

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
18 January 2021

Overview

- Enhanced anomalous convection persists over the Maritime Continent in response to the active La Niña.
- Dynamical model MJO forecasts predict an event emerging over the West Pacific during late Week-1 or early Week-2.
- RMM forecasts are often influenced by the low frequency La Niña signal, which can result in them incorrectly predicting strong MJO events.
 - This has been the case during the past several weeks and will remain a concern throughout the duration of the La Niña event, which means we are likely to have reduced confidence in MJO forecasts during this time.

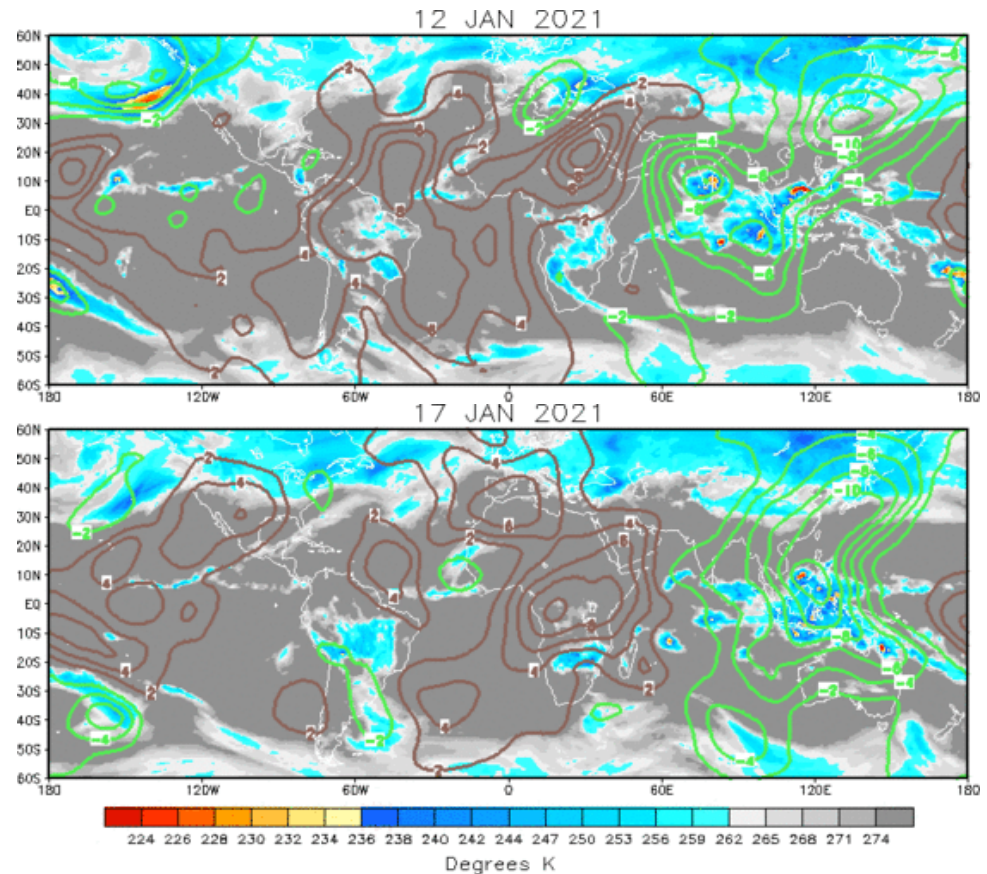
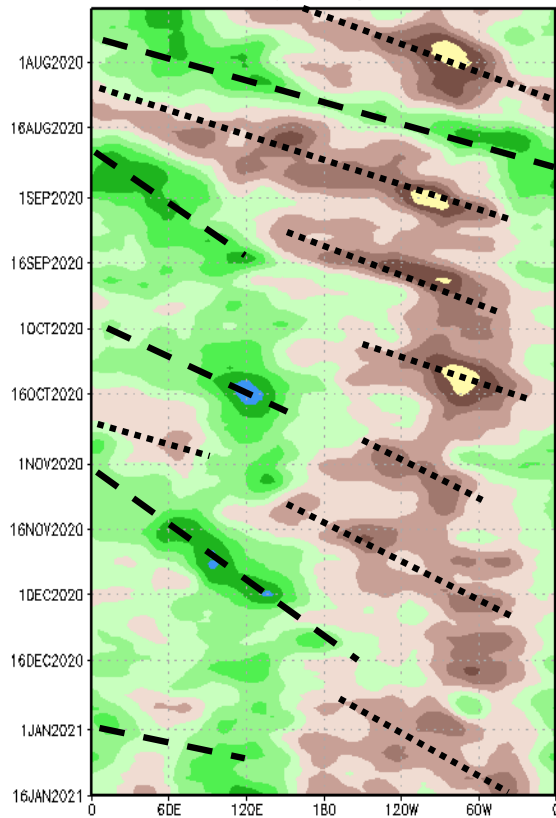
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

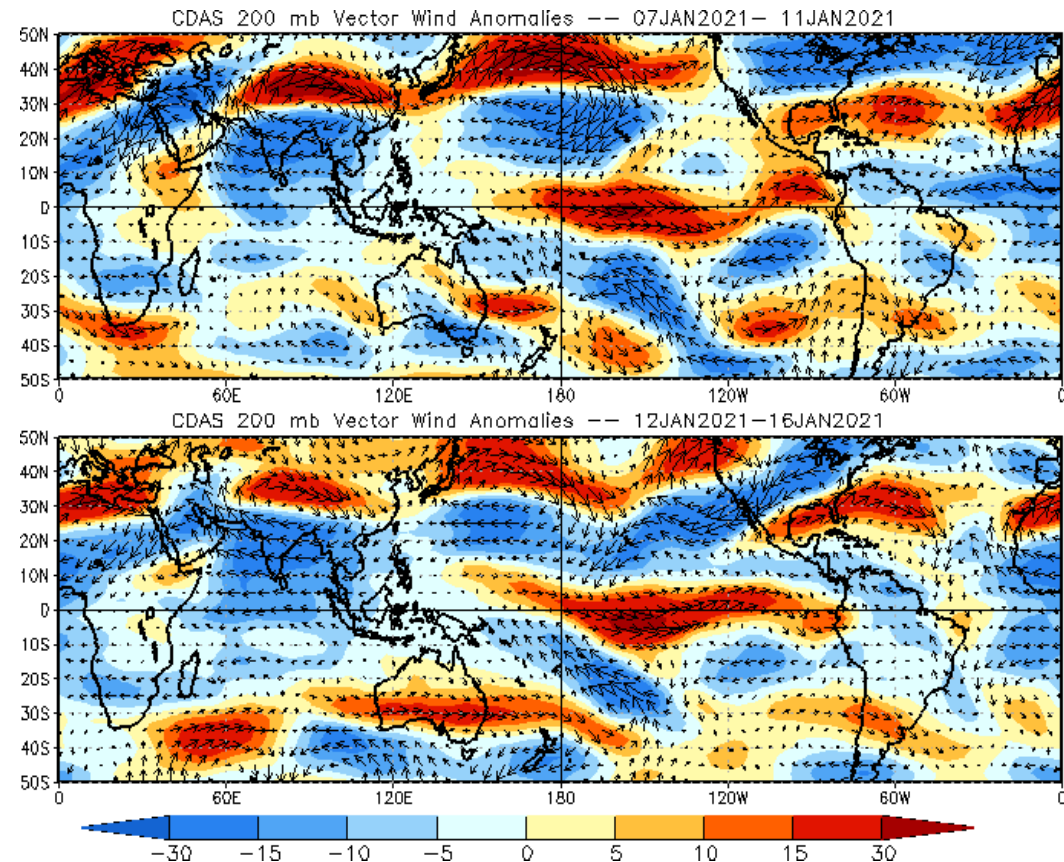
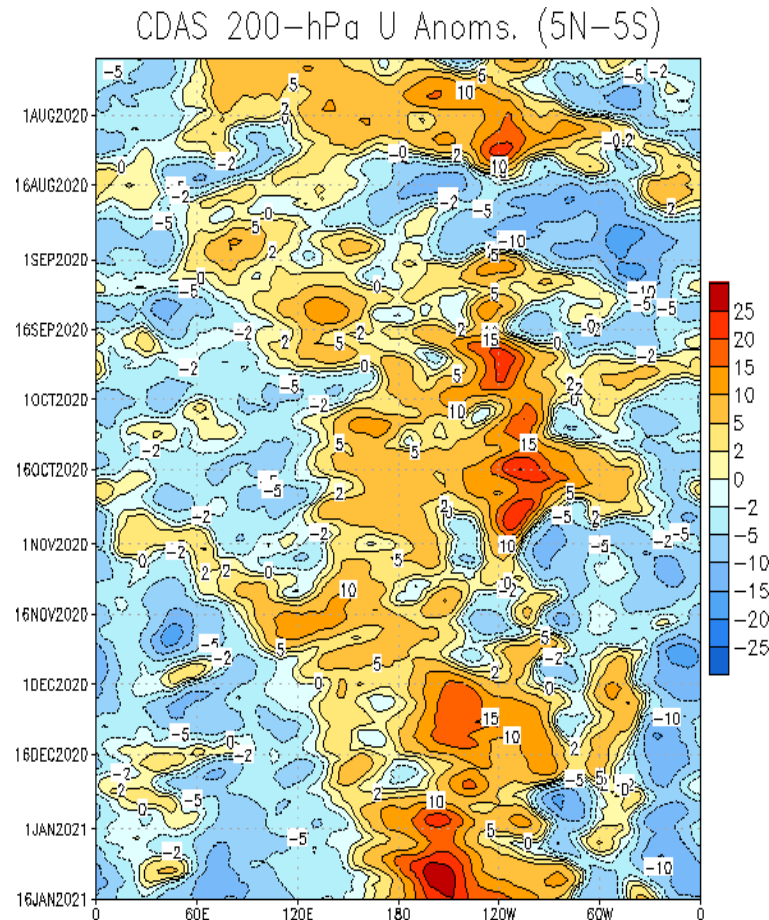
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- The MJO had periods of activity during November and December, as midlatitude wavebreaking events onto the tropical Indian Ocean generated eastward moving convective envelopes.
- Since mid-December, the low-frequency La Niña base state has been the dominant feature, resulting in persistent anomalous convection over the Maritime Continent.

200-hPa Wind Anomalies

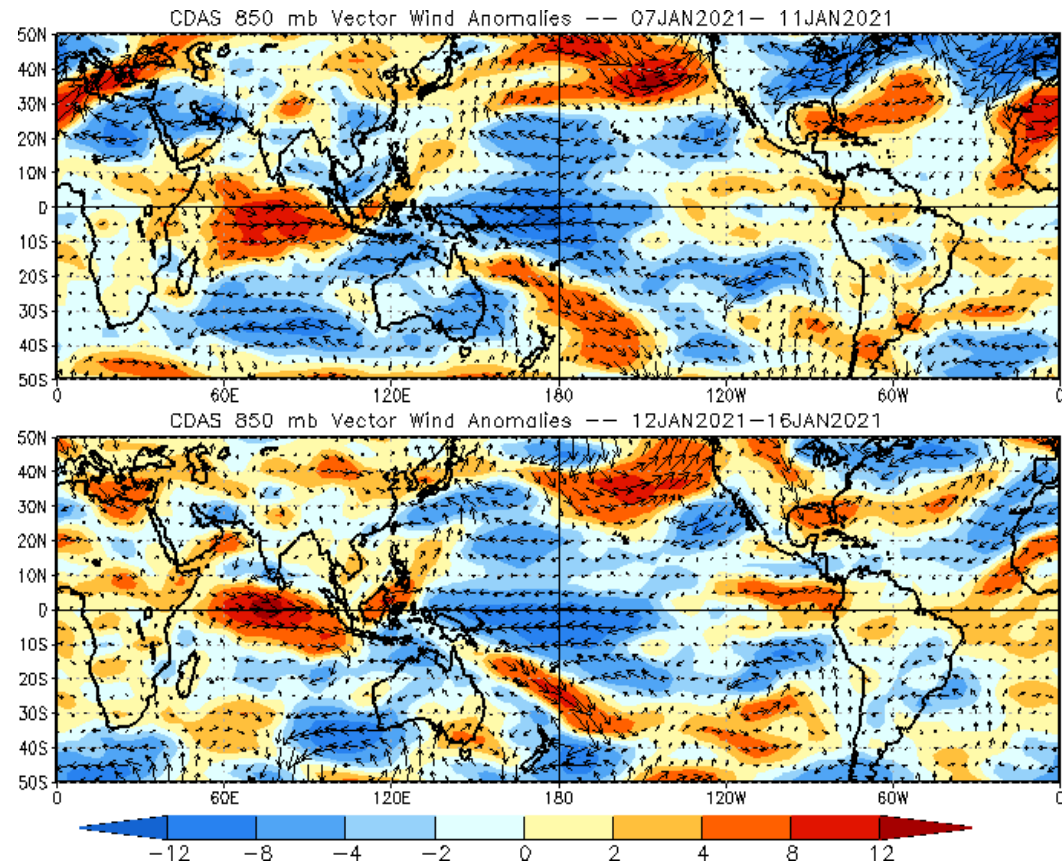
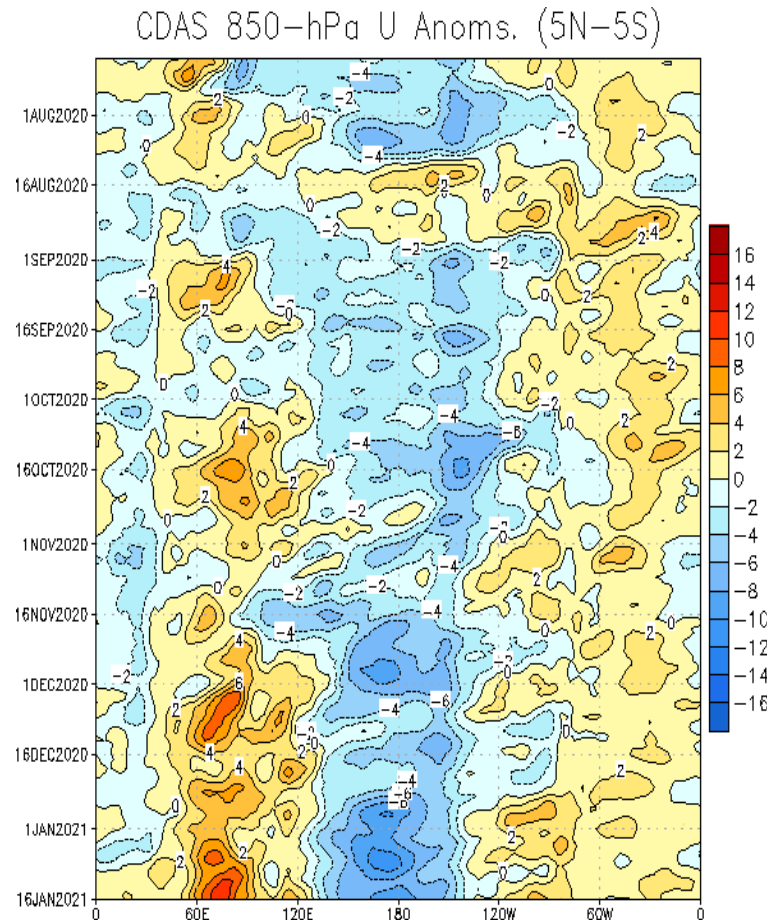
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous upper-level westerlies extend across much of the central and eastern equatorial Pacific, consistent with a climatological La Niña pattern.
- There has been frequent wave breaking from the mid-latitudes around the end of the North Pacific jet into the tropics. Such wave breaking can help enhance the equatorial anomalous westerlies.

850-hPa Wind Anomalies

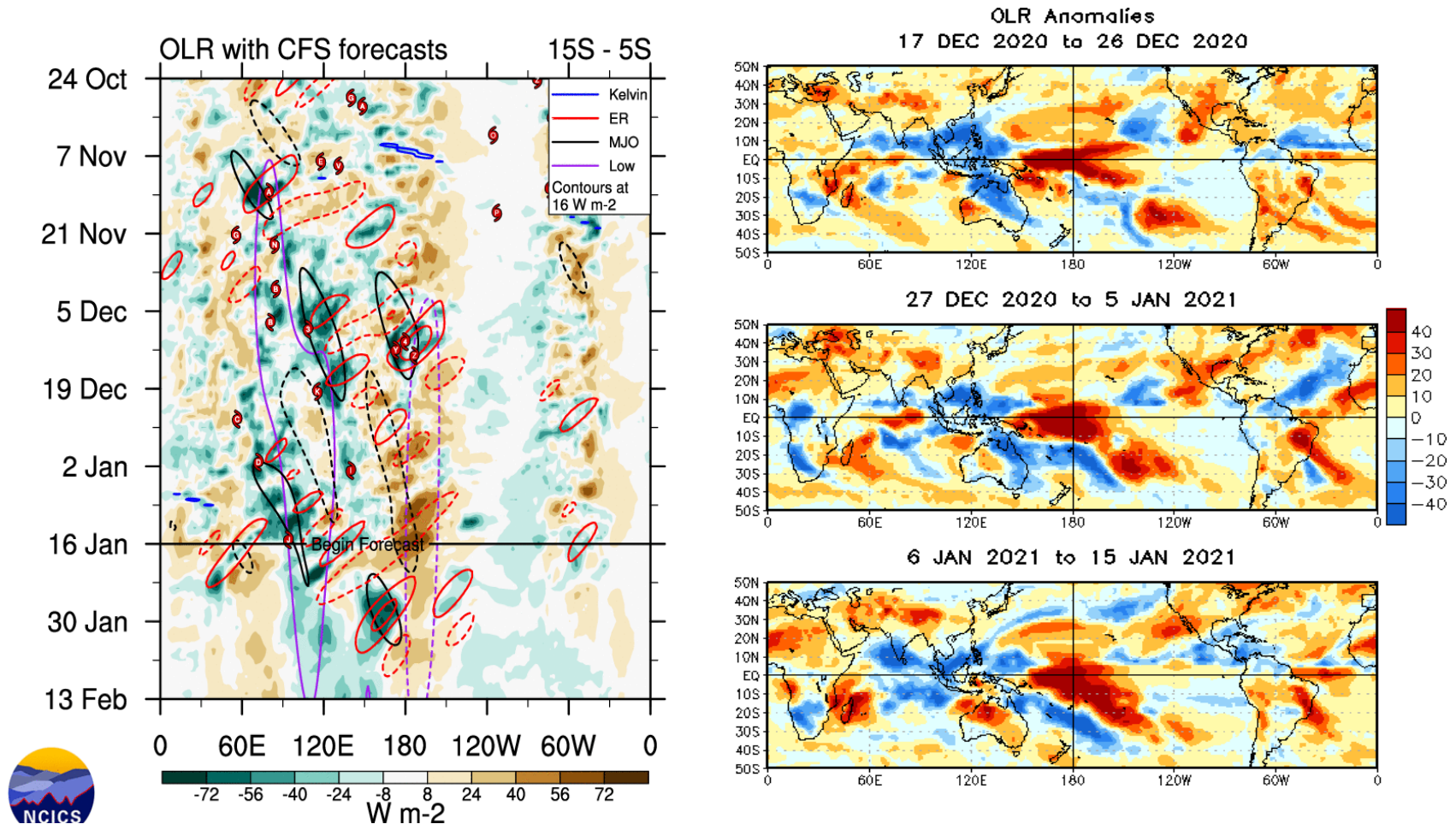
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Enhanced convergence along the equator near 120°E is tied to the low-frequency La Niña state.
- Anomalous westerly winds increased over the equatorial Indian Ocean during the past two weeks.

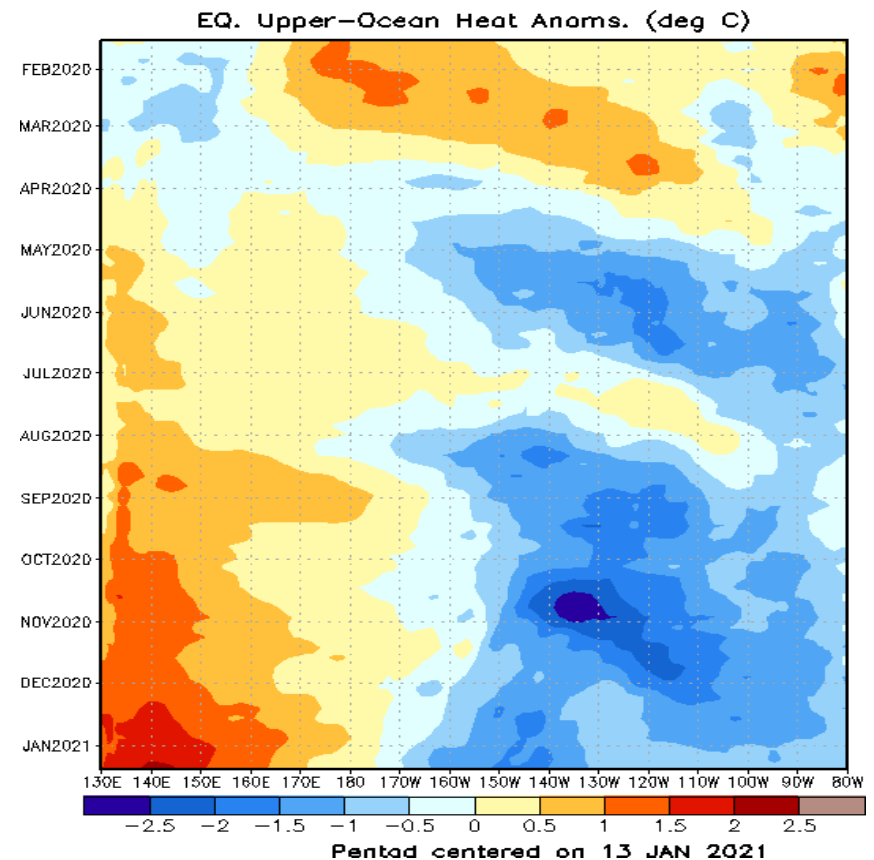
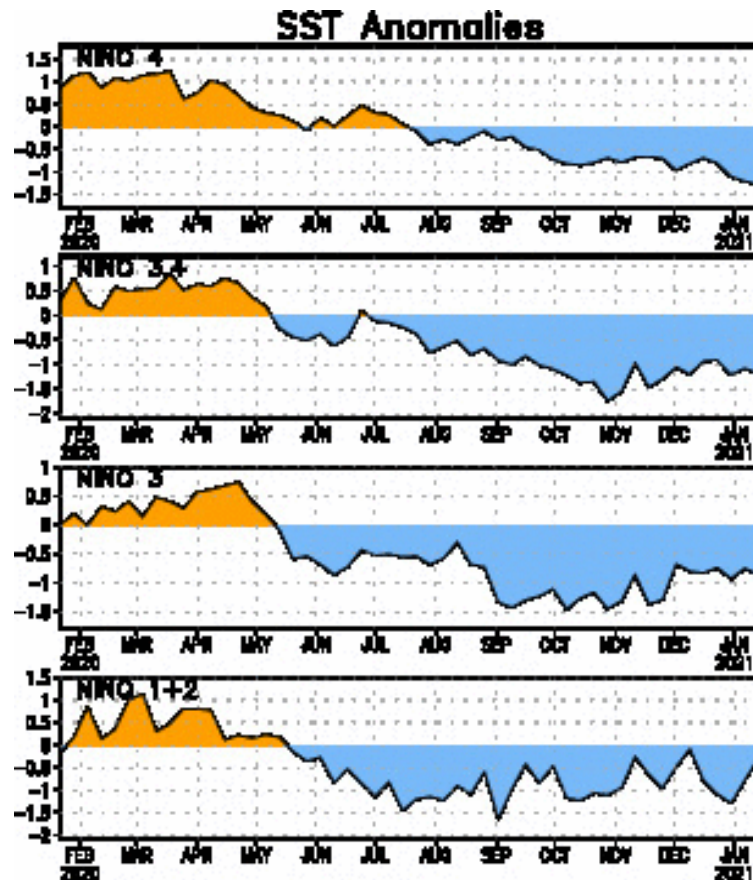
Outgoing Longwave Radiation (OLR) Anomalies

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



- Convection has been established over the Maritime Continent since mid-December in association with warm sea surface temperatures and the ongoing La Niña.
- Convection has increased over the Indian Ocean, which the CFS forecasts to persist through mid-February.

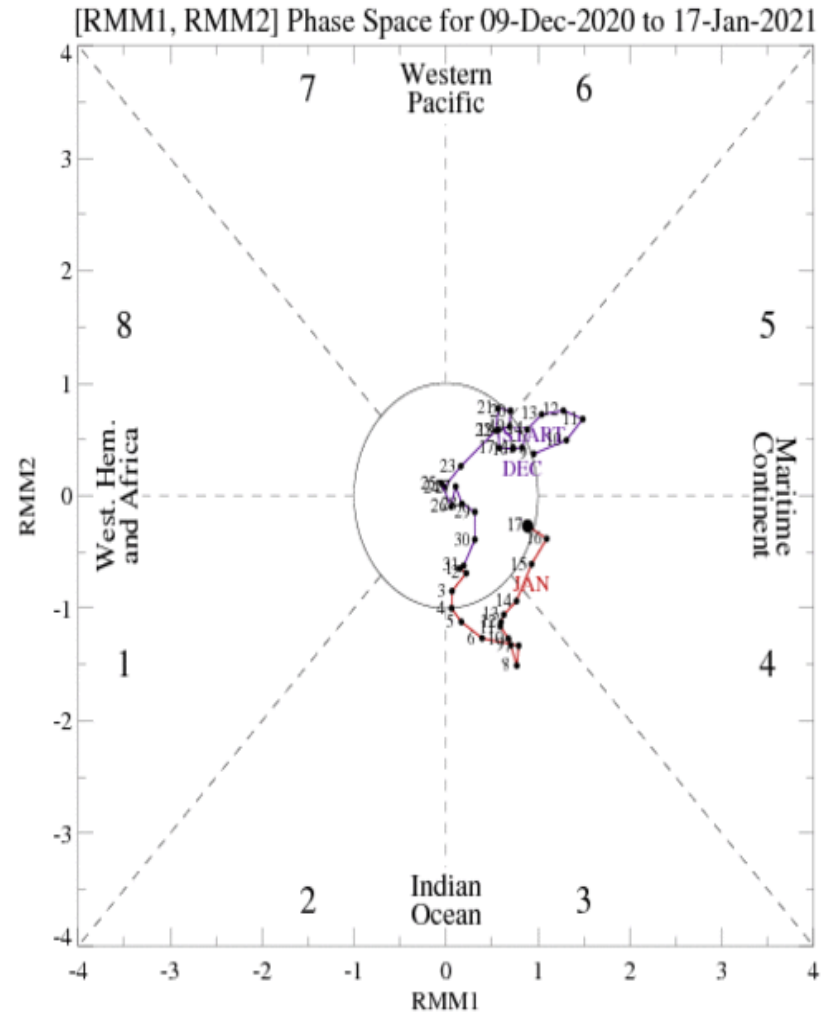
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Following destructive interference with the base state by a downwelling Kelvin wave during July, the subsequent upwelling phase pushed the Pacific into La Niña conditions.
- Anomalous cold has shifted slightly westward across the central Pacific since November.

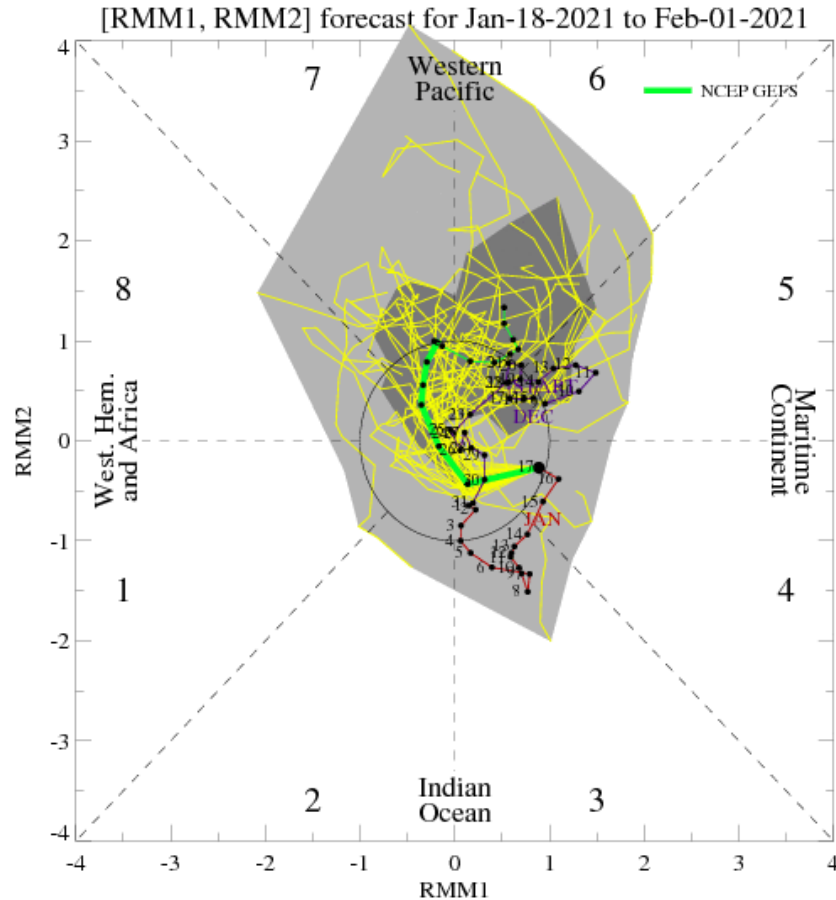
MJO Index: Recent Evolution

- The tropical convection and wind patterns do not project strongly onto the RMM index suggesting a weak MJO.

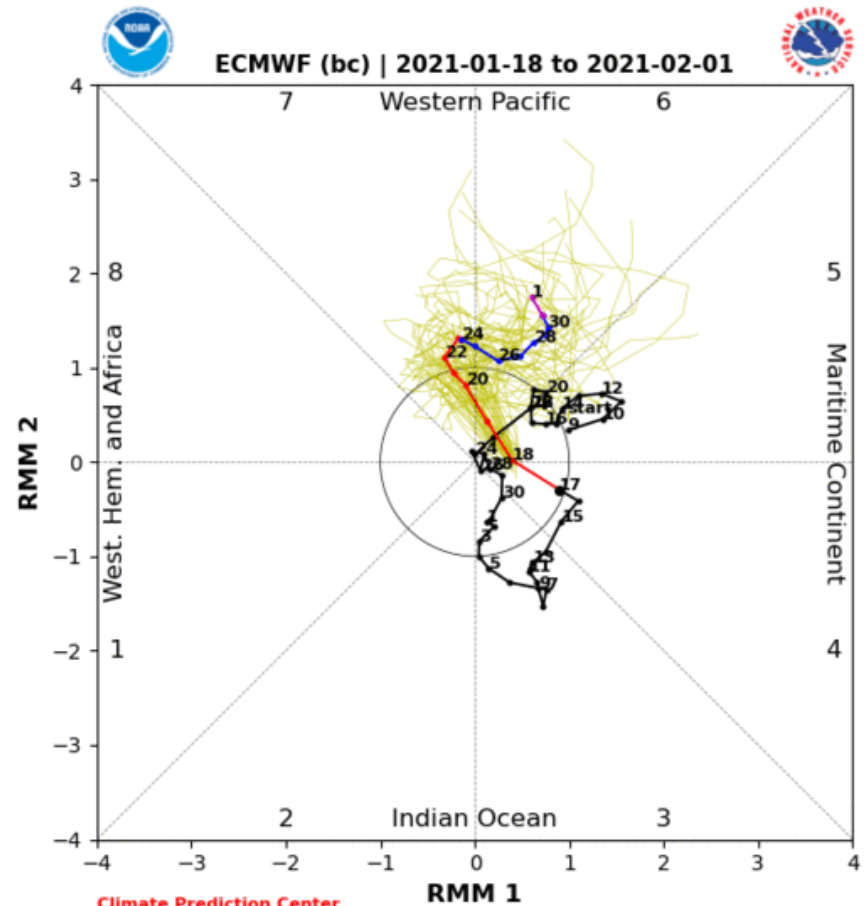


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



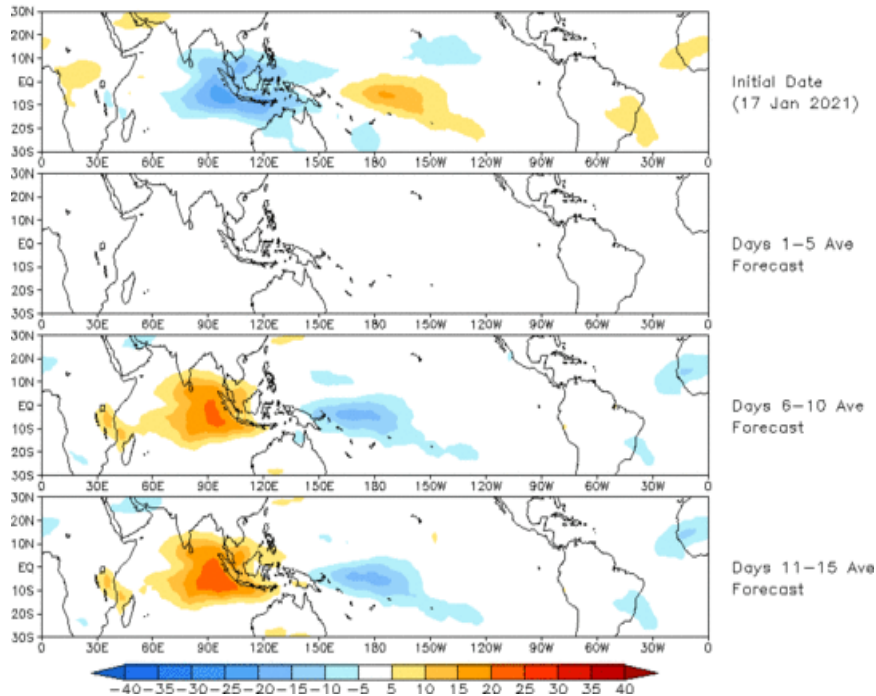
ECMWF Forecast

- Many ensemble members in the GEFS and ECMWF predict the MJO to emerge over the Western Pacific during the next two weeks.
- This forecast should be taken carefully; both of these models have had similar forecasts over the past month, which have not verified.

MJO: GEFS Forecast Evolution

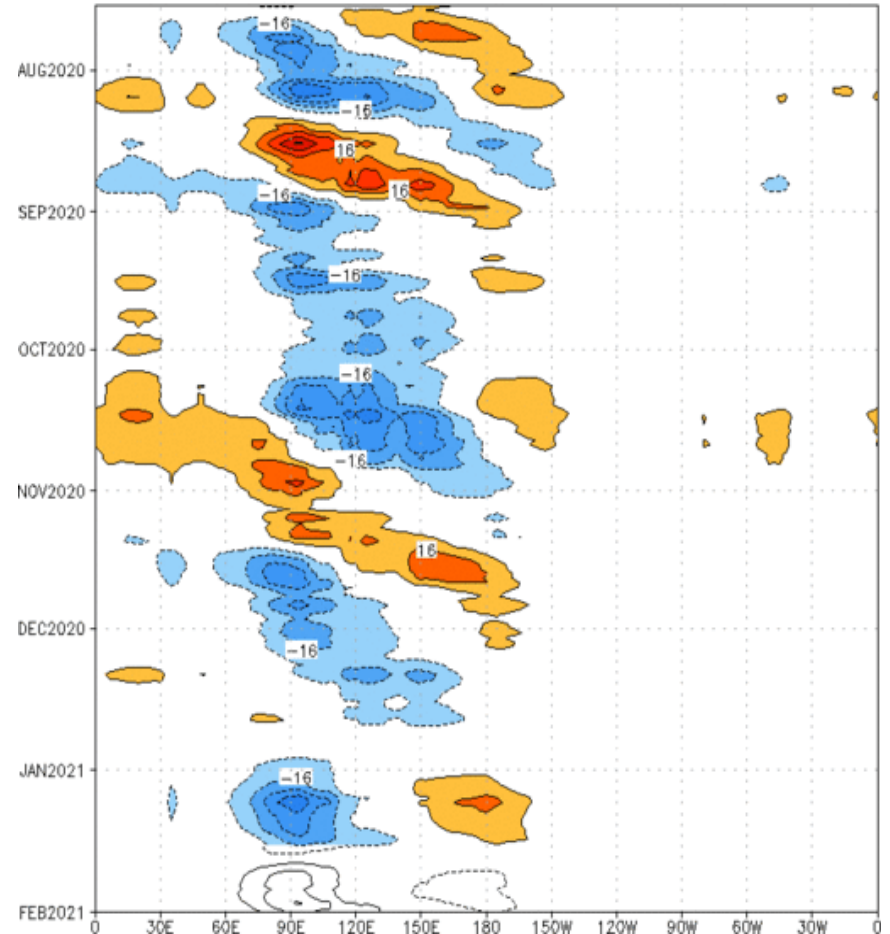
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Prediction of MJO-related anomalies using GEFS operational forecast
Initial date: 17 Jan 2021
OLR



- The GEFS predicts an active MJO signal over the Pacific by early Week-2.

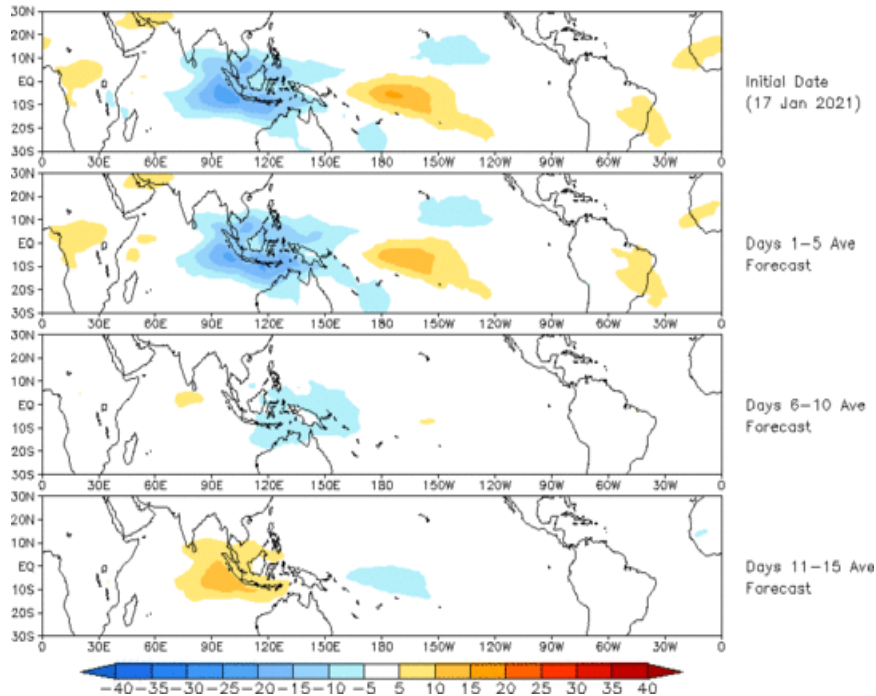
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$] ($\text{cont: } 4\text{Wm}^{-2}$) Period: 18-Jul-2020 to 17-Jan-2021
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days



MJO: Constructed Analog Forecast Evolution

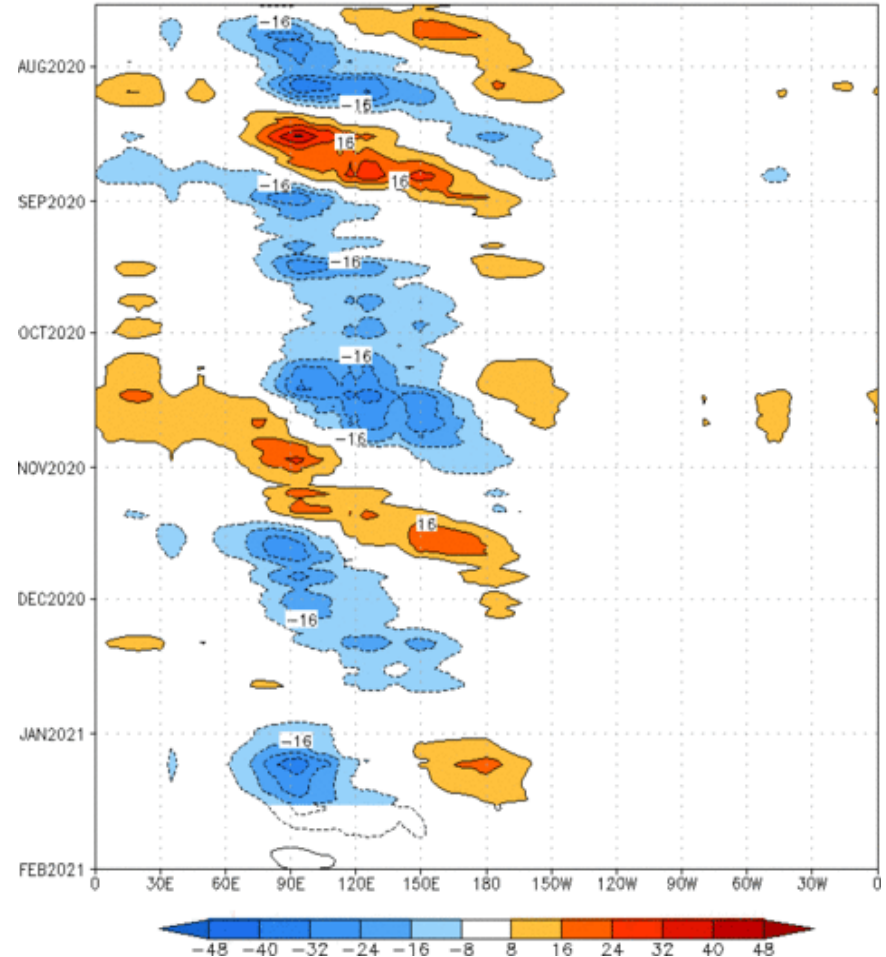
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (17 Jan 2021)



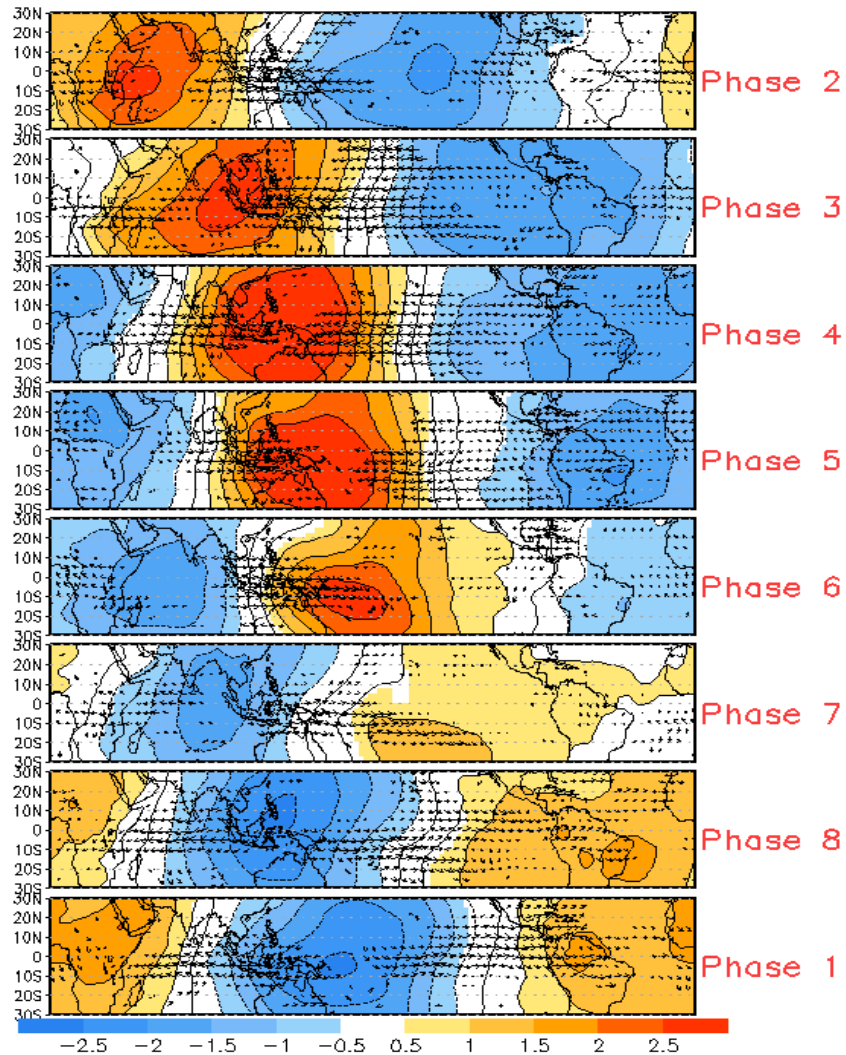
- The constructed analog also has a weak MJO signal.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:18-Jul-2020 to 17-Jan-2021
The unfilled contours are CA forecast reconstructed anomaly for 15 days



MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



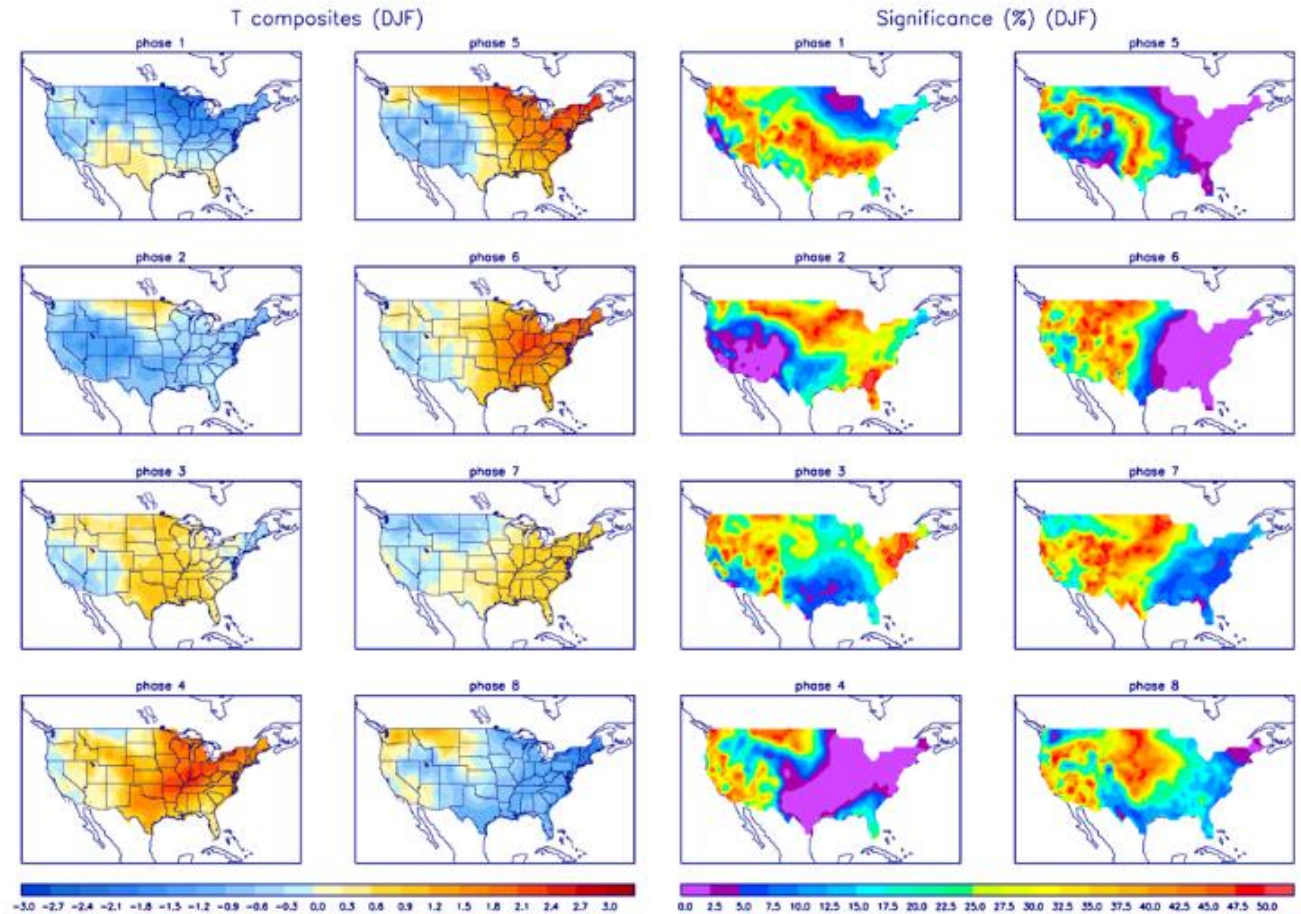
Precipitation Anomalies



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.

