

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

Anonymous Referee #2

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This paper describes the enhancement in absorption by black carbon in snow when BC is present as multiple inclusions in snow grains. Multiple approaches to calculating BC absorption are discussed and compared, as are the processes leading to BC being externally and internally mixed with snow grains. Global model calculations are used to explore the impact on snow albedo reductions and radiative forcing by BC in snow on land and sea ice when this enhanced absorption is accounted for.

The paper is an extremely comprehensive end-to-end treatment that explores assumptions and sensitivities and highlights what processes lead to both variability and uncertainties in the results. The paper is long but also well-written and I think the length is justified by the level of detail and completeness of the analysis. This will allow others to build on this analysis and allows other to properly incorporate their technique into

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other models.

The paper subject matter is appropriate to ACP and should be published with a few very minor revisions.

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.

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.

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?

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.

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

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