Geophysical Research Abstracts
Vol. 15, EGU2013-9727, 2013
EGU General Assembly 2013

A combined wavelet – ARFIMA model for daily streamflow forecasting considering long range dependence

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Short term streamflow forecasting is of importance in water resources management, especially from the point of view of operational flow control and risk management. Beside deterministic rainfall runoff and flow routing models, stochastic time series models are also in operational use for this purpose. The fitting of such stochastic models is preceded, when suitable, by removing the systematic components in the time series (such as trends, seasonality). Usually the interest of practitioners lies in the fitting of the stochastic part of the time series model and removing the systematic components is considered rather a routine task. However, each deseasonalization method has an effect on time series analyzed, affecting the autocorrelation structure and thus influencing the following model choice and the fitted model parameters.

When choosing an appropriate stochastic model the practitioners often neglect the presence of long range dependence when considering short term forecasting. This, however, might have an effect on the forecasts even in short term horizon. The autoregressive integrated moving average models (ARFIMA) are often used for modelling of time series displaying long range dependence in hydrology.

In hydrology, wavelets are mostly applied for feature extraction and process description rather then modelling and forecasting. In this work we attempted to improve the deseasonalization step of the modelling process by using wavelet analysis. We proposed to combine an ARFIMA model with a wavelet transform used for deseasonalization.

The quality of the model is tested on one to ten days ahead forecasts of mean daily runoffs from the Danube River measured at Kienstock in Lower Austria. A comparison with two other models – an ARFIMA model combined with moving average deseasonalization and a linear wavelet based model was performed.

The results of the model comparison showed that use of wavelets provides a suitable alternative to the moving average deseasonalization. For one and two days forecasting horizon the new approach did not show improvement in the forecasting performance over the other tested models. However, for longer forecasting horizons, the wavelet deseasonalization - ARFIMA combination outperforms the other two models, thus offering improvement compared to the usual moving average deseasonalization.

Since none of the three models was able to remove autocorrelation from the squared residuals, usually indicating heteroscedasticity in the time series, the concept of the wavelet deseasonalization may be explored further in combination of other possibly suitable model, such as a fractionally integrated generalized autoregressive conditional heteroscedasticity model type.