Five years of routine Raman lidar measurements at Kühlungsborn (LIDARNET/EARLINET)

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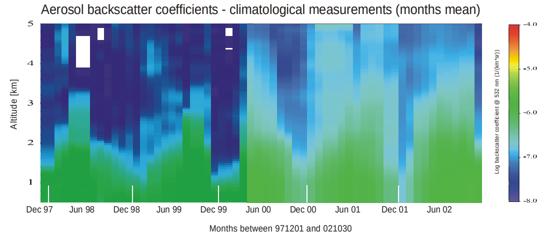
EARLINET - European Aerosol Research Lidar Network

EARLINET is a joint project of 23 European lidar groups to establish a quantitative comprehensive statistical data base of both horizontal and vertical distribution of aerosols on a continental scale. The goal is to provide aerosol data for unbiased sampling, selected important processes, and air mass history. The use of data, both by internal and external scientists, will contribute significantly to the quantification of aerosol concentrations, radiative properties, long-range transport and budget, and prediction of future trends. The objectives is using advanced quantitative laser remote sensing (multispectral backscatter lidar mostly combined with Raman lidar) to measure directly the vertical distribution of aerosol. A major part of the measurements will be performed on a fixed schedule to provide an unbiased statistically significant data set. Additional measurements will be performed to address specifically important processes that are localised either in space or time. All lidar measurements will be supported by a suite of more conventional observations. Special care will be taken to assure data quality, including intercomparisons at instrument and evaluation levels.

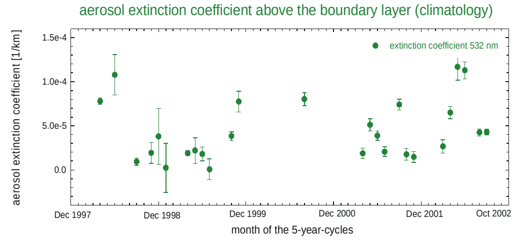
Five years of routine Raman lidar measurements: Backscatter and Extinction coefficients

Aerosol backscatter coefficients - climatological measurements (months mean)



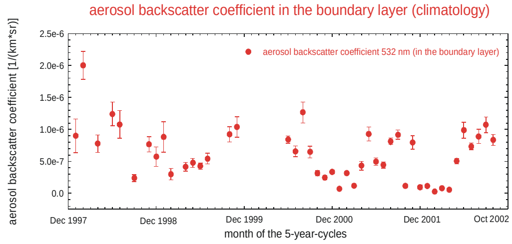
Annual cycle of aerosol backscatter coefficients (532 nm), cloudless day only. Shown are monthly mean values, smoothed with a running mean over three months. White areas indicate values below the detection limit.

aerosol extinction coefficient above the boundary layer (climatology)



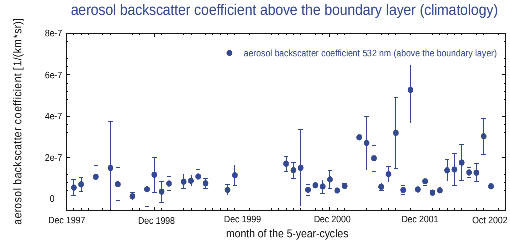
Shown are monthly mean values of the aerosol extinction coefficient at the wavelength 532 nm above boundary layer and 5 km.

aerosol backscatter coefficient in the boundary layer (climatology)



Shown are monthly mean values of the aerosol backscatter coefficient at the wavelength 532 nm in the boundary layer.

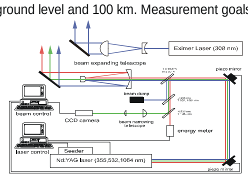
aerosol backscatter coefficient above the boundary layer (climatology)



Shown are monthly mean values of the aerosol backscatter coefficient at the wavelength 532 nm above boundary layer and 5 km.

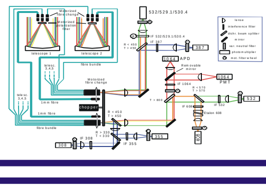
System description RMR-Lidar Kühlungsborn

The Rayleigh/Mie/Raman (RMR) lidar system at the Leibniz-Institut für Atmosphärenphysik (IAP), Kühlungsborn, Germany (54°07' N, 11°46 'E), was designed for measurements at altitudes between ground level and 100 km. Measurement goals are aerosol properties (extinction, backscatter, composition, size distribution), as well as atmospheric temperatures.



Transmitters

A seeded Nd:YAG laser emitting simultaneously the fundamental (1064 nm) and the second and third harmonic wavelengths (532 & 355 nm). Before the laser beam is widened for transmission into the atmosphere, it is actively stabilized in order to keep the beam in the field-of-view of the receiving telescopes. Therefore, about one percent of the laser beam is coupled out, reduced in width and guided onto a CCD camera. From the measured center position of the beam on the CCD camera, the beam control computer calculates the new mirror positions and adjusts the two piezo-driven mirrors.



Receivers

The light backscattered from the atmosphere is received by up to 5 telescopes (active diameter: 50 cm each), one of which (telescope 1) is mounted coaxially to the laser beam. The light reflected from the parabolic mirrors is transmitted via glas fibre bundles to the optical bench. The wavelengths are seperated by dichroic beam splitters. Detected wavelengths include the Rayleigh/Mie backscatter signals at the emitted wavelengths, the vibration-shifted N_2 Raman signals at 387 and 608 nm, the rotation-shifted Raman signals at 529.1 and 530.4 nm. For tropospheric measurements, telescope 1 is used for the detection of the fundamental wavelengths, the 608 nm Raman signal, and the 308 nm wavelength. Full geometric overlap is reached above 500 m. The 387 nm Raman signal is detected via the second telescope. Due to the off-axis geometry of this telescope, full geometric overlap is reached at altitudes above 2 km. A telescope with a short focal length to detect the 608 nm Raman signal from direct above ground level is presently under construction.

Publications

- Alpers, M., R. Eixmann, J. Höffner, T. Köpnick, J. Schneider, und U. von Zahn, The Rayleigh/Mie/Raman lidar at IAP Kühlungsborn, *J. Aerosol Sci., 30, Suppl. 1*, 637-638, 1999.
- Wiegner, M., J. Bösenberg, C. Böckmann, R. Eixmann, V. Freudenthaler, I. Mattis und T. Trickl, Lidar network to establish an aerosol climatology, *J. Aerosol Sci., 30, Suppl. 1*, 429-430, 1999.
- Eixmann, R., J. Schneider, V. Matthias, I. Mattis und St. Kreipl, Tropospheric lidar measurements during a cold front passage in January 2000 over several stations of the German Lidar Network, *Atmos. Res.*, 63, 39-58, 2002.
- Schneider, J., und R. Eixmann, 3 years of routine Raman lidar measurements of tropospheric aerosols: Planetary boundary layer heights, extinction and backscatter coefficients, *Atmos. Chem. Phys.*, 2, 313-323, 2002.

Results

- We have performed a five-year series of routine lidar measurements on a climatological base. To obtain an unbiased data set, the measurements were taken at preselected times.
- The measurements were performed between 1 December 1997, and 30 November 2002, at Kühlungsborn, Germany (54°07' N, 11'46' E). Using a Rayleigh/Mie/Raman lidar system, we measured the aerosol extinction and backscatter coefficients at the wavelength 532 nm (355 nm and 1064 nm) in and above the boundary layer.
- The backscatter coefficients in the boundary layer were found to be about 10 times higher than above.