Streamflow hindcasting with lagged particle filtering and multivariate rainfall ensemble generator using a distributed hydrologic model

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In this study, a combination of two recently proposed filtering and ensemble generation methods is evaluated for streamflow hindcasting using a distributed hydrologic model: lagged particle filtering and multivariate rainfall ensemble generator. Lagged particle filtering (Noh et al., 2011) performs an analysis step in a lag-time window and updates past and current state variables at the same time. This ensures that the response times between internal hydrologic processes and measured discharge observations are taken into account. Multivariate rainfall ensemble generator (Rakovec et al., 2012) produces ensemble scenarios using time-dependent multivariate conditional simulations, which provide uncertainty conditions of input forcing for ensemble-based data assimilation.

The proposed method is applied for streamflow hindcasting of several flood events in a small-sized Japanese catchment. Rainfall ensembles, produced by multivariate rainfall ensemble generator, are used as input forcing of a distributed hydrologic model and model ensembles, analyzed within a lag-time window, are updated by streamflow observation. Discussion is focused on how uncertainties of input forcing and state variables are propagated and how this robust method can contribute to improvement of streamflow prediction via various illustrations of open loop and data assimilation cases. With multivariate rainfall ensembles, excessive perturbation of state variables can be mitigated. Lagged filtering and regularization of ensembles can improve accuracy and stability of ensemble forecasting.