

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



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
20 September 2021

Overview

- The RMM index depicts a weak MJO signal over the Indian Ocean and Maritime Continent, with the low frequency state becoming more influential.
- Both the GEFS and ECMWF ensemble means depict a slight eastward shift of the intraseasonal signal over the Maritime Continent. Individual members are suggestive of Kelvin Waves traversing the Pacific, while keeping the overall MJO signal weak.
- Enhanced easterly waves continue to favor tropical cyclone activity across the Atlantic and East Pacific during the peak of hurricane season, although activity is more muted due to the suppressed convection present over the Western Hemisphere.

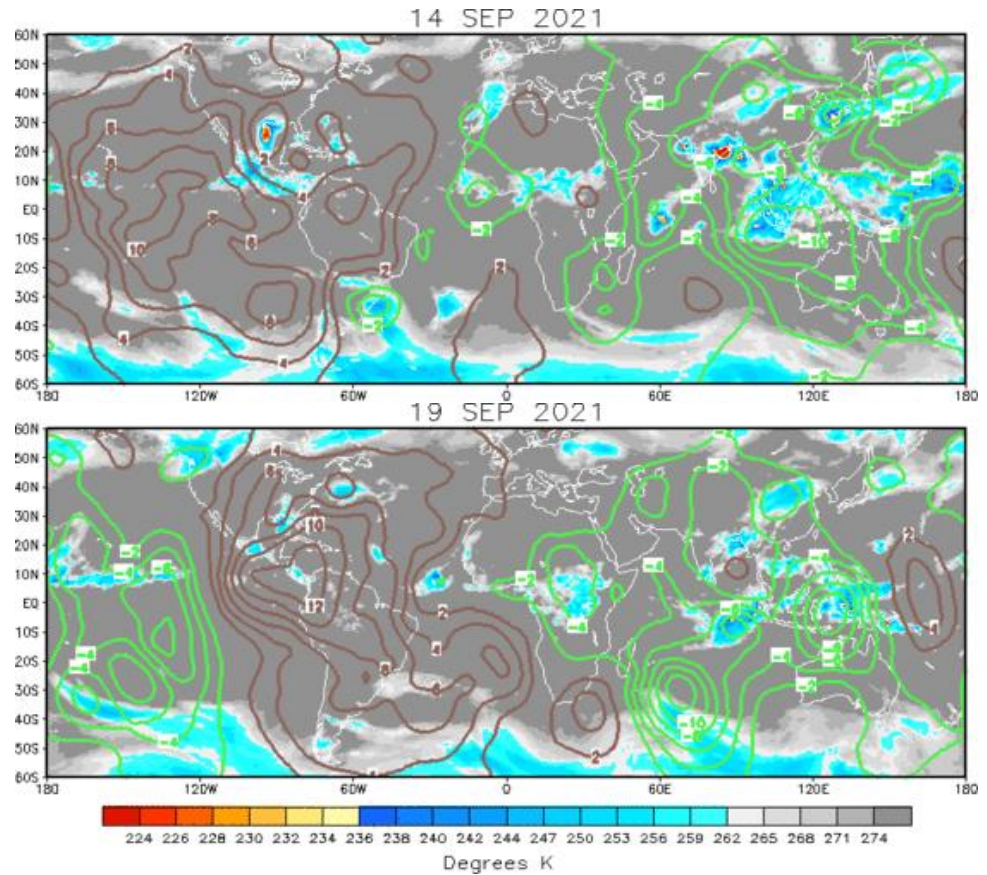
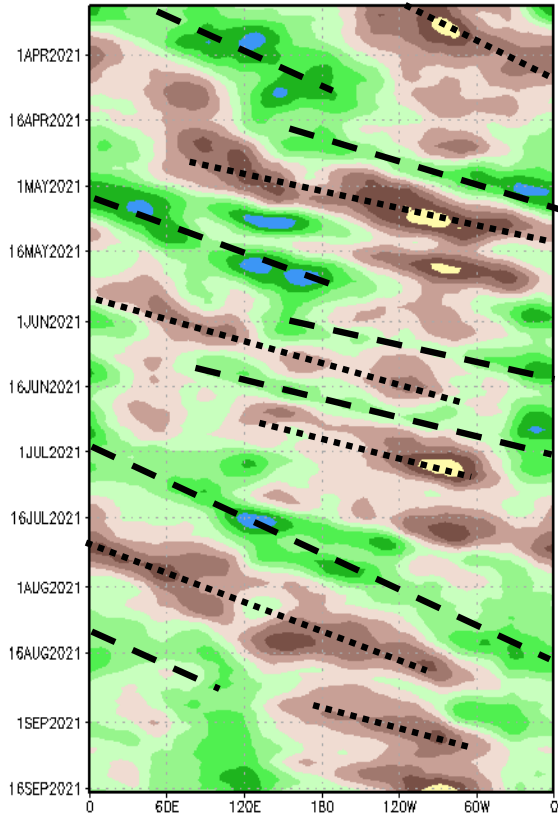
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

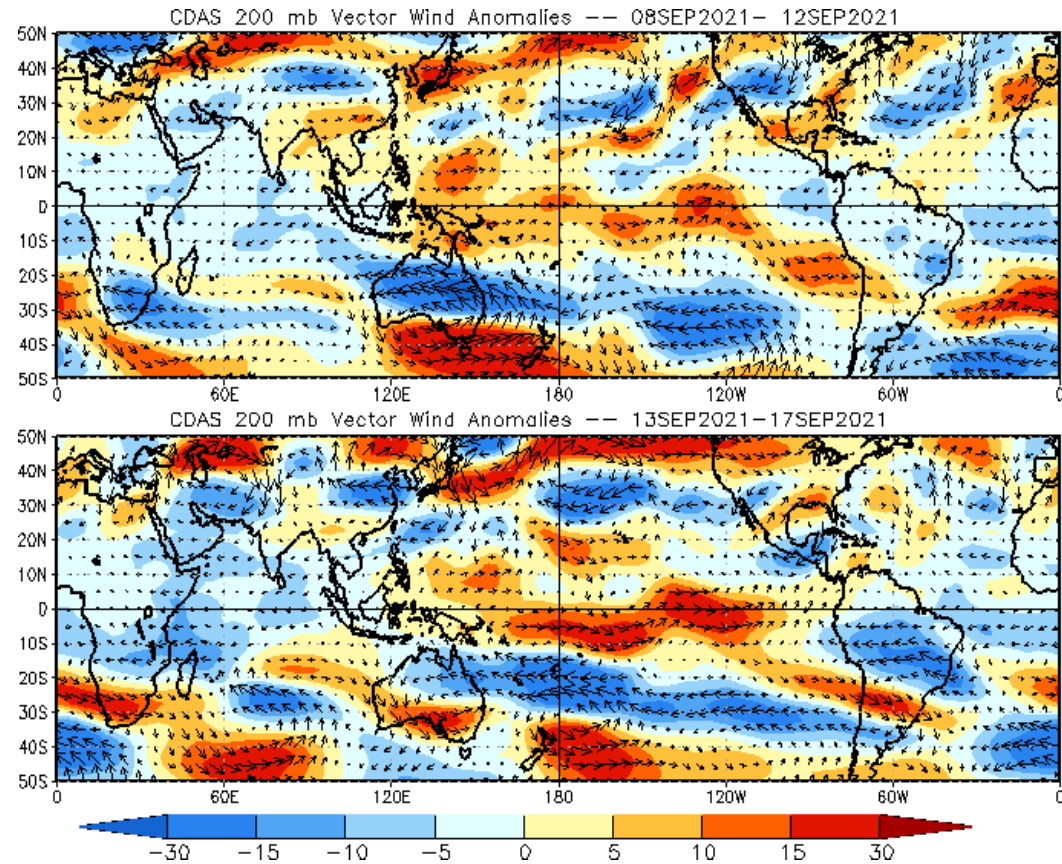
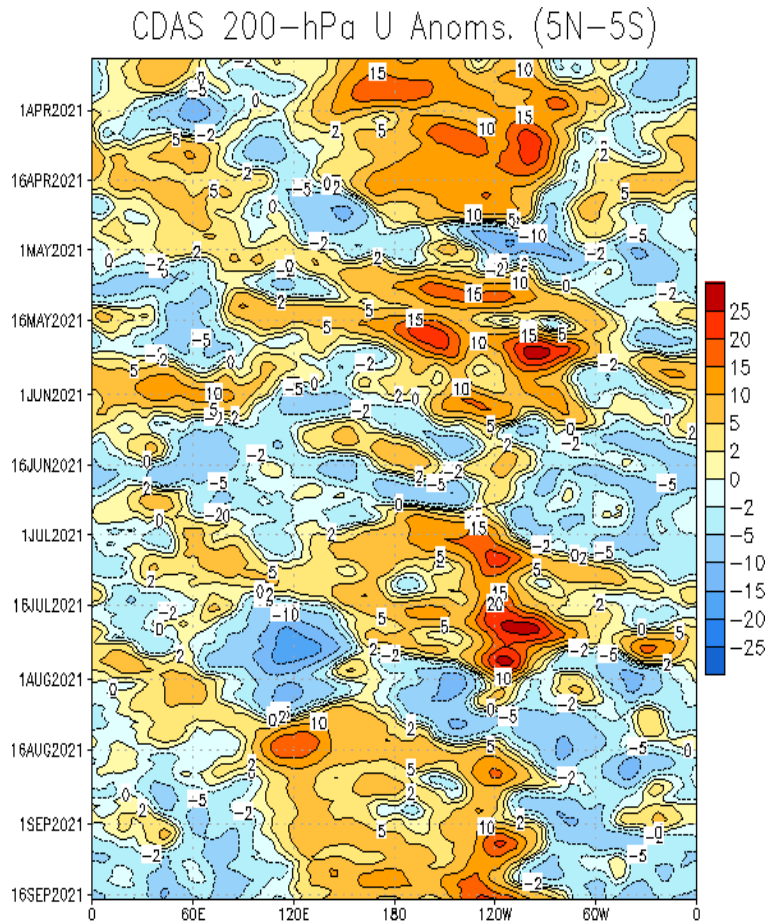
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- Velocity potential remains consistent with Wave-1 pattern with suppressed convection across much of the Western Hemisphere and enhanced convection over the Indian Ocean and Maritime Continent, with a slight eastward shift in the overall pattern compared to last week.
- Following an active MJO, there is increasing evidence with regards to a return of a low frequency state and limited propagation of the intraseasonal signal.

200-hPa Wind Anomalies

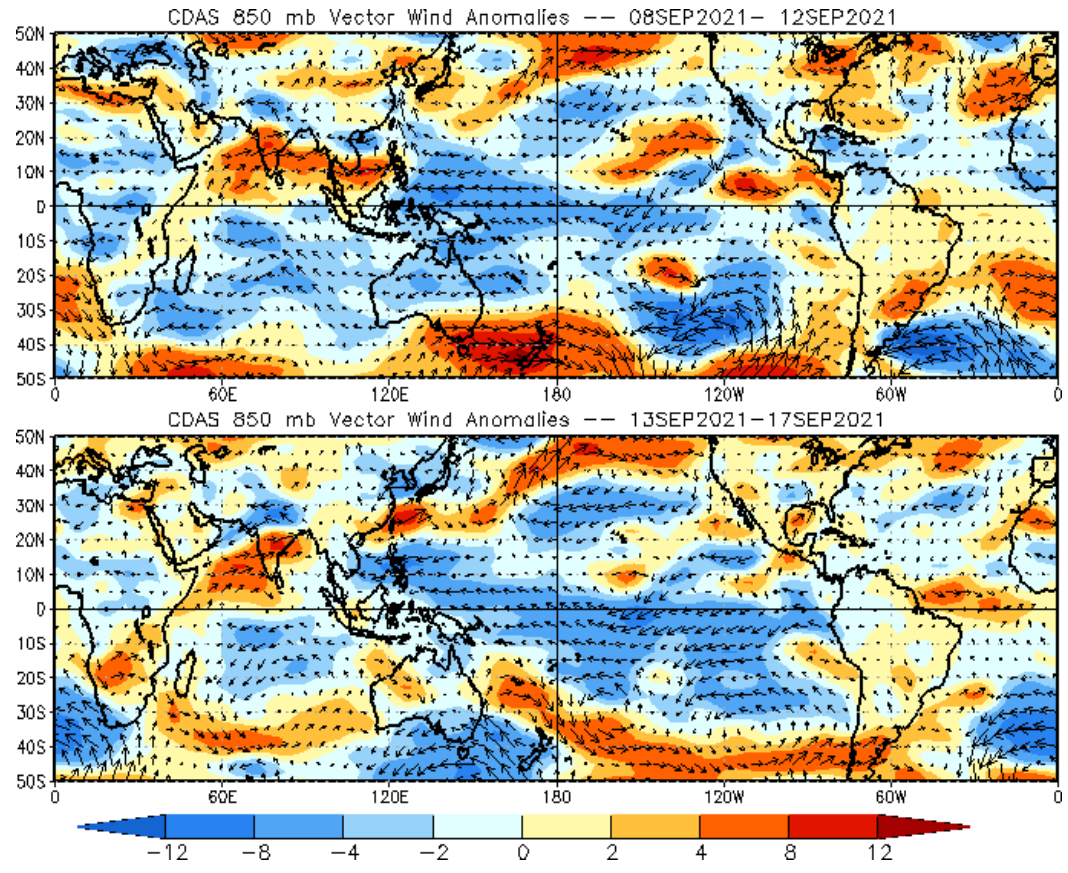
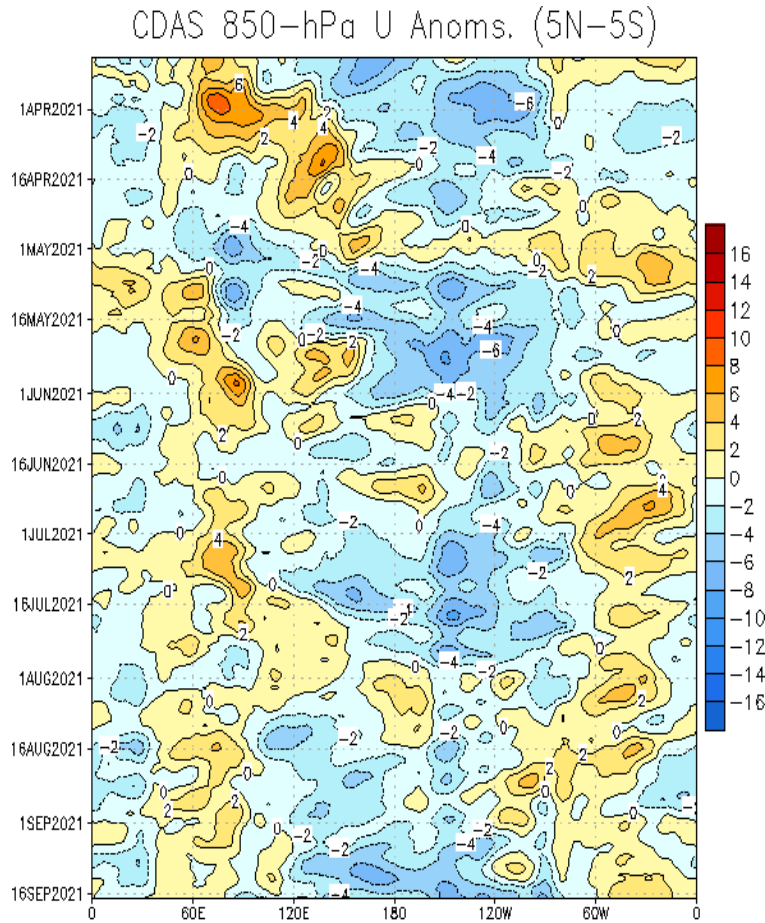
Shading denotes the zonal wind anomaly. **Blue shades: Anomalous easterlies.** **Red shades: Anomalous westerlies.**



- The upper-level zonal wind pattern shows a fairly coherent Wave-1 asymmetry, with westerly anomalies over the Pacific, and easterly anomalies extending across the Atlantic, Africa, and the Indian Ocean.
- Westerly anomalies have increased across the equatorial Pacific compared to last week, consistent with an enhanced Walker Circulation and a emergent low frequency signal.

850-hPa Wind Anomalies

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



- MJO activity was weakly evident in the low levels during the Boreal Summer as brief westerly bursts overcame the low frequency state favoring enhanced trades across the Pacific.
- Low level anomalous easterlies have since increased in coverage across the Equatorial Pacific heading into late September, making it more difficult for MJO propagation.

Outgoing Longwave Radiation (OLR) Anomalies

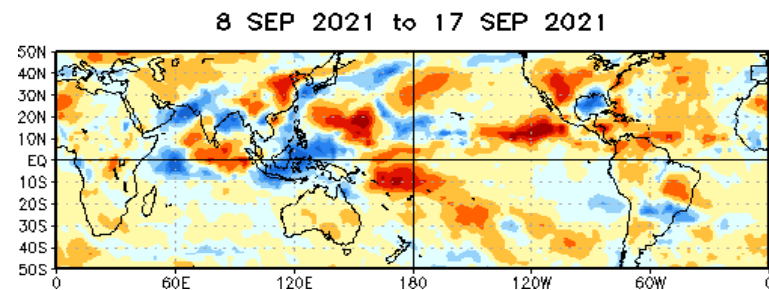
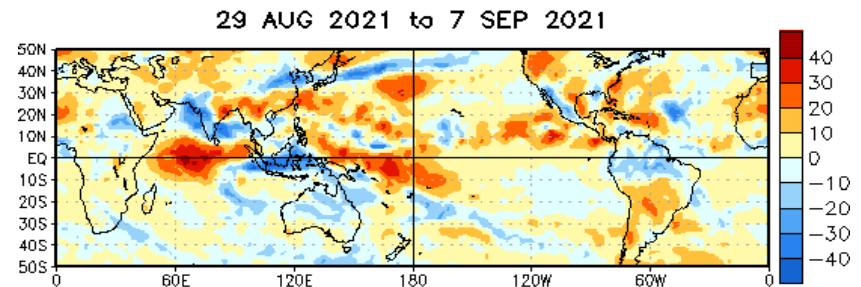
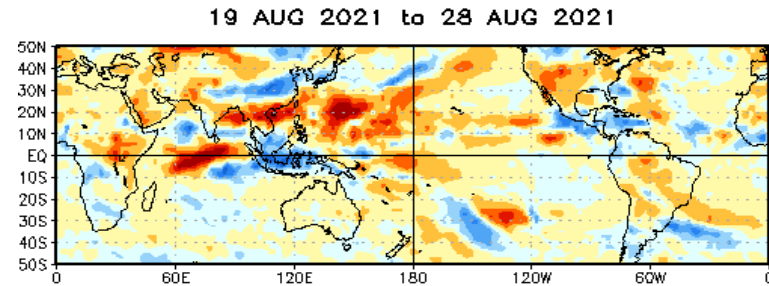
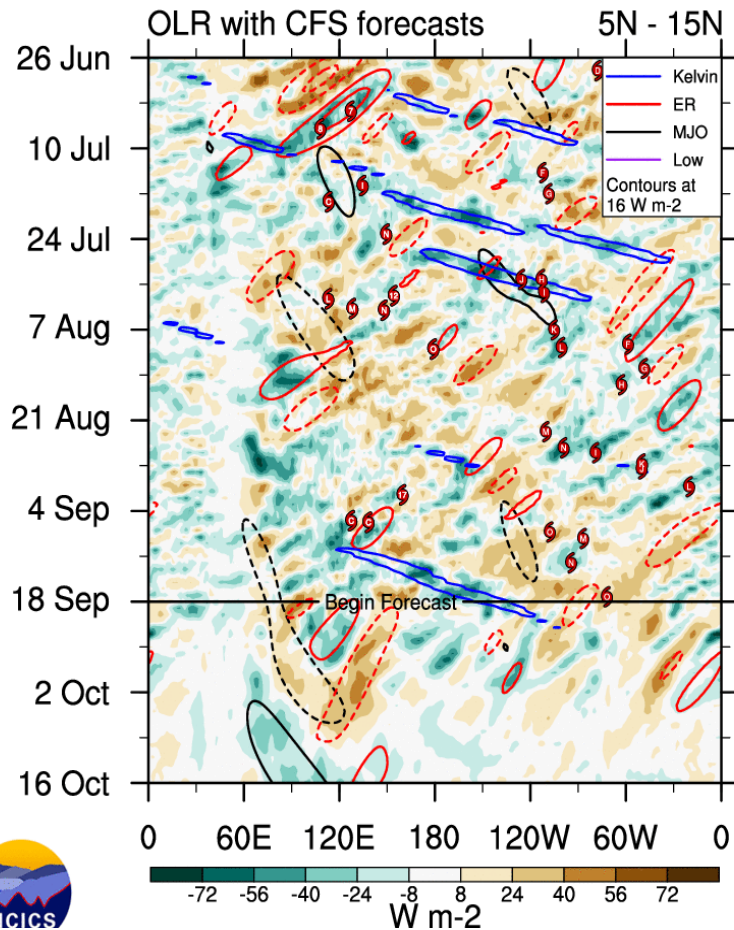
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)

Blue shades: Anomalous convection (wetness)

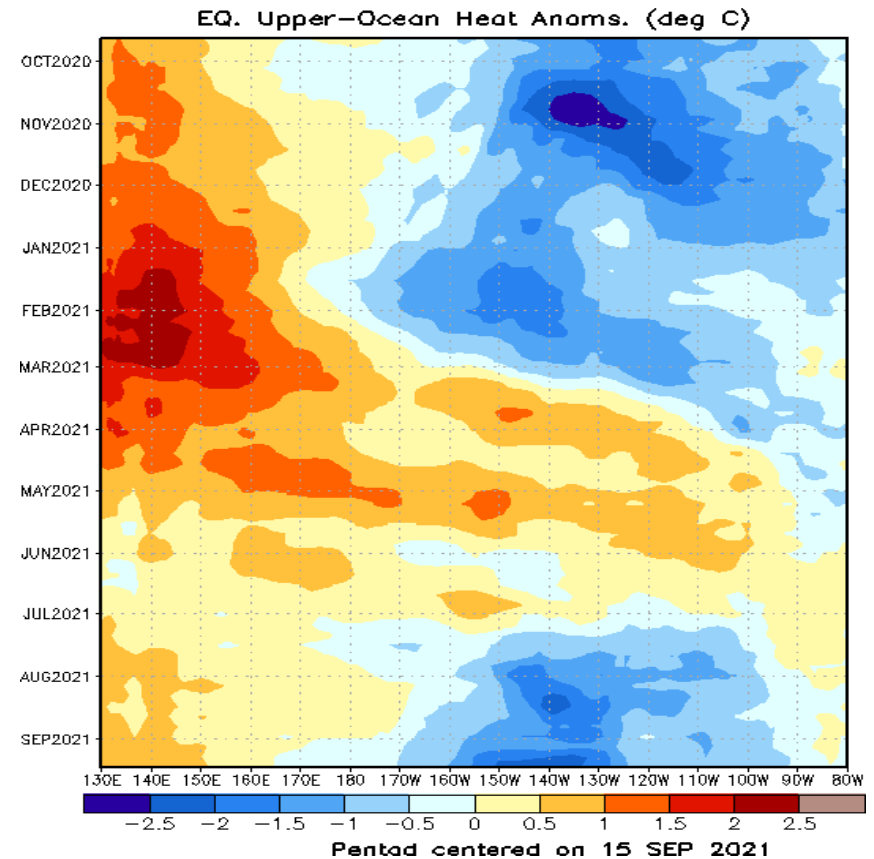
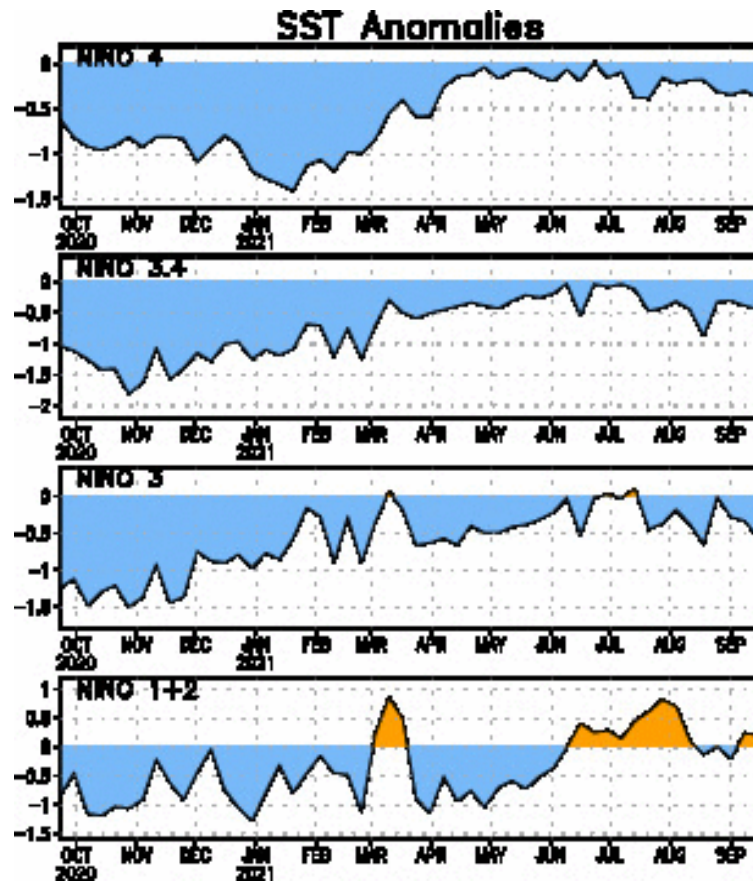
Red shades: Anomalous subsidence (dryness)

OLR Anomalies



- Enhanced convection extended from the Maritime Continent northwestward to the monsoon regions of South and Southeast Asia during early to mid September.
- Increased Rossby Wave activity continues to destructively interfere with the propagation of the intraseasonal signal, preventing an eastward expansion of the OLR anomalies, and suppressing convection across the West Pacific.

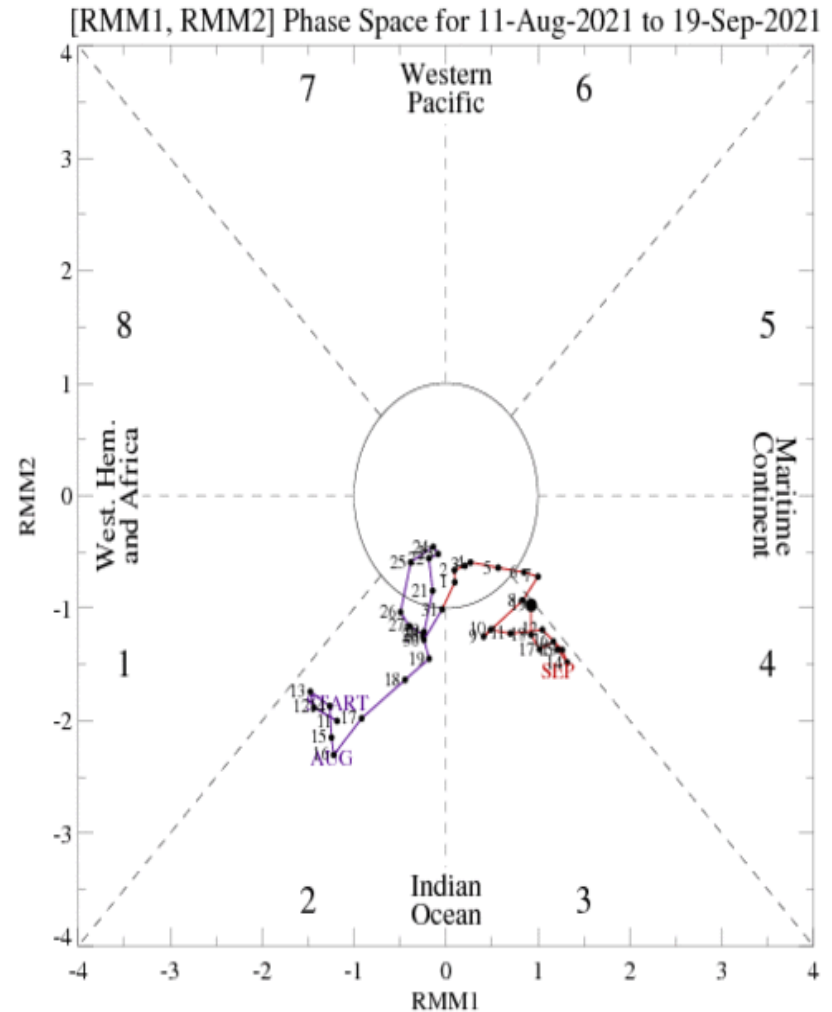
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Multiple episodes of oceanic Kelvin wave activity led to an increase of upper-ocean heat content during this past spring. However, these positive anomalies have since weakened, as negative anomalies have been strengthening across much of the Pacific since July.
- Below normal sea surface temperatures are observed over all Niño regions except the far east Pacific, consistent with a forecast trend toward La Niña.

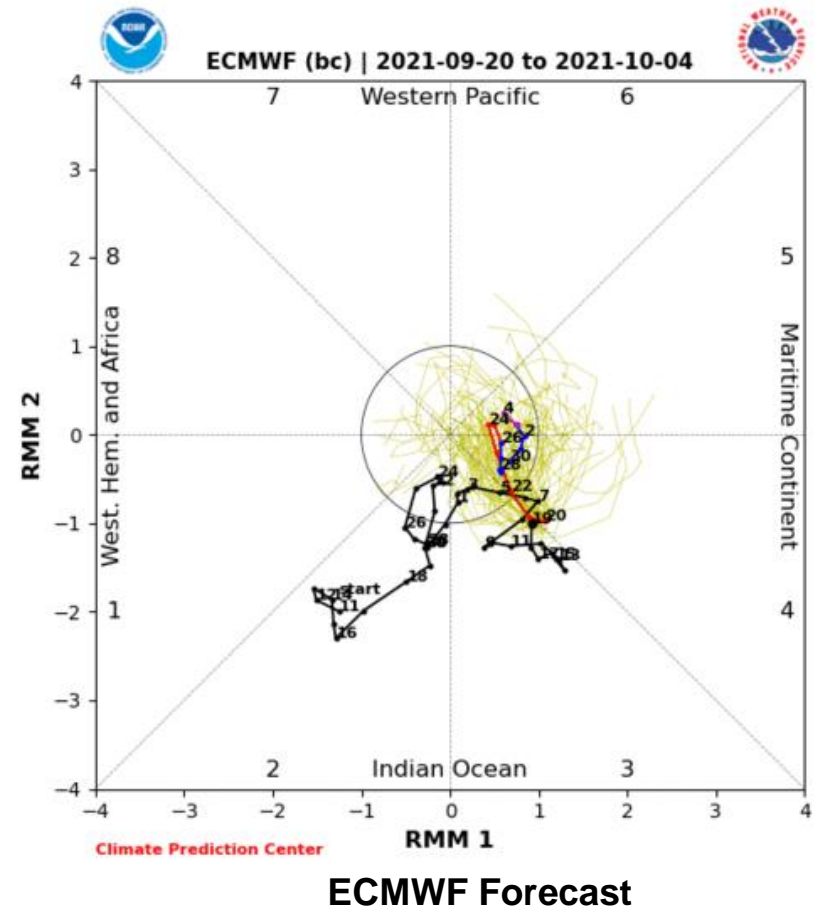
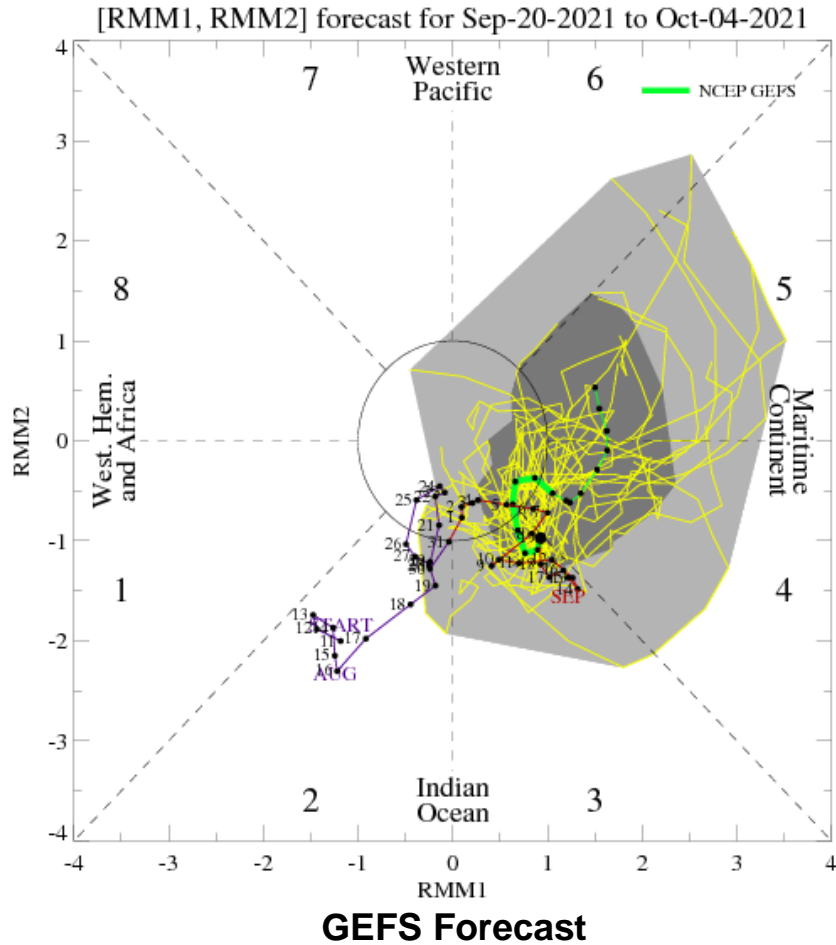
MJO Index: Recent Evolution

- The RMM index has had a slow meandering transit across the Indian Ocean over the past few weeks, resulting from interference from higher frequency modes.
- The amplitude of the RMM index has slightly increased during the past week, but this may be more indicative of an emerging low frequency state rather than a true MJO signal.



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

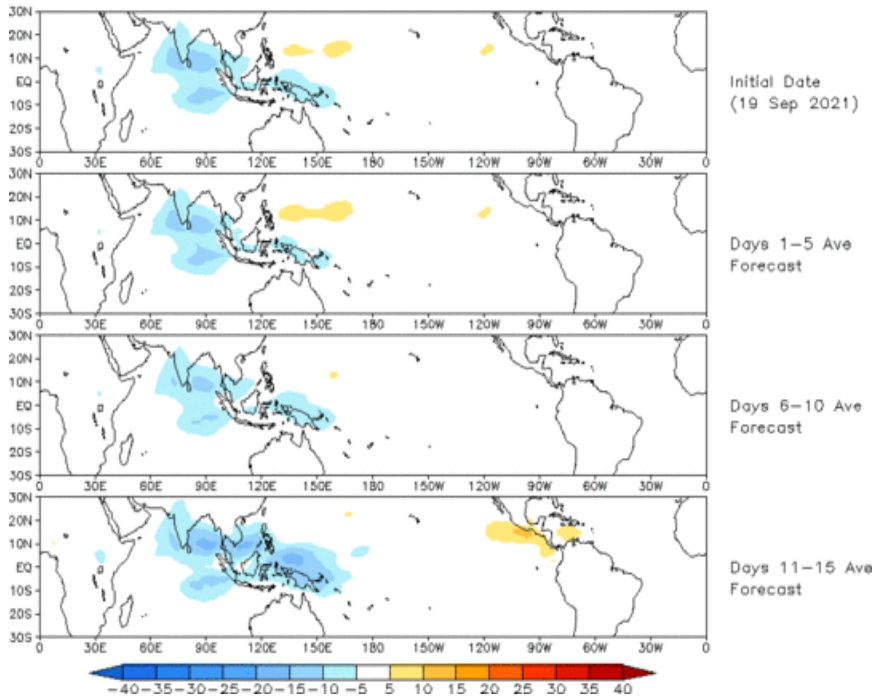


- Both the GEFS and ECMWF ensemble members indicate a continued slight eastward shift of the intraseasonal signal over the Maritime Continent and toward the West Pacific, but with a generally low amplitude.
- Higher amplitude GEFS members likely representative of enhanced Kelvin Wave activity forecast over the Pacific.

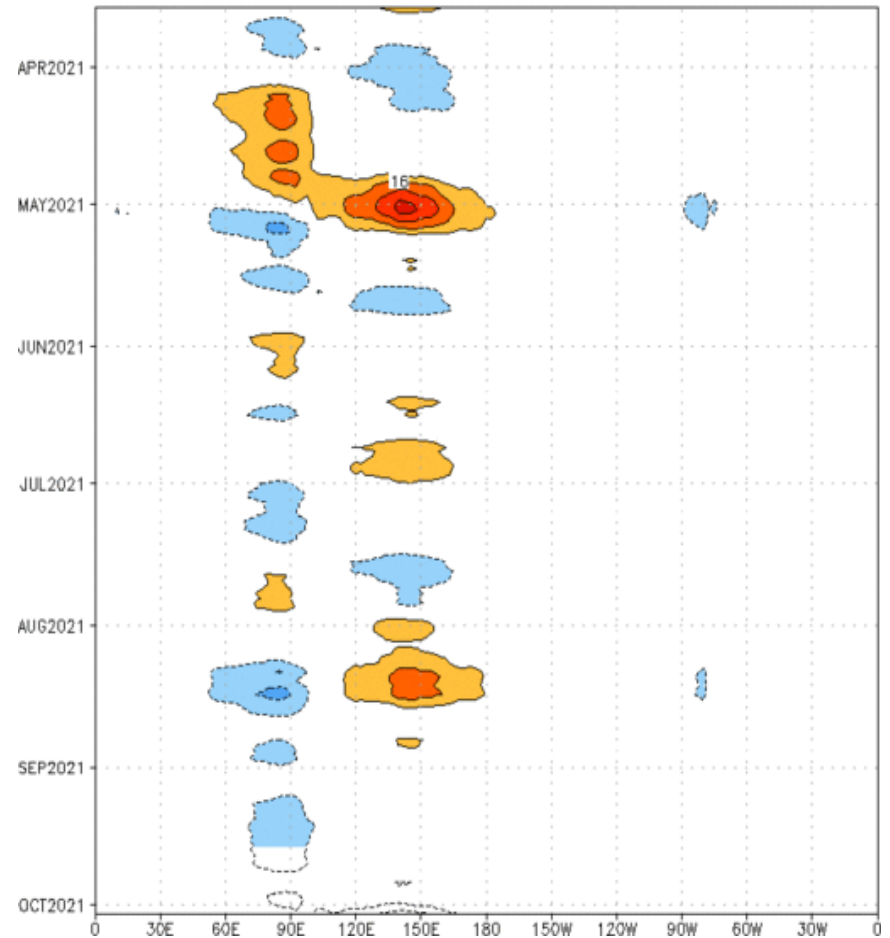
MJO: GEFS Forecast Evolution

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: 19 Sep 2021
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: 19-Mar-2021 to 18-Sep-2021
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

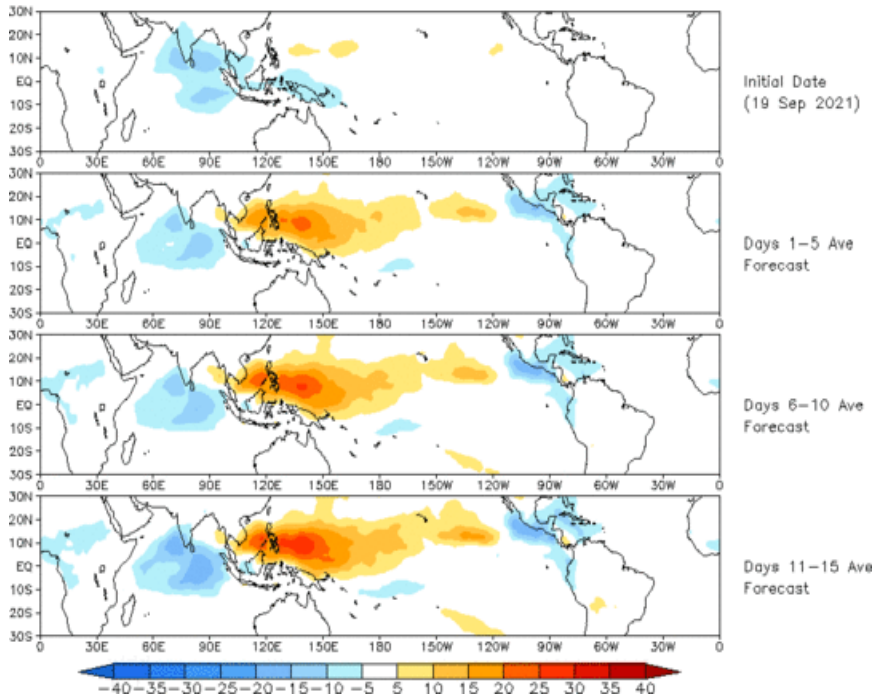


- The GEFS RMM-based OLR anomaly forecast features a strengthening signal, with enhanced convection over the Indian Ocean and Maritime Continent increasing in coverage and magnitude with time.

MJO: Constructed Analog Forecast Evolution

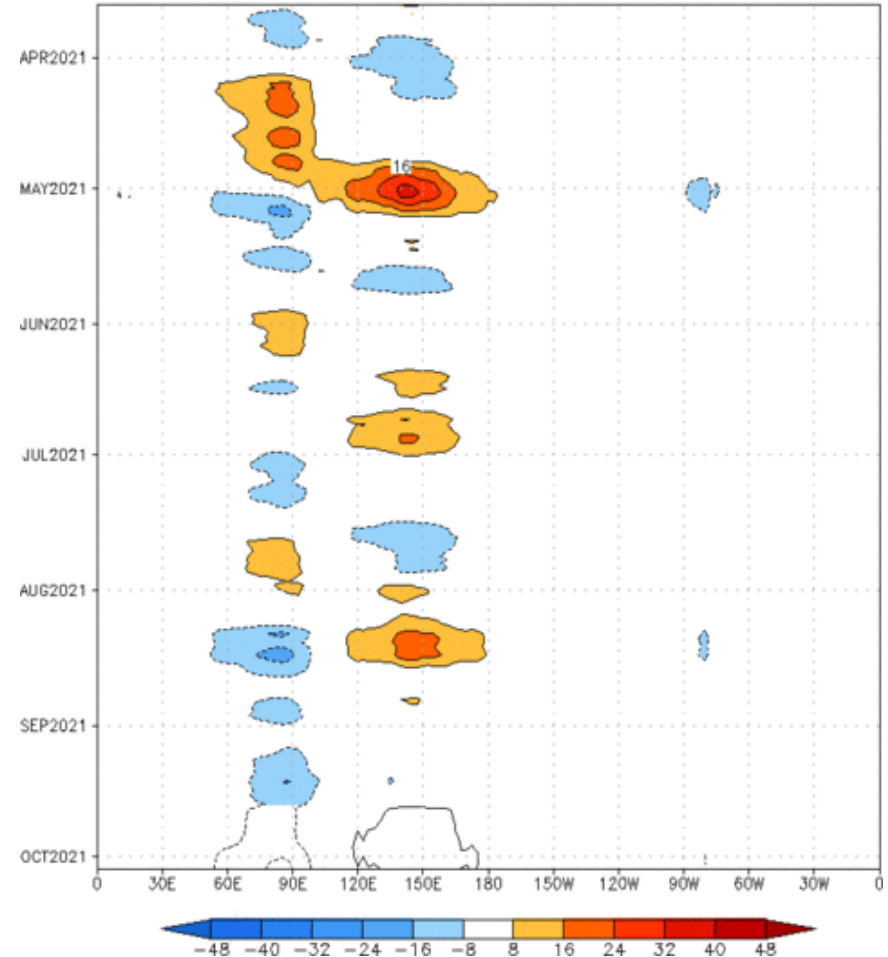
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (19 Sep 2021)



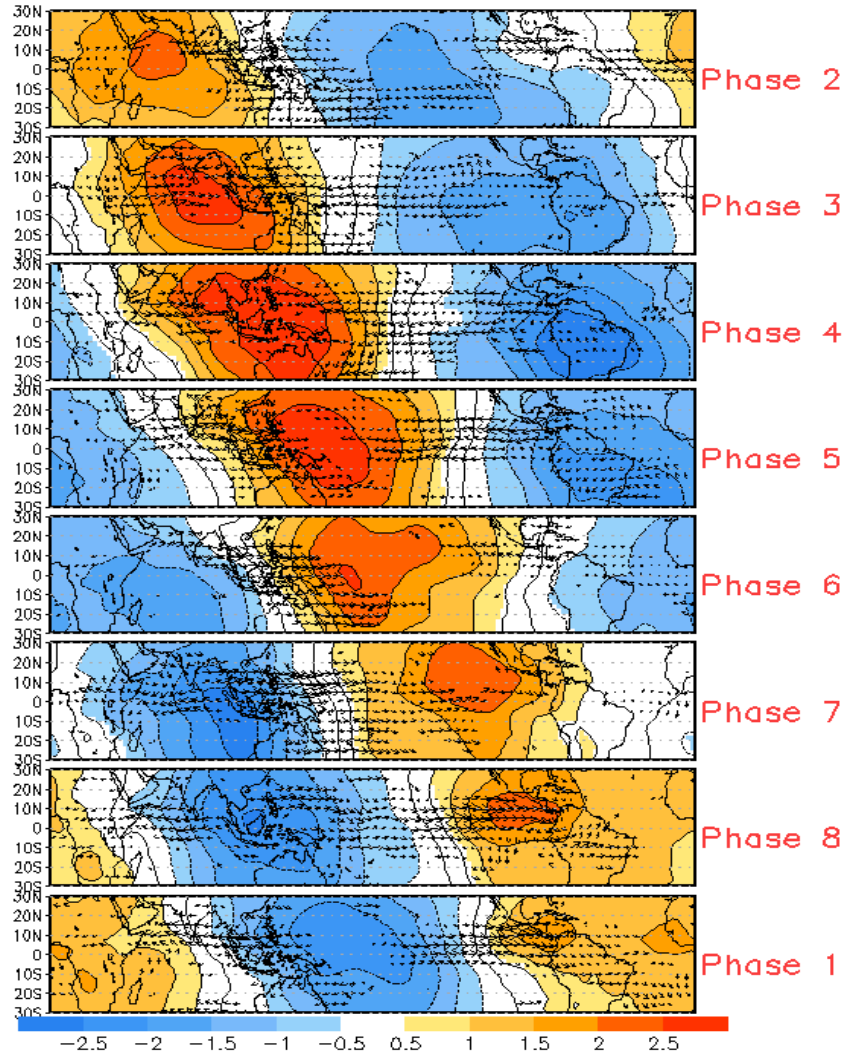
- The constructed analog forecast depicts a more stationary pattern with enhanced convection over the Indian Ocean and suppressed convection over the West Pacific.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:20-Mar-2021 to 19-Sep-2021
The unfilled contours are CA forecast reconstructed anomaly for 15 days

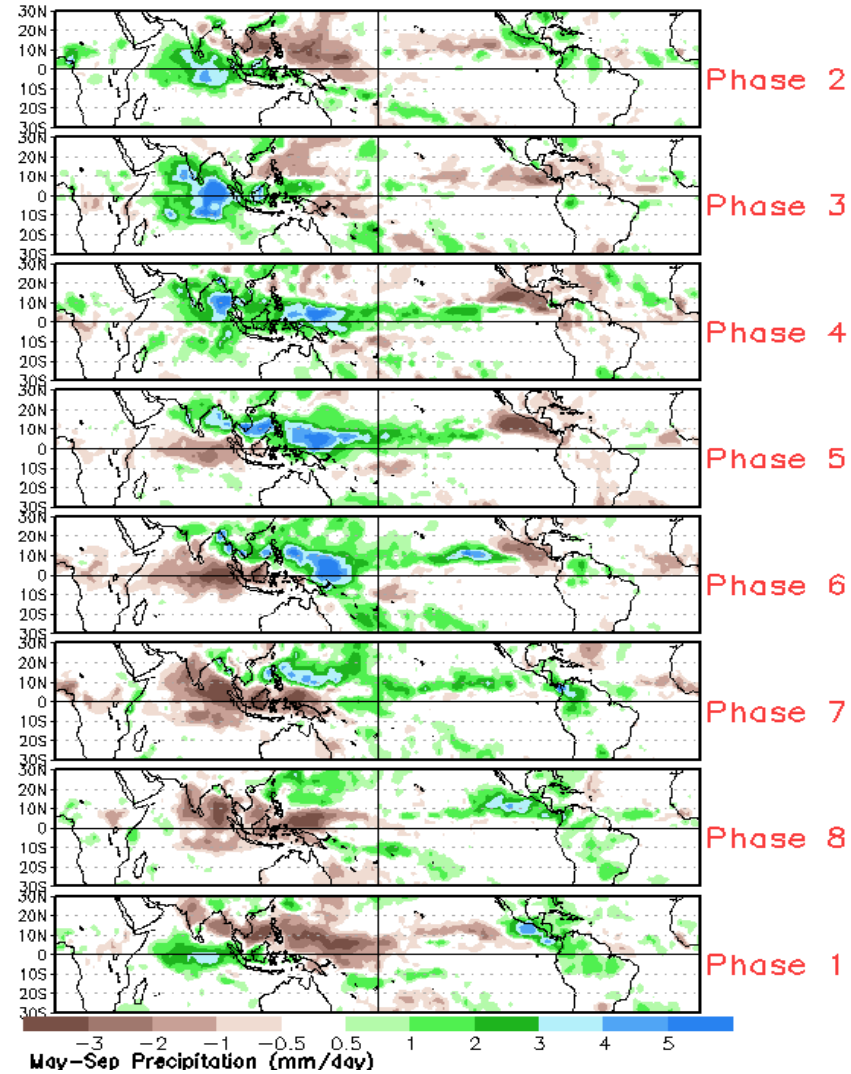


MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



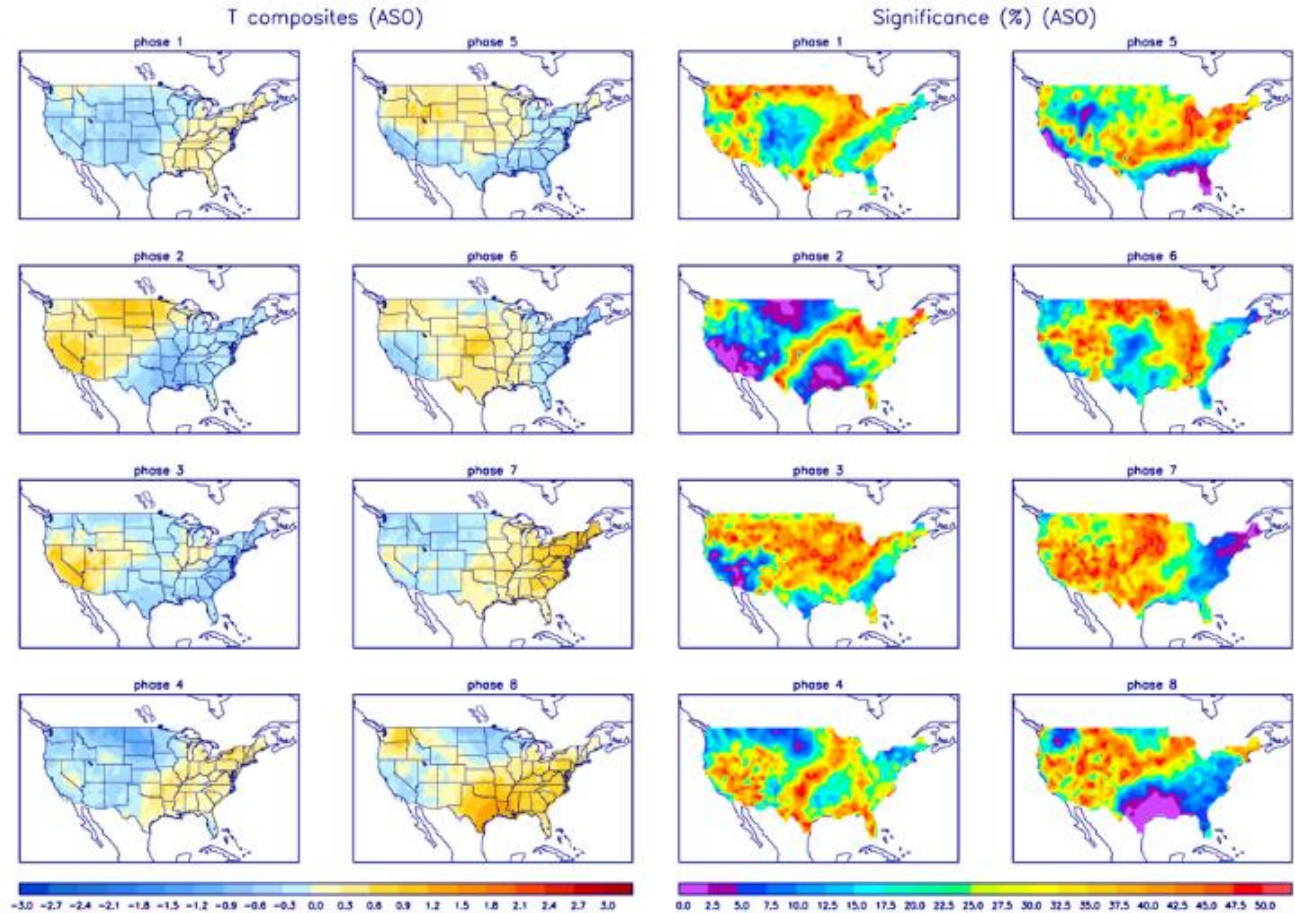
Precipitation Anomalies



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.

