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Interactive comment on "Interannual snow accumulation variability on glaciers derived from repeat, spatially extensive ground-penetrating radar surveys" *by* Daniel McGrath et al.

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McGrath et al (2018) provide a detailed comparison of GPR accumulation measurements and in situ observations on two Alaskan glaciers where long term glacier mass balance monitoring has also occurred. To fill in areas lacking observations they used two statistical approaches. They further explored six different approaches to estimating glacier wide mass balance. Overall this paper has considerable value: 1) For identifying the potential for GPR to validate reference stake observations on glaciers with ongoing mass balance observations. 2) In assessment of inter annual variability of the winter accumulation pattern and 3) In best practices for filling in data gaps.

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The suggested revisions almost all fall into the category of additional references that either support their observations and or provide an avenue for a more robust comparison and contrast with other studies and methods. The authors underestimate the number of studies that have used detailed in situ winter balance observations and detailed in situ mass balance observations that can be used to address the question of inter-annual spatial variability of winter accumulation in SWE.

Specific Comments:

15: "...observations on two glaciers in Alaska during the spring for five consecutive years.

34: "...of winter accumulation in SWE is only a ..."

51: Many alpine glaciers have much a higher density of measurements in the spring via probing than late summer using only stakes note the NVE network in Norway for example, this should be acknowledged.

93: It is true in the context of snow distribution on glaciers that inter-annual variability has not been examined a great deal, however, a number of studies have examined this in terms of annual mass balance and specific observations of winter and summer balance at specific points note Vincent et al (2017). Could be worth citing Fountain and Vecchia (1999) who look at how many stakes are needed for annual balance work, but this does have bearing on winter balance. There are also numerous detailed published multi-year winter balance maps that have been used by investigators to identify that in fact there is limited inter-annual variability on their particular glacier justifying the use of stakes in their processes, such as on Silvretta, Hinterisferner, Nigardsbreen, Storbreen, Storgalcaren, White, Urumqi etc.

114: This assumption can be verified in other ways for annual balance, for example the WGMS reports the relationship between snowline and annual balance or ELA and annual balance for all glaciers in the detailed reports of their bulletin. If the correlation

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is good that indicates the consistency of the annual balance distribution and cannot be achieved without a consistent SWE distribution (WGMS, 2017). Rabatel et al (2017) conclude that, "the snow-map method shows better performance for the quantification of the winter SMB because the method is based on the variations of the seasonal altitude of the snow cover distribution, which are significantly representative of the winter SMB; whereas in summer, the variations of the seasonal altitude of the snow cover distribution are lower and limited to representing the high year-to-year variations of summer SMB." The approach of this study identifies limited inter-annual variability and uses a separate approach.

139: Any temperature gradient information that can be reported?

200: A mean density was found to be most representative on the Greenland Ice Sheet as well, would be useful to reference (Fausto et al, 2018).

362: Worth noting other balance gradients, can be done in discussion at line 532 instead of at this specific location. Lemon Creek= 470 mm 100 m-1 (Pelto et al, 2013) Taku Glacier= 350 mm 100 m-1 (Pelto, 2008). What about on Eluktna and Scott Glacier (McGrath et al, 2015)?

387: Exceeded by how much?

387:". . .in the northeast quadrant of the glacier where wind drifting is prevalent."

421: This variability from scour to deposition zones illustrates the importance of stake placement in such a portion of the glacier that is neither scour nor deposition.

447: Figure 12 add little value.

481: Is this typically expected to be the case? It seems not so what is typical for this stake location?

517: For many glaciers the transient snow line is a single distinct feature from early until late summer. This indicates the similarity of accumulation along that line across

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the width of the glacier in that elevation range (Mernild et al 2013). Is this the case on Wolverine or Gulkana Glacier early in the summer season? The images I have seen of the TSL on Wolverine indicate this to be the case note Figure 2 from McGrath et al (2015).

549: Lemon Creek Glacier also has wind scour leading to less accumulation at the very highest elevations as at least one of your authors has observed.

564: Do your result allow determination if the redistribution represents any net change in accumulated SWE or simply increasing the variability is SWE distribution?

637: Illustrates issues of a small network on glaciers with different accumulation basins.

643: I am confused that Fig. 13 shows a negative bias, what am I missing?

646-649: Suggest removal since this is an just a speculative suggestion without evidence.

725: Fischer et al (2016) utilize TLS to compare detailed in-situ and geodetic observations. I believe their paper supports your conclusions, though this maybe not be the best placement in the paper for such a reference.

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