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TreePulser : Growth Phenology and Physiological Responses of Temperate Tree Species Under Environmental Drivers

Harold Hauzeur
University of Liège, Gembloux Agro-Bio Tech, Forest Resource Management, Gembloux, Belgium
(harold.hauzeur@uliege.be)

The TreePulser project investigates how short-term environmental variability and species-specific physiological strategies interact to shape intra-annual tree growth dynamics in temperate forests. It relies on an extensive monitoring network of 300 dominant trees clustered within study sites distributed across Belgium, where a coordinated, multi-layer measurement set-up captures both environmental conditions and tree functioning.

A first, growth-centred approach integrates dendrometer-derived time series with a broad suite of exogenous drivers to characterise species- and site-specific growth phenology. Environmental monitoring includes atmospheric conditions (air temperature, relative humidity, precipitation, radiation), soil conditions (soil moisture and temperature), and physical soil characterisation aimed at capturing spatial variation in soil water availability. Stand structure and local competitive environment are incorporated through neighbourhood surveys quantifying the size, distance, and spatial arrangement of surrounding trees. Together, these variables are used to analyse growth onset and cessation, seasonal growth rates, and short-term variability, as well as to quantify the relative contributions of climatic, edaphic, and competitive drivers and the temporal lags between environmental variation and growth responses.

A complementary, mechanism-centred approach focuses on identifying the physiological and functional traits underlying observed growth patterns and drought sensitivity. Repeated canopy sampling provides measurements of predawn and midday leaf water potential, capturing seasonal dynamics in tree water status and nighttime rehydration capacity. Stomatal strategies are investigated through anatomical traits, including stomatal density and size. Hydraulic functioning is characterised using pressure–volume curves and xylem vulnerability measurements to quantify drought-relevant properties related to tissue water relations and resistance to embolism. Additional traits associated with leaf and wood economics, including specific leaf area, leaf nitrogen content, and wood density, provide a broader functional context by describing contrasting resource-use strategies.

By integrating high-frequency growth monitoring with multi-dimensional site characterisation and ecophysiological measurements on dominant trees, the project aims to better represent the interconnected processes governing tree performance in natural stands, where atmosphere, soil conditions, local competition, and endogenous regulation interact across multiple temporal scales.

This integrative design supports the identification of trait-based predictors of growth sensitivity to atmospheric demand and soil water availability, thereby improving the capacity to anticipate species performance under increasingly variable climatic conditions.