

## ***Interactive comment on “Brief communication: Glacier run-off estimation using altimetry derived basin volume change: case study at Humboldt Glacier, Northwest Greenland” by Laurence Gray***

### **Anonymous Referee #2**

Received and published: 12 November 2020

This manuscript presents a concise and well-thought-out analysis of mass balance for a small but interesting piece of Humboldt Glacier. Although it does not try to solve the entire problem to ice-sheet mass balance, it contains a thorough and detailed analysis that would be a good model for other studies of the same type. I was happy with the way the material was presented, except for a piece of the analysis of the altimetry that I didn't understand, and that I think needs either more detail or a more convincing argument.

The section that I found problematic was the treatment of the mass balance for the high-elevation portion of the basin. Here, Dr. Gray writes: “Thirty-day height change data

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derived from all the CryoSat POCA data for basin 3 above 1300 m (Fig. 3) shows that there was a melt season height decrease in this area only in 2012, 2015 and 2019 (Fig. 3B). As there is no evidence of run-off to lower elevations or of an associated change in speed, I ascribe these height changes predominantly to surface melt and sub-surface refreezing, i.e., firn densification, and reduce the volume loss using these values so that the mass loss can be estimated. The average summer height losses associated with densification (Fig. 3B) were  $0.42 \pm 0.08$  m (2012),  $0.45 \pm 0.08$  m (2015) and  $0.4 \pm 0.08$  m (2019) based on the 44,756 POCA height results spanning the nine years and the area of basin 3 above 1300 m.”

It seems to me that we should expect to see surface lowering during the summer. Even in an area of a glacier where the velocity is constant, for steady state the accumulation need only balance ice flow in the annual average. During the winter, we would expect to see accumulation in excess of that needed to balance ice flow and consequent surface rise, and during the summer, we would expect to see too little accumulation to balance ice flow, and consequent surface lowering. It seems that to assess the contributions of accumulation and densification to volume change we need external information. It may be that the MAR data provide clues about this, and there’s been some extra analysis that didn’t make it into the manuscript, but I didn’t see a strong argument for why all the surface lowering should be due to firn densification. Absent this argument, might it make more sense to remove the area upstream of 1300 m from the analysis? It seems that it’s not the source of significant runoff.

My other comments are editorial.

Line 18: Should give an example of the use of the model, not just a reference to the model.

Line 20: “height when” -> “height with radar altimeters when”

Line 37: small -> weak

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Line 38: “to the supra-glacial” -> “for the supra-glacial”

Line 38: add “of the lake” after “estimation”

Line 39: “By using” -> By selecting

Line 43: This paragraph needs an introductory sentence that summarizes the method and helps provide some context for the trade off between patch size and accuracy.

Line 43: “data is” -> “data are”

Line 47: rather than saying that the size of the window can be increased, say that you increased it (otherwise it’s ambiguous what was done in the study).

Line 51: add comma after “this period”

Line 52: add comma after “369 days”

Line 53: add comma between “next” and “many

Line 55: “year-to-year work” -> “year-to-year differences”

Line 57: “has provided” -> “provides

Line 58: add comma after moderate

Line 61: “sampling is 2.4 km” -> “bin spacing is increased to 2.4 km.

Line 66: “good weather data” -> “accurate weather data”

Line 74: change-> vary

Line 103: thickness and speed should both be plural.

143-144: “are available as mm” -> “are provided in units of mm”

144: I think the units are most likely mm water equivalent (not per square meter). This is numerically the same as  $\text{kg} / \text{m}^2$ .

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145: “at 150 m” -> “on a 150-m grid”

164: “is less” -> “are fewer

165: “less than that” -> “smaller than those”

166: add comma after “four gates”

173: comma after “balance”

208: delete quotes around 30-day

235: issue->question

Data availability: Need to provide a source for the MAR accumulation data.

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2020-220>, 2020.

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