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Comparison of long-term refraction seismic and ERT monitoring to detect and quantify ground ice loss at Alpine permafrost sites

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Geophysical monitoring has become more and more popular in permafrost environments due to its remarkable success to detect permafrost thawing and associated spatio-temporal changes in the ground ice content. Hereby, geoelectric methods such as Electrical Resistivity Tomography (ERT) are usually applied due to the strong differences in the electrical properties between frozen and unfrozen state. However, also seismic properties change markedly upon freezing/thawing and time-lapse refraction seismic tomography has been shown to be applicable to permafrost over smaller time scales (e.g. Hilbich 2010). The reason why only few studies employ long-term seismic monitoring in permafrost is probably due to the higher logistical effort that is required. At two permafrost monitoring sites in the Swiss Alps yearly refraction seismic surveys are conducted since more than 10 years, in addition to standard borehole temperature, climatic and ERT measurements. Data sets are recorded using a comparatively small geophone spacing of 2 meter and a limited number of geophones and shot points (24/∼20). Measurement geometry is held constant and a sledgehammer is used as source. The monitoring aim is to image the interannual changes of the depth of the active layer, i.e. the maximum thaw depth of the near-surface layer in summer as well as differences in ice content within the permafrost layer below. In this contribution we will focus on two 10-year long seismic data sets, their interpretation with respect to climate-induced thawing, as well as on an evaluation of the advantages and disadvantages of seismic monitoring compared to the more standard ERT monitoring. The results will also be analysed with respect to their suitability for future ERT-seismic joint inversion approaches in a monitoring context (cf. Mollaret et al. EGU 2019, Wagner et al. EGU 2019).

References:
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