

# **Madden-Julian Oscillation:**

## **Recent Evolution, Current Status and Predictions**



**Update prepared by the Climate Prediction Center**  
**Climate Prediction Center / NCEP**  
**22 March 2021**

# Overview

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- Intraseasonal activity remains active over the western Indian Ocean. There is some question as to whether this feature corresponds to a relatively fast Madden-Julian Oscillation event or an atmospheric Kelvin wave.
- Model guidance consistently strengthens this signal over the next two weeks while propagating eastward to the West Pacific.
- Intraseasonal activity crossing the Indian Ocean during the next week could help drive tropical cyclone activity over the Southern Indian Ocean. As the signal crosses the Maritime Continent the following week, tropical cyclogenesis chances are likely to increase to the north of Australia and potentially across the West Pacific.
- The typical lagged response across the North Pacific and North America over the two weeks immediately following intraseasonal activity shifting across the Eastern Hemisphere is extension of the Pacific jet toward the West Coast and anomalous troughing (ridging) building across Alaska and western Canada (the Great Lakes). Dynamical models show some alignment with this pattern, although this circulation may not be explicitly tropically derived.

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

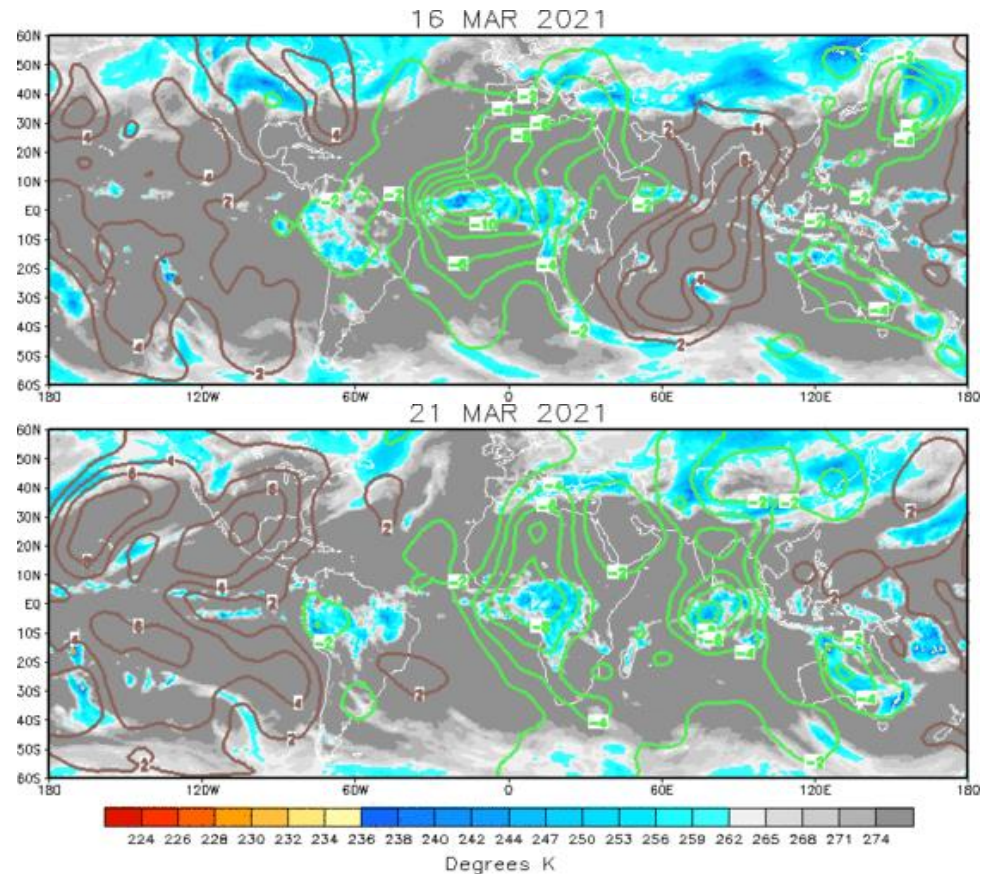
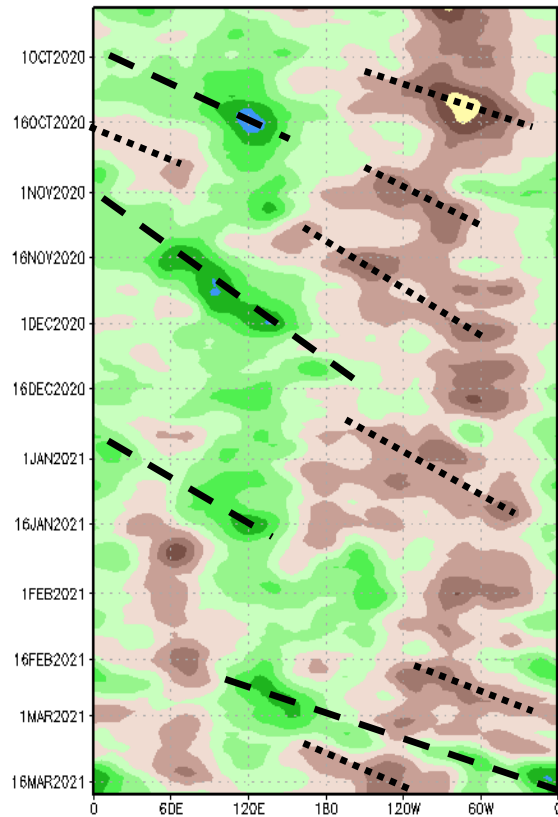
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

# 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

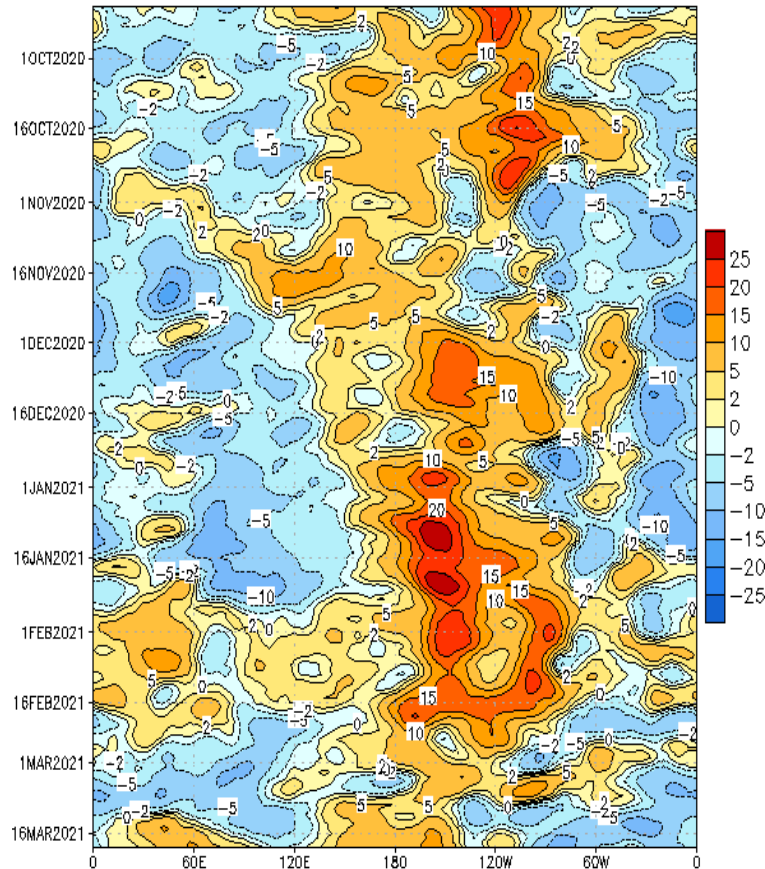


- Since mid-February, eastward propagation of the MJO has been evident, with the enhanced phase recently crossing the Prime Meridian.
- Anomalous upper-level convergence has increased across the Central and East Pacific, tied to the suppressed MJO envelope.

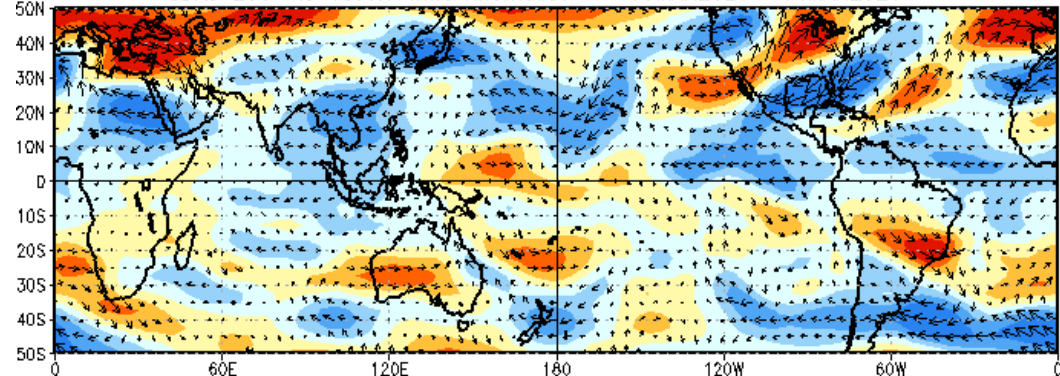
# 200-hPa Wind Anomalies

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

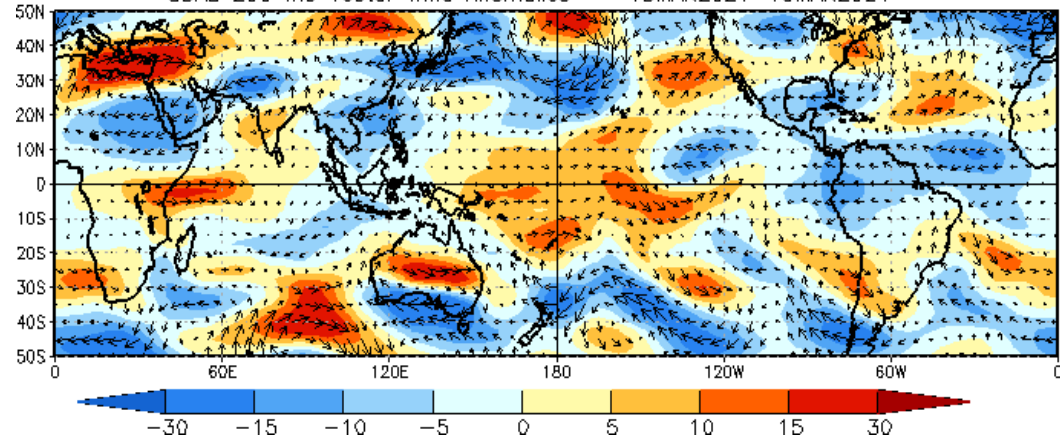
CDAS 200-hPa U Anoms. (5N–5S)



CDAS 200 mb Vector Wind Anomalies -- 10MAR2021– 14MAR2021



CDAS 200 mb Vector Wind Anomalies -- 15MAR2021–19MAR2021

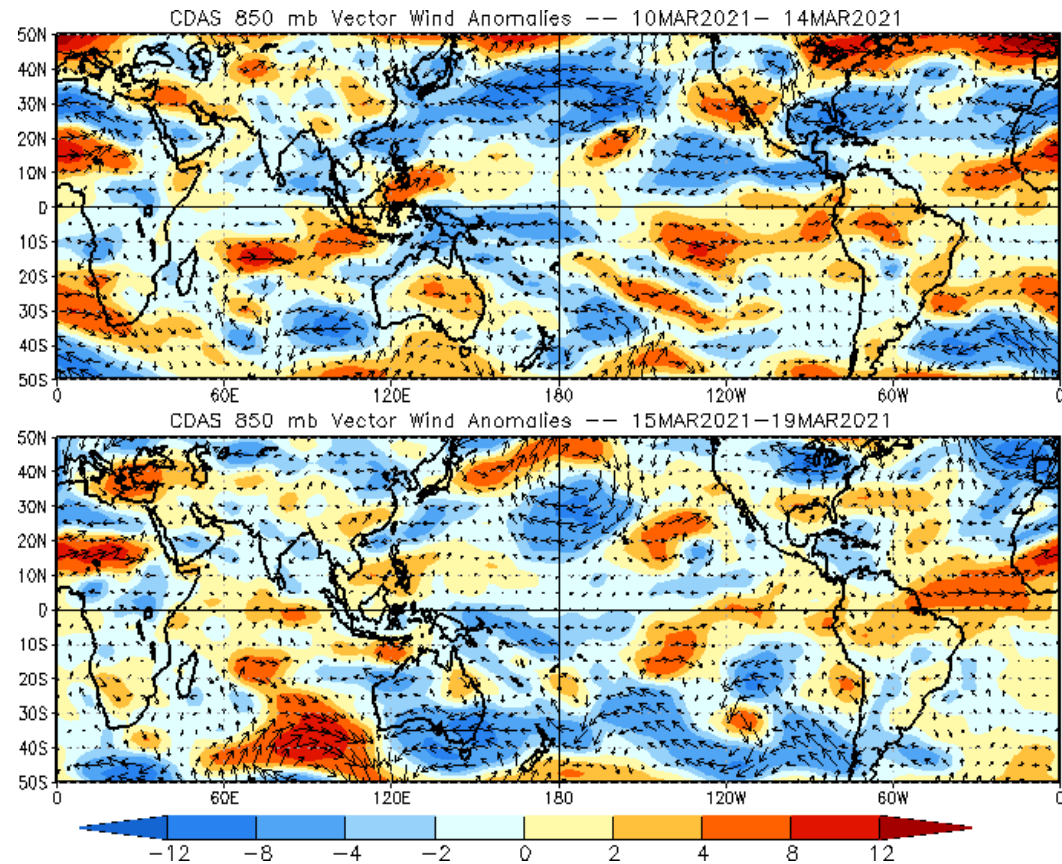
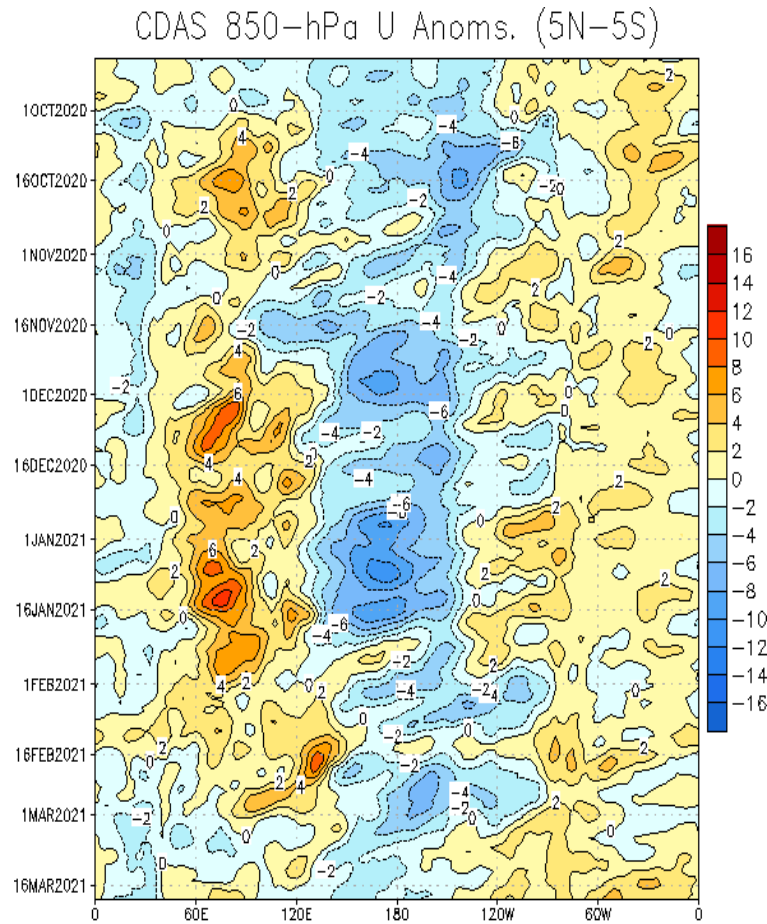


- Wave breaking near 150°E from both hemispheres is helping to reinforce anomalous westerlies along the equator over the West and Central Pacific.
- Westerlies developing across the western two-thirds of the Indian Ocean during mid-March is likely tied to the advancing intraseasonal envelope.



# 850-hPa Wind Anomalies

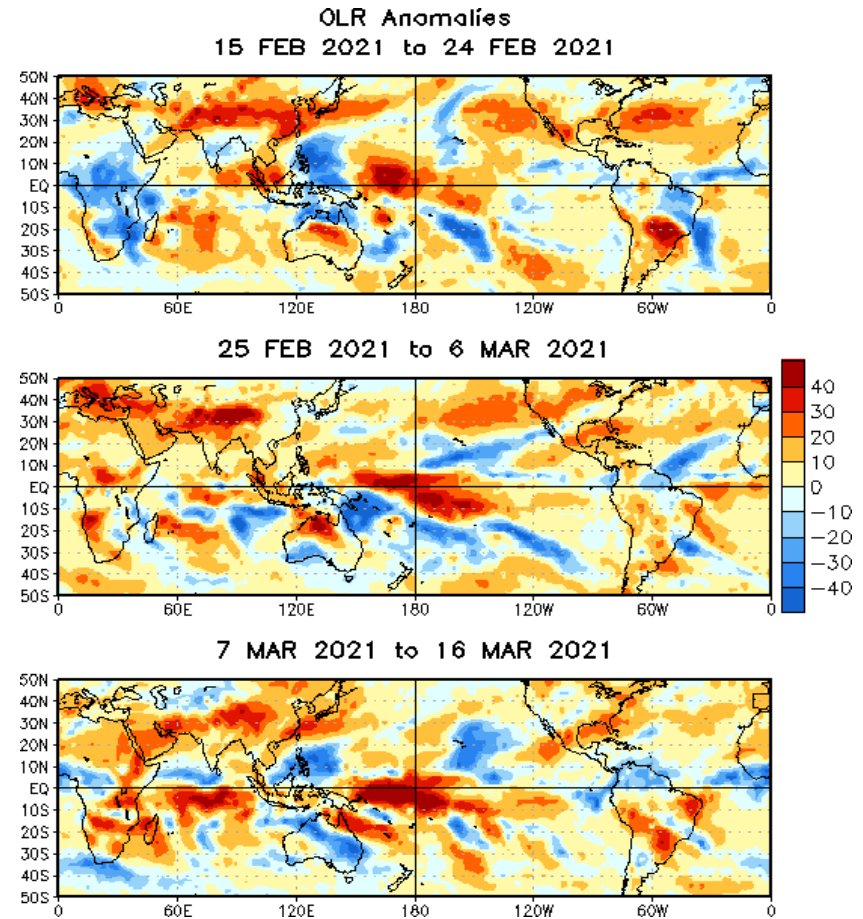
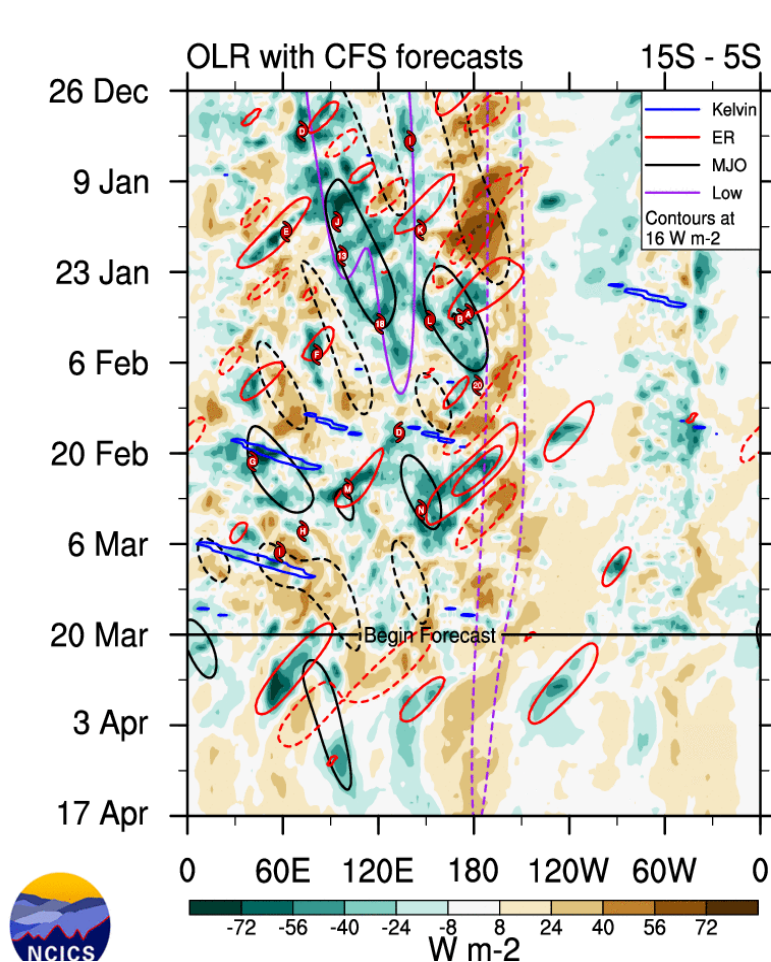
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous westerlies strengthened along the equatorial Indian Ocean, again likely tied to the intraseasonal state.
- Strengthened trades persist across the equatorial West Pacific, although anomalous westerlies have persisted east of 150°W throughout March. This evolution appears tied to the transition from La Niña toward ENSO-Neutral conditions.

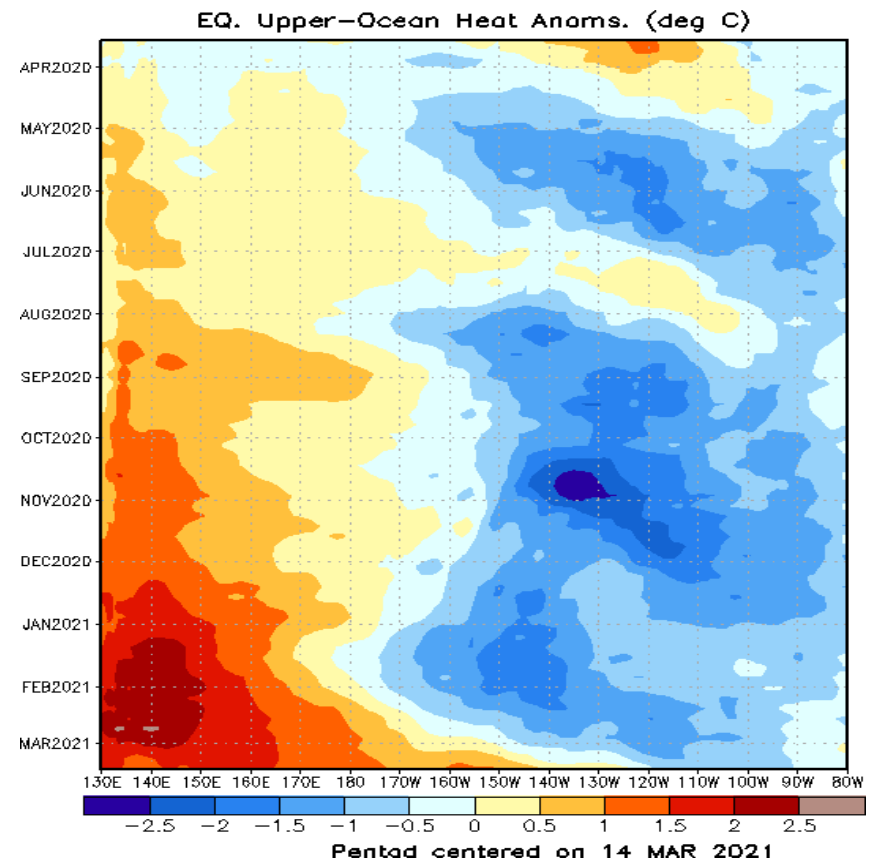
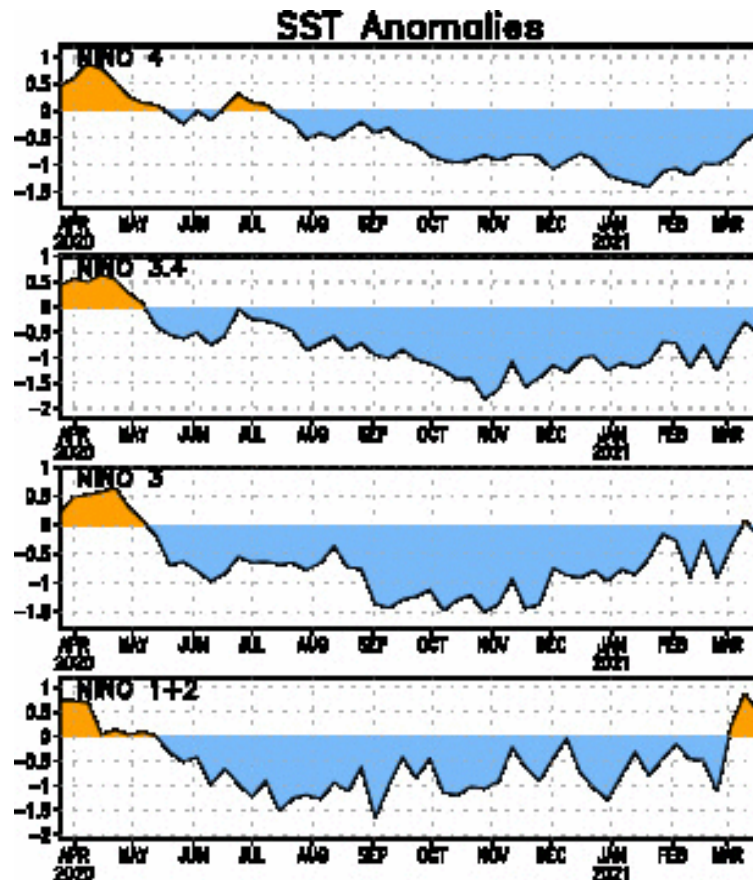
# Outgoing Longwave Radiation (OLR) Anomalies

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



- Enhanced convection was observed across portions of equatorial Africa (MJO-based) and portions of the western Indian Ocean (equatorial Rossby wave-driven) during early to mid-March.
- Suppressed convection tied to the low frequency state remains anchored over the equatorial West Pacific.

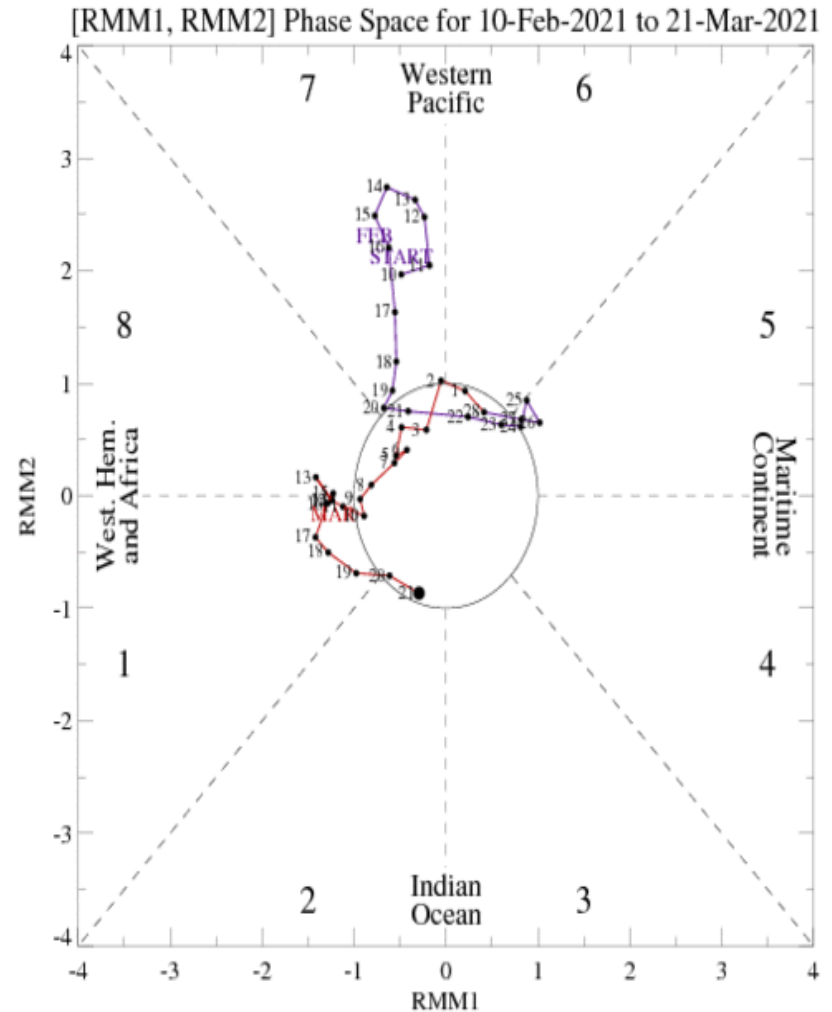
# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- La Niña conditions have been present since August 2020.
- Strong Rossby wave activity over the West Pacific in February generated a westerly wind burst that initiated a downwelling oceanic Kelvin wave. This Kelvin wave continues to push warmer water within the upper-ocean across the Central and East Pacific.

# MJO Index: Recent Evolution

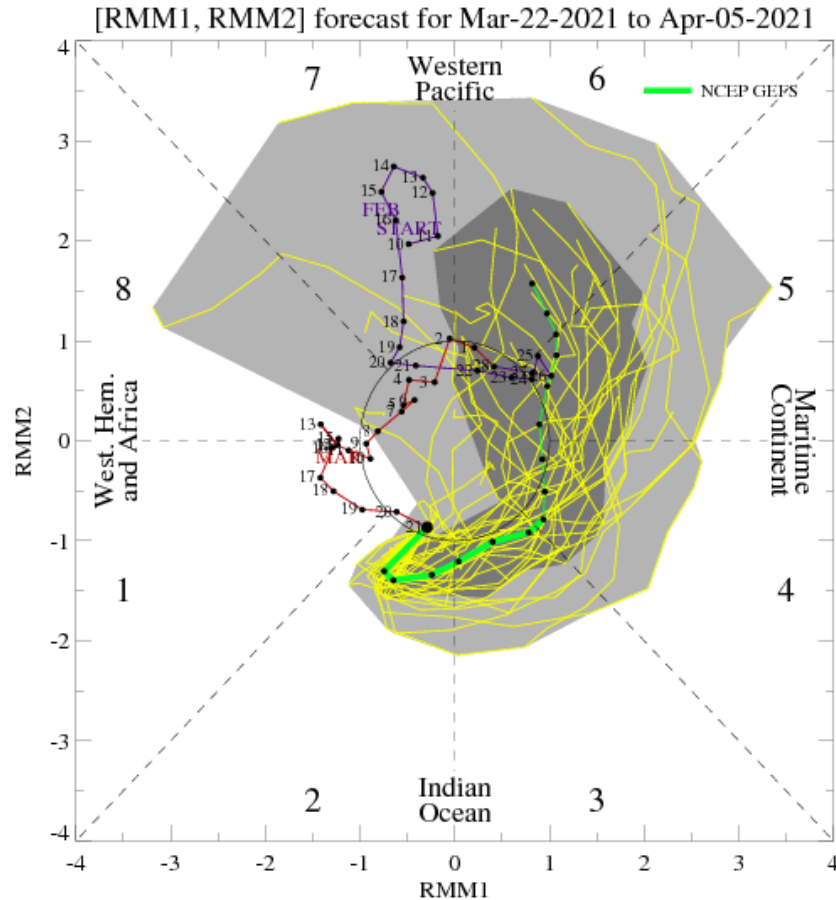
- The RMM index currently lies just within the unit circle over the western Indian Ocean.



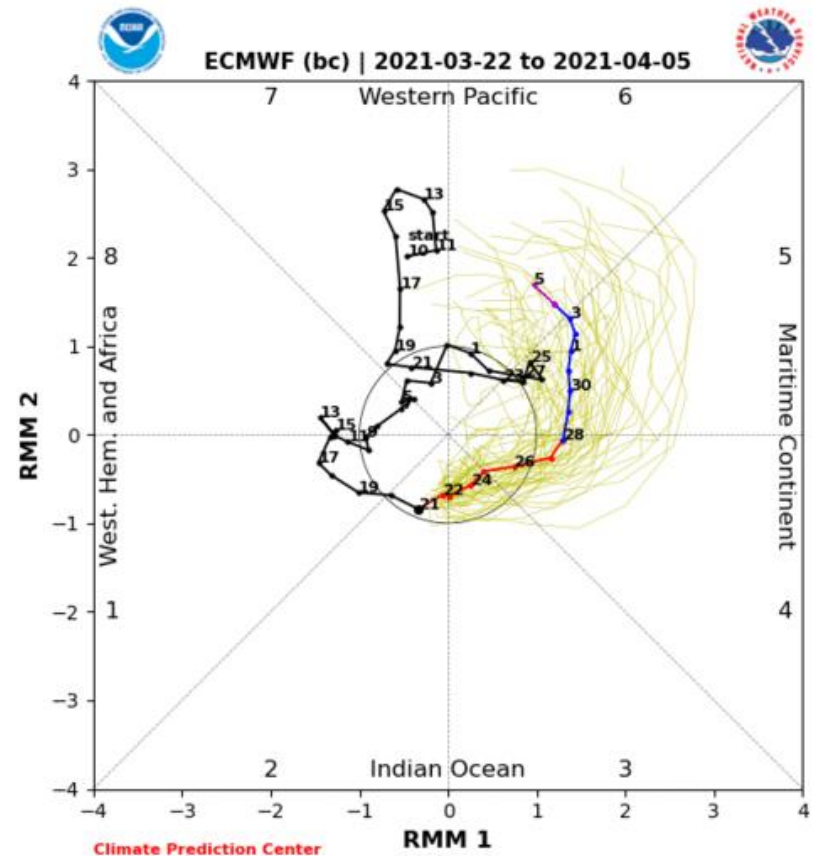
For more information on the RMM index and how to interpret its forecast please see:  
[https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC\\_MJOinformation.pdf](https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf)



# MJO Index: Forecast Evolution



**GEFS Forecast**



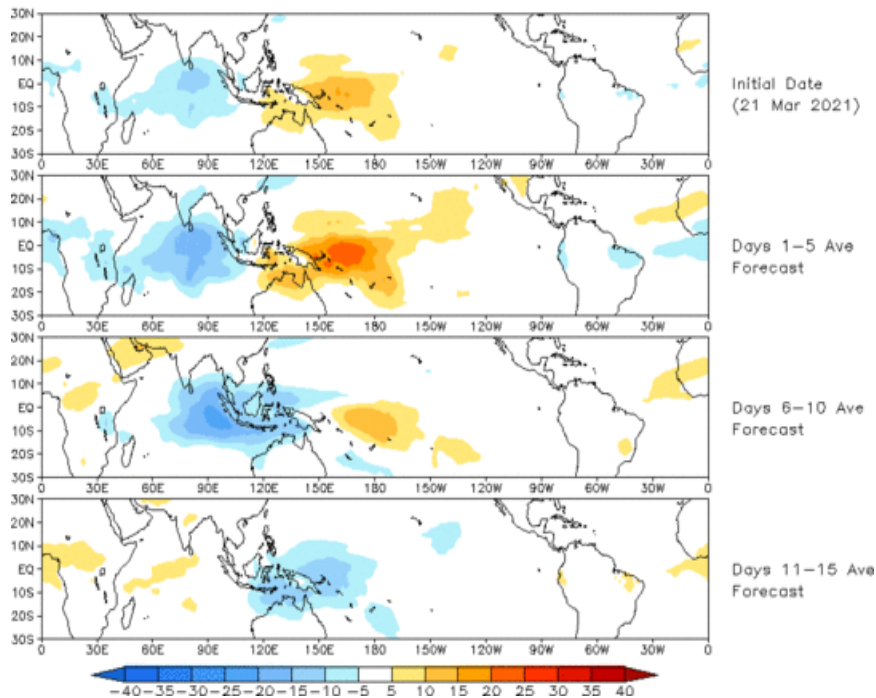
**ECMWF Forecast**

- Both the GEFS and ECMWF forecasts portray a robust intraseasonal event that makes it to the West Pacific during the next two weeks. This would be on the faster side of the archetypical MJO event, where there is some question as to whether a Kelvin wave exists.
- ECMWF members exhibit less spread than the GEFS, which has some outlier solutions that approach the Western Hemisphere again in only two weeks time.

# MJO: GEFS Forecast Evolution

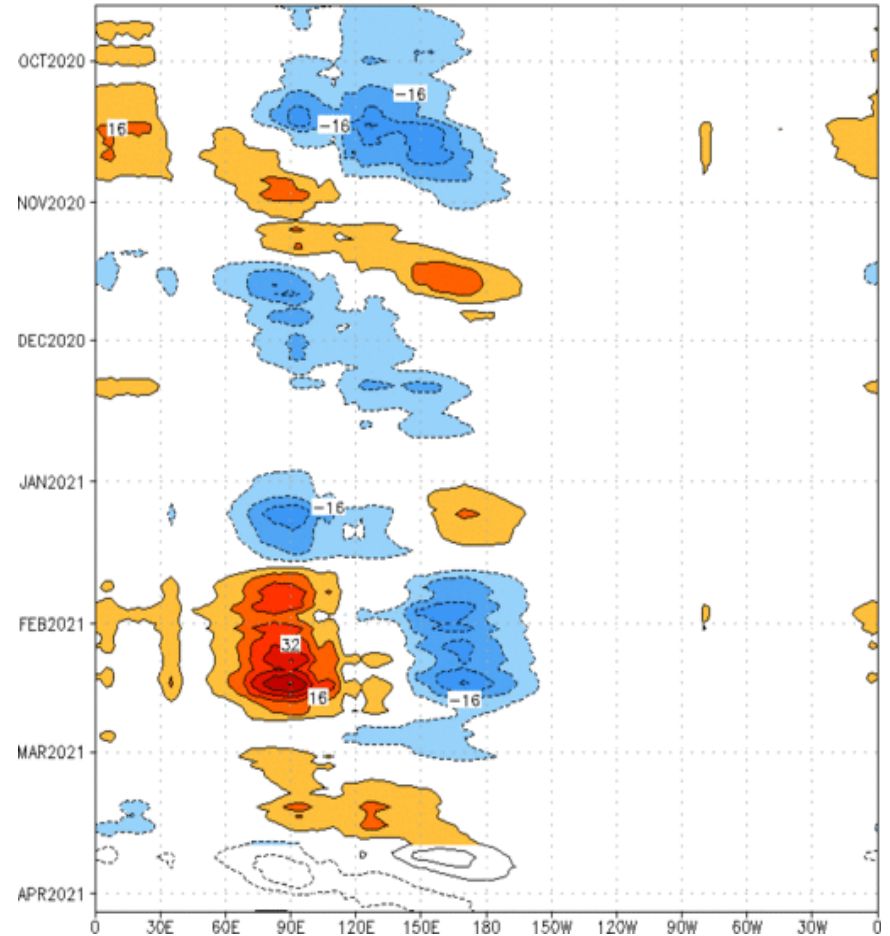
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Prediction of MJO-related anomalies using GEFS operational forecast  
Initial date: 21 Mar 2021  
OLR



- The GEFS RMM forecast based OLR anomalies exhibit eastward propagation of enhanced convection from the Indian Ocean to the West Pacific during the next two weeks. Concurrently, suppressed convection decays over the West and Central Pacific, while emerging somewhat over the Indian Ocean.

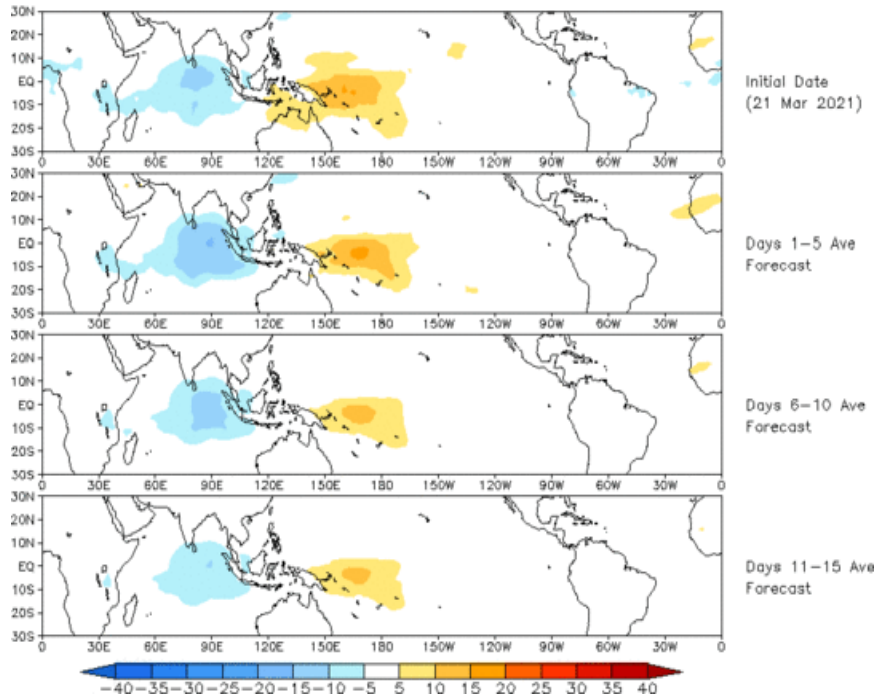
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2  
OLR [7.5°S, 7.5°N] (cont: 4Wm<sup>-2</sup>) Period: 19-Sep-2020 to 21-Mar-2021  
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days



# MJO: Constructed Analog Forecast Evolution

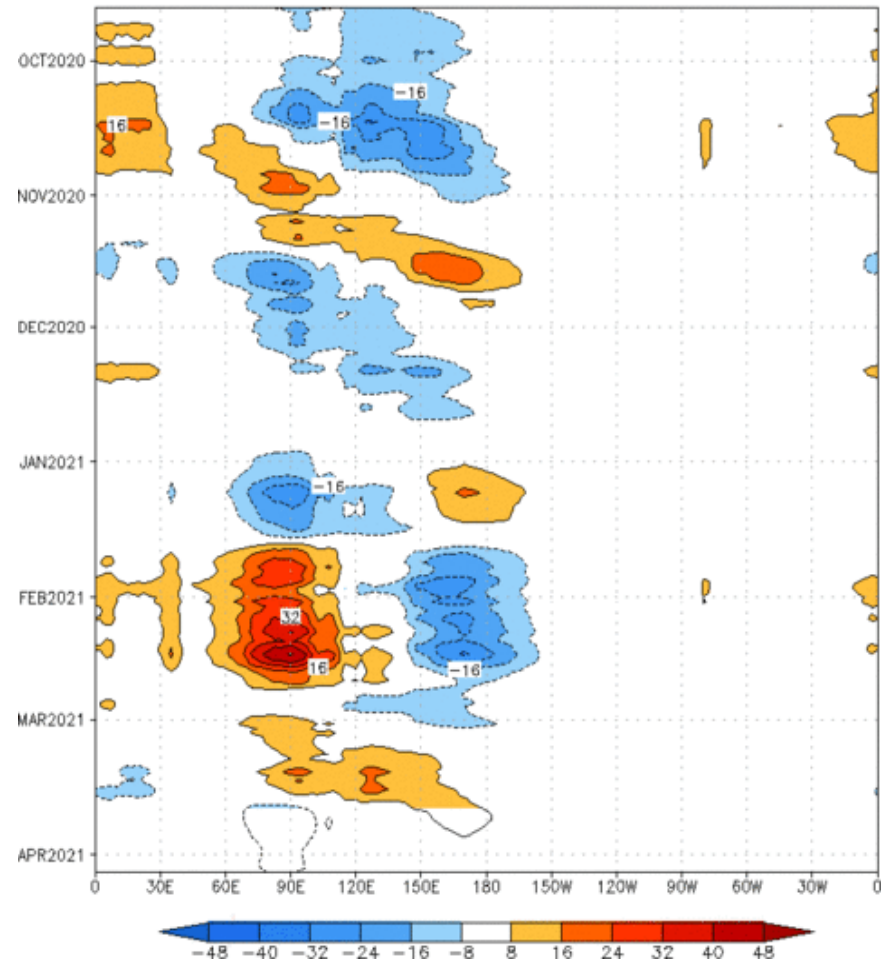
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (21 Mar 2021)



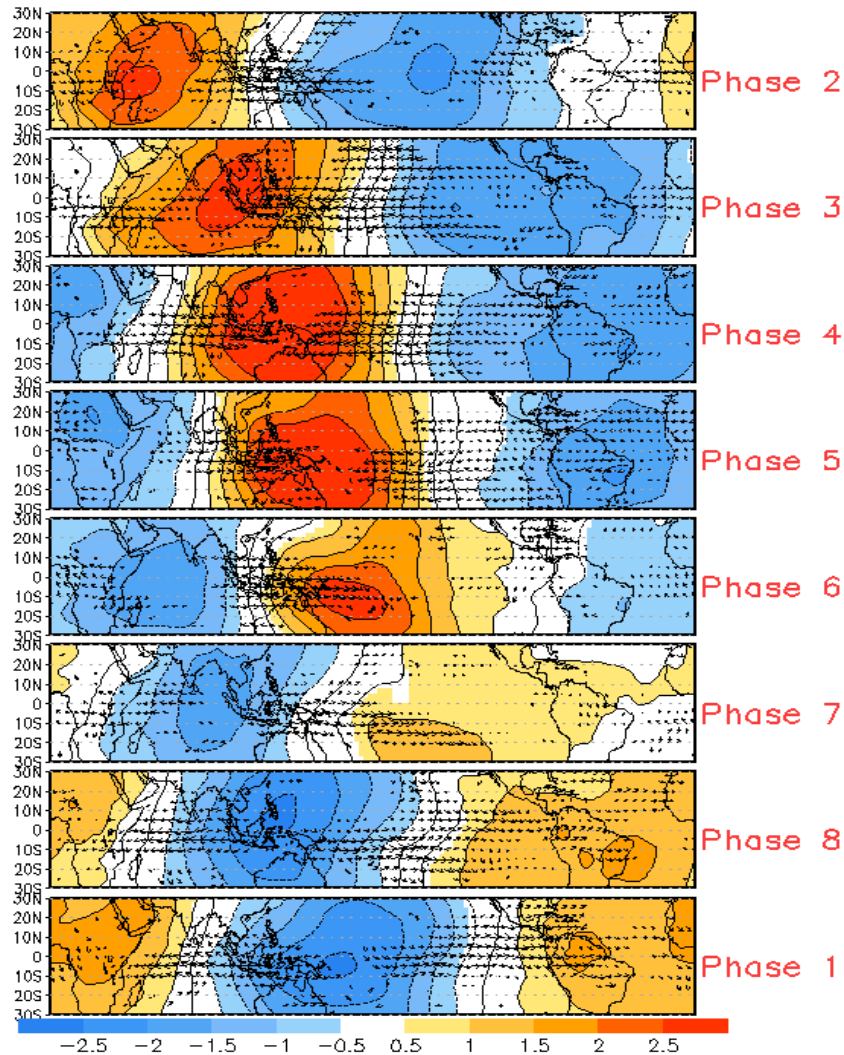
- The constructed analog perspective exhibits a quasi-stationary pattern the next two weeks with convective anomalies generally decaying with time.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S, 7.5°N] (cont: 4Wm<sup>-2</sup>) Period: 19-Sep-2020 to 21-Mar-2021  
The unfilled contours are CA forecast reconstructed anomaly for 15 days

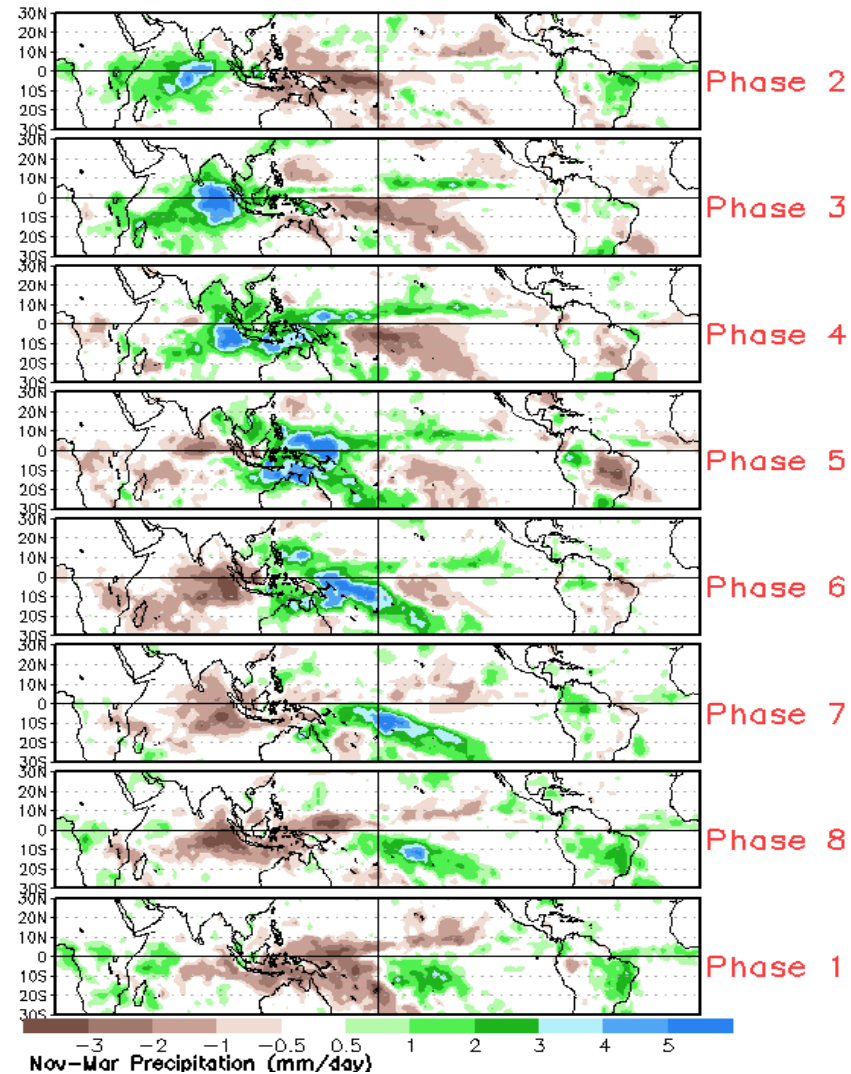


# MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and  
Wind Anomalies



Precipitation Anomalies

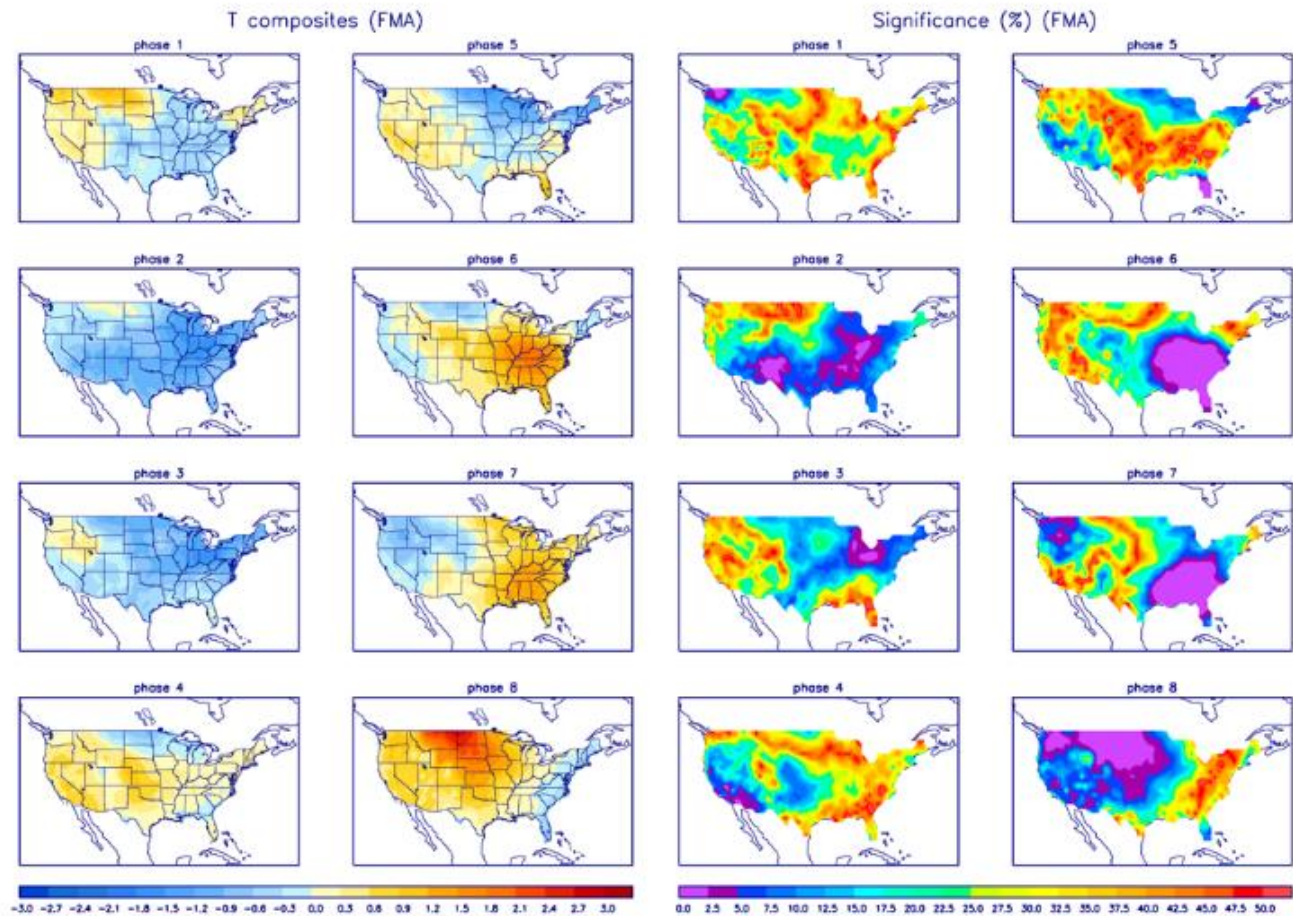




# MJO: CONUS Composite Maps by RMM Phase - Temperature

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.

