

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
16 May 2022

Overview

- Constructive interference between a Kelvin and Rossby Wave resulted in an increase in convection across the Indian Ocean and Maritime Continent during the past week, which has quickly shifted eastward into the Pacific.
- Although the RMM-based MJO index depicts an elevated amplitude, the phase speed of the wave is more indicative of a Kelvin Wave.
- This Kelvin wave is forecast to continue to propagate quickly across the Pacific and possibly into the western Atlantic, potentially leading to early season tropical cyclone development.

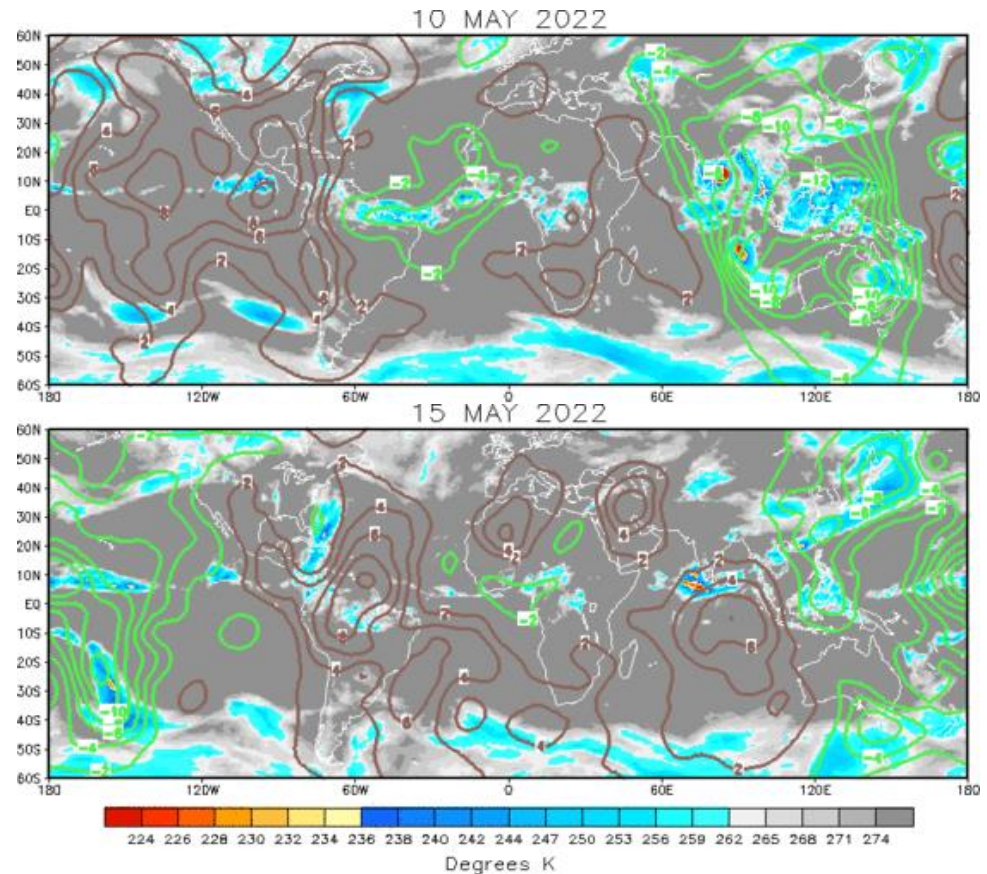
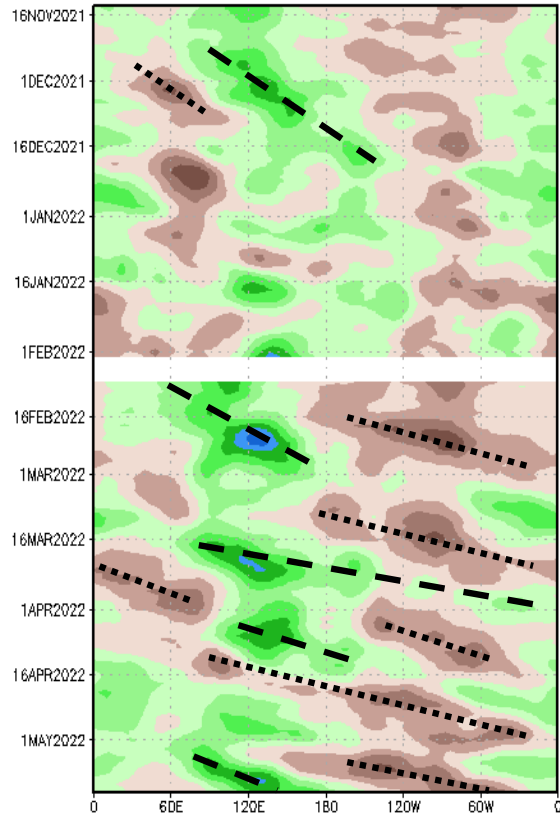
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

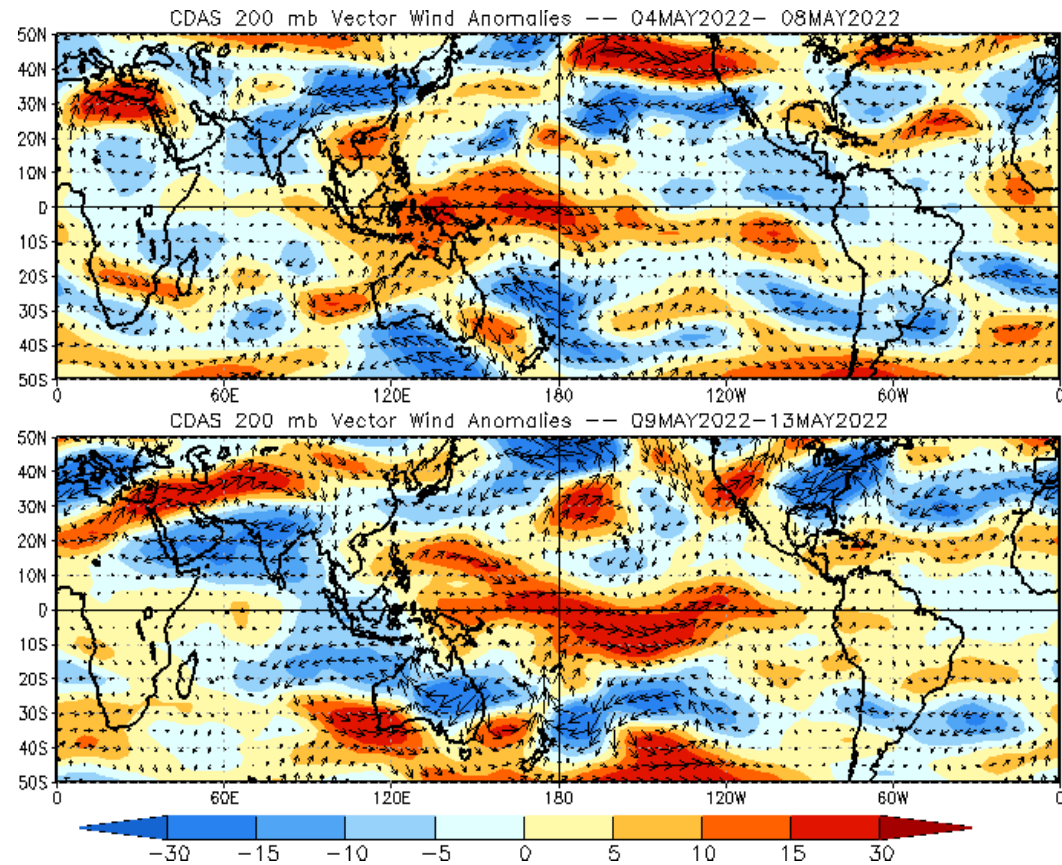
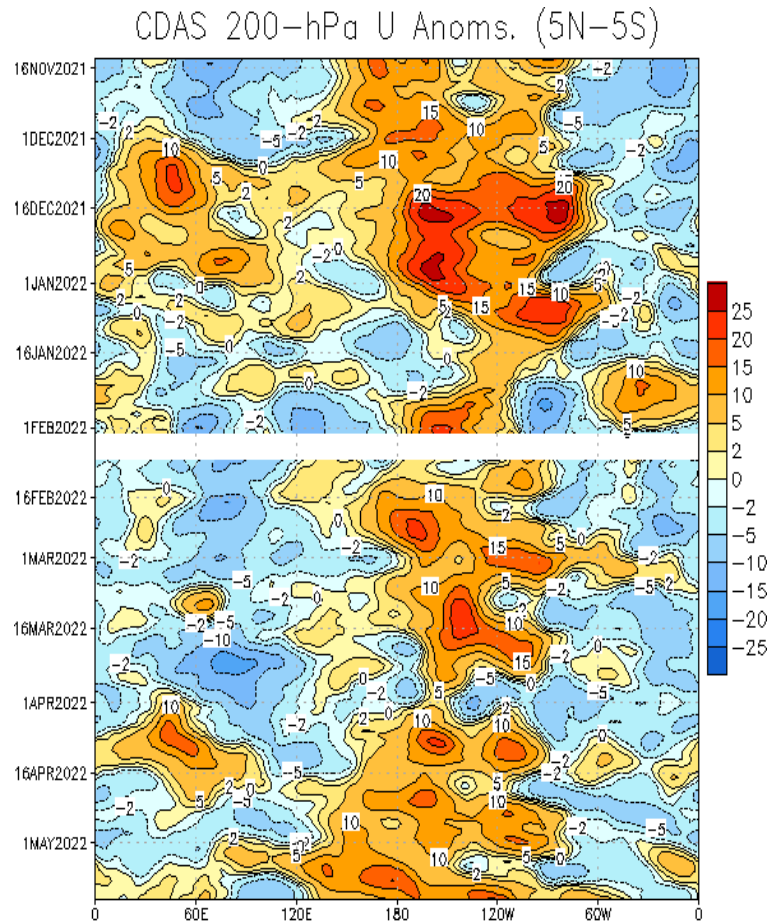
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- A wave-1 asymmetry pattern in the spatial velocity potential field is noted, with anomalous divergence across much of the Pacific, and anomalous convergence over the Americas, Atlantic, Africa, and the Indian Ocean.
- This convective pattern has shifted eastward compared to last week, and is consistent with a strong Kelvin Wave moving into the Pacific.

200-hPa Wind Anomalies

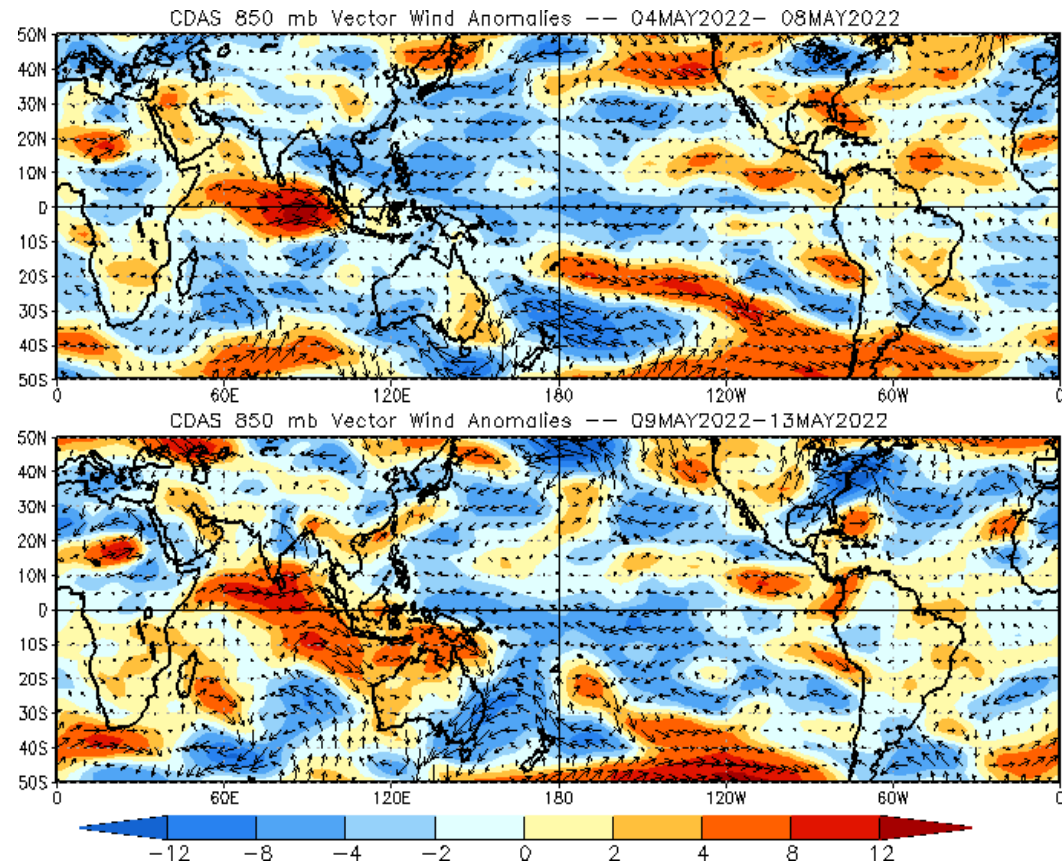
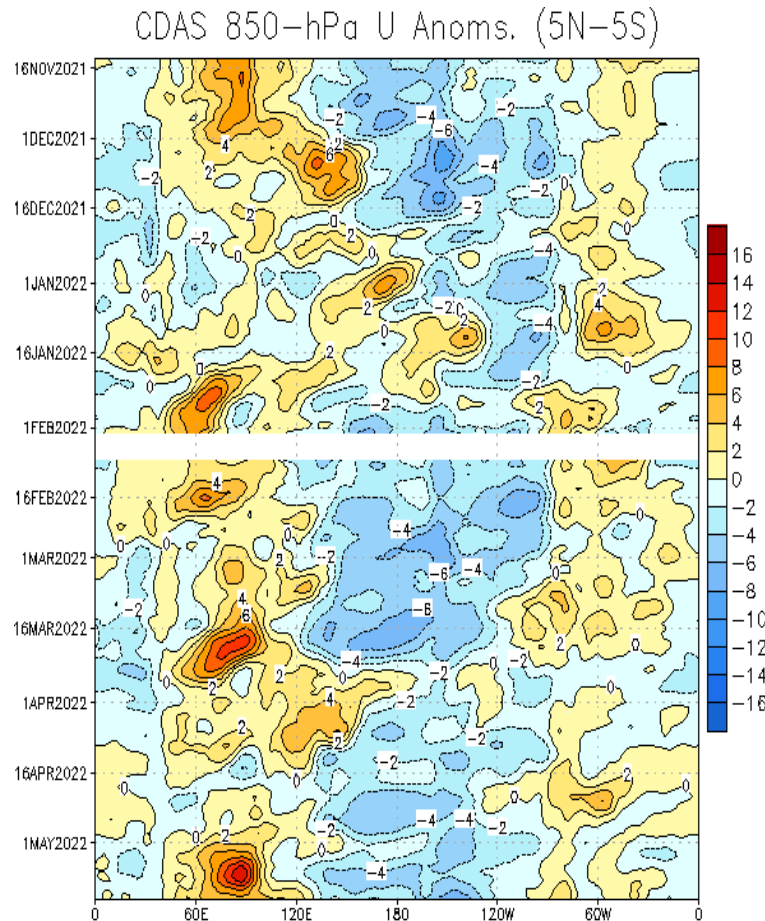
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous upper-level westerlies have strengthened throughout the equatorial Pacific, consistent with ongoing La Niña conditions.
- Anomalous upper-level easterlies are highlighted across the Northern Indian Ocean, Maritime Continent, Australia, and the eastern U.S.

850-hPa Wind Anomalies

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

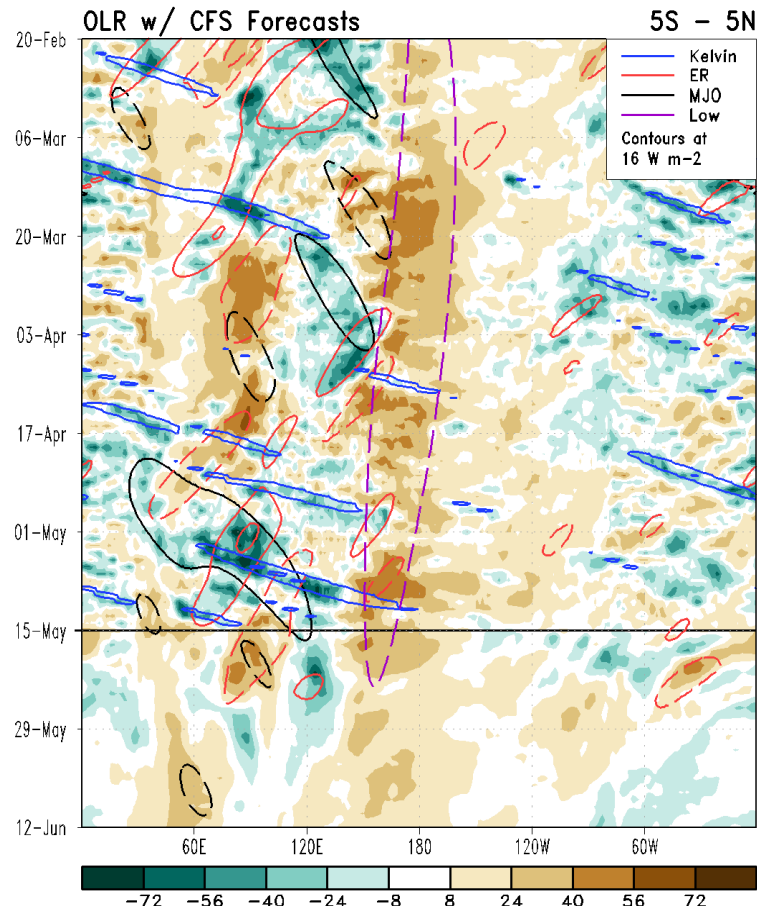


- La Niña conditions continue to support enhanced trade winds across the equatorial Pacific.
- Low-level westerly anomalies expanded across the Indian Ocean, Maritime Continent, and Australia in the wake of an eastward propagating Kelvin Wave.
- Anomalous westerlies also increased across parts of the eastern Pacific and Caribbean.

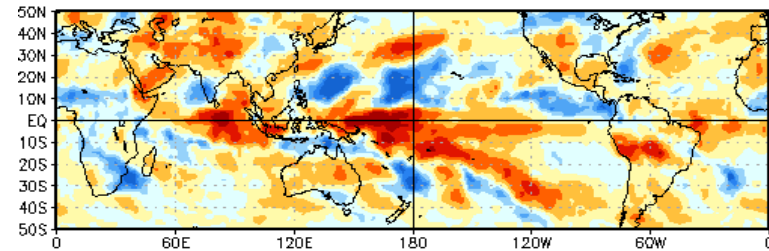
Outgoing Longwave Radiation (OLR) Anomalies

Green shades: Anomalous convection (wetness)

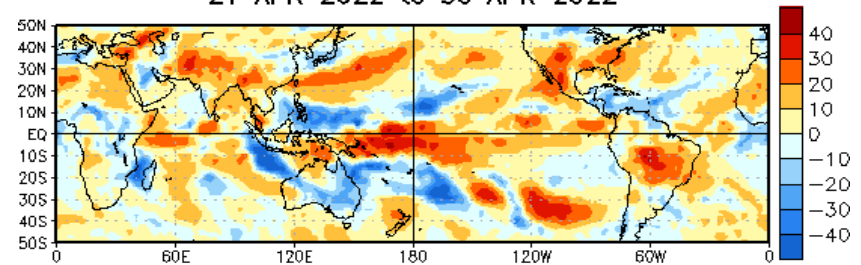
Brown shades: Anomalous subsidence (dryness)



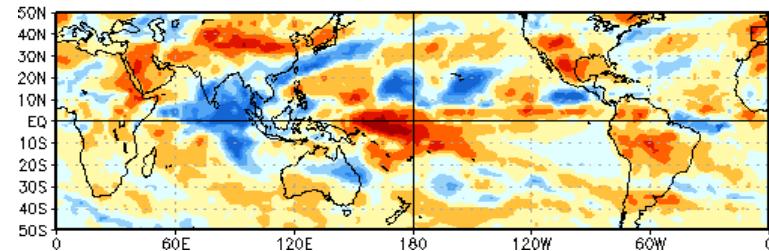
OLR Anomalies
11 APR 2022 to 20 APR 2022



21 APR 2022 to 30 APR 2022

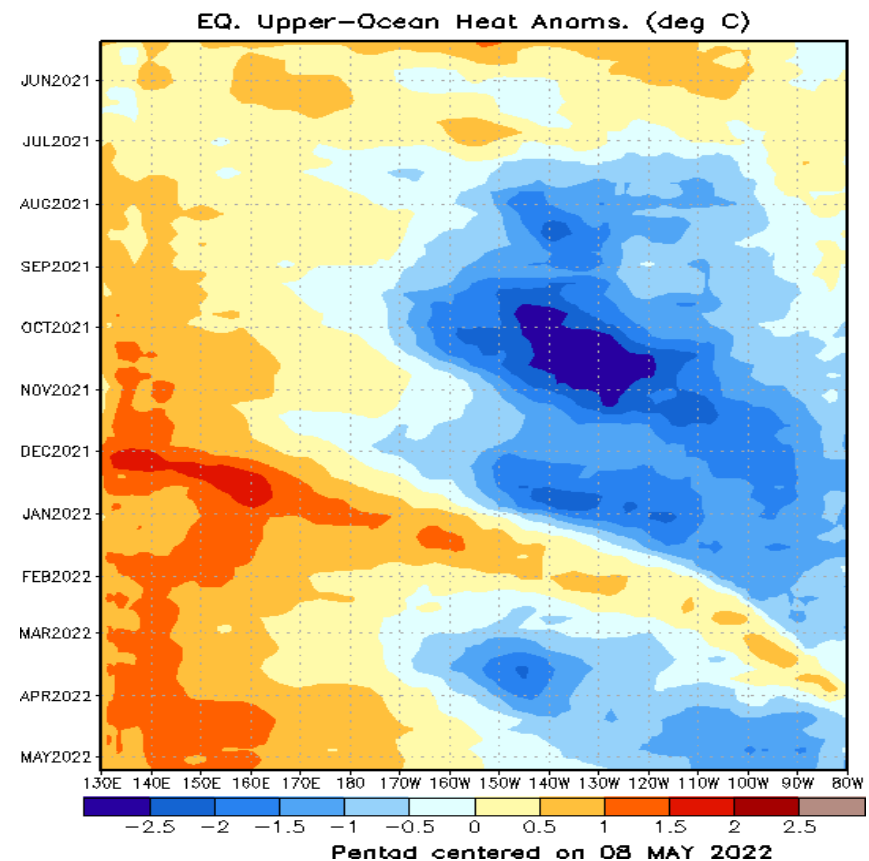
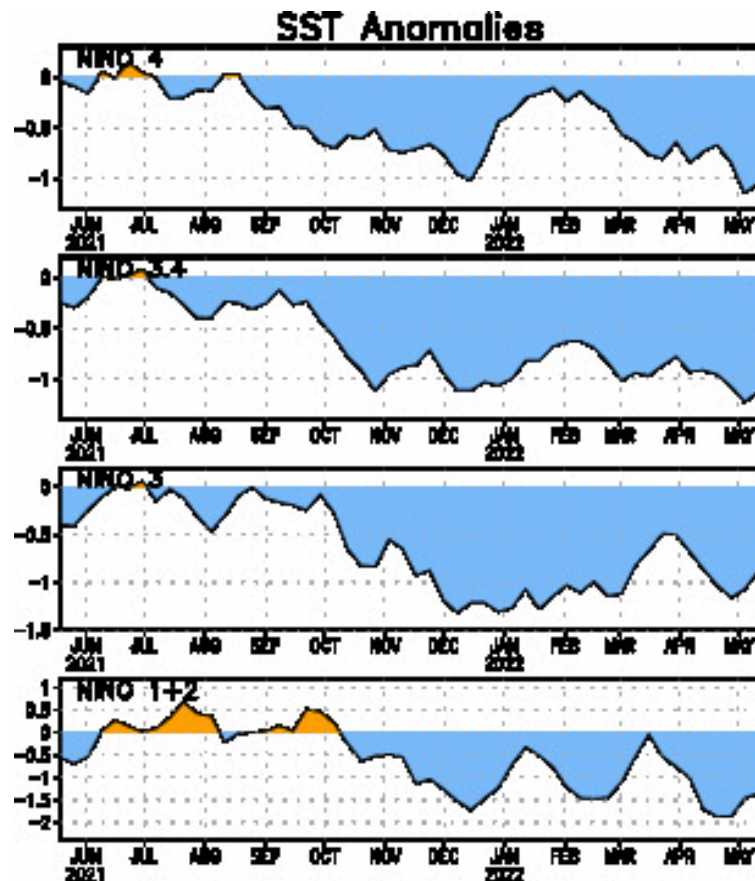


1 MAY 2022 to 10 MAY 2022



- Tied to the ongoing La Niña, strongly suppressed convection along and to the west of the Date Line remains the most prominent feature in the OLR field over the past several months.
- Enhanced convection is noted across the Indian Ocean due to combined Kelvin and Rossby Wave activity.

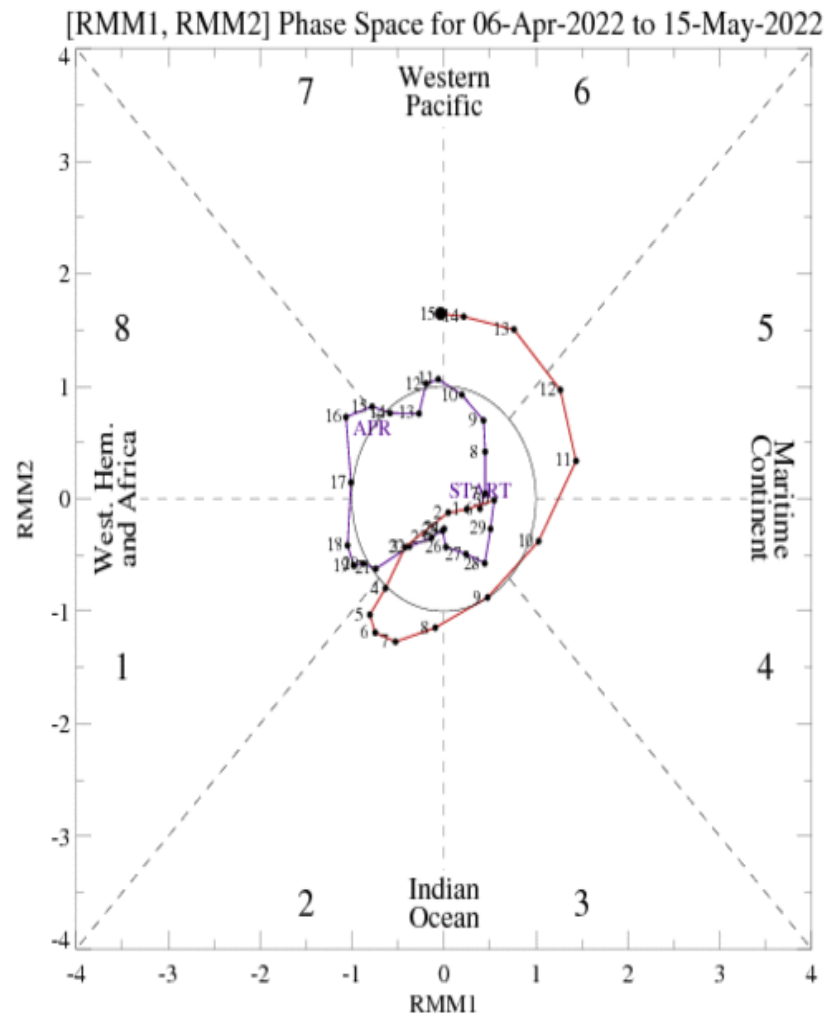
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Following a moderation of sea surface temperatures (SSTs) in parts of the central and eastern Pacific likely tied to an oceanic downwelling Kelvin wave this past winter, SSTs have re-cooled considerably since mid-March.
- There has been an eastward expansion of the positive ocean heat content anomalies near the Date Line associated with the eastward propagating convective envelope.

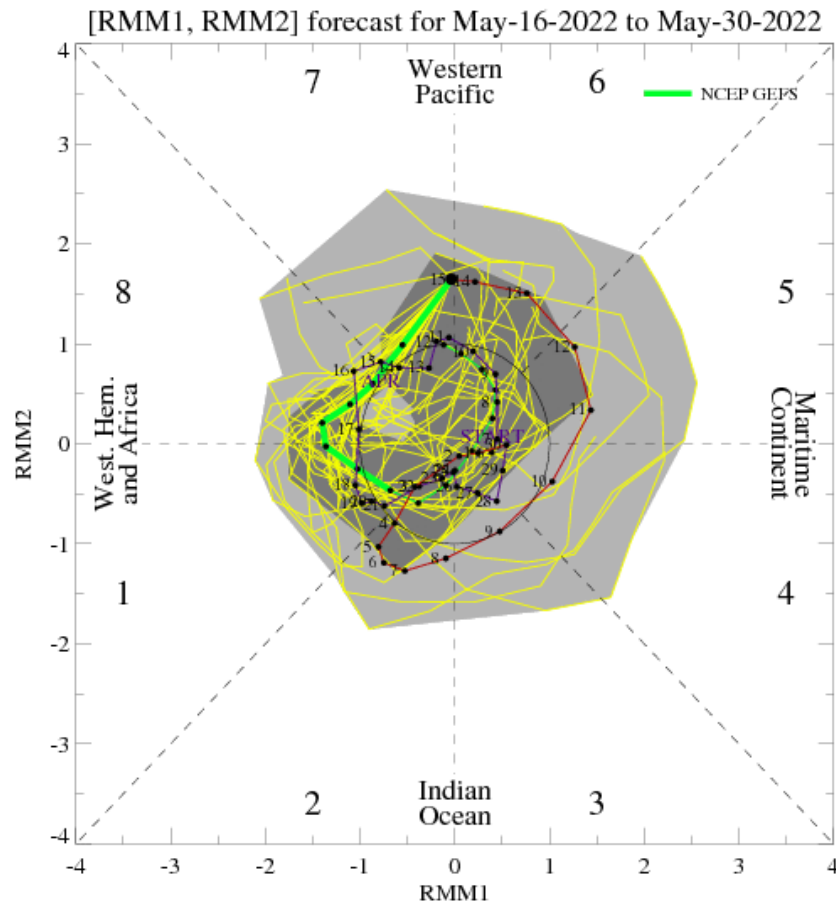
MJO Index: Recent Evolution

- The constructive interference of a Kelvin and Rossby Wave led to an increase in the RMM-based MJO index during early May across the Maritime Continent and West Pacific.
- The propagation speed is more indicative of a Kelvin Wave than a canonical MJO.

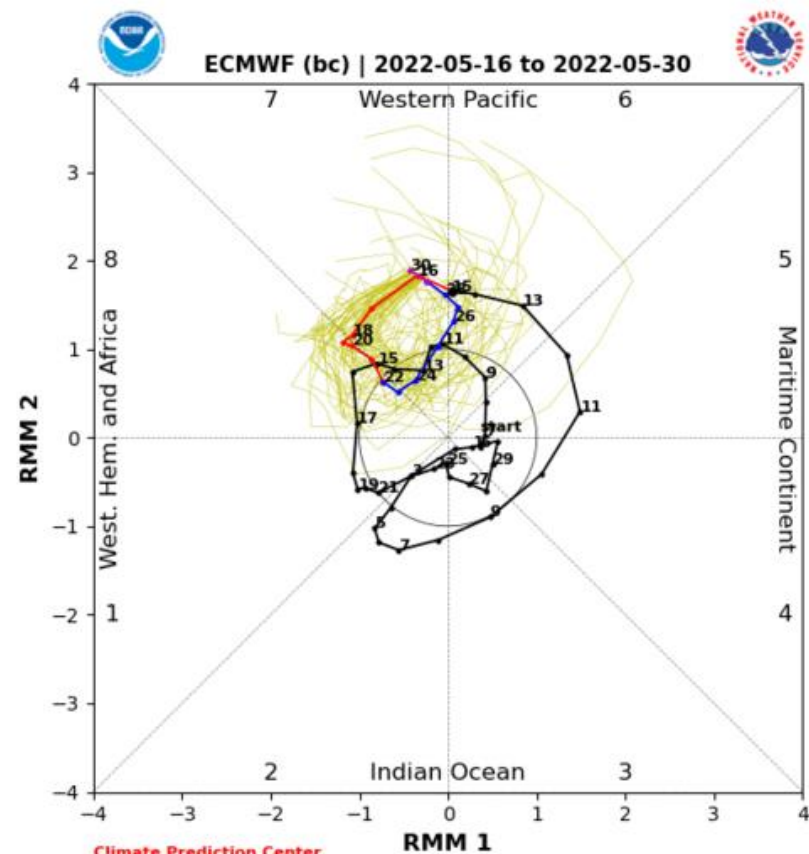


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



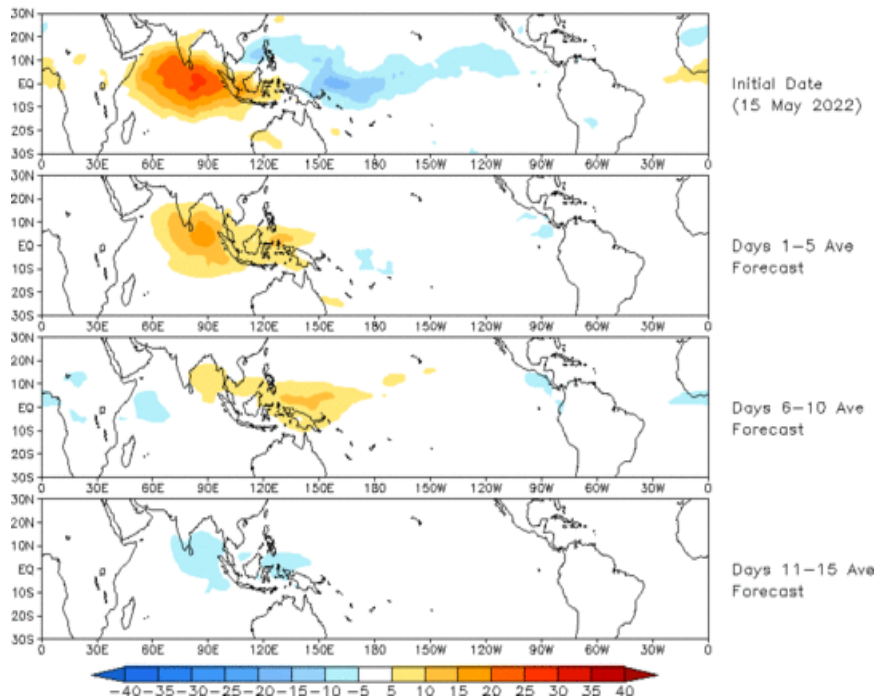
ECMWF Forecast

- The GEFS depicts a fast eastward circumnavigation of the enhanced RMM-based signal during the next 2 weeks, consistent with a convectively coupled Kelvin wave.
- The ECMWF ensembles depict a meandering signal across the west-central Pacific, with limited eastward propagation likely due to destructive interference with La Niña.

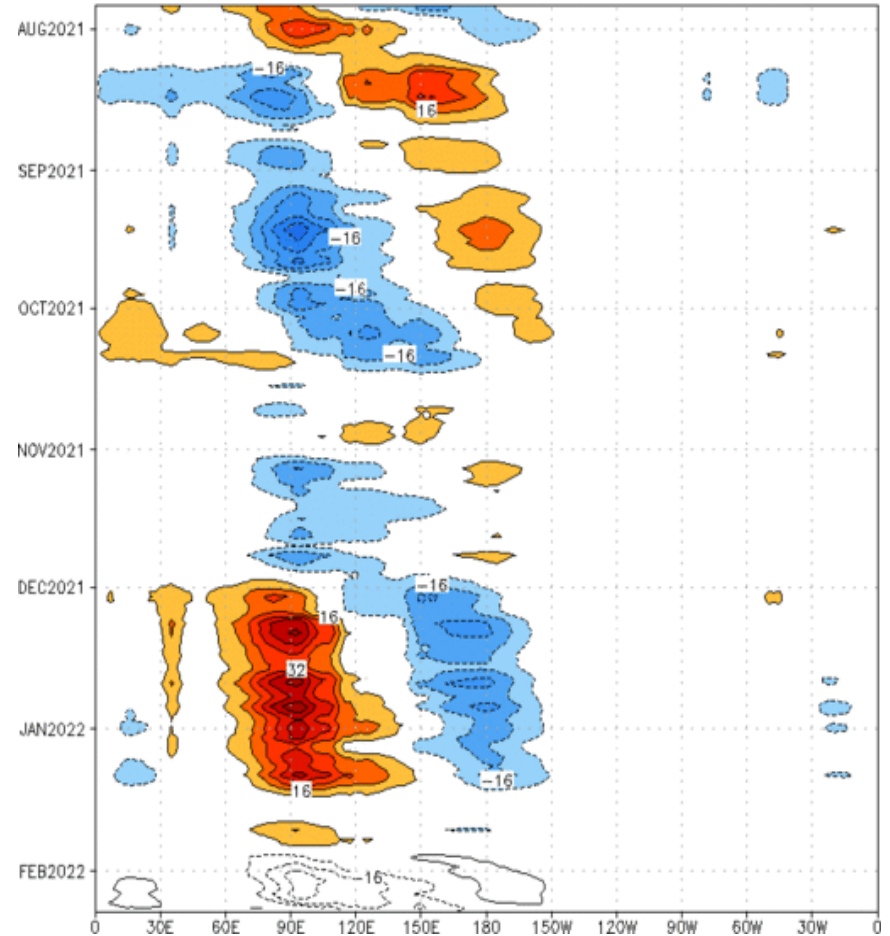
MJO: GEFS Forecast Evolution

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: 15 May 2022
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$] ($\text{cont: } 4\text{Wm}^{-2}$) Period: 27-Jul-2021 to 26-Jan-2022
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

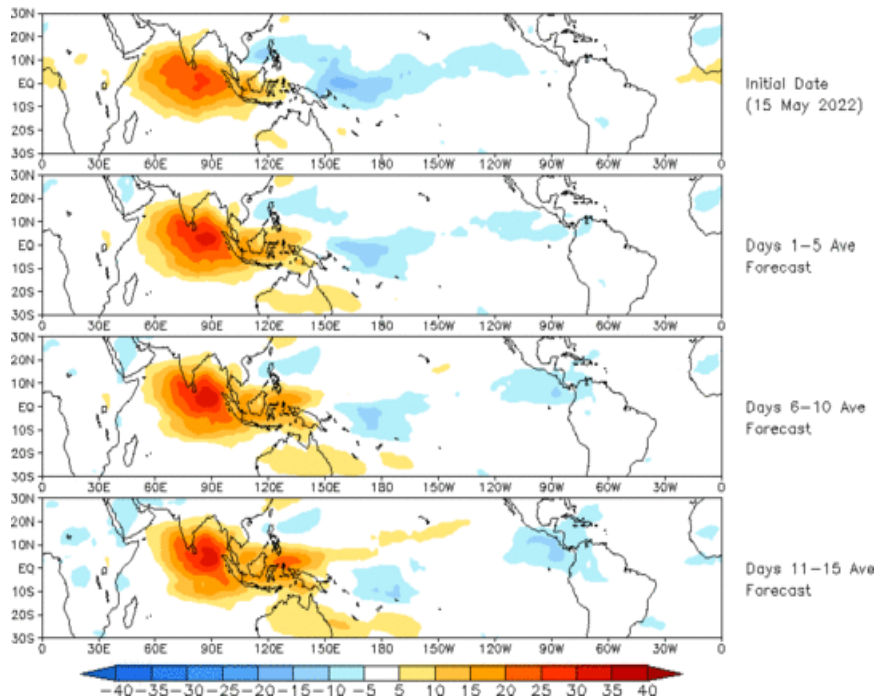


- The GEFS RMM-based OLR field depicts positive OLR anomalies (suppressed convection) across the Indian Ocean, and negative OLR anomalies (enhanced convection) across the equatorial Pacific and Central America during week-1.
- By week-2, OLR anomalies become slightly negative over parts of the eastern Indian Ocean, with positive OLR anomalies shifting into the western Pacific.

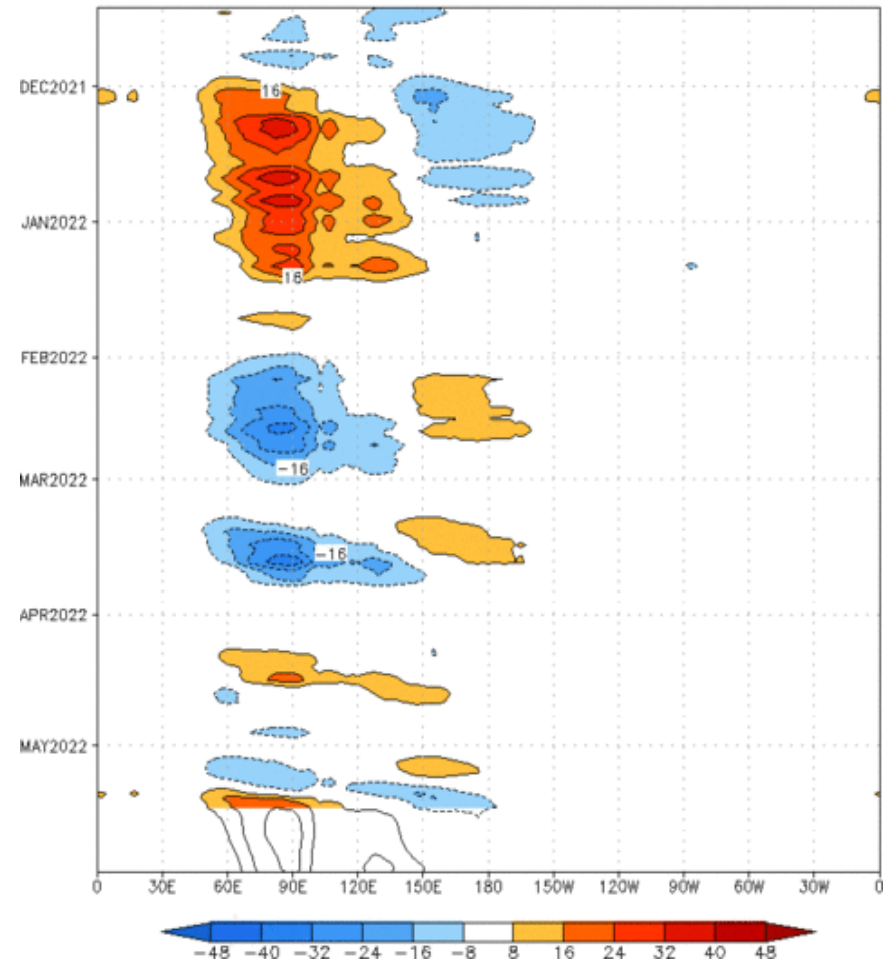
MJO: Constructed Analog Forecast Evolution

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 (15 May 2022)



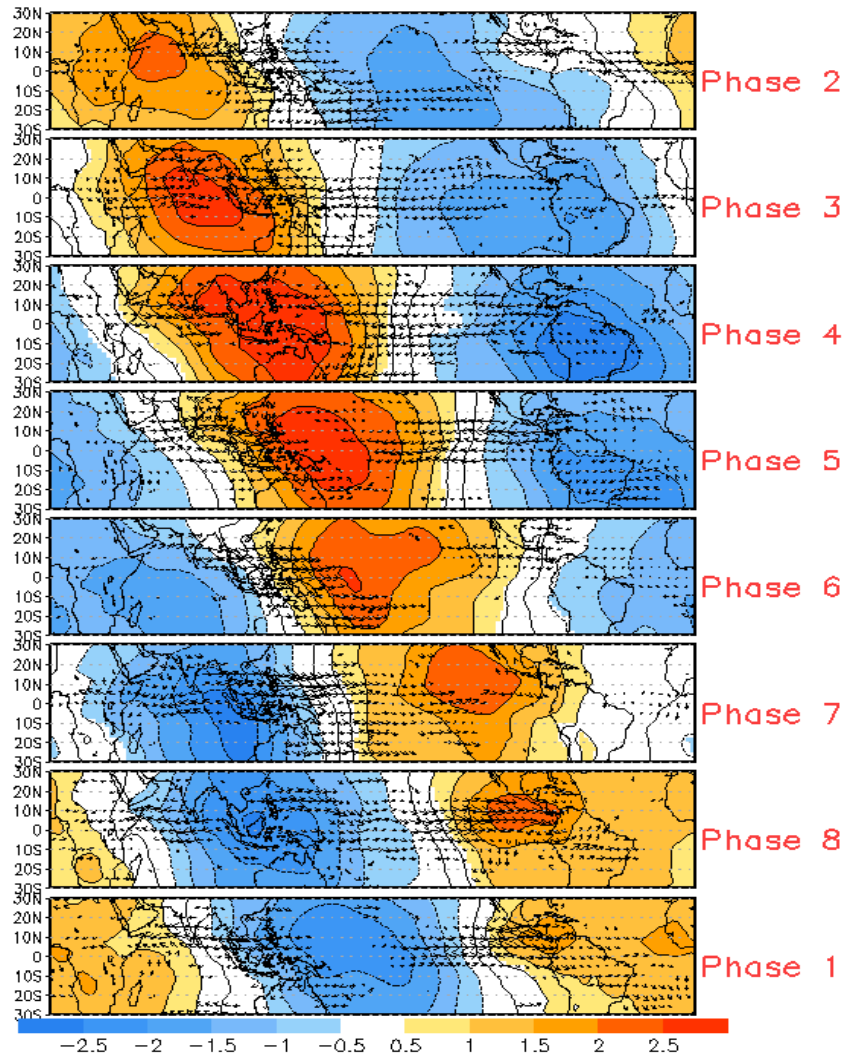
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:13–Nov–2021 to 15–May–2022
The unfilled contours are CA forecast reconstructed anomaly for 15 days



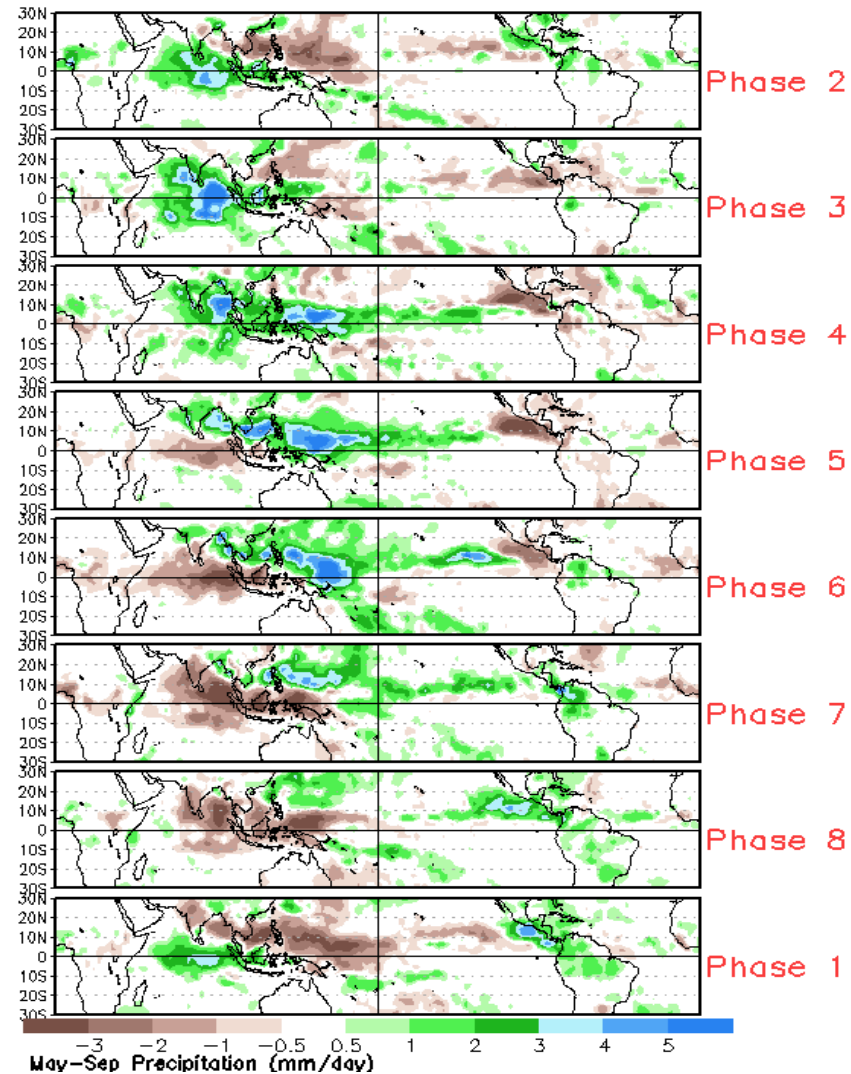
- The constructed analog forecast of RMM-based OLR anomalies indicates a more persistent pattern, with positive OLR anomalies across the Indian Ocean and extending into the Western Pacific through week-2.
- Negative OLR anomalies are indicated over the remainder of the Pacific and into parts of the Americas.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



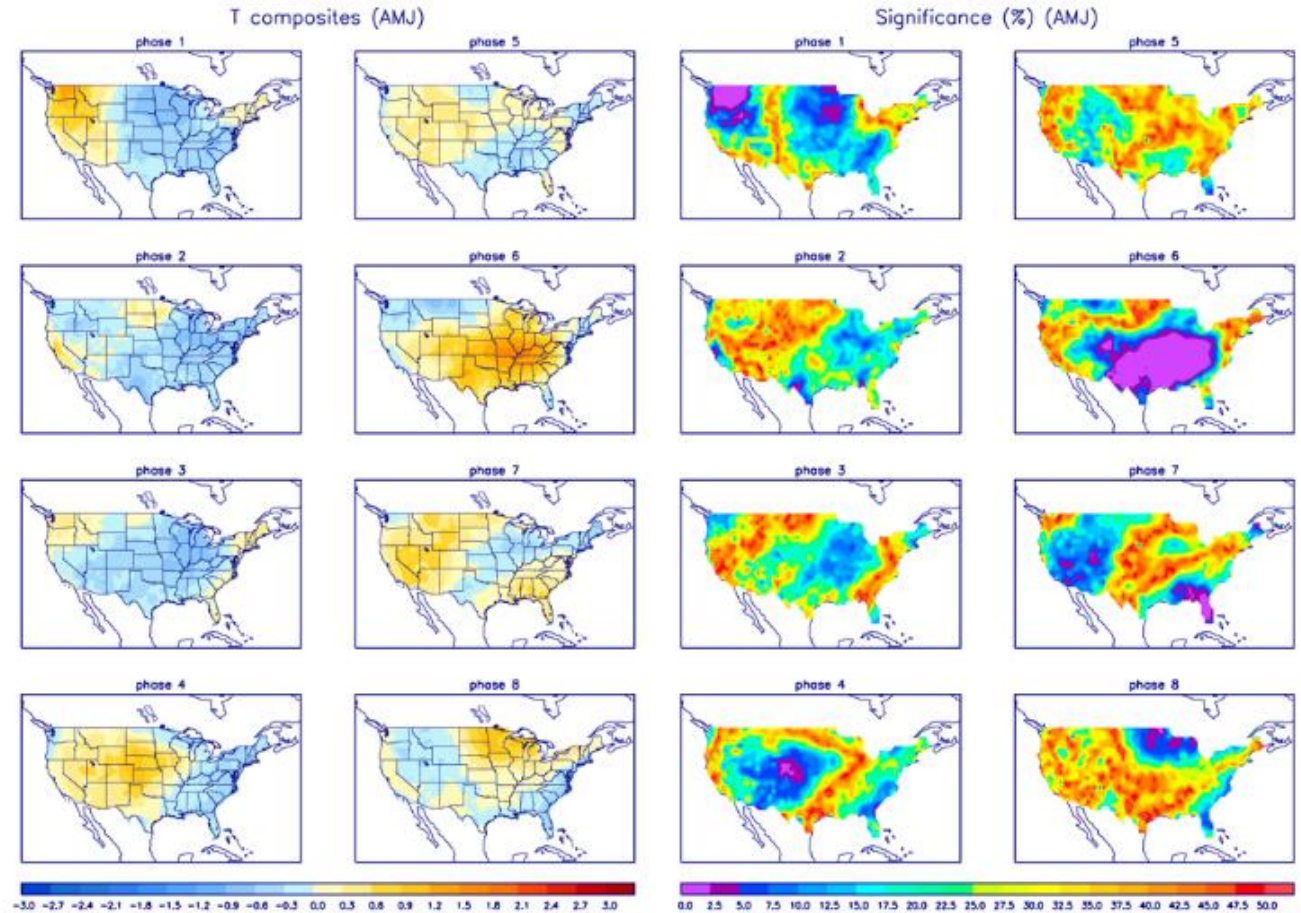
Precipitation Anomalies



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 - Temperature

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.

