

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



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
21 December 2020

Overview

- Both the RMM-based MJO index and upper-level wind field reflect a slow eastward evolution of the MJO, with the enhanced phase crossing the Maritime Continent over the past two weeks.
- Other modes, including Rossby wave activity and tropical cyclones, have interfered with the MJO signal at times, contributing to the slowed evolution.
- Additional Rossby wave activity in conjunction with the ongoing La Niña will likely cause the MJO signal to rapidly weaken during the upcoming week.
- Dynamical models favor little to no MJO activity during Week-1, but suggest potential renewed MJO activity over the Indian Ocean during Week-2.
- Given the weak signal, the MJO is unlikely to substantially influence the tropical convective pattern or subsequent extratropical response. The ongoing La Niña remains the primary tropical convective driver.

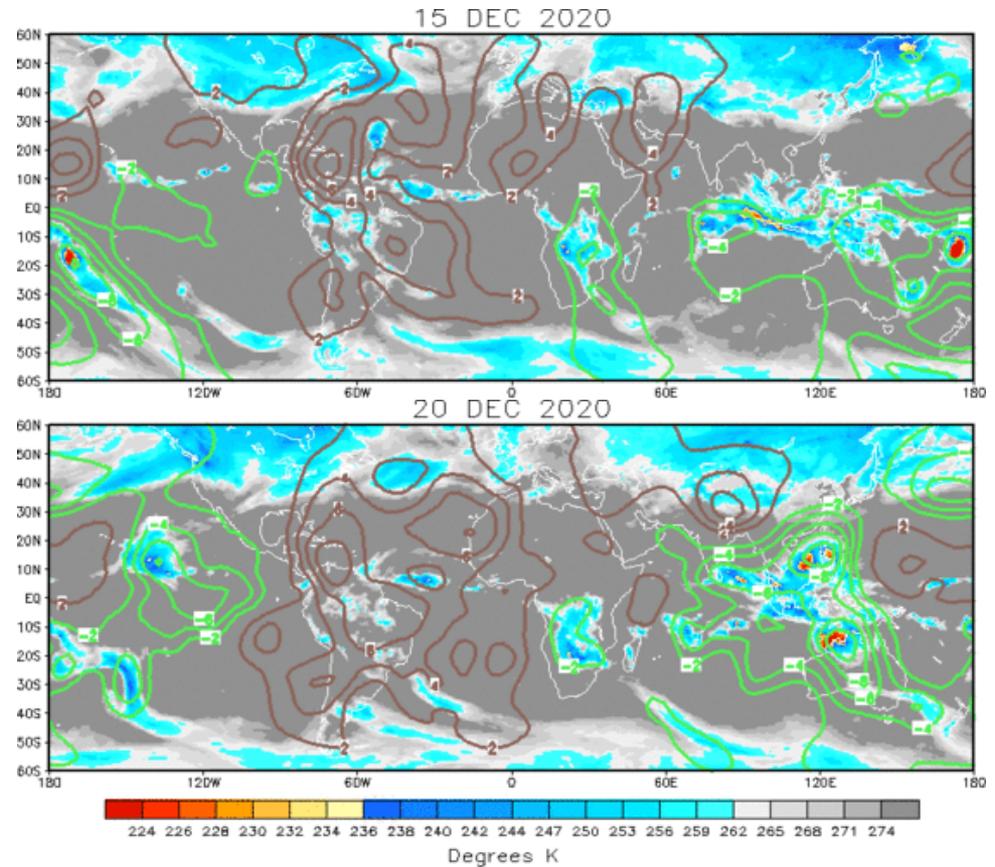
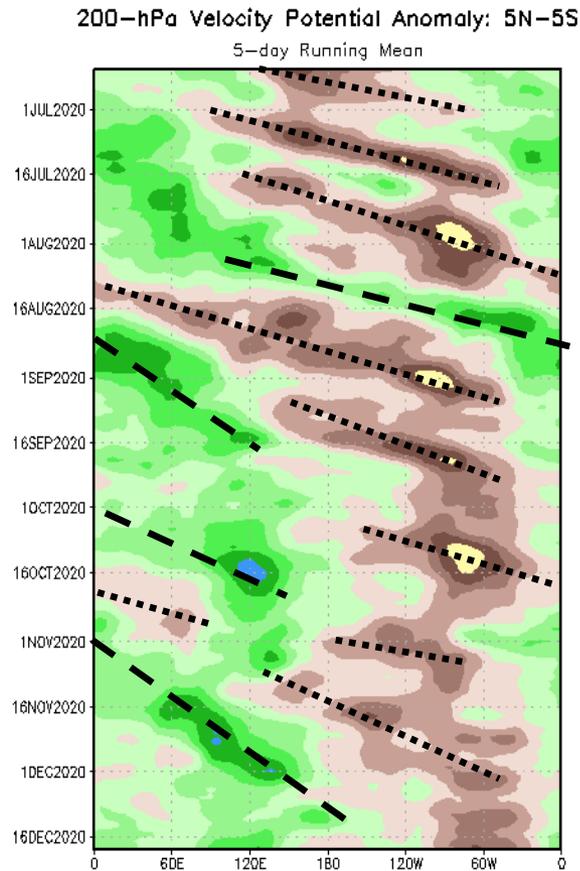
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

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

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

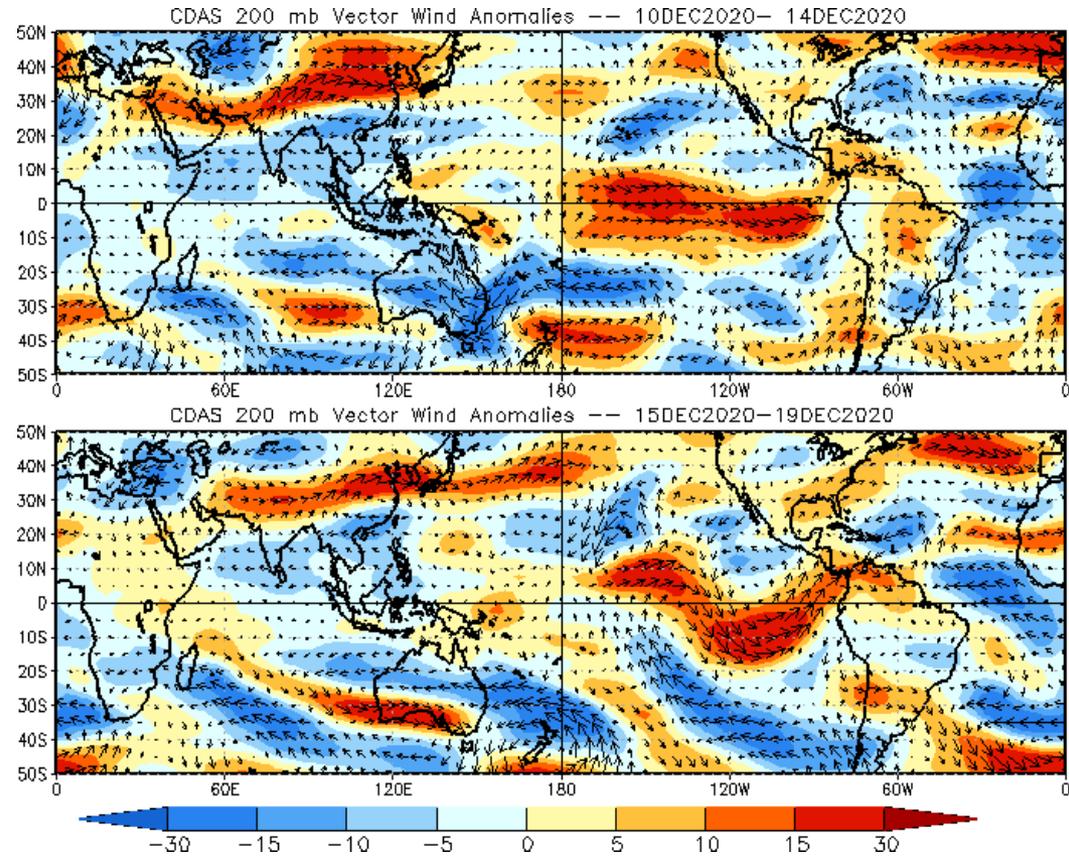
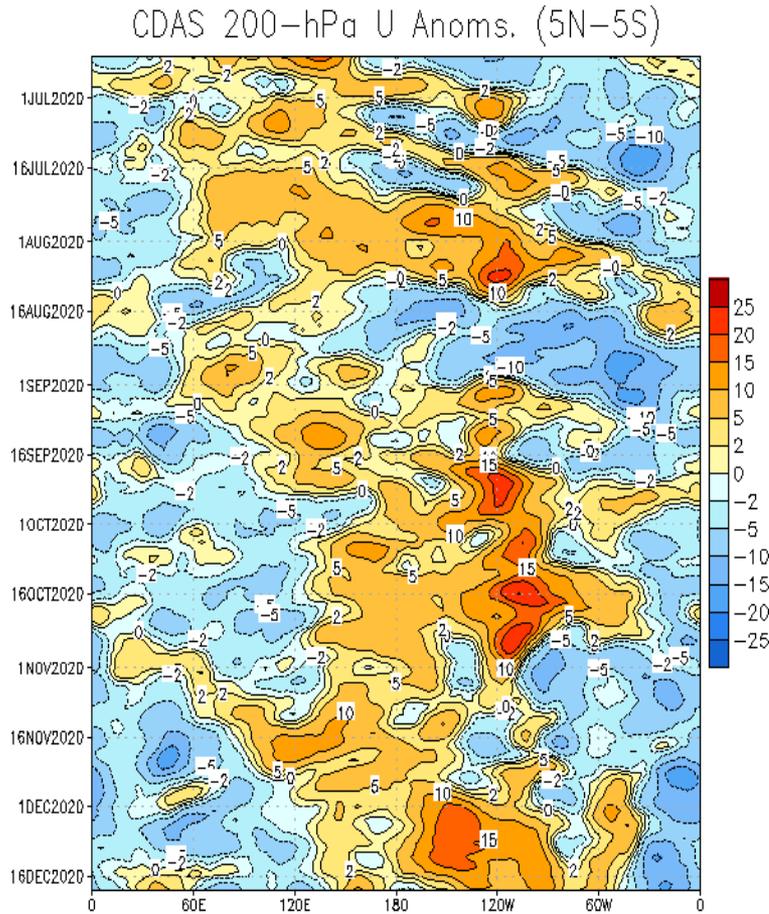
Brown shades: Anomalous convergence (unfavorable for precipitation).



- From mid-November through early December, MJO activity was apparent, with slow eastward propagation from the Indian Ocean to the far West Pacific.
- The upper-level pattern has become increasingly disorganized as the intraseasonal envelope moves away from a constructively interfering phase with the ongoing La Niña over the Maritime continent towards destructive interference over the Pacific.

200-hPa Wind Anomalies

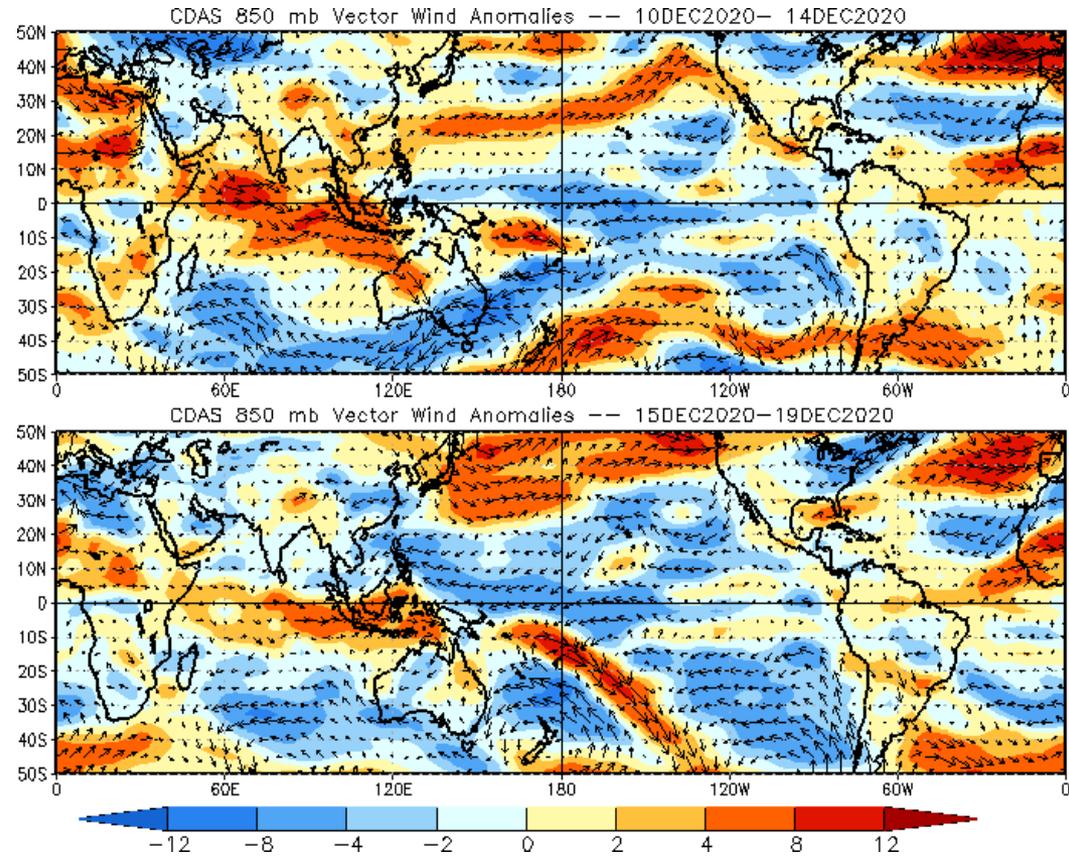
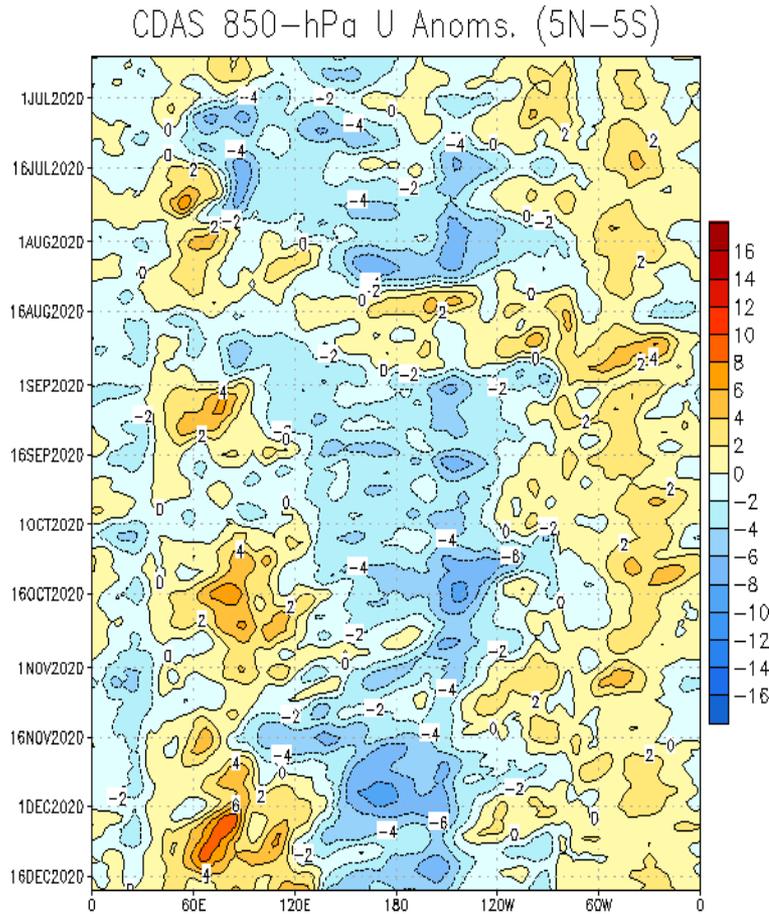
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Weak divergence is evident in the upper-level zonal wind field west of the Date Line.
- Considerable convergence is evident over the Pacific east of the Date Line, which is consistent with a La Niña response. Extratropical influences are resulting in a more chaotic pattern than what was observed earlier in December.

850-hPa Wind Anomalies

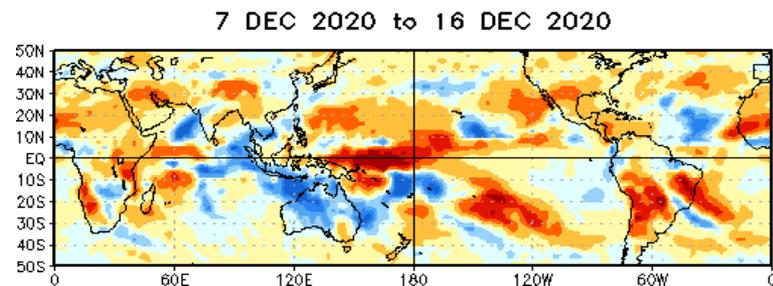
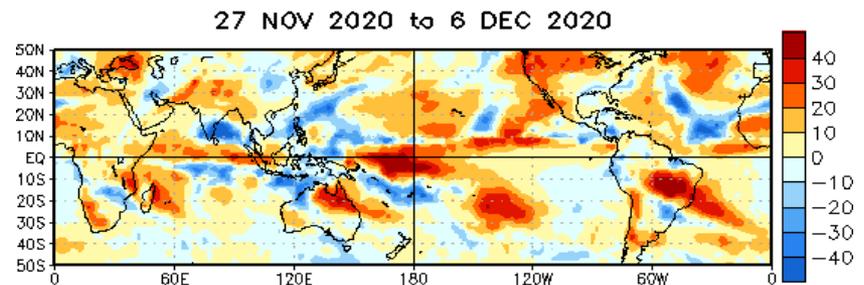
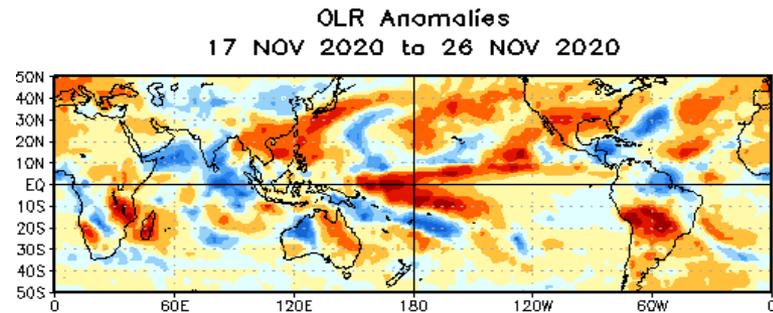
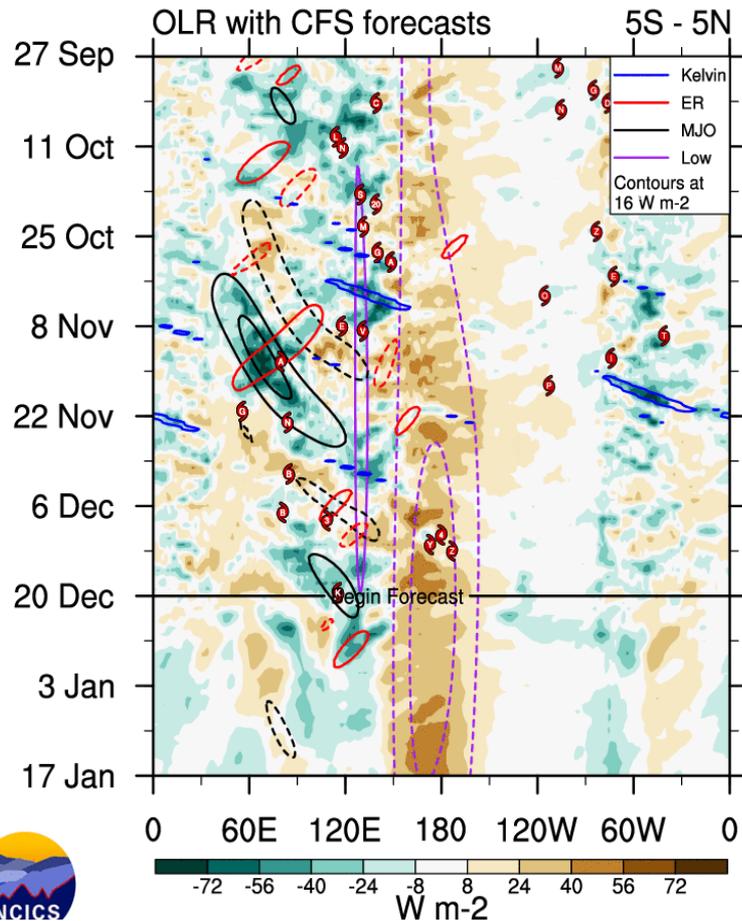
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Westerly anomalies progressed slightly eastward across the Maritime Continent, reflecting ongoing MJO activity.
- Enhanced trades, which had recently weakened over the West Pacific ahead of the approaching MJO envelope, strengthened again considerably west of the Date Line in response to an equatorial Rossby wave.
- Due to interference from both this Rossby wave activity and the ongoing Pacific signal, the MJO is unlikely to make further eastward progress.

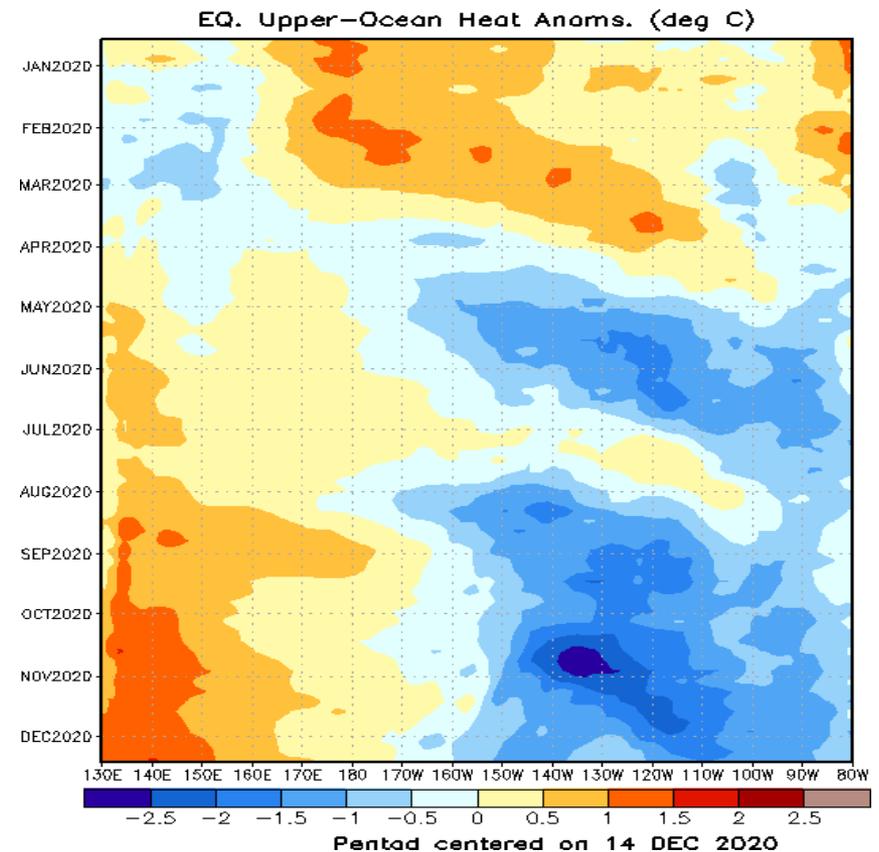
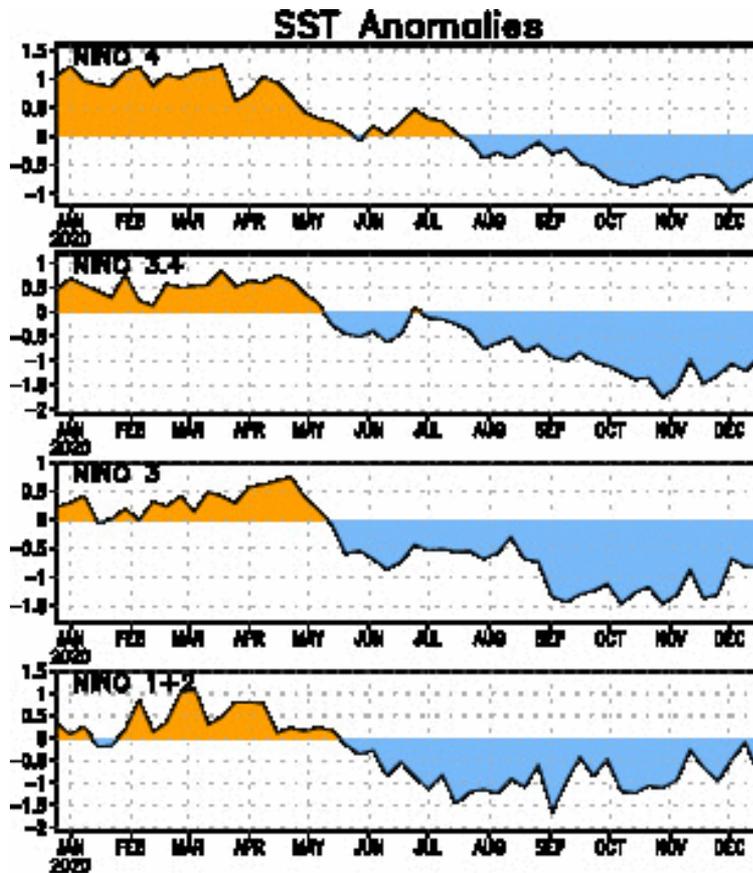
Outgoing Longwave Radiation (OLR) Anomalies

Blue shades: Anomalous convection (wetness). **Red shades: Anomalous subsidence (dryness).**



- Enhanced convection has shifted eastward from the Indian Ocean to the Maritime Continent during December, but the extent of the enhanced envelope has not been robust, and an equatorial Rossby wave interfered with the signal in early December.
- The suppressed signal over the equatorial Pacific moved westward during mid-December in response to another equatorial Rossby wave.

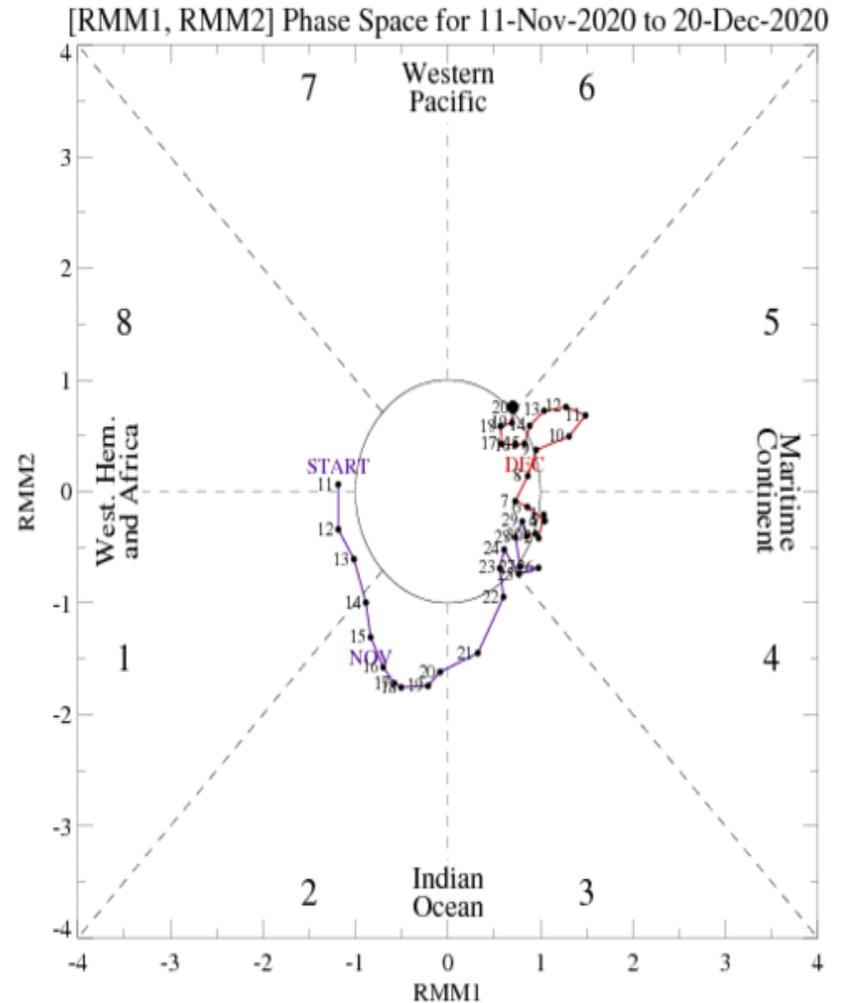
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Following destructive interference with the base state by a downwelling Kelvin wave during July, the subsequent upwelling phase has pushed the Pacific into La Niña conditions.
- Cold anomalies shifted slightly westward across the central Pacific during November and early December.

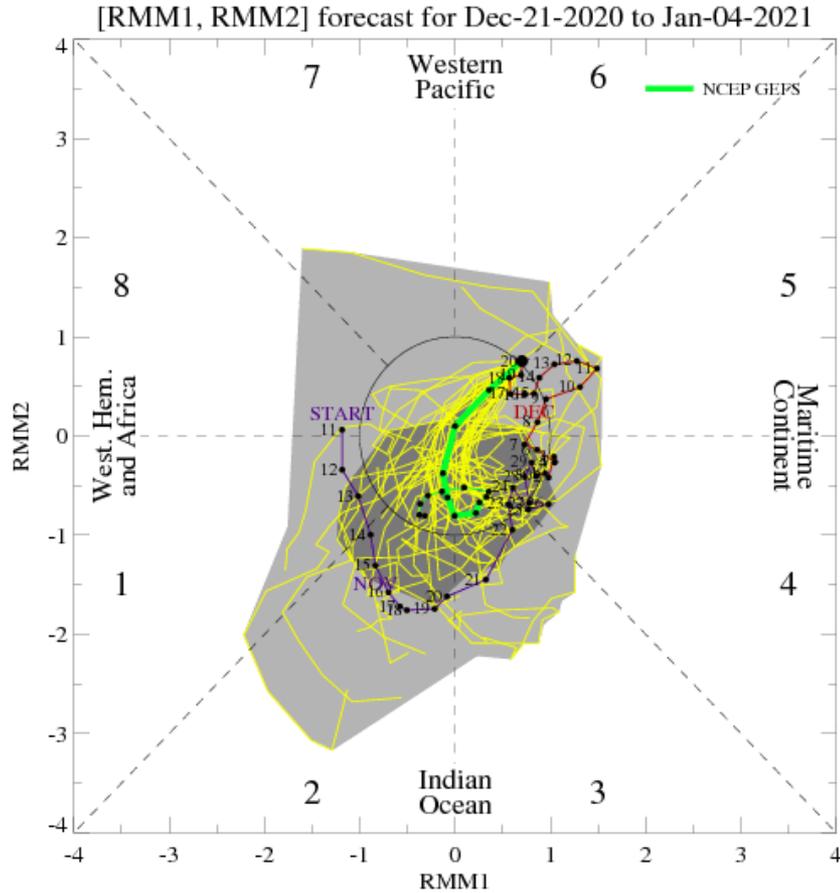
MJO Index: Recent Evolution

- The RMM index reflects a slow eastward propagating signal that has encountered sporadic interference from Rossby wave activity over the past few weeks.
- After a brief period of strengthening over the Maritime Continent, the signal weakened again as it approached the West Pacific.

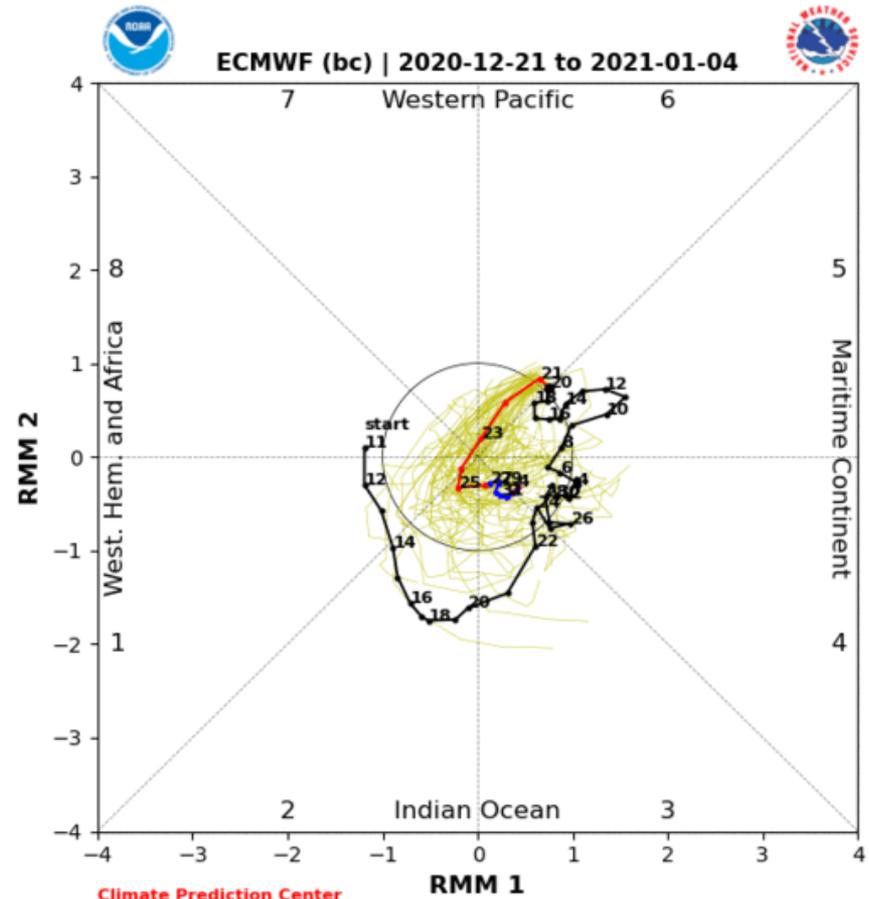


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



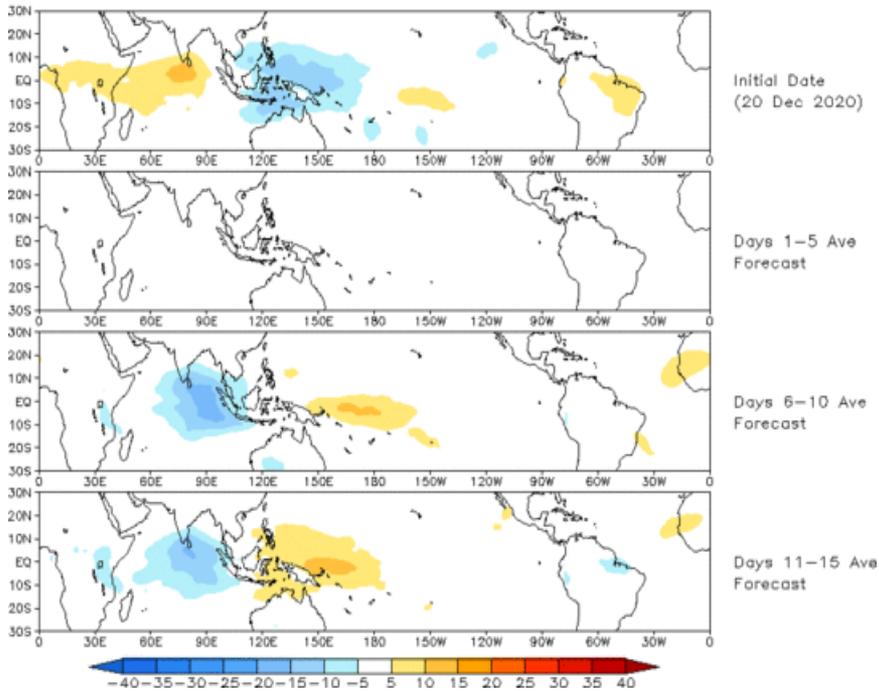
ECMWF Forecast

- Both the GEFS and ECMWF depict rapid weakening of the MJO signal, with the sharp “left turn” into the unit circle potentially indicative of Rossby wave interference.
- While most ensemble members maintain a fairly weak signal throughout the upcoming two-week period, there is some indication that the models are depicting renewed MJO activity initiating over the Indian Ocean by the end of Week-2. This renewed activity appears to be unrelated to the current signal favored to weaken before crossing the Pacific.

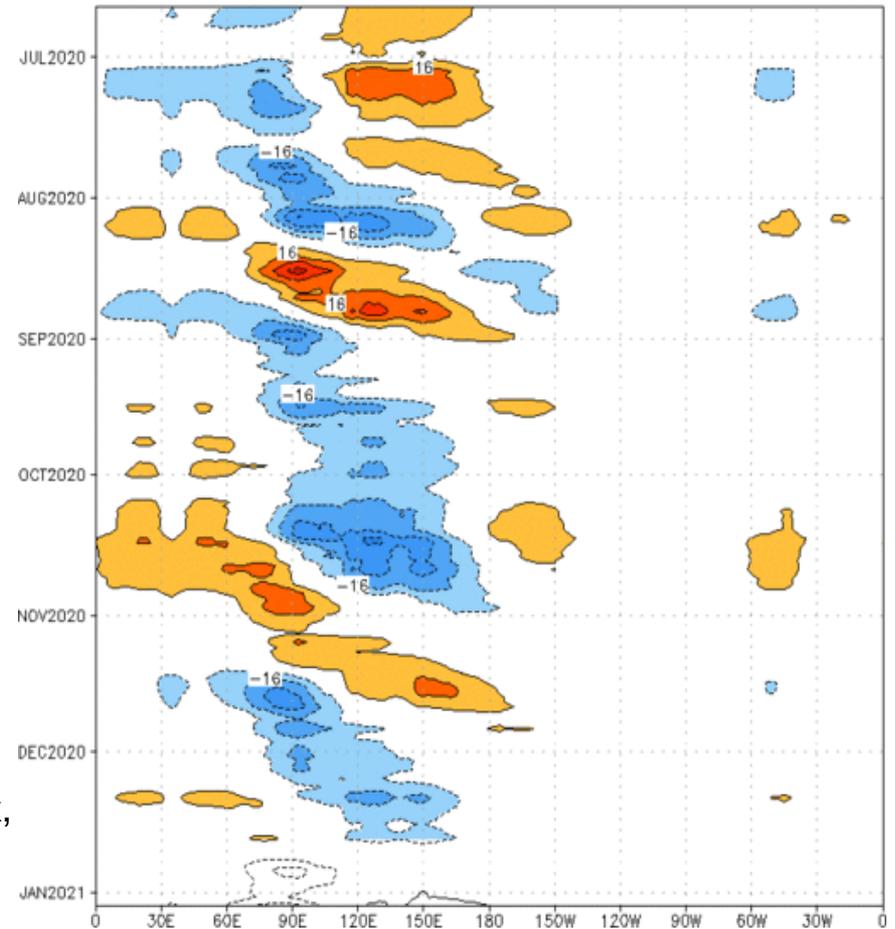
MJO: GEFS Forecast Evolution

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: 20 Dec 2020
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$] (cont: 4Wm^{-2}) Period: 20-Jun-2020 to 20-Dec-2020
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

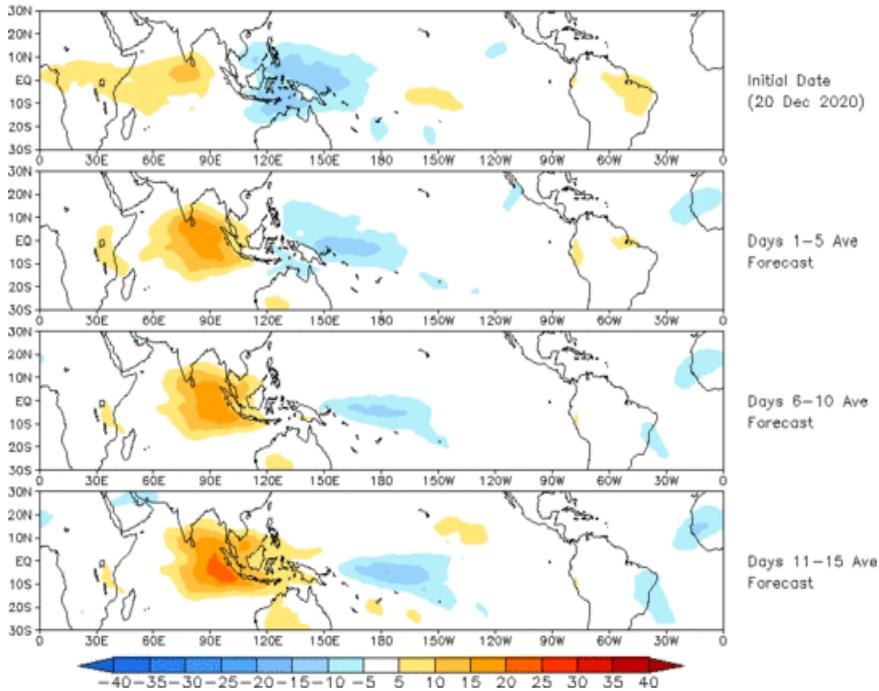


- The GEFS forecasts indicate rapid weakening of the OLR anomalies associated with the RMM index, followed by rapid development of a new couplet consistent with an Indian Ocean MJO event.

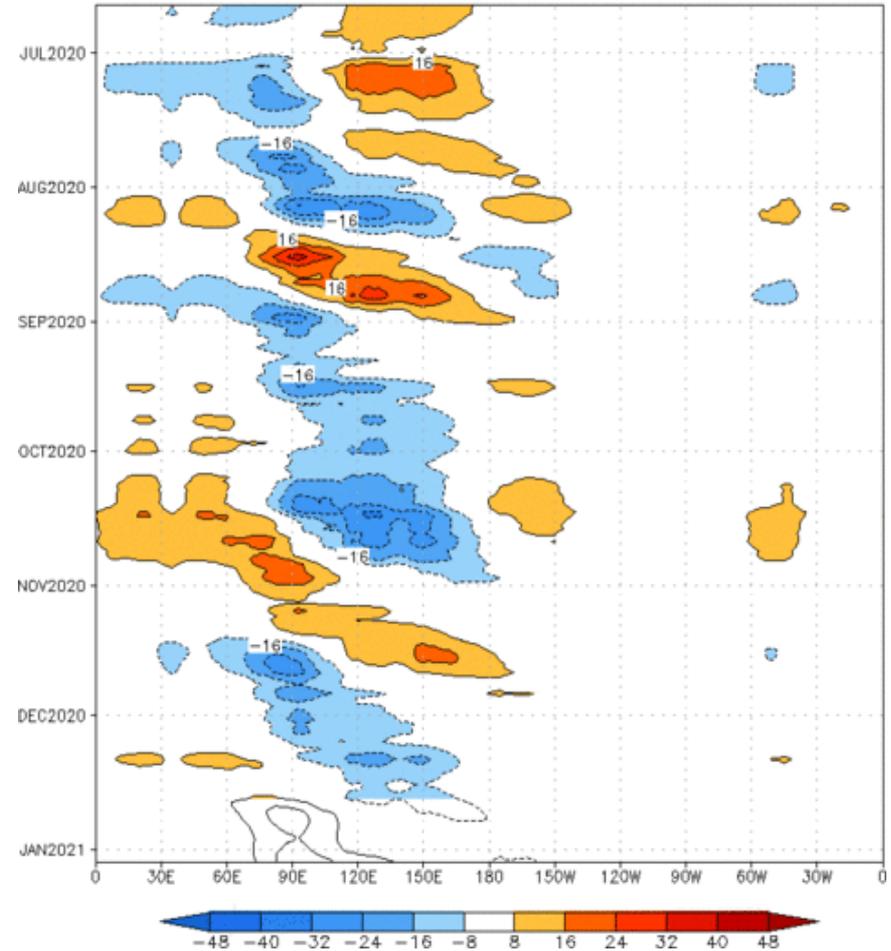
MJO: Constructed Analog Forecast Evolution

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 (20 Dec 2020)



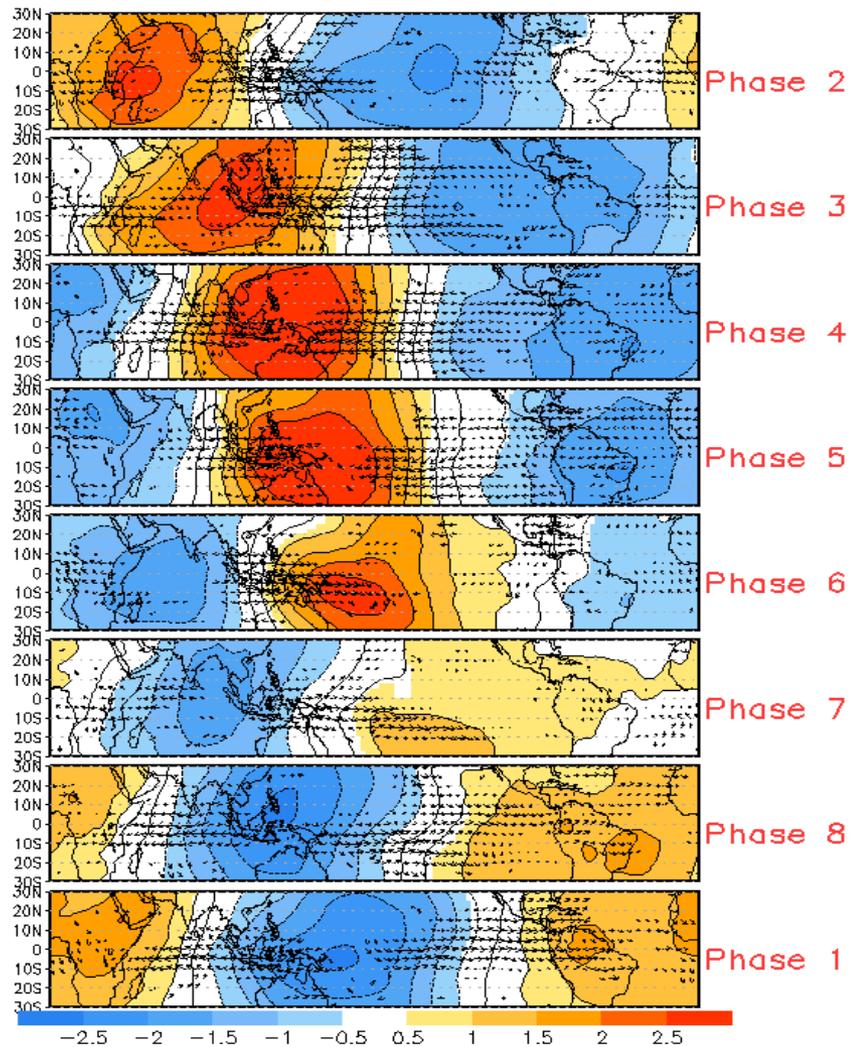
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:20-Jun-2020 to 20-Dec-2020
The unfilled contours are CA forecast reconstructed anomaly for 15 days



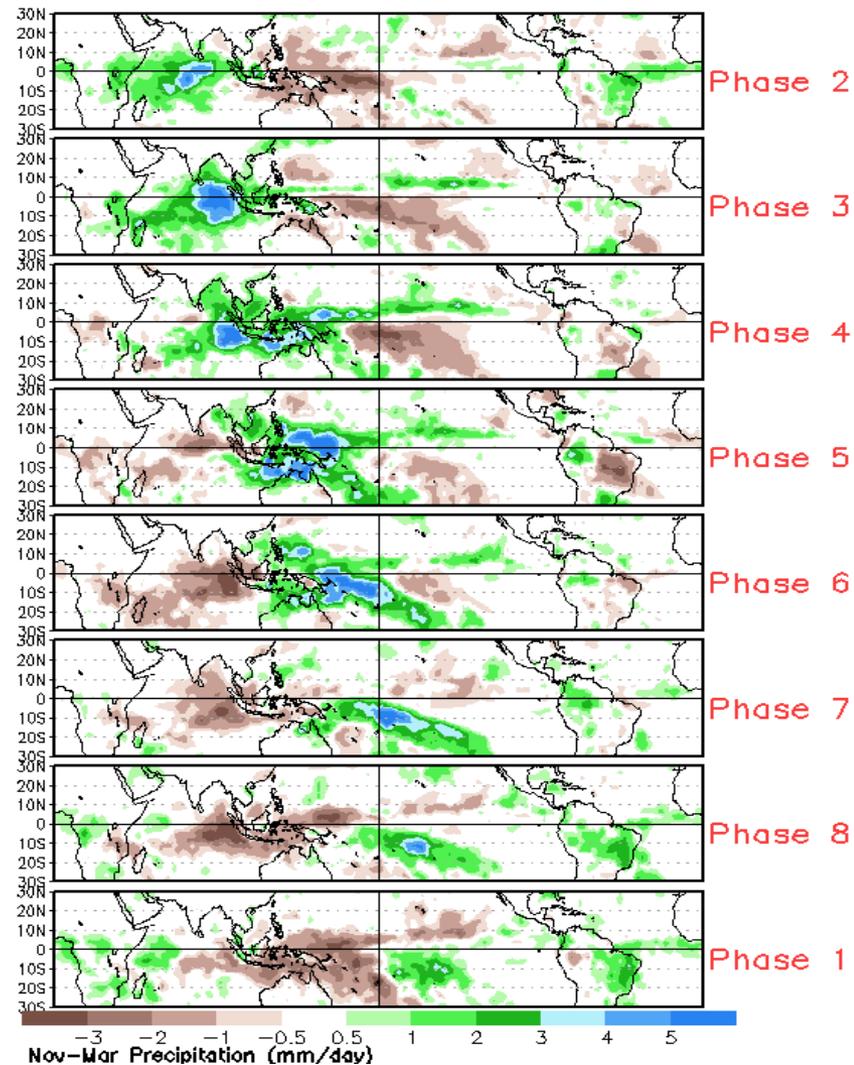
- The constructed analog depicts a more canonical eastward progression of the current MJO signal across the Pacific to the Western Hemisphere over the next two weeks.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



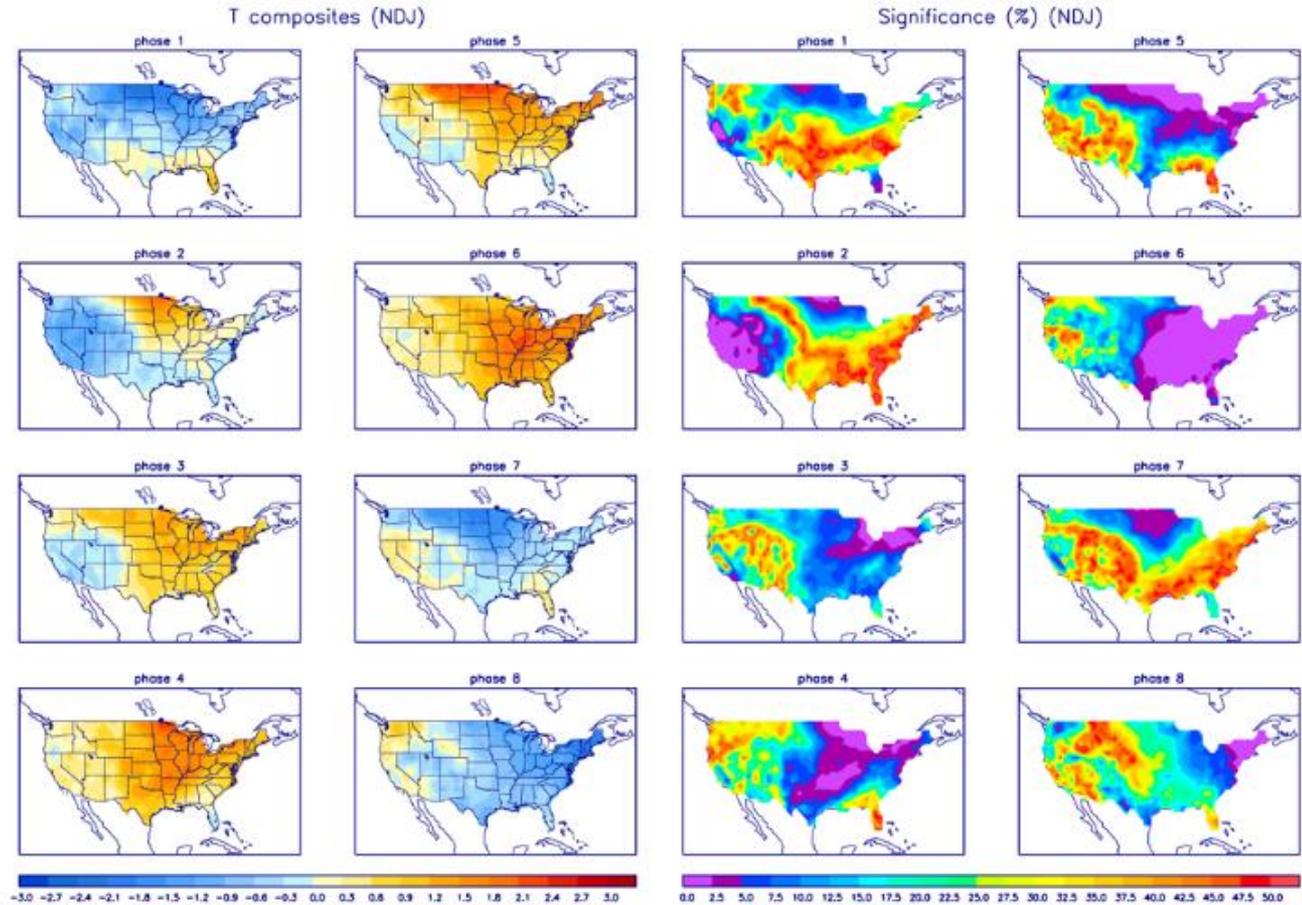
Precipitation Anomalies



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.

