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Bayesian calibration of glaciological systems models

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The glaciological, climate, and earth system modelling communities have been slow to incorporate, in any statistically self-consistent way, the objective determination of model and data uncertainties into their results. Though ensemble calculations offer a first step, statistically self-consistency requires the propagation of model parameter and constraint data uncertainties into the ensemble results. Bayesian model calibration addresses this key issue. We present a Bayesian framework for model calibration based on a combination of artificial neural networks and Markov Chain Monte Carlo methods. The calibration provides a posterior distribution for model parameters (and thereby in our case modelled glacial histories) given the observational data sets. This methodology therefore also takes into account constraint data uncertainty. This approach is highly applicable to cluster computing environments in which one can generate order 100 model runs per month of real time with dozens of ensemble parameters. The methodology also allows the incorporation of diverse and large sets of noisy constraint data into the calibration procedure and is suitable for complex nonlinear models. A discussion of on-going experiences and challenges encountered in the application of this methodology to the calibration of the U of T Glacial Systems Model will be presented.