Title - *Seismic Full Waveform Inversion: feasibility for measuring firn properties*

The transformation of snow into ice is a fundamental process in glaciology. The yearly accumulation of fresh snowfall increases the overburden pressure, changing the snow's properties such that it transitions into firn and pure glacier ice thereafter. Therefore, firn characteristics provide a tool for evaluating past and present climate conditions relating to the amount of snow accumulation, melt, temperature conditions and the subsequent preservation of the snow.

Due to the importance of relationships between firn and other glaciological processes (e.g., settling, sublimation, recrystallization and other deformation processes) it has not been possible to develop a theoretically-based model which accurately predicts firn properties with depth. Therefore, methods of measuring firn are either intrusive or rely on (potentially unreliable) empirical conversions. Full Waveform Inversion (FWI) may offer a new standard for glaciological seismic modelling, mitigating issues within current seismic modelling techniques and paving the way for the recovery of elastic properties, including density. Using seismic datasets obtained from both Norway's Hardangerjøkulen Ice Cap and Pine Island Antarctica, we show how FWI can mitigate the dependence on borehole/core techniques and empirical relationships. Using seismic refractions and reflections, we are able to arrive at an estimate for both subsurface acoustic and elastic parameters which, when compared to ground truth data, show an improvement from current seismic techniques.