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Bayesian inference of ice thickness from remote-sensing data

Mauro A. Werder and Matthias Huss
ETH Zurich, VAW, Zurich, Switzerland (werder@vaw.baug.ethz.ch)

Knowledge about ice thickness and volume is indispensable for studying ice dynamics, future sea-level rise due to glacier melt or their contribution to regional hydrology. Accurate measurements of glacier thickness require on-site work, usually employing radar techniques. However, these field measurements are time consuming, expensive and sometime downright impossible. Conversely, measurements of the ice surface, namely elevation and flow velocity, are becoming available world-wide through remote sensing.

The model of Farinotti et al. (2009) calculates ice thicknesses based on a mass conservation approach paired with shallow ice physics using estimates of the surface mass balance. The presented work applies a Bayesian inference approach to estimate the parameters of a modified version of this forward model by fitting it to both measurements of surface flow speed and of ice thickness. The inverse model outputs ice thickness as well the distribution of the error. We fit the model to ten test glaciers and ice caps and quantify the improvements of thickness estimates through the usage of surface ice flow measurements.