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

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Comment: This paper presents a new data set of the GrIS accumulation, which will be notably useful for validating RCM's in the dry snow zone. This paper fits well with TC, is well written and deserves to be published. However, before publication, a comparison with up-to-date RCM outputs will be more interesting and relevant, if it is not a too big job for the authors. The RCM outputs used here seem to be the ones used in Vernon et al. (2013)? Moreover, as already pointed by Reviewer #1, the discussion about the temporal variability is not enough scientifically robust to be published as it without additional validations.

Response: The most recent RCM outputs have now been used for this study. We now

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Discussion paper

compare IceBridge accumulation with MAR v3.5.2 and RACMO2.3.

Comment: 1. This paper compares the Ice Bridge data set with outdated RCM outputs for them the accumulation biases highlighted in this paper (e.g. RACMO too dry and MAR too wet) were already identified and corrected in part (Noel et al., 2016; Fettweis et al., 2016). When MAR or RACMO outputs are shown, the used version of the RCMs should be at least mentioned. Are they the ones used in Vernon et al. (2013)? Last MARv3.5.2 outputs (used in Fettweis et al., 2016) can be found here: ftp://ftp.climato.be/fettweis/MARv3.5.2/Greenland/ Monthly outputs extrapolated at 5km can for example be found on ftp://ftp.climato.be/fettweis/MARv3.5.2/Greenland/NCEPv1_1948-2015_20km/monthly_outputs_interpolated_at_5km/ Idem for RACMO. The dry RACMO biases is now corrected in the 1km product based on the 11 km RACMO outputs (Noël et al, 2016). I am sure that Brice Noël will provide you these new outputs for an up-to-date comparison.

Response: We now use the most recent model outputs.

Comment: Finally, a comparison with Polar MM5 is shown although this model is not more used. A comparison with the Box et al. (2013) data set as done in (Fettweis et al., 2016) will be more interesting and relevant, if this does not request a too big job for the authors.

Response: We now include accumulation data from Box et al. (2013).

Comment: 2. My main critic is the discussion of the IceBridge temporal variability (in particular lines 21-34 of page 11) as already pointed out by Reviewer #1.

Response: We have addressed the reviewers' concerns about the temporal variability discussion. Please see response to Reviewer #1.

Comment: Firstly, I am very surprised that IceBridge does not see any trend in accumulation from 1712 to 1980's while for example, ice cores (Mernild et al., 2015), Box's

reconstruction and MAR based outputs suggest a significant accumulation increase over 1920-1950's (as discussed in Fettweis et al., 2016) and at large scale, over the whole century (an increase of 0.1mm/yr2 over the last century is mentioned by Mernild et al. (2015)).

Response: IceBridge does see trends in accumulation from 1712-1980, but they are not as large nor as significant as the later trends. We have added IceBridge accumulation trends to Table 1.

Comment: How does the IceBridge data compare with the ice core based trends listed in Table 6 of Mernild et al. (2015)? The ice cores D2, D3, D4, D5,NEEM, NASA-U and SUMMIT are in the IceBridge domain.

Response: We calculated accumulation trends for ice cores and nearest IceBridge radar traces in Table 1 of this study. The IceBridge and ice core trends agree within error for the corresponding time periods. Likewise, accumulation trends agree with those from Mernild et al. (2015) for longer time periods, as reflected in Table 1. With our 15-30 year temporal resolution over the 20th century, it is difficult to directly compare with 30-year trends from Mernild et al. (2015).

Comment: Secondly, how does the IceBridge interannual variability correlate with RCM outputs? Over 1976-2014? As discussed in Fettweis et al. (2016), the MAR interannual variability before 1950's can be questioning but over 1976-2014, the RCM interannual variability (fully driven by the renanalysis variability) is robust and should correlate with the IceBridge data set? How does the IceBridge interannual variability compare in respect to the RCM based one? The IceBridge signal seems to be very smoothed. Is there an interannual variability in the density used to extract the accumulation from the IceBridge signal?

Response: Similar to the RCMs, we see less accumulation variability towards the interior of the ice sheet than towards the south and the coasts. Our calculated variability is the same order of magnitude as RCM variability (0.03-0.06 m w.e a-1 in the north-

ern interior and 0.1-0.15 m w.e a-1 in the south), however our variability is not nearly as smooth since we are calculating variability using internal reflection horizons form airborne radar. We did not perform an extensive statistical review on these data since they agree with RCMs and our expectations. See figure below. There is no interannual variability in the density used to extract accumulation. We use a steady state Herron-Langway (1980) profile to drive our depth-density model.

Comment: Finally, the trends shown in Fig. 11 are very small (only 1-2 mmWE/10yrs2 !!) and are for me not enough significant to be mentioned according to the inter-annual variability (∼30 mmWE/yrs) and the absolute value (∼3000 mmWE/10 yrs). Such an accumulation increase over the recent decades has never been discussed/shown in previous studies and attributing these changes to AMO is dangerous (why does AMO not perturb accumulation over 1712-1980?). Below, there are the trend as well as the interannual variability simulated by MAR forced by NCEP1 over 1976-2014. Although MAR suggests rather a surface mass loss over the studied period, the MAR simulated trends are not significant in respect to the MAR based interannual variability (see attachment). Units are mmWE/yr2 and not mmWE/10yr2 !

Response: The reviewer's point is well taken. The trends shown in original Fig. 11 were not statistically significant, so we have removed this figure and related discussion from the manuscript.

Figure: SMB interannual variability calculated as one standard deviation of 1921-2014 accumulation for each radar trace.

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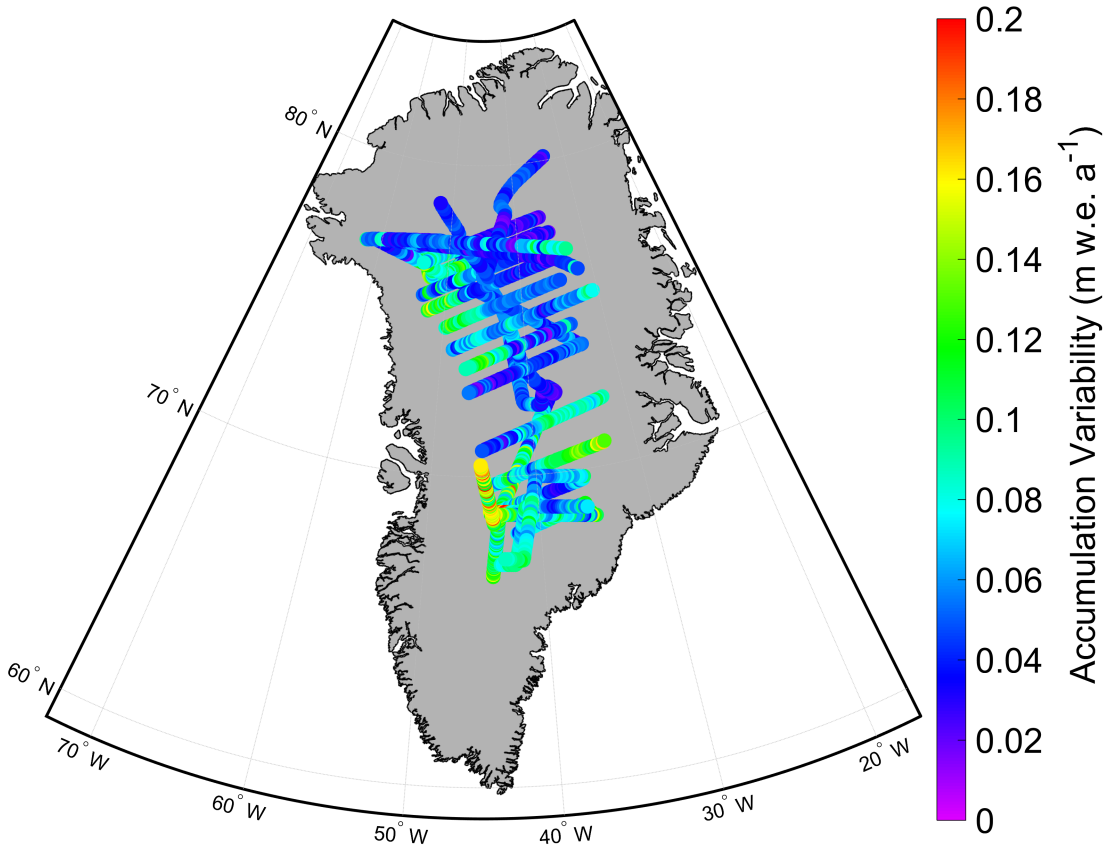
80° N
70° N
60° N
70° W
60° W
50° W
40° W
30° W
20° W
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Accumulation Variability (m w.e. a-1)

Fig. 1.