RCE and processes in deep convective organization
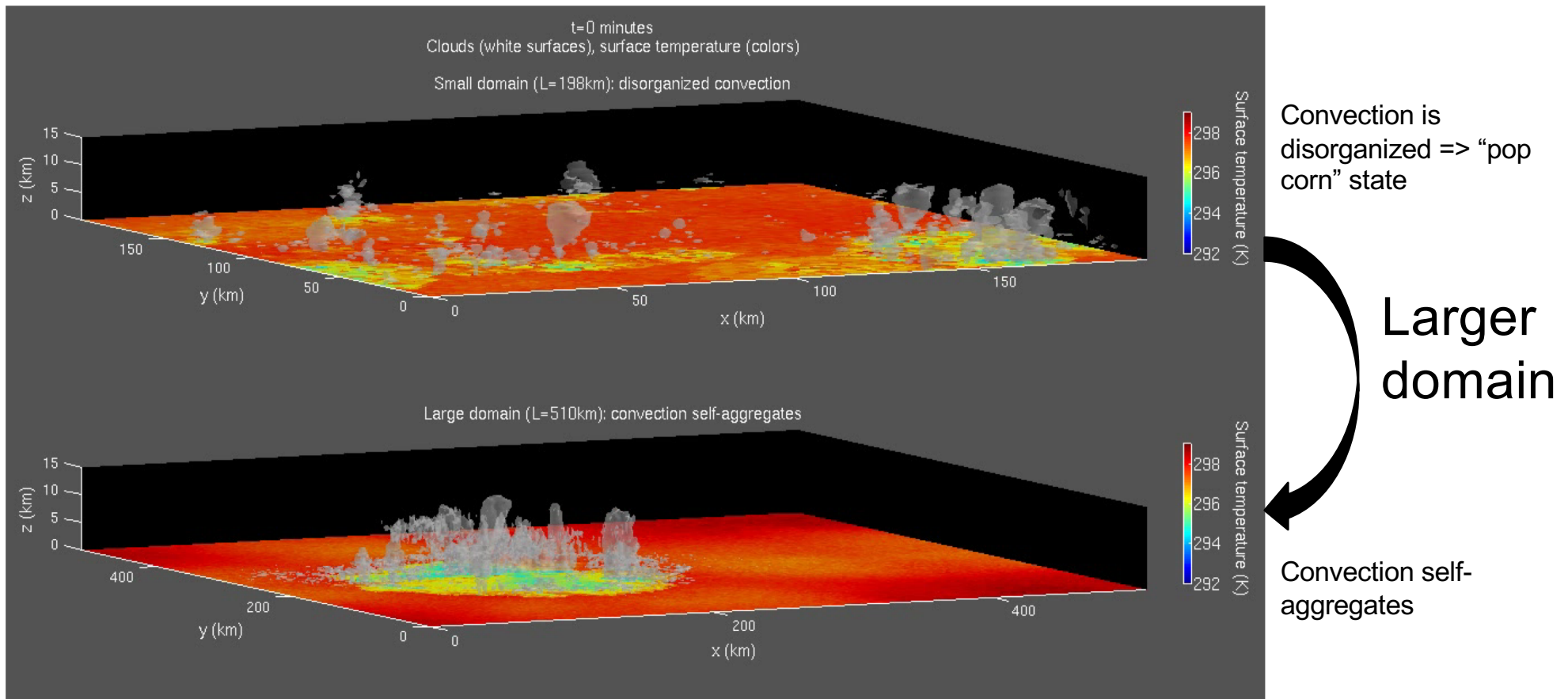
*Caroline Muller*

Self-aggregation feedbacks

« self-aggregation » = spectacular ability of deep convection to spontaneously organize in space, despite homogeneous conditions

Clouds over near-surface temperature

t=0 minutes
Clouds (white surfaces), surface temperature (colors)

Small domain (L=198km): disorganized convection

Convection is disorganized => "pop corn" state

Larger domain

Large domain (L=510km): convection self-aggregates

Convection self-aggregates

[Held Hemler Ramaswamy 92; Raymond, Zeng 2000; **Bretherton, Blossey, Khairoutdinov, 2005**; *Muller, Held 2012; Tobin, Bony, Roca, 2012; Tobin et al, 2013; Emanuel, Wing, Vincent 2013; Jeevanjee Romps 2013; Khairoutdinov Emanuel, 2013; Wing Emanuel 2014; Shi Bretherton 2014; Muller Bony 2015; Mapes 2016; Holloway&Woolnough 2016; (…) Wing Holloway Emanuel Muller 2017 (review simulations); Wing 2019 (climate); Muller Yang Craig Cronin Fildier Haerter Hohenegger Mapes Randall Shamekh Sherwood 2021 (review theory)]*
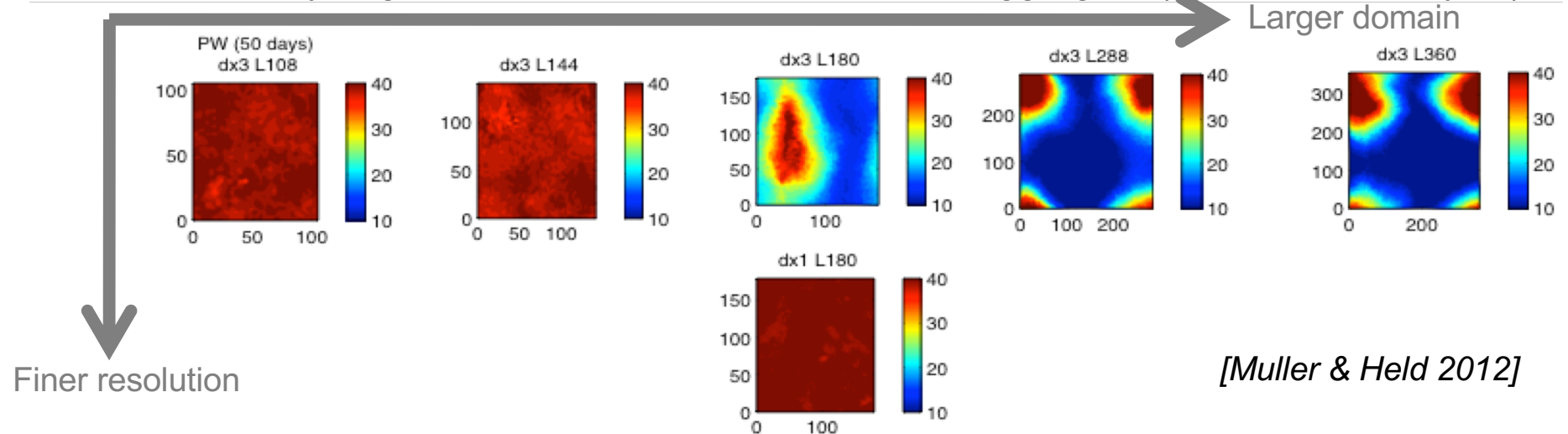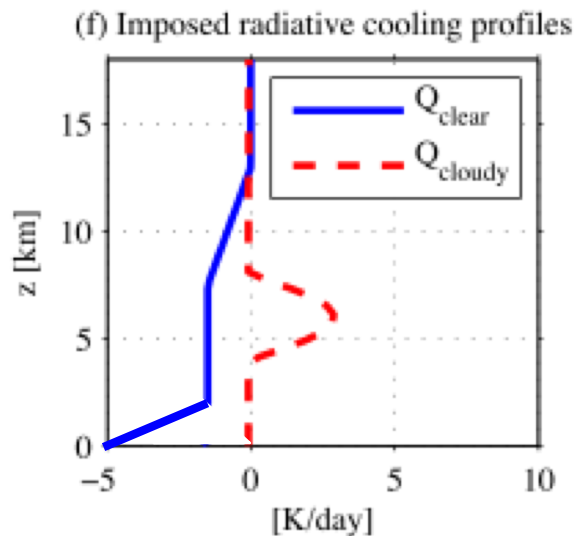
Self-aggregation feedbacks

PW(mm) t = 1 days
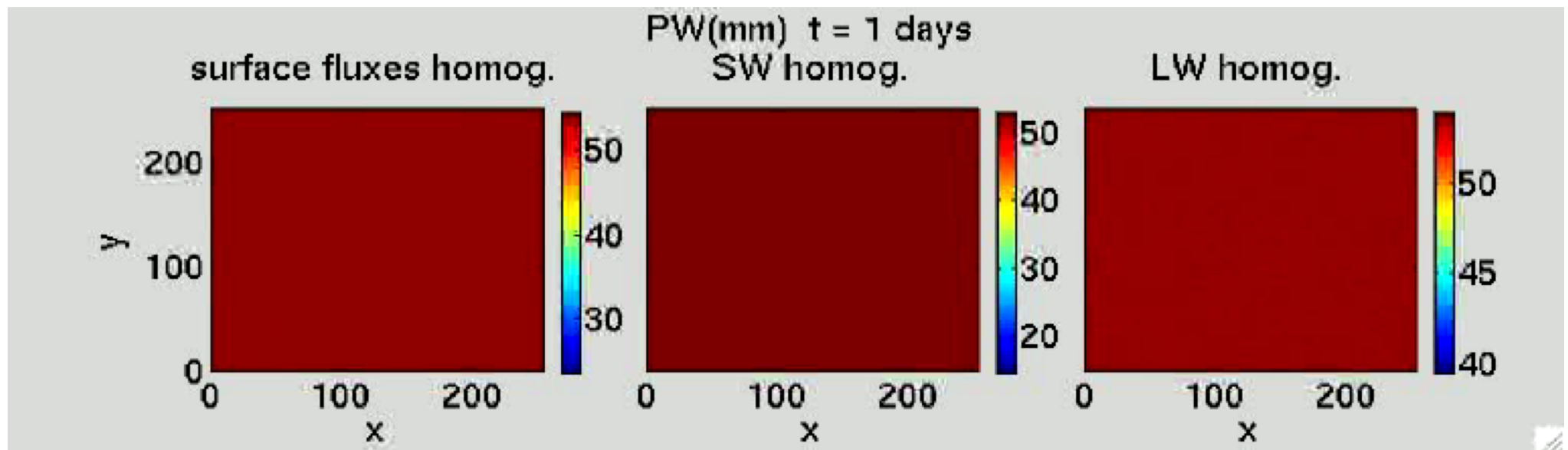
⇒ LW interactive radiation important

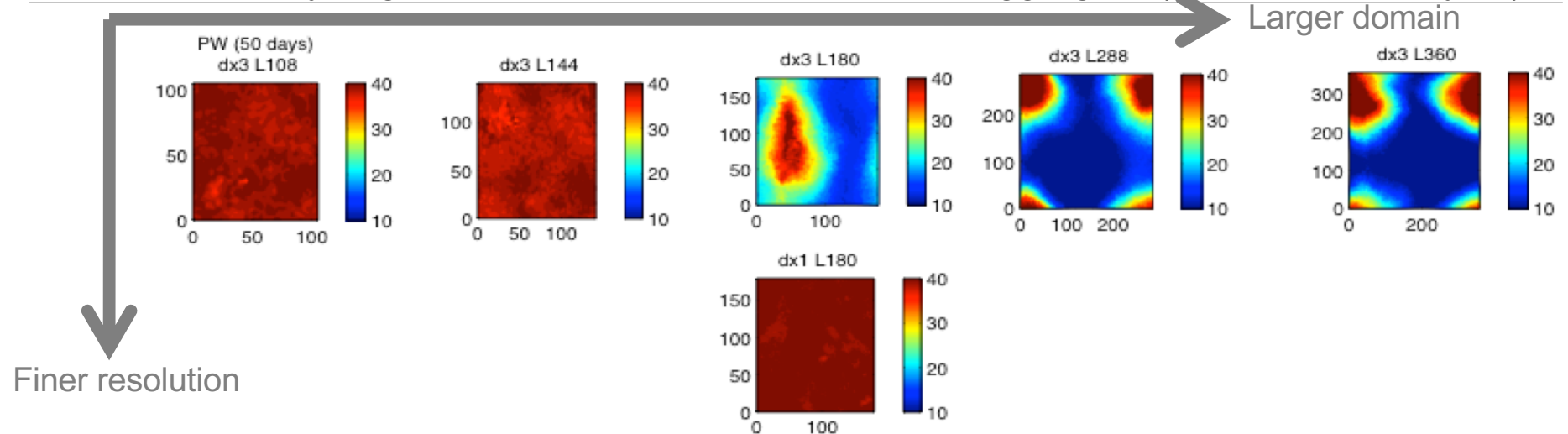• Interactive rad => only large domains and coarse resolutions aggregate (without diurnal cycle):

• Fixed rad BUT 2 profiles (one for dry region, one for moist region)

[Muller & Held 2012]

• Interactive rad => only large domains and coarse resolutions aggregate (without diurnal cycle):

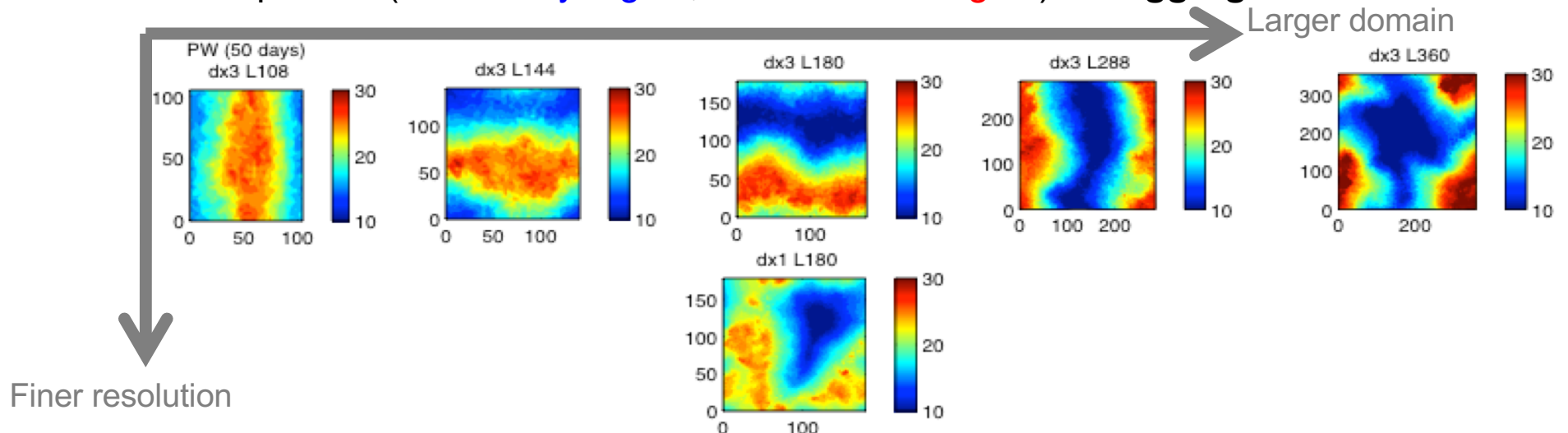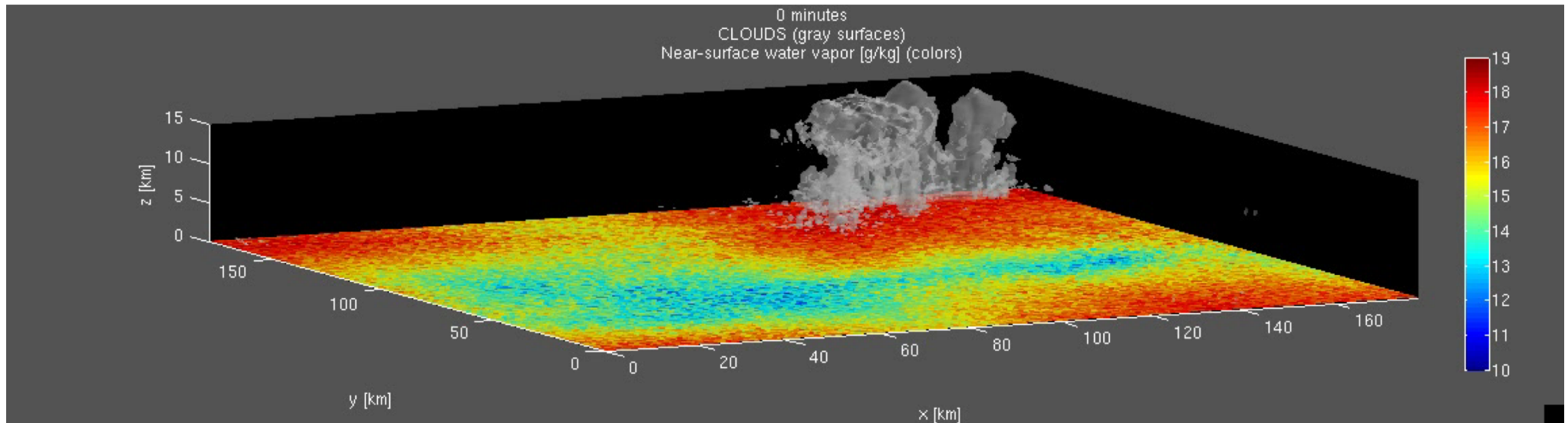• Fixed rad BUT 2 profiles (one for dry region, one for moist region): **all aggregate**

⇒ Domain size & resolution dependence due to variability in radiative cooling between dry and moist regions

Self-aggregation feedbacks

Clouds over near-surface humidity

Simulation without cold pools with fixed radiation aggregates !

$\Rightarrow$ not same feedback

« moisture memory » feedback is responsible for aggregation *[Tompkins JAS 2001, Craig&Mack JGR 2013]*, no downdraft to kill the cloud

[Muller & Bony GRL 2015]

RCE and processes in deep convective organization

⇒ *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