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Quantitative wood anatomy opens a weekly to millennial time window in tree-ring research

Georg von Arx (1), Marco Carrer (2), Jesper Björklund (1), and Patrick Fonti (1)

(1) Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Dendrosciences Group, Birmensdorf, Switzerland (georg.vonarx@wsl.ch), (2) Dipartimento Territorio e Sistemi Agro-Forestali, Universitá degli Studi di Padova, Legnaro, Italy

The analyses of xylem anatomical features have been long considered a promising method to extract novel and high-resolution environmental information from tree-rings. The advantage compared to traditional ring width is two-fold. First, the sequential radial progression of cell growth from earlywood to latewood allows the matching of intra-ring cell position with intra-annual time of formation. Second, xylem cell structure and function are mutually linked true to the concept “form fits function”. This means the structural properties of xylem cells define their function and inversely, woody plant responses to environmental variability impact the structural properties of xylem cells. Thus, several novel proxies related to water transport and carbon allocation can be derived from the same anatomical measurements. These characteristics make the investigation of xylem cell structure – or quantitative wood anatomy (QWA) – an extremely powerful source of information. Yet, methodological improvements only recently allow to access the full wealth of the xylem cell archive.

Here we present the state-of-the art of “dendroanatomy” where we show how QWA can be used in a broad range of the studies from wood formation processes up to millennial climate reconstructions. The added value of QWA in such temporal upscaling is based on an improved mechanistic understanding of tree growth and how it is influenced by internal and external factors. Dendroanatomy thus opens novel high-resolution and long-term perspectives to tree-ring research.