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Skill of hydrological drought forecasts beyond 2 months

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Drought is one of the most severe weather-related natural disasters, which causes damages and losses comparable to other destructive hazards, such as floods and landslides. One of the most effective strategies to reduce the impact of the drought hazard is by issuing a timely warning signal to agencies and stakeholders coping with drought. Unlike an Early Warning System (EWS) for floods that requires hourly and daily forecasts, a drought EWS should be able to produce a warning signal with lead times of a few months ahead up to a season. This paper explores the capability of the high-resolution LISFLOOD hydrological model (5 by 5 km) fed by seasonal weather forecasts (SEAS), i.e. 15 ensemble members of the ECMWF Integrating Forecasting System (IFS) S4 to predict hydrological droughts up to 7 months ahead. The study was carried out for the extreme 2003 pan-European drought. Drought events are derived from forecasted gridded time series of hydrological variables (soil moisture, runoff, discharge, and groundwater) using the Variable Threshold Method to forecast hydrological droughts. The LISFLOOD model forced with ground observations (e.g., radar, weather stations) is used as a proxy for observed data. Forecasting skill is calculated using drought classes (mild, moderate, severe, and extreme drought), which are derived from drought severity. A high forecasting skill is achieved if there is no difference between drought classes derived from observed data and the median of the ensemble of forecasted data. Our results show that the forecasting skill is high during winter and autumn, and declining during spring and summer. In winter, hydrological droughts can be predicted up to 6 months ahead and in summer, however, the prediction is only skillful for 2-months lead time. Hydrological drought forecasting using variables with a longer memory (soil moisture and groundwater) is more skillful than using the ones with shorter memory (runoff and discharge). The drought forecasts in general underestimate the observed droughts in the Temperate Oceanic Climate and Warm-summer Humid Continental Climate, whereas these are overestimated in the Subartic Climate. The highest forecasting skill is achieved in the semi-arid region or Mediterranean Climate region.