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

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

Overview

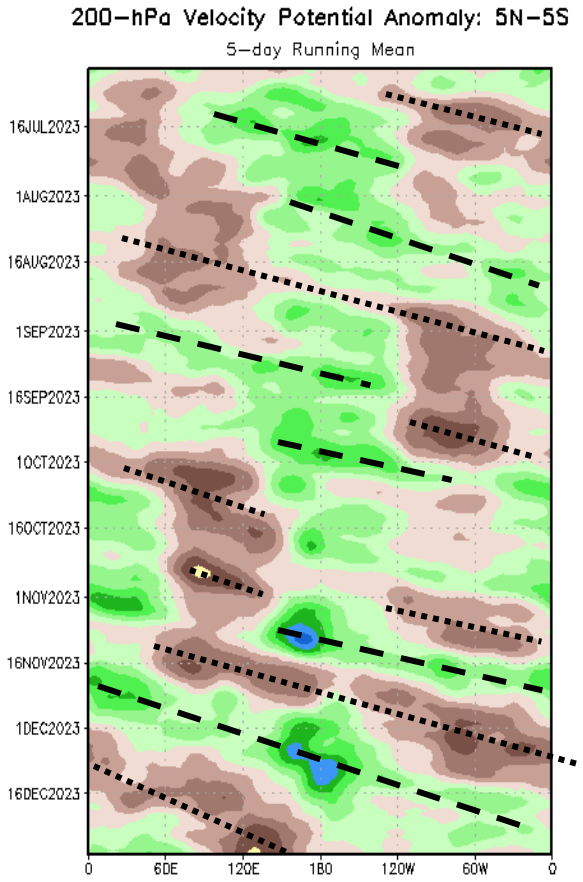
- The MJO remains active, with the enhanced phase now crossing the Indian Ocean.
- The intraseasonal signal completed a circumnavigation of the world in approximately 40 days, which is consistent with canonical MJO activity.
- Dynamical and statistical model guidance continue to reflect continued MJO activity; however, the GEFS and ECMWF ensembles now depict a much slower evolution across the Indian Ocean over the next two weeks.
- A weakening +IOD response may be playing a role in the forecasts for slower evolution, as well as destructive interference between the MJO and the ENSO signal, which favors suppressed convection over the Maritime Continent.
- Longer range dynamical model forecasts show a resumption of steady eastward propagation by Week-3, with the signal crossing the Maritime Continent and possibly returning to the Pacific by Week-4.
- An active MJO pattern is likely to induce pattern changes across the mid-latitudes; however, these impacts will be strongly influenced by the ongoing ENSO response.

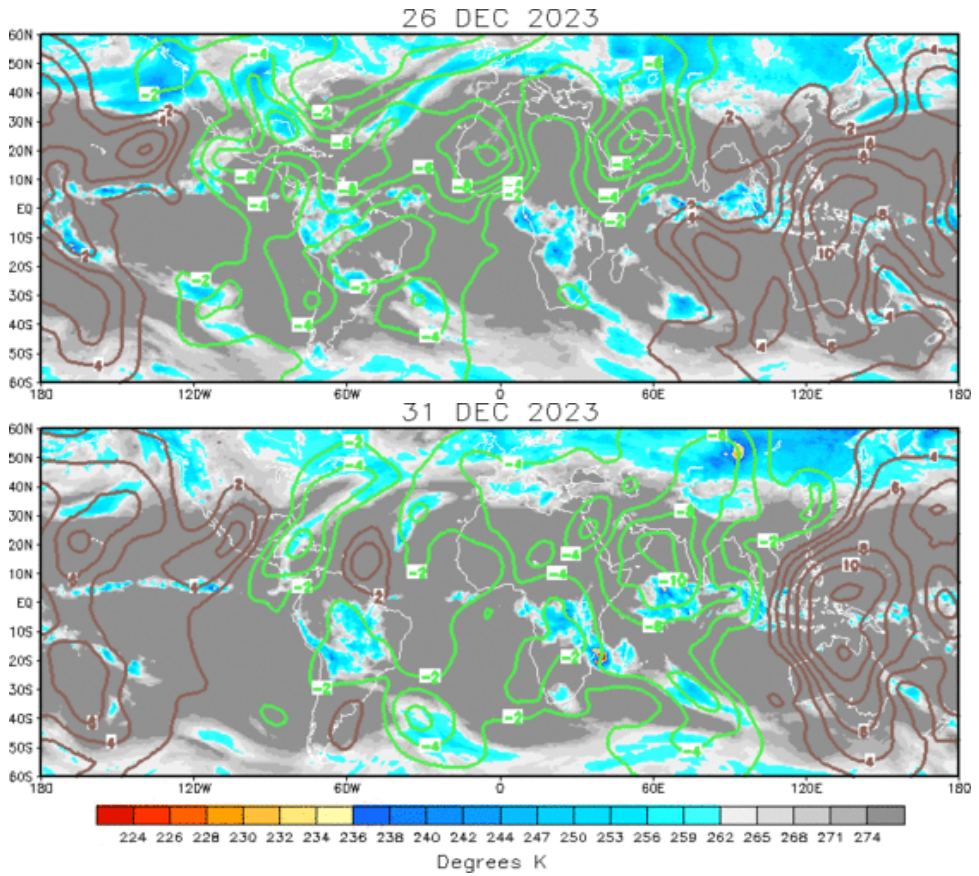
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

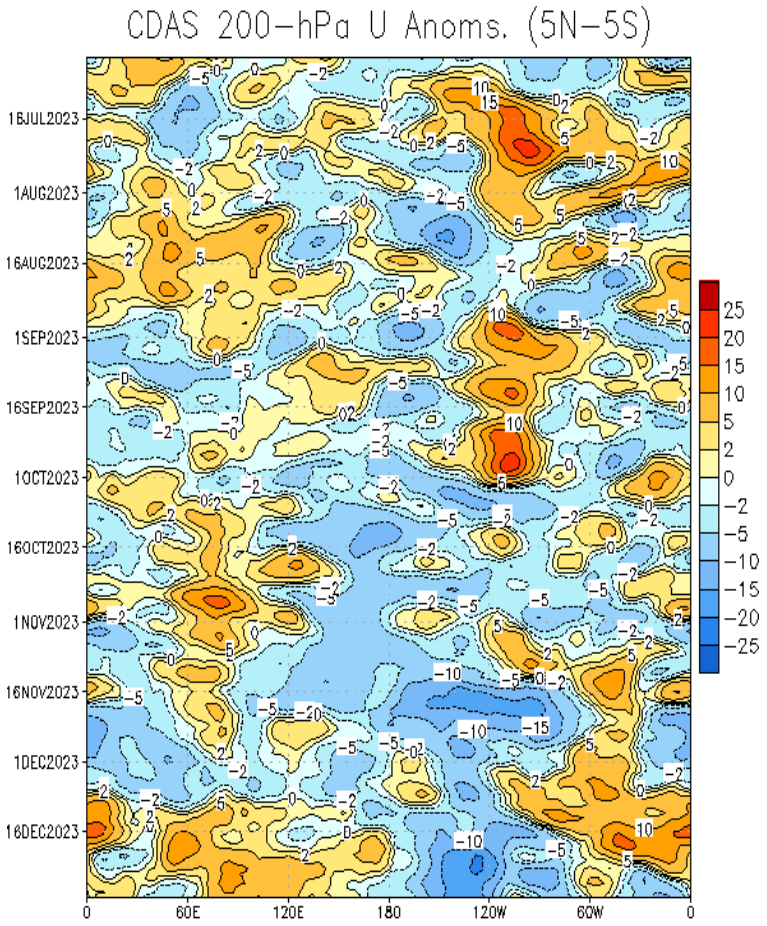


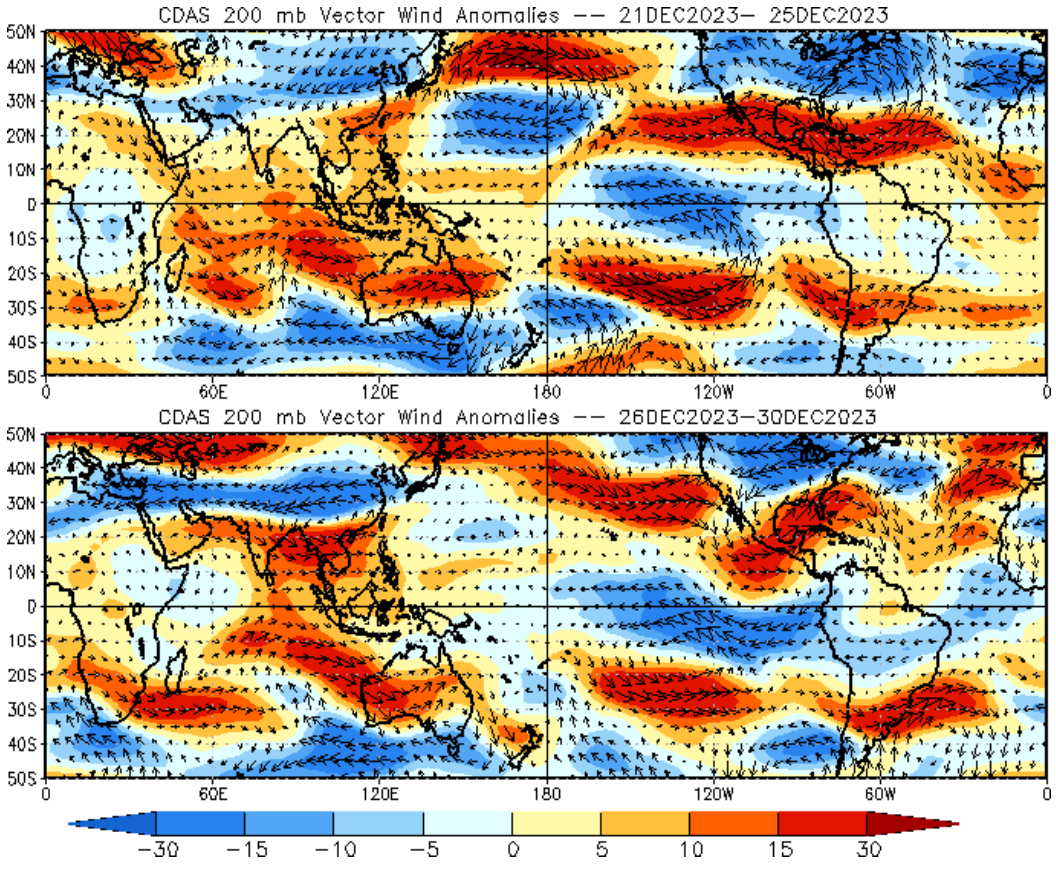


- An active MJO pattern continues, with the enhanced convective phase crossing the Western Hemisphere and beginning to enter the Indian Ocean basin.
- Destructive interference between the MJO and the low frequency +IOD and El Niño base state is becoming increasingly apparent.

200-hPa Wind Anomalies

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

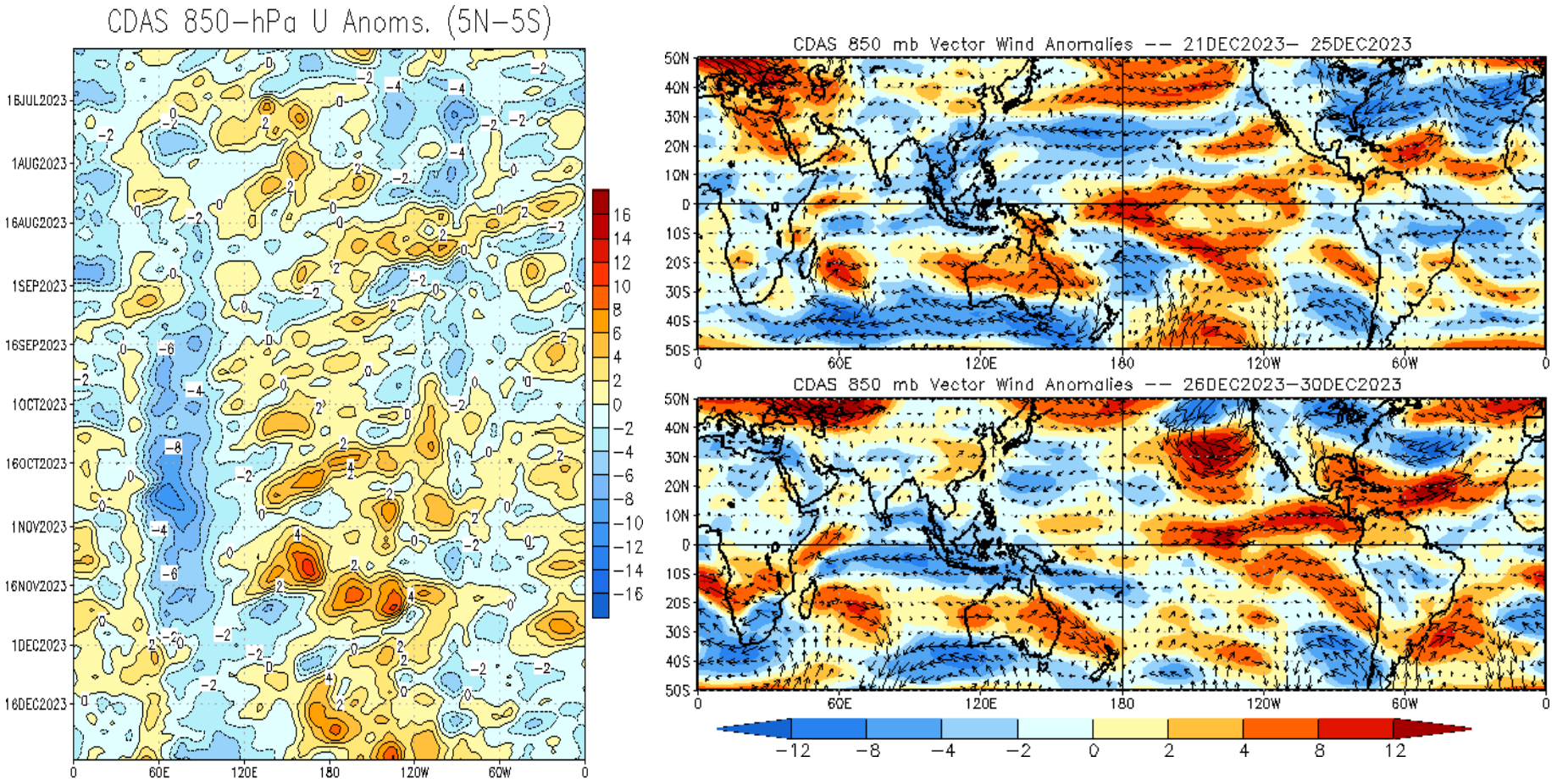




- Eastward propagation of upper-level westerly anomalies to the Maritime Continent is consistent with MJO activity.
- Persistent easterly anomalies over the eastern Pacific are driven by the atmospheric response to El Niño conditions, but are not inconsistent with the intraseasonal signal.
- Some interference with the MJO is apparent, with easterly anomalies persisting along the Date Line.

850-hPa Wind Anomalies

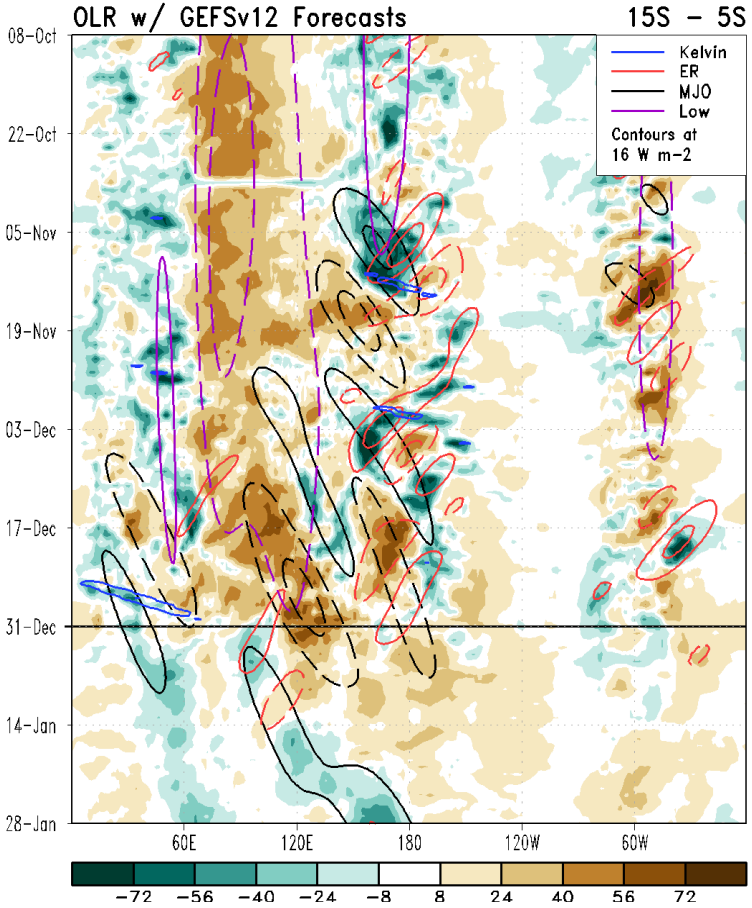
Shading denotes the zonal wind anomaly. Blue shades: Anomalous easterlies. Red shades: Anomalous westerlies.

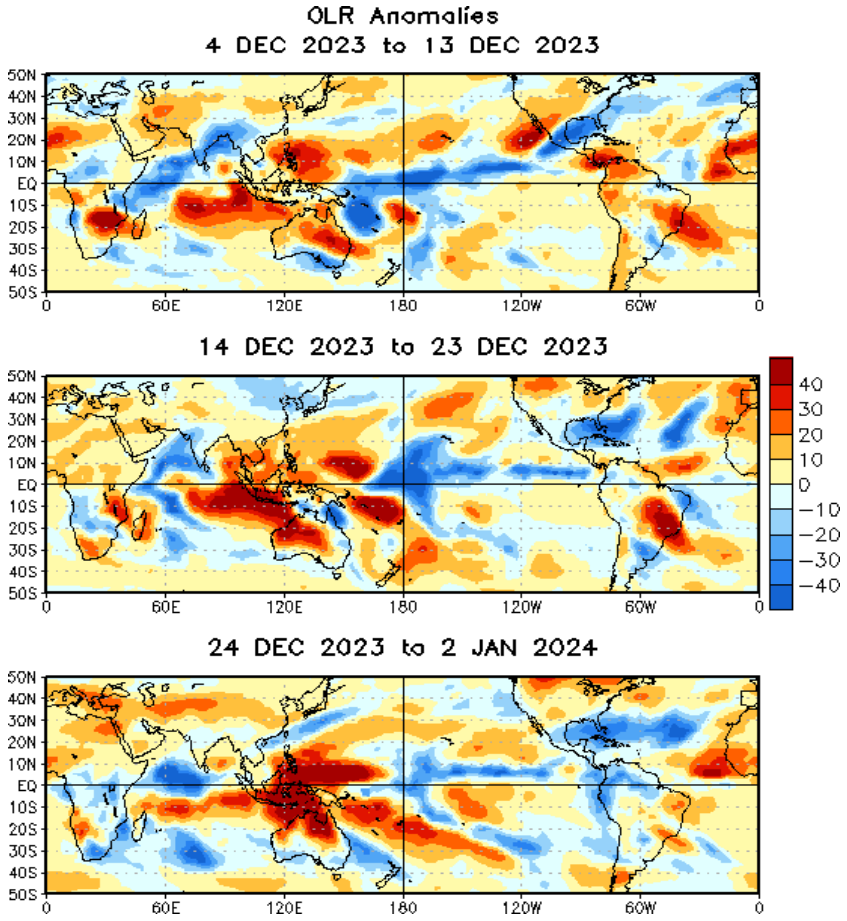


- Eastward propagation of low-level westerly anomalies across the Western Hemisphere is consistent with MJO activity.
- The response to the low frequency base state (+IOD and El Niño) remains strongly apparent in the low-level wind field, with westerlies persisting across much of the Pacific and easterlies strengthening across the Maritime Continent and the central and eastern Indian Ocean.

Outgoing Longwave Radiation (OLR) Anomalies

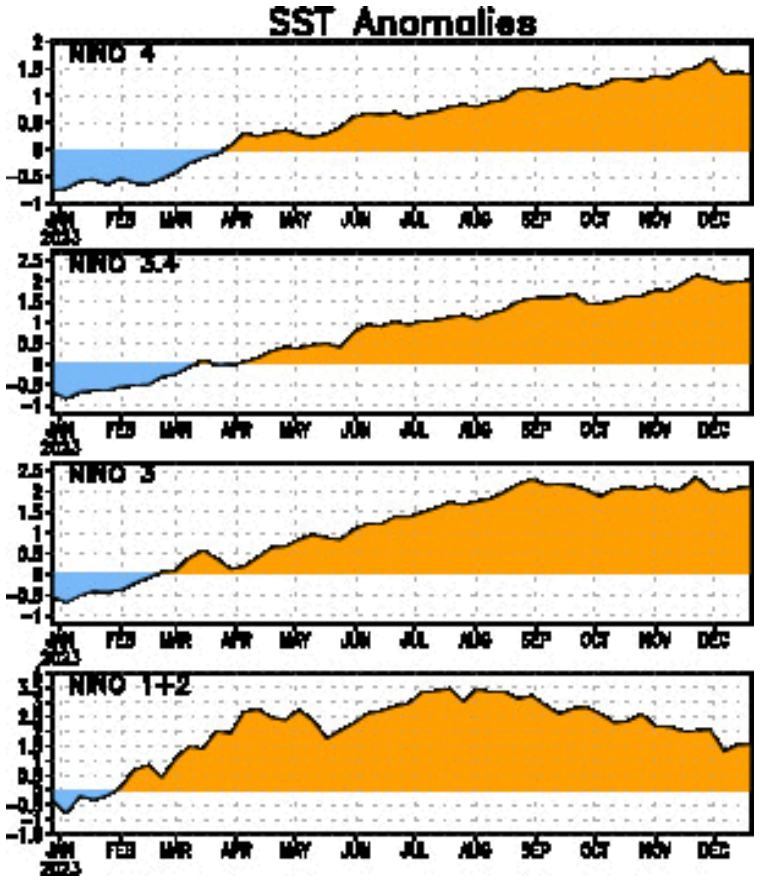
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

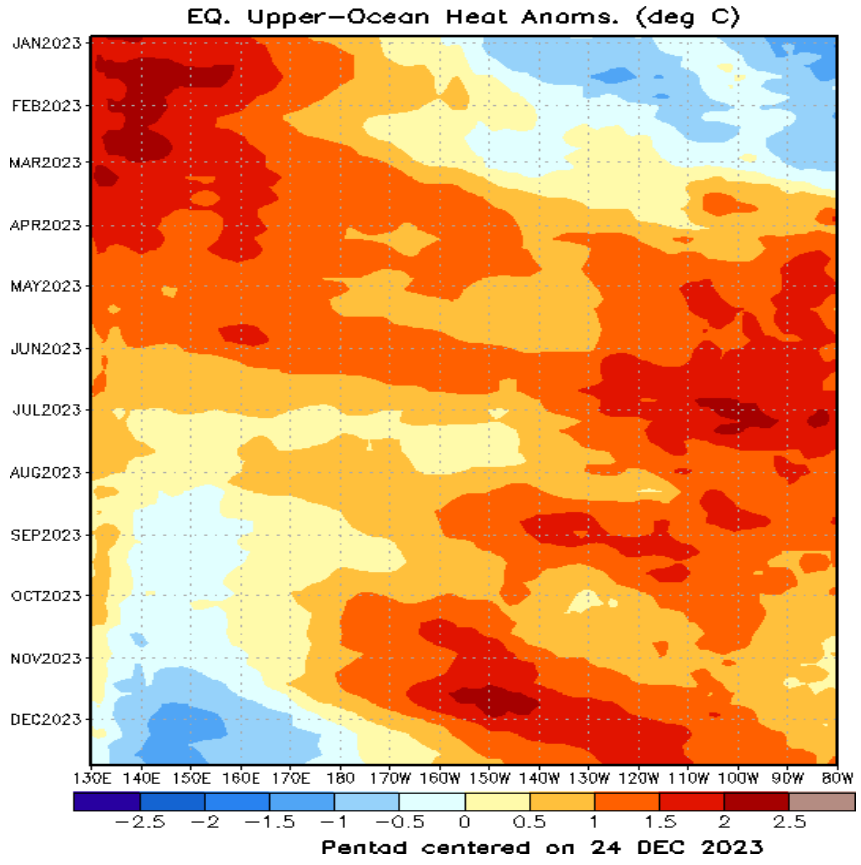




- El Niño and +IOD remain the primary drivers of global tropical convective anomalies, with enhanced (suppressed) convection across the central and eastern Pacific (Maritime Continent and eastern Indian Ocean).
- Constructive interference between the MJO and the El Niño base state promoted strong suppression across the Maritime Continent.
- More recently, convection has increased across the western Indian ocean as the MJO propagated eastward.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

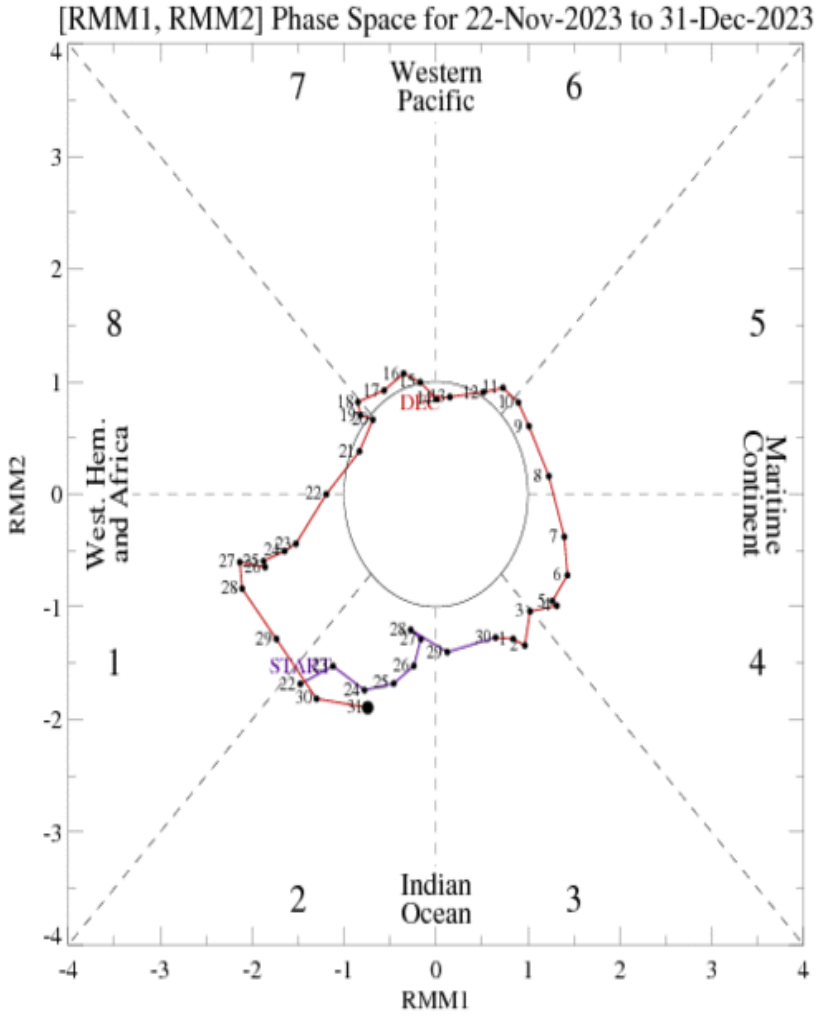




- Low-level westerly wind burst activity across the Pacific during November have resulted in rising SSTs across the Central Pacific, with the NINO 3.4 region now indicating SST anomalies greater than +2.0°C.
- Negative upper-oceanic heat anomalies expanded eastward to the Date Line associated with the upwelling phase of the oceanic Kelvin wave. SSTs across the West Pacific remain above-average, however.

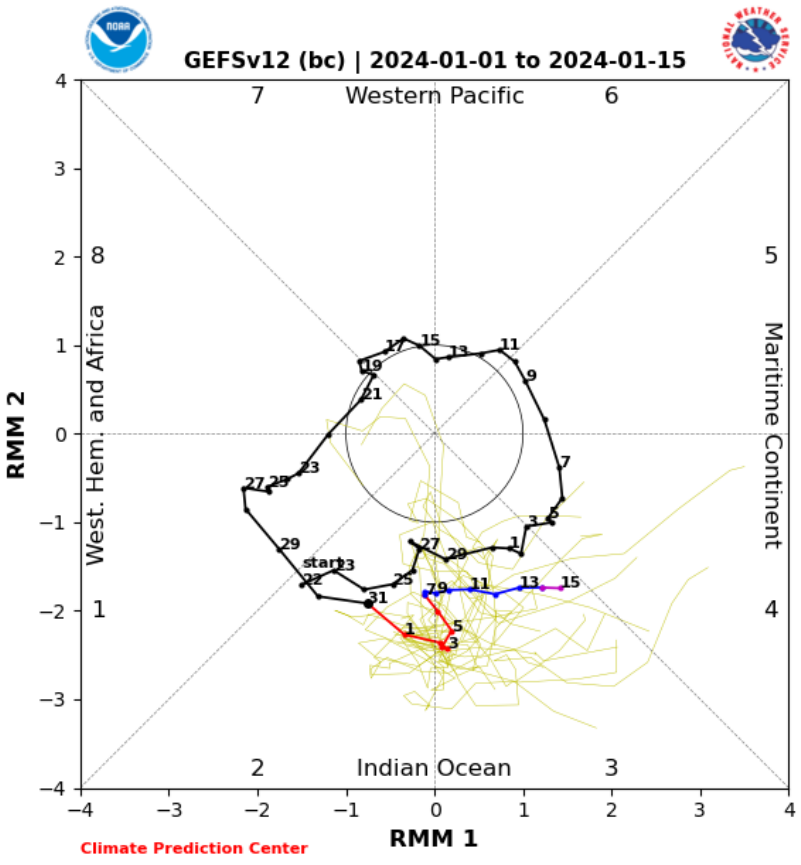
MJO Index: Recent Evolution

- The MJO index returned to the Indian Ocean, completing a circumnavigation of the globe in approximately 40 days.
- The phase speed of the RMM index has increased over the past several days.

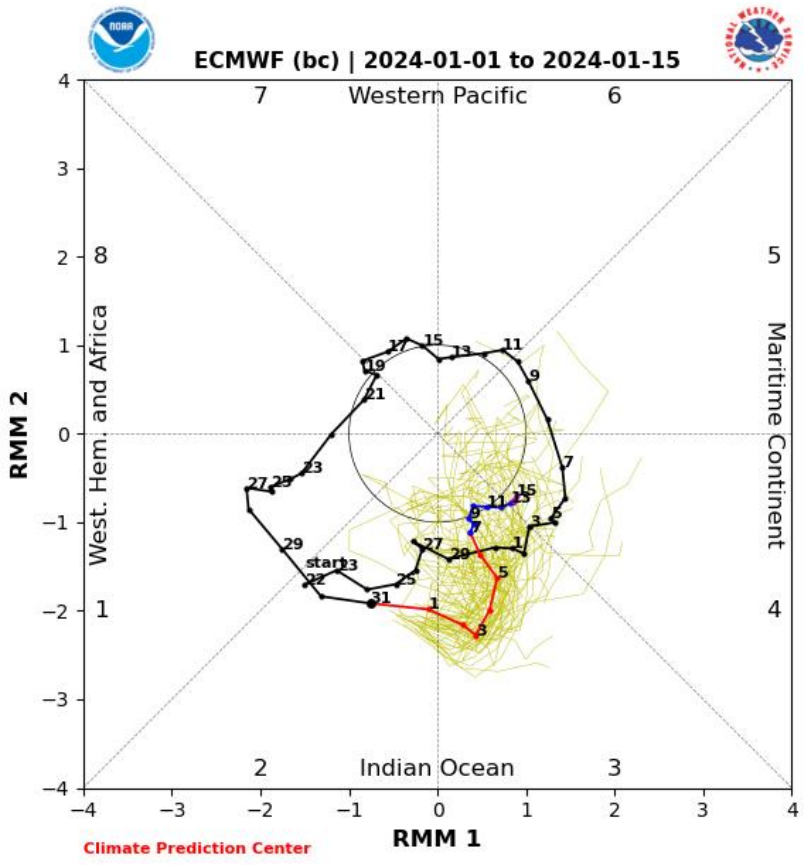


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

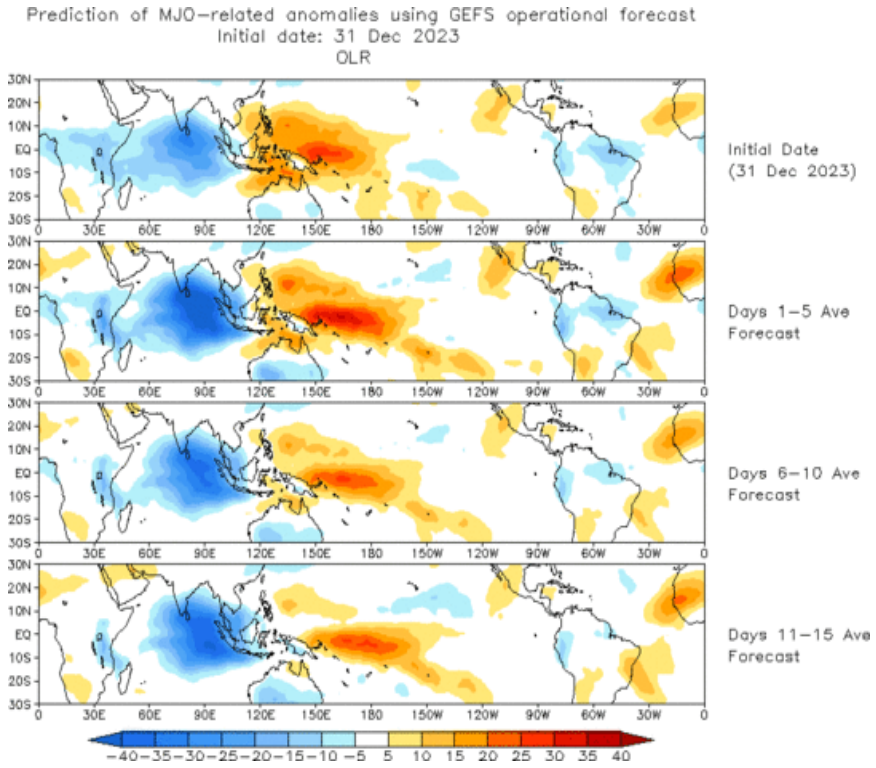


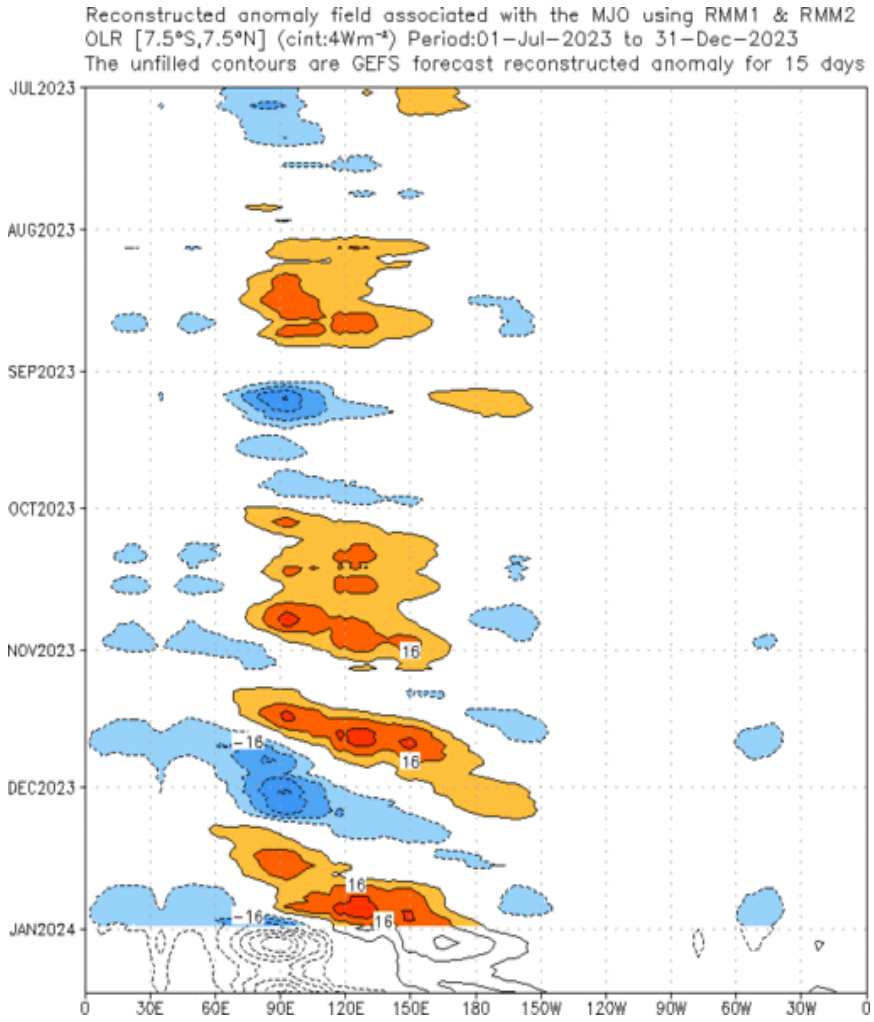
ECMWF Forecast

- Dynamical model forecasts from the GEFS and ECMWF continue to depict an active MJO signal crossing the Indian Ocean over the next week or two.
- The phase speed of the forecast MJO activity has slowed in comparison to model runs a week ago.
- Both models indicate a potential for interference from other modes (e.g., Rossby wave activity) that could modulate the MJO signal's amplitude during Week-1.

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.)

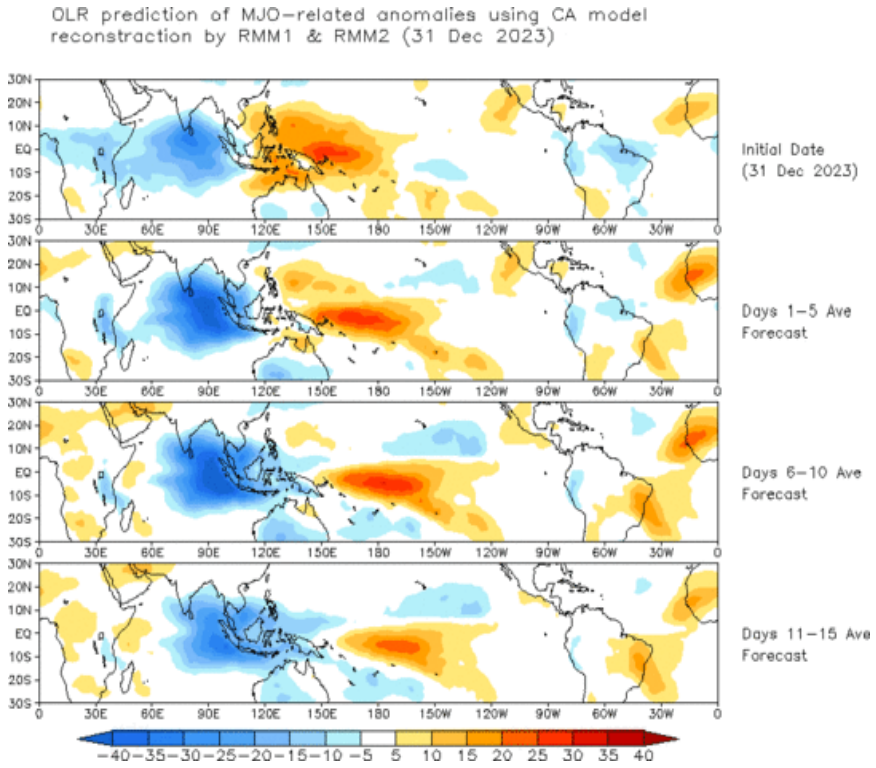


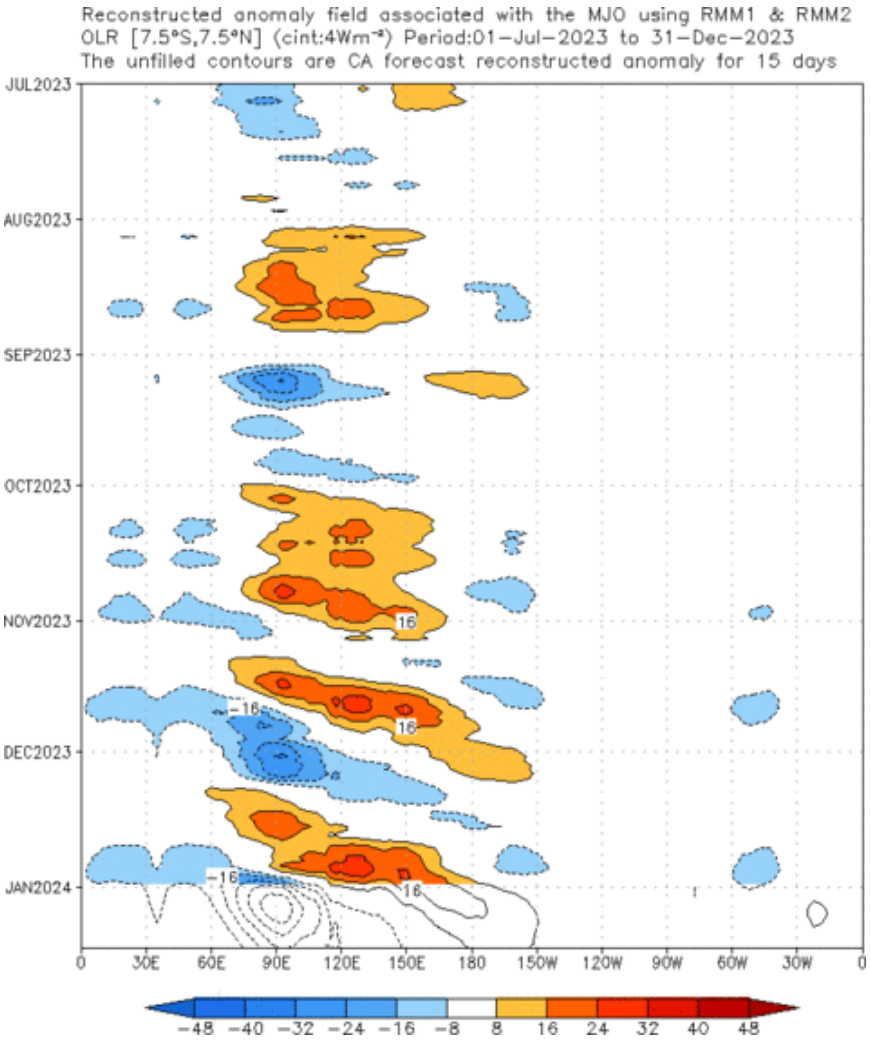


- The GEFS RMM-based OLR forecast depicts a robust wave-1 pattern that propagates slowly eastward across the Indian Ocean over the two-week period.

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.)

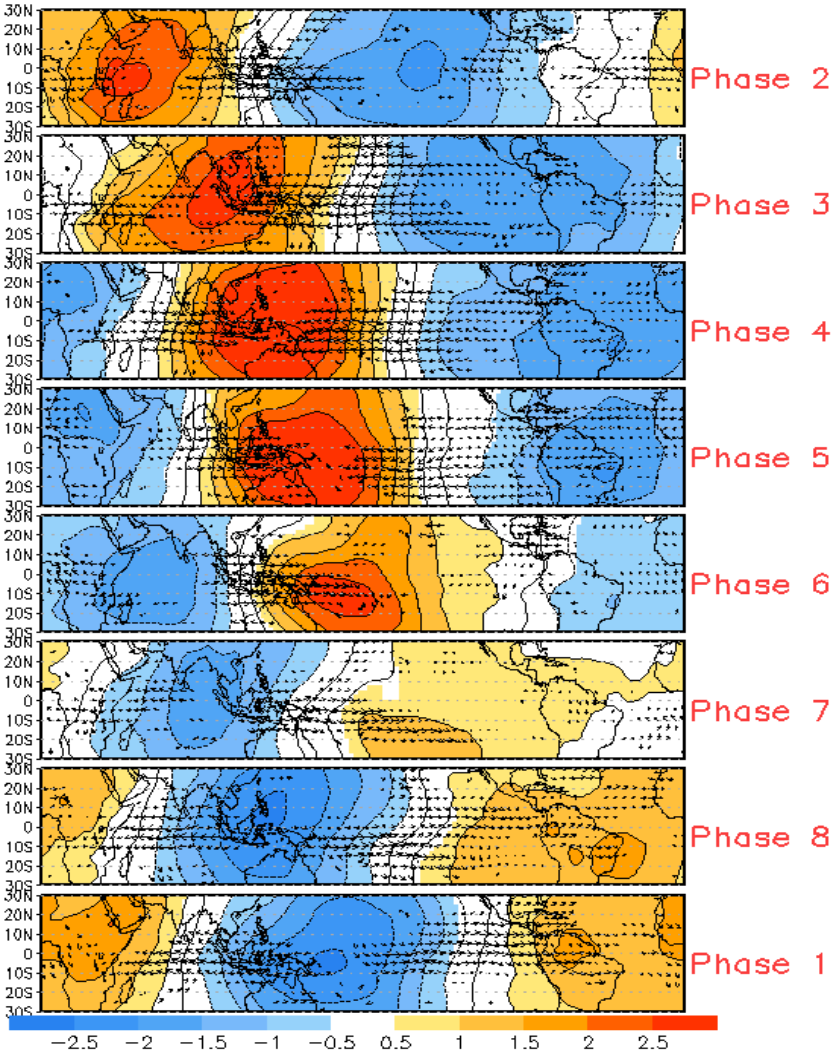




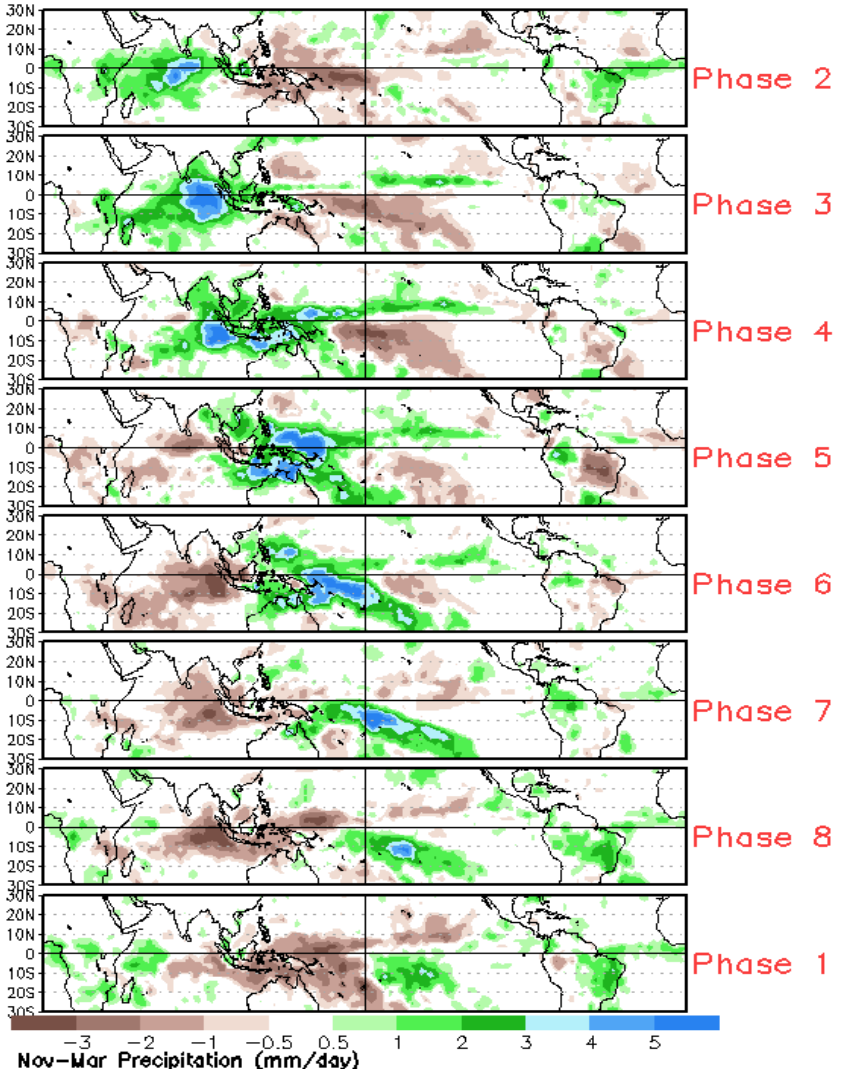
- The constructed analog (CA) RMM-based forecast remains highly amplified, with a more progressive intraseasonal signal in comparison to the GEFS solution.
- By Week-2, the strong MJO signal reaches the Maritime Continent and far western Pacific.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



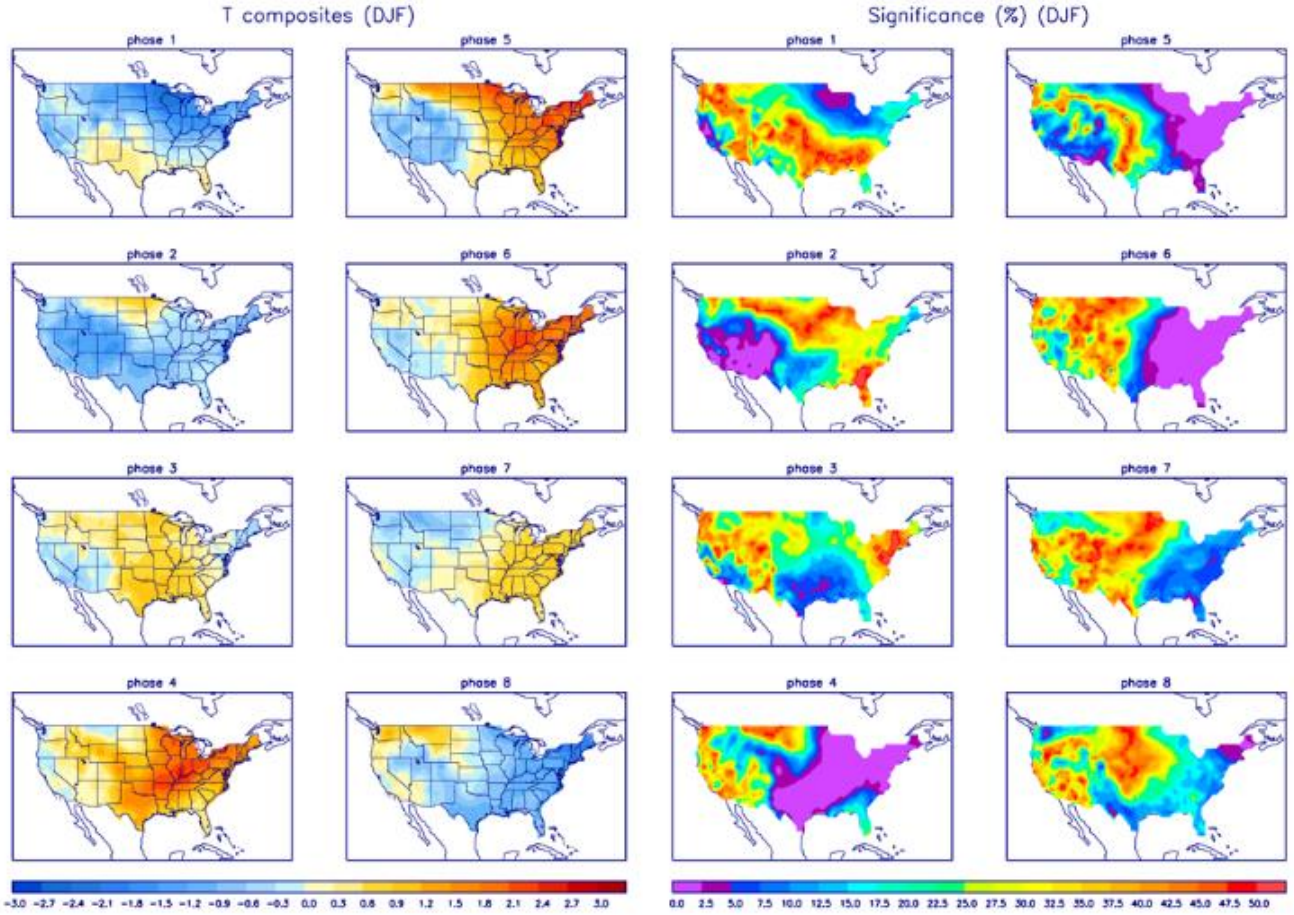
Precipitation Anomalies



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.

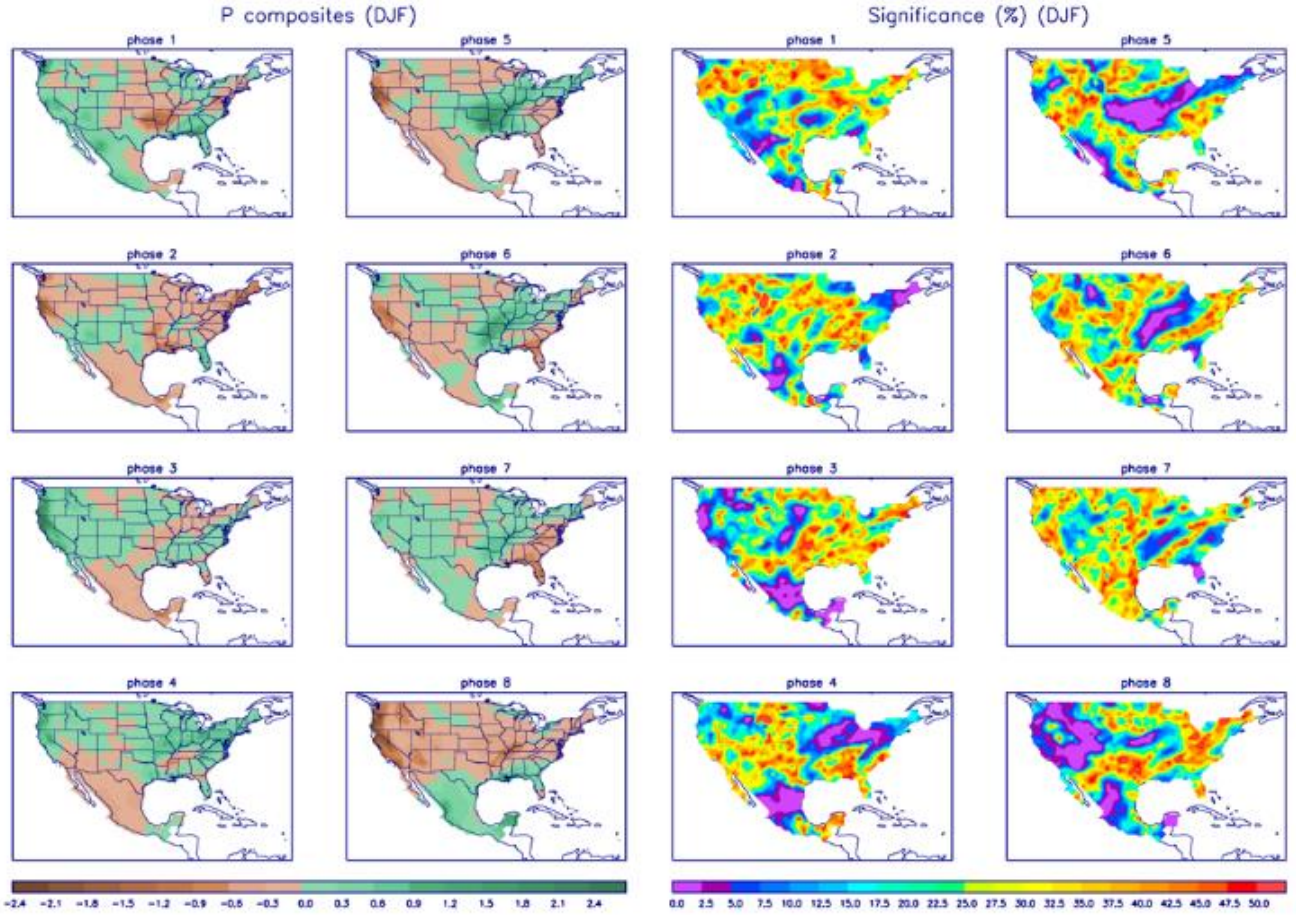


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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.



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