Propagation of gas embolism in plants.

Abstract
Water enters the plant through the roots and flow up through the xylem towards the leaves, where photosynthesis takes place (fig a and b). This produces sugar transported by the sap to the whole plant through another organ, the phloem (fig a and b).
We are interested in the ascending water that flows from the roots to the leaves. The driving force for this ascent is evapotranspiration that decreases pressure of sap. This system is very sensitive to water deficit, for example when there is a drought. A consequence of a severe drought is the apparition and propagation of gas embolism in the tree that eventually leads to its death.
The propagation of gas embolism has a time scale of 1 minute in the complex sap network of a tree (fig c) which has a typical length scale of 10µm. To resolve it, we made 3D observations of a wood sample in drought conditions, using rapid — 1 second — computed tomography (fig d and e). With those observations, we try to understand how gas embolism propagates through the plant and what are the critical water deficits that kill plants.

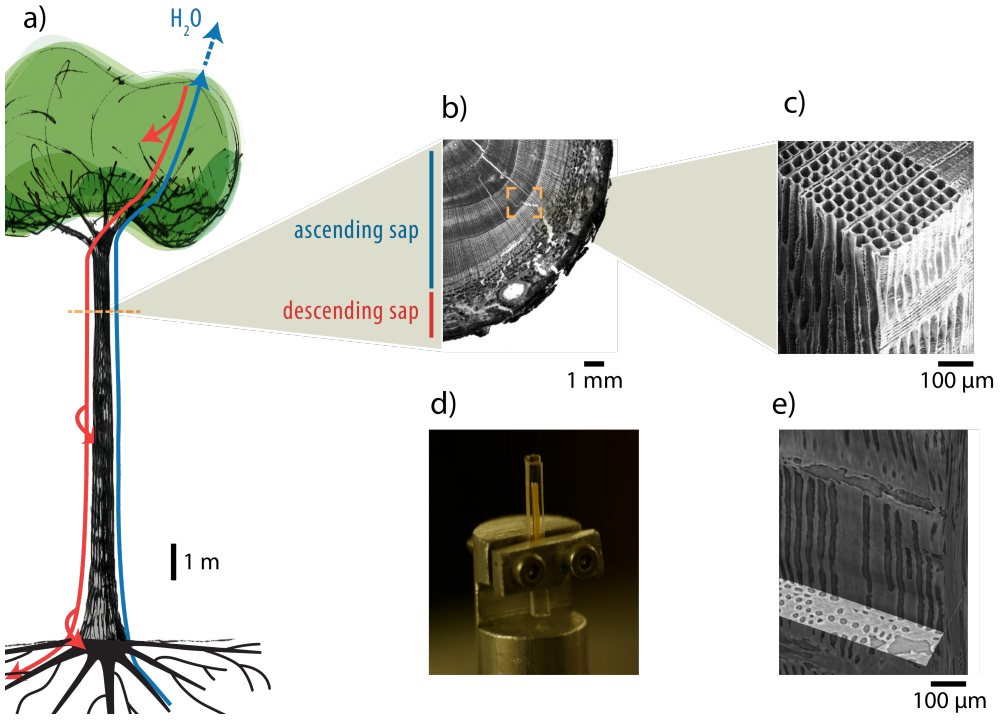

figure 1. WOOD ANATOMY. a) flows of sap in a tree. b) horizontal cut of the trunk showing the two organs where sap flows up and down, xylem and phloem respectively. c) zoom on the xylem where sap ascends in conduits that are 20µm in diameter and 10mm in length. 3D OBSERVATION d) a 3x3x40mm wood sample in artificial condition ready for 3D observation at ESRF Synchrotron, Grenoble. e) a virtual cut in the wood sample reveals growing gas embolism in the sap network.