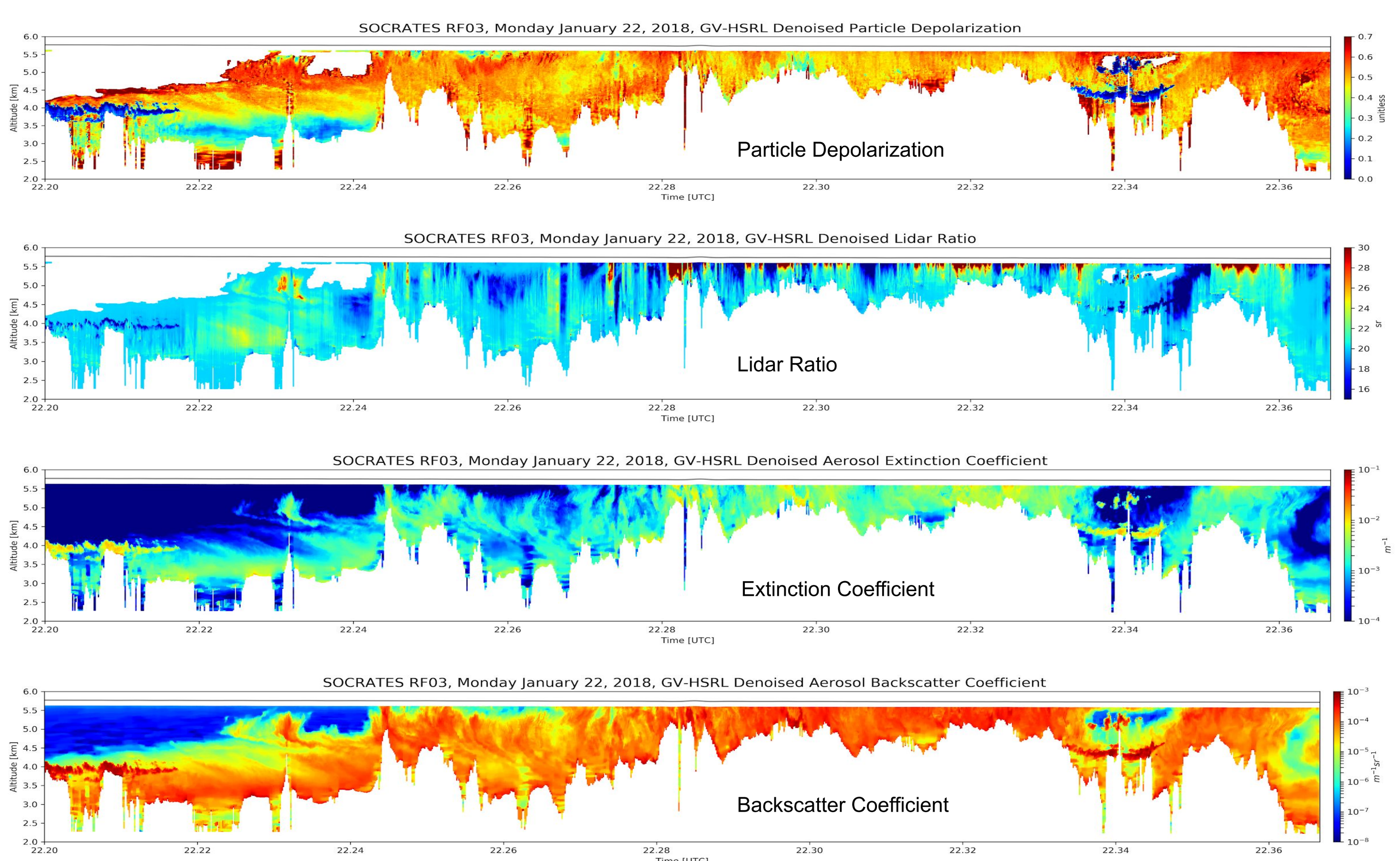
GV-HSRL
High Spectral Resolution Lidar

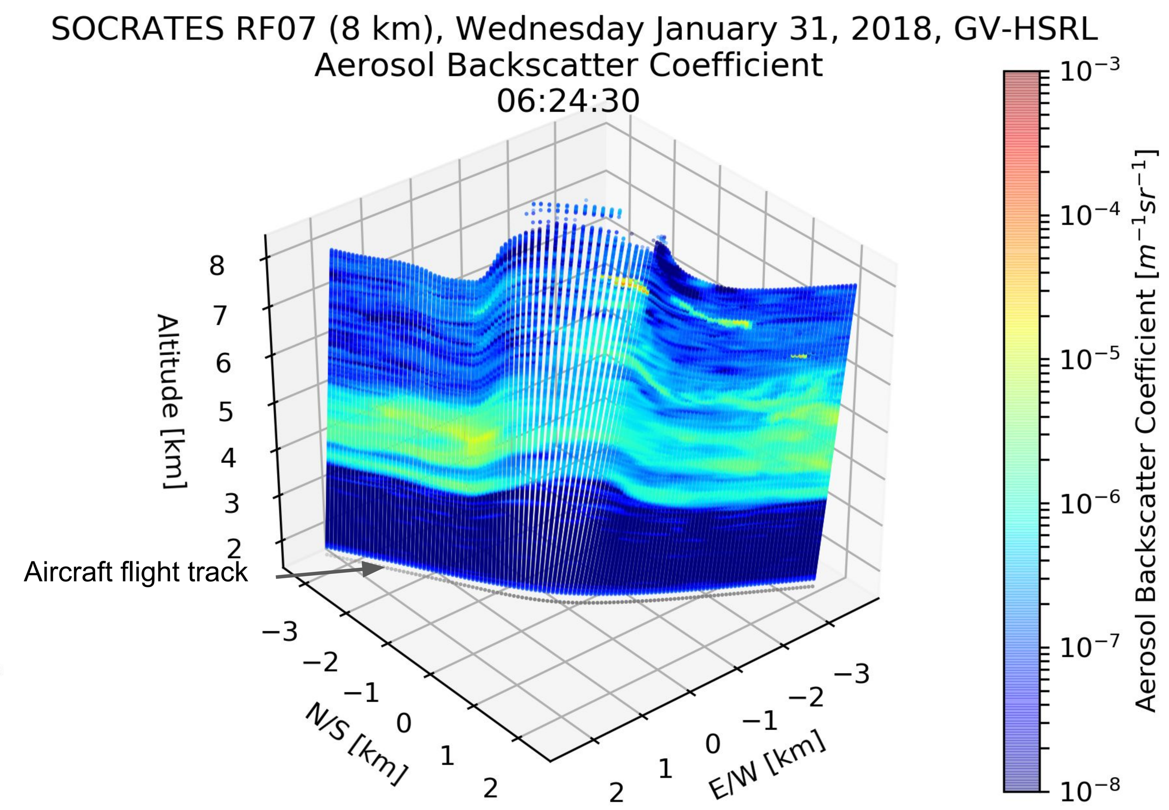
NCAR | NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

The GV-HSRL was designed and built by University of Wisconsin SSEC to operate on the NSF HIAPER (GV) in either up or down pointing modes (switchable).

High Spectral Resolution Lidar (HSRL) provides directly calibrated observations of Cloud/Aerosol
- Backscatter Coefficient
- Extinction Coefficient
- Particle Depolarization
- Lidar Ratio

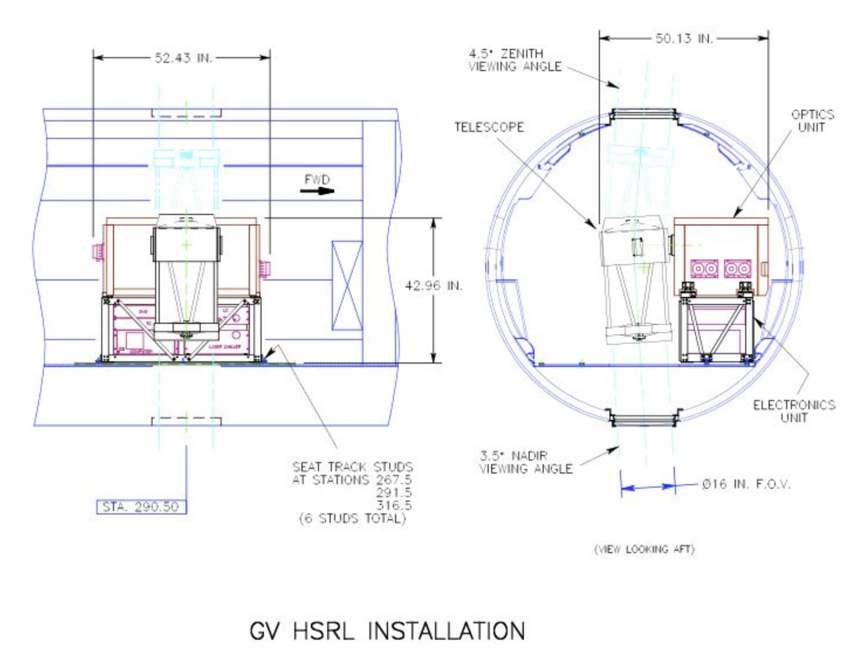
Data Examples from SOCRATES[1]





Challenges for GV-HSRL

Since delivery in 2010, the GV-HSRL has participated in 3 field projects.
Practical limitation of the instrument:
- Occupies space of 4 instrument racks limiting payload
- Only installs on the GV (no C-130)
- Requires highly specialized staff to repair/maintain



Why HSRL

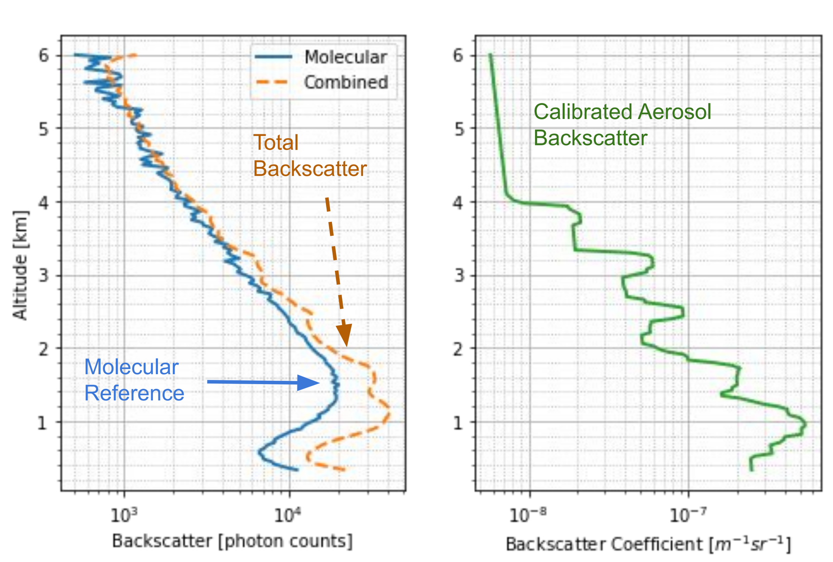
The standard backscatter lidar:
1 measurement and 3 unknowns

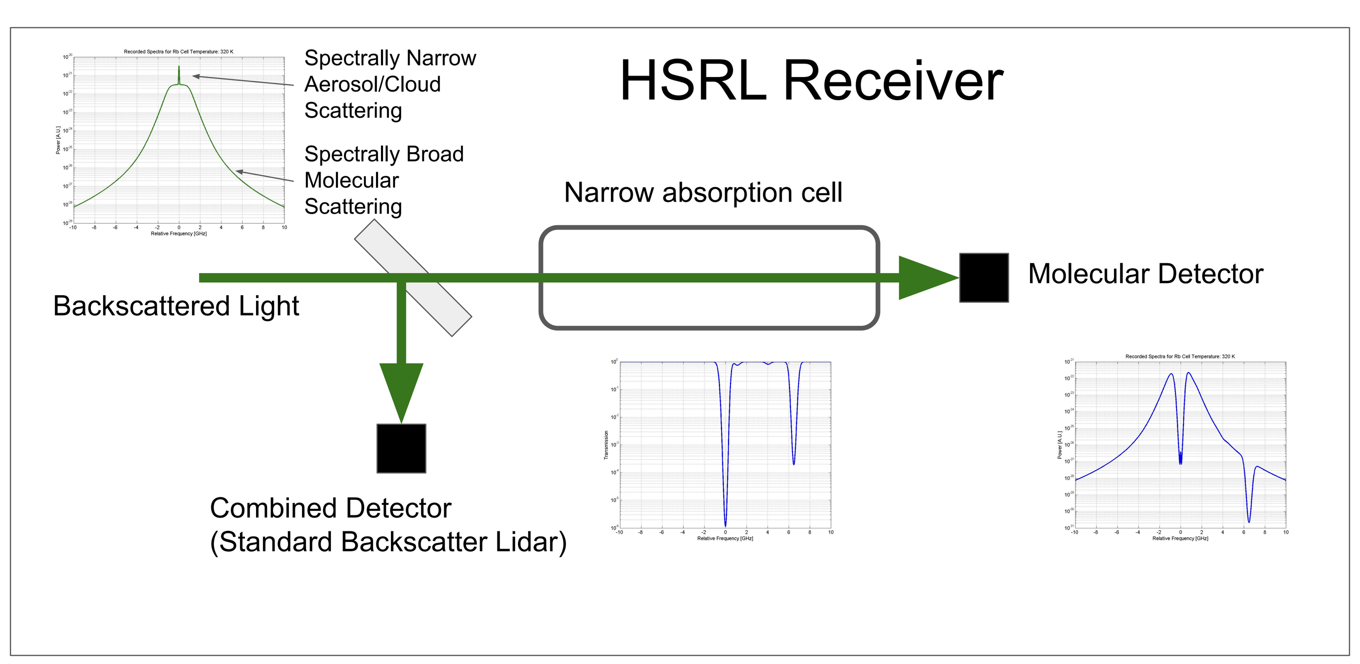
$$s(r) = \eta(r)\beta(r)t(r)^2$$

Measured range dependent signal | Instrument effects | Atmospheric Backscatter | Atmospheric Transmission

Solving with only one measurement:
- Assume relationships between atmospheric terms
- Assume, ignore or indirectly infer instrument term
- No diagnostic for the accuracy of these assumptions

HSRL (and Raman lidar) use a second molecular-only signal as a backscatter reference which
- Reduces the impact of instrument effects
- Enables direct calibration of residual instrument effects (HSRL only)
- Enables two measurements for two remaining atmospheric unknowns

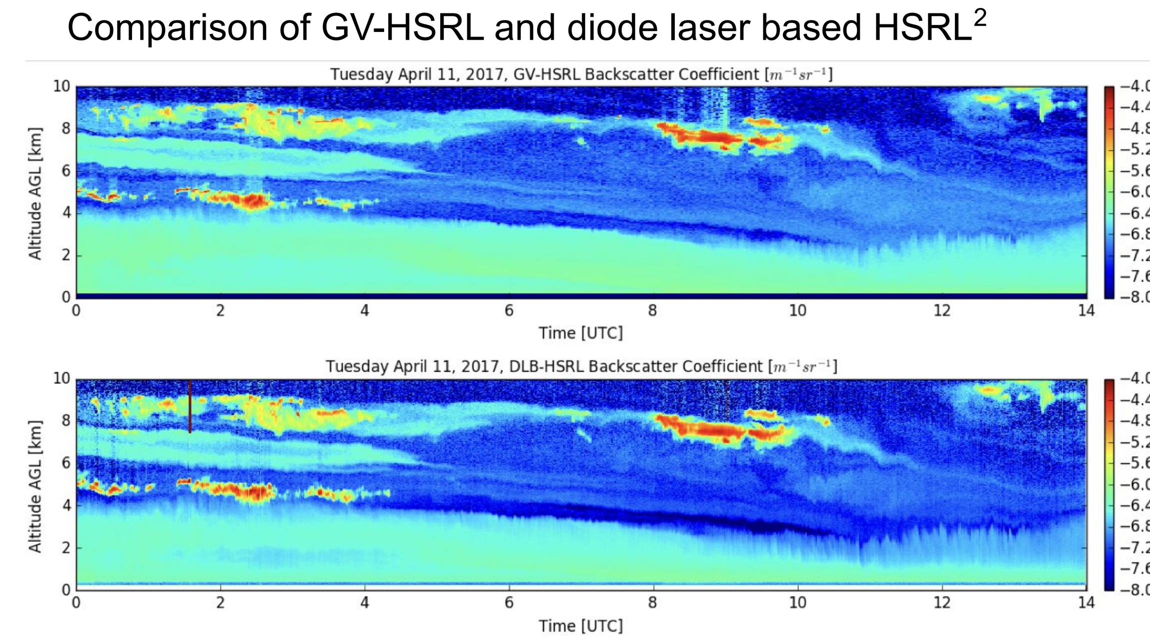




Next Generation

The next generation airborne HSRL at NCAR should address the practical limitations of the current GV-HSRL.
Diode-laser-based architectures similar to the MicroPulse DIAL (MPD) provide an effective path forward.
The concept for a diode laser based HSRL was demonstrated in 2017 by NCAR[2]
Five diode laser based HSRLs are currently part of the operational MPD instrument package

Comparison of GV-HSRL and diode laser based HSRL[2]



Potential Benefits:
- Reduced install footprint
- Platform flexibility (GV and C-130)
- Reduced maintenance requirements
- Design for RT situational awareness
- Simultaneous up/down profiling

Risks
- Reduced signal-to-noise
- Development time, staff and resources

References

NCAR/EOL HSRL Team. 2018. SOCRATES: NCAR HSRL lidar data, CfRadial. Version 1.0. UCAR/NCAR - Earth Observing Laboratory. https://doi.org/10.5065/D6TB15R4. Accessed 06 Sep 2019

Hayman and Spuler, "Demonstration of a diode-laser-based high spectral resolution lidar (HSRL) for quantitative profiling of clouds and aerosols," Opt. Express 25, A1096-A1110 (2017). https://doi.org/10.1364/OE.25.0A1096

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