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Development of a software framework for data assimilation and its applications for streamflow forecasting in Japan

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Data assimilation methods have received increased attention to accomplish uncertainty assessment and enhancement of forecasting capability in various areas. Despite of their potentials, applicable software frameworks to probabilistic approaches and data assimilation are still limited because the most of hydrologic modeling software are based on a deterministic approach.

In this study, we developed a hydrological modeling framework for sequential data assimilation, so called MPI-OHyMoS. MPI-OHyMoS allows user to develop his/her own element models and to easily build a total simulation system model for hydrological simulations. Unlike process-based modeling framework, this software framework benefits from its object-oriented feature to flexibly represent hydrological processes without any change of the main library. Sequential data assimilation based on the particle filters is available for any hydrologic models based on MPI-OHyMoS considering various sources of uncertainty originated from input forcing, parameters and observations. The particle filters are a Bayesian learning process in which the propagation of all uncertainties is carried out by a suitable selection of randomly generated particles without any assumptions about the nature of the distributions. In MPI-OHyMoS, ensemble simulations are parallelized, which can take advantage of high performance computing (HPC) system.

We applied this software framework for short-term streamflow forecasting of several catchments in Japan using a distributed hydrologic model. Uncertainty of model parameters and remotely-sensed rainfall data such as X-band or C-band radar is estimated and mitigated in the sequential data assimilation.