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Skill and limits of predictability for a sub-seasonal-to-seasonal (S2S) hydrological forecasting system over Europe

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Hydrological forecasts with a lead-time from medium-range (15 days) to seasonal (6 months) has the potential to be very useful for decision-makers, but has up until very recently not received much attention. One reason for that has been the lack of forecast skill on longer lead times. Currently, numerical weather prediction models (NWP) are developing into fully integrated earth system models (ESM) by including the representation of the most relevant coupled processes at the monthly time scales, such as ocean/sea-ice interaction and troposphere-stratosphere feedbacks already from day one. This study explores the sub-seasonal to seasonal (S2S) predictability for a European hydrological application. We used the seamless setup of the European Flood Awareness System (EFAS), which combines the 46-day ECMWF extended ensemble prediction system (ENS) with the seasonal forecasting system (System-4) and provides biweekly forecast updates with a maximum horizon of 6 months. The forecasts were evaluated against a water balance run forced with observed meteorological input, and the evaluation was done over a 20-year hindcast period. The results indicate that the average predictability window for river discharge at station points extends to around 30 days; beyond this limit, climatology is as good as using a full dynamical model. However, there are both areal and seasonal variations to this limit. The skill also varies with low- or high flow. Large river basins tends to extend the predictability to up to 45 days and there is a very relevant increase in the predictability up to 60 days for low-flow events, showing that a hydrological drought and low-flow early warning system could provide skilful information of anomalous conditions on the S2S lead time.