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An algorithm for the estimation of time invariant model parameters within a Bayesian Framework using the sequential incorporation of data

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A common problem in hydrology is the estimation of the time invariant parameters of an, often deterministic, model. This can be readily cast in a Bayesian inference framework resulting in a posterior distribution for the model parameters. In many cases the intractable nature of this distribution means it is approximated by a sample of parameter vectors. As more data, in the form of additional observations, becomes available the posterior distribution is altered and the approximating sample requires updating. Existing methodologies in the hydrological literature for updating the sample are either computationally inadequate (e.g. Theiman Water Res. Res. 37, 2001) or do not ensure the continuity of the states (e.g. Moradkhani Water Res. Res. 41, 2005; Ensemble Kalman filter). That is the states assigned to a parameter vector at a given point in time are not the result of evolving the model through all the data with the selected parameter vector. An alternative methodology based on Sequential Monte Carlo sampling that ensures the continuity of the states is presented. The resulting computational algorithm is demonstrated on two case studies.