Science Objectives
(Kosiba and Wurman)

- LLAP band meso/miso scale structure, kinematics, and associated precipitation
  - What type of environment is conducive to fine-scale structures (e.g., meso and miso vortices)?
  - Are these structures associated with significant vertical motion?
    - Vertical motion and lightning. **Collaborative with Scott?**
  - Precipitation type and amount
  - Longevity of structures and overall intensity of the band
  - Wind effects on the impacts? (Drift, Lower visibility, etc. on roads)
  - Do structures (cold pool, boundary) impact band propagation?

- Comparison between X-band and S-band dual-polarization fields
  - Signatures (Zdr and KDP)
  - Snowfall rates (Z)
  - Hydrometeor/Precipitation classification

Background: LLAP band meso/miso scale structure, kinematics, and associated precipitation

- Mesoscale Structures
  - Supercells?
  - Mesovortices (QLCS-type)?

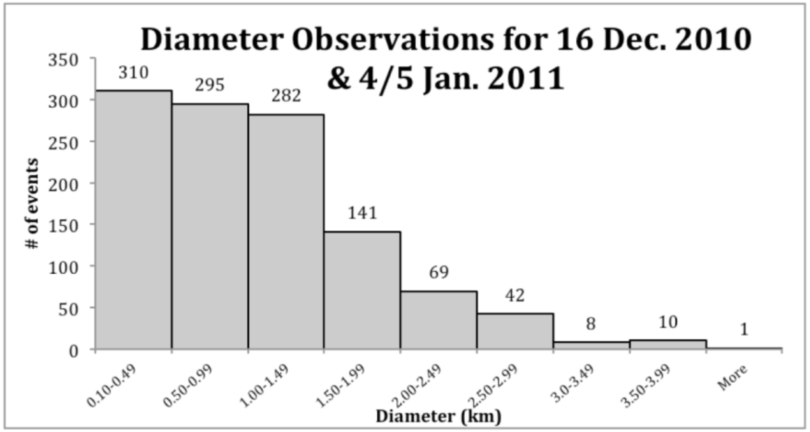
- Are the mesovortices associated with lightning?
  - Lightning (e.g., Schultz 1999; Maekawa et al. 1992; Steiger et al. 2009)
    - Location of the -10 C isotherm
    - Higher temperatures and dewpoints in the lower troposphere and significantly lower lifted indices than lake-effect snowstorms without lightning

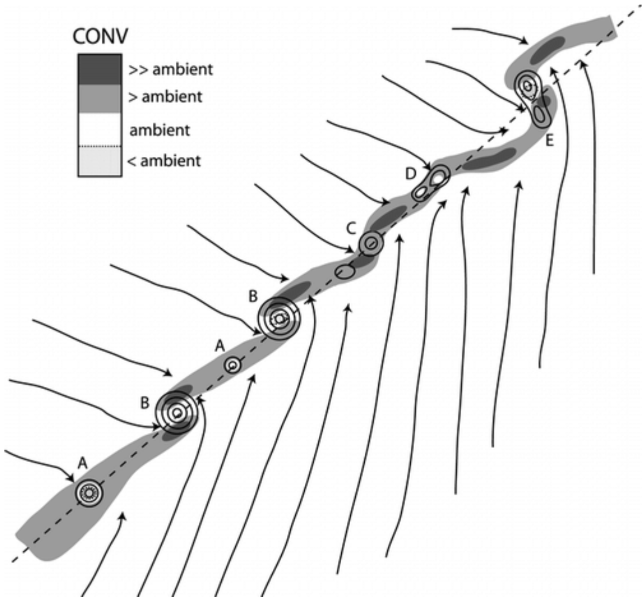
- Environment
  - Buoyancy confined to LLs
  - Shear

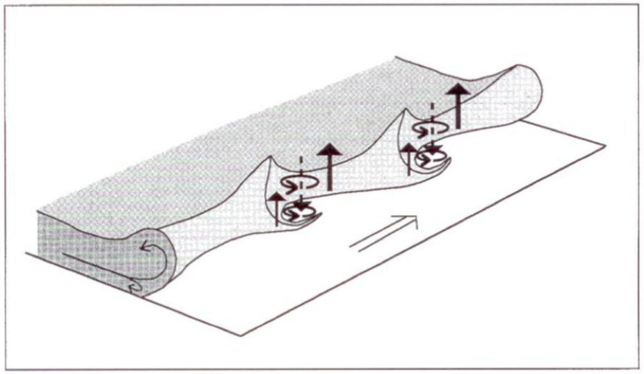
More precipitation?

Background: LLAP band meso/miso scale structure, kinematics, and associated precipitation

- Misoscale Structures
  - Shearing instability
  - Location along boundary
    - Number
    - Spacing
  - Boundary convergence and shear
    - Relation to Misocyclone strength
  - Interaction with larger-scale features
  - Enhanced convergence? Location?
  - Mergers?

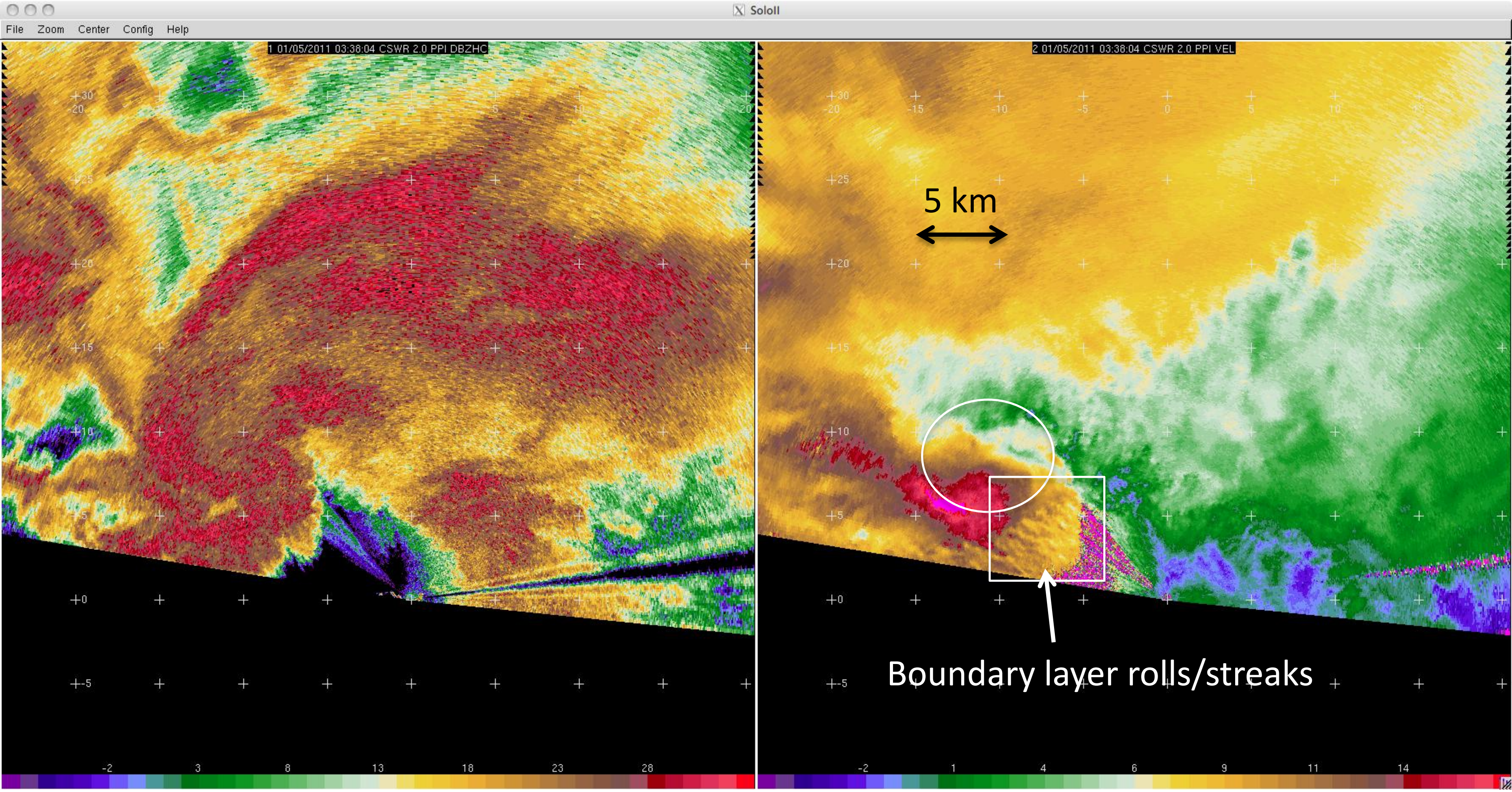




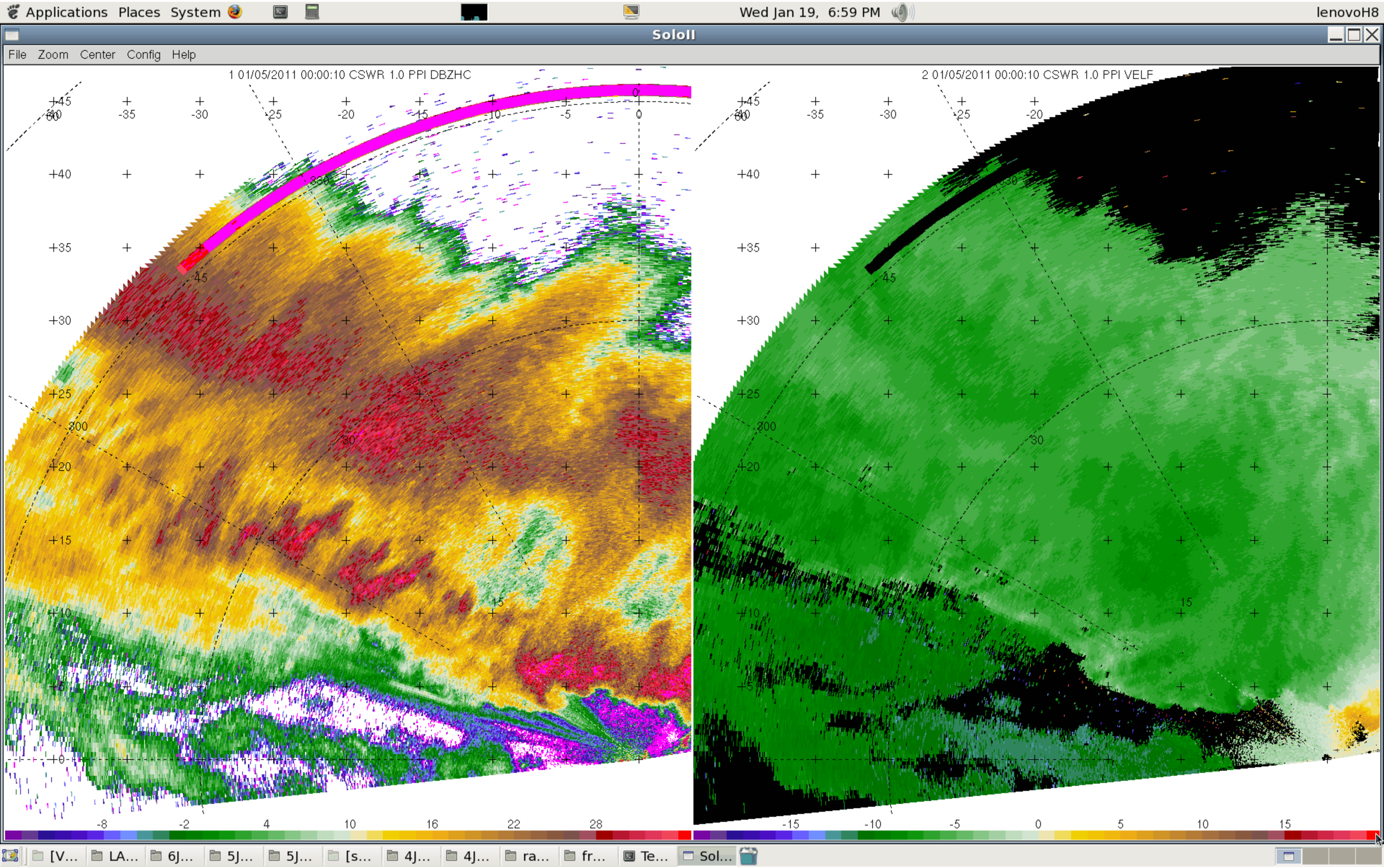


More precipitation?

LLAP (04 January 2011): Example of a Mesovortex (L ~ 5-7 km)

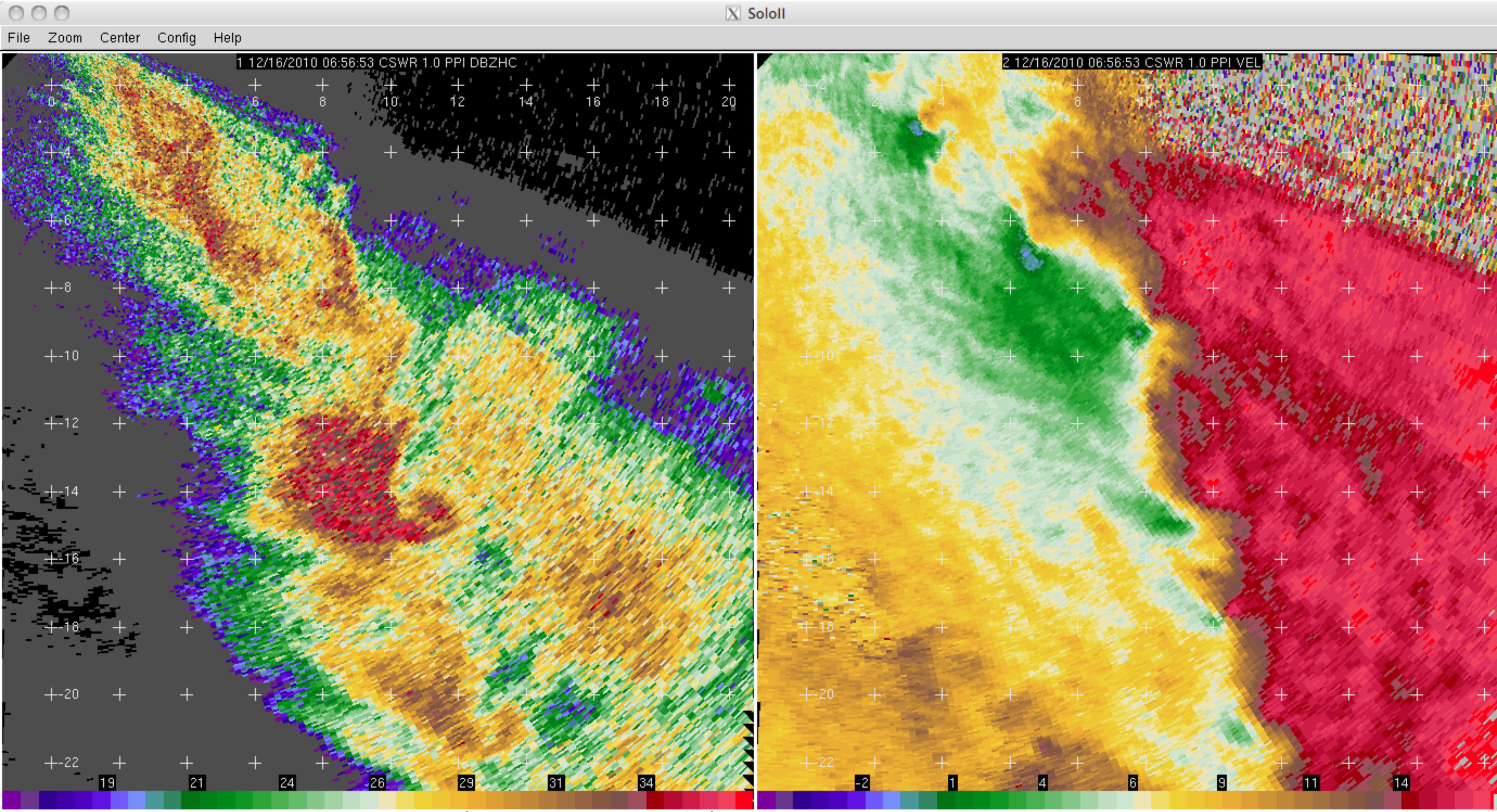


Three-dimensional structure (depth, strength, vorticity) – updraft strength (lightening)
Lifetime and system longevity, intensity, and motion
Associated snow fall rate and hydrometeor type/distribution
Environment – Buoyancy (and shear?) driven? (vertical profile of the atmosphere)
QLCS mesovortex (streamwise) versus supercell (Cross-wise)



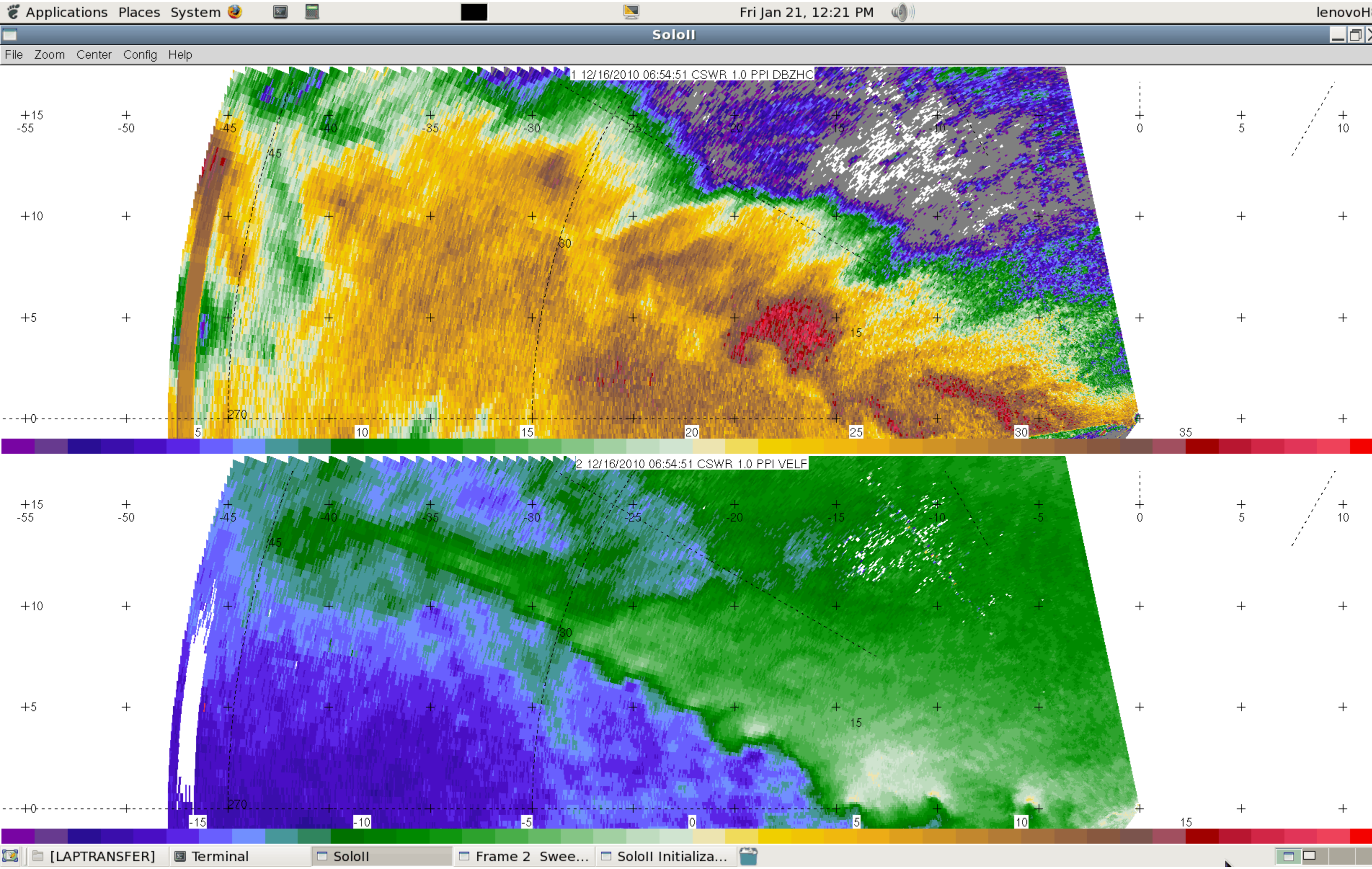
Applications Places System
Wed Jan 19, 6:59 PM
lenovoH8
SoloII
File Zoom Center Config Help
1 01/05/2011 00:00:10 CSWR 1.0 PPI DBZHC
2 01/05/2011 00:00:10 CSWR 1.0 PPI VELF
-8 -2 4 10 16 22 28
-15 -10 -5 0 5 10 15

LLAP (16 December 2010): 2-4 km spacing between structures

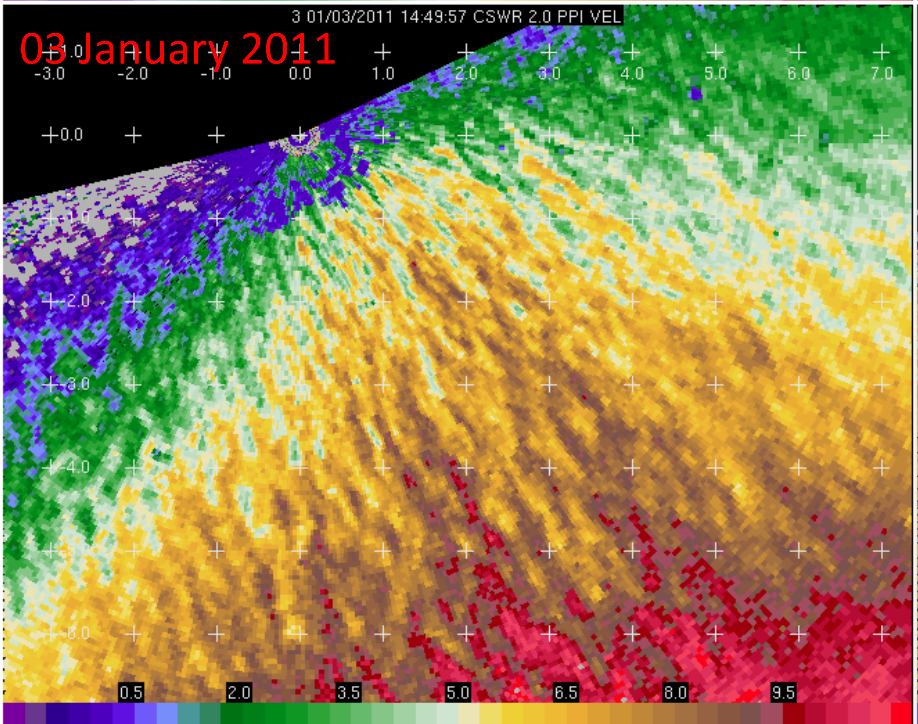


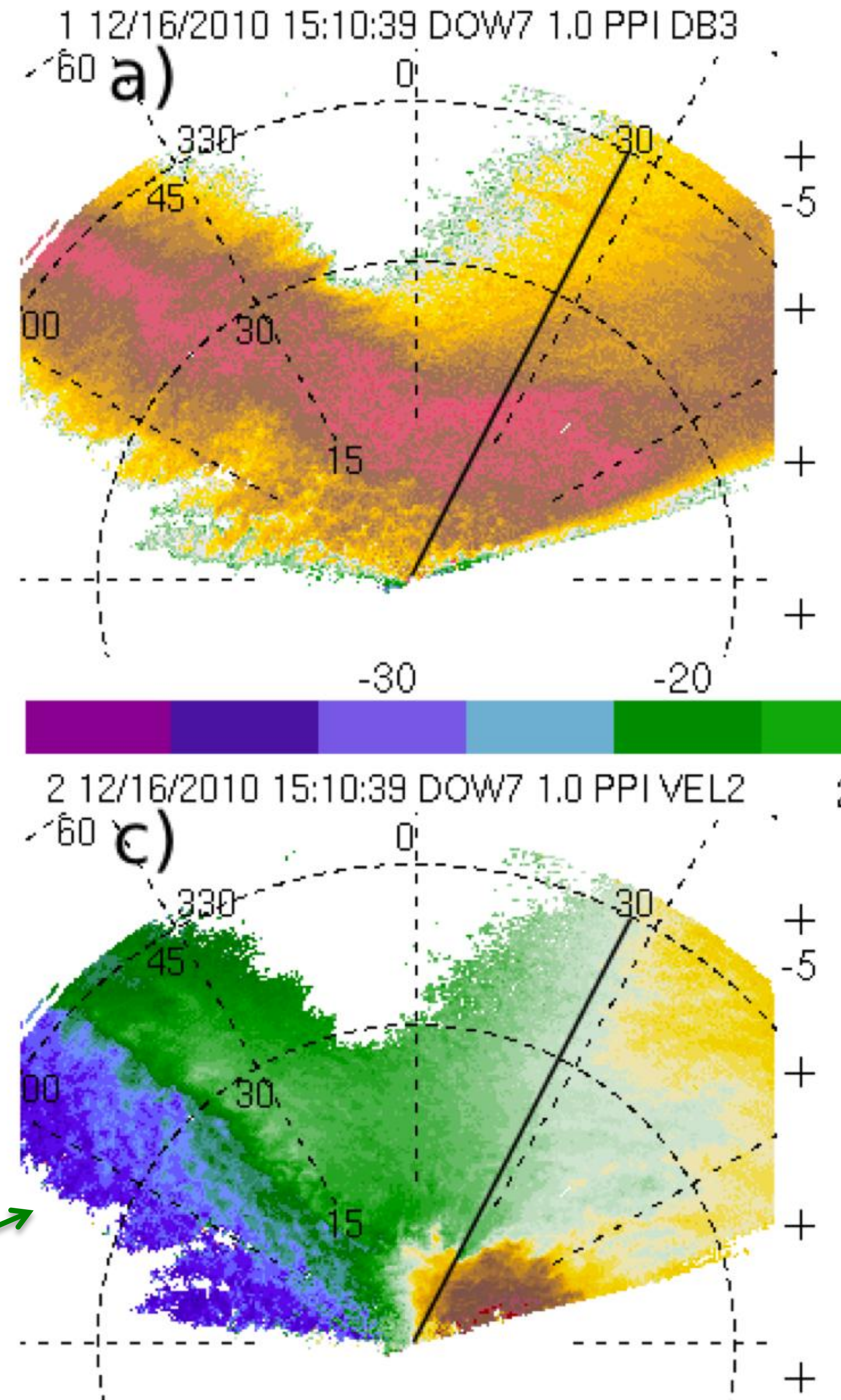
Three-dimensional structure (depth, strength)
Lifetime
Snow fall
Hydrometeor type
Environment – Shear driven?

Form along airmass boundaries?
Mixing?
Interaction with other structures?
Enhanced convergence?
Mergers?



Propagation of band	Boundary layer streaks



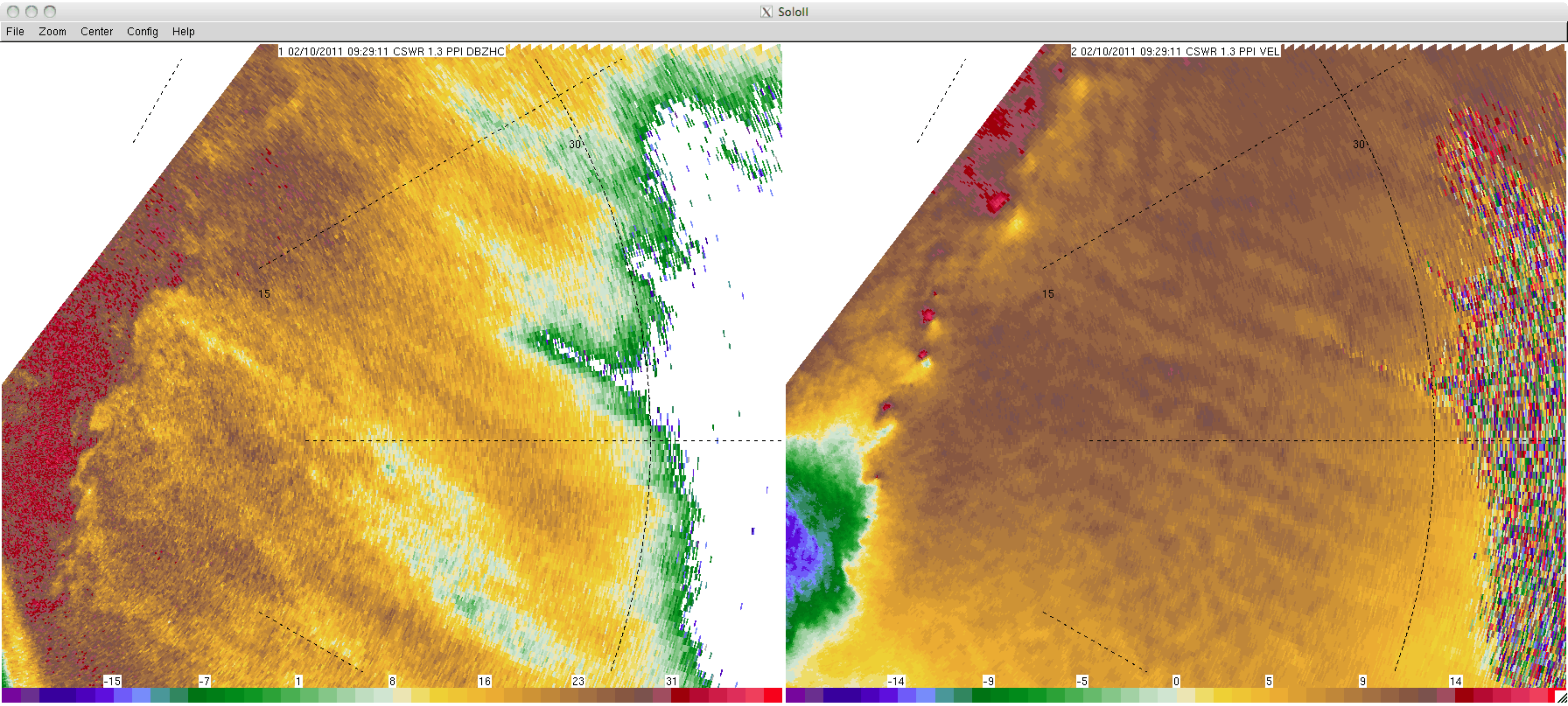


Boundary layer rolls/streaks – LL shear
Sub-kilometer scale (like hurricane BLs)
Not HCRs

Is there moisture convergence associated with these structures? Are they imbedded in larger scale (> 1km) HCRs rolls

Boundary layer cells?
Linear to cellular structure – change in meso/miso vortices

Different Scales



Background: Comparison between X-band and S-band dual-polarization fields

- Signatures:
  - High Z, Low Z_{DR}, and high ρ_{hv} immediately above the ML are believed to be associated with convective turrets containing heavily aggregated or rimed snow that supply water/ice mass that later result in enhanced regions of precipitation near the surface
    - Schuur, T., A. Ryzhkov, D. Forsyth, and H. Reeves, 2012: Precipitation observations with NSSL's X-band polarimetric radar during the SNOW-V10 campaign, *Pure and Applied Geophysics,* (10.1007/s00024-012-0569-2).
  - Enhanced (positive) KDP at ~-15C isotherm was linked to increased surface precipitation rates, suggests rapid dendrite growth
    - Kennedy, Patrick C., Steven A. Rutledge, 2011: S-Band Dual-Polarization Radar Observations of Winter Storms. *J. Appl. Meteor. Climatol.*, **50**, 844–858.

- Classification
  - Fuzzy logic algorithms (Z, Zdr, Kdp, LDR, Rhohv). **Collaborative effort.**
  - Thermodynamic profiles and/or RUC data

Data Collection and Deployment Strategies

- Instruments/Needs
  - Dual-polarization radars
  - Disdrometers (hydrometeor size and velocity distribution)
  - Surface observations of temperature, RH
  - Surface observations of precipitation type/size
  - Environmental vertical temperature profile
  - In-Situ aircraft observations through boundaries

- DOW Scan Needs:
  - Want to capture fine-scale DD structure and "microphysics" – Include Vertical scans and RHIs for microphysics
  - Rapid updates
  - LLAP bands shallow
    - Convective elements: height = 2-4 km

Data Collection and Deployment Strategies

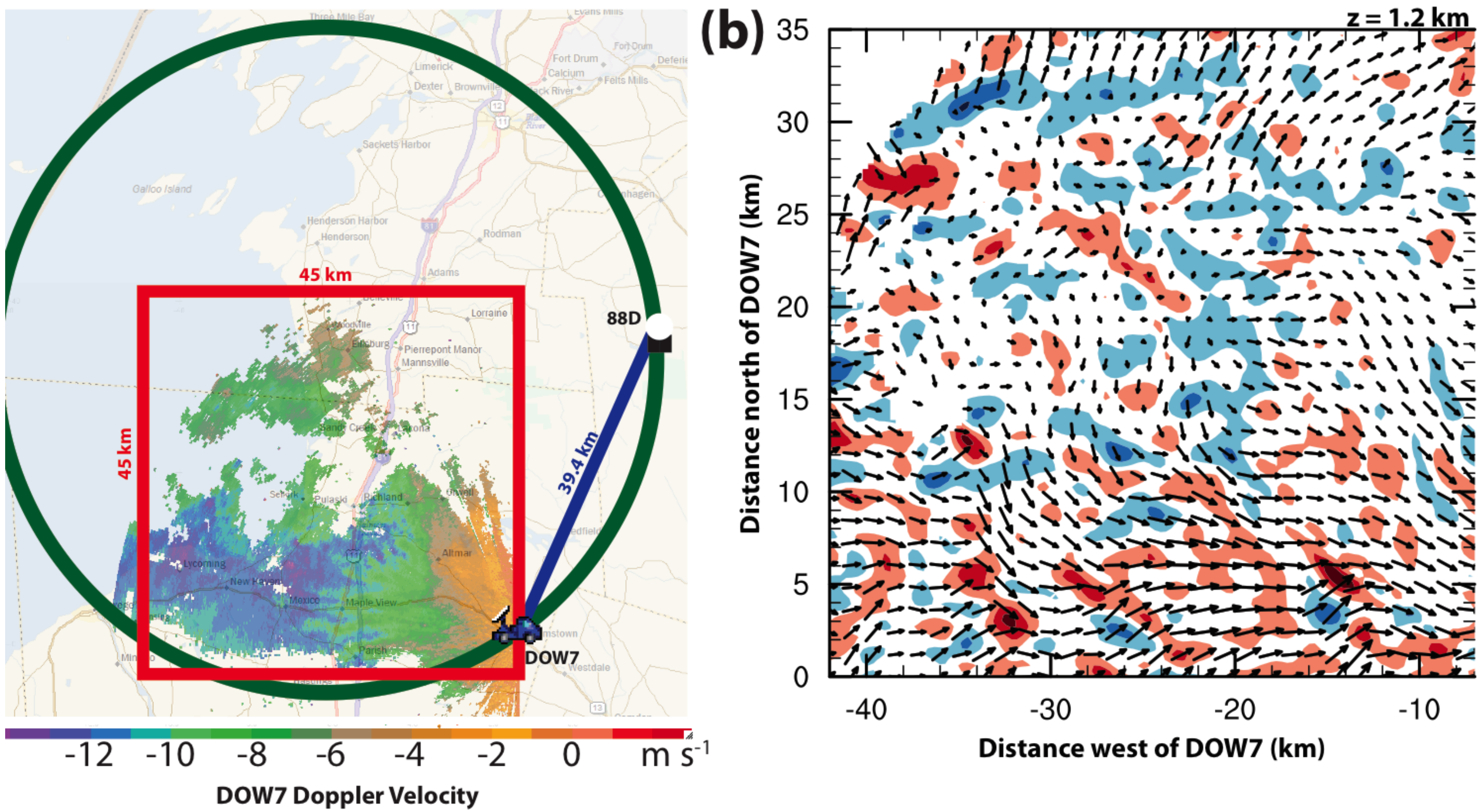
- DOW Configuration
  - DD Baseline: <=20 km
  - Vertical depth ~ 3 km

- DOW Scan Strategies
  - 30 degree/sec
    - 20 tilts, 4-minute volumes
    - 15 tilts, 3-minute volumes (1-10, 12, 14, 16, 18, 20)
    - RHIs? Vertical Scans?
  - 50 – 100 m gating

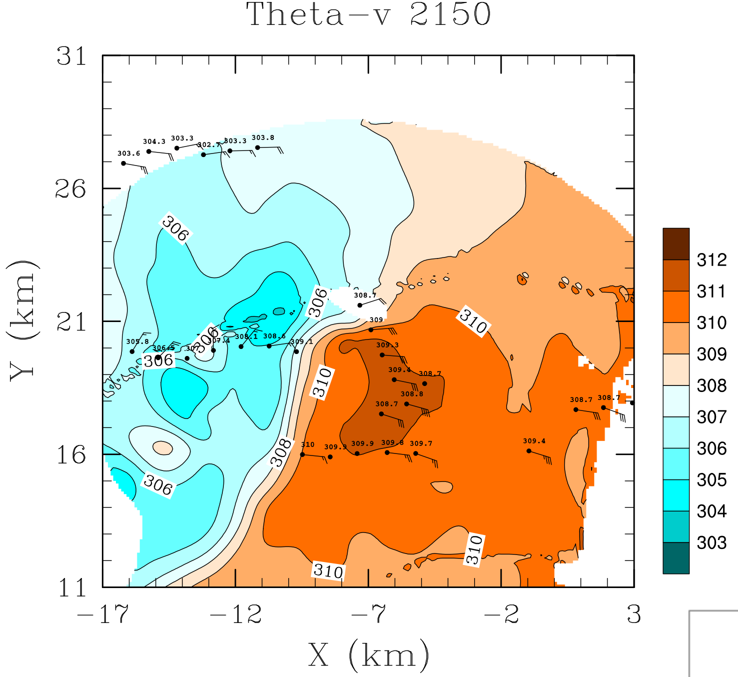
- 3rd, Fast-scanning radar, with 25 -50 m gates

Data Analysis Methods: LLAP band meso/miso scale structure, kinematics, and associated precipitation

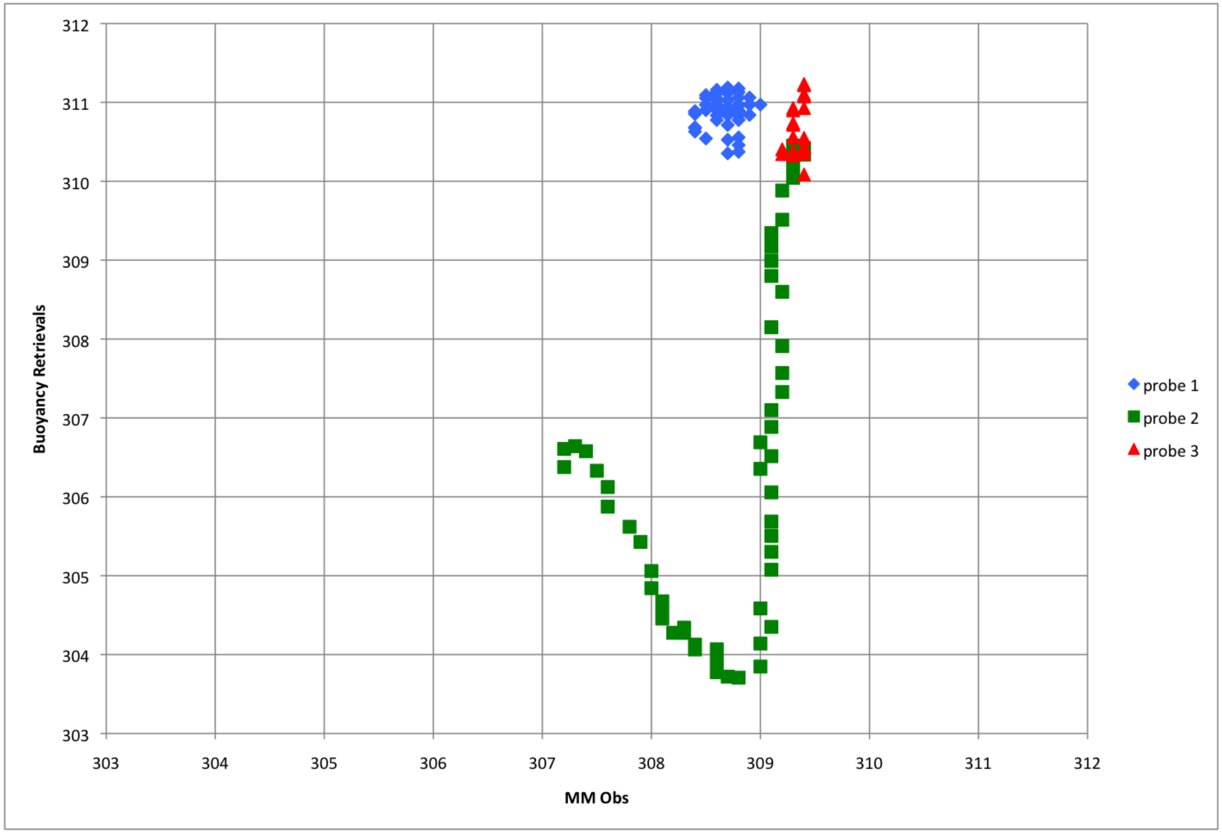
- Classify environment
- Dual-Doppler analysis
  - Spatial scale azimuthally limited
    - Grid spacing (< 100m)
- Integrate fast, single-Doppler observations for fast temporal evolution
- Integration of thermodynamics: Mobile mesonet/pod/airplane transects
  - Boundaries (outflow, airmass, at the shore)
- Hydrometeor classification and dual-polarization signatures



45 km
45 km
88D
39.4 km
DOW7
Sackets Harbor
Galloo Island
Henderson Harbor
Henderson
Rodman
Adams
Lorraine
Pierrepont Manor
Mannsville
Sandy Creek
Lacona
Pulaski
Richland
Altmar
Lycoming
New Haven
Mexico
Maple View
Parish
Limerick
Dexter
Fort Drum
Calcium
Felts Mills
Westdale
-12 -10 -8 -6 -4 -2 0 m s-1
DOW7 Doppler Velocity
(b)
z = 1.2 km
35
30
25
20
15
10
5
0
Distance north of DOW7 (km)
-40 -30 -20 -10
Distance west of DOW7 (km)



Horizontal Gradients did not match between DD and MM



Data Analysis Methods: Comparison between X-band and S-band dual-polarization fields

- Signatures at X- and S-Band and Associated Precipitation/Hydrometeors
  - Enhanced regions of K_{DP} and Z_{dr}
    - Location of -15 C isotherm
  - ML and Z, Low Z_{DR}, and high ρ_{hv}
  - Snowfall rate
    - Matrosov, Sergey Y., Carroll Campbell, David Kingsmill, Ellen Sukovich, 2009: Assessing Snowfall Rates from X-Band Radar Reflectivity Measurements. *J. Atmos. Oceanic Technol.*, **26**, 2324–2339.

- Hydrometeor Classification:
  - Dual-polarization fields in combination with RUC thermodynamics (or observations)
    - Schuur, Terry J., Hyang-Suk Park, Alexander V. Ryzhkov, Heather D. Reeves, 2012: Classification of Precipitation Types during Transitional Winter Weather Using the RUC Model and Polarimetric Radar Retrievals. *J. Appl. Meteor. Climatol.*, **51**, 763–779.
  - Fuzzy logic algorithms
    - Dolan, Brenda, Steven A. Rutledge, 2009: A Theory-Based Hydrometeor Identification Algorithm for X-Band Polarimetric Radars. *J. Atmos. Oceanic Technol.*, **26**, 2071–2088.

- **Need for surface observations/verification.**