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Climate of the Past Discussions

Interactive comment on "Investigating the past and recent δ^{18}O-accumulation relationship seen in Greenland ice cores" *by* S. L. Buchardt et al.

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We thank the two referees for their constructive comments.

Comments by the reviewers are shown in italic, and our responses are indicated by ">". A revised manuscript with changes shown in red can be found in the Supplement.

Reply to comments by referee #1, Roger Bales

Authors should indicate where (what archive) original annual data for the cores from the 52 sites are available in digital form.

>Annually resolved δ^{18}O data from all sites are available from the Centre for Ice and Climate database. This is now indicated in the caption of Table 1 in the revised manuscript.

There are insufficient data to support findings about warming in the most recent decades being recorded in the ice cores. The authors could examine natural variability in replicate records from a single site to show this, and then apply uncertainty estimates to the more-recent records.

>We agree with the referee and we have changed the text.

The section labeled "conclusions" is more of a summary, and the paper could benefit from a succinct statement of conclusions.

>We have relabeled the section "Summary and conclusions", and added a succinct statement of conclusions at the end.

Reply to comments by referee #2, anonymous

The manuscript would be improved by including more details about the annual layer counting using the δ^{18}O curve method, including errors associated with it. It would also and where available, comparison to other methods of determining annual layers, as for many of the data sets used in this study, those data exist.

>A section on this topic has been added under "Method".

The equations presented on page 4110 should be presented with goodness-of-fit information. Here the equations are presented as if they are all equally representative

of the data set from each region, when in reality, some of the equations do not fit the data as well, and some of the equations are based on limited data (this is addressed in the text, but only in respect to equation 4).

$>$ R^2 values are now stated for all equations, and a short paragraph of text commenting on the values is added.

Figure 2, page 4118, There are two issues with the data set here that should be better addressed in the text: 1. There is a great deal of inhomogeneity in the data sets from the different regions, i.e. the SE region data set contains many shorter cores relatively close to one another, while the central region is comprised of fewer, longer cores. Perhaps, as an exercise, it would be useful to examine the same time frame, with similar spacing in between cores for all regions to see if that changes the conclusions?

$>$We assume that the comment is referring to Fig. 3 on page 4119. Indeed, the data set is inhomogeneous, and especially the SE group contains many very short cores covering only 1-2 decades (mainly the 1960's and early 1970's) drilled close to each other upstream from Dye-3. However, as these cores are so short their contribution to the total number of data points in the SE group is small (26 data points out of 129). Excluding these cores from the calculations does not change the least squares fit significantly, but the R^2 value increases.
The differences in the periods that the cores cover makes it difficult to examine the different regions with the same time period and similar spacing between cores. However, looking at the period 1778–1966 AD we can examine 15 cores on the main ice sheet that represent all regions except NE. The spacing between cores within a region still differs between the groups, but to a lesser extent, and the number of cores are between 3 and 5 in each group except for NE with no data and SW with only 1 core. As illustrated in Fig. 1 and Table 1 below, this exercise does not

change the main conclusions. However, there seems to be indications of a change in accumulation rate across the ice divide in Central Greenland which is not evident from the full data set. Furthermore, the larger (negative) sensitivity for the SW group is seen because the Dye-2 core is the only core from this region covering the period 1778–1966, so the effect of the cores closer to the ice divide is not seen in this analysis.

Table 1. The sensitivity of accumulation rate A to changes in δ^{18}O (%‰$^{-1}$).

Group	All data (51 cores)	1778–1966 (15 cores)
NW	10.0±0.3	11.0±0.4
NE	2.3±4.2	-
CW	14.0±0.2	13.4±0.4
CE	13.7±1.5	14.3±2.0
SW	−6.0±2.7	−9.3±6.5
SE	12.2±1.2	13.1±2.1

2. The scatter within individual data sets seems to be a factor of the number of cores comprising the data set as well as an actual difference between cores from high accumulation sites versus low accumulation sites, but these effects are confused because it appears that the high accumulation sites are also sites where more cores comprise the data set. Could one contributing factor to the spread in these data sets be the sampling of spatially variable accumulation patterns? For instance, what if topographical effects on accumulation rates are compounding the conclusions about the closely spaced SE data set? Closely spaced cores might experience the same temperature patterns, but different accumulation rates due to location.

$>$We agree that the number of cores in the data sets influence the spread. We look again at the period 1778–1966 that is covered by 16 cores in our data set (15 cores on the main ice sheet and the Renland core). From these data we cannot

conclude that the spread is significantly higher for the high accumulation sites, and we have changed the text accordingly. In the case of the SE data set, the closely spaced cores are for the most part quite short and thus contribute little to the overall picture from this region.

Figure 4, page 4120, There is too little data to draw any major conclusion about accumulation patterns in recent decades from these plots. The statement in the abstract, page 4106 line 12 and in the conclusions page 4112, line 18 that "none show evidence of increased accumulation" is not quite right. It should say something to the effect of "no conclusive statement can be made about accumulation rate from these data."

>We agree, and the text has been changed.

Technical Comments: Page 4106, line 25, define RCM.

>Done.

Please also note the supplement to this comment:
http://www.clim-past-discuss.net/8/C2419/2012/cpd-8-C2419-2012-supplement.pdf

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Interactive comment on Clim. Past Discuss., 8, 4105, 2012.

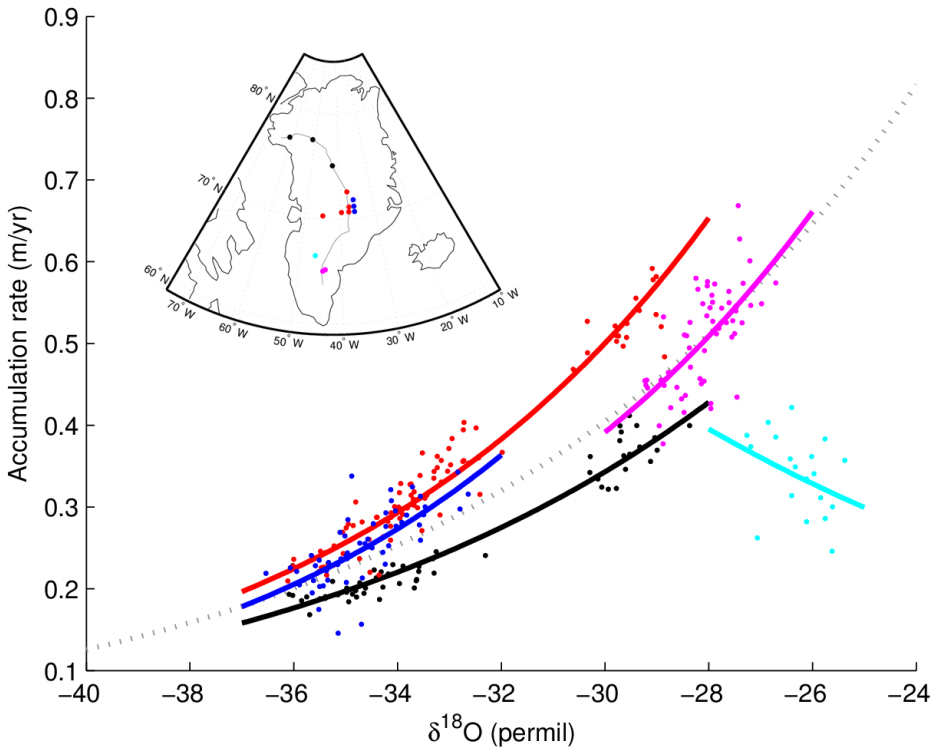

Fig. 1. 10 yr averages of ice equivalent accumulation rate and δ18O from 15 sites on the Greenland ice sheet covering the period 1778–1966 AD. The insert shows the grouping of the cores.