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Enhancement of seasonal hydrological forecasting with "pattern-based" large-scale climatology

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The hydrological forecasting on seasonal (up to 7 months ahead) timescales is needed for decision-making in the hydropower sector. Being one of the vital influencing factors on hydro-production, a lot of development in dynamical forecasting at seasonal timescales has been done recently. However, the forecast bias still remains in different variables and consequently the skill of corresponding streamflow forecasts varies from month to month.

This study aims to explore the potential for "pattern-based" seasonal hydrological forecasts that make use of hydrological weather regimes and teleconnection indices to improve forecast skill. The work is built on the hypothesis that hydrological weather regimes and teleconnection indices can be used to select analogue years (setting an ensemble) from a record of historical precipitation and temperature data with which to force a hydrological model to generate tailored seasonal forecasts of reservoir inflows. The hydrological weather regimes have been classified based on the concept of fuzzy sets using the anomalies of daily mean sea level pressure from reanalysis data (i.e., ERA-Interim). Precipitation records, measured in the Umeälven river basin during 1981-2016 are used as local observations to optimize each fuzzy rule that describes a type of "average" variability of local climate in terms of the frequency and magnitude of precipitation events. The teleconnection indices are compiled from the Climate Prediction Center, which describe global atmospheric variability. The methodology has been applied to 84 sub-catchments across seven of the most important hydropower producing river systems in Northern Sweden. However, the performance for the Umeälven river system is of particular interest here.

Comparing to the traditional Ensemble Streamflow Prediction (ESP) method, the "pattern-based" seasonal hydrological forecasting shows a marked improvement, which is likely due to the weighted analogue-ESP approach as well as the selected analogues using the large-scale climate information described by hydrological weather regimes and teleconnection indices. The general performance of the two different approaches for selecting the analogues are similar; however, occasionally there are large differences in both the best analysis lead times and the spread of skill across the sub-catchments suggesting that those results are achieved using analogues based on different physical processes.