**B2d: WOOD AND TREE-RING STUDIES OF FOREST ADAPTATION TO CLIMATE CHANGE: IMPLICATIONS FOR WOOD PRODUCTION**

**Functional role of Eucalyptus wood in terms of drought resistance traits: trends at interspecific and intraspecific levels**

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Multispecies surveys have shown that there is a weak but significant tradeoff between xylem efficiency and safety in woody species, and that there are no species occupying the space with high efficiency and high safety. Large vessels and tracheids result in high vulnerability to xylem cavitation (VC) due to tension. Moreover, relationships between xylem structure and function are studied mostly at the interspecific level, with few studies considering the relationships at the intraspecific level, particularly in angiosperms. Recent studies in Quercus species, focusing on trends in wood anatomy-function relationships concerning the interspecific and the intraspecific levels, raises the question about the value of multispecies studies to shed light over what is adaptive within a given species. Eucalyptus species share with Quercus a xylem anatomy composed by solitary vessels surrounded and connected to imperforate tracheary cells and parenchyma, a type of wood anatomy which is poorly understood in functional terms. Contrary to results in that genus, our results in four Eucalyptus species revealed that the trends observed between vessel size (mean and distribution) and VC are similar at the interspecific and intraspecific (i.e. *globulus*) levels. No tradeoff was observed between xylem efficiency and safety: the largest the vessels, the lower the VC. The amount of cells around different size-vessels could be helpful to widen our vision about the role of wood in adaptation to drought stress.

**Wood anatomical traits reveal water constraints on black spruce xylem formation in the Boreal ecosystem**

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One of the most evident effects of the rapid warming occurring recently in cold and high-latitude forests is the lengthening of the growing season, with the concurrent extension of the period of wood formation. In addition, the increase of evapotranspiration demand is starting to induce drought-stress conditions. By selecting the same black spruce (*P. mariana*) trees (20 trees in 4 sites along a latitudinal gradient in Quebec, Canada) where xylemogenesis analyses were performed in the last years, we investigated long-term series of wood anatomical traits and compare them to previous short-term findings. Time series of wood anatomical traits were correlated to chronologies of daily temperature, VPD and precipitation during the period 1936-2010. In all sites, tracheid area correlated negatively with June-September temperature and VPD, and positively with precipitation. Meanwhile, cell-wall thickness and the number of cells per ring in the northernmost site were positively affected by spring and summer temperature. While previous monitoring studies evidenced temperature as the key climate variable influencing the timing of xylemogenesis phases, our results show that water availability plays a central role in shaping xylem cell features in boreal black spruce. This stresses the importance of an integrated approach to better understand the relationships between wood formation and climate variability at both intra-annual and long (decadal) time scales. This approach will hopefully reduce the uncertainties and skewed interpretations of models on how boreal forest will perform in the future.

**Impact of drought on Eucalyptus wood chemistry by near infrared hyperspectral imaging**

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The aim is to study tree development submitted to different water and mineral constraints. The objective is to correlate spatial distribution of wood chemistry with wood density, secondary growth. We sampled wood discs from 54 trees in rainfall exclusion design with *Eucalyptus grandis* at Esalq-USP, Itainga Station, Brazil. We felled the 5 years old trees growing under different water availability. For each tree, we acquired an image with a near infrared (SWH) hyperspectral camera (hsh, spicm, pxigg: 625 x 625mm). The challenge here was to transfer our previous NIR calibrations for total extractives built with a benchtop spectrometer (vector, bruker) to a hsh camera using standard sample set measured on the two devices. An efficient model were built for the hsh camera with a prediction error of 10.3% compared to the prediction error of 11.6% for our previous calibration with benchtop spectrometer. Then, based on spectra from the chemical properties, we studied extractive contents and built images. These allow us to compare their spatial distributions according to the growth conditions. In the absence or presence of fertilization, trees with higher water stress showed a higher heterogeneous distribution, from pith to bark, for the total extractive contents and a higher average mean value in perspective, these data will allow us to study and refine the knowledge on causton activity according to climatic variations by crossing variability of the chemical properties, x-ray micro-density and anatomy of wood, and diameter growth rate measured by electronic densitometers.

**Spatial variation of wood density for Eucalyptus wood by near infrared hyperspectral imaging combined with X-ray analysis**

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Most near-infrared spectroscopy (NIRS) studies for wood density use multiple spectral acquisitions taken manually at several points from pith to bark. Recently, the use of near-infrared hyperspectral imaging (NIR-HSI) has shown good performance in predictions of wood properties, allowing high spatial resolution predictive images. The combined use of NIR-HSI and X-ray microdensity imaging (X-ray MDI) could be more practical for evaluation of spatial variation of wood density. The aim was to develop a wood density calibration model for NIR-HSI (625 μm pixel size) and X-ray MDI (30 μm pixel size) and evaluate the spatial variation of wood density along stem cross-section in Eucalyptus grandis trees. Wood discs were collected from 18 trees of 6 years old, submitted to two different water availability, located in São Paulo, Brazil. The challenge here was to match the pixels of X-ray MDI to pixels of NIR-HSI (2 mm width radial region) to transfer accurate values of wood density to each pixel of NIR-HSI. The R² of the model was 0.72, while the root mean squared error was and 4.8 × 10⁻² g cm⁻³ for the validation group. The prediction model allows comparing their spatial distributions according to the growth conditions. Trees with higher water stress showed higher wood density. Treatments showed similar spatial variation of wood density, increasing from pith to bark. In perspective, these data will allow evaluating the spatial distribution of wood density intra and inter-tree rings in relation to meteorological variability.

Geographical patterns and drivers of regeneration and growth dynamics of Quercus variabilis

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Impeding climate warming is expected to influence plant regeneration, growth and distribution ranges. However, synchronous comparisons of regeneration and growth dynamics associated with biotic factors across latitudinal, longitudinal and altitudinal gradients at a single species level have received little attention. In the present study, we investigated regeneration (seedling and sapling) and growth variations (radial and height growth) of Quercus variabilis along latitudinal, longitudinal and altitudinal gradients, meanwhile, the effects of environmental factors (climate, soil and stand conditions) on regeneration and growth across the three geographical gradients were ranked and apportioned using linear mixed-effects models. Our results indicated that the regeneration of Chinese cork oak decreased from middle to the range limit, the radial growth of ringwood and latetwood increased with latitude, and latewood and height growth decreased with longitude; furthermore, the growth sensitivity to climate were less in the southern and eastern populations than the northern and western. When pooling all sites data, we found that climate variables were not solely decisive factors to drive the geographic variations in the regeneration and growth of Q. variabilis.