SESSION: (A4) S2S forecasts for decision making

(A4-03)

Improving the predictability of streamflow for hydropower production in Canada using S2S ensemble meteorological forecasts

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Currently, long-term hydrological forecasts at Hydro-Quebec (Quebec's main hydro-power producer) are Extended Streamflow Predictions (ESP), derived from climatology. This process rests on a strong assumption of stationarity which may not hold in a changing climate. Our main working hypothesis is that hydrological forecasts based on dynamic meteorological forecasts have better predictive skill than ESP. By « better », we mean they are more skillful than ESP for lead-times longer than 10 days. In many operational contexts, ESP are used instead of dynamical forecasts beyond this period.

To verify our hypothesis, we rely on a testbed of ten catchments exploited by Hydro-Quebec for hydropower. HSAMI, the conceptual global hydrological model used operationally by Hydro-Québec, was successively fed by three different types of ensemble meteorological forecasts: 1- the 30-day ahead forecasts produced by the European Center for Medium range Weather Forecasts (ECMWF), retrieved from the global S2S database (Vitart et al. 2017); 2- the 7-month ahead forecasts from ECMWF's System4 (Molteni et al. 2011); 3- the ECMWF's SEAS5 forecasts (released in November 2017). In all cases, the forecasted precipitation and temperature (min and max) were used as inputs to HSAMI, with daily time steps. The period from 1995 to 2014 is the same for the three types of forecasts, although they have different issue dates.

Biases in raw meteorological forecasts were first quantified. In some cases, biases were so large that raw forecasts did not lead to any gain in predictability and one might as well use climatology instead of forecasts as inputs to HSAMI. Consequently, biases were removed from precipitation and temperature forecasts using a simple but efficient linear scaling.

Hydrological forecasts skill was assessed using the Continuous Ranked Probability Score (CRPS), as well as the reliability diagram and the rank histogram. ESP were used as a benchmark, as they represent « the system to beat ».

For streamflow forecasts, performance metrics and diagrams were computed using (1) the observed streamflow; and (2) a simulation run for which HSAMI was fed with precipitation and temperature observations. The latter allows for an assessment of forecasts that is free from model and observation uncertainties. However, we consider important to verify forecasts skill against real-life observations, despite the associated flaws and uncertainties, as the goal of forecasting is precisely to anticipate those observations.

The relative performance of the three different types of ensemble forecasts is discussed and compared according to watersheds and seasons. For most watersheds, streamflow and volume forecasts computed from dynamical forecasts were found to be more skillful than ESP for the first 30 days, which confirms our hypothesis. Surprisingly however, streamflow forecasts based on 30-day meteorological forecasts from the S2S database did not in general outperform those based on System4 and SEAS5.

Issues related to the fair comparison of different types of forecasts which do not share common issue dates still need to be addressed in future studies, as well as possibilities for a seamless combination of medium and long term meteorological forecasts into the same hydrological forecasting framework.