

## ***Interactive comment on “Recent Precipitation Decrease Across the Western Greenland Ice Sheet Percolation Zone” by Gabriel Lewis et al.***

**Anonymous Referee #2**

Received and published: 5 August 2019

**GENERAL OVERVIEW:** Lewis et al. work titled “Recent Precipitation Decrease Across the Western Greenland Ice Sheet Percolation Zone” reconstructs annual accumulation rates by using a well-known method of combining snow/firn density profiles from ice cores with the depth at which radar isochrones are found; in the dry-snow zone, radar isochrones are related to the depth-hoar formed at the end of summer, effectively marking annual accumulation layers. Here, they use the methodology in the percolation zone, and compare results with those of regional climate models to conclude that precipitation rates in the percolation zone of western Greenland show a decreasing trend. The data presented is of interest, and the radar data obtained over the percolation zone is certainly of importance. The paper is well written and clear, and I have few corrections regarding that. The methodology is well described, but I

C1

do however have some comments regarding the validity of the it given the interpretation of results. The paper could also do a better job summarizing recent studies in the area; this needs to be addressed to avoid any impression that authors are cherry-picking results to reinforce their conclusions. Only Overly et al. findings are quoted using a similar method, but there are several studies showing that accumulation rates are increasing in this area (e.g. Koenig et al.). There is too much emphasis on the comparison with IceBridge radars, but clear differences between the VHF pulse radars and microwave phase-sensitive radars must be made because they operate differently. Although the uncertainties in the shallow firn core data are well explained, there is not sufficient details on the radar uncertainties, which are definitely large enough. This can even be seen at the sites where the shallow firn cores were taken (e.g. Figure 5). In my opinion, the emphasis should not be so much decreasing accumulation, which the authors hypothesize is caused in part by blocking of storms in the summer; the models only show a very slight decrease when looking at decadal trends, and the differences with the radar-estimated rates are larger than that, even over the core sites (Figure 5). I have specific comments as well that should be addressed before this paper is accepted. **SPECIFIC COMMENTS:** Section 2.2. How do you differentiate between annual accumulation layers (depth hoar formed in September/October) from percolation layers formed during the summer? As stated, unlike phase-sensitive radars, GSSI pulse radars can penetrate ice layers if they are thin enough, but without power analysis they look the same as depth hoar. Ln 157 A radar isochrone is by definition continuous IRHs, so this is redundant. What you really mean is that the isochrones observed have been related to annual accumulation layers. Ln 233 Why is the diameter needed? isn't the diameter of the cores approximately the same? If this is due to irregularities in the shape core, then it has to be explained that the core is assumed to have a cylinder-like shape with measured diameter. Ln 253-254. This phrase is not clear; please explain better. Ln 256-260. It is really hard to believe this statement without more in-situ data. As a matter of fact, there are studies that show that 21st Century percolation facies not only consist of pipes and lenses, but widespread layers that do amount to a fraction of

C2

the total accumulation (Perry et al., 2007; Helm et al., 2006; de la Pena et al., 2015; Machguth et al., 2016). At the very least, an assessment of the uncertainties related to this should be given. Section 2.4. Is this different as what is shown in Figure 2? Section 2.2 states a constant dielectric to estimate depth. Please clarify. Section 2.5. It is stated that sometimes a “layer appears to bifurcate...”. How does the authors know that the layer being traced is an actual annual layer (e.g. a depth hoar) and not a percolation feature? Ln 313-318. If the range resolution of the radar as stated in Section 2.2 is 0.35 m, then how it is possible that two radar samples are 0.12 m? This is inconsistent. My guess is that the uncertainty in accumulation estimates just from this would be at least the resolution times density, which is much higher than what is stated here. Ln 325-326. But it was stated in Section 2.3. that variable percolation facies do not affect estimates. I know is further discussed in Section 3.5, but my opinion is that more emphasis should be made in the variable structure of firn over the percolation zone. Ln 673-674. Please provide references. Ln 677-678. I do not believe this statement is correct. Uncertainties in radar-derived rates are in my opinion much larger. Figure 1. Please include elevation contour lines, it would be helpful for the reader even if most of the traverse is along an elevation of 2100 masl. Figure 5. Please add error bars to the GPR-estimated accumulation. Figure 5 and 12. Please use a larger font size.

---

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-103>, 2019.