

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



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
14 October 2024

Overview

- The MJO remains fairly coherent despite RMM observations showing a slowed and weakened MJO signal over the Indian Ocean during the past week. This behavior appears to be tied to competing interference with higher frequency variability in the tropics
- There remains good run-to-run continuity in the dynamical models favoring an amplifying MJO signal over the Maritime Continent that propagates eastward into the Western Pacific towards the end of week-2.
- The strengthening MJO may trigger a Westerly Wind Burst (WWB) event in the equatorial Indian Ocean based on improved agreement in the models.
- Towards the end of October, uncertainty arises in the MJO outlook due to the Maritime Continent Barrier, as well as differences in the subseasonal phase speed favored among the dynamical models, with the ECWMF (GEFS) continuing to favor a comparably faster (slower) mean solution.
- Regardless of these uncertainties, the large-scale environment is expected to be favorable for tropical cyclone development in the Indian Ocean (week-1 into week-2) and Western Pacific (weeks 2 and 3), with decreased chances of development over the eastern Pacific and Atlantic.

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

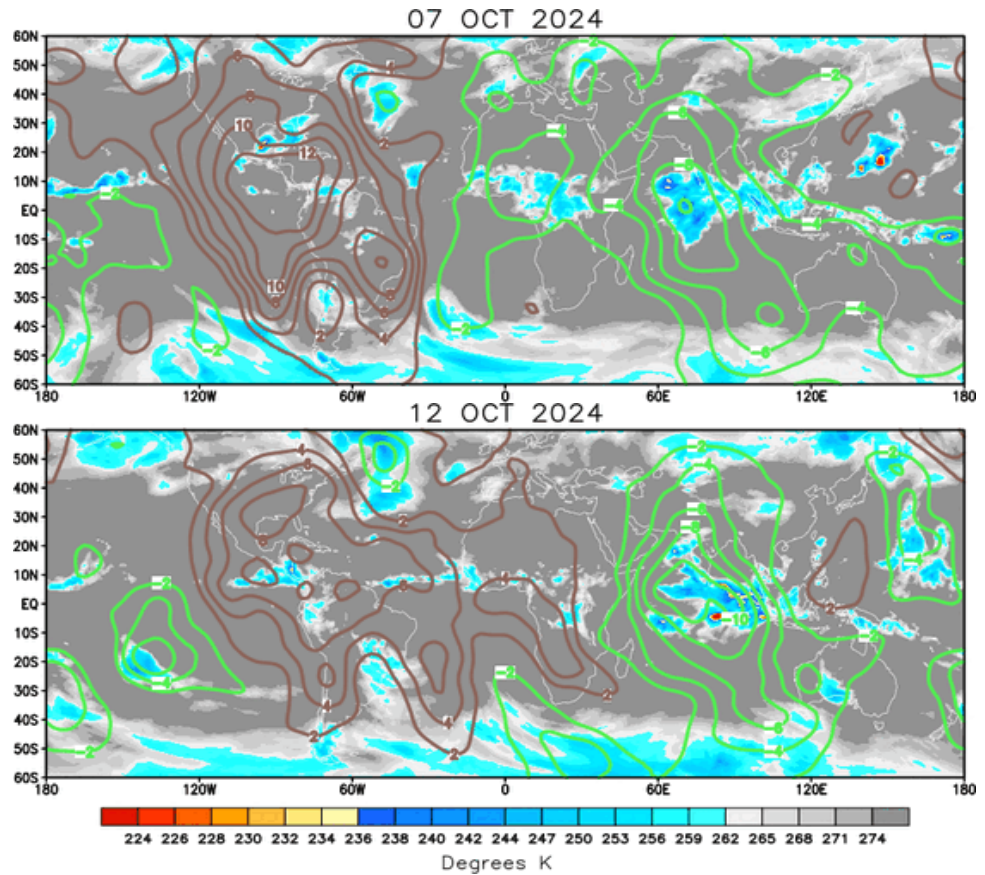
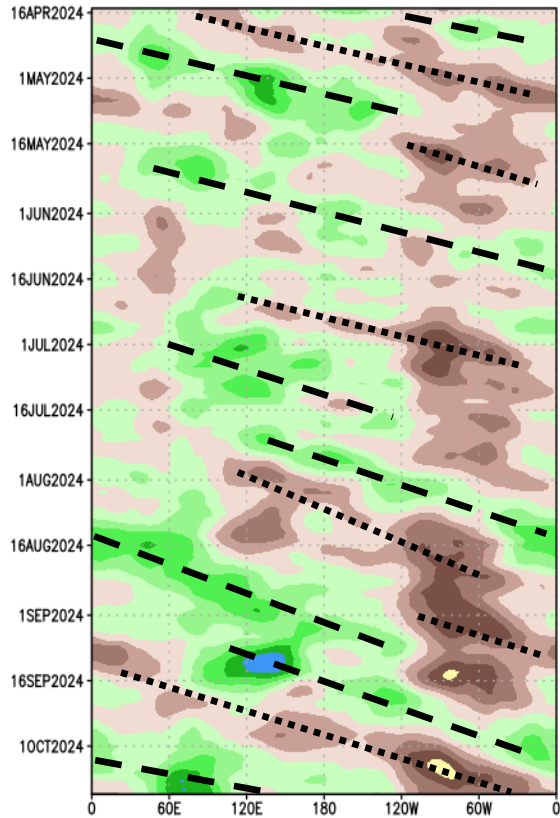
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

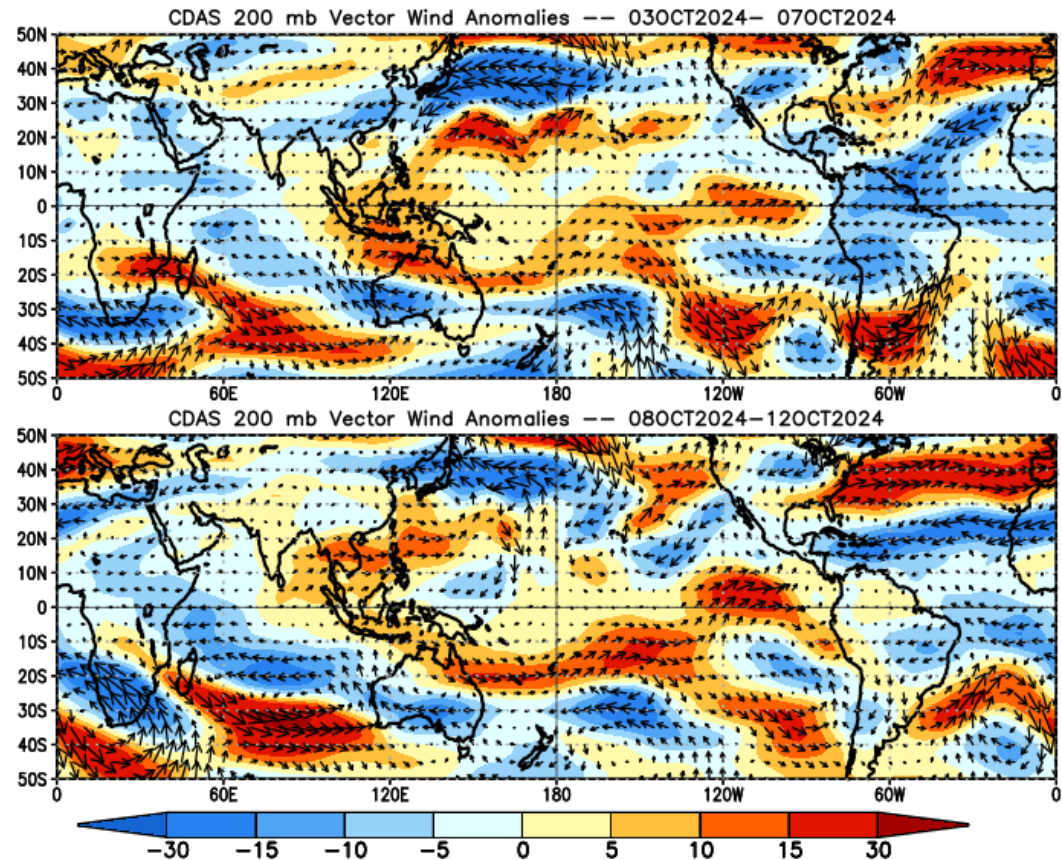
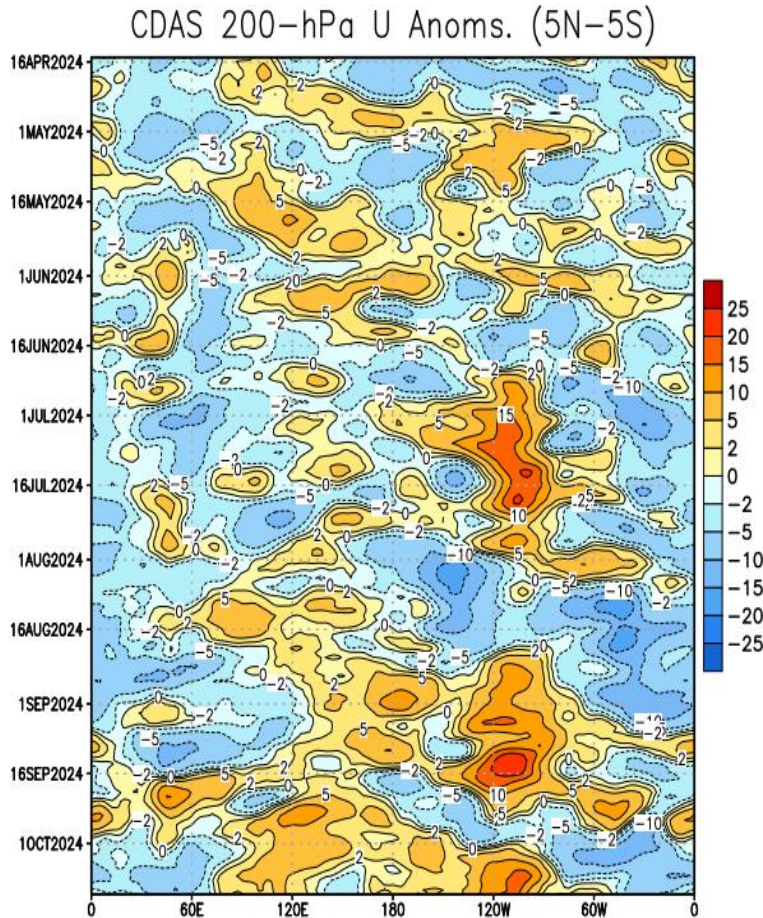
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- Upper-level velocity potential anomalies generally show a wave-1 pattern, where the enhanced (suppressed) divergence envelope is observed shifting eastward with time.
- A growing weakness is depicted near 120E, which appears to be tied to an equatorial Kelvin wave moving ahead and separating from the main convective MJO envelope.

200-hPa Wind Anomalies

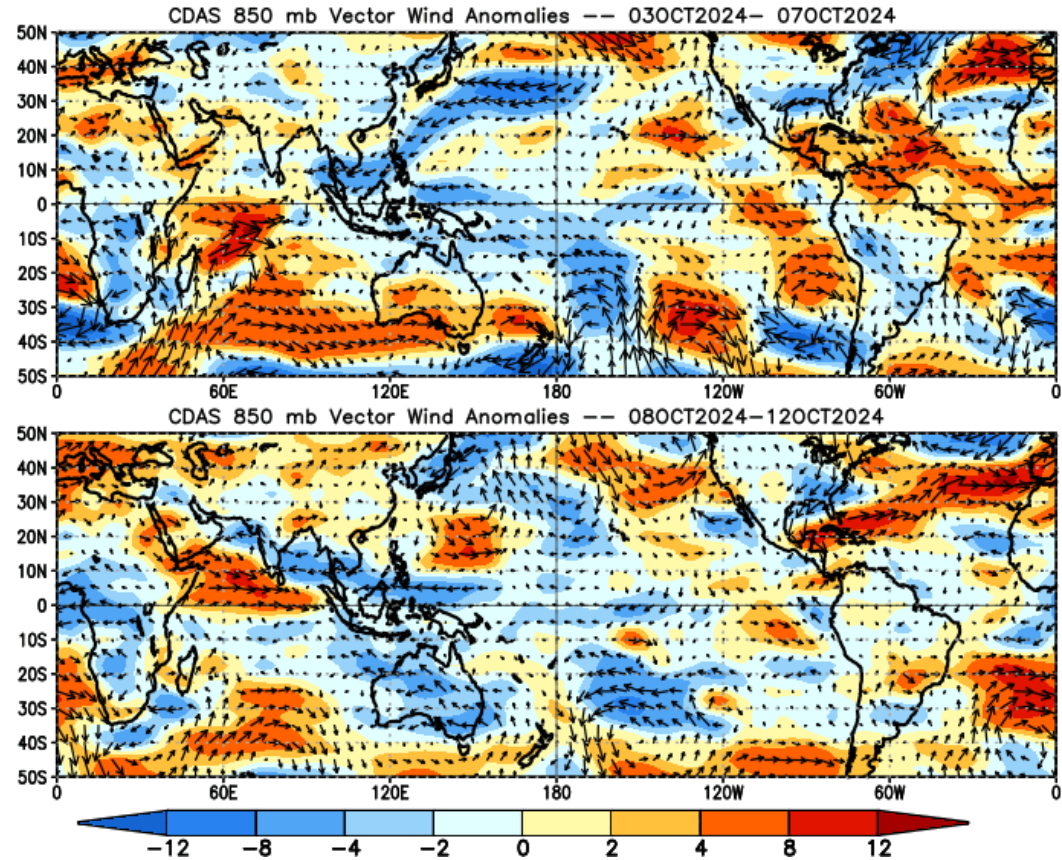
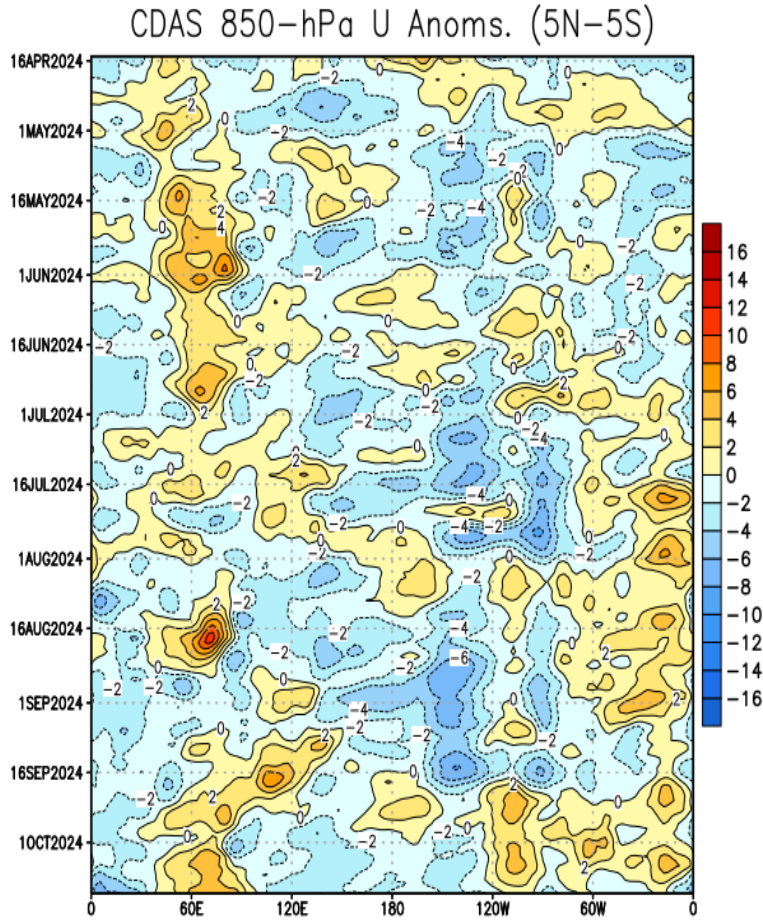
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- The westerly phase of the MJO is evident in the time longitude plot, and is contributing to a strong uptick in the signal near 120W along the equator.
- Conversely, the easterly phase of the MJO has struggled to propagate eastward over the equatorial Indian Ocean, likely due to anomalous westerlies aloft protruding westward associated with equatorial Rossby wave activity.

850-hPa Wind Anomalies

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

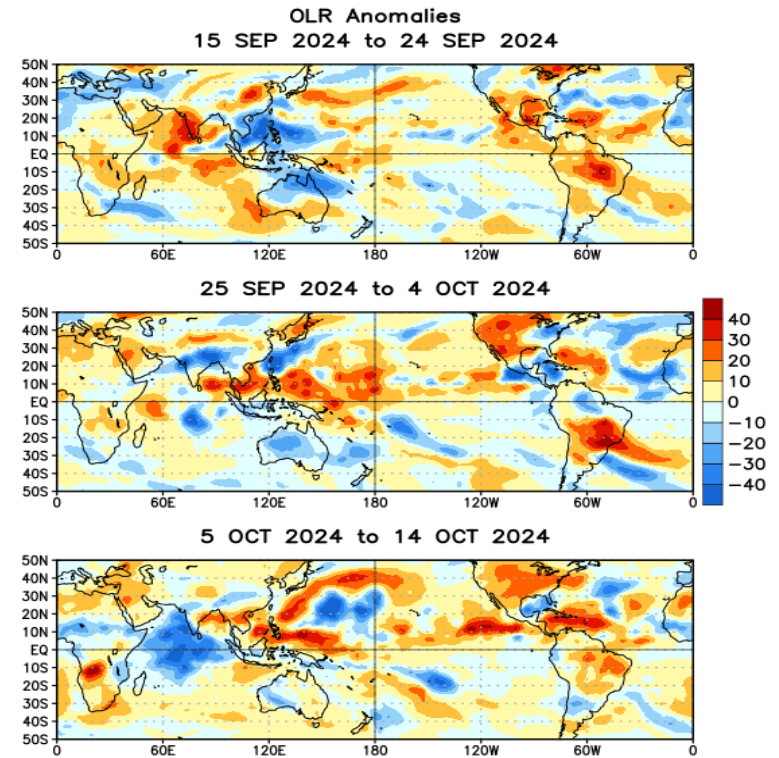
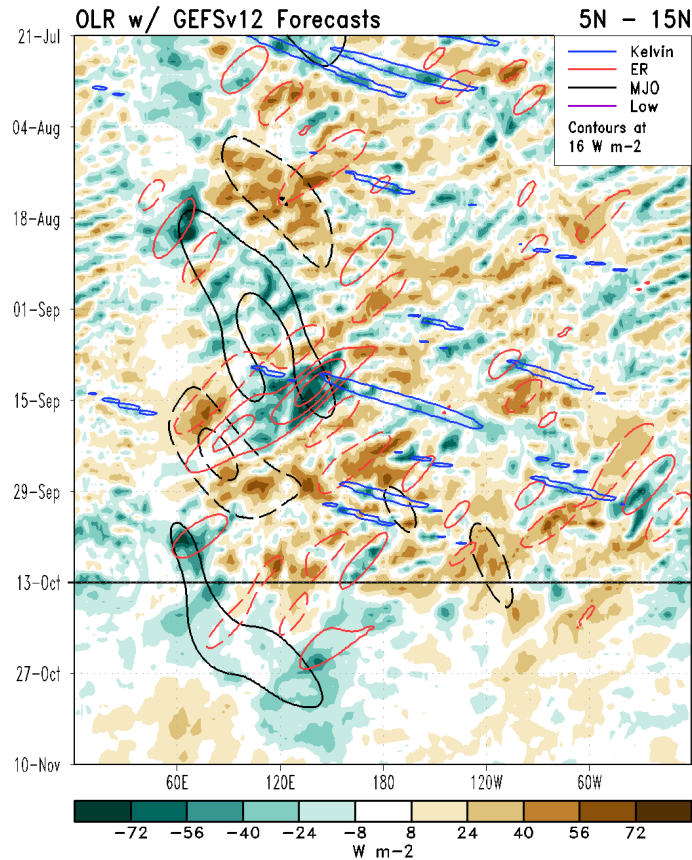


- Anomalous westerlies recently began to shift eastward in the western Indian Ocean, though some persistence near 60E could be pointing to a low frequency response unfolding.
- Since early October, the easterly phase of the MJO appears more modest over the equatorial Pacific compared to its previous trips.
- A strong anomalous cyclonic circulation is featured over the Gulf of Mexico associated with Hurricane Milton.

Outgoing Longwave Radiation (OLR) Anomalies

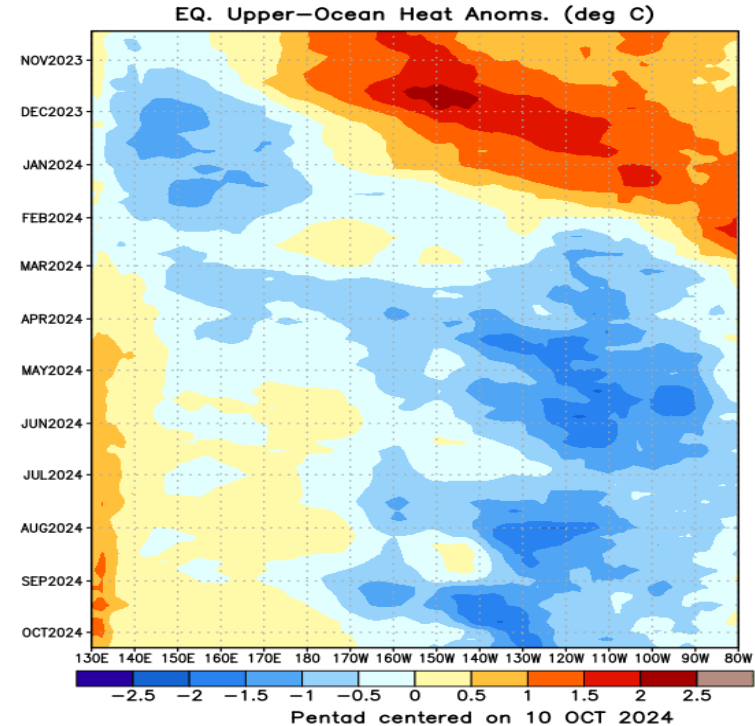
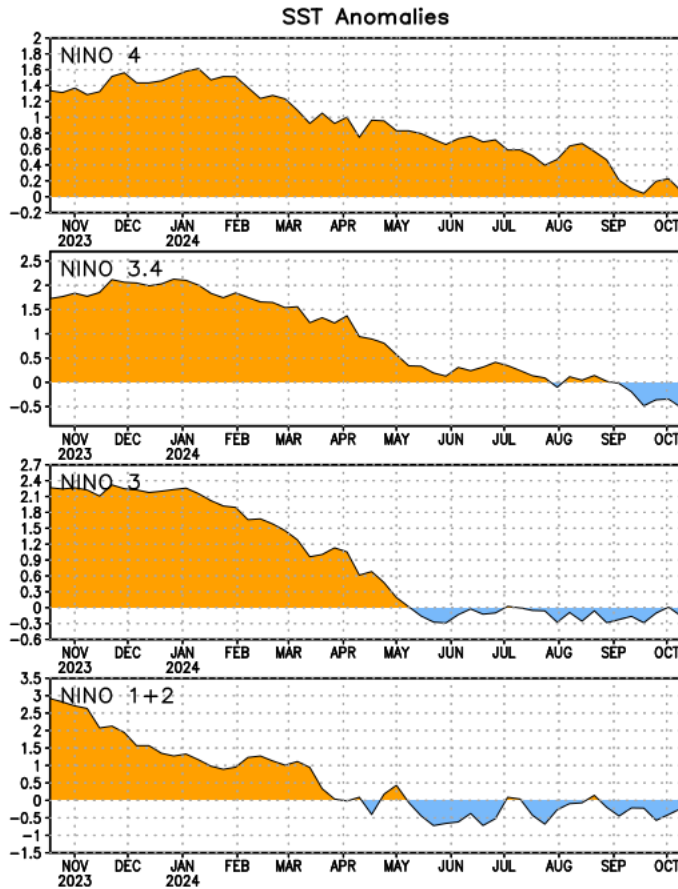
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- Tied to the Indian Ocean MJO, a broad area of enhanced convection was observed over the western and central parts of the basin, with suppressed convection prevailing over the western Hemisphere.
- OLR forecasts from the GEFS (focused north of the equator) show MJO activity coming through the filtering and propagating into the western Pacific later in October.

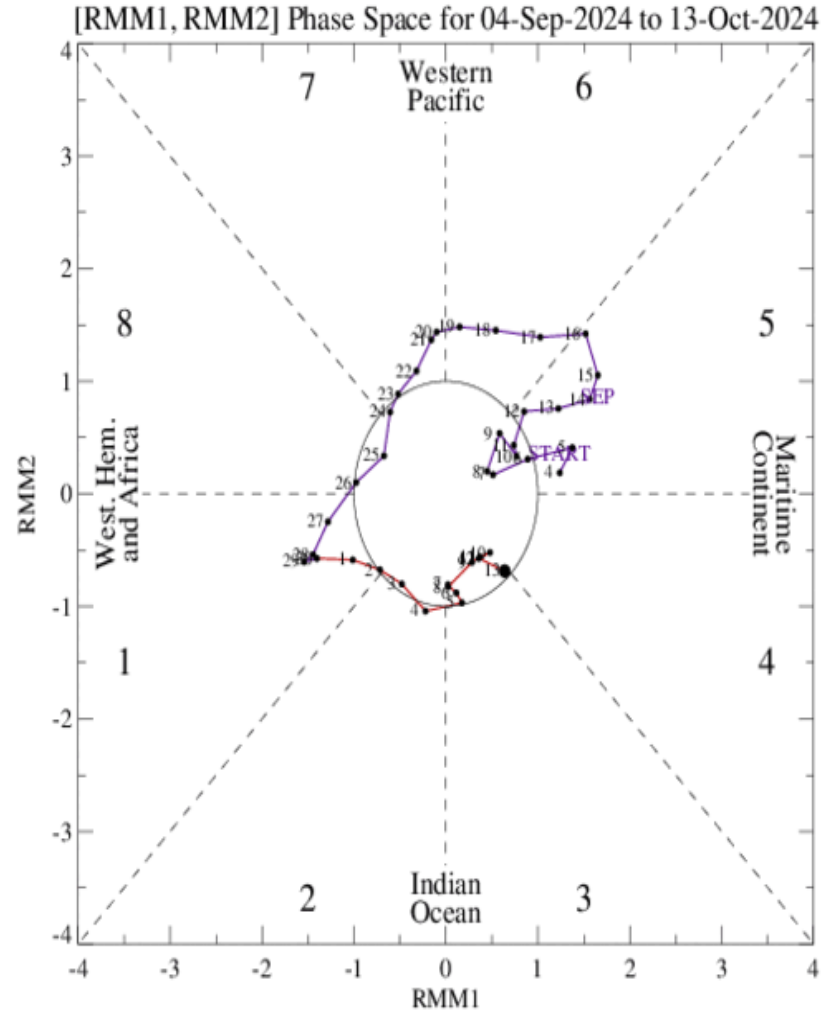
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- The eastern Niño regions remain neutral to slightly below normal, with Niño 4 registering slightly above-average.
- Except for waters between 140°W and 120°W, subsurface temperature anomalies are not markedly anomalous, akin to the surface.

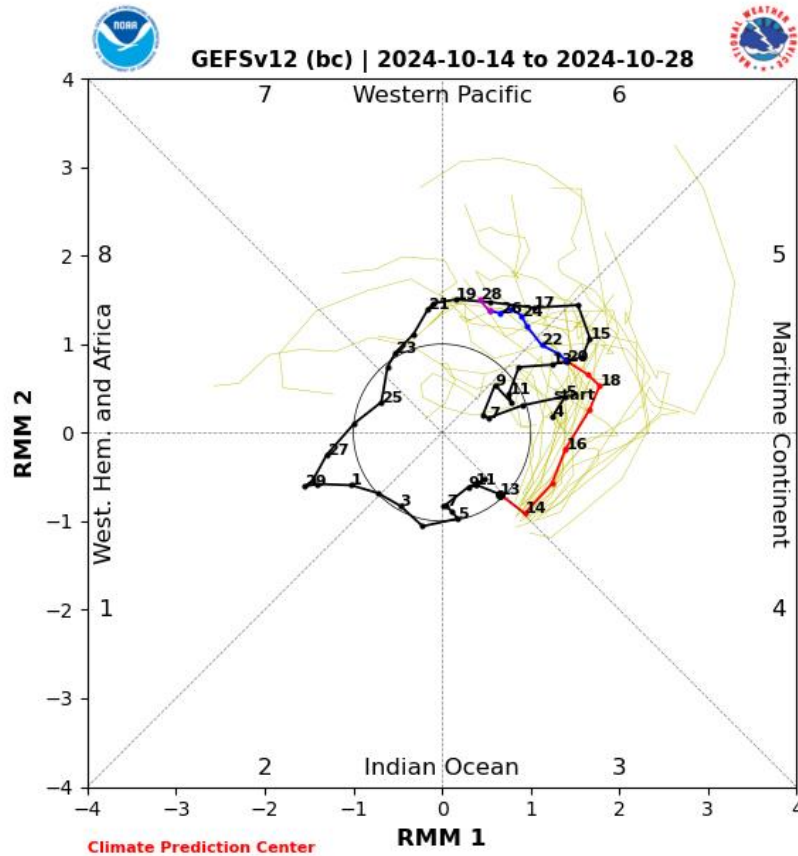
MJO Index: Recent Evolution

- Since propagating at a moderate amplitude over the Western Hemisphere during late September, RMM observations have weakened and slowed over the Indian Ocean more recently.
- The weakened RMM observations are somewhat at odds with the upper-level velocity potential anomaly fields which suggest more coherent subseasonal activity.

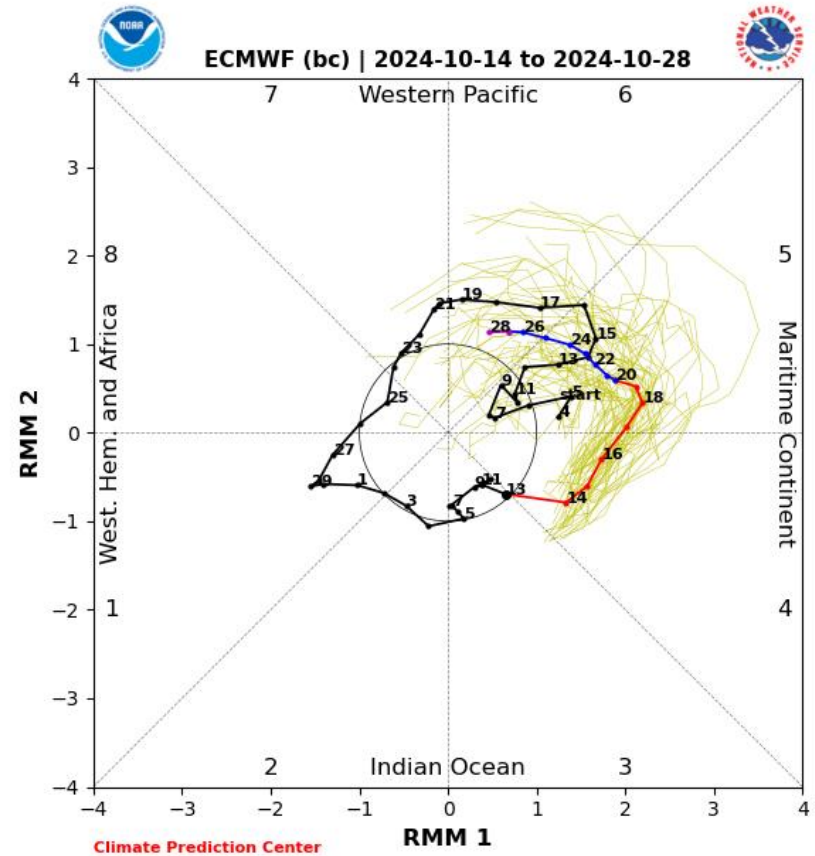


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



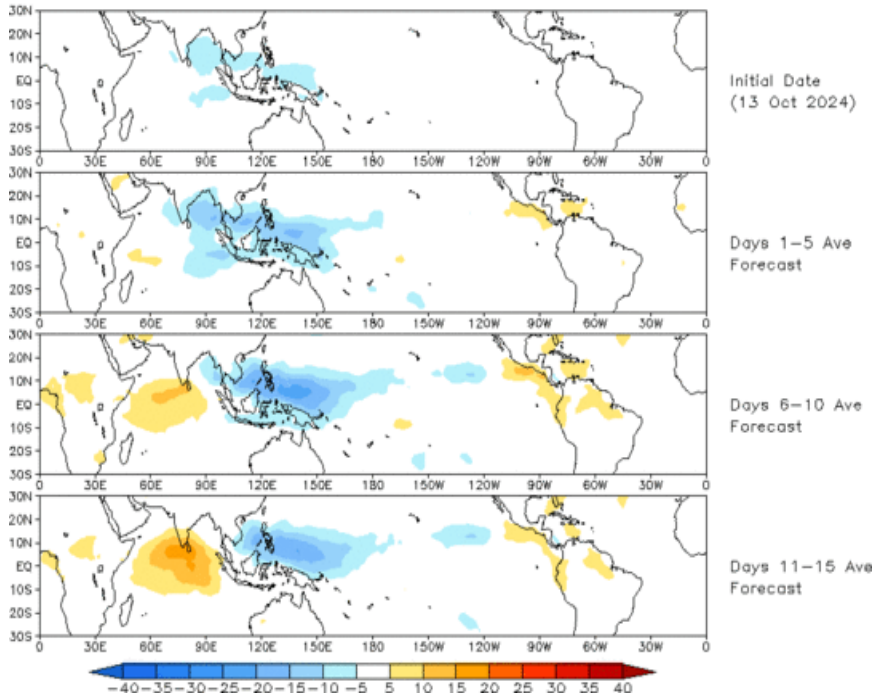
ECMWF Forecast

- Dynamical models are in pretty good agreement favoring a reemploying MJO signal over the Maritime Continent with eastward propagation into the Western Pacific by the week-3 timeframe.
- Extended range solutions of the ECMWF and GEFS (not pictured) disagree with the eventual phase of the speed of MJO as it crosses the Western Pacific, with ECMWF favoring a faster mean solution.
- There is also uncertainty in the MJO to fully propagate out of the Maritime Continent, based on its previous two trips over this part of the tropics

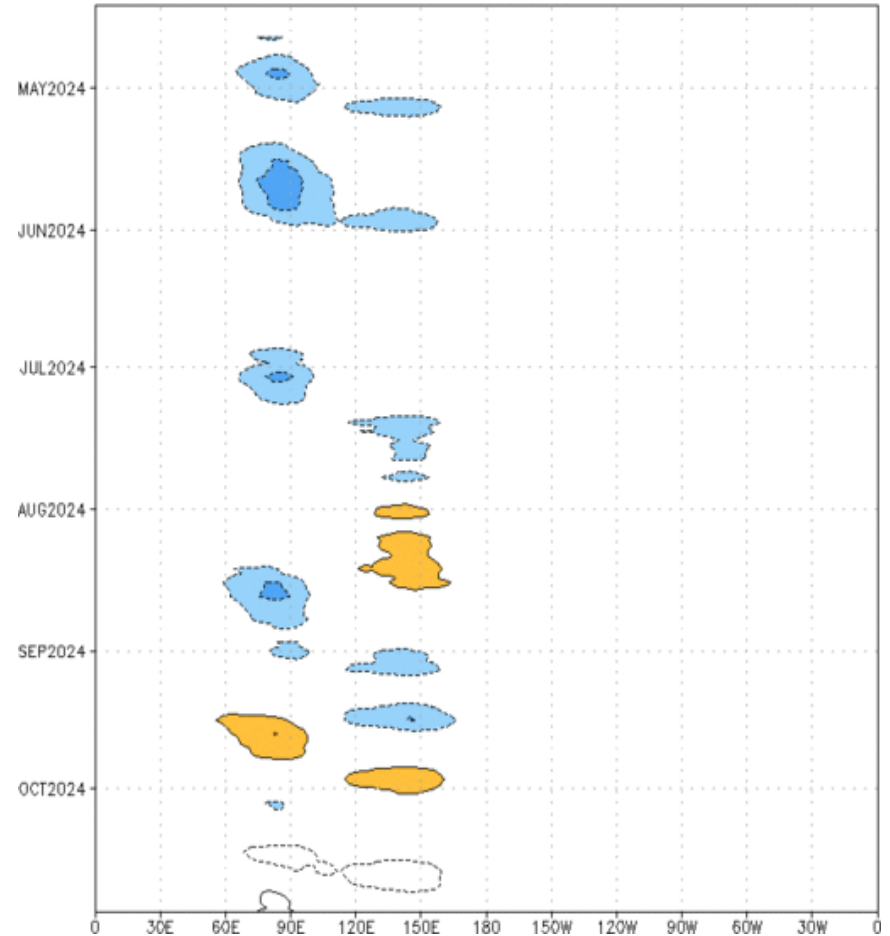
MJO: GEFS Forecast Evolution

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: 13 Oct 2024
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:13-Apr-2024 to 13-Oct-2024
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

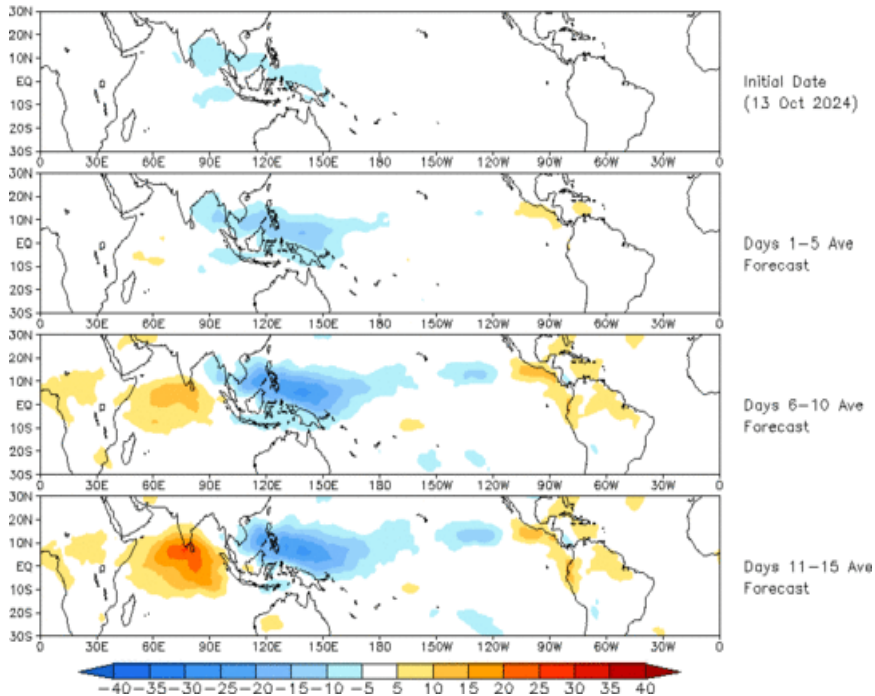


- The GEFS OLR anomaly forecast depicts enhanced convection strengthening and slowly shifting eastward into the Maritime Continent and western Pacific.
- Suppressed convection is favored to develop over the tropical Americas and Indian Ocean later in week-2.

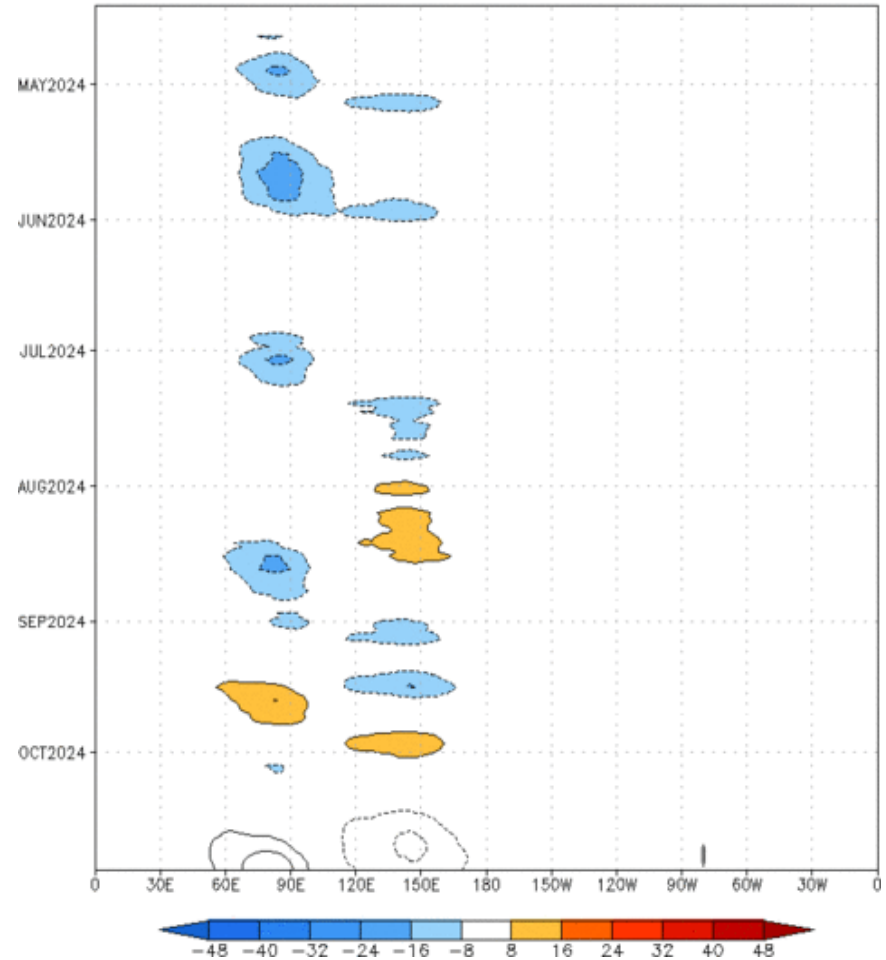
MJO: Constructed Analog Forecast Evolution

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 (13 Oct 2024)



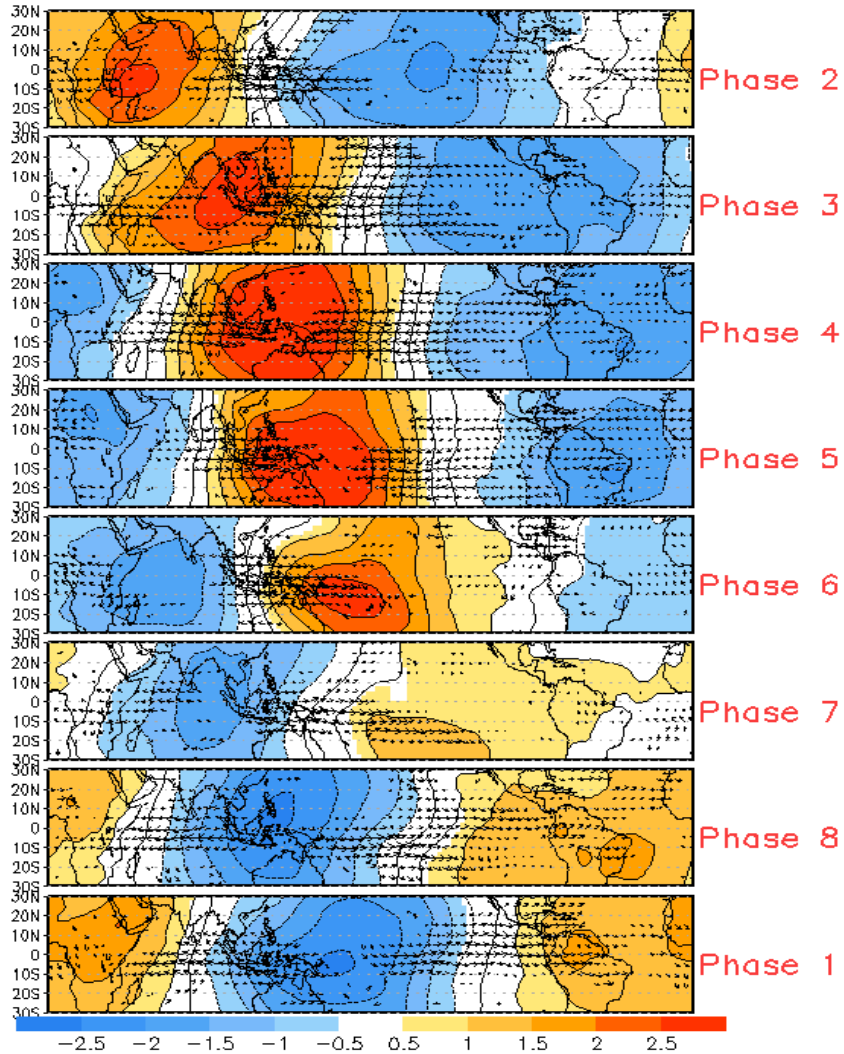
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:13-Apr-2024 to 13-Oct-2024
The unfilled contours are CA forecast reconstructed anomaly for 15 days



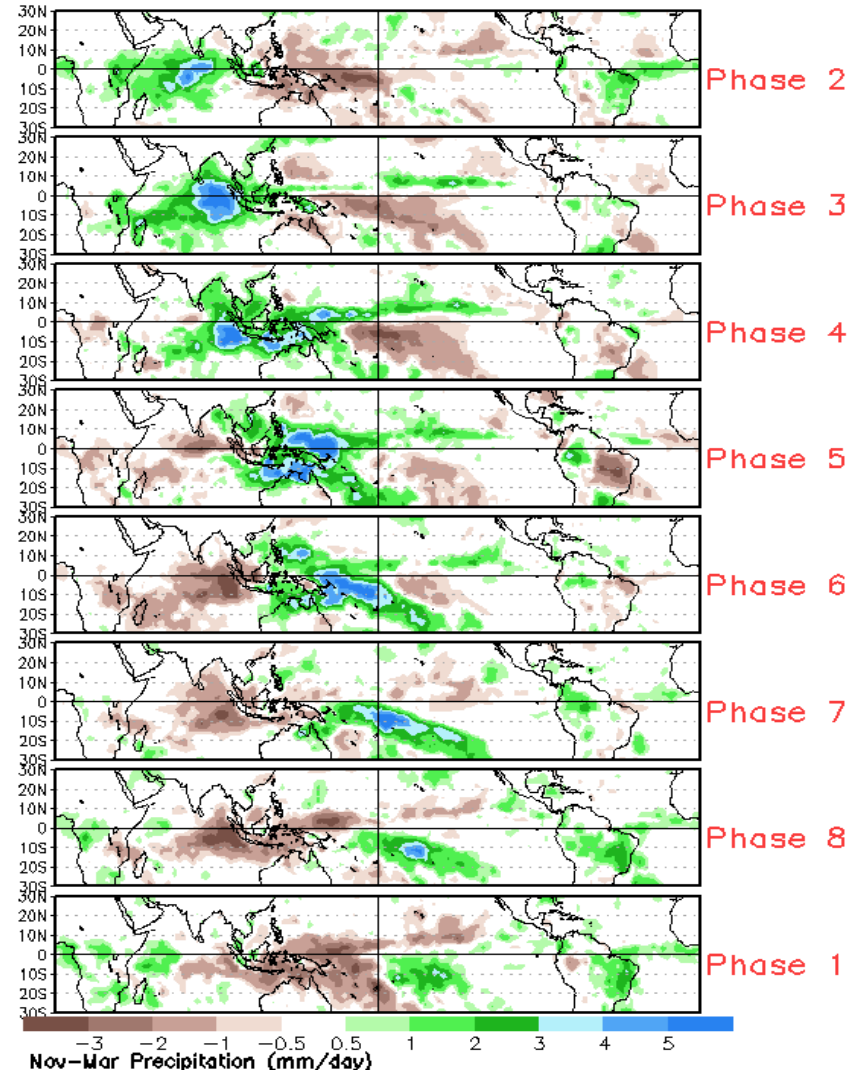
- The constructed analog forecast is similar to the GEFS in but overall slightly stronger in magnitude.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



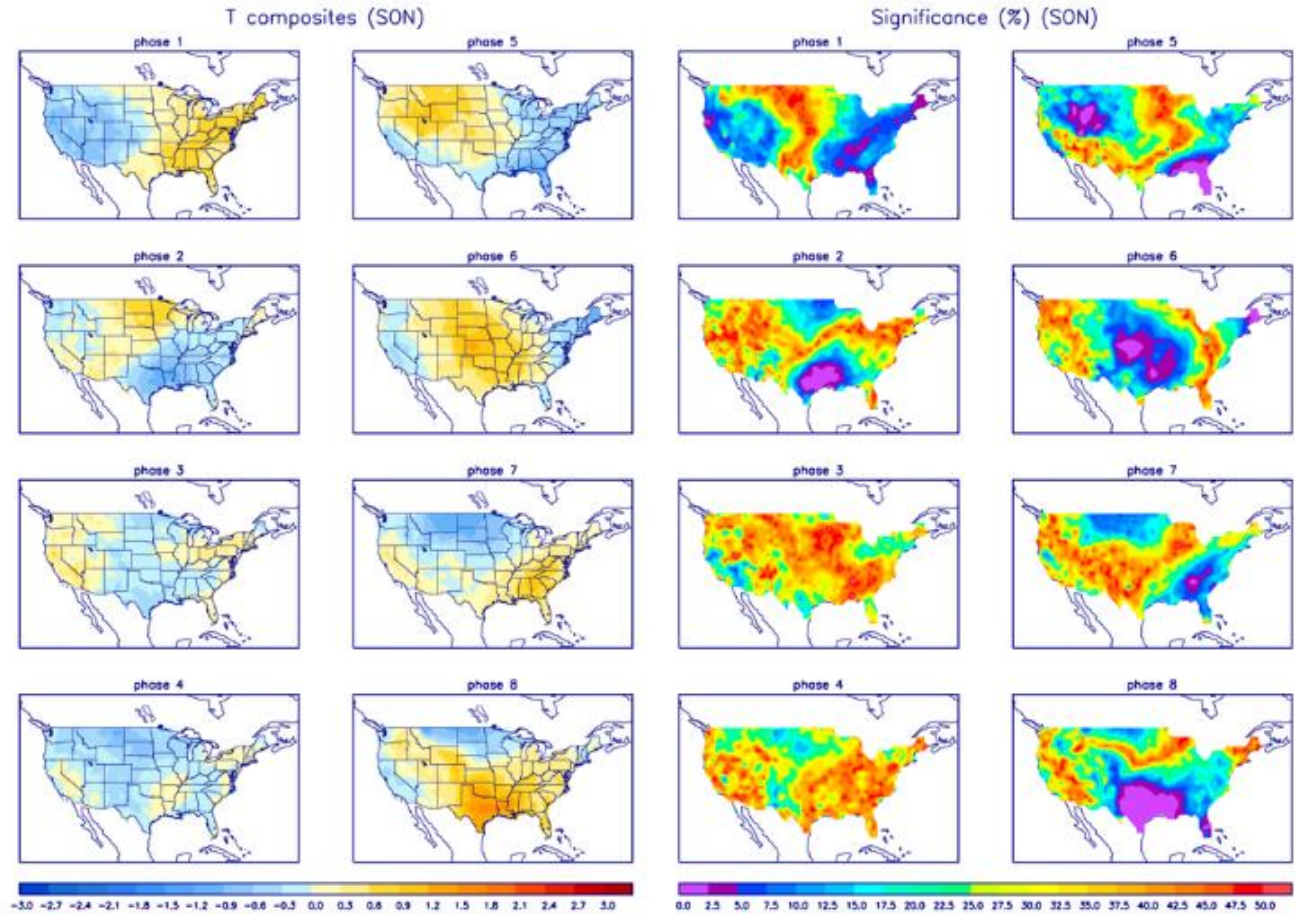
Precipitation Anomalies



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.

