

Interactive comment on “Enhanced solar energy absorption by internally-mixed black carbon in snow grains” by M. G. Flanner et al.

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We also thank referee # 2 for reading through the manuscript and providing instructive comments. Below we respond to each comment.

1. On pg 2065 it's noted that while this study is of absorption enhancement for BC the results would also apply to mineral dust. Then on pg. 2066 it's noted that Eqn 1 is satisfied for most BC particles because they are geometrically small enough. However, dust is much larger than BC, so would Eqn 1 be satisfied for dust (i.e. because m is also smaller)? An explicit statement to this effect would be helpful.

We agree that because dust particles are typically much larger than BC particles, they are more likely to violate the criteria for Equation 1 to be valid. To reflect this, the text

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on pg 2065 now reads "... but many of the concepts also apply to mineral dust" instead of "...results apply...". Secondly, we changed a sentence on pg 2066 to read: "Most BC particles are small enough to fall within the extended domain of applicability, but many of the dust particles in typical size distributions do not."

2. pg 2071 "In all experiments dust is radiatively active and hence decreases the forcing by BC (Flanner et al. 2009)." It should be pointed out that enhanced absorption by dust if it were internally mixed in snow is not accounted for. If this were accounted for the albedo reduction and forcing by BC inclusions would be lower.

We added the following sentence to this passage: "Accounting for enhanced absorption by internally-mixed dust, however, could further decrease BC forcing."

3. pg 2084: Figure 7 shows "the fraction of deposition over snow and sea-ice that occurs within precipitation hydrometeors." In this sentence, in the figure caption and in the discussion that follows it's not clear if "within precipitation hydrometeors" means only the BC incorporated as inclusions inside the hydrometeors or BC that's both present as inclusions and BC on the exterior of the hydrometeors (i.e. gathered by impaction as the hydrometeors fall). Is the fraction given the fraction of deposition from wet vs dry deposition or is it the fraction of BC as inclusions vs. external to the hydrometeors?

These fractions only include BC that is incorporated as inclusions, and do not include BC attached to the outside of hydrometeors (e.g., collected via below-cloud scavenging). To clarify this, we added on pg 2084: "...(not including BC attached to the exterior of the hydrometeor, collected by falling precipitation)".

4. In the conclusions, I think there should be some focus on the fact that much of the large range in enhancement factors comes from uncertainty in basic understanding of aerosol (specifically BC) cloud nucleation processes and therefore the BC scavenging efficiency by hydrometeors, rather than uncertainties in e.g. the optics of BC/ice interactions.

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We altered our conclusions a bit, and included the following sentence to reflect this suggestion: "We believe that uncertainty in this forward-derived (forcing) estimate arises more from uncertain representation of aerosol-cloud-precipitation interactions than of optical characteristics of BC/ice composites."

5. Figure 3: I'd suggest moving the legend out of the figures and making the legend a fourth panel to improve readability.

We added the legend as a fourth panel, and agree that it improves readability.

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