

RCE and Processes in Deep Convective Organization

Workshop on Spatial Organization of Convection, Clouds and
Precipitation

May 5-7, 2021

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Some introductory and motivational thoughts...

Convection in Earth's atmosphere organizes on a variety of spatiotemporal scales

O(100 km)

Squall lines

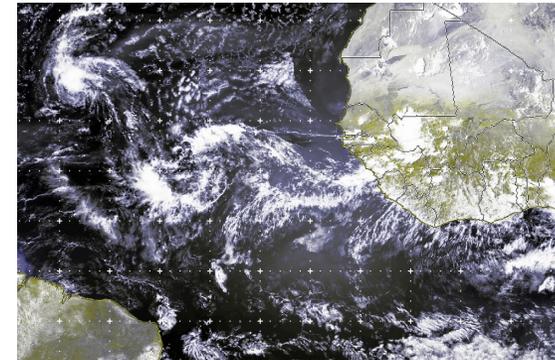
Mesoscale convective systems



O(1000 km)

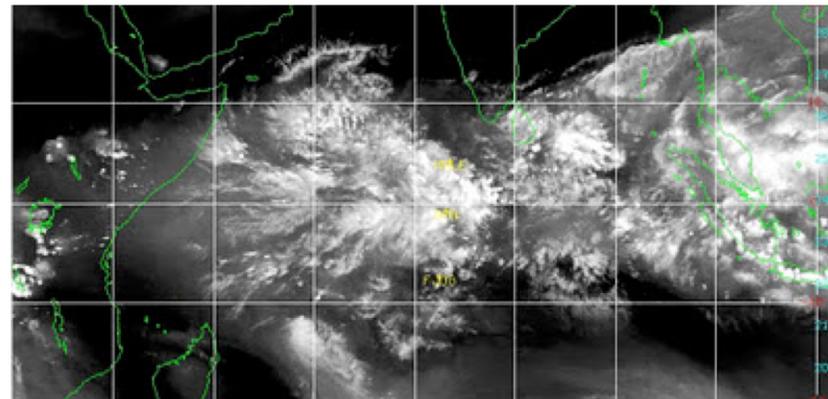
Tropical cyclones

Equatorial waves



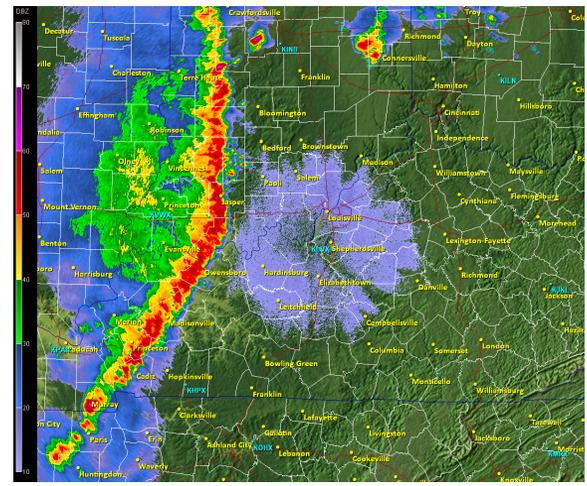
O(10,000 km)

Madden-Julian Oscillation

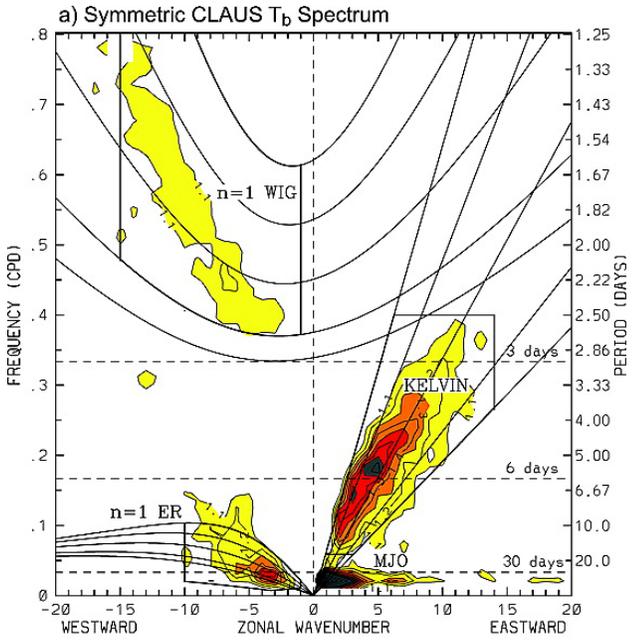


...and is organized by a variety of mechanisms

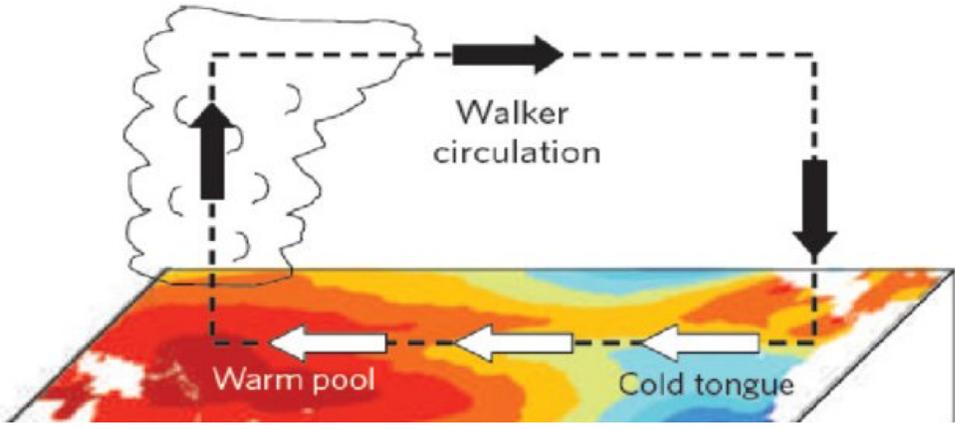
Vertical wind shear



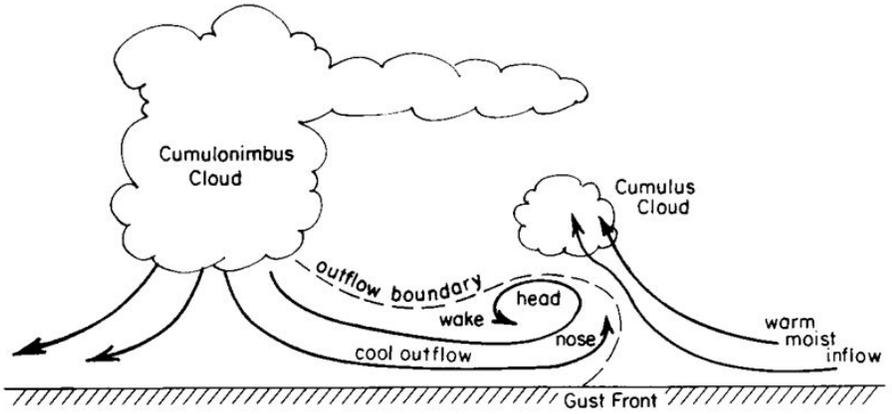
Dynamical disturbances and waves



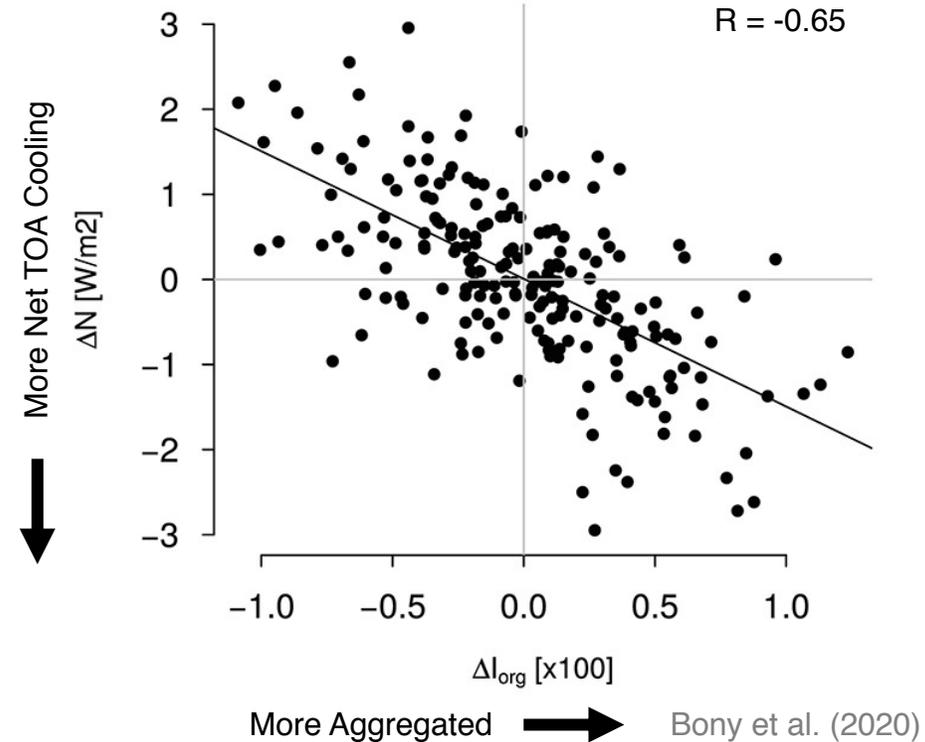
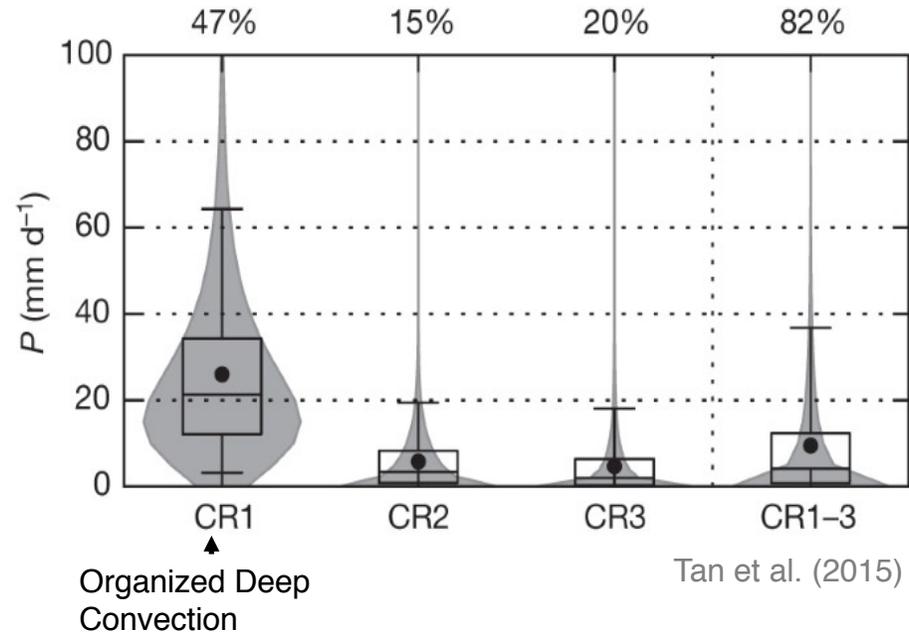
Sea surface temperature gradients



Cold pool interactions



And this organization of convection matters for climate



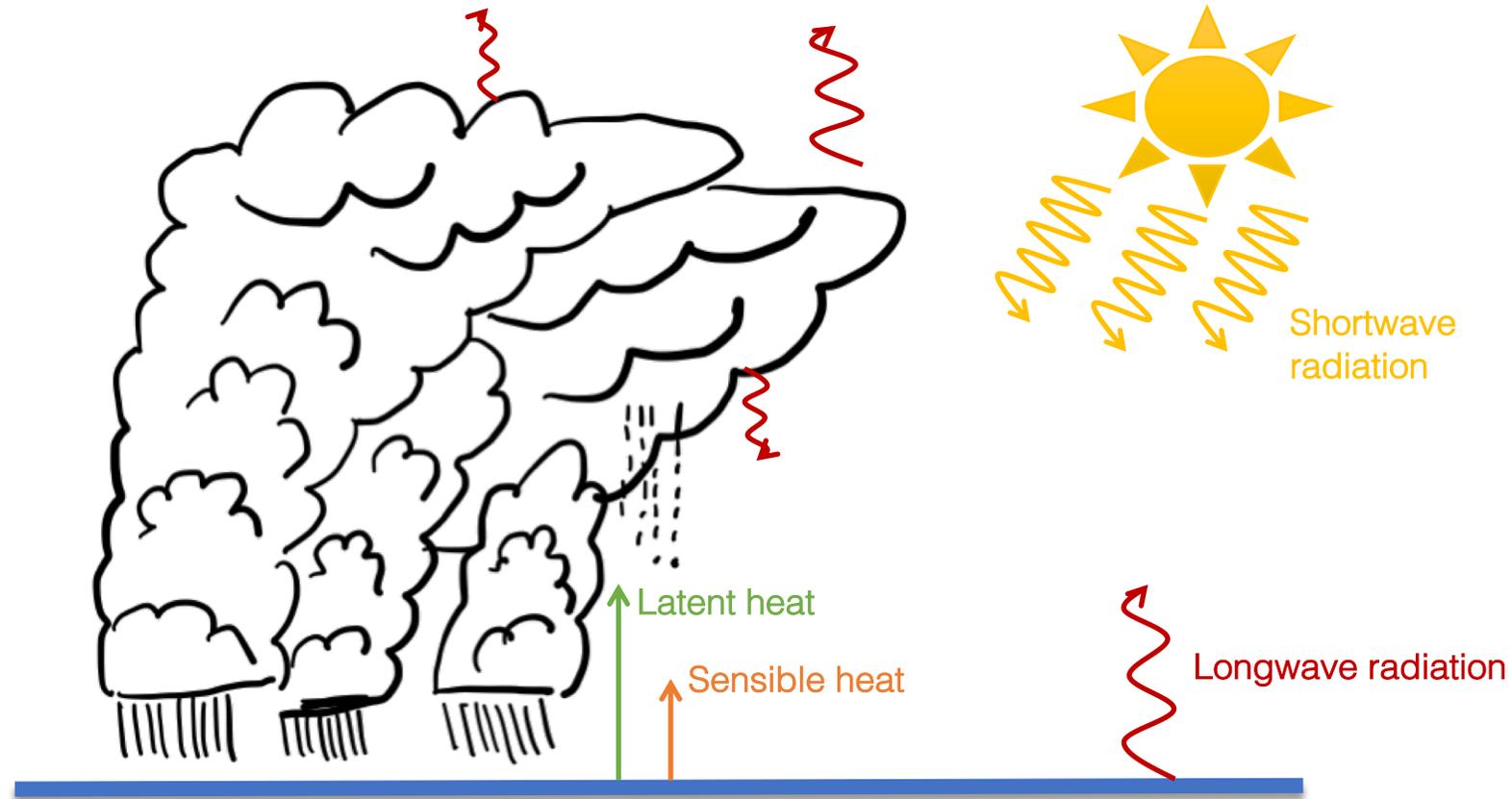
Observed mesoscale organized convection contributes ~half of total tropical rainfall & a significant fraction of cloudiness.

Most of the observed regional increases in tropical precipitation are associated with an increase in the frequency of organized convection

More aggregated observed states

- Are drier
- Have fewer high clouds
- Have more low-level clouds (at some scales)
- Greater OLR & tropos. radiative cooling
- Enhanced net cooling at TOA

Idealized simulations of radiative-convective equilibrium are one tool to study convective organization

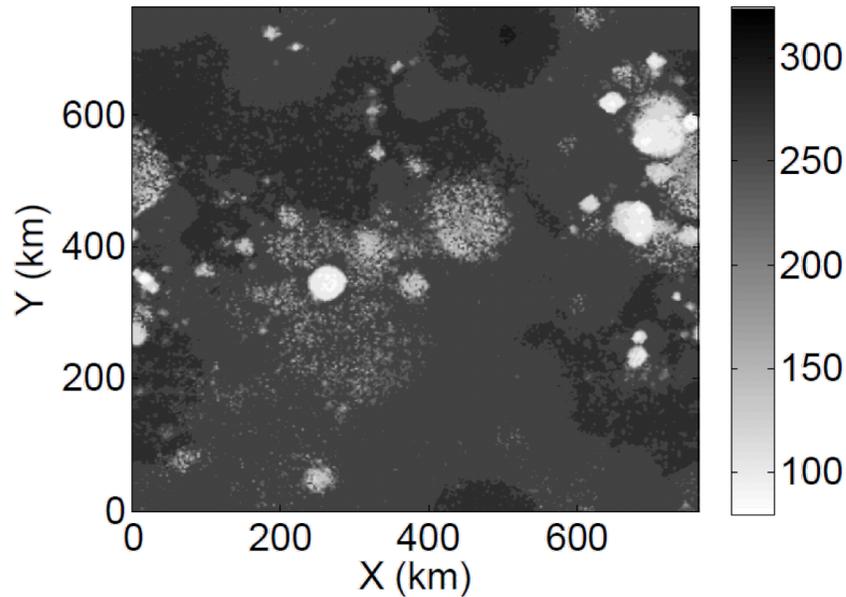


A theme of today: the value of idealized simulations such as RCE to answer questions about mechanisms and impacts of organization → *to be discussed more in the panel discussion!*

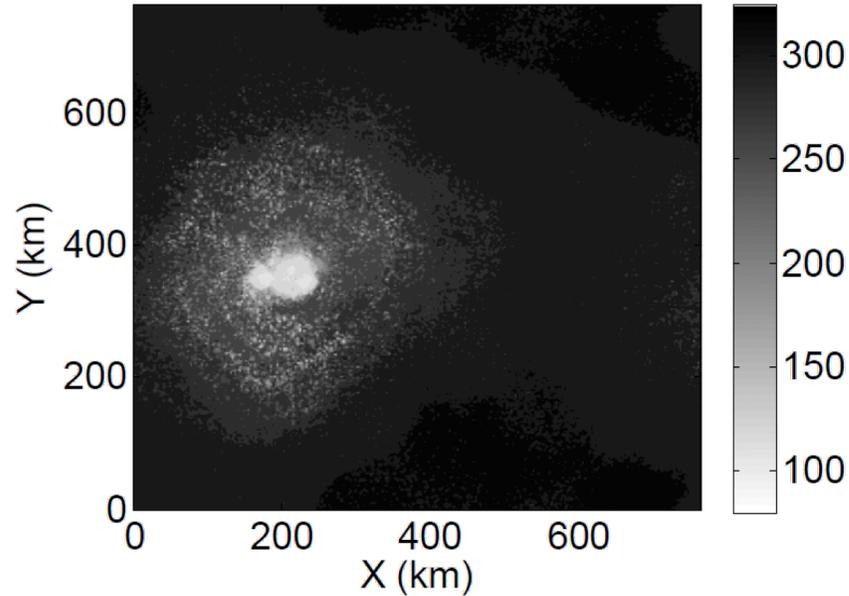
One Type of Convective Organization: Self-Aggregation

A spontaneous transition from randomly distributed to organized convection despite homogeneous boundary conditions

Day 10 OLR (W/m^2)



Day 80 OLR (W/m^2)



Manifestation of radiative-convective instability in RCE:

Driven by interactions between convection and environment involving clouds, water vapor, radiation, circulation, and surface fluxes → *Caroline will introduce more, next!*

Localization of convection first seen:

Held et al 1993

Reviews: Wing et al 2017, Wing 2019

Some Questions:

- How does self-aggregation impact the mean state?
- How does self-aggregation change with warming?
- Does self-aggregation impact climate sensitivity?
- How are the mechanisms of organization modified when elements of realism are added to RCE?
- How do different mechanisms of organization interact with each other?