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A comparison of different approaches for forecasting spring floods in Sweden

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In seasonally snow covered regions, such as Sweden, the winter precipitation often falls as snow which is temporarily stored in the snow pack during the colder months. This storage is later released over a relatively short period of intense flows during in the warmer months. These spring flood events dominate the hydrology of these regions and therefore there is a real interest in reliable hydrological forecasts of these events.
In the state-of-the-art forecasting approach for three catchments in Sweden, the HBV model is firstly run using observed temperature and precipitation up until the time of the forecast, that way producing an optimal description of the hydro-meteorological conditions. Then temperature and precipitation data, for the period corresponding with that being forecasted, from all historical years since 1961 is used to create an ensemble of model runs representing possible evolutions in the coming period. Since all historical years are used, the (median) forecast is climatological, i.e. it predicts the spring flood under the assumption that the development of the weather in the forecasting period will be normal. The forecast error will thus be larger the more unusual the weather develops, provided that the initial HBV-condition represents reality well.
In this study, three different ensemble forecast approaches to spring flood forecasting were compared to the state-of-the-art operational method. (1) A reduced historical ensemble approach, where analogue years from the historical dataset are selected to run the hydrological model. (2) Using meteorological seasonal forecasts from the European Centre for Medium-Range Weather Forecasts (ECMWF) to run the hydrological model. (3) Statically downscaling large-scale circulation variables from ECMWF seasonal forecasts to accumulated discharge using the Singular Value Decomposition method. The different approaches were evaluated for forecasts issued on 1/1, 1/3 and 1/5 for the spring floods 2000-2010 in the rivers Vindelälven, Ångermanälven and Ljusnan. The evaluation was mainly performed in terms of the mean absolute error (MAE) of accumulated discharge with the state-of-the-art forecast as a reference. Also the frequency of cases when the new approach outperformed the state-of-the-art forecast was calculated and used.
The results indicate that some reduction of the forecast error seems attainable for Vindelälven and Ångermanälven, whereas none of the single approaches generated any clear improvement for Ljusnan. This is probably because the spring floods in the former rivers are more clearly related to snow melt. The largest improvement was found for the 1/1-forecasts using the statistical downscaling approach, while the reduced ensemble approach gave the best improvement when considering all forecast dates. Using ECMWF seasonal forecasts approach did not generate any improvements; an analysis of the ECWMF forecasts indicated clearly overestimated precipitation in Feb-Apr and temperature in Jun-Jul, as compared with catchment observations.