The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC1
https://doi.org/10.5194/tc-2021-370-RC1, 2022

Comment on tc-2021-370

Anonymous Referee #1

Referee comment on "Three different glacier surges at a spot: what satellites observe and what not" by Frank Paul et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-370-RC1, 2022

This paper provides an interesting review of the contrasting behaviour of adjacent surge-type glaciers in the Karakoram, and in particular how a very slowly surging glacier (likely controlled by changes in basal thermal conditions) can exist next to rapidly advancing ones (likely controlled by changes in basal hydrological conditions). These changes are well documented and illustrated through changes in terminus position, surface elevation and ice velocity, both in the main paper and the extensive supplemental material. I haven't seen many comparisons of surging glaciers which contrast in their behaviour over such a short distance before, so this provides the primary novel contribution of this study. However, the current title doesn't well describe this: from the title I expected the paper to provide a methodological assessment of the pros and cons of different remote sensing methods for detecting glacier surges (and how some methods might 'miss' features due to low spatial or temporal resolution), but the paper doesn't really do this; the main finding is that most methods actually work pretty well for detecting surges and their associated velocity and elevation changes. So I recommend that the title be changed to something that better describes the actual content of the paper, which if we rearrange the wording from the first sentence of the Conclusions (L833-835) could be something like: 'Contrasting characteristics and forcing mechanisms of three glacier surges in the central Karakoram'. Rearrangement of a few sentences or sections in the main text to better reflect this focus could help.

My specific comments are below. The biggest one is that the Discussion and Conclusions would benefit from better referencing to previous work.

Detailed comments

L27/28: provide some more information about the 'full suite of satellite sensors' and 'DEMs from different sources' that you used – e.g., names of sensors, resolution, repeat coverage period. This is one of the most useful things that I would like to know when reading the abstract, more so than some of the other background information currently provided.

L43: fit neatly with what? Clarify

L52: change 'provides' to 'provide'

L72-75: it might be useful to add reference to Hewitt (2005) here, which provides some discussion of the different potential causes of Karakoram surges, particularly in relation to changes in basal thermal regime: Hewitt, K. 2005. The Karakoram Anomaly? Glacier Expansion and the 'Elevation Effect,' Karakoram Himalaya. *Mountain Research and Development*, 25(4), 332-340.

L107: I think that you mean 35.94N, not 5.94N!

L163: seems to be missing 'with' before 'the Landsat 7…'

L173: I don't really understand what 'virtual' refers to here. Either needs more explanation, or stating something like 'we digitized likely maximum extents' would seem to be clearer.

L177: What does 'spatially consistent' refer to? E.g., orthorectified?

L168-201: For readers who may be unfamiliar with the satellite sensors used, please make it clear as to which are optical and which are SAR. Also provide the resolution for the optical scenes (you currently only mention this for SAR).

L188: please state whether you selected different image types from particular times of the year. E.g., was SAR data preferentially acquired in the winter? Was optical data preferentially collected under summer snow-free conditions?

L207: the SPOT5 DEM is stated as being from January 2010 here, but the date is listed as 31 Oct 2010 in Table 2

L216: Hugonnet et al. (2021) list their datasets as being from 2000-2004 and 2005-2009

L244: state why a two-pixel change is important. Related to the above comment, the resolution of the image sources is also needed to understand what two pixel relates to in real world distance for different image types.

L260: when you mention the offset-tracking here, are you referring to the TSX data? Please clarify

L295: These dates are difficult to decipher. Do you mean '4 Nov. and 16 Nov., 2020'? If so, then write out the dates like this.

L310-312: this statement requires better justification for ignoring microwave penetration in the SRTM DEM. Gardelle et al. (2012) state that it averages 3 m in the Karakoram, so this should be compared to the elevation changes caused by the surges.

L363: since you have information concerning the retreat rates of South Chongtar and NN9 prior to their recent surges (e.g., from Fig. S7), then I wonder if it would be useful to plot these on Fig. 4a? Seeing their rate of retreat would be useful to compare to their rate of advance, and help to support the retreat patterns that you describe later in this section.

L557: I'm unclear as to what 'compensation effects' is referring to here

L579: probably useful to remind the reader here and earlier in this section as to which sensors are optical (Landsat, Planet, Sentinel 2), and which are SAR (TSX, Sentinel 1).

L596: I'm unclear as to the date of the HMA 2015 DEM as the label at the top of Fig. S12 specifies 'spring 2015', but Table 2 indicates Feb.-Aug. 2015. Please clarify.

L661: provide ref(s) to support the statement that these are likely the highest and lowest surge velocities in the Karakoram

L674: clarify as to exactly what characteristics you're referring to when you say that these glaciers 'developed nearly all characteristics of a surge'

L697: can you refer to any modelled mass balance data from this region to indicate whether positive mass balance conditions have occurred there recently? That could help to support or refute your statements about potential causes of the observed glacier changes.

L659-740: overall this section could do with better referencing to existing literature. For example, you refer several times to the characteristics of hydrologically controlled vs. thermally controlled surges, but don't refer to the previous literature which describes this (both for the Karakoram and elsewhere) and the evidence for the different types of flow patterns and lengths of active and quiescent phases. There are many 'classic' papers which can be useful here, such as Sevestre and Benn (2015), Murray et al. (2003), Benn et al. (2019; https://doi.org/10.1017/jog.2019.62), and Kamb et al. (1985; https://doi.org/10.1126/science.227.4686.469).

L748: it's confusing to have the (3) in brackets here; just write out the sentence to describe Sentinel-2 and Planet separately

L755: change 'relative' to 'relatively'

L758: change 'reliable' to 'reliably'

L765 & L810: a major difference between the sensors that you haven't mentioned is that some are optical and some are SAR, so it would be useful to discuss whether this has any impact on the measured velocities and how suitable different scene pairs are for deriving them. E.g., effect of snow cover, effect of surface melt, SAR layover/foreshortening effects, SAR penetration, optical shadows?

L793: change word order to 'not yet'

L831-880: similar to my comment above for L659-740, the Conclusions would benefit from better referencing to previous studies so that it's clear how your findings compare to those of others. At the moment you don't have a single reference in this section!

L875: would be more accurate to say: '…*the termini of* South Chongtar and NN9 are now colliding"

Tables and Figures

Table 3: Add reference to Fig. S5 in the caption so that it's clear as to which areas were used for the volume calculations

Fig. 1: I would like to see distance markers along the centrelines, so that it's easier to understand how the distances shown in other figures (e.g., Figs. 6, 7) relate to physical locations along the glaciers

Fig. 2: It would be useful to split the lines into two groupings: those that rely on DEMs (upper), and those that rely on optical or SAR images (bottom), such as by adding a blank line between them and changing the 'Sensors' label on the y-axis to something more descriptive. This is because some of the DEM sources (e.g., ASTER, SPOT) can also provide optical images, but you don't use images of that type in this study.

Fig. 4: increase the font size for the legend

Figs. 5, 8, 11: the velocities would be easier to see if you cropped out the data to only show it over glaciers, and not over bedrock

Fig. 6: I find it hard to understand the dates of some of these velocity profiles as the colours are pretty similar in the legend (the Landsats are all a pretty similar blue, the more recent S2s all a similar red). Can you use a better colour scale to help separate them, or perhaps used dashed lines for some periods?

Fig. 9: Add a reference to Fig. 1 in the caption to indicate where the cross-profile is located. Also misspelling of 'Grey **n**umbers…'

Supplemental

L12: Sentine-2 is misspelled

Table S1: please use the format yyyy/mm/dd for the dates so that they’re consistent with Table 2. Also use the same font size throughout.

Fig. S2 and others: state in the caption as to what coordinate system is used for these plots (e.g., UTM 34N?)