**Atmospheric
Chemistry
and Physics
Discussions**

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

M. G. Flanner et al.

flanner@umich.edu

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We thank referee # 1 for reading through the manuscript and providing instructive comments. Below we respond to each comment.

Comments and suggestions:

(1) p. 2073: What is the reason for excluding the first year of simulation from the analysis?

Snow and atmospheric BC masses were initialized to zero, so we discarded the first year of each simulation to allow the modeled BC masses to equilibrate. To clarify this, we added "...to enable spin-up of BC in the atmosphere and snow".

(2) p. 2075: The given range of the BC to ice volume ratio is extremely wide and provides no useful information. Perhaps you can provide separate values for Antarctica, Arctic and typical continental values.

We agree that these derived ranges are quite wide. Narrowing the ranges by region is difficult because there are few measurements of the isolated size distribution of black carbon in polar regions, and the variability in BC and ice size distributions in continental regions is as large as the variability we have reported. Nonetheless, we have included a refined estimate for the Arctic, where Brock et al (2011) report aerosol size distribution measurements for anthropogenic and biomass burning plumes. It is important to note, however, that these size measurements include all aerosols, not just BC. We have added the following text:

"Considering aerosol size distributions measured within Arctic air masses of anthropogenic and biomass burning origin (Brock et al, 2011, table 3), typical Arctic BC/ice volume ratios might be about 3×10^{-11} and 10^{-13}, respectively, in non-melting and melting snow."

and:

"In the Arctic, (the number of BC particles per ice grain) might be between 70 and 2×10^5, assuming the volume ratios described above and background BC/snow concentrations of 3–30 $\mathrm{ng\,g^{-1}}$ (Doherty et al, 2010)."

(3) In eqs. (13) and (14) what are the limits on the wavelength?

These functions were applied to a wavelength range of 0.3 to 5.0 μm (now added to the text). We note that the original (unmodified) functions originally listed by Chang and Charalampopoulos (1990) are valid from 0.4 to 30 μm.

(4) p. 2077: Why not to specify where is the peak at 550 nm wavelength?

We performed additional calculations to address this, and changed the passage in question to read: "The BC radius where $k_{\mathrm{bc,ext}}$ peaks is about 63 nm, smaller than the

80 nm peak for 550 nm $k_{\mathrm{bc,ext}}$"

(5) In general the paper is too long and not easy to read and enjoy. It may by worth to consider shortening the main text and to present the technical details in an appendix.

We agree that the paper is long. Referee # 2 also commented that the paper is long, but stated: "I think the length is justified by the level of detail and completeness of the analysis." As a result, we have chosen to leave the manuscript in its present structure.