Abstract

In Sweden, almost half of the electricity produced comes from hydropower. However, the amount of water in the reservoir catchments is not evenly distributed throughout the year. During the colder months, precipitation usually falls as snow and accumulates into a snowpack. This frozen water is not available to the energy producers until the spring snow melt when as much as 70% of the annual discharge will be generated. This can create a situation where there is a shortage of water resources during the winter when demand and energy prices are high, and a surplus during the spring and summer when demand and prices are lower. Hydropower plant operators try to minimize this asymmetric distribution through regulation of reservoir storages and hydrological forecasts are crucial for this.

However, the predominant method for hydrological seasonal forecasting the spring flood period in Scandinavia is the Ensemble Streamflow Prediction (ESP) approach. ESP uses historical observations of precipitation and temperature from previous years (a so-called historical ensemble) to force the hydrological model. The problem is that these forecasts are climatological in character, i.e. it performs well when the weather during the forecast period evolves normally, however if the development of weather conditions is not "normal", the season forecast will be more or less wrong.

The thesis of this work is that this is possible to improve seasonal forecasts so that they still have skill even when the weather deviates from the normal climate during the forecast period. By better understanding what affects the variability in the hydrology and using that information to inform how to modifying or replace the ESP forecasting approach, it is possible to real skilful improvements over the ESP.

In this work it is shown that selected teleconnection patterns are the leading source of variability in the seasonal river discharge volumes in Sweden. In the case of the spring flood period in northern Sweden, these are the North Atlantic Oscillation, Arctic Oscillation, and Scandinavian pattern. With the help of information garnered by investigating these connections it is possible to modify different forecast modelling chains, that on their own show limited (if any) skill over ESP, and combine them into a multi-chain forecast system that does show skill over the ESP. A Multi-model ensemble of modelling chains made up of three different individual modelling chains, using a simple weighting scheme to combine them, is able to improve the general skill of spring flood volume forecasts and improve their ability to predict non-normal events.