Geophysical Research Abstracts
Vol. 19, EGU2017-11197, 2017
EGU General Assembly 2017

Practical implementation of a particle filter data assimilation approach to estimate initial hydrologic conditions and initialize medium-range streamflow forecasts

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In an automated forecast system, hydrologic data assimilation (DA) performs the valuable function of correcting raw simulated watershed model states to better represent external observations, including measurements of streamflow, snow, soil moisture, and the like. Yet the incorporation of automated DA into operational forecasting systems has been a long-standing challenge due to the complexities of the hydrologic system, which include numerous lags between state and output variations. To help demonstrate that such methods can succeed in operational automated implementations, we present results from the real-time application of an ensemble particle filter (PF) for short-range (7 day lead) ensemble flow forecasts in western US river basins. We use the System for Hydromet Applications, Research and Prediction (SHARP), developed by the National Center for Atmospheric Research (NCAR) in collaboration with the University of Washington, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation. SHARP is a fully automated platform for short-term to seasonal hydrologic forecasting applications, incorporating uncertainty in initial hydrologic conditions (IHCs) and in hydrometeorological predictions through ensemble methods.

In this implementation, IHC uncertainty is estimated by propagating an ensemble of 100 temperature and precipitation time series through conceptual and physically-oriented models. The resulting ensemble of derived IHCs exhibits a broad range of possible soil moisture and snow water equivalent (SWE) states. The PF selects and/or weights and resamples the IHCs that are most consistent with external streamflow observations, and uses the particles to initialize a streamflow forecast ensemble driven by ensemble precipitation and temperature forecasts downscaled from the Global Ensemble Forecast System (GEFS). We apply this method in real-time for several basins in the western US that are important for water resources management, and perform a hindcast experiment to evaluate the utility of PF-based data assimilation on streamflow forecasts skill. This presentation describes findings, including a comparison of sequential and non-sequential particle weighting methods.