

RCE and Processes in Deep Convective Organization

Workshop on Spatial Organization of Convection, Clouds and Precipitation

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Some introductory and motivational thoughts...

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

$O(100 \text{ km})$

Squall lines

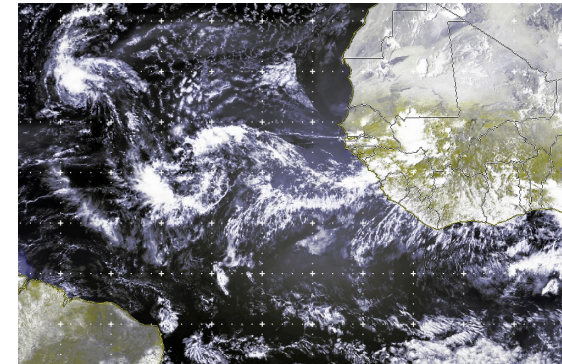
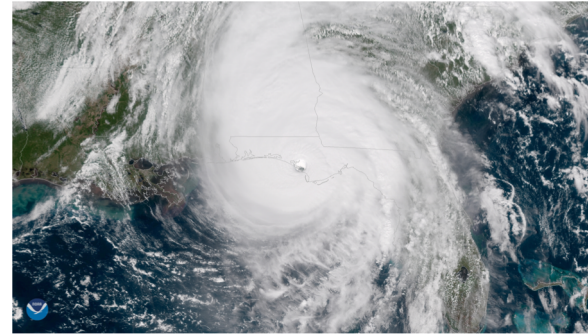
Mesoscale convective systems



$O(1000 \text{ km})$

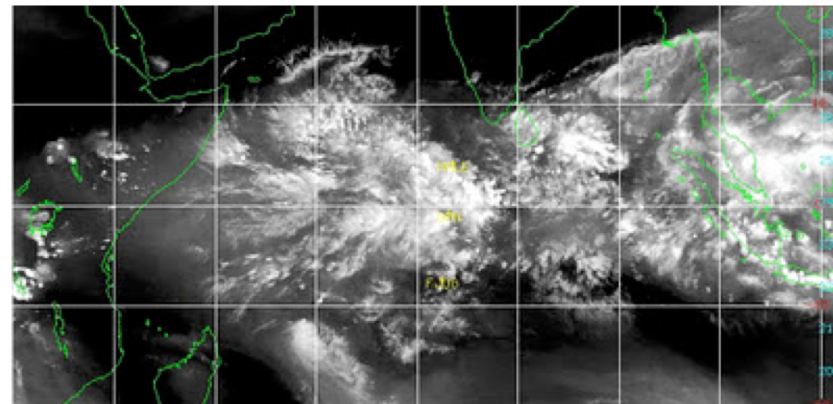
Tropical cyclones

Equatorial waves



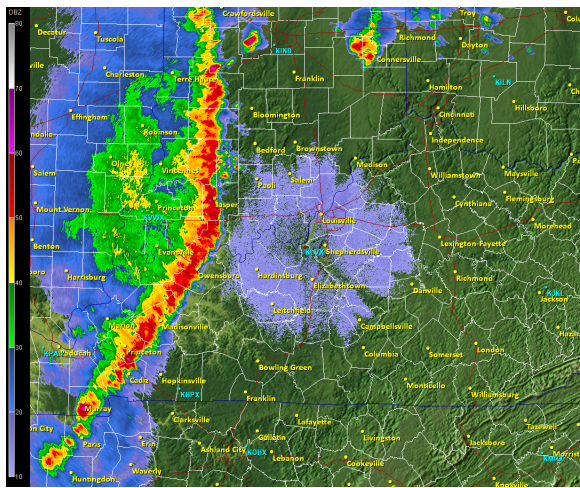
$O(10,000 \text{ km})$

Madden-Julian Oscillation

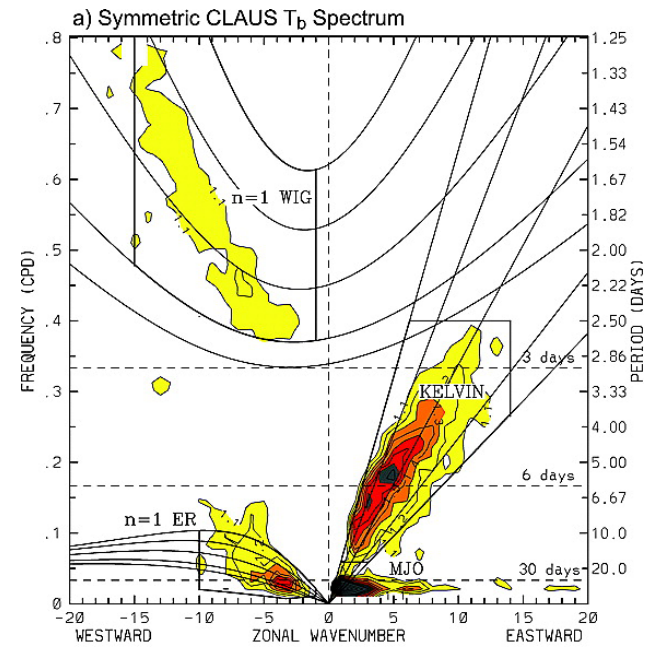


...and is organized by a variety of mechanisms

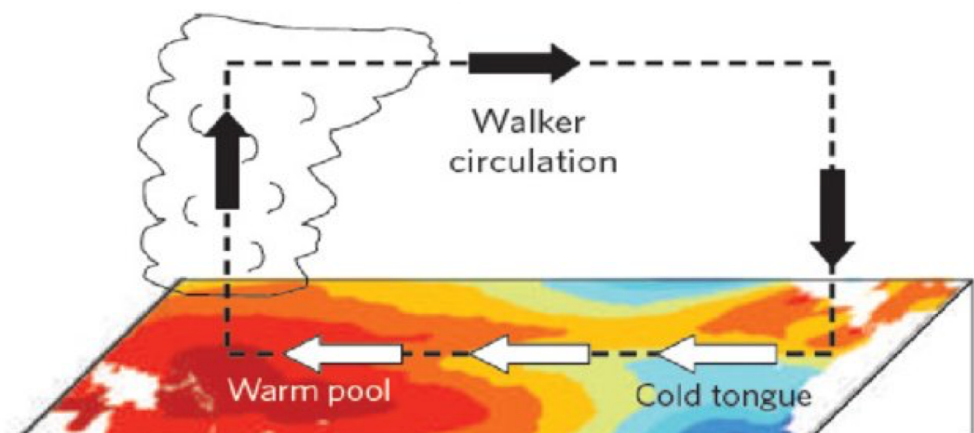
Vertical wind shear



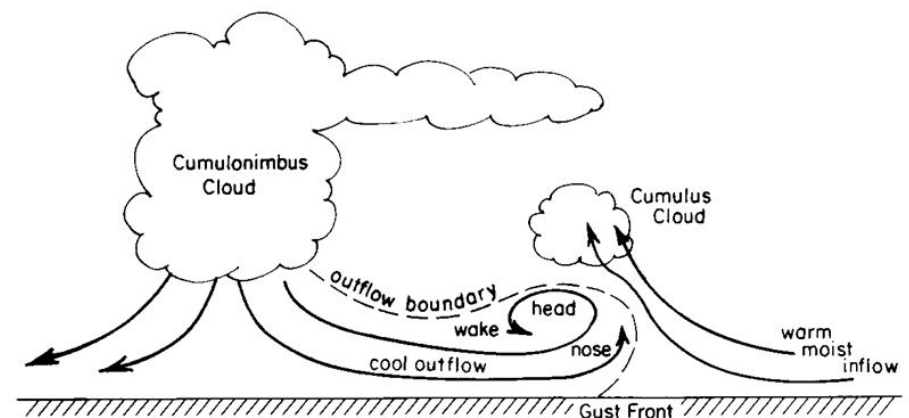
Dynamical disturbances and waves



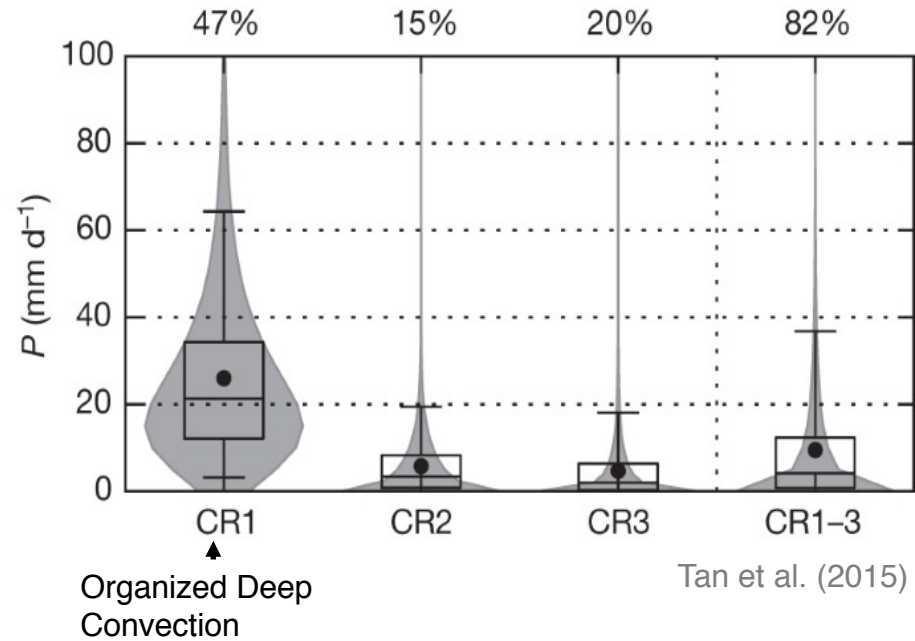
Sea surface temperature gradients



Cold pool interactions

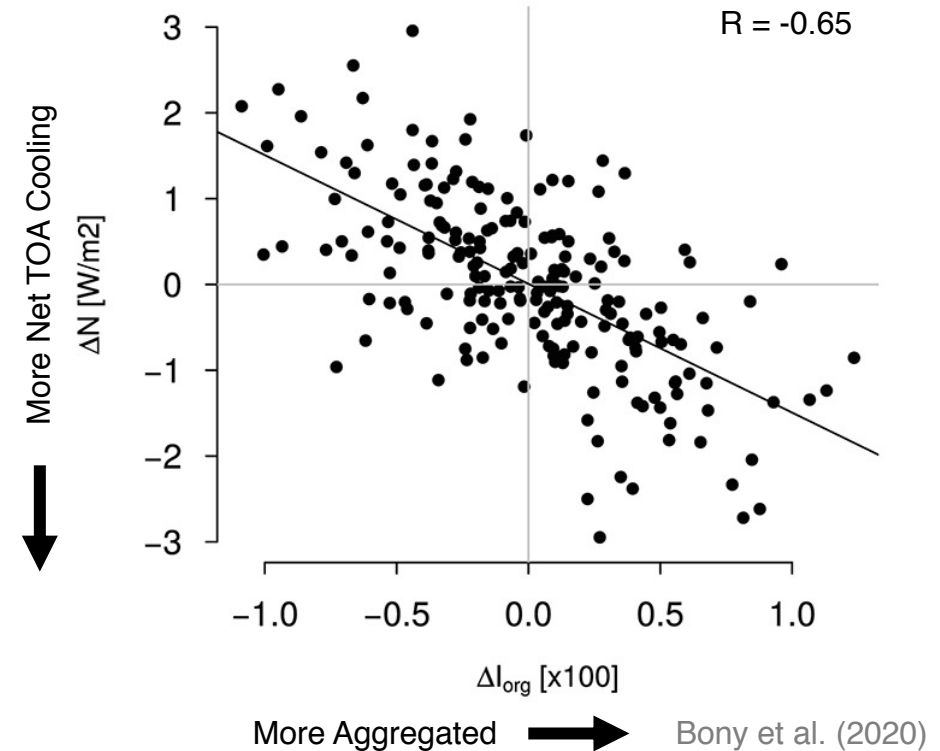


And this organization of convection matters for climate



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

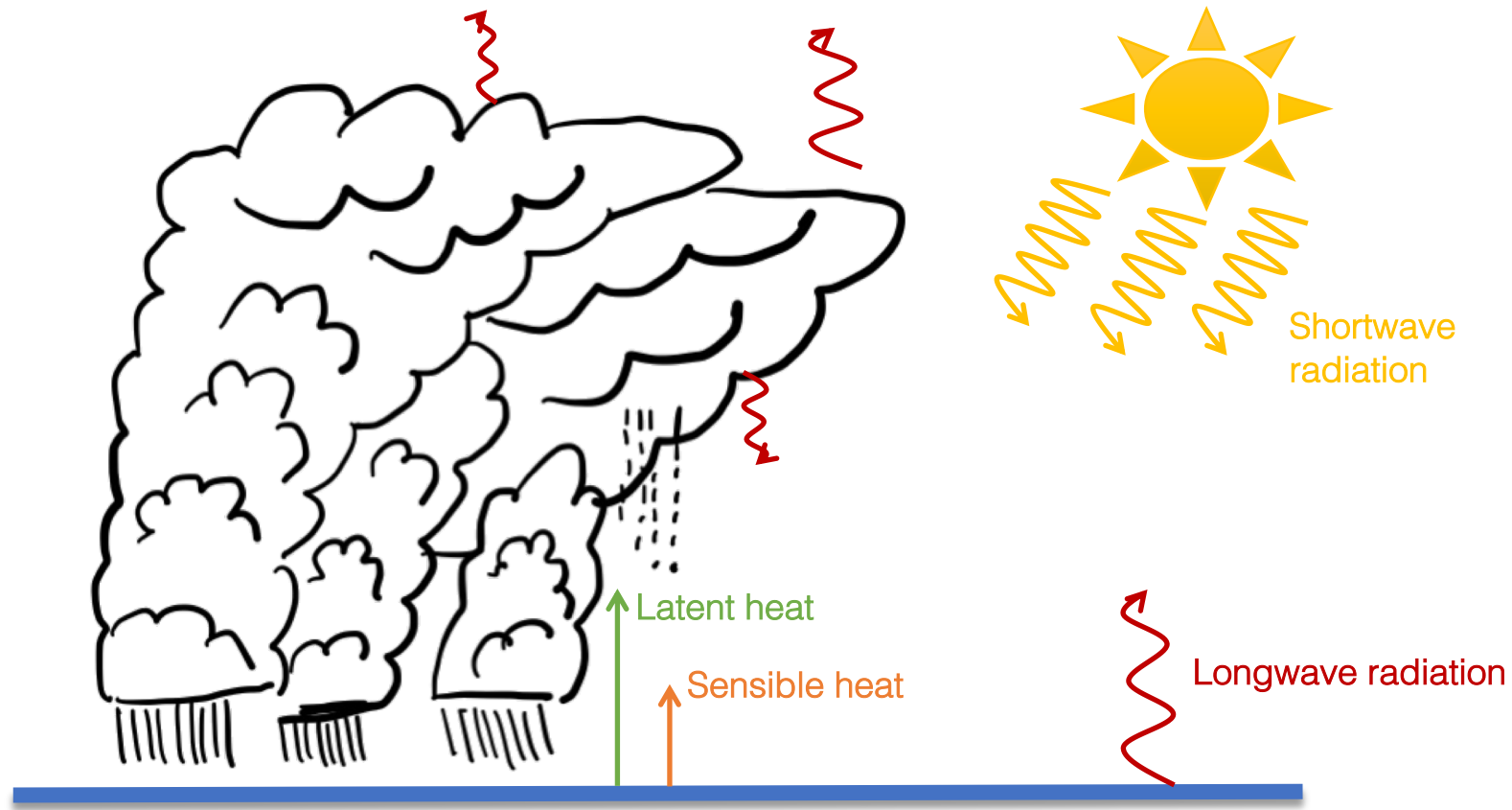
Most of the observed regional increases in tropical precipitation are associated with an increase in the frequency of organized convection



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

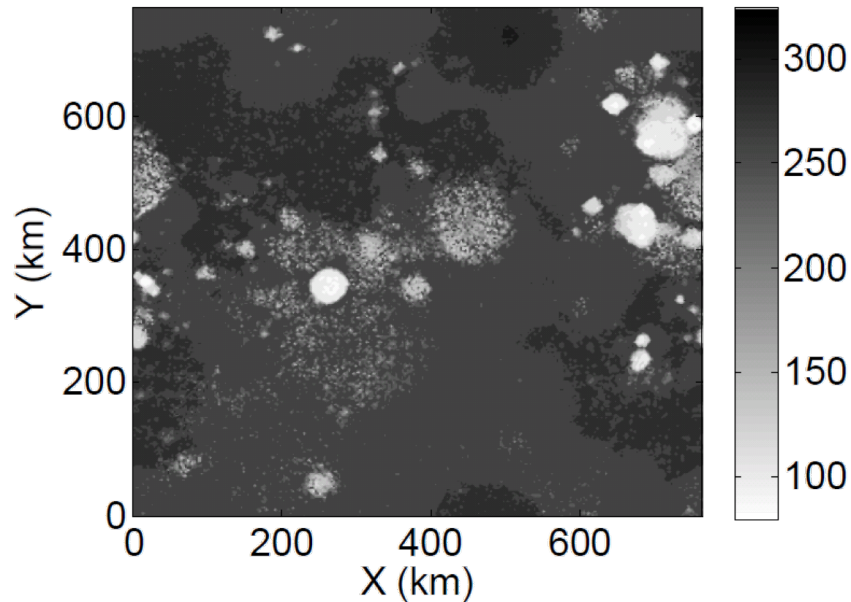


A theme of today: the value of idealized simulations such as RCE to answer questions about mechanisms and impacts of organization → *to be discussed more in the panel discussion!*

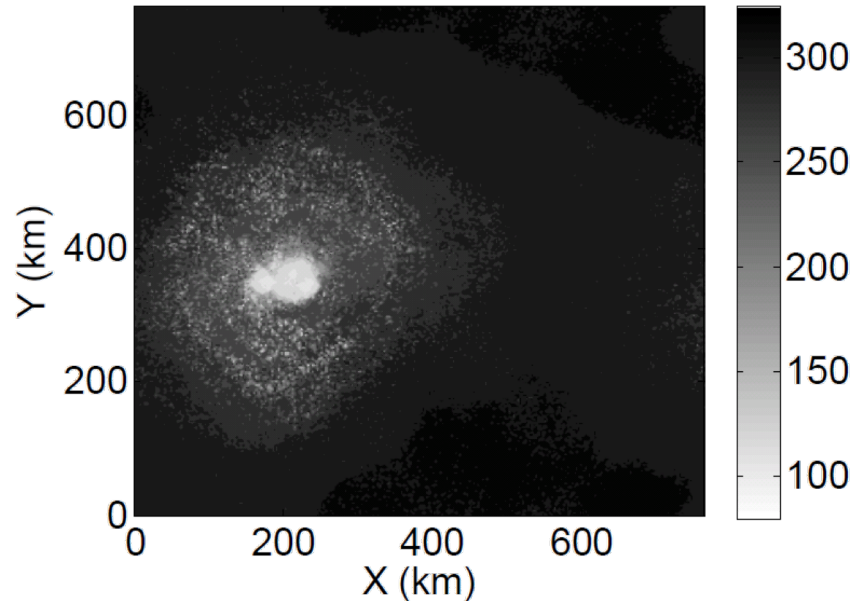
One Type of Convective Organization: Self-Aggregation

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?