

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



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

Overview

- The amplitude of the RMM-based MJO index is the highest its been since July 2021, and is currently located in phase 7 (Western Pacific).
- The GEFS and ECMWF ensembles depict the MJO continuing to propagate eastward over the western and central Pacific during mid to late December.
- This MJO event is likely to destructively interfere with La Niña, and there remains uncertainty as to whether the MJO will maintain an organized structure as it moves near the Date Line, as evidenced by large ensemble spread in the RMM forecasts.

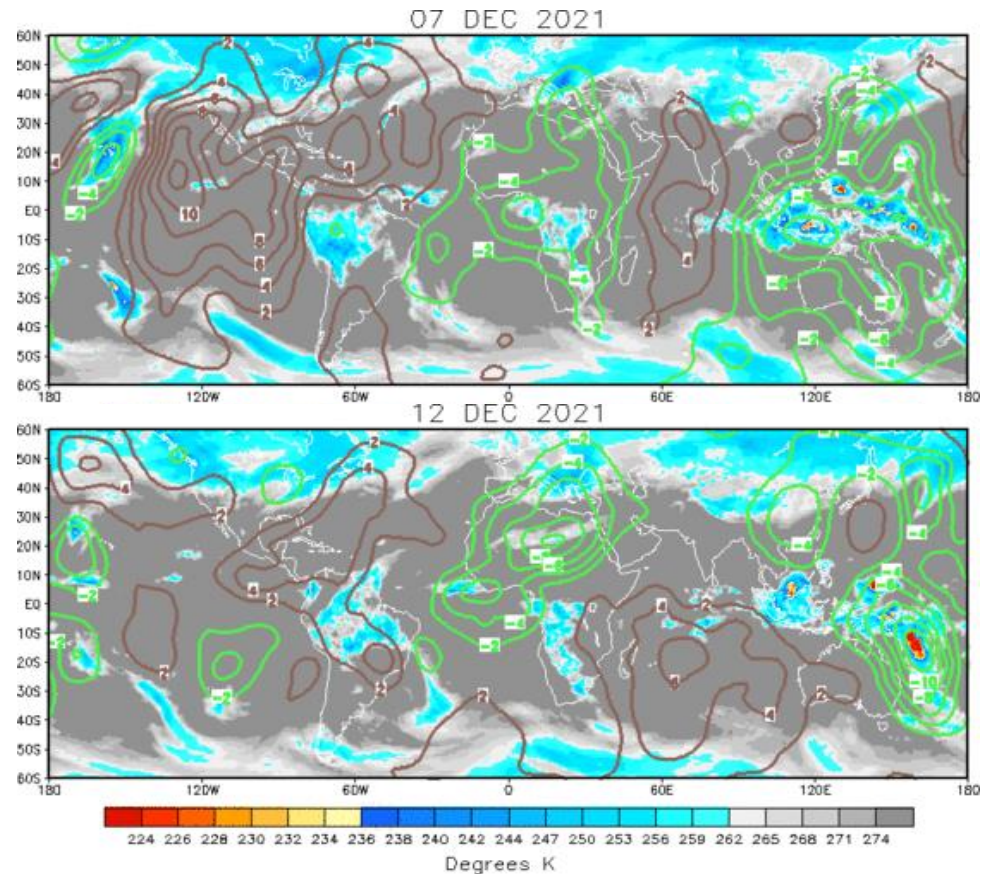
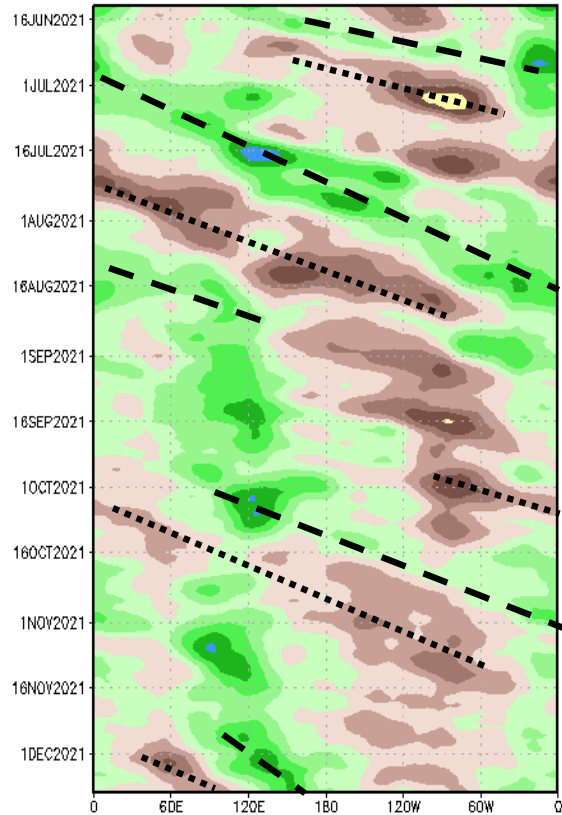
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

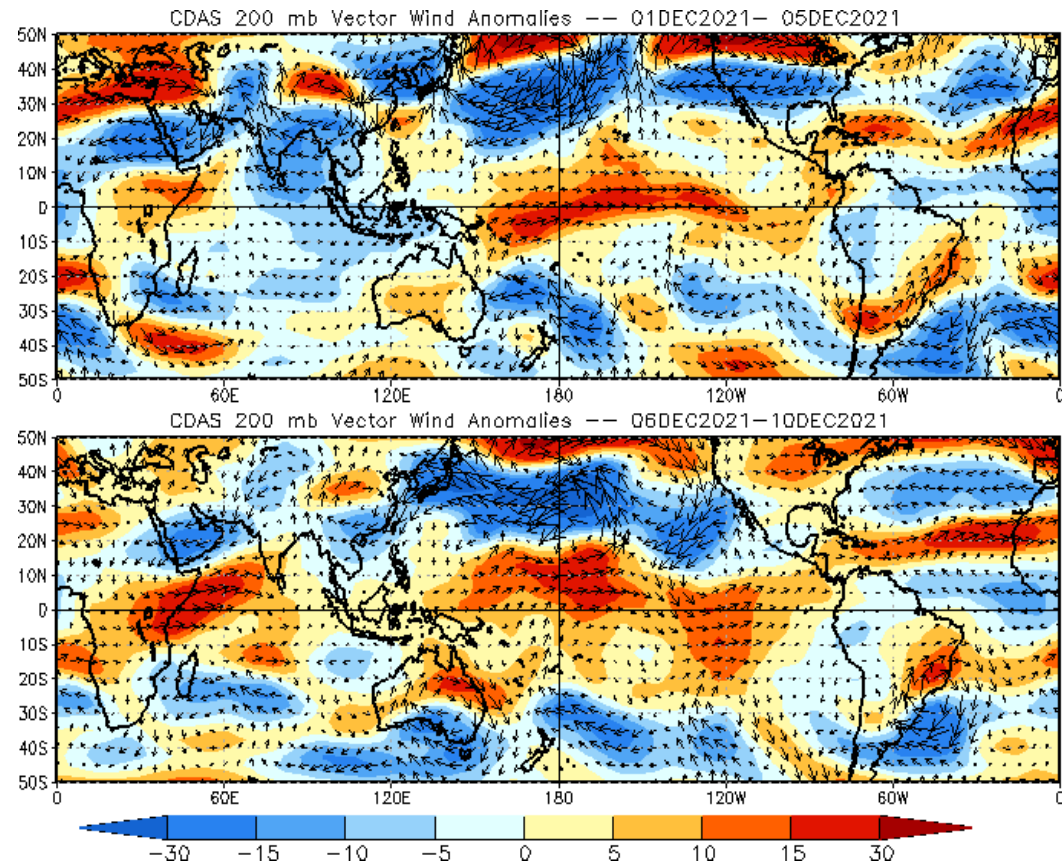
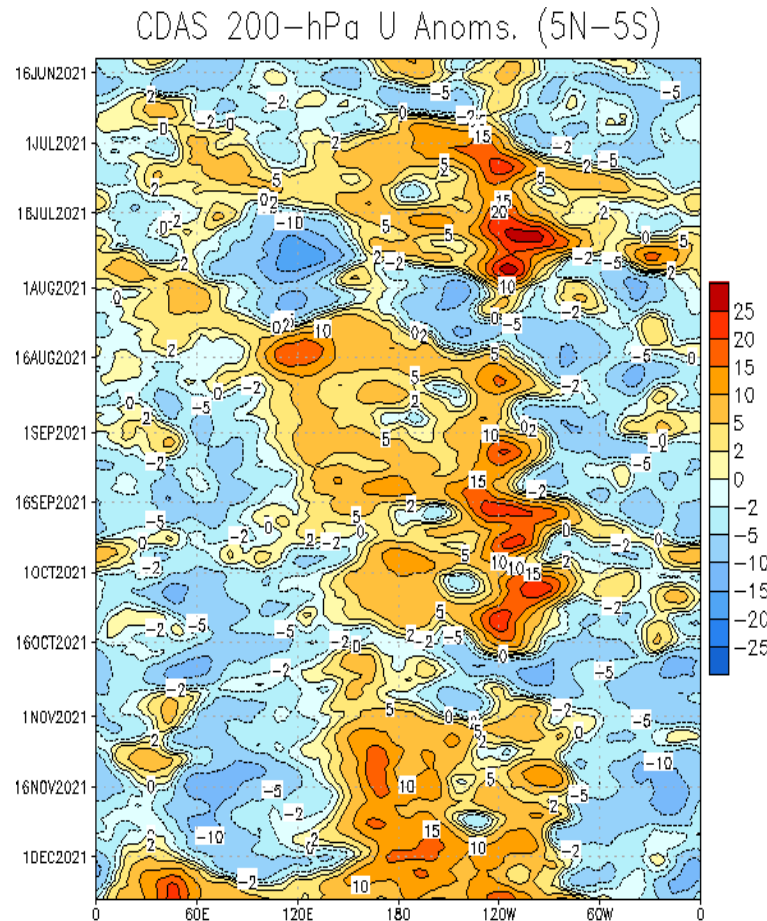
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- A wave-2 velocity potential pattern is observed, with an active MJO resulting in enhanced convection over the Maritime Continent and West Pacific, and enhanced upper level divergence over Africa in its wake.
- Suppressed convection remains over much of the eastern Pacific, North Atlantic, and Indian Ocean.

200-hPa Wind Anomalies

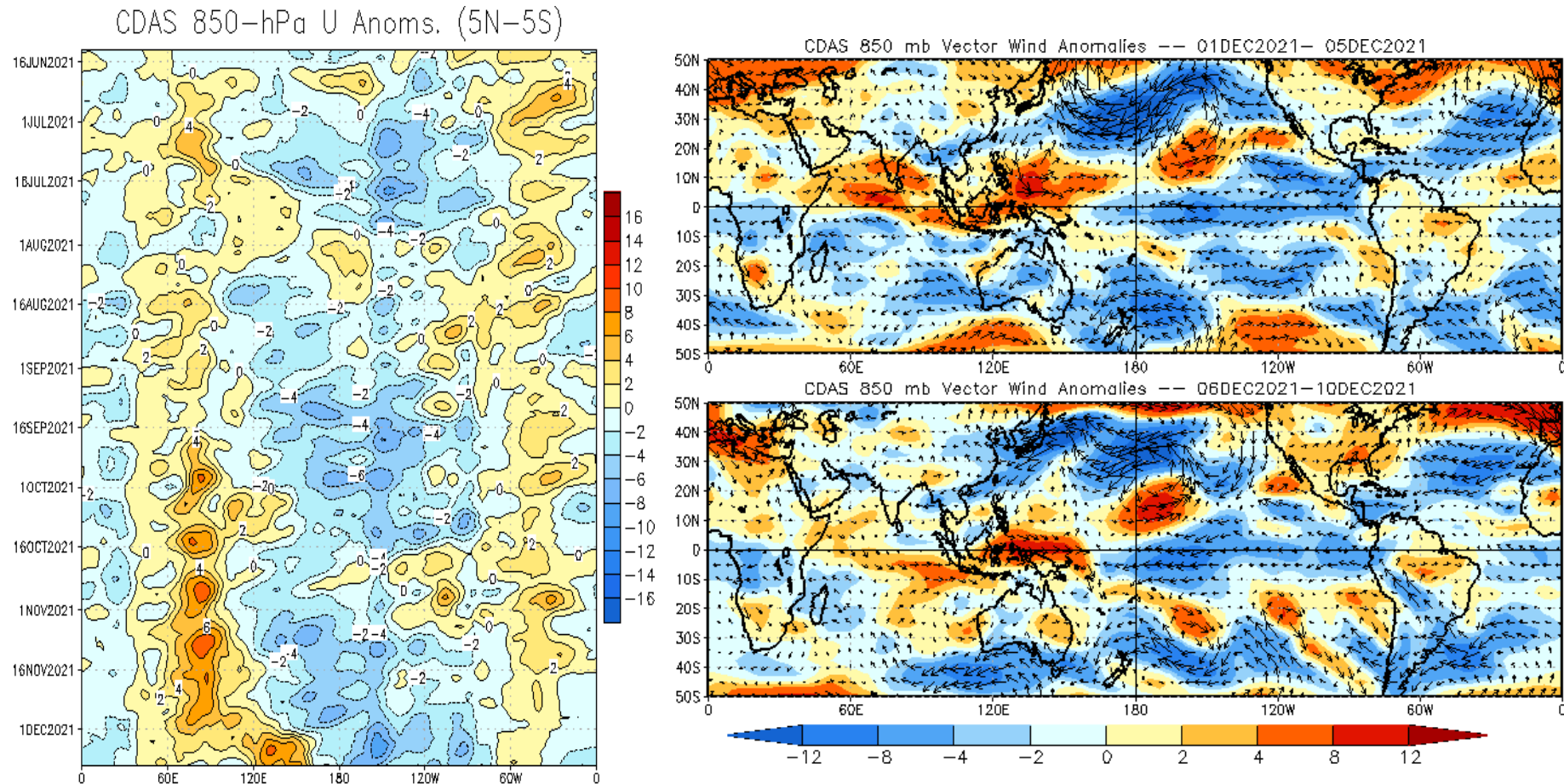
Shading denotes the zonal wind anomaly. **Blue shades: Anomalous easterlies.** **Red shades: Anomalous westerlies.**



- Easterly upper level wind anomalies over the Indian Ocean have transitioned to westerly anomalies in the wake of the departing MJO.
- Anomalous westerlies persist across much of the equatorial Pacific, consistent with La Niña.

850-hPa Wind Anomalies

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



- Westerly wind burst observed over the Maritime Continent and western Pacific resulting from eastward propagation of the MJO.
- Along the equator, anomalous easterlies remain across the central and eastern Pacific, consistent with the low frequency La Niña state.

Outgoing Longwave Radiation (OLR) Anomalies

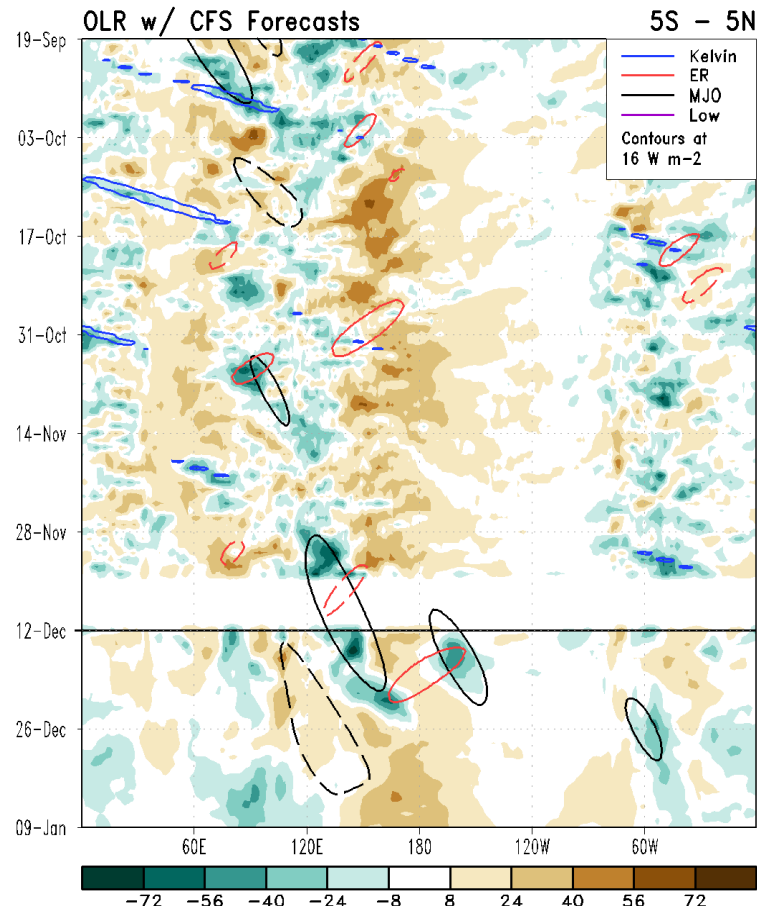
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)

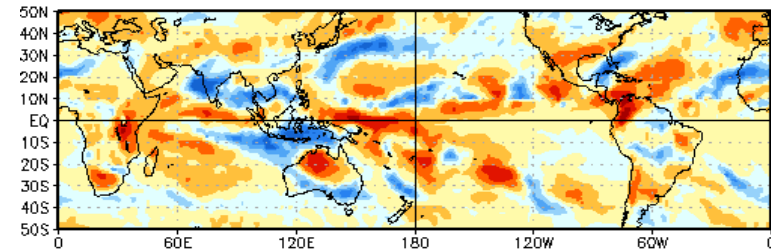
Blue shades: Anomalous convection (wetness)

Red shades: Anomalous subsidence (dryness)

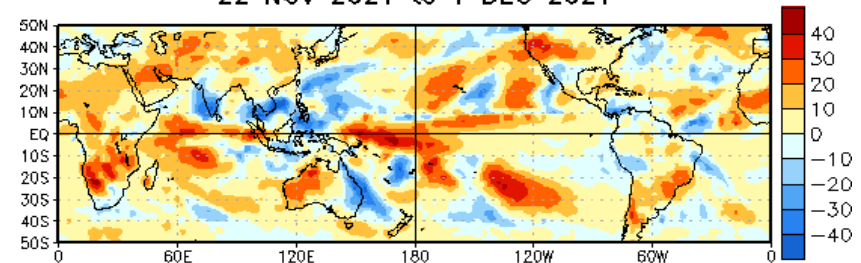
OLR Anomalies



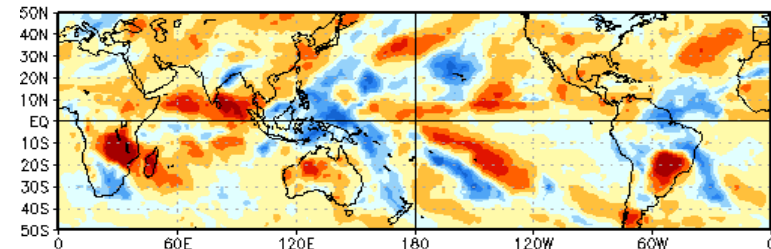
12 NOV 2021 to 21 NOV 2021



22 NOV 2021 to 1 DEC 2021

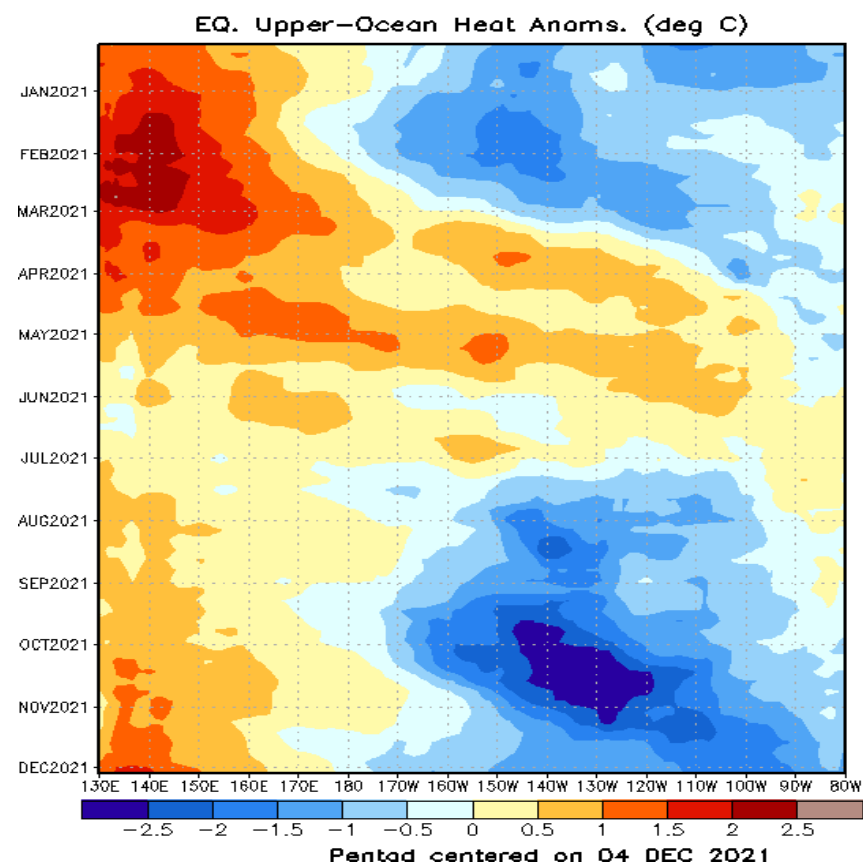
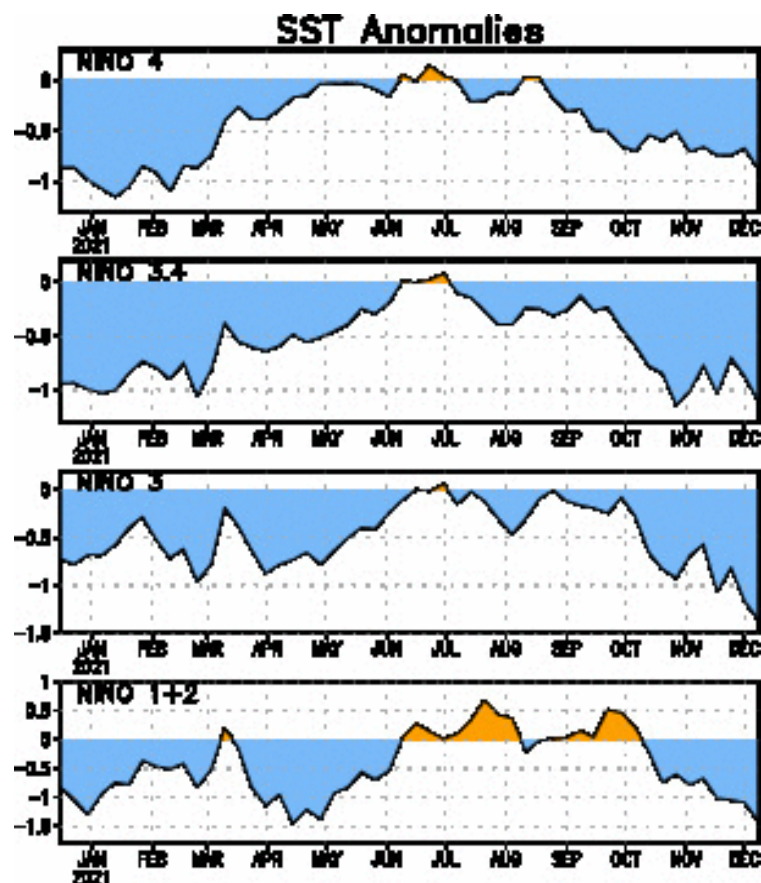


2 DEC 2021 to 11 DEC 2021



- Convection has been suppressed to the west of the Date Line, and over the central and eastern Pacific north of the equator since October.
- However, the CFS ensemble depicts enhanced convection developing near the Date Line during the next 2 weeks, and destructively interfering with the established low-frequency base state.

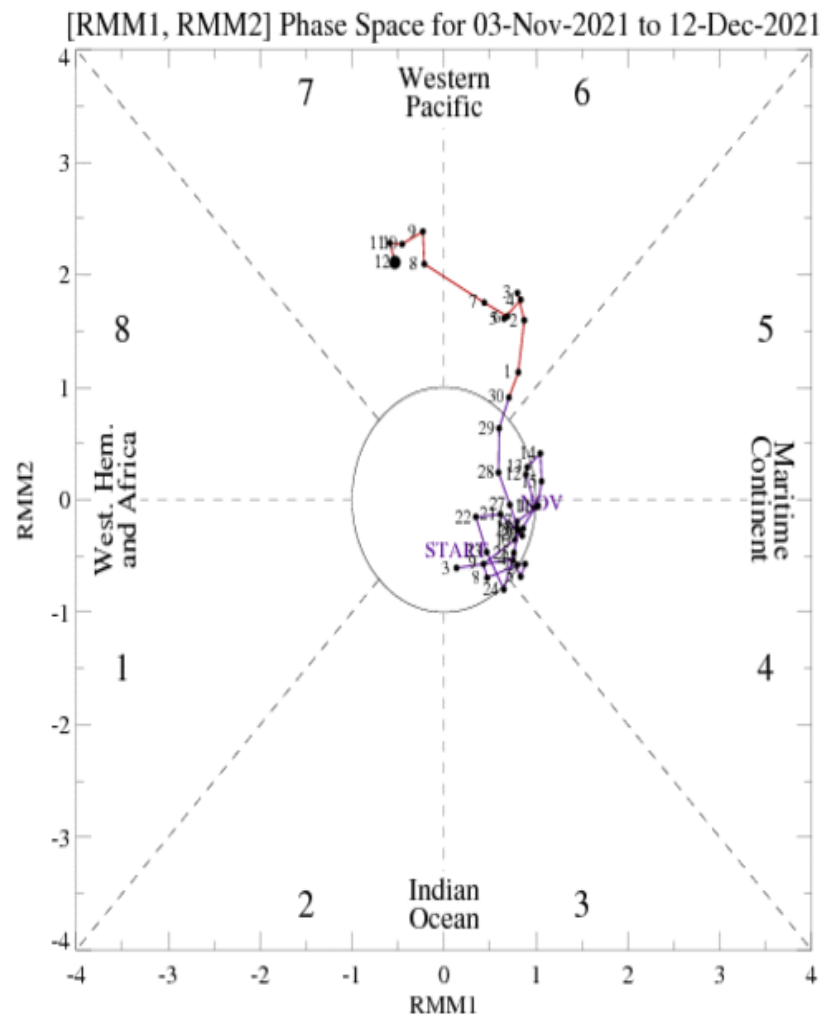
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Negative upper-ocean heat content anomalies have relaxed across the central and eastern equatorial Pacific, with much of the sub-surface cooling continuing to expand eastward since early October.
- Positive upper-ocean heat content anomalies have increased across the West Pacific during the past month.
- Consistent with La Niña, below-normal sea surface temperatures (SSTs) continue to be observed within all Niño regions, with SSTs holding steady or decreasing during November and early December

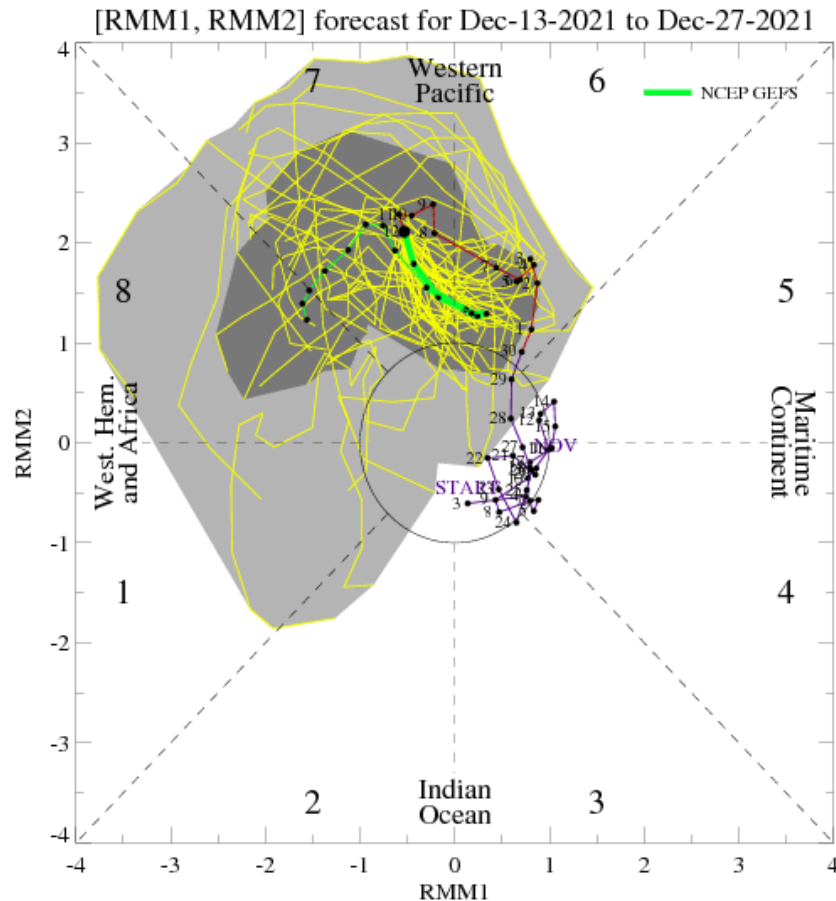
MJO Index: Recent Evolution

- The RMM based MJO index features eastward propagation from the Maritime Continent since late November and an increase in amplitude over the West Pacific during early December.

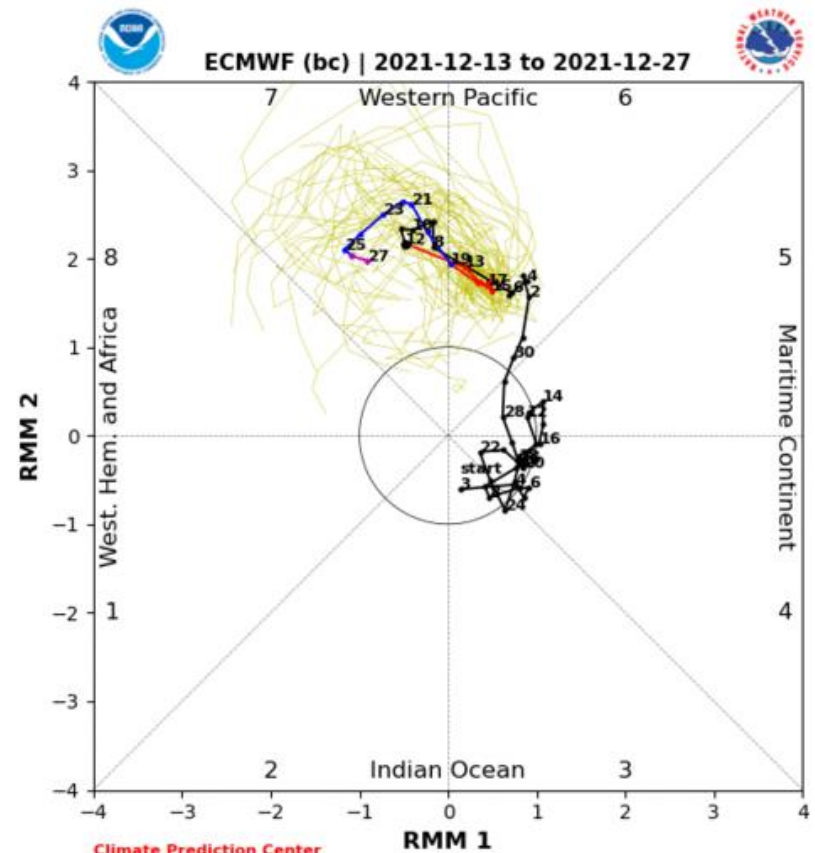


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



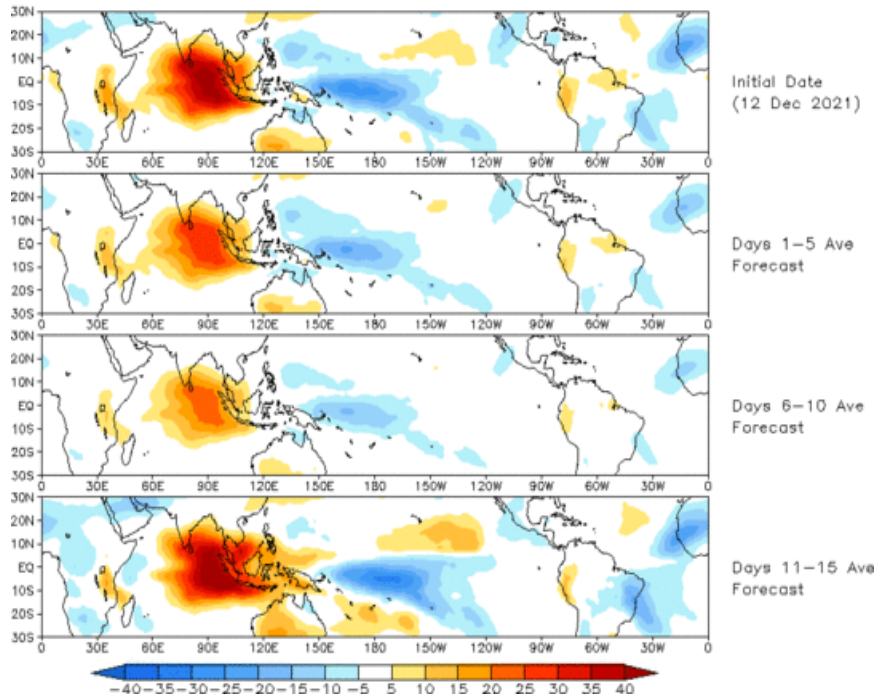
ECMWF Forecast

- Both the GEFS and ECMWF ensembles depict a robust MJO event currently in RMM phase 7.
- In the near term, propagation over the West Pacific is forecast to slow down or perhaps retrograde due to destructive interference with the low frequency base state and enhanced Rossby Wave activity.
- Renewed eastward propagation is forecast by week-2, although uncertainty remains high as some individual ensembles considerably weaken the intraseasonal signal.

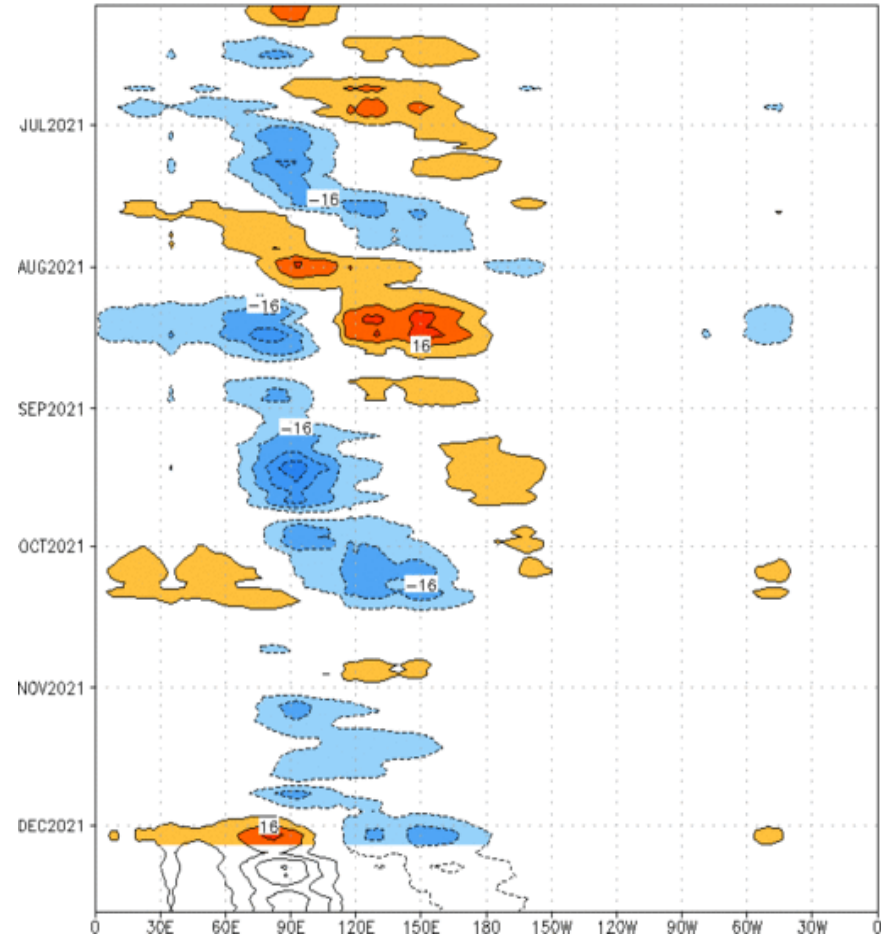
MJO: GEFS Forecast Evolution

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 Dec 2021
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$] ($\text{cint: } 4\text{Wm}^{-2}$) Period: 05-Jun-2021 to 05-Dec-2021
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

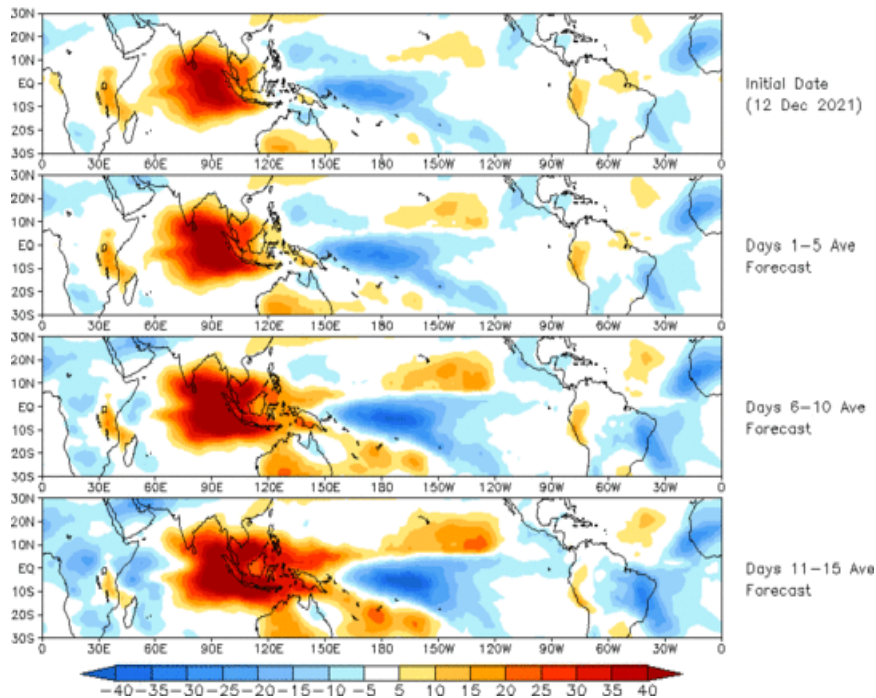


- The GEFS RMM-based OLR anomaly forecast depicts enhanced convection shifting eastward toward the Central Pacific during the next two weeks, while suppressed convection expands east from Indian Ocean to the Maritime Continent.

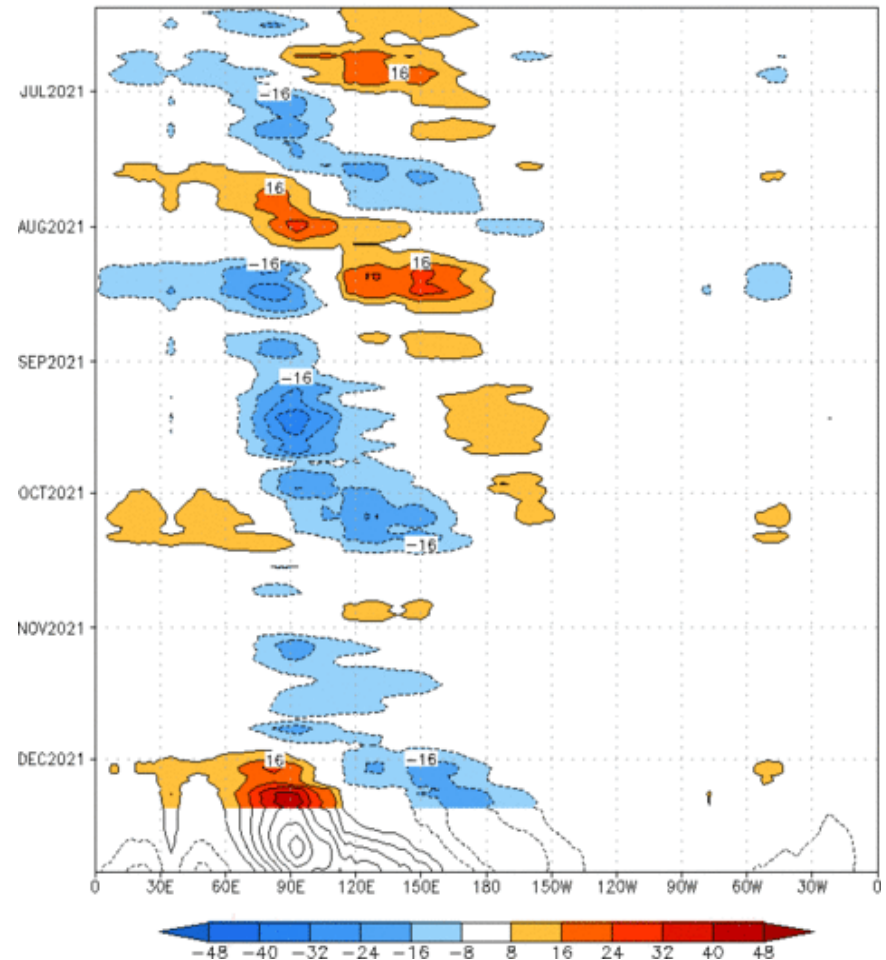
MJO: Constructed Analog Forecast Evolution

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 Dec 2021)



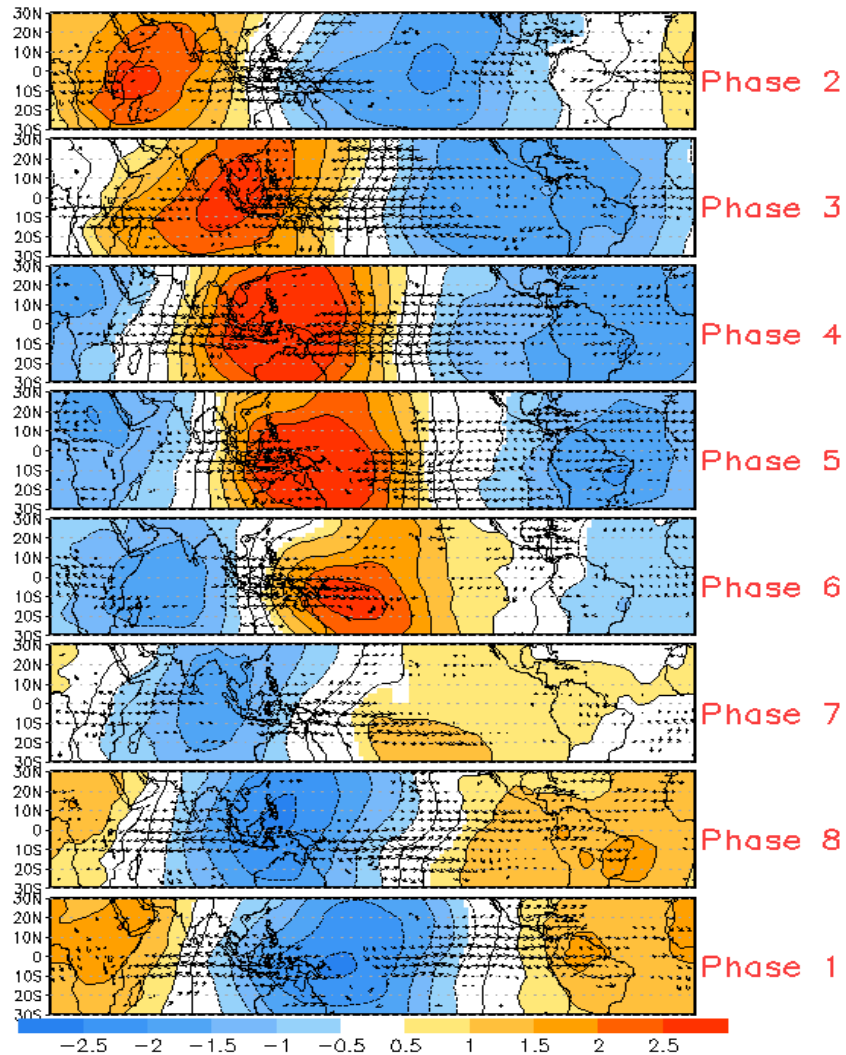
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:12-Jun-2021 to 12-Dec-2021
The unfilled contours are CA forecast reconstructed anomaly for 15 days



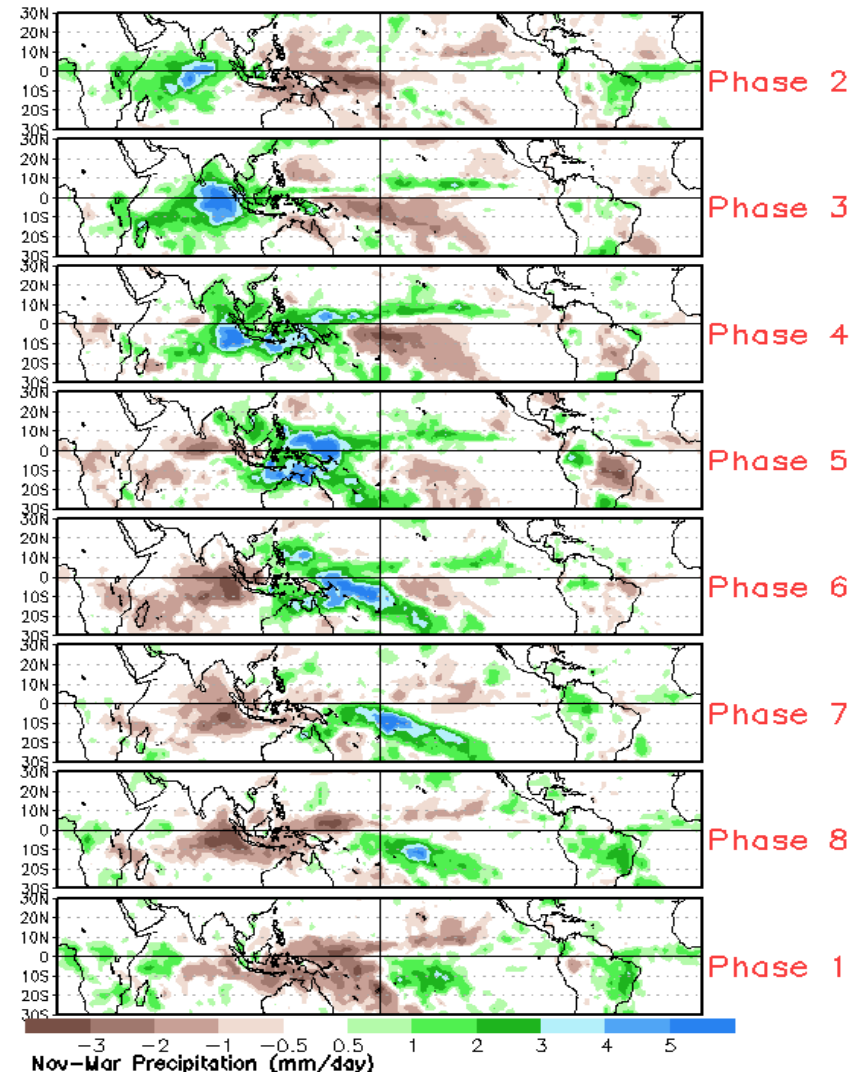
- The constructed analog depicts a similar evolution to the GEFS, with enhanced convection overspreading the equatorial Pacific and suppressed convection developing across the Maritime Continent.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



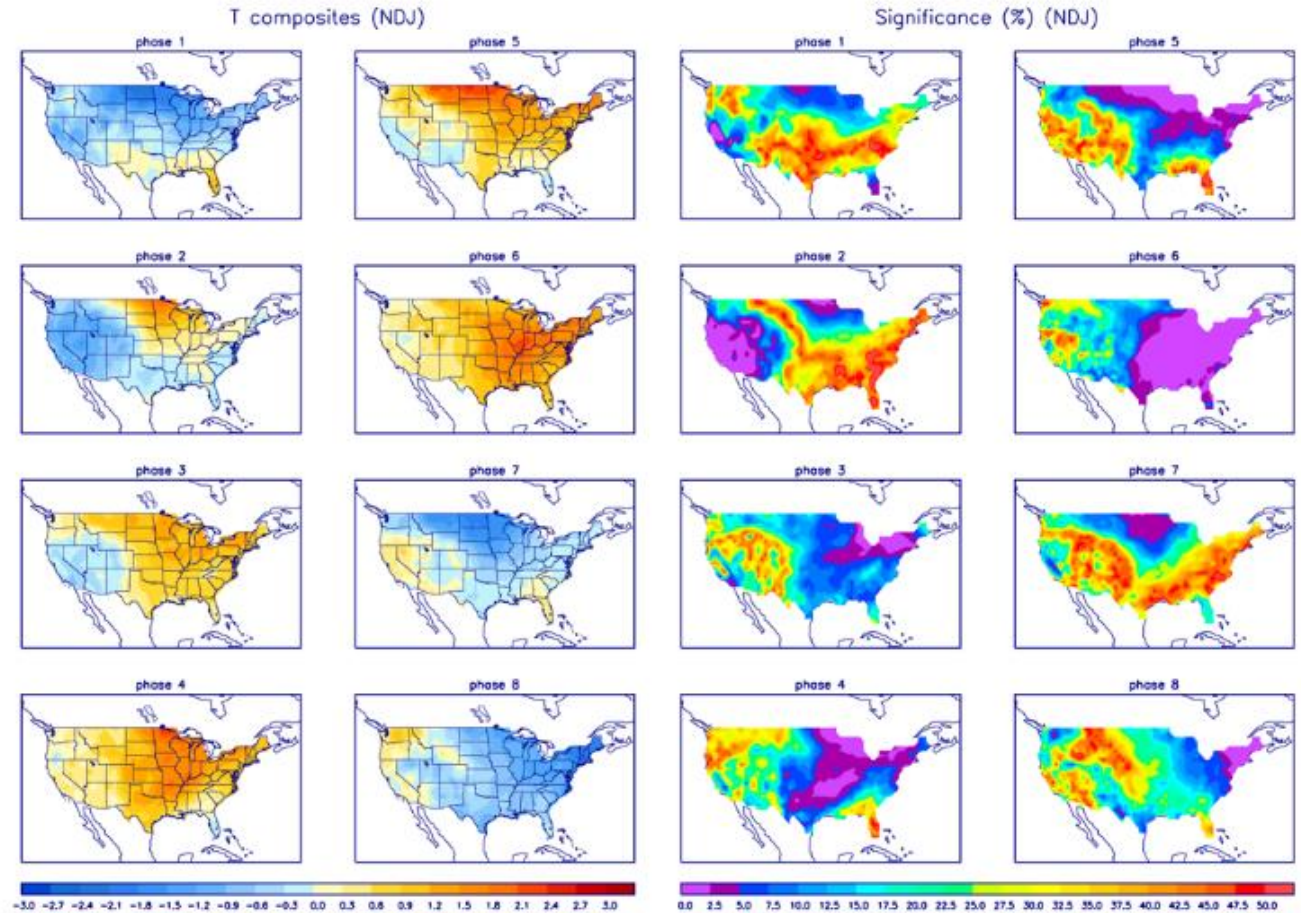
Precipitation Anomalies



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.

