

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



**Update prepared by the Climate Prediction Center  
NWS / NCEP / CPC  
4 July 2022**

# Overview

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- The RMM-based MJO index and numerous atmospheric fields, including upper-level velocity potential anomalies, are reflective of MJO activity currently crossing the Maritime Continent.
- A MJO enhanced phase over the Maritime Continent phases well with La Niña conditions, and is likely contributing to an increase in the trade wind regime across the tropical Pacific.
- Dynamical model MJO index forecasts are mixed, with some ensemble members showing continued MJO propagation across the Pacific, while other members weaken the signal, possibly due to destructive interference from ENSO and equatorial Rossby wave activity.
- MJO activity over the Maritime Continent is typically associated with a reduction in tropical cyclone activity across both the East Pacific and Atlantic basins, although cyclogenesis can still occur in association with higher frequency signals such as Kelvin waves, or along stalled frontal boundaries.

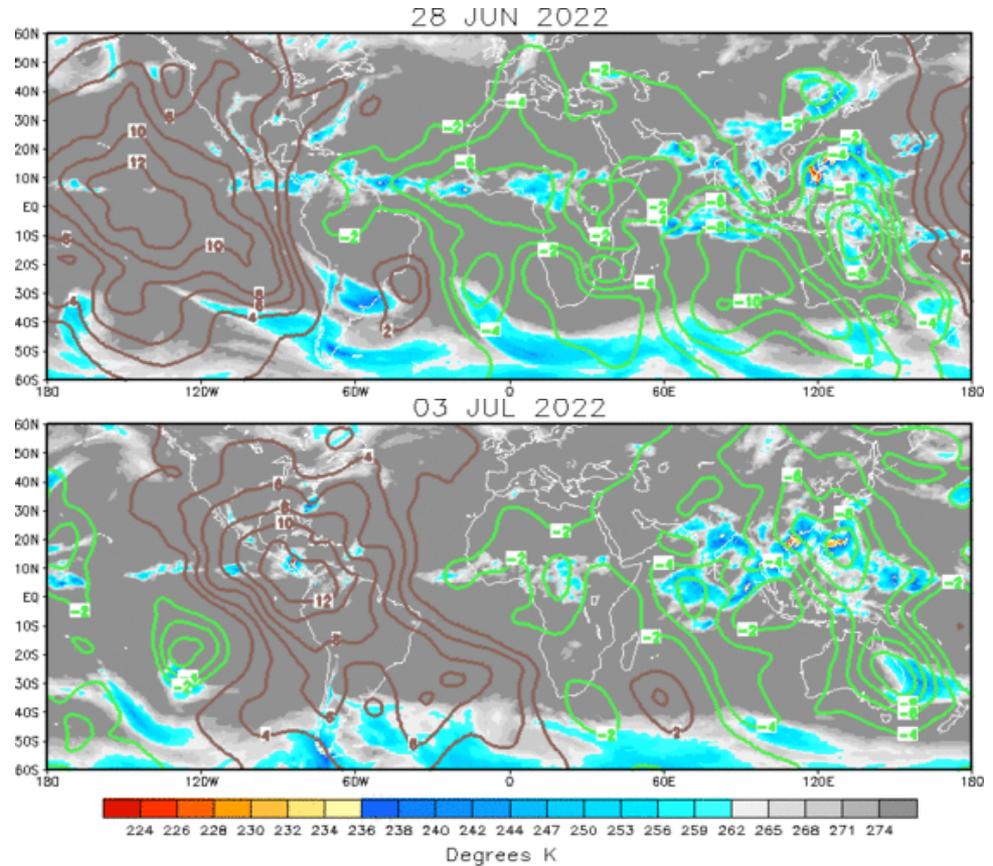
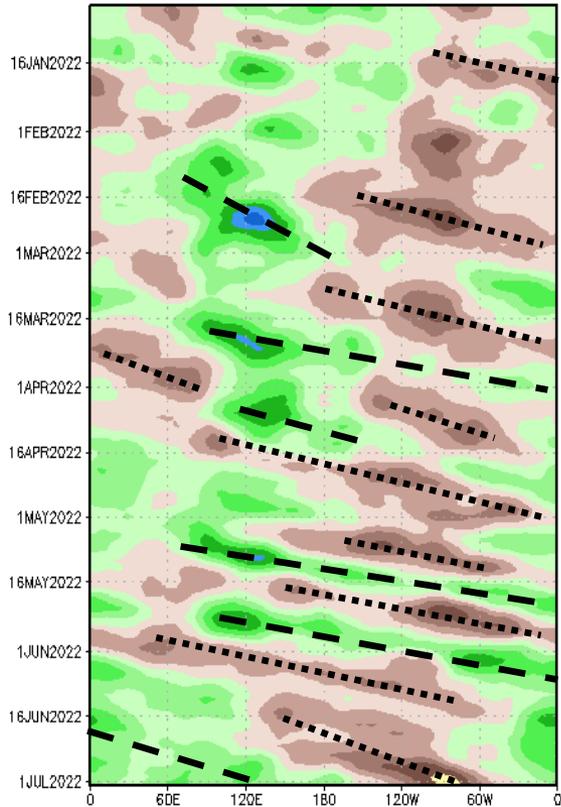
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:  
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

# 200-hPa Velocity Potential Anomalies

**Green shades: Anomalous divergence (favorable for precipitation)**

**Brown shades: Anomalous convergence (unfavorable for precipitation)**

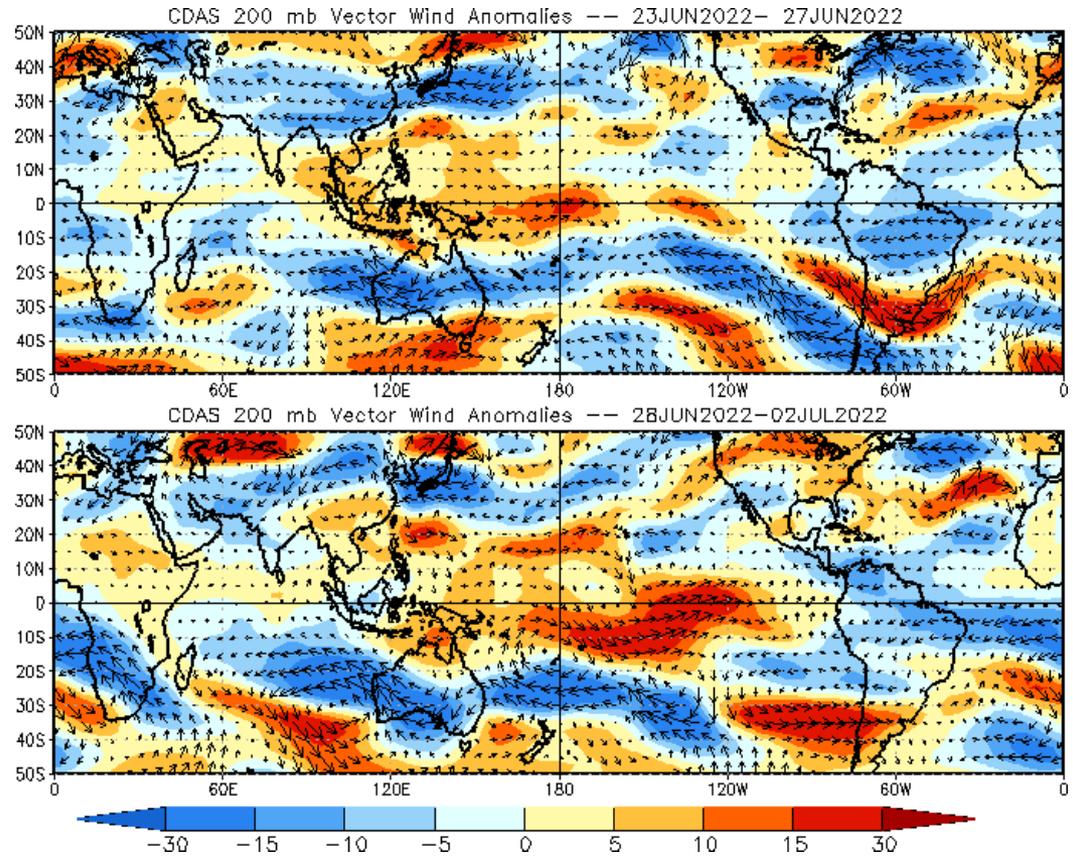
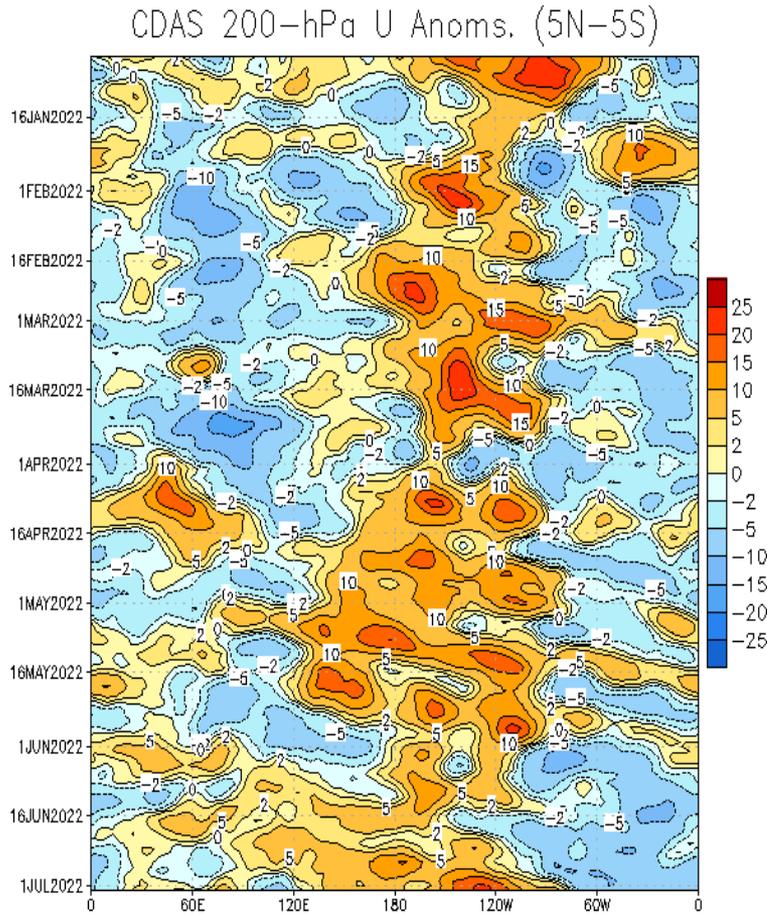
200-hPa Velocity Potential Anomaly: 5N-5S  
5-day Running Mean



- Following a remarkable series of strong, convectively coupled Kelvin waves during May and early June, a slower evolving pattern more typical of a La Niña response emerged by mid-June.
- More recently, robust eastward propagation was observed, reflective of MJO activity propagating from the Indian Ocean to the Maritime Continent.

# 200-hPa Wind Anomalies

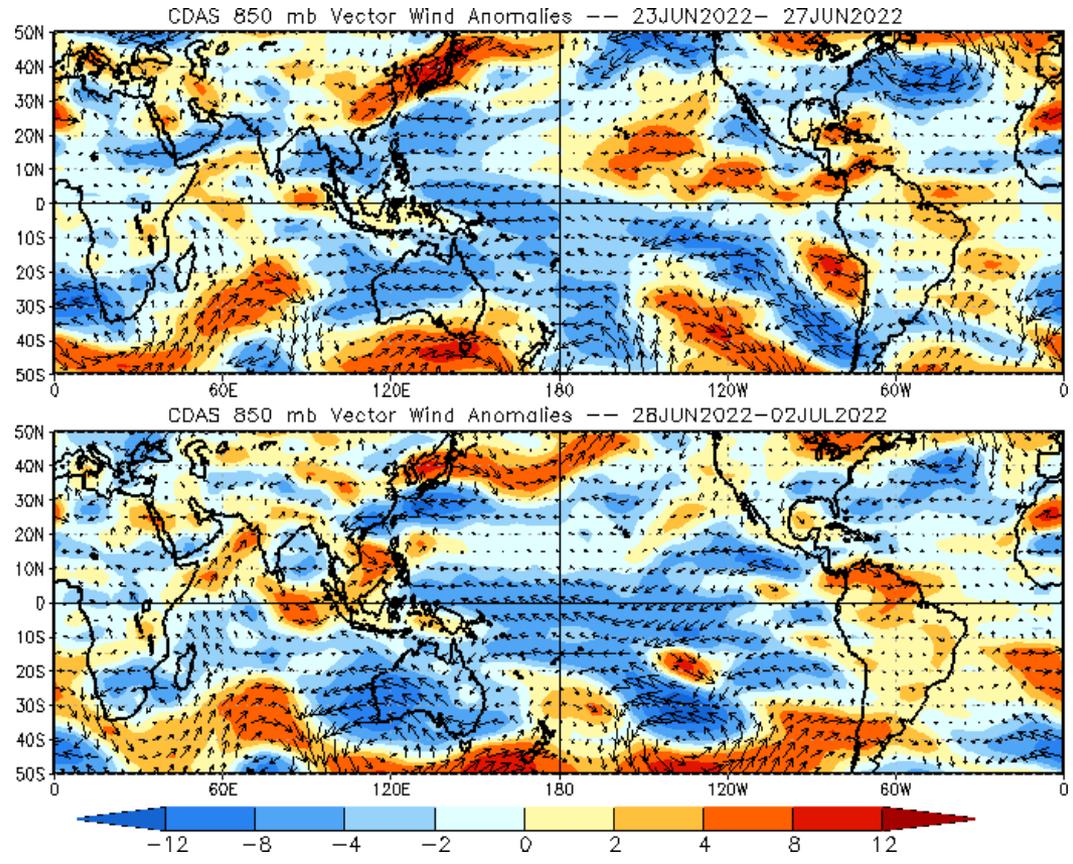
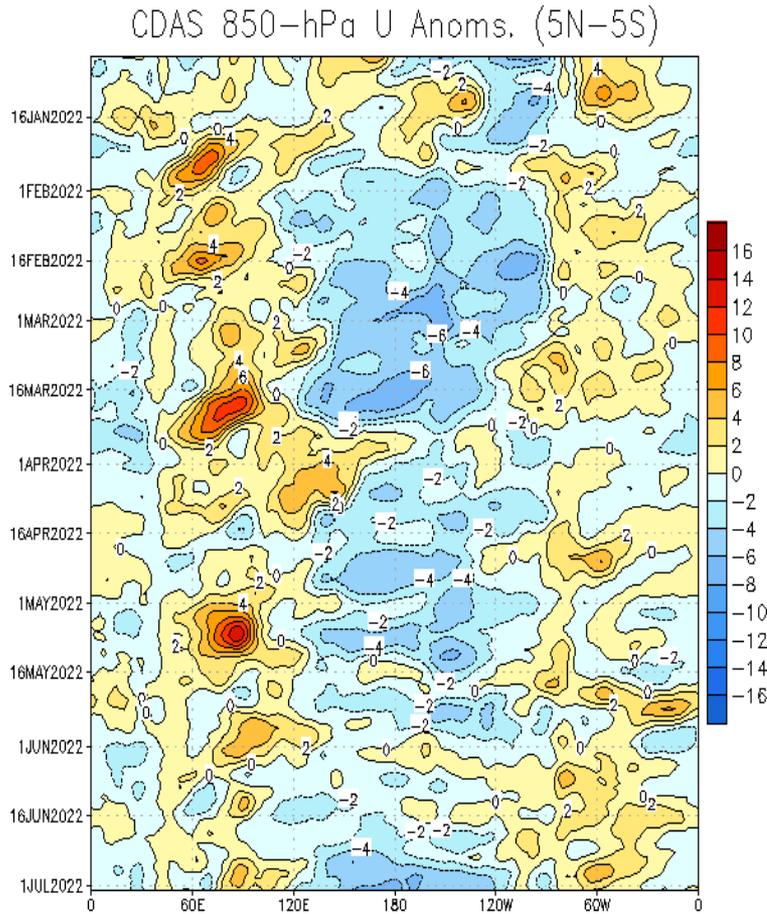
Shading denotes the zonal wind anomaly. **Blue shades: Anomalous easterlies.** **Red shades: Anomalous westerlies.**



- Since mid-June, large-scale regions of anomalous westerlies (easterlies) have propagated across the Pacific (Pacific to Western Hemisphere), indicative of potential MJO activity.
- The subseasonal oscillations and ENSO patterns are currently constructively interfering.

# 850-hPa Wind Anomalies

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

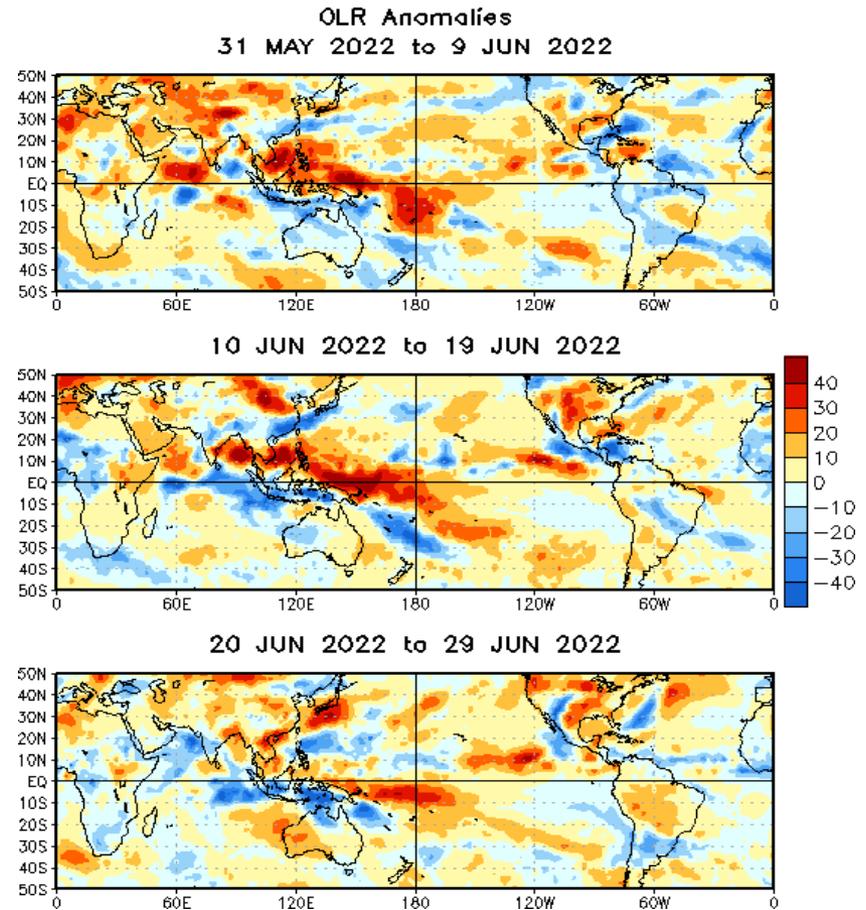
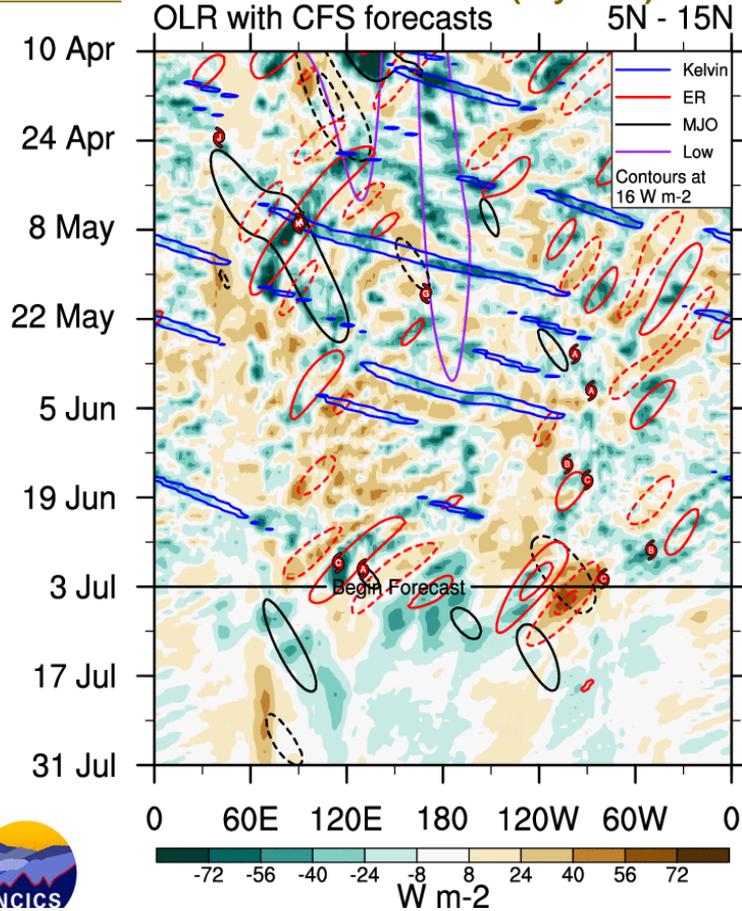


- Anomalous westerlies, typically observed in association with the enhanced convective phase of an MJO, are largely absent, possibly due to Rossby wave interference or Asian monsoon interaction, though pockets of westerly anomalies have strengthened over the Maritime Continent more recently.
- Consistent with the idea of constructive interference between the MJO and ENSO, strongly enhanced trades have overspread almost the entire Pacific basin.

# Outgoing Longwave Radiation (OLR) Anomalies

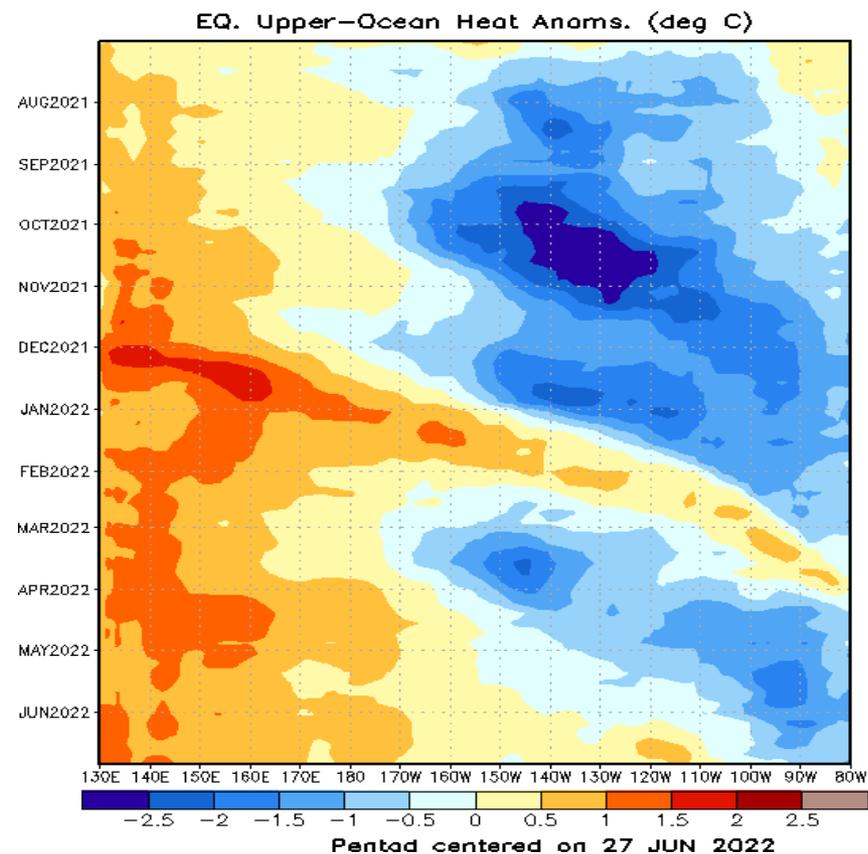
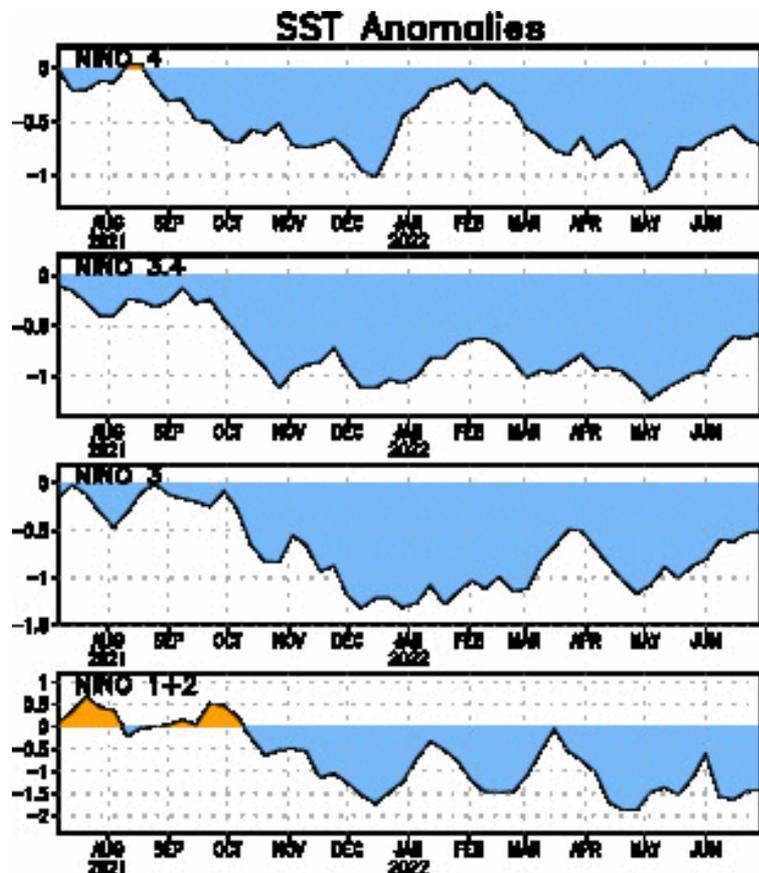
**Green shades: Anomalous convection (wetness)**

**Brown shades: Anomalous subsidence (dryness)**



- Equatorial Rossby wave activity is apparent in the OLR field across both the Maritime Continent and the Western Hemisphere. Despite the strongly enhanced trade winds, areas of enhanced convection across the north-central Pacific near 10N have been observed.
- CFS forecasts indicate a continuation and expansion of enhanced convection across the North Pacific. This may be due to equatorial Rossby wave activity, but may increasingly reflect a propagating MJO signal.

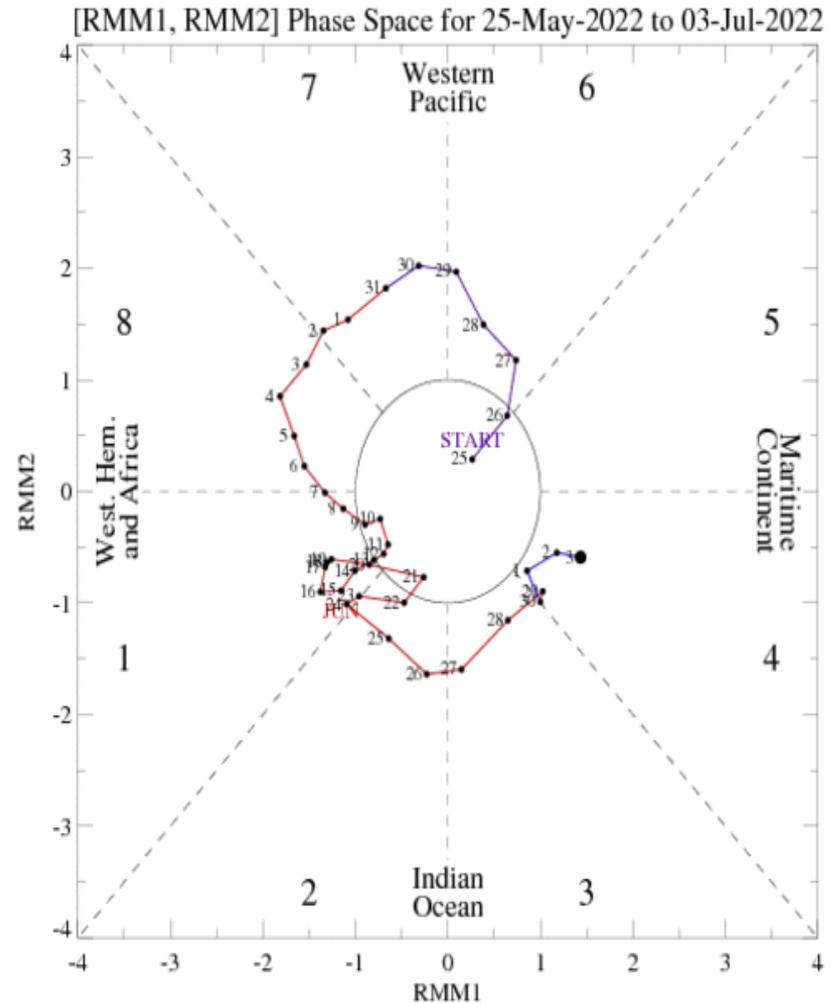
# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- SST anomalies remain negative across the Pacific, reflective of ongoing La Niña conditions, though the anomalies weakened somewhat during June.
- Robust Kelvin wave activity during May helped initiate a low-amplitude downwelling Kelvin wave. With enhanced trade winds in place more recently, an upwelling phase is likely to follow.

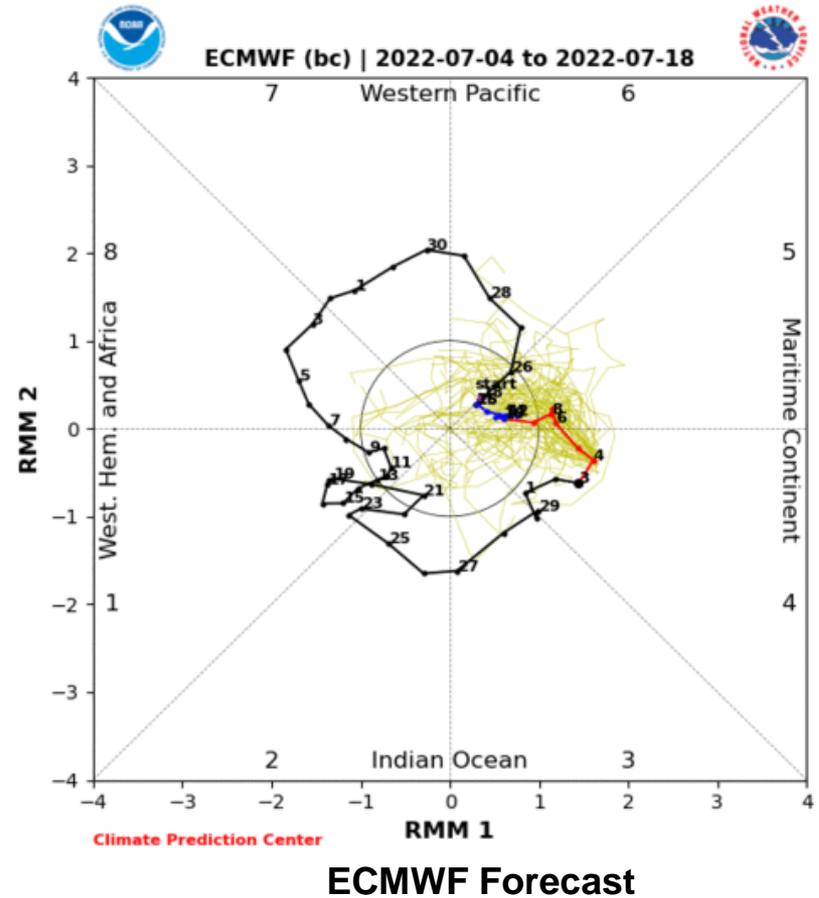
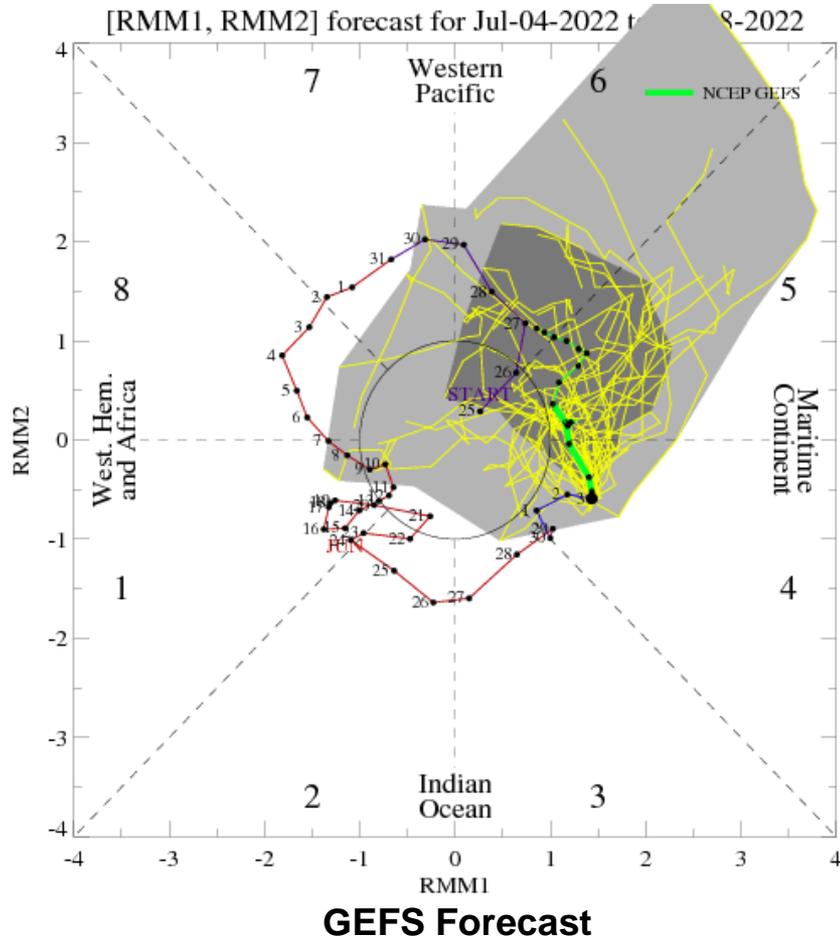
# MJO Index: Recent Evolution

- Sustained eastward propagation of the RMM index was established during the past week, with a fairly rapid transition across the Indian Ocean to the Maritime Continent.
- More recently, the index has slowed down and increased in amplitude.



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

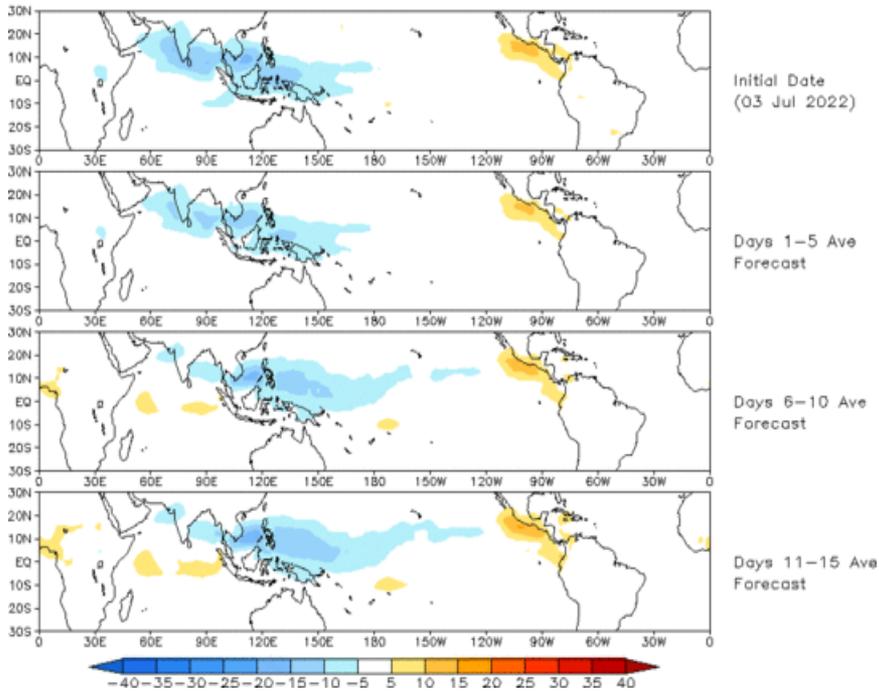


- The GEFS and ECMWF both reflect a large degree of uncertainty regarding future MJO evolution, with ensemble solutions from both models depicting continued propagation to the West Pacific, including some GEFS members showing high amplitude, while other ensemble members reflect rapid weakening of the signal.
- Destructive interference among MJO, La Niña, and equatorial Rossby wave activity may be contributing to the weakening signal reflected by many of the ensemble solutions.

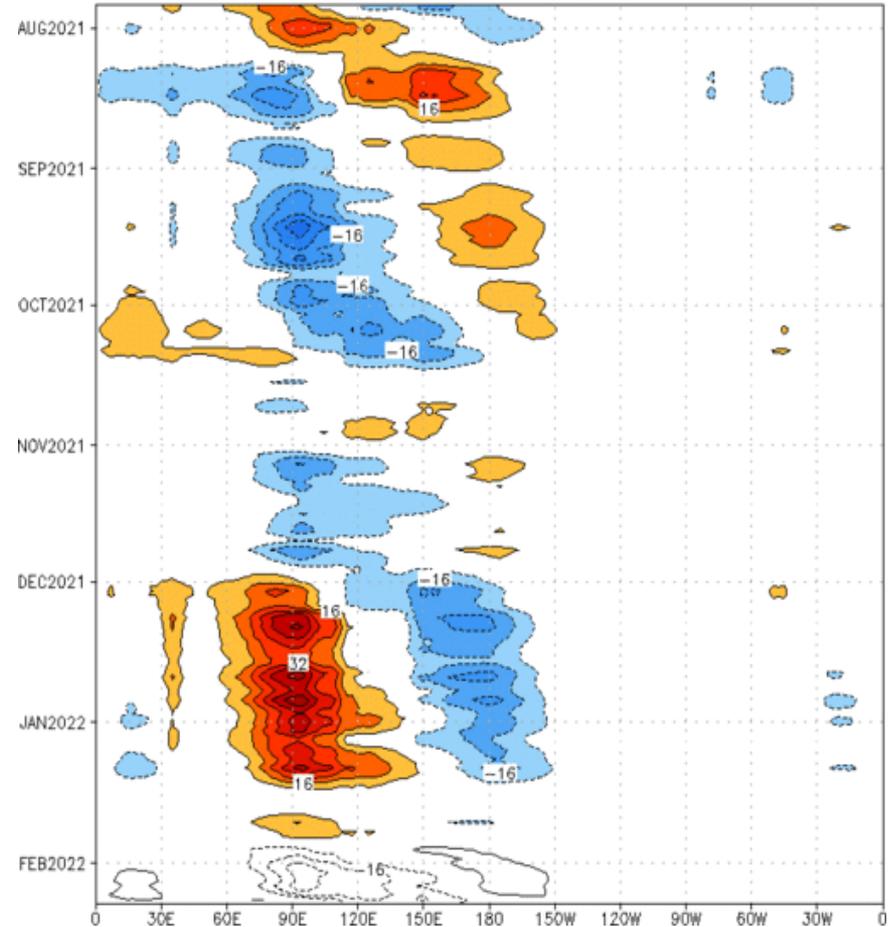
# MJO: GEFS Forecast Evolution

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 Jul 2022  
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2  
OLR [7.5°S,7.5°N] (cint:4Wm<sup>-2</sup>) Period:27-Jul-2021 to 26-Jan-2022  
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

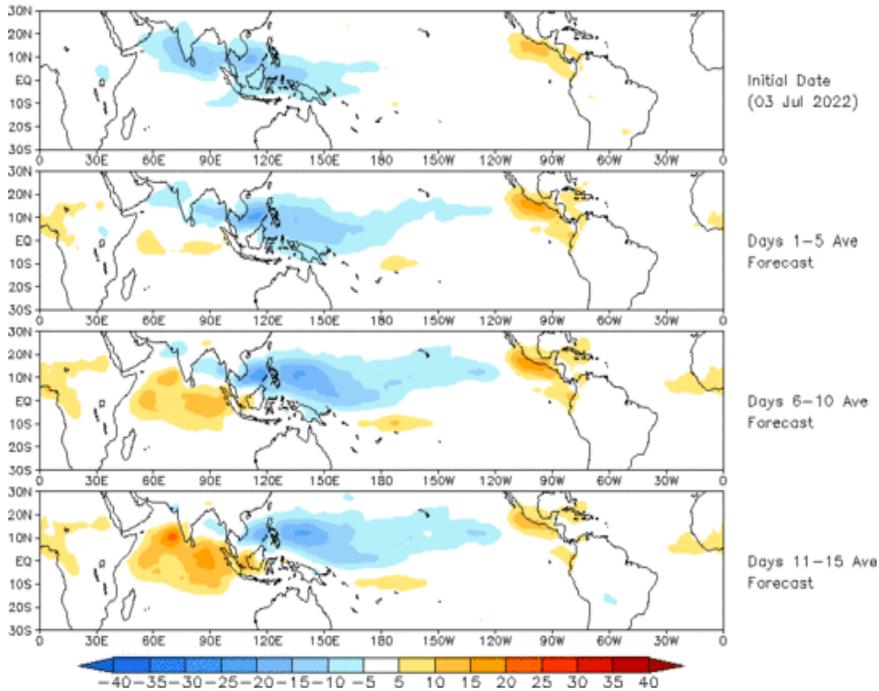


- The GEFS RMM-index based OLR anomaly field depicts fairly robust MJO activity propagating from the Maritime Continent to the West Pacific over the next two weeks.

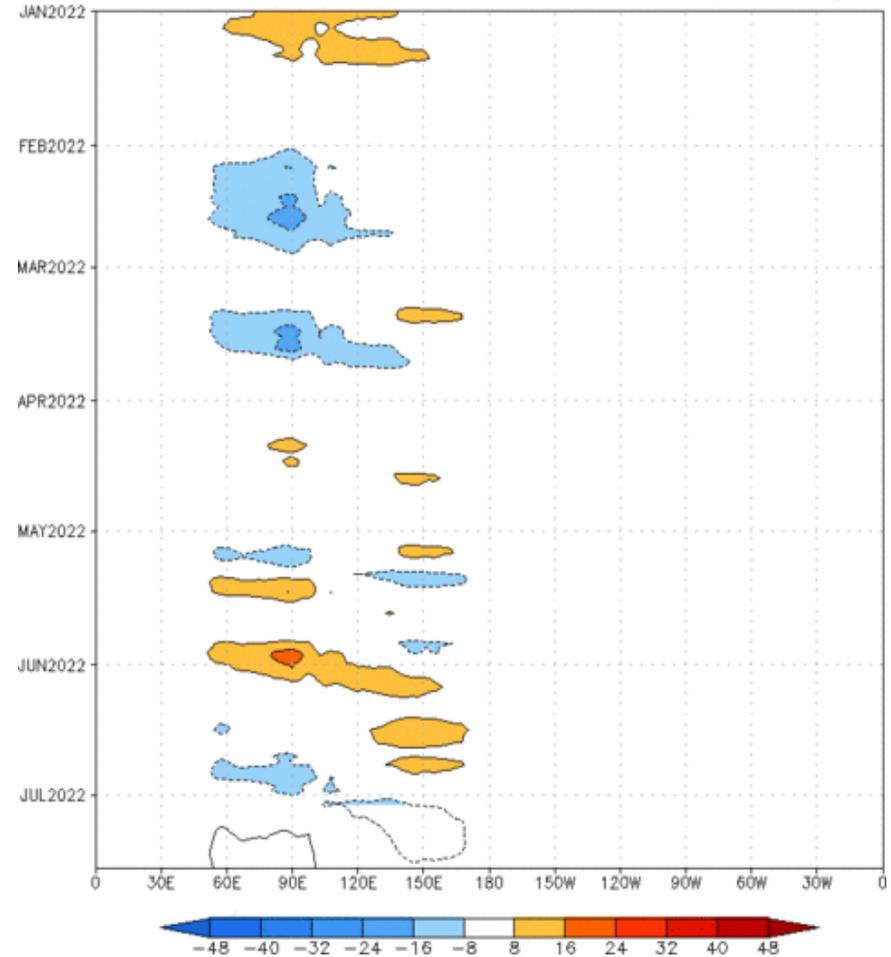
# MJO: Constructed Analog Forecast Evolution

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 Jul 2022)



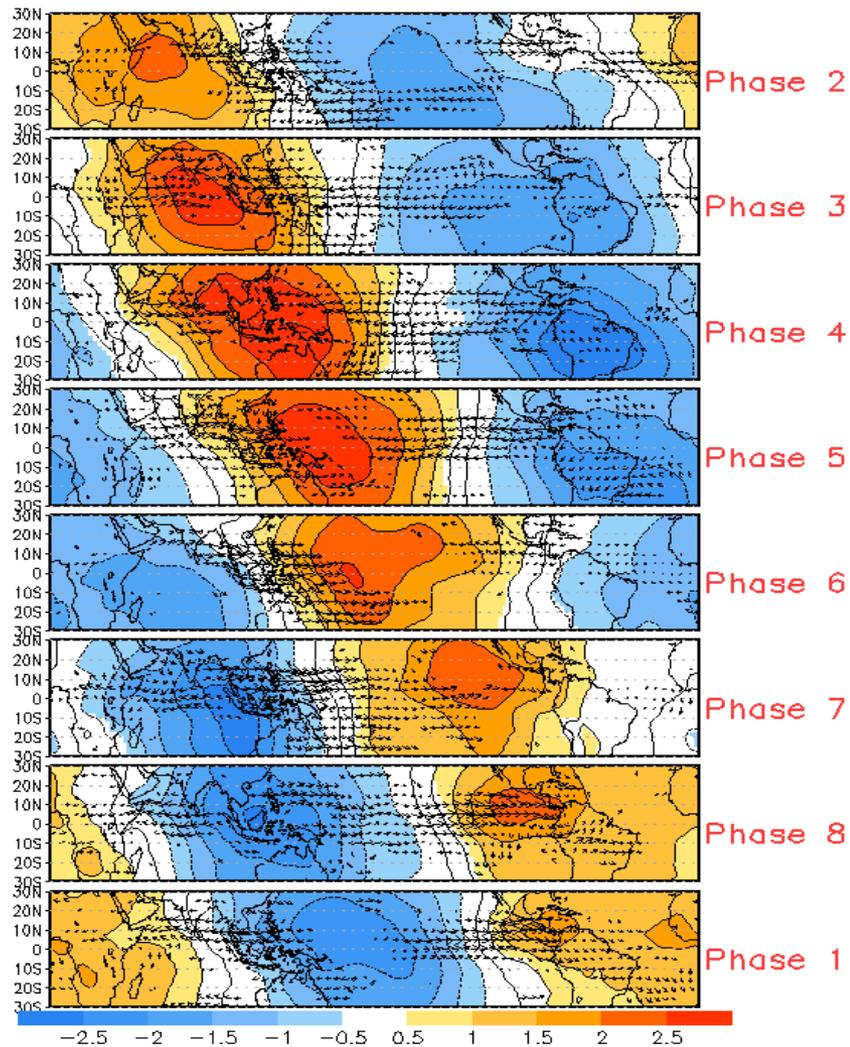
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:01-Jan-2022 to 03-Jul-2022  
The unfilled contours are CA forecast reconstructed anomaly for 15 days



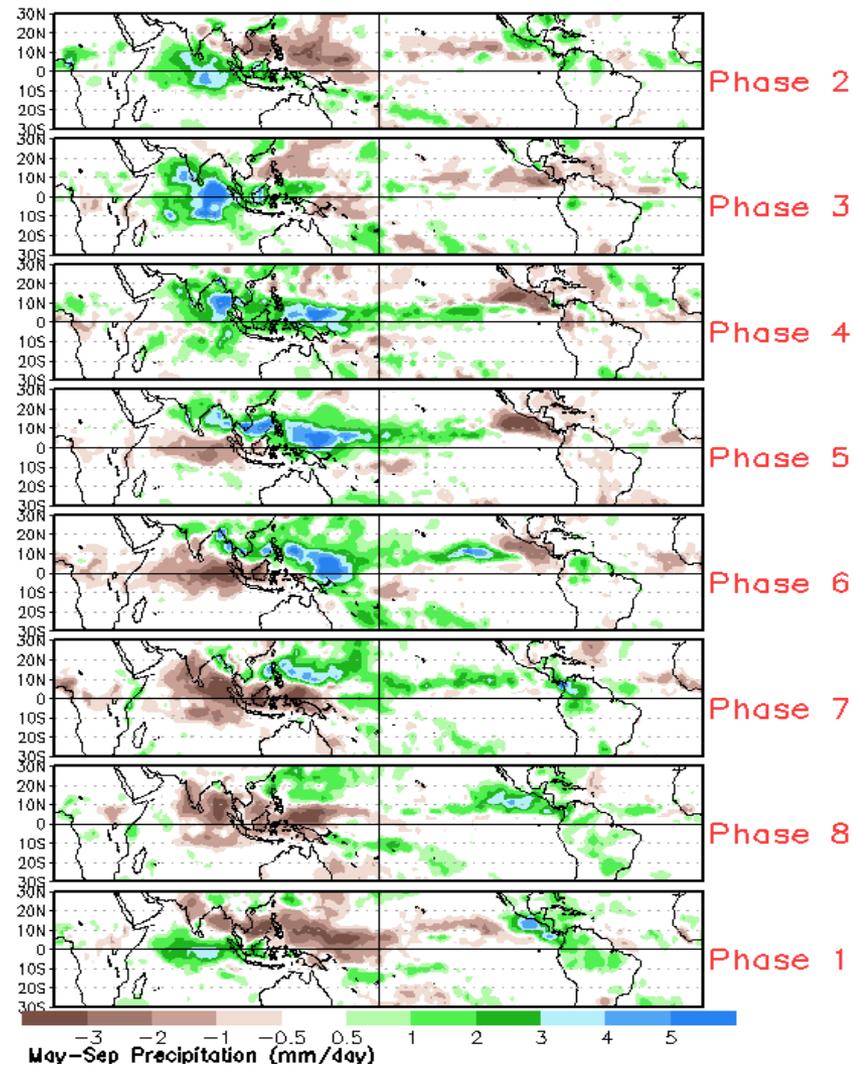
- The constructed analog forecast of RMM-based OLR anomalies also depicts robust MJO activity propagating across the West Pacific over the next two weeks.

# MJO: Tropical Composite Maps by RMM Phase

## 850-hPa Velocity Potential and Wind Anomalies



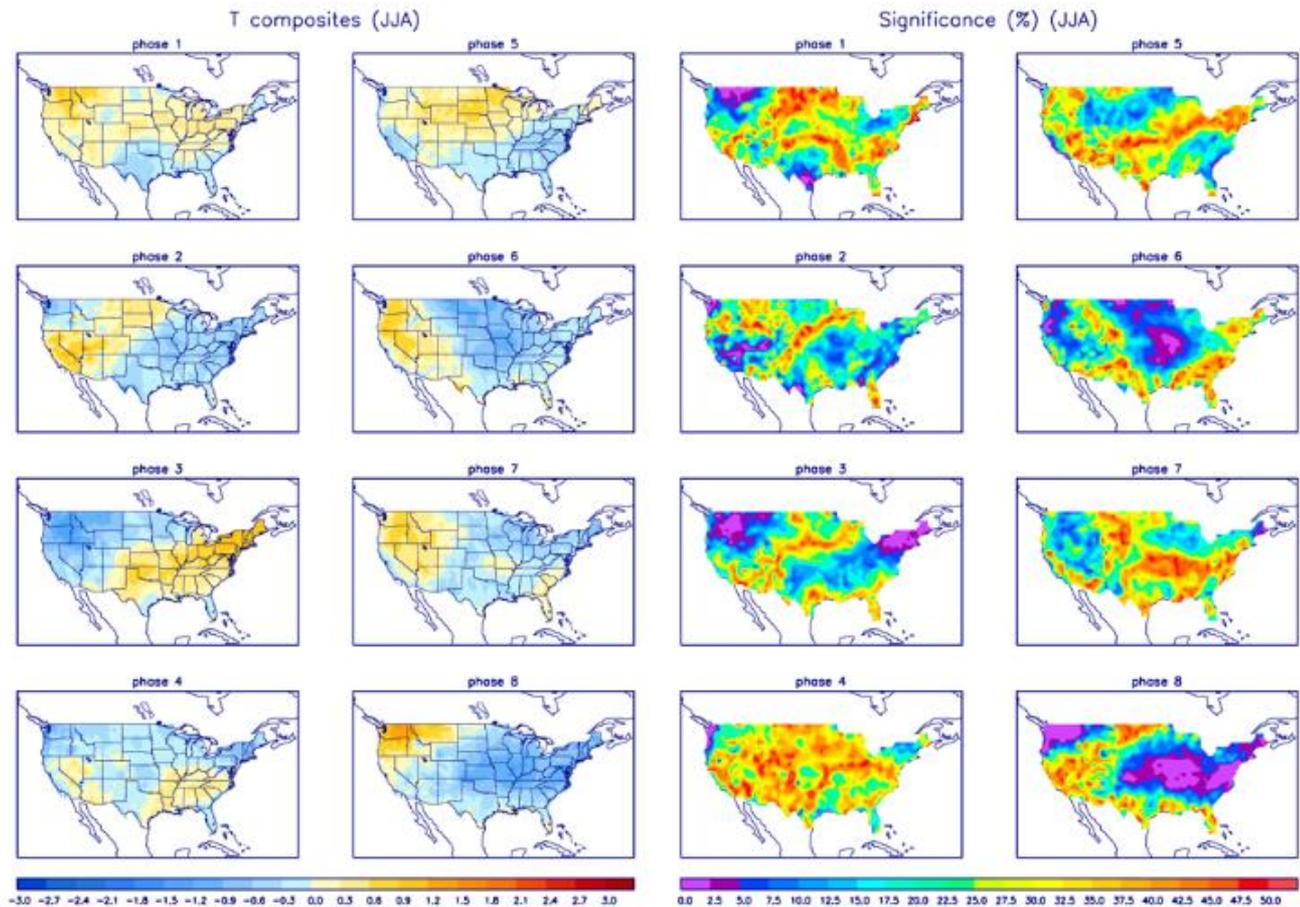
## Precipitation Anomalies



# 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.

