Geophysical Research Abstracts
Vol. 21, EGU2019-2317, 2019
EGU General Assembly 2019

Quantifying bed roughness beneath contemporary and palaeo-ice streams

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Bed roughness is the vertical variation in elevation along a horizontal transect. It is an important control on ice stream location and dynamics. Previous bed roughness studies have typically used data from radio echo sounding (RES) transects over Antarctic and Greenland Ice Sheets. However, the coarse spacing of RES transects limits the connections that can be made between roughness and ice flow. Here, we use measurements of bed topography over an exposed palaeo-ice stream to investigate basal roughness, and how this controls ice stream behaviour. Transects were set up over the Minch Palaeo-Ice Stream (NW Scotland) with the same spacing as RES flight lines over Institute and Möller Ice Streams (Antarctica). We investigated how data-resolution, transect orientation and spacing, affected roughness measurements. Our results showed that fast palaeo-ice flow can occur over a rough, hard bed. This differs from most previous studies, which suggested that fast ice flow occurred over smooth, soft beds. In addition, smooth sections of the bed were found to occur over areas of both bedrock and sediment cover. Our work enabled us to propose that the spacing of RES transects is often too wide to measure the bed roughness of landform assemblages, and that transect orientation impacts bed roughness measurements of contemporary and palaeo-ice streams. Considerations of transect spacing and orientation is therefore of the utmost importance when designing RES surveys for exploring basal roughness of contemporary ice masses.