

The life cycle of Ice Sails

Geoff Evatt (1), Christoph Mayer (2), I.d Abrahams (1), Lindsey Nicholson (3), Amy Mallinson (1), and Matthias Heil (1)

(1) University of Manchester, School of Mathematics, University of Manchester, Alan Turing Building, Manchester, United Kingdom (Geoffrey.evatt@manchester.ac.uk), (2) Bavarian Academy of Sciences and Humanities, (3) University Innsbruck

The Karakoram mountain region is host to many debris-covered glaciers. A notable feature from a sub-set of mainly larger glaciers with flat tongues, is the phenomenon of 'Ice Sails'. These Ice Sails are clean ice structures that protrude out of the surrounding debris-covered glacier. They can be up to 20 meters in height, with widths of up to 90 meters, and generally have flat-sided faces. They appear to grow out of areas of glacier with thin debris coverage, then persist for decades as the glacier flows downstream, before declining back into the glacier several kilometres later. Here we aim to define and categorise these ice structures, and then explain their growth, persistence and decay. In particular, we show that their growth is due to the melt rate of inclined clean-ice being smaller than that of the surrounding flat thinly-debris-covered ice, allowing these structures to appear to grow out of the debris layer. But as the glacier flows downstream, this debris thickness slowly thickens, causing the corresponding melt-rate of the underlying ice to decline. Eventually, the melt-rate of the debris-covered ice becomes lower than that of the Ice Sail's melt-rate, at which point the decaying process of the Ice Sail commences. We develop a model to quantify this process, and in so doing, draw out the key parameters that govern the existence of Ice Sails.