

## ***Interactive comment on “Historical black carbon deposition in the Canadian High Arctic: A 190-year long ice-core record from Devon Island” by Christian M. Zdanowicz et al.***

### **Anonymous Referee #1**

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The authors present valuable new BC data from the severely under-sampled Arctic. Historical BC records from different locations within the Arctic are essential for reliable model validation, and generally to understand the spatial and temporal variations in BC trends and processes affecting BC concentration and deposition patterns. Furthermore, discussion on post-depositional factors affecting BC records, such as wind scouring, is particularly welcome, as these are currently quite superficially known. The manuscript is well written and easy to follow. The used methods are appropriate, and the presented hypotheses are well justified and thoroughly discussed. I recommend publication if the following points are addressed in the revised manuscript.

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#### Specific comments:

Generally, the authors are advised to more carefully choose citations.

Page 2, Line 14: Is the citation to Koch et al., 2011 and Lee et al. 2013 appropriate here, as these modelling papers don't present new ice core BC observations, as currently suggested by the sentence? For clarity, I'd suggest to replace these references with other appropriate work (e.g. McConnell 2010; Zennaro et al. 2014; Sigl et al. 2015) or modify the sentence. For instance, the Koch et al. (2011) cite McConnell et al. (2007), McConnell (2010) and McConnell and Edwards (2008) for the ice core observation data used in their modelling study.

P 6, l 27: Please, remove the citation to Koch et al. 2011, and replace e.g. with McConnell 2010 (if you like). Also, on P 6, l 28, Skeie et al. 2011 doesn't present any own BC emission inventory data, so please remove this citation as well.

P 12, l 12: The citation to Ruppel et al. (2014) is incorrect in this context. It should be replaced e.g. by Garrett et al. (2011) who study the issue of BC scavenging efficiencies during atmospheric transport to the Arctic (while Ruppel et al. (2014) only present hypotheses on the matter).

P 3, l 19-23: Could you clarify what these microparticles are, i.e. for instance give examples on what type of particles are meant?

Section 3.3 discusses impressively the uncertainties caused by stochastic spatial variations of deposition of the aerosols in snow, and post-depositional modifications (e.g., by wind scouring) in the ice core record, while actual measurement uncertainties of the nebulizer and SP2 instrumentation are not included. However, there is reason to believe that the chosen analysis methodology itself may cause significant uncertainties for the rBC record as well. As the authors discuss in the last paragraph of Section 4.2 (P8, l 18-31) it is known that the used nebulizer doesn't effectively aerosolize larger rBC particles which however may constitute a notable part of the total BC in the stud-

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ied ice core, as it is shown to be affected by post-depositional processes (e.g. summer melt) which are known to increase the BC particle size in snow (e.g. Schwarz et al., 2013). The manuscript should therefore determine clearly which size fraction of rBC is quantified here. It is understandable why the nebulization and SP2 quantification efficiency is only discussed in Section 4.2, after discussing summer melt of the ice core. However, these uncertainties should at least be mentioned (if they are too difficult to be quantified) already in Section 3.3, and Section 4.2 referred for further discussion. Currently, in Section 3.3 the reader is erroneously led to believe that all uncertainties of the BC record are unrelated to the used rBC quantification methodology.

Finally, it would be good if the authors would present a total estimate (in numbers, %) of how large the uncertainties of the results are. P 5, l 27-28 says “Because the magnitude of  $\epsilon_s$  is independent from that of errors that arise from ice core dating uncertainties ( $\epsilon_t$ ), the combined uncertainty was calculated as the quadratic sum of these terms ( $\pm 2\sigma$ )”. Is the uncertainty seen in any of the figures? How large is the combined uncertainty? If these uncertainties ( $\epsilon_s$  and  $\epsilon_t$ ) cannot be combined with the analytical method uncertainties, it would be good if these uncertainty percentages were presented separately (currently no uncertainty is given for the analytical methodology).

P 12, l 16: For clarity, I'd suggest the following addition (in parenthesis): “The time series differs from the Greenland records (measured with the same analytical methodology as used here) in that it...”. The addition could clarify that the differences of the Devon Island BC record to the Greenland records are surprising as they are analyzed with the same methodology, while differences to the Svalbard record may be expected due to different methodology.

Technical corrections:

P 3, l 13: Consider replacing “sticks” with subsamples.

P 9, l 26: Replace “Their” with “their”.

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P 10, l 2: Remove comma ( , ) before the reference.

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