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Atmospheric Measurement Techniques Discussions

Interactive comment on "Development of an improved two-sphere integration technique for quantifying black carbon concentrations in the atmosphere and seasonal snow" *by* Xin Wang and Xueying Zhang

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We are very grateful for the referee's critical comments and suggestions. The followings are our point-by-point responses to the comments. Our responses start with "R:".

The paper describes a new methodology for quantifying black carbon concentration in the atmosphere and seasonal snow. The article is appropriate for the AMT journal. The authors have described the methodology in detail and have presented comparison with

thermal-optical method. Real data from field has also been presented. I recommend that the article may be published in the AMT journal.

My specific comments are:

1.Line 260: What are the factors contributing to the uncertainty? How they are estimated. A little bit more explanation is desired.

Response: As Schwarz et al. (2012) illustrated, the total uncertainty associated with the filter-based ISSW technique on BC concentration determination for ambient snow has previously been estimated as 40 %, which is the sum, in quadrature, of 11% for instrumental uncertainty, 15% for undercatch uncertainty (loss of insoluble light-absorbing impurities), 17% for BC MAC uncertainty, and 30% for uncertainty in the AAE of non-BC material (Doherty et al., 2010; Grenfell et al., 2011). The relative description has been added in introduction section in Page 4, Line 99-105.

2.Line 213, line 231-234, and 278: Mass absorption cross-sections (MAC) at 550 nm 525 nm were assumed. Any reference related to this that may be cited? How broad of the spectrum was averaged for computation using MAC at these wavelengths? Could the uncertainty due to the error in the assumption of MAC be quantified?

Response: Generally, the MAC has been widely reviewed as $\sim$7.5 m2 g$-$1 at _=550 nm by previous studies (Clarke et al., 2004; Bond and Bergstrom, 2006). However, to estimate the BC radiative forcing in snow, what we really need to know is not the mass of BC but rather its effect on snow albedo, which is closely related to its absorptance on the filter. As a result, Doherty et al. (2010) reported that the MAC should be used withβabs =6.0 m2 g-1 at λ = 550 nm or else scaled appropriately in radiation models. In this study, the value of mass absorption coefficient is given as 6.22 m2 g-1 at 550 nm, which is consistent with recent studies by Wang et al. (2013). As illustrated by Swcharz et al. (2012), the total uncertainty associated with the filter-based ISSW technique on BC concentration determination for ambient snow has previously been estimated as 17% for BC MAC uncertainty.

Reference

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3.Figure 2 depicts the schematic of the developed TSI instrument. It would be beneficial to list out the components used in the instrument. For example, what was the light source, what wavelength range etc. Similarly on the detector side, and if any optical filters were used.

Response: Figure 2 has been updated based on the reviewer's suggestion, and all major components used to design this instrument are listed.

4.Is broadband attenuation measurement possible with this instrument? If so could this be useful for further speciation based on broad absorption properties?

Response: This instrument is designed to measure the total light absorption due to the insoluble light-absorbing impurities at the visible wavelengths. Right now, we have confidence that this instrument could be updated to capture the fluorescence signals in the ultraviolet (UV) wavelengths by changing a strong power UV light sources. However, we have no idea if the similar instrument is effective on the broadband attenuation measurement.

5.Filter loading is a common problem in similar instruments. Some details on how this was dealt with would be beneficial.

Response: The filter-based technique on measuring light-absorbing aerosols in the atmosphere and snow/ice is designed since 1965, and has been developed for half century. The accuracy on measuring BC based on this technique has been enhanced significantly. However, due to the complex of the BC mixing status in the atmosphere and snow/ice, there are still visible uncertainties. According to the previous study by Schwarz et al. (2012), the total uncertainty associated with the filter-based ISSW technique on BC concentration determination for ambient snow has previously been estimated as 40 %, which is the sum, in quadrature, of 11% for instrumental uncertainty, 15% for undercatch uncertainty (loss of insoluble light-absorbing impurities), 17% for BC MAC uncertainty, and 30% for uncertainty in the AAE of non-BC material (Doherty et al., 2010; Grenfell et al., 2011). Therefore, the major novelty of this updated technique is to minimize the light scattering due to the insoluble impurities based on two integrating sphere configurations. Finally, we also assess the loss of the BC concentration using Nuclepore filters with 0.4-μm and 0.2-μm pores during the filtration process.

Reference

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