

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



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

Overview

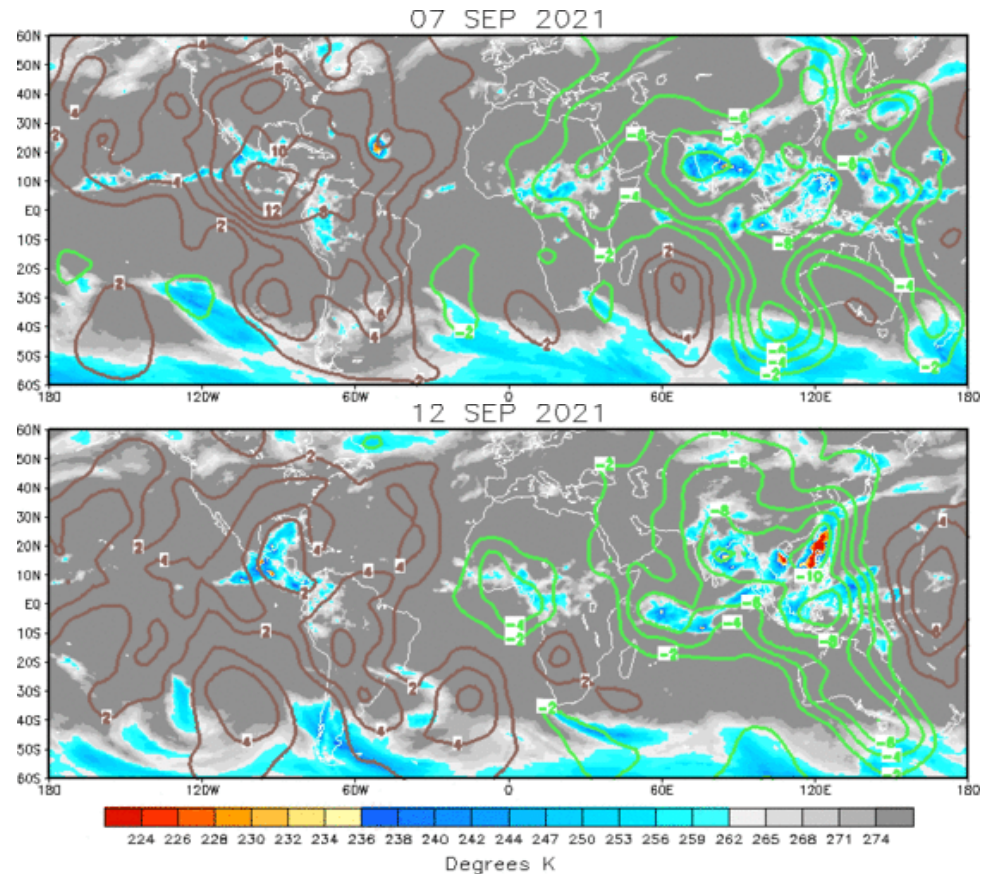
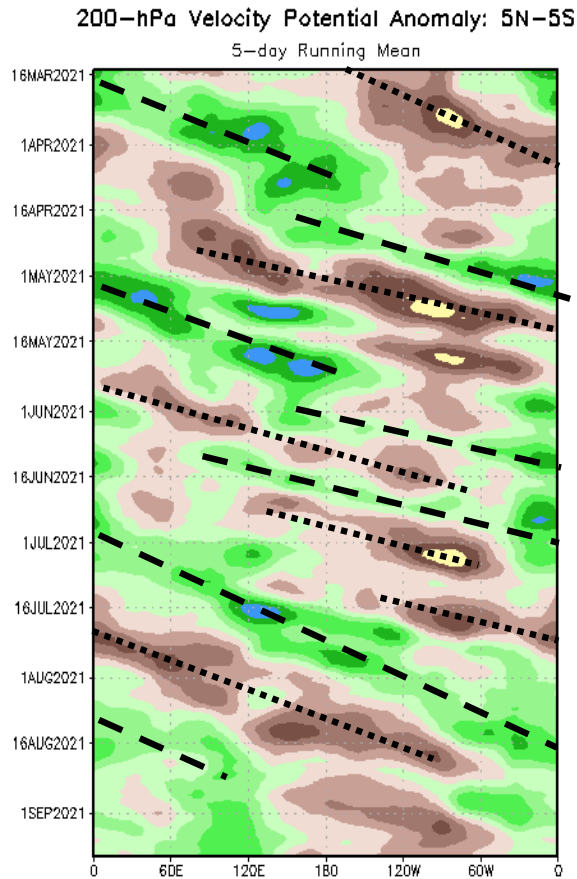
- The RMM index depicts a strengthening signal over the eastern Indian Ocean, where enhanced convection has persisted for the past several weeks.
- Dynamical model MJO index forecasts are remarkably similar to those depicted last week, with the GEFS depicting a robust MJO event crossing the Maritime Continent and the ECMWF favoring a weaker and slower evolution. There is considerable spread among the ensemble members, indicating increased uncertainty.
- An MJO signal transitioning from the Maritime Continent to the West Pacific is typically associated with a reduction in Atlantic tropical cyclone activity.
- Despite the intraseasonal pattern, easterly waves continue to emerge from the coast of Africa and tropical cyclogenesis is still possible across the Atlantic during the peak of hurricane season.

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).

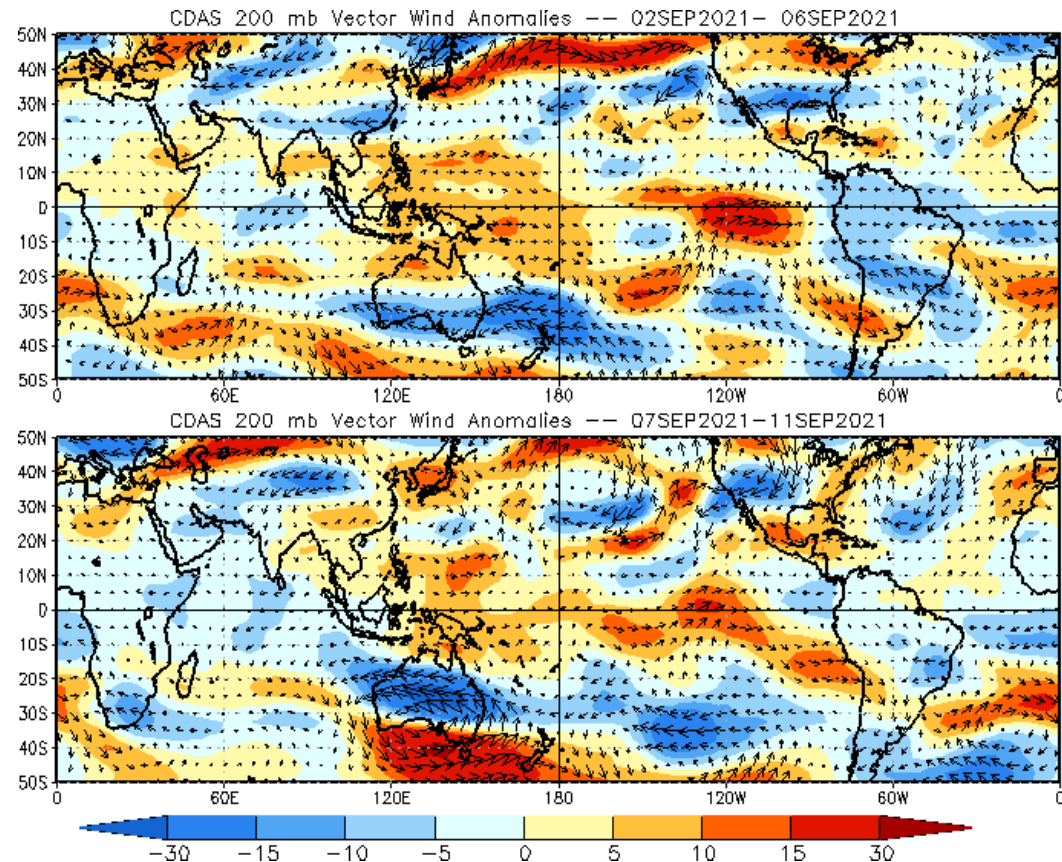
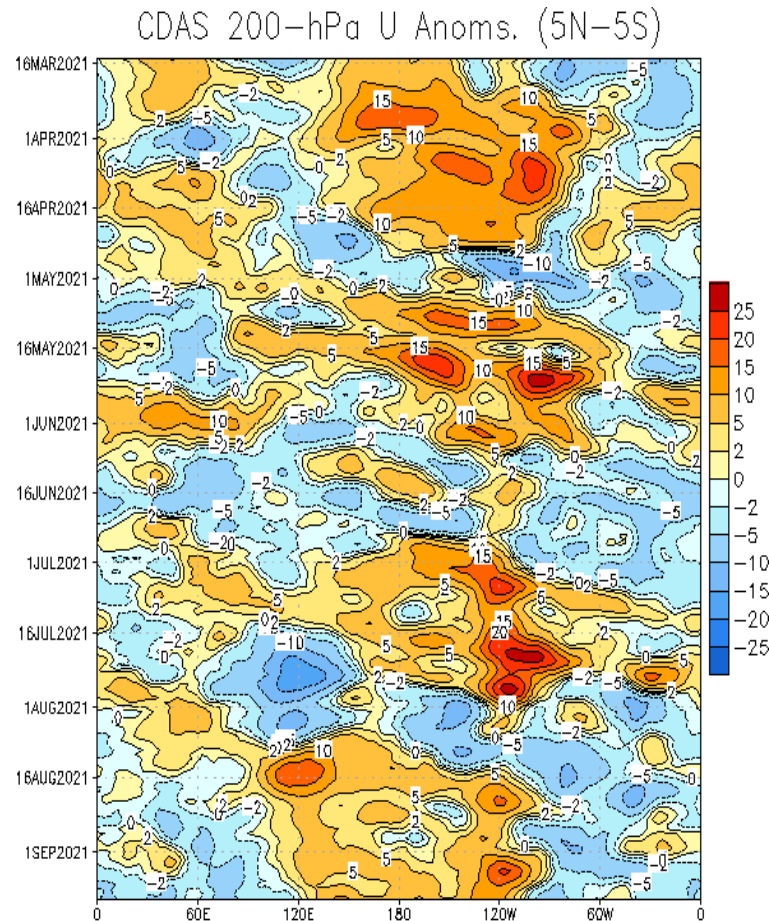
Brown shades: Anomalous convergence (unfavorable for precipitation).



- Following a period of fairly pronounced MJO activity through the Northern Hemisphere Summer months, a lower frequency pattern has emerged, favoring enhanced convection over the Indian Ocean and Maritime Continent.
- Other modes, such as transitioning monsoon patterns, Rossby waves, African easterly waves, and Kelvin waves, have influenced the pattern at times.

200-hPa Wind Anomalies

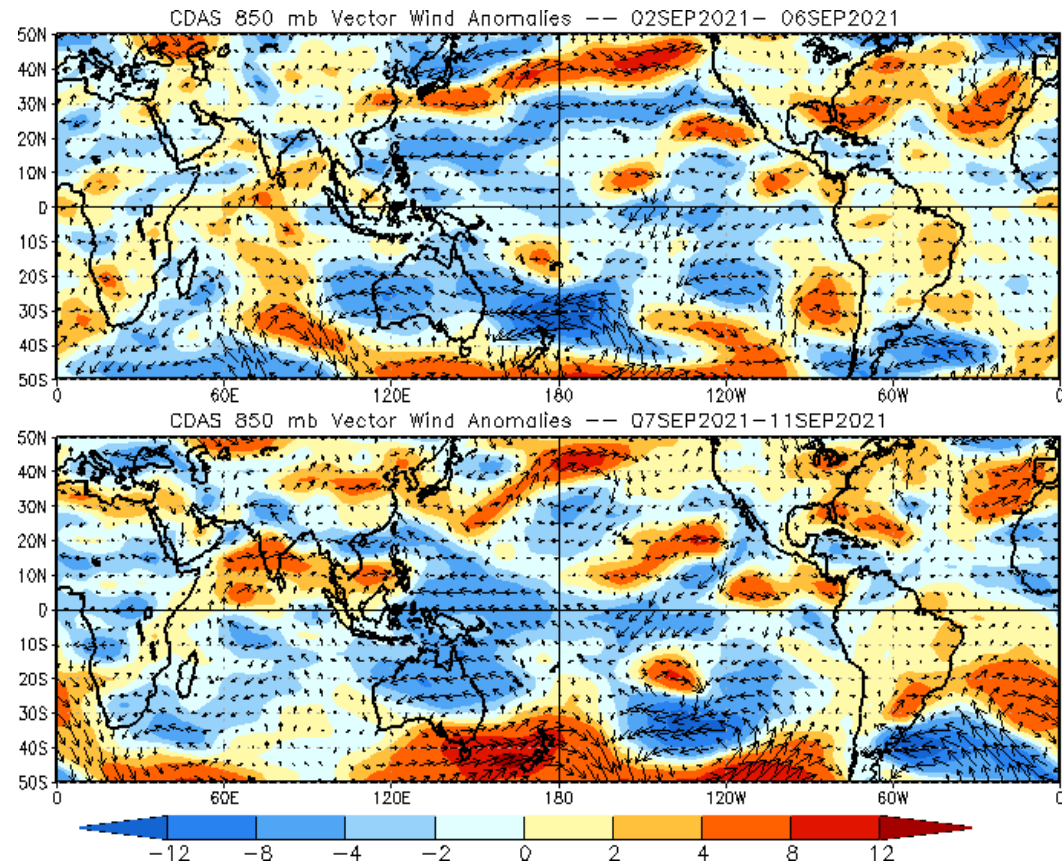
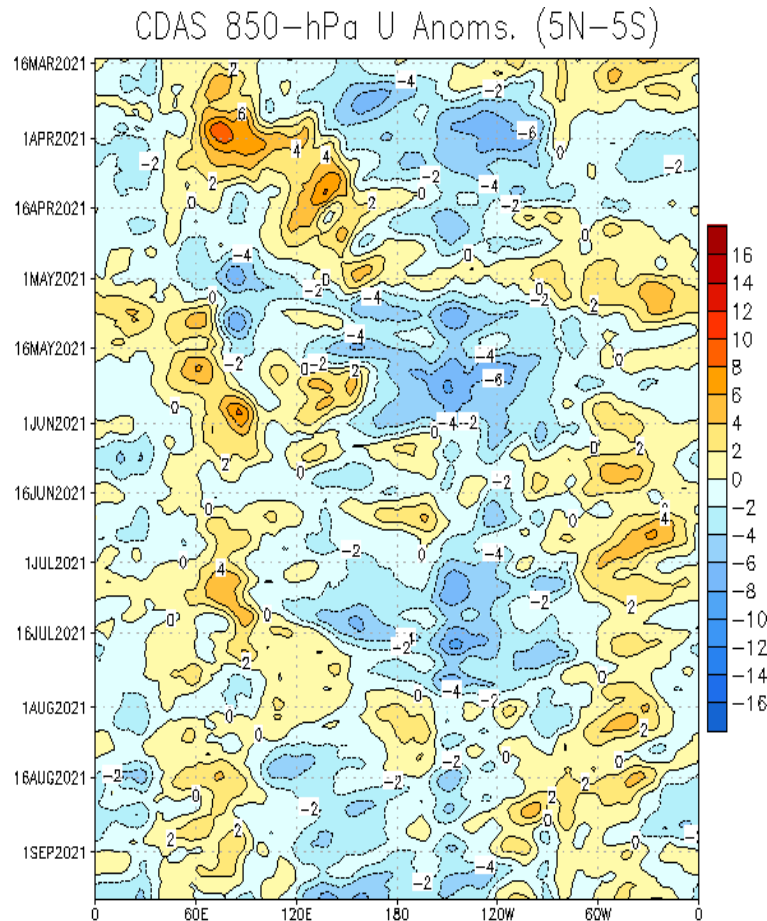
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- 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.
- The zonal extent of the westerly anomaly envelope has decreased over the past week, potentially reflective of interference between any remaining intraseasonal signal and Rossby wave activity over the East Pacific.

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.
- The low frequency state appears to have become more prominent during early September.

Outgoing Longwave Radiation (OLR) Anomalies

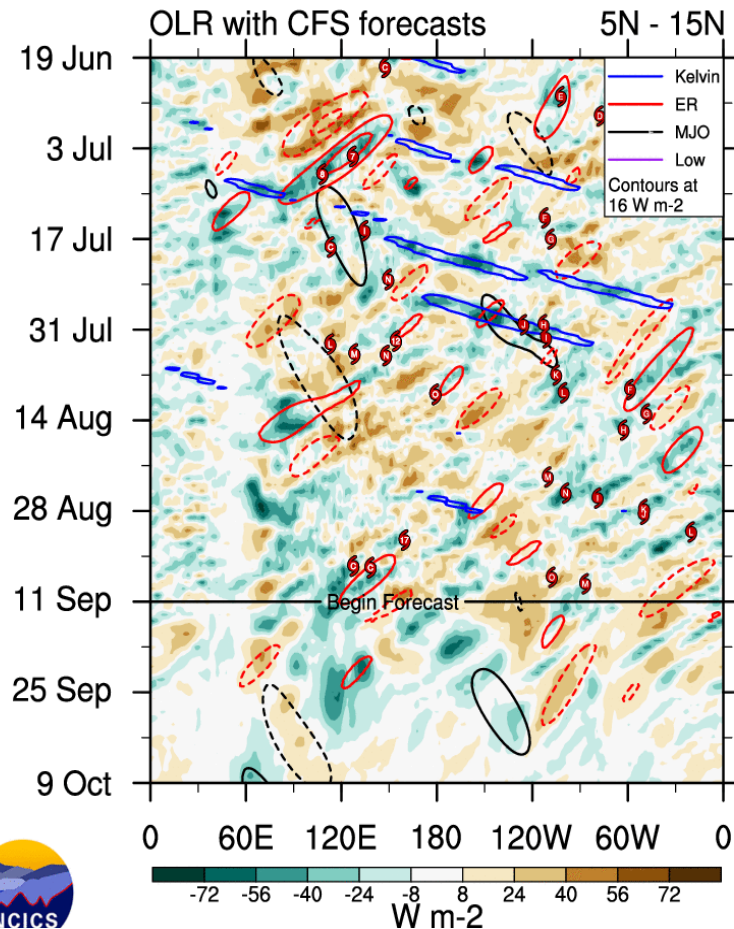
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)

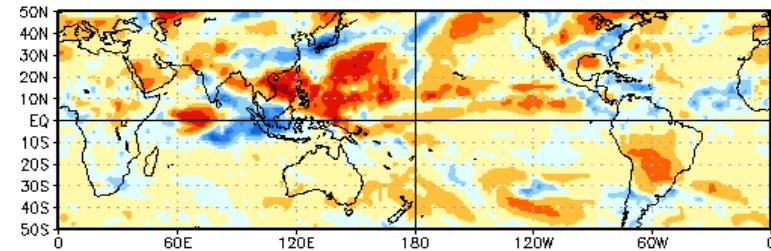
Blue shades: Anomalous convection (wetness)

Red shades: Anomalous subsidence (dryness)

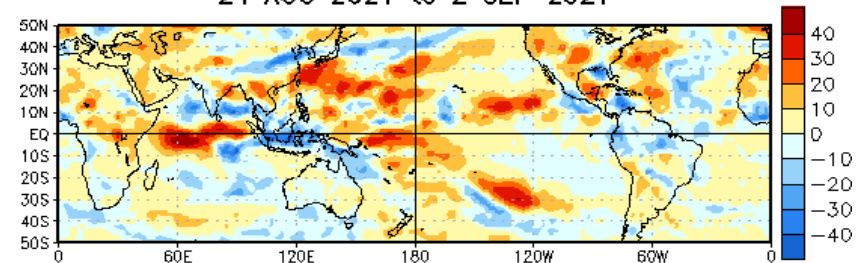
OLR Anomalies



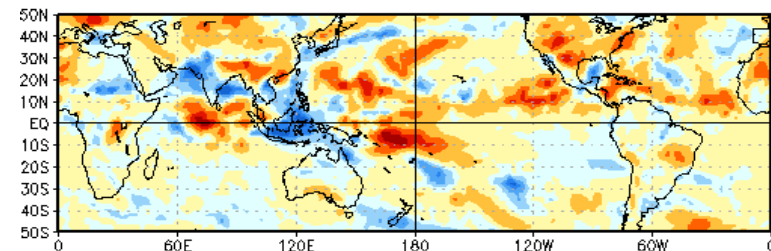
14 AUG 2021 to 23 AUG 2021



24 AUG 2021 to 2 SEP 2021



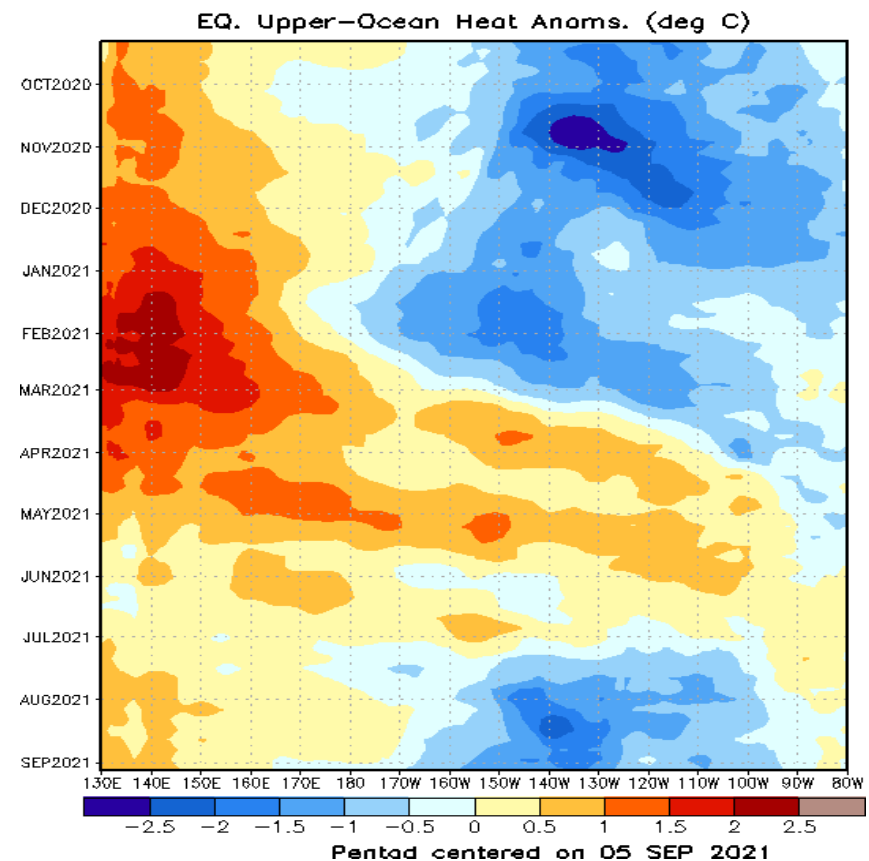
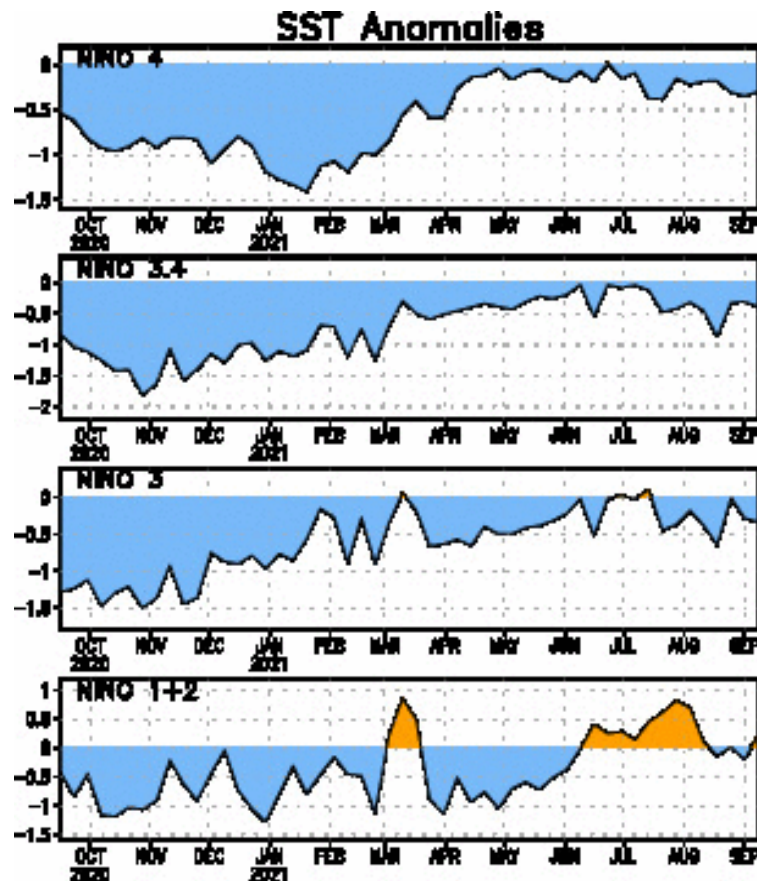
3 SEP 2021 to 12 SEP 2021



- Enhanced convection extended from the Maritime Continent northwestward to the monsoon regions of South and Southeast Asia during early September.
- Rossby wave activity over the Pacific limited any eastward progression of the enhanced convective phase of the intraseasonal signal.



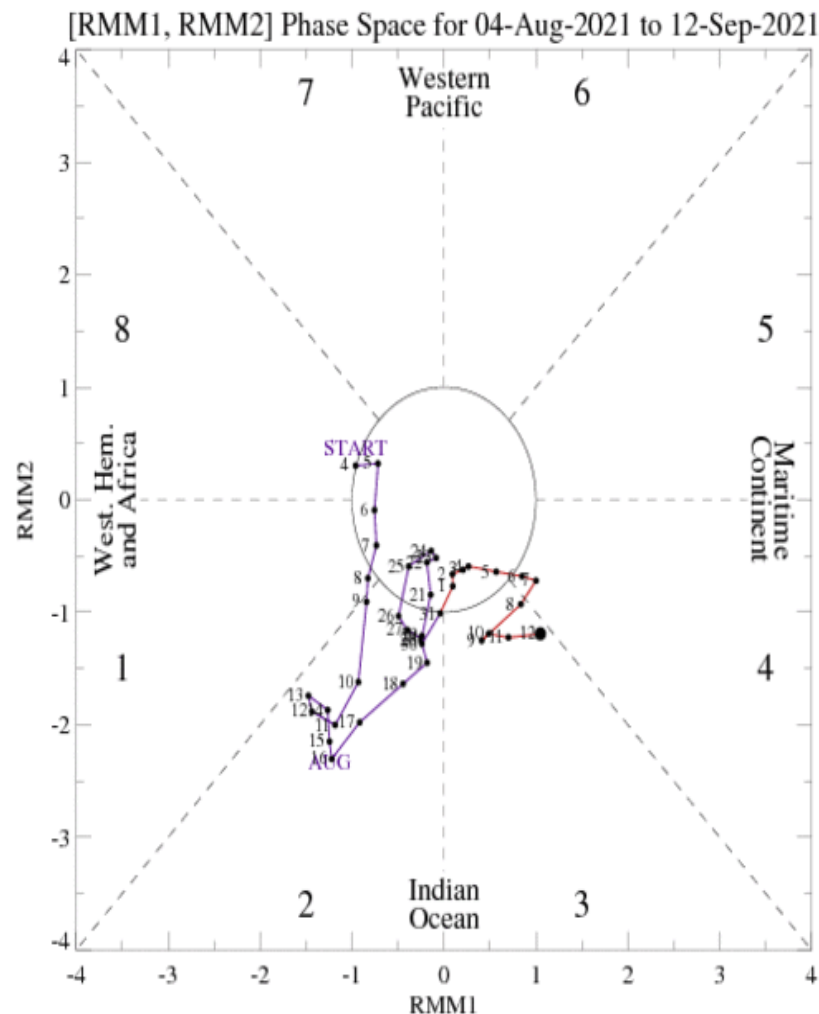
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Multiple episodes of oceanic Kelvin wave activity led to a 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 Nino regions except the far east Pacific.

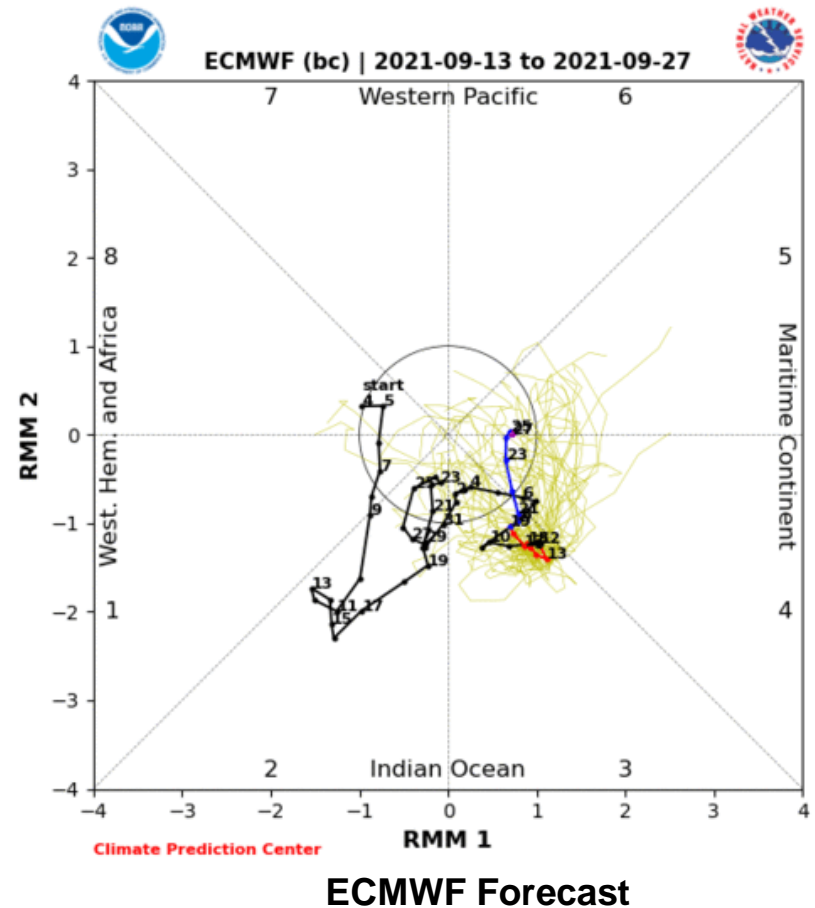
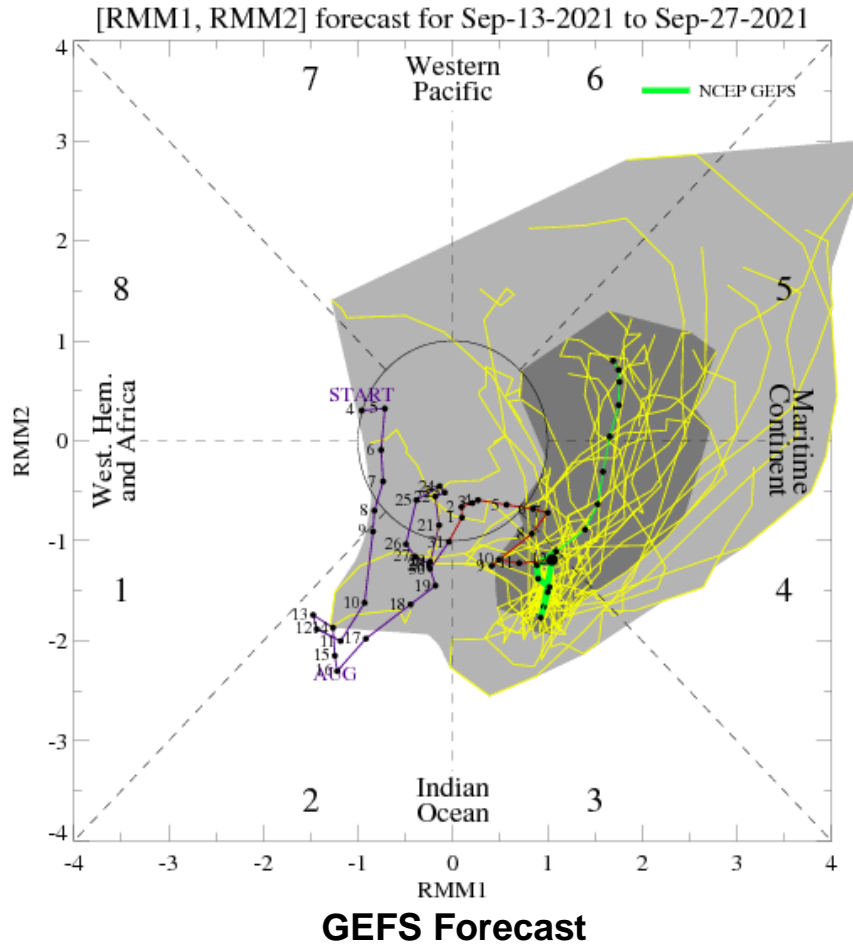
MJO Index: Recent Evolution

- The RMM index has had a slow meandering transit across the Indian Ocean over the past few weeks, indicative of a low frequency pattern punctuated by interference from faster transient modes.
- The amplitude of the RMM index has increased during the past week as the zonal wind and OLR anomalies became more consistent with an intraseasonal 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

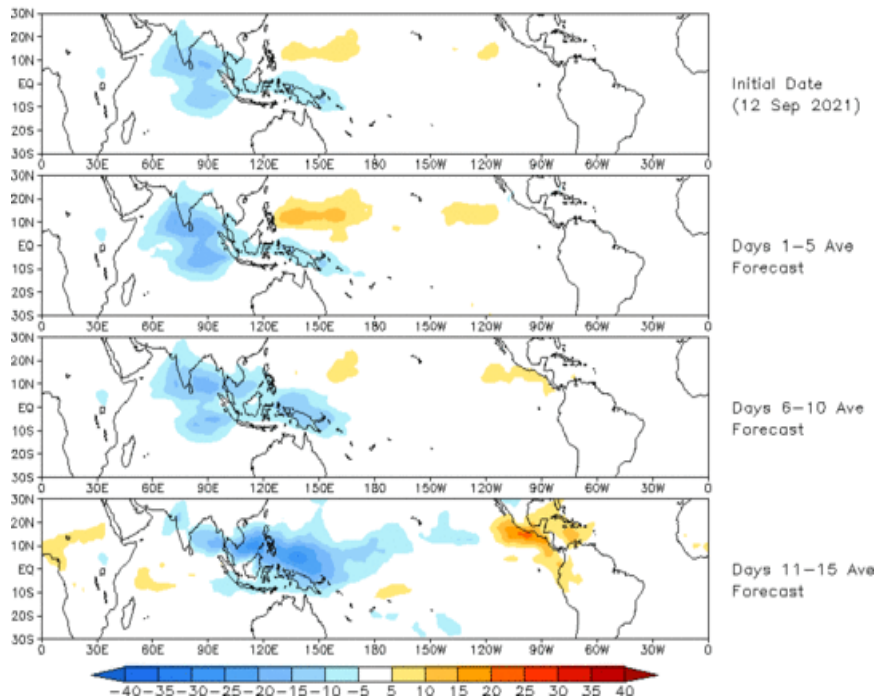


- The GEFS remains bullish forecasting a robust Maritime Continent MJO, similar to last week. Some GFS ensemble members depict a very strong event.
- The ECMWF also shows renewed eastward propagation, but slower and with a weaker amplitude overall.
- Some ensemble members from each model system depict very different solutions (e.g., a return to Phase-1), highlighting increased uncertainty.

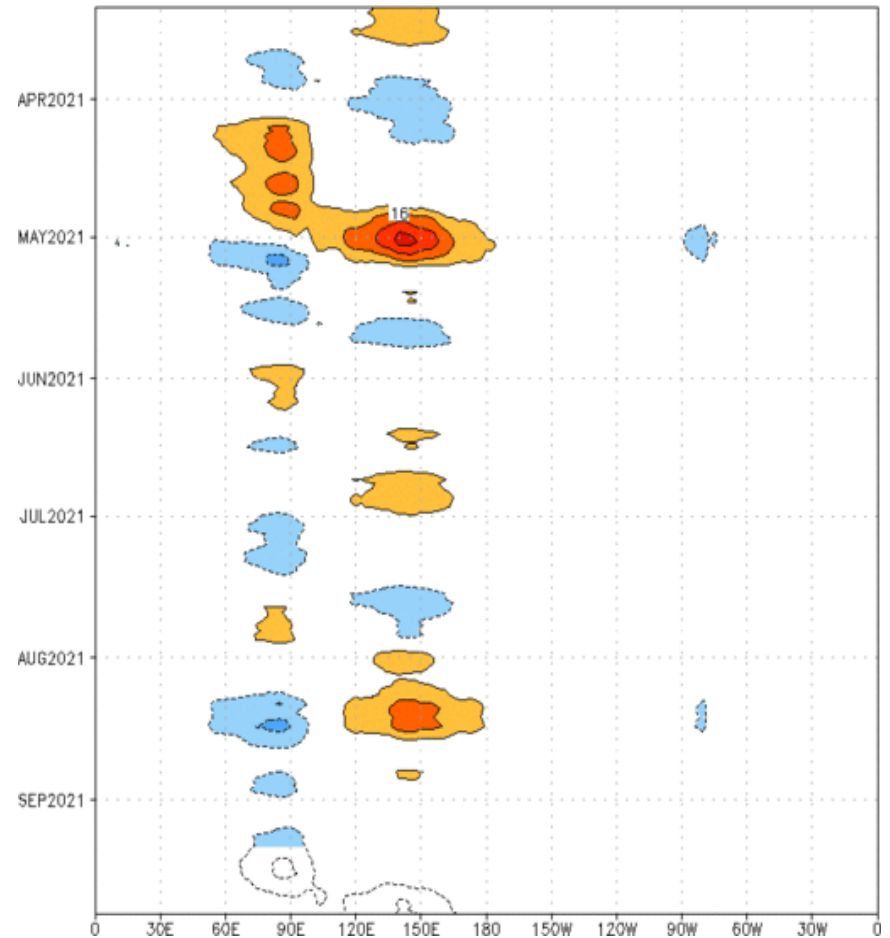
MJO: GEFS Forecast Evolution

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: 12 Sep 2021
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S,7.5°N] (cint:4Wm^{-2}) Period:12-Mar-2021 to 11-Sep-2021
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

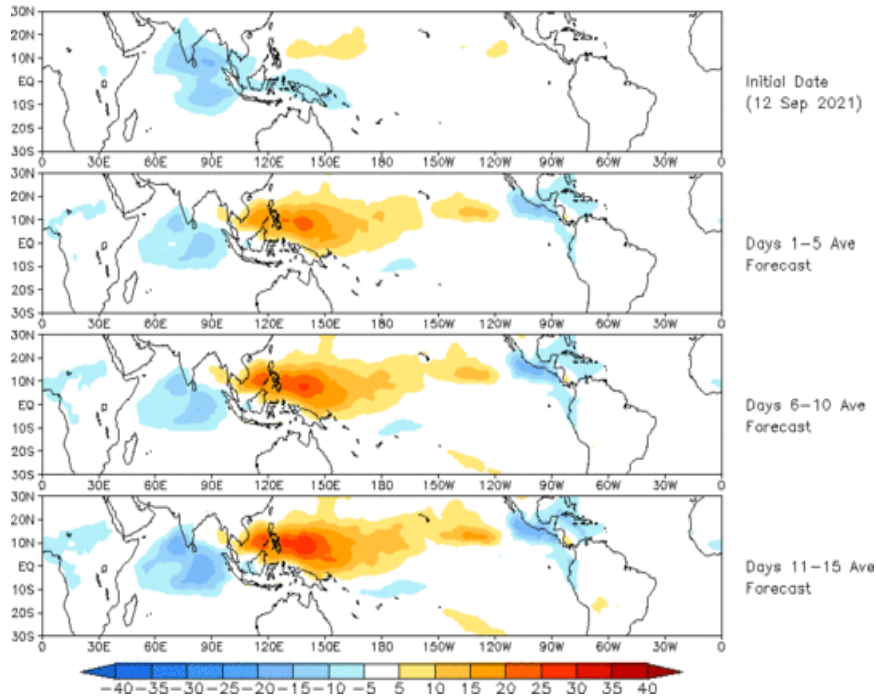


- Similar to last week, the GEFS RMM-based OLR anomaly forecast features a strengthening signal and a progressive pattern, with enhanced convection transitioning from the eastern Indian Ocean to the West Pacific.

MJO: Constructed Analog Forecast Evolution

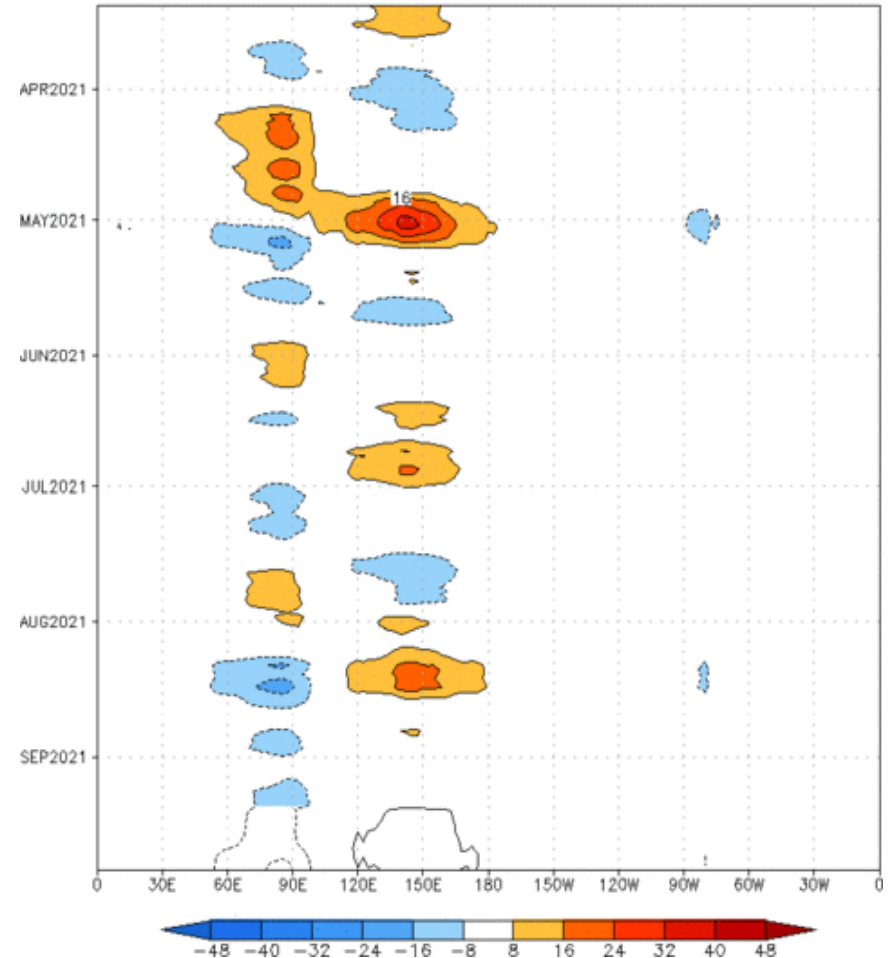
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (12 Sep 2021)



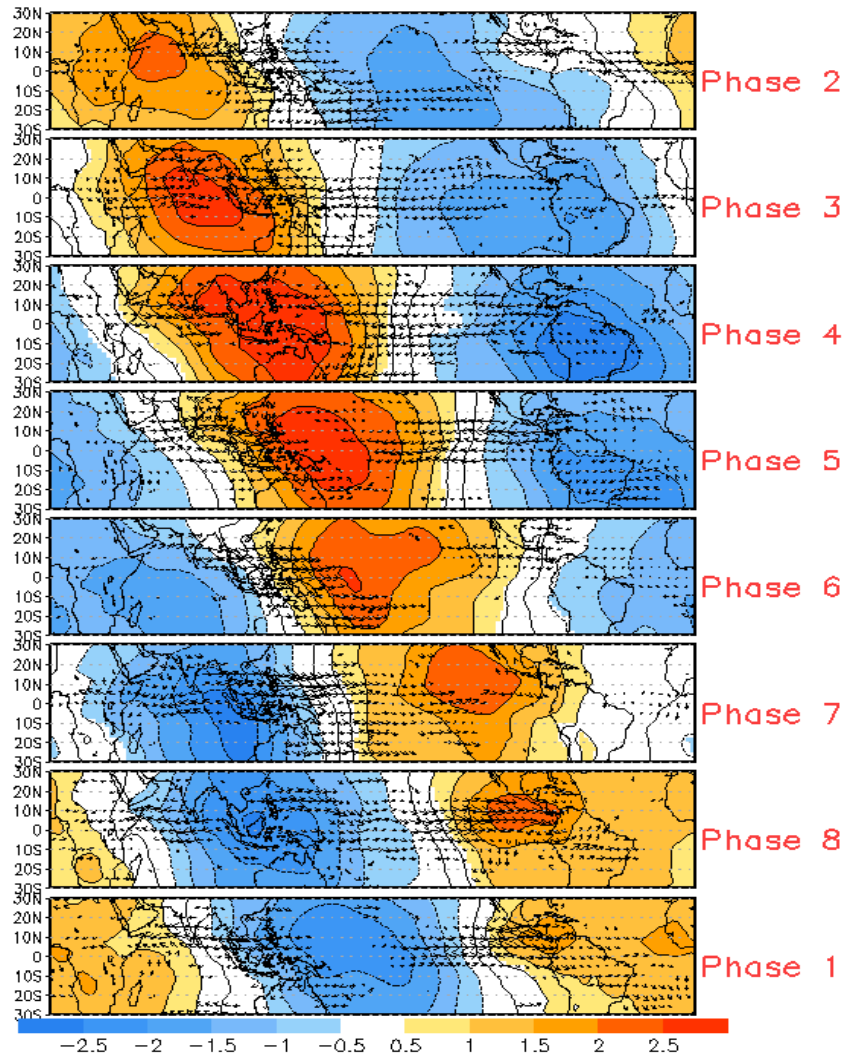
- The constructed analog forecast is also similar to last week's and depicts a strengthening but more stationary pattern.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:13-Mar-2021 to 12-Sep-2021
The unfilled contours are CA forecast reconstructed anomaly for 15 days

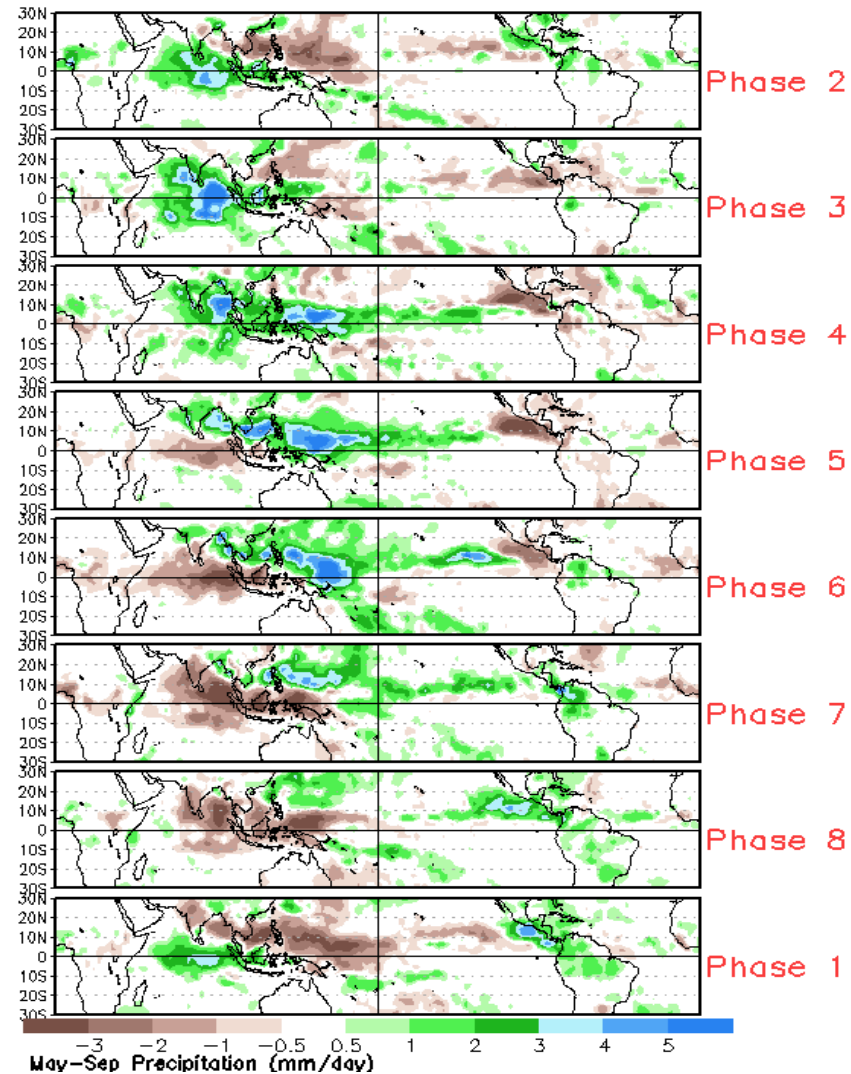


MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



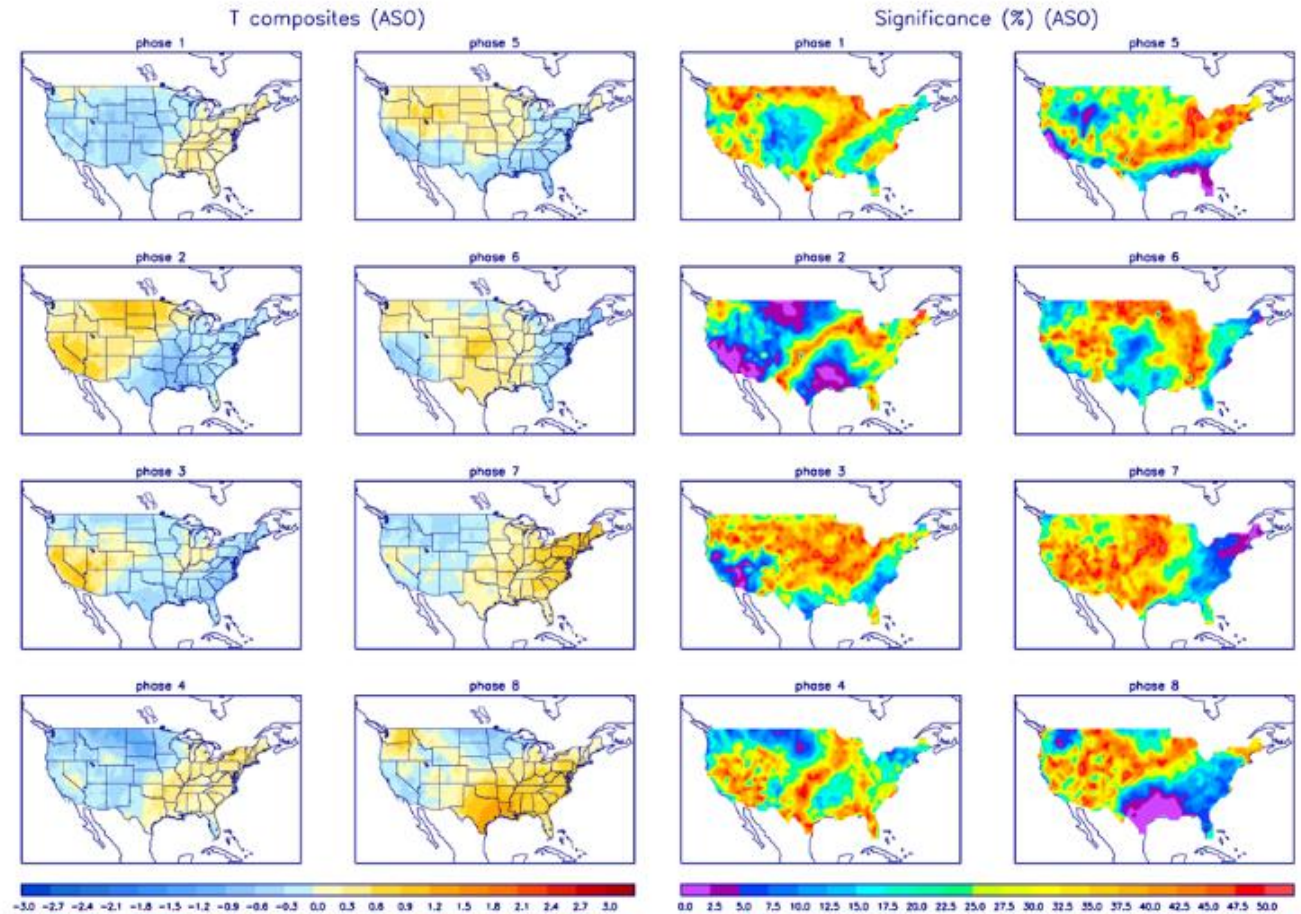
Precipitation Anomalies



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.

