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A new born hypothesis for the Madden-Julian Oscillation (MJO)

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More than half of the globe is considered the tropics, thus a proper understanding of the tropical atmosphere is crucial for improved global forecasts as well as the projections of the global climate change. The tropical atmosphere is traditionally considered dominated by moist cumulus convection associated with strongly divergent horizontal flows. The Madden-Julian Oscillation (MJO) is the dominant slowly eastward propagating mode of intra-seasonal planetary scale variability in the tropical atmosphere. Previous theoretical studies, modeling, and field observations have contributed positively to our understanding of MJO; nevertheless, there is no robust theory for a few aspects of the dynamics of MJO such as its initiation, role of moist-convection on propagation speed, the barrier effect of the Maritime Continent on MJO propagation, and its slowly eastward propagation mechanism, which are poorly understood. Understanding the essential dynamics of the MJO is the "holy grail"in the study of tropical dynamics and atmospheric science research (Fuchs & Raymond, 2017). By using a hierarchy of models and theoretical studies, we raise this hypothesis that MJO-like skeleton can be generated in a self-sustained manner from a large-scale localized heating in the lower troposphere, over the warm pool, as a "hybrid structure". The latter is constituted by combination of a "equatorial modon"and convectively coupled by detaching baroclinic Kelvin wave that lasts for an interseasonal scale. The presentation includes a summary of five articles that have been published recently in some ISI journals by the authors.

Firstly, we show the construction of new improved moist-convective Rotating Shallow Water (mcRSW) model (Rostami and Zeitlin, 2018) and its well-balanced, shock capturing, front resolving, finite volume scheme features. Secondly, we explain one of the main observations of the authors that was discovery of a nonlinear dynamical regime in the Rotating Shallow Water (RSW) model which arises in the limit of small pressure variations and gives a slow propagating coherent dipolar structure so called "Equatorial Modon"(Rostami and Zeitlin, 2019a). Thirdly, we demonstrate that in the pioneering work by authors (Rostami and Zeitlin, 2019b) the Equatorial Modon's structure can also be emerged from the process of geostrophic adjustment of localized large-scale depression-type disturbance in the mcRSW model on the equatorial beta-plane. Other dynamical features of equatorial modons, such as loss of coherency, eastward propagating phase speed, role of bottom topography, etc have been investigated too (Rostami and Zeilin, 2020a). Finally, by reproducing "generation"of MJO-like structure from geostrophic adjustment of baroclinic disturbances in tropical atmosphere, we propose the aforementioned hypothesis as the backbone structure of the MJO (Rostami and Zeitlin, 2020b).

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