

***Interactive comment on* “Brief communication: An alternative method for estimating the scavenging efficiency of black carbon by meltwater over sea ice” by Tingfeng Dou et al.**

Anonymous Referee #1

Received and published: 24 July 2019

This study presents a new and efficient technique to determine the meltwater scavenging efficiency of black carbon in snow overlying sea-ice. Simply, the concentrations of BC within a melt-refreeze layer and within the overlying snow are compared, and the assumption is adopted that BC and ice have been conserved within these two layers during the melt event. Conservation within about 7% is indeed shown for a limited number of test cases, in comparison with mass measurements that were made before melt commencement. The technique is also shown to produce consistent results with those from the more rigorous repeated sampling technique employed by Doherty et al (2013). Overall, the technique described here shows promise and is attractive because of its simplicity. Several issues should be addressed prior to publication, however.

General issues:

- It is a bit frustrating to have to refer to supplementary figures and tables for a 'Brief Communication'. This may indicate that the material should instead be presented in a standard paper rather than a brief communication. Alternatively, could the supplemental figures (especially S2, which I think is important for conceptual understanding of the technique) be worked into the main body of the paper?
- The abstract (and manuscript, generally) should acknowledge more clearly that the technique requires the presence of a 'melt-refreeze ice layer', or some term that is similarly precise. Although the abstract refers to sampling of an "ice layer within the snowpack", it is not clear until later what the nature of this ice layer is, and confusion arises especially because the previous sentence refers to sea ice. Furthermore, a re-freeze layer will not always exist, for example when persistently warm conditions cause complete meltout of thin snow layers, and this limitation could perhaps be acknowledged more clearly.
- The applied technique also assumes that the refreezing process does not preferentially exclude BC, i.e., that the BC concentration in the ice layer will be identical to that in the melt water. Please comment on this assumption, how it could affect the utility of the technique, and any observational evidence you have that can shed light on this matter.
- Abstract, line 20: "It is concluded that MSC exhibited a regional difference in the western Arctic during the sampling period" - These differences are not very large, however (i.e., they are all substantially less than 100%, indicating inefficient scavenging of BC). Are they even statistically different from each other? If so, can you speculate on why they varied? Are there regional differences in the environment that would be expected to translate into systemic differences in the MSC? Or do these differences perhaps reflect random variability in BC properties? I suggest either downplaying these differences (because they do not appear substantial) or briefly speculating on potential

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sources of such differences.

- The grammar and writing in general should be proofed by a native English speaker prior to publication.

Technical comments:

Abstract, line 15: Please specify that Elson Lagoon is near Barrow Alaska. Most readers will be unaware where the lagoon is.

Abstract, line 16: "The bias of estimated MSC ranges from ..." - What is this bias with respect to? Please briefly clarify how the 'truth' was determined.

line 58: Where was the 3rd Chinese Arctic expedition conducted? Please mention it here and also how/why these measurements are included in the present study, since they do not include BC. (i.e., the relevance of this campaign is not clear at this point in the text).

line 87: "excluding blank contributions" -> maybe "subtracting blank contributions" ?

line 98-99: "However, the BC concentrations in these two types of ice layers are in the same order of magnitude as those of new or recently-fallen snow." - But meaning what? That these types of layers could be identified via their measured BC concentration? This needs better context.

Similarly, line 102: "These two types of ice layers ... were not considered in this study." What criteria were used to identify and discard these layers? The paragraph starts out well, by describing conditions in general that can lead to ice layers, only some of which are useful for measuring MSC. Please elaborate.

line 106: Where and when was this BC concentration measured?

line 141: What do the subscripts for MSC mean? And why is MSC₂ included in parenthesis? Please clarify this notation.

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lines 148-153: Do the +/- values represent variability or uncertainty? I assume the former, but please specify.

line 187: missing URL

Figure 3: Please denote the technique that was used to determine these values, i.e., repeated sampling or the ice layer approach?

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