Seasonal hydrological ensemble forecasts over Europe

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This study investigates the limits of predictability in dynamical seasonal discharge forecasting, in both space and time, over Europe. Seasonal forecasts have an important socioeconomic value. Applications are numerous and cover hydropower management, spring flood prediction, low flow prediction for navigation and agricultural water demands. Additionally, the constant increase in NWP skill for longer lead times and the predicted increase in the intensity and frequency of hydro-meteorological extremes, have amplified the incentive to promote and further improve hydrological forecasts on sub-seasonal to seasonal timescales.

In this study, seasonal hydrological forecasts (SEA), driven by the ECMWF's System 4 in hindcast mode, were analysed against an Ensemble Streamflow Prediction (ESP) benchmark. The ESP was forced with an ensemble of resampled historical meteorological observations and started with perfect initial conditions. Both forecasts were produced by the LISFLOOD model, run on the pan-European scale with a spatial resolution of 5 by 5 km. The forecasts were issued monthly on a daily time step, from 1990 until the current time, up to a lead time of 7 months. The seasonal discharge forecasts were analysed against the ESP on a catchment scale in terms of their accuracy, skill and sharpness, using a diverse set of verification metrics (e.g. KGE, CRPSS and ROC).

Additionally, a reverse-ESP was constructed by forcing the LISFLOOD model with a single perfect meteorological set of observations and initiated from an ensemble of resampled historical initial conditions. The comparison of the ESP with the reverse-ESP approach enabled the identification of the respective contribution of meteorological forcings and hydrologic initial conditions errors to seasonal discharge forecasting uncertainties in Europe. These results could help pinpoint target elements of the forecasting chain which, after being improved, could lead to substantial increase in discharge predictability over Europe.