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The Cryosphere Discussions

Interactive comment on "Brief Communication: Twelve-year cyclic surging episode at Donjek Glacier in Yukon, Canada" *by* T. Abe et al.

Anonymous Referee #1

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GENERAL COMMENTS This paper provides a summary of the recent changes in area and velocity of Donjek Glacier, with the main finding that the glacier has had a 12-year surge periodicity for its past 3 surges. This information is useful and interesting, but it does not provide the novel information that the authors claim it does. The main problem is that the authors provide poor referencing to previous studies, and miss out many important papers that describe previous surges of this glacier and others nearby. If the results from this previous work are properly incorporated into this study, then the authors could reconstruct the past 6 surges of Donjek Glacier and therefore make much more useful comments about the surge periodicity of this glacier and whether it has been changing over time. Better information is also needed about the potential impacts of differences in the acquisition time of Landsat imagery on the reported velocity

patterns (e.g., whether image pairs capture summer speed up events).

Finally, the English language needs to be improved as explanations are difficult to follow in places. I have made some suggestions below to improve the language, but the text needs to be thoroughly read and corrected by a native English speaker prior to publication.

SPECIFIC COMMENTS (by page and line #) P5944, L7: change 'narrows than upstream' to 'narrows upstream'

P5944, L10-16: the explanation of glacier surging needs to be more clearly described, and a distinction made 'Alaskan-type' and 'Svalbard-type' surges and their respective surge and quiescent periods

P5944, L17: change 'called as build-up' to 'called the build-up

P5944, L20-21: the statement that 'detailed observations of the repeating surge cycles have been extremely limited' isn't really correct. Although there aren't large numbers of such observations, there are several key papers in the study area that reconstruct surges up to the past 100 years for Variegated Glacier: Eisen et al. 2005. Variegated Glacier, Alaska, USA: a century of surges. Journal of Glaciology, 51, 399-406

. . .and up to the past 65 years for Lowell Glacier: Bevington and Copland. 2014. Characterisics of the last five surges of Lowell Glacier, Yukon, Canada, since 1948. Journal of Glaciology, 60, 113-123.

. . .and similar papers for other regions. These need to be properly reviewed and assessed in the introduction.

P5945, L2: change 'allowed' to 'allows'

P5945, L9-10: I would merge these two sentences, so that they read '. . .derive the spatial-temporal changes in both the velocity field and the terminus area of Donjek Glacier'.

P5945, L13: it would be useful to show the location of these other glaciers in the figure

P5945, L15: delete the sentence 'As shown in the result. . .' – this describes results, which should be kept in that section

P5945, L19: previous studies on these outburst floods should be referenced here, such as: Clarke and Matthews. 1981. Estimates of the magnitude of glacier outburst floods from Lake Donjek, Yukon Territory, Canada. Canadian Journal of Earth Sciences, 18(9): 1452-1463.

P5945, L20: key references that describe previous surges of Donjek Glacier (in 1935, 1961 and 1969) are missing here, such as: Johnson. 1972. The morphological effects of surges of the Donjek Glacier, St. Elias Mountains, Yukon Territory, Canada. Journal of Glaciology, 11, 227-234 Johnson. 1970. Ice Cored Moraine Formation and Degradation, Donjek Glacier, Yukon Territory, Canada. Geografiska Annaler, 53, 198

. . .these previous surges, together with the 1978 surge described by Clarke and Holdsworth (2002) need to be properly described. Indeed, the incorporation of the known dates for these previous surges with the new findings from this paper can enable the reconstruction of surges of the Donjek Glacier back to at least the early 1960s. Doing this would significantly enhance the findings and conclusions of this paper, and enable more meaningful discussion of whether the surge periodicity has changed over time and how it compares to the frequency of other surge-type glaciers in this region.

P5946, L2-3: the wording needs to be corrected here: terminus fluctuations were examined from 1973 to 2014, but the flow speed evolution was only examined from 1986 to 2014

P5946, L12: no information is currently provided in the main text or supplementary material about the exact dates of the image pairs that were used for velocity derivations. However, this information is crucial to understand whether and how image pairs have been influenced by summer speed ups or winter slow-downs. For example, an

image pair from Jun-Aug in the same year would likely show higher velocities (when standardized to m/day) than an image pair from August one year to June the next year, irrespective of surge conditions. The dates for image acquisitions therefore need to be provided (e.g., in a Table in the supplementary material), and the potential effect of seasonal variability in velocities needs to be discussed.

P5947, L2-3: the wording here is unclear: it reads as if the 2, 4.5 and 3 m/day values relate to 'other years' (i.e., quiescent years), when they actually relate to surging years.

P5947, L8-10: I don't follow the explanation here of what a 'velocity front' is, and how it propagates downstream. Showing these patterns in a figure would be useful, and I would like to see explanation of this point expanded as it can provide useful insight into the propagation mechanism of the surges

P5947, L21-27: this paragraph is missing temporal resolution: please provide months, as well as years, for events. There are frequent repeat images available for the recent surges, so it should be possible to better define them than 'about 1 year'.

P5948, L1 (and elsewhere): secular is an unusual word to use here. Something like 'gradual' would be better

P5948, L3: it's a very broad, and somewhat inaccurate, statement to say that the negative trend is due to 'recent global warming'. It's more accurate to say that it's due to 'negative mass balance', and provide some references to studies from this region that indicate that.

P5948, L6-9: the connection between the surge cycle and 'wax and wane of the terminus area' needs to be better developed. This is a crucial point, as if you can clearly demonstrate that terminus area provides a proxy for surge activity, then it enables the timing of the late 1970s surge to be confirmed (as also suggested by Clarke and Holdsworth, 2002). This would enable the surge record to be extended further back in time.

P5948, L11: an important question is whether the velocity matching technique could actually capture velocity changes in the accumulation area due to a lack of surface features to track. For example, Bevington and Copland (2014) limited their velocity-matching measurements to the lower part of nearby Lowell Glacier for this reason. It therefore needs to be clarified as to whether the observed velocity variations over the lower 20 km of the glacier are simply due to better measurements there, or whether they really reflect glacier-wide changes.

P5948, L21: the recurrence interval is actually very similar to the recent surges of Lowell Glacier described by Bevington and Copland (2014), and not that different to some of the surge periods of Variegated Glacier described by Eisen et al. (2001, 2005).

P5948, L23-25: this is a key item that needs to be updated: as discussed above, previous literature indicates that surges of Donjek Glacier also occurred in 1961, 1969 and 1978. This information needs to be incorporated with the text here to provide a better long-term record of the surges of this glacier and their variability over time.

P5949, L3-7, L15: I would remove most of the detailed references to the surges of Medvezhiy Glacier. This is a glacier that is very far away from the study site and in a different climate regime, so I don't think that it makes a good comparison to Donjek Glacier. Instead, a comparison with detailed studies of the repeat surges of glaciers nearby to the Donjek (e.g., Bevington and Copland, 2014; Eisen et al., 2001, 2005) should be the focus here.

P5949, L7-9 & P5950, L11-21: if slope changes and changes in ice thickness are going to be invoked as a causal mechanism for surges, then they need to be properly described and evaluated. At the moment there is no evidence provided to back up any of the statements made here, so they are unconvincing.

P5951, L2-3: this last sentence doesn't really say anything. E.g., exactly kind of measurements should be made? Can they be made from space? Or are local field mea-

surements necessary?

P5951, L8: change 'grand' to 'grant'

Fig. 1a: need to provide image date in caption. 1b & 1c: The colour scales used in these two figures need to be the same, rather than plotting one as linear and one as logarithmic.

Fig. 2a: add numbers to the secondary y axis.

Fig. 3: provide exact image dates, rather than just years

Supplementary material P1, L17: the mean error is quoted in m/day, but this isn't very meaningful as the error will vary depending on the time between image acquisitions (greater time separation results in lower error in m/day). This effect therefore also needs to be discussed.

P2, L2: 'snapshot s' should be 'snapshots'

P2, L32 7 L34: reference here should be to Figs. 2a, 2c and 2e

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Interactive comment on The Cryosphere Discuss., 9, 5943, 2015.