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High resolution monitoring of a calving glacier using a wireless network of GNSS sensors.

Nick Selmes (1), Robin Aspey (3), Stuart Edwards (4), Timothy James (1), Pavel Loskot (2), Ian Martin (4), Anas Moshin (2), Tavi Murray (1), Meredith Nettles (5), Tim O'Farrell (3), Jonathan Rigelsford (3), and Ian Rutt (1)

(1) Geography Department, College of Science, Swansea University, United Kingdom (n.selmes@swansea.ac.uk), (2) College of Engineering, Swansea University, United Kingdom, (3) Department of Electronic and Electrical Engineering, University of Sheffield, United Kingdom, (4) School of Civil Engineering and Geosciences, Newcastle University, United Kingdom, (5) Department of Earth and Environmental Sciences, Columbia University, USA

Calving glaciers have been identified as having a crucial role in the mass balance of the Greenland Ice Sheet, with acceleration and retreat of these glaciers resulting in major mass loss from the ice sheet interior, leading to a corresponding sea level rise. The ability to reproduce observed glacier behaviour in calving models is very desirable, but this is hindered by the difficulty of obtaining appropriate field measurements, combined with the complex interaction of the possible controls on iceberg calving.

Our project brings together experts in glaciology, Global Navigation Satellite Systems (GNSS) technology and processing, and wireless networking, to design, install and operate a wireless network of GNSS sensors at the margin of a heavily crevassed Greenland outlet glacier. The network will provide velocity and elevation data of unprecedented resolution in time and space for the key marginal area of the glacier, where recent changes in glacier dynamics appear to have initiated. These will be analysed in conjunction with contemporaneous auxiliary data, such as surface and airborne lidar measurements of surface topography, crevasse spacing and calving rates, to yield new insights into processes active at the margins of tidewater glaciers.

Our major field campaign will be in summer 2013, with a network of approximately 20 GNSS sensors being deployed, and a suite of ancillary data being collected in tandem. In preparation, we deployed a small test network of three GNSS sensors along the Helheim Glacier flowline in summer 2012, and here we present results from these sensors as a demonstration of the detail we expect to obtain in our main field season.

The deployment of our GNSS sensors in summer 2012 coincided with a large calving event. We have no direct observations of this event; however, 250-500 m of ice was lost from the northern half of the calving front during the period 22-24th July, inferred from MODIS imagery. This retreat coincided with a significant glacial earthquake and increased noise in the fjord on the evening of 25th July giving a probable timing for the calving event. Our data shows a similar step change in glacier velocity to those demonstrated by previous authors, and also shows evidence of tidal signals in both the horizontal and vertical velocity components within 800 m of the calving front, suggesting that part of the glacier was at or very near flotation during this period.