Permafrost monitoring through resistivity time-series analysis: the PERMOS ERT Database

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Mountain permafrost monitoring has a long tradition in Switzerland and is institutionally organised within the Swiss Permafrost Monitoring network PERMOS since 2000. Since 2005, annually repeated ERT measurements are included in the monitoring strategy of PERMOS, and permanently installed ERT profiles exist at 5 different sites in Switzerland, including a rock glacier, talus slopes and bedrock sites. The longest time series is collected on the Schilthorn summit since 1999, including quasi-annual manual measurements until 2009, and automated data acquisition with up to daily resolution since then. By now, the Schilthorn data set comprises more than 1070 individual measurements, and data from the other sites range from 14 to 80 measurements in total per site.

To allow for a comparative analysis of the long-term resistivity evolution in the context of climate-induced permafrost degradation, this huge amount of data requires systematic and automated data management and processing. Automated filter routines were developed (Hilbich et al. 2011, doi.org/10.1002/ppp.732; Rosset et al. 2013, doi.org/10.3997/1873-0604.2013003), and later extended to a systematic data processing (Mollaret et al. 2019, doi.org/10.5194/tc-13-2557-2019), including the analysis of contact resistances and the application of automatic processing routines (multi-site data import, filtering, data inversion, time series analysis, and visualisation).

This systematic processing approach was developed in combination with standardized data archiving within the PERMOS database, which regroups all monitoring variables of the PERMOS network, namely ground temperatures, kinematic data, meteorological data and ERT. A unique database structure was developed for ERT monitoring data, which enables the storage of not only the final data product (i.e. inverted resistivity) but also the raw data and the relevant meta-information pertaining to the field site (i.e. elevation, landform type, etc.), the individual surveys (i.e. configuration, instrument, etc.) as well as the processing steps (i.e. site-specific filter thresholds, inversion errors, etc.). The PERMOS ERT database aims at ensuring the long-term archiving of permafrost data, the traceability and reproducibility of the processing steps as well as a timely access to the data. Today, it includes more than 1000 data sets (divided within 5 sites), which are publicly accessible via a web interface. This online browsing tool enables user-defined querying of the database and provides standardized tools for data visualization and time series analysis, as well as download of selected data sets.

The joint analysis of all ERT data within the database reveals a consistent long-term resistivity decrease observed for all field sites. It confirms significant ground ice degradation for a variety of landforms and substrates and for a period of up to 20 years, which is of a unique value in permafrost science. The remarkably high overall quality of the data sets often acquired under harsh and remote measurement conditions (despite a couple of data sets with weak quality because of too high coupling resistances in winter time) justifies the reliability of the results and the integrative interpretation of all available time series.