Polarimetric Radar Characteristics of Warm-Season Updrafts over KSC/CCAFS

Mark Wilson/Getty Images, http://i.usatoday.net/tech/gallery/2011/twis/twis110401/08-pg-horizontal.jpg

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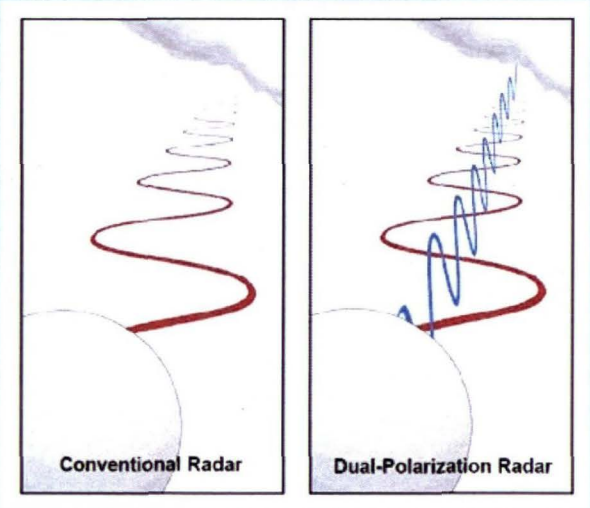
August 7, 2012

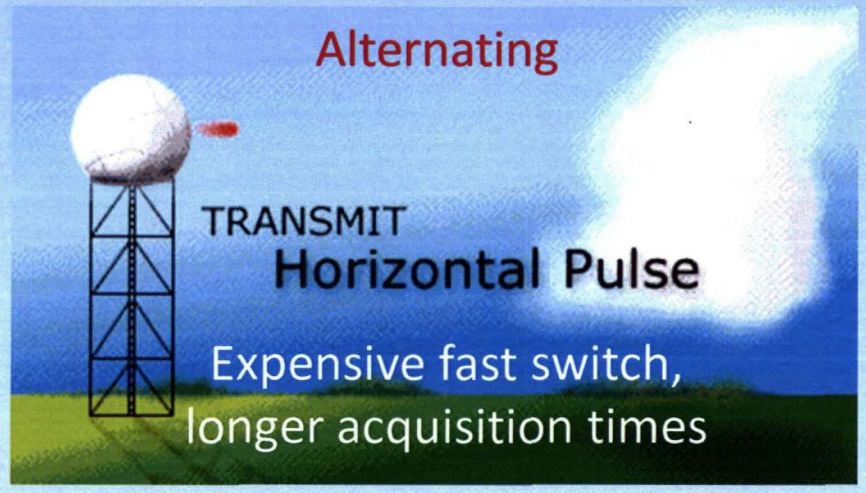
Dual-Polarization: Quick Refresher

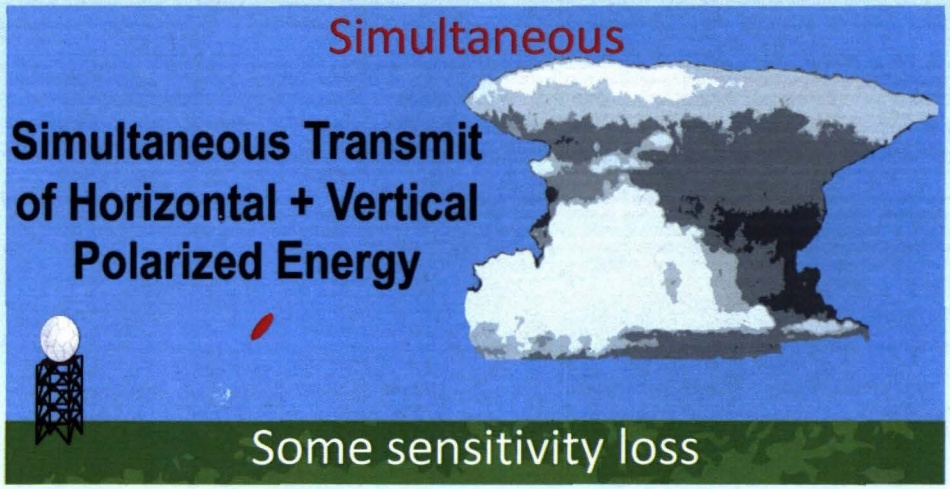
Dual-pol radar:

Receives horizontally and vertically oriented backscatter



Two methods:



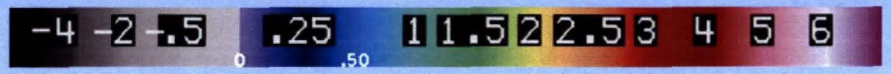


http://www.roc.noaa.gov/WSR88D/dualpol/

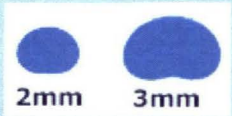
http://www.nssl.noaa.gov/projects/wof/documents/radarda2011/presentations/Burgess_SSDA_workshop.pptx

Dual-Polarization Products

Differential Reflectivity (Z_{DR}) [dB]



- Average horizontal vs. vertical dimensions of targets in a volume

>0 dB	~0 dB	<0 dB
Horizontal	Spherical	Vertical
Rain  Water-coated, smaller hail	Drizzle Tumbling dry hail	Very large hail (Mie), some ice, some clutter
Biological		
Ice depends on wetness, density, preferred orientation; **-2 to 4 dB**		

http://ga.water.usgs.gov/edu/raindropshape.html

AP Photo / Charlie Riedel
http://en.wikipedia.org/wiki/File:Record_hailstone_Vivian,_SD.jpg

Dual-Polarization Products

Correlation Coefficient (CC or ρ_{HV}) [unitless]

- Conforming behavior of targets from pulse to pulse in a volume

Near 1.0	0.8 to 0.97	<0.8
Meteorological uniform	Meteorological non-uniform	Non-meteorological
		Clutter, Smoke, Tornado debris
>1.0 Untrustworthy values in weak signal		

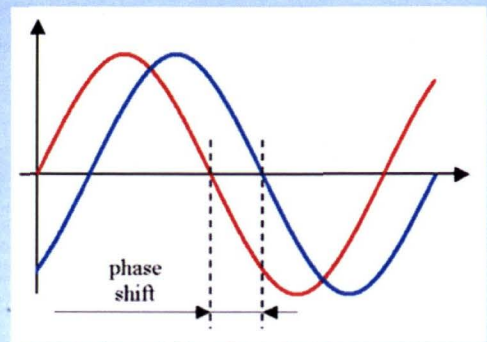
http://www.wdtb.noaa.gov/courses/dualpol/Products/CC/player.html

ROSS TUCKERMAN/AFP/Getty Images

Dual-Polarization Products

Differential Phase Shift (Φ_{DP}) [degrees]

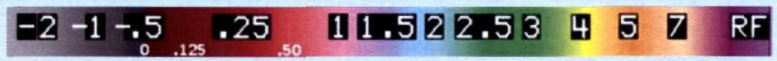
- Horizontal vs. vertical radar wave phase shift
- Occurs rapidly in heavy rain.
  - Large droplets and high concentration
- Accumulates down radial.

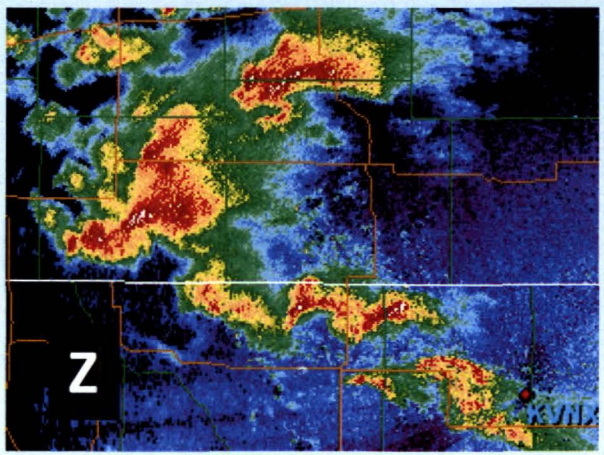


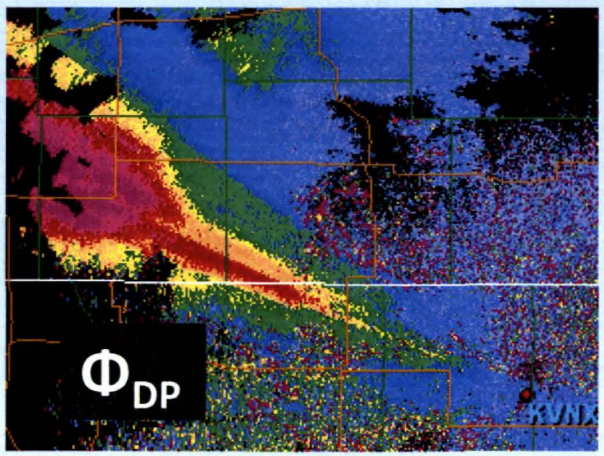
Australian Government – Bureau of Meteorology

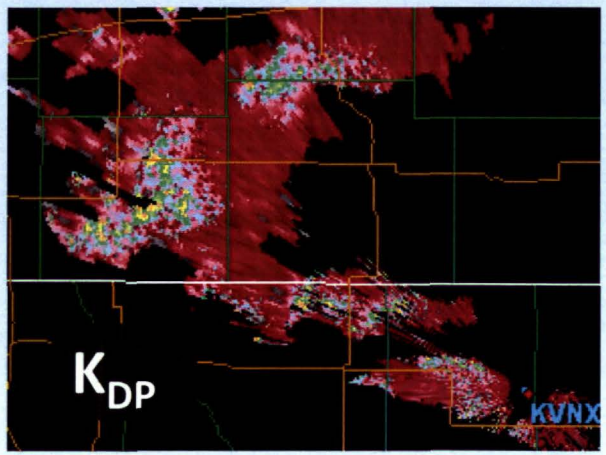
Specific Differential Phase Shift (K_{DP}) [degrees km^{-1}]

- Range derivative of Φ_{DP}



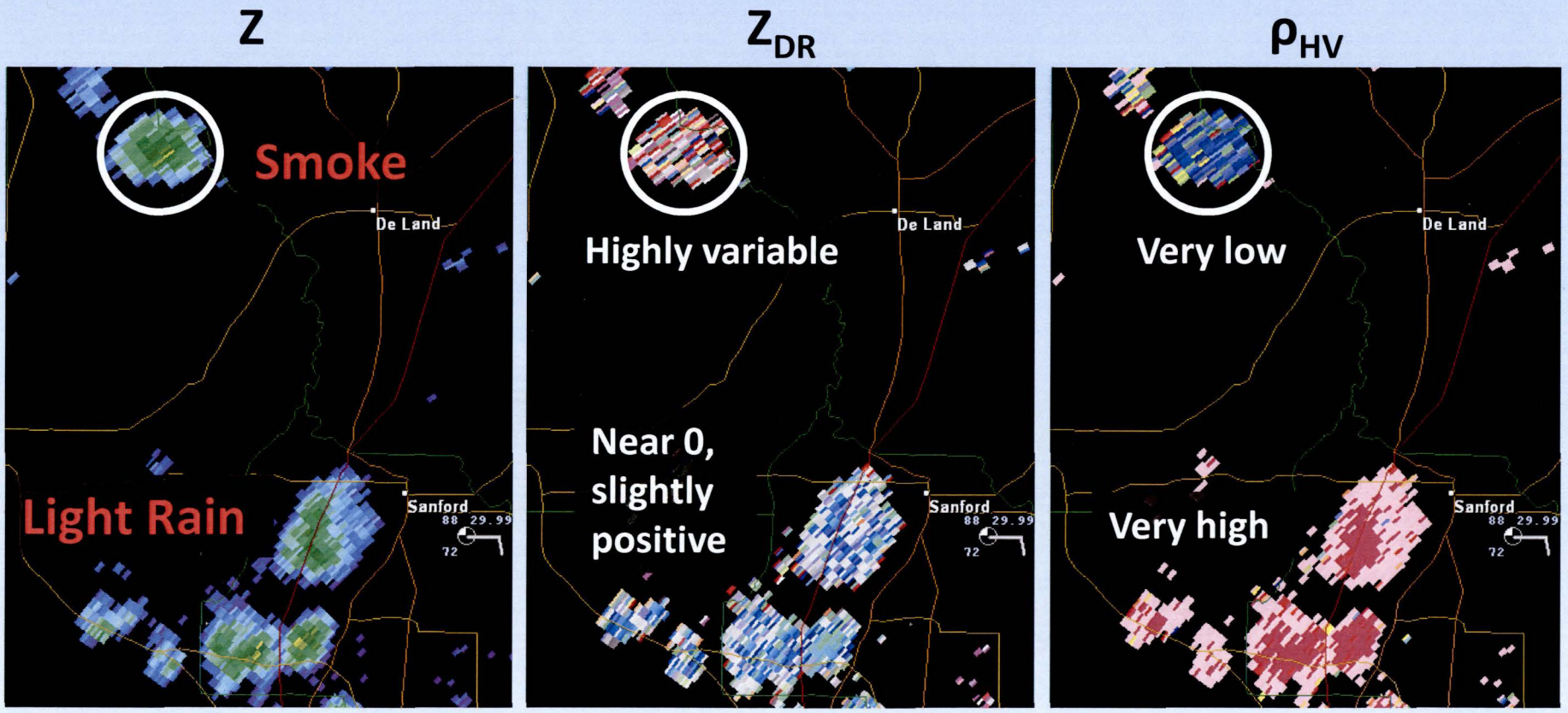






One of these things is not like the others

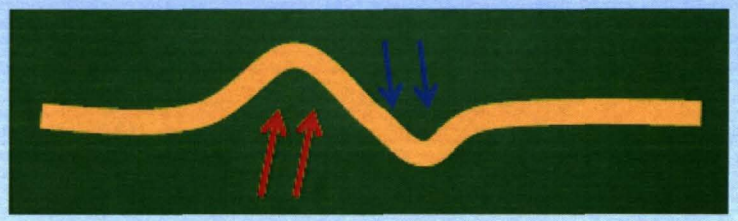
1637 UTC, 21 June 2012

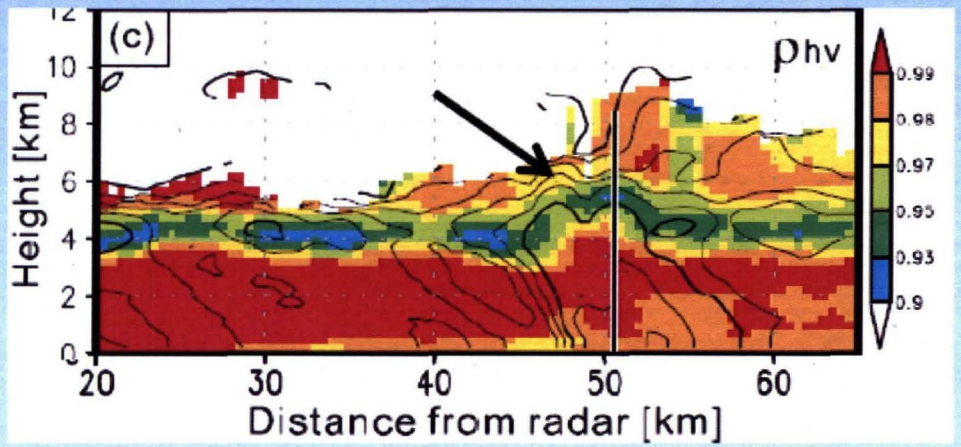


Updraft Melting Layer Signature; Harris (2011)

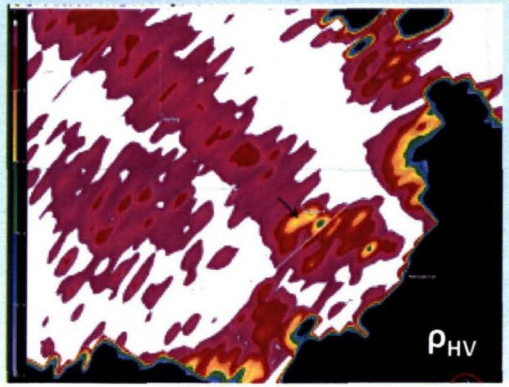
Proof of concept in preparation for KSC/CCAFS studies.

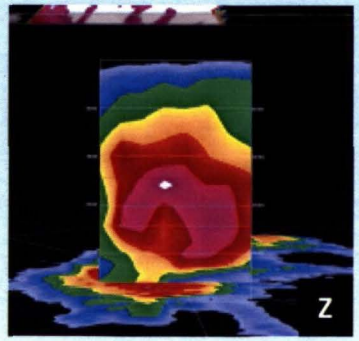
Melting Layer displacement in convection (Shusse *et al*. 2011).

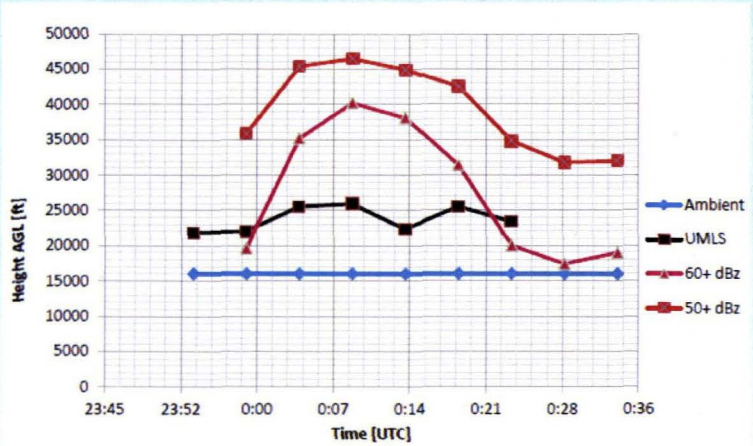




Updraft Melting Layer Signature (UMLS) heights at KVNX and KICT vs. SPC wind reports.





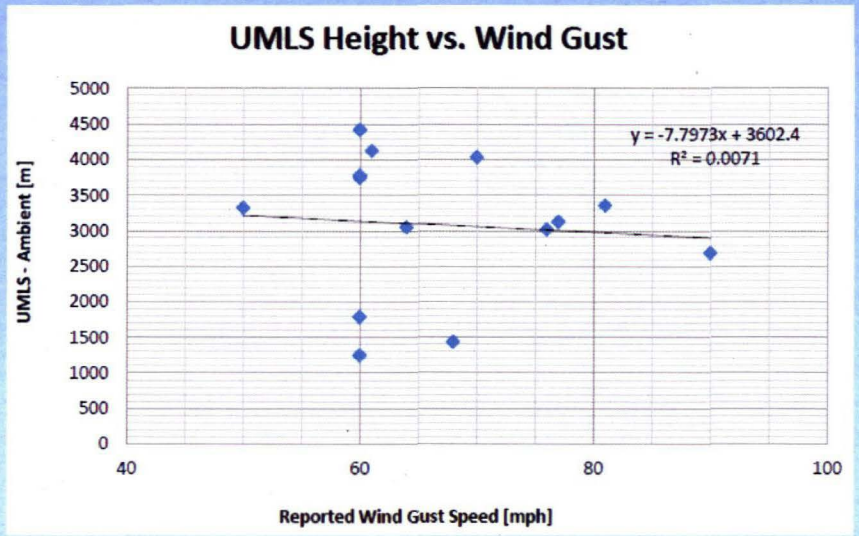


Updraft Melting Layer Signature; Harris (2011)

No correlation found.

Many reasons why:

- Low density, perhaps unreliable max wind reports.
- Radar beam-spreading errors.
- Differing thermodynamic environment from case to case.
- Updraft and downdraft strengths controlled separately.

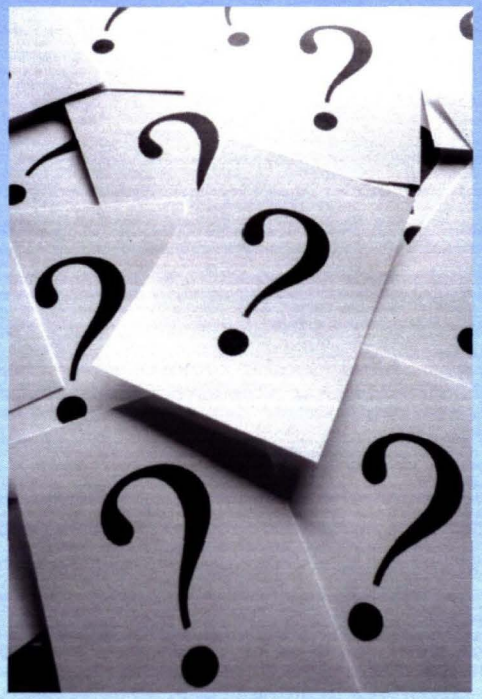


My turn: KMLB dual-pol upgrade, GR2Analyst version 1.92b

- Dual-pol products in cross sections.
- K_{DP} available.
- High density wind mesonet.

Challenges

1. Physical/Environmental
2. Observation (Radar)
3. Visualization/Interrogation



http://nonprophetstatus.com/wp-content/uploads/2010/11/question-marks.jpg

Challenges

1. Physical/Environmental

- FL warm-season convection *vs.* Harris (2011) severe Plains convection?

  Lower shear → sharper gradients of precip intensity

  Sporadic updrafts → chaotic storm structure

- Maximum realistic lead time?

  From radar observation of new precip-laden updraft

  to downdraft ground winds → 10-20 minutes?

- Locally modified thermodynamic environment?

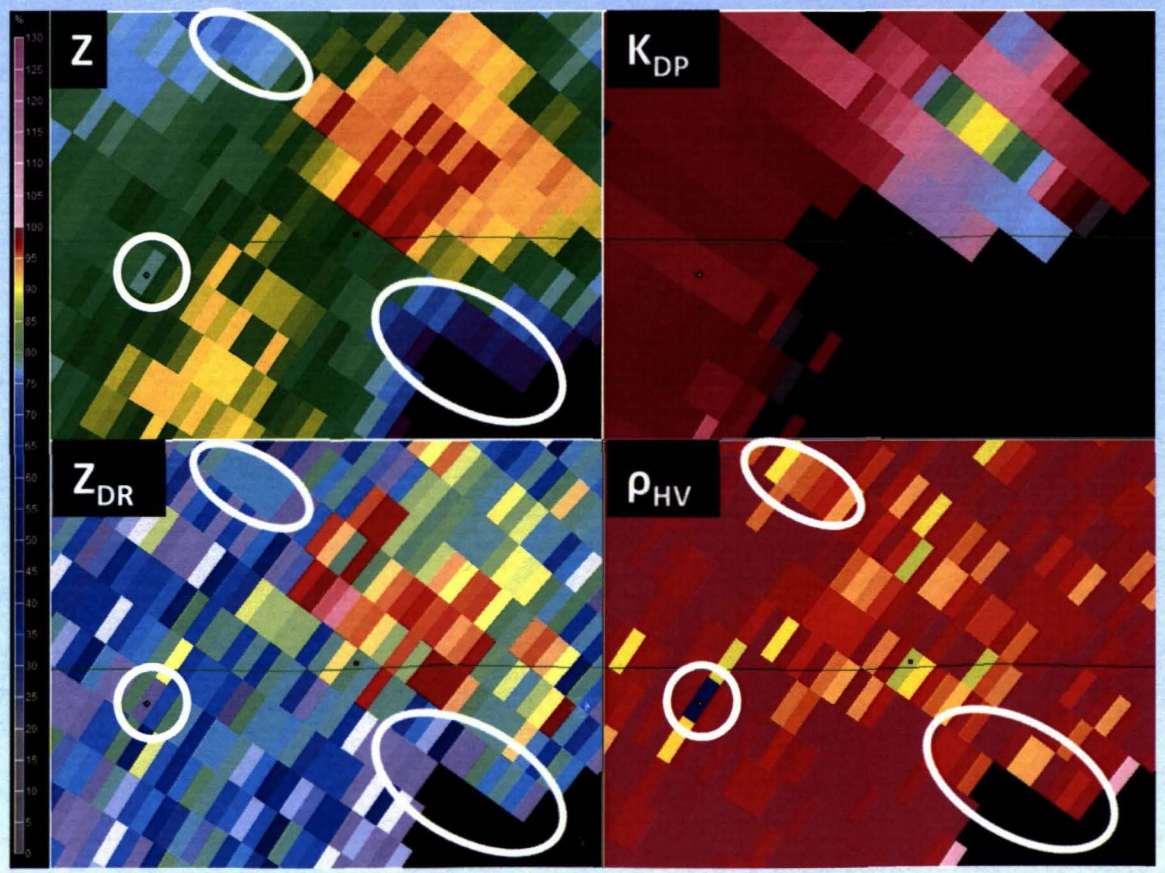
  Successful radar-based nowcasting tool will likely need context of

  local thermal/moisture profile.

Challenges

2. Radar

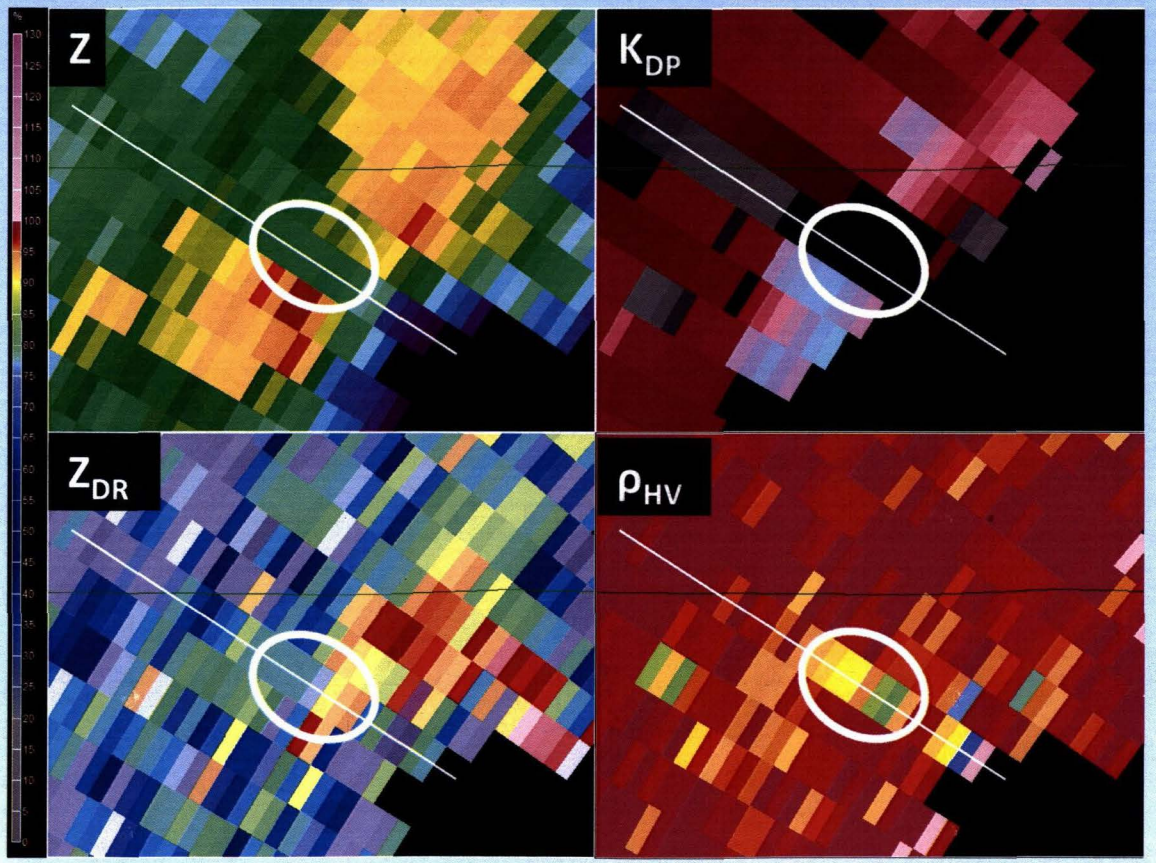
- Low signal-to-noise ratio (SNR) (low reflectivity) → low ρ_{HV}
- Low SNR and $\rho_{HV} < 0.95$ → ZDR errors >0.3 dB, can appear noisy



Challenges

2. Radar

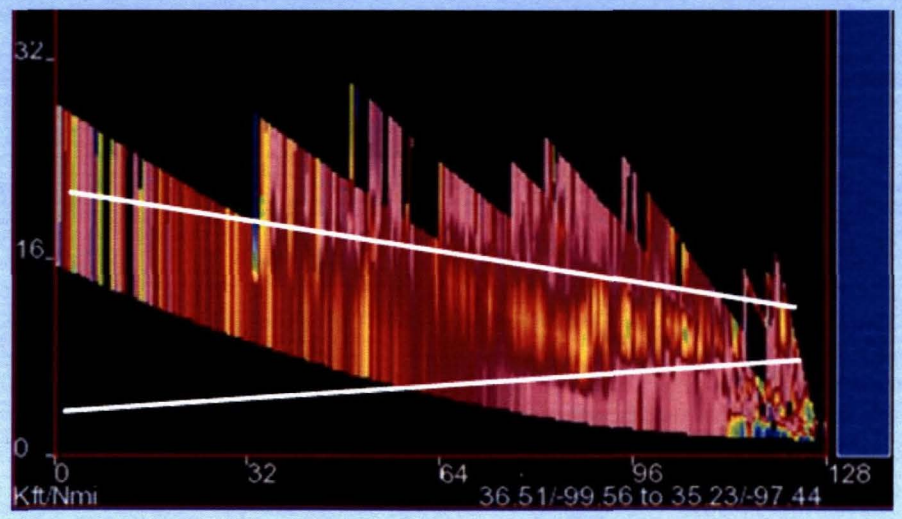
- Non-uniform beam filling (sharp reflectivity gradients) → low ρ_{HV}
- If $\rho_{HV} < 0.9$ → Φ_{DP} noisy and unreliable → K_{DP} not computed



Challenges

2. Radar

- Beam broadening leads to apparent smearing of the melting layer.
  - ML typically a few hundred meters thick.
  - At 60 km range (KMLB to LC-39B), radar beam is 1 km thick.



- 1.0° x 0.25 km horizontal bins for tilts sampling KSC melting layer.
  - 1.0° is approx. 0.5 km near the Port, 1.25 km near northern KSC.
  - Fairly coarse resolution for small-scale FL convection.