MMM SEMINAR SERIES

How the cloud greenhouse effect reconciles the stratiform paradox

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Our emphasis on distinct tropical cloud types has evolved over the decades with advancements in our understanding, especially of the complex links between the convective scale and larger scales. Early undilute plume views of tropical convection emphasized deep cumulonimbi and their associated latent heating as a fundamental component of the ascending branch of the Hadley cell. Later, emphasis on tropical shallow and congestus clouds increased as we better grasped the acute sensitivity of tropical convection to water vapor in the free troposphere, prompting major reconsiderations for how to represent moist convection in numerical models. In this context, we advocate for revisiting the role of stratiform and anvil clouds: we argue that these clouds play an essential role in convective-scale dynamics in the tropics through their longwave radiative forcing. The magnitude of longwave radiative forcing relative to latent heating within these clouds is very large, significantly affecting both buoyancy and circulation. It increases moist entropy and suppresses evaporatively driven mesoscale downdrafts, resulting in greater upward motion per unit precipitation. This effect fosters growth of the parent convective system, constituting a positive feedback. The radiative forcing of these clouds, which are much larger and longer-lived than their parent deep convective elements, acts as an important link between the convective scale and larger scales. Hence, while stratiform and anvil clouds are indeed biproducts of deep convection, they should also be recognized as active players in tropical organized convection. Consequently, any comprehensive model or parameterization of tropical convection must account for the bidirectional forcing between deep convective systems and their attendant stratiform and anvil cloud signatures. In this presentation I lay out this case and examine the feedback through a series of ensemble convection-permitting WRF simulations of early-stage TC development, alongside idealized simulations conducted in the radiative–convective equilibrium framework.

Thursday, 24 July 2025, 3:00PM

Refreshments 2:45PM

Please also join colleagues for refreshments and informal discussion after the seminar until 3:30PM

NCAR-Foothills Laboratory, 3450 Mitchell Lane

FL2-1022, Large Seminar

Seminar will also be live webcast

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Participants may ask questions during the seminar via Slido.