

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

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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.**

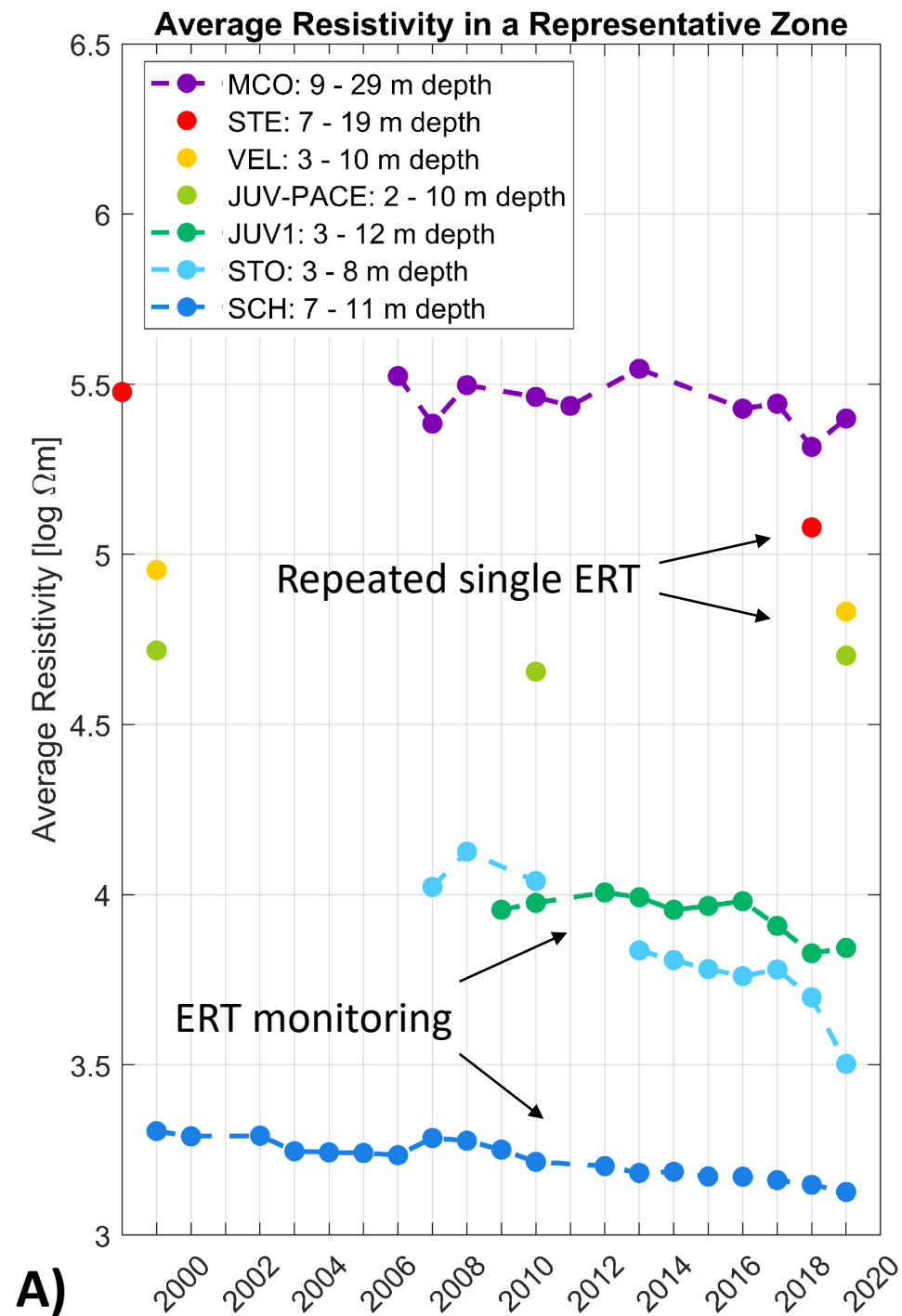
Single ERT survey are however numerous!

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.**



International Permafrost Association (IPA) Action Group

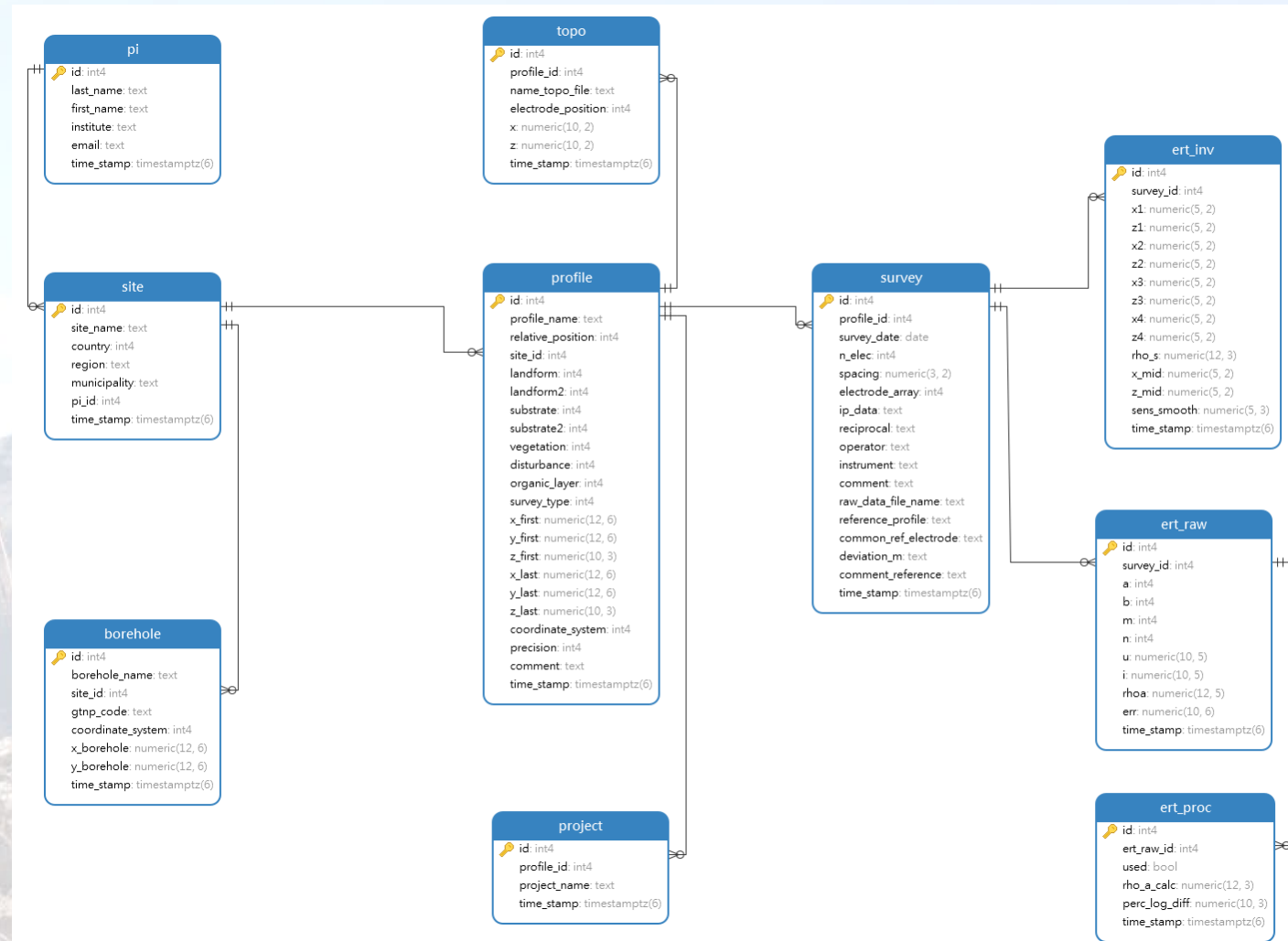
- Launched in 2020 (running until 2023)
- The IPA Action Group members constitute a **network of more than 50 scientists interested in permafrost geophysics** from 11 countries.
- Several online meetings. 7 working groups (WG).
- **Metadata call** in July 2021 (still open)
- **Data call** foreseen in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

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



Current content of the database

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

```
resl 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 | Farzaman | 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

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).**

The screenshot displays the MobaXterm Personal Edition v21.1 interface. The top menu bar includes Terminal, Sessions, View, X server, Tools, Games, Settings, Macros, and Help. Below the menu is a toolbar with icons for Session, Servers, Tools, Games, Sessions, View, Split, MultiExec, Tunneling, Packages, Settings, and Help. A 'Quick connect...' field is visible. The left sidebar shows a file explorer for the /var/lib/pgsql/ directory, listing files like .cache, .config, .ssh, backups, data, python_scripts, .bash_history, .bash_profile, .psql_history, .python_history, .viminfo, and initdb_postgresql.log. The main terminal window shows an SSH session to root@svx-uo7635resi.unifr.ch. It displays the MobaXterm version and a list of SSH session details: Direct SSH (checked), SSH compression (checked), SSH-browser (checked), and X11-forwarding (disabled or not supported by server). Below this, it shows the command to activate the web console: systemctl enable --now cockpit.socket. It then shows the registration of the system with Red Hat Insights: insights-client --register. The terminal also shows the last login time and the user switching to postgres. The postgres user runs the command psql -U resi -d resi_base, and the password for user resi is entered. The psql (10.17) prompt is shown, and the user enters \d to list the relations. The output shows a table of relations with columns Schema, Name, Type, and Owner.

| Schema | Name | Type | Owner |
|--------|-----------------|----------|-------|
| public | borehole | table | resi |
| public | borehole_id_seq | sequence | resi |
| public | data_inv | table | resi |
| public | data_inv_id_seq | sequence | resi |
| public | data_proc | table | resi |

UNREGISTERED VERSION - Please support MobaXterm by subscribing to the professional edition here: <https://mobaxterm.mobatek.net>

Interactive webmap (under development – WG 7)

International Database of Geoelectrical Surveys on Permafrost (IDGSP)



Filter by:

Contains data in date range

07/20/2009 → 10/04/2021

Country

United States

Main landform class

Retrogressive thaw slump

Site name

Toolik Lake

Principal investigator

Lewkowicz

Showing the 5 surveys that meet filtering criteria
(out of 210 total in database)

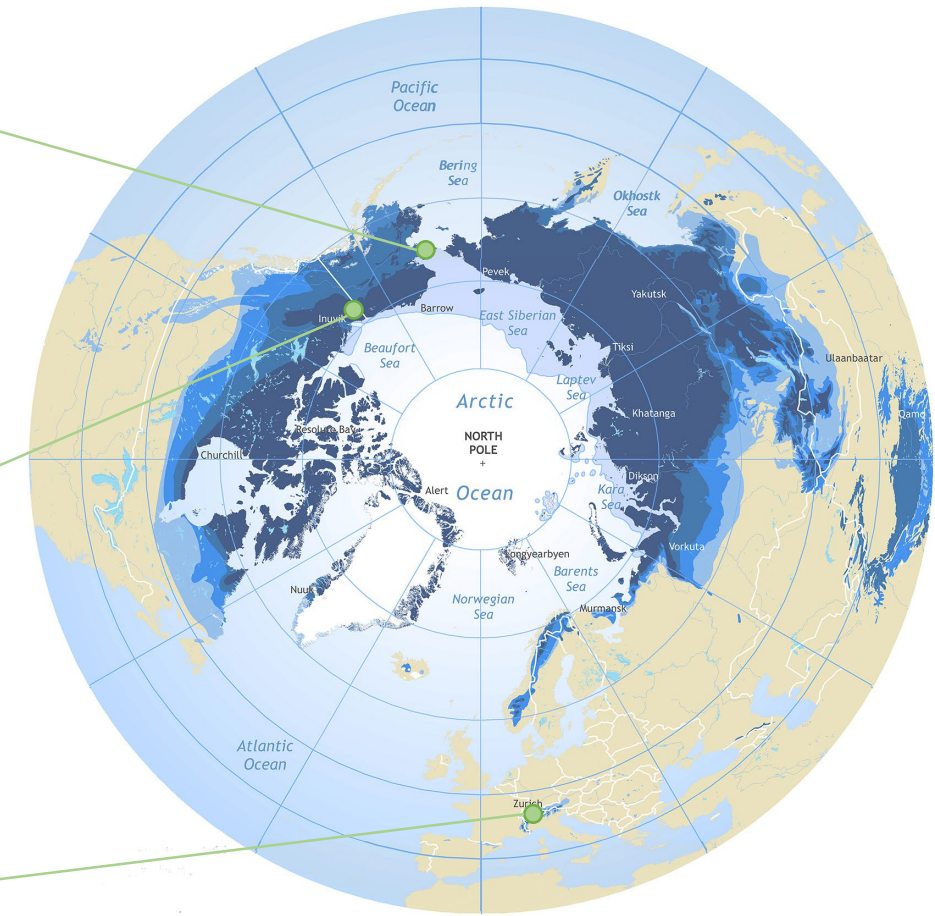
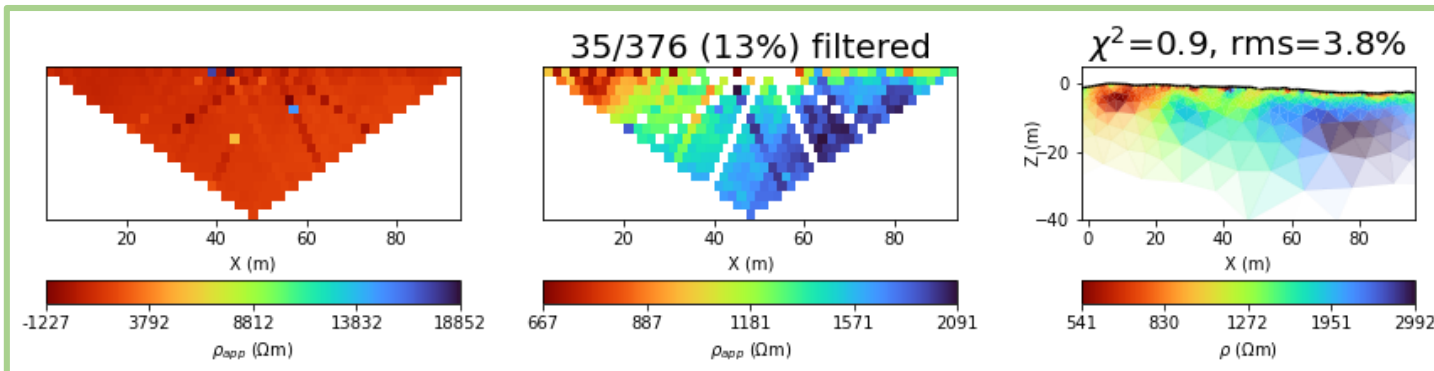
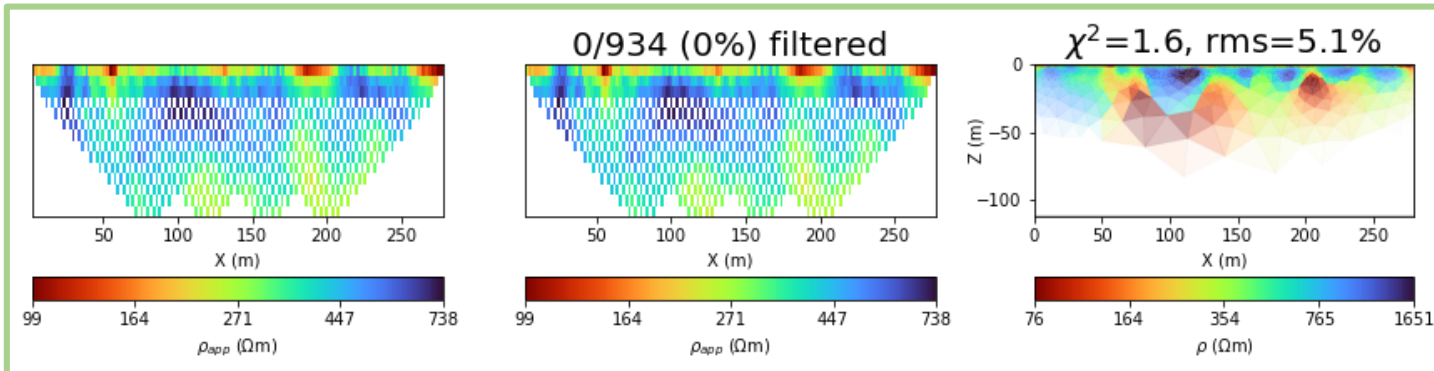
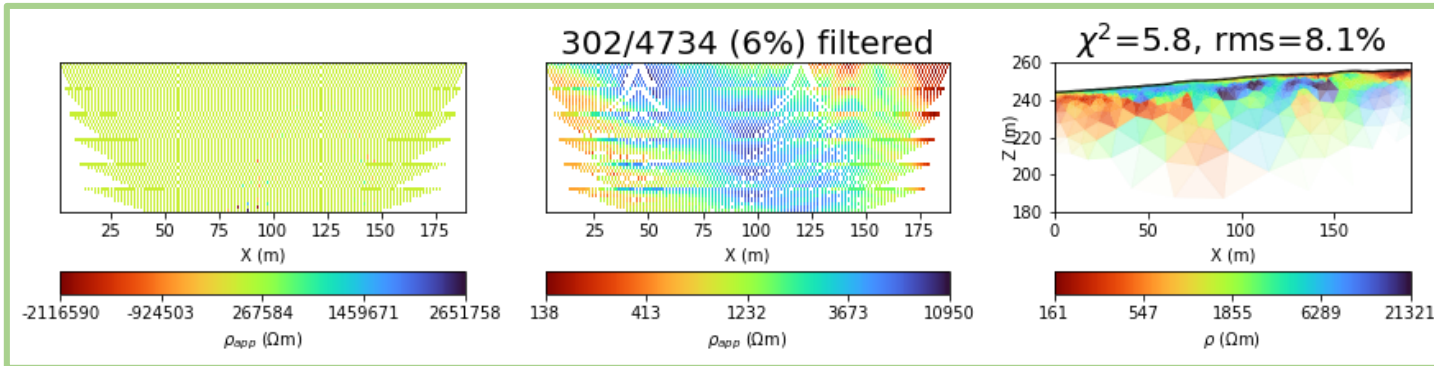
Reset filters

Search function per date
country, landform class,
site name and PI.



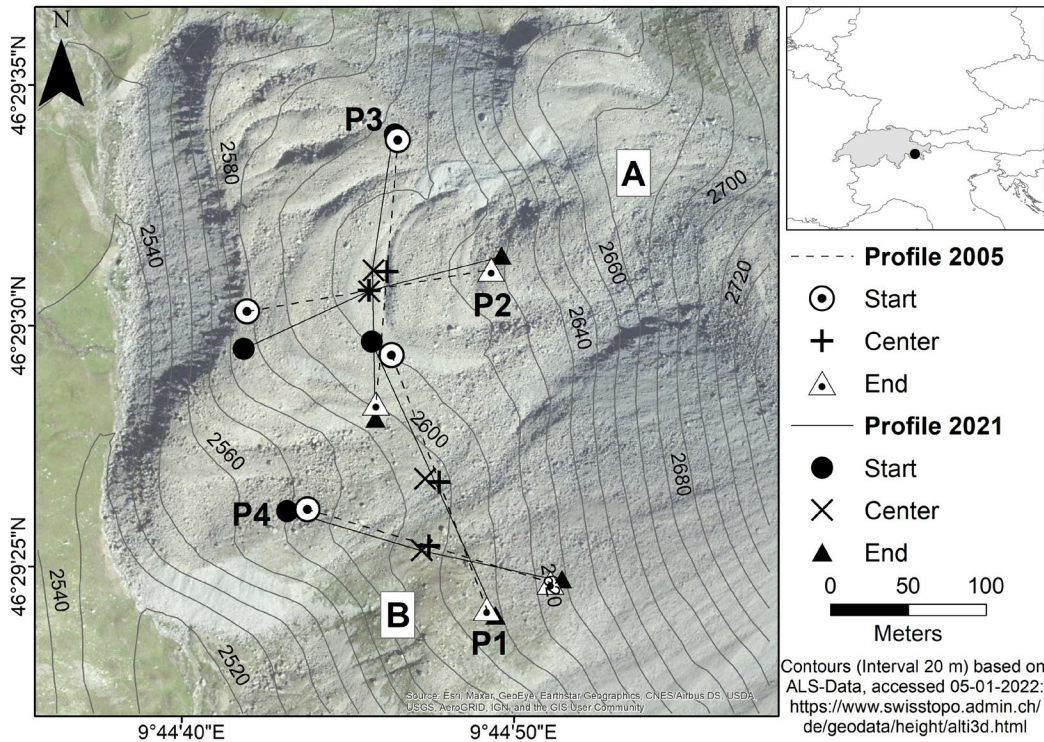
Access to the metadata
of each profile

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



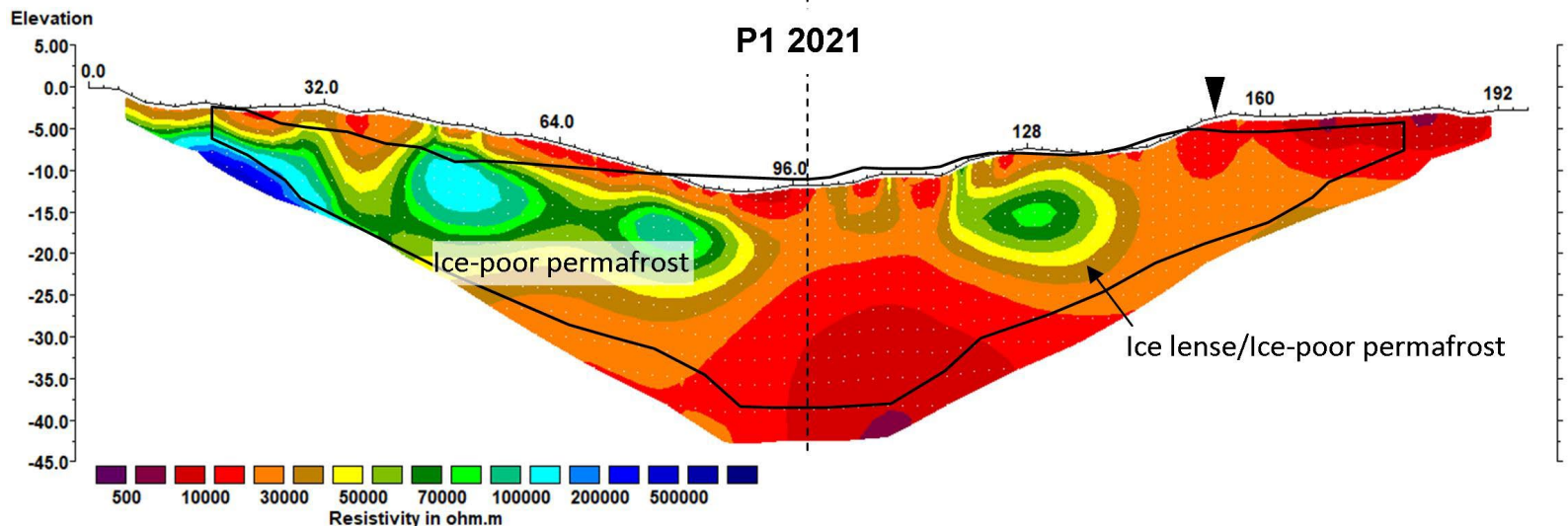
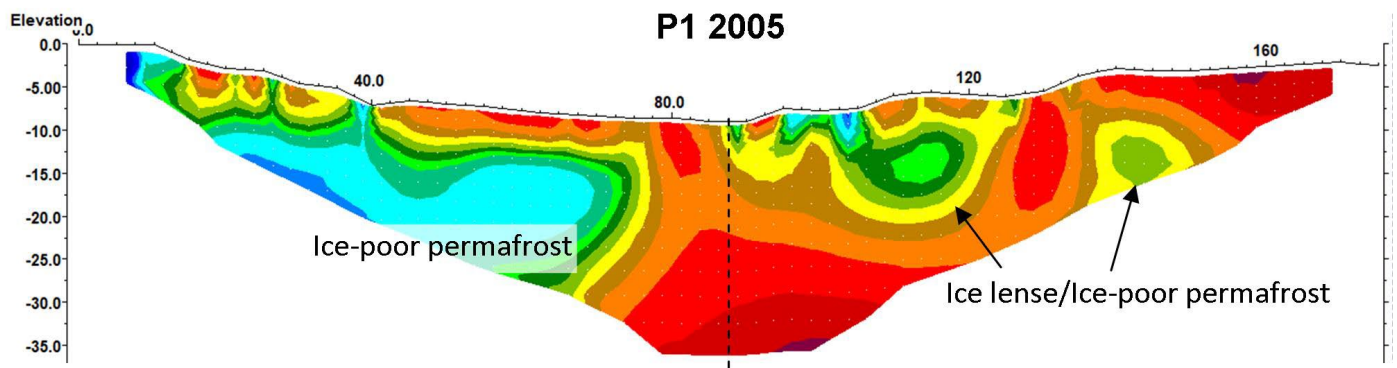
Collaboration with the IPA Action Group (feel free to join us on [Github](#))

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



Degradation of ice-poor permafrost on a inactive/relict rockglacier (B):

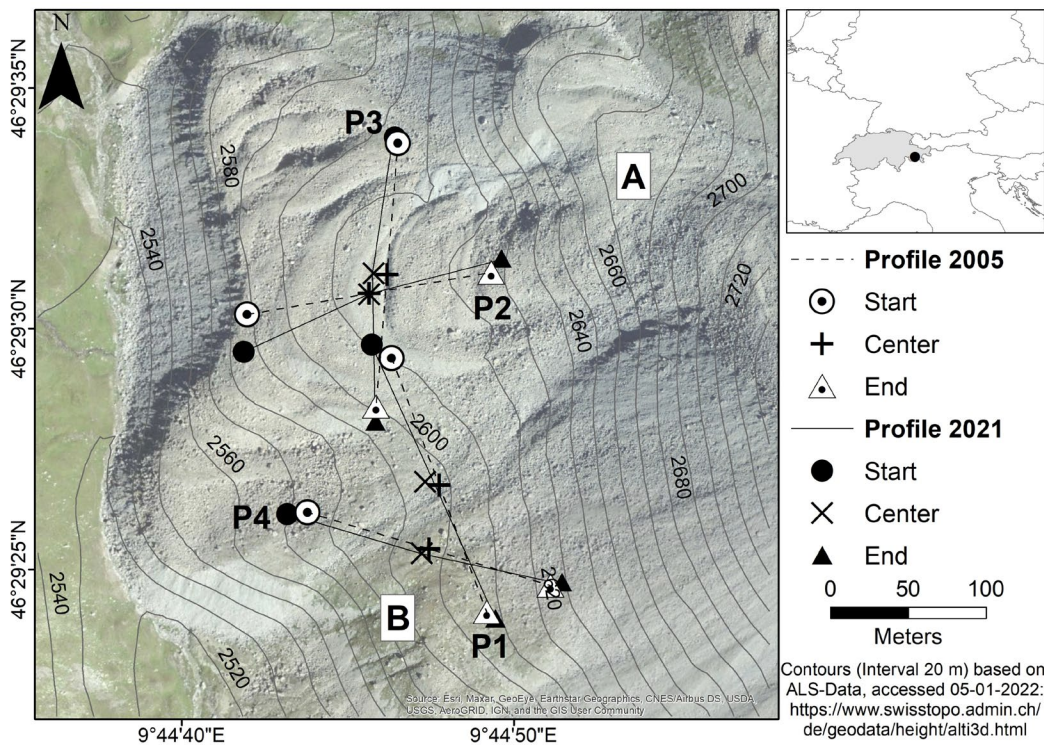
- Contiguous section of permafrost melt into ice lenses.
- Ice lense is vanished



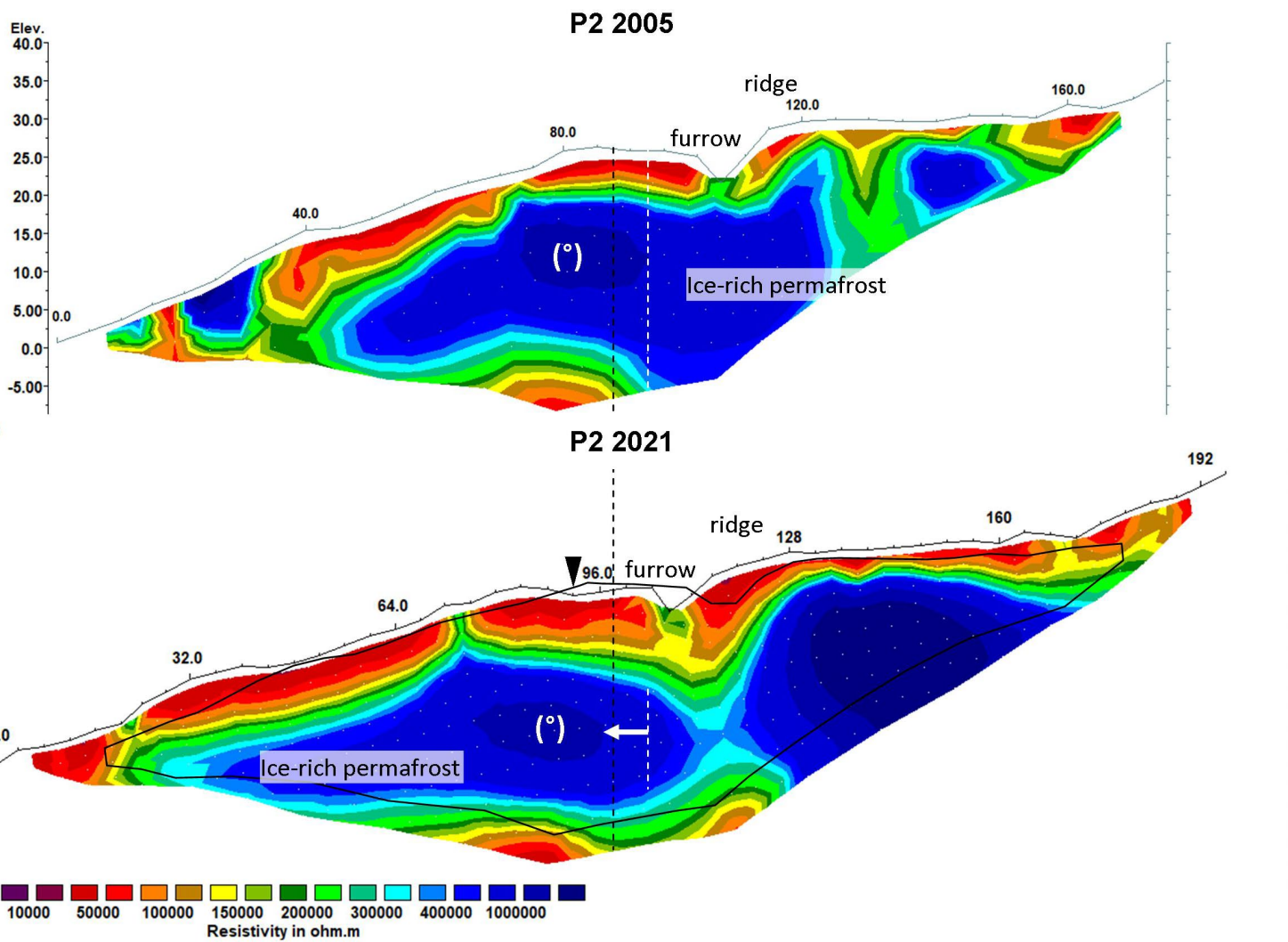
| Material | Resistivity [kΩm] |
|---|-------------------|
| Ice-less sediment (moist – dry) | 1 – 50 |
| Ice-poor permafrost (ice lenses, ice-interspersed debris) | 50 – 150 |
| Ice-rich permafrost (debris-interspersed ice) | > 150 |

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

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



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)



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

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

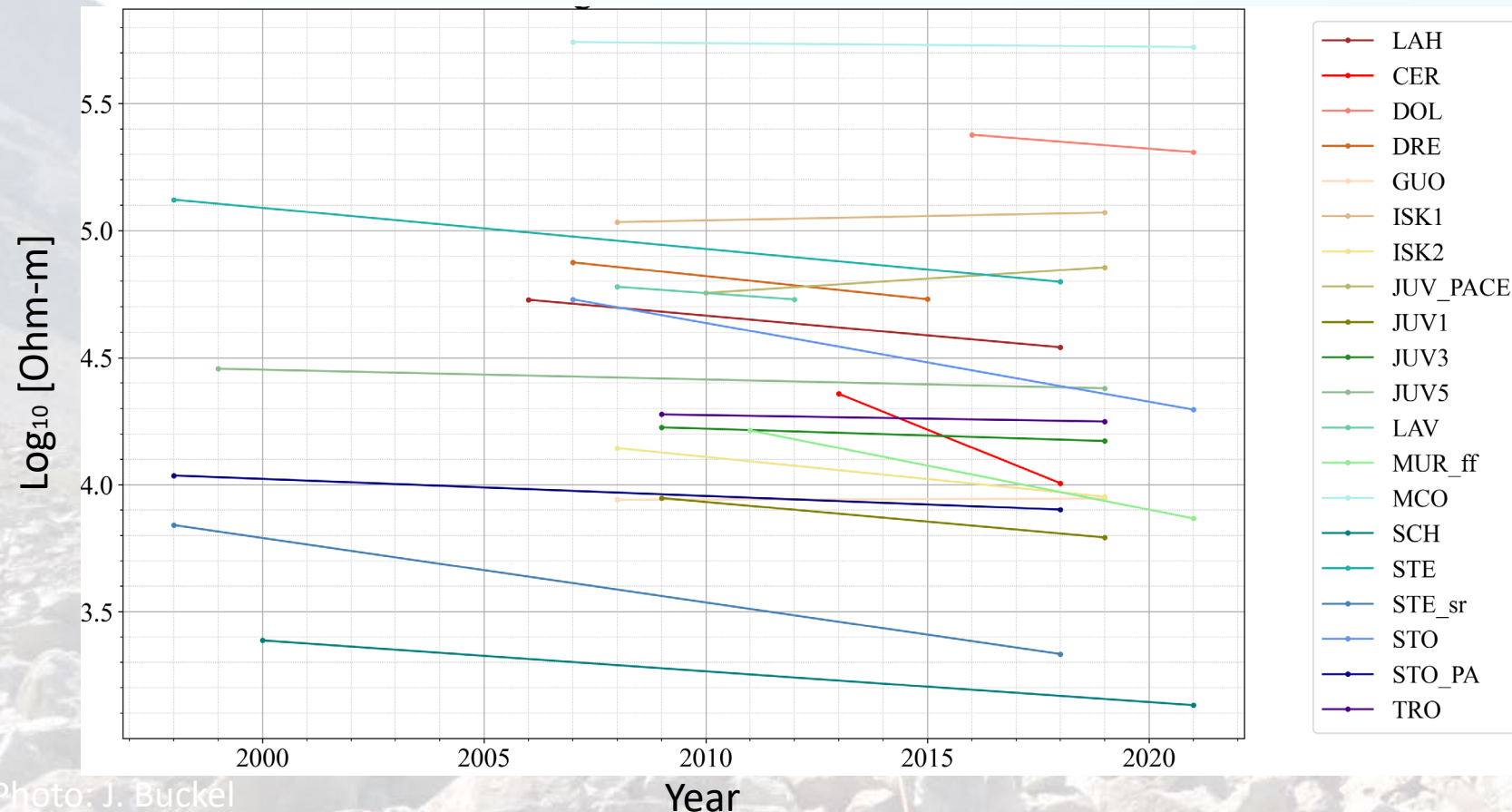
Repeated ERT profiles – a first joint analysis (by C. Hauck) – WG 6

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]

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](#) 😊