Demonstration of high spectral resolution lidar (HSRL) measurements of aerosols and clouds using a coherent Doppler wind lidar

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Introduction

Coherent Doppler Wind Lidar (CDWL)
- measures wind speed based on Doppler shift of aerosol backscatter signal
- relies on spectrally resolving narrowband aerosol backscatter signal

High Spectral Resolution Lidar (HSRL)
- provides quantitative aerosol optical properties by independently measuring aerosol and molecular backscatter signals
- uses optical filters to separate aerosol and molecular signals

Proposed Research:
- make spectrally resolved measurement of molecular backscatter signal using a CDWL
- provides aerosol to molecular backscatter ratio needed for HSRL measurements

Advantages:
- simultaneous wind and aerosol measurements
- spectral separation in digital domain
- potential new aerosol/temperature lidar

Modification

Replaced digitizer and detector for extended bandwidth measurement
- Modified LabVIEW data acquisition software to acquire data at 1.5 Gs
- Developed analysis software
- Characterized different noise sources

Simulation

- Rayleigh-Brillouin spectrum at 1.5 μm
- Backscatter power spectrum at 750 MHz bandwidth
- Separated aerosol and molecular spectra
- Integrate aerosol and molecular backscatter spectra for quantitative aerosol backscatter coefficient

Results

- Measured molecular and aerosol backscatter spectra from atmospheric return
- Retrieved aerosol backscatter coefficient

Summary and Future Work

- Successfully measured spectrally resolved atmospheric molecular backscatter signal using coherent detection technique.
- Demonstrated possibility for simultaneous wind and quantitative aerosol optical properties measurements.
- Perform further verification, validation and range resolved measurements.

<table>
<thead>
<tr>
<th>Lidar parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength (nm)</td>
<td>1543.00</td>
</tr>
<tr>
<td>Average power (mW)</td>
<td>800</td>
</tr>
<tr>
<td>Pulse Energy (μJ)</td>
<td>40</td>
</tr>
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<td>Pulse Length (ns)</td>
<td>166-1000</td>
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<td>Pulse repetition rate (kHz)</td>
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All components are off-the-shelf

Lidar parameter Specification

Wavelength (nm) 1543.00
Average power (mW) 800
Pulse Energy (μJ) 40
Pulse Length (ns) 166-1000
Range resolution (m) 25-150
Pulse repetition rate (kHz) 18-20
Maximum Range (km) 8.3-7.5
Beam rate (Hz) 1-10
Intermediate Frequency (MHz) 62.5
Sampling Rate (MHz) 250

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