Intercomparison of Lidar Aerosol Backscatter and in-situ Size Distribution Measurements

**Motivation**

Aerosol point sensors cannot fully represent the variability of atmospheric aerosol in time and space. Aerosol backscatter lidars may provide valuable information about the spatial distribution of aerosol concentrations.

**Instrumentation**

- REAL (Raman-shifted Eye-safe Aerosol Lidar)\(^1\) 1543 nm wavelength, 170 mJ pulses at 10 Hz
- CLASP aerosol spectrometer\(^2\) 16 size channels, 600 nm – 17 μm diameter at 10 Hz
- LasAir aerosol spectrometer (PMS, Boulder, CO, USA) 8 size channels, 100 nm – 10 μm, 5 min resolution

**Spatial variability of backscatter signal**

- Large variation of backscatter intensity is observed both in horizontal and vertical dimensions.
- Identification of aerosol plumes and tracking of plume transport is possible.

**How is this variability reflected in aerosol size and number?**

**Field experiments**

- **Canopy Horizontal Array Turbulence Study\(^3\), 2007:** Horizontal and vertical lidar scans over walnut orchard, and in-situ aerosol spectra measurements
- **Chico State University Farm, 2011:** Horizontal lidar stares 3 m above ground towards aerosol spectrometer 1320 m from lidar:
  
  Fig. 1: a) REAL at Chico State University Farm; b) CLASP mounted 3 m above ground, October 2011.

**Sensitivity to aerosol concentration changes**

- Small changes in aerosol properties are readily observed in backscatter intensity on time scales of seconds: 10 Mm\(^{-1}\)/dB resolution with \(\sigma_{\text{residuals}} = 4.3 \text{ Mm}^{-1}\)
- Counting statistics of aerosol spectrometer limit the comparability at high time resolution (1 Hz and faster).

**Backscatter signal vs. aerosol properties**

**Conclusions and outlook**

- REAL backscatter signal reveals spatial variability of aerosol distribution within several kilometers.
- Backscatter intensity is correlated with aerosol properties measured in-situ.
- Uncertainty analysis of lidar and aerosol spectrometer data required for further intercomparison studies.
- Sensitivity analysis of aerosol refractive index in calculation of scattering coefficient required for lidar vs. in-situ closure study.

References:


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**Objective**

Compare lidar backscatter and aerosol size distribution data, and characterize the sensitivity of an aerosol backscatter lidar to changes in aerosol size and concentration.