EGU2020-17646, updated on 28 Sep 2021
https://doi.org/10.5194/egusphere-egu2020-17646
EGU General Assembly 2020

Spatial and temporal patterns in seasonal forecast skill based on river flow persistence in Irish catchments

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In this study we assess the seasonal hydrological forecast skill of river flow persistence across a sample of 46 catchments representative of Ireland's diverse range of hydrogeological conditions. This statistical approach is straightforward to implement as it uses a river's most recently observed flow anomaly (calculated over a predictor period of a given duration) as its forecasted flow anomaly (for a given horizon). In our hindcast experiment, persistence skill is evaluated against a streamflow climatology benchmark and by assessing the correlations between predicted and observed anomalies. Using the most skilful predictor period of 1-week, we find that the majority of persistence forecasts outperform the benchmark between April and September at the 1-month forecast horizon. However, this narrows to solely the summer months when using 2- and 3-month horizons. Skill declines with increasing durations of the predictor and/ or forecast horizon period as a catchment is given more time to "forget" initial anomalous streamflow conditions and/or to be impacted by "new" anomalies. High rainfall events, for example, tend to disrupt the persistence of flows and greater forecast skill is thus found in the relatively drier months.

The degree of persistence skill is also strongly conditional on the "memory" inherent to each catchment (i.e. their storage capacity), as indicated by physical catchment descriptors such as the Base Flow Index (correlation ρ with skill = 0.86). Persistence skill is greatest in lowland regions characterised by permeable lithologies, well drained soils and lower annual average rainfall totals. Physical descriptors can thus be used to anticipate the likely performance of river flow persistence as a forecasting tool in rivers outside the catchment sample. Through multiple linear regression analysis, we identified the combination of predictors that produced the best-performing model (adjusted R^2= 0.89) and used it to predict the persistence forecast skill level expected in 215 catchments across the country at different horizons and seasons. Highlighting exactly when and where persistence provides higher predictive skill than the reference climatology forecast, we show the value of statistical flow persistence methods as a tougher-to-beat benchmark in the development of more sophisticated seasonal river flow forecasting methods at the catchment-scale. This research also underscores the scope for development of dynamical hydrological

forecasting approaches in the wetter, poorly drained catchments underlain by impermeable lithologies, found mainly in the north-western and south-western regions of Ireland.