Stochastic Behaviour of Convection: A paradigm for Active versus Suppressed Phase

Boualem Khouider (University of Victoria)

Andrew Majda and Yevgeniy Frenkel (Courant Institute, NYU)

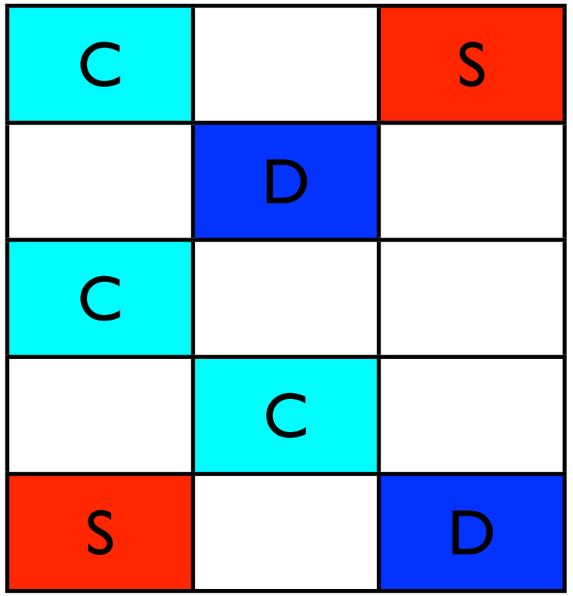
Christian Jakob and Karsten Peters (Monash U.)

DYNAMO Workshop, Hawaii, March 4-8:

Break up Session 4B (Convection-Environment Interaction)

Stochastic Multicloud Model

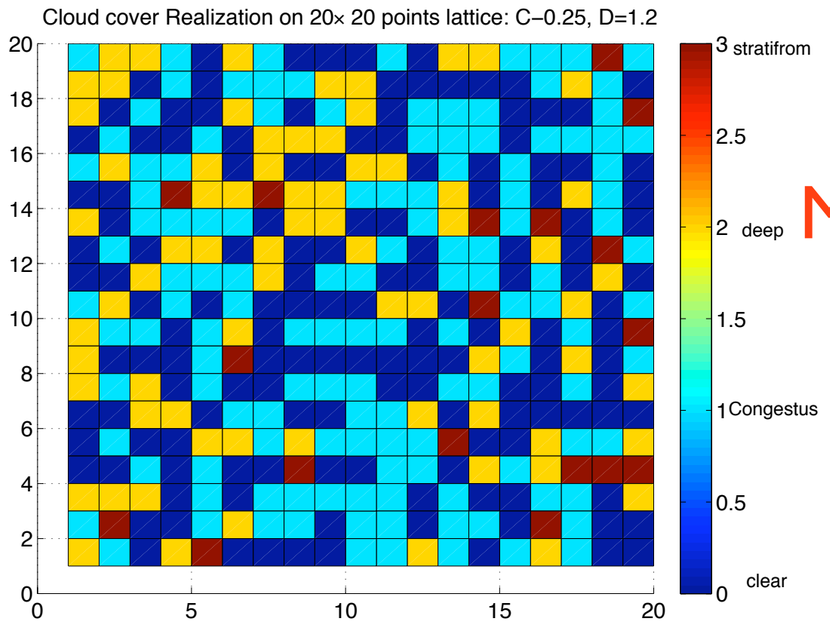
- Self-similarity paradigm of tropical convective systems: Building block hypothesis of Mapes et al. (2006)
- Lattice points take values 0,1,2, or 3
- Three order parameters c,d,s taking values 1 or 0, at a given lattice point, depending on whether we have a congestus, a deep, or a stratiform cloud, or none, respectively.
- A sequence of four states, multivariable Markov chain.



Intuitive transition rules

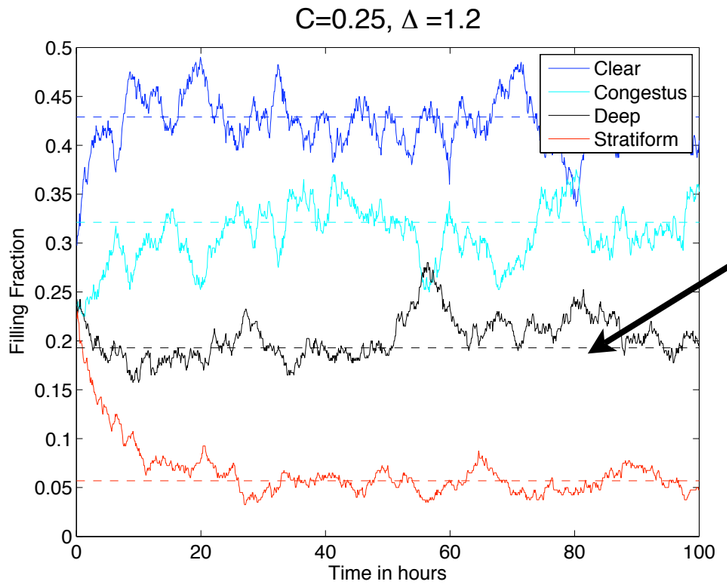
- A clear sky site turns into a congestus site with high probability if CAPE>0 and middle troposphere is dry.
- A congestus or clear sky site turns into a deep site with high probability if CAPE>0 and middle troposphere is moist.
- A deep site turns into a stratiform site with high probability.
- All three cloud types decay naturally according to prescribed decay rates.

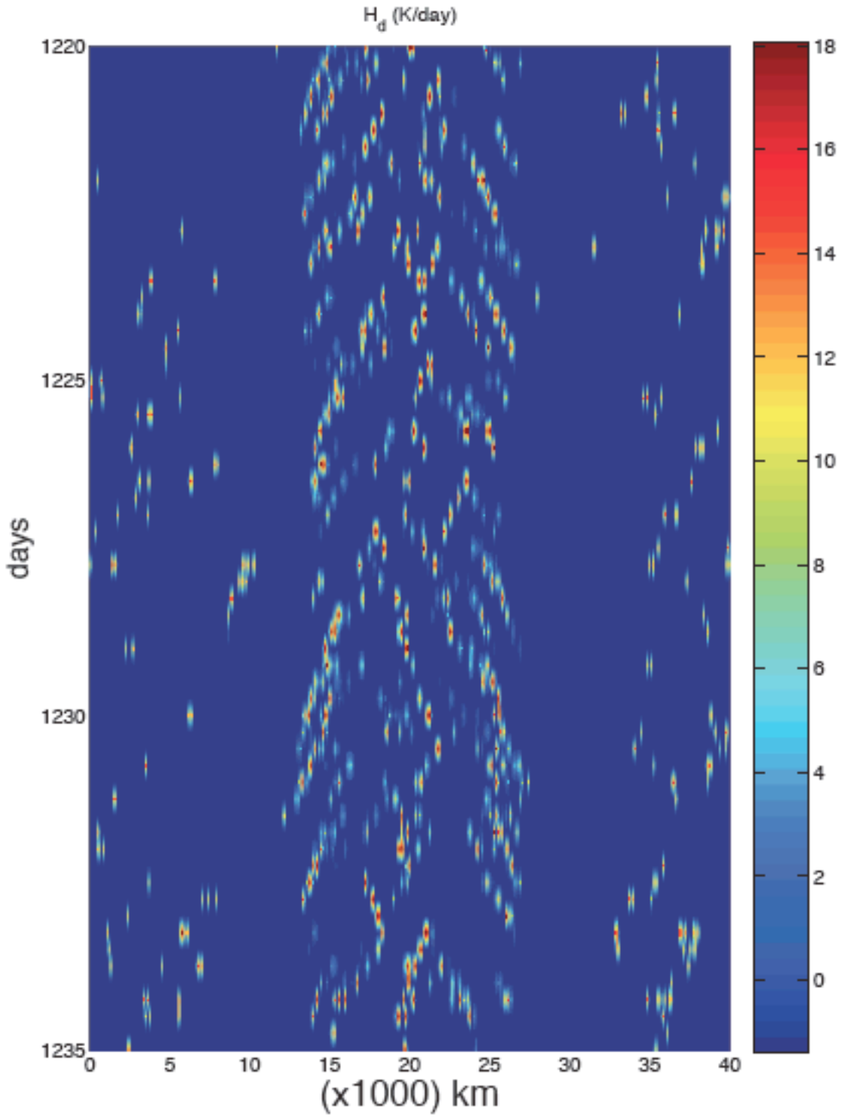
Stochastic Behaviour and effect on CCWs



Waves in idealized Warm Pool Simulation

Mean Area Fraction is set by environmental condition; Interaction with convection Modifies Environmental conditions gives rise to variability and waves (organization)





Captures well observed stochastic behaviour of convection Peters et al. (JAS, 2013)

Stochastic Tropical Convection

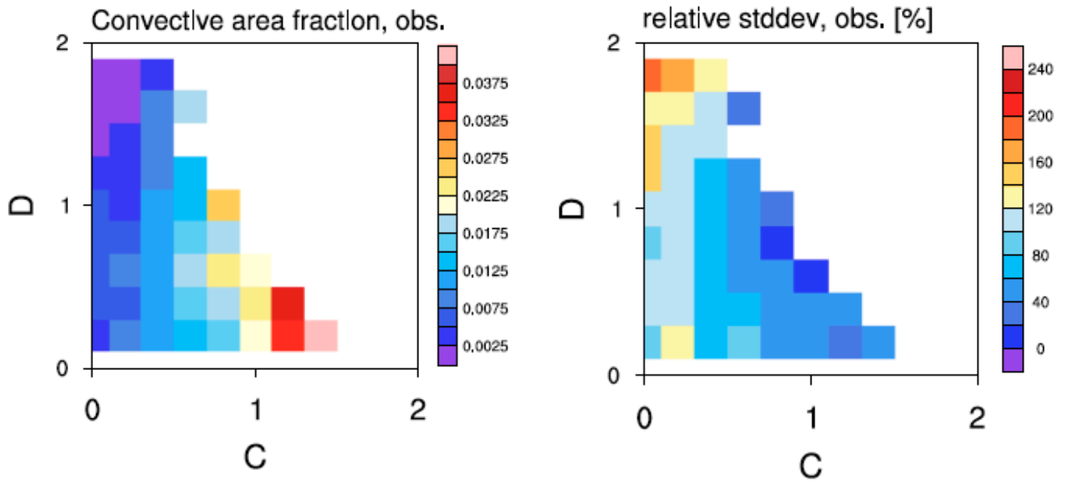
Model vs. Observations

C: ω_{500}

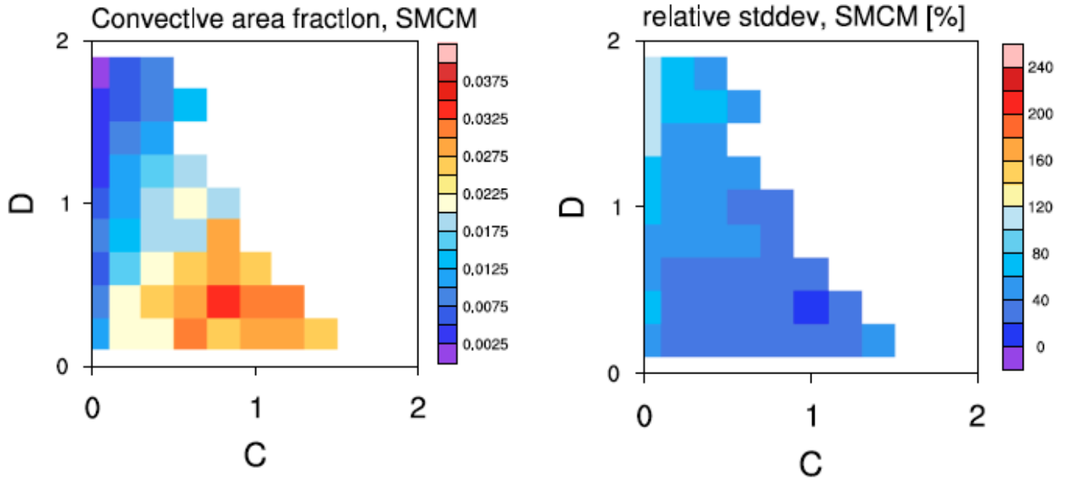
D: RH_{500}

Statistics similar between model vs. observations

Model "levels" the signal



OBS



SMC

Convection is not a Poisson Process

and SMC captures it!

Not a linear stochastic noise.

ARC CENTRE OF EXCELLENCE FOR CLIMATE SYSTEM SCIENCE

MONASH University