

Mechano-Biology of Tree Growth

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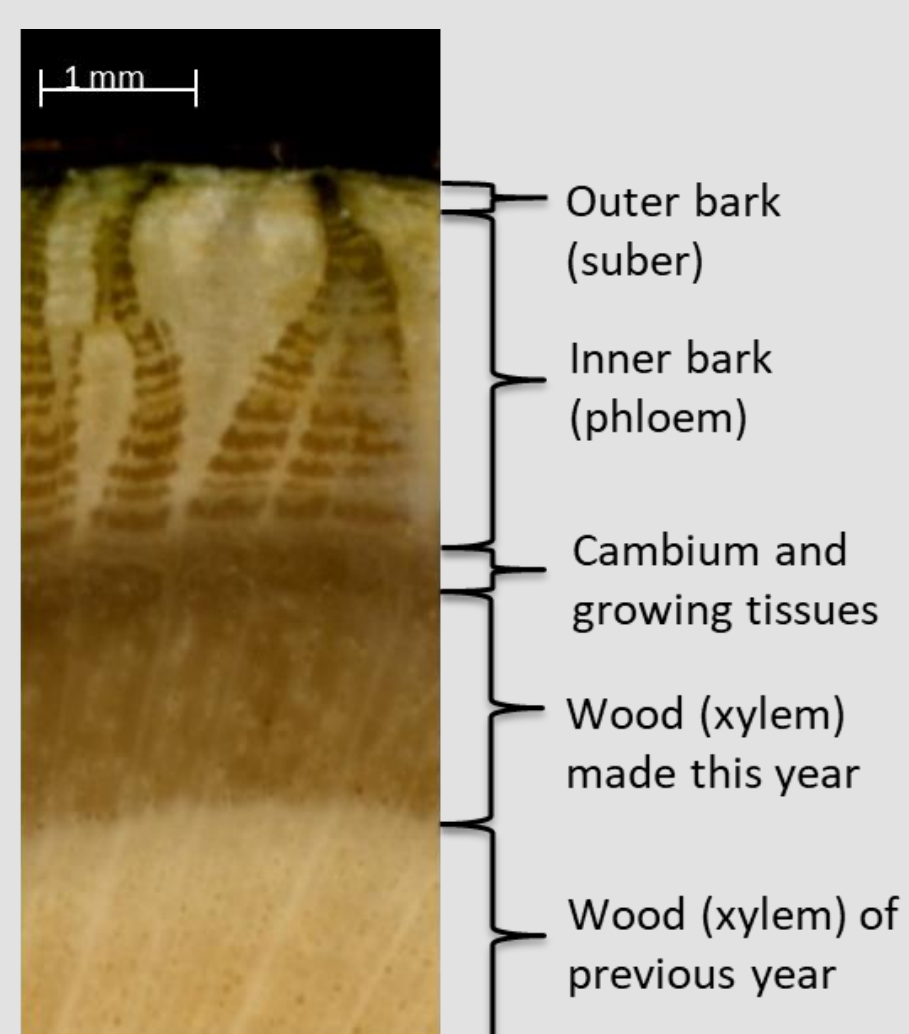
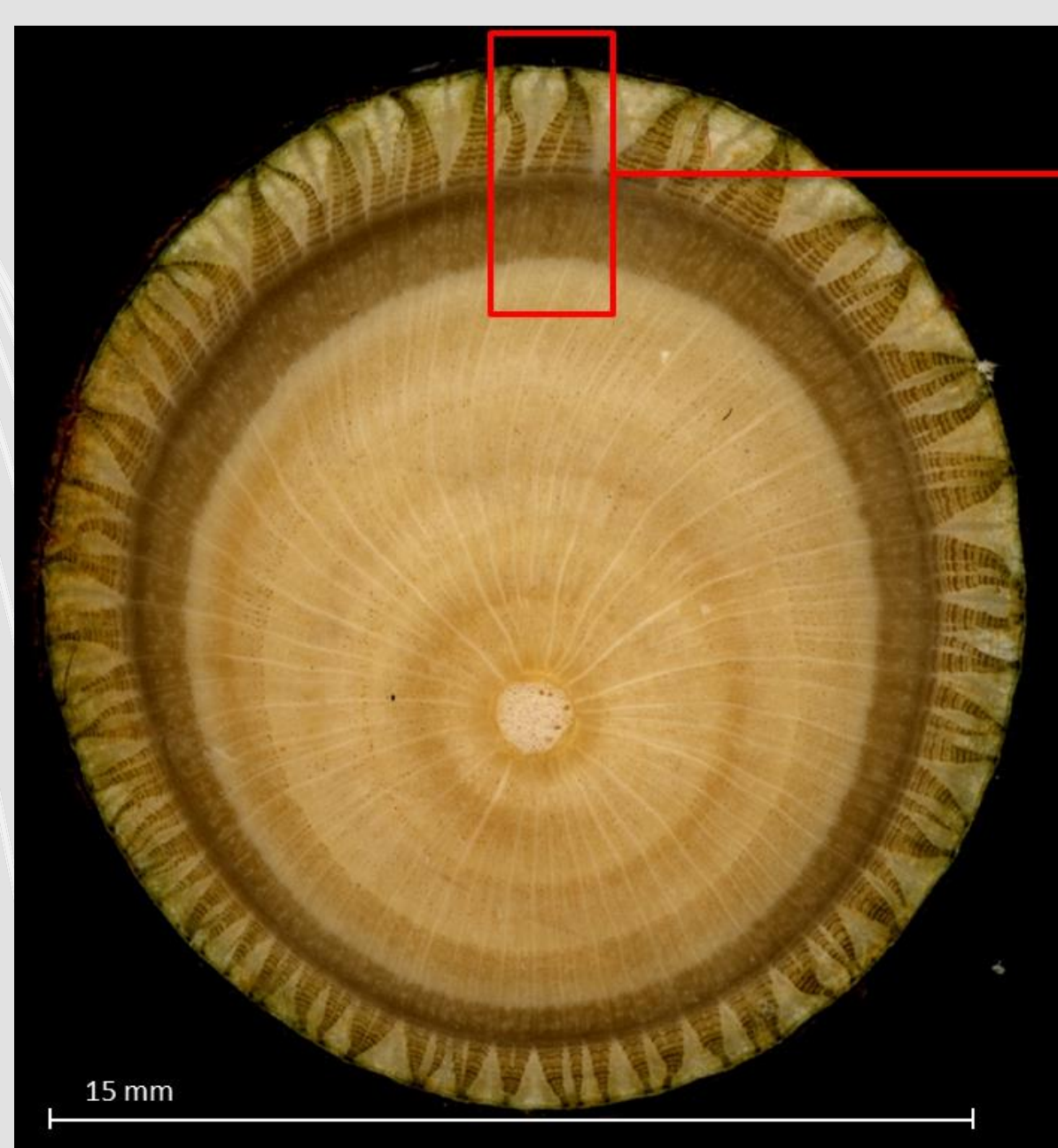
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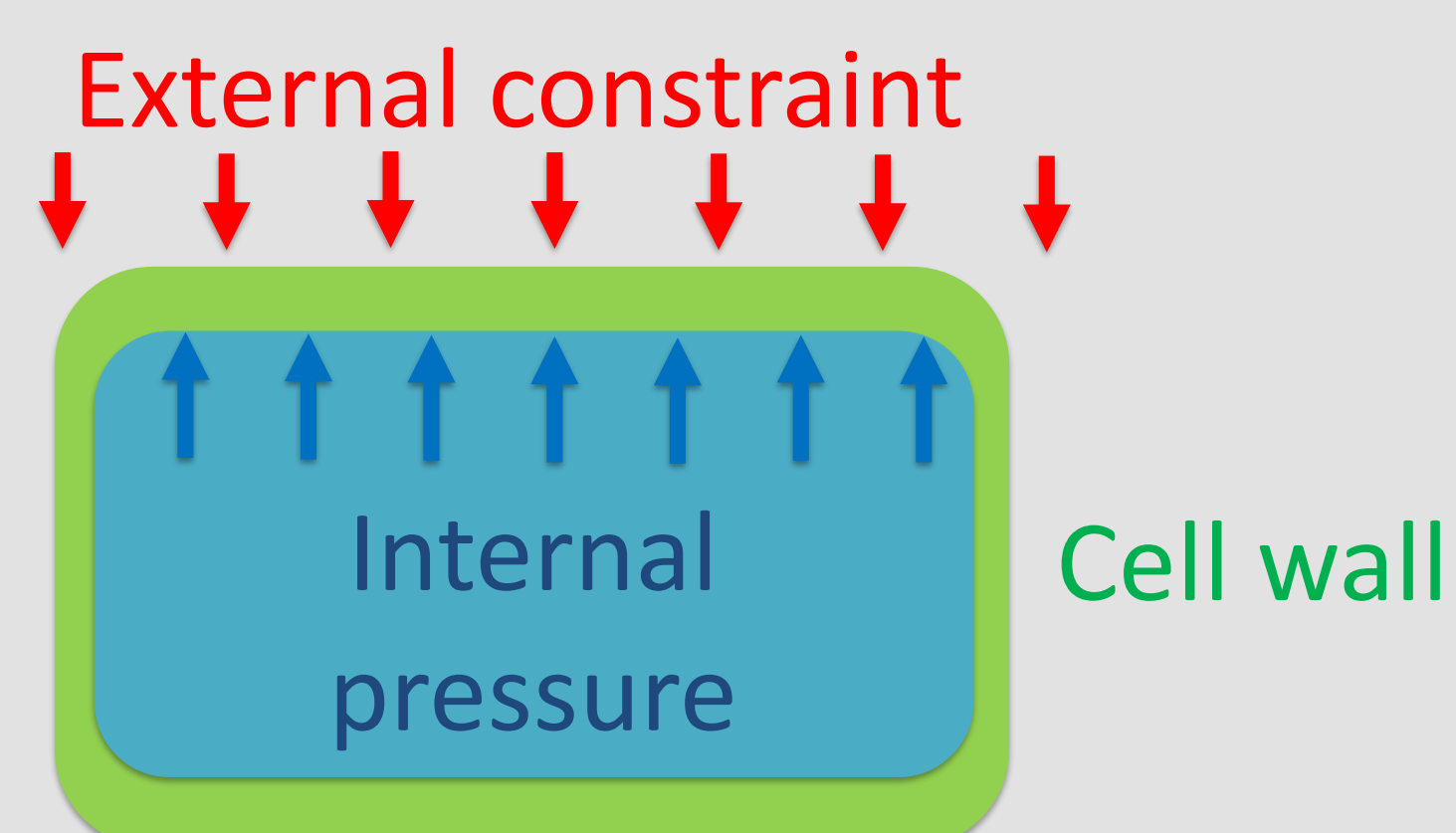
Context

- One of the main challenge for the 21th century is the increase in atmospheric CO₂
- Through photosynthesis, trees transform CO₂ into biomass
- Most of earth's biomass is made of wood
- It is thus essential to understand how the formation of wood proceeds

Background



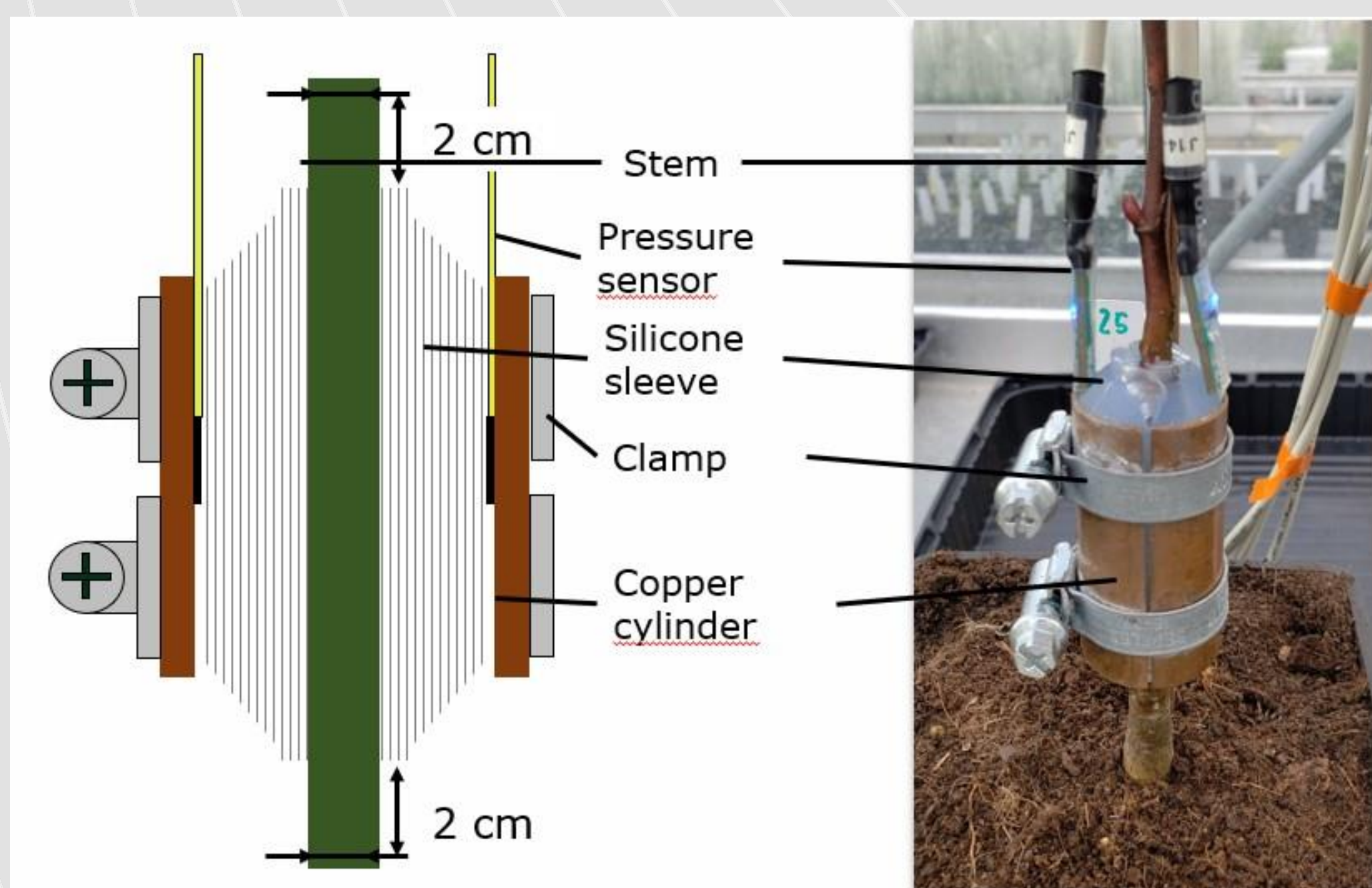
- The location of cambium makes it confined between stiffer tissues
- At the cell level, plant cell growth is made possible by the effect of "turgor pressure" that permanently deforms the cell wall to extend the cell.



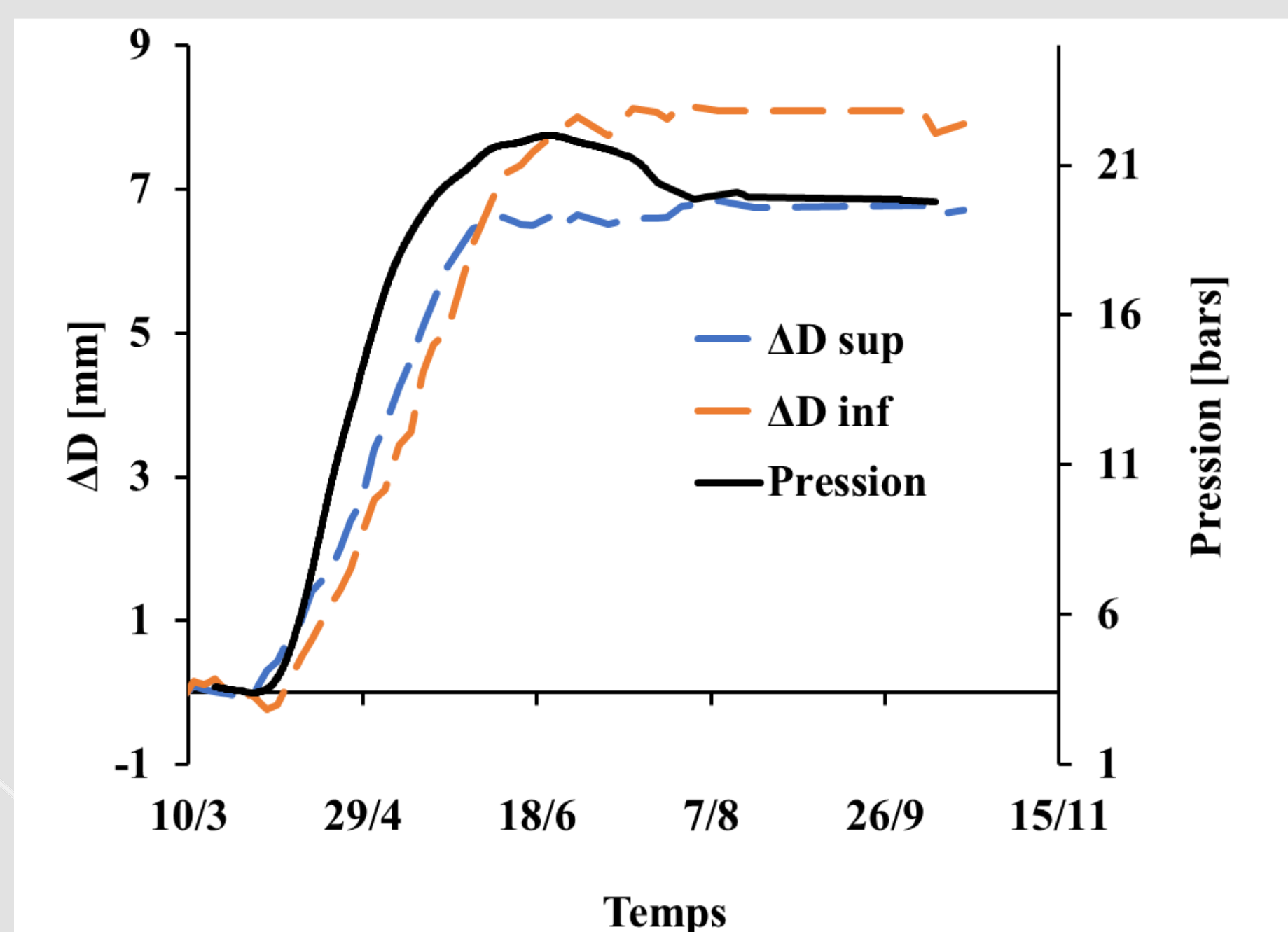
- Tree diameter growth takes place in a layer of cells located between wood and bark : the cambium.
- The cambium produces both the wood (inward) and the bark (outward)

- The constraint imposed by bark is opposed to the internal growth pressure
⇒ How does mechanical stress contribute to the regulation of tree growth?

Experiments : constrained growth



Experimental set-up : the diameter growth of a tree stem is constrained by a silicon sleeve.



Measurement of diameter growth above (sup) and below (inf) the sleeve, and pressure in the sleeve.



Shape of the stem after growth : thinner below the sleeve.

Modeling objectives

Finite Element Model
(Python, LMGC90 library)



Mechano-biological growth law

- The growth of the stem (increase in diameter) creates a field of stress in the silicon sleeve
- The stress upon the stem modifies its growth
⇒ Strong interaction between growth and stress

Objectives:

- quantify how tree cambial growth depends on mechanical stress
- extend the model by considering the growth of bark and wood separately

