Black carbon measurements in snow with the single particle soot photometer

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Quantifying light-absorbing impurities in snow is a critical parameter needed to evaluate snow reflectance. The presence of light-absorbing particles, such as black carbon (BC), significantly lowers the albedo, and contributes to earlier melting of the snow pack (e.g. Flanner et al., 2007).

At present, there are mainly three different techniques used to measure BC in snow. Two methods collect the particles on filters for analyses with optical and thermal-optical methods. The third and newest developed technique does not utilize filters, instead it uses the single particle soot photometer (SP2) to quantify the BC mass concentration through laser-induced incandescence (McConnell et al., 2007). An additional benefit of using the SP2 is that the size distribution of the BC particles can be derived unlike the case in the other two filter based methods.

Due to the SP2's nature of measuring ambient aerosol, the need to aerosolize the BC particles in the melted snow introduces additional uncertainties in the measurements. This is system set-up dependent and an initial assessment has been done (Schwarz et al., 2012). There is still a great need, however, to deepen our understanding of these measurements. In this study we used an empirical approach similar to that used by Schwartz et al. (2012), in which particles in liquid were nebulized and thereafter measured with the SP2.

Polystyrene latex spheres (PSL) of know concentrations with diameters of 100, 202, 304, 360, 498, 802, and 1112 nm were used to determine the efficiency of the ultrasonic nebulizer (U5000AT+, Cetac) utilized to aerosolize the particles in the liquid. The efficiency at which particles were nebulized and detected by the SP2 was shown to be dependent of the peristaltic flow supplying the nebulizer. The flows with the greatest efficiency were determined to be in the range of 0.02-0.04 mL/min, where the average efficiency for all sizes was 0.04. Each PSL's size efficiency in this flow range is shown in figure 1.From this figure it can be noted that there is a reduction in efficiency of particles with a size greater than 800 nm.

The efficiency that different BC sizes were nebulized was also investigated. This was achieved through a DMPS, where certain sizes of BC particles were selected from a solution of Aquadag (a standard BC material used to calibrate the SP2). These measurements revealed an average efficiency of 0.4 for BC particles in the size range 100-600 nm. Gravimetric BC samples were then measured to observe the response of our measurement set-up. Using the efficiency for the PSL's and the BC sizes we were able to get the corresponding BC concentration of the gravimetric samples (fig. 2). This figure shows PSL's overestimate while the BC size correction underestimates.

Utilizing this measurement approach will be done for snow samples collected in Arctic Scandinavia, 2013, and a comparison with the established OC/EC method for measuring EC in snow will also be carried out before the EAC.

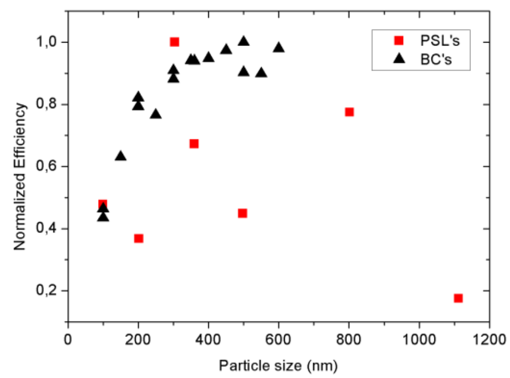

Figure 1. Normalized efficiency for PSL's and selected BC sizes.

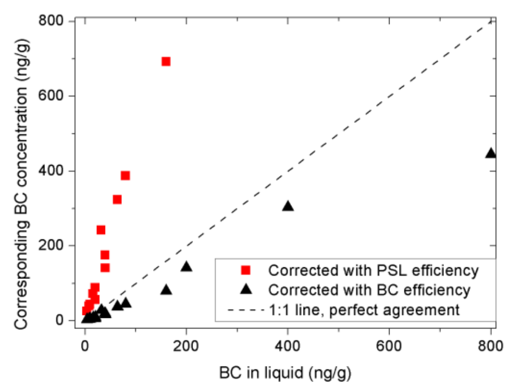

Figure 2. Analyzed gravimetric samples and their corrected BC concentration using the efficiencies from the PSL's (red points) and BC sizes (black points).

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