Geophysical Research Abstracts
Vol. 16, EGU2014-16903-1, 2014
EGU General Assembly 2014

Improving data-driven hydrological forecasting by data assimilation using copulas

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Traditionally flow forecasting relies upon the use of physically-based (hydrologic and hydrodynamic) models. Data assimilation like states updating and error correction have been explored with the aim to increase accuracy and obtain uncertainty estimates of the forecasts. At the same time data-driven (regression) models have shown their ability to generate accurate forecasts for short lead times. In this work we attempt to add the data assimilation to a data-driven model, and for this we use copula functions as a post-processing tool serving as an error corrector. Based on forecast ensembles obtained from a hydrological neural network model, we fit marginal forecast distributions with historical observations of flow to create a multivariate joint distribution of flow for each time step in the forecast period. Using separate marginal distributions of each data time series, we tested four copula families with different properties in order to fit the best multivariable distribution. It is worth noting that the error estimates are not deterministic but probabilistic which makes the output of the forecasting model probabilistic as well. This technique is applied to the Meuse river basin in Belgium. The results show that the copula-based post-processing increases the accuracy of model forecast, and computationally inexpensive which is important for operational hydrological forecasting.

Keywords: Flow forecasting, Copula function, neural network model, Meuse river basin