CLiMMATE

CLoud Microwave Measurements of ATmospheric Events

Microwave Remote Sensing

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IEEE Student ComSoc

Use of microwave sensors to study atmosphere constituents

Understanding the role of clouds in the Earth's heat budget and the radiation transfer processes is vital for global climate models and meteorological studies. This research comprises the areas of remote sensing of the frequencies.

- Atmospheric attenuation
- Clouds
- Precipitation

using microwave sensors such as radars and radiometers at several frequencies.

Goal

- Develop codes to align, process and analyze data from microwave sensors to retrieve physical parameters such as
  - hydrometeor drop size distribution
  - liquid water content
  - rain rate
  - effective drop diameter

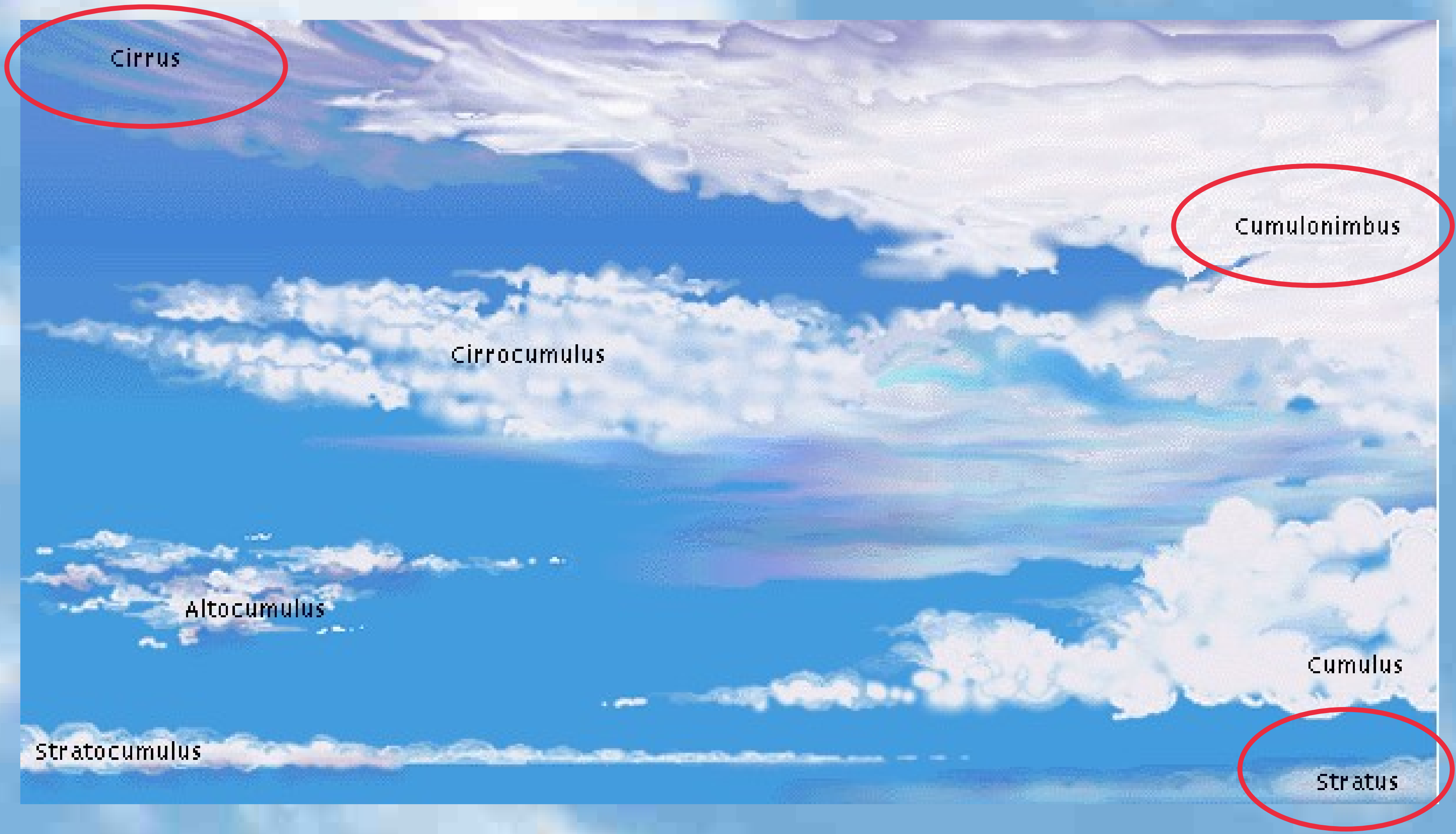
Clouds

- Large horizontal extent
- High optical extinction rates
- Affect Earth’s radiation budget

>Improve global climate models (GCM)

>Improve reliability of forecasts

Different Clouds on the Atmosphere



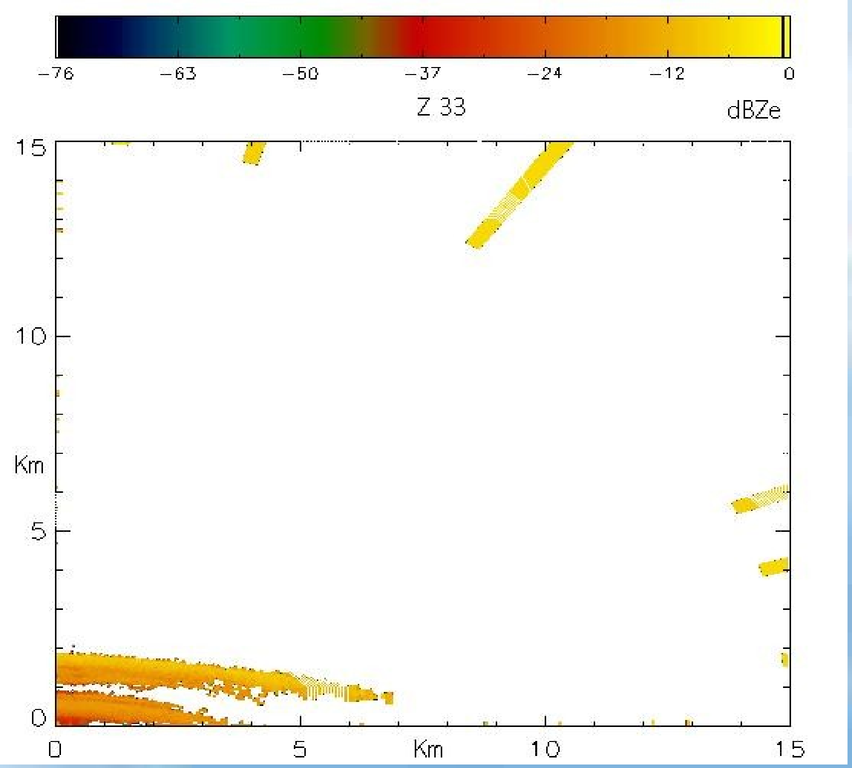
UMass Cloud Profiling Radar System (CPRS)

- 1-m diameter dielectric lens antenna
  - Collocated radar reflectivity measurements
  - Ka-band (33 GHz) and W-band (95 GHz)
  - Scans in elevation angle (*from* 10^{o}-103^{o})

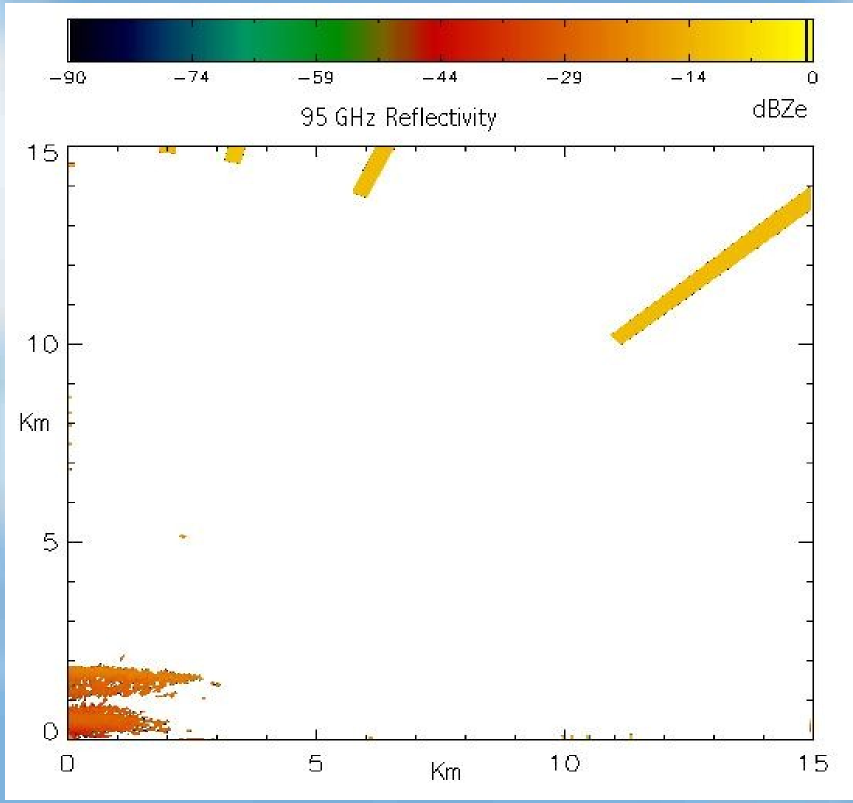
Graduate Student: Nivia Colón , MS 2002

Stratus Cloud reflectivity, *dBZ*

Height , km

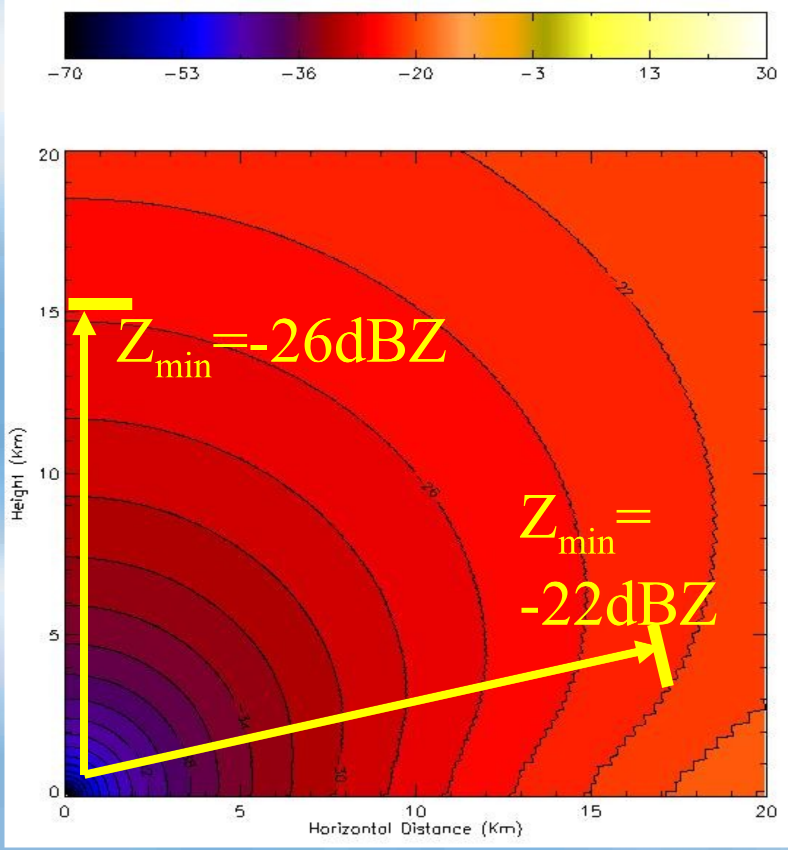


Ka band
(33GHz)

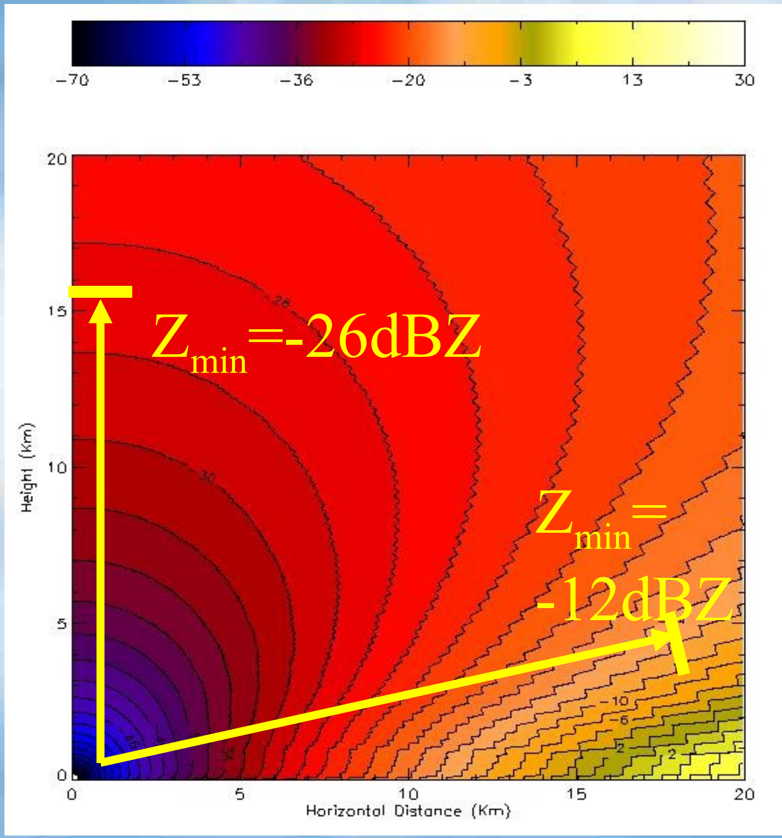


W band
(95GHz)

Scanning simulation, Z_{min} detectable



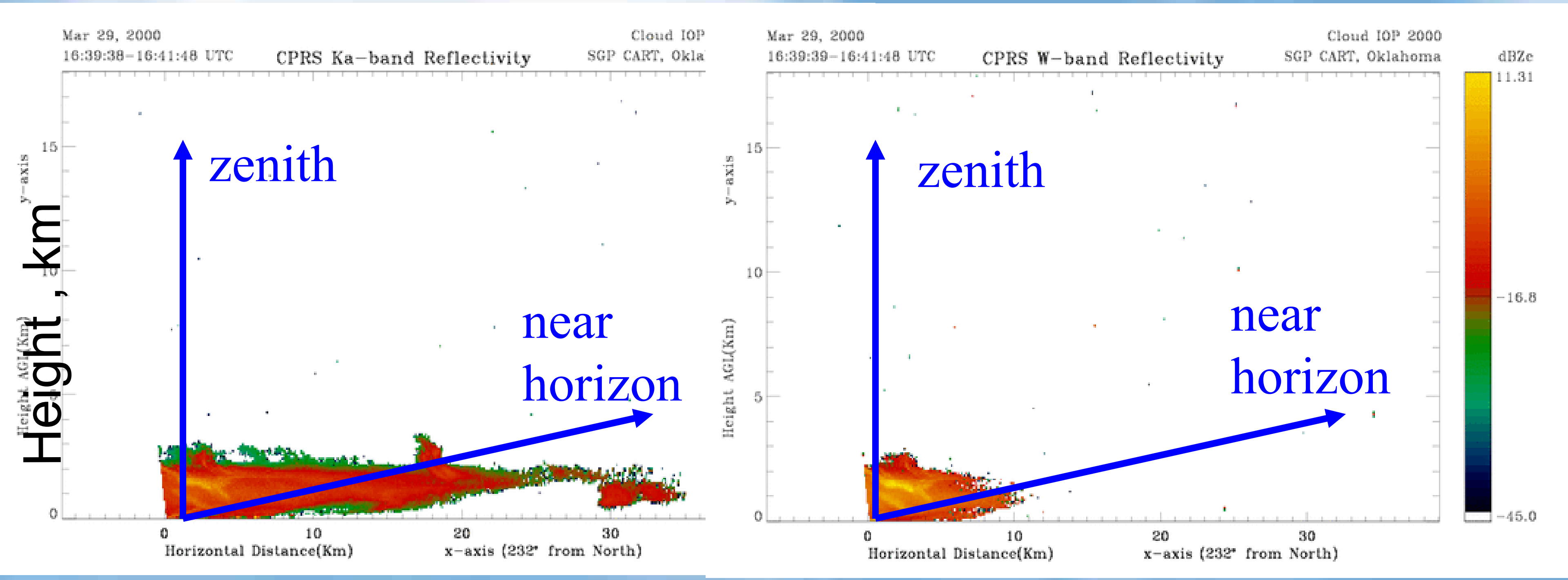
Ka band
(33GHz)



W band
(95GHz)

Graduate Student: Jorge Villa, MS 2002

Stratus Cloud reflectivity, dBZ



Horizontal distance , km

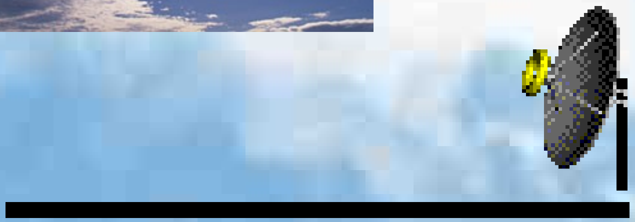
Horizontal distance , km

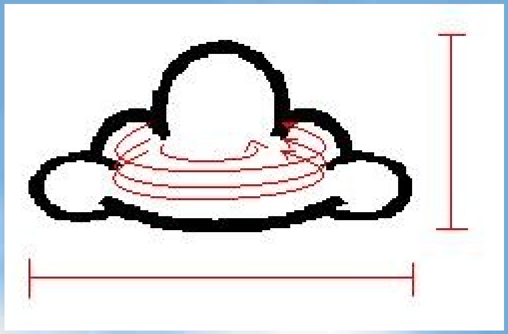
Ka band (33GHz)

W band (95GHz)

•Macrophysics characteristic :

Layers, top height, base long, etc.





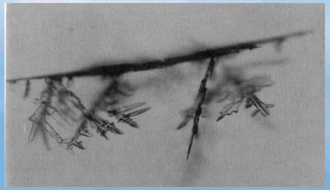
Microphysics components:

•Ice water content

•Crystal size distribution

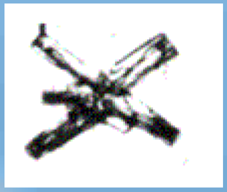
• Crystals’ shape

Hexagonal Plates



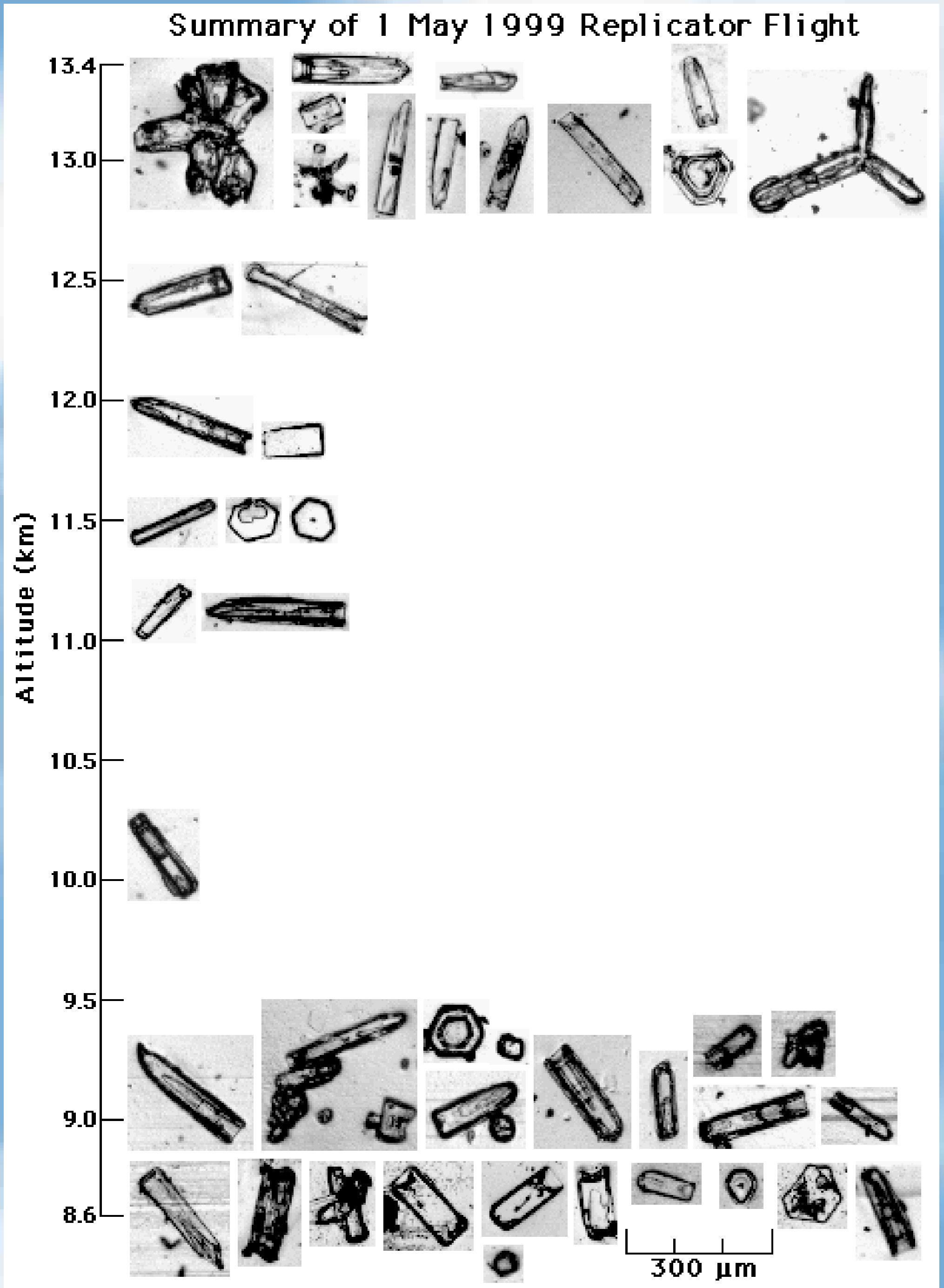
Dendrite

Bullet



Bullet Rosettes

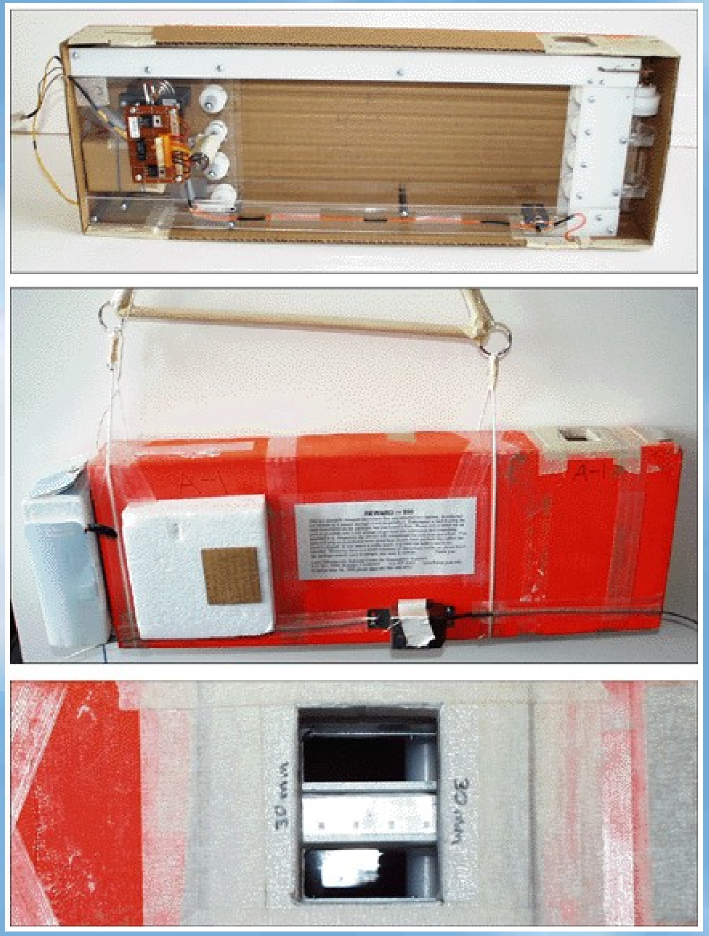
Cirrus Ice Crystals

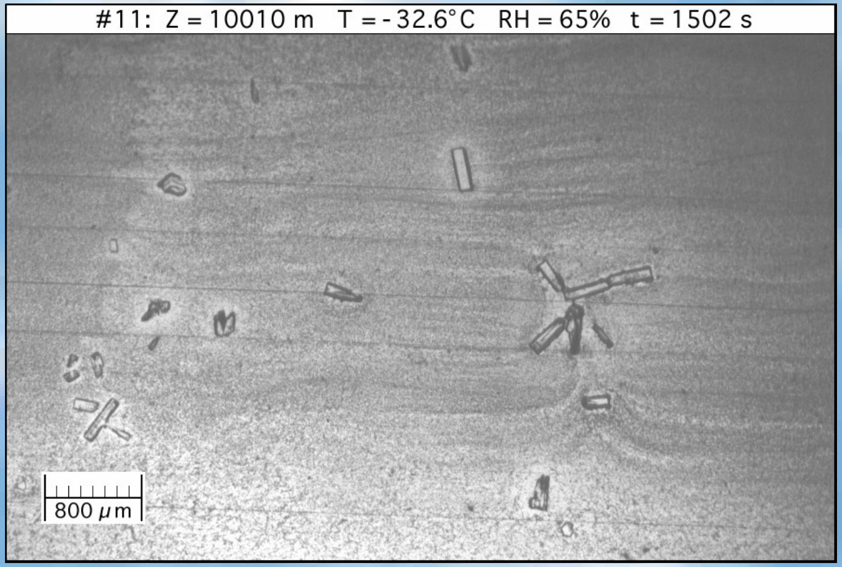


Bullet and Bullets Rosettes Model

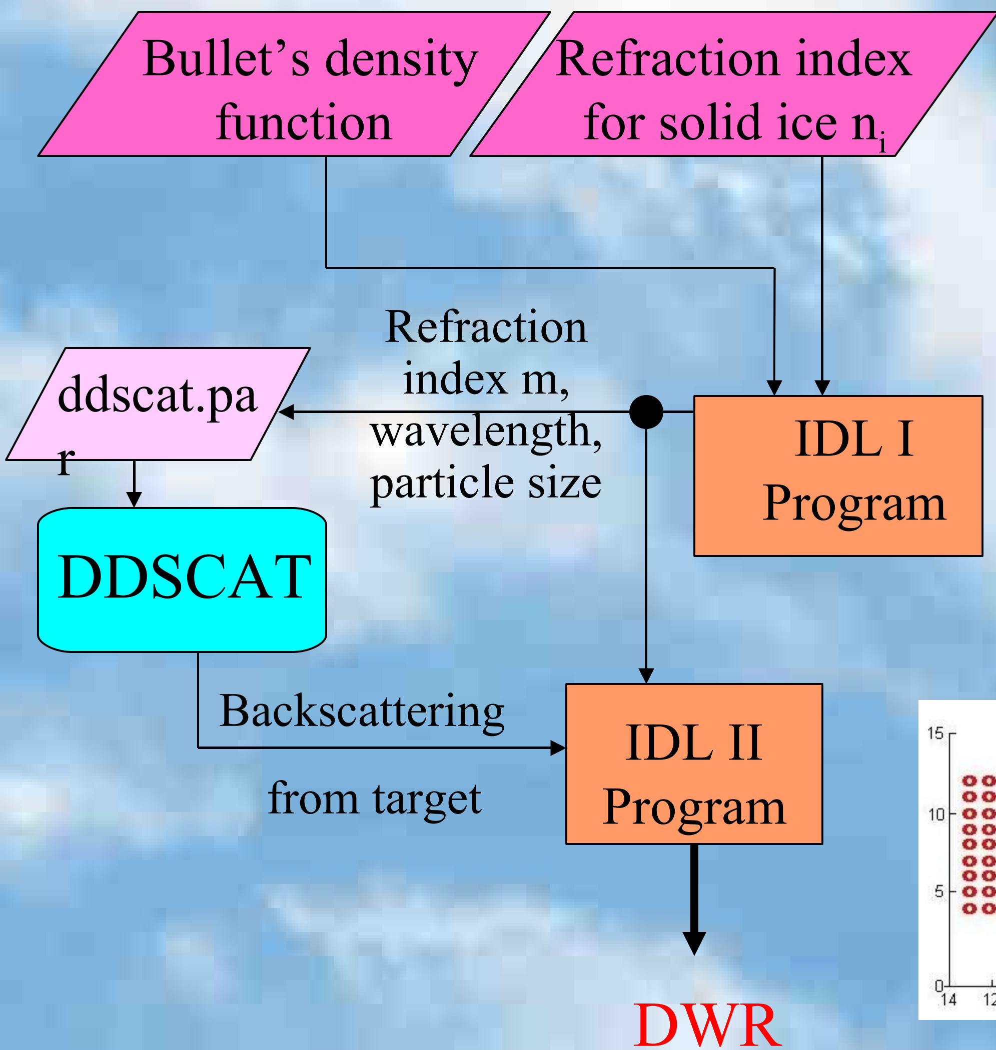
National Center for Atmospheric Research (NCAR)

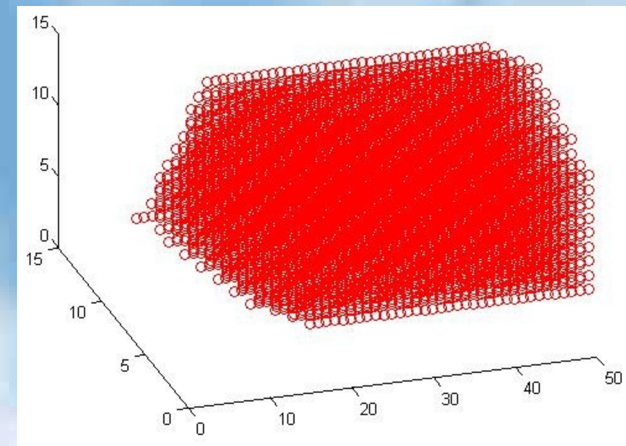
Video Ice Particle Sampler (VIPS)



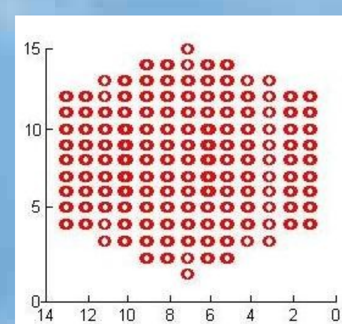


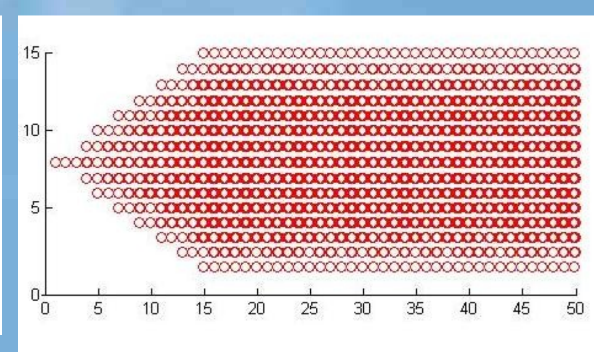
Bullet Simulation





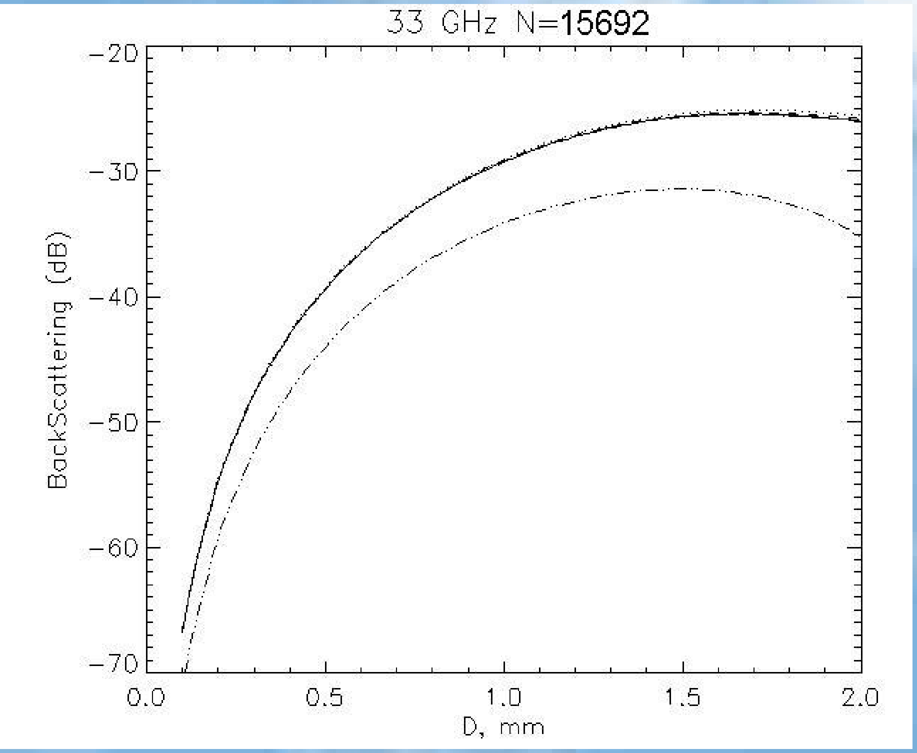
- N = 2304 dipoles
- m =1.04595 + j4.459e-5



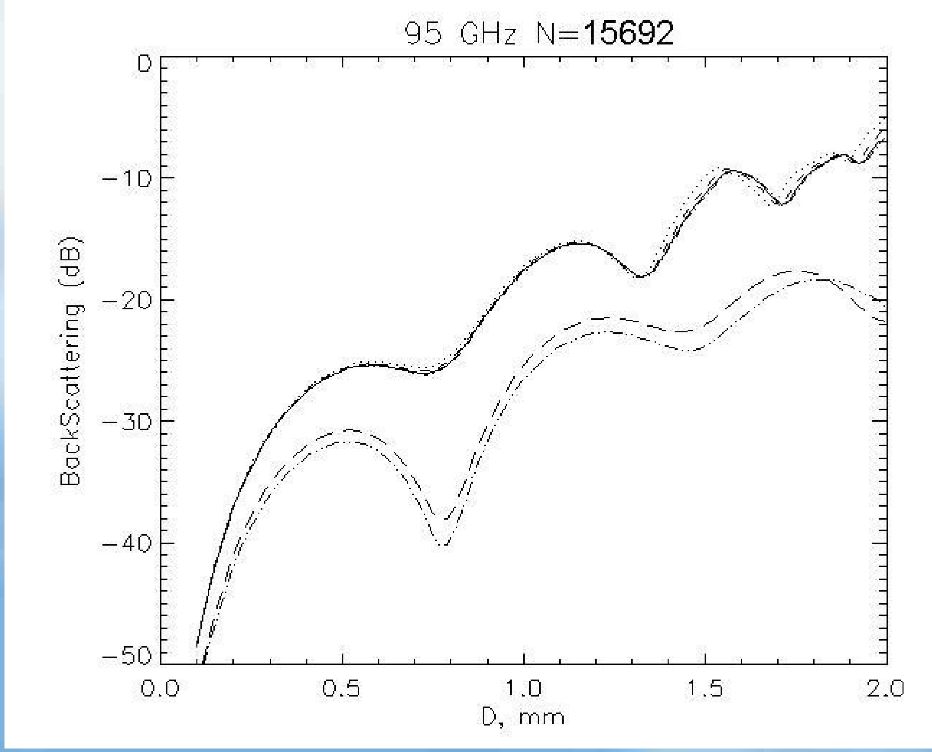


Backscattering from Bullet ice crystal

The top traces are for density as a function of L, and the bottom group of traces is given with ρ constant.



33GHz



95GHz

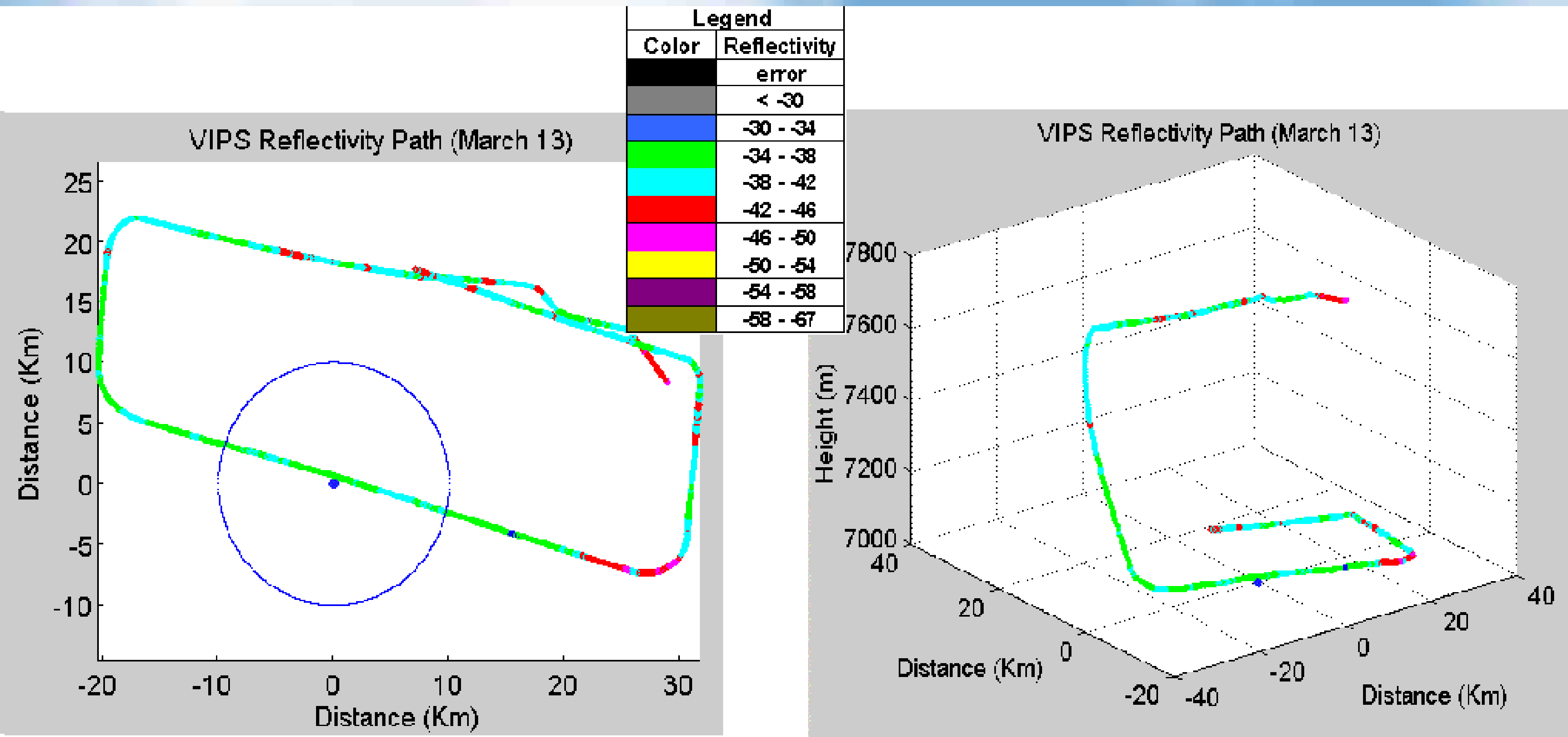
Cirrus Clouds Millimeter-Wave Reflectivity Comparison with *In-Situ* Ice Crystal Airborne Data

Sensors:

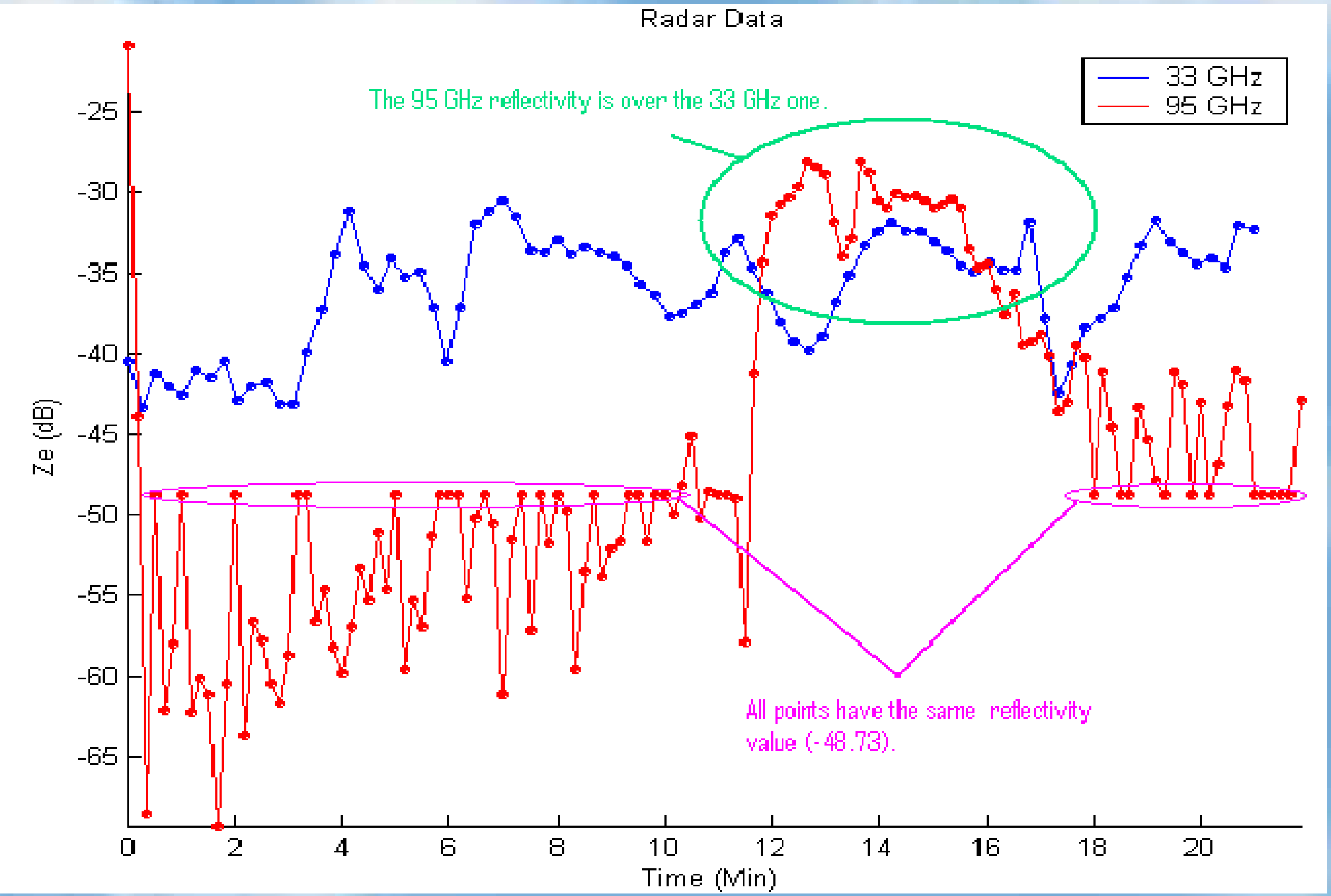
- **Umass CPRS Ka and W bands ground-based radar**
- **NCAR VIPS**

Graduate students: José Morales, Jorge Trabal (MS 03), Jorge Villa (MS 02)

VIPS Reflectivity Path



a) b)

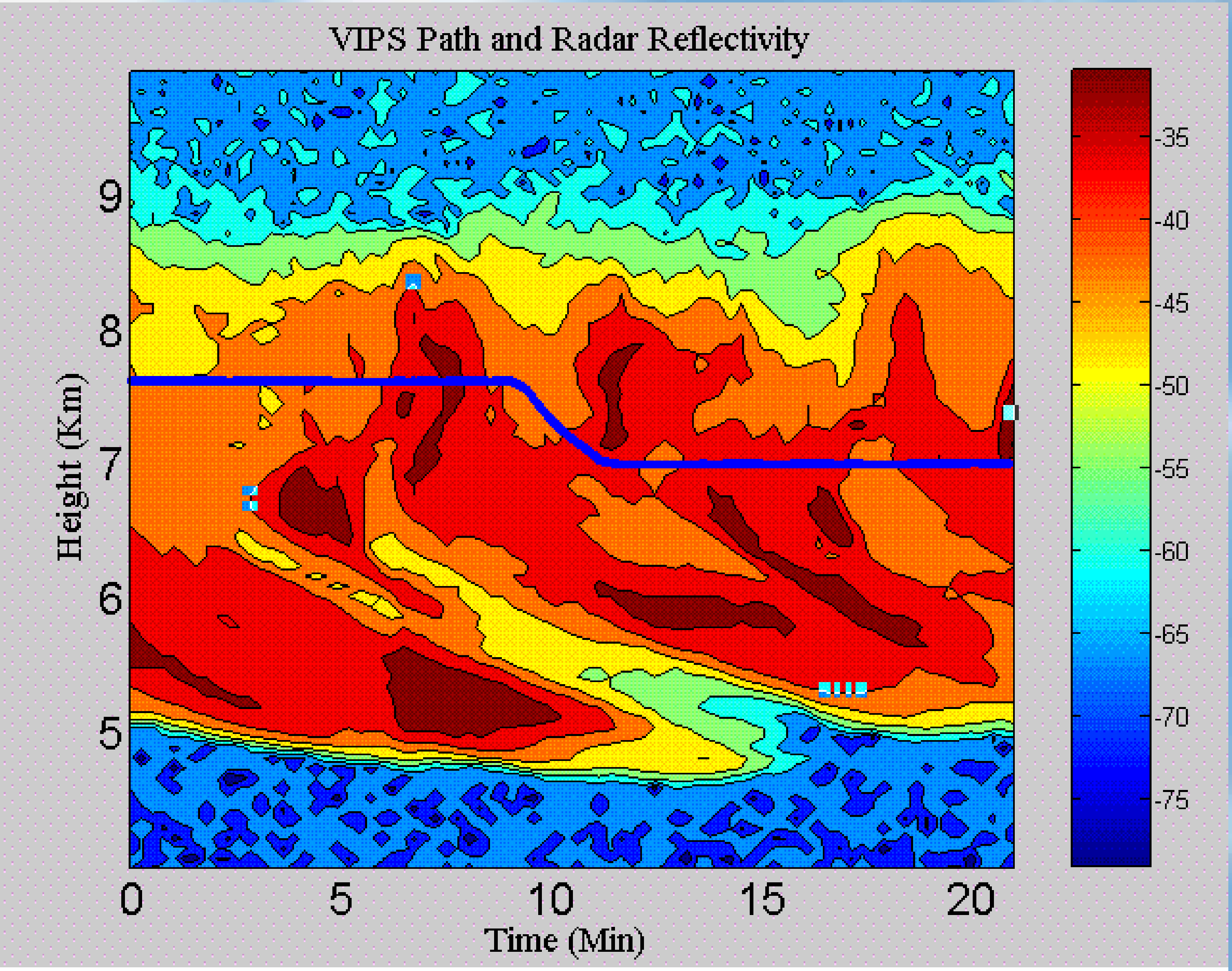


$$RMS_{Z_e} = \sqrt{\frac{(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2 + \ldots + (a_n - b_n)^2}{n}}$$

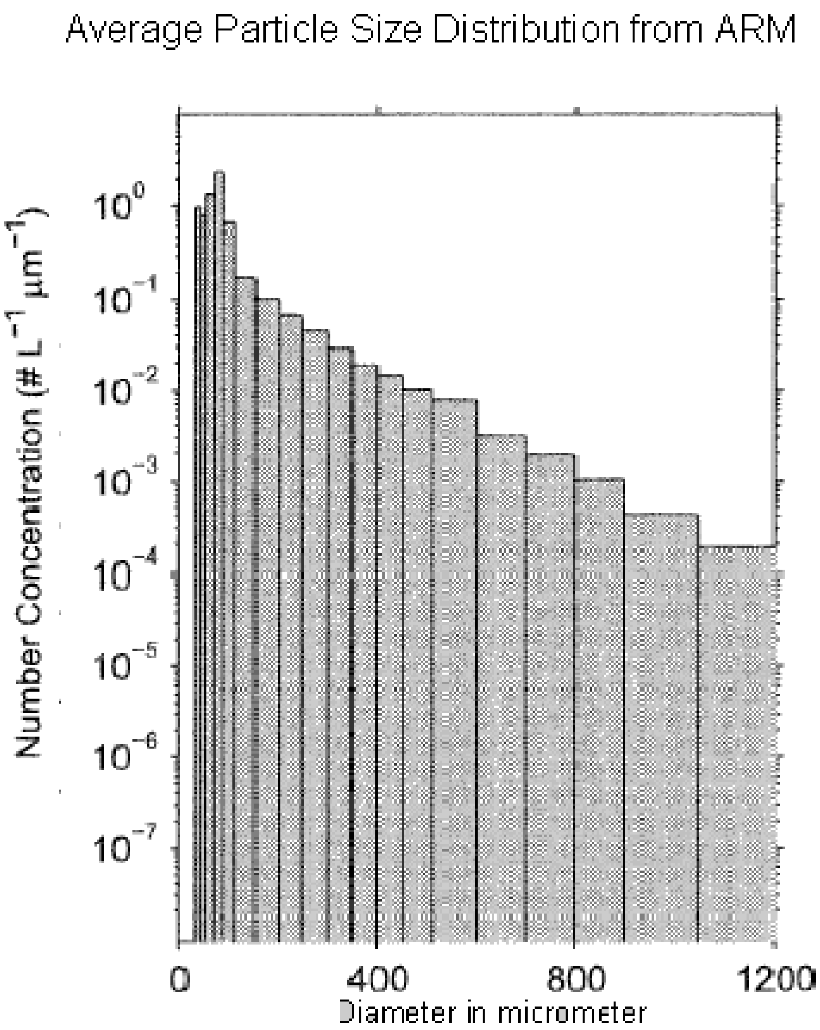
RMS versus distance

- The resulting RMS for a distance up to 10km between instruments is 4.673 dBZ and for a distance up to 5km is 1.311dBZ
- As expected, when airplane flies closer to the radar below, the smaller rms is obtained.

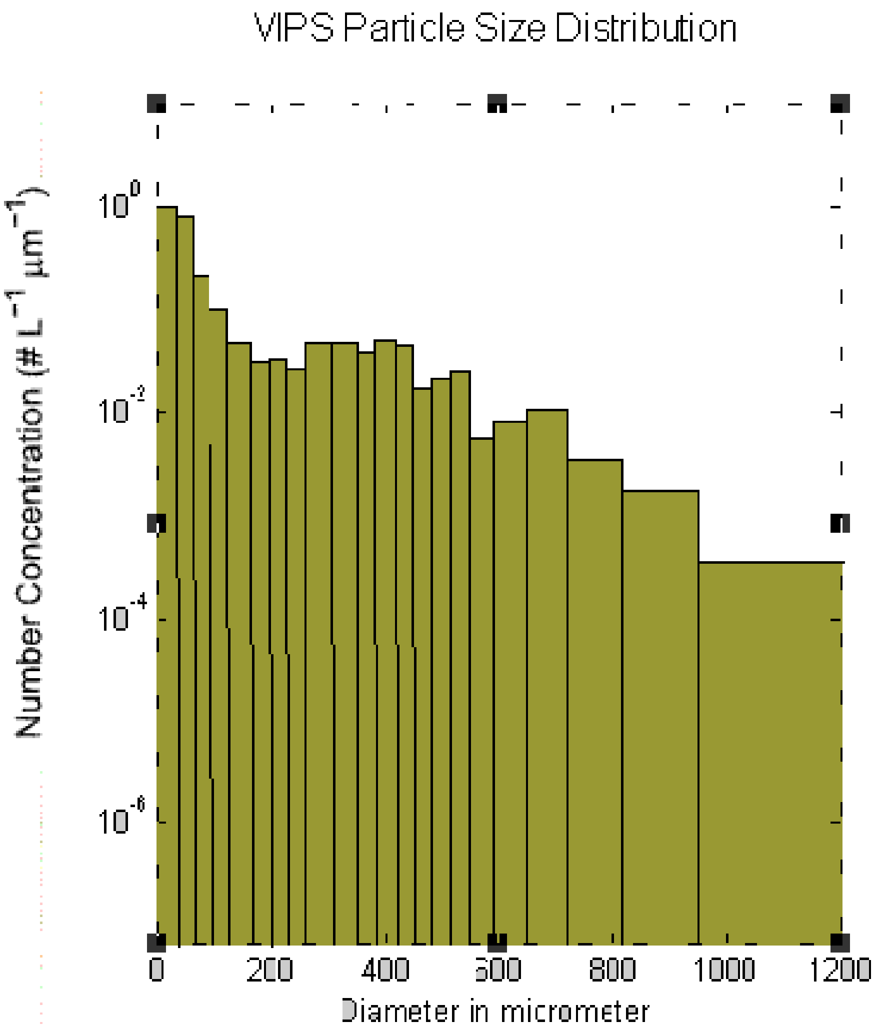
CPRS Radar Reflectivity vs Time



CPI and VIPS Particle size distributions



a)



b)

Precipitation

- NOAA wind profiler - 2.8GHz (S-band)
- UMass radar - 95GHz (W-band)
- Operation: remotely controlled from UPRM

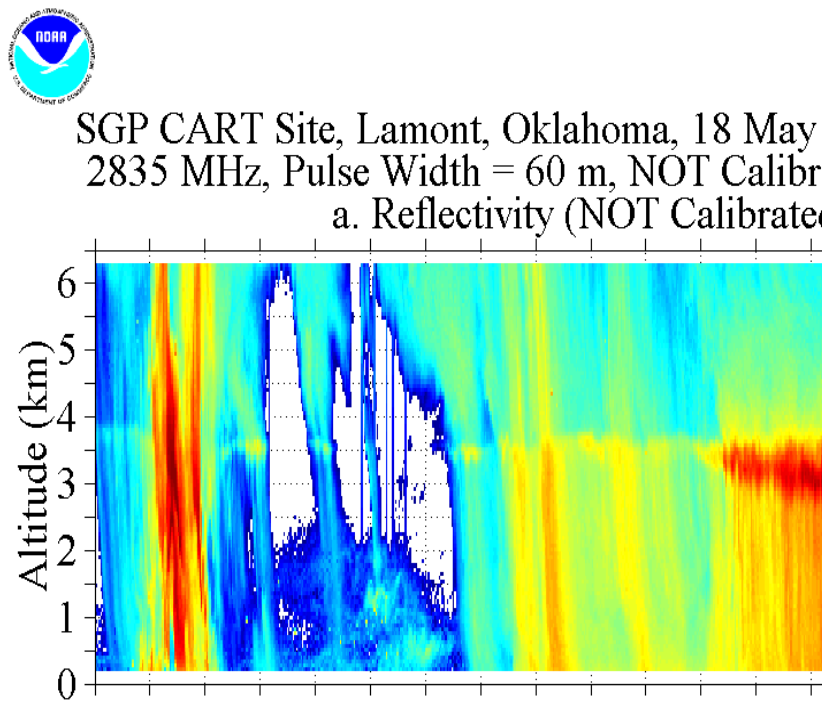
Rain rate

- Once we determine *N(D)* we can find
  - liquid water content
  - rain rate from the active observations

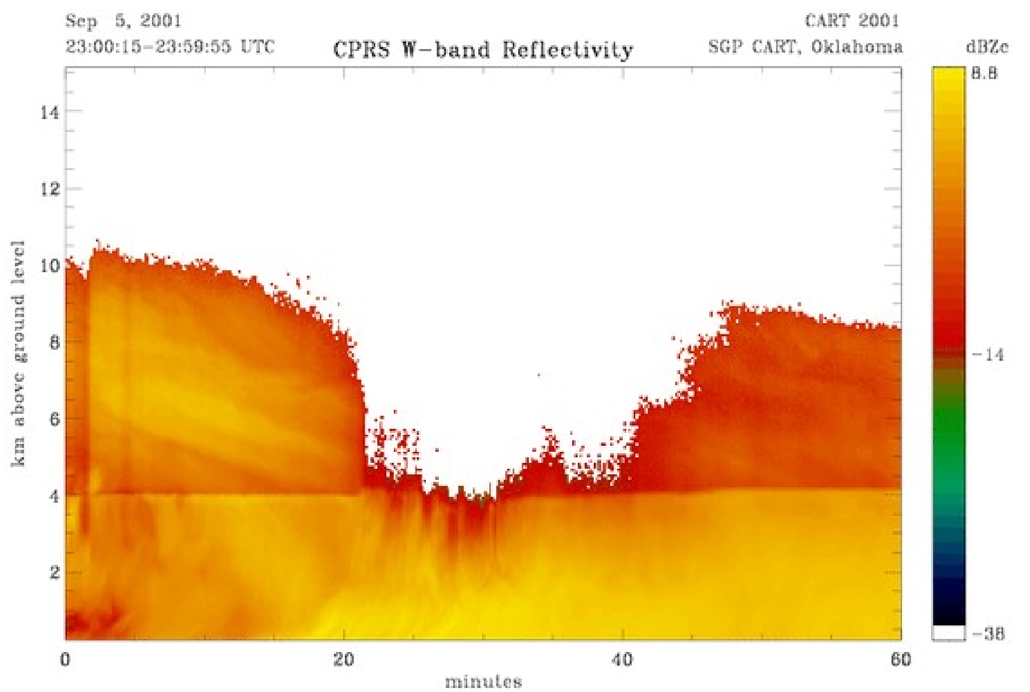
Graduate Student: Leyda León, MS 04

Data from rain events

- S-band (2.8GHz)



- W-band (95GHz)



$$DWR_{2.8,95} = 10\log\left(Z_{2.8} / Z_{95}\right)$$

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