Dear Editor,

Thank you very much for providing us the opportunity to address the reviewers' comments on our paper. We have thoroughly revised the manuscript according to these comments and suggestions. Enclosed please find the revised manuscript and the responses to the referees, including a list of changes.

We hope that these revisions have improved our manuscript to make it suitable for publication in the *Earth System Science Data*. If you have any questions or concerns about this paper, please don't hesitate to let me know. We look forward to hearing from you soon.

Sincerely yours,

Xiaoqing Peng and Guangshang Yang

The summary of the changes and responses to the referees' comments are listed below. The page, line, and figure numbers refer to our revised manuscript. The changes have been indicated in the paper using blue font.

RC1: 'Comment on essd-2023-431', Anonymous Referee #1：

Major comments:

The data set (shapefile) only has two attributes (O_name and Areas). What does O_name mean? Could you add more attributes: the person who identified the features, The type (RTS? Active-layer detachment, and thermos-erosion gully), the acquisition dates of satellite imagery for identifying the features, the source of satellite/UAV imagery, the initiation time (year) of the features, and so on?

AC: Thank you for these great suggestions. We revised the meaning of the attributes and updated the dataset as follows: (1) We have updated our dataset, including point data for hillslope thermokarsts (named HTs_points.shp) and vector boundary data (named HTs_polygons.shp). (2) In the HTs_points.shp file, we revised it to indicate three attributes: 'Latitude', 'Longtitude', and 'Initiation Time', which represent the latitude and longitude of the HTs, and the initiation time of the HTs, respectively. Due to limitations in obtaining long-term, continuous, and high spatial and temporal resolution satellite imagery, we cannot provide finer distinctions in the initiation time of HTs than the three categories of A (initiated after 2015 and including 2015), B (initiated between 2010 and 2015), and C (initiated before 2010, excluding 2010). (3) The HTs_polygons.shp file includes attributes including "Area," "Round," and "Satellite Date," which are the area and perimeter of each HT polygon, and the satellite overpass time used to delineate the HT polygon, respectively. Our visual interpretation work primarily relies on Google Earth. However, Google Earth

currently does not provide a direct feature to view specific details such as the satellite name for each location. Users can only access information such as satellite imagery providers, capture dates, coordinates, and more. Therefore, adding detailed satellite/UAV imagery sources to the attribute table in our dataset proves challenging for us.
The visual interpretation of HTs was primarily conducted by Yang, as outlined in the author contributions, and we will update this information in the data description document (readme.txt).
Additionally, our results were mainly obtained through visual interpretation of satellite imagery. Distinguishing different types solely from images is impractical, as acknowledged by other researchers. For example, Yin et al.'s 2021 publication (DOI 10.1007/s10346-021-01669-7) stated: "it was impractical to distinguish the RTSs from ALDs in the GE, they were treated as one TL (Thermokarst Landslide) class in this study." Furthermore, different types of permafrost slope instability modes often undergo mutual transformation. For instance, active layer detachment may evolve into a retrogressive thaw slump due to continuous exposure and melting of ground ice at the headwall, complicating the classification. More field work and long term and high spatial-temporal resolution images are needed for a detailed classification of hillslope thermokarst types.

The data set contains 2717 polygons, but the manuscript said there are 1064 HT features, how does each polygon correspond to each HT feature?
AC: Thank you for prompting us to clarify this. The reason there are 2717 polygons in the HTs_polygons.shp file in our newly submitted dataset is because this file contains vector boundary data for all HTs at different time periods. Users can determine whether these polygons belong to the same HT feature by examining if different polygons are located in the same position and if there are overlapping areas between them. To facilitate useability, we have added point data for HTs (HTs_points.shp) in the resubmitted dataset.

When you analyzed the spatial distribution and characteristics of these features, could you group the features based on their types: retrogressive thaw slumps, active layer detachment, thermo-erosion gullies, and then conduct the analysis separately? Different types of hillslope thermokarst are quite different in shape, geomorphology, and triggering factors. For example, gullies have narrow and elongated shapes, but you concluded that all features are not elongated.
AC: Thank you for this suggestion. When we initially designed the experimental plan, we shared a similar perspective. However, during the actual implementation, we encountered challenges in achieving this goal. Distinguishing between different types of hillslope thermokarst based solely on satellite imagery is impractical, given the limited information obtained from these images. Morphologically differentiating retrogressive thaw slumps, active layer detachment, and thermo-erosion gullies based on satellite imagery alone is inaccurate. Also, in different regions, the triggers for thermokarst events differ, resulting in distinct morphological features even within the

same type of thermokarst. Simply relying on satellite imagery makes it difficult to accurately identify the type of permafrost degradation. Additionally, different types of slope instability in permafrost areas often undergo transformations; for example, active layer detachment may evolve into retrogressive thaw slumps due to continuous exposure and melting of subsurface ice at the headwall. This complexity requires more measurement methods and comprehensive field survey data for the classification of hillslope thermokarst types. To reduce uncertainty and errors for the dataset users, we thus did not classify the features into the more detailed types. Of course, in our future work, we will conduct more field investigations and obtain more high resolution imagery to improve this initial product.

Minor comments:

L32: shallow active layer depth? What's the depth of the active layer?

AC: Thank you, we have added clarification on lines 30-31 of the revised manuscript: "The thermokarst terrain is observed primarily in areas with a shallow active layer depth (average thickness: 2.98 m)."

L49: "instoring" to "in storing"

AC: Thank you, yes, we have fixed this formatting error.

L57-59: Olefeldt et al., 2016 focused on the Arctic and didn't have any data for Tibet. Do you have a better citation for this sentence? How about other works based on field investigation and remote sensing? I believe there are several published papers related to this statement.

AC: Thank you very much. We have added further references in the manuscript including studies in the Arctic and the Qinghai-Tibet Plateau region (Olefeldt et al., 2016; Yin et al., 2021; Huang et al., 2023; Yang et al., 2023).

L60-61: permafrost lake? Change to "thermokarst lakes"?

AC: Yes, thank you, we have changed "permafrost lakes and ponds" to "thermokarst lakes".

L67: what are "Google Earth satellite images"? By the way, Lewkowicz & way, 2019, used Google Earth "Engine".

AC: We apologize for our inadvertent misrepresentation of of this article, which we have corrected on lines 65-66 of the new manuscript: "...based on the interpretation of a Google Earth Engine Timelapse dataset."

L69: "circumpolar Alaska" What does this mean?

AC: Thank you very much for your comment. The term 'circumpolar Alaska' in the original manuscript was intended to refer to "the region of Alaska within the circumpolar Arctic." We have corrected this grammatical expression in line 68 of the new manuscript.

L83-84: Qilian Mountains is only a sub-region of QTP, how it affect the ecology of the QTP? This sentence is confusing.
AC：Thank you, there are indeed some problems with this expression, which we have corrected on lines 86-87 of the new manuscript: "Frequent occurrence of hillslope thermokarst hazards due to permafrost degradation could have significant ecological impacts on the Qilian Mountains."

L89: “in the region”, which region? you were talking about Qilian Mountain but cited a paper for Alaska.
AC: In the original manuscript, "the region" refers to the Qilian Mountains region, and the citation of Gooseff et al. 2009 at the end of the sentence is to illustrate that hillslope thermokarst includes RTS, active-layer detachment slides, and thermal erosion gullies as hazard types. Since this citation may indeed have caused some confusion for readers, we have made some edits to the sentence:
L90-93: "Meanwhile, there is little to no information regarding hillslope thermokarst (HT) features such as RTSs, active-layer detachment slides, and thermal erosion gullies (Gooseff et al., 2009) in the Qilian Mountains."

L90-91: what are “terrain features”? By the way, when you identify hillslope thermokarst, how did you distinguish normal landslides (not caused by permafrost degradation) and those features caused by permafrost degradation?
AC: Thank you very much for your comment. "Terrain features" was intended to mean "HTs" in the original manuscript. Since this expression may be confusing for readers, we have changed it to "HTs" on line 102 of the new manuscript. In addition, in the course of our work, the distinction between normal landslides and HTs is based on two main factors: (1) Unlike normal landslides, which are generally one-time landslides, HTs continue to develop as a result of permafrost degradation over many years. This difference can be distinguished by viewing satellite images taken at different times. (2) Conventional landslides typically manifest as slopes with a certain degree of inclination, often revealing exposed rock. In contrast, hillslope thermokarsts may involve the melting of subsurface ice, resulting in surface collapse, subsidence, and predominantly fine-grained minerogenic soils deposition (Korosi et al., 2022). These distinctions can be identified through high-resolution satellite imagery, topographic maps, and other remote sensing data. Finally, we also conducted field surveys to validate our visual interpretation results.
Korosi, J. B., Coleman, K. A., Hoskin, G. N., Little, A. J., Stewart, E. M., and Thienpont, J. R.: Paleolimnological perspectives on the shifting geographic template of permafrost landscapes and its implications for Arctic freshwater biodiversity, Can. J. Fish. Aquat. Sci., 79, 1162–1172, https://doi.org/10.1139/cjfas-2021-0280, 2022.

L99: do you have specific values of the mean or max of the annual precipitation? Otherwise, how do you know the variation of the precipitation was high?

AC: Thanks, although we did not specifically conduct a precipitation analysis for the Qilian Mountain region, in the referenced study from Li et al., 2022, they concluded based on comparing different precipitation datasets for the Qilian Mountains area: "...the precipitation decreases from southeast to northwest in the Qilian Mountains, where the East Asian monsoon is blocked and uplifted to form rich precipitations. There is more precipitation in the eastern Qilian Mountains under the combined actions of water vapor from East and South Asia. The eastern Qilian Mountains has the most amount of precipitation." According to their research, the difference in precipitation between the western and eastern Qilian Mountains can reach 30 mm/month or even higher.

Li, Y., Qin, X., Liu, Y., Jin, Z., Liu, J., Wang, L., and Chen, J.: Evaluation of Long-Term and High-Resolution Gridded Precipitation and Temperature Products in the Qilian Mountains, Qinghai–Tibet Plateau, Front. Environ. Sci., 10, 906821, https://doi.org/10.3389/fenvs.2022.906821, 2022.

L104: “security” of what?

AC: Sorry for our misuse of the word "security," we meant “safety” in regards to human life. We have changed it to "safety" on line 116 of the new manuscript.

Figure 1: What’s the white region in (a)? lake? unfrozen ground? Others? Could you mark the locations of features in (b) to (h) in (a)? Could you also name the features (e.g. gully or RTSs) in (b) to (h)? In (a), you only show the extent of permafrost. Could you show the extent of continuous, discontinuous permafrost?

AC: Thank you for these valuable suggestions! We have incorporated location information for (b)-(h) in the revised Figure 1 (a) by reorganizing the field survey data. The white area in Figure 1 (a) represents the non-permafrost zone, and also includes some lakes and rivers. Existing permafrost distribution data, balancing global and regional scales, lack the precision required. Sheng et al. produced a 100 m resolution permafrost distribution map for the Qilian Mountains by combining field surveys, road inspections, borehole data, and previous information on the lower boundary of permafrost obtained through extensive scientific exploration. They validated the map with 548 long-term borehole data points, achieving a classification accuracy of 90.11%, thus representing is the best permafrost map for this study area. While this comprehensive permafrost map, detailing the complex mountainous terrain, aligns well with our needs, it only outlines the extent of permafrost in the Qilian Mountains region without distinguishing between continuous or discontinuous. Since our focus is on hazards occurring in permafrost regions in general, we did not further process the map to try and display the range of continuous and discontinuous permafrost. Additionally, due to the satellite image-based visual interpretation nature of our study, attempting to differentiate between different hazard types solely based on images is impractical, as concluded in Yin et al.'s 2021 publication (DOI 10.1007/s10346-021-01669-7): "it was impractical to distinguish the RTSs from ALDs in the GE, they were treated as one TL (Thermokarst Landslide) class in this study."

L117: what is Omap? Could you provide a link or citation to it? I think most people don't know this, unlike Google Earth.
AC: Thank you for the suggestion, we have added a link to the official download of the Omap software on lines 410-411 of the new manuscript.

L120: tabulate? Change to calculate?
AC: Thanks for your tip, we changed it to "calculate" in the new manuscript.

L122-124: do you have a citation for this formula? How did you define the region of interest? What's the size of the region of interest? What's the physical meaning of the TPI?
AC: Thank you, we have cited the original article introducing this formula on lines 134-135 of the new manuscript. This formula was first proposed by Zeng and colleagues from Peking University, aiming to establish the topographic differences among landscape distributions. There are significant differences in the computation of this index compared to Weiss's method proposed in 2001 (Weiss, A. (2001, July). Topographic position and landforms analysis. In Poster presentation, ESRI user conference, San Diego, CA (Vol. 200)).

1. Zeng et al.'s approach considers that a single elevation or slope indicator cannot fully represent the comprehensive impact of terrain on landscape distribution. Hence, it combines elevation and slope to form a composite terrain factor, measuring the overall impact of the terrain.
2. Weiss's method is currently a more mainstream approach for calculating the topographic position index. It reflects the positional relationship of a point on the ground by calculating the difference between its elevation value and the average elevation of other surrounding points.

Ultimately, we chose the method proposed by Zeng et al. to compute and analyze the topographic position indices corresponding to HTs within the Qilian Mountain range, in an attempt to extract more potential information regarding the distribution characteristics of HTs. Additionally, our area of interest covers the entire Qilian Mountain range, therefore the average elevation and slope used in the formula represent those of the entire Qilian Mountain region. We have clarified this in the new manuscript on line 138.

L138-139: here "2 m" mean 2 m above ground? Not their spatial region is 2 m? right?
AC: Yes, thank you, we have revised the statement on line 148 of the new manuscript to: "We have obtained monthly mean air temperature and precipitation data at 2 m above ground level from the fifth generation of the European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis."

Figure 2: what's the implication of the latitudinal and longitudinal distribution?
AC: The statistical distribution of longitude and latitude in Figure 2 is merely presented to show readers the spatial distribution of HTs in the directions of longitude

and latitude, without further significance or deeper implications. In the new manuscript, we have revised the information in Figure 2 by removing the distribution of HT in longitude and latitude.

L162: what do you mean by “thermokarst landslides”? RTS? Active-layer detachment slides? Or Others? What is the difference between “thermokarst landslides” and those landslides not in permafrost regions?
AC: Sorry, this was a wording error; we have corrected it in the new manuscript on lines 169-171 to "These features are tonally and morphologically different from their surroundings in color satellite images during the thawing season." According to Lewkowicz and Way's 2019 publication (Lewkowicz, A. G. and Way, R. G. Extremes of summer climate trigger thousands of thermokarst landslides in a High Arctic environment, Nat. Commun., 10, 1329, https://doi.org/10.1038/s41467-019-09314-7, 2019), "thermokarst landslides" refer to RTS (retrogressive thaw slumps). The mechanisms behind thermokarst landslides and conventional landslides differ significantly. The former typically occurs in permafrost regions, resulting from internal thawing or melting of permafrost layers, leading to soil instability and collapse. In contrast, conventional landslides can be triggered by various factors such as rainfall, seismic activity, or soil erosion, and their occurrence is not contingent upon the presence of permafrost.

L165-168: I don’t understand this sentence.
AC: We have revised the sentence to better convey the idea:
L173-176: “Their morphological characteristics vary based on vegetation cover, slope, and permafrost conditions, but common features include highly disturbed slopes, lateral shear zones, and fracture zones formed after the sliding of the active layer.”

L174-176: a situation where an HT feature already existed for a long time then captured by satellite imagery. Is this still ok?
AC: For HTs that have been in existence for a long time, we are unable to determine their initiation dates. Hence, we categorize them into three groups based on their initiation dates: HTs initiated before 2010, those between 2010 and 2015, and those initiated after 2015.

L190: “al”?
AC: Thank you very much for your comment, it was a spelling mistake and we have corrected it to "a".

L192: “Shiyanghe basin” and “Datonhe-Huangshui basin” are not in Figure 4.
AC: The reason that these two basins are not included in Figure 4 is that HT has little or no distribution in these two basins (Tsaidam basin).

Table 1: how do you know imagery resolution in Google Earth Pro is 0.6 m? As I know, the resolution could vary in different locations and time, and the data source could also include others such as WorldView 1, 2,3, and 4.
AC: Thank you very much for your reminder. Indeed, the image resolution in Google Earth varies at different times and locations. Additionally, the sources of image data are not limited to those listed in the table. We have revised the description in the table accordingly.

What is “Esri Wayback Imagery”? The source could also be some satellites.
AC: Esri World Imagery is a high-resolution satellite and aerial imagery service provided by Esri. It offers global coverage and gathers high-quality imagery from various sources. We have updated the 'Data Sources' information about 'Esri Wayback Imagery' in our new manuscript.

L204-208: what’s the value range of LSI?
AC: Theoretically, the range of values for LSI calculated based on the formulas in the manuscript is any positive value greater than 0.

L212-215: I don’t understand this sentence.
AC: Thanks, we have changed "the elements" to "HTs" in the original manuscript for the sake of accuracy.
L218-220 means that there is a 99% probability that HTs are clustered within the study area, and the smaller the p-value and the larger the z-score, the greater the probability that such spatial patterns are clustered.

L221-228: what are the purposes of the autocorrelation? The correlation between what and what? This part is confusing.
AC: Sorry for the confusion. Our aim in conducting spatial autocorrelation analysis is to determine whether there is a clustering or dispersal in the spatial distribution of HTs within the Qilian Mountain range. This process measures the correlation of HTs with themselves in space. We have revised this unclear expression on lines 228-236 of the new manuscript: "The local autocorrelation analysis categorizes regions into four types based on the local Moran's index: High-High (HH) clustering, High-Low (HL) clustering, Low-High (LH) clustering, and Low-Low (LL) clustering. HH signifies a region with both a higher amount of HT and neighboring regions also having a higher amount of HT; HL indicates a region with a higher amount of HT surrounded by neighboring regions with a lower amount of HT; LH indicates a region with a lower amount of HT neighboring areas with a higher amount of HT; and LL represents a region with both a lower amount of HT and neighboring regions with a lower amount of HT."

L234: How do you calculate the average here? Spatial? Or temporal? Why need the average?

AC: The term "mean processing" mentioned in the manuscript refers to the temporal and spatial averaging of temperature and precipitation data in the Qilian Mountains region from 2000 to 2020. We have reworded this in the revised manuscript to prevent any potential misunderstanding among readers. The reason for adopting this approach is twofold: first, it aims to provide a straightforward and intuitive examination of the climatic changes in the Qilian Mountains over the past two decades, and second, to identify years with temperatures and precipitation exceeding the mean plus one standard deviation. This processing method is primarily inspired by the work of Luo et al. (Luo, J., Niu, F., Lin, Z., Liu, M., Yin, G., and Gao, Z.: Inventory and Frequency of Retrogressive Thaw Slumps in Permafrost Region of the Qinghai–Tibet Plateau, Geophys. Res. Lett., 49, https://doi.org/10.1029/2022GL099829, 2022.)

L259-260: this sentence mentioned HT, but Luo et al., 2022 only focused on retrogressive thaw slumps.
AC: Thanks for alerting us to this discrepancy, we have modified "HT" to "RTS" on line 267 of the revised manuscript.

L268-269: “most HT is simple in shape and compact in morphology, rather than elongated”. If this is a statement for retrogressive thaw sumps, then it’s ok. But HT also includes thermo-erosion gullies, which are usually narrow and long.
AC: Yes, you are generally correct, but we arrived at this conclusion because the statistics indicate that 75% of HTs have LSI values close to 1. While thermo-erosion gullies typically exhibit an elongated shape, the actual proportion of thermo-erosion gullies in the HT dataset is relatively small. But to avoid any potential ambiguity and misunderstanding, we have removed the phrase "rather than elongated" on lines 276-277 of the revised manuscript.

L270: and you also cited Yang et al., 2023, which only focused on retrogressive thaw slumps.
AC: Thanks. While our work shares similarities with Yang et al., who focused exclusively on retrogressive thaw slumps, we acknowledge that their statement regarding the higher likelihood of reactivation for slumps with a more elongated shape is not rigorously supported. In the revised manuscript, we have removed this statement for clarity.

L276: “bordering the Heihe basin”. I don’t understand.
AC: To address the unclear expression in the original manuscript, we have revised it on lines 281-283 of the new manuscript to: "Much of the newly initiated HT occurred in the Heihe basin and the middle and upper reaches of the Datonghe basin."

L336: why did earthquakes cause permafrost warming?
AC: Earthquakes cause permafrost warming due to seismic vibrations. These vibrations lead to cracking and deformation of the ice layers within the permafrost,

releasing moisture and heat, consequently resulting in a temperature rise of the permafrost. Additionally, earthquakes can induce the flow of pore water within the permafrost, further influencing its temperature (Che et al., 2014). We have added this explanation to the revised manuscript on lines 342-346.

Che, A., Wu, Z., and Wang, P.: Stability of pile foundations base on warming effects on the permafrost under earthquake motions, Soils and Foundations, 54, 639–647, https://doi.org/10.1016/j.sandf.2014.06.006, 2014.

L324-337: the analysis of the seismic data is quite weak. You know the timing of earthquakes, but how do you know the initiation time (iin hours or minutes) of these HT features? The only information is the spatial distribution of HT features and earthquake epicenters. As shown in Figure 7, there are clusters of earthquake epicenters in the lower left, but no HT feature there. How do you explain this? Figure 6 is simple but needs to be clarified. How do you define extreme weather events based on the ERA5 data? What kind of extreme events? The horizontal line represents the mean of what?

AC: Thank you for these comments. Due to the difficulty in obtaining public continuous high-resolution imagery, the precise start date of our HT dataset cannot be accurately pinpointed to a specific moment. Therefore, studying the temporal correlation between earthquakes and HT occurrences is challenging. However, we can roughly infer the spatial relationship between earthquakes and HT by examining their locations. In Figure 7, there is a cluster of earthquake epicenters in the lower-left corner, but the absence of significant HT events in that area is primarily because it falls outside the permafrost regions. We have added a sentence clarifying this on lines 347-349. Additionally, HT occurrences are influenced by factors such as temperature, precipitation, vegetation type, and earthquakes serve as one of the triggering factors. The study of the mechanism of earthquake effects on hillslope thermokarsts requires finer field monitoring and the support of a large amount of data. Therefore, we cannot give a definite conclusion, which is beyond the scope of this paper's contribution.

In Figure 6, the horizontal lines represent the mean values of temperature and precipitation. We define precipitation and temperature exceeding the sum of the mean and one standard deviation as extreme precipitation and extreme high-temperature events, respectively. To avoid confusion for the readers, we have added clarifications on Lines 360-362 “..... The solid horizontal line represents the mean air temperature and precipitation, respectively, and the dashed line represents ±1 standard deviation.”

L359: where are these peaks?

AC: In the original manuscript, the term "peaks" referred to the extreme precipitation events in 2007 and 2018. To prevent any potential misunderstanding, we have clarified this on lines 370-371 of the new manuscript, specifically indicating the position of these "peaks" in Figure 6b.

RC2: 'Comment on essd-2023-431', Haijun Qiu:

Data:
The file name of the data seems not normalized, e.g. ‘shp’. I suggest the Polygons revised as HTs.
The meaning of HTs_V1 seems not clear, which could be as HTs_Shapefile.
The data “read me” (file description) file needs more detail and clear for readers, e.g. ‘"O_Name" field indicates the time of the satellite imagery for this morphological element,’. These should be more detail for the name of satellite.
AC: Thank you for your specific suggestions regarding our dataset. Based on these, we have updated our dataset and rewritten the data documentation (readme.txt)
“Before downloading and applying this dataset, please read this text carefully.

----------general information----------

The HTs_shapefile primarily consists of two datasets: HT point data within the Qilian Mountain range (named HTs_points.shp) and vector boundary data (named HTs_polygons.shp).

1. The HTs_points.shp file includes three attributes: "Latitude," "Longitude," and "IT." The first two attributes represent the latitude and longitude of the HT locations, while the "IT" field indicates the initiation time of the HT, categorized into three classes: A, B, and C. Class A signifies HTs initiated after 2015 (including 2015), class B represents those initiated between 2010 and 2015, and class C represents those initiated before 2010 (excluding 2010).

2. The HTs_polygons.shp file comprises three main attributes: "Area," "Round," and "Sat Date." The first two indicate the area and perimeter of each HT boundary polygon, while the "Sat Date" field represents the satellite overpass time used to delineate the HT polygon, respectively.

----------coordinate information----------

Data Type: Shapefile Feature Class

Geographic Coordinate System: GCS_WGS_1984

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Specific Comments

As we know that, the thermokarst are mostly used or defined in the permafrost regions. However the hillslope thermokast is unusual. So, please explain it in detail for hillslope thermokarst.
AC: Thank you for allowing us to clarify. Hillslope thermokarst refers to a specific type of thermokarst formation that occurs in permafrost regions. While it is similar to regular thermokarst features, what distinguishes hillslope thermokarst is its occurrence on sloped terrain or hillsides, where permafrost thaw leads to slope instability. This can result in various landforms like retrogressive thaw sumps, thermo-erosion gullies, or active layer detachments, affecting the stability and shape of hillslopes in permafrost regions. These features can significantly impact the landscape and have implications for infrastructure, ecosystems, and land use in areas affected by hillslope thermokarst processes (Kokelj and Jorgenson, 2013; Olefeldt et al., 2016; Gooseff et al., 2009).

Kokelj, S. V. and Jorgenson, M. T.: Advances in Thermokarst Research: Recent Advances in Research Investigating Thermokarst Processes, Permafrost and Periglac. Process., 24, 108–119, https://doi.org/10.1002/ppp.1779, 2013.

Olefeldt, D., Goswami, S., Grosse, G., Hayes, D., Hugelius, G., Kuhry, P., McGuire, A. D., Romanovsky, V. E., Sannel, A. B. K., Schuur, E. A. G., and Turetsky, M. R.: Circumpolar distribution and carbon storage of thermokarst landscapes, Nat Commun, 7, 13043, https://doi.org/10.1038/ncomms13043, 2016.

Gooseff, M. N., Balser, A., Bowden, W. B., and Jones, J. B.: Effects of Hillslope Thermokarst in Northern Alaska, Eos Trans. AGU, 90, 29–30, https://doi.org/10.1029/2009EO040001, 2009.

The sentence in line 103: "Permafrost instability in the Qilian Mountains has gradually increased, resulting in HT formation including RTSs, thermokarst lakes, and thermal erosion gullies" is incorrect. As thermokarst lakes are not included in the hillslope thermokarst hazard.
AC: Thank you for alerting us to this mistake, we have replaced "thermokarst lakes" with "active-layer detachment slides" on line 115 of the manuscript.

I suggest changing "freeze/thaw-induced hazards" to "hillslope thermokarsts" in line 84.
AC: The expression "freeze/thaw-induced hazards" in the original manuscript was indeed ambiguous to the reader, and we have changed it to "hillslope thermokarsts."

Line 1 invertony should be as inventory.
AC: Thank you, we have corrected that spelling error.

Please note that there are some English grammar and presentation problems in the article, as well as formulas in lines 122, 204-205 that do not appear properly in the manuscript.
AC: Thank you, we also noted grammatical and presentation problems in the manuscript, which we have now improved in the new manuscript. The reason the equations on lines 122, 204-205 do not display correctly in the manuscript may be due to format conversion of the preprint file, thanks for the heads up.

Lines 600-602 do not have DOI added to the citations of the reference, please uniform the citation in manuscripts.
AC: Thank you very much for your reminder, however, we no longer cite this document in the new manuscript.

I think you have some problems in section 4.1, such as the lack of precision and clarity of "HT", "thermokarst landslides" and "landslides" in lines 161-163.
AC: Thank you very much for your comments, the presentation in the original manuscript did have some problems and we have modified it in lines 169-171 of the new manuscript: "These features are tonally and morphologically different from their surroundings in color satellite images during the thawing season."

The Jilin-1 satellite image you mention in "7 Data Availability" does not seem to be used in "4 Methods" or other chapters, and the authors should make a clear statement as to whether or not this data is used, and how it is used.
AC: Thank you very much for the heads up. In our work, this imagery along with Wayback imagery provided by ESRI was used to aid in the verification of the accuracy of our HT dataset, and we have added a note in the "3 Data Sources" section of the new manuscript: "...and Jilin-1 satellite imagery (0.75 m) provided free of charge by China Commercial Satellite Corporation to aid in the identification." and in the "4 Methods" section, the information on the Jilin-1 satellite in Table 1 were updated.

Please carefully check the format of article, for example line 358 “HTwas”, line 414 “mid- and upstream”.
AC: Thanks, we've fixed those formatting issues.

In lines 261-262 of the manuscript, the authors state that 90% of the RTSs tend to be distributed in the altitude range of 3200-4000 m. Is this statement accurate? In context, it would be more standardized to use "90% of HTs" instead of "90% of RTSs".
AC: Thank you very much for catching that the statement in the original manuscript was indeed inaccurate, and we have changed "90% of RTSs" to "90% of HTs" on line 270 of the new manuscript.

In the study, there are several river basins, but it does not appear in the figures, please added it.

AC: Thank you—we have ensured that all of the basins mentioned in the manuscript are shown in Figures 1, 4, and 5; for example, in Figure 1(a), the different basins are labeled on the map with their corresponding names.

About the potential influence factors, it is simple for the impacting factor earthquake, which could be more detail for explaining. For example, it can be seen that there are some fissures after earthquake, which could be the important factors controlling the HTs development.
AC: Thank you for your specific feedback. Due to the lack of specific initiation times for HTs, analyzing the temporal correlation between earthquakes and HT initiation has proven to be challenging for us. As a result, in Figure 7, we are only showing the positions of seismic epicenters in relation to HTs. Regarding the impact of earthquakes causing surface fissures and subsequently exposing substantial ground ice, this is elaborated on lines 335-338 of the manuscript: "During our field investigations, we found a nearly 3 km long and 2 m deep slope fracture caused by a 6.9-magnitude earthquake in 2022, resulting in a massive exposure of subsurface ice…"
We have added further detailed descriptions to the new manuscript based on your suggestions:
L339-349:The occurrence of an earthquake can result in an instantaneous increase in pore water pressure and sliding forces that reduce slope stability and potentially leads to a massive exposure of subsurface ice (Niu et al., 2016; Xia et al., 2022), sediment liquefaction (Dadfar et al., 2017), and permafrost warming due to the seismic vibrations. These vibrations lead to cracking and deformation of the ice layers within the permafrost, releasing moisture and heat, consequently resulting in a temperature rise of the permafrost. Additionally, earthquakes can induce the flow of pore water within the permafrost, further influencing its temperature (Che et al., 2014), creating the ideal setting for active-layer detachment slides.

Line 120, the word tabulate is not suitable.
AC: Thanks, we changed it to "calculate" in the new manuscript.

Line 190, what is ‘al’?
AC: Sorry, it was a spelling mistake and we have corrected it to "a."

In the discussion, the climate factors does not show detail in the methods.
AC: Thank you for catching this. We have made revisions as follows:
L242-245: "To explore the effects of climate on HT, we acquired monthly mean air temperature and precipitation data at 2 meters above ground level from ERA5 for the period 2000–2020. Subsequently, we computed their annual spatial means and standard deviations (Figure 6)."

CC1: 'Comment on essd-2023-431', Ionut Cristi Nicu:

Dear Authors,
Congrats on trying to improve the general understanding of cryospheric hazards through the sharing of significant features in the Qilian Mountains. However, your paper needs some improvements regarding readability and consensus regarding the use of specific terms that refer to cryospheric hazards. Also, the paper would highly benefit from some changes made by a native English speaker. Some specific comments are made in the attached .pdf file.
Some general comments refer to the fact that the paper lacks a bit of international context and of the fact that more references should be added. Those referring to the automatic mapping of RTS features by using deep learning should also be highlighted.
The dataset is of high importance in today's climate context.
Kind regards!

Dear Dr. Nicu,
We sincerely appreciate your recognition of our work and the valuable insights you have provided. Your suggestions regarding improving the readability of the paper, ensuring terminology consistency, and incorporating more international perspectives are highly valued. We have carefully considered the specific feedback you outlined in the attached .pdf file and made necessary modifications and enhancements to our manuscript based on these suggestions.
However, we have decided to retain the term "hillslope thermokarst" in the manuscript, as opposed to changing it to "cryospheric hazards" after thorough deliberation. Because cryospheric hazards encompass various types such as glacier hazards, ice jams, ice floods, snow disasters, frozen ground hazards, our research focuses only on a subset of these (Shijin, W. and Jiahong, W.: Characteristics, Influence of Cryosphere Disaster and Prospect of Discipline Development, 2018.). Using the term "cryospheric hazards" might inadvertently exaggerate the scope of our study. Nonetheless, we sincerely appreciate the suggestion you provided for us. Below we address each specific comment provided in the attached .pdf file. Thank you again for your thoughtful feedback, and we look forward to further improving our work based on your insights.

Line1：you mean Inventory
AC: Thank you, we have rectified this spelling error in the revised manuscript.

Line54: reference missing here
AC: We have added references to new articles in the manuscript to substantiate this statement.

Line89: thermo-erosion gullies

AC: Thank you, we have corrected this spelling error in the manuscript.

Line120: confusing wording
AC: Thank you; we have amended it to "calculate" in the revised manuscript.

Line161: please offer a more complete definition and context for the formation of RTSs. Have a look at this paper https://doi.org/10.1007/s10346-021-01684-8 and of the references it contains
AC: Thank you for your recommendation; we have incorporated this new citation into the manuscript to enrich our perspectives.

Line188：correct is thawing
AC：Thank you for your feedback; we have addressed and corrected this error.

Due to the numerous changes, we invite you to review our updated manuscript.
We sincerely appreciate your valuable input and time.
Best regards!