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Do more complex hydrological models produce more skilful streamflow forecasts?

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Ensemble streamflow prediction (ESP) is a well-established and widely used approach to hydrological forecasting, the application of which requires a hydrological model that can contribute to forecast skill by providing: (i) accurate initial hydrological conditions; and (ii) accurate transformation of climate to river flow signals. It is widely known that there exists a relationship between ESP skill and the hydrological regime of a catchment, and several studies have correlated forecast quality with sets of catchment descriptors. The choice of hydrological model is therefore significant. Whilst a parsimonious structure may be preferable for efficiency, potential skill could be lost if the model's simplicity means it cannot adequately reproduce key hydrological processes in the catchment. This work seeks to examine the contribution of hydrological model complexity to forecast skill. Using a parsimonious model as a reference, we investigate if additional model complexity adds forecast skill at different lead times and initialisation months through the use of models with different structures and parametric complexity. Forecast skill is evaluated within a hindcast experiment for a selection of Irish river catchments using the continuous ranked probability skill score. Results are presented for our reference model, GR4J (Génie Rural à 4 paramètres Journalier), and our complex model, SMART (Soil Moisture Accounting and Routing for Transport). The performance of each model is viewed in the context of its ability to reproduce key hydrological signatures known to control forecast quality in Ireland (e.g., baseflow index).