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Variability of radial growth and carbon isotope composition in tree rings of Pinus sylvestris L. and Picea obovata L. in middle taiga of the Central Siberia

M. Skomarkova (1), E.A. Vaganov (2), and C. Wirth (3)

(1) Institute of forest SB RAS, Akademgorodok, Krasnoyarsk, 660036, Russia (mvskomarkova@forest.akadem.ru), (2) Siberian Federal University, Svobodnyj av. 79, Krasnoyarsk, 660041, Russia (eavaganov@forest.akadem.ru), (3) Max-Planck Institute for Biogeochemistry, Box 100164, 07701 Jena, Germany (cwirth@bgc-jena.mpg.de)

Tree rings have been used extensively as a proxy for climatic conditions in the past. The experimental analysis of seasonal tree ring formation in relation to weather conditions during the growing season were carried out for the Siberian site Zotino (Russia) (60°75' N, 89°38' E).
Tree cores of pine (Pinus sylvestris L.) and spruce (Picea obovata Ledeb.) were sampled and analyzed. Each core was used for measurement of tree ring width and 13 data. The effect of climatic factors on the inter-annual variability of tree-ring growth was estimated through correlations between the chronologies and monthly climatic data from the meteorological stations. Long-term meteorological data (monthly temperature and precipitation) were used from weather station Bor for the period 1901-1998. The carbon isotope analysis in tree rings was determined using a laser ablation-combustion line coupled to an isotope-ratio-mass-spectrometer as described in detail by B. Schulze et al (2004). Profiles of 13 were measured on 5 sample trees for each species for the ten-year period 1996 – 2006.
It was clearly shown that sensitivity of ring width to climatic variables explained less than 53.5% of the variation of consecutive years. For pine this influence was weak because of the mixed climatic signal. Correlation coefficients of tree ring width for all species with climatic parameters indicate that annual variability of trees growth is mainly determined by June temperature.
The seasonal changes of 13 within tree rings of spruce and pine show a common pattern. At the beginning of the season average 13C was about 0.4%■ lower than the tree ring average. In narrow rings 13C values gradually increase during wood formation across the whole width of the ring. In contrast, in rings of intermediate width, a small decrease in 13 values during latewood formation can be observed. In wide rings this decrease following a maximum value starts earlier during ring formation, and it becomes increasingly negative (low 13C values) during late wood formation in wide rings. The maximum and minimum values of 13 are ranging between -23.9%■ and -27.1%■ for spruce, and from -22.6%■ to -27.9%■ for pine. The stable carbon isotope composition significantly varies both from year to year within one sample and between samples for the same year. This variability was the reason to compare the intra-annual variations of 13 as deviation from the mean value for a given tree ring. In pine there is a weak but significant positive correlation between tree ring width (in mm) and the average value of 13 within a tree rings.
The seasonal 13 variations in tree rings of conifers allow determining main period of the growing season which influence on tree ring formation. 13 correlated neither with precipitation nor with temperature, but a highly significant correlation was found between 13 of early wood and late wood of the previous year indicating a carry-over effect of growing conditions of the previous season on current wood production. The pattern, however, was complex, showing a step decrease as well as a step increase between late wood and early wood. The results are interpreted by various pathways by which carbohydrate storage and growth are linked.

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