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Process-based modeling of tree-ring formation and their relationships with climate data on the Tibetan Plateau

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Response of climate warming on tree-ring formation has attracted much attention during recent years. However, most studies are based on statistical analysis, lacking understanding of tree-physiological processes, especially on the mountainous region of the Tibetan Plateau (TP). Herein, we firstly use an updated new version of the tree-ring process-based Vaganov-Shashkin model (VS-oscilloscope) to simulate tree-ring formation and its relationships with climate factors during the past six decades. Our analysis covered 341 sampled trees, with elevation ranges from 2750 to 4575 m a.s.l. at five sampling sites from southern to northern part of the TP. Simulated tree-ring width series are significantly ($p < 0.01$) correlated with actual tree-ring width chronologies during their common interval periods. Starting dates of tree-ring width formation are all determined by temperature at the five sampling sites. After the initiation of tree stem cambial activity, soil moisture content has a significant effect on tree-ring growth. Ending dates are driven by temperature in the study region. Simulated results indicate the difference between wide and narrow tree-ring formation is mostly induced by soil moisture content, especially at the first half of the growing season, while effect from temperature is minor. Interestingly, we detected significantly ($p < 0.001$) increased relative growth rate due to soil moisture (GrW) after the year 1985 at the five sampling sites. However, the variability of mean relative growth rate due to temperature (GrT) is negligible before and after that. Based on the successful application of VS-oscilloscope modeling on the high-elevation tree stands of the TP, our study provides a new perspective of tree radial growth process and their relationships with climate data during the past six decades.