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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
8 January 2024

Overview

- By the end of December, the intraseasonal MJO completed a circumnavigation of the world in approximately 40 days which is consistent with a canonical MJO.

- The MJO remains active, with the enhanced phase crossing the Indian Ocean.

- Following a stalling of the MJO, the GEFS and ECMWF ensembles depict a renewal of eastern propagation with it shifting eastward to the Maritime Continent and West Pacific during the latter half of January.

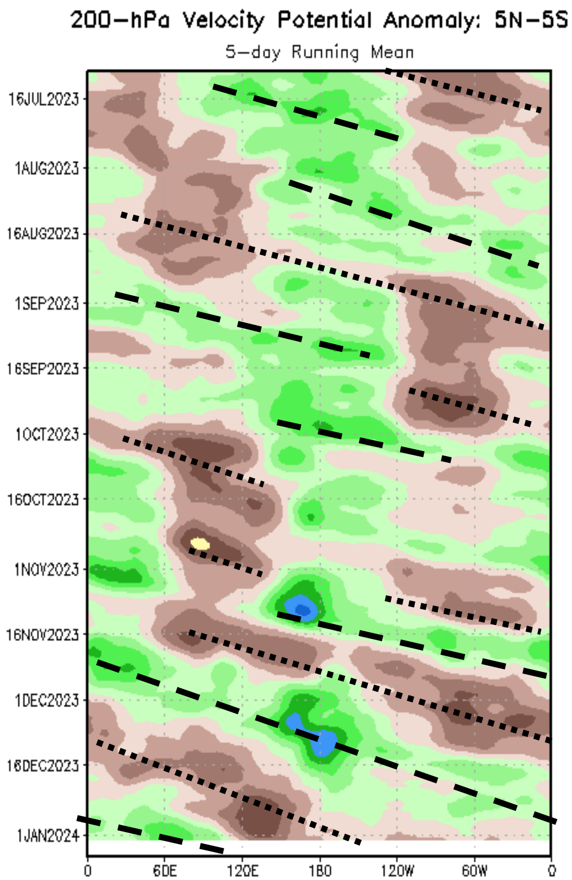
- This MJO evolution favors tropical cyclone development across the southern Indian Ocean and surrounding northern Australia.

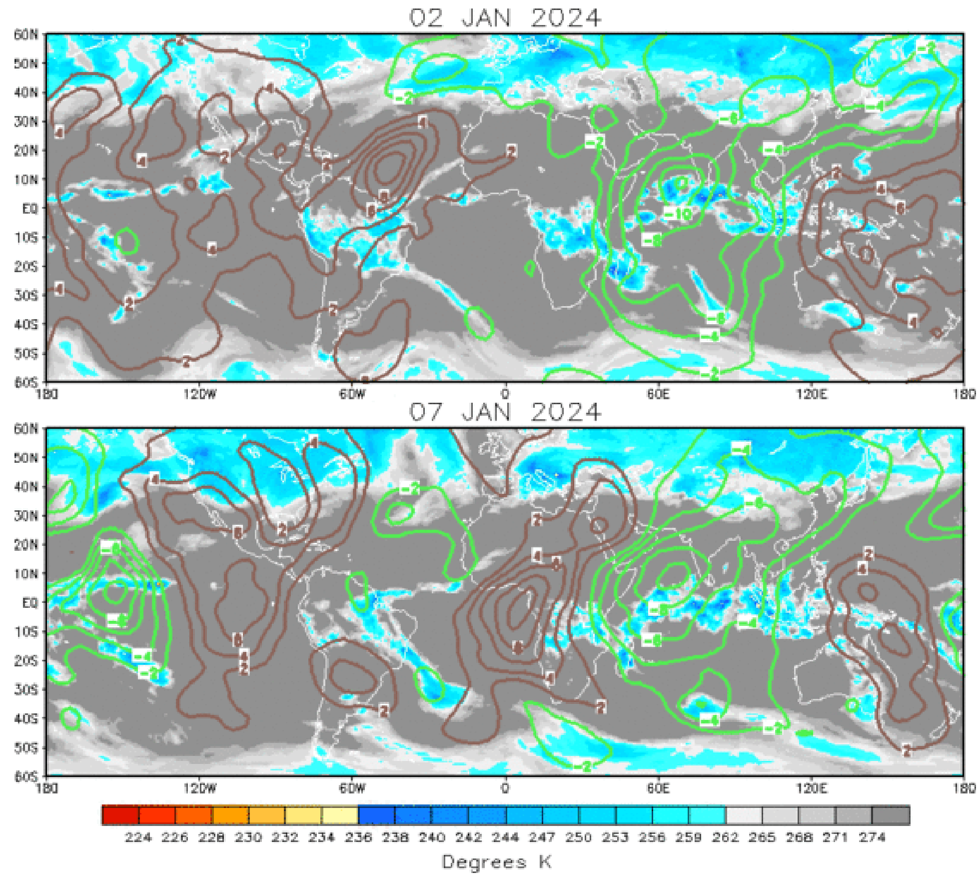
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

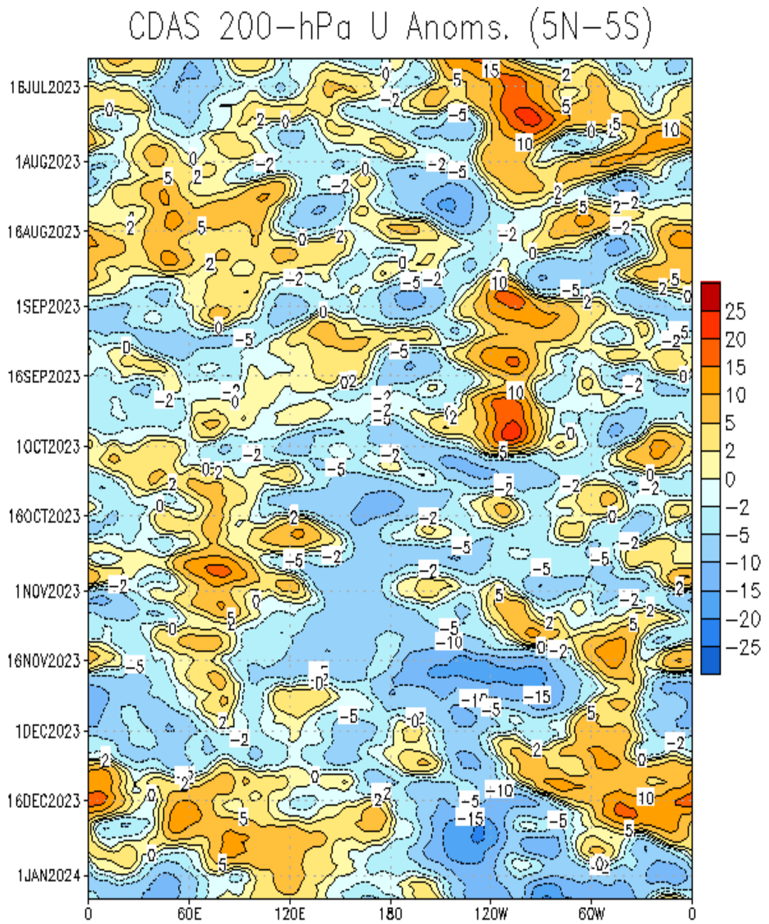


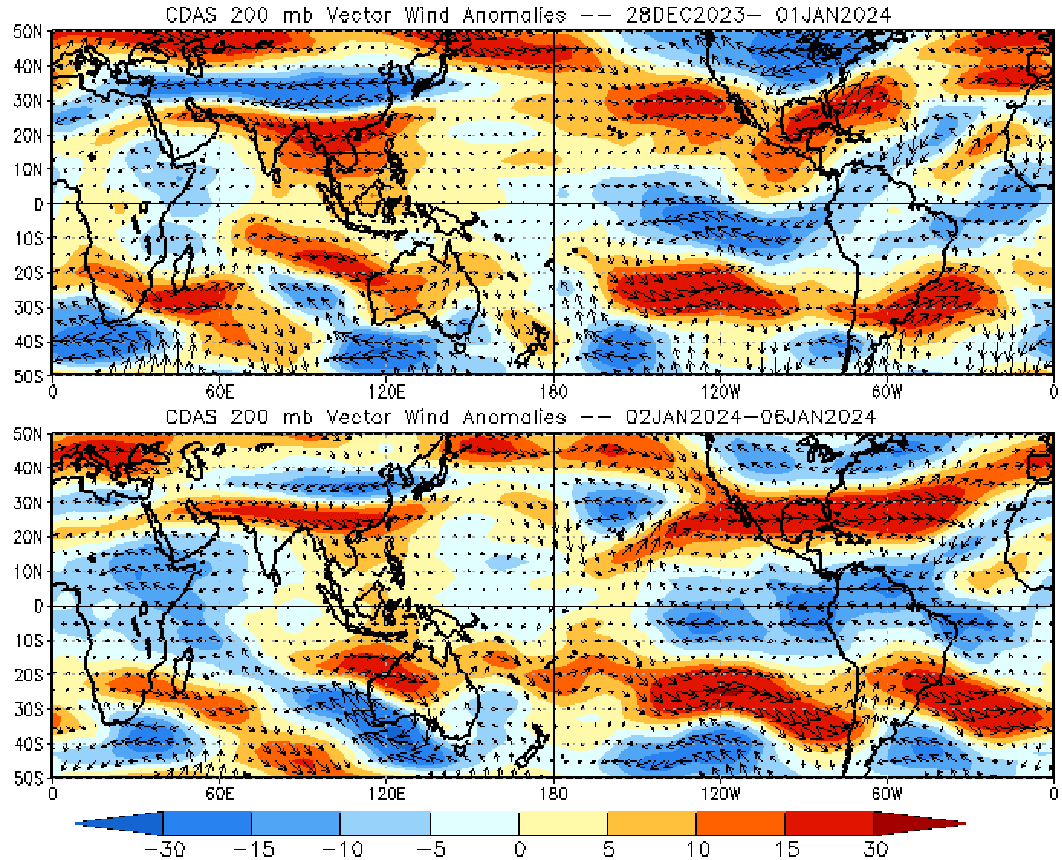


- The MJO remained active since mid-November with the its enhanced convective phase over the Indian Ocean.
- Destructive interference between the MJO and the El Niño base state occurred from late December into the beginning of January.

200-hPa Wind Anomalies

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

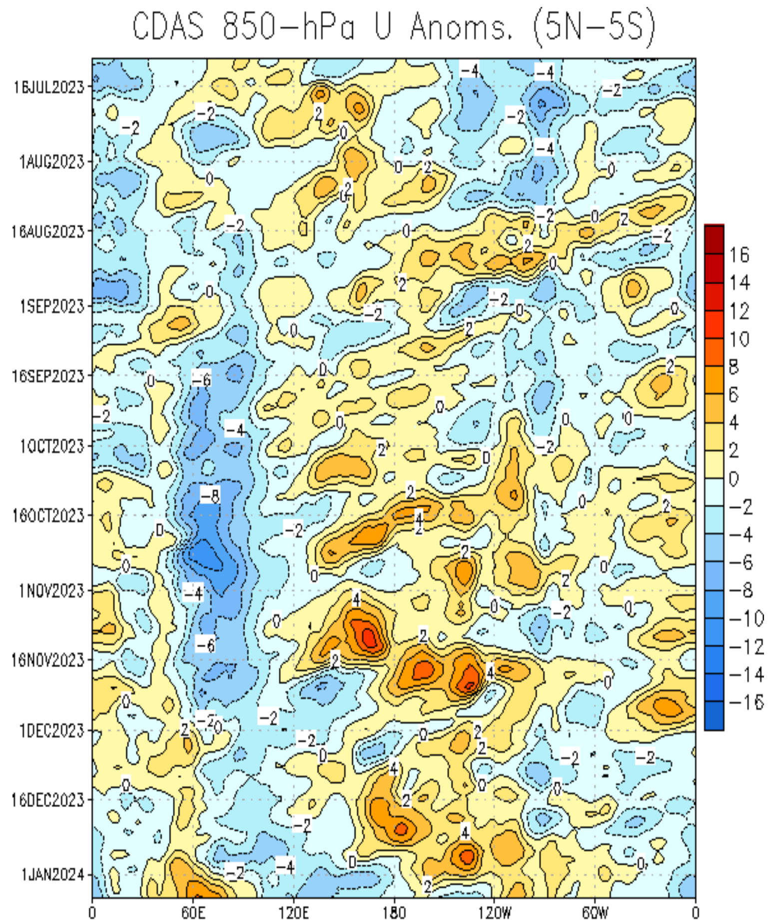


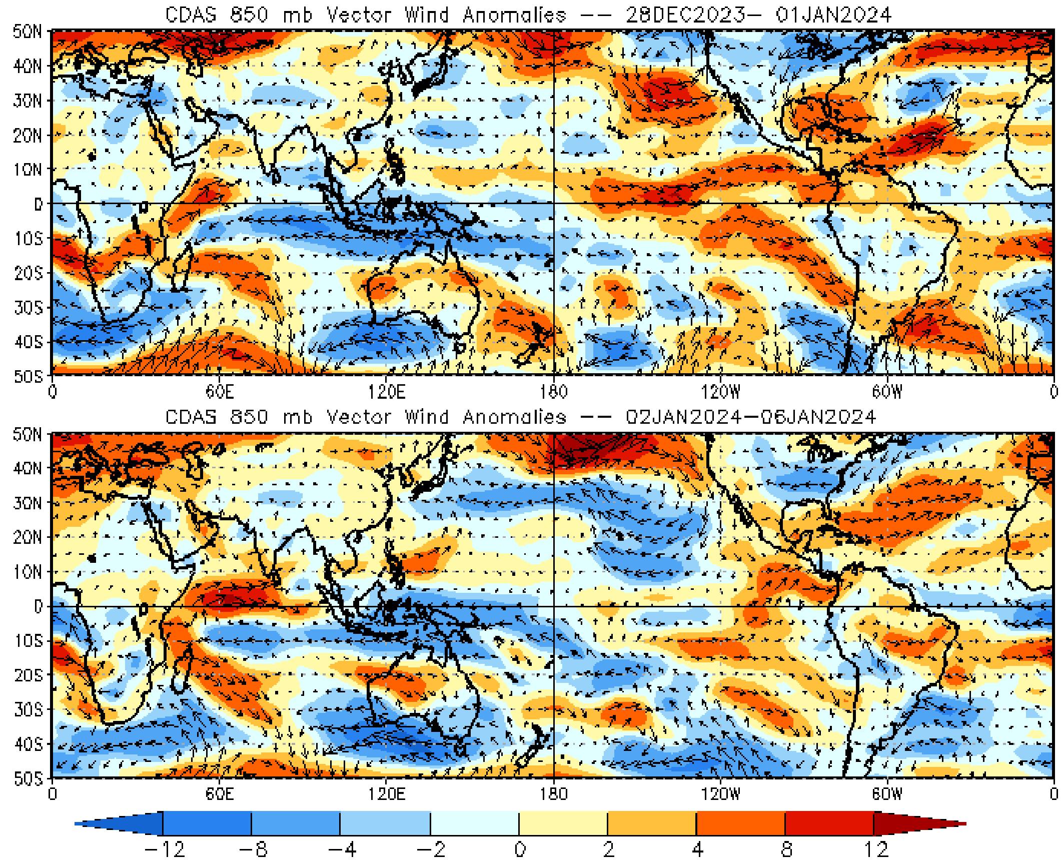


- Eastward propagation of upper-level westerly anomalies to the Maritime Continent is consistent with MJO activity.
- Persistent easterly anomalies over the eastern Pacific are driven by the atmospheric response to El Niño conditions, but are not inconsistent with the intraseasonal signal.
- Easterly anomalies weakened or reversed sign near the Date Line due to the MJO.

850-hPa Wind Anomalies

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

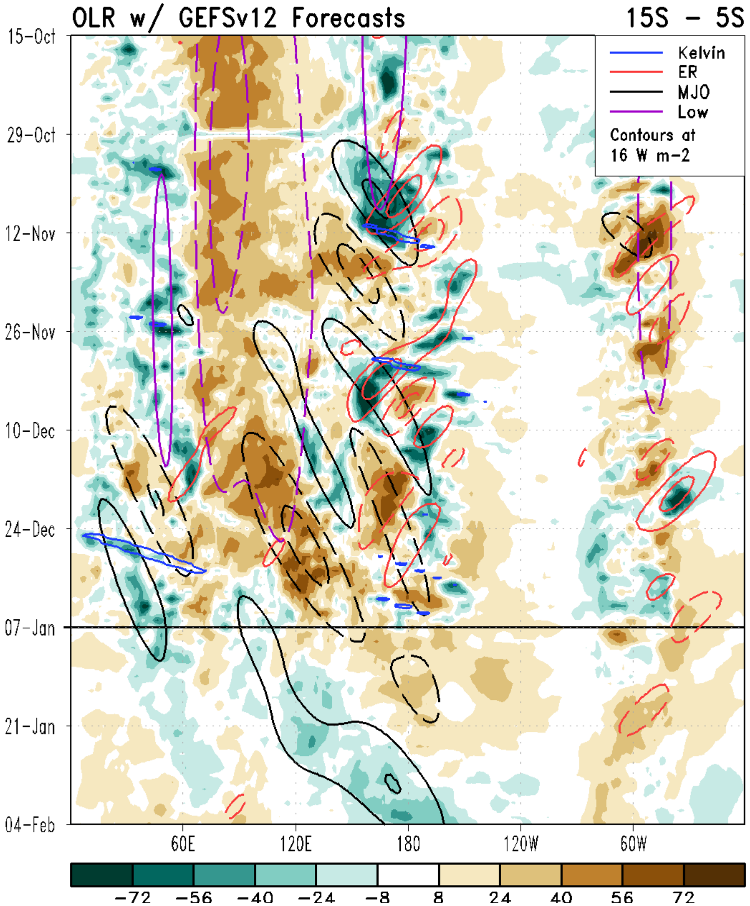


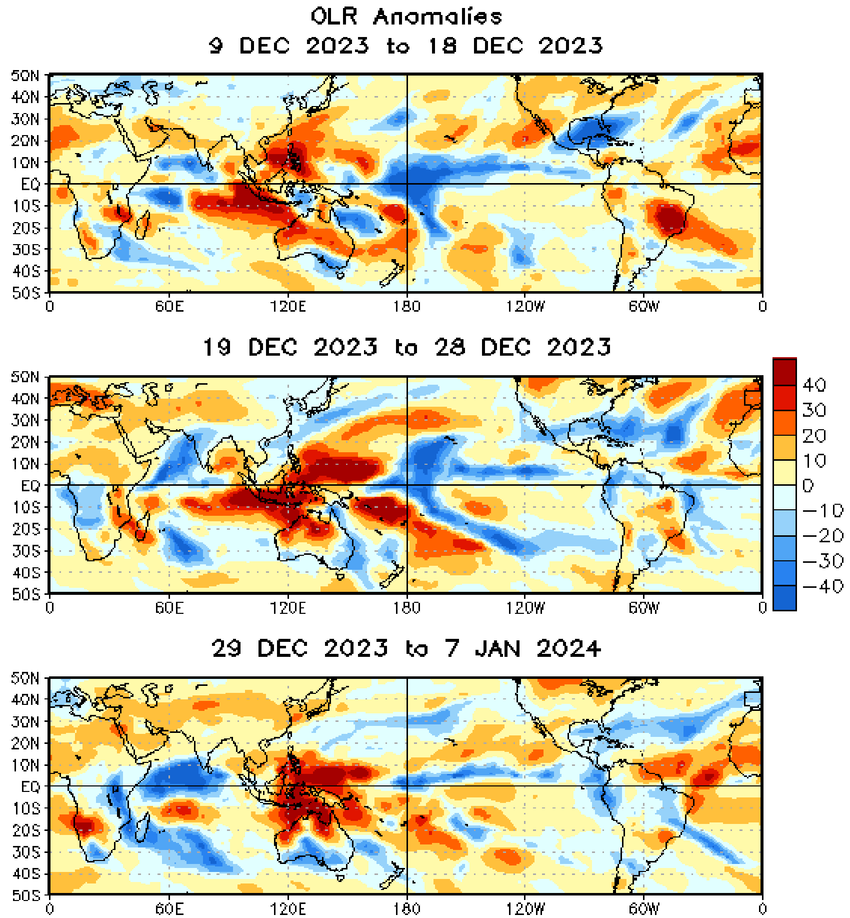


- Eastward propagation of low-level westerly anomalies from the Western Hemisphere to the western Indian Ocean is consistent with MJO activity.
- Similar to changes with the upper-level wind field, the MJO was able flip low-level westerlies to easterlies near the Date Line.

Outgoing Longwave Radiation (OLR) Anomalies

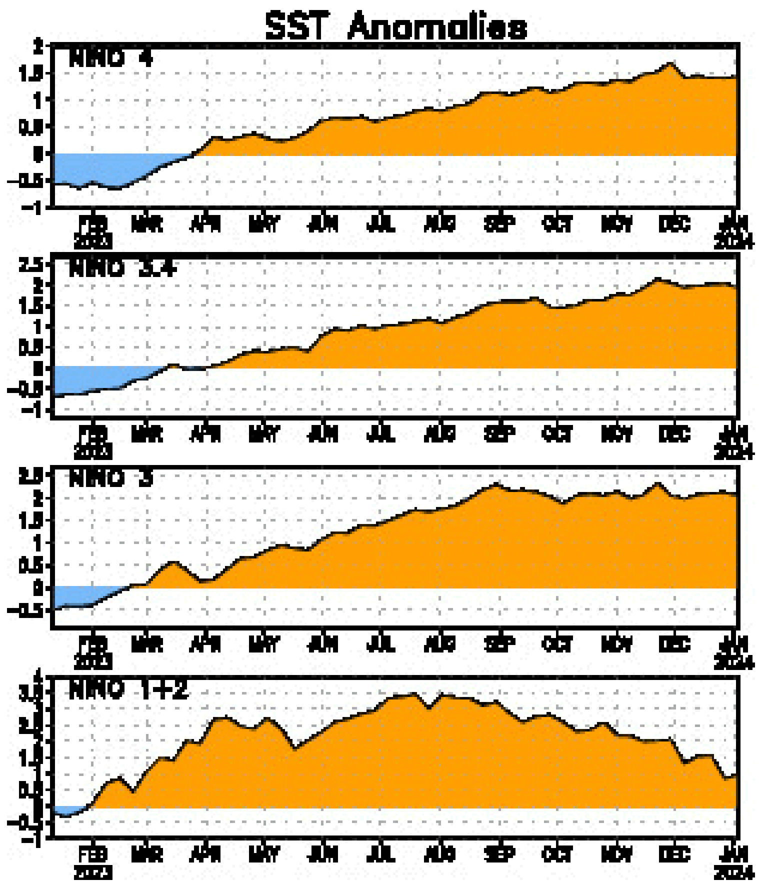
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

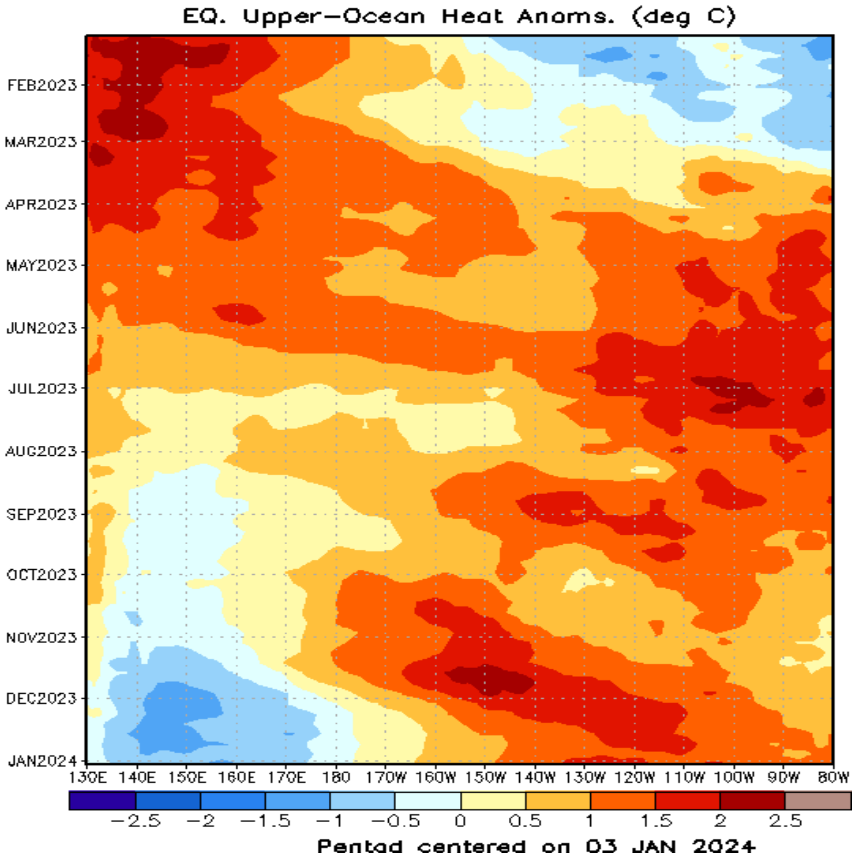




- El Niño and +IOD were the primary drivers of global tropical convective anomalies through late December, with enhanced (suppressed) convection across the central and eastern Pacific (Maritime Continent and eastern Indian Ocean).
- More recently, the MJO weakened the +IOD and caused an increase in convection across the eastern Indian Ocean.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

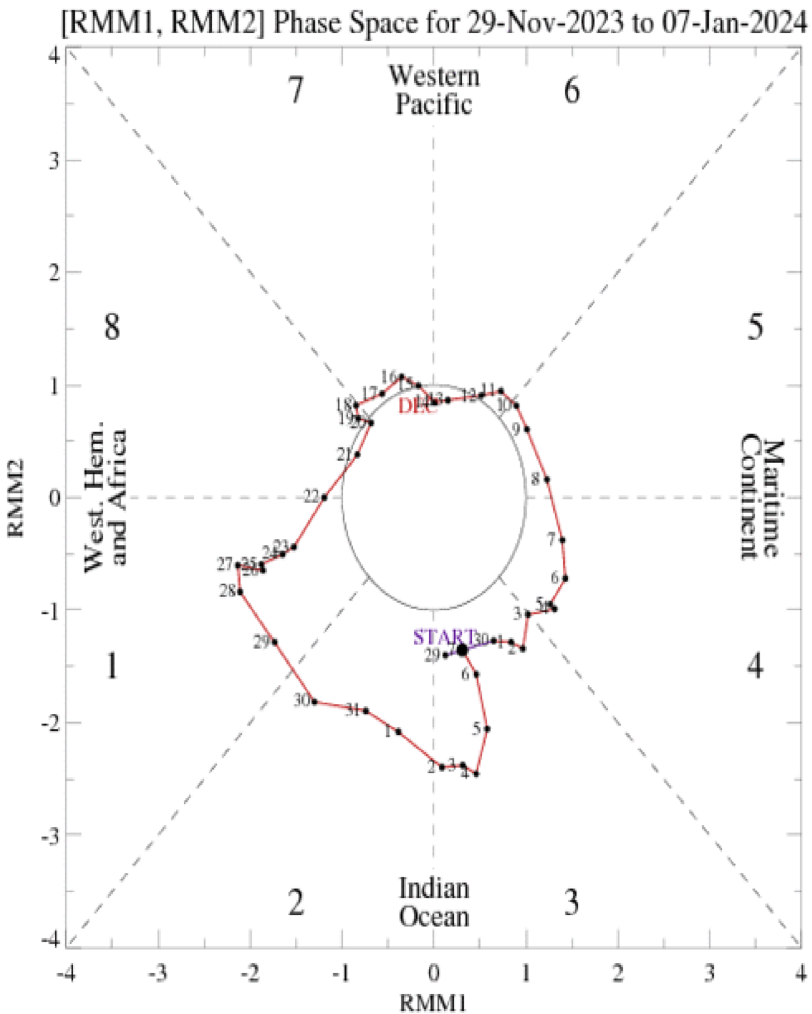




- Low-level westerly wind burst activity across the Pacific during November have resulted in rising SSTs across the Central Pacific, with the NINO 3.4 region now indicating SST anomalies near +2.0°C.
- Negative upper-oceanic heat anomalies expanded eastward to the Date Line by early December, associated with the upwelling phase of the oceanic Kelvin wave. SSTs across the West Pacific remain above-average, however.

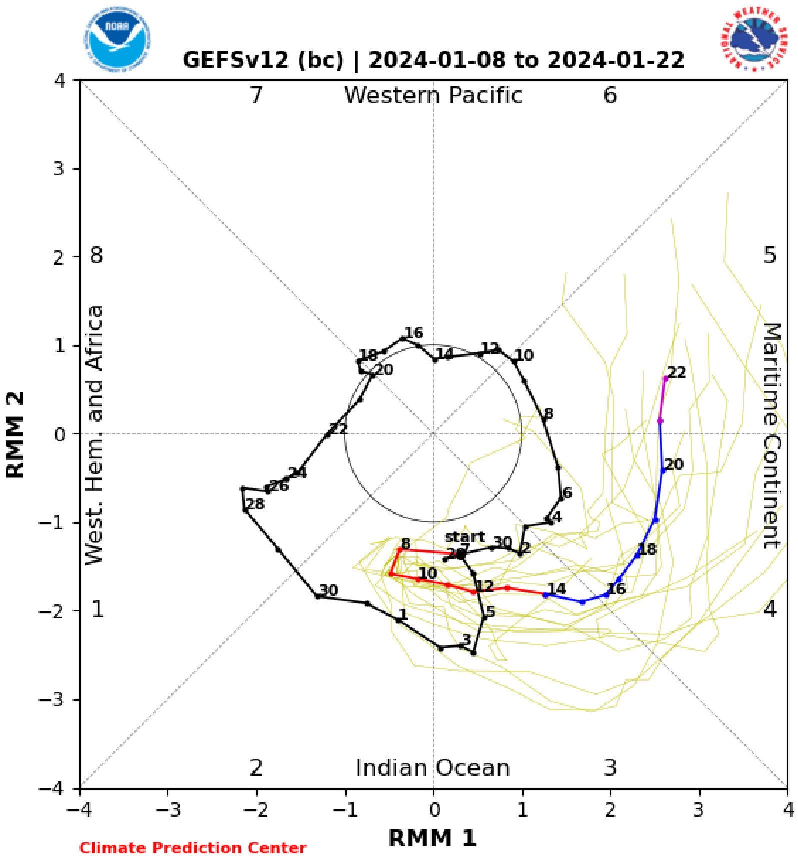
MJO Index: Recent Evolution

- The MJO index returned to the Indian Ocean by the end of December, completing a circumnavigation of the globe in approximately 35 days.
- The amplitude of the MJO index decreased recently due to destructive interference with the +IOD and/or equatorial Rossby Wave activity.

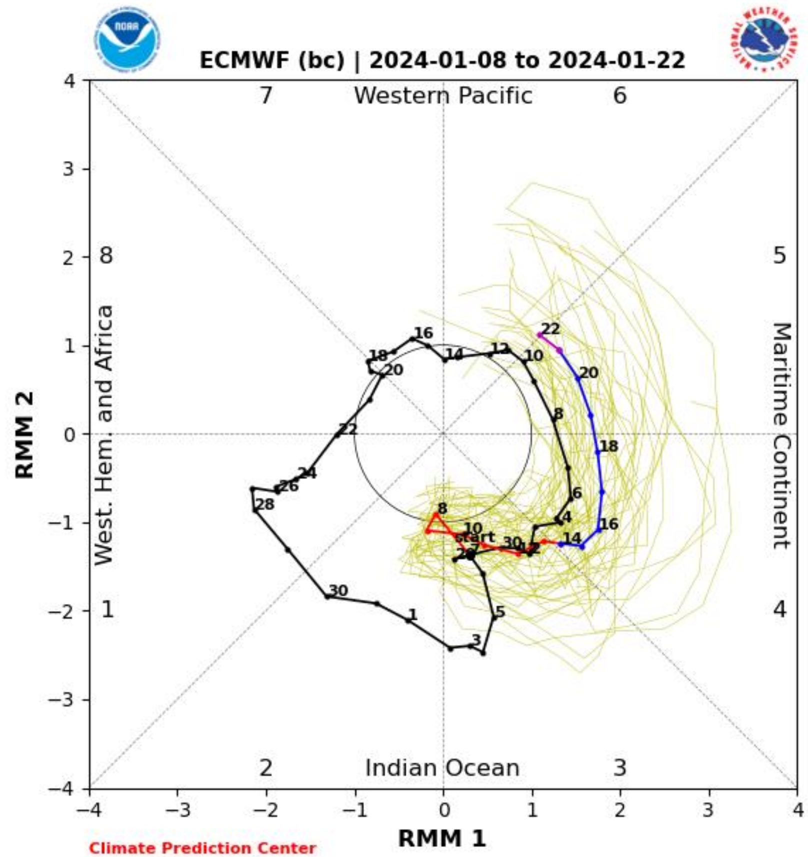


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

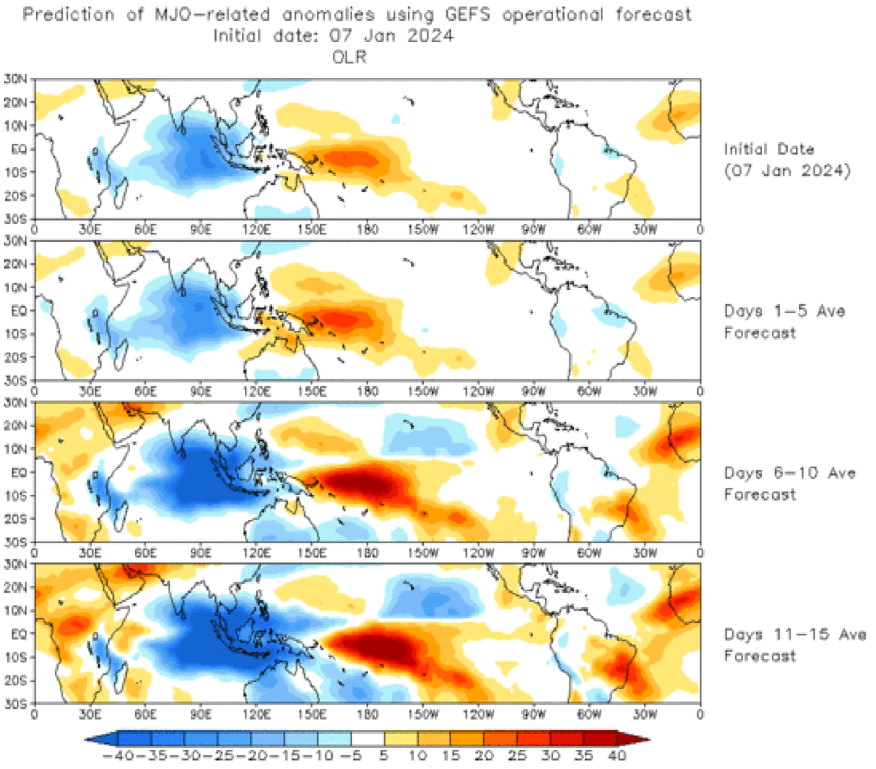


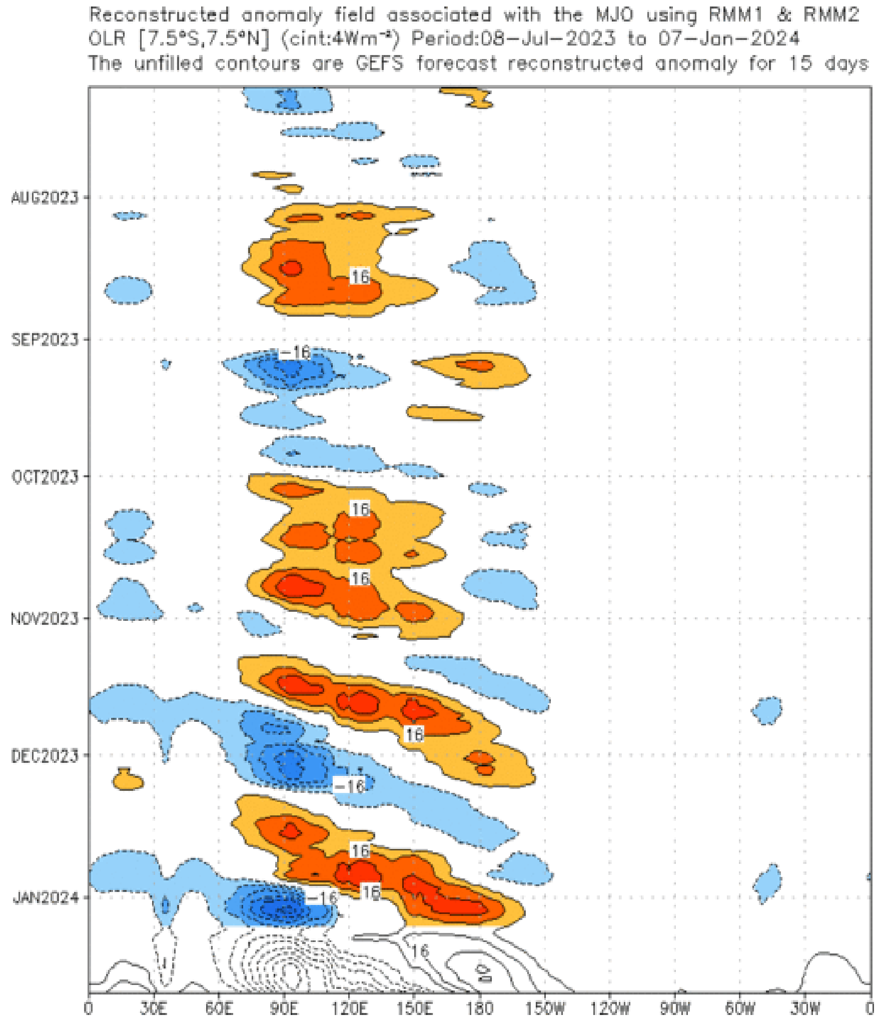
ECMWF Forecast

- Dynamical model forecasts from the GEFS and ECMWF depict the MJO resuming eastward propagation to the Maritime Continent during mid to late January.
- Many of the GFS ensemble members have a high amplitude as it crosses phases 4 and 5.

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.)

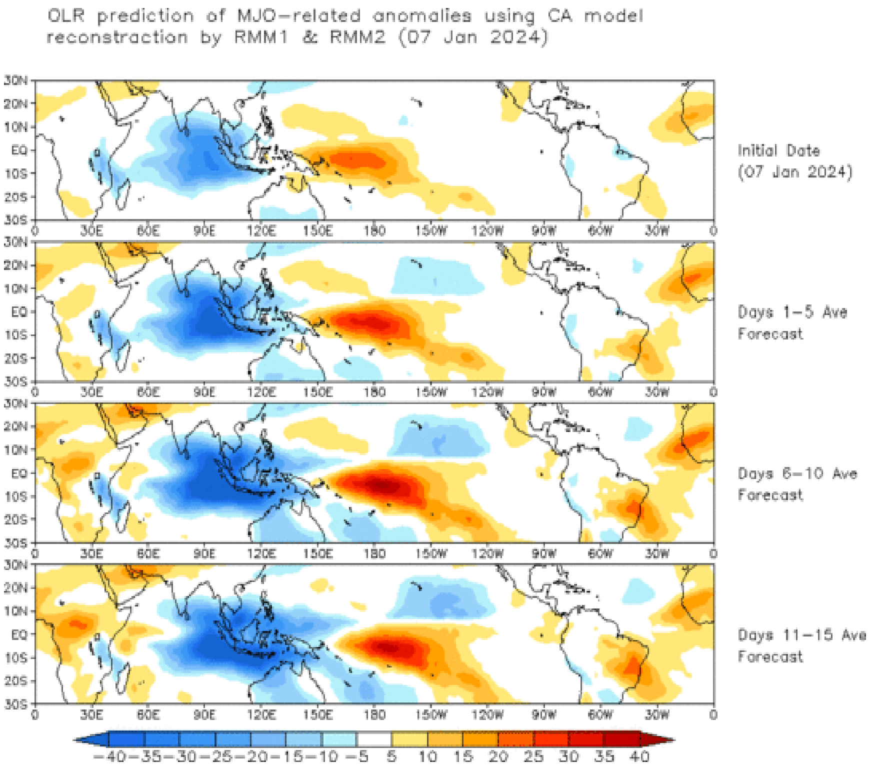


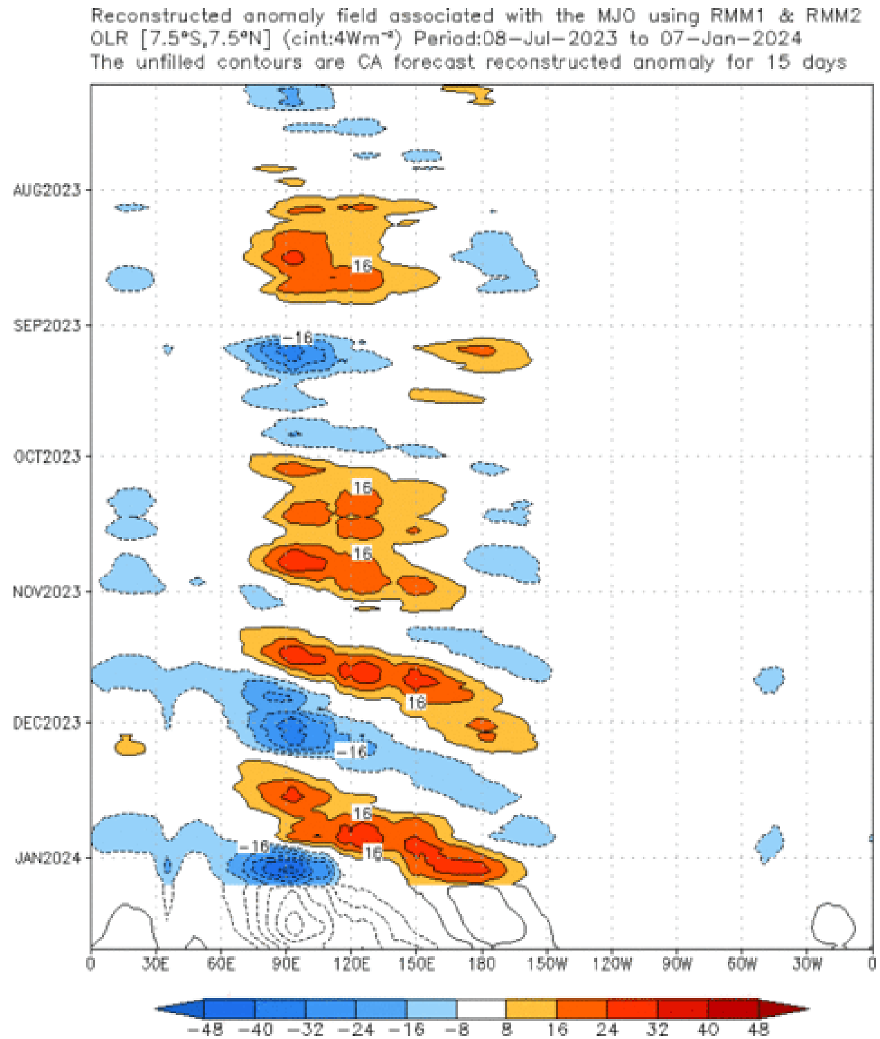


- The GEFS RMM-based OLR forecast depicts strengthening destructive interference between MJO and El Niño.

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.)

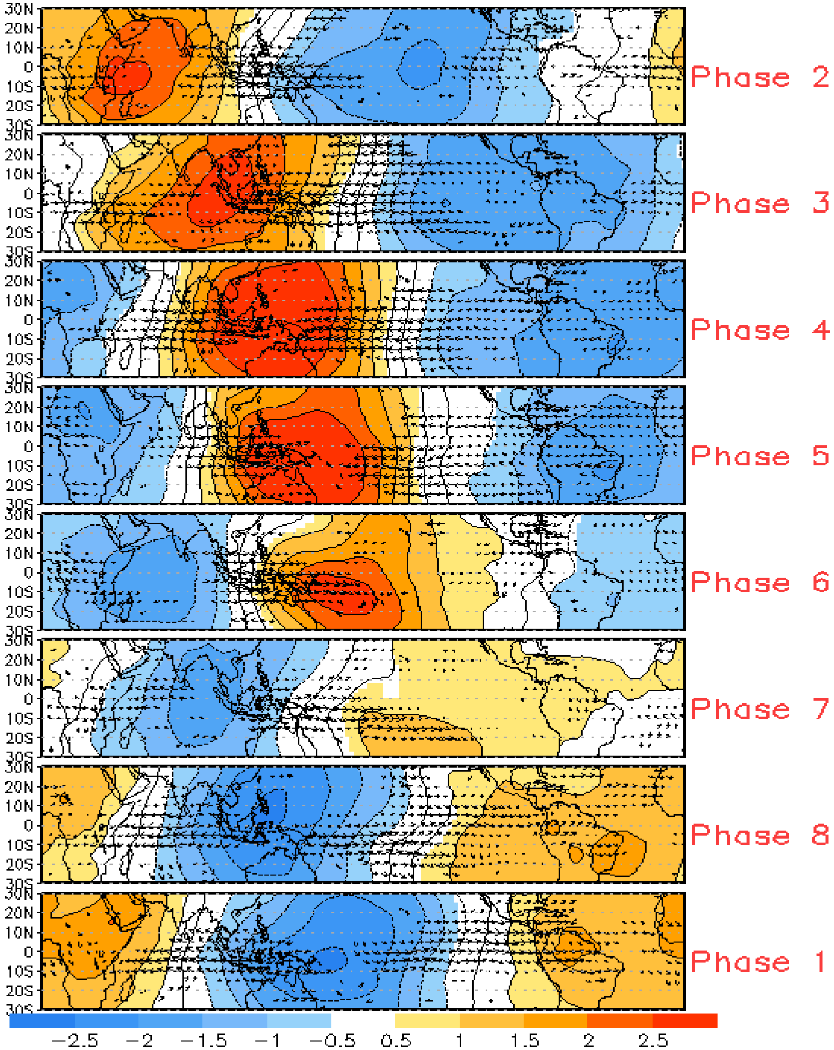




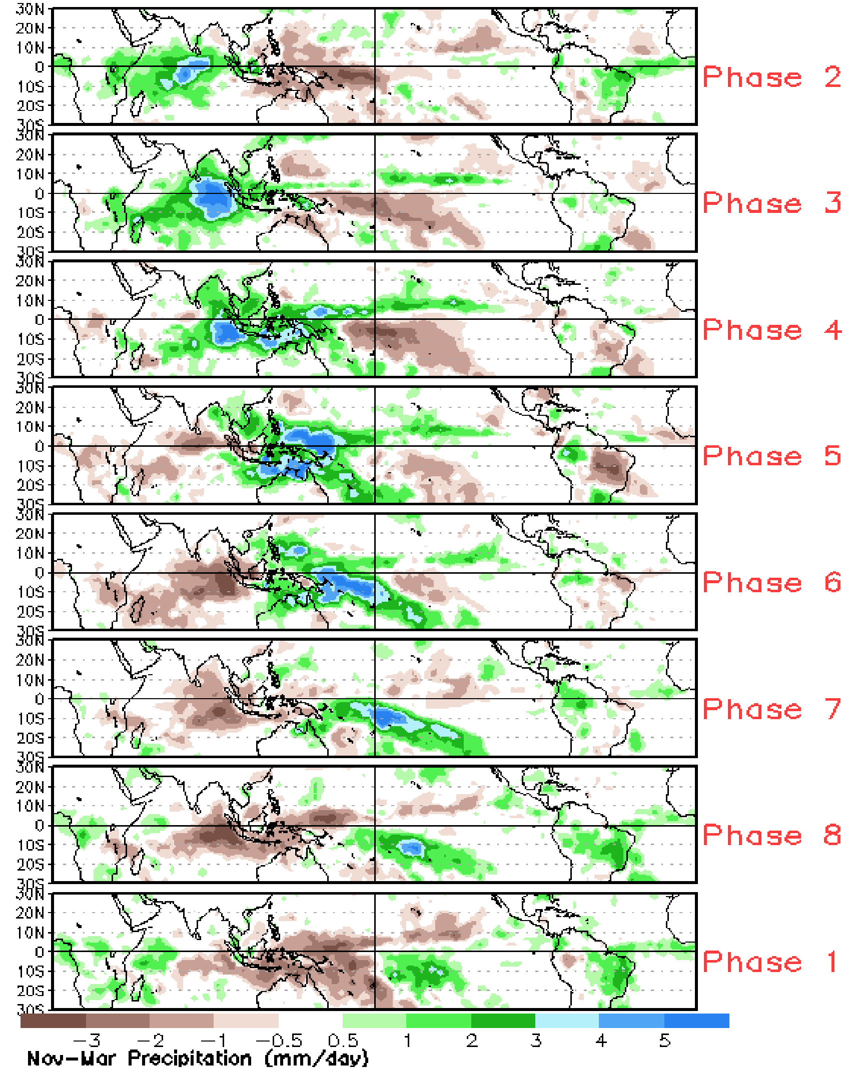
- The constructed analog (CA) RMM-based forecast also features destructive interference with the base state with enhanced convection overspreading the Maritime Continent.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



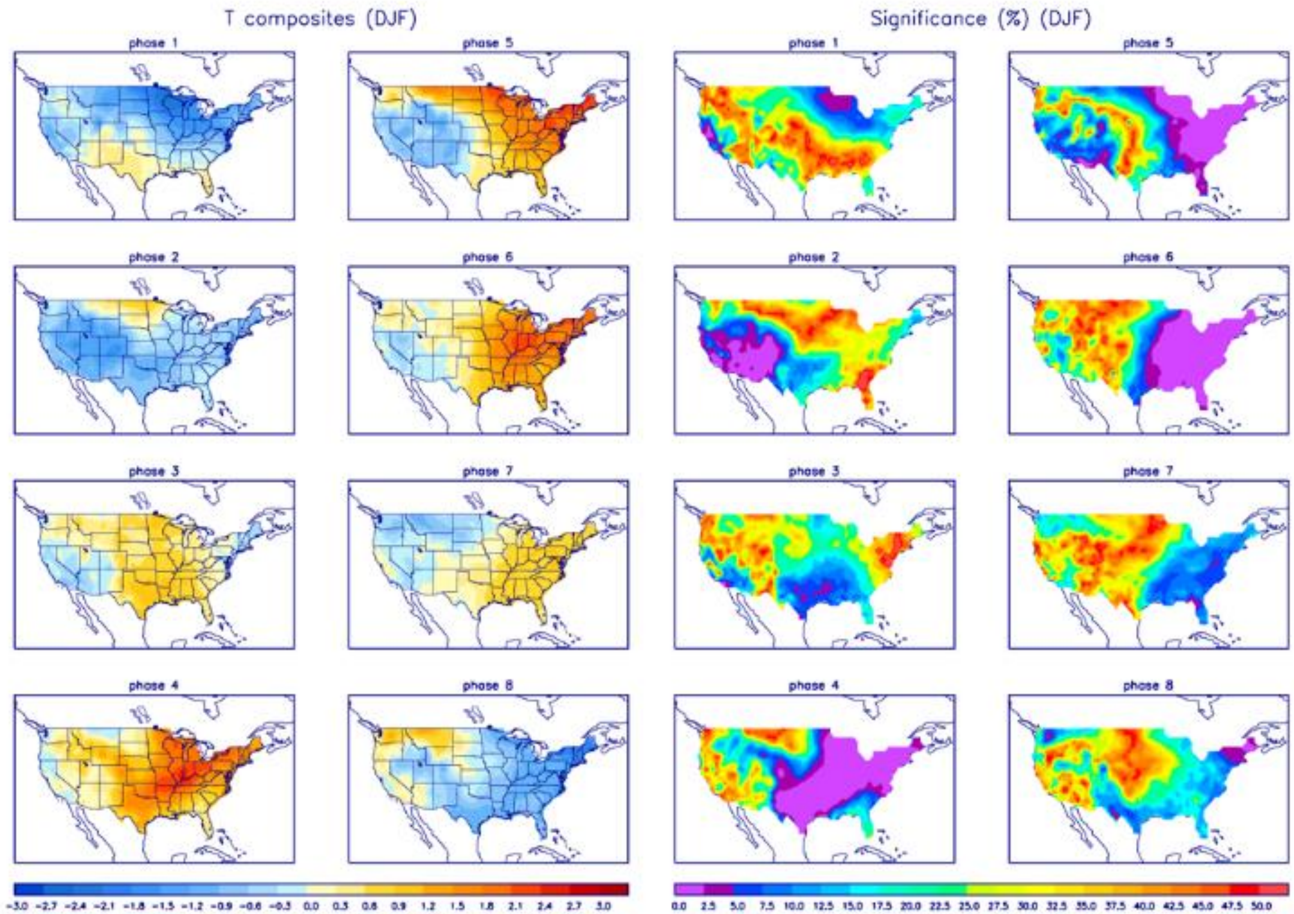
Precipitation Anomalies



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.

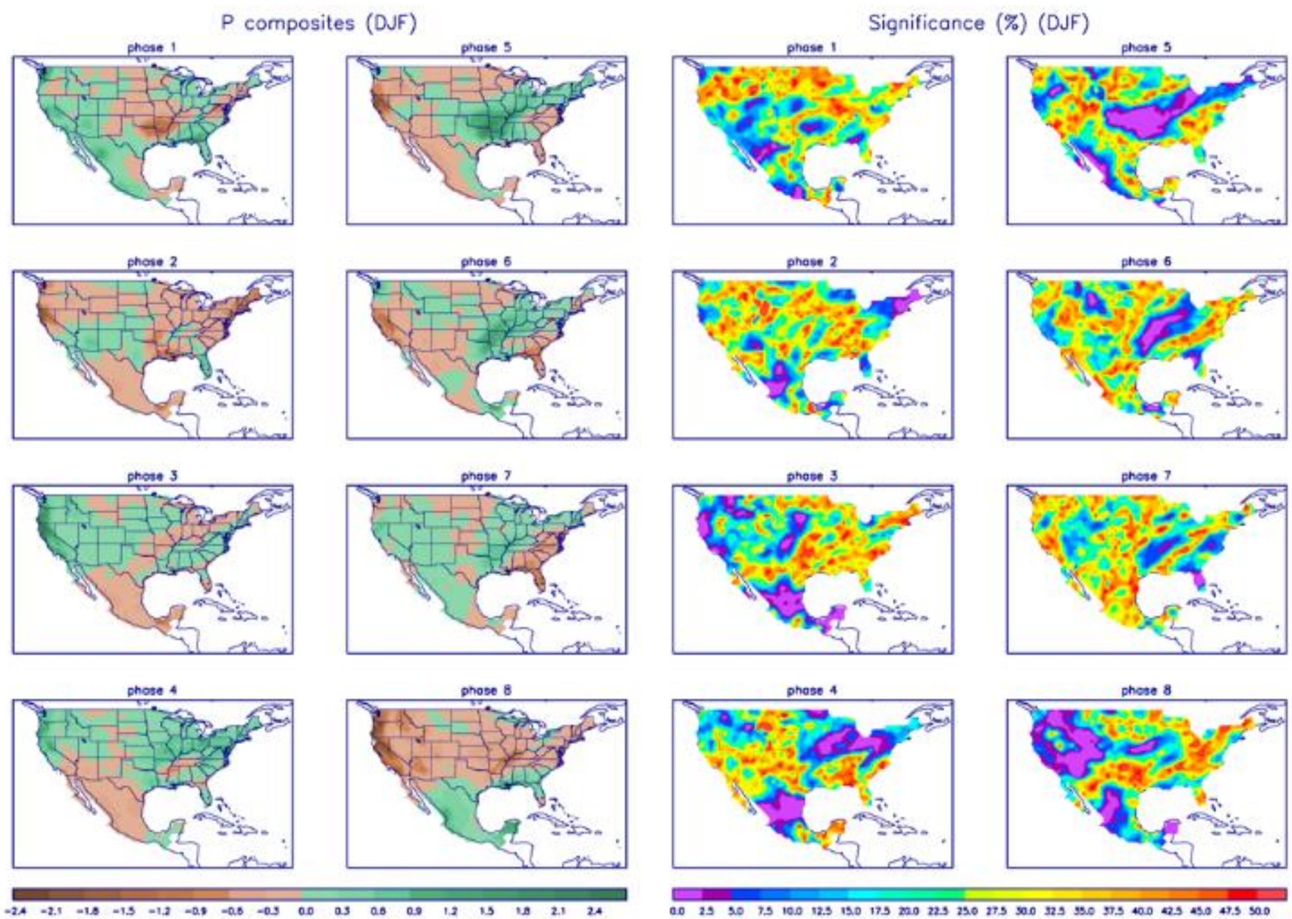


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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