A comparative study between the ensemble Kalman Filter and the particle filter in rainfall-runoff models

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I. Introduction

Rainfall-runoff models are hydrologic models and they play a very important role in flood forecasting. Hydrologic systems are featured by a non-linear behaviour with large uncertainties in the model itself and in the input data. The use of state estimation or data assimilation techniques is important in order to improve the model predictions.

Evensen [1] presents the Ensemble Kalman Filter (EnKF) as a Monte Carlo approach to the nonlinear filtering problem. Recently, the Particle Filter (PF), which is a sequential Monte Carlo method for state estimation, has been widely applied in mobile robot localization with promising results [2].

This paper presents the performances of the EnKF and the PF applied to a rainfall-runoff model. A comparison is done in order to determine the advantages and disadvantages of both techniques.

II. State estimation

The well known Kalman filter (KF) is the optimal estimator for linear systems with Gaussian distributions. Several extension to the Kalman filter has been developed mainly to deal with nonlinearities in the system and non-Gaussian distributions.

The Extended Kalman filter (EKF) is probably the most used nonlinear version of the KF. The EKF linearizes the system around the mean and covariance using the Taylor series. The Unscented Kalman Filter (UKF) is based on the unscented transformation, the transformation consists in the parametrisation of the means and covariances of the probability distributions using a set of appropriately chosen weighted points.

In the field of Geosciences, where the systems are high-dimensional with high nonlinear behavior and most of the times without continuous measurements and non-Gaussian distributions, the EnKF was proposed as a solution to the estimation problem. Recently, research has been conducted in the application of particle filters in Geosciences for parameter and state estimation.

A description of the EnKF and the particle filter is provided in this paper.

III. Conclusions

Results show that the standard particle, which is easier to implement, and the EnKF filters perform similar with the surface soil moisture as the estimated variable and using synthetic generated data.

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References

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[2] M. Sanjeev Arulampalam, Simon Maskell, and Neil Gordon, "A tutorial on particle filters for online nonlinear/non-gaussian bayesian tracking," *IEEE Transactions on Signal Processing*, vol. 50, pp. 174–188, 2002.