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Dynamical forecast vs Ensemble Streamflow Prediction (ESP): how sensitive are monthly and seasonal hydrological forecasts to the quality of rainfall drivers?

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Seasonal forecasting of hydrological extremes is challenging for the hydro-meteorological modelling community, and the performance of hydrological forecasts at lead times over 1 month is still poor especially for catchments with limited hydrological memory.

A considerable amount of effort is being invested within the meteorological community to improve dynamic meteorological forecasting which can then be used to drive hydrological models to produce physically-driven hydrological forecasts. However, currently for the UK, these meteorological forecasts are being produced at 1 month or seasonal time-step, whereas hydrological models often require daily or sub-daily time-steps. A simpler way to get seasonal forecasts is to use historical climate data to drive hydrological models using Ensemble Streamflow Prediction (ESP). This gives a range of possible future hydrological status given known initial conditions, but it does not contain any information on the future dynamic of the atmosphere. The error is highly dependent on the type of catchment, but ESP is an improvement compared to simply using climatology of river flows, especially in groundwater dominated catchments.

The objective of this study is to find out how accurate the seasonal rainfall forecast has to be (in terms of total rainfall and temporal distribution) for the dynamical seasonal forecast to beat ESP. To this aim, we have looked at the sensitivity of hydrological models to the quality of driving rainfall input, proxy of 'best possible' forecasts. Study catchments representative of the range of UK's hydro-climatic conditions were selected. For these catchments, synthetic rainfall time series derived from observed data were created by increasingly degrading the data. The number of rainy days, their intensity and their sequencing were artificially modified to analyse which of these characteristics is most important to get a better hydrological forecast using a simple lumped hydrological model (GR4J), and how much improvement do we get compared to a benchmark forecast method such as ESP.

The results of this work will hopefully help the meteorological modelling community to identify where to focus their efforts in order to increase the usefulness of their forecasts for hydrological forecasting systems.