

The Cryosphere Discuss., referee comment RC2  
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## **Comment on tc-2022-36**

Nina Nesterova (Referee)

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Referee comment on "Accelerated mobilization of organic carbon from retrogressive thaw slumps on the northern Taymyr Peninsula" by Philipp Bernhard et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2022-36-RC2>, 2022

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### **General comments**

The manuscript by Berhhard et al. is dedicated to the study of retrogressive thaw slump activity in recent years in the Northern Taymyr Peninsula. By using SAR TanDEM-X data, the authors identified the volume change and estimated the RTS-related organic carbon release. This work brings new insights and data for the Northern Taymyr region and thus is of great importance to scientific knowledge. The manuscript is well-structured, and easy to read and navigate. The main research questions are clearly defined, and the results are well described. The manuscript is well suited for publication after several minor corrections. The manuscript will benefit from:

- Clarifying of RTS terminology used
- Including regional field knowledge and data
- Adding several issues to the discussion

### **Specific comments**

#### **Introduction**

*Lines 36-41:*

Please, define the term RTS in your study more specifically. What do you include when saying RTS?

For example, H. Lantuit and W. H. Pollard, 2005, draw a scheme where characteristics of RTS include the presence of a headwall, slump floor, mudlobe etc. So, I'd suggest a bit more of description and mechanisms behind RTS occurrence.

In the line 39 you state "On 40 a pan-Arctic scale, RTSs have a large variation in size, ranging from small active-layer detachments to large mega slumps with headwalls heights of up to 40m (Kokelj et al., 2015; Murton et al., 2017)."

Active layer detachment slides and RTS in some publications are considered to be of different types.

Please, check: Active Layer Detachment Slides and Retrogressive Thaw Slumps Susceptibility Mapping for Current and Future Permafrost Distribution, Yukon Alaska Highway Corridor Andre Ì□e Blais-Stevens, Marian Kremer, Philip P. Bonnaventure, Sharon L. Smith, Panya Lipovsky and Antoni G. Lewkowicz.

However, if you merge all genetically different types of cryogenic landslides in one term "RTS" in this study, then just, please, state it clearly in terminology definition.

Please, check: Leibman, M., Khomutov, A., & Kizyakov, A. (2014). Cryogenic landslides in the Arctic plains of Russia: Classification, mechanisms, and landforms. In *Landslide Science for a Safer Geoenvironment* (pp. 493-497). Springer, Cham.

*Line 61:* "In this work our goal is to map and investigate RTSs on the northern Taymyr Peninsula, a region that is known to be susceptible to thaw slumping." – please, add the reference.

As you have stated in line 36 the RTS occurrence is linked to the ground ice thawing. In my opinion it is important to mention what kind of ground ice was found in Taymyr that can be "responsible" for RTS occurrence (this will perfectly explain thaw slumping susceptibility).

Massive ground ice thawing was reported to lead to RTS occurrence in the Kara sea region (Belova, 2020; <https://www.poac.com/Proceedings/2021/POAC21-005.pdf>). The presence of massive ground ice in the Northern Taymyr was mentioned in Massive ground ice database.

Please, have a look at: Streletsкая, I.D., Ukraintseva, N.G. & Drozdov, I.D., 2001. Massive ground ice database. [Online] Available at: <http://www.geogr.msu.ru/cafedra/crio/Tabular/>

Locations of massive ground ice in the Northern Taymyr: <http://www.geogr.msu.ru/cafedra/crio/Tabular/Data/Regions/TAYMIR%20PENISULA%20AND%20LAPTEV%20SEA%20COAST.htm>

Moreover, field observations stated in the Geocryology of the USSR, 1989\* declare the presence of massive ground ice in Taymyr reaching up to 3 m of thickness as well as the occurrence of ice wedges up to 6 m of depth.

\*- Yershov, E.D. (ed.). 1989. Geocryology of the USSR. Central Siberia. Moscow: Nedra, 414 pp. (in Russian). Open access, in Russian: [https://www.studmed.ru/ershov-e-d-red-geokriologiya-sssr-srednyaya-sibir\\_2217c861271.html](https://www.studmed.ru/ershov-e-d-red-geokriologiya-sssr-srednyaya-sibir_2217c861271.html)

## **Study area**

*Line 86:* "During winter the region experiences monthly mean temperatures below -30° C (Matveyeva, 1994)." – this is a bit outdated due to climate warming (also: "air" is missed in the sentence).

For example, mean air temperature from the meteorological station at the Cape Chelyuskin for the coldest winter months of December, January and February was -24° for 2010/2011 and -22° for 2020/2021.

Thus, I'd suggest the following:

- Please, define the exact months you were working with since "the winter" in the Siberian Arctic starts in ~October and lasts till ~May. It would be great if months will be added at Fig.2 as well.
- Create a graph with monthly mean air temperature for the months that were considered in the research.

I am pretty sure that recent in-situ air temperature data will update and enhance current study area description a lot.

You can look at the archived meteorological data freely available for your area at the:

meteorological station at the Cape Chelyuskin (77° 43' N., 104° 18' E) [https://rp5.ru/%D0%90%D1%80%D1%85%D0%B8%D0%B2\\_%D0%BF%D0%BE%D0%B3%D0%BE%D0%B4%D1%8B\\_%D0%BD%D0%B0\\_%D0%BC%D1%8B%D1%81%D0%B5\\_%D0%A7%D0%B5%D0%BB%D1%8E%D1%81%D0%BA%D0%B8%D0%BD](https://rp5.ru/%D0%90%D1%80%D1%85%D0%B8%D0%B2_%D0%BF%D0%BE%D0%B3%D0%BE%D0%B4%D1%8B_%D0%BD%D0%B0_%D0%BC%D1%8B%D1%81%D0%B5_%D0%A7%D0%B5%D0%BB%D1%8E%D1%81%D0%BA%D0%B8%D0%BD)

It is in Russian, but built-in browser translator should help, otherwise I can help.

Meteorological station at the Sterlegov Cape (75° 24' N, 88° 47' E)

[https://rp5.ru/%D0%90%D1%80%D1%85%D0%B8%D0%B2\\_%D0%BF%D0%BE%D0%B3%D0%BE%D0%B4%D1%8B\\_%D0%BD%D0%B0\\_%D0%BC%D1%8B%D1%81%D0%B5\\_%D0%A1%D1%82%D0%B5%D1%80%D0%BB%D0%B5%D0%B3%D0%BE%D0%B2%D0%B0](https://rp5.ru/%D0%90%D1%80%D1%85%D0%B8%D0%B2_%D0%BF%D0%BE%D0%B3%D0%BE%D0%B4%D1%8B_%D0%BD%D0%B0_%D0%BC%D1%8B%D1%81%D0%B5_%D0%A1%D1%82%D0%B5%D1%80%D0%BB%D0%B5%D0%B3%D0%BE%D0%B2%D0%B0)

*Line 93:* "During the Middle and Late Weichselian (MIS 4 to 2) the ice retreated step-wise and also temporary re-advanced leading to several ice-marginal zones (NTZ) north of the Byrranga Mountains with associated features of glacial, glaciofluvial and glaciolacustrine deposits including buried glacial ice."

This is one of the geological concept stating the presence of the deposits only of the glacial genesis. Meanwhile in the Geocryology of the USSR (page 142, in Russian) it is stated that there are not only glacial but also marine deposits on the Taymyr peninsula.

The following are the sheets of the state geological (quaternary) map for the Northern Taymyr peninsula, where marine deposits also take place. Blue «m» index stands for marine deposits:

State geological map. Scale 1: 1,000,000 (third generation). Taimyr-Severnaya Zemlya series. Sheet S-47 (Taymyr Peninsula), 2015. Map of Quaternary formations. VSEGEI: St. Petersburg.

[https://webftp.vsegei.ru/GGK1000/S-47/S-47\\_KQO\\_1.pdf](https://webftp.vsegei.ru/GGK1000/S-47/S-47_KQO_1.pdf)

State geological map. Scale 1: 1,000,000 (third generation). Taimyr-Severnaya Zemlya

series. Sheet T-45-48 (Taymyr Peninsula), 2013. Map of Quaternary formations. VSEGEI: St. Petersburg.

[https://webftp.vsegei.ru/GGK1000/T-45-48/T-45-48\\_KQO\\_1.pdf](https://webftp.vsegei.ru/GGK1000/T-45-48/T-45-48_KQO_1.pdf)

State geological map. Scale 1: 1,000,000 (third generation). Taimyr-Severnaya Zemlya series. Sheet S-46 (Taymyr Peninsula), 2016. Map of Quaternary formations. VSEGEI: St. Petersburg.

[https://webftp.vsegei.ru/GGK1000/S-46/S-46\\_KQO.pdf](https://webftp.vsegei.ru/GGK1000/S-46/S-46_KQO.pdf)

So, please mention this point of view as well.

## **Methods**

*Line 121:* "In the manual inspection of the detection location, as well as in the delineation of the affected area, we additionally used time-series of Sentinel-2 and Planet Rapid-Eye images (Drusch et al., 2012; Planet-Team, 2018). For each RTS we computed the volumetric and area change based on the drawn polygons."

*Regarding the manual identification:*

How is the manual identification verified? Unfortunately, in the error calculations no human error of manual identification was implied. For example, in the study of Lewkowicz and Way, 2019, where manual identification also took place, the authors applied 5 iterations to examine the data. If any kind of such verification is not possible to perform now, then, please, at least mention the possible human error in the Discussion.

*Regarding the manual delineation of the affected area:*

When looking at your data it is noticeable that some of the polygons are located very close to each other, thus can represent not two separate RTSs (as stated in the manuscript) but two active parts of one RTS. I have compared the polygons 1075 and 1074 that are identified for TP2, in particular between 01.2018 and 01.2021. According to the satellite image available at the Planet for the September 2020 these two polygons lie within one RTS. Thus, it is incorrect to calculate them as two different. I can assume there could be

more of such errors in the data because I've randomly checked only few polygons. Please, check the data for such cases and elaborate this point in your discussion as another human error option.

*Line 178:* "Additionally to the SOC, the massive ice content needs to be known. Here the data availability is even more scarce and uncertain than for the SOC content."

Ice content for Taymyr is more or less covered in the Geocryology of USSR by Yershov, 1989 (pages 145, 146, in Russian): it ranges from 30% to 70%, which is nicely in line with your initial assumptions, that is worthy to mention.

## **Results**

*Line 298:* "during 2020 related to a Siberian heatwave (Overland and Wang, 2021)"

Please, move this reference to the first mention of "Siberian heatwave" - somewhere to section 3.5

## **Discussion**

*Line 314:* "This study is the first that identified such an initiation event also for RTSs in the north-Siberian Arctic."

This is not correct. Field observations by Khomutov et al., 2017 demonstrated the activation of different cryogenic landslides and thermocirques (RTS) initiation in Yamal linked to the extremely warm summer in 2012. Please, correct accordingly: Khomutov, A., Leibman, M., Dvornikov, Y., Gubarkov, A., Mullanurov, D., & Khairullin, R. (2017, May). Activation of cryogenic earth flows and formation of thermocirques on central Yamal as a result of climate fluctuations. In Workshop on World Landslide Forum (pp. 209-216). Springer, Cham.

## **Technical corrections**

Abstract Line 3: "carbon mobilization on the Taymyr Peninsula" -> "carbon mobilization on the Northern Taymyr Peninsula"

Comment: to be consistent it is better to use the capital letter "N" in "the Northern Taymyr" everywhere. Since the study was for the northern part of the peninsula, thus it should be stated as "Northern" everywhere related to the study area.

*Line 61:* northern Taymyr -> Northern Taymyr.

*Line 77:* northern Taymyr -> Northern Taymyr.

Figure 1 caption: northern Taymyr Peninsula -> Northern Taymyr Peninsula.

Figure 1 caption: northern Taymyr Ice-Marginal Zones (NTZ 1-3) -> Northern Taymyr Ice-Marginal Zones (NTZ 1-3).

*Line 93:* Please, add the definition of "NTZ" acronym in the text as well. Now it is described only in the figure caption.

*Line 132:* Please, define elevation error sign.

*Line 193:* Please, add the definition of "resp." abbreviation.

*Line 226:* northern Taymyr Peninsula -> Northern Taymyr Peninsula.

*Line 235:* Taymyr Ice-Marginal Zone -> Northern Taymyr Ice-Marginal Zone

*Line 247:* You probably meant colon ":" not a semicolon ";", right? Otherwise, it seems to be a bit complicated to read.

Fig.7 caption: show -> showS; are -> area.

Fig. 8 caption: the description for "b)" is missing.

Heading of the section 5.1 "Acceleration of RTS activity on the Taymyr Peninsula" -> "Acceleration of RTS activity on the Northern Taymyr Peninsula"

Heading of the section 5.3 "Acceleration of RTS activity on the Taymyr Peninsula" -> "Acceleration of RTS activity on the northern Taymyr Peninsula"

The caption of Fig. 11: The marker location correspond to -> corresponds to.

*Line 382:* "carbon on the Taymyr Peninsula " -> "carbon on the northern Taymyr Peninsula"

**Thank you for the new knowledge of permafrost thaw in Russian Arctic you brought to the scientific community with this great work!**

Please also note the supplement to this comment:

<https://tc.copernicus.org/preprints/tc-2022-36/tc-2022-36-RC2-supplement.pdf>