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Regionalizing sensitivity of long-term forecasts over Europe

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Many socio-economic sectors, such as energy production, risk management or tourism, can benefit from hydrologic forecasts at monthly to seasonal horizons. An increasing number of hydrologic forecasting systems are being developed along these lines, for scales ranging from the catchment through to the continental and global scales. Such forecasts are communicated along with a diagnostic of their performance with the month of the year and the lead time. The skill of hydrologic forecasts results from and is subject to different sources of uncertainty, i.e. model structure, parameters, initial conditions and meteorological forcing input. Identifying and quantifying the sensitivity of forecast systems to these different sources of uncertainty can guide the choice of components of a forecast system, or more generally foster efforts and investments for a given catchment, such as model improvements, new data acquisition tools or better meteorological forecasts.

We investigate the relative contributions of initial hydrologic conditions (IHCs) and meteorological forcing (MF) to the skill of a pan-European seasonal hydrological forecasting system. The end point blending (EPB, Arnal et al., 2017), a computationally-light version of the variational ensemble streamflow prediction assessment (VESPA, Wood et al., 2016), which provides diagnostics of skill sensitivity to IHC and MF over forecast months and forecast aggregations, is applied in a set of catchments that are representative of the European hydro-climatic gradient. For this analysis, four ensembles are produced based on the European version of the HYPE hydrological model (E-HYPE) for the period 1981-2010. An ensemble based on modelled climatology blends uncertainties in IHCs and MF, an ensemble based on perfect forecasts without uncertainty from any of the two, Extended Streamflow Prediction (ESP) representing uncertainties in MF, and reverse ESP representing uncertainties in IHCs. In all analyses, both model state initialisation and provision of climatology are based on forcing input derived from the WFDEI product, a combination of the ERA-Interim reanalysis and of satellite products.

In a previous study, eleven types of European catchments were identified in terms of prevailing hydro-climatic conditions and seasonal forecast skill. Here, the EPB method is applied in 550 basins selected uniformly within these eleven catchment types. From this analysis, we highlight characteristic patterns in skill sensitivity to IHCs and MF over Europe, and link these patterns to catchment hydrological features. We also investigate how and how fast sensitivity in IHCs and MF changes with the lead time. Finally, a regionalization of statistics in sensitivity patterns is investigated.

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