Mesoscale cloud and drizzle transitions

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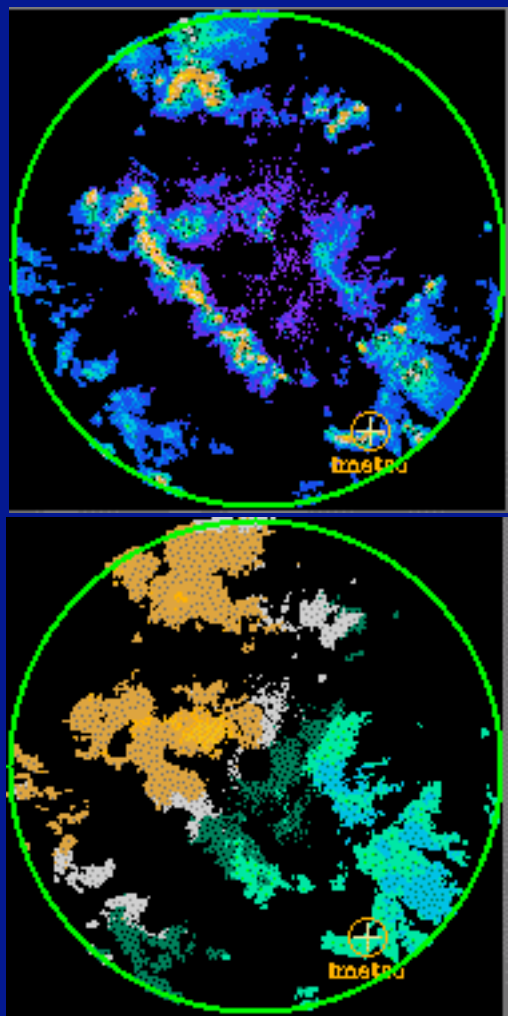
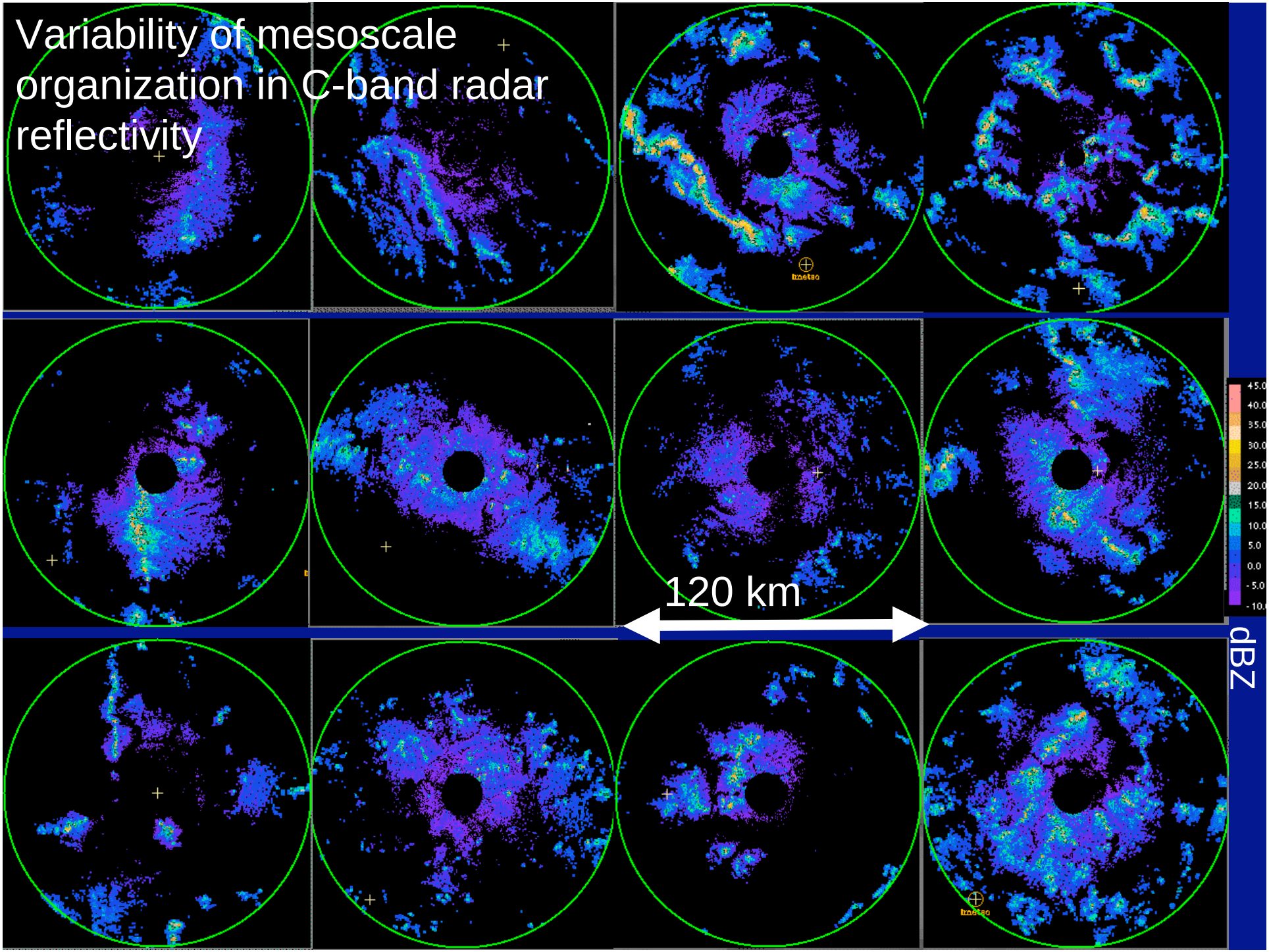
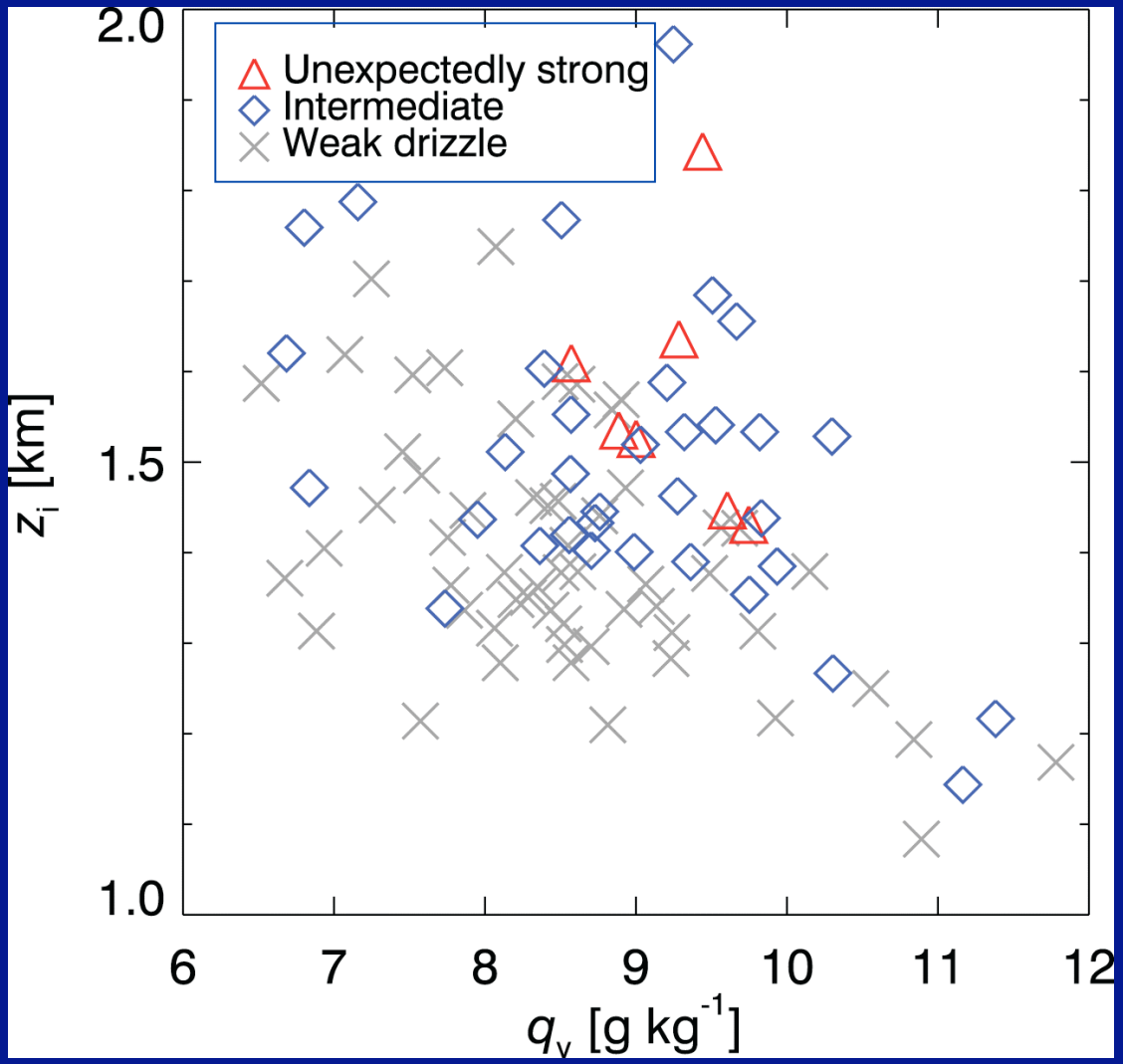
RHB C-band radar netcdf files QC version 1, Aug 2009

- PPI radar volume every 3 minutes
- Cartesian interpolation (Cressman-weighted) Δx= 250 m, Δz=500 m
  - Reflectivity--relative calibration is steady through cruise (absolute calibration not applied yet)
  - Radial velocity as observed (mean wind not removed yet)
- Individual files with bad sea clutter contamination deleted



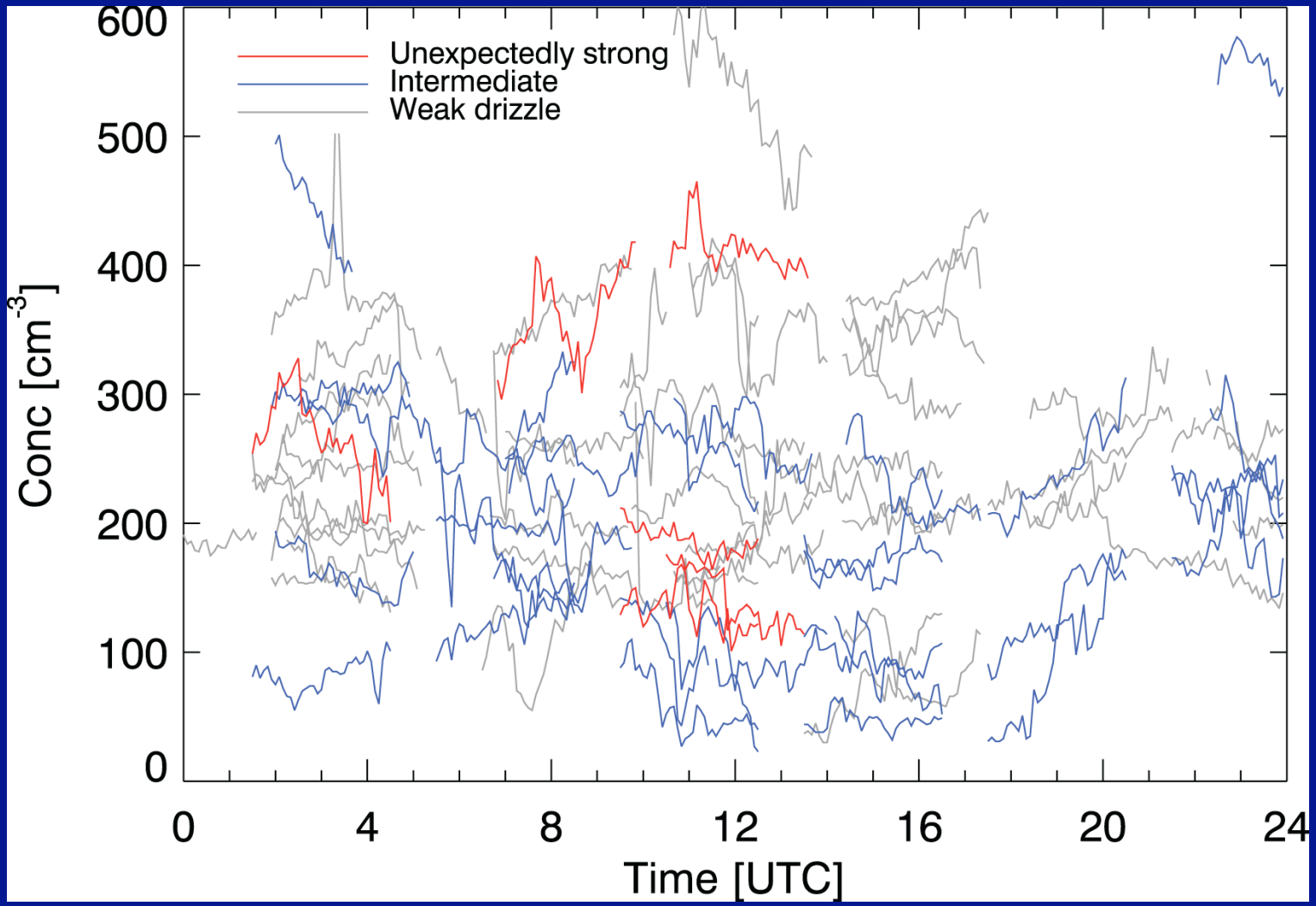

Variability of mesoscale organization in C-band radar reflectivity
120 km
dBZ

Mean moisture over the 10-200 m layer (q_v) versus inversion height (z_i) for different drizzle conditions



Boundary layers were both moist and deep (1.4 to 2 km in height) for stronger drizzle events compared to the typical, weaker drizzle events that tended to be either drier or shallower.

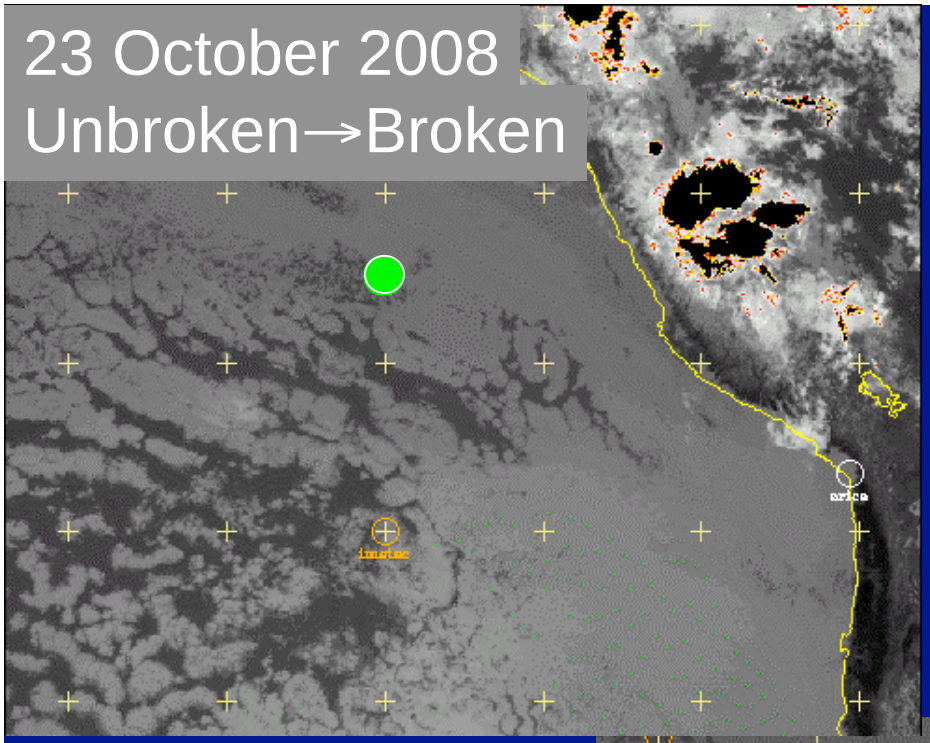
Ship-based CCN data for different drizzle categories

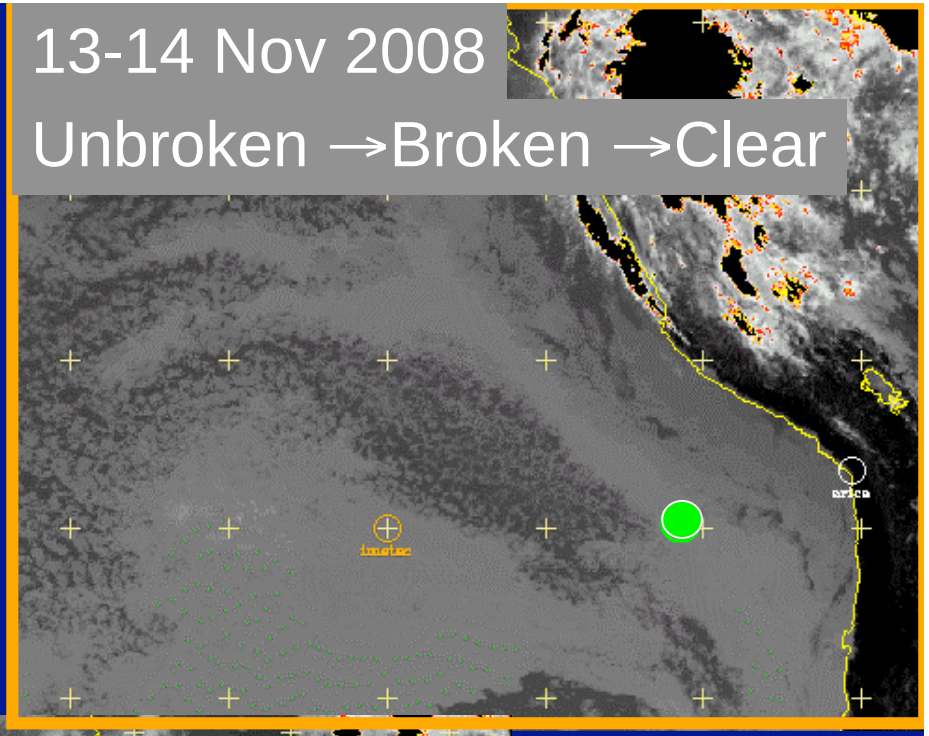


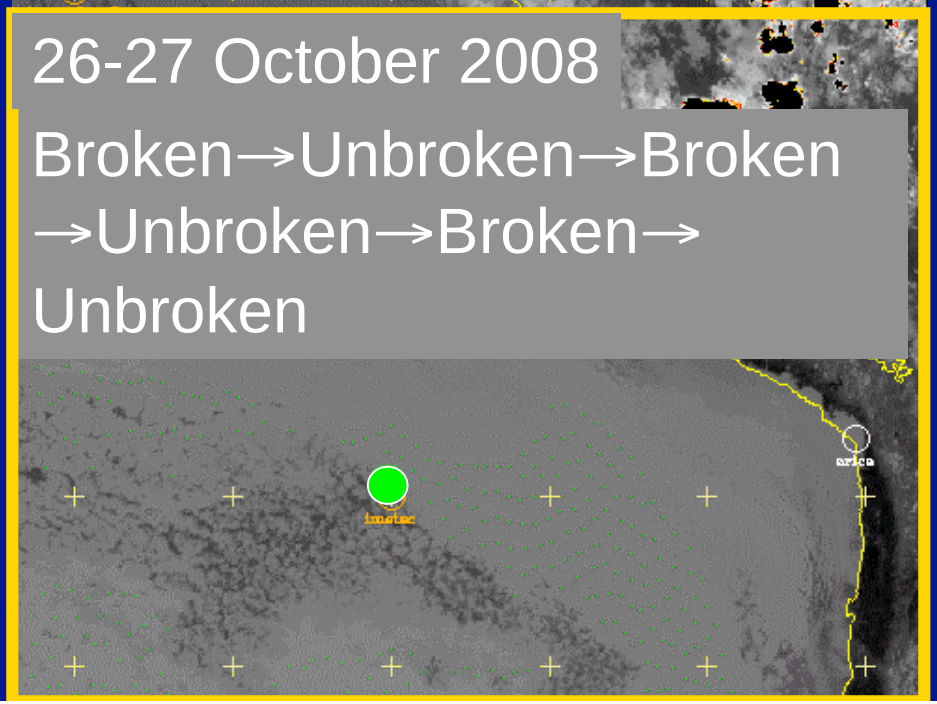
Each trace is ±1.5 h from sounding time

CCN data from Dave Covert

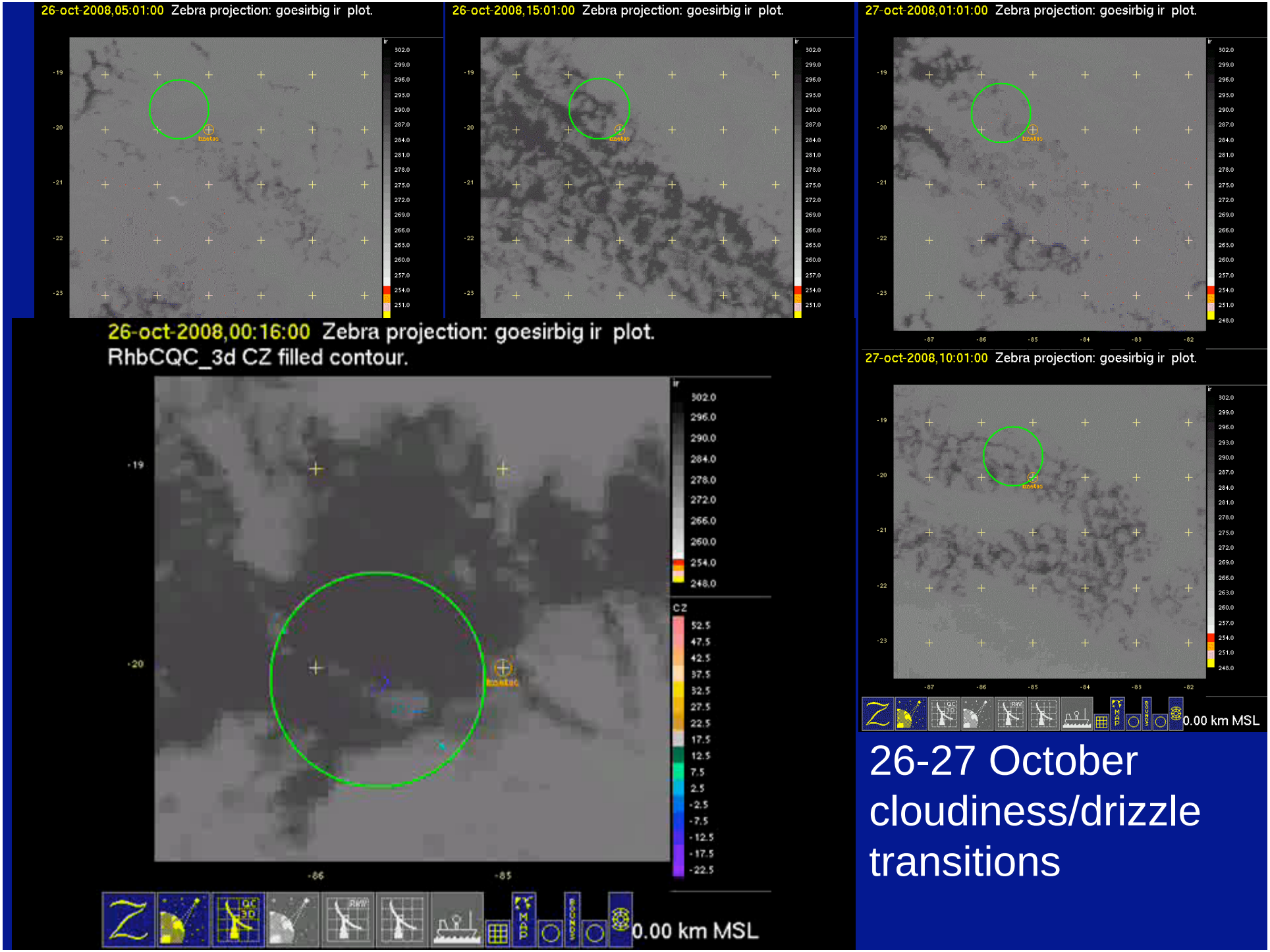
Cloudiness Transitions



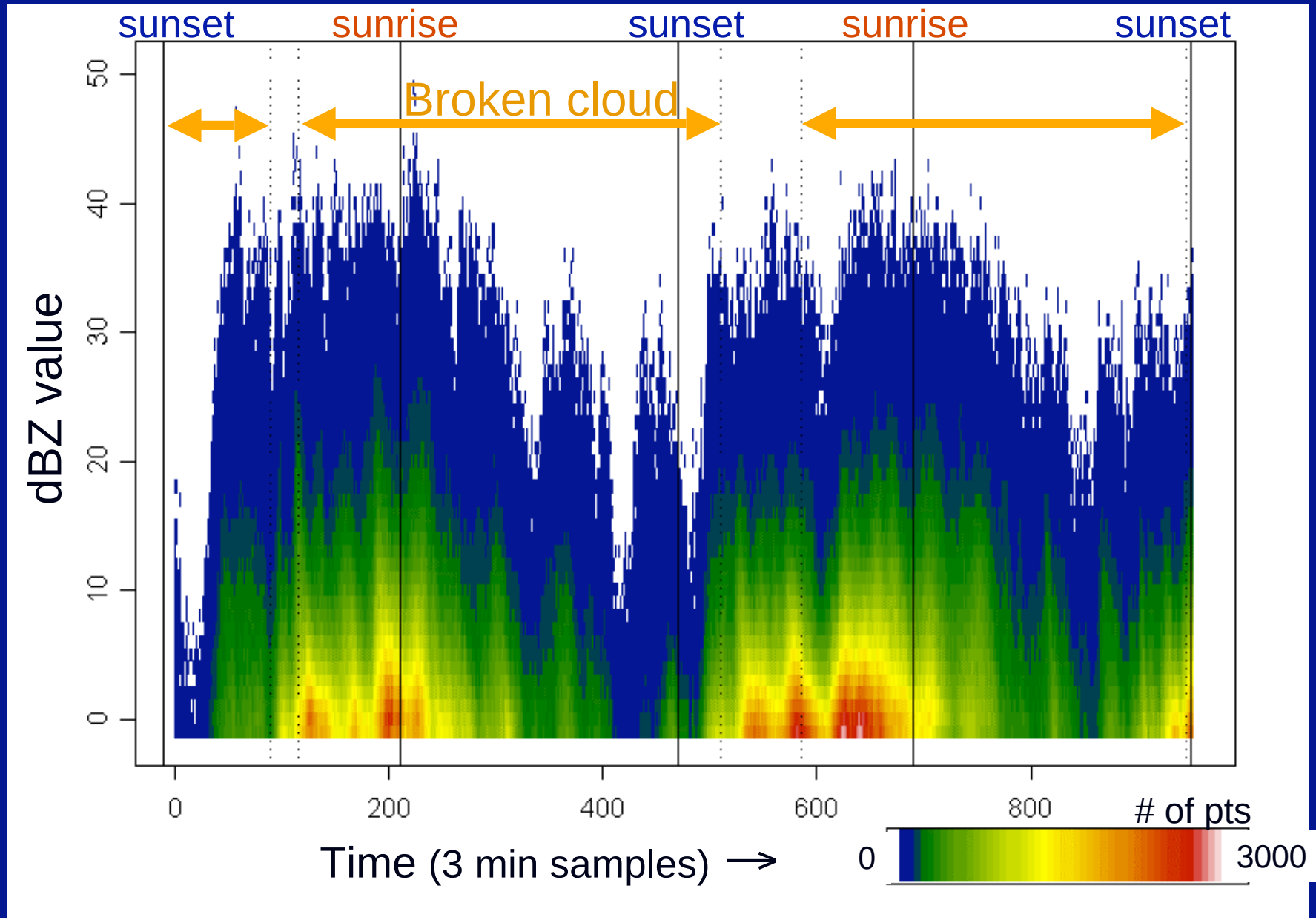


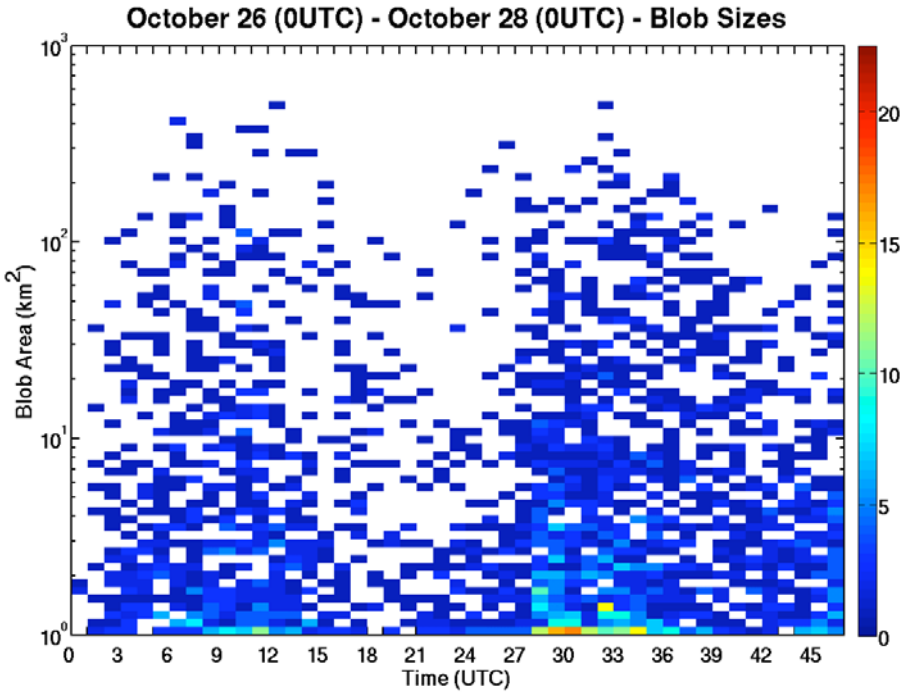


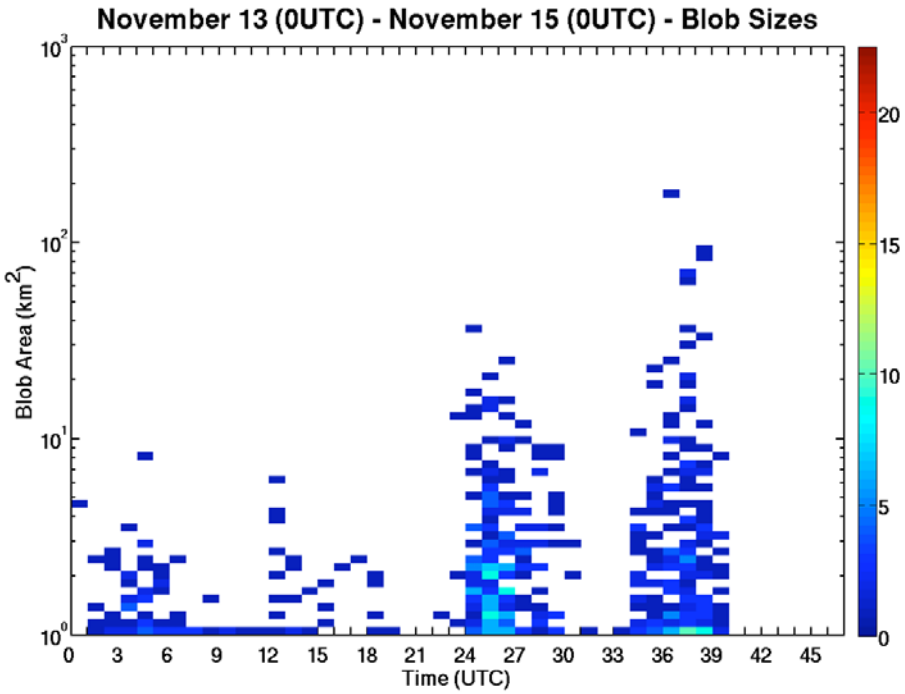
● RHB location


26-oct-2008,05:01:00 Zebra projection: goesirbig ir plot.
26-oct-2008,15:01:00 Zebra projection: goesirbig ir plot.
27-oct-2008,01:01:00 Zebra projection: goesirbig ir plot.
26-oct-2008,00:16:00 Zebra projection: goesirbig ir plot.
RhbCQC_3d CZ filled contour.
27-oct-2008,10:01:00 Zebra projection: goesirbig ir plot.
ir
CZ
0.00 km MSL
26-27 October cloudiness/drizzle transitions

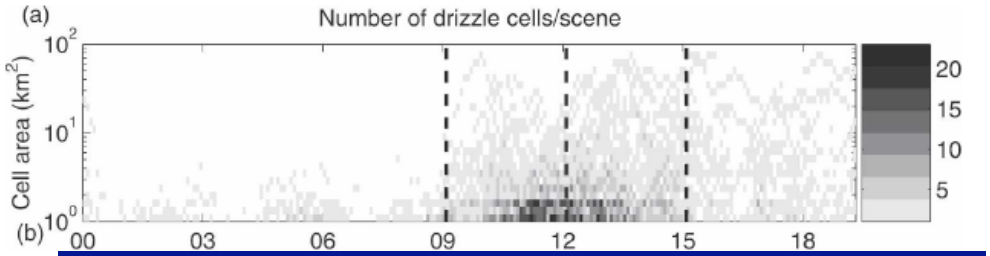
0 UTC 26 Oct to 0 UTC 28 Oct, evolution of C-band radar reflectivity distribution







Cell number/size evolution

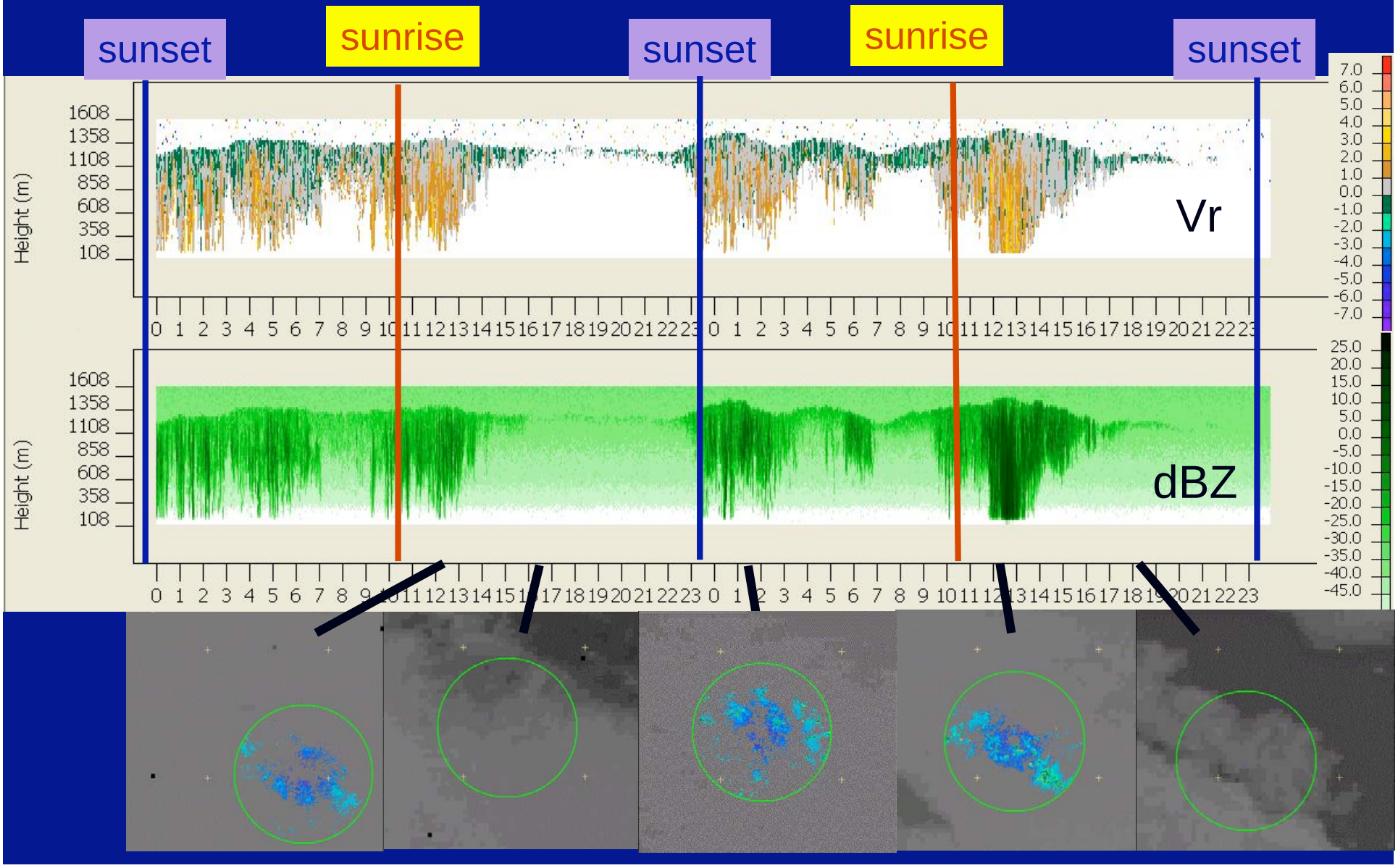


Comstock et al. 2007

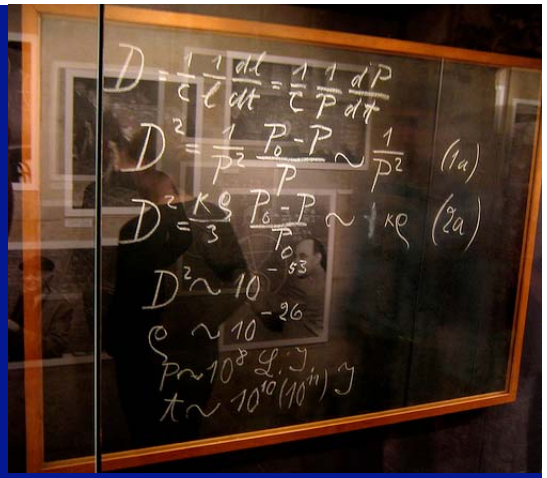
Contiguous drizzle cell definition:
Threshold = 5 dBZ
Minimum size = 0.5 km^2

VOCALS radar domain is 4x larger than in EPIC Sc

NOAA/ESRL vertically-pointing Cloud Radar data 13 -14 Nov 2008, longitude ~76° W



Preliminary “almost LES” numerical simulations

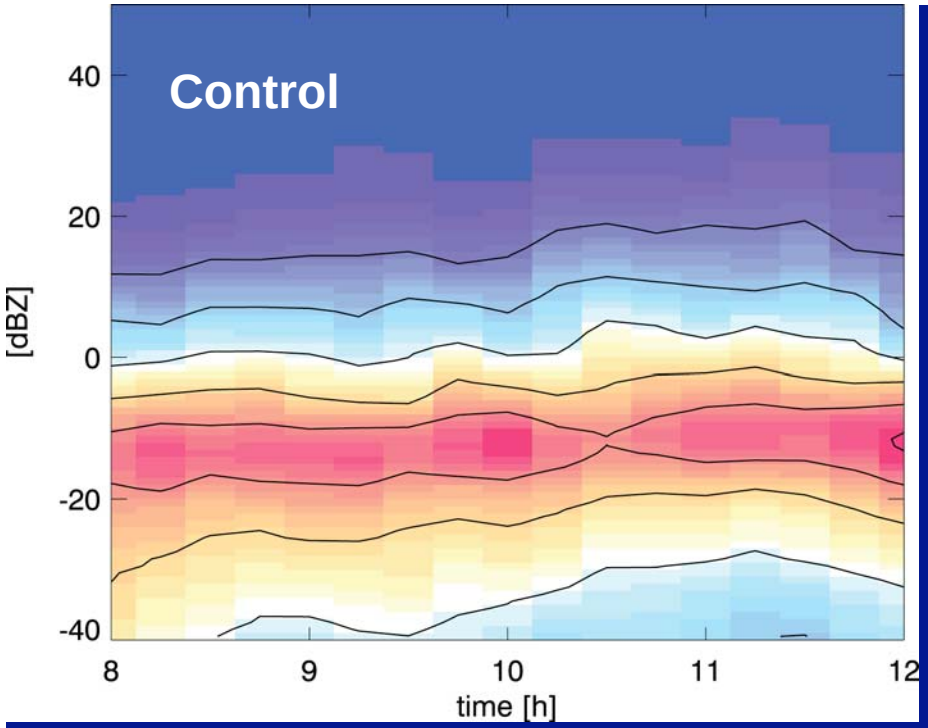


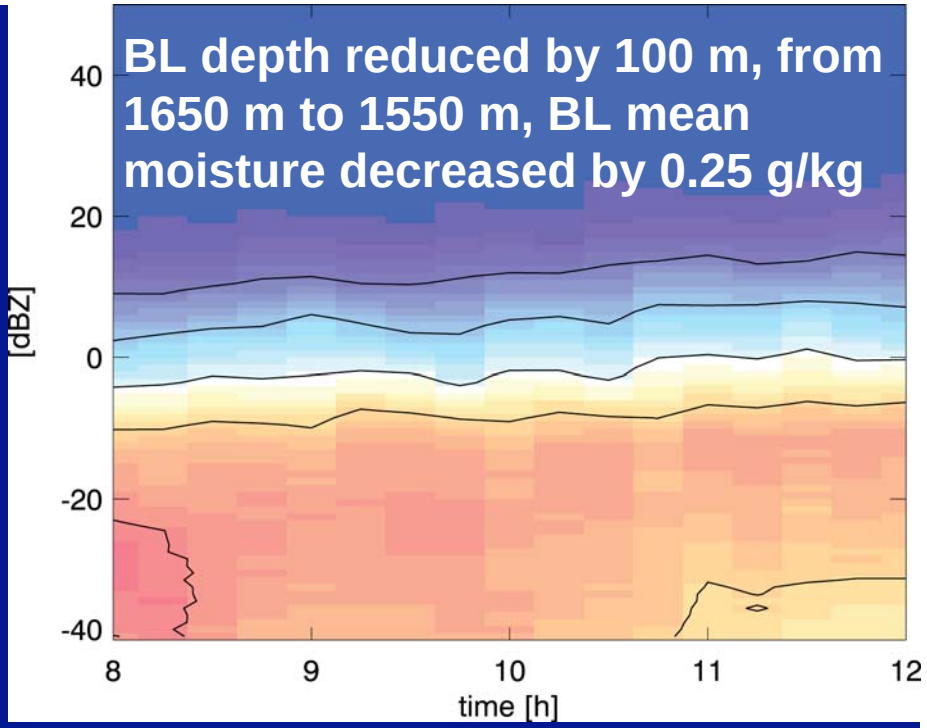
System for Atmospheric Modeling (SAMEX) — Explicit Microphysics; Khairoutdinov and Randall (2003); microphysics based on Kogan (1991)

- Horizontally homogeneous initial conditions based on soundings
- Initialized with random 0.1 K noise to break up symmetry
- LW radiation
- Size-resolved (“bin” or “explicit”) microphysics
- 34 droplet bins; 19 CCN bins
- Initial CCN ~104/cc, (baseline distribution from RICO)
- **Reflectivity calculated directly from DSD**

Domain

- dx=dy=150 m (57.6 x 57.6 km^2 domain)
- dz stretched: 25 m at z = 0; 40 m at z = 800 m; 25 m at 1800 m
- 384 x 384 x 96, run for 12 h





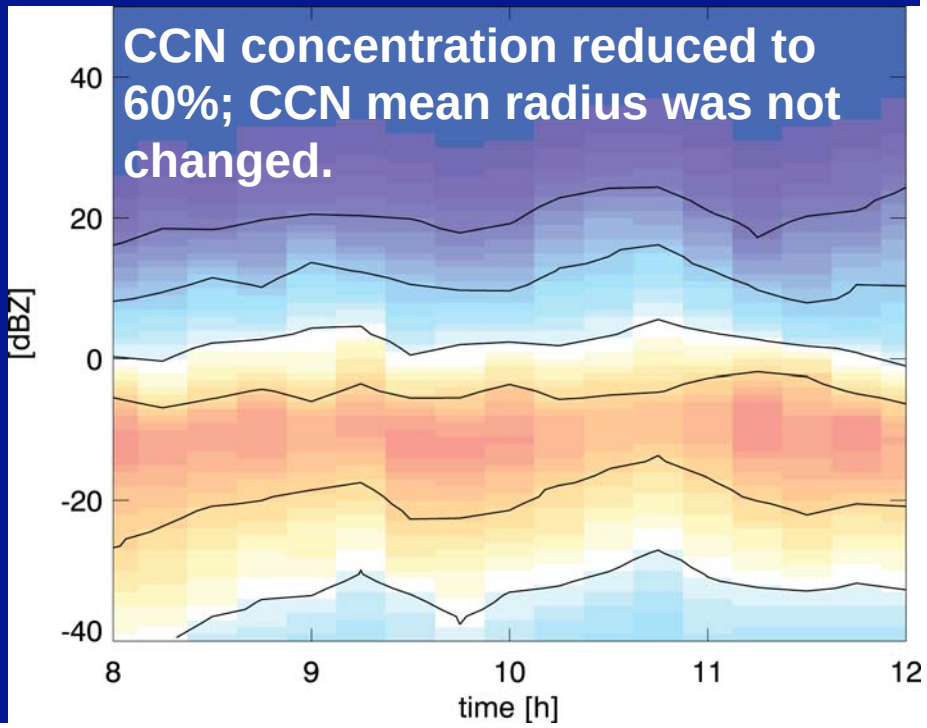
Mesoscale-almostLES model

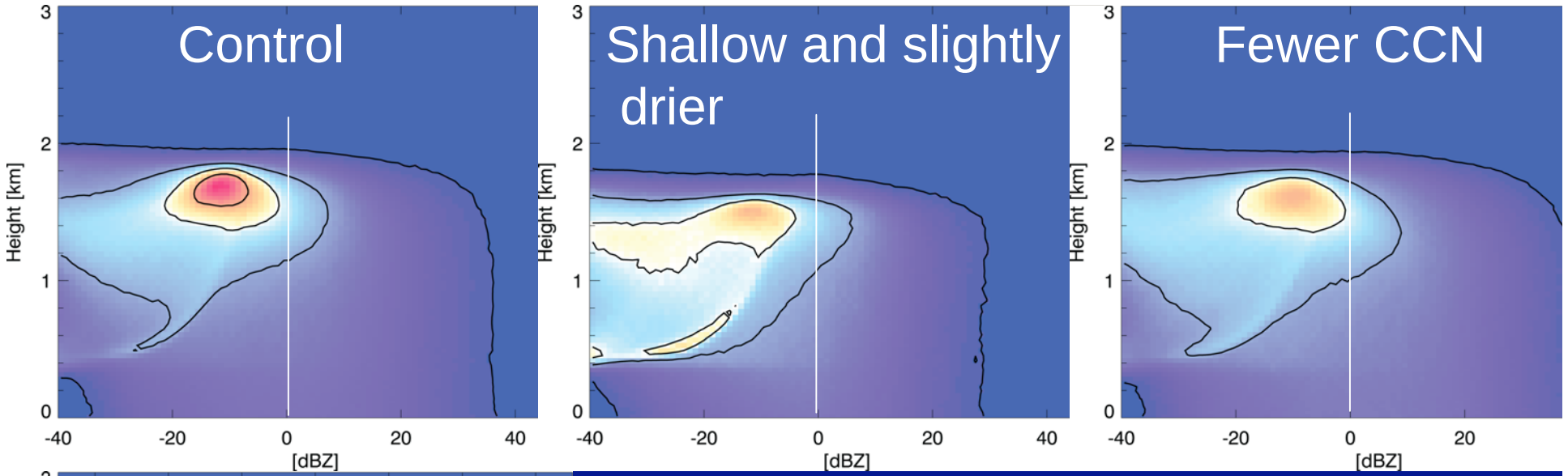
Control uses 26 Oct 12 UTC RHB upper air sounding

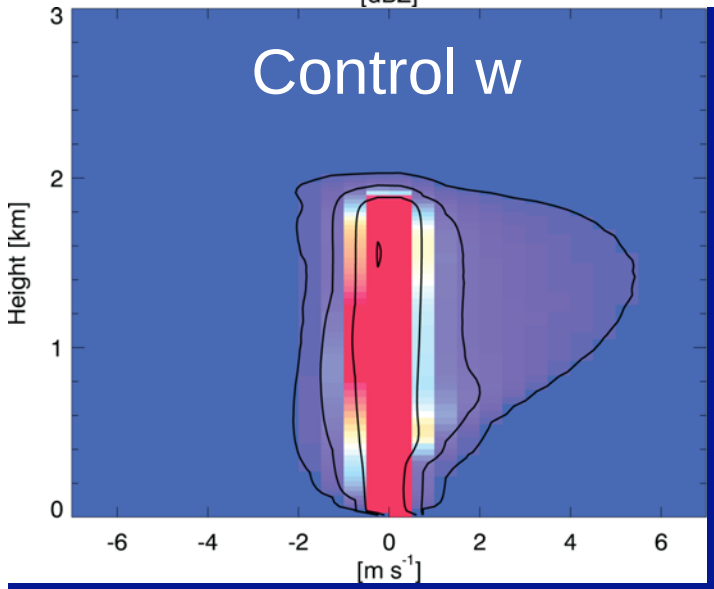
Sensitivity tests:

*** Shallower BL depth and slightly drier**

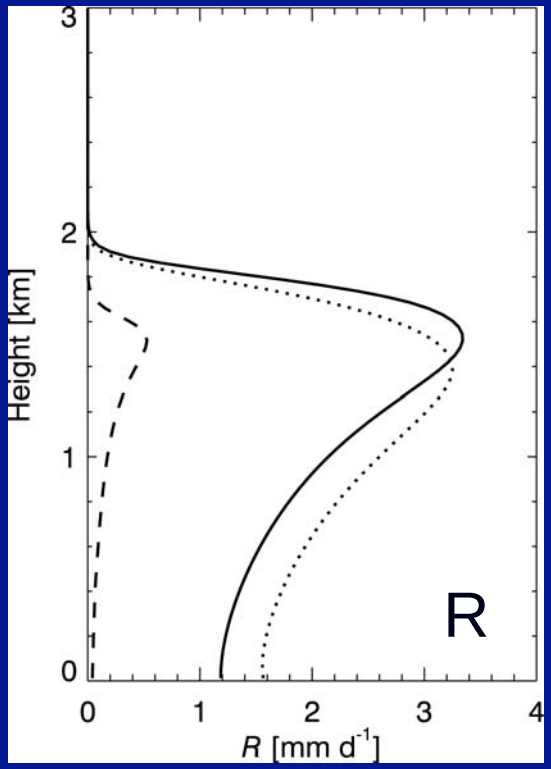
*** Fewer CCN**

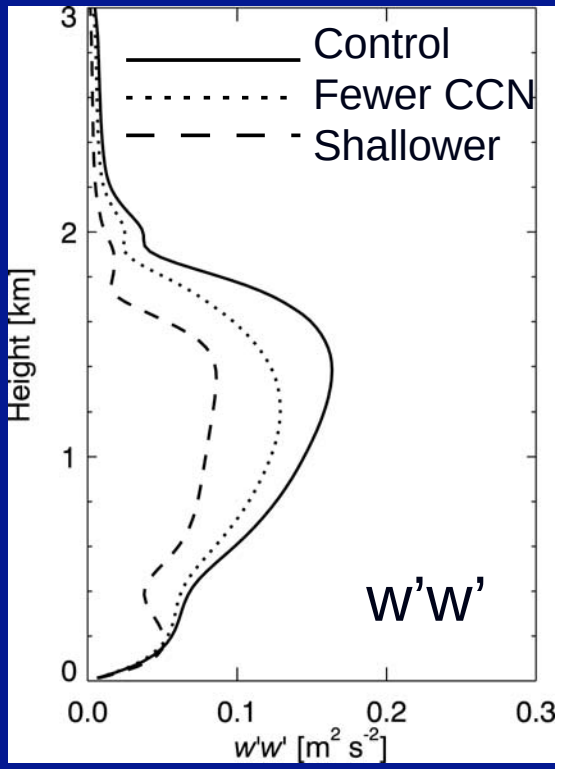






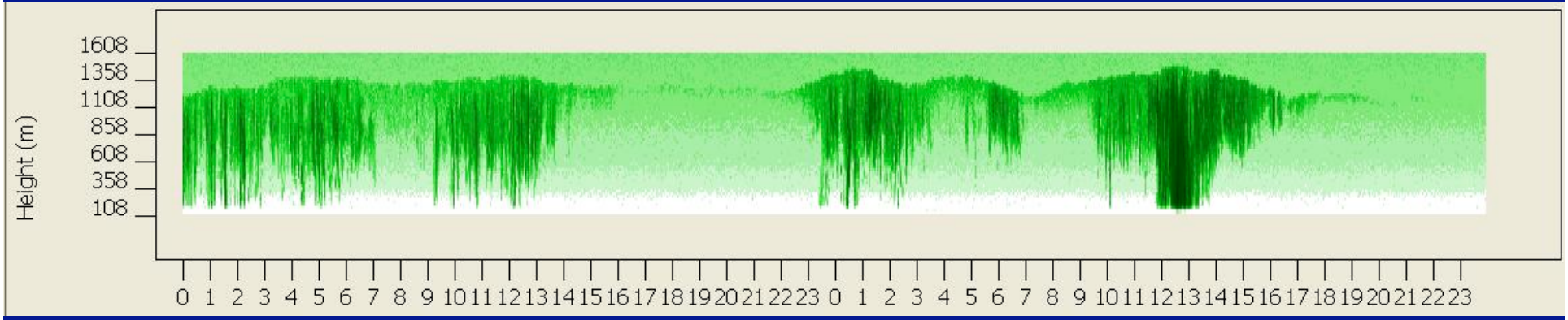
Model precip. is more sensitive to thermodynamics than CCN conc



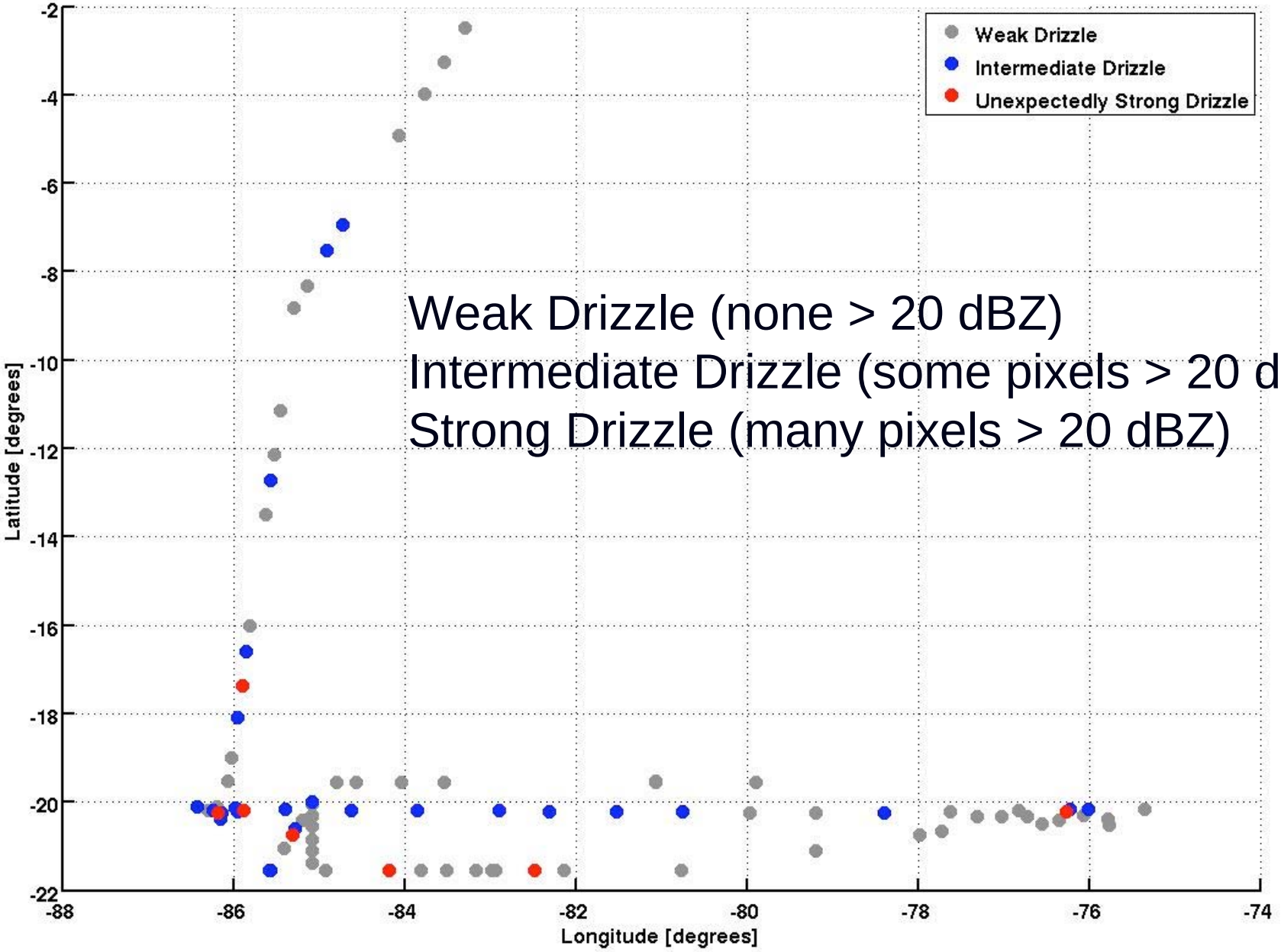


Conclusions

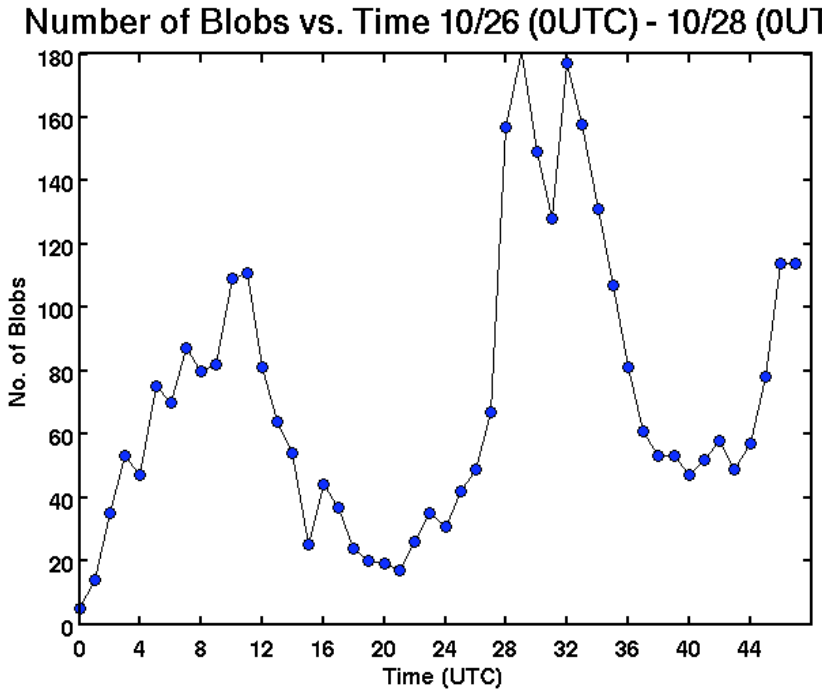
- RHB observed several cloudiness/drizzle transitions
- Drizzle mesoscale organization includes linear, hexagonal, shelf, and patchy features
- Stronger drizzle occurrence associated with a combination of deep and moist boundary layer
- Preliminary almostLES model sensitivity tests indicate precipitation is very sensitive to small changes BL height (-100m) and moisture (-0.25 g/kg), which may be swamping signal of variations of CCN

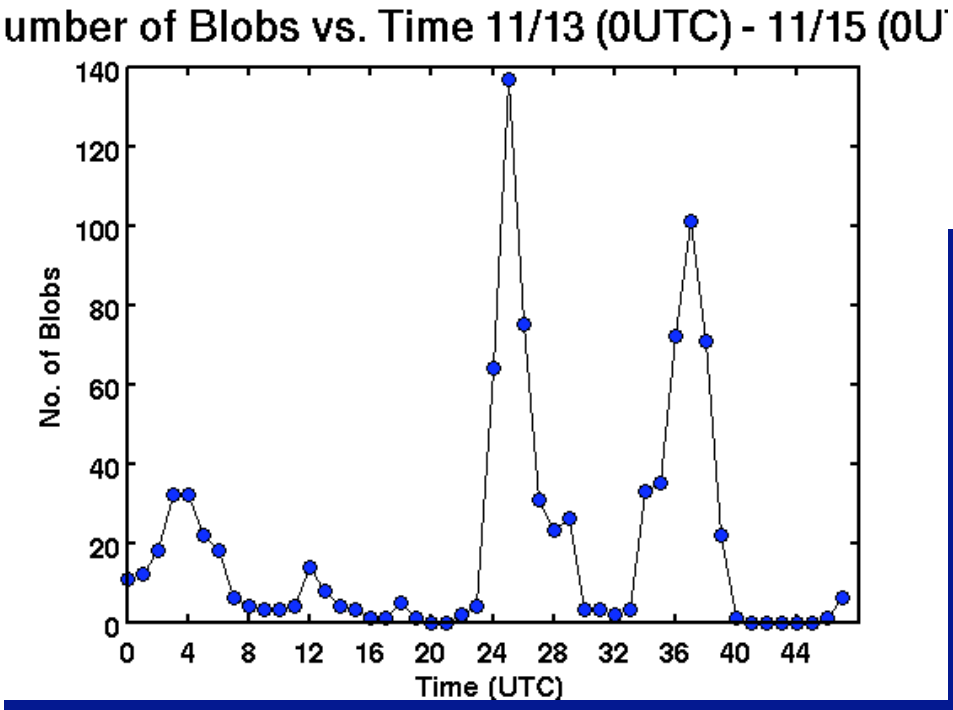


Locations of different drizzle categories



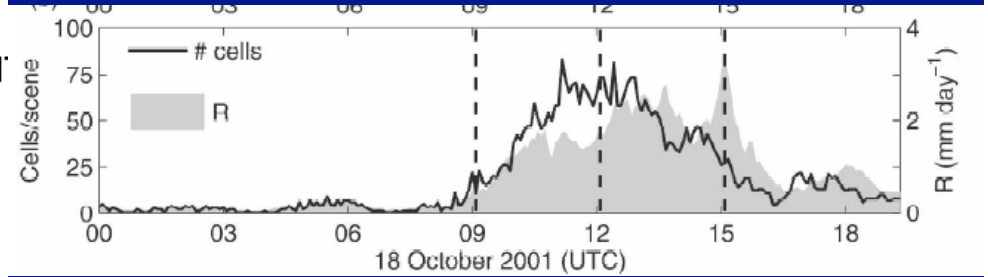
Weak Drizzle (none > 20 dBZ)
Intermediate Drizzle (some pixels > 20 dBZ)
Strong Drizzle (many pixels > 20 dBZ)



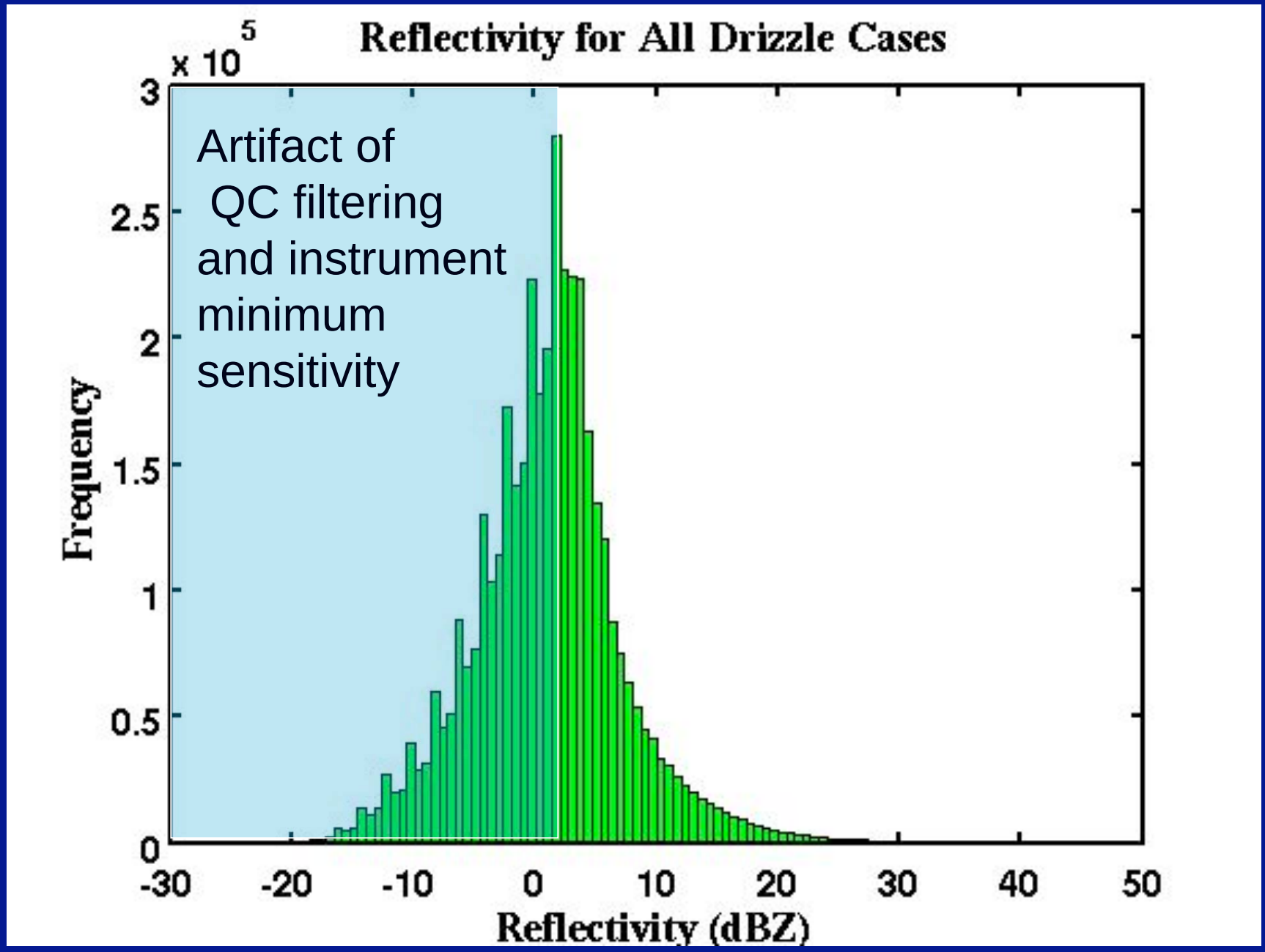


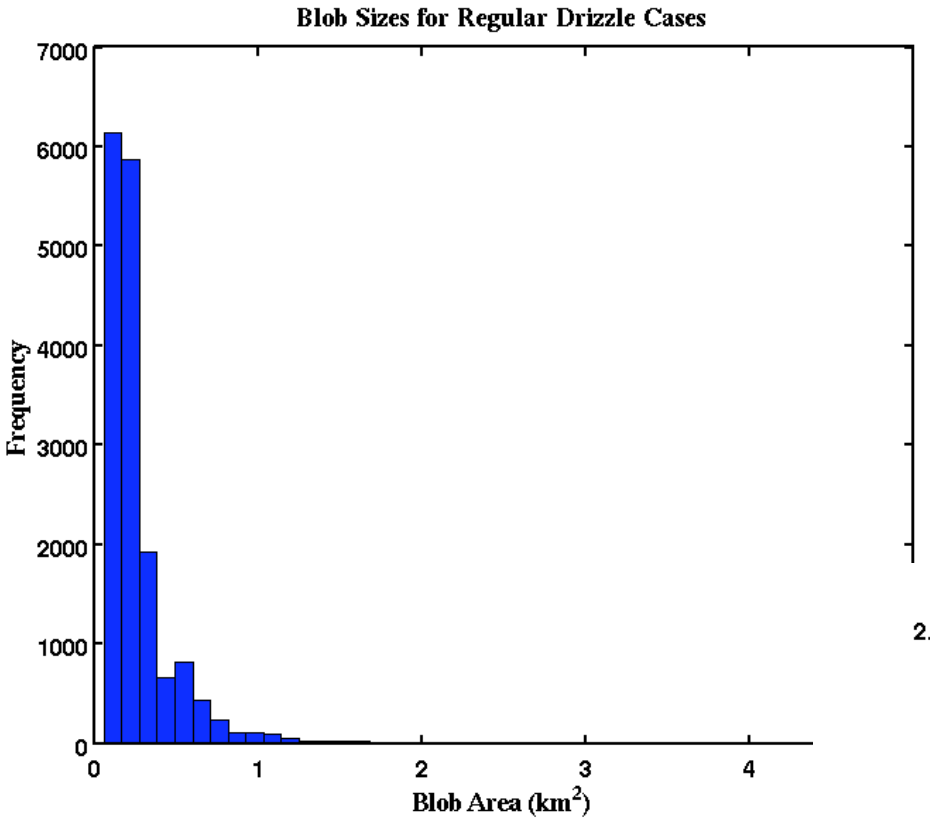
threshold = 5 dBZ
Minimum blob size = 8 pixels

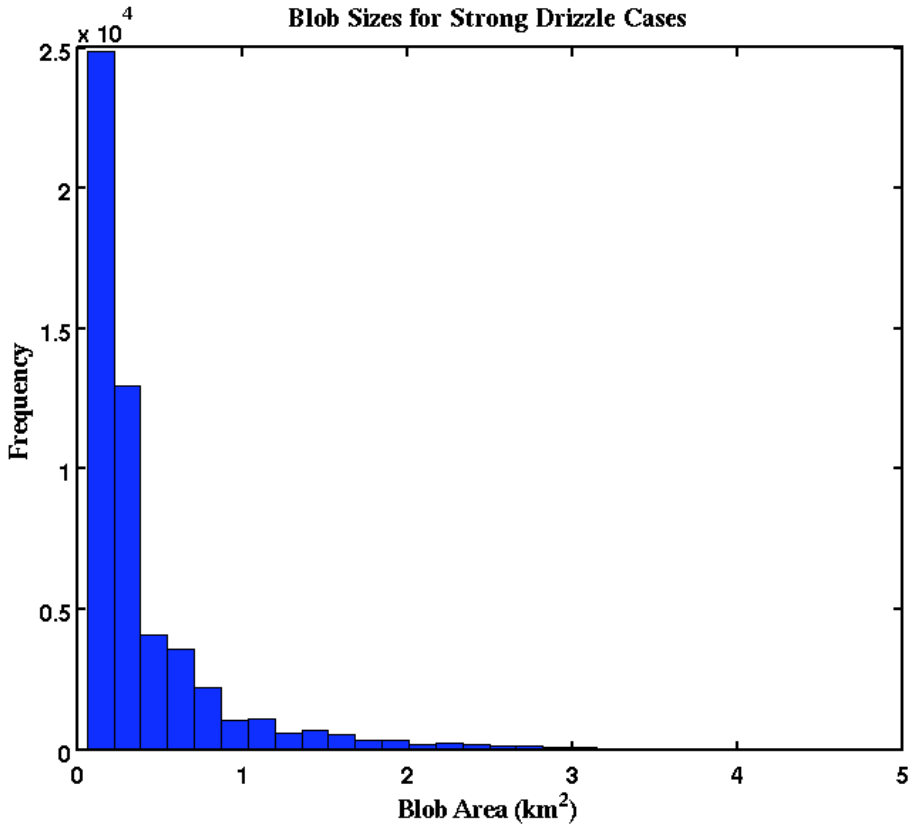
VOCALS radar domain is 4x larger than in EPIC Sc



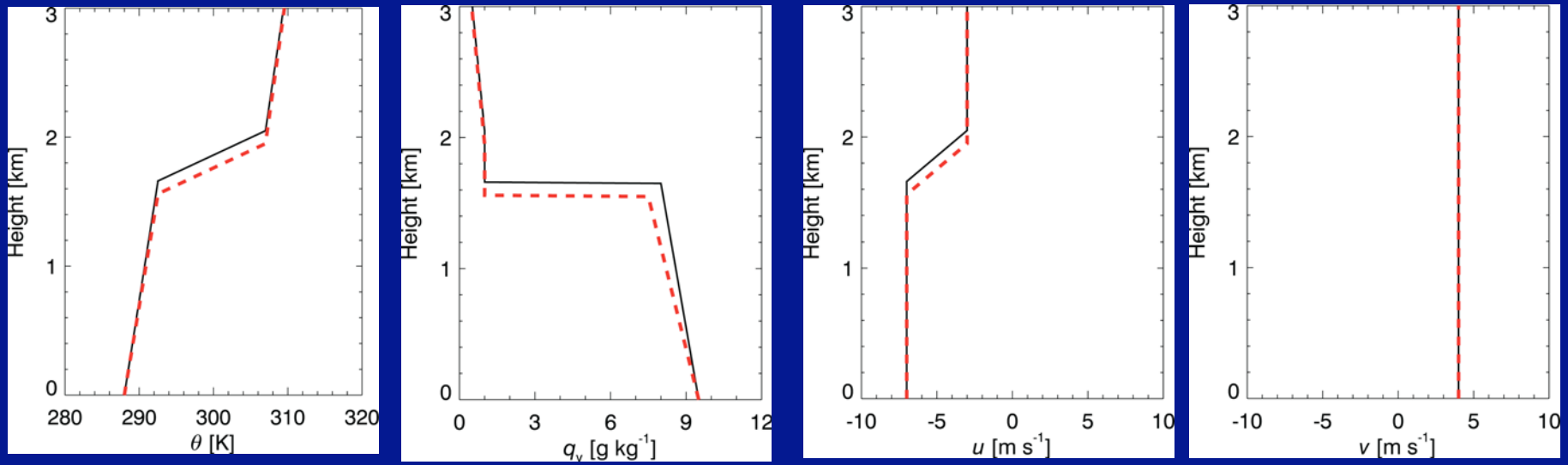
Comstock et al. 2007


Reflectivity for All Drizzle Cases
x 10^5
3
2.5
2
1.5
1
0.5
0
Frequency
Artifact of
QC filtering
and instrument
minimum
sensitivity
-30
-20
-10
0
10
20
30
40
50
Reflectivity (dBZ)


Blob Sizes for Regular Drizzle Cases
Frequency
Blob Area (km2)
0
1000
2000
3000
4000
5000
6000
7000
0
1
2
3
4


Blob Sizes for Strong Drizzle Cases
x 10^4
Frequency
Blob Area (km2)
0
0.5
1
1.5
2
2.5
0
1
2
3
4
5

Control and shallow sensitivity simulations (as implemented)



Sensitivity profile was “squished” down in the vertical by 100 m, and qv at the inversion base was reduced by 0.5 g kg^{-1} (0.25 g kg^{-1} in mean). Moisture at the surface was not changed.

These changes correspond to moving down and to the left on the qv vs. zi parameter space.