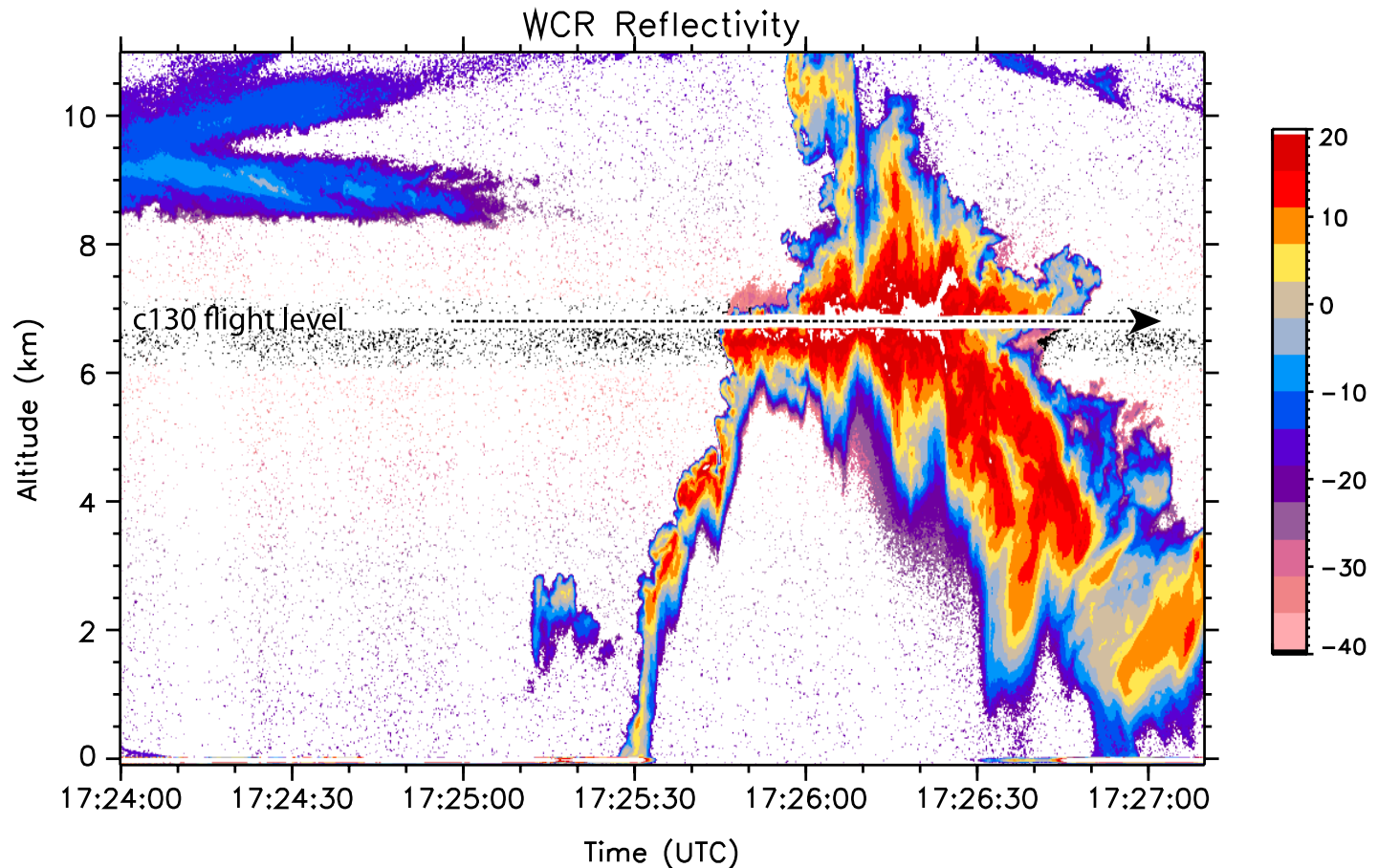
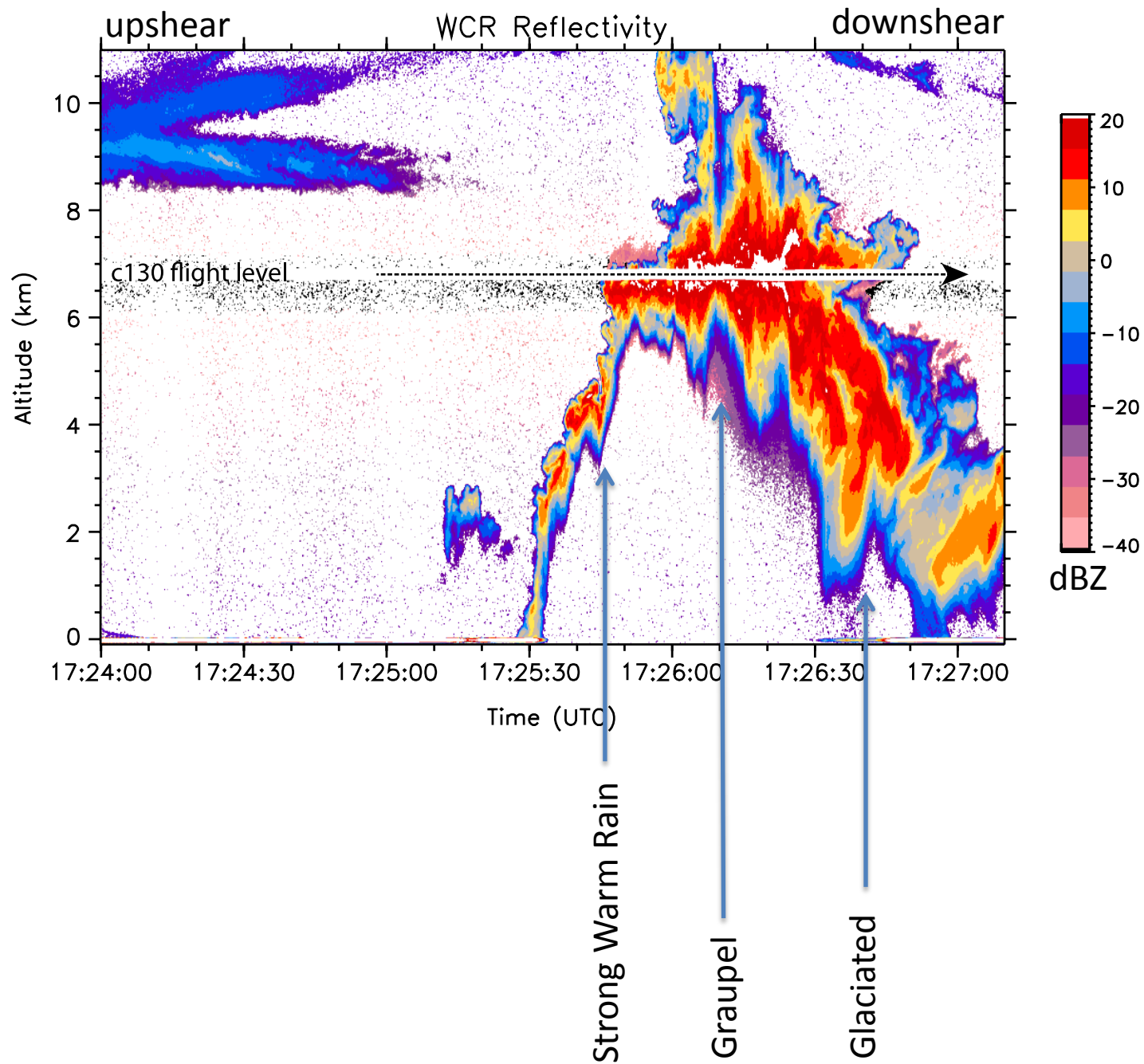
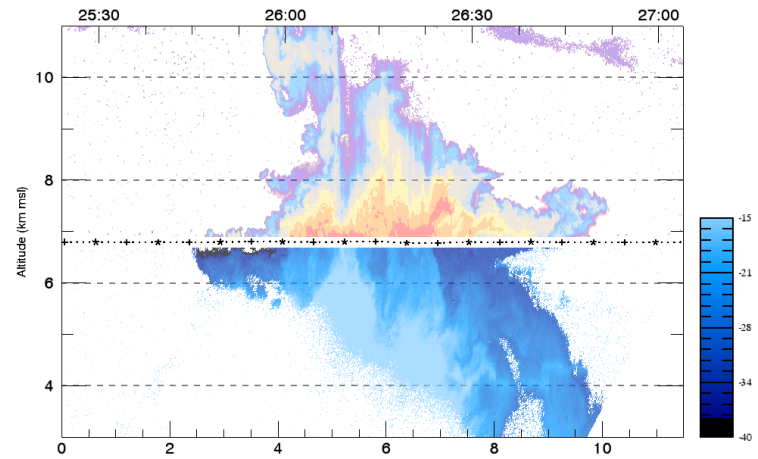
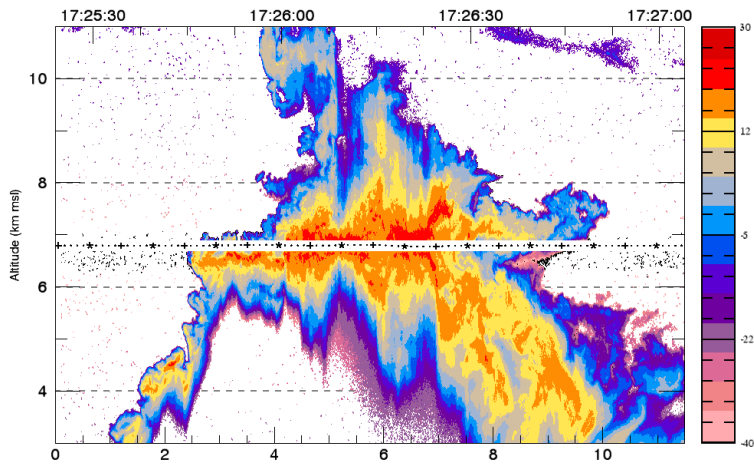


ICE-T: Remote Sensing of Hydrometeor Type

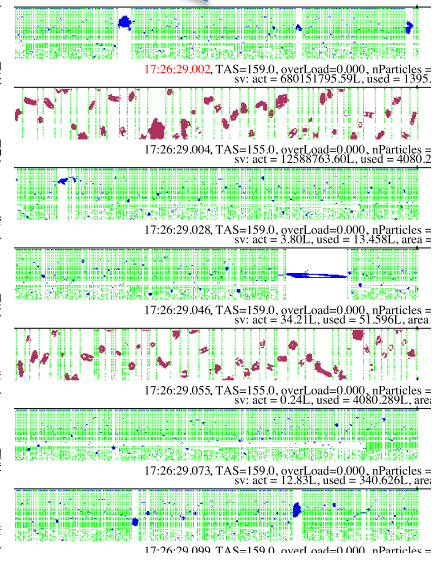
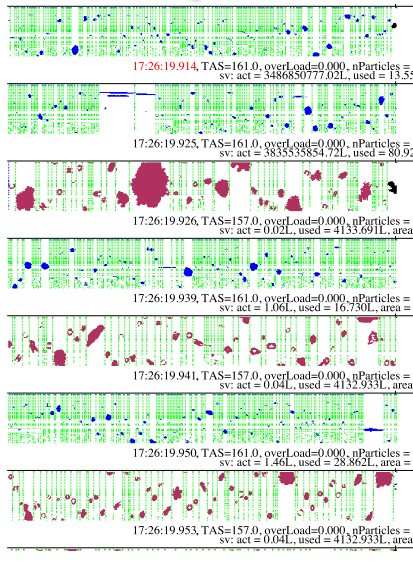
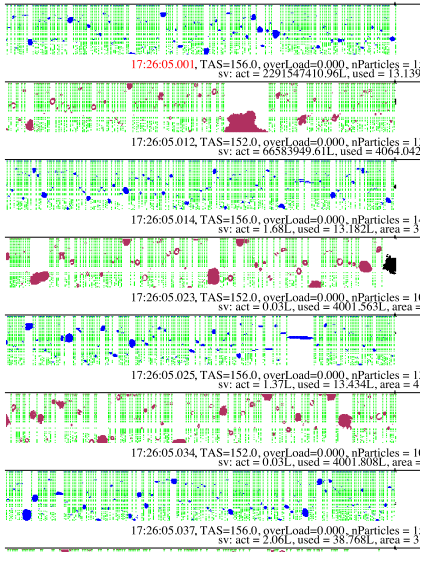
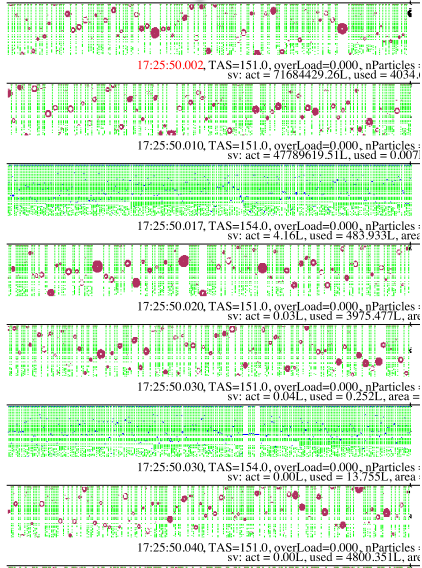
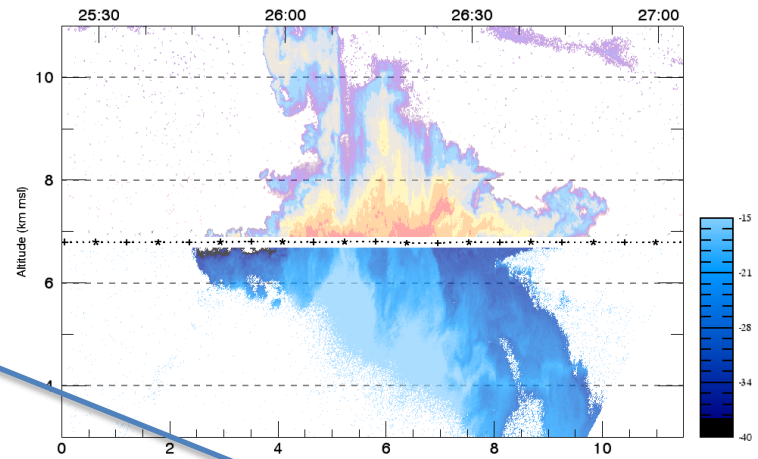
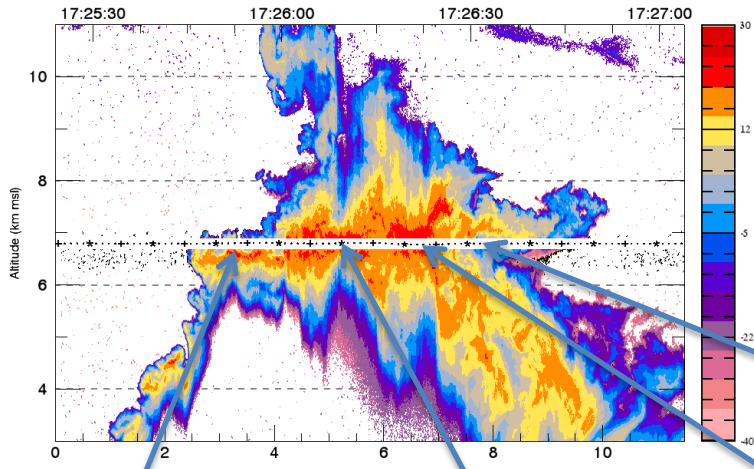
David Leon & Sonia Lasher-Trapp with contributions from many others



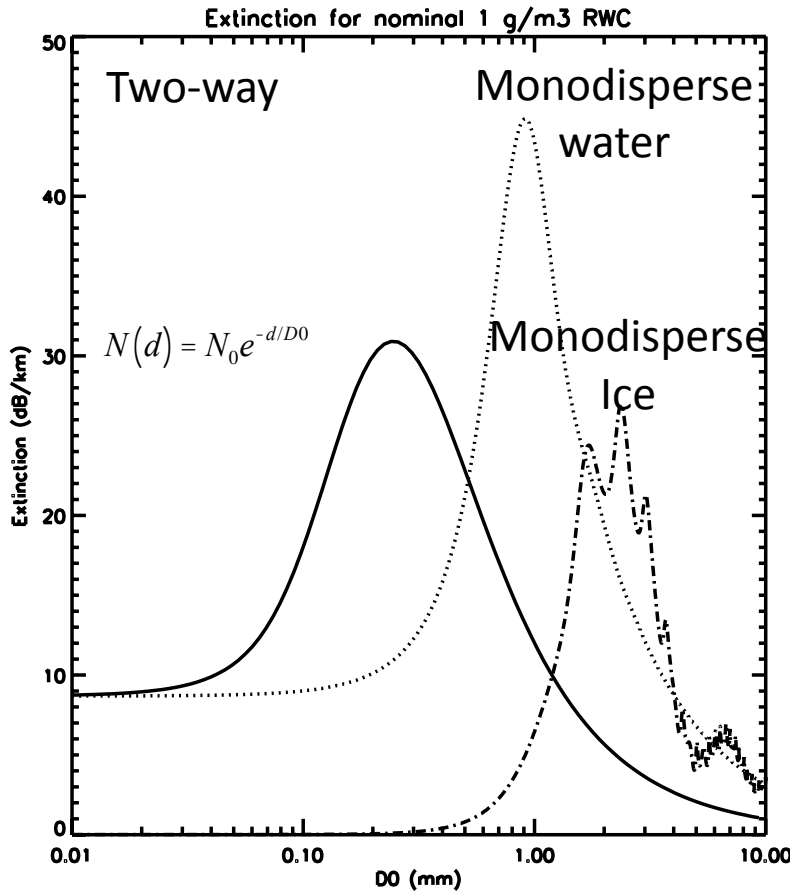




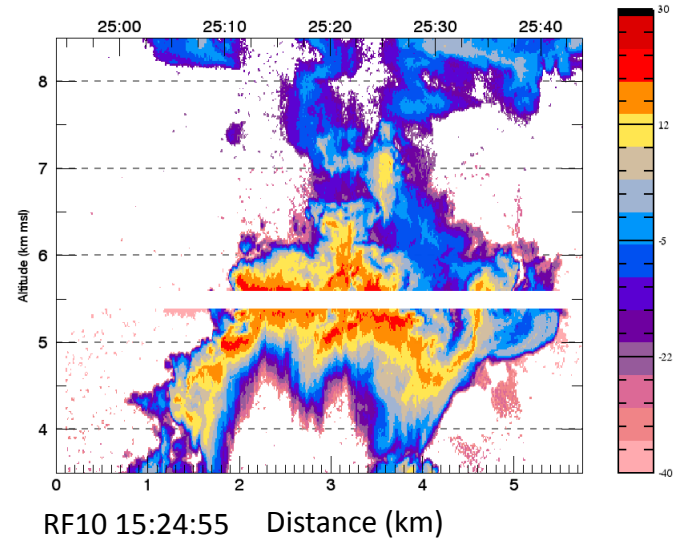
	Cloud Drops	Raindrops	Graupel
Reflectivity	Low (< -15 dBZ)	High	High
Attenuation/Extinction (two-way)	~9 dB km ⁻¹ per g kg ⁻¹	V. High (> 75 dB km ⁻¹ observed on occasion)	High* * scattering dominated
LDR	None	None* * Multiple scattering may lead to apparent LDR increasing w range	-18 - -22 dB



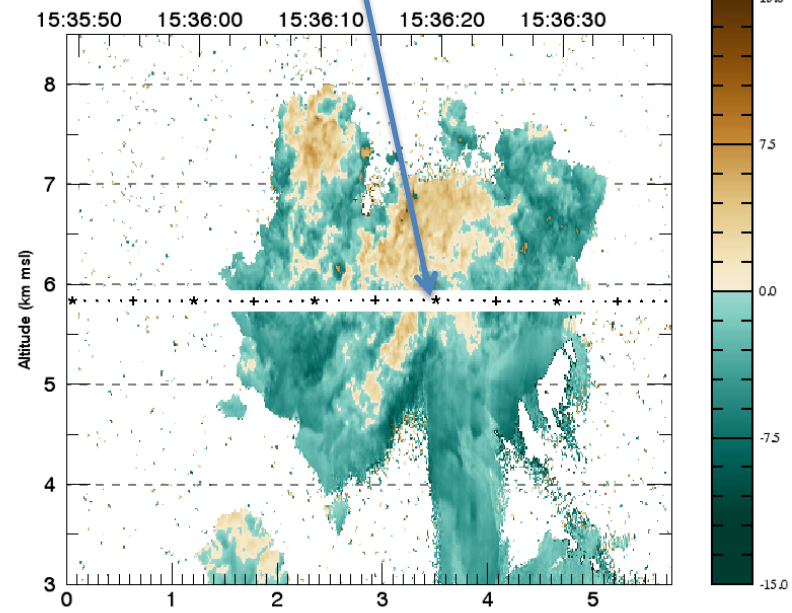
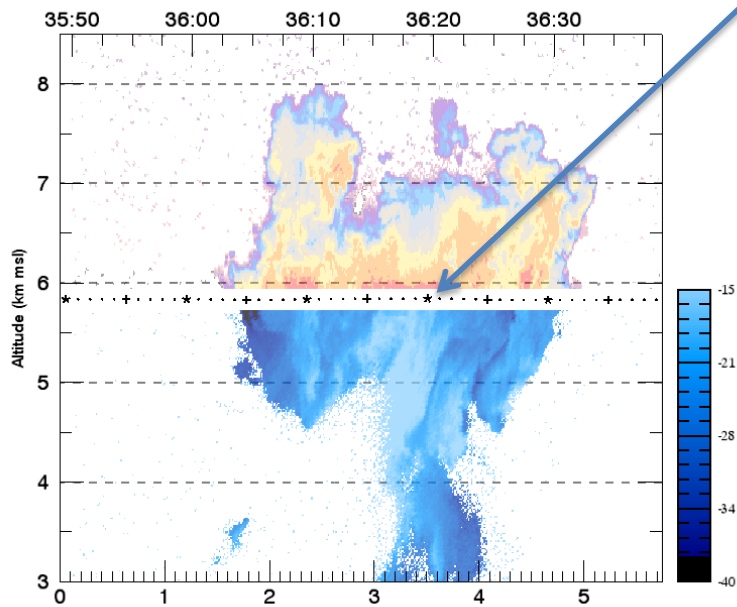
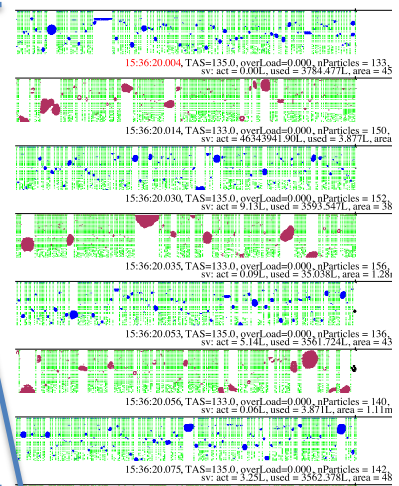
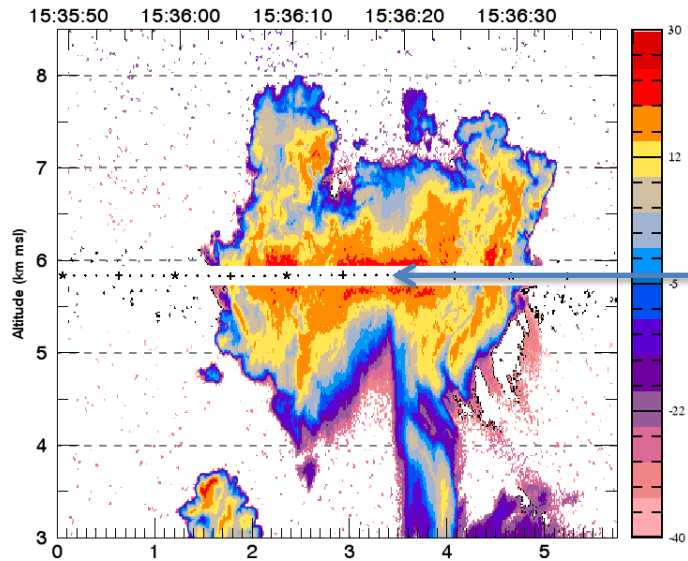
Using Attenuation to Constrain RWC/LWC



When attenuation is large (often),
can be estimated from gradient in reflectivity



Value for 0.9 mm drops provides **minimum** RWC to produce observed attenuation
 Value for negative exponential distribution provides more likely estimate of RWC
 Significant extinction from ice requires larger particles and is dominated by scattering



LDR of graupel-rain mix

$$LDR_{obs} = \frac{LDR_g Z_g + LDR_{other} Z_{other}}{Z_g + Z_{other}}$$

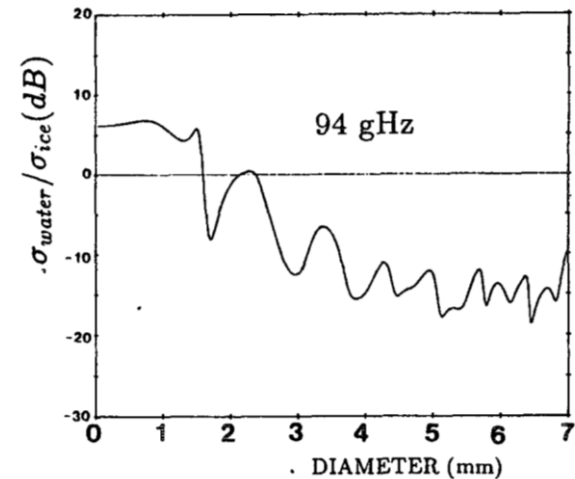
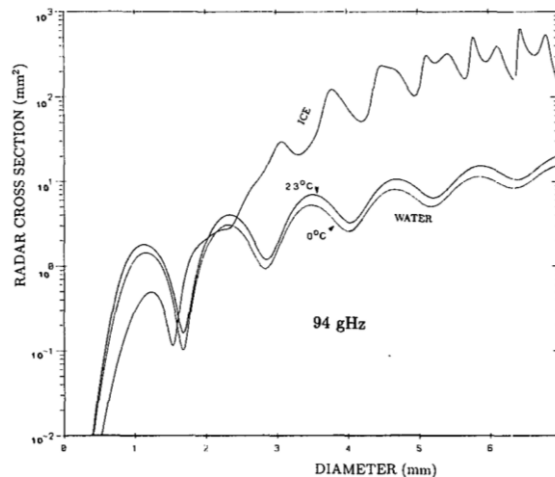
LDR_g -18 dB -- -22 dB based on observed values in regions dominated by graupel

Cross-channel isolation of antenna is -35 dB,

Following correction, values as low as -38, perhaps even -40 can be detected*

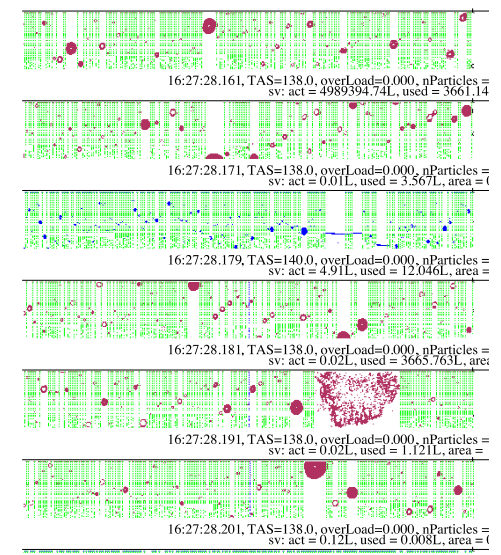
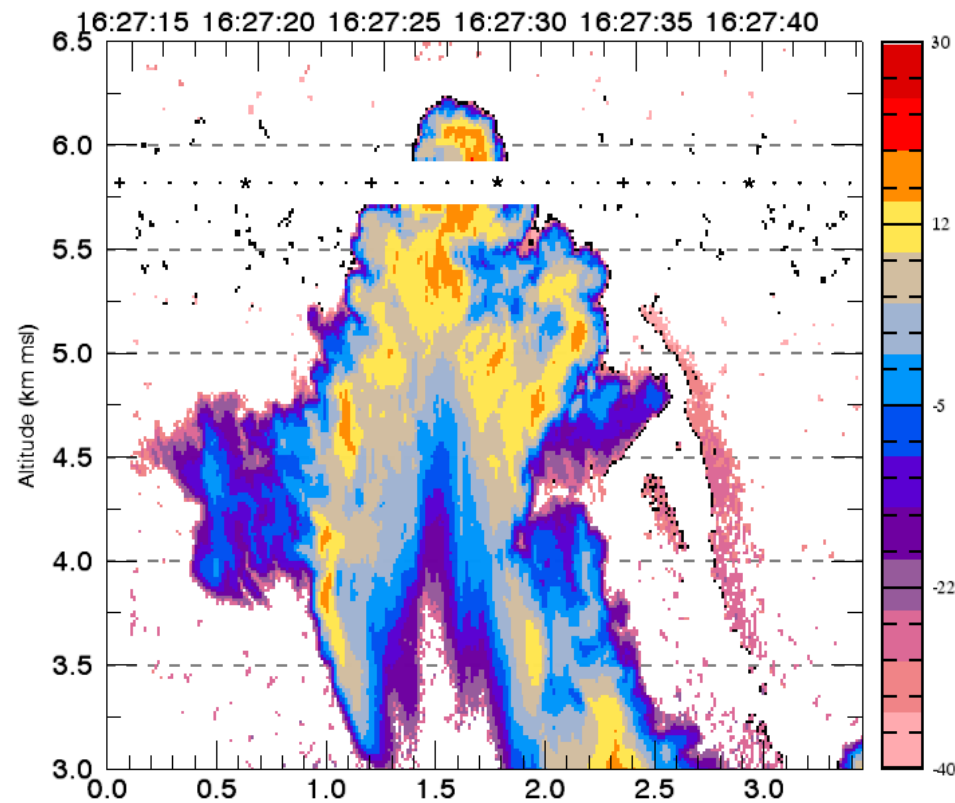
*where there is sufficient signal

So, Z_g can be 16 – 20 dB (or more) below Z_{other} and still produce detectible LDR



From Lhermitte 1990

Fraction that must be frozen to produce this depends on size of frozen particles.
 For particles < ~2.5 mm dia scattering from ice is ~6 dB less than from water
 so as much as 10% of distribution may need to be graupel



Date Time Z (dBZ) LDR (dB) LDRMin (dB) Cross-Co Vel Diff (m/s)

20110730	16:27:27.04	16.87	-47.60	-70.27	0.11	-51.23	-69.34	0.18
20110730	16:27:27.15	15.65	-100.00	-68.98	0.07	-100.00	-68.51	0.12
20110730	16:27:27.26	15.30	-47.78	-68.57	0.21	-100.00	-65.94	0.13
20110730	16:27:27.37	17.06	-42.46	-70.29	0.16	-46.16	-66.68	0.22
20110730	16:27:27.47	18.17	-41.99	-71.40	0.12	-42.68	-69.33	0.12
20110730	16:27:27.57	19.25	-39.39	-72.44	-0.09	-39.76	-70.48	-0.18
20110730	16:27:27.67	19.32	-38.39	-72.51	0.06	-38.29	-71.65	0.15
20110730	16:27:27.79	16.42	-45.33	-69.61	0.19	-46.35	-69.48	0.15
20110730	16:27:27.89	16.30	-44.28	-69.49	-0.01	-47.61	-67.45	0.18
20110730	16:27:28.00	18.03	-38.06	-71.18	0.16	-39.74	-67.52	0.33
20110730	16:27:28.10	19.74	-34.50	-72.84	0.17	-37.28	-70.47	0.01
20110730	16:27:28.20	20.05	-33.92	-73.12	0.18	-35.78	-72.14	0.20
20110730	16:27:28.31	19.91	-36.35	-72.97	0.09	-36.75	-72.04	0.10
20110730	16:27:28.42	19.11	-38.57	-72.16	0.03	-38.91	-71.44	0.15
20110730	16:27:28.52	18.02	-43.08	-71.07	0.30	-48.76	-70.22	0.23
20110730	16:27:28.63	17.13	-45.59	-70.16	0.16	-100.00	-69.17	0.10
20110730	16:27:28.74	15.27	-100.00	-68.34	0.02	-49.62	-65.05	0.09
20110730	16:27:28.85	7.55	-100.00	-60.61	-0.25	-100.00	-61.63	-0.11
20110730	16:27:28.96	5.61	-48.63	-58.68	0.29	-100.00	-62.21	-0.02

