UPDATE

DEVELOPMENT OF A REMOTE-SENSING TESTBED FOR TROPOSPHERIC AIR QUALITY AND WINDS

University of Alabama in Huntsville
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NASA Marshall Space Flight Center
Tim Miller, Steve Johnson

Simpson Weather Associates
Dave Emmitt

Working Group on Space-Based Lidar Winds
Welches, Oregon, June 27-30, 2006

Huntsville/Madison Urban Corridor and Redstone Arsenal In Northern Alabama
• hosting Army Workshop

• installing Doppler lidar scanner

• integrating lidar winds with radar winds

• initiating NOAA Air Quality research

• integrating Huntsville assets
Workshop on a Soldier-Scale Atmospheric Testbed (SSATB)

March 29-31, 2006, Huntsville, Alabama

Sponsored by the Army Research Office (ARO, Walter Bach)
Coordinator by the Aviation and Missile Research, Development, and Engineering Center (AMRDEC, Henry Everitt)
Hosted by the University of Alabama in Huntsville (UAH, Mike Newchurch)

ATTENDANCE
• 30 attendees, civilian (UAH, NASA/MSFC) and military (Army, Air Force)

ISSUES
• improved characterization of the atmospheric boundary layer
• comparison of model results to observations
• high spatial and temporal resolution
• data collection requirements

FOLLOWUP
• pending review
Installation of Doppler Lidar Scanner

2 μm Doppler lidar transceiver provided by Earth Science Office (ESO) NASA Marshall Space Flight Center (MSFC)

transceiver status
– operating

scanner mount design
– completed

scanner mount assembly
– completed

scanner mirror recoating
– in progress

scanner installation
– summer 2006

scanner georegistration
– summer 2006

lidar characterization
– fall 2006

DFM alt/azimuth scanner provided by Simpson Weather Associates

Doppler lidar chimney – interior view

retractable grating
cable conduit

Doppler lidar chimney – exterior view

mount location
Installation of Doppler Lidar Scanner

National Space Science and Technology Center: View from West

Penthouse Rooftop Platform 1
Platform 3: NE Rooftop
Lightning Tower NW Rooftop
Doppler lidar chimney
Main Rooftop Platform 2
RAPCD / AμOR Laboratories 4th Floor Under Penthouse
## Integrating Lidar Winds with Radar Winds

<table>
<thead>
<tr>
<th>SPECIFICATION</th>
<th>DWL</th>
<th>ARMOR</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength</td>
<td>2.017 µm</td>
<td>C-band, 5.625 GHz (5.333 cm)</td>
<td>X-band, 9.4 GHz (3.2 cm)</td>
</tr>
<tr>
<td>Pulse Rate</td>
<td>6.6 Hz</td>
<td>250 Hz - 2 kHz</td>
<td>2 kHz max</td>
</tr>
<tr>
<td>Pulse Length</td>
<td>0.7 µs (FWHM)</td>
<td>0.5 - 2.0 µs</td>
<td>0.4, 0.8, 1.2, 2.0 µs</td>
</tr>
<tr>
<td>Pulse Strength</td>
<td>50 mJ</td>
<td>350 kW</td>
<td>200 kW</td>
</tr>
<tr>
<td>Exit Beam Diameter</td>
<td>0.08 m (1/e²)</td>
<td>1.1° FWHM</td>
<td>0.9° FWHM</td>
</tr>
<tr>
<td>Gate Spacing</td>
<td>105 m</td>
<td>75 – 1000 m</td>
<td>30 – 300 m</td>
</tr>
<tr>
<td>Minimum Range</td>
<td>150 m</td>
<td>1 km</td>
<td>2 km</td>
</tr>
<tr>
<td>Maximum Range</td>
<td>10 km</td>
<td>50-200 km</td>
<td>50-200 km</td>
</tr>
</tbody>
</table>

**DWL** = Doppler Wind Lidar  
**ARMOR** = Advanced Radar for Meteorological and Operational Research (*dual polarization*)  
**MAX** = Mobile Alabama X-Band Radar (*dual polarization*)
Integrating Lidar Winds with Radar Winds

• emphasize clear-air wind analyses in the atmospheric boundary layer (ABL)

• dual polarization radars minimize contamination from birds and insects

• dual Doppler radar coverage centered over Doppler lidar domain

• in-house tests show Advanced Regional Prediction System (ARPS) Data Analysis System (ADAS) superior to Local Analysis and Prediction System (LAPS)

• high-resolution nested mesoscale models generate gridded wind fields

• minimizes need for 4-D variational assimilation of Doppler lidar data

• routine wind fields for studying ABL structures and processes
Objective: To study and predict the impact of air pollution on climate, health and other environmental applications.

Anticipated Start: Summer 2006
Integration of Related Components, Sources, Sponsors, and Collaborators

- UAH: PBL Air Chemistry
- ARMY/RSA: Soldier-Scale Atmospheric Test Bed
- UAH: Weather Radar
- NOAA: Air Quality Forecasting Test Bed
- NOAA/NASA: Hazardous Weather Test Bed
- UAH: OGC Sensor-Web Enablement (SWE)
- NASA/MSFC: Sensor-Web Atmospheric Test Bed
- UAH: PBL Dynamics

ASSIMILATION
QUANTIFY UNCERTAINTY
MODELING

coordinated multi-agency research and development, with rapid-prototyping user-responsive transition to transferable operations
Integration of Research Activities and Huntsville Distinctives

ARMY/RSA
- Soldier-Scale Atmospheric Test Bed
- Weather Radar

NOAA
- Air Quality Forecasting Test Bed

NOAA/NASA
- Hazardous Weather Test Bed

UAH
- PBL Air Chemistry
- OGC Sensor-Web Enablement (SWE)
- Sensor-Web Atmospheric Test Bed
- PBL Dynamics

ASSIMILATION
QUANTIFY
UNCERTAINTY
MODELING

Diverse weather
Other agencies
Satellite data analysis
Complex terrain
Diverse airmasses
Multiple applications
Surface energetics
Diverse land usage

Coordinated multi-agency research and development, with rapid-prototyping user-responsive transition to transferable operations.
coordinated multi-agency research and development, with rapid-prototyping user-responsive transition to transferable operations
Integration of Existing/Planned Assets (Most Installed in or Near Huntsville)

- UAH
  - PBL Air Chemistry
  - Ozone sondes
  - Ozone lidar
  - Aerosol lidar
  - Doppler wind lidar
  - Spectroscopy lab
  - Chemistry trailer

- ARMY/RSA
  - Soldier-Scale Atmospheric Test Bed
  - 100-meter mega-tower, surface network, Doppler lidar, Doppler radar, radiosondes, instrumented UAV’s, tracer releases, AutoNowcaster, incident simulations, laser test facility, scintillimeters, ceilometer, microsats

- UAH
  - Weather Radar
  - Dual polarization Doppler radars
  - C-band, X-band, W-band

- NOAA
  - Air Quality Forecasting Test Bed
  - HSV NWS Forecast Office
  - Operational satellite sensors
  - Geostationary satellite risk reduction
  - AERONET multispectral sunphotometer
  - MPL-NET Micropulse Lidar

- NOAA/NSAA
  - Hazardous Weather Test Bed
  - HSV NWS Forecast Office
  - Short-Term Prediction Research/Transition Center
  - NEXRAD Doppler radar network
  - Satellite-based sensors
  - Significant weather events

- NASA/MSFC
  - Sensor-Web Atmospheric Test Bed
  - Short-Term Prediction Research/Transition Center
  - Regional Visualization & Monitoring System
  - Research satellite sensors, microsats, Lightning Mapping Array, instrumented UAV’s

- UAH
  - PBL Dynamics
  - Ceilometer, tethersonde
  - Doppler sodars
  - 915 MHz profiler
  - Mu-wave radiometer
  - Surface energy flux
  - Mobile platforms

- Other agencies
  - Nested observations
  - Stationary sensors
  - Guest investigators
  - Intensive ops periods
  - Multiple parameters
  - Routine operation
  - Complementary sensors
  - Nested models
  - Surface energetics
  - Diverse land usage
  - Diverse airmasses
  - Multiple applications
  - Coordinated multi-agency research and development, with rapid-prototyping user-responsive transition to transferable operations

- Complex terrain
- Diverse weather
- Other agencies

- Satellite data analysis
- Surface
- Surface

- Quantify
- Uncertainty
- Modeling

- Surface energetics
- Diverse land usage
- Diverse weather
- Other agencies

- Coordinated multi-agency research and development, with rapid-prototyping user-responsive transition to transferable operations

- Short-term prediction research/transition center
- Regional visualization & monitoring system
- Research satellite sensors, microsats, Lightning Mapping Array, instrumented UAV’s

- UAH
  - OGC Sensor-Web Enablement (SWE)
  - SensorML development
  - SWE architecture
Focus of Integrated Research Activities

**ARMY/RSA**
- Soldier-Scale Atmospheric Test Bed
  - 100-meter mega-tower, surface network, Doppler lidar, Doppler radar, radiosondes, instrumented UAV's, tracer releases, AutoNowcaster, incident simulations, laser test facility, scintillometers, microsats

**UAH**
- PBL Air Chemistry
  - ozone sondes
  - ozone lidar
  - aerosol lidar
  - Doppler wind lidar
  - spectroscopy lab

**NOAA**
- Air Quality Forecasting Test Bed
  - HSV NWS Forecast Office
  - operational satellite sensors
  - geostationary satellite risk reduction
  - AERONET multispectral sunphotometer
  - MPL-NET Micropulse Lidar

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  - research satellite sensors, microsats, Lightning Mapping Array
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- Sensor-Web Development (SWE)
  - SensorML development
  - SWE architecture

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- PBL Dynamics
  - ceilometer, tethersondes
  - Doppler sodars
  - 915 MHz profiler
  - µ-wave radiometer
  - surface energy flux
  - mobile platforms

**NOAA**
- Sensor-Web Enablement (SWE)
  - OGC Sensor-Web

**UAH**
- OGC Sensor-Web Enablement (SWE)

**MM5→WRF←RAMS, CMAQ; LES**
- decision support tools
- improved PBL forecasts

**QUANTIFY**
- improved PBL diagnostics
- theory, knowledge base
- GSI, ADAS (VDRAS? VLAS?)

**ASSIMILATION**
- with user acceptance

**MODELING**
- improved PBL forecasts
- with user acceptance

**Diverse**
- applications
- airmasses
- terrain
- weather
- land usage

**Coordinated**
- multi-agency research and development, with rapid-prototyping user-responsive transition to transferable operations
Conclusions

• developing university-coordinated multi-agency partnership

• exploit existing, pending, proposed, and planned assets

• attract other agencies and local Army/NASA support contractors

• create national asset for boundary layer research and operations

• meet emerging weather needs for testing, training, and operations

• transfer knowledge and user-validated decision-making tools to other areas