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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Large scale changes in 20th century black carbon deposition to Antarctica" *by* M. M. Bisiaux et al.

Anonymous Referee #1

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This paper presents original datasets documenting the variability in refractory black carbon (rBC) concentrations and fluxes in two Antarctic ice cores, from 1850 to 2001. Such datasets are needed to document past changes in black carbon in the southern hemisphere, and their radiative impacts. The authors highlight three points: (i) the coherence of rBC records in two ice cores, located 3500 km apart; (ii) the links with ENSO variability; (iii) a large scale reduction of rBC from 1950 to 1990. However, their analyses in support of these main conclusions remain qualitative (point iii), inconclusive (point ii) or are lacking (point i).

I suggest the following major revisions :

- A more accurate title would be: Investigations of past changes in black carbon deposition in Antarctica using two ice core records.

- The abstract should highlight the differences between the two ice core records (or quantify their coherence), and mention the changes from 1950 to 1990 in the perspective of earlier changes, showing large decadal variability.

- Some parts of the introduction should be revised. Text in Page 27817, lines 7 to 11 does not read easily. I would suggest to first mention findings from northern hemisphere (Greenland, Tibet ice cores), and then differences expected in the southern hemisphere regarding the sources of BC.

- There is a missing section on the investigations of back trajectories of air masses transported to Law Dome or WAIS sites, which could be useful when discussing causes for differences (and the importance of air masses from different ocean basins) (e.g. Reijmer et al, J. Clim., 2002 albeit not for the two sites investigated here).

- In Sections 1 or 2, the reader should be guided to understand the choice of the two investigated ice cores. While the WAIS ice core offers seasonal resolution and accurate dating, the choice of DSSW19K remains more difficult to understand, as dating is more uncertain, and post deposition effects limit the temporal resolution of the record. Section 2.1 should introduce the other DSS ice cores used to guide the dating of DSSW19K. Section 2.2 should summarize the information from the appendix, and particularly quantify the uncertainty associated with the analytical method. Aerosol records from Antarctica are known to be characterized by a significant deposition noise. Is there any information available, related to the signal to noise level of rBC records between nearby ice cores at the same location?

- Section 3.1 discusses mean concentrations and fluxes in the two ice core records. Some sentences are difficult to understand, such as "The DSSW19K rBC concentrations were less variable. . ." and "The DSSW19K rBC concentrations were more variable. . .". Please explain what is compared to what. How are results from two ice cores integrated over the whole continent?

- Please show estimates of rBC fluxes for the two records (only concentrations are

shown).

- Section 3 should be reorganized with 3.1) mean concentration and fluxes, 3.2) temporal variability and comparison with the variability of accumulation and Na fluxes, 3.3) relationships with ENSO, and 3.4) comparison with SH rBC emission inventories.

- The comparison between Na and rBC records needs to be written more clearly. One may first compare the mean seasonal cycles, and then the temporal variations for annual mean values. Investigations of coherency at the inter-annual or decadal scales are not discussed.

- Regarding the inter-annual variability, systematic comparisons with SAM and ENSO power spectrum, and coherency and phase analyses should be conducted each rBC record and indices of modes of variability. Why didn't the authors also investigate the relationships with regional sea ice information, from 1979 to 2001?

- What are the analyses supporting statements such as "The time lags between the ice core records and rising emissions in the inventories.. suggest that these records may be insensitive to BC emissions transported across the Atlantic sector. . ." ?

- Causes for differences in the two ice core records prior to 1950 should be discussed.

- In the discussion of ENSO impacts on ice core rBC records, a futher discussion of transport versus source effects would be appreciated.

Minor comments:

- Table 1 should be reorganized to place all Antarctic information together, for an easier comparison.

- Figure 1 should show the accuracy of measurements. Figures 1 and 2 may also show estimates of fluxes (not only concentrations).

- How much of the power spectrum of concentrations is related to that of accumulation? Figure 3 should also include the power spectrum of ENSO and QBO

- Figure 4 shows emissions from fossil fuels and grass fires on different vertical scales. Do I understand correctly that Australian biofuel emissions are two orders of magnitude smaller than the other rBC emission sources? What is then the relevance of showing them? Could the authors include a more quantitative discussion of the coherency between the Antarctic ice core rBC decadal variations, and the rBC inventories, given transport aspects?

- Appendix : some statements are wrong, such as "the two ice core records have monthly to seasonal resolution" (this is not the case for the DSS record as discussed in the main text).

- Appendix, Dating : what is the uncertainty on the DSS ice core accumulation?

- Appendix, Spectral Analysis : none of this is new, I would suggest to remove this. However, the authors should justify the choice of 21 year running analyses.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 27815, 2011.