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Estimating basal properties of ice streams from surface data

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We introduce a Bayesian inversion approach to estimating the shape of the glacier bed and the glacier bed resistance to basal sliding (basal slipperiness) from glacier surface velocities and surface geometry. Inverse estimates of bed topography and basal slipperiness are refined in an iterative way through a Bayesian inversion of the differences between measured surface data and the results of the forward model. In each such inverse step, the forward model derivatives are approximated using analytical (Gudmundsson, 2003) and numerical transfer functions (Raymond and Gudmundsson, 2005). This is a crucial feature of the proposed method, which greatly enhances its numerical efficiency. The forward model is a non-linear finite element model which solves Stokes flow using the full set of the momentum equations. We present case studies using noise-degraded synthetic data. The synthetic data is generated using rheological parameters, basal conditions, and ice geometry that can be considered to be typical of active ice streams.