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

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

Overview

- The MJO amplitude increased over the east-central Indian Ocean during late January, as depicted by the RMM-based and CPC velocity potential based MJO indices.

- Dynamical model MJO index forecasts depict eastward propagation of the MJO to the Maritime Continent and West Pacific through mid-February.

- Based on this MJO evolution, tropical cyclone development is favored across the southern Indian Ocean and near the Kimberley Coast of western Australia during week-2.

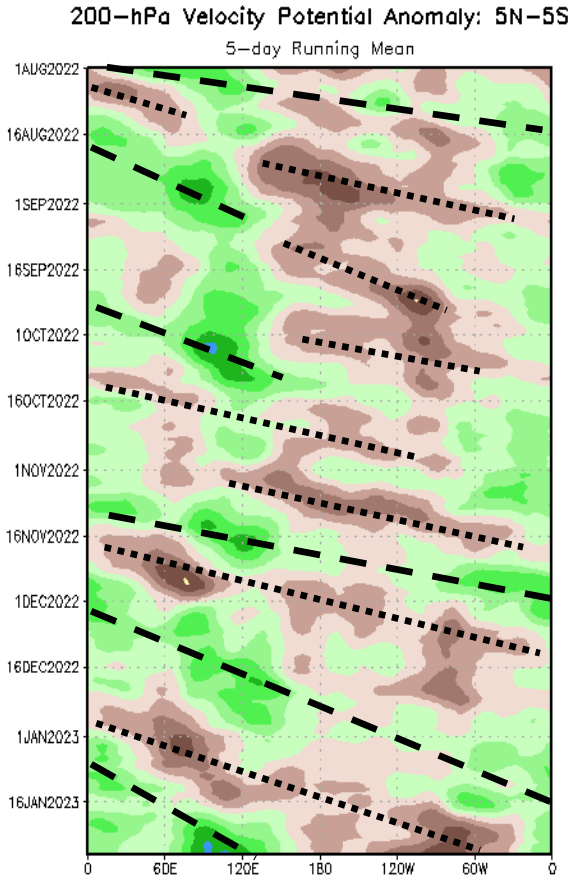
- The MJO teleconnects well with the extratropical pattern during the Boreal Winter. An eastward propagation of the MJO from the Indian Ocean to the Maritime Continent favors above-normal temperatures across the eastern United States during mid-February.

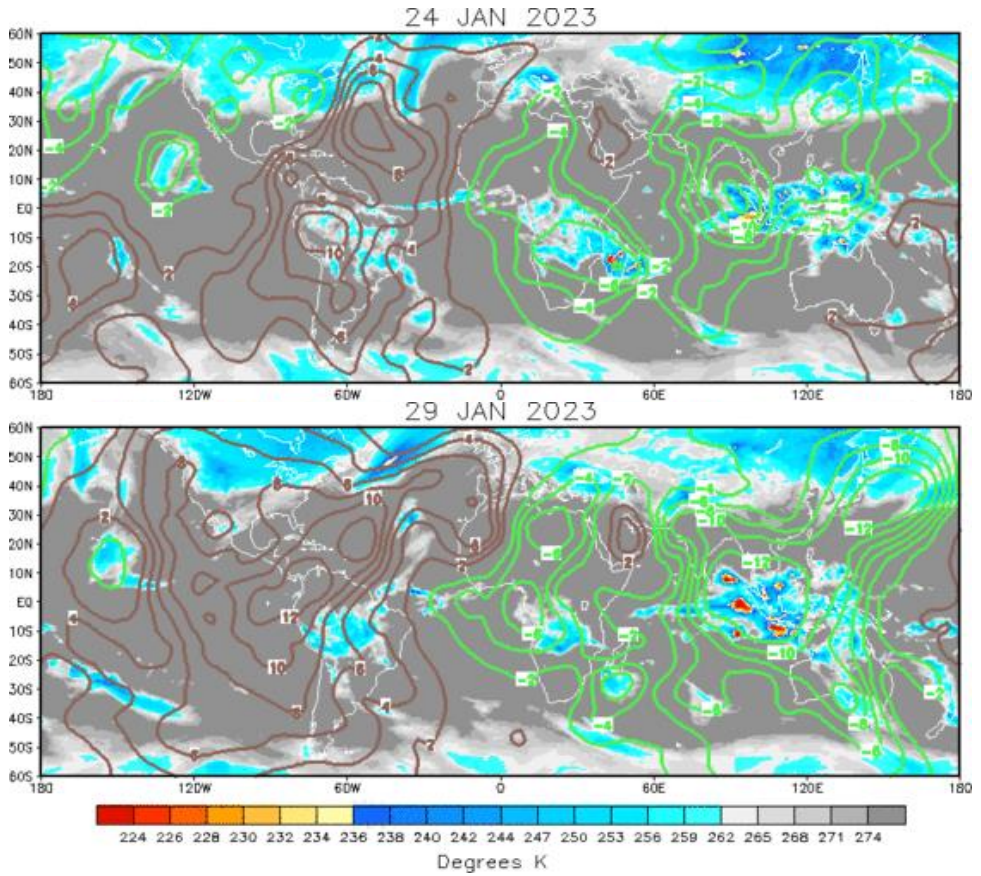
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)



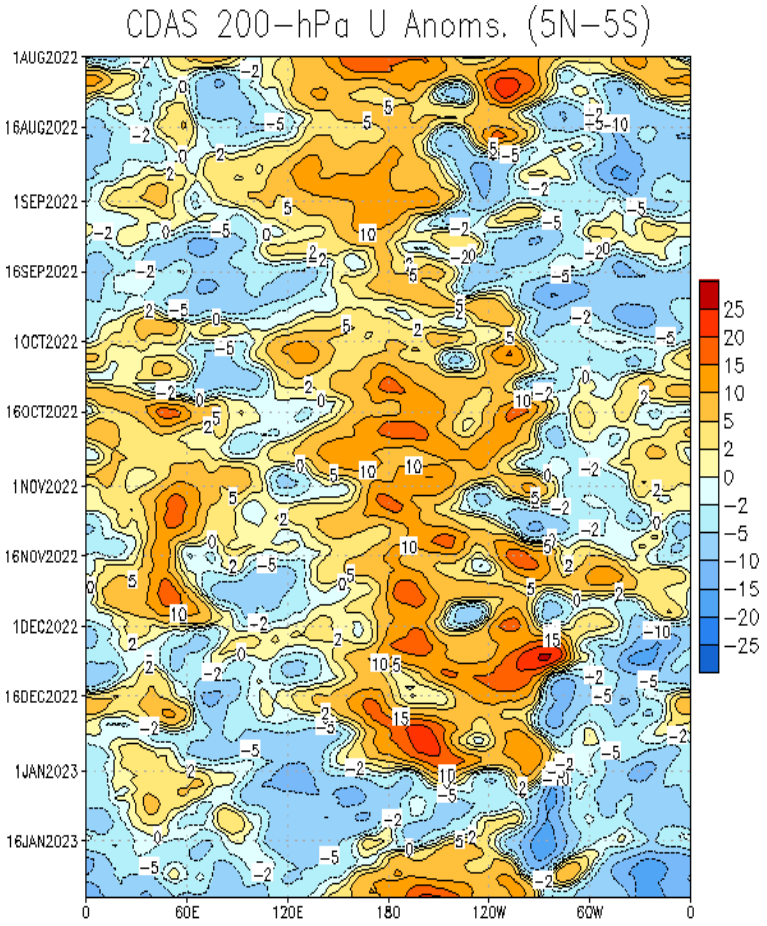


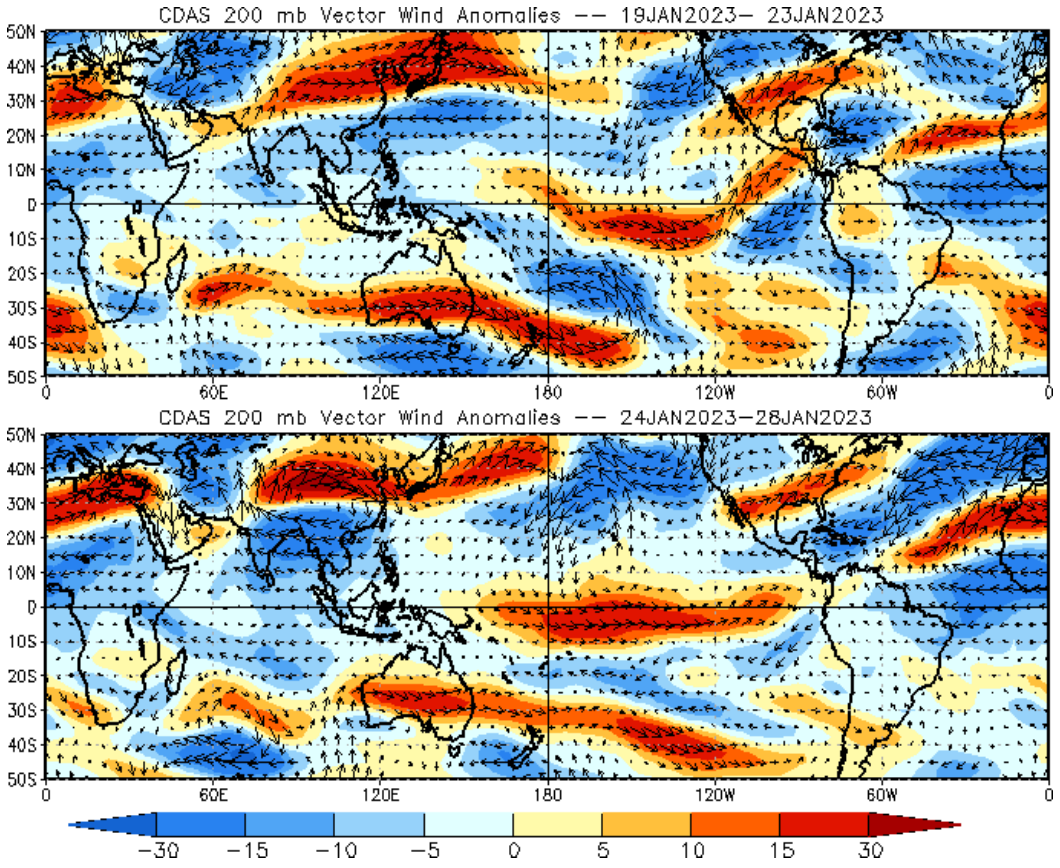
- Compared to last year, the MJO has been more coherent in the upper-level velocity potential field during the Boreal winter, and has increasingly overwhelmed the low frequency La Niña base state.

- The MJO enhanced convective envelope is centered over the Indian Ocean and its eastward propagation slowed during the final week of January, due to interaction with an equatorial Rossby wave.

200-hPa Wind Anomalies

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

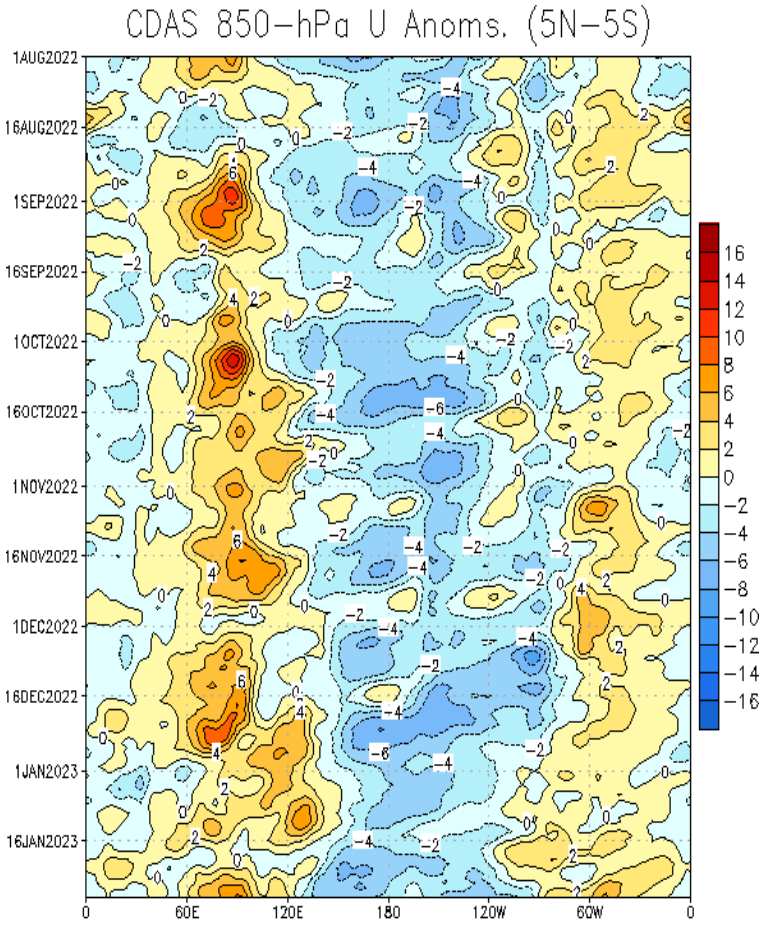


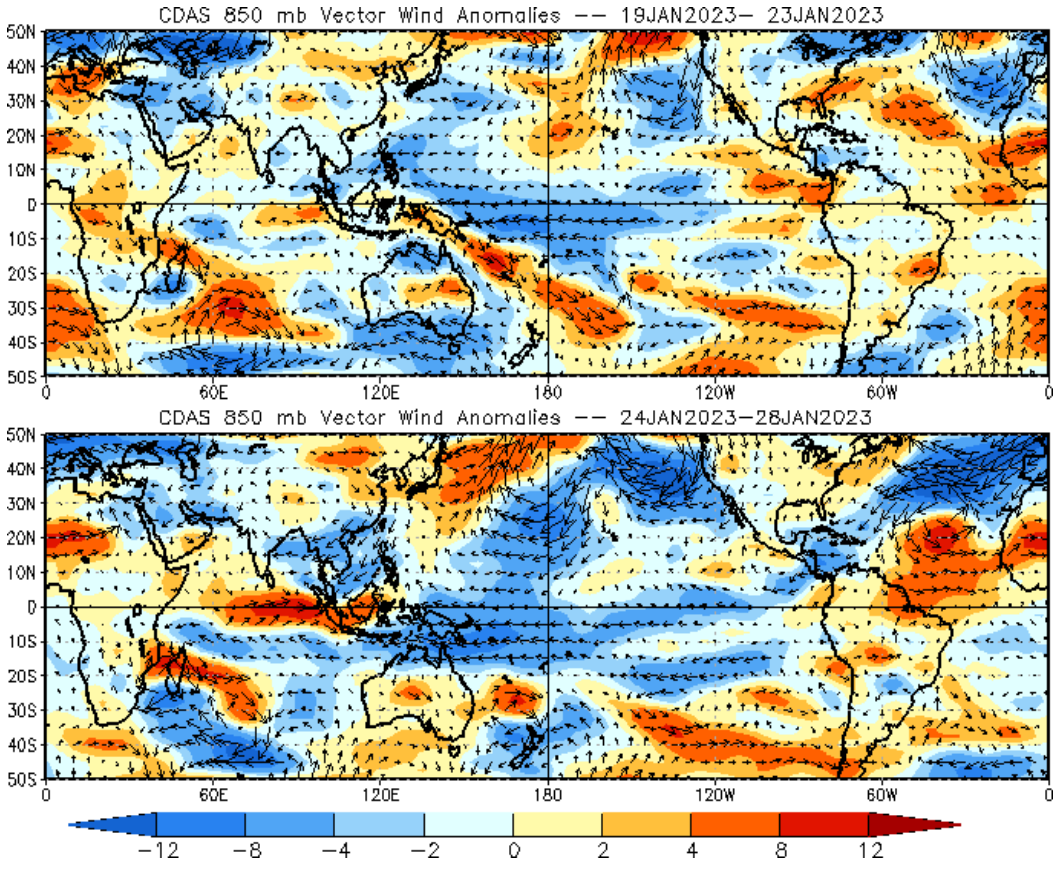


- Following a substantial disruption of the low frequency state due to the MJO enhanced phase crossing the Pacific at the end of December 2022, anomalous upper-level westerlies returned to the equatorial Central Pacific.
- The anomalous upper-level westerlies strengthened by late January, as the MJO began constructively interfering with the background La Niña.
- Anomalous upper-level easterlies have reduced wind shear and provided a favorable large-scale environment for tropical cyclone development across the Indian Ocean basin.

850-hPa Wind Anomalies

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



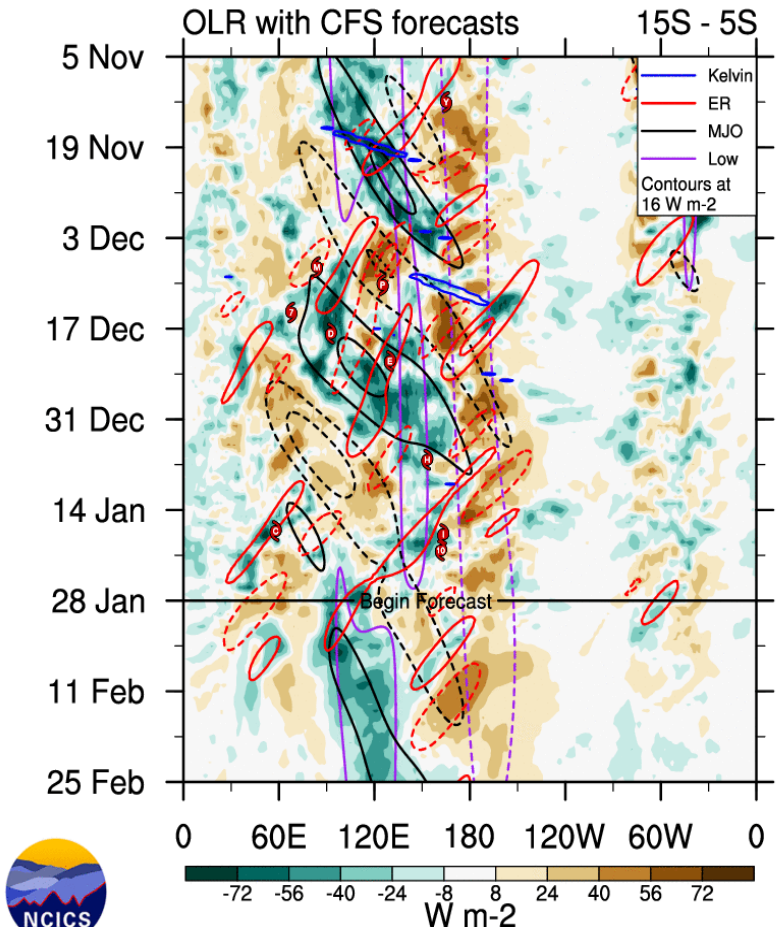


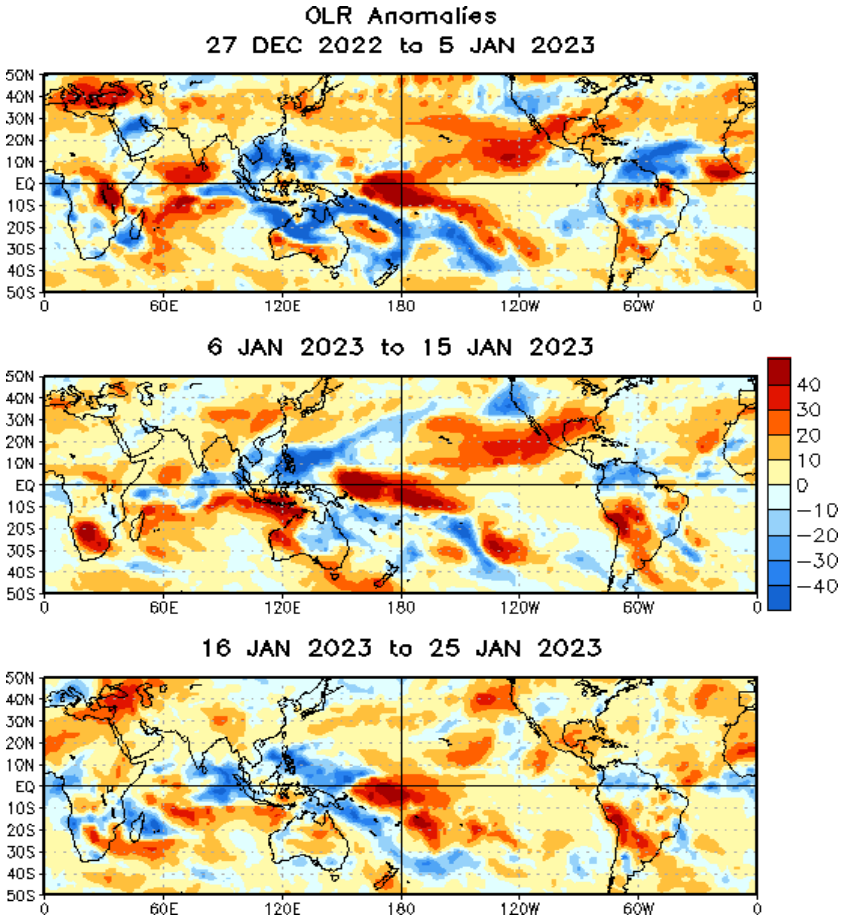
- Low-level westerly anomalies, associated with the MJO, have strengthened recently and expanded eastward to the western Maritime Continent.

- Enhanced trade winds associated with the La Niña persist throughout the equatorial Central Pacific.

Outgoing Longwave Radiation (OLR) Anomalies

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

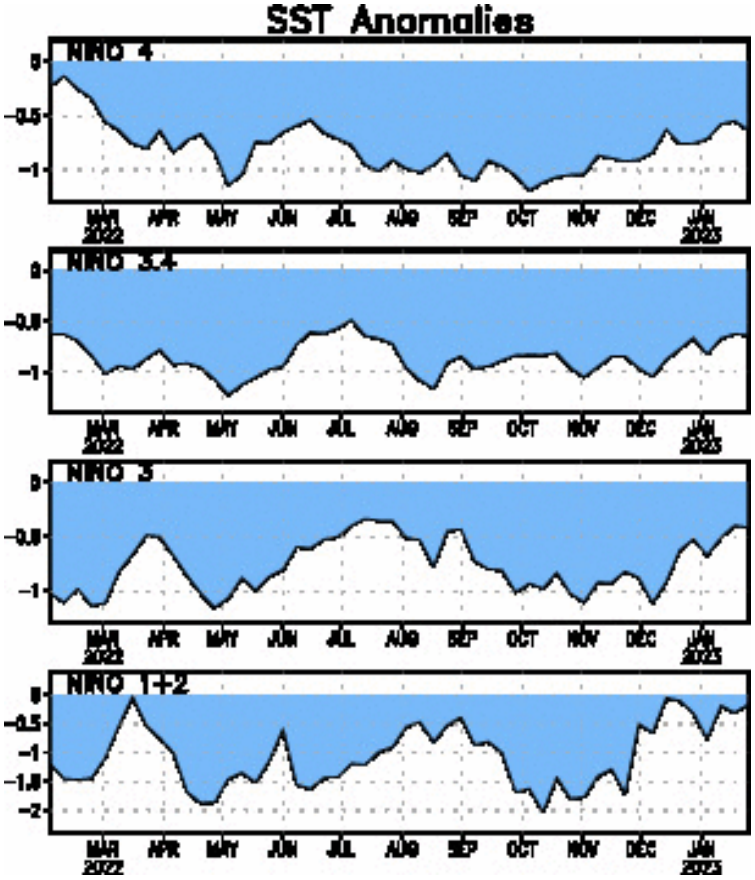


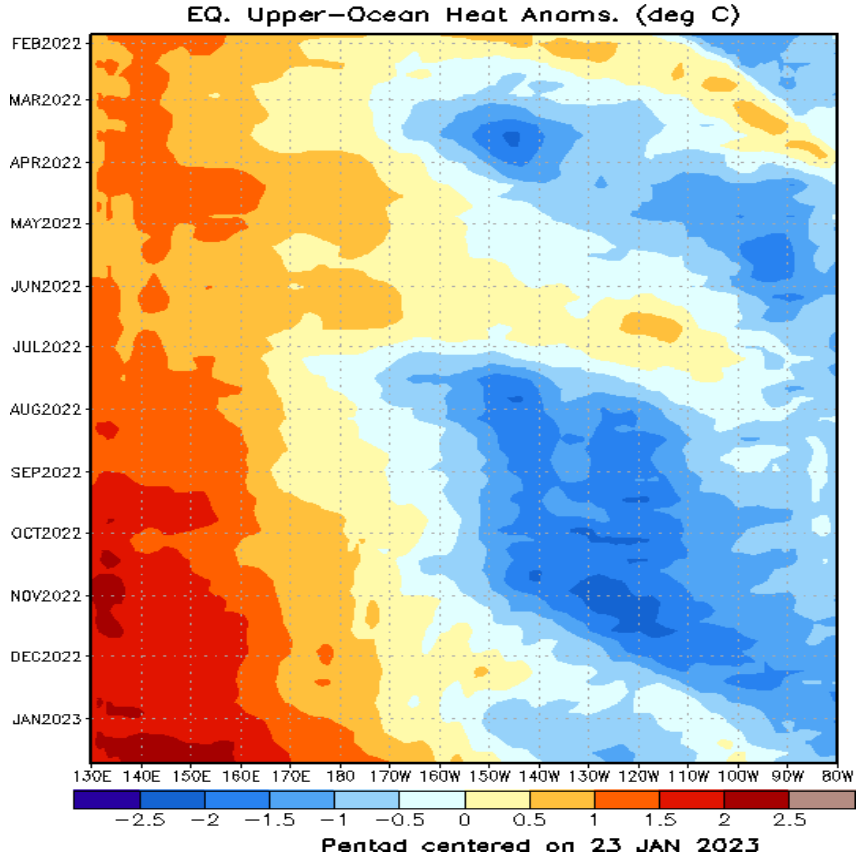


- Following negative OLR anomalies earlier in January, related to the wet pattern along the West Coast of the United States, a drier pattern developed by the latter half of January.

- The MJO is constructively interfering with an equatorial Rossby wave and the background La Niña, resulting in enhanced convection across parts of the Indian Ocean and Maritime Continent.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

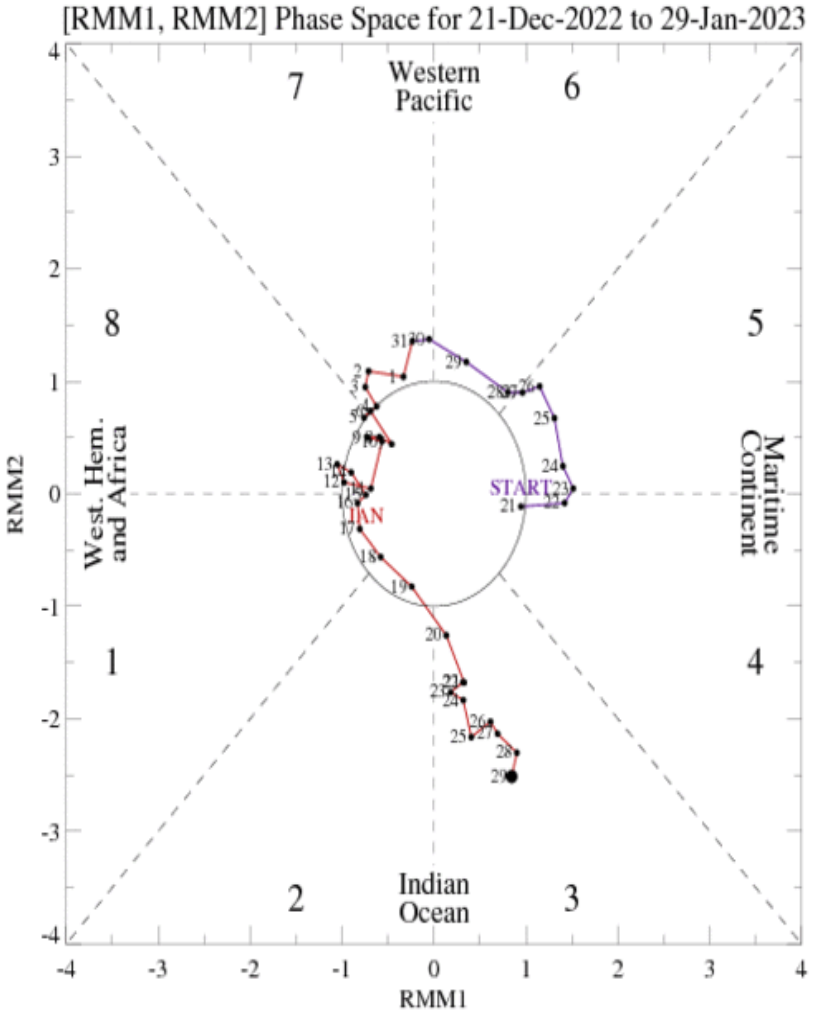




- Similar to a couple episodes last year, an oceanic downwelling Kelvin wave aided in the reduction of negative subsurface anomalies over the equatorial Pacific, though colder waters appear to be reforming from 150W to 120W during January.
- Much of this warming is reflected at the surface in the Niño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

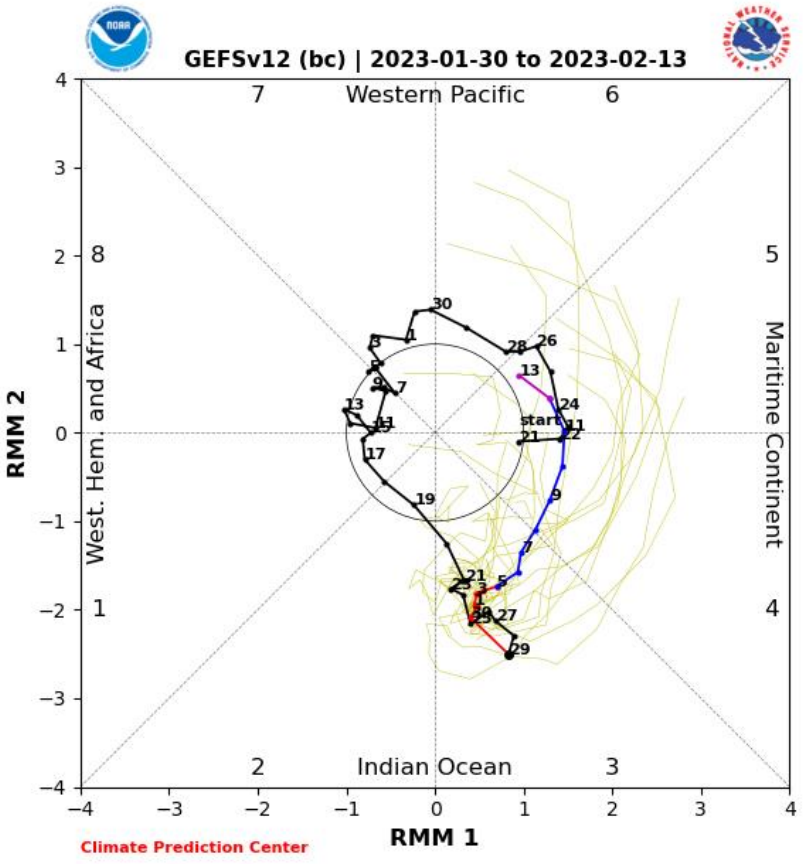
MJO Index: Recent Evolution

- During late January, the RMM-based MJO index has increased in amplitude over the Indian Ocean.
- The eastward propagation of the MJO slowed recently, due to influence from an equatorial Rossby wave.

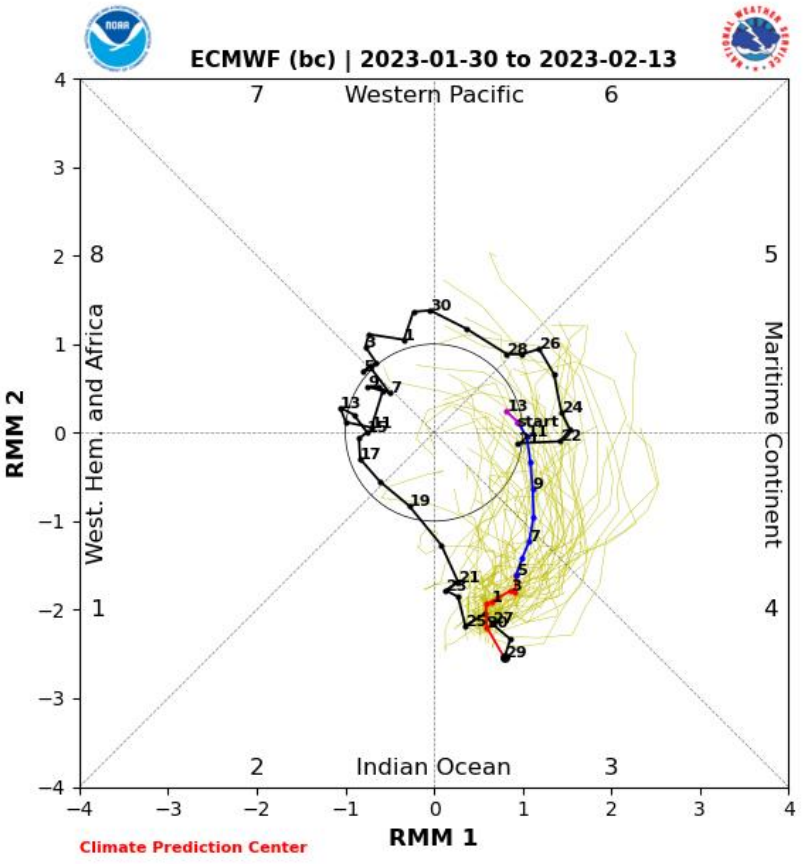


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

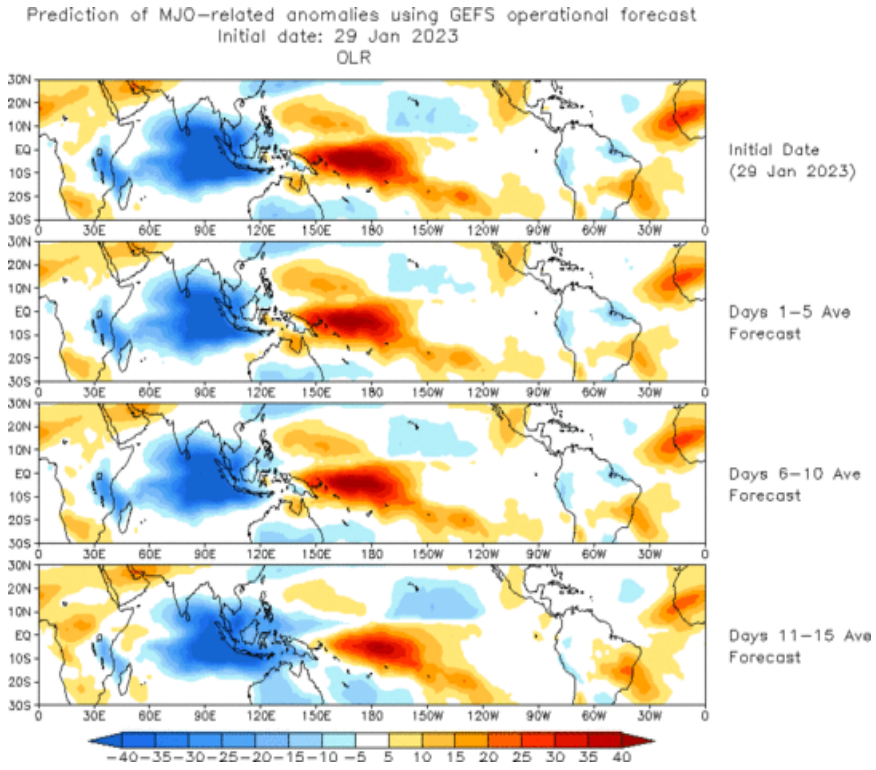


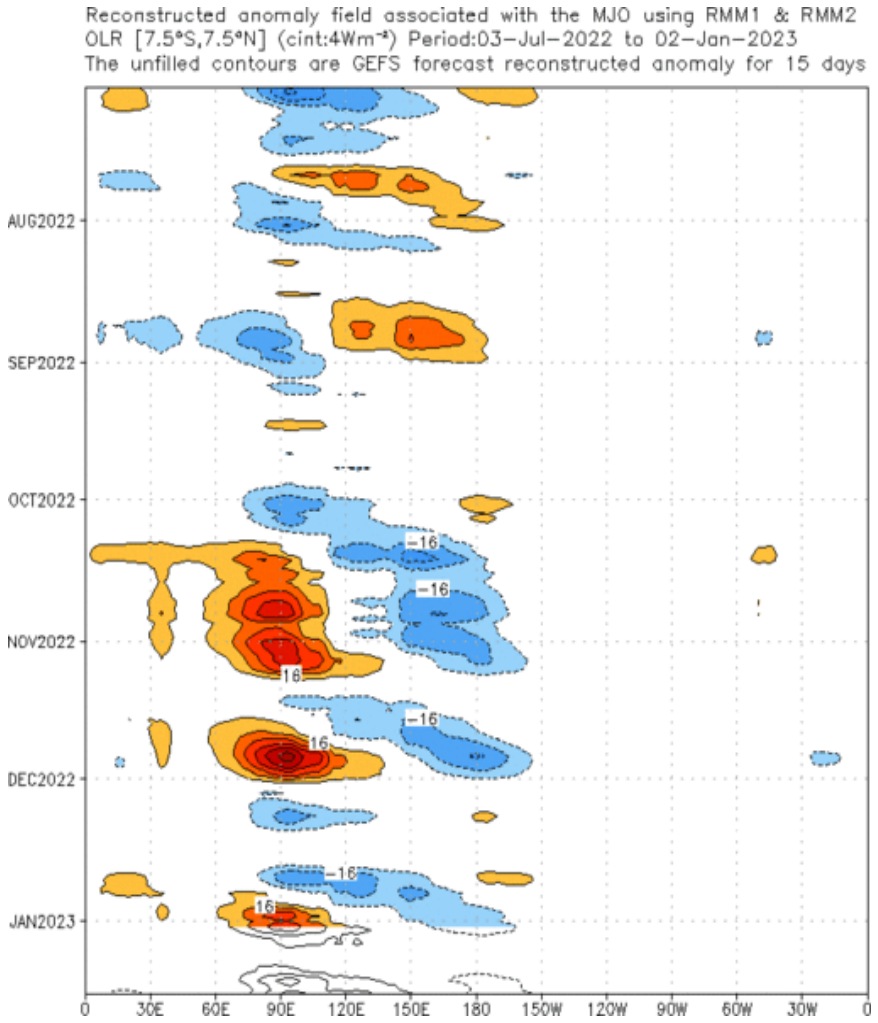
ECMWF Forecast

- The GEFS and ECMWF ensemble means are in good agreement that the MJO resumes eastward propagation to the Maritime Continent during the next two weeks.
- Longer range model predictions favor continued eastward propagation 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.)

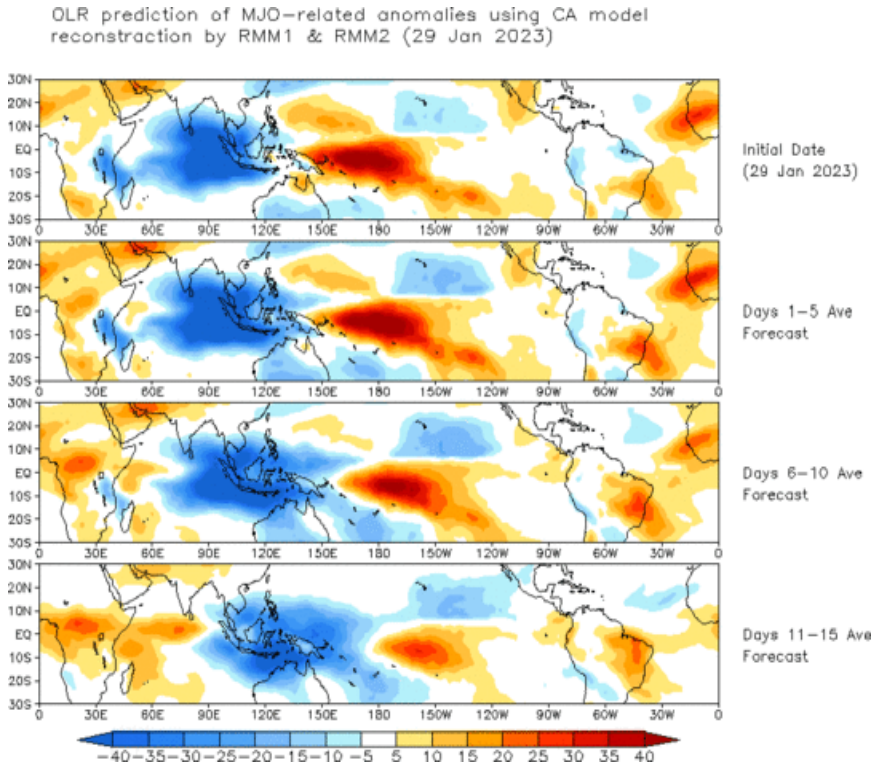


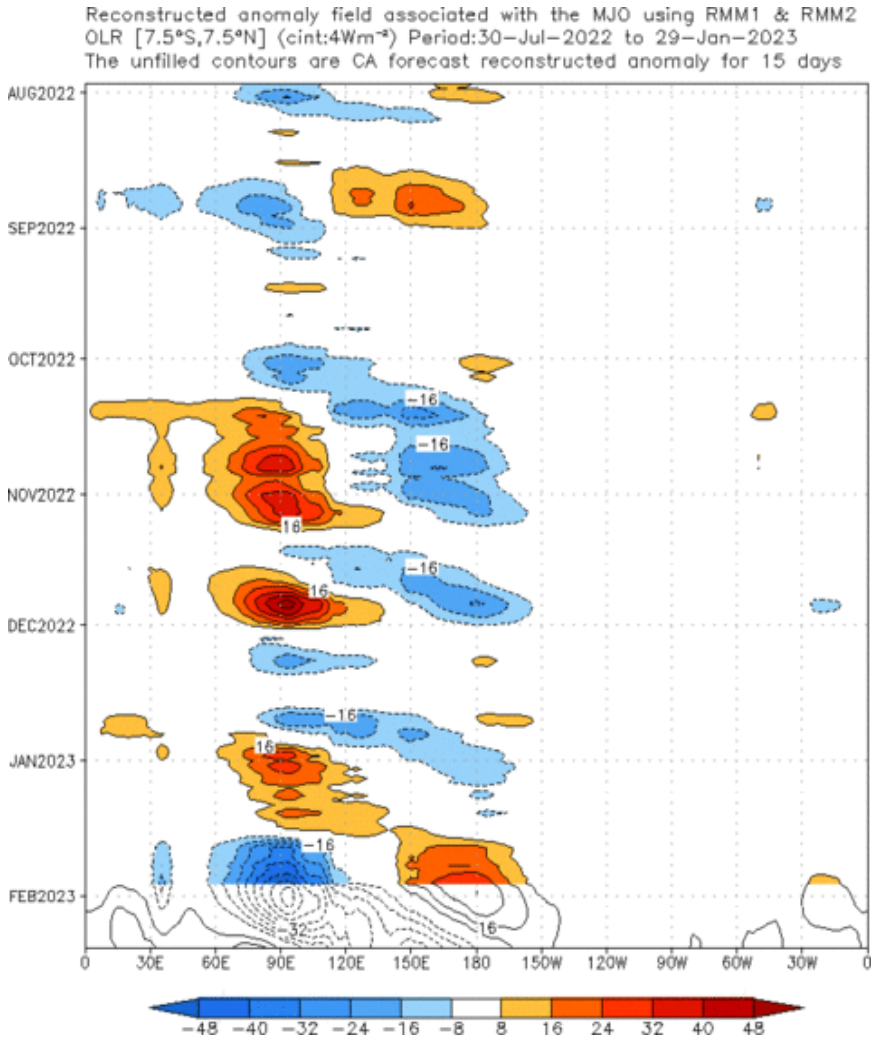


- The GEFS RMM-index forecast based OLR anomaly fields maintain a high amplitude MJO with enhanced rainfall expanding east to the Maritime Continent, West Pacific, and Australia. A drier pattern is forecast for parts of South America and Africa.

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.)

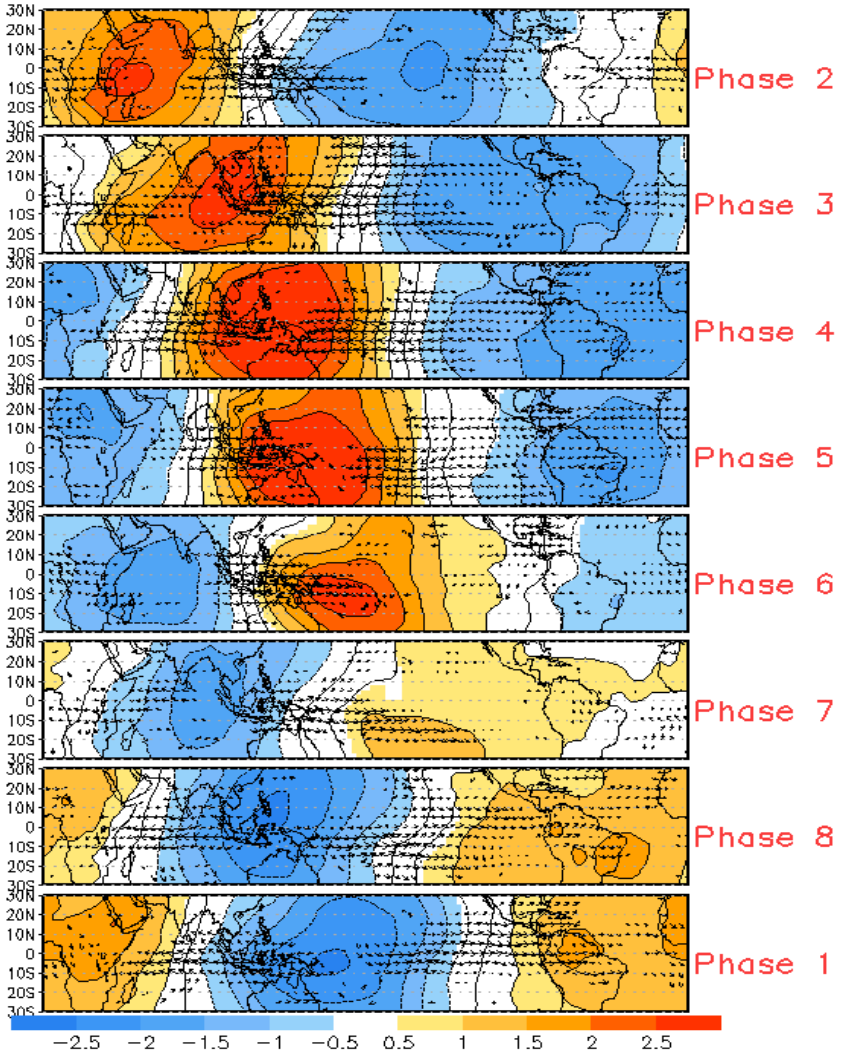




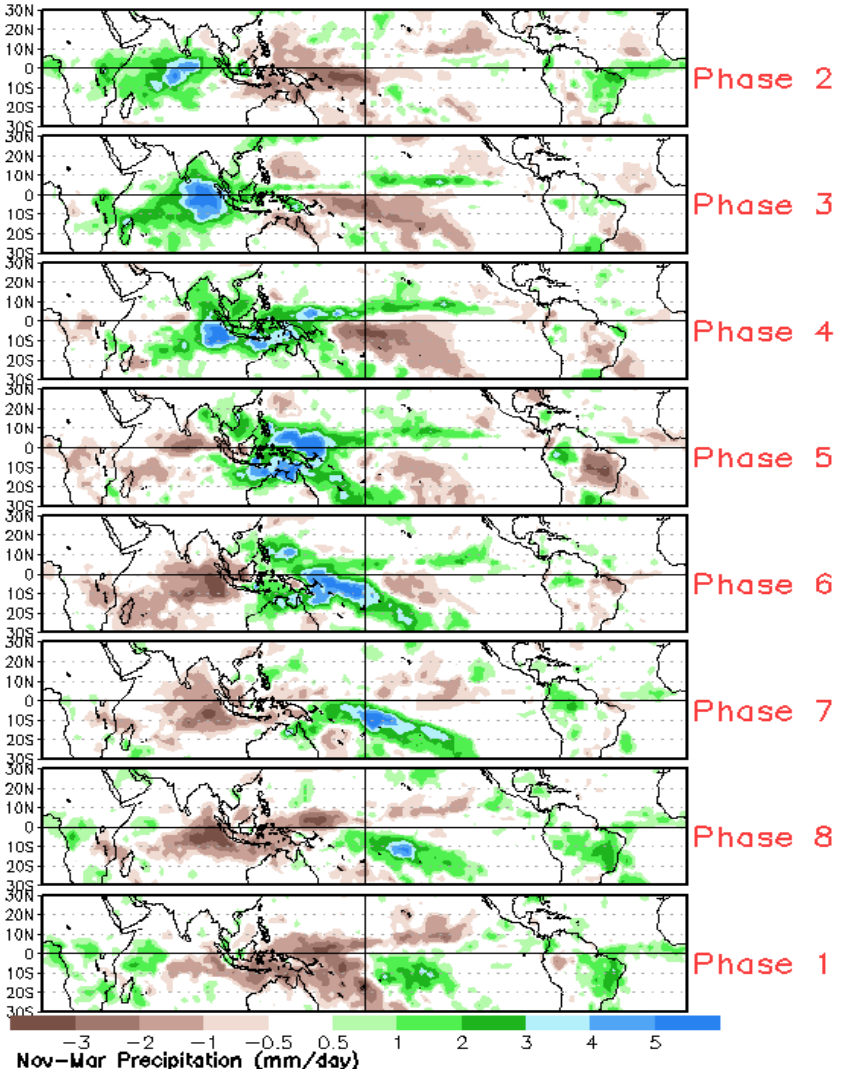
- The constructed analog forecast of RMM-based OLR also shows a robust anomaly dipole, with an established eastward propagation that is consistent with canonical MJO events.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



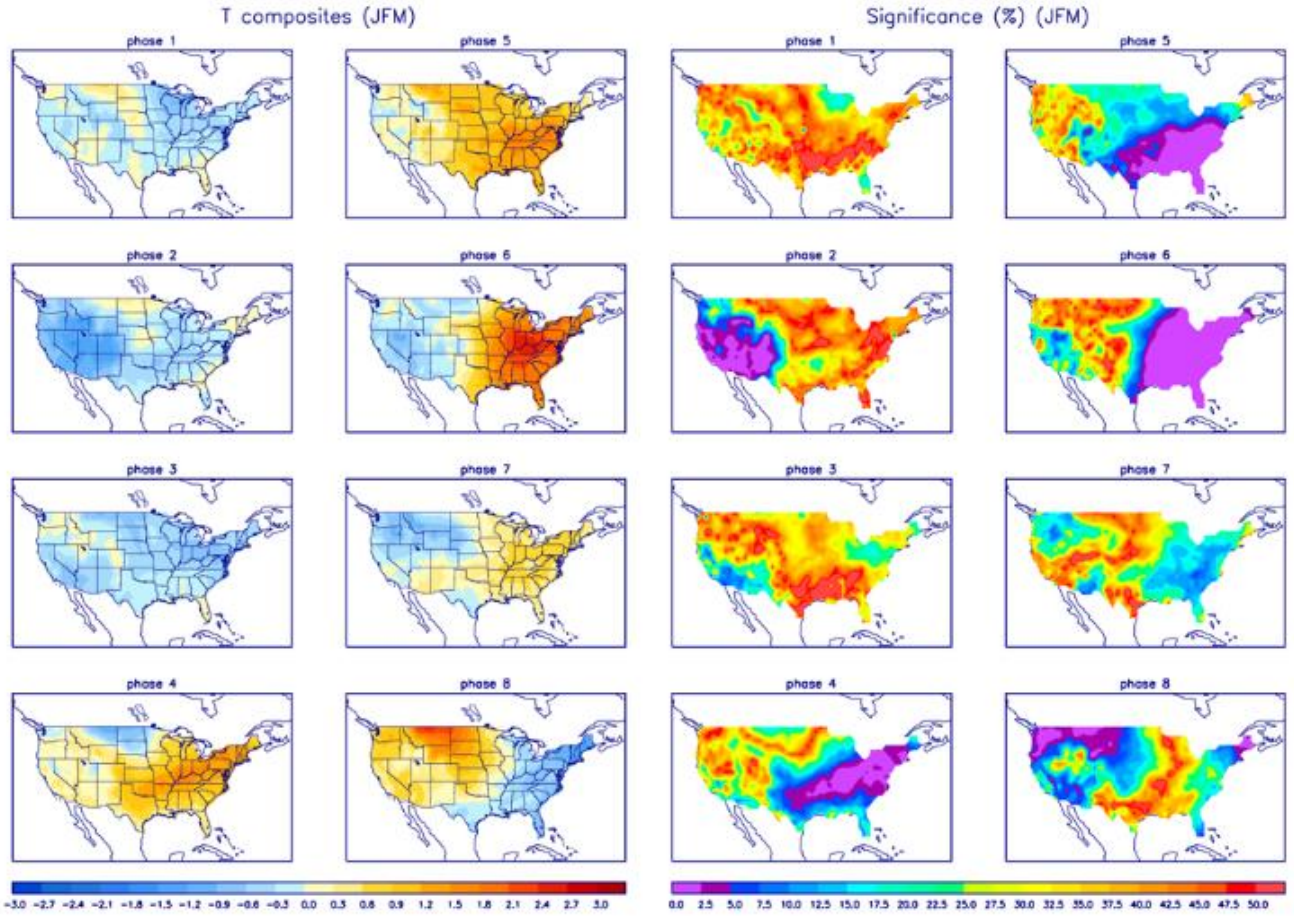
Precipitation Anomalies



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.

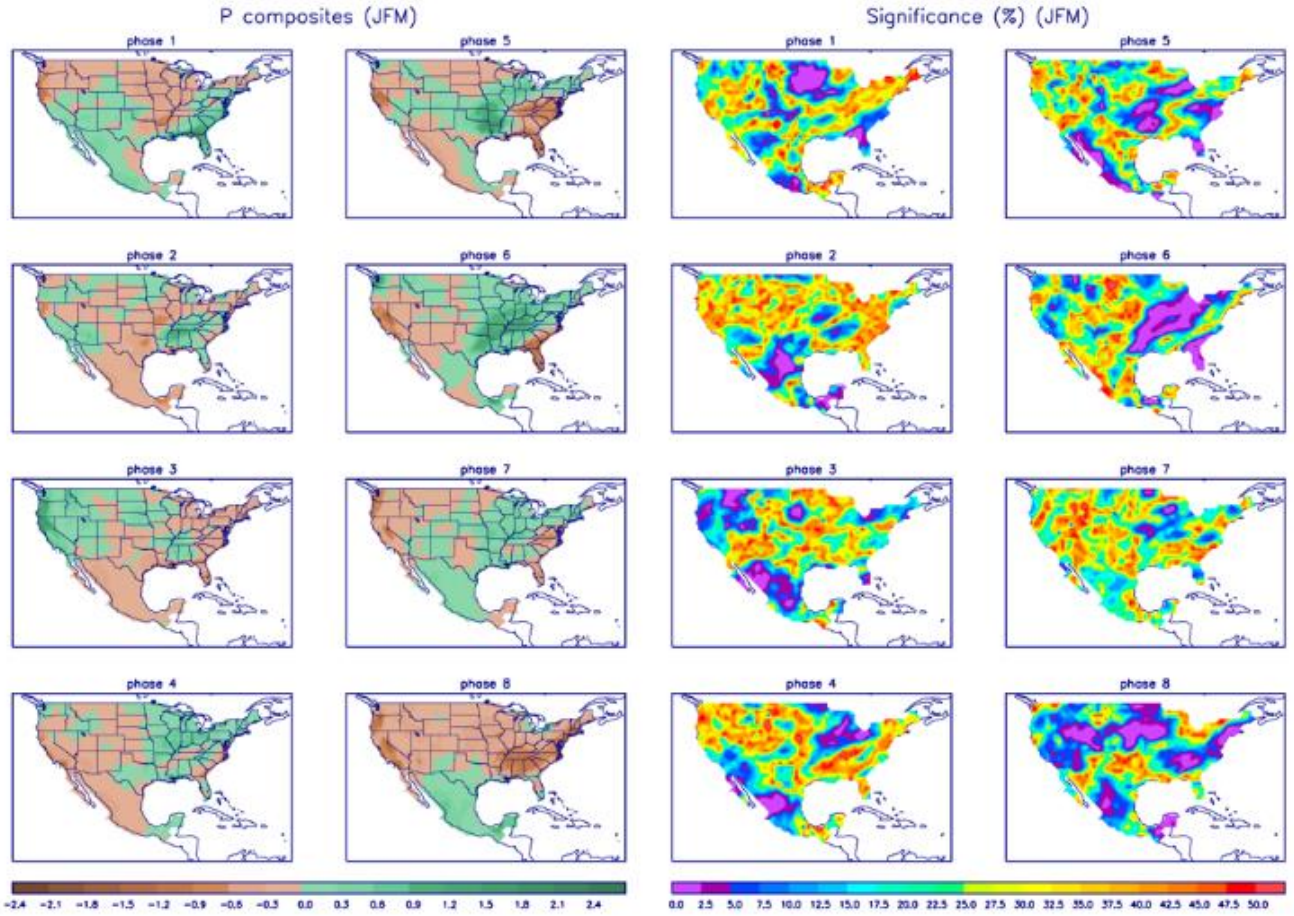


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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