Aerosol backscatter, optical depth, and other optical properties from the SSEC Portable Atmospheric Research Center (SPARC) High Spectral Resolution Lidar (HSRL) during the CHEESEHEAD campaign

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1. Introduction

The SSEC Portable Atmospheric Research Center (SPARC, Wagner et al. 2019) was deployed at the WLEF-TV tall tower site for the duration of CHEESEHEAD. Among the instruments deployed aboard SPARC is a High Spectral Resolution Lidar (Shipley et al. 1983; Eloranta 2005) from which absolutely-calibrated high temporal resolution profiles of aerosol and molecular backscatter can be obtained. Data have been processed into profiles with resolution of 30 s and 30 m. Users are invited to visit the following website:

http://hsrl.ssec.wisc.edu/by_site/32/custom_netcdf/

where they can choose different parameters for the temporal and vertical resolution of the data if different parameters are required. Temporal resolution can be set as low as 0.5 s and vertical resolution can be as low as 7.5 m, though such parameters would result in a noisier dataset than the present one.

2. Instrument Description

The following paragraph is taken from Wagner et al. 2019: Backscatter lidars are often deployed to measure the range-resolved backscatter induced by aerosols suspended in the atmosphere, but the backscatter signal at a given height is attenuated by both molecular and aerosol scattering of the atmosphere between the lidar and that height. Traditional backscatter lidars that measure the backscattered return only at the laser's wavelength are unable to unambiguously discriminate between the two types of scattering signals: a layer with a small backscattering cross section with low extinction between the lidar and the layer or a layer that has a high backscattering cross section and larger extinction between the lidar and the layer. An HSRL is able to provide calibrated measurements of the backscatter and extinction cross section by including a detection channel that is sensitive to only the molecular scattering. The resulting measurements can be used to discern aerosol backscatter cross section, particulate optical depth, particulate depolarization, and other characteristics of aerosols.

This particular HSRL is not the system that normally travels with SPARC, as that version was on an overseas deployment. Instead, this HSRL was borrowed from NCAR where it is normally deployed aboard their Gulfstream-V aircraft.

3. Data Processing

Data were processed on the aforementioned website using the default parameters. The version of the data presented here, while encompassing the entire CHEESEHEAD deployment, are representative of the kinds of data that can be produced by end users. This dataset therefore represents a permanent EOL-based archive of the HSRL during CHEESEHEAD while other versions can be produced on demand on the website.

4. Data Description

The data are stored in netCDF files, with 24 hours of data per file starting at 0000 UTC (7 PM CDT). Files are named in the following way:

gvhsrl_day_YYYYMMDDTHHNN_yyyymmddhhnn_30s_30m.nc

where YYYYMMDD is the date of the start of the file and HHNN is the time of the first valid data in that file, while yymmddhhnn is the date of the end of the file and hhnn is the time of the end of the file.

The metadata included within every netCDF file contains a brief description of the data; however, here are some of the variables of greatest interest to CHEESEHEAD researchers. Many more can be found within the files themselves.

Time and height variables

base_time:	time at the start of the file, in UNIX epoch [s]
time:	seconds since base_time [s]
altitude:	height above the instrument [km AGL]

Derived Variables

od:	aerosol + molecular optical depth
od_aerosol:	aerosol optical depth
extinction:	aerosol + molecular extinction [m^{-1}]
extinction_aerosol:	aerosol extinction [m^{-1}]
beta_a_backscat:	particulate backscatter cross section per unit volume [m^{-1} sr^{-1}]

Quality control

qc_mask: bit resolved quality control field. See the metadata of any netCDF file for details.

5. References

Eloranta, E. W., 2005: High spectral resolution lidar. *Lidar: Range-Resolved Optical Remote Sensing of the Atmosphere*, K. Weitkamp, Ed., Springer-Verlag, 143–163

Shipley, S. T., D. H. Tracy, E. W. Eloranta, J. T. Trauger, J. T. Sroga, F. L. Roesler, and J. A. Weinman, 1983: A High Spectral Resolution Lidar to measure optical scattering properties of atmospheric aerosols. Part I: Instrumentation and theory. *Appl. Opt.*, **22**, 3716–3724.

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