Specifying light absorbing properties of fresh snow samples

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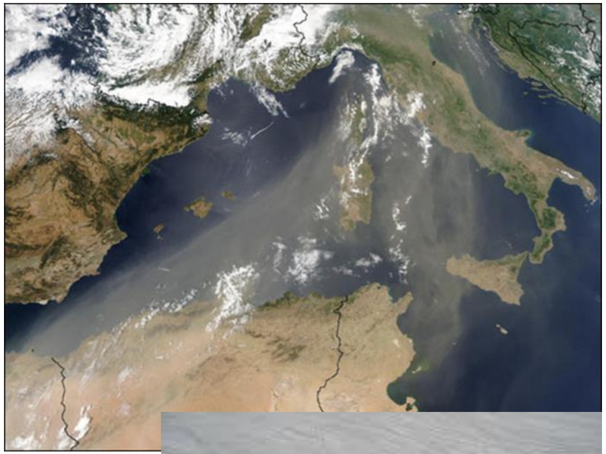
Motivation

Light absorbing particles deposited on pure snow and ice surfaces

→ reduce the snow albedo

→ increase the solar absorption

→ speed up melting processes



Airborne particles of

Natural origin

→ Mineral dust particles, Volcanic ash, Carbonaceous particles (forest fire)

Anthropogenic origin

→ Carbonaceous particles (industry, traffic, heating)

To what extend do different deposited particle types contribute to light absorption in snow ?

Aim of study

Isolating the insoluble particles from snow

→ determine light absorbing properties

- Melt, aerosolize and dry „snow“ sample
- Absorption coefficients by photoacoustic spectrometry

  → at 3 wavelengths in VIS (405nm, 532nm, 658nm)

- Mass concentrations by Single Particle Soot Photometer (SP2)

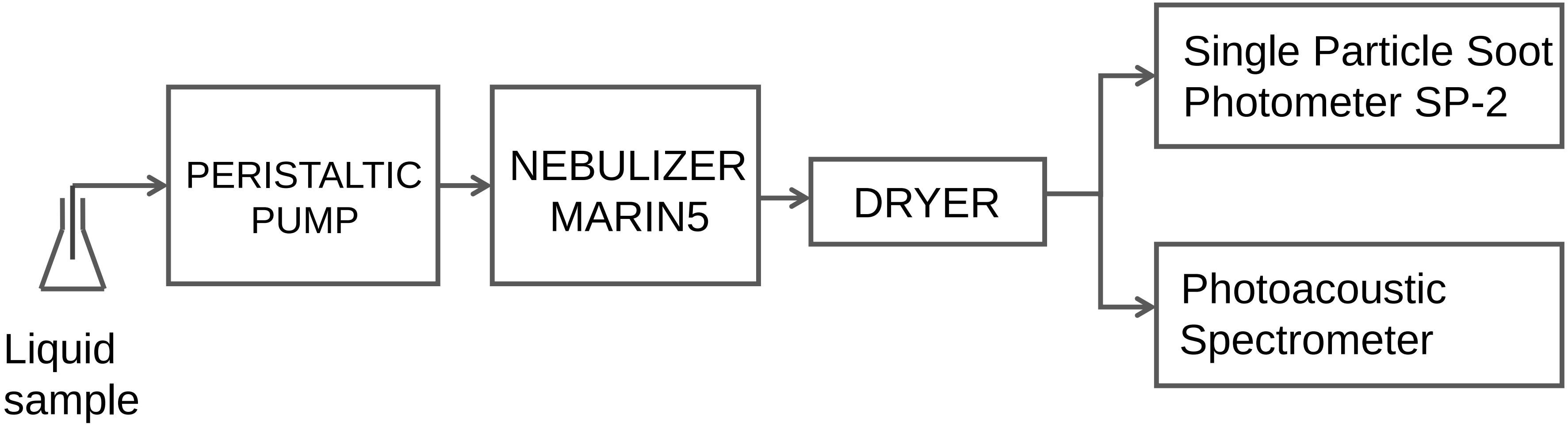
  → as refractory Black carbon (rBC)

Snow samples Environmental Resarch Station Schneefernerhaus (UFS)

Karlsruhe Institute of Technology

- Period of time: December 2016 - May 2017
- After every snowfall event
  samples of freshly fallen snow were taken
- Location of sampling: UFS
  Level 7 exposed windy, sunny conditions
  Level 9 sheltered, shady conditions
  @ each Level = 33 samples
- Storage: sealed in plastic bags
  frozen for storage in freezer at -18°C
  frozen transportation into laboratory
- Directly before measurement
  each sample was melted via ultrasonic bath (RT)

Setup of instruments



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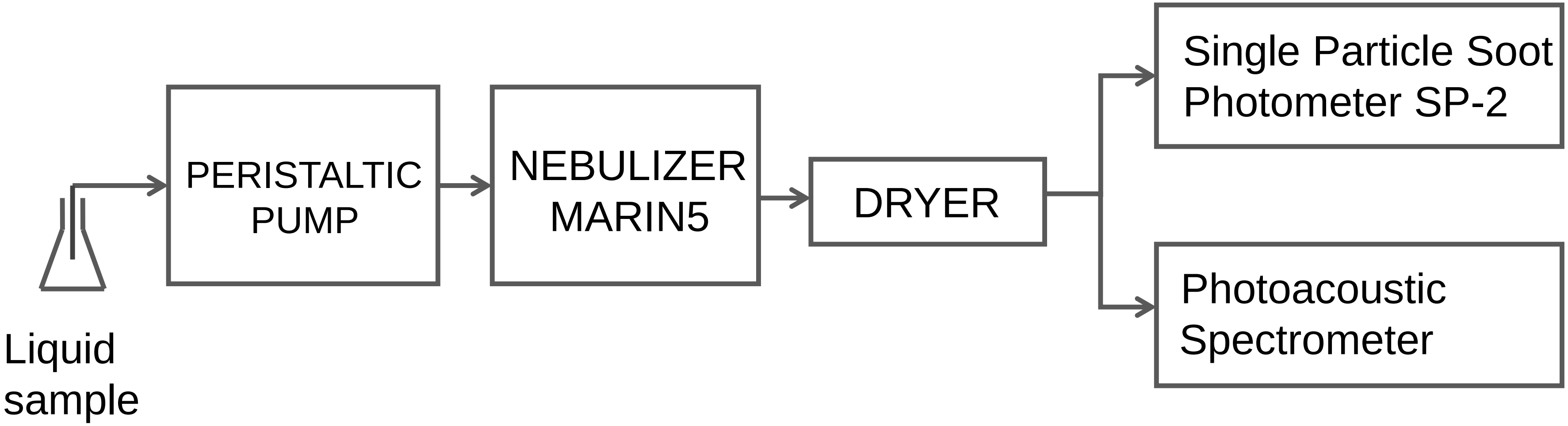
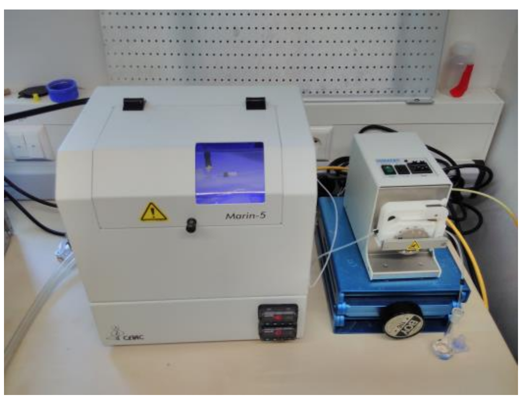
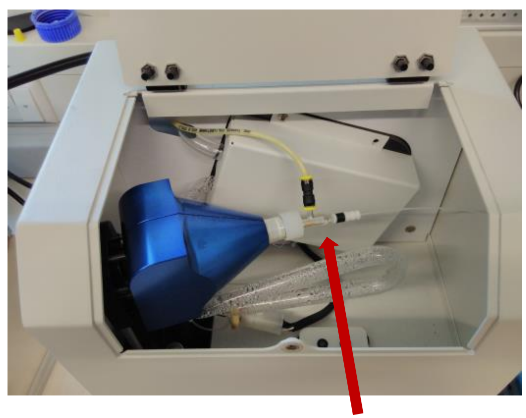
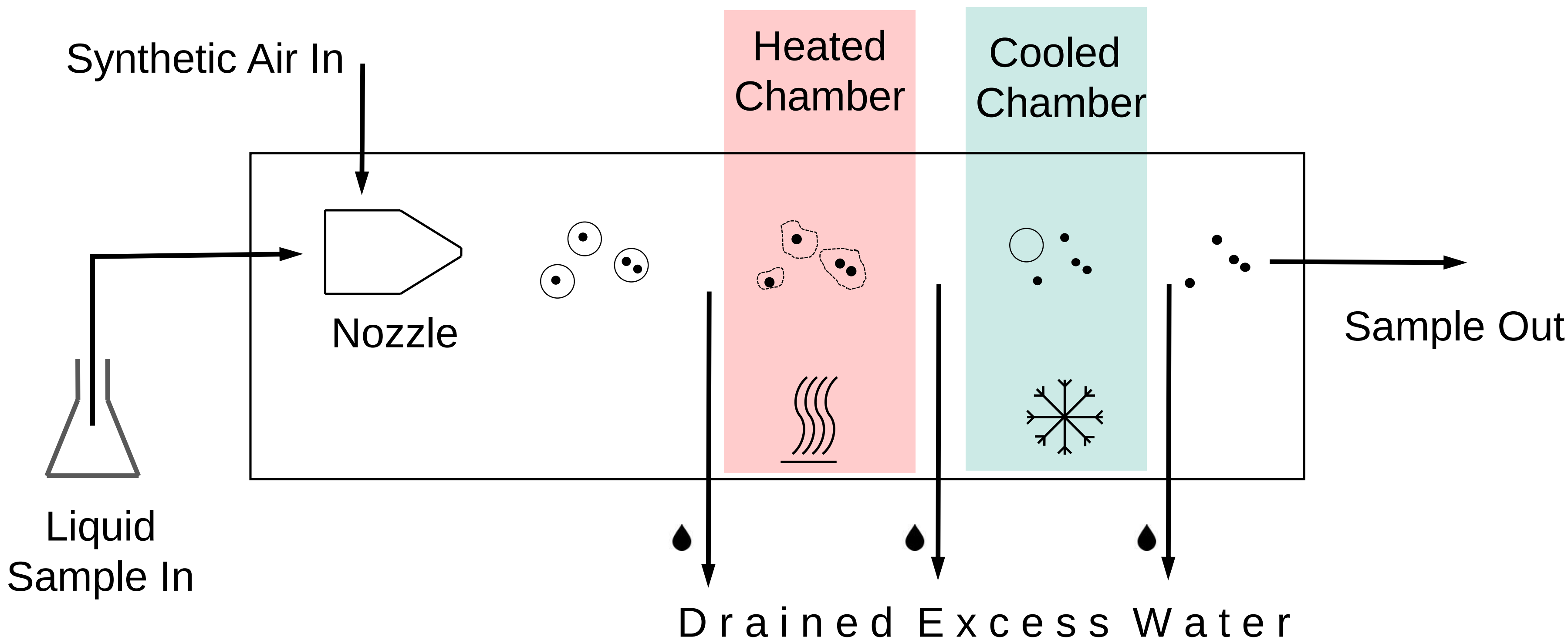






Nebulizer nozzle

Pneumatic Nebulizer MARIN 5



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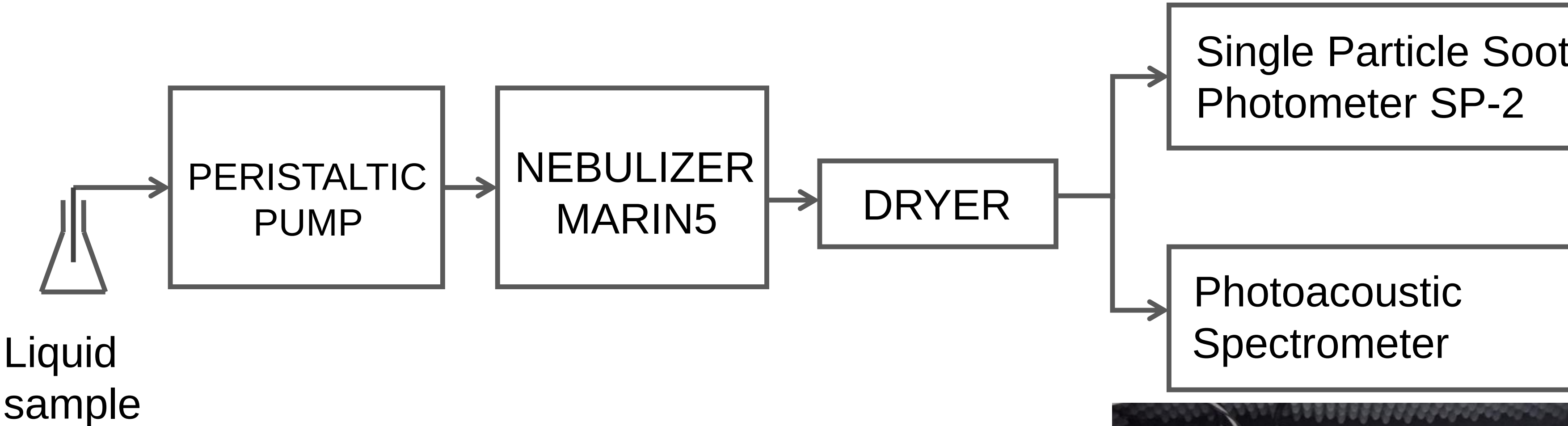
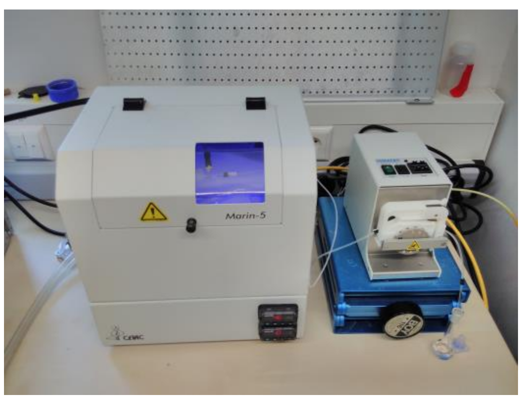
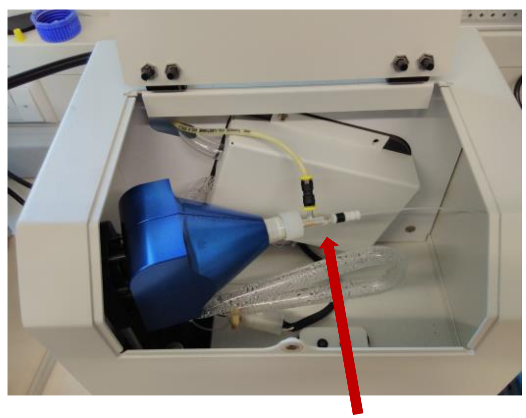
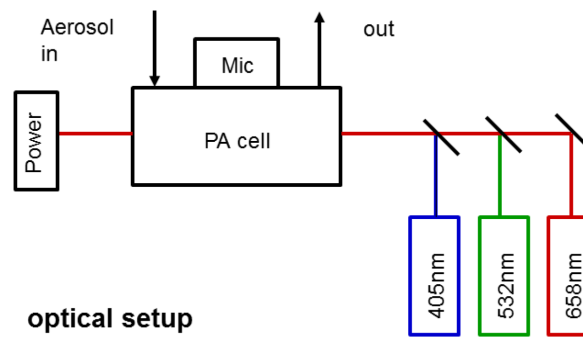




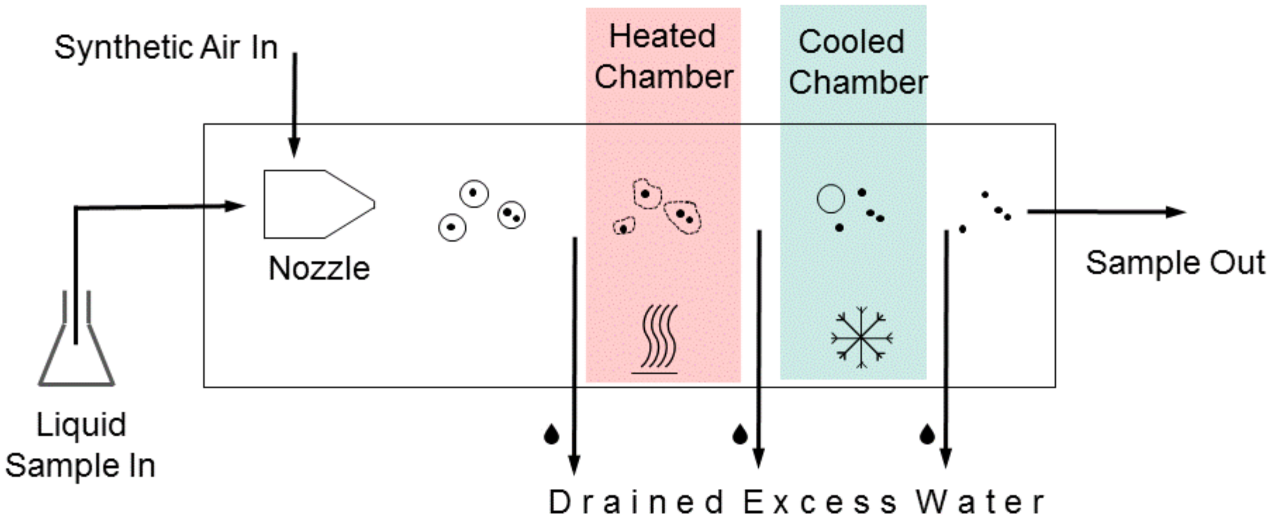


Nebulizer nozzle



optical setup

Nebulizer MARIN 5



Efficiency of Nebulizer:

- gas flow synthetic air R_{gas}
- liquid flow of peristaltic pump $R_{peristpump}$
- Temperatures of heated/ cooled chamber

Stock suspension → Fullerene mass concentration

Fullerene in water → Fullerene standards suspensions

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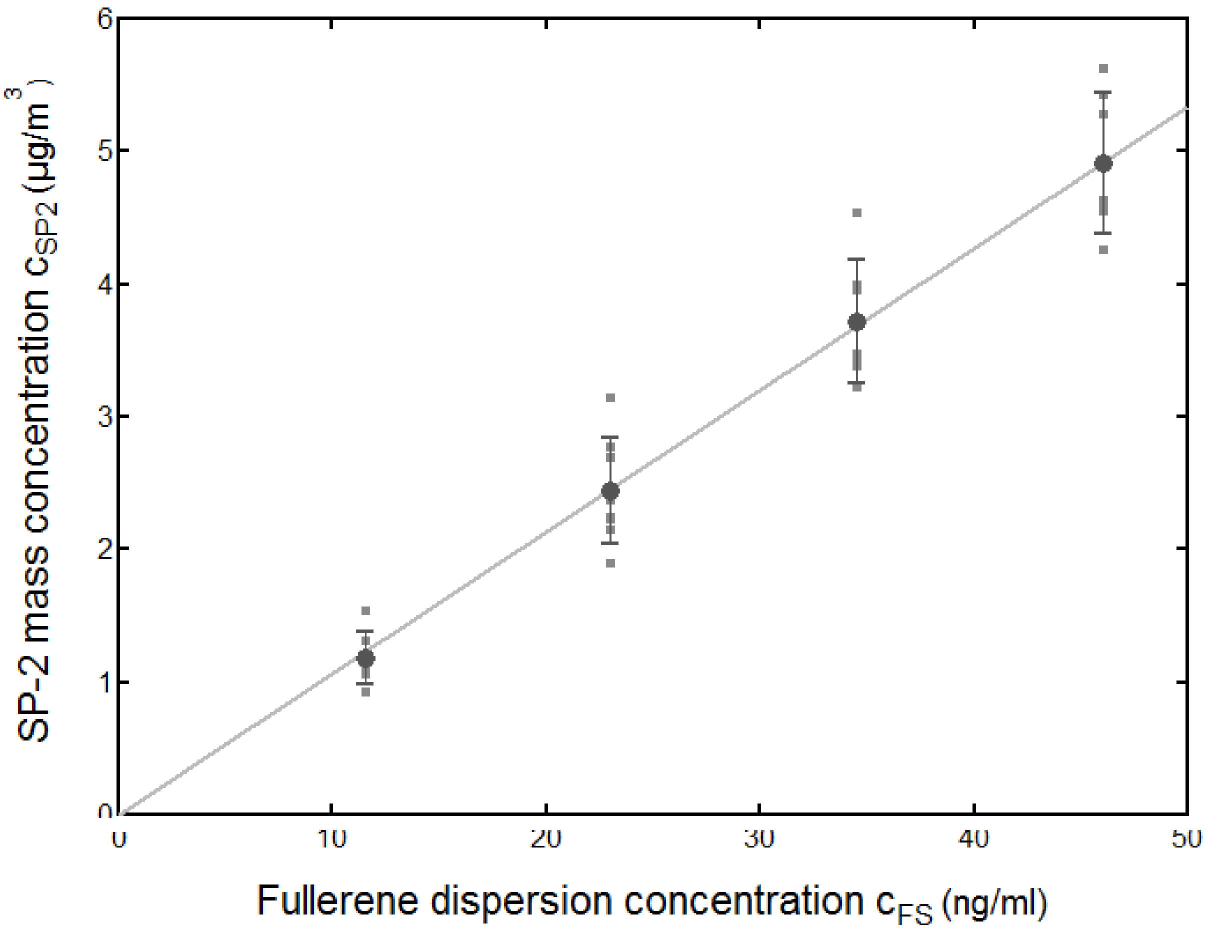
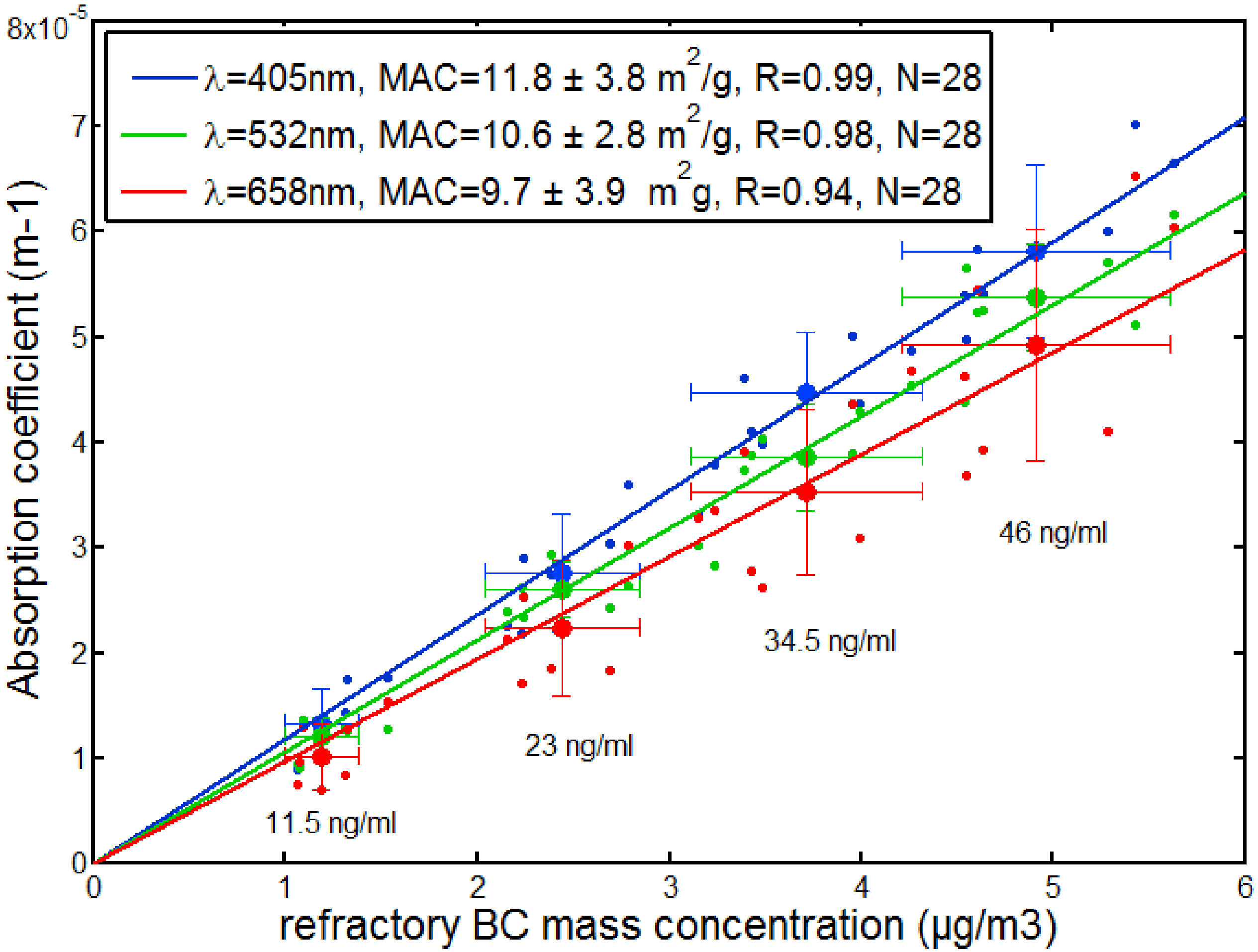
Nebulizer MARIN 5



Nebulizing efficiency ε

$$\varepsilon = \frac{c_{SP2}}{c_{FS}} * \frac{R_{gas}}{R_{liquid}} = 0.36$$

Absorption coefficients of Fullerene Standards



ANG exponent Fullerene range$_{(405\text{-}658nm)}$ = 0.5

→Baumgardner et al. Atmos.Meas.Tech. 5 (2012)

Detection limit PAS MARIN5 measurement
405nm $6*10^{-6}$ m^{-1}
532nm $6*10^{-6}$ m^{-1}
658nm $3*10^{-6}$ m^{-1}

Mass concentrations determined from photoacoustic and rBC measurement for snow samples

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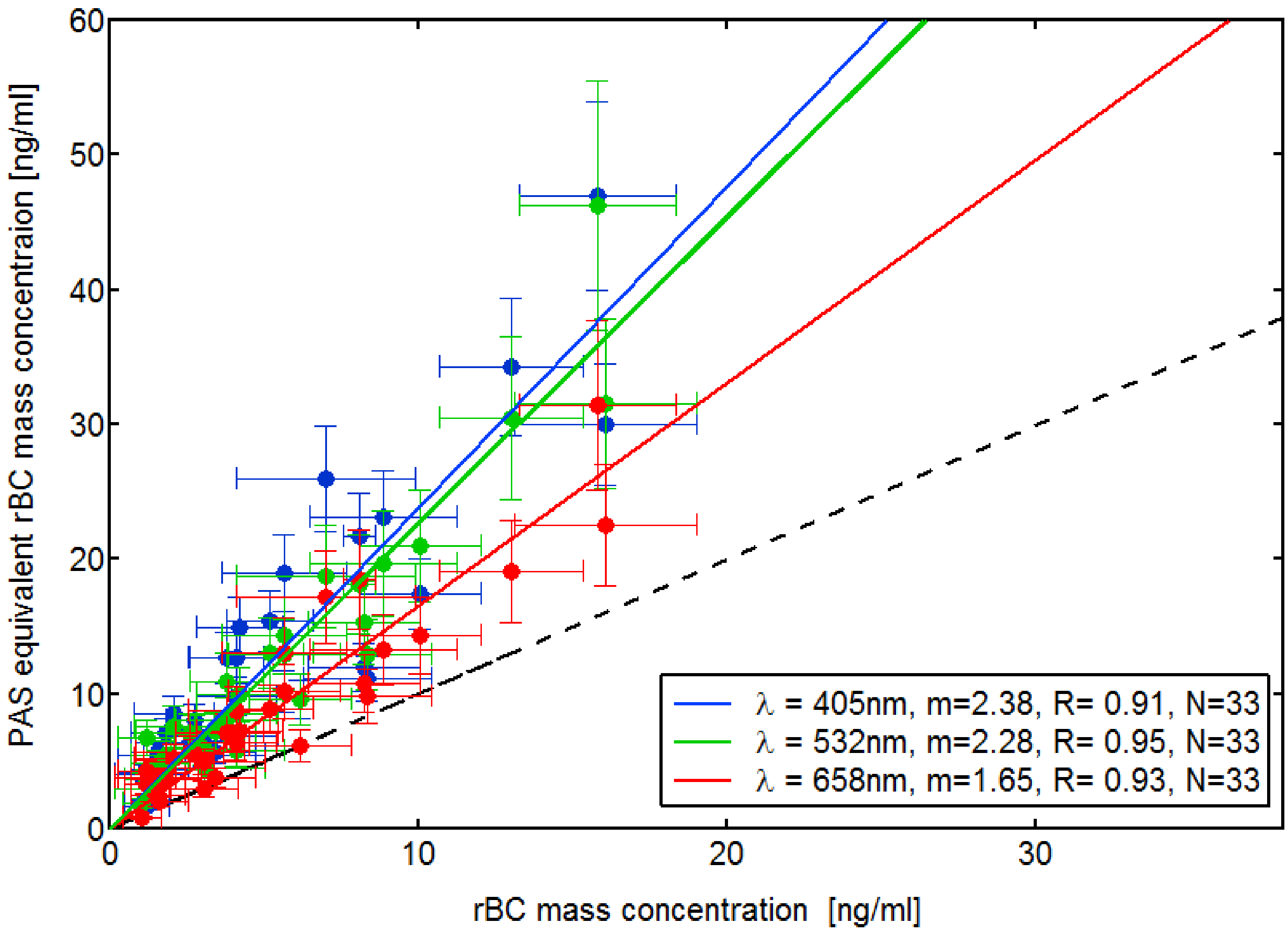


UFS snow samples

Until now:

No correlation with meteorogical data (DWD UFS):

- precipitation
- temperature
- sunshine duration
- snow height
- wind speed

No apparent correlation with MAAP Data (UBA UFS)

Next steps:

- ➢ Environmental scanning electron Microscopy (ESEM)
- ➢ Analysis of ionic and mineralogical compounds of UFS snow samples
- ➢ Fluoreszenz measurements WIBS4 of UFS snow
- ➢ Comparison with saharan dust events at UFS (back-trajectories)

Summary

We successfully prepared snow samples to determine the remaining solid particles by 3 λ-photoacoustic spectrometer

rBC mass concentrations and light absorbing properties of the samples were determined

The efficiency of the used nebulizer was quantified by fullerene standard suspensions

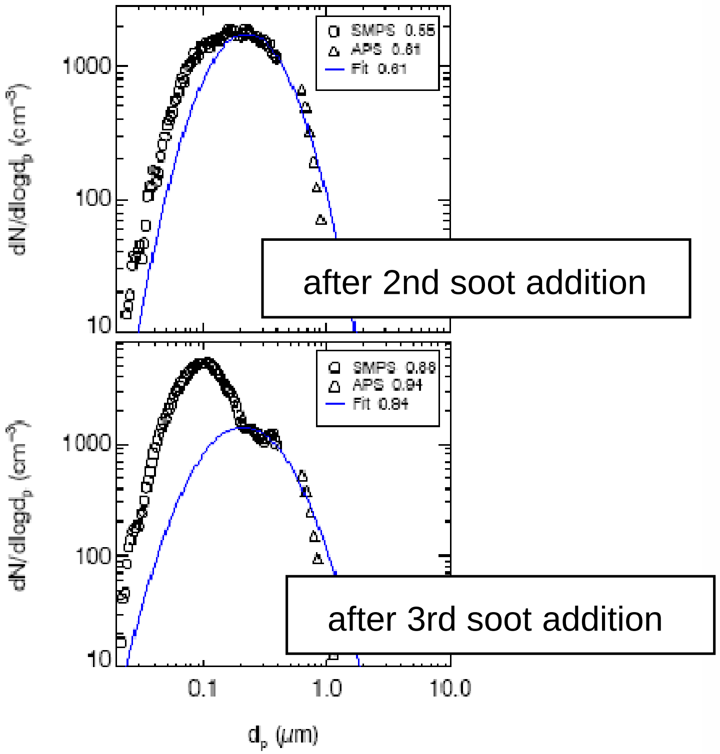
The PASequivalent rBC mass concentrations derived from the measured absorption coefficients of UFS snow samples are higher than measured rBC

This indicates that the optical properties of the enclosed solid particles are different from refractory BC

Further chemical, mineralogical and ESEM analysis should clearify the specific type of material of this particles

Laboratory study with mixtures of mineral dust and CAST soot

- Stepwise soot addition to a natural mineral dust aerosol (SAMUM) significantly reduces strong wavelength dependence (Angström Exponent) of pure mineral dust (2008)



Mineral dust concentration 100µg/m³
Detection limit soot (PAS) 0,5µg/m³