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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.

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Point by point responses below

Specific comments:

1. 27818-line 11. These should be specified as ice-equivalent accumulations

Change made accordingly

2. 27819-line 22. The geomeans should be 0.08 and 0.09, at least according to Fig1...

Typo fixed.

3. 27822-lines 5-26. The evaluation of historical fire emission data is quite limited. The authors claim "common variability" in the records between the 1950's and 1980's but

don't really address what this means for the period between 1850 and 1950. Since this is the first high-resolution BC record for Antarctica, the authors should put more effort into understanding how much of the variability is due to ENSO and how much is due to source changes, and more adequately link source changes to the Antarctic sinks. If the majority of dust deposited in Antarctica originates from South America, shouldn't more effort be made to characterize South American fire history?

Response: For the period 1850-1950, little evidence of anthropogenic disturbance in biomass burning or rBC emission is known at such fine scale. Thus, we do think that the variability in the records from 1850 to 1950 is likely to be more "natural" and ENSO may play an important role in some of this variability. We thus modified the text to make this point clearer: "On the other hand, during the earlier period of the records (1850-1950), the two series don't share the same variability, and little evidence of anthropogenic disturbance of rBC emissions in the SH has been documented (Mouillot and Field, 2005; Lamarque et al., 2010). Even if coal mining and burning had started to grow at the end of the 19th century in Australia and South Africa (Vallelonga et al., 2002 and references therein), it was shown that this was probably not a pollution source for Lead in Antarctica (Vallelonga et al., 2002), and therefore not likely to be a source of rBC either. We thus suggest that the rBC signal for this period is closer to that of natural variability, maybe influenced by ENSO, and which anthropogenic fire suppression and fossil fuel combustion have overwhelmed since the 1950's."

Regarding transport, we also added a paragraph to section 3.2: "Ultimately variability in the ice core records reflects variability in rBC emissions, atmospheric transport, deposition during transport and physical processes at the ice core site. Stohl and Soderman (2010) developed a 5.5-year climatology (1999 to 2005) for atmospheric transport into the Antarctic troposphere using a Lagrangian particle dispersion model (FLEXPART). The study used rBC emissions described in Bond et al. (2007) and Schultz et al. (2008) and did not include depositional processes. The results of the study suggest that the rBC in the Antarctic troposphere is most sensitive to austral-winter Australian and South American fire emissions as well as South American anthropogenic emissions. Surprisingly, Southern Africa, which, has the largest rBC emissions, had the least potential to influence Antarctic rBC. De Dekker et al. (2010) investigated dust transport from Australia using the NOAA Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT, R. R. Draxler and G. D. Rolph, Hybrid Single-Particle Lagrangian Integrated Trajectory model, 2003). The back trajectory analysis showed that aerosols (rBC and dust), from central Australia may perturb the aerosol mass loading over West Antarctica before circumnavigating Antarctica. By virtue of its location, the Law Dome site should be sensitive to changes in atmospheric transport from South Eastern Africa. We speculate that enhanced meridional transport of African rBC prior to the 1950's may account for the lack of correlation between the records, but further general circulation modelling studies are needed."

In terms of ENSO, please see response to comment 5.

4. In figure 4 I would expect at least one reconstruction of ENSO variability to be shown.

Response: Due to the complexity of the link between ENSO and rBC, it is not possible to do a direct comparison of ENSO and rBC records (only an ENSO periodicity "signature" could have been found in the records). Thus, we would prefer to not add the ENSO index to Figure 4. Also, please see response to next comment.

5. At the end of the discussion, it seems that the authors are arguing that the ice core pattern is due to ENSO (transport) rather than source changes?

Response: We would like to stress that the ice core pattern since the 1950's is probably due to anthropogenic disturbance of fire regime as well as deforestation and fossil fuel combustion rather than ENSO-influenced transport. We rewrote part of the text, to make clearer the link between ENSO and rBC deposition, which we do not think is linked to transport processes but more likely to source variability. We added this sentence to the text: "Compared to the Law Dome Na record, the rBC-ENSO periodic-

ities were found to be systematically delayed by 0.3 to 2.2yrs (Fig. SI-4d). The delay suggests that, at Law Dome, ENSO influences the rBC record in a differently than the Na record. This is coherent with the current understanding of fire occurrence in response to changes in rainfall, which is also modulated by ENSO (Chen et al., 2011). For instance, an El Niño event may induce exceptional moisture in South America and prevent fires from occurring notably in forests. On the contrary, an increase in rainfall during La Niña may accelerate vegetation growth in Australian savannahs, increasing fire emissions for several years after the La Niña (Krawchuk and Moritz, 2011). Thus, the link between rBC emissions and ENSO may be related to changes in SH rainfall rather than atmospheric transport. This may explain the delay found between the Law Dome ENSO rBC and Na."

Technical corrections: 27818-line 20. Spelling: "SP2, Droplet..." 27820-line21: Grammar: "at for" 27827 - footnote a: "outlier" 27831 - it would be good to write on the figure that a is WAIS and b is Law Dome (Figure 4) Response: All changes made accordingly.

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