EGU2020-7271
https://doi.org/10.5194/egusphere-egu2020-7271
EGU General Assembly 2020

Subglacial water pressure records from a fast-flowing outlet glacier in Greenland

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Glacier motion is resisted by basal traction that can be reduced significantly by pressurised water at the ice-bed interface. Few records of subglacial water pressure have been collected from fast-flowing, marine-terminating glaciers despite such glaciers accounting for approximately half of total ice discharge from the Greenland Ice Sheet. The paucity of such measurements is due to the practical challenges in drilling and instrumenting boreholes to the bed, in areas that are often heavily-crevassed, through rapidly-deforming ice that ruptures sensor cables within weeks. Here, we present pressure records and drilling observations from two sites located 30 km from the calving front of Store Glacier in West Greenland, where ice flow averages ~600 m yr^{-1}. In 2018, boreholes were drilled 950 m to the bed near the margin of a large, rapidly-draining supraglacial lake. In 2019, multiple boreholes were drilled ~1030 m to the bed in the centre of the drained supraglacial lake, and in close proximity to a large, active moulin. All boreholes drained rapidly when they intersected or approached the ice-bed interface, which is commonly interpreted as indicating connection to an active subglacial drainage system. Neighbouring boreholes responded to the breakthrough of subsequent boreholes demonstrating hydrological or mechanical inter-connection over a distance of ~70 m. Differences in the time series of water pressure indicate that each borehole intersected a distinct component of the subglacial hydrological system. Boreholes located within 250 m of the moulin reveal clear diurnal cycles either in phase or anti-phase with moulin discharge. Pressure records from boreholes located on the lake margin, however, show smaller amplitude, and less distinct, diurnal cycles superimposed on longer-period (e.g. multiday) variability. We compare these datasets to those in the literature and investigate consistencies and inconsistencies with glacio-hydrological theory.

How to cite: Doyle, S., Hubbard, B., Christoffersen, P., Bougamont, M., Law, R., Chudley, T., Prior-Jones, M., and Schoonman, C.: Subglacial water pressure records from a fast-flowing outlet glacier in Greenland, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-7271, https://doi.org/10.5194/egusphere-egu2020-7271, 2020