



swissBEDROCK

Release notes for Release 1

General information about swissBEDROCK

The boundary between solid rock and unconsolidated rock is crucial across various disciplines. This transition markedly alters most physical and chemical properties of deposits. Factors such as strength, lithology, conductivity, porosity, and permeability are significantly influenced by this interface. Hence, understanding its depth beneath the topographic surface is essential. It plays a key role in assessing groundwater resources, potential water contamination, and predicting natural hazards like landslides and mudslides.

Therefore, the Federal Office of Topography swisstopo has developed swissBEDROCK, with the aim of automated revisions to incrementally increase the information on the bedrock surface. swissBEDROCK is a high-resolution (10 x 10 meter) national dataset developed by the Federal Office of Topography (swisstopo) that provides detailed geological information on Switzerland's bedrock interface. It includes:

- Bedrock elevation model (BEM): the elevation of the bedrock surface.
- Thickness model (TMUD): the thickness of unconsolidated deposits above the bedrock.
- Uncertainty data: estimated accuracy of the provided values.
- Version history: records of changes across dataset versions for each cell.
- Change data: quantifies differences between the current and previous versions.
- Author information: each version includes a numeric ID identifying the contributor of that update.

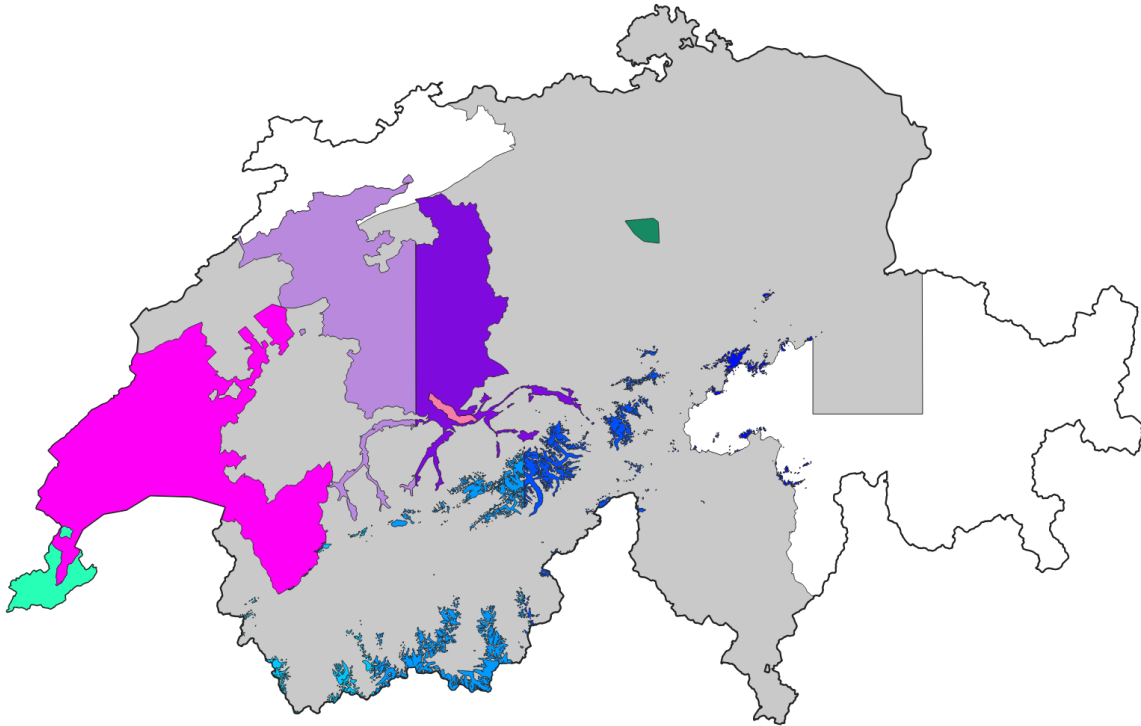
Structure and maintenance of swissBEDROCK

swissBEDROCK consists of model parts provided by external sources or third parties and model parts made by the Federal Office of Topography. These model parts are clearly attributed to their respective authors for further details. swissBEDROCK also features a versioning system, ensuring transparency and traceability over time. For each cell in the dataset, previous values are retained, along with change values, enhancing the ability to track modifications and updates accurately. This comprehensive approach enables users to access reliable and detailed geological information essential for various applications across Switzerland.

Maintenance is done with automated processes within a defined area/perimeter. Within this perimeter, the model is either replaced with a third-party model (Regional Replace) or it is readjusted within the perimeter to new drilling data and GeoCover (Regional Update). More information on these automations and the workflow can be found in the [swissBEDROCK model description](#).

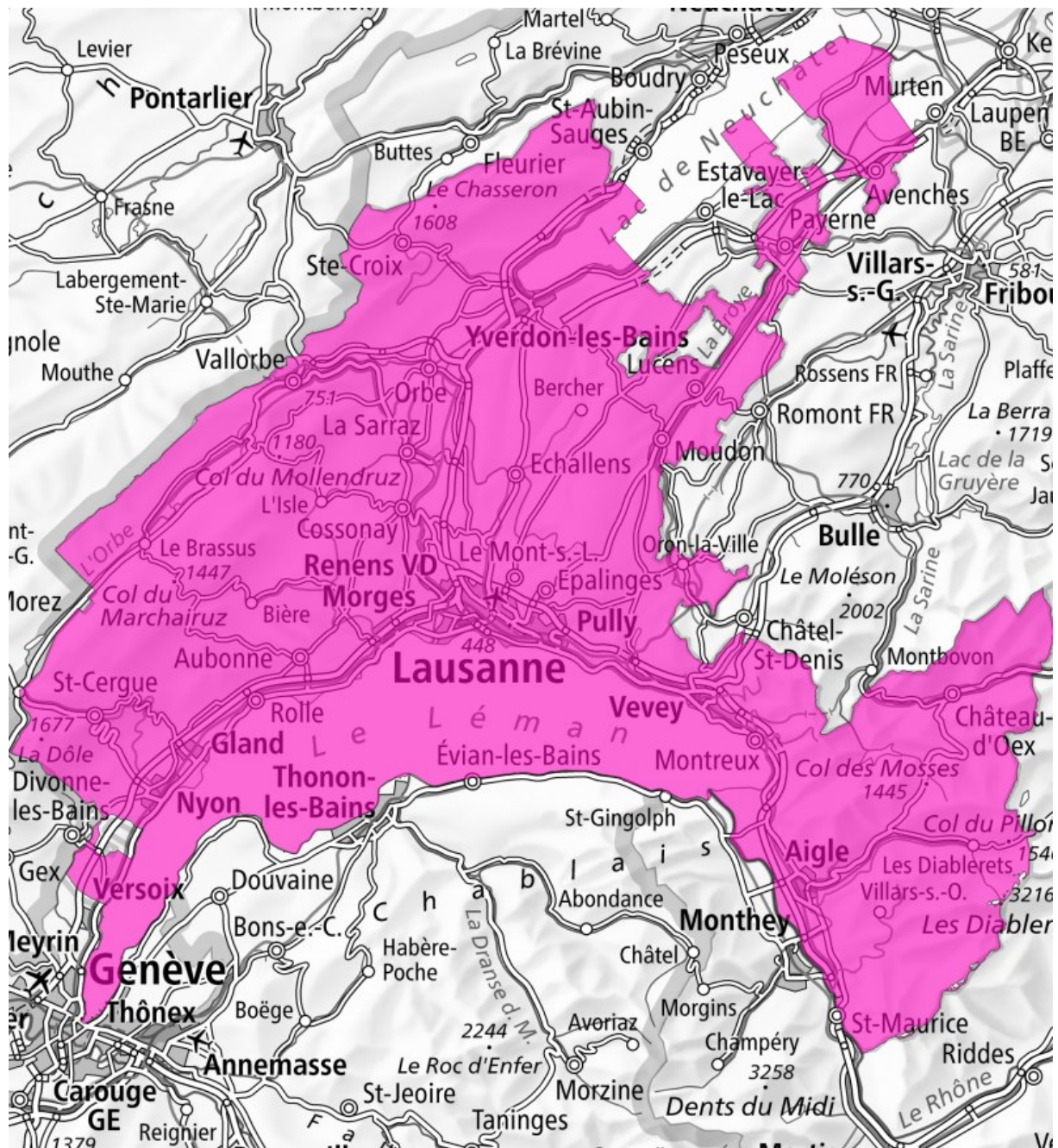
Release 1

This release consists of several regional changes (versions) to the current model (in grey). For this first release the current model is Version 221104 (Dürst Stucki 2015, revised swisstopo 2021). The image below shows the regions that have been revised. Each color corresponds to a version.



Version	Name	Automation method	Author	Color
241206	Toit du Rocher 2021	Regional Replace	VD	Pink
250228	GLAMOS part1	Regional Replace	GLAMOS (2020)	Cyan
250303	GLAMOS part 2	Regional Replace	GLAMOS (2020)	Blue
250306	GLAMOS part 3	Regional Replace	GLAMOS (2020)	Dark Blue
250321	GLAMOS part 4	Regional Replace	GLAMOS (2020)	Purple
250425	BE_250424 part 1	Regional Replace	BE	Light Purple
250428	BE_250424 part 2	Regional Replace	BE	Dark Purple
250430	Thunersee	Regional Replace	swisstopo	Red
250515	Baarerbecken	Regional Replace	ZG	Green
250519	GE_2021	Regional Replace	GE	Orange

Version 241206 Toit du Rocher 2021



Reason for revision:

The reason for a revision in this area is that the previous version in this area is version 221104 (authored by swisstopo), which is based on data up to 2013-2015 and a cell size of 25m. The Canton of Vaud has published a new model for this area; *Toit du Rocher 2021* (specifically, the file "Altitude_Toit.tif") based on:

- (i) new survey data collected since 2018,
- (ii) (ii) the reinterpretation of the seismic campaigns of Lake Geneva and the Rhône plain by the Cantonal Museum of Geology, and
- (iii) (iii) local manual corrections.

Additionally, the cell size of *Toit du Rocher 2021* is 10m. For more information on the original third-party model go here: <https://www.vd.ch/environnement/geologie/cadastre-et-connaissances-geologiques/geologie-en-3d/cartes-du-toit-du-rocher>

Automation method:

The version consists of a Regional Replace revision. This means that a third-party model has been used to replace part of the existing model. The supplied 3rd party model is respected, meaning that adjustments have been made outside the regional perimeter to ensure a fit with the existing model. Adjustments were made within a 200 meter buffer zone. More information on these automations and the workflow can be found in the [swissBEDROCK model description](#).

Notable features:

Overall, version 241206 shows areas where the bedrock elevation is much lower than in the previous model (blue, colors in image below. Several hundred meters). When these large differences occur along the cantonal boundary, the buffer zone adjustment is abrupt and a successive revision of the adjacent region is recommended.

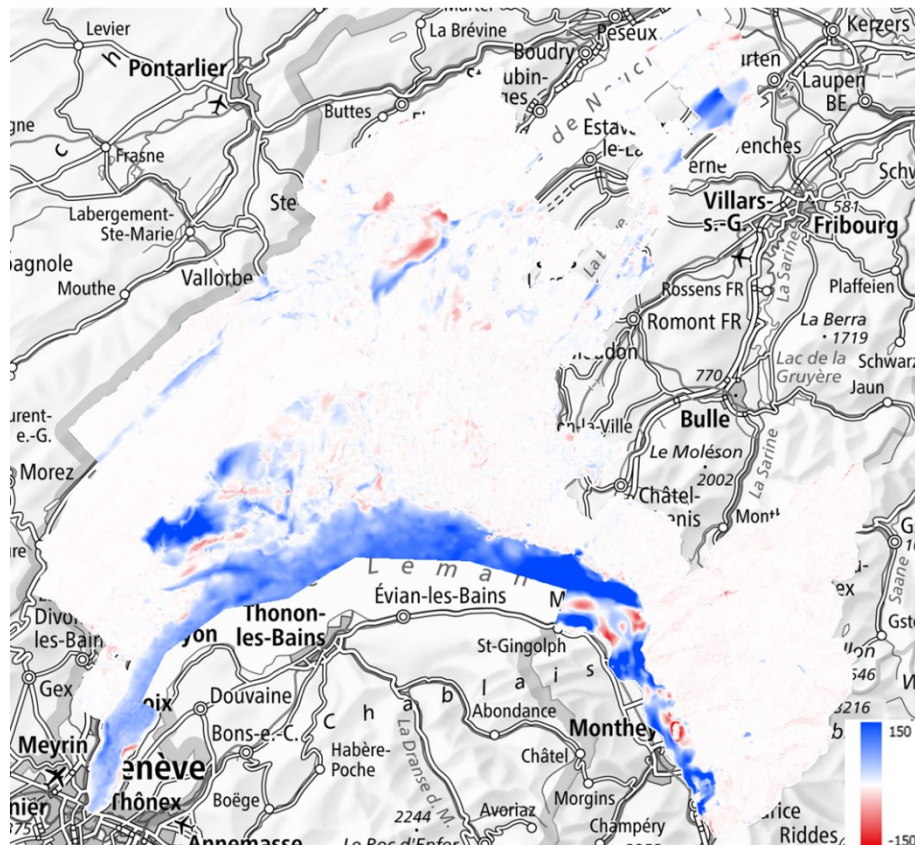
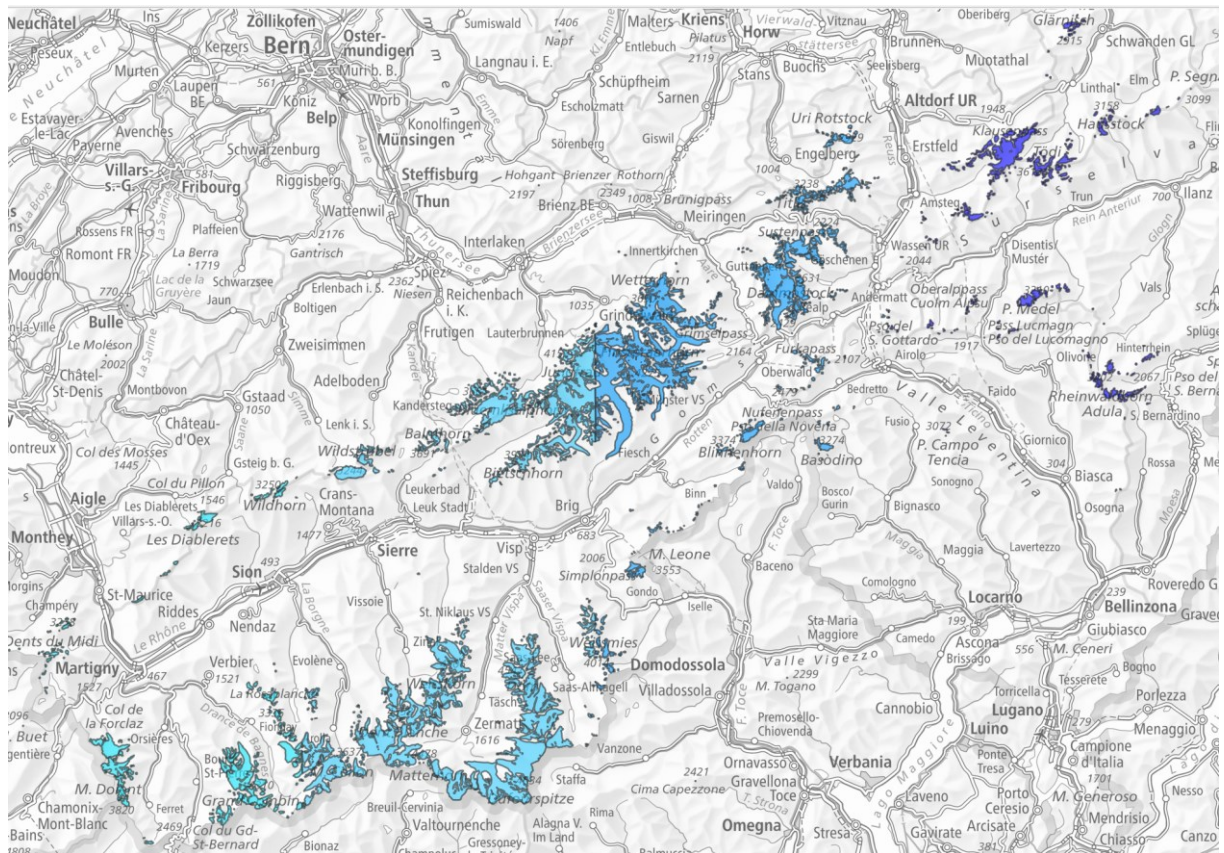


Figure 1, Change map. Showing the changes to the previous model per cell. Where the new model is either lower (blue) or higher (red) in elevation.

Version 250228, 250303, 250306, 250321 GLAMOS 2020



Reason for Revision:

The previous version of this model segment (Version 221104, authored by swisstopo) was based on data collected between 2013 and 2015, with a 25 m cell size. In glacier-covered areas, it used the surface topography (DEM25) as a proxy for bedrock due to the lack of subglacial data. To improve accuracy, we now incorporate modeled ice thickness data from Glacier Monitoring Switzerland (GLAMOS 2020). By subtracting this ice thickness from the surface topography (swissALT13D 10 m), we obtain a maximum estimate of the bedrock surface — excluding any unconsolidated deposits. The integration of this data significantly enhances the swissBEDROCK model's accuracy in glaciated regions.

For practical implementation, the GLAMOS 2020 dataset was subdivided into several sections, leading to the sequential incorporation of Versions 250228, 250303, 250306, and 250321.

More information on the GLAMOS dataset is available here:

https://doi.glamos.ch/data/icethickness/icethickness_2020_r2020.html

Automation Method:

These versions represent a Regional Replace revision. A third-party model (GLAMOS 2020) was used to replace a specific region of the existing model. The imported dataset was preserved without modification within its core extent. To ensure continuity with surrounding areas, adjustments were applied within a 200-meter buffer zone at the model boundaries. Details on this automation workflow are available in the swissBEDROCK model documentation.

Notable Features:

Incorporating the GLAMOS dataset substantially improves bedrock estimates beneath glaciers. A particularly striking example is found under the Konkordiaplatz, where the difference between the prior DEM-based estimate and the GLAMOS-constrained model highlights the impact of using glacier thickness to estimate bedrock. Note that unconsolidated deposits are not accounted for, so the actual bedrock elevation may be lower than estimated.

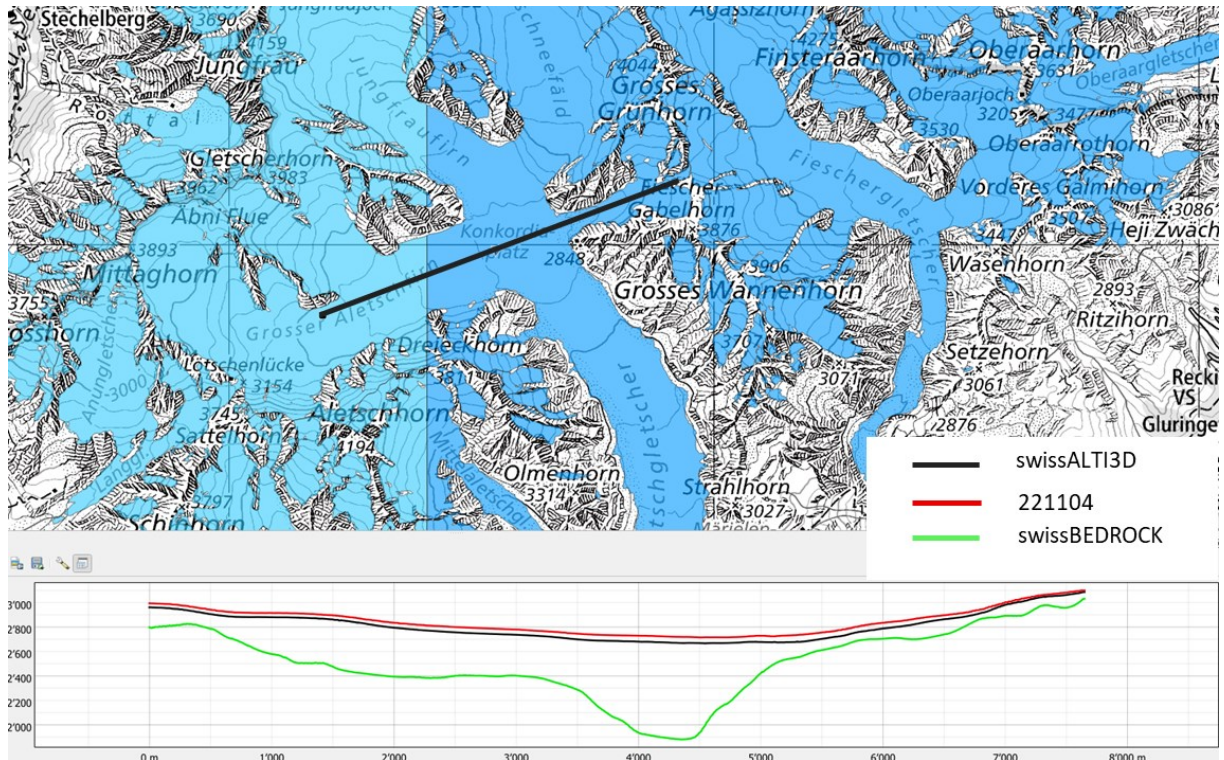
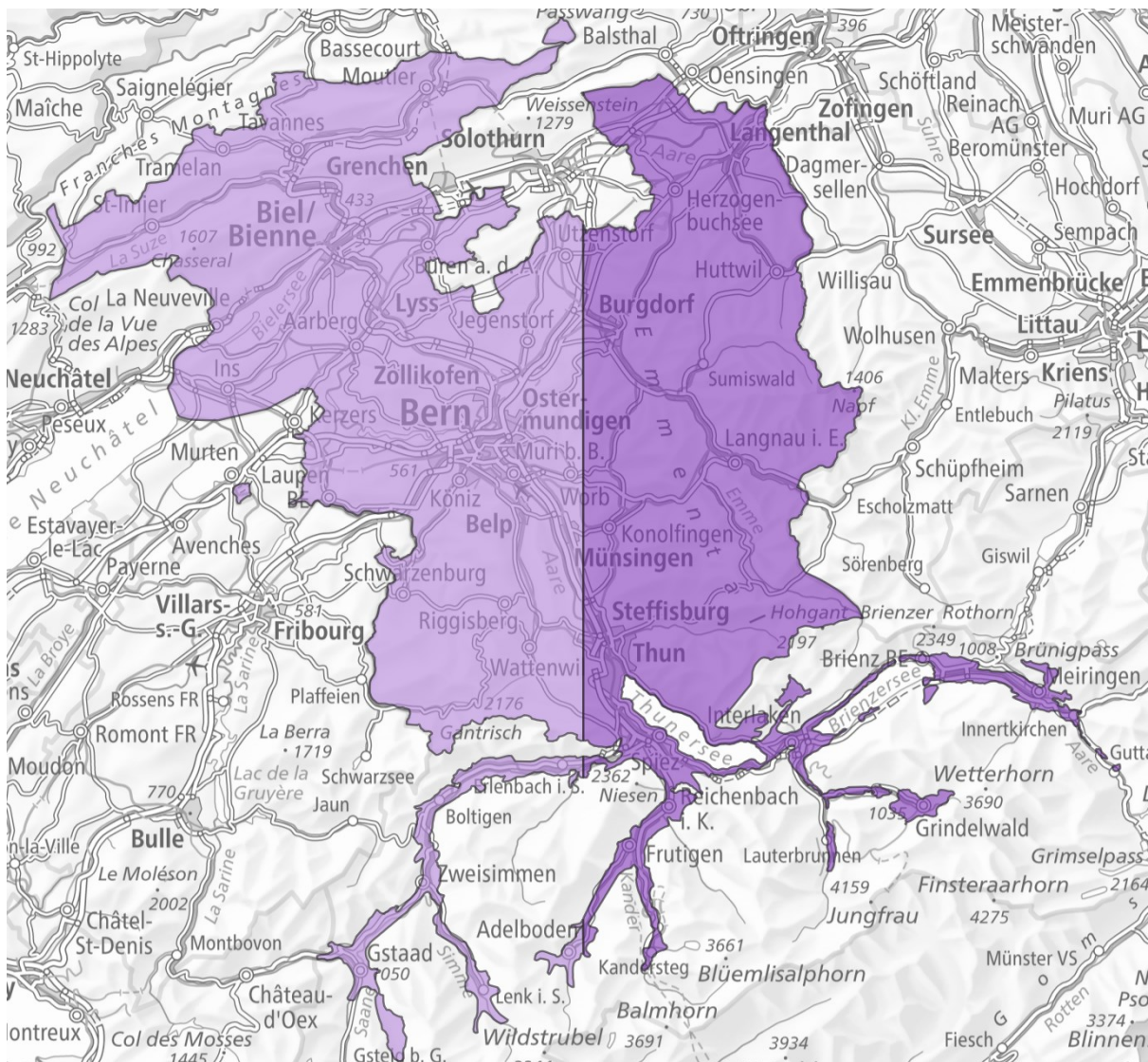


Figure 2, A cross-section through the Konkordiaplatz. The swissBEDROCK (with version 250303 and 250306) is updated with the GLAMOS (2020) dataset and shows a very large difference to the old 221104 version. We also see the difference between DEM25, which is identical with version 221104 and swissALTI3D.

Version 250425, 250428 BE



Reason for revision:

The reason for a revision in this area is that the previous version in this area is version 221104 (authored by swisstopo), which is based on data up to 2013–2015 and a cell size of 25m. In the meantime, the Canton of Bern has developed a new model (released on 250424), which incorporates more and newer borehole data, as well as geophysical measurements (gravimetry). This model also improves spatial resolution with a cell size of 10m. Due to the size of the area, the update has been split into two parts: version 250425 and 250428.

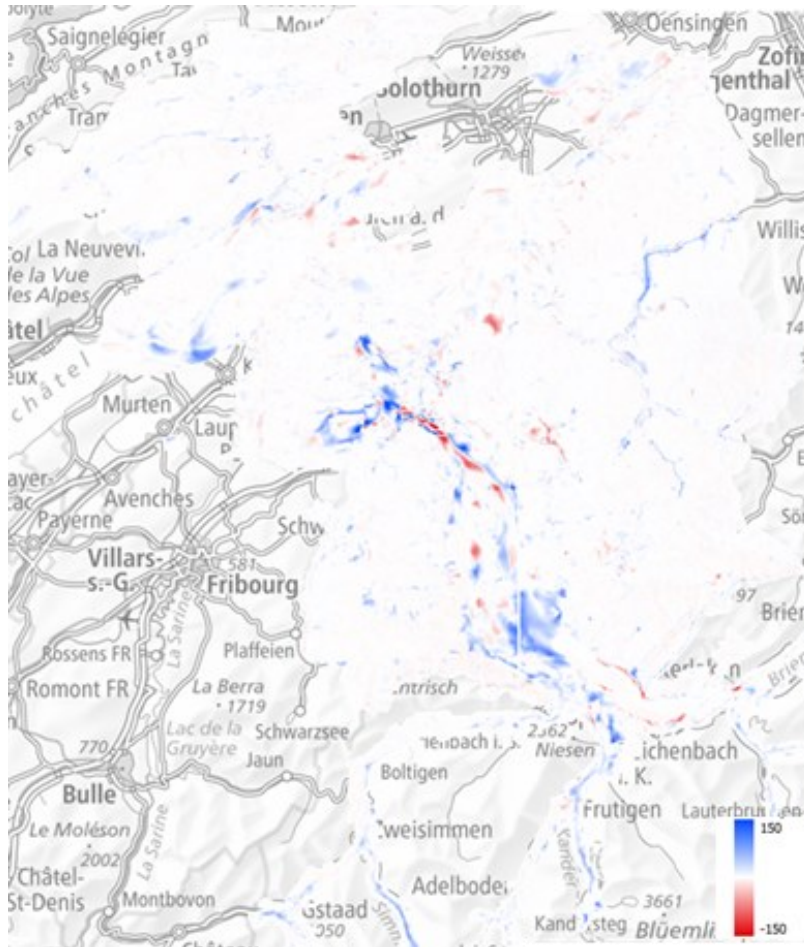
For more information on the original third-party model go here:

<https://www.agi.dij.be.ch/de/start/geoportal/geodaten/de-tail.html?type=layer&code=FELSRAS>

Automation method:

The version consists of a Regional Replace revision. This means that a third-party model has been used to replace part of the existing model. The supplied 3rd party model is respected, meaning that adjustments have been made outside the regional perimeter to ensure a fit with the existing model. Adjustments were made within a 200 meter buffer zone. More information on these automations and the workflow can be found in the [swissBEDROCK model description](#).

Overall, the inclusion of the model of canton Bern shows many large changes (up to 150 m). These are most prominent along the Aare and Gürbe valleys. The cantonal model shows greater depth around the city of Thun (about 50 meters deeper than the previous model).



In the area of the city of Bern, the combination of dense borehole data and gravimetric measurements reveals a canyon-like morphology of the bedrock surface. This interpretation differs substantially from the previous model (221104), which lacked the data resolution to capture such features.

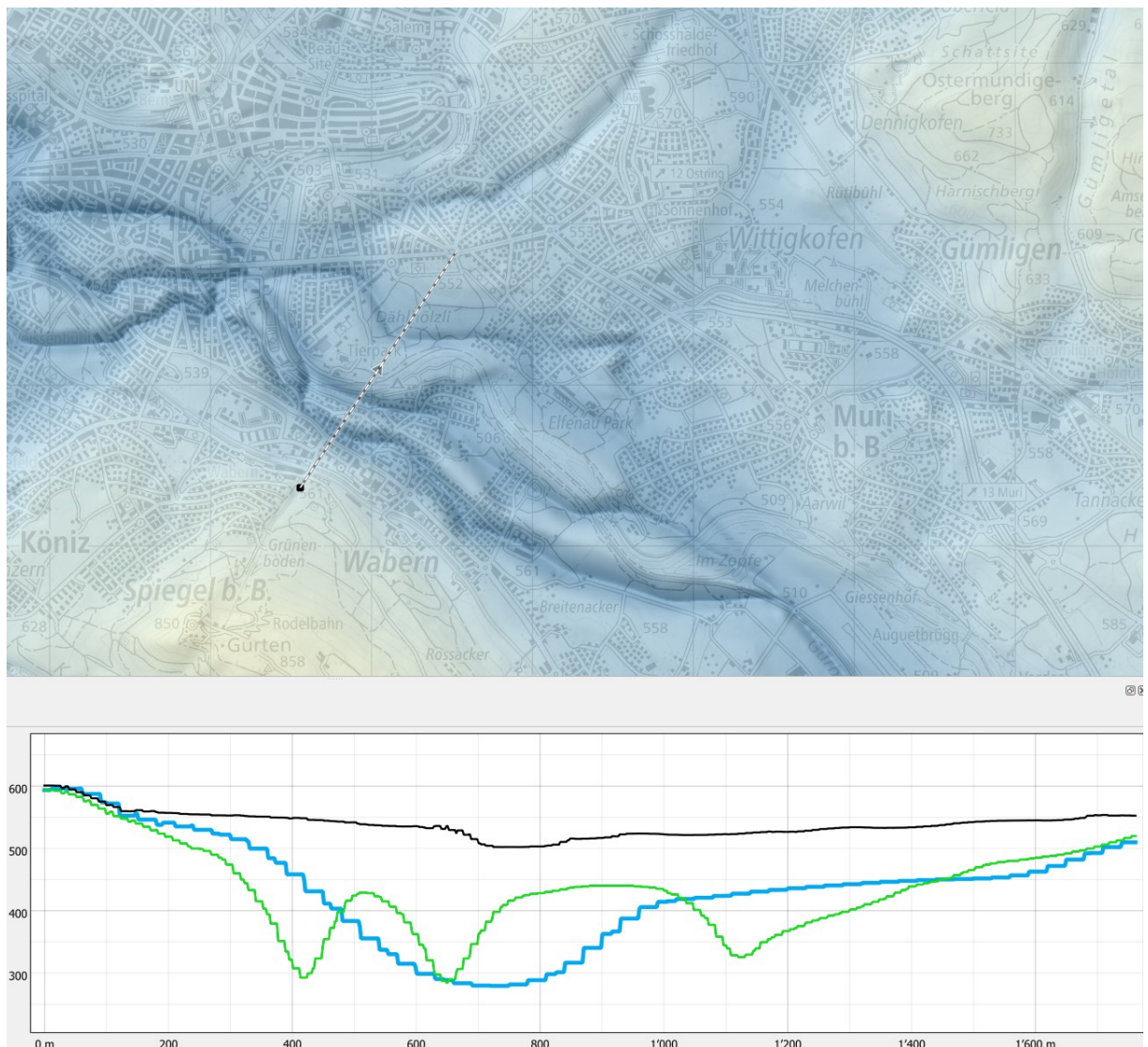
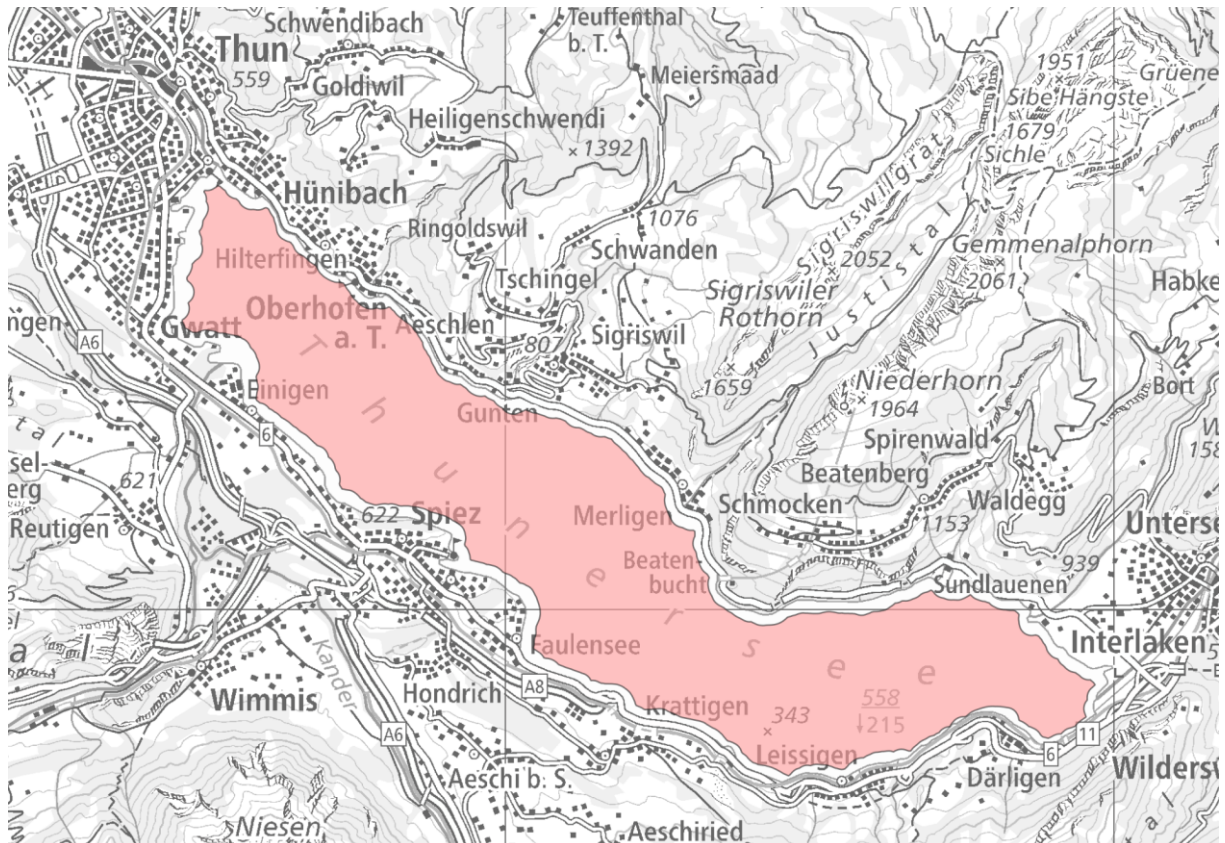


Figure 4, Map view of the part of the city of Bern. In the cross-section view below the blue line represents the previous model and the green line the current model with the integrated Version. Clearly visible is the canyon like geometry obtained from more detailed information.

Version 250430 Thunersee



Reason for revision:

During the incorporation of Version 250428, modelling artefacts were identified within the Lake Thun area. Version 250428 showed bedrock above bathymetry close to the edges of the lake (see green line in figure below). To correct these anomalies, a defined perimeter around Lake Thun was established. Within this boundary, the model has been reverted to the original swisstopo Version 221104. Although this version is generally outdated, it remains the most accurate representation of the Lake Thun area currently available. For more information on the original swisstopo 221104 model, see: [swisstopo – wissen wohin](#) (Dürst Stucki 2015. swisstopo 2021)

Automation method:

The version consists of a Regional Replace revision. This means that a third-party (in this case swisstopo is treated as the 3rd party) model has been used to replace part of the existing model. The supplied 3rd party model is respected, meaning that adjustments have been made outside the regional perimeter to ensure a fit with the existing model. Adjustments were made within a 200 meter buffer zone. More information on these automations and the workflow can be found in the [swissBEDROCK model description](#).

Notable features:

The inclusion of Version 250430 has corrected the issue along the edge of lake Thun. This Version is now respects the bathymetry.

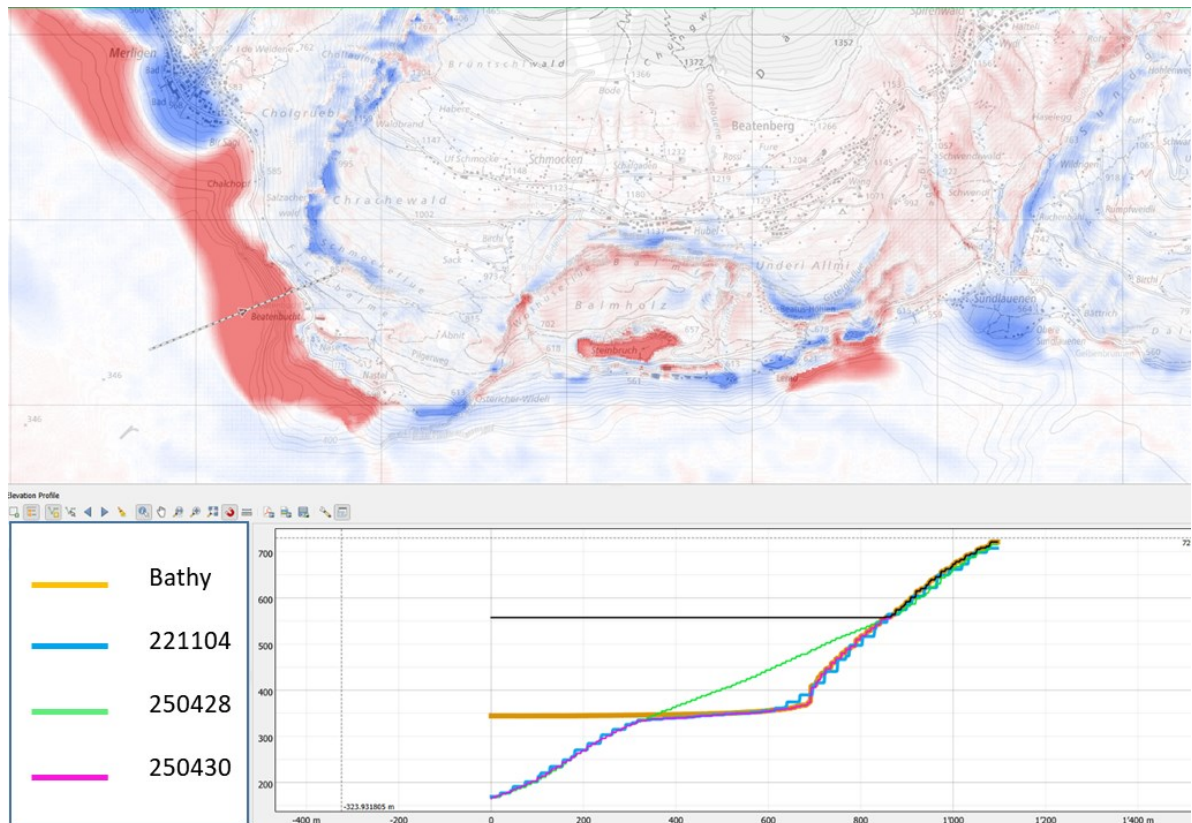
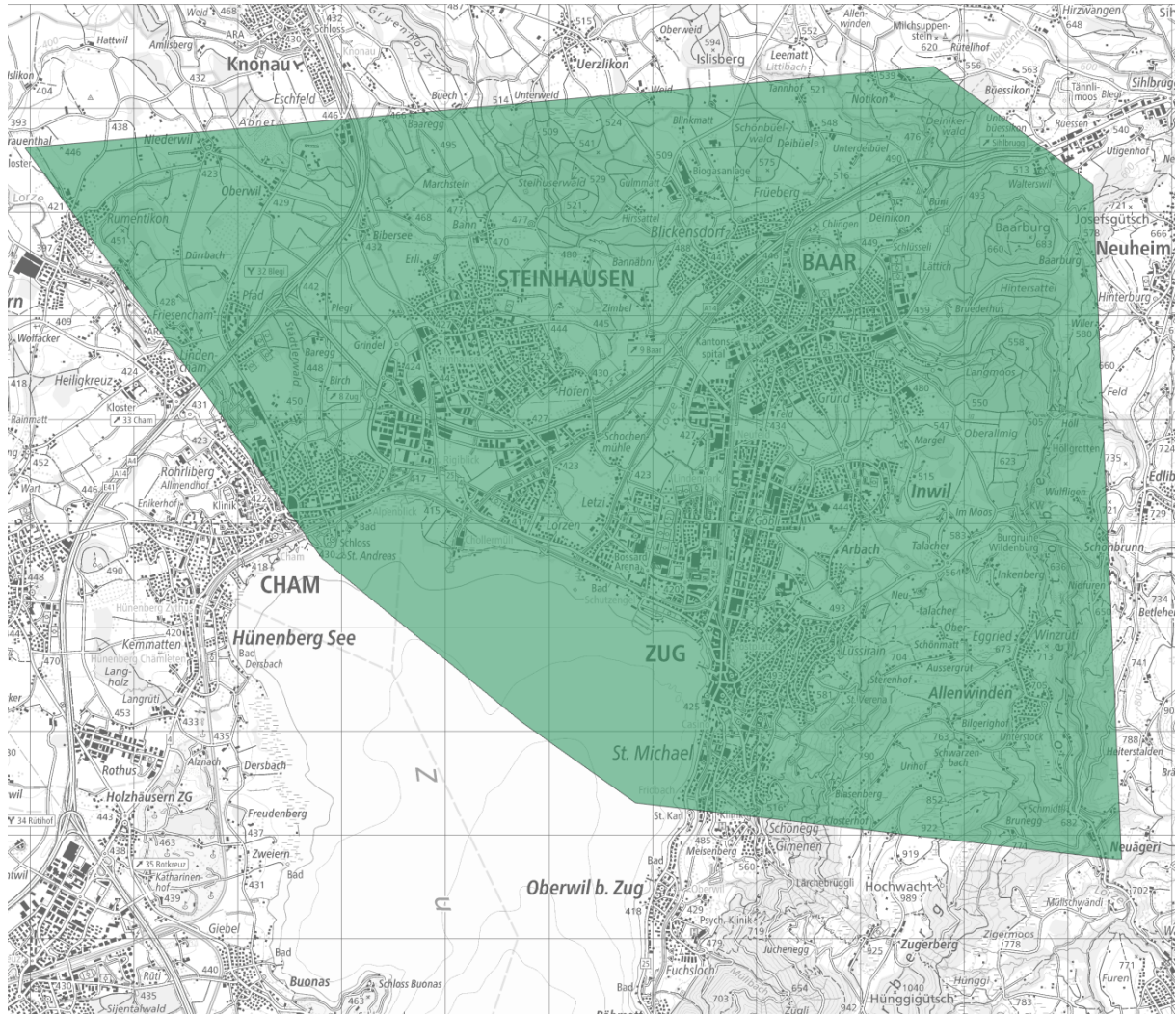


Figure 5, cross-section through the Beatenbucht area. Displayed are the various versions. Version 250428 clearly shows the anomaly close to the edge of the lake, where the model is above the bathymetry. The previous version 221104 has been used to correct this issue. The resulting version 250430 is correct and stays below the bathymetry from the lake edge to the deeper part of the lake.

Version 250515 Baarerbecken



Reason for revision:

The reason for a revision in this area is that the previous version in this area is version 221104 (authored by swisstopo), which is based on data up to 2013-2015 and a cell size of 25m. The canton of Zug commissioned a new evaluation of geological data for a study on the thermal potential of a deeper unconsolidated rock aquifer in 2023. The modeling of the bedrock elevation surface was part of this assignment. Additional to the re-evaluation of geological data (and the potential for more recent data) also the model was made with a finer resolution of 5x5 meter cell size.

For more information on the original third-party model go here:

<https://staka.zug.ch/organization/kantonale-behoerden/vollziehende-gewalt/baudirektion/amt-fuer-umweltschutz/wasser>

Automation method:

The version consists of a Regional Replace revision. This means that a third-party model has been used to replace part of the existing model. The supplied 3rd party model is respected, meaning that adjustments have been made outside the regional perimeter to ensure a fit with the existing model. Adjustments were made within a 200 meter buffer zone. More information on these automations and the workflow can be found in the [swissBEDROCK model description](#).

Notable features:

Overall, the changes are relatively small, with the largest variations being around plus or minus 50 meters. A notable feature in the Unterägeri region is a possible continuation of a subglacial tunnel valley extending northward, potentially connecting to the well-known Richterswil-Zug subglacial tunnel valley.

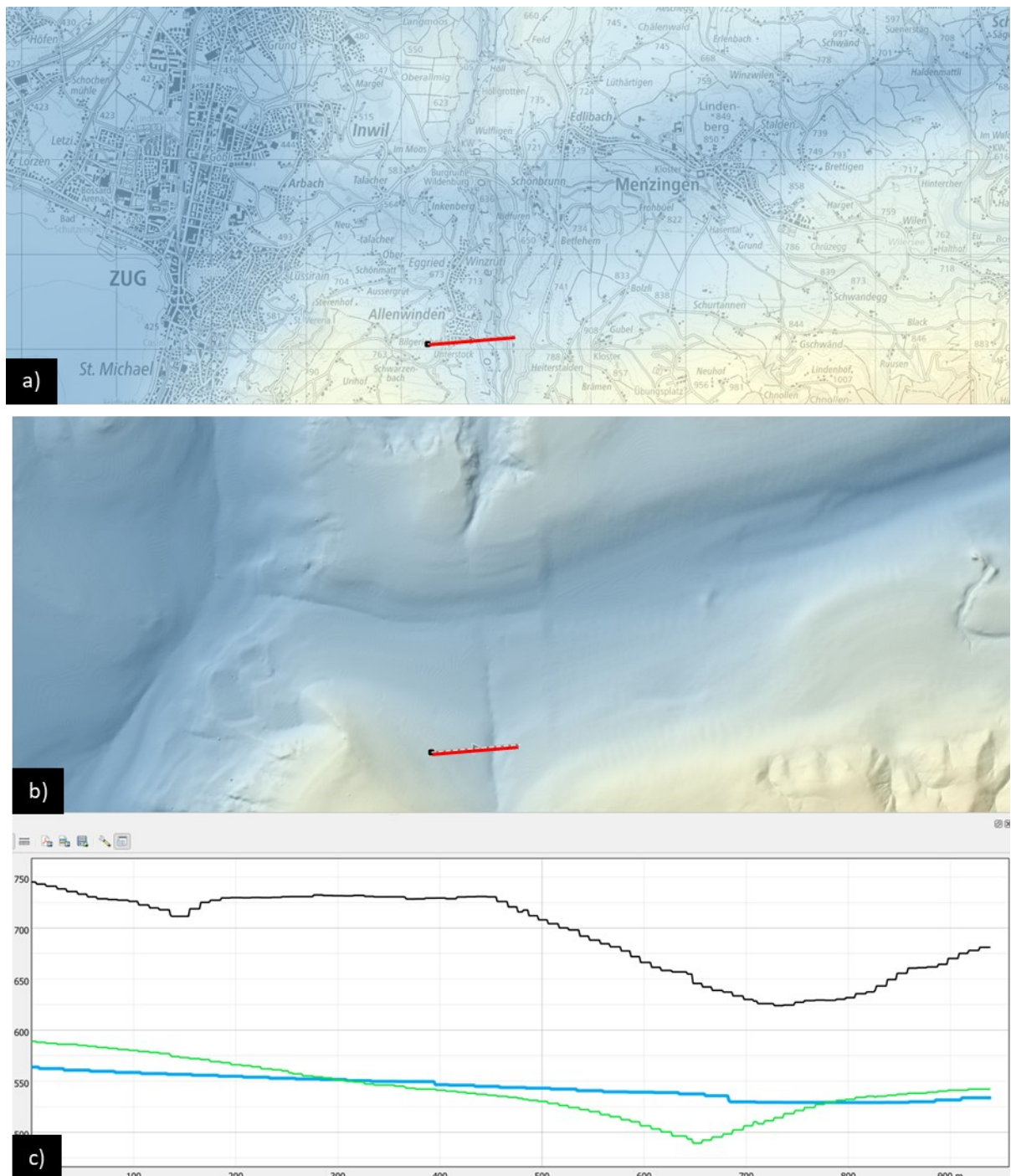
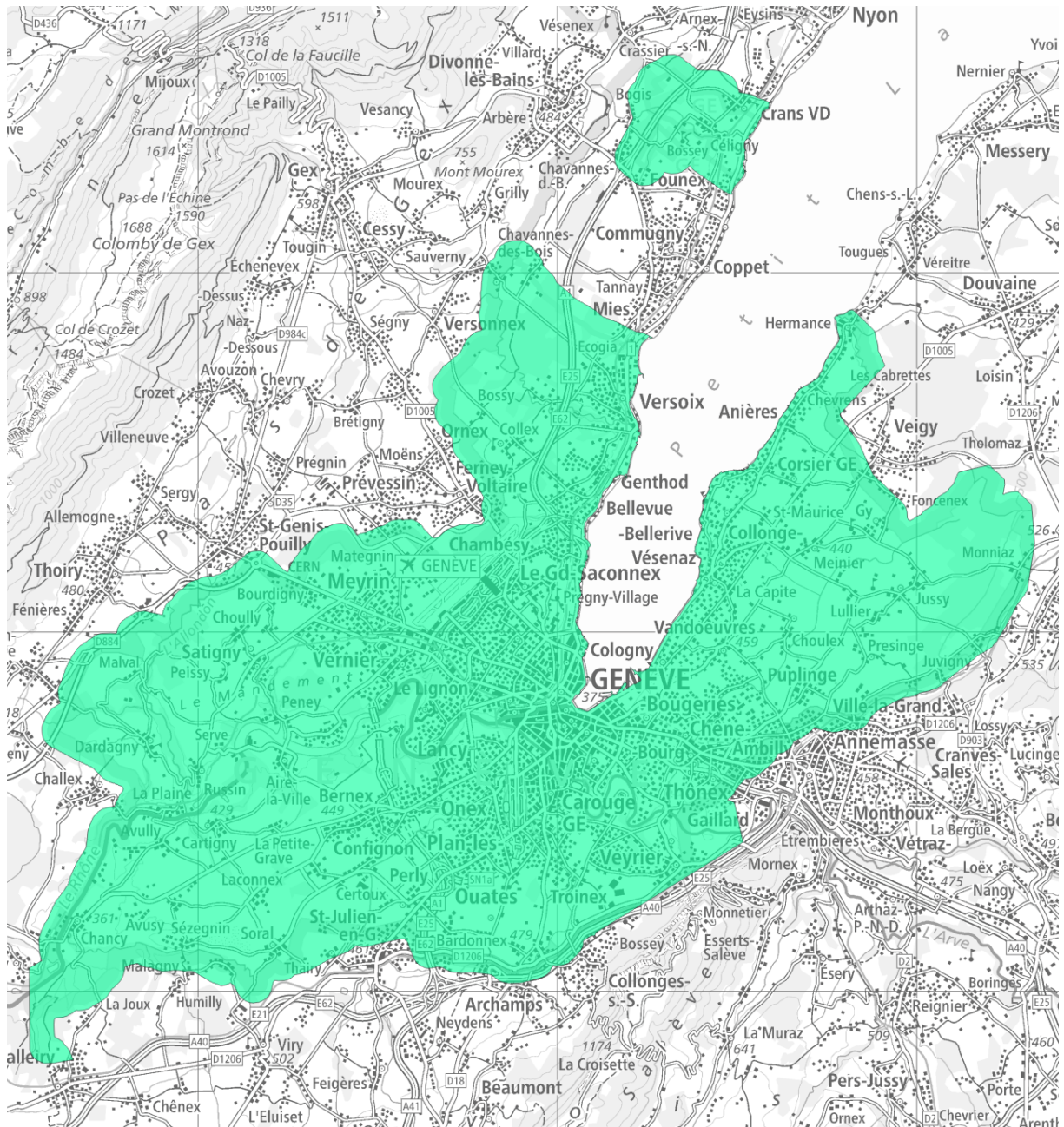


Figure 6

Version 250519 GE_2021



Reason for revision:

The reason for a revision in this area is that large part of the region has the previous version in this area is version 221104 (authored by swisstopo), which is based on data up to 2013-2015 and a cell size of 25m. The canton of Geneva has provided a model with published by the canton in July 2021 (GE_2021). The model incorporates more recent data and has a finer resolution of 10x10 meters.

For more information on the original third-party model go here:

<https://sitg.ge.ch/donnees/gol-alt-toit-molasse>

Part of the model region, lake Lemman, has version 241206 as a previous model (also in this release). After consulting with canton Geneva, it was concluded that the 241206 model in the lake Lemman region has higher quality and is preferred over the GE_2021 model. Hence the perimeter has been adjusted to exclude lake Lemman from the replacement.

Automation method:

The version consists of a Regional Replace revision. This means that a third-party model has been used to replace part of the existing model. The supplied 3rd party model is respected, meaning that adjustments have been made outside the regional perimeter to ensure a fit with the existing model. Adjustments were made within a 200 meter buffer zone. More information on these automations and the workflow can be found in the [swissBEDROCK model description](#).

Notable features:

Overall, there are considerable changes. However the largest changes occur where the version 250519 is tied to version 241206 in lake Lemman, the largest variations being around plus or minus 125 meters. In the image below b) shows the bedrock elevation model of swissBEDROCK release 1 (which entails both version 241206 and 250519), although most transitions are smooth, there are parts along the lake boundary where the transition is more abrupt or steep. This is not necessarily false but is a feature that can be addressed for a following update.

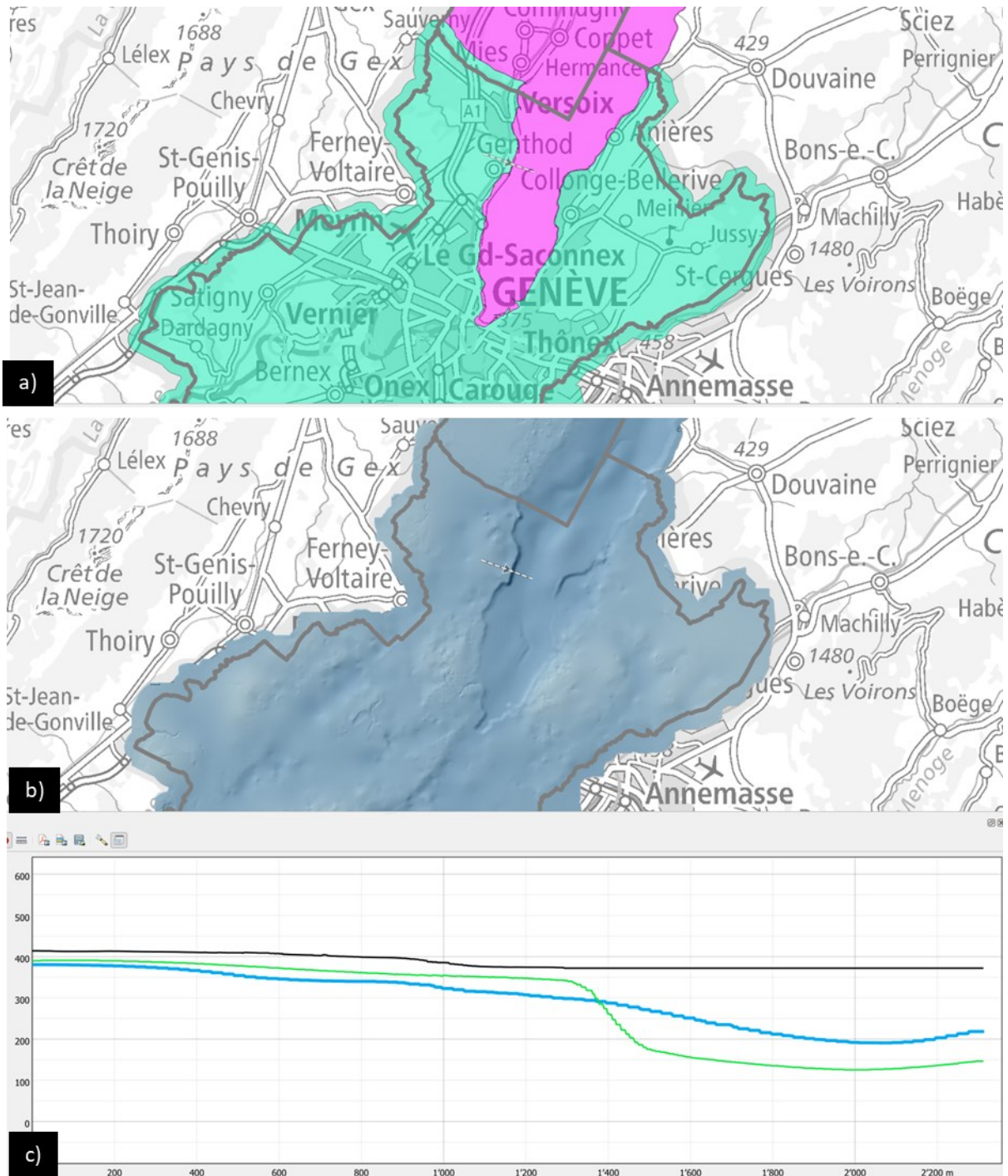


Figure 7, the perimeter of canton Geneva has been cut back with the lake perimeter (a). Here the pink colour shows the fact that version 241206 is valid in lake Lemman and version 250519 is valid in the rest of the canton of Geneva. The bedrock elevation (b) shows a steep decrease in elevation towards the lake bottom. This is illustrated in cross-section c). Here, the green line shows the bedrock elevation model of swissBEDROCK release 1 (green line), which is a combination of version 250519 on the shore and version 241206 on the lake side. This is a marked change from version 221104 (blue line)

Known issues

Topographic constraint in Version 221104

The original model 221104 has limitations in staying below the topographic surface. This is mainly due to the use of the older DHM25 digital elevation model instead of swissALTI3D, and its linkage to GeoCover. As a result, in certain areas the model may exceed the topography. As more regions are updated these issues will disappear over time.

Buffer zones in integrated versions of this Release

The buffer zones around the integration perimeters in this Release are constrained to swissALTI3D but not to GeoCover.

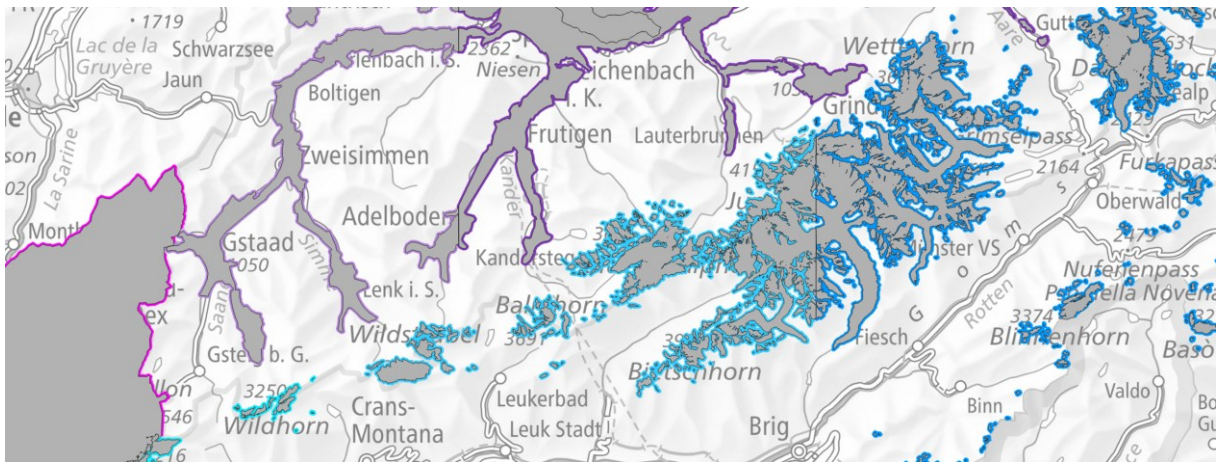


Figure 8, Image shows the integration perimeters (grey) and the buffer zones (coloured). As is obvious from this issue, it is mainly the GLAMOS perimeters that have a relatively high buffer zone to perimeter ratio.

In steep areas where bedrock is outcropping, this may cause the bedrock elevation model to be underestimated, leading to an erroneous thickness of unconsolidated deposits. The possible affected area by this issue is about 6% with respect to all Versions and 2% of the total model.

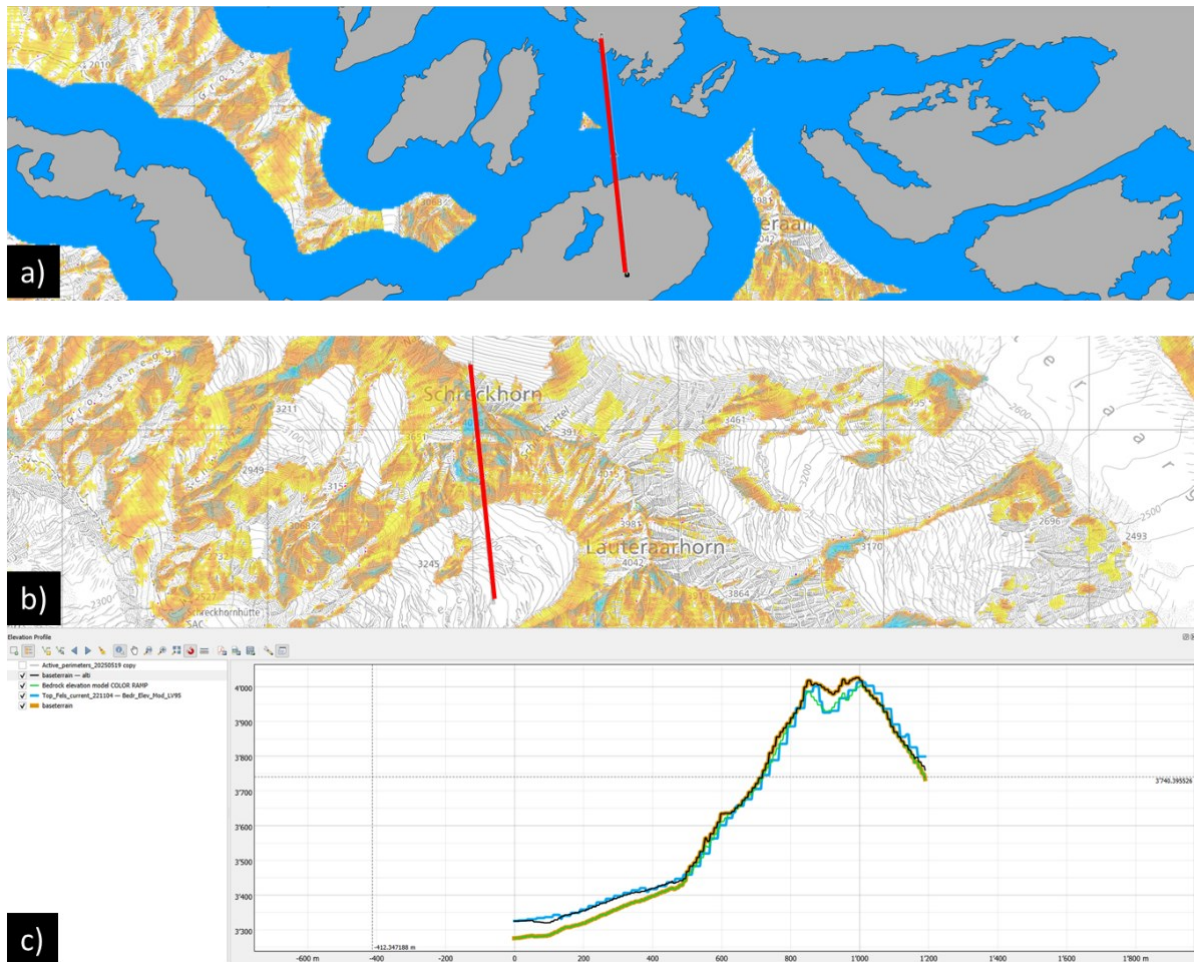


Figure 9, a) shows the integration perimeter (grey) the buffer zone of 200 meter (blue). B) shows the thickness model of unconsolidated deposits. The redline indicates the cross section c) which cuts through Schreckhorn. It is clear from both b) and c) that both the 221104 (blue line) and the new 250306 (GLAMOS 202, green line) model show this issue. With version 250306 (green line) it is the part of the buffer zone around the actual perimeter where the issue occurs.

Moreover, the alpine regions (GLAMOS area) is most affected since the irregular polygons enhance the relative percentage of buffer to perimeter area, plus these are the areas with steep terrain and bedrock outcrop. **The user is advised to always consult and prioritize GeoCover when using the model within the buffer zone.**

In the next release we plan to incorporate GeoCover (and borehole data) to constrain the modelling within the buffer zone. With this we improve the model quality within the buffer zone.

Uncertainty

There are currently two main limitations regarding the uncertainty estimation:

- General reliability – Although great care has been taken, the overall reliability of the uncertainty estimates is still under development. The current values do not yet fully capture the variability of the model.
- Loss of uncertainty in progressively modeled areas – In areas that are modeled more than once, the uncertainty estimate is lost. This is a consequence of the current estimation method rather than the data itself.

Both issues are known and will be addressed in the next release, with the aim of providing more consistent and reliable uncertainty information.

References

Dürst Stucki, M. 2015: GeoMol – Geopotentiale des Schweizer Molassebeckens: Schlussbericht Modellierung Felsoberfläche. Bundesamt für Landestopografie swisstopo

swisstopo 2021: Felsoberflächenmodell (TopFels25), Modellbeschreibung. Bundesamt für Landestopografie swisstopo