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

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

Overview

- Evident Madden-Julian Oscillation (MJO) activity continues after a robust signal during March. Tropical tropospheric zonal wind anomalies are now more reflective of MJO activity than the previously dominant La Niña base state.

- Enhanced convective envelope is currently situated over Western Pacific, with suppressed conditions over the Indian Ocean. Model guidance generally favors a continued eastward propagation of MJO signal over the next two weeks.

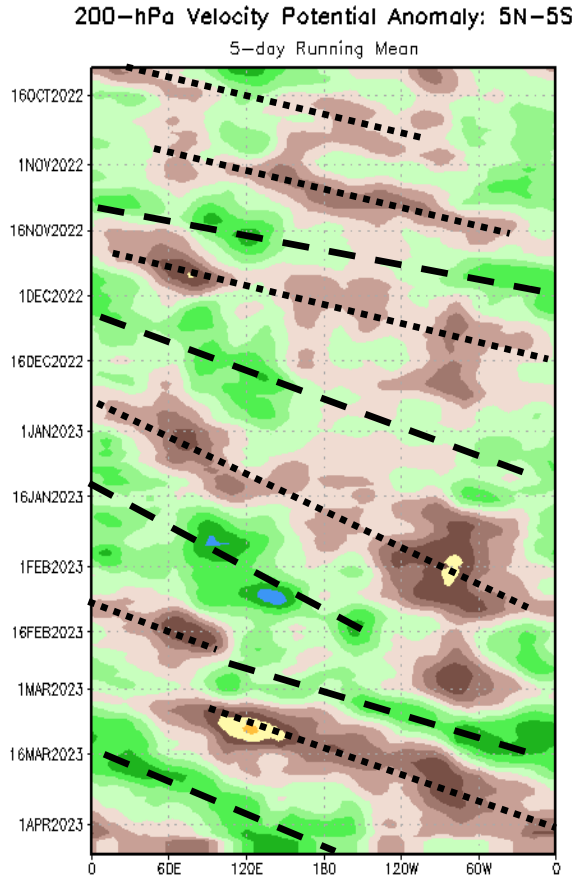
- Increased chances for tropical cyclone formation to the north of Australia and Western Pacific continue, while the evolving MJO increases chances for TC formation over the western Indian Ocean during week-2.

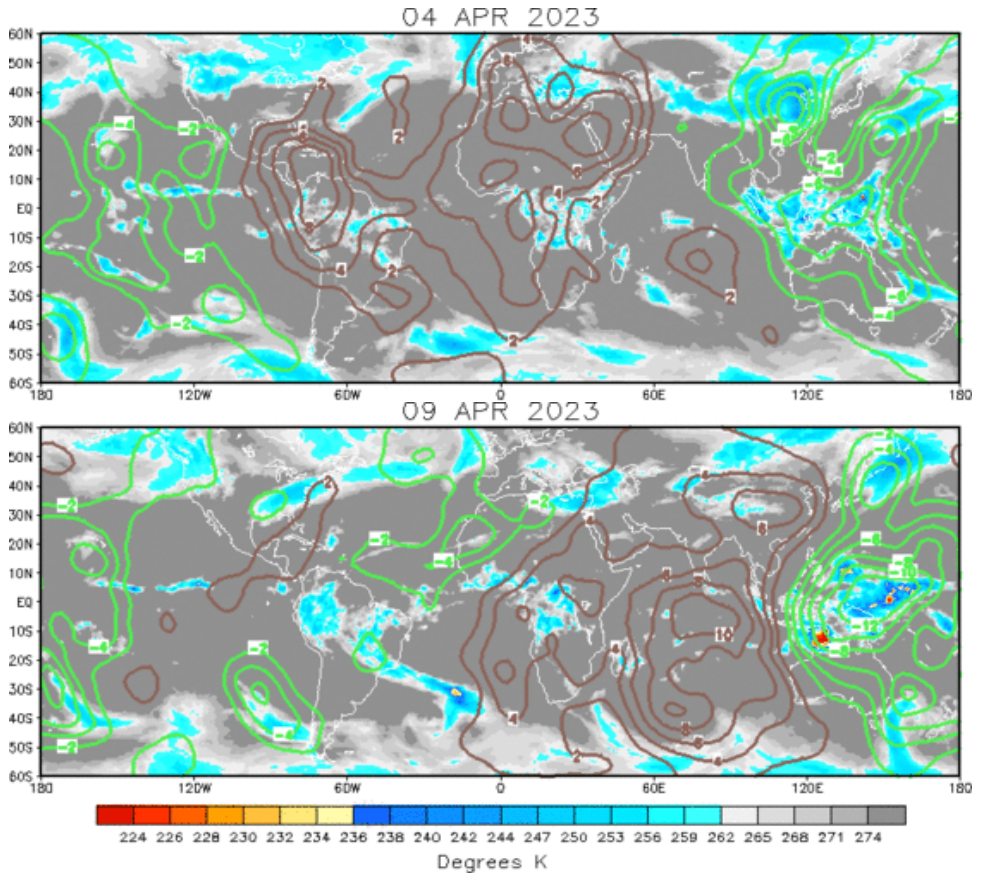
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

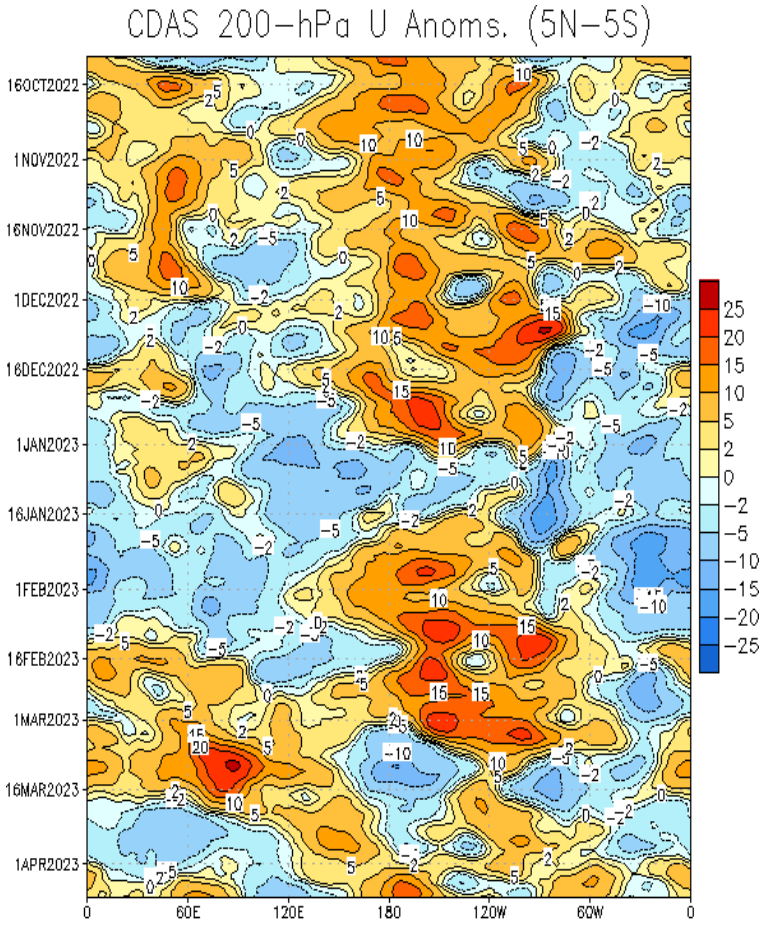


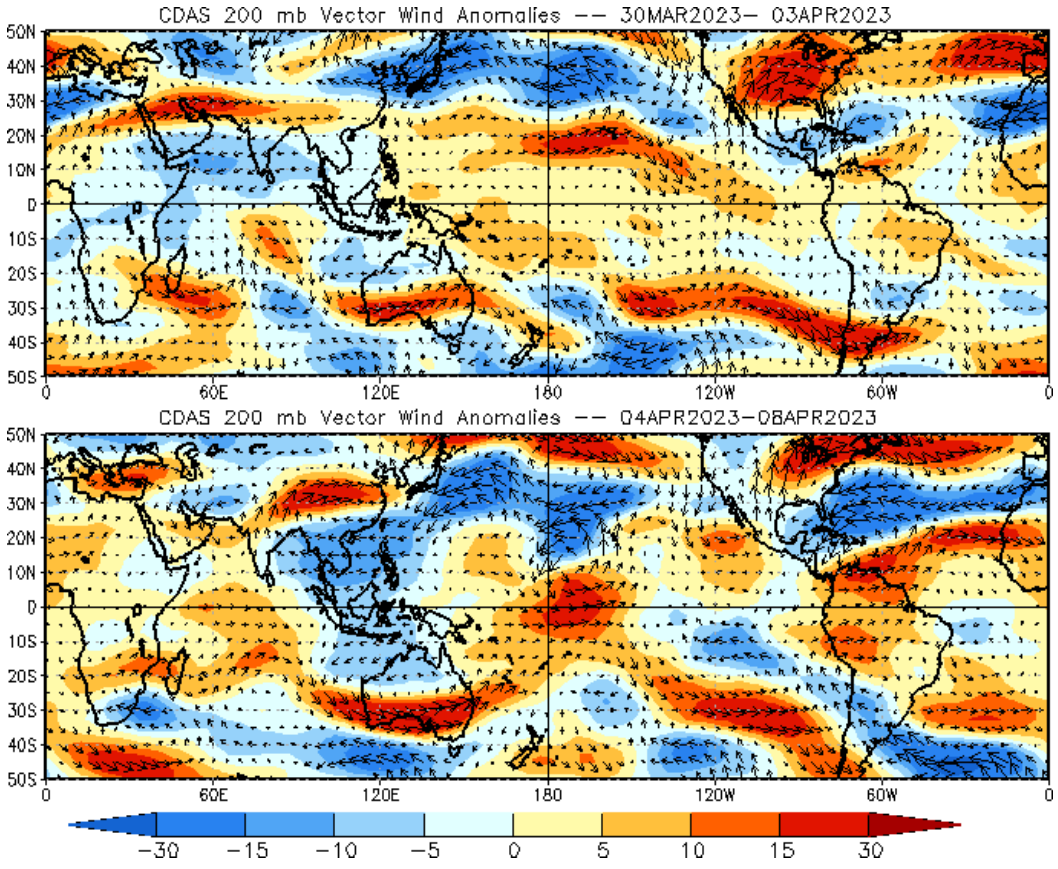


- Robust MJO activity since mid-January is evident in the Hovmoller plot, with a brief break-down in the second half of February. MJO has been especially strong during March.
- Wave-1 pattern is still evident in latest velocity potential anomalies, though there is a slight disruption over the Americas in the latest observation. Enhanced convective envelope is currently moving from the Maritime Continent into the Western Pacific.

200-hPa Wind Anomalies

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

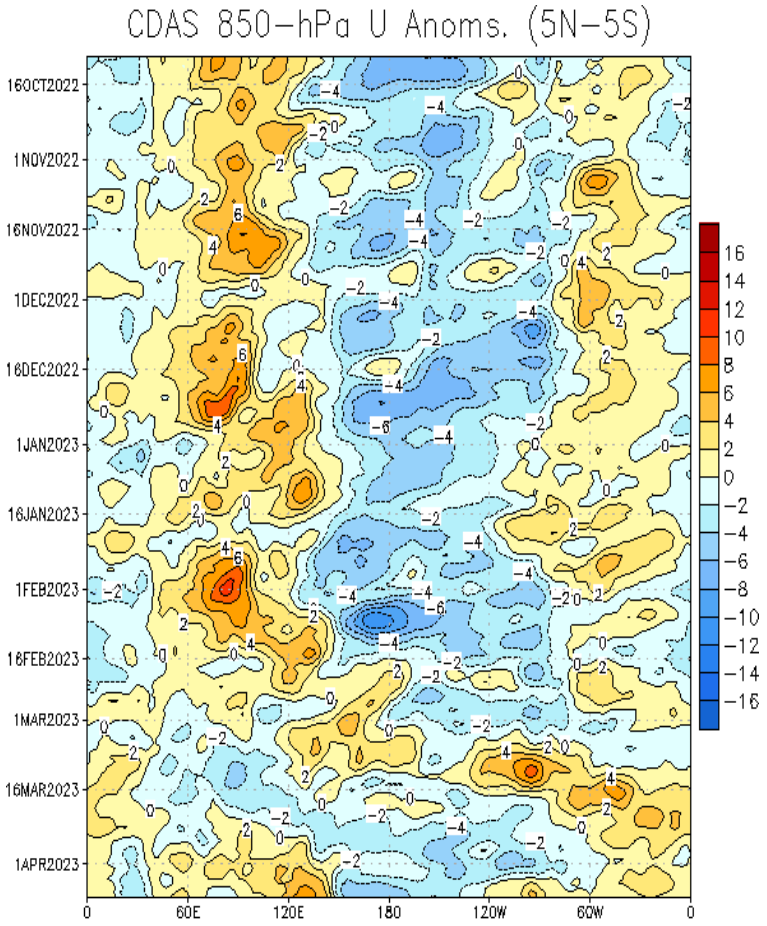


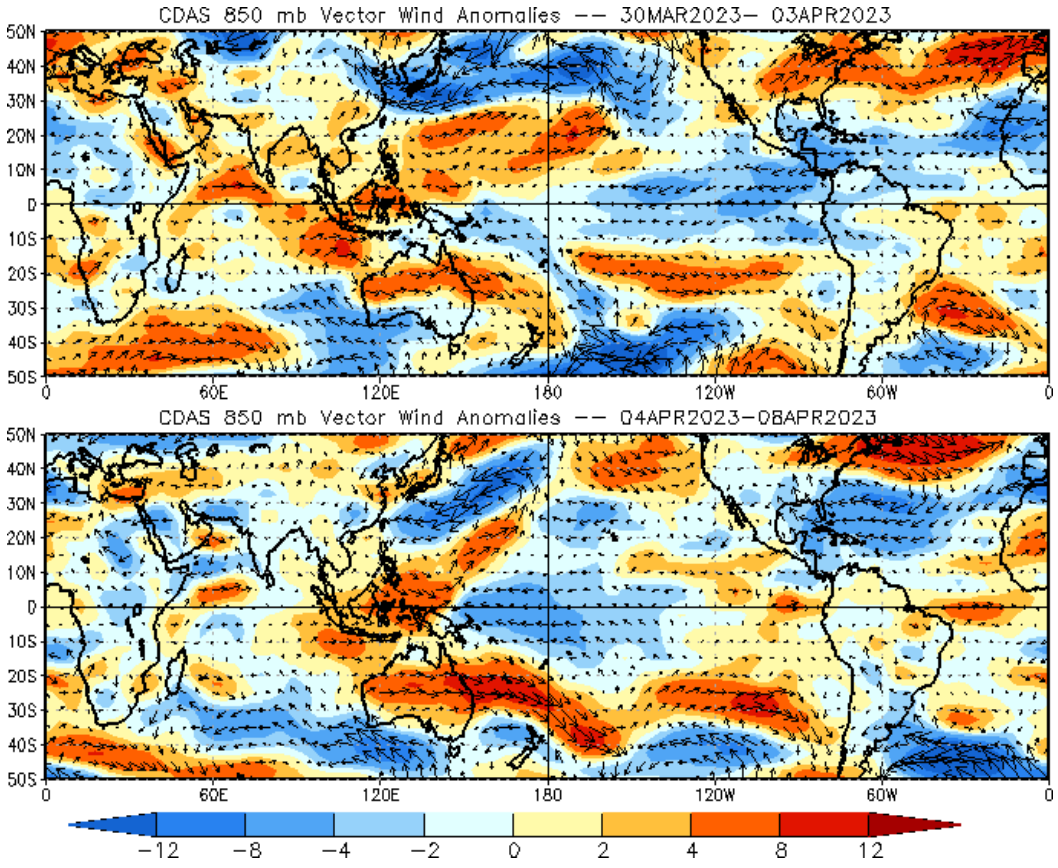


- After a long period of the 200-hPa zonal winds being dominated by the La Niña base state, upper-level wind anomalies are now coupling with MJO activity more closely, with eastward propagation of anomalous winds.
- A wave of anomalous westerlies has been moving eastward and is currently situated over the Date Line. A similar area of anomalous easterlies is trailing and is currently over the Maritime Continent.

850-hPa Wind Anomalies

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

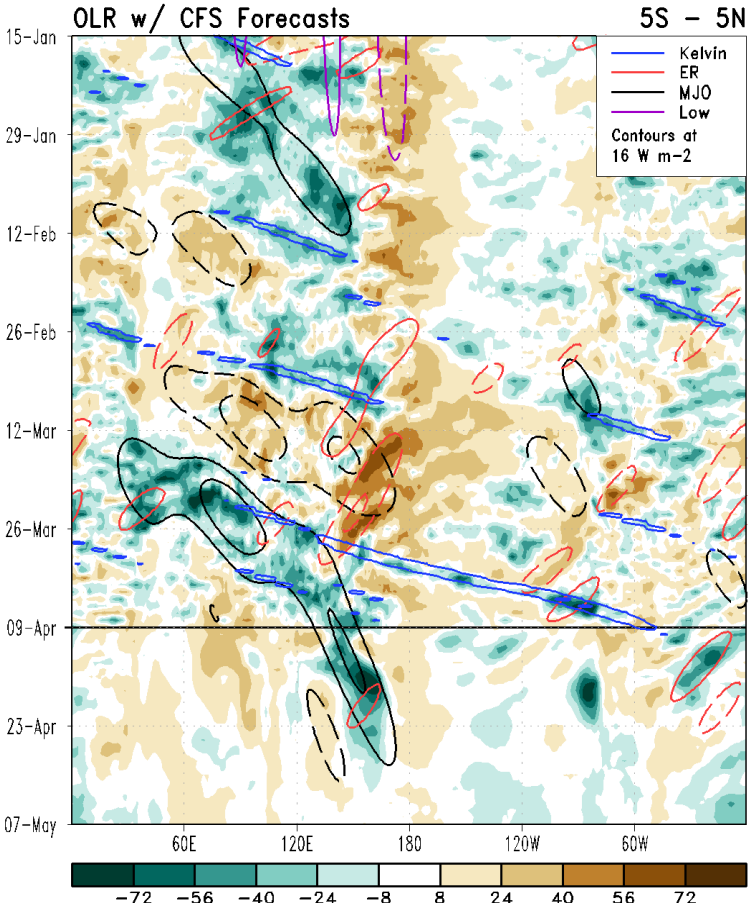


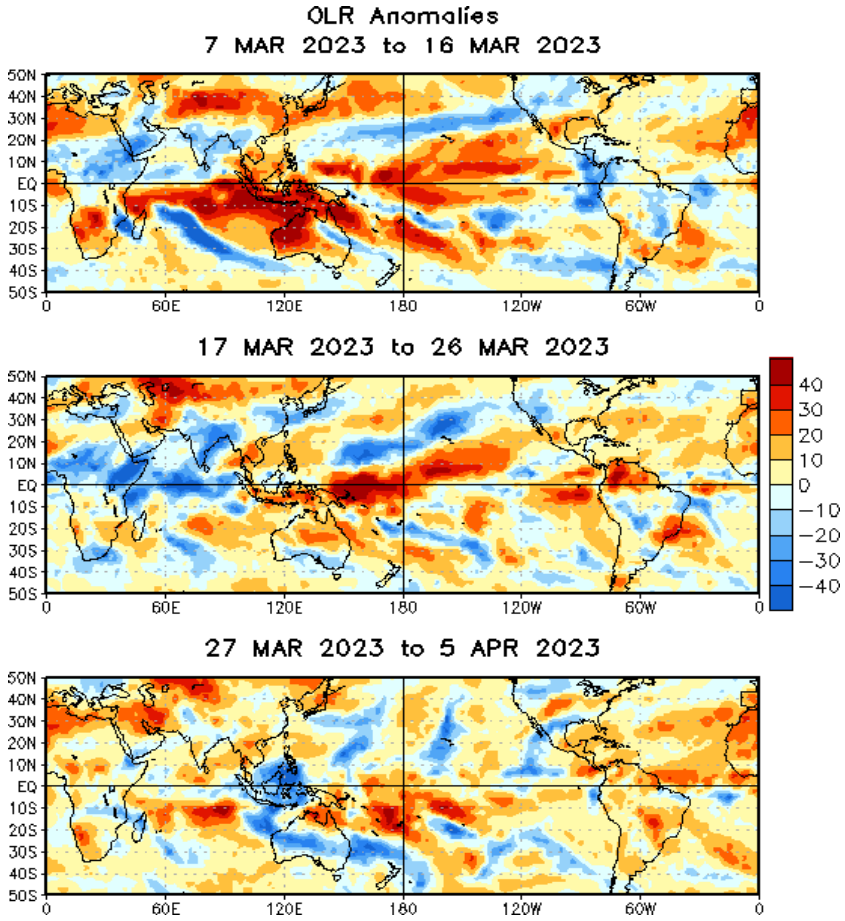


- A similar regime change is seen in the 850-hPa zonal anomalies, with a long period dominated by enhanced Pacific trade winds yielding to eastward-propagating westerly wind anomalies.
- Anomalous easterlies over the Western Pacific and westerlies over the Maritime Continent result in enhanced low-level convergence over New Guinea.

Outgoing Longwave Radiation (OLR) Anomalies

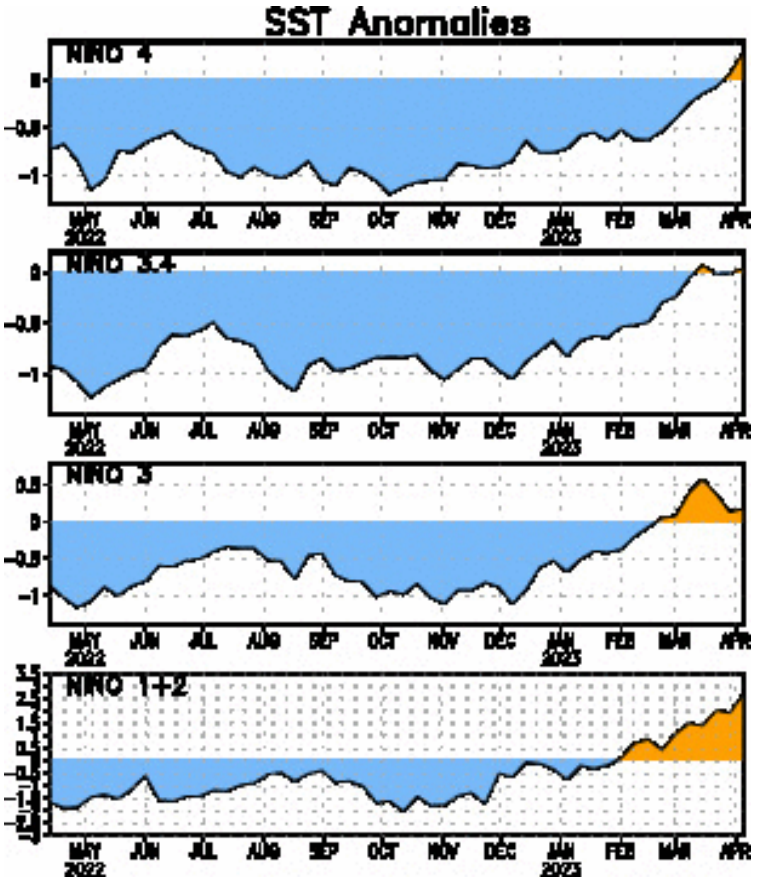
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

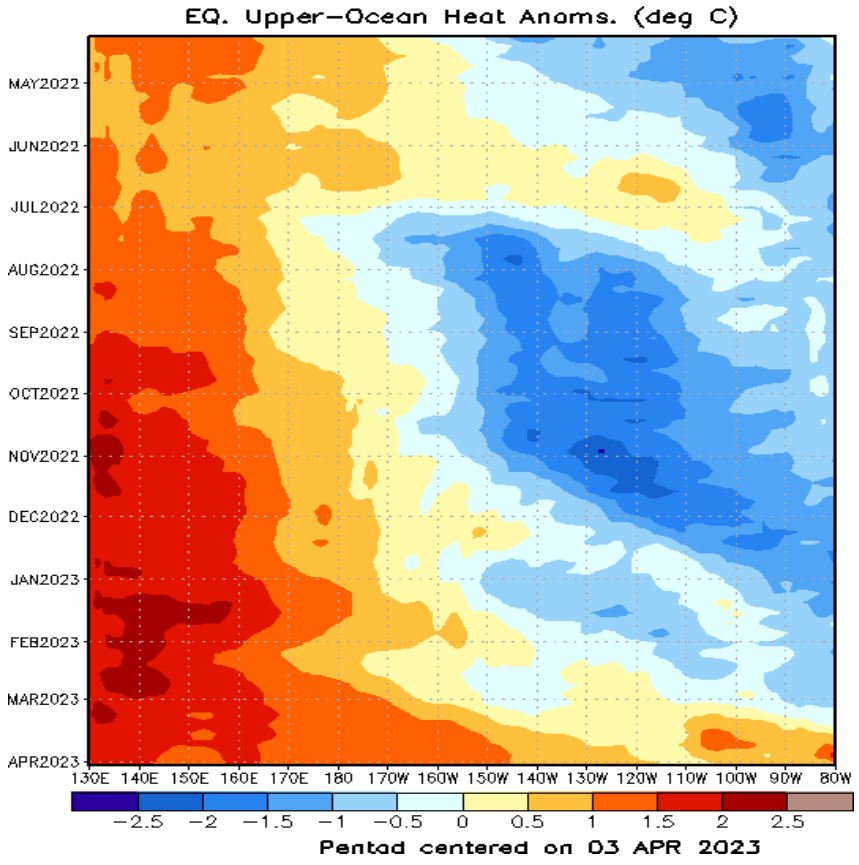




- Robust MJO activity is evident in OLR anomalies as well. In mid-March suppressed (enhanced) convection was widespread over the Indian Ocean and the Maritime Continent (Africa). By early April the suppressed (enhanced) convection has shifted eastward to the Date Line (Maritime Continent).
- The magnitude of anomalous convective regions has diminished in the last week. Model guidance favors a strengthening of enhanced convective envelope in coming weeks.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

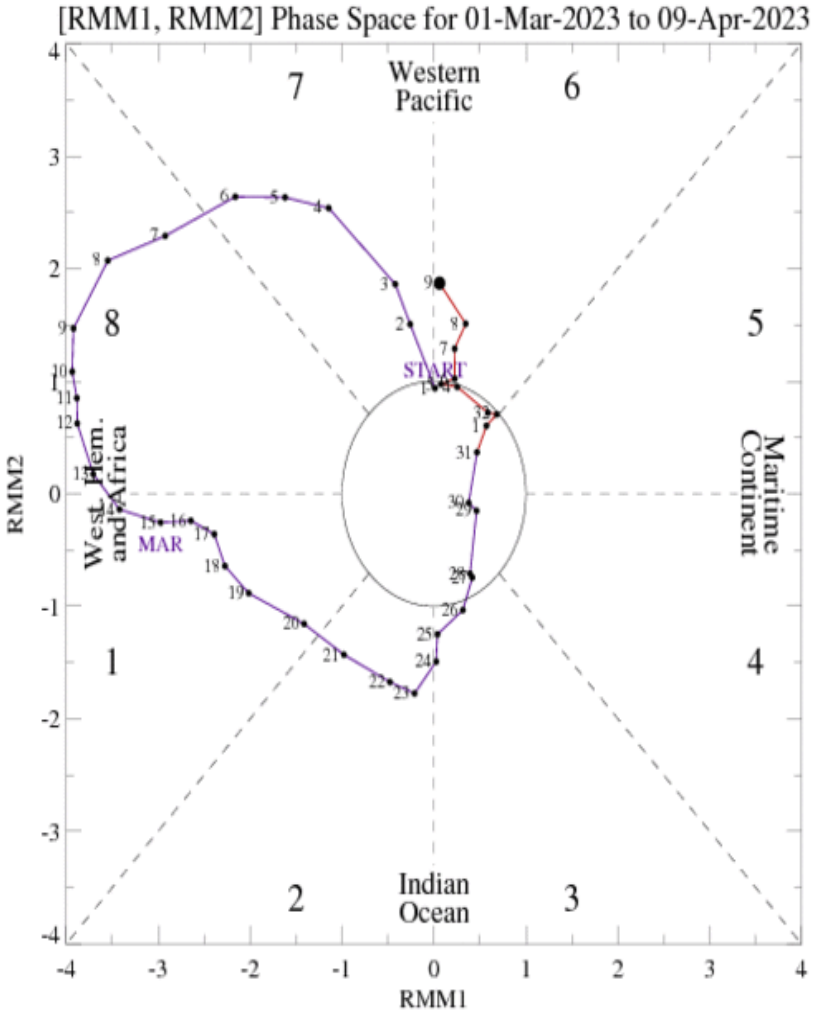




- Upper-ocean heat content is now above normal across the entire Pacific as a downwelling oceanic Kelvin Wave led to warming east of the Date Line, with more pronounced warming noted in the Eastern Pacific.
- SSTs in the Niño 1+2 and 4 regions continue to warm, while Niño 3 cooled somewhat in late March.

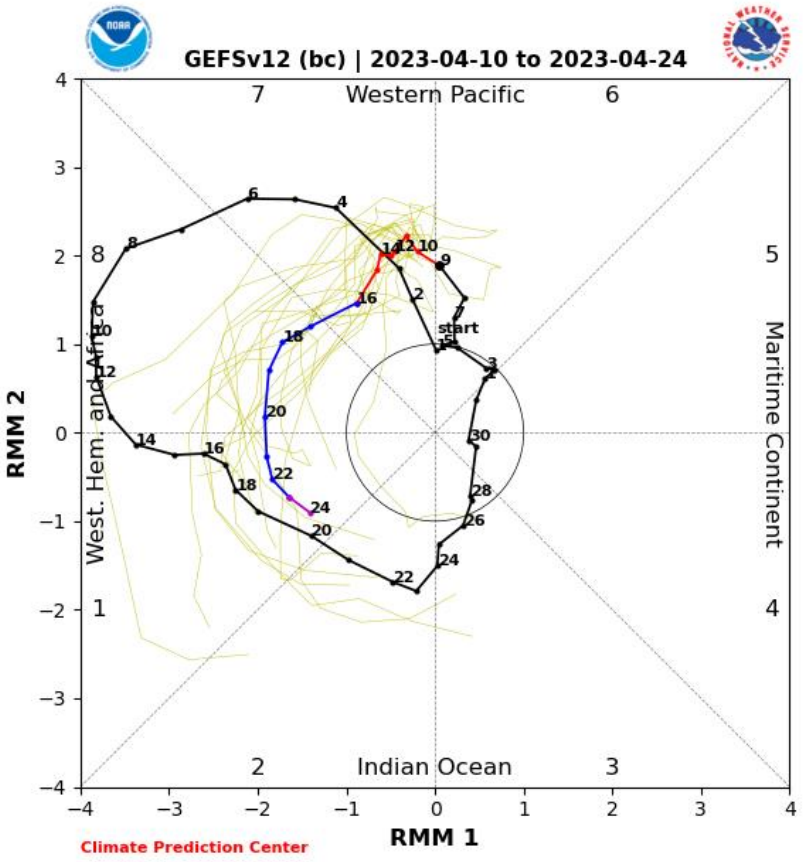
MJO Index: Recent Evolution

- A strong RMM-based MJO was apparent across the Western Hemisphere during March.
- MJO activity has remained robust despite the RMM index moving through the unit circle. There has been much discussion about the RMM index being displaced during the transition away from La Nina conditions, which may explain this incongruence.
- RMM index currently indicates MJO moving from phase 6 into 7, although a right shift would put the index closer to the 5-6 transition.

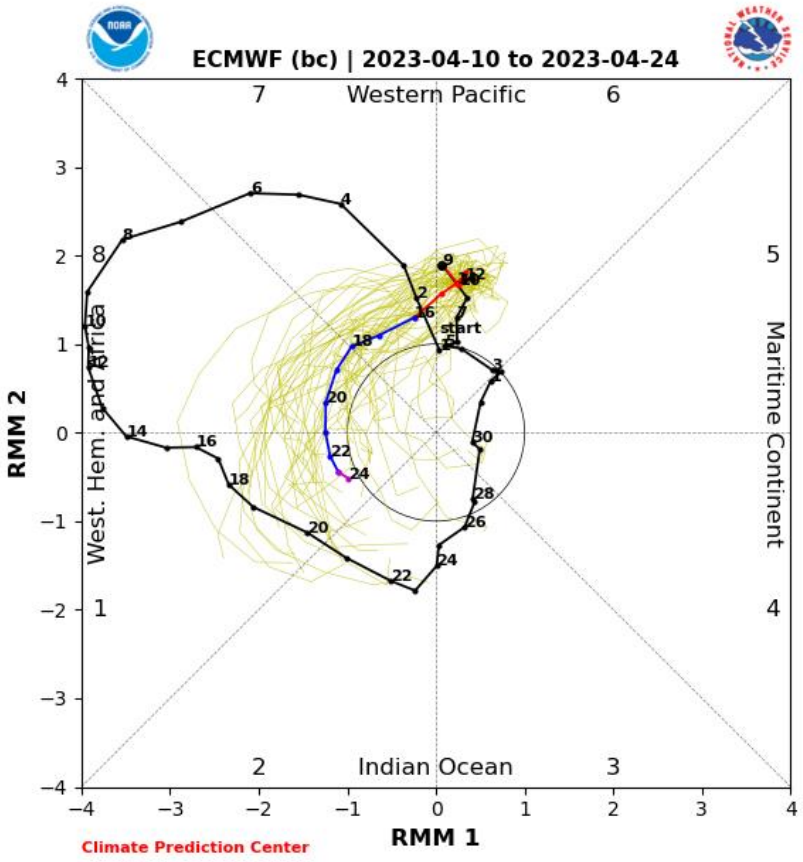


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

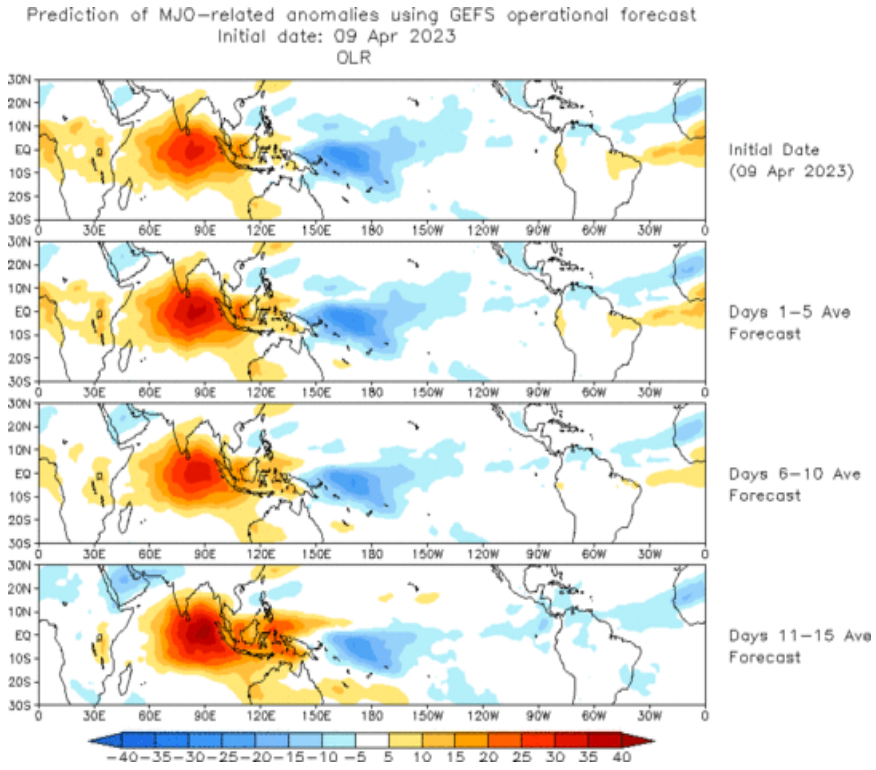


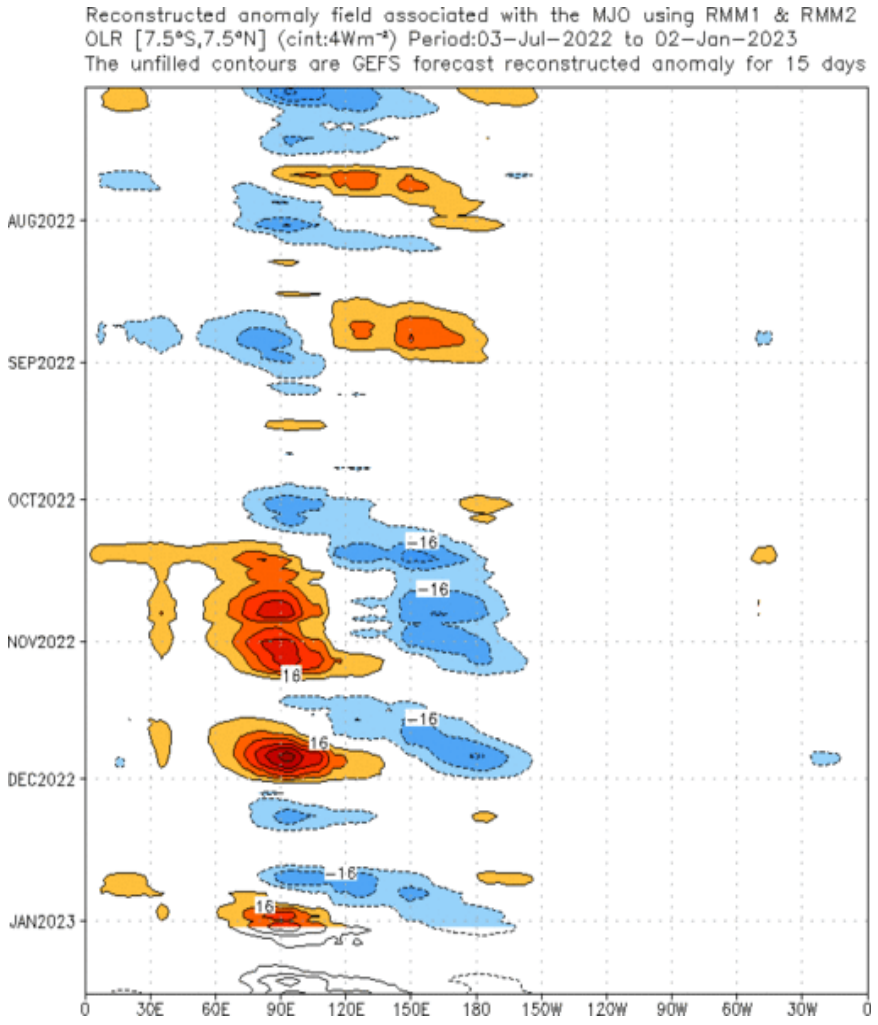
ECMWF Forecast

- The GEFS and ECMWF dynamical model ensembles are in good agreement regarding continued MJO propagation over the Western Pacific and into the Americas during the next two weeks.
- GEFS maintains a stronger signal, while the ECMWF favors a lower amplitude solution.

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.)

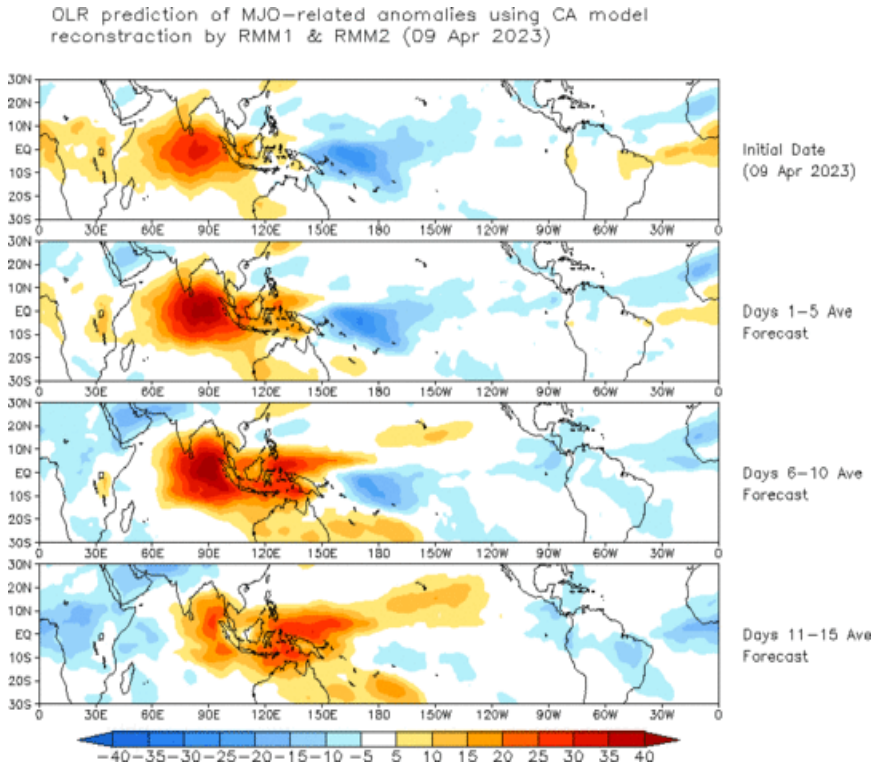


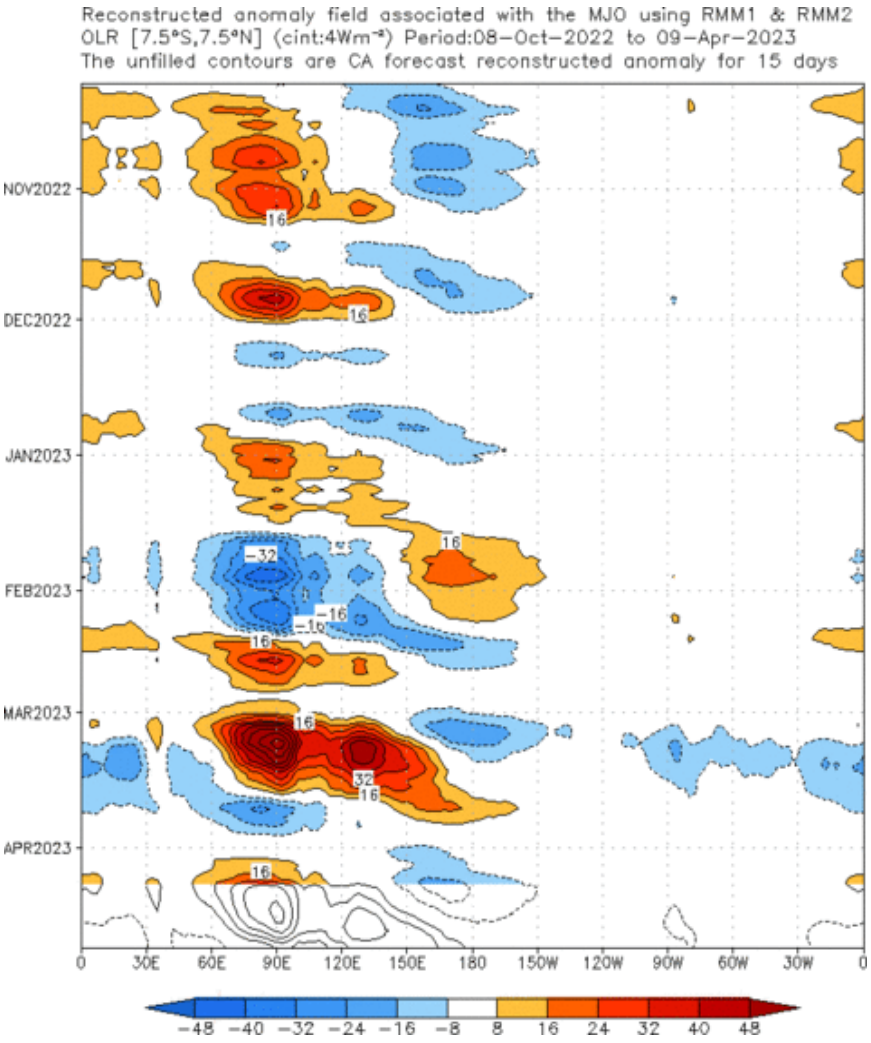


- The GEFS RMM-based forecast depicts a strong OLR dipole with suppressed (enhanced) convection over the Indian Ocean (Western Pacific).
- Intensity of dipole is maintained throughout the week-2 period, with very little eastward propagation.

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.)

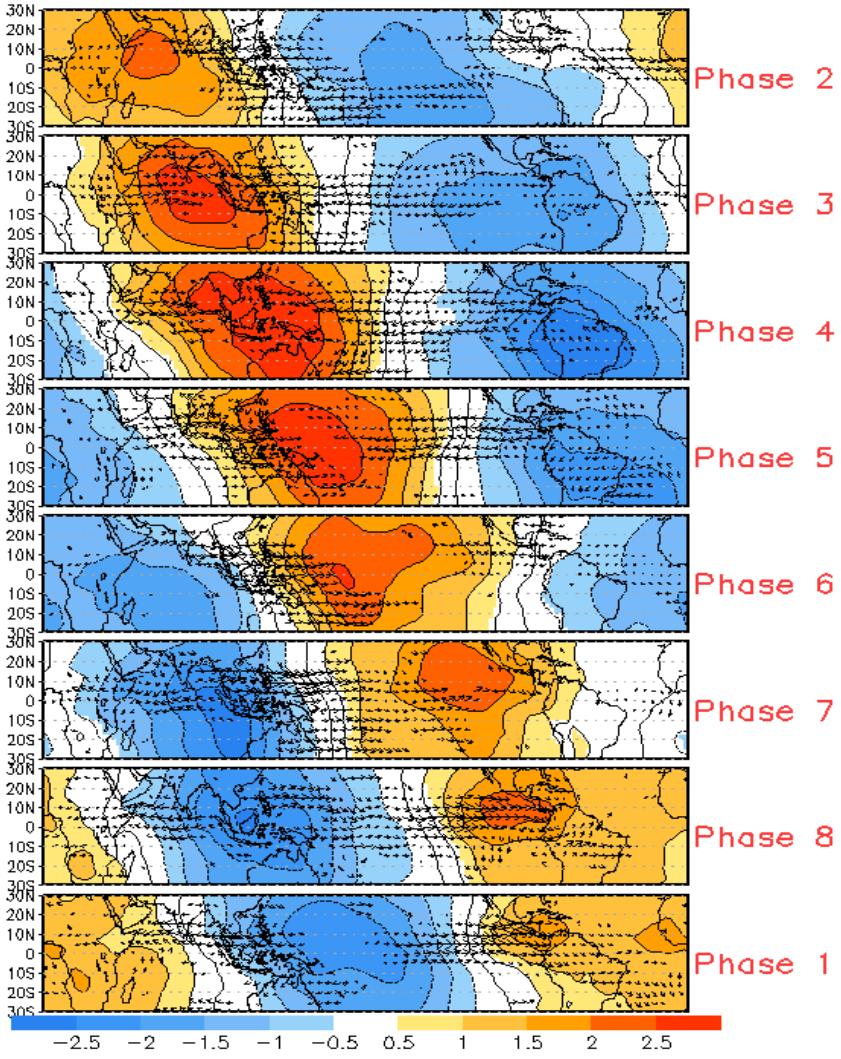




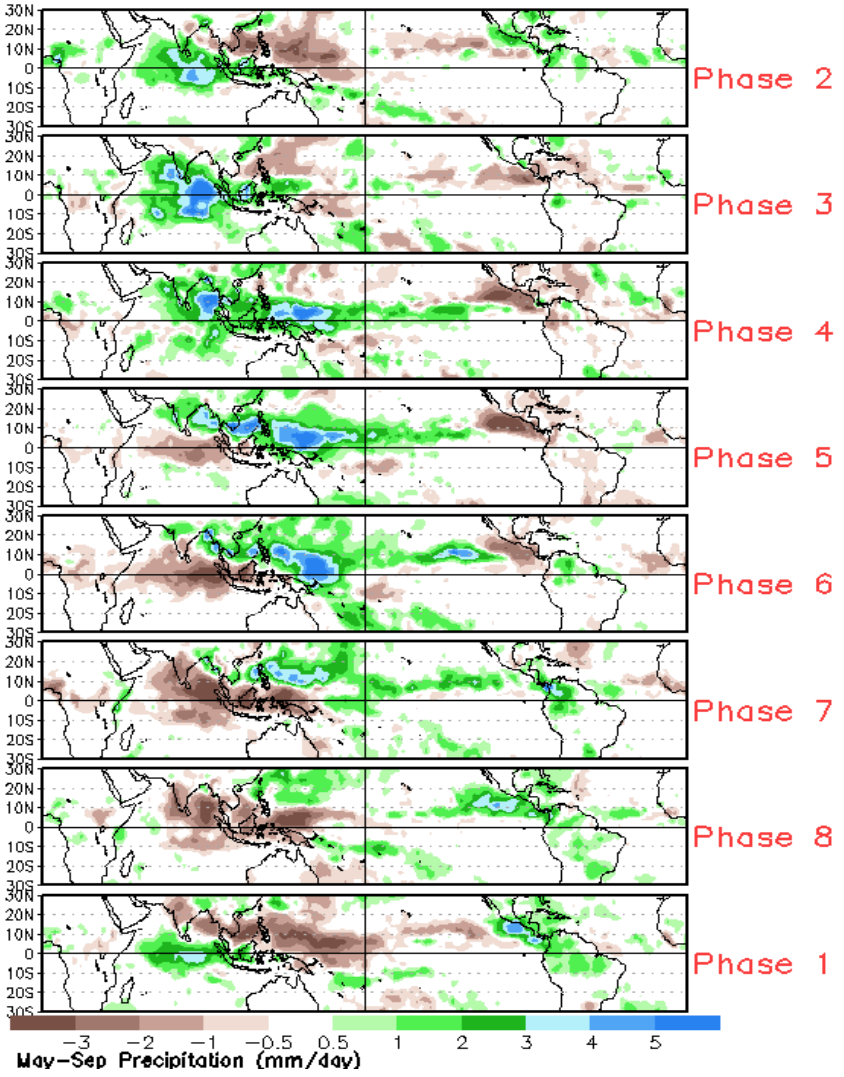
- The constructed analog RMM-based forecast more progressive than the GEFS, with eastward displacement of suppressed convection from the Indian Ocean into the Maritime Continent and re-development of enhanced convection over Africa.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



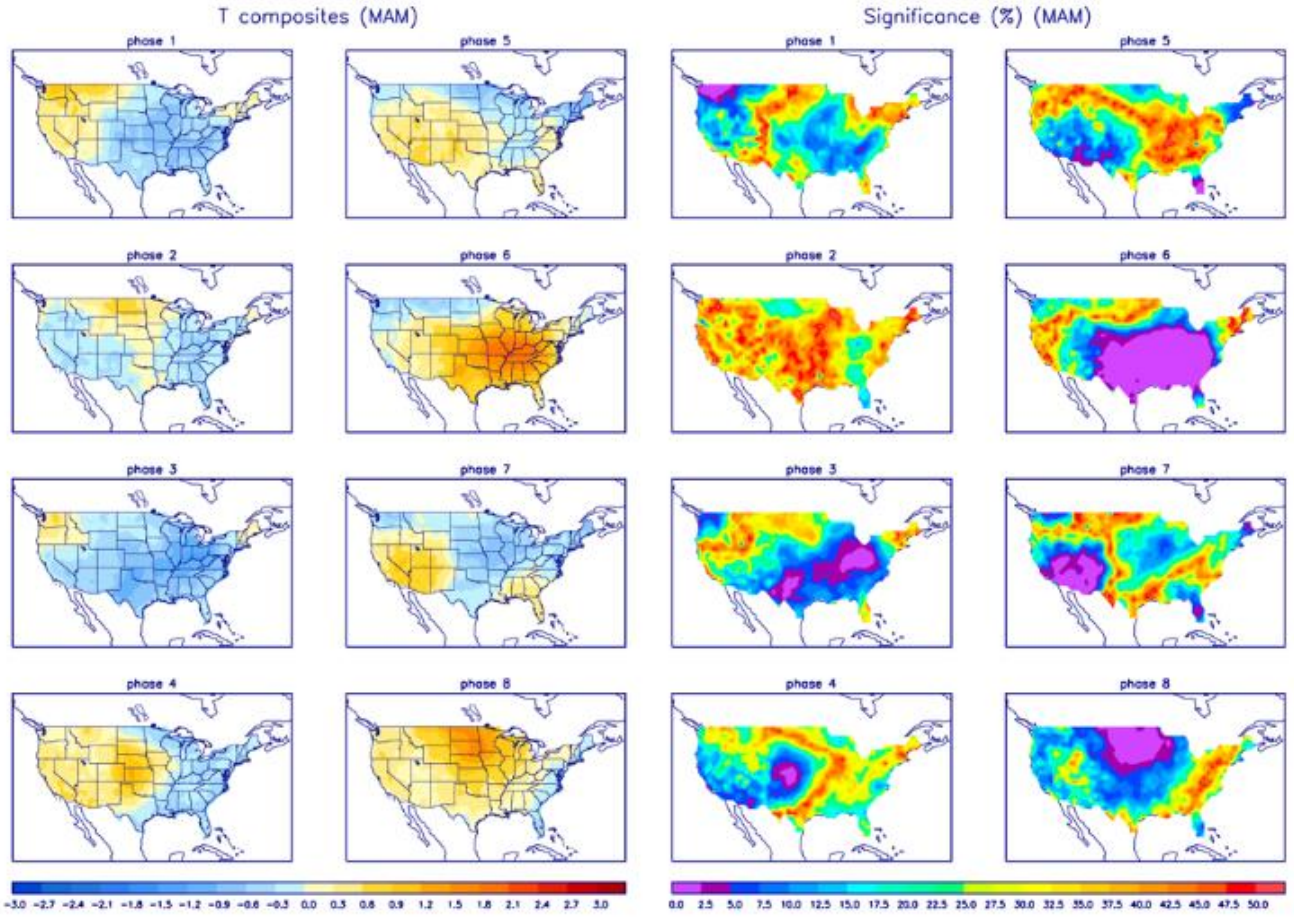
Precipitation Anomalies



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.

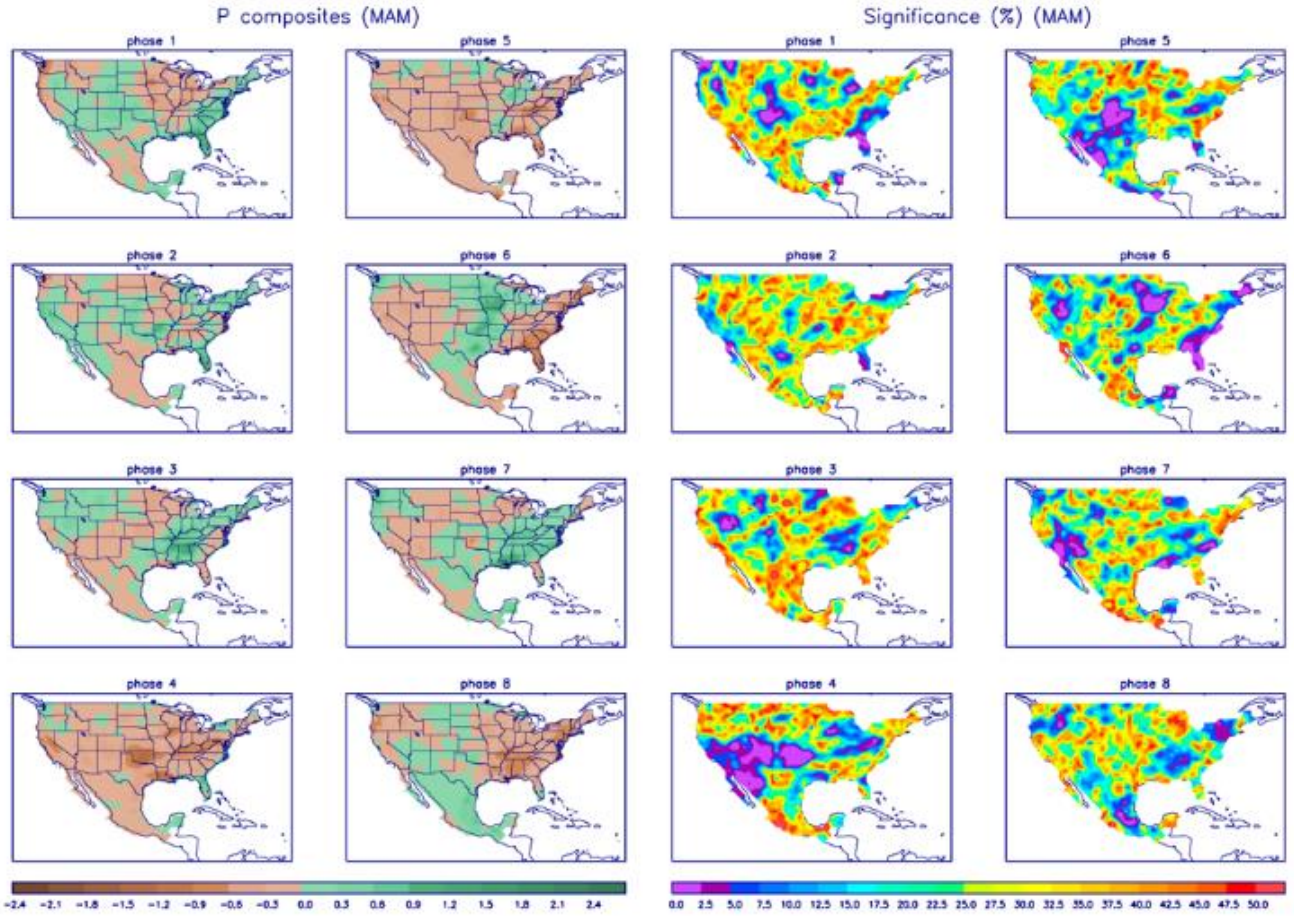


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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