The Cryosphere Discuss.,
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The Cryosphere Discussions

Interactive comment on "Influence of light absorbing particles on snow spectral irradiance profiles" *by* François Tuzet et al.

Anonymous Referee #2

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This study describes a novel and rapid technique to make in-situ measurements of the vertical profile of light absorbing impurities in snow. The technique relies on spectral irradiance measurements conducted via a narrow probe that is slowly inserted into the snow. Because the technique relies purely on radiative transfer theory, it does not require snow samples to be transported to the laboratory for chemical measurements. The underlying theory is nicely presented, and although the technique 'should' work well in principle, as with many ideal techniques there is substantial bias between the theoretically-derived and directly-measured impurity contents, as clearly acknowledged by the authors. The study presents a nice exploration of sources of uncertainty via parameter perturbations, and as far as I can tell the study has adequately explored all likely sources of bias. Unsurprisingly, the optical properties of BC and dust, which

must be known apriori for this technique, are plausible culprits for the bias. Real uncertainty and variability in these properties could, by themselves, explain much of the reported bias. Overall, this is a very thorough and well-written paper describing a novel technique, and I recommend publication after the minor issues described below are addressed.

General issues:

Equation 1: It is noted that Phi represents the dust -> eqBC conversion function but this function is not really described in much detail. Please elaborate on what precisely this function is and/or how it is calculated. A related question is: Why is the eqBC vs dust line shown in Figure 1 not perfectly linear? This suggests that the conversion function is not so simple.

Minor issues:

p3, lines 26-28: "Picard et al (2016) ... meaning that SIP measurements could be an order of magnitude more sensitive to LAP than albedo measurements." - This statement implies that BC concentrations less than 50 ng/g cannot be detected via albedo measurements. This threshold seems a bit high, especially for visible wavelengths. Are you referring to broadband albedo? Please clarify or justify.

p6, line 10: "It is to note" -> "It is noteworthy"

p6, line 12: "... the unit of ng/g eqBC refers to 1 ng/g of eqBC concentration" - This seems either unnecessarily obvious or needs elaboration.

p7, line 8: "ice matrix surface (m2)" -> "ice matrix surface area (m2)"

p7, Eqns 10 and 11: It is a bit confusing that sigma_a and gamma both represent absorption coefficients of ice. It appears that sigma_a is the absorption coefficient of "snow due to ice", whereas sigma is the absorption coefficient of bulk ice. Please clarify the wording to communicate this.

p7, Eqn 10: Maybe clarify that rho is the density of snow, if this has not already been done.

p10, line 3: "did not fit well the" -> "did not fit well with the"

p10, line 27: Please clearly communicate the sign of the bias. i.e., Was the chemically-determined or SOLEXS-derived BC estimate higher?

p12, line 6: "an higher" -> "a higher"

p13, line 2: "the radiative impact" -> "the calculated radiative impact", correct? Or if not, please clarify this sentence, again with respect to the sign of the bias (higher derived-BC or chemically-measured BC?).

p13: line 27: "In some case, an abnormally" -> "In some cases, an abnormally"

p14, line 15: "clearly break" -> "clearly breaks" or better "clearly violates"

p14, line 24: "more impacting" -> "more impact"

Figures 6, 13 and 14: In the legend, why does one curve show BC and the other rBC? Please remind readers of why this distinction is needed here. It seems confusing and potentially unnecessary.

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