

Interactive comment on “Black carbon in the atmosphere and snow, from pre-industrial times until present” by R. B. Skeie et al.

Anonymous Referee #2

Received and published: 19 April 2011

The paper discusses the historical evolution of black carbon (BC) aerosols and their associated direct and snow-albedo forcings. This is an interesting study, with section 3.5 on regional contributions to Arctic BC and the discussion in section 4 being particularly informative. I suggest some minor revisions below in order to make some points clearer and the wording more accurate in places.

1 Main comments

- Latitudinal and seasonal ageing coefficients are taken from an M7 version of the CTM. Is there any reason why that model version was not used for the study and the authors

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chose to parameterise ageing instead? Also, as discussed in section 4, it is likely that ageing coefficients have varied historically. I would be interesting to discuss how results can be affected by that variation: if pre-industrial lifetimes were longer, would that mean that BC radiative forcing were stronger than modelled here?

- What is the residence time of BC in snow, from deposition to removal when snow melts?

- Figures 1 and 9 provide important informations but a timeseries of zonal means is a lot to put on one figure. It could be clearer to present timeseries of global averages on one panel, with the corresponding zonal means for selected years on another panel. Selected years could be limited to 1750, 1970, and 2000 since those years incorporate the more important changes in magnitude and location.

- Figures 12: I understand that the inter-annual variability shown in 12b is used to obtain the error bars in 12a. I also understand (although it is not clear from the text) that since 2006 is associated with the largest values (12b), then all model simulations done with meteorology for the year 2006 (12a) are assumed to be high estimates, with error bars applied downward. It is a strange assumption: using meteorology for 1977 could have lead to even higher values, for example. So you can't assume that using meteorology for 2006 will always lead to the highest values. Your measure of year-to-year variability (error bars) should be centered on 2006 values. The same comment is valid for figure 15b.

2 Other comments

Page 7470, line 23: Forest fines can be anthropogenic as well - in fact, in some countries wildfires are mostly man-made. I suggest giving "lightning-induced forest fires" as an example of purely natural biomass burning.

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Page 7470, line 25: Black carbon is known for its large absorption, but around 40% of its extinction remains due to scattering. The direct effect is due to both scattering and absorption.

Page 7471, line 25: Be more specific than "recently".

Page 7473, line 28, and page 7487, line 18: "real time" has a different meaning than used here, typically referring to operational systems where data is processed shortly after being produced. I suggest "meteorological data for the years simulated".

Page 7474, line 21: I would think that other species, such as volatile organic compounds, also play a role in BC coating.

Page 7477, line 14: Lamarque *et al.* [2010] provide both biomass and fossil-fuel emissions of BC and OC, yet only their biomass emissions are used here, with FF emissions coming from another dataset. What is the reason behind that choice?

Page 7477, line 25: Different spatial distributions? What are the main differences? Could those differences be due to the industrial revolution that occurred between 1750 and 1850? If so, the scaling applied by the authors is not justified: spatial distributions have changed.

Page 7478, line 21: Comparing to the ranges of observed BC concentrations given in the text, Figure 2a seems to show that modelled concentrations over China, Europe, and the Arctic are on the low side.

Page 7480, line 21: A reference is needed for issues with PSAP measurements at high relative humidity.

Page 7486, line 2: The authors should discuss why fossil-fuel BC dominates in the model, while biomass-burning BC dominates in the observations. Is it due to different regions of the Arctic being dominated by different source types? Is there a large uncertainty in the source attribution of observed BC?

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Page 7496, line 20: The strength of the direct effect is not only related to the amount of sunlight. The solar zenith angle is also important, with the direct effect being stronger at intermediate values. Optical depth and single-scattering albedo being fixed, the direct effect is stronger at mid-latitudes, although the large absorption of BC will complicate things. To be more convincing on the issue of changes in radiative forcing efficiency, I would show the distribution of annual-averaged RF exerted by a constant BC optical depth.

Page 7497, line 2: Any physical explanation for this counter-intuitive result?

Page 7501, line 8: This statement is speculative since the paper has not demonstrated such a strong link between BC forcing and global-averaged temperature.

Page 7502, line 26: Which physical process is represented by including wet-deposited BC into the two top snow layers instead of the topmost layer only?

3 Technical comments

Page 7471, line 9: "reduce" should read "reducing".

Page 7471, line 16: "climate forcers" is a bit awkward. I suggest "climate forcing agents".

Page 7475, line 8: Opening bracket in citation is missing.

Page 7484, line 17: "relative" should read "relatively".

Page 7485, line 22: "in the western Russian" should read "in western Russia".

Page 7492, line 24: "but only less than 20% higher than the RF in 1910" could be better written as "but remains within 20% of the RF in 1910".

Page 7494, line 13: "range from 1-30m² g⁻¹" should read "are in the range 1-30 m²g⁻¹".

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Page 7494, line 23: "there are a relatively good consistency" should read "there is".

Page 7495, line 16: Period is missing at the end of the sentence.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, 11, 7469, 2011.

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