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Potentials and limitations of seasonal runoff predictions for Swiss mesoscale basins

Simon Schick, Ole Rössler, and Rolf Weingartner
Group of Hydrology, University of Bern, Switzerland (simon.schick@students.unibe.ch)

Prediction of long-term runoff (i.e. month, season, year) is a valuable information for decision-makers in hydropower industries, water resources management and inland water transports. Common approaches for seasonal runoff forecasts can mainly be categorized by the integration or disintegration of numerical climate predictions. While the former is a quite new development in this research field, the latter has been introduced already in the 1950s for Swiss basins using a linear regression model and several case studies can be found. Nevertheless scientific literature lacks an overview concerning spatial as well temporal differences of seasonal runoff predictability in Swiss basins.

In this study we applied a simple partial least squares regression model to predict seasonal runoff and evaluated how this approach performs across different discharge regimes and over the year. Here, we defined season as a time window of 91 consecutive days with arbitrary position within the calendar year. Furthermore, the quartiles of these 91 daily runoff values were choosen as the target values and temperature, precipitation and runoff prior to the forecast date as predictors. Hence, the model itself does not make any assumptions about future weather and climate – the forecasts are based on the disposition of the specific basin at the date of forecast and assume a memory effect caused by interactions of water storages such as soil, groundwater, lakes and snow.

Seasonal runoff forecasts for 24 Swiss mesoscale basins (100-2000 km^2) were then analyzed to estimate temporal and spatial differences in goodness of prediction. We show that model skill varies strongly through the calendar year. In spring and autumn we observe best model performance, whereas for summer the prediction benefit is smaller relative to the discharge regime as reference. On the other hand spatial differences in goodness of prediction were much smaller – alpine catchments show best predictability by trend, because of snow accumulation during winter and delayed melting in spring. In addition the study showed the importance of lakes for seasonal runoff predictions. Integrating seasonal climate predictions in a next step is expected to increase model skill, but will remain a challenging task because of the low predictability of climate over Central Europe.