

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



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

Overview

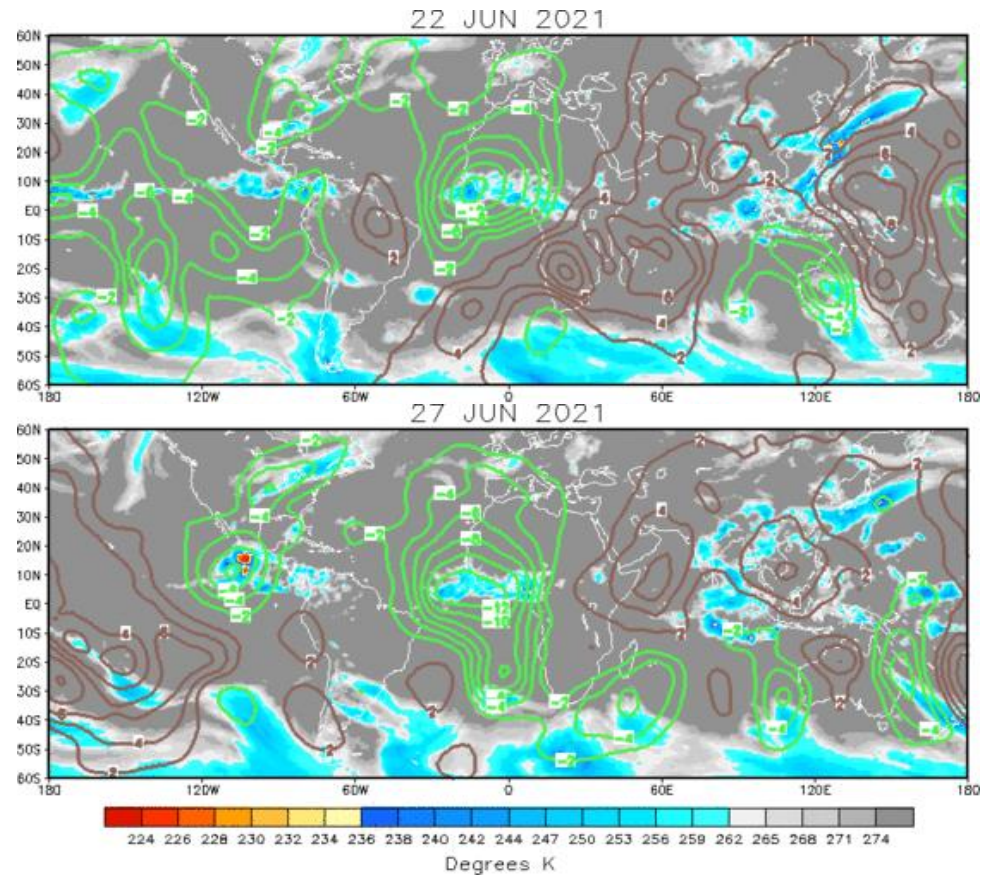
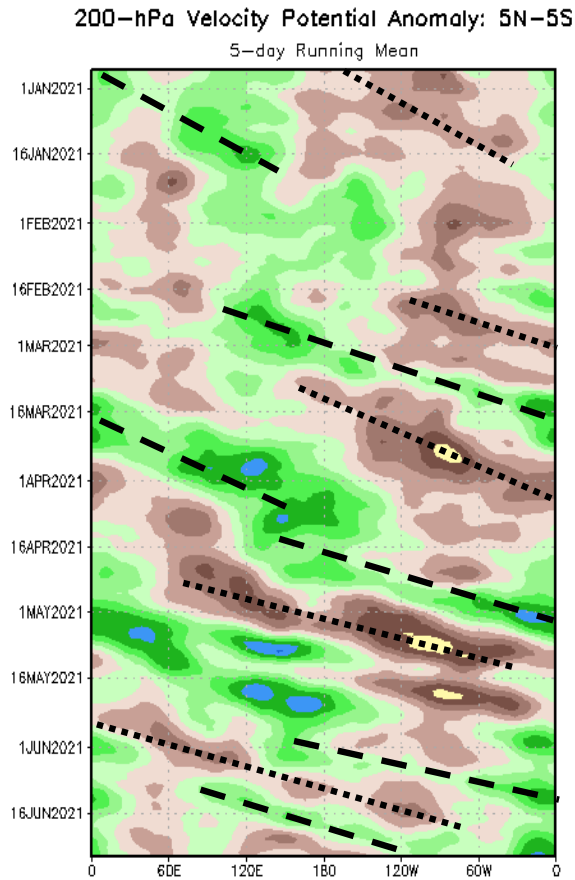
- A pair of atmospheric Kelvin waves are presently observed roughly 180 degrees out of phase with each other across the global tropics. These waves and active monsoon areas are competing with any MJO organization. The RMM index is emphasizing the convection over Africa, likely associated with the West African Monsoon, as the global velocity potential anomalies and wind patterns are not consistent with a robust MJO.
- 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. Many model members have the MJO signal maintaining across the Indian Ocean and moving to the Maritime Continent.
- 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. If the MJO forecasts verify, west Pacific tropical cyclone development could be enhanced though week-2.

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).

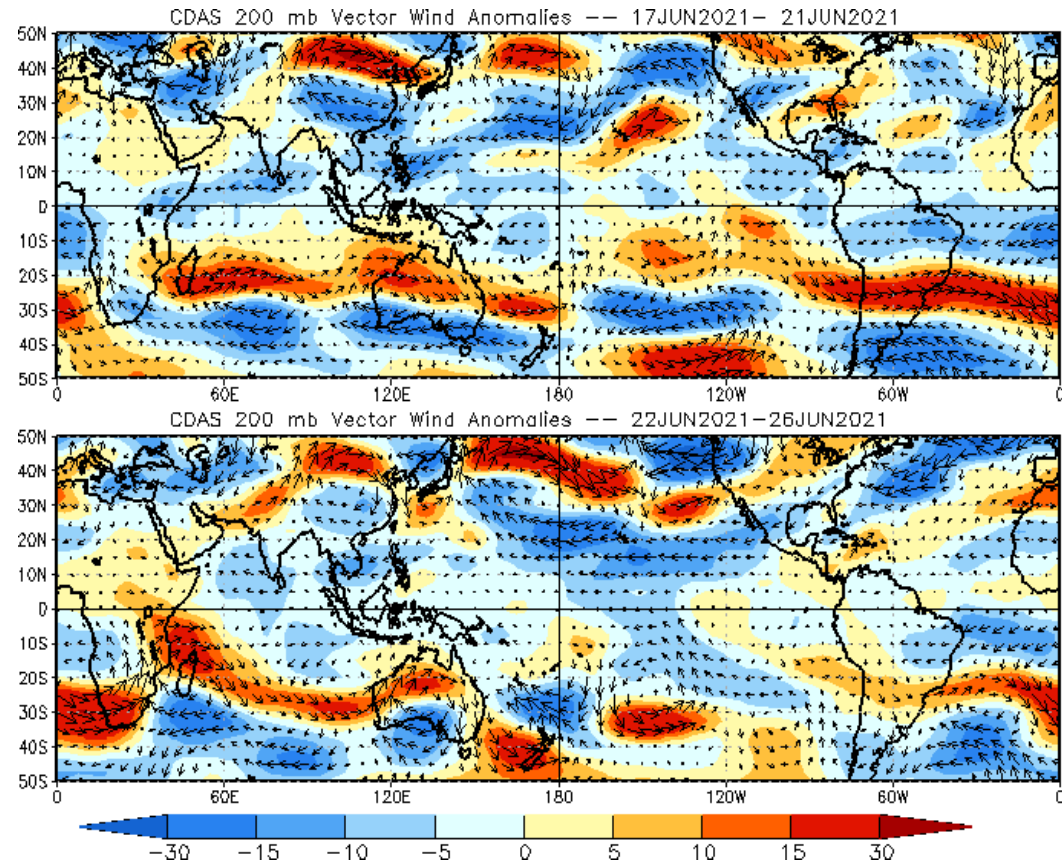
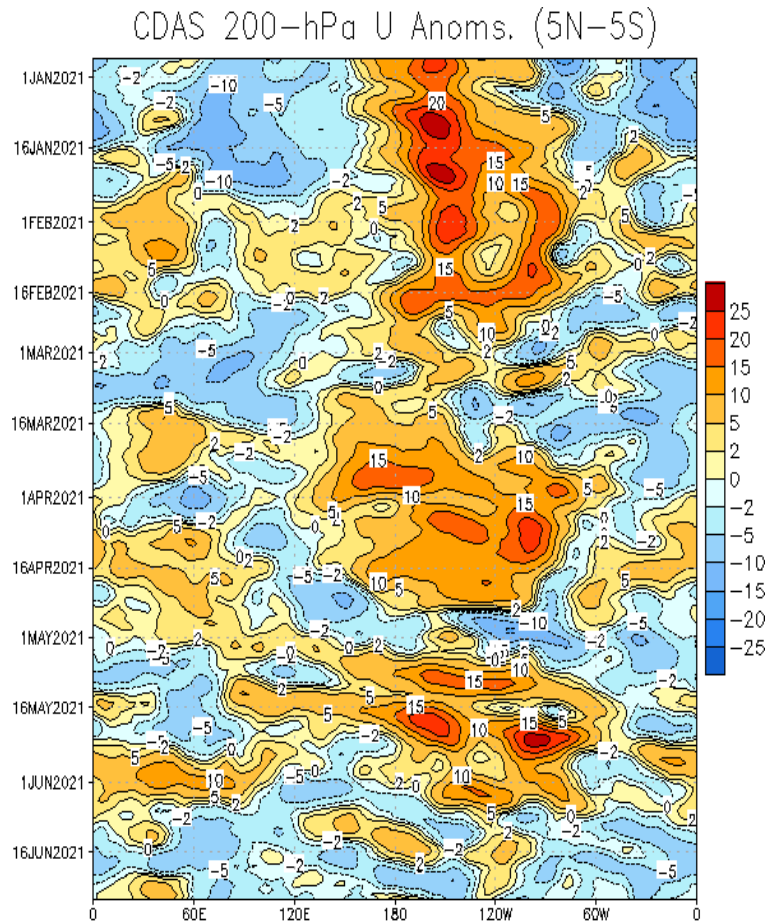
Brown shades: Anomalous convergence (unfavorable for precipitation).



- 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.
- The spatial pattern appears more consistent with localized monsoonal circulations and modes of higher frequency than MJO.

200-hPa Wind Anomalies

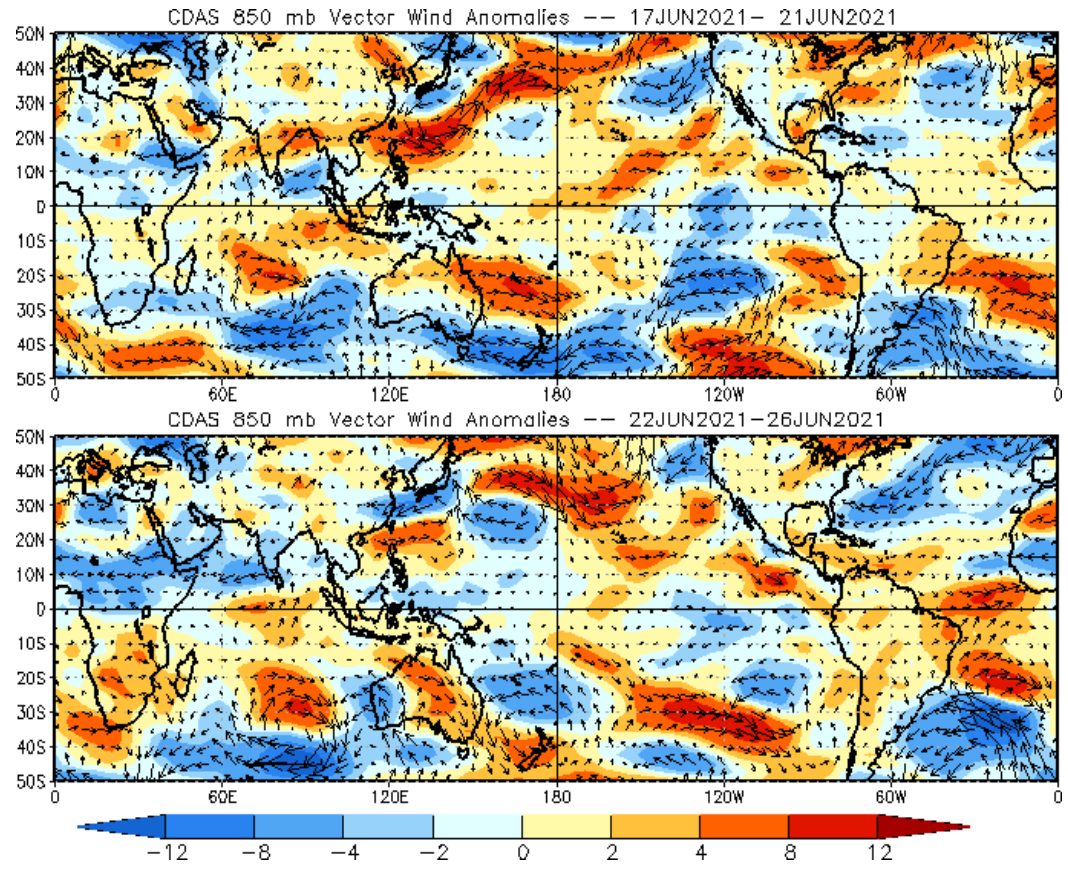
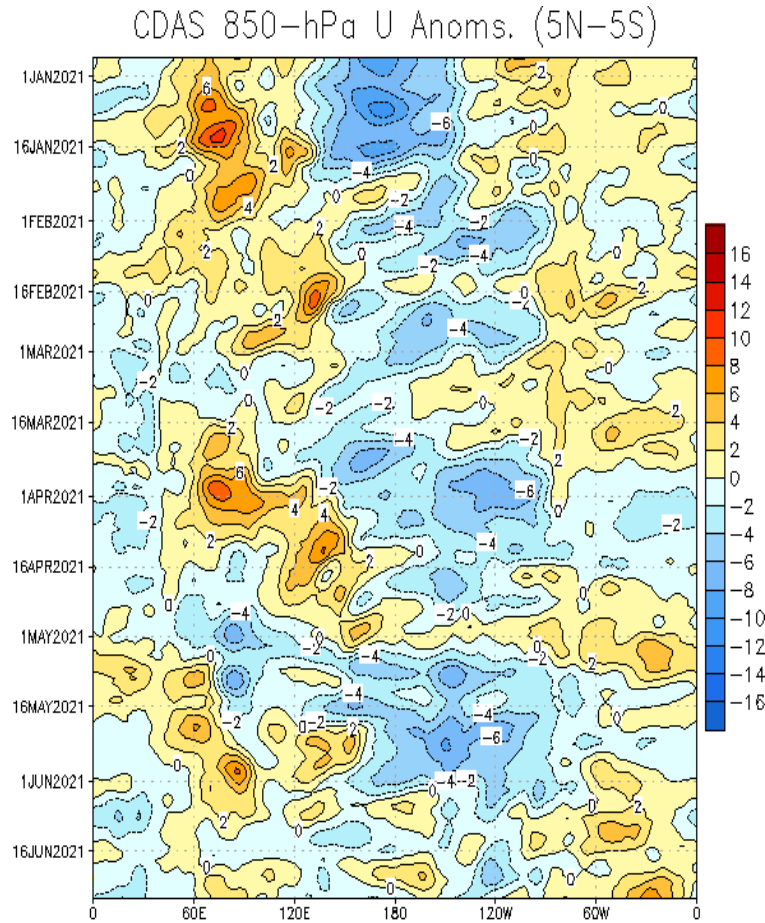
Shading denotes the zonal wind anomaly. **Blue shades: Anomalous easterlies.** **Red shades: Anomalous westerlies.**



- Westerly anomalies increased over the equatorial western Indian Ocean.
- Anomalous easterlies have developed across the central Pacific tied to mid-latitude wave breaking in both hemispheres.
- Some upper-level anomalous troughing extends from the Caribbean to the Northeast as the anomalous ridging has waned.

850-hPa Wind Anomalies

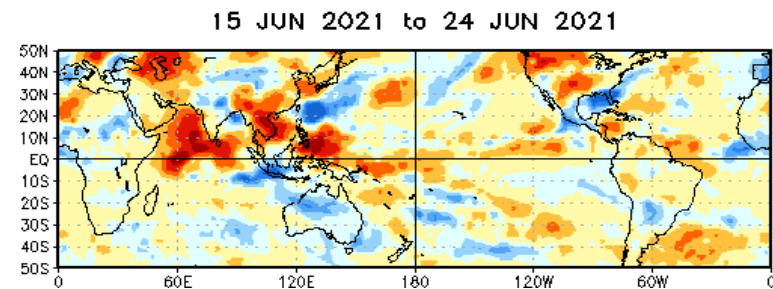
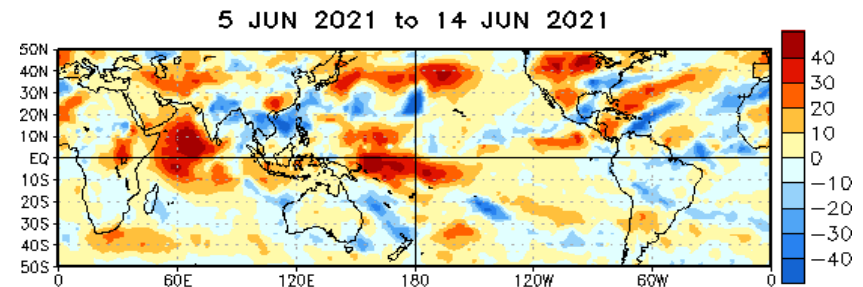
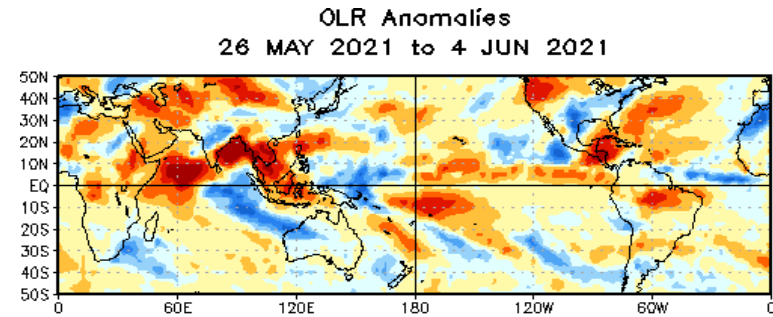
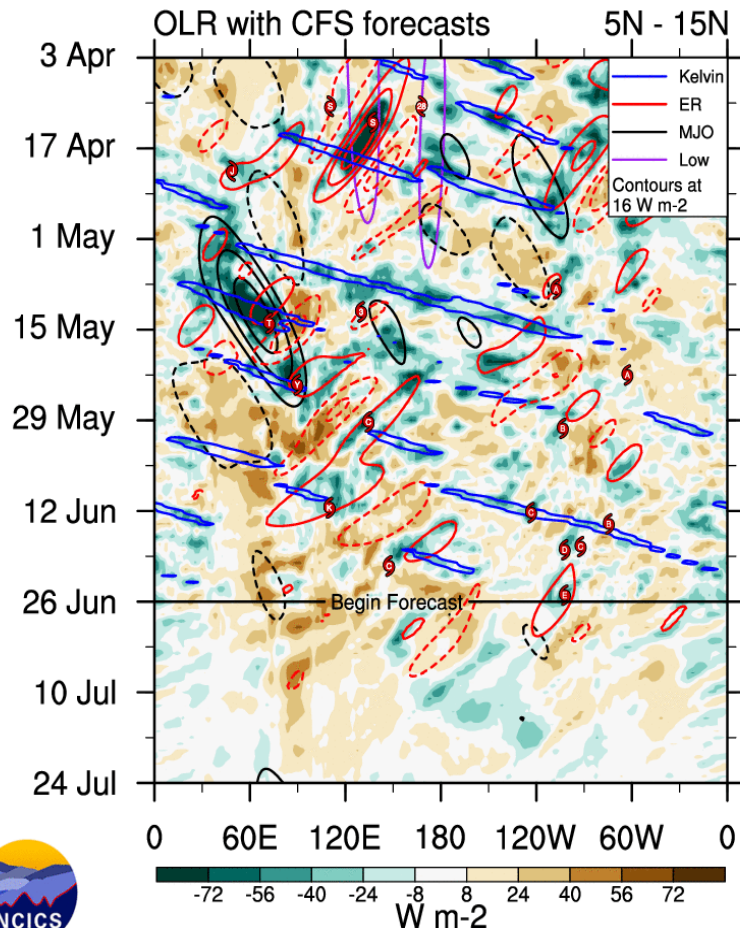
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Flow along the equator has been fairly incoherent over the past week, mostly highlighted by equatorial Rossby wave activity over the Pacific.
- The monsoonal flow over South Asia relaxed somewhat from last week, with a break over Southeast Asia and India.
- Trades over the Caribbean and tropical Atlantic have weakened in the last 5 days.

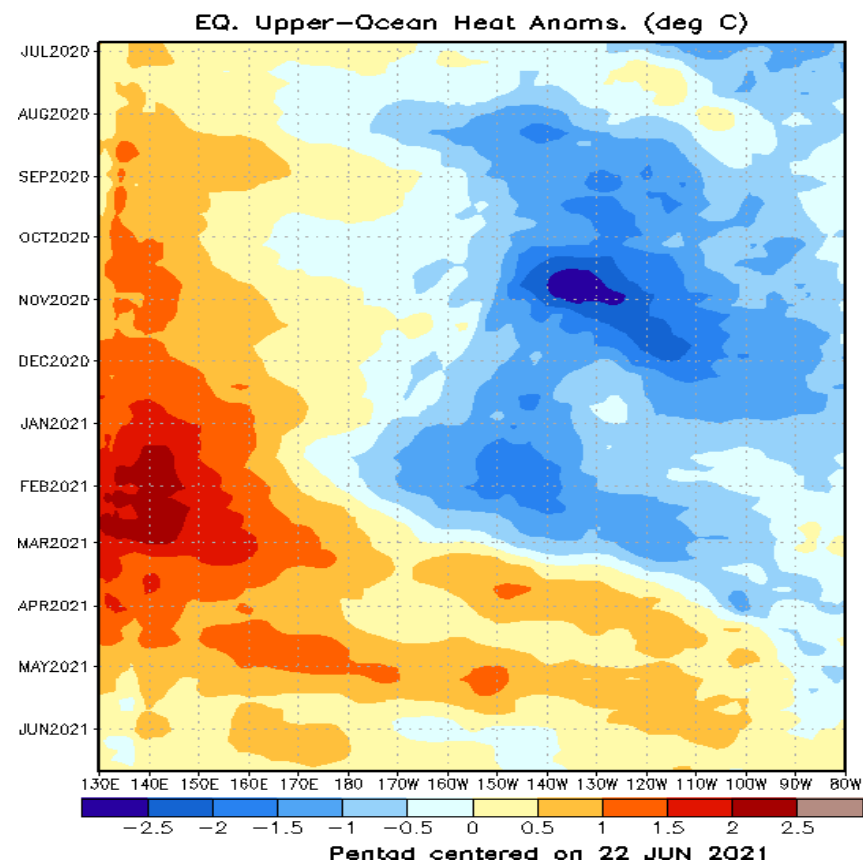
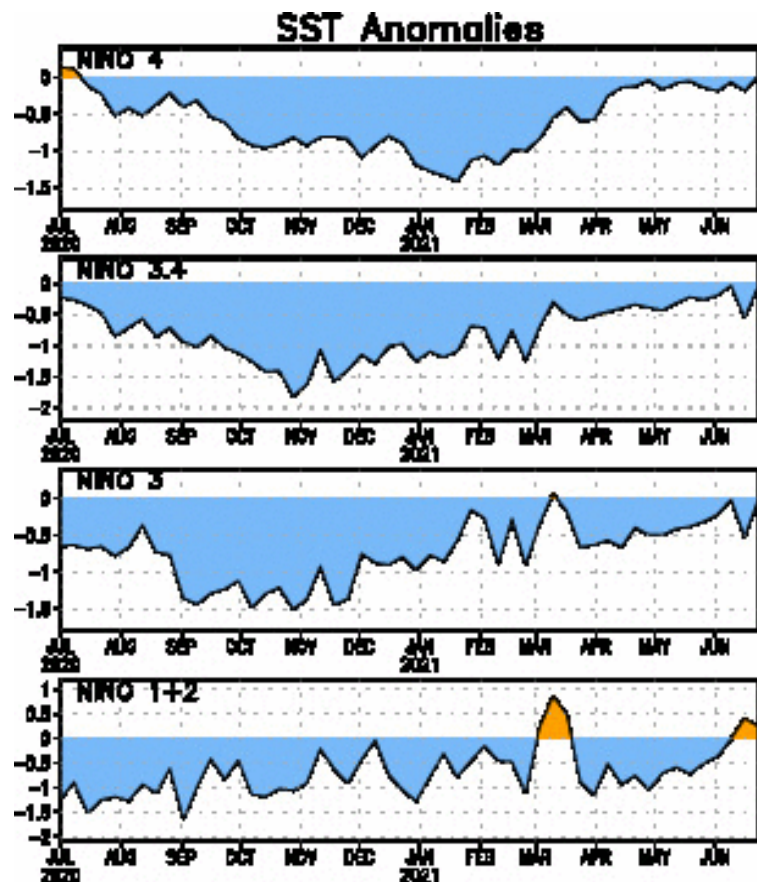
Outgoing Longwave Radiation (OLR) Anomalies

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 suppressed east of New Guinea and over of the much of Northern Indian Ocean since early June.
- Suppressed convection built in across Southeast Asia, indicating a potential monsoon break.

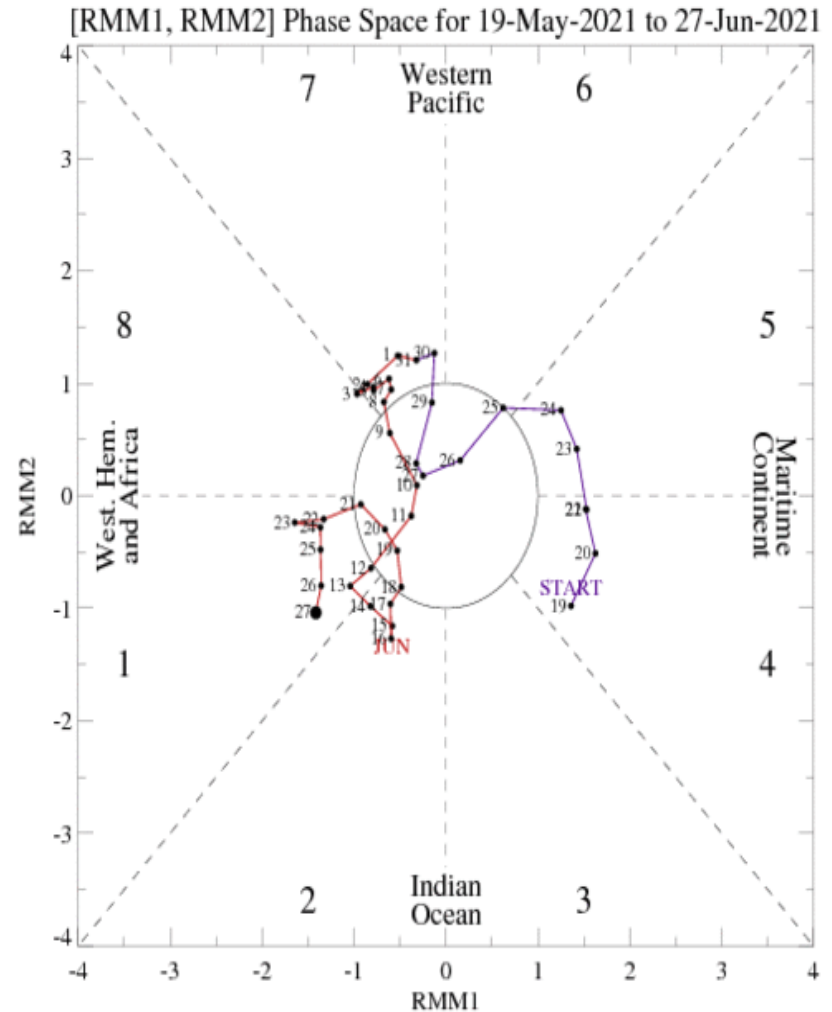
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- 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 150W.
- Niño indices continue to remain marginally 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.

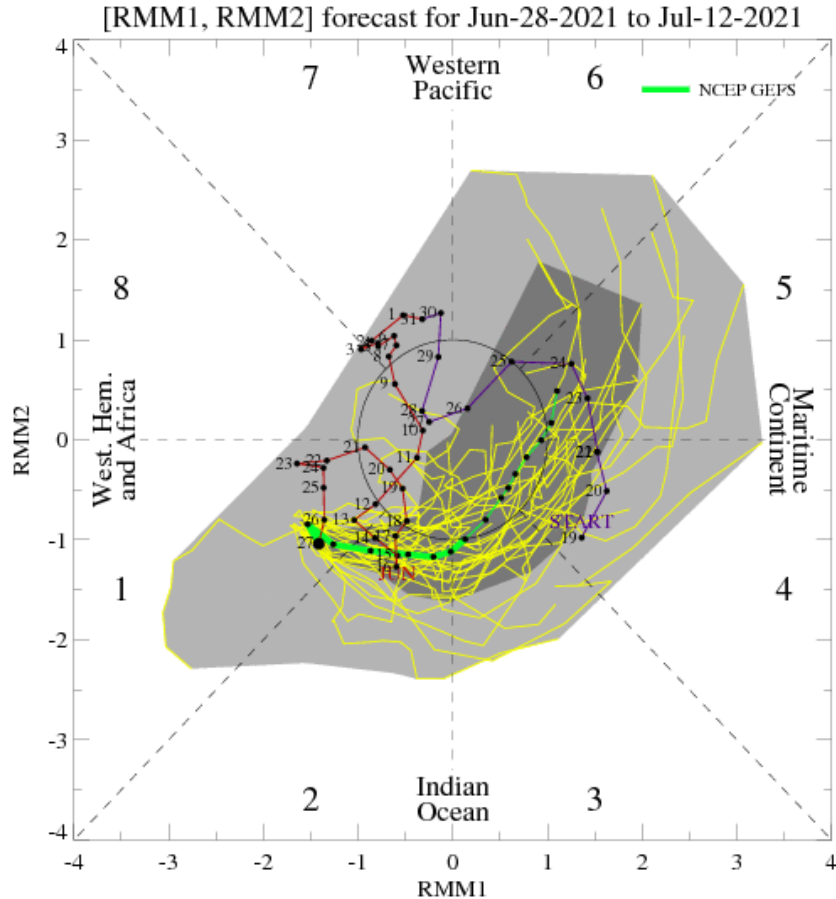
MJO Index: Recent Evolution

- The RMM index emerged from the unit circle, with a signal over Africa which is evident in the velocity potential anomalies.
- The stronger signal over Africa is projecting onto the RMM index, though there are other areas of competing influence due to Southern Hemisphere wave breaking into the western Pacific as well as ongoing tropical activity over the Eastern Pacific.

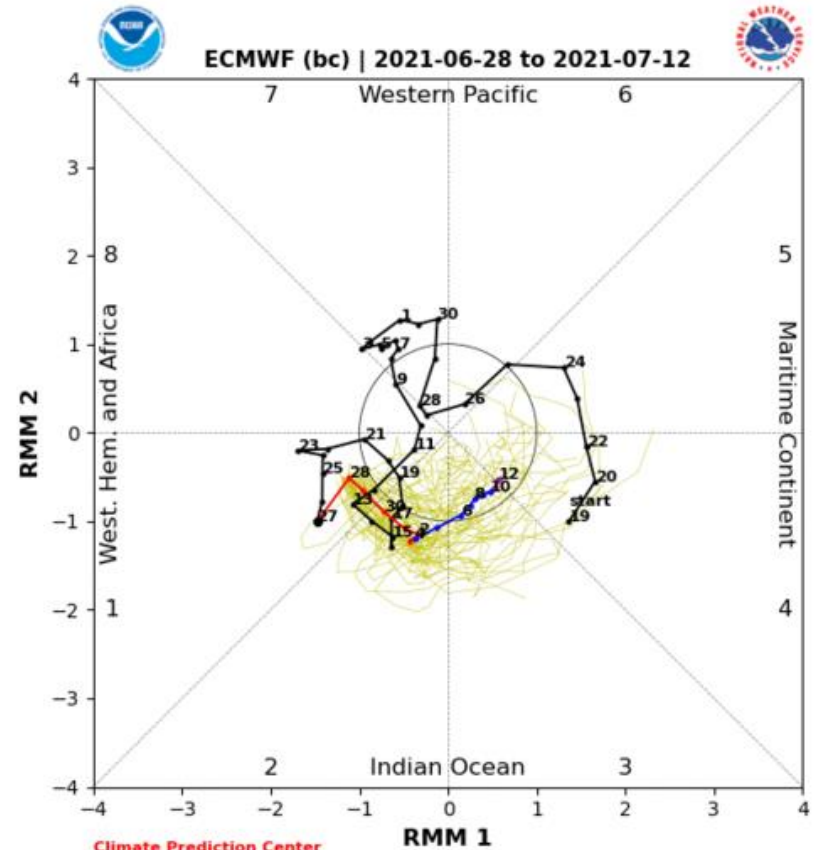


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



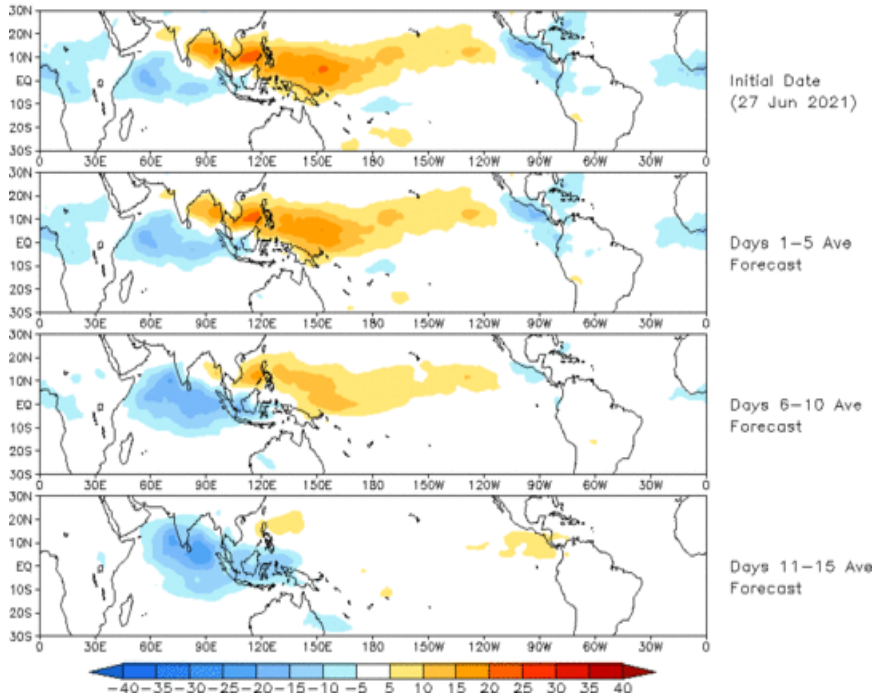
ECMWF Forecast

- Both the GEFS and ECMWF ensemble means show an eastward propagating signal during Week-1. The signal into Week-2 wanes, likely due to competing modes, but the MJO is likely to remain coherent.
- The GEFS depicts large ensemble spread, whereas the ECMWF has less spread among the members and a slower propagation of the signal. Both models suggest a continued eastward propagation of the intraseasonal signal into phases 3 or 4 in Week-2.

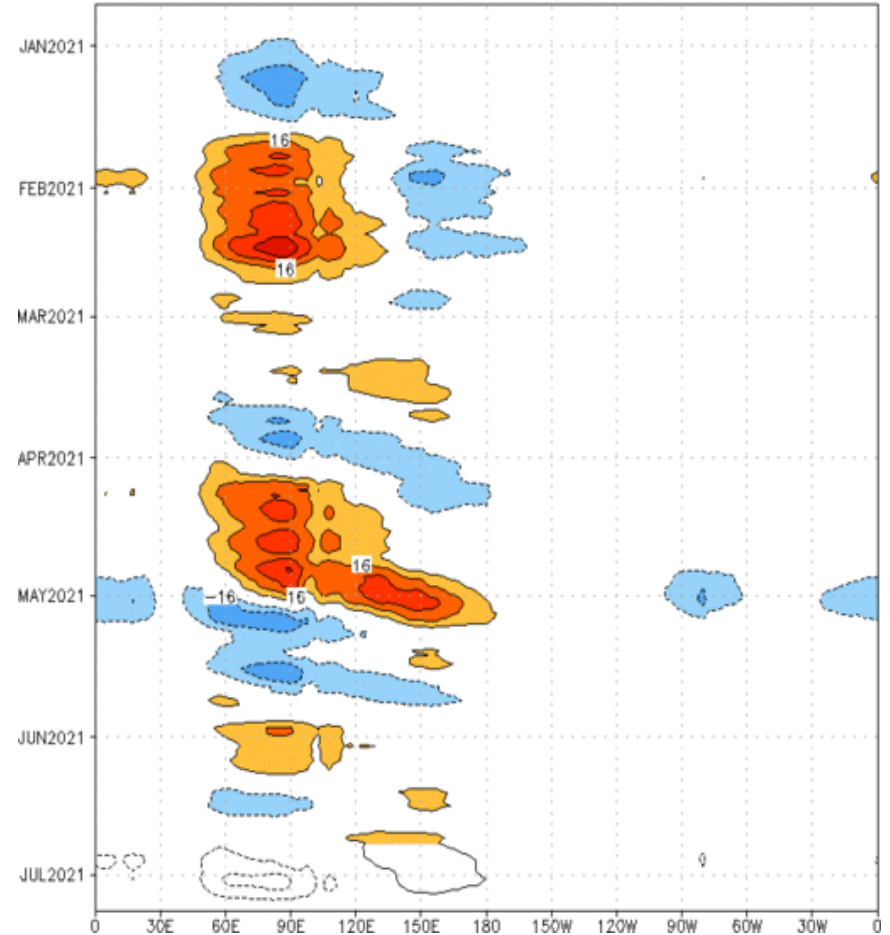
MJO: GEFS Forecast Evolution

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: 27 Jun 2021
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$] (cont: 4Wm^{-2}) Period: 23-Dec-2020 to 24-Jun-2021
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

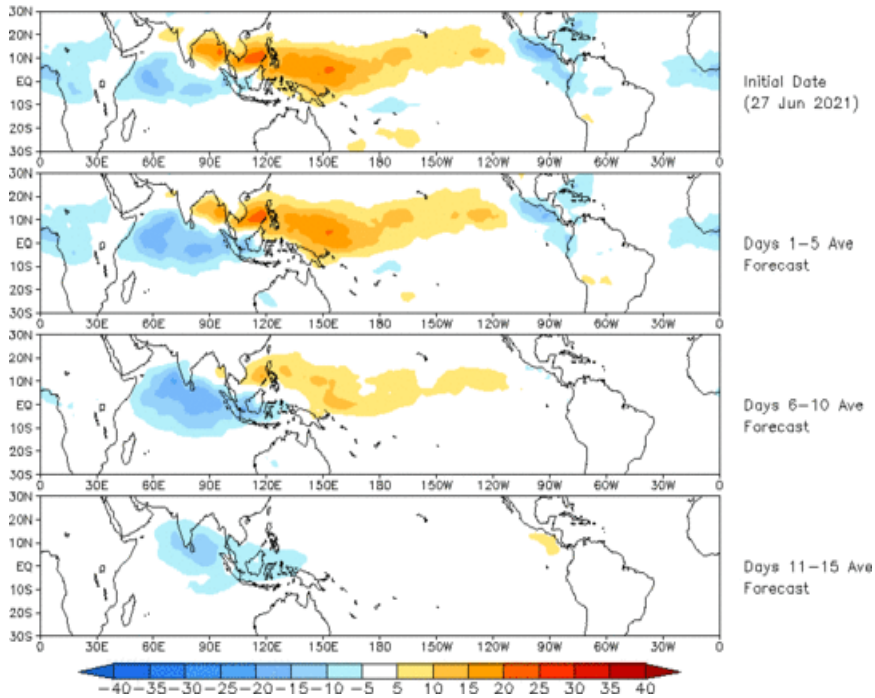


- The GEFS RMM-based OLR anomaly forecast shows a slow propagation eastward, and some influence on the Asian Monsoon convection..

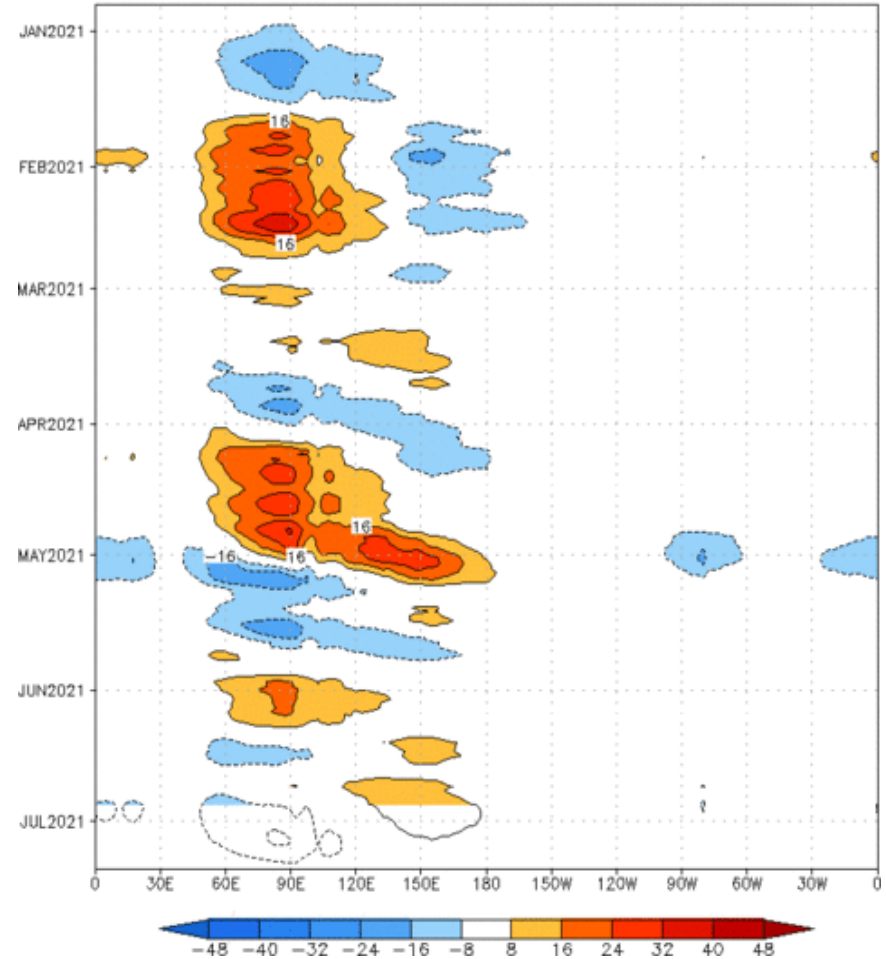
MJO: Constructed Analog Forecast Evolution

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 (27 Jun 2021)



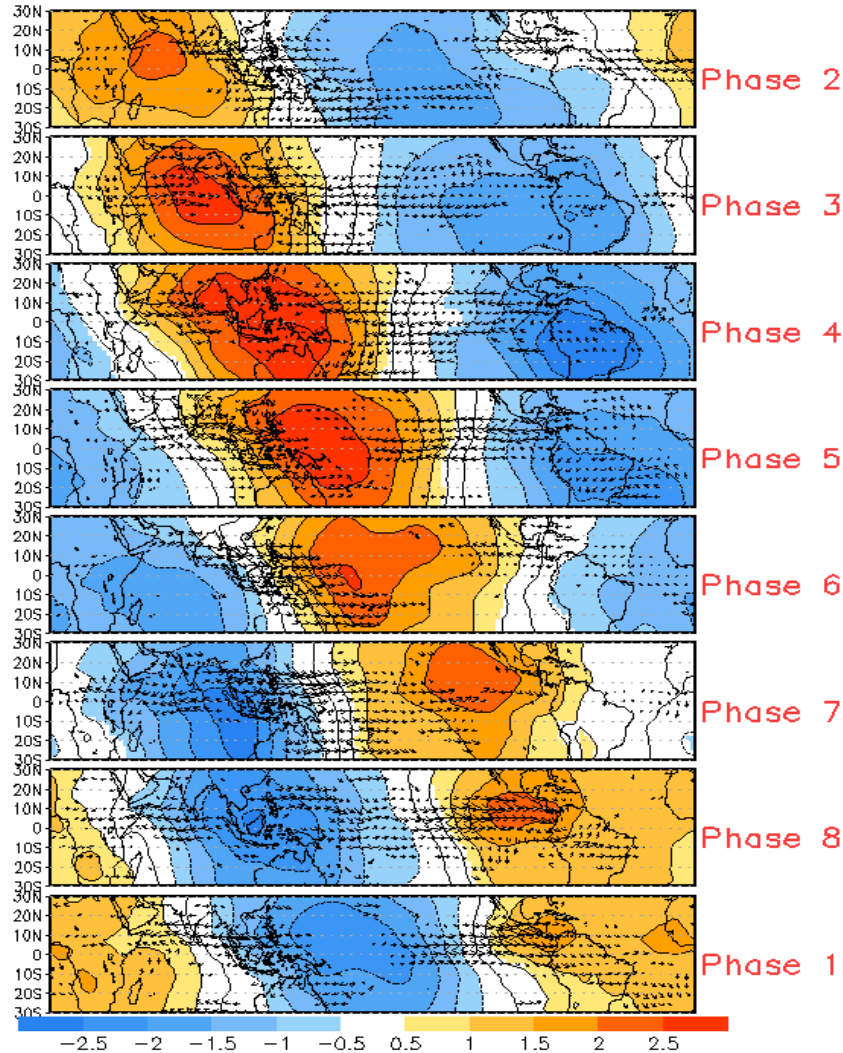
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:26-Dec-2020 to 27-Jun-2021
The unfilled contours are CA forecast reconstructed anomaly for 15 days



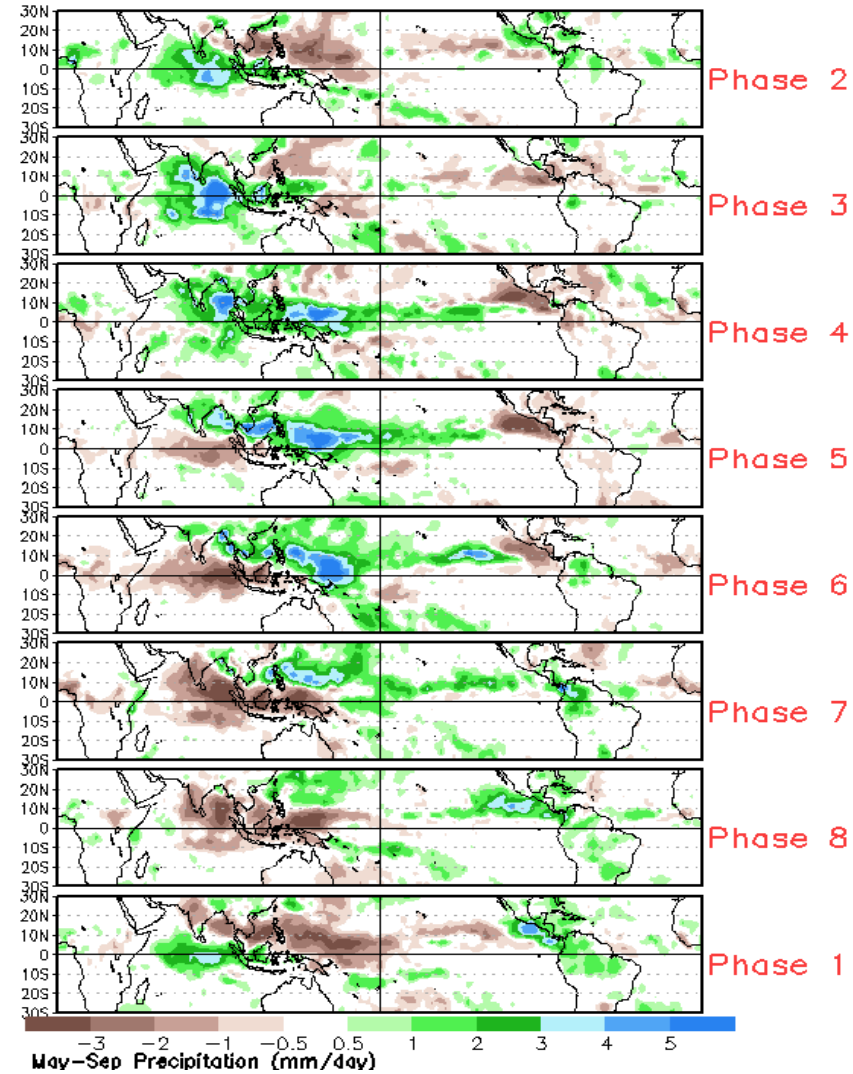
- The constructed analog forecast is similar to that of the GEFS, but exhibits weaker convective anomalies during week-2

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



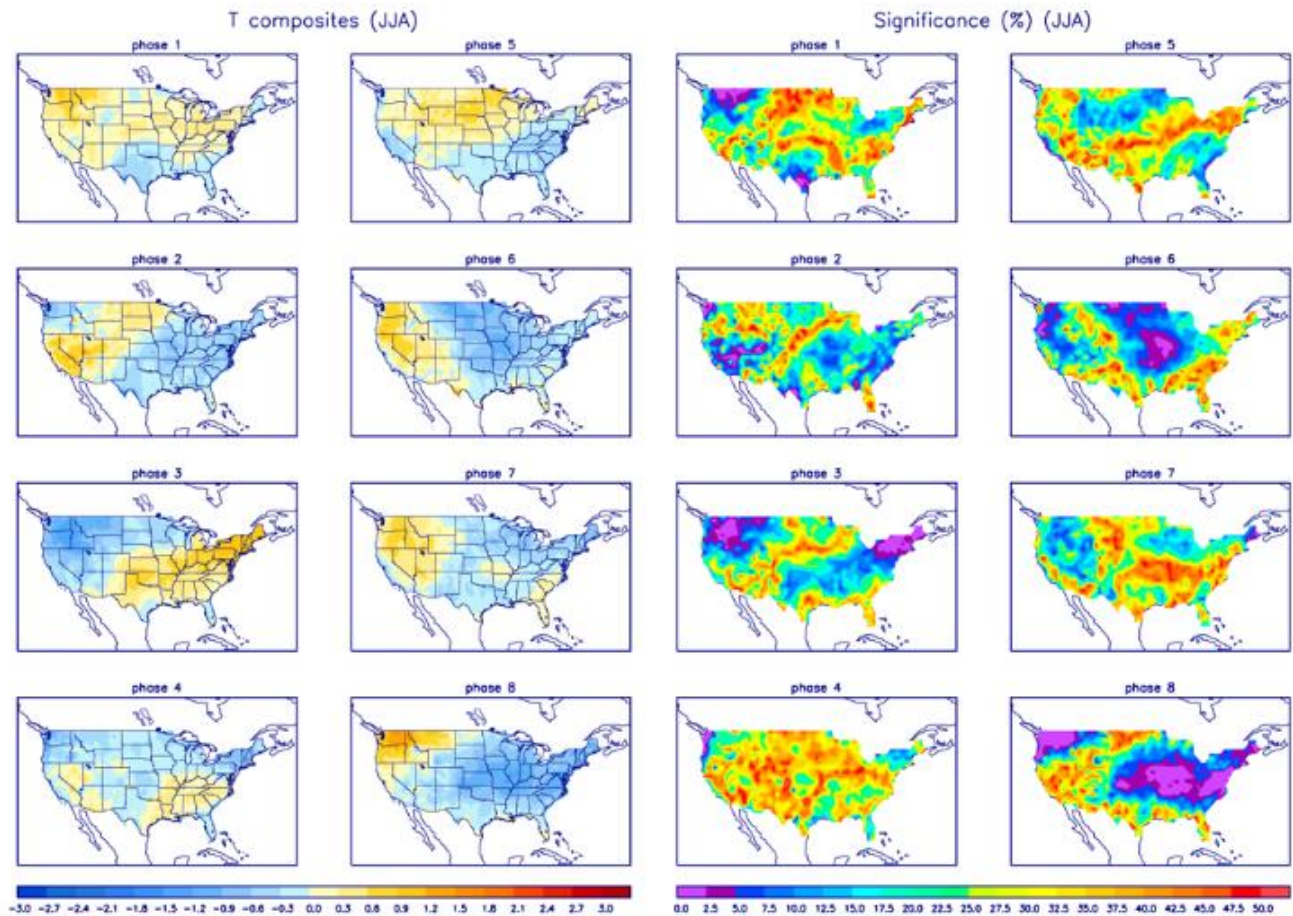
Precipitation Anomalies



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.

