Response of the Tropical Boundary Layer to Weak Surface Forcing

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During the Tropical Ocean Global Atmosphere Coupled Ocean Atmosphere Response Experiment (TOGA COARE), a series of airborne thermal infrared observations and in situ atmospheric measurements were made near the sea surface through heights exceeding 4 km. Near surface radiometric measurements obtained for atmospheric conditions under which the surface exchange is primarily buoyancy driven demonstrate that sea surface temperature (SST) in the tropics is not homogeneous over 1 to 100 km spatial scales. Variations as large as 1.5 °C can occur in just tens of kilometers. Under conditions of suppressed convection, small-scale cloud processes which moisten levels above the marine atmospheric boundary layer (MABL) may be directly coupled to SST variation. The tropical boundary layer is typically capped by a weak temperature inversion, so that the growth of the boundary layer by encroachment simply depends on buoyancy supplied by water vapor. The amount of available water vapor in turn is determined by the SST. Under these conditions, therefore, the depth of the boundary layer increases with SST. An examination of boundary layer humidity structure reveals that during periods of high insolation, the height of the MABL nears the observed maximum when the SST exceeds 29 °C. This observation holds only for low wind conditions. Temperature mixing curves show the MABL and atmosphere above is near saturation. Hence, high SST may be important precursor for deep convection, since a small perturbation in the boundary layer could result in saturation throughout the column.

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