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A stochastic subglacial drainage system model for data assimilation.

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The study of the subglacial drainage system is challenging due to the inaccessibility of such environments, resulting in a lack of direct observations. Even though physical subglacial hydrology models have been built in recent years, it is still difficult to validate them against observations and to perform sensitivity analysis.

Here, we aim to infer the spatial structure, channel geometry and hydraulic conductivity of the subglacial drainage system based on indirect data such as water pressure and tracer experiment. We develop an approach that uses a combination of stochastic and physical processes where an inversion procedure is used to determine a set of equiprobable models that all fit the data. The proposed methodology incorporates three main components: 1) a stochastic channel generator to produce realistic geometries for the subglacial drainage system; 2) a physical model where water pressure and mass transport are computed over the domain; 3) A Bayesian inverse framework for data assimilation where the output (pressure, tracer travel times) are compared to observed data. The model is tested for a synthetic ice sheet geometry under variable recharge scenarios and different data sets. This enables us to assess the parameter uncertainty and the significance of data.