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Extratropical forcing of tropical wave disturbances along the Indian Ocean ITCZ

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The role of extratropical waves in the excitation of tropical waves along the Indian Ocean Intertropical convergence zone (ITCZ) during Austral summer is investigated using the JRA-25 products and NOAA outgoing long wave radiation data. The analysis period is December-February 1979/80-2007/08. The tropical waves along the ITCZ are identified by an extended EOF (EEOF) analysis on submonthly (6-30 days) filtered daily 850-hPa meridional wind anomalies. Composite analyses based on the EEOF results reveal the basic structure and evolution of the wave train along the ITCZ in the tropical Indian Ocean. The tropical waves with zonal wavelength of 3000-5000 km exhibit westward and southwestward phase propagation. Troughs and ridges of the wave train migrate westward and southwestward from the west of Sumatra into Madagascar. On the other hand, eastward and northeastward amplification of the wave train occurs associated with the successive growth of new troughs and ridges over the eastern Indian Ocean. This could be induced by wave energy dispersion along the mean monsoon westerly flow. The wave train seems to be a mixture of distorted equatorial Rossby waves and Mixed Rossby Gravity waves, and they play a vital role in modulating the ITCZ convection. The linkage between the tropical and extratropical waves which is responsible for the formation and strengthening of the tropical wave train is examined by performing a non-hierarchical cluster analysis on the meridional wind anomalies. The K-means clustering method is used to classify wave patterns over the Indian Ocean. Four circulation regimes (CR1-4) which represent tropical-subtropical wave patterns in their developing/decaying and mature stages are identified. Then transitions between two different regimes are considered to detect tropical wave development events associated with the extratropical wave propagation. Composites of circulation anomalies keyed to the regime transitions reveal that certain regime transitions exhibit a clear tropical-extratropical connection. One of the transition evens (transition CR3 to CR2) shows the progression of the mid- and high latitude Rossby wavetrain propagating eastward and northeastward from the South Atlantic into the subtropical Indian Ocean around the onset of the latter regime (CR2). As troughs and ridges that are part of the extratropical wavetrain approach southern Africa-Madagascar region, a wavetrain originating from those subsequently extends toward the tropical eastern Indian Ocean. By one day after the onset, a southwest-northeast oriented wavetrain extending across the higher latitude South Atlantic to the lower latitude Indian Ocean is established, and its tropical part is maximally amplified. Wave activity flux diagnostics indicate that wave energy dispersion into the tropical Indian Ocean occurs along this wavetrain. These results suggest that the tropical-extratropical interaction associated with the extratropical Rossby wave propagation plays an important role in reinforcement of the tropical waves along the Indian Ocean ITCZ.