



Some Initial Results from the HCR and HSRL during CSET

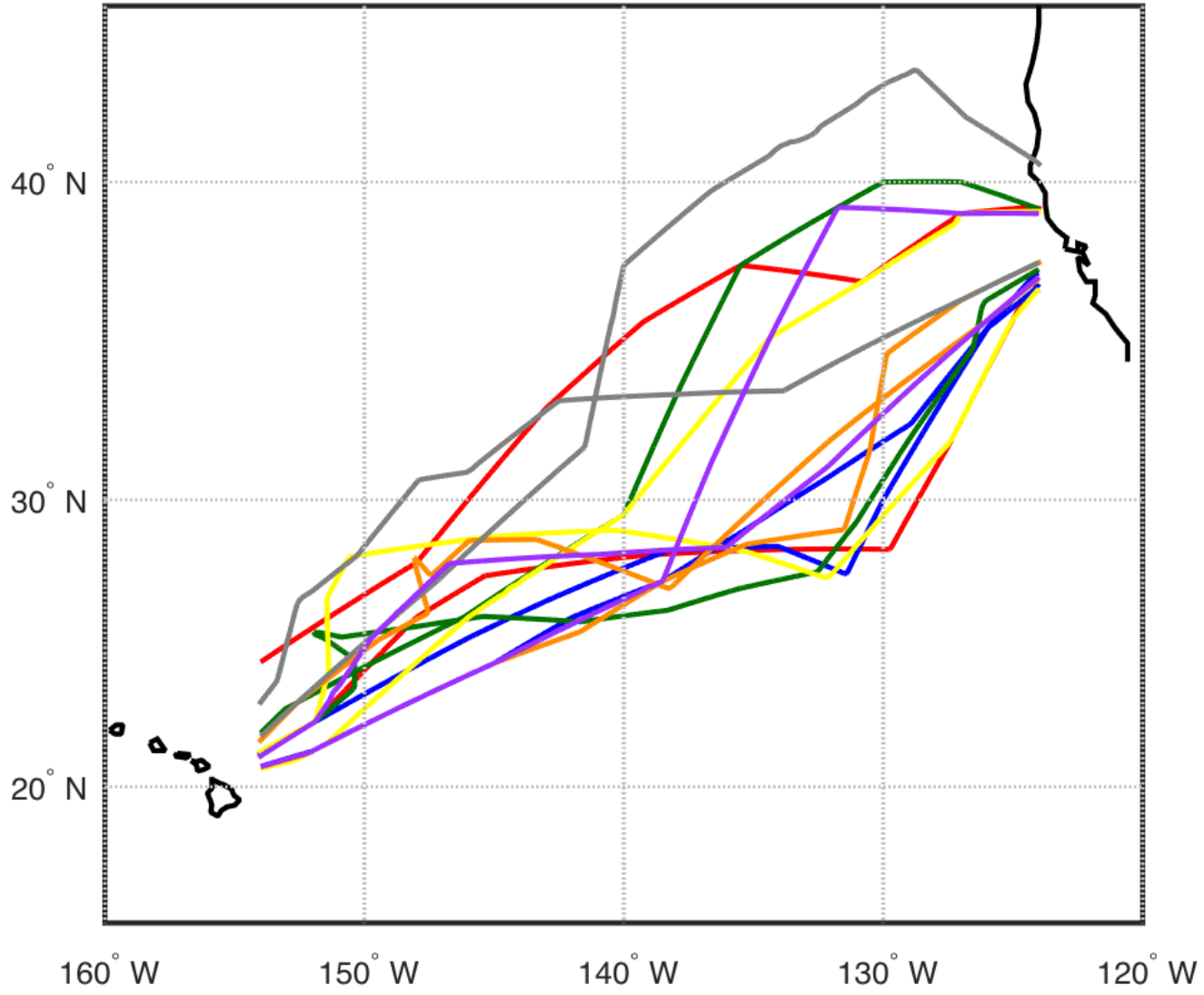
Christian Schwartz

Argonne National Lab/University of
Chicago



7 Round Trips (plus some other stuff)

CSET: July/August 2015
7 Color-Coded Round Trips Made by GV



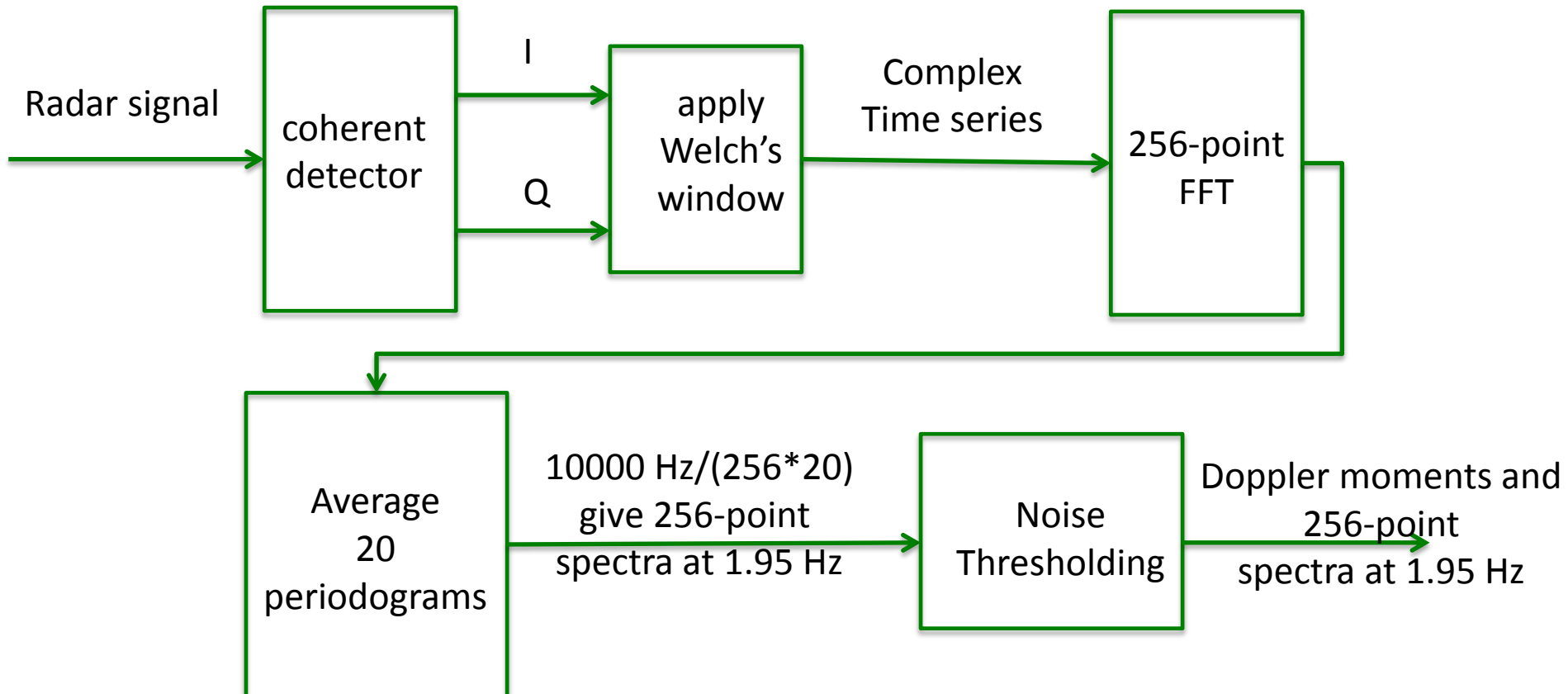
Work in the Following Areas

- Doppler spectral processing
 - Complete Doppler spectra
 - Spectral moments
 - Why?
- Hydrometeor masking
 - HCR and HSRL
 - Issues
- Thin cloud and drizzle retrievals

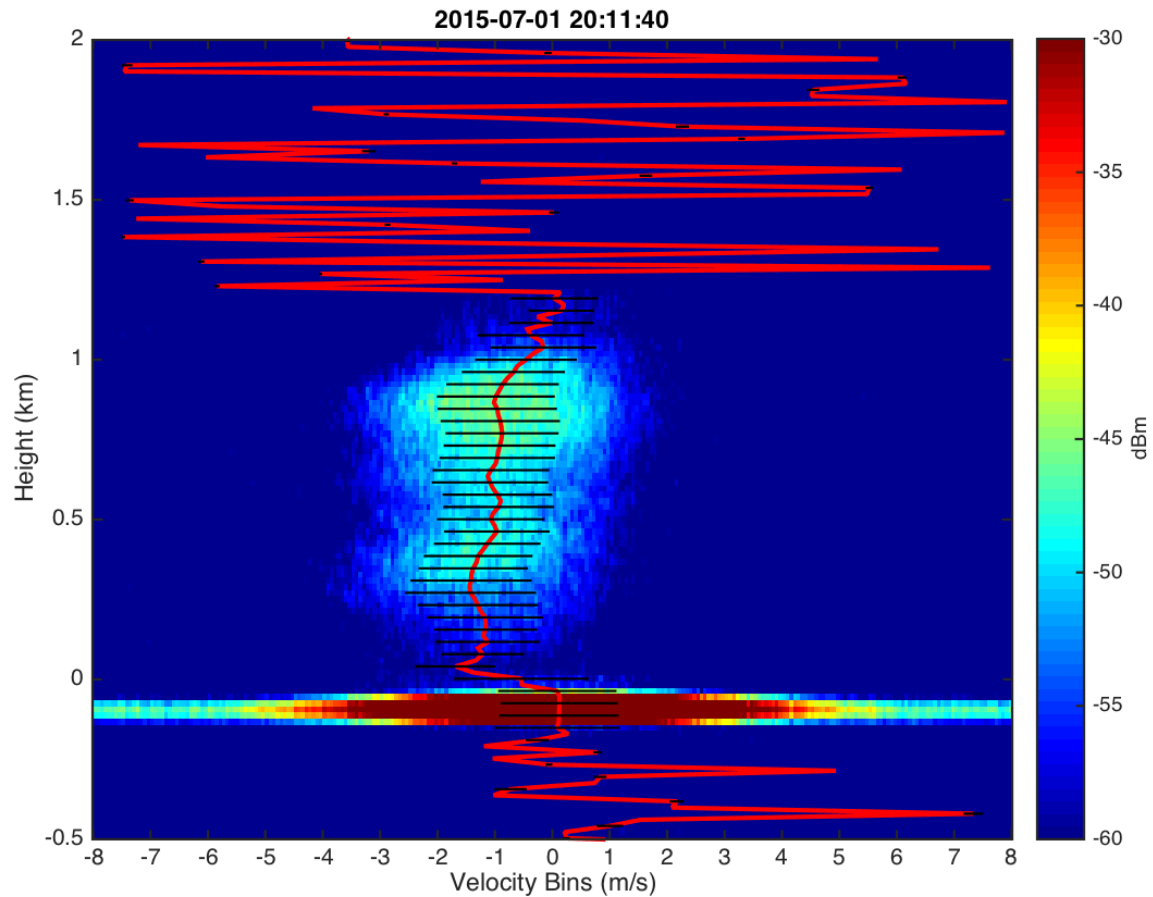
HCR

- Center Frequency = 94.4 GHz
- PRF = 10,000 Hz
- Range resolution = ~ 37 m
- Unambiguous velocity (Nyquist) = ± 7.75 m/s
- → Sample power at each range bin @ 10,000 Hz
- Amount of data
 - ~ 1.5 -2 TB per flight
 - Time series data unpacked, then spectral processing performed and individual spectra stored

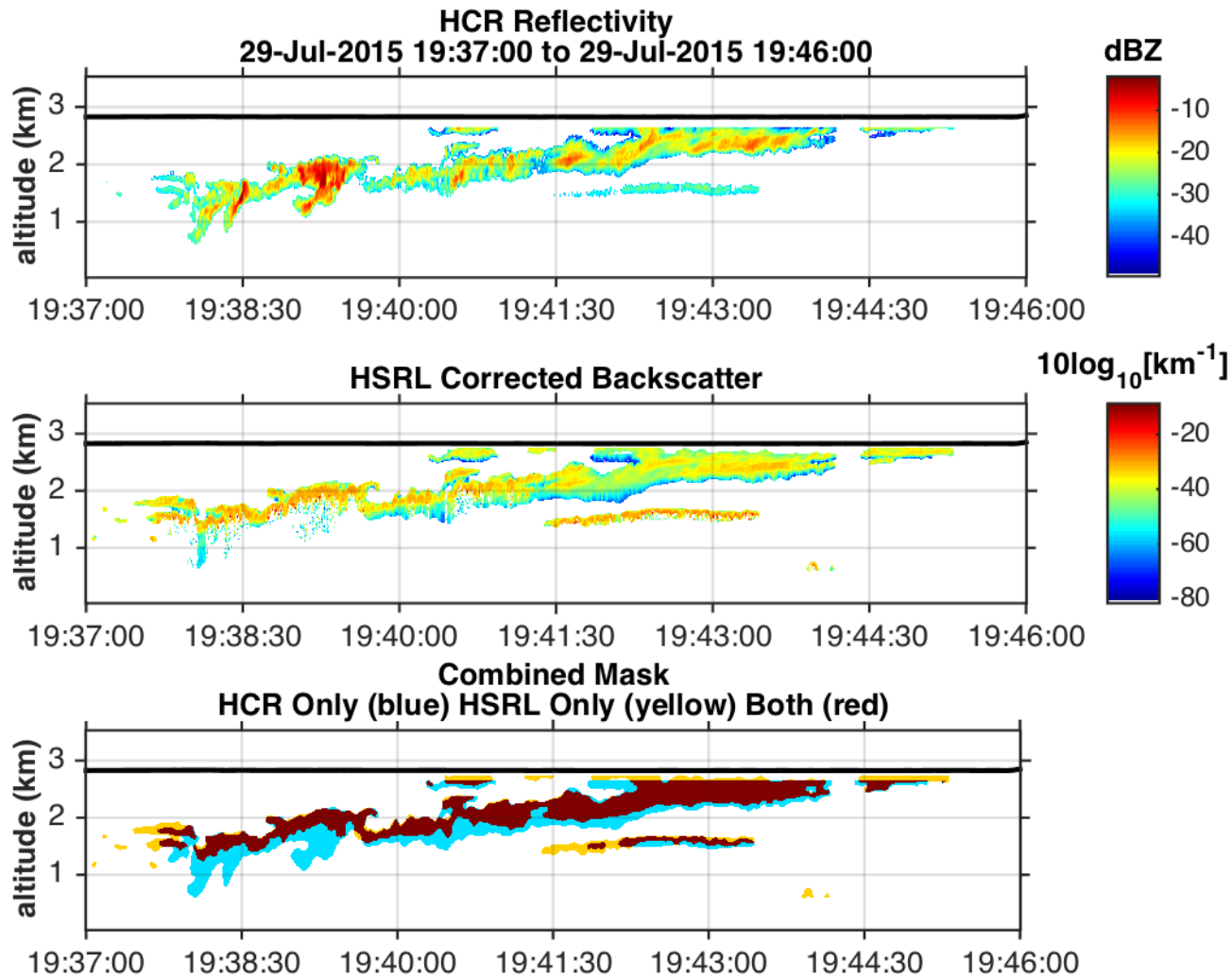
Doppler Spectral Processing



Example Spectra From Time Series

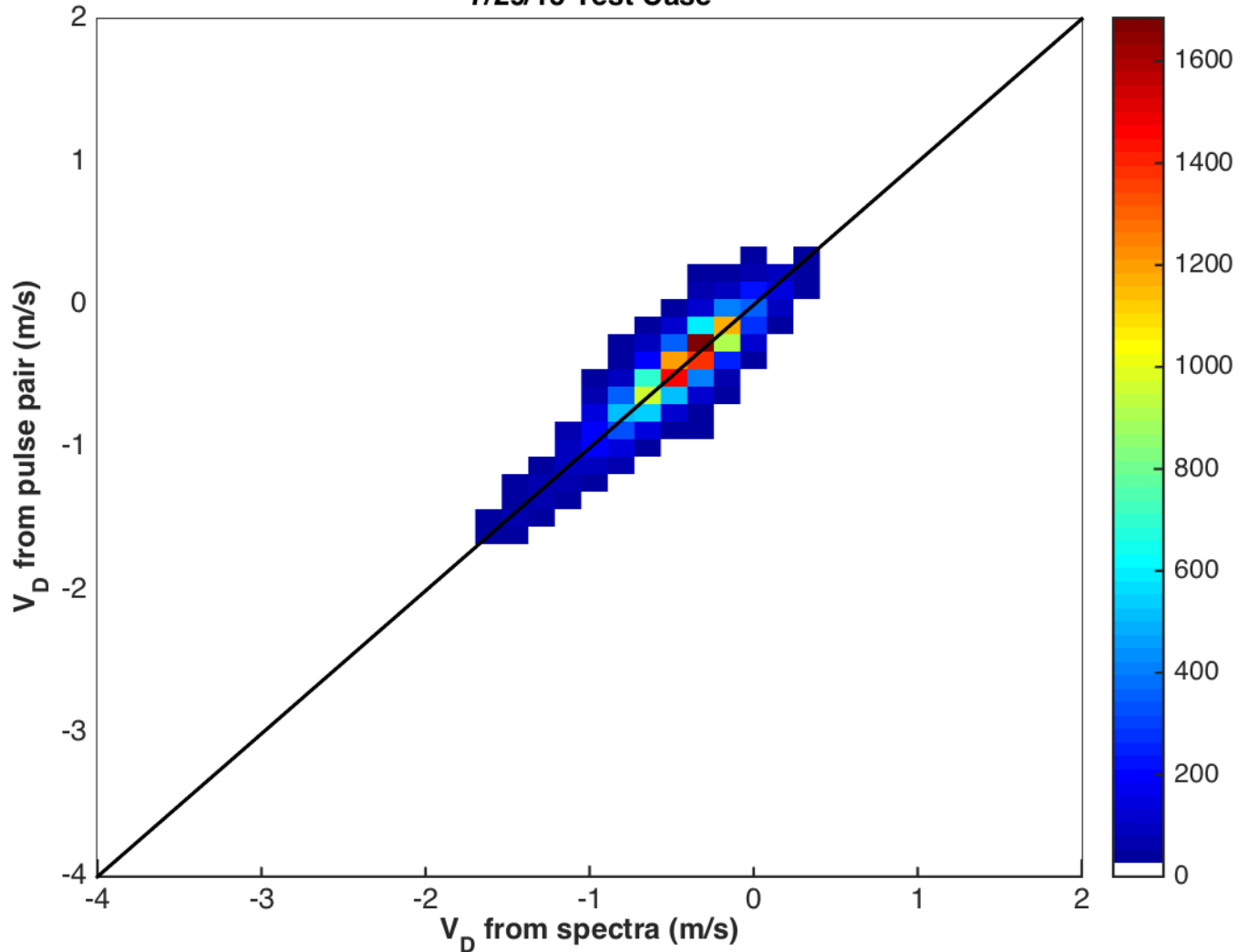


Test Case 1: Perform Radar/Lidar Retrieval



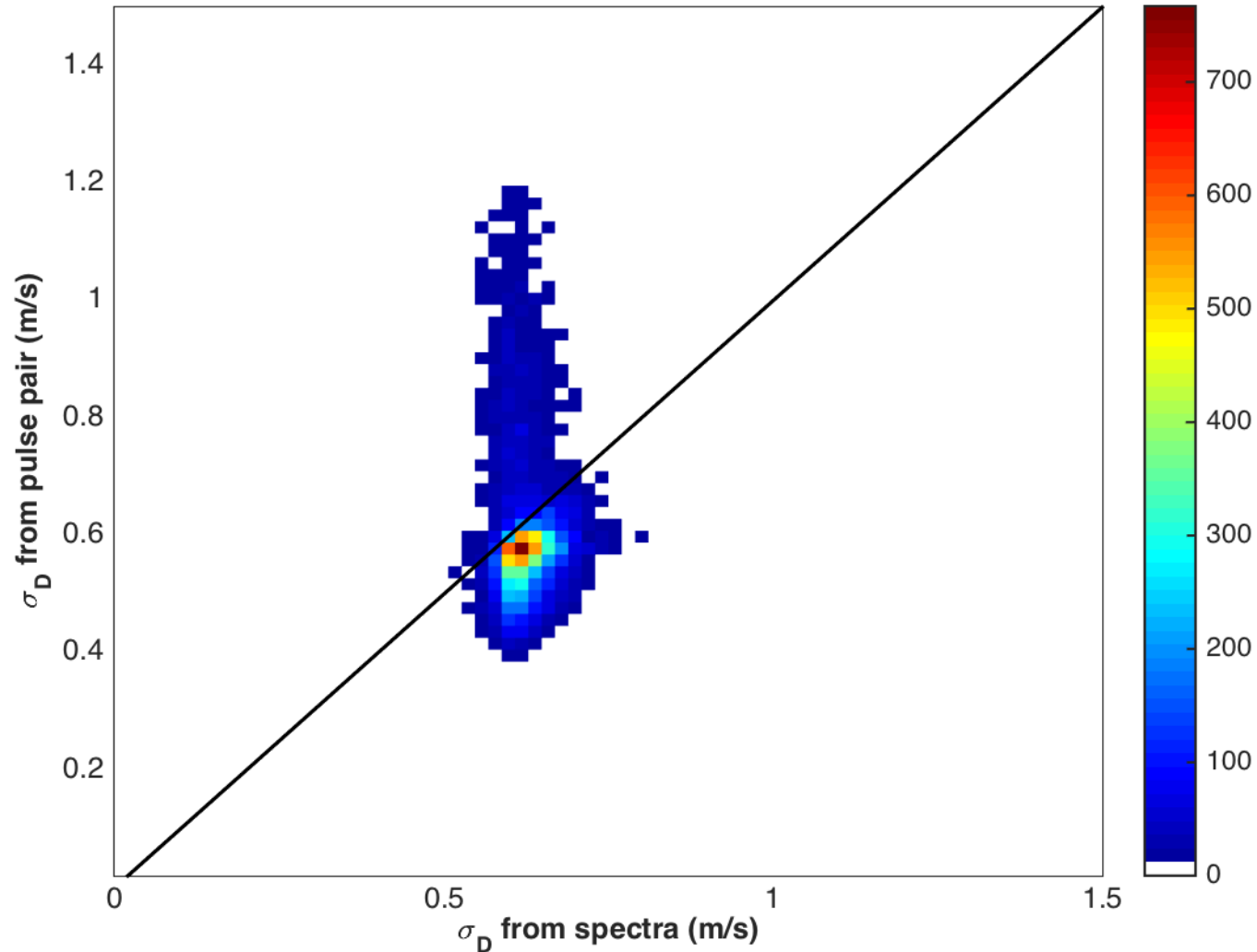
Comparison of Spectral Moments with Pulse Pair Processing

Comparison of Raw Mean Doppler Velocity
7/29/15 Test Case



Comparison of Spectral Moments with Pulse Pair Processing

Comparison of Doppler Spectral Width
7/29/15 Test Case



Problems

- Uncertainty in spectral width remains
 - Needed for estimation of eddy dissipation
 - Eddy dissipation figures in estimation of entrainment rates
- Accurate spectral widths needed in order to perform retrievals
 - E.g., O'Connor et al. (2005)
- Drizzle modes and Mie notches obscured by motion of aircraft and finite beamwidth (not shown)
 - No figure included in talk, will be happy to provide to parties of interest
 - Doppler spectra are convolved with finite beamwidth effects
 - Need corrected spectra for retrievals that make use of spectra (e.g., Kollias)

Ongoing Work

- Constant correction to Doppler spectra for aircraft pitch and roll—will shift spectra
- Investigate correction of spectra due to finite beam width and aircraft forward motion
 - In mathematical exploration
- When velocity corrections made, spectra and derived moments will be made available upon request

Dual Masking

- Goal: make a hydrometeor mask by combining HCR and HSRL returns
- Purpose: facilitate retrievals and other analysis requiring cloud boundaries and location of precipitation
- Method:
 - Mask HCR
 - Mask HSRL
 - Combine resulting masks

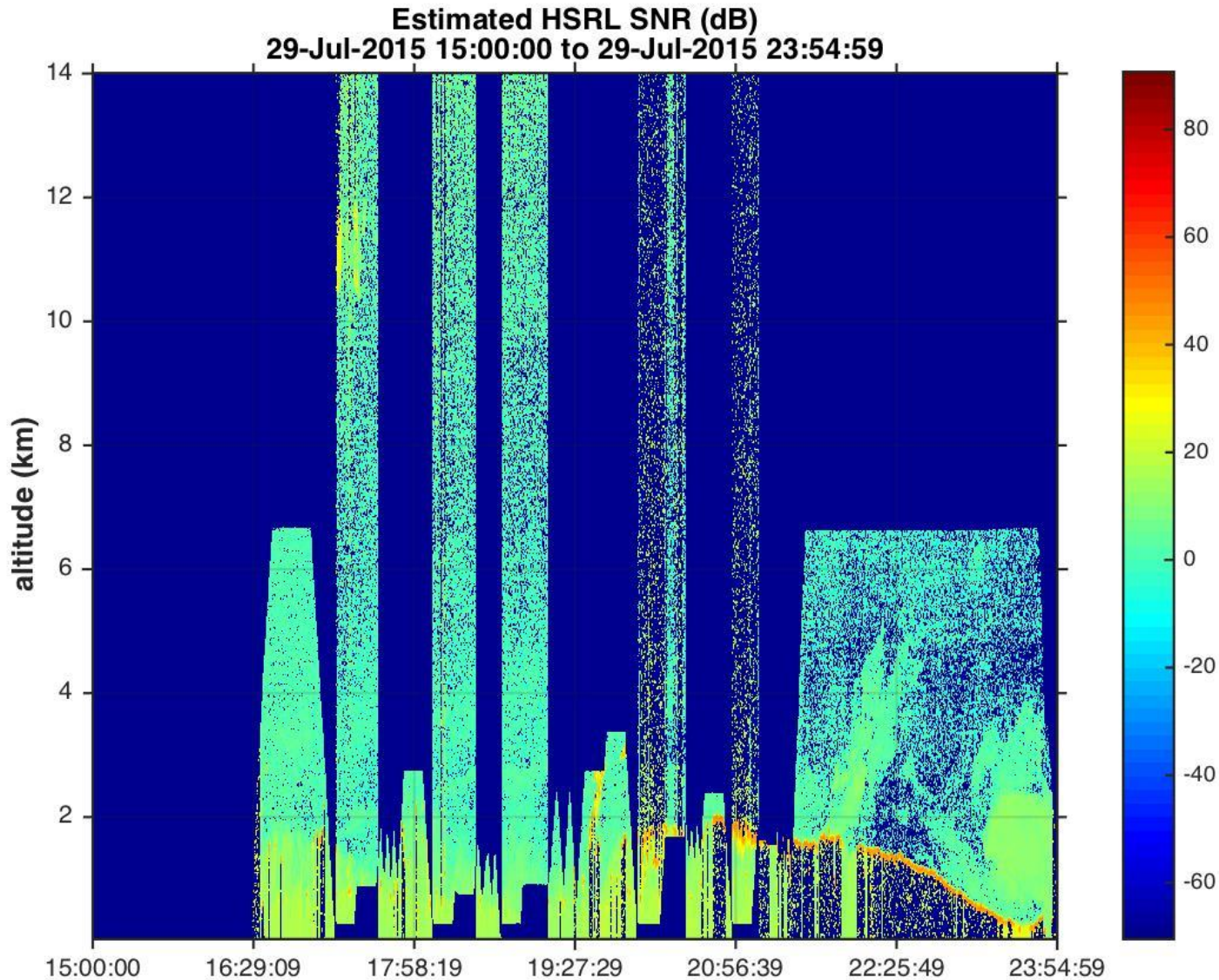
Masking HCR for Hydrometeors

- First 22 range gates removed
 - First 12 are negative range, next 10 disposed of to insure removal of all questionable returns (from visual inspection)
 - 184 meter dead zone
- Interpolated to 20 meter grid
- Periods blanked out as “missing”
 - Calibration periods
 - Off-nadir or off-zenith
 - Times when reported elevation angle apparently incorrect
 - Other spurious returns determined by Z/width threshold masked out (case-by-case)
- SNR threshold to mask, followed by spatio-temporal filter (Clothiaux et al., 1995) to remove speckle

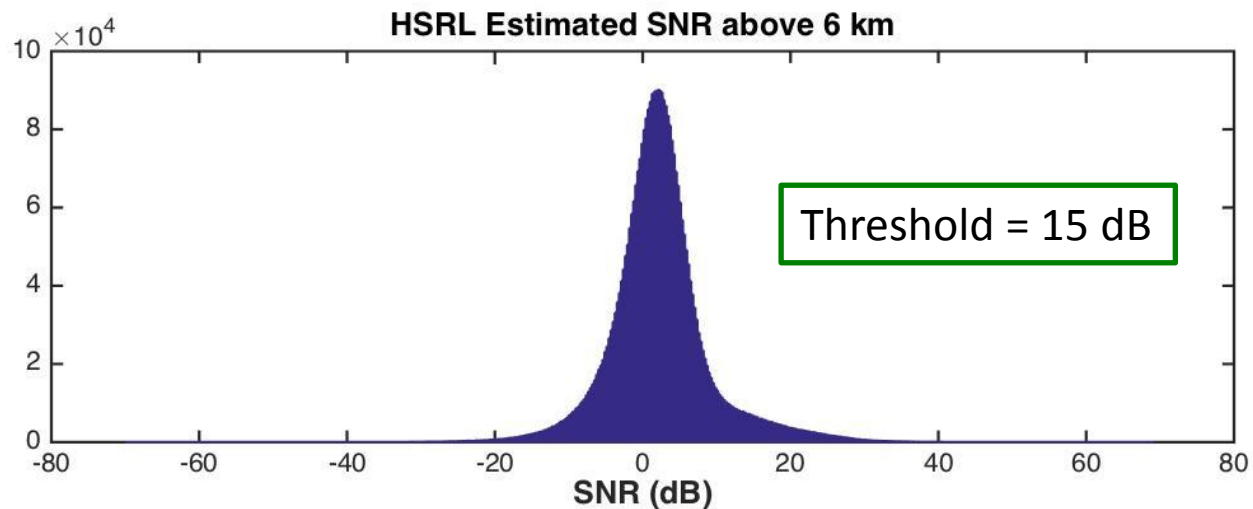
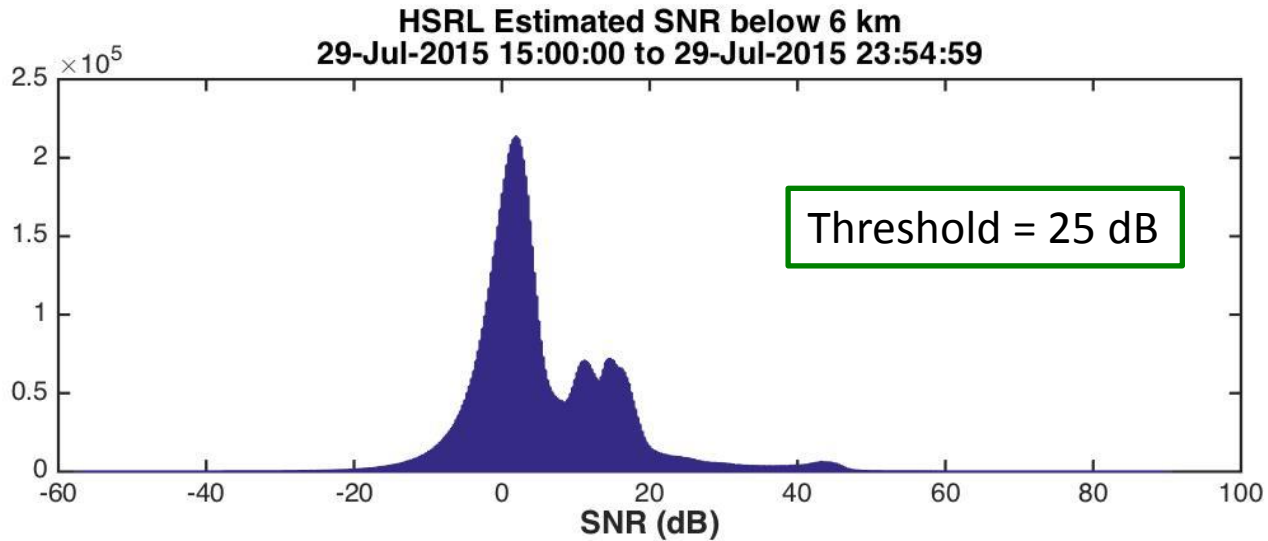
Masking HSRL for Hydrometeors

- Calibrated backscatter provided by HSRL
- Grid to same height scale as HCR (2 Hz already)
- Use SNR to distinguish between aerosol and hydrometeor returns
- For example...

Estimated SNR, 7/29/15



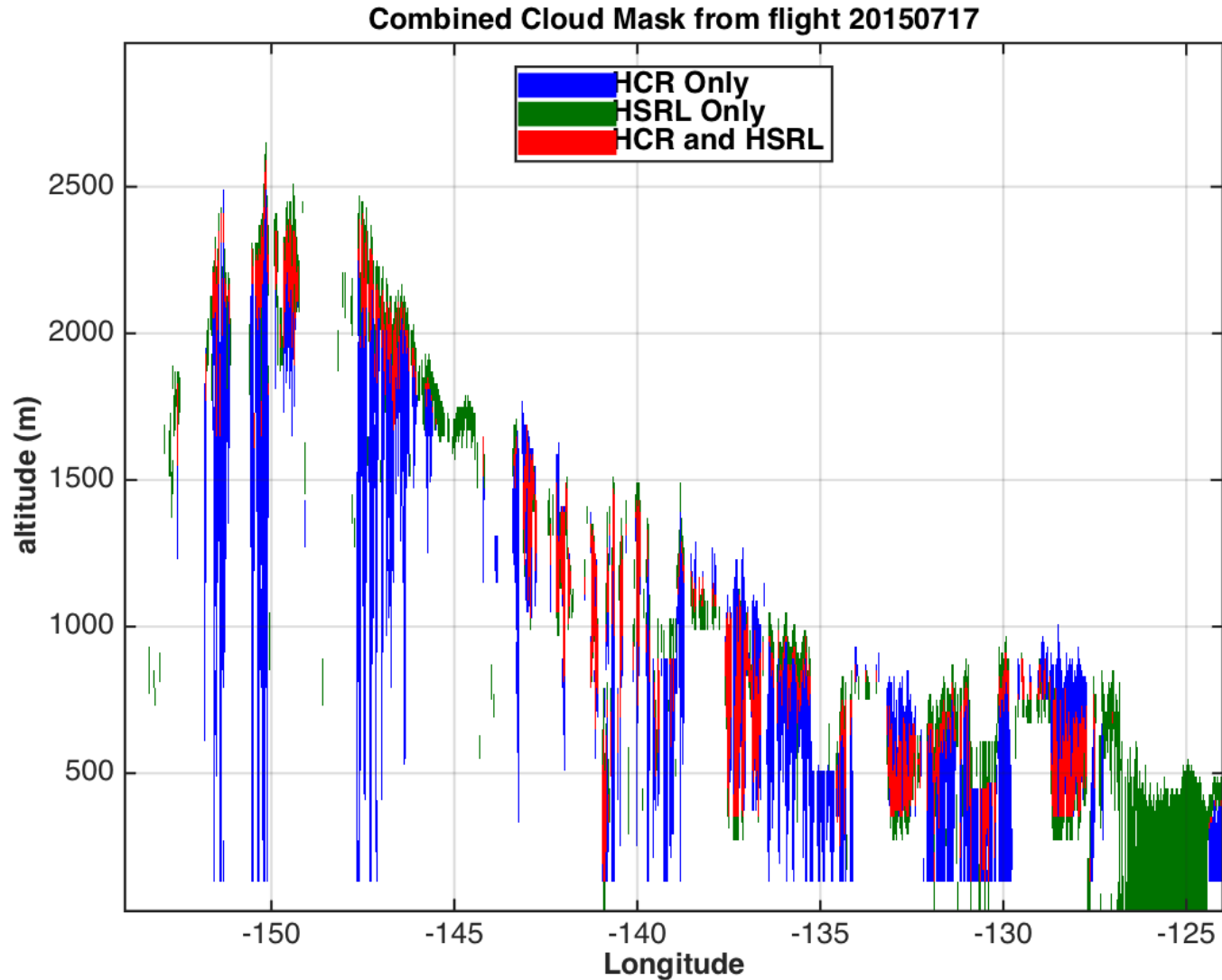
Histograms of SNR above and below 6 km



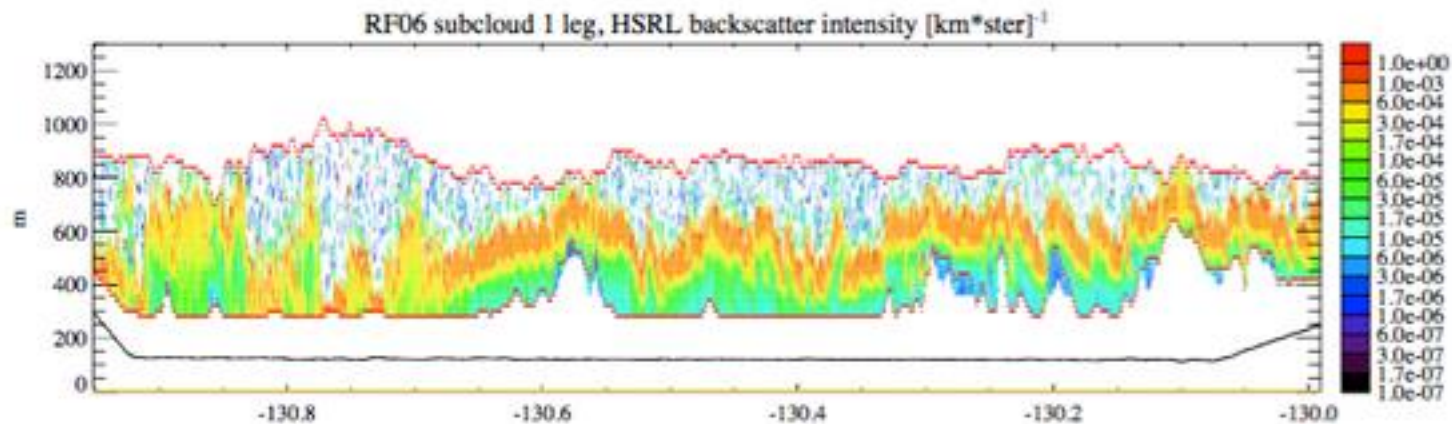
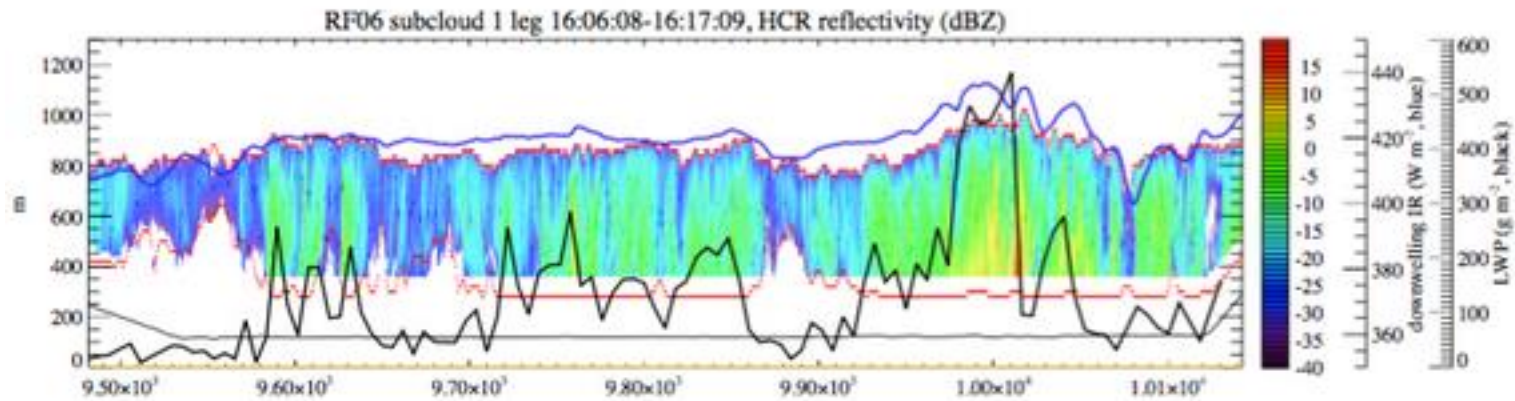
Threshold, Remove Speckle



Combine Masks by taking their Union



An issue (courtesy of Paquita)



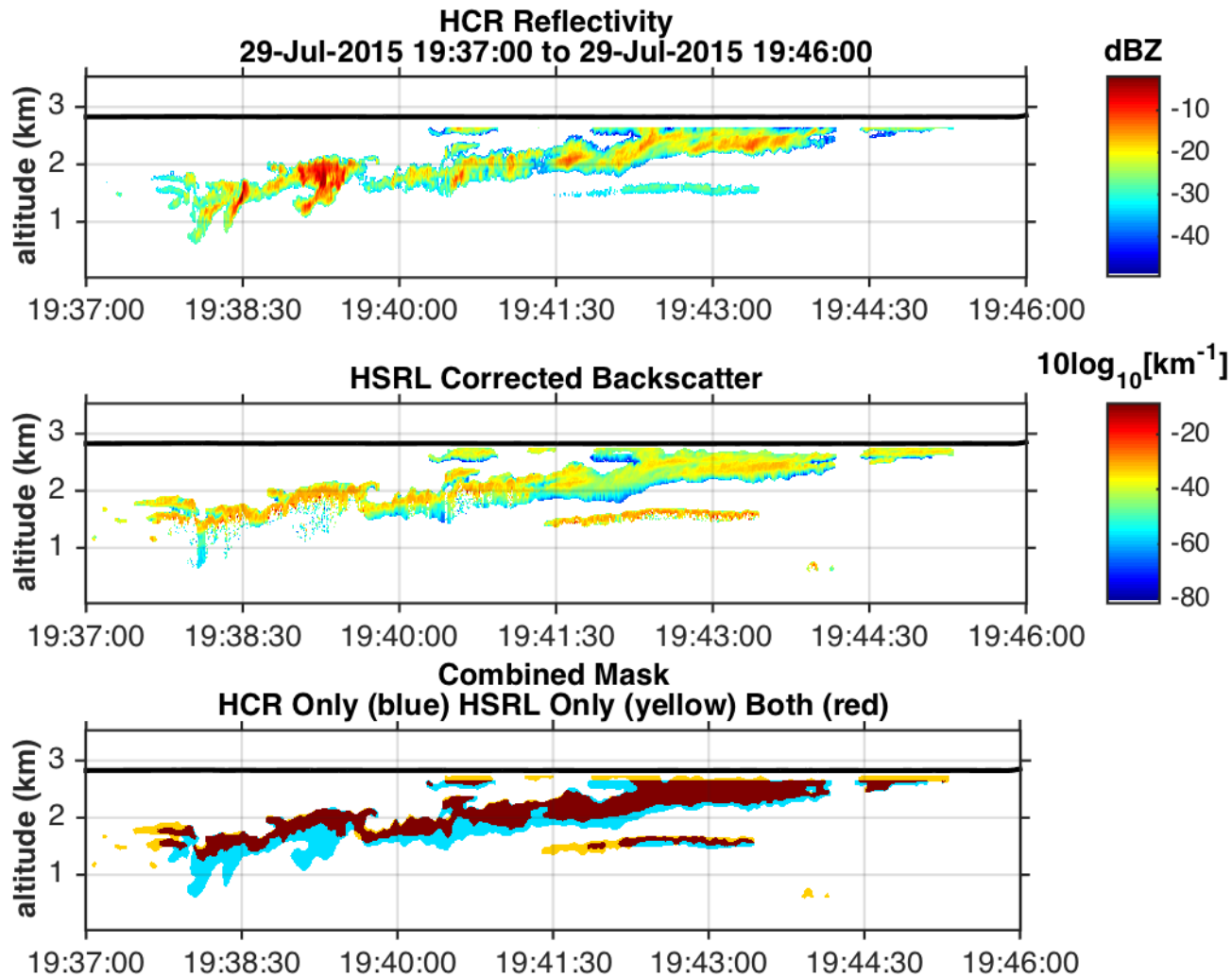
Issues to Deal With

- Need to positively identify cloud base and not just hydrometeor base
- Discrepancies with aircraft altitudes as reported by INS in HCR and aircraft data, as well as the gridded HSRL
- To distribute update to extant version

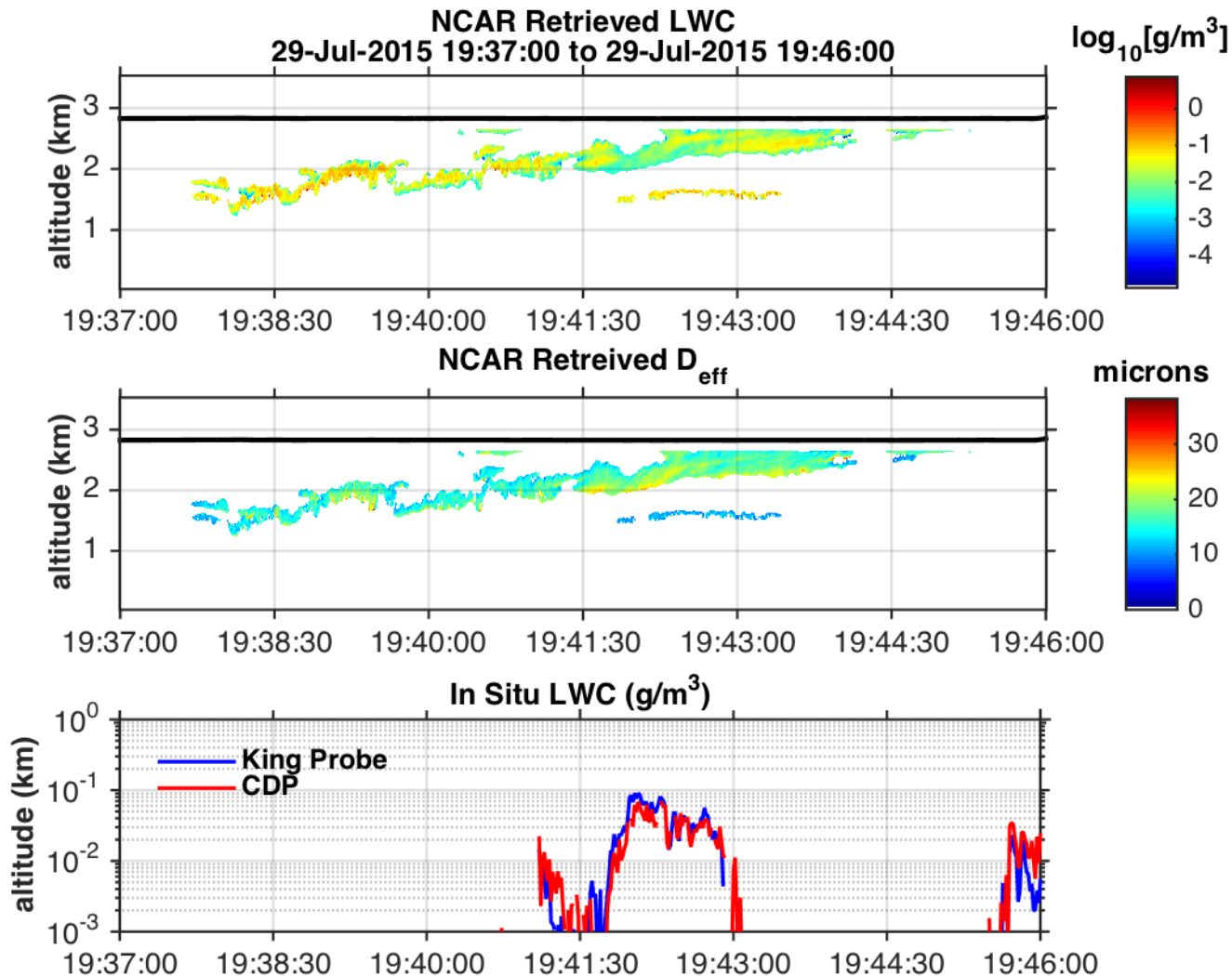
Thin Cloud (and precip) Retrievals

- NCAR retrievals
- Some proximate in situ LWC measurements
- O'Connor et al. in progress—some kinks in data in process of being worked out

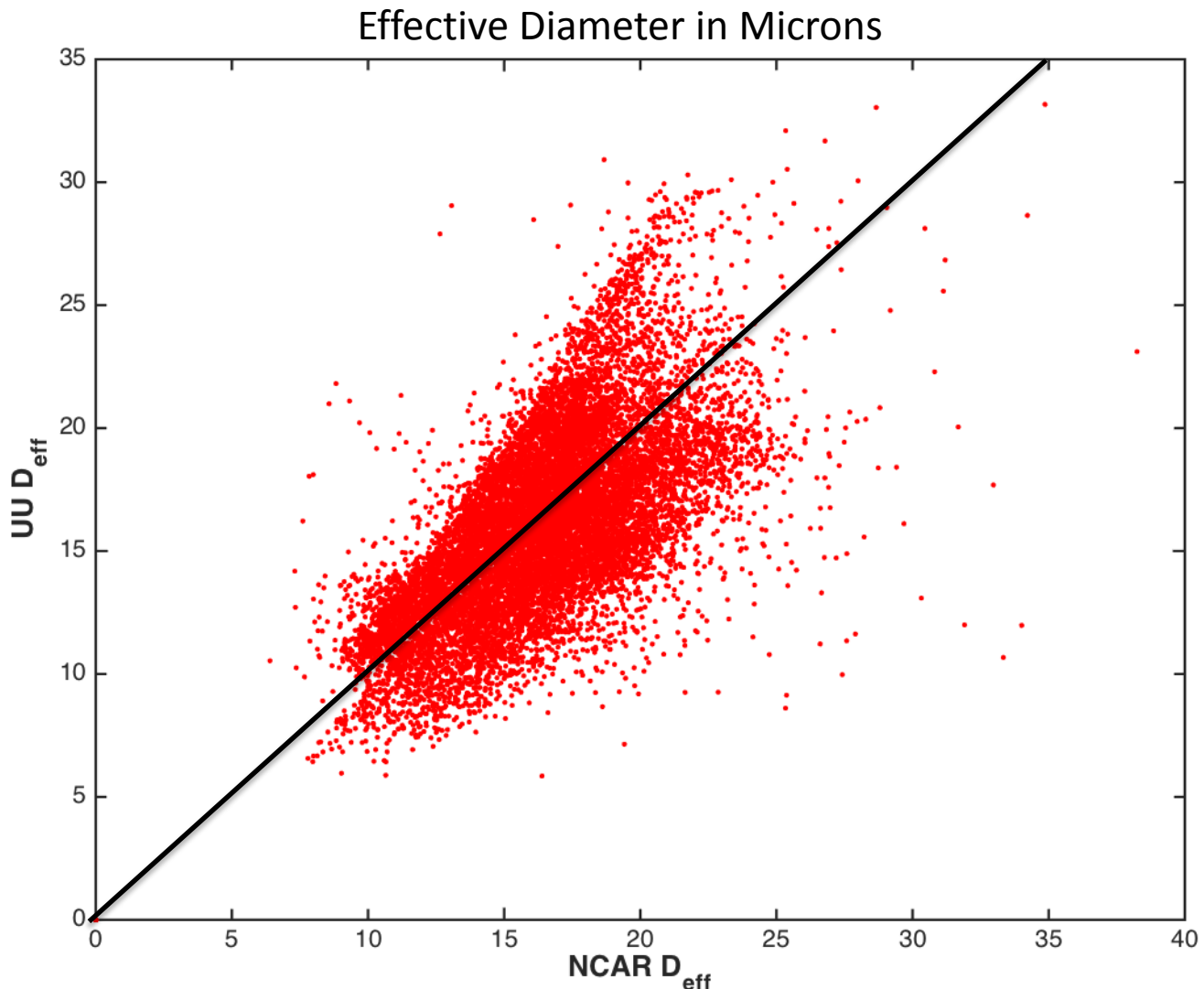
Test Case 1: Perform Radar/Lidar Retrieval



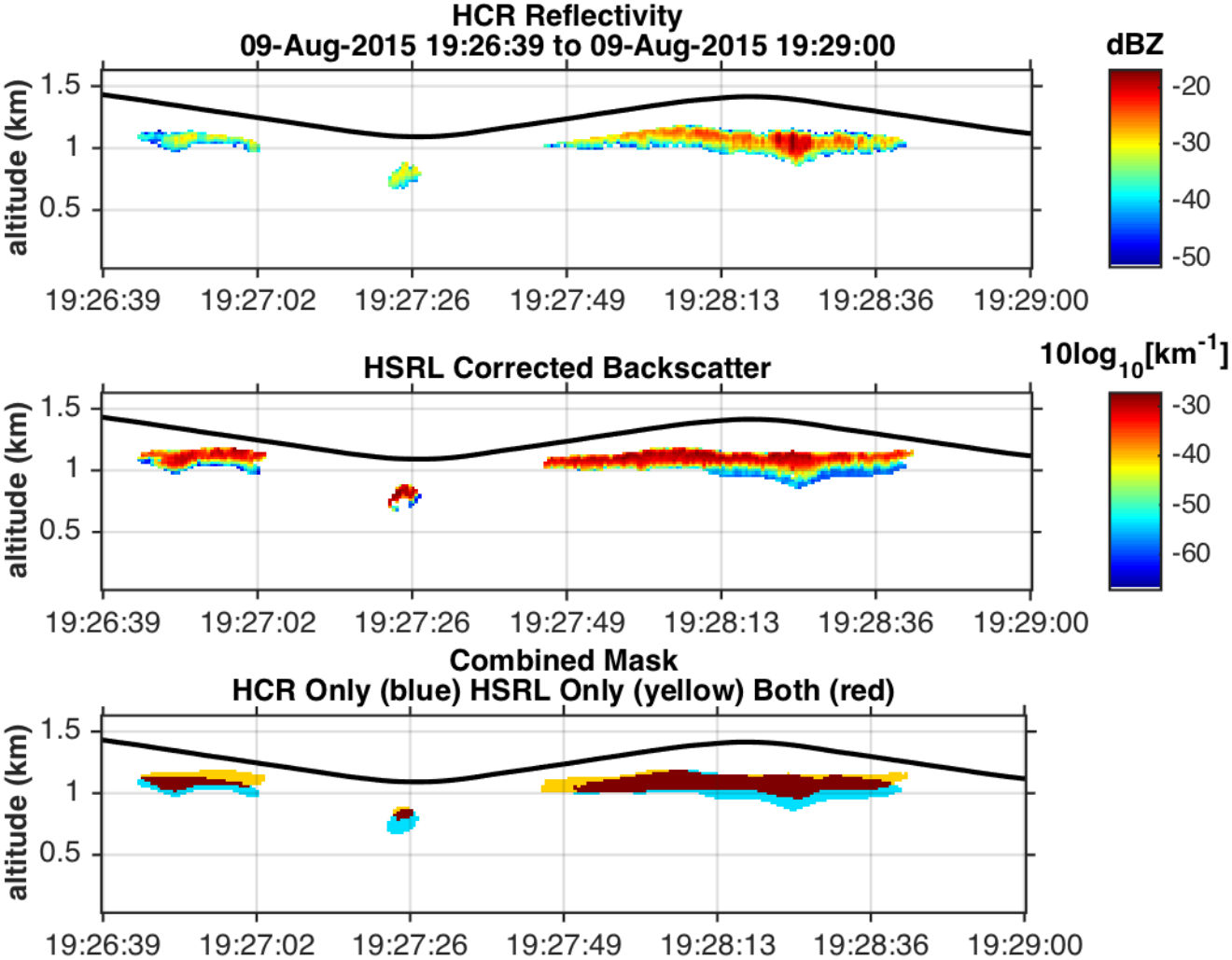
Retrieve LWC and D_{eff}



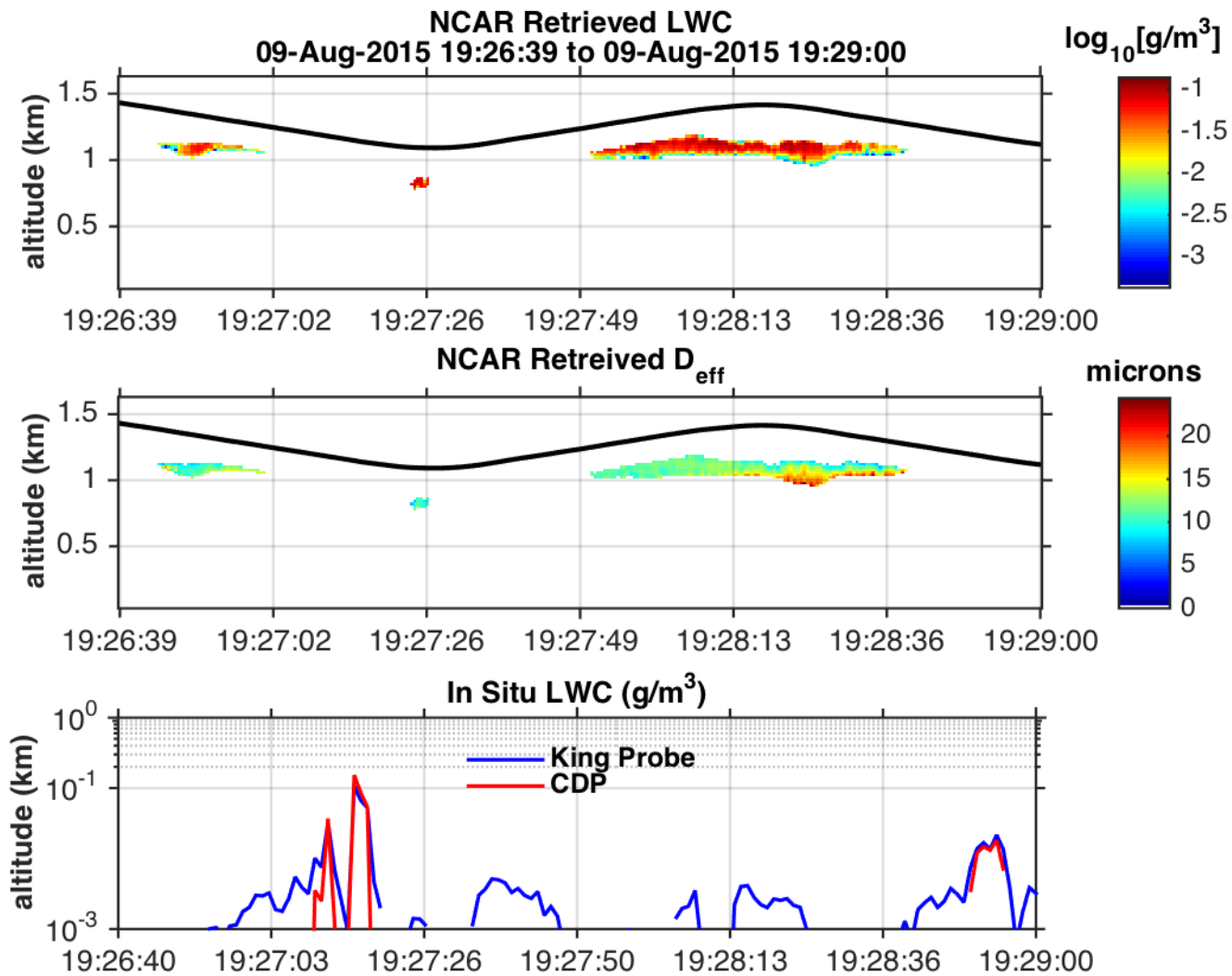
Comparison of NCAR w/ Dong and Mace (2003)



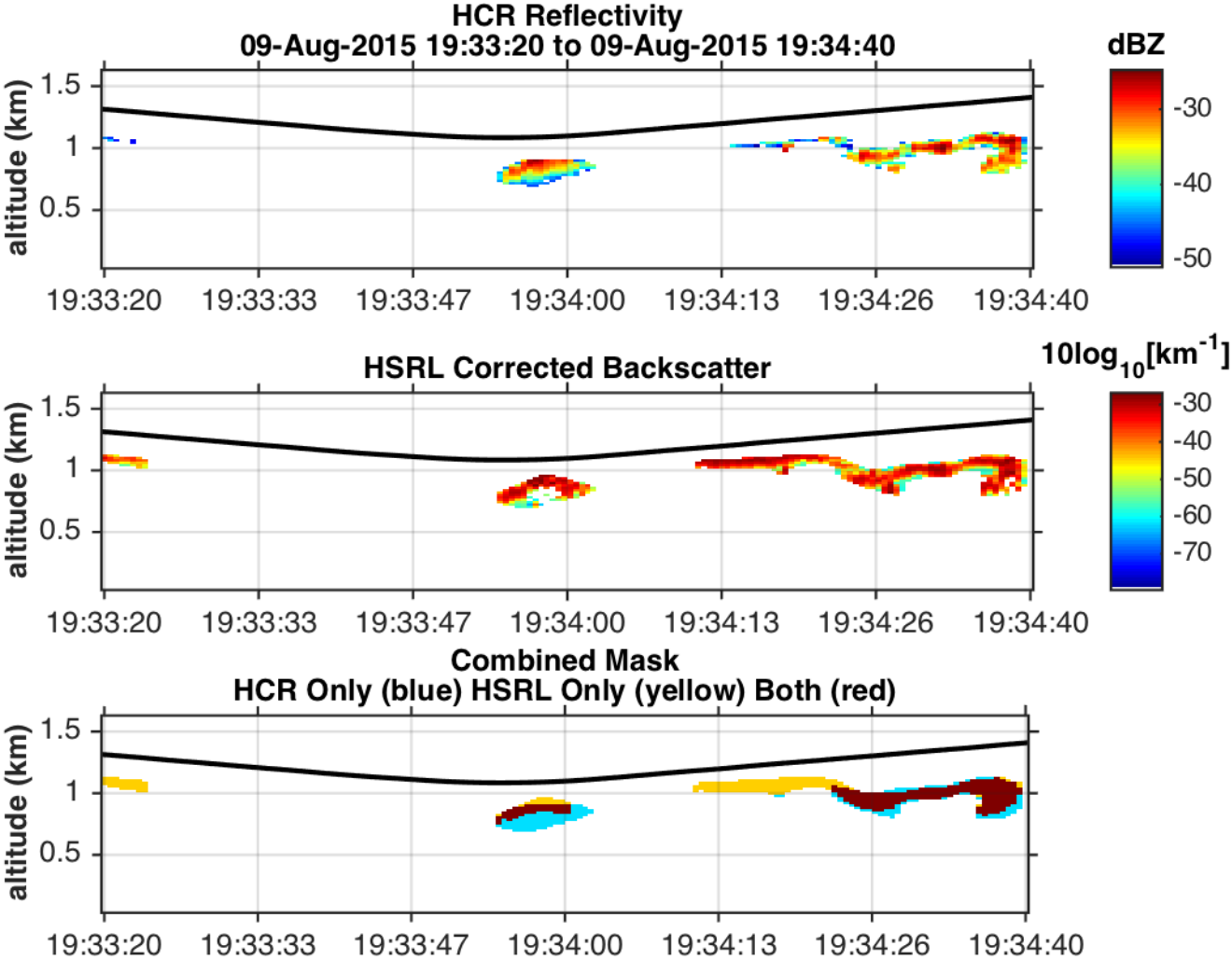
Test Case 3: Perform Radar/Lidar Retrieval



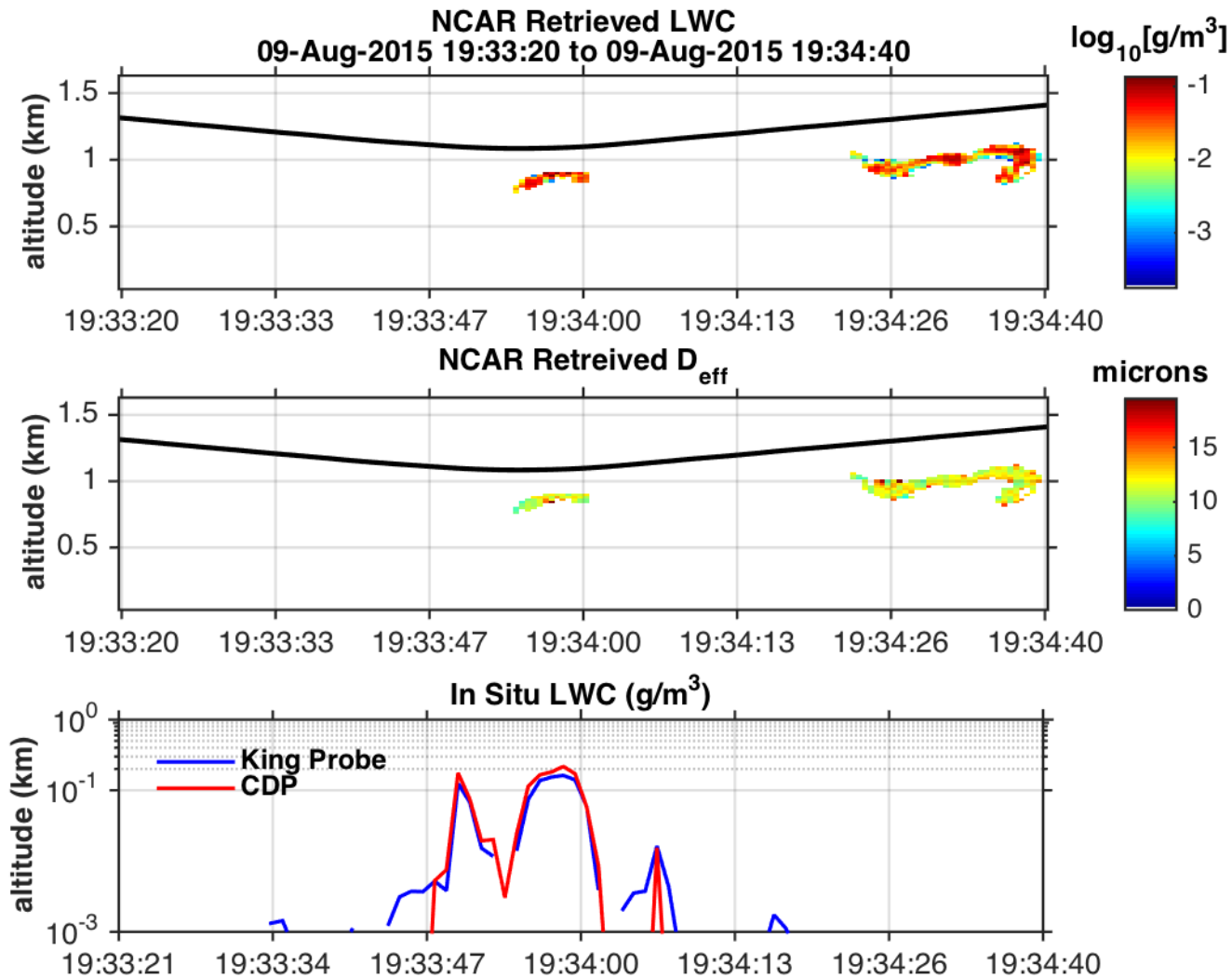
Retrieve LWC and R_{eff}



Test Case 4: Perform Radar/Lidar Retrieval



Retrieve LWC and R_{eff}



On-Going Work

- O'Connor (lidar/radar) retrievals for thin cloud and for drizzle for comparison with NCAR retrieval
- Computation of skewness in spectra for investigation of drizzling areas
- Will use precipitation retrievals in paper
 - Study of precip in CSET
 - Relation with aerosol, mesoscale features, transitional areas
- Processing of spectra very time intensive—will take some time to correct V_d and skewness, corrected spectra some time out