“Essential dynamics of the Madden-Julian Oscillation”

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Understanding the origin and perpetuation of the Madden-Julian Oscillation (MJO) has eluded scientists for decades. In this presentation, I shall first discuss the fundamental features of MJO and boreal summer intraseasonal oscillation (BSISO) that request theoretical explanations. I shall then discuss physical processes that are involved in the MJO dynamics. A general theoretical framework with a model describing MJO dynamics is proposed in an attempt to unify the existing theories.

A frictionally coupled Kelvin-Rossby wave theory with two types of simplified cumulus parameterizations will be presented to explain some indispensable atmospheric dynamics of MJO by addressing the following questions: (a) how equatorial Kelvin and Rossby waves that propagate in opposite directions can couple together with convection and select slow eastward propagation; (b) what the instability and energy sources are for sustaining MJO, and (c) why MJO has a preferred planetary zonal circulation scale.

A more general intermediate-complexity model will be further formulated to explain the observed characteristics of BSISO by including the impacts of boreal summer mean states. Using this intermediate model, I will further discuss how the boreal summer mean state affects BSISO, in particular, why the BSISO has maximum variability centers in the monsoon trough regions, and why the BSISO features a NW-SE titled rainfall band and moves dominantly northward in the monsoon regions.

If time allows, a theoretical model for MJO interaction with synoptic scale eddies will be used to discuss how and the way by which the upscale eddy momentum, heat, and moisture transfer could affect MJO dynamics.