Insights from Spaceborne and Field Campaign Precipitation Measurements on Model Representations of Convective Systems

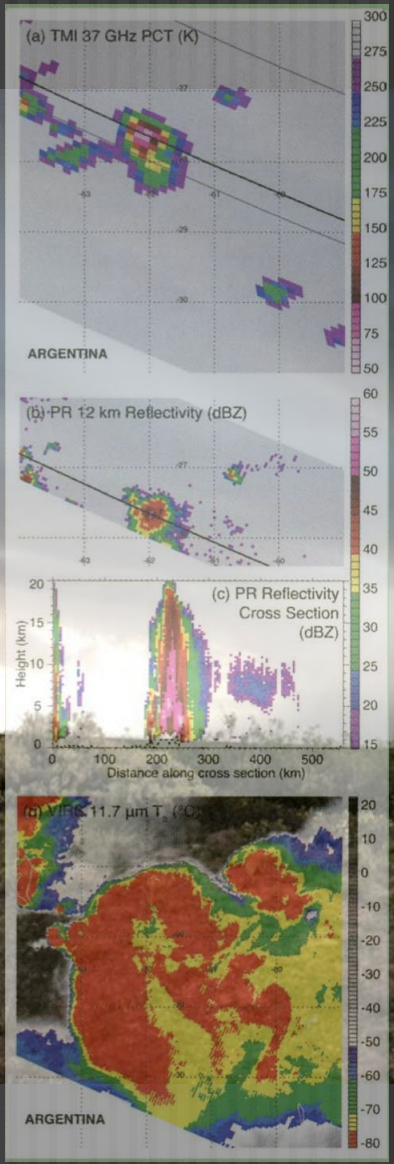

Photo: Holly Mallinson, UIUC

Steve Nesbitt
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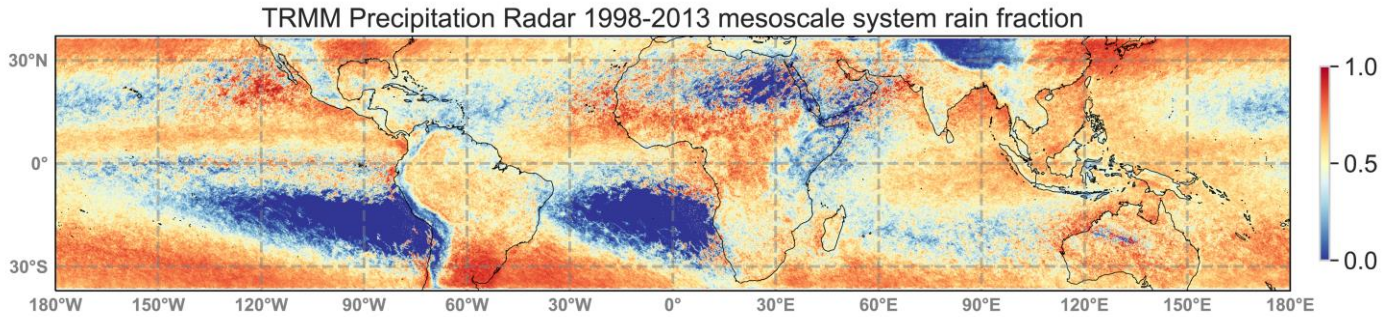
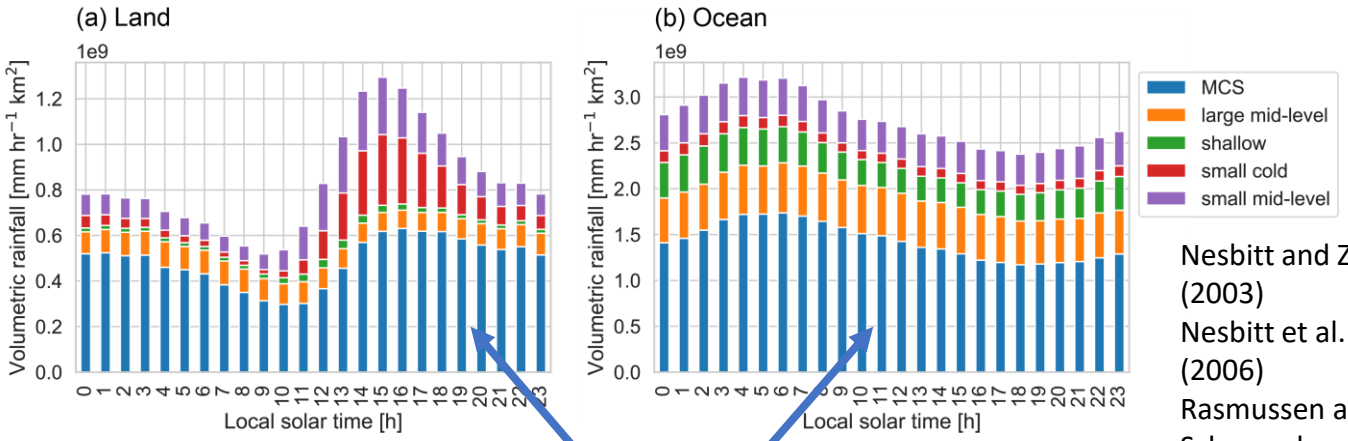
TRMM (+ now GPM) opened our eyes to the variability of tropical and warm season rainfall

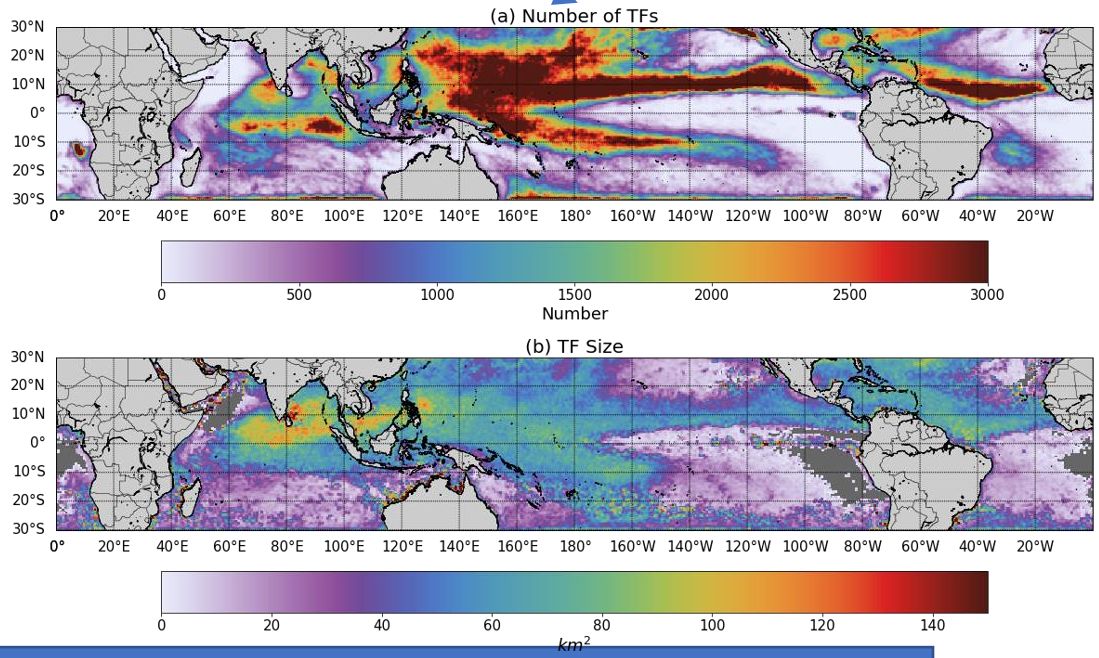




Nesbitt and Zipser (2003)
Nesbitt et al. (2006)
Rasmussen and Schumacher (2020)

Processes controlling mesoscale organization are not well understood or modeled

Some first steps: Identifying oceanic cold pools in buoys+scatterometer winds, and comparing with convection permitting models. (Garg et al. 2020a, 2020b + 2020c in prep)



More than 50% of tropical rainfall originates from Mesoscale Convective systems (58% over land, 52% over ocean)

Processes/building blocks that control mesoscale organization of convection are key for understanding and parameterizing tropical and warm season precipitation

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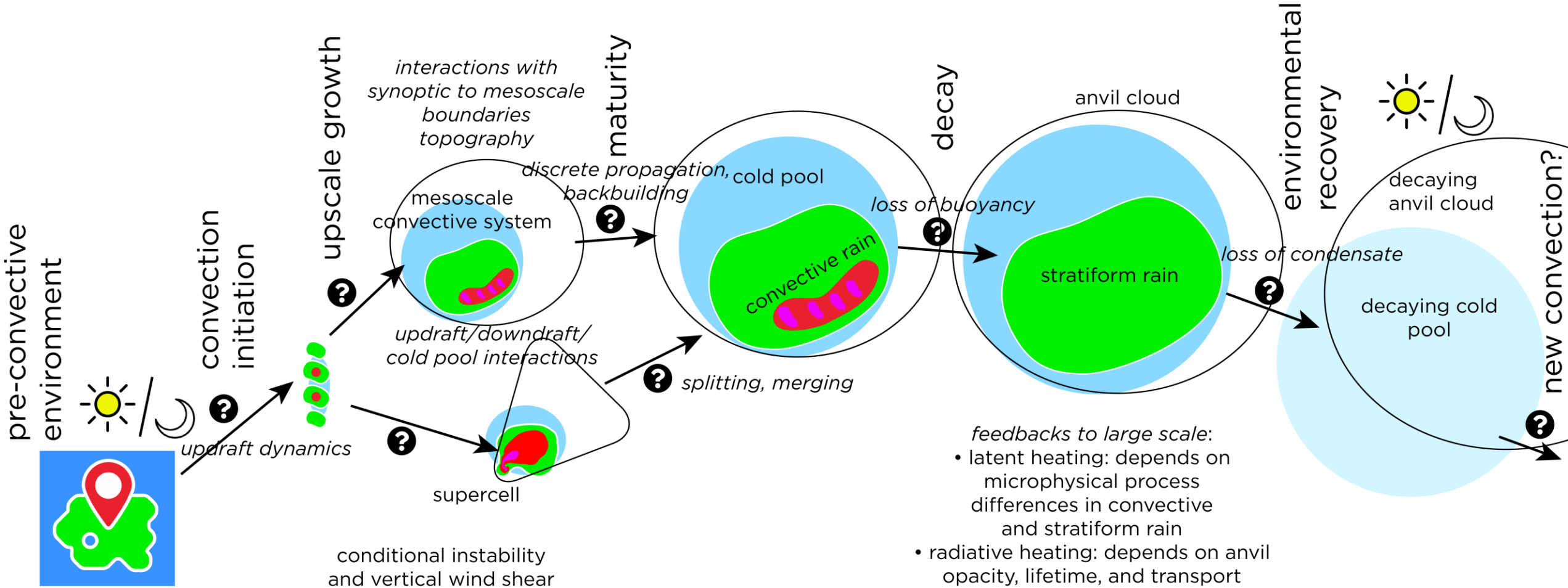
Organized Convective System Lifecycle



convection initation depends on updraft survival (moisture, instability, trigger) impacted by surface fluxes, PBL processes, updraft dynamics, and entrainment

conditional instability and vertical wind shear impact convective updraft dynamics, determining convective mode, which impacts microphysical processes, propagation, and probability of hazards (flooding, tornadoes, hail, straight line winds)

feedbacks to large scale:
- latent heating: depends on microphysical process differences in convective and stratiform rain
- radiative heating: depends on anvil opacity, lifetime, and transport
- impacts on surface fluxes

Doswell, Brooks, Maddox (1996):

rainfall = instantaneous rain rate * duration

(moisture, updraft dynamics, microphysics) (propagation, system lifetime)

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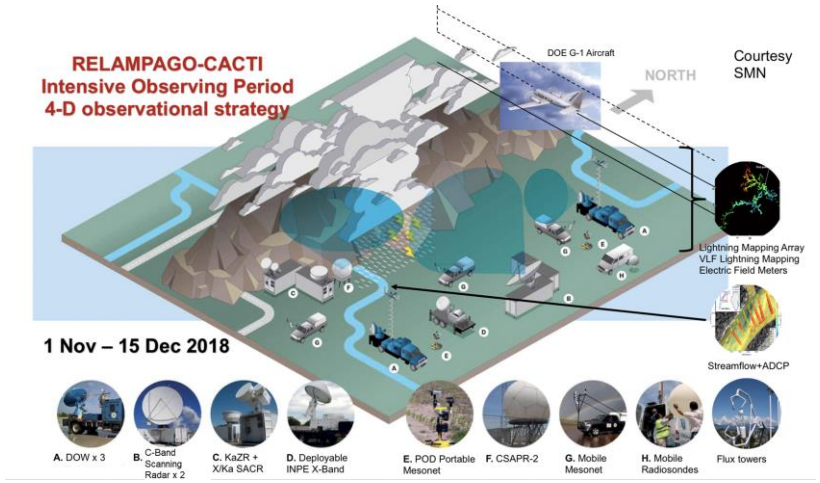
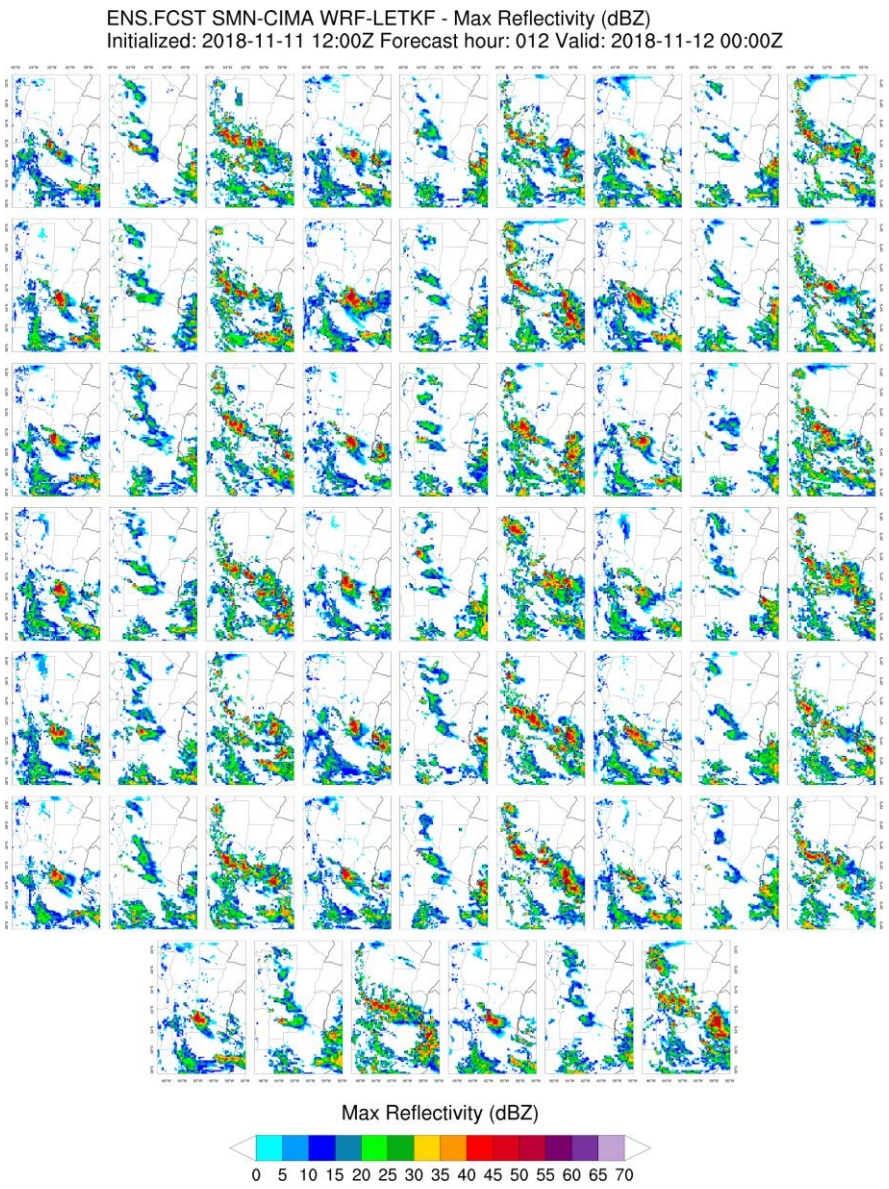
RELAMPAGO – CACTI (NSF-DOE-NOAA-NASA) field campaign. Córdoba & Mendoza, Argentina, 2018-2019





Kilometer scale models + ensembles of them have critical biases that impact weather prediction and assessments of hazards due to poor representation of key processes. **Need repeated observation of these processes across scales.**

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