# Microphysical and Dynamical Properties of Drizzling Stratocumulus

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# Motivation

better represent MBL cloud base height, the height of the major cloud layer, and the daily cloud cover variability. CLUBB also better simulates the relationship of cloud fraction to cloud liquid water path (LWP) most likely due to CLUBB's consistent treatment of these variables through a probability distribution function (PDF) approach. Subcloud evaporation of precipitation is substantially enhanced in simulations with CLUBB-MG2 and is more realistic based on the limited observational estimate. Despite these improvements, all model versions underestimate MBL cloud cover. CLUBB-MG2 reduces biases in in-cloud LWP (clouds are not too

Comparison between CAM default, CLUBB-MG1, CLUBB-MG2

Zheng et al. 2016

Focused on spurious oscillations in LWP, CF etc. in CLUBB-MG2

Zheng et al. 2017

**Table 1.** Summary of the Working Hypotheses for the Cloudy PBL Oscillation

| Testing Hypotheses | Description | Outcome |
|---|---|---|
| Hypothesis 0 | The large-scale horizontal advection causes the cloudy PBL oscillation | Rejected |
| Hypothesis 1a | The PBL turbulent fluxes/moments in CLUBB are too sensitive to the precipitation evaporation due to the oversimplified coupling between evaporation and variances | Approved |
| Hypothesis 1b | Even without the oversimplified coupling between evaporation and variances, the Cu-topped BL in CLUBB is generally too sensitive to the precipitation evaporation if the evaporation occurs | Rejected |
| Hypothesis 2a | The representation of precipitation evaporation in MG2 is unrealistic so that the PBL is stabilized and decoupled | Approved |
| Hypothesis 2b | The cloud is depleted by the raining process in MG2, thus the PBL is decoupled and collapsed without the turbulent mixing generated by cloud processes | Rejected |

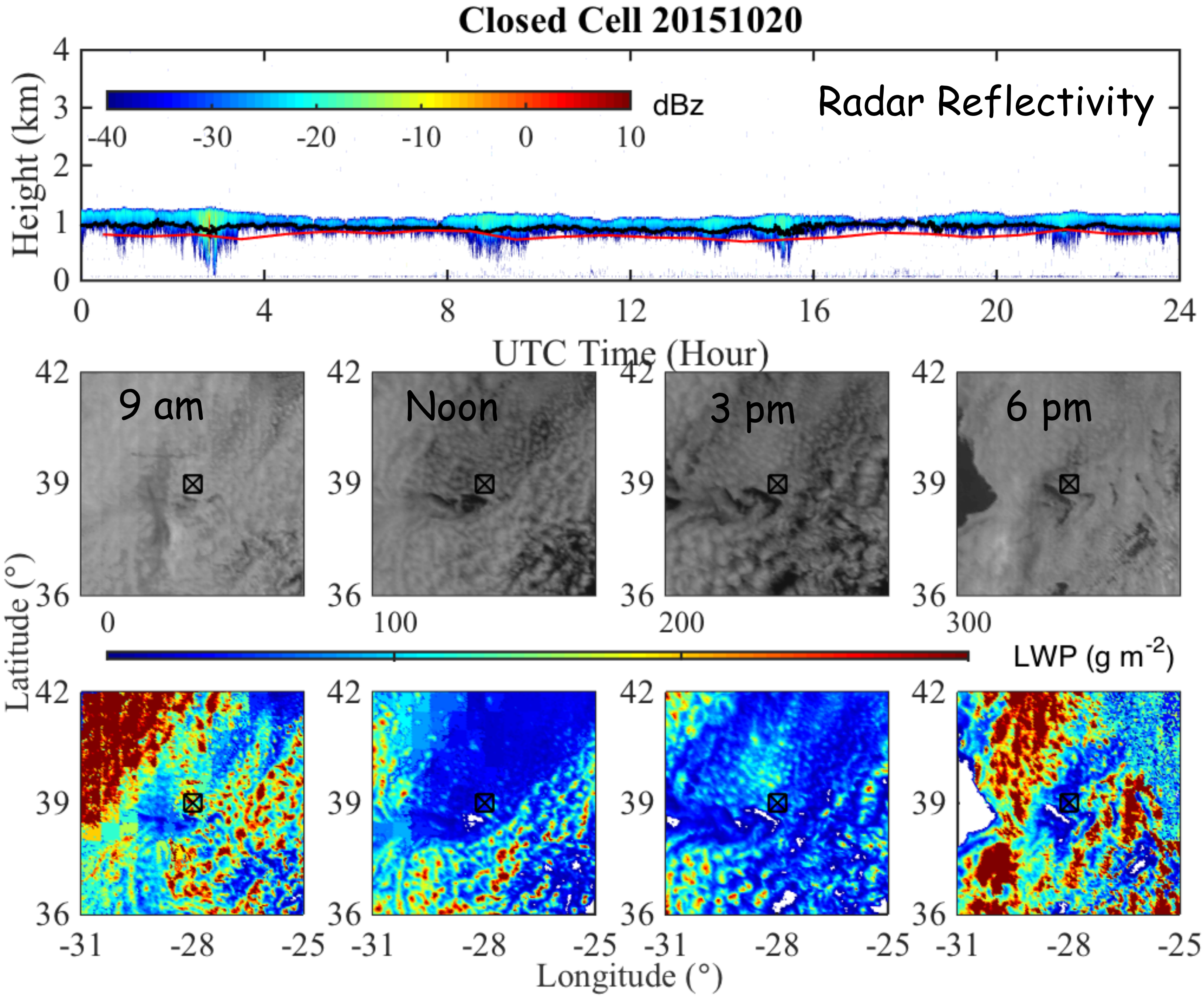
# Question

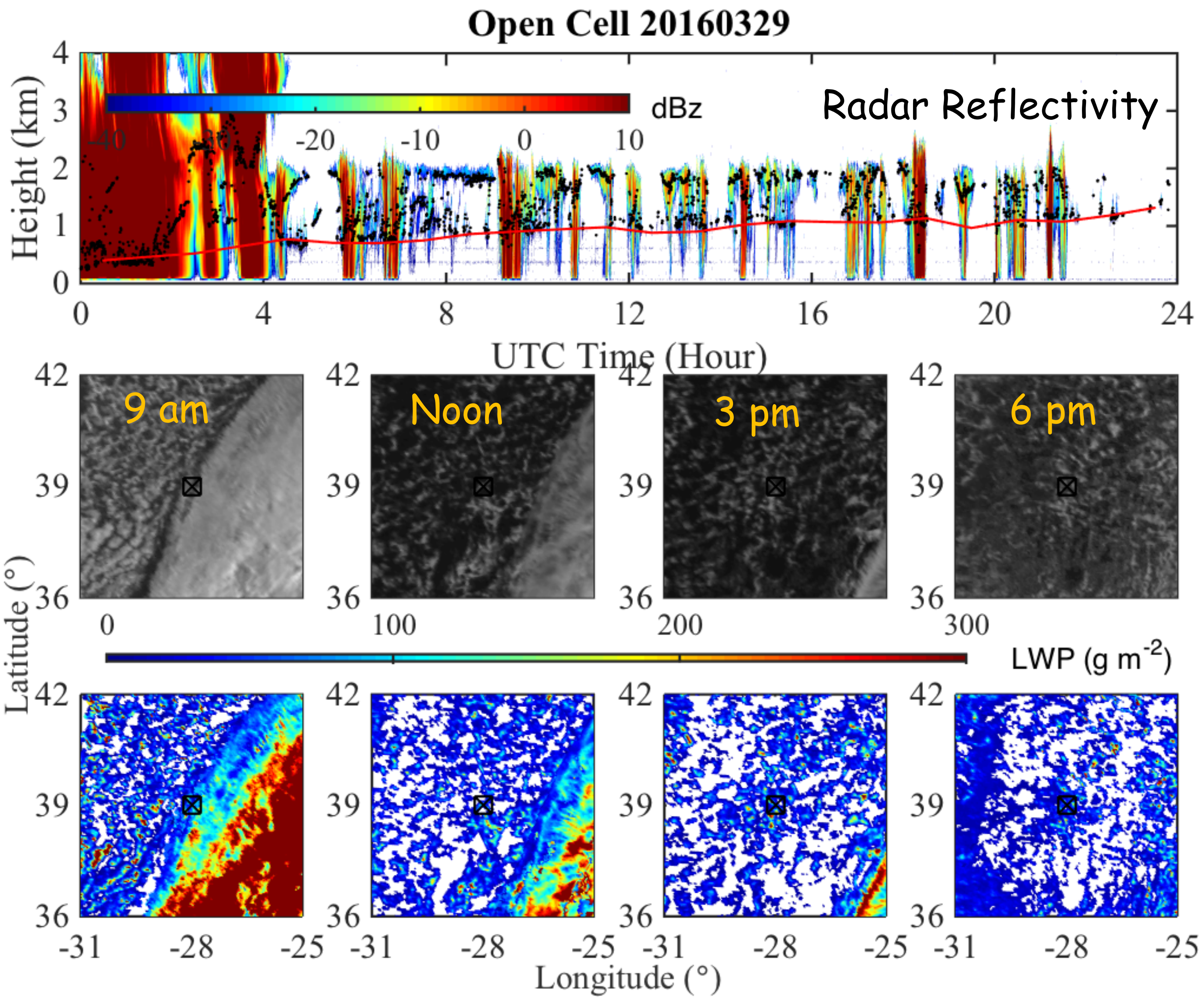
- What is the impact of drizzle evaporation on turbulence in marine stratocumulus clouds?

# Approach

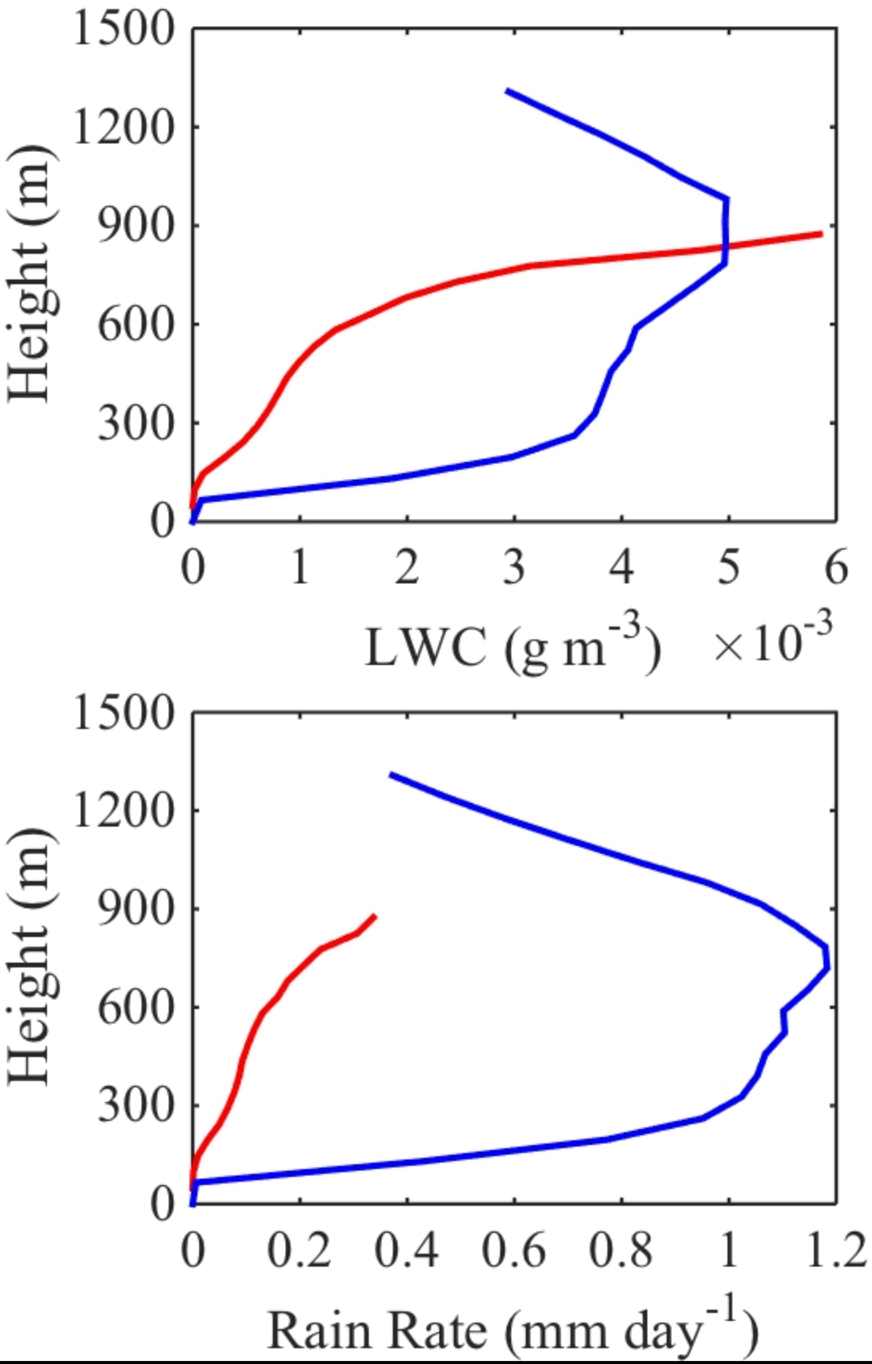
- Identified 12 cases (288 hours) of Closed mesoscale cellular convective (MCC) organization and 9 cases (216 hours) of Open MCC.
- Retrieved cloud and drizzle microphysical properties by combining data from ceilometer and KAZR.
- Retrieved the sub-cloud layer vertical air motion from Doppler Lidar and KAZR.
- Simulated radiative fluxes using RRTM.

O'Connor et al., 2005

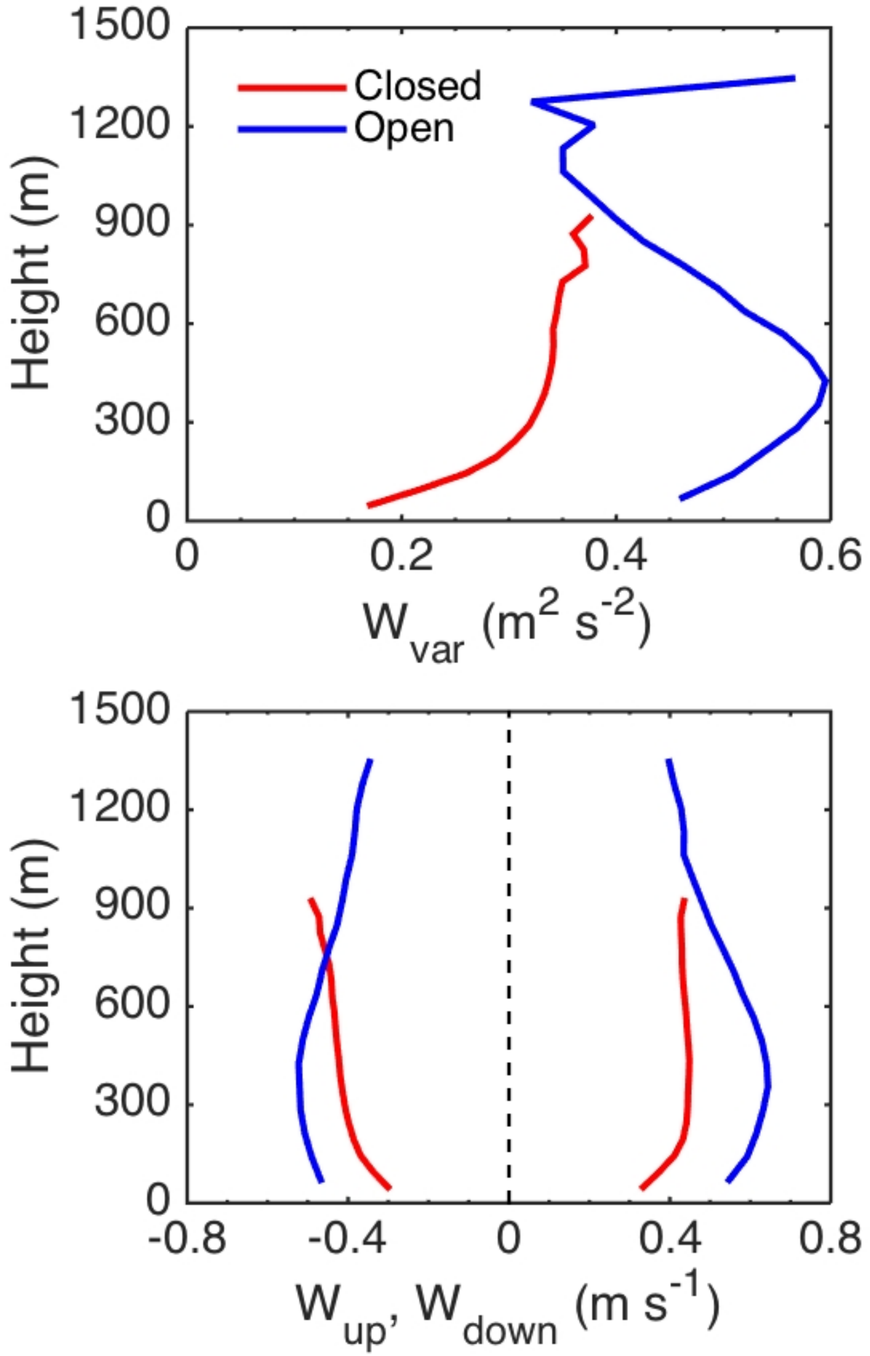

Closed Cell 20151020
Radar Reflectivity
dBz
-40 -30 -20 -10 0 10
Height (km)
UTC Time (Hour)
9 am
Noon
3 pm
6 pm
Latitude (°)
LWP (g m-2)
0 100 200 300
Longitude (°)



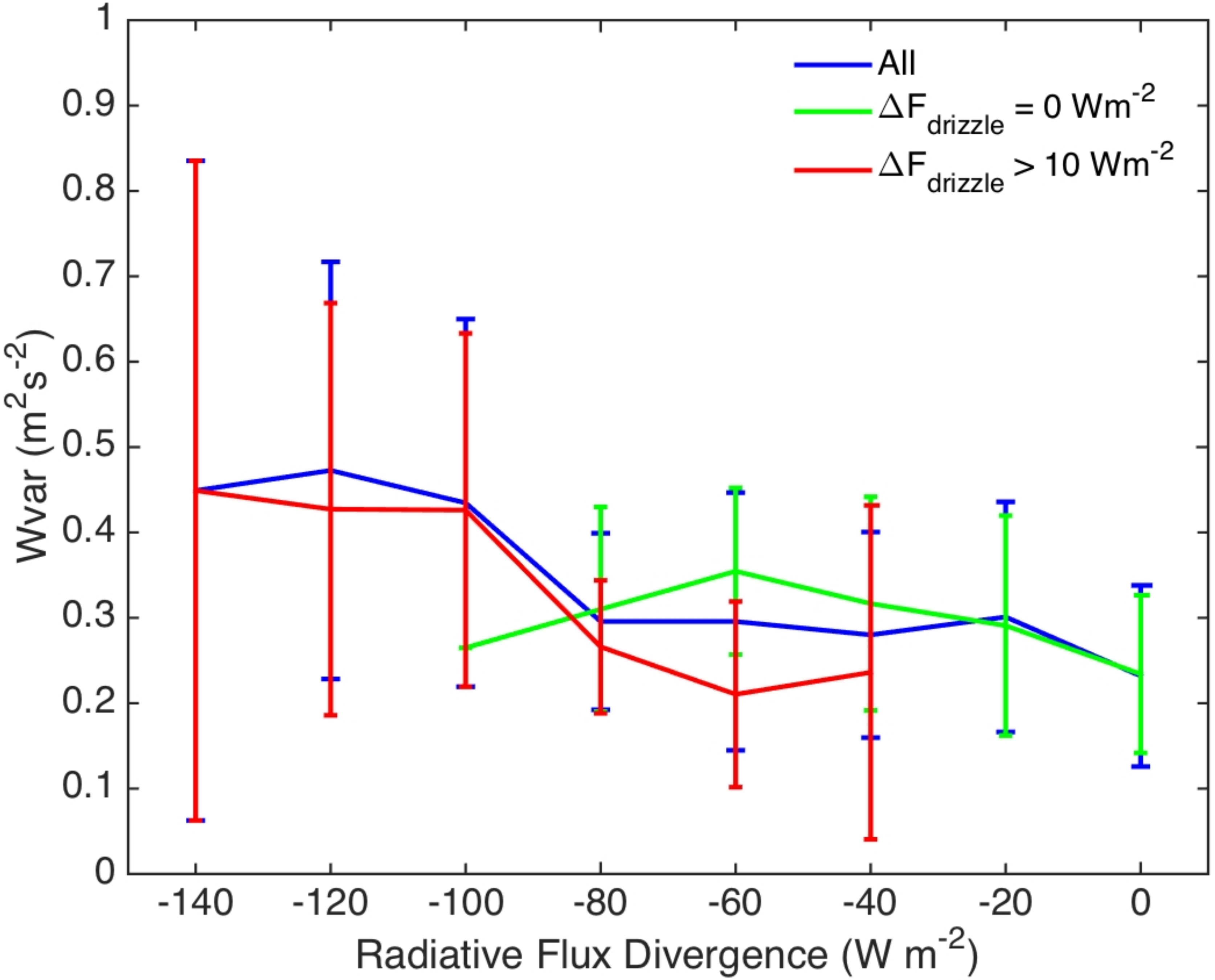
Open Cell 20160329
Radar Reflectivity
dBz
-40
-30
-20
-10
0
10
Height (km)
UTC Time (Hour)
9 am
Noon
3 pm
6 pm
LWP (g m-2)
0
100
200
300
Latitude (°)
Longitude (°)




Closed Cell: 288 hours
Open Cell: 216 hours




**Closed Cell: 288 hours**
**Open Cell: 216 hours**



All
$\Delta F_{drizzle}$ = 0 $Wm^{-2}$
$\Delta F_{drizzle}$ > 10 $Wm^{-2}$
Wvar ($m^2s^{-2}$)
Radiative Flux Divergence (W $m^{-2}$)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
-140
-120
-100
-80
-60
-40
-20
0

# Preliminary Results

- Boundary layer with open cellular stratocumulus were deeper, more turbulent and heavily precipitating compared to those with closed cellular stratocumulus.
- For a radiative flux divergence of -60 $Wm^{-2}$, drizzle evaporation can reduce the variance of vertical velocity from 0.35 $m^2s^{-2}$ to 0.21 $m^2s^{-2}$, a reduction of 40%.

Posters by Maria Cadeddu (Part I: retrieval development) and Virendra Ghate (Part II: impact on turbulence) on Tuesday 5-6:30 pm.