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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
29 January 2024

Overview

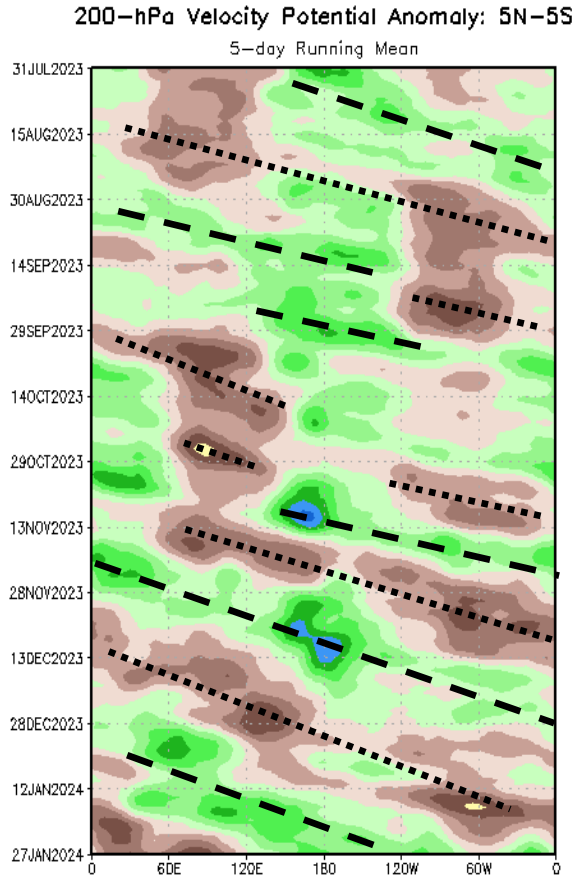
- A strong MJO event continues as the RMM-index has moved into phase 7 (Western Pacific).
- Dynamical model solutions diverge more this week, but still generally portray a weakening signal in the near future as the MJO is favored to encounter competing interference with other modes of tropical variability.
- Enhanced convection associated with MJO activity and a westerly wind burst (WWB) is expected to provide favorable conditions for Tropical Cyclone (TC) development over the South Pacific Ocean throughout the coming forecast period.
- Strong subtropical westerly flow is forecast both near the surface and aloft, potentially leading to an atmospheric river event to affect the West Coast of the U.S. during the week-2 period.

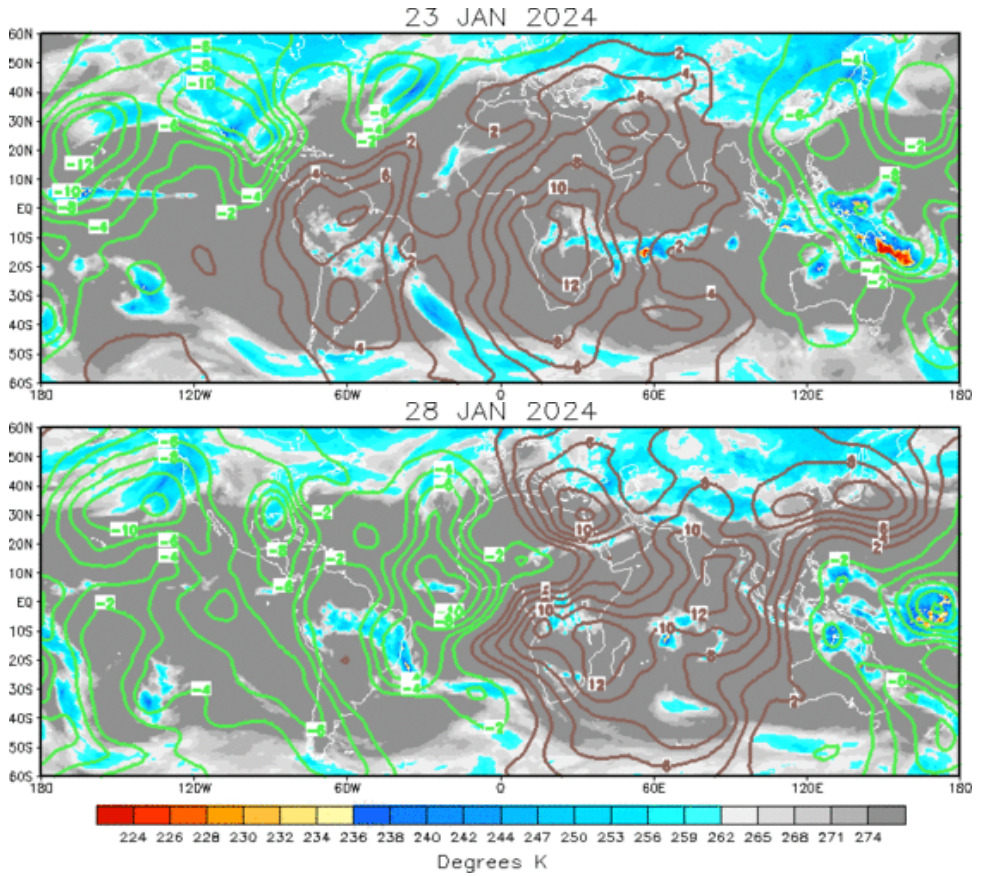
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)



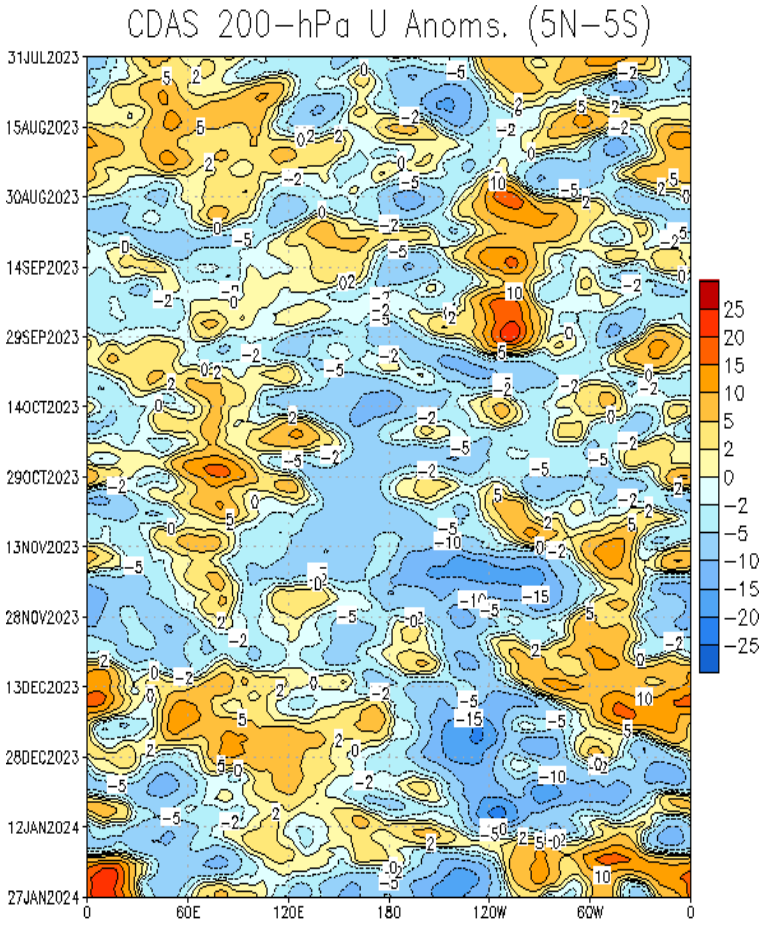


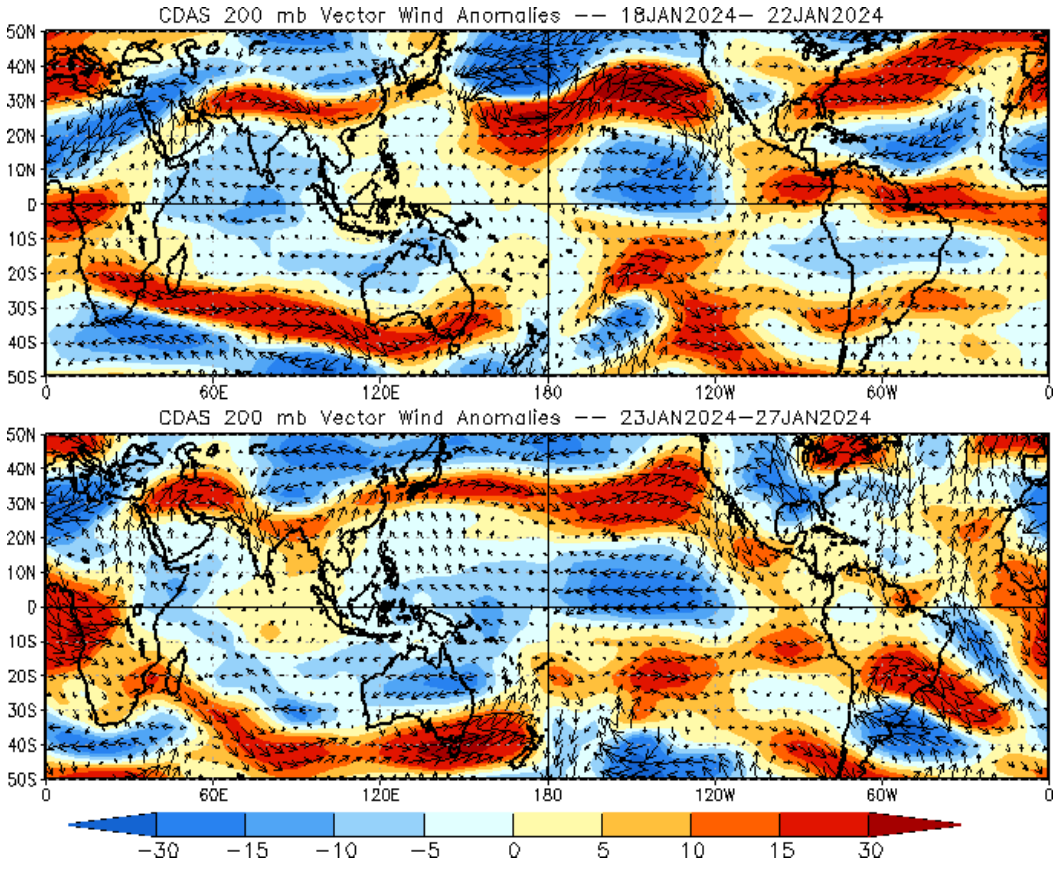
- Robust MJO activity is evident in the Hovmoller plot since mid-November. There was a brief period of incoherence right around the New Year, but wave-1 symmetry has become well-established since.

- Recent observations show a very well-defined wave-1 pattern in late January, with the enhanced convective envelope covering most of the tropical Pacific and expanding into the Americas.

200-hPa Wind Anomalies

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

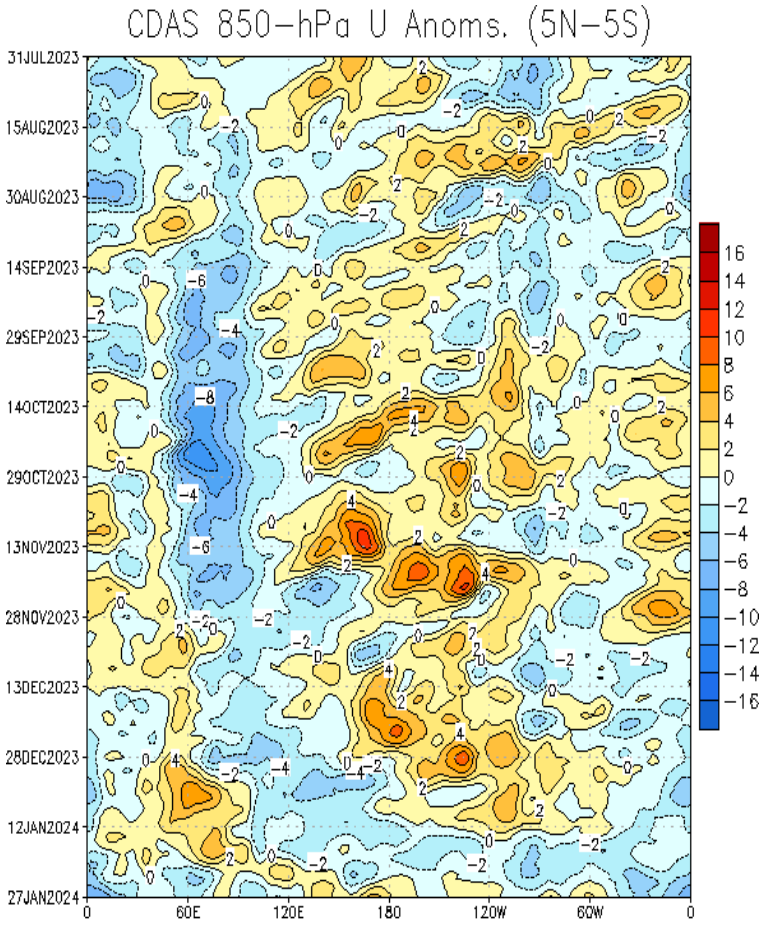


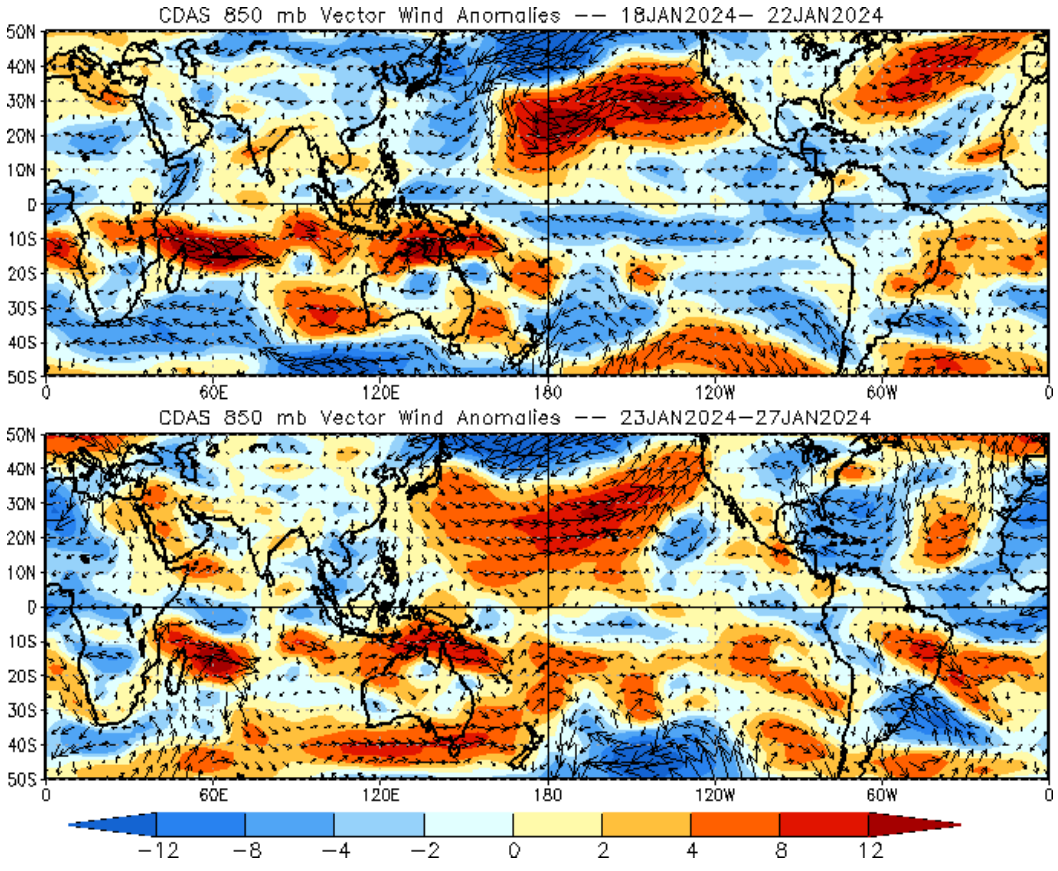


- As the westerly phase of the MJO moved across the Prime Meridian, very strong anomalous westerlies developed over the Gulf of Guinea, similar to mid-December of 2023.
- Enhanced easterlies have increased over the Western and Central Pacific as MJO-related interference with the El Nino atmospheric response has eased.
- An enhanced jet continues over the subtropical Pacific as atmospheric river conditions settle into the West Coast of the U.S.

850-hPa Wind Anomalies

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

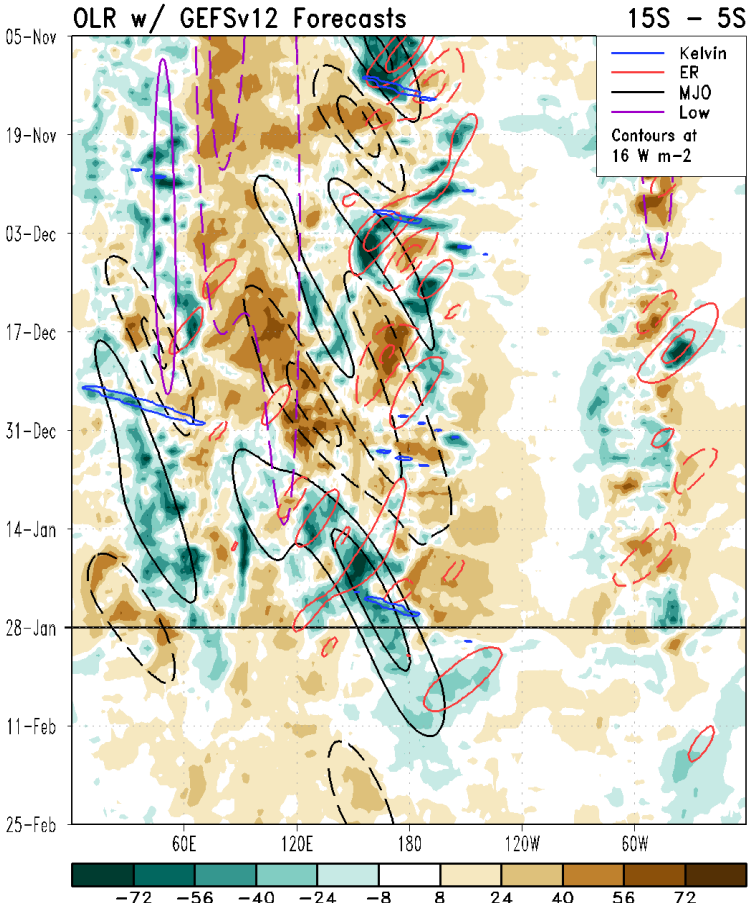


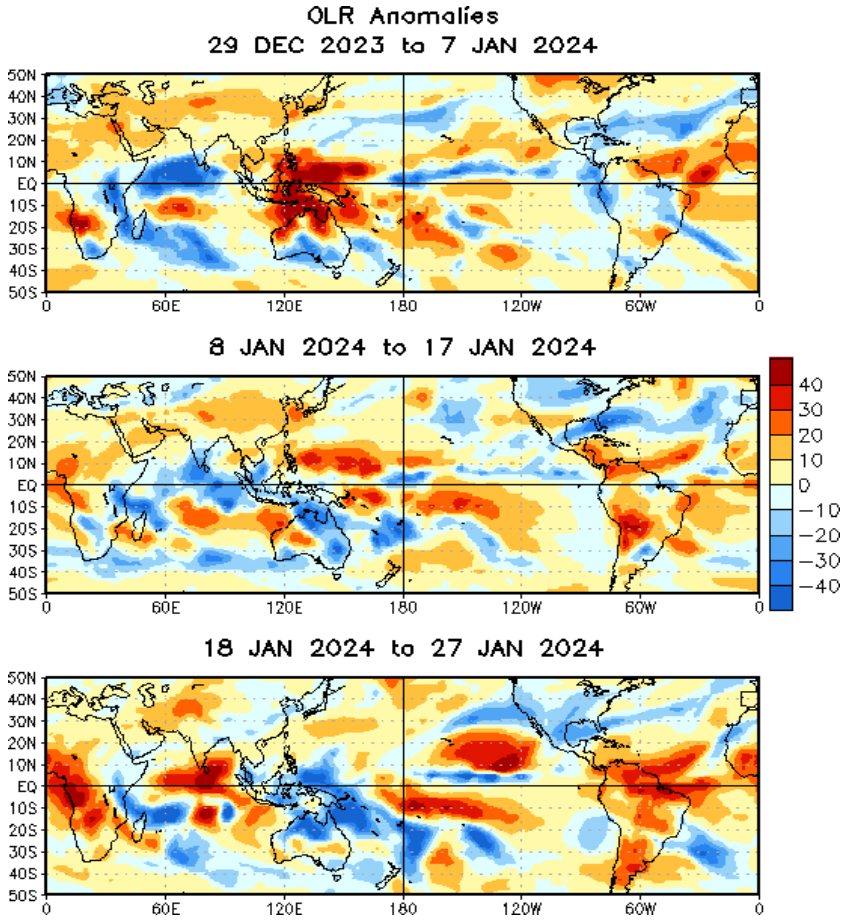


- The eastward propagation of anomalous westerlies stalled over the Indian Ocean in early January, but have since moved steadily across the Indian Ocean and into the Maritime Continent.
- Model solutions are in good agreement on a strong band of anomalous westerlies to occur over the Western Pacific in the coming weeks.
- Persistent westerlies continue across much of the subtropical Pacific, funneling moisture into the West Coast.

Outgoing Longwave Radiation (OLR) Anomalies

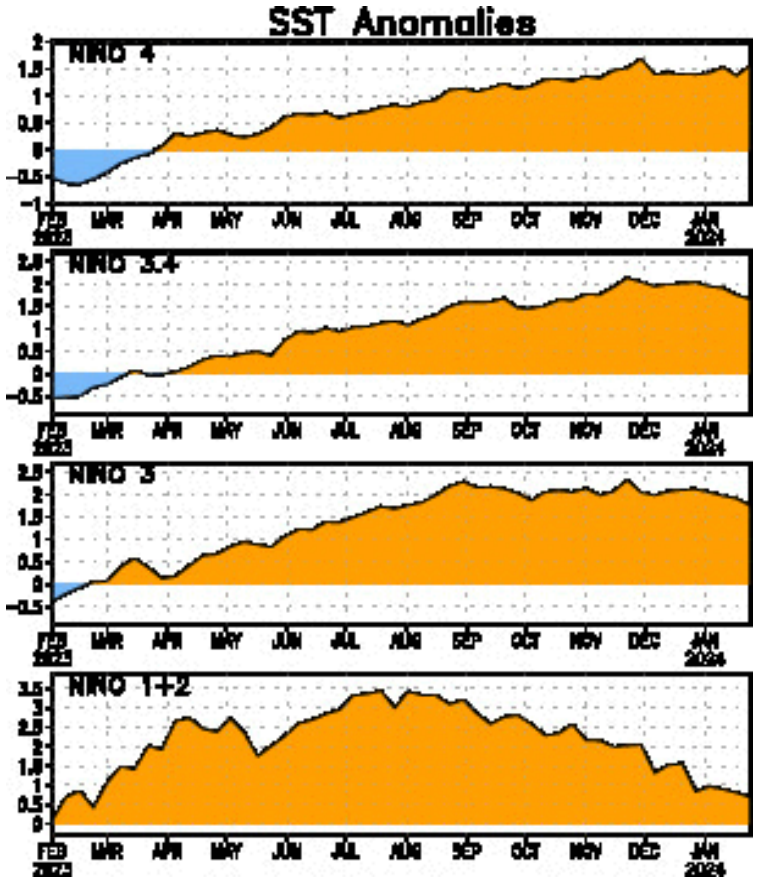
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

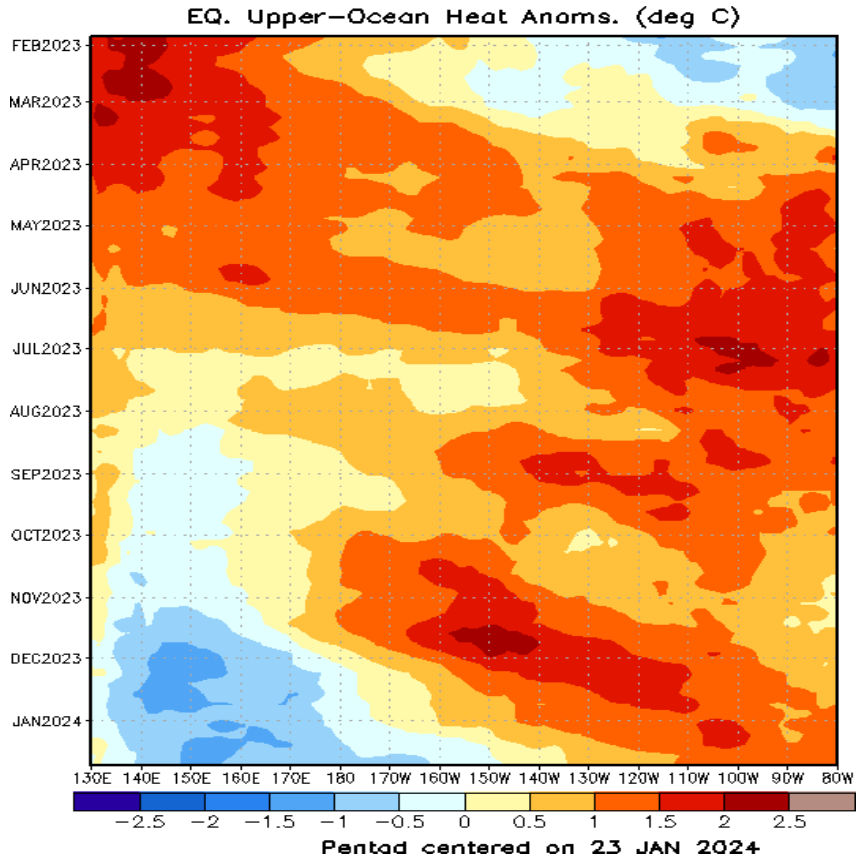




- Continued MJO activity resulted in the reversal of the convective pattern over the eastern Indian Ocean and Maritime Continent, with a much weaker low frequency convective response east of the Date Line.
- OLR forecasts show an envelope of enhanced convection propagating eastward into the Western Hemisphere heading into February, then reforming near the Prime Meridian later in February.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

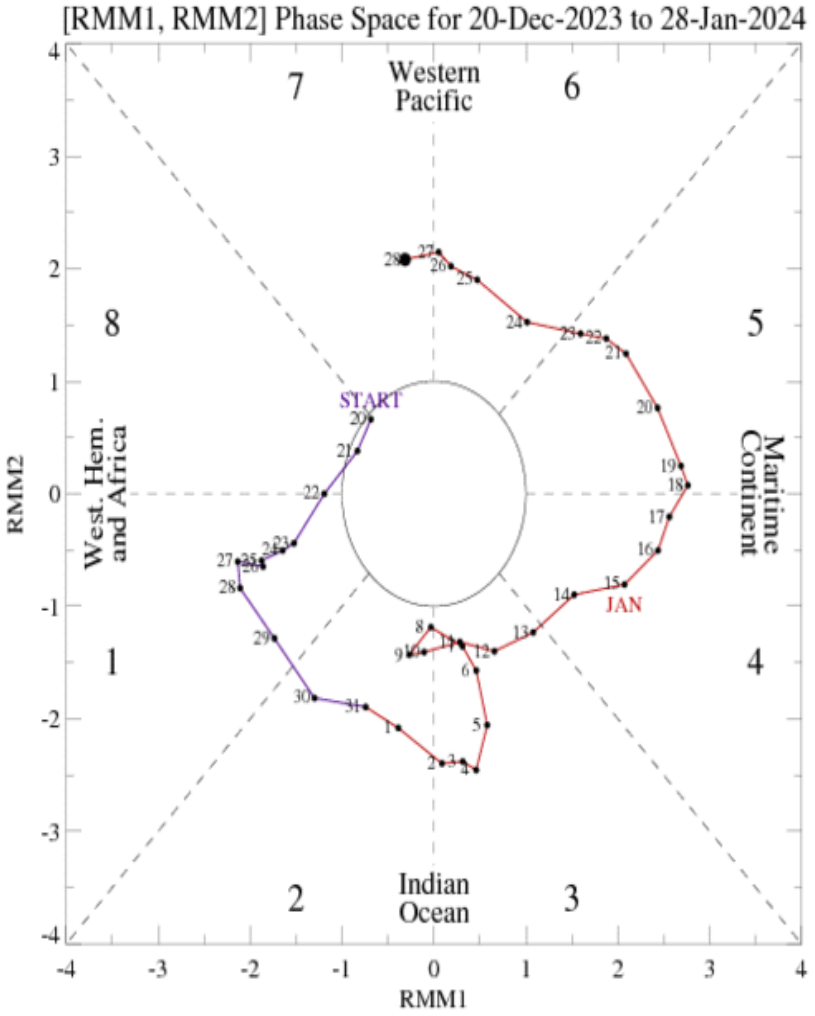




- Nino 4 and 3.4 are beginning to trend downward while Nino 1+2 which continues to weaken and trend towards neutral. Only Nino 4 remains steady near its peak values.
- Tied to the upwelling phase of an oceanic Kelvin wave, negative upper-oceanic heat anomalies expanded eastward beyond the Date Line, with strongly positive subsurface anomalies persisting over the eastern Pacific.

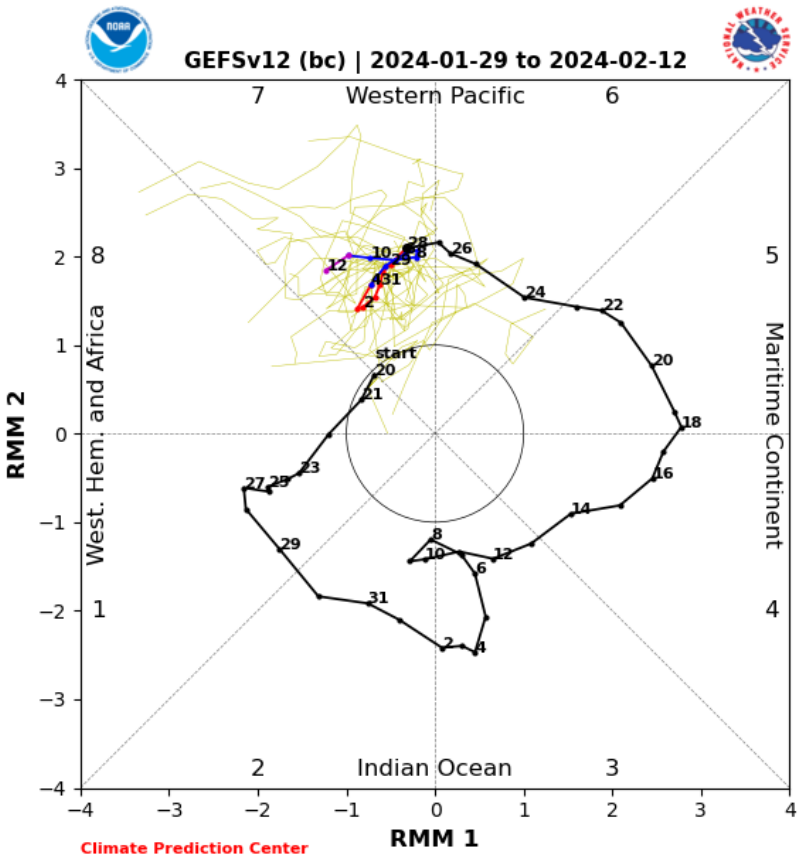
MJO Index: Recent Evolution

- The RMM index has indicated robust MJO activity since late December, except a brief period in January. Currently the MJO is in phase 7 and has nearly completed a complete circuit around the globe over the past month and a half.

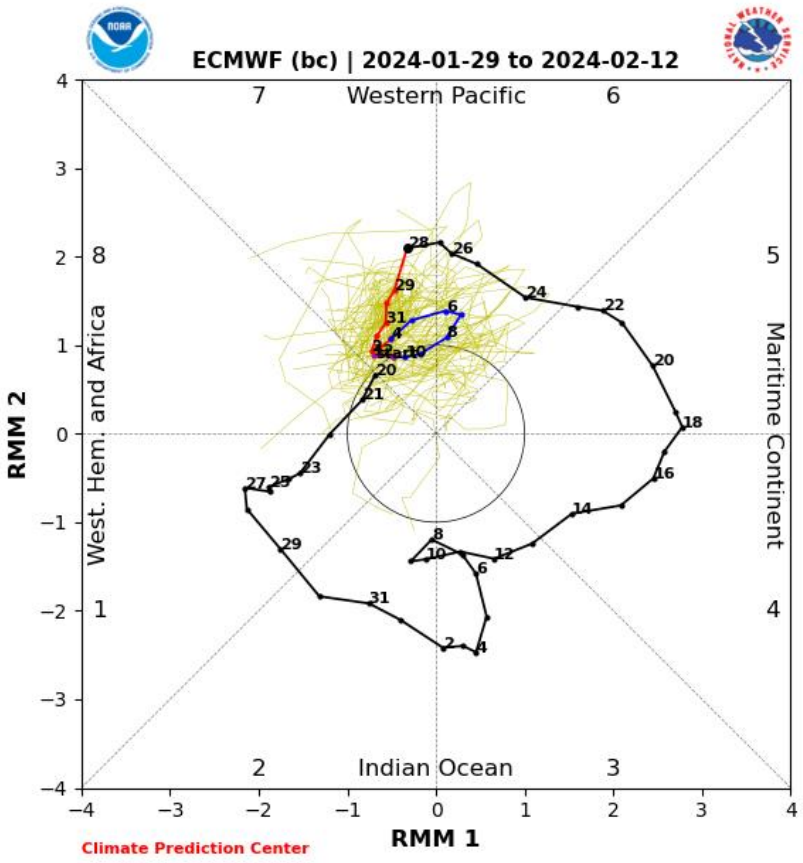


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

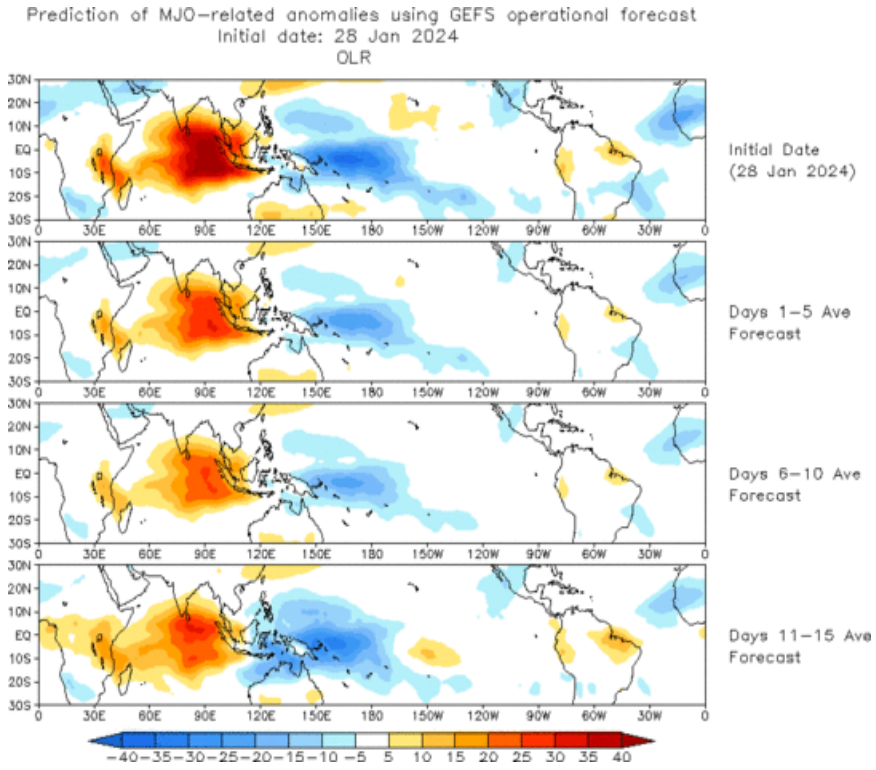


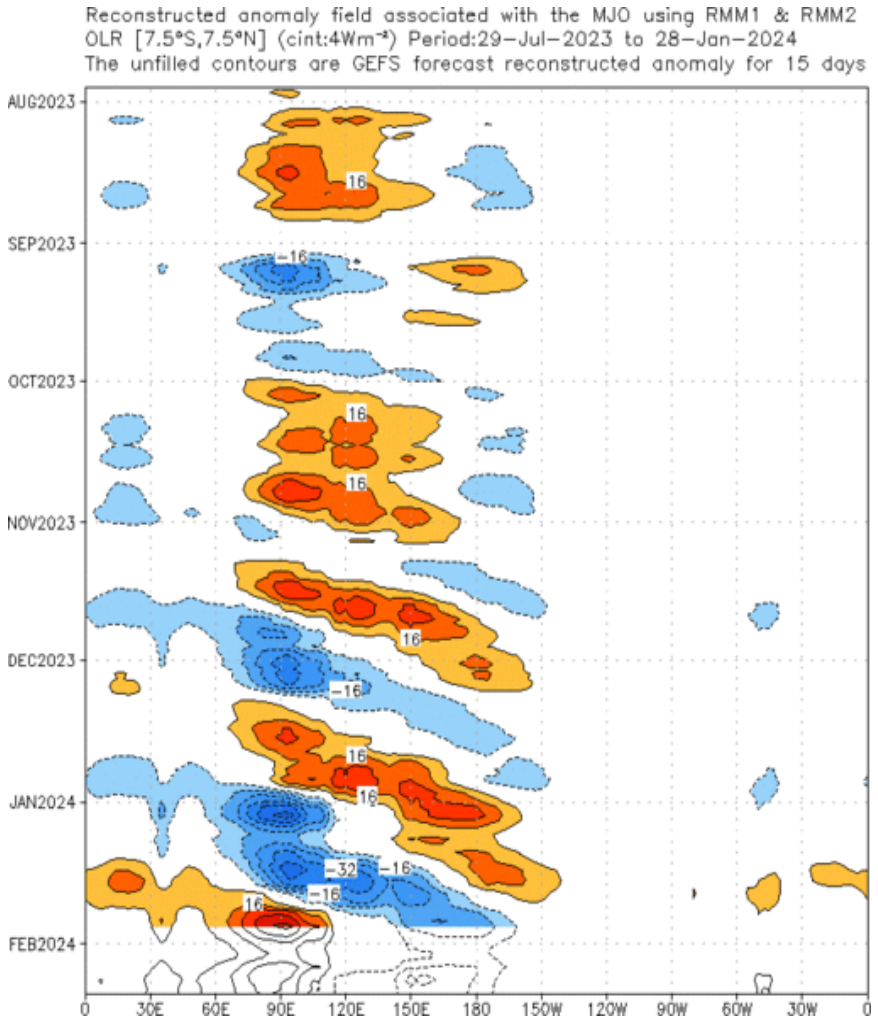
ECMWF Forecast

- Model solutions show less agreement than last week, but generally indicate a weakening of the RMM signal with a slower phase speed during week-1. This tracks well with forecasts from last week, both in terms of the general picture portrayed and the increased model spread.
- This has a similar appearance to the “hiccup” in early January as the MJO encountered interference with the quasi-stationary El Nino footprint, and likely has a similar explanation as the dry phase of the MJO begins to interact with the ENSO-enhanced precipitation near the Date Line.

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.)

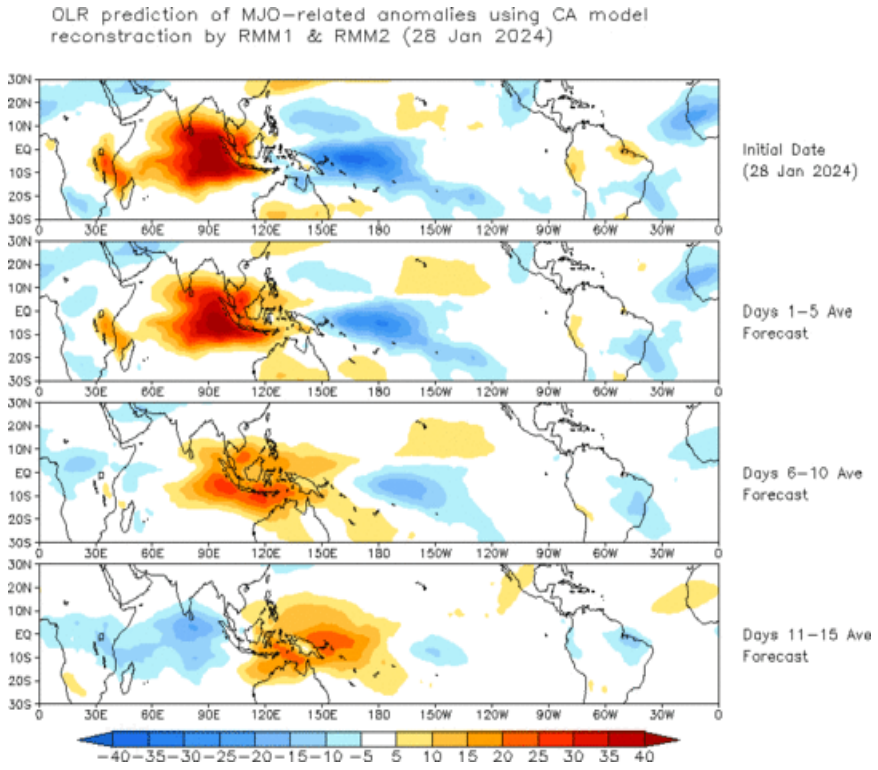


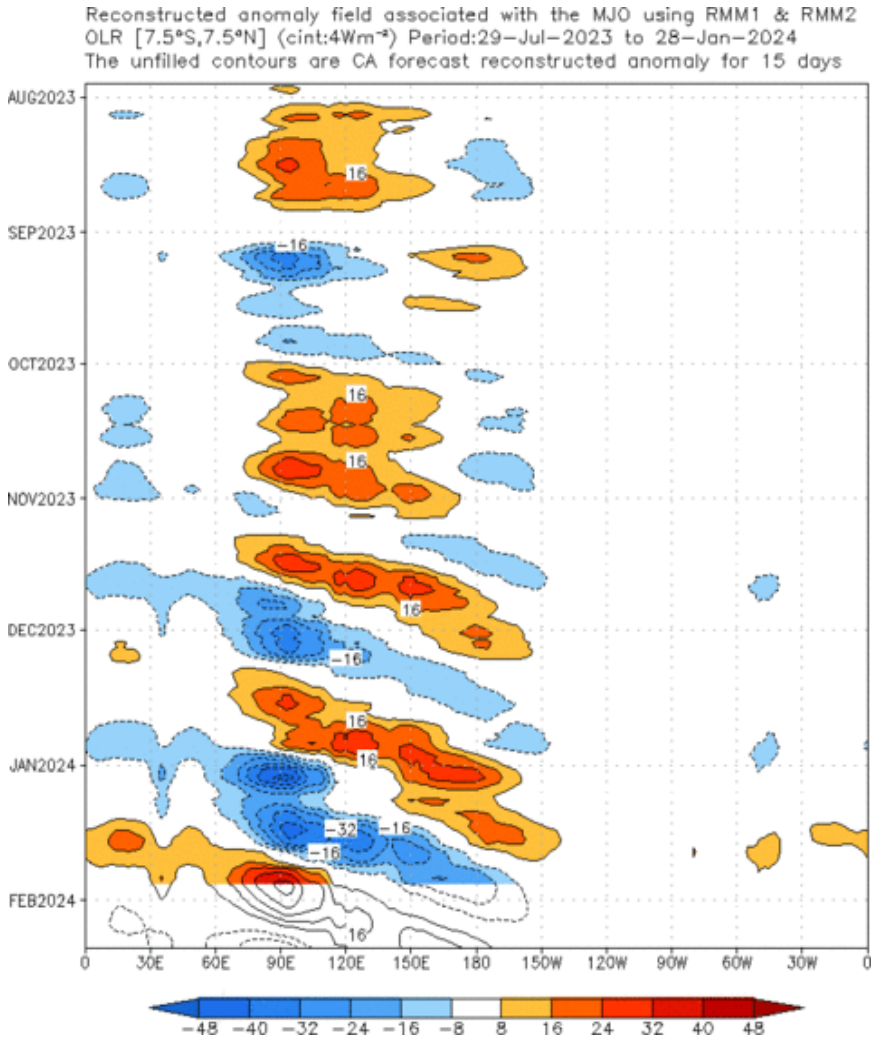


- The GEFS RMM-based OLR forecast depicts a fairly stationary pattern, with enhanced convection over the Maritime Continent and suppressed convection over the Western Indian Ocean. These features remain fairly robust into week-2.

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.)

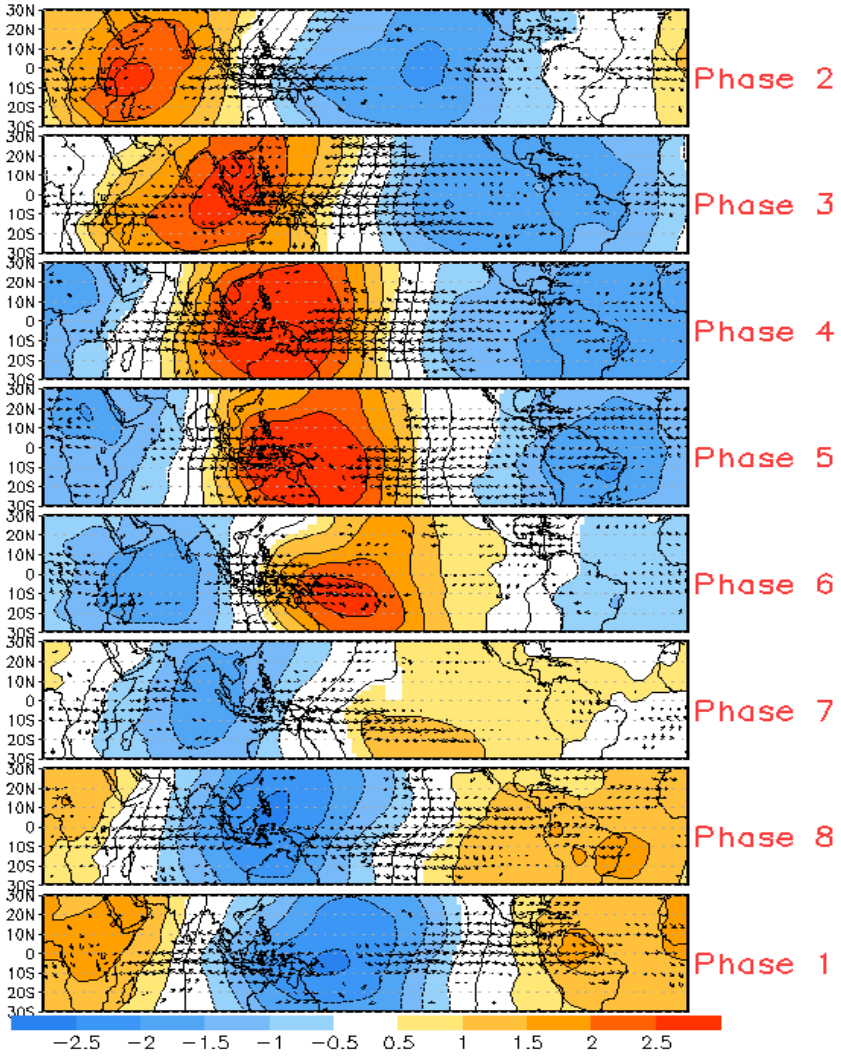




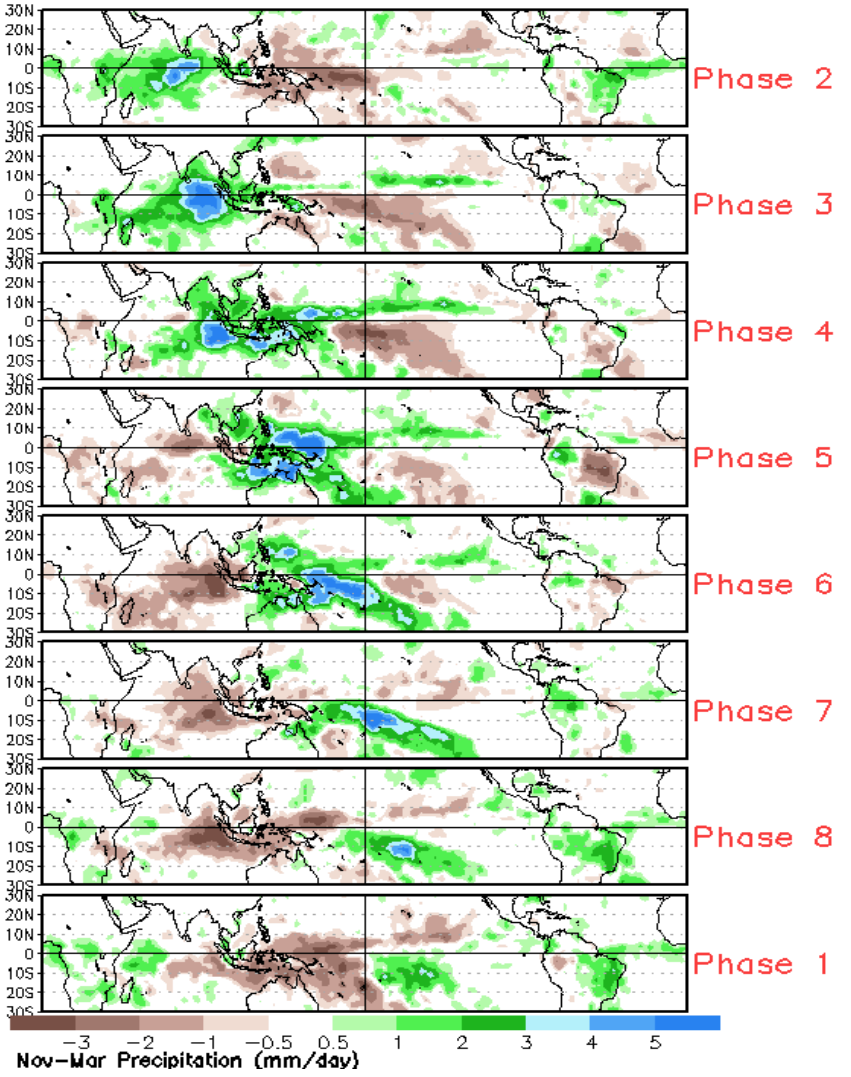
- The constructed analog (CA) RMM-based forecast is more progressive and favors continued strong MJO activity.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



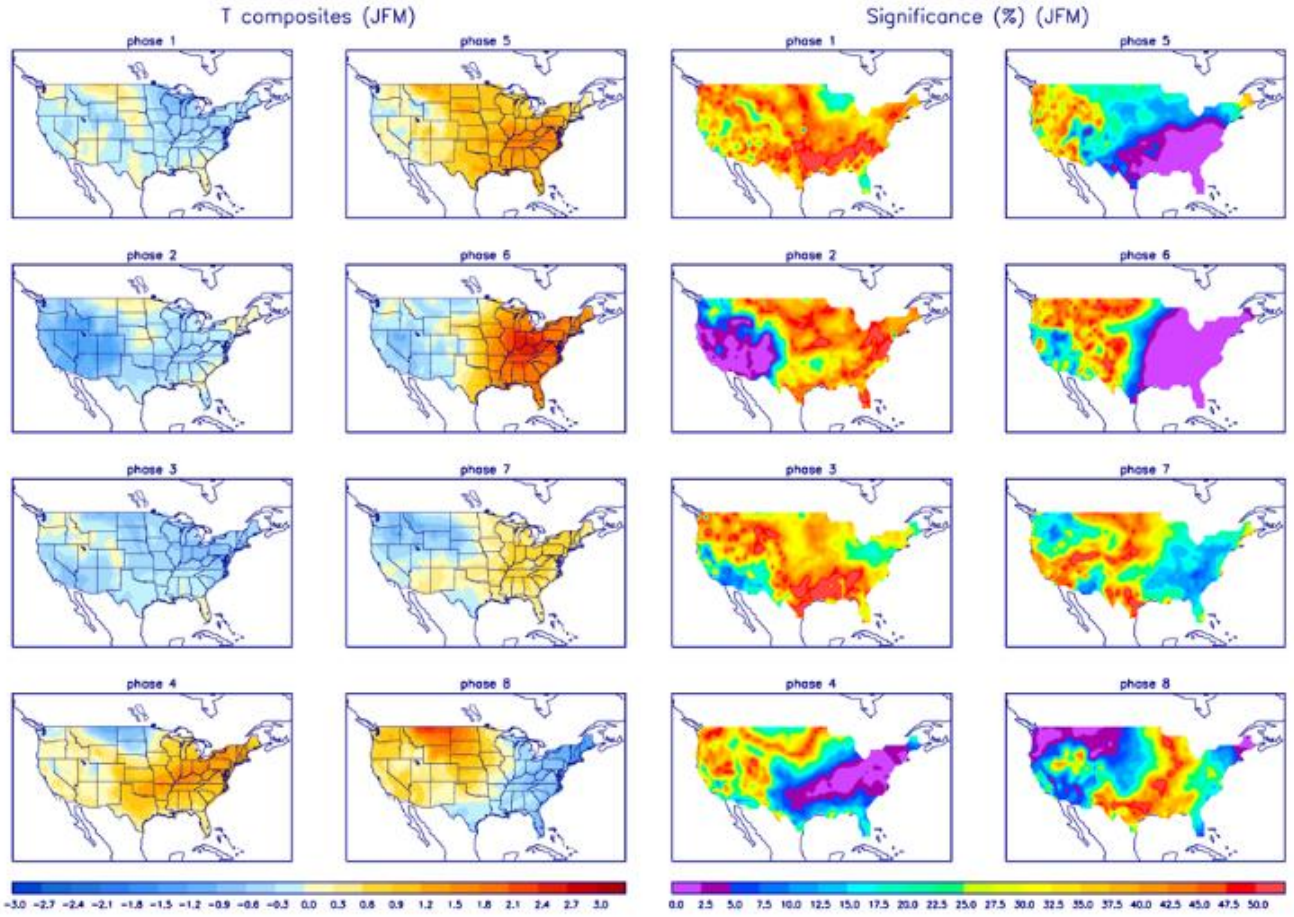
Precipitation Anomalies



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.

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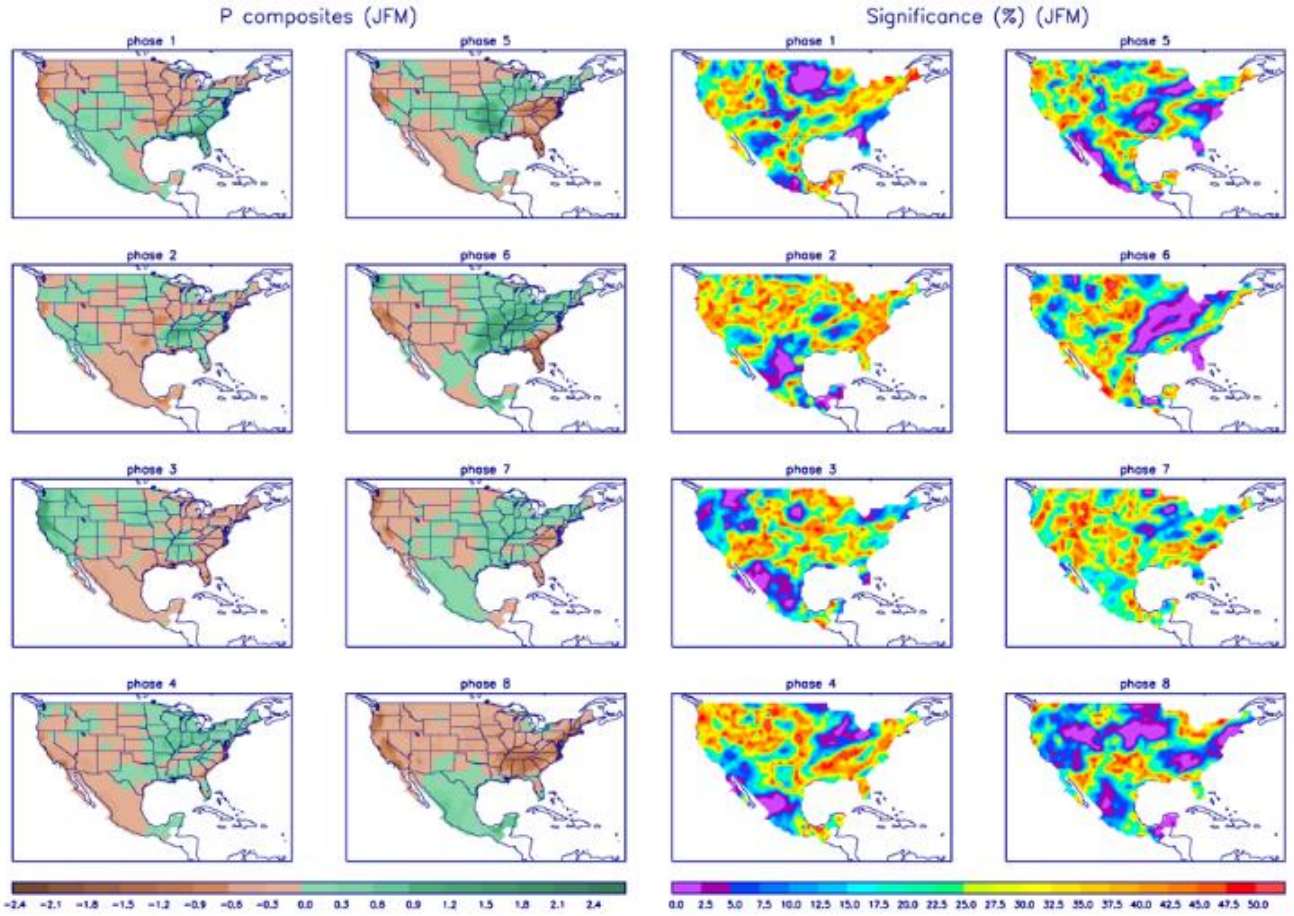

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