Response to Point 9 for Referee #2 (lines 4740, 27):

Concerning the radiative properties of the BC in our snow model, the first version of our paper explained "*Black carbon is assumed to follow a log-normal size distribution with a median number radius of 11.8 nm, characteristic of freshly emitted soot (Dentener et al., 2006, Jacobson et al., 2004). In the real world, this diameter increases quickly, as BC undergoes ageing and coagulation and can be coated by other aerosols in the atmosphere. However, as we do not consider internal mixtures for BC in snow, we consider that BC aerosols regain their initial size when incorporated in the snowpack. We considered a BC density of 1 g cm^{-3}, and the refractive index for BC is taken to be m=1.75-0.45i. Refractive indices for ice are taken from the GEISA database (Jacquinet-Husson et al., 1999).*" The second referee should like us to list the mid-visible mass absorption cross-section (MAC) of BC resulting from these assumptions of size distribution, density, and refractive index. Applying a Mie code with these assumptions, we find for λ=545 nm:

$$\begin{cases} Qext = 0.498 \\ \omega = 0.208 \\ g = 0.34 \end{cases}$$

According to Boucher (2011), we can write: $Q_{abs}=(1-\omega)Q_{ext}$ and $Q_{abs}=\sigma_{abs}/\sigma$

Following Bond and Bergrstrom (2006), the mass absorption cross-section (MAC) is defined by:

$$MAC = \frac{\sigma_{abs}}{M_{bc}} = \frac{\sigma * Q_{abs}}{M_{bc}} = \frac{N_0[\int_0^\infty \pi r^2 n(r)dr] * Q_{abs}}{N_0[\int_0^\infty \frac{4}{3}\pi r^3 n(r)dr] * \rho_{bc}} = \frac{\pi r_0^2 \exp\left(\frac{4\sigma_{bc}^2}{2}\right) * Q_{abs}}{\frac{4}{3}\pi r_0^3 \exp\left(\frac{9\sigma_{bc}^2}{2}\right) * \rho_{bc}}$$
$$= \frac{3 * Q_{abs}}{r_0 \rho_{bc} \exp\left(\frac{5}{2}\sigma_{bc}^2\right)}$$

With:

M_{bc} the mass of BC particles.

σ_{bc}=log(2) the standard deviation of the lognormal distribution of BC aerosol radius.

ρ_{bc} the volumic mass of BC particles.

r_0 the mean diameter of the aerosol population

We found **MAC = 7.6 m².g-1**. As we do not want to make to heavy our manuscript with such formulae (which has been published in many books and papers), we decided not including such equations in the new version. However, we suggest to add the following statement: "*The corresponding mass absorption cross-section (MAC) of BC resulting from these assumptions of size distribution, density, and refractive index reaches a value of 7.6 m².g^{-1} at 545 nm (mid-visible, see the MAC definition of Bond and Bergrstrom, 2006, and Boucher, 2011). This value is comparable to 7.5 ±1.2 m².g^{-1}, a value found by Flanner et al (2007) and Bond and Bergrstrom (2006). Such value could however be reevaluated in further study, as Flanner et al. (2012) found larger values considering internal mixing for snow and aerosol.*"

References:

Bond, T.C. & Bergstrom, R.W.: Light Absorption by Carbonaceous Particles: An Investigative Review, Aerosol Science and Technology, 40:1, 27-67, 2006.

Boucher, Olivier: *Aérosols atmosphériques, propriétés et impacts climatiques*, ed. Springer, 248 pp., 2011.

Flanner, M. G., Liu, X., Zhou, C., Penner, J. E., and Jiao, C.: Enhanced solar energy absorption by internally-mixed black carbon in snow grains, Atmos. Chem. Phys., 12, 4699-4721, doi:10.5194/acp-12-4699-2012, 2012.