

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
26 December 2022

Overview

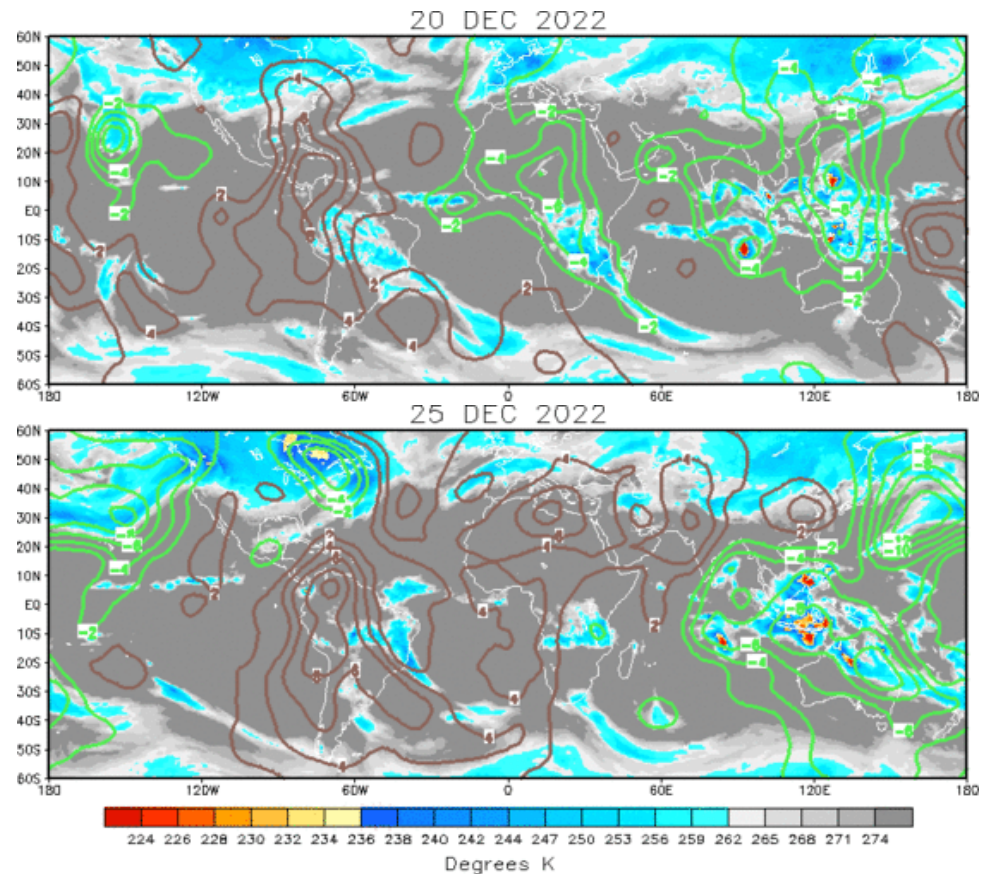
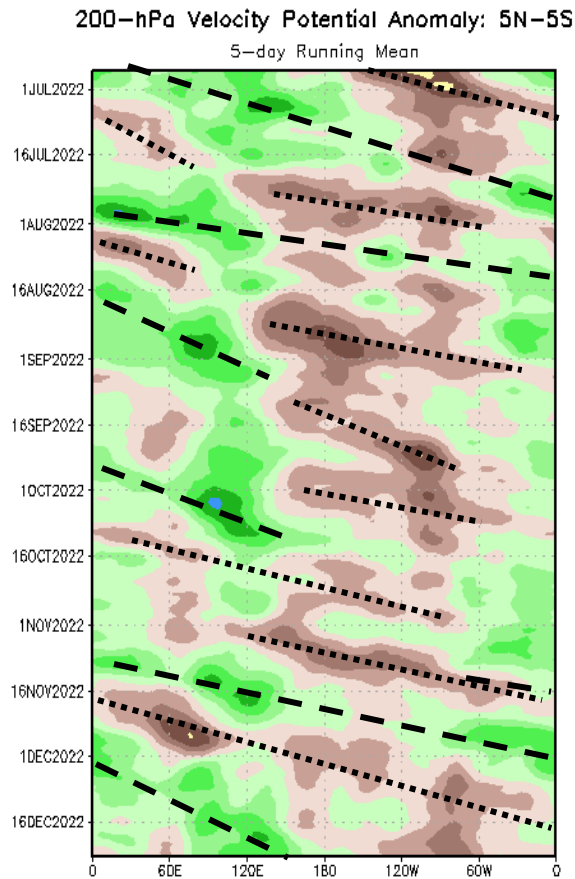
- An active MJO signal is crossing the Maritime Continent following a period of interference from Rossby waves over the Indian Ocean.
- Dynamical model RMM forecasts are in fair agreement with the MJO signal propagating eastward over the West Pacific into early 2023.
- The MJO may contribute to a tropical cyclone formation threat that shifts from the central Indian Ocean to the Maritime Continent and far western Pacific over the next few weeks
- During Maritime Continent MJO events, the lagged extratropical response historically favors the development of above-normal temperatures over eastern North America.
- A pattern change favoring more troughing over eastern North America is possible following West Pacific MJO activity.

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)

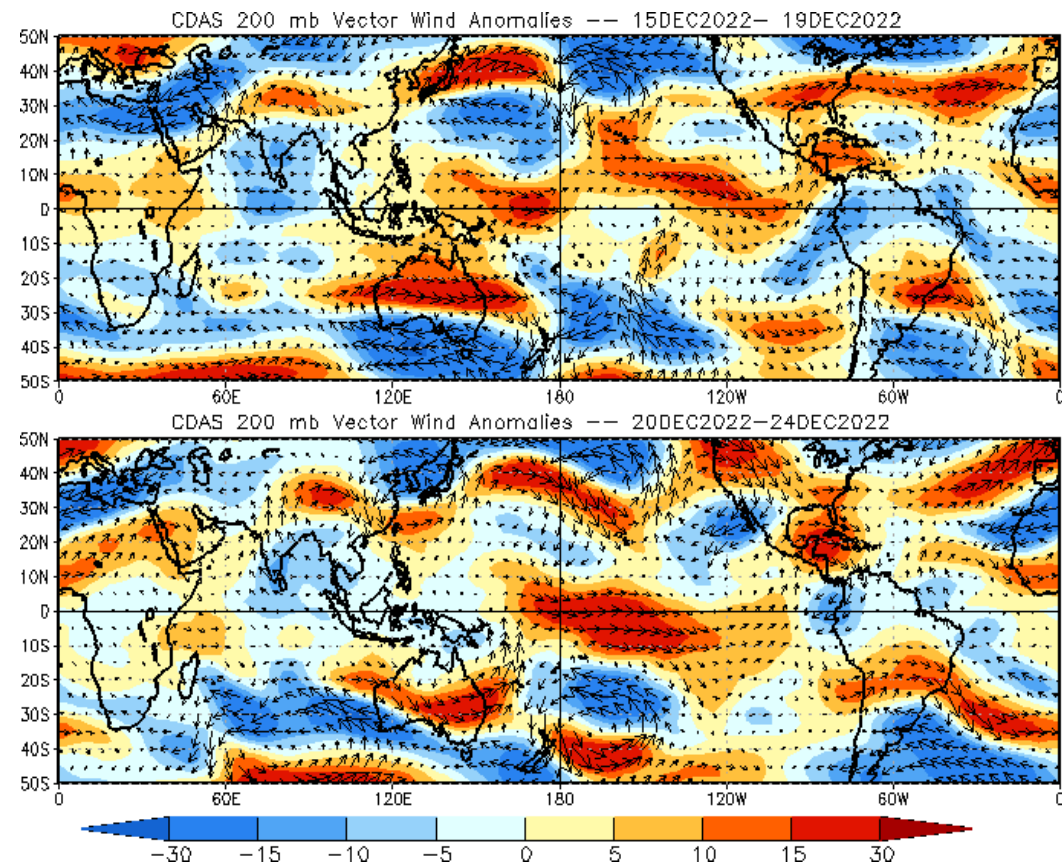
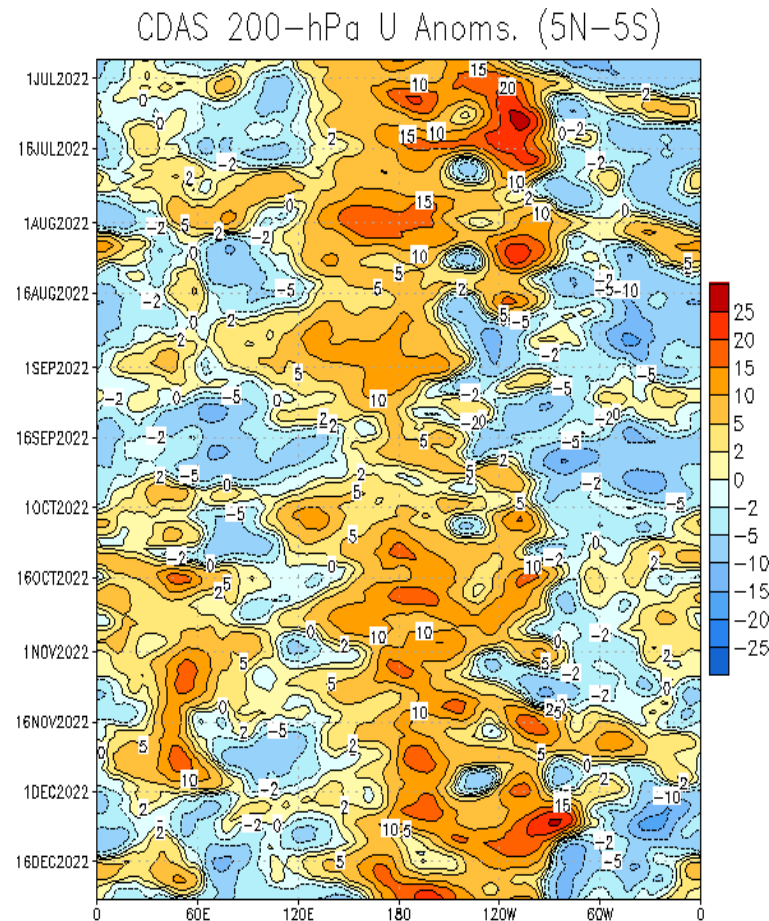
Brown shades: Anomalous convergence (unfavorable for precipitation)



- The MJO has been active during the last few months, with the enhanced convective phase increasingly managing to interfere with the La Niña base state.
- More recently, the MJO is constructively interfering with the base state, with convectively coupled Kelvin waves also influencing the pattern.

200-hPa Wind Anomalies

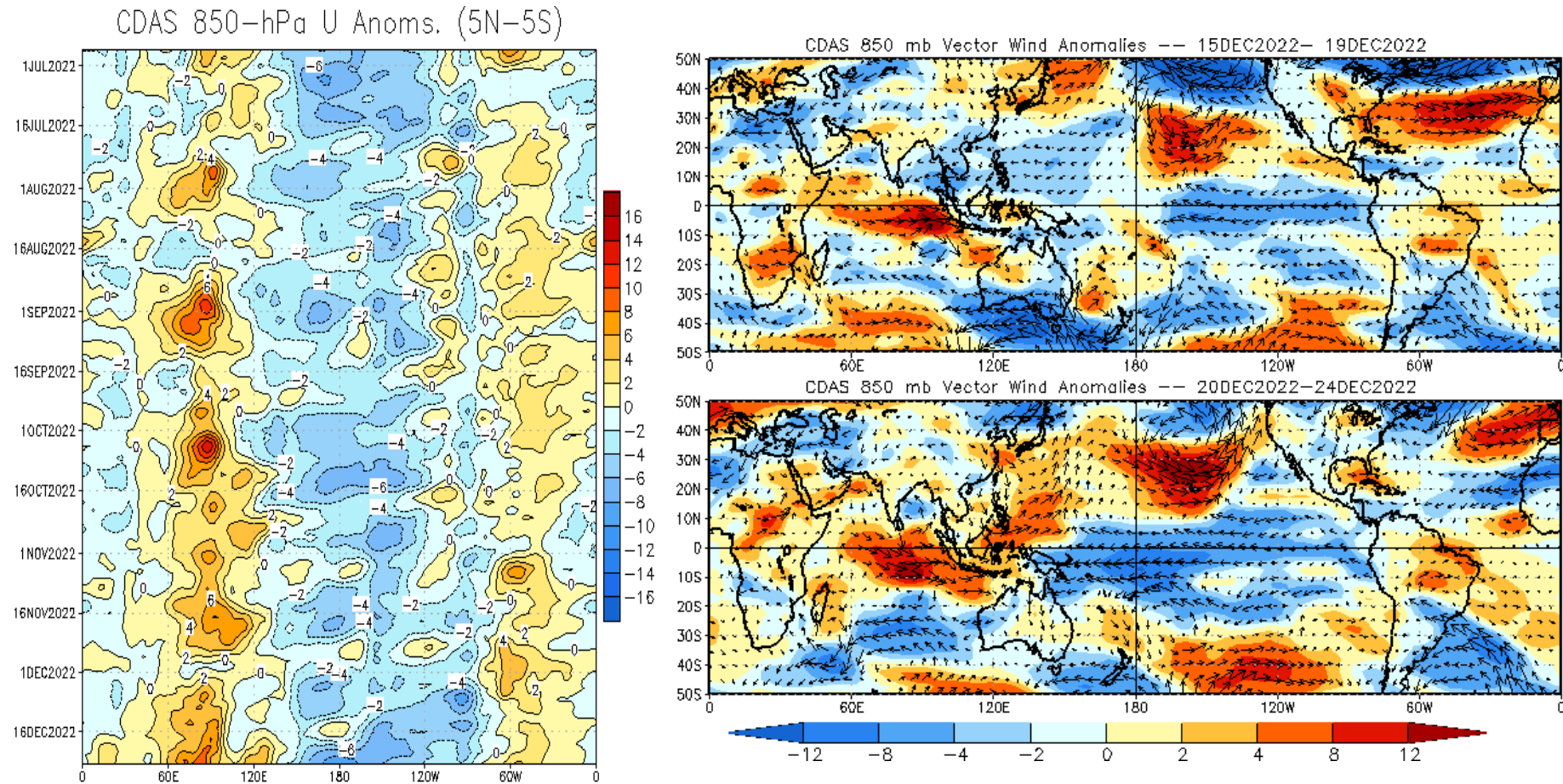
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Strong upper-level westerly anomalies continue to dominate the tropical Pacific, though a clear eastward propagation is evident.
- Anomalous easterlies extended to just west of the Date Line.

850-hPa Wind Anomalies

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

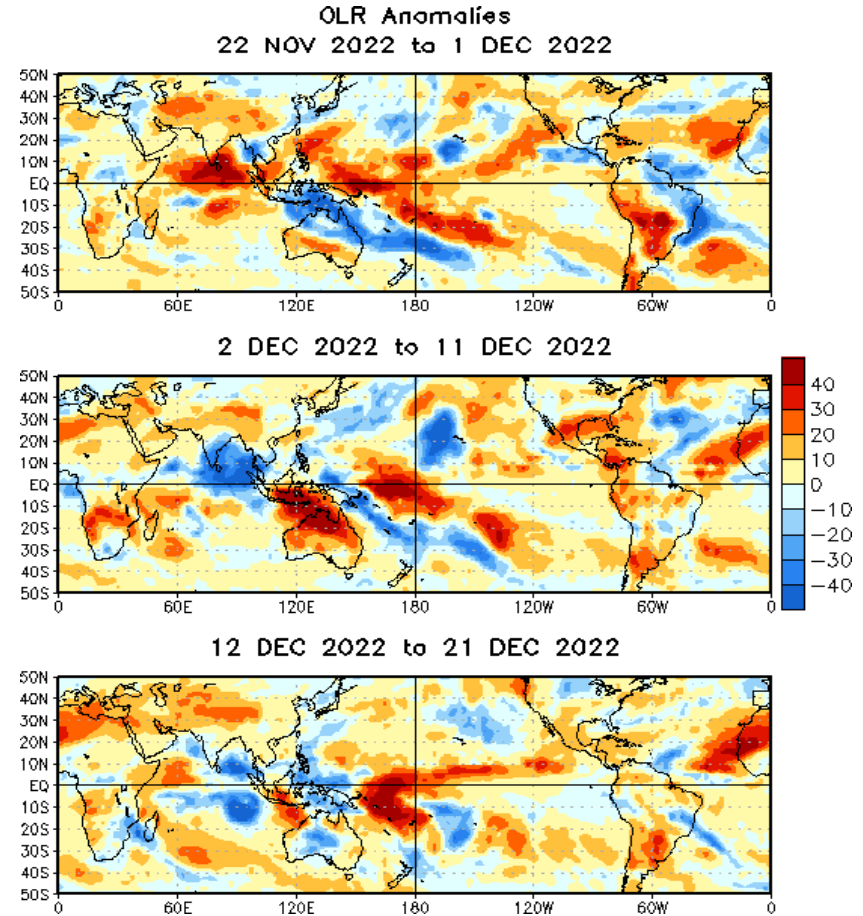
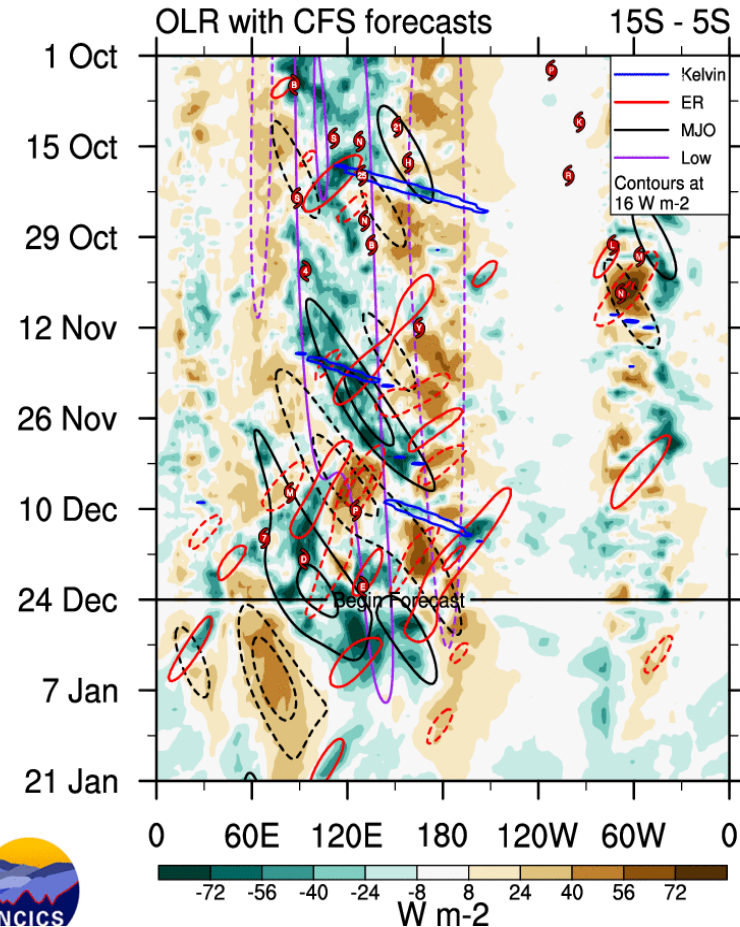


- Easterly anomalies strengthened over the equatorial West Pacific, due to constructive interference with the Maritime Continent MJO and potential Rossby wave activity.
- Eastward propagation of westerly anomalies is evident north of the Equator over the Northwest Pacific.

Outgoing Longwave Radiation (OLR) Anomalies

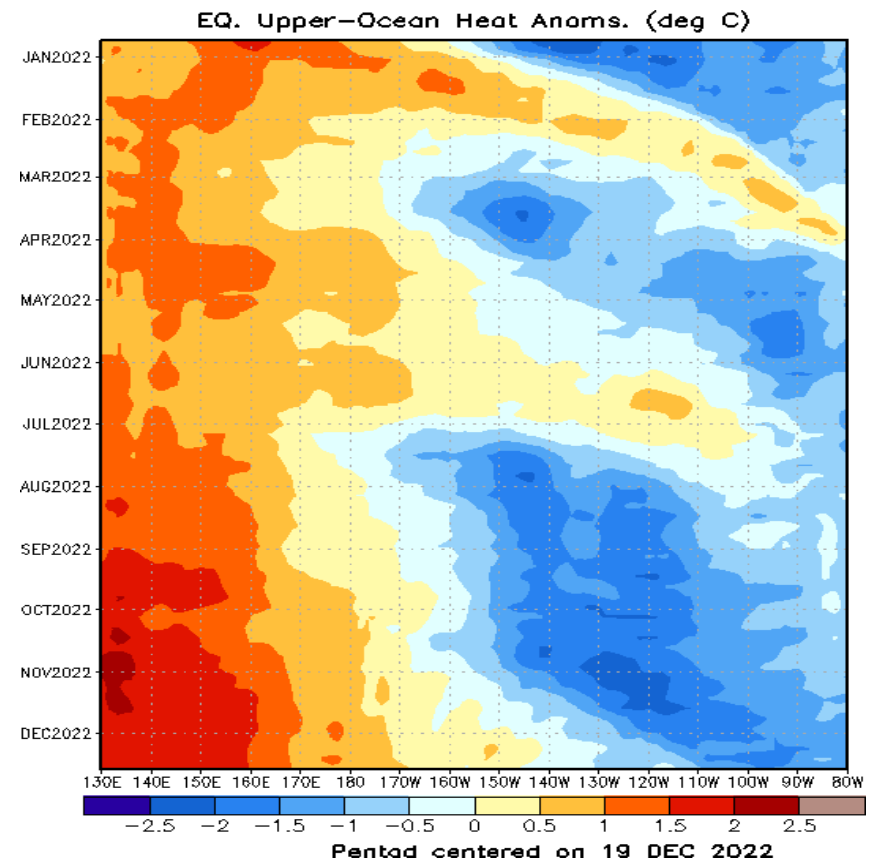
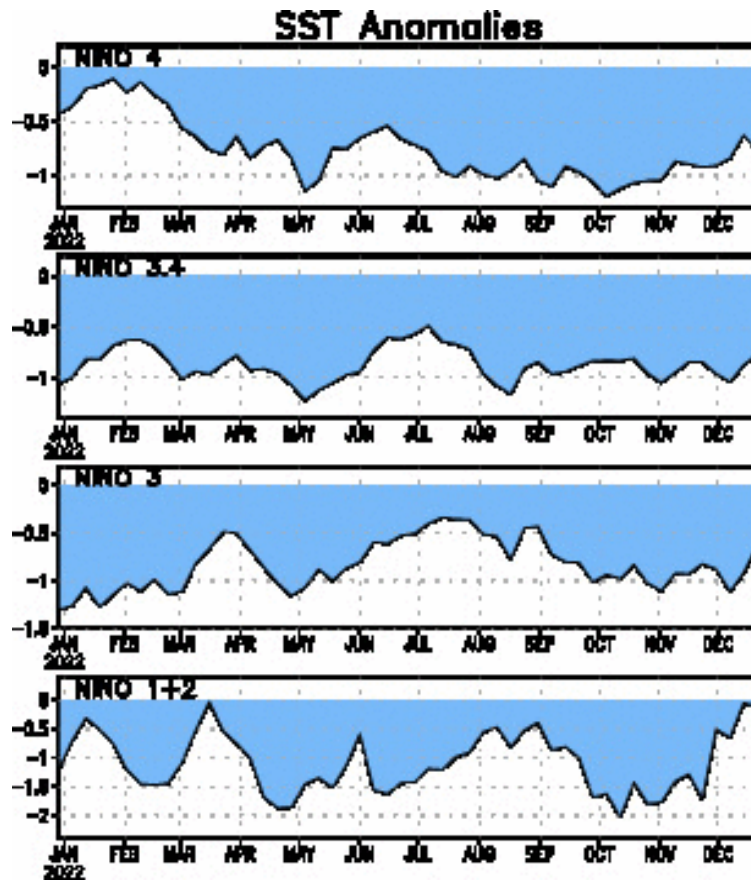
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- The low frequency ENSO base state and MJO remains the most dominant features in the OLR field.
- Rossby wave activity is interfering with the enhanced convective envelope, but continued eastward propagation is evident.
- OLR forecasts reveal continued MJO activity over the next two weeks..

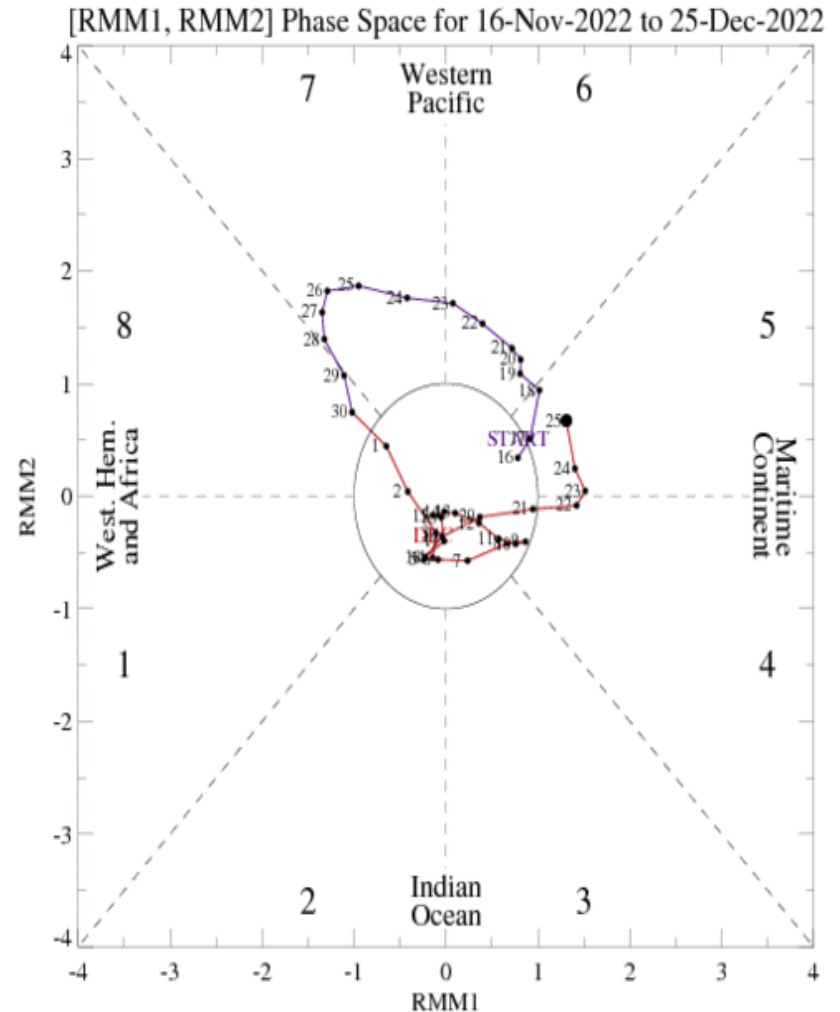
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Negative upper-ocean heat anomalies have continued to become more zonally narrow during the boreal autumn, with more subsurface warming expanding further eastward near 140W during mid-December.
- SSTs remain well below average across all Niño basins, except the eastern Pacific (Niño 1+2) where a sharp warming trend is indicated since late November.

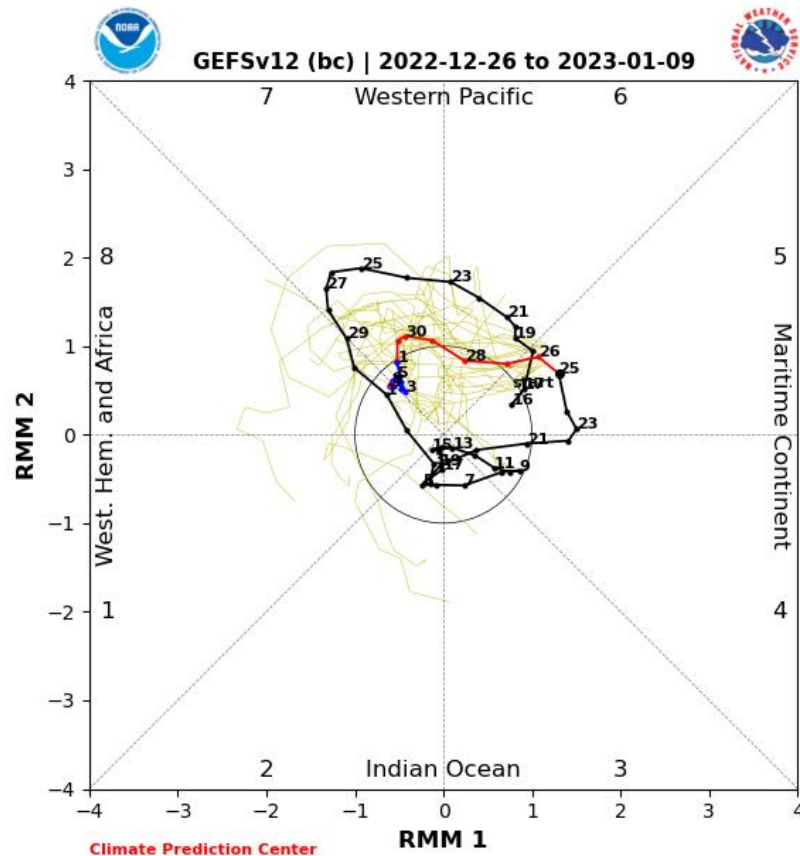
MJO Index: Recent Evolution

- Following a period of Rossby wave influence, a clearer eastward propagation became established on the RMM-based MJO index over the Maritime Continent.

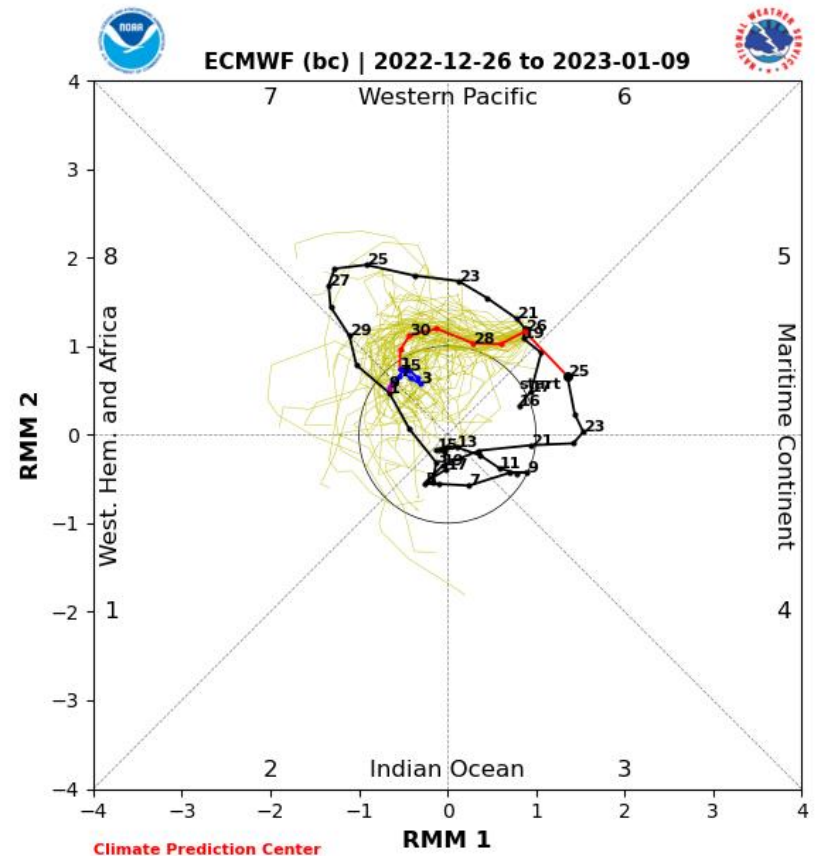


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



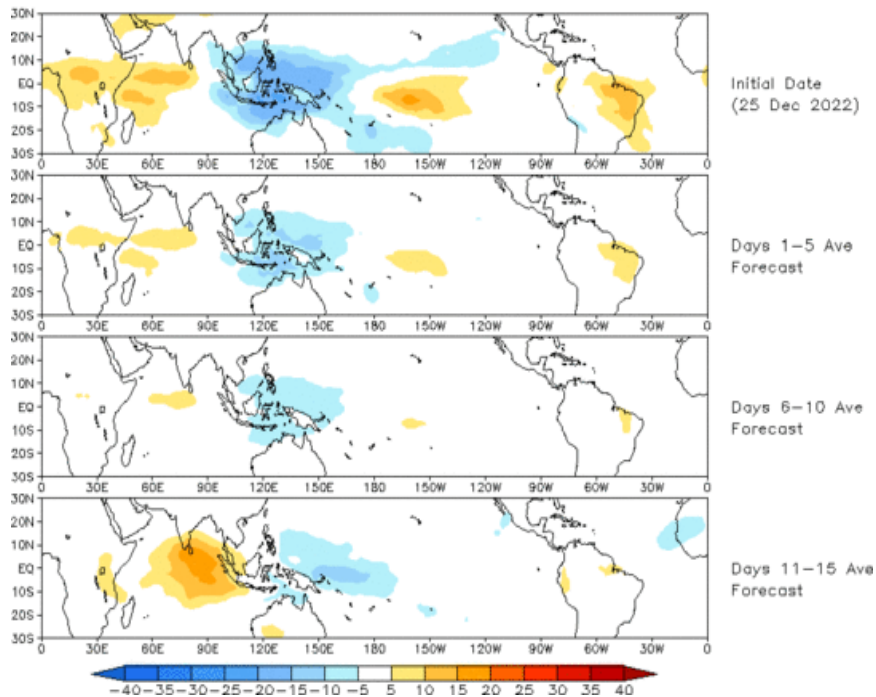
ECMWF Forecast

- Both the GEFS and ECMWF RMM forecasts favor the resumption of a slow eastward propagating MJO signal over the western Pacific during the next two weeks, with many ensemble members showing weakening amplitude.

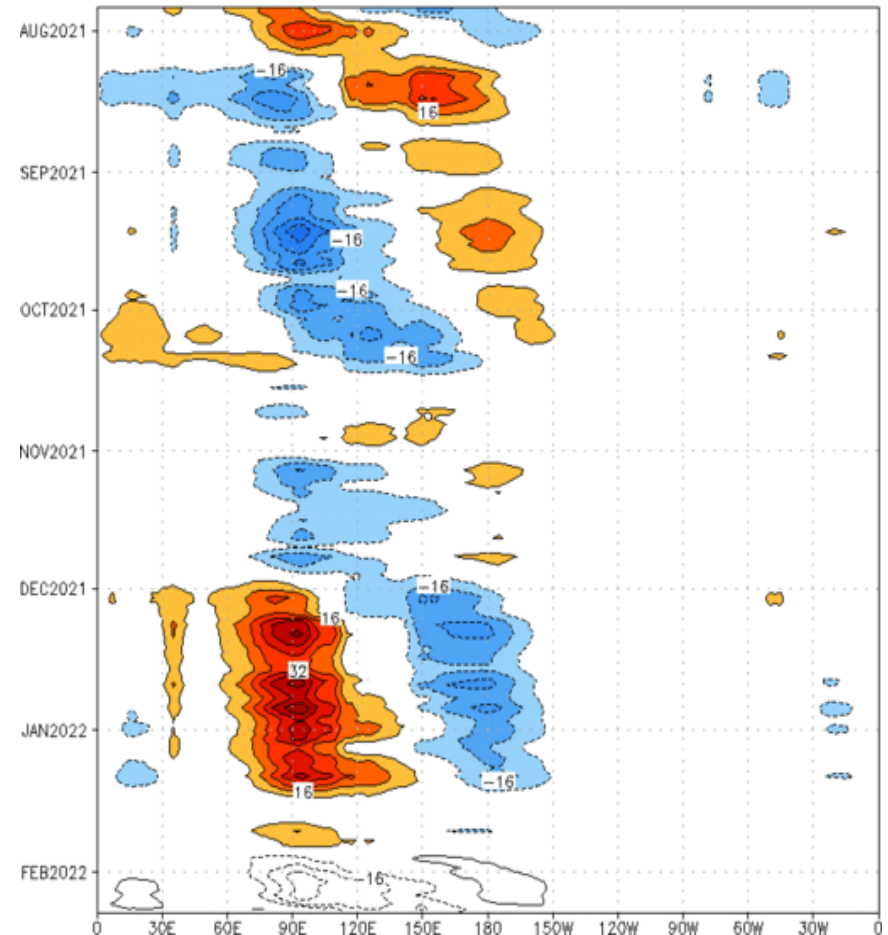
MJO: GEFS Forecast Evolution

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: 25 Dec 2022
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: 27-Jul-2021 to 26-Jan-2022
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

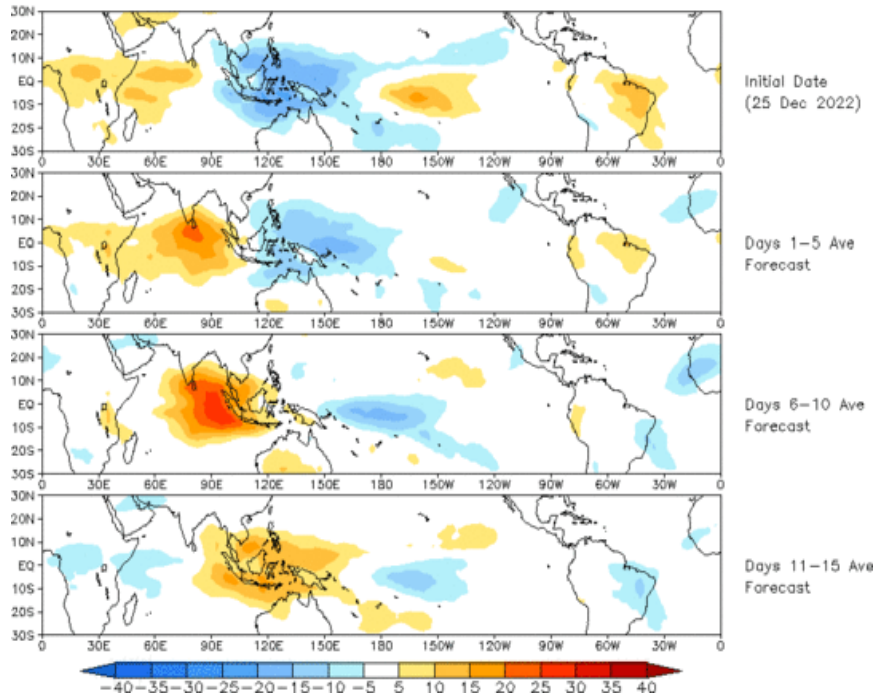


- The GEFS-based OLR anomaly fields depict enhanced convection transitioning slowly from the Maritime Continent to the West Pacific.

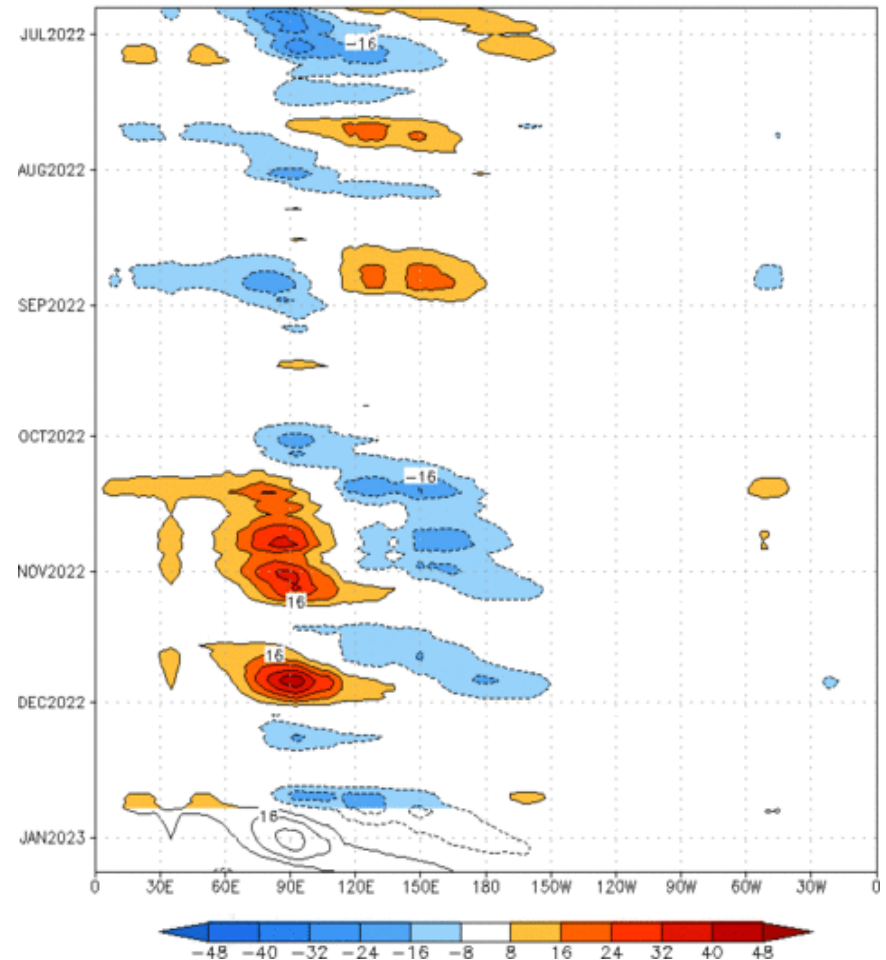
MJO: Constructed Analog Forecast Evolution

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 (25 Dec 2022)



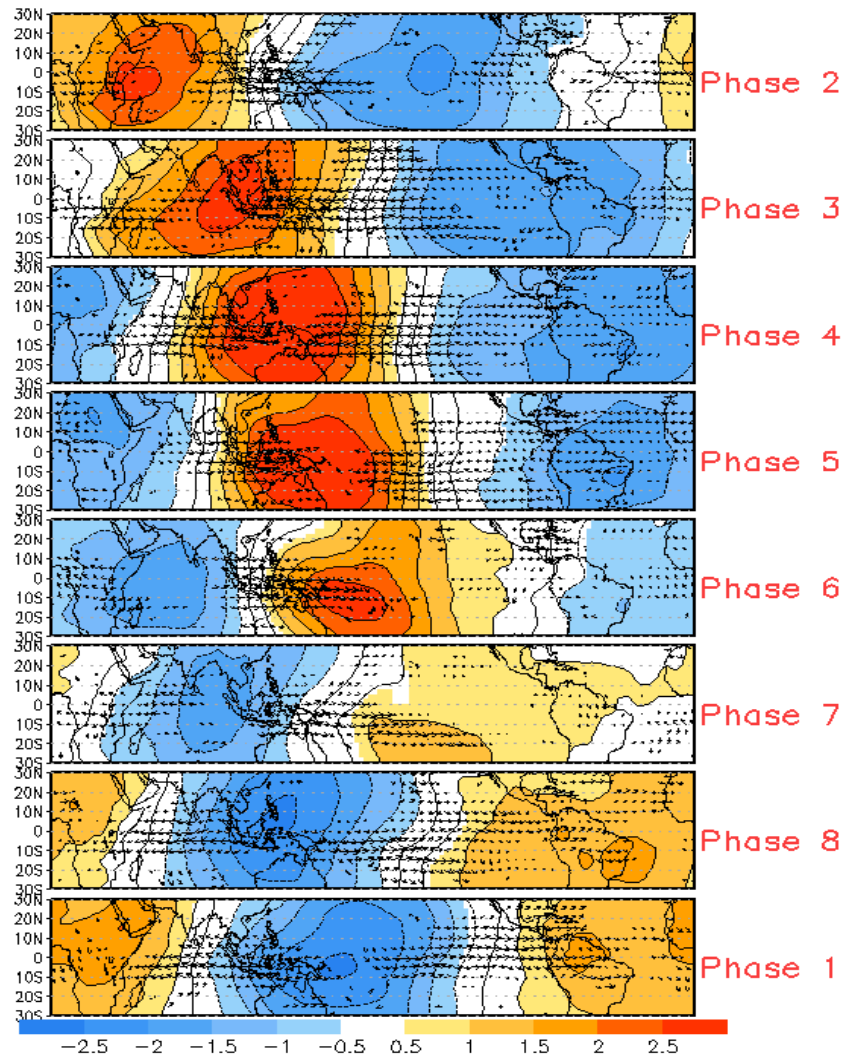
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:25-Jun-2022 to 25-Dec-2022
The unfilled contours are CA forecast reconstructed anomaly for 15 days



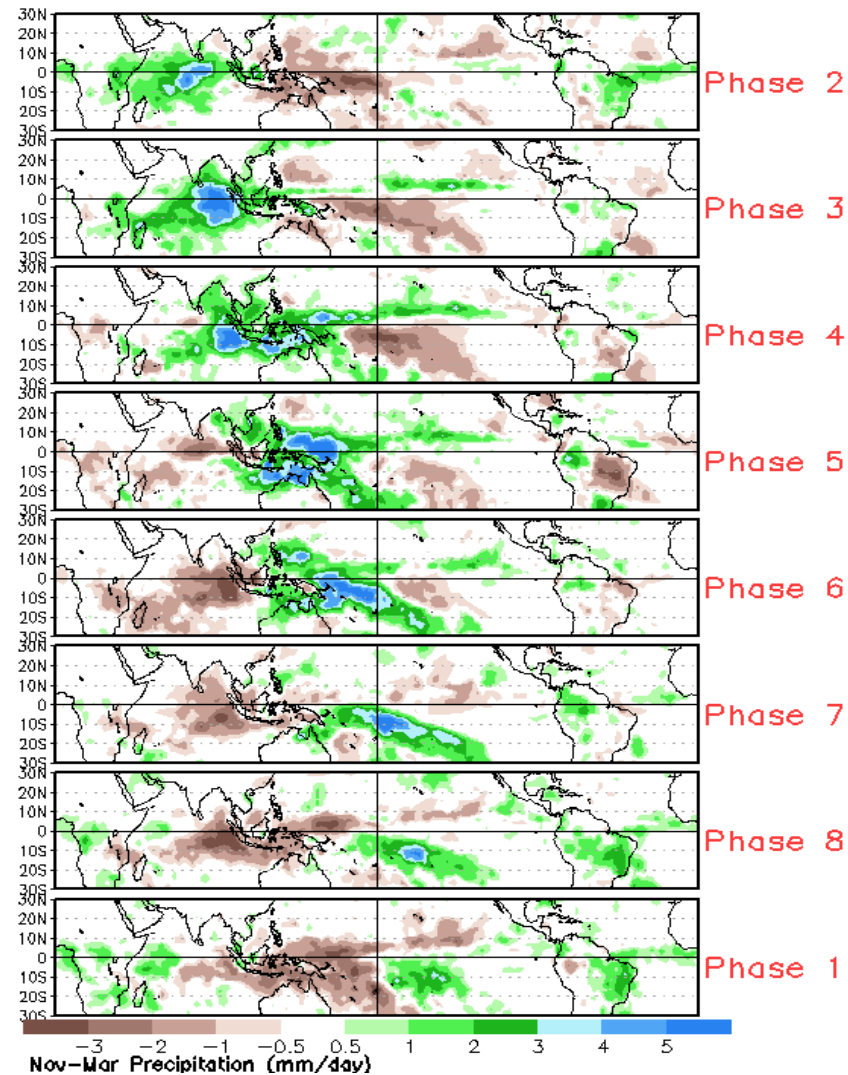
- The constructed analog forecast of RMM-based OLR depicts a more progressive and stronger MJO signal compared to the GEFS.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



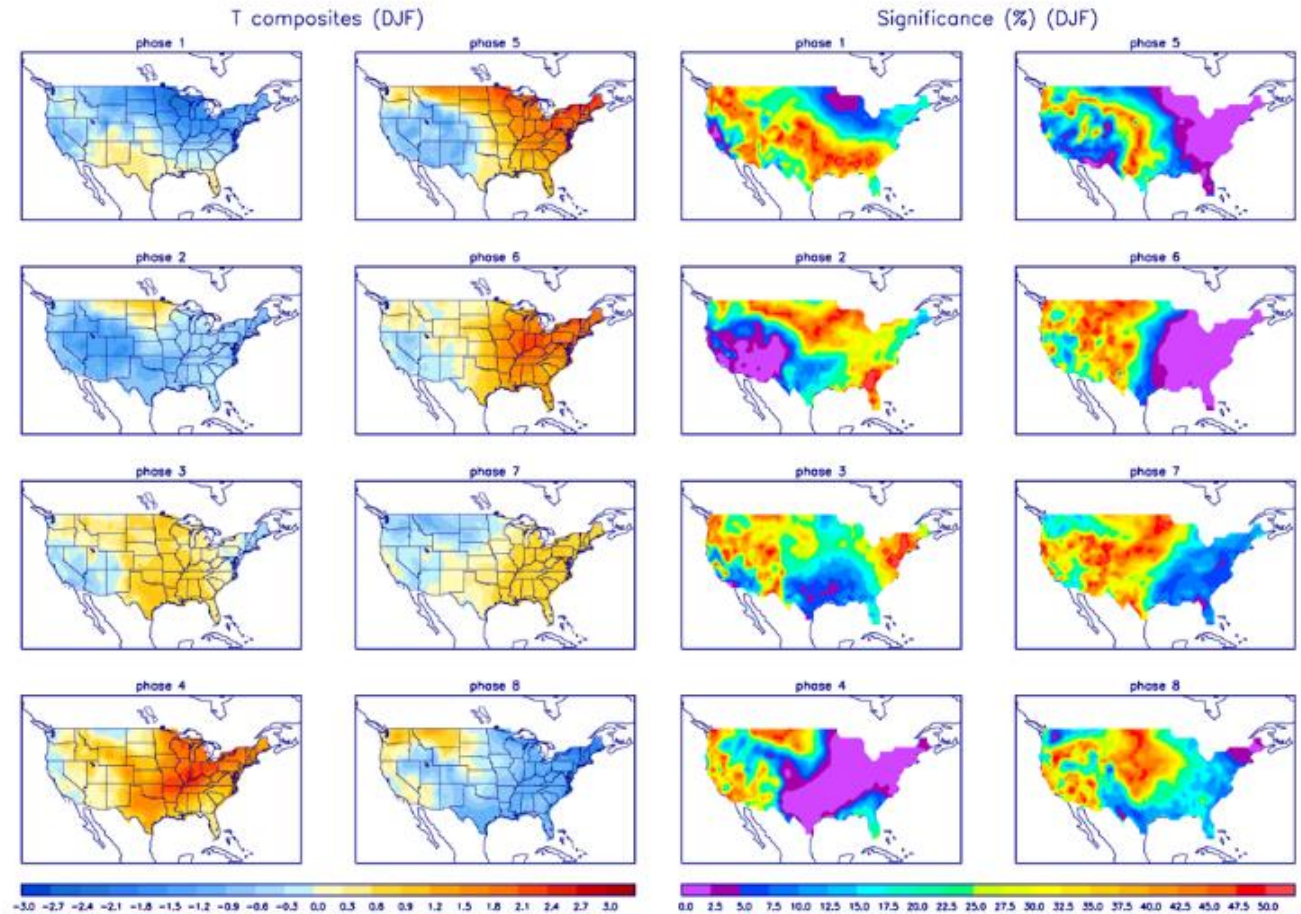
Precipitation Anomalies



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 - Precipitation

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.

