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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
23 January 2023

Overview

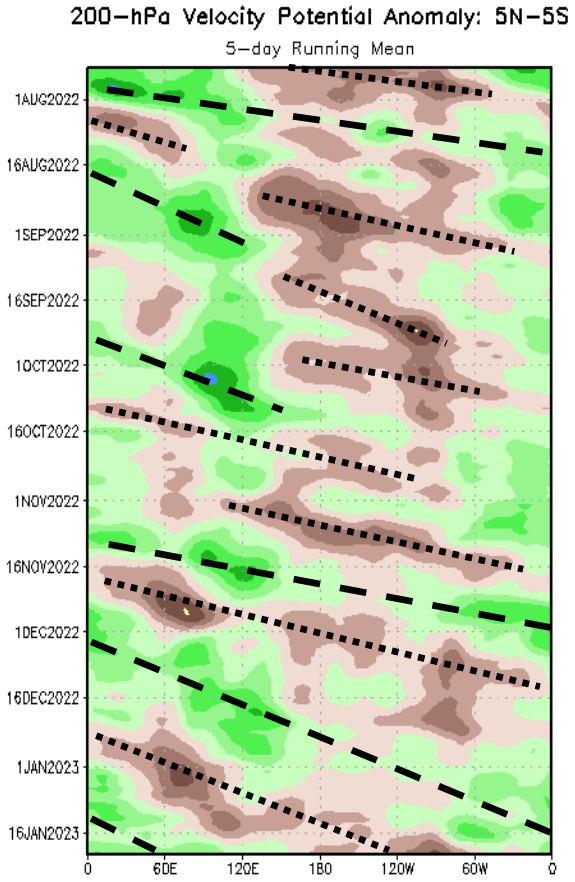
- The MJO signal strengthened over the east-central Indian Ocean, as depicted by both the RMM-based and CPC velocity potential based MJO indices.
- This amplification of the MJO signal was well forecasted by dynamical models over the past week.
- Dynamical model MJO index forecasts show continued high amplitude with a slow evolution during Week-1, possibly due to influences from tropical cyclone activity. Eastward propagation across the Maritime Continent becomes more established during Week-2, with longer range runs of the GEFS and ECMWF showing the signal crossing the West Pacific during Week-3.
- Based on the anticipation of an active MJO signal, tropical cyclone activity is favored across the southern Indian Ocean during Weeks 1 and 2, with the favored development regions shifting towards the vicinity of northern Australia and the northwestern Pacific by Week-3.
- Dynamical models do not favor tropical cyclogenesis over the Coral Sea of southwestern Pacific.
- The MJO teleconnects well with the extratropical pattern during the Boreal Winter. Indian Ocean MJO events favor a pattern shift during Weeks 2-3 towards increased ridging and a warmer pattern over the eastern contiguous United States.

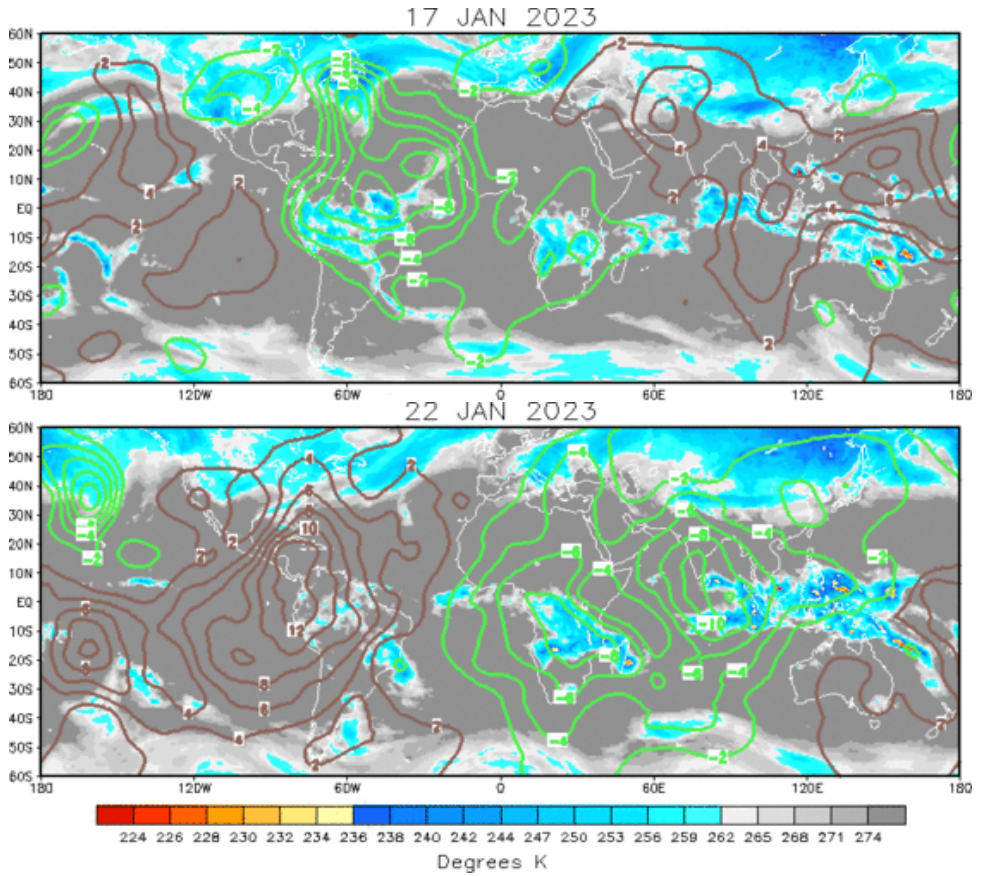
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)



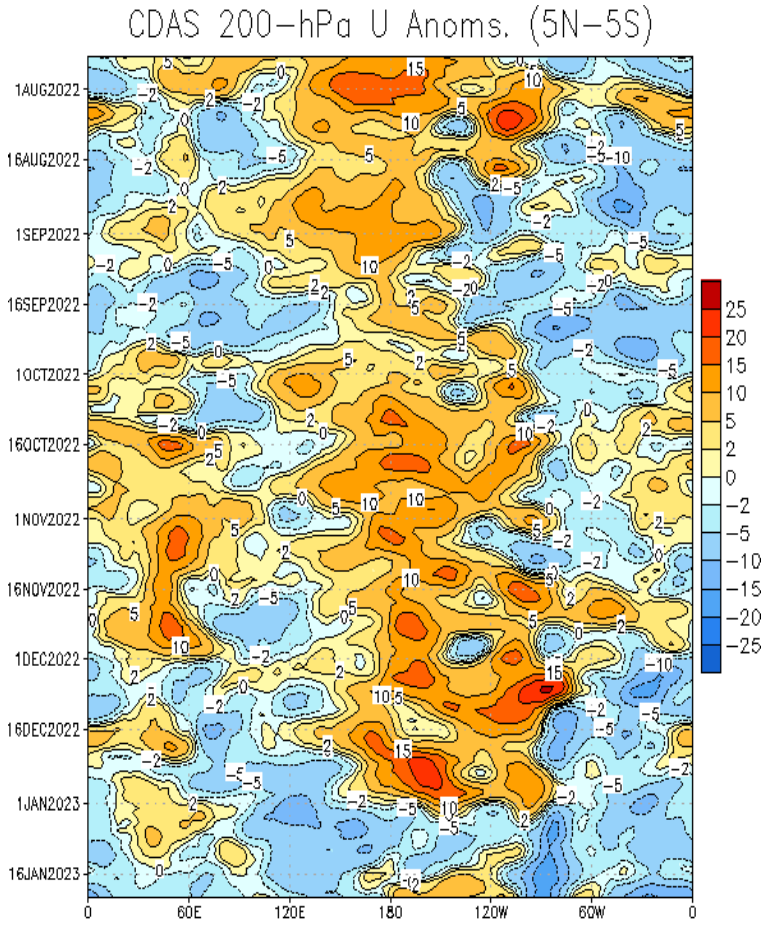


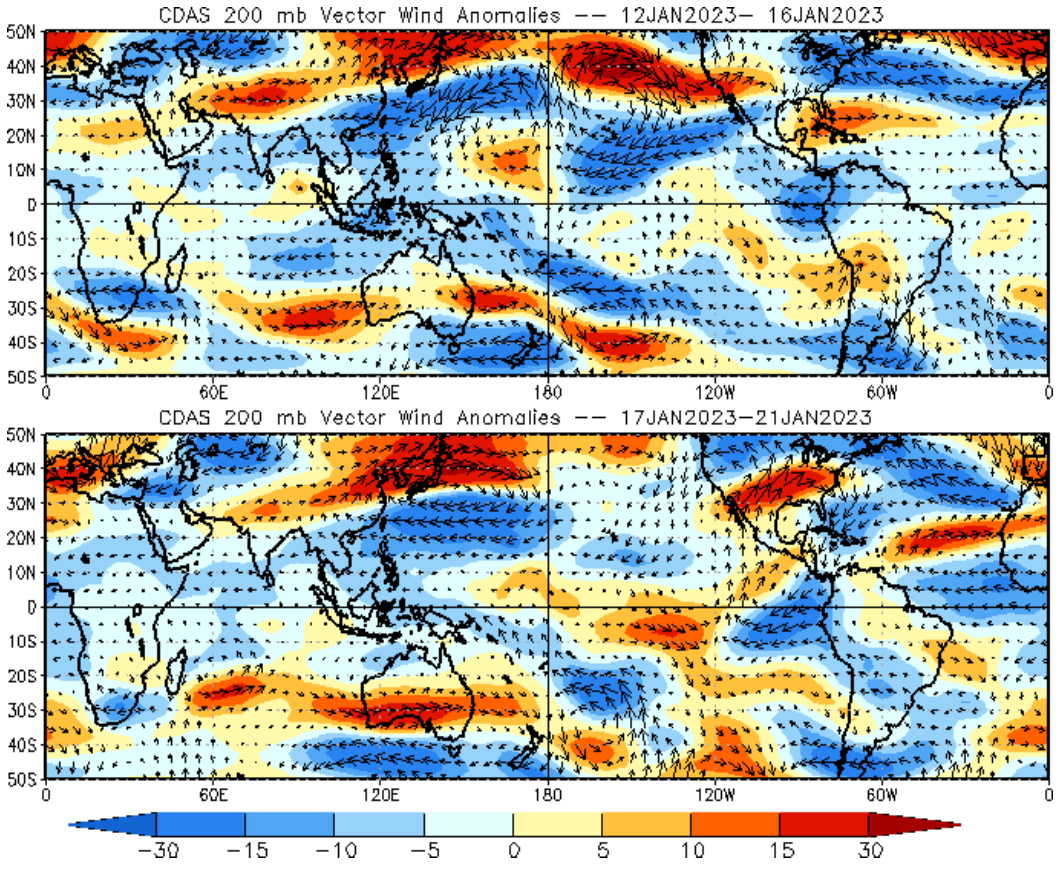
- Compared to last year, the MJO has been more coherent in the upper-level velocity potential field during the Boreal winter, and has increasingly overwhelmed the low frequency La Niña base state.

- The MJO enhanced convective envelope is currently over Africa and the Indian Ocean basin, with the suppressed phase over the East Pacific.

200-hPa Wind Anomalies

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

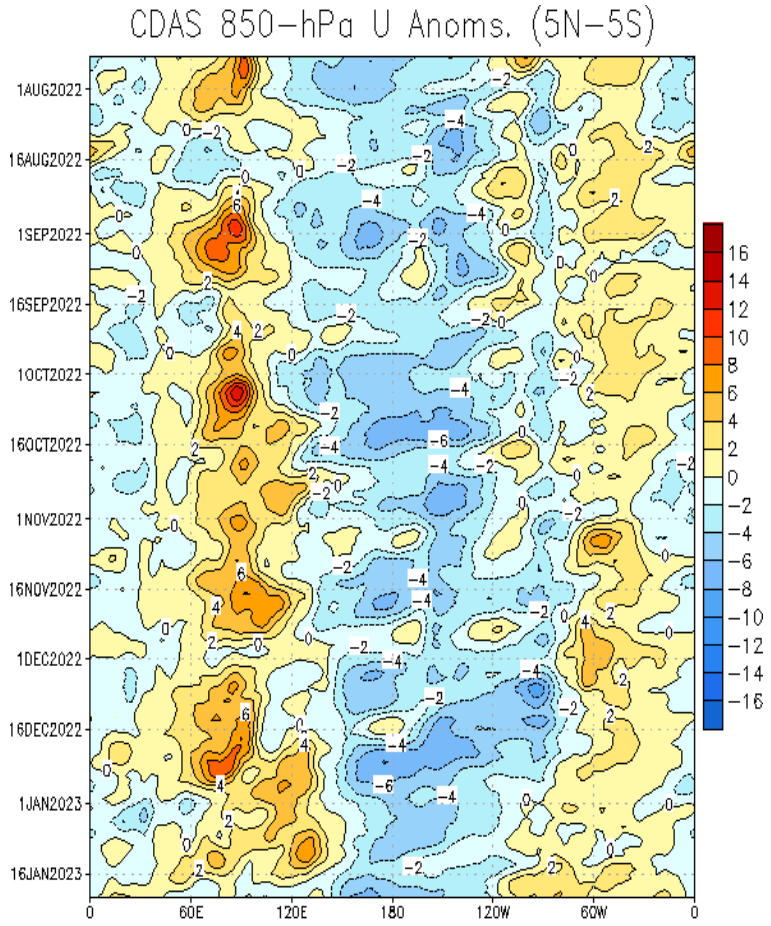


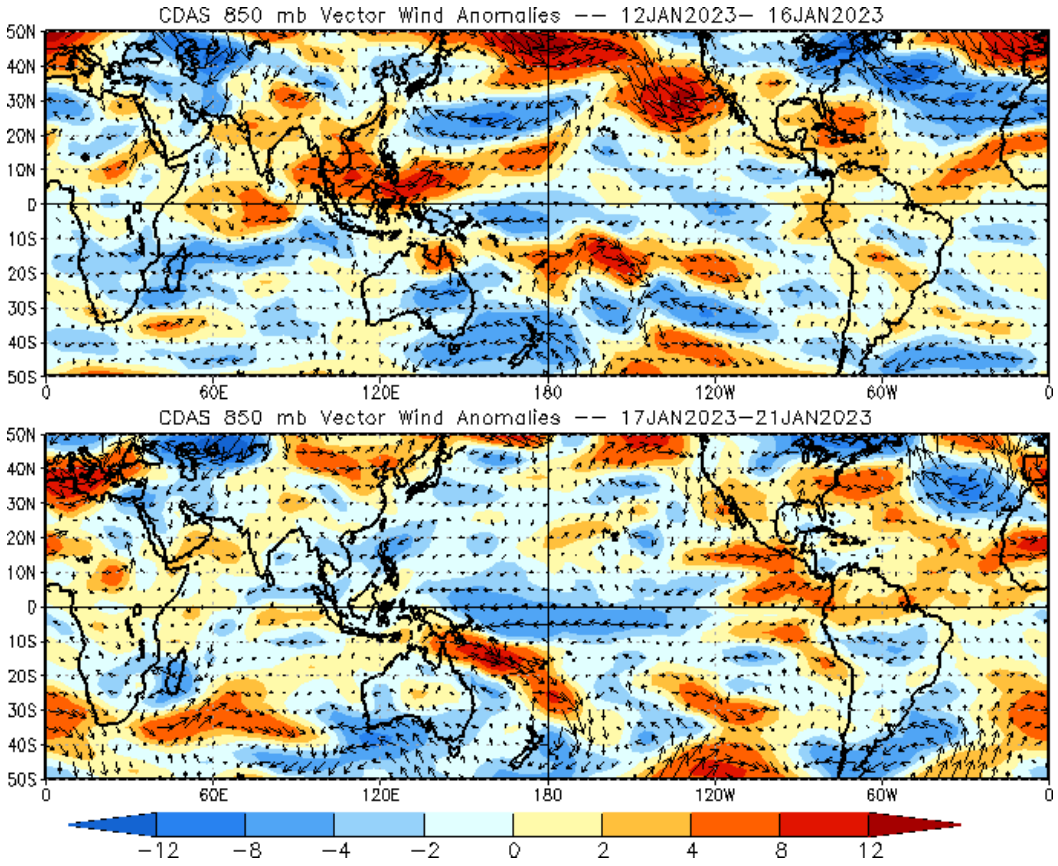


- Following a substantial disruption of the low frequency state due to the MJO enhanced phase crossing the Pacific, upper-level westerlies have begun to return to the Equatorial Pacific.
- Robust Pacific flow into western North America has decreased in late January, though strong southerly flow from the East Pacific continues to feed into a strong ridge over the southeastern and south-central US.

850-hPa Wind Anomalies

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

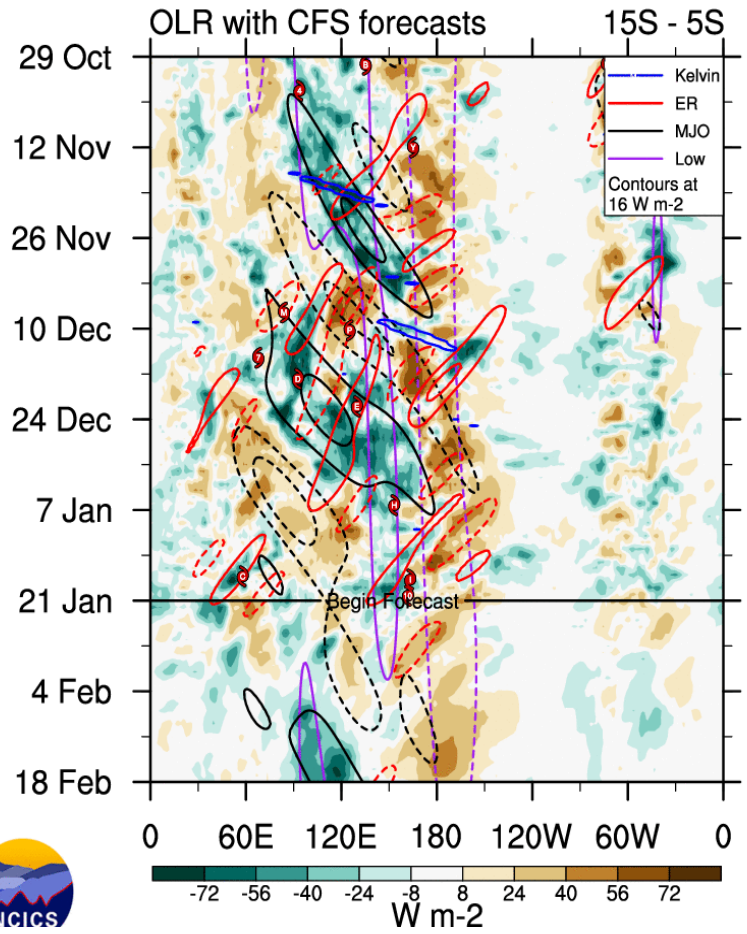


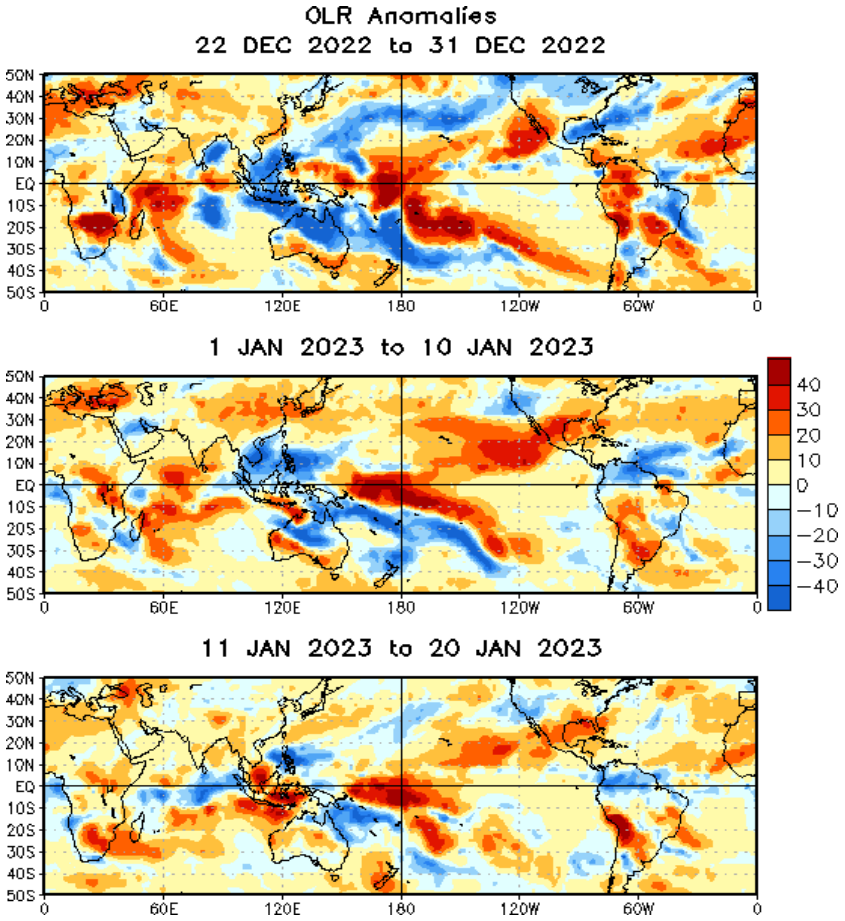


- The MJO signal is least apparent in the low-level zonal wind field, with enhanced Pacific trades associated with the ongoing La Niña response remaining largely unbroken near the Equator.
- Westerly anomalies associated with the MJO passage are more apparent away from the Equator.
- Westerly anomalies have strengthened over the East Pacific, which seems to be in opposition to the current MJO phase.

Outgoing Longwave Radiation (OLR) Anomalies

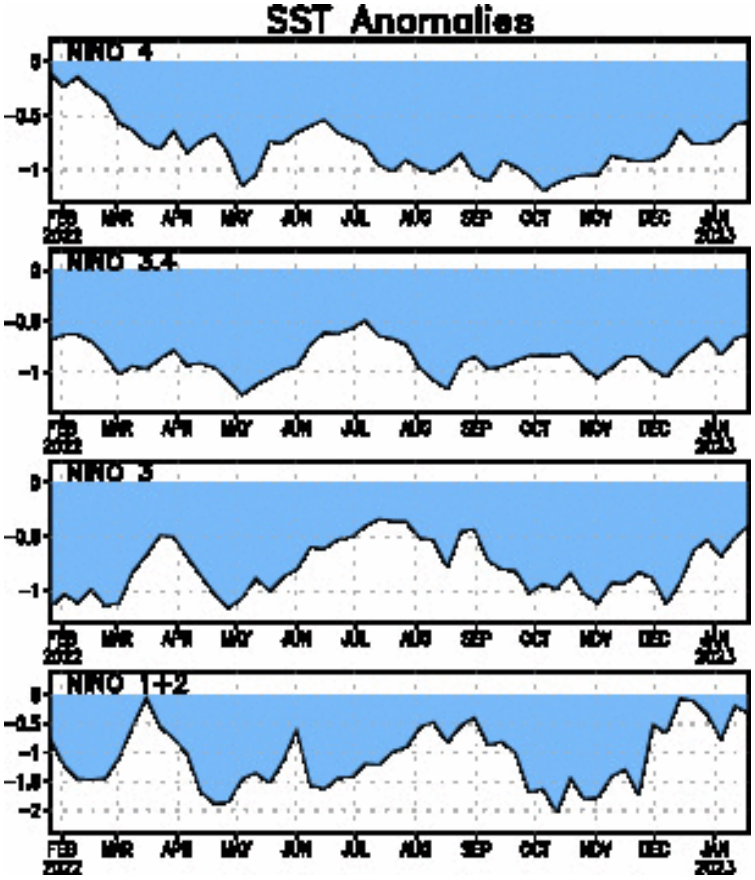
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

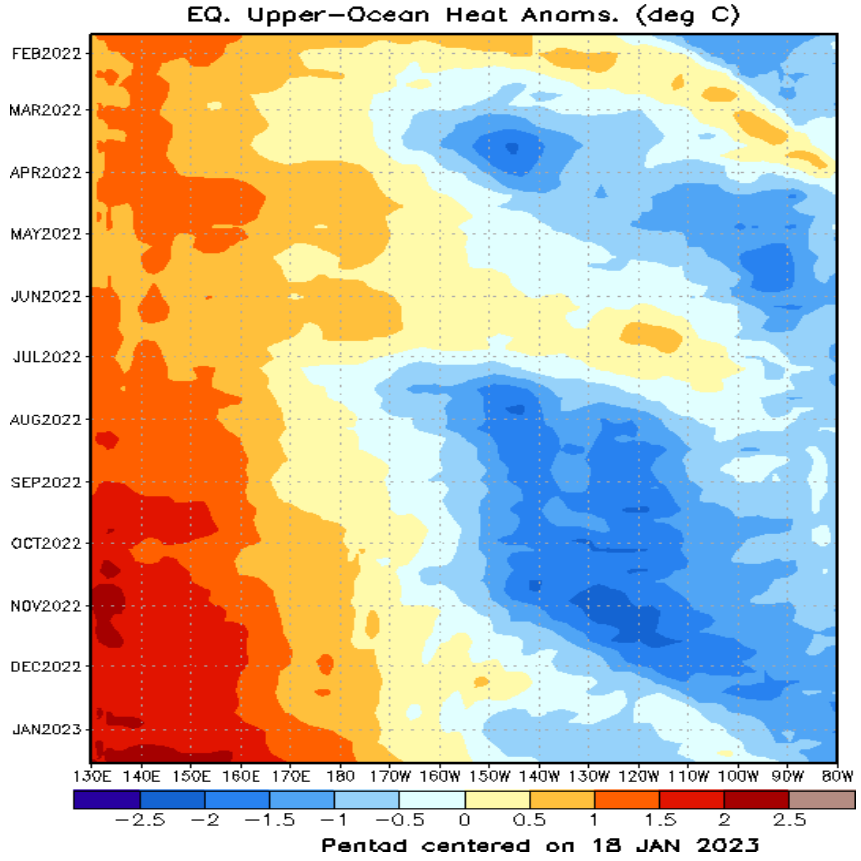




- MJO activity was strongly apparent in the evolution of organized convection over the Southern Hemisphere through late 2022 into early 2023.
- More recently, the MJO signal weakened in the OLR field as it entered the Indian Ocean, possibly due to Rossby wave interference.
- Recently analyses depict a marked uptick in convection over the Maritime Continent, which is more consistent with MJO activity.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

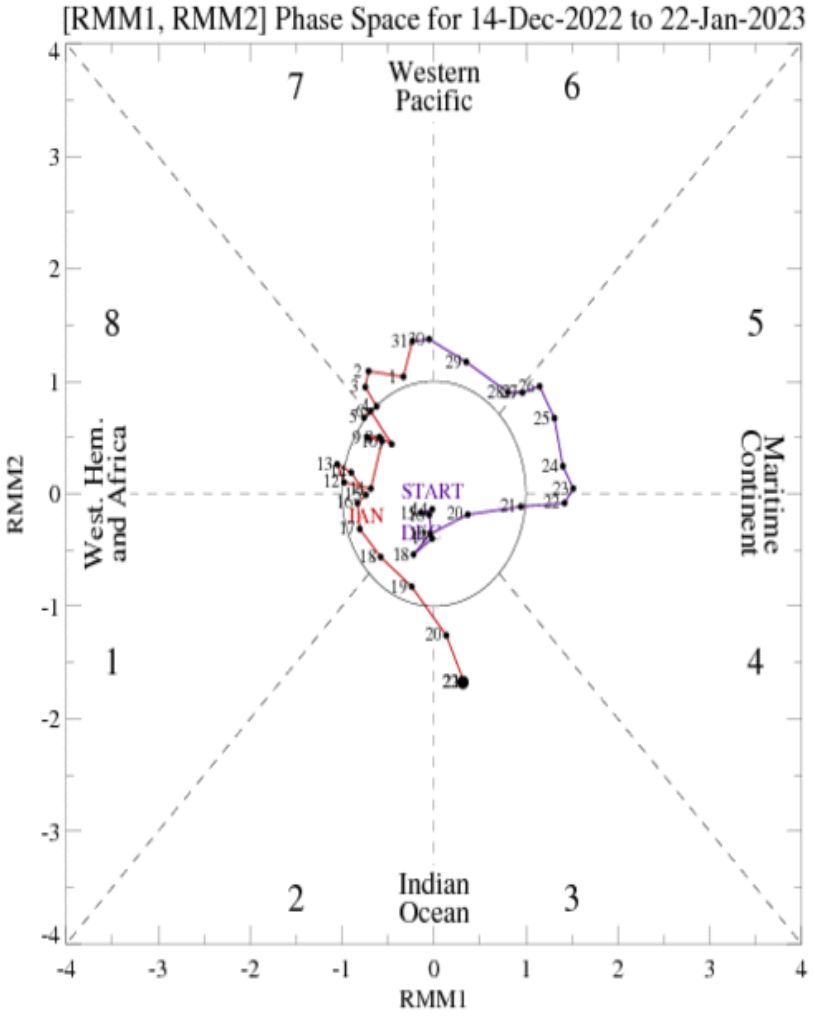




- Similar to a couple episodes last year, an oceanic downwelling Kelvin wave aided in the reduction of negative subsurface anomalies over the equatorial Pacific, though colder waters appear to be reforming from 150W to 120W more recently.
- Much of this warming is reflected at the surface in the Nino indices since December.

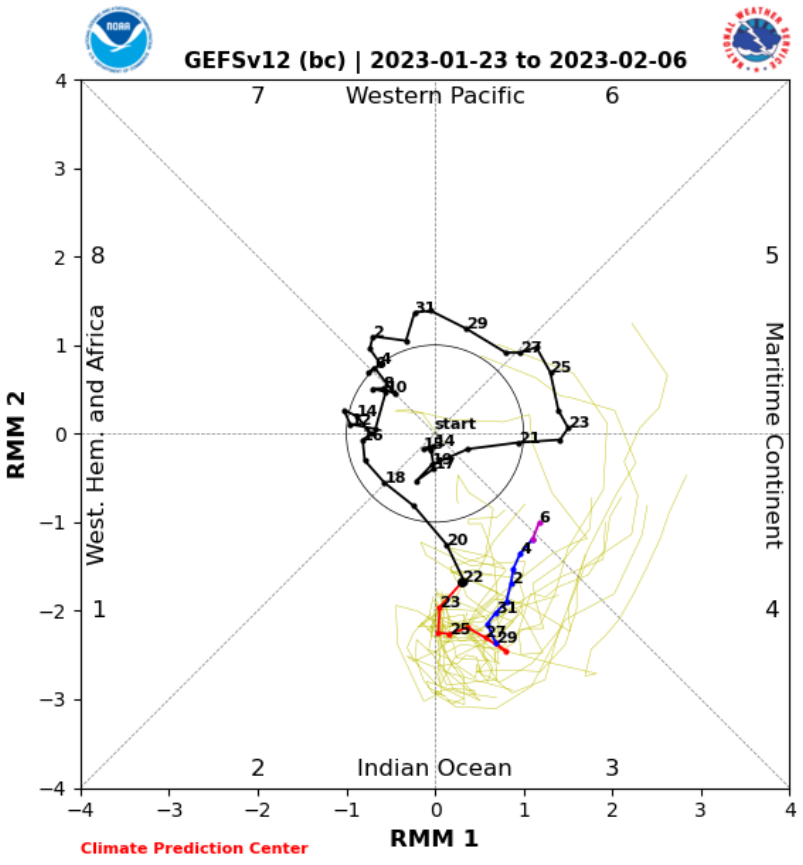
MJO Index: Recent Evolution

- Over the past several days, the RMM-based MJO index has increased in amplitude over the east-central Indian Ocean.
- The increase in amplitude was well forecasted by dynamical models last week.

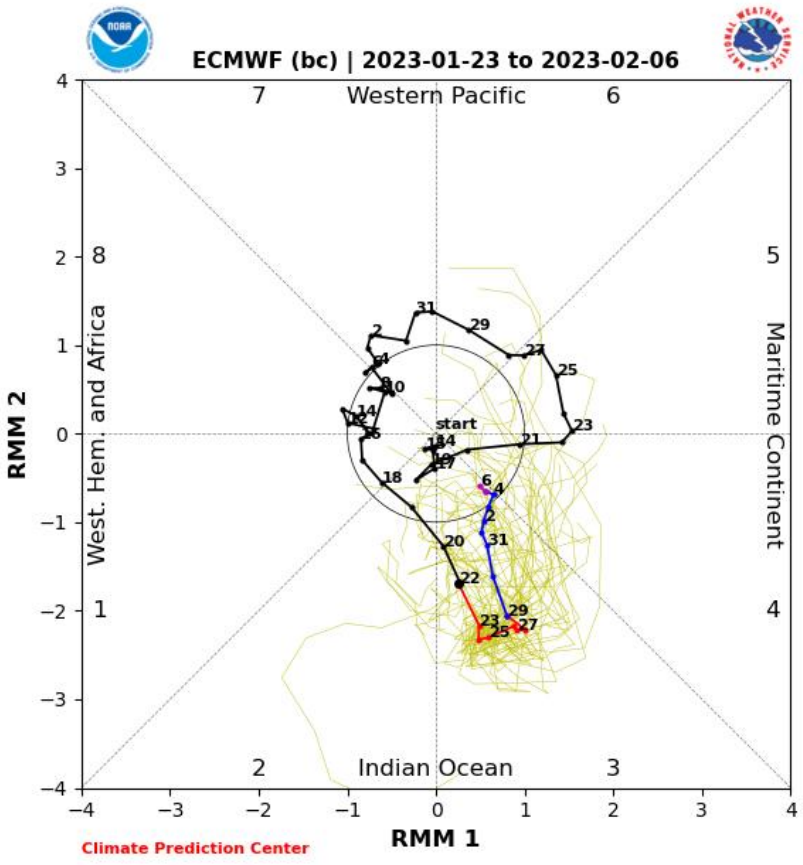


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

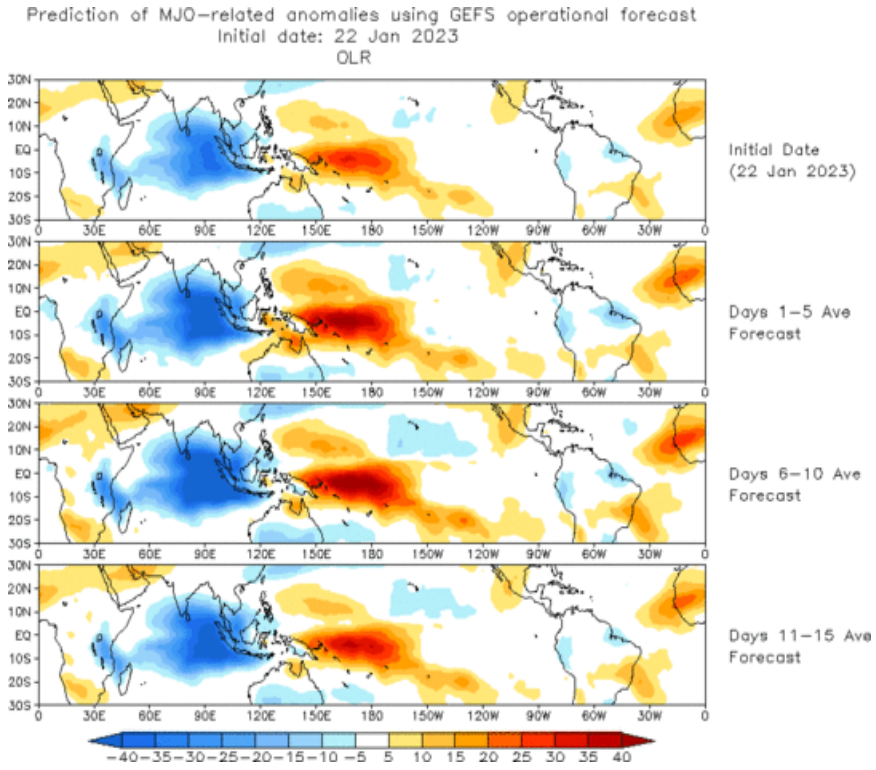


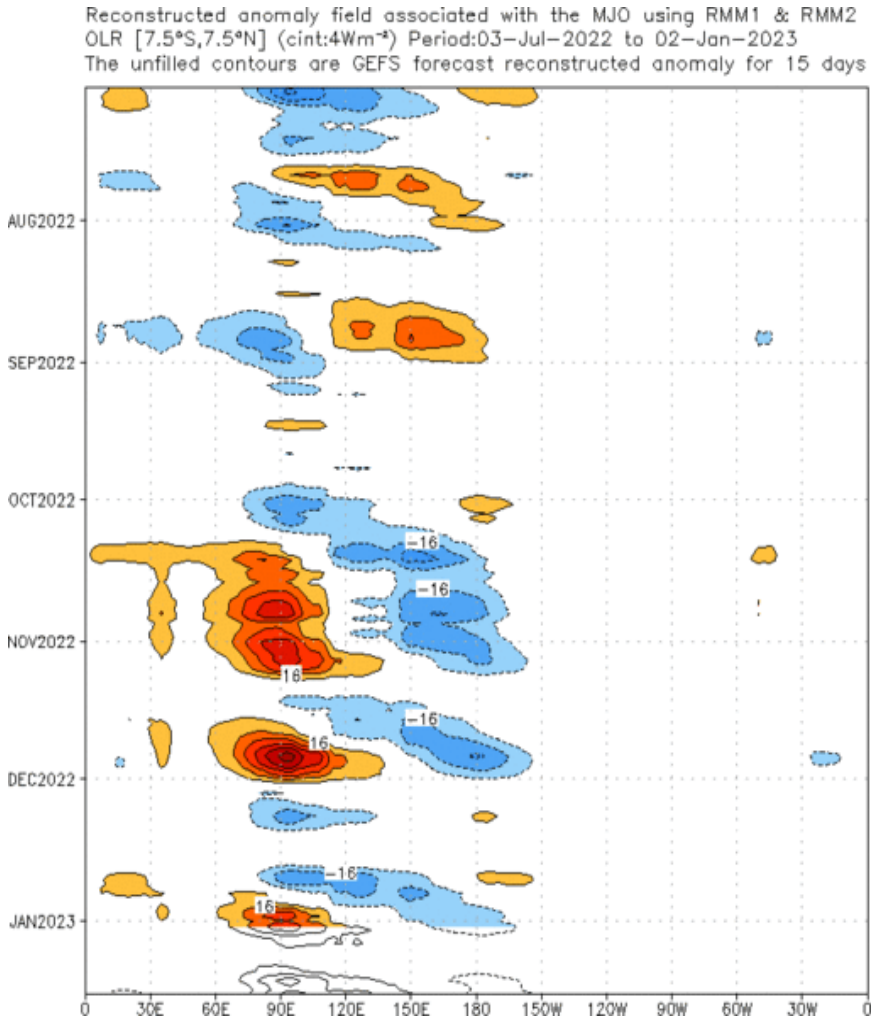
ECMWF Forecast

- Following a high amplitude period over the eastern Indian Ocean during Week-1, both the GEFS and ECMWF depict some eastward propagation over the Maritime Continent.
- Both ensemble systems suggest a potential for weakening amplitude, but have been having trouble resolving MJO evolutions across the Maritime Continent with the La Niña background state.
- Long range model predictions favor continued MJO evolution across the West Pacific beyond Week-2 into Week-3.

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.)

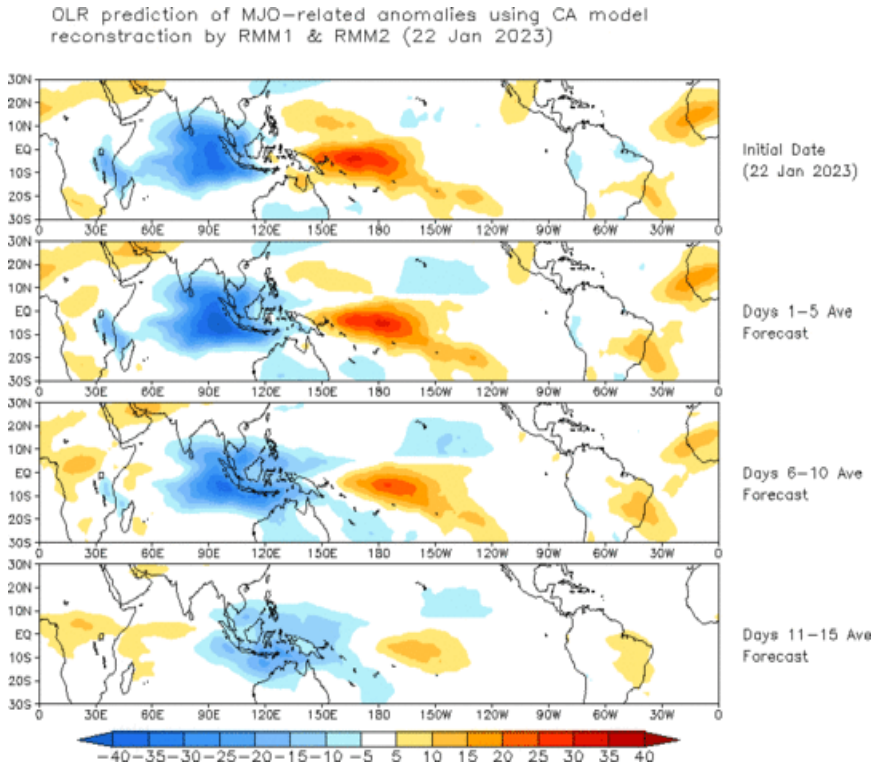


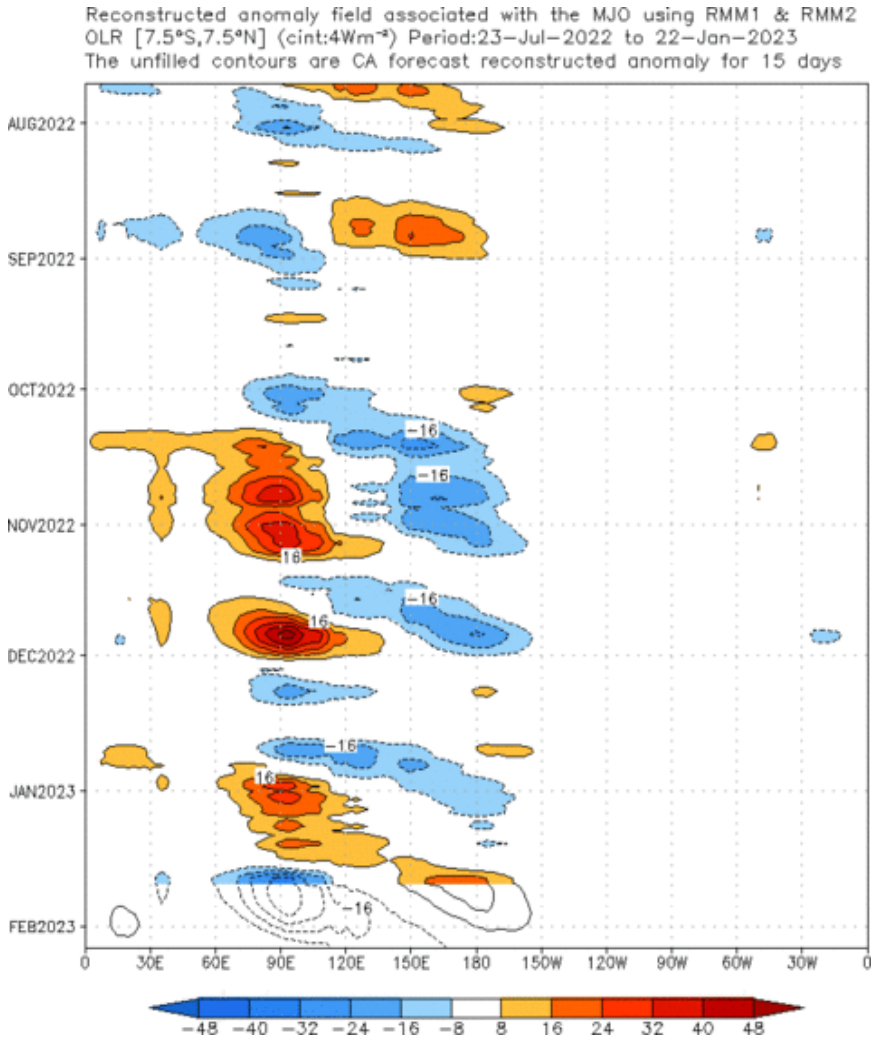


- The GEFS RMM-index forecast based OLR anomaly fields maintain a high amplitude dipole during the next two weeks, with a fairly stationary pattern as the index only propagates towards the Maritime Continent towards the end of Week-2.

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.)

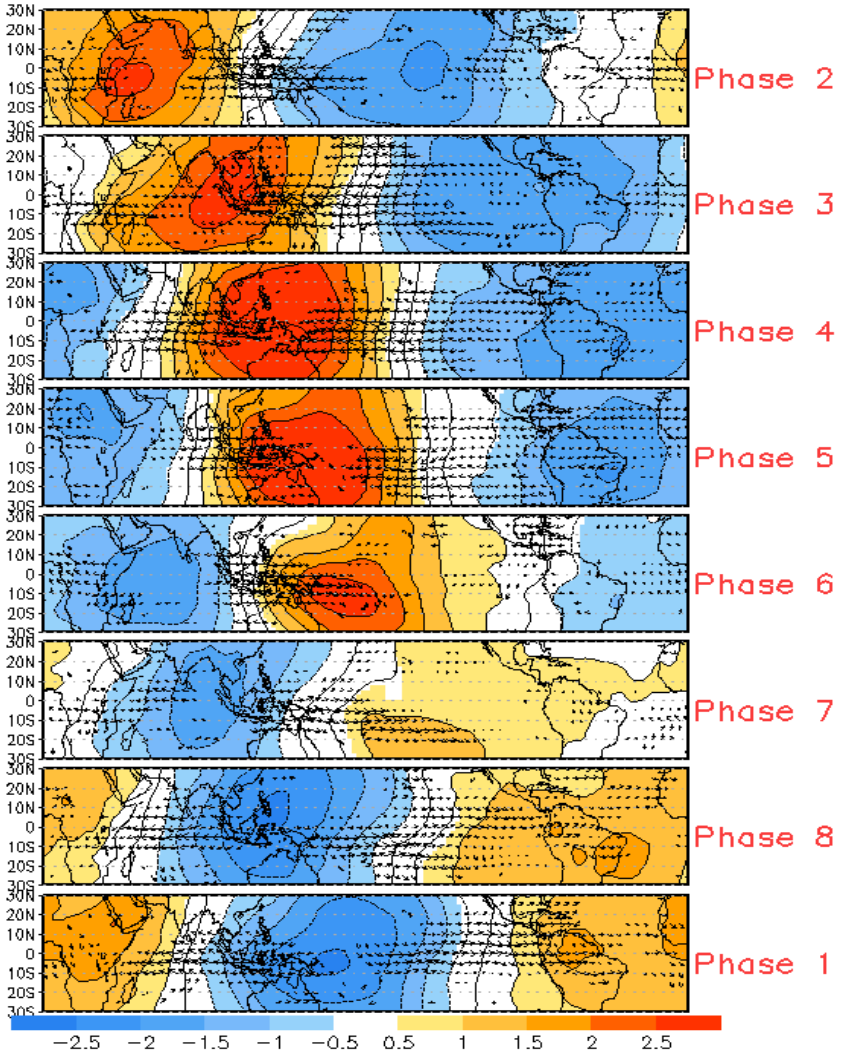




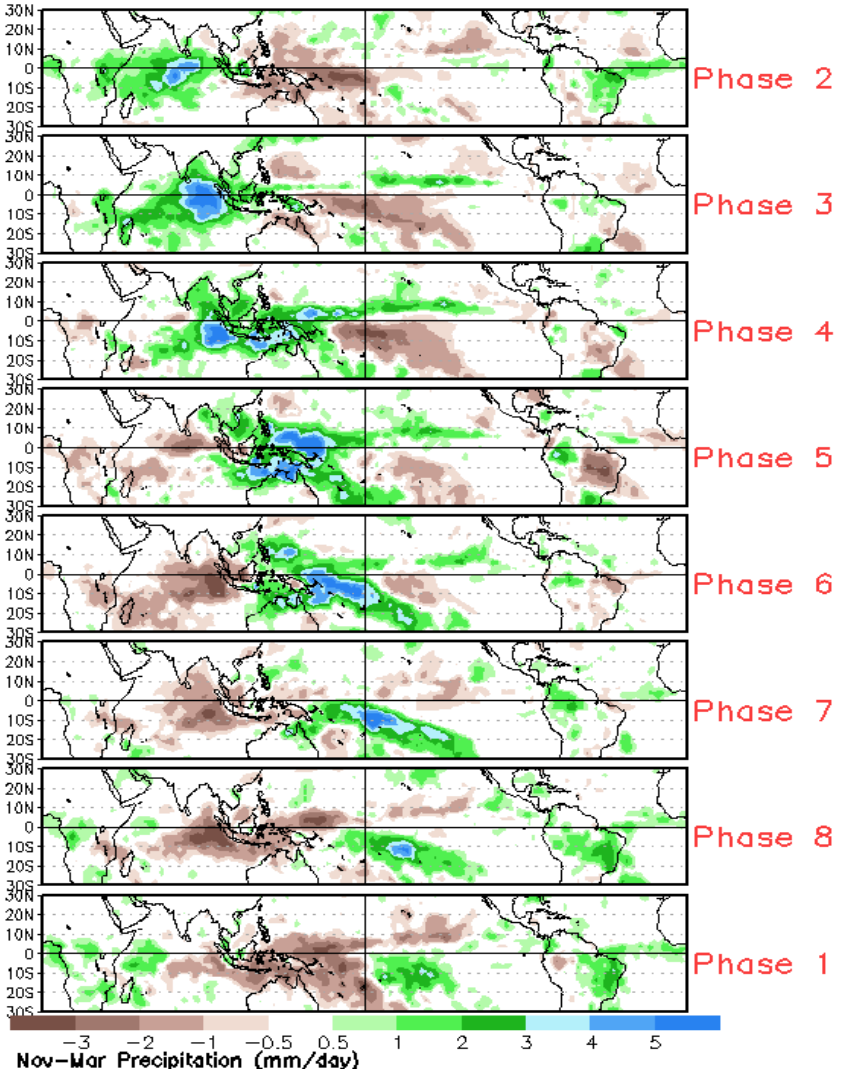
- The constructed analog forecast of RMM-based OLR also shows a robust anomaly dipole, with an established eastward propagation that is more consistent with canonical MJO events.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



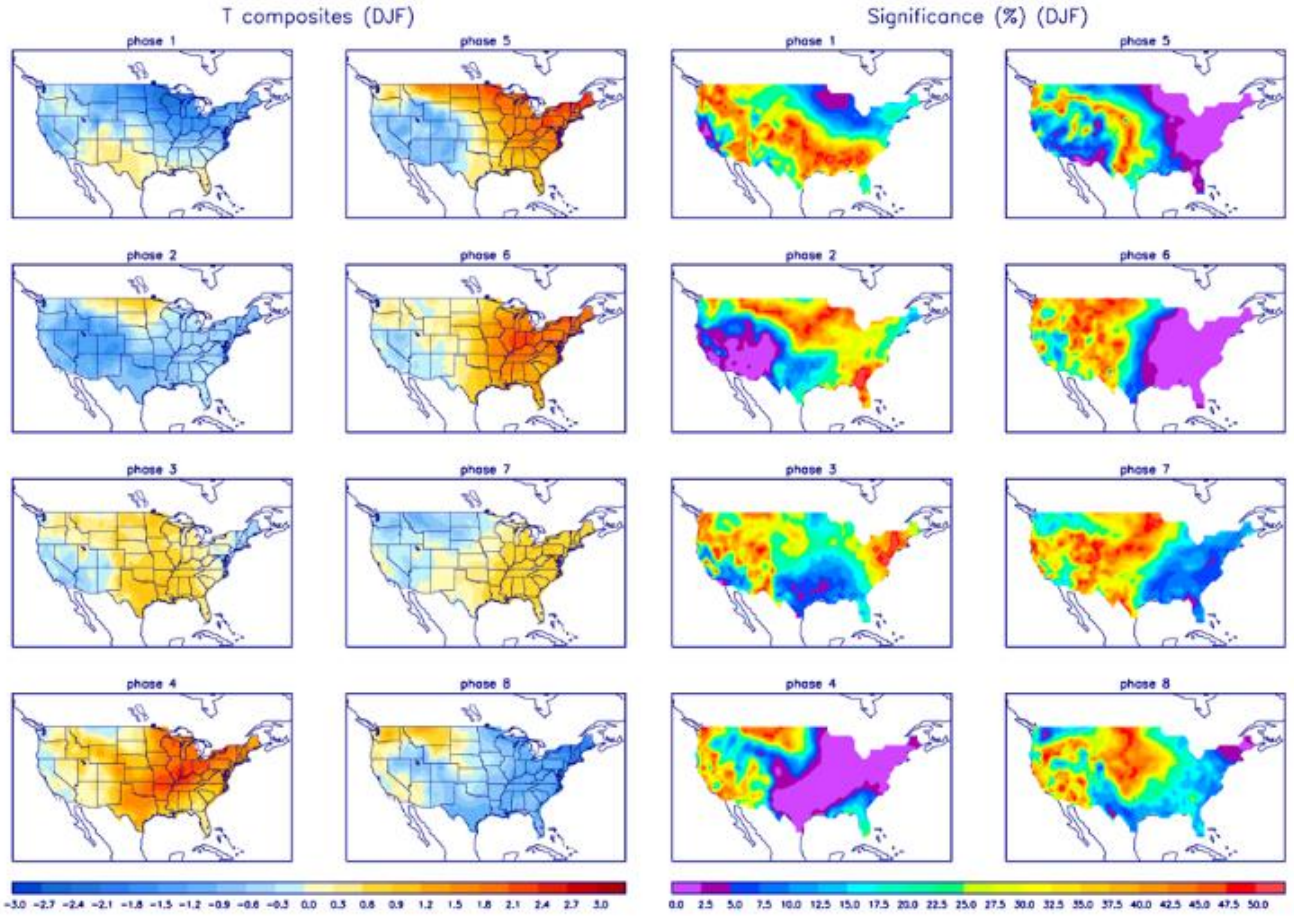
Precipitation Anomalies



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.

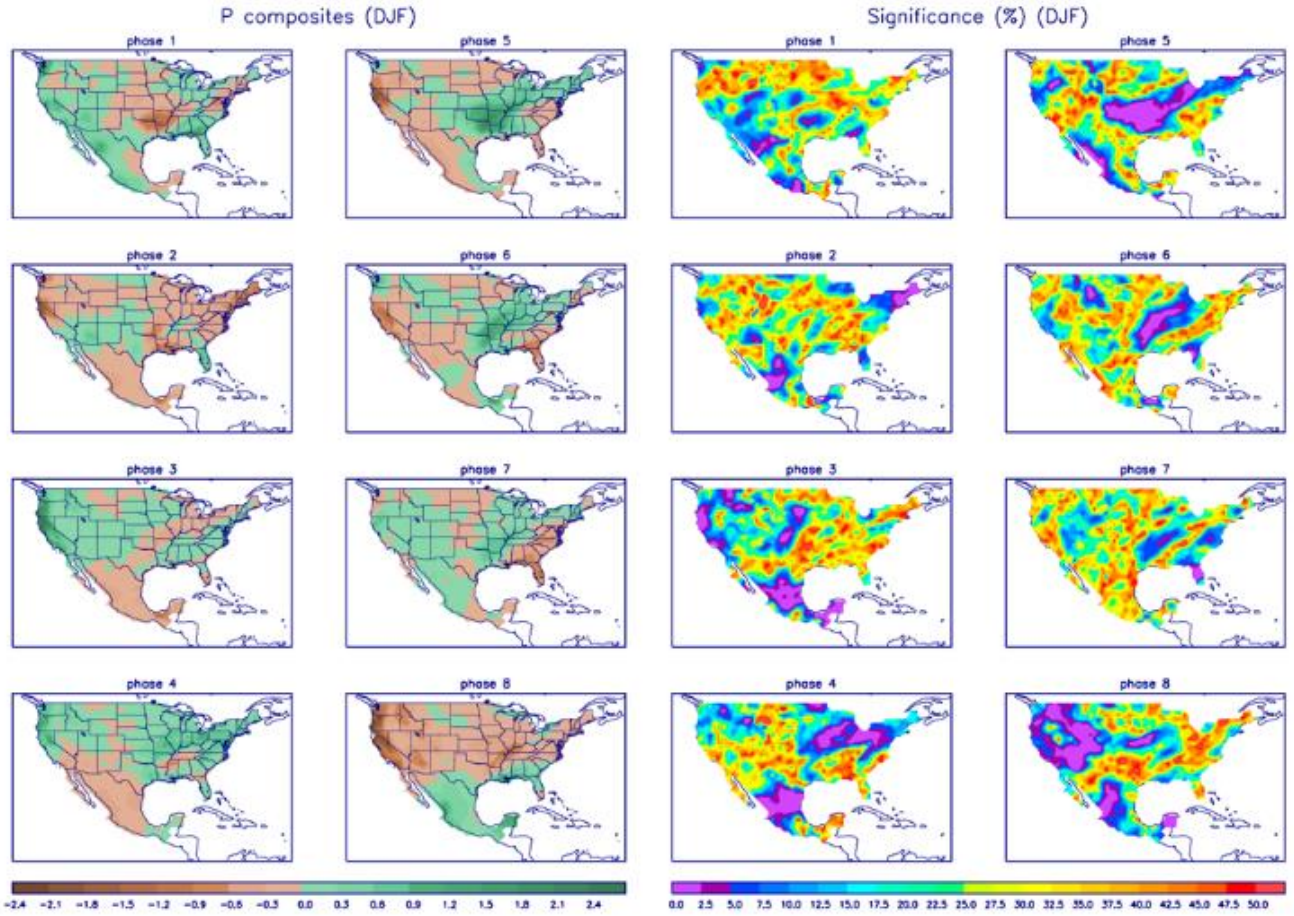


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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