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Monthly streamflow forecasting in the Rhine basin

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Forecasting seasonal streamflow of the Rhine river is of societal relevance as the Rhine is an important water way and water resource in Western Europe. The present study investigates the predictability of monthly mean streamflow at lead times of zero, one, and two months with the focus on potential benefits by the integration of seasonal climate predictions. Specifically, we use seasonal predictions of precipitation and surface air temperature released by the European Centre for Medium-Range Weather Forecasts (ECMWF) for a regression analysis.

In order to disentangle forecast uncertainty, the 'Reverse Ensemble Streamflow Prediction' framework is adapted here to the context of regression: By using appropriate subsets of predictors the regression model is constrained to either the initial conditions, the meteorological forcing, or both. An operational application is mimicked by equipping the model with the seasonal climate predictions provided by ECMWF. Finally, to mitigate the spatial aggregation of the meteorological fields the model is also applied at the subcatchment scale, and the resulting predictions are combined afterwards.

The hindcast experiment is carried out for the period 1982-2011 in cross validation mode at two gauging stations, namely the Rhine at Lobith and Basel. The results show that monthly forecasts are skillful with respect to climatology only at zero lead time. In addition, at zero lead time the integration of seasonal climate predictions decreases the mean absolute error by 5 to 10 percentage compared to forecasts which are solely based on initial conditions. This reduction most likely is induced by the seasonal prediction of precipitation and not air temperature.

The study is completed by bench marking the regression model with runoff simulations from ECMWFs seasonal forecast system. By simply using basin averages followed by a linear bias correction, these runoff simulations translate well to monthly streamflow. Though the regression model is only slightly outperformed, we argue that runoff out of the land surface component of seasonal climate forecasting systems is an interesting option when it comes to seasonal streamflow forecasting in large river basins.