

New Doppler Lidar Remote Sensing Capability within ARM

ASR STM, Vertical Velocity Focus Group Breakout

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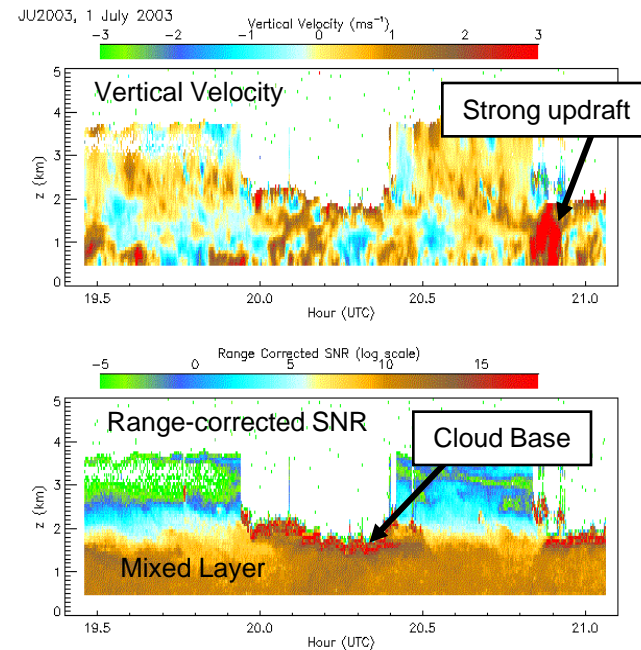
ARRA Lidar Procurements

In 2009 ARM received money through ARRA for instrument acquisitions and upgrades. A significant portion of these funds are being used to acquire new advanced lidar systems for all of the ACRF sites. Efforts are currently underway to develop the following systems:

- One Raman lidar
 - TWP-Darwin
- Two High Spectral Resolution Lidars (HSRL)
 - NSA-Barrow
 - AMF2
- **Three Doppler lidars**
 - SGP**
 - TWP-Darwin**
 - AMF1**

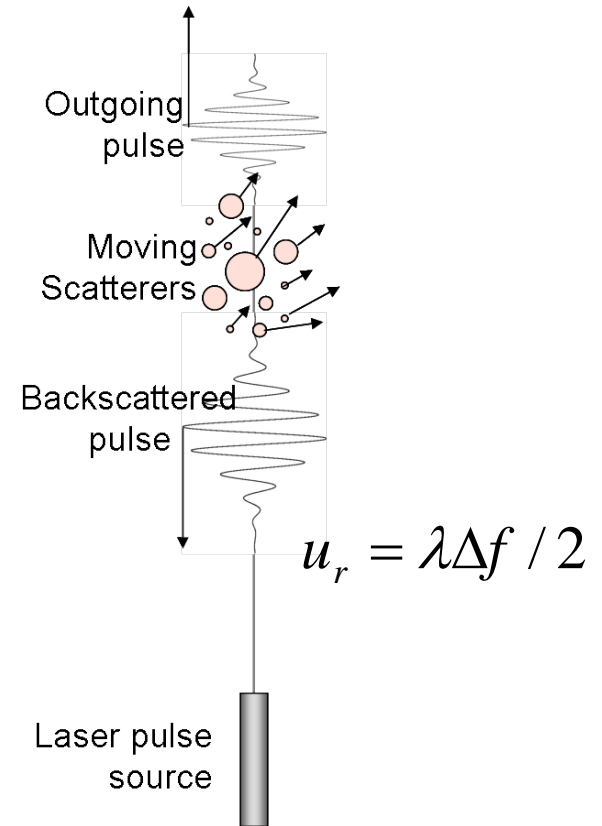
Doppler Lidar

- Doppler lidars provide time and height resolved measurements of the radial (line-of-sight) component of air velocity and (molecular and/or aerosol) backscatter.
- Two types of systems
 - Direct detection
 - Coherent detection

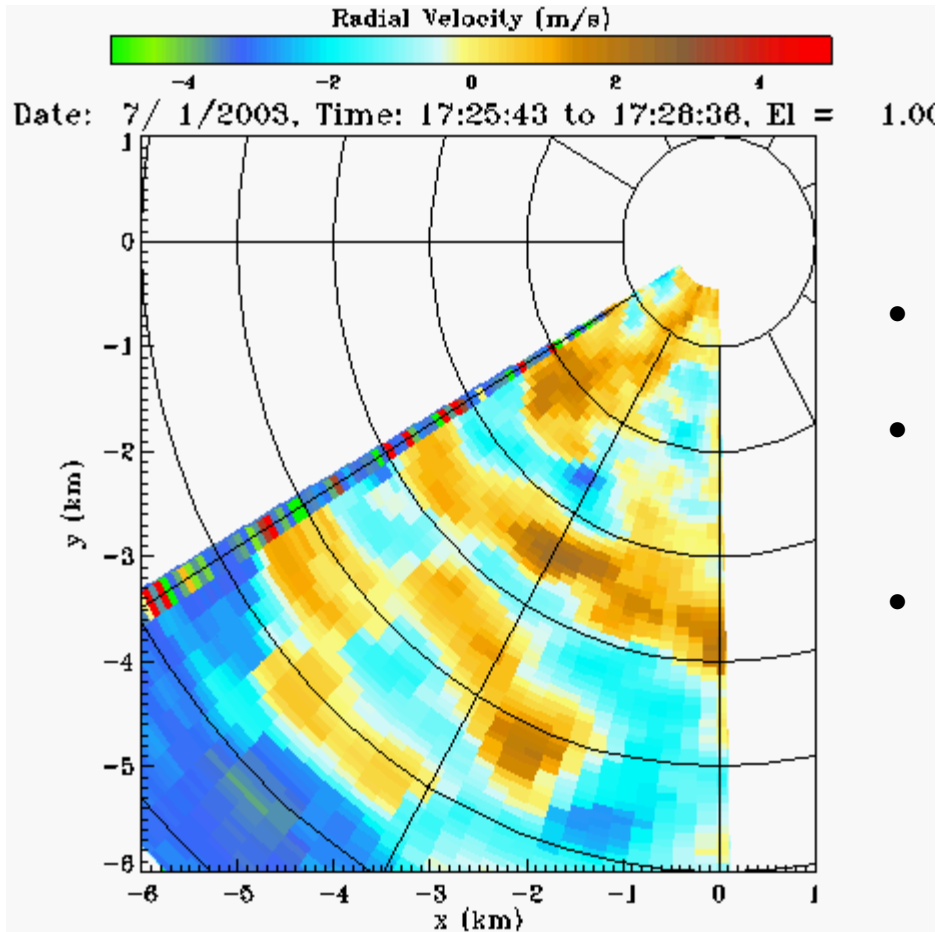


Coherent Lidar

- Doppler shift is measured using heterodyne detection (as in radar)
- Speckle effects limit application to longer wavelengths (i.e. IR)
 - Sensitive to aerosol backscatter, insensitive to molecular backscatter
 - Restricted primarily to the boundary layer
- Very sensitive detection technique
 - Short averaging times (~1 sec)
 - Measurement error on the order of 10 cm/sec
- Several commercial systems available

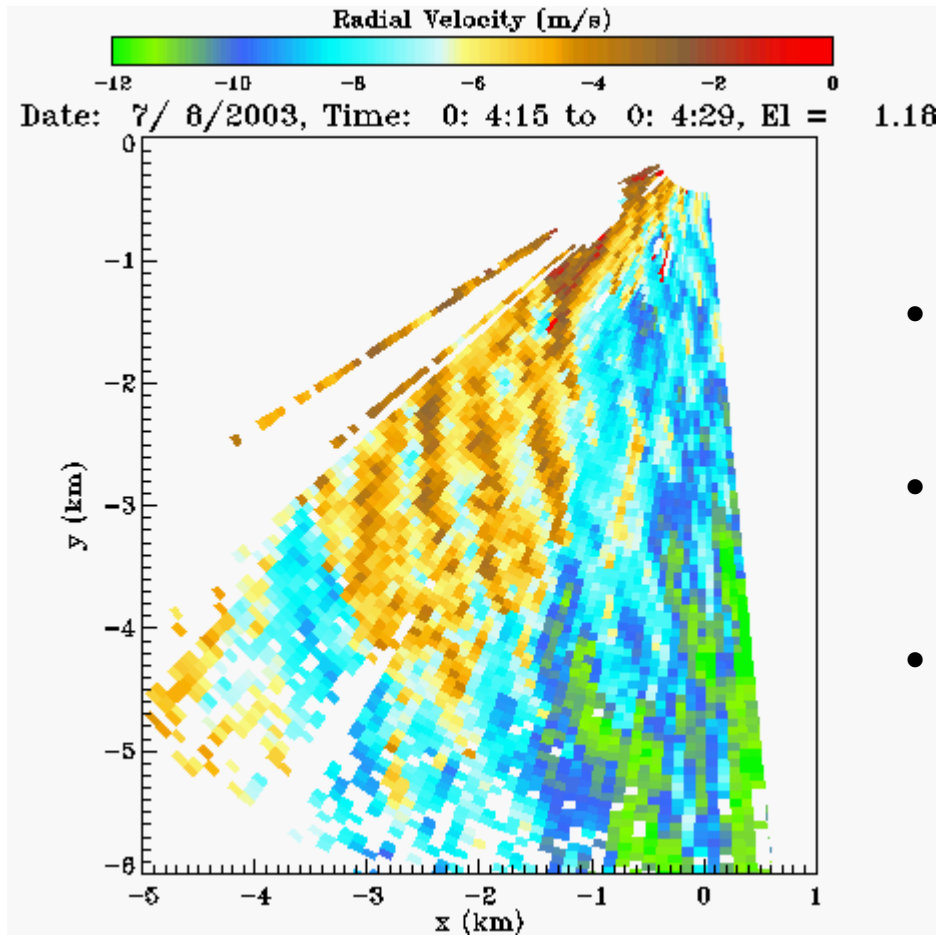


Doppler Lidar Data Samples



- Nearly free convection
- Calm hot sticky summer day in OKC
- ~one hour animation

Doppler Lidar Data Samples



- Closer to neutral stability
- Cooler windier summer evening in OKC
- ~3 minute animation

ARRA Lidar Specs and Vendor Selection

Major Performance Specifications

- Eye safe
- Vertically pointing (scanning optional if price is right)
- Data products: radial velocity, SNR, Doppler spectra
- Range: 100 m to 10 km
- Pulse width < 30m (pulse duration <200ns)
- Temporal Resolution (after averaging) < 1 s
- Velocity Precision < 20 cm s⁻¹
- Mass < 2000 kg
- Volume < 10 m³
- Power consumption < 3kW, 120 or 240 VAC, single phase
- Delivery in December of 2010

Vendor Selection

- Proposals were received from 2 vendors in September 2009
- Halo Photonics (UK) was awarded contract

HALO PHOTONICS DOPPLER LIDAR



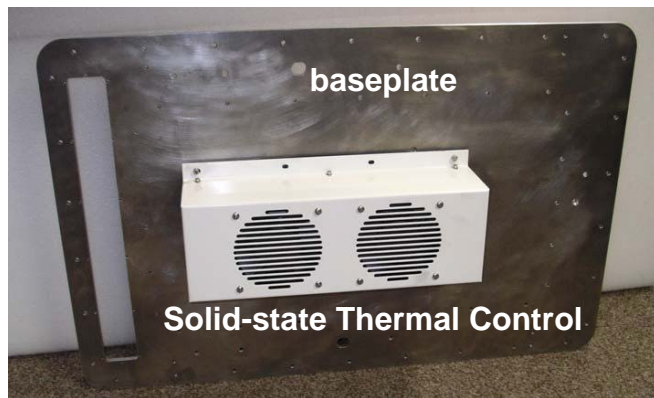
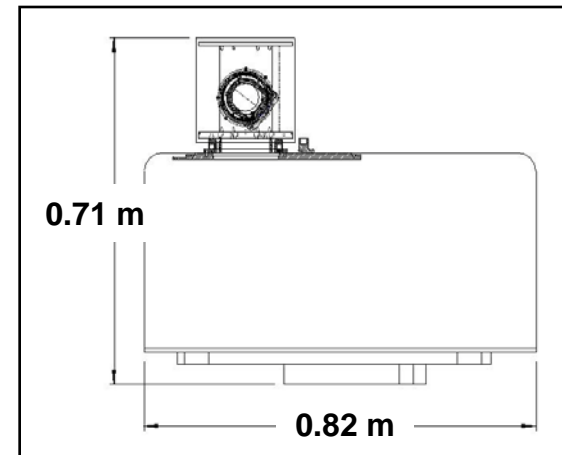
- High temporal and spatial resolution
 - 20-50m range gates
 - 20m –10km range
 - 1 second per line-of-sight
- Wavelength ~ 1500 nm
- Autonomous, 24/7 mode of operation
- Remote control and data offload via web
- All-sky scanning capability
- Level 1 data
 - Range gated return power and line-of-sight velocity
 - Co-and cross-polarized returns
- Level 2 data: Wind profile, backscatter profile, turbulence, cloud phase & dynamics
- Nearly 4 years of 24/7 unattended operation demonstrated

(<http://www.met.rdg.ac.uk/radar/chilbolton.html>)

DEVELOPMENT STATUS

as of 1 March 2010

ARM Doppler Lidar Enclosures



- Completed fabrication of enclosures, baseplate and legs.
- Completed thermal design study
- Began internal development effort to optimize design of new 75 mm aperture scanner

OPERATIONAL CONFIGURATIONS

A few things the user community should consider

Proposed scan strategies and scan schedules

1. Vertical stare for 45 min
2. PPI and/or RHI scans for 15 min
3. Go to 1
4. Horizontal stare or PPI 2-4 times daily for calibration

Temporal and Range Resolution (proposed)

- Velocity and SNR
 - 10 sec and 50-m for staring
 - 1 sec and 50-m for scanning
- Spectral data at 1 sec regardless of scan

		Time Resolution (sec)		
		1	10	30
Range Resolution (m)	30	583 Mb/day	58 Mb/day	19 Mb/day
	50	350 Mb/day	35 Mb	12 Mb/day

Data storage requirements for just velocity & SNR

Time resolution	Spectral Data size
1 sec	2000 Mb/day
10 sec	200 Mb/day
30 sec	67 Mb/day

Data storage requirements for just Doppler spectra