Geophysical Research Abstracts
Vol. 19, EGU2017-3579, 2017
EGU General Assembly 2017

Hydrologically active palaeofluvial and subglacial channel networks beneath Humboldt Glacier, Greenland

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Subglacial drainage systems influence both the flow of overlying ice and the evolution of subglacial landscapes. Yet, the persistence, pattern, origin and spatio-temporal evolution of subglacial drainage remains poorly understood. Whilst the beds of former ice sheets record numerous examples of channelized subglacial drainage systems, any influence these may have had upon ice sheet dynamics is difficult to decipher without contemporary analogues. Therefore, in order to understand the fates of past, present and future ice sheets, further study of contemporary subglacial hydraulic systems is required. Here, we present evidence from satellite imagery, digital elevation models and radio-echo sounding data for previously unknown channelized networks beneath Humboldt Glacier, northern Greenland. We find that two major channel networks exist beneath Humboldt Glacier: (i) a dendritic channel network to the north of the catchment, which extends for over >250 km beneath the ice sheet; and (ii) a series of linear channels in the south of the catchment, which are up to 80 km in length, 2.5 km wide and 400 m deep. These two morphologically contrasting systems likely have separate origins. We interpret the dendritic channel network to be of palaeofluvial origin, whilst the linear channels are likely to be subglacially formed tunnel valleys – analogous to those observed on former ice sheet beds. Radio-echo sounding indicates that basal meltwater is actively being routed along both systems. The dichotomy in subglacial drainage system origin corresponds to a division in ice flow regime, with faster flowing ice occurring over the palaeo-fluvial system. We therefore hypothesise that the large-scale bed channelization by subglacial meltwater erosion, which occurs beneath the slower flowing southern portion of Humboldt, results in a long-term reduction in basal water pressures and ice flow velocities.