

The Subglacial Access and Fast Ice Research Experiment (SAFIRE): 1. Borehole-based englacial and subglacial measurements from a rapidly-moving tidewater glacier: Store Glacier, Greenland

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As part of the Subglacial Access and Fast Ice Research Experiment (SAFIRE) pressurised hot water was used to drill four 603-616 m-long boreholes to the bed of the Greenland Ice Sheet at a site located 30 km from the calving front of fast-flowing, marine-terminating Store Glacier (70 degrees N, ~1000 m elevation). Four wired sensor strings were successfully installed in three of the boreholes. These included a thermistor string to obtain the englacial temperature profile installed in the same borehole as a string of tilt sensors to measure borehole deformation, and two sets of combined water pressure, electrical conductivity and turbidity sensors installed just above the bed in separate, adjacent boreholes. The boreholes made a strong hydrological connection to the bed during drilling, draining rapidly to ~80 m below the ice surface. The connection of subsequent boreholes was observed as a perturbation in water pressure and temperature recorded in neighbouring boreholes, indicating an effective hydrological connection between them. The sensors, which were wired to data-loggers at the surface, operated for between ~30 and >80 days from late summer into autumn before the cables stretched and snapped, with the lowermost sensors failing first. The records obtained from these sensors reveal (i) subglacial water pressures that were close to overburden but which generally increased through the period of measurement and varied diurnally by ~0.3 m, (ii) a minimum englacial temperature of -21 degrees C underlain by a zone of temperate ice, some tens of m thick, located immediately above the bed, and (iii) high rates of internal deformation and strain that increased towards the bed. These borehole observations are complemented by GPS measurements of ice motion, meteorological data, and seismic and radar surveys.