

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
4 January 2021

Overview

- Recent observations continue to align best with the influence of La Niña, with limited intraseasonal contributions to the global tropical convective pattern.
- What remains of the enhanced MJO envelope is currently over the Indian Ocean and models suggest this may build over the coming week. Uncertainty grows heading into Week-2 as to whether model guidance emphasizes Rossby wave activity over the Indian Ocean or the MJO signal. This is coupled with typical model difficulties in propagating the MJO across the Indian Ocean, despite constructive interference with the low frequency state.
- Tropical cyclone activity over the Indian Ocean may be enhanced the next two weeks.
- Should the MJO maintain itself and continue propagating to the Pacific, this would likely result in a relatively warm (relatively cool) pattern across the Lower 48 states (Alaska) during middle to late January.

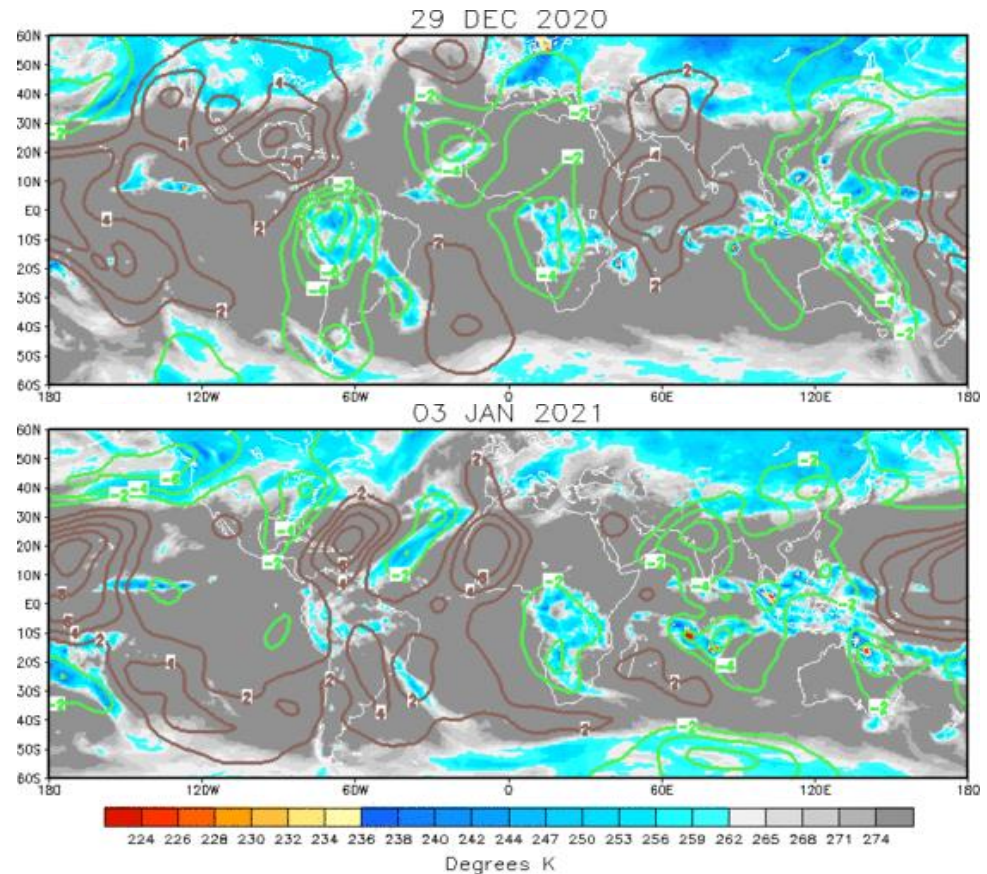
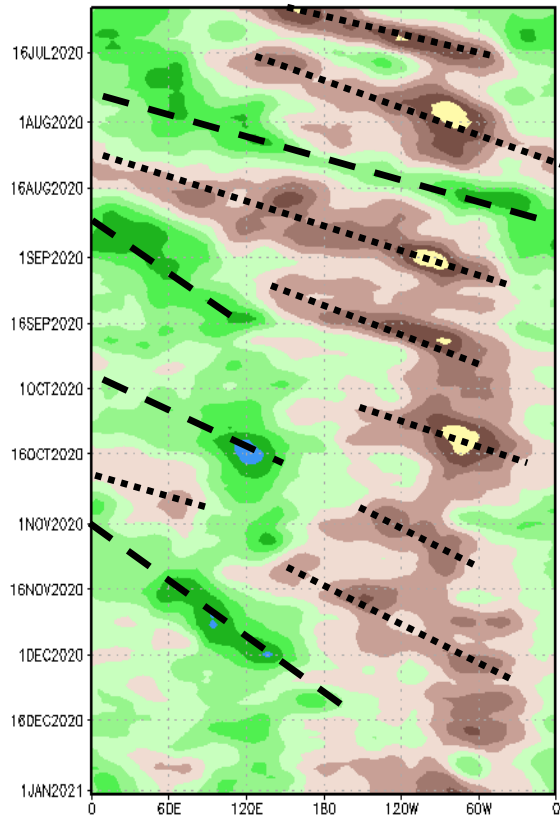
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

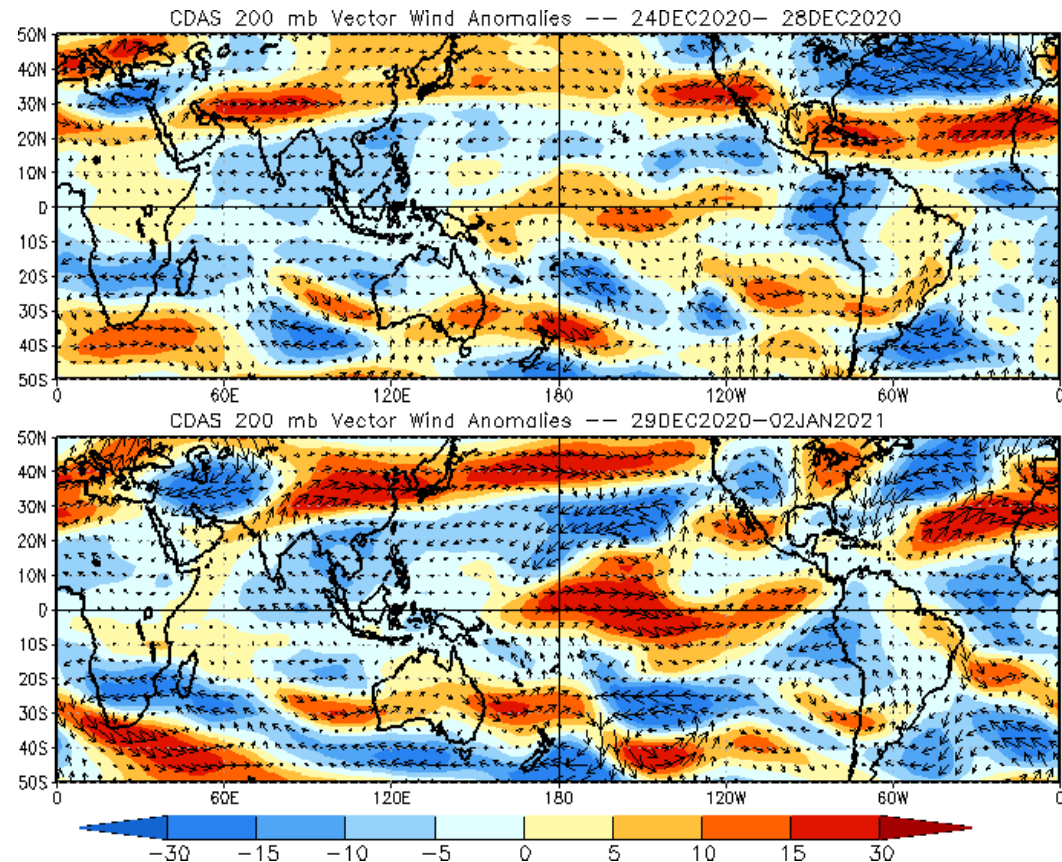
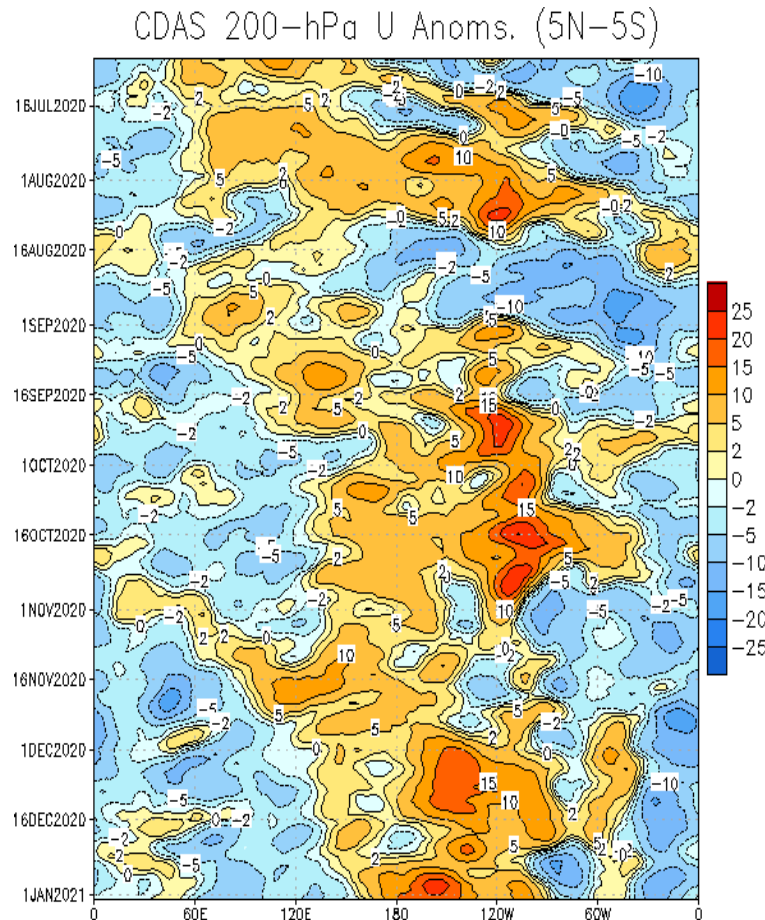
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- The MJO was active during much of November and the first half of December, with slow eastward propagation from the Indian Ocean to the Central Pacific.
- The pattern as of 2021 is more reminiscent of La Niña, with the remnant eastward-propagating intraseasonal signal likely over Africa.

200-hPa Wind Anomalies

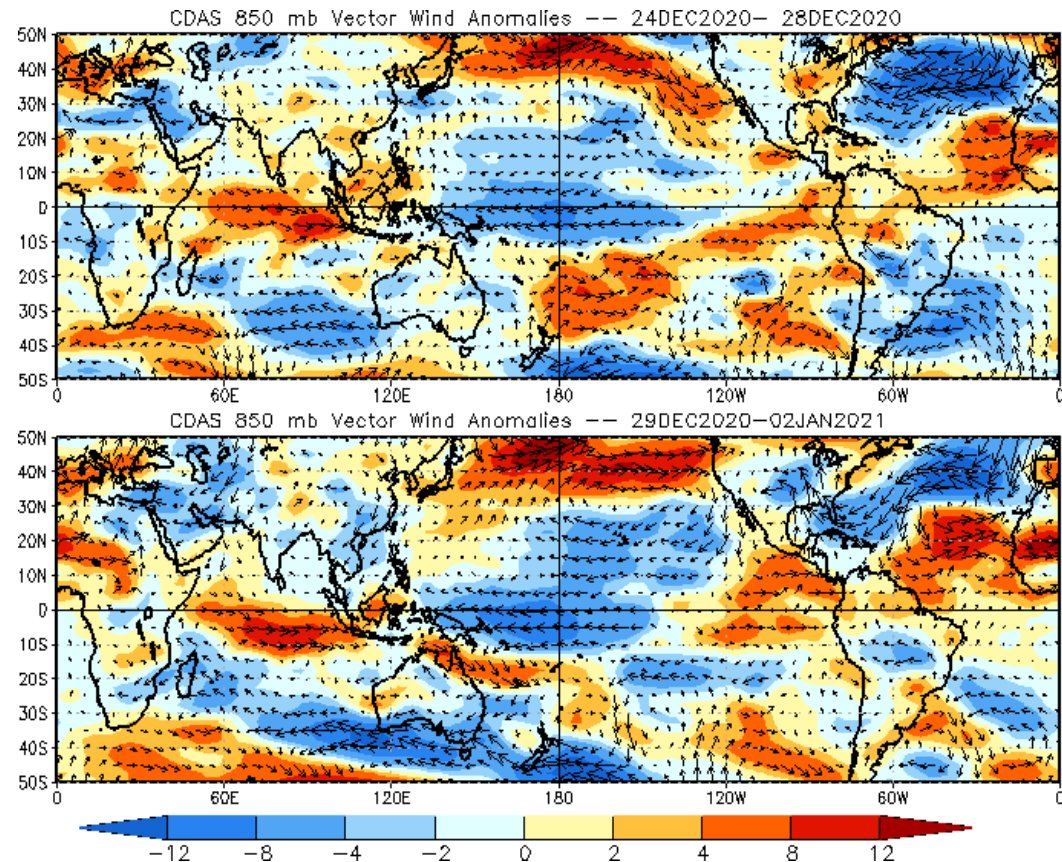
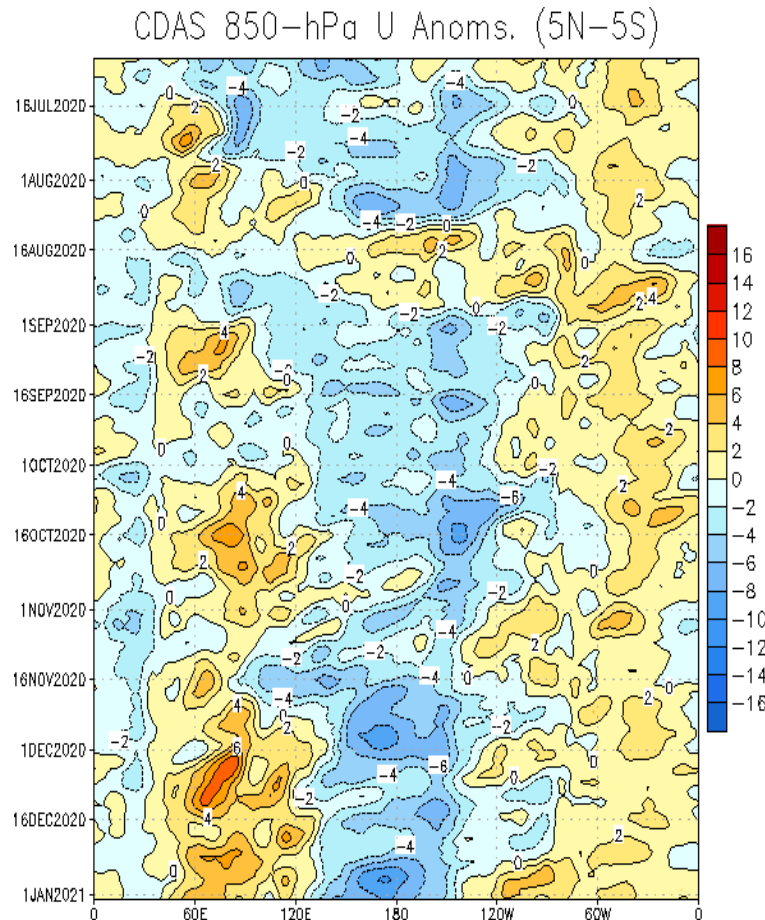
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous westerlies have strengthened over the Central and Eastern Pacific since late December, which can be traced to mass being transported onto the equator near the Date Line from the extratropics.
- A robust extension of the jet stream across the Northern Hemisphere mid-latitudes is observed during late 2020 and early 2021 .

850-hPa Wind Anomalies

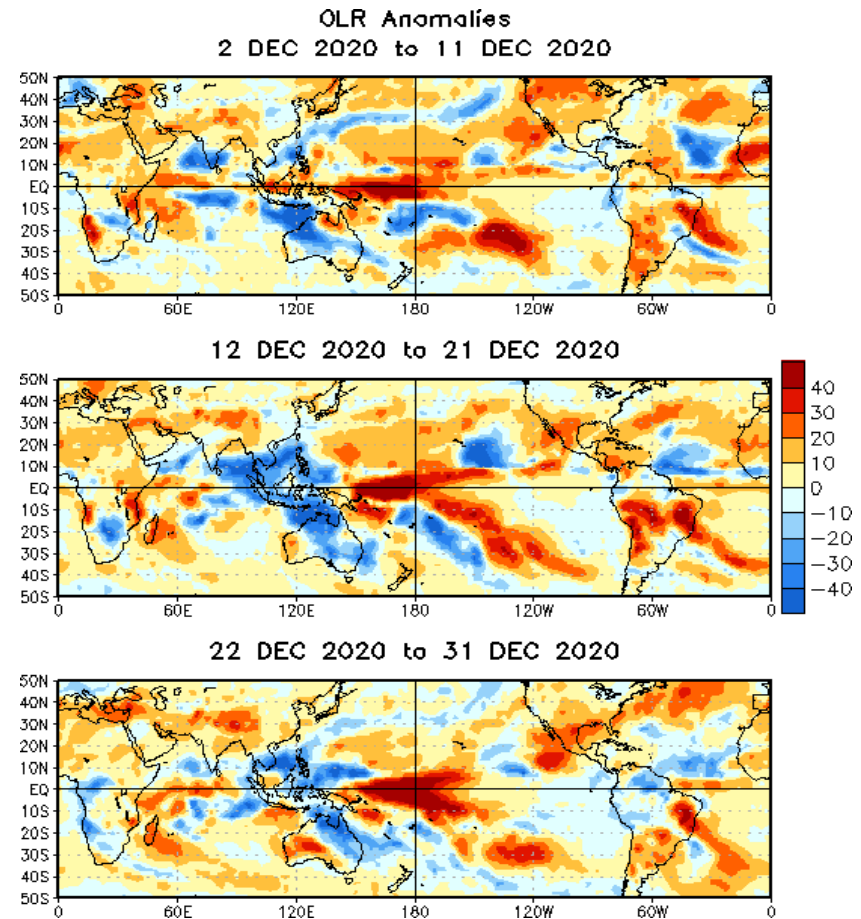
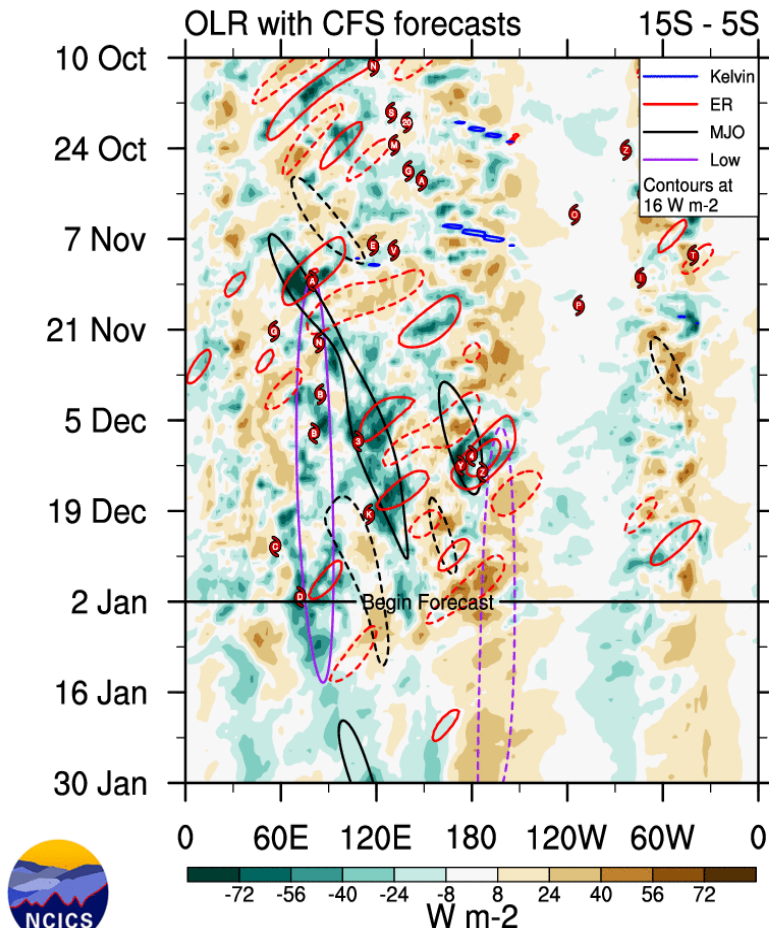
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Enhanced convergence along the equator near 120E is tied to the low-frequency state.
- The South Pacific Convergence Zone has become increasingly defined in recent days.

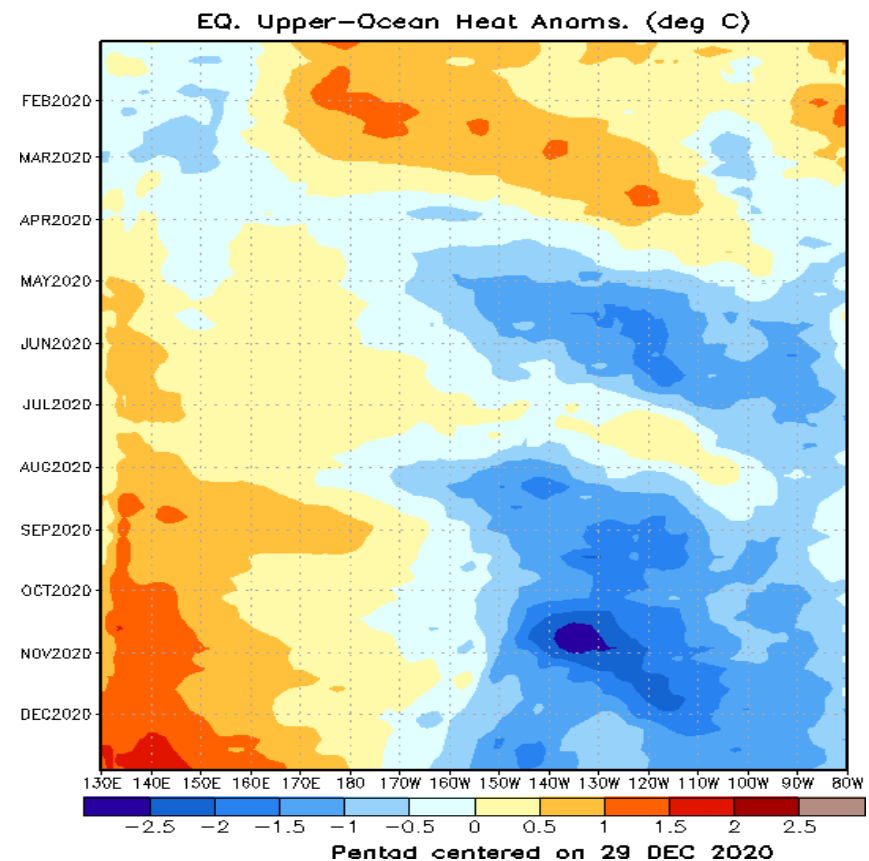
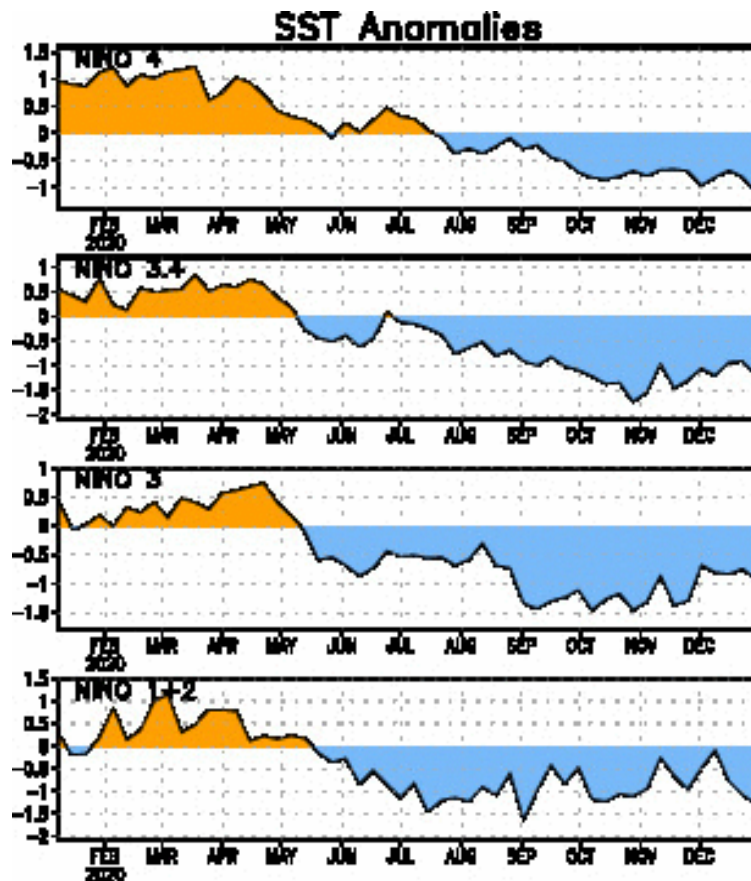
Outgoing Longwave Radiation (OLR) Anomalies

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



- Convection has been established over the Maritime Continent since mid-December in association with warm sea surface temperatures and the ongoing La Niña.
- Suppressed convection to the east of New Guinea shows little sign of its western edge being encroached upon despite shortwave effects acting as a cap on how cool the sea surface temperatures can become.

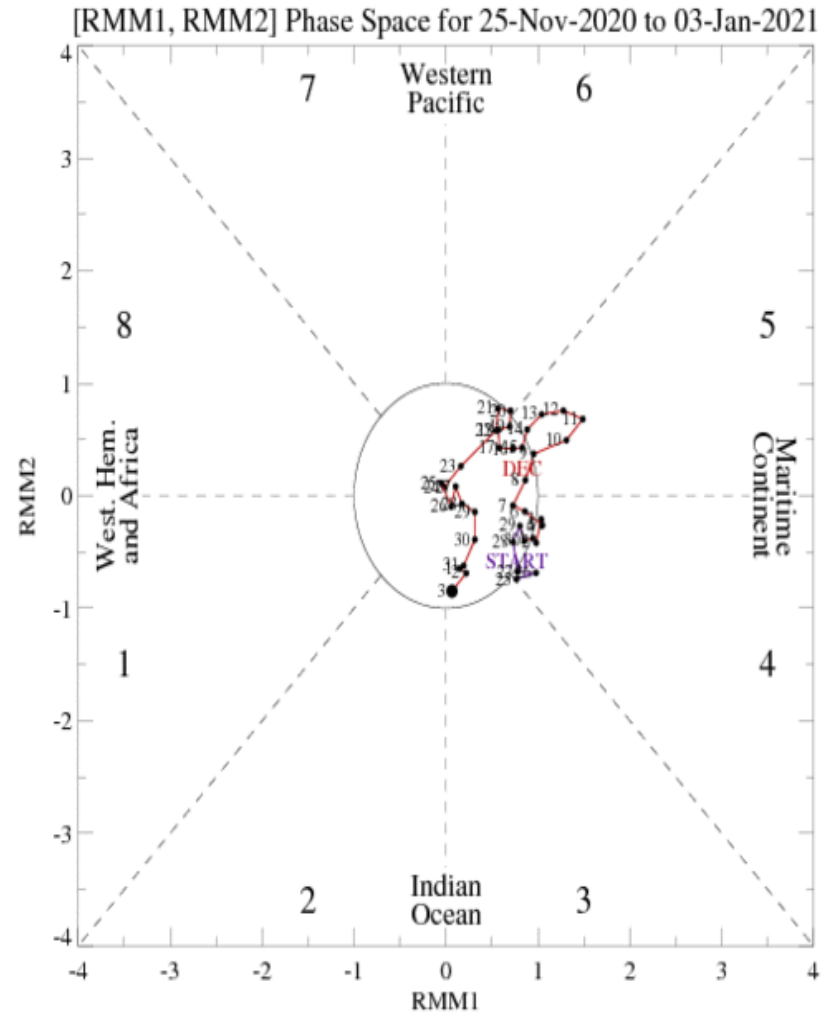
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- 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 have shifted slightly westward across the central Pacific since November.

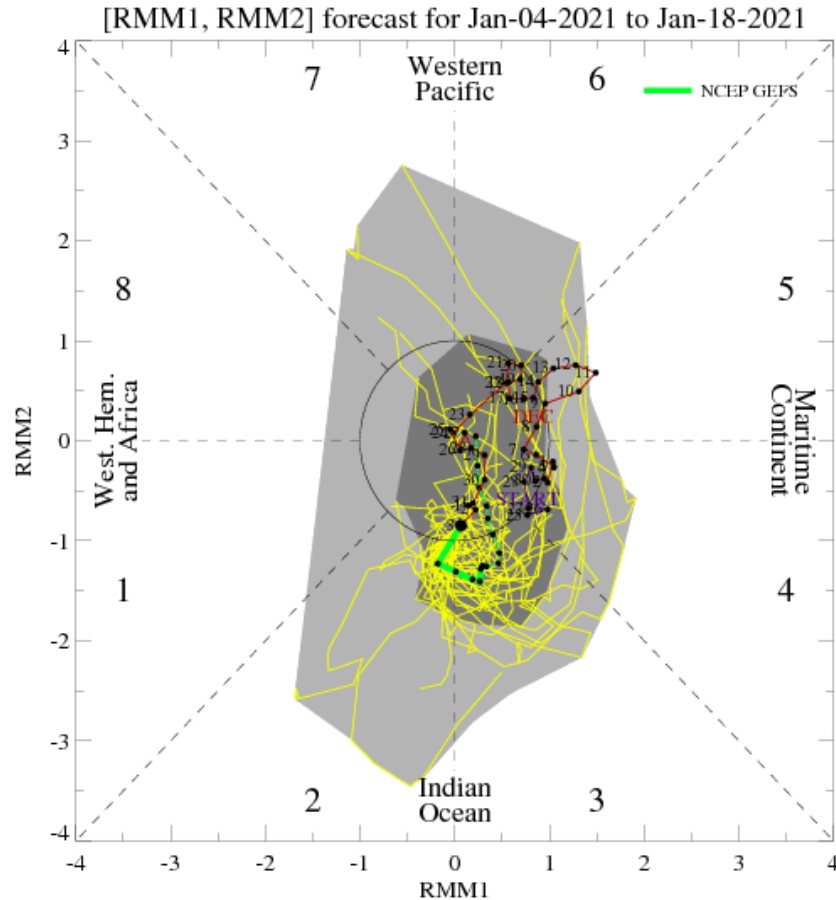
MJO Index: Recent Evolution

- The RMM index has been incoherent since late November.
- There has been a visible shift of the signal over the last week to more negative values of RMM2 despite no emergence over the Indian Ocean.

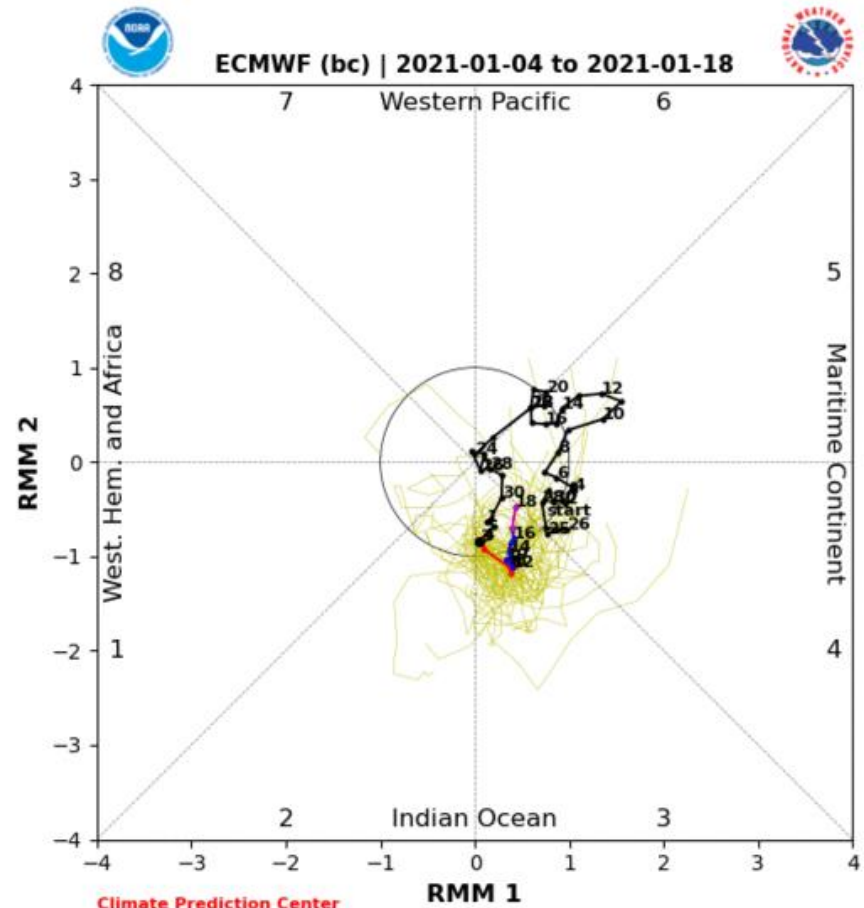


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



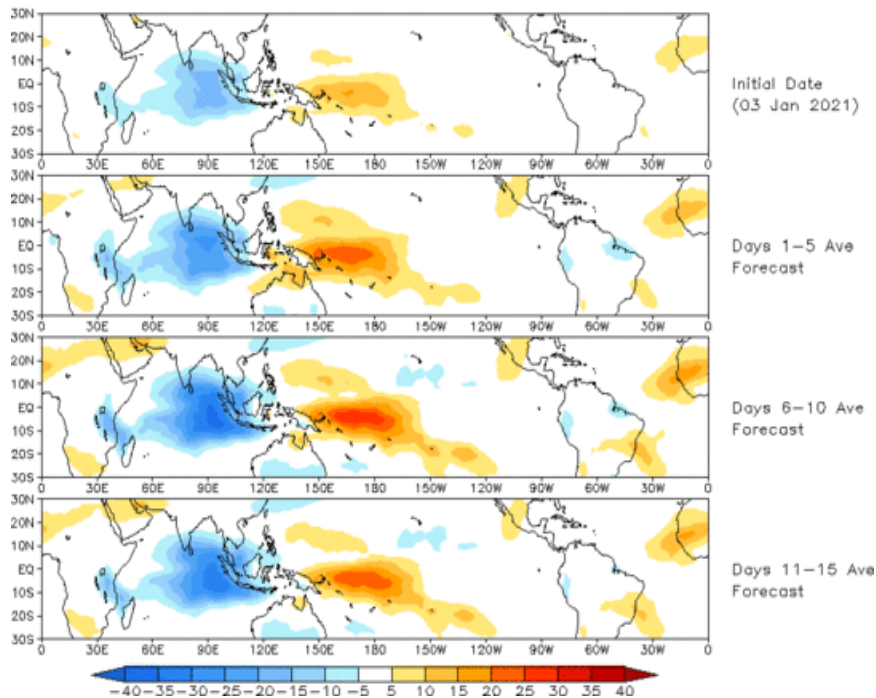
ECMWF Forecast

- The GEFS anticipates an Indian Ocean MJO event that lasts for roughly 10 days. Spread among members reveals some with canonical MJO phase speeds, faster members that reach the West Pacific (Kelvin wave activity emphasized), and some westward moving members (keying more on equatorial Rossby wave activity).
- The ECMWF forecasts shows the MJO emerging over the Indian Ocean this week and some eastward propagation the next two weeks, despite the amplitude dropping off again quickly. Spread among its ensemble members is fairly large, but lacks the Kelvin wave signal apparent in some GEFS members.

MJO: GEFS Forecast Evolution

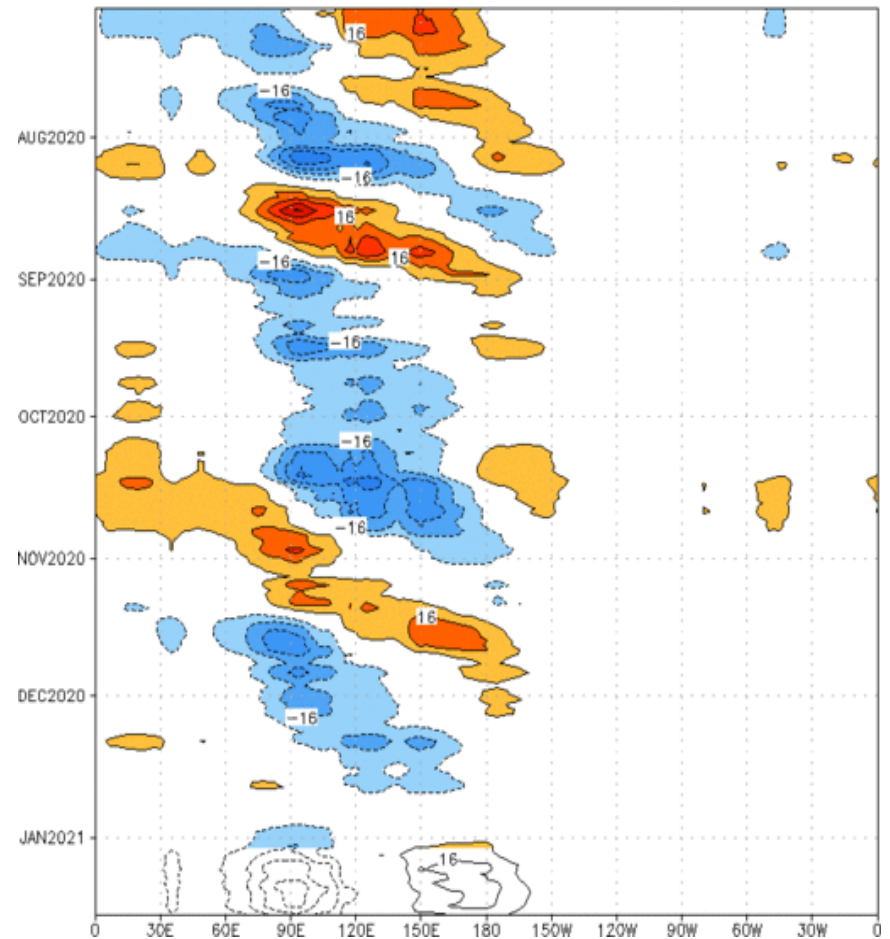
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Prediction of MJO-related anomalies using GEFS operational forecast
Initial date: 03 Jan 2021
OLR



- This GEFS forecast shows a strengthening MJO event over the Indian Ocean, but little to no propagation the next two weeks.

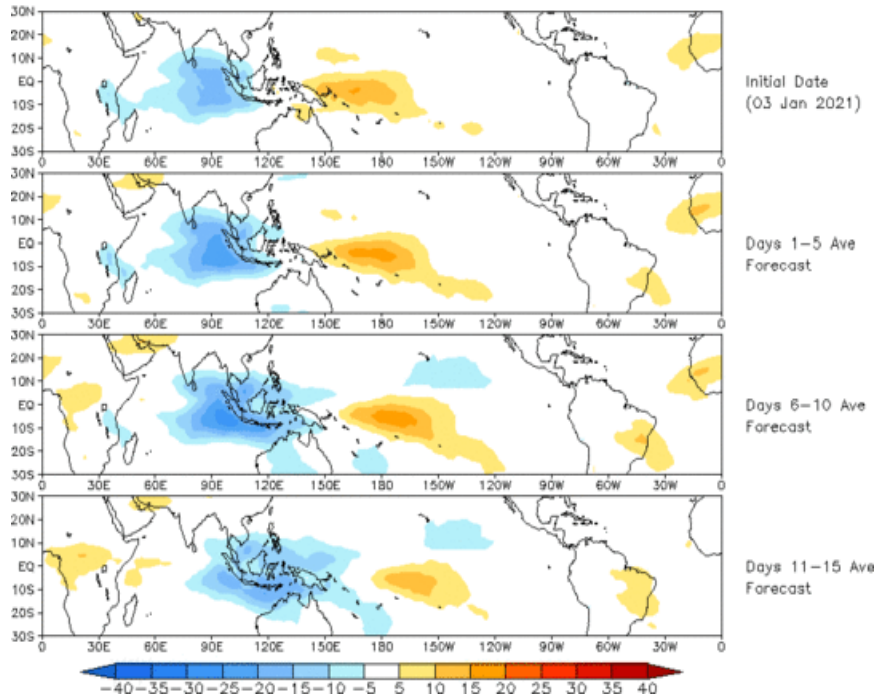
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S, 7.5°N] ($\text{cint: } 4\text{Wm}^{-2}$) Period: 04-Jul-2020 to 03-Jan-2021
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days



MJO: Constructed Analog Forecast Evolution

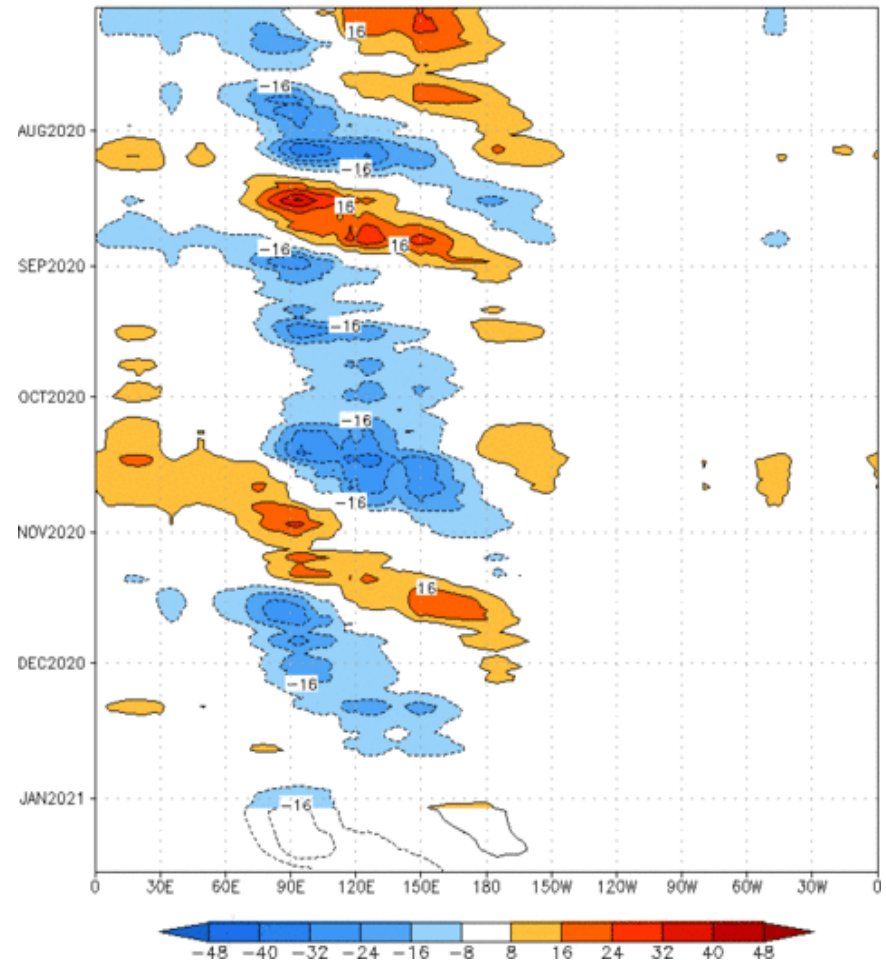
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (03 Jan 2021)



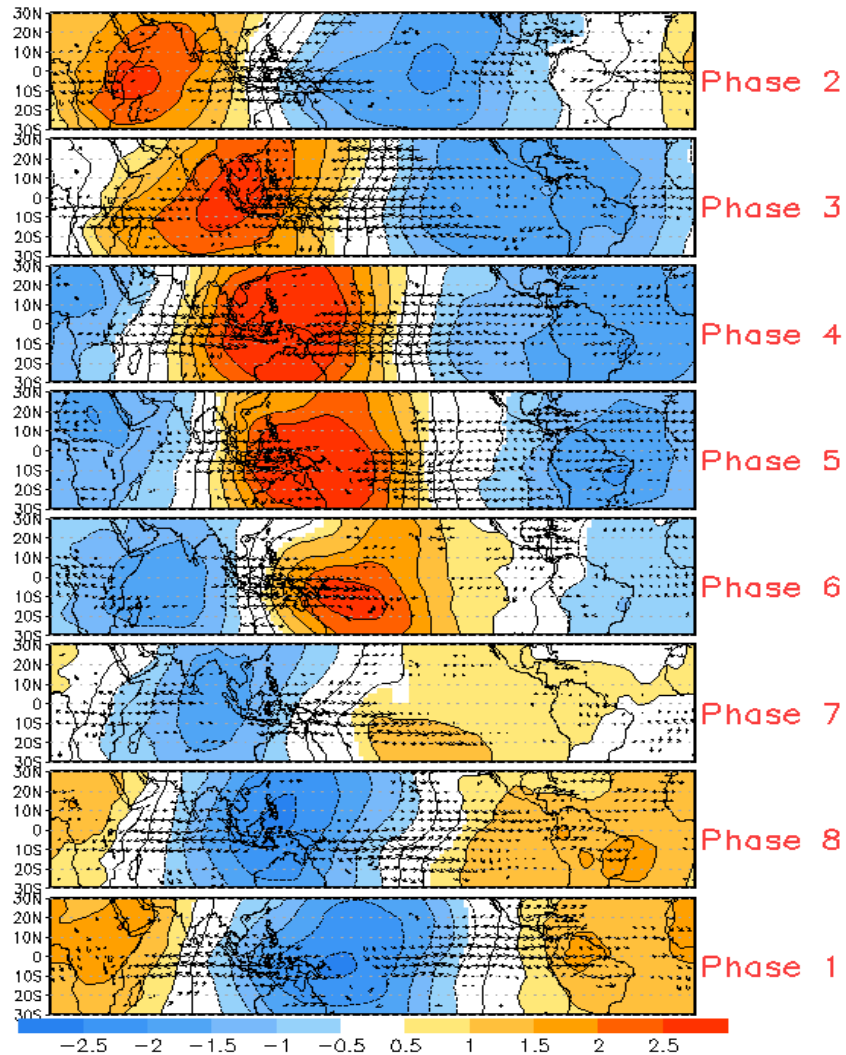
- The constructed analog MJO forecast is more progressive than the GEFS but exhibits a less intense intraseasonal signal.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:04-Jul-2020 to 03-Jan-2021
The unfilled contours are CA forecast reconstructed anomaly for 15 days

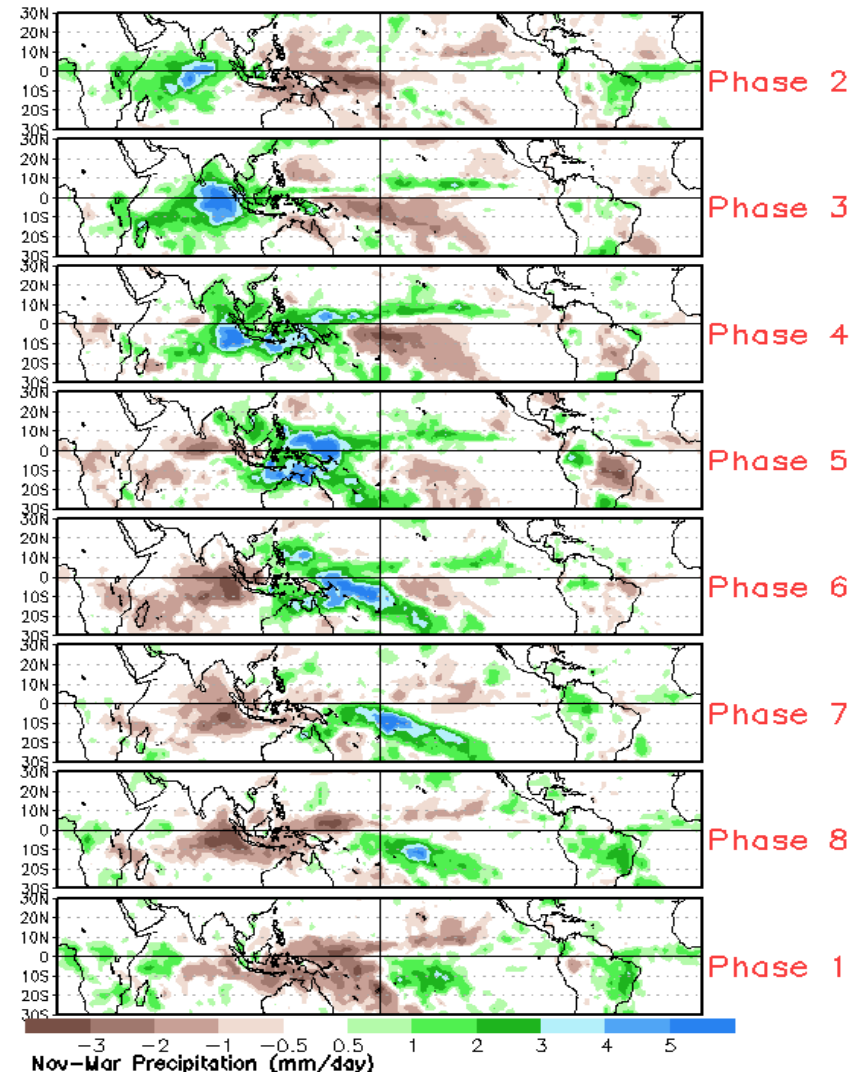


MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



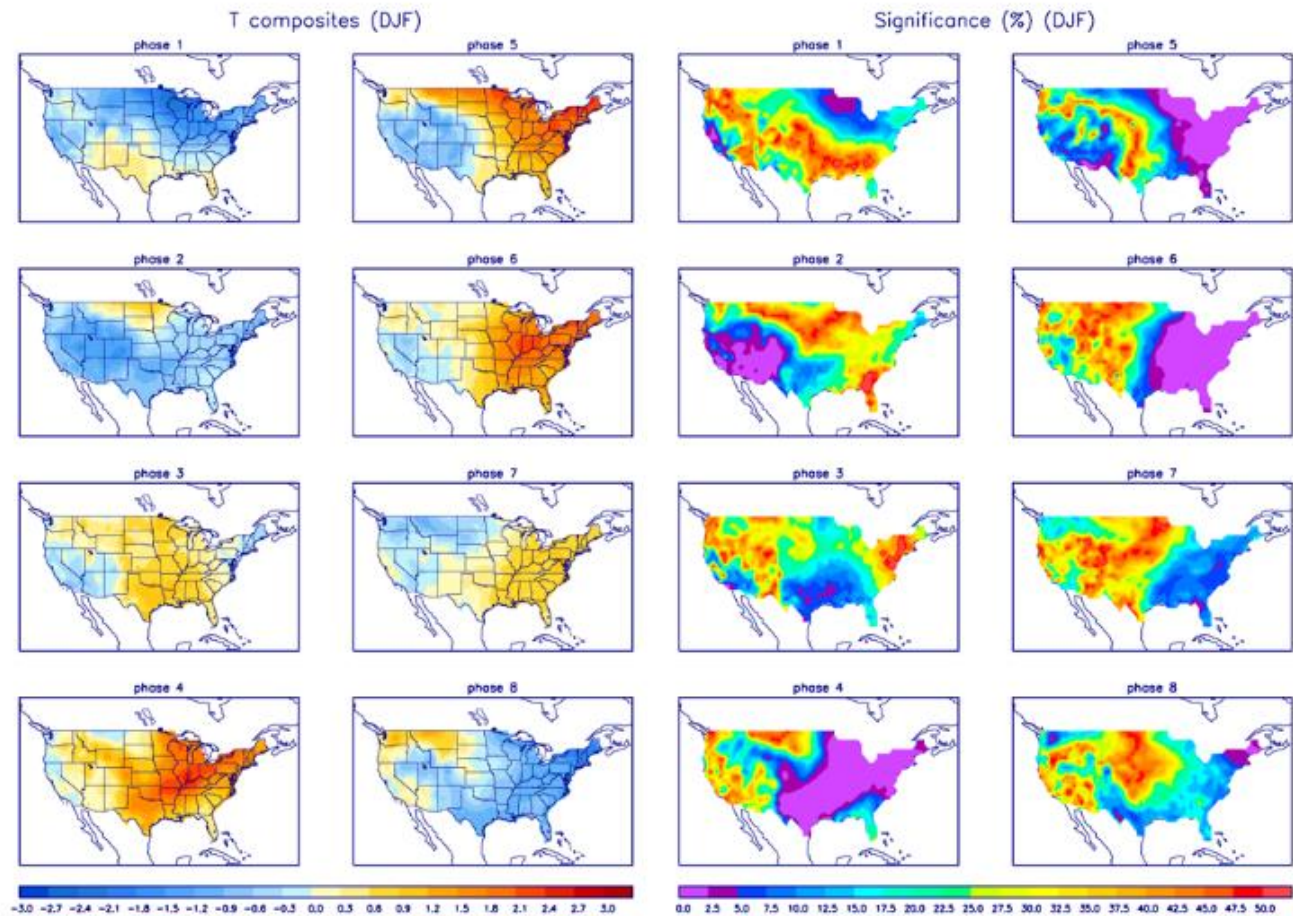
Precipitation Anomalies



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.

