

## Poster abstract

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The Madden-Julian oscillation (MJO), the dominant tropical intraseasonal variability with widespread meteorological impacts, continues to puzzle the climate research community on both theoretical and modeling fronts. Motivated by a recent interest in the role of humidity in tropical dynamics, this research hypothesizes that the MJO is a nonlinear moisture mode whose existence depends on moisture-convection feedback, the feedback between deep convection and environmental free-tropospheric humidity, and that weak moisture-convection feedback in general circulation models accounts for their deficiencies with the MJO simulations.

In particular, it hypothesizes that (1) in the initial stage of the MJO, a quasi-stationary moisture mode grows over the Indian Ocean; and (2) in the second stage, the nonlinearly saturated moisture mode moves eastward because of moist processes.

Linear analysis with the quasi-equilibrium tropical circulation model (QTCM) of Neelin and Zeng demonstrates that a moisture mode is unstable if the moist static energy sources exceed its export as Fuchs and Raymond found in previous studies. Perturbation expansion shows that the weak temperature gradient approximation of Sobel et al. describes the small-scale limit of the moisture mode. Gustiness plays a key role as a moist static energy source, along with cloud radiative forcing.

To explore the nonlinear regime of a moisture mode, numerical calculations of a simplified QTCM on the equatorial beta-plane have been performed. A classical Gill model augmented with a prognostic humidity variable captures the nonlinear dynamics of the moisture mode. In particular, nonlinear advection of dry air by Rossby gyres is found to move the moisture mode eastward.

Although the research illuminates a new physical process, it suffers from a number of problems. The most significant issue is that moisture mode instability favors the smallest scale in the linear regime, as found in previous studies. The author suggests that scale interaction and its effect on the humidity budget might be an important research topic.