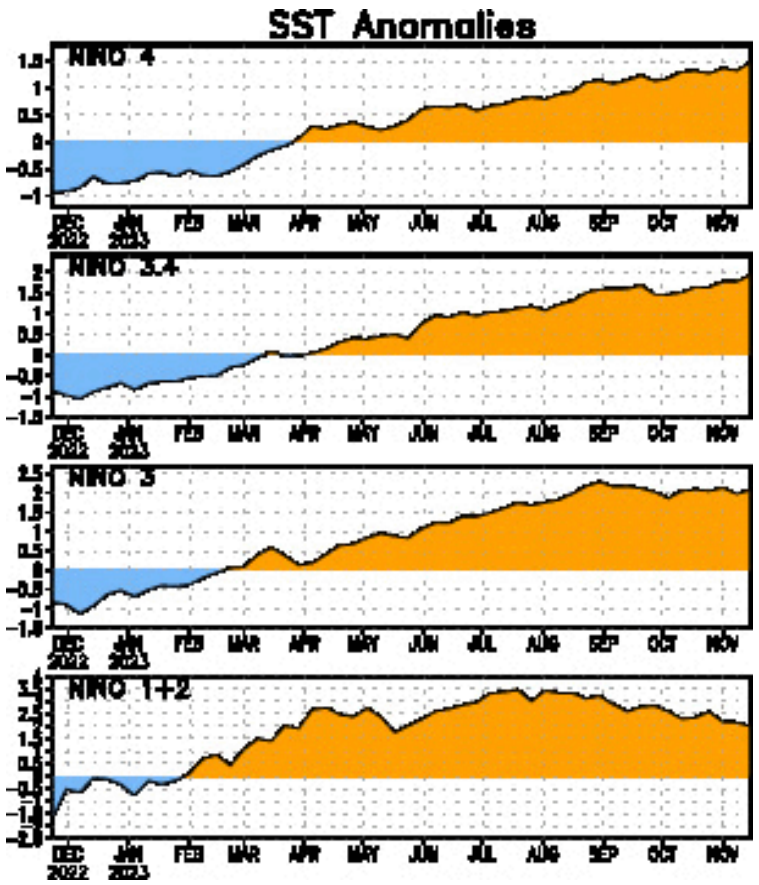
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

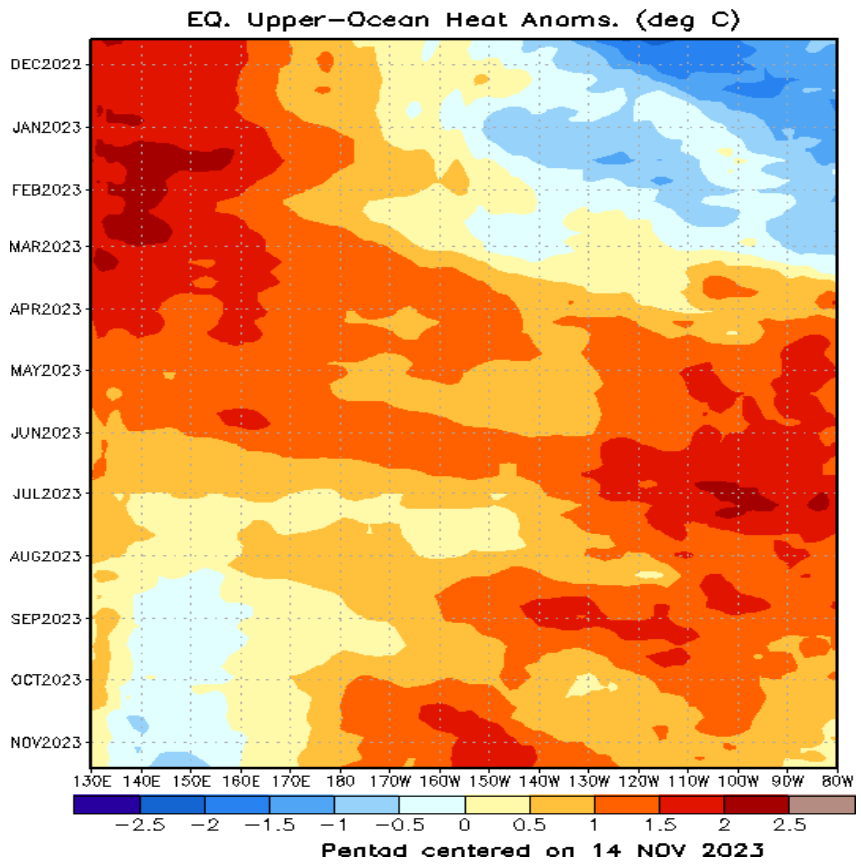




- The OLR pattern continues to predominately reflect low frequency features, while more enhanced convection was observed over the southern tier of the CONUS likely tied to the enhanced phase of the MJO and consistent with El Nino composites.
- OLR forecasts favor a reduction of the enhanced ENSO response along the Date Line indicative of a destructively interfering MJO. Conversely, constructive interference with the +IOD looks to promote widespread enhanced convection over equatorial Africa through the end of November.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

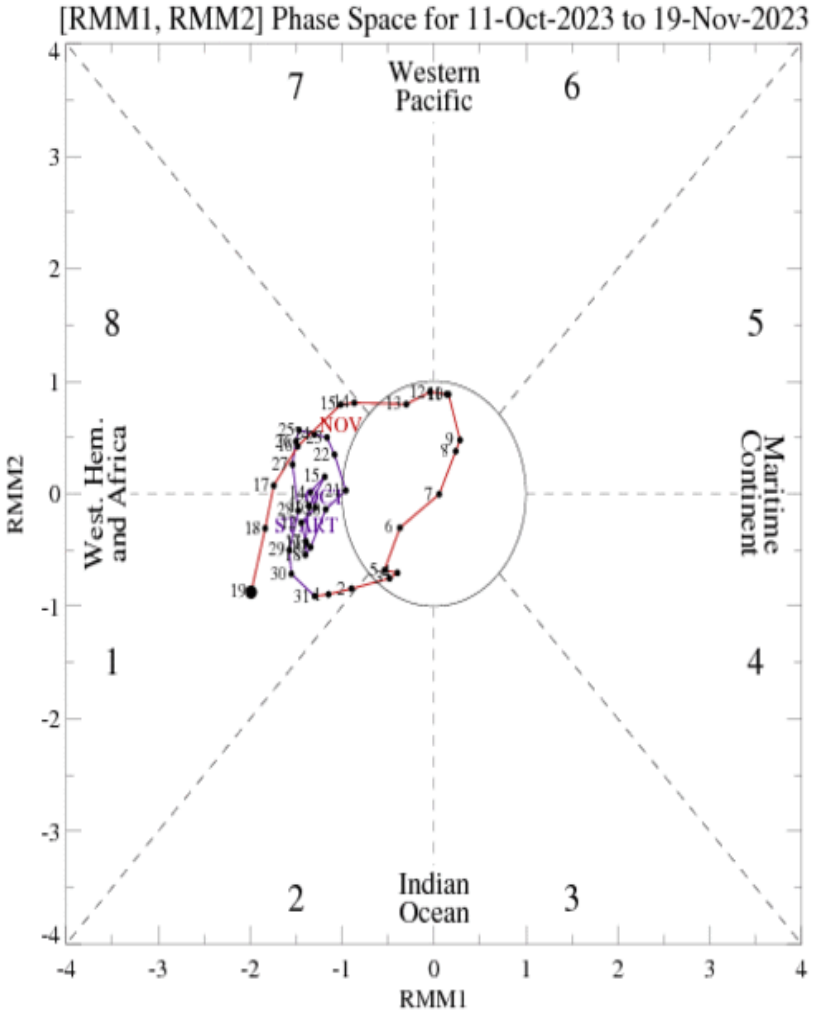




- El Niño conditions are present across the equatorial Pacific with SST anomalies remaining positive in all of the Niño basins. A gradual reduction of the warm anomalies is observed in the Nino 1+2 region.
- An area of negative upper-ocean heat content anomalies continues gradually strengthen in the Western Pacific.
- Ongoing oceanic downwelling Kelvin wave activity continues to bring warmer subsurface waters into the eastern Pacific (approaching 120W).

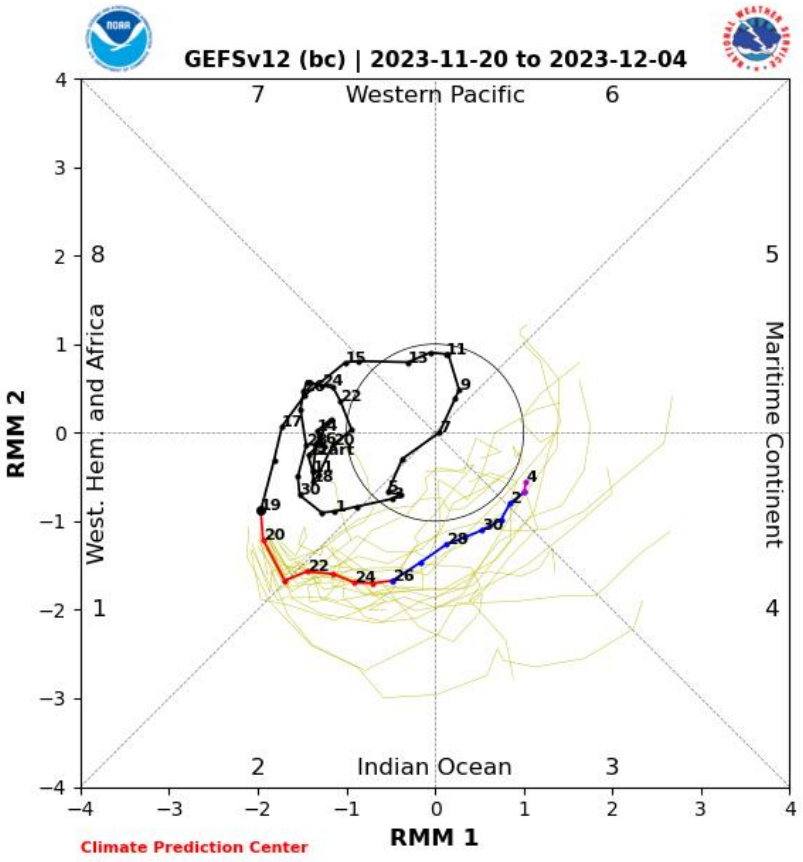
MJO Index: Recent Evolution

- Consistent with the upper-level velocity potential anomaly fields, the RMM-based MJO index indicates fast eastward propagation from the western Pacific into the Western Hemisphere and Africa, while steadily gaining amplitude during the past week.

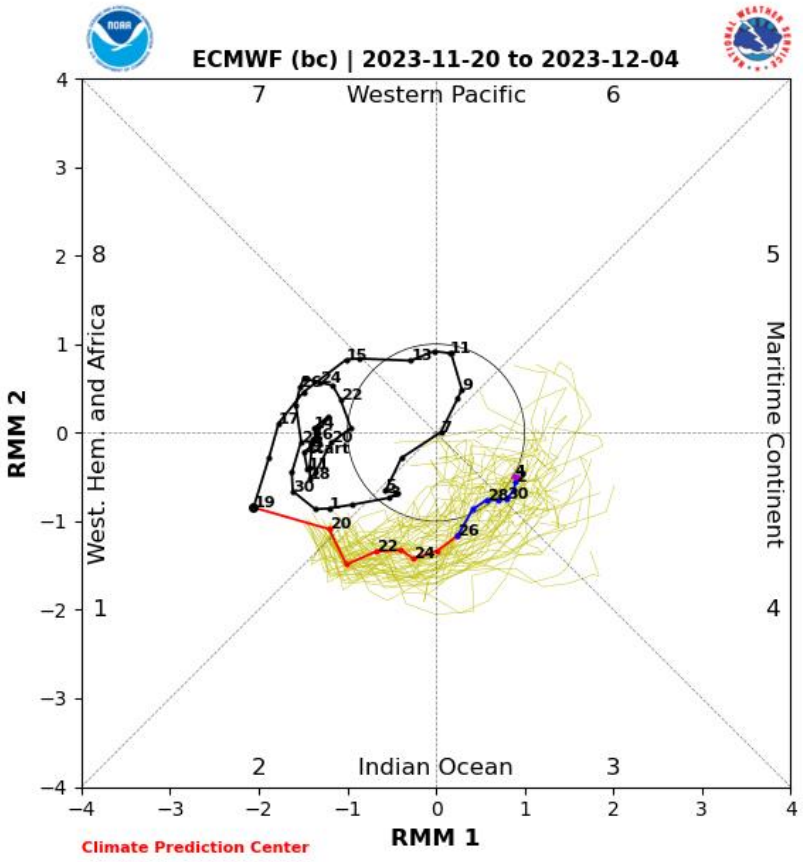


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

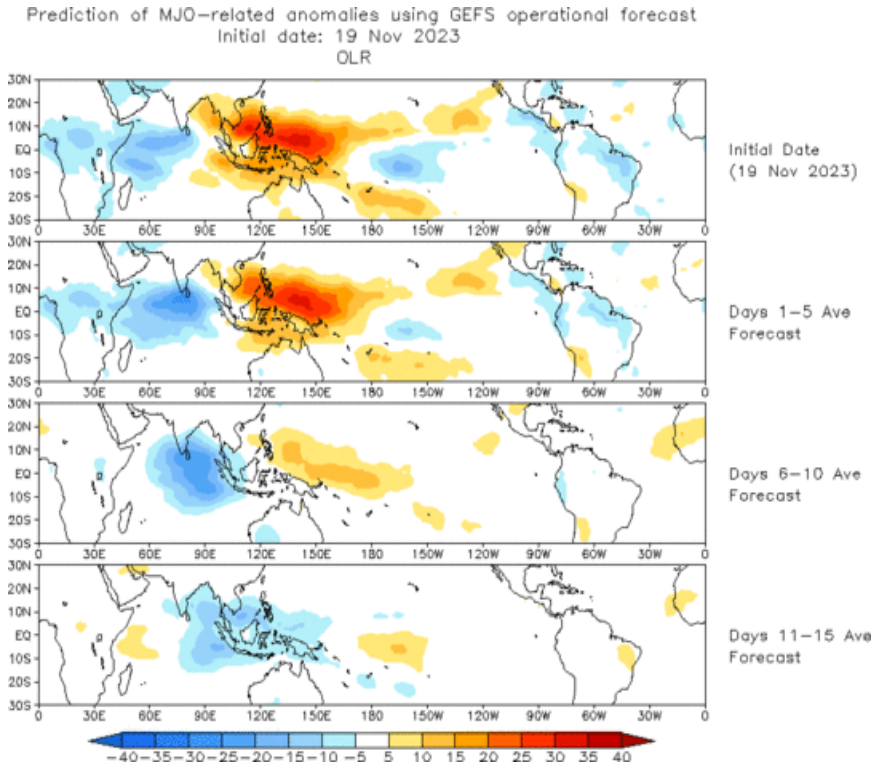


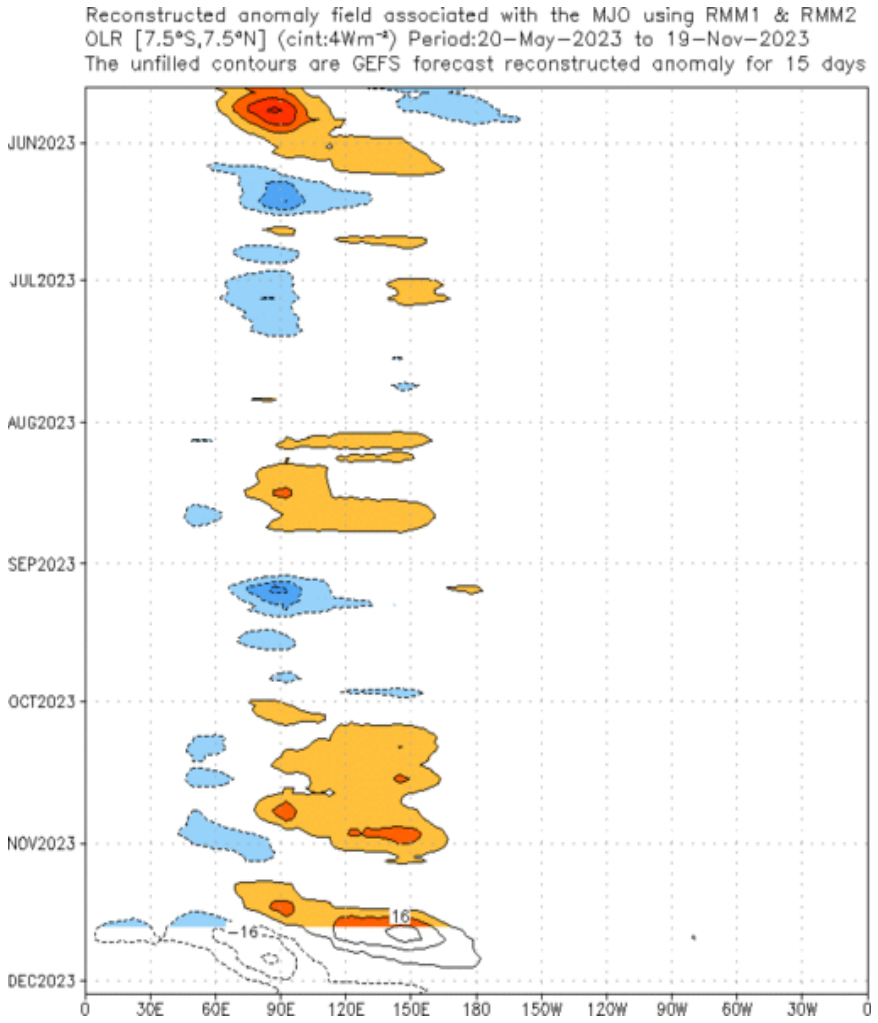
ECMWF Forecast

- Good agreement exists in the dynamical models favoring continued eastward propagation of the MJO at a high amplitude over the Indian Ocean, that gradually decreases in amplitude as it approaches the Maritime Continent towards the end of November and into early December.
- The favored increases (decreases) in amplitude appears to be tied to constructive (destructive) interference with the +IOD (El Nino and other modes of variability) during the forecast period.

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.)

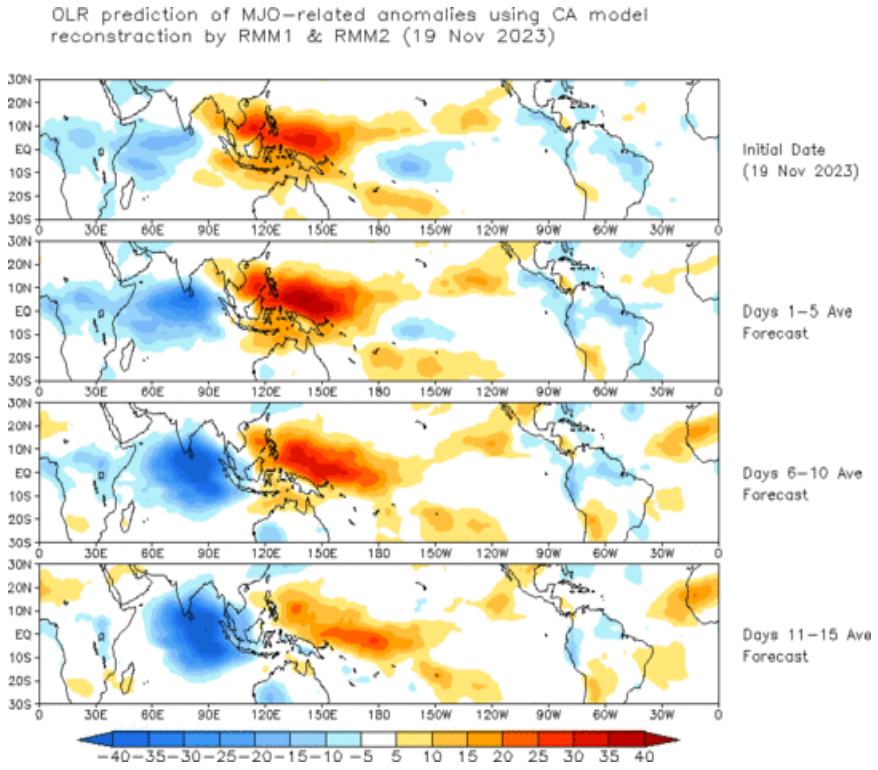


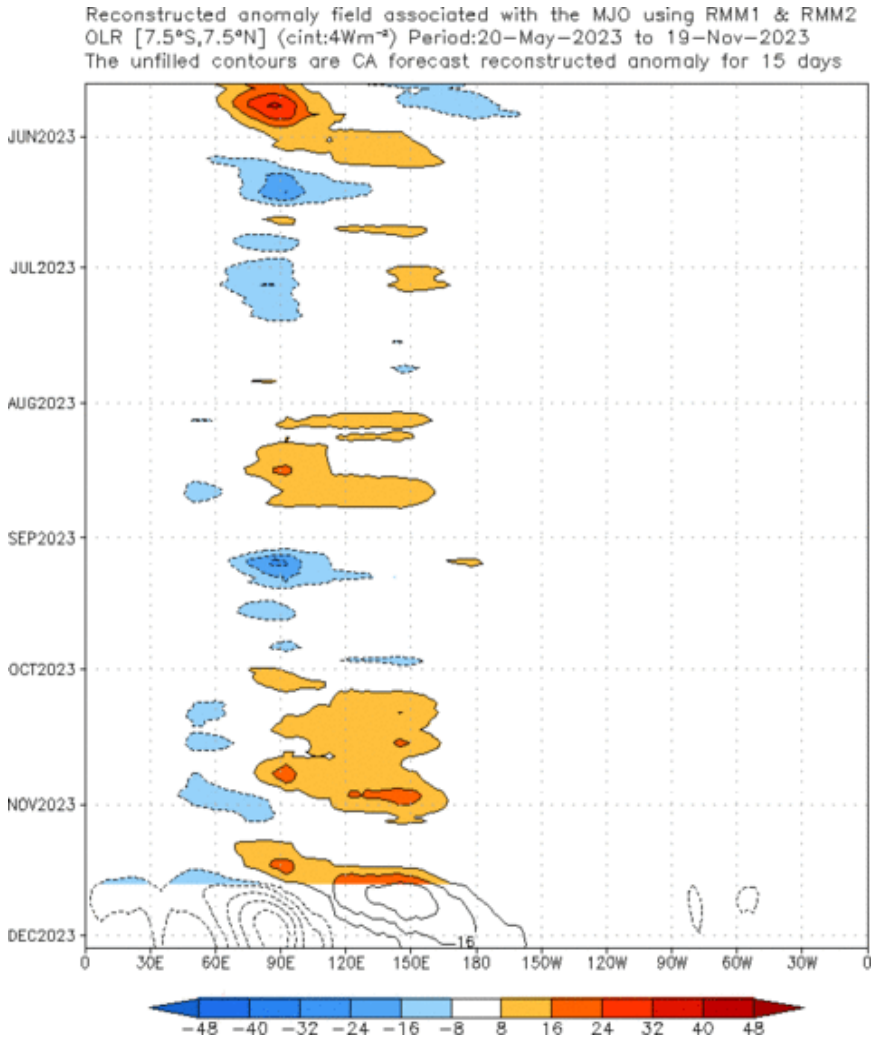


- The GEFS RMM-based OLR forecast depicts a canonical evolution of an Indian Ocean MJO event during the next two weeks.

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.)

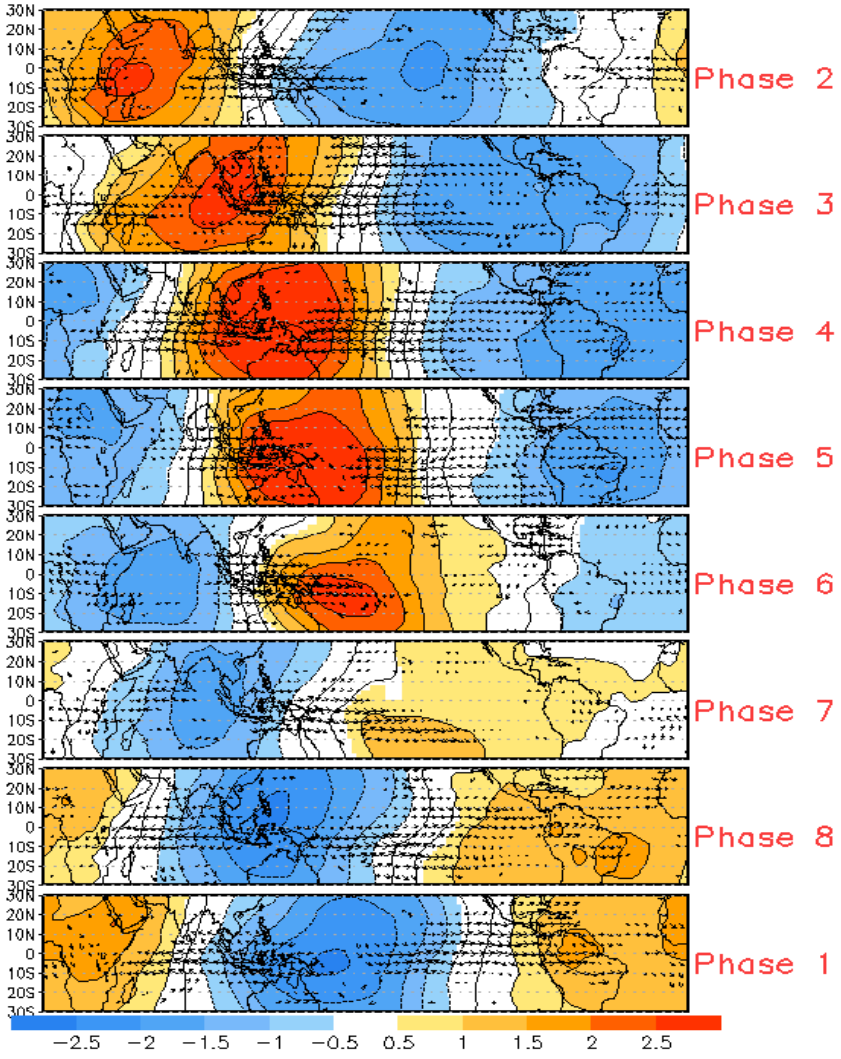




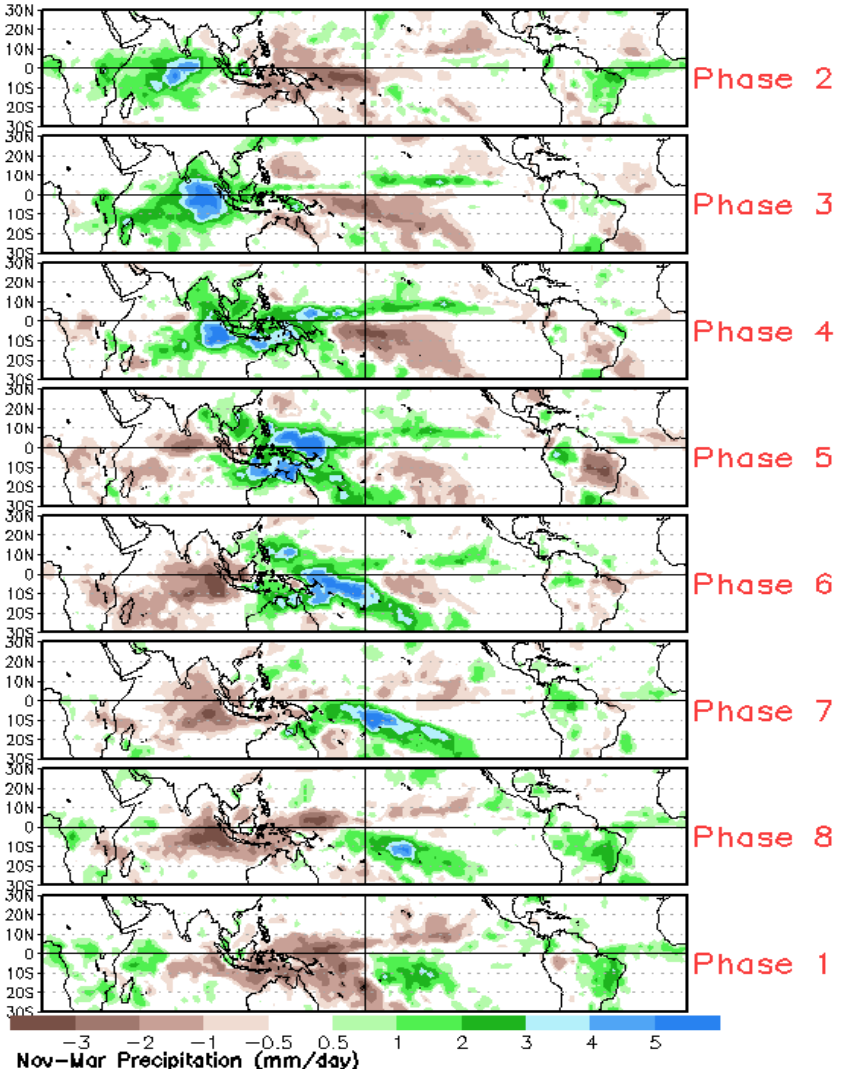
- The constructed analog RMM-based forecast depicts a stronger convective pattern, though less progressive than the GEFS counterpart.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



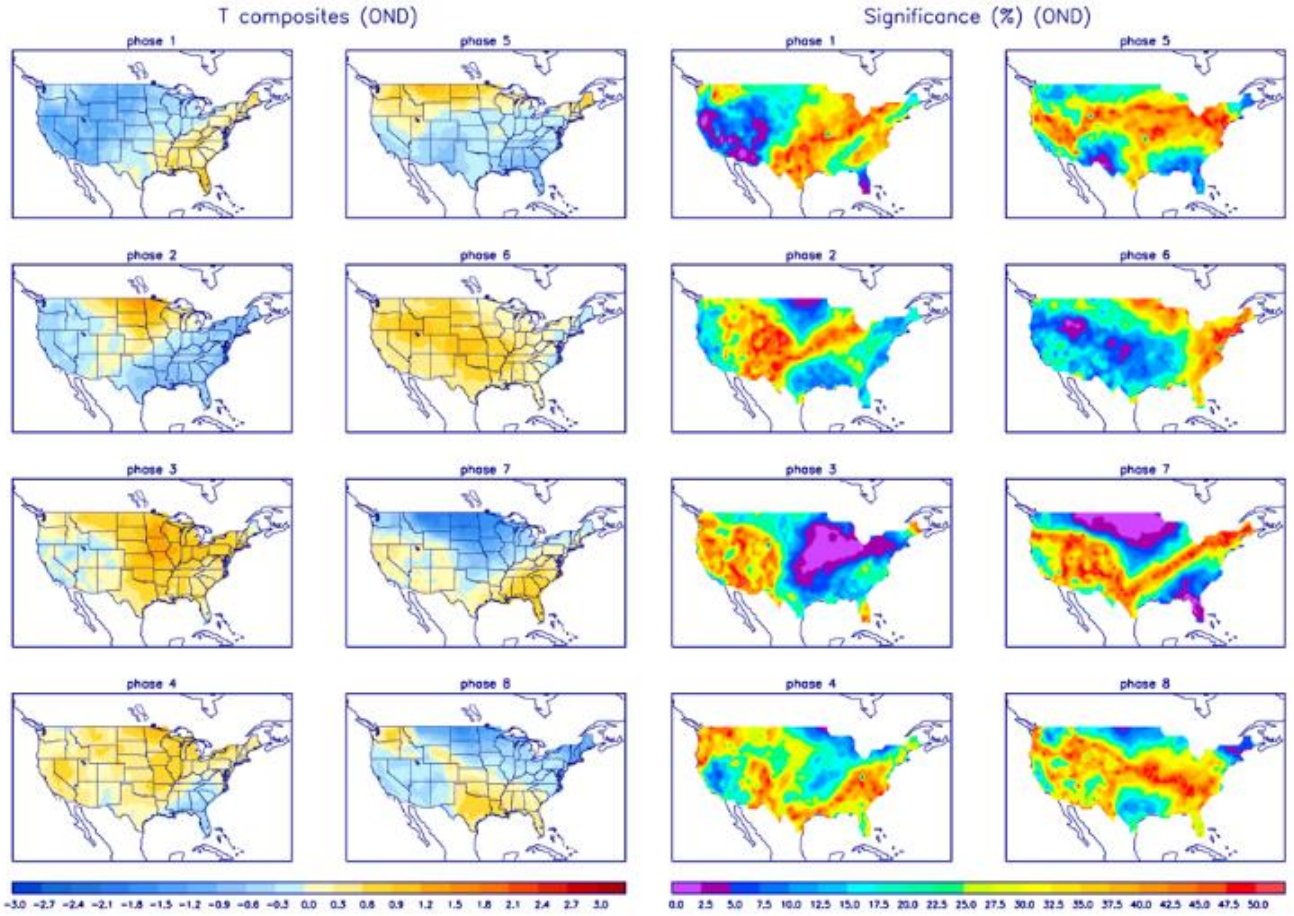
Precipitation Anomalies



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.

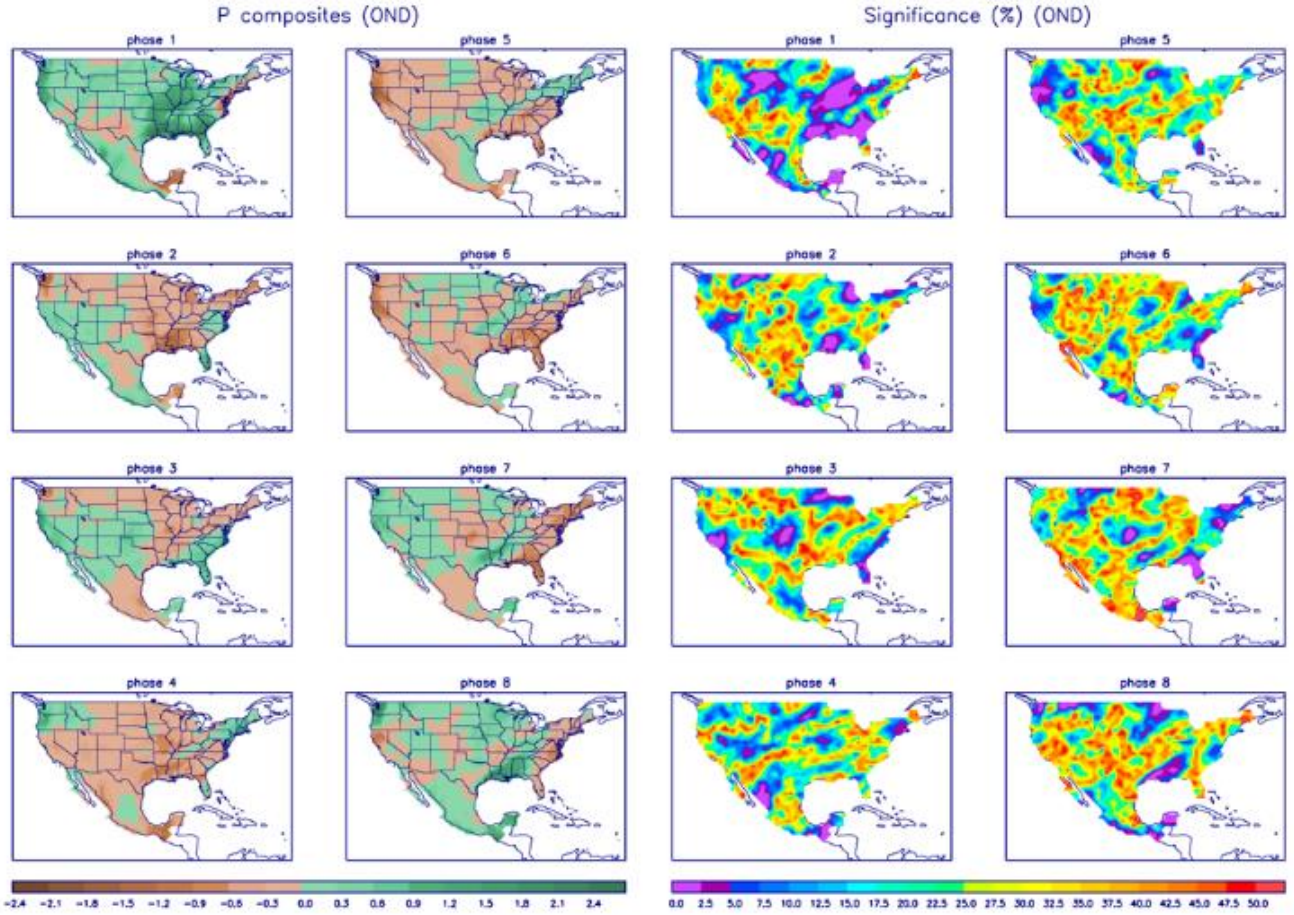


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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