Effect of cumulus parameterization assumptions on MJO simulation

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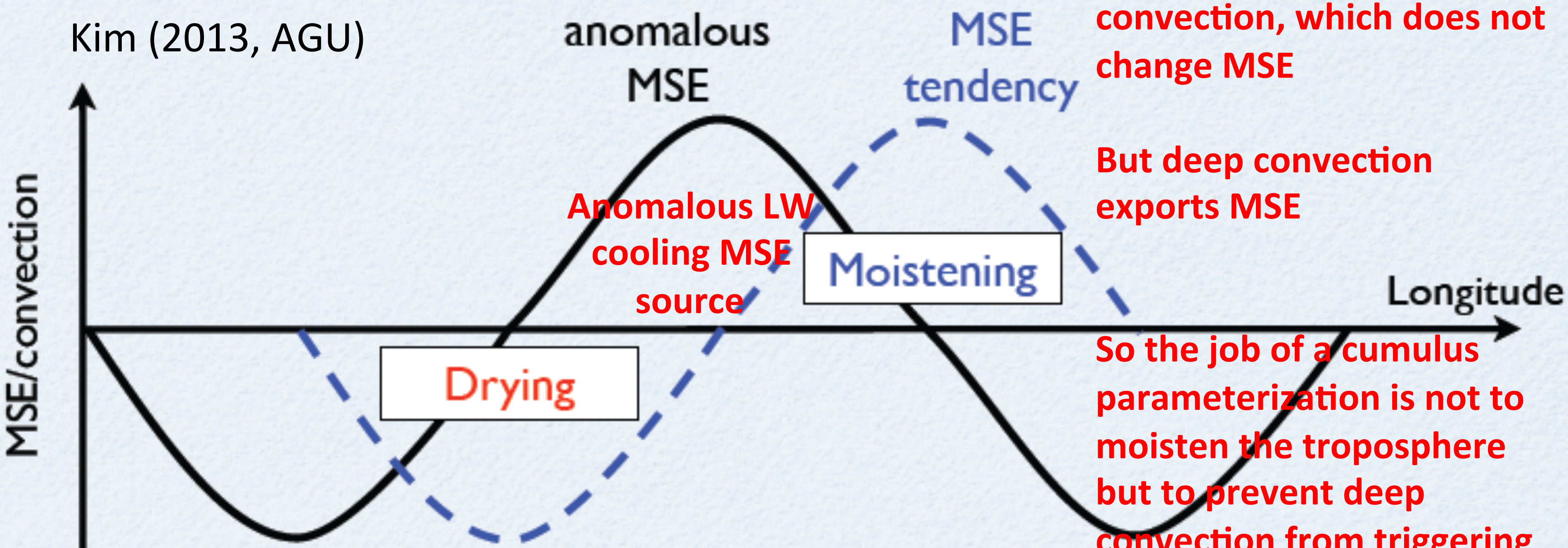
ASR MJO breakout

3/10/14

Propagation mechanism of the MJO

Kim (2013, AGU)



Anomalous LW cooling MSE source

No effect from shallow convection, which does not change MSE

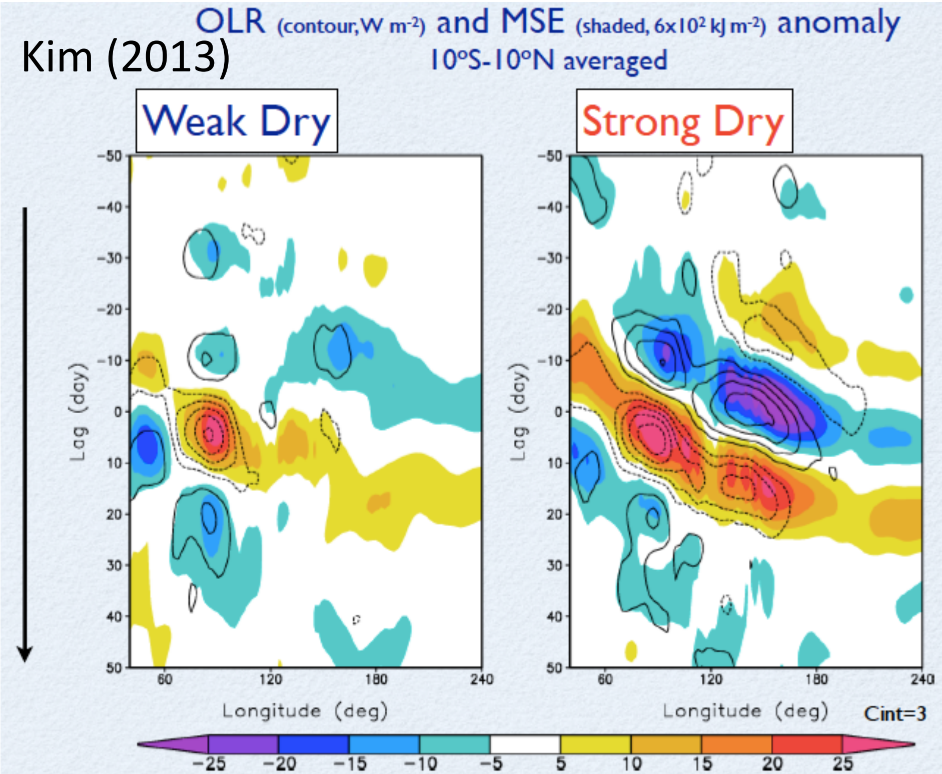
But deep convection exports MSE

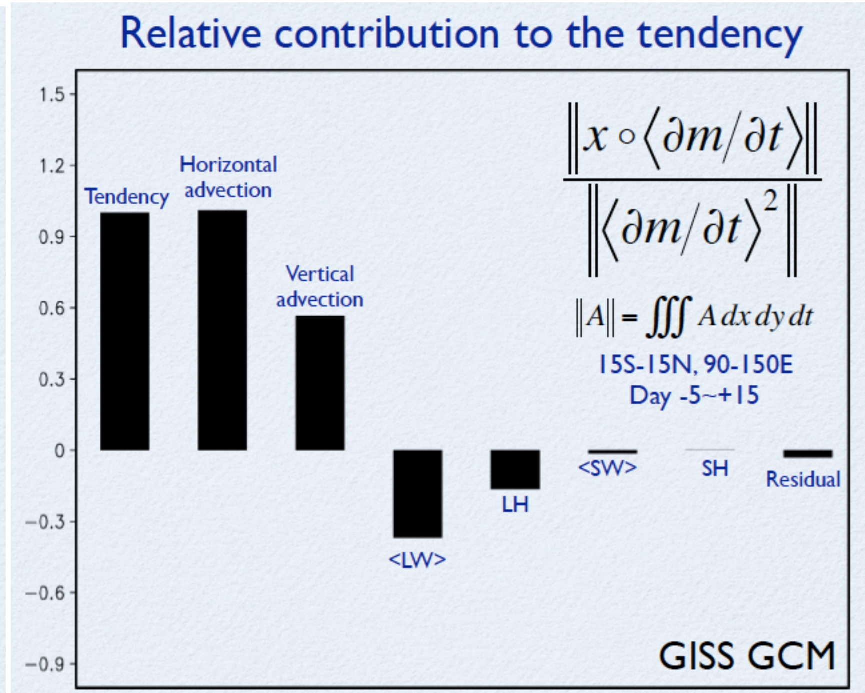
So the job of a cumulus parameterization is not to moisten the troposphere but to prevent deep convection from triggering before MSE builds up

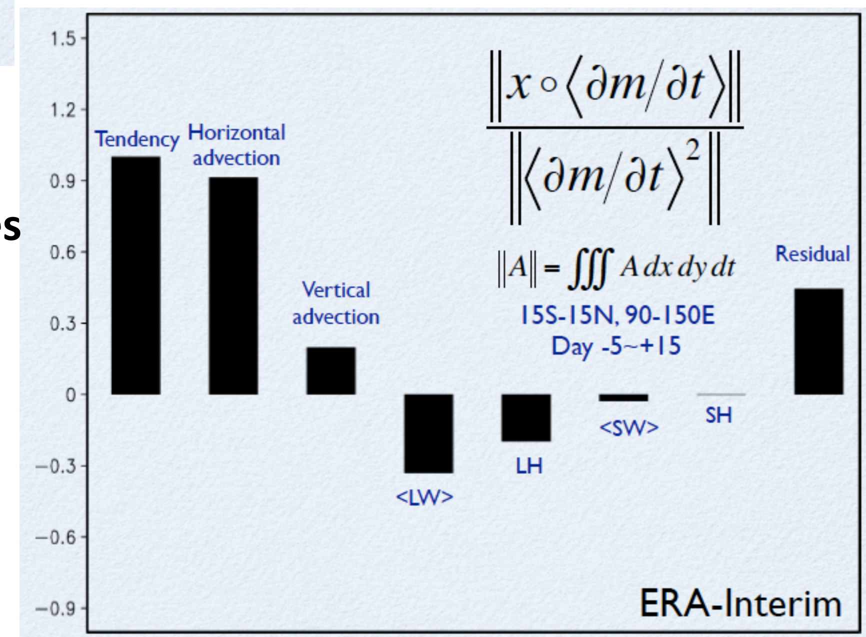
Column integrated moist static energy budget (MJO-filtered)

$$\left\langle \frac{\partial m}{\partial t} \right\rangle = -\left\langle \vec{v}\nabla \cdot m \right\rangle - \left\langle w\frac{\partial m}{\partial z} \right\rangle + L \cdot Evap + Sens + \left\langle LW \right\rangle + \left\langle SW \right\rangle$$

Tendency | Horizontal advection | Vertical advection | Surface turbulent fluxes | Radiative fluxes







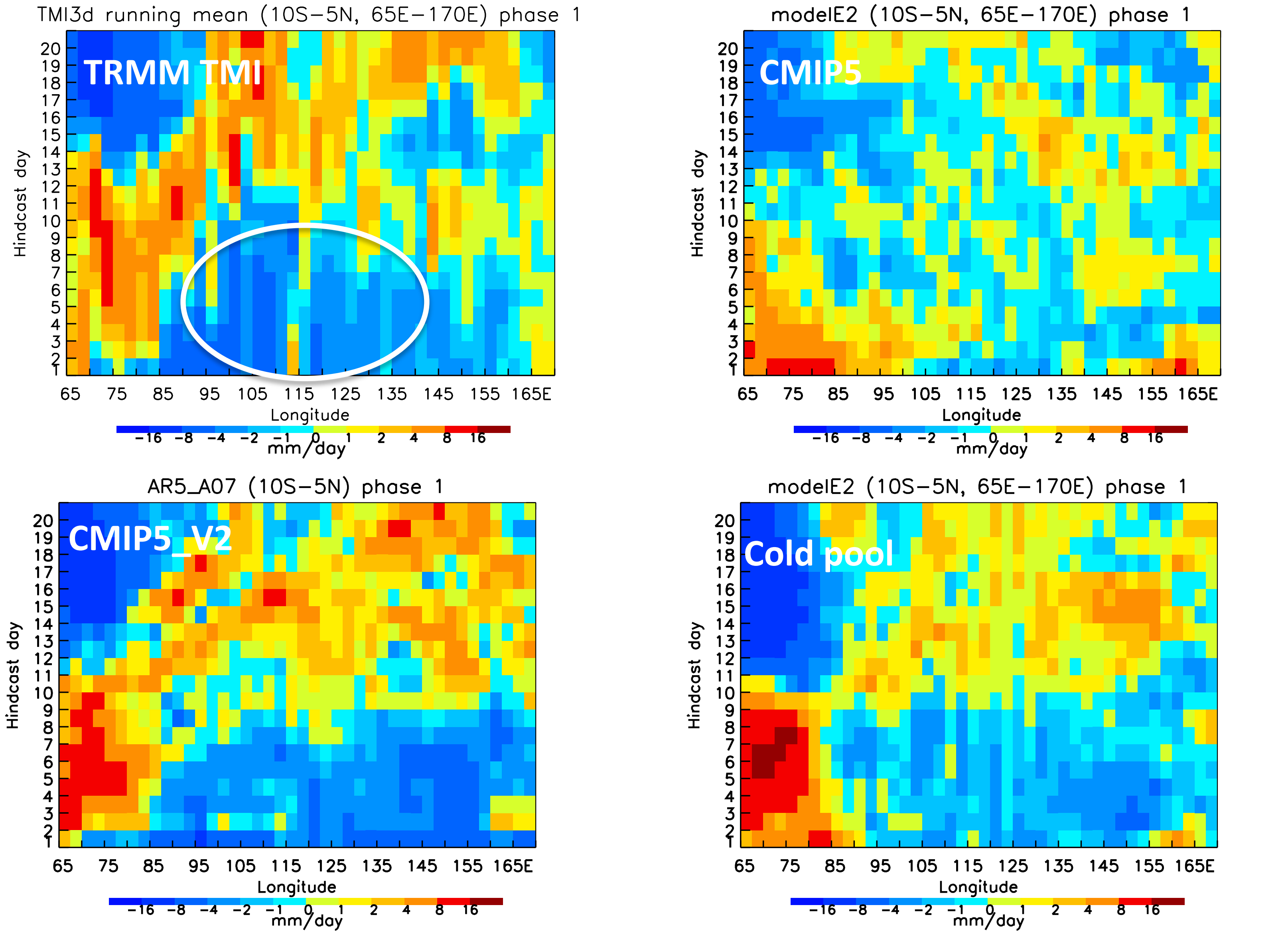
Strength of dry anomaly in West Pacific and Maritime Continent at MJO onset distinguishes events that propagate from those that do not (Kim et al. 2014)

Horizontal (mostly meridional) advection dominates MSE budget in both ERA-Interim and modified GISS Model E2

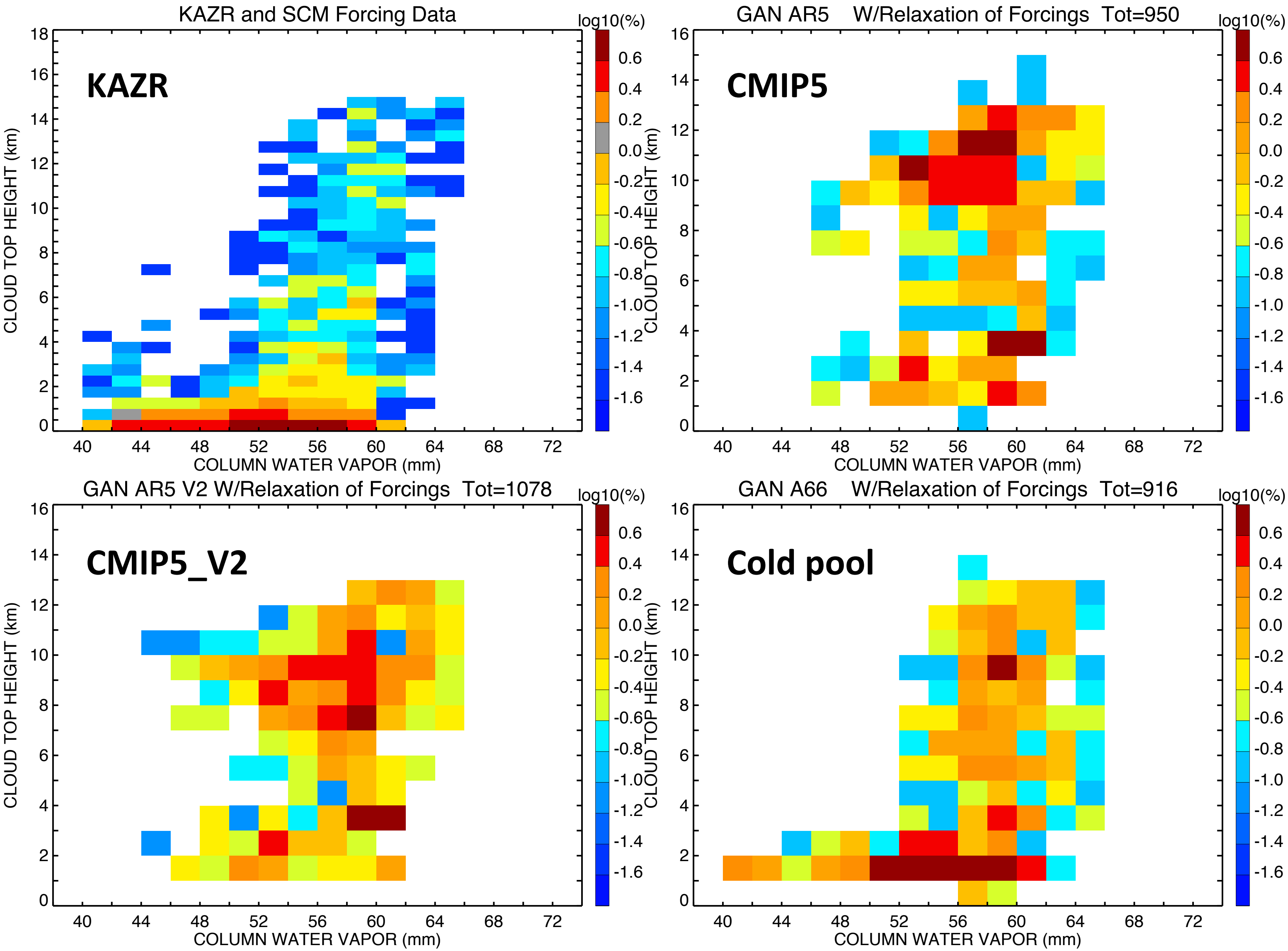
GISS cumulus parameterization:
Mass flux, divided into 2 "plumes"
(more vs. less entraining, $\varepsilon = CB/w^2$)
For this talk, 3 flavors:

- CMIP5: $C_1 = 0.3$, $C_2 = 0.6$: No MJO in climatological mode
- CMIP5_V2: $C_1 = 0.4$ instead: Makes pretty decent MJO; also includes stronger convective rain evap, stronger downdraft, but not necessary for MJO to occur
- Experimental Cold Pool version: Like V2 but Plume 1 only exists when cold pool is present and deep enough to lift undisturbed PBL air to LFC: Makes MJO but a bit weaker than V2

YOTC MJO 20-day hindcasts (2009 Event E)
Hovmöller composite of all W-H phase 1 rain anomalies



SCM, AMIE-Gan forcing, 3 hr relaxation
Convective cloud top height vs. column water vapor



Cold pool model responds very differently to AMIE-Gan forcing than in YOTC hindcasts

Model version	Plume 1 fraction of total convection	# of convective events relative to AR5
AR5		
SCM	0.48	1.00
Hindcast	0.48	1.00
AR5_V2		
SCM	0.49	1.14
Hindcast	0.49	1.20
Cold Pool		
SCM	0.03	2.06
Hindcast	0.22	1.29

Keys to simulating MJO?

- Presence of dry suppressed region east of disturbed area appears to be important to MJO propagation
- Sufficiently strong convective entrainment to keep that region from triggering deep convection too quickly matters – not moistening by shallow convection
- KAZR convective cloud top heights show expected sensitivity to moisture during AMIE-Gan, a good test for cumulus parameterizations…
- But only IF the forcing gives us an accurate thermodynamic structure; subtle differences between Gan forcing and YOTC hindcasts apparently make big difference to cold pool presence and MJO
- Anomalous LW cooling in disturbed region likely the energy source – organized convection?