

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



**Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
5 August 2024**

Overview

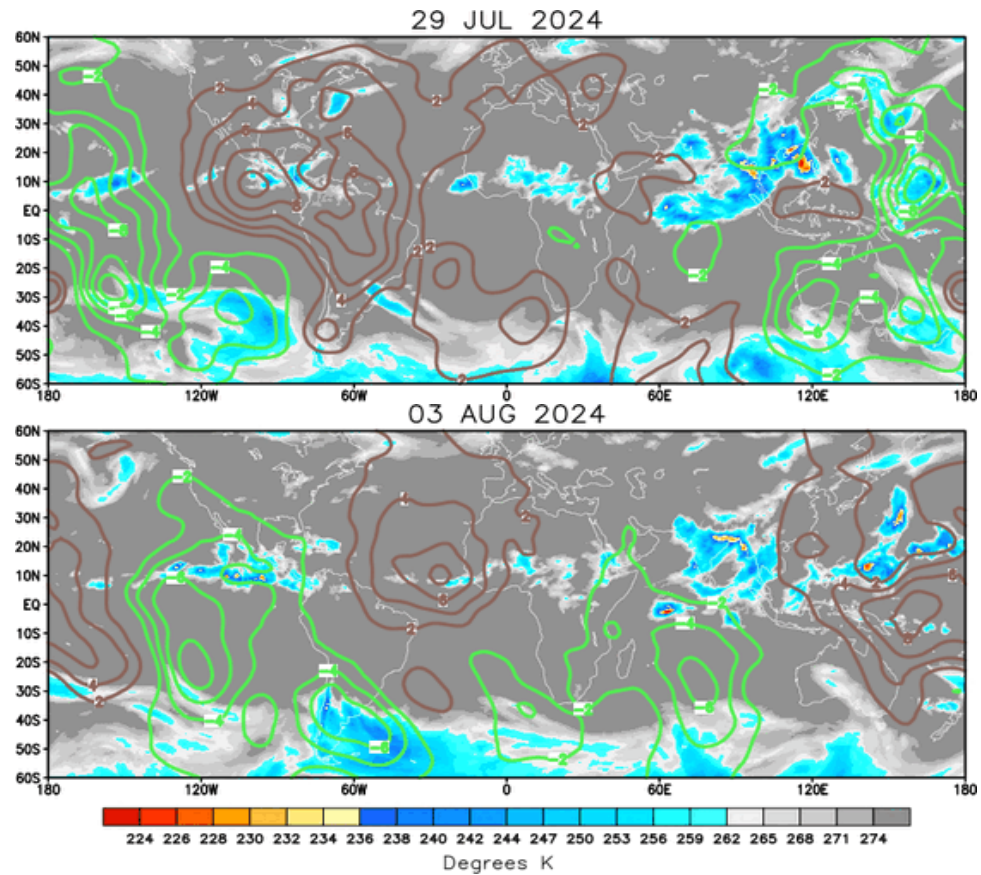
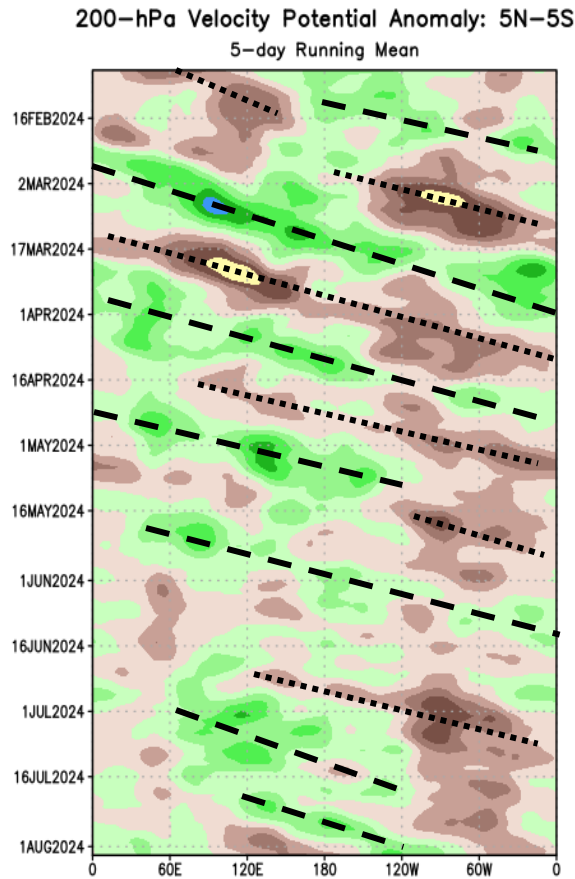
- The RMM-based MJO index showed a quick jump from a slightly enhanced signal over the Maritime Continent to enhancement over the East Pacific. This shift may be due in part to strong convectively coupled Kelvin wave activity that crossed the Pacific, as well as increased tropical cyclone activity over the East Pacific.
- MJO index forecasts are in good agreement depicting more canonical MJO activity crossing the Western Hemisphere during Week-1, and the Indian Ocean during Weeks 2-3. Constructive interference between the aforementioned Kelvin wave and a slower enhanced signal over the Indian Ocean may be contributors to the development of this subseasonal signal.
- Based on these outlooks, the MJO is favored to play a role in the evolution of the global tropical convective pattern during the next several weeks.
- MJO activity entering the Indian Ocean favors increased tropical cyclone activity over the Atlantic basin, with activity becoming more suppressed over the West Pacific and East Pacific.

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)

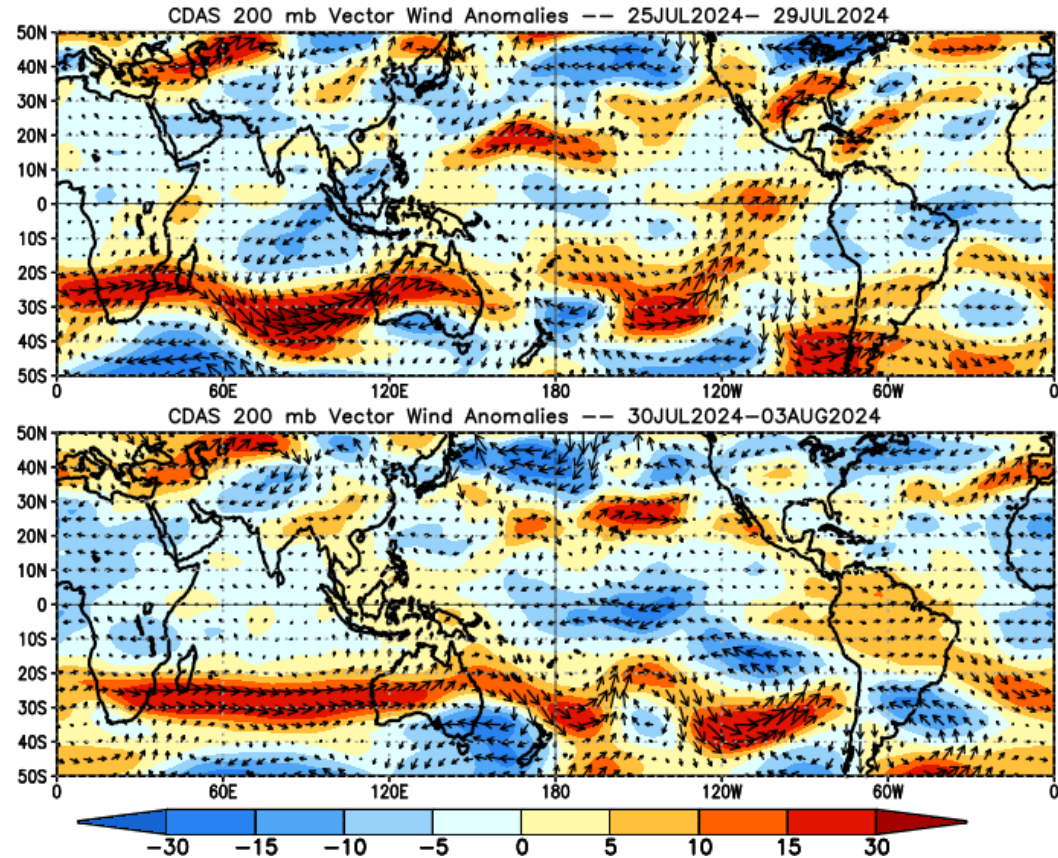
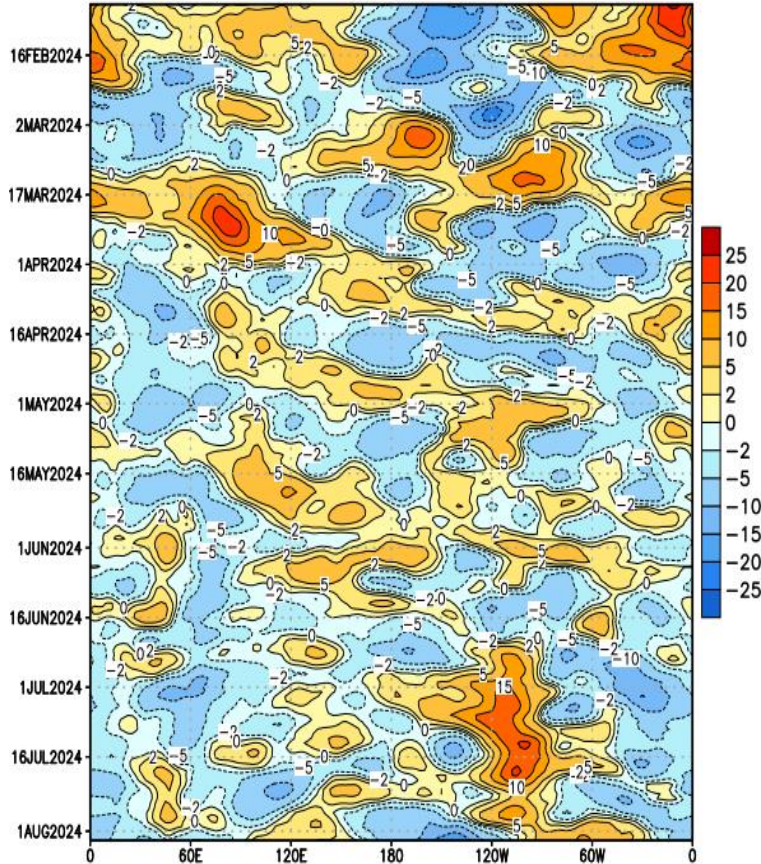


- Recently, a Wave-2 pattern with fast eastward propagation emerged, suggestive of Kelvin wave activity.
- Increased divergence aloft helped create a favorable environment for East Pacific tropical cyclone development and weakened shear over the western Atlantic basin, aiding in the formation of Hurricane Debby.
- A second area of enhancement has begun to build across the Indian Ocean basin.

200-hPa Wind Anomalies

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

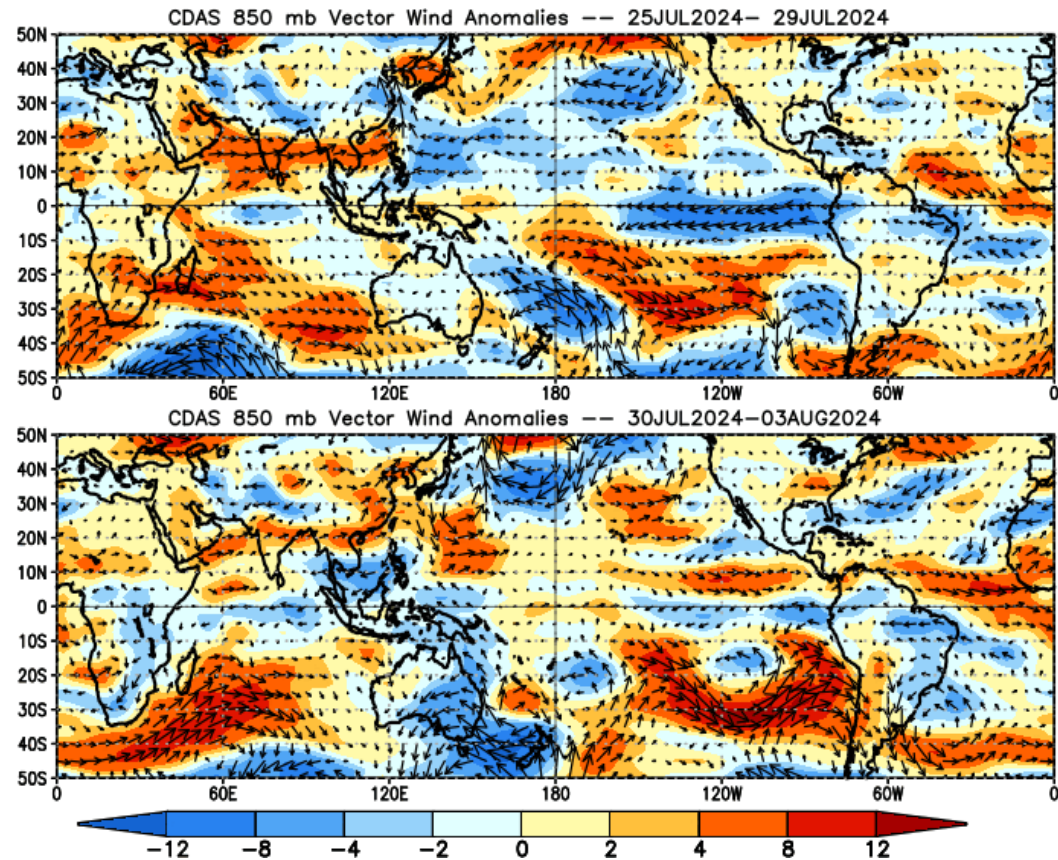
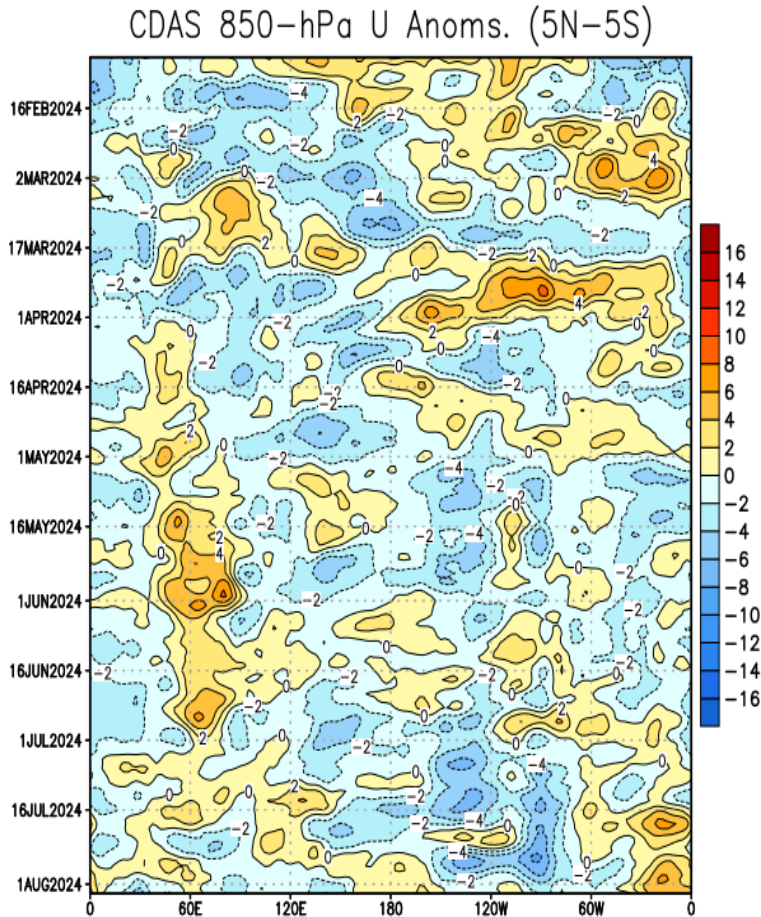
CDAS 200-hPa U Anoms. (5N-5S)



- Easterly anomalies strengthened across the east-central Pacific, helping to reduce shear across the East Pacific and allowing for a period of increased tropical cyclone activity. This feature appears to be propagating eastward, and reversed the previously persistent westerlies near 120W.
- Easterly anomalies over Africa and a weaker pattern across the Maritime Continent have increased overall upper-level divergence across the Indian Ocean basin.

850-hPa Wind Anomalies

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

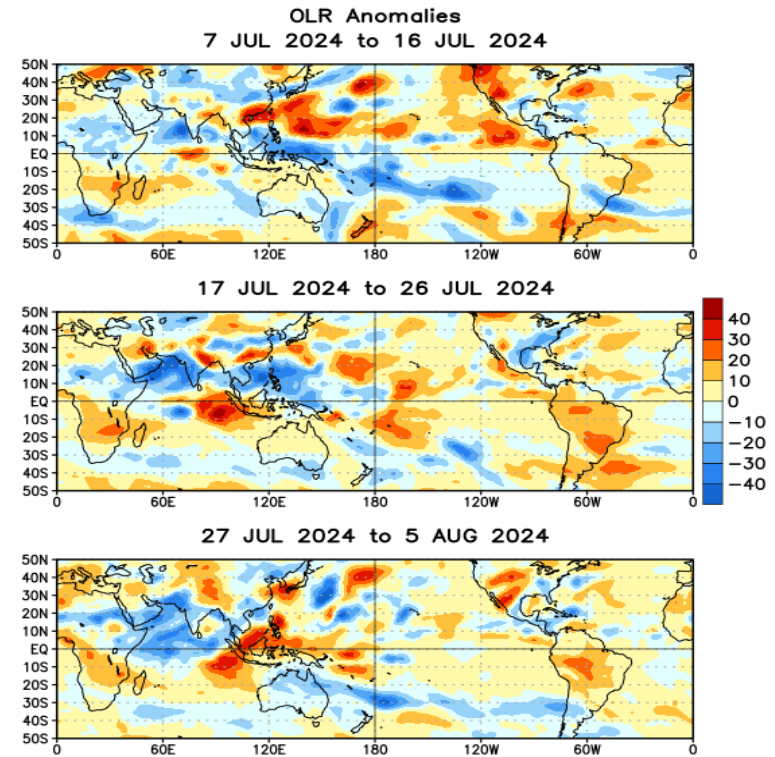
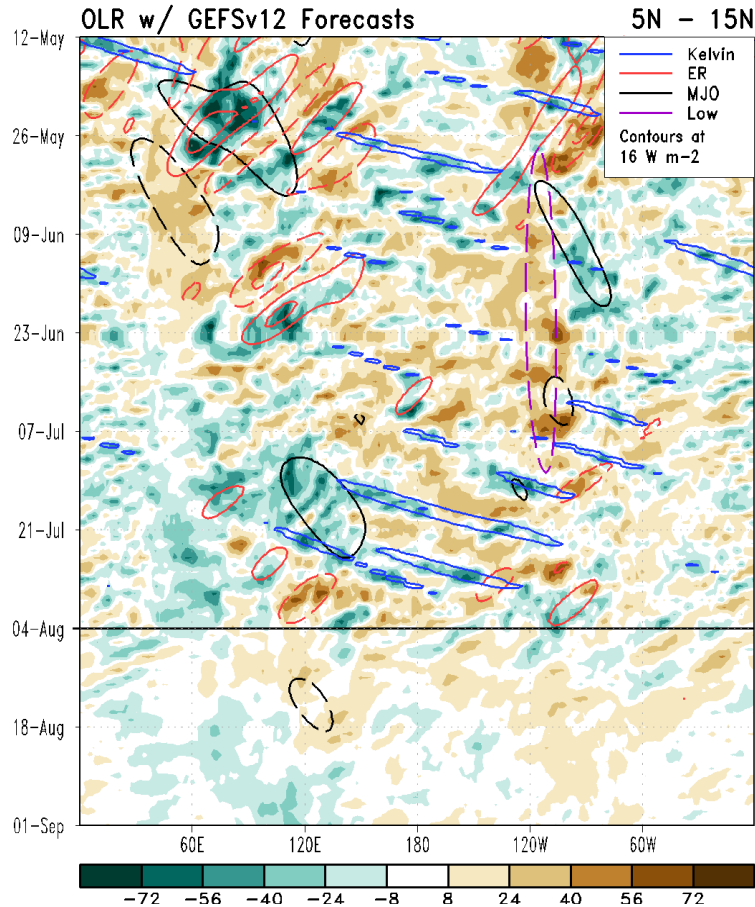


- Eastward propagation of westerly anomalies is evident across the Pacific basin since late June.
- A belt of westerly anomalies extends across the northeastern tropical Pacific, while a small area of easterly anomalies (enhanced trades) persists just along the Equator.
- Easterly anomalies increased across the Maritime Continent and equatorial Indian Ocean.

Outgoing Longwave Radiation (OLR) Anomalies

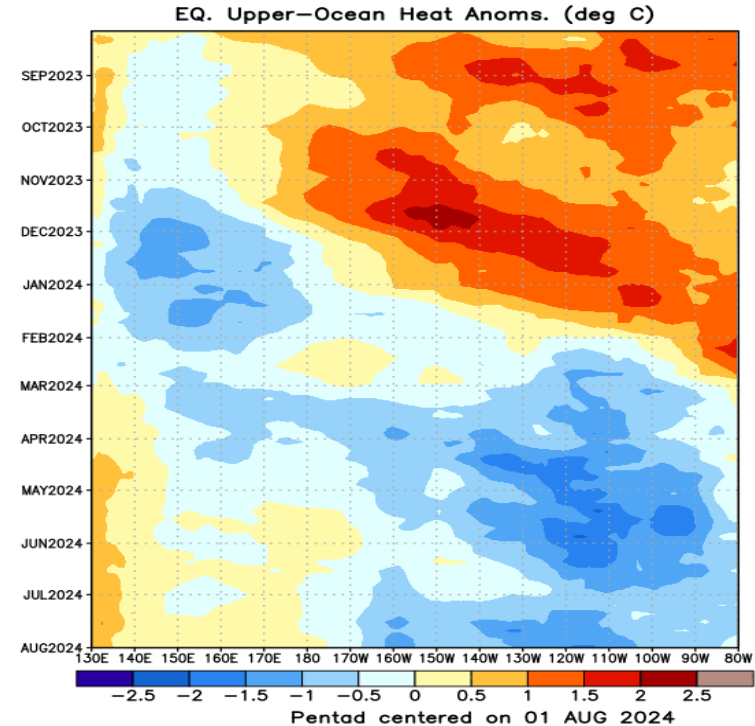
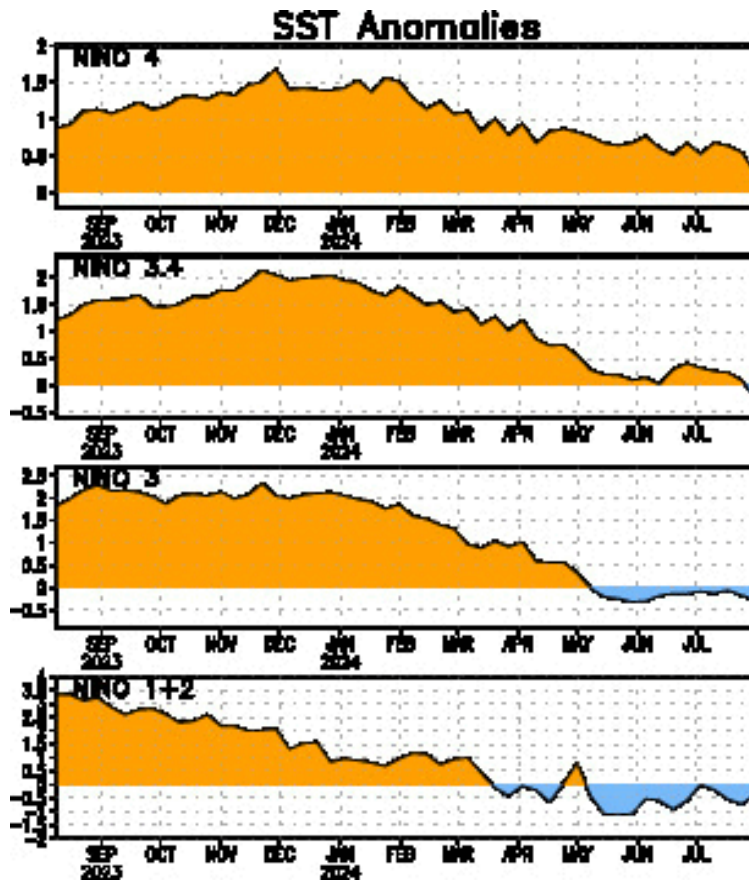
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- Enhanced convection developed across the equatorial Indian Ocean, while suppressed convection increased across the Maritime Continent.
- Kelvin wave activity is evident crossing the Pacific, and this activity superimposing onto the enhanced Indian Ocean signal appears to result in a more MJO-like evolution across the Indian Ocean and Maritime Continent during mid- to late August.

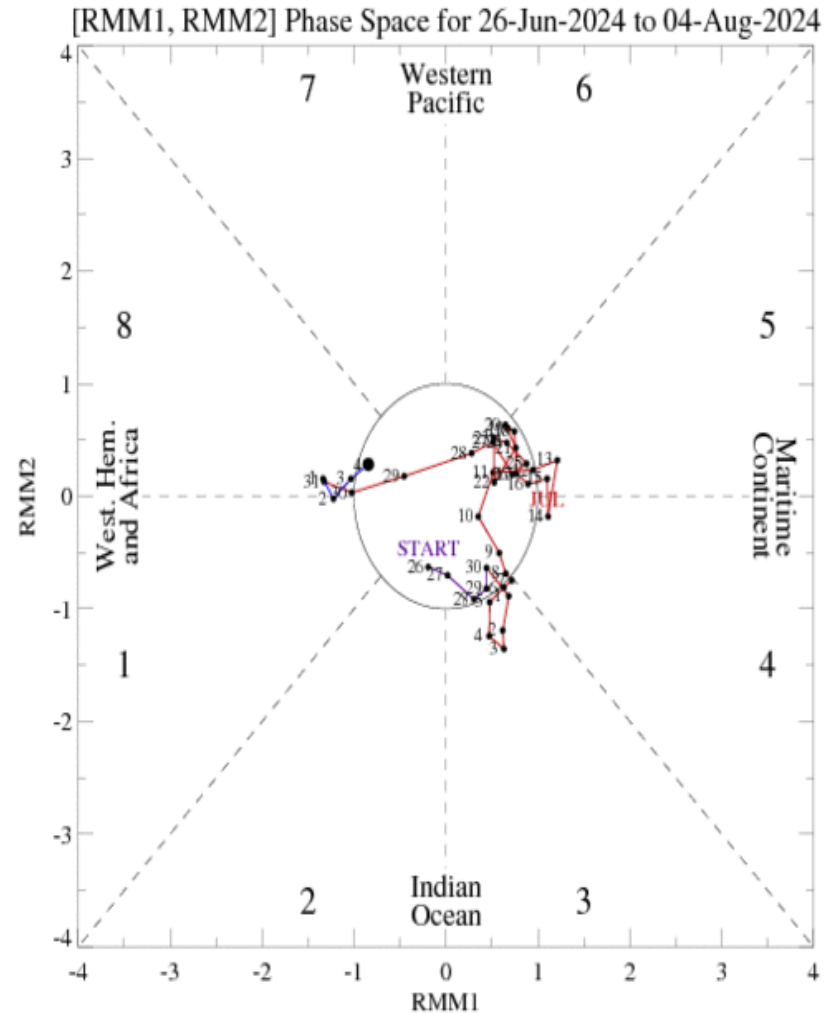
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- SST anomalies have become negative across the central Pacific Niño 3.4 region.
- Following an oceanic downwelling event, negative oceanic heat content anomalies have gradually strengthened over the eastern half of the Pacific since early July, with cooler subsurface temperatures west of the Date Line more recently.

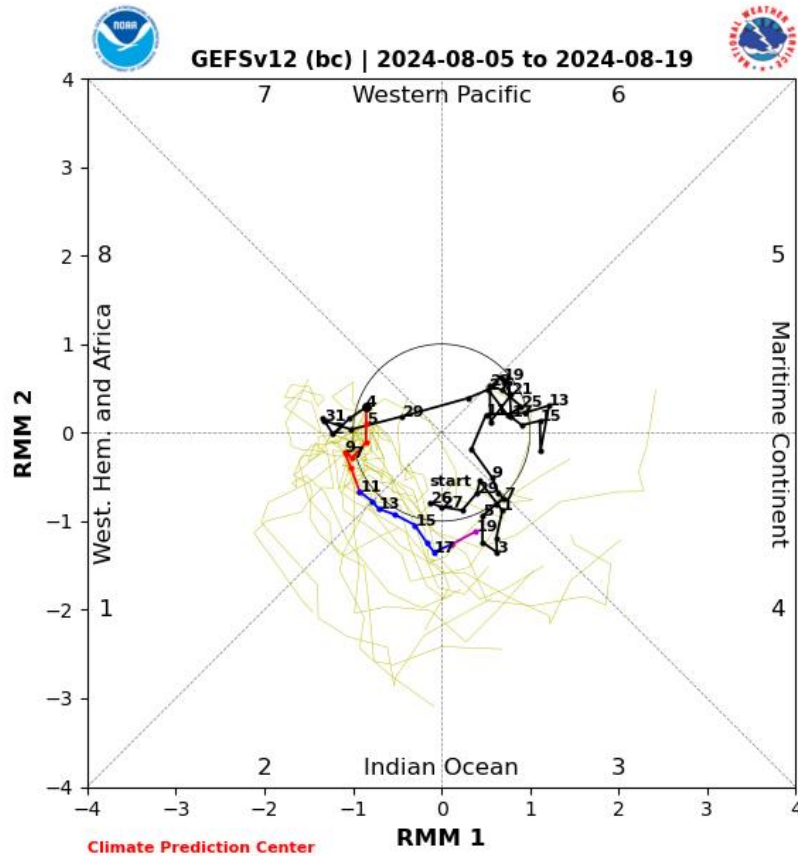
MJO Index: Recent Evolution

- Following a period of disorganized activity near the Maritime Continent, the RMM index quickly shifted to the East Pacific. This appears indicative of other tropical modes playing a role.

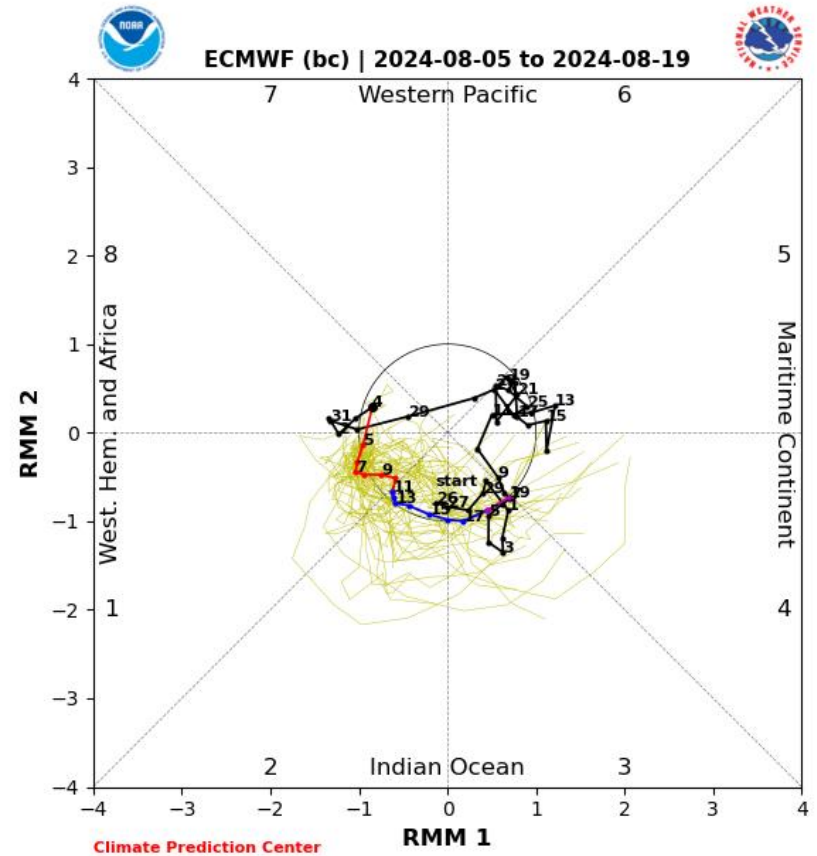


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



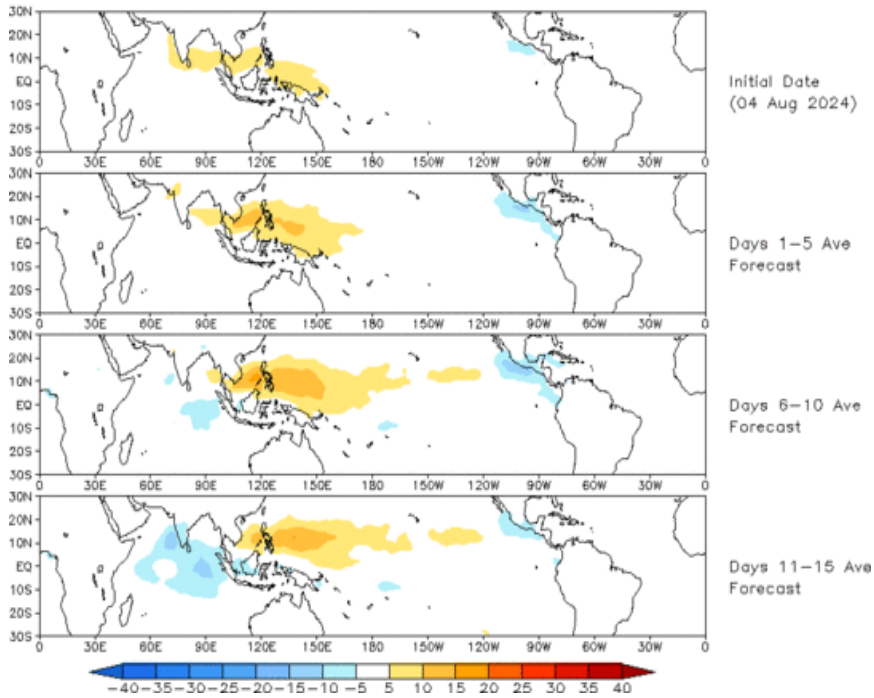
ECMWF Forecast

- Both the GEFS and ECMWF depict more canonical MJO activity crossing the Western Hemisphere during Week-1, and the Indian Ocean during Week-2.
- Model agreement is quite high, though there are differences among the ensemble members pertaining to the amplitude of the event.

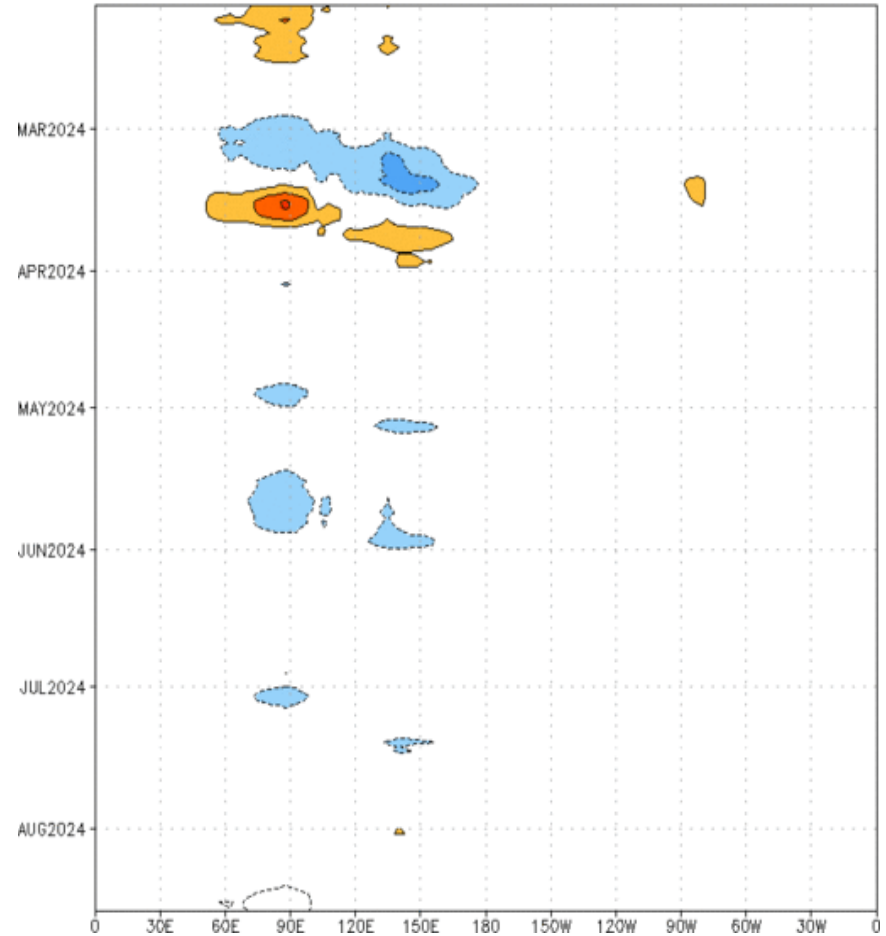
MJO: GEFS Forecast Evolution

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: 04 Aug 2024
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:03-Feb-2024 to 04-Aug-2024
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

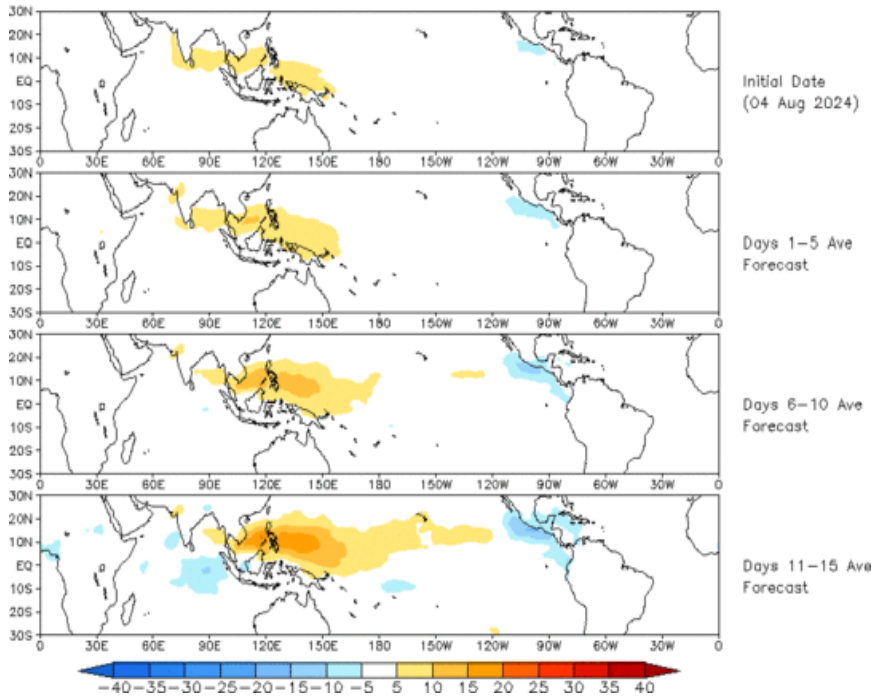


- The OLR anomaly evolution based on the GEFS RMM index shows a progressive evolution consistent with MJO activity shifting from the East Pacific and Western Hemisphere to the Indian Ocean by the end of Week-2.

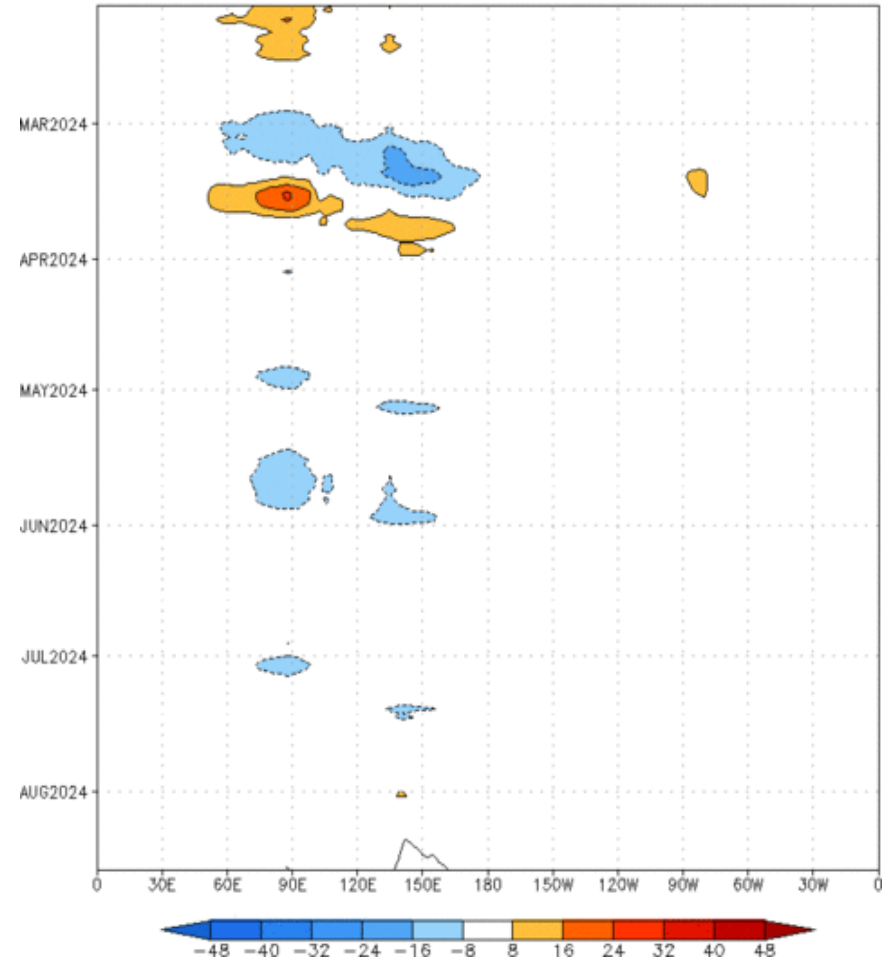
MJO: Constructed Analog Forecast Evolution

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 (04 Aug 2024)



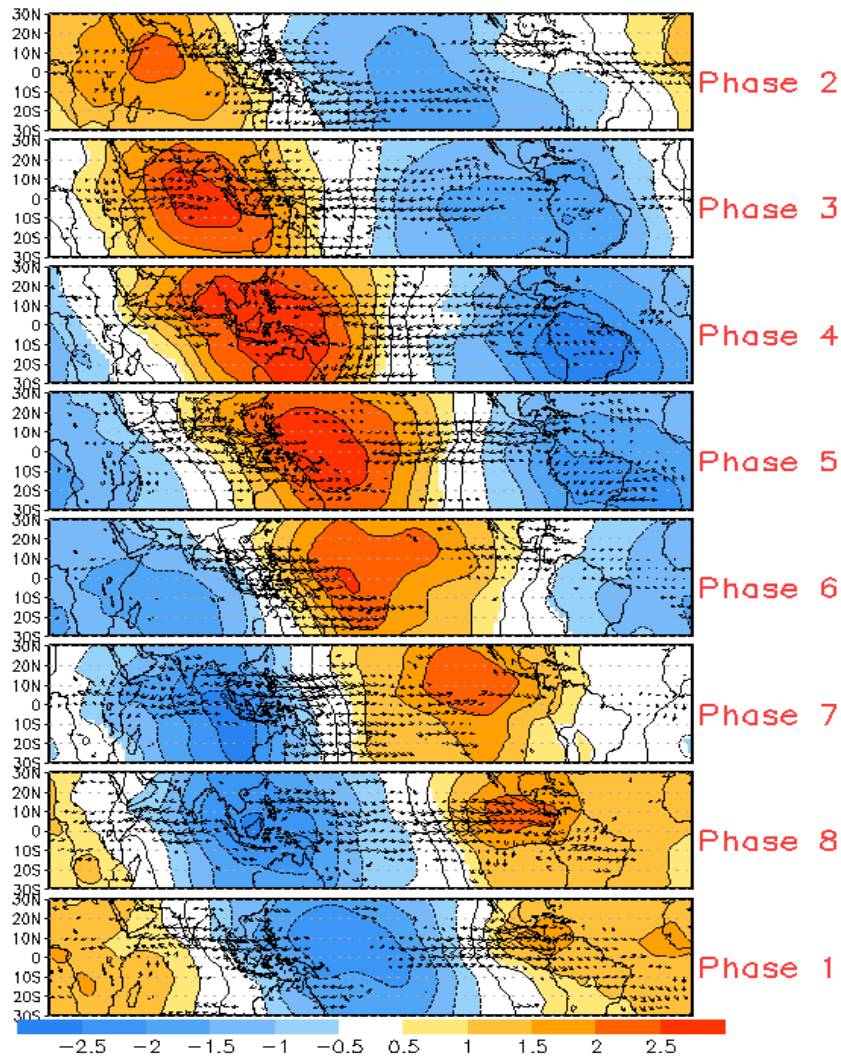
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:03-Feb-2024 to 04-Aug-2024
The unfilled contours are CA forecast reconstructed anomaly for 15 days



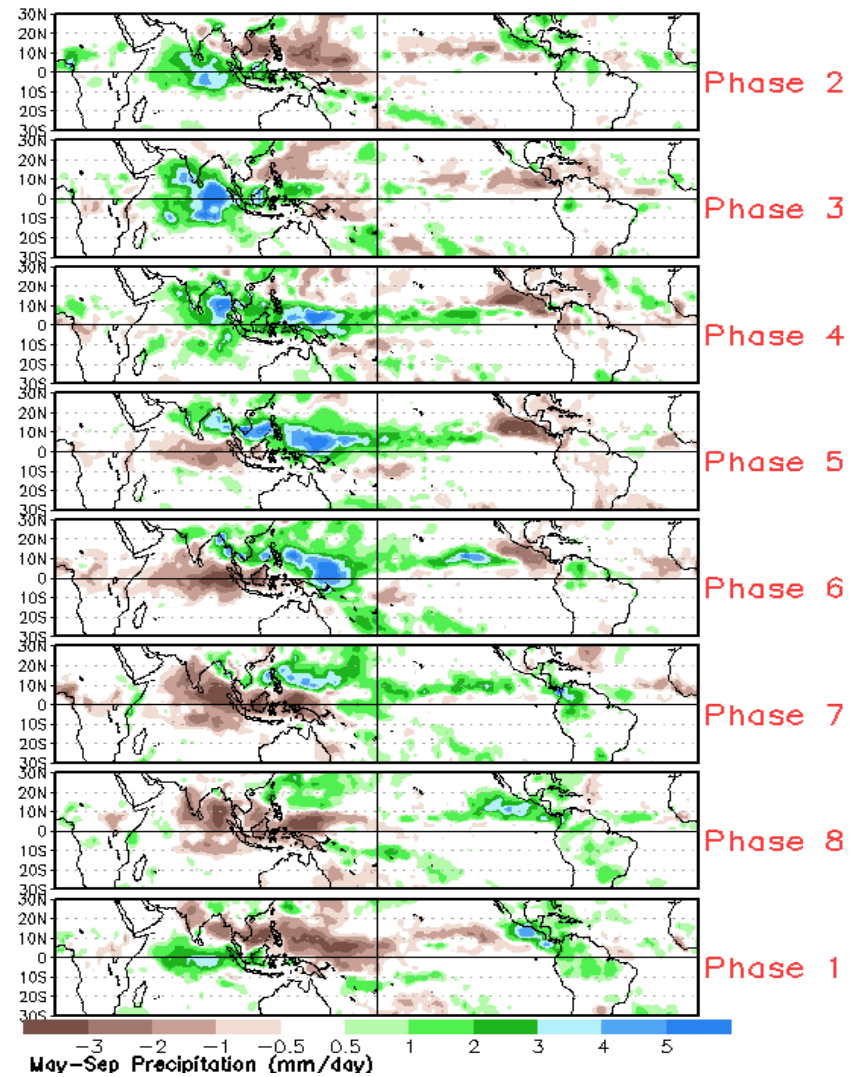
- The constructed analog is similar to the GEFS, with a slightly decreased amplitude.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



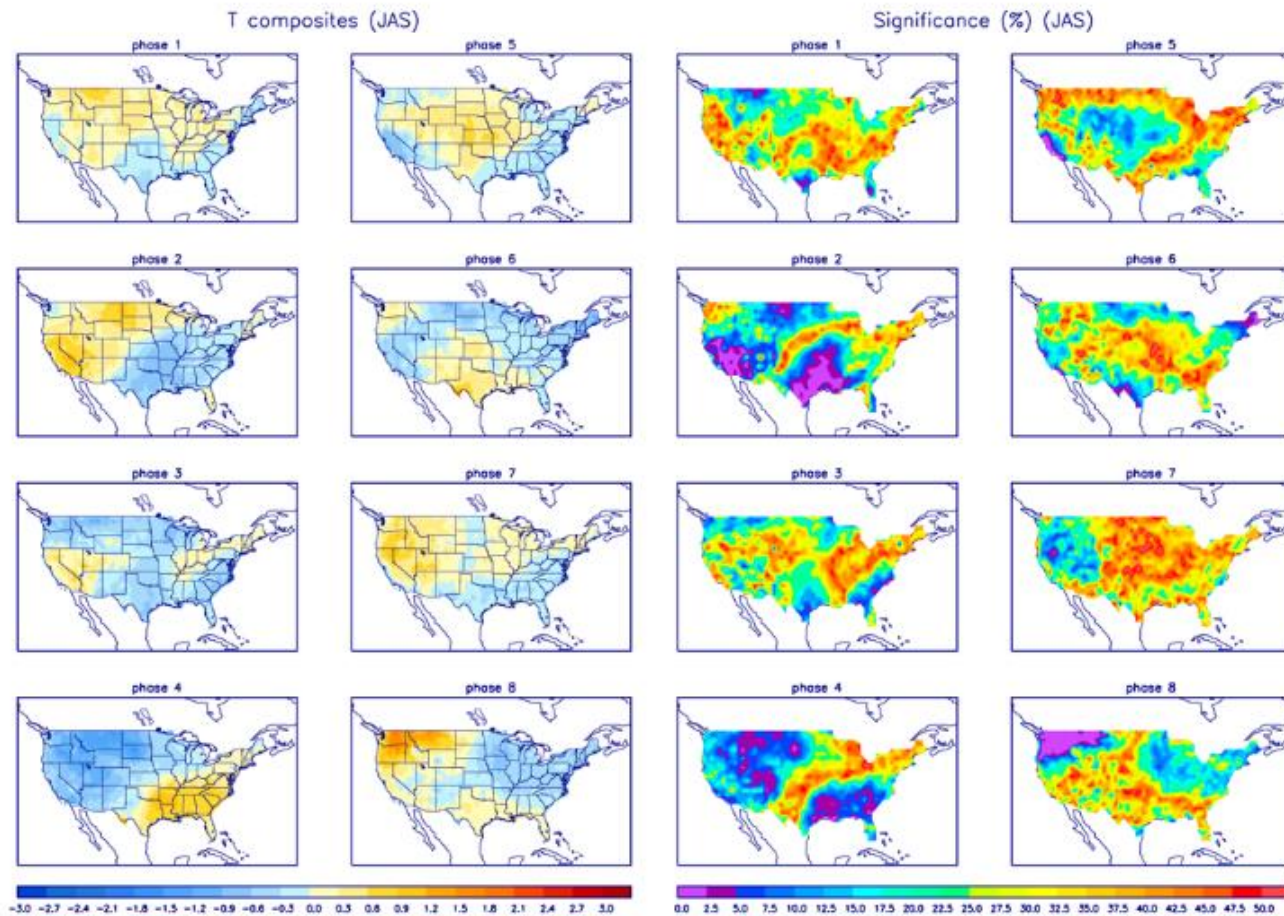
Precipitation Anomalies



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.

