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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
4 September 2023

Overview

- An active El Nino base state with increasing influence is dominating the tropics and is mostly drowning out any MJO activity, which is weak to begin with.

- Variability in tropical convection patterns is currently mostly coming from Kelvin and Rossby wave activity, both of which can play a role in tropical cyclone (TC) formation.

- Dynamical model MJO index forecasts depict a short-lived increase in signal amplitude before returning to a diminished state, with the RMM index staying mostly within the Maritime Continent quadrant.

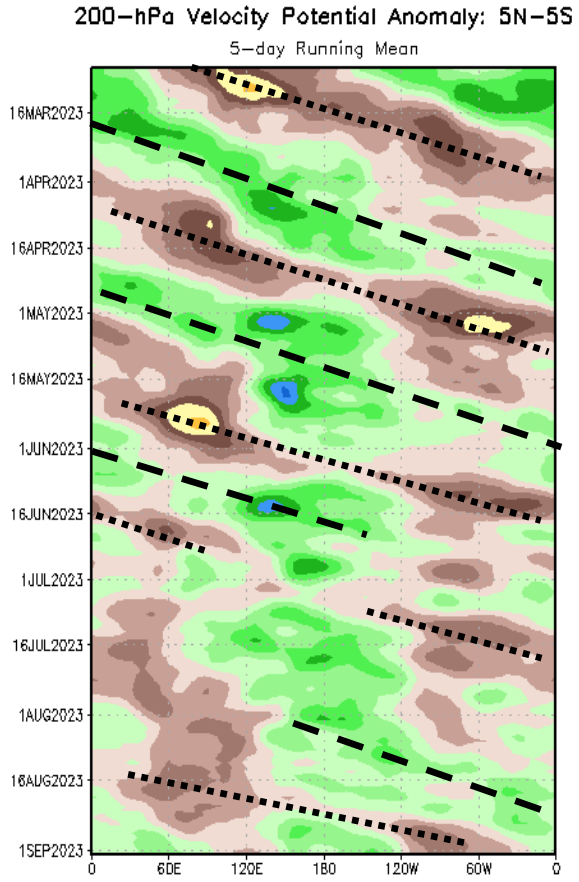
- Models indicate a slight reduction in the probabilities of TC formation for the East Pacific and Atlantic basins during week-2 before ticking up once again in week-3. With enhanced convection over the Maritime Continent, increased probabilities for TC genesis over the Western Pacific are indicated throughout the forecast period.

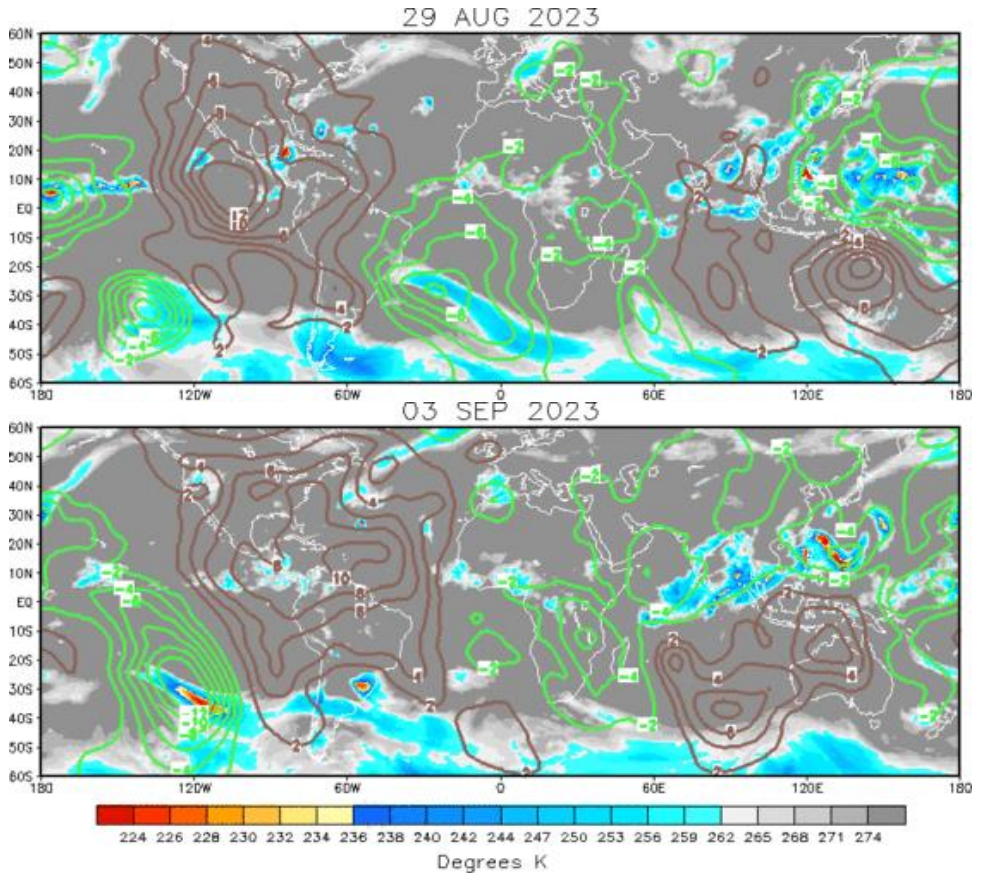
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)



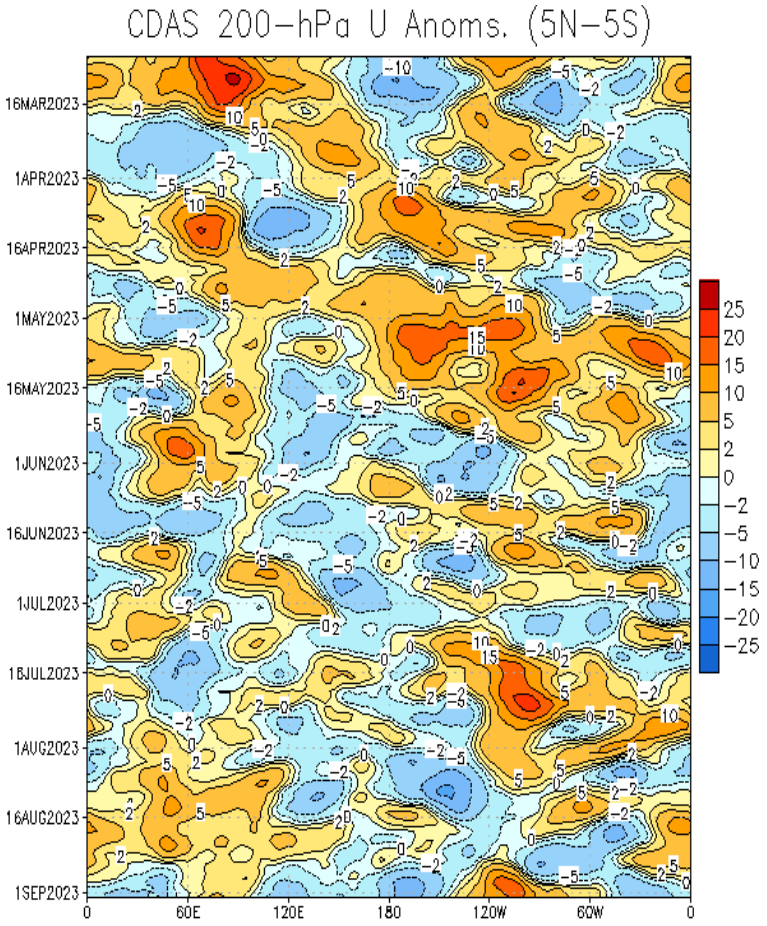


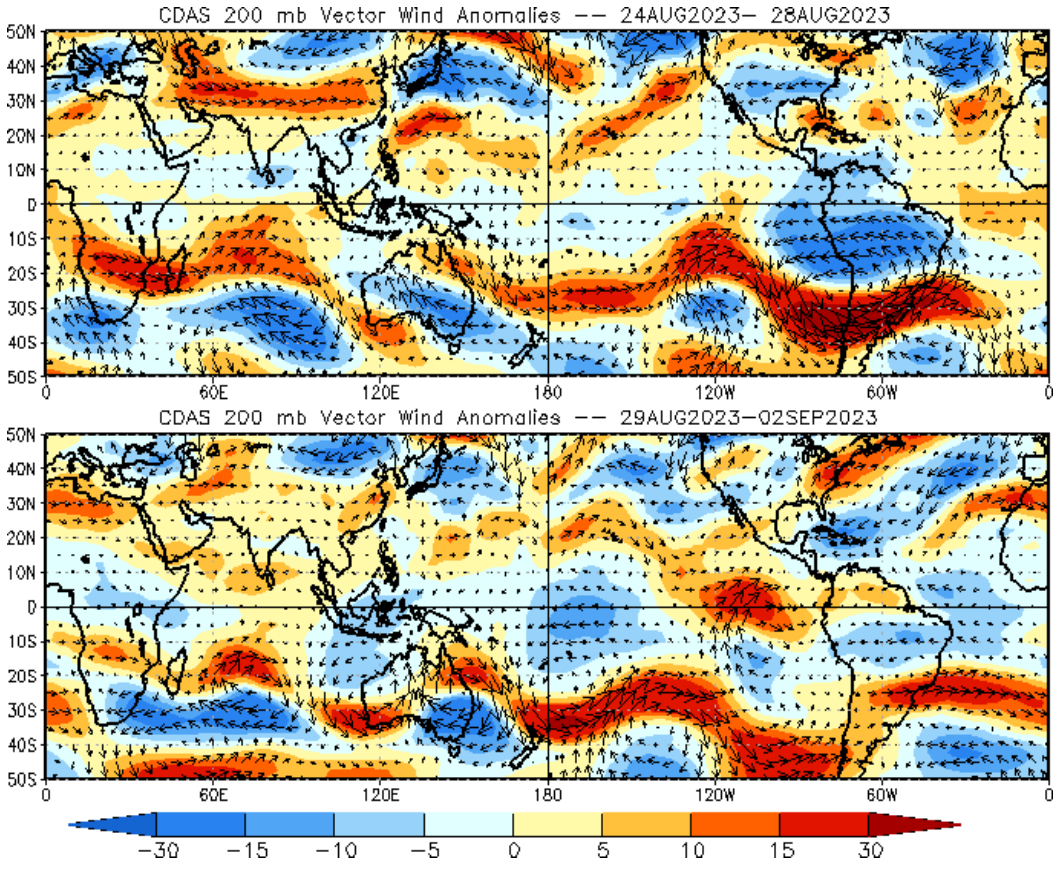
- Since mid-July, El Nino has become an increasingly dominant driver of global tropical convection, with quasi-stationary enhanced(suppressed) convection near the Date Line (over the Indian Ocean).

- Occasional Kelvin wave activity has emerged from the El Nino dipole and moved out into the Eastern Pacific, but organized MJO-like activity has been greatly diminished since the early summer.

200-hPa Wind Anomalies

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

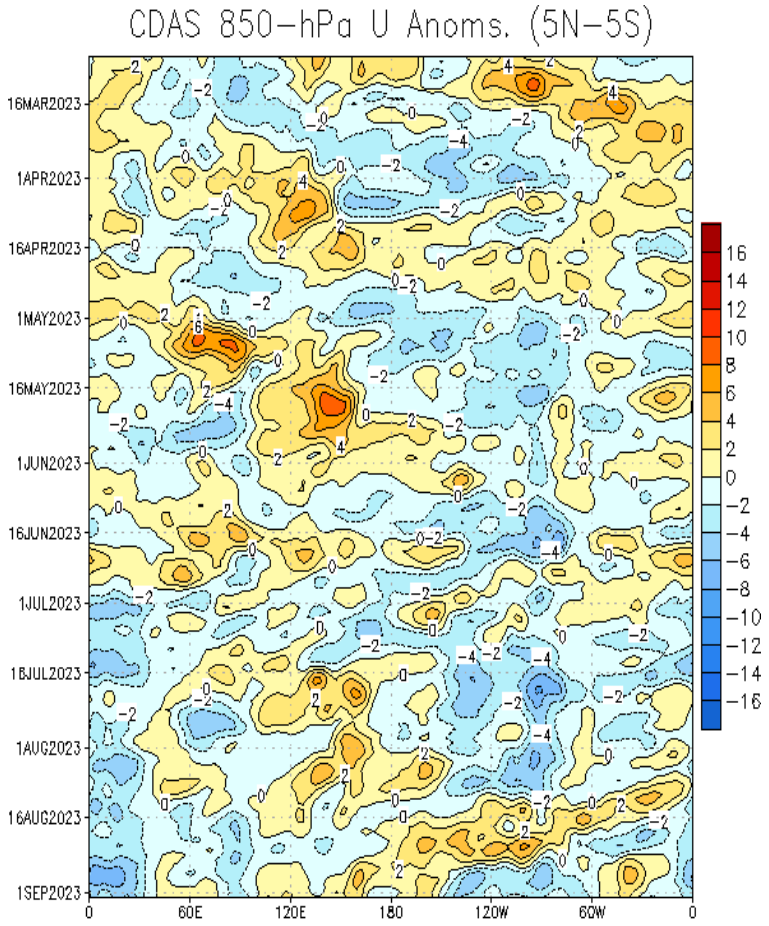


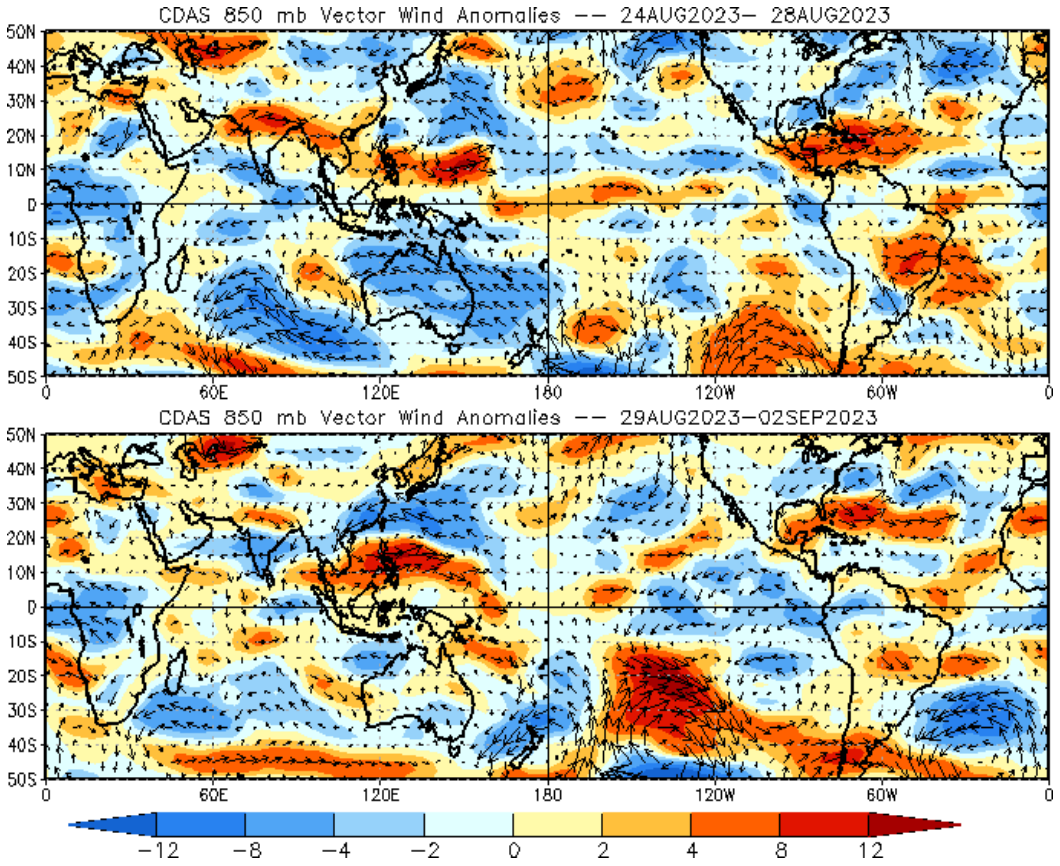


- After a lull in upper-level anomalies over the Tropical Pacific, anomalous easterlies have reemerged near the Date Line, while weak westerly anomalies remain over the Indian Ocean.
- The Southern Hemisphere jet stream remains active, injecting Rossby wave energy into the tropics periodically, such as what is occurring over the Eastern Pacific and northeast Australia.

850-hPa Wind Anomalies

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

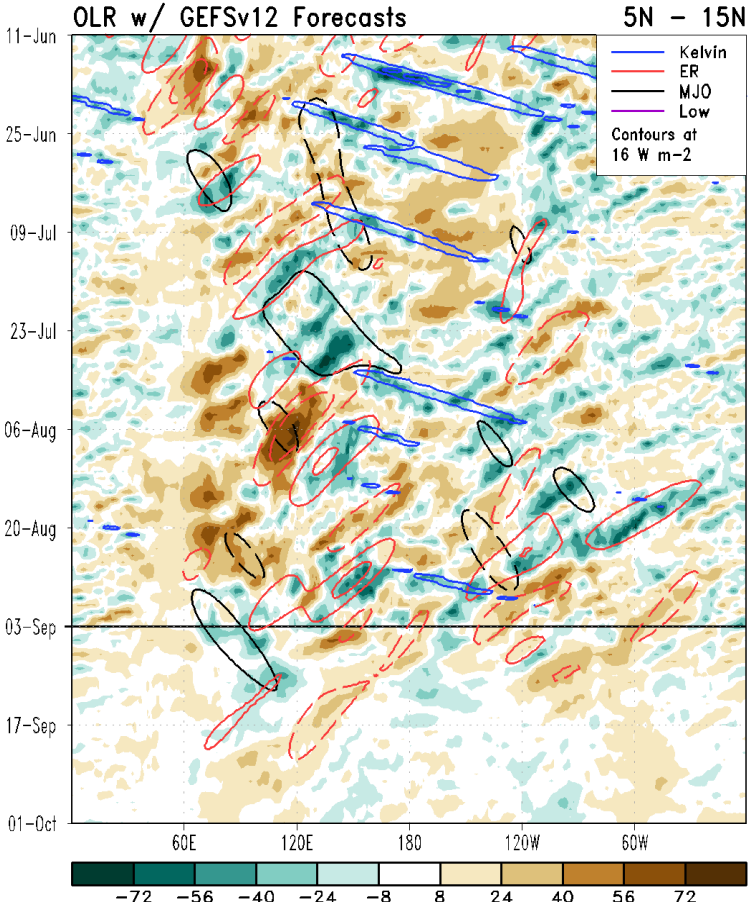


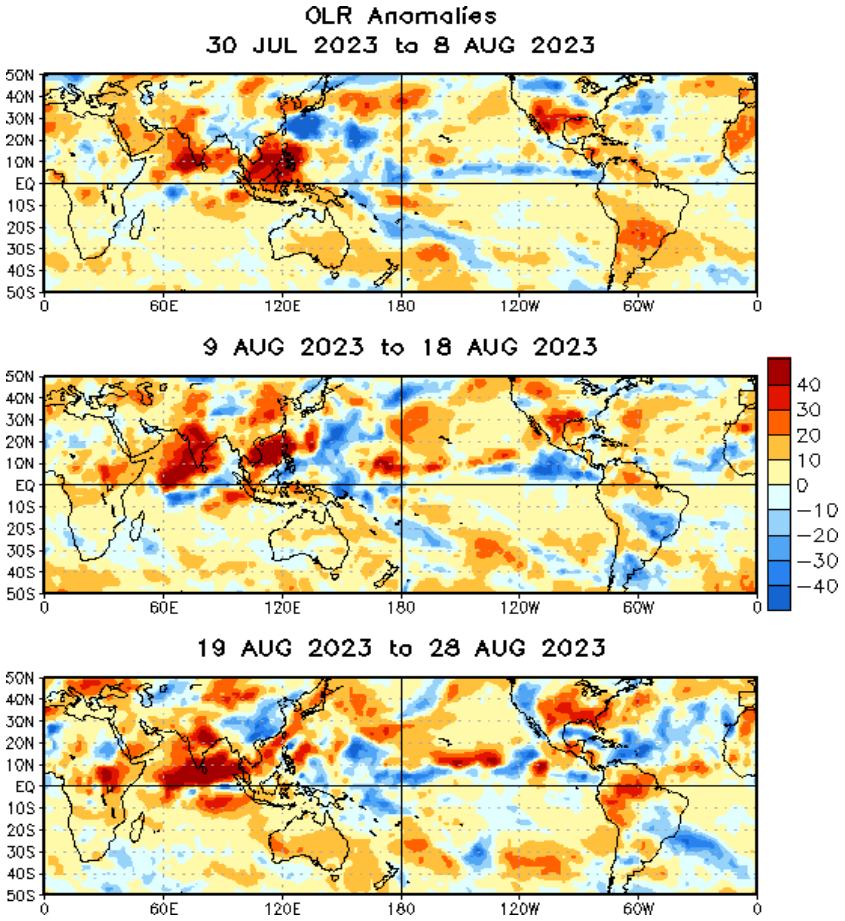


- The low-level wind field remains fairly chaotic, with a lot of variability in the trade winds over the Eastern Pacific in the last month.
- Low-level westerly anomalies reflect a response to El Niño conditions across the Central and Eastern Pacific, though easterly anomalies returned over the Eastern Pacific recently.
- Westerly anomalies remain in place for large portions of the Atlantic basin.

Outgoing Longwave Radiation (OLR) Anomalies

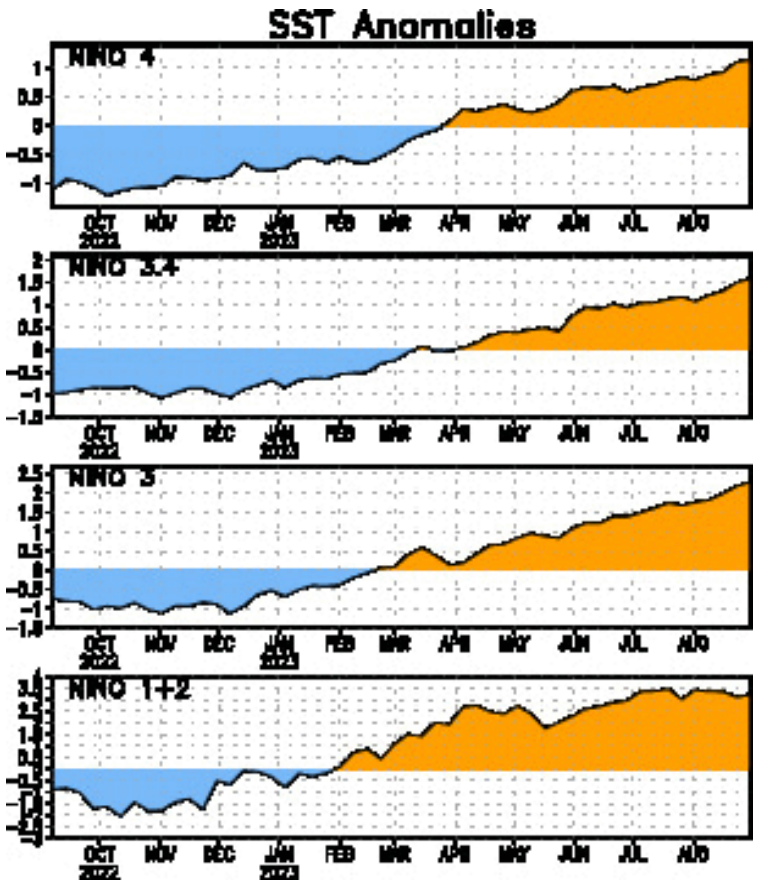
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

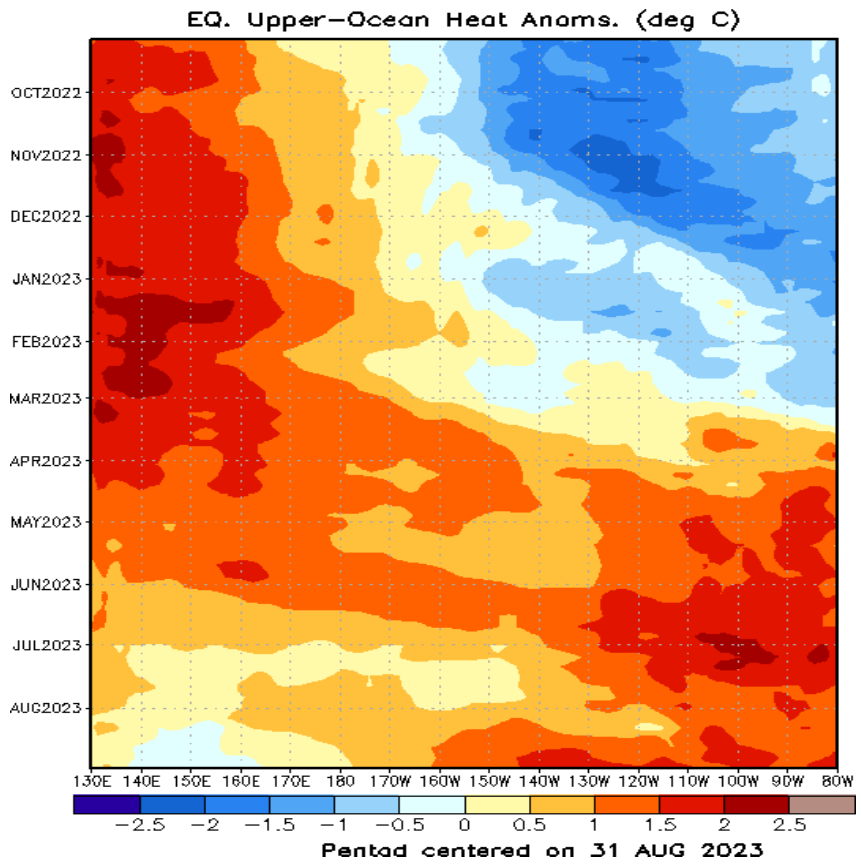




- The South and Southeast Asia Monsoon remained weak through late July and much of August, consistent with El Niño conditions.
- Continued ridging over the Southwest U.S. has led to anomalously dry conditions for much of the Lower 48 over the last month.
- The OLR forecast shows only modest MJO activity, with Rossby waves providing most of the variability.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

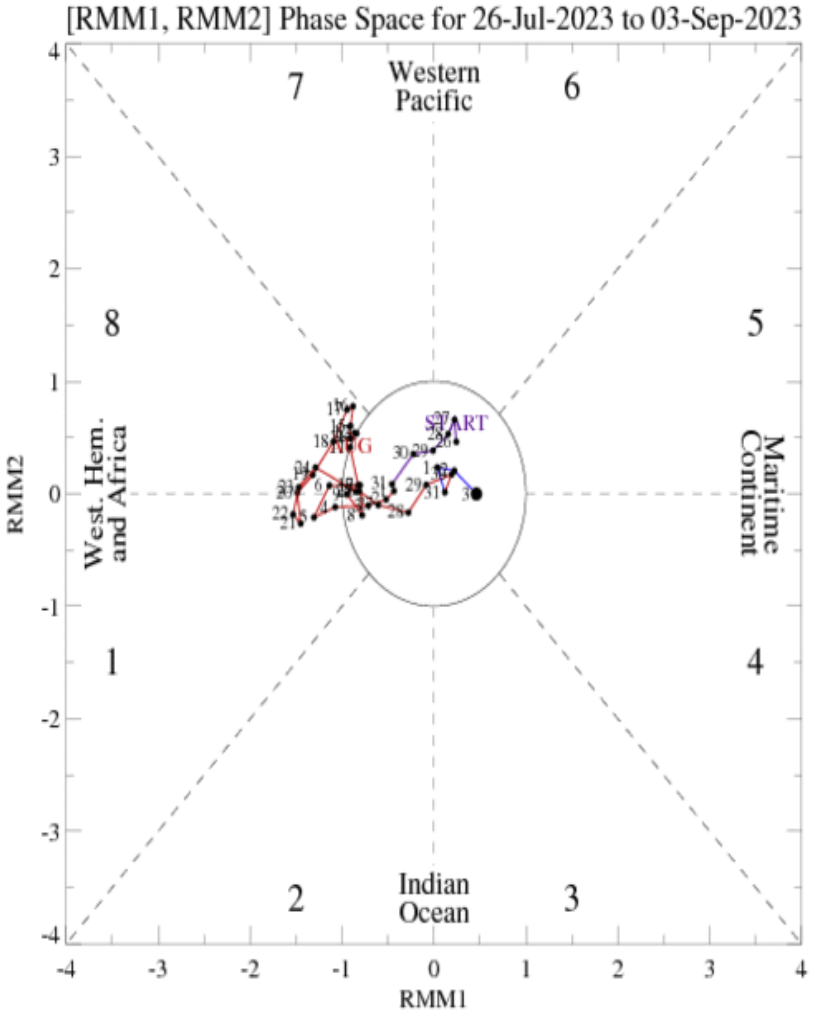




- El Niño conditions are present across the equatorial Pacific as SST anomalies continue to climb in most of the Nino regions. Nino 1+2 has plateaued, but is currently over +3 degC, an impressive anomaly.
- Following some attenuation during July, a new downwelling oceanic Kelvin wave appears to have been initiated, bringing warmer subsurface ocean water eastward across the central Pacific. Negative heat content anomalies are now appearing in the West Pacific Warm Pool.

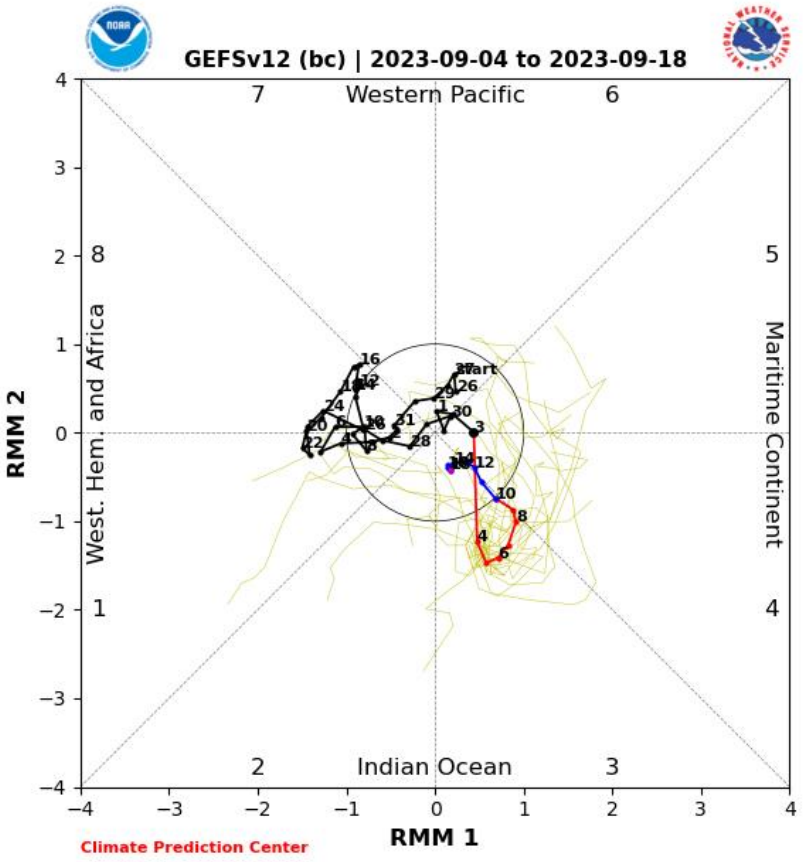
MJO Index: Recent Evolution

- After an increase in amplitude in mid- to late July, the RMM index has once again weakened, moving back into the unit circle, currently locating the MJO weakly in phase 4.
- Though the signal is very weak, there is some indication of eastward propagation of the convective envelope (this can also be seen in the 200-hPa velocity potential Hovmoller). Whatever MJO activity is actually present though is being obscured by the growing influence of El Nino.

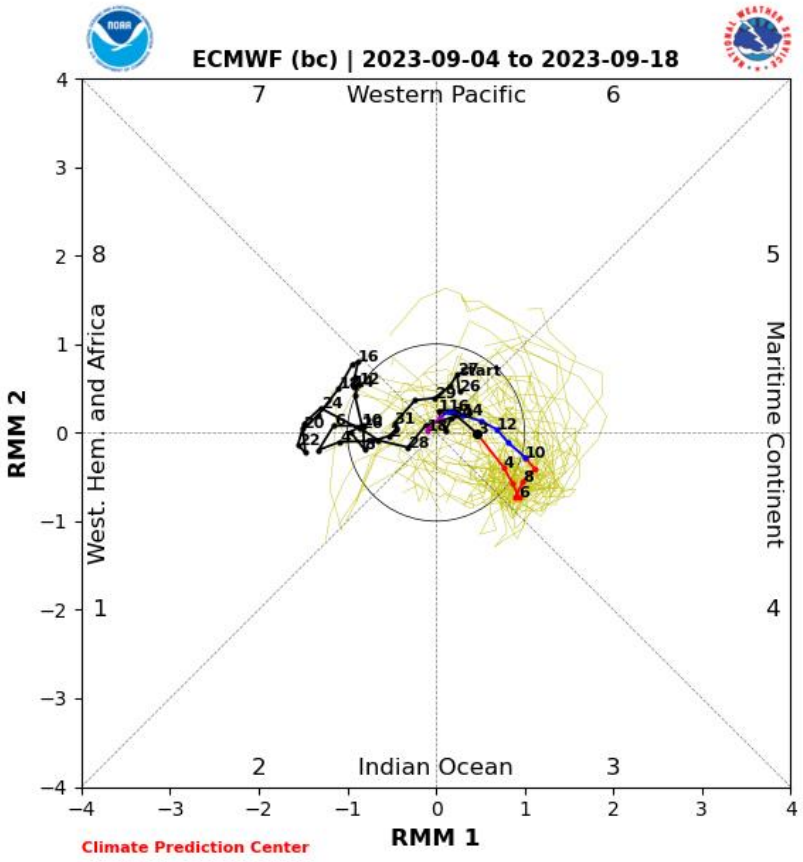


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

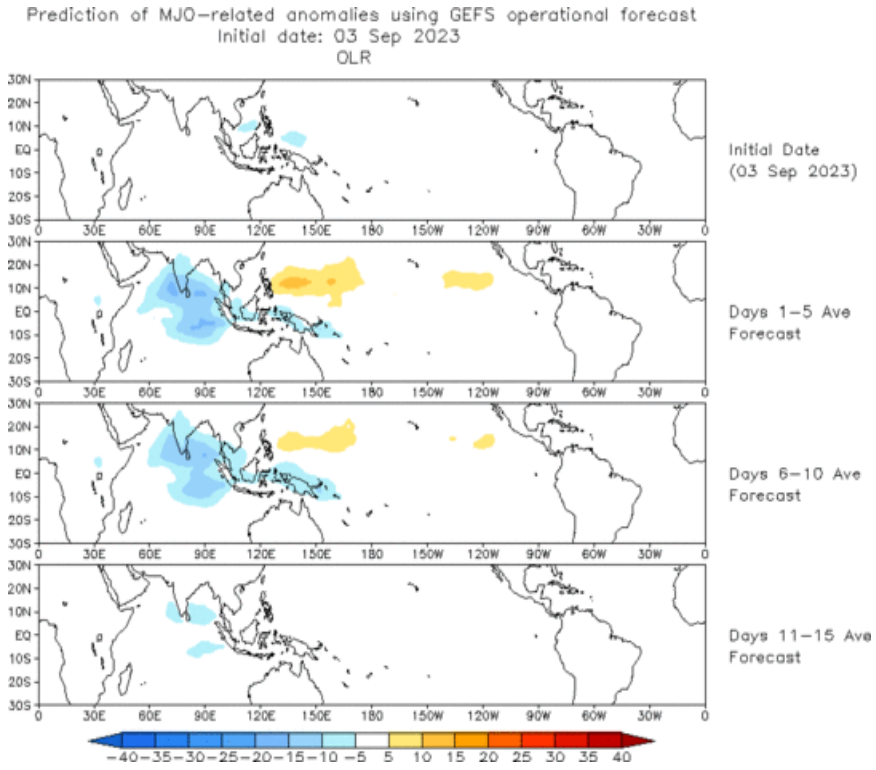


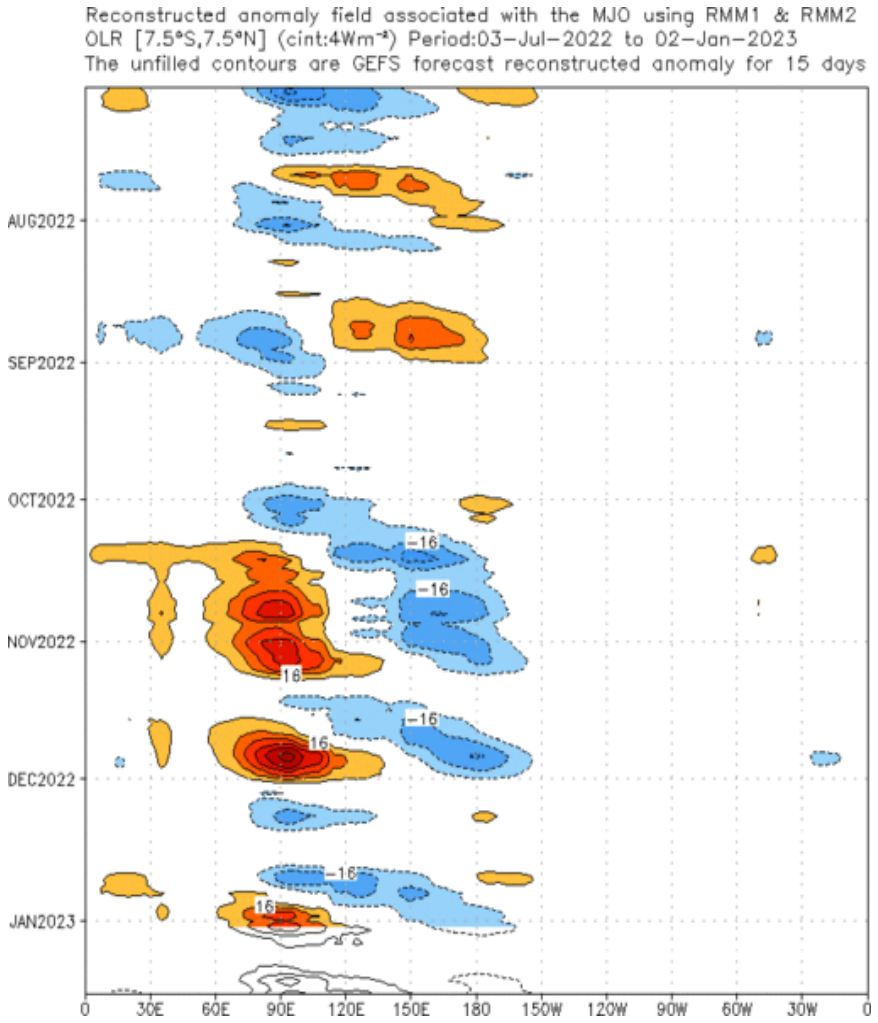
ECMWF Forecast

- Both the GEFS and ECMWF depict a fast increase in signal amplitude during week-1, after which the signal once again drops into the unit circle.
- Both models also show very little eastward movement of the RMM signal. This, as well as the rapid oscillation in signal strength could be the result of interference with the El Nino base state as a convective envelope tries to propagate eastward.

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.)

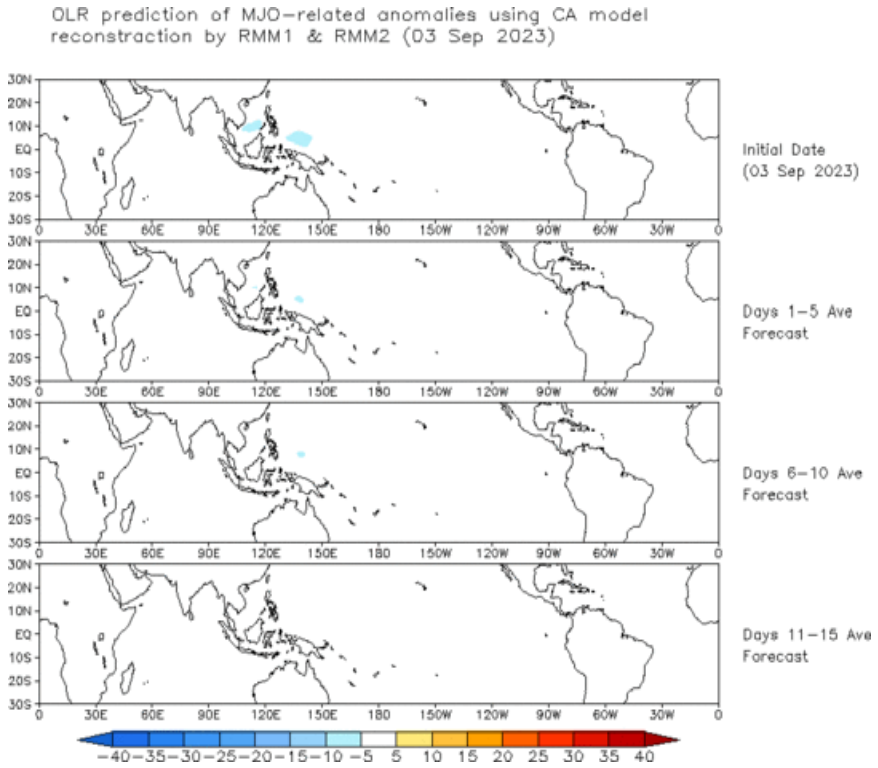


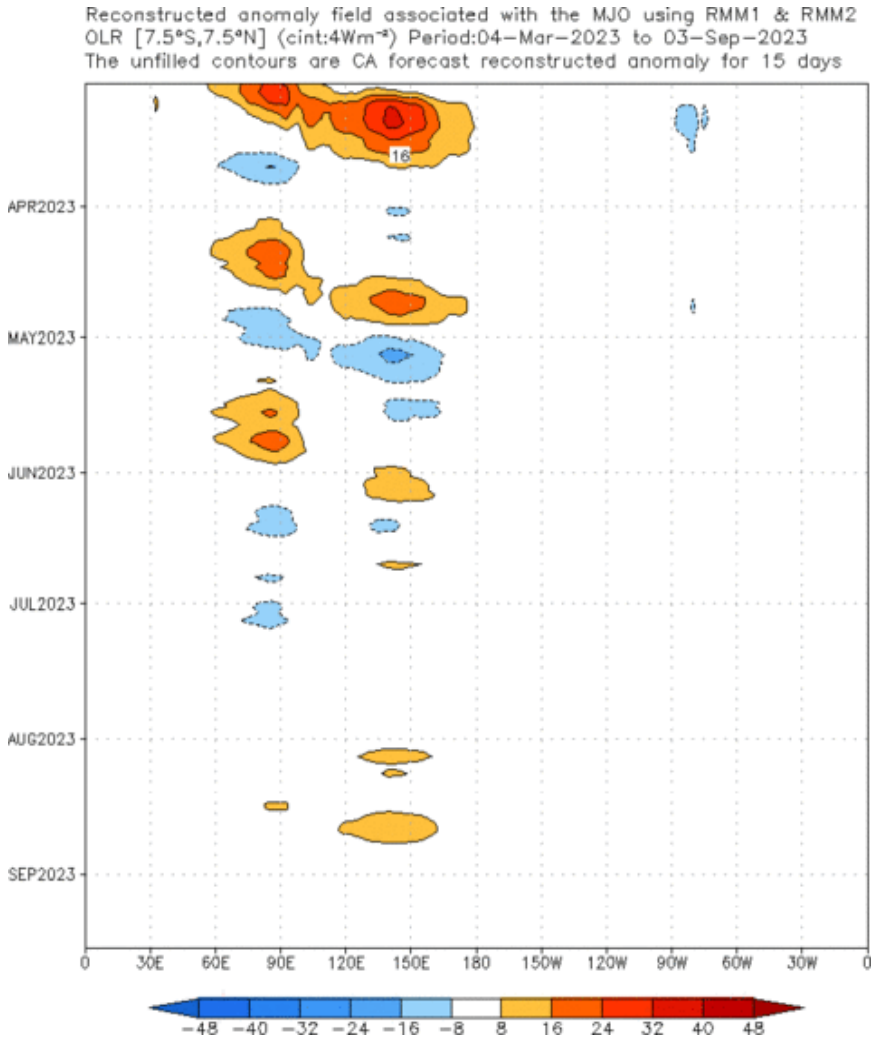


- The GEFS RMM-based OLR forecast shows a brief surge of anomalous convection over the Indian Ocean during week-1 that fades quickly during week-2.

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.)

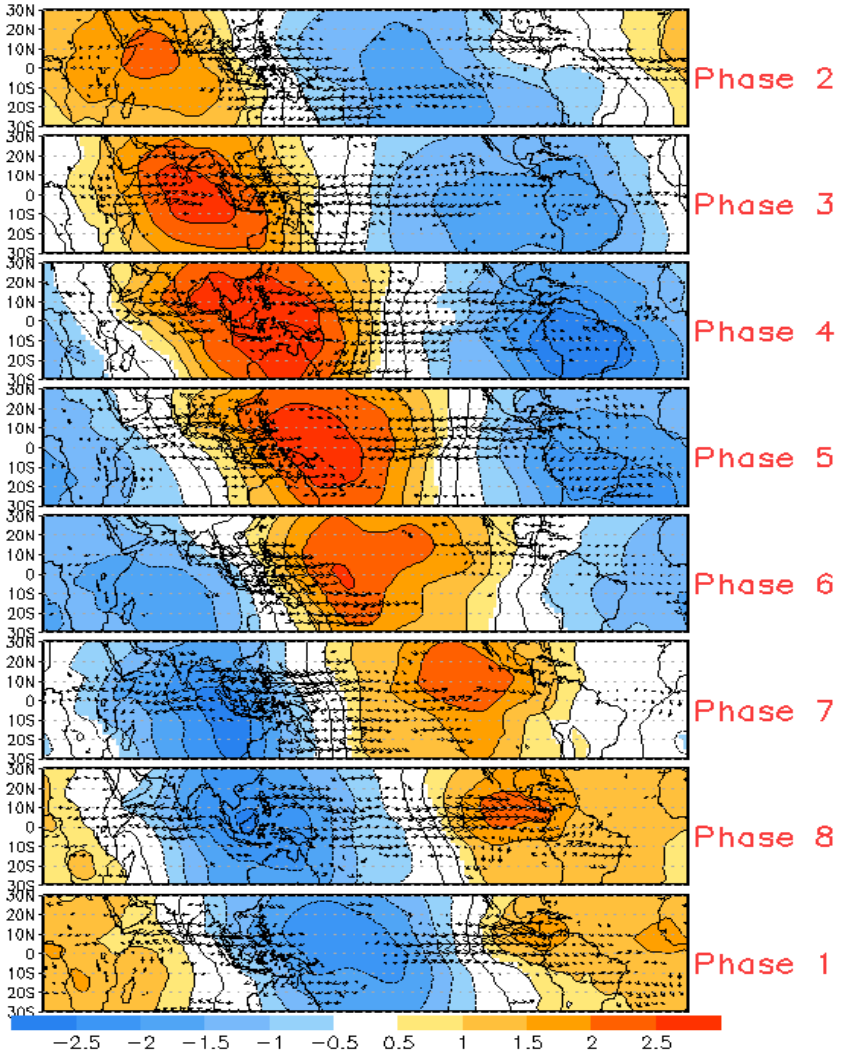




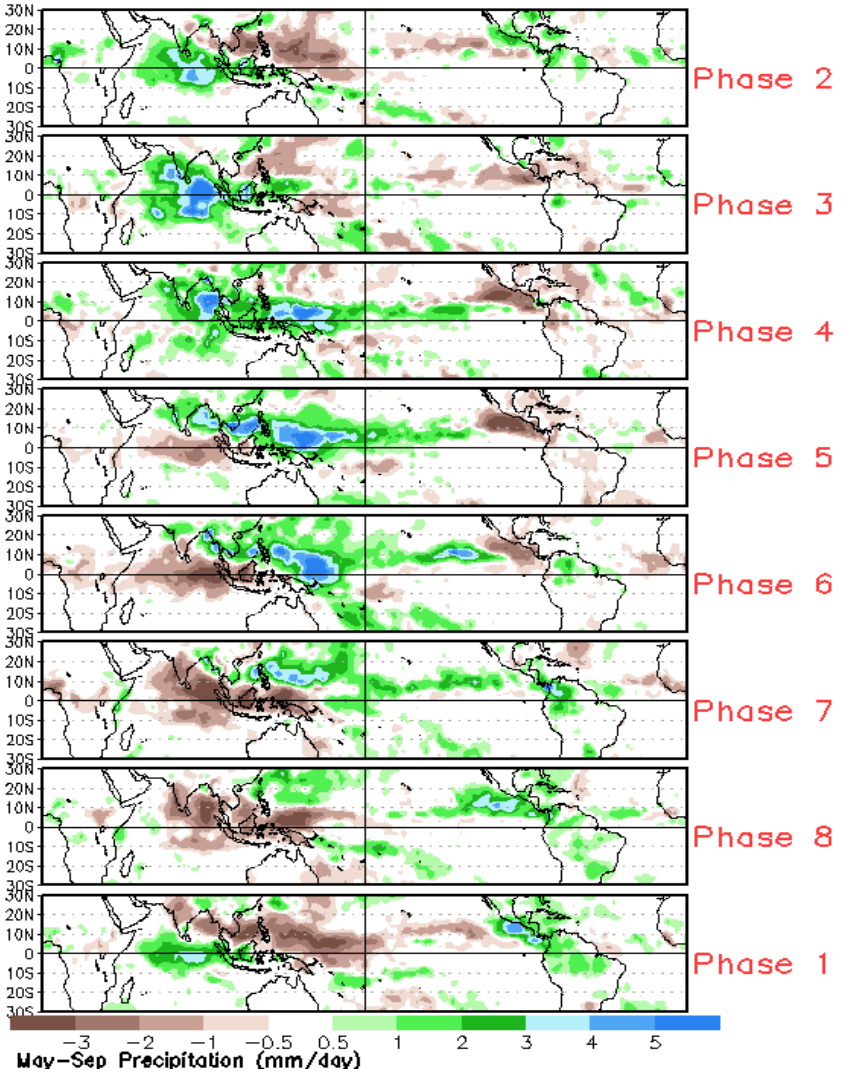
- The constructed analog RMM-based forecast does not seem to be responding to the current initial conditions and has almost no anomalous convection through the week-2 period.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



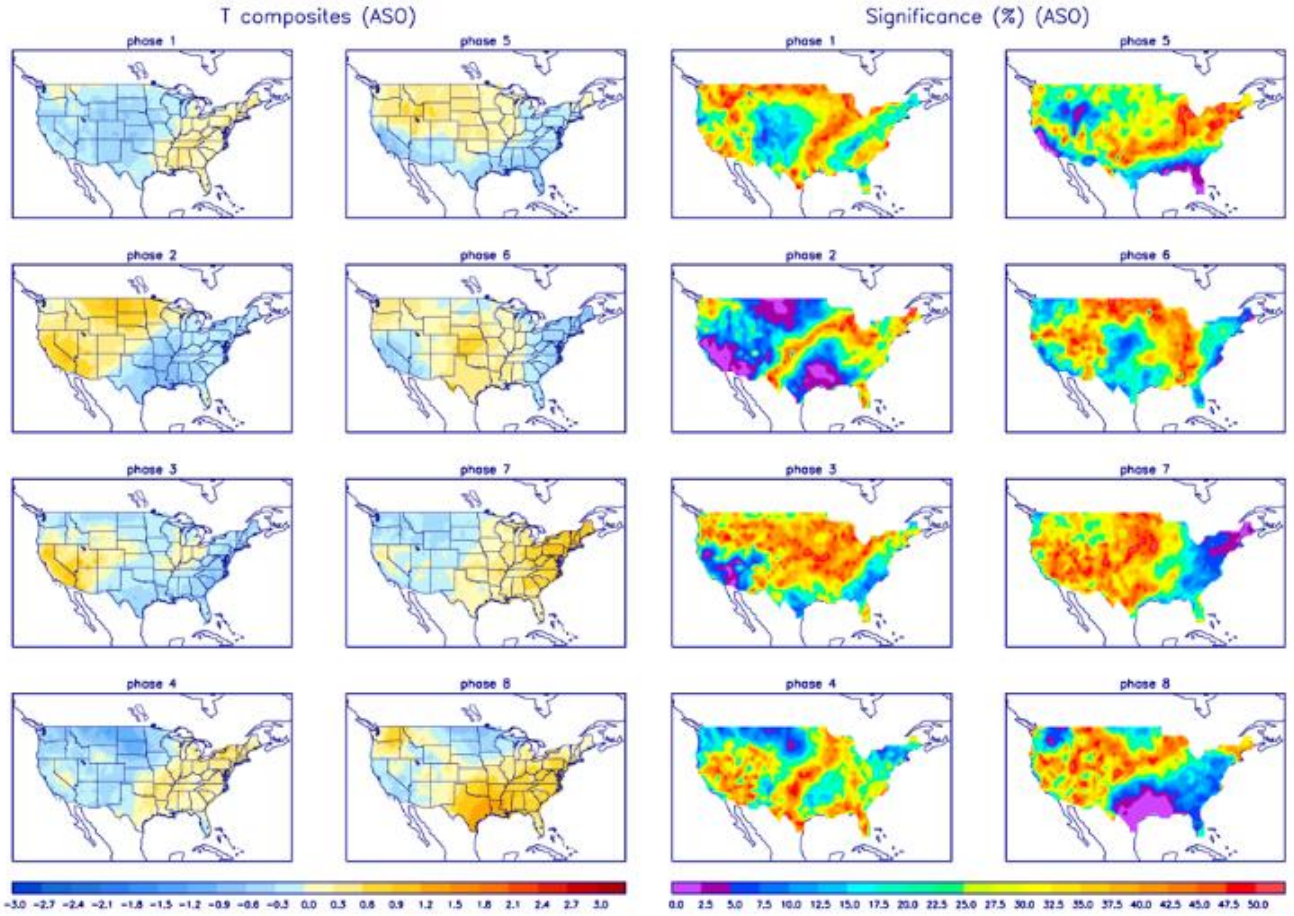
Precipitation Anomalies



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.

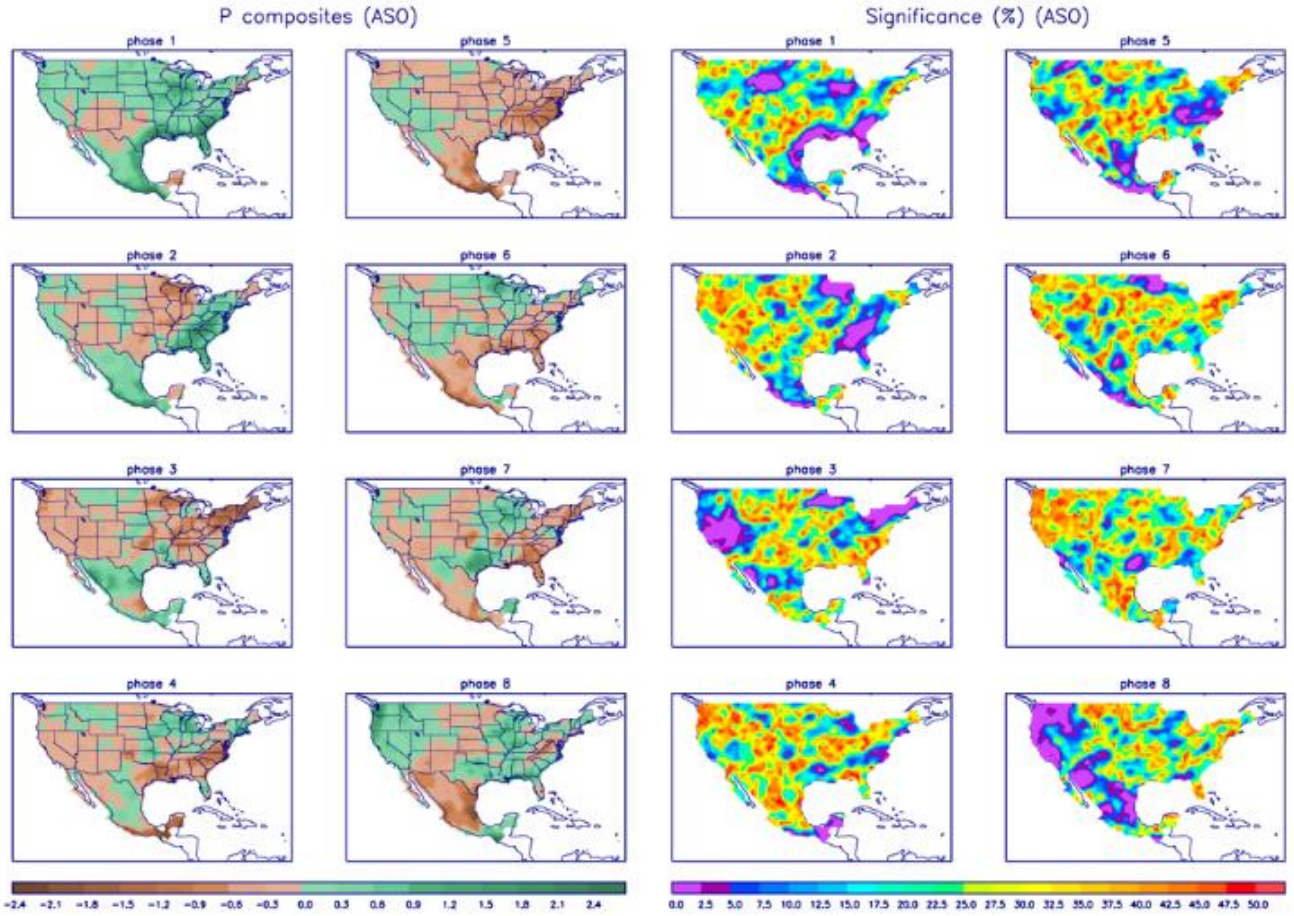


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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