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Field constraints on the effect of water supply on the evolution of the subglacial drainage system

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Surface water that reaches a glacier bed can reduce friction between at the base of the ice and facilitate sliding. This has been documented for both, valley glaciers and the Greenland ice sheet. The relationship between meltwater supply, basal water pressure, and basal sliding is determined by the configuration of the subglacial drainage system. That configuration is not fixed but evolves over the melt season from a less efficient, distributed system to a more highly developed, channelized one. In order to investigate the evolution of the subglacial drainage system, we use a subglacial water pressure data set from a small, surge-type, polythermal valley glacier in St. Elias Mountains, Yukon. Common pressure variations shared by different boreholes can be interpreted as evidence of an efficient hydraulic connection between them. We cluster boreholes based on the similarity in response to diurnal surface melting. This allows us to identify a main drainage system and determine a representative water pressure evolution. We estimate the forcing that produces this response in the form of water supply to the bed. We use an enhanced temperature-index model to estimate hourly melt-rates. The model differentiates between the snow and ice covered surface, so it is important to know the snow distribution over the glacier surface at the beginning of the melt season. We develop a new photogrammetric method to improve estimates of the initial snow distribution, and use a Lagrangian water routing model for the glacier surface based on the surface slope gradient. This is combined with crevasse locations to determine where water is supplied to the bed. As a first step, we then use the modelled meltwater supply as an input for a zero-dimension box model of the subglacial drainage system, and invert the observed pressure signal in the main drainage system for model parameters.