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A mechanism for formation of TTL cirrus associated with deep convection

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In-situ measurements from off the coast of Honduras during the July 2002 CRYSTAL-FACE experiment showed an example of TTL cirrus associated with, and penetrated by, deep convection. The cirrus was enriched with total water compared to its surroundings, but was composed of extremely small ice crystals with effective radii between 2 and 4 μm. Through gravity wave analysis, and intercomparison of measured and simulated cloud microphysics, it is argued that the TTL cirrus in this case originated neither from detrainment, convectively-forced gravity wave motions, nor environmental mixing alone. Rather, it is hypothesized that some combination was involved in which, first, forced cooling ahead of convective uplift led to pileus cloud forming within TTL air; second, the convection punctured the pileus layer, contributing larger ice crystals through interfacial mixing; third, the addition of condensate inhibited evaporation of the original pileus ice crystals in the warm phase of the ensuing gravity wave; fourth, through successive pulses, deep convection formed the observed layer of TTL cirrus. While the general incidence and longevity of the process remains unknown, in-situ measurements, and satellite-based Microwave Limb Sounder retrievals, suggest that much of the tropical TTL is sufficiently humid to be susceptible to pileus formation. Where these pileus clouds form and persist, there is potential for an irreversible repartition from water vapor to ice at cold temperatures.