

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



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

Overview

- The RMM-based MJO signal continues to remain amplified and has propagated eastward into the Indian Ocean. Dynamical models depict continued eastward propagation during the next 2-3 weeks.
- Several competing modes of tropical variability have resulted in an overall weakening of the canonical El Niño pattern across the global tropics during the past week, although this is forecast to be short-lived given the increasing sea surface temperatures (SSTs) over the Central Pacific and the MJO possibly beginning to constructively interfere with El Niño by week-2.
- During the next 2 weeks, tropical cyclone formation is favored across the Indian Ocean and spreading into the Western Pacific on either side of the equator, consistent with the projected MJO propagation and December climatology.

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

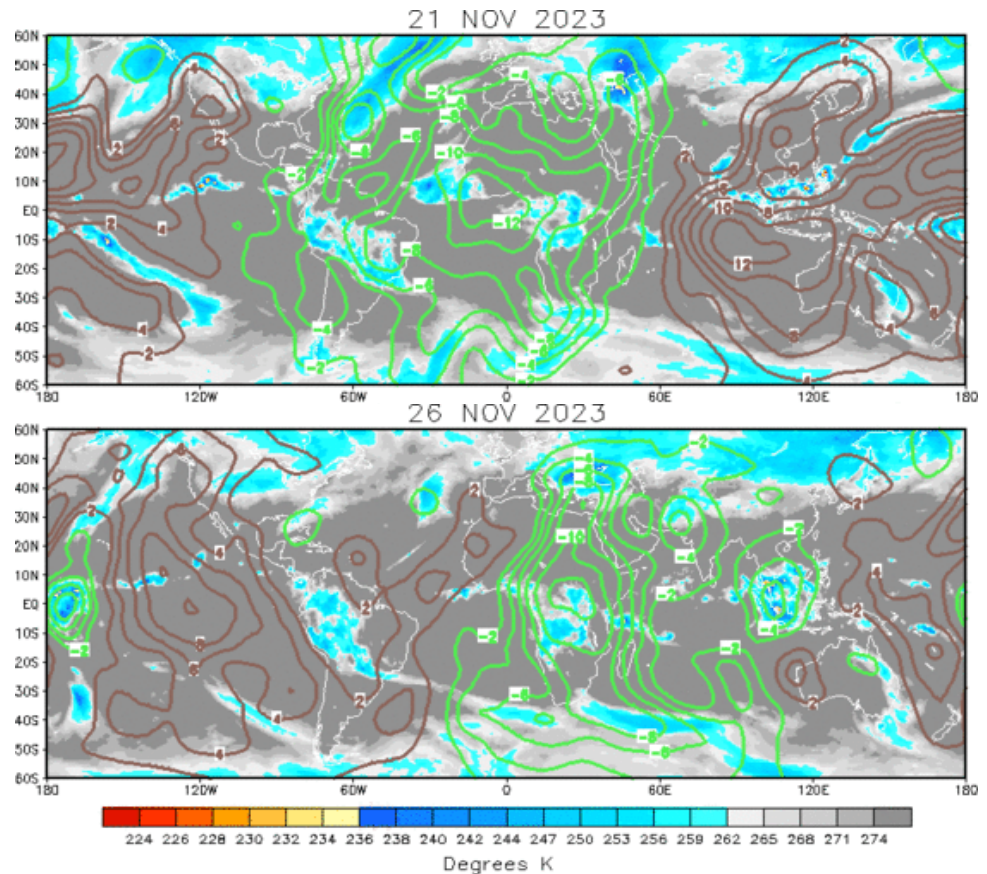
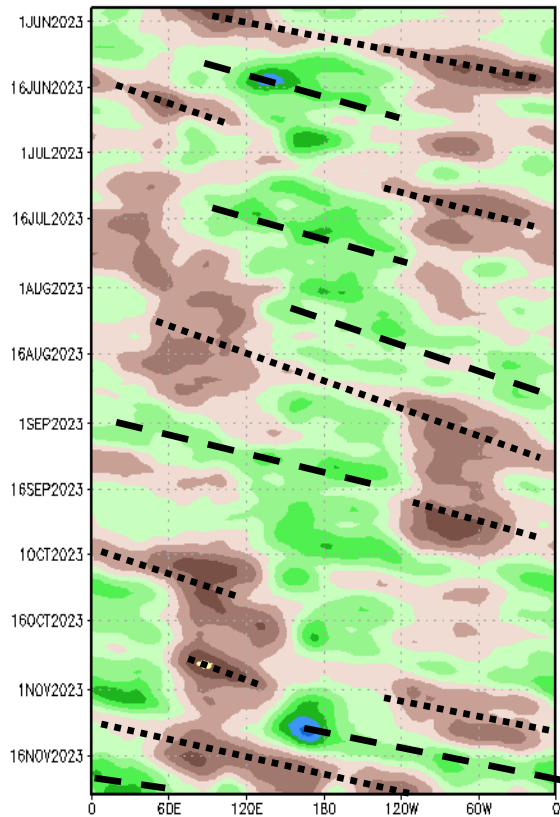
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

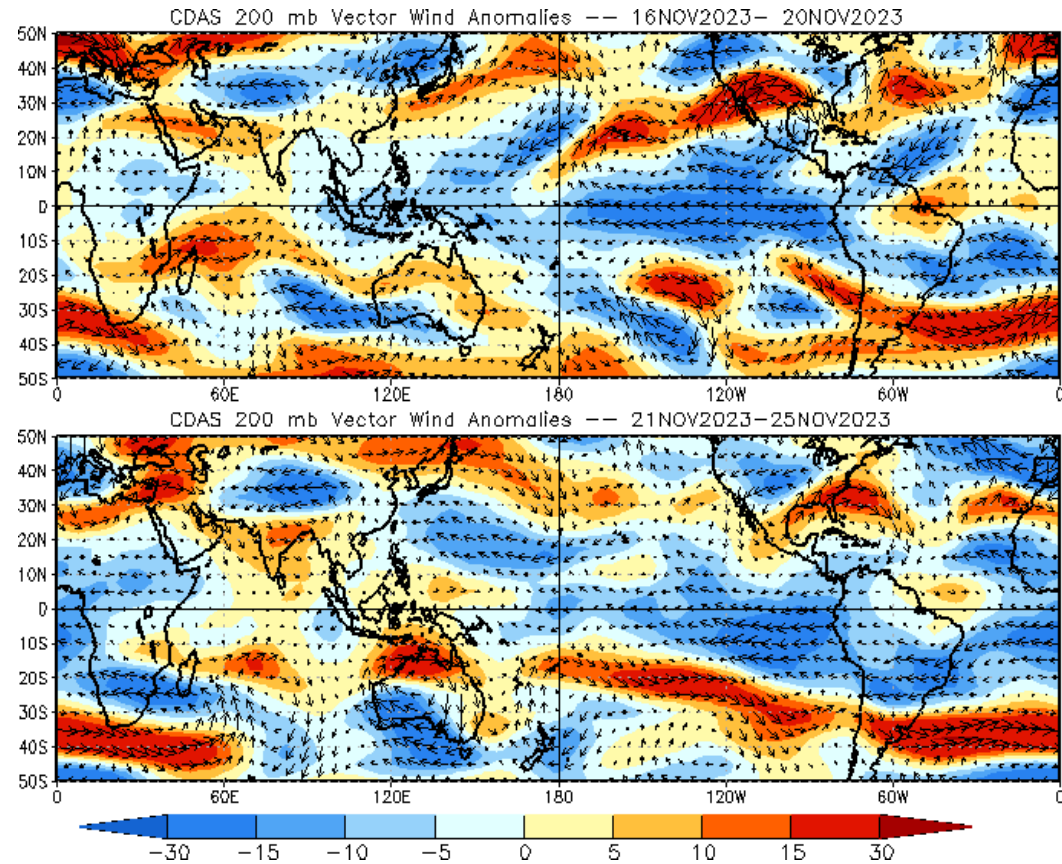
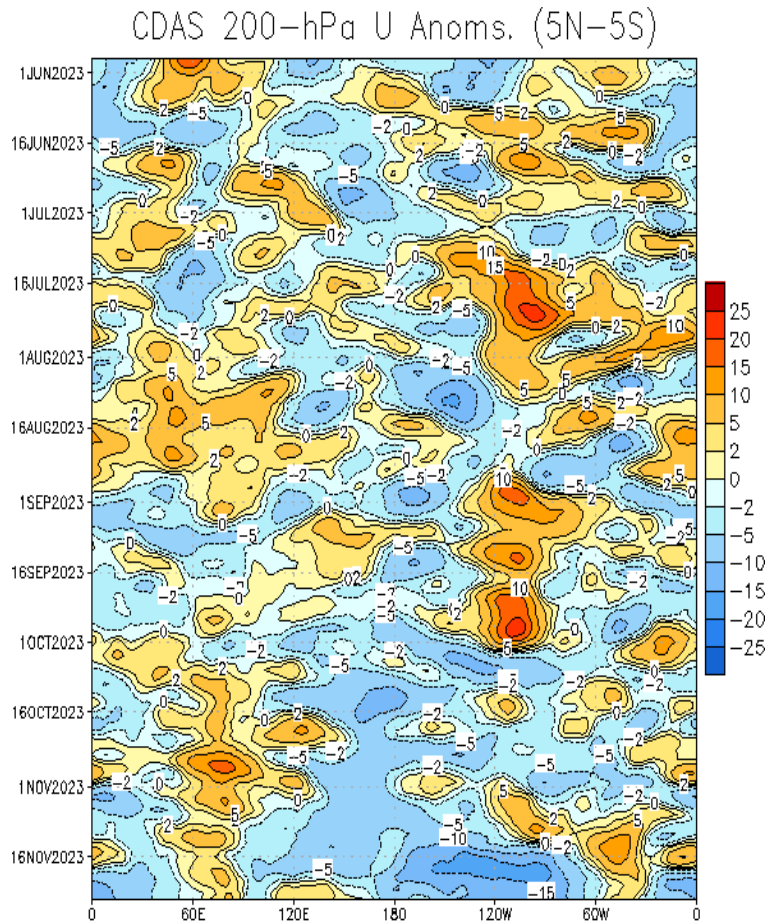
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- A wave-1 asymmetry in the global upper-level velocity potential pattern across the globe has shifted slightly eastward compared to last week, with anomalous divergence over the Indian Ocean and Maritime Continent, and anomalous convergence over much of the Western Hemisphere.
- This pattern aligns with the current MJO evolution, and destructively interferes with the low frequency El Niño base state.
- Conversely, constructive interference between enhanced Rossby Wave activity and El Niño has resulted in anomalous upper-level divergence near the Date Line.

200-hPa Wind Anomalies

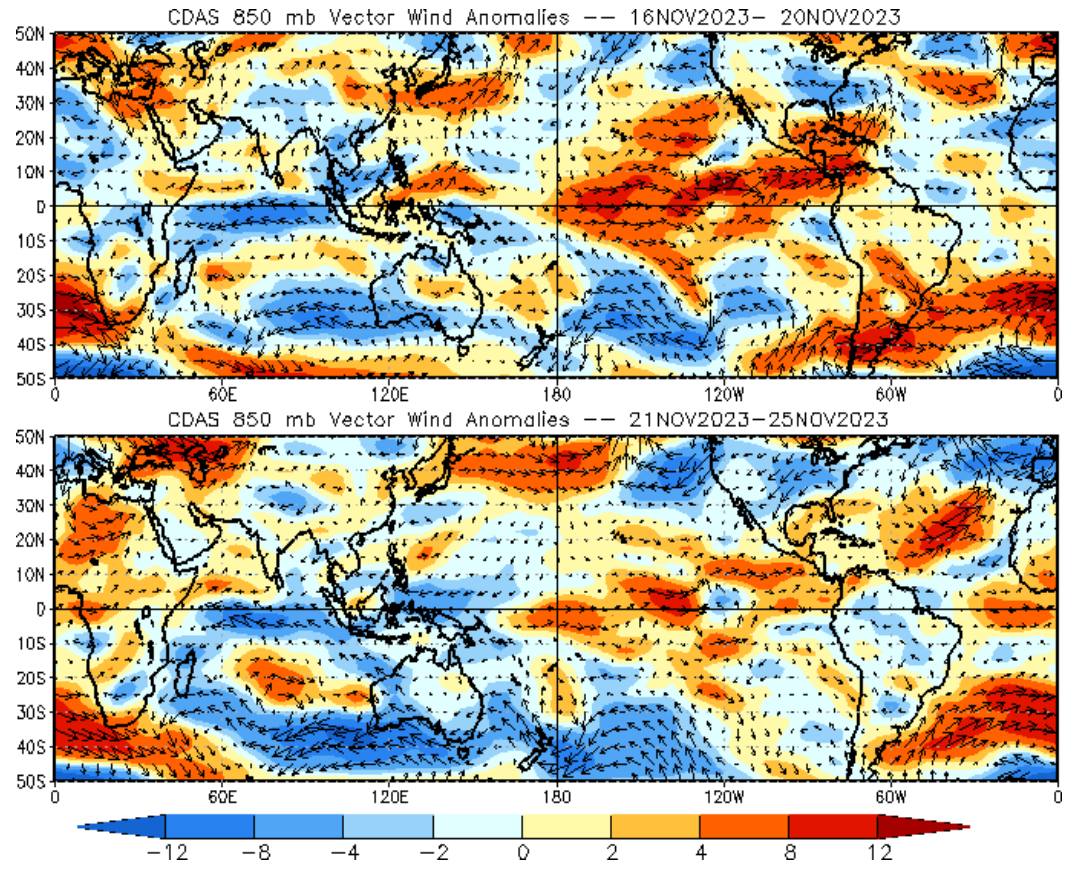
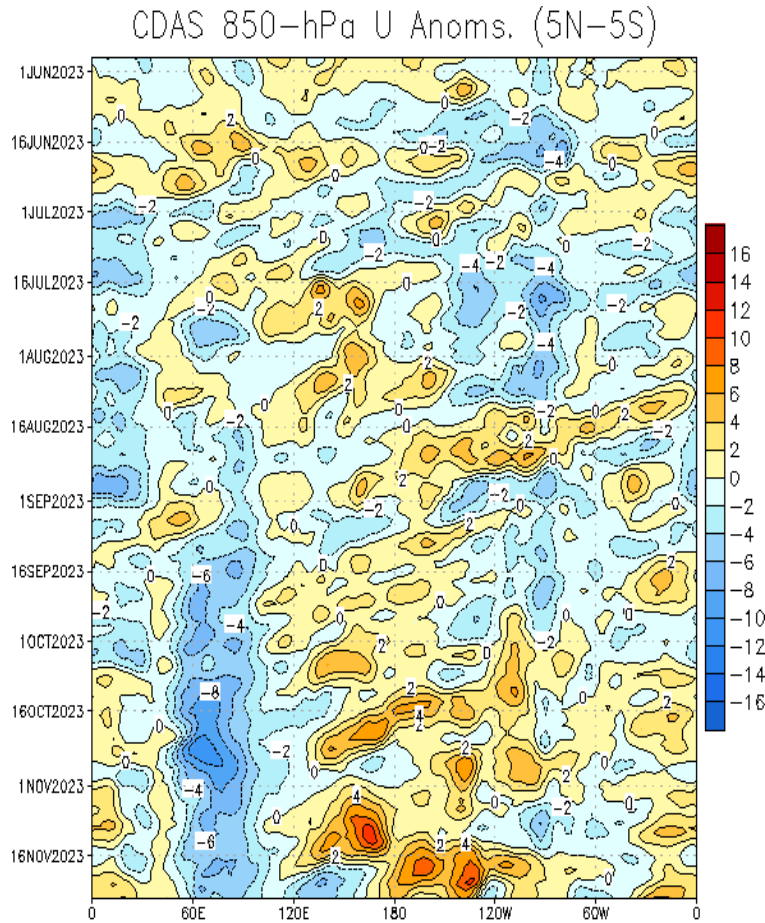
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Tied to a weakening positive Indian Ocean dipole (IOD), anomalous upper-level westerlies have continued to decrease across the Indian Ocean.
- Anomalous upper-level easterlies are depicted across the eastern Pacific, in what has been a reversal of the normal Walker Circulation across the Pacific.
- Increasing upper-level cyclonic flow is noted across northern Australia and Indonesia.

850-hPa Wind Anomalies

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

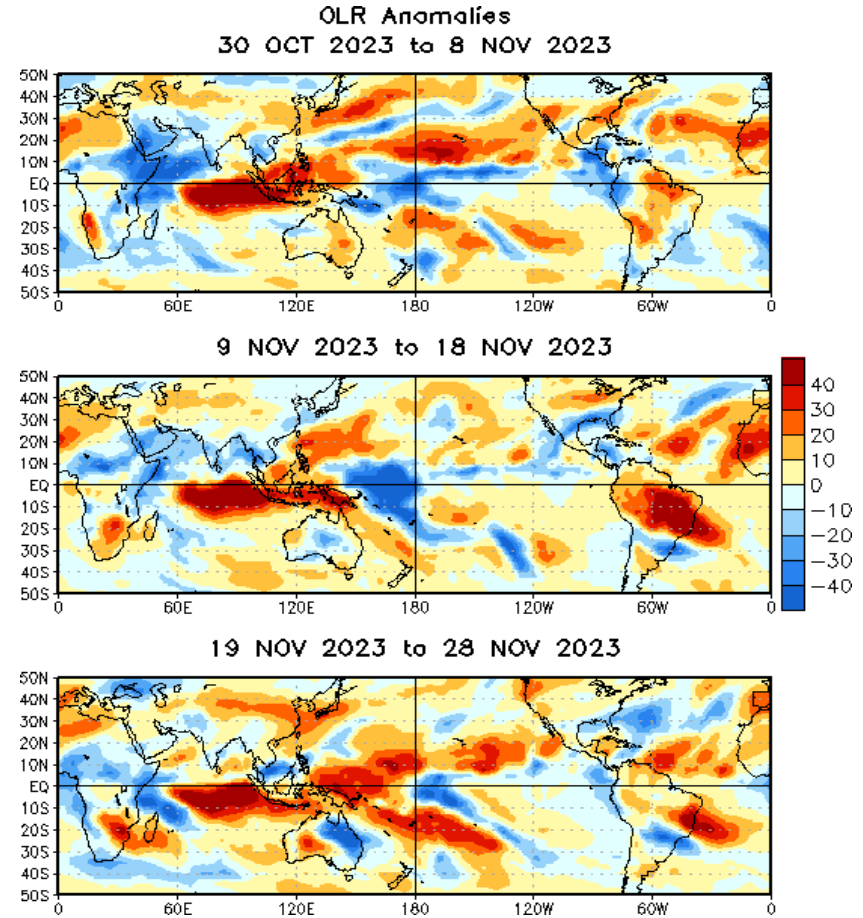
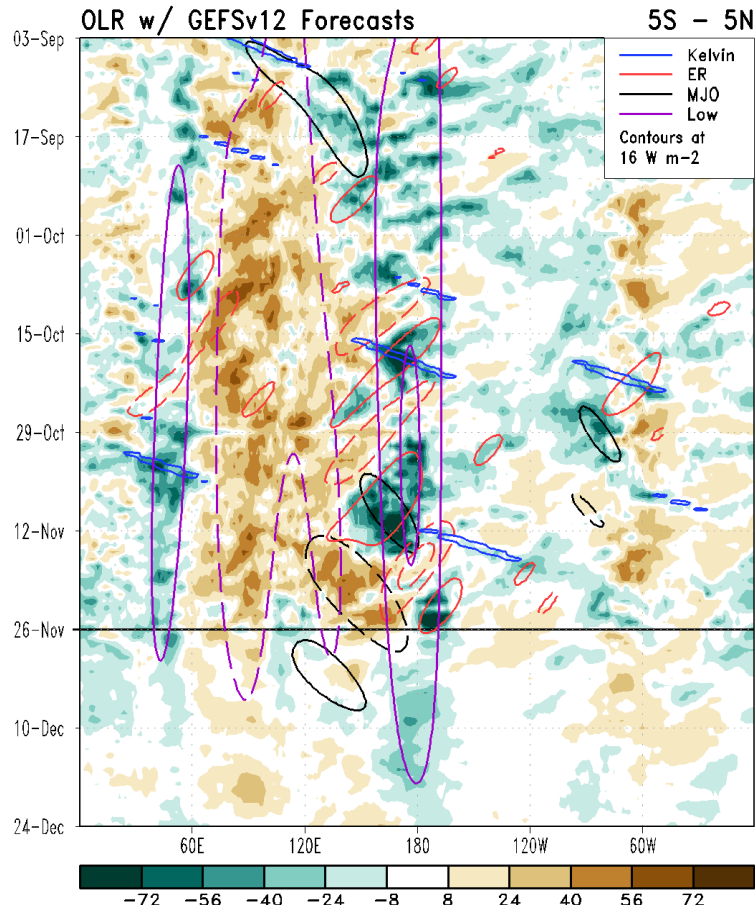


- A series of westerly wind events have extended into parts of the central and eastern Pacific during the past several weeks.
- Enhanced low-level easterlies persist across the Indian Ocean but have weakened slightly over the past month, suggestive of a weakening, but still positive IOD.
- Low-level cyclonic circulation is noted across the eastern U.S. during the past week bringing enhanced precipitation into the Southeast, consistent with El Niño.

Outgoing Longwave Radiation (OLR) Anomalies

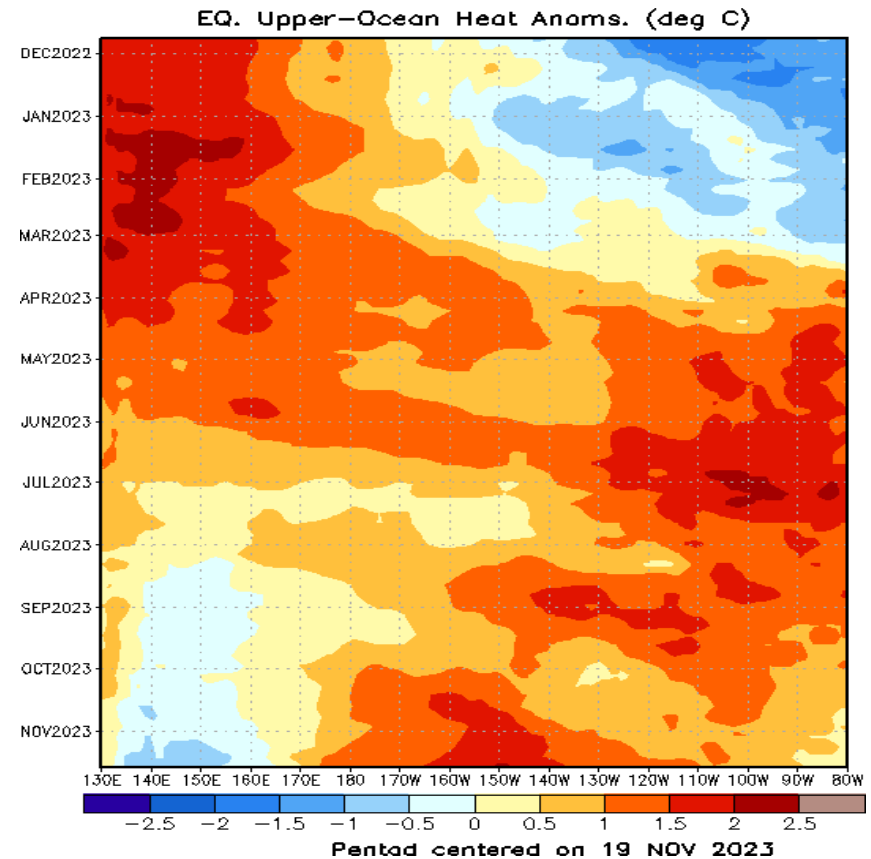
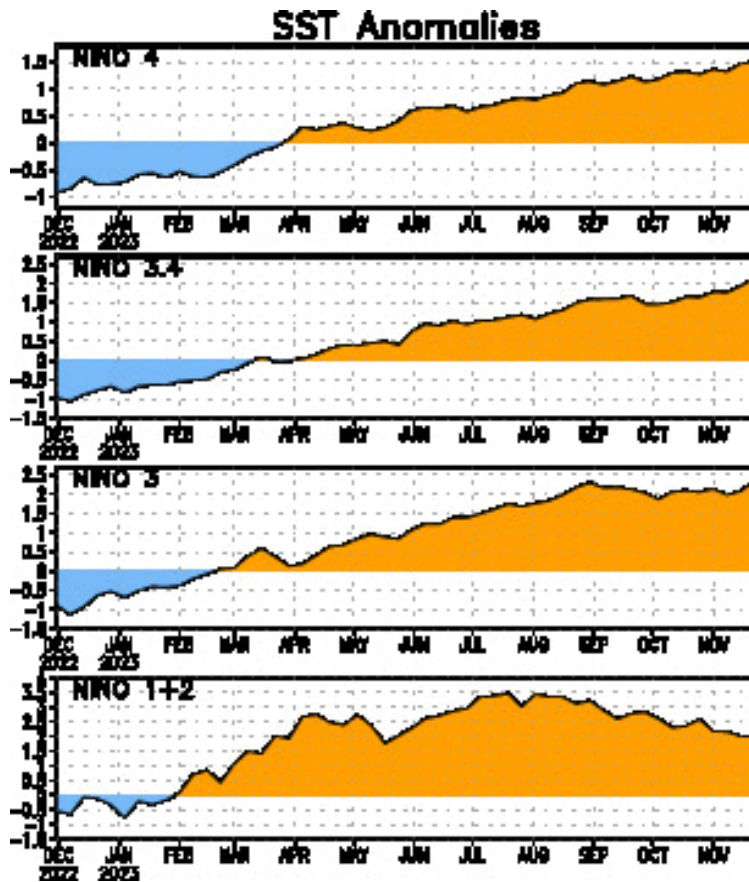
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- The positive IOD, MJO, El Niño, and enhanced Rossby Wave activity have contributed to substantial interference with each other in the overall convective pattern across the tropics in the past week.
- Generally, positive OLR anomalies are noted across the Indian Ocean and Western Pacific, with negative OLR anomalies over Africa.
- OLR forecasts indicate a return to a pattern more typical of El Niño by early December as the various competing factors relax.

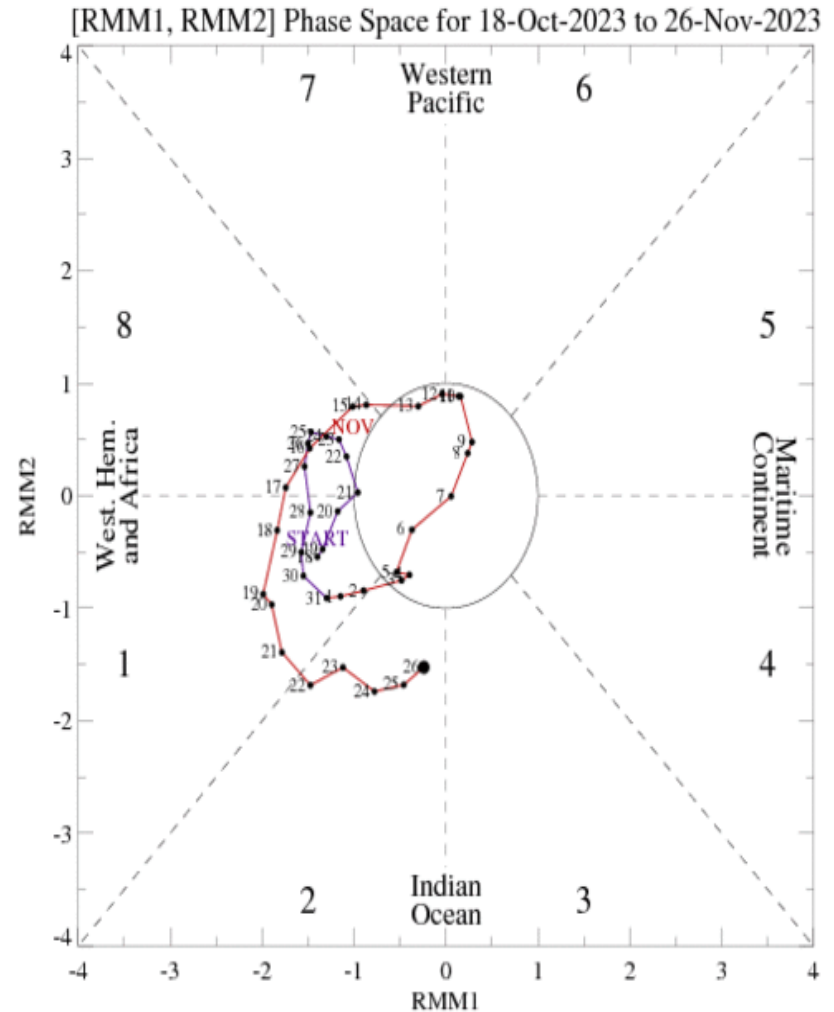
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- The low-level westerly wind burst across the Pacific during November has resulted in rising SSTs across the Central Pacific, with the NINO 3.4 region now indicating SST anomalies greater than +2.0°C.
- Negative upper-ocean heat content anomalies have increased across the Western Pacific.

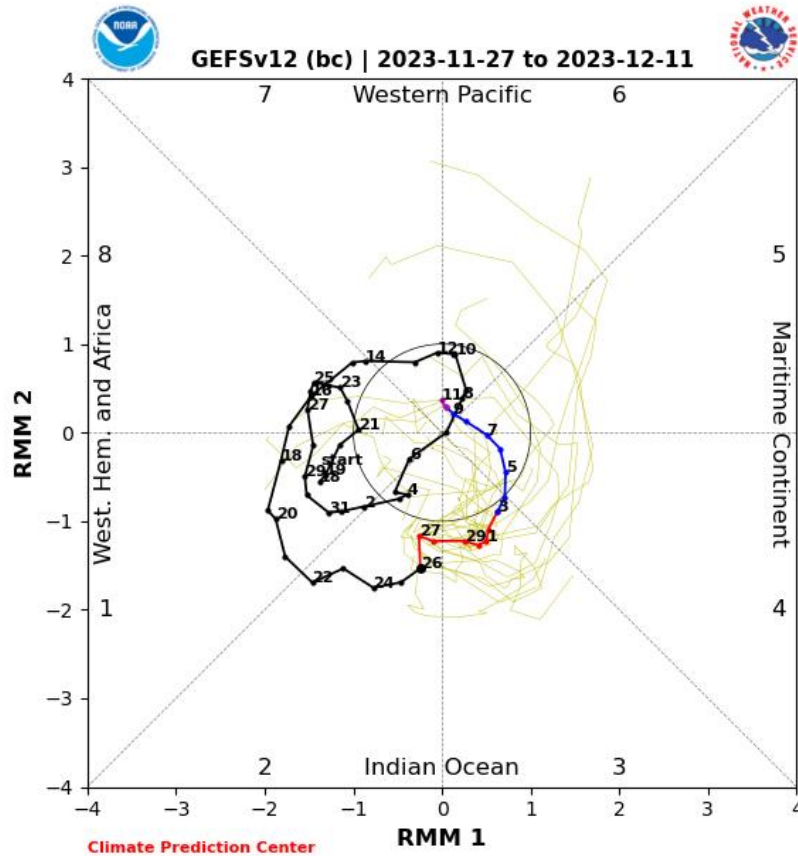
MJO Index: Recent Evolution

- The RMM-based MJO index has remained amplified during the past week, with eastward propagation into the Indian Ocean.

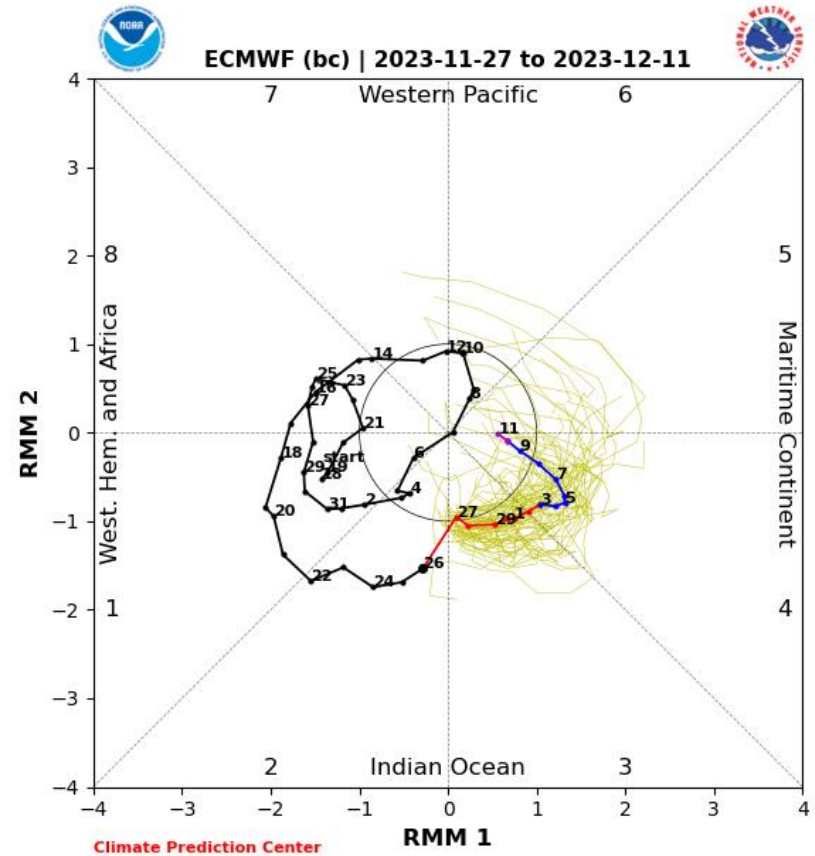


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



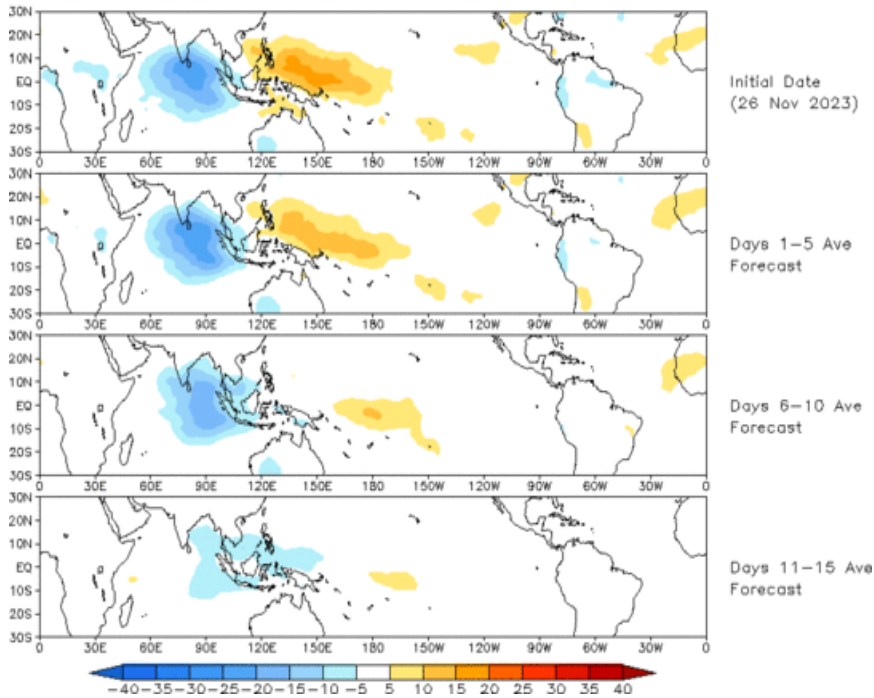
ECMWF Forecast

- The GEFS and ECMWF ensembles are in good agreement that the MJO will remain amplified and propagate eastward into the Maritime Continent and Western Pacific during the next 2 weeks.
- In the near-term, the MJO is forecast to destructively interfere with El Niño, with more constructive interference becoming possible as the intraseasonal signal moves toward the Date Line.

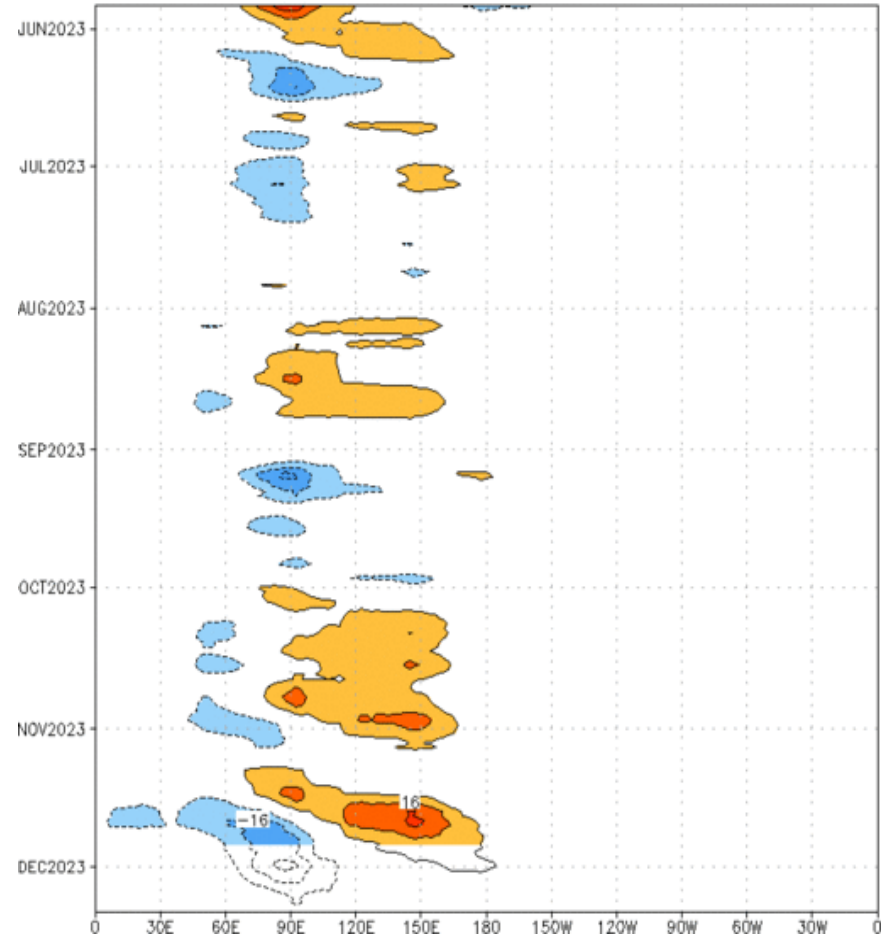
MJO: GEFS Forecast Evolution

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: 26 Nov 2023
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}S, 7.5^{\circ}N$] (cont: $4Wm^{-2}$) Period: 27-May-2023 to 26-Nov-2023
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

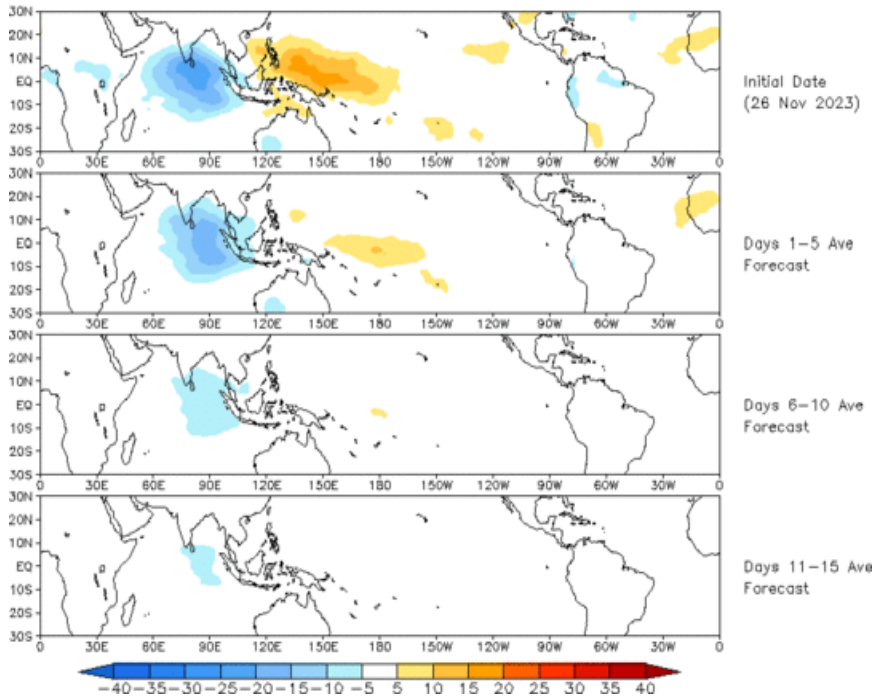


- The GEFS RMM-based OLR forecast depicts negative (positive) OLR anomalies across the Indian Ocean (Western Pacific) during week-1.
- By week-2, negative anomalies over the Indian Ocean weaken and spread into the Western Pacific.

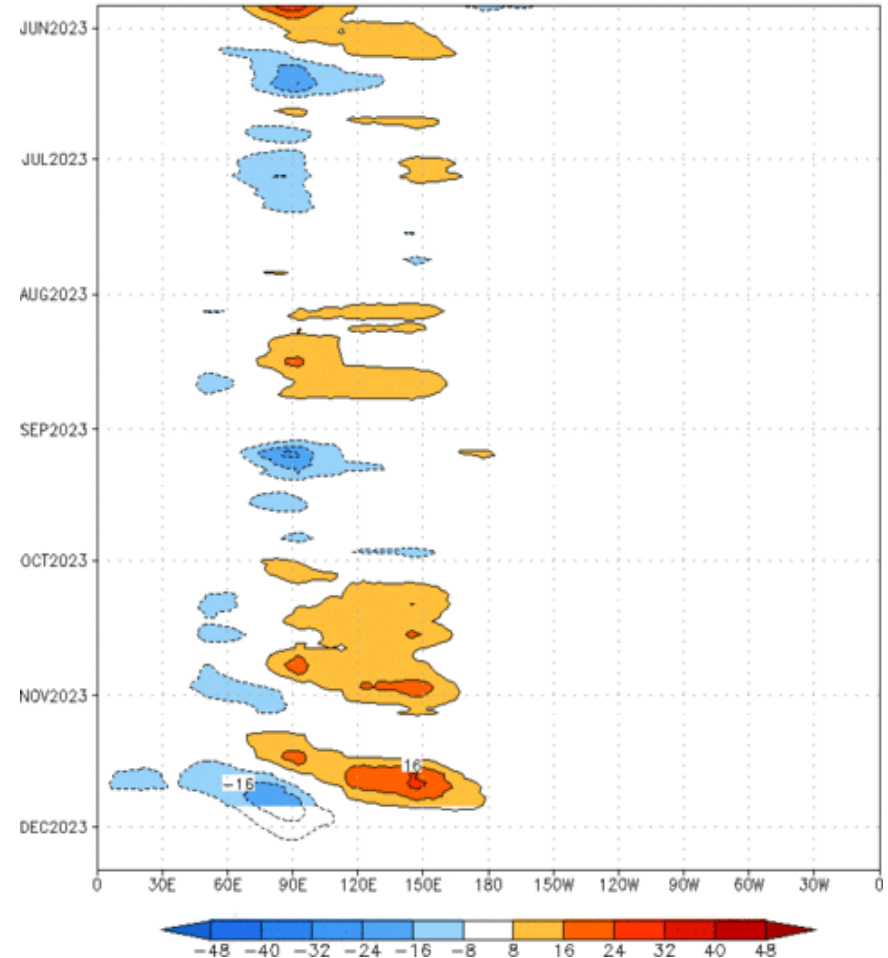
MJO: Constructed Analog Forecast Evolution

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 (26 Nov 2023)



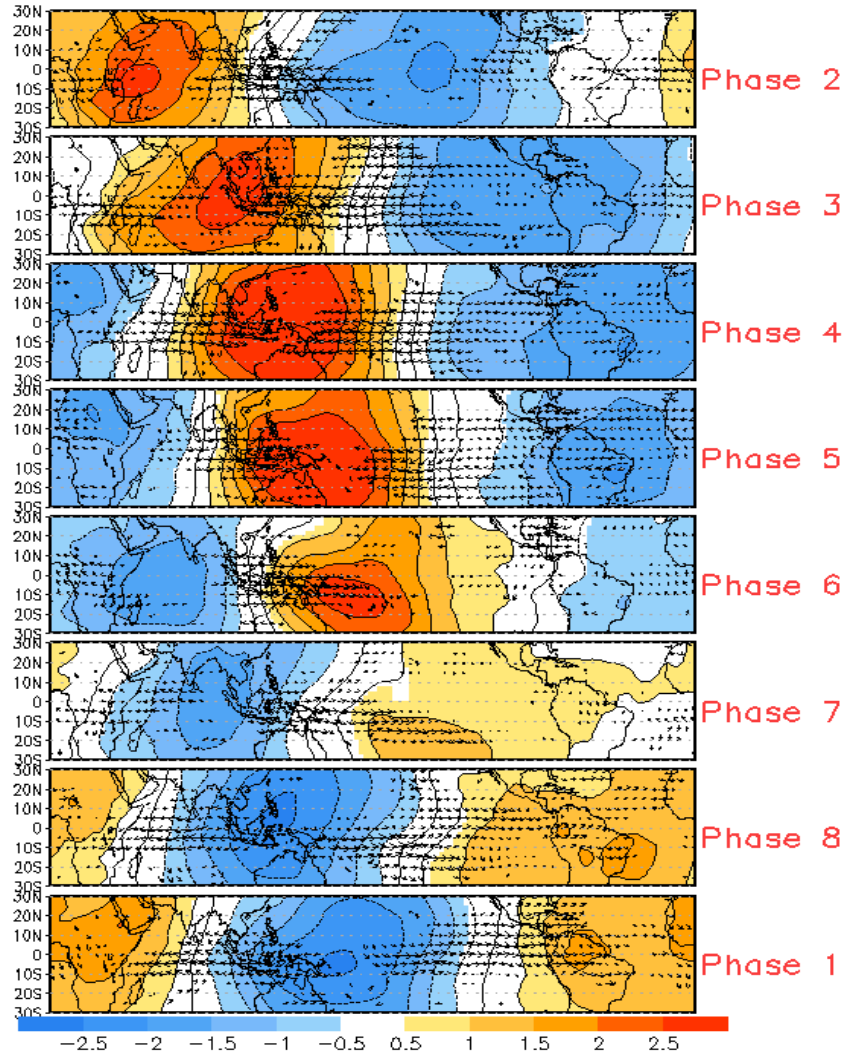
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:27-May-2023 to 26-Nov-2023
The unfilled contours are CA forecast reconstructed anomaly for 15 days



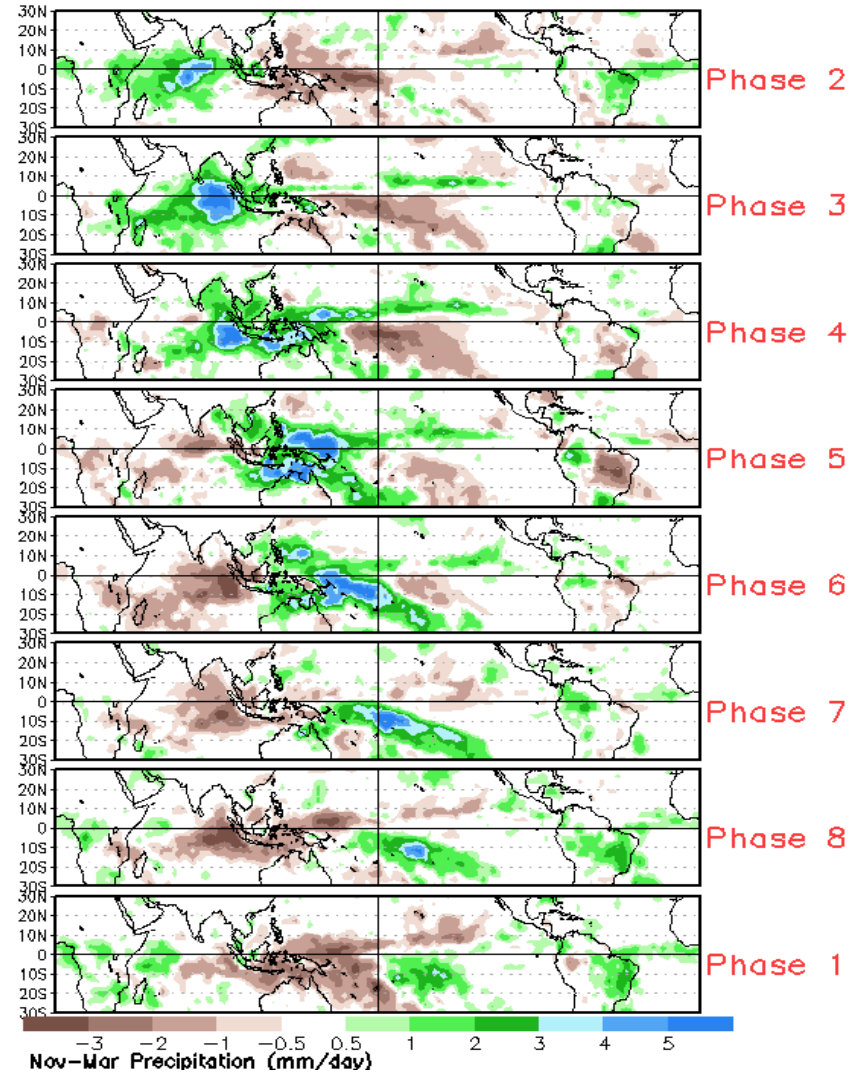
- The constructed analog RMM-based forecast closely matches the GEFS, with a faster weakening of the positive and negative OLR anomalies by week-2.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



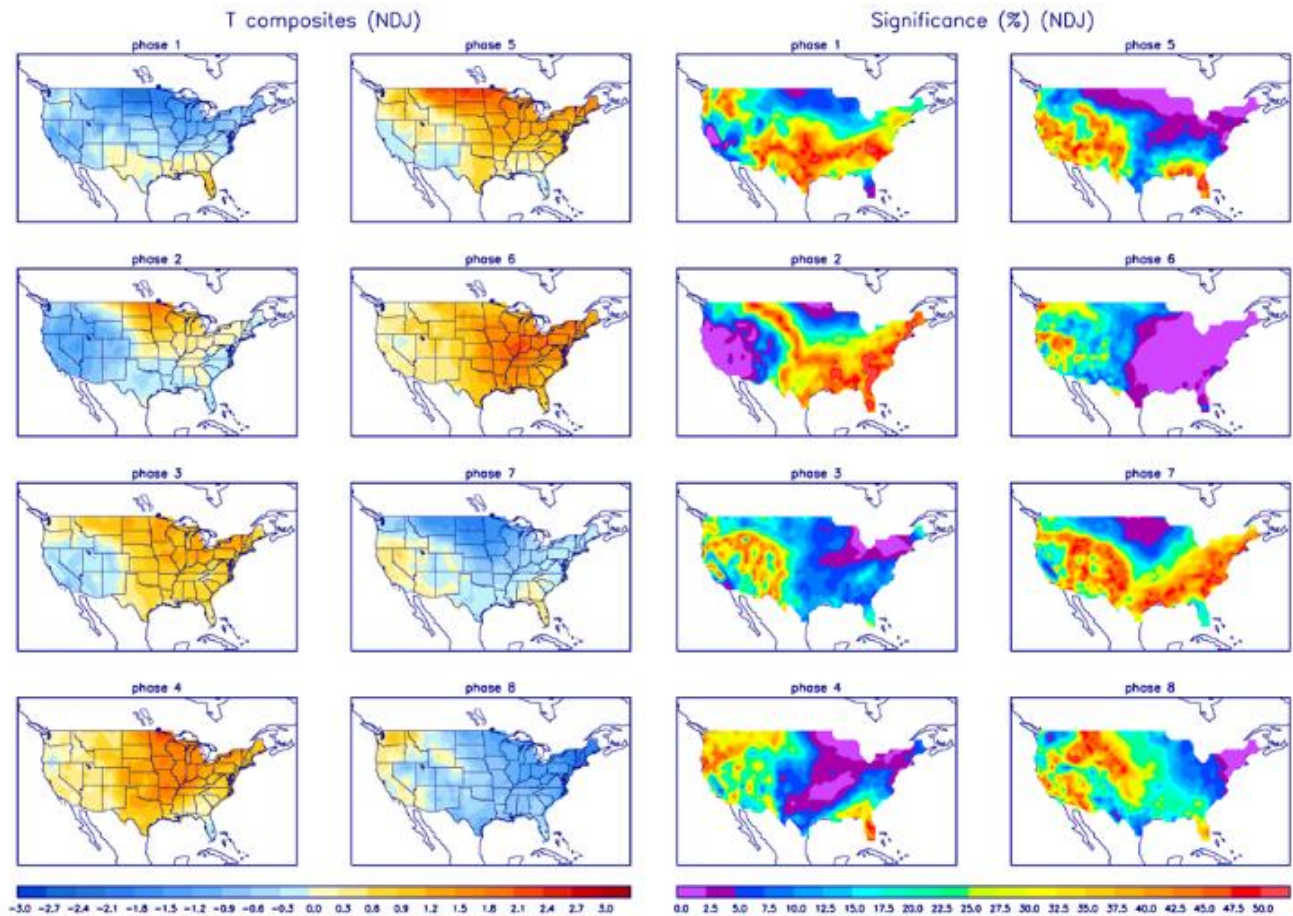
Precipitation Anomalies



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.

