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

Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
11 March 2019

Overview

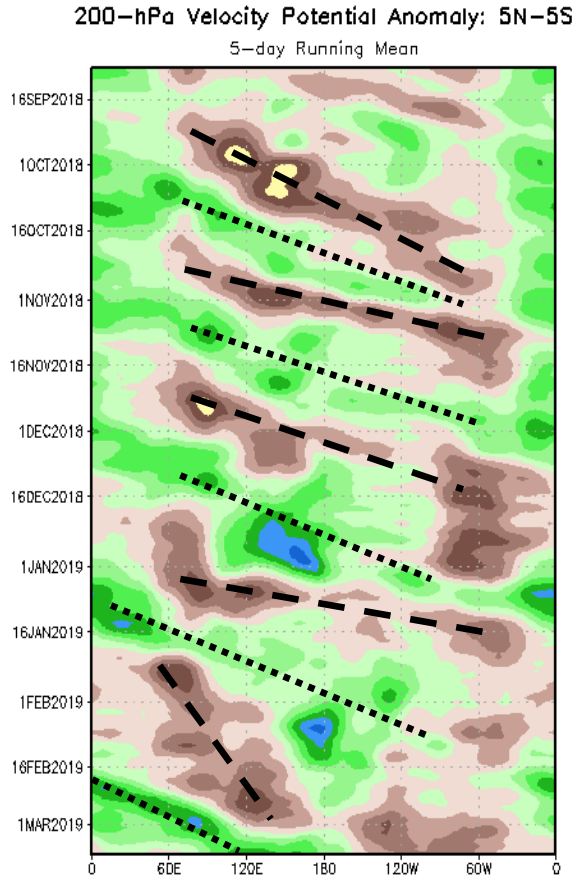
- The Madden Julian Oscillation continues to hang on as it moves over the Maritime Continent.
- Model guidance continues to forecast the MJO to weaken soon. This is not unusual as the MJO moves over the Maritime Continent; dynamical models often have difficulty with complex land interactions.
- The (purely statistical) constructed analog model forecasts the MJO to continue at roughly its current amplitude around the globe and re-emerge in RMM Phases 1/2 by the end of Week-2.
- These forecasts are very similar to last week's and highlight the models' inability to accurately capture the important interactions between the MJO and land, as well as Kelvin and equatorial Rossby wave activity.

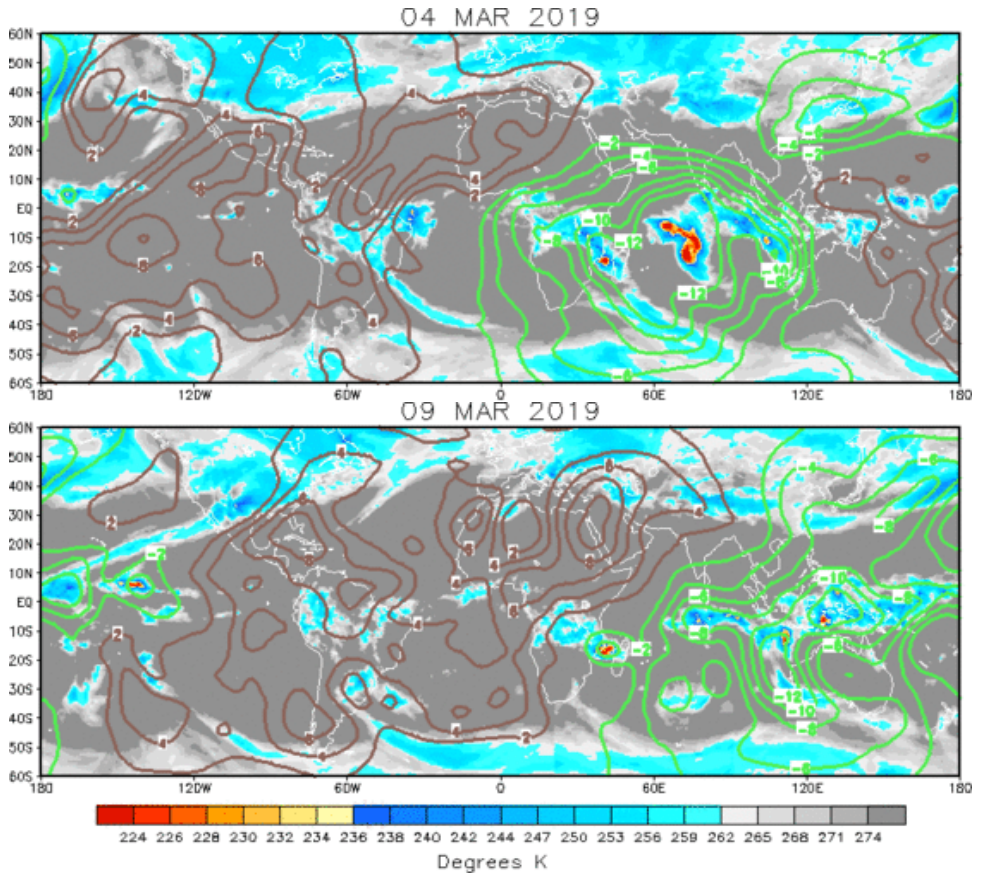
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

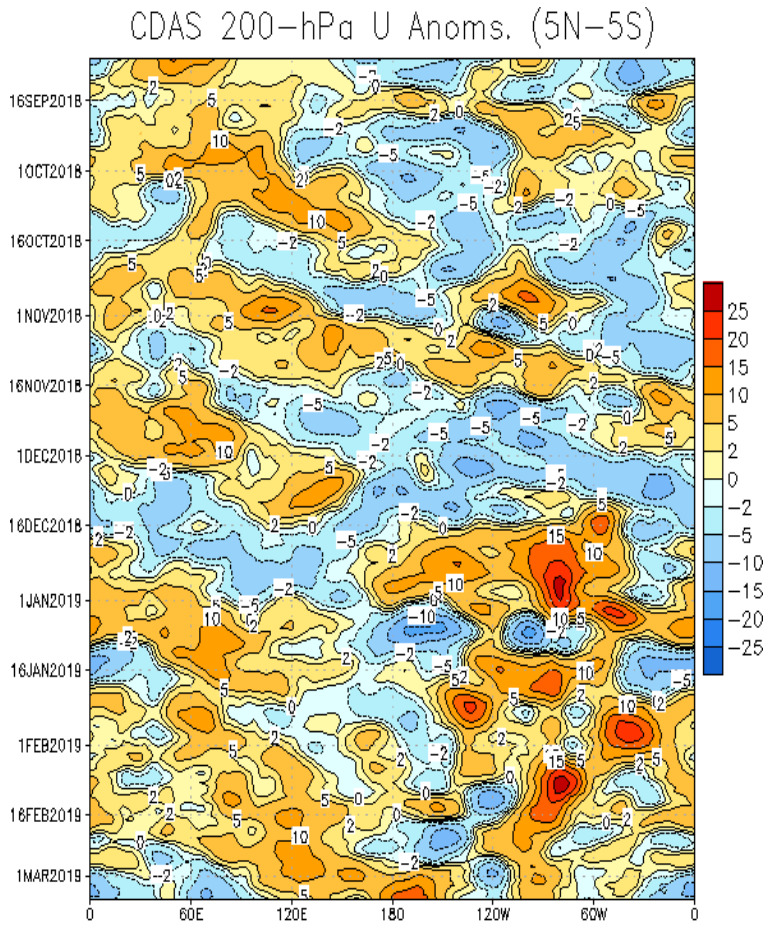


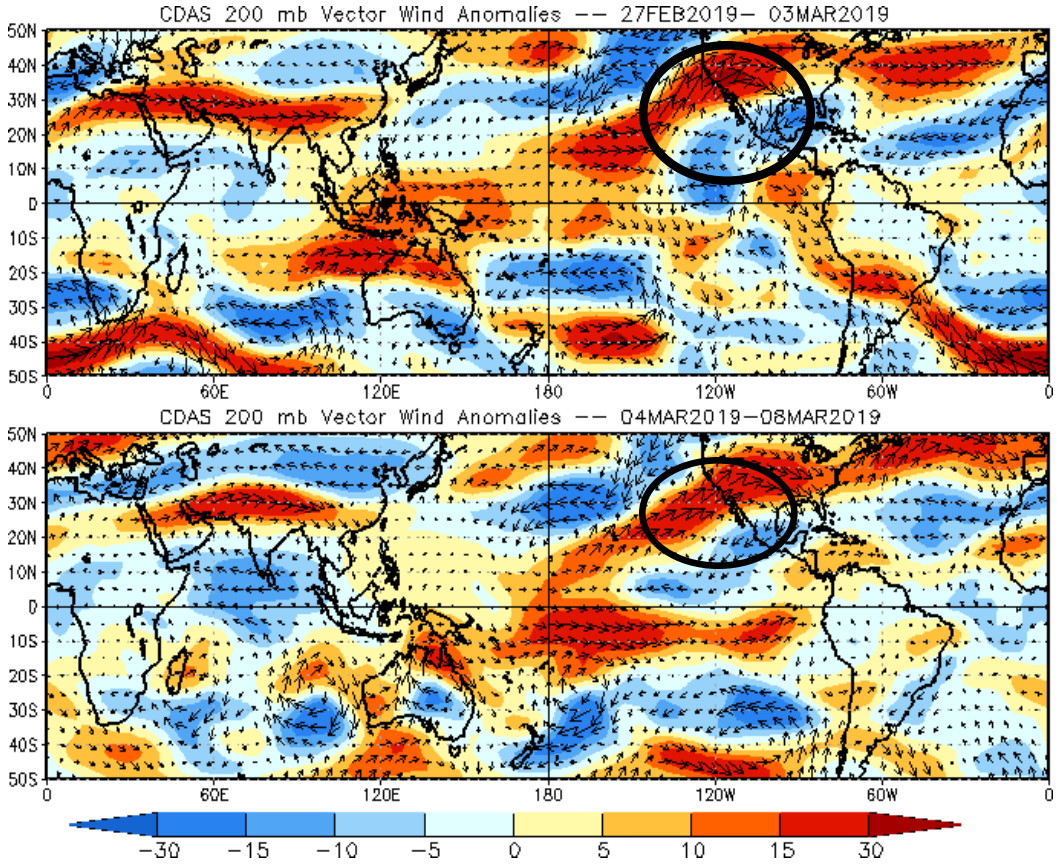


- The MJO has been active since September.
- Atmospheric Kelvin and equatorial Rossby wave activity have also been high during the past several months. There is evidence of a Kelvin wave circumnavigating the globe at least twice, most recently emerging from the Prime Meridian in mid-February.
- The upper-level velocity potential signal has weakened over the Maritime Continent during the past few days, consistent with the MJO's weakening.

200-hPa Wind Anomalies

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

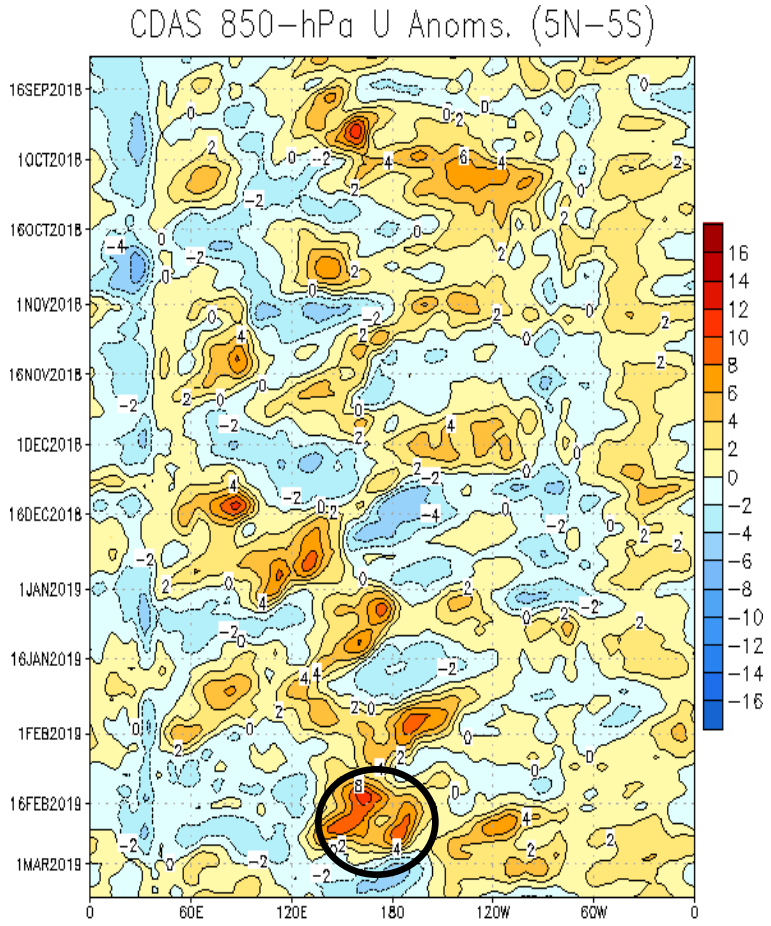


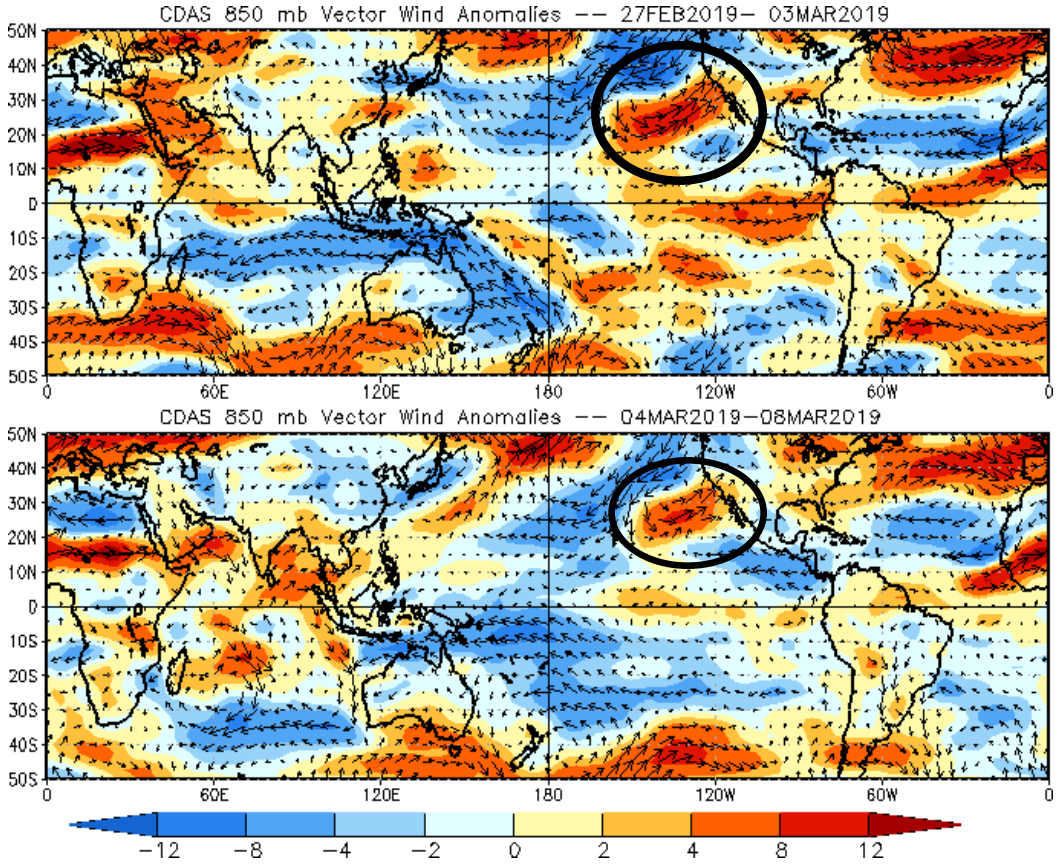


- The MJO has been active since September.
- There has been anomalous flow into southern California during the past few weeks, leading to above-average rainfall.
- There is evidence of mid-latitude wave breaking into the tropics, which helps enhance the cross-equatorial flow in the eastern Pacific and even contributes to the formation of an equatorial Rossby wave in late February.

850-hPa Wind Anomalies

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

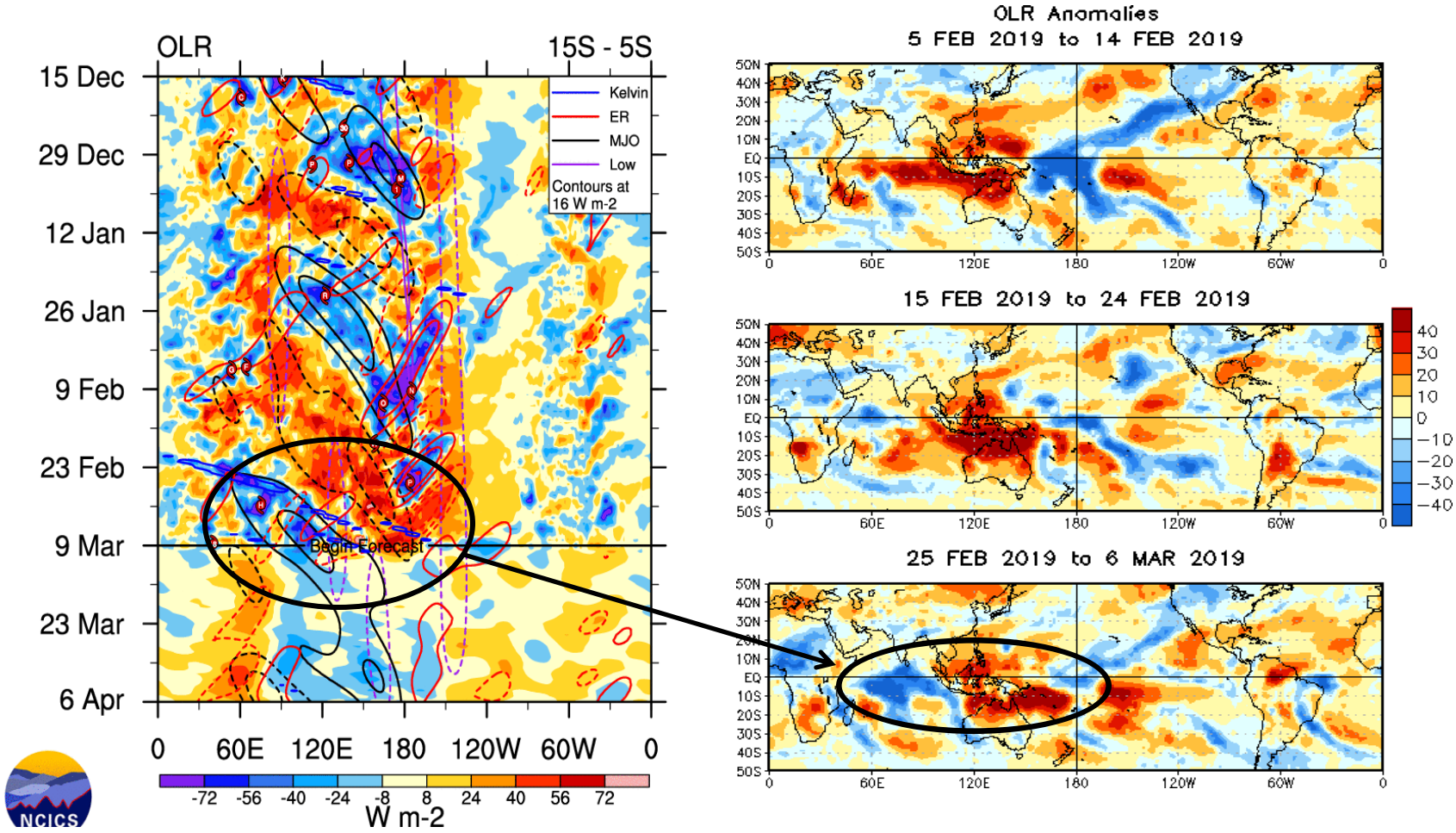




- The most recently westerly wind burst occurred around mid-February just west of the Dateline, partially the result of constructive interference between the MJO and an equatorial Rossby wave.
- There has been anomalous flow into southern California during the past few weeks, leading to above-average rainfall.

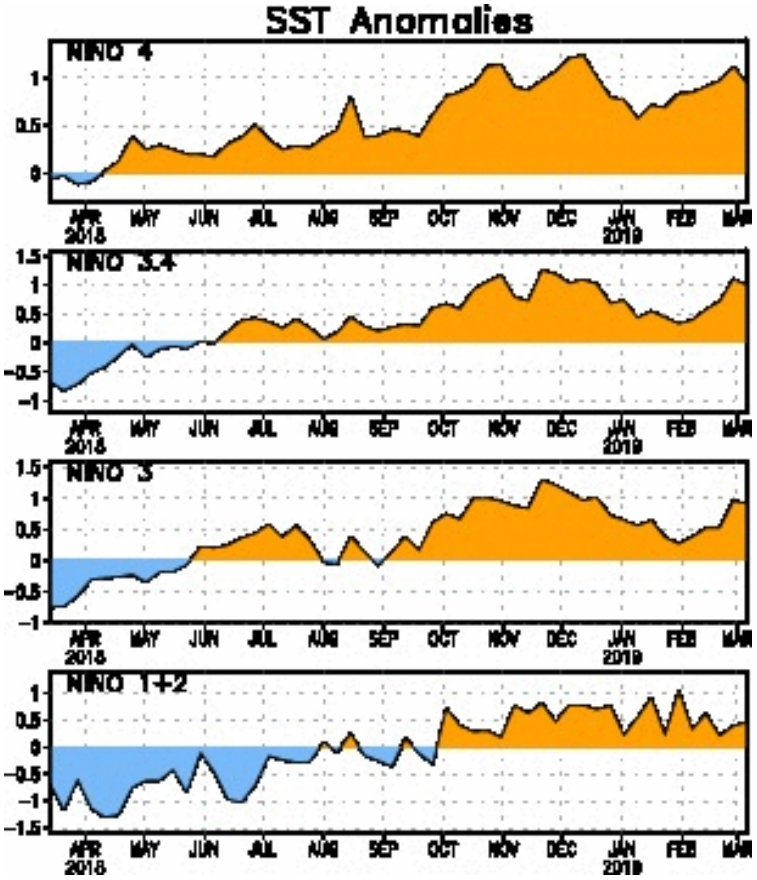
Outgoing Longwave Radiation (OLR) Anomalies

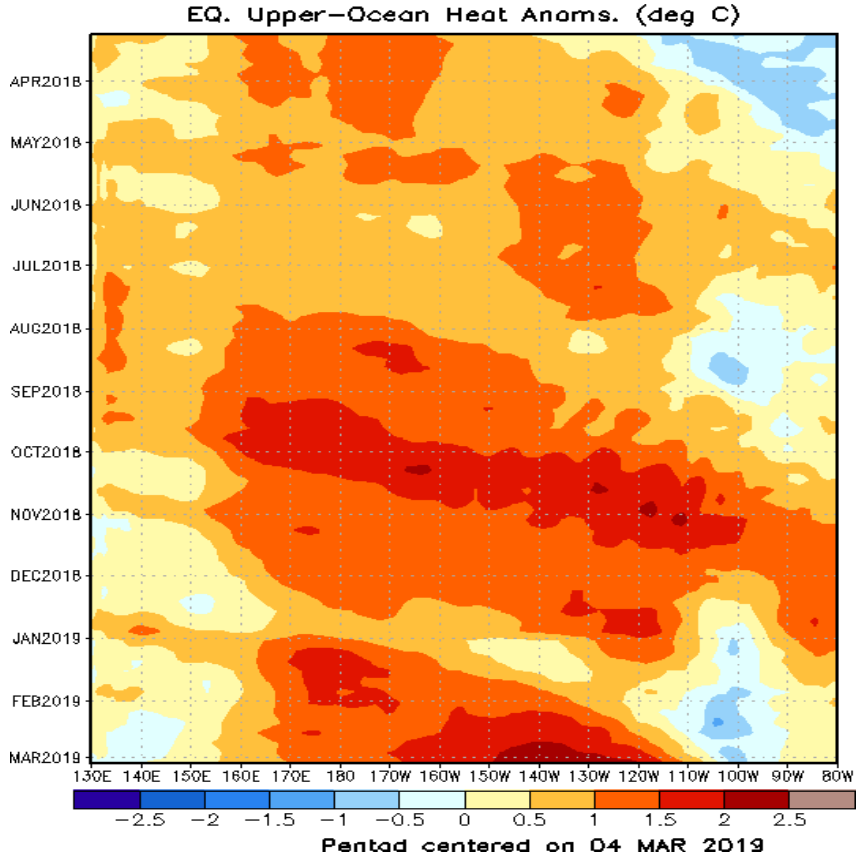
Blue shades: Anomalous convection (wetness). Red shades: Anomalous subsidence (dryness).



- Kelvin wave (blue contours) and equatorial Rossby wave (red contours) activity was observed going through the MJO's convective envelope (black contours) lately, which amplifies the MJO's usual footprint.
- The superposition of these three wave modes is responsible for the enhanced convection signal over the Indian Ocean and suppressed convective signal over the Maritime Continent.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

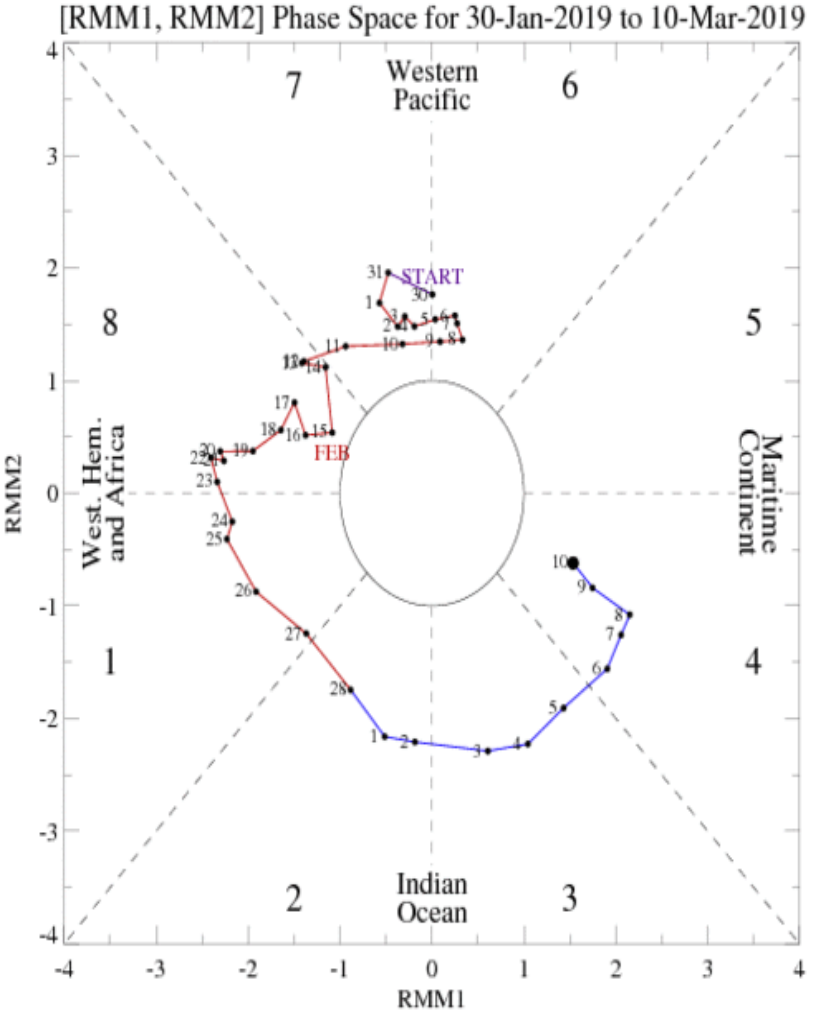




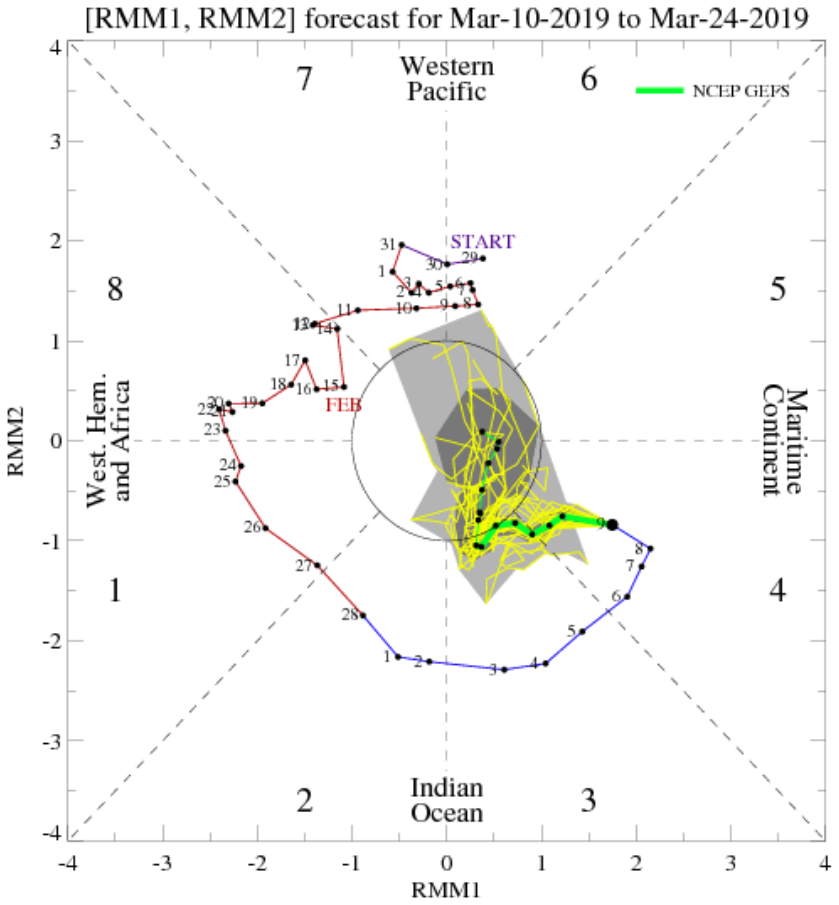
- SST anomalies in all four Niño regions are above climatology, consistent with an El Niño event.
- Positive oceanic heat content anomalies have been observed over most of the Pacific basin since last April.
- There was a downwelling Kelvin wave last Fall and another that began around the turn of the year. These likely helped push the thermocline down and develop the current El Niño.

MJO Index: Recent Evolution

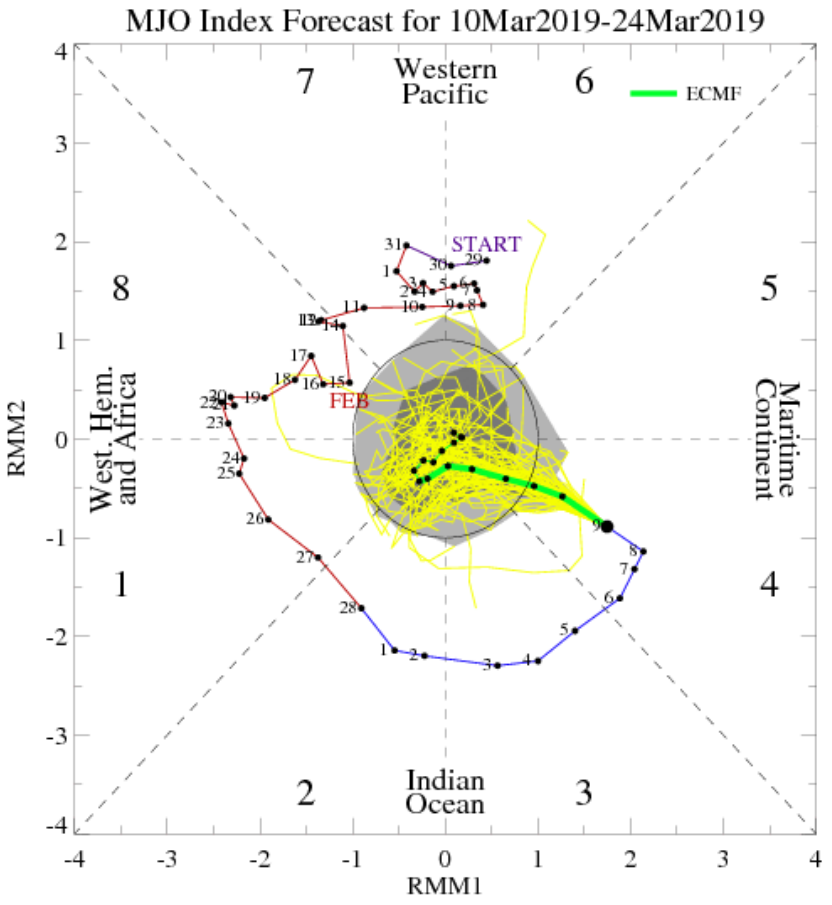
- The MJO is currently over the Maritime Continent in RMM phase 4.
- It has weakened substantially, in an RMM sense, during the past two days.
- The strong Kelvin wave that passed through the active portion of the MJO during the past two weeks is partially responsible for the high RMM amplitude in Phases 1-3 recently. This Kelvin wave has since moved out of the active MJO envelope, causing the RMM amplitude to weaken.



MJO Index: Forecast Evolution



GEFS Forecast

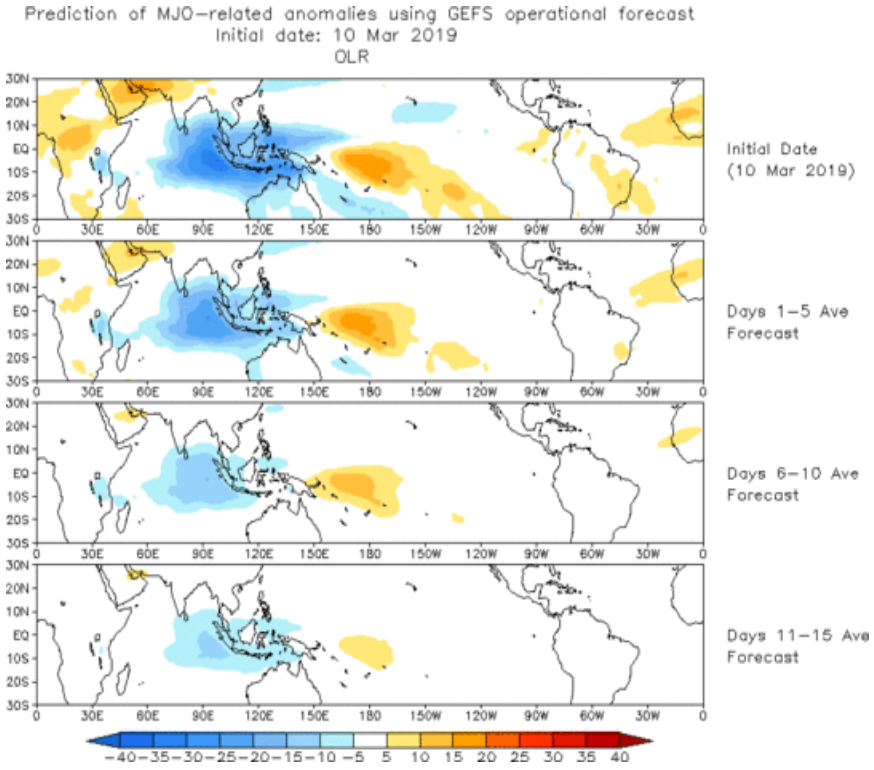


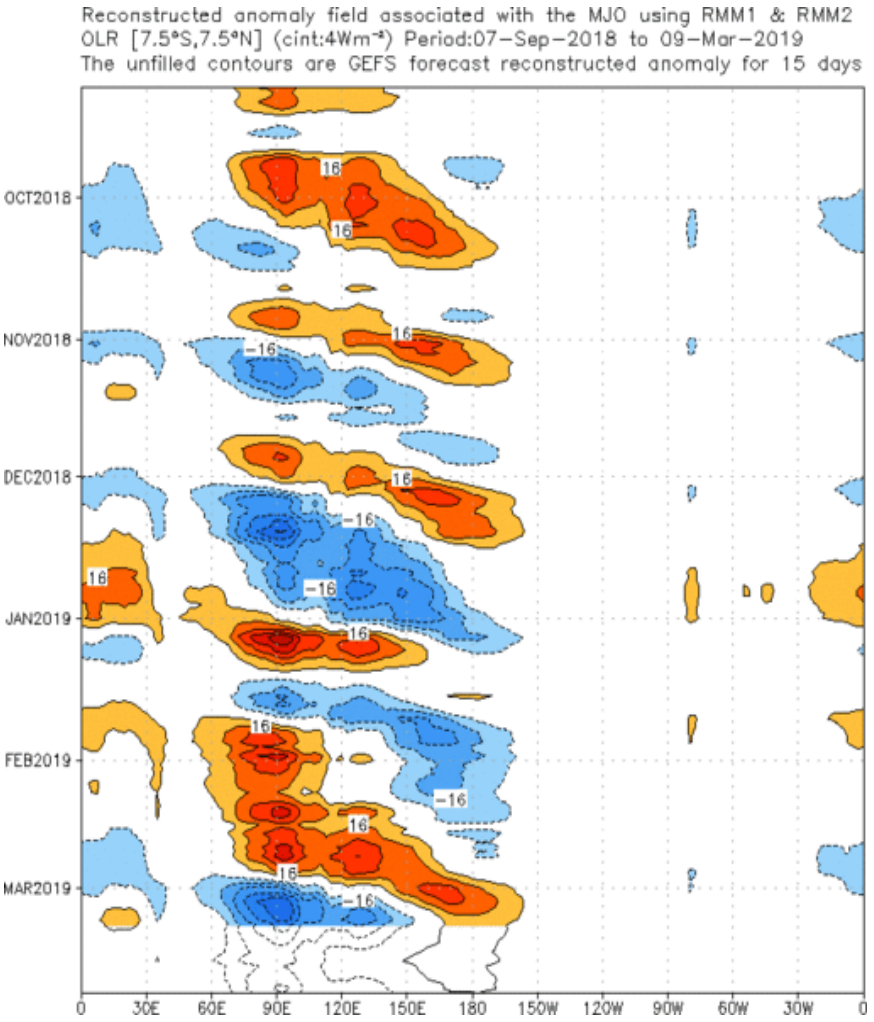
ECMWF Forecast

- The GEFS and ECMWF forecasts suggest that the MJO will weaken during Week-1.
- The GEFS holds on to stationary active convection over the Indian Ocean much longer than the ECMWF does.
- There is little evidence in dynamical models here or elsewhere that the MJO will re-emerge any time soon.

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.)



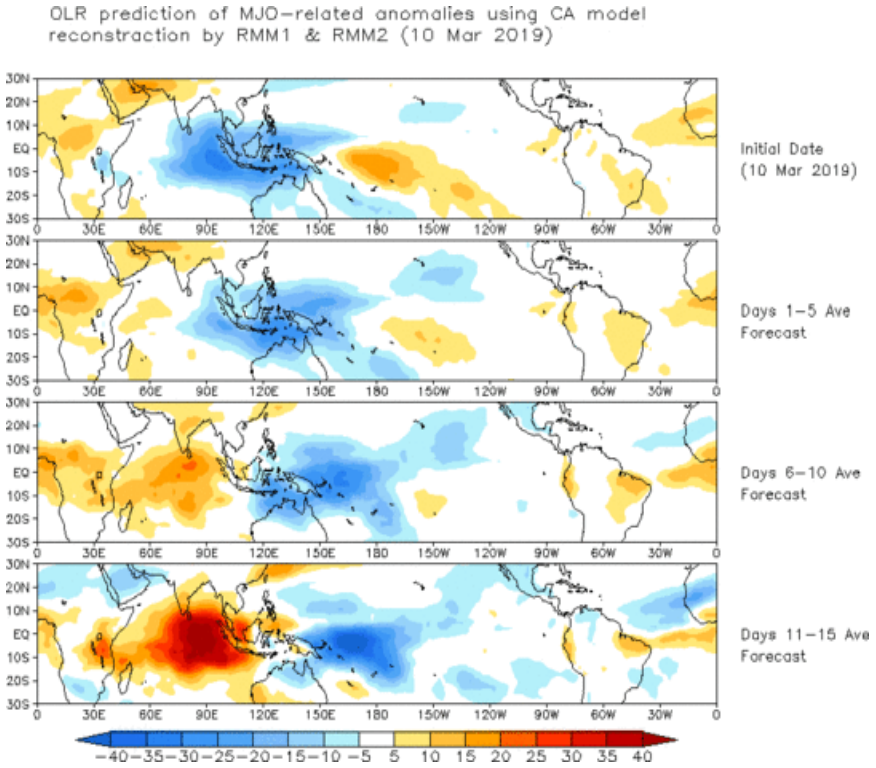


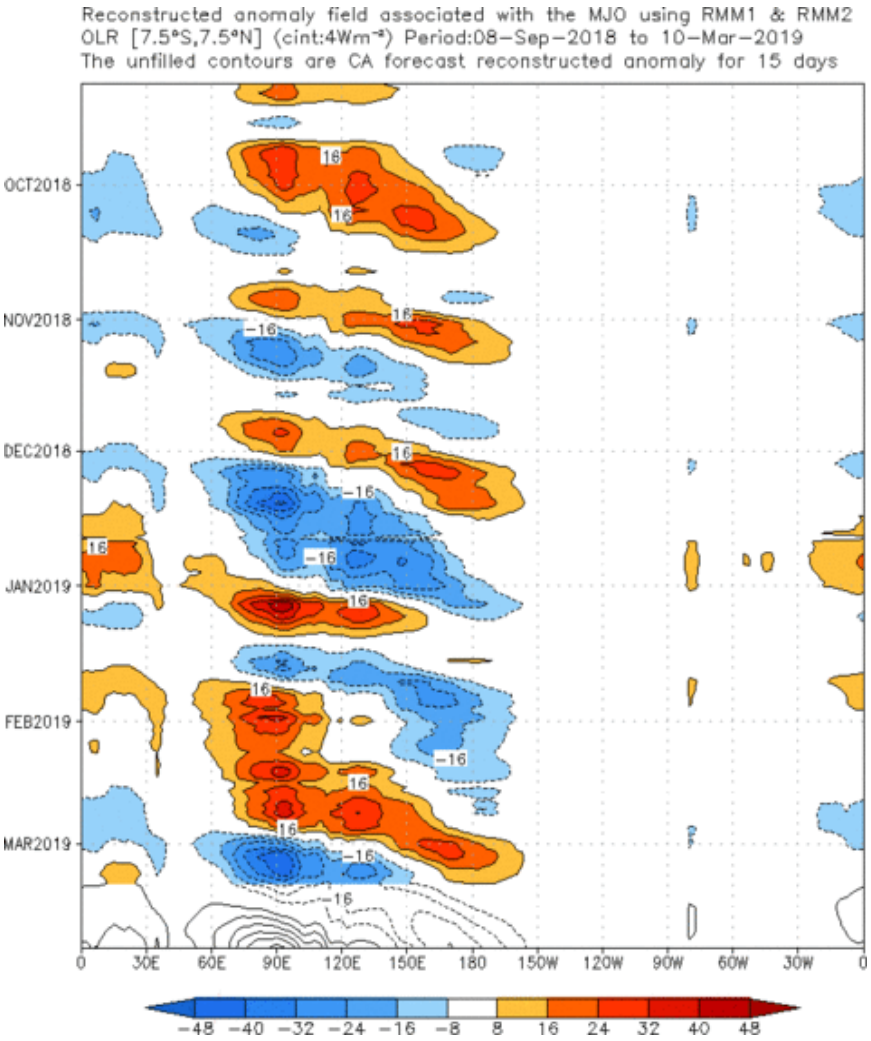
- Active convection associated with the MJO over the Indian Ocean is forecast to be stationary and weaken during the next two weeks.

- This is consistent with the GEFS RMM forecast from the previous slide.

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.)

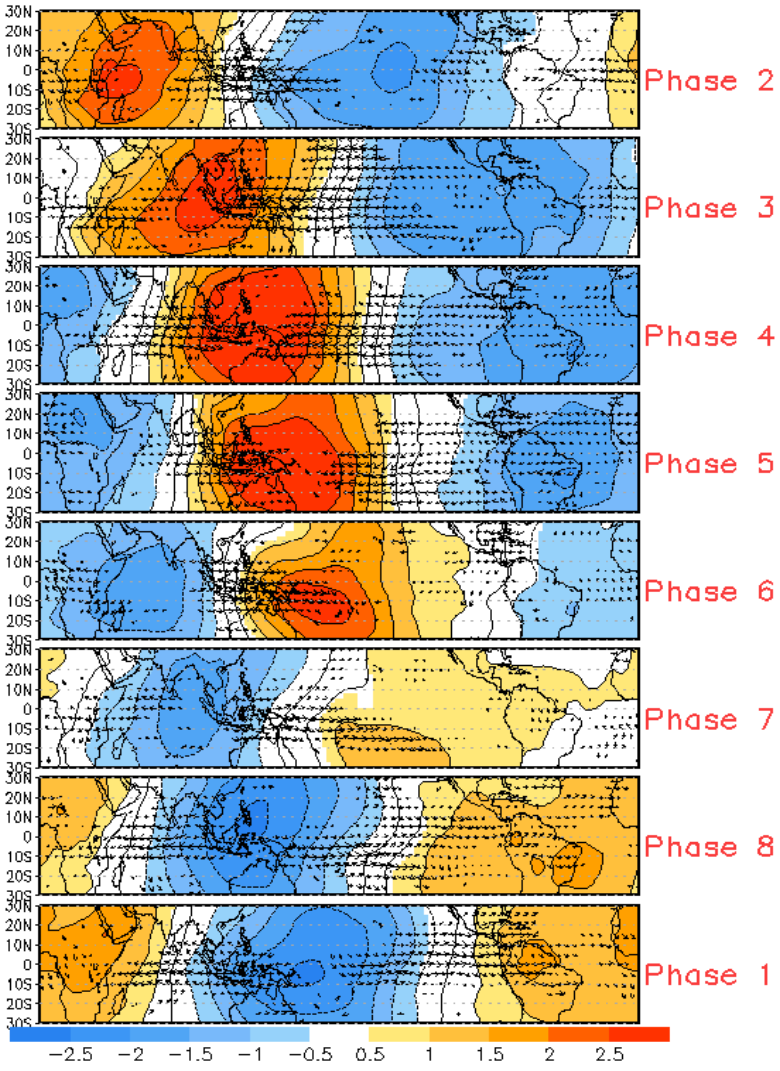




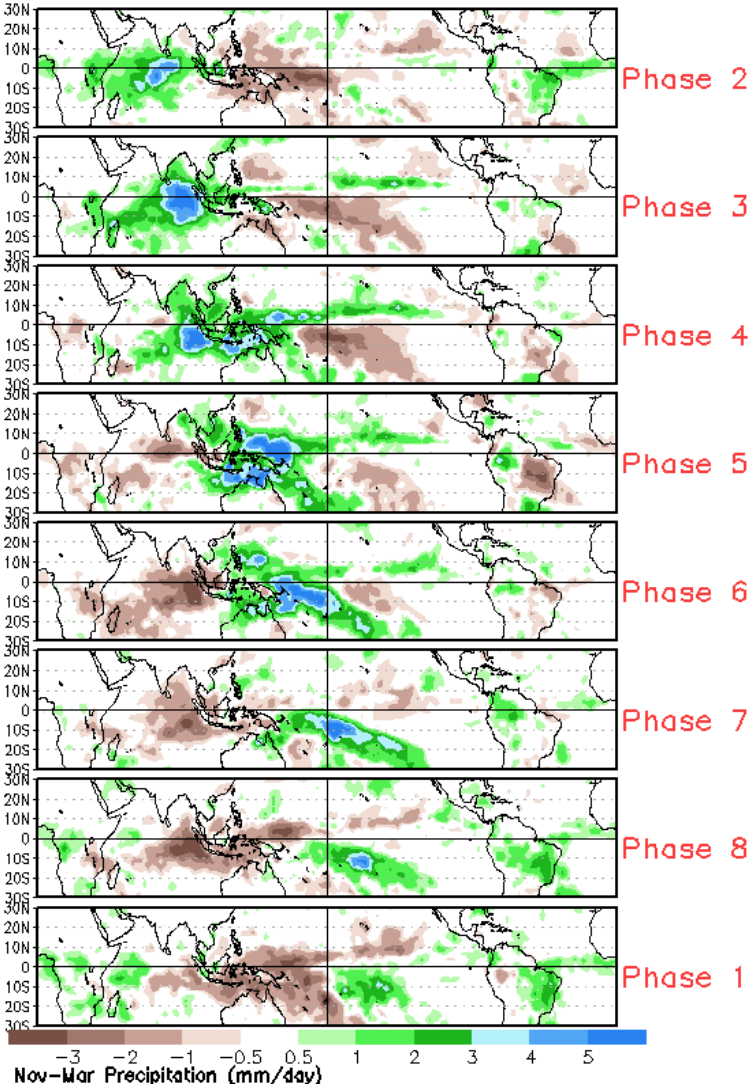
- The constructed analog propagates the MJO eastward quickly and showed evidence of it re-emerging over the Indian Ocean by the end of Week-2.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies (Nov - Mar)



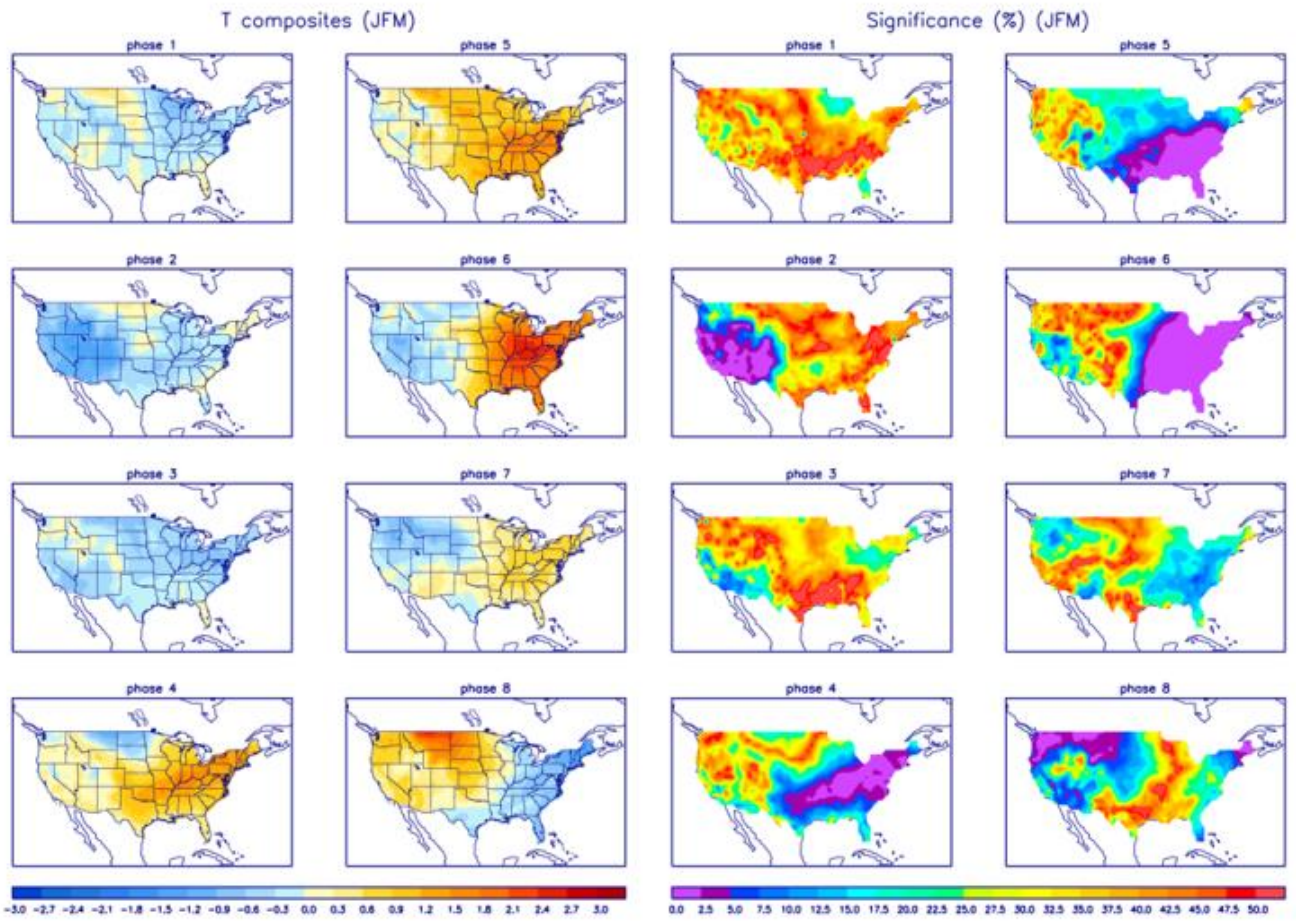
Precipitation Anomalies (Nov - Mar)



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 (orange) 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.

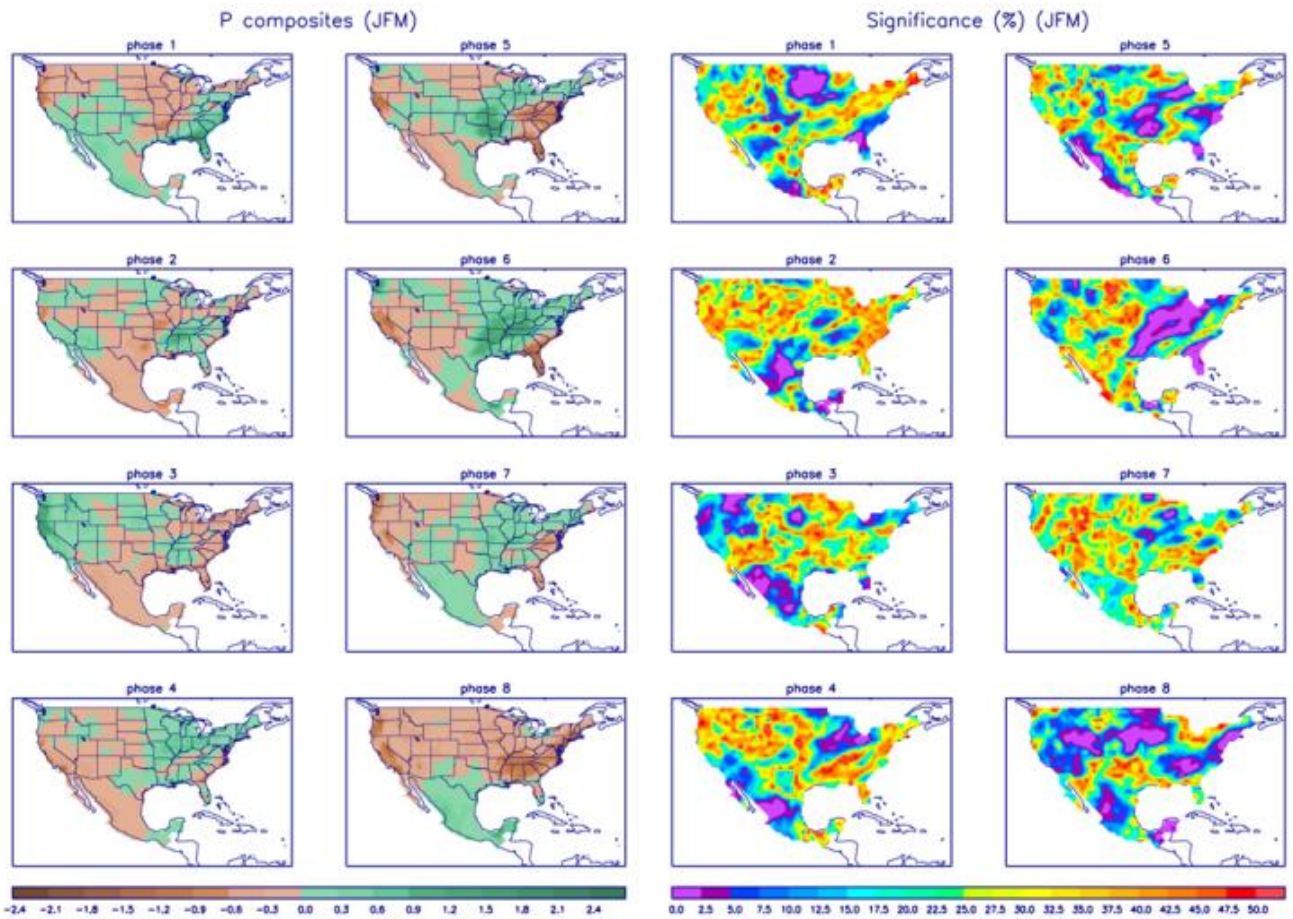


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

MJO: CONUS Composite Maps by RMM Phase - 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.



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