A Satellite Study of the Atmospheric Forcing and Response to Moist Convection

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In this talk a satellite data analysis is presented to explore the thermodynamic evolution of tropical and subtropical atmospheres prior and subsequent to moist convection, motivated to offer an observational testbed for convective adjustment central to the quasi-equilibrium hypothesis. Tropical Rainfall Measuring Mission (TRMM) and Aqua satellite measurements are projected onto a composite temporal sequence over an hourly to daily time scale by exploiting the temporal gap between the local satellite overpasses that changes from a day to another. The atmospheric forcing and response to convection are investigated separately for deep convective and congestus clouds. Convective adjustment is found quick and efficient in the deep Tropics during times when deep convection is active. Moisture transport from the atmospheric boundary layer (ABL) to the free troposphere is evident in association with deep convection. The evolution of convective available potential energy (CAPE), however, is controlled not only by the ABL moisture but also largely by a coincident lower-tropospheric cooling. CAPE exhibits a rapid drop for 12 h preceding convection and a following restoring phase lasting a day or two as the cool anomaly recovers. The lower-tropospheric cooling is accompanied 180° out of phase by a mid- to upper-tropospheric warming, together comprised of a bipolar temperature anomaly. The behavior of CAPE is quite different when moist convection is brought by congestus clouds with no deep convection nearby. CAPE gently increases over a period of 1-2 days until congestus occurs and then declines as slowly back to the initial level. Convective adjustment is not efficiently at work even in the deep Tropics at times when convective clouds are not developed so deep as to penetrate the whole troposphere. Subtropical atmosphere shows no sign of convective adjustment whether or not vigorous convection is present.