High-Spectral Resolution Lidar

The NCAR High Spectral Resolution Lidar (HSRL) is an eye-safe calibrated lidar system that can measure backscatter cross-section, extinction, and depolarization properties of atmospheric aerosols and clouds. It can also be used to detect the presence of oriented scatterers in the atmosphere and determine the full (Mueller) backscatter phase matrix. The system can be deployed on the NSF/NCAR HIAPER aircraft or in a customized shipping container for surface-based observations.

The high-repetition, low-pulse energy laser is expanded to fill the telescope aperture so it meets the eye-safety criteria of the American National Standards Institute at all ranges. The design uses a shared telescope that gives the same field of view to both the transmitter and receiver so the lidar alignment is very stable.
**About HSRL**

The HSRL provides information for characterizing cloud and aerosol particles, and provides real-time, calibrated, atmospheric vertical profiles of:

(a) cloud optical depth,
(b) aerosol optical depth,
(c) backscatter cross-section,
(d) extinction cross-section, and
(e) depolarization ratio.

**HSRL in Combination with HCR**

The HSRL in combination with the HIAPER Cloud Radar (HCR) will extend capabilities of both systems for investigating interaction of aerosol, cloud, and precipitation. The HCR is capable of detecting cloud boundaries, cloud liquid, and ice along with estimating radial winds. By combining HCR and HSRL measurements the accuracy in quantitative estimation of ice and liquid water content amounts, detection of particle types, and mean particle size will be considerably improved.

**High-Quality Data**

The HSRL provides absolute measurements of backscatter and extinction coefficients. These parameters are retrieved directly, without assumptions of lidar ratio needed in iterative retrievals used in conventional backscatter lidar. This improves the retrieval accuracy and decouples precision error between different altitudes (which accumulate when using iterative retrievals). The instrument’s depolarization channel is also highly calibrated. This includes a range dependent overlap calibration and full knowledge of the instrument transmit and receive Mueller matrices that enable observation of fine structure in ice nucleation, growth, and sedimentation in ice clouds. Finally, the instrument can operate in full polarization mode, where it retrieves the full backscatter phase matrix of the particles so that polarization data can be interpreted without assuming all particles are randomly oriented.

**Typical Applications**

The HSRL can be used to provide validation and important content for passive retrievals. The direct observation of aerosol extinction by the instrument has been used to validate aerosol extinction estimates from passive radiometers. HSRL can also provide a higher resolution range resolved observation than most passive sensors and can be useful for providing constraints to broadband radiometric retrievals.