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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
5 June 2023

Overview

- Although both RMM and upper-level velocity potential based MJO indices suggest a more disorganized signal likely tied to competing modes of variability through early June, the MJO has continued to propagate eastward across the western Hemisphere.

- Since last week, RMM forecasts have grown more supportive of a coherent MJO propagating across the Indian Ocean during week-1, and into the Maritime Continent during week-2.

- While RMM ensemble spread is high towards mid-June, these forecasts point to an uptick in amplitude over the Maritime Continent, while continuing to propagate the signal into the western Pacific during week-3, which is supported by upper-level velocity potential forecasts.

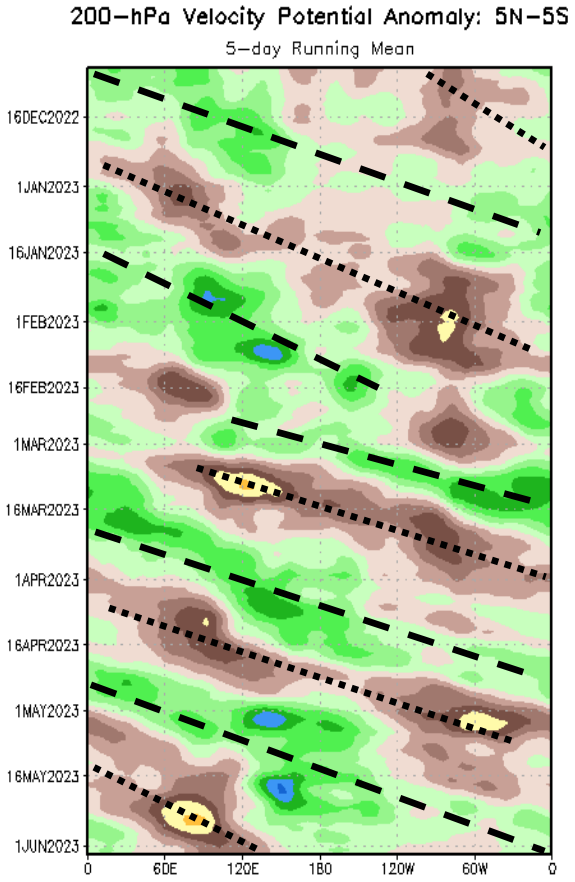
- The enhanced phase of the MJO is expected to be favorable for tropical cyclogenesis in the Indian Ocean and western Pacific through late June. Conversely, there are decreased chances for TC development over the eastern Pacific and Atlantic basins. However, formation cannot be discounted given probabilistic guidance and a more active climatology later in June.

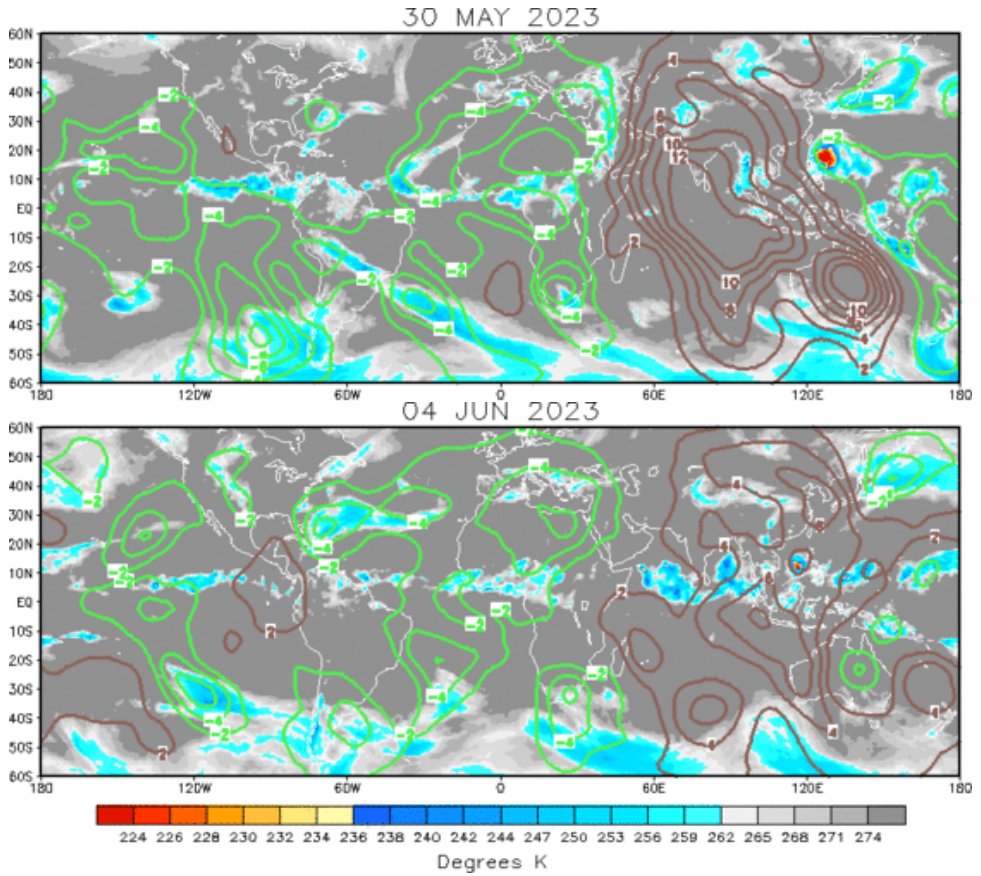
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)



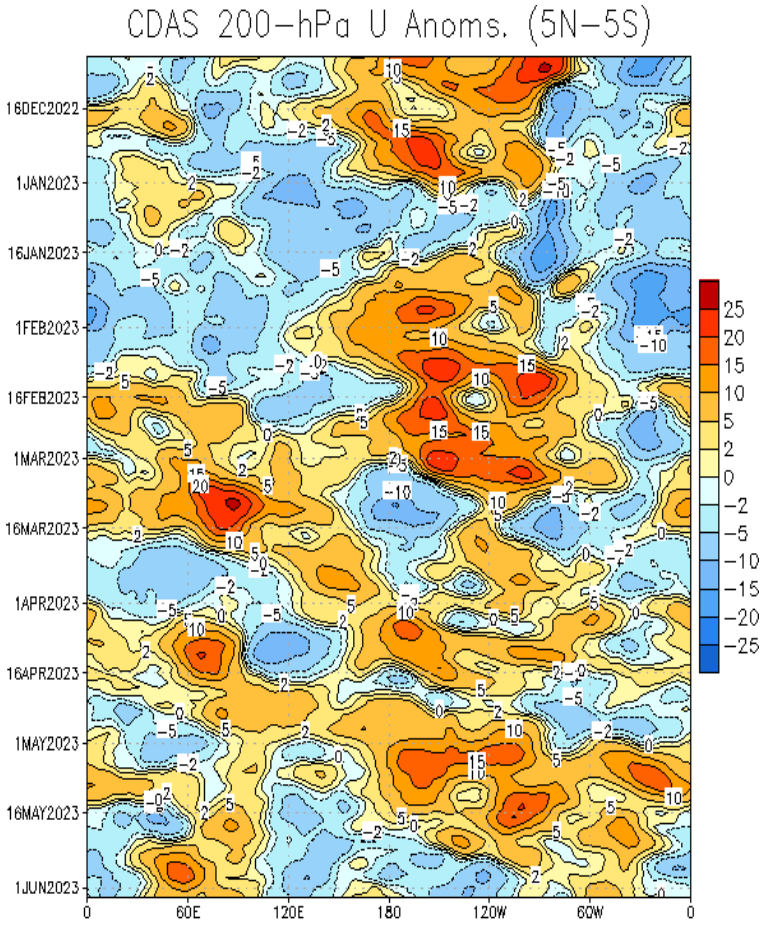


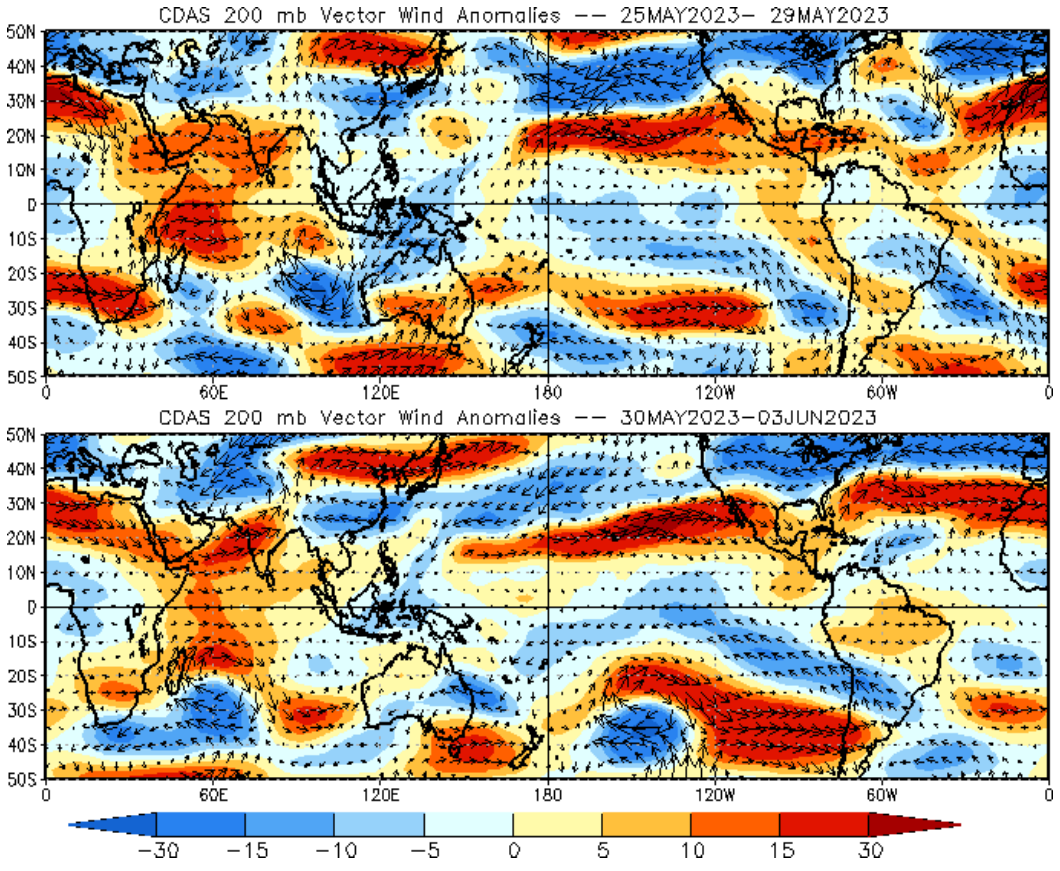
- The envelope of enhanced upper-level divergence became less coherent since late May, where its leading edge returned over Africa and the western Indian Ocean.

- Following interference with Typhoon Mawar, the suppressed phase of the MJO also shifted eastward into the western Pacific but is more pronounced south of the equator.

200-hPa Wind Anomalies

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

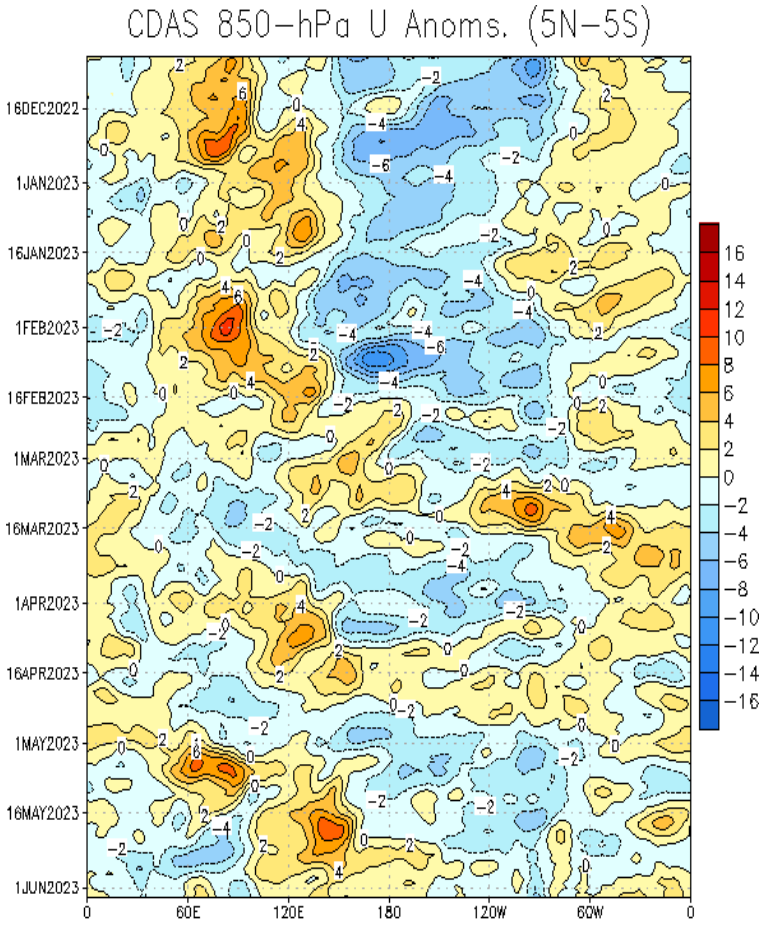


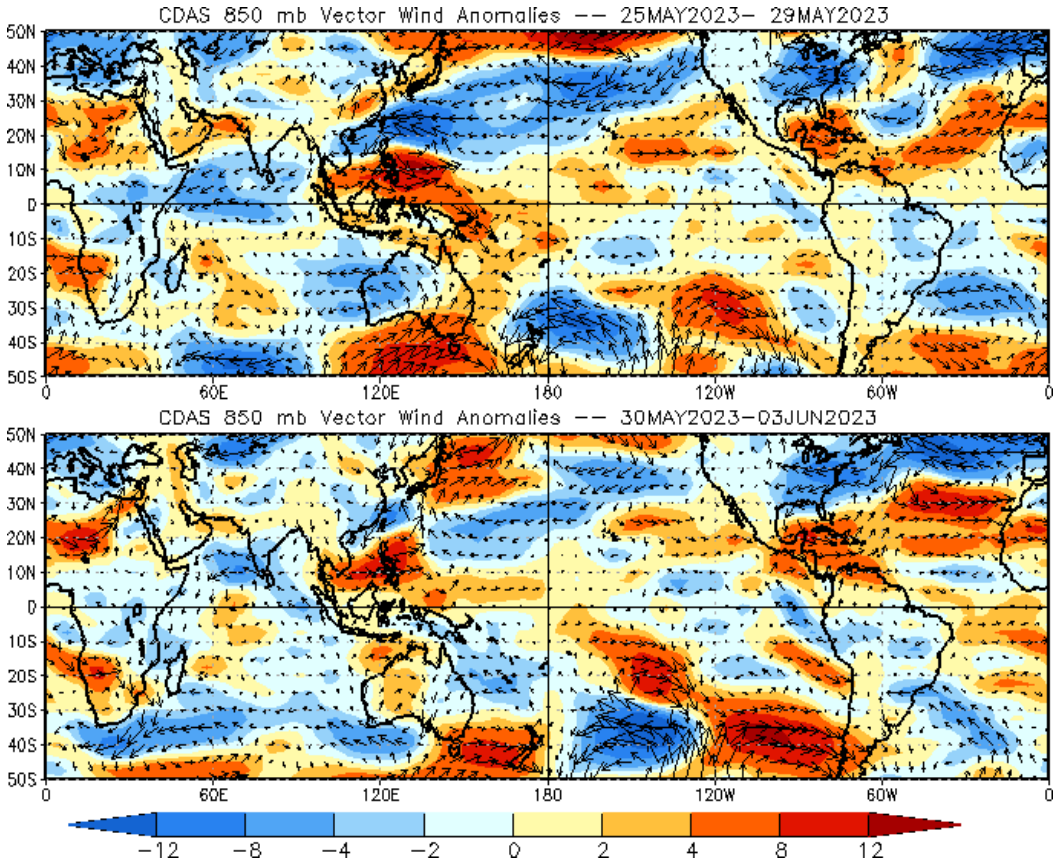


- Anomalous easterlies expanded eastward into the eastern equatorial Pacific consistent with the continued propagation of the MJO.
- An enhanced subtropical jet is evident over the central and eastern Pacific, with deep troughing extending into the Caribbean. This likely contributed to a high shear environment to inhibit tropical cyclone development to the south of Mexico.
- Anomalous westerlies remain entrenched over the western Indian Ocean.

850-hPa Wind Anomalies

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

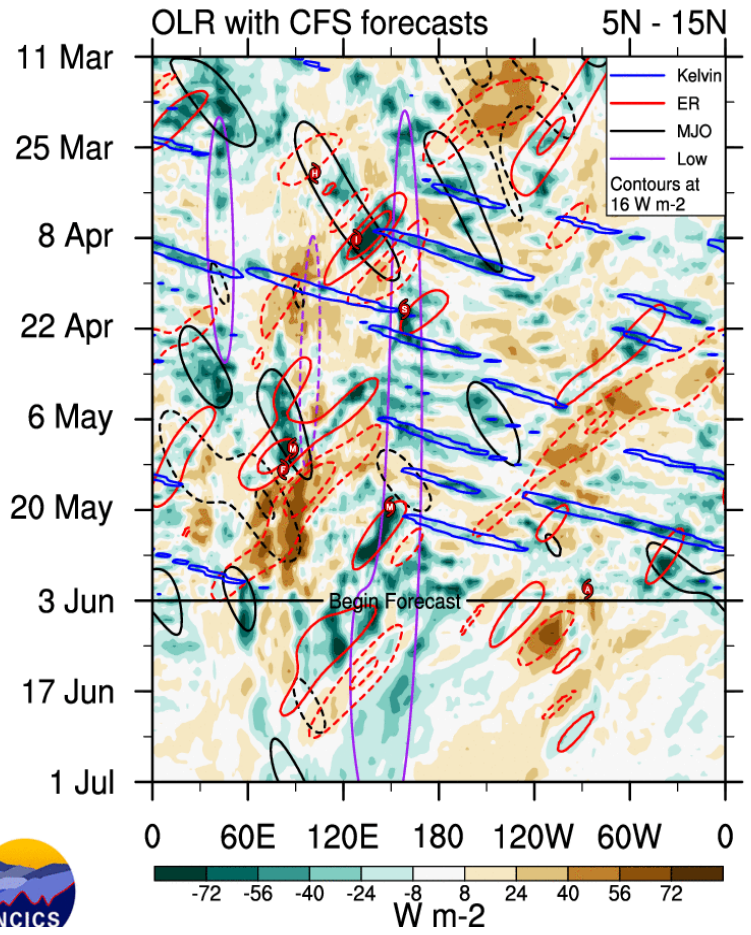


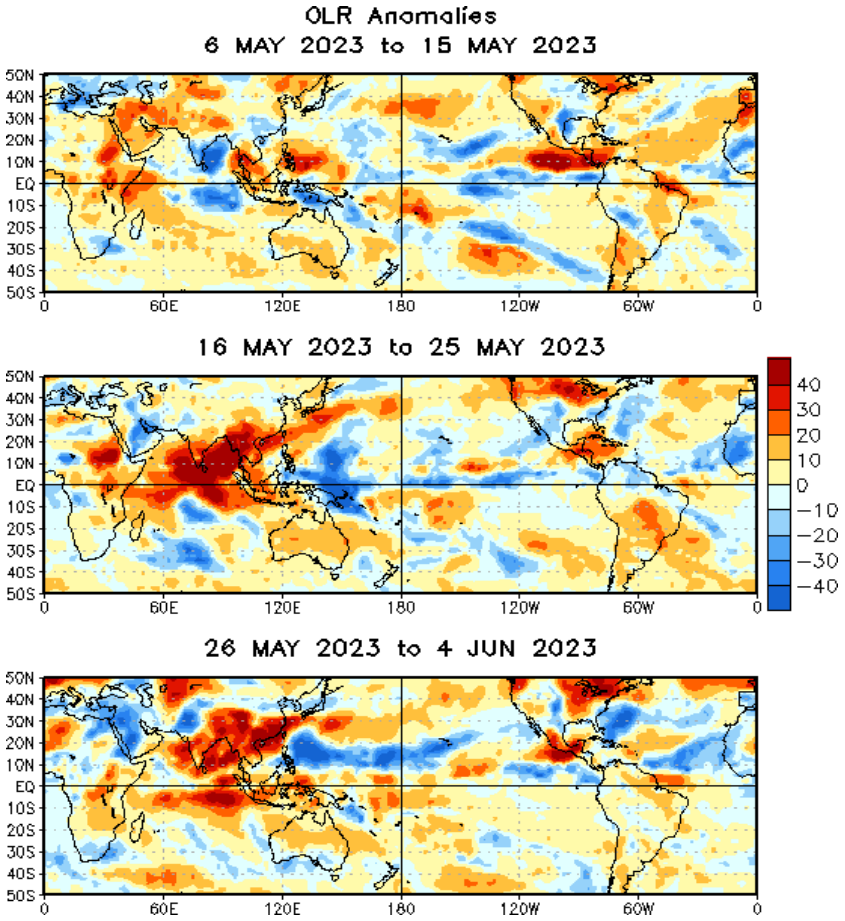


- Anomalous lower-level westerlies extended eastward over the Americas, but is less apparent along the equator compared to the two previous MJO cycles.
- Anomalous easterlies have weakened over the western Indian Ocean ahead of the MJO enhanced envelope.
- Broadly anomalous cyclonic circulations persisted over the western Pacific (TC Mawar), and over the Atlantic/Caribbean likely resulting in the formation of a pair of low pressure systems (one non-tropical and Tropical Storm Arlene) during the past two weeks.

Outgoing Longwave Radiation (OLR) Anomalies

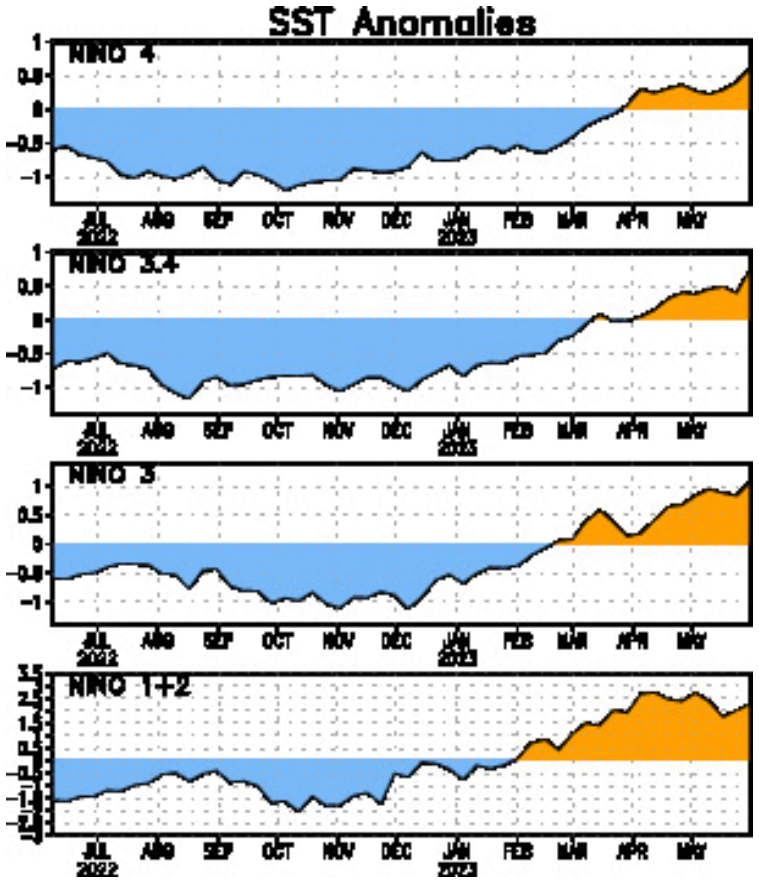
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

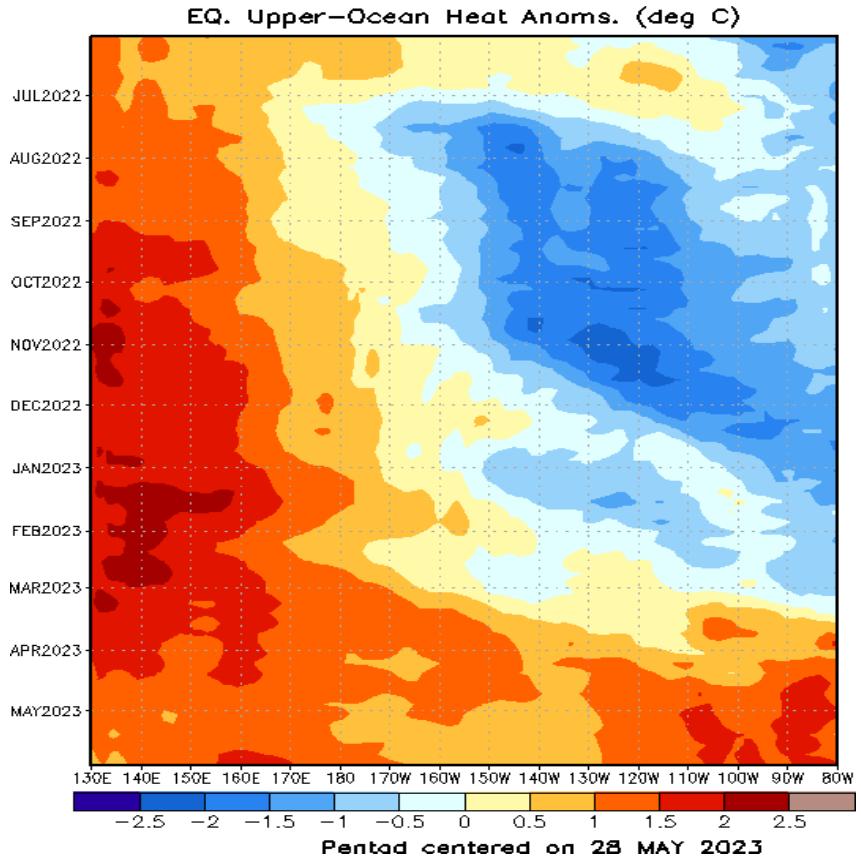




- Strongly suppressed convection overspread much of the Indian Ocean from mid-May to early-June.
- Enhanced convection shifted eastward over the western Hemisphere with MJO activity coming through the filtering
- North of the equator, enhanced convection is favored to develop over the Maritime Continent likely tied to Rossby Wave activity during the next two weeks.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

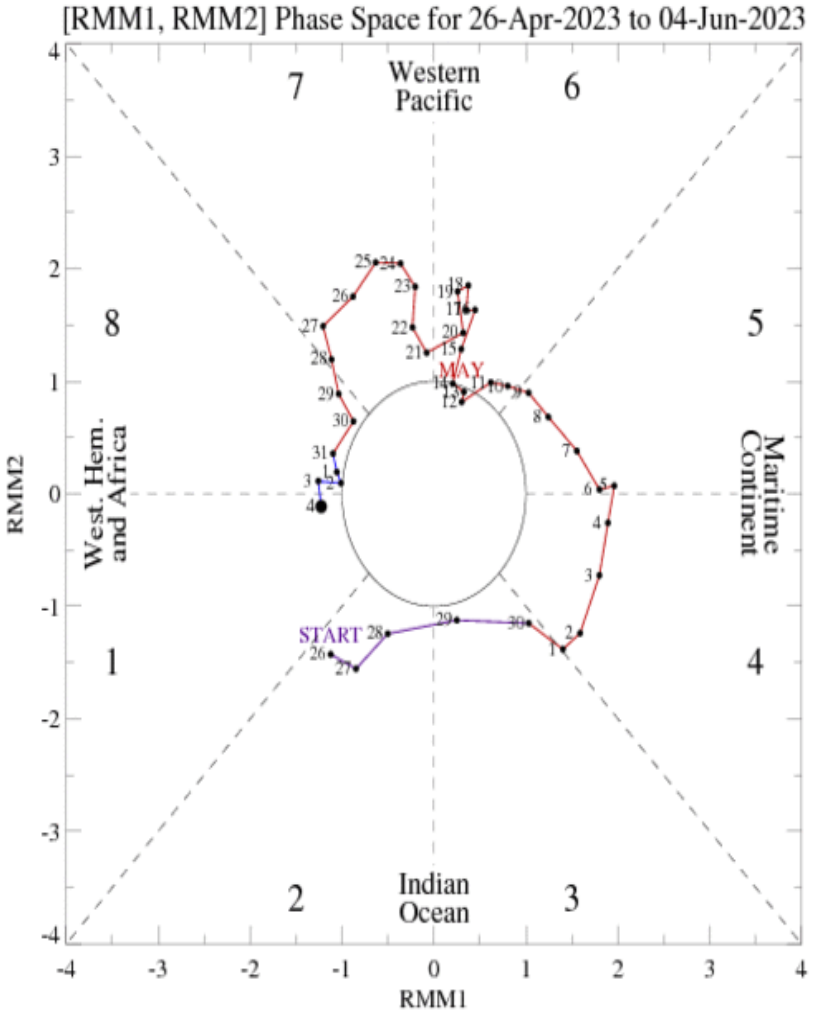




- Increasingly positive subsurface temperature anomalies engulf the entire Pacific, driven by multiple MJO events and subsequent oceanic downwelling Kelvin Waves beginning in March.
- SSTs in all of the Niño basins are now above normal, where the warmest anomalies remain over the eastern Pacific.
- Additional warming has been observed recently in the Nino 4 and 3.4 regions

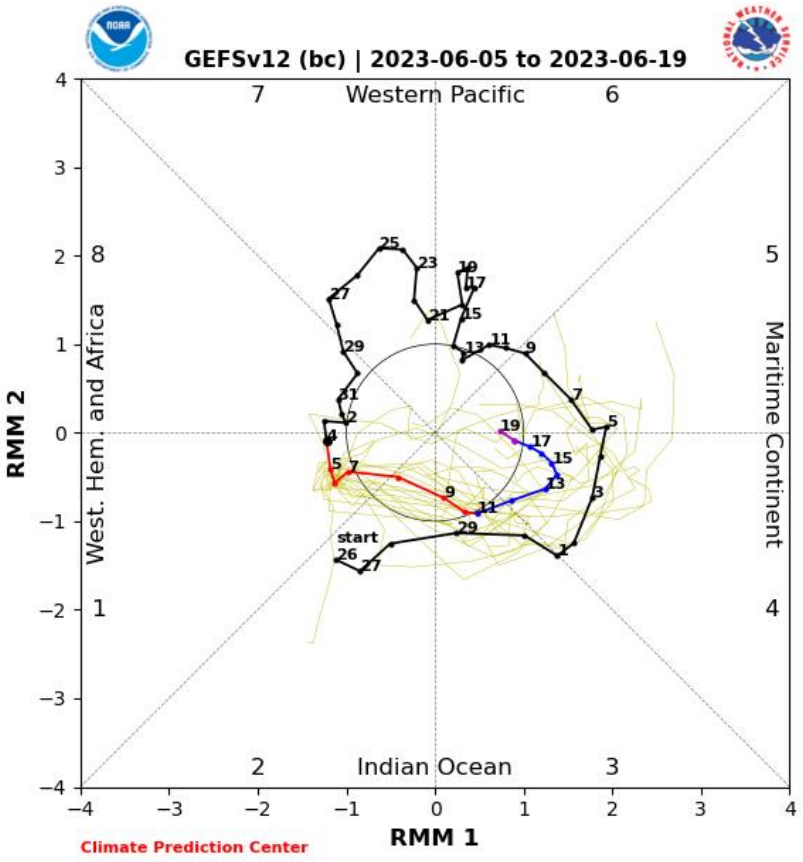
MJO Index: Recent Evolution

- The RMM index shows the MJO signal propagating eastward from the western Pacific into the Western Hemisphere, where it has lost some its amplitude and slowed down during the past week.

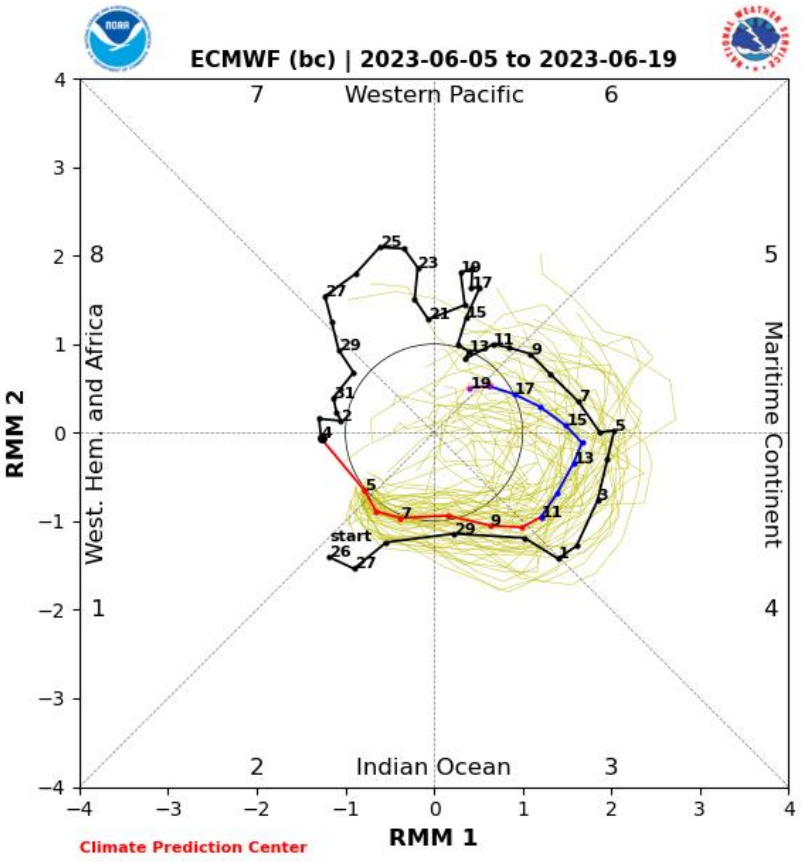


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

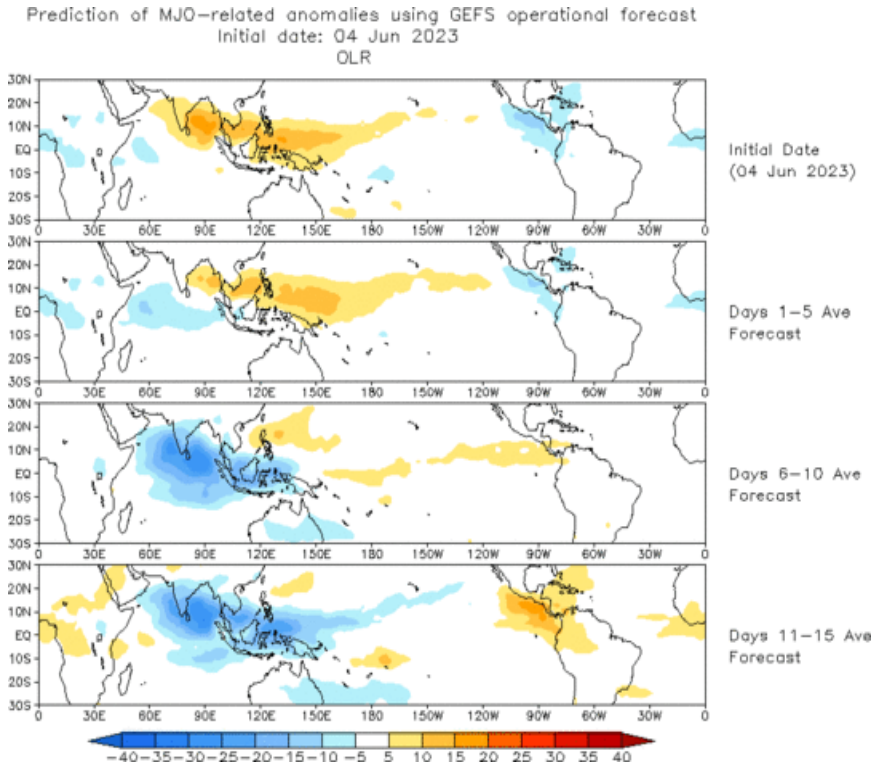


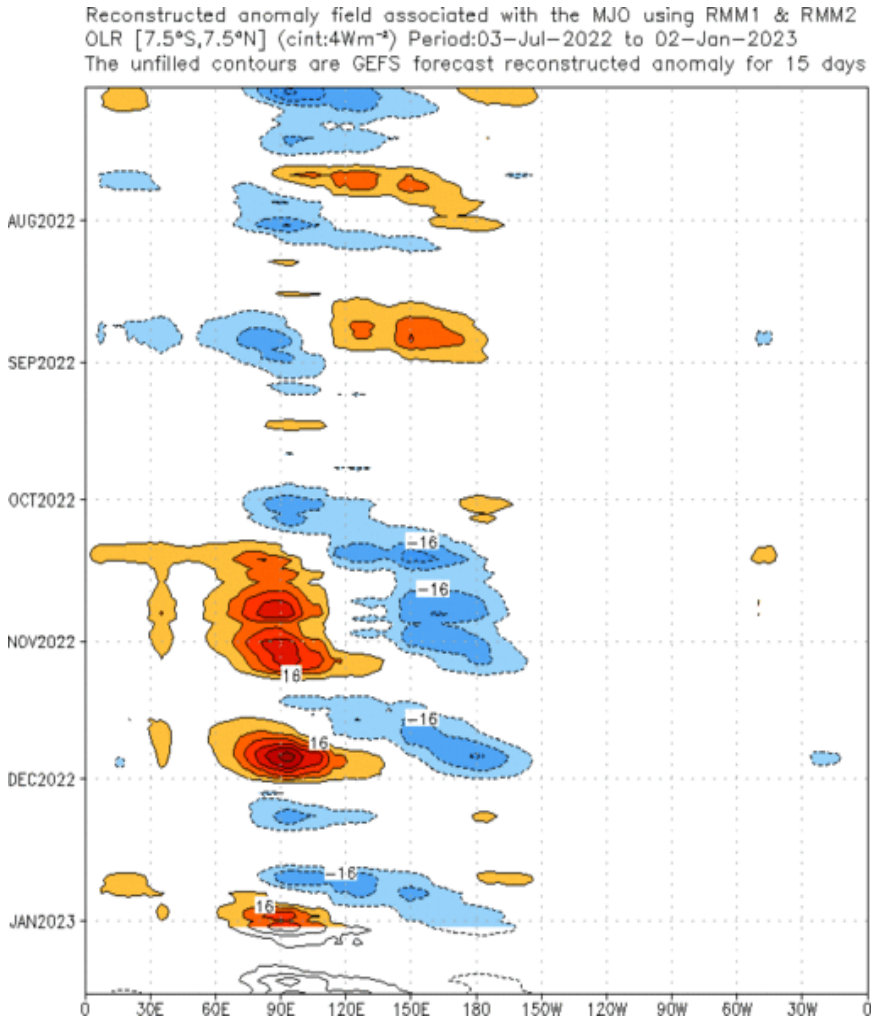
ECMWF Forecast

- There is good agreement in dynamical models favoring continued eastward propagation of the MJO across the Indian Ocean at a low amplitude during week-1, and regaining amplitude over the Maritime Continent during week-2
- Large ensemble spread exists in the extended range RMM forecasts, however upper-level velocity potential forecasts suggest a more coherent MJO over the western Pacific towards the end of June.

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.)

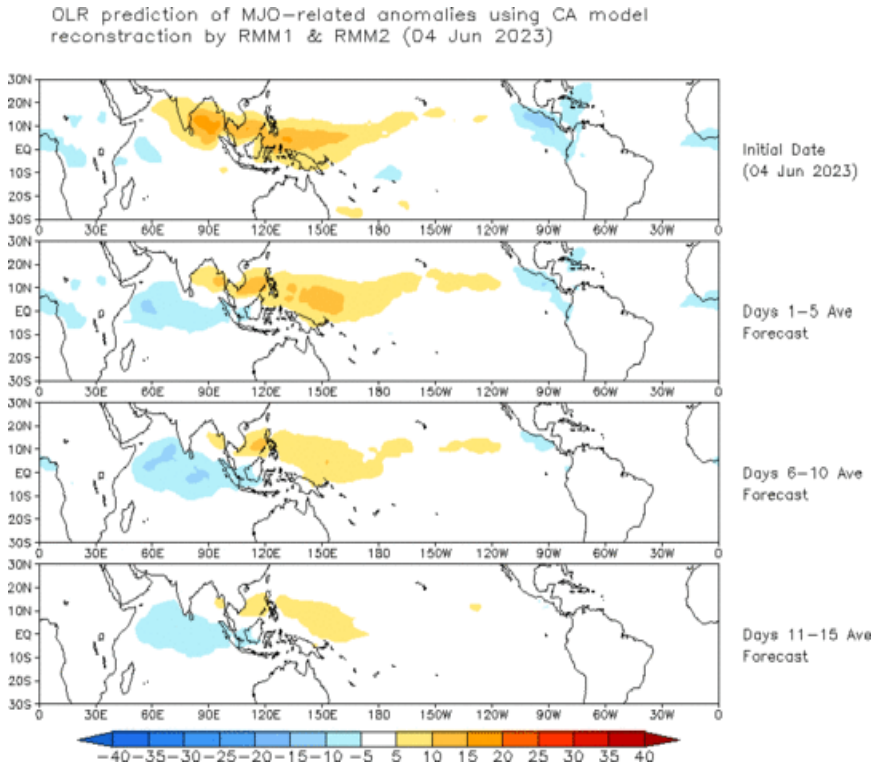


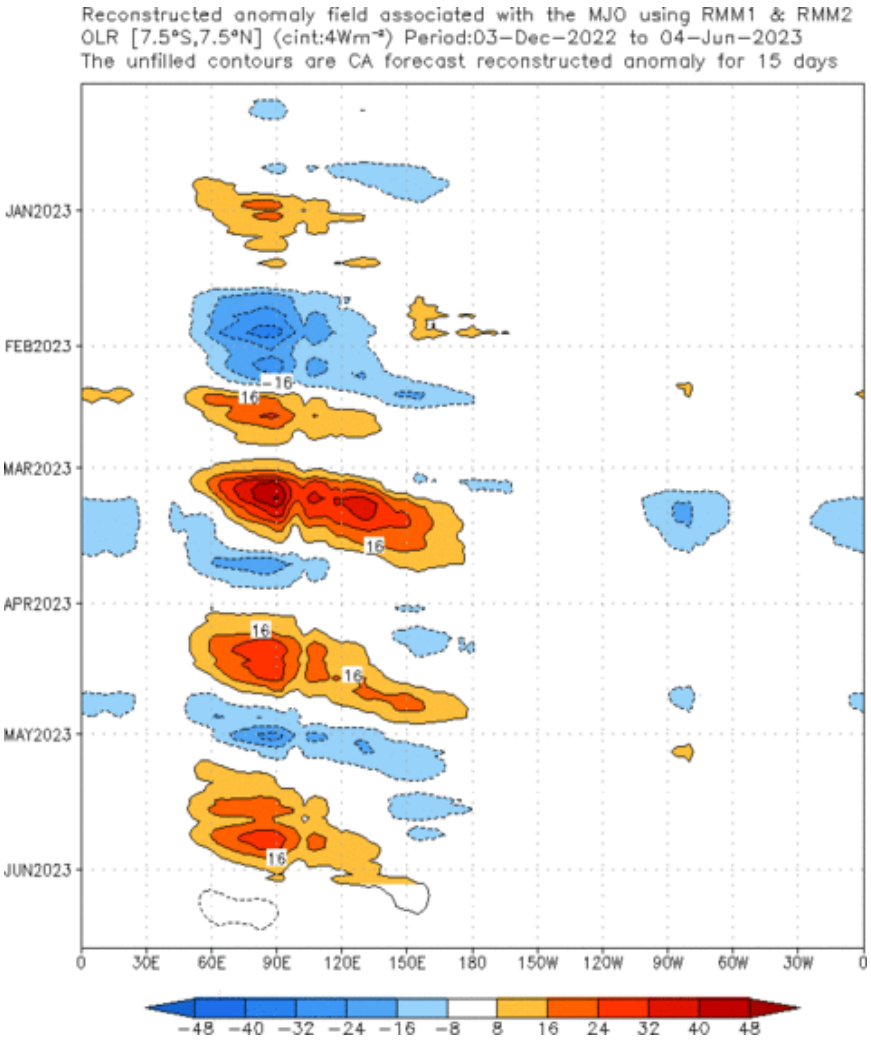


- The GEFS RMM-based OLR forecast depicts a the development of enhanced convection over the Indian Ocean with suppressed convection emerging over the equatorial Pacific.

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.)

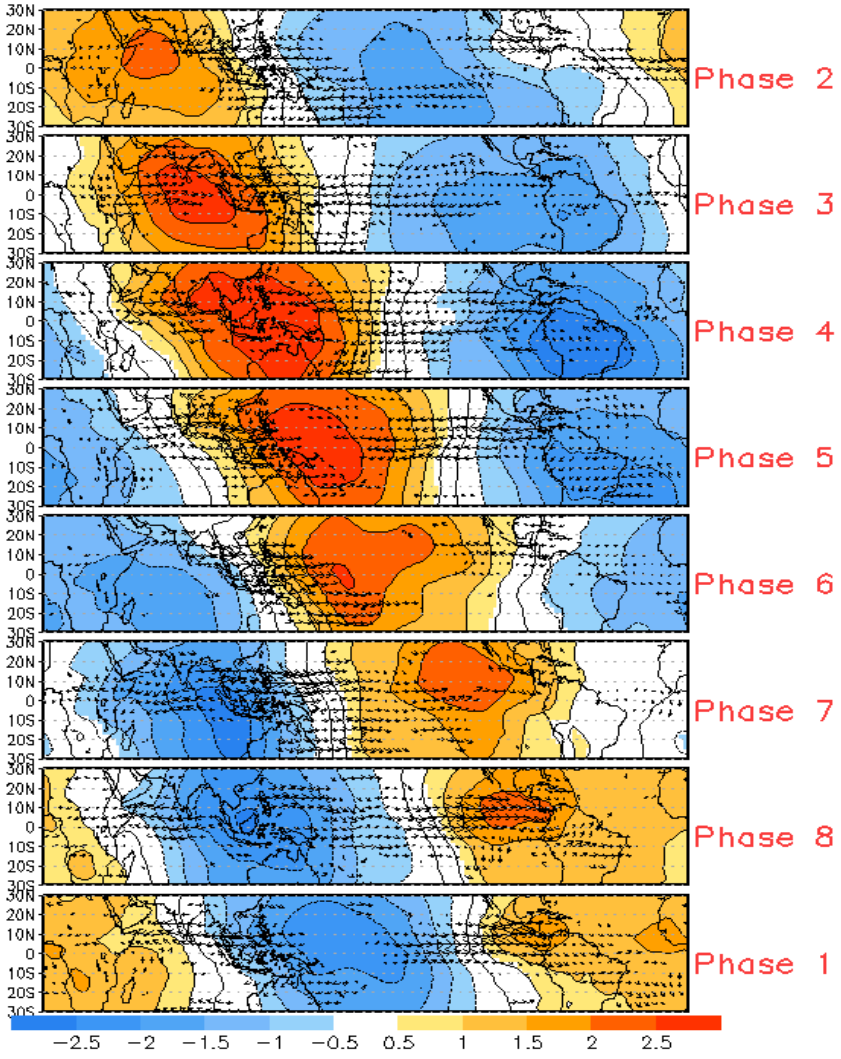




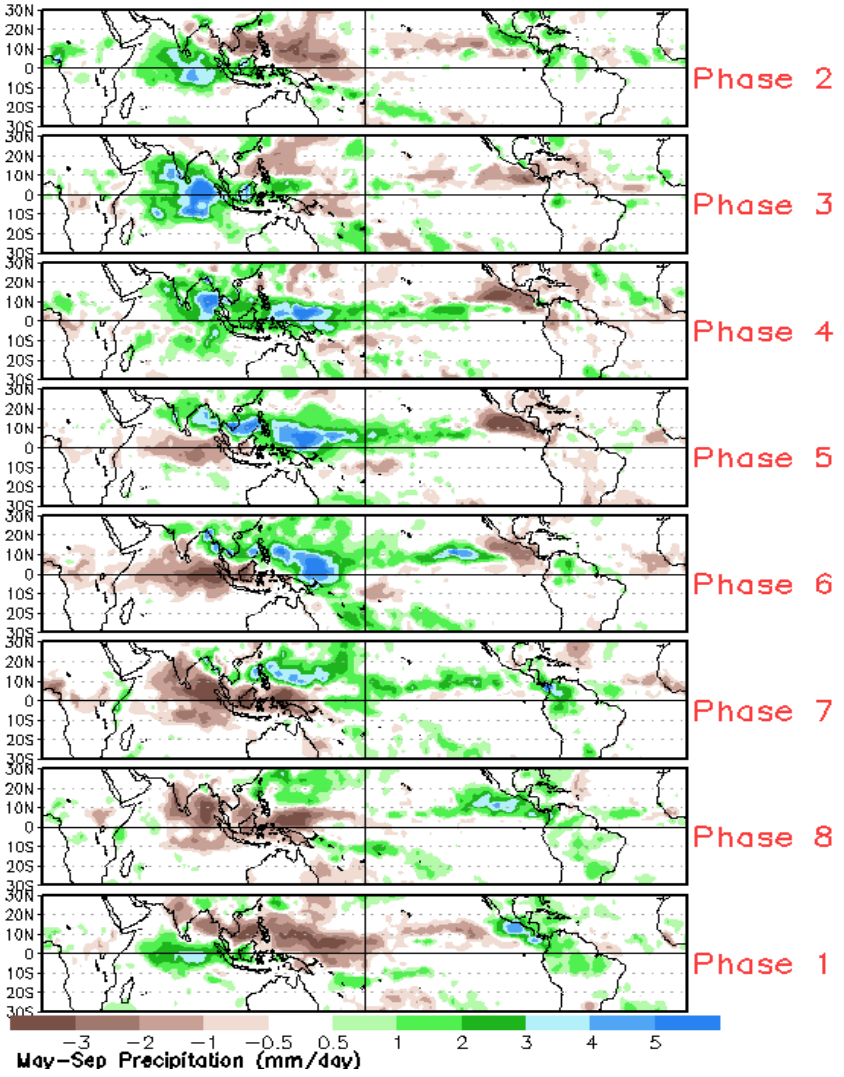
- The constructed analog RMM-based forecast favors a more stationary convective pattern, with enhanced convection lingering over the eastern Pacific and Americas through week-2.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



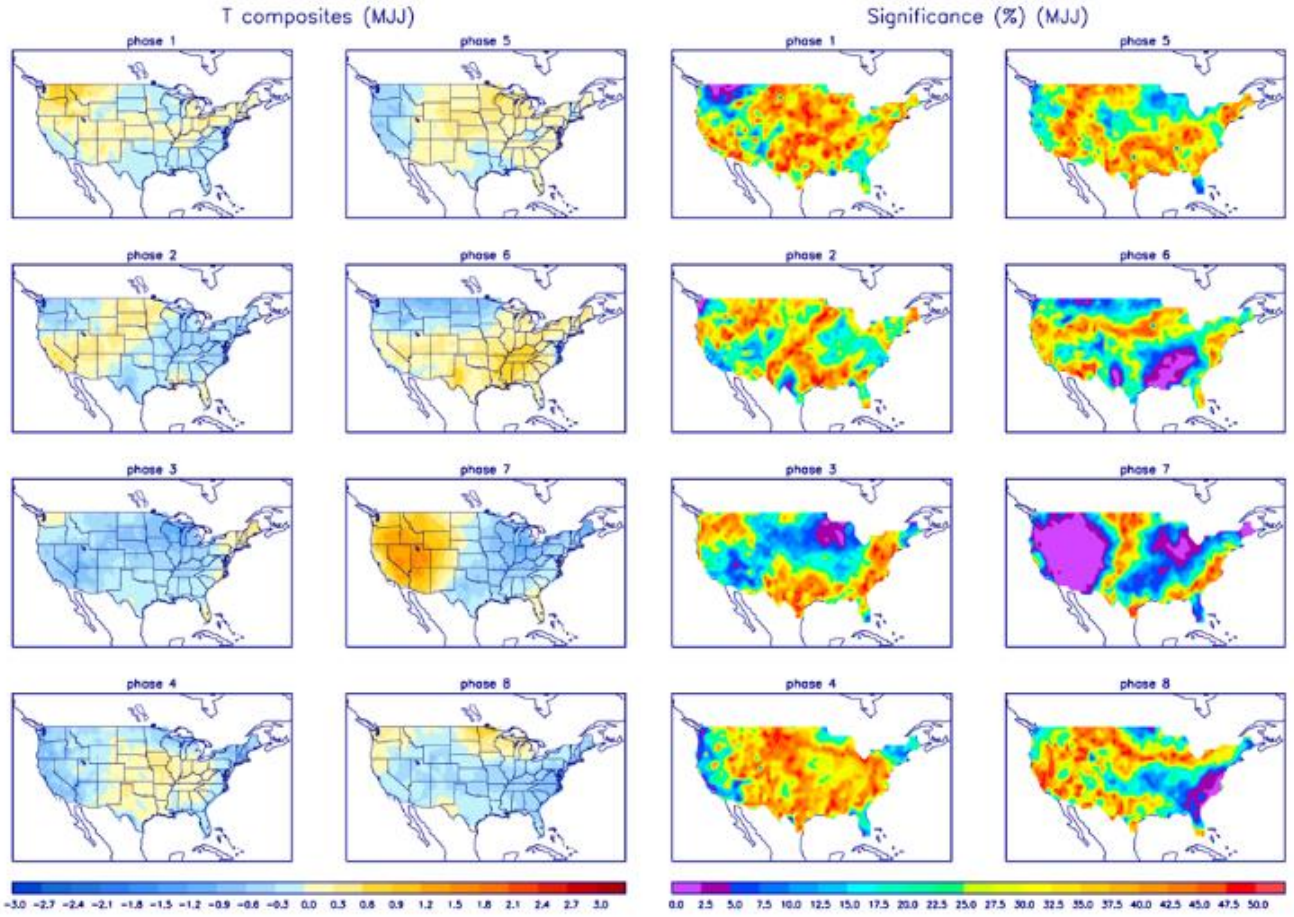
Precipitation Anomalies



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.

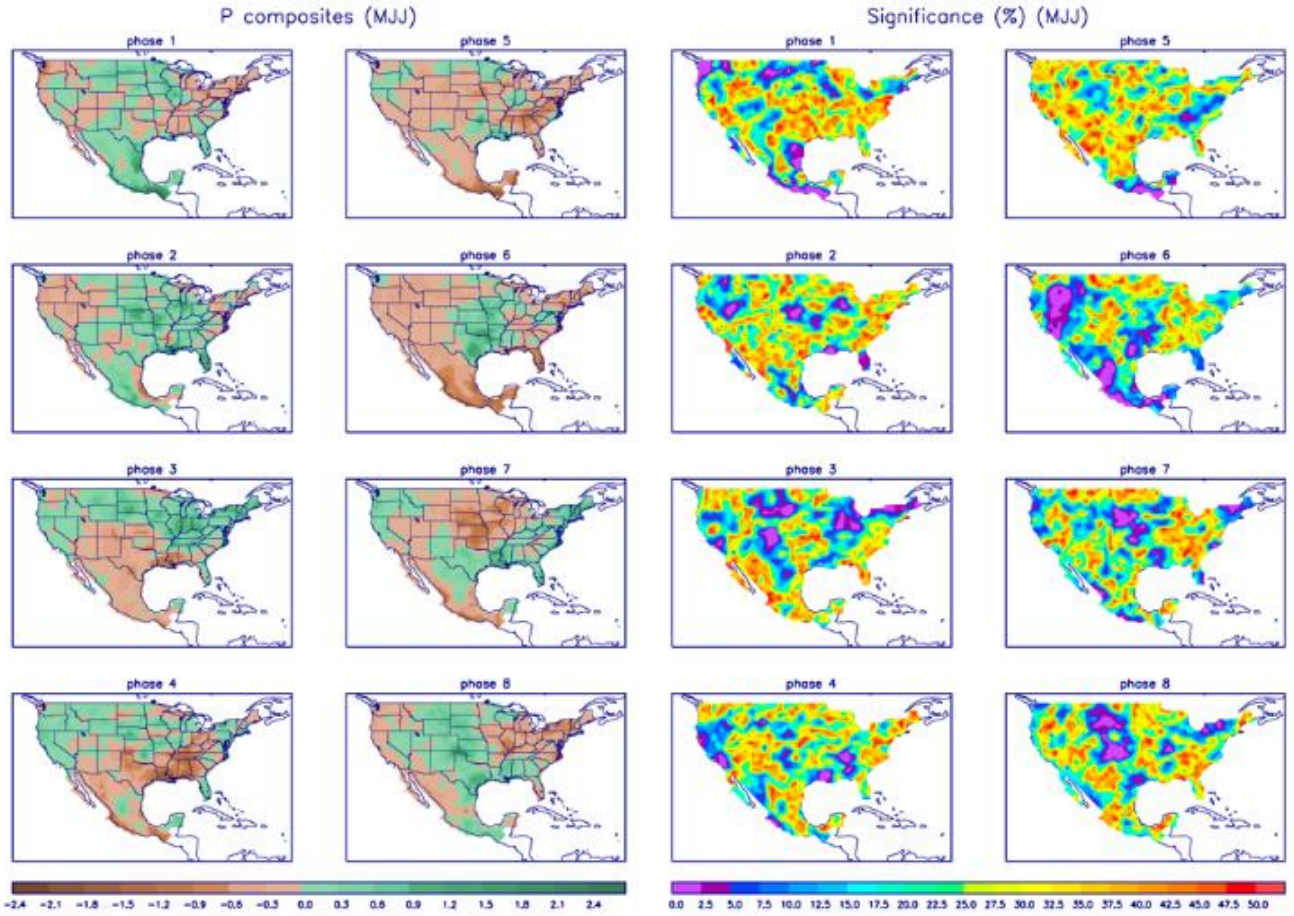


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

MJO: CONUS Composite Maps by RMM Phase - Precipitation

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.



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