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Modelling and forecasting monthly river discharge considering autoregressive heteroscedasticity

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Monitoring water scarcity conditions requires medium term streamflow forecasting. In this contribution stochastic models for the forecasting of monthly flows were compared.

Data measured in monthly time step from the Hron and the Morava Rivers in Slovakia were considered. When analyzing this data in a shorter, daily time step, it was verified, that the from econometry known, so – called heteroscedasticity effect, i.e. the non-constant variance of the time series was present. Here it was investigated, whether this was the case if considering the data with a monthly time step. In addition, the time series were analyzed from two different perspectives: using a purely data driven stochastic model and a hybrid approach, combining physics based conceptual model with a data driven model for the residuals.

To model the heteroscedasticity in the time series, the GARCH (generalized autoregressive conditional heteroscedasticity) family of models was fitted to the time series. So far, only a few attempts to apply GARCH class models used on discharge data were reported in the hydrological modelling literature.

The goal of investigation was to try to expand the knowledge in the time series modelling of hydrological time series with the aim to test the possibility to use the GARCH family of models on time series with monthly time step and comparing forecasting performance with traditional ARMA models.
In order to achieve this, following steps were taken:
1. The presence of heteroscedasticity was verified in time series.
2. An ARMA type model combined with a GARCH model was fitted to the data (either directly on the discharge time series or on the error series resulting from a conceptual model).
3. One – step – ahead forecasts from the fitted models were produced, performing comparisons to forecasts obtained by using only an ARMA class model on the same data.

In the case of the purely data driven model it was found, that the medium time step was not fine enough to catch the heteroscedasticity effect, which is present in the data when considering a finer time step at all. Considering the hybrid framework, even though heteroscedasticity was not rejected in the error series, the GARCH family of models did not offer any forecasting improvement compared to the simpler ARMA class of models. This result shows the existence and thus the need of modelling the non-linearities in some cases in the medium step, even if different methods offering better forecasting performance need to be investigated.