

## A constraint upon the basal water distribution and thermal state of the Greenland Ice Sheet from radar bed-echoes

Thomas Jordan (1,2), Christopher Williams (1,3), Dustin Schroeder (2,4), Yasmina Martos (5,6), Michael Cooper (1), Martin Siegert (7), John Paden (8), Phillippe Huybrechts (9), and Jonathan Bamber (1)

(1) School of Geographical Sciences, University of Bristol, Bristol, UK., (2) Department of Geophysics, Stanford University, Stanford, USA., (3) Now at British Geological Survey, Nottingham, UK., (4) Department of Electrical Engineering, Stanford University, Stanford, USA., (5) Department of Astronomy, University of Maryland, College Park, USA., (6) NASA Goddard Space Flight Center, Greenbelt, USA., (7) Grantham Institute and Department of Earth Science and Engineering, Imperial College, London, UK., (8) Center for Remote Sensing of Ice Sheets, University of Kansas, Lawrence, USA., (9) Earth System Science and Department of Geophysics, Vrije Universiteit Brussels, Brussels, Belgium.

There is widespread, but often indirect, evidence that a significant fraction of the Greenland Ice Sheet is thawed (above the pressure melting point) at the bed. This includes the major outlet glaciers and their tributaries and a large area around the NorthGRIP borehole in the ice-sheet interior. The ice-sheet-wide distribution of basal water is, however, poorly constrained by existing observations. In principle, airborne radio-echo sounding (RES) enables the detection of basal water, but unambiguous ice-sheet-wide mapping using bed-echo reflectivity is limited by uncertainty in signal attenuation. Here we introduce a new RES diagnostic for basal water that is associated with wet-dry transitions in bed material: bed-echo reflectivity variability. Importantly, this diagnostic is insensitive to attenuation and enables combined analysis of over a decade's worth of Operation Ice Bridge RES survey data across the ice-sheet.

The basal water distribution is compared with existing analyses for the basal thermal state (regions of predicted frozen and thawed beds) and geothermal heat flux. In addition to widespread water storage in thawed marginal regions, we also observe water storage in the Northern and Eastern interior. Notably, we observe a quasi-linear 'corridor' of basal water extending from NorthGRIP to Petermann glacier that spatially correlates with elevated heat flux predicted by a recent magnetic model. With a general aim to stimulate future regional and process specific investigations, the basal water distribution is then compared with bed topography, predicted subglacial flow paths, and ice-sheet motion. The basal water distribution, and its relationship with the basal thermal state, provides a new constraint for numerical models at the ice-sheet scale.