Cryoegg: development and field trials of a wireless subglacial probe for deep, fast-moving ice

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Subglacial hydrological systems require innovative technological solutions to access and observe. Wireless sensing systems can be used to collect and return data, but their performance in deep and fast-moving ice requires quantification. We report experimental results from Cryoegg: a spherical probe that can be deployed from a borehole in ice and transit through the subglacial hydrological system. The probe makes measurements in-situ and sends them back to the surface via a radio link. Cryoegg uses very high frequency (VHF) radio to retrieve data through up to 1.3km of cold ice to a surface receiving array. It measures temperature, pressure and electrical conductivity and returns all data wirelessly. The wireless transmission uses Wireless M-Bus on 169MHz; we present a simple radio link budget model for its performance in cold ice and experimentally confirm its validity. We demonstrate Cryoegg's utility in studying englacial channels and moulins, including estimating moulin discharge through in situ salt dilution gauging. Future iterations of the radio system will allow Cryoegg to transmit through up to 2.5 km of ice.