Institute of Meteorology and Climate Research
Atmospheric Aerosol Research

Light absorbing properties of particles extracted from snow samples

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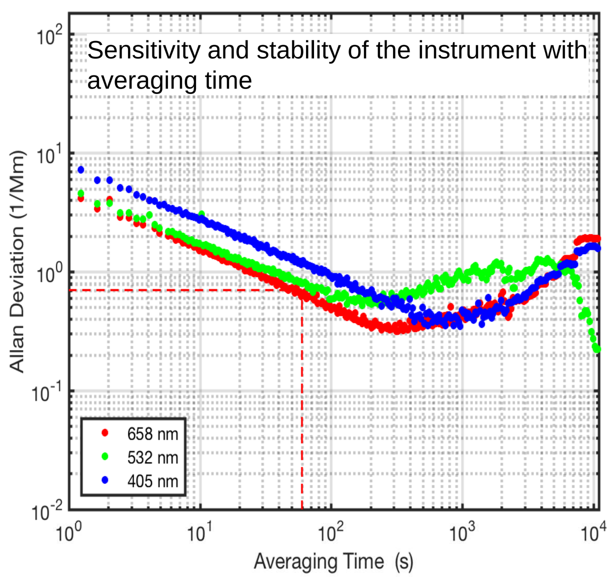
Introduction:

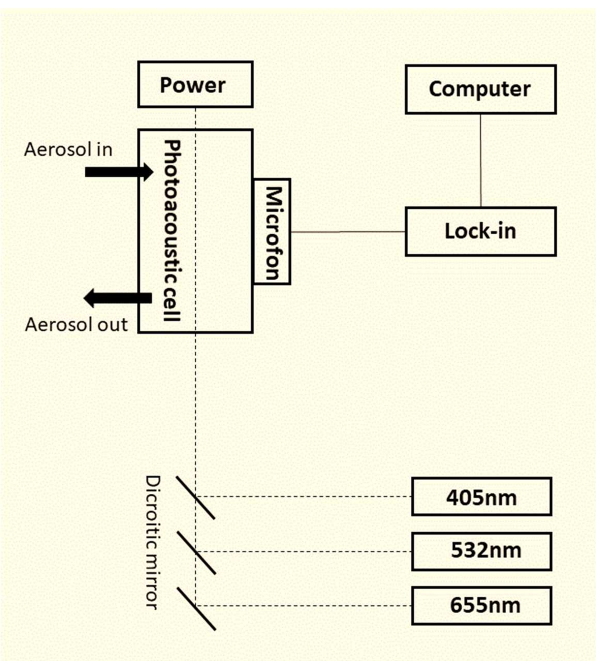
Impurities on snow or ice surfaces reduce the earth albedo and probably induce melting processes. Because snow is the most reflective natural surface on earth even small amounts of absorptive particles might have significant impact on Arctic and glacier regions. Although Black Carbon (BC) is the dominating absorbing aerosol component in the atmosphere, there are numerous other non-BC components which are able to contribute to aerosol light absorption. To specify the absorbing properties of particles trapped in snow we combined efficient nebulization technology with photoacoustic absorption and single particle mass spectrometry to simultaneously determine the volume visible absorption cross section and the refractory BC mass concentration of snow samples.

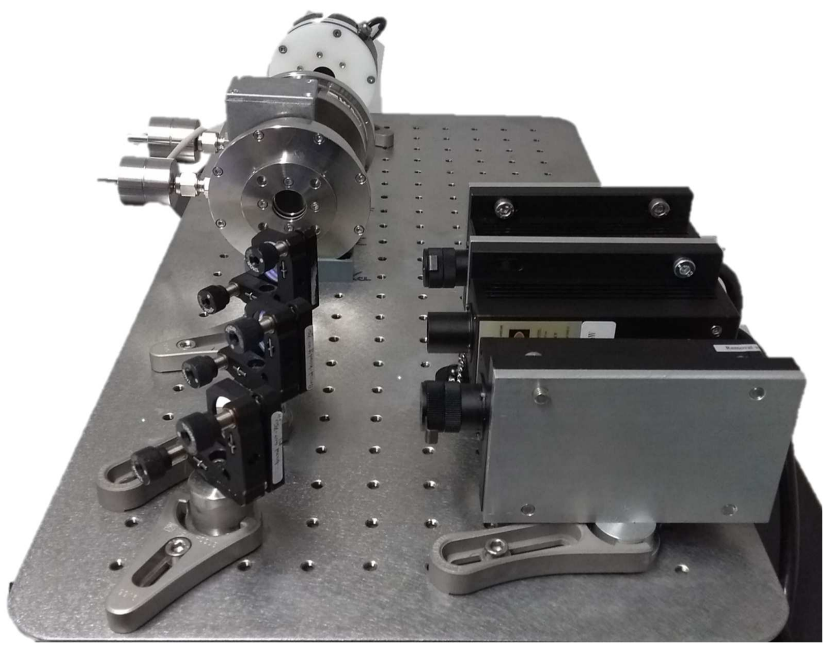
Photoacoustic Spectrometer PAAS-3λ:

Aerosol absorption measurements for

- ambient and
- re-suspended snow samples
- Three wavelength (405nm-660nm)
- Single cavity instrument
- Aerosol flow rate 1 L/min
- Detection limit: 0.7 Mm^{-1} @ 60s averaging time

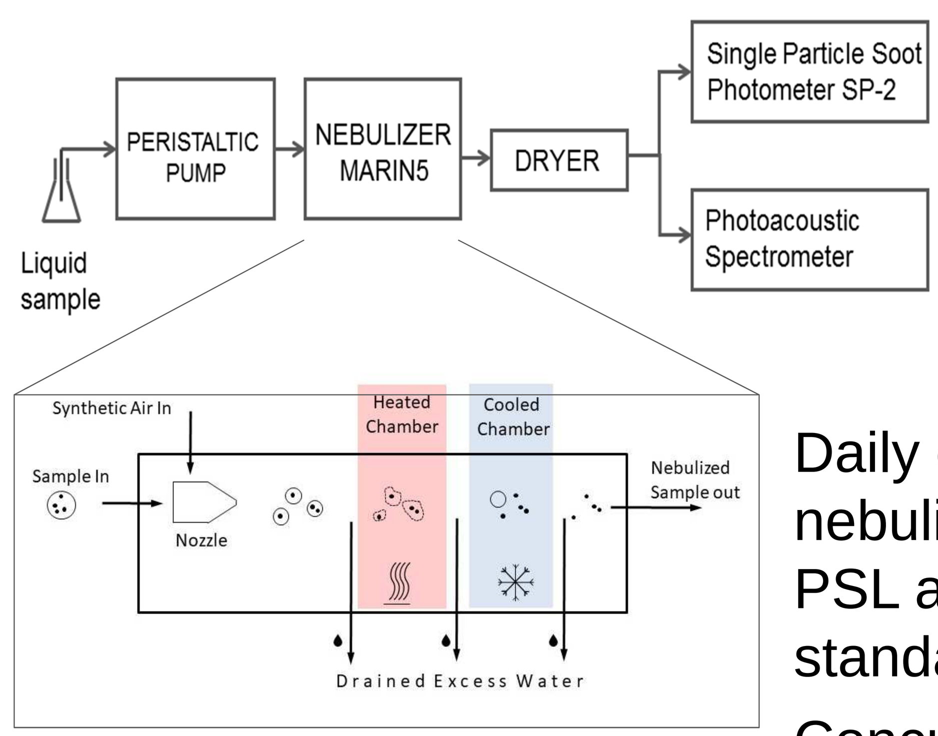


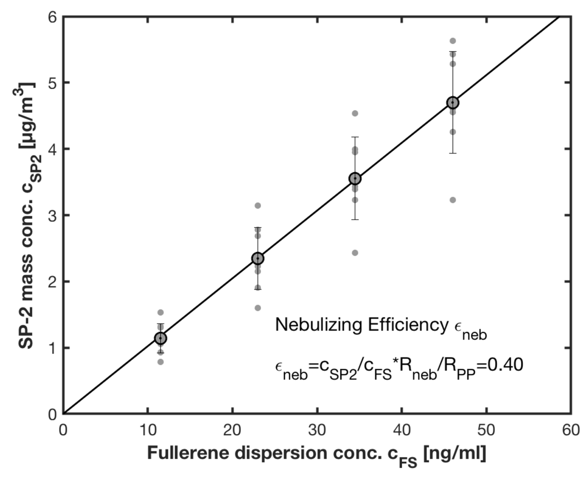




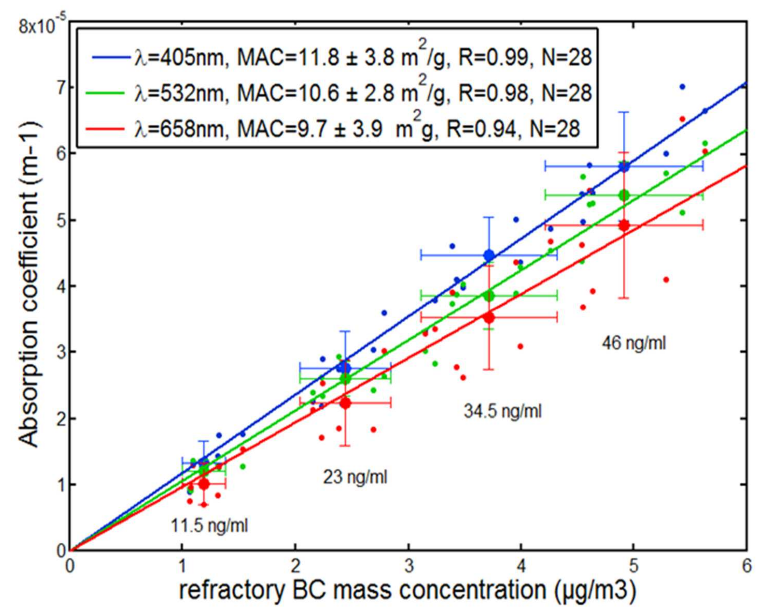
PAAS-3λ has been designed and built at KIT and is marketed by schnaiTEC GmbH

Experimental Setup:





Daily characterisation of the nebulizing efficiency ε with PSL and Fullerene particle standards.



Concurrent measurement of the absorption coefficients at three visible wavelengths and refractory Black Carbon (rBC) mass concentrations.

Mass specific absorption cross section of Fullerene particle standard determined at each wavelength.

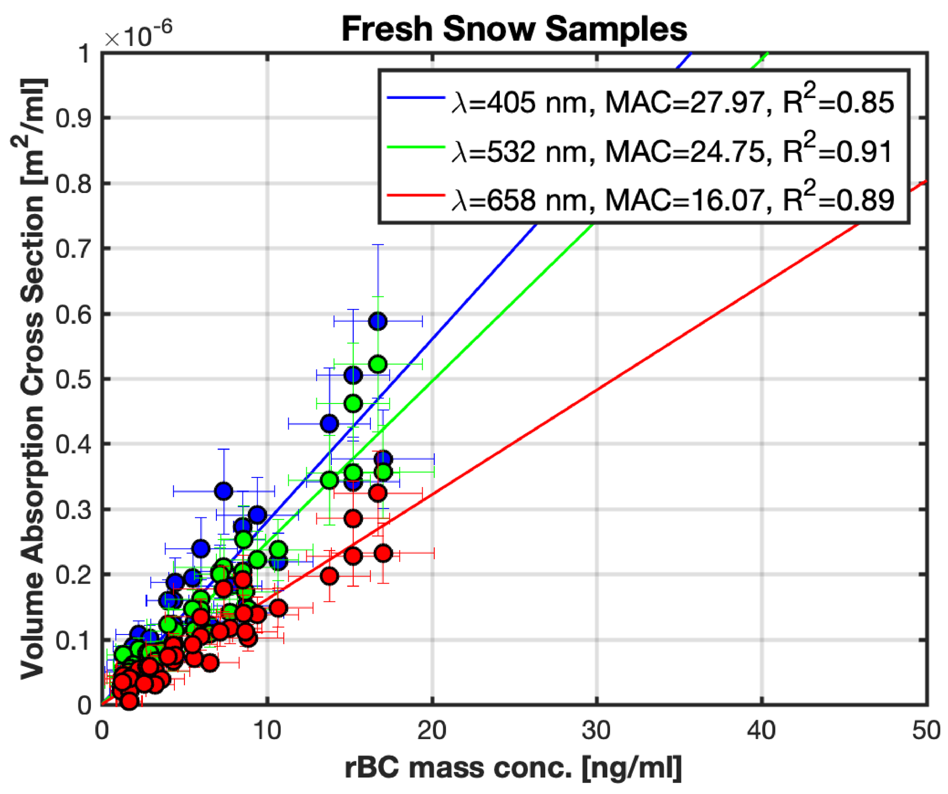
Results

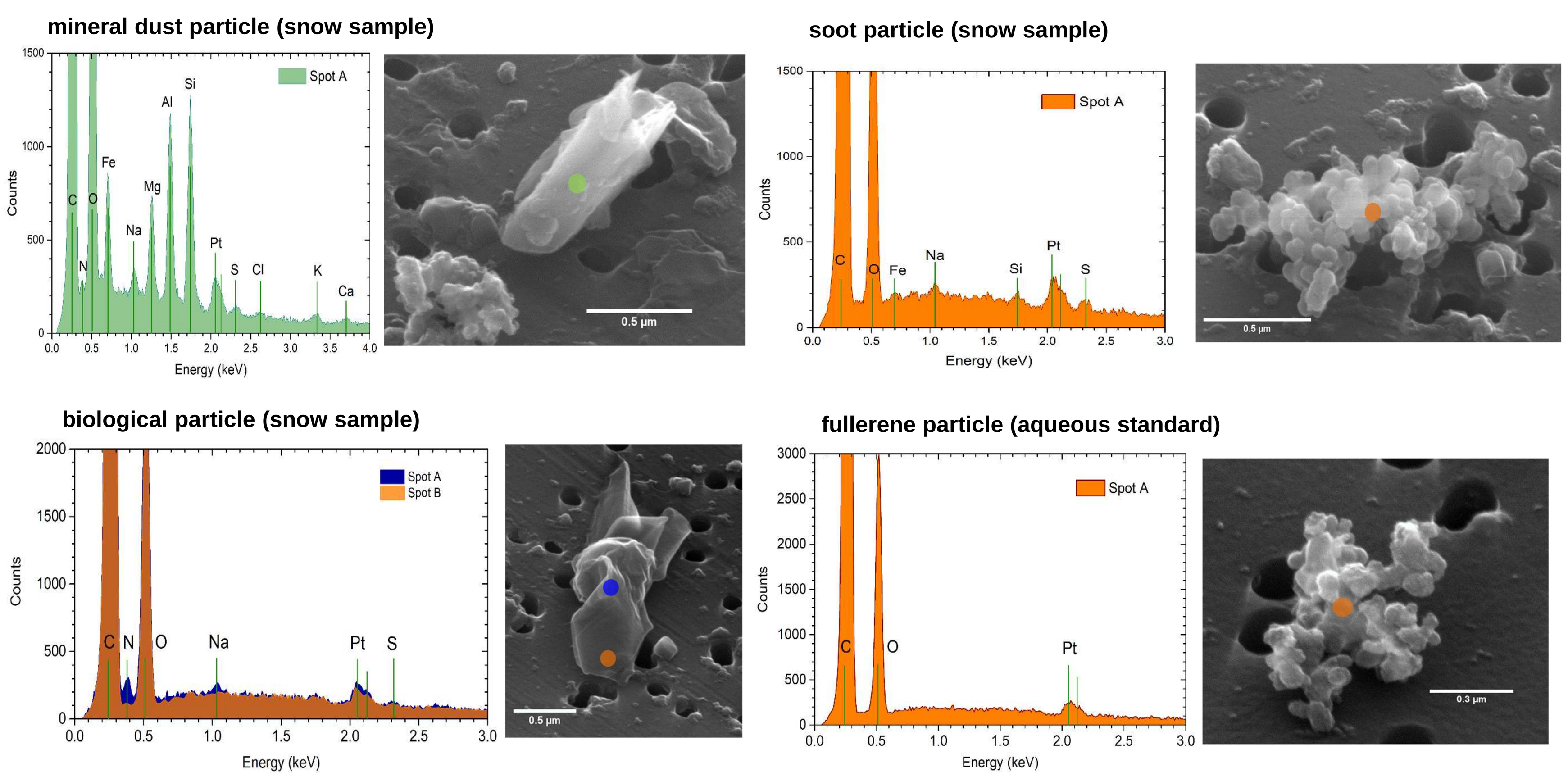
Total absorption cross sections per volume melted snow determined from the PAAS-3λ absorption coefficients using the nebulizing efficiency ε and the flow settings of the nebulizer.

Correlating the rBC mass concentrations with the absorption cross sections of the snow samples reveals significantly larger MACs (factor 2 - 3) compared to those of the Fullerene particle standards.

The MAC of the snow samples increases towards shorter wavelengths with a mean Absorption Angström Exponent (AAE) of 1.3 that is significantly larger than 0.5 determined for the Fullerene standards.

These findings indicate that light absorbing non-BC particles are co-deposited in the snow.





For one snow sample collected on March 10, 2017 ESEM microscopy combined with EDAX microanalysis was performed to get further information on the deposited particles.

The microanalysis reveals that particles of sizes larger than 500 nm predominantly consist of biological material, like debris of membranes, spores, pollen, bacteria and mixtures

Mineral dust typically contain heavier elements, like Al, Si, K, Fe, Ti. Mineral dust particles are present in the samples but to a less extent than expected.

Due to their small sizes only a few larger BC particles could be identified in the ESEM. These BC particles appear very similar in shape and composition to the Fullerene particle standard.

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