The Cryosphere Discuss.,
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Interactive comment on "The Impact of Climate on Surging at Donjek Glacier, Yukon, Canada" *by* William Kochtitzky et al.

Anonymous Referee #1

Received and published: 28 May 2019

General comments

Glacier surges have been shown to cluster non-randomly in many mountain regions of the world but the underlying processes remain little understood. This manuscript presents an innovative approach to the study of the climatic forcing of glacier surges in Donjek glacier, Canada, with a combination of ice core, meteorological, remote sensing and GPR data, giving an strong insight on the glacier surging main forcings. The work compiles existing data from a series of previous works of this well studied glacier, and builds on with significant new evidence. The results are convincing and conclusions seem particularly strong because they apply to seven surge cycles. Discussion is valuable and focusses on the interpretation and some limitations of the results.

I have some comments regarding a small part of the methods, some of the writing and some of the graphs, which are detailed in the following sections.

For these reasons I suggest the paper should be accepted with minor revisions.

Specific comments

In the methods section it is clear that the multimethod approach relies on other work which is duly cited. Nevertheless I consider it is important to briefly and clearly outline the methods used in the datasets analyzed in this manuscript, so that the reader does not need to constantly refer to other papers. In particular organization of the ice core and remote sensing methods and materials could be clarified and improved.

One methodological observation I formulate is the interpretation of a small section of the snowline as representative of the entire glacier. I propose a semiautomatic method that could provide more robust glacier-wide snowline data.

Another methodological observation is the interpretation of the extent of reservoir data. I think it is important to show some complete longitudinal profile of the glacier elevation change, so that the area where the flowing instability occurs is clearly identified (e.g.: Burgess and others, 2012, Fig. 3; Pitte and others, 2016, Fig. 4). I could not help to notice strong elevation changes above the proposed threshold of 20 km (Fig 5) and wonder how much higher it originates. Related to this point, once the reservoir and receiving area are clearly established I suggest calculating the displaced volumes based on the areal data of these two zones. A match of these volumes, within error bars, would strengthen the interpretation of the abovementioned zones.

The graphs are generally hard to read, consider widening the figures and using larger font. Also the graphs and maps have a reference box, but much of the information is repeated in the caption. I suggest taking advantage of the reference and keeping the captions shorter.

Another suggestion is that, for clarity, multiple bar plots be replaced by lines, which might facilitate the comparison between the different surge cycles or variables repre-

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sented.

Technical corrections

Line 1. Consider the use of capitals only for proper names.

Line 99. Figure 1a. Include elevation of some summit, Eclipse icefield met station and/or glacier front to give and idea of the elevation range. Figure 1b. In the location map, considering including a shading for mountain areas (e.g. over 2000-3000m and/or glacier distribution). It is not necessary to repeat in the figure caption the information already in the reference (Eclipse station, 5 km marker, etc.).

Line 107. Include some more information regarding glacier classification, shape and morphometry (elevation range). Also here or in the final part of the introduction include the number/area of glaciers in the region and the number of surging ones.

Line 114. Please remove this last sentence. Ice coring is extensively described in methods. Consider including a paragraph descrining climatic setting.

Line 117. Please rephrase this paragraph to describe events in chronological order.

Line 129. In Figure 2 the ordinate axis (y) is not really used. Consider including a variable such as glacier area, length of velocity to give an idea of the different surge magnitudes (e.g.: Donjek et al 2016, Fig 2a).

Line 135. This paragraph is crowded with data which makes the reading hard. Separate in two paragraphs: one for general description of the cores and another for describing dating methods. Consider including a table with the main metadata of the ice cores (date of collection, length, age range, dating methods and reference).

Line 155. Insert: “equation 1”

Line 156. Start by mentioning the aim of this step: “In order to obtain an annually-dated timescle, five individuals. . .”.

Line 176. Figure 3, considering using full page width for this figure. The two panels could be combined (e.g.: Ginot et al 2006, fig 3). To facilitate inter-comparison, considering plotting the original series shaded in the background and moving averages in the foreground.

Line 203. Again this paragraph is crowded with data. Add horizontal resolution and source to Table 1 and focus on the comparative aspects of the different elevation datasets.

Line 223. The method used to identify the glacier ELA is rather sui generis. The snowline separates the entire accumulation zone from the entire ablation zone. This is a very large glacier and although the snowline of the trunk glacier (as used in Fig 6) might be representative of the whole glacier, this is not proven. I suggest using, for the selected images, a standard method (thresholded band ratio or NDSI) to obtain the snow covered area of the entire glacier and use the average lower boundary (i.e.: Kargel et al 2014 section 4.3.3.5 and 4.3.3.9, Rabatel and others, 2012).

Line 295. Figure 4. Consider using lines for multiple bar plots. Bar plots are adequate to represent accumulation but when one or two detailed series are plotted together comparison is tricky. In particular, to identify lines intersections were the different records inter-consistency changes. Consider using the yearly average (black continuous and dashed lines). This would allow analyzing differences in accumulation rates during the different buildup phases. Do not repeat in the caption information given in the graph reference.

Line 321. The interpretetaion of the reservoir are could be supported by additional evidence if the volume loss of the reservoir area and the volume gain of the receiving are were calculated and found to be similar within error bars. I suggest including this calculation in this section.

Line 322-326. This lines should be moved to methods (were part of this is already explained).

Line 343. The snowline for the entire glacier should be calculated and discussed, especially if the AAR is to be considered. See comment in line 223.

Line 346. In climatology it is customary to present decadal rates. Check manuscript for consistency.

Line 354. This figure is a little too busy. Fig 6b some elevation data would be welcome to illustrate the elevation change range of the ELA. Consider including the colomap, hillshaded relief in this figure. The full set of snowlines is of little use other than showing the detailed work (maybe put it in SM). Instead, consider showing a limited number full glacier AAR in a set of panels to show variability. The full time series is already shown in Fig 7a. Figure 6a, topographic information of the entire glacier should be included in an enlarged version of Fig 1 as contours and point elevation values rather than as an insert here.

Line 361. Fig 7 consider including the fit (r^2) of the linear regressions. Inter-annual precipitation variability is usually not adequately represented by linear trends. Linear trends are also highly sensitive to first and last year of the records, this effect can be quite strong in discontinuous datasets such as the snowline (Fig. 7 a). It short it might not be the most adequate parameter to find a trend in such variables. Fig 7b. Temperature should be expressed as anomalies so the bias of the different records is removed and they can be more easily compared. Figure 7c and d, consider including a running average with a 10-12 window that could highlight the variability at the surge-cycle scale.

Line 378. Figure 8. Provide a caption of the location of the transects here rather than in Fig 1. It is great to see some direct field measurements of glacier thickness and bed topography, yet the relevance depends on the accurate definition of the reservoir area (see Specific comments).

Line 382. Consider the tittle “Temperature and precipitation trends”, patterns would be more adequate for analysys of the geographic distribution of the variables

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Line 395. This is a bit simplistic since ELA depends on both temperature and precipitation.

Line 402. Verify if the unit is m.e. instead of m^2.

Line 405. After enlarging consider including 5 yr markes on the x axis of Fig 7.

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