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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 #2

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This study reports on high-resolution 1850-2001 black carbon (BC) records derived from SP2 measurements of two Antarctic ice cores. This appears to be the first publication of BC concentrations within these two Antarctic ice cores, and adds to a very small number of BC records from all of Antarctica. These data will be useful for other researchers, including those engaged in the evaluation of global aerosol models and historical emission inventories. The study is therefore worthy of publication. There are, however, a couple of issues related to the interpretation of these records that should be elaborated upon or clarified before the article is published in ACP.

General issues:

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1) My primary recommendation for improvement is to elaborate on the linkage of BC variability to ENSO. The authors showed that the variance in BC concentration peaks with frequencies similar to those of ENSO, but did not go much further than this. Similar frequencies of variability do not necessarily imply causation, and the authors seem to acknowledge this, i.e., with their statement in conclusions: "These records appear to be influenced by variability similar to tropical Pacific climate variability (ENSO)." The paper would be stronger if something more concrete could be said about this, and a more thorough analysis may produce a clearer picture. For example, there are publicly-available ENSO phase/index data back until at least 1950, and likely earlier. Is there any coherence between the BC deposition and the ENSO phase? (i.e., does deposition tend to be greater during EL Nino phases?) If so, can these observations be related to a specific ENSO-related emission pattern or transport pathway?

2) Related to (1), the discussion on coherence between the two sites also needs some more detail. Specifically:

- p.27821,23: "These periodicities were coherent..." - Please explain the coherence coefficient and calculation in a bit more detail. What is the meaning of a coherence coefficient > 0.38, and why does this threshold define coherence?

- Are the periodicities coherent over 1850-1970? Why was coherence only calculated over 1970-2001? If the records are not coherent prior to 1970, what are some possible explanations for why the level of coherence changed?

- Significant periodicities of 1.7 and 5 years were found at one site, and 2.3 and 6 years at the other site. Given that the temporal resolution of the ice measurements was limited to about 1 year at Law Dome (p.27818,14 and section 2.3), is it possible that these periods are the same in both cores? Can this likelihood be described statistically? (Does the temporal resolution / dating uncertainty factor into the coherence calculation? If not, should it?)

3) It would be helpful to see some more detail/discussion on transport pathways and

potential dominant source regions of particles for these two sites. Such detail could come from back-trajectory analysis or reference to other publications that have explored atmospheric transport to Antarctica. A more detailed back trajectory analysis of source regions could incorporate BC emission inventories (such as that used from Lamarque et al, 2010), whereas a simple analysis or discussion of air parcel trajectories would also be helpful.

Related to this: p.27822,25: "... these records may be insensitive to BC emissions transported across the Atlantic sector of the Southern Ocean." This hints that these two sites may not be (frequently) exposed to Atlantic air masses (or that deposition occurs before air masses reach these sites). There must be references or meteorological data showing dominant wind directions or transport pathways to these two sites which could be used to evaluate this idea.

Minor comments:

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p.27816,23: What is the reference for 1.2 W/m2 forcing?

section 2.1: What is the context or protocol for the ice core labels (WDC06A and DSSW19K)? After introducing these tags, it would be helpful to simply refer to the two cores/sites with more common names (e.g., "WAIS divide" and "Law Dome").

section 2.1: What are the altitudes of the two sites?

section 3.1: "Concentrations of rBC in both records were lognormally distributed." - This is interesting. What is the geometric standard deviation of these lognormal distributions?

section 3.1 : "Geometric means of 0.8 and 0.9 ug/kg." - Are these values mis-quoted by an order of magnitude? They are inconsistent with subsequent text and the means listed in Table 1.

section 3.1: "After 1950, concentrations decreased until (about) 1980 and then rose to pre-1950 concentrations." - Looking at Figure 2, the inflection points in both red curves are prior to 1980. (I would say closer to 1970 or 1975).

p.27820,25-30: The wording is a bit unclear here.

p.27822,2: "However, the rBC signal was found to be systematically delayed from Na by 0.3 to 2.2 yrs." - Why? Do you propose any mechanism to explain this?

p.27822,14: "Similar temporal variability does not occur in the emission inventory of SH forest fires." - Please elaborate on this. Is the variability in emissions less than that seen in the ice core?

p.27822,21: "Emissions from SH deforestation, forest fires, and fossil fuel combustion increased markedly after 1950 (..., fig 4)." - Fig 4 actually only shows the increase associated with SH fossil fuels. It would be helpful to also show SH forest fire / deforestation emissions on this plot.

Table 1 caption: "... annual concentrations are calculated from the log values of monthly data..." - Why are log values used to calculate the mean?

Table 1 caption: "out-layer" -> outlier ?

Figure 1 caption: Annual smoothing is shown in the thick line

Figure 2 caption: Maybe reword "decimal"?

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