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Tree growth and forest ecosystem functioning in Eurasia under extreme climate conditions

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The main goal of this study is to improve our understanding of the influence of a changing climate on trees in extreme conditions by a detailed analysis of the factors controlling tree-ring growth. We investigated forest ecosystems in regions that are very sensitive to climatic changes and where rapid and dramatic environmental and climatic changes are on-going, namely, the high latitude permafrost region in Central Siberia (Russia), the semi-arid dry areas in Central Asia (Uzbekistan) and high-altitude sites in the Alps (Switzerland). Tree-ring parameters studied were ring-width, density, cell number and structure and the ratio of carbon and oxygen isotopes. An important aspect of the work was the characterization of seasonal growth and water supply of trees. Intra-seasonal dynamics of tree-ring formation was correlated with monitored environmental factors, such as air and soil temperature and moisture, permafrost depth and the isotope composition of soil water, of precipitation, and of stream water. Intra-annual and long-term variability of the main tree-ring parameters were compared for the different regions.

The results obtained help us to understand better tree-physiological processes valid under contrasting environmental conditions. For instance, the relationship between the onset of cell division in the cambium and the thermo-hydrological soil regime was used to determine the period of the year with the highest influence on the start of tree-ring formation. Seasonally resolved oxygen isotope depth profiles of soil water and concurrent xylem and leaf water measurements show the importance of time-lags between precipitation, leaf processes and growth. The data obtained are important for improving tree-ring growth models and estimating future tree growth under climate change.

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