

Page/line numbers are referred to the editorial tracking version.

P1L20: SMN -> SMB. Also, sensitivity of what?

P1L22: "120-m-long"

P1L23: DML is not used in the abstract.

P1L26: The bottom of the ice core is dated as 1759 +/- 16 AD, so that the ice core includes the climate proxies in the past 240 years, not only in the 20<sup>th</sup> century as it is said in the manuscript title and at the end of the abstract (20<sup>th</sup> and 21<sup>st</sup> centuries).

P1L32: What does "in at least the last 50 years" mean? I think that the authors want to say "Reconstructed SMB increases with time in the last 50 years by 30%" or "Reconstructed SMB increases with time, and this trend becomes even clearer in the past 50 years".

P2L11: see my comment above about "20<sup>th</sup> and 21<sup>st</sup> centuries."

P2L18: remove "coastal". Ice discharge always happens at the coast.

P2L21: balanced -> compensated?

P3L20-24: Please rewrite these new sentences. In particular, I have no idea what "with high SMB" means at the line 21.

P4L2: "120-m-long"

P4L8: remove ", including DML,"

P4L14-15: "preliminary ice core analysis" refers an earlier work of what is reported in this manuscript, I believe. So, it is not appropriate to cite that result in this way. Is it possible to show stake-measured SMB instead (as it is independent of the ice core work reported here)?

P4L26: Change to "Radar stratigraphy shows that locally maximum SMB happens about 4 km upwind of the ice core site"? And consider adding a figure showing the ice core site together with layer-depth SMB and surface elevations in contours (similar to Fig. 4 of Drews et al., 2015).

P7L5-10: Because Kjær et al. is still under review, please include sentences that describe the magnitude of this correction. I assume that this method removes long-term trends but not short-term variations so that determining annual cycles in the ECM record is not sensitively affected by this correction. Also, it is hard to match depths of the ice core and borehole (Hubbard et al., 2013) precisely (Reviewer pointed out this issue but the authors did not respond clearly).

P7L28: change to "and rheological anisotropy of the ice. The strain rates are insensitive to the surface thinning and the strain rates remain the same even if the surface elevation is kept uniform in the model" or such. Also, be more specific which Drews's model result is used here. I think you used "A(n=3), dH = 100, chi = 0.03 m/a, layer-depth SMB, (anisotropic rheology)" in Fig. 11 of Drews et al.

P7L29: change to "Separately, we used GPS data to derive the horizontal strain on the surface."

P7L30: change “0.002 a-1” to “ $2 \times 10^{-3} \text{ a}^{-1}$ ”

P8L1: What does “scaled” mean here? Do you mean “The vertical strain rates derived by Drews et al. (2015) is xx so we increased (or decreased?) Drews’s vertical strain rate by xx uniformly”?? Even with this change, it is unclear what “best fit” means (if Drews’s profile is simply shifted, not shape of the depth function is changed).

P8L7: Change “alternatively” to “The other method we used to derive the vertical thinning rates is ....”

P8L12-13: Figure 2b shows that Drews et al. and DJ model show distinct  $e_{zz}$  over the ice-core depths. They are different by ~13%. Is it significant for your discussion, i.e. do you need to develop the historical SMB records each for Drews’s strain rate and for DJ strain rate?

P8L15: do you mean “We used Drews’s and DJ’s strain rates to compensate dynamic thinning in the annual layer thickness in order to estimate past SMB.”?

P9L11: Please add a sentence to describe how this model is used in this paper.

P9L26: What do you mean by “trend”? Is it east-west trend, temporal trend??

P10L7: change to “These properties change smoothly over a few very thin ice layers (white dots in Fig. 3) so we assume that they are not disturbed by surface melting”.

P10L22: change to “the reference surface (November 2012 AD)”

P10L23: change to “correspondingly dated to 1775 AD and 1743, respectively, or 1758 +/- 16 AD.” (the mean of 1775 and 1743 is 1759, not 1758, but I assume that this difference is related to the timing of the drilling in 2012).

P10L28: Do you want to say “Hereafter, we examine volcanic signals in ECM signals as possible age controls to more precisely develop the depth-age scale bounded by the oldest and youngest cases.”

P11L9: Be careful to say “threshold”. If I understand correctly, the authors want to say “the preliminary depth-age scale developed with layer counting shows that the largest ECM peak beyond 4 sigma presents at 1815 so we interpreted it as the Tambora eruption. The secondary peak associated with the Tambora peak is found as well (unknown source, 1809) but its ECM peak reaches only 2 sigma. This ECM peak is lower than those found in most ice cores [ref] but still in a range of previously reported values [ref]. We found 13 other ECM peaks beyond 2 sigma, which can be potentially matched with known volcanic events. Nevertheless, there are many other ECM peaks beyond 2 sigma as well. So, we conclude ....”.

P11L17: “absolute”, not “relative”? I believe that the authors say that the absolute dating using volcanic eruptions remain uncertain.

P11L19: The response letter says that the authors prefer the oldest estimate. If it is the case, develop the argument here further and say something like “We believe that the oldest depth-age scale is more realistic than the youngest estimate because of matching with the Tambora eruption, though it is not really convincing. Therefore, we use ...”

P12L6: Add thinning rate corrections.

P12L8: The authors said that they cannot conclude whether the young or old depth-age scales are better, but the age of the ice-core bottom shown here (1744) is probably tied to the oldest estimate (but if so, it would be 1743 not 1744). Also, Why is the youngest age in the core changed to 201 from November 2012?

P12L9: move the sentence “without correction for layer thinning” above so that you report the layer thickness first, and then derived SMB. Also, show the range of annual layer thickness (max, min, mean), instead of just reporting the mean value.

P12L12: I got confused. The paragraph immediately above reports the derived SMB, so I assume that the thinning corrections are already made. Please reorganize paragraphs in Section 3.2 to clearly demonstrate the logical flow.

P12L14: Is it really Section 4.2 (Discussion)? If so, it’s better to say something like “we discuss this point further in Section 4.2.”

P12L28-30: Remove the sentence about dynamic thinning; it is obvious and rather confusing. You just say here that the layer has been thinned, not thickened.

P13: see comments to Table 1. Consider moving these paragraphs about averaged SMB values to a discussion section where you compare these values to previous studies.

P14L4: add “~240 years” after “the whole period”

P14L6: change to SMB.

P14L8: “bounded”, instead of “determined”? The real SMB is expected to be somewhere between the oldest and youngest estimates.

P14L11: Here you explain the error bars in Figure 6, but the explanation is too brief to give a comprehensive idea what they are. If I understand correctly, the authors assume that the summer peak can be shifted up to 5 cm to both sides. In other words, if the annual layer is A cm thick, the thickest possible layer can be A + 10 cm (5 cm widen to both sides), and the thinnest possible layer can be A - 10 cm. Then you applied the thinning factor to estimate the uncertainty of the estimated SMB value. Do I understand correctly? However, if this is the case, the error bar is shorter when the SMB value is small, and it is longer otherwise. I cannot see such feature in Figure 6.

P14L11-13: I cannot understand this argument. Consistent features between isotopes and ions support an hypothesis that both represent seasonal changes. However, because both were sampled by 5 cm or 10 cm, both depth profiles may overlook an annual cycle that appears less than 5 cm thick. Uncorrected layer thickness (orange curve in Fig. 6a) shows that it is unlikely to miss such thin annual layers, but similarity of isotope and ion profiles cannot be the evidence for this argument.

P14L22: Provide reference/status of this paper.

P15L6ff: “in the vicinity of the crest”; topographic feature (Crest), not ice-flow feature (divide), should be cited in terms of SMB’s spatial pattern. I saw that “divide” is used at some other places as well; please correct them as well.

P15L7: Drews et al. did not exclude a possibility of recent crest migration, which is too young to deform the Raymond Arches found at depths greater than 50-100 m where Raymond Arches become more visible.

P15L21: here you say that the ice-core-derived results are compared with two climate models, but later you compare the results with ERA-Interim, RACMO2, and CESM.

P15 L25: replace R2 with correlation coefficient or such.

P15L30: please add more information to explain why a freely-evolving model output cannot be compared directly but still your discussion here can be valid.

P16L1: CESM output of the SMB mentioned here (0.295) is an average value for a certain period or the most recent SMB in 2011?

P16L11: How many days is this region covered with sea ice? This information is necessary to judge how 20-40 days fewer sea ice coverage is significant.

P17ff: Section 4.1 shows many numbers and it is very hard to keep tracking the main argument. Please carefully review this section and re-organize it so that the discussion can be presented more clearly.

P17L23: Drews's Figures 3b and 7 shows that anomalously low SMB is persistent at the current position to the age of ice at 60 m depth. This is I think support evidence of author's argument that the observed trend of SMB in the ice core presents the temporal changes, not migrating spatial patterns.

P20L6: change accumulation to SMB.

P20L9: indicate the name of these two coastal sites that show significant increase of SMB in the last 20 years compared to the last 200 years.

P20L13: change "less important" to "insignificant" or "less visible".

P21L28: remove "2009 and 2011" so it will be "than average SMB years (Table 2)."

P22L15: It is said that detrended dataset is not shown, but the authors presented 11-year running mean SMB (Figure 6). Is this running mean record good enough to identify anomalous events in 2-4 years (1991-95 and 1940-42)?

P24L11: "A 120-m-long", change "divide" to "summit" or "ridge (or crest)".

P24L14: "Therefore we counted annual layers to develop oldest and youngest estimates of the ice. The annual layer thickness, density, and thinning functions are applied to derive time series of SMB from annual layer thicknesses."

P24L20: do you mean that "wind re-distribution is significant near the ice-core site but it is likely that this effect is persistent over time so that ice-core records represent SMB time series rather than migrating spatial patterns of SMB"?

P24L25-27: I cannot agree. Probably you want to say "Neither currently available climate models and re-analysis data cannot resolve ice-rise topography so their predictions are hard to match with the ice-core-derived SMB. Nevertheless, their temporal trends can be compared, and ...."

P25L10: I believe that the authors can be more confident about their results. Clear seasonal cycles (not only thin ice layers!) found in this ice core clearly demonstrated the potential of a deep core from this site as excellent paleoclimate proxies.

P25L21: Change “uncorrected SMB” to “annual layer thickness in ice”? “uncorrected SMB” sounds quite confusing.

Table 1

- I am not really sure how these average values for different periods are important. You said that it is for comparison with other studies and if so please consider adding an extra column showing the SMB values obtained from previous studies and compared with the average values that you are reporting.

Figure 1

- Change “accumulation” in the figure to “SMB”.

Figure 3

- Add something like “d18O profiles are shown multiple times to better illustrate correlations between d18O and major ion profiles”.

Figure 5

- It’s very hard to see thin gray bands. Use more distinct color (red, blue, or such, not gray).

Figure 6

- Please align all four panels vertically so each panel can be a bit wider for full one-column width, and it is easier to compare time series. When I saw these panels first time, I had an impression that panels a and b are paired and c and d are paired.
- What do error bars in panels b and c show?
- How is the uncertainty range (panel d) derived? Please explain more clearly in the main text.

Figure 7

- Distinguish curve and line in the caption. Pink and blue are curves, while black one is a line.
- Please rewrite this caption; it is quite confusing. I believe that three datasets are normalized to their average values for the 1084-2000 period and their temporal variations are shown relative to those average values. I believe that “1979-1989” and “1850-2011” are typos.

Figure 8

- The caption is confusing. I believe that you want to say “Large-scale atmospheric and sea ice anomalies observed in CESM historical time series (1850-2005) for the years when ice-core-derived SMB is within highest 10% of the all SMB values in the past ~240 years.....”

Figure 9

- Change “accumulation” in the figure to “SMB”.

- Change the caption so that it is clearer that this figure shows SMB reconstructed with ice cores over the continent.

#### Figure S1

- Change to "...sections of sampling for major ions at 10 cm and 5 cm intervals. Isotope samples were taken at 5 cm intervals for the entire core."
- 2 sigma is used in Figure 5 to identify volcanic signals, whereas 4 sigma is used in this figure. I don't really see the merit to see this line; remove this line or justify why not 2 but 4 sigma is used here as a reference.
- It is impossible to distinguish light and dark gray colors in the ECM plot. And it is more important to show the 301-point (30 cm?) –smoothed ECM values in the figure because the smoothed ECM was used to facilitate annual layer counting.
- I believe that only ECM data are shown in terms of the standard deviation, but not water stable isotopes and major ions (change the caption).

#### Figure S2

- Add unit "sigma" to the first ECM panel.

#### Appendix

- Again, use "accumulation" and "SMB" consistently.
- Are latitude/longitude given in decimal degrees?