This document includes the authors's comments *(italic font)* to the review (normal font) RC2 of Anonymous Referee #2, from 2 July 2020. Planned changes in the revised document are mentioned in […].

Review of "Insights in a remote cryosphere: A multi method approach to assess permafrost occurrence at the Qugaqie basin, western Nyainqêntanglha Range, Tibetan Plateau" by Johannes Buckel et al..
In this interesting work, the authors combined three distinct methods: (i) geomorphological mapping to identify periglacial landforms, (ii) geophysical (ERT) survey to evaluate the presence of ice, and (iii) satellite Synthetic Aperture Radar Interferometry to investigate surface displacements of periglacial landforms that can be used as a proxy of ice occurrence. These methods were applied in the remote Qugaqie basin in Tibet. Despite the logistical problems due to high altitude and extreme climatic conditions, field campaigns were conducted in this area for ERT survey. This study increases the knowledge of poorly studied periglacial geomorphology in Tibet, including the permafrost occurrence within a basin where no borehole measurements are available.

Here some general comments about the manuscript, followed by some detailed comments. A careful proofread is needed.

General comments.
The study area and the three methods used in this work are well described in their respective sections. However, further information on the approaches and criteria used to outline the identified landforms should be added, including some examples with their associated uncertainties.
Figure 9 will be extended by a new part (A). This part shows a Landsat image and indicates quite well the outlines (represented in very thin lines) of the periglacial landforms. So the reader has the opportunity to see the landform and the associated outline to check the mapping accuracy. The outlines base only on the mapping procedure described in section 3.1, not on InSAR-data. This section will be extended by more information on the used optical images (same issue mentioned by Referee#1).

About the method that describes the Synthetic Aperture Radar Interferometry, different geometries (i.e. ascending and descending) are used. However, the Authors should explain how they used these different geometries (combination of both, choosing the most appropriate, etc.).
L250 will be changed to: [Both ascending (satellite travelling south to north) and descending (satellite travelling north to south) acquisitions are therefore sensitive to vertical surface displacement and towards the East or West respectively but very insensitive to displacement towards the North or South. We always select the geometry with the highest sensitivity towards the expected displacement direction to calculate our displacement and velocity results. To that end we calculate a sensitivity coefficient for each pixel which is explained in the following.]
The following will be added to L262: [If both ascending and descending velocity LOS data is available for the same pixel, then we use only the geometry with the higher sensitivity coefficient, i.e. better sensitivity, to calculate the downslope velocity and ignore the other geometry to keep the precision of the projection as high as possible.]

In the results section, velocity values are showed in the text, tables and figures. However, disagreements are apparently visible, probably due to the different "observation periods" in which the velocities were computed (e.g. velocity computed in annual periods vs velocity computed in summer periods?) not specified in the text. The Authors should clarify how the velocity are computed and in which observation periods, in order to avoid misunderstandings.
These disagreements will be corrected in tables and the text. They did not describe different observation periods (all velocity values in the manuscript refer to the entire observation period of 2015 - 2018) but described different parts

of the landforms. We made changes to the tables and text to describe the same parts of the landforms in both. We also added the observation period to a number of figure captions and paragraphs in the text to make it easier for the reader to follow. More detailed information regarding the changes we made can be found under the specific comments (L376 (table 3) + L365) made by the reviewer detailed comment section .

Furthermore, measurements are often shown with different units, but the same unit should be used (mm/yr and mm or cm/yr and cm).
This will be checked and all units will be adapted.

In the discussions there is not a paragraph or section that discusses the mapping of landforms. The same landform can be outlined following different approaches. As suggested by Brardinoni et al. 2019 (https://doi.org/10.1002/esp.4674) the uncertainty on mapping rock glacier is very high. IPA Action Group is now working on baseline concepts and practical guidelines to produce uniform rock glacier inventories (https://www3.unifr.ch/geo/geomorphology/en/research/ipa-action-group-rock-glacier/).

We follow the geomorphological approach and mapped the extended geomorphological footprint, according baseline concepts. Following the suggestions of reviewer No. 1 and No. 2, we will add more details on the mapping procedure in the Methods section. The outlining of landforms can be subjective, as shown by Brardinoni et al. 2019. However, in our case we are not aiming at quantitative estimates, such as the total area, but only in the existence of certain landforms, to produce an inventory of altitude-zonal localization and to assess the probable occurrence of permafrost.
We will add a brief discussion of this aspect in the discussion section.

Detailed comments
L 56: unclear sentence.
Will be changed.

L 78: this sentence seems to be a "general research question". As you already mention, Barsch, 1996; Schrott, 1996, Scapozza, 2015 say this. Specify that this sentence is related to TB landforms.
We assume that the reviewer means "landforms on the Tibetan Plateau". Because almost no literature was found about ice content of periglacial landforms at the Tibetan Plateau, we ask this general question. We will add a sentence in L 74:[Especially on the TP only less literature (Fort and van Vliet-Lanoe, 2007; Wang and French, 1995) is available that describes periglacial landforms and permafrost occurrence. However, this periglacial indicators are essential creating large-scale permafrost distribution maps (e.g. Schmid et al., 2015).

L 97: specify what the ISM acronym is (now it is in the L 106).L 114, Figure 1A: wind systems are not visible in the figure A. Add the position of Nyainqêntanglha in figure A.
Will be changed.

L 152 – 154: unclear sentence.
Will be changed: [So, permafrost occurrence is indicated by activity of landforms and the corresponding surface structures like bulges, furrows, ridges or lobes]

L 168: here you say "excluding glacially-conditioned environments", but in the following parts you mapped also glaciers. Be clearer.
"excluding glacially-conditioned environments" will be deleted. The headline of 3.1 will changed to "Inventory of meso-scaled landforms", which includes streams, glaciers, rockglaciers and so on.

L 171: the meaning of "manually" is unclear (after the field campaign?). Be clearer.
“Manually mapped information” will be changed to “field-mapped landforms”

L 173: add the parameters used to derive the hillshade (azimuth and inclination of light source).
Will be changed.

L 175: IPA Action Group is working on Baselines and Practical Guidelines for mapping rock glaciers.
Will be changed: [We follow the geomorphological mapping approach based on the baseline concepts (V 4.0) of the IPA Action Group “Rock glacier inventories and kinematics” and mapped the extended geomorphological footprint of the rockglaciers.]

L 176: unclear sentence.
Will be deleted.

L 181: Location of the photos at Figure 6 and 9.
Will be added.

L 236: specify that displacements higher than half of the SAR wavelength are undetectable (e.g. rockfall) and coherence also decreases.
We will add: [Coherence also decreases with increasing displacement and displacements larger than half the SAR wavelength (~2.8 cm for Sentinel-1) cannot be determined accurately.]

L 237: How do you choose the threshold of 0.3? Motivate your choice.
We will add the following sentence to L 238: [This threshold is similar to the one chosen by Sowter et al. (2013) and provides good spatial data coverage while also excluding unreliable data.]

L 254: Describe how you used the ascending and descending dataset (do you combine them? Or do you select one depending on the landform orientation?).
This issue concerns to a previous comment of the reviewer. Accordung to that we will change L250 to: [Both ascending (satellite travelling south to north) and descending (satellite travelling north to south) acquisitions are therefore sensitive to vertical surface displacement and towards the East or West respectively but very insensitive to displacement towards the North or South. We always select the geometry with the highest sensitivity towards the expected displacement direction to calculate our displacement and velocity results. To that end we calculate a sensitivity coefficient for each pixel which is explained in the following.]
The following will be added to L262: [If both ascending and descending velocity LOS data is available for the same pixel, then we use only the geometry with the higher sensitivity coefficient, i.e. better sensitivity, to calculate the creeping rate and ignore the other geometry to keep the precision of the projection as high as possible.]

L 262: coefficient lower than 0.2 is possible, but it is not used in order to avoid an excessive amplification of displacements and associated errors (from Notti et al. 2014).
We will change L 262 to: [The coefficient can vary between 0 for areas where the satellite’s sensitivity is low to 1 where the sensitivity is very high. Values below 0.2 are not used to avoid excessive amplification of displacements and associated errors.]

L 274: a table containing the parameters used during the processing (or the reference) can be useful here.
We will add the following table:[Table 1:Summary of ISBAS processing parameters.]

Geometry	***Observation period***	***Acquisitions***	***Interferograms***	***Temporal baseline***	***Coherence threshold***
ascending	*2015-06-05 to*	*74*	*278*	*12 to 72*	*0.3*

	2018-12-22			*days*	
descending	*2015-11-15 to 2018-12-29*	*63*	*257*	*12 to 96 days*	*0.3*

L 277: provide the locations and outlines of these stable areas (e.g. in figure 6 or 9).
Will be added to Figure 9.

L278 will be changed to: [Reference points are located on bedrock whenever possible and on ridges or moraines with good coherence if no coherent bedrock was available.]

L 300, figure 6: Inside the figure 6 replace Figure 10 with 9.
Will be changed

L 312: talus slope and protalus rampart also provide sediments in the rooting zone of rock glaciers (visible in figure 6).
Will be changed: [Moraine deposits, talus slopes and protalus ramparts provide…]

L 346, figure 8: use the “k ohm m” unit in the figure 8 (as in the text). Add the cartesian coordinates on each profile (e.g. West and East for A A').
Will be changed

L 365: specify how you compute the mean velocity of the landforms, not only in the caption of table 3 (do you selected some points inside the landforms? Or do you use all the points inside the delineated landforms?), and add the observation periods (e.g. velocity computed in annual periods or velocity computed summer periods?).
To specify this issue we will change L252 to: [Mean velocities were calculated by dividing the cumulative displacement observed during the observation period by the length of the observation period (2015-2018). All surface velocity data of periglacial landforms have been projected along the direction of the steepest slope under the assumption that the motion of the described landforms is mainly gravity-driven. Hereafter we will refer to the mean surface velocity of periglacial landforms projected along the steepest slope as “creeping rates” to reflect this assumption.]

L366 will be changed to: [Mean creeping rates during the entire observation period (2015-2018) for all data points within the landforms are higher on rockglaciers (26.8 mm/yr) than protalus ramparts (12.7 mm/yr).]

In general, we write creepings rates if we mean displacement in slope direction. This will be added in the Chapter 3.3, too

L 371: use always the same units in the text (mm/yr and mm or cm/yr and cm).
Will be changed

L 376, table 3:
- the computation of "downslope velocity precision" is not clear.
- the "interpolated time periods" is not defined.
- there are apparent disagreements between this table and the text below. For example, from this table the maximum downslope velocity expected for rock glacier is 47.2 mm/yr (26.8±20.4), but velocities up to 153 mm/yr are visible in figure 9 and 10. This is probably due to different points

investigated or different “observation periods” where the mean velocities were computed (e.g. annual periods vs summer periods?). please specify how these values are obtained.
Table 3 displays the mean downslope velocity and the standard deviation, while the values shown in figures 9 and 10 represent the range of the downslope velocity. We will add a column in Table 3 describing the range of rockglaciers and protalus ramparts to make this clear. We will add the following to the caption of Table 3: [Creeping rate precision is calculated by dividing the LOS precision of 2.4 mm/yr by the sensitivity coefficient. The percentage of interpolated time periods describes how many interferograms are incoherent and therefore require interpolation with the ISBAS algorithm.]

L 386, Figure 9: Specify if the "creeping rates" are along LOS or slope direction. Indicate the observation period of the velocities showed in the figure.
The creeping rates are along the slope direction and the observation period is from 2015 – 2018. This will be added in the figure caption.

L 390: these values (“from 10 mm/yr to 80 mm/yr”) are apparently in disagreement with those in table 3 (the mean downslope velocity is 12.7±9.2 mm/yr). Explain why (different observation periods?).

The values used in the text describe only a part of the data points, while the values in the table describe all data points on the respective landforms. This should have been mentioned in the text. As this is confusing to the reader and unnecessary, we decided to use the same values in the table and the text. In L366 we mention the mean velocities of the landforms. It should therefore not be necessary to mention them again in L386. L386 will therefore be changed to: [The creeping rate of protalus ramparts is lower and shows more pronounced seasonal variations than that of rockglaciers.]

L 397 – 398: this sentence is not supported by results and data. Time series of temperature and precipitation are not shown. Provide data (or references) to support, or remove this sentence.
We will remove the sentence

L 401, figure 10: indicate the observation periods of the velocities showed in the maps B and C.
The figure caption will be adapted. Observation periods were mentioned for Map A, B and C.

L 433: specifies whether the layer refers to the ice layer.
It refers to the active layer thickness. “active” will be added

L 466 – 469: rephrase these two sentences (it is not clear that these two sentences are not related to your work).
These lines will be changed: [Using rockglaciers and their long-term ice content as indicators for permafrost occurrence must be critically evaluated because rockglaciers can overcome long distances and the terminus is far away from the routing zone (Bolch and Gorbunov, 2014; Halla et al., 2020)]

L 483: Sentinel 1 is not a high-resolution satellite.
We will delete “high–resolution”.