Challenges in PBL and Innovative Sensing Techniques

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Current Sensing Systems

- Designed to support aviation – raobs, sfc. wx
- Modified network for NWP
- Integration of satellite – clouds, sfc. radiance
- ACARS added
- Wind profilers – troposphere, PBL
- Dense sfc. systems – often urban

Look to Future Needs & Users

- Small scales (0.01< X <10 km; 10 < t < 10^3 sec)
  - Urban Meteorology
  - Wind Energy
  - CBRN Dispersion
  - Military Operations
  - Public Health / Air Quality
  - Surface Transportation

Forecast Challenges - PBL

- Heterogeneity
- Surface Layer – u_*, Q_*, H_*, stability
- Vertical distributions of **V**, T, q, tke, ε, Ri
- BL height – Z_i , thickness of inversion
- Turbulence Parameterization
- Clouds / Radiation
- Precipitation
- Terrain – elevation, soils, moisture
- Meeting user needs

Observing Challenges

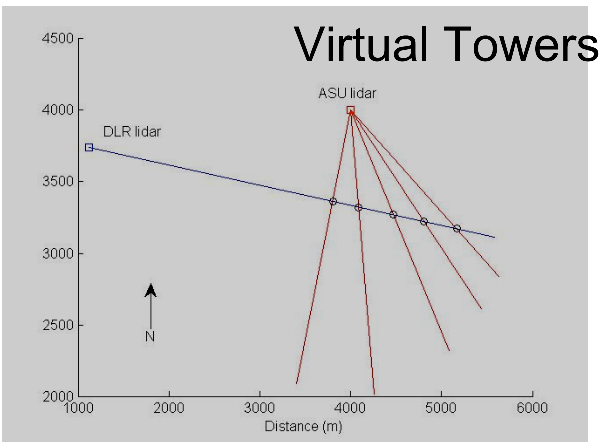
- Continuity, Correlation & Coherence across scales
- Continuity of special observing systems
- Few opportunities for sustained analyses
- PBL is 4-dimensional
- Volumetric measurement capability
- Rapid memory loss @ high resolution means rapid refresh rate
- Interaction with users and modelers

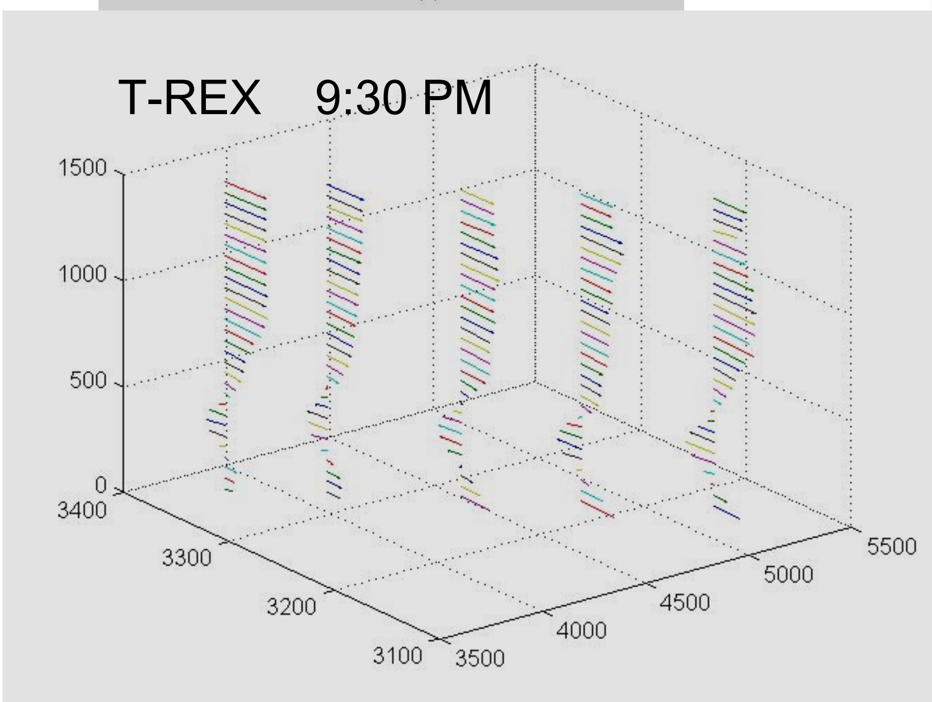
Some Approaches

- Doppler Wind Lidars
  - Paired - planar winds, virtual towers
  - Airborne
  - Satellite
  - Turbulence Profiler (concept)
- Backscatter Lidar
- Radar
  - FM/CW wind profiler
  - NetRad Distributed Network
- Acoustic Tomography
- Temperature & Moisture Profilers

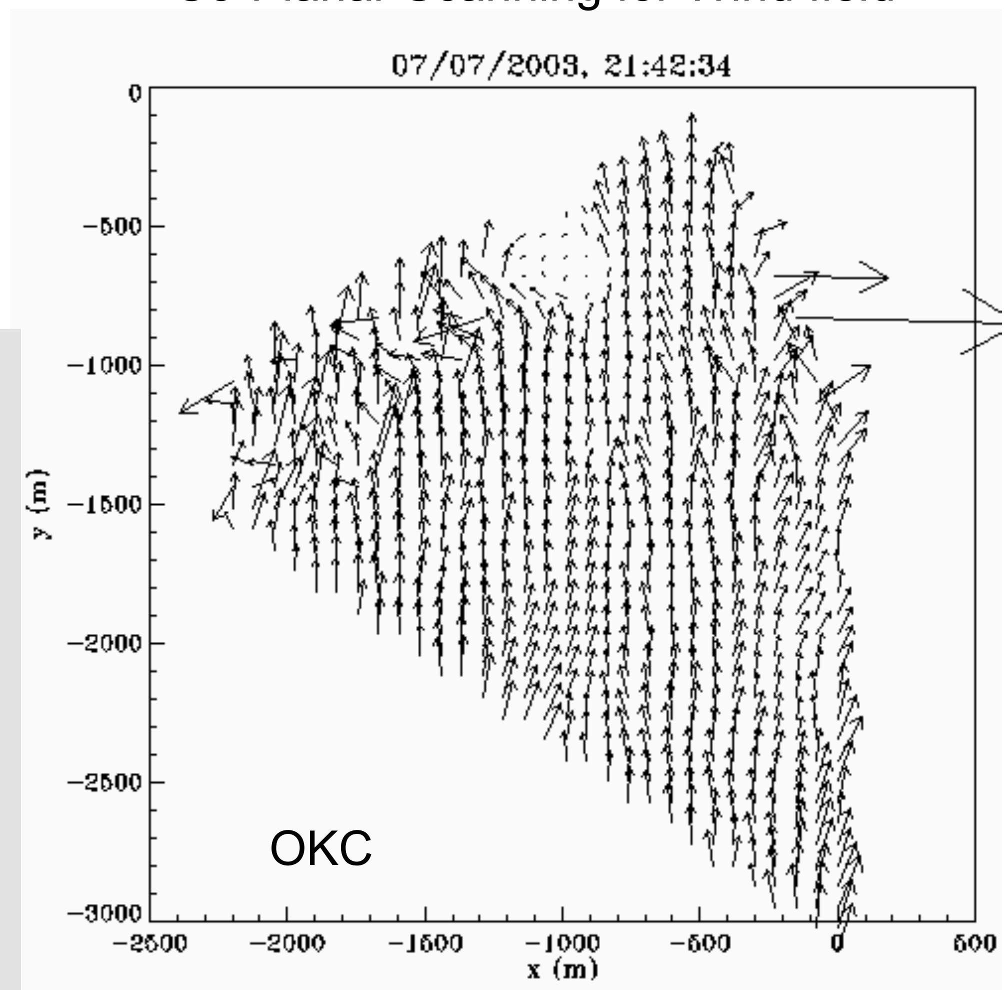
Surface Based Doppler Wind Lidars

Ron Calhoun, Arizona State





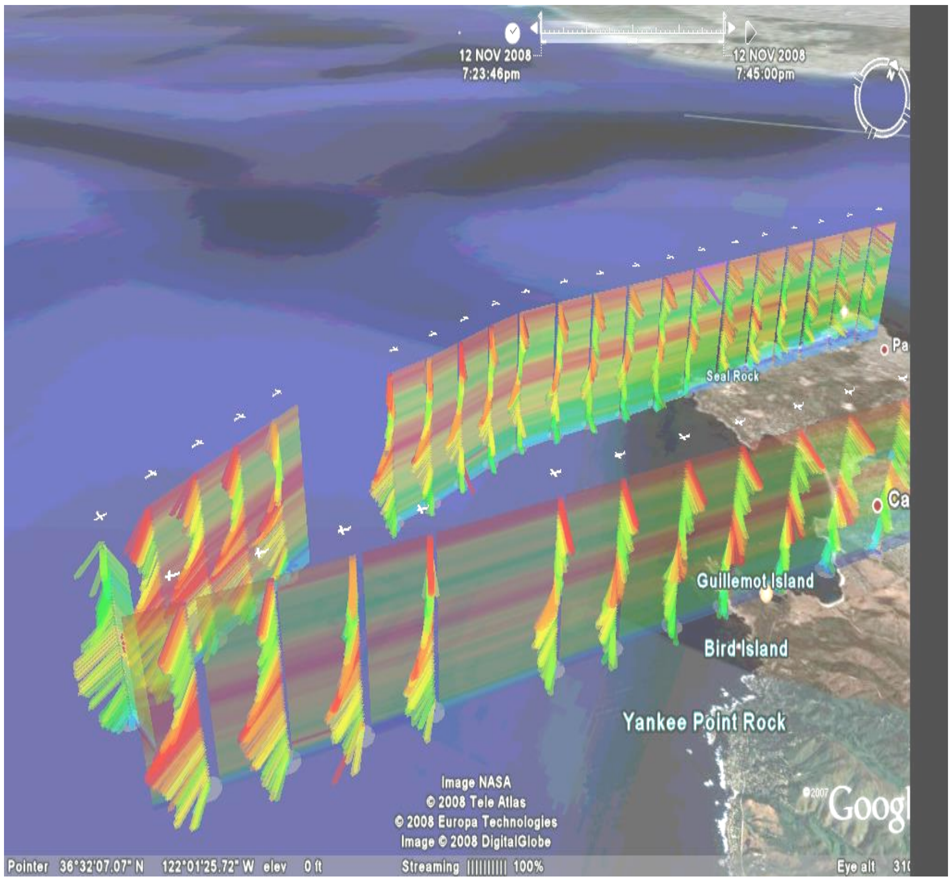
Co-Planar Scanning for Wind field



Airborne Doppler Wind Lidar

David Emmitt, Simpson Weather Assoc.

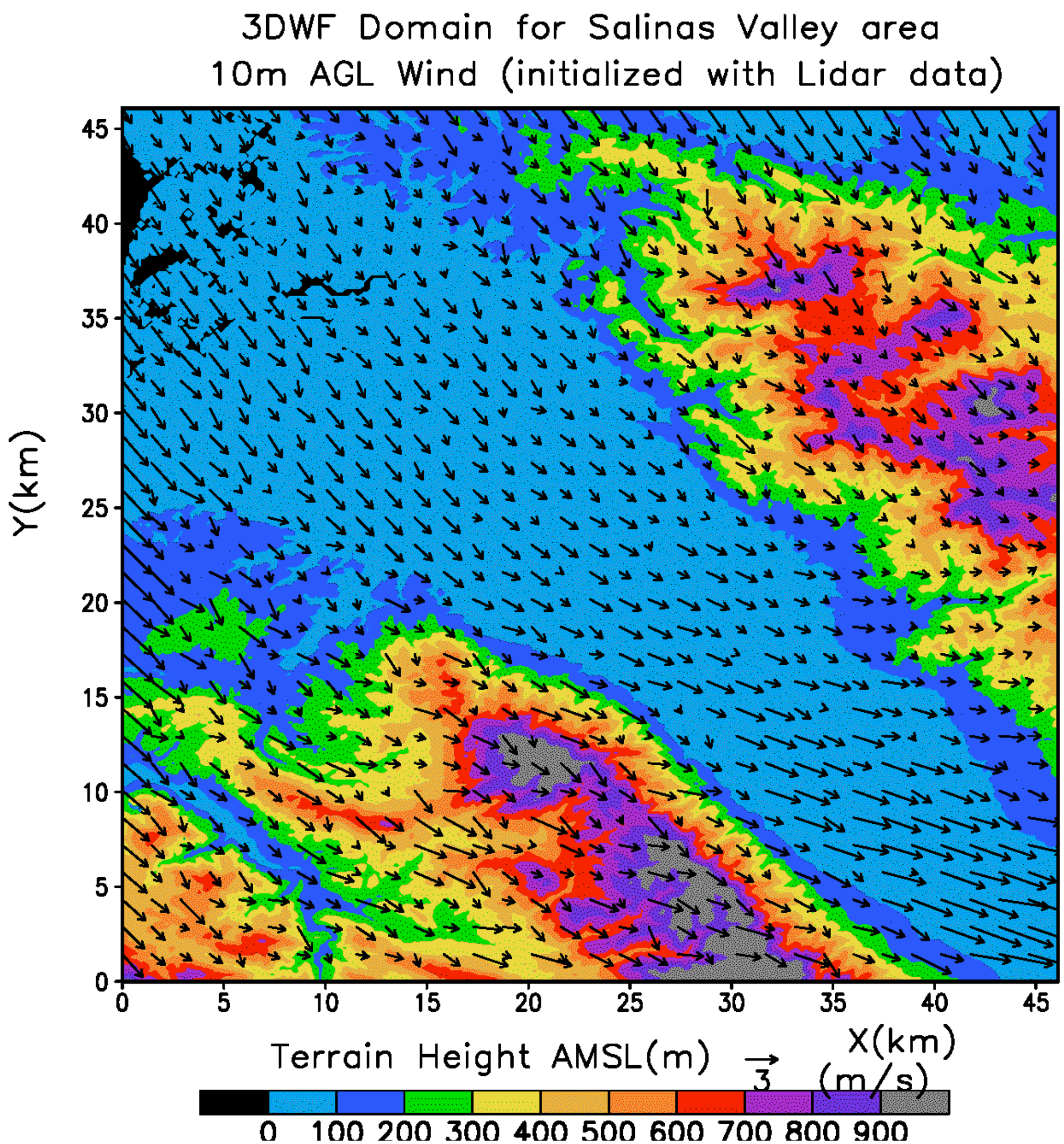
50 m DZ 30 sec



DWL wind speed profile vs. MM5 same grid volume & time

Derived 10 m Wind Field

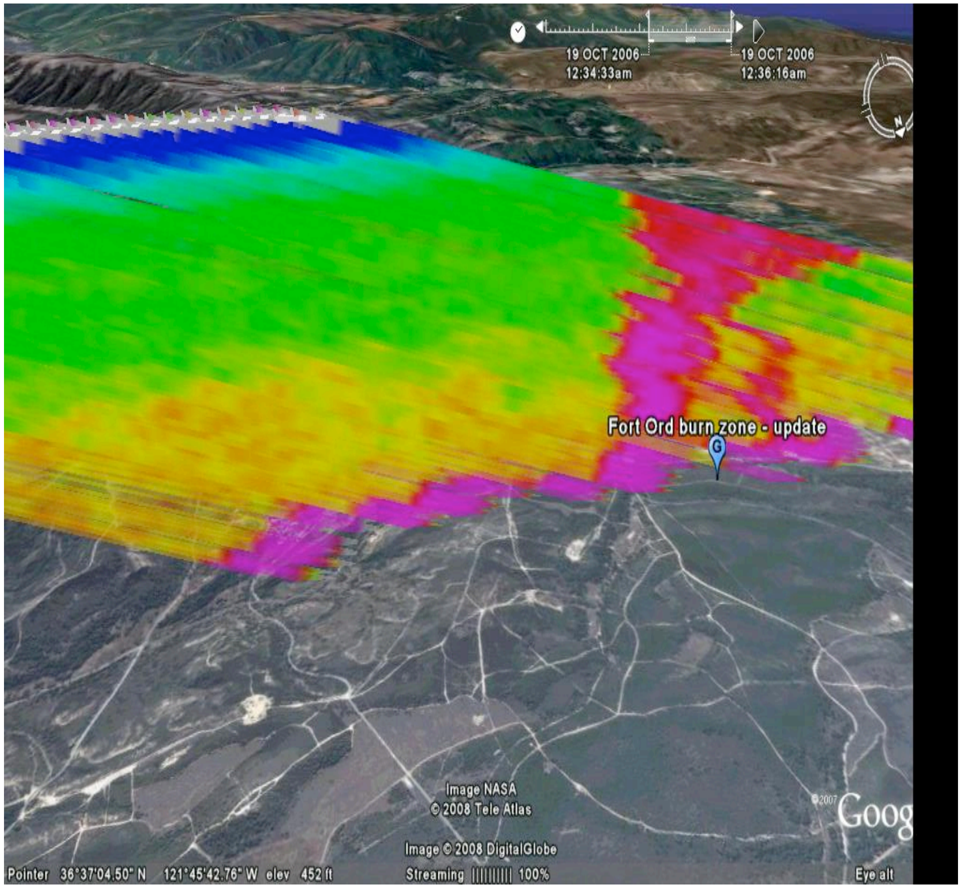
Yansen Wang, Army Res. Lab.

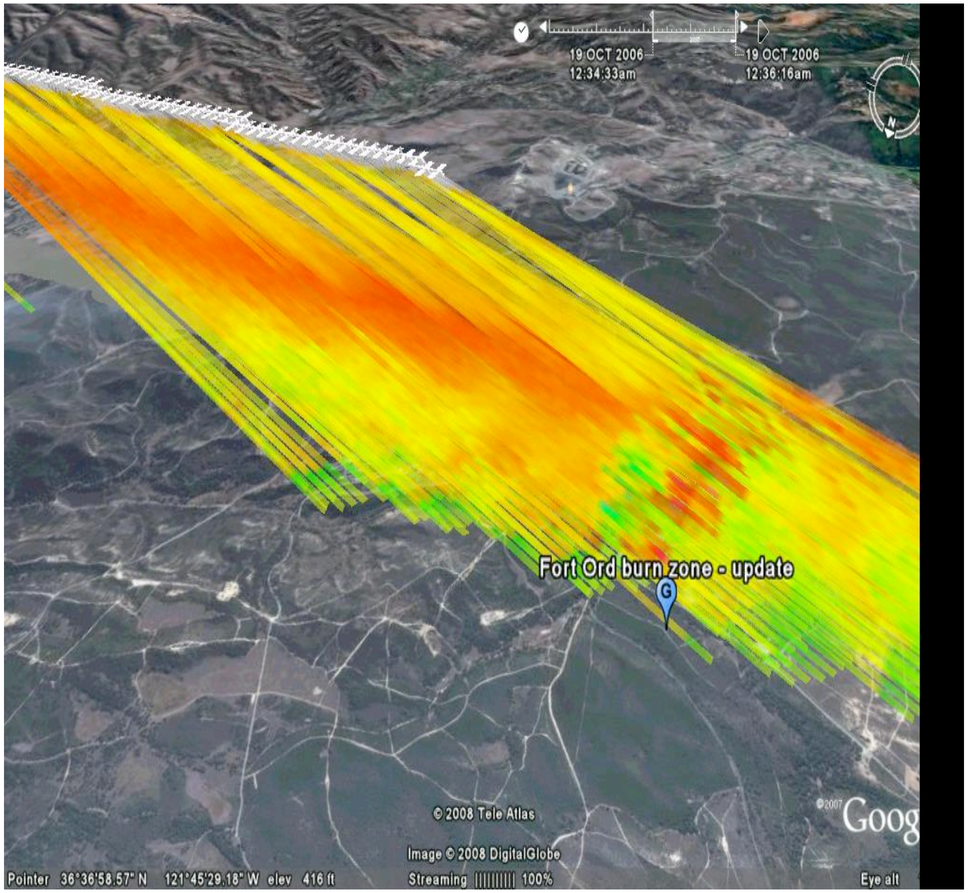


Used 20 Lidar profiles

Army 3DWF Diagnostic model

Smoke Plume


19 OCT 2006
12:34:33am
19 OCT 2006
12:36:16am
Fort Ord burn zone - update
Image NASA
© 2008 Tele Atlas
Image © 2008 DigitalGlobe
Pointer 36°37'04.50" N 121°45'42.76" W elev 452 ft
Streaming |||||||||| 100%
Eye alt


19 OCT 2006
12:34:33am
19 OCT 2006
12:36:16am
Fort Ord burn zone - update
© 2008 Tele Atlas
Image © 2008 DigitalGlobe
Pointer 36°36'58.57" N 121°45'29.18" W elev 416 ft
Streaming |||||||||| 100%
Eye alt

Low-cost Remote Wind Profiling

SBIR Phase I

- Dr Scott Shald Coherent Technologies Inc -

Doppler Lidar Wind Profiling

Object:

Measure U,V,W at 10 Hz in 10 m increments from 10 to 100 m AGL with near sonic quality (< 0.1 m s^{-1})

Purpose:

Low cost, ***transportable*** instrument to measure lower BL wind velocity profile **and** turbulence.

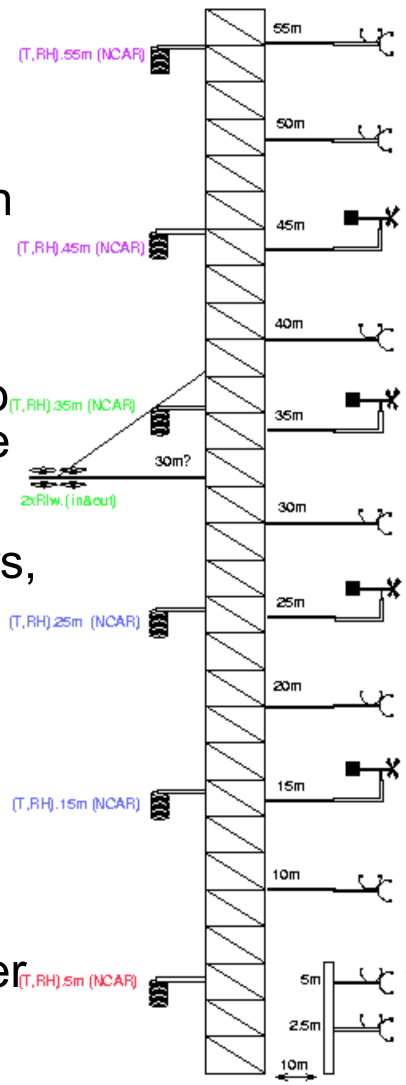
Augment / replace fixed towers, sodars, and 915 MHz wind radars for observations.

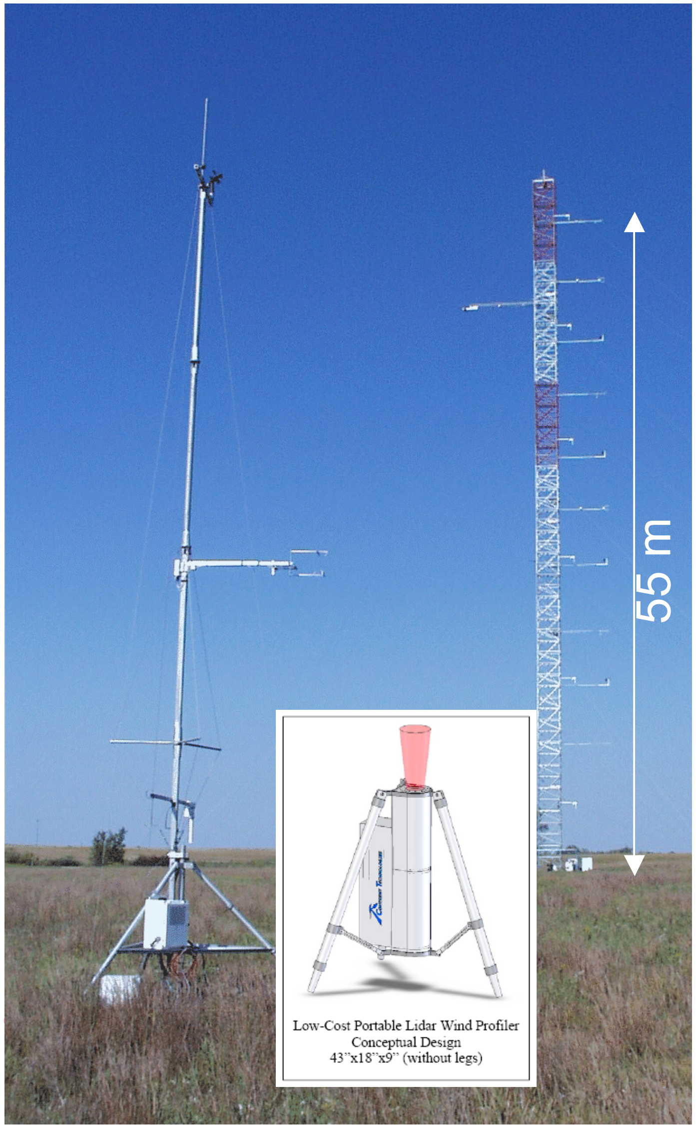
Applications:

Real time low level jets and shear – UAV's, artillery, CBRN dispersion models

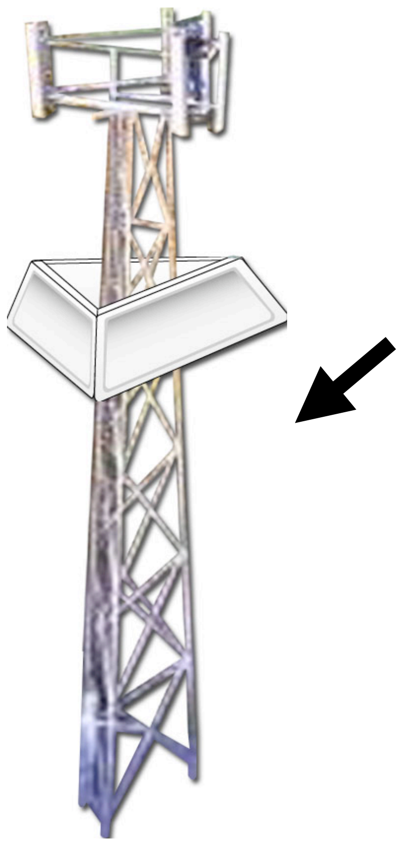
Spatial variability or coherence in lower BL (lateral scales of motion)

Urban wind / turbulence profiles





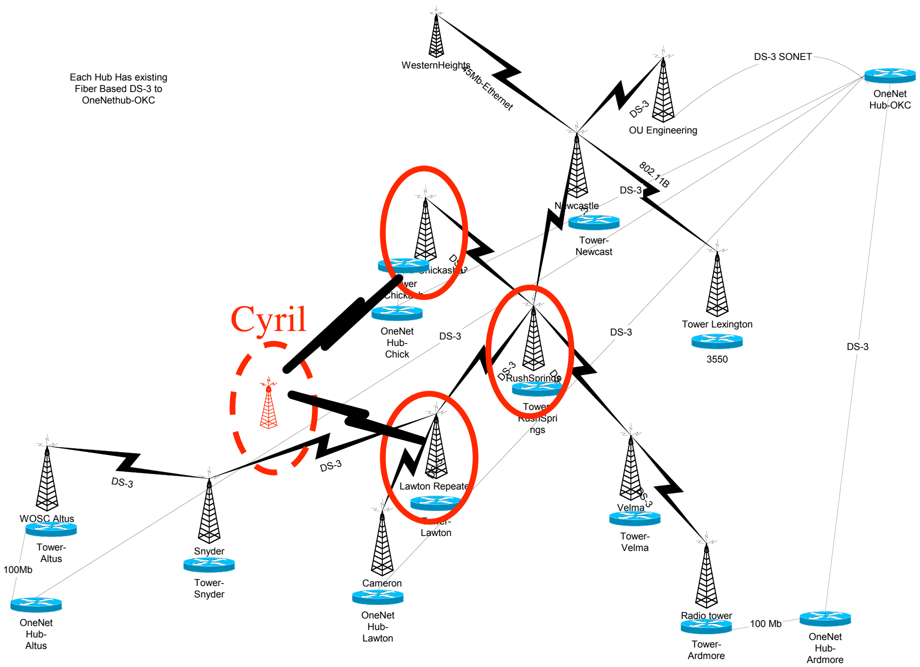
Low Power NetRad Antennas



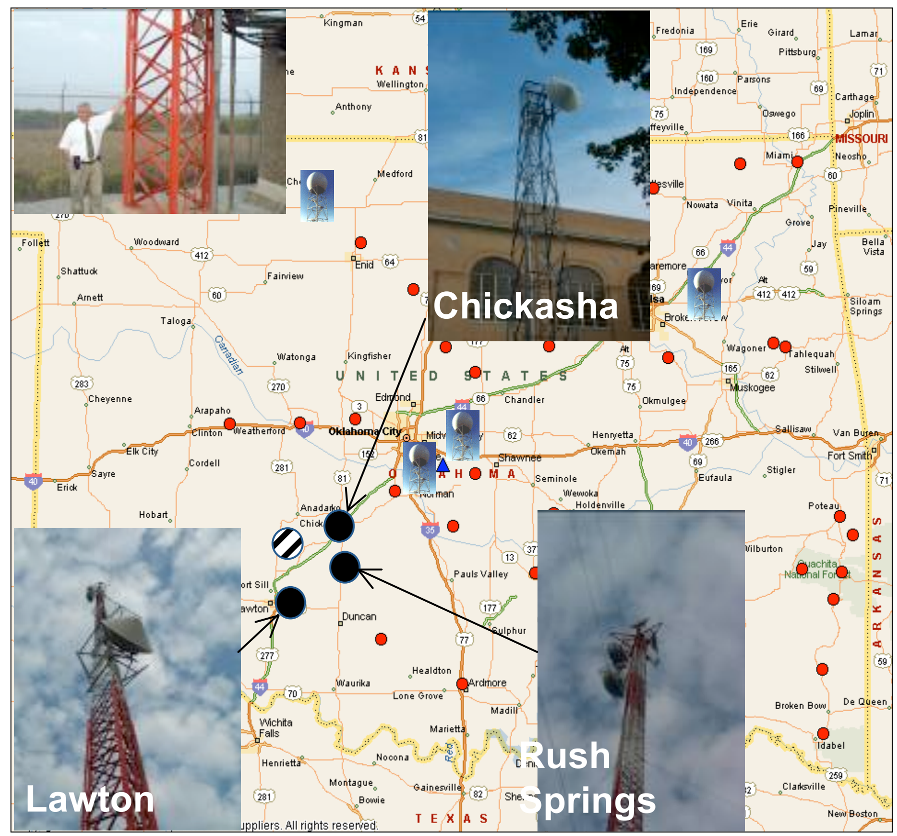
Specifications:

- 1 m x 1 m X-band antennas
- 2D Electronic scanning
- 2 degree pencil beam
- Dual linear (V & H) polarization
- 14 degree elevation; 90 degree azimuth scan
- 10’s Watt average power
- $10k target cost per panel (in 2005 dollars, projected 10 years ahead)

CASA Distributed Radar Network



- Avg. Separation 25.3 km
- Coverage 6947 km^2
- 98% coverage below NEXRAD
- 41% coverage is dual-Doppler (2850 km^2)
- 25% coverage below 250 m
- Avg. AGL NetRad – 364 m
- Avg. AGL NEXRAD – 1000 m

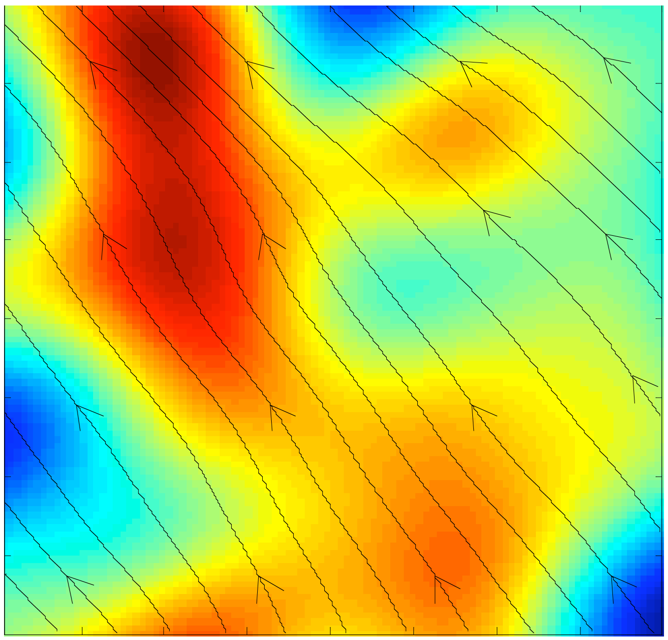


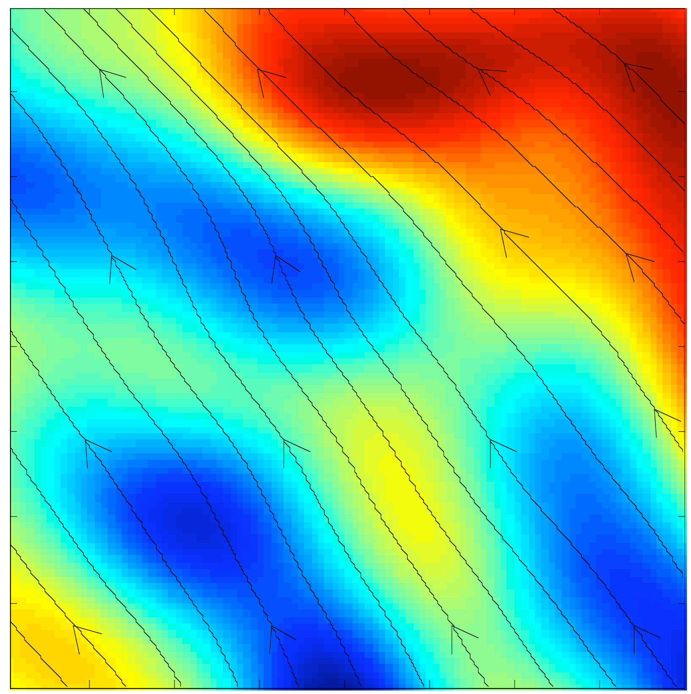
Goal: **Map winds below 3 km with 500 m resolution**

David McLaughlin, U. Mass

Acoustic Tomography

Vladimir Ostashev, NMSU & CIRES





NCAR REAL Lidar

Backscatter 6 m range gate