

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



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
27 February 2023

Overview

- The MJO signal has weakened over the last week after several weeks of a robust signal with typical eastward propagation from the Indian Ocean into the Central Pacific.
- Interference from various modes, including the ongoing La Niña, have resulted in period of erratic behavior in the RMM index.
- Dynamical model MJO index forecasts generally depict a re-emerging stronger Pacific signal during week-1, followed by a resumption of eastward propagation of the signal during week-2.
- Pacific MJO activity may help further weaken the La Niña signal through low-level westerly wind anomalies promoting eastward propagation of warmer water across the Pacific.

A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

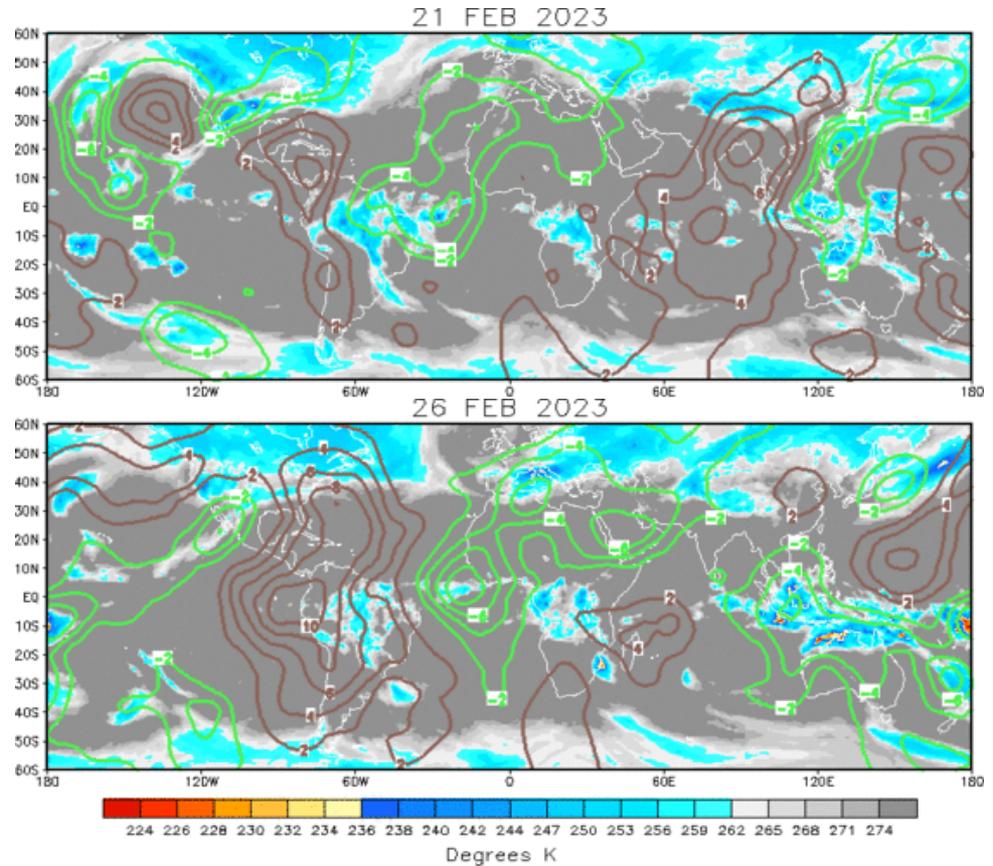
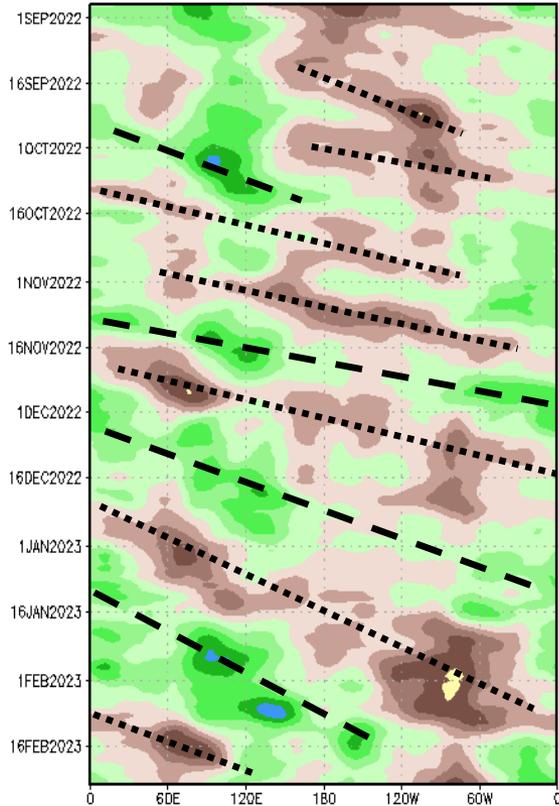
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

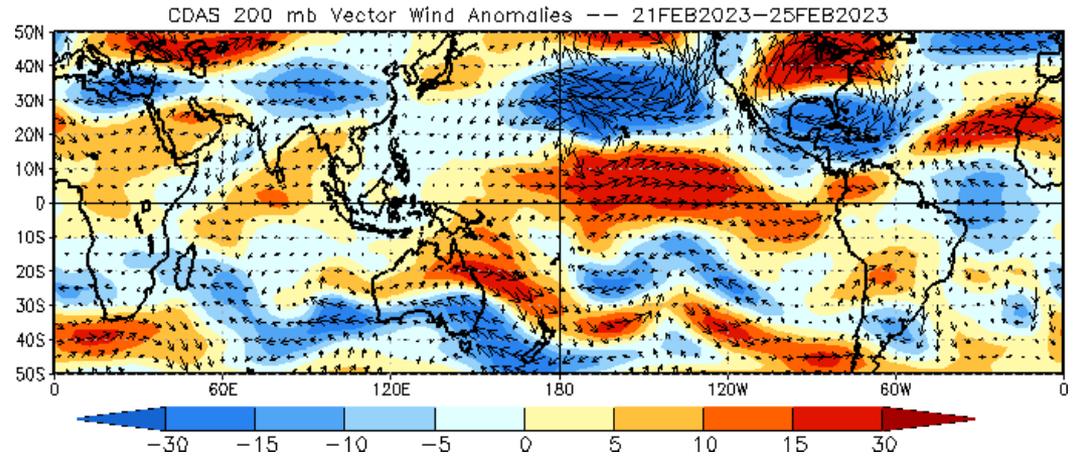
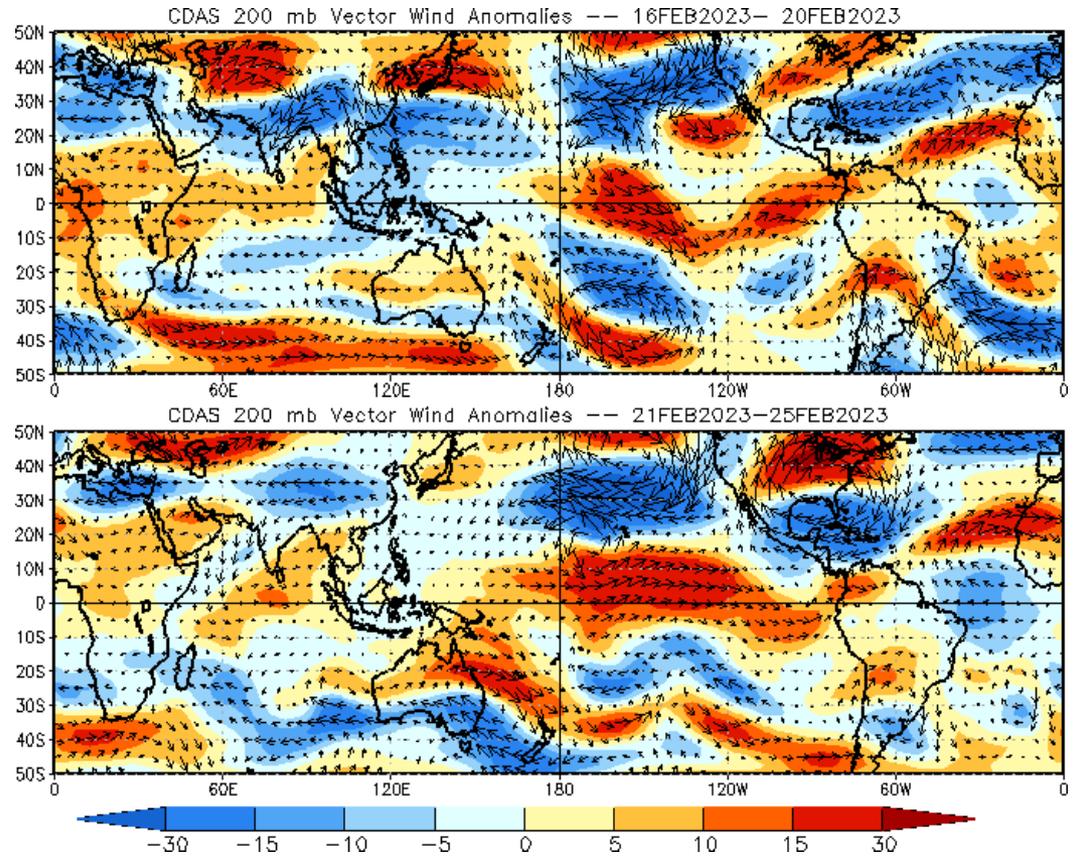
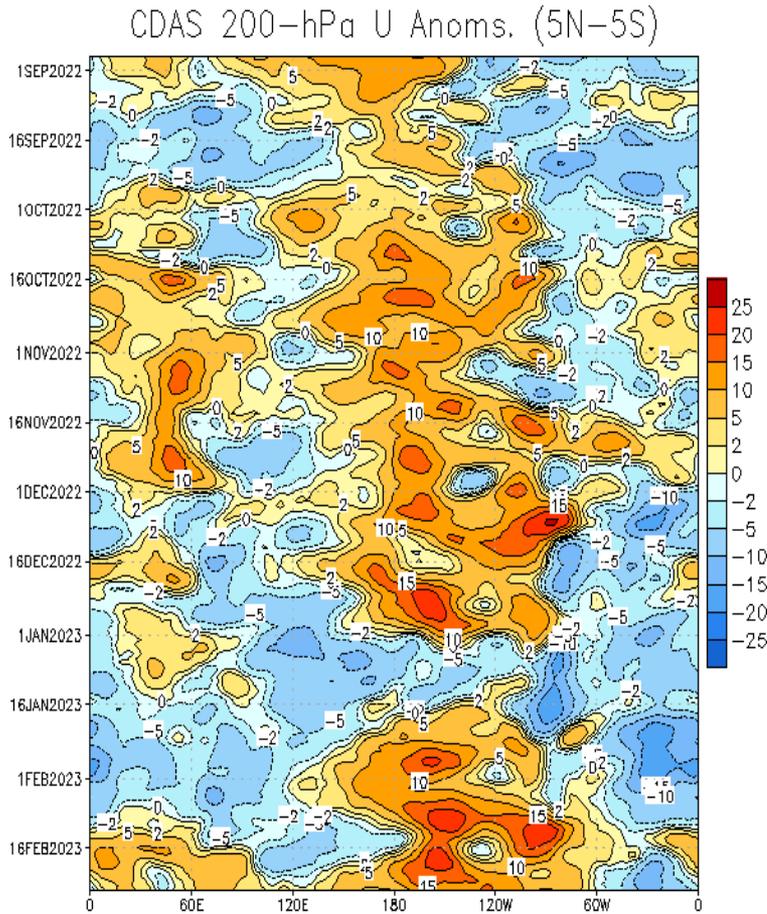
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- After a period of robust MJO activity which is clearly evident in the Hovmoller plot, the signal has weakened somewhat as tropical convection has become less organized.
- Anomalous divergence is currently over the Maritime Continent and near the Prime Meridian, with anomalous convergence emerging and strengthening over the Americas.

200-hPa Wind Anomalies

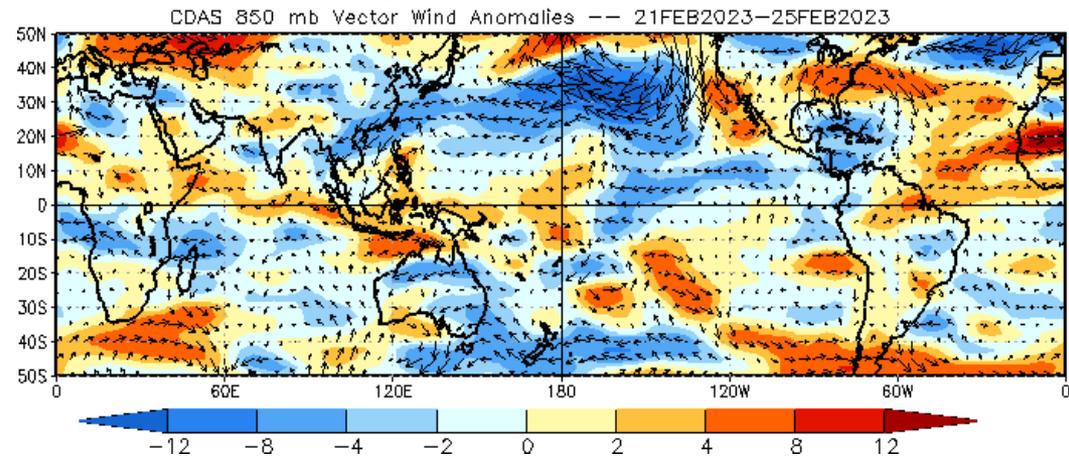
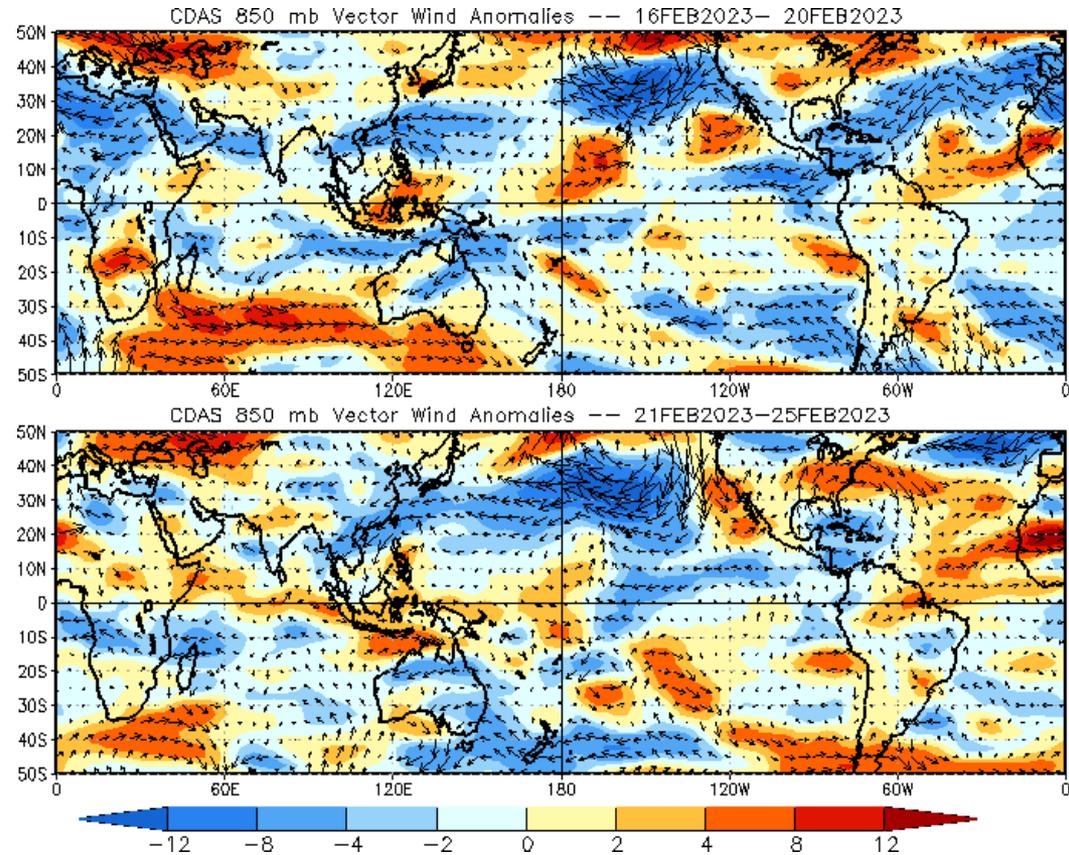
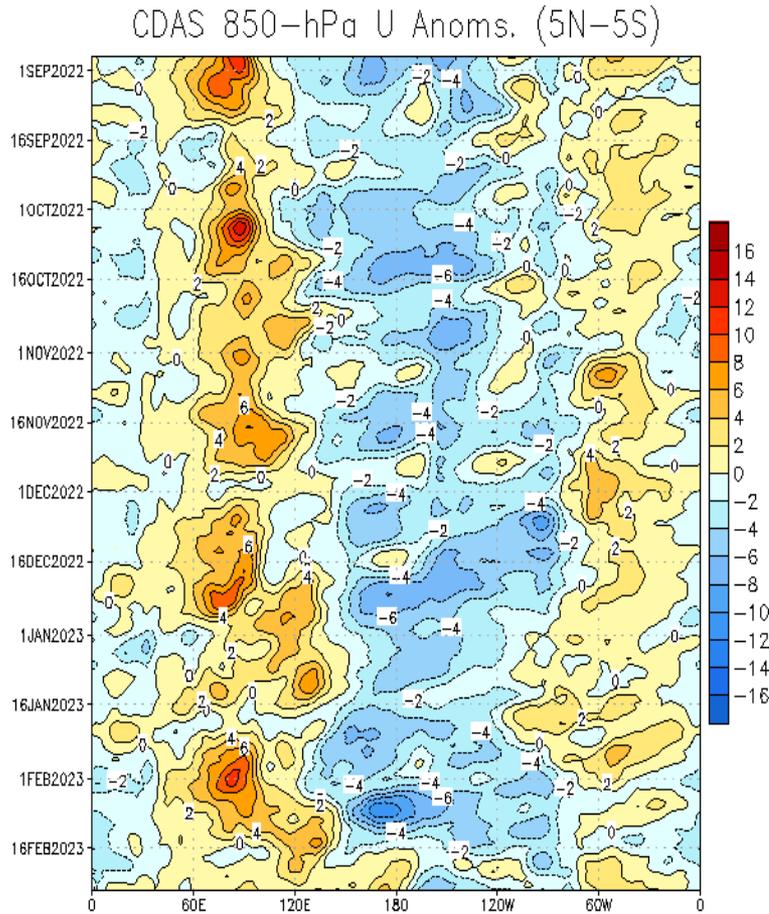
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous westerlies near and east of the Date Line have increased in strength after a brief lull in mid-February.
- A persistent anticyclone remains over the northeast Pacific, with a second large anticyclone emerging over the eastern CONUS over the last week.

850-hPa Wind Anomalies

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

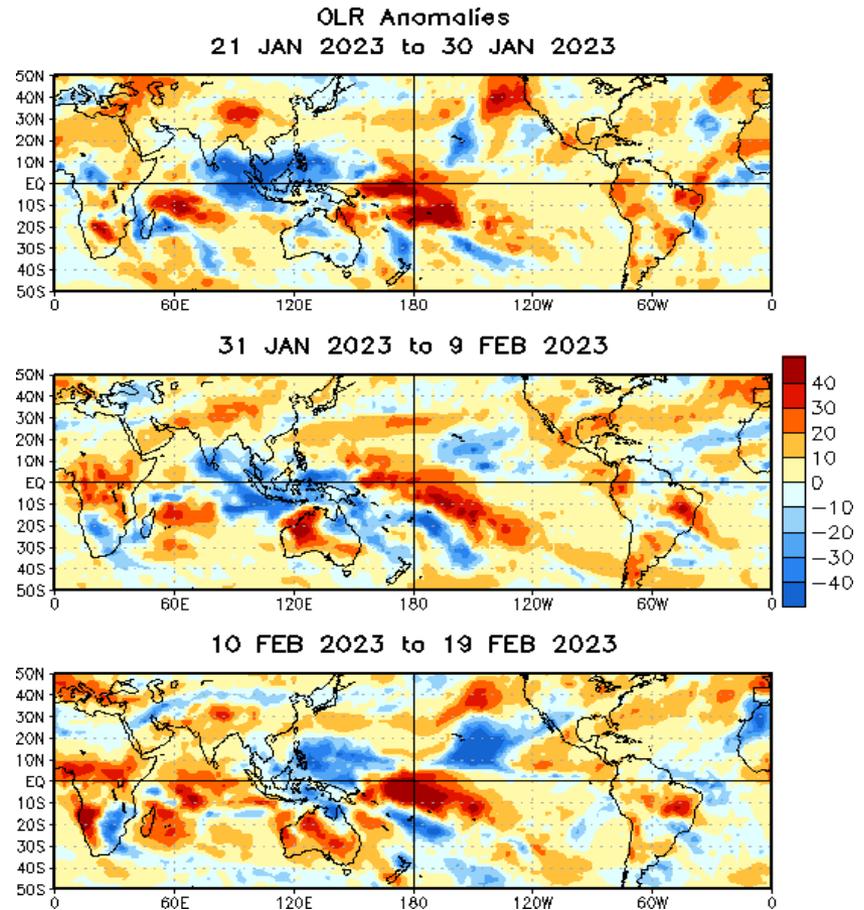
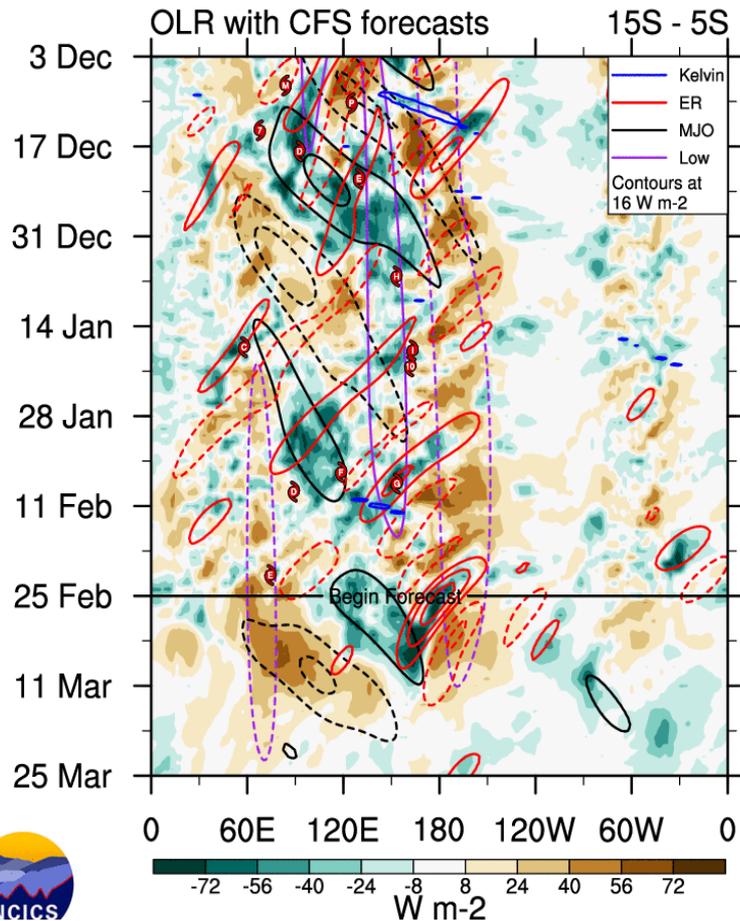


- A westerly wind burst over the eastern Indian Ocean that emerged during mid-February has diminished.
- Broad anomalous westerlies persist over much of Equatorial Indian Ocean and Maritime Continent.
- Enhanced trade wind regime over the Pacific has been significantly weakened. Some anomalous easterlies remain but cover a much smaller area than what has been seen in weeks past.

Outgoing Longwave Radiation (OLR) Anomalies

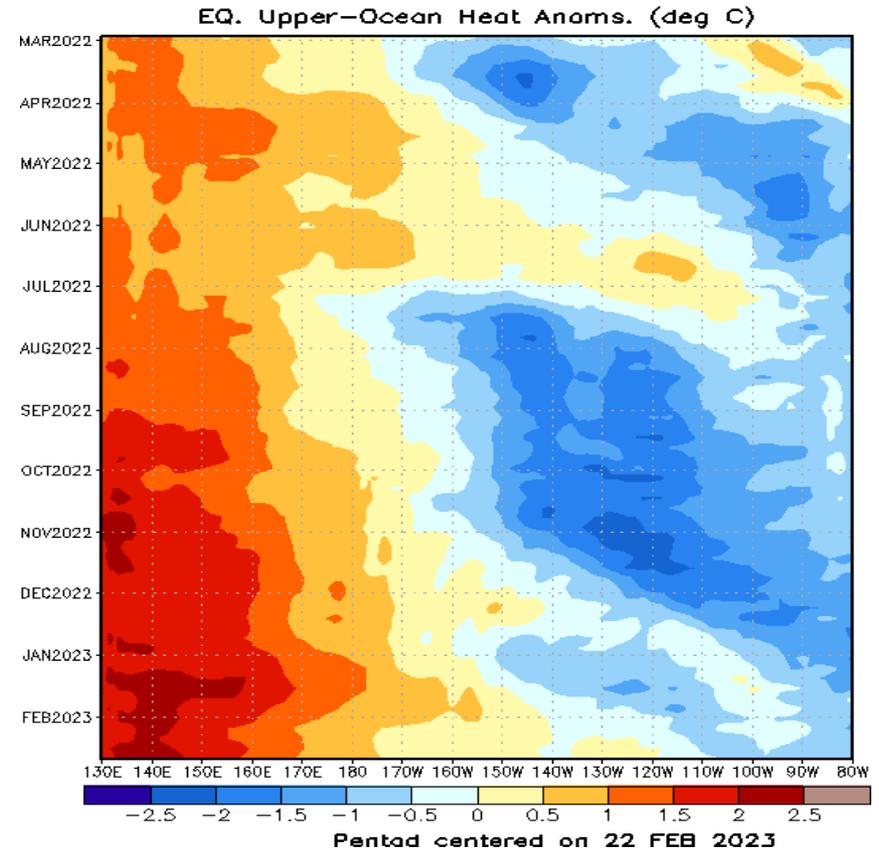
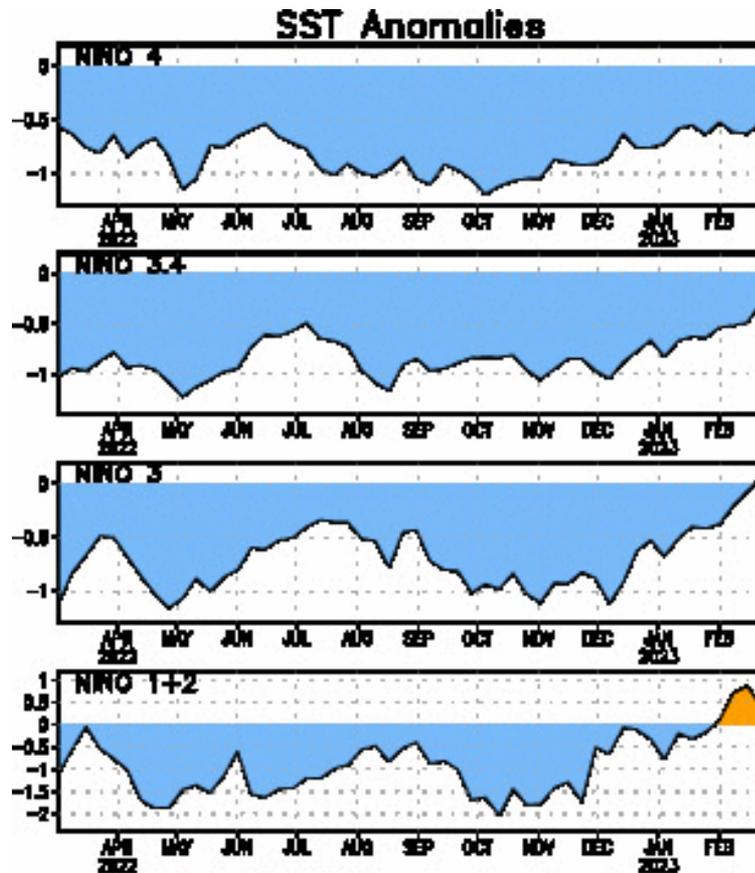
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- A new area of anomalous enhanced convection emerged over the Maritime Continent; model guidance propagates this feature eastward as the next pulse of MJO activity in the coming weeks.
- MJO signal is subject to a lot of interference from copious Rossby Wave activity in addition to the lingering La Niña base state.

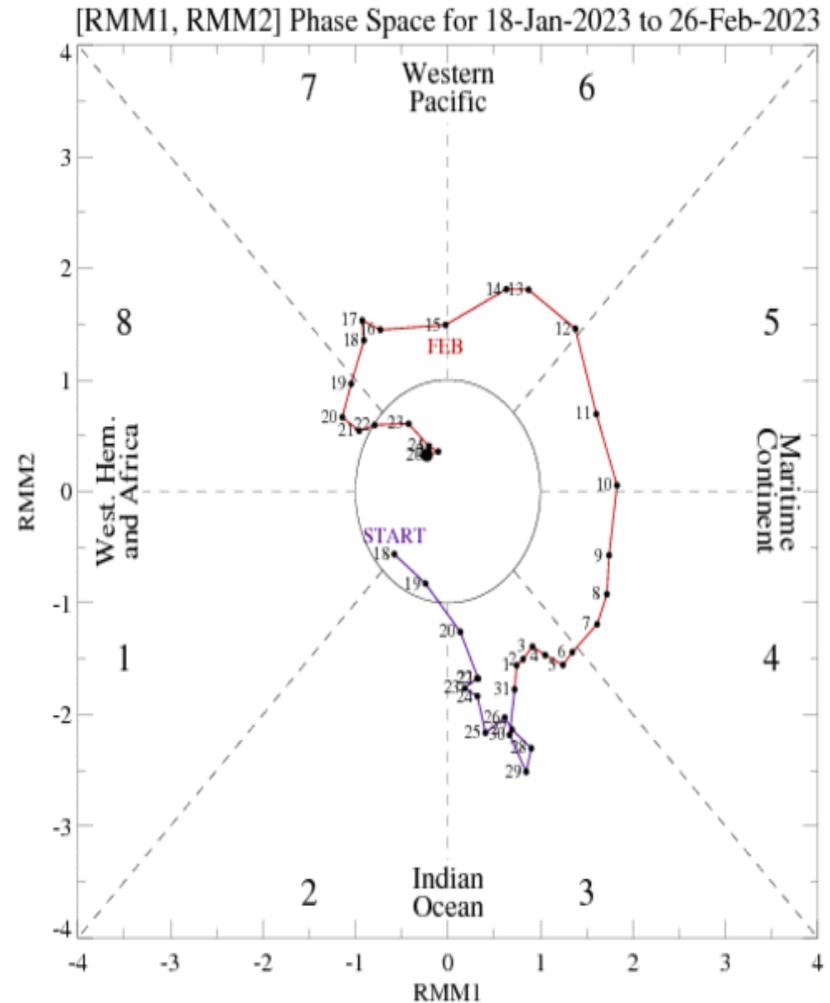
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Oceanic downwelling Kelvin wave activity has led to a gradual erosion of the anomalously cold subsurface waters in the central and eastern equatorial Pacific.
- A warming trend is noted in all of the Niño indices since December, with the eastern Pacific (Niño 1+2) now indicating above-normal conditions and Niño 3 at or just above zero as well.
- Dynamical models indicate a potential for enhanced low-level westerly anomalies across the Equatorial Pacific, which may initiate a reinforcing downwelling Kelvin wave.

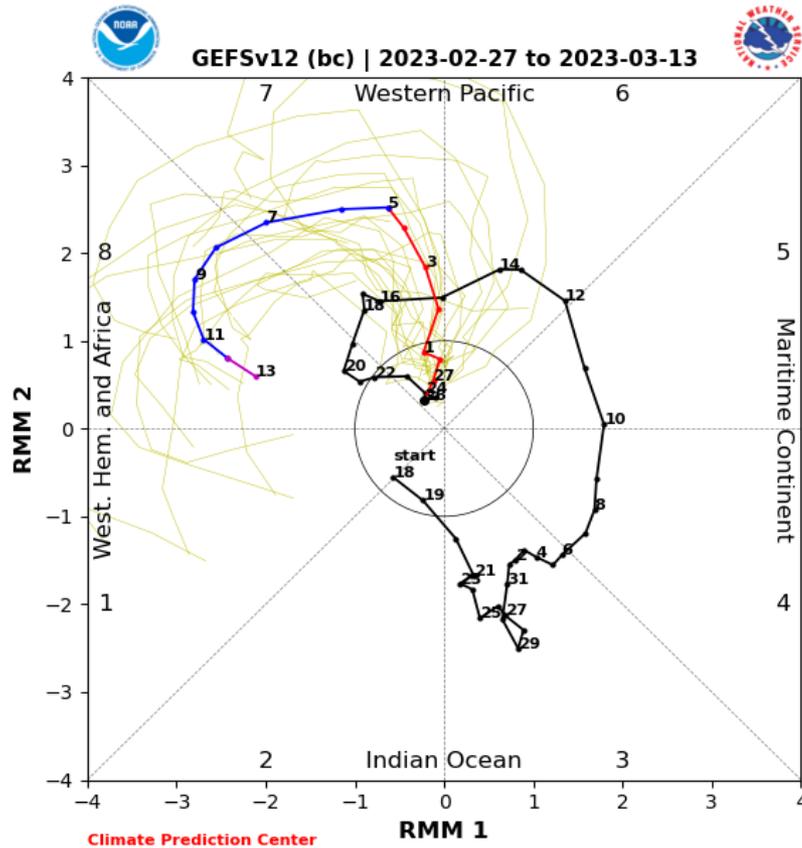
MJO Index: Recent Evolution

- The RMM-index has exhibited robust eastward propagation during February, although the signal strength has diminished over the last week and now lies within the unit circle.
- The MJO is currently subject to interference from multiple sources, which has made the RMM signal a little noisier and resulted in erratic propagation from the Indian Ocean to the Pacific.

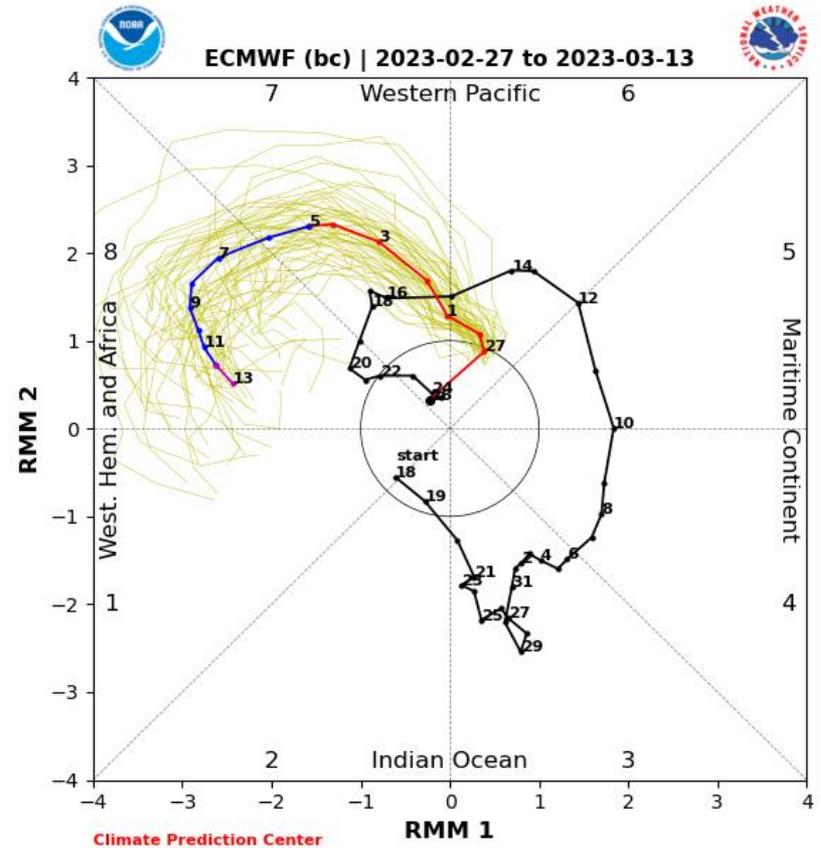


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



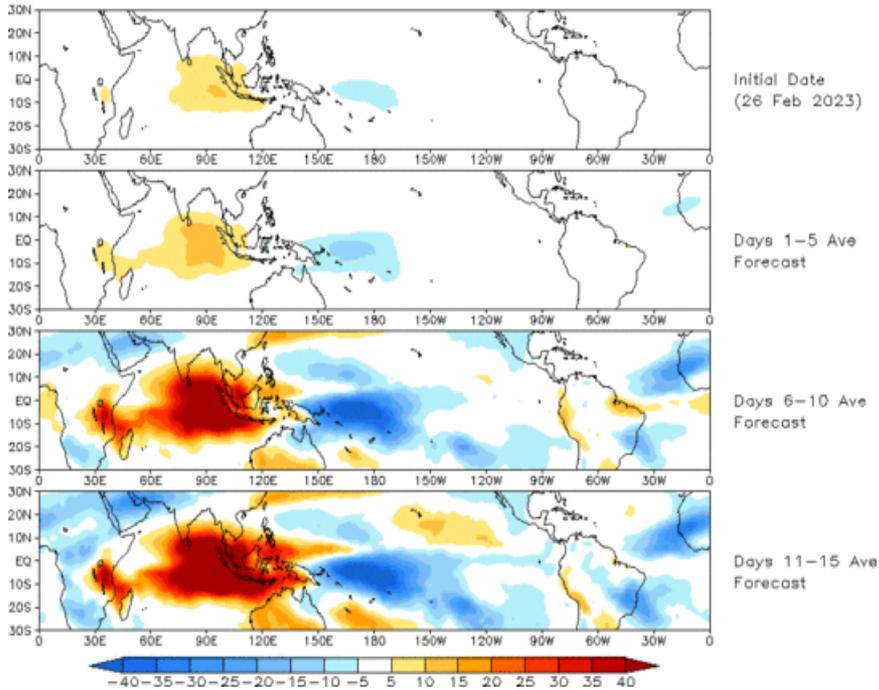
ECMWF Forecast

- Dynamical model MJO index forecasts generally show a strengthening signal during Week-1, followed by a resumption of eastward propagation during Week-2.
- The frequent changes in signal strength may reflect other modes interfering with the broader MJO signal.

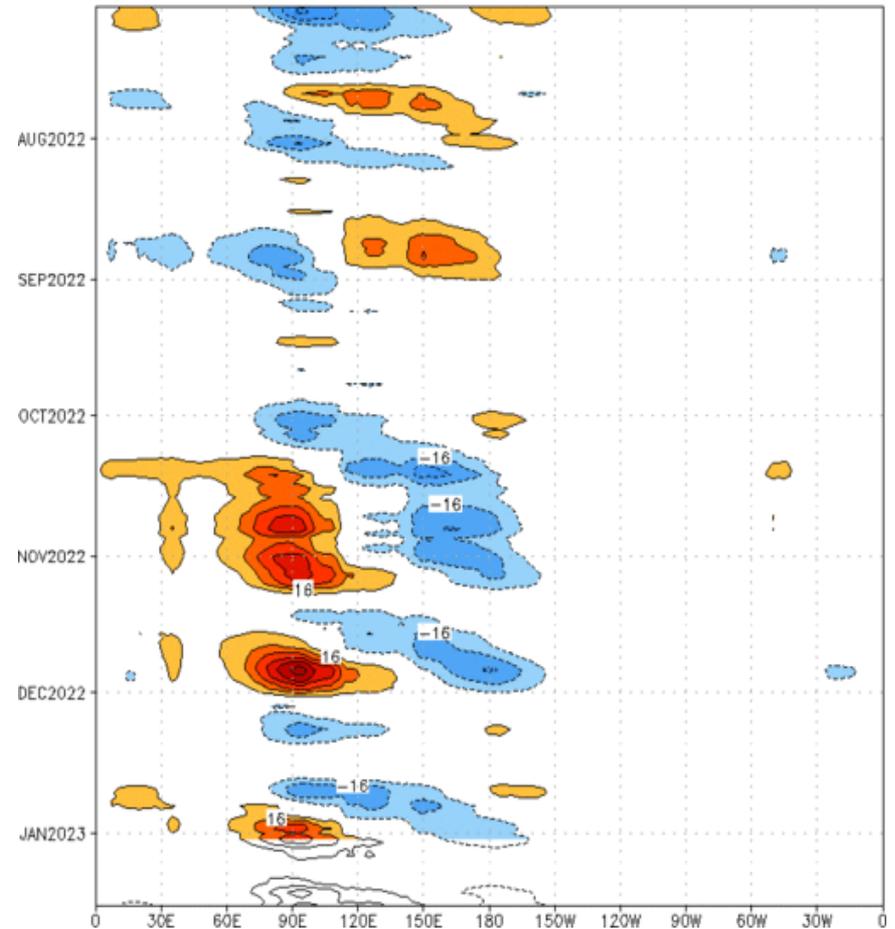
MJO: GEFS Forecast Evolution

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.)

Prediction of MJO-related anomalies using GEFS operational forecast
Initial date: 26 Feb 2023
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:03-Jul-2022 to 02-Jan-2023
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

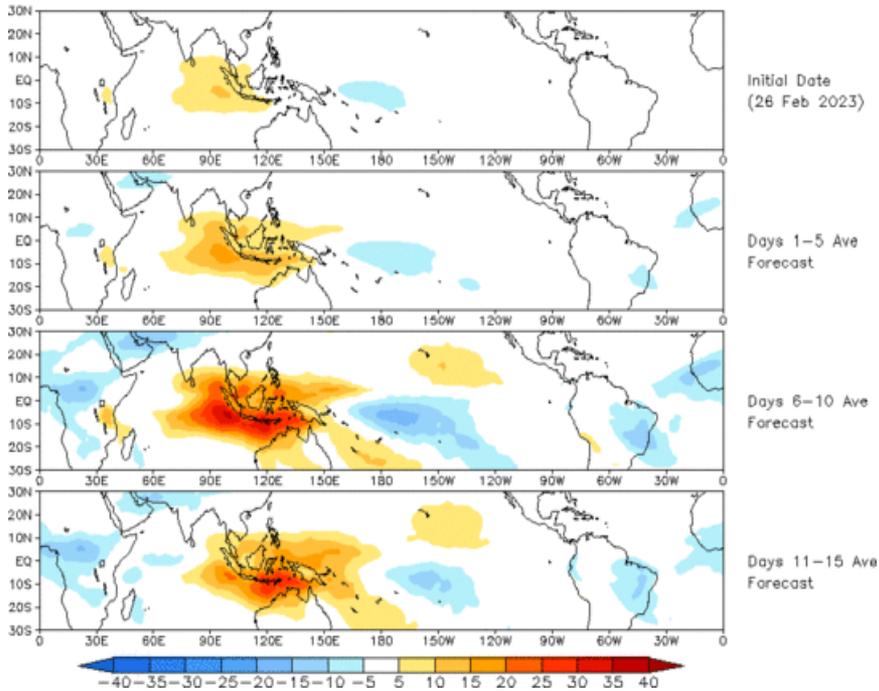


- The GEFS RMM forecast based OLR anomaly outlook depicts a mostly stationary pattern, which strengthens substantially and shows some eastward propagation by week-2.

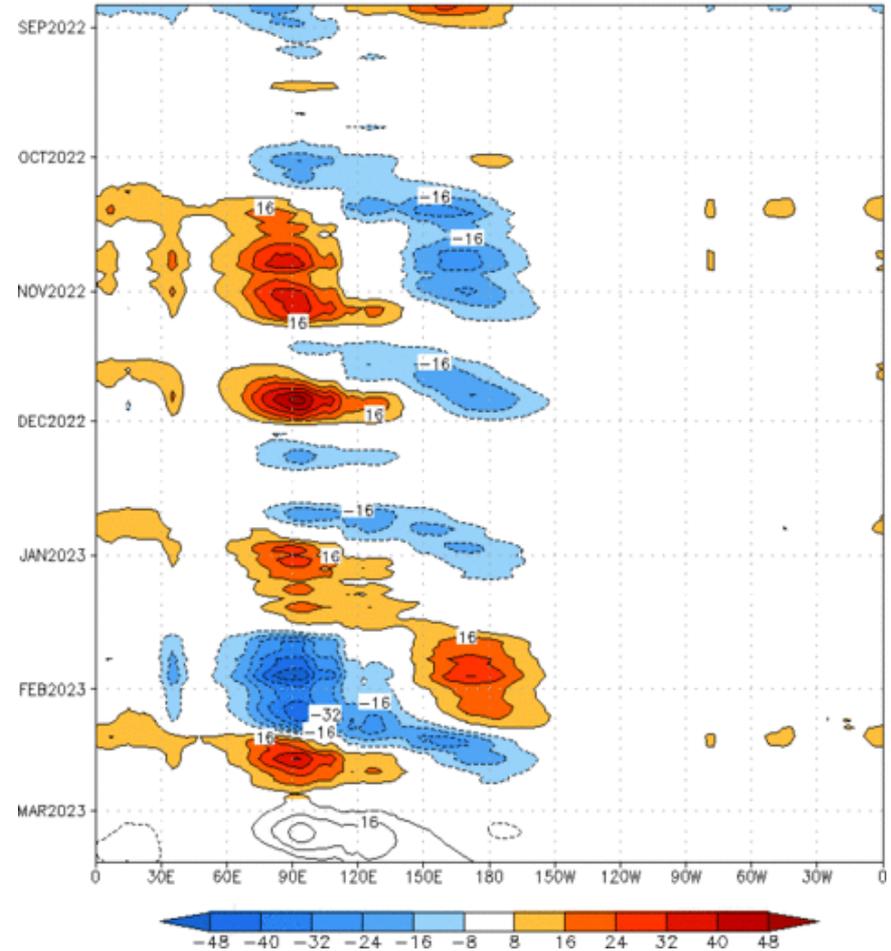
MJO: Constructed Analog Forecast Evolution

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.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (26 Feb 2023)



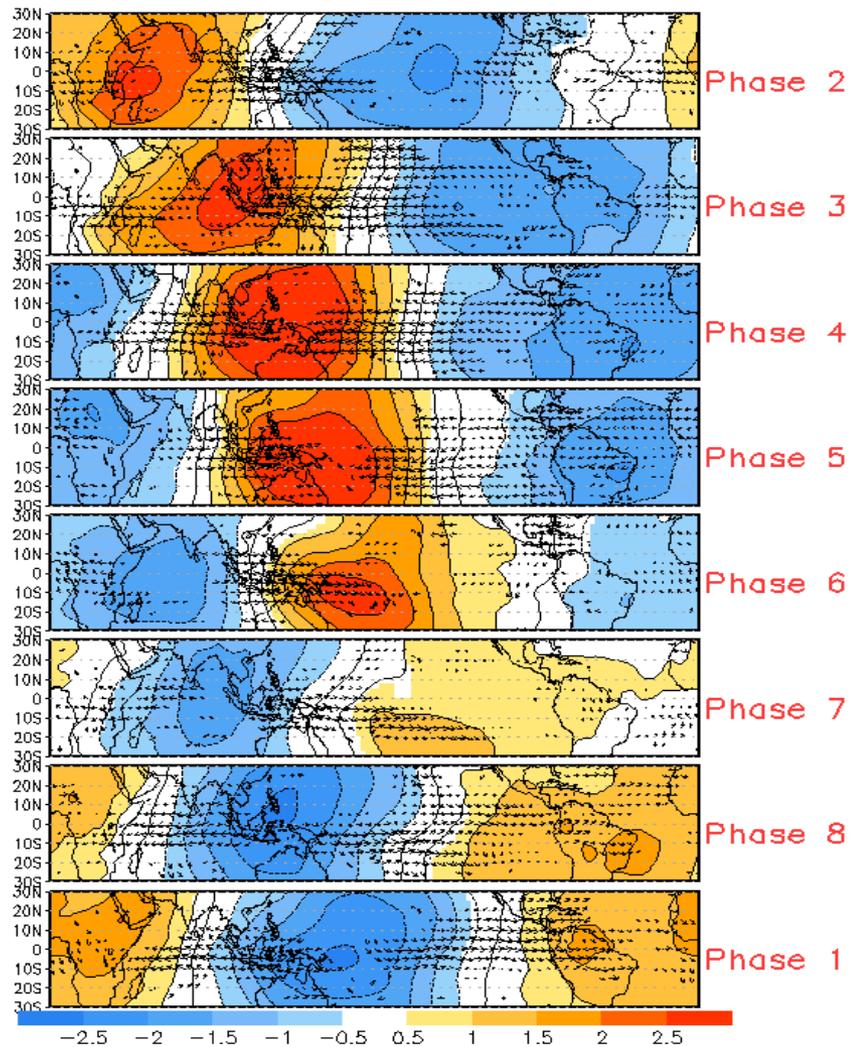
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:27-Aug-2022 to 26-Feb-2023
The unfilled contours are CA forecast reconstructed anomaly for 15 days



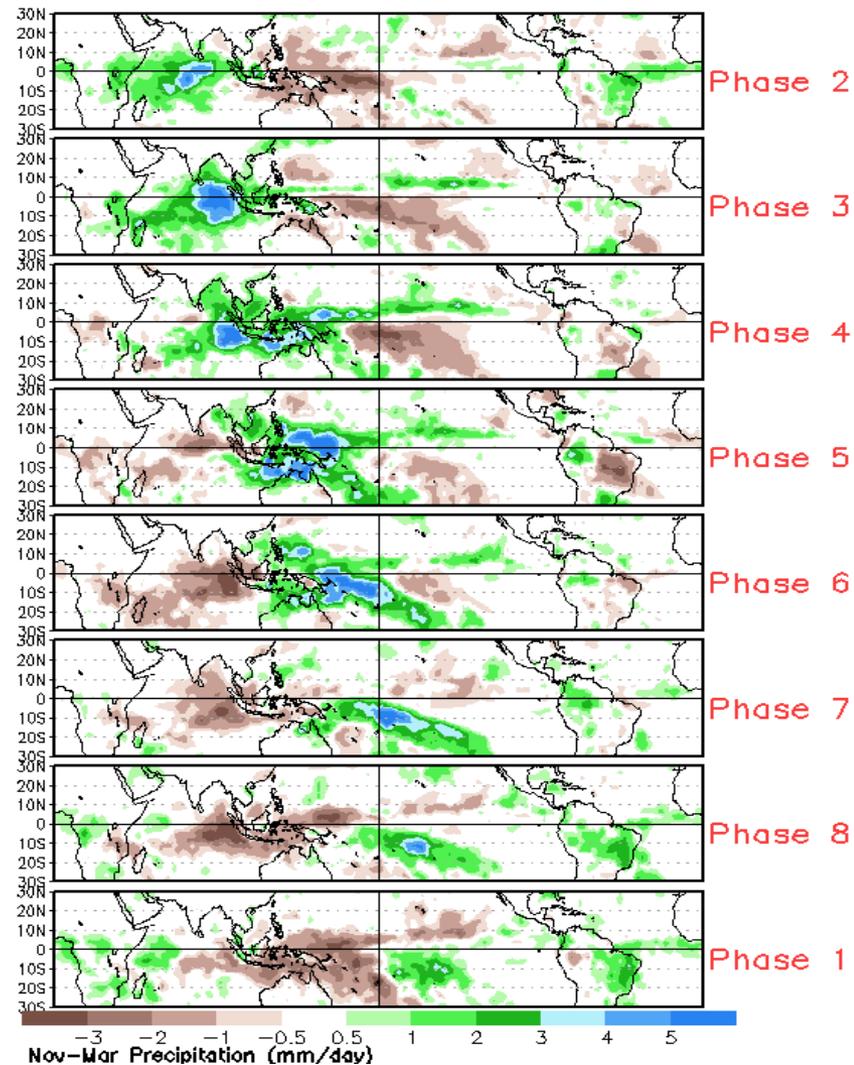
- The constructed analog forecast depicts a similar scenario, with an initially weak signal that becomes more pronounced and begins eastward propagation during the week-2 timeframe.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



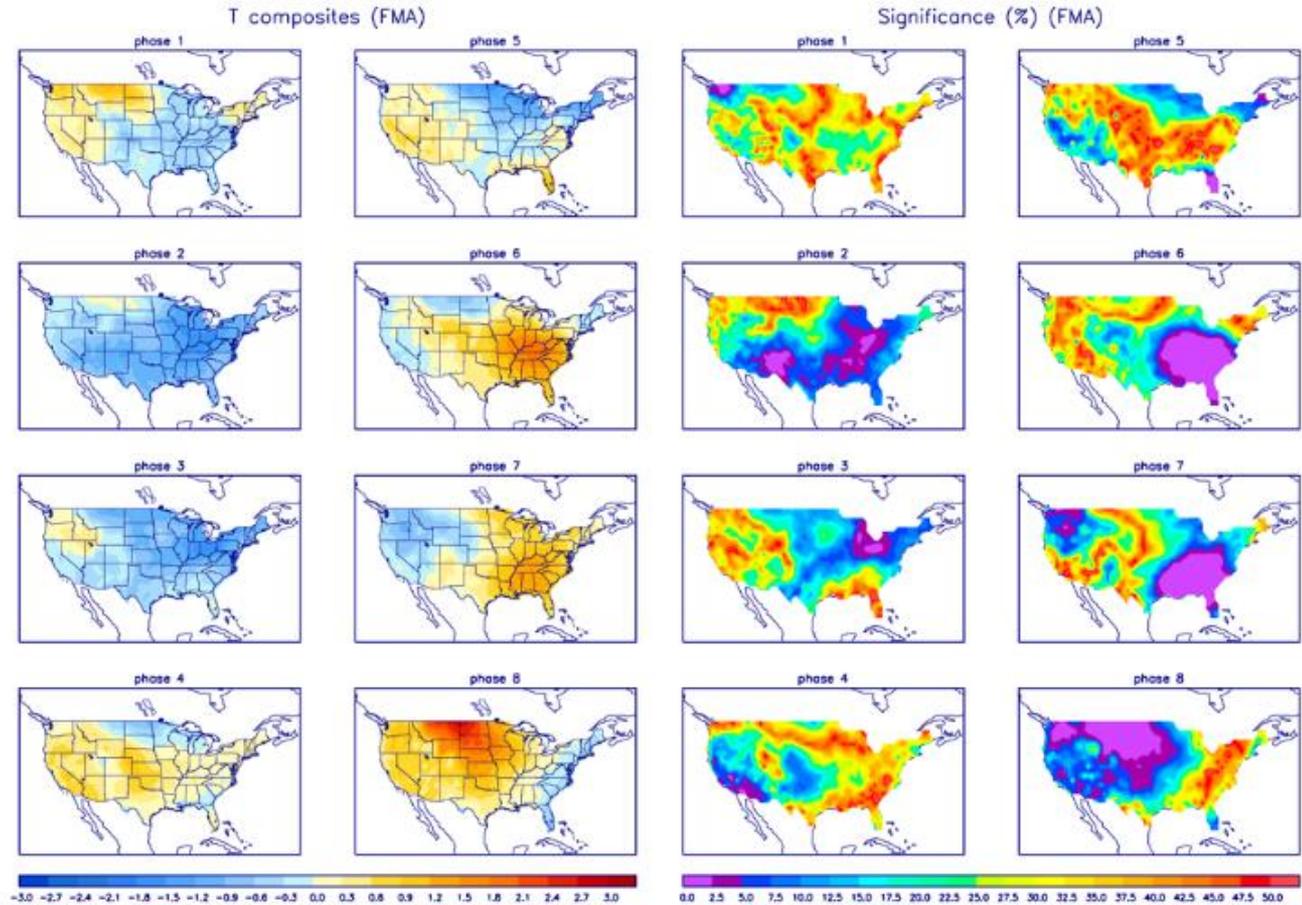
Precipitation Anomalies



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.



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.

