

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



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
6 June 2022

Overview

- Strong Kelvin Wave activity continues across the Western Hemisphere, following a complete circumnavigation during the past month.
- This has resulted an uptick in tropical cyclone activity across the East Pacific and Atlantic basins. Notably, Hurricane Agatha made landfall as a strong category-2 system across southern Mexico on 5/30 (strongest May landfall). It's remnant circulation contributed to a new tropical disturbance over the Gulf of Mexico, which brought flooding rains to South Florida. The disturbance further developed into Tropical Storm Alex on 6/5 over the Western Atlantic.
- The ongoing Kelvin Wave activity has projected onto the RMM-based MJO index. While forecasts indicate a gradual weakening of the RMM-based index during the next week, a meandering convective signal is likely to persist across the Western Hemisphere.
- This evolution may promote additional tropical cyclone development across the East Pacific during week-2, with suppressed tropical activity generally favored elsewhere across the globe.

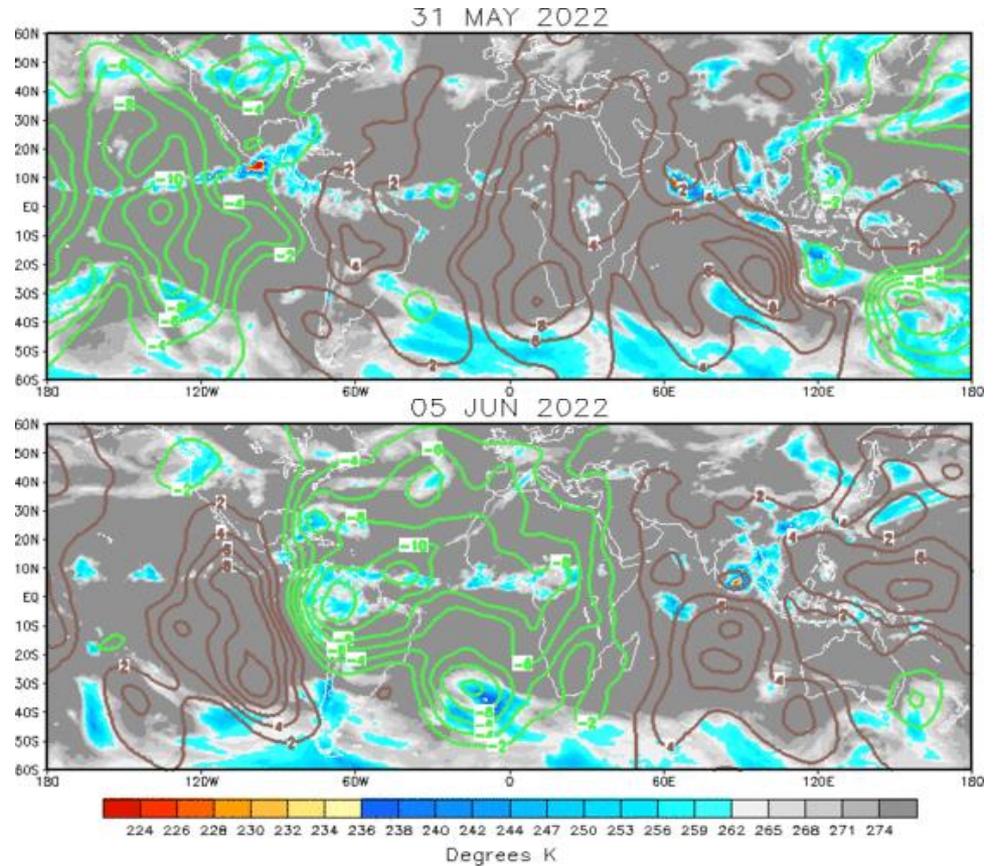
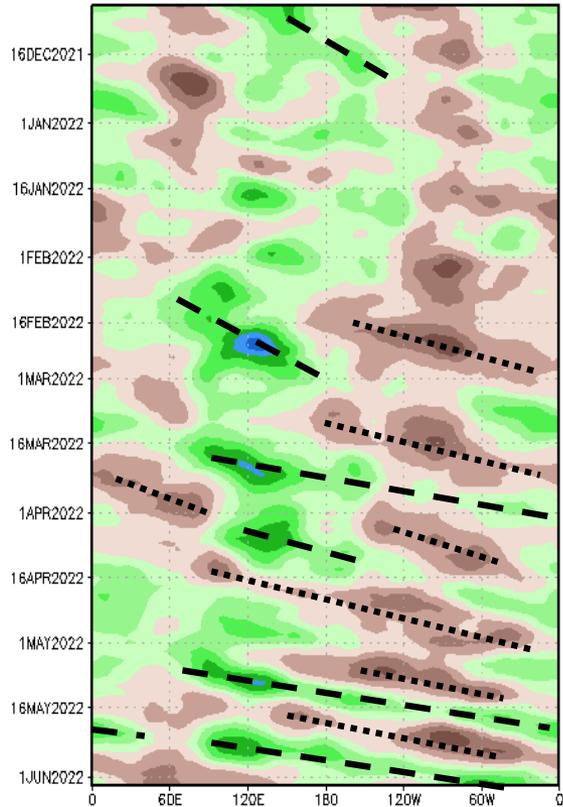
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

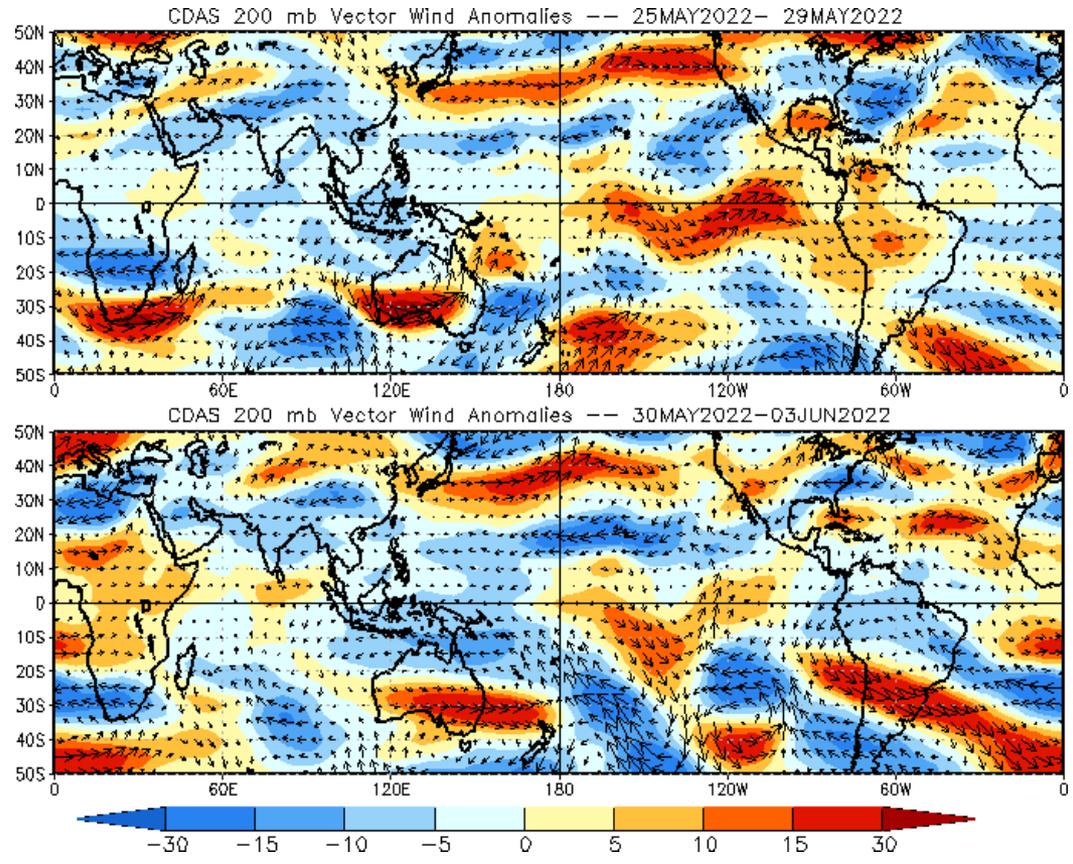
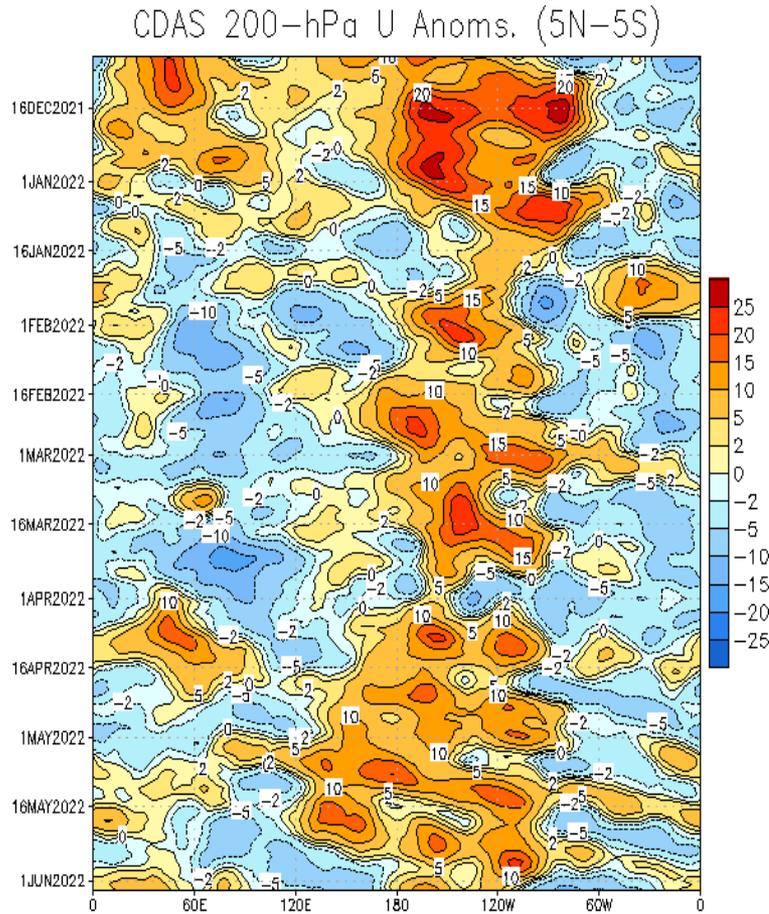
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- The spatial pattern of upper-level velocity potential anomalies resembles a coherent wave-1 asymmetry, and indicates a fast-moving convective envelope propagating across the globe consistent with continued Kelvin Wave activity.
- Currently, anomalous divergence is depicted across much of the Atlantic Ocean, with anomalous convergence generally depicted elsewhere across the globe.

200-hPa Wind Anomalies

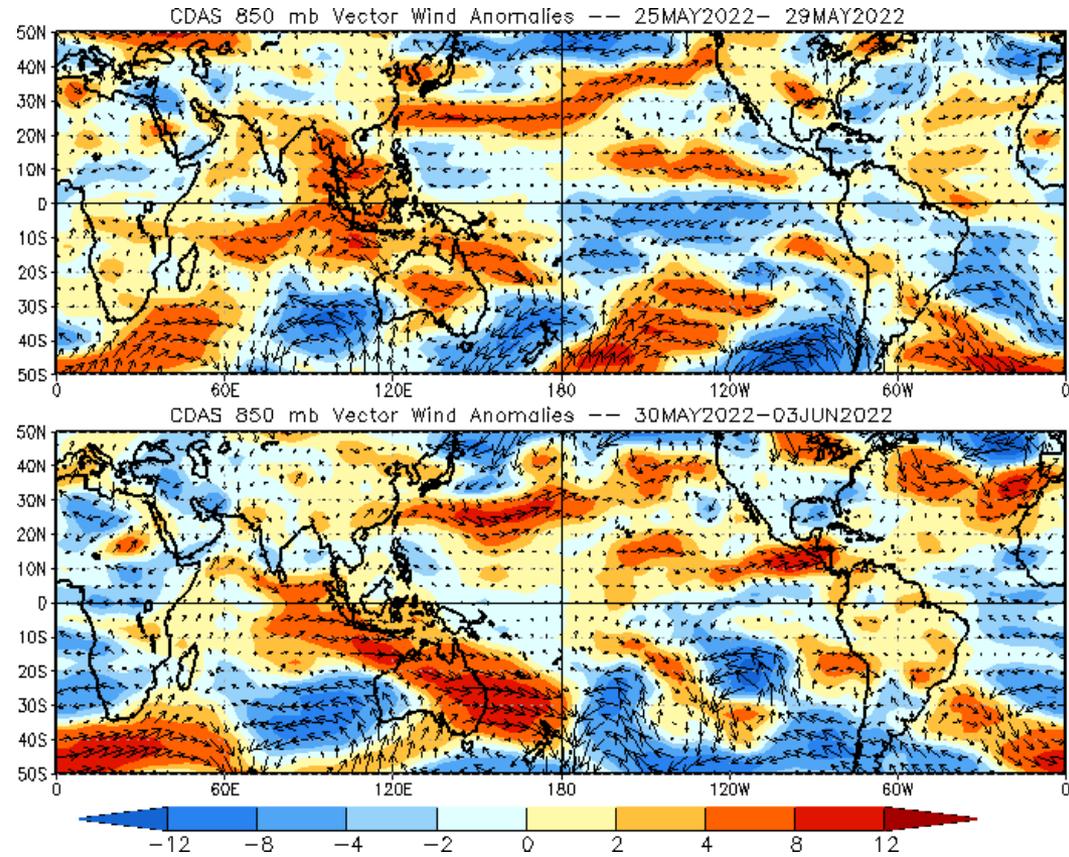
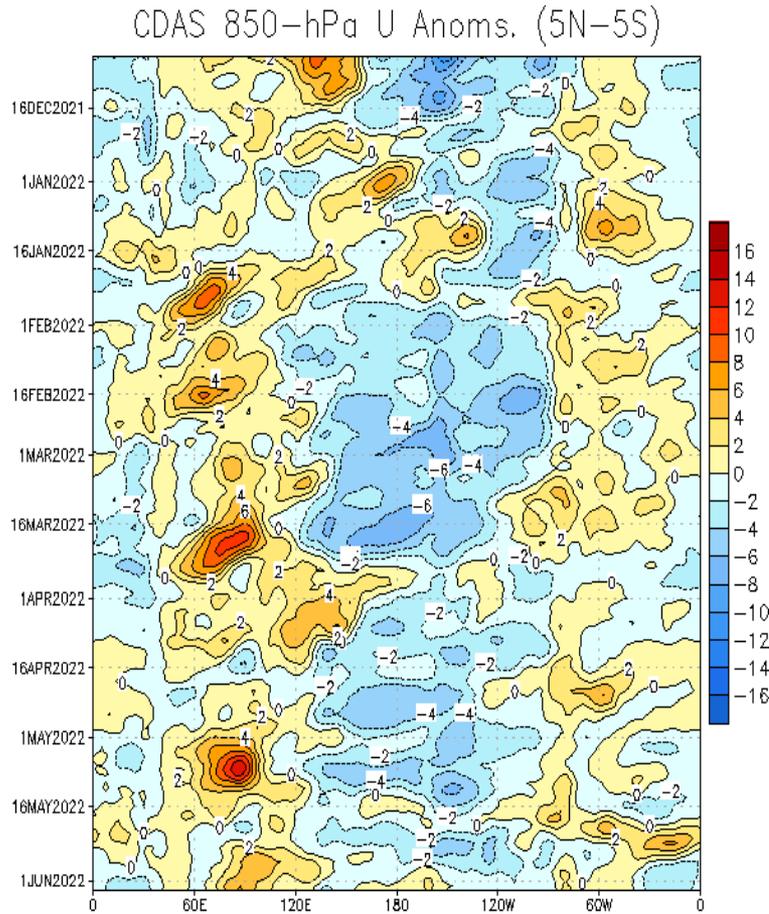
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Fast moving Kelvin Wave leads to a lack of coherency in the spatial upper-level wind field.
- Some weakening of the anomalous upper-level westerlies is noted over the equatorial Pacific, with an increase in easterlies west of the Date Line.

850-hPa Wind Anomalies

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

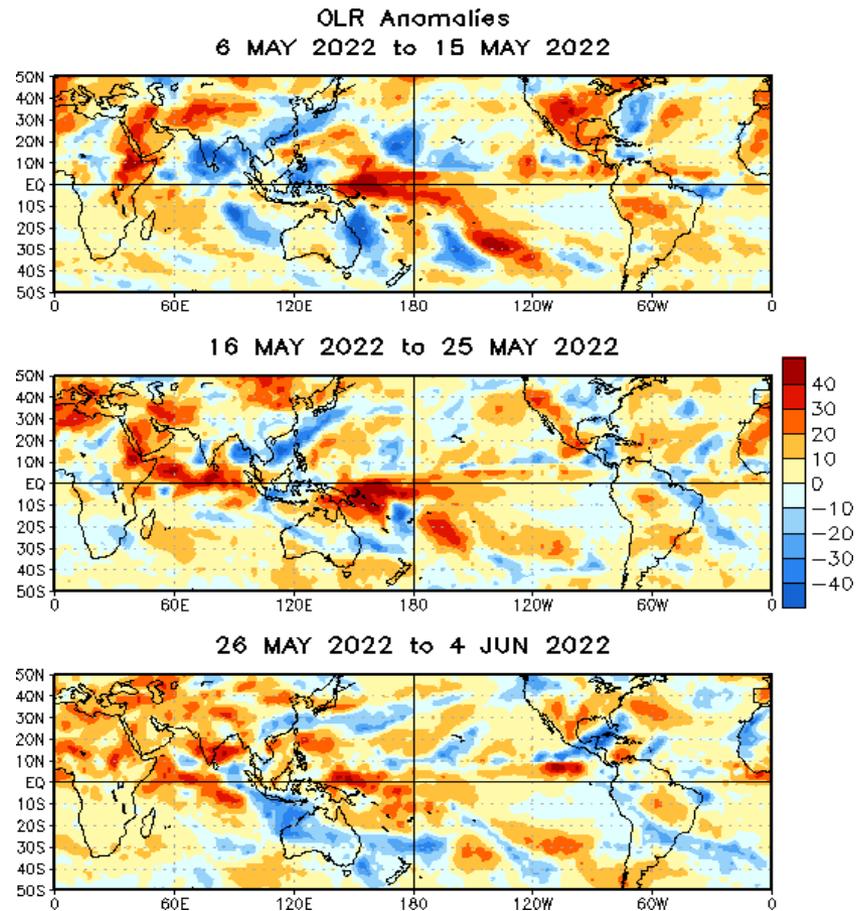
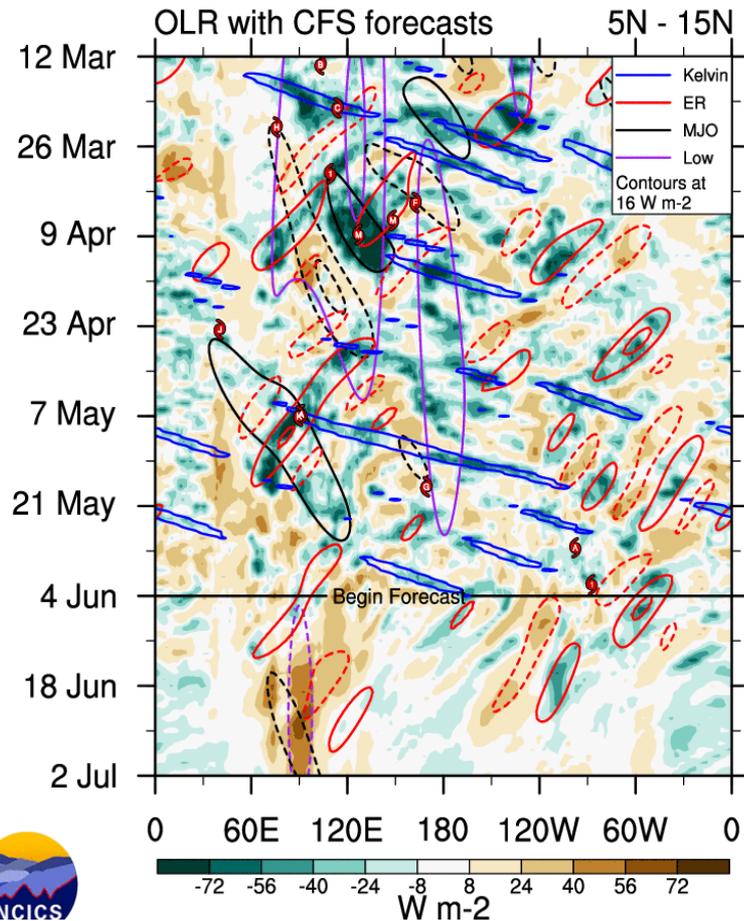


- Increased Kelvin Wave activity across the Pacific in late May resulted in a weakening of the trades
- Strong westerly wind anomalies are depicted across the Maritime Continent and Southwest Pacific.

Outgoing Longwave Radiation (OLR) Anomalies

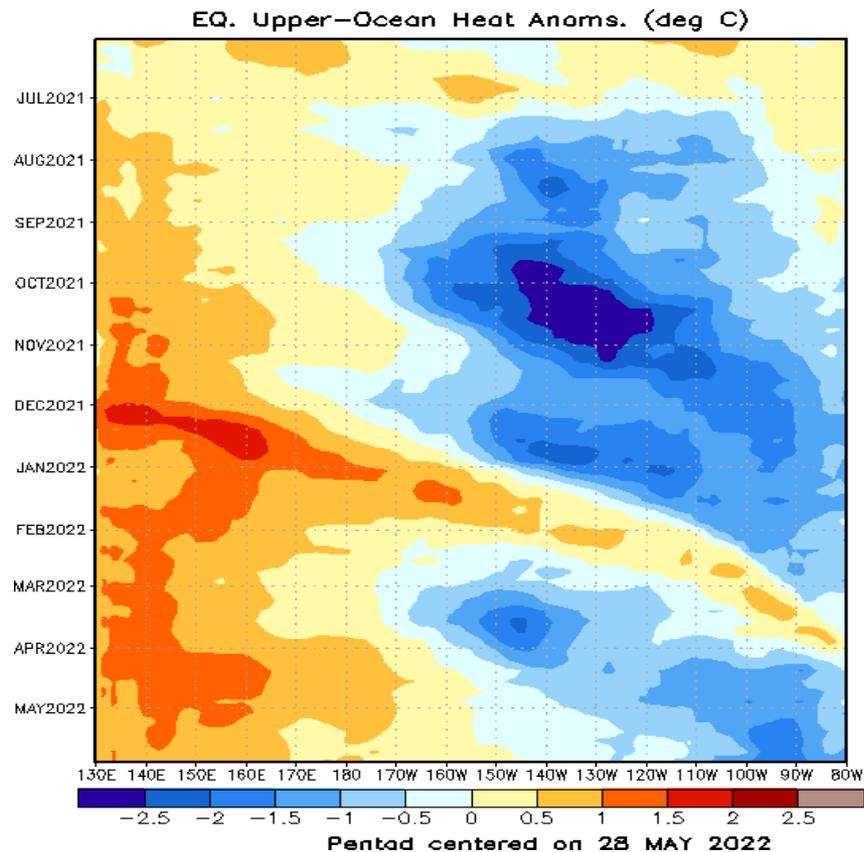
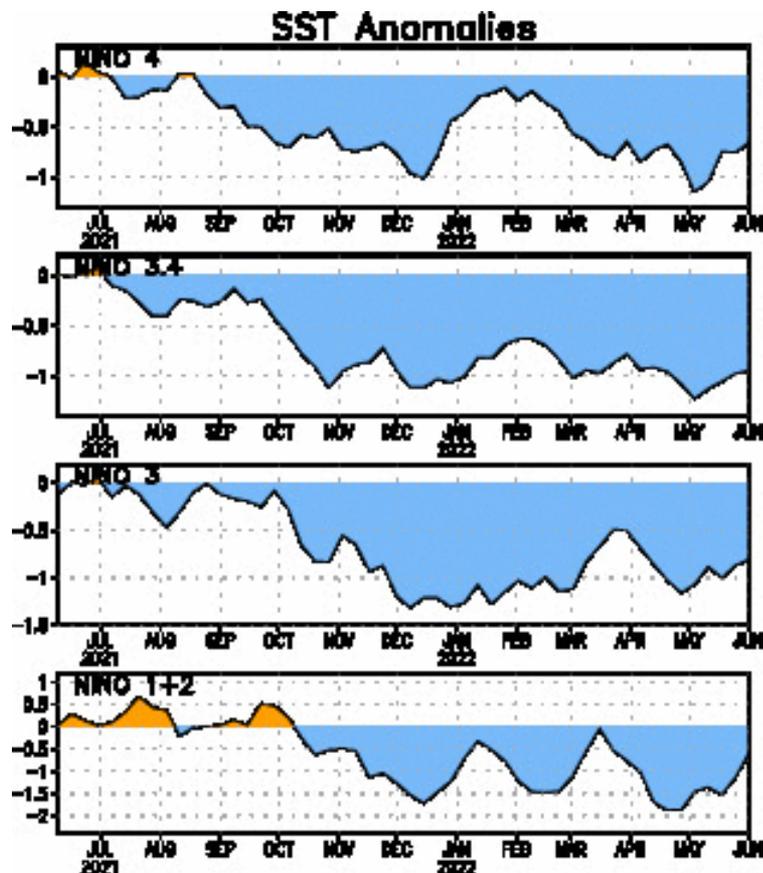
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- Convectively-coupled Kelvin wave activity has disrupted the low-frequency signal during the past month.
- Constructive interference with Rossby Wave activity across the Maritime Continent and western Atlantic resulted in further enhancement of the negative OLR anomalies in those regions.
- Convection remains strongly suppressed across the equatorial Pacific due to La Niña.

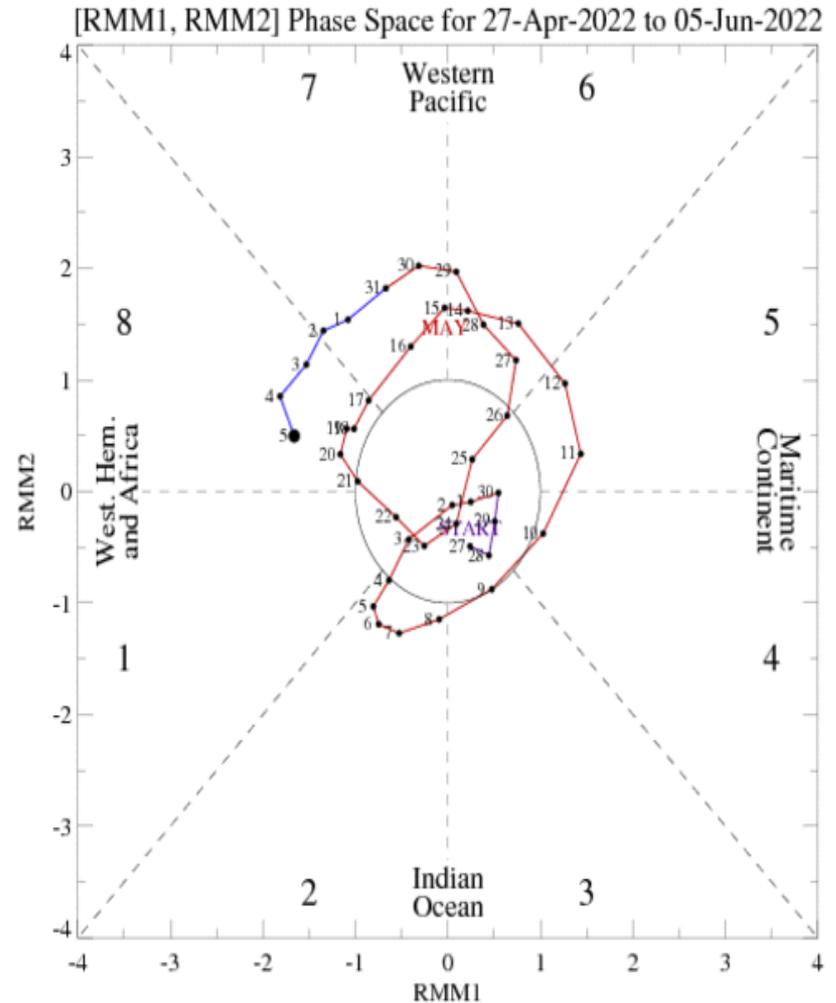
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Increased low level westerly wind bursts tied to Kelvin Wave activity has resulted in an increase in sea surface temperatures across the Niño Regions during the past week, although anomalies remain negative.
- Positive subsurface temperature anomalies are noted west of 150°W, with some decrease in the magnitude of the negative subsurface temperature anomalies across the rest of the Central and Eastern Pacific. However, the warming is modest compared to that from earlier in the year.

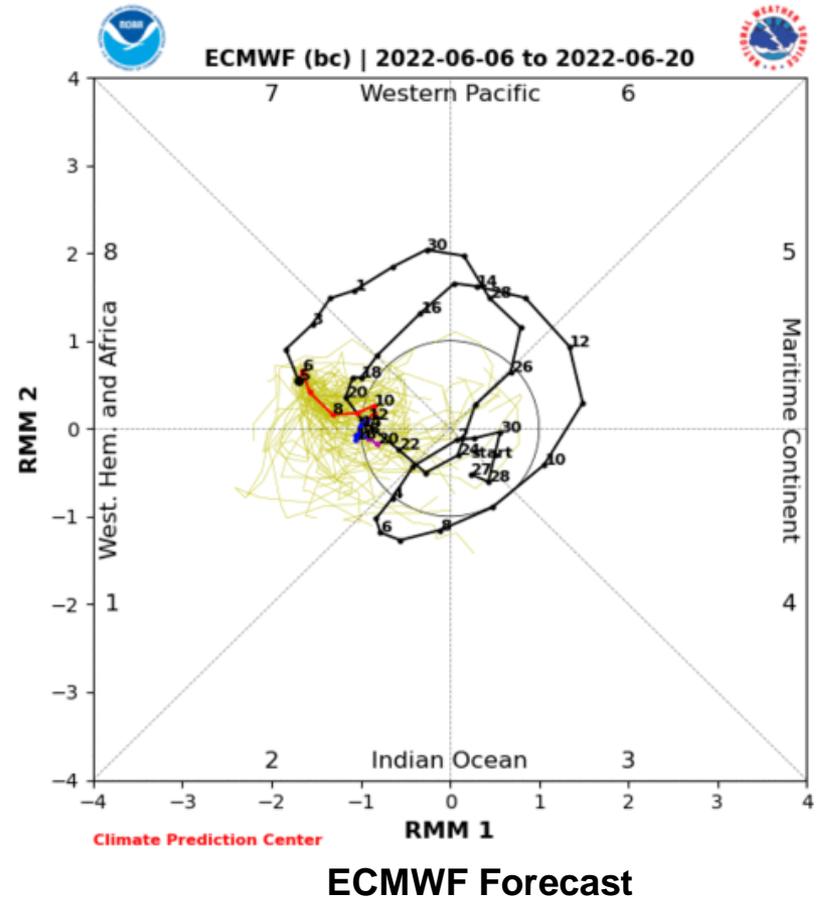
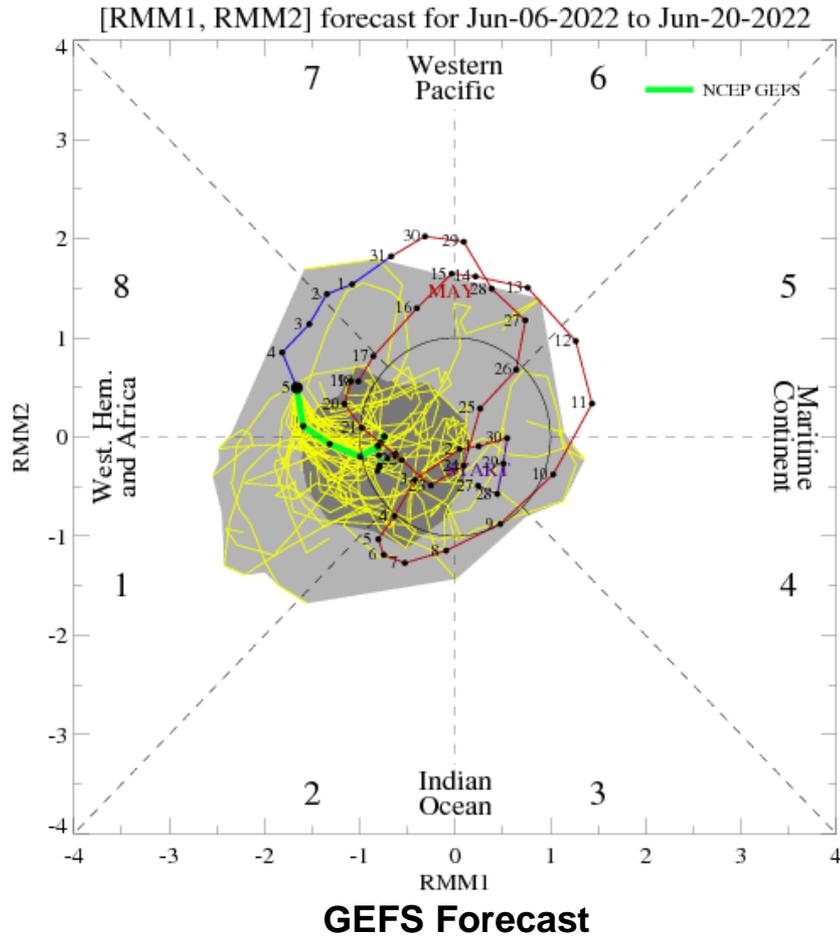
MJO Index: Recent Evolution

- Kelvin wave activity projected strongly onto the RMM index during May, with a full circumnavigation of the globe completed.
- The Kelvin wave has since begun a second propagation around the globe, and is currently situated across the Atlantic, contributing to the first tropical cyclone formation of the season (Alex).



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

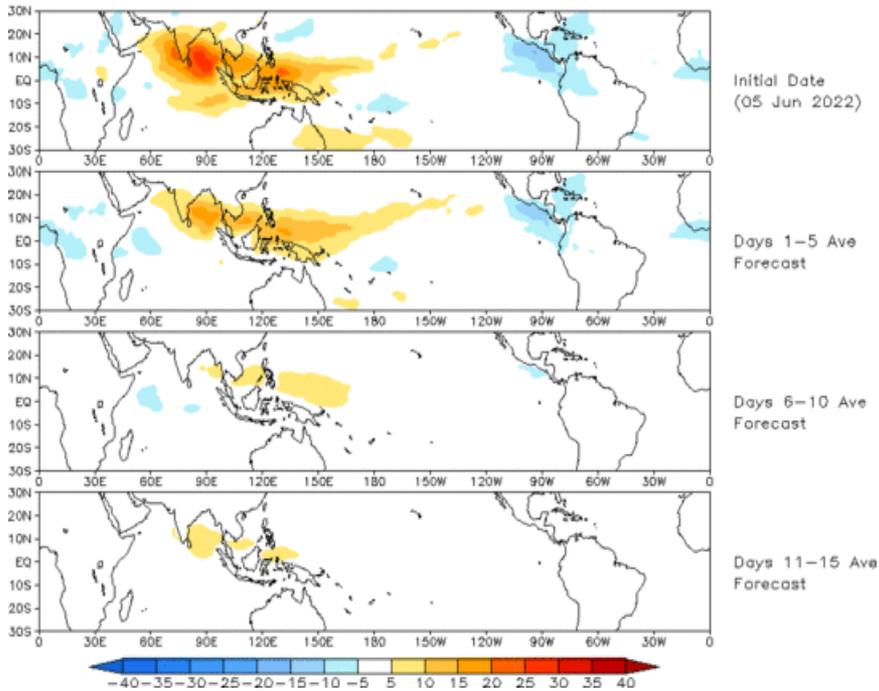


- The GEFS and ECMWF both depict a weakening of the RMM-based MJO index during the next week
- Despite a weakened MJO, models indicate a nearly stationary, meandering convective signal persisting across the Western Hemisphere during the next 2 weeks.

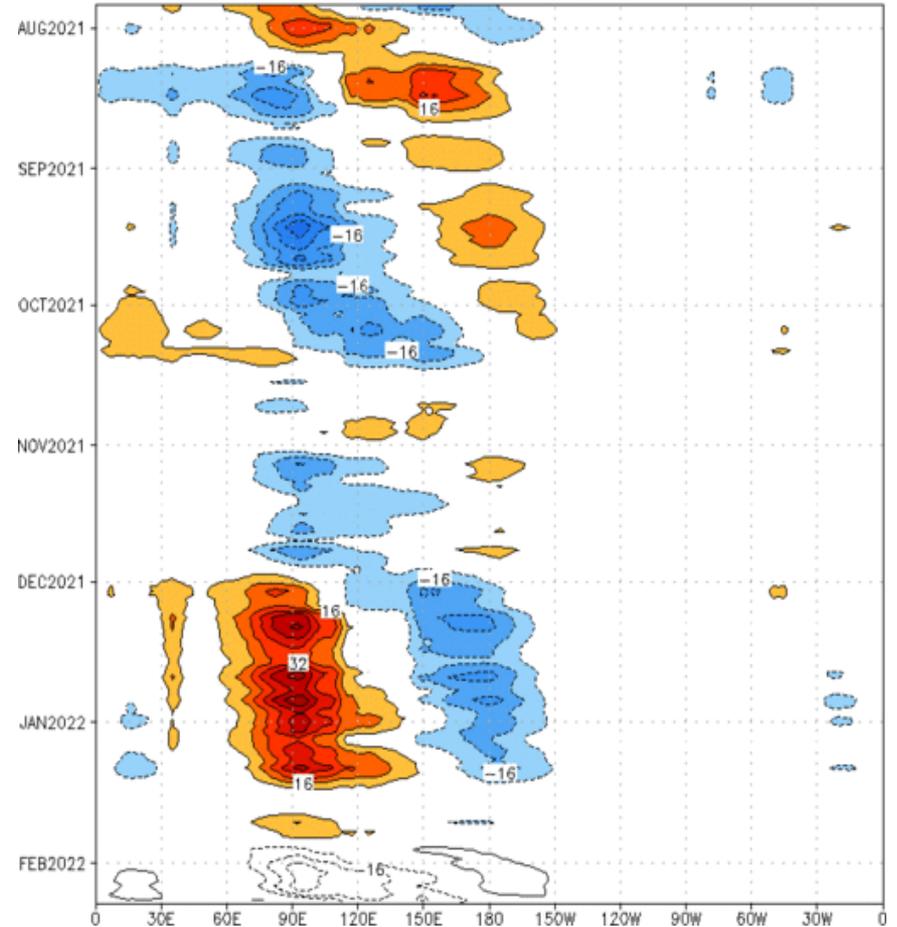
MJO: GEFS Forecast Evolution

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: 05 Jun 2022
OLR



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

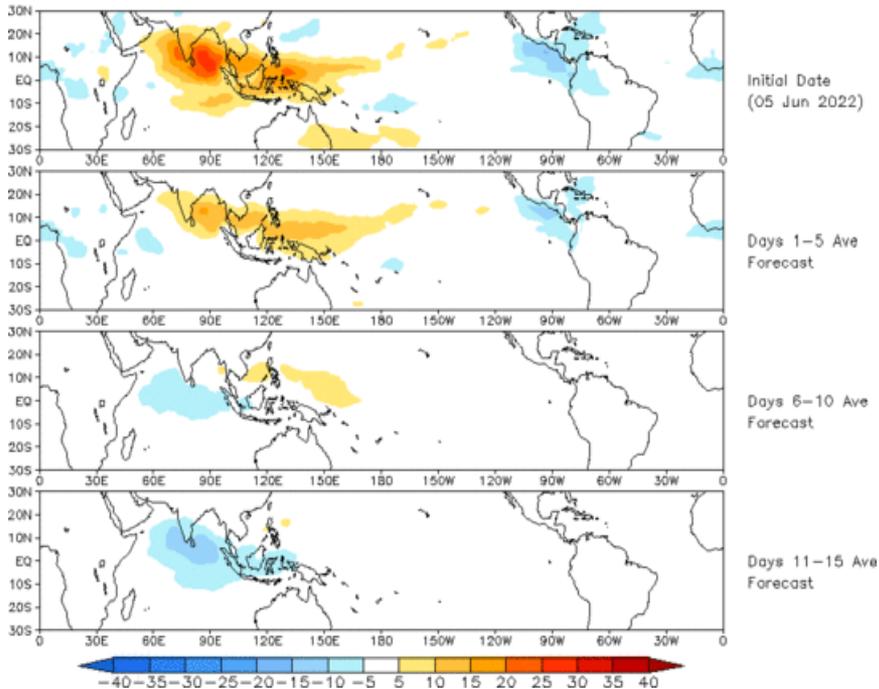


- The GEFS RMM-based OLR field depicts positive OLR anomalies (suppressed convection) across the Indian Ocean and Western Pacific and negative OLR anomalies (enhanced convection) across Central America and the Caribbean.
- These signals diminish in magnitude by week-2.

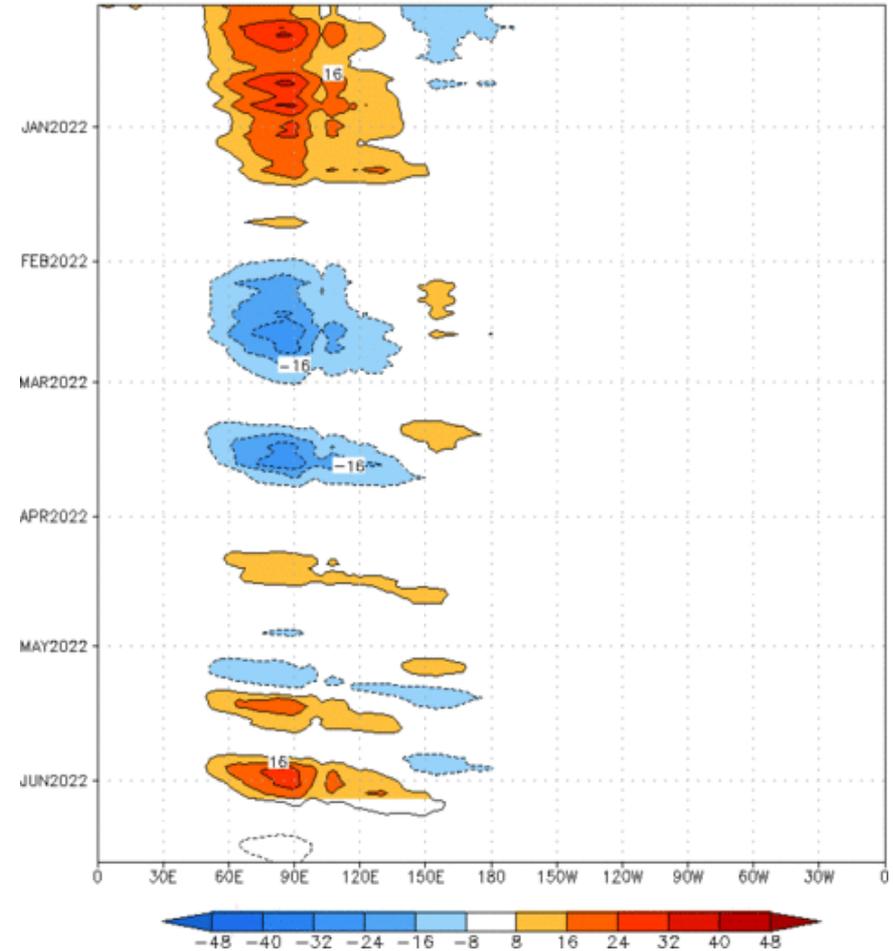
MJO: Constructed Analog Forecast Evolution

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 (05 Jun 2022)



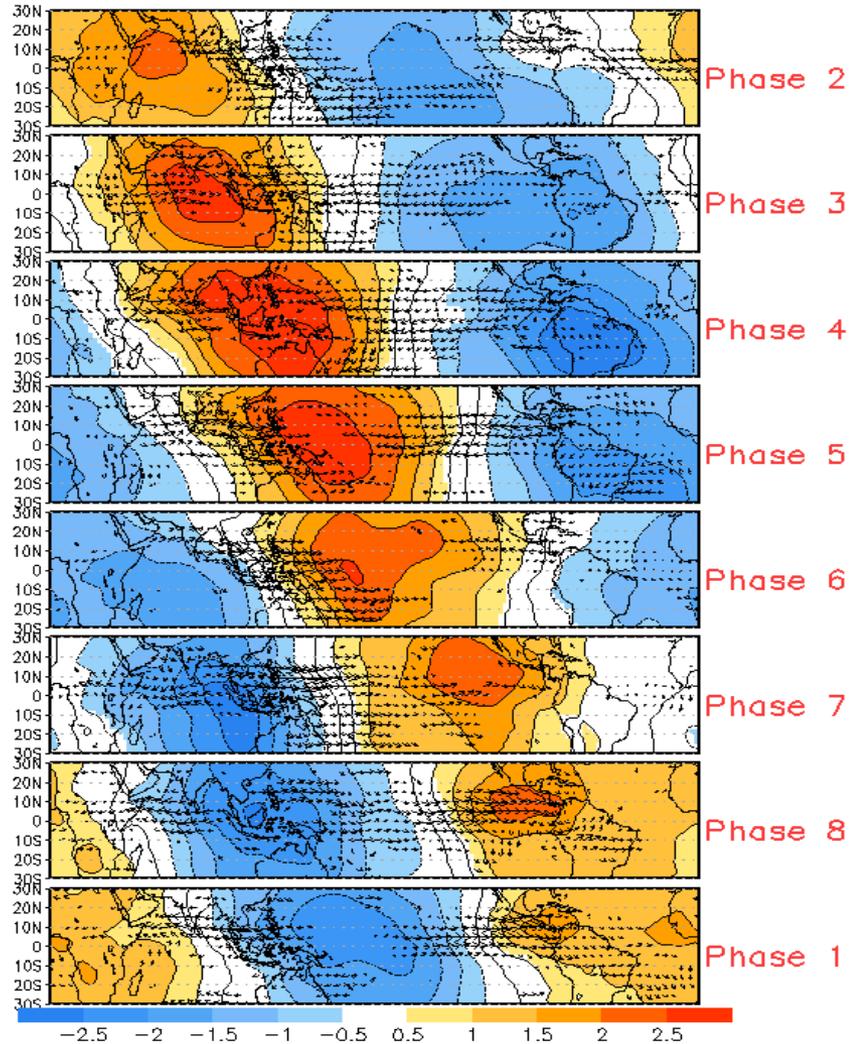
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:04-Dec-2021 to 05-Jun-2022
The unfilled contours are CA forecast reconstructed anomaly for 15 days



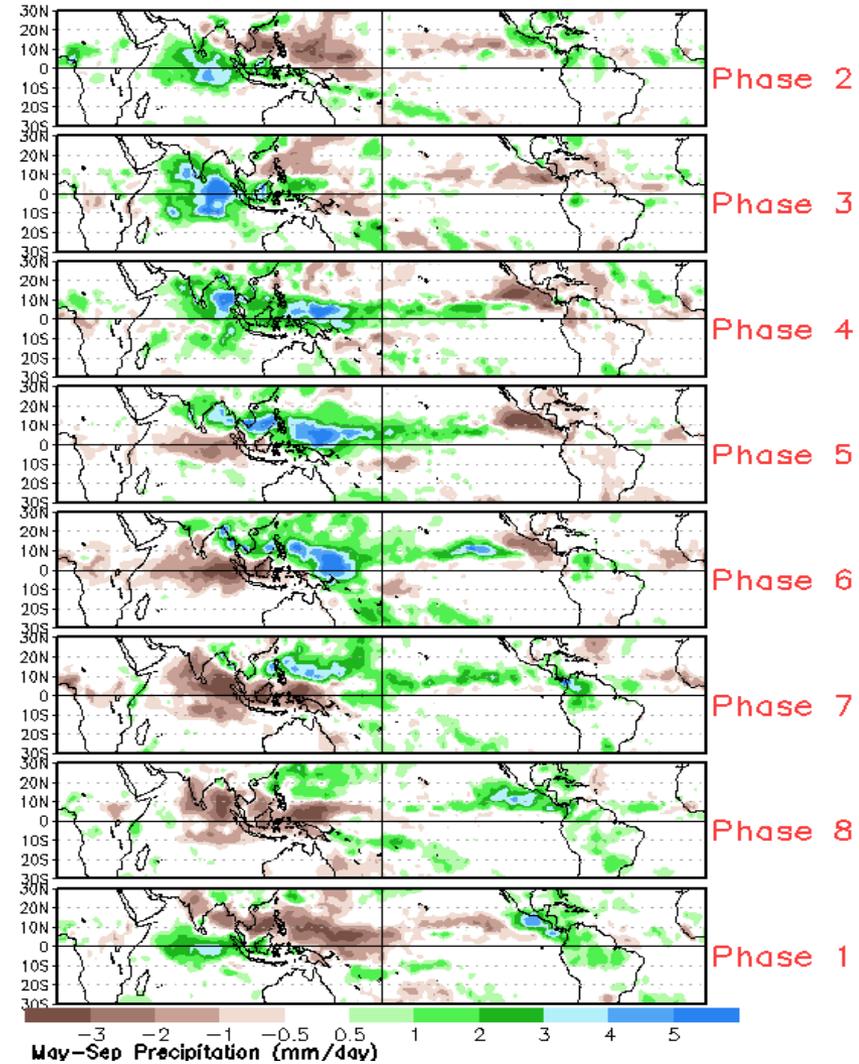
- The constructed analog forecast of RMM-based OLR anomalies is similar to the GEFS forecast during week-1, but indicates a switch to negative OLR anomalies (enhanced convection) over the Indian Ocean during week-2.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



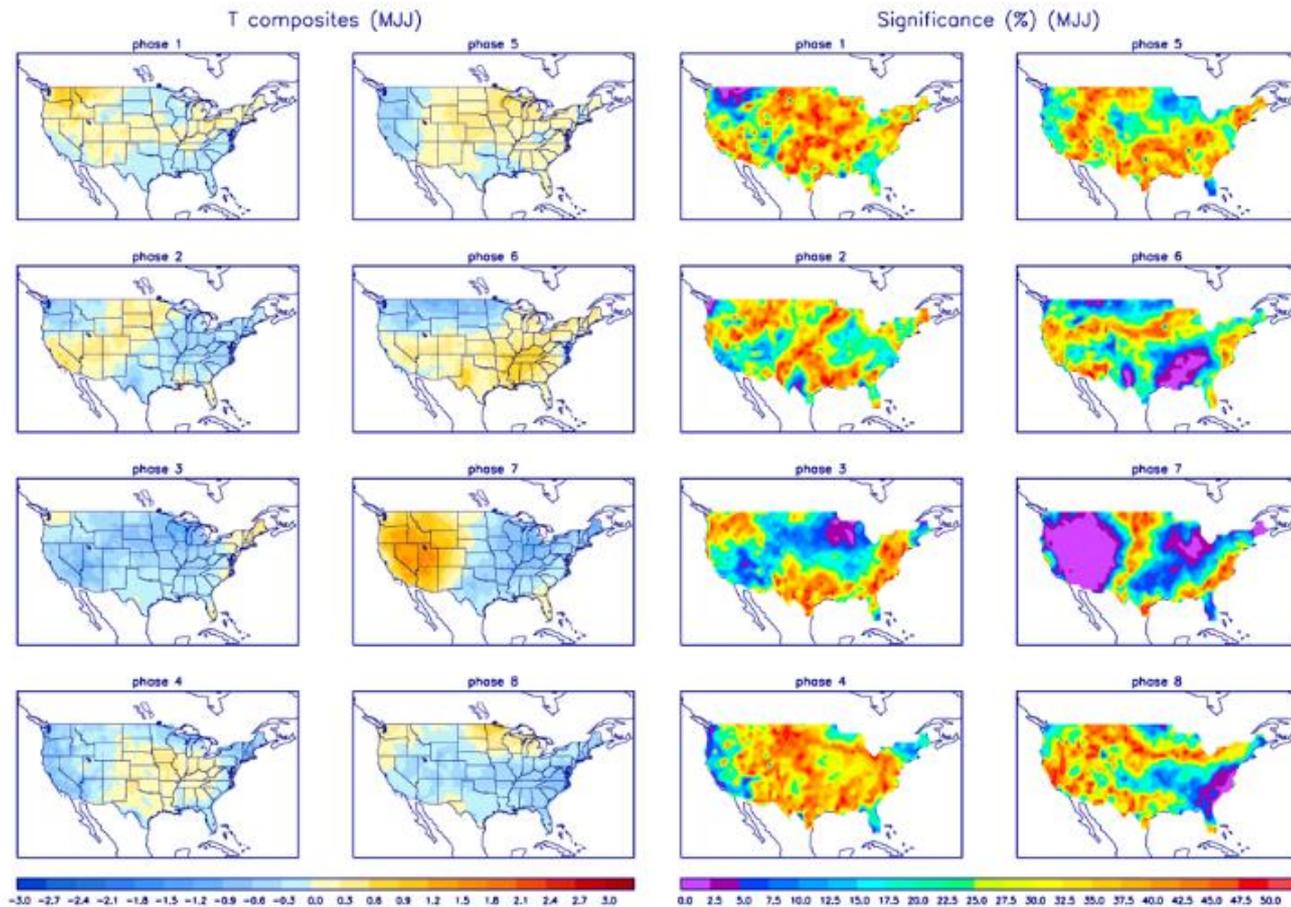
Precipitation Anomalies



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.

