

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



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

Overview

- An active MJO signal propagated from the Maritime Continent across the Pacific over the past two weeks.
- Interference from various modes, including the ongoing La Niña, have resulted in a weaker presentation of the intraseasonal signal, particularly in the zonal wind and OLR anomaly fields.
- Dynamical model MJO index forecasts generally depict a weakening MJO signal over the next week, with a re-emerging stronger Pacific signal during Week-2.
- The extratropical response associated with western Hemisphere MJO events during boreal winter typically favors warmer (colder) than normal conditions developing across the western (eastern) U.S., however this is at odds with the latest dynamical model guidance which maintains more of a La Niña pattern heading into March.
- Pacific MJO activity may help weaken the La Niña signal through low-level westerly wind anomalies promoting eastward propagation of warmer water across the Pacific.

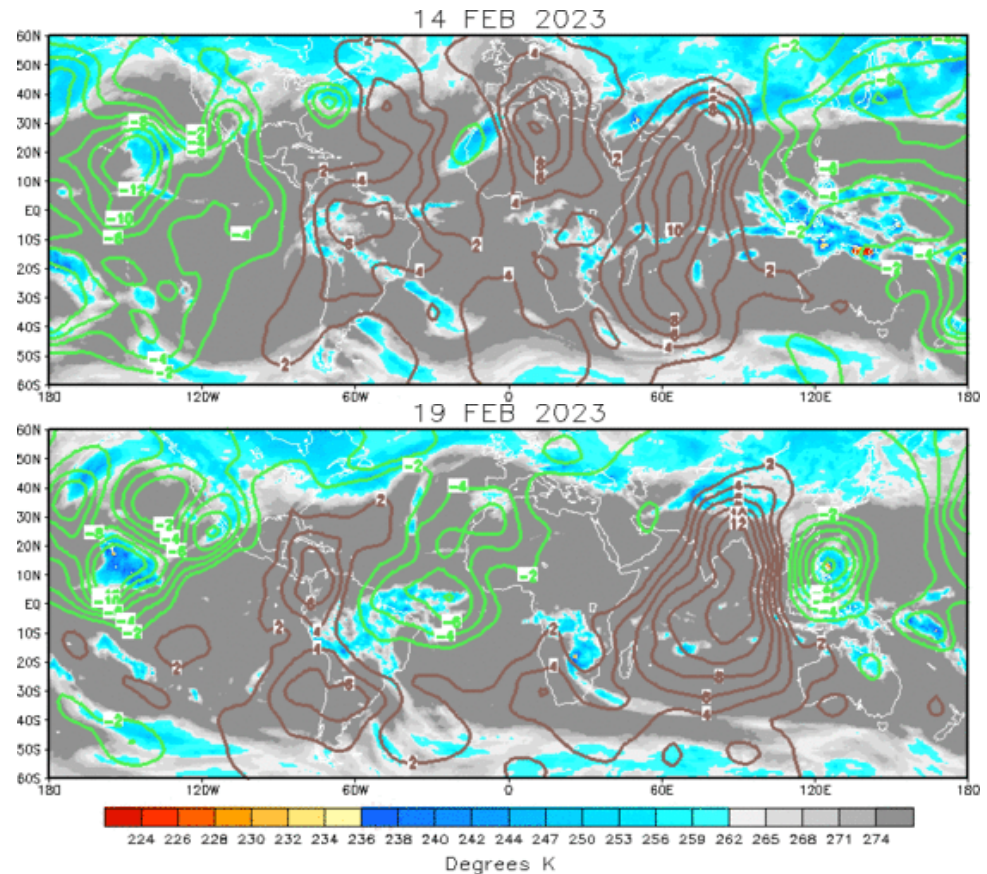
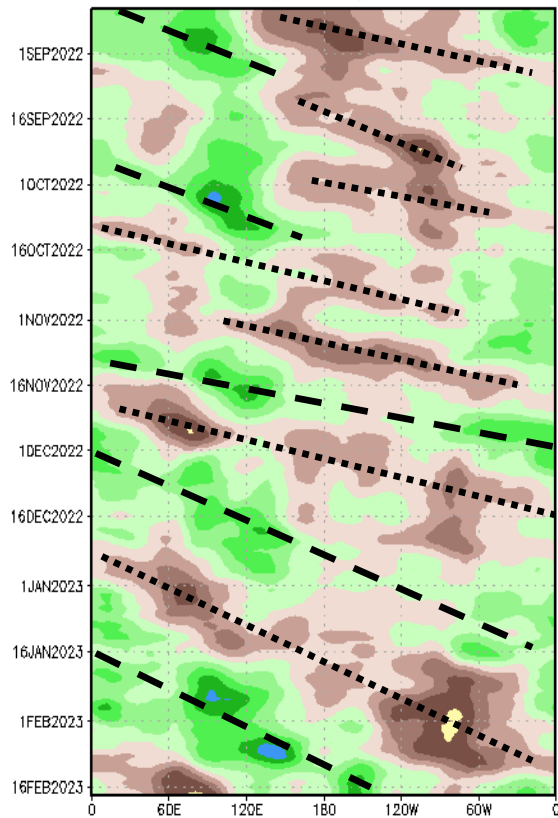
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

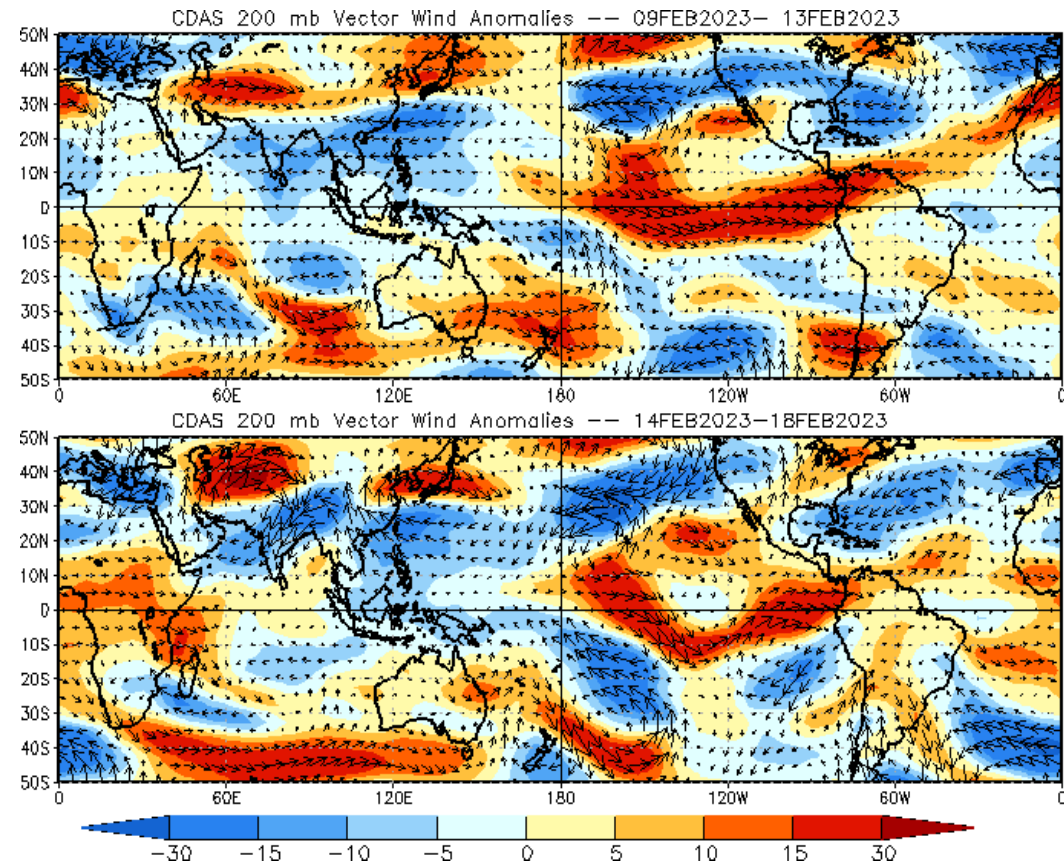
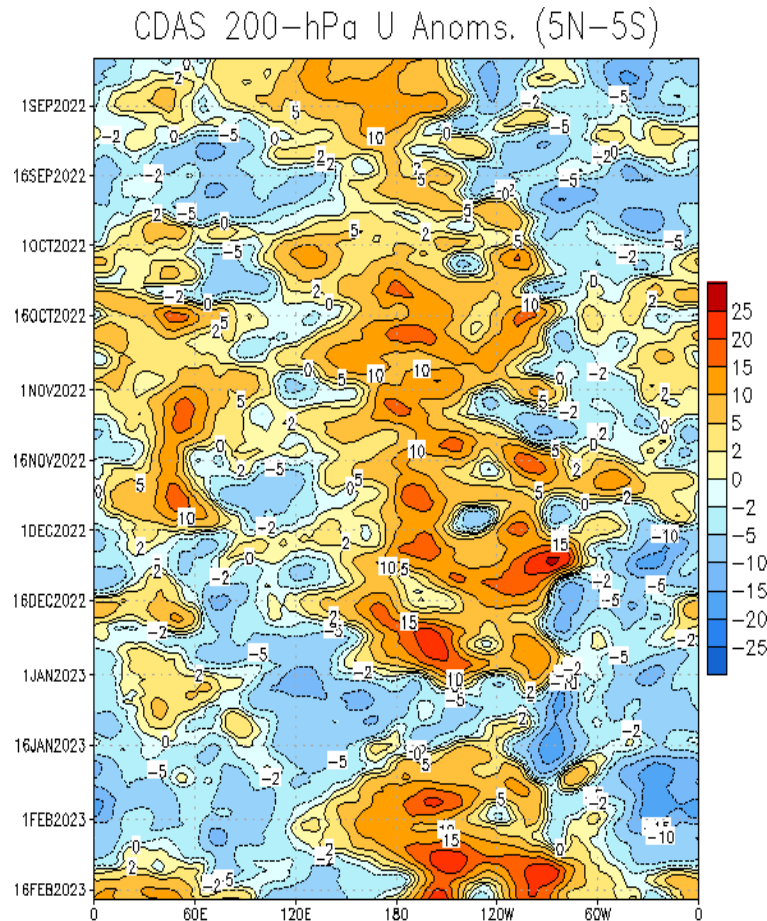
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- Well established eastward propagation of coherent upper-level velocity potential anomalies is evident, reflecting MJO activity propagating from the Maritime Continent to the Pacific since the beginning of February.
- More recently, other modes have interfered with the pattern.

200-hPa Wind Anomalies

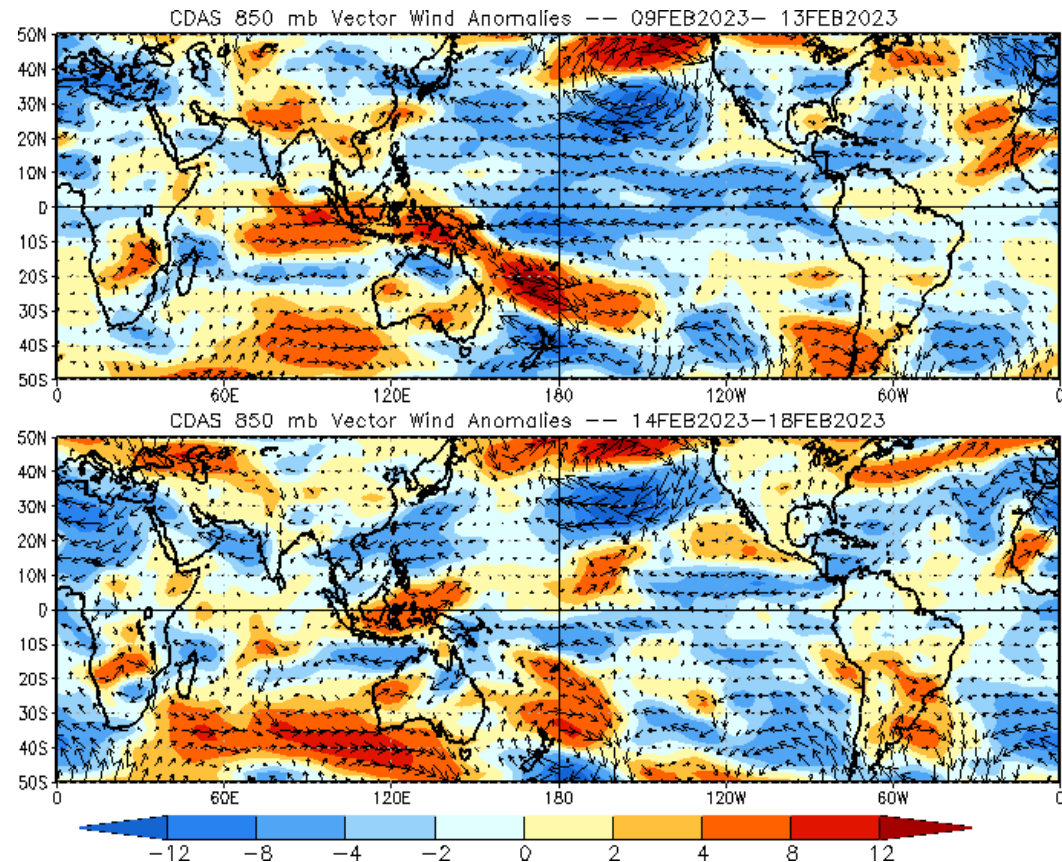
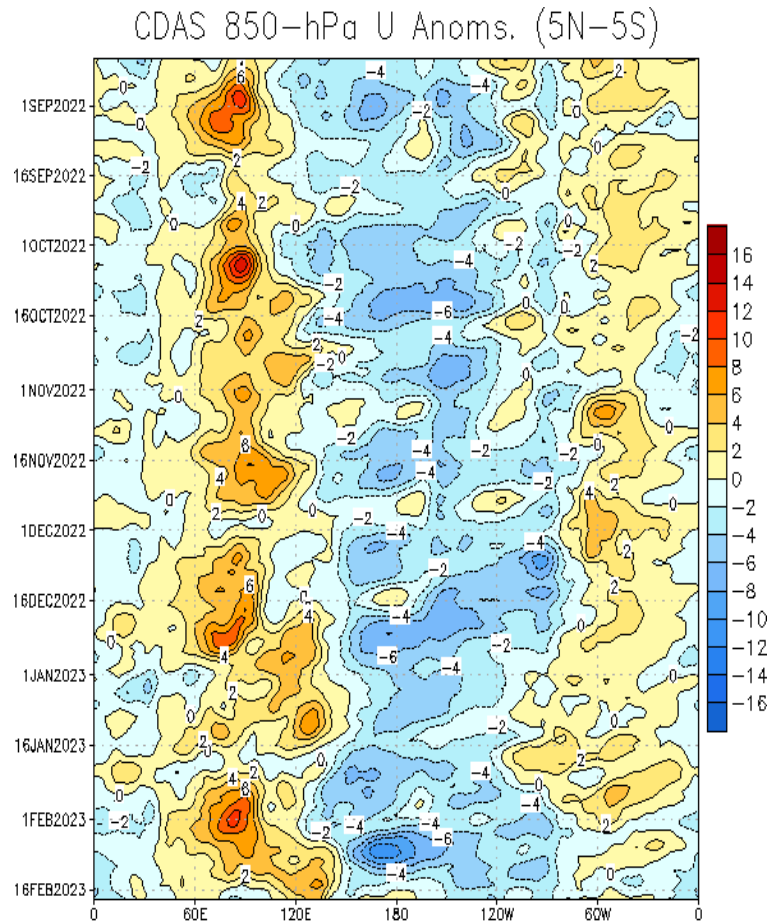
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- An anomalously divergent pattern aloft over the central Pacific is consistent with ongoing MJO activity.
- Eastward propagation of zonal wind anomalies is evident in the time-longitude plot.
- Westerly anomalies persist over the Pacific just east of the Date Line.

850-hPa Wind Anomalies

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

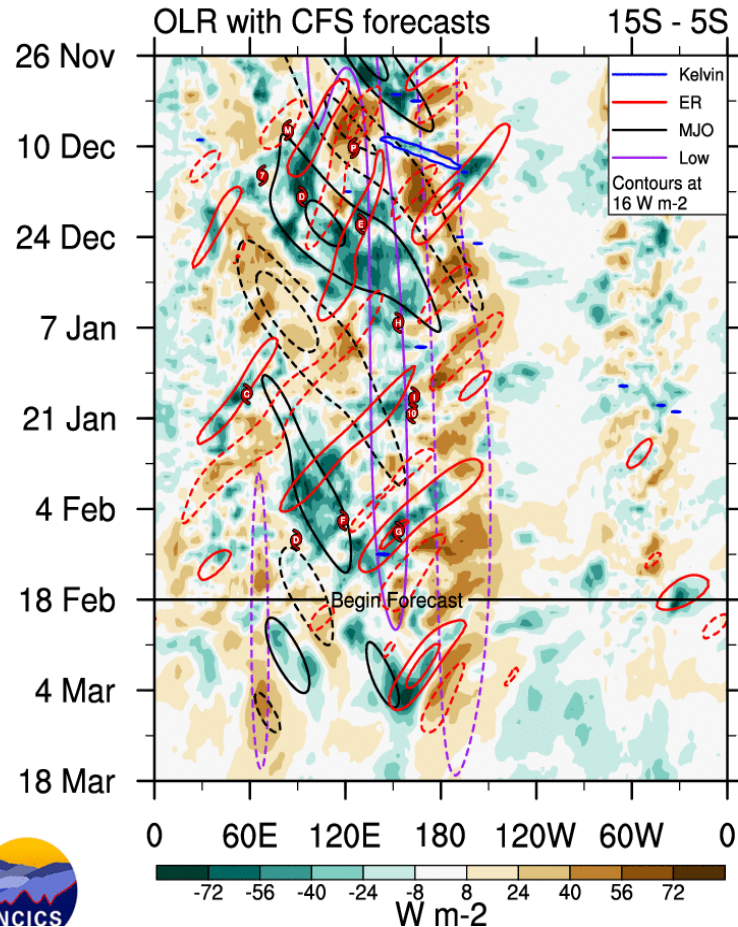


- Destructive interference between the MJO and the ongoing La Niña resulted in a weakening of the envelope of eastward propagating westerlies, as well as a breakdown in the enhanced trade wind regime over the West Pacific.
- Weak westerly wind anomalies extend east of the Date Line just north of the Equator.

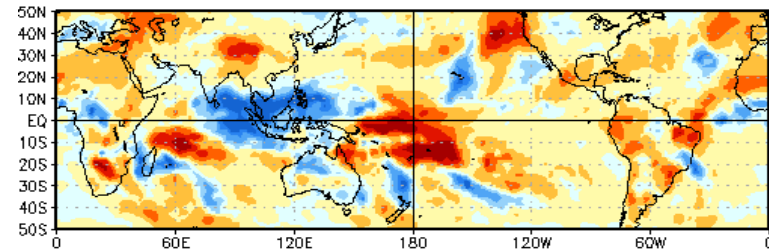
Outgoing Longwave Radiation (OLR) Anomalies

Green shades: Anomalous convection (wetness)

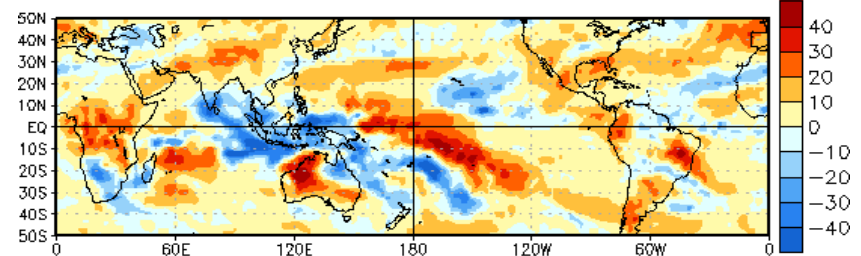
Brown shades: Anomalous subsidence (dryness)



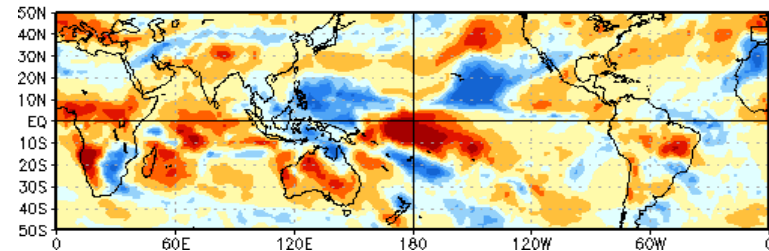
OLR Anomalies
21 JAN 2023 to 30 JAN 2023



31 JAN 2023 to 9 FEB 2023

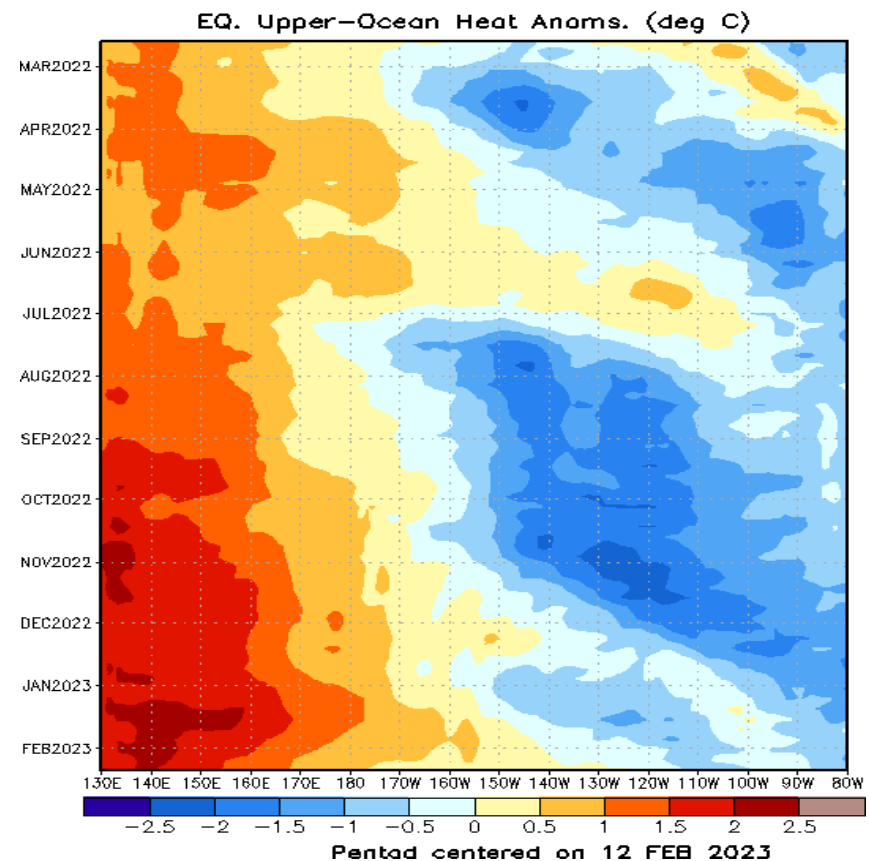
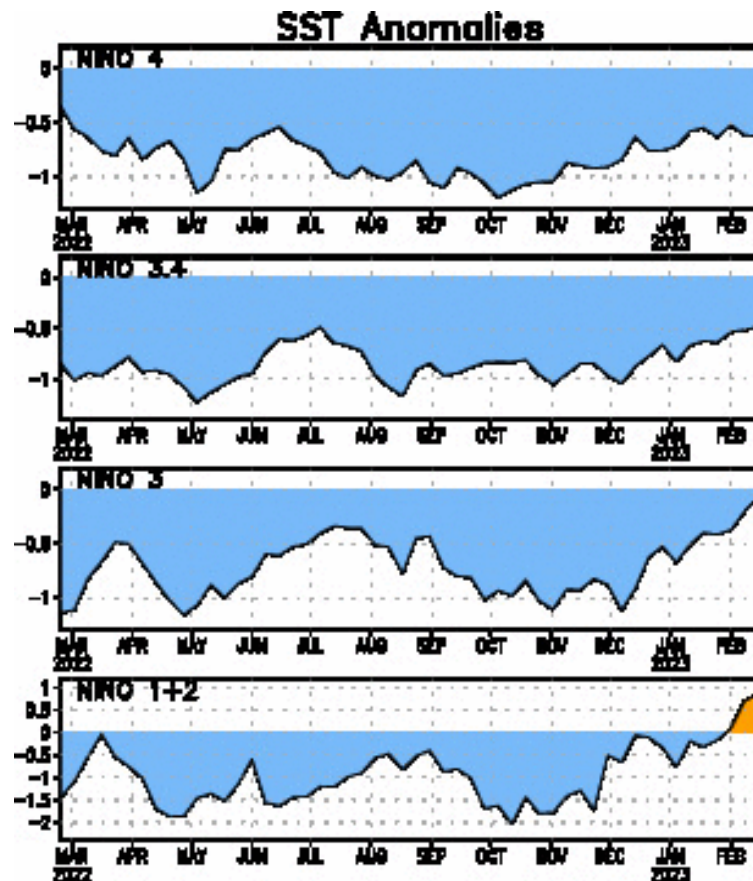


10 FEB 2023 to 19 FEB 2023



- OLR anomalies progressed slowly eastward from the eastern Indian Ocean to the West Pacific since late January.
- Poleward evolution of enhanced convection over the West Pacific is indicative of MJO activity; however, the MJO was unable to overcome the strong suppressed signal near the Date Line.
- Enhanced convection is evident over the North Pacific southeast of Hawaii.

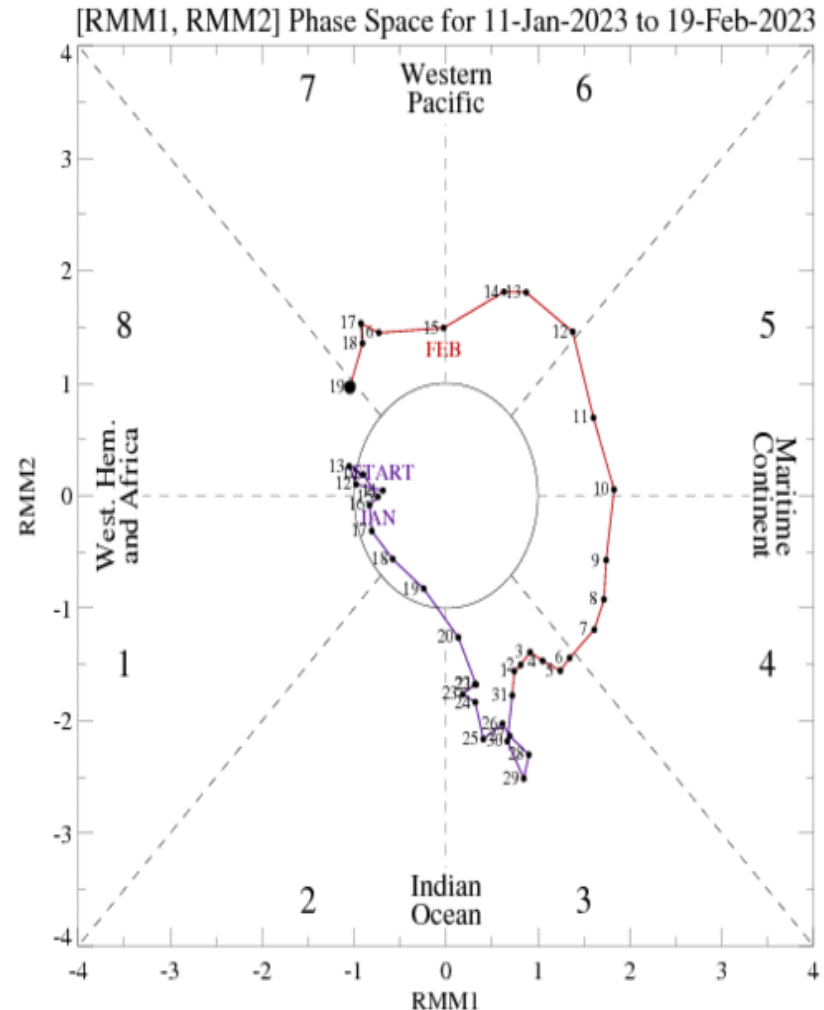
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



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

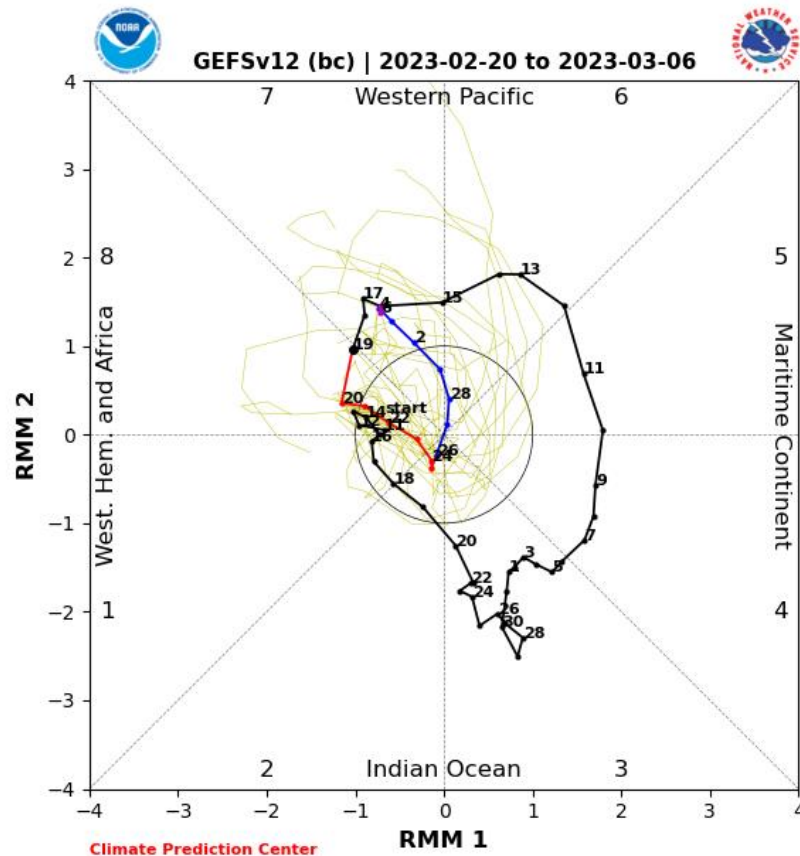
MJO Index: Recent Evolution

- The RMM-index has exhibited robust eastward propagation during February, shifting from the eastern Indian Ocean to the east-central Pacific over the past 3 weeks.
- The slow evolution over the eastern Indian Ocean following by a rapid adjustment over the Maritime Continent may be due to interference with the signal from the ongoing La Niña.

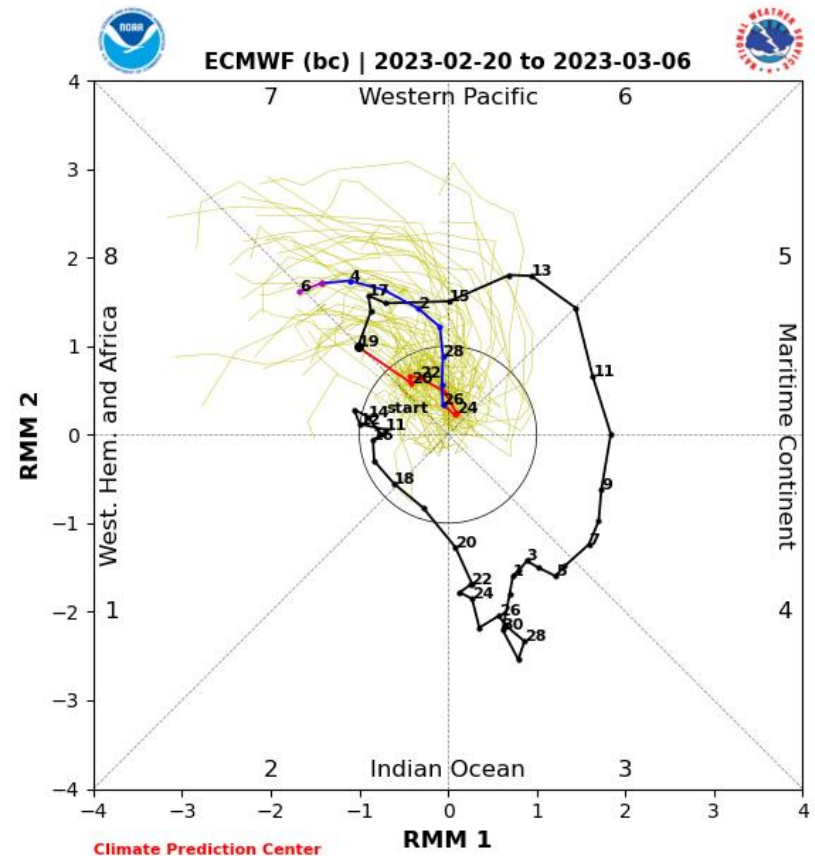


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



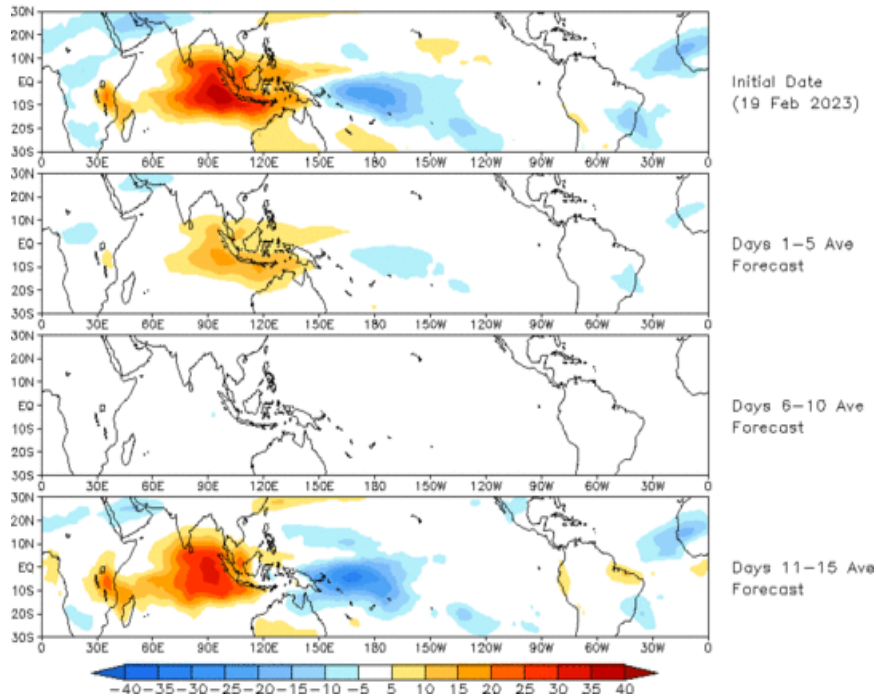
ECMWF Forecast

- Dynamical model MJO index forecasts generally show a weakening signal during Week-1, followed by a re-amplification of the index over the Pacific during Week-2.
- The weakening and subsequent re-amplification of the index may reflect other modes interfering with the broader MJO signal.
- The ECWMF in particular re-establishes robust eastward propagation across the Pacific by Week-2.

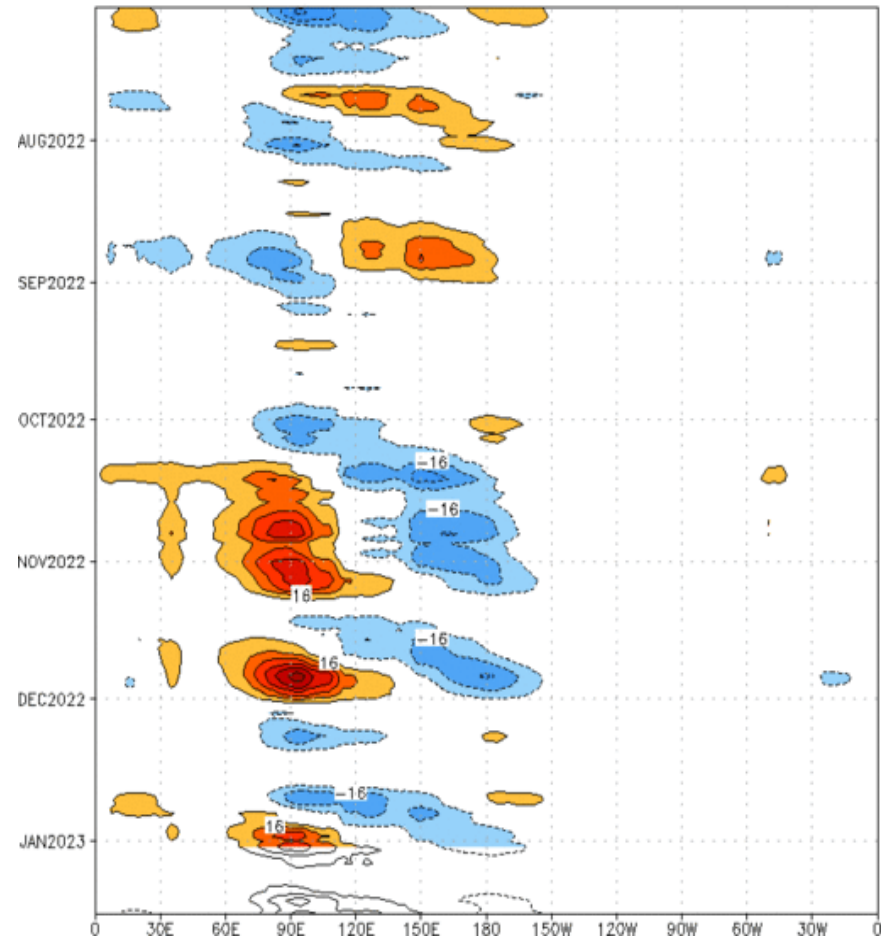
MJO: GEFS Forecast Evolution

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: 19 Feb 2023
OLR



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

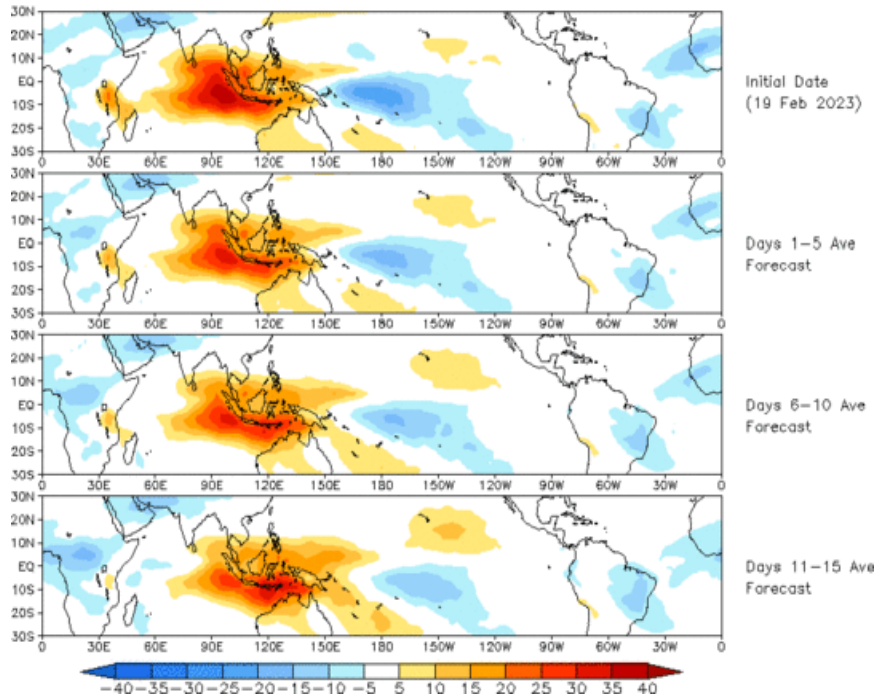


- The GEFS RMM forecast based OLR anomaly outlook depicts a weakening Pacific event during Week-1, followed by a strong re-amplification over the Pacific by the end of Week-2.

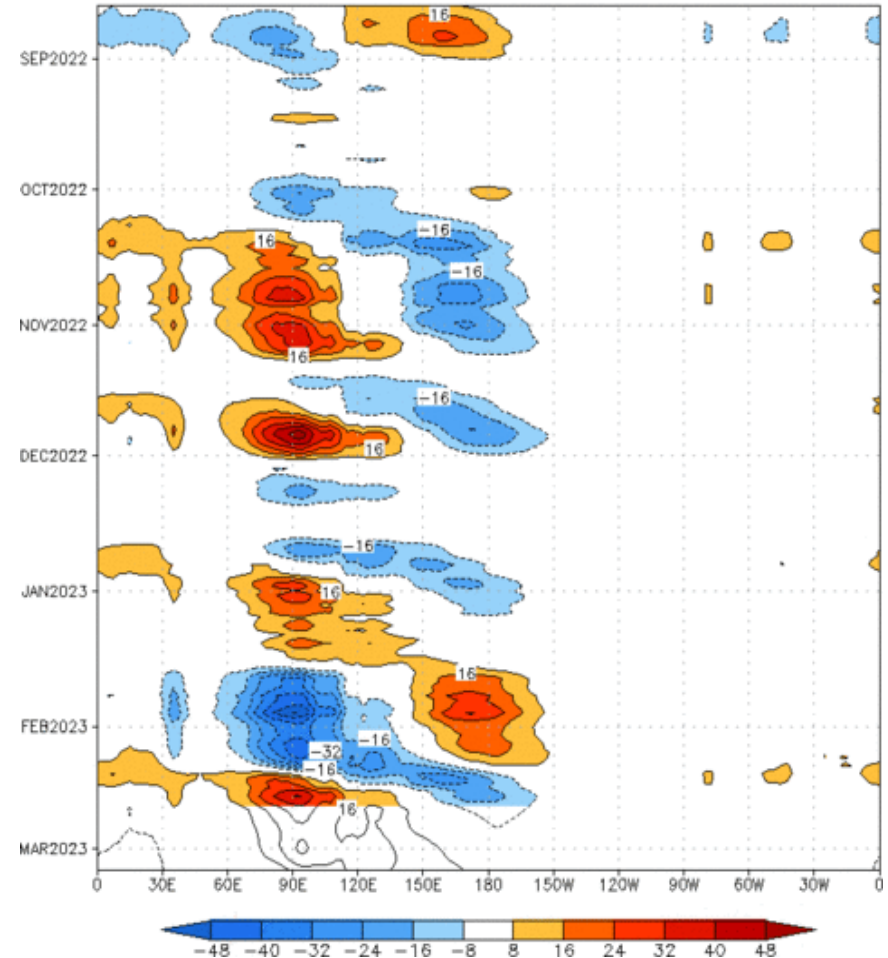
MJO: Constructed Analog Forecast Evolution

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 (19 Feb 2023)



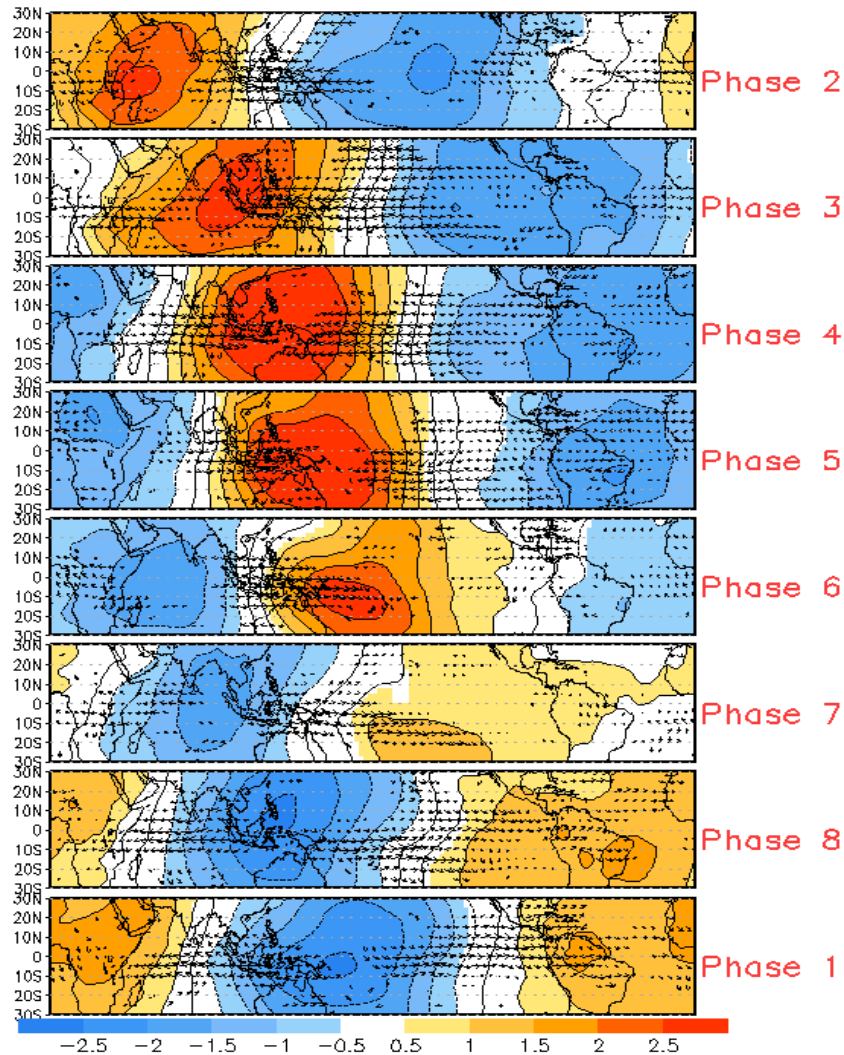
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:20-Aug-2022 to 19-Feb-2023
The unfilled contours are CA forecast reconstructed anomaly for 15 days



- The constructed analog forecast depicts a slow evolution of strong MJO convective envelopes across the Pacific over the next two weeks.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



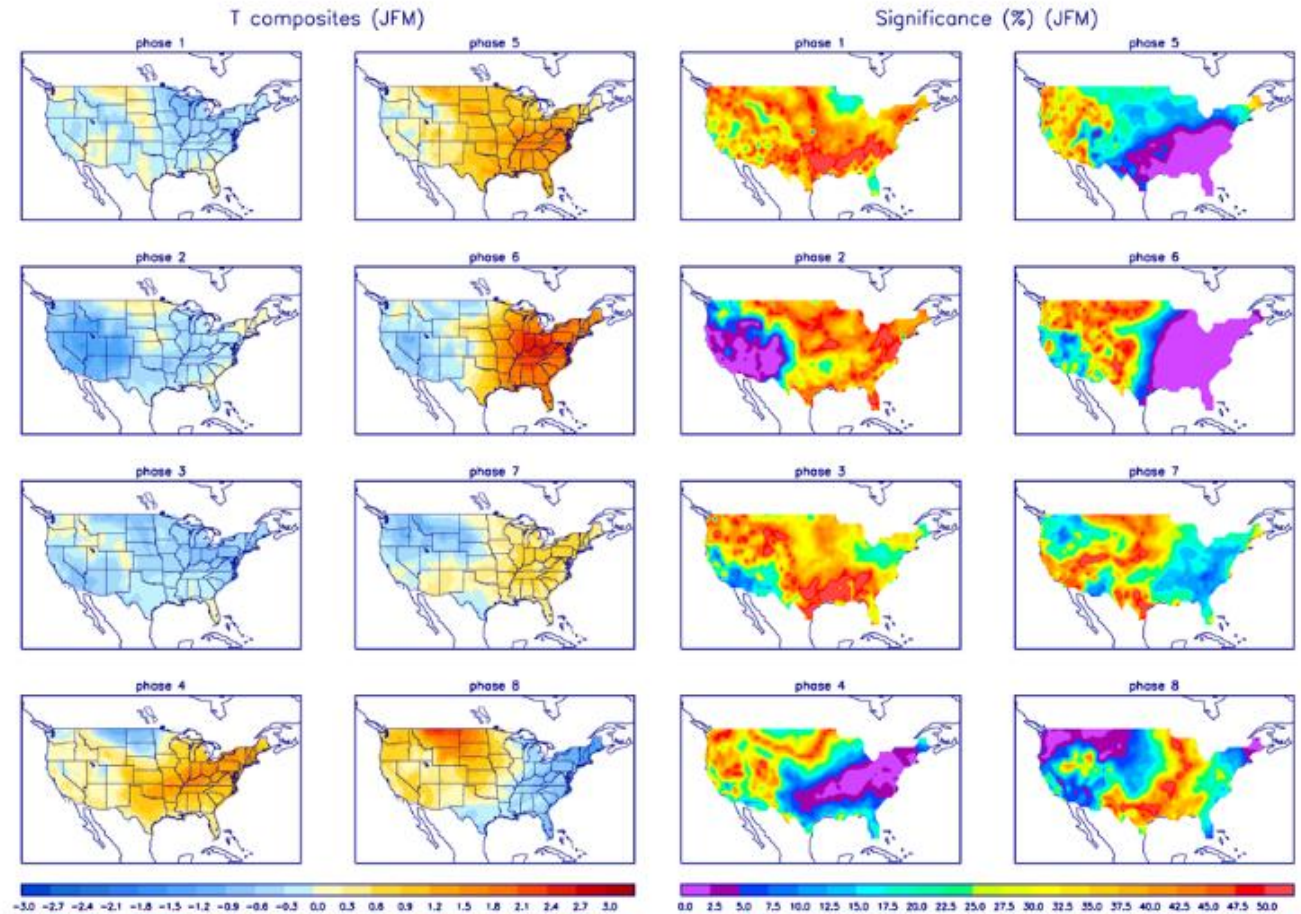
Precipitation Anomalies



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.

