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Ensemble predictions of future streamflow drought in Europe

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Recent developments in climate modeling suggest that global warming and growing human water use are likely to favor conditions for the development of streamflow droughts in several parts of Europe by the end of this century. In this study, we quantify how future drought hazard in Europe may develop in view of these drivers by comparing low-flow predictions of the LISFLOOD hydrological model coupled to a water consumption module and driven by an ensemble of climate projections. This ensemble consists of 12 bias-corrected climate simulations conducted within the ENSEMBLES project, forced by the A1B emission scenario for the period 1961-2100. For time slices of 30 years, low-flow characteristics – quantified in terms of minimum flows, environmental flows and deficits – are derived from the simulated streamflow series and further analyzed using extreme value theory. Changes in extreme river conditions are then analyzed with respect to the 1961-1990 control period. Two main domains with opposite signal of change in drought characteristics can be identified in Europe, as well as a transition zone between them. Southern parts of Europe - from the Iberian to Balkan Peninsula- but also France, Belgium and British Isles are expected to be more prone to severe and persistent low-flow conditions. In contrast, the Scandinavia Peninsula and Northeast Europe show a robust decrease in future drought hazard. In a transition zone between these two regions, climate-induced changes are projected to be marginal. Water use under an A1B-consistent scenario will further aggravate drought conditions in the south as well as in the transition zone. In the regions with a clear pattern of change in streamflow drought, indices derived from the hydrological simulations for different climate experiments are highly consistent, whereas in the transition zone between North and South Europe the consistency in changes amongst the ensemble members is lower.