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Madden-Julian Oscillation: Its potential vorticity vs. Gill-model interpretations

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The challenge of understanding and predicting the Madden-Julian Oscillation (MJO) motivated a major international field campaign over the tropical Indian Ocean to study convective initiation of the MJO (CINDY/DYNAMO, October 2012 – March 2013). An introduction to this field campaign, its data collection and preliminary results is given in Session AS1.9. In this talk, connections between field observations, especially diabatic heating, and large-scale dynamics of the MJO are discussed.

The Gill-model solutions have been commonly used to interpret the dynamic structure of the MJO. The zonal wind anomalies east of the MJO convection center are generally described as the Kelvin wave component of the MJO and the low-level (high-level) cyclonic (anticyclonic) circulations as the equatorial Rossby wave component. A potential vorticity (PV) analysis indicates that such interpretation of the MJO in terms of the Kelvin and Rossby waves are not always accurate and can be misleading. The circulation pattern of the MJO is distinct from those of the Kelvin and Rossby waves and other types of non-MJO convective activities. It is suggested that large-scale convective organization in a certain way that allows PV generation of the MJO is a key to MJO dynamics. Two processes dominate PV generation of the MJO. One is MJO self-sustainment, which involves diabatic heating of the MJO and planetary vorticity. Another represents stochastic processes contributed from diabatic heating and vorticity unrelated to the MJO and other equatorial waves.