Geophysical Research Abstracts
Vol. 18, EGU2016-5349, 2016
EGU General Assembly 2016

The Subglacial Access and Fast Ice Research Experiment (SAFIRE): 2. High magnitude englacial strain detected with autonomous phase-sensitive FMCW radar on Store Glacier, West Greenland

Tun Jan Young (1,2), Poul Christoffersen (1), Keith Nicholls (2), Lai Bun Lok (3), Samuel Doyle (4), Bryn Hubbard (4), Craig Stewart (1), Coen Hofstede (5), Marion Bougamont (1), Joseph Todd (1), Paul Brennan (3), Alun Hubbard (4,6)

(1) University of Cambridge, Scott Polar Research Institute, Lensfield Road, Cambridge, United Kingdom, (2) British Antarctic Survey, High Cross, Madingley Road, Cambridge, United Kingdom, (3) Department of Electronic & Electrical Engineering, University College London, Torrington Place, London, United Kingdom, (4) Centre for Glaciology, Department of Geography & Earth Sciences, Penglais Campus, Aberystwyth University, Aberystwyth, United Kingdom, (5) Alfred Wegener Institute, Helmholtz Centre for Polar & Marine Research, Am Alten Hafen, Bremerhaven, Germany, (6) Department of Geology, Centre for Arctic Gas Hydrate, Environment & Climate, University of Tromsø, Tromsø, Norway

Fast-flowing outlet glaciers terminating in the sea drain 90% of the Greenland Ice Sheet. It is well-known that these glaciers flow rapidly due to fast basal motion, but its contributing processes and mechanisms are, however, poorly understood. In particular, there is a paucity of data to quantify the extent to which basal sliding and internal ice deformation by viscous creep contribute to the fast motion of Greenland outlet glaciers. To study these processes, we installed a network of global positioning system (GPS) receivers around an autonomous phase-sensitive radio-echo sounder (ApRES) capable of imaging internal reflectors and the glacier bed. The ApRES system, including antennas, were custom-designed to monitor and image ice sheets and ice shelves in monostatic and multiple-input multiple-output (MIMO) modes. Specifically, the system transmits a frequency-modulated continuous-wave (FMCW) that increases linearly from 200 to 400 MHz over a period of 1 second. We installed this system 30 km up-flow of the tidewater terminus of Store Glacier, which flows into Uummannaq Fjord in West Greenland, and data were recorded every hour from 06 May to 16 July 2014 and every 4 hours from 26 July to 11 December 2014. The same site was used to instrument 600 m deep boreholes drilled to the bed as part of the SAFIRE research programme. With range and reflector distances captured at high temporal (hourly) and spatial (millimetre) resolutions, we obtained a unique, 6-month-long time series of strain through the vertical ice column at the drill site where tilt was independently recorded in a borehole. Our results show variable, but persistently high vertical strain. In the upper three-fourths of the ice column, we have calculated strain rates on the order of a few percent per year, and the strain regime curiously shifts from vertical thinning in winter to vertical thickening at the onset of summer melt. In the basal ice layer we observed high-magnitude vertical strain rates on the order of 10-20 percent per year due to significant horizontal compression. With eight transmitting antennas and eight receiving antennas, we were also able to analyse strain in 2 and 3 dimensions. This imagery revealed the spatial dimensions of the two ice layers as well as the ice-bed interface, and with the system advecting with the ice flow we were able to track key features, e.g. moulins and internal layers, over the period of observation. Here, we present a complete record of the internal and basal contributions to ice sheet motion and we visualise the variability of ice deformation on a major outlet glacier in Greenland. The results demonstrate the potential of using ApRES to image strain in high temporal resolution and multiple spatial dimensions.