8.22-P **Three Generations of Raman-shifted Eye-safe Aerosol Lidars**

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1. Abstract

REAL (Raman-shifted Eye-safe Aerosol Lidar) is a scanning elastic backscatter lidar that operates at 1.5 microns wavelength. This wavelength falls within a narrow band in the near-infrared that offers maximum eye-safety and thereby enabling transmission of high pulse energy into the atmosphere. The first generation transportable prototype (REAL "v1") was designed to provide time-lapse animations of atmospheric structure as revealed by the aerosol backscatter distribution. It also features backscatter depolarization sensitivity for information on relative changes in aerosol particle shape. In addition to the shipping-container based prototype, a more compact version of REAL (called REAL "v2") was designed and constructed by ITT Industries for continuous and unattended operation at a fixed, permanent location. REAL v2 has been in operation in a major urban area since November 2005. REAL "v3" is currently being developed at NCAR. It will feature twice the pulse energy and 5 times the pulse rate of our v1 for longer range and faster scanning. Moreover, it will feature narrow linewidth which may be of use in more advanced lidar applications such as aerosol backscatter calibration.

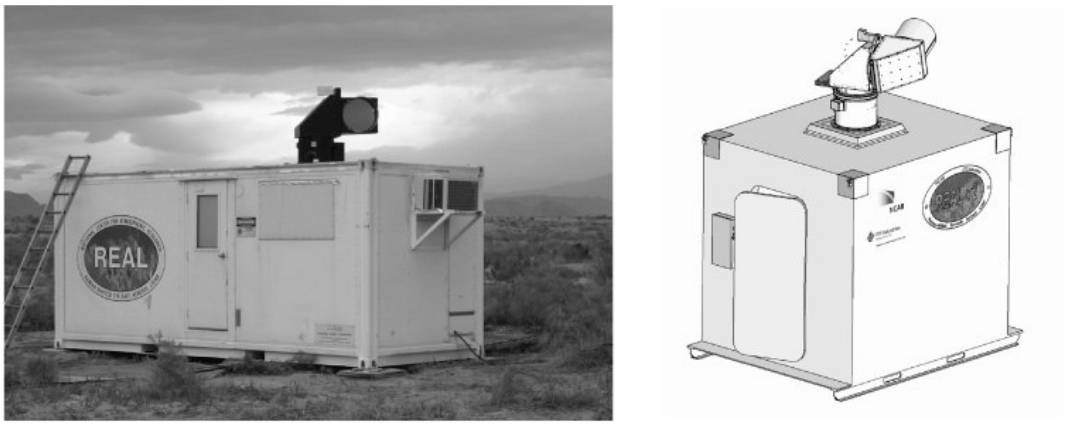
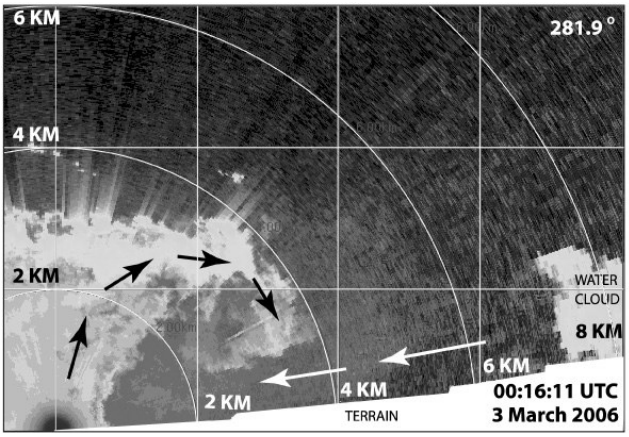


Figure 1: Left: Photograph of the field deployable REAL v1 at Dugway Proving Ground in October of 2004. Right: Drawing of REAL v2 that is currently in continuous and unattended operation from a permanent location in a major city for the surveillance of aerosol plumes.

2. REAL v1: Field deployable prototype

We refer to the original REAL is as "v1" (Mayor and Spuler 2004, Spuler and Mayor 2005, Mayor et al. 2005). We began its development in 2002 and collected scans with it for the first time in 2004. Its size and form are that of a transportable laboratory prototype to facilitate the testing of incremental system improvements at various field sites. V1 operates from a 20-ft shipping container that is transported by truck. Thus far, it has served in 5 field deployments. The v1 transceiver operates from a 3-foot by 5-foot optical table inside a small room in the container. The remaining area is used as an office for data acquisition and system control and monitoring. An azimuth-over-elevation type beam-steering-unit is lifted on to the roof of the container at field sites to permit full hemispherical scanning. The system is capable of transmitting 10 laser pulses per second with each pulse containing approximately 200 mJ of energy at 1.54 microns. The system features backscatter depolarization sensitivity that can be used to infer relative changes in shape of aerosol and cloud particles (i.e. droplets versus crystals). Backscatter signals are digitized at 50 MSPS with 14-bit quantization and recorded by a PC running Windows and Labview.

While the beam-steering unit is capable of moving at much faster angular rates, a typical 360-degree scan from v1 requires about 60 s. This is usually adequate for creating time lapse animations that reveal the motion aerosol structures. Smaller sector scans require proportionally less time.



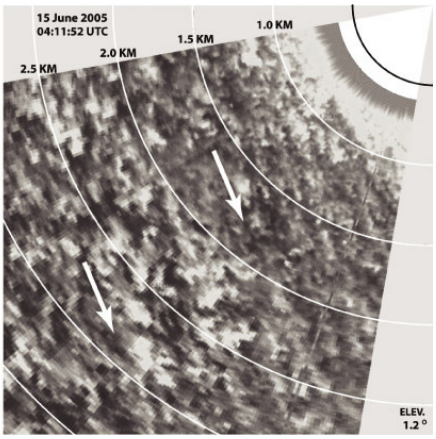


Figure 2: Left: Vertical scan from REAL v1 at T-REX in March 2006. The animation of this sequence reveals terrain induced rotation of flow around an axis that extends in and out of the page. Right: Near-horizontal scan from Dugway Proving Ground in June of 2005. This scan shows the organization, motion and lifetime of turbulent coherent structures in the atmospheric surface layer.

3. REAL v2: Unattended and continuous operation from a permanent site

The second generation REAL ("v2") was redesigned under a technology-transfer licensing agreement between UCAR and ITT Industries for unattended and continuous operation at a permanent location. The design and fabrication of the first v2 began in the autumn of 2004 and was installed in November of 2005. It operates today in a major urban area as part of a suite of sensors to protect buildings from chemical, biological and nuclear attack. The role of v2 is to locate approaching aerosol clouds so that building ventilation systems can be shut off until other sensors identify the aerosol type. Algorithms process the v2 backscatter data in real-time to identify plumes from the background aerosol structure. V2 operates with 20 laser pulses per second and approximately 200 mJ/pulse. It does not yet feature the backscatter depolarzation capability of v1. The system is operated by a network connection from a remote location.

4. REAL v3: Longer range, faster scans, narrow linewidth

Many applications of REAL would benefit from longer range detection and faster scanning. Therefore, we have developed a next-generation transmitter that is capable of operating with pulse energies of at least 350 mJ and repetition rates of 50 Hz. In addition to these improvements, the new transmitter features spectral linewidth of approximately 200 MHz (Spuler and Mayor 2006) which is a requirement for the spectral separation of molecular and aerosol backscatter for calibration purposes. Presently, this next-generation transmitter operates only from our laboratory and has not been tested with our receiver or data acquisition system. We plan to integrate these components within the next year and collect interleaved vertical and near-horizontal scans.

5. References

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