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Equatorial Rossby waves during the Year of Tropical Convection.

Stephanie Leroux[†]; George Kiladis
[†] ESRL, NOAA, USA
Leading author: stephanie.leroux@noaa.gov

The analysis of Equatorial Rossby (ER) waves is perhaps more problematic than any of the other Convectively Coupled Equatorial Waves (CCEWs) since their slow phase speeds and broad spatial scales allows them to be strongly modulated by propagation through varying background wind states. In particular, wind anomalies associated with the Madden-Julian Oscillation (MJO) are similar in magnitude to the phase speeds of ER waves. Conversely, ER waves ahead of a propagating MJO may modulate its amplitude and timing. In any case, the way ER waves are affected by and interact with the MJO remains unclear. Here we combined a statistical description of ER wave structures by season through EOF analysis with the examination of 3 individual cases observed during the coordinated observation period of the "Year" of Tropical Convection (YOTC), showing each different timing relationships with respect to the MJO. We first isolate ER waves through an Empirical Orthogonal Function (EOF) analysis performed on the whole tropical band and on various subdomains of both westward filtered NOAA 2.5ox2.5o Outgoing Long-wave Radiation (OLR) data (used as proxy for tropical deep convection) and NCEP reanalysis stream-function at 850 hPa. The statistical structure of ER waves is then revealed by projecting dynamical variables and raw OLR onto the principal components (PCs) for different time-lags. The analysis shows strong variations from one season to the other, consistently with the results of previous statistical studies. ER waves with symmetric structures across the equator are mostly seen propagating from the Central Pacific to the Warm pool during the northern hemisphere winter (November-March). Interestingly, these are clearly statistically preceded by a strong extra-tropical wave signal in the upper levels in the East Pacific. For the summer season (May-September), the EOF analysis emphasizes a more asymmetric structure, with northern gyres being considerably more developed than their southern counterparts as they propagate northwestward over the warm pool. Based on the Principal Components' (PC) time-series of the above analysis, we describe the variations in ER wave activity during the Year of Tropical Convection (YOTC), and we select 3 cases of observed individual ER within the periods of high activity to investigate in more detail. A first case is examined in May 2008, when no strong eastward MJO signal can be observed. A second case is examined in January/February 2009 during which a separate, slow eastward propagating convective anomaly is initiating at the same time over the Indian Ocean. This feature subsequently dies off before the dateline, possibly as a result of the merging with the ER wave signal. A third case that differs from the EOF patterns described before is also examined in October 2008, when an ER-like structure is observed propagating westward in the Indian Ocean at the same time as an MJO starts moving eastwards in the basin. Interestingly, this ER wave signal reaches East-Africa and may subsequently have a role in modulating convection in the West-African monsoon. For each of the 3 cases, the horizontal and vertical structure of the ER wave is analyzed, and shows significant variations with longitude.