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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
17 April 2023

Overview

- An active MJO signal remains apparent, with the enhanced convective phase now crossing the Pacific.

- The MJO has disrupted the trade wind regime across the Pacific, while downwelling oceanic Kelvin wave activity has helped transport anomalously warm waters across the entire basin.

- Other modes appear to be disrupting the intraseasonal signal, including Kelvin wave activity crossing the Western Hemisphere ahead of the MJO enhanced convective envelope, Rossby wave activity over the Maritime Continent, and a stubborn suppressed signal near the Date Line.

- Dynamical model MJO index forecasts continue to depict an active MJO crossing the Western Hemisphere and Indian Ocean over the next couple of weeks. There is uncertainty regarding the amplitude of this signal and the overall phase speed.

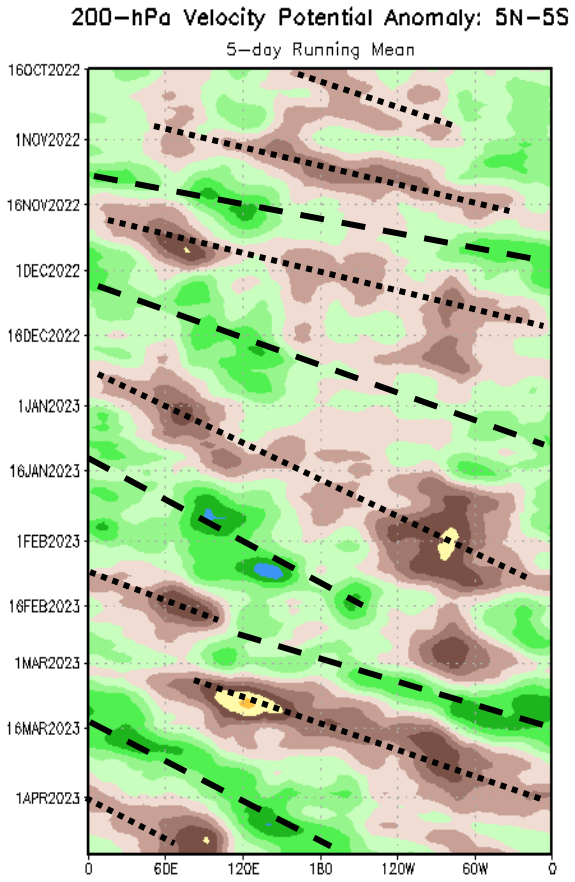
- The MJO is anticipated to remain a dominant driver of large scale global tropical convective anomalies during the next several weeks.

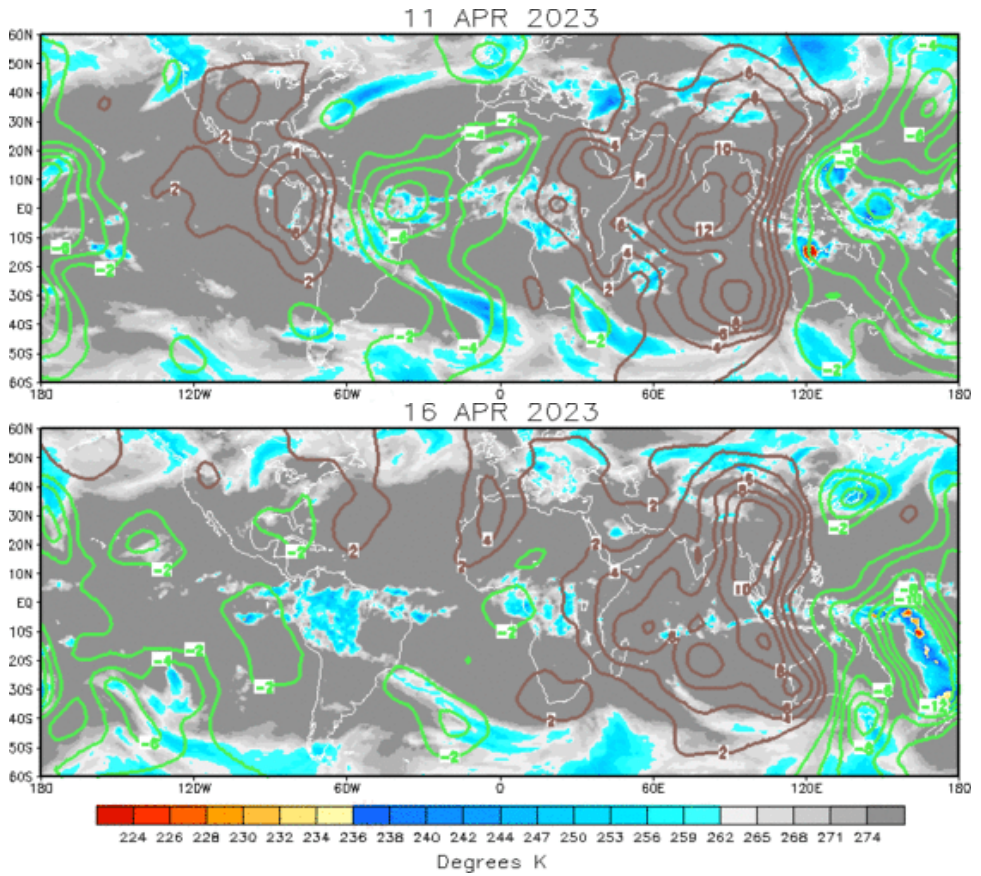
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

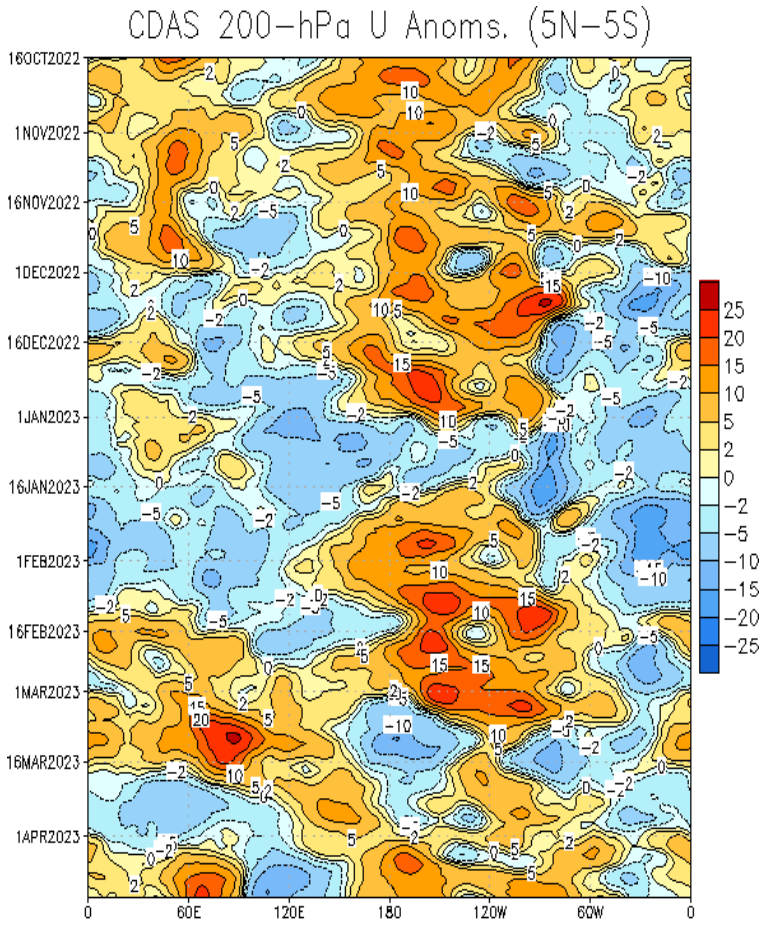


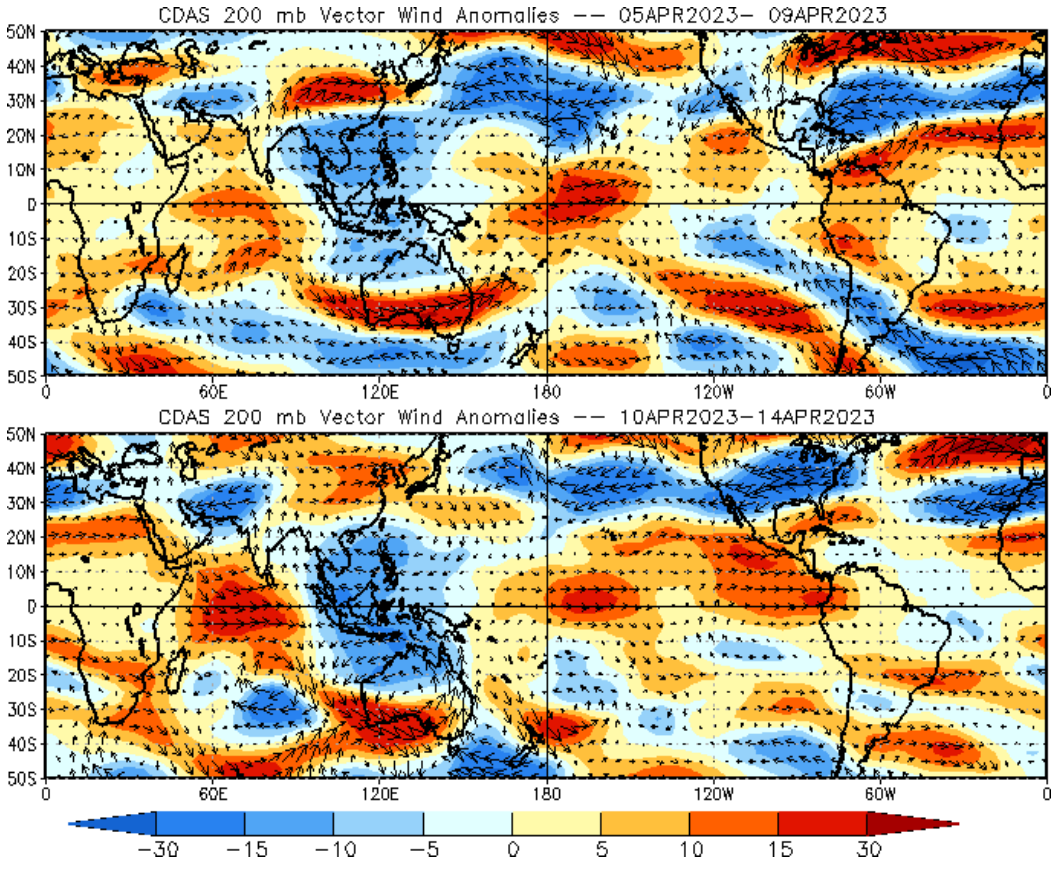


- The intraseasonal signal has been largely active since December 2022 as the low frequency La Niña base state began to wane.
- An active MJO signal remains apparent in recent observations, with the enhanced convective phase now over the Pacific.
- Other modes appear to be influencing the pattern, including Kelvin wave activity crossing the Western Hemisphere, and a slower evolving signal over the Indian Ocean.

200-hPa Wind Anomalies

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

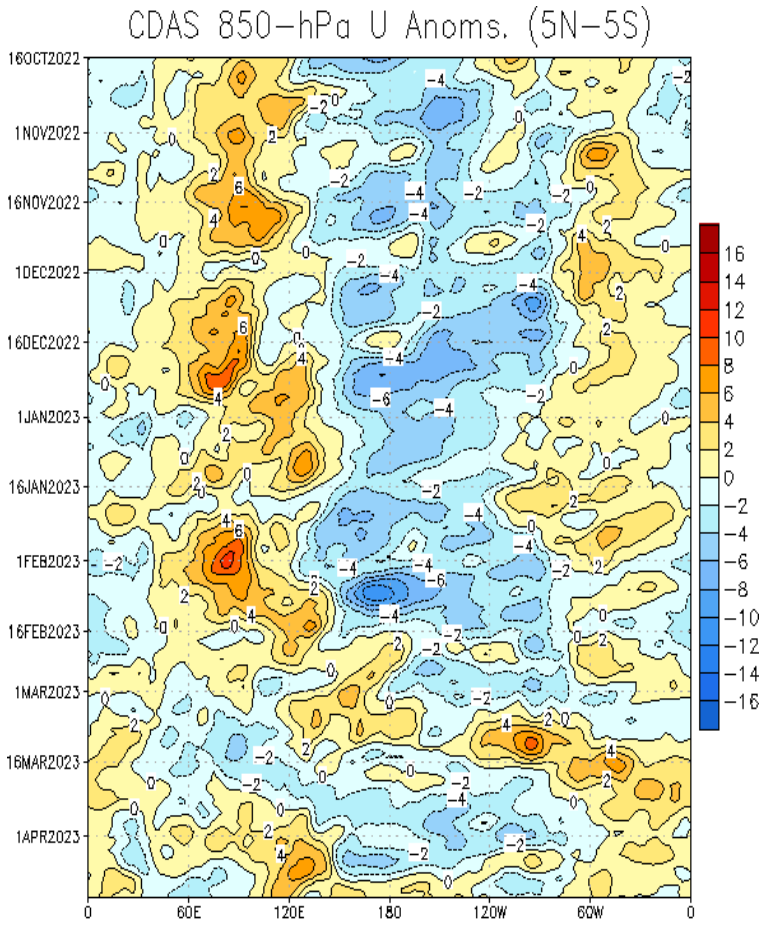


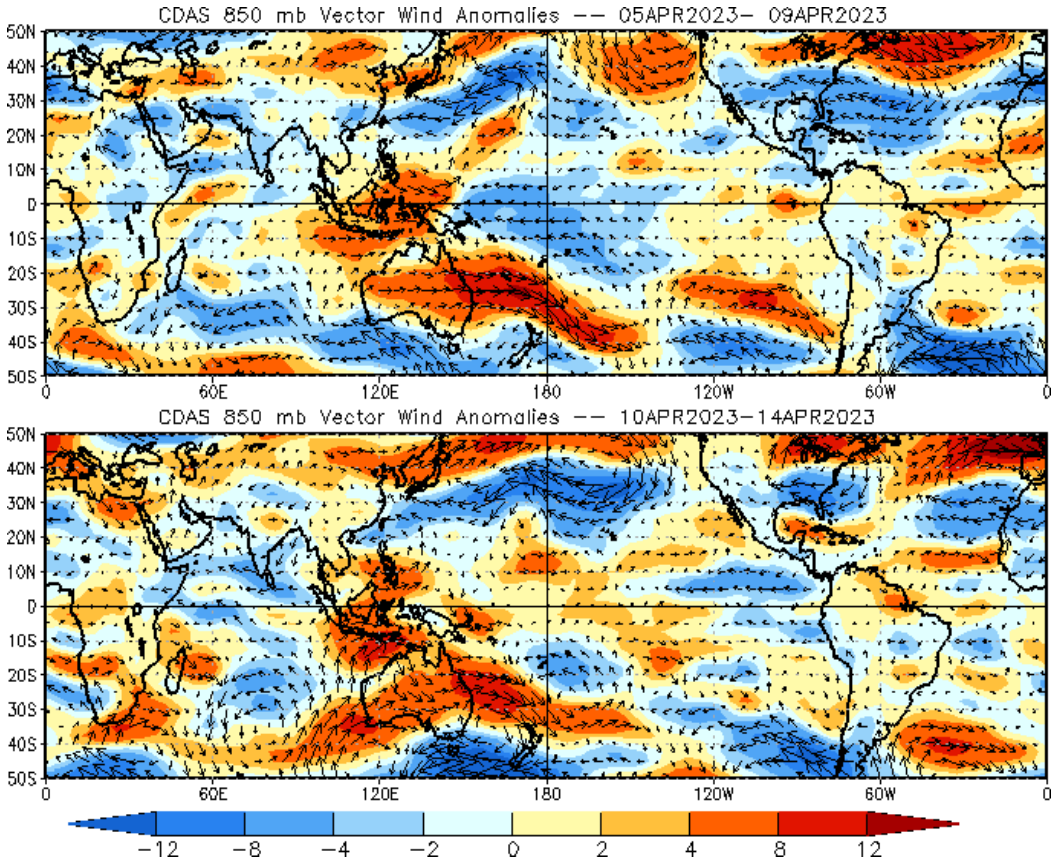


- MJO activity is apparent in the upper-level zonal wind anomalies, with clear eastward propagation of an envelope of westerly anomalies crossing the Indian Ocean and Pacific during March and April.
- Westerly anomalies have persisted near the Date Line, somewhat disrupting the pattern more recently.
- Strong convergence over the eastern Indian Ocean appears related both to MJO activity and extratropical influences.

850-hPa Wind Anomalies

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

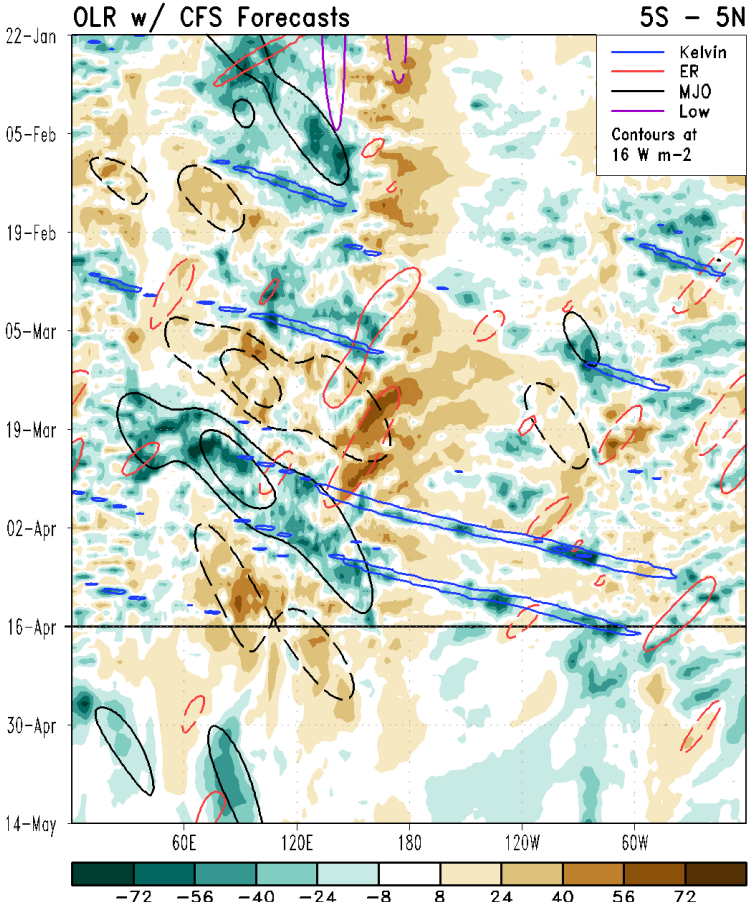


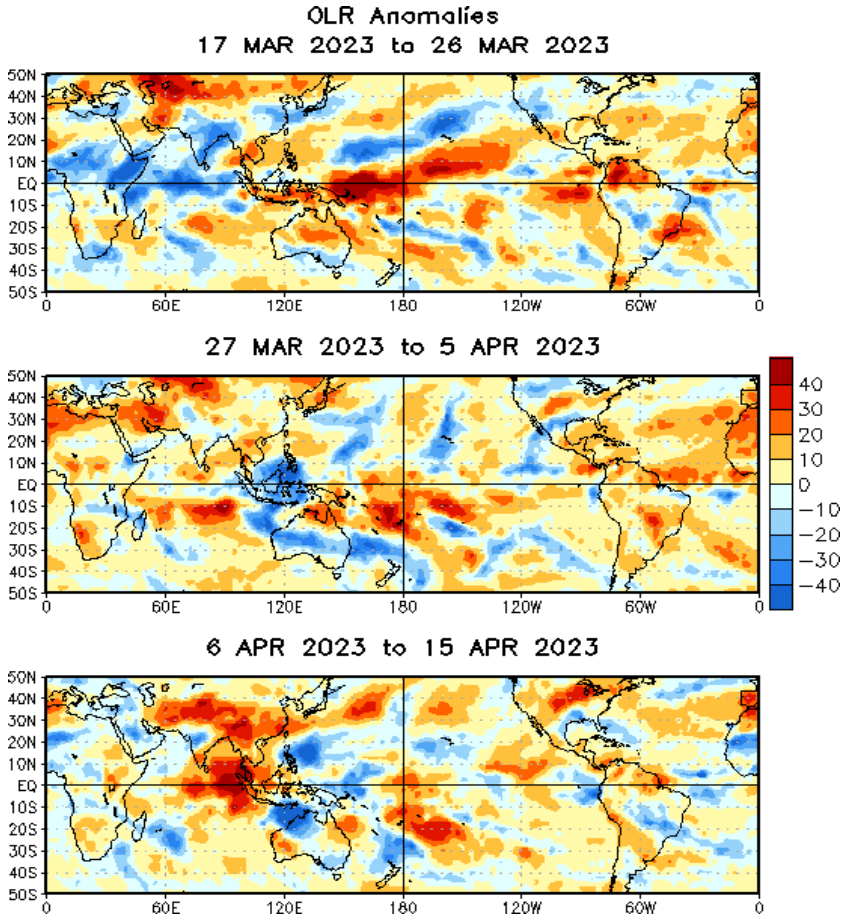


- MJO activity over the Pacific has resulted in a fairly widespread disruption of the trade wind regime.
- Strong westerlies remain entrenched over the Maritime Continent, due to Rossby wave activity spurred by extratropical influences.

Outgoing Longwave Radiation (OLR) Anomalies

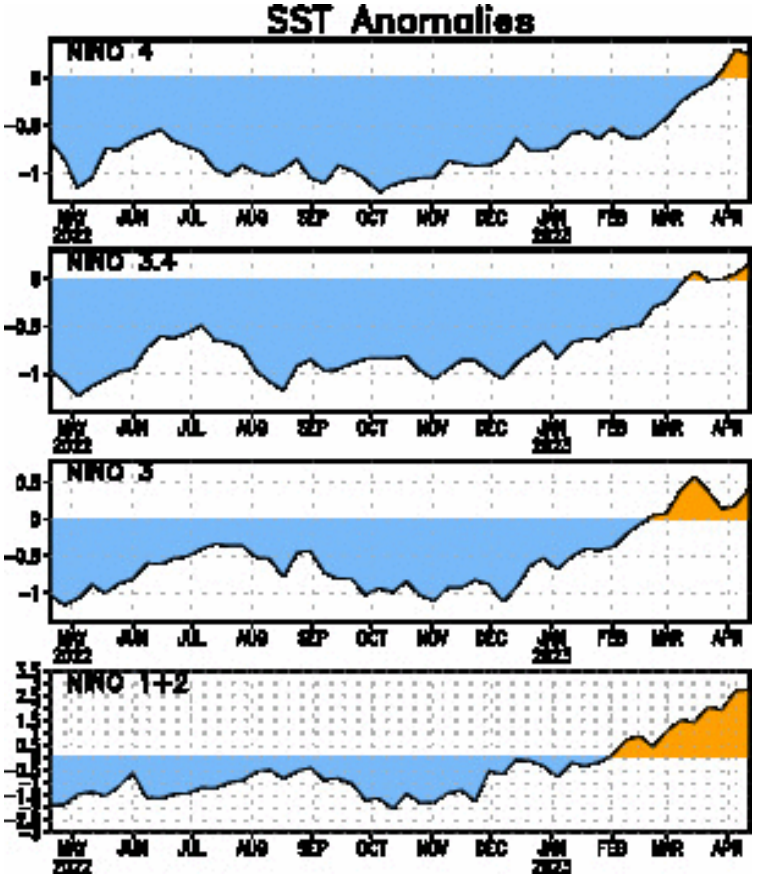
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

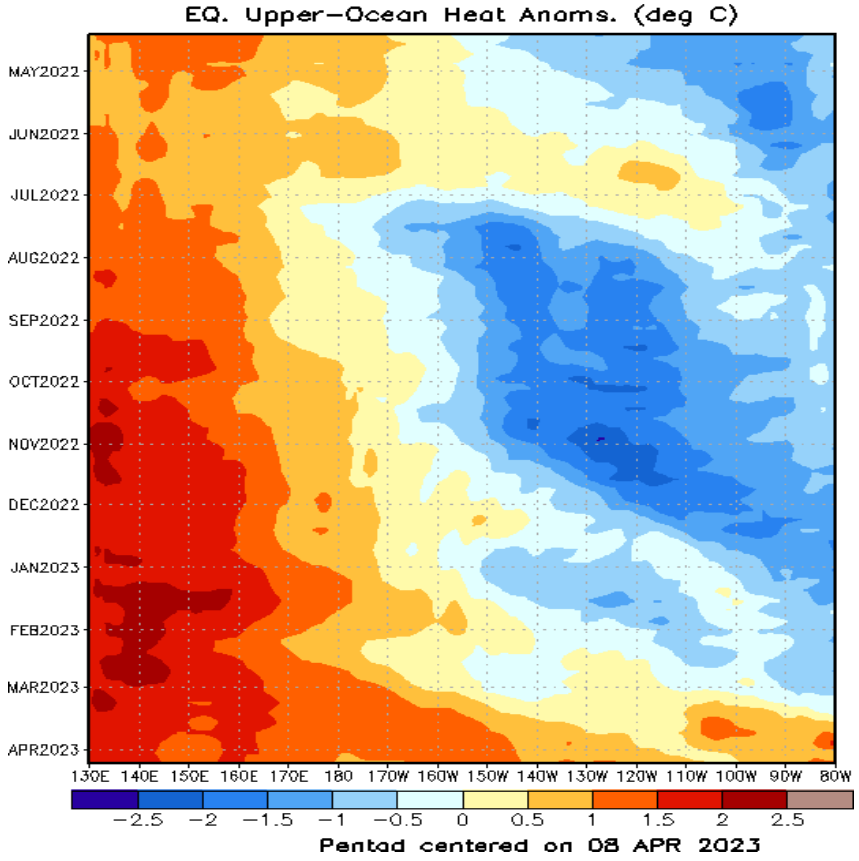




- The MJO enhanced convective phase was strongly apparent crossing the Indian Ocean and Maritime Continent during March and early April.
- More recently, the enhanced convective phase became more incoherent, with Kelvin waves crossing the Pacific ahead of the envelope, and a persistent suppressed signal remaining entrenched near the Date Line.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

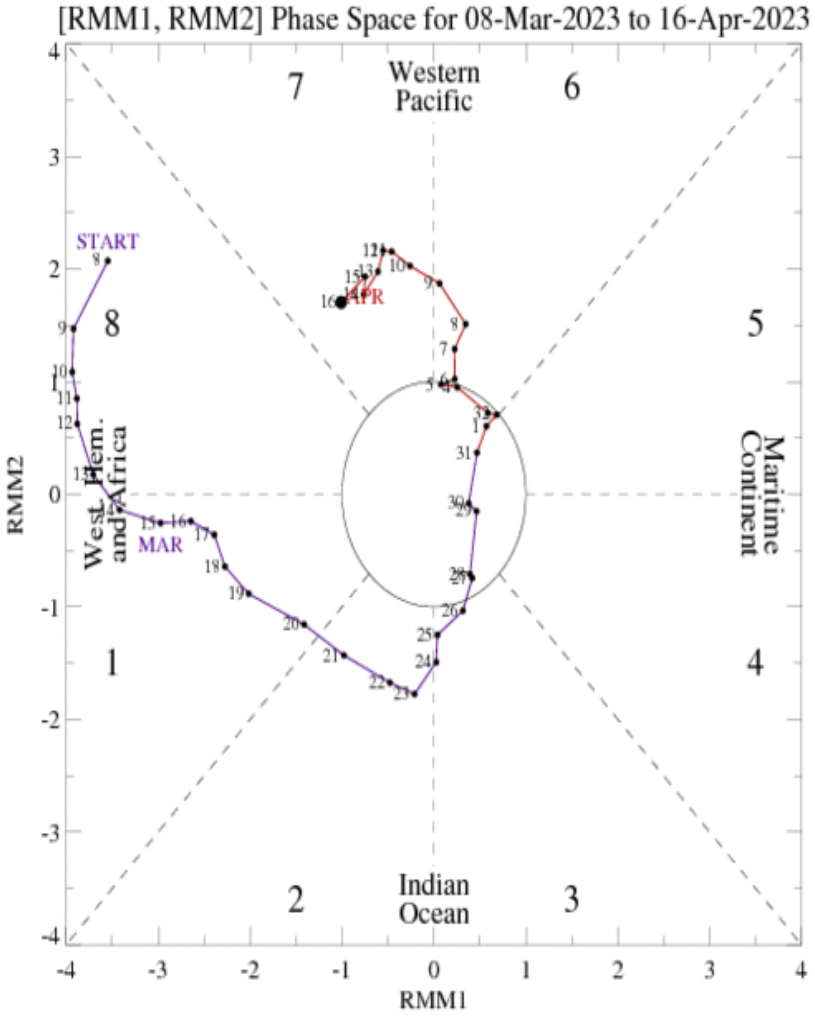




- MJO activity during early 2022 helped generate a series of downwelling oceanic Kelvin waves, bringing warm water from the strongly enhanced West Pacific warm pool across the entire basin.
- SSTs in all of the Niño basins are now above normal, reflecting the end of the long lasting La Niña event.

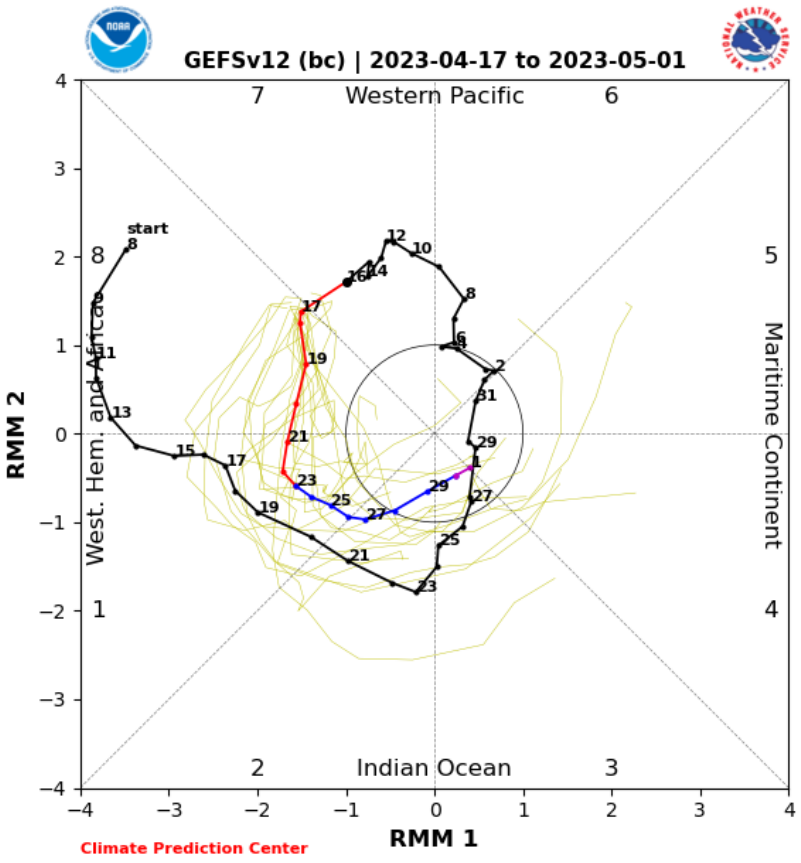
MJO Index: Recent Evolution

- The RMM-based MJO index reflects robust MJO activity, with the signal propagating from the Western Hemisphere during early March to the Indian Ocean by late March.
- Despite the weakened projection during late March and early April across the Maritime Continent, eastward propagation of the enhanced convective phase remained robust. The weakening may be partly due to the removed 120-day period mean continuing to reflect a strong La Niña response as the base state has more recently evolved towards an ENSO-neutral phase.
- More recently, the MJO has been crossing the Pacific, with a slowdown of the eastward propagation due to interference from other modes.

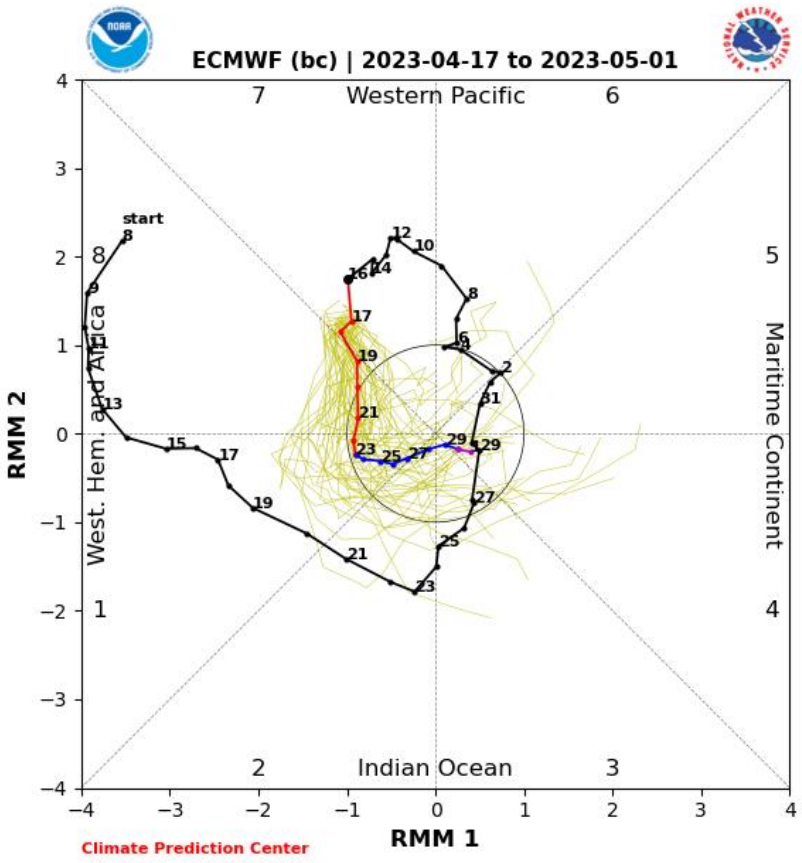


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

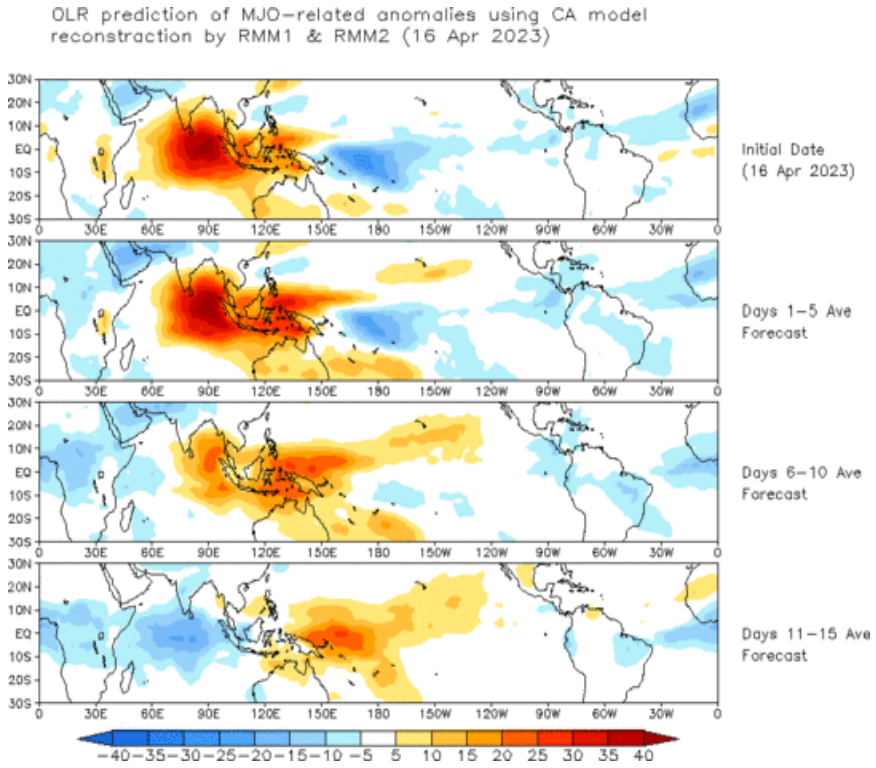


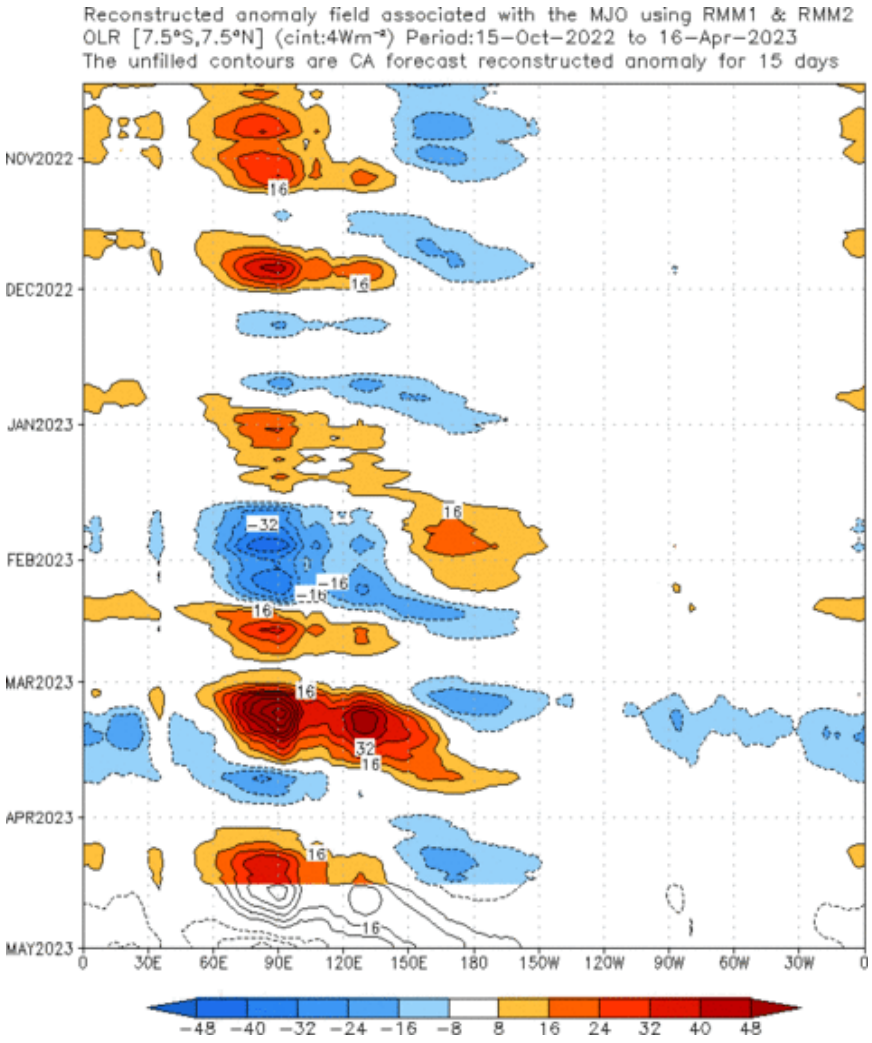
ECMWF Forecast

- Both the GEFS and ECMWF depict continued MJO evolution over the next week, with the enhanced convective phase crossing the Western Hemisphere.
- The GEFS shows a robust MJO event crossing the Indian Ocean during Week-2, with some of the faster solutions reaching the Maritime Continent by the end of Week-2.
- The ECMWF reflects a weaker amplitude event overall, with a potential for disruption of the signal during Week-2, potentially tied to Rossby wave activity over the Indian Ocean.

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.)

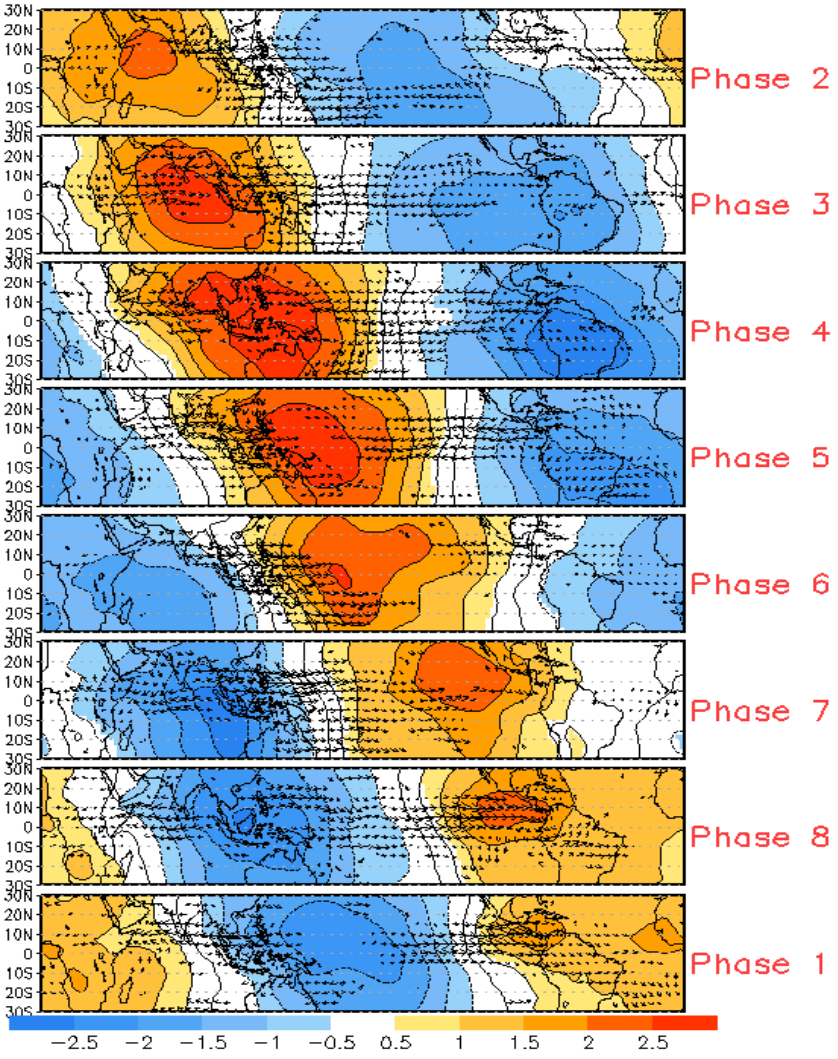




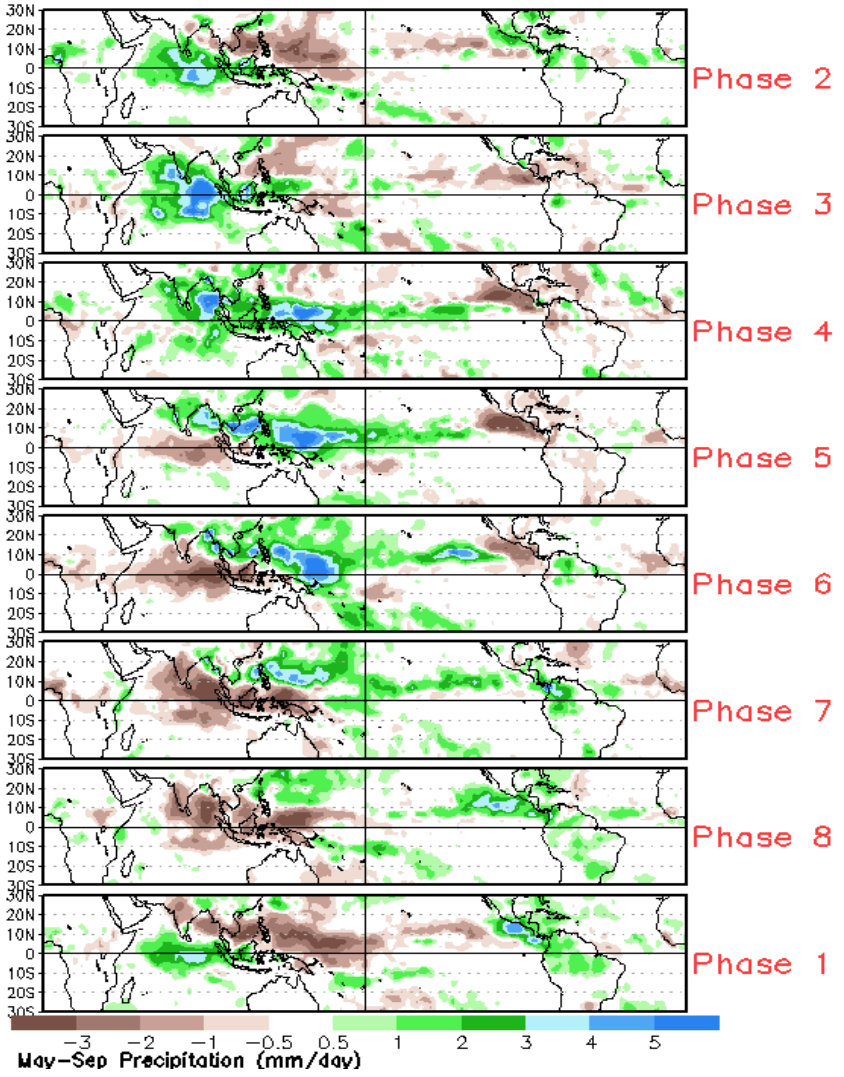
- The constructed analog RMM-based forecast reflects strong MJO activity, with the enhanced convective phase crossing the Western Hemisphere and returning to the Indian Ocean over the next two weeks.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



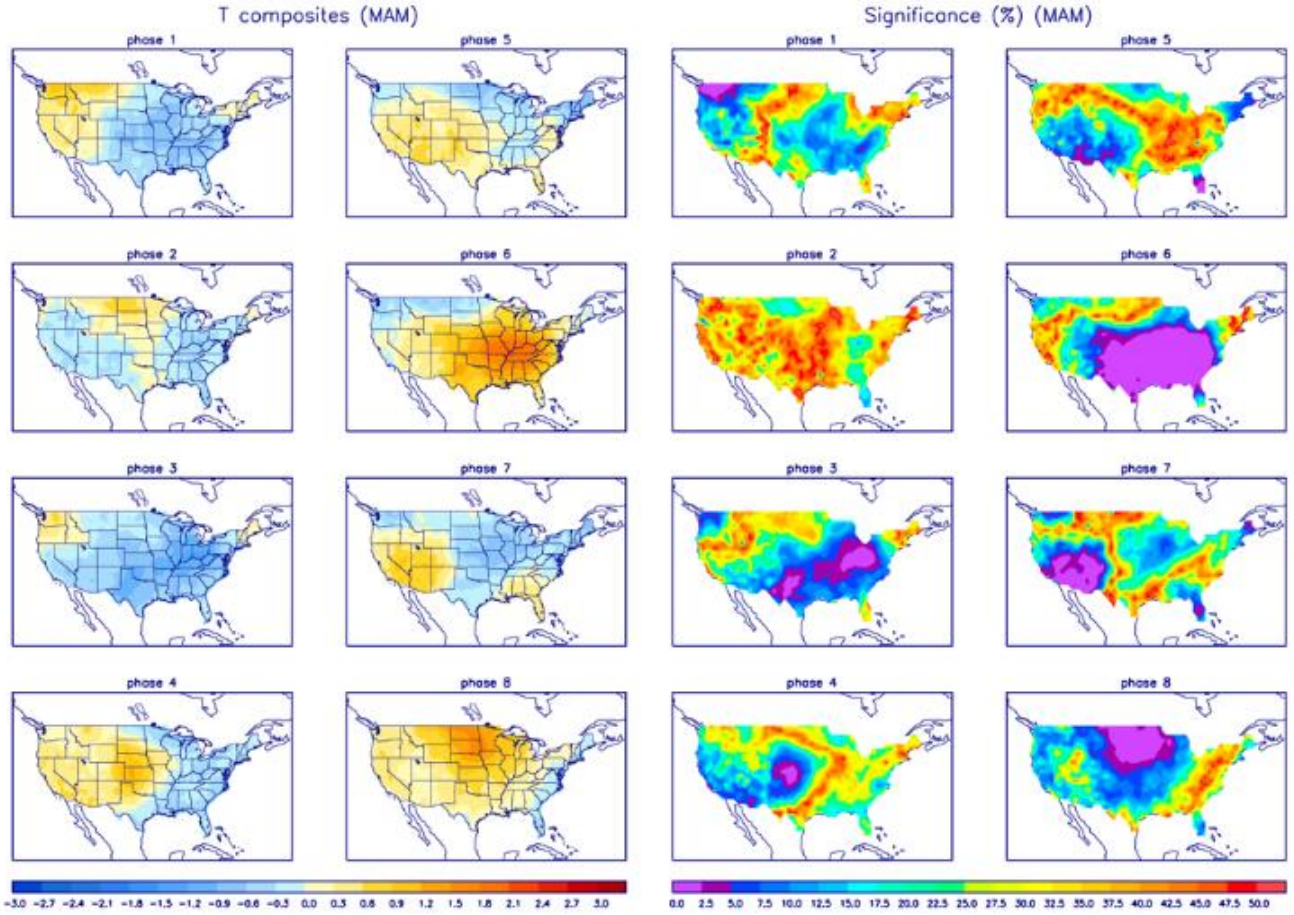
Precipitation Anomalies



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.

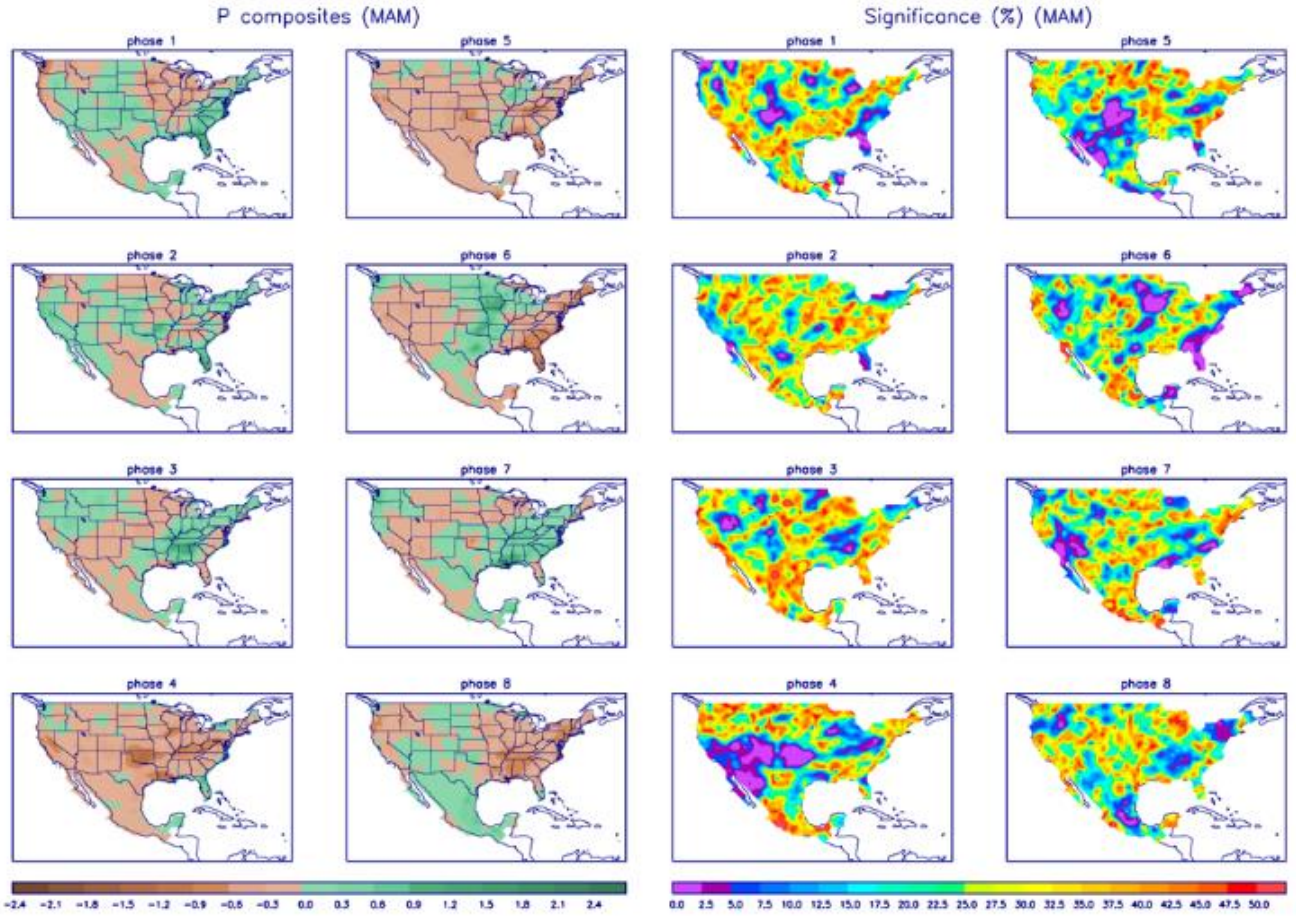


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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.



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