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A Survey of Synoptic Waves over West Africa

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Motivated by the pronounced wave-to-wave variability in African easterly wave (AEW) circulation, the three-dimensional structure of synoptic waves over West Africa is revisited with an Empirical Orthogonal Function (EOF) approach to isolate the dominant wave pattern. In this talk we present results of EOF analyses conducted with brightness temperature (Tb) derived from satellite observation and meridional wind at multiple levels from reanalysis data to examine the characteristics and variability of synoptic waves. The structure of waves is extracted by projecting the wind fields and Tb onto the principle components associated with EOF patterns of appropriately filtered parameters.

The Tb EOF shows a confined AEW circulation centered around 7.5°N and a distinct evolution of convection within the wave in line with previous research. However, in striking contrast to the confined flow pattern in the Tb EOF, the EOF of 700-hPa meridional wind is distinguished by a meridionally broad AEW circulation. While the peak in circulation is centered around 10°N, there is marked cross-equatorial flow that is associated with an antisymmetric geopotential signature across the equator. This suggests the presence of a mixed Rossby-gravity wave (MRG) structure consistent with Matsuno's shallow water theory. Granted that the vast majority of studies on MRGs focus on the central and western Pacific region, this "hybrid" between AEWs and MRGs over West Africa and Atlantic sector has received little attention and more work regarding the nature and causes of its wave structure and behavior is needed.

In addition, an upper-level synoptic wave is captured by EOFs of 200-hPa meridional wind. The kinematic fields reveal a continental-scale wave straddling the equator that resembles an MRG. This upper-level MRG appears to develop in situ over the Horn of Africa and intensifies as it moves across the continent. The associated lower-level structure shows an AEW-like circulation but with a larger spatial extent. This finding motivates the need for more in-depth investigations of synoptic wave variability over the region including an assessment of the direction of causality between the upper-level MRG and the lower-level AEW.

This study highlights the various synoptic wave structures over West Africa and their interaction with AEWs. The results suggest the variability of AEW activity could be modulated by, in addition to the large-scale environment, other synoptic waves in the region. We will pursue the EOF approach to shed light on the characteristics and causes of the variability in synoptic wave activity over West Africa.