

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



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
17 May 2021

Overview

- The enhanced MJO envelope remains active over the Indian Ocean. Its presence has contributed to the development of Tropical Cyclone Tauktae over the Arabian Sea during the past week.
- Forecasts of the RMM index anticipate the MJO to continue its eastward propagation and reach the West Pacific by late May.
 - This solution needs to be taken with some caution given its rapid progression, atypical ease of crossing the Maritime Continent, and robust projection in Phases 4/5 despite the transition from La Niña to ENSO-neutral conditions (which in essence shifts the RMM index to favoring negative values of RMM1).
 - An atmospheric Kelvin wave appears to be co-located with the active MJO envelope, which is being captured by the RMM indices as the primary mode of eastward propagating, wave-1 intraseasonal tropical variability. There is also a slower moving envelope of enhanced convection which is likely to approach the Maritime Continent over the next two weeks that projects onto the MJO wavenumber/frequency band.
- Regardless of causal mechanisms or semantics, tropical cyclone formation chances are likely to remain elevated across the Indian Ocean and South China Sea during the next week, while shifting to the South China Sea and West Pacific during the last week of May.

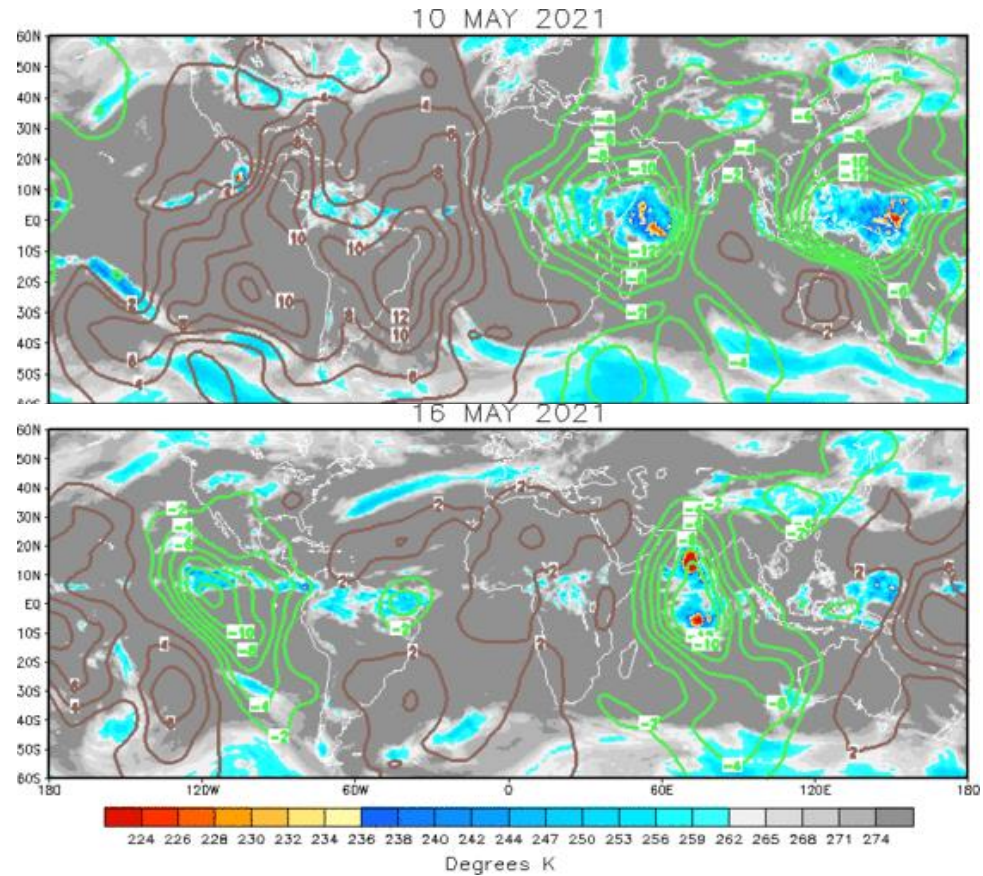
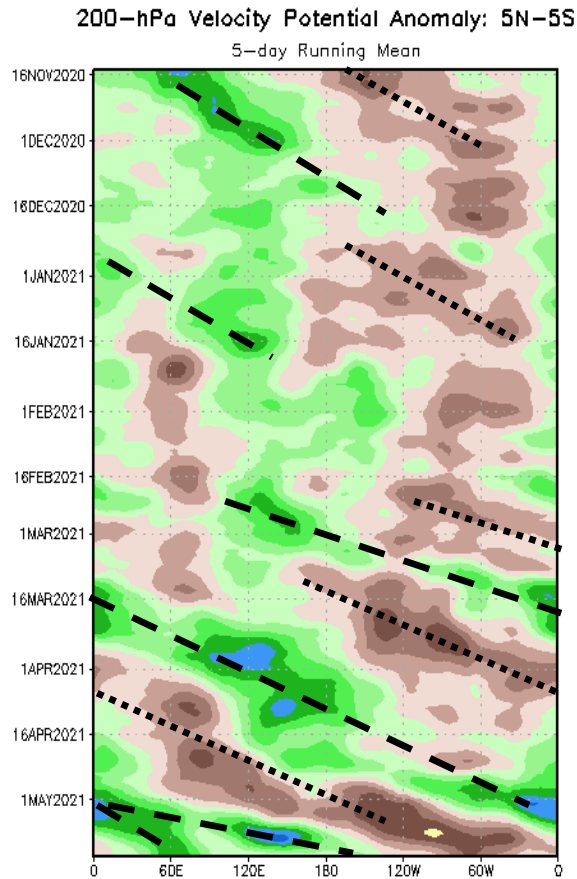
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

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

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

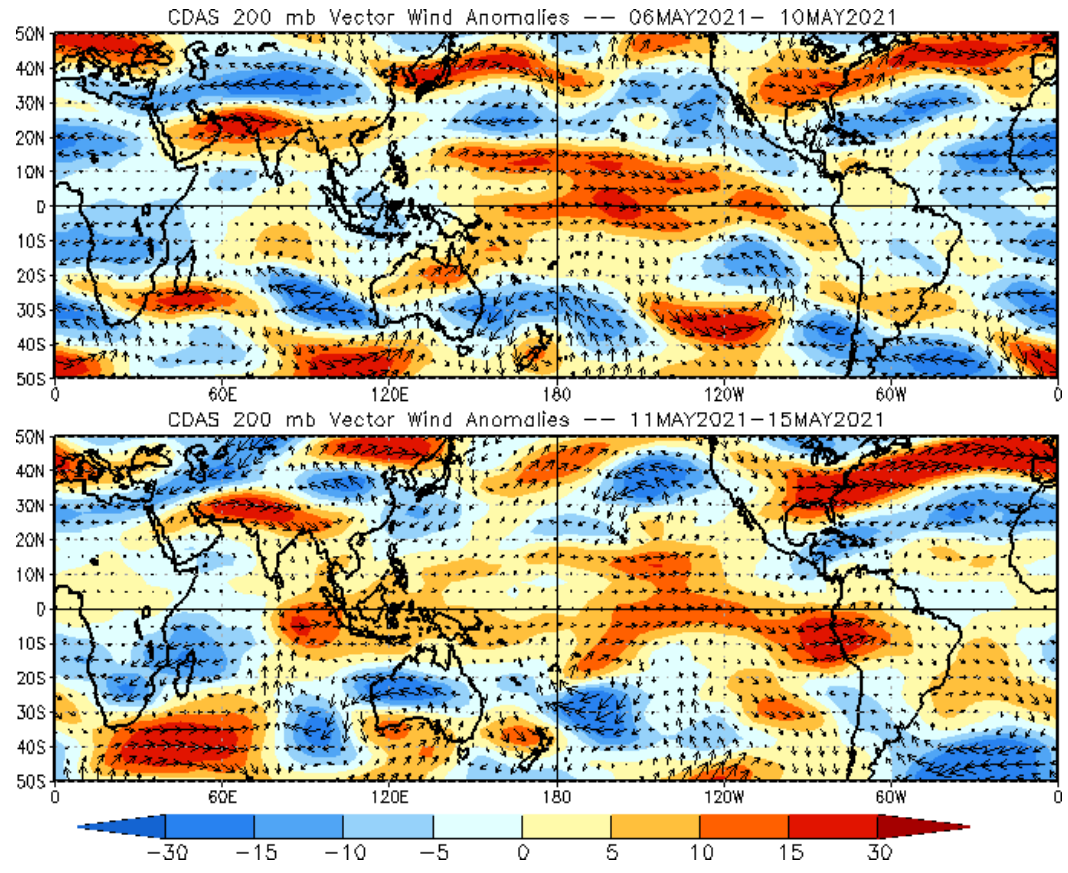
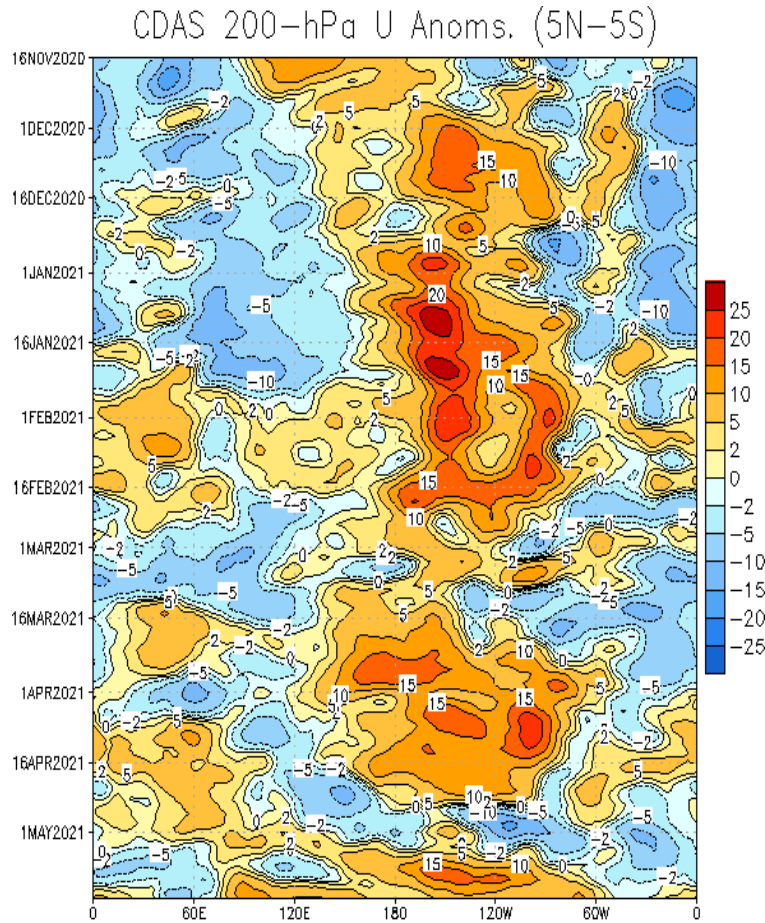
Brown shades: Anomalous convergence (unfavorable for precipitation).



- Both the Hovmöller diagram and spatial plots show a transition away from a wave-1 toward a wave-2 pattern over the last week.
- This evolution is tied to a slower moving envelope over the Indian Ocean (the MJO) and a more progressive eastward-propagating feature shifting from the West Pacific to East Pacific (atmospheric Kelvin wave) during the past week.

200-hPa Wind Anomalies

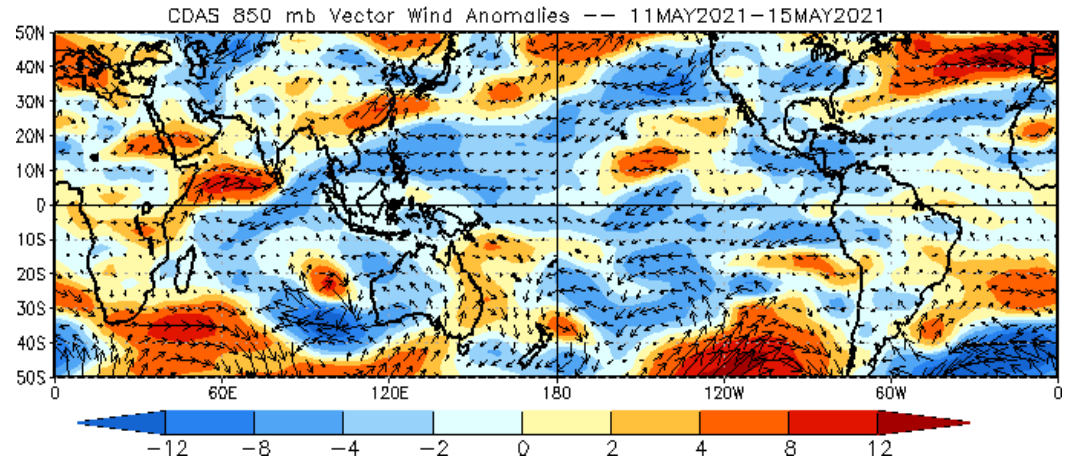
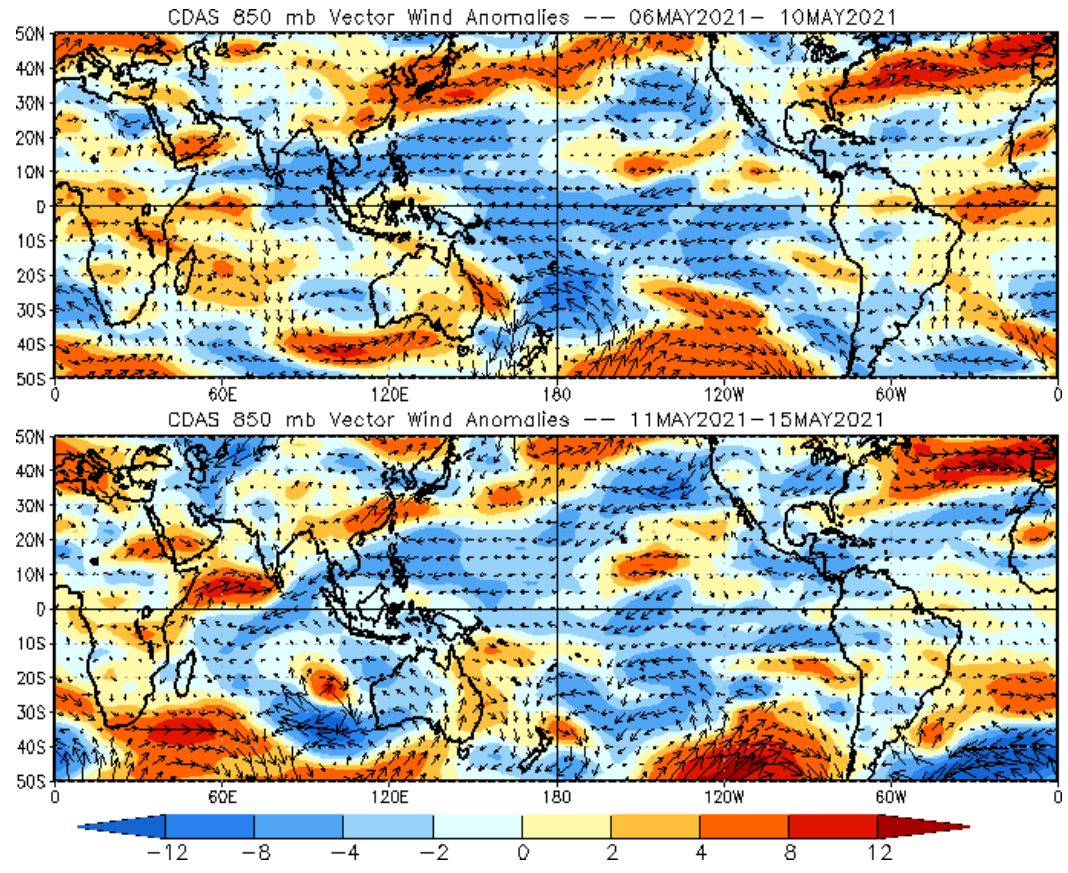
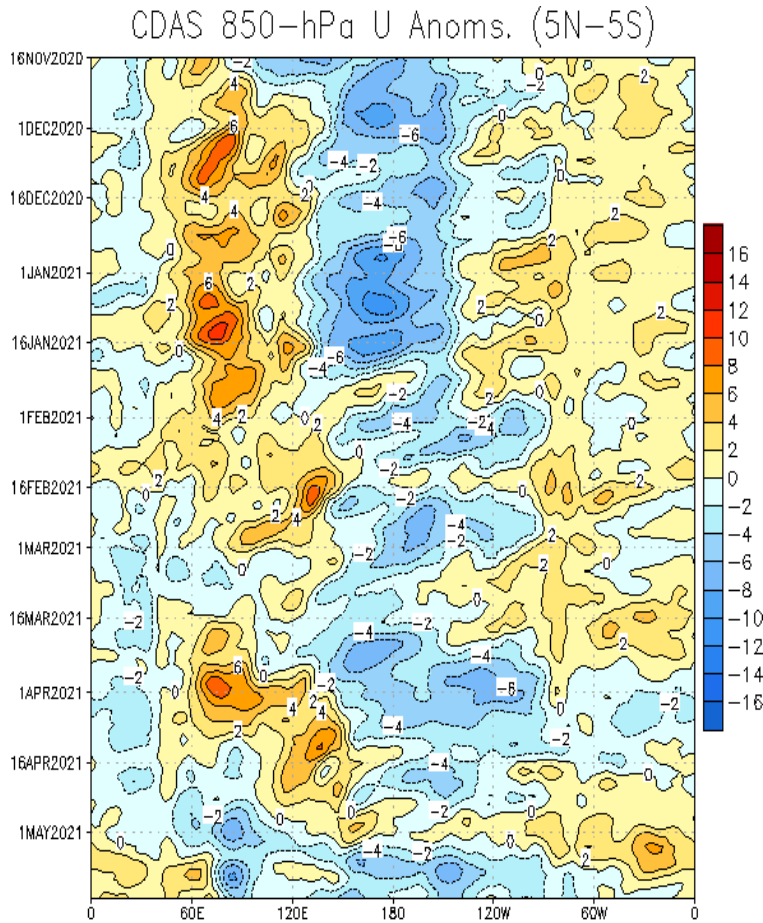
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous upper-level westerlies continue to persist across much of the Tropical Pacific.
- Wavebreaking from both hemispheres has increased upper-level convergence across the eastern Indian Ocean in recent days, with this being exacerbated by outflow aloft by the active MJO envelope to the west.

850-hPa Wind Anomalies

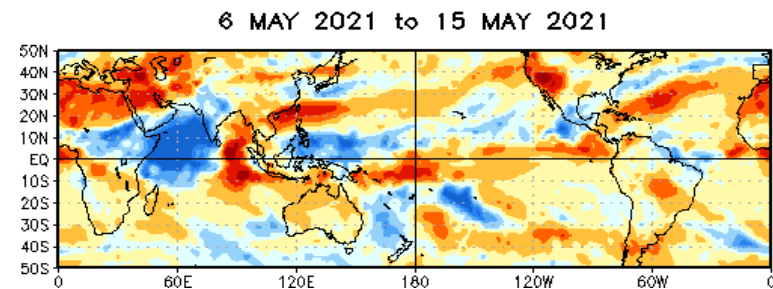
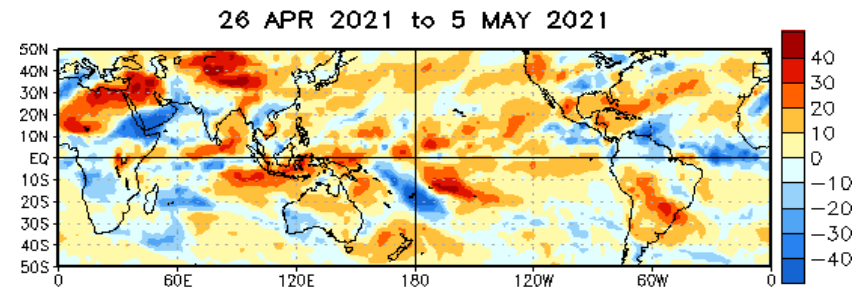
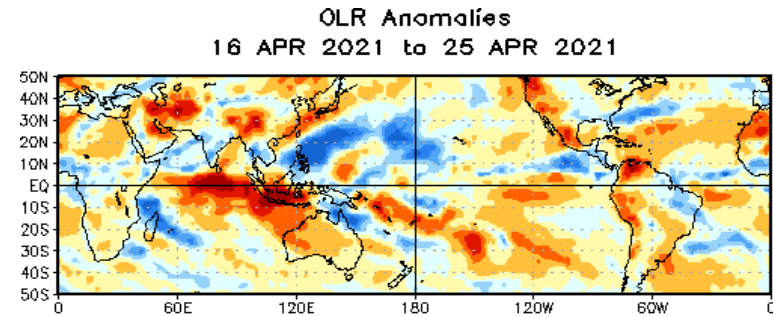
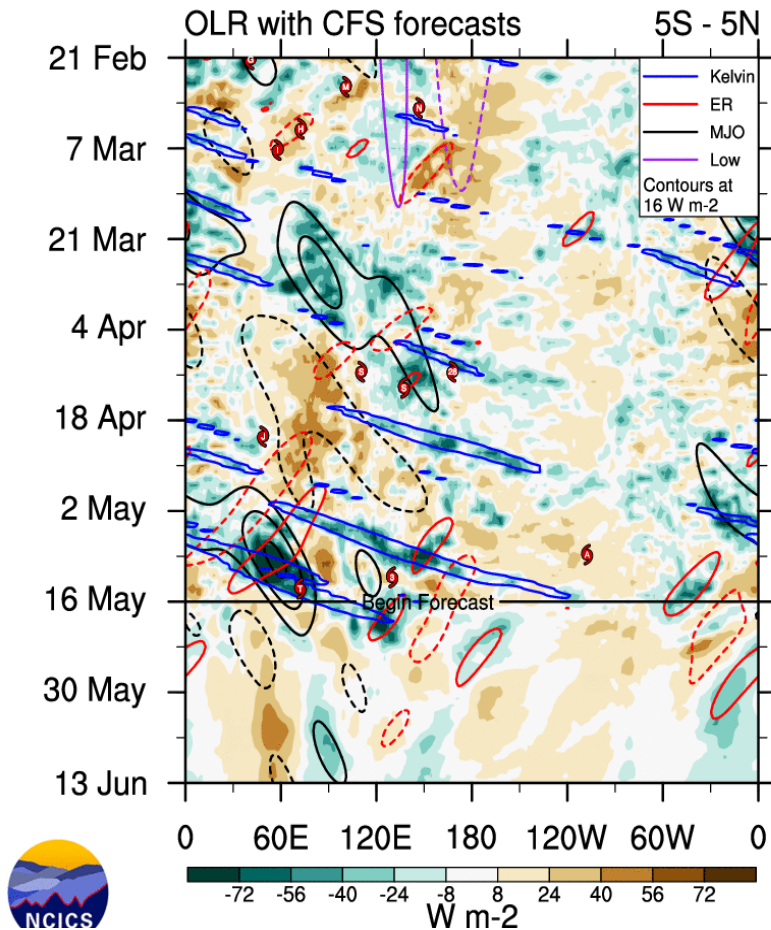
Shading denotes the zonal wind anomaly. **Blue shades: Anomalous easterlies.** **Red shades: Anomalous westerlies.**



- Enhanced westerlies over the western Indian Ocean are linked to the enhanced MJO envelope, and helped induce a cyclonic circulation that was favorable for the formation of Tropical Cyclone Tauktae.
- Enhanced trades persist across the Equatorial Pacific despite the demise of La Niña.

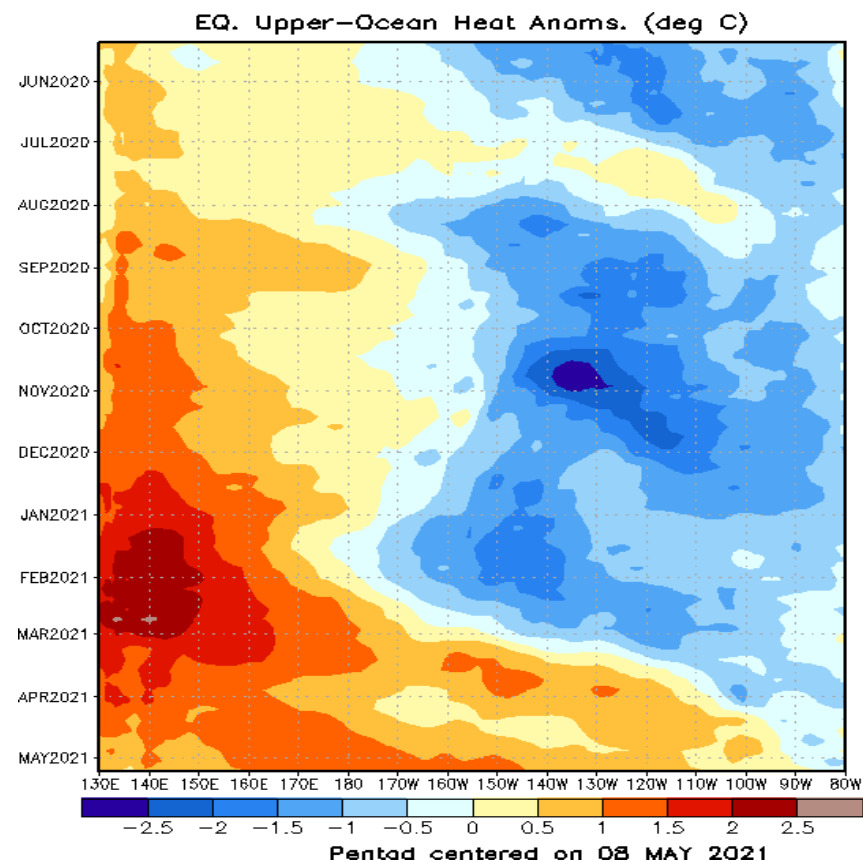
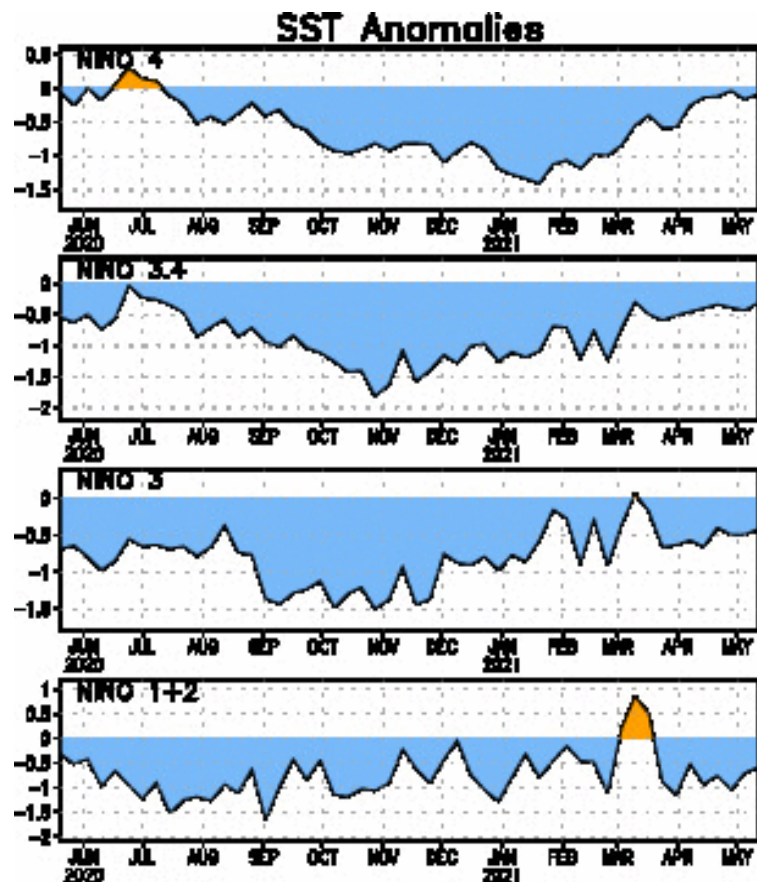
Outgoing Longwave Radiation (OLR) Anomalies

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



- Objective wavenumber/frequency filtering analyzes the Kelvin wave emerging from the slower-propagating MJO envelope near 90°E. These features are in addition to another Kelvin wave presently near 120°W.
- Multiple equatorial Rossby waves are also present over the Indian and western Pacific Oceans.

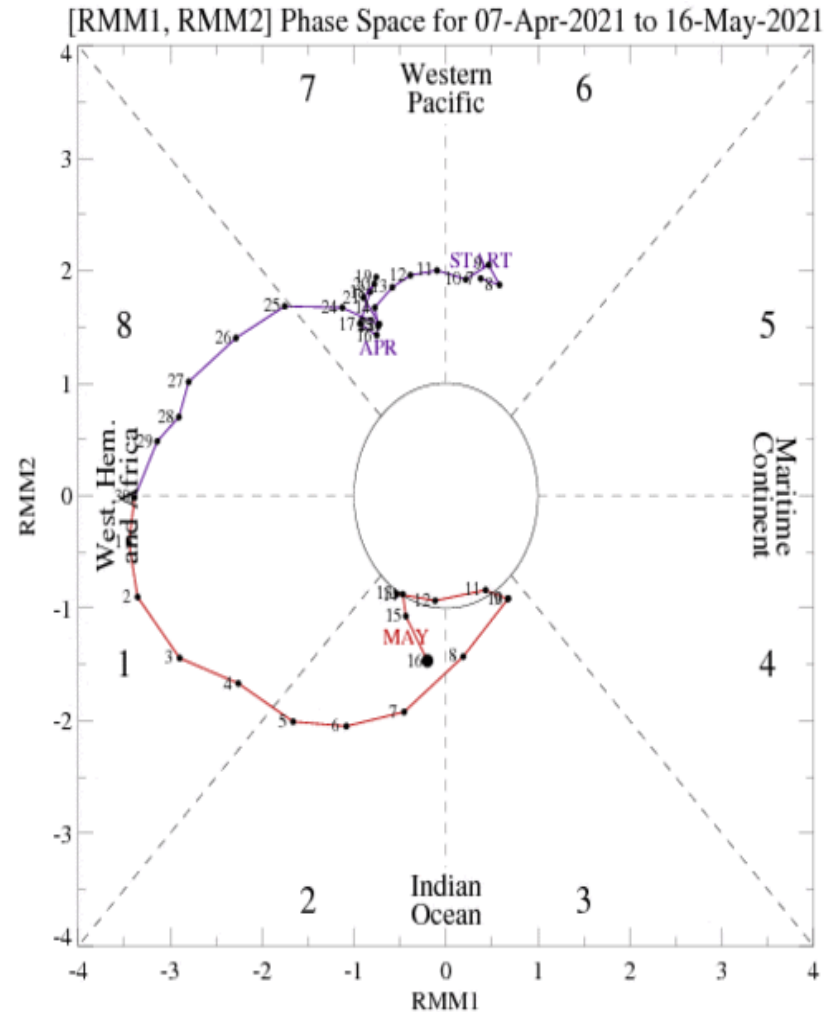
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Upper-ocean heat content is above-normal along the equator for areas west of 90°W as a result of multiple downwelling oceanic Kelvin waves since March.
- Niño indices still generally remain below-normal, although the vertically-integrated heat content suggests any cold water is extremely shallow.

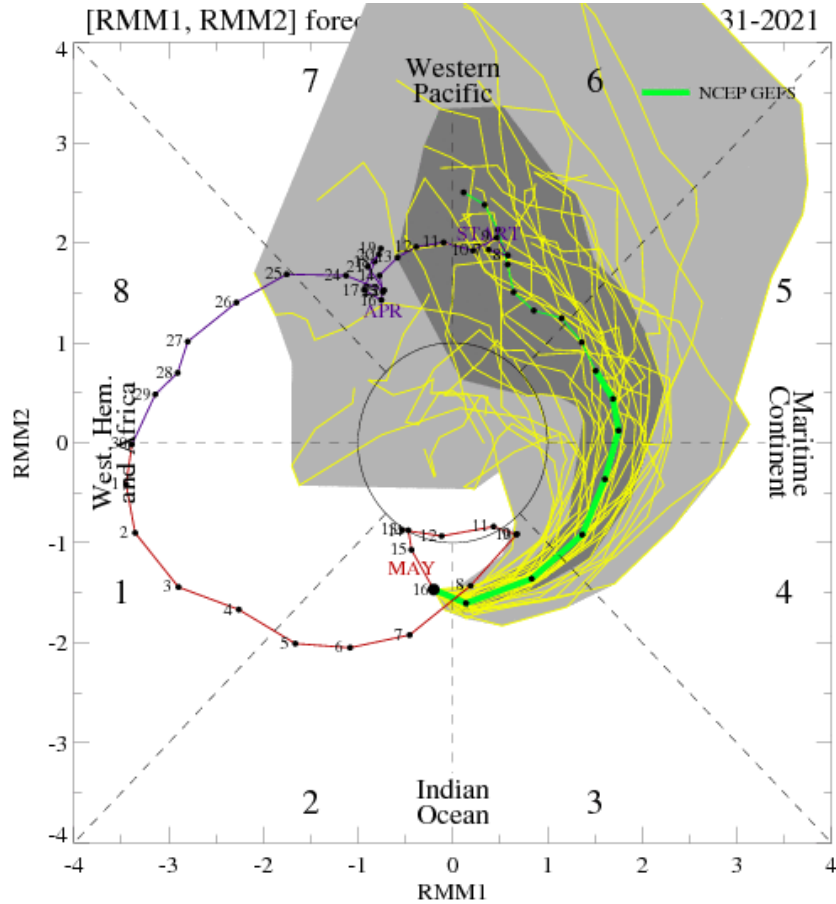
MJO Index: Recent Evolution

- The MJO is currently in RMM Phase 2.
- The RMM index looped westward over the past week, tied to the analysis framework switching its focus from the Kelvin wave presently over the East Pacific to the MJO and second Kelvin wave over the Indian Ocean. Equatorial Rossby wave (tropical cyclone) activity over the Arabian Sea may have also contributed to the westward shift.

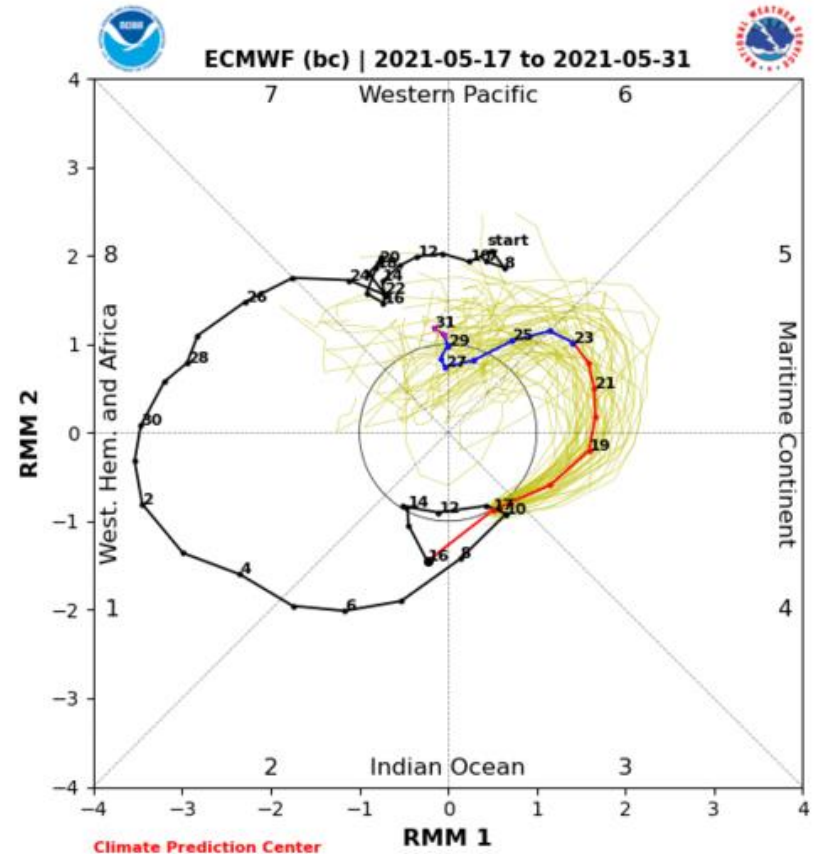


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



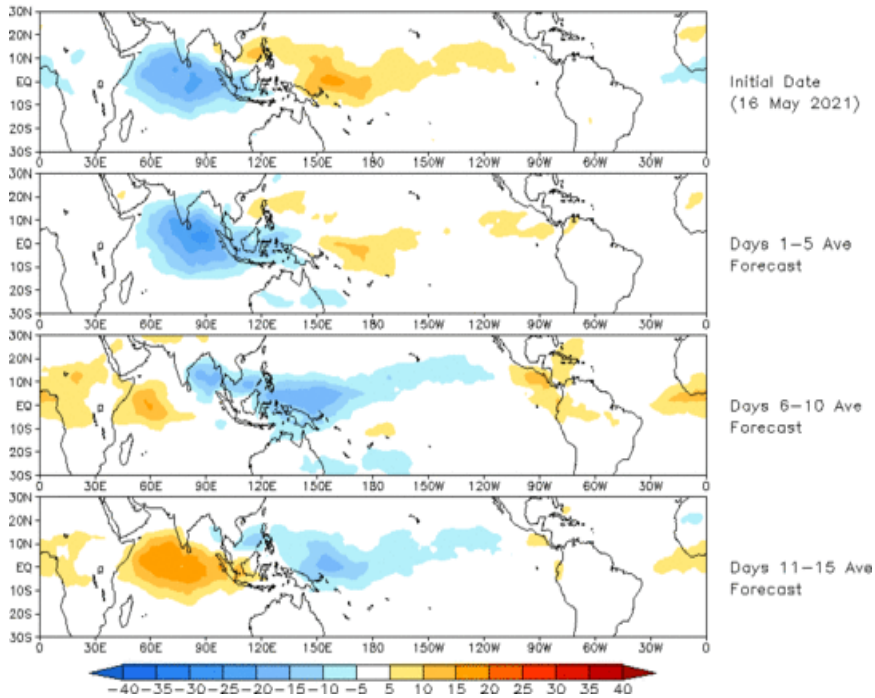
ECMWF Forecast

- Both the GEFS and ECMWF forecasts of the RMM index show an intraseasonal signal propagating from the Indian Ocean to the West Pacific through the end of May.
- The GEFS is faster and has a stronger projection in RMM2 over the Pacific, likely emphasizing the Kelvin wave more than the slower and more subdued ECMWF model. Spread is pronounced in these GEFS forecasts.

MJO: GEFS Forecast Evolution

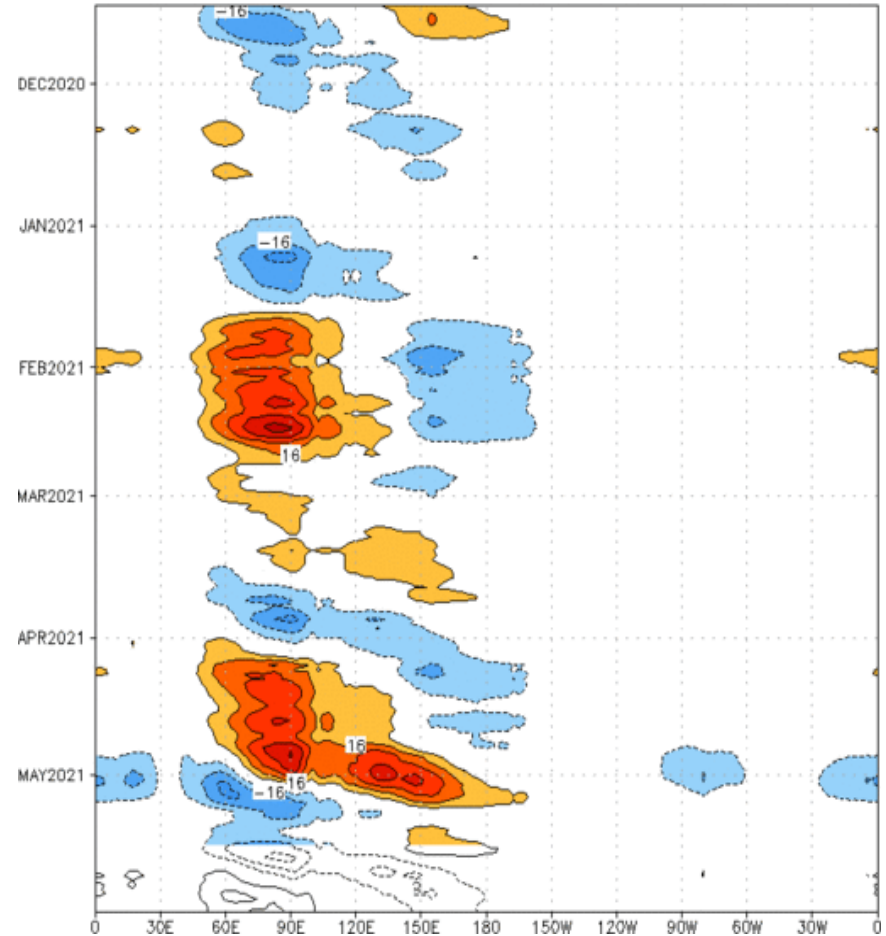
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Prediction of MJO-related anomalies using GEFS operational forecast
Initial date: 16 May 2021
OLR



- The GEFS shows enhanced convection shifting from the Indian Ocean to Pacific over the next two weeks, while suppressed convection wanes over the Pacific and begins to build back across the Indian Ocean.

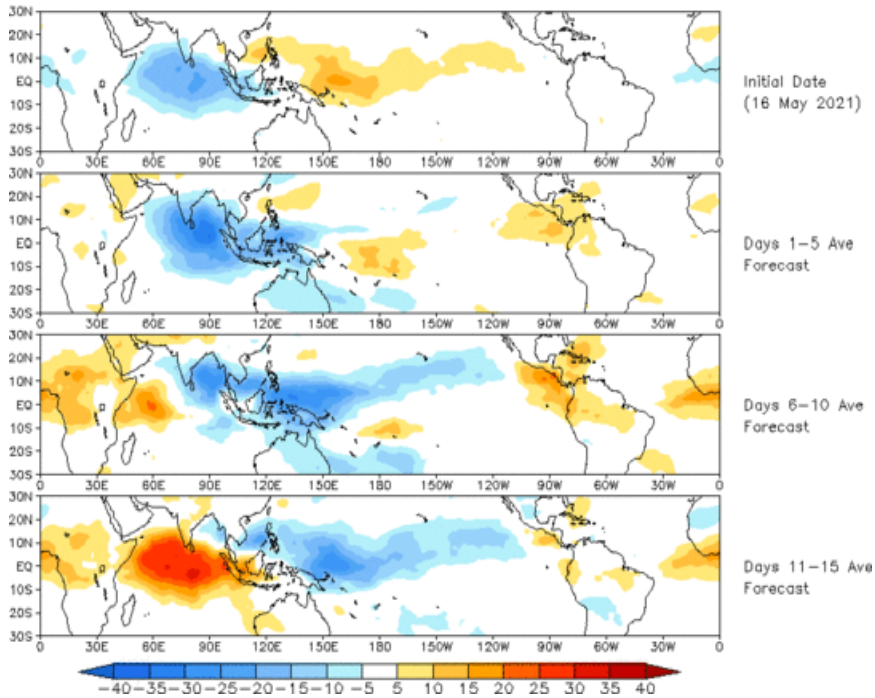
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:14–Nov–2020 to 16–May–2021
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days



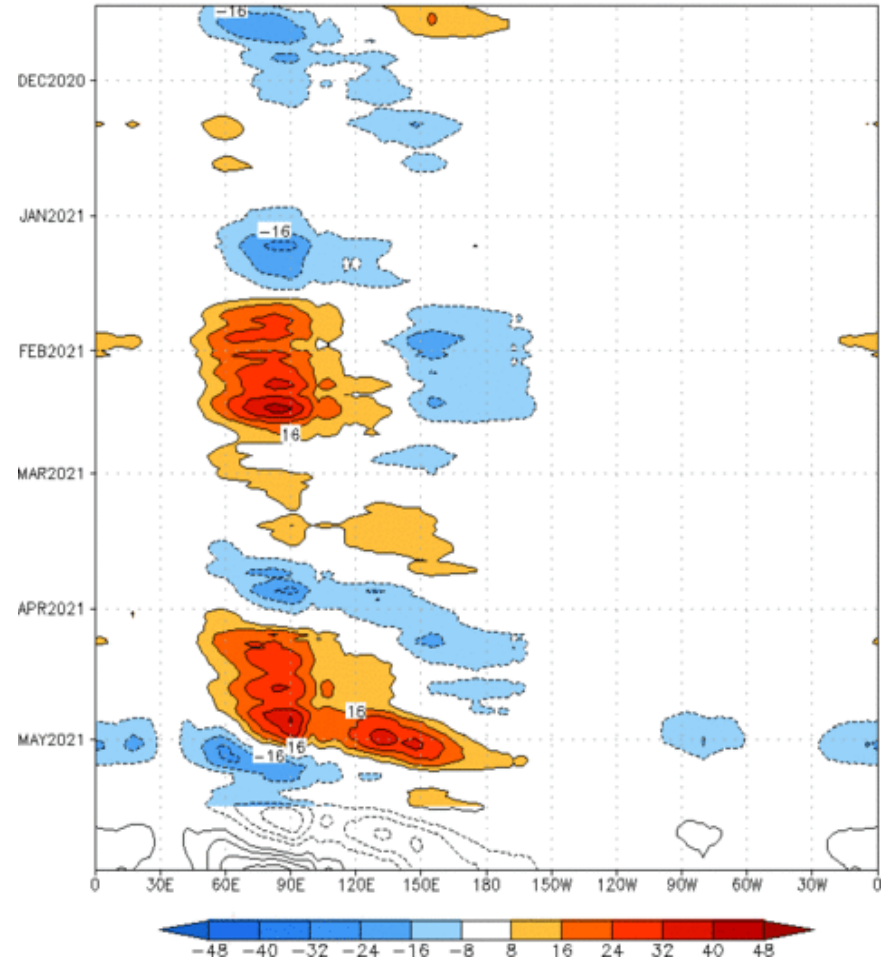
MJO: Constructed Analog Forecast Evolution

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 (16 May 2021)



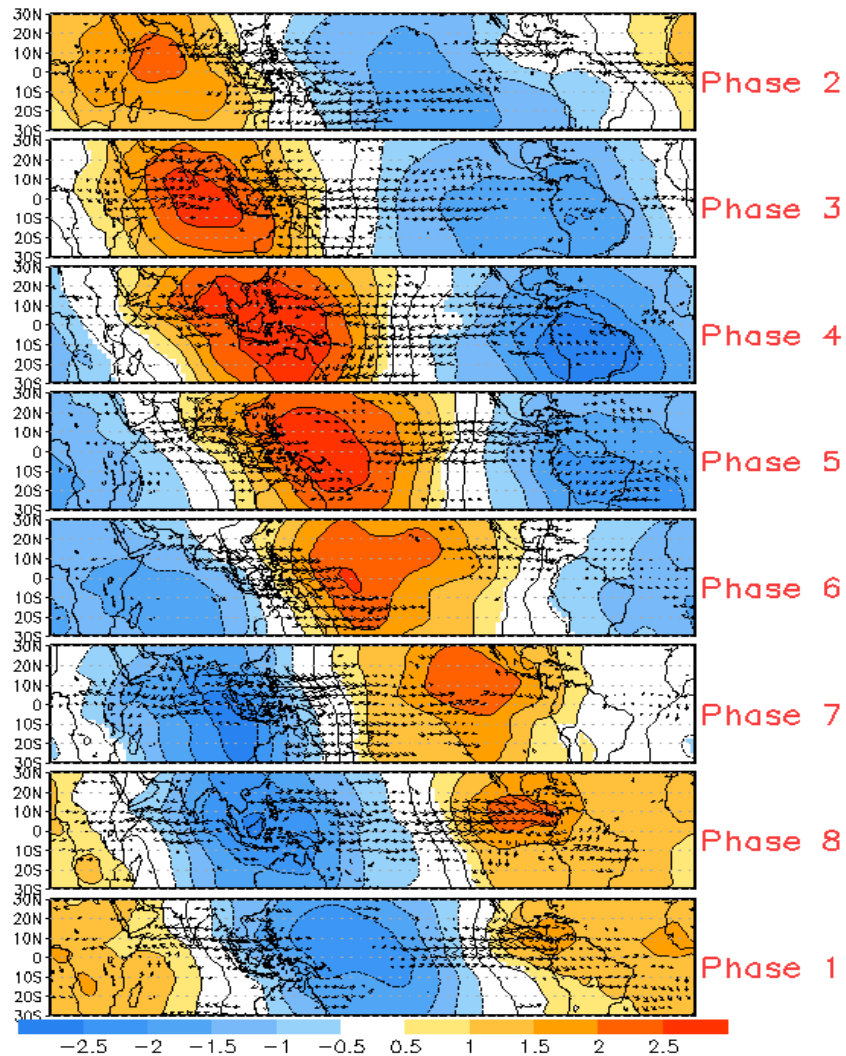
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:14-Nov-2020 to 16-May-2021
The unfilled contours are CA forecast reconstructed anomaly for 15 days



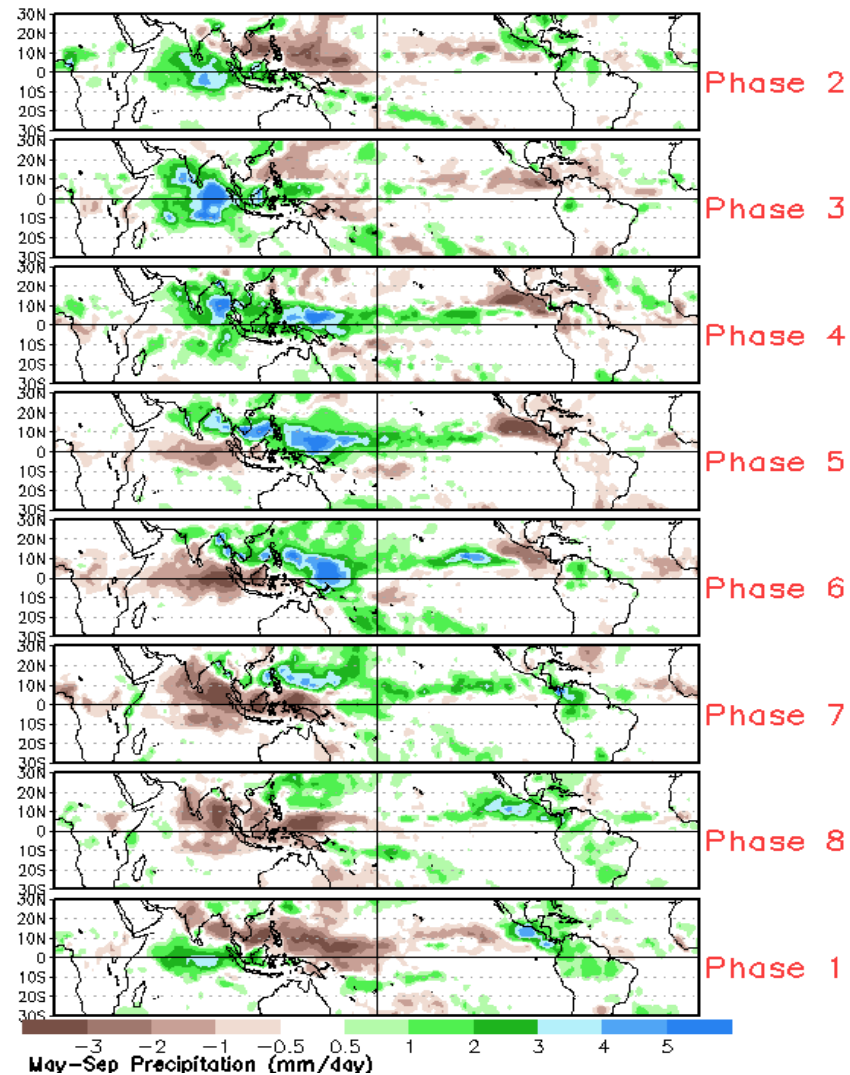
- The constructed analog forecast is very similar to the GEFS, although at a generally higher amplitude.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



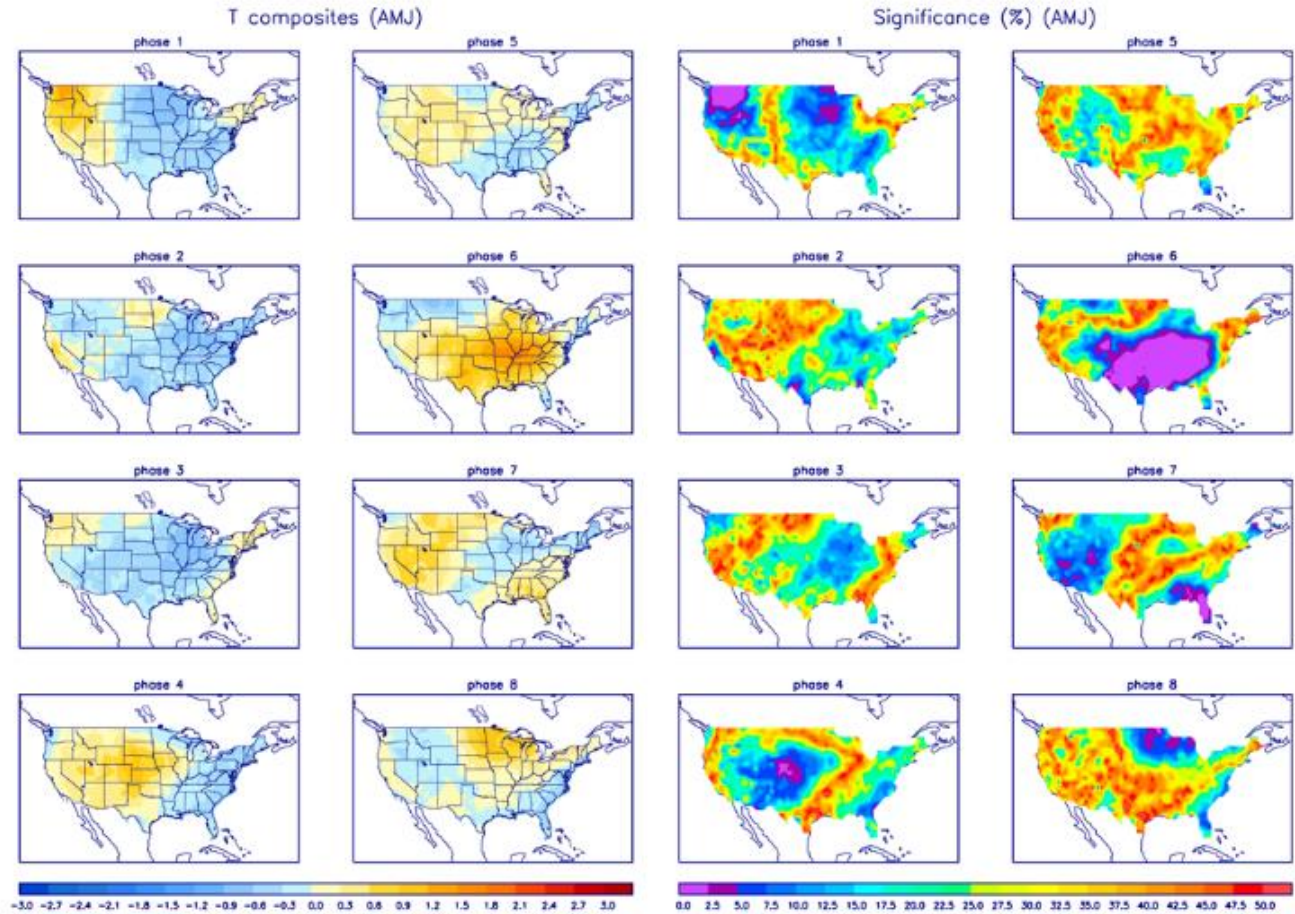
Precipitation Anomalies



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.

