Radar Resources for the Houston Deep Convective Clouds Study: Discussion on Radar Measurement Capabilities and Limitations

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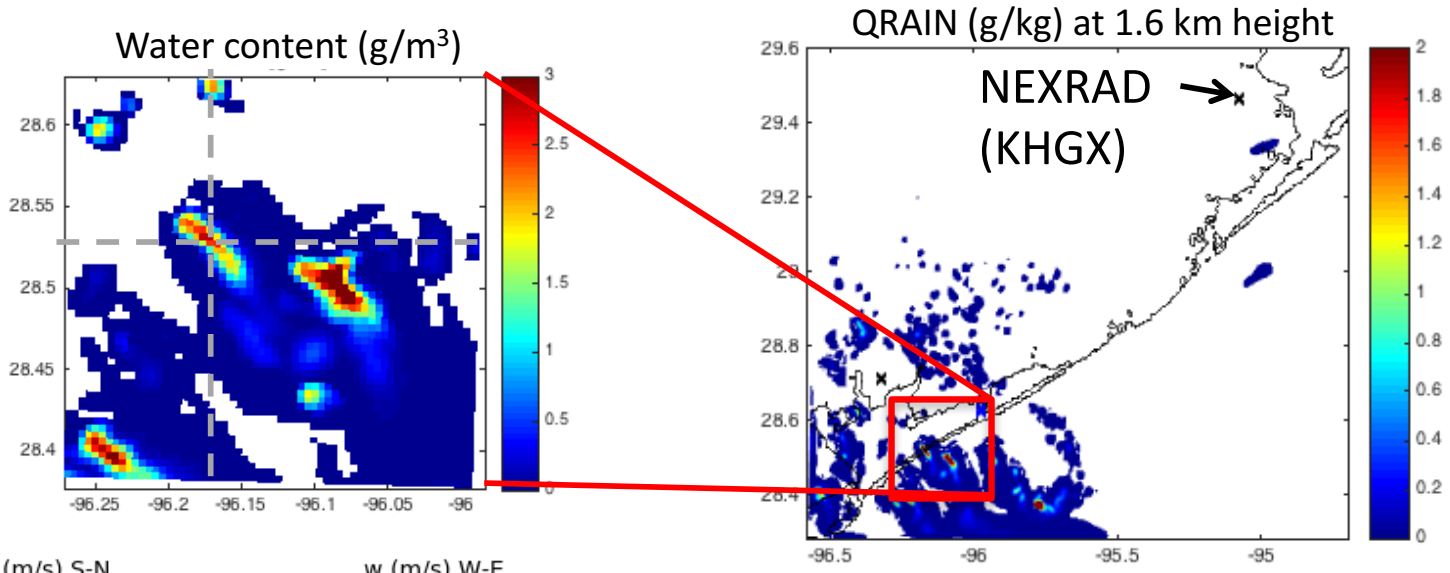
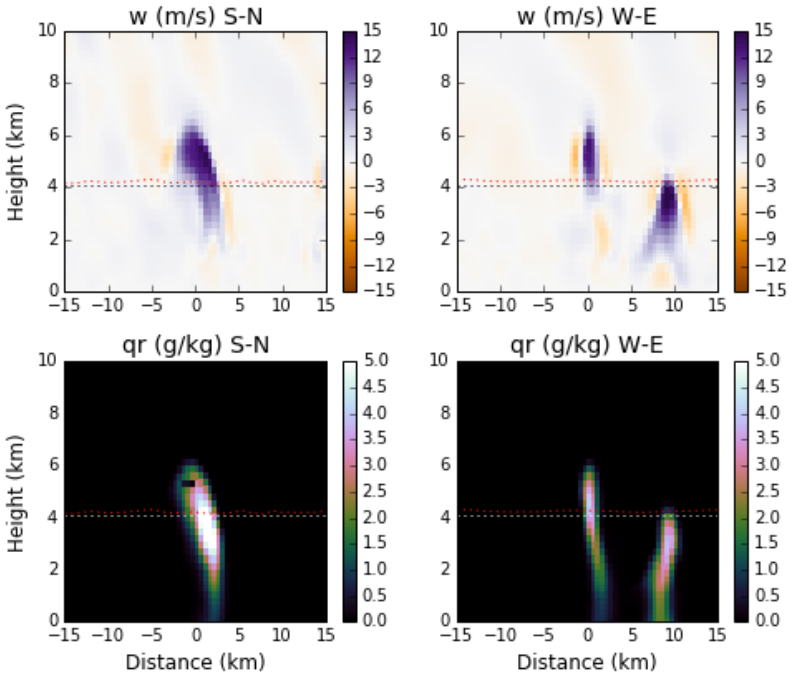
Radar Simulations for Isolated Convective Cells

WRF simulation, 2013/06/08 15:15 UTC



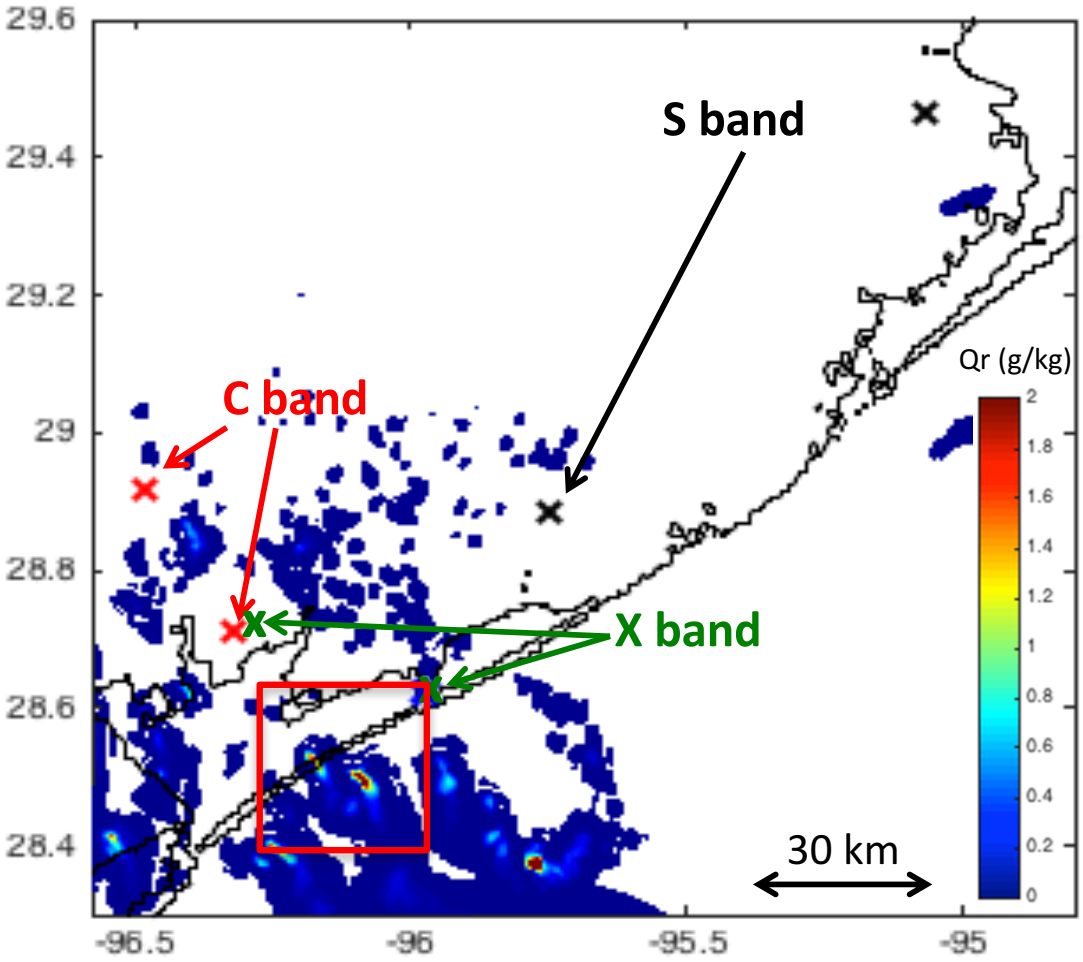


Available radars: NEXRAD at Houston, C-SAPR, X-band polarimetric radars (e.g., DOWs, phased array radar)

How polarimetric variables and wind retrieval change with different radar setting?

- Different wavelength
- Attenuation effect
- Resolutions (i.e., distance between radar and clouds)

Simulations of Multi Radar Observations



WRF configurations

- Horizontal resolution = 0.5 km
- Morrison double-moment microphysics
- 2013/06/08 15:15 UTC

Radar settings

C-band radar (e.g., C-SAPR)

- Dual polarization
- Distance
  1) 30 km from the storm
  2) 60 km from the storm
- Elevation angles
  1) PPI: 17 angles (Same as SGP)
  2) RHI: 0°-90° with 1° increments

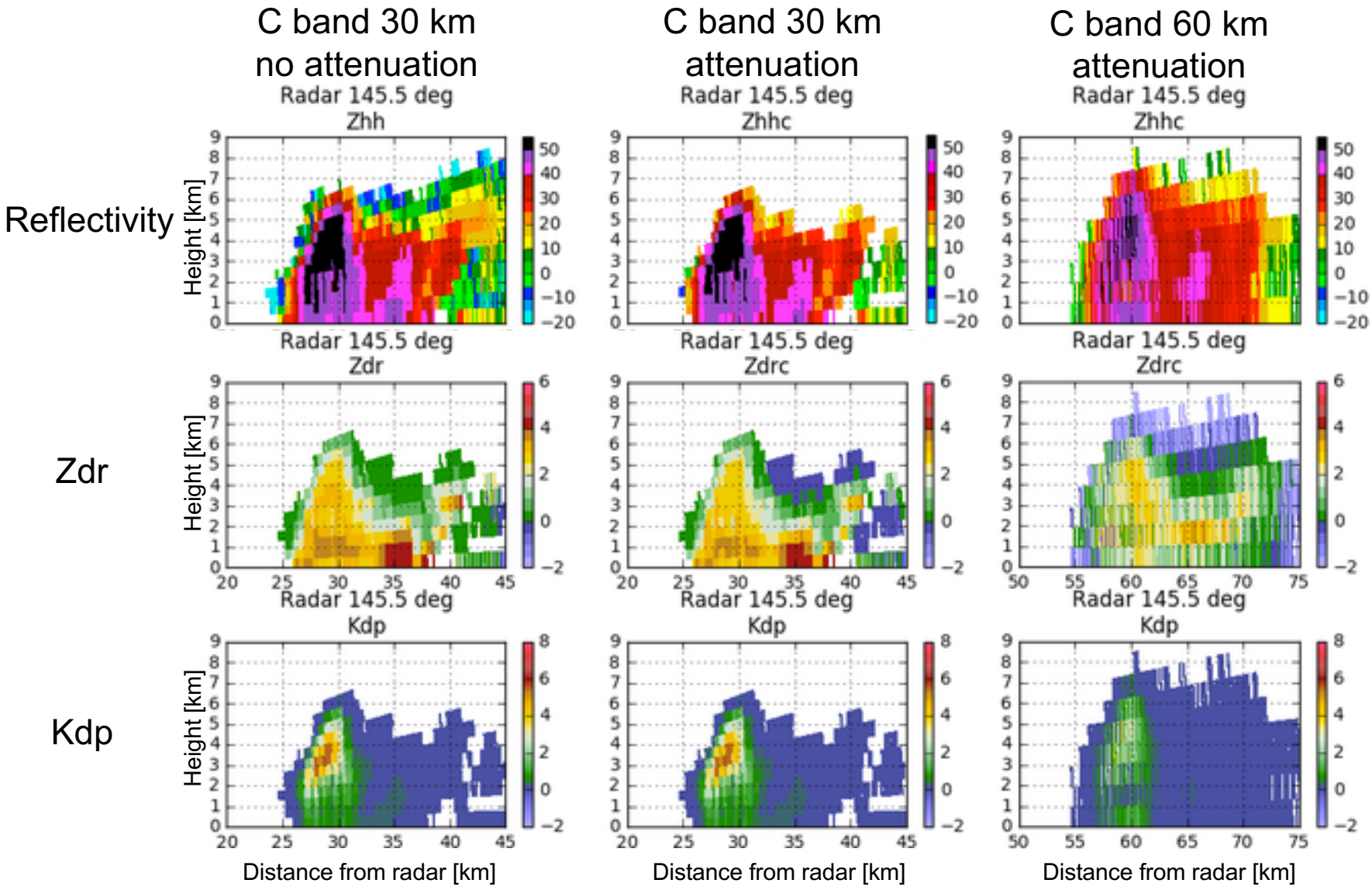
X-band radar (e.g., DOW)

- Dual polarization
- 30 km distance from the storm
- Elevation angles
  1) PPI: 24 angles (Same as SGP XSAPR)
  2) RHI: 0°-90° with 0.9° increments

S-band radar (e.g, NEXRAD)

- Dual polarization
- 60 km distance from the storm
- 14 PPI elevation angles (same as NEXRAD)

Polarimetric Parameters: C-Band RHIs at 30 km & 60 km



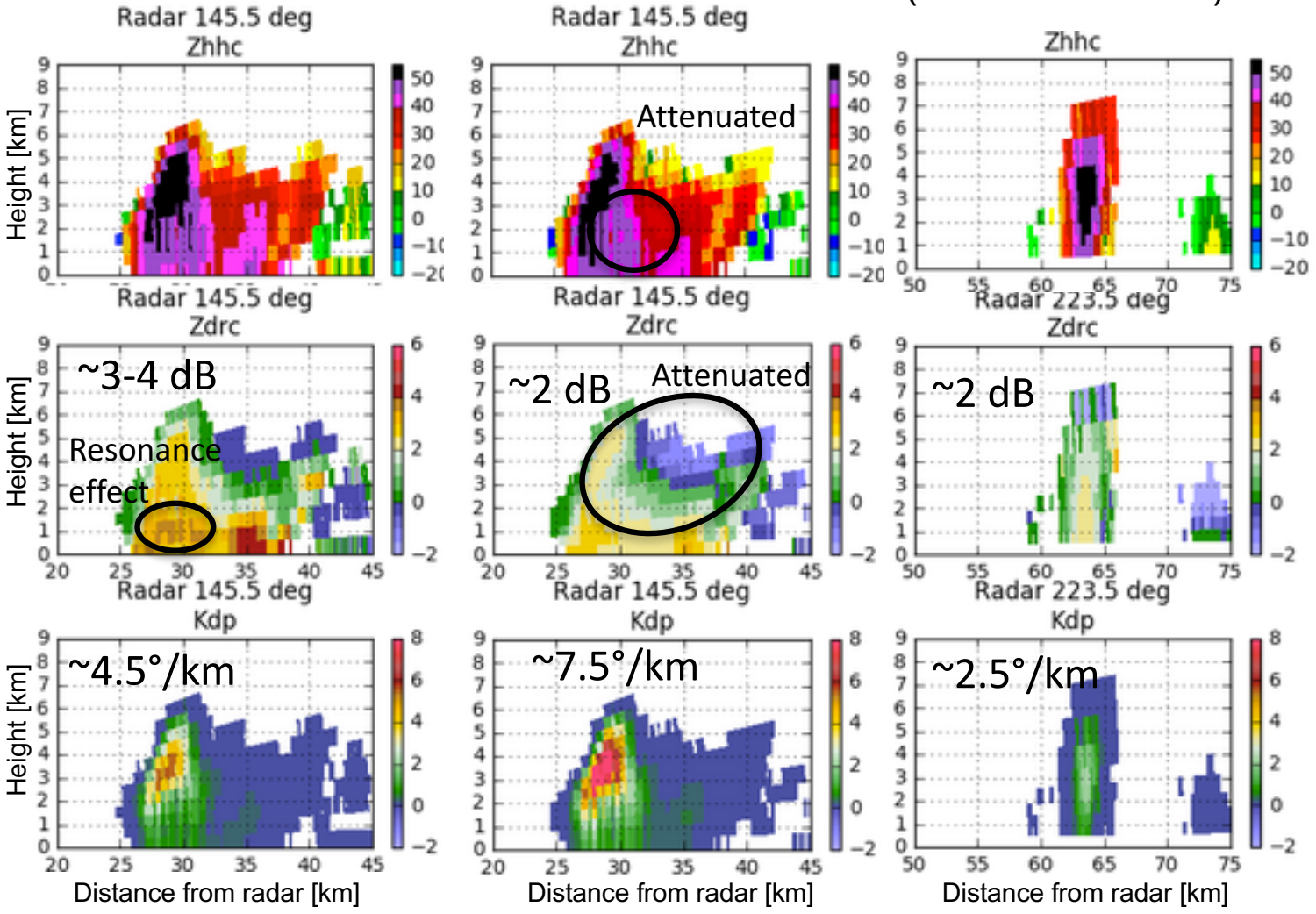
- C-band radar at 30 km can capture Zhh, Zdr and Kdp without significant attenuation, but at 60 km cannot resolve well because of larger sampling volume.

Polarimetric Parameters:
C- and X-Band RHIs and S-Band PPI

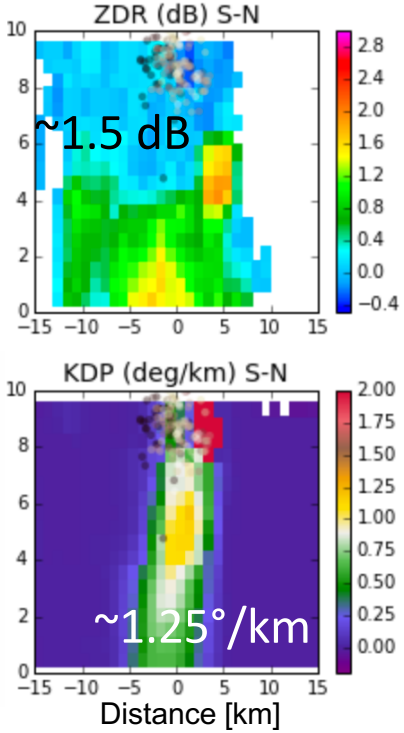
C band 30 km attenuation

X band 30 km attenuation

S band 60 km (different azimuth)

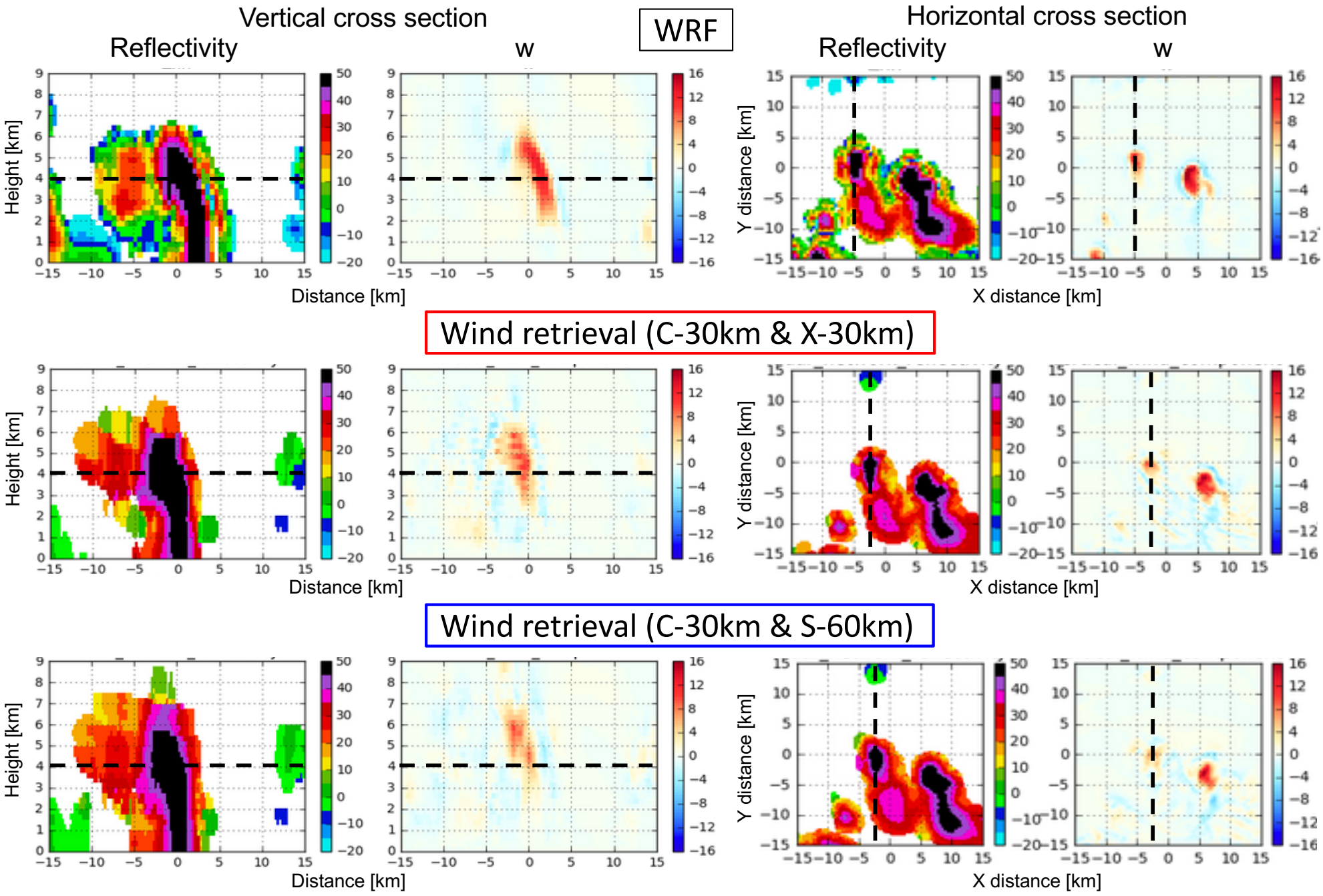


NEXRAD real observation (001, 16:53)

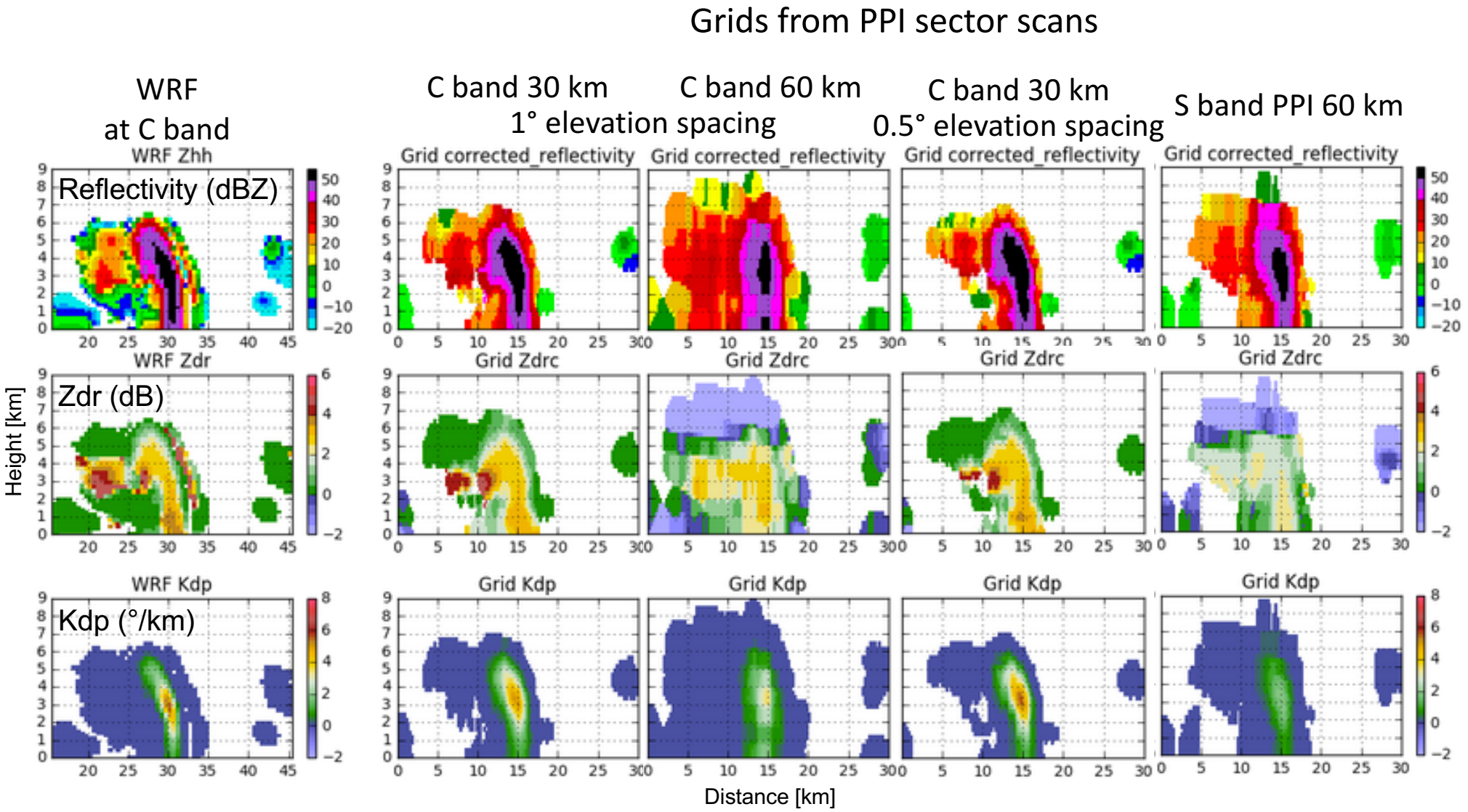


Wind Retrieval:

C- (30 km) and X- (30 km) & C- (30 km) and S- (60 km) Radars

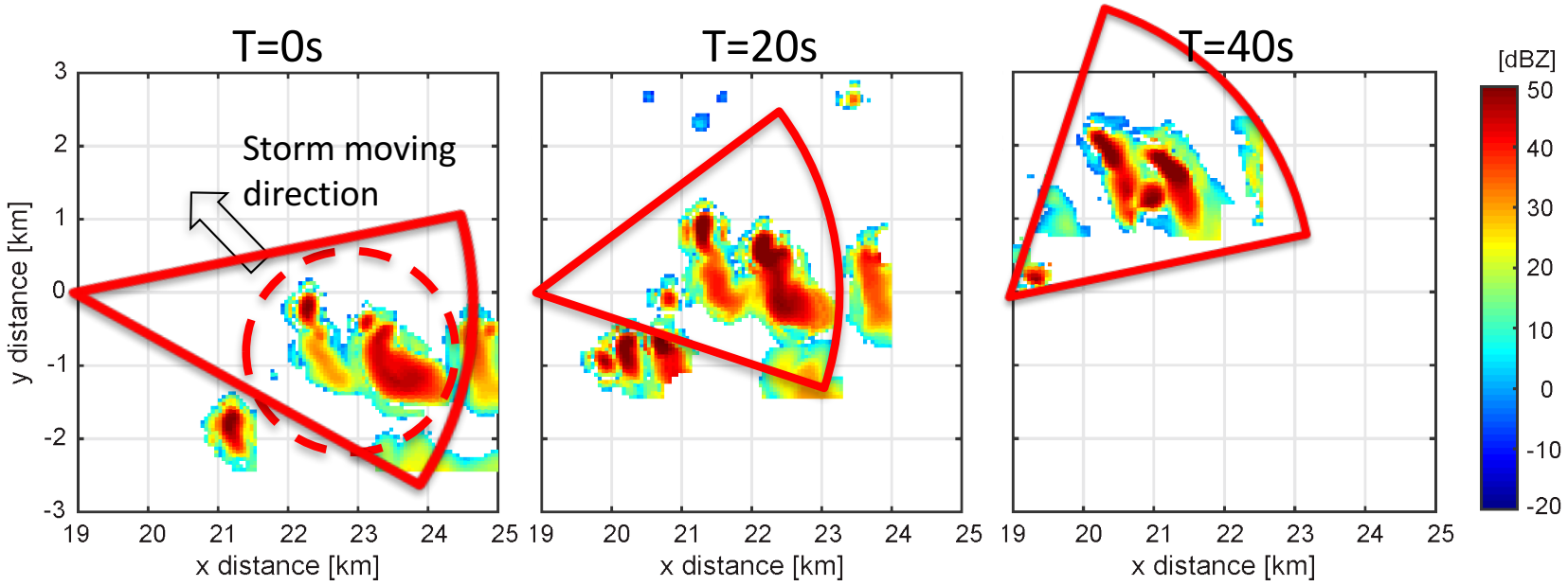


Discussion: PPI and RHI Sector Scans



Discussion: PPI and RHI Sector Scans

Sector scans need to identify and track a convective cloud.



- Collaboration with the Dynamical and Microphysical Evolution of Convective Storms (DYMECS) project (R. Hogan et al.).
- Including storm tracking algorithm to decide sector regions.

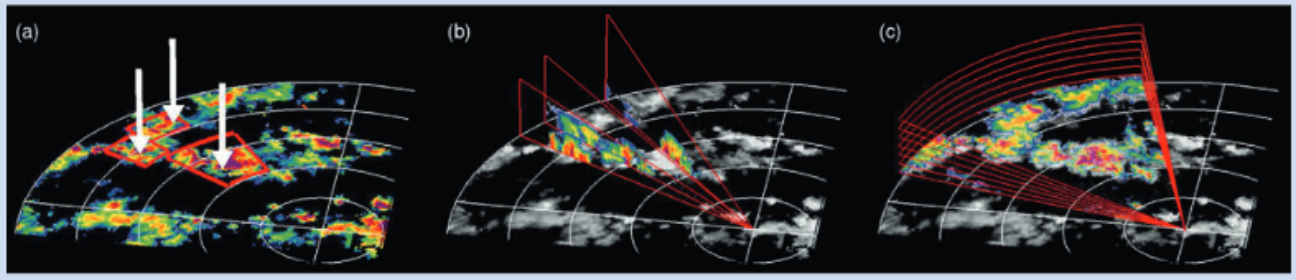
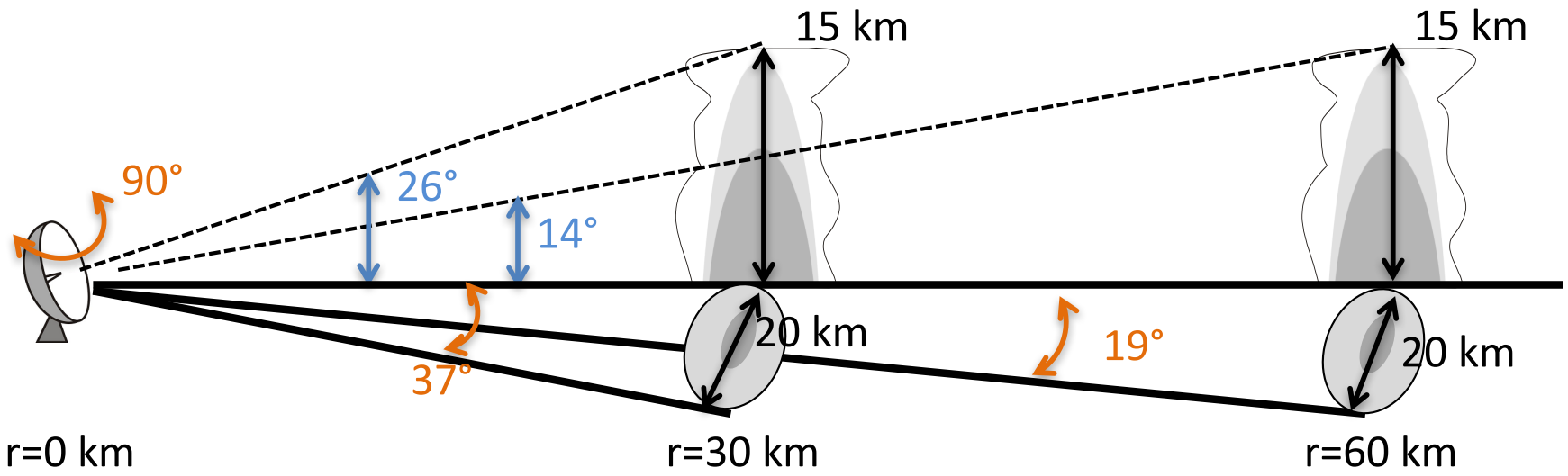


FIG. SB1. Illustration of three steps in the scanning strategy. The Chilbolton radar is at the center of the circles, which are 25 km apart. (a) Storms are tracked in the surface-rainfall data (colors), and three storms are prioritized (red boxes), including their locations of rainfall cores (white arrows). The Chilbolton radar is then instructed to do RHIs (b) first through the cores (colors show reflectivity) and (c) then stacked PPIs to retrieve three-dimensional structures of storms (colors show reflectivity in the bottom scan). Stein et al. (2015)

Discussion: PPI and RHI Sector Scans



C-band radar specifications (same as SGP C-SAPR)

- Beam width: 1.0°
- Azimuth spacing: 1.0°
- Elevation spacing:1.0°
- Antenna rotation speed for PPI: 14.6°/sec, 33% overhead time for changing sweeps
- Antenna rotation speed for RHI: 4.8°/sec, 33% overhead time for changing sweeps

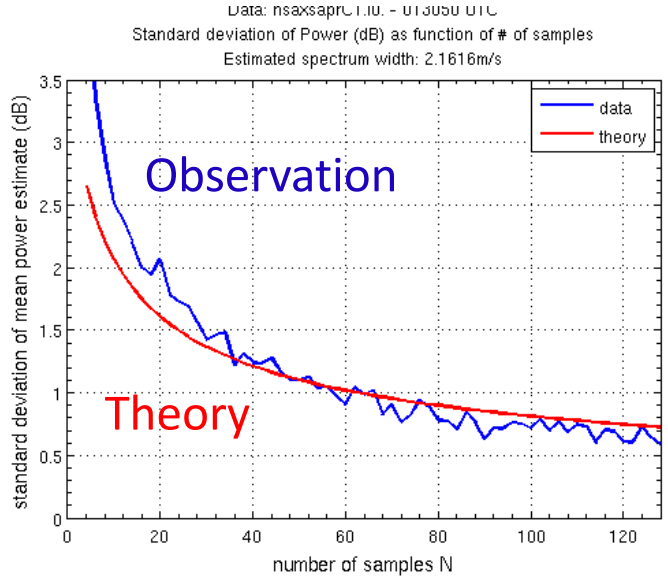
	PPI		RHI	
Distance	30 km	60 km	30 km	60 km
Azimuth sector	90°	90°	37°	19°
Elevation sector	26°	14°	26°	14°
minutes	3.6 min	1.9 min	4.5 min	1.2 min

Summary and Suggestions

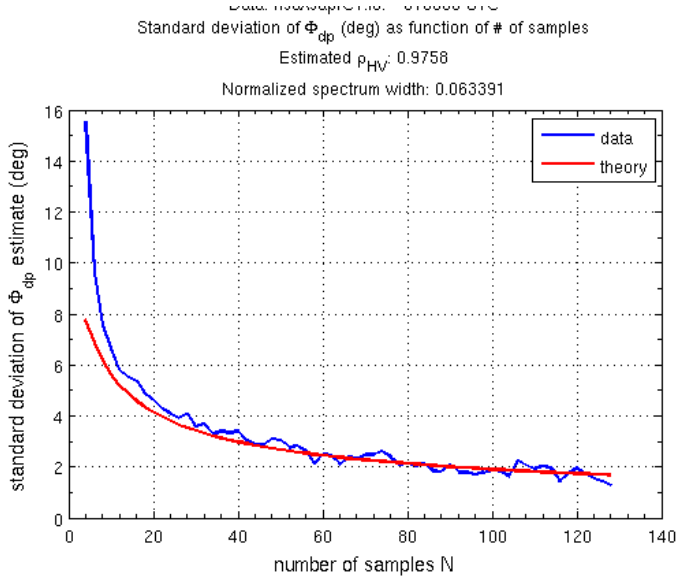
- Distance between radar and target (i.e. resolution of radar observation) can impact on polarimetric observations and wind retrievals. NEXRAD radar can be useful when target is close to the radar (< 60 km).
- Attenuation at C band is not significant for isolated cases, as long as there are not strong echoes before the target.
- Attenuation at X band can impact on Zdr measurements, but not significant for wind retrievals.
- The 3 wavelength radars can observe reasonable Kdp without attenuation effect as long as the radars observe at high resolution.
- Next step: Simulations of storm tracking and sector scans.
- While fast scanning is important to capture snapshots of storms without time gaps, enough number of pulses for averaging should be needed to obtain meaningful polarimetric variables.

Standard deviation vs number of samples @ range =23 km (NSA XSAPR)

Std(P) vs N

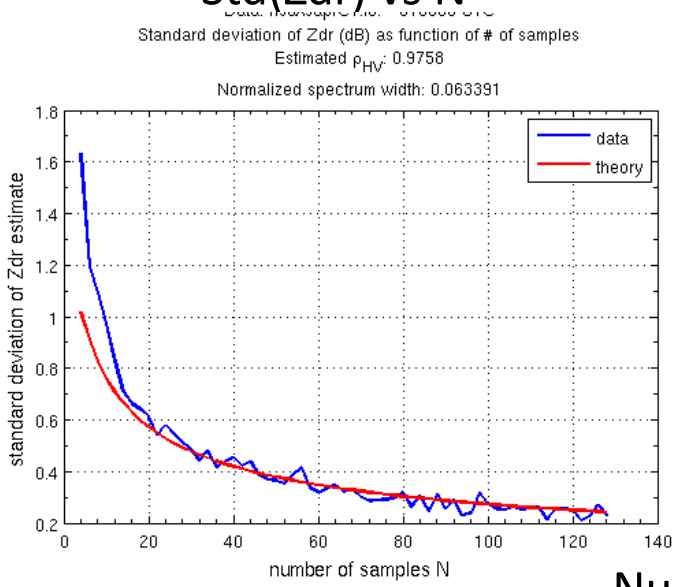


Std(Phidp) vs N

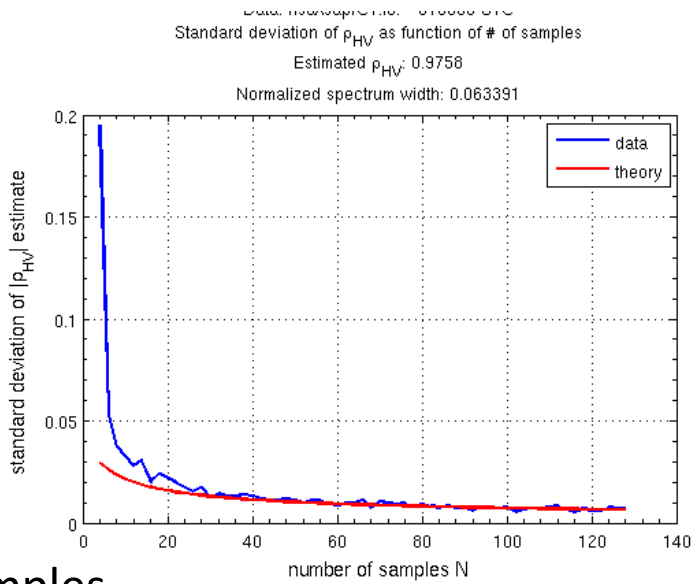


Standard deviation

Std(Zdr) vs N



Std(rhoHV) vs N

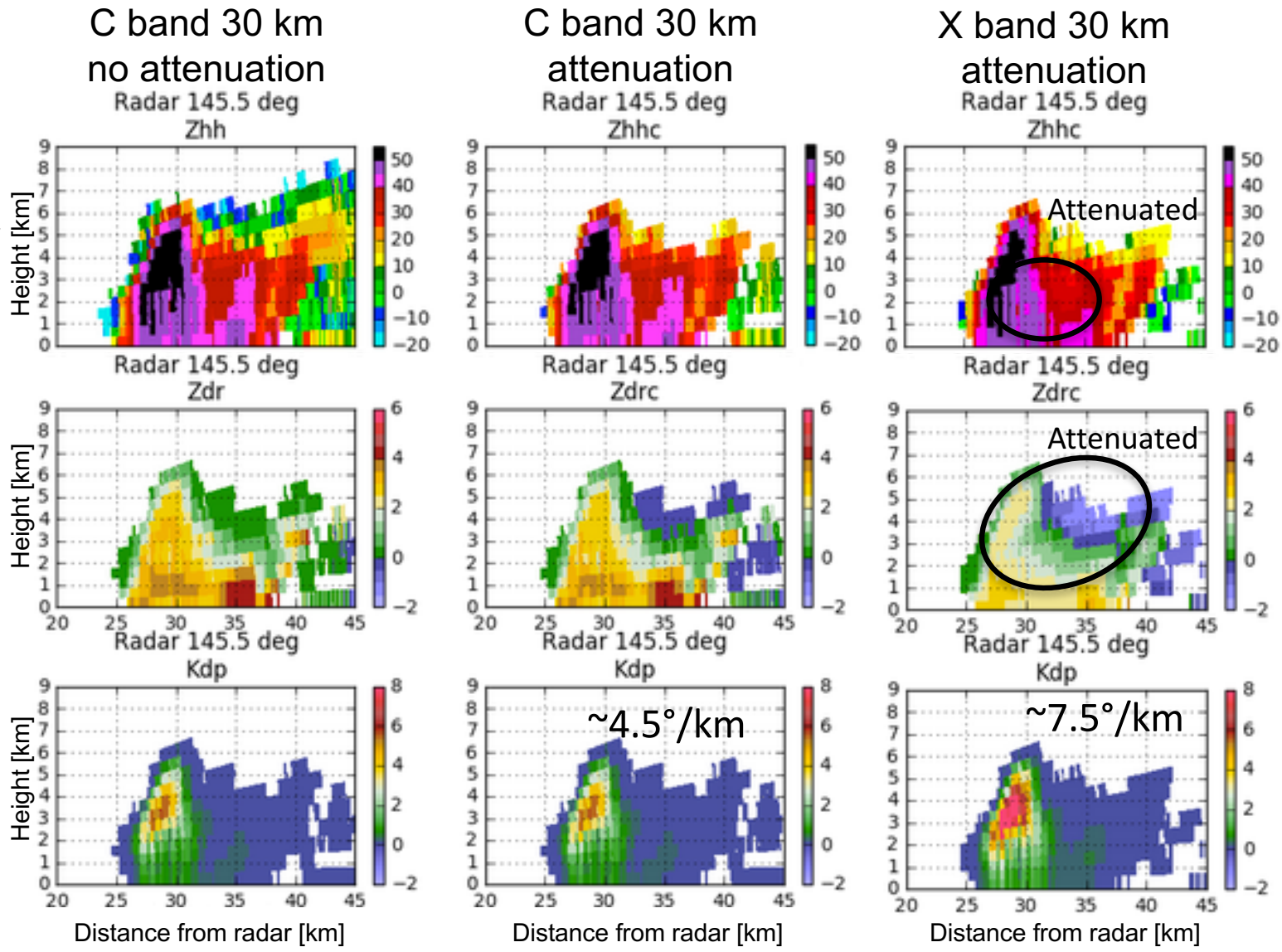


Standard deviation

Number of samples

Figures provided by Dr. Chandrasekar (2014.3)

Polarimetric Parameters: C- and X-Band RHIs at 30 km



- X-band Zhh and Zdr show attenuation effect.
- X-band Kdp shows stronger signal than at C band, consistent with wavelength effect.

Horizontal cross section (Grid from PPI)

Zhh (no attenuation, n sensitivity)

Zhh (+sensitivity, attenuation)

Doppler velocity

Zdr (no attenuatio

Zdr (+sensitivity, attenuation)

Kdp