

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



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
6 January 2020

Overview

- The MJO was incoherent over the past week, but exhibits signs of emerging over the Maritime Continent around the 7th of January.
- Dynamical model guidance quickly strengthens this MJO event over the Maritime Continent during the next two weeks, while bringing the signal into the West Pacific by late in Week-2.
- The Indian Ocean Dipole has continued its decline, helping to permit convection to re-emerge over the Maritime Continent, while also bringing some likely relief to the heat and fire conditions that have been observed across Australia. This low-frequency shift in convection across the Indian Ocean and Maritime Continent is likely biasing the RMM index somewhat toward Phase 3/4 and could play some role in making the forecast MJO event appear stronger than it really is.
- The MJO's anticipated emergence across the Maritime Continent and forecast propagation to the West Pacific over the next two weeks would typically support an initial continuation of the relatively cold (warm) pattern for the western (eastern) U.S. Over time the cold in the West would be expected to slowly abate with time while warmer conditions overspread North America, before some potential colder weather would emerge over the Northeast by early February. It remains to be seen if the extratropical circulation response will align with historical expectations.

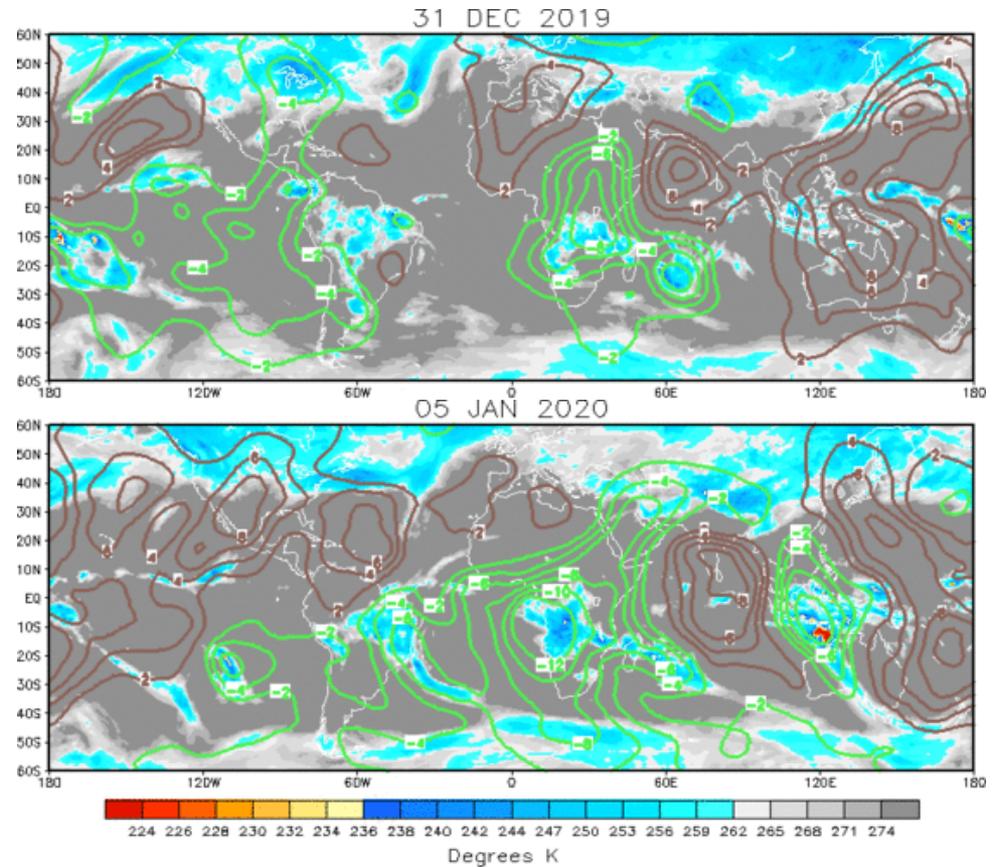
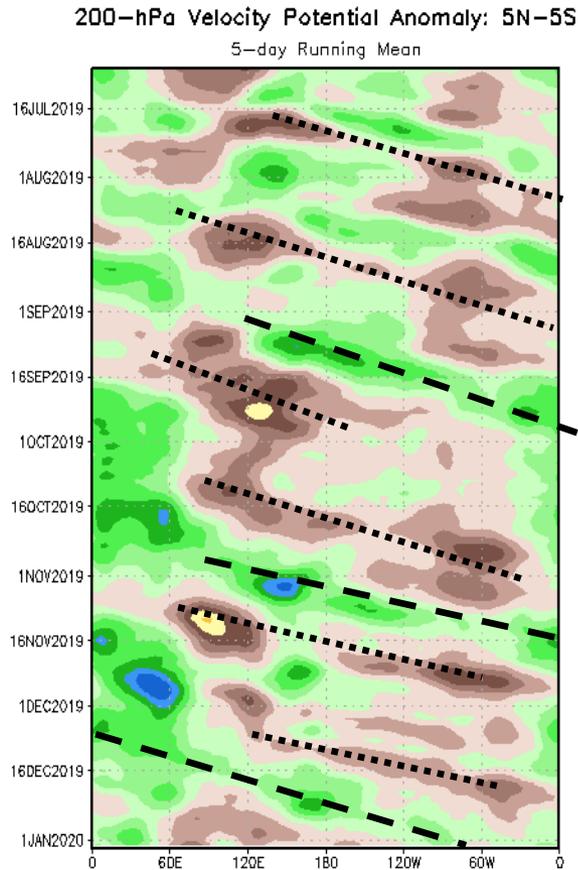
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

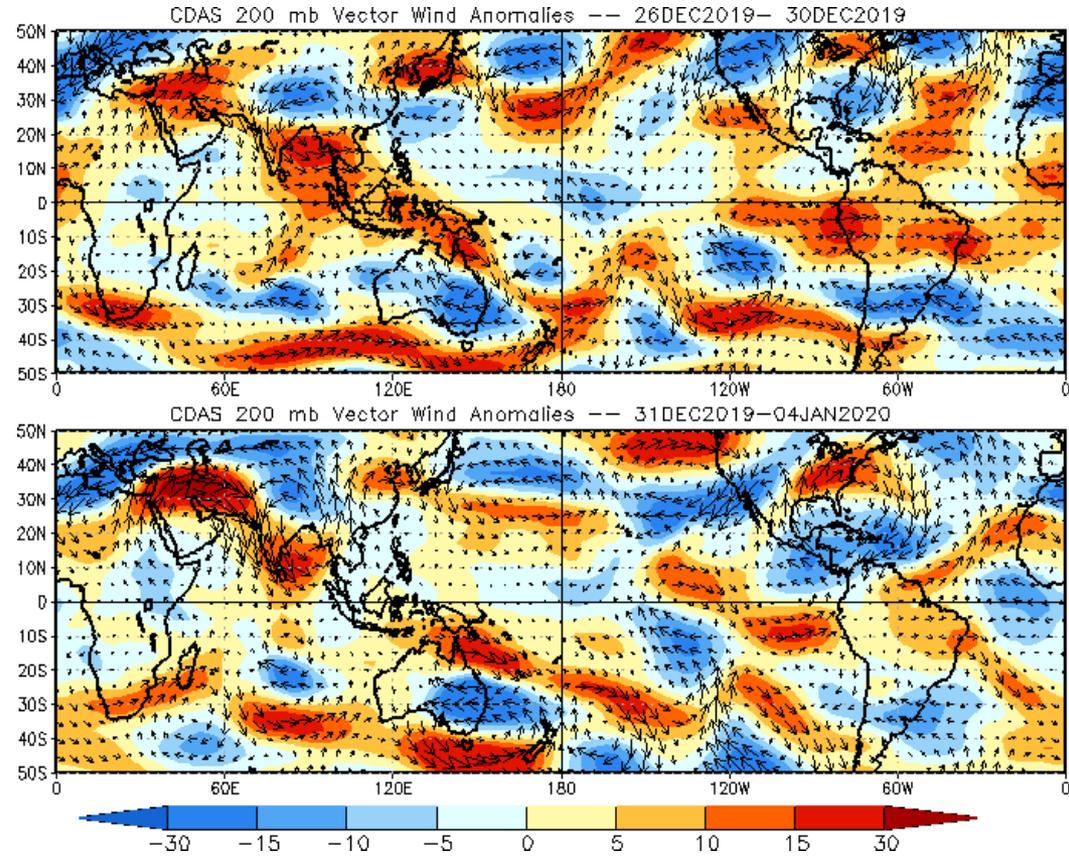
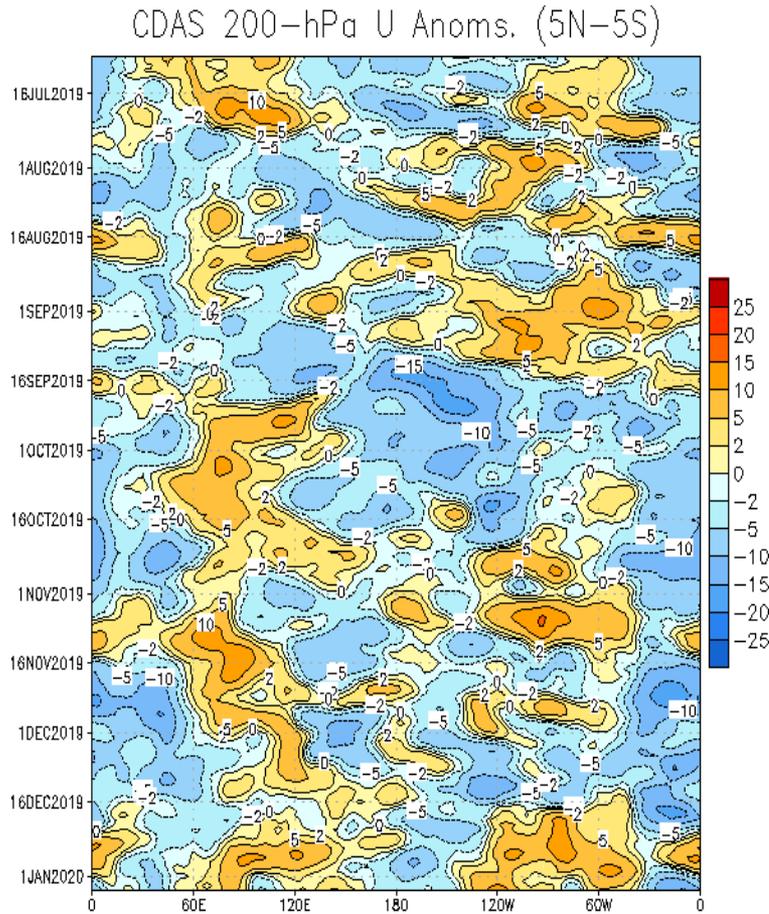
Brown shades: Anomalous convergence (unfavorable for precipitation).



- A major reversal in the pattern occurred over the Western Maritime Continent/Eastern Indian Ocean, with convection emerging across the region as the positive phase of the Indian Ocean Dipole continues to decay. Some of this convection can be attributed to Tropical Cyclone Blake off the Kimberley Coast.
- Low-frequency convection remains focused over Africa, as has been typical since mid-September.

200-hPa Wind Anomalies

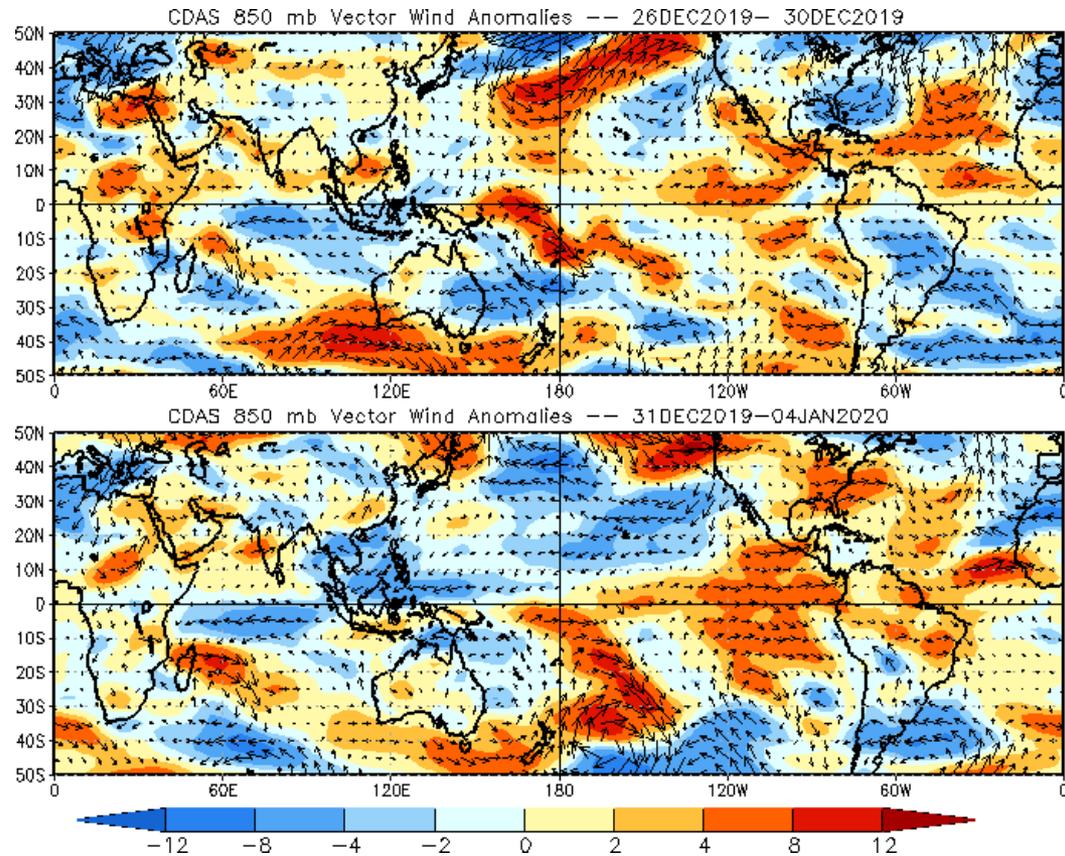
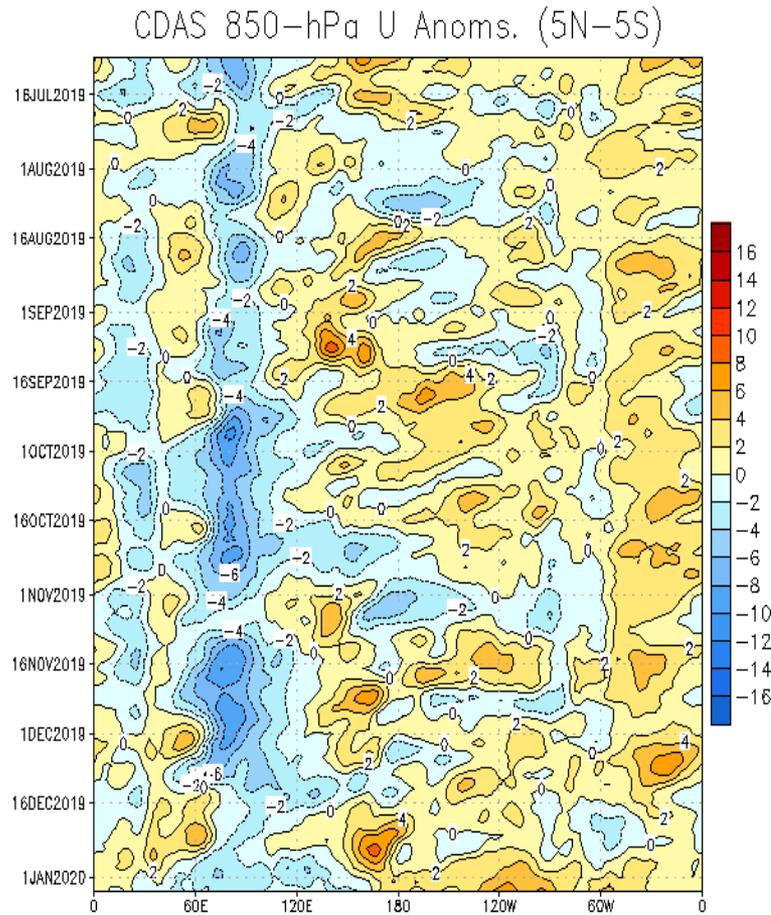
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous divergence emerged along the equator near 100E for the first time in months, as the IOD's footprint lessened.
- Wavebreaking into the Indian Ocean from the Northern Hemisphere was apparent, although the most robust wavetrain emanating from the tropics is focused across the Southern Hemisphere from Australia through the South Pacific.

850-hPa Wind Anomalies

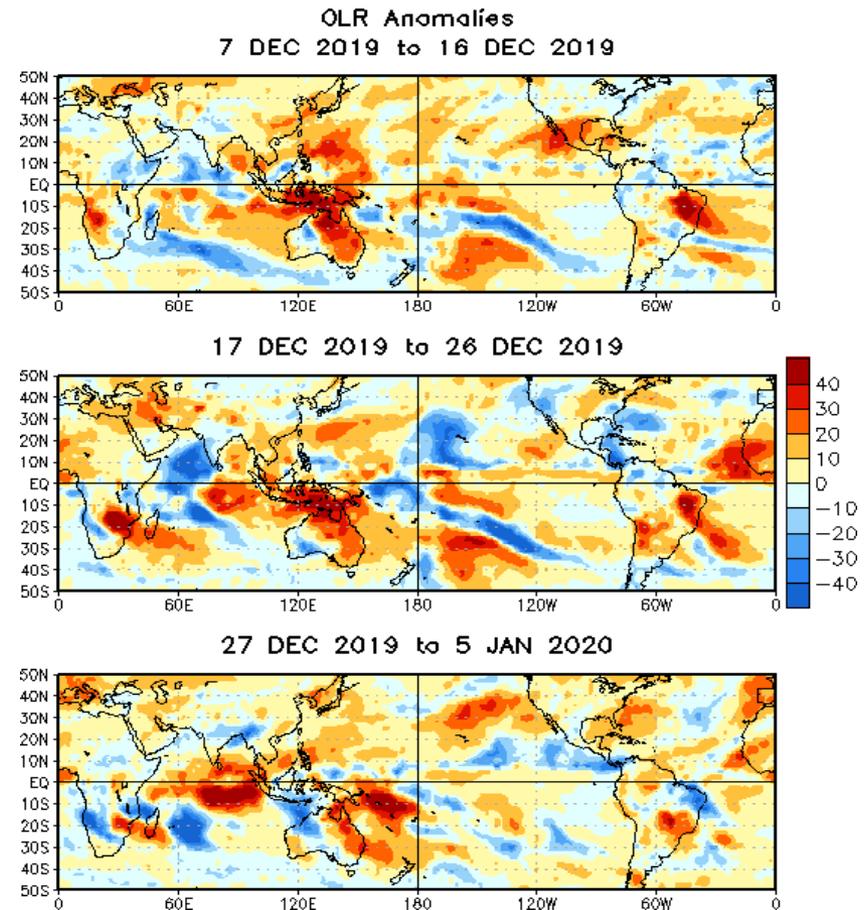
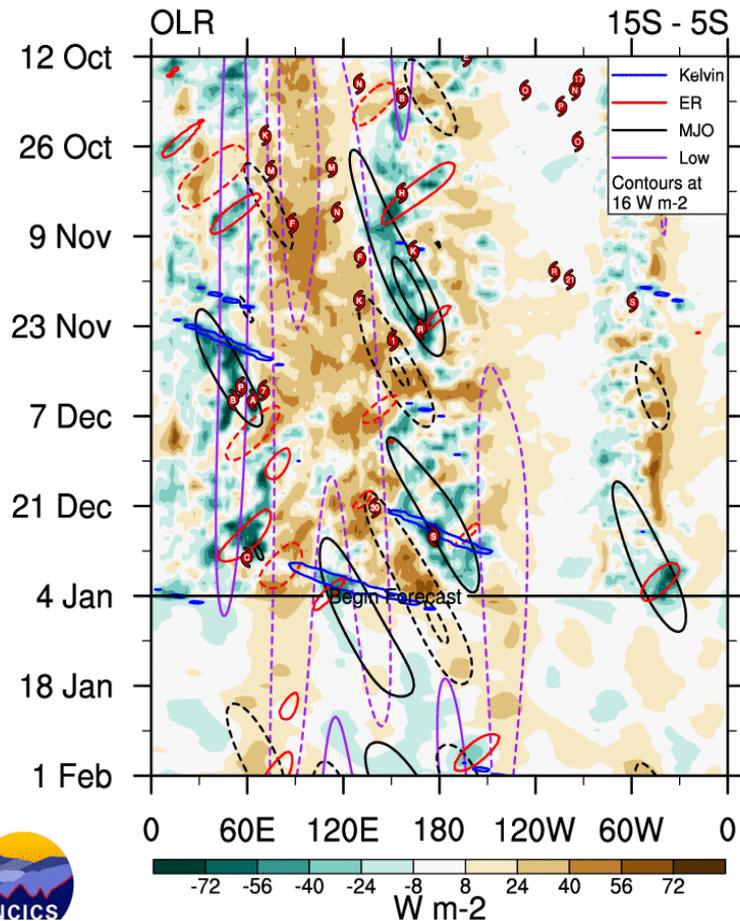
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous low-level westerlies remained across the Indian Ocean, in line with a weakened +IOD.
- Recent rains across the Lower Mississippi Valley, Tennessee Valley, and Southeast appear linked to anomalous westerlies stretching from the East Pacific across the Gulf of Mexico that helped bring tropical moisture into the region.

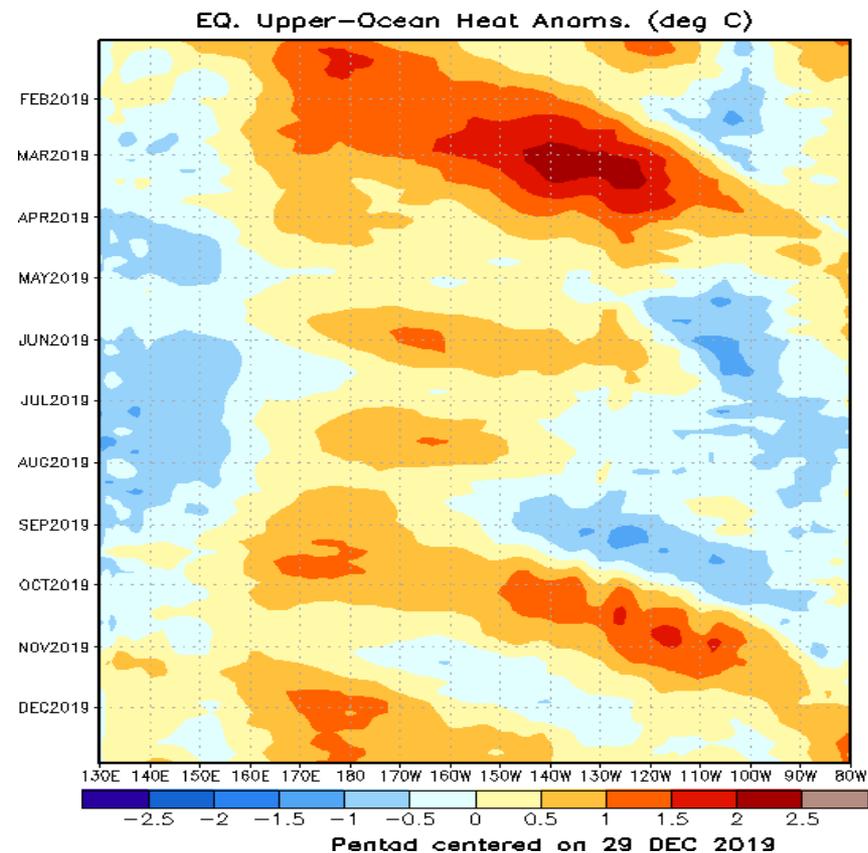
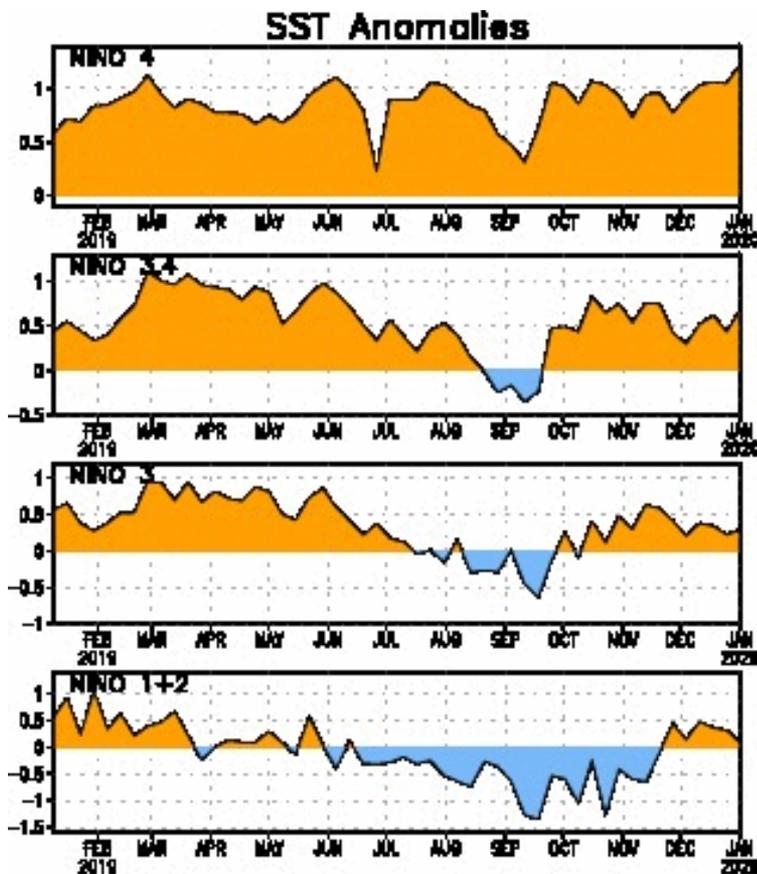
Outgoing Longwave Radiation (OLR) Anomalies

Blue shades: Anomalous convection (wetness). **Red shades: Anomalous subsidence (dryness).**



- Enhanced convection occurred near 120E for the first time since at least mid-October, breaking the IOD's hold on the region. This appears tied to multiple modes of tropical convection (MJO, Kelvin wave, equatorial Rossby wave/tropical cyclone) constructively interfering.
- Conversely, enhanced convection across the Arabian sea and western Indian Ocean has turned suppressed, linked to the weakening IOD and MJO's emergence east of the region.

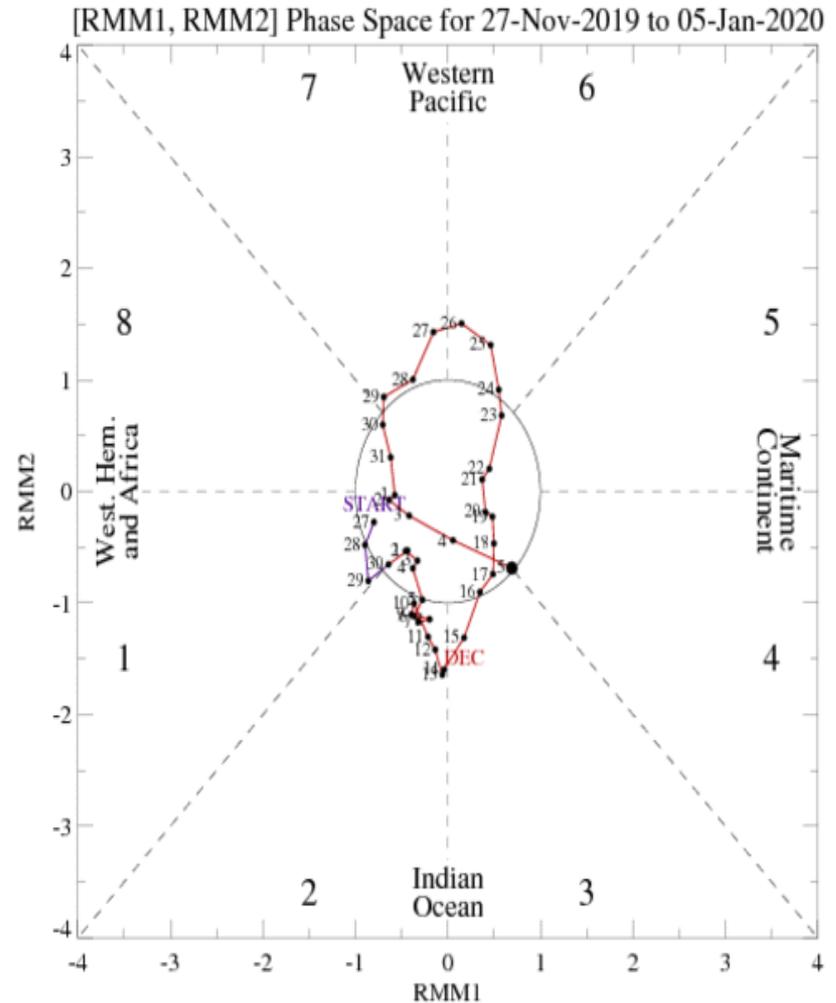
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Upper-oceanic heat content anomalies remain slightly above-normal across most of the basin.
- Several westerly wind bursts over the West Pacific resulted in new downwelling Kelvin wave activity near the Date Line since November.

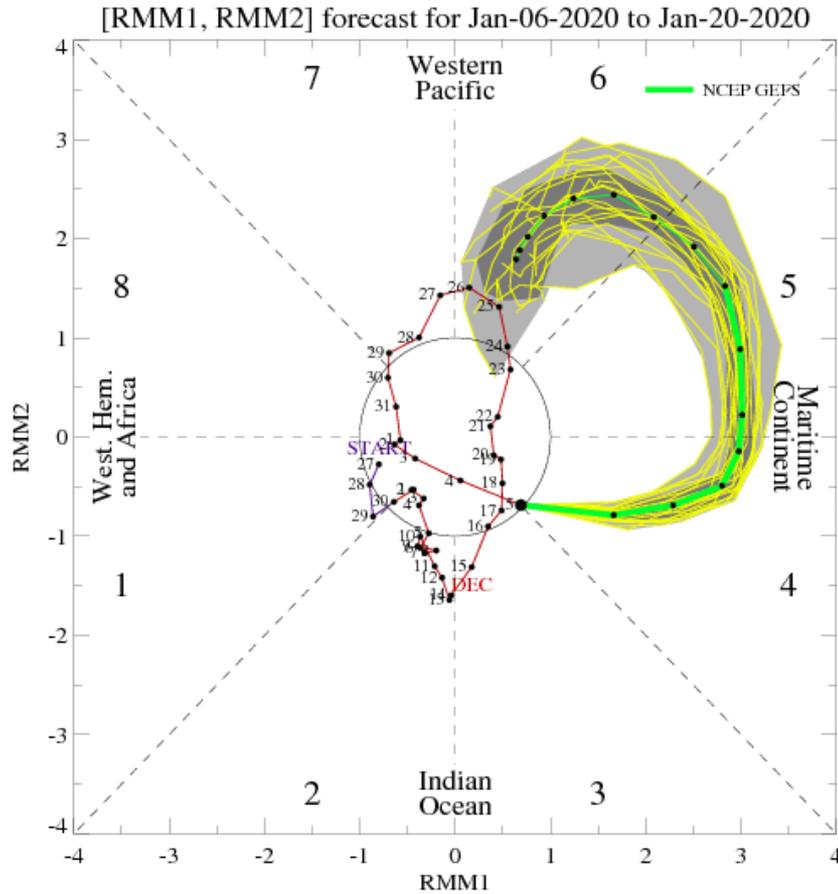
MJO Index: Recent Evolution

- The RMM index shows the MJO as being on the cusp of emerging outside the unit circle and into Phase 4 over the Maritime Continent.
- The decay of the IOD is likely being aliased into the RMM index, with the change in the low-frequency convection across the Indian Ocean and Maritime Continent biasing the MJO index toward being in Phases 3/4.

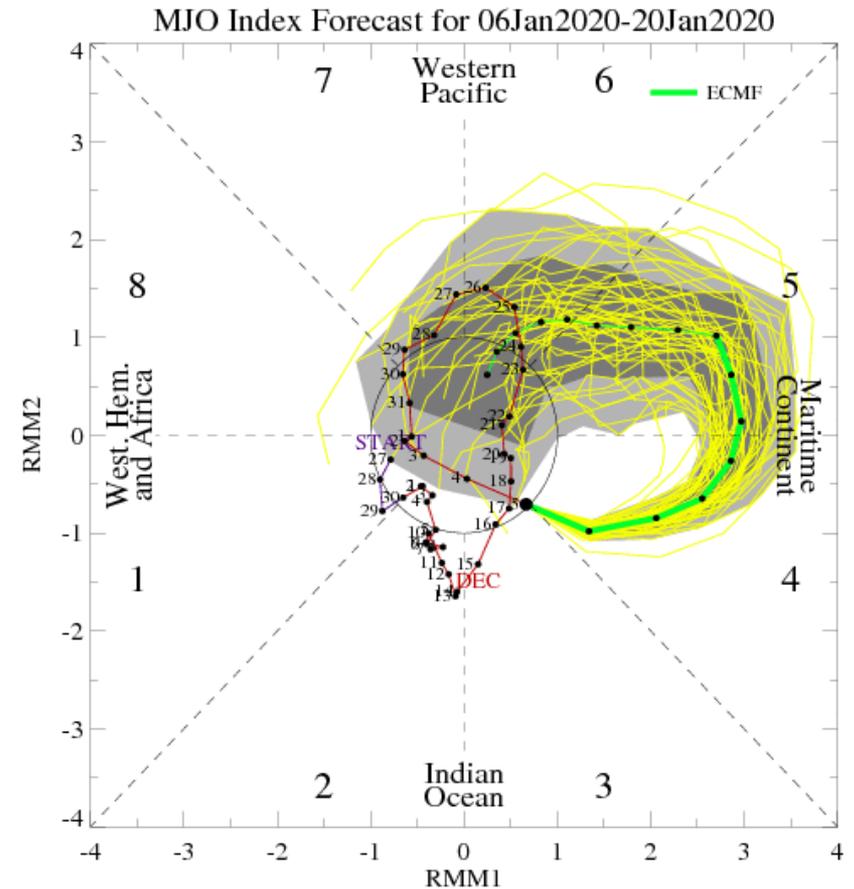


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



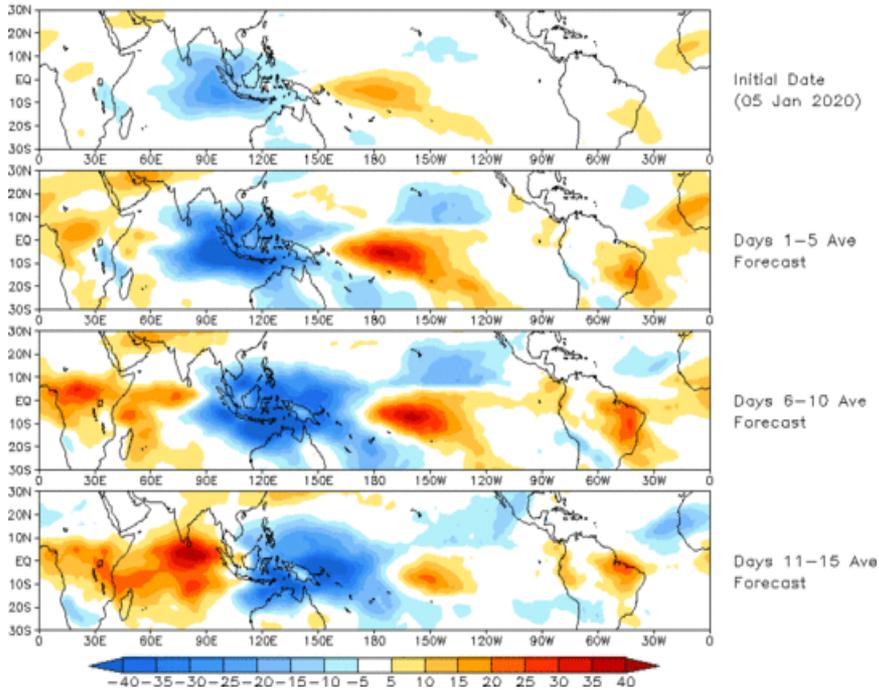
ECMWF Forecast

- The GEFS and ECMWF both forecast a strengthening MJO over the next week, with the signal crossing the Maritime Continent and reaching the West Pacific by late in Week-2.
- Some of the amplitude of this event in Phases 4/5 is likely attributed to the evolving low-frequency state with the demise of the +IOD, as noted on the prior slide.

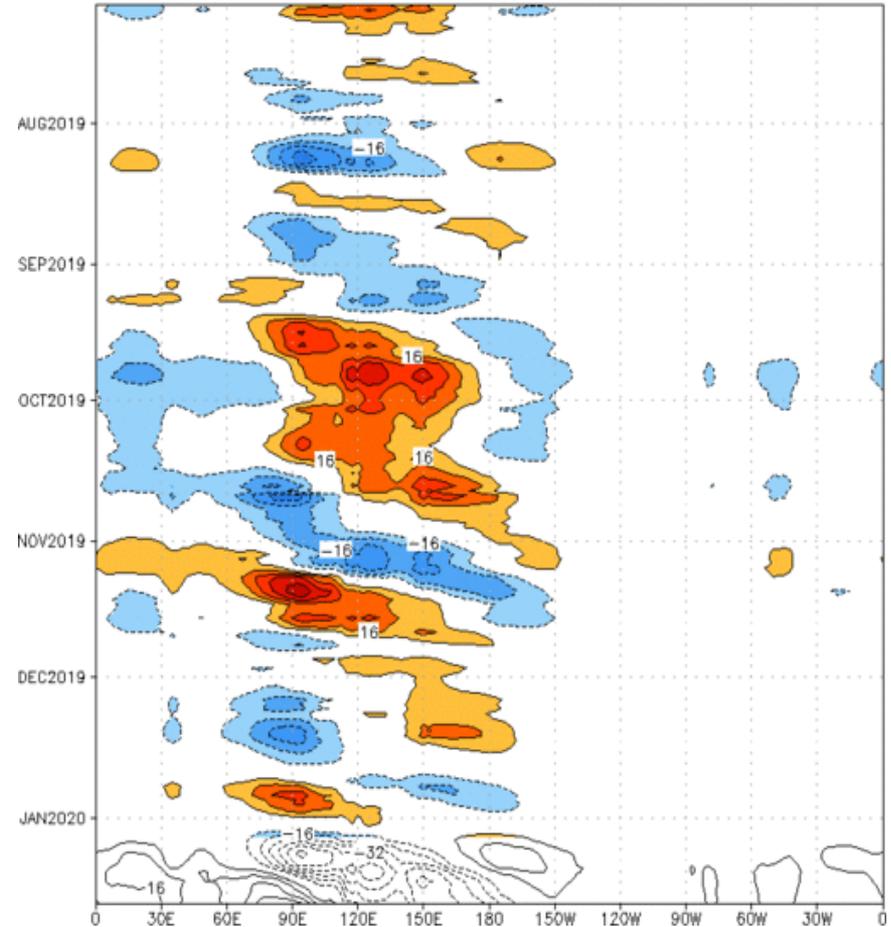
MJO: GEFS Forecast Evolution

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: 05 Jan 2020
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}S, 7.5^{\circ}N$] (cont: $4Wm^{-2}$) Period: 06-Jul-2019 to 05-Jan-2020
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

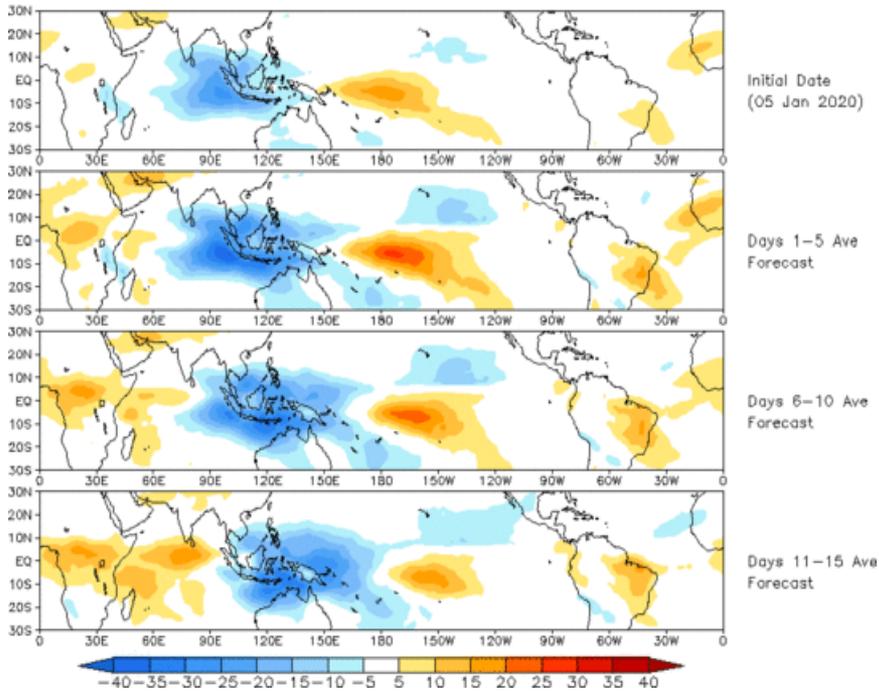


- The GEFS spatial forecast of the MJO exhibits a convective dipole initially across the eastern Indian Ocean/West Pacific shifting eastward and becoming a tripole spanning from Africa through the Central Pacific by the end of Week-2.

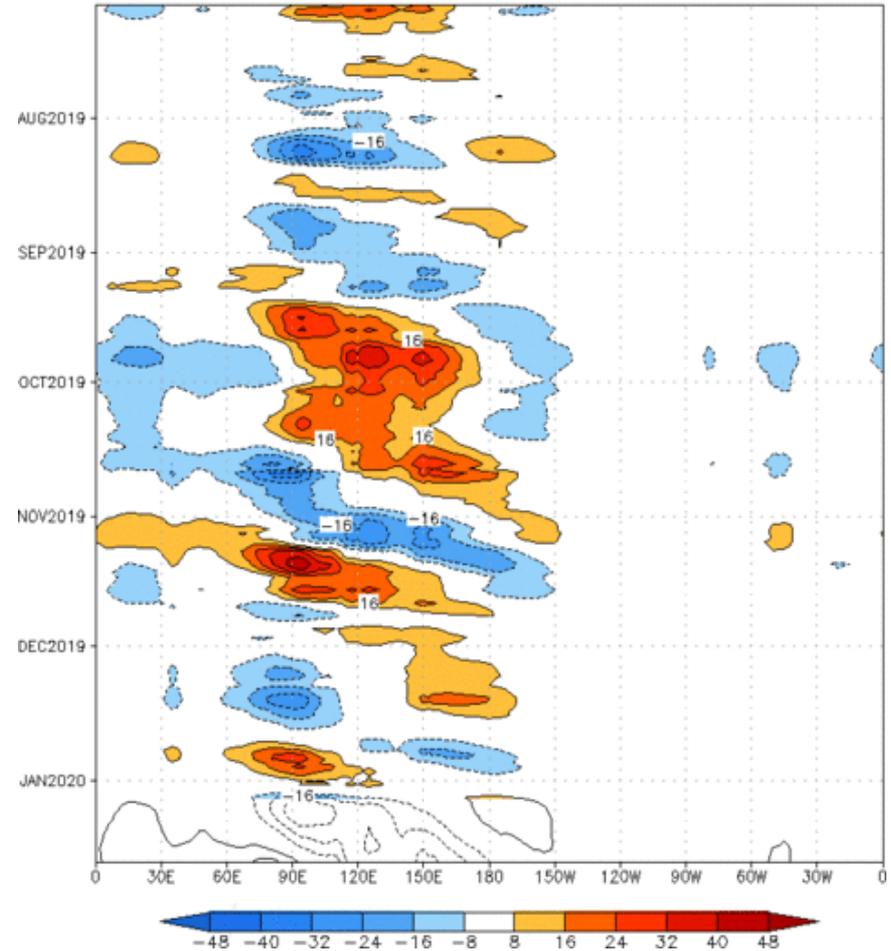
MJO: Constructed Analog Forecast Evolution

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 (05 Jan 2020)



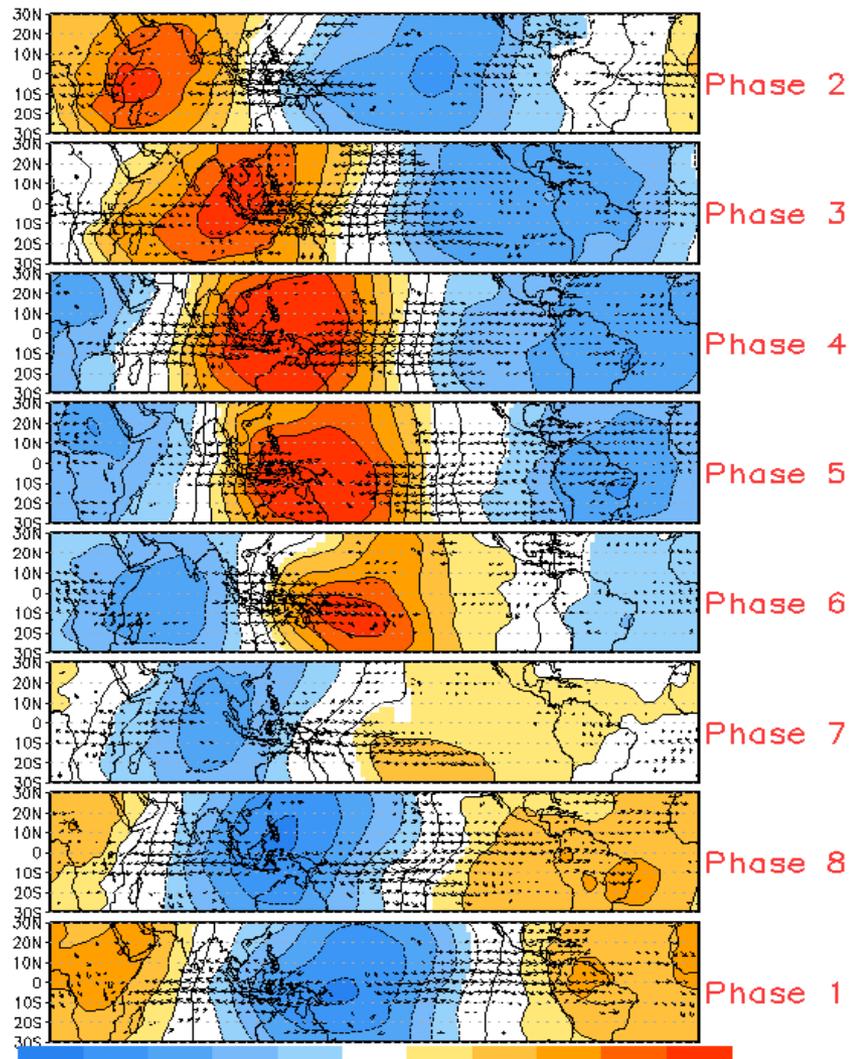
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:06-Jul-2019 to 05-Jan-2020
The unfilled contours are CA forecast reconstructed anomaly for 15 days



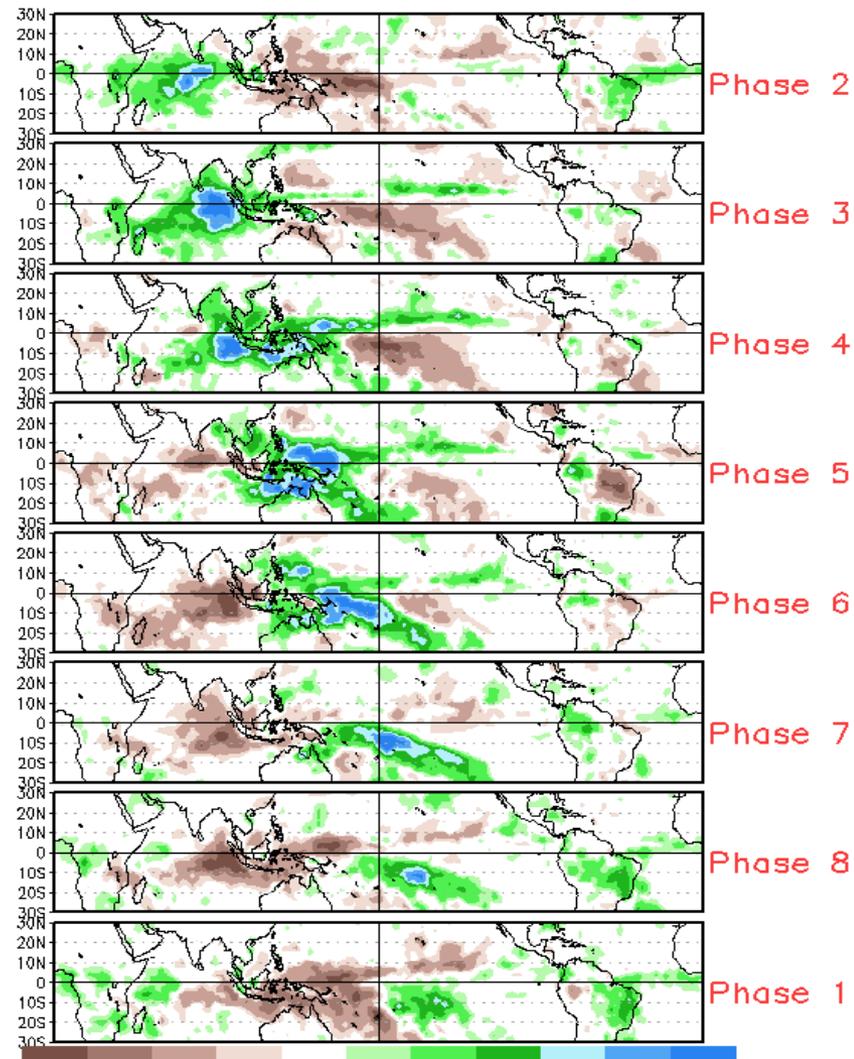
- The constructed analog MJO forecast is similar to the GEFS, but at a reduced amplitude.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



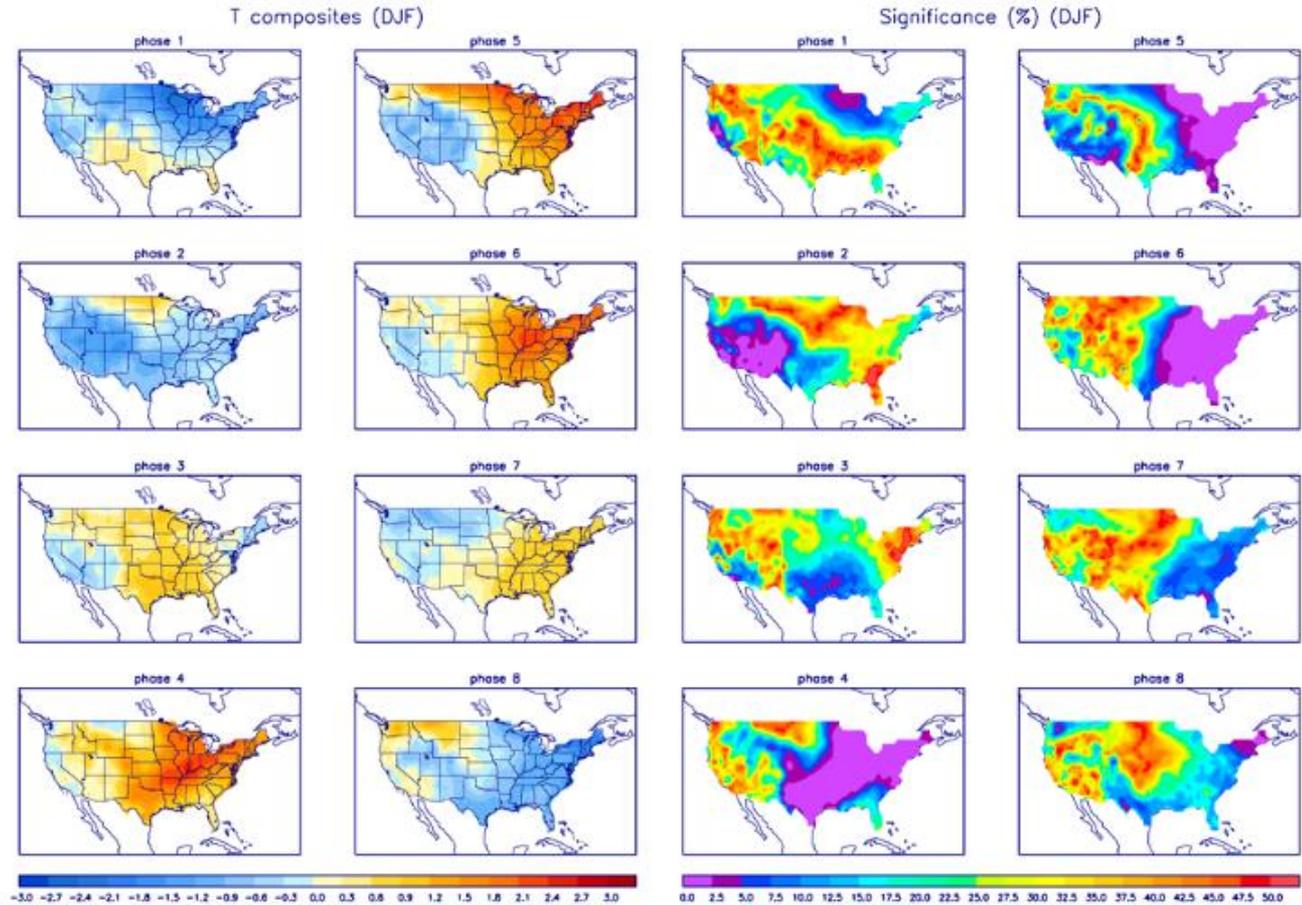
Precipitation Anomalies



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 - Temperature

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.

