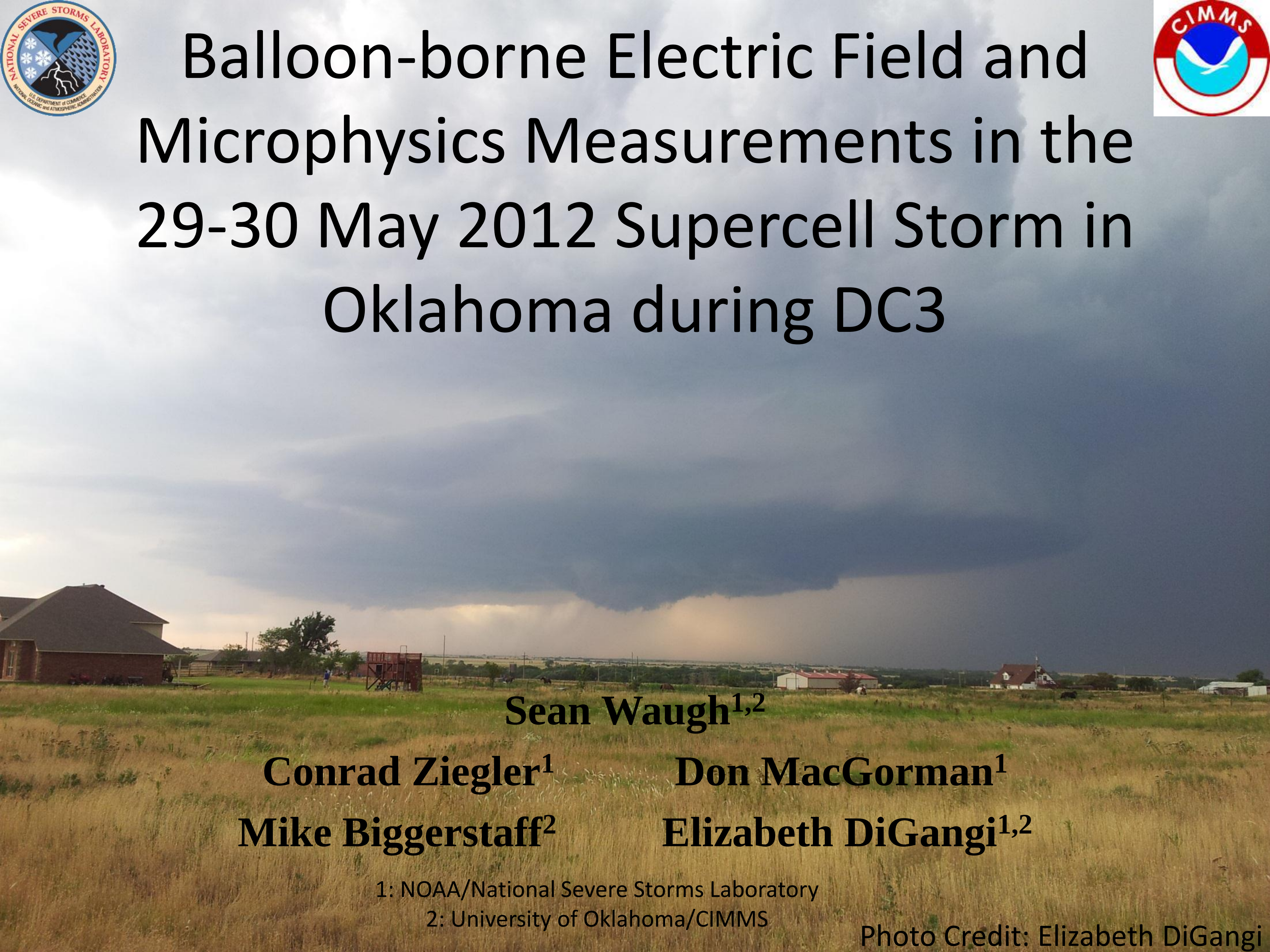
Balloon-borne Electric Field and Microphysics Measurements in the 29-30 May 2012 Supercell Storm in Oklahoma during DC3



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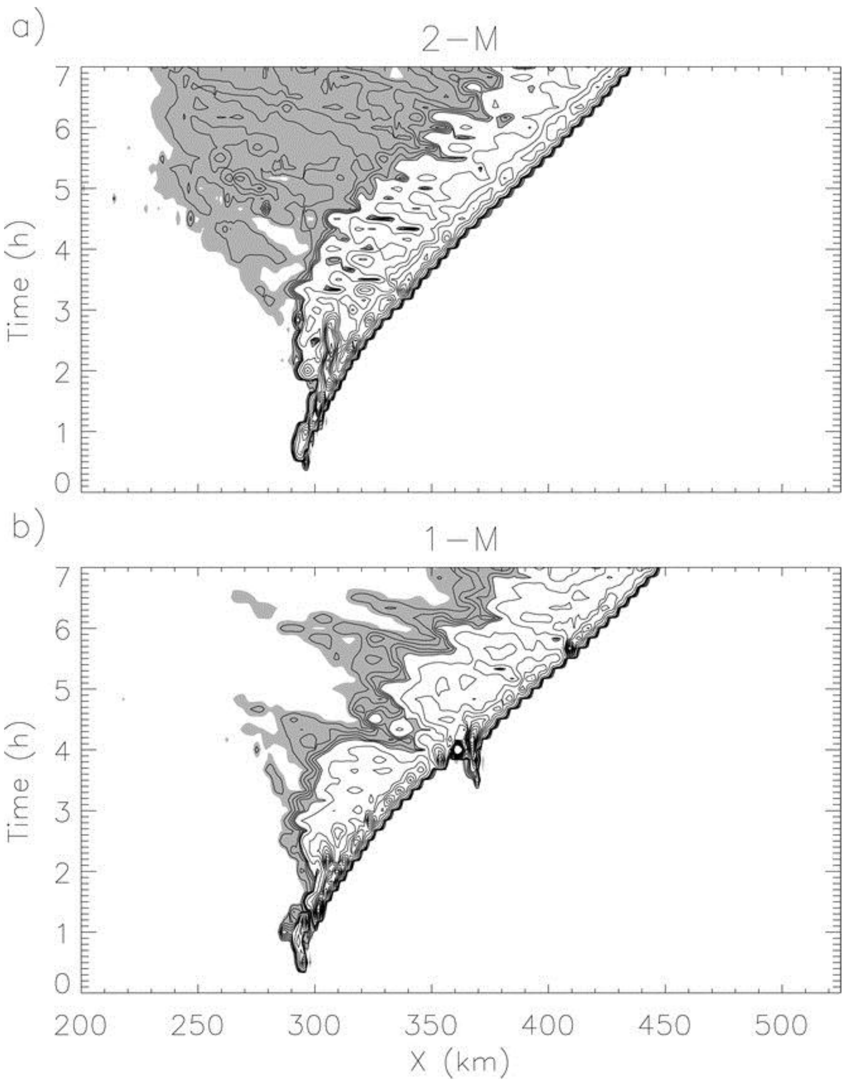
Mike Biggerstaff[2] **Elizabeth DiGangi[1,2]**

1: NOAA/National Severe Storms Laboratory

2: University of Oklahoma/CIMMS

Photo Credit: Elizabeth DiGangi

Why are microphysics measurements important?



- Hovmöller plot of simulated surface rainfall for a a) 2-Moment (2-M) scheme and b) 1-Moment (1-M) scheme. From Morrison et al., 2009.
- 1-M predicts Number concentration, 2-M predicts number concentration and mixing ratio.
- Idealized two-dimensional squall line
- Simulations differ only in microphysics, large impact on result.
- Highlights importance of correct scheme
- What about 3-Moment?

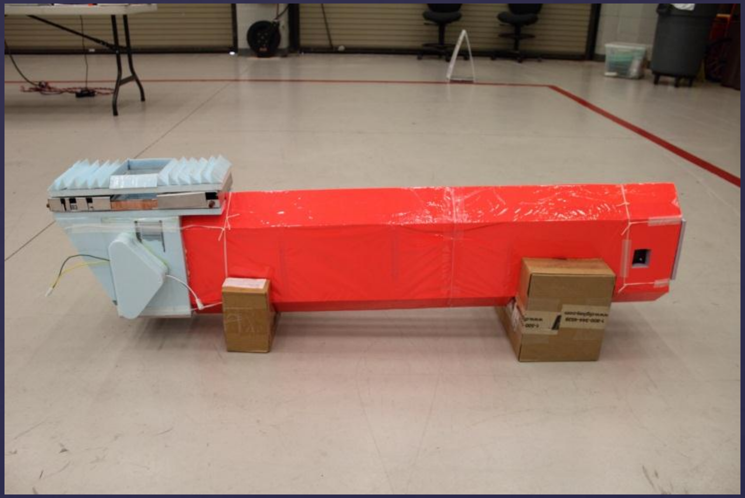
PASIV

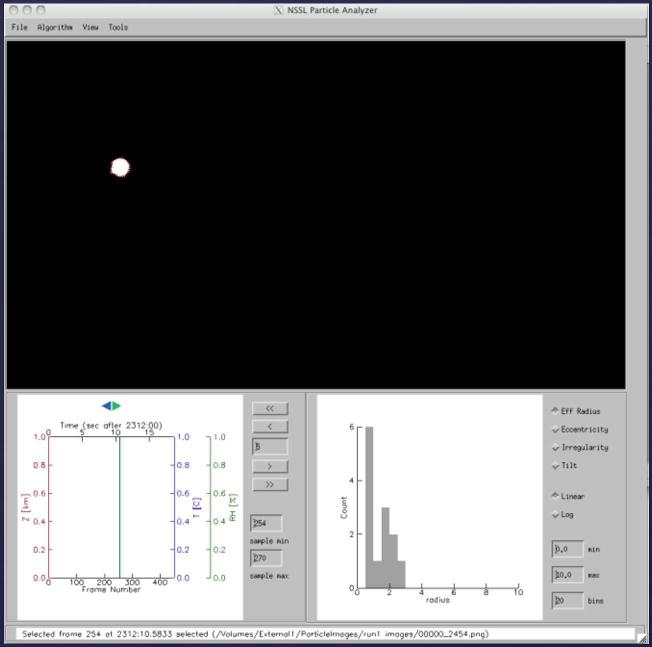
- <u>PA</u>rticle <u>S</u>ize, <u>I</u>mage, and <u>V</u>elocity Probe

- Dual Instrument System:
  - HD Camera
  - PARSIVEL Laser Disdrometer
  - ~6lbs total weight

- Other videosondes exist (Takahashi, 2010; Boussaton et al, 2004; Murakami and Matsuo, 1990)

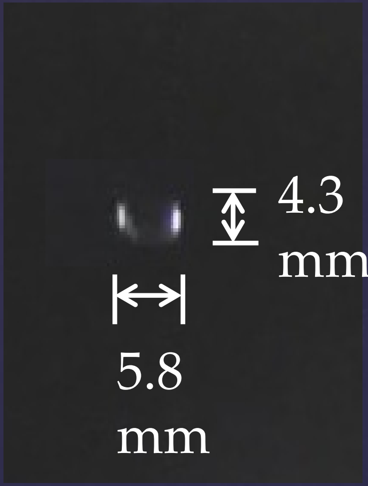
- Measurements include:
  - Effective radius spectrum
  - Concentration spectrum
  - Major/Minor Axis Length
  - Particle Type/Habit
  - Eccentricity
  - Irregularity
  - Thermodynamic Profile (with radiosonde)

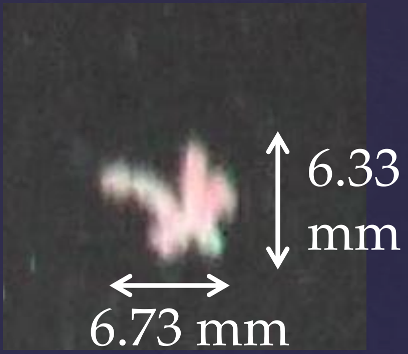




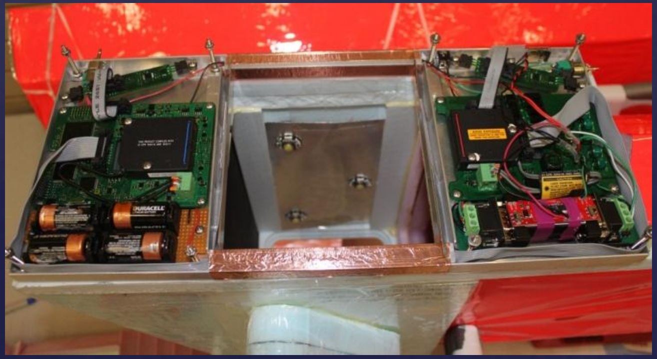
PASIV - Specifications

- HD Camera:
  - Panasonic Model HDC-SD9P
  - 1920x1080 Resolution
  - 1/8000 s shutter speed
  - 24 frames per second



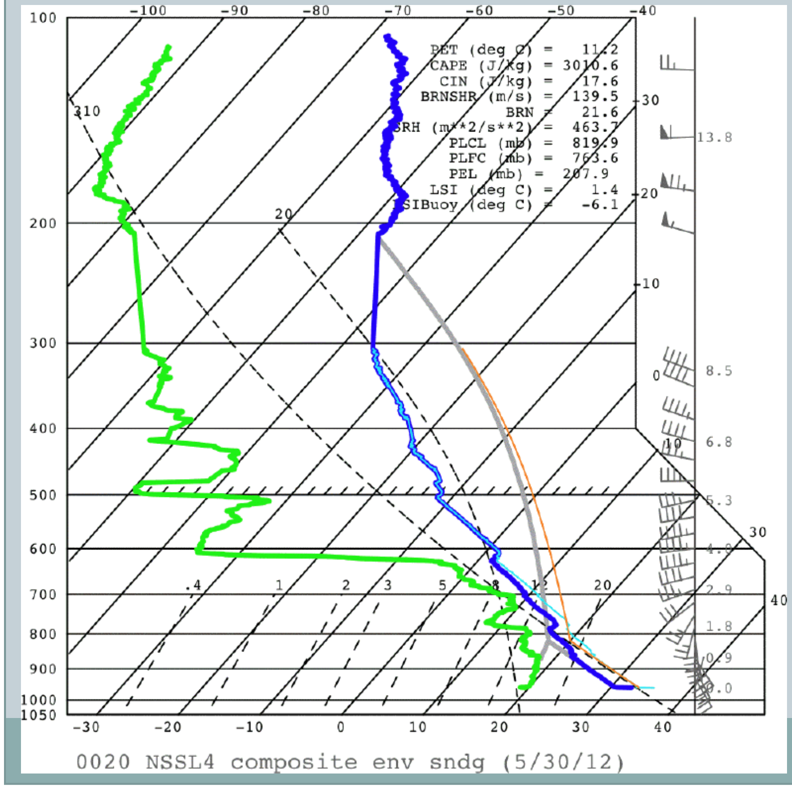


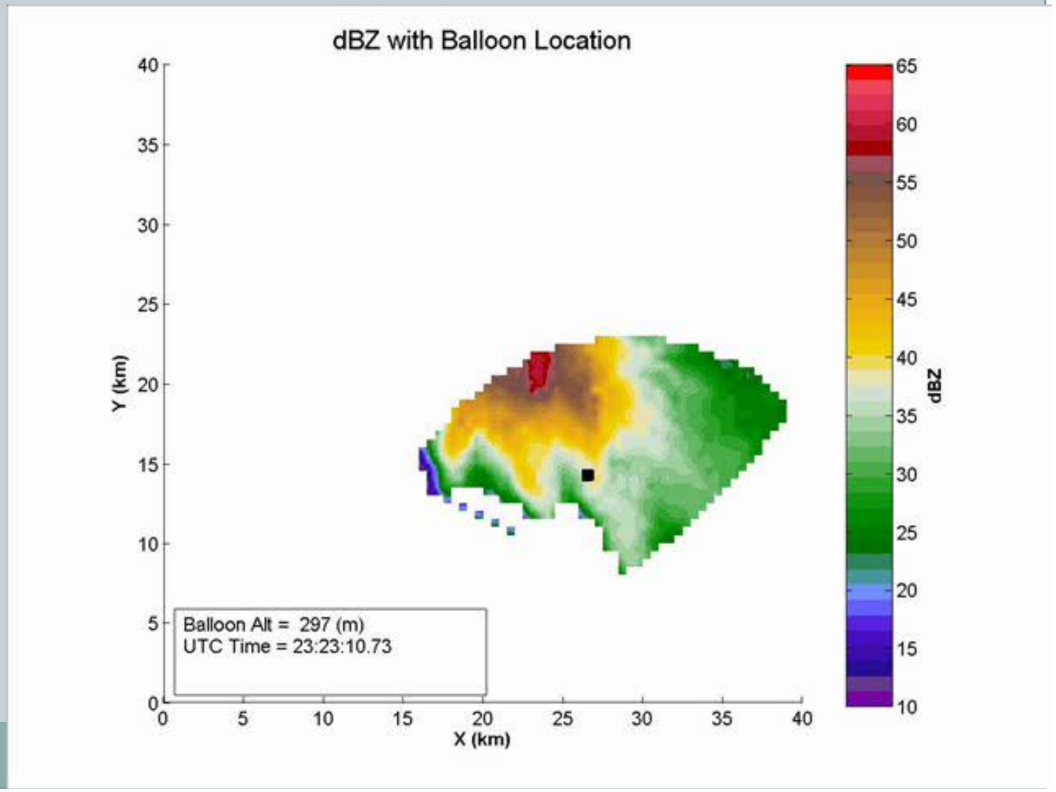
- PARSIVEL Laser Disdrometer
  - Manufactured by OTT Hydromet
  - 780 nm Laser
  - 10 sec data interval
  - Binned PSD according to Size/Velocity



May 29th, 2012 DC3 – Tornadic Supercell

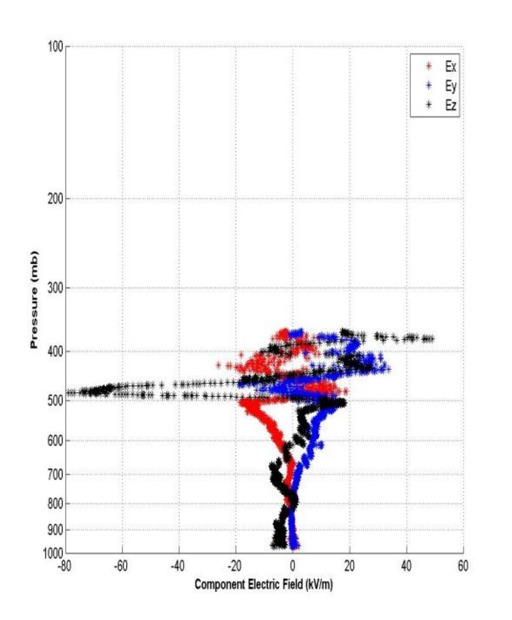
- First Flight (out of two)
  - Sounding, EFM (MacGorman and Rust, 1998), and Camera only PASIV, but no PARSIVEL
  - Launched in forward anvil region, ahead of core





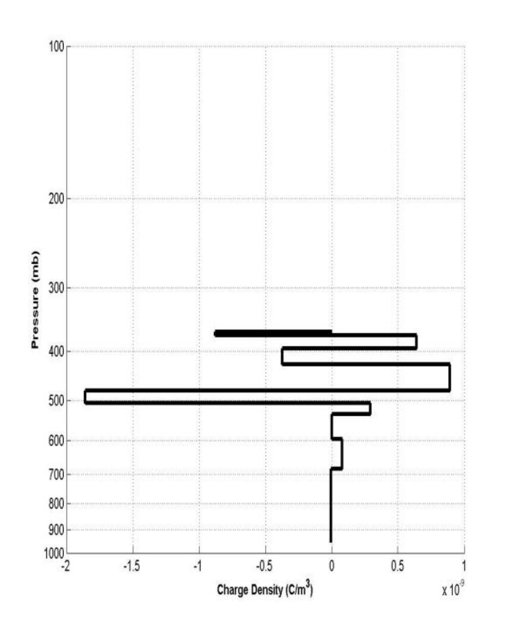
May 29th, 2012 DC3 - Overview

Electric Field Profile

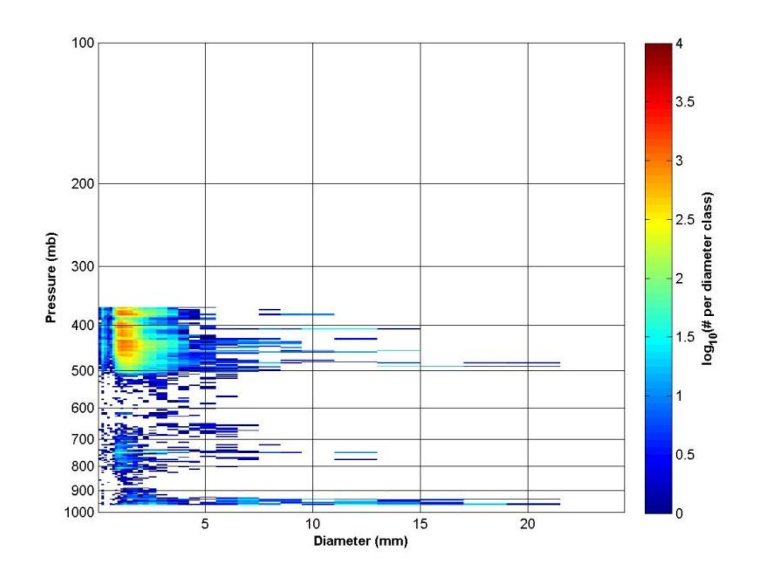


$$\rho = \epsilon_a \frac{dE_z}{dZ}$$

Charge Layer Analysis

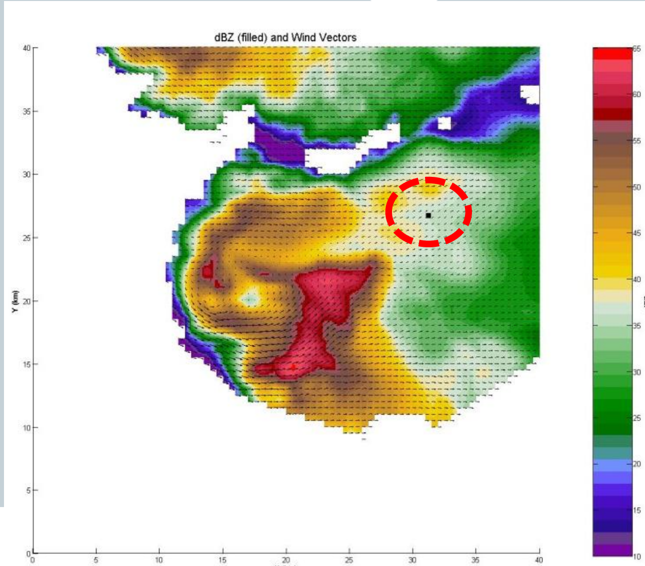


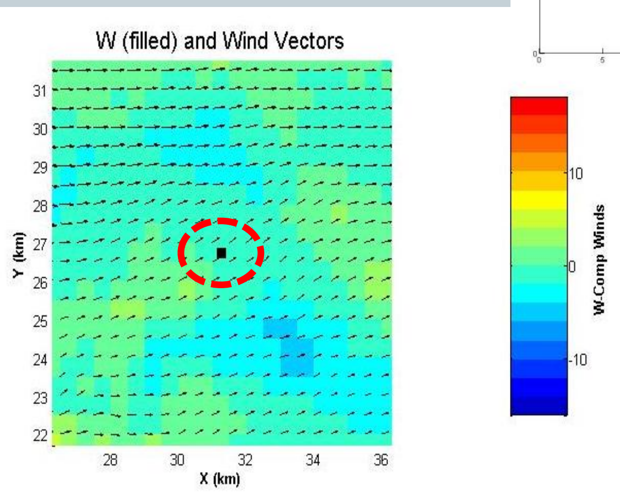
Vertical Profile of the PSD

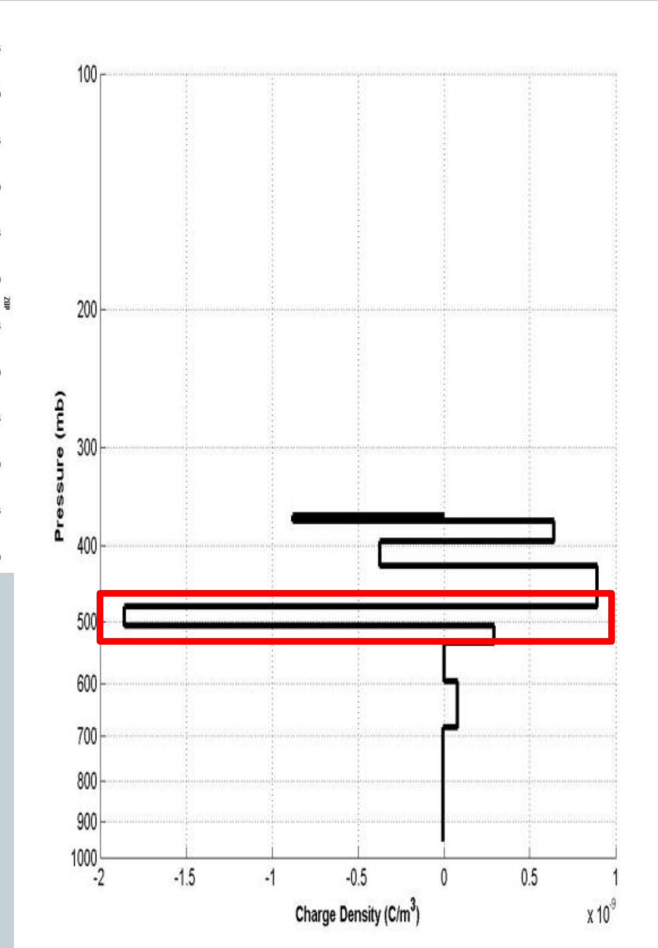


May 29th, 2012 DC3 – Negative Charge Layer

- Focus on PSD at 23:42:35 UTC
- Pressure range: 509 – 474 mb (5653 – 6182 m)
- Slightly negative vertical motions







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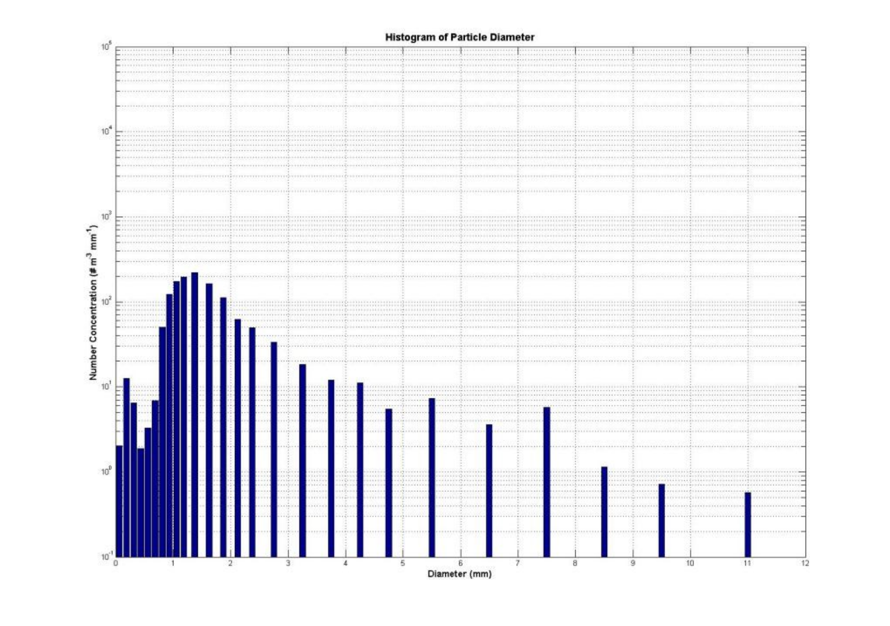

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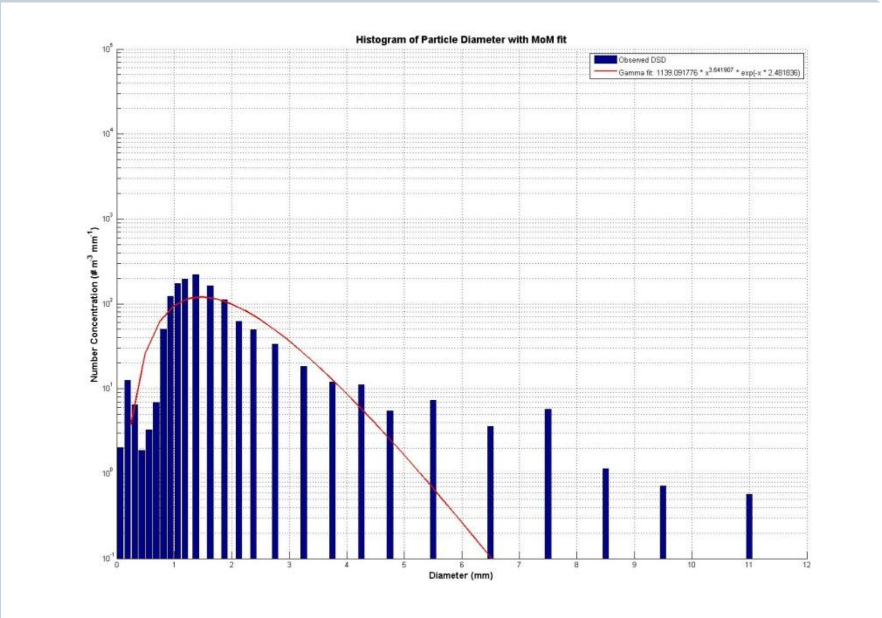
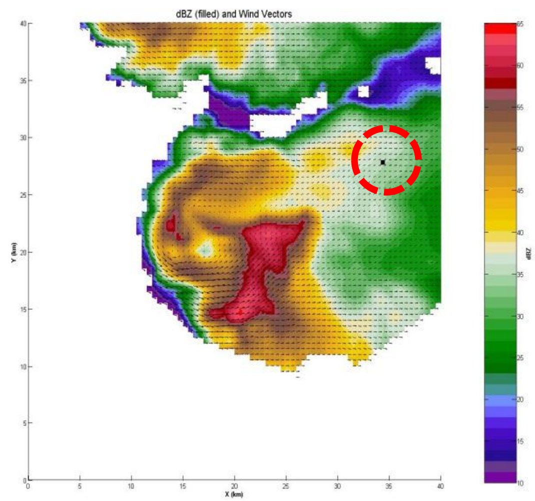


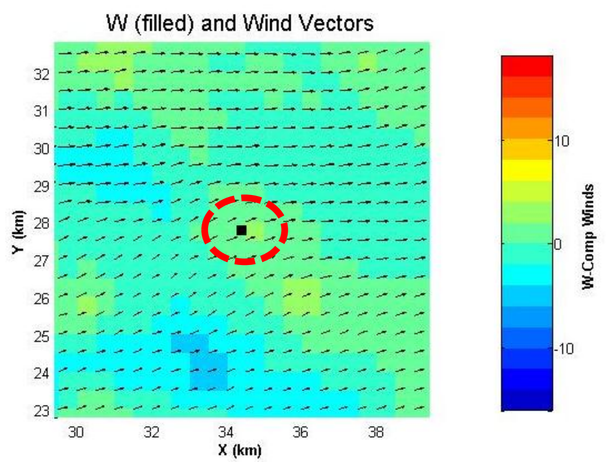
D = 2.6 mm

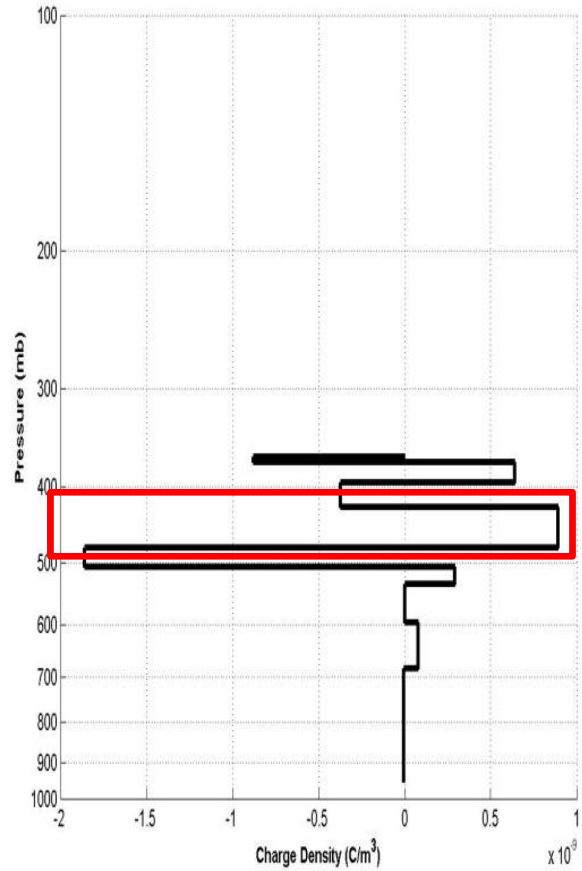
- Method of Moments: $N(D) = NoD^{\mu}e^{-\lambda D}$
- Small graupel
- Low concentrations
- A few large stones (possibly hail)

May 29th, 2012 DC3 – Positive Charge Layer

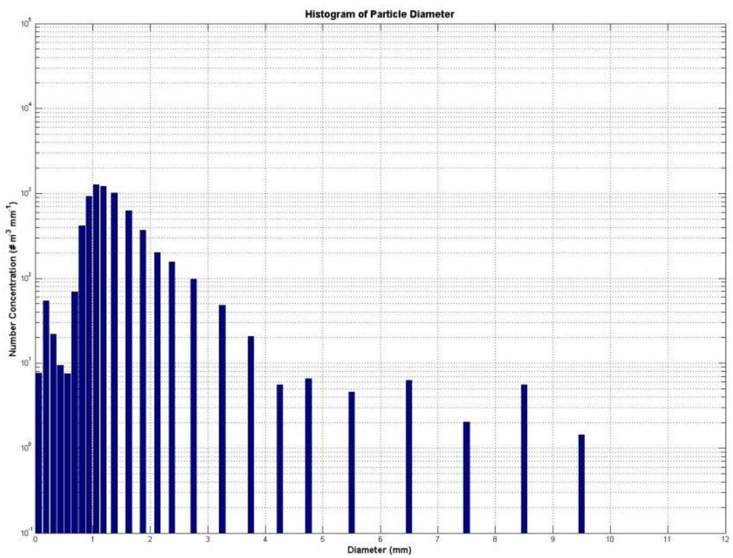
- Focus on PSD at 23:46:14 UTC
- Pressure range: 474 - 429 mb (6182 – 6944 m)
- Slightly positive vertical motions



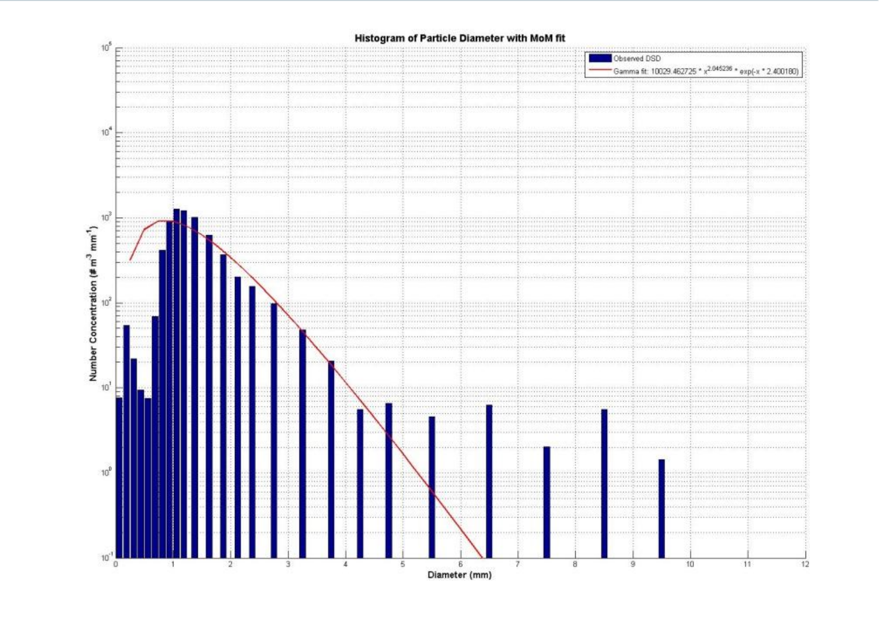




May 29th, 2012 DC3 – Positive Charge Layer



May 29th, 2012 DC3 – Positive Charge Layer



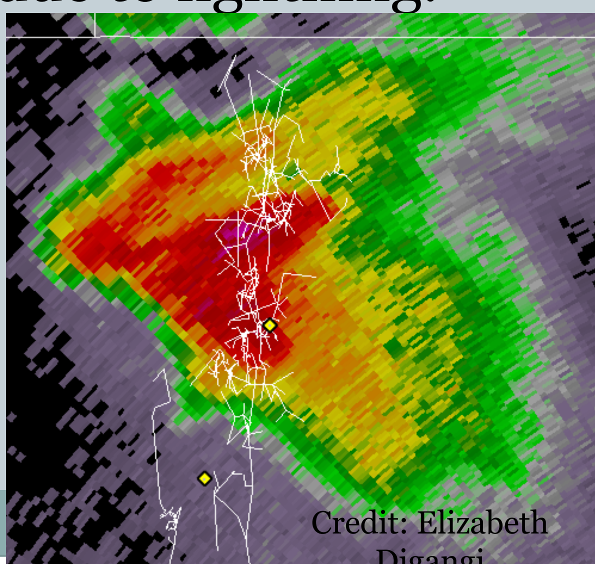
Major axis
6.2 mm

- Method of Moments: $N(D) = NoD^{\mu}e^{-\lambda D}$
- Mostly small crystals (highly eccentric), some graupel
- Higher concentrations
- A few large stones (possibly hail)

An untimely end…

- Balloons can go through some rough conditions
  - Lightning
  - Hail
  - Strong updrafts/Shear

- May 29th Flight stopped at 350 mb due to lightning.



Credit: Elizabeth Digangi

Conclusions

- Tornadic Supercell sampled with PASIV
- *In situ* PSD data for most of storm
- Negative charge layer showed small concentrations of graupel, with weak downward motion
- Positive charge layer showed larger concentrations of mostly ice crystals, with weak upward motion
- Predominant ice precip habits and inferred charges consistent with findings from Ziegler & MacGorman, 1994.

References

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