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Integrating tree-ring and wine data from the Palatinate (Germany)

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Tree-ring growth of conifer trees originating from central European low mountain ranges often reveal indistinct growth-climate relationships. Temperature variations can play a crucial role, whereas water availability can also control the annual growth and become the main dominating factor. The low mountain range Pfälzerwald in the Palatinate region represents the largest contiguous forested area in Germany and features at its most eastern limitation a unique ecological setting due to its sandy soils and reduced water availability. In addition, its north-south orientation and associated lee-effects due to predominating westerlies together with altitudinal differences of more than 300 m lead to higher temperatures, lower precipitation amounts, and, as a forest management consequence, to a proportion of up to 80 % of pine trees. Despite these exceptional ecological and climatological prerequisites, calibrating tree-ring width data from 487 Pinus sylvestris core samples against regional meteorological stations (1950-2011) and gridded data (1901-2011) confirm alternating climate control mechanisms. Comparison with drought-related indices (scPDSI), combining precipitation and temperature, unfolds highest correlations with May-July conditions ($r=0.34$, $p<0.05$), however, lacking temporal robustness in the early 20th century.
The vegetation outside the forested areas in the plain can be characterized as agricultural croplands with vineyards, representing one of the largest wine-growing regions in Germany. We collected and analyzed a 24 datasets of 57 consecutive years (1959-2015) of must sugar content, acidity, alcohol content, and sugar-free extracts in Riesling, Pinot Gris, Pinot Blanc, and Silvaner wines, originating from 15 wineries adjoining the forested area into the plain. Correlation of Riesling must sugar content against regional April-August temperature data reveals a highly significant signal ($r=0.73$, $p<0.01$; high-pass filtered $r=0.49$, $p<0.01$). Sugar-free extract variations of Pinot Gris are significantly controlled by March-September precipitation ($r=0.76$, $p<0.01$; high-pass filtered $r=0.77$, $p<0.01$). In this low mountain range, tree-ring growth from conifers is not solely controlled by one climatic variable, though it is that combining tree-rings with must sugar content and sugar-free extract data from Riesling and Pinot Gris wine can further elucidate our understanding of longer-term climate variability in the Palatinate region.