

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
15 May 2023

Overview

- The MJO remains active where the enhanced phase propagated eastward from the Maritime Continent into the western Pacific during the past week.
- Following a ongoing period of destructively interfering Kelvin and Rossby wave activity, RMM forecasts generally show the MJO regaining amplitude over the western Pacific, albeit at a much slower phase speed compared to its observed evolution during the past several weeks.
 - The predicted slowing is notable as its suggestive of convective and circulation features becoming more stationary over the Pacific.
- There are increased chances for tropical cyclone (TC) development over the western Pacific, with this potential gradually increasing over the eastern Pacific later into June. Conversely, the large-scale environment is expected to be unfavorable for TC formation in the Indian Ocean.

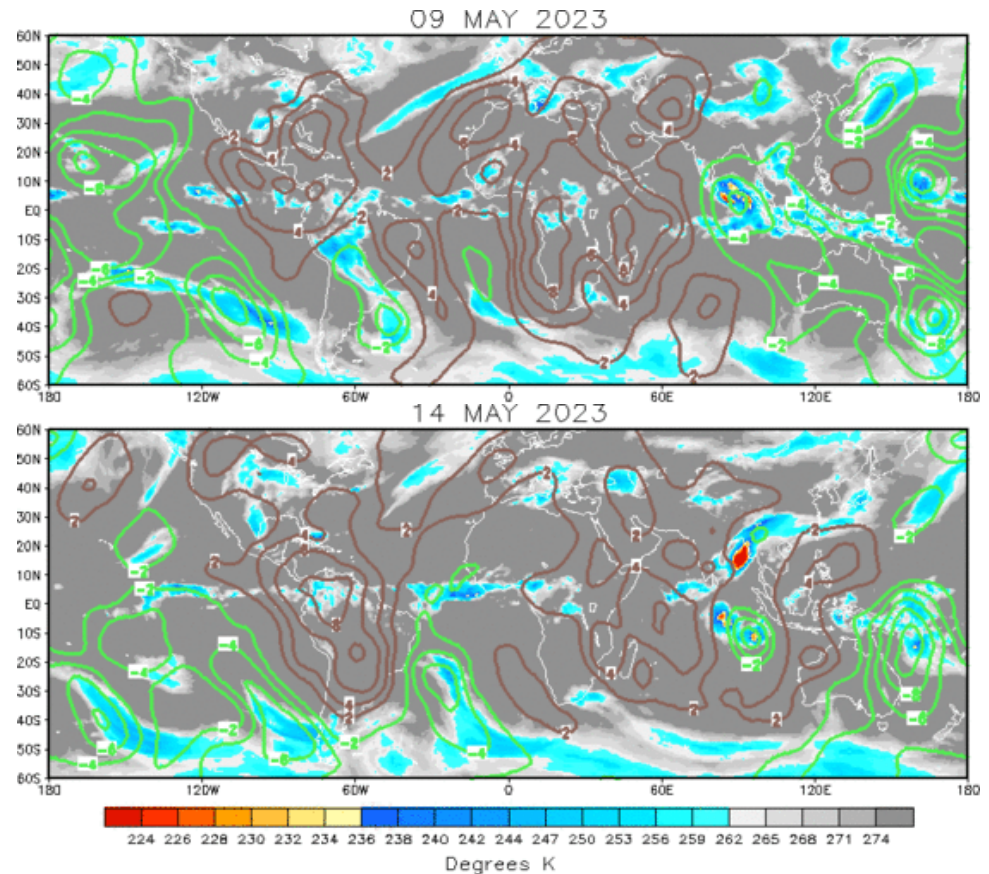
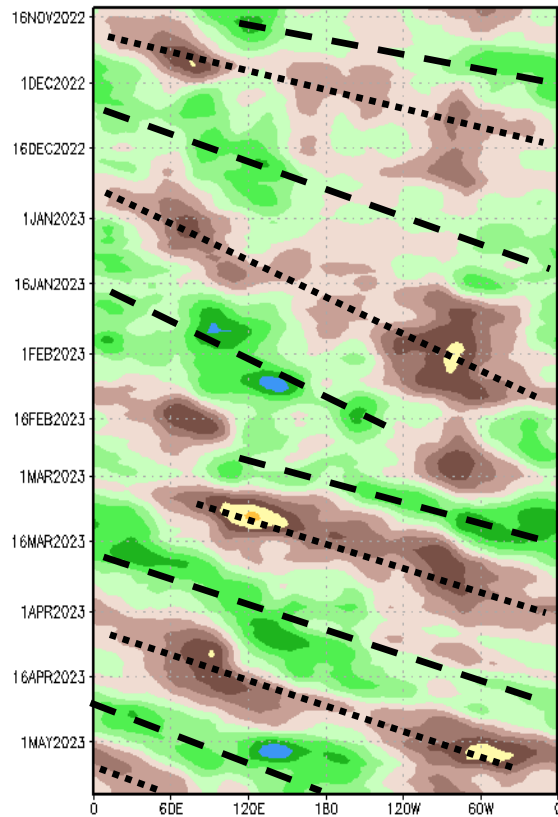
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

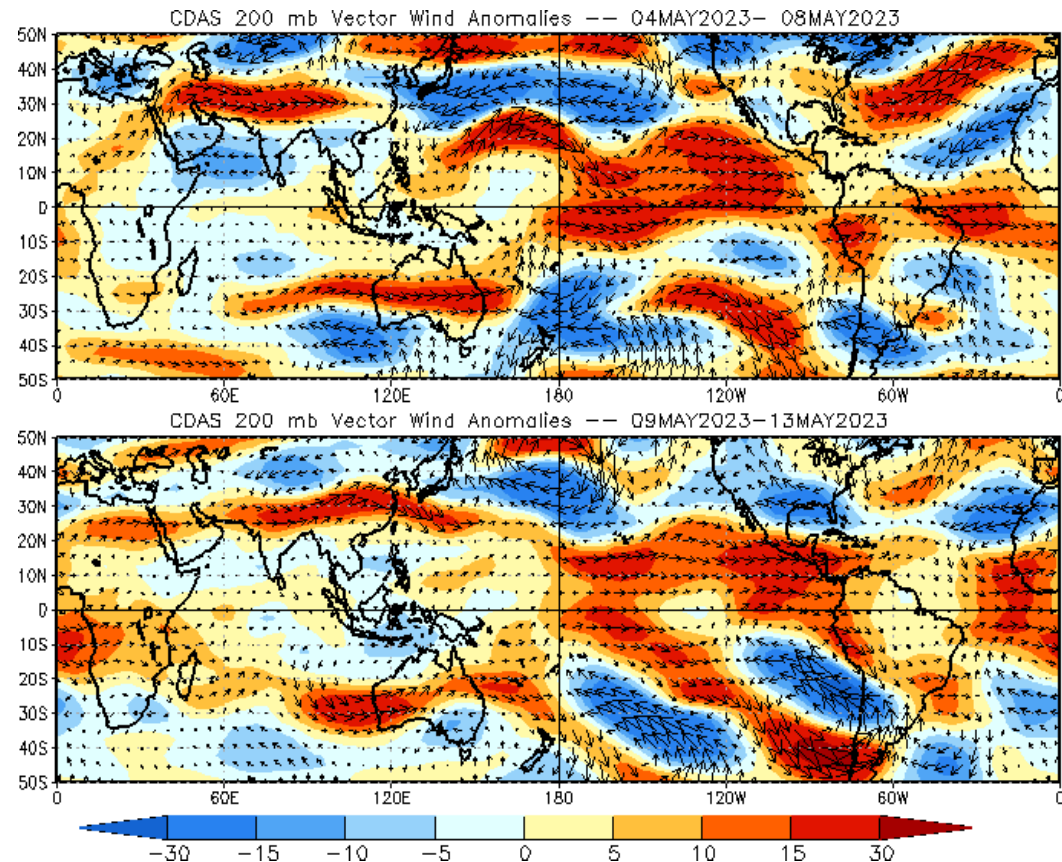
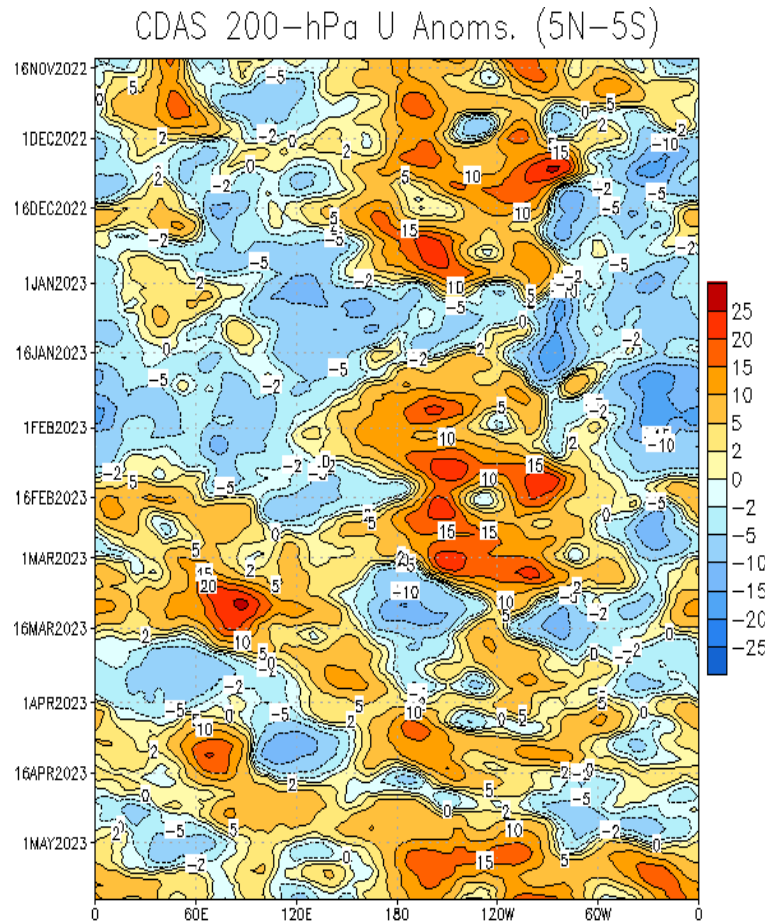
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- Upper-level velocity potential anomaly fields indicate continued MJO activity into mid-May, with the suppressed envelope of the MJO crossing the Prime Meridian and into the western Indian Ocean.
- Kelvin wave activity appears to be destructively interfering with the MJO over tropical Atlantic recently.

200-hPa Wind Anomalies

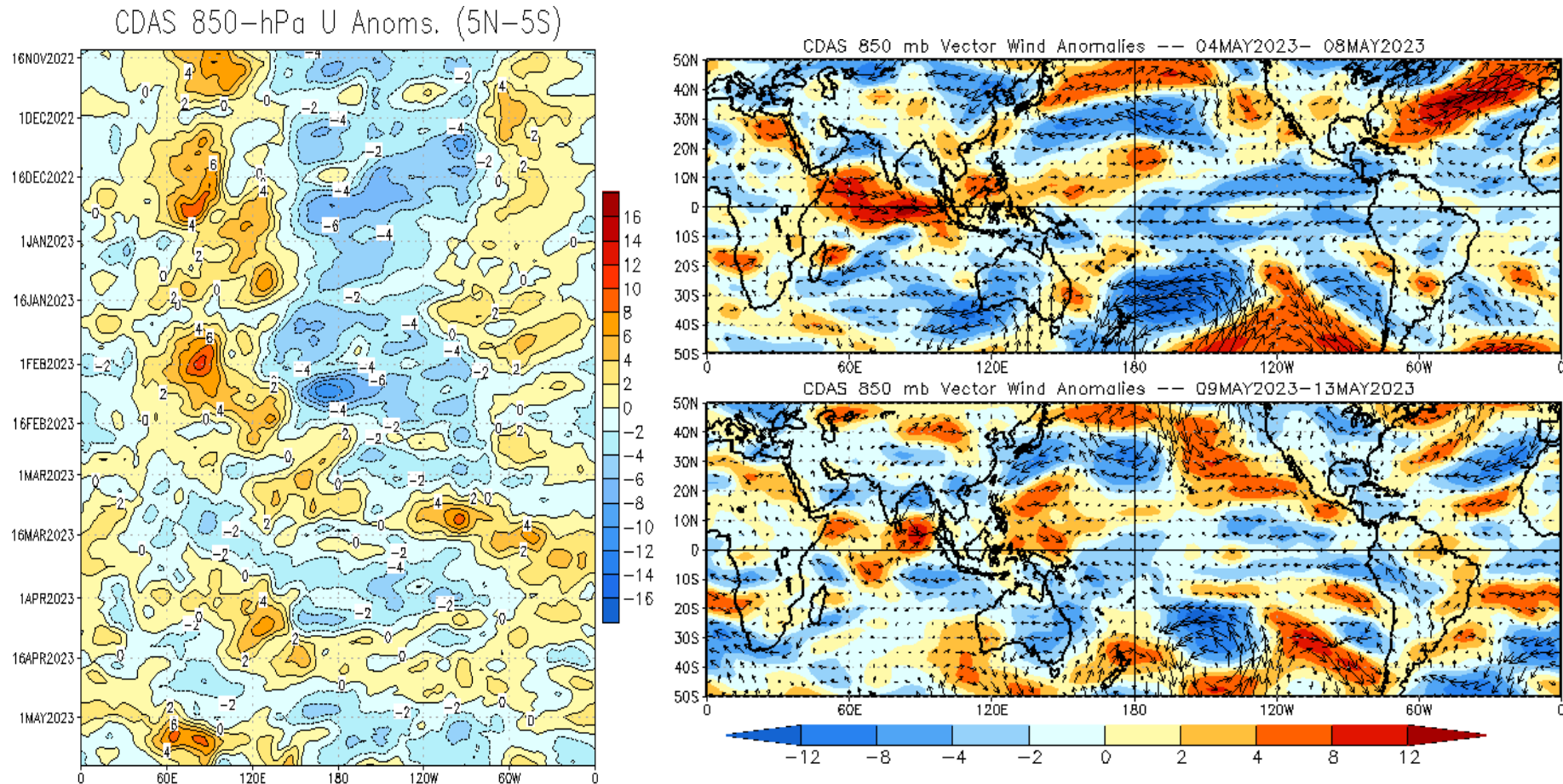
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous upper-level westerlies continue to overspread Africa, and extend into the Indian Ocean
- Anomalous easterlies aloft shifted eastward into the Maritime Continent during May, but are weaker compared to its previous cycle in April.
- A pair of anomalous cyclonic circulations aloft in the southern Hemisphere have aided in the persistence of anomalous westerlies along the equator and east of the Date Line.

850-hPa Wind Anomalies

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

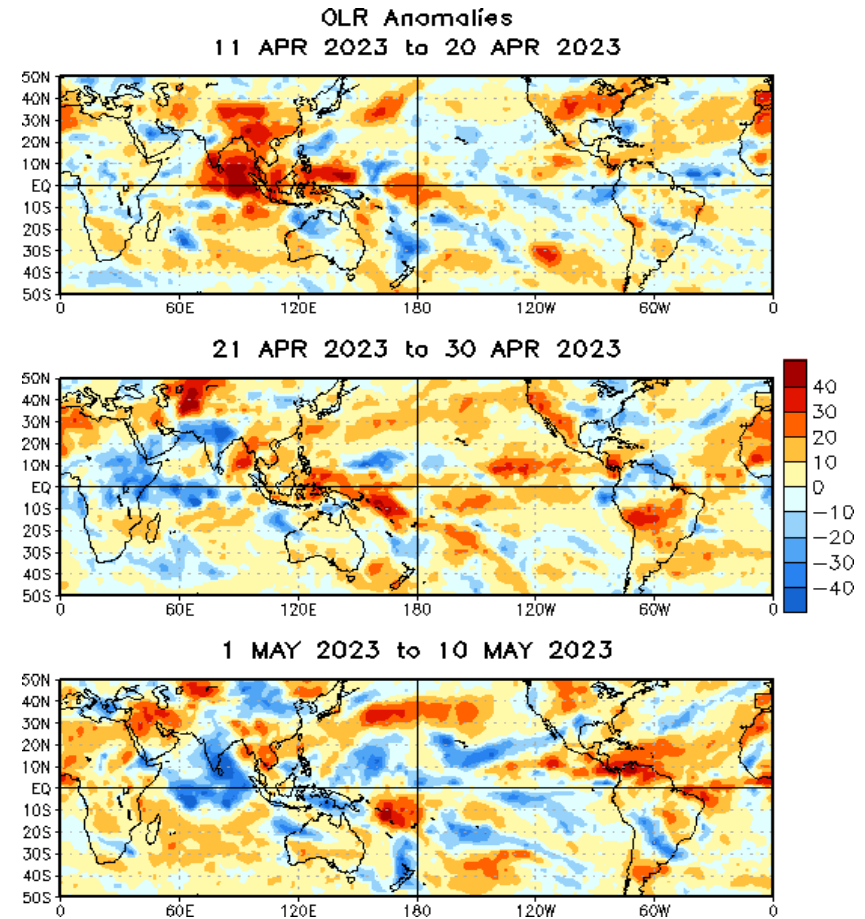
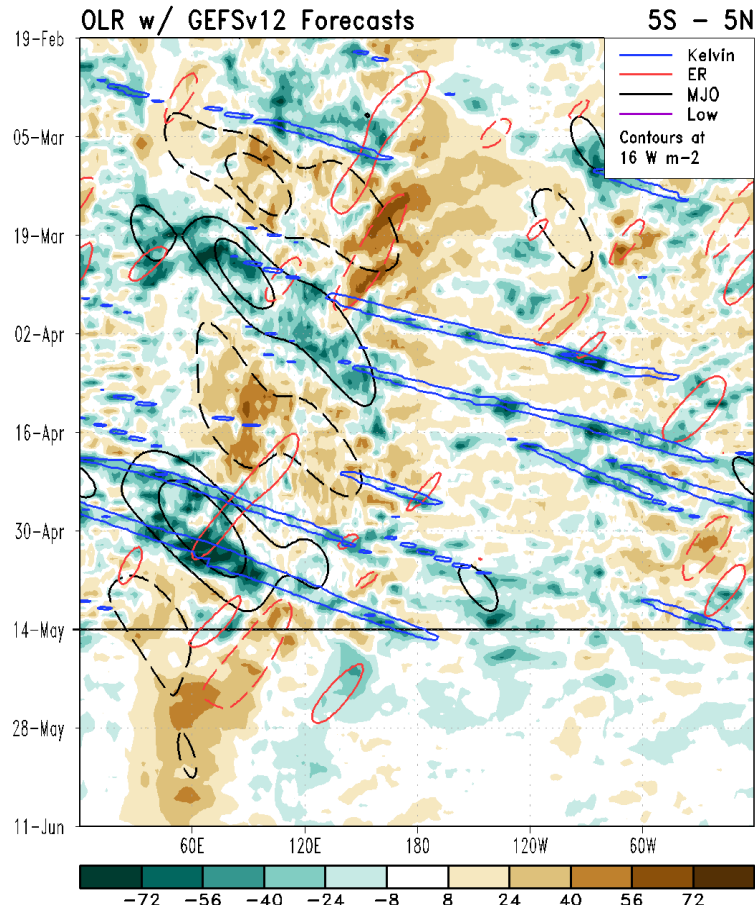


- A broken band of anomalous lower-level westerlies is featured from the Indian Ocean to the Maritime Continent, where the strongest anomalies resulted in an environment conducive for tropical cyclone activity.
- The low-level easterly phase of the MJO appears less coherent than its counterpart, with pockets of anomalous westerlies observed along the equator in the western Hemisphere.
- Though not shown, a strong uptick in anomalous westerlies is favored in the model guidance over the western Pacific, implicating the potential strength of El Niño favored later this year.

Outgoing Longwave Radiation (OLR) Anomalies

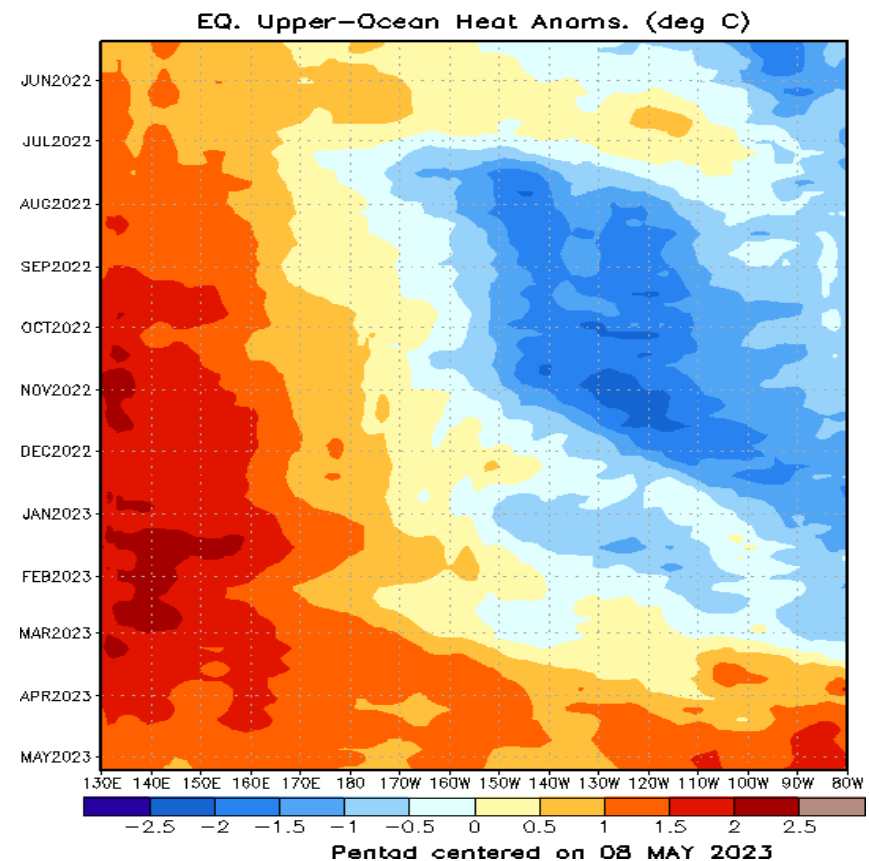
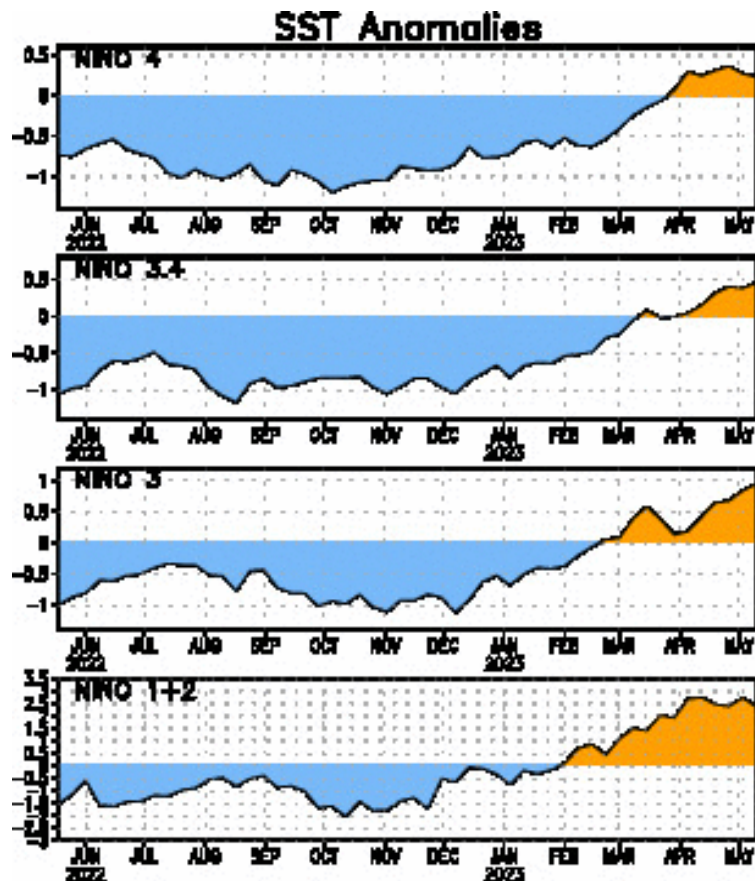
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- A broad area of enhanced (suppressed) convection shifted eastward into the Maritime Continent (Americas) during early May.
- More suppressed convection is favored to overspread Africa and the Indian Ocean during the forecast period.
- Wave filtering of OLR fields reveals increased Kelvin and Rossby wave activity interfering with the MJO

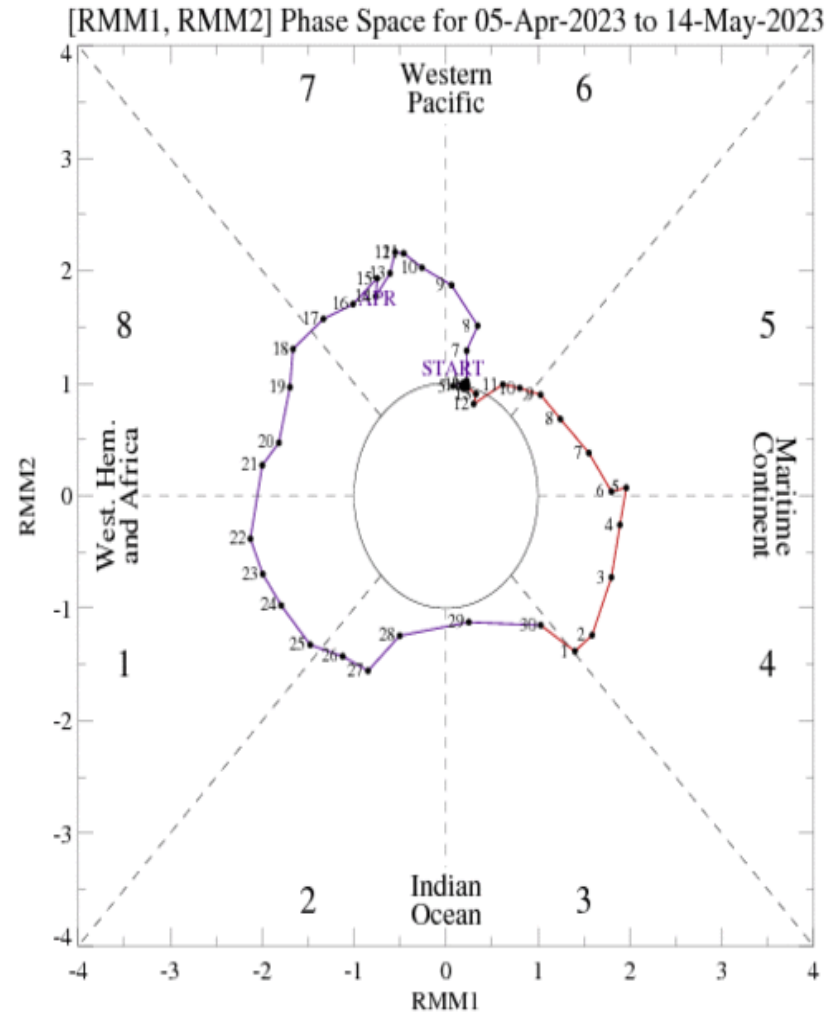
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Increasingly positive subsurface temperature anomalies engulf the entire Pacific, driven by multiple MJO events and subsequent oceanic downwelling Kelvin Waves beginning in March.
- SSTs in all of the Niño basins are now above normal, where the warmest anomalies remain over the eastern Pacific.

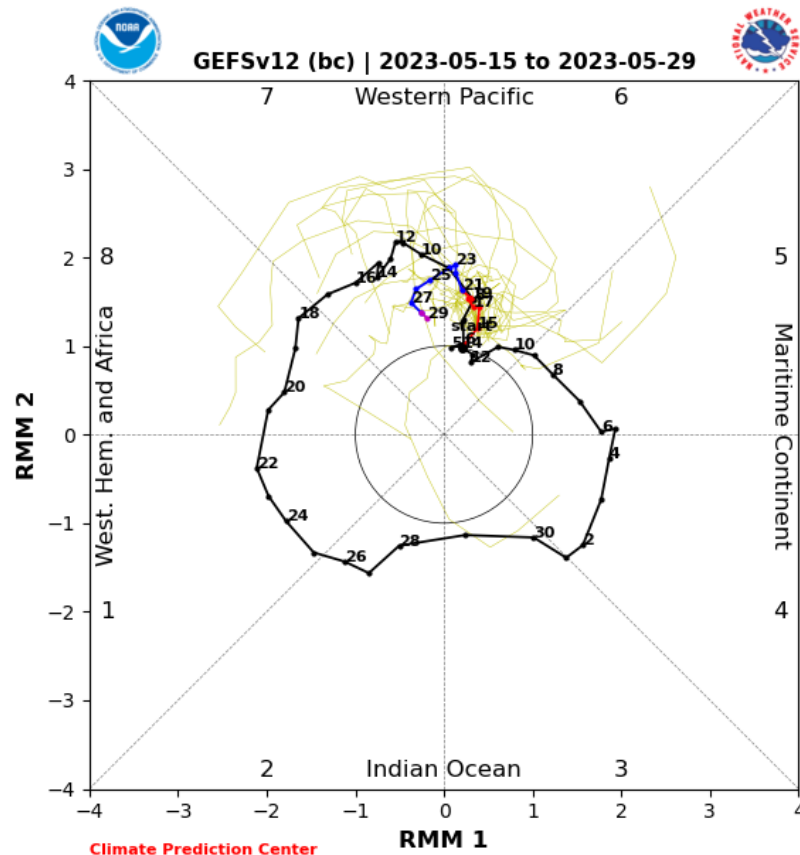
MJO Index: Recent Evolution

- The RMM index indicates the MJO signal has completed another global circumnavigation, where it recently decreased in amplitude over the western Pacific.

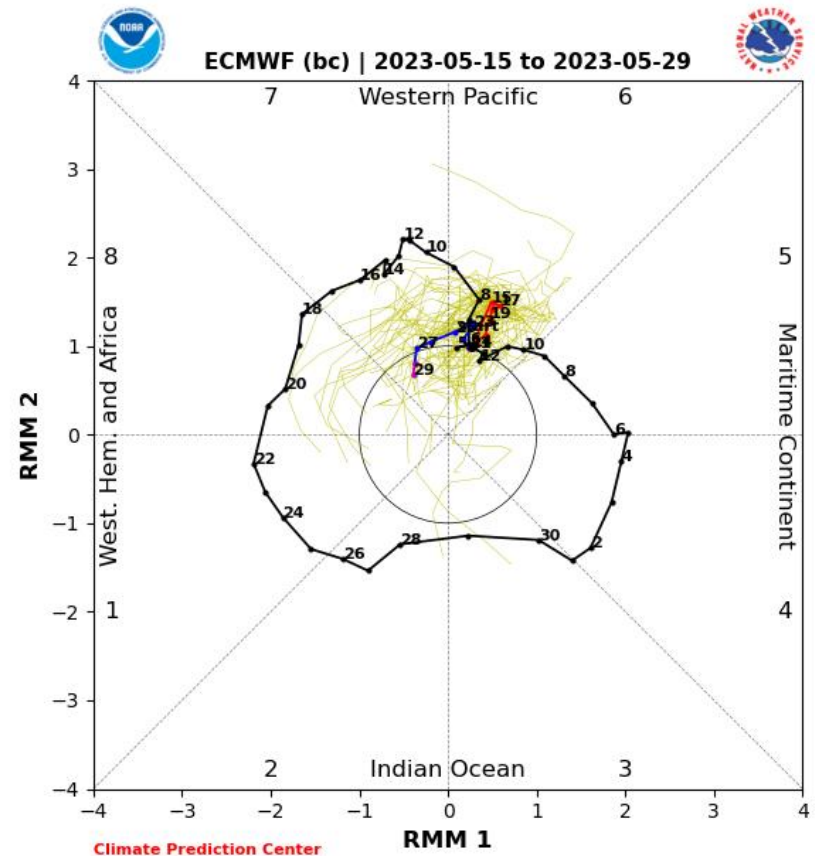


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



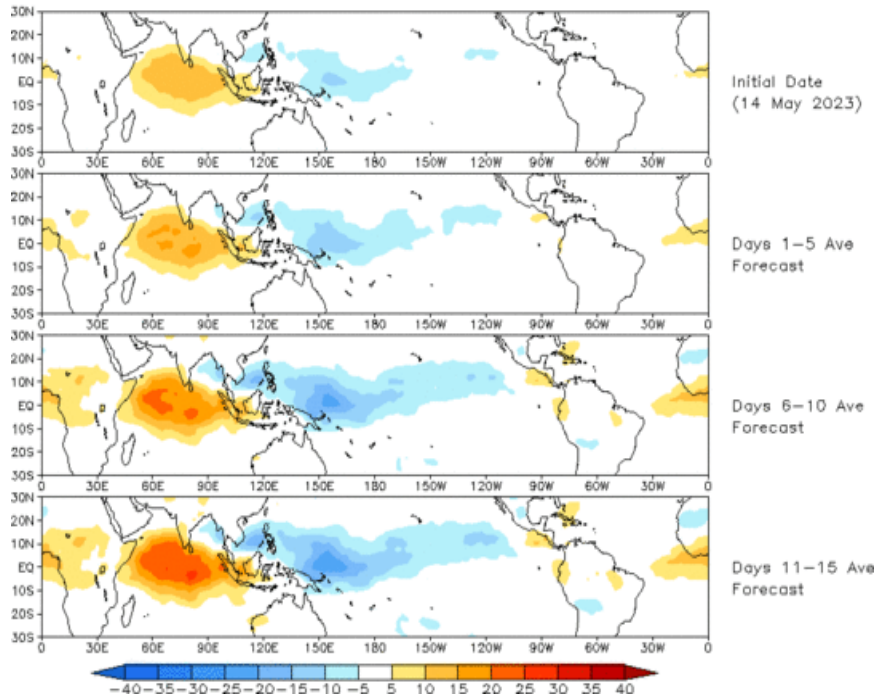
ECMWF Forecast

- Both the GEFS and ECMWF ensembles favor the MJO to regain its amplitude during week-1, and propagate slowly across the western Pacific through late May.
- Relative to the MJO's phase speed during the past several weeks, the forecast slowing is noteworthy and is suggestive of convective and circulation anomaly features becoming more stationary over the equatorial Pacific.

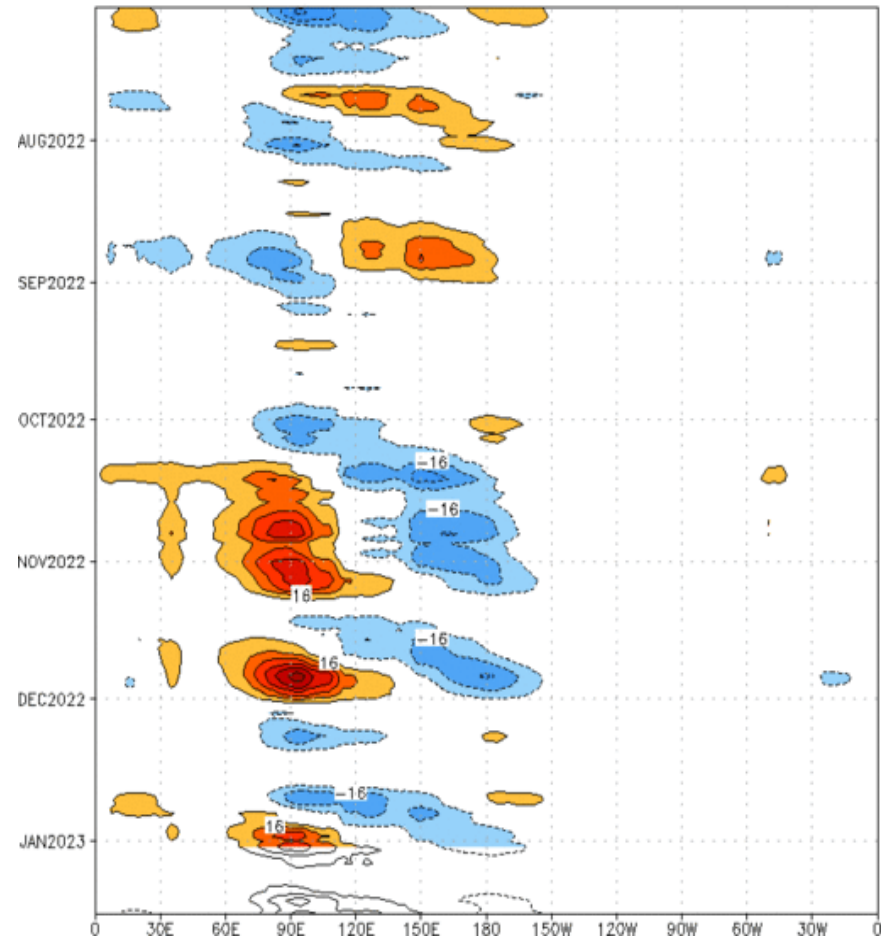
MJO: GEFS Forecast Evolution

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: 14 May 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: 03-Jul-2022 to 02-Jan-2023
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

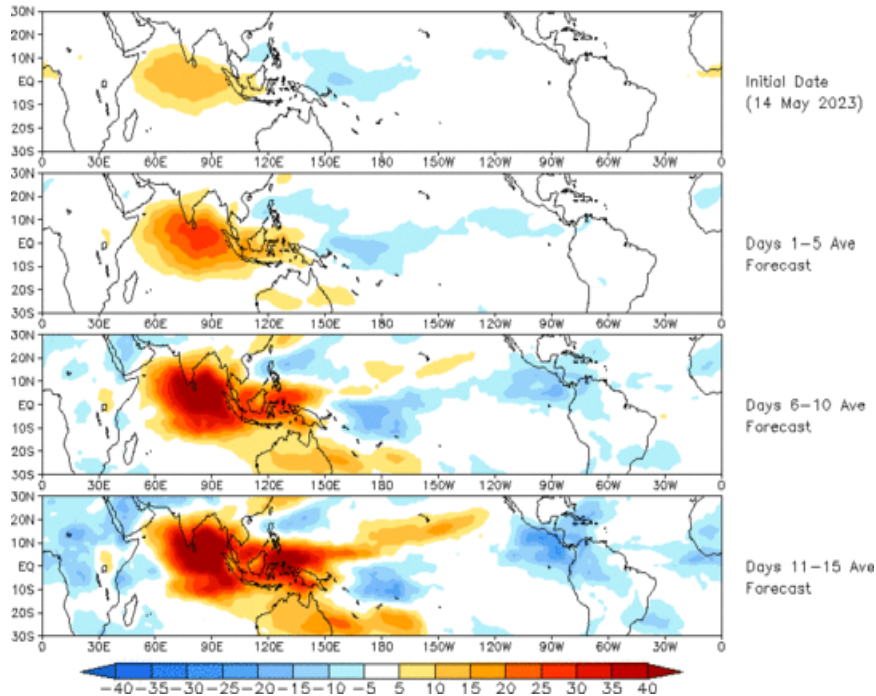


- The GEFS RMM-based forecast depicts a nearly stationary OLR anomaly pattern, that increases in magnitude during the next two weeks.

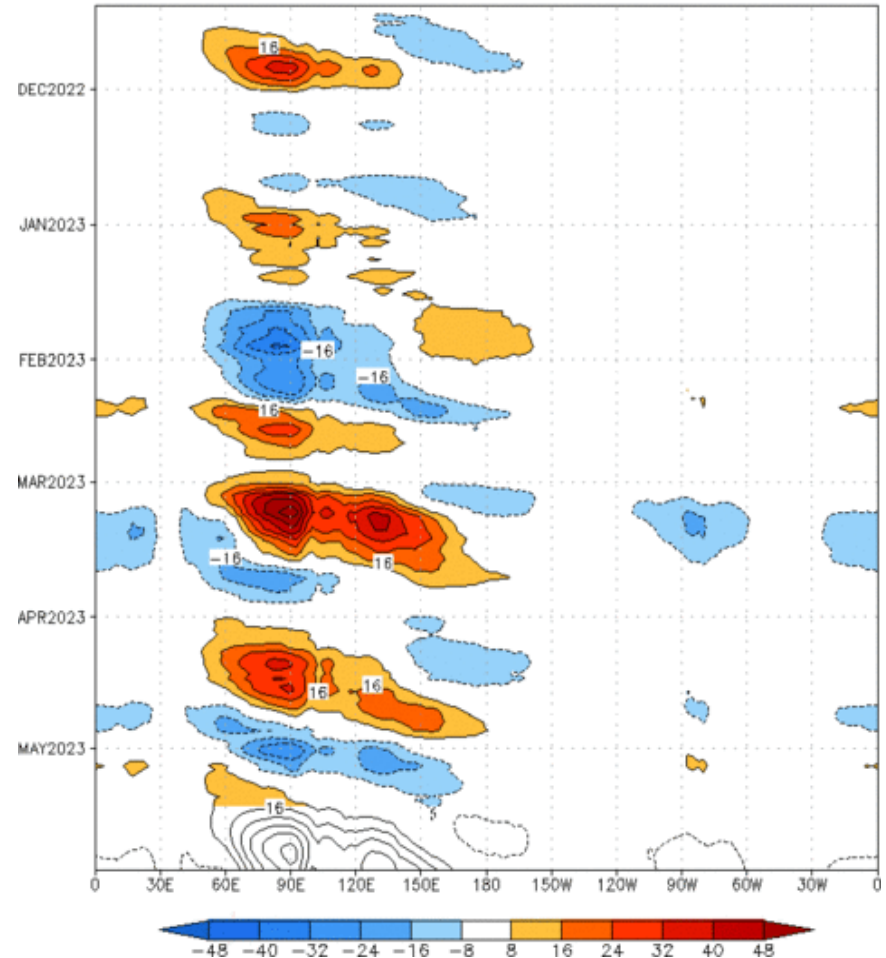
MJO: Constructed Analog Forecast Evolution

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.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (14 May 2023)



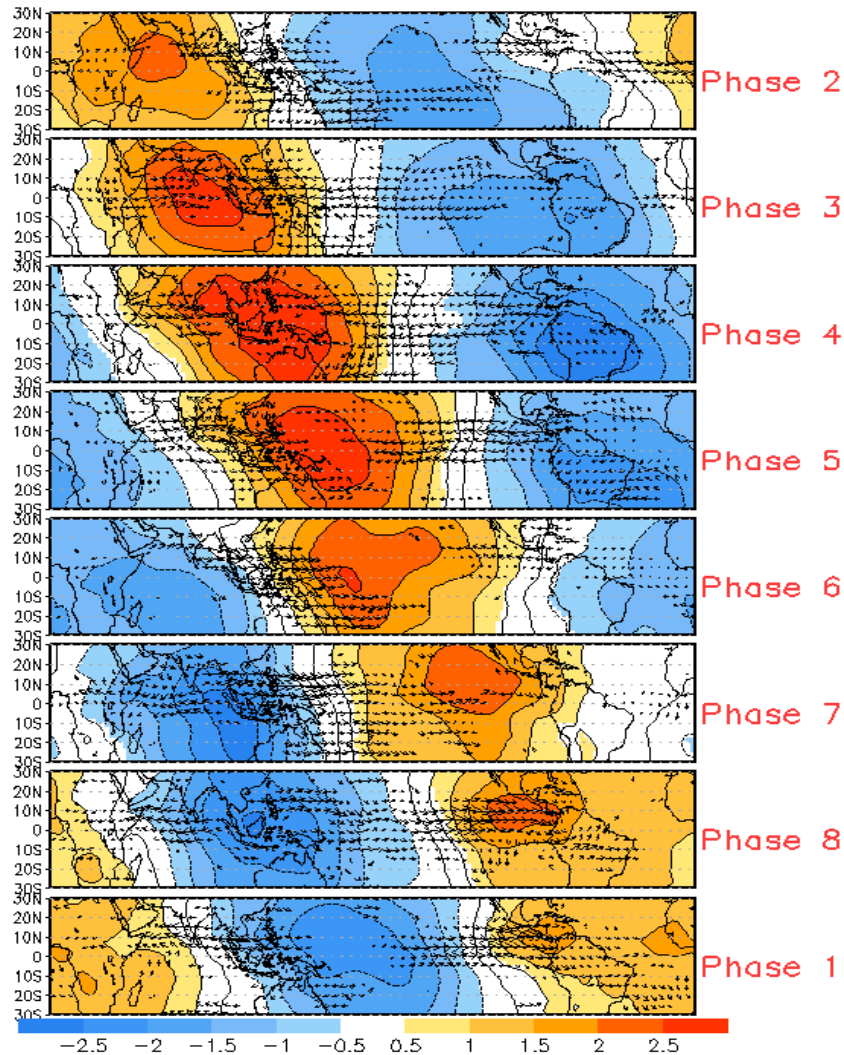
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:12–Nov–2022 to 14–May–2023
The unfilled contours are CA forecast reconstructed anomaly for 15 days



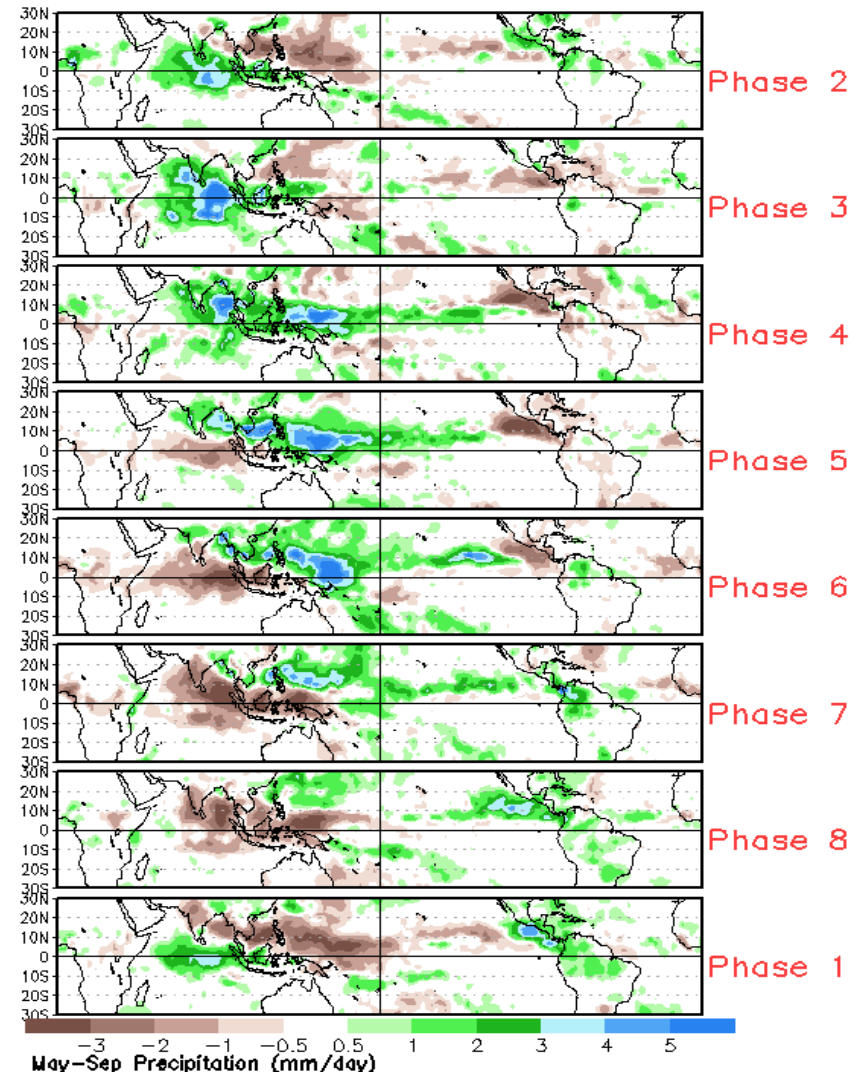
- The constructed analog RMM-based forecast more progressive than the GEFS, while favoring a stronger MJO signal.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



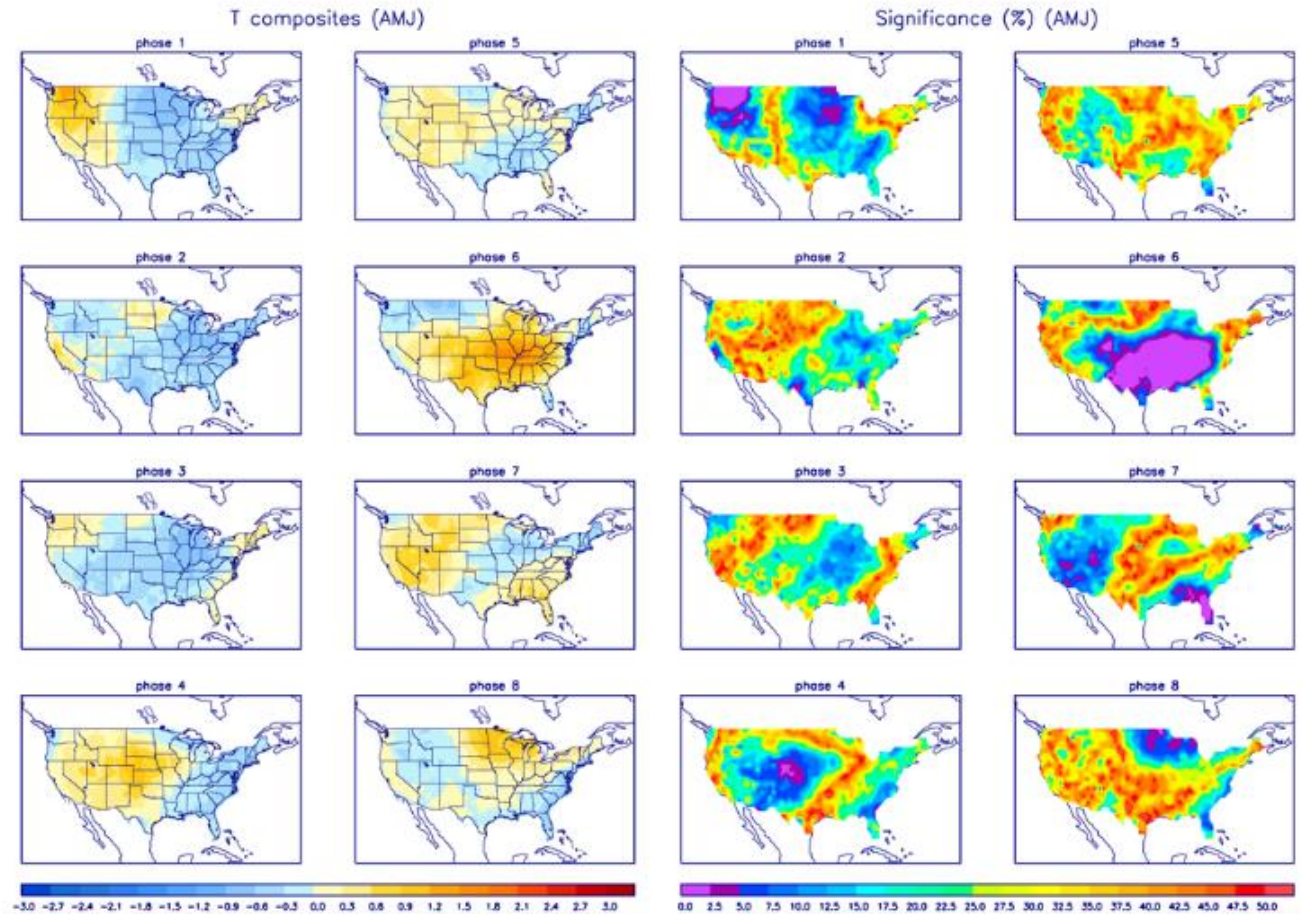
Precipitation Anomalies



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.

