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Diffraction imaging of alpine glacier GPR data

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Over the past decades, ground-penetrating radar (GPR) has become a fundamental tool in glaciological studies thanks to its tremendous capacity to provide high-resolution images in snow and ice. 3D acquisitions in particular can give detailed information on the internal structure, properties, and dynamics of glaciers. For imaging and highlighting important englacial and subglacial features such as meltwater tunnels and voids, an analysis of the spatial distribution of diffractions in the data holds great potential. However, the diffracted wavefield typically has low amplitude and is often masked by more prominent arrivals. Diffraction separation and imaging procedures have already become topics of significant interest in the field of exploration seismology, and may potentially open new possibilities for the analysis of glacier GPR data.

Here, we explore the potential of recent advances in diffraction imaging for the analysis of alpine glacier GPR data. To this end, we consider a 3D data set acquired on the Haut Glacier d'Arolla (Valais, Switzerland) using a 70-MHz single-antenna real-time-sampling GPR system. The approach we use coherently approximates the dominant reflected wavefield and subtracts it from the data. The remaining diffracted wavefield is then enhanced using local coherent stacking. We find that this methodology is highly effective at isolating diffractions in glacier GPR data and provides clean images of the diffracting structures. Current work includes investigation of the correlation between these structures and the englacial and subglacial hydrological network.