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Uncertain precipitation change signal – robust projections of drought risk for forests?

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Damage chains in the beech and oak forests induced by recurrent severe droughts of the last decades emphasize the need for the development of adaptation measures in forestry that requires robust projections of drought tendencies. However, for the Carpathian Basin regional climate models have rather large spread and uncertainty, especially for precipitation. Therefore the aim of this study was (1) to evaluate whether the climate models are able to capture the frequency, severity and length of the drought periods and (2) to analyze whether the climate change projections for droughts are robust enough to detect potential impacts in forestry.
Two case study regions in the Carpathian Basin (approx. 5000 km2 each) were selected for the analyses, where in the periods 1992-1994 and 2000-2003 the largest beech and oak mortality was detected, so far. Meteorological drought was defined applying existing monthly based temperature-precipitation indices. For evaluation, regional climate model simulations provided via the EURO-CORDEX initiative and driven by the ERA-Interim products were used. These simulations have been compared to the gridded observational data from the CarpatClim project. Until 2099, the direction and the range of the projected drought tendencies were quantified for three 10-10 member multi-model ensembles assuming representative concentration pathways (RCP4.5 and RCP8.5) and emission scenario (SRES A1B) of the IPCC. The spatial resolution of the simulations was 0.11° * 0.11° for the RCP scenarios, and 0.22° * 0.22° for the SRES A1B scenario, respectively.
For drought frequency and severity, half of the analyzed models show a good agreement with the observations, whereas the others simulate more frequent hotter and/or drier droughts. Towards the end of the century, even in the case of the scenario with lower radiative forcing, the expected increase of temperature is large enough to induce robust increasing tendency in the probability, severity and length of drought periods, in spite of the large spread and uncertain sign of the simulated precipitation changes. For all analyzed scenarios and independently from the applied drought index it is likely that consecutive drought periods occur that are longer and more severe than the most extreme drought in the last century that have led to tree mortality. Consequently, larger damages in forestry can be expected than those that have ever been observed, so far.
Our results confirm that despite the uncertainty of the precipitation change signal, the projections on drought risk can already be robust enough to detect potential impacts and thus they can already support the development of adaptation measures in forestry.

Keywords: climate projections, regional climate model ensembles, meteorological drought, robustness, forest ecosystems

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