

We thank again the two reviewers for their valuable comments and provide hereby our responses on how we have addressed the raised issues. The final adjustments and comments deviate in a few cases from the preliminary answers; this is indicated in the answers. We provide the final responses in italics.

RC1: **Citation:** <https://doi.org/10.5194/essd-2025-134-RC1>

We thank RC1 a lot for the constructive comments.

Review of Thermo-hydrological observatory in a permafrost river valley landscape in Syrdakh, Central Yakutia by Pohl et al. for Earth System Science Data

General overview:

This is an exhaustive dataset of a variety of commonly used measurements to characterize permafrost in an area where it is changing rapidly. Overall, it is well written and the explanations are ample to be able to repeat the measurements. In a few locations I suggest further information/clarification. This paper will be of interest to other permafrost scientists but also provides a strong example of how to design a long-term field experiment and name and organize a disparate dataset. The dataset is unique, useful, and complete. The abstract and introduction use carbon as a main motivation to measure/study permafrost. However, I would argue that other biogeochemical parameters, hydrologic changes, and of particular interest infrastructure (linear and horizontal) are also affected by permafrost degradation. Many of the measurements provided could be used to instrument buildings, bridges, airfields, or roads to identify change. Mentioning these additional reasons to study permafrost would strengthen the impact and relevance of the work.

We added references on infrastructure and the biogeochemical cycle in the introduction and adjusted the initial statement, so it reads as equally important. Immediately hereafter we set then the focus on thermal processes, the main relevance of this database. The changes are in lines 22 ff.

The tense bounces around a lot. For example, around line 254 “were conducted”, at 257: “is provided”, 262: “are based”, 267: “was used” and throughout. Maybe this works to bounce around like this but it is worth making sure it is as consistent as possible.

We thoroughly checked the entire manuscript for tense consistency and adjusted also passive to active voice where suitable. We also tried to use simple past for most of the description of what has been done and speak in present tense to highlight theoretical background. We hope to have made the text consistent now.

Comments keyed to the text:

2: permafrost-affected

The meaning is “regions with permafrost that are affected by permafrost thaw”. We changed this to “thaw-affected permafrost”

3: use a different word so as to not use “ubiquitous” twice in a row. Or remove second instance- not needed

We removed the second instance.

7: provide total depth here

We added the maximum depth.

10: what parameters?

The idea here was to provide a concise overview of measured variables and parameters and not list everything. We changed the sentence to “Air, water, and ground temperatures, as well as physio-chemical river water and soil properties of the surrounding environment were measured continuously or during annual field campaigns and are provided as time-series or single tests.”

12: GIS database

We adjusted this.

37: define “thermokarst lakes” here- what are they and how do they form? What do they represent?

We reconsidered the proposed change. As it marks the second occurrence, we decided to change instead the first occurrence in line 25. This reads now as: “One specific feature of thawing ice-rich permafrost is the formation of thermokarst lakes (French, 2017), which are impoundments of water in the resulting depressions with positive feedback between lake growth and permafrost thaw (Grosse et al., 2013).”

42: put talik definition in parentheses instead of using the “i.e.”

This is adjusted now.

49: is “Yedoma Permafrost Domain” a real name?

I recommend providing a sentence identifying/defining yedoma as high ice content, high carbon and organic matter content permafrost comprised of fine-grained soils and that due to these characteristics state that yedoma is particularly susceptible to thermokarst formation. This is currently mostly provided at 66-69 but is better to move here.

It is a coined term in the referenced article but not in general. We adjusted the writing and moved the relevant text passage to the first occurrence in line 52:

“This paper presents a database of an observatory of a small non-perennial river or stream (namely the Syrdakh River) in the Syrdakh valley in Central Yakutia, Eastern Siberia (Pohl et al., 2025). This region is underlain by the Yedoma ice complex (30 m to 50 m), defined as ice-

rich, fine-grained permafrost deposits of late-Pleistocene age (about 70%–80% ice per volume), composed of frozen silts and silty sands penetrated by several meter-thick syngenetic ice wedges (Ivanov, 1984; Strauss et al., 2021)."

Provide general latitude and longitude here.

We referenced Figure 1 at this point in the text to provide the geographical reference; outlining the Yedoma region is not straight-forward due to its patchy and wide-spread occurrence. We added and adjusted the information (see previous comment), and added the coordinates of the bounding box of the river site in the site description:

"The Syrdakh River (62.555°N to 62.562°N, 130.900°E to 130.961°E) is located about 100 km northeast of Yakutsk in Central Yakutia (Eastern Siberia), Russia (Fig. 1), within the continuous permafrost zone (300 m in thickness, Soloviev (1973))."

73: you defined taliks earlier

We merged this at the first mentioning in line 43:

"Compared to perennially unfrozen water bodies of lakes and large rivers, where ice thicknesses might reach a maximum of 1.5 m to 2 m (Lütjen et al., 2024), small rivers and creeks might experience freeze-through. Here, the water bodies do not provide heat to maintain a talik (an unfrozen zone underneath the river or lake bed that can form for large enough water bodies (Kurylyk and Walvoord, 2021; Léger et al., 2023))."

80: reference for these protocols?

We missed what this comment was referring to. We apologize for this. Our use of "measurement protocols" was referring to the previous installations governed by the Melnikov Permafrost Institute and the expertise of technicians helping in the field for operating machinery, e.g., the drilling, but also power supply for instruments, and general setup that would allow for data procuring. It also reflects the choice of installation depths at 60, 120, 240, and 320 cm that is used by Roshydromet. In later installations different installation depths were chosen, disbanding this scheme. We changed the sentence to clarify this, and we also added additional technical information about the thermistor chain installation in the respective section. The relevant part in the site description (lines 78 ff.) reads now as:

"In 2012, we installed the first thermistor chains at various depths, following a similar installation setup for ground temperature measurements elsewhere in Siberia by the Melnikov Permafrost Institute (MPI). Various depths, either using the common measurement depths by the Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) at 60 cm, 120 cm, 240 cm, and 320 cm or at evenly spaced depths of 1 m, 2 m, 3 m, and 4 m were used. When it comes to using the data for numerical modeling, both setups have advantages and disadvantages; the latter provides more data at different depths (rather than a higher resolution at shallower depths)."

86: in addition, the focus

Corrected.

88: was installed

Corrected.

109: and creating

Corrected.

110: depths and velocities

Corrected.

Table 1. This is a great list of measurements! Font is extremely small though. Perhaps make it landscape to provide room for a larger font?

We made the table landscape format and allowed for a table break. We believe that the typesetting service of Copernicus will help in the last adjustment steps to make this table look neater. The readability should be greatly improved now.

Is there a day/date associated with the thaw depth measurements to discern between seasonal thaw and active layer?

Yes, each measurement has a date associated with it. This information is included in the individual files and it is mentioned now in the text (line 196).

Maybe break the active layer/thaw dataset into two since it is important to know whether it is a true active layer or just seasonal thaw at a given moment in time. At the least the “actl” label is misleading if it means “active layer thickness.”

All the measurements conducted in the field should first be seen as thaw depths. However, as all these measurements were conducted at the end of the thawing period (mid to late September), these depths can be assumed to be close to the actual active layer depths. This is supported by the temperature time series that show the cooling onset throughout all boreholes around August to September. How long and how much deeper the thaw is occurring during the cooling of the ground has not been assessed. We removed the label “active layer thickness” and now refer to these measurements throughout the manuscript as thaw depth “td”. The axes labels in Figure 5 were corrected also.

Figure 1. I recommend splitting this into a few Figures either here or in an appendix.

In accordance with our response to RC2 on this issue, we split the figure to provide a better overview of the landscape setting in Figure 1. A second figure provides a more detailed view on the two instrumented field sites. We do not include labels as this was overloading the figure.

Red labels in B are unreadable

We removed the DSM figure but show instead a Google Earth image in Figure 1B.

Maybe keep A and B as is (Figure 1) but without larger labels on B and then provide C and D as Figures 2 and 3.

In line with Reviewer 2, we split Figure 1 into two parts: one showing the overview and landscape features, and a second figure that shows the two main sites along the small river that connects the thermokarst lakes with more detail.

155-161: any information on how these installations were done? Maybe a schematic cross section? Or a description? For the HOBO loggers the borehole diameter and construction?

We added additional information on this in the text and reference a schematic for the hobo installation at the two cross sections (appendix). The installation positions can be seen in the GIS database (the project file is now available). We believe this provides a good overview about the installation. We also added information on the HOBO logger pre-assembly, including a photo that we added in the appendix. The updated description of the loggers is in lines 190 ff.

Figure 3. State that the depths of these thermistors are provided as, for example “300” (which I assume means 300 cm).

The information was added in the figure caption:

“Measurement depths are indicated in the subscript of axes labels and in the variable names within the figure legends, e.g. "tsl0200" is at 200 cm depth.”

203-207: are there any “true” active layer depths in the area to compare to?

To our knowledge there are no “true” active layer depths measurements available at Syrdakh or in the vicinity. Also, in response to RC 2, we renamed active layer to thaw depth throughout the manuscript and adjusted the file names to do this justice. We checked on other studies reporting thaw depth measurements in the wider area and added a study from near Yakutsk (Spasskya-pad) within a larch forest by Iijima et al. (2010) in line 73 ff., and another study with the same values as reported already in the study site description for southeast of Yakutsk (Yukechi) from Fedorov and Konstantinov (2014).

Figure 5. Also provide some of these measurements over time for given locations to look for trends? Maybe the different ties/dates in September make this not worth doing? Would be good to at least provide the plot and some discussion.

We understand the ESSD format as strictly data revolving and therefore decided to not run any analysis that is not related to data presentation or quality.

The data shall serve first to provide some general idea of the order of magnitude for the thaw depths (active layer thickness) in the region. As Figure 5 already shows, there is considerable variability and it is also apparent that there is no clear trend (e.g. Figure 5b); sometimes, points of an earlier year show shallower, and sometimes deeper thaw depth than a later year. In order to do a proper analysis of how different locations evolve, we would have to consider also the water level, the meteorological variables, etc. We think this is certainly beyond the scope of ESSD. We added to the figure caption that the information of the measurement data for individual years of thaw depth measurement is included both in the main data files, as well as in the geopackage files within the GIS database. We hope this is acceptable.

Or a separate plot of just “true” active layer values (presumably you have this for at least 2017 and 2028, maybe other years?).

Without a continuous observation technique identifying the thaw depth, there is no chance to report the true active layer depth. Because all field campaigns were conducted in early autumn, we believe that the thaw depth measurements are close to the true active layer depths. But this remains unverified. We changed the naming to “thaw depth” and use the abbreviation “td” now throughout the manuscript to avoid the confusion. We have no “true” (as in verified maximum thaw depth) measurements for any year as we have never stayed over an extended period of time to perform continuous (daily) thaw depth measurements, nor did we have (or found in other studies) a setup with thermistors so closely spaced that it would allow clearly identifying the active layer depth.

235-242: This seems to be in the wrong place. It is not related to the ERT.

We understand the confusion and have adjusted the paragraph. We believe it makes sense to have the uncertainty of all three methods combined – this is the general section for the uncertainties and errors of the thaw depth measurements. We added a sentence at the beginning of the paragraph to clarify this:

“The determination of thaw depths using any of the applied methods were subject to different sources of error and have varying uncertainty. “

307: the true active layer or seasonable thaw at that time?

As outlined above, we only use the term “thaw depth” now.

361: “do not derive significantly”- not sure what this means. Do not drift?

Yes, this is a spelling mistake. We changed this to “do not drift”.

366: “do not derive significantly”- not sure what this means. Do not drift?

Yes, this is a spelling mistake. We changed this to “do not drift”.

Figure 14. Provide “north and south” or whatever directions work for this cross section (i.e. the -1000 and 1000).

We added the labels “Left bank” and “Right bank” into the figure and mention in the figure caption that these refer to the downstream direction.

433: “do not derive significantly”- not sure what this means. Do not drift?

We changed this to “do not drift”.

Appendices provide wonderful photos of field site activities and measurements.

We added an UAV oblique aerial view photo in Figure 1 to give a better impression about the landscape.

RC2: **Citation:** <https://doi.org/10.5194/essd-2025-134-RC2>

We thank RC2 a lot for the constructive comments.

The manuscript describes a rich dataset from multiple environmental parameters collected in a study area located between two lakes connected by a stream in a permafrost area in Central Yakutia. Despite the small size of the study area, its geomorphological and hydrological setting, together the rich set of variables measured makes this data set of high scientific value for studying the dynamics of permafrost environments.

The manuscript is well-written and the dataset is presented in a generally clear way. It is associated to a rich dataset, which has several gaps and also some problems due to changes in instruments and techniques, with large uncertainty in some variables. However, given the harsh environmental conditions and timespan of the measures, this could be expected, and most key data is highly relevant. The authors decided to make all data available and this is of high value.

Overall, I missed a better description of the geographical setting of the study site. Actually, it was only after reading the whole document and when inspecting the Zenodo dataset, that I found a clear picture that encompasses the landscape setting. It is an oblique aerial picture that you should include in the body of the manuscript as support for the site description. An inspection of Bing virtual earth imagery of the area shows the remarkable landscape setting with thermokarst lakes, but this is almost entirely missed in the manuscript. A better description of the geographical framework accompanied by illustrations would increase the potential interest and usage of the dataset.

We made this clearer. Inside an adjusted paragraph about the site description, we reference the overhauled Figure 1. Figure 1 is split now so that a first part now shows a larger overview (GoogleEarth imagery) and an UAV aerial oblique view from the upstream thermokarst lake over the valley, including alas lakes in the surrounding forests. These features are already mentioned in the text. We then present the two focused-on field sites in a separate figure allowing to show some more details than before. We hope this provides now the deserved detail to understand the landscape setting better.

In what concerns to the dataset in Zenodo, one important issue is the lack of the QGIS project file that should allow to open all geographical data. This is important and needs to be made available for review and for final acceptance of the manuscript.

We are sorry for this oversight and have uploaded an updated version including the QGIS project file.

Besides these more general comments, below you may find a list of edits and some comments to be addressed by the authors.

Title: "Thermo-hydrological observatory in a permafrost river valley landscape in Syrdakh, Central Yakutia". Consider mentioning Yedomá in the title and add the period of observations.

We have changed the title to "Thermo-hydrological river valley observatory in Yedomá permafrost from 2012 through 2022 in Syrdakh, Central Yakutia".

Line 78. Describe the thermokarst lakes, as their characteristics are relevant to the hydrological dynamics of the stream. A better description of the catchment is also needed.

We added information about lake sizes, lake depth (upper lake), and ice cover (upper lake) (lines 84 ff.). Together with more information on the catchment, as well as the reworked Figure 1, this hopefully provides now a better description of the field site.

Line 95. The name Quantum GIS was abandoned and the software is named QGIS.

We adjusted this.

Line 96. "at various depth" should be "at various depths".

We changed this.

line 101. 3.2 "Data location" should better read as "Location of observations" or "Location of observation points". Consider improving this subsection title.

We changed the section name to "Locations of observations".

Line 102-115. Section 3.2. The problems with the position of the data collection points are not clearly explained. Make it clearer as a correct understanding of the positioning is essential. Consider presenting the non-corrected (or original) coordinates, as well as the corrected geographical coordinates. As it is, it is not straightforward to understand the problems.

We have reworked the sections "Locations of observations" and "Geographic positions". The idea is to provide, first, in "Location of observations" a general description of how the spatial information is integrated in the database. Because we do not want to go into detail about the GPS measurement uncertainties at this point yet (subject to the actual measurement section), we want to only briefly mention that there were problems, that this has led to the chosen design with the GIS serving as the main tool for a user to ensure all positions make sense for an analysis. From here, one can use the provided and described Python script to extract the coordinates from the geopackage files. Therefore, we have now shifted all information about the uncertainties and imprecision to the actual measurement section and keep this introduction section as brief as possible. We reference all sections about the scripts and measurements now. The updated section reads as:

“The compilation of measurement points over multiple years made use of a differential GPS (dGPS), a theodolite, and handheld GPS instruments (see Section 4.4.2 for details). The accuracy and precision of instruments to obtain measurement locations varied between instrument types and between years. To obtain a coherent set of coordinates, we aligned all points relative to the imagery obtained with an Uncrewed Aerial Vehicle (UAV)(Section 4.4.1) inside the GIS database. We prioritized having the measurement locations placed correctly relative to the landscape features in the UAV imagery, e.g., having a water level sensor being placed centred in the river, or having a ground surface temperature logger at the transition from meadow to forest being placed at this identifiable transition in the imagery. The feature vector files holding the positional information are described in Section 4.4.4.

The resulting coordinates can be extracted manually or using a provided Python script (Section 4.4.3). Making use of this, the user can adjust the locations for experiments by editing the feature shape files and creating their own coordinate lookup table using the script. This also facilitates the generation of figures requiring the spatial information (Section 4.4.3). For river cross section water depths and velocities, relative positions from one shoreline to the other one, or with respect to the river position are reported in the CSV files; these dimensions might not match the provided UAV imagery as the width of the river might have changed between years. In each of the individual data files the location name is mentioned so that users can adjust such a profile according to their application needs with relevant information of the surrounding landscape available in the GIS database.”

Line 123: Rather than presenting this as an equation, it should be referenced as the file name structure.

We changed this to an in-text explanation.

Line 128: Modify order: L0, L1, L2

We changed the order.

Line 134. It is not an equation.

We changed this.

Line 134. Metadata and not meta-data

We changed this.

Lines 144-145. "Monotonous temperature shifts": does that this mean monotonic? Clarify the sentence. Do you mean isolated peaks? always $n=1$?

We rewrote the sentence. This was meant to say indeed monotonic, and $n=1$ was supposed to highlight that this occurred only once. It now reads as:

“[...] or when temperatures exhibit a constant-rate (linear) change over time, which occurred only once.”

Line 155. Indicate and explain the time-intervals of the measurements, as in Table 1, which is not very clear, there are measurements with intervals from 1h to 1 year.

We included the measurement interval information in the paragraph and reference Table 1. Table 1 contains in the table header now the information about the confusing hour-to-year intervals.

Line 160: Indicate all measurement depths in the thermistor chains as well as the installation setup (boreholes, or other; type of casing, casing diameter, infill medium)

We added these pieces of information now in the description.

Lines 198-199: Rephrase in order to clarify: "The calculation of thermal properties of the KD2 Pro device might have high uncertainties. This is because significant differences in some cases between the also utilized Anritsu thermometer are apparent".

We elaborated on this part after revisiting also the technical description in the KD2 Pro manual. The updated paragraph now reads as:

“Errors might be present in the calculation of thermal properties using the KD2 Pro device. This is because the KD2 Pro temperature measurements showed significant differences to the Anritsu thermometer (Fig. 5). The manual of the KD2 Pro highlights that the relevant formulas for the calculation of thermal properties use changes in temperature during the measurements rather than absolute temperatures (Decagon Devices Inc., 2016), thus a constant bias in the temperature measurements would not affect the calculation. If the temperature offset, however, indicates a more severe issue with the KD2 Pro temperature, this could mean that derived thermal properties were affected. As we did not conduct any controlled experiments on this issue, we cannot assess the potential scale of the error. The accuracy of the thermal parameters (other than stated in Table 3) could therefore not be assessed as the relevant information is not publicly available. The obtained value ranges for the different soil grain size compositions and SWC contents are similar to values obtained in other studies in the region (Zhirkov et al., 2021).”

Lines 214-217: The subsection is titled boreholes and piezometer tubes, but it does not contain information about the borehole setting nor piezometer tubes. Check the text and add information about these.

The section name was misleading. We changed the name to “Drill and probing rods”. The information about piezometer tubes was moved to the general site description as these tubes served multiple purposes and would not be well placed in a specific instrument section. Information on their installation was added there. Otherwise, the description of the “Drill and probing rods” section was not changed.

Line 220: "Upper thawed layer depths" should rather be "when thaw propagation was maximum"

We changed the naming entirely throughout the manuscript. We now use the variable name thawing depth (td). Filenames and folder names were adjusted accordingly.

Line 229: 71.5 m

We corrected that.

Line 276: "Deviations from the reporting classes exist." Please clarify what this means. The reader figures that the Malvern is used after 2017, but still the "deviations" part needs to be clarified.

Thanks for pointing this out. This part had in fact multiple errors. First, we clarified the "deviations" part that was referring to a deviation of the two finest grain size classes for the year 2013. This is explicitly mentioned now. Second, it was not reading that "some" of the samples were analysed with the laser grain size diffraction method but all of them. This has been fixed. Third, the file structure was described incorrectly. The CSV files hold the measurements for each individual depth as a separate column. This has been corrected. The paragraph now reads as:

"Grain size distributions were measured until 2017 at MPI and classified mostly using the Kachinsky classification (Kachinsky, 1968 [in Russian]) with around 10 relevant grain size classes. Grain sizes were determined using sieves with mesh sizes according to this classification (Kachinsky, 1968 [in Russian]). The reporting classes for 2013 deviated from other years for the two finest grain size classes (0.01 mm-0.005 mm, and <0.005 mm as compared to 0.01 mm-0.002 mm, and <0.002 mm). Some samples after 2017 were measured using a laser diffraction grain size analyzer Mastersizer 2000 HYDRO-G (Malvern) that provides a discrimination into 100 classes. Without relevant information available to homogenize these classes, we provide the classes as they were reported. For the file structure, this results in relevant grain size classes in one column and their respective weight % in a separate column; each measurement depth within a soil pit is reported as a single column. From 2012 through 2019, one or multiple soil pits were dug each year, but granulometric analyses were not performed each year."

Line 324 - Correct typo "unceertainty".

We corrected that.

Line 331 - Indicate if a solar radiation shield was used and type. From a photo in the dataset I see a logger attached to a tree. In what way does it affect temperatures? What is the aspect? Does it stay shadowed all year? These need to be addressed.

We added information on the shielding, orientation, and the location of instruments. The paragraph has been updated. The section (including the changes in response to the next comment) now reads as:

"[...] or with a vanEssen Micro Divers DI601 (D) (same as in Section 4.3.1). All instruments were installed at 2 m elevation from the ground at an approximate elevation of 149 m a.s.l. TB and D loggers were attached to the north-facing sides of larch tree stems. All but two loggers were installed at the southern side of CS 9 at Site 2. These two loggers were installed near CS 2 at Site 1: one similar to the other loggers at the transition from meadow to forest in the southern part of the valley, and one in the open valley section at a free-standing tree. TB and D loggers were installed with the exception of one TB (open valley section at Site 1) within the first few meters of the forest with a nail or a metal wire; the sensor of TAIR was attached at Site 2 underneath its logger housing box that was strapped to a tree a few more meters inside the forest. The sensors were installed north-facing to prevent direct solar

insolation. There was no shielding installed against diffusive radiation nor against any other kind of external influence.

The closest long-term meteorological station is located in Yakutsk (Yakutsk - WMO ID=24959, 103 m a.s.l.), around 100 km southeast. The data archive for Yakutsk was obtained via the website rp5.ru (Raspisaniye Pogodi Ltd., 2004) and is provided under "auxiliary/external". A correlation analysis for the period 2017 through 2018 (Fig. A3) showed a coefficient of determination of 0.991. The Yakutsk data are provided to facilitate a continuous time-series analysis, as none of the here-presented measurements were continuous at any of the locations."

Lines 331-332 - Why do you make reference to section 4.3.1?

This was done to reference the instrument description of the TB instruments. We added the information that this is the same logger type as in the referenced section.

Line 333 - Indicate the distance of the Yakutsk meteorological station.

We added this information.

lines 336-337 - Rephrase. The reference to "reasonable representation of air temperatures" is subjective. You may mention that the high coefficient of determination supports the good quality of the data and the regional climate signal's influence on local conditions at the study site.

We changed this sentence and also added additional information after adding the extended description (previous comments). The Uncertainty and errors section now reads as:

"Uncertainty and errors: The low maximum sun elevation angle in Syrdakh of about 51° at summer solstice, together with the dense forest prevent any direct solar insolation; whether the air temperatures of the single TB instrument near Site 1 in the open valley section were affected by direct solar insolation was not tested. Riming and snow cover might have affected the measurements of the exposed TB and D sensors; snow cover could be excluded as an external factor on the measured air temperatures obtained with the TAIR sensor due to its sensor location underneath its logger box. For using an external time-series from a meteorological station with a longer record, the Yakutsk WMO station is a possible candidate. The high correlation of the data from this station with the local measurements supports the assumption of the regional climate influencing the local conditions in Syrdakh and support the use of the continuous time-series from Yakutsk for studies in Syrdakh after correction. However, stronger deviations were present in winter (Fig. A3). No analysis on possible reasons for the seasonal deviation has been performed."

Line 378 - Correct "a coefficient"

We corrected that.

Line 437: Indicate if it is WGS84 UTM Zone 52N or other datum.

We added that this is WGS84 datum.

Line 441: You mention the use of GCPs in 2021, but please indicate the accuracy. It is also important to know the image overlap in the flight, as well as flight height, if available. In the following subsection you mention a 0.5m absolute accuracy. Is this horizontal? What about vertical? How was the correction made, as 0.5m is really a large positional error.

We have added additional information on the processing. There was a misunderstanding within our team about the details on the availability of GCPs in 2021. As in an earlier campaign the instrument was not operational so that the DSM was generated in fact without GCPs. An earlier attempt with imagery from 2017 did not work either when the dGPS was broken. Unfortunately, we have no means to correct this. As described in the manuscript elsewhere, the absolute positioning of various points was subject to many failures and problems. This is mentioned (in a shortened form) in the paragraph now.

Regarding the precision of the Leica Viva Uno 10 system, we adjusted the description. The reported accuracy of a RTK system with a base station that runs for several hours seems overly conservative with the provided 0.5 m. We added information stating this now. We also added to the paragraph that the system was running in RTK mode with initialisation of the base station for a few hours. For this setup the expected accuracy would be in the few-centimetre range. However, in the homogenization process, we compared the coordinates of the same locations for different years and found offsets of up to 1 m. Without additional information available on which positions were more reliable, or possible reasons for this offset, and additionally facing the problem of the somewhat inaccurate georeferencing of the derived orthophoto and DSM without GCPs (instruments were too small to unambiguously identify and mark), we had to decide on what would be the most useful way for homogenization. We decided to use the DSM (as is) for the basis for homogenization and align all the points on identifiable features as explained elsewhere.

We adjusted the text accordingly and added a theoretical expected conservative accuracy estimate of 5 cm to 20 cm (included also in Table 1, where a footnote mentions the observed offset and refers to the relevant Section). The updated paragraph now reads as:

“Positions of measurement locations were recorded using one or multiple of the three devices: 1) Leica Viva Uno 10 (GPS+GLONASS) differential GPS (dGPS) system, 2) a Ural Optical and Mechanical Plant 3T5KP Theodolite with 2 (5) arcseconds horizontal (vertical) resolution, 3) GARMIN handheld GPS with around 10 m accuracy. The Leica Viva Uno 10 was operated in differential RTK mode using a temporary base station that was established through multi-hour static observations (between 1 and 3 hours) and subsequently used for short-baseline RTK measurements (100 m to 3 km). Under such conditions, typical absolute positioning accuracy was expected to be within few centimeters to decimeters (5 cm to 20 cm).

However, as base stations were re-established independently for different campaigns and cross-sections, small systematic offsets between campaigns are expected. Investigation of the positions of different years for the same locations showed, however, differences of up to 1 m. For the different campaigns, additional information was unavailable about which positions were more reliable, or about possible reasons for this offset. In order to coherently homogenize all measurement positions with the landscape features (Section 4.4.1), the DSM (as is) was used as the basis for homogenization and to maximize the usefulness of the database. Hence, the measurement points were manually aligned within the GIS database with identifiable landscape features. For this, the points were aligned to known fix points in

the orthomosaic photo, like the river shoreline or forest-meadow boundary. In case a user requires more accurately or differently aligned points, it is possible to adjust the positions of features in the GIS project and extract the resulting adjusted positions using a provided Python script (Section 4.4.3).

The expected uncertainties from using the dGPS with re-initializations for different measurement locations and different years were significantly lower than the observed differences identified between different years (up to 1 m). We do not have the means to assess the sources of error. By adjusting points manually to align with identified points in the orthomosaic, we additionally introduced a maximal horizontal error of around 3 m. However, based on the reasoning to prioritize a coherent alignment of points with landscape features in the DSM, the relative error was assumed to be < 1 m.”

Line 448. You mention Leica Viva Uno 10 (GPS+GNSS). Do you mean GPS+GLONASS?

Yes, we changed this.

Line 453. See comment for lines 110-115.

The answer to this has been added to the paragraph presented in the answer to the previous comment about the GPS accuracy.

Figures and Tables

Figure 1. A map is needed showing the framework of the site, especially showing the two lakes and the general landscape features.

We split Figure 1 into two figures. The first shows now the general overview by making use of Google Earth imagery and a UAV oblique aerial view image. The second figure shows a more zoomed in view. Displaying labels within the figures would overload the figure. The GIS database will serve any user to see the details.

Figure 3 - The depths from the sensor names do not correspond to the boundaries in the Y axis.

This is not clear to us. We checked each sensor name and the depth of a sensor indicated in the file name (as shown in the figure legends); we find that these depth descriptions are matching the depth range indicated by the label on the y-axis in all cases. We updated the figure caption to make this clearer. We do not see any misplaced time-series though.

Table 1 is very complete but the font size is too small for reading. Consider improving it. Measuring intervals are not clearly understandable from the table. They should be readable according to instrument types horizontally.

Measuring intervals were supposed to show each possible measuring interval; we change this to the range of measuring intervals, e.g. “(2 to 8) hours”. The table has been converted to a split landscape table allowing for bigger font size and better readability. The measuring interval writing was adjusted, and we add additional information on that in the table caption. We would adjust the font sizes further in a potential typesetting procedure with the technical staff of Copernicus to fit the table perfectly on two pages.

Zenodo dataset

- The QGIS project file syrdakh_gis_2025-06-10.qgz is not in the dataset and needs to be included.

We are sorry for this oversight have uploaded an updated version including a project file.

- DEM: Actually it is a DSM and not a DEM as correctly described in the manuscript, but the file (and those mentioning a DEM) must be named accordingly. I also recommend masking the DSM using the boundaries of the Orthomosaic, as there are large parts of the DEM that are just noise and should be removed. If the data is to be used by modelers, then the DEM should include only the area with good data (despite the other severe limitations with slope that are mentioned in the manuscript). A good way to make this data useful, especially given the poor GCPs in the terrain, would be to make all aerial photos available in the Zenodo dataset. This would allow for future reprocessing.

Due to publishing of some of the raw imagery as single scenes in in another journal, we prefer to not make all the UAV imagery available but will include a statement in the data availability section. We want to state that these specific raw data, which themselves are not part of the here presented dataset, can be obtained through one of the co-authors.

All mentions of DEM are adjusted to read now DSM. Regarding the UAV raw imagery, we did not see a data availability section to provide the statement “upon request”. Should this be possible later on in the review workflow, we will add this statement there.

Regarding the usability of the DSM, we added two masks in geopackage format that allow clipping the input raster data. The DSM has been clipped already to exclude clear artifacts, but we provide the orthomosaic in its full extend as it provides some insights on the forest cover. The geopackage file is mentioned in the respective section about the DSM.