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Hydroclimate variability in NE-Germany: A view on the summer drought of 2018 based on multi-centennial records of tree ring stable isotopes of pine and oak

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The sensitivity of European lowlands to the hydrological impacts of climate change has manifested in flood and drought events of increasing severity over recent decades. Reconstructing the long-term history of hydroclimatic fluctuations in this region is critical to our understanding of its current and future ecosystem dynamics. This is especially important considering that this region is widely susceptible to anthropogenic influences (e.g. large monoculture farms and forests, vast drained peatlands), and it also contains unique, near-natural habitats, including registered UNESCO World Heritage sites (e.g. Müritz National Park). In this study, we use annually resolved multi-centennial records of stable carbon and oxygen isotope chronologies from tree ring cellulose in lowland (50-90m asl.) pine and oak trees (P. sylvestris, Q. petraea) in NE-Germany to reconstruct hydroclimatic variability. Using a calibration and verification approach, we have evaluated the response to instrumental climate data and trends in variables such as local temperature, precipitation, drought indices (PDSI, SPEI), soil moisture, evapotranspiration potential (ETP) and vapor pressure. While ring widths correlate strongly to winter temperature in the study region, strong correlations with summer hydroclimatic conditions were found for both tree-ring 13C and 18O. The strongest relationships occur with ETP, soil moisture, and SPEI. From 1979 to 2010, current-year ETP (JJA) and soil moisture (JJA) show no significant relationships to 13C, but they are strongly correlated to 18O (r=0.66, ETP; r=-0.65, soil moisture). Slightly weaker correlations exist with SPEI (JJA) (r=-0.53, 18O; r=-0.42, 13C). In general, climate relationships with 13C are consistently weaker than those with 18O, but all correlations are significant at the 99% level. Based on a detailed assessment of stable isotope-climate relationships and resulting reconstruction of hydroclimatic baseline variability, we will attempt to assess the sensitivity of tree ring stable isotopes to summer drought. Special attention will be paid to the most recent droughts of 2003 and 2018, the latter of which is considered unprecedented in view of instrumental weather records. Wood anatomical analyses of tree rings from 2018 have revealed that most pine trees formed relatively few latewood cells this year. In contrast, oak tree rings showed normal latewood to earlywood proportions in 2018. Investigation of this discrepancy by additional intra-annual isotope analyses will inform the discussion of the possible limitations of using stable isotope records to reconstruct severe droughts.