Atmos. Meas. Tech. Discuss., 5, C1703–C1707, 2012
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Atmospheric Measurement Techniques Discussions

Interactive comment on "Assessing recent measurement techniques for quantifying black carbon concentration in snow" *by* J. P. Schwarz et al.

Anonymous Referee #1

Received and published: 2 August 2012

This study evaluates the accuracy of two instruments that have been applied previously to measure BC content in snow: the Single Particle Soot Photometer (SP2) and the Integrating Sandwich Spectrophotometer (ISSW). This study provides a more thorough analysis of measurement uncertainty for these two instruments (as applied to BC in snow) than any previous study, and includes an assessment of how particle size distribution, co-presence of mineral dust and other scattering particles, and nebulizer efficiency can bias derived BC concentrations. This is a useful contribution to the literature, and the material appears suitable for this journal. This study, ideally published years ago, will provide helpful context for interpreting published measurements of BC

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in snow.

Addressing the following issues will help clarify and improve the study:

The uncertainty associated with nebulizer efficiency is slightly confusing to those unfamiliar with the SP2. Presumably the mass of water that is aerosolized is known precisely. If particles within this water do not make it to the SP2, where do they go? Do they become trapped in the nebulizer? Or, is the uncertainty truly associated with the mass of water that becomes nebulized (3777,9)?

The issue of "detecting" larger particles with the SP2 (3774,19) is also a bit unclear to me. Section 2.1.1 mentions that the SP2 was originally calibrated with particles over the range of 0.5-40 fg. The text seems to infer that larger particles still incandesce when they pass through the SP2. Assuming so, is the problem that incandescence events associated with larger particles were beyond measurement detection in previous studies, or were they measured but discarded? Section 2.1.1 goes on to describe the extended calibration technique for measuring large particles in this study. It would be helpful to state the calibration equation that was applied here, so the variable dependencies can be known precisely by readers.

It is mentioned in several places that BC particles in snow are larger than those in the atmosphere, but little explanation is given for why. I am not sure that this result has been previously reported, and it may be important, e.g., for the optical properties of BC in snow. It would be helpful if potential explanations can be given for this observation, though reasons may be unknown. Is the primary attribution of this that: "individual freeze/thaw cycles cause the agglomeration of a small fraction of BC mass into larger sizes, without dramatically shifting the underlying BC size distribution." (3780,16)?

3784,5: "Undercatch was 38% based on refiltering postfilter liquid using finer-mesh (0.2um) nuclepore filters." Does this assessment assume that the BC collected on the 0.2um filter represents all BC missed by the 0.4um filter? Since a substantial portion of BC particles in typical size distributions are smaller than 0.2um, I would think some

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BC particles may also pass through the 0.2um filter.

3786,8: "The monodisperse nature of the PSL-containing test standards produced strong wavelength dependence in the inferred ISSW absorption, hence these results are not quantitatively presented". - I don't see why this would preclude a quantitative assessment of the ISSW absorption. Please elaborate on this, or include some assessment of the magnitude of bias in ISSW-derived BC concentration that resulted with inclusion of the PSL standard (e.g., in the text and also potentially in Table 1 and Figure 3). Two sentences after this statement includes references to "size of excursions" and "significantly bias", implying that some sort of quantitative assessment was already performed.

In general it would he useful to mention specific methods applied in previous studies, if they are known, so that findings from the current study can be easily applied by readers to help interpret previous quantifications of BC in snow. Some specific examples where previous studies could be cited are listed below.

Finally, this study applies well-characterized laboratory standards of soot and other particles for evaluating the instruments. This is certainly a logical starting point for analyzing instrument accuracy. A nice addition to this study would be to compare side-by-side measurements of different natural snow samples with unknown BC concentrations and physical properties.

Minors issues:

3772,11: ISSW was already defined.

3772,17: "the ratio of light scattering to light extinction" is not "snow albedo".

3773,27: "to quantification"

3775,27: I don't think "PSL" has been previously defined.

3776,1: How does this laser intensity compare with that applied in previous studies

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(if known)? Were previous intensities sufficient to measure large particles, if a proper calibration had been implemented?

3776,14-16: This wording is slightly confusing.

3776,28: "used in previous SP2 determinations of BC in ice" - Please include references for the previous studies mentioned.

3778,7: Please define "particle stopping distance".

3779,26: I don't think the Arctic samples are discussed anywhere else, so I see no need to even mention them here or in the previous paragraph.

3779,26: "sonewhat"

3780,4: Please quantify "slight reduction", so the sentence afterward can be placed in proper context.

3780,10: "showin"

3781,23: Did previous BC studies store melted snow in polyethylene bottles before conducting measurements?

3783,1: "The total uncertainty associated with the ISSW BC concentration determination for ambient snow is estimated as 40%..." - This uncertainty in 'concentration' assumes that the sample BC MAE is identical to the calibration MAE. As discussed later in the manuscript, differences in MAE may introduce another 40% or more uncertainty in derivation of BC concentration.

3783,1-4: Were these uncertainty components published previously? If not, they should be discussed a bit more here, including the basis for each uncertainty component.

3783,7: Are the optical properties of the test dust known? If so, please include them. In particular, it would be useful to know how absorptive the dust is. If the properties are

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unknown, perhaps the dust could be described qualitatively in terms of its absorptance, color, and mineralogy. This seems especially relevant for the ISSW interpretation of BC+dust samples.

3783, 23: "range observed in ... China" - please provide a reference for these observations.

3786,3: "high dust:BC" -> "high dust:BC ratios"

3786,13: "significantly bias affect"

3787,13: Do you mean "accuracy" instead of "efficiency"?

Table 1: I suggest adding "ratio" to describe the SP2:grav and ISSW:grav headings. "Absorp. A" could instead be "AAE" for consistency with the text. If need be, the headings could be described in more detail in table footnotes.

Figure 1: Although this depicts a normalized (unitless) efficiency, it would be helpful to list the units of the absolute efficiency in the caption, so the quantity can be understood more clearly.

Figure 3: These figures should also include 1-to-1 lines.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 3771, 2012.