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Estimating the configuration of the subglacial drainage system under a mountain glacier in St. Elias Mountains, Yukon

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Numerous studies have documented that water at the ice-bed interface can affect ice flow dynamics of both, mountain glaciers and the Greenland ice sheet. Water at the bed is routed through a complex network of conduits that form a subglacial drainage system. The subglacial drainage system evolves over the melt season in response to the changes in the meltwater supply. However, it is challenging to study due to the inaccessibility of the glacier bed. We use an extensive near-bed water pressure data set from an ablation zone of a small, polythermal, mountain glacier in St. Elias Mountains, Yukon. Pressure sensors, that exhibit common diurnal variations, are considered to be connected to a hydraulically active drainage system.

We use a simplified two-dimensional continuum version of the subglacial drainage model with an additional assumption that changes in drainage configuration are negligible over a short time period. Spatially varying permeability function is used as a proxy for the subglacial drainage configuration, assuming that the areas of high (low) permeability correspond to the areas that are connected (disconnected) to a hydraulically active system. In order to study the evolution of the subglacial drainage system over the melt season, we divide the melt season in a series of short time periods. We then use the inverse model to estimate the permeability function for each of these time periods. Continuity is ensured by using, respectively, the final pressure distribution and the estimated permeability function of the previous period, as the initial condition and the a priori estimate for the consequent time period.