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Seasonal UK hydrological forecasts using rainfall forecasts – what level of skill?

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Skilful winter seasonal predictions for the North Atlantic circulation and Northern Europe, including the UK have now been demonstrated and the potential for seasonal hydrological forecasting in the UK is now being explored. The Hydrological Outlook UK (HOUK: www.hydoutuk.net) is the first operational hydrological forecast system for the UK that delivers monthly outlooks of the water situation for both river flow and groundwater levels. The output from the HOUK are publicly available and used each month by government agencies, practitioners and academics alongside other sources of information such as flood warnings and meteorological forecasts.

The HOUK brings together information on current and forecast weather conditions, and river flows, and uses several modelling approaches to explore possible future hydrological conditions. One of the techniques combines ensembles of monthly-resolution seasonal rainfall forecasts provided by the Met Office GloSea5 forecast system with hydrological modelling tools to provide estimates of river flows up to a few months ahead. The approach combines a high resolution, spatially distributed hydrological initial condition (HIC) provided by a hydrological model (Grid-to-Grid) driven by weather observations up to the forecast time origin. Considerable efforts have been made to accommodate the temporal and spatial resolution of the GloSea5 rainfall forecasts (monthly time-step and national-scale) in a spatially distributed forecasting system, leading to the development of a monthly resolution water balance model (WBM) to forecast regional mean river flows for the next 1 and 3 months ahead.

The work presented here provides the first assessment of the skill in the HOUK national-scale flow forecasts using an ensemble of rainfall forecasts (hindcasts) from the GloSea5 model (1996 to 2009). The skill in the combined modelling system has been assessed for different seasons and regions of Britain, and compared to what might be achieved using other approaches such as use of an ensemble of historical rainfall, or a simple flow persistence forecast. It has also been possible to attribute overall forecast skill to the different model components such as the HIC, and use of either the whole GloSea5 ensemble or just the ensemble mean.

When performance is analysed by season the utility of GloSea5 seasonal rainfall forecasts in autumn and winter becomes apparent, particularly at the 3-month lead time. The analysis finds little skill in summer flow forecasts whatever type of rainfall forecasts is used, and seasonal forecasts of flows in spring have only modest skill, achieved using an ensemble of historical rainfall estimates.

Given the high spatial heterogeneity in typical patterns of UK rainfall and evaporation, future development of skilful spatially distributed seasonal forecasts could lead to substantial improvements in seasonal flow forecast capability, benefitting practitioners interested in predicting hydrological extremes, not only in the UK, but potentially across Europe.