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Title: Planetary Circulations in the Presence of Transient and Self-Induced Heating

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Background: The research program focuses on large-scale circulations and their interaction with the global convective pattern.

Progress: An 11-year record of global cloud imagery and contemporaneous fields of motion and temperature have been used to investigate organized convection and coherent variability of the tropical circulation operating on intraseasonal time scales. This study provides a detailed portrait of tropical variability associated with the so-called "Madden-Julian Oscillation" (MJO). It reveals the nature, geographical distribution, and seasonality of discrete convective signal, which is a measure of feedback between the circulation and the convective pattern. That discrete spectral behavior has been evaluated in light of natural variability of the ITCZ associated with climatological convection.

A composite signature of the MJO, based on cross-covariance statistics of cloud cover, motion, and temperature, has been constructed to characterize the lifecycle of the disturbance in terms of these properties. The composite behavior has also been used to investigate the influence the MJO exerts on the zonal-mean circulation and the involvement of the MJO in transfers of momentum between the atmosphere and the solid Earth.

The aforementioned observational studies have led to the production of two animations: One reveals the convective signal in band-pass filtered OLR and compares it to climatological convection. The other is a 3-dimensional visualization of the the composite lifecycle of the MJO.

Current Research: With a clear picture of the MJO in hand, feedback between the circulation and the convective pattern can be diagnosed meaningfully in numerical simulations. This process is being explored in calculations with the linearized primitive equations on the sphere in the presence of realistic stability and shear. The numerical framework represents climatological convection as a space-time stochastic process and wave-induced convection in terms of the vertically-integrated moisture flux convergence.

In these calculations, frictional convergence near the equator emerges as a key to feedback between the circulation and the convective pattern. At low latitudes, nearly geostrophic balance in the boundary layer gives way to frictional balance. This shifts the wave-induced convection into phase with the temperature anomaly and allows the attending heating to feed back positively onto the circulation. The calculations successfully reproduce the salient features of the MJO. They are being used to understand the growth and decay phases of the composite lifecycle and the conditions that favor amplification of the MJO.

Publications:

Salby, M. and H. Hendon, 1992: Intraseasonal behavior of clouds, temperature, and motion in the tropics. *J. Atmos.* (to be submitted).

Hendon, H. and M. Salby, 1992: The structure and evolution of the Madden-Julian oscillation. *J. Atmos.* (to be submitted).

Hendon, H. and M. Salby, 1992: Vertical momentum transfer associated with the Madden-Julian oscillation. *J. Geophys. Res.* (to be submitted).

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Tanaka, K., Hendon, H., and M. Salby, 1992: Intraseasonal Behavior of Convection in the Tropics. Computer animation, SVHS video, 10 mins. Available from CATA.

Callaghan , P., Tanaka, K., Salby, M., and H. Hendon, 1992: Structure and Evolution of the Madden-Julian Oscillation. Computer animation, SVHS video, 5 mins. Available from CATA.