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How to compare what seems incomparable in seasonal hydrological forecasting?

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A number of climate forecasting systems have been developed at the global scale allowing the production of seasonal hydrological services at the regional, national and continental scales. With these services becoming increasingly available to dissemination institutes and occasionally directly to the public, forecasters have been requesting information on the reliability of the forecasts, particularly when they need to select one system for a specific application. The quality of the forecasts depends on the hydrological model used and, consequently, on its setup, structure, objective, and performance. These characteristics can be very different among models, adding a degree of complexity to any model output inter-comparison analysis. Here, we propose a framework to compare outputs from different modelling systems. We compare the seasonal streamflow forecasts produced by a continentally-calibrated complex model (E-HYPE) and a regionally-calibrated parsimonious model (GR6J) to forecast streamflow in a set of French catchments. Streamflow forecasts are obtained by using bias adjusted ECMWF System 4 seasonal precipitation and temperature forecasts as input to the E-HYPE and GR6J hydrological models. We first identify within the forecasting chain the origin of the differences between the two hydrological systems. We use the evaluation of forecast skill to highlight and isolate the differences in meteorological forcing, initial hydrological conditions and historical model performance, respectively. Forecast skill is thus evaluated by considering different benchmarks based on: i) historical observed streamflow, ii) historical simulated streamflow, and iii) the Extended Streamflow Prediction (ESP) system which uses meteorological climatology as input to the hydrological models. We also present the dependence of forecast quality (i.e. sharpness and reliability) on the hydrological models used. Lastly, we assess the impact of the two different model structures on forecast uncertainty, by evaluating the evolution of forecast spread (an indicator of forecast uncertainty) from forcing inputs to model states and streamflow response.