Assimilation of Electrical Resistivity Tomography (ERT) and Ground-Penetrating Radar (GPR) data in the inversion of Refraction Seismic Tomography (RST) data for an improved spatial characterization of alpine permafrost

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In frame of the ATMOperm project funded by the Austrian Academy of Sciences, several geophysical methods were applied at the summit of Hoher Sonnblick (3106 m.a.s.l.) with the objective to determine the distribution of frozen and unfrozen materials in the subsurface. The geophysical survey included Refraction Seismic Tomography (RST), Electrical Resistivity Tomography (ERT) and Ground Penetrating Radar (GPR). RST permits to solve for variations in the velocity of seismic waves, with several studies exploiting the increase in P-wave velocities (Vp) with increasing ice content, and thus, permitting to map frozen rocks. However, at the Hoher Sonnblick, changes in the seismic velocity with depth have been reported to be associated with the presence of frozen fractured rocks in the near surface and the bedrock. Hence, further information is required to improve the interpretation of the seismic results for an improved delineation of the active layer. Therefore, we conducted ERT and GPR surveys, which represent well-established methods for the characterization of permafrost rocks, exploiting the significant contrast in the electrical properties from ice and water. Moreover, GPR permits to solve for structural variations in fractured rocks with high spatial resolution. Hence, we present here the first results regarding the assimilation of ERT and GPR data to improve the inversion of RST surveys conducted at Hoher Sonnblick. In this study, we investigate the incorporation of structural information obtained from the processed GPR data to define the geometry of the initial model whereas ERT imaging results are used to refine its elastic parameters. Statistical analysis of the inversion results obtained using an ensemble of different initial models allowed the quantification of the impact of the complementary information as well as an investigation of the limitations of this joint processing approach.