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** \((0.01 < X < 10 \text{ km}; \ 10 < t < 10^3 \text{ sec})\)
  - 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, $\varepsilon$, $Ri$
- 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

Virtual Towers

Co-Planar Scanning for Wind field

T-REX 9:30 PM

OKC
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.

3DWF Domain for Salinas Valley area
10m AGL Wind (initialized with Lidar data)

Used 20 Lidar profiles
Army 3DWF Diagnostic model
Smoke Plume
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 km²
- 98% coverage below NEXRAD
- 41% coverage is dual-Doppler (2850 km²)
- 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