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The Subglacial Access and Fast Ice Research Experiment (SAFIRE): 1. Programme of investigation on Store Glacier, West Greenland

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Marine-terminating outlet glaciers drain 90 percent of the Greenland Ice Sheet and are responsible for about half of the ice sheet's net annual mass loss, which currently raises global sea level by almost 1 mm per year. Understanding the processes that drive the fast flow of these glaciers is crucial because a growing body of evidence points to a strong, but spatially varied and often complex, response to oceanographic as well as atmospheric forcing. While the bed of glaciers elsewhere is known to strongly influence the flow of ice, no observations have ever been made at the bed of a marine-terminating glacier in Greenland. The flow of ice in numerical models of the Greenland Ice Sheet consequently rely on untested basal parameterisations, which form a likely and potentially significant source of error in the prediction of sea level rise over the coming decades and century.

The Subglacial Access and Fast Ice Research Experiment (SAFIRE) is addressing this paucity of observational constraints by gaining access to the bed of Store Glacier, a marine-terminating outlet of the Greenland Ice Sheet which has a drainage basin of 35,000 square kilometres and terminates in Uummannaq Fjord. In 2014, the SAFIRE programme drilled four boreholes in a region where ice flows at a rate of 700 m per year and where a seismic survey revealed a bed consisting of soft sediment. (See joint abstract by Hofstede et al. for details.) The boreholes were 603-616 m deep and direct access to the bed was confirmed by a clear hydrological connectivity with a basal water system. (See joint abstract by Doyle et al. for details.)

With sensors deployed englacially (temperature and tilt) and at the bed (water pressure, turbidity, electrical conductivity), the SAFIRE will inform the ratio of internal ice deformation and basal slip, vertical strain, ice temperature, and fluctuations in water pressure linked to supraglacial lake drainage as well as diurnal drainage into moulins. In 2015, we plan to extract core samples from the bed in order to establish the rheology of the basal sediment and use repeat inclinometry to verify basal and englacial ice deformation rates, while using an optical televiewer to identify layering and texture of ice. With the additional installation of instruments on the glacier's surface (GPS, AWS, passive seismics and radar) and forefield (time-lapse cameras and repeat UAV missions over the calving ice front), the SAFIRE project aims to resolve the basal control on ice flow as well as the dynamics associated with iceberg calving. The observational outcomes will demonstrate how the flow of a major marine terminating outlet glacier in Greenland is influenced by atmospheric and oceanic forcings, while also enabling numerical ice flow modelling to be undertaken with a much improved basal parameterisation.