

Postprint: Simulation Study on Radial Growth of *Picea schrenkiana* Based on Tree-Ring Physiological Models

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Abstract

Picea schrenkiana is an important forest species in the Tianshan Mountains region. To understand the response mechanism of radial growth of trees at the upper forest limit to climatic conditions in the Tianshan Mountains, dendroclimatological methods were employed. Using a standardized tree-ring width chronology established from tree core samples collected from the upper limit of *Picea schrenkiana* forest in the Barkol Mountains of eastern Tianshan, the VS-oscilloscope model was applied to simulate the radial growth process of *Picea schrenkiana* and reveal its relationship with environmental factors over the past 55 years. The results indicate: (1) The correlation coefficient between the simulated tree-ring width index and the actual tree-ring width index was 0.645 ($P < 0.01$). The two showed good consistency in their variation trends, indicating that the model achieved favorable simulation performance. (2) The main limiting factors for tree radial growth were soil moisture during April-May and July-August. Temperature was the primary factor determining the start of the growing season, while the growth rate determined by temperature did not significantly influence the formation of wide and narrow rings. (3) The correlation coefficient between the simulated tree-ring width index and the growing season end date was -0.413 ($P < 0.01$), indicating that the end date of the growing season significantly influenced tree-ring width growth. (4) Since 1984, with the gradual rise in regional temperature, the length of the tree growing season has shown a prolongation trend, while tree radial growth has exhibited a decline. The temperature increase since 1984 may be the main cause of the tree growth decline. Therefore, this study reveals the main limiting factors and limiting periods in the radial growth process of trees at the forest upper limit in eastern Tianshan from a physiological perspective, aiming to provide reference for future dendrochronological studies in this region.

Full Text

Process-Based Modeling of Radial Growth of *Picea schrenkiana* in the Eastern Tianshan Mountains

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Abstract

The Tianshan Mountains represent one of the most important tree-ring research areas in China. To understand the response mechanism of radial growth of trees in the upper forest to environmental conditions, this study conducted simulations to reveal the relationship between radial growth processes and environmental factors based on the VS-oscilloscope model. The simulations utilized observed daily temperature and precipitation data from Balkun Weather Station in Hami City, Xinjiang, China from 1960 to 2015, along with 52 tree cores from 26 trees collected at the upper forest of Balkun Mountain in the eastern Tianshan Mountains. Following standard dendrochronological methods, all samples were surfaced, cross-dated, and measured. Finally, tree-ring width chronologies were established from core samples of *Picea schrenkiana*. The results show: (1) The correlation coefficient between simulated tree-ring width index and actual tree-ring width index is 0.645 ($P < 0.01$), with consistent trends indicating that the model achieved good simulation results. (2) The main limiting factors for tree radial growth are soil moisture from April to May and from July to August. Temperature is the main factor determining the beginning of the tree growing season, but the growth rate determined by temperature is not obvious in the formation of wide and narrow rings. (3) The correlation coefficient between simulated tree-ring width index and the end date of the growing season was -0.413 ($P < 0.01$), showing that the end date of the growing season has some influence on tree-ring width growth. (4) Additionally, simulation results show that with the gradual temperature increase in the region since 1984, the length of the tree growing season has tended to increase, but overall tree growth rate has declined. The temperature increase since 1984 may be the main reason for the decline in tree growth. This study reveals, from a physiological perspective, the main limiting factors and time periods in the radial growth process of upper forest trees in the eastern Tianshan Mountains, which could provide reference for future tree-ring studies in this area.

Keywords: tree rings; *Picea schrenkiana*; radial growth; VS-oscilloscope model

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