Cloud and Precipitation during SEAC4RS: The APR-2 Perspective, Surprises, and Confirmations

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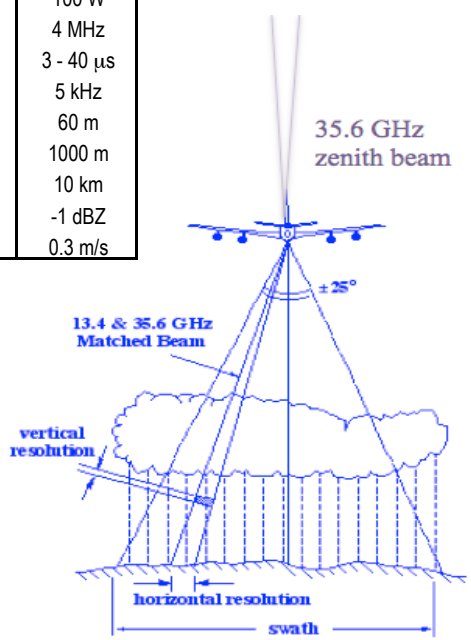
The Airborne Precipitation Radar 2nd Generation (APR-2) in the SEAC4RS Field Campaign 2013

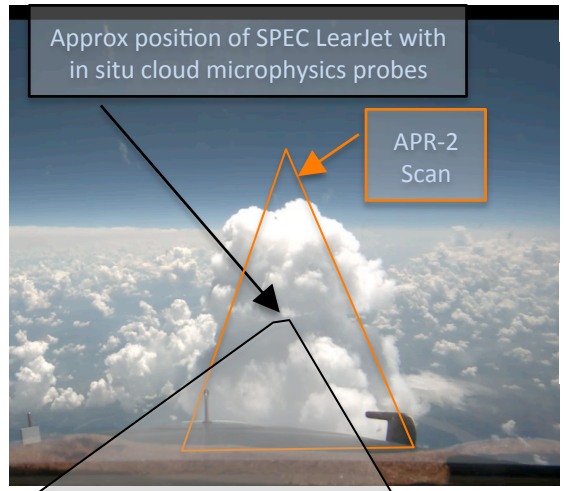
- **APR-2** was developed (ESTO IIP '99 E. Im, PI) to support the science of **GPM** and to demonstrate **advanced radar techniques to monitor precipitation from space**.

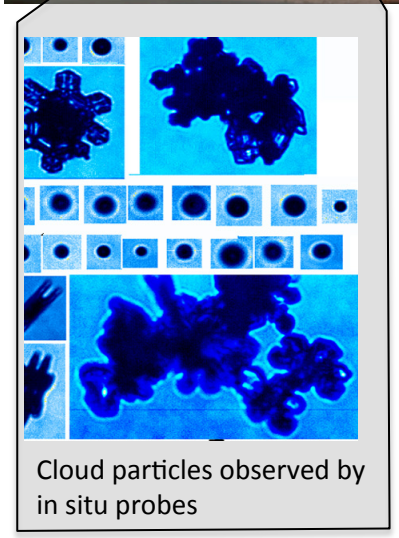
Table I: APR-2 parameters (GRIP 2010)

Parameters	Ku-band	Ka-band
Frequency (GHz	13.4	35.6
Polarization	HH, HV	HH, HV
Antenna eff. diameter	0.4 m	0.14 m
Antenna gain	34 dBi	34 dBi
Antenna sidelobe	-30 dB	-30 dB
Antenna scan angle	±25°	±25°
Polarization isolation	-25 dB	-25 dB
Peak power	200 W	100 W
Bandwidth	4 MHz	4 MHz
Pulsewidth	3 - 40 μs	3 - 40 μs
PRF (pulse rep. freq.)	5 kHz	5 kHz
Vertical resolution	60 m	60 m
Hor.res.(@10 km alt.)	800 m	1000 m
Ground Swath	10 km	10 km
Sens.(@10km range)	10 dBZ	-1 dBZ
Doppler precision	0.3 m/s	0.3 m/s

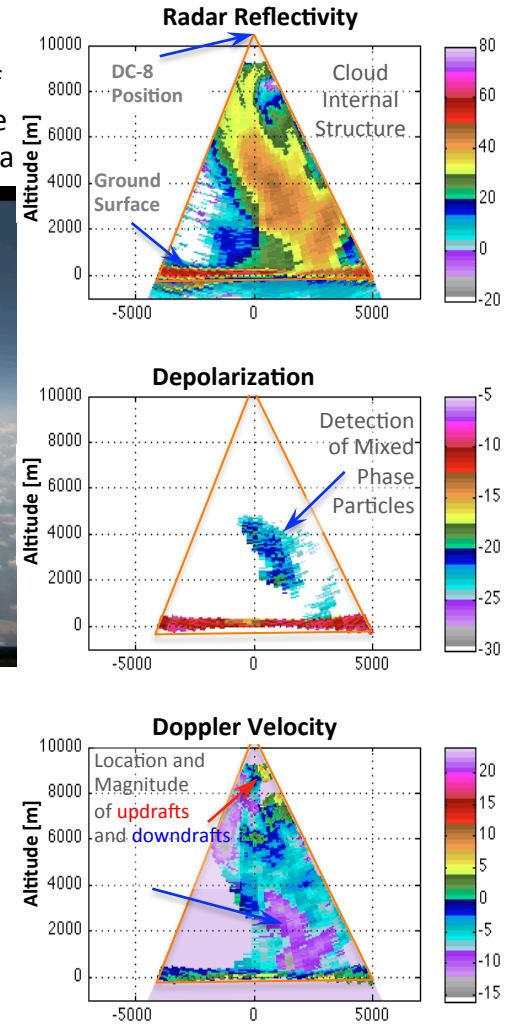


NASA DC-8 forward camera view of convective tower a few seconds before was overflown in Aug 2013 over Alabama



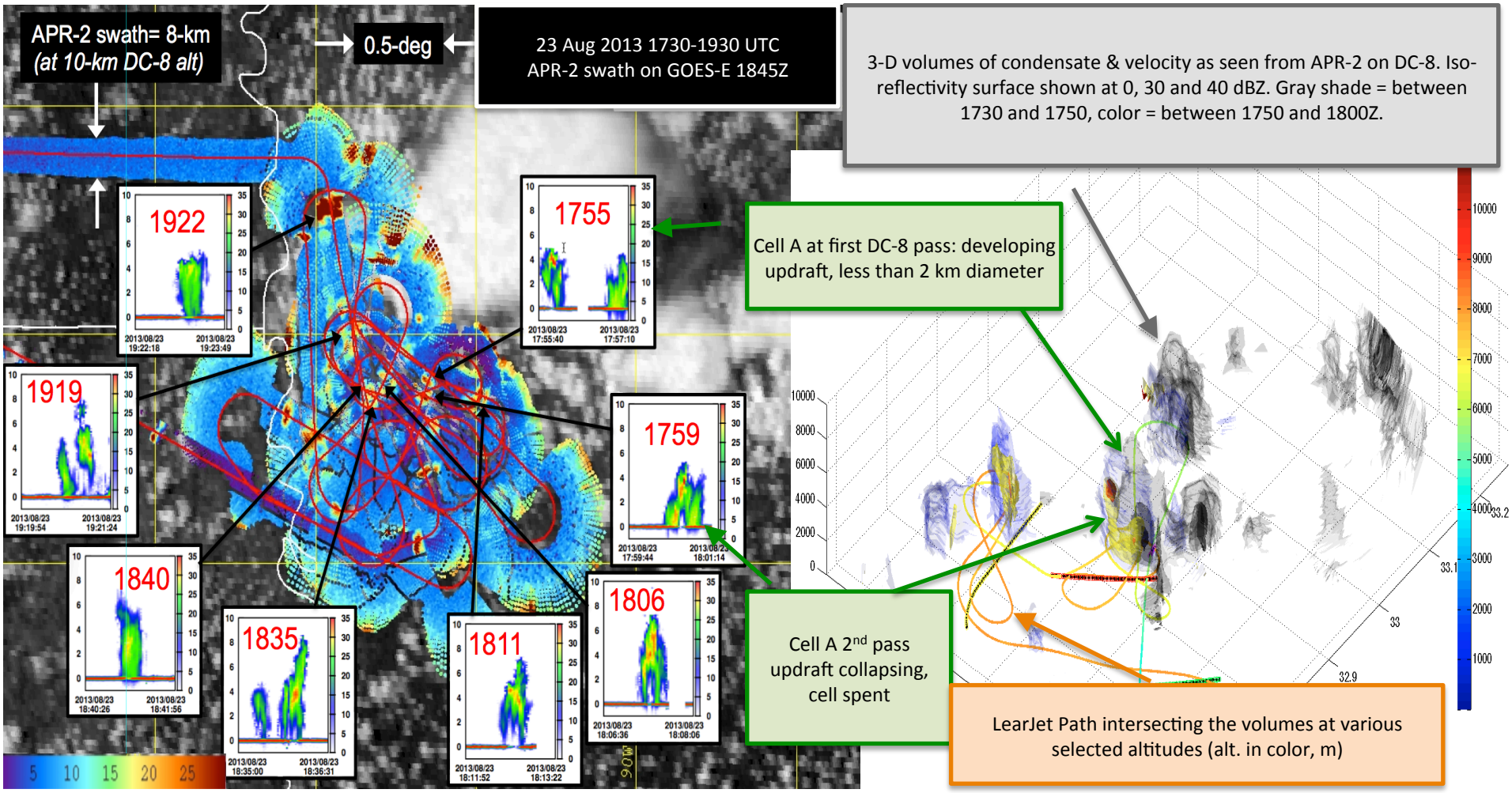


SPEC Image Courtesy of P. Lawson and R. Bruntjes

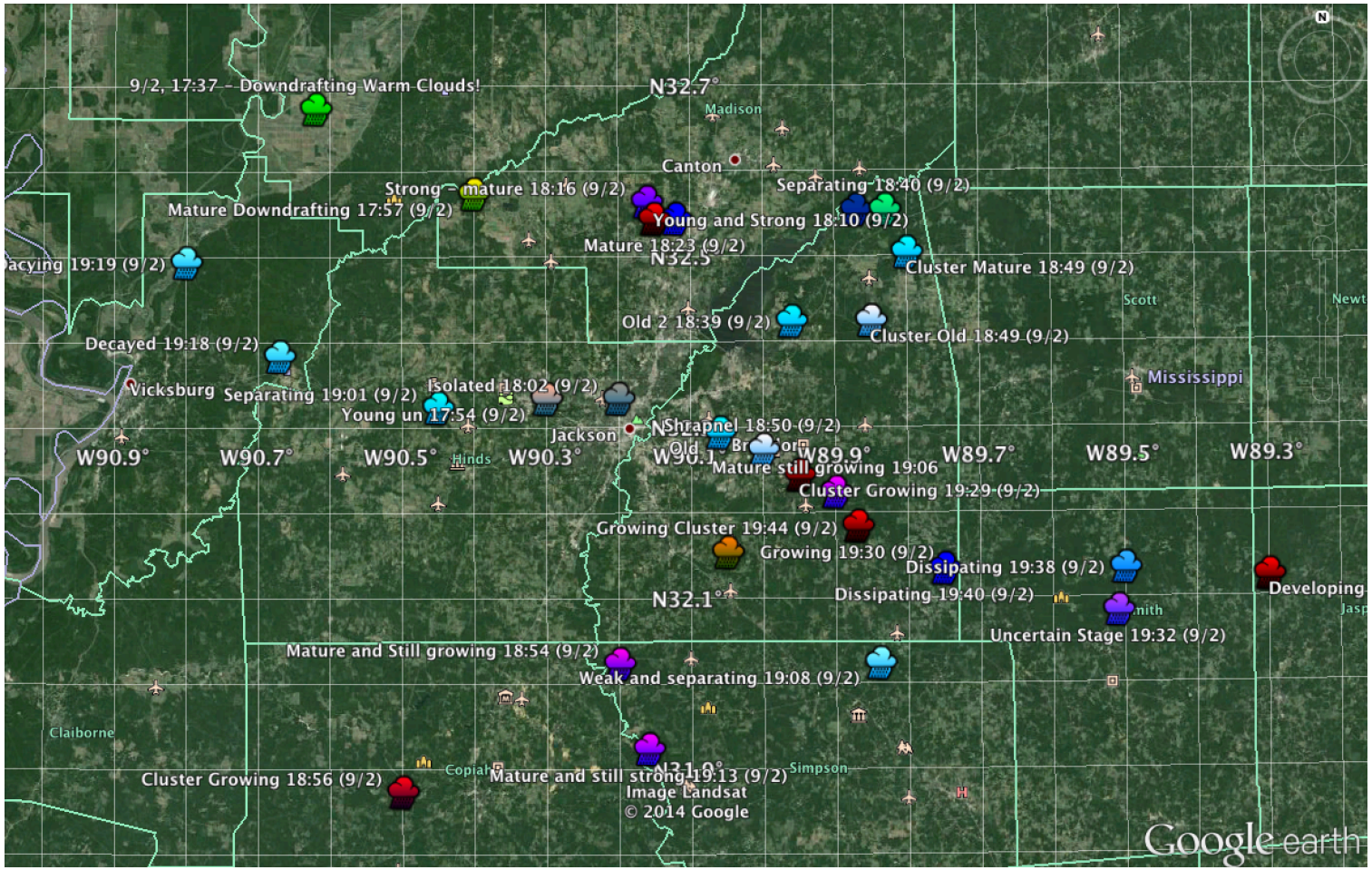


APR-2. Radar reflectivity, signal depolarization and Doppler velocity provide a high resolution view of the thundercloud where the in situ samples were collected.

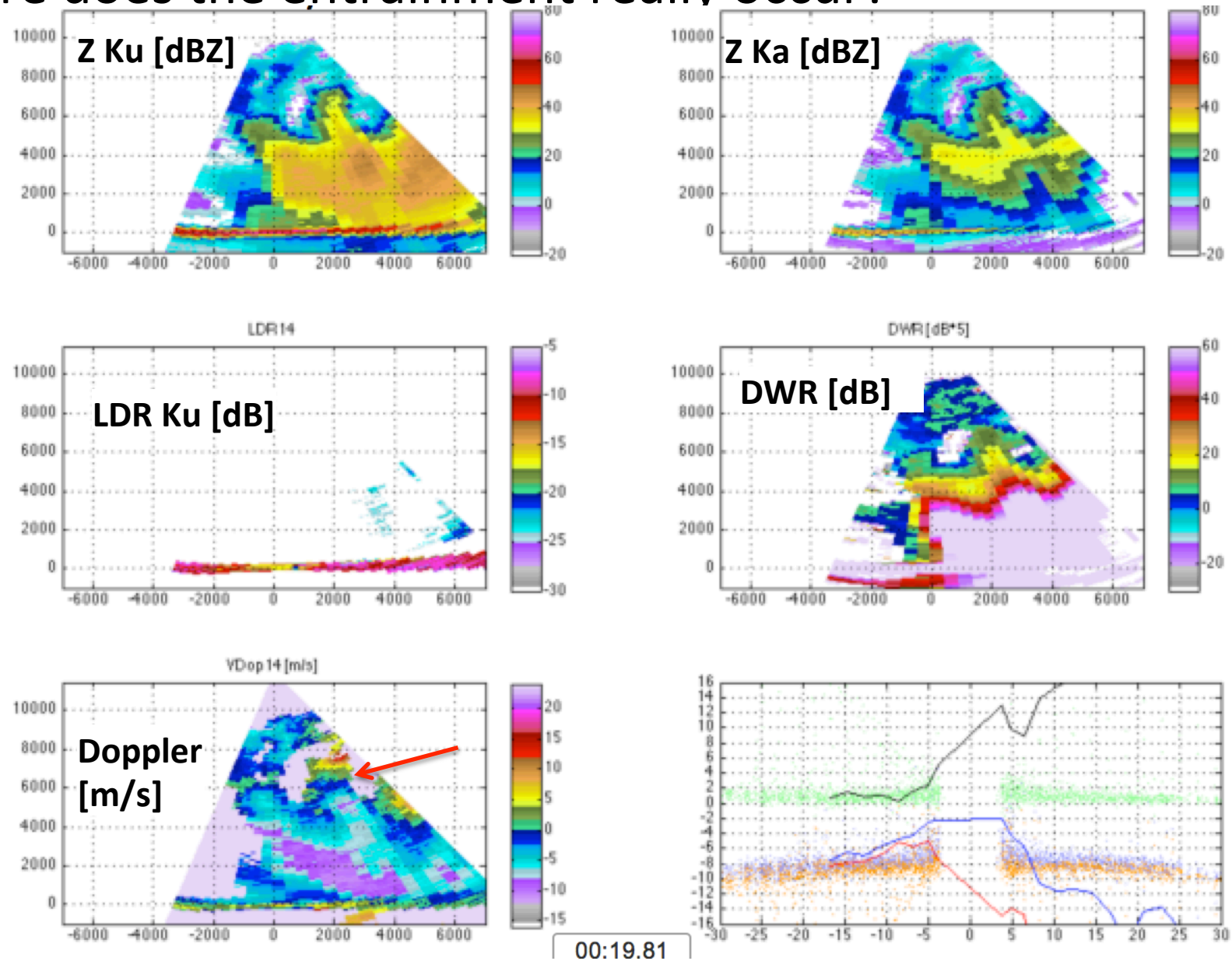
Single cell approach:
aka: why spaghetti is good for you



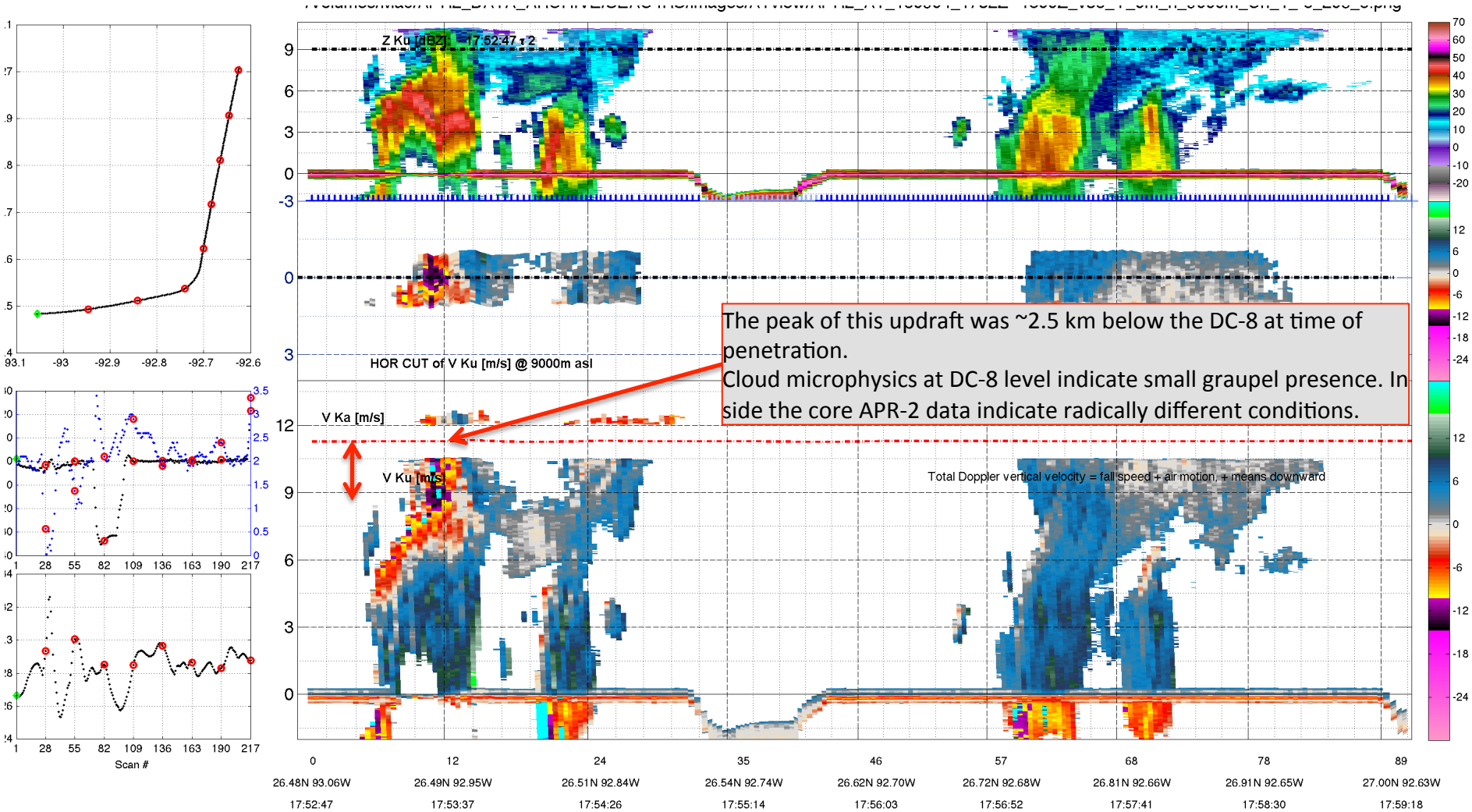
Ergodic approach
aka strength in numbers
Sept 2: hit 30 cells in 2 hrs



Detailed 3-D high resolution view of the dynamics: where does the entrainment really occur?

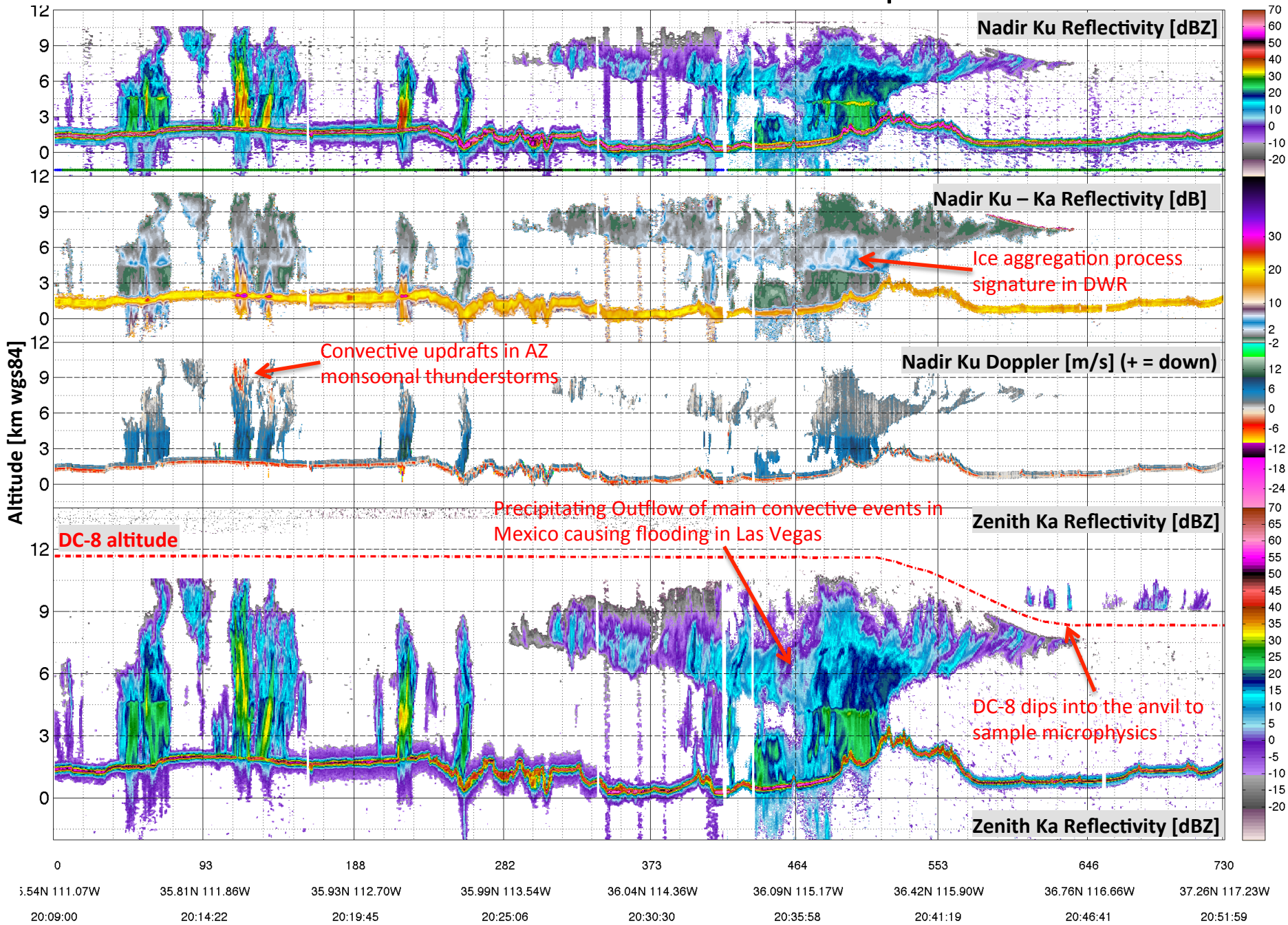


Positioning of the DC-8 data wrt the active portions of convection



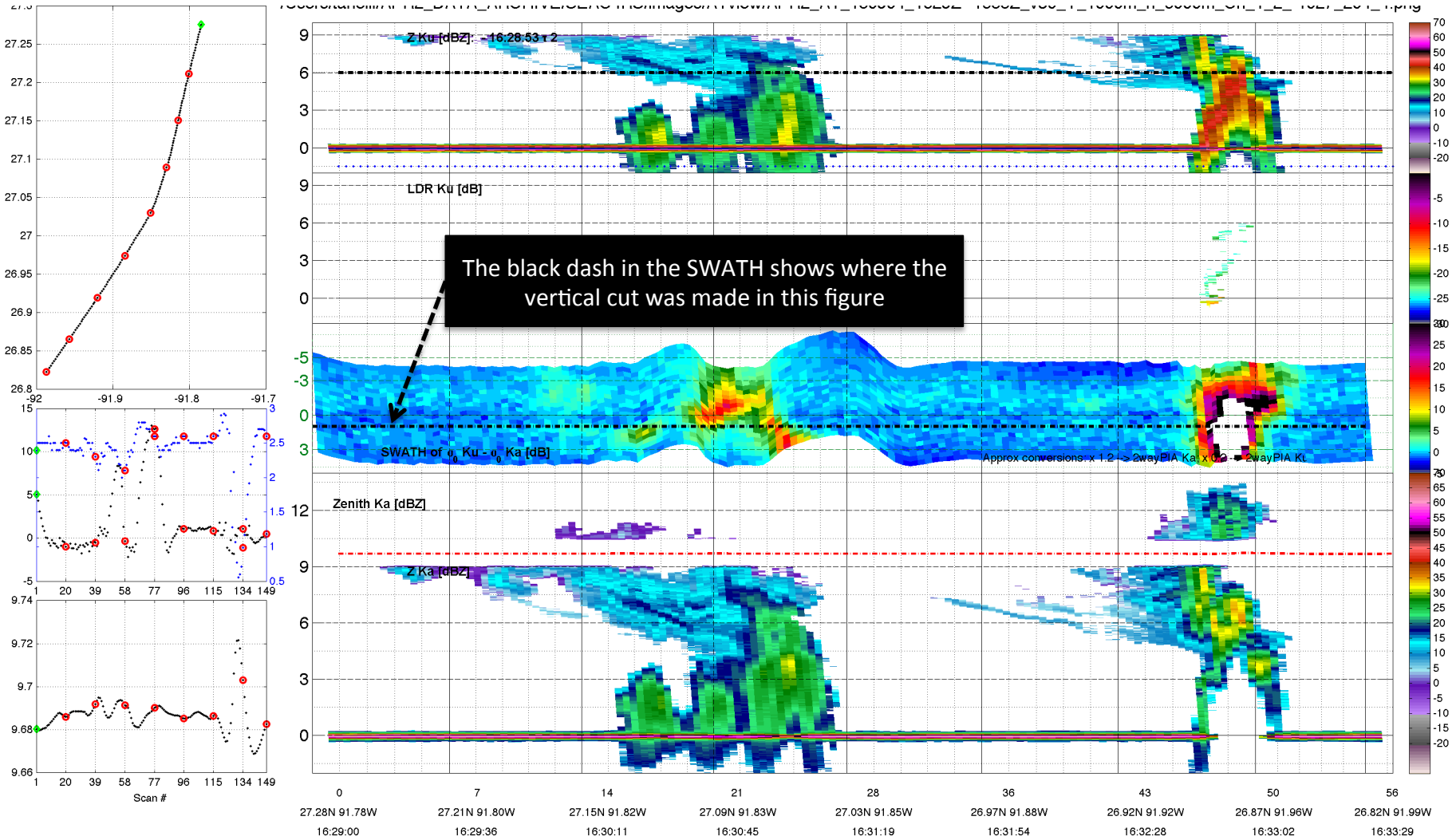
The peak of this updraft was ~2.5 km below the DC-8 at time of penetration.
Cloud microphysics at DC-8 level indicate small graupel presence. Inside the core APR-2 data indicate radically different conditions.

Cloud environment awareness & in situ probes.



How to interpret the Browse Images (1/3)

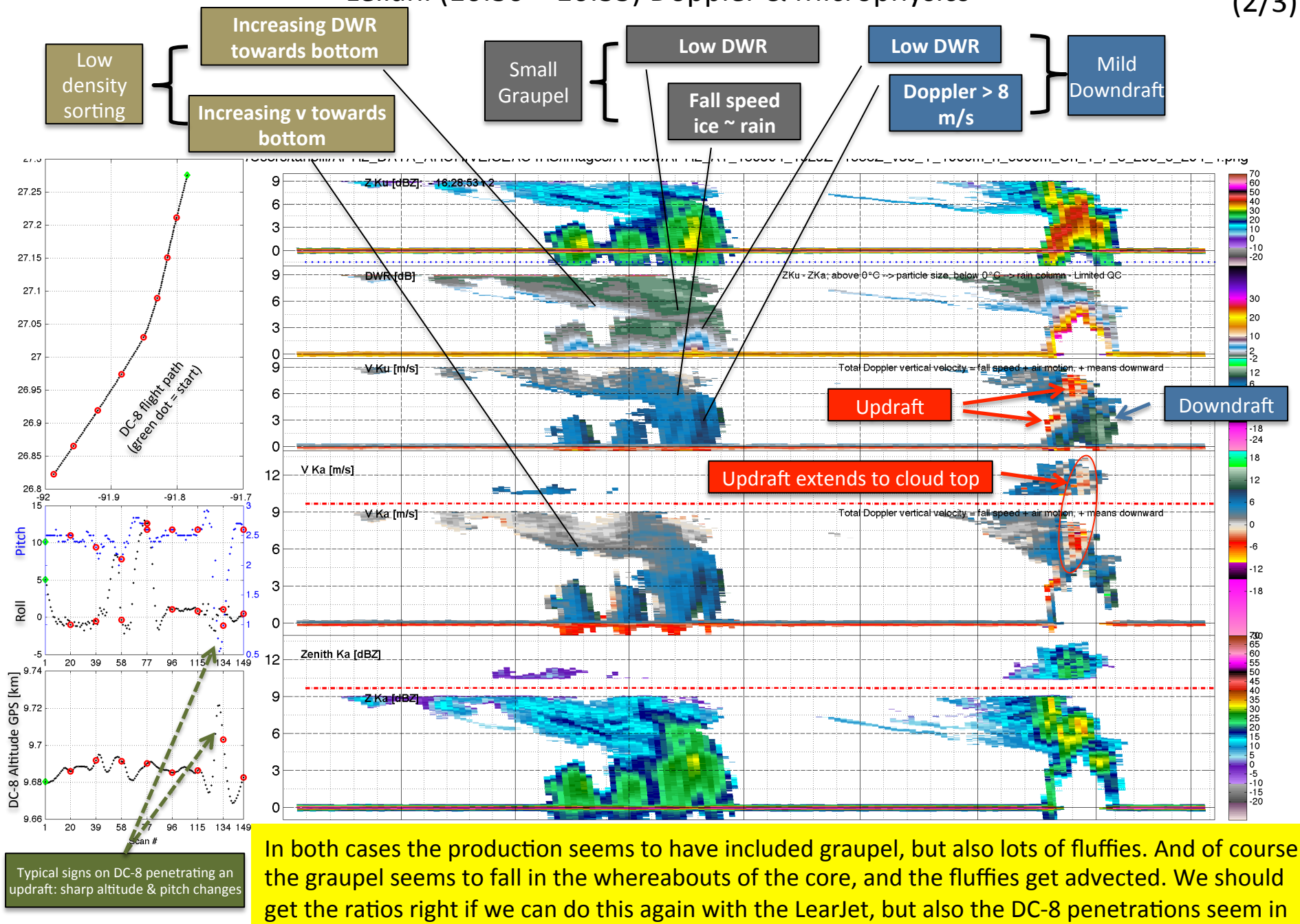
Leilani (16:30 – 16:33) Vertical Cut moved 1 km to the right (~West in this case)



By moving just 1 km to the right we now see the three cells within the old cluster, and we are more in the geometric middle of the active cell. Even less mixed phase here.

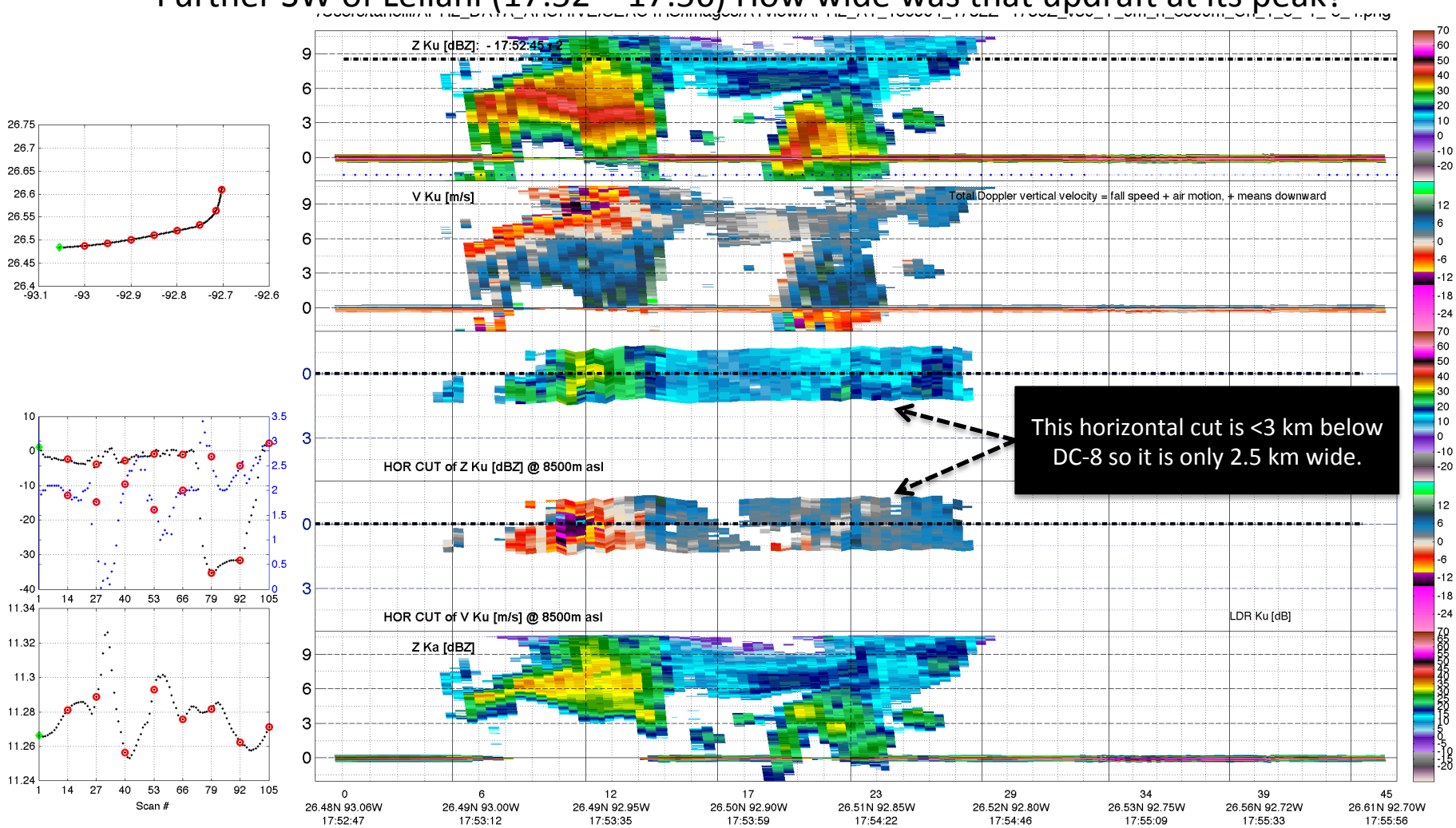
Leilani (16:30 – 16:33) Doppler & Microphysics

(2/3)



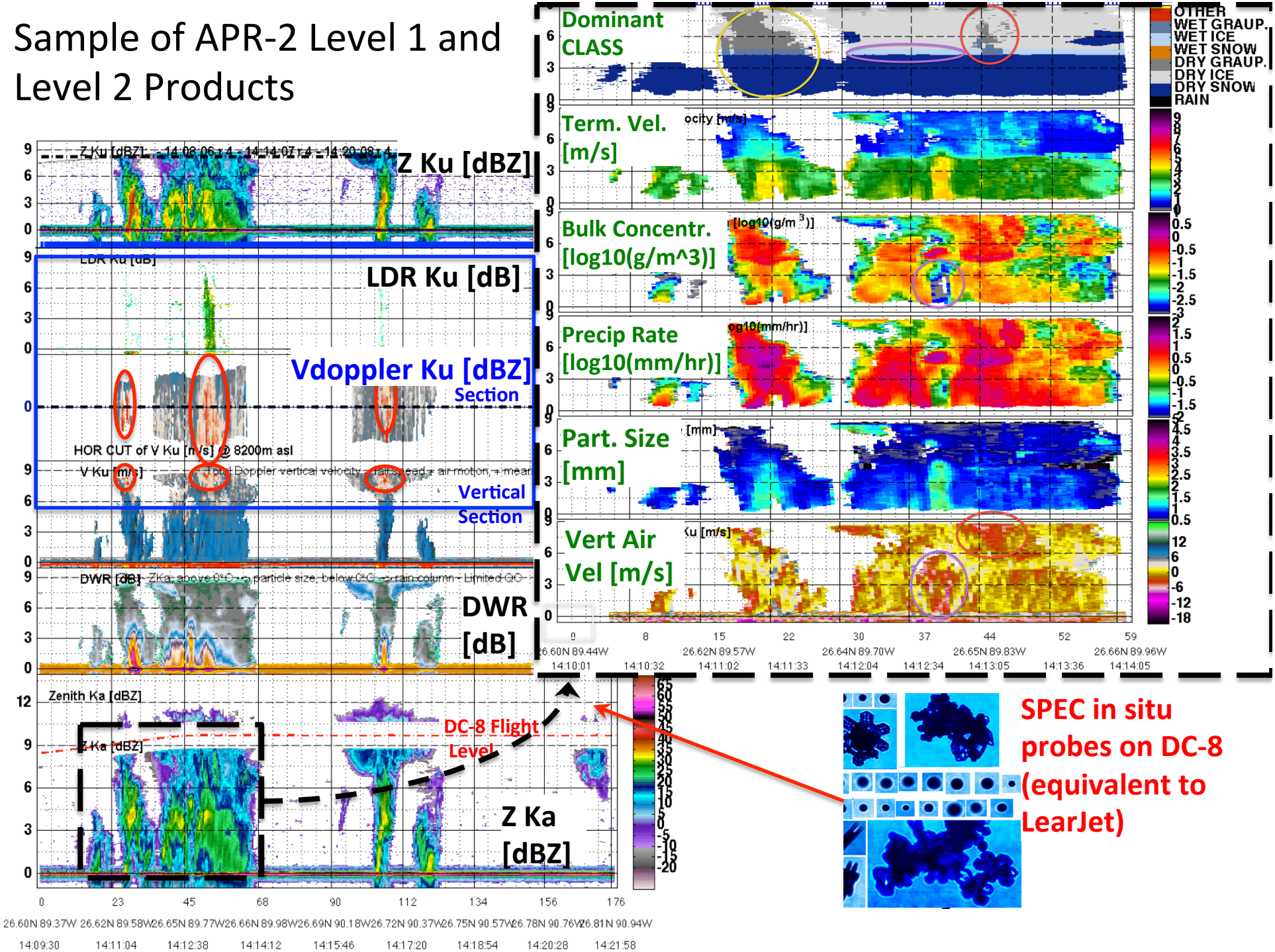
In both cases the production seems to have included graupel, but also lots of fluffies. And of course the graupel seems to fall in the whereabouts of the core, and the fluffies get advected. We should get the ratios right if we can do this again with the LearJet, but also the DC-8 penetrations seem in the right place.

Further SW of Leilani (17:52 – 17:56) How wide was that updraft at its peak?

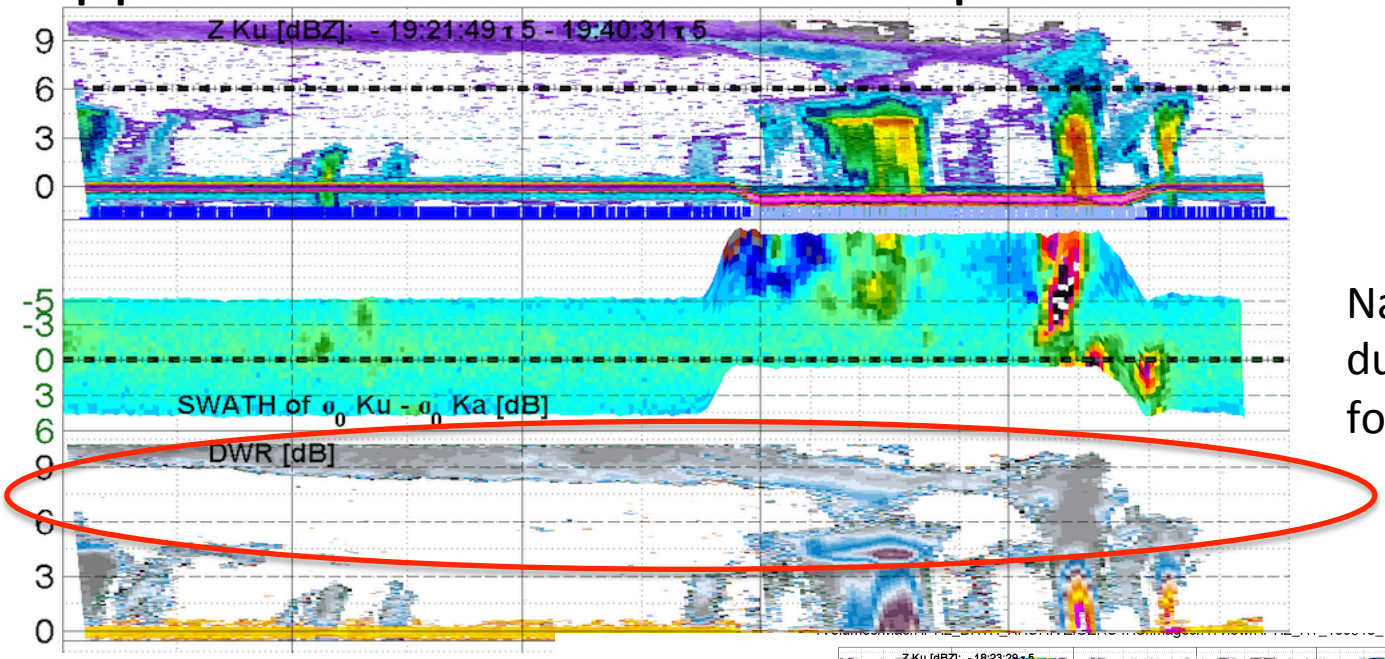


To answer question in title, select horizontal cut at 8500 m (shown by the black dash in the first panel), the horizontal sections are marked by blue y-axis in the panels, the legend says also at what height. In this case we were 1) high enough and 2) very lucky: the updraft is that red-black bull's eye, abut circular, approx 2 km dia core, in excess of 15 m/s at 8500 m, terminal velocities must have been small (see small DWR and low reflectivity). As often seen: next to peak dBZ, not on it.

Sample of APR-2 Level 1 and Level 2 Products

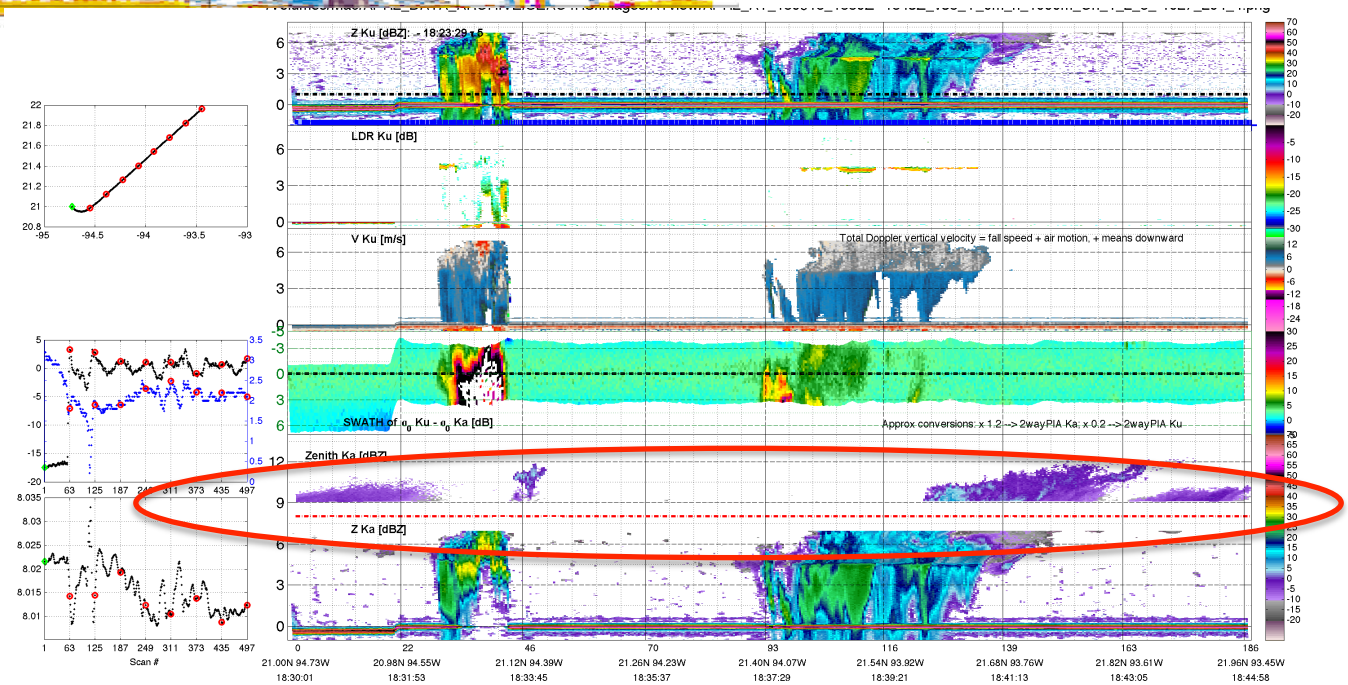


Support for Cirrus retrievals: Sept 13 case.

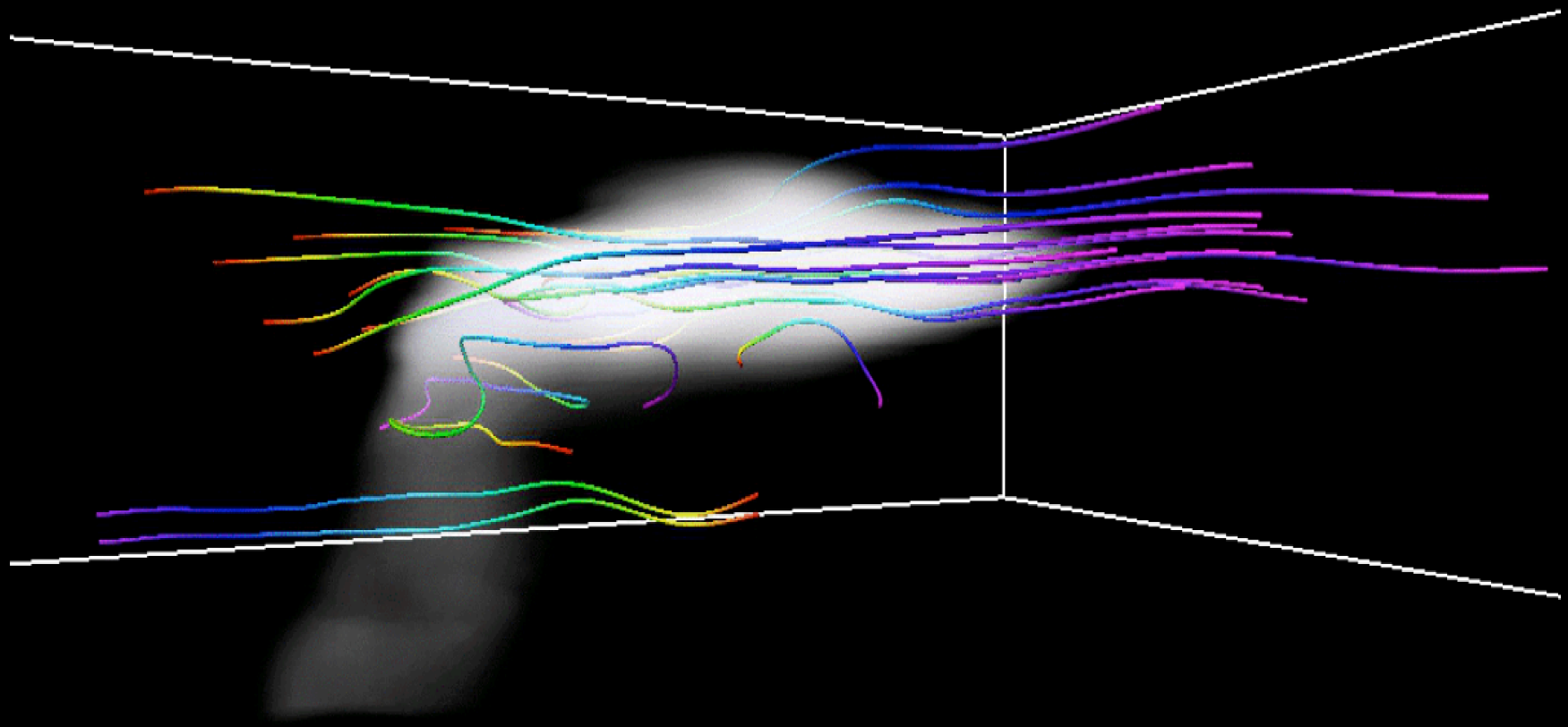


Nadir Observations are dual frequency: sizing for large particles.

Zenith observations are single frequency: good to constrain IWC once you have a radius retrieval

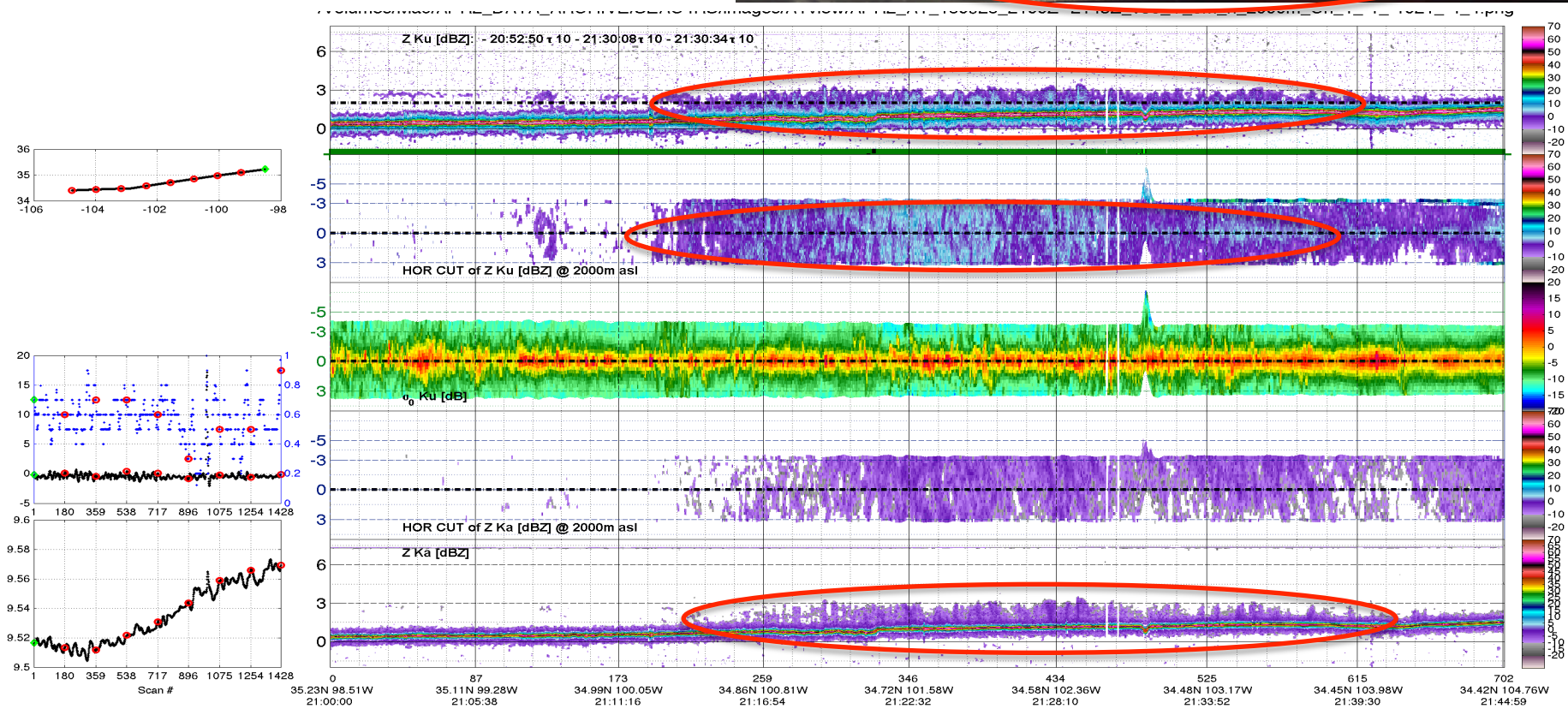


High space- and time- resolution models are used to understand the processes. They require statistically rich and global datasets to be validated and refined.

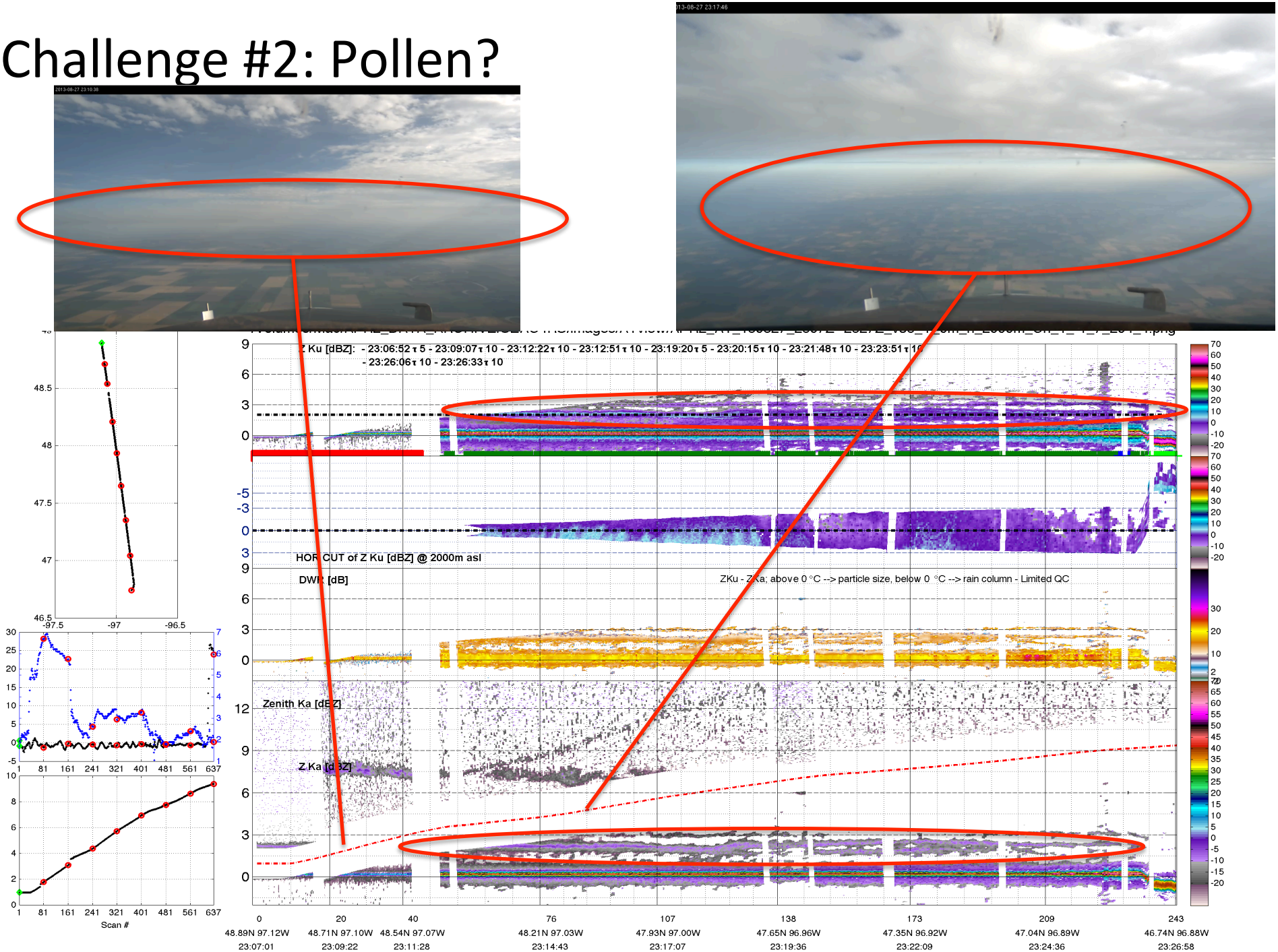


Total condensate and streamlines. Color indicates position on the flow where red is the start. View is from the SW. Courtesy: Sue van den Heever (CSU)

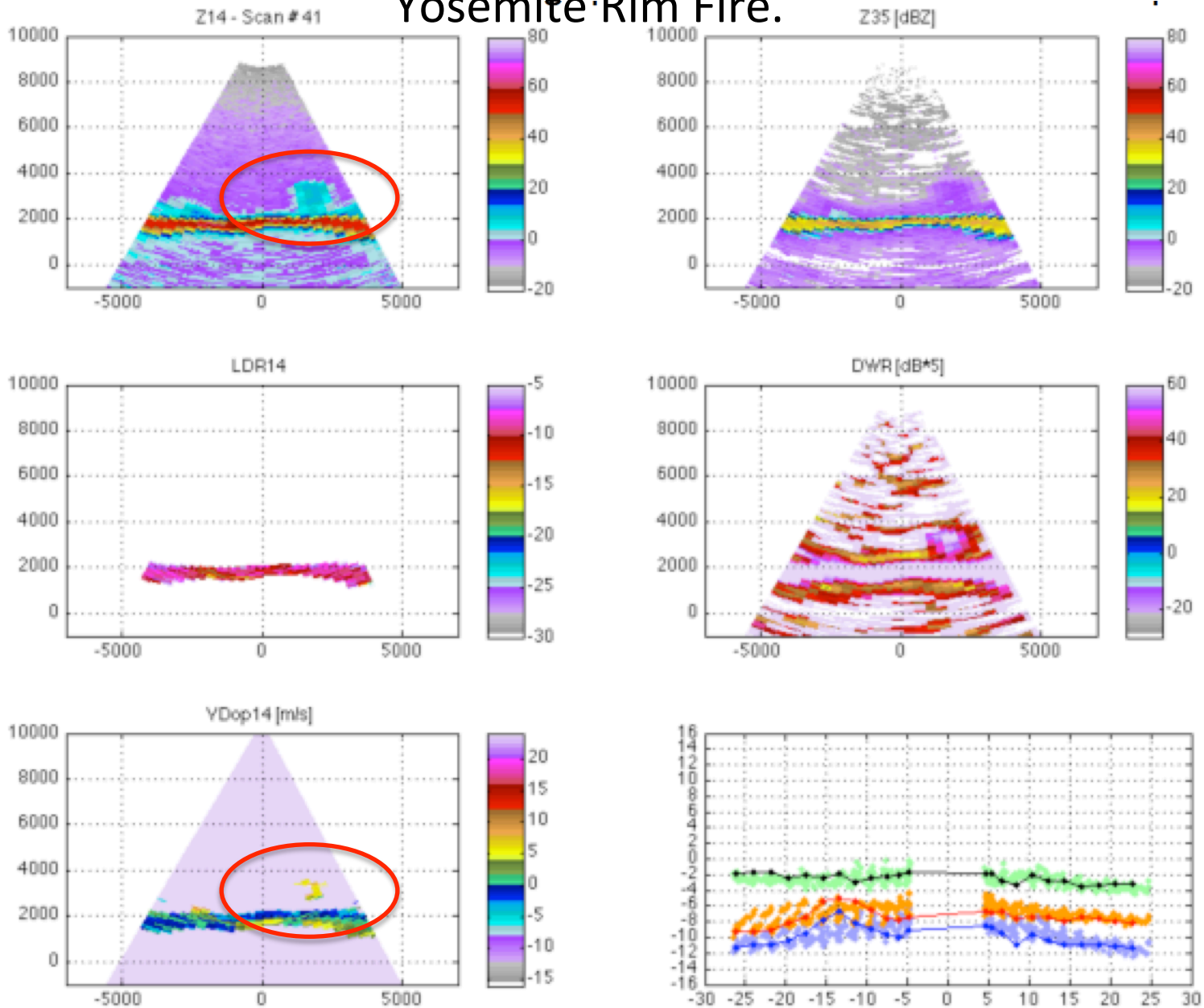
Challenge #1: Reconcile the DC-8 video and the APR-2 observations

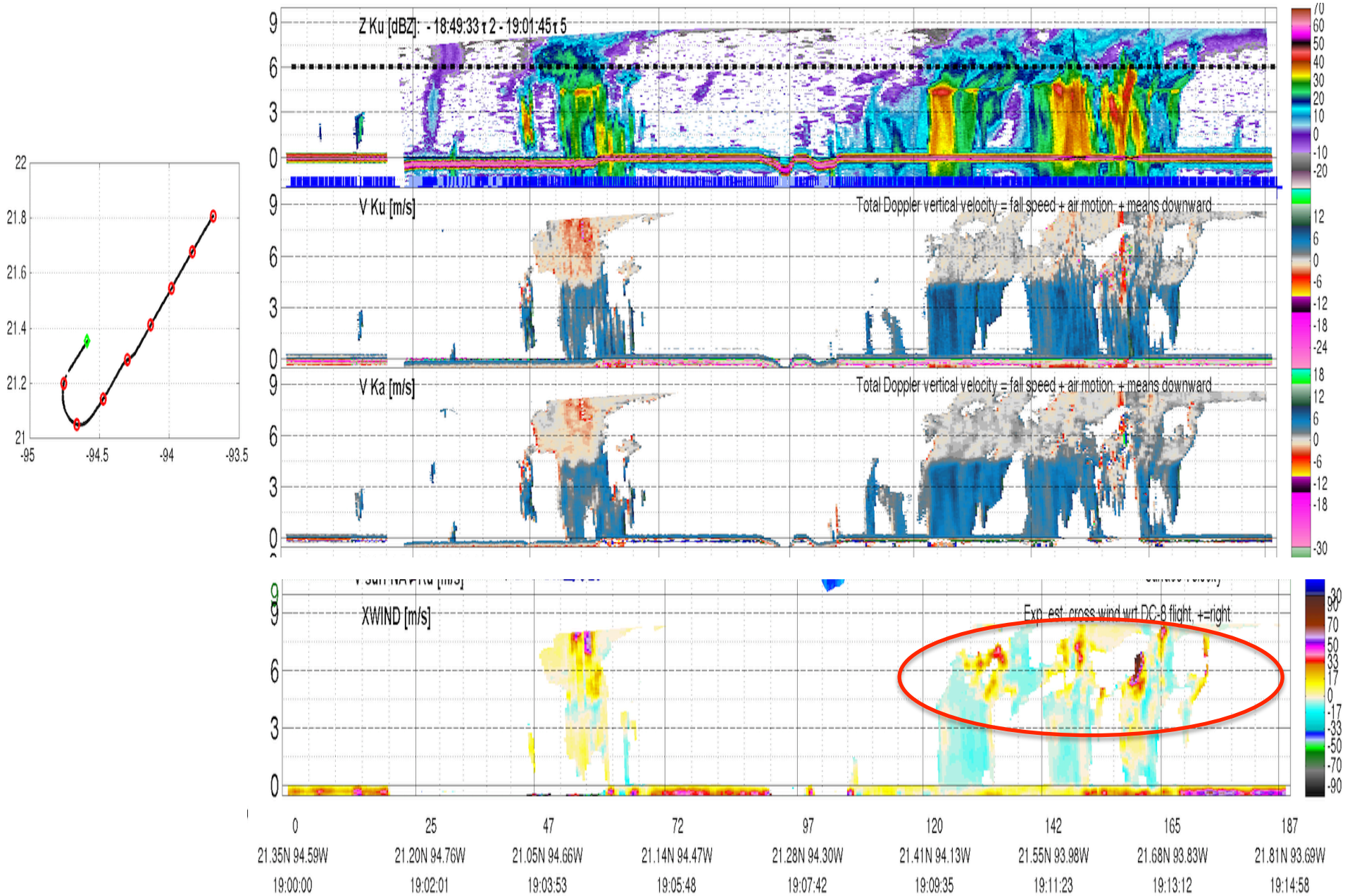


Challenge #2: Pollen?



First APR-2 detection of smoke upwelling velocity. Yosemite Rim Fire.



Scan #41L Large particles in Rim fire smoke moved up at 6 m/s

Mid level jets in Ingrid's outer bands?