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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
5 February 2024

Overview

- The MJO remains active, and has almost completed a circumnavigation of the globe since late-December, currently residing in phase 7 (Western Pacific).

- There is increasing variability in the dynamical model ensembles regarding the continued eastward propagation of the MJO as the intraseasonal signal is forecast to interact with El Niño and enhanced Rossby Wave activity over the Central Pacific.

- Enhanced convection associated with MJO activity and climatology support high chances of tropical cyclone development across the southern tropical Pacific during the next few weeks.

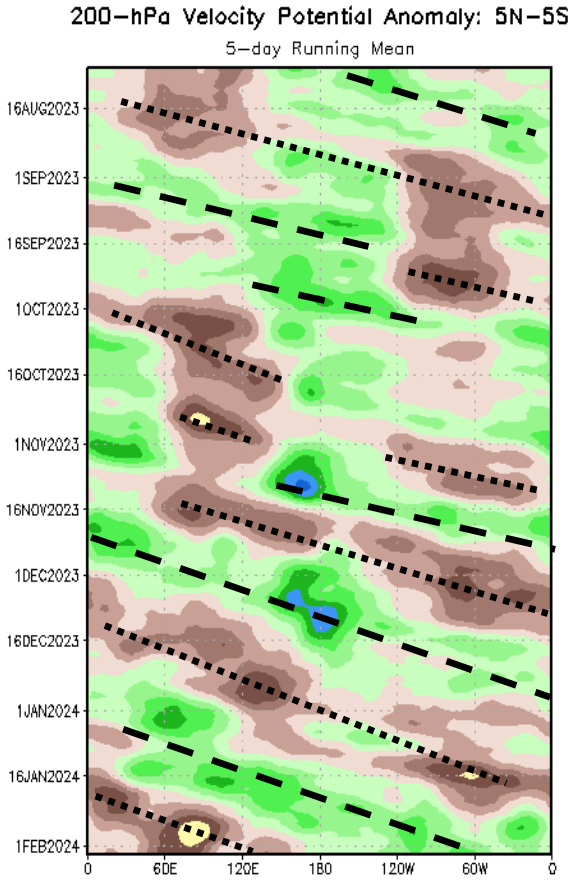
- While there is considerable uncertainty in the MJO evolution going forward, a transition to a relatively cooler pattern across the CONUS is possible by late-February, especially if the MJO moves further eastward into the Western Hemisphere.

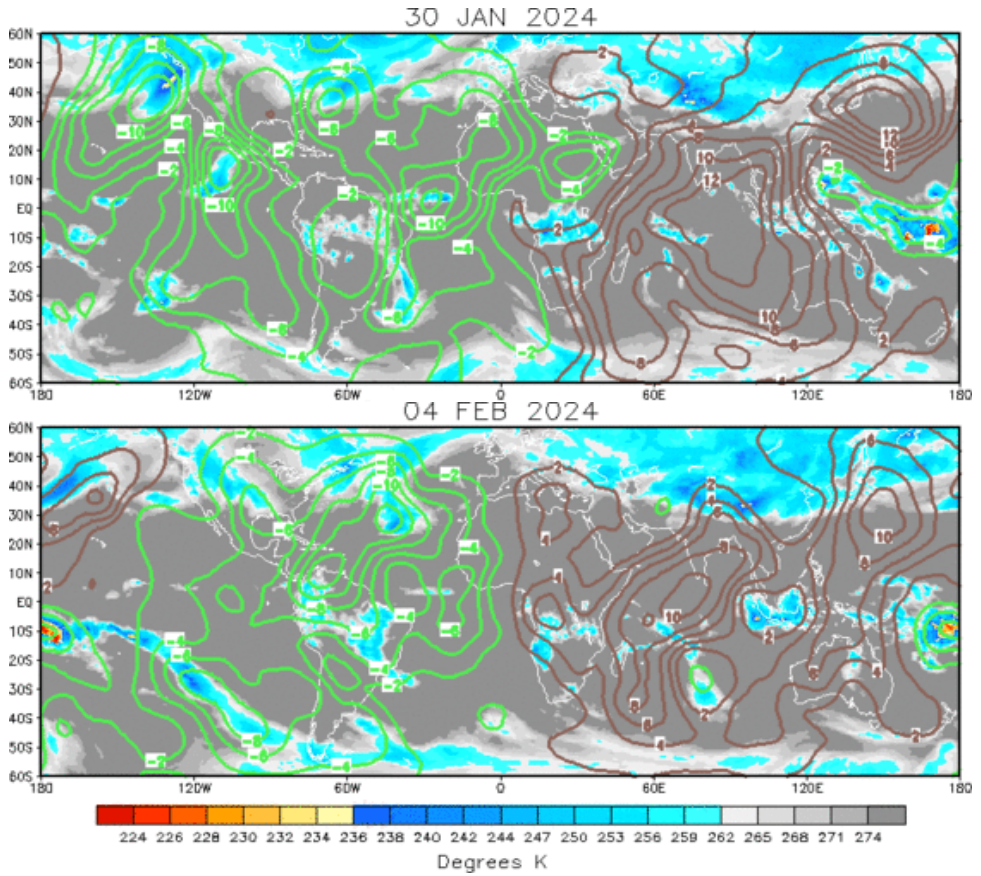
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

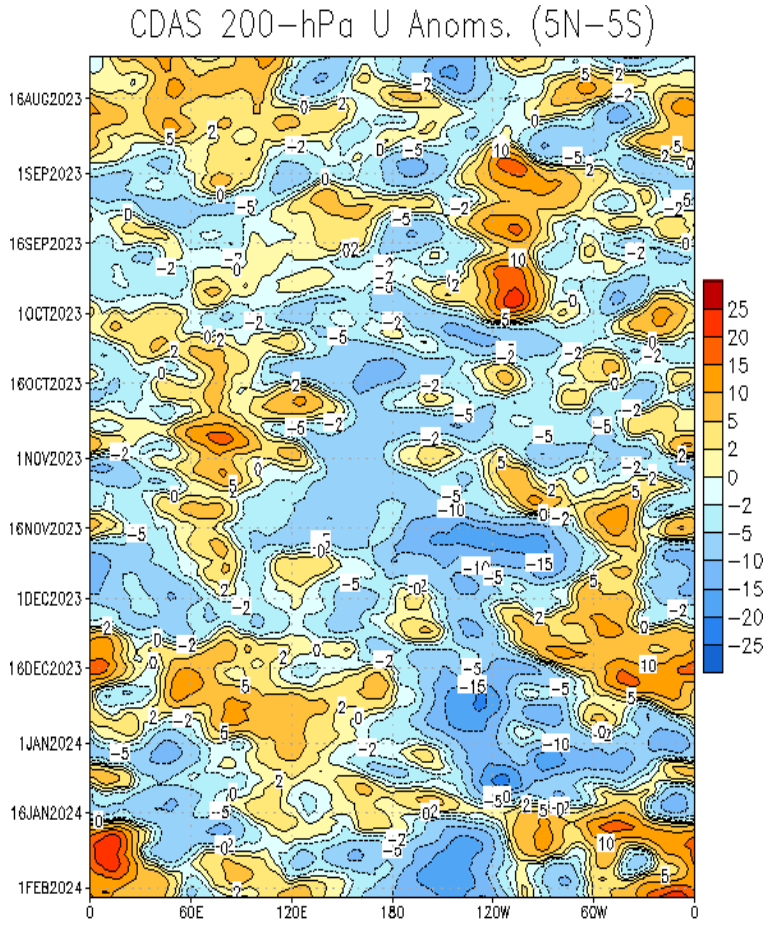


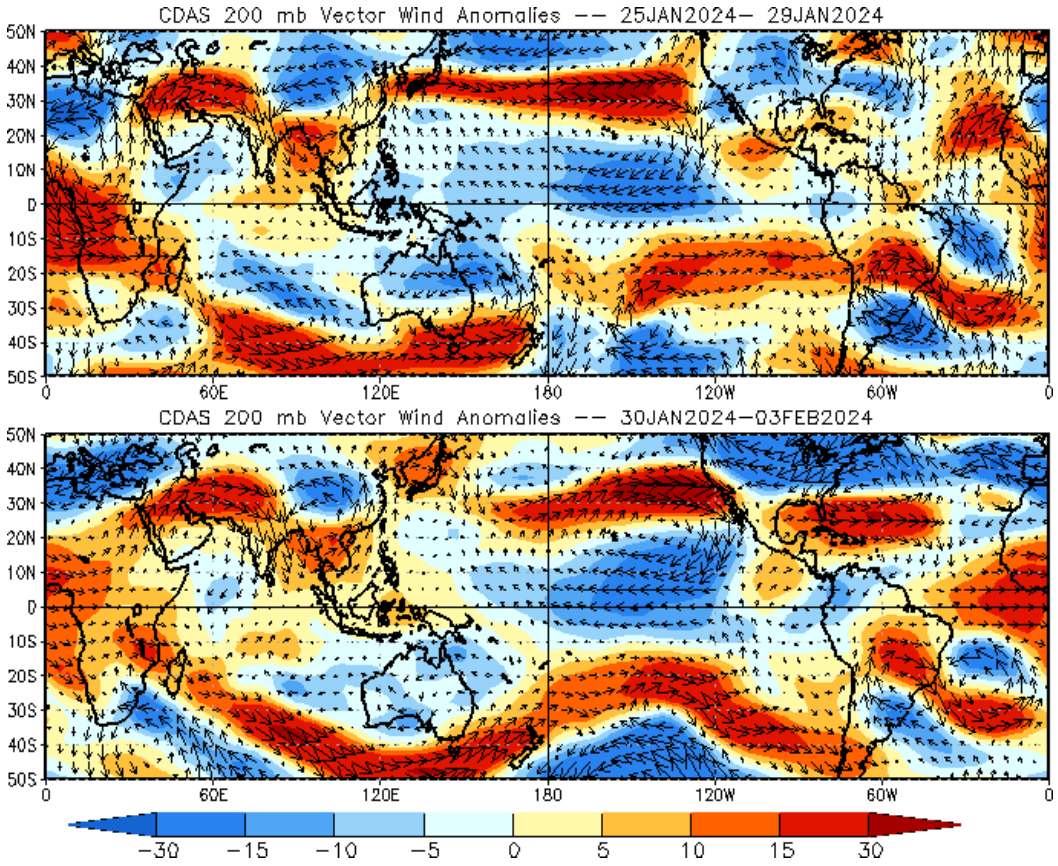


- Multiple propagations of the enhanced and suppressed phases of the MJO have occurred since late-November.
- A nearly stationary wave-1 asymmetry pattern is observed across the globe during late-January and early-February, with anomalous upper-level convergence (divergence) across much of the Eastern (Western) Hemisphere.

200-hPa Wind Anomalies

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

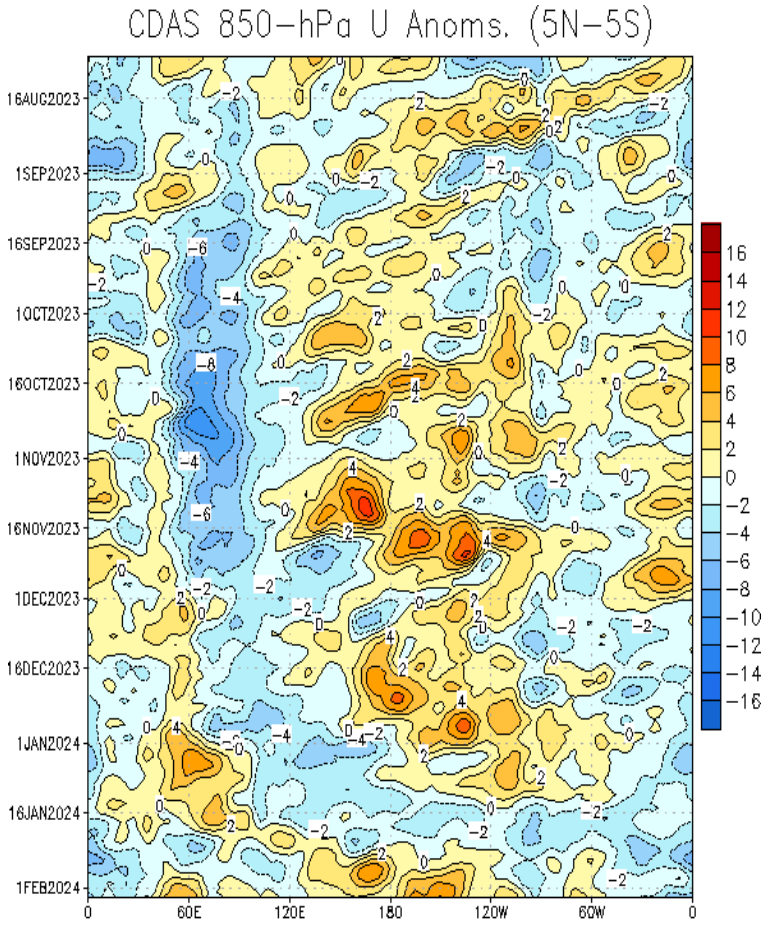


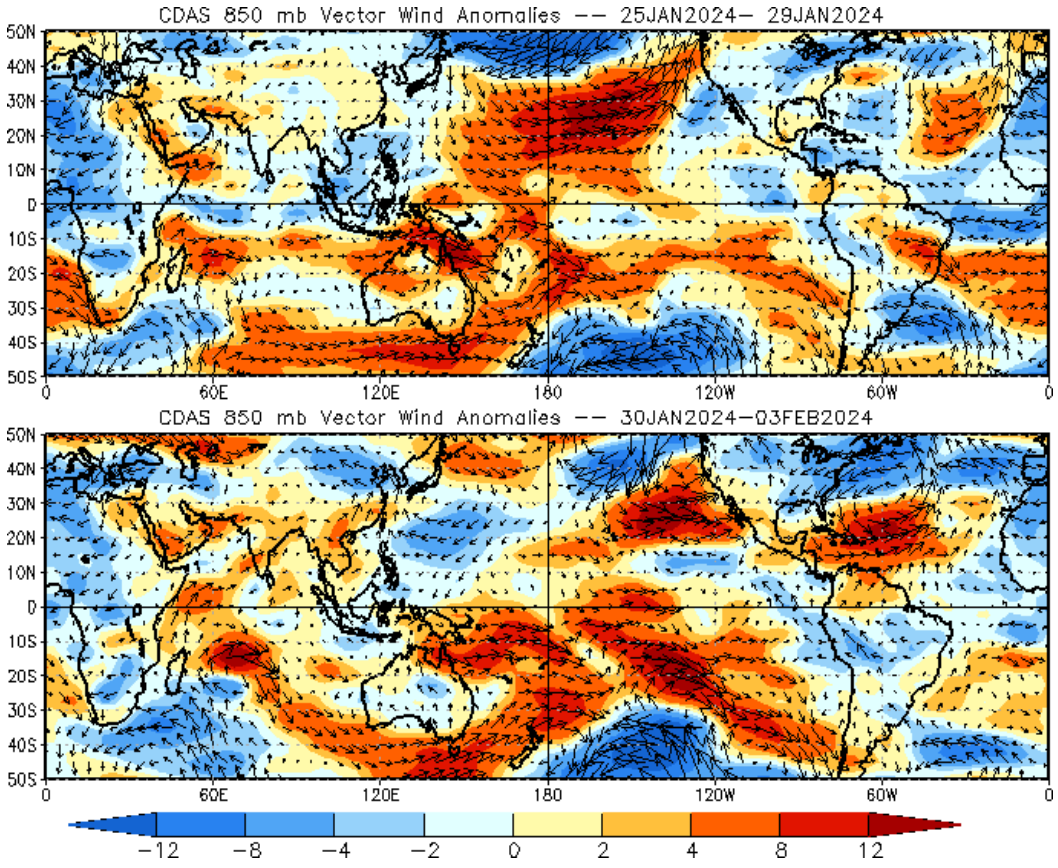


- Anomalous upper-level westerlies have increased across the Indian Ocean and Maritime Continent as the MJO propagates further eastward into the Pacific.
- Anomalous upper-level easterlies remain across the central Pacific to the north of the Equator tied to high pressure located between Hawaii and the U.S. West Coast.
- An enhanced jet is observed across the subtropical Pacific and extending into the southwestern CONUS coinciding with ongoing atmospheric river activity.

850-hPa Wind Anomalies

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

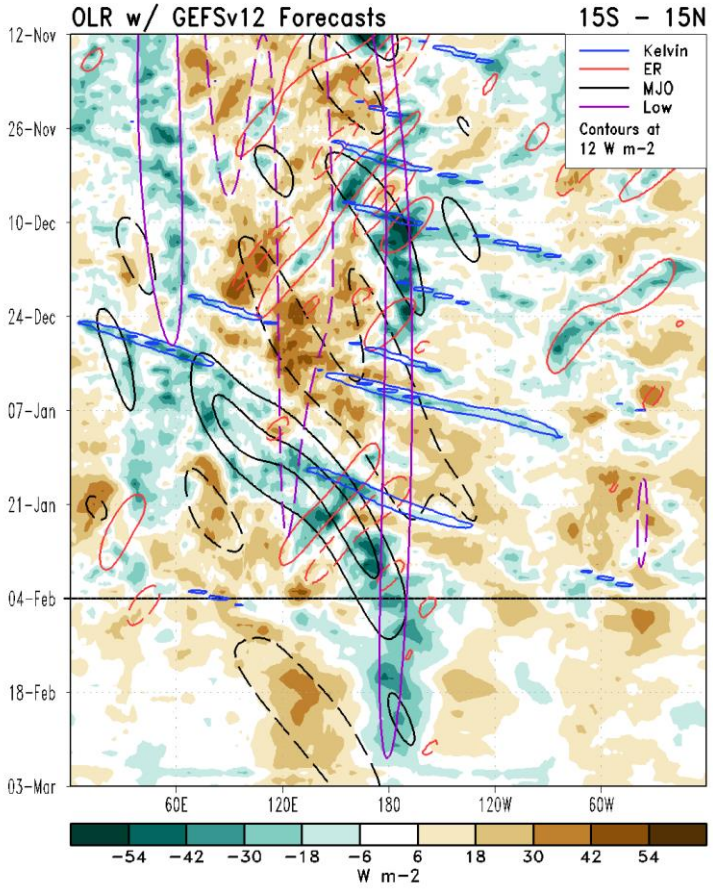


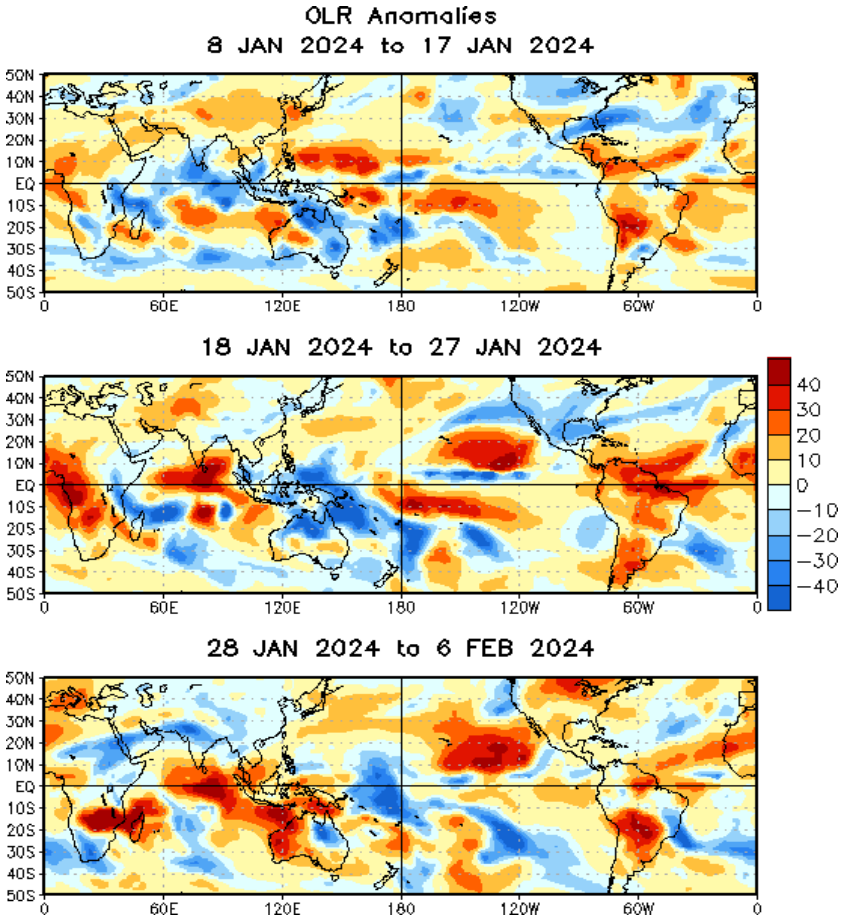


- Anomalous low-level westerlies continued to propagate across the Pacific tied to the MJO.
- Persistent anomalous low-level westerlies remain across the eastern Pacific and into the West Coast of the U.S. consistent with ongoing atmospheric river activity.

Outgoing Longwave Radiation (OLR) Anomalies

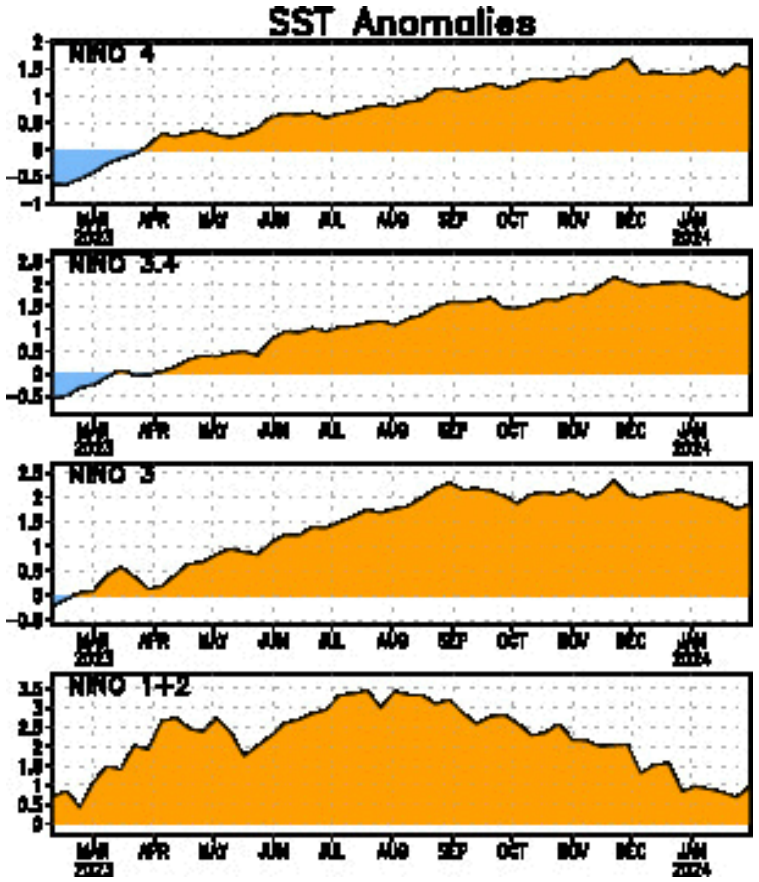
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

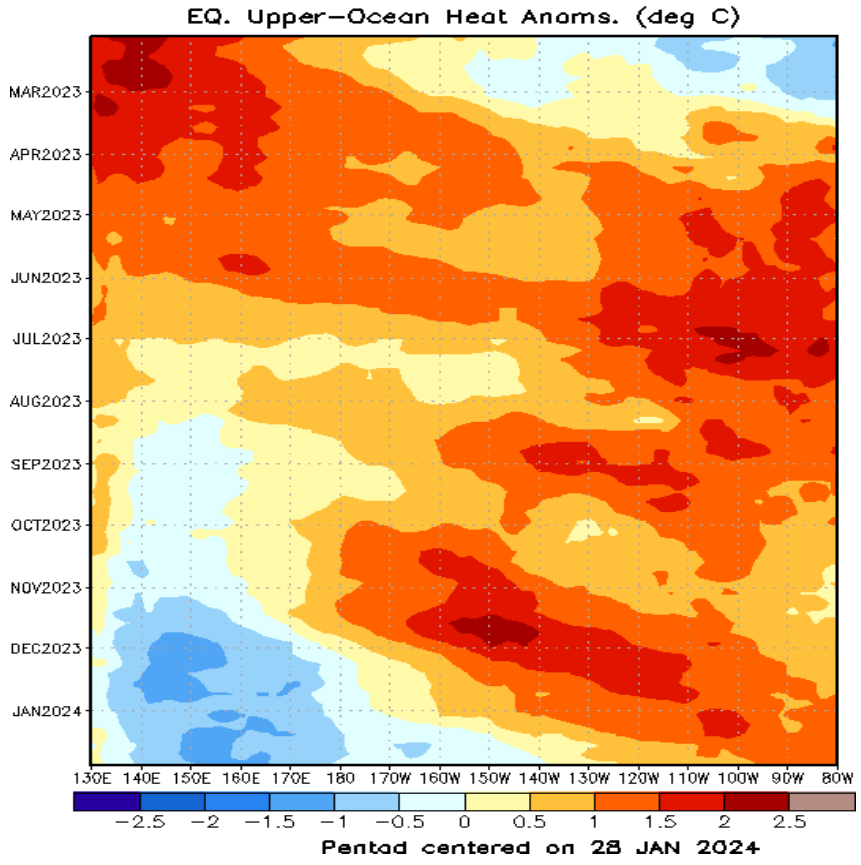




- A robust MJO signal is apparent through the OLR filtering during the past month. However, the signal is beginning to interfere with the low frequency El Niño footprint and enhanced Rossby Wave activity along the Date Line, resulting in a forecast stalling of the anomalous convection near the Date Line.
- During the past week, positive OLR anomalies increased across the Indian Ocean and Maritime Continent in the wake of the eastward propagating MJO. Negative OLR anomalies shifted into the west-central Pacific.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

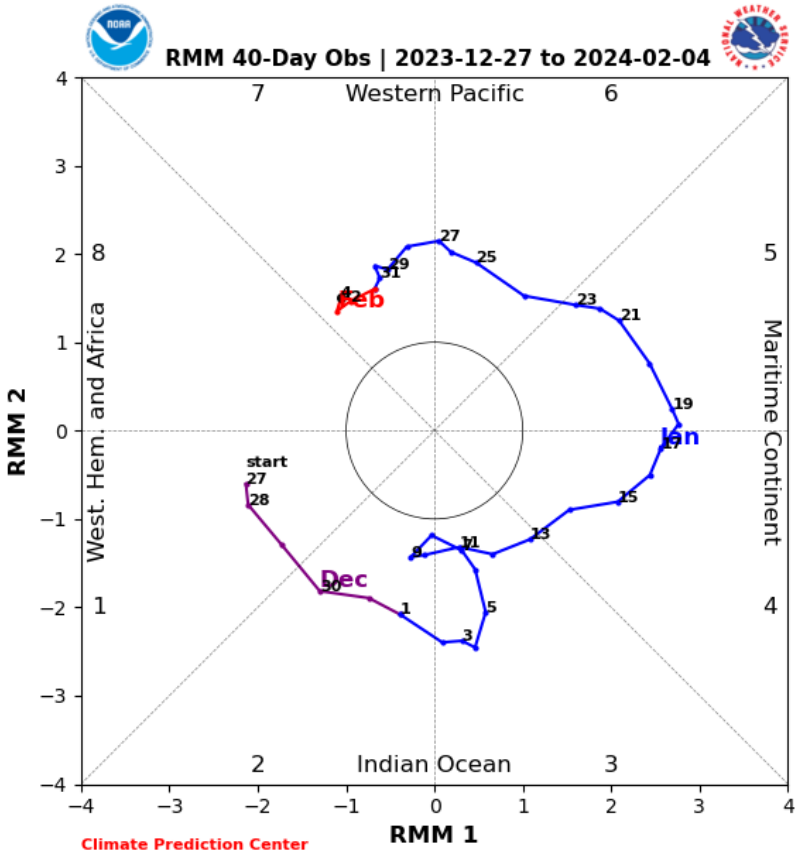




- SSTs are generally steady in the NINO regions, with a larger downward trend noted in the NINO 1+2 region over the past few months.
- Negative upper-ocean heat content anomalies continue to expand eastward to 140°W during the past week tied to a downwelling oceanic Kelvin Wave, although the strongest negative anomalies remain west of the Date Line. Positive upper-ocean heat content anomalies remain in place east of 140°W.

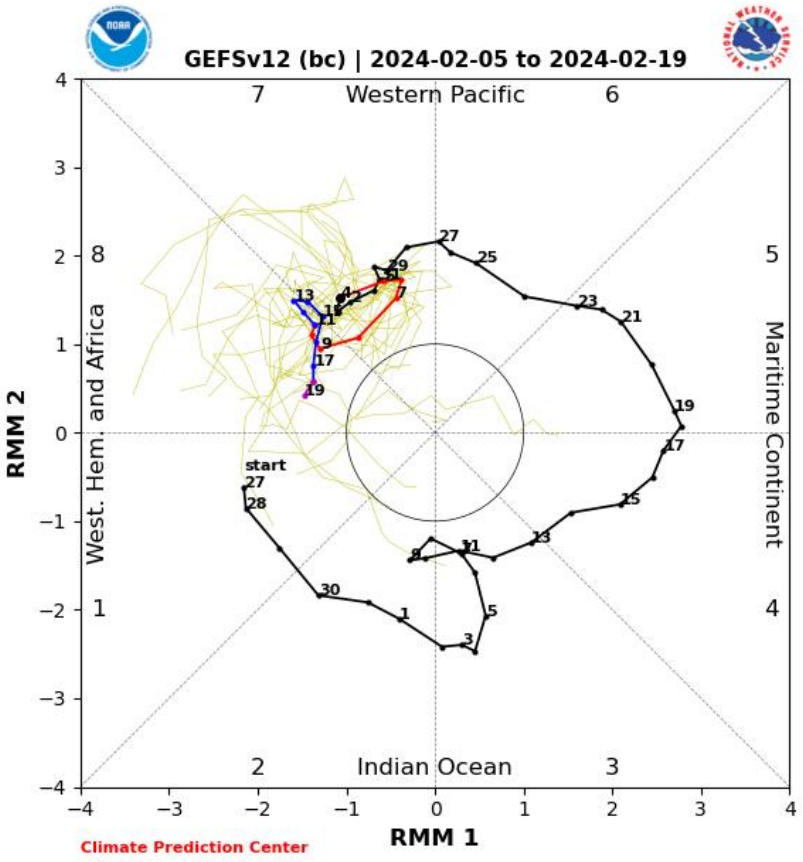
MJO Index: Recent Evolution

- The RMM-based MJO index has been active since late-December and has almost completed a full circumnavigation, now residing in phase 7.

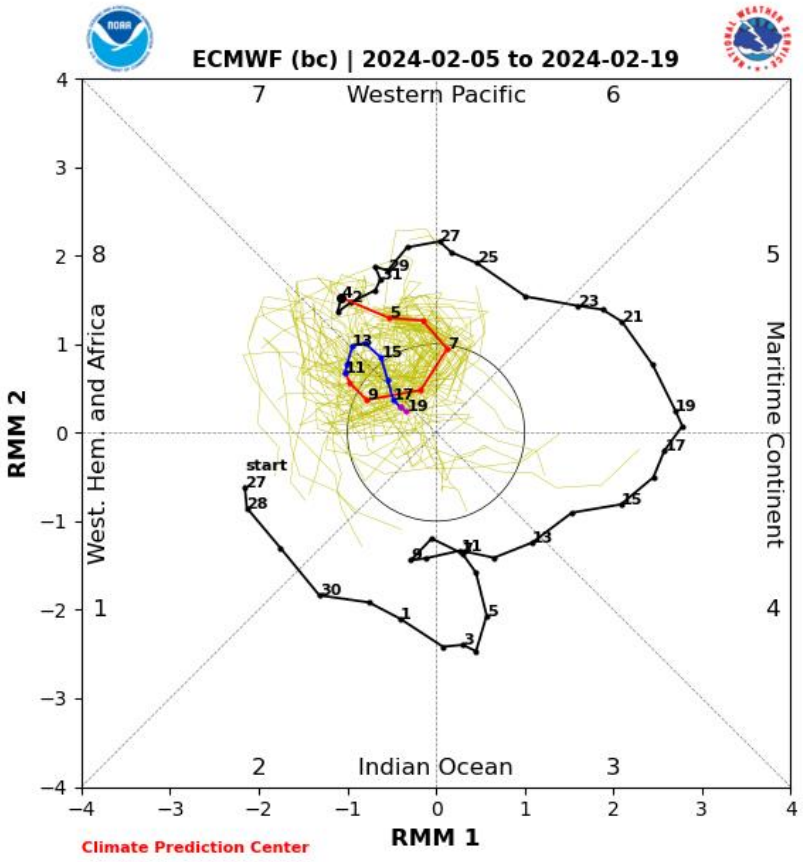


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

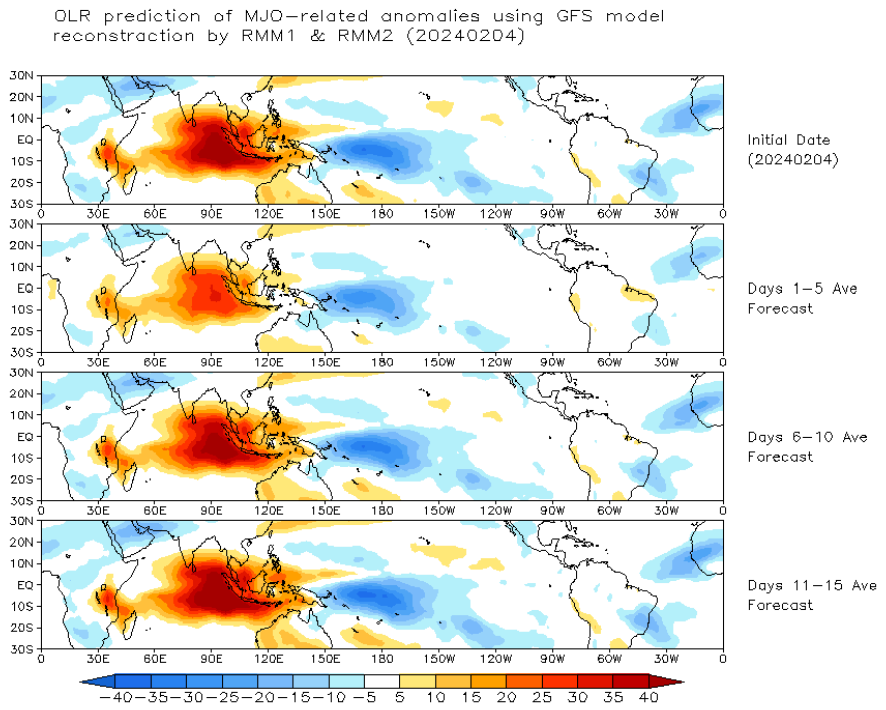


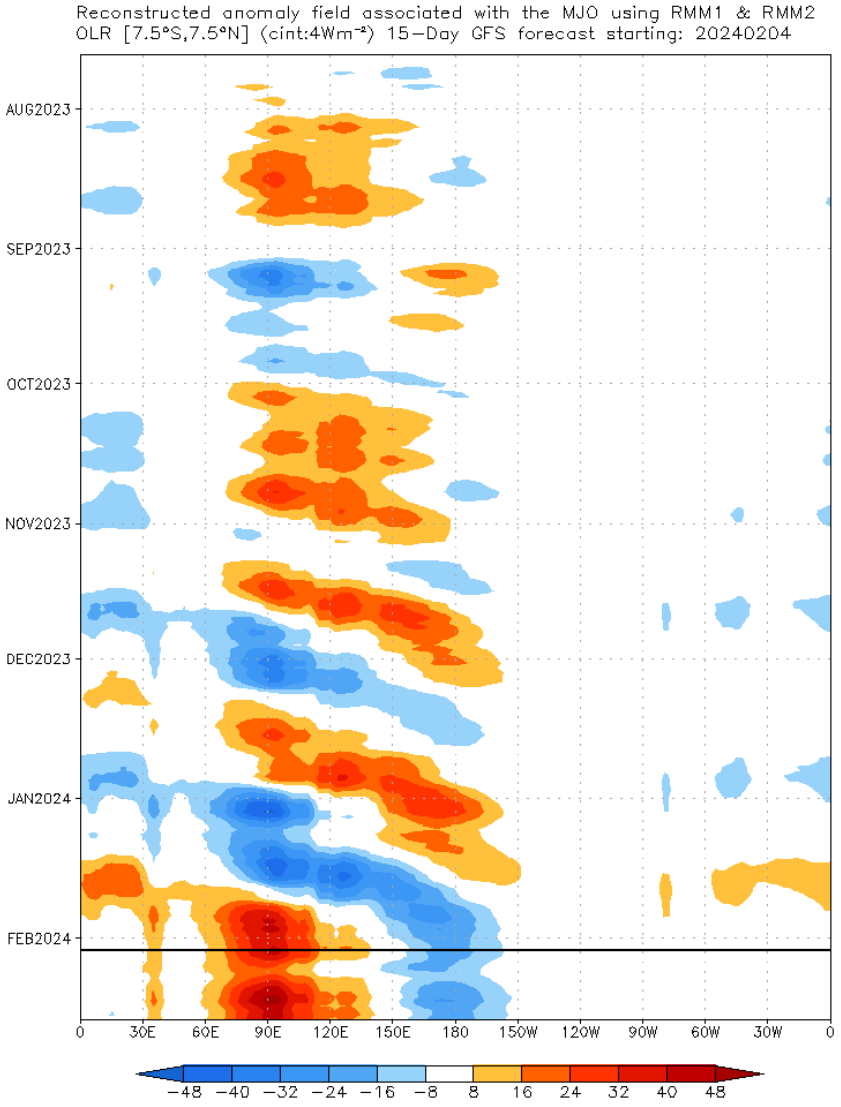
ECMWF Forecast

- Both the GEFS and ECMWF ensembles indicate a slowing of the MJO signal as it approaches the Western Hemisphere, with some ensemble members returning the RMM-based MJO index to the unit circle, while others depict a healthier propagation into phases 8 and 1.
- The degree of interaction with the low frequency El Niño footprint along with increased Rossby Wave activity across the Central Pacific will influence the behavior of the MJO during the next few weeks.

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.)

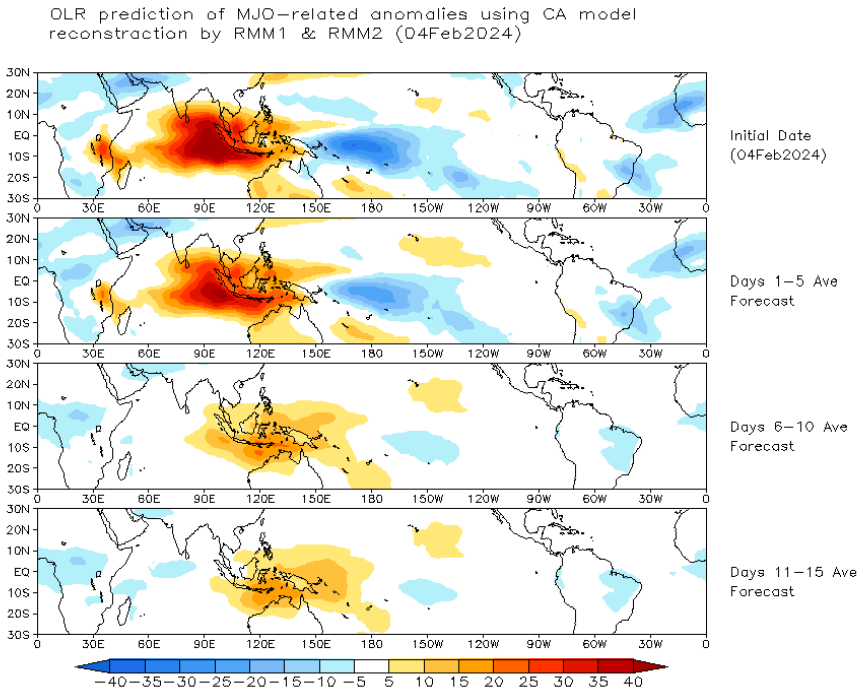


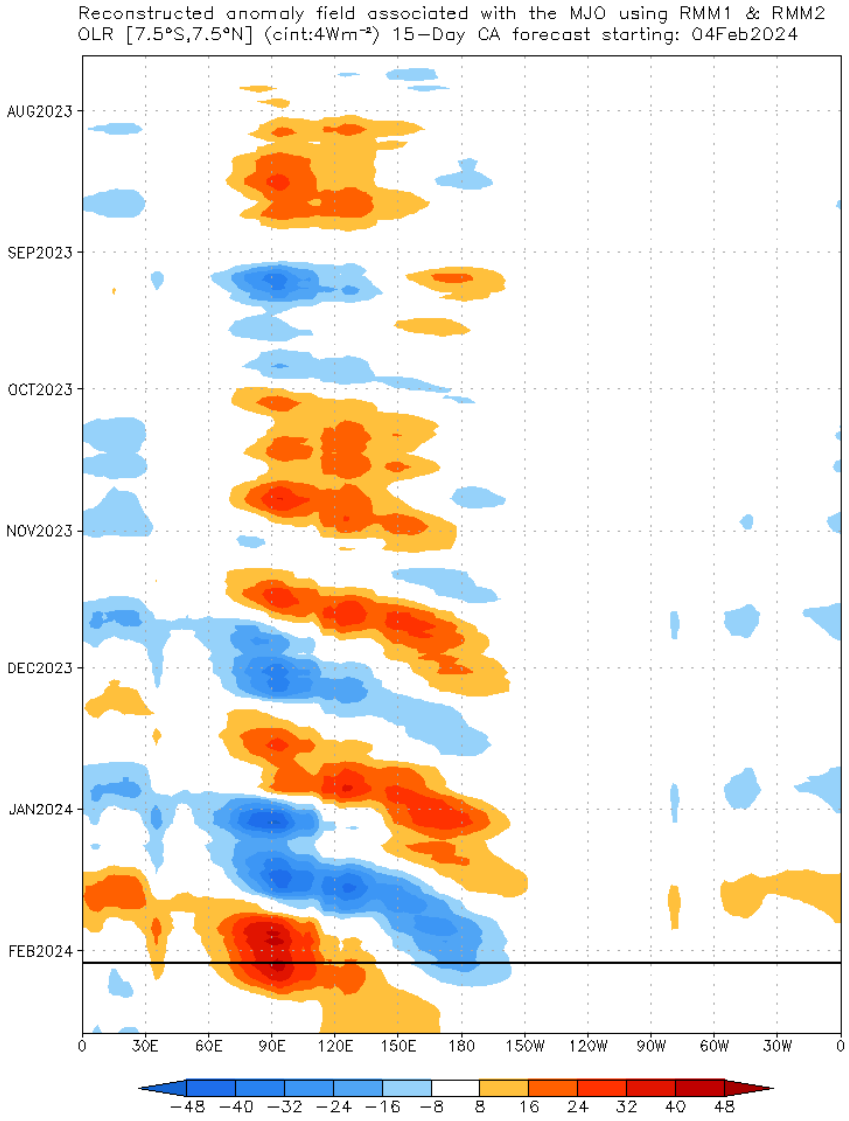


- The GEFS RMM-based OLR forecast depicts slight eastward propagation of negative OLR anomalies (enhanced convection) across the Central Pacific and positive OLR anomalies (suppressed convection) expanding across the Indian Ocean and Maritime Continent.

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.)

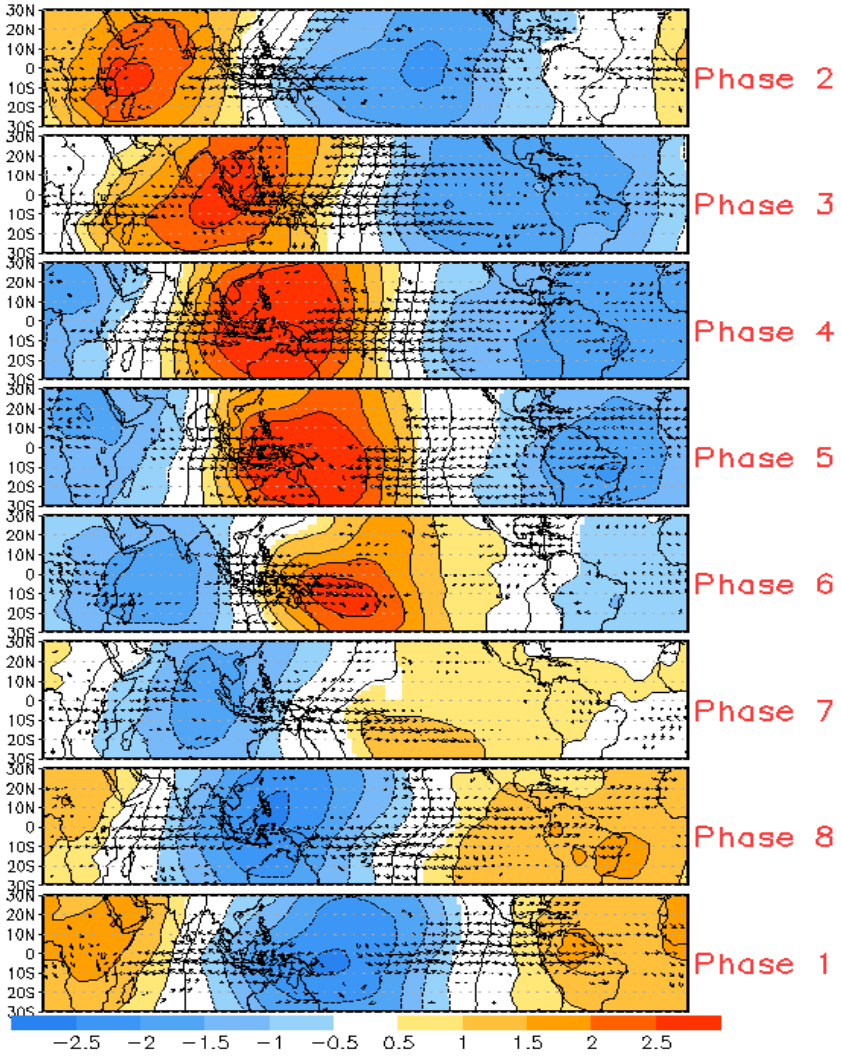




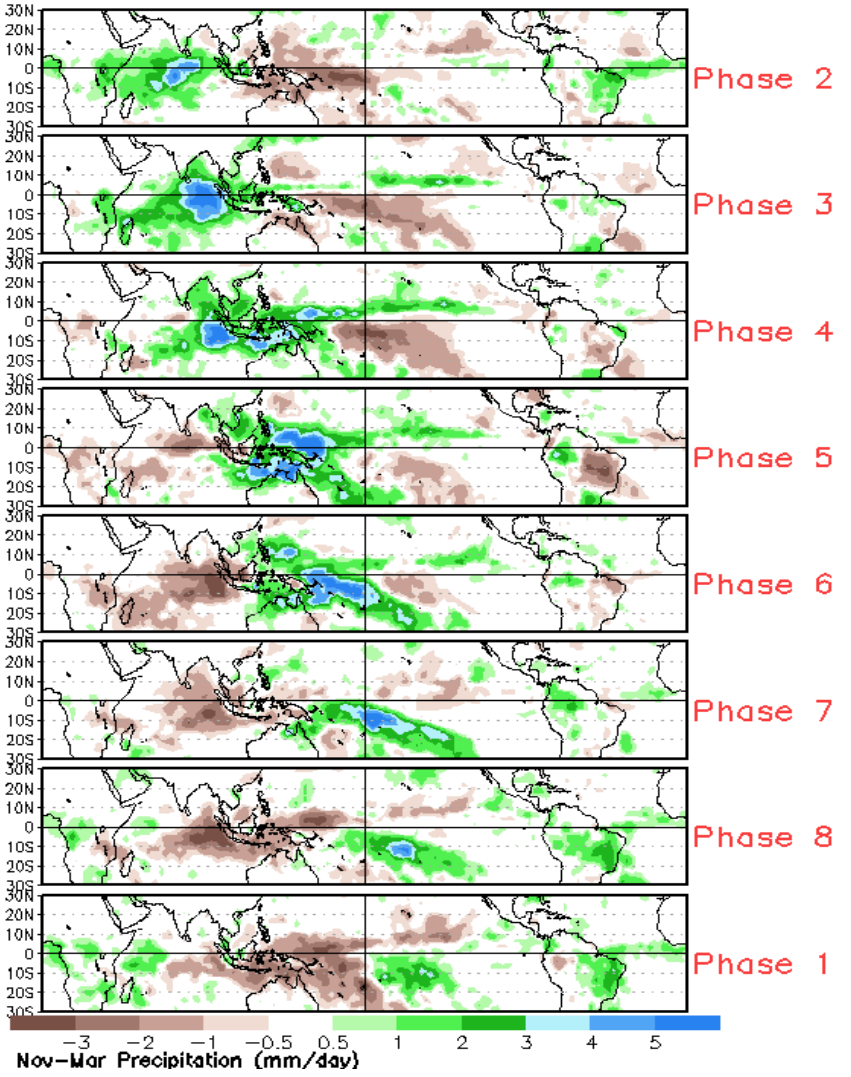
- The constructed analog (CA) RMM-based forecast is more progressive and depicts positive OLR anomalies reaching the Pacific by week-2, and negative OLR anomalies returning to the Indian Ocean.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



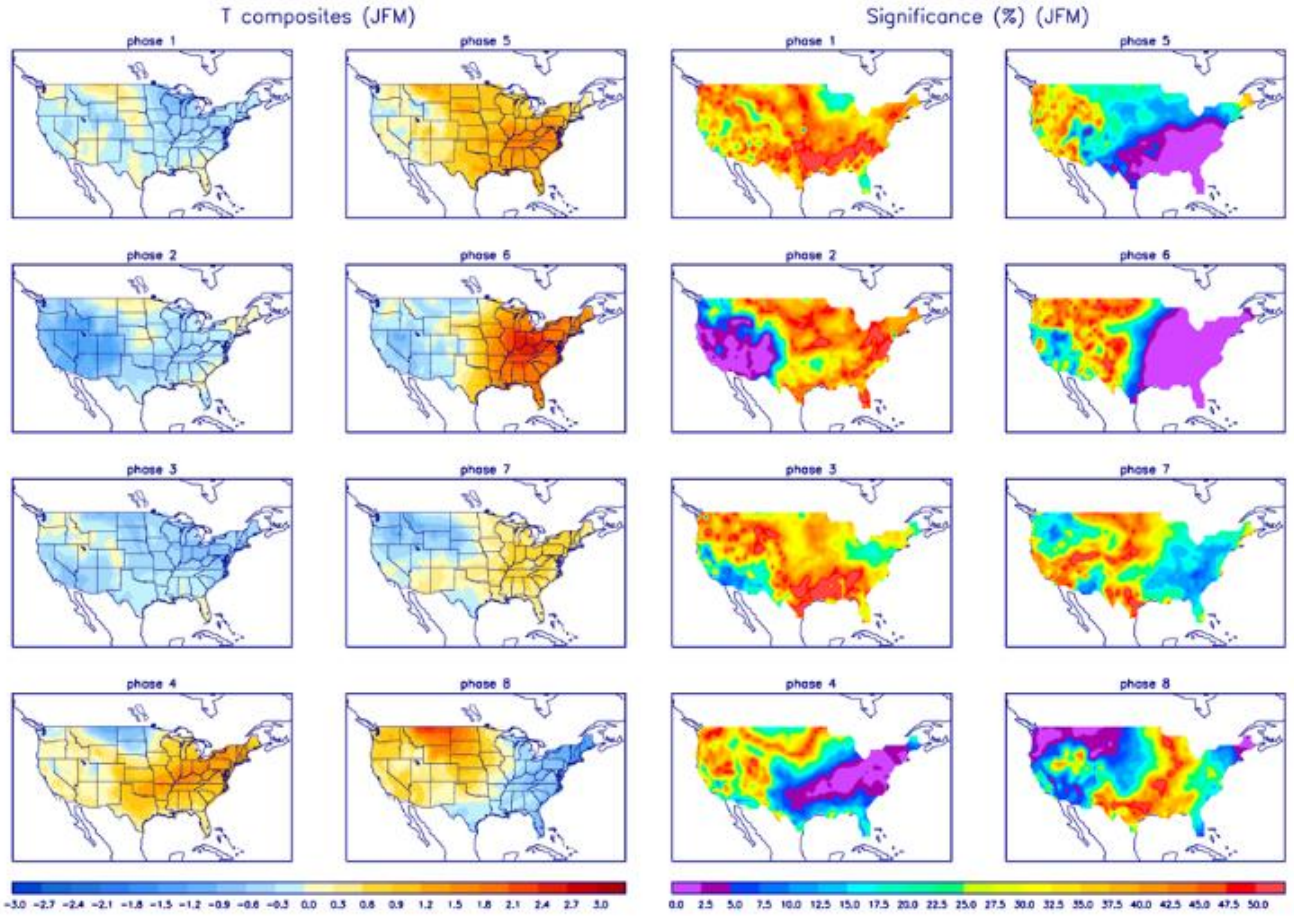
Precipitation Anomalies



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.

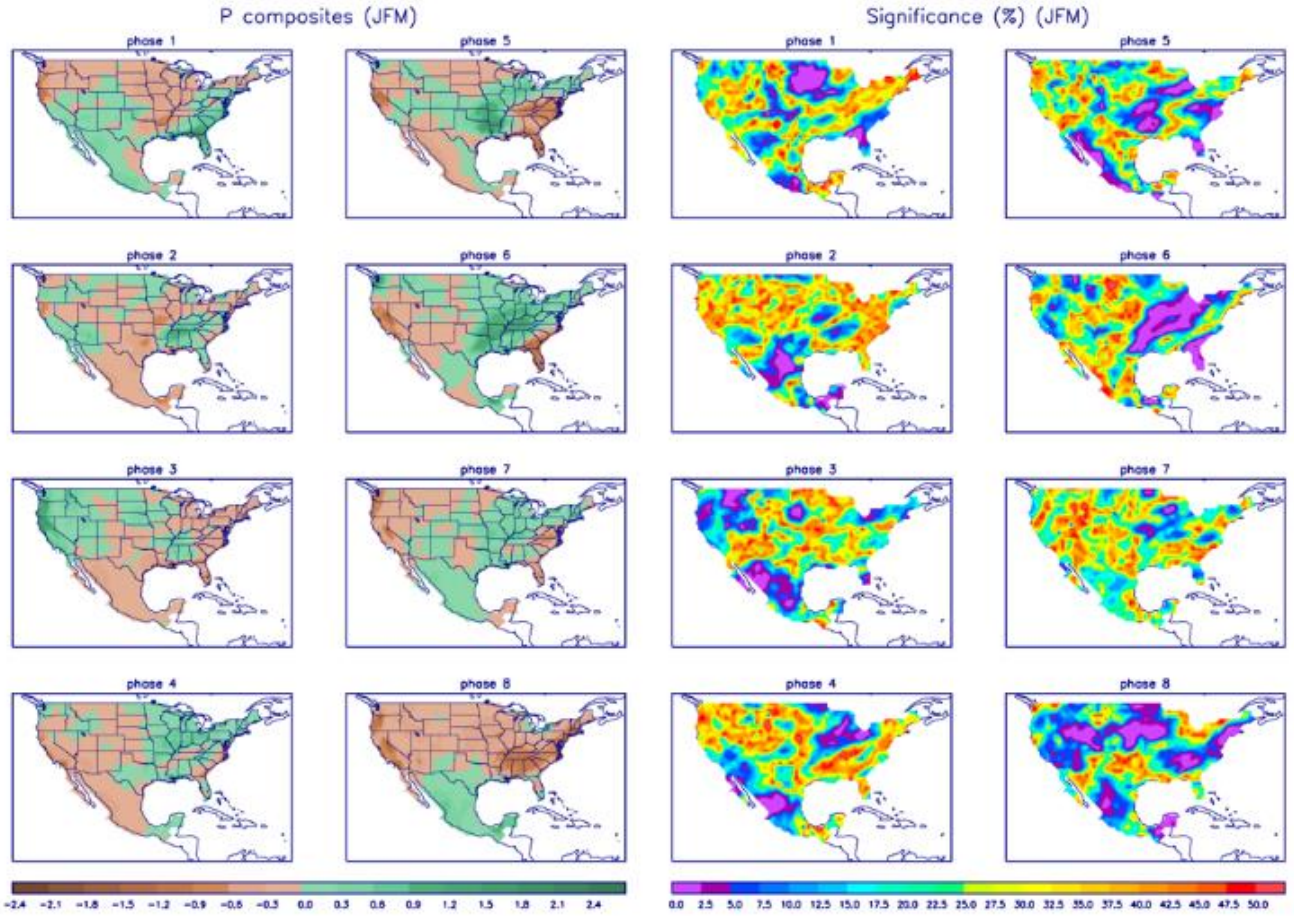


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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