Observing and quantifying dipping internal reflectors in 3-dimensions using phase-sensitive ice-penetrating radar

Tun Jan Young[1,2], Dustin M. Schroeder[3,*], Poul Christoffersen[1], Lai Bun Lok[4], Keith W. Nicholls[2], Paul V. Brennan[4], Samuel H. Doyle[5], Bryn Hubbard[5], Alun Hubbard

[1] Scott Polar Research Institute, University of Cambridge
[2] British Antarctic Survey, National Environmental Research Council
[3] Department of Geophysics, Stanford University
[4] Department of Electrical and Electronic Engineering, University College London
[5] Centre for Glaciology, Aberystwyth University
[6] Centre for Arctic Gas Hydrate, UiT The Arctic University of Norway
[*] Presenting author

Investigating the geometry of internal layers within glaciers and their underlying basal topography provides insight into past and present flow dynamics. The spatial variability of internal layers is a record of the ice sheet's response to past surface and basal forcings. Stationary autonomous phase-sensitive radar (ApRES) is a newly-developed and powerful tool emerging from this area of research that has so far been used successfully to estimate vertical strain and basal melt rates in 1-D applications on ice shelves. Here, we use a multiple-input multiple-output ApRES to image the internal stratigraphy of Store Glacier – a fast-flowing tidewater glacier in West Greenland. We observe and quantify the 2- and 3-D orientation of dipping internal reflectors, thereby extending the capabilities of ApRES beyond 1-D depth profiles. By doing so we demonstrate that ApRES is capable of resolving ice deformation and advection from internal layering identified in 2-D and 3-D images. Through comparison between field measurements and artificial simulations of the MIMO array, we identify marked differences in specularity between internal layers and the underlying basal layer. In response we identify those array configurations that determine the optimal ApRES array factor to best resolve these two types of reflectors.