EGU General Assembly 2022

May 25th 2022

Initiation of an international **database of geoelectrical surveys on permafrost** to promote data sharing, survey repetition and standardized data reprocessing

IPA Action Group: Coline Mollaret, Christin Hilbich, Teddi Herring, Mohammad Farzamian, Johannes Buckel, Baptiste Dafflon, Daniel Draebing, Hannelore Fossaert, Rebecca Gugerli, Christian Hauck, Julius Kunz, Antoni Lewkowicz, Jonas K. Limbrock, Theresa Maierhofer, Florence Magnin, Cécile Pellet, Sebastian Pfaehler, Riccardo Scandroglio, Sebastian Uhlemann, Bernsteiner Heidi, Etzelmüller Bernd, Flores Orozco Adrian, Hördt Andreas, Kemna Andreas, Kneisel Christof, Lambiel Christophe, Onaca Alexandru.

Photo: J. Buckel

Motivation for the establishment of a database for permafrost electrical data

Electrical resistivity is related to ground ice content.

Electrical Resistivity Tomography (ERT) **Monitoring data are rare**.

Single ERT survey are however numerous!

But they are neither included in a dedicated database nor have they been analysed in a uniformized way.

Single ERT surveys can be repeated!

Repeated ERT can infer the change in ice/water content due to climate warming.

By **archiving geoelectrical data on permafrost**, the ambition of this project is the **reanalysis of the full database and its climatic interpretation**.

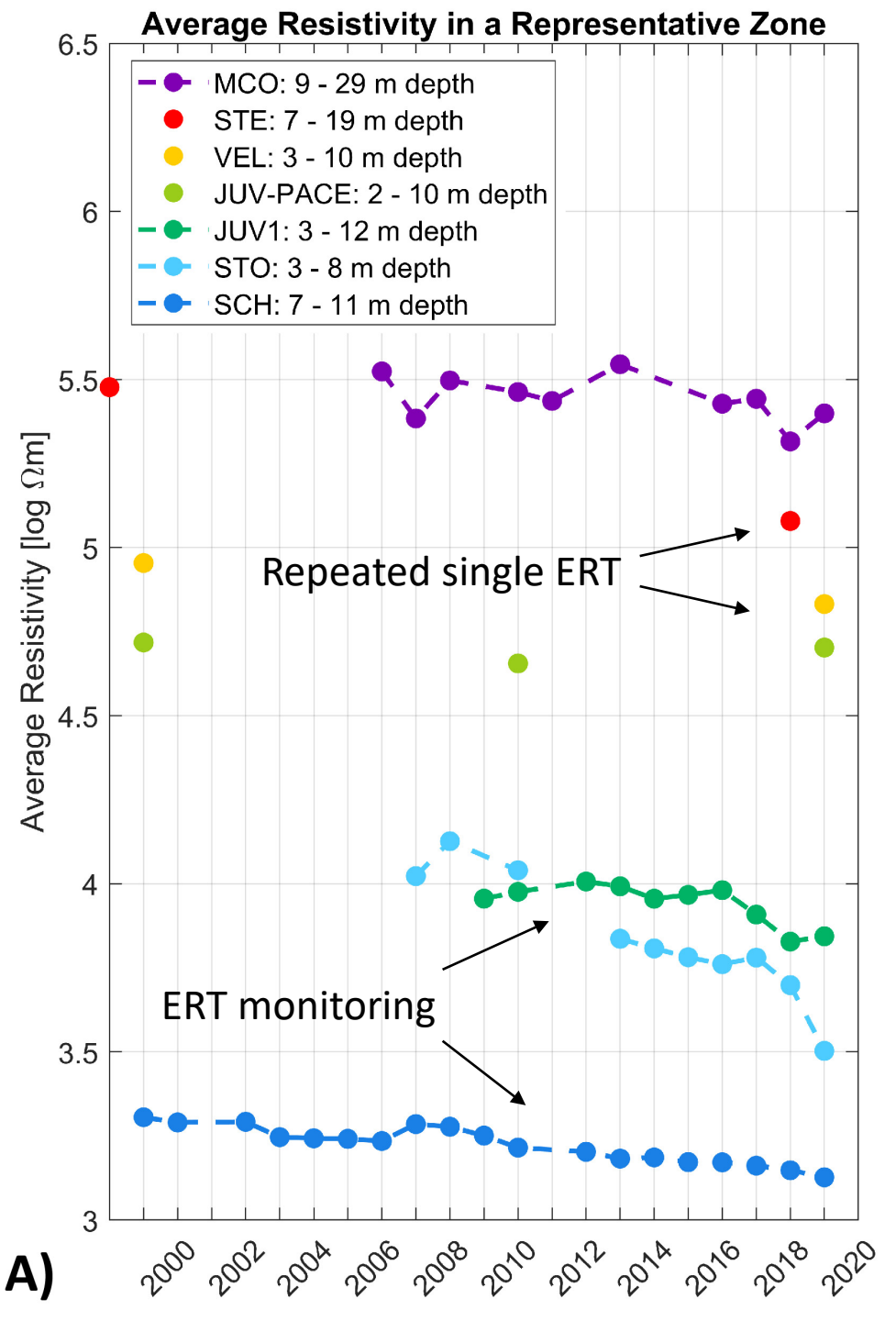


Photo: J. Buckel

Modified from Etzelmüller et al. 2020

International Permafrost Association (IPA) Action Group

- Launched in 2020 (running until 2023)
- The IPA Action Group members constitute a **network of more than 50 scientists interested in permafrost geophysics** from 11 countries.
- Several online meetings. 7 working groups (WG).
- **Metadata call** in July 2021 (still open)
- **Data call** foreseen in June 2022 (will remain open)

Objectives of the Action Group

- **Collect** and **archive** existing historical ERT data sets
- **Reprocess** all data sets in a consistent and transparent way
- **Elaborate a strategy** of repetition of ERT measurement
- **Repeat** historical ERT surveys
- **Analyse** the electrical resistivity time series in the climatic context
- **Publish** the database guidelines and the analysis of the repeated ERT data

Photo: J. Buckel

Structure of the relational database (WG 1 & 2)

- **Metadata and data format harmonization**
- 12 **related tables** including:
  - **meta data**
  - **raw data**
  - **processed data**
- Implementation of raw data is work in progress
- The definition of the entries of the processed data tables is still work in progress

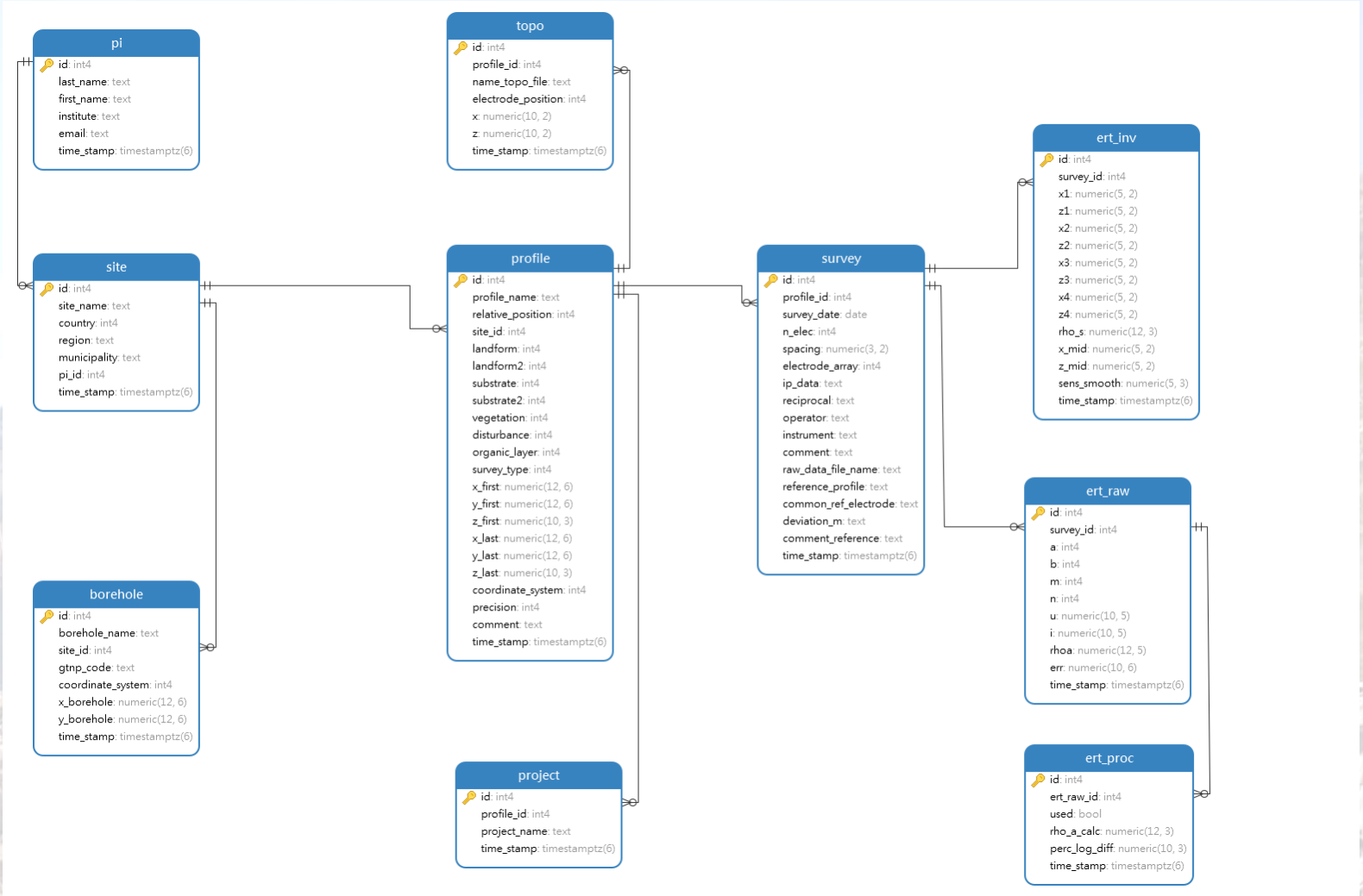


Photo: J. Buckel

Current content of the database

Many thanks to all the metadata contributors
(PI, PhDs, students, etc.)!!

```
resi_base=> select * from pi;
 id |   last_name   |  first_name  |           institute            |
----+---------------+--------------+--------------------------------+-----
  1 | Hilbich       | Christin     | UNIFR                          | chri
  2 | Lewkowicz     | Antoni       | University of Ottawa           | alew
  3 | Lambiel       | Christophe   | University of Lausanne         | chri
  4 | Magnin        | Florence     | EDYTEM (CNRS-USMB)             | flor
  5 | Kneisel       | Christof     | University of Wuerzburg        | knei
  6 | Farzamian     | Mohammad     | University of Lisbon           | moha
  7 | Scandroglio   | Riccardo     | Technical University of Munich | r.sc
  8 | Michael       | Krautblatter | Technical University of Munich | m.kr
  9 | Onaca         | Alexandru    | West University of Timisoara   | alex
 10 | Pellet        | Cécile       | UNIFR                          | ceci
 11 | Flores Orozco | Adrián       | TU Wien                        | flor
 12 | Bodin         | Xavier       | Univ. Savoie Mont-Blanc        | xavi
 13 | Hauck         | Christian    | UNIFR                          | chri
 14 | Uhlemann      | Sebastian    | Lawrence Berkeley National Lab | suhl
 15 | Dafflon       | Baptiste     | Lawrence Berkeley National Lab | bdaf
(15 rows)
```

Number present in the Database	
15	Principal Investigator
11	Country
240	Profile (metadata)
357	**Survey (metadata)**
29	Project
35	Publication
32	**Data set & topo**
1 813	Topo point
21 604	Apparent resistivity (i.e. quadrupole)
0	Inverted resistivity

→ From 11 universities/research institutes

→ i.e. 357 – 240 = 117 surveys are repeated ones

→ 32 out of 357 data sets already in the database

Only data from UniFribourg to test/develop codes

→ No processed data in the database yet

Photo: J. Bucker

Accessibility of the database (WG 1 & 7)

Server setting to host the database

- Help of the IT service of UniFribourg
- Operating system:
  Red Hat Enterprise Linux (RHEL)
- MobaXterm used as interface
  to access to the remote server

Difficult to have a direct access to the server for researchers outside from UNIFR due to IT security reasons.
→ **Solution: interactive website (where data can be visualized without direct access to the database).**

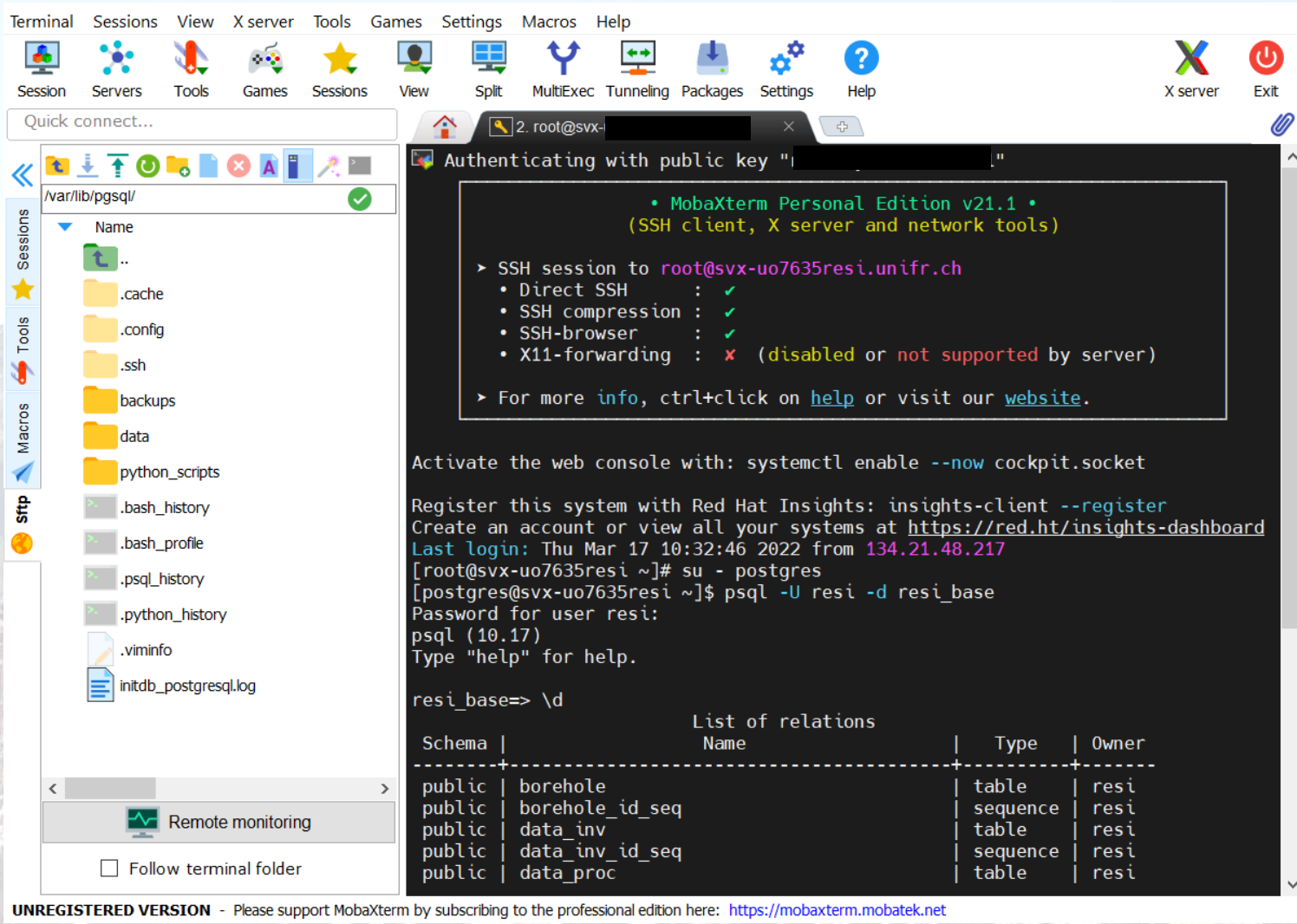
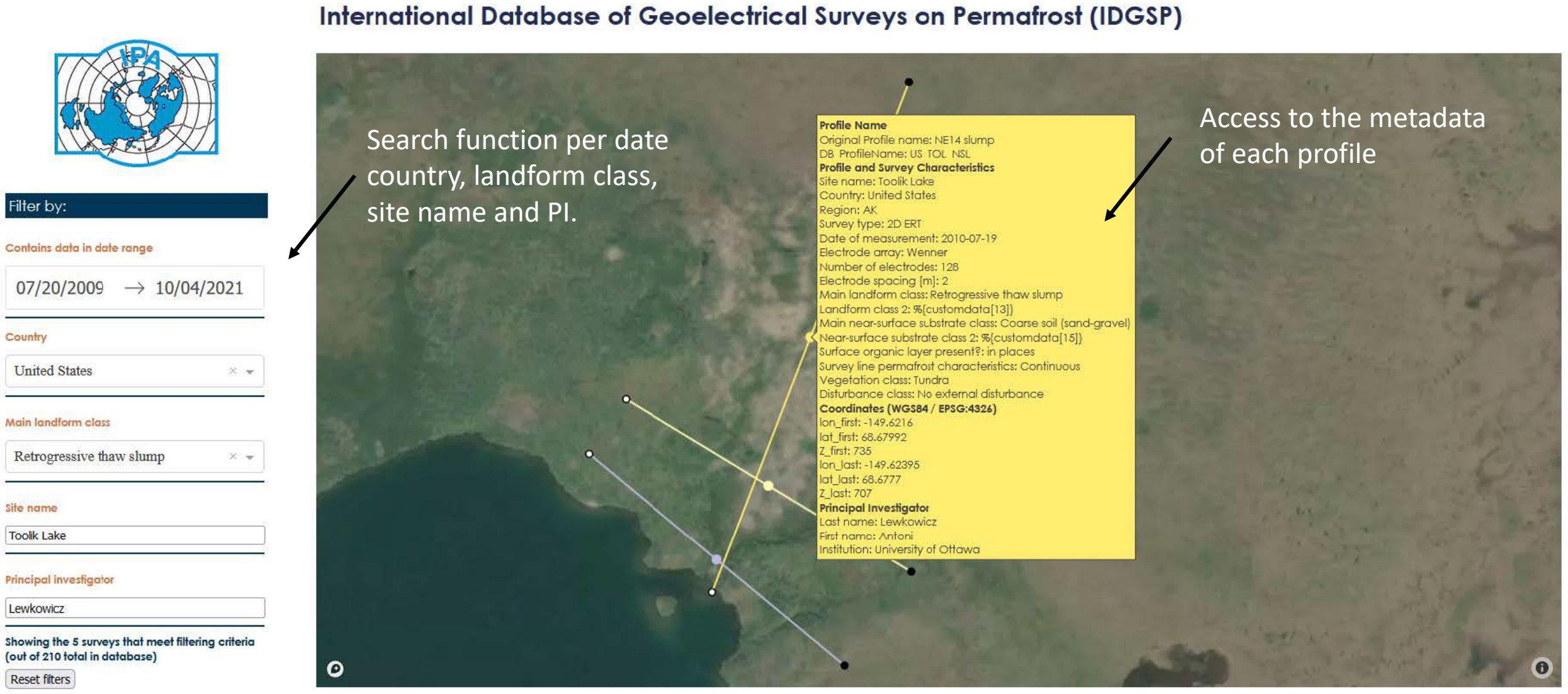
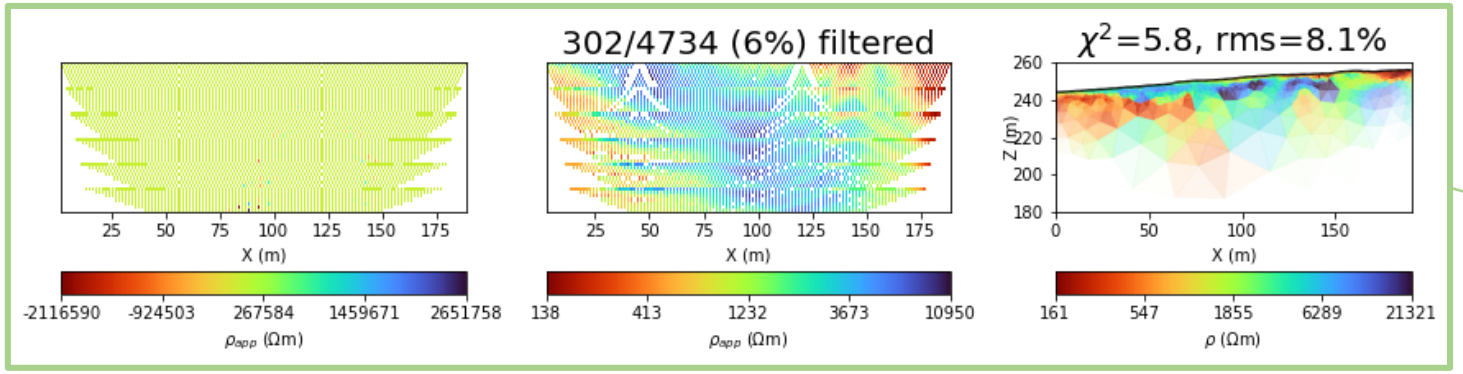


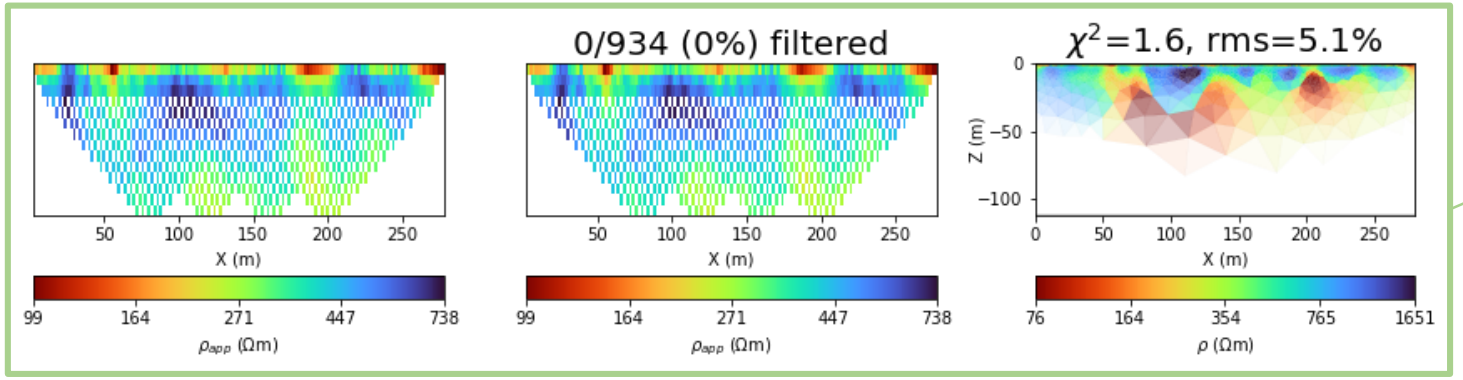
Photo: J. Buckel

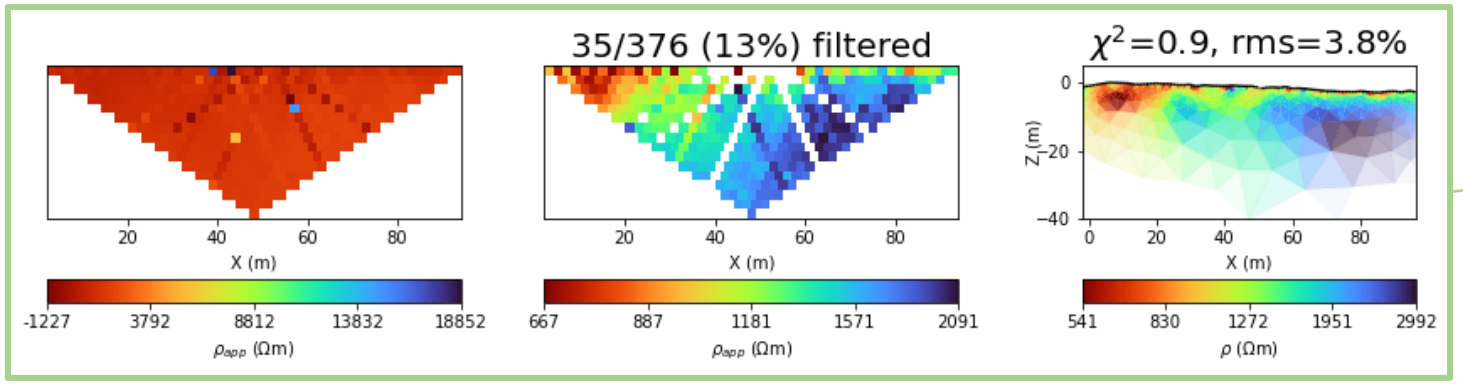
Interactive webmap (under development – WG 7)

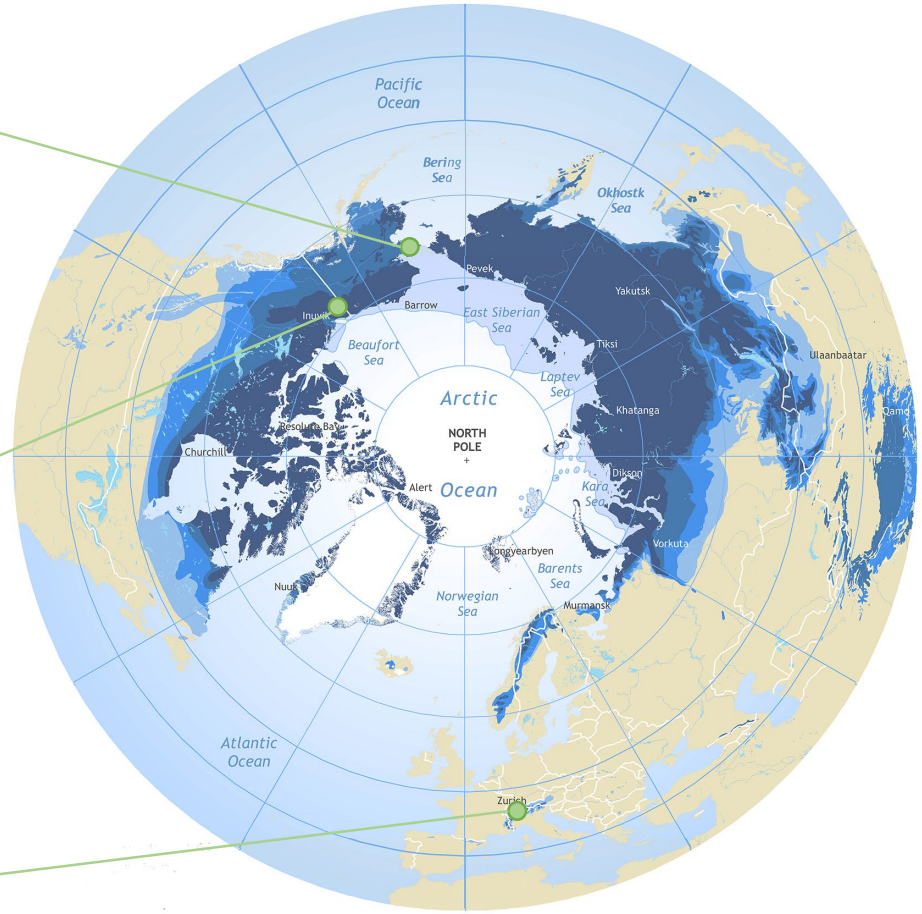


Standardized data processing (by T. Herring) – WG 4



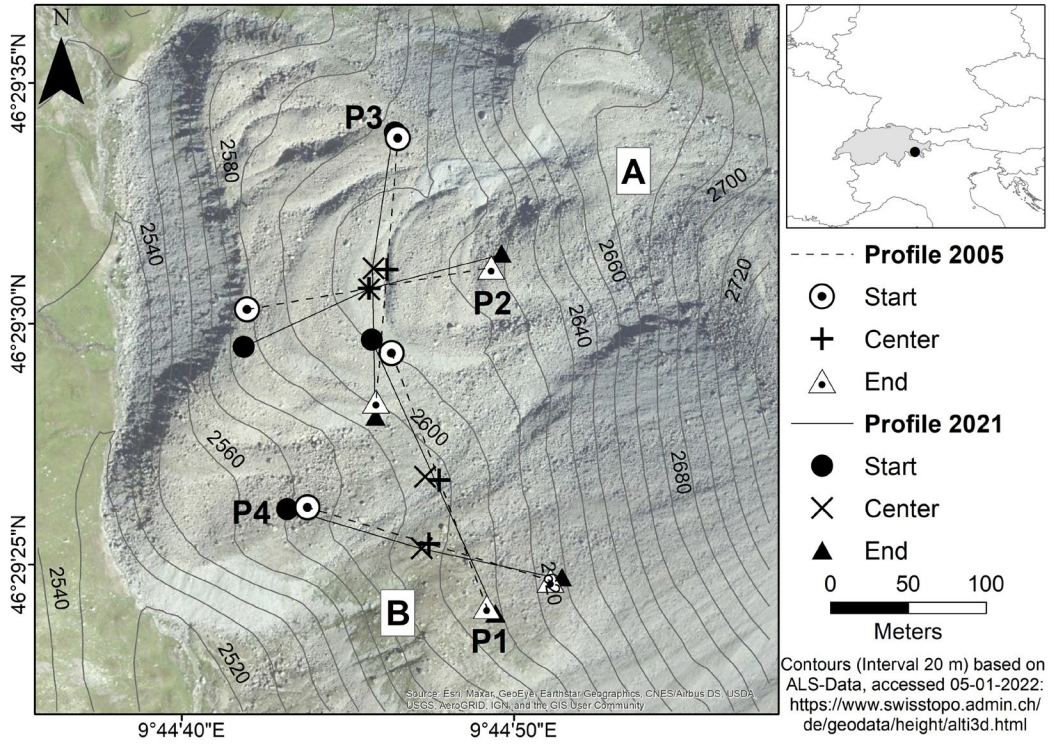






Collaboration with the IPA Action Group (feel free to join us on Github)

Examplary result: Gianda Grischa rockglacier (by. J. Buckel)

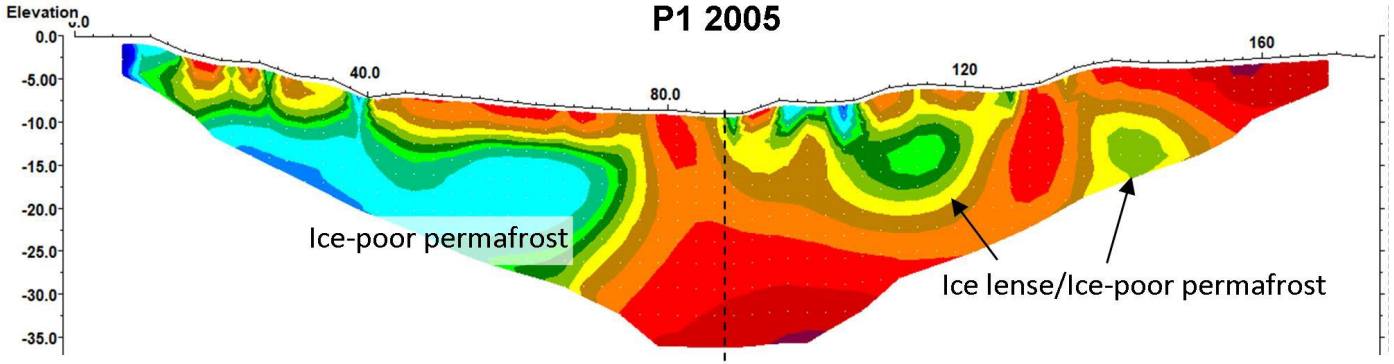


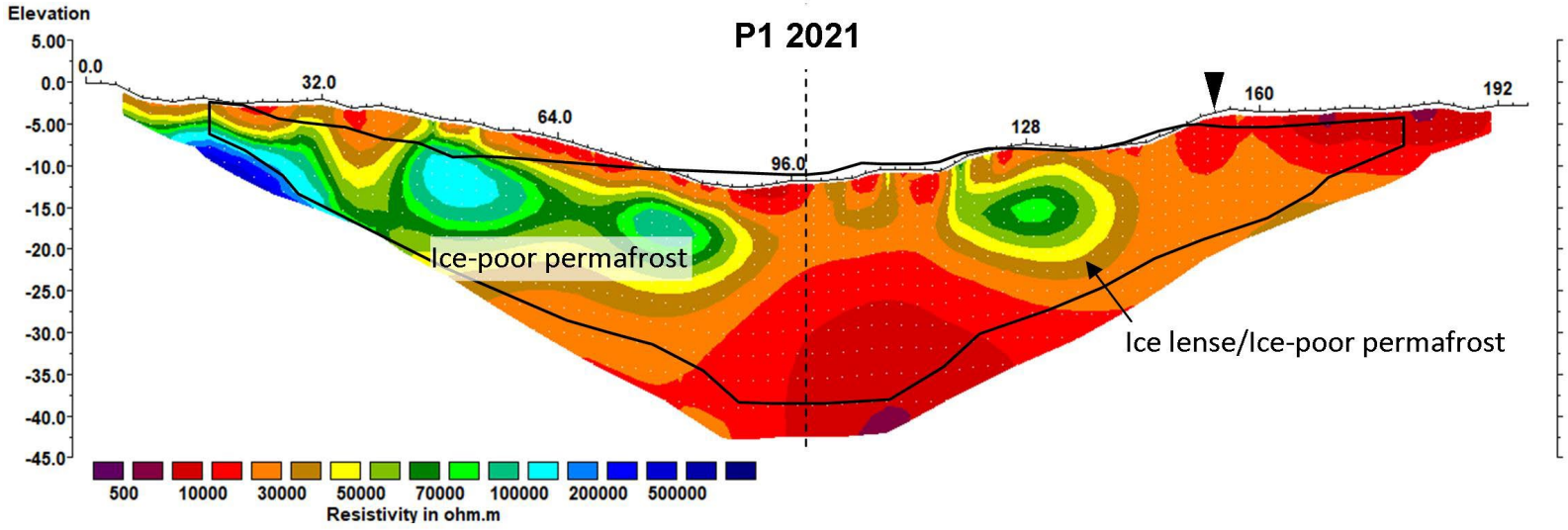
Profile 2005
Start
Center
End
Profile 2021
Start
Center
End
0 50 100
Meters

Contours (Interval 20 m) based on ALS-Data, accessed 05-01-2022: https://www.swisstopo.admin.ch/de/geodata/height/alti3d.html

Material	Resistivity [kΩm] Gianda Grischa
Ice-less sediment (moist – dry)	1 – 50
Ice-poor permafrost (ice lenses, ice-interspersed debris)	50 – 150
Ice-rich permafrost (debris-interspersed ice)	> 150

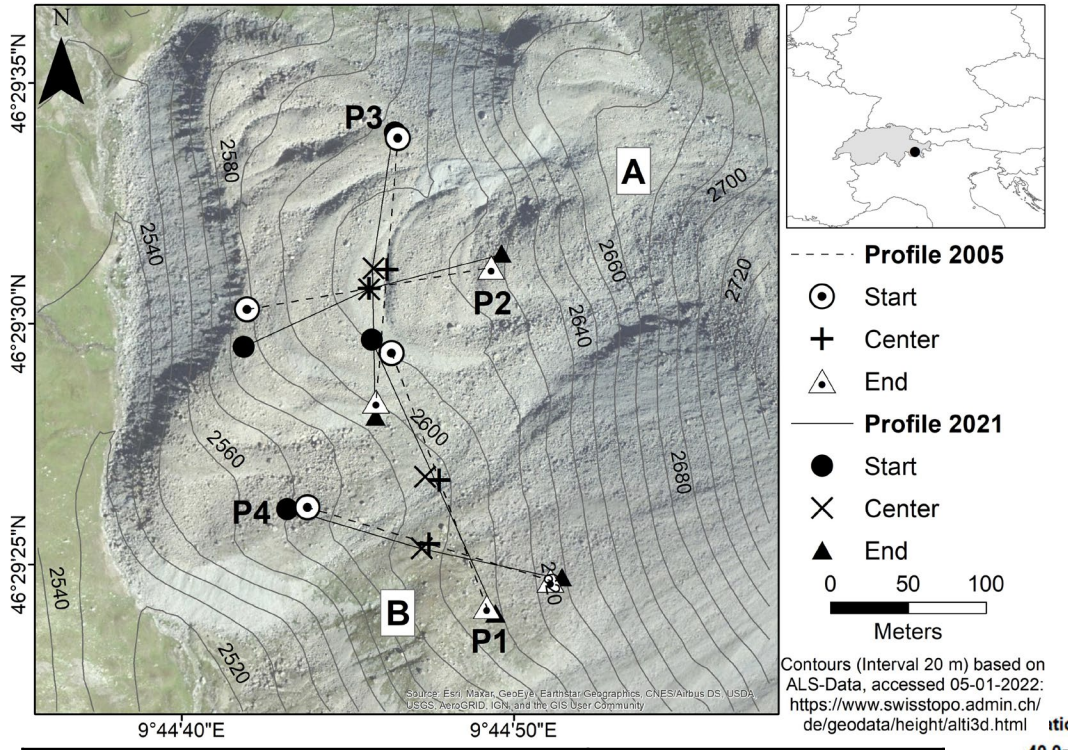
Degradation of ice-poor permafrost on a inactive/relict rockglacier (B):
-Contiguous section of permafrost melt into ice lenses.
-Ice lense is vanished





Buckel et al. (in prep): Identifying mountain permafrost degradation by repeating historical ERT-measurements

Examplary result: Gianda Grischa rockglacier (by. J. Buckel)



Profile 2005
Start
Center
End
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Start
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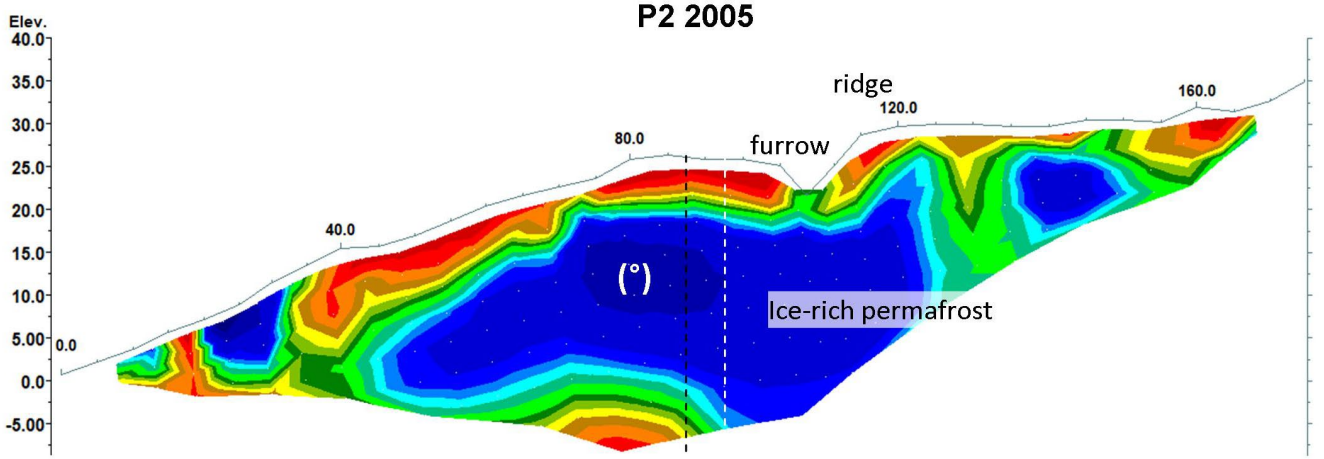
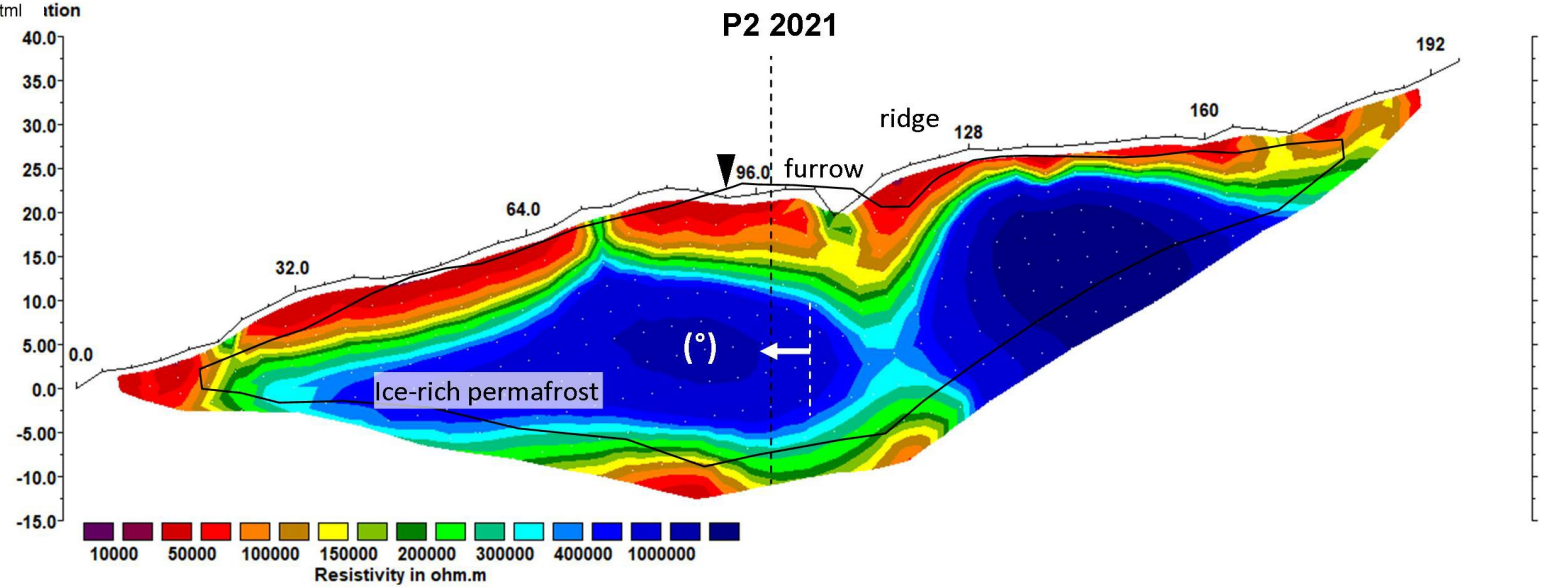
No degradation of ice-rich permafrost on active rockglacier (A):
Resistivity values stagnated or increased.
→The ERT location recieved ice-rich material from above due to the high activity (0.5-1 m/a, Frauenfelder et al. 2008)





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Frauenfelder et al. (2008): An integrative observation of kinematics and geophysical parameters of Gianda Grischa rockglacier, Upper Engadine, Swiss Alps, in Proceedings of the 9th International Conference on Permafrost, Fairbanks, Alaska, vol. 8.

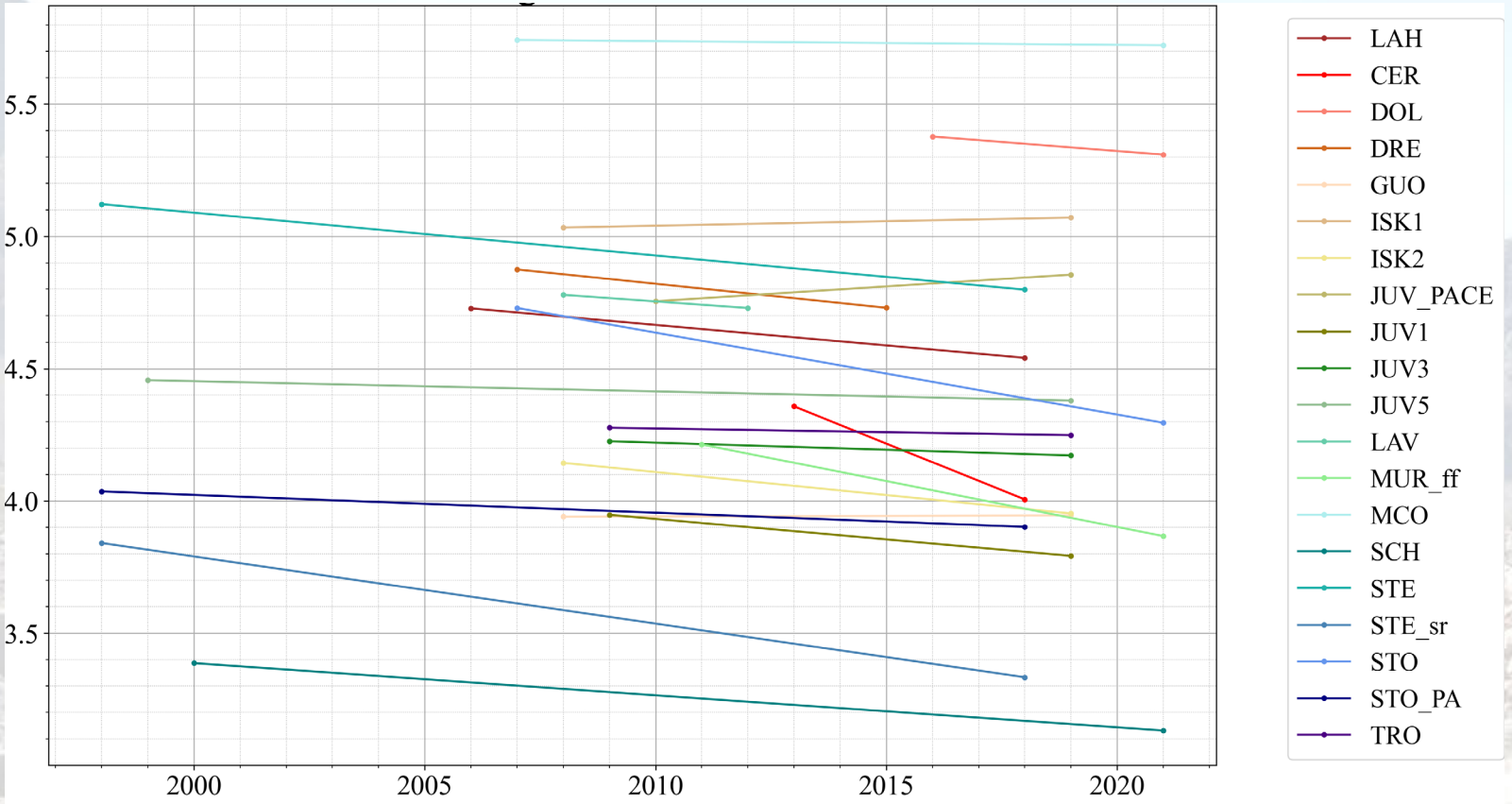
Repeated ERT profiles – a first joint analysis (by C. Hauck) – WG 6

20 profiles from Switzerland, Italy & Norway so far

Processing

- Filtered, Res2dinv inverted, mean resistivity of ZOI
- Zone of interest (ZOI) within main permafrost body
- **No influence of active layer deepening included**

Mean inverted specific resistivity within ZOI



[A. Stalder, BSc thesis, in progress 2022]

Photo: J. Buckel

Conclusion

- The IPA Action Group successfully **brings together the international community** interested in geoelectrical measurements on permafrost.
- **Database set up and filled up with many metadata already!**
- The metadata call remain open.
- The data call will soon be officially launched (in June!).
- First campaigns to repeat historical ERT surveys were successfully initiated and conducted.
- **Promising first results of joint analysis**.

Perspective

- The public access of meta data may encourage and enable more **repetitions of historical ERT measurements**.
- The integration of resistivity data will enable a unique possibility of integrative **data reanalysis**.

Feel free to join our Action Group!
Please write us to ertdb@unifr.ch, sign up to our mailing list or visit our webpage ☺

Photo: J. Buckel