

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



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
21 June 2021

Overview

- A pair of atmospheric Kelvin waves are presently observed roughly 180 degrees out of phase with each other across the global tropics, with little evidence for an active MJO. The RMM index is transitioning between emphasizing these two features, and appears to be having difficulty with isolating the large-scale character of the tropics.
- Model forecasts of the RMM index tend to emphasize a growing intraseasonal signal over the Indian Ocean during the next two weeks, but are highly diverse in terms of the associated modes of variability (e.g. Rossby wave contributions) or how the background state will influence the intraseasonal envelope (i.e. strength of anomalous easterlies over the Indian Ocean and how much control this will have over the phase speed of intraseasonal variability).
- Little to no influence from the tropics is anticipated on the extratropics over the next two weeks. Periodic increases in tropical cyclone formation are possible across the Pacific the next two weeks as the Kelvin waves generate cyclical favorable and unfavorable environments while propagating eastward.

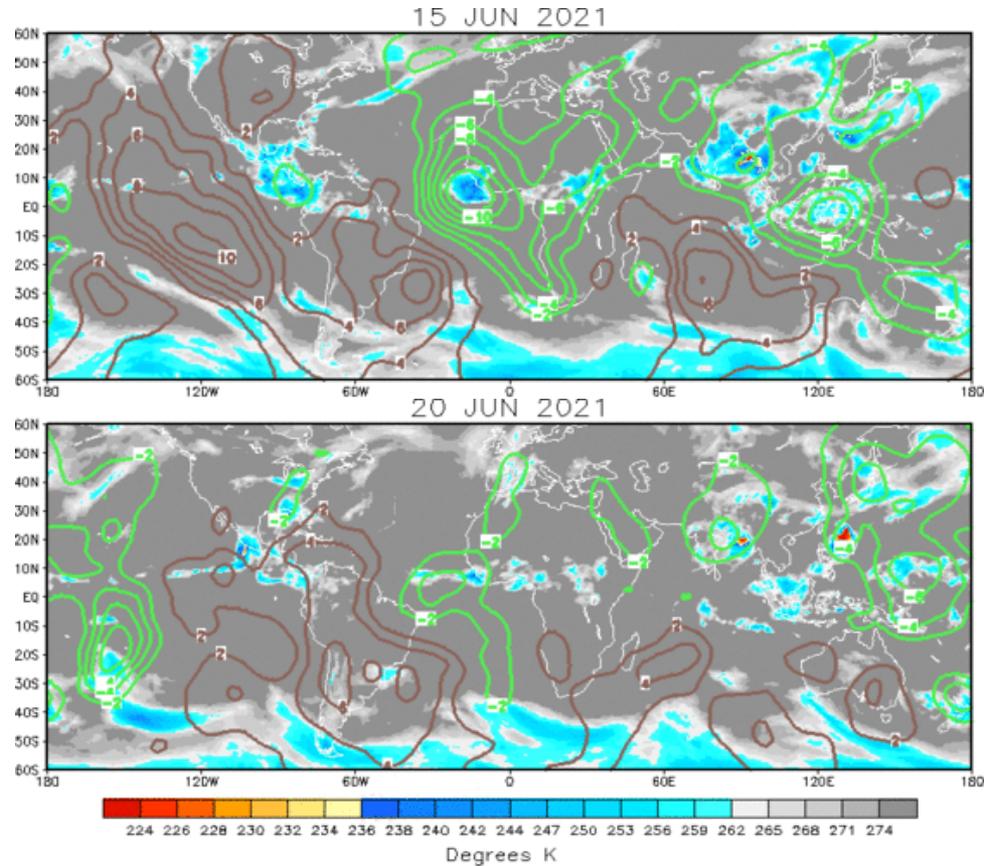
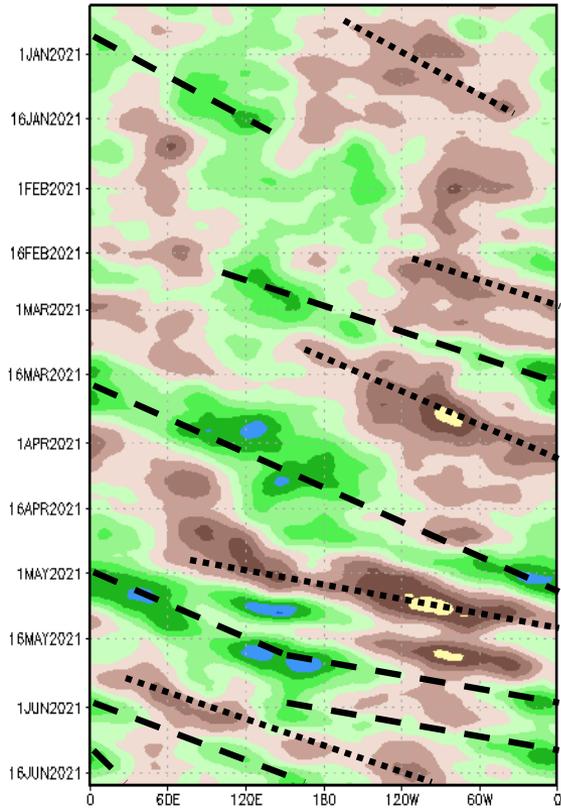
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at: <http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

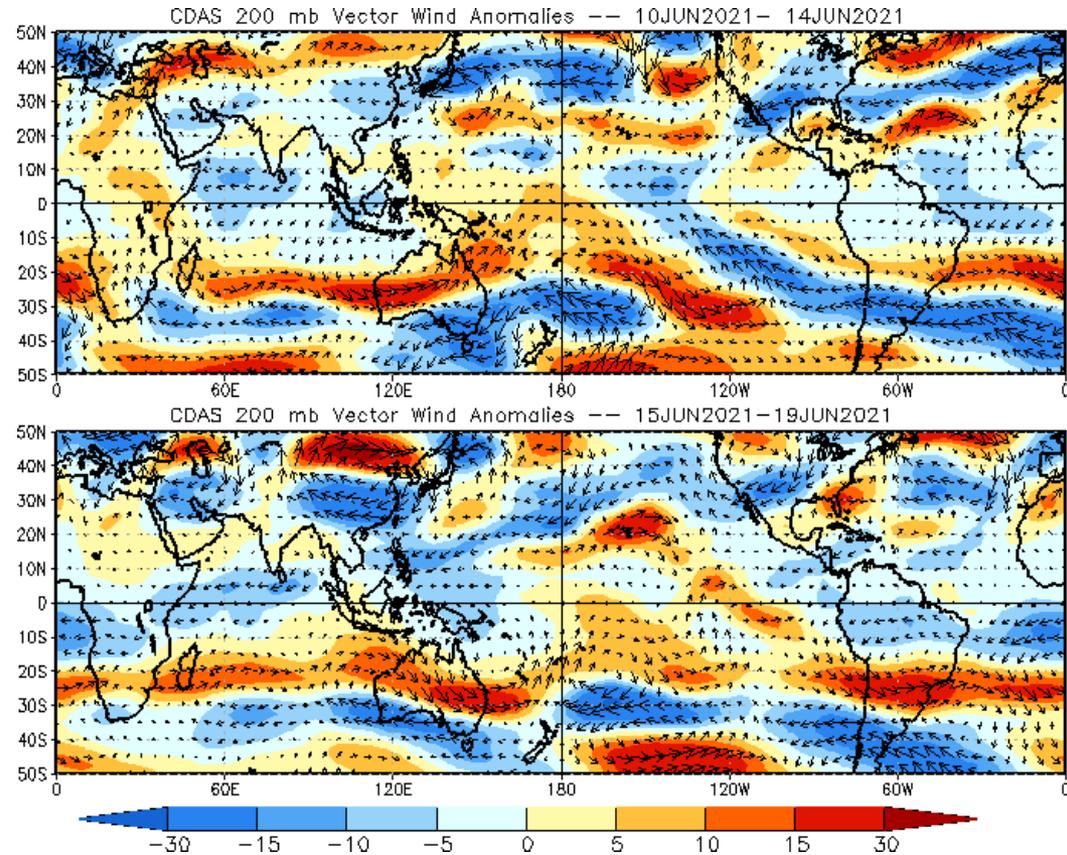
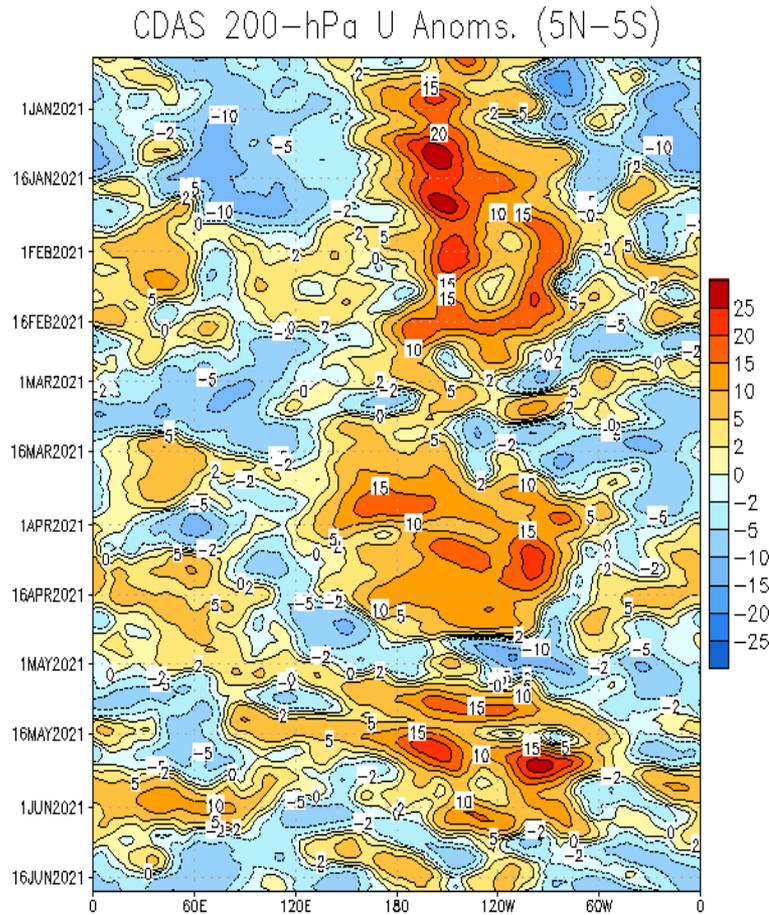
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- A pair of atmospheric Kelvin waves have been present since early June, displaced from one another by nearly 180 degrees.
- There are signs that both of these Kelvin waves remain present, with the latest circulation anomalies increasingly incoherent given the two features being relatively out of phase with one another.

200-hPa Wind Anomalies

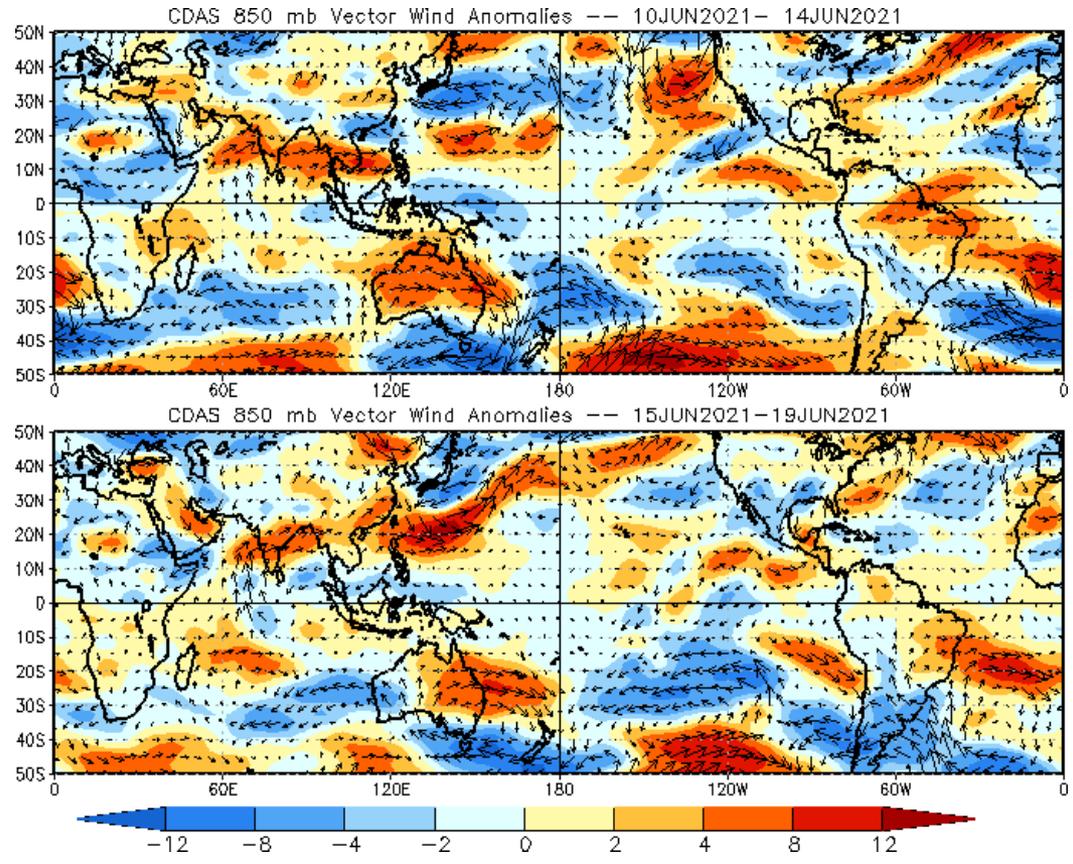
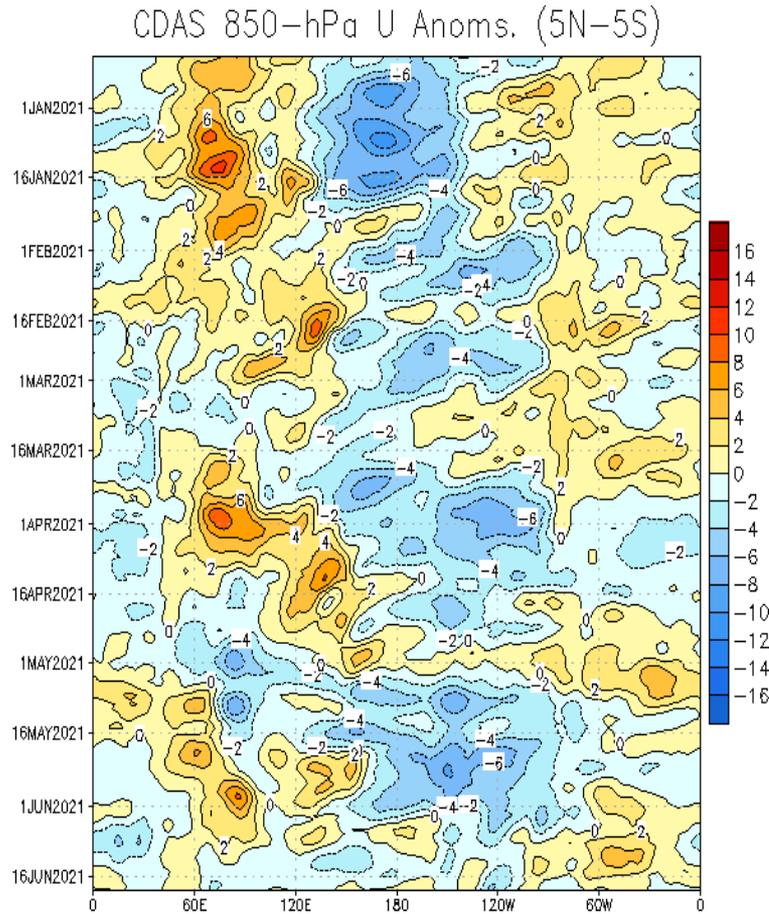
Shading denotes the zonal wind anomaly. **Blue shades: Anomalous easterlies.** **Red shades: Anomalous westerlies.**



- Anomalous westerlies shifted eastward across the equatorial Pacific during mid-June, and now appear predominantly linked to wavebreaking from the Southern Hemisphere.
- Anomalous ridging between the Caribbean and Africa has weakened over the past 10 days, resulting in a weaker projection along the equator there.

850-hPa Wind Anomalies

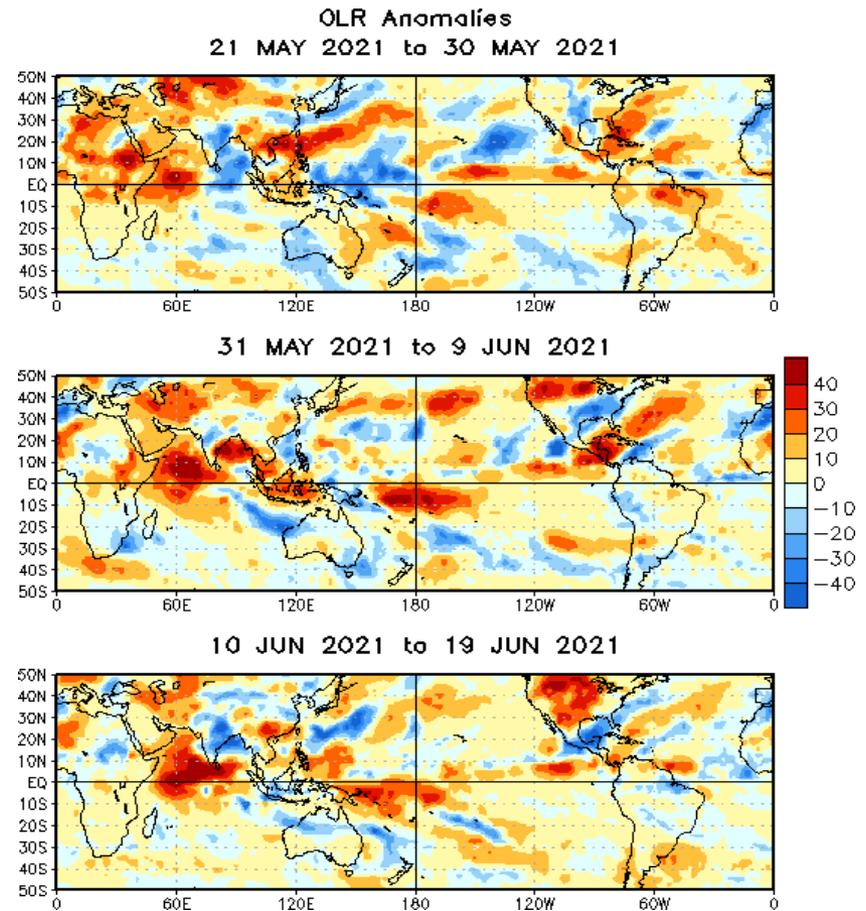
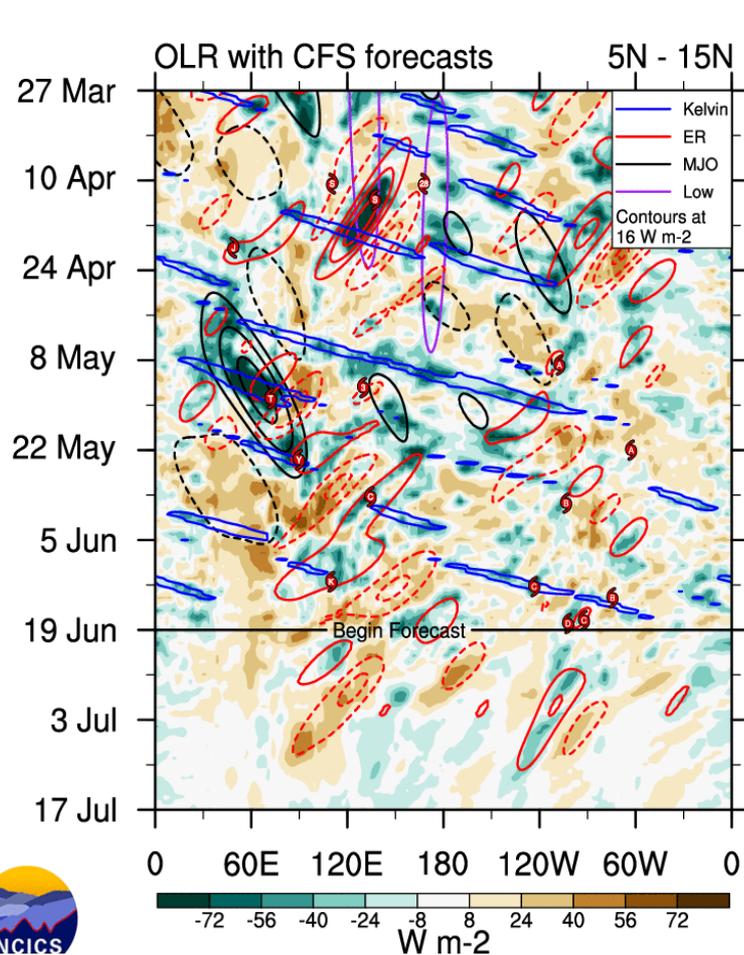
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Flow along the equator has been fairly incoherent over the past week, mostly highlighted by equatorial Rossby wave activity over the Pacific.
- The Meiyu front became increasingly prominent over the past 5 days, and can be tracked back to strong cross-equatorial flow across the western Indian Ocean.

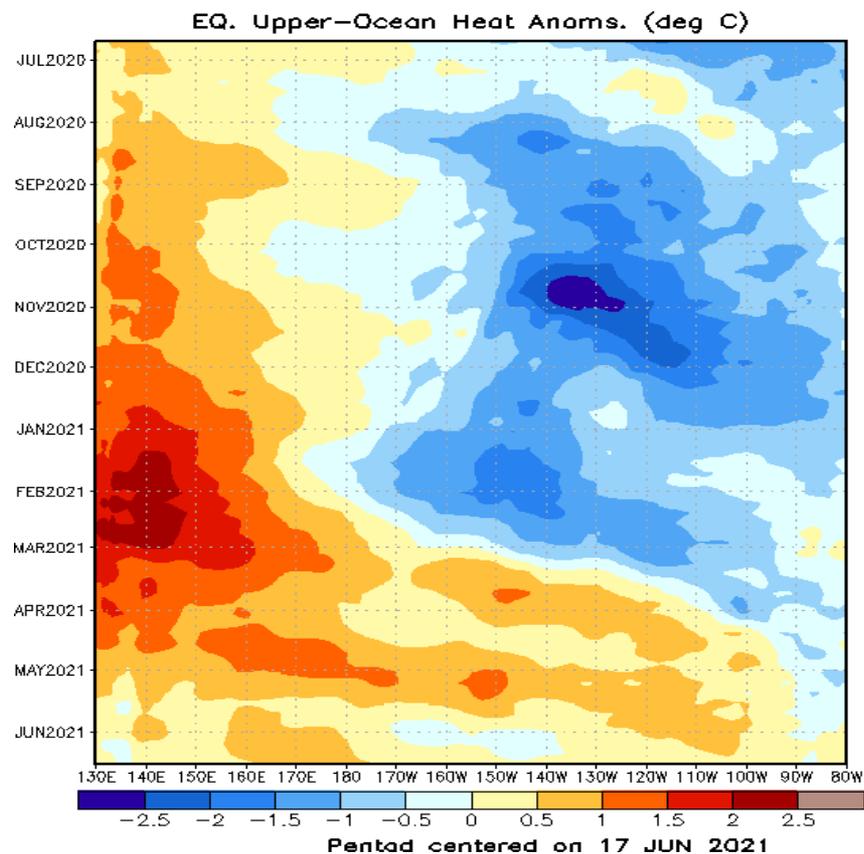
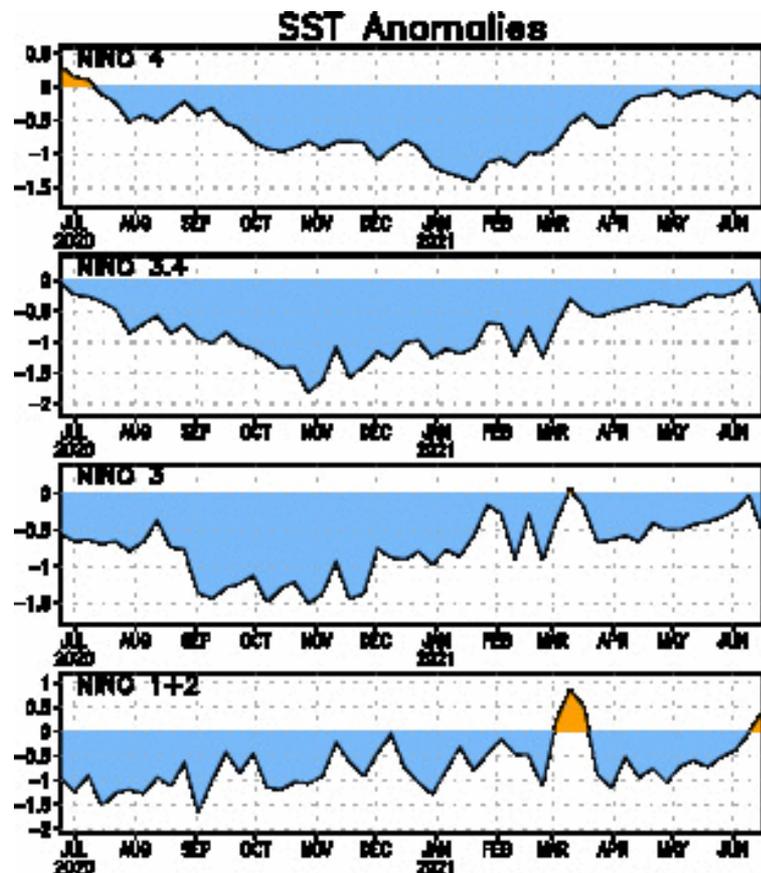
Outgoing Longwave Radiation (OLR) Anomalies

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



- While the objective filtering does not analyze the pair of Kelvin waves, signs of each remain present despite interruptions by westward-moving convective features.
- Convection has been persistently suppressed east of New Guinea since late May.
- Anomalous dryness has persisted across much of the northern Indian Ocean since late May.

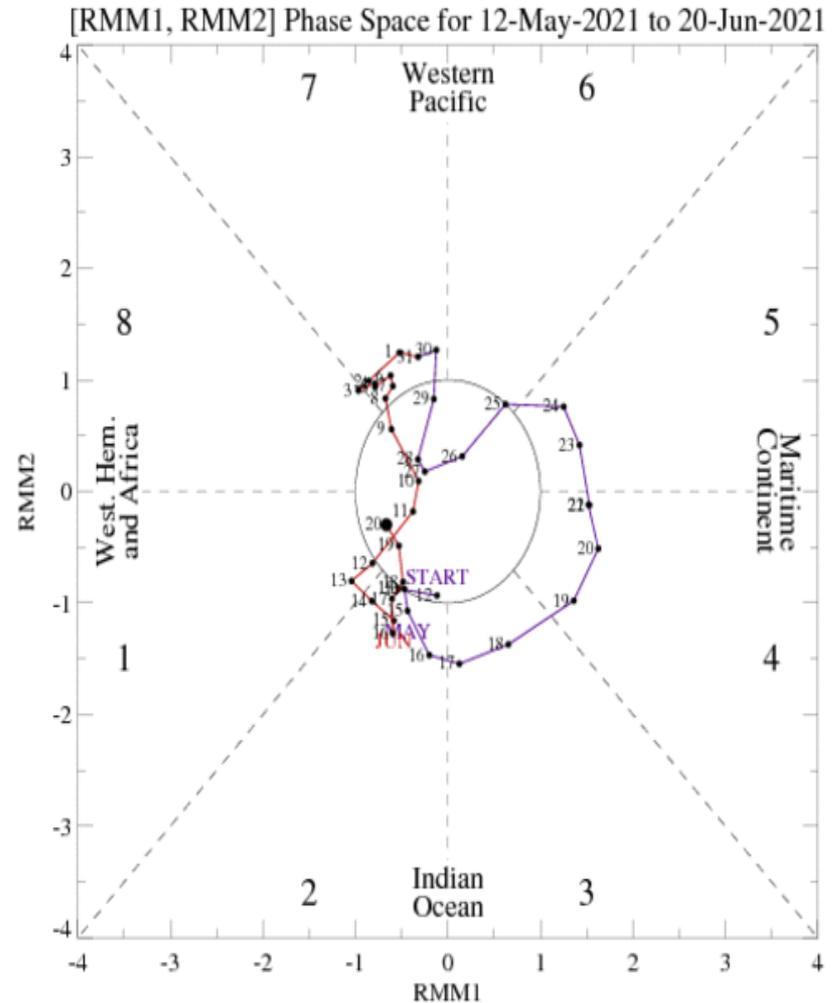
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Upper-ocean heat content is above-normal along the equator as a result of three downwelling oceanic Kelvin waves since March. The latest downwelling feature is currently near the Date Line.
- Niño indices continue to remain below-normal with the exception of Niño 1+2, although the vertically-integrated heat content near the surface suggests any cold water volume is extremely shallow.

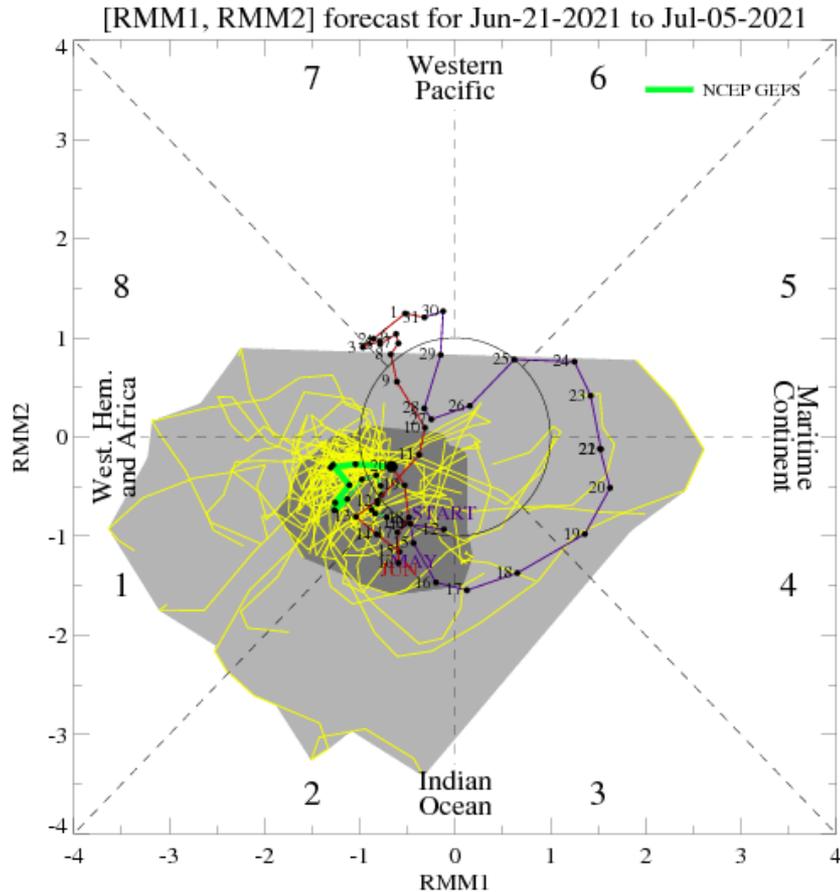
MJO Index: Recent Evolution

- The RMM index retreated inside the unit circle over the course of the past week, following some time in Phases 1 and 2.
- This transition appears to be due to the RMM index having trouble maintaining focus on a single mode of eastward-propagating tropical variability with the pair of Kelvin waves splitting the signal. The recent westward retreat is actually a shift from emphasizing one Kelvin wave to focusing on the other.

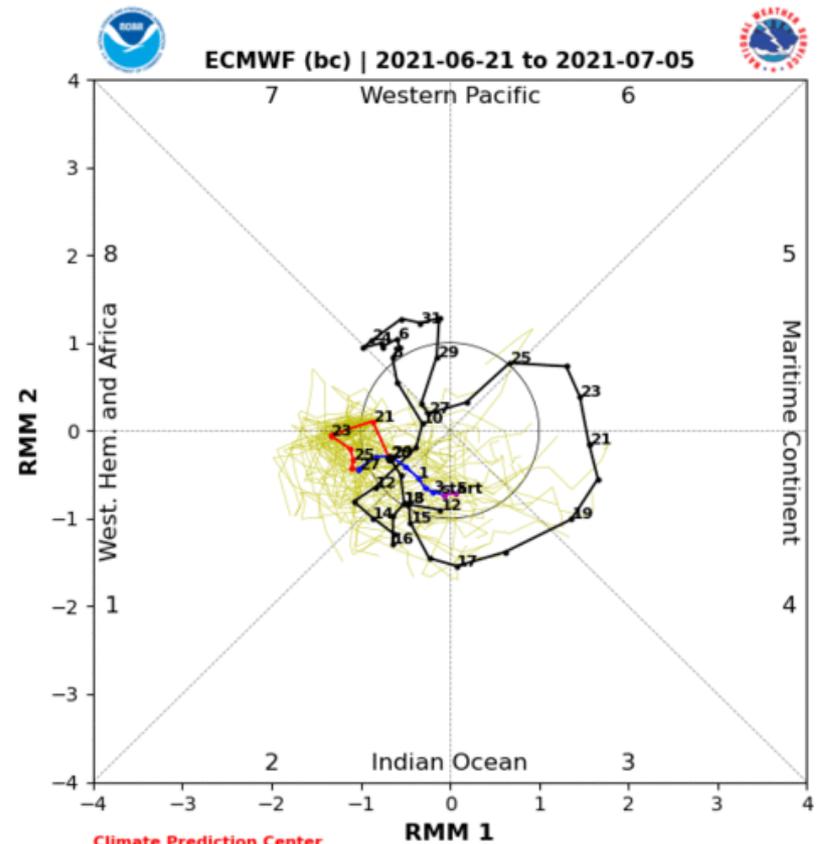


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



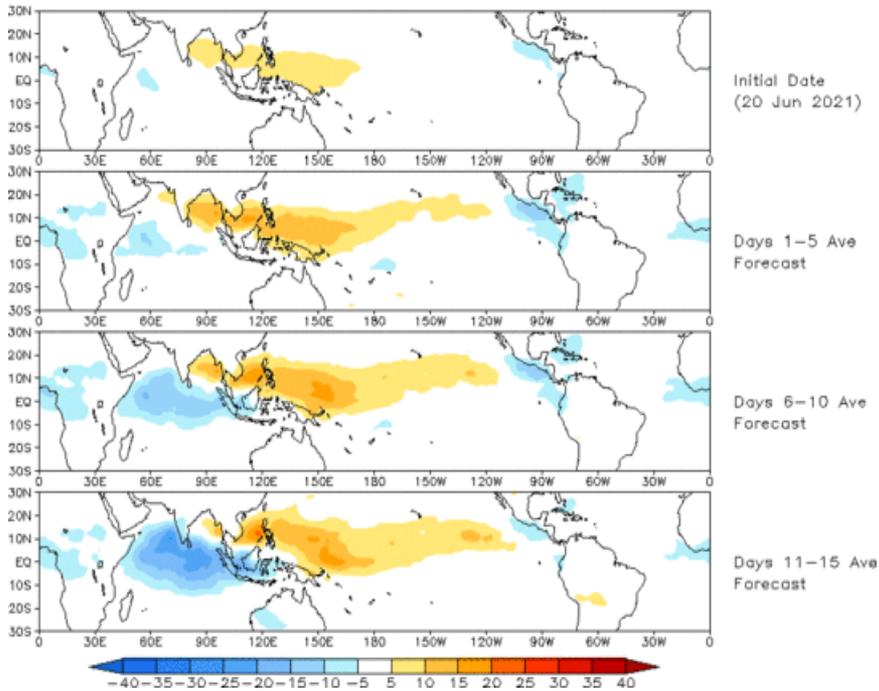
ECMWF Forecast

- Both the GEFS and ECMWF ensemble means show some growth in amplitude and eastward progression over the Western Hemisphere and Indian Ocean the next to weeks.
- The GEFS is highly diverse, with a wide range of forecasts in RMM1 space although these are generally negative in RMM2. The ECMWF clusters closely together around its ensemble mean, with most differences associated with phase speed variation for faster solutions or slower ones that are likely tied to the magnitude of the background upper-level winds over the Indian Ocean (currently anomalous easterlies).

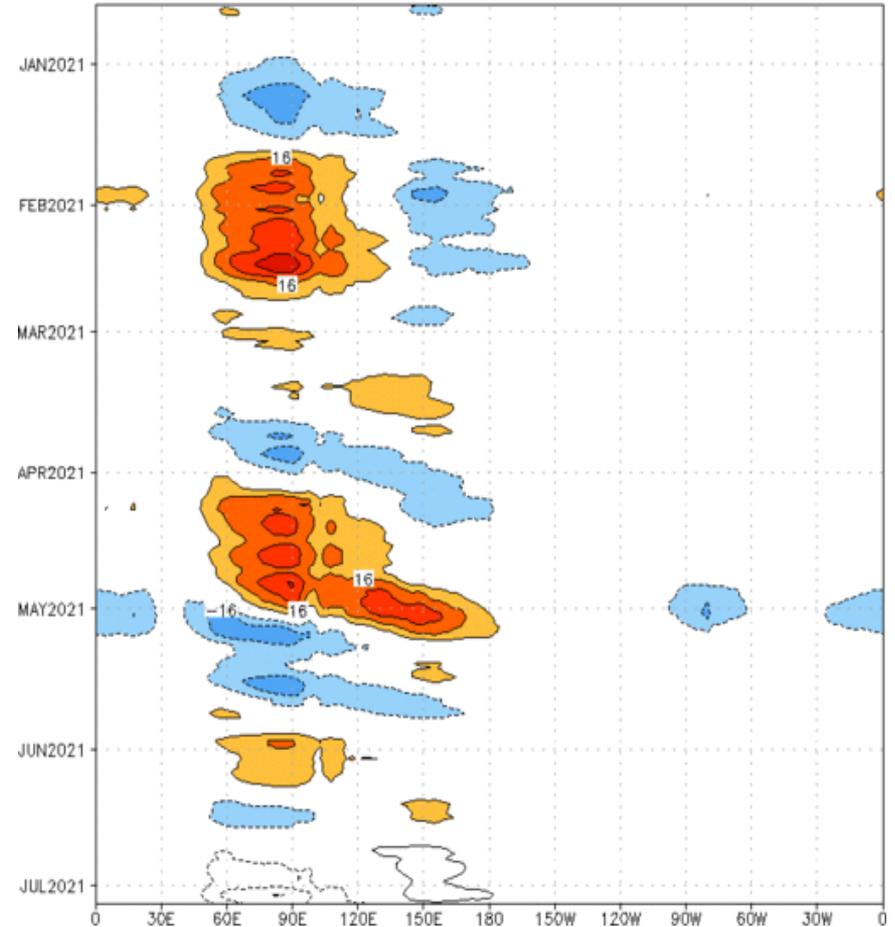
MJO: GEFS Forecast Evolution

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: 20 Jun 2021
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}S, 7.5^{\circ}N$] (cont: $4Wm^{-2}$) Period: 19-Dec-2020 to 20-Jun-2021
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

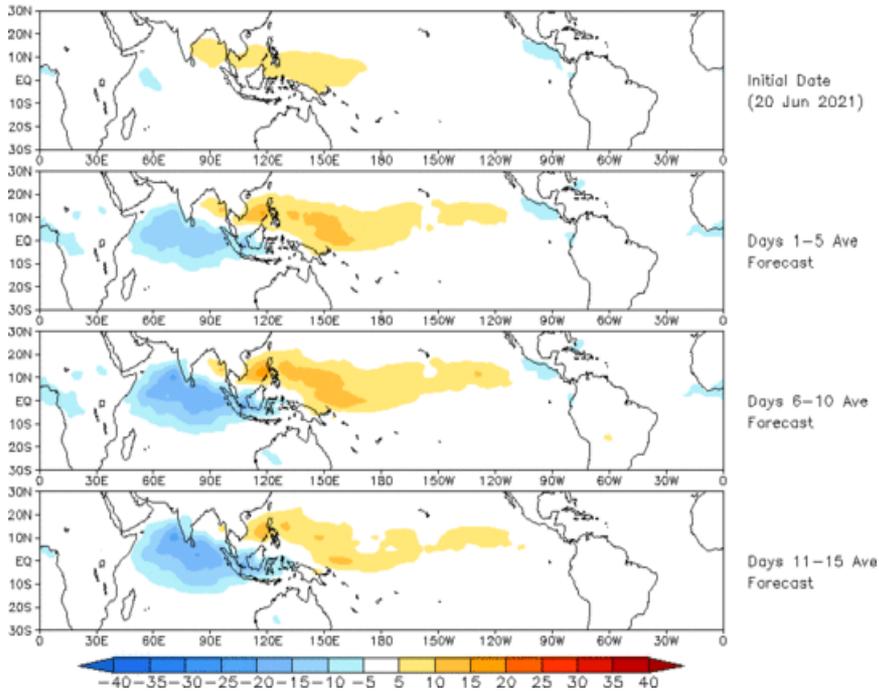


- The GEFS RMM-based OLR anomaly forecast shows a relatively stationary pattern with some growth of anomalous convection over the Indian Ocean the next two weeks.

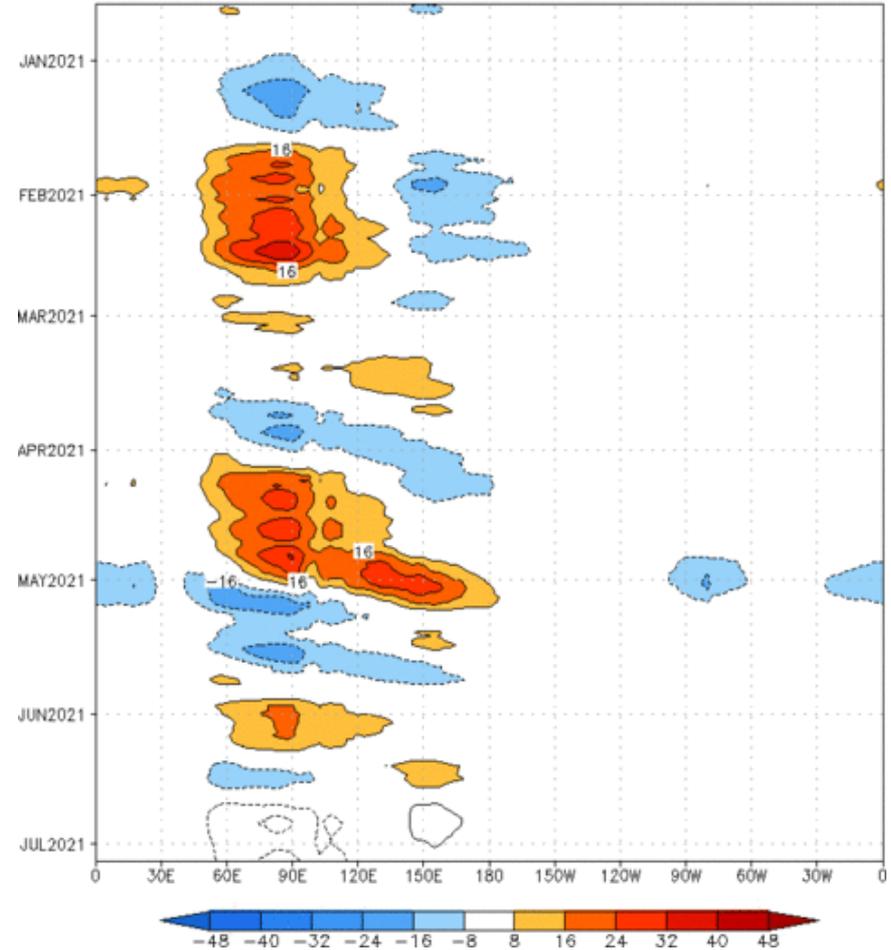
MJO: Constructed Analog Forecast Evolution

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 (20 Jun 2021)



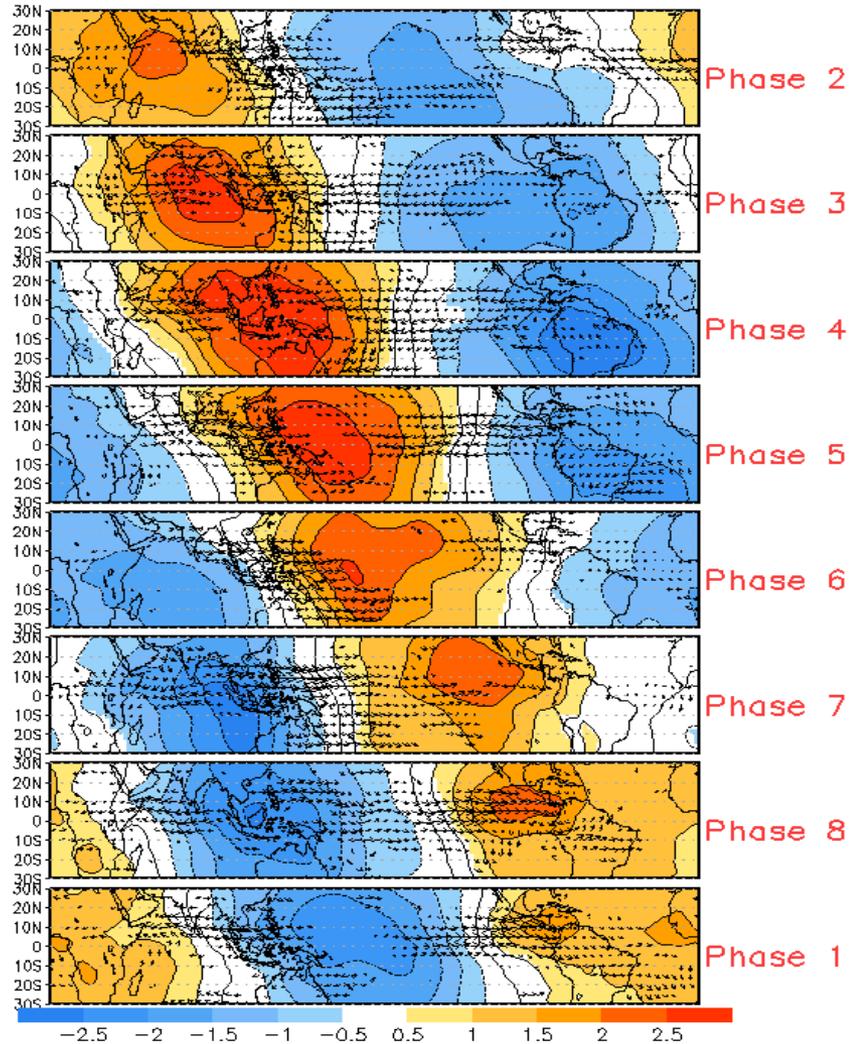
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:19-Dec-2020 to 20-Jun-2021
The unfilled contours are CA forecast reconstructed anomaly for 15 days



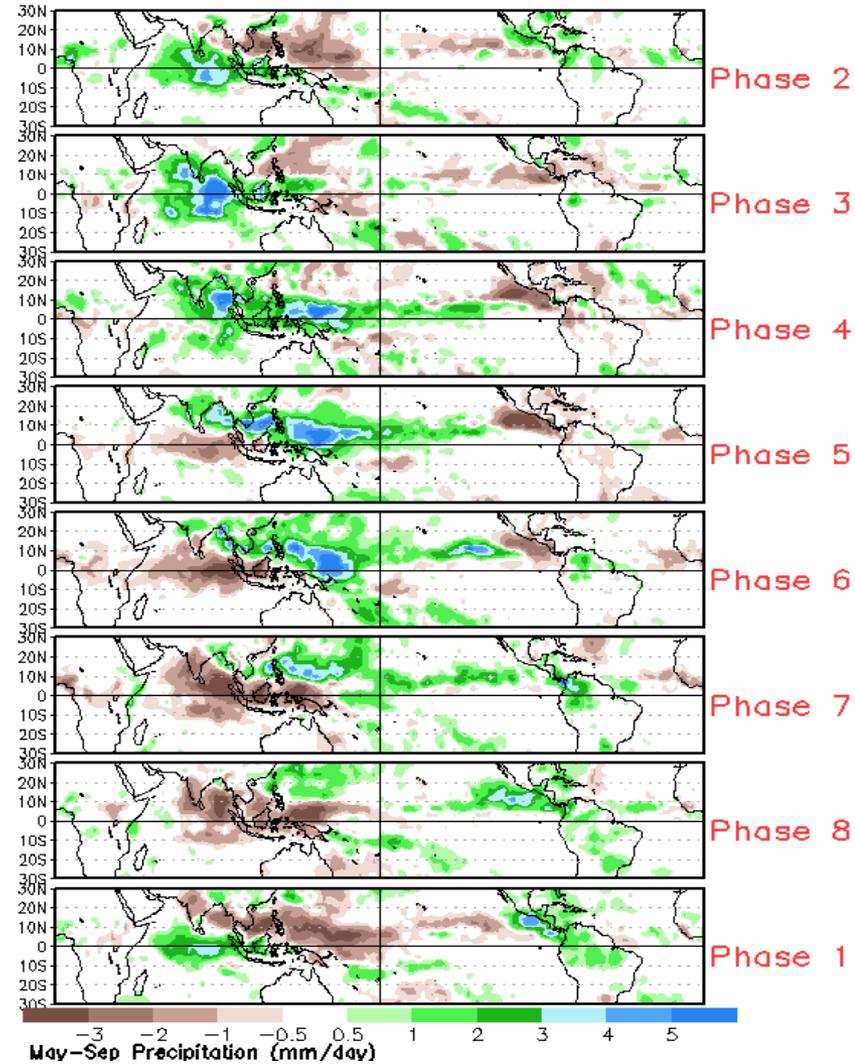
- The constructed analog forecast is similar to that of the GEFS, but exhibits less intensification of the convective anomalies by July.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



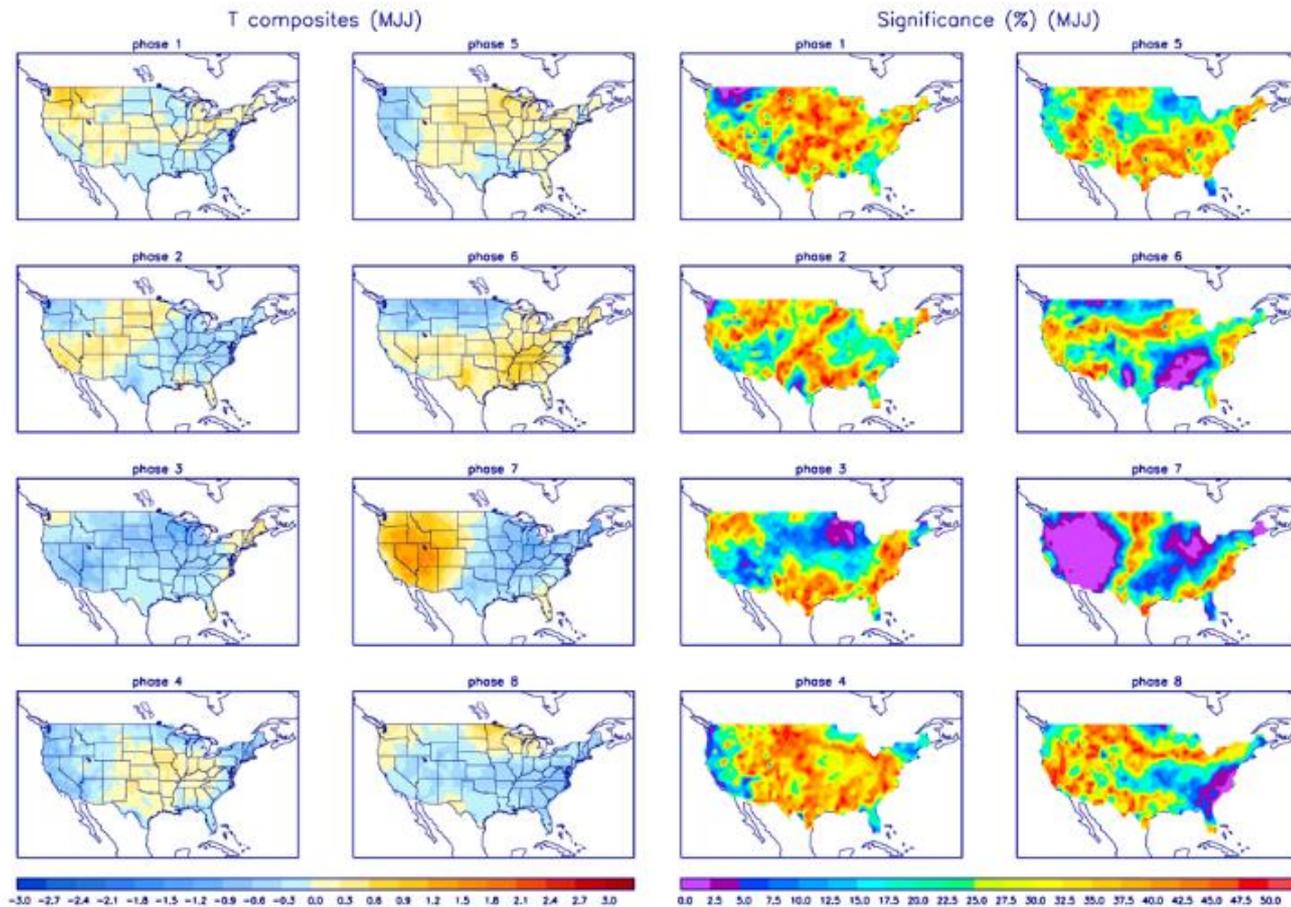
Precipitation Anomalies



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.

