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Influence of Hydrological Response Time on the Sensitivity of Pan-European Runoff to the North-Atlantic Oscillation

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The North Atlantic Oscillation (NAO) is a major factor determining winter temperature and precipitation anomalies over Europe. Through these anomalies the NAO influences river discharge and the strength of the NAO signal has been used to predict seasonal discharge of European rivers and to identify river regimes potentially sensitive to climate change. In a comprehensive analysis of Pan-European runoff simulated with the macro-scale hydrological model PCR-GLOBWB, the sensitivity of rivers to the historical NAO signal was established. In a related numerical experiment its seasonal predictability was investigated. The results showed that many rivers display a distinct sensitivity to the NAO, particularly those crossing different climate zones (e.g., Danube, Volga), and that in many parts of Europe the skill of predicting winter discharge can, in theory, be quite large. However, this achieved skill mainly comes from knowing the correct initial conditions of the hydrological system (i.e., groundwater, soil moisture conditions and persistence of snow cover), rather than from the use of NAO-based seasonal weather prediction. For predicting subsequent summer discharge these factors are equally important although the relative importance of the weather prediction increases with the increasing uncertainty in inherited initial conditions. In order to assess the influence of the hydrological response time on these initial conditions we investigated the predictive skill of the simulations in the light of variations in groundwater residence times and snow melt rates. These variations are based on the confidence intervals associated with the calibrated model parameters and provide essential insight into the long-term predictability of large-scale hydrological systems.