

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
3 April 2023

Overview

- Following a very strong MJO signal across the Western Hemisphere during March, the intraseasonal signal has since retreated back into the RMM-based unit circle.
- Dynamical models are in good agreement regarding a renewed MJO signal emerging over the Western Pacific during the next week, with less coherency regarding its eastward propagation by week-2.
- The MJO supports increased chances for tropical cyclone formation to the north of Australia and possibly over the Western Pacific.
- Anomalously warm temperatures are possible in week-2 over the contiguous U.S. tied to the MJO over the Western Pacific and a La Niña-like response.

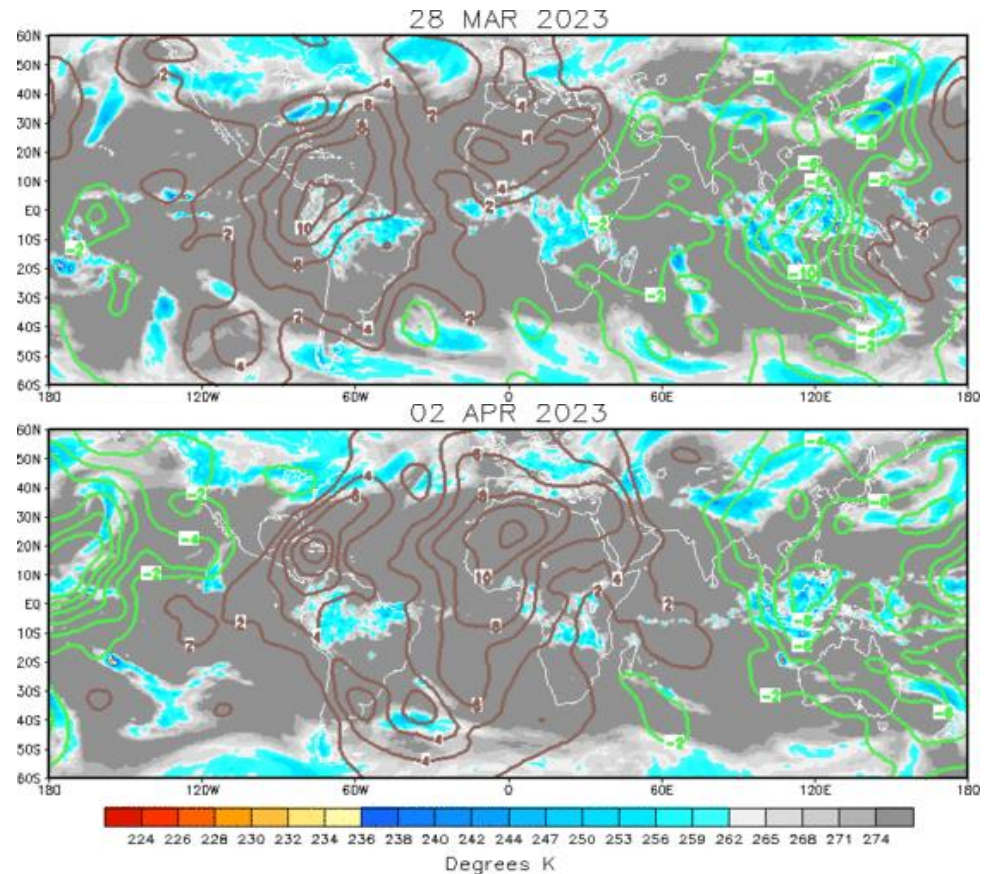
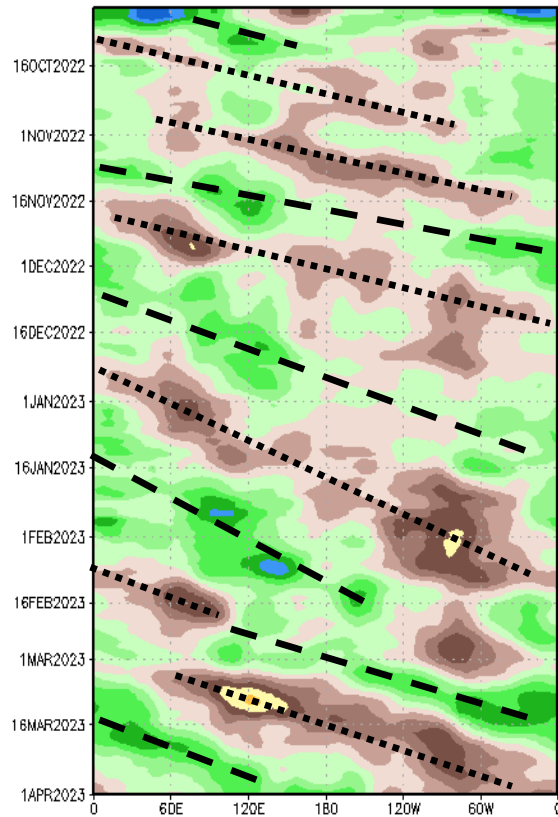
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

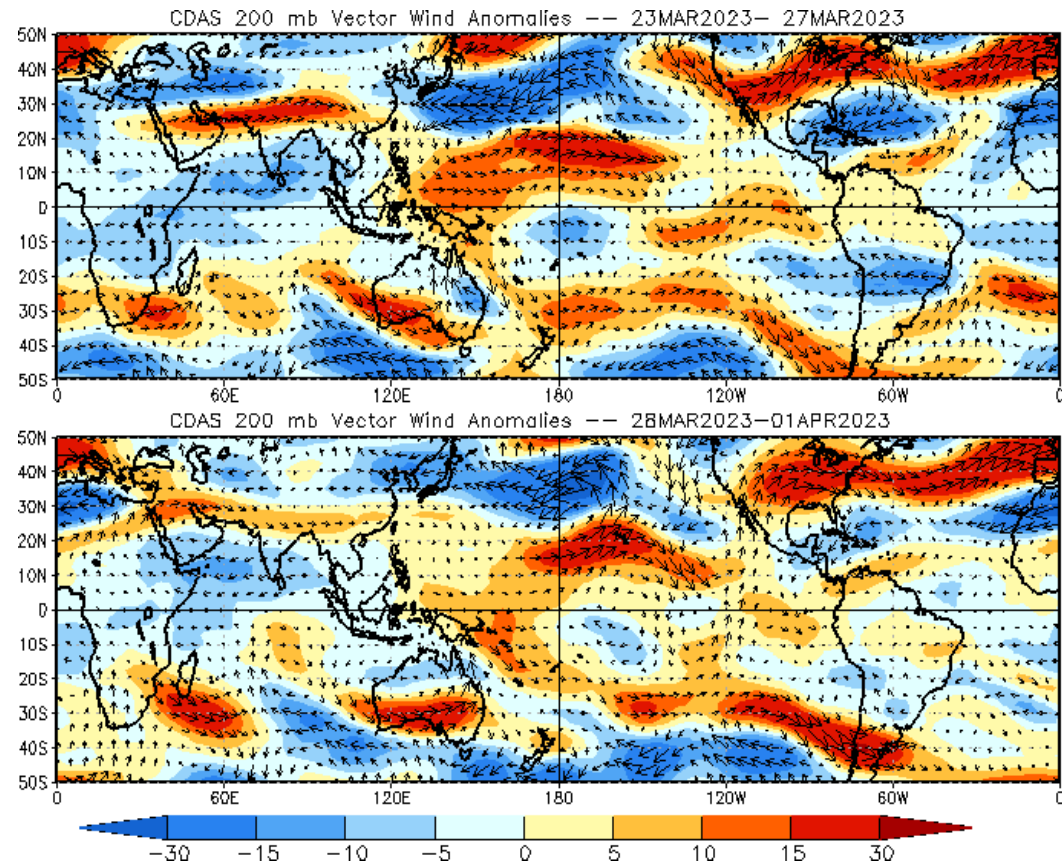
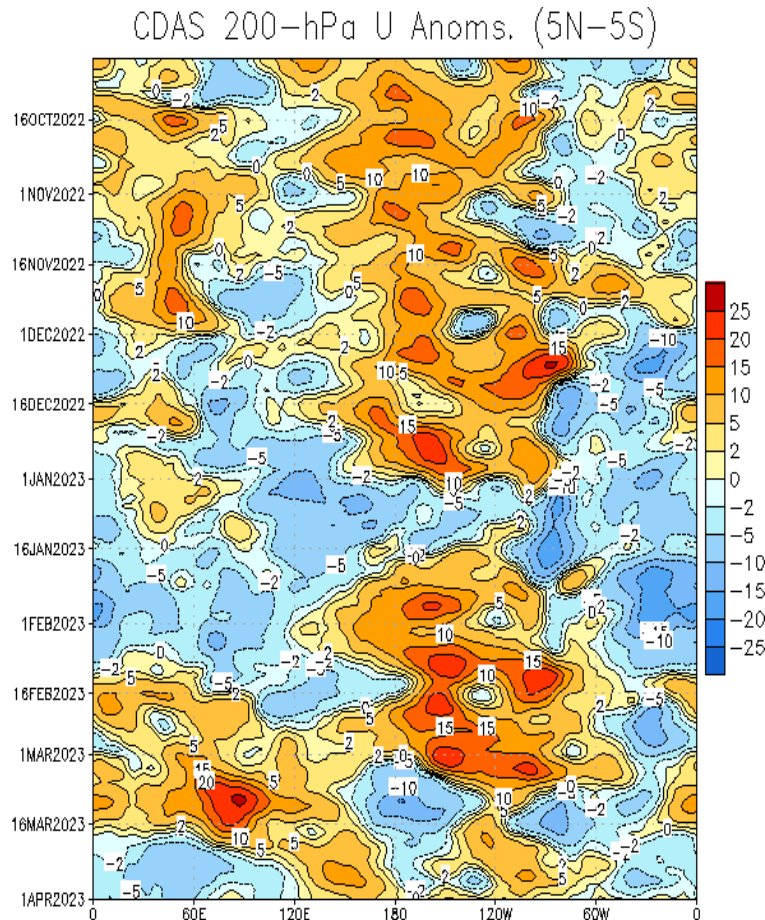
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- The spatial upper-level velocity potential pattern across the globe resembles a wave-1 asymmetry tied to the enhanced and suppressed phases of the MJO.
- Anomalous divergence is depicted across the Maritime Continent and Pacific, with anomalous convergence over South America, the Atlantic, and Africa.

200-hPa Wind Anomalies

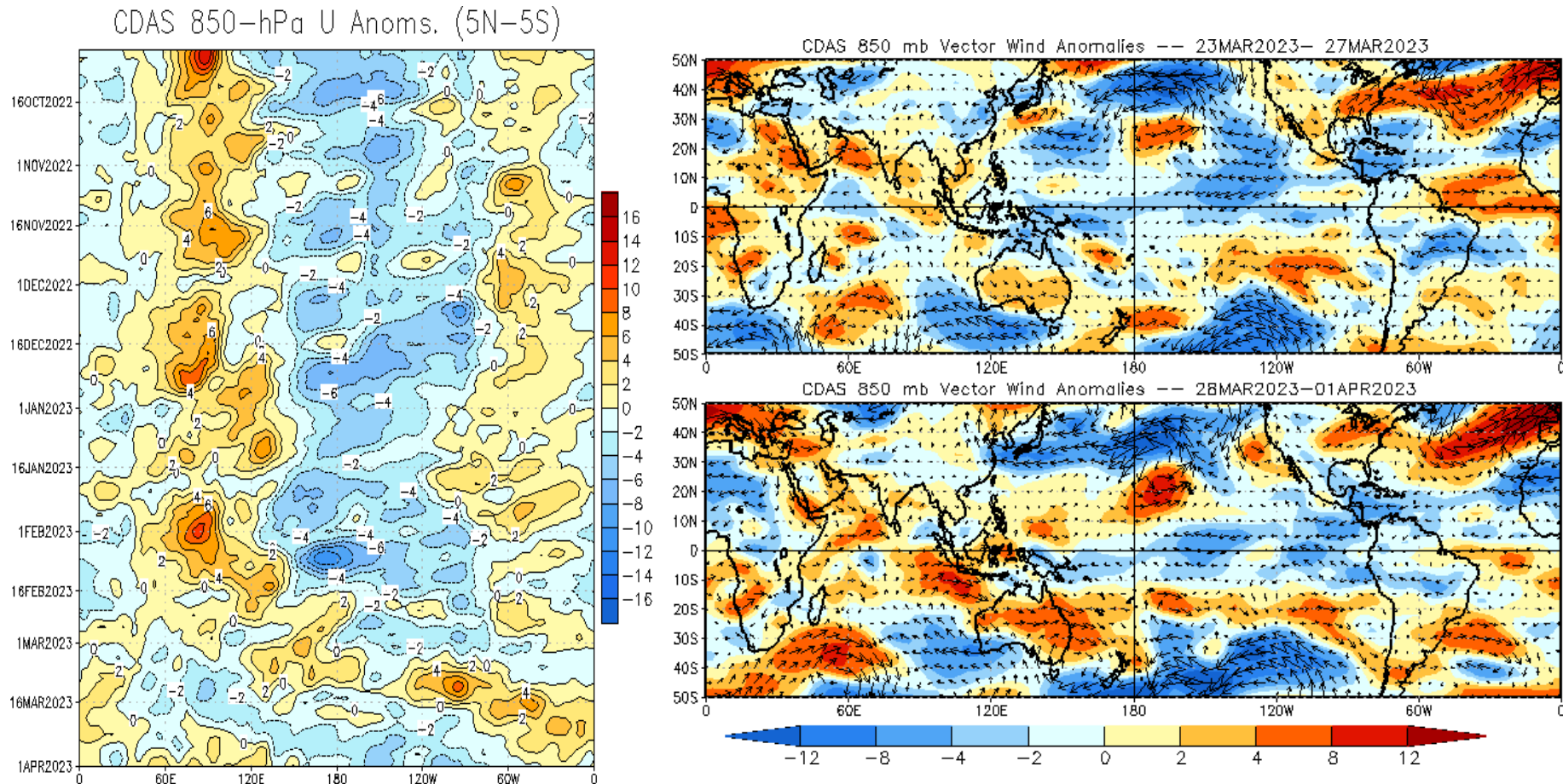
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Upper-level westerly wind anomalies increased across the Western Pacific, with upper-level easterly wind anomalies expanding across the Indian Ocean.
- Anomalous upper-level westerlies are also indicated over the Eastern Pacific and northwestern South America.
- Anti-cyclonic upper-level flow was apparent across the eastern United States during the past 2 weeks.

850-hPa Wind Anomalies

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

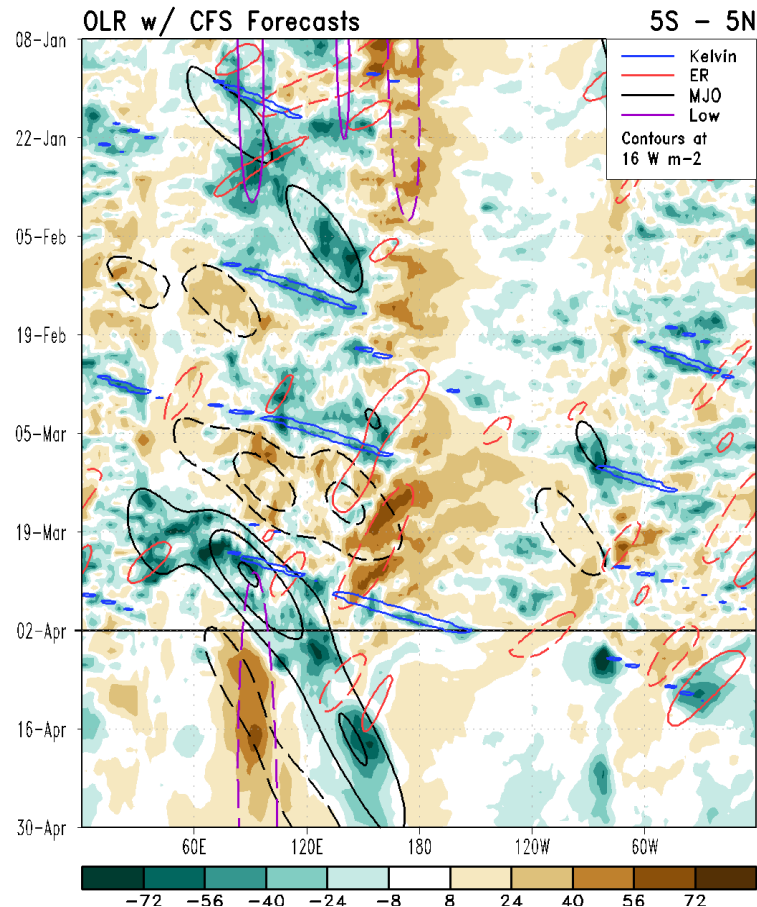


- Following a clear eastward progression across the globe, anomalous low-level westerlies are now focused across the eastern Indian Ocean and Maritime Continent.
- Enhanced trades are noted across the equatorial Pacific.
- Anti-cyclonic flow over the eastern U.S. is also apparent at 850-hPa, although is weaker compared to last week.

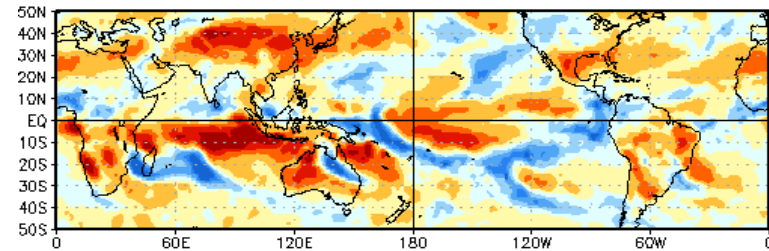
Outgoing Longwave Radiation (OLR) Anomalies

Green shades: Anomalous convection (wetness)

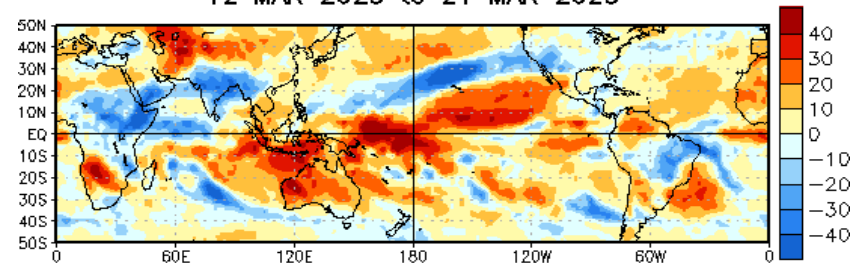
Brown shades: Anomalous subsidence (dryness)



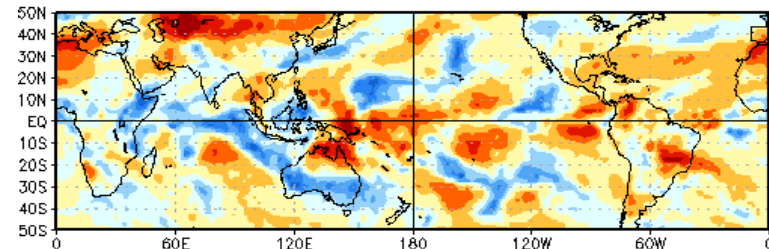
OLR Anomalies
2 MAR 2023 to 11 MAR 2023



12 MAR 2023 to 21 MAR 2023

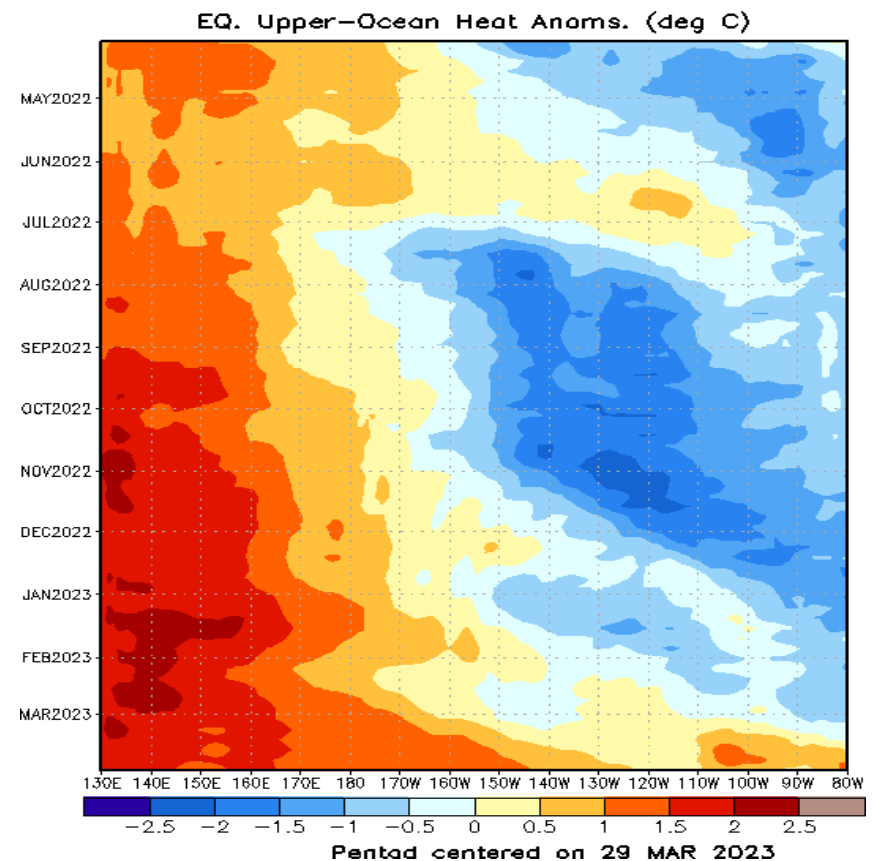
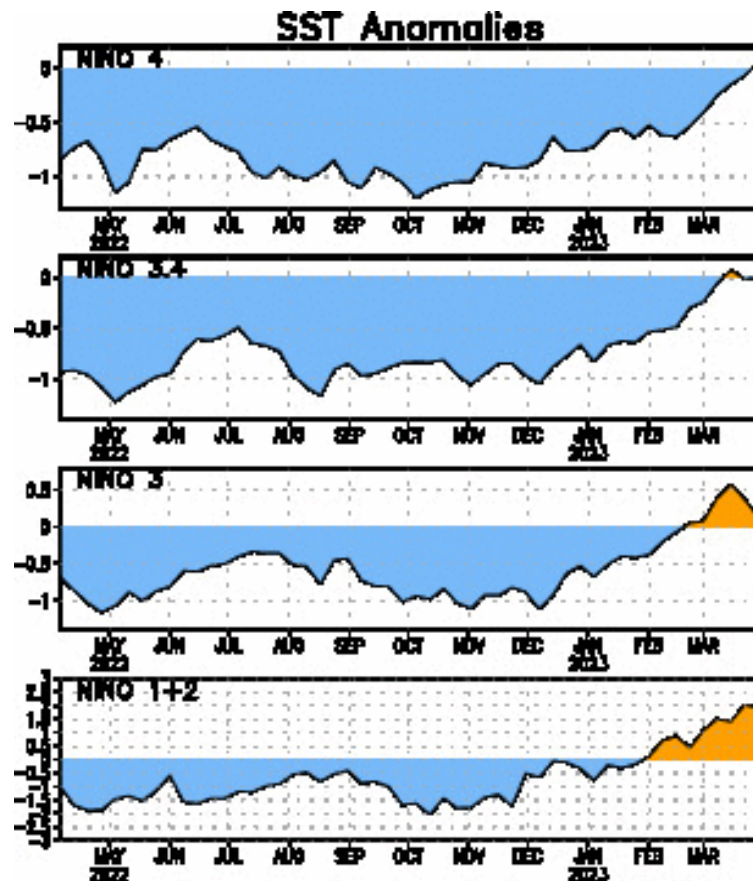


22 MAR 2023 to 31 MAR 2023



- A transition from positive to negative OLR anomalies was noted across the southeastern Indian Ocean and Maritime Continent during the past week, tied to the MJO signal.
- Positive OLR anomalies remain across much of the equatorial Pacific, Americas, and Atlantic.
- The CFS forecast depicts a slow propagation of the MJO across the Western Pacific, with a Convectively-Coupled Kelvin Wave emerging from the OLR filtering across the Western Hemisphere by mid-April.

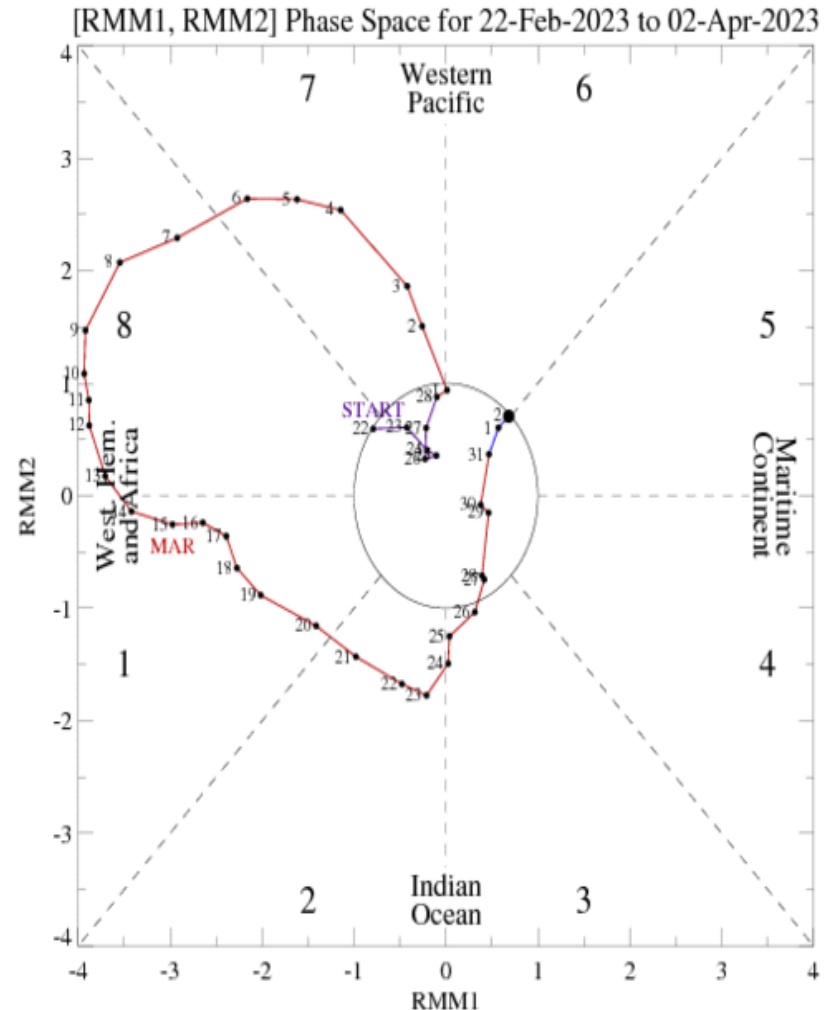
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Upper-ocean heat content is now above normal across the entire Pacific as a downwelling oceanic Kelvin Wave led to warming east of the Date Line, with more pronounced warming noted in the Eastern Pacific.
- SSTs in all of the Niño regions have trended upwards during the past month and are now close to or above normal. The largest positive SST anomalies are over the Niño 1+2 region.

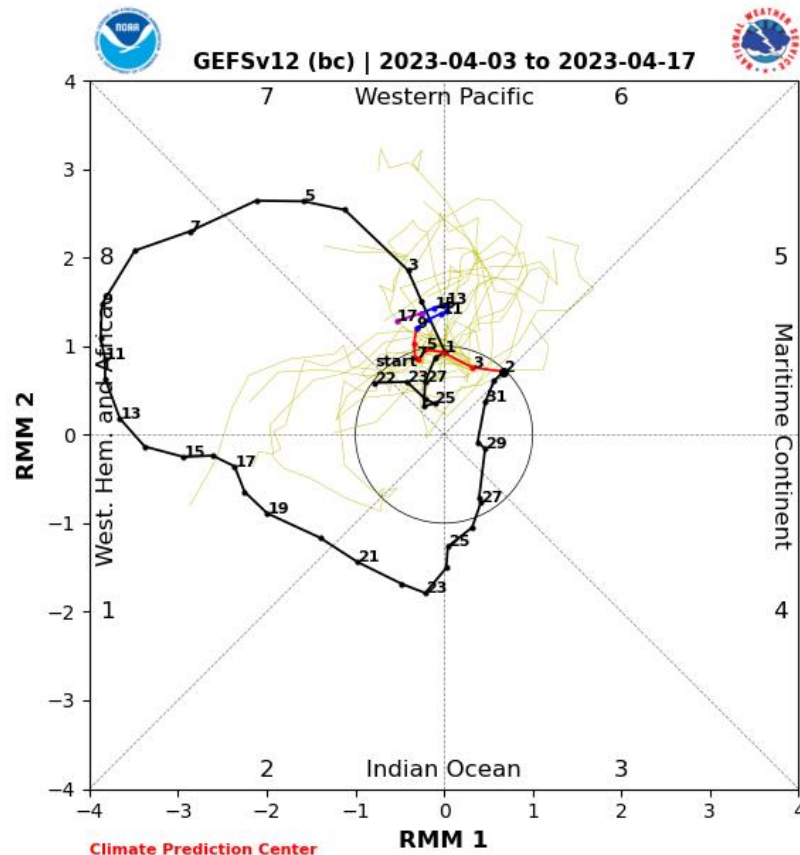
MJO Index: Recent Evolution

- A strong RMM-based MJO was apparent across the Western Hemisphere during March.
- The signal is now located along the edge of the unit circle bordering the Maritime Continent and Western Pacific where it is expected to strengthen over the next few days.

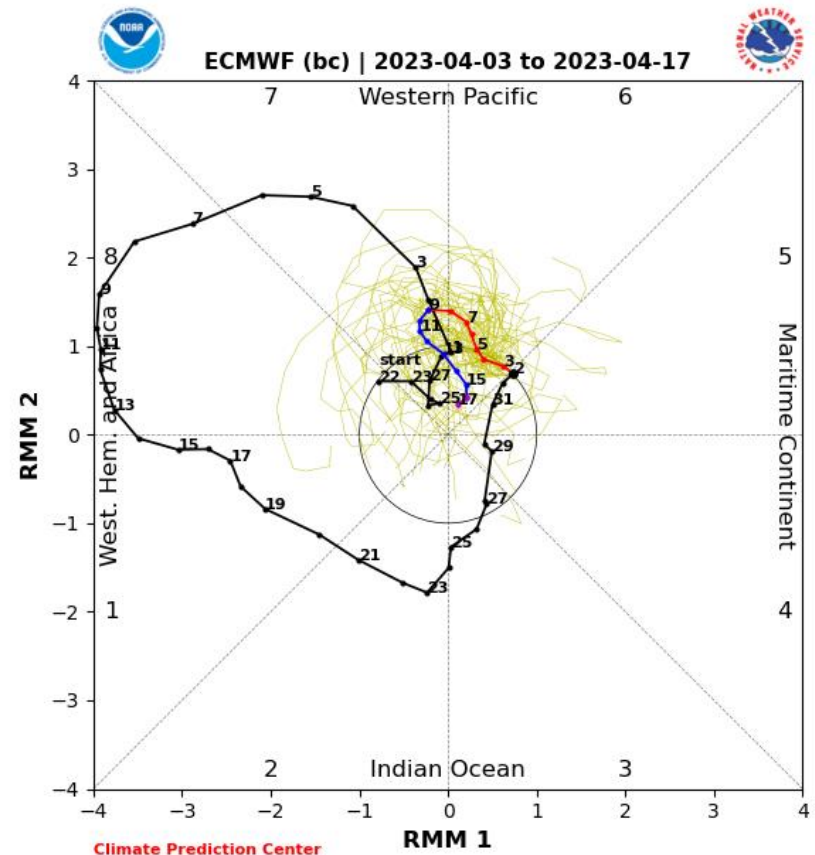


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



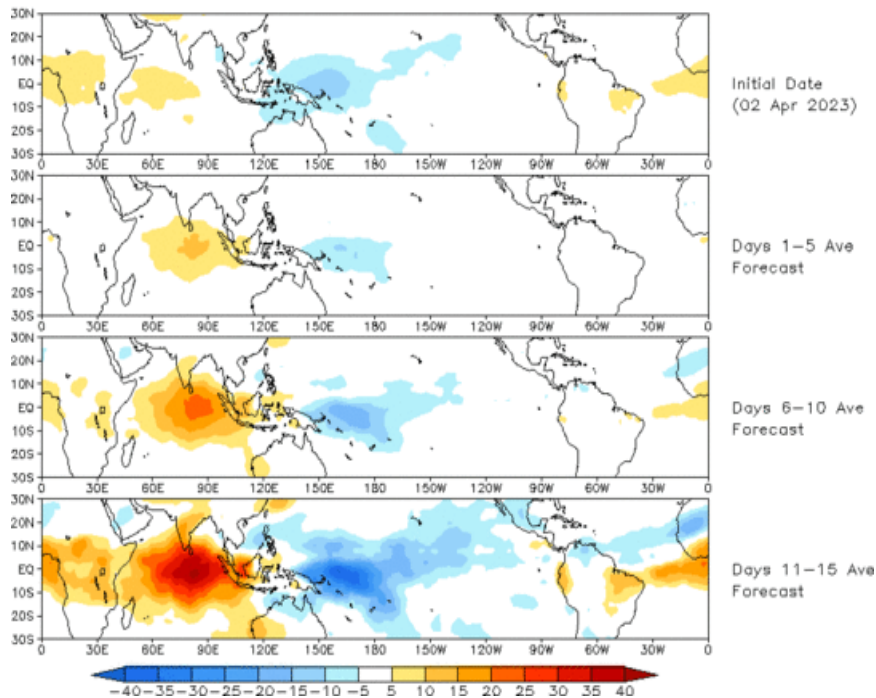
ECMWF Forecast

- The GEFS and ECMWF dynamical model ensembles are in good agreement regarding a renewed MJO propagation over the Western Pacific during the next week.
- By week-2, the propagation of the intraseasonal signal is less coherent, although some ensembles depict propagation into the Western Hemisphere.
- This may be more indicative of a Convectively-Coupled Kelvin Wave rather than true MJO propagation.

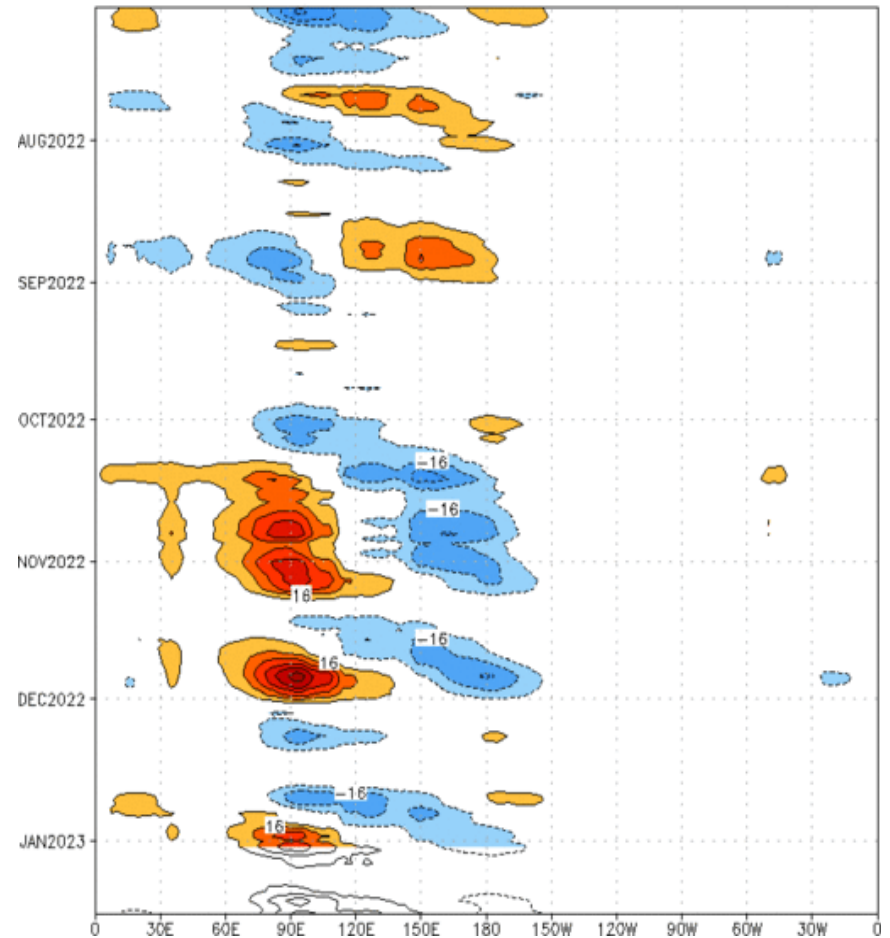
MJO: GEFS Forecast Evolution

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: 02 Apr 2023
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S,7.5°N] (cint:4Wm^{-2}) Period:03-Jul-2022 to 02-Jan-2023
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

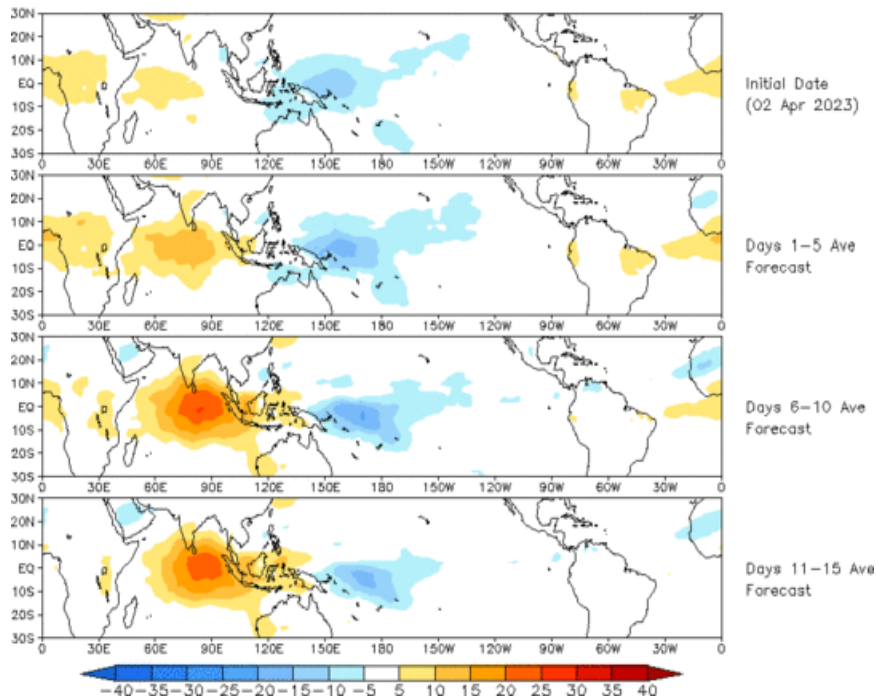


- The GEFS RMM-based forecast depicts negative OLR anomalies (enhanced convection) expanding across the Pacific during the next 2 weeks.
- Conversely, positive OLR anomalies (suppressed convection) are forecast to increase across Africa and the Indian Ocean.

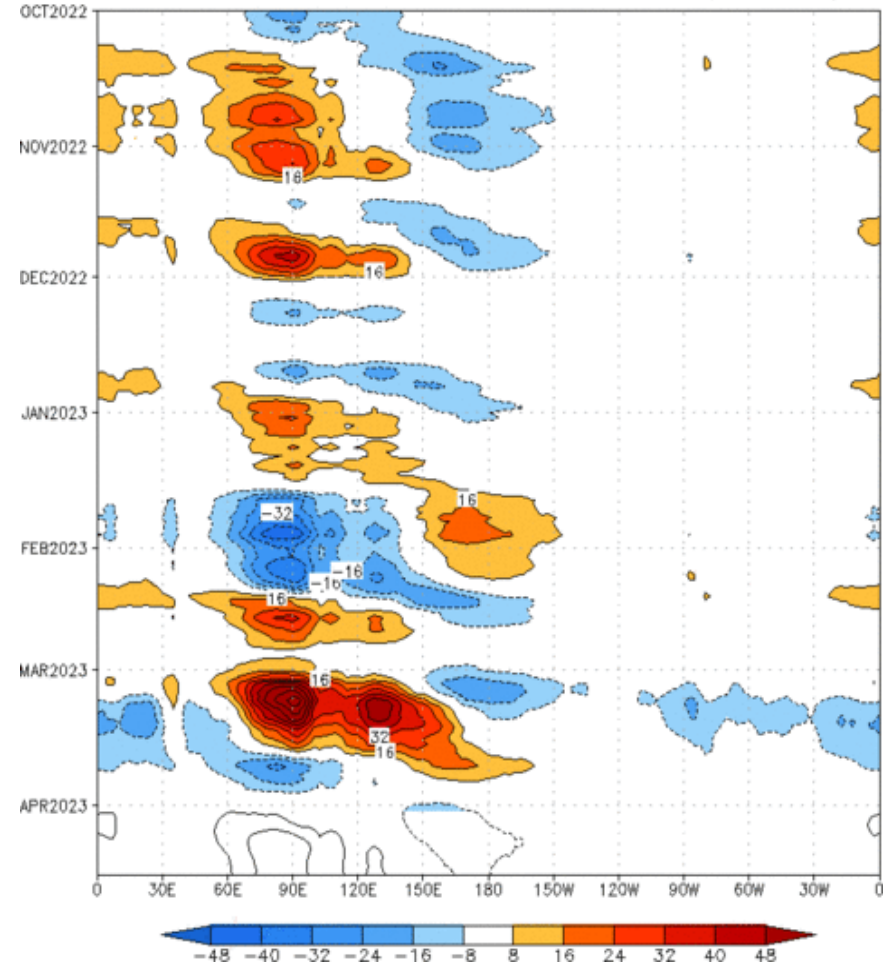
MJO: Constructed Analog Forecast Evolution

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 (02 Apr 2023)



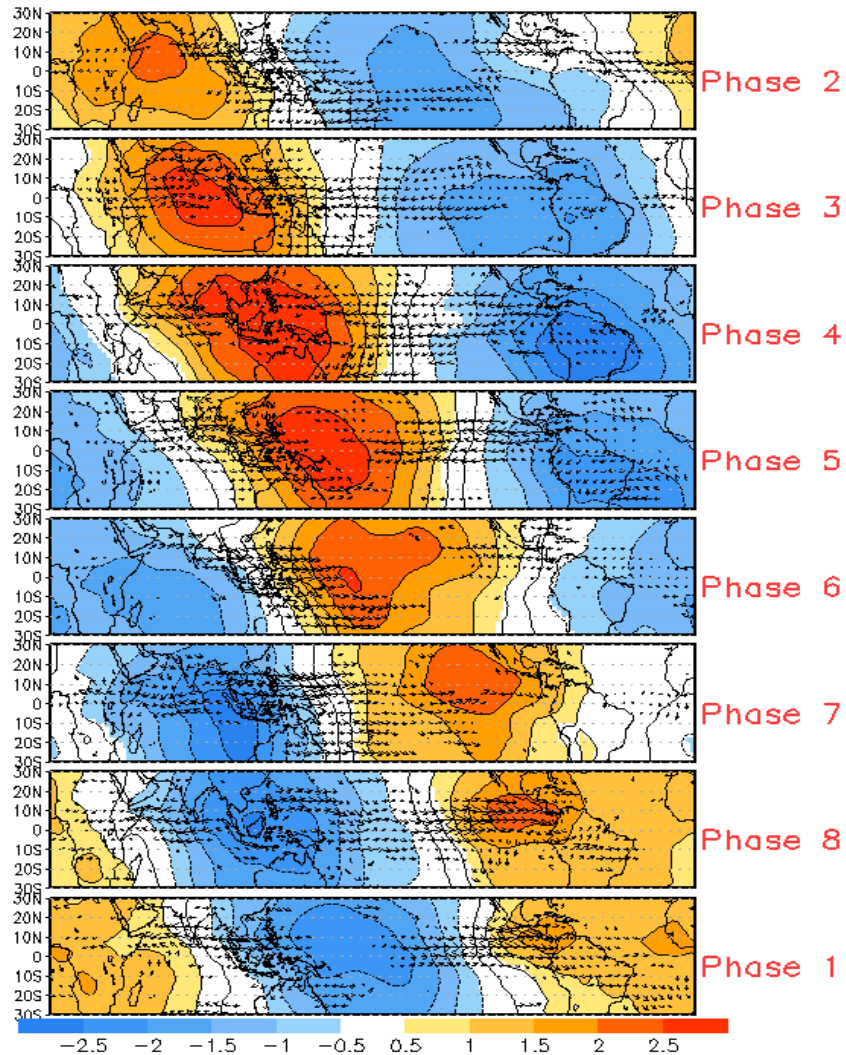
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:01–Oct–2022 to 02–Apr–2023
The unfilled contours are CA forecast reconstructed anomaly for 15 days



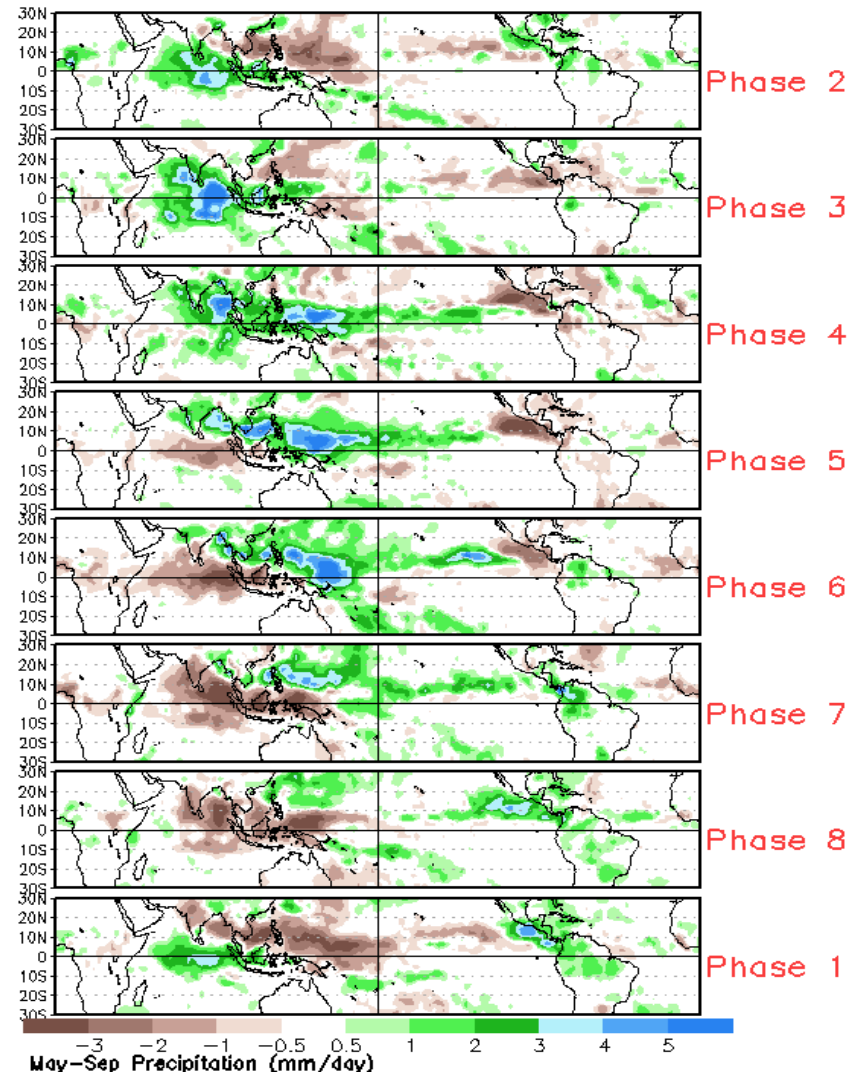
- The constructed analog RMM-based forecast is similar to the GEFS, with negative (positive) OLR anomalies across the Pacific (Indian) Ocean.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



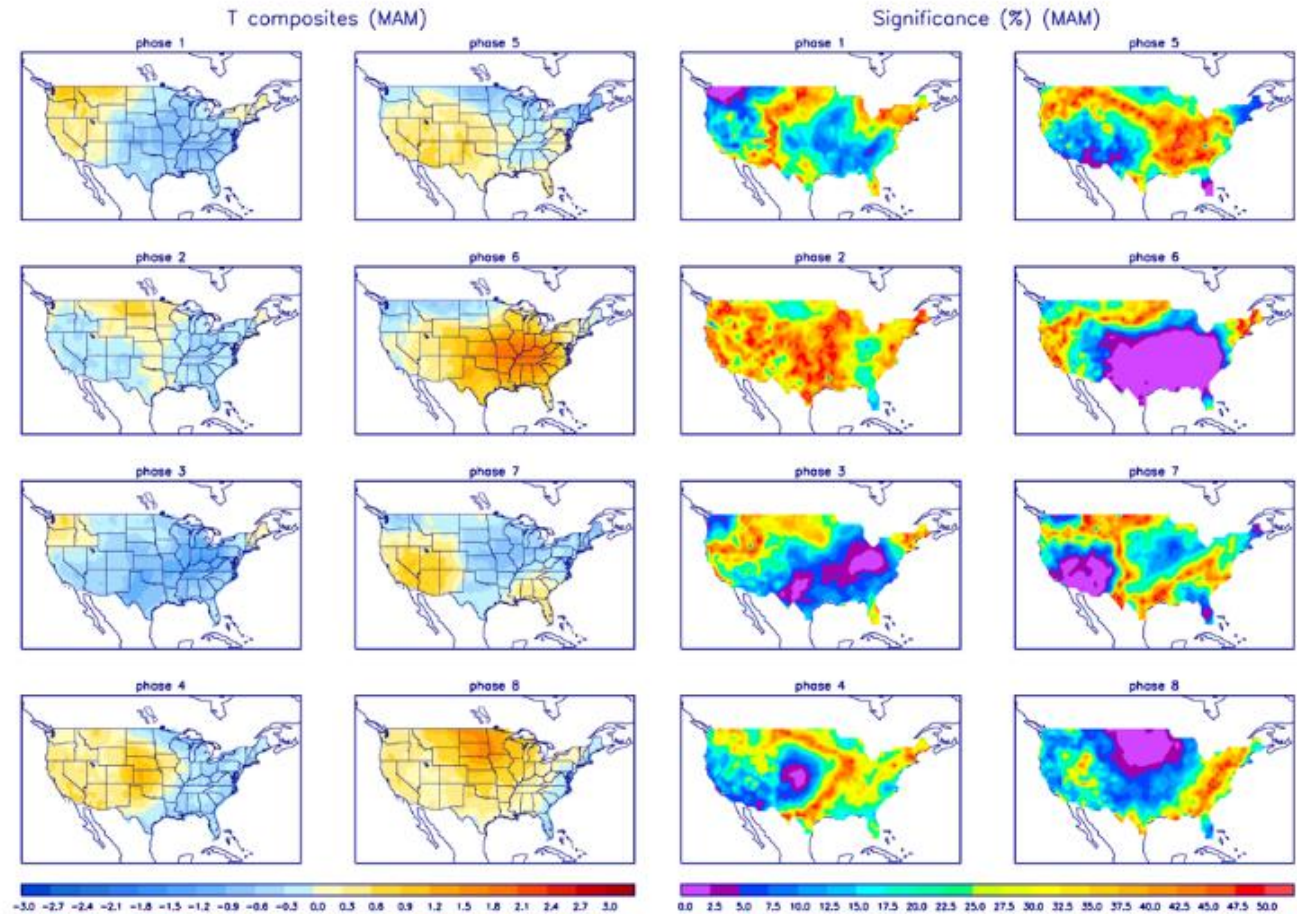
Precipitation Anomalies



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.



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.

