RCE and processes in deep convective organization

Still many open questions…
Maybe to be solved in RCE?

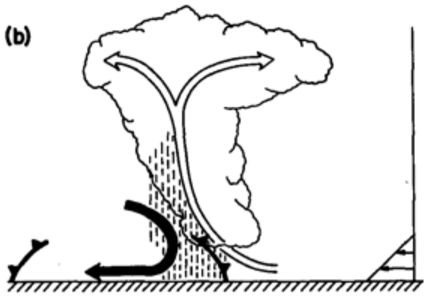
Many processes which can lead to convective organization
In the **real world**

Whose studies in idealized settings lead to improved understanding

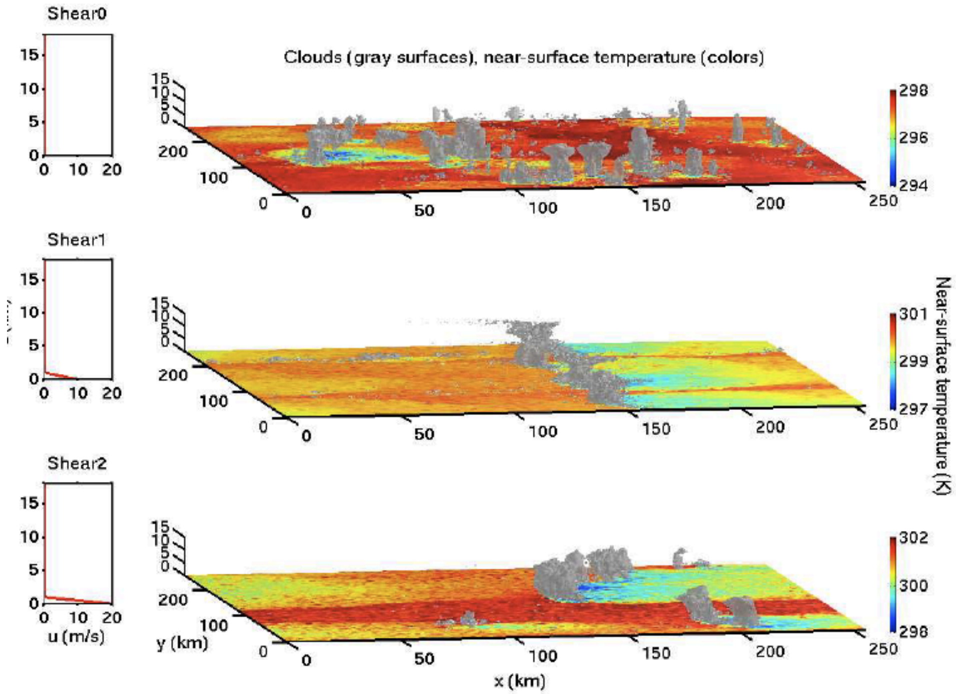
Interaction with vertical shear : A theory of long-lived convective systems and squall lines « RKW »

Squall lines

Role of vertical shear & cold pools (*Mapes*)



[Thorpe et al 1982; Rotunno et al 1988]



*[**Rotunno Klemp Weisman 1988**; Fovell and Ogura 1988; Garner and Thorpe 1992; Weisman and Rotunno 2004; Houze 2004; Moncrieff 2010]*

No shear

Top view

Color: PW

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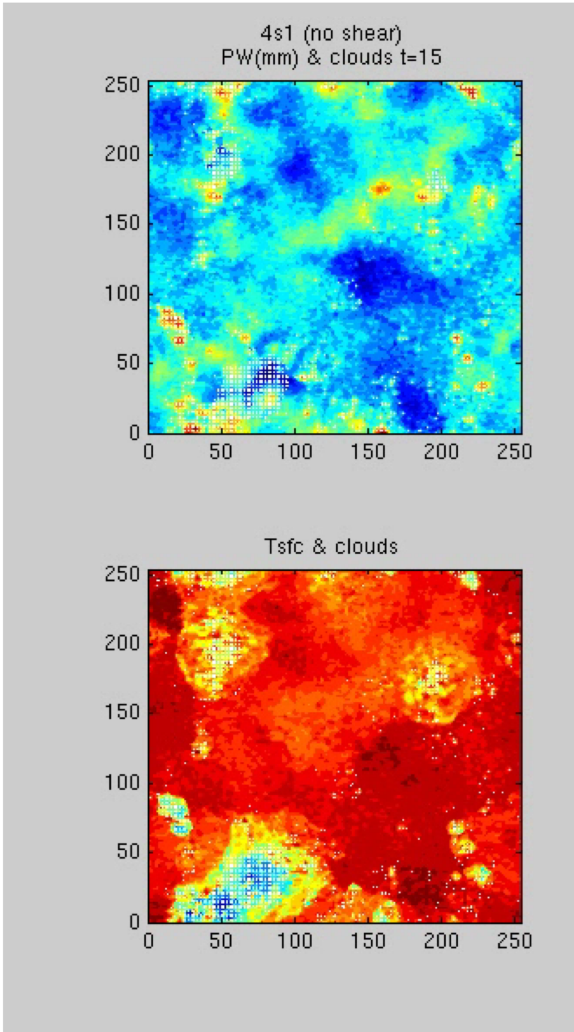
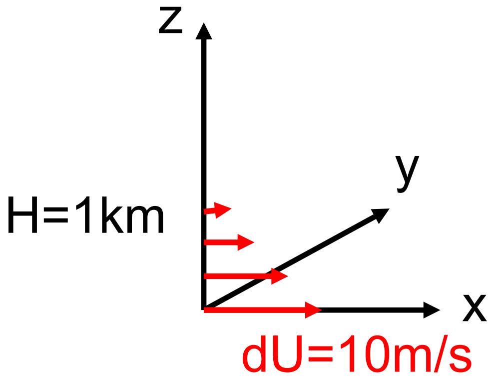


Critical shear



Top view

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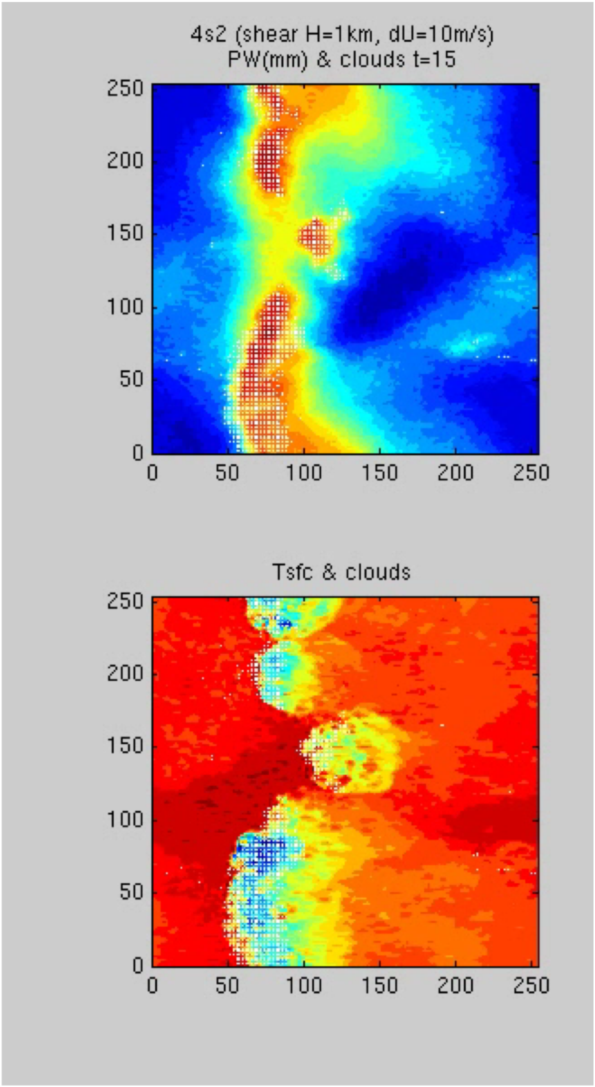
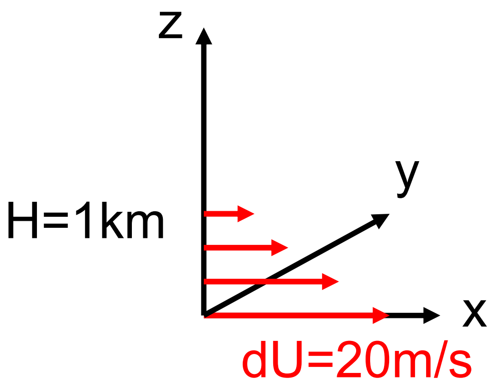


Super critical shear



Top view

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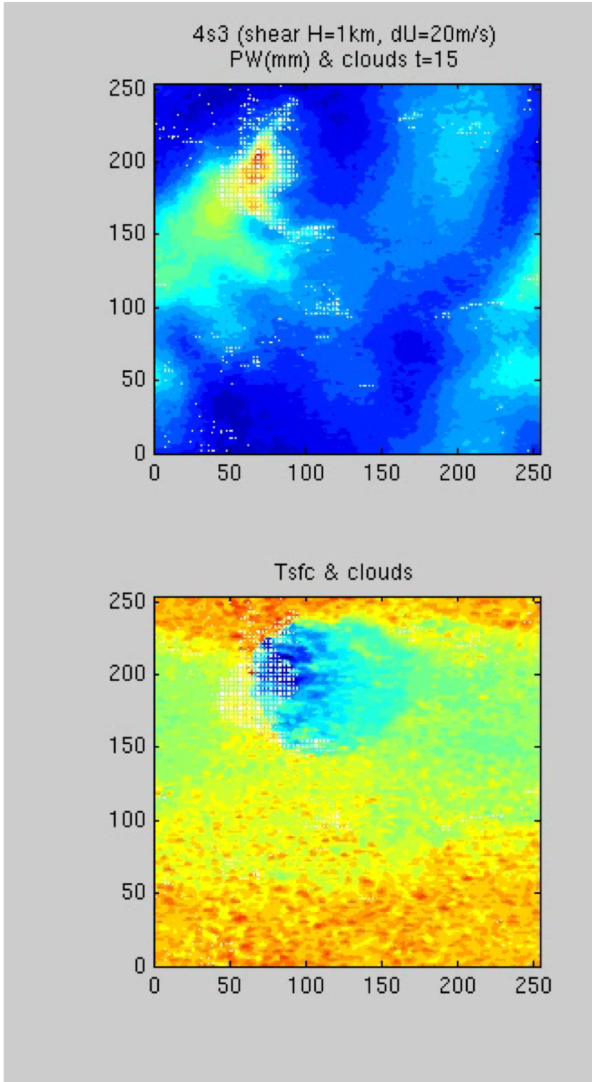
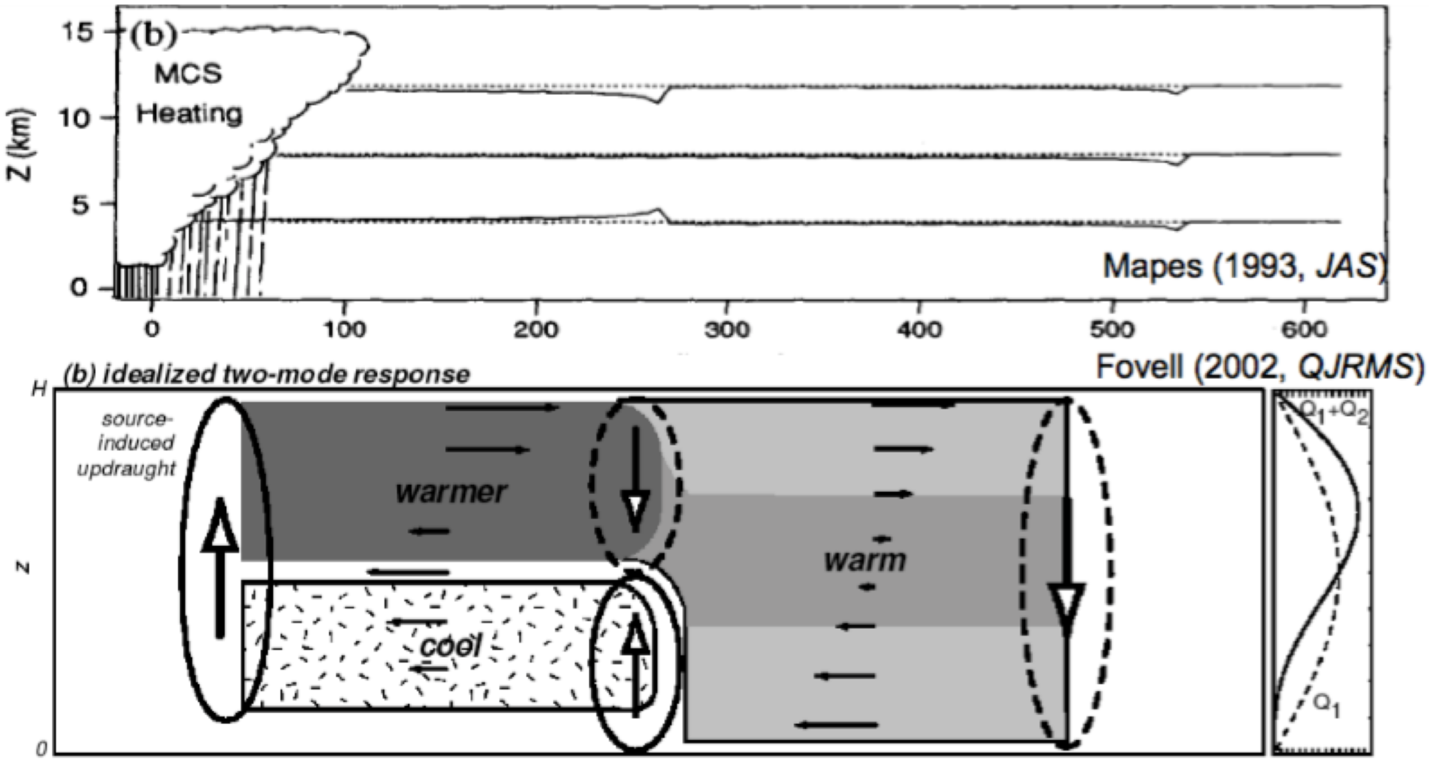


[Robe & Emanuel 1996; Muller 2013]

Shear alone cannot explain organization of all convective systems in tropics :

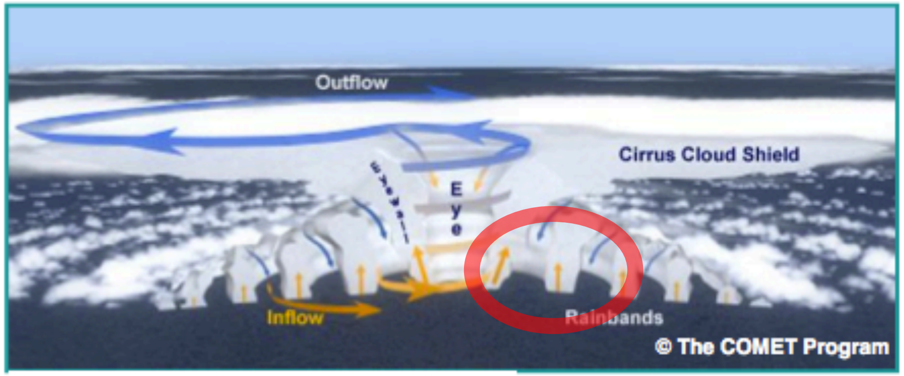
- wind shear is often too weak
- upscale growth is ubiquitous, occurring beyond the extent of cold pools
- convective inhibition is small => small perturbations can easily initiate new convection

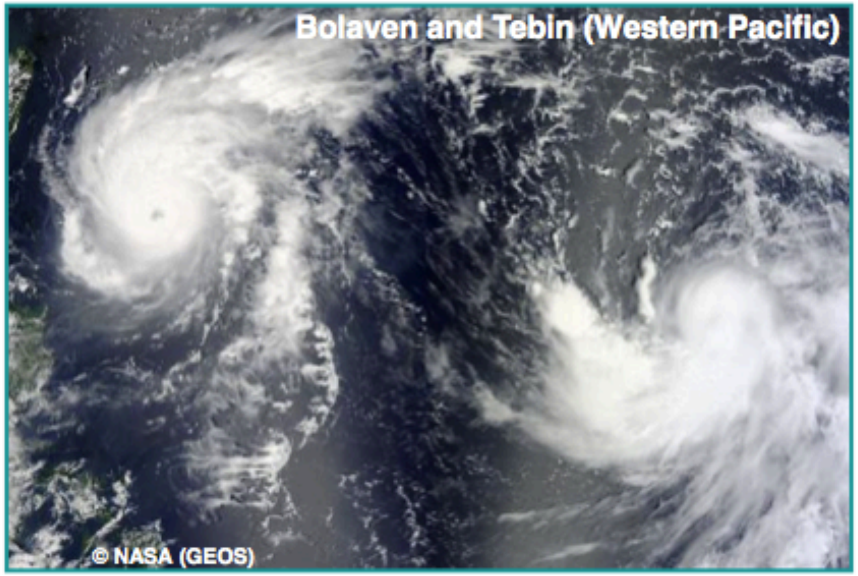
=> **Mapes (1993, *JAS*)** described tropical convection as 'gregarious', prone to form in clusters, as a result of horizontally propagating gravity waves destabilizing the cloud environment



- Deep heating generates deep waves that propagate fastest and warm (stabilize) the troposphere;
- Shallow (evaporative) cooling generates shorter waves that cool (destabilize) the low levels, destabilizing the environment and promoting new convection nearby

Hurricanes



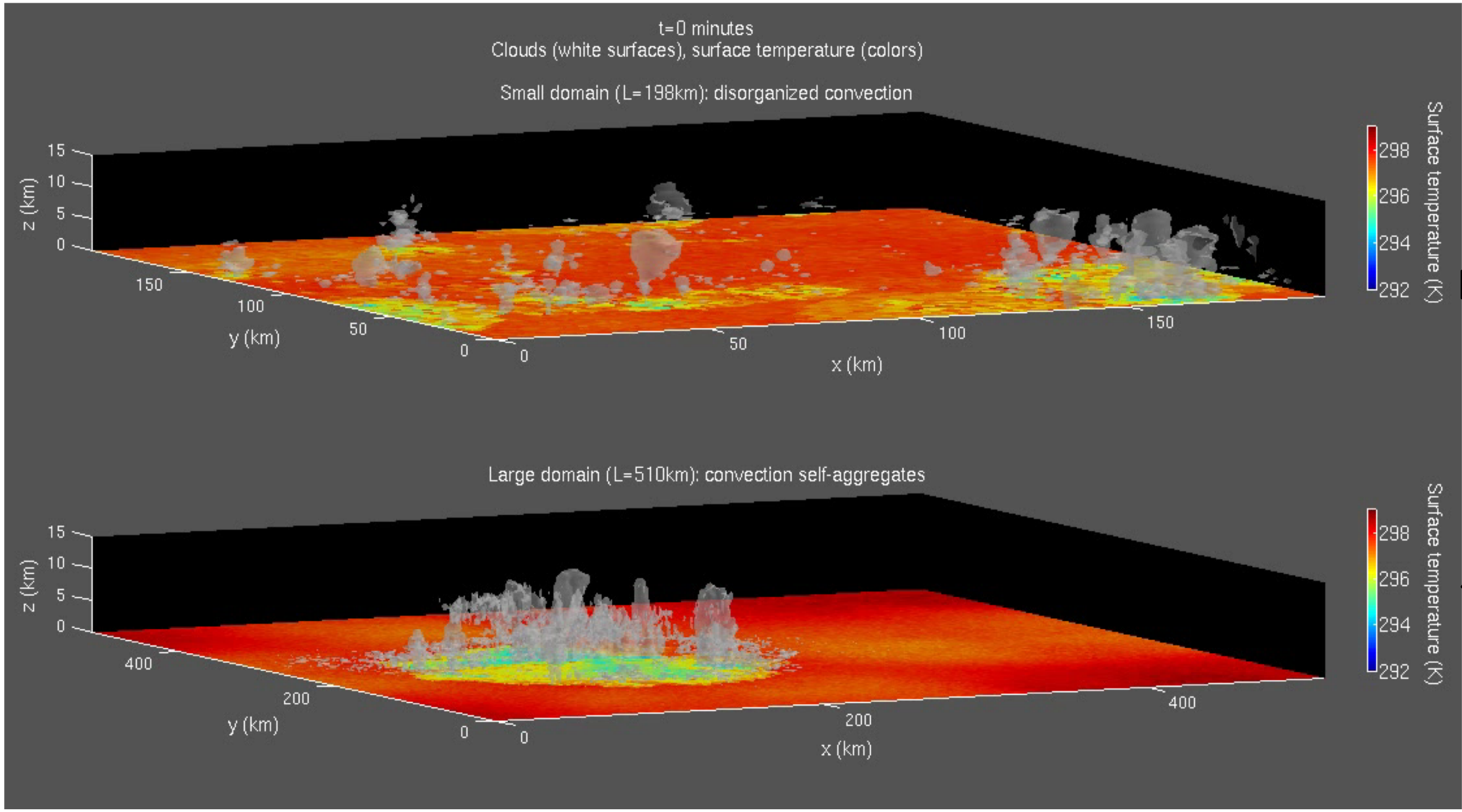


« Wind-induced surface-heat exchange » (WISHE):
Surface fluxes are enhanced in the moist eyewall region

⇒ energy (MSE) increases in the high-energy region
⇒ positive feedback on convective organization

[Emanuel 86; Wing Camargo Sobel 2016; Muller Romps 2018]

Clouds over near-surface temperature



Convection is disorganized => “pop corn” state

Larger domain

Convection self-aggregates

How about the real world?

⇒ *Learnt a great deal from RCE ! On processes and implications (e.g. precip extremes, climate sensitivity…)*

Beydoun, Wing, Bao, Da Silva, Drotos

⇒ *Radiation important*

Holloway, Fildier

⇒ *Convective moistening important (through cold pool dynamics or entrainment/detrainment)*

Lochbihler, Nissen, Gronemeyer, Biagioli

⇒ *Towards more realism (shear/land/convective moistening/SST variations/microphysics/subsidence…)*

Meyer, Mapes, Muller, Semie, Coppin, Tompkins, Hohenegger, Tompkins, Van Heerwaarden

But … Do we care too much about the real world ?

Importance of process studies in RCE,
and more generally the importance of idealized simulations, and the exciting research they lead to (then adding realism, e.g. interactive SST, diurnal cycle, SST gradients, shear etc).

Even if what we discovered in idealized settings is not robust or only 2nd order in reality, we've learnt so much along the way !

So yes, understanding the real world is our ultimate goal, but sometimes going away from the real world can actually teach us more than staying in realistic parameter ranges.

Mesoscale convective systems