

Interactive comment on “Regional Greenland Accumulation Variability from Operation IceBridge Airborne Accumulation Radar” by Gabriel Lewis et al.

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Received and published: 13 December 2016

This is a very nice study and it is good to see the accumulation radar datasets being put to use. We have just published a similar study also using Operation IceBridge data and a comparison between our two results would be very interesting. It could certainly give some insights into the robustness and reproducibility of this method for reconstructing past accumulation rates. For example, we retrieved higher than average accumulation rates during the past 100yr – does this dataset show the same? Our article can be found here: <http://journal.frontiersin.org/article/10.3389/feart.2016.00097/full> and the data here: <http://www.iceandclimate.nbi.ku.dk/data/> or on the Pangaea website. Feel free to contact me if you need additional data for comparison.

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Additionally, I would welcome some comments from the authors on a few points.

Age assignment

The IRHs are dated using an age-depth scale from a Summit core drilled in 2007. Presumably, when transferred to the radar data, this age-scale is corrected for the fact that 6-7 years of accumulation has been added in the time between the core was drilled and the radar data were acquired. However, this is not stated explicitly. Furthermore, it would be worth mentioning how far from the radar flightline this core was drilled. We found that even a few kilometres of distance between the radar data and our dated ice core (the NEEM 2011 S1 core) meant that the radar data had to be offset by 50ns due to snow accumulated around camp. At Summit, the snow has been moved around extensively due to camp activities and I would assume that a direct transfer from the Summit timescale to the radar data is not possible. Since our tests indicate that an error in dating of the order of +/- 15yr could lead to large changes in resulting accumulation rate (upwards of 20%) a more rigorous treatment/discussion of the dating of the IRHs is called.

Density profiles

The calibrated Herron-Langway model is only briefly described and the paragraph raises a few questions. E.g., where are the in-situ measurements of surface density located that were used to calibrate the model? How spatially variable are the densities in the data domain? The adjustment of +/- 5% to accumulation rates and surface density for testing the sensitivity of the final accumulation rates also seems a bit low. In our study, we retrieved the surface density using an inverse method, and found that the surface density varied by 2%. Our study area is in the dry snow zone at the ice divide, and therefore most likely less variable than the surface density closer to the margins. Furthermore, the difference between the IceBridge accumulation rates and the accumulation rates from Burgess et al. 2010 exceed 5% according to Table 2. Increasing the adjustment to 10% probably still returns accumulation rates well within the stated

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uncertainty but it is worth a mention.

Layer thinning

It is not explicitly stated but I assume that the thinning of the layers due to downwards advection has been corrected for? If not then the accumulation rates are consistently underestimated for older layers. This would lead to a systematic bias in the result.

Ice flow

The manuscript contains no discussion on the influence of ice flow on the accumulation estimates. The movement of ice particles from, for example, low accumulation areas to high accumulation areas leads to an underestimation of the accumulation rate in the final measurement point. While 300yr is a relatively short time span and the ice particles have probably not moved very far there are some areas in the study region where ice flow velocities are high enough that it might have an impact. Again, this leads to a systematic over/underestimation rather than a random error.

Comparison with ice core / shallow core measurements

The IceBridge accumulation rates are compared to ice core accumulation “over the time domain of each ice core”. Does this imply that the IceBridge accumulation rates are compared to accumulation rates from the entire NEEM core including the last glacial period? I would assume not but a direct indication of which time periods are used for this comparison would be very helpful. I also wonder why cores from the central and northern part of Greenland are not included? For example, accumulation rates from the NGRIP core and from the cores B26 and B29. Accumulation rates from the latter two were recently published by Weissbach et al., 2016, *Climate of the Past*.

I realise that some of these effects might lead to smaller uncertainties than the stated uncertainty in accumulation rate of ± 0.127 m w.e./yr. However, by not mentioning these complications a reader could get the impression that no such complications exist.

Finally, a comparison between the uncertainty with the accumulation rates from Fig.

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5 indicates that this corresponds to at least 25% (highest accumulation rate is 0.5 m w.e./yr) or more for lower accumulation rate areas. In that context, how can the % differences in Table 2 be significant even at less than 10% difference? Am I missing something here?

Figures

Figure 2: The label on the colorbar says “Age of oldest layer” but presumably, it should say date of the IRH (in Common Era)? Figure 3: This figure implies that the accumulation rate was calculated as an average for the period 1712-2014 but from Figure 2 parts of these lines do not have layers that go that far back in time.

I apologise if this echoes any comments from reviewer #2. I wrote this before the second review had been posted.

Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2016-248, 2016.