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Specifying the light-absorbing properties of aerosol particles in fresh snow samples, collected at the Environmental Research Station Schneefernerhaus (UFS), Zugspitze

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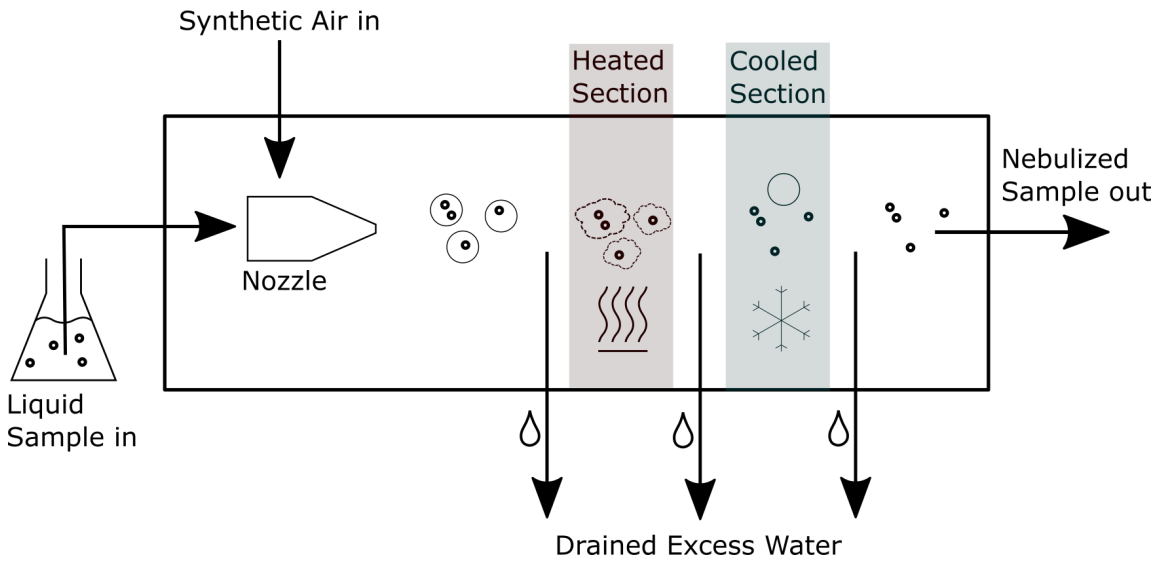
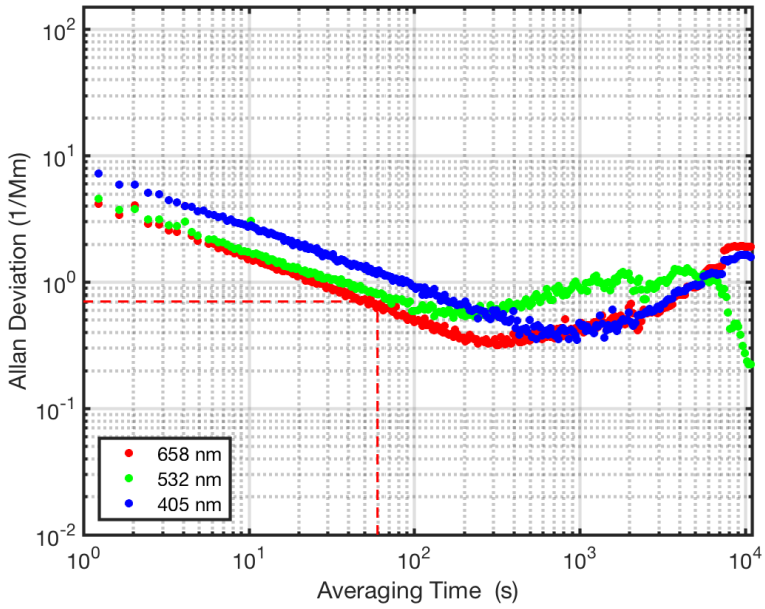
Supplementary Material



S1: Operation principle of the CETAC Marin-5 nebulizer used in the present study.

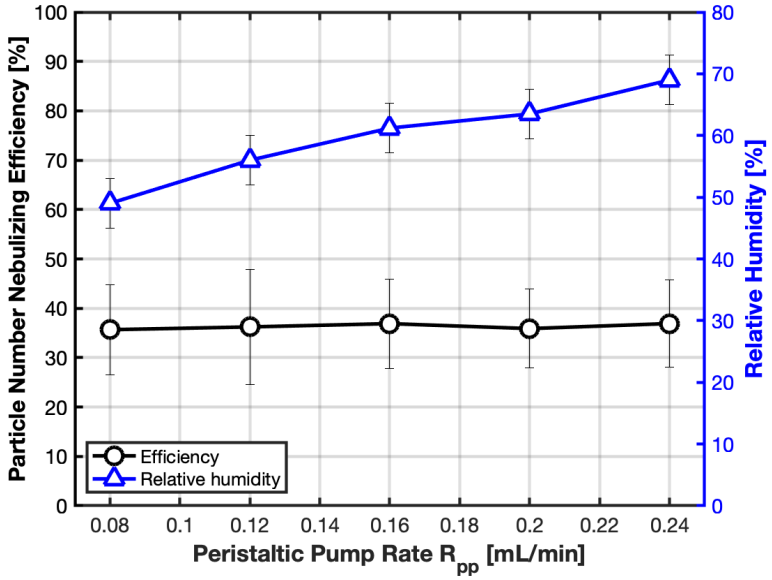


S2: Allan deviation analysis of a long-term photoacoustic background measurement. The red dashed lines indicate the typical averaging time of 60 s used in the PAAS-3λ measurements and the corresponding Allan deviation (1σ) of 0.7 Mm^{-1}.

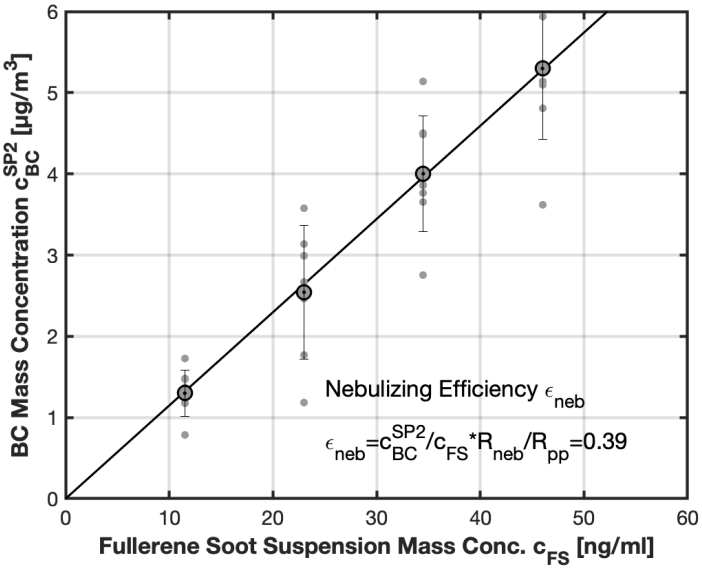
Results of the Marin-5 characterization

It turned out that the temperature of the cooled section of the Marin-5 nebulizing chamber only has a minor influence of a few percent on the dispersion efficiency and the relative humidity in the output flow. Thus these results are not shown here. In Fig. S3 the PSL particle number nebulizing efficiency and the relative humidity of

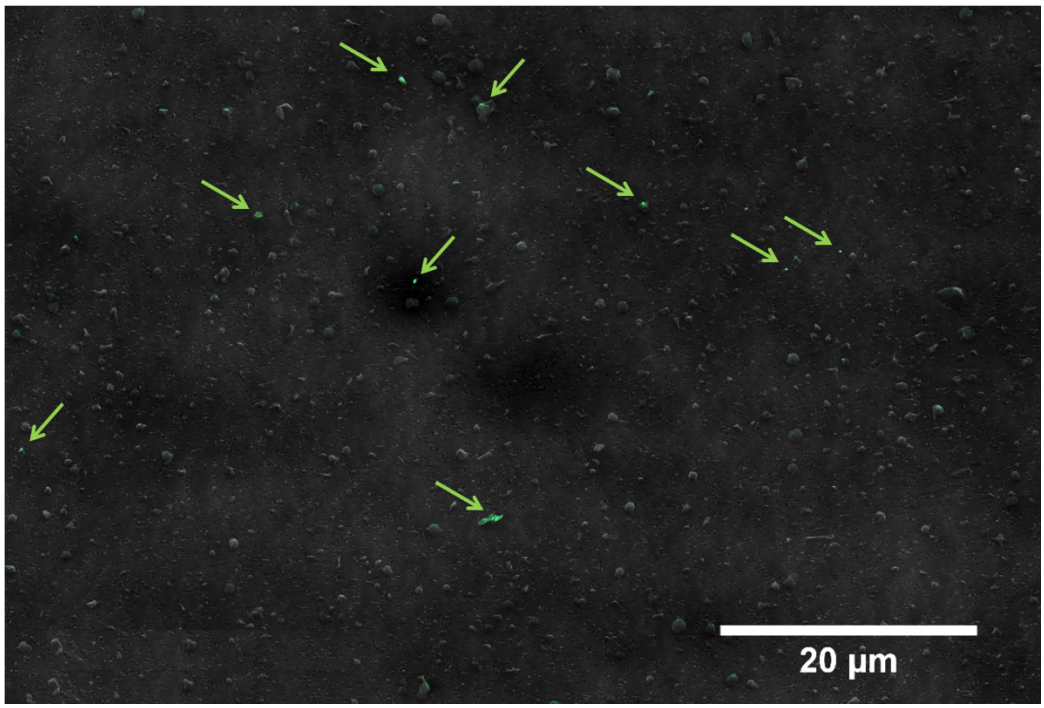
the Marin-5 exit flow are shown as a function of the liquid sample flow rate R_{pp} of the nebulizer. From S3 it is clear that the higher the applied sample flow rate R_{pp} the higher the relative humidity is measured at the exit with a fairly constant efficiency of around 36%. Note that the observed constant nebulizing efficiency reflects a nearly linear correlation between the PSL number concentration at the nebulizer exit and the liquid supply rate R_{pp} at the input. Even for the lowest R_{pp} of 0.08 mL/min the relative humidity approaches 50% and is therefore far above the threshold humidity of 30% for unbiased photoacoustic measurements. Therefore, the silica gel aerosol dryer downstream the Marin-5 is a prerequisite in the fullerene soot and snow sample analysis with the PAAS-3λ instrument. The PSL number concentration and relative humidity behave in a similar way when R_{pp} is kept constant at 0.16 mL min^{-1} and the temperature of the heated section of the chamber is varied between 110 and 150°C, i.e. higher values with higher temperatures (not shown here).



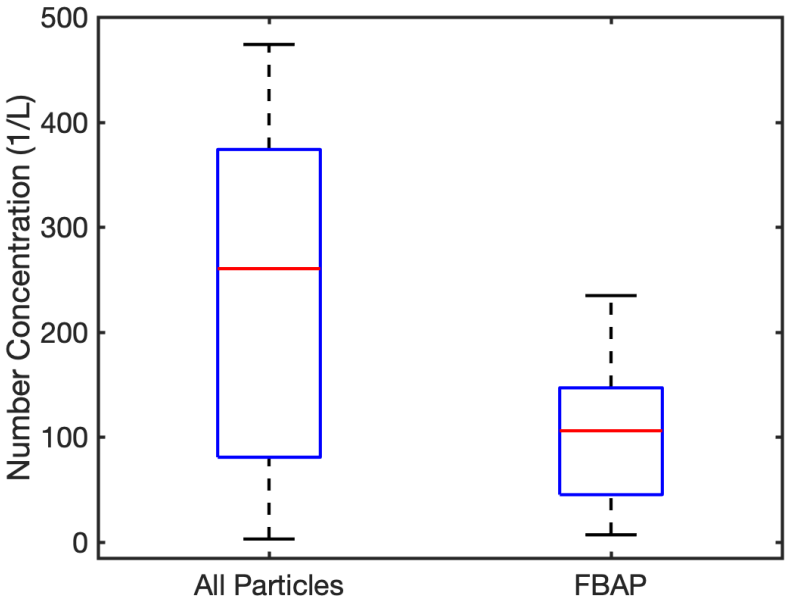
S3: Particle number nebulizing efficiency and relative humidity of the output aerosol flow as a function of the peristaltic pump flow rate applied in Marin-5 nebulizing tests with PSL particle suspensions.



S4: Particle mass nebulizing efficiency of the Marin-5 nebulizer using fullerene soot suspensions with defined BC mass concentrations c_{FS}. The refractory BC mass concentration c_{BC}^{SP2} was measured in the dry aerosol exit flow of the nebulizer using a Single Particle Soot Photometer (SP2). R_{neb} and R_{pp} define the flow rates of the dispersing gas and the liquid sample supply, respectively. See text for details.



S5: Overview of residual particles extracted from a snow sample via Marin-5. The image is a false color overlay from secondary electron (SE) detector (black and white image) and backscatter electron detector, BSED (the green spots). The particles containing elements with higher atomic number are visible as green spots and are highlighted by green arrows.



S6: Result of the WIBS4 analysis of the March 10, 2017 snow sample showing a high fraction of Fluorescing Biological Aerosol Particles (FBAP) of 43%.