

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
15 November 2021

Overview

- The circulation pattern over the Equatorial Pacific returned to being consistent with La Niña, following a disruption during the past month tied to a convectively coupled Kelvin Wave.
- Some strengthening of the intraseasonal signal was observed during the past week across the Indian Ocean and Maritime Continent as this Kelvin Wave constructively interfered with the established low frequency base state.
- Model spread remains very high in terms of MJO propagation, and it is more likely that the current enhanced signal will gradually wane during the next 2 weeks as a result of the well pronounced suppressed convection to the west of the Date Line preventing any coherent eastward propagation of the MJO.

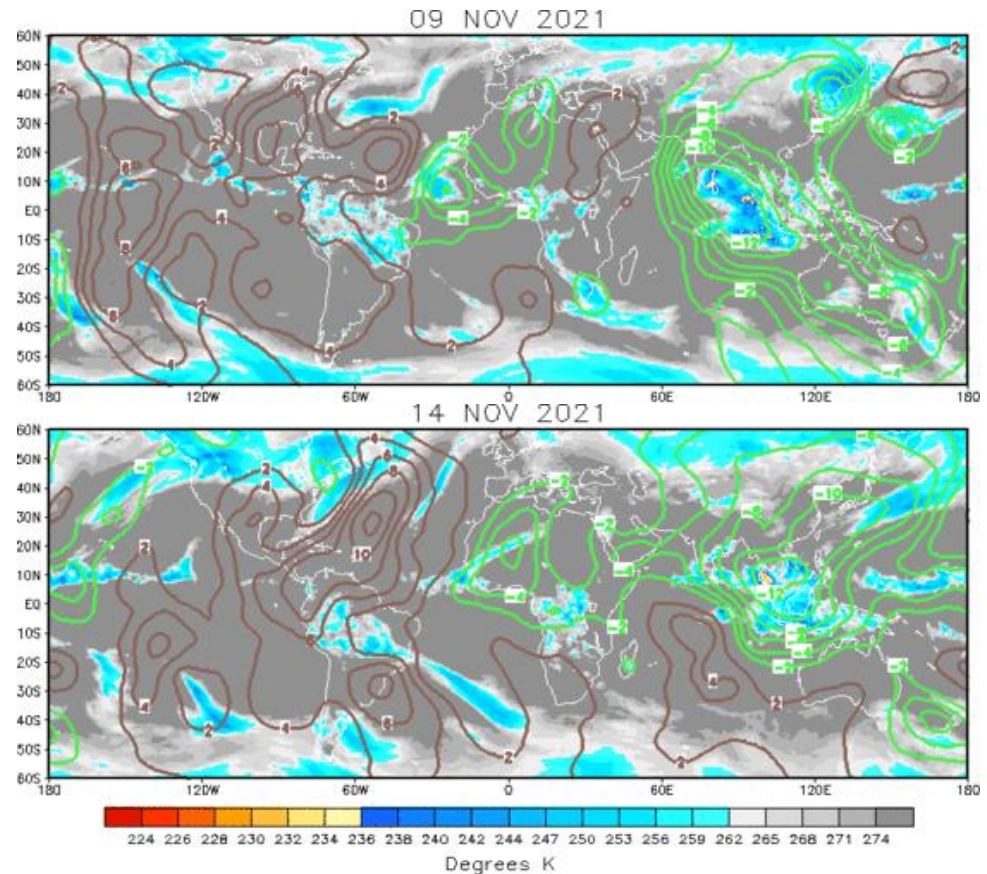
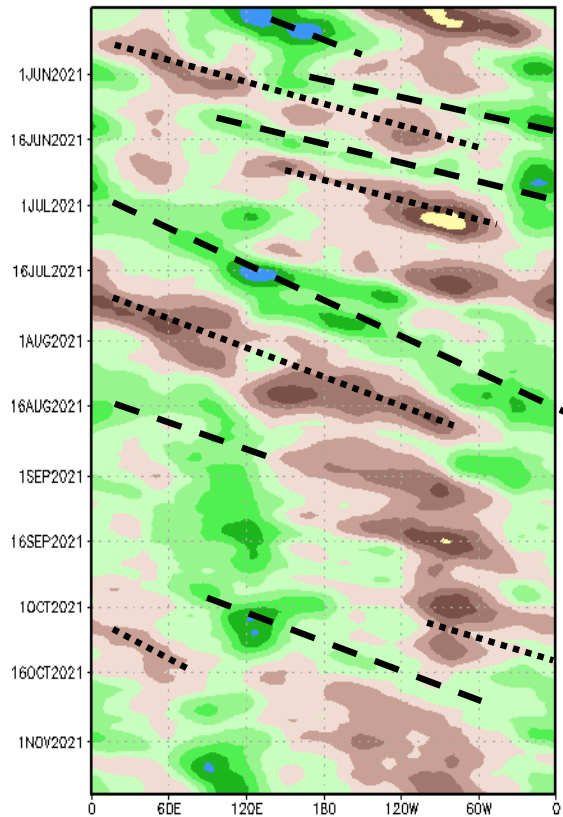
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

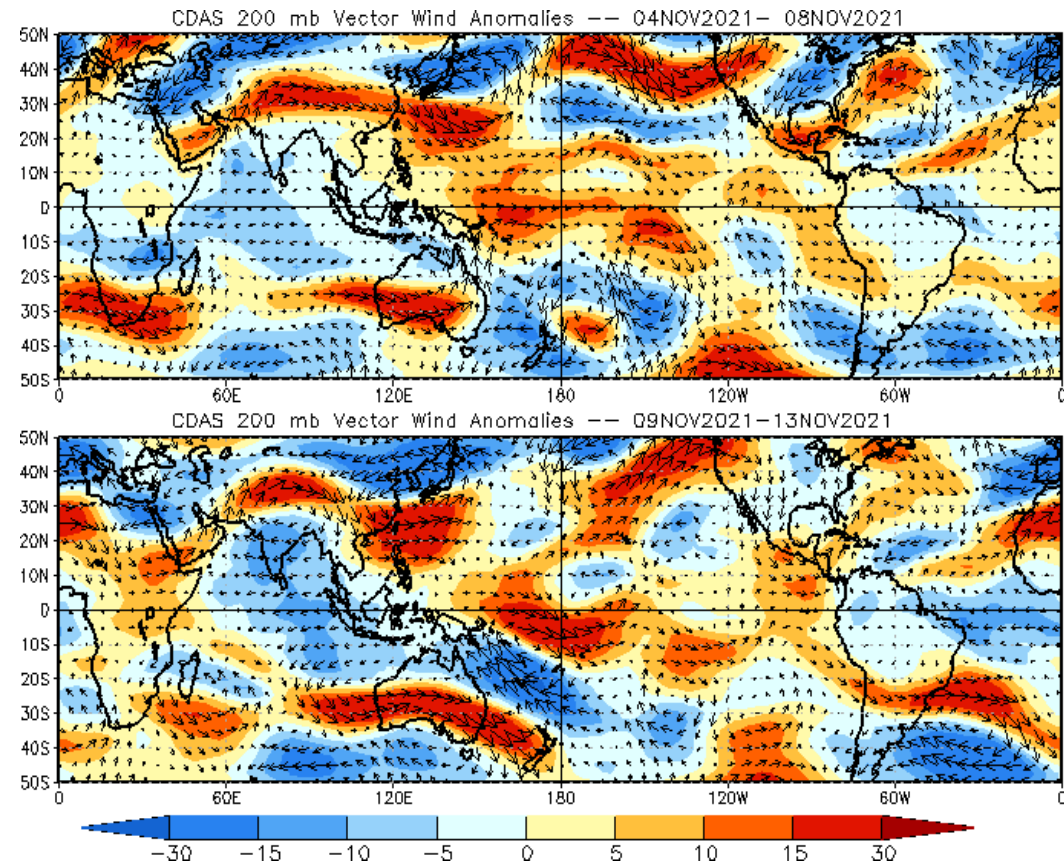
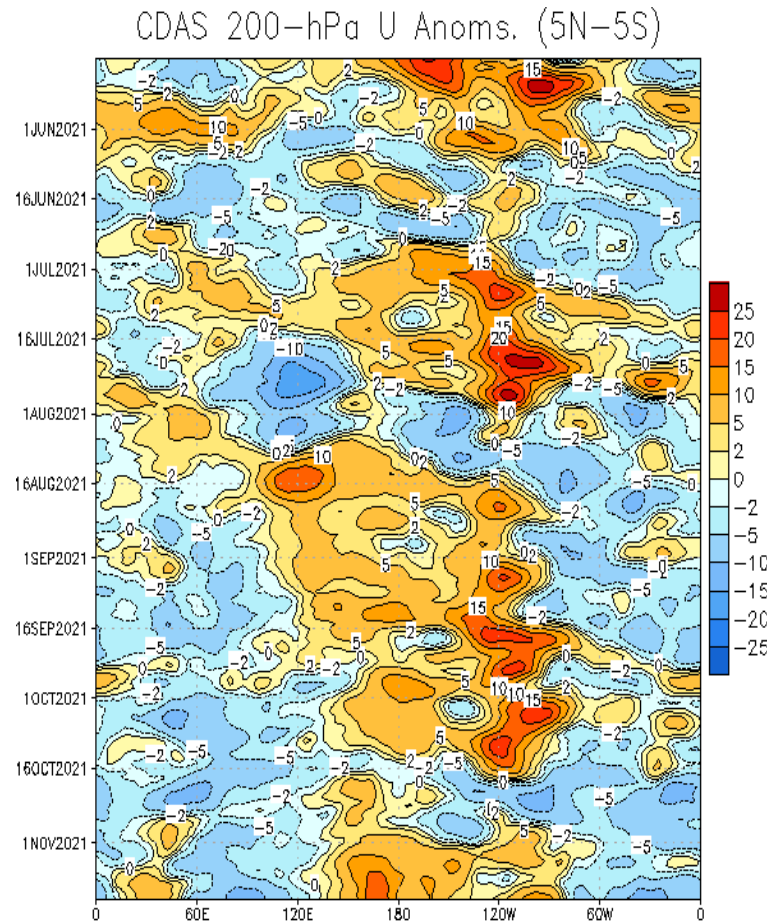
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- Amplification of the upper-level velocity potential apparent over the Indian Ocean and Maritime Continent as a convectively coupled Kelvin wave constructively interfered with the established low frequency state.
- Suppressed convection continues across the Eastern Pacific and much of the Atlantic, with some enhancement contributed to weak Rossby wave activity in the vicinity of West Africa.

200-hPa Wind Anomalies

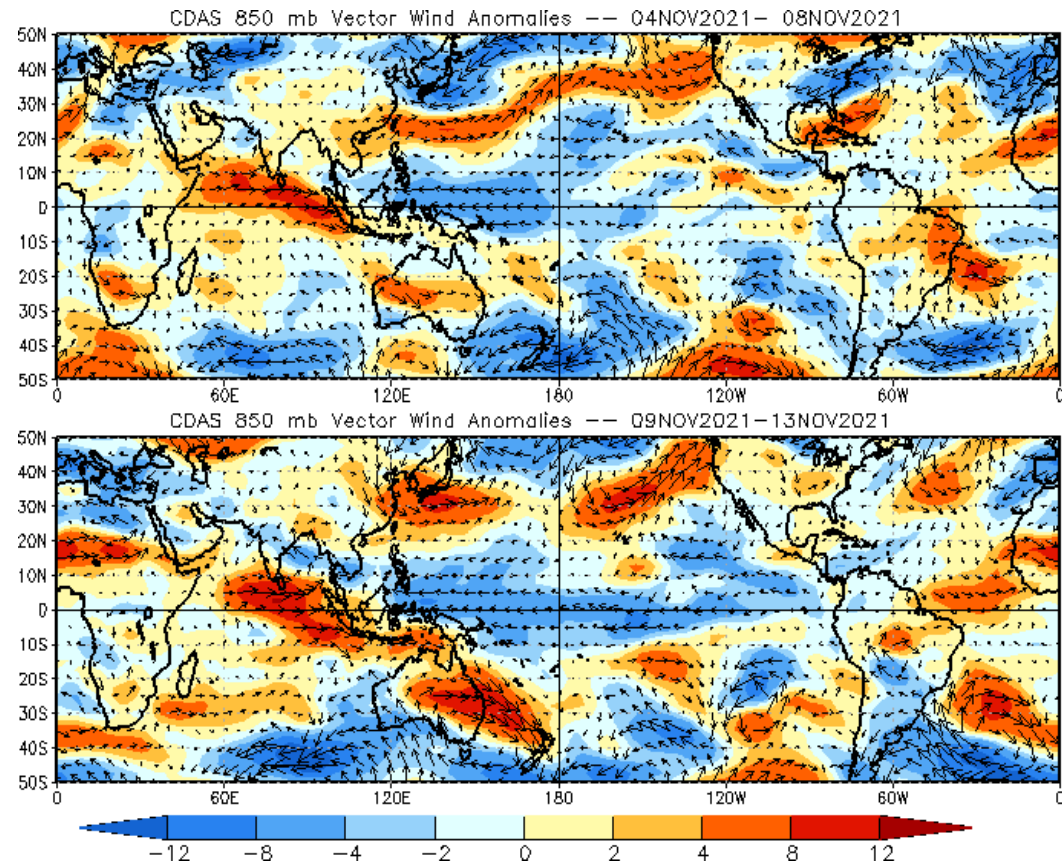
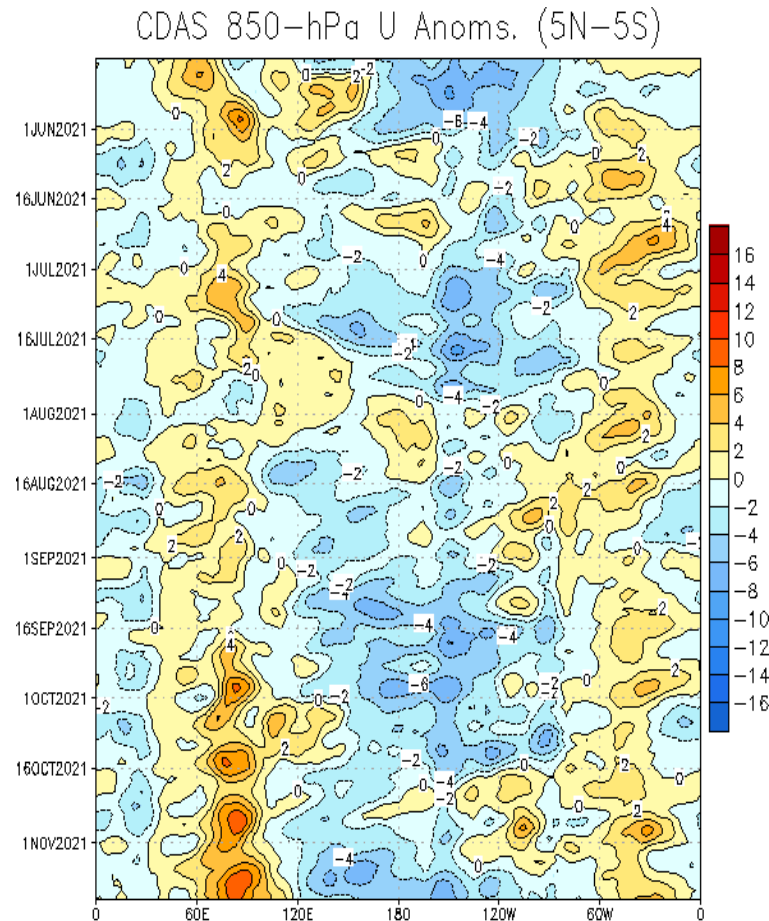
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- During mid to late October, an eastward propagating Kelvin Wave resulted in anomalous upper-level easterlies developing across the Pacific.
- As this feature continued eastward, anomalous westerlies have since redeveloped over the Pacific, consistent with the La Niña base state.
- Anomalous easterlies strengthened across the Indian Ocean and Maritime Continent.

850-hPa Wind Anomalies

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



- Anomalous low-level easterlies have redeveloped across the Pacific, consistent with the eastward propagating Kelvin Wave exiting the region.
- Anomalous westerlies have strengthened across the Indian Ocean aiding in the enhancement of low-level convergence across the eastern Indian Ocean and Maritime Continent.
- Anomalous westerlies remain over the Atlantic.

Outgoing Longwave Radiation (OLR) Anomalies

Green shades: Anomalous convection (wetness)

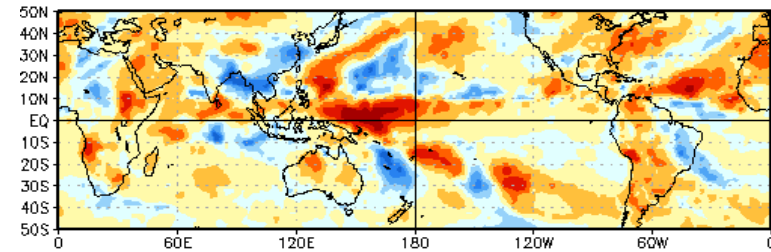
Brown shades: Anomalous subsidence (dryness)

Blue shades: Anomalous convection (wetness)

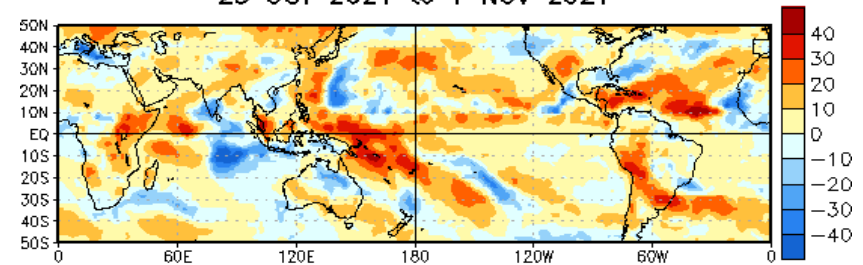
Red shades: Anomalous subsidence (dryness)

OLR Anomalies

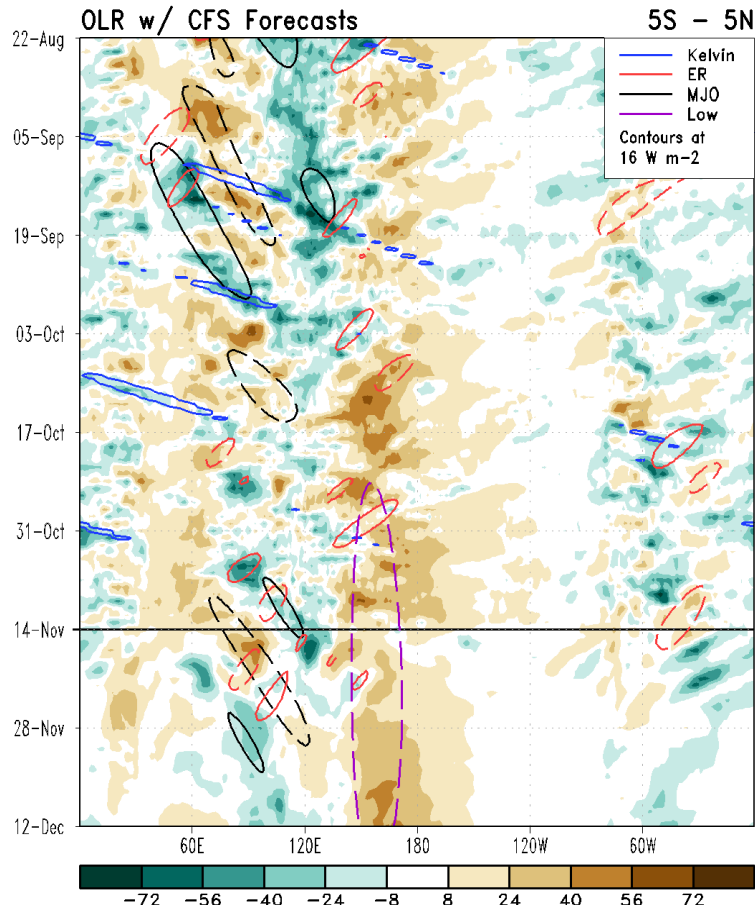
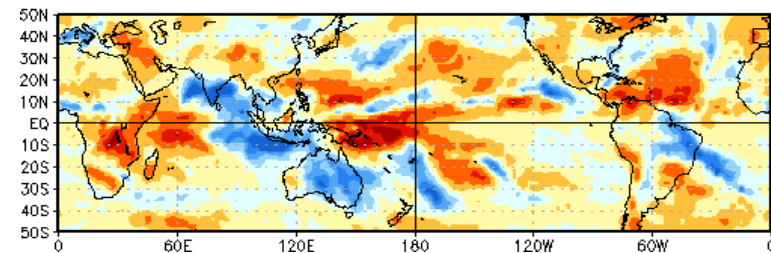
13 OCT 2021 to 22 OCT 2021



23 OCT 2021 to 1 NOV 2021

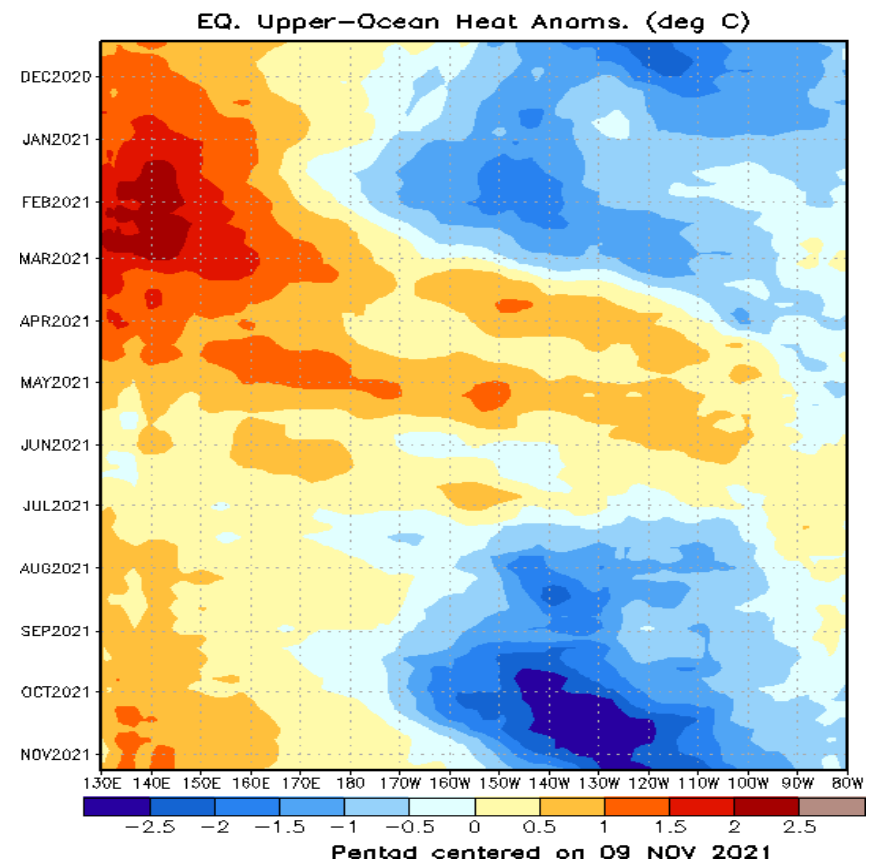
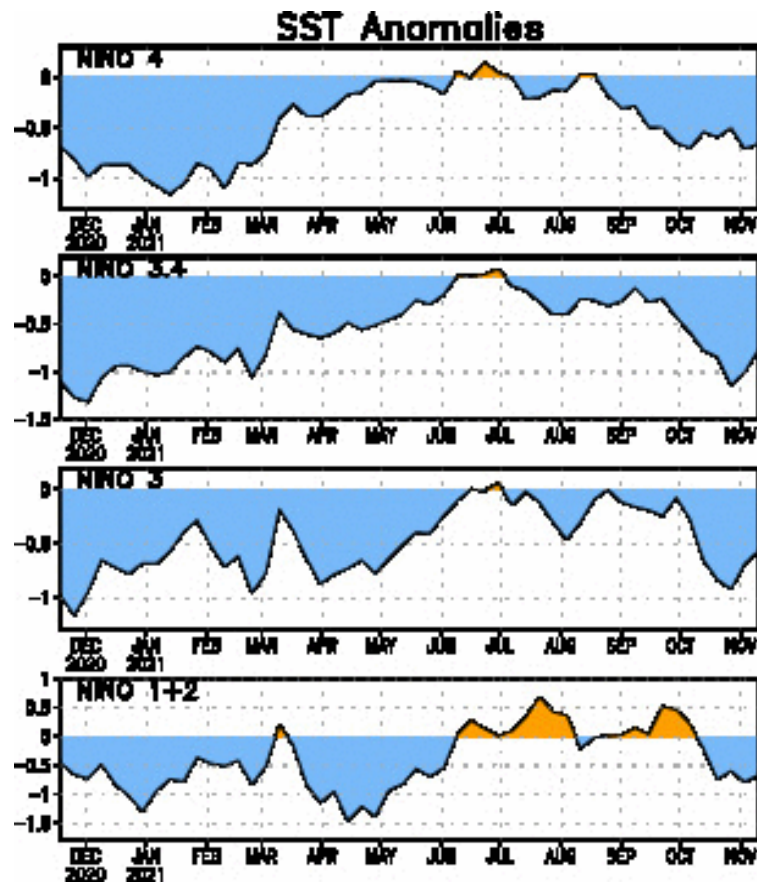


2 NOV 2021 to 11 NOV 2021



- Enhanced convection developed across the eastern Indian Ocean and Maritime Continent, consistent with the evolving circulation pattern.
- Suppressed convection remains well established just to the west of the Date Line, likely preventing any eastward MJO propagation.

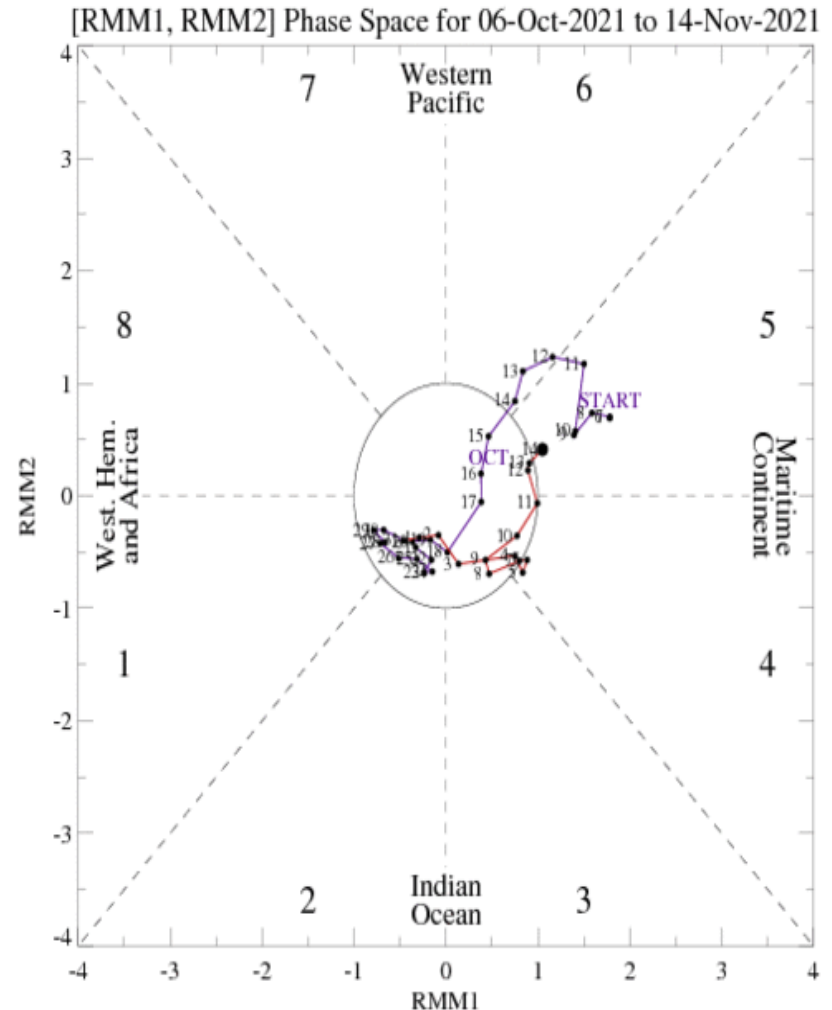
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Upper-ocean heat content is markedly below average across much of the central and eastern equatorial Pacific, as this sub-surface cooling has expanded eastward since early October.
- Consistent with La Niña, below-normal sea surface temperatures (SSTs) continue to be observed within all Niño regions, with SSTs holding steady or warming slightly in the past month possibly due to the disruption of the low frequency signal during October.

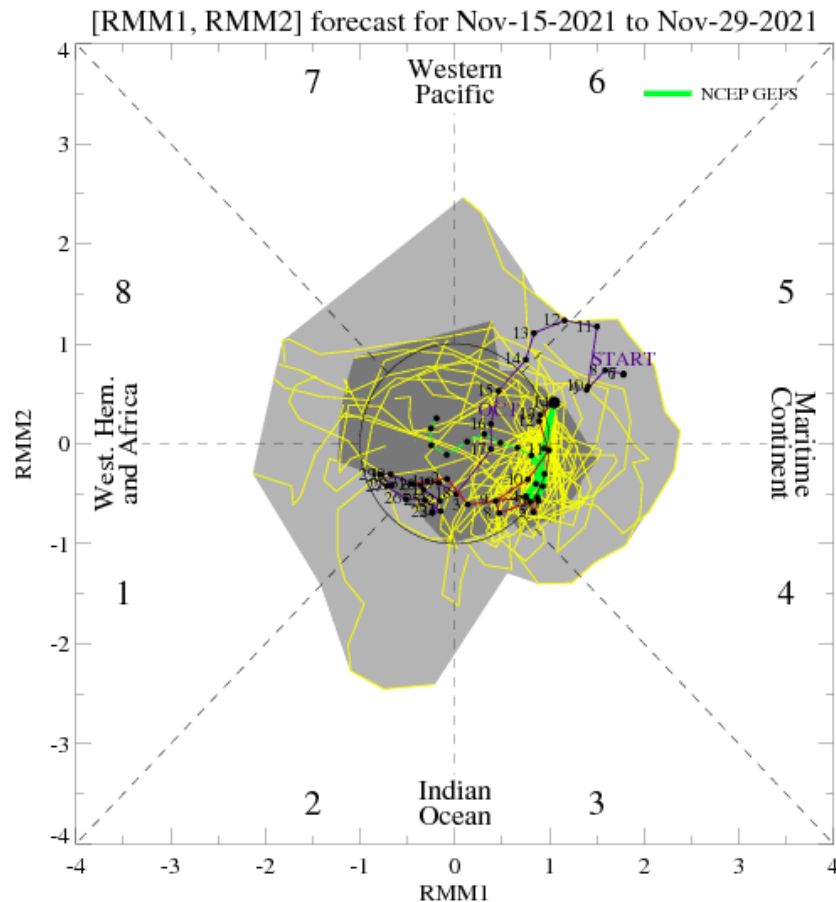
MJO Index: Recent Evolution

- The RMM index indicates some strengthening of the intraseasonal signal along with eastward propagation over the Maritime Continent during the past week, but its magnitude still remains weak and near the edge of the RMM unit circle.
- The eastward evolution of this signal is likely tied to the interaction between a Kelvin Wave and the low frequency state rather than a true MJO signal.

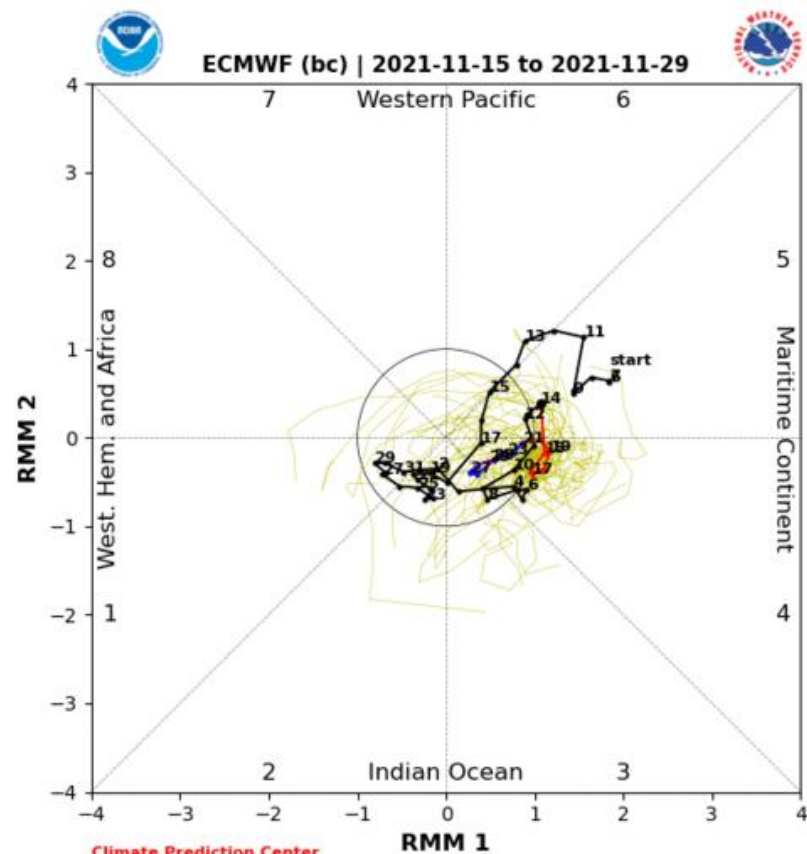


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



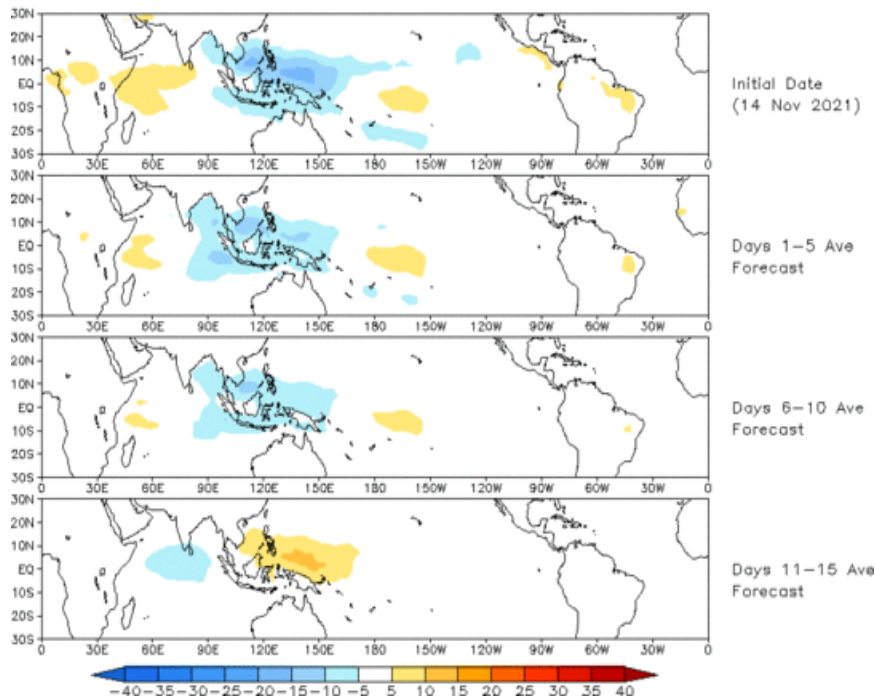
ECMWF Forecast

- GEFS and ECMWF ensemble means indicate a slight retrogression of the intraseasonal signal as the low frequency state prevents eastward propagation.
- Ensemble spread is very high, further supporting the lack of a coherent MJO signal emerging during the next 2 weeks, with the signal in more amplified members likely tied to higher frequency activity.

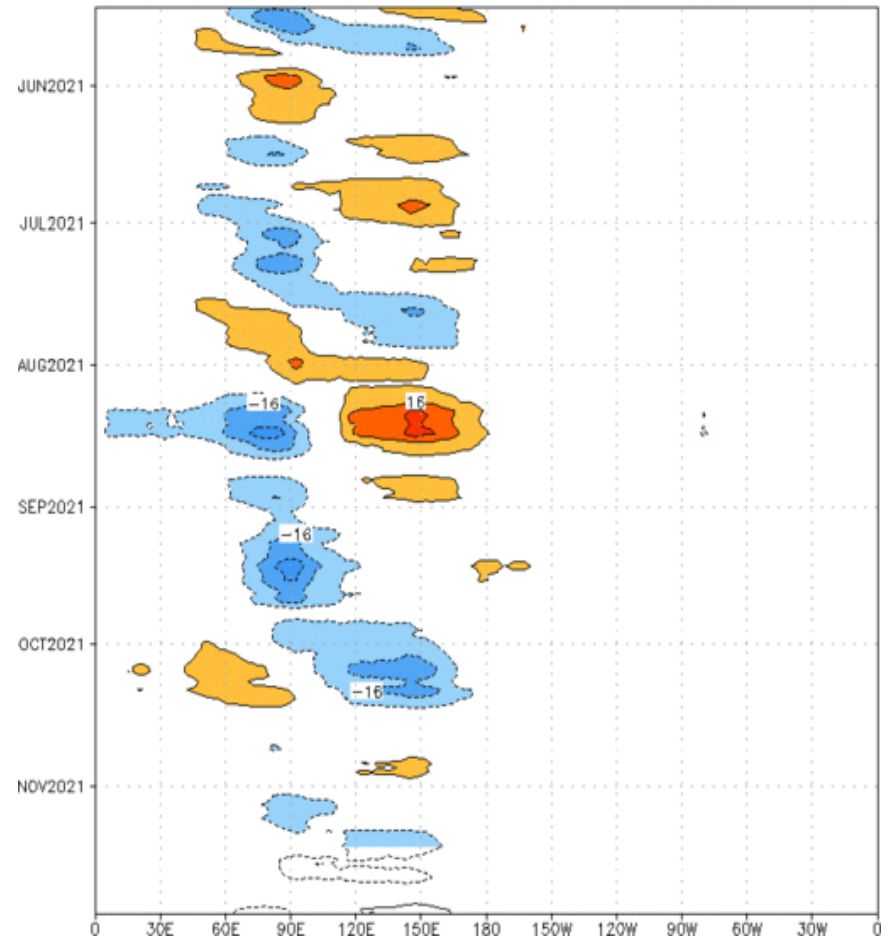
MJO: GEFS Forecast Evolution

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 Nov 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: 15-May-2021 to 14-Nov-2021
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

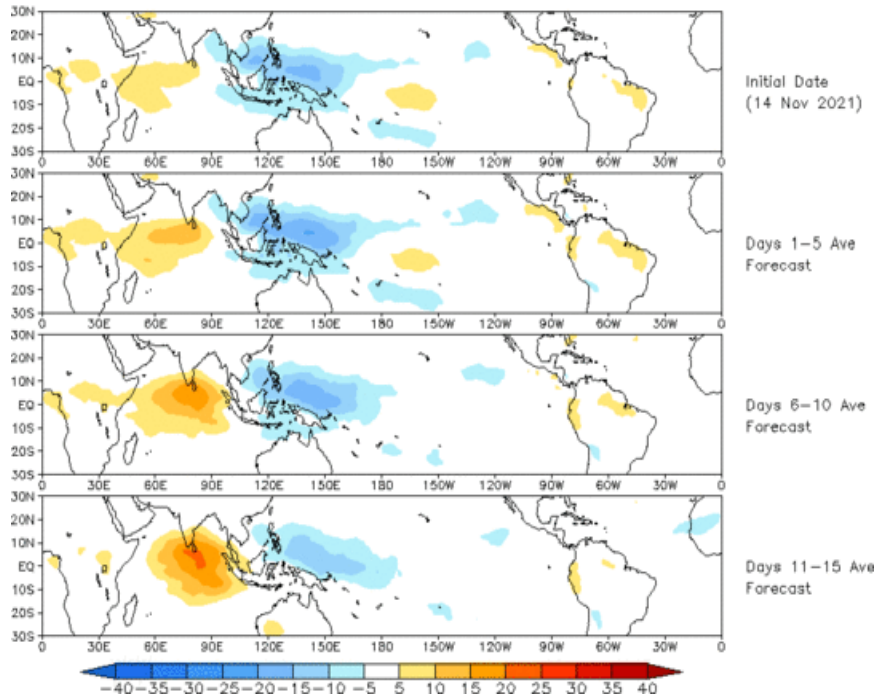


- The GEFS RMM-based OLR anomaly forecast features a gradual weakening of the enhanced convection across the Maritime Continent during the next 2 weeks.

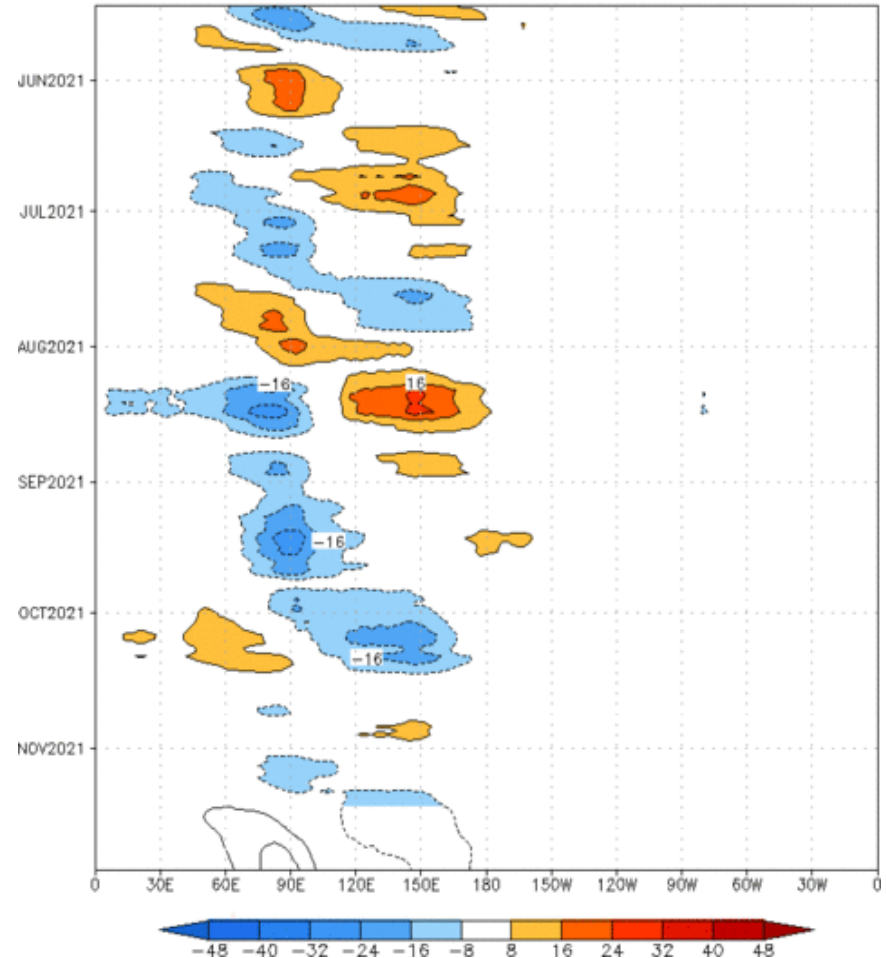
MJO: Constructed Analog Forecast Evolution

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 Nov 2021)



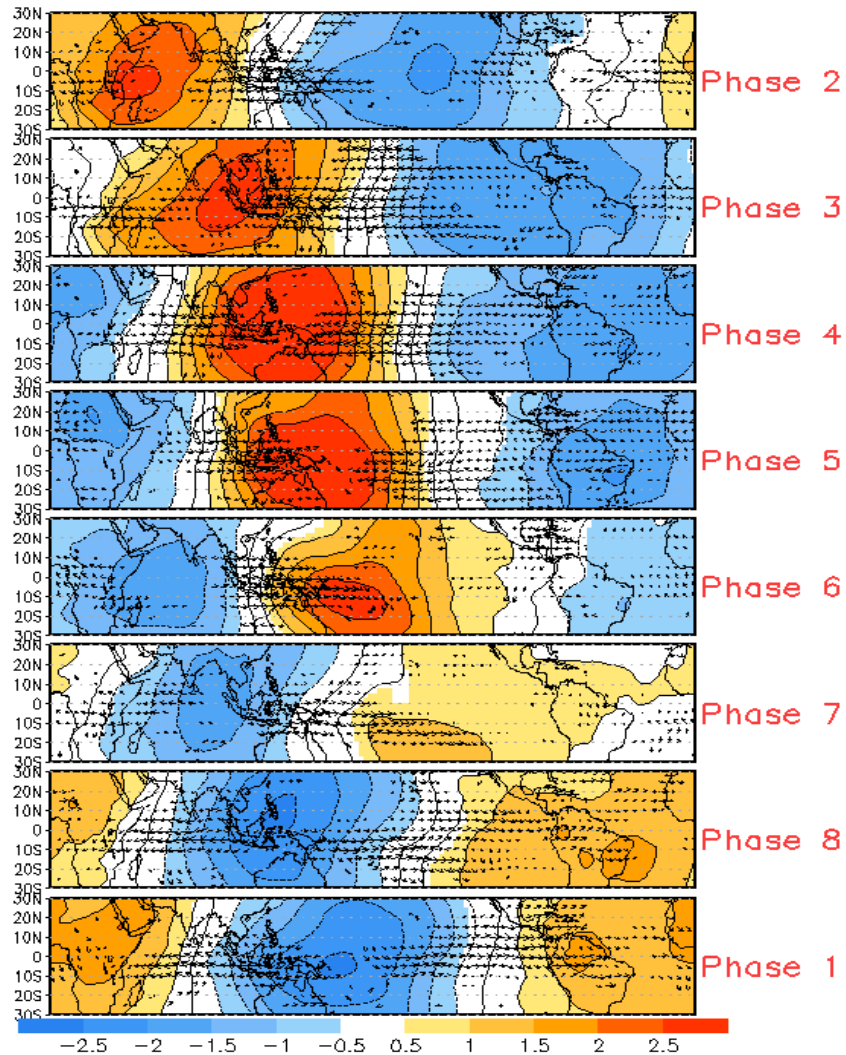
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:15-May-2021 to 14-Nov-2021
The unfilled contours are CA forecast reconstructed anomaly for 15 days



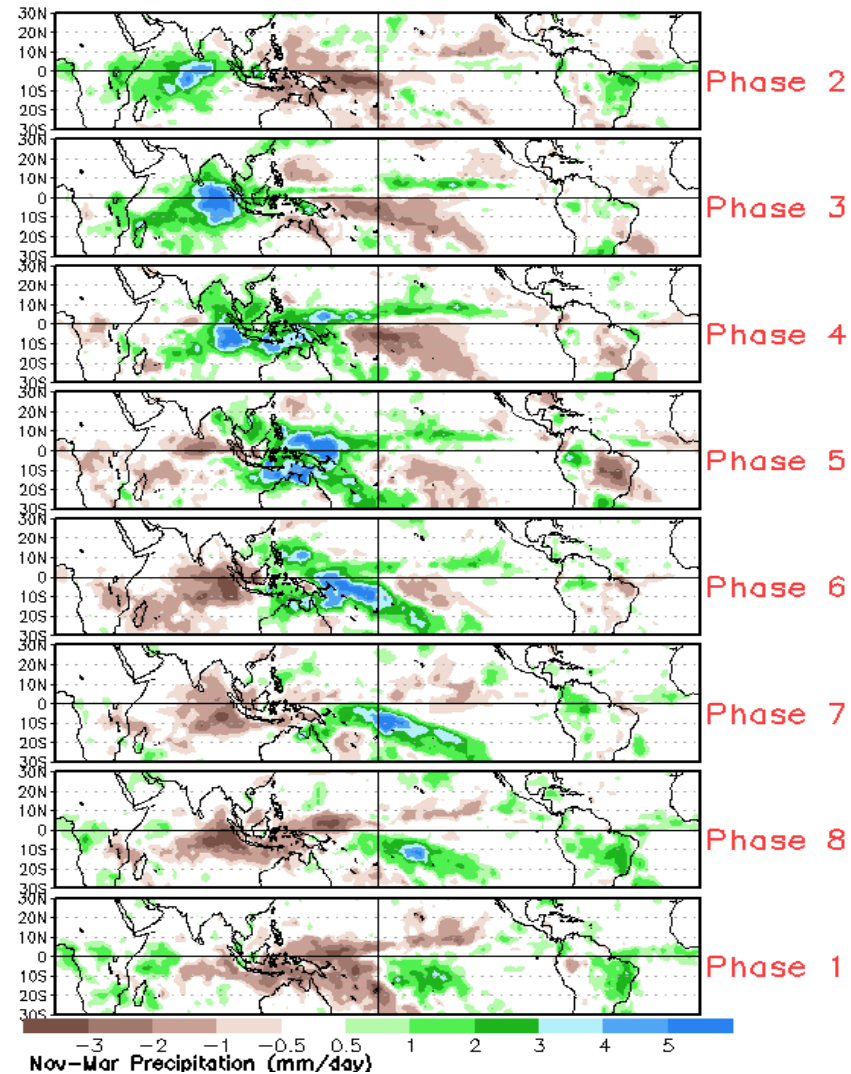
- The constructed analog also depicts weakening of the enhanced convection across the Maritime Continent, but is not as robust with the weakening compared to the GEFS.
- Suppressed convection becomes established in the Indian Ocean.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



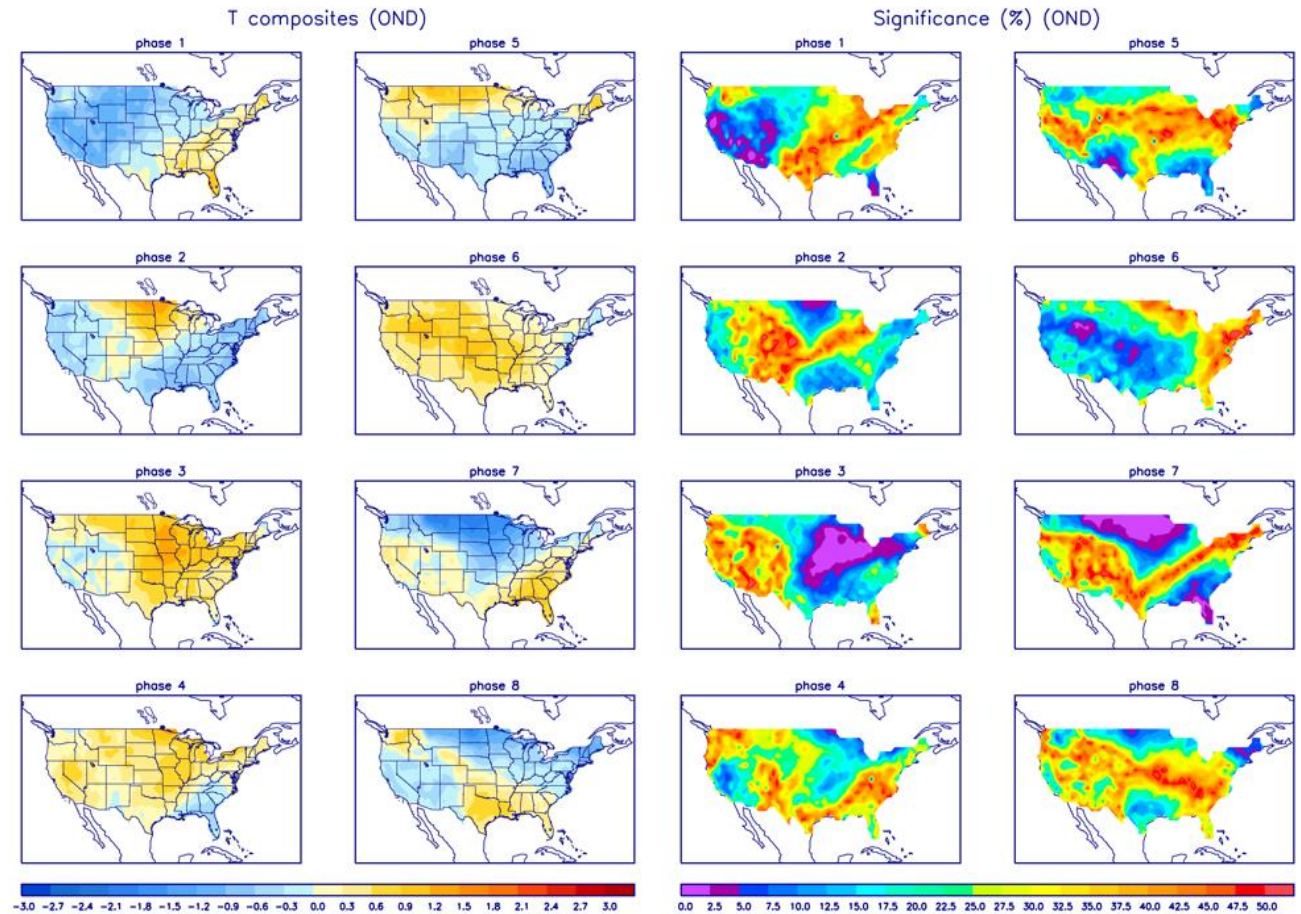
Precipitation Anomalies



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.

