2nd UGCT seminar
10 September 2015

Micro-CT: a technology for direct visualisation and quantification in plant ecophysiology

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Keywords: **cavitation, hydraulic functioning, pinning, plants, stem growth, vulnerability curves, xylem embolism**

ABSTRACT

Drought in trees has gained increasing interest because of the recent coupling between forest decline and global change associated droughts (Allen *et al*. 2010, Anderegg *et al*. 2012). Drought leads to important changes in the hydraulic functioning of trees, and also has an important impact on radial stem growth (Steppe *et al*. 2015). To better understand how forests will cope with future droughts, a quantitative analysis of the physiological mechanisms governing drought stress at individual tree level is crucial. To this end, we use micro-CT for direct visualisation and quantification of cavitation, a phase change from liquid water to vapour when the xylem water potential becomes too negative. The resultant air emboli block the xylem conduits and reduce the tree's ability to move water from soil to leaves. With micro-CT, the content of intact xylem conduits (i.e., water- or air-filled) can be visualised and vulnerability curves (Fig. 1) can be developed (Cochard *et al*. 2015, Vergeynst *et al*. 2015). These direct observations assist us to better understand vulnerable of tree species to drought-induced embolism.

Drought-induced changes in the water status of trees have also an important impact on radial stem growth, and wood formation (Steppe *et al*. 2015). Cambial wounding and pinning is an established method used to assess wood formation in a specific period of time (Gricar *et al*. 2007). We used micro-CT to enhance our knowledge on anatomical responses to cambial wounding, and to assess stem growth responses in well-watered and drought-stressed trees.

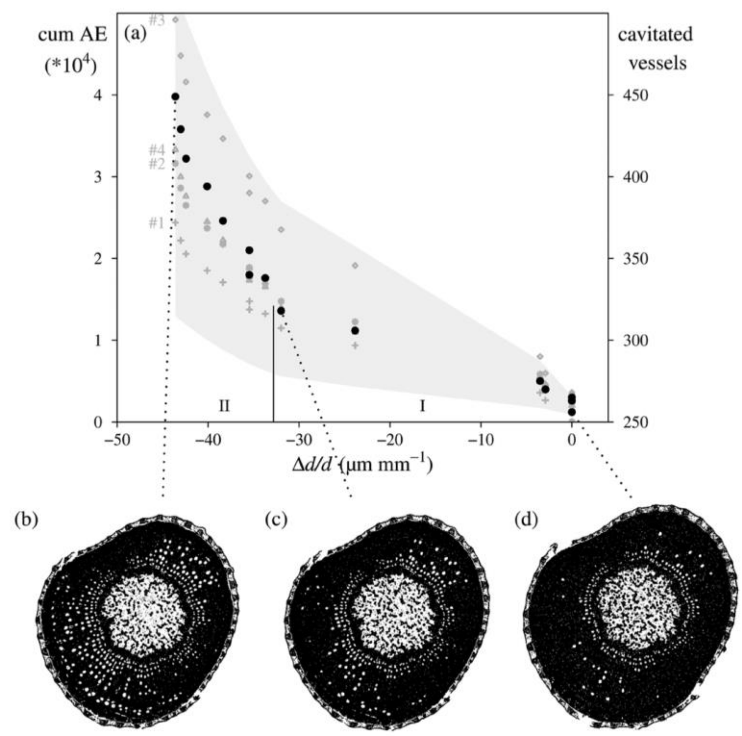

Figure 1: (a) Cumulative acoustic emissions (cum AE, grey symbols, left y-axis) detected by the four sensors (1–4) showed a pattern similar to the number of cavitated vessels (black symbols, right y-axis) counted on micro-CT images when plotted against relative radial diameter shrinkage (Δd/d). The micro-CT cross-sections of the grapevine branch are shown for the beginning (d) and end (b) of the dehydration experiment and at the breakpoint (c). (Vergeynst et al., 2015)

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