**Review** "*Meltwater Storage in the firn of Kaskawulsh Glacier, Yukon Territory, Canada"* by N. Ochwat.

The authors study the density profile of two firn cores drilled in spring 2018 in the accumulation zone of Kaskawulsh Glacier (Yukon, Canada). These cores are used to calculate local firn density and the impact of meltwater retention and refreezing on surface lowering that must be accounted for to correct geodetic mass balance estimates. The authors obtain an average firn density of 670 ± 2 kg $m^{-3}$ in the 36 m deep core, and estimate an average surface lowering of 10 ± 0.8 cm per year over the period 2005-2018. The authors also identify a perennial firn aquifer below ~35 m depth.

The paper suffers from major issues including the robustness of the methodology, results and uncertainty estimates, making the conclusions difficult to trust. In addition, some terms used are unclear; the authors sometimes expect a priori knowledge from the readers (e.g. Section 3.3). The reviewer also noted that results reported in the main text and tables are often not matching, and that the conclusions lack of novelty. The paper is mostly descriptive and does not provide novel insight on geodetic mass balance uncertainties compared to previous studies. Therefore, the reviewer deems that the manuscript should be **rejected** in its current form. Below, the authors can find the reviewer's major concerns, listed as General and Point comments.

**General comments**

1. Results are based on "subjective" approximations that may alter the conclusions. For instance, the completeness of the two firn cores section is assessed based on "visual inspection" by three persons. How do the resulting "random" and "human" errors impact the firn density calculated in Eq. 1? In L120, the authors provide a 10-20% uncertainty in estimating the factor f in Eq. 1 (L125-126)? This would lead to a ~100 kg $m^{-3}$ uncertainty in firn density (assuming the 670 kg $m^{-3}$ value reported here), in line with 110 kg $m^{-3}$ estimated in Foy et al. (2011; see L287). However, the authors report uncertainties ranging from 2 to 6 kg $m^{-3}$. Please elaborate. See also Point comment in L137-140.

2. Across the manuscript, the authors report results that are not matching between the main text and tables, making the conclusions hard to trust. For instance, in L18 the authors report an average surface lowering of 10 ± 0.8 cm $yr^{-1}$ between 2005-2018. In L356, the authors report 10 ± 8 cm $yr^{-1}$ for the same period. In L322, this annual rate is cumulated over the period 2005-2018 to obtain 1.3 ± 0.8 m in ~13 years. What uncertainty was used here (0.8 or 8 cm)? Please elaborate. Similar issues can be found across the whole manuscript and are listed in the Point comments.

3. The 13-year period (2005-2008) is estimated using calculated total water content of 23.22 m w.e. at the drilling site and assuming an average accumulation rate of 1.76 m w.e. $yr^{-1}$ (1960s). The authors do not assess the robustness of this estimate given the uncertainty in firn density. Please elaborate.

4. The term "melt-affected firn" is often used in the manuscript but not explained. Is this firn affected by the presence of refrozen meltwater in pore space? What are the associated visual features as stated in L204-205? Perhaps a photo of the cores would help the interpretation. The same holds for "Ice content" in L134, that is sometimes defined as the cumulative thickness of ice layers in the core expressed in m, or as a fraction after being normalized by the length of the firn core (see e.g. L192 and Table 1).

5. The authors sometimes expect "a priori" knowledge from the reader. Section 3.3 on stable isotopes is a good example: how to interpret the summer peaks at -22‰ in Fig. 4? This section is not necessary and the results are not further discussed in the text, except in L244-246 that relates low ion concentrations to active meltwater percolation/motion in firn.

6. The conclusions lack of novelty compared to previous studies that also estimated surface lowering in the region (see L334-339). The paper does not provide a convincing estimate of (local) surface lowering uncertainty for geodetic mass balance measurements, nor estimate

the regional mass change accounting for density correction. In L328-330, the authors claim that density estimated at the two cores are representative of a larger region, which cannot be proved using only two cores as stated in L371-376. The authors should consider combining their core measurements with firn modeling to obtain spatially continuous density profiles and estimate regional mass balance uncertainty due to firn processes.

**Point comments**

L92-94: Are the measurements from the snow pit discussed somewhere in the manuscript or shown in Fig. 2? Please clarify.

L135-136: What does "melt percent" mean? How is this calculated?

L137-140: This is unclear, why should the thickness of ice lenses be divided by a factor two?

L161-164: The authors should provide some references on the methods used to study isotopes.

L184-190: This paragraph includes numerous errors in reporting results. In L186, "571 ± 3 kg $m^{-3}$" is reported in the text while Table 1 lists 518 kg $m^{-3}$ at core 2 between 4-14 m depth. In L187, "608 ± 2 kg $m^{-3}$" is reported while Table 1 lists 618 kg $m^{-3}$ between 4-21 m depth. The authors report an extremely small density uncertainty of 2-3 kg $m^{-3}$ while Figs. 2a and b show much larger uncertainties. In L229-230, the authors state that densities larger than 917 kg $m^{-3}$ are eliminated. However, Fig. 2a shows values of ~1000 kg $m^{-3}$ or larger at 6 and 10 m depth. To the reviewer, it is hard to judge whether these errors are due to negligence or calculation errors. Please elaborate.

L185, 187, 188: For clarity, the authors should better write: "between 4 and 14 m depth" instead of "in the upper 10 m"; "between 4-21 m depth" instead of "in the upper 17 m"; and "between 4-36 m depth" instead of "representing ~32 m". The same holds for L284-286.

L193: 660 kg $m^{-3}$ is actually 1.5% smaller than the firn density of 670 kg $m^{-3}$ reported in L189.

L276: What do the authors mean by "summer melt extent"? Do they mean meltwater production in mm w.e. $yr^{-1}$ as listed in Table 2? Please clarify.

L278: It is hard to assess the robustness of the results in this paragraph. In L278, the authors state that summer 2015 was the warmest in the period 2014-2018, whereas Table 2 shows that it was actually summer 2016 (-1.0ºC in 2016 vs. -1.8ºC in 2015). The same goes for annual mean temperature in 2015-2016 (-9.0ºC in 2016 vs. -9.6ºC in 2015). How to interpret the larger PDD and melt rates in 2015 then? Please clarify.

L284: Again 608 kg $m^{-3}$ is reported in the text whereas 618 kg $m^{-3}$ is listed in Table 1.

L315: What do the authors mean by "certain amount"? Ice layer thickness?

Table 3: What does "1.5-2g" mean in the personal communication of Sass and O'Neel?