

Snowflake Size Distribution Measurements in South Central Ontario, Canada

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Canadian CloudSat/ CALIPSO Validation Project (C3vp) Field Campaign Center for Atmospheric Research Experiments (CARE) Precipitation Observation Site

Parsivel disdrometer (NASA/GSFC)

2d video disdrometer (CSU)

Snow video imager (NASA/WFF)

Heated tipping bucket gauge (HS)

Fd12p visibility sensor (EC)

Hotplate (EC)

Particle Occurrence System Sensor (EC)

Geonor weighting bucket gauge (CRN)

Multi-frequency radar (UMASS)

W-band radar (NASA/JPL))

X-band Doppler radar (McGill)

C-band polarimetric radar (EC)

Campbell Scientific Weather Station (EC)

More Information: c3vp.org



IOP1: October 31 - November 9, 2006

IOP2: November 30 - December 11, 2006

IOP3: January 17 - January 28, 2007

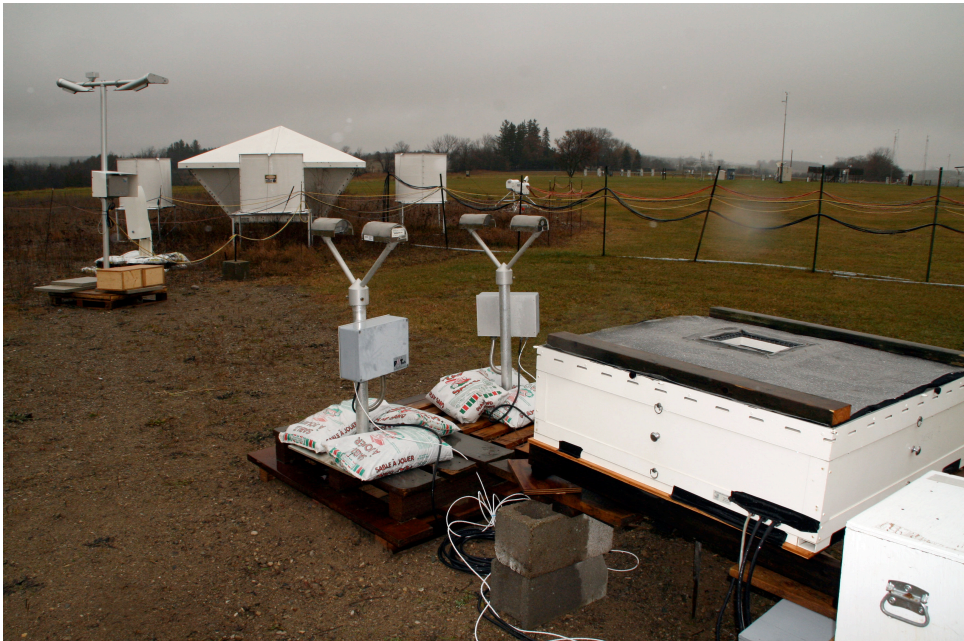
IOP4: February 18 - March 1, 2007

Acknowledgments

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Peter Ward (Hydrological Services)

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Richard Lawrence (NASA/GSFC)
John Gerlach (NASA/WFF)



Parsivel (Laser Optical) Disdrometer

PI: Ali Tokay (JCET/UMBC, NASA/GSFC)

Measures size and fall velocity of hydrometeors

Present weather sensor

Sampling area: $\sim 50 \text{ cm}^2$, varies with drop diameter

Number of size and velocity bins: 32 x 32 matrix

Drop size range: 0.06-24.5 mm

Velocity range: 0.05-20.8 m/sec

Operation period at Wallops Island, VA: Spring 2002 - present

Manufacturer: OTT in Germany www.ott-hydrometry.de



Shortcomings

- Measures maximum diameter of the 1-D projection of the particle.
- Spurious drops - rain drops falling at velocities that differ $\pm 50\%$ from terminal fall speed are rejected.
- Spurious drops - two particle in the light sheet at the same time (raindrops larger than 8 mm are rejected).
- Spurious snowflakes - flakes having larger than 4 m sec^{-1} fall velocity are rejected.
- Underestimates the drop concentration at diameters $< 1 \text{ mm}$.
- Quantization error due to binning the observed diameter and velocity.

More Information: Löffler-Mang and Joss (2000), Löffler-Mang and Blachak (2001), Yuter et al. (2006)

2-Dimensional Video Disdrometer

PI: V. N. Bringi (Colorado State University)

Measures size and fall velocity, and shape of hydrometeors

Sampling area: $\sim 100 \text{ cm}^2$

Time stamp, diameter, fall velocity, axis ratio of each particle

Horizontal resolution $< 0.19 \text{ mm}$

Vertical resolution $< 0.19 \text{ mm}$ (vertical velocity $< 10 \text{ m sec}^{-1}$)

Vertical velocity accuracy $< 4\%$ (vertical velocity $< 10 \text{ m sec}^{-1}$)

Manufacturer: Joanneum Research in Austria www.distrometer.at



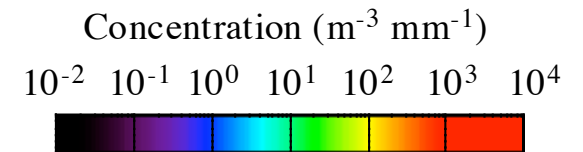
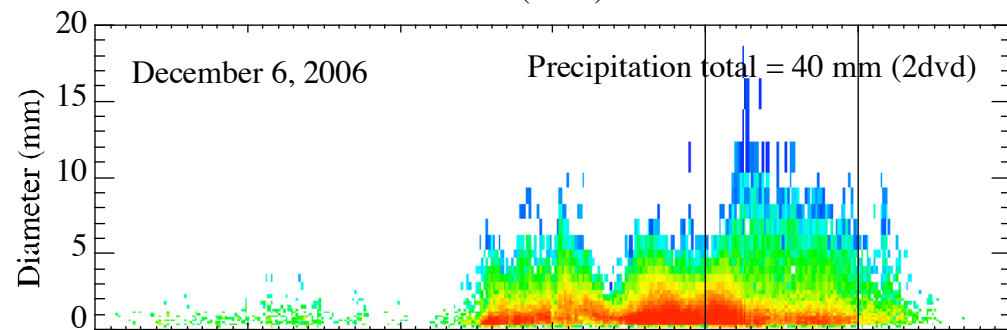
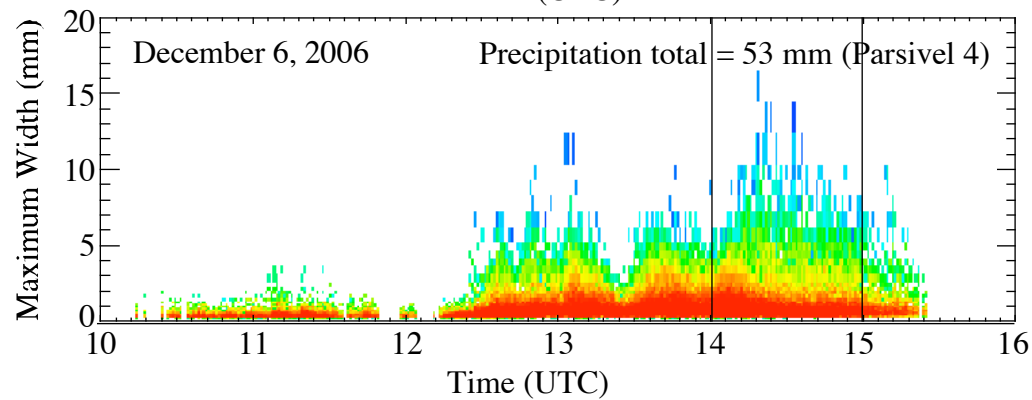
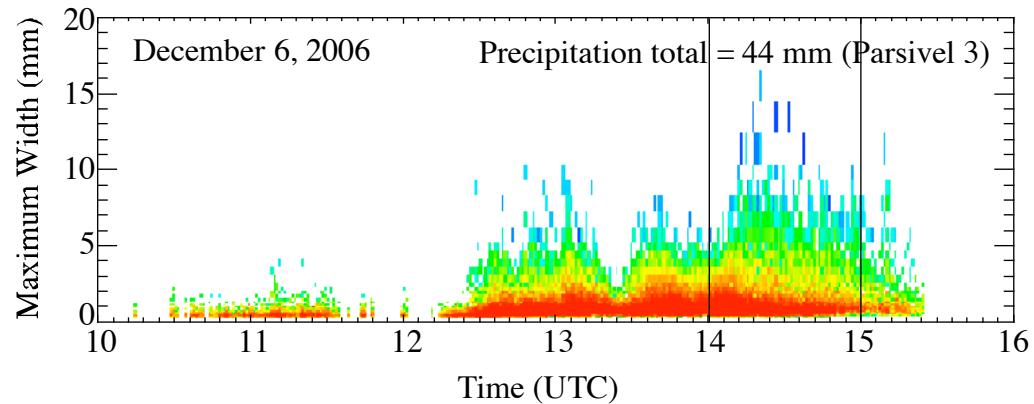
Shortcomings

- Requires frequent attention - dropouts due to misalignment.
- Spurious drops - rain drops falling at velocities that differ $\pm 50\%$ from terminal fall speed are rejected.
- Spurious drops - raindrops larger than 8 mm are rejected.
- Spurious snowflakes - flakes larger than 4 m sec^{-1} fall speed are rejected.
- Mismatched particles.

More Information: Kruger and Krajewski (2002), Brandes et al. (2007)

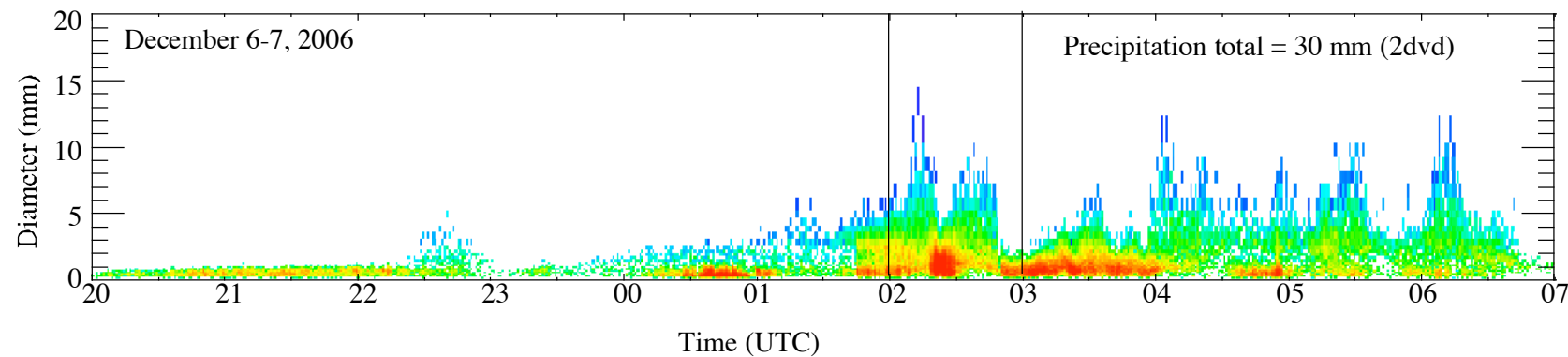
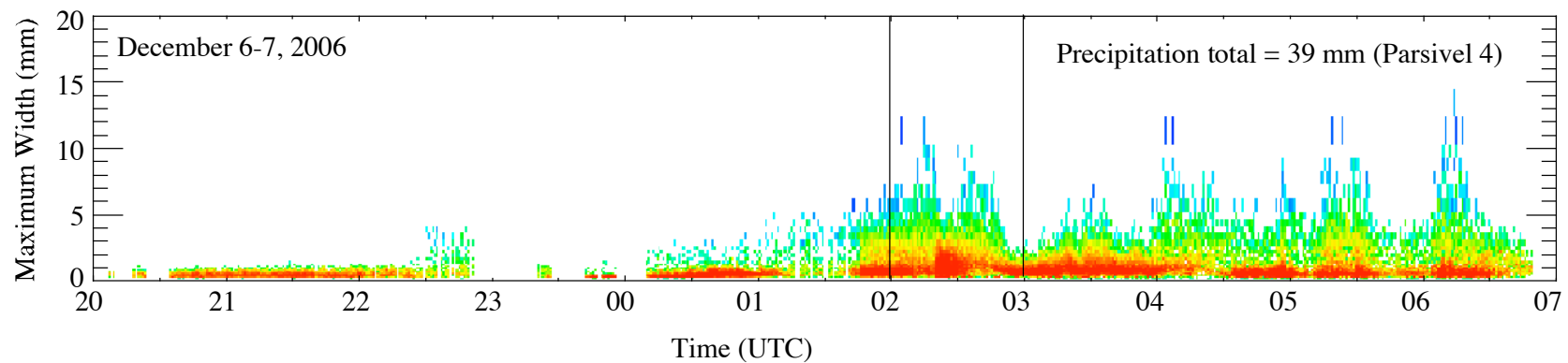
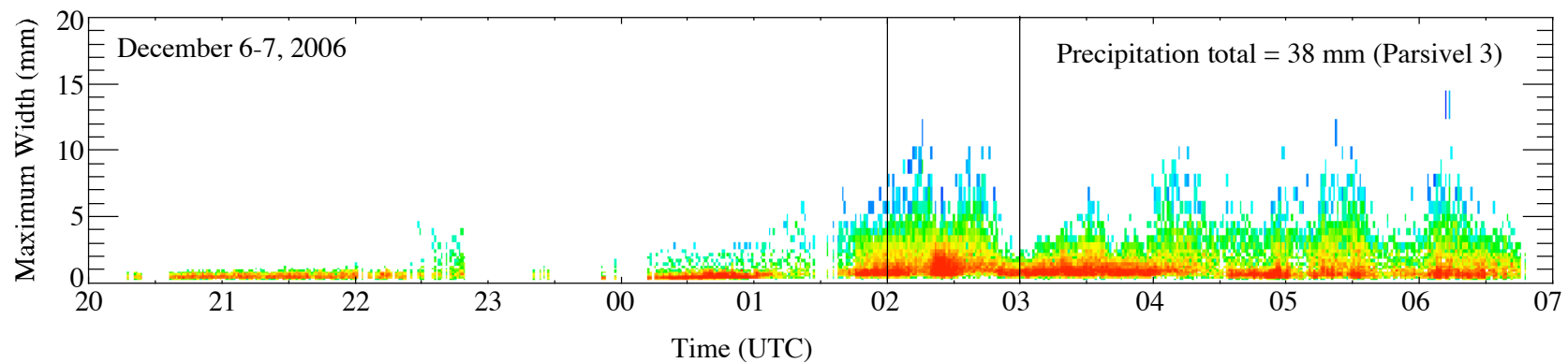
Case Study #1a: December 6, 2006

Particle Size Distribution



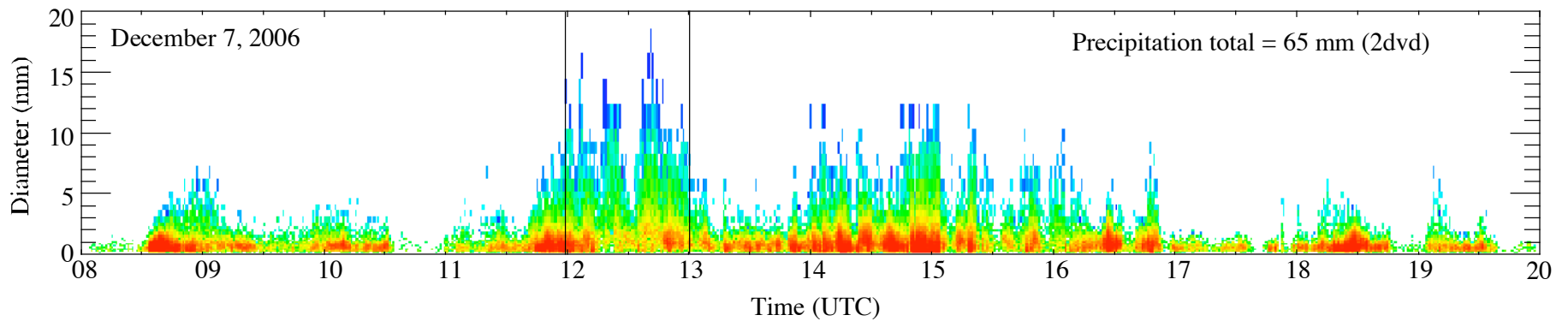
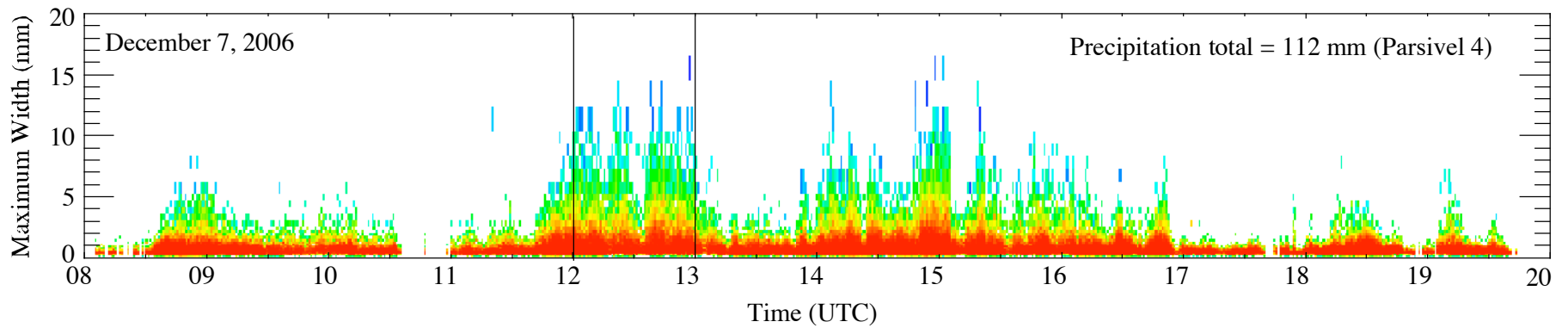
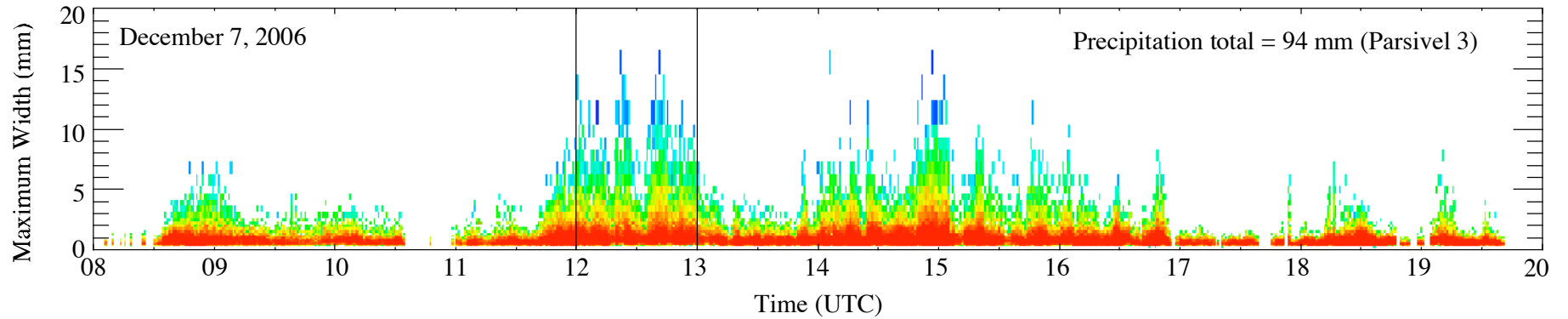
Case Study #1b: December 6-7, 2006

Particle Size Distribution



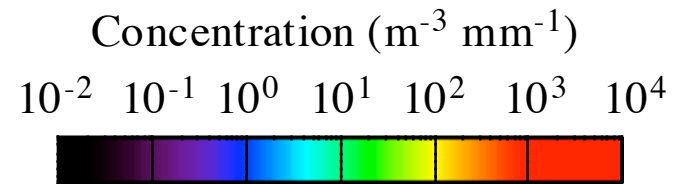
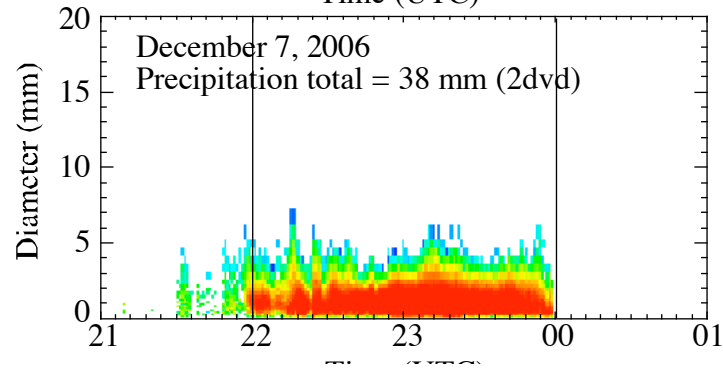
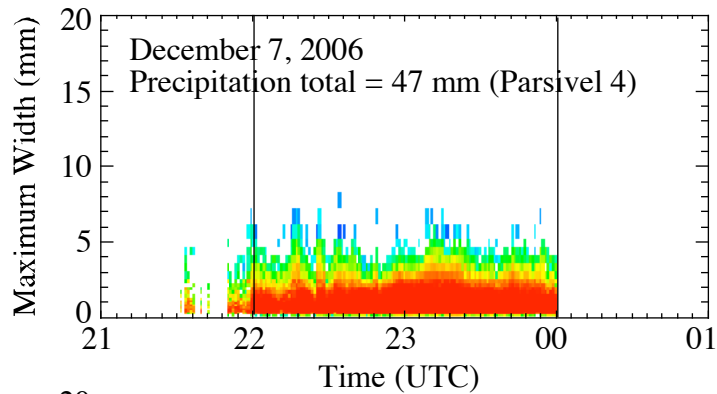
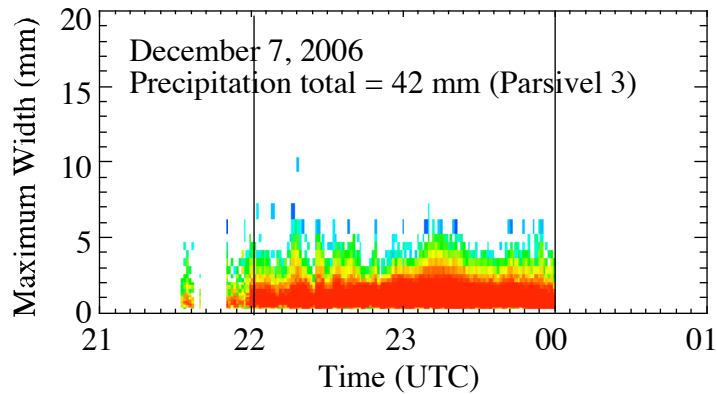
Case Study #1c: December 7, 2006

Particle Size Distribution



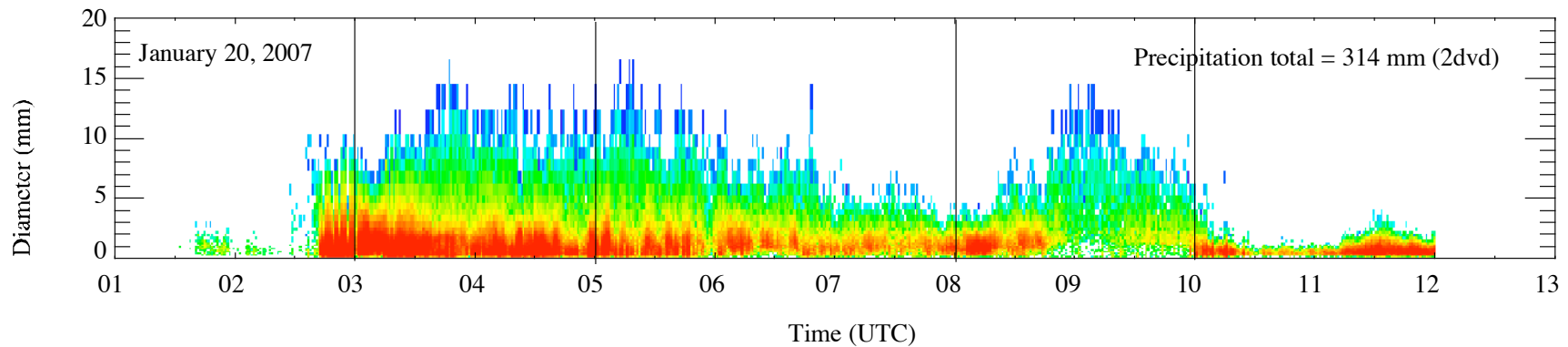
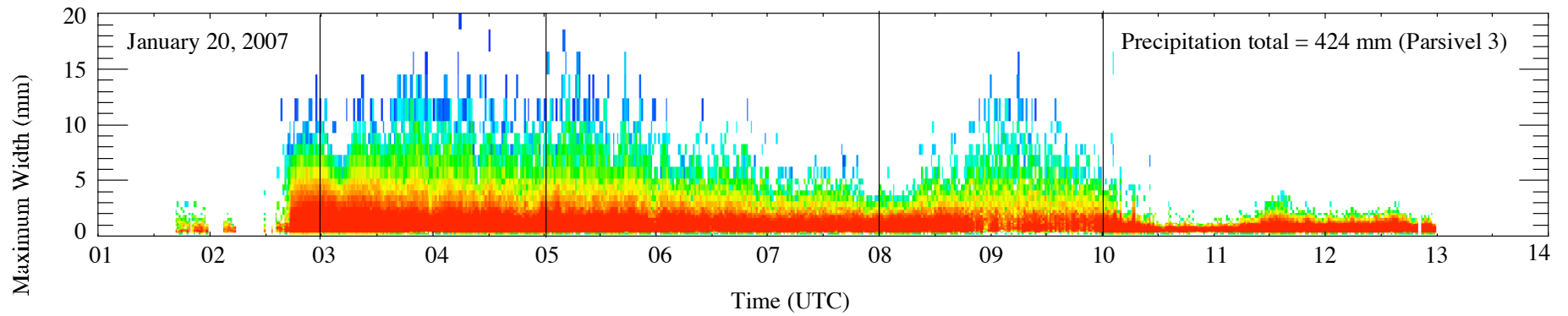
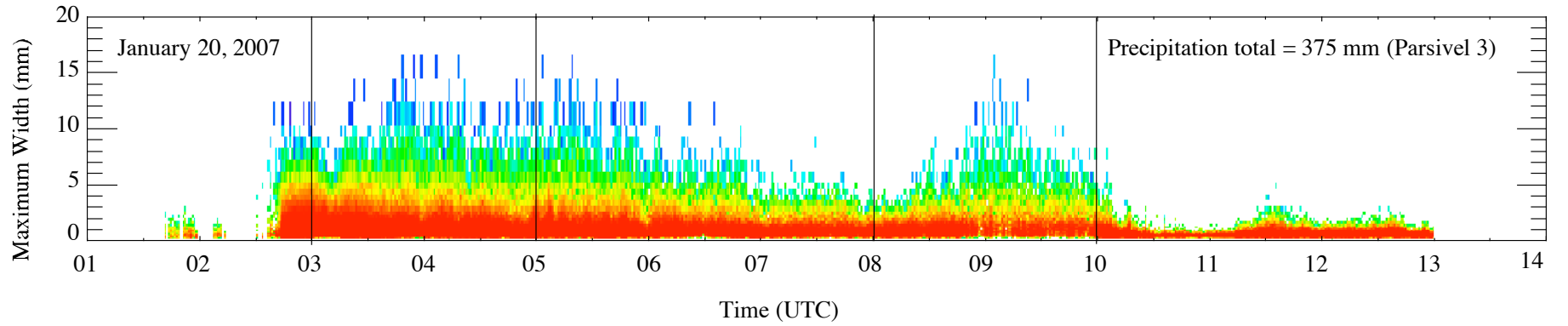
Case Study #1d: December 7, 2006

Particle Size Distribution



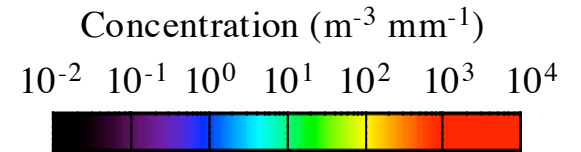
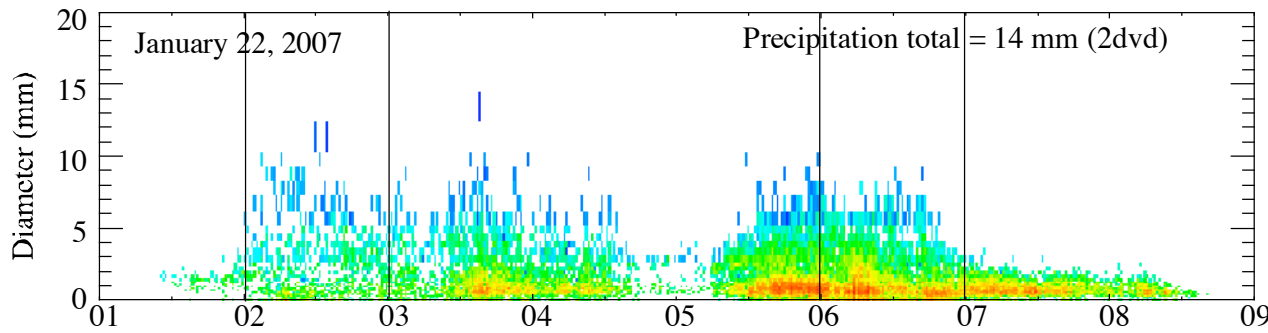
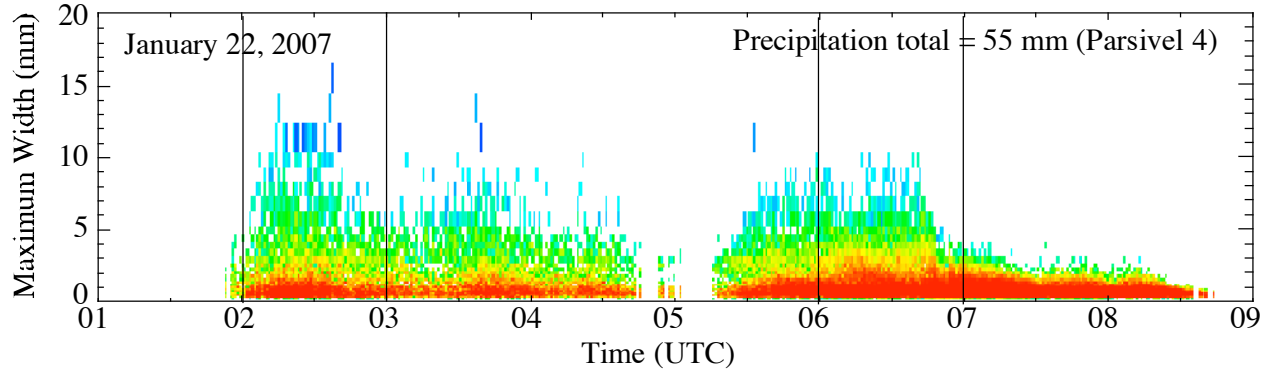
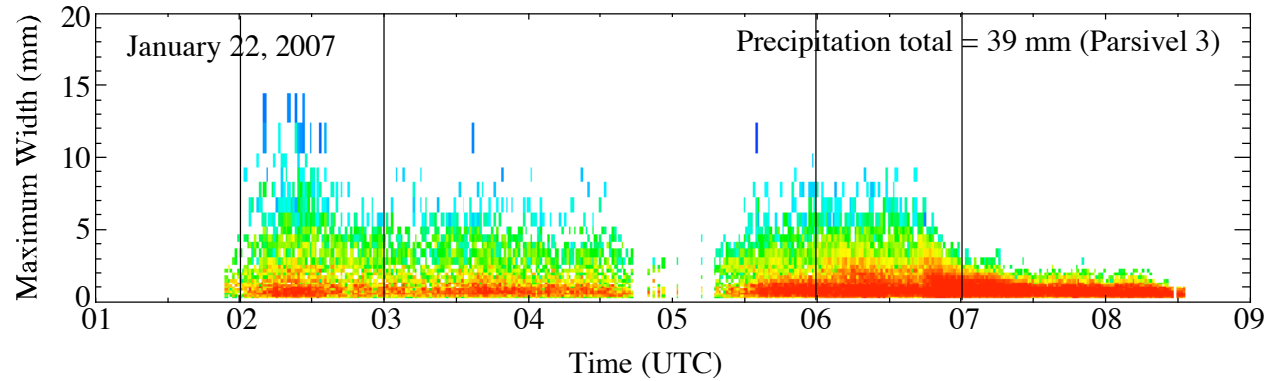
Case Study #2: January 20, 2007

Particle Size Distribution



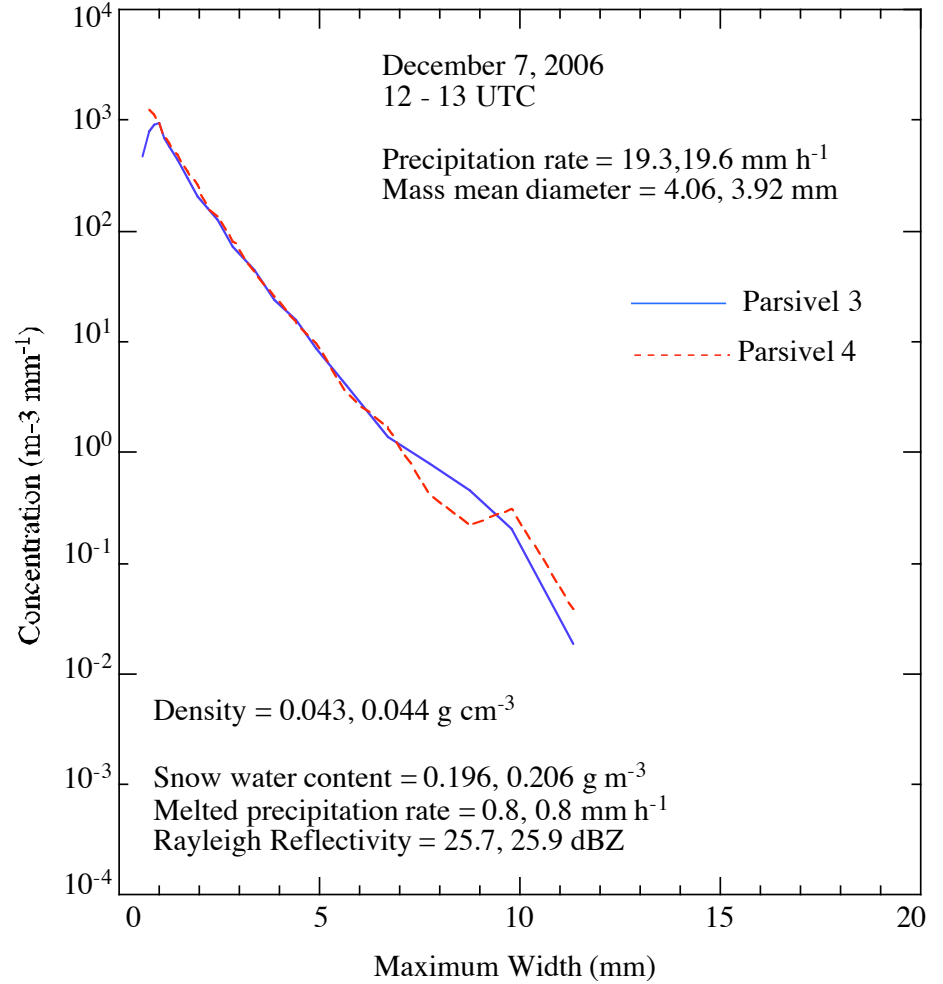
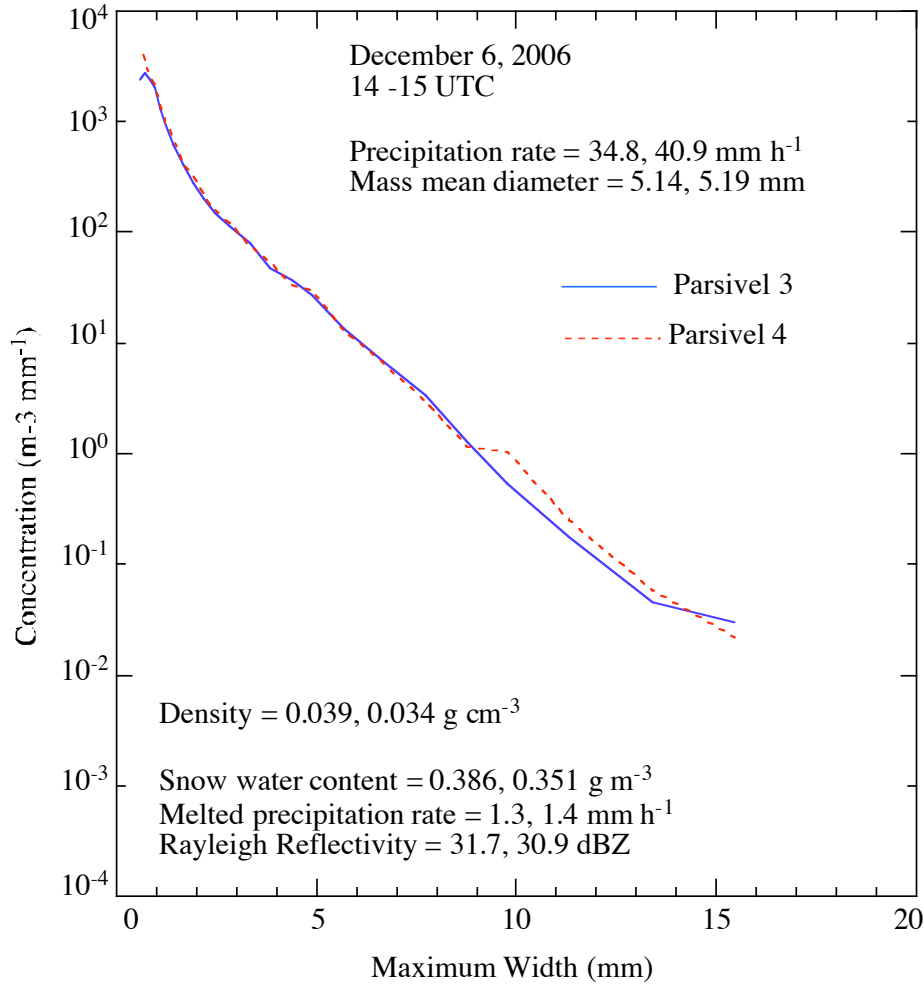
Case Study #3: January 22, 2007

Particle Size Distribution



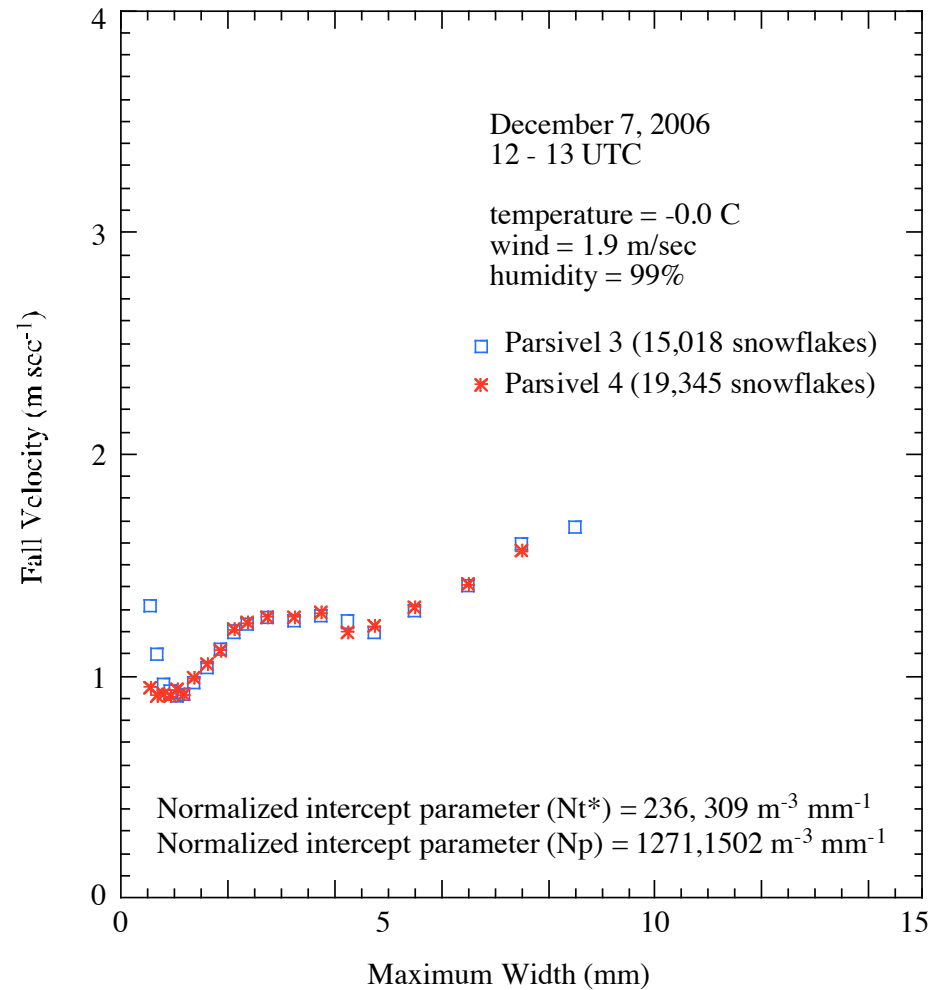
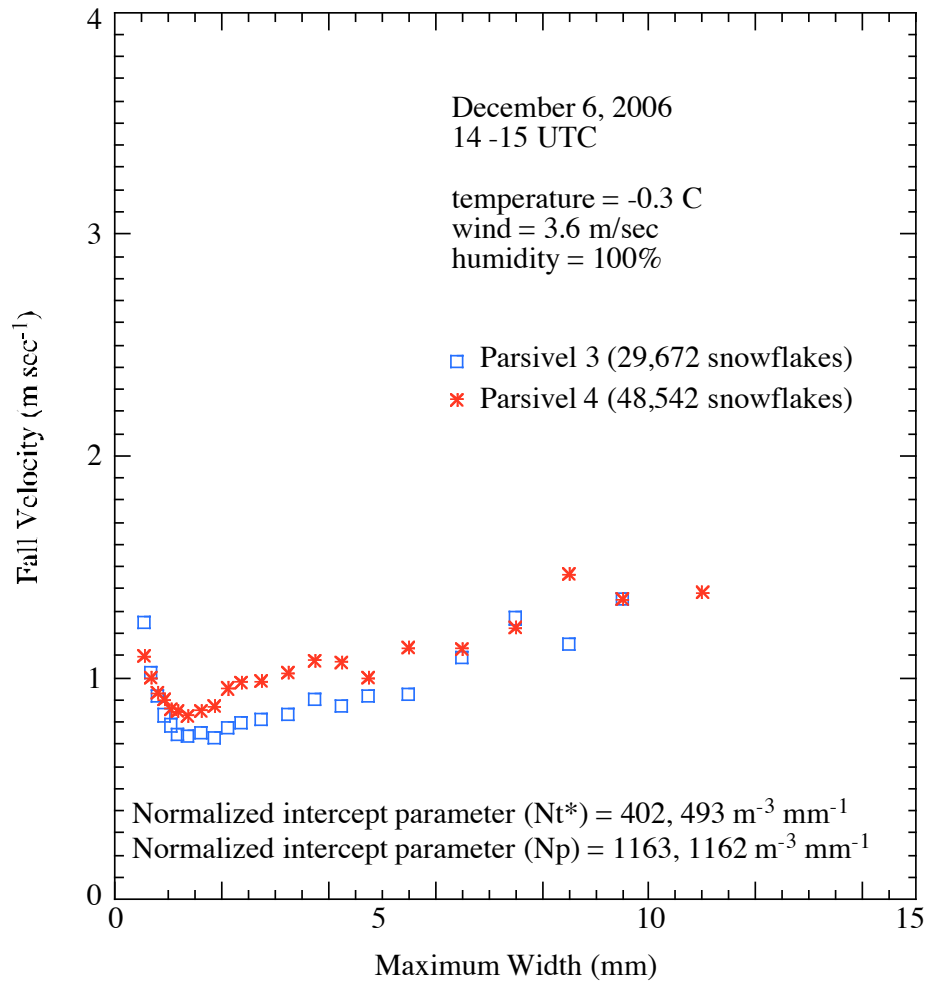
Case Study #1a-b: December 6-7, 2006

Composite Spectra



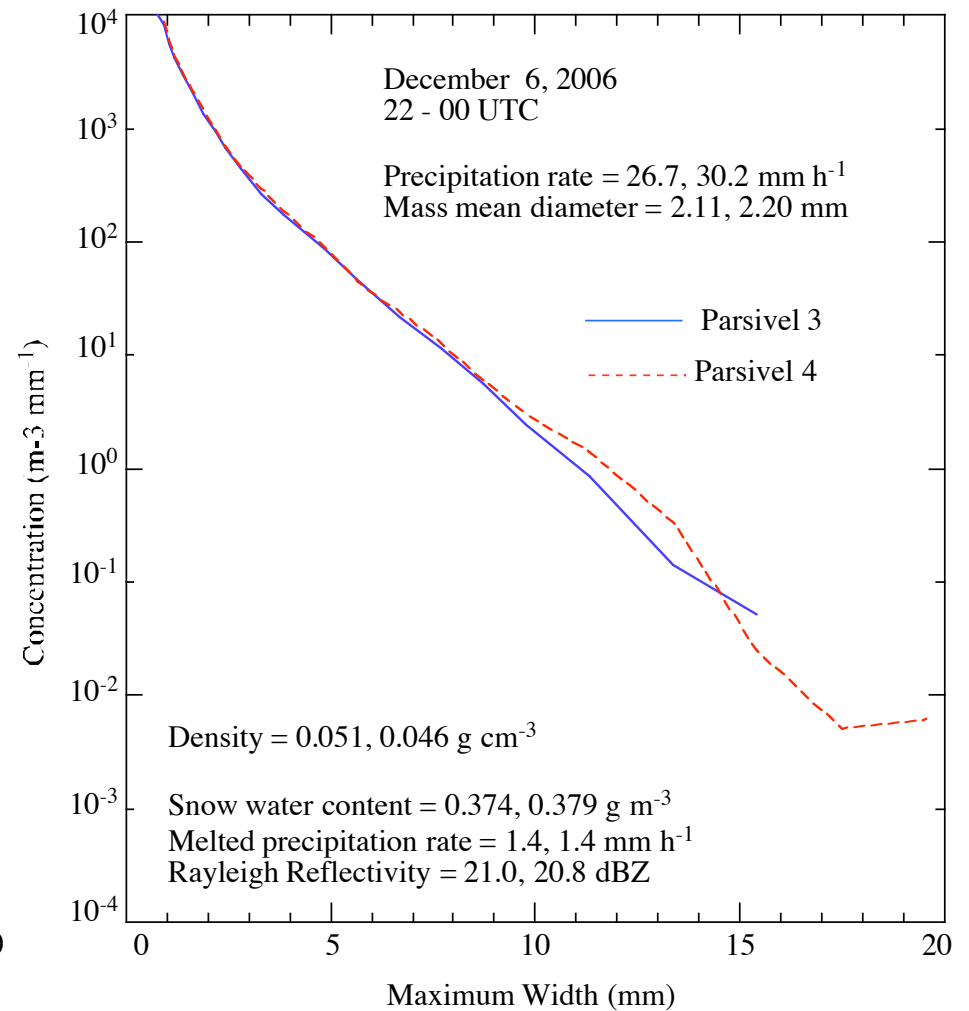
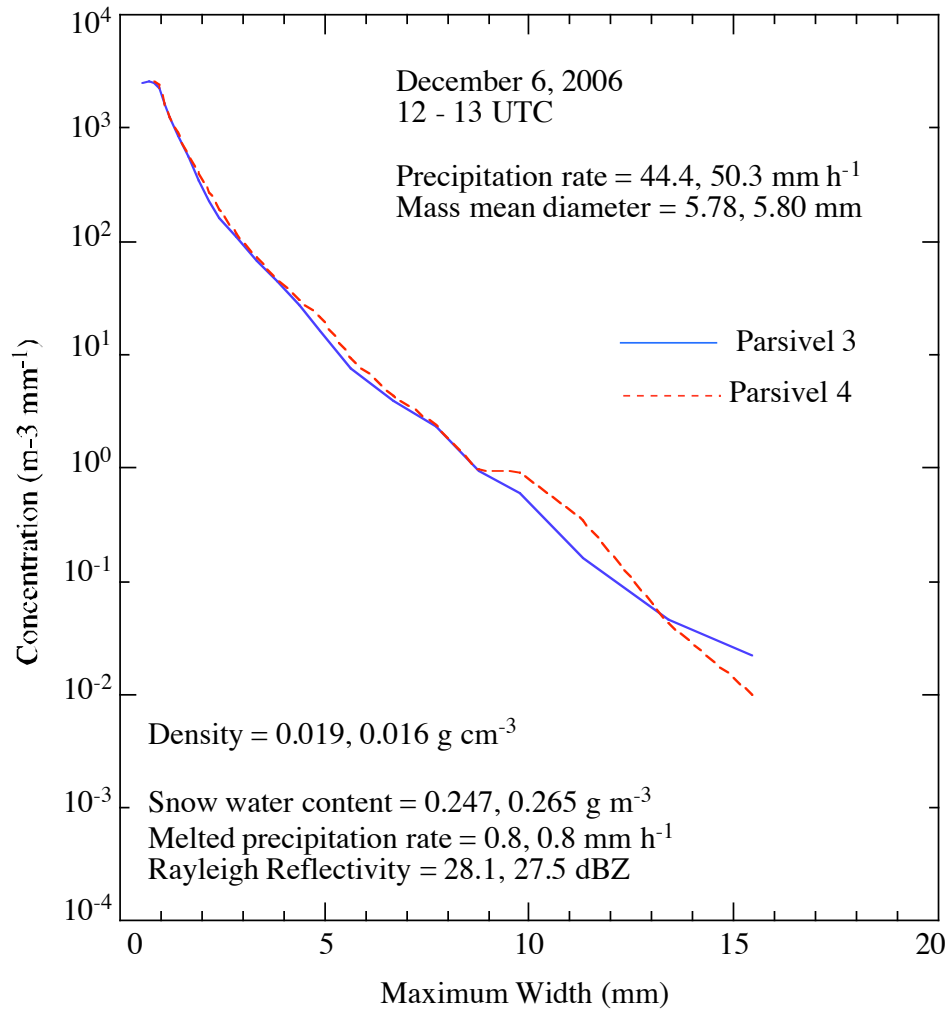
Case Study #1a-b: December 6-7, 2006

Particle Fall Velocity



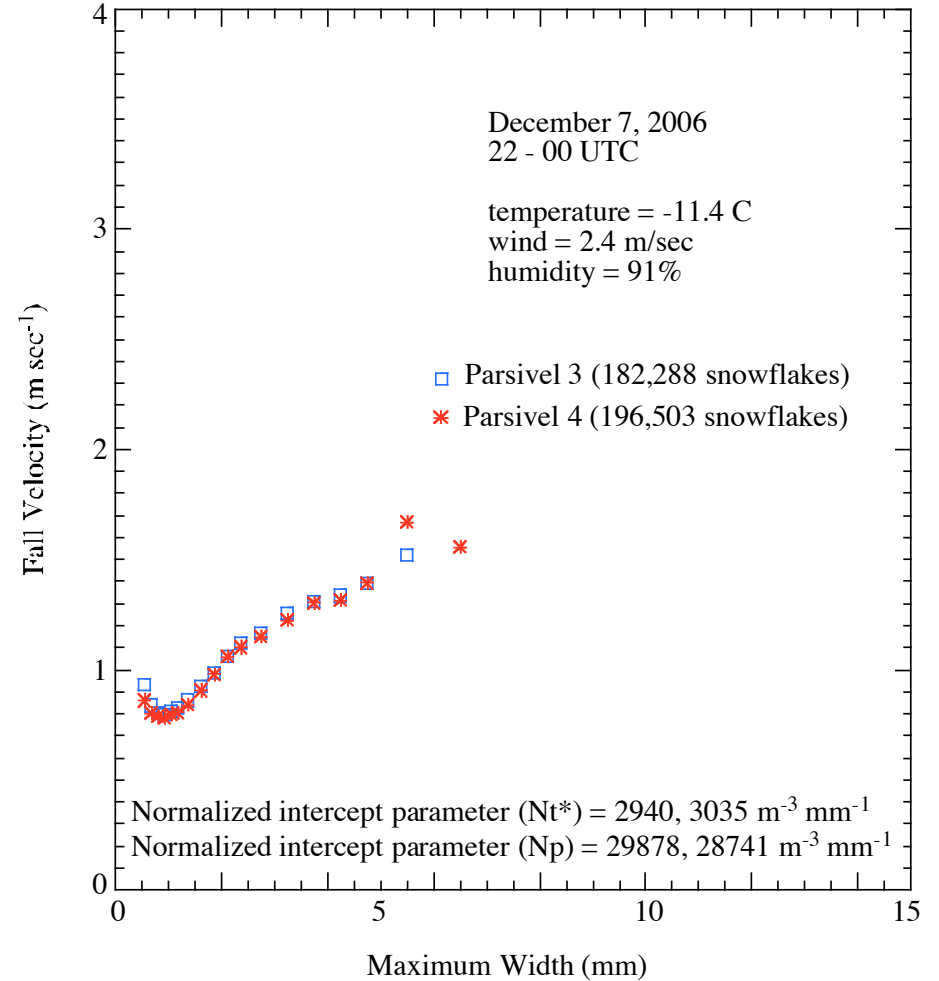
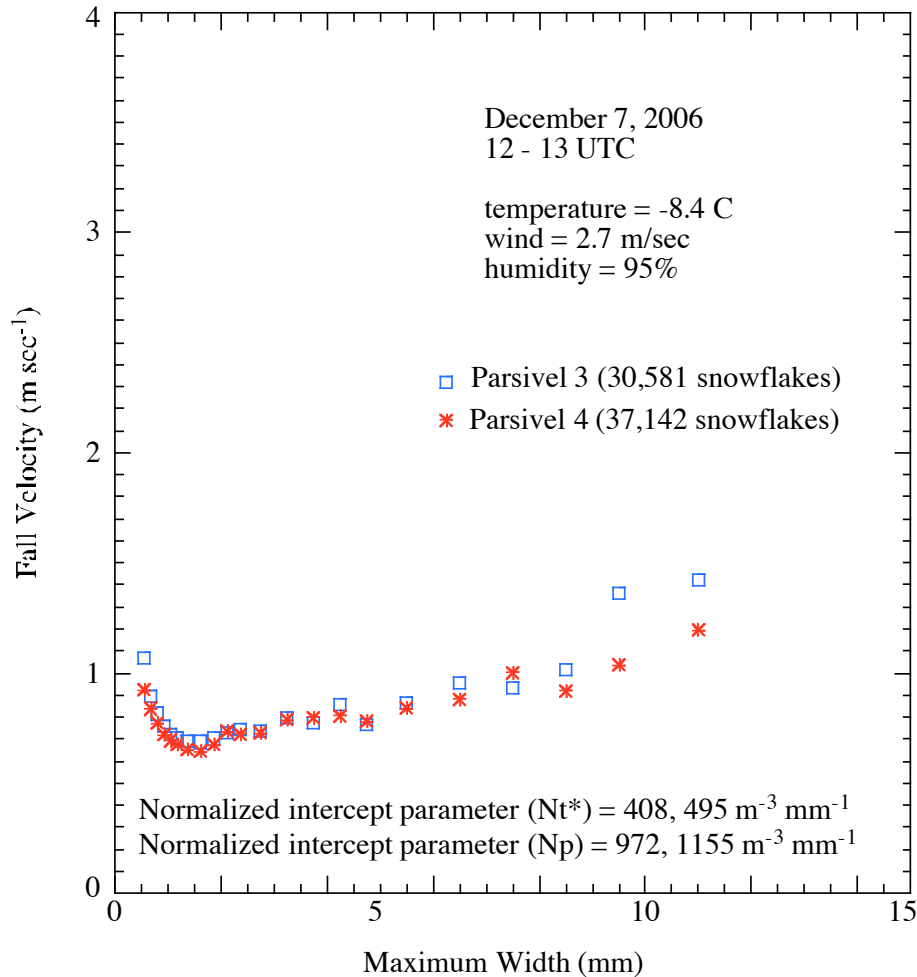
Case Study #1c-d: December 7, 2006

Composite Spectra



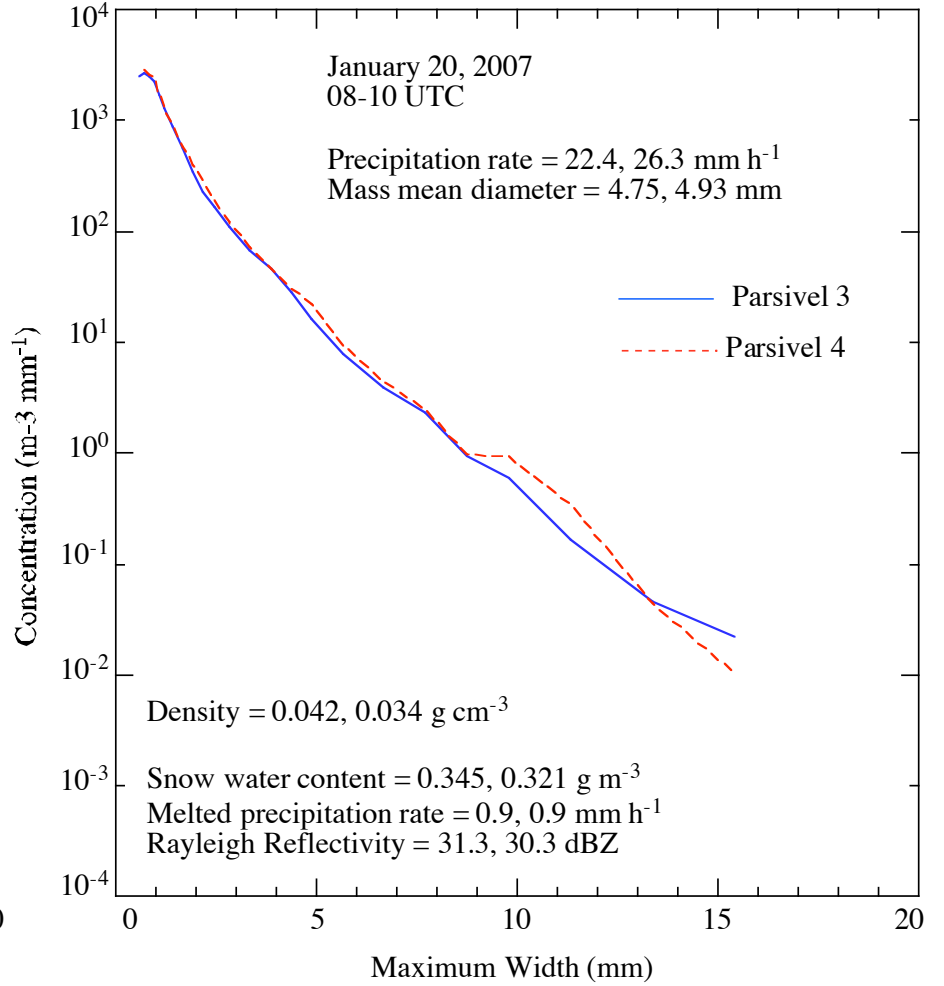
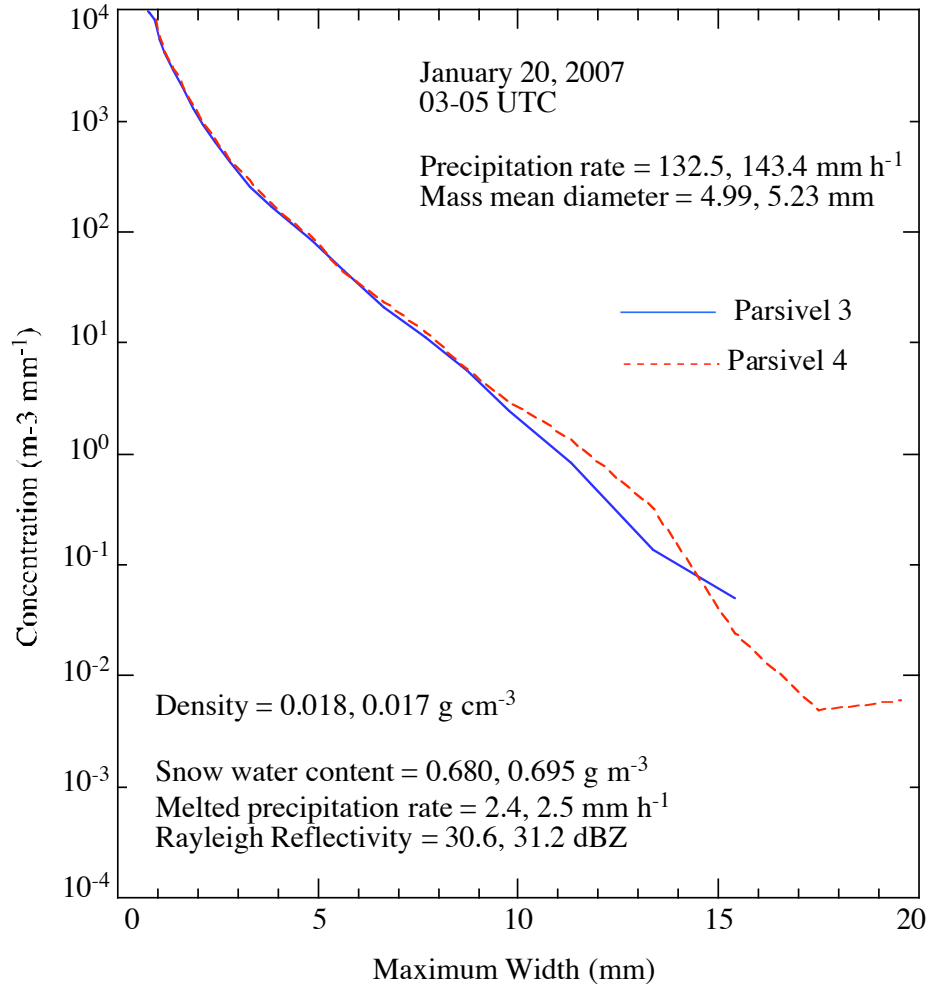
Case Study #1c-d: December 7, 2006

Particle Fall Velocity



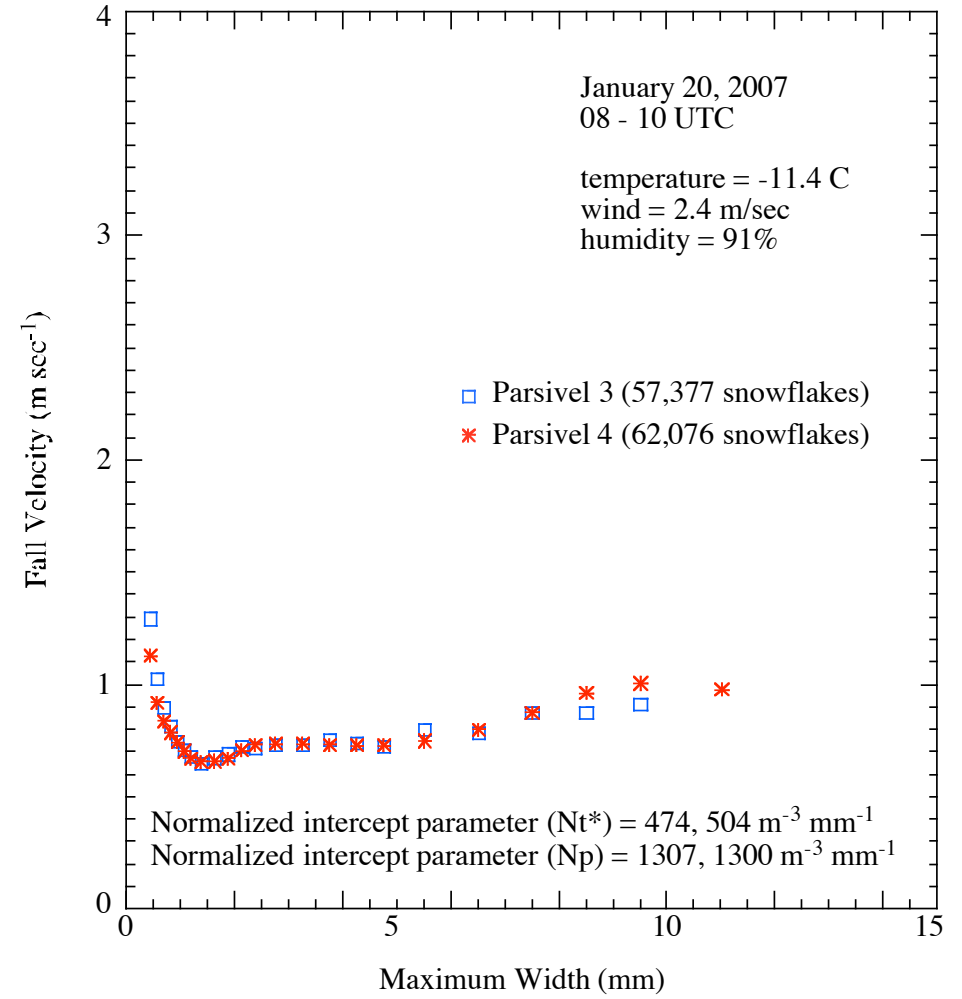
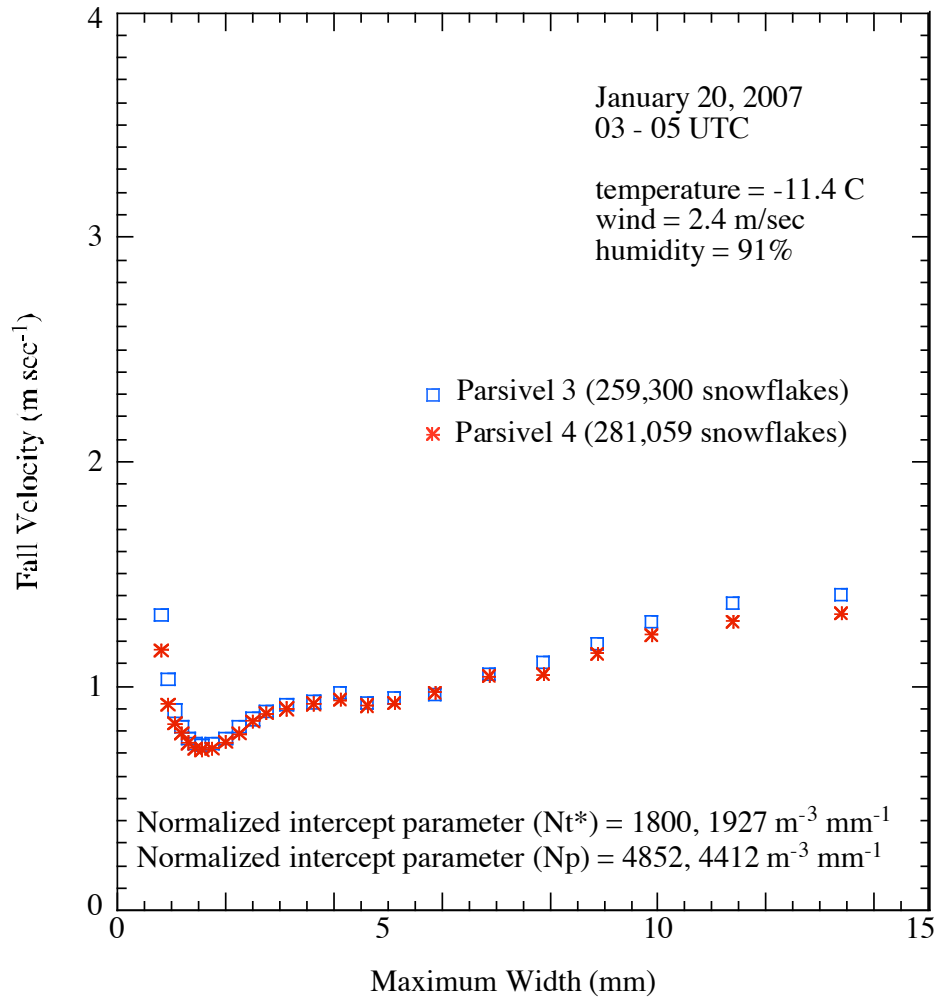
Case Study #2: January 20, 2007

Composite Spectra



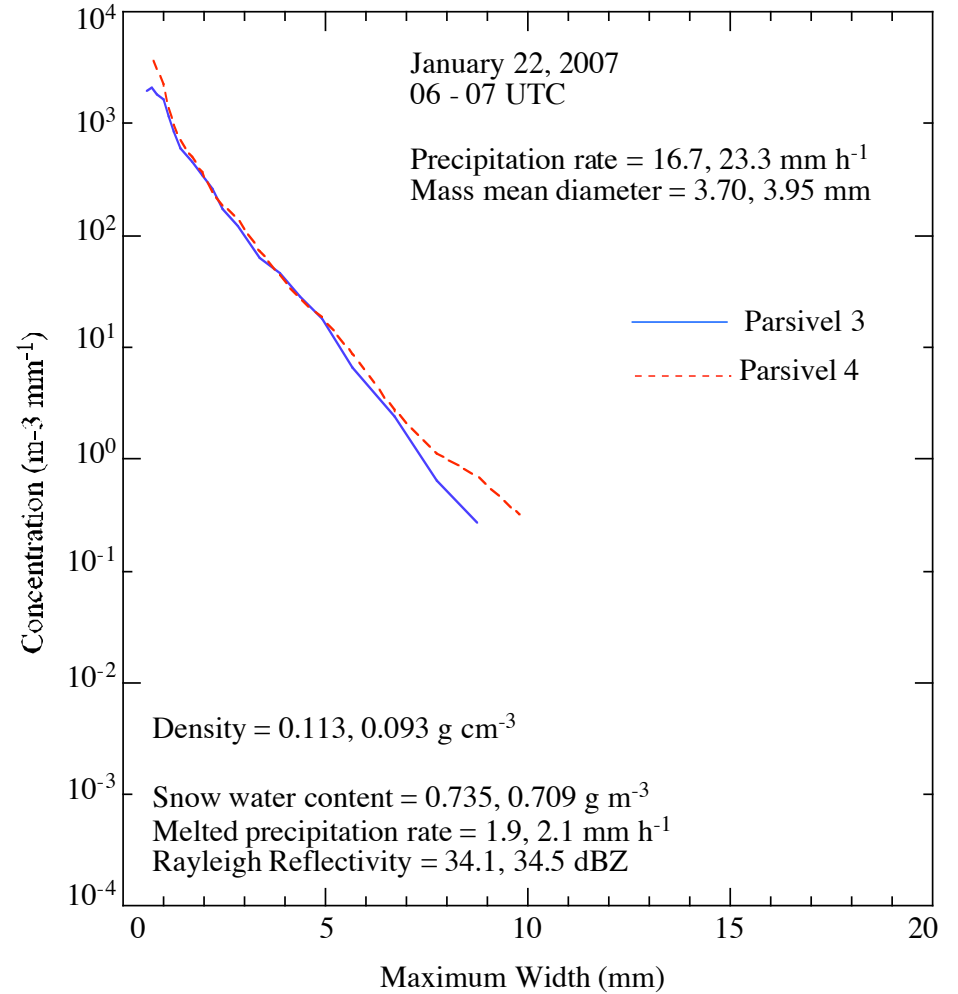
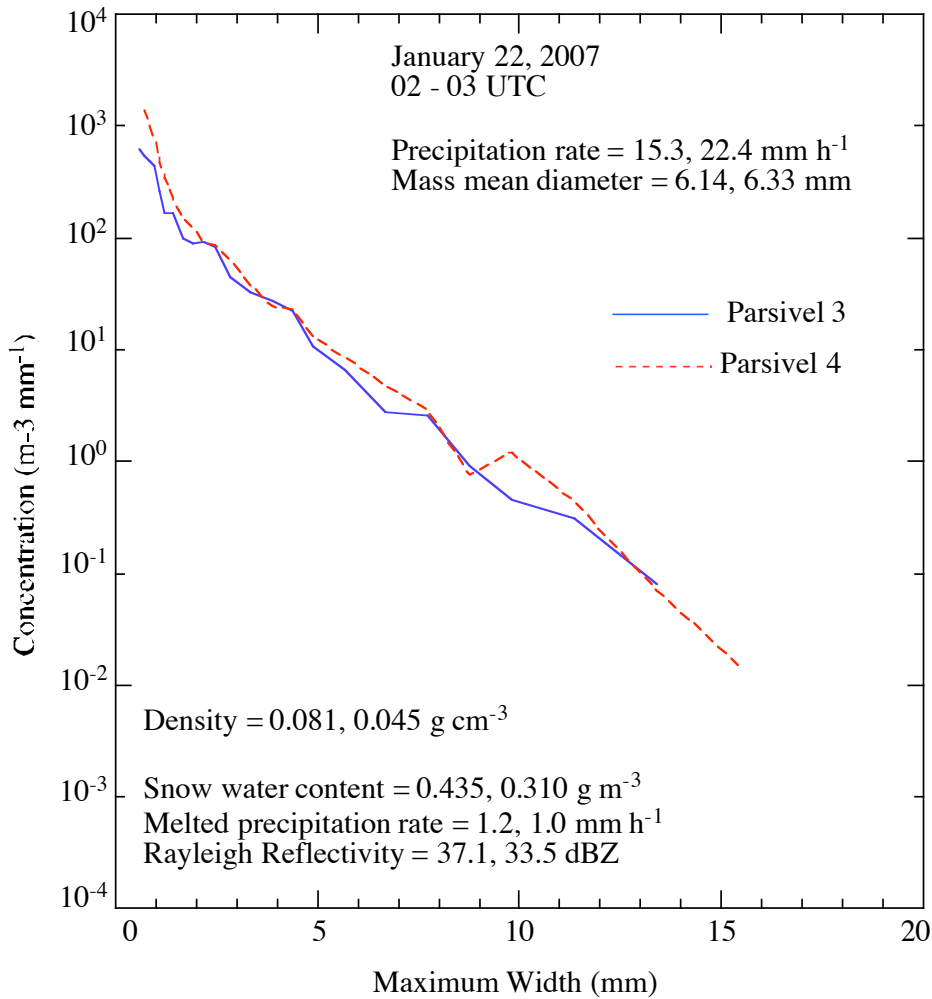
Case Study #2: January 20, 2007

Particle Fall Velocity



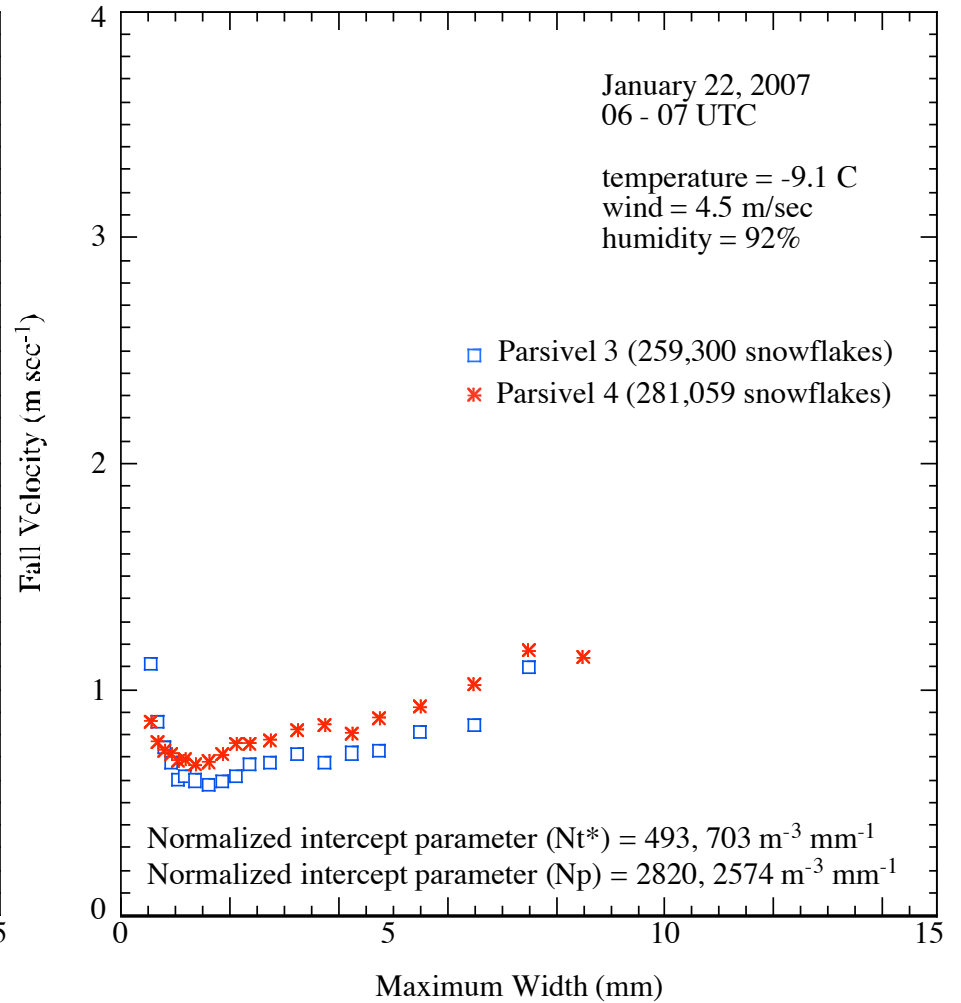
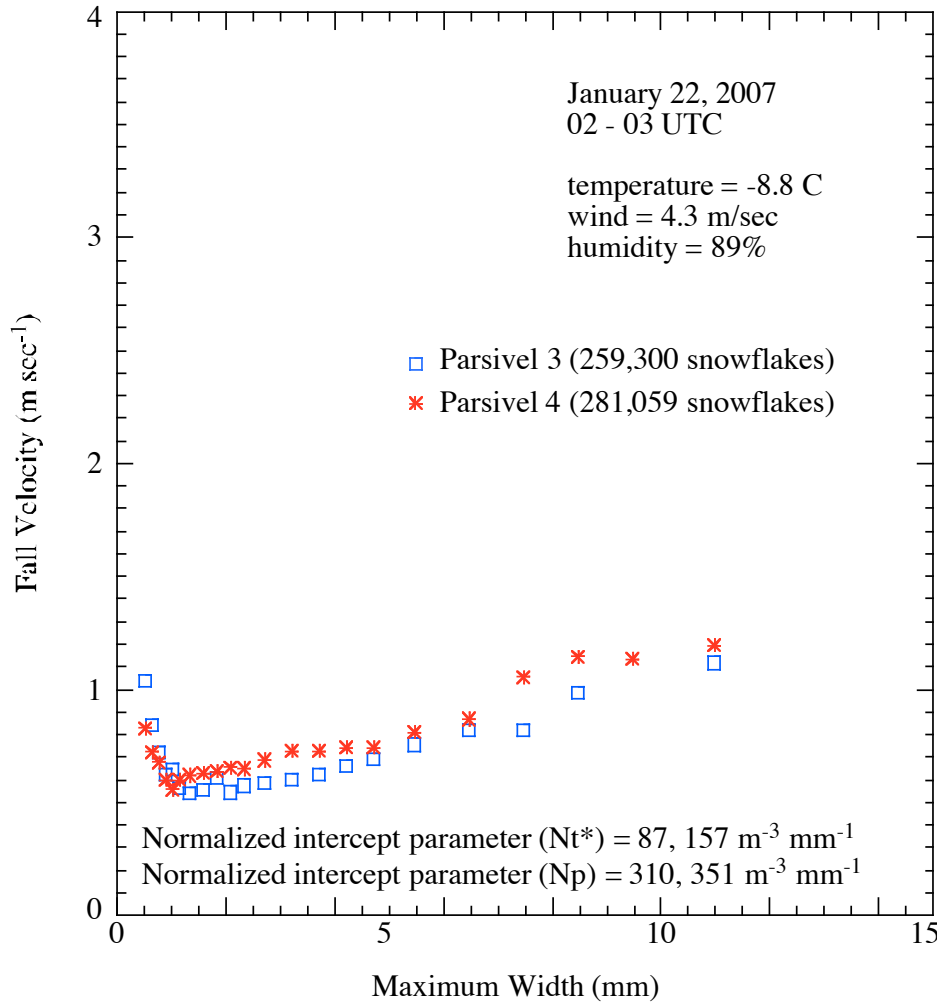
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Composite Spectra



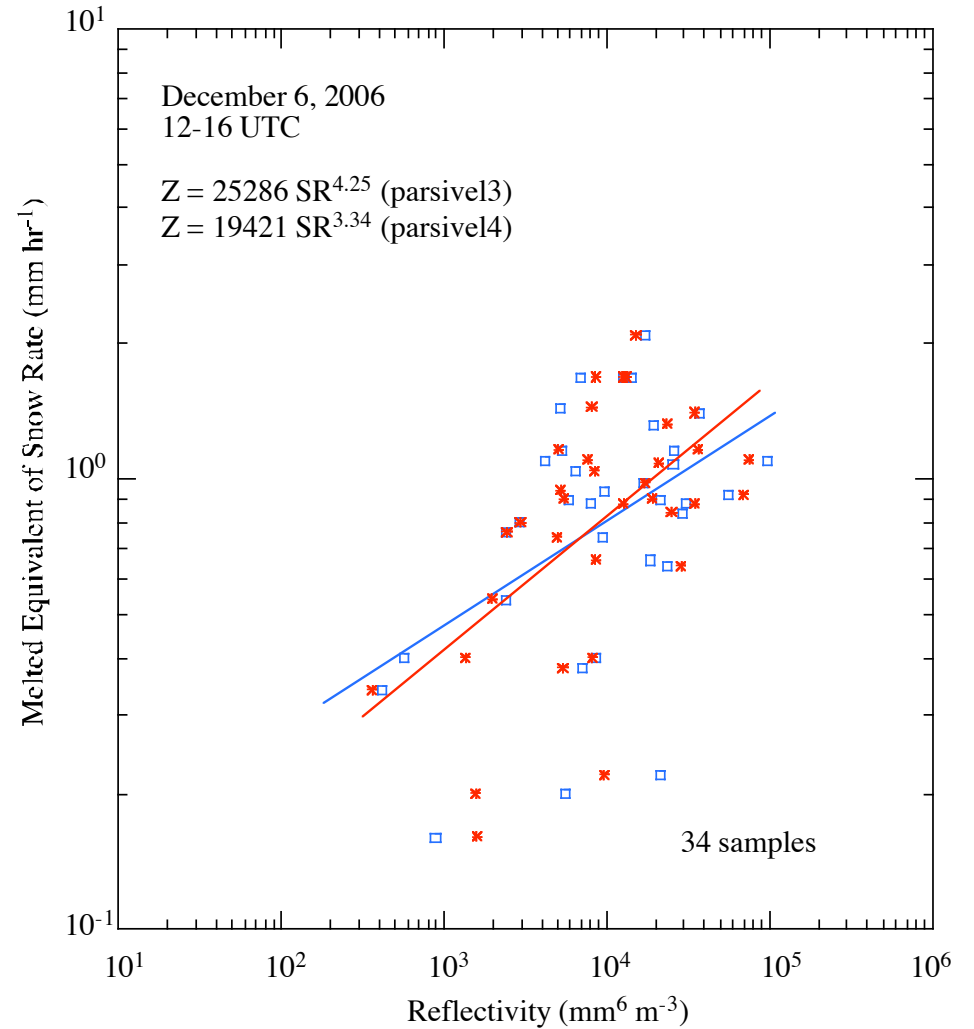
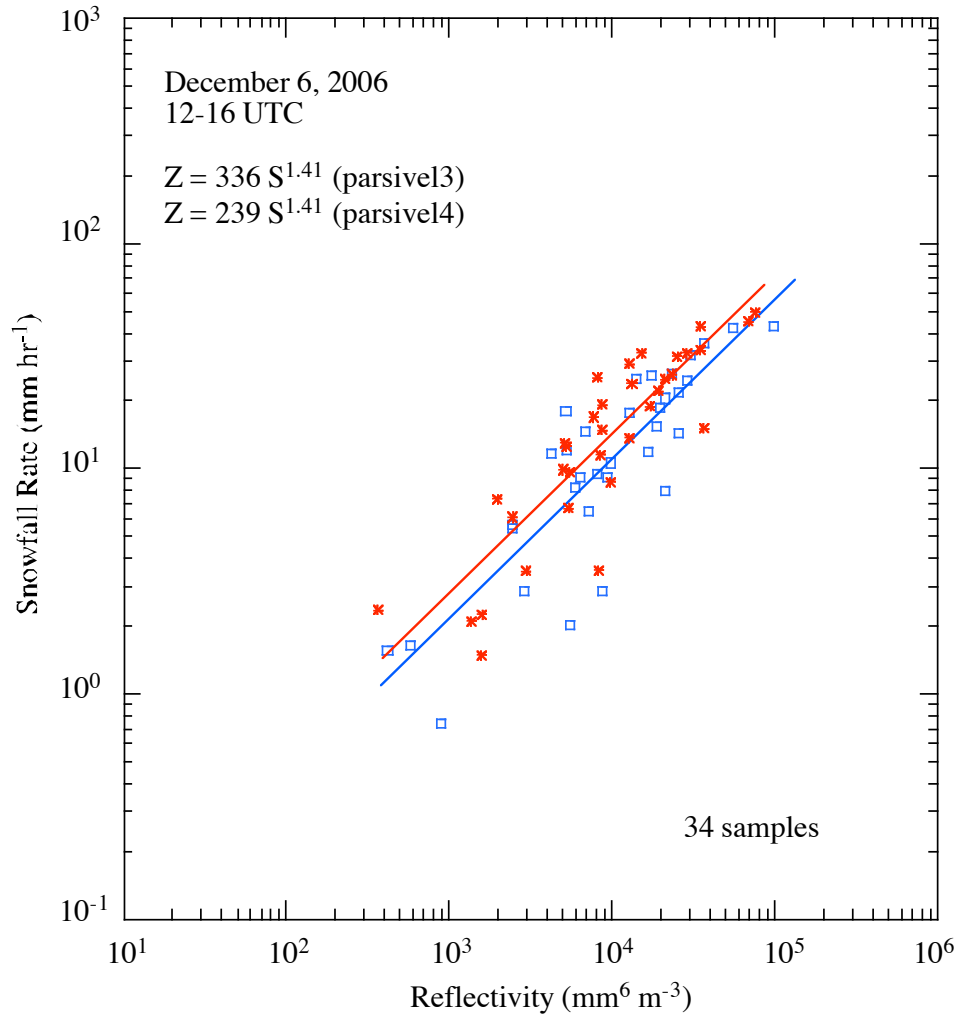
Case Study #3: January 22, 2007

Particle Fall Velocity



Case Study #1a: December 6, 2006

Z-S and Z-SR relationship



Case Study #4: January 22, 2007

Z-S and Z-SR relationship

