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What is the relative role of initial hydrological conditions and meteorological forcing to the seasonal hydrological forecasting skill? Analysis along Europe's hydro-climatic gradient

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Recent advances in understanding and forecasting of climate have led into skilful seasonal meteorological predictions, which can consequently increase the confidence of hydrological prognosis. The majority of seasonal impact modelling has commonly been conducted at only one or a limited number of basins limiting the potential to understand large systems. Nevertheless, there is a necessity to develop operational seasonal forecasting services at the pan-European scale, capable of addressing the end-user needs. The skill of such forecasting services is subject to a number of sources of uncertainty, i.e. model structure, parameters, and forcing input.

In here, we complement the "deep" knowledge from basin based modelling by investigating the relative contributions of initial hydrological conditions (IHCs) and meteorological forcing (MF) to the skill of a seasonal pan-European hydrological forecasting system. We use the Ensemble Streamflow Prediction (ESP) and reverse ESP (revESP) procedure to show a proxy of hydrological forecasting uncertainty due to MF and IHC uncertainties respectively. We further calculate the critical lead time (CLT), as a proxy of the river memory, after which the importance of MFs surpasses the importance of IHCs. We analyze these results in the context of prevailing hydro-climatic conditions for about 35000 European basins. Both model state initialisation (level in surface water, i.e. reservoirs, lakes and wetlands, soil moisture, snow depth) and provision of climatology are based on forcing input derived from the WFDEI product for the period 1981-2010. The analysis shows that the contribution of ICs and MFs to the hydrological forecasting skill varies considerably according to location, season and lead time. This analysis allows clustering of basins in which hydrological forecasting skill may be improved by better estimation of IHCs, e.g. via data assimilation of in-situ and/or satellite observations; whereas in other basins skill improvement depends on better MFs.