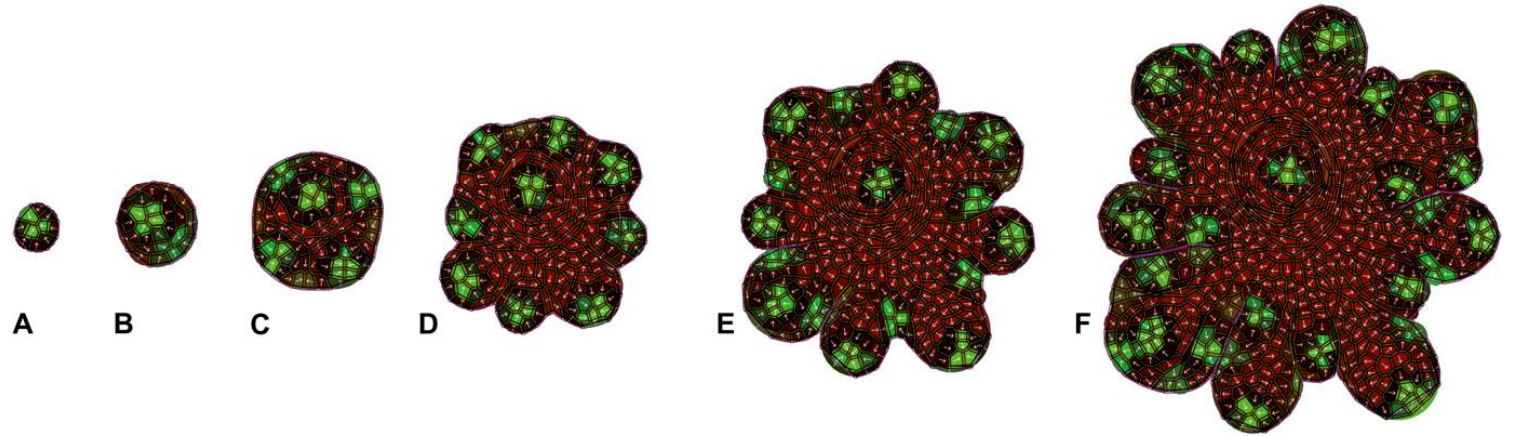


Virtual Leaf

Merks et al. 2011

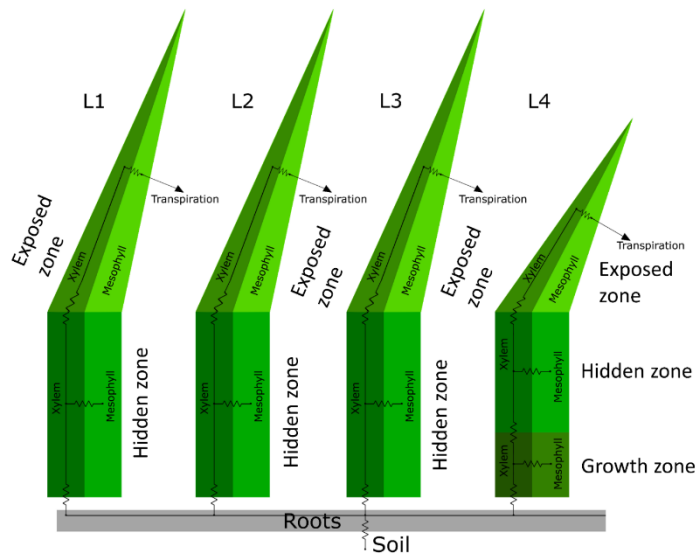


Virtual Plant

Coussement et al. 2020



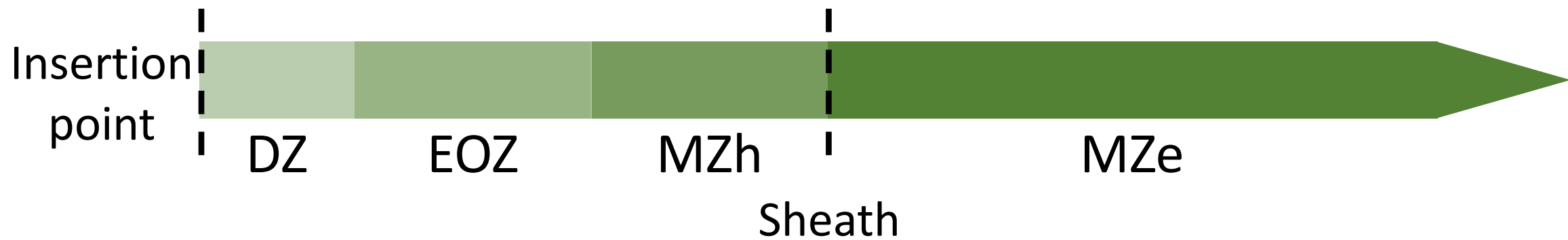
A hydraulic model framework for grass leaf growth

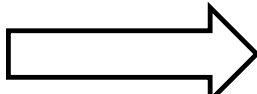


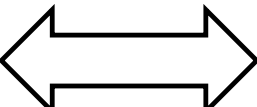
Tom De Swaef
Mathias Cougnon
Romain Barillot
Jean-Louis Durand

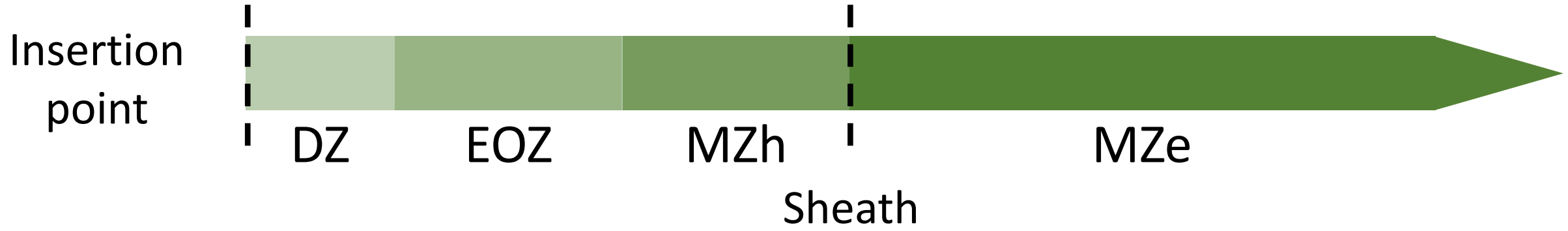
ILVO
Flanders research institute for
agriculture, fisheries and food

INRAE

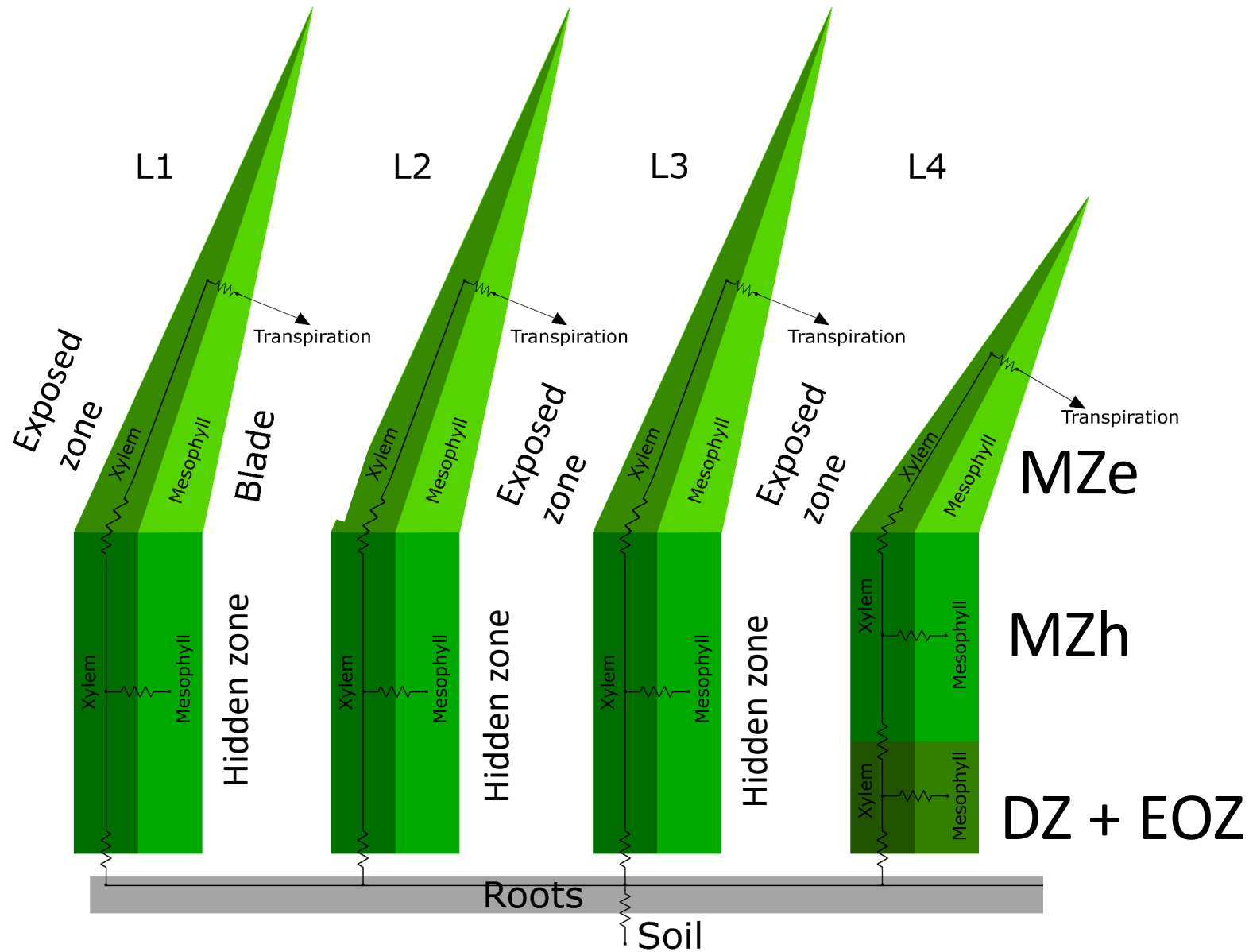


Source - sink  Harvestable plant part

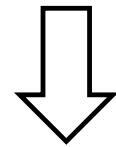
Leaf growth  Plant development



The hydraulic model: *Festuca arundinacea*

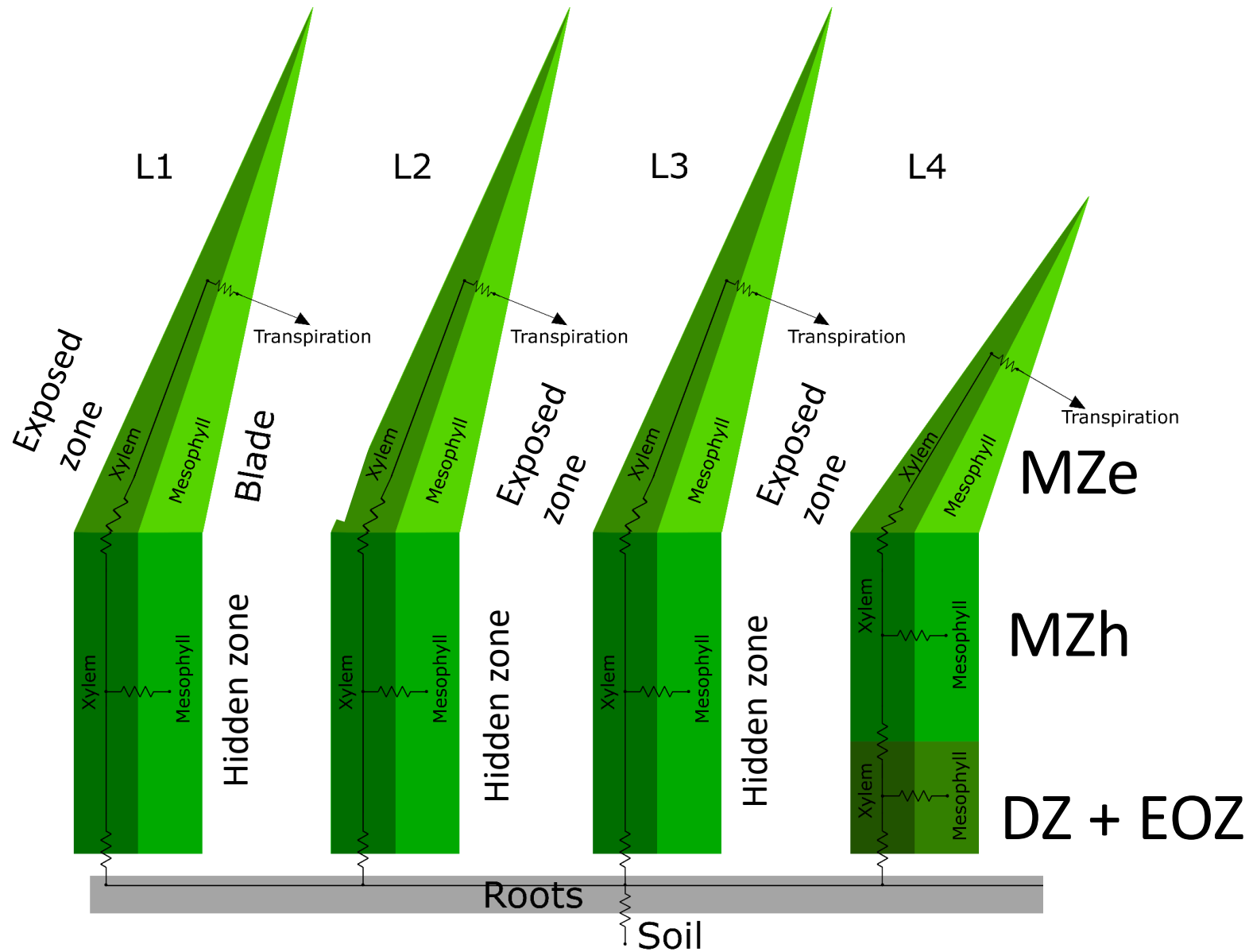


Hydraulics x Ontogeny



Growth

The hydraulic model: *Festuca arundinacea*



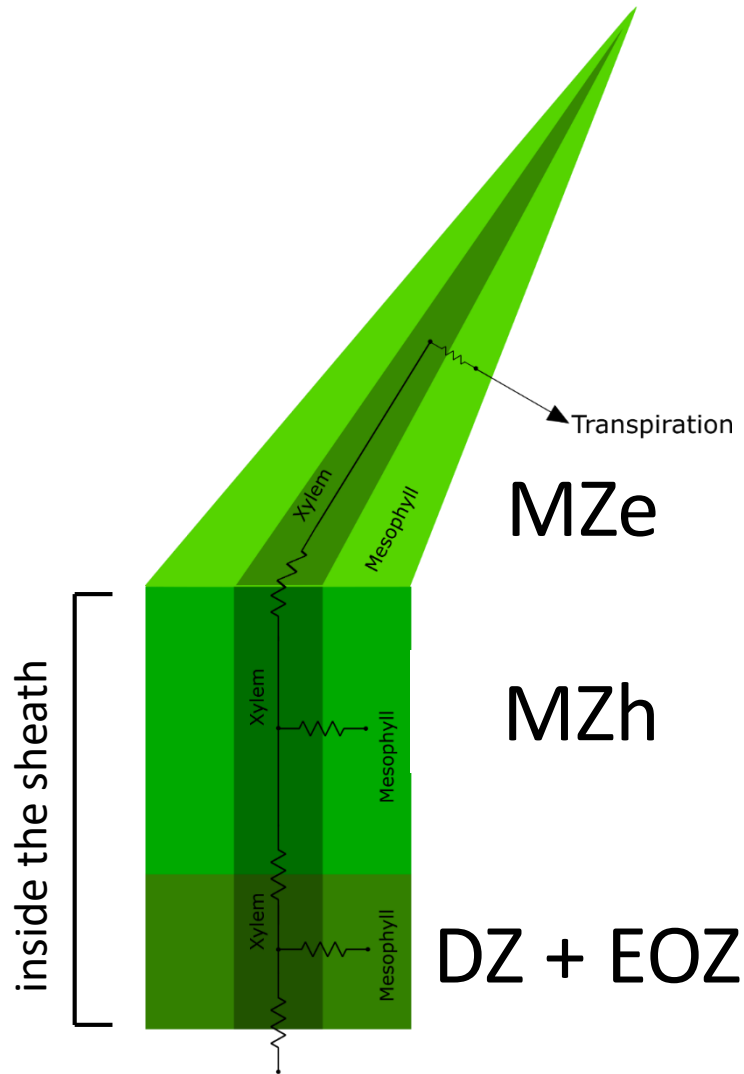
Hydraulics x Ontogeny



Growth

MZe
MZh
DZ + EOZ

The hydraulic model: hydraulic architecture



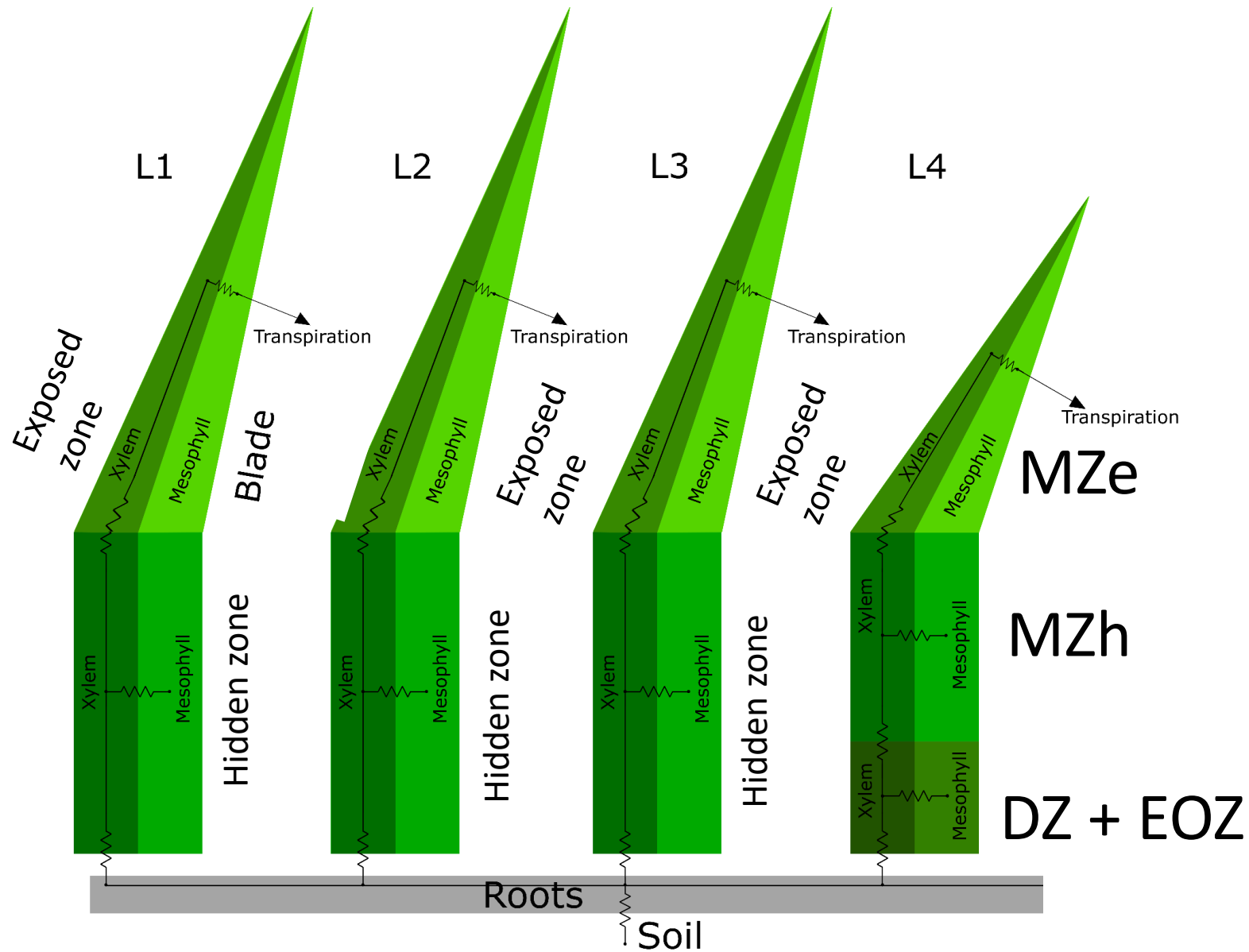
Ψ Water potential
 Π Osmotic pressure
 P Hydrostatic pressure

$$\Psi = P - \Pi$$

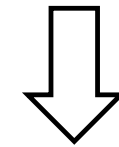
F Water flow
 K Hydraulic conductance

$$F = K \times \Delta\Psi$$

The hydraulic model: *Festuca arundinacea*

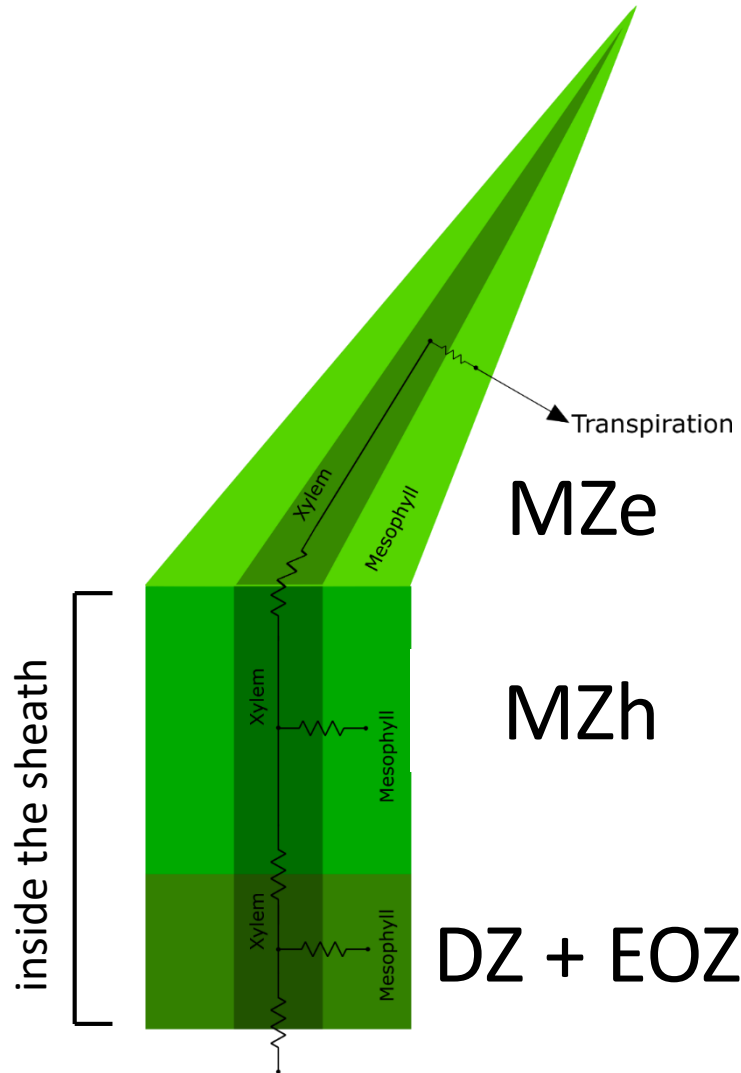


Hydraulics x Ontogeny



Growth

The hydraulic model: mechanisms of growth



$$\frac{dW}{dt} = F_{in} - F_{out}$$

$$\frac{dP}{dt} = \frac{\varepsilon}{W} \cdot \frac{dW}{dt}$$

elastic

$$\frac{dP}{dt} = \frac{\varepsilon}{W} \cdot \frac{dW}{dt}$$

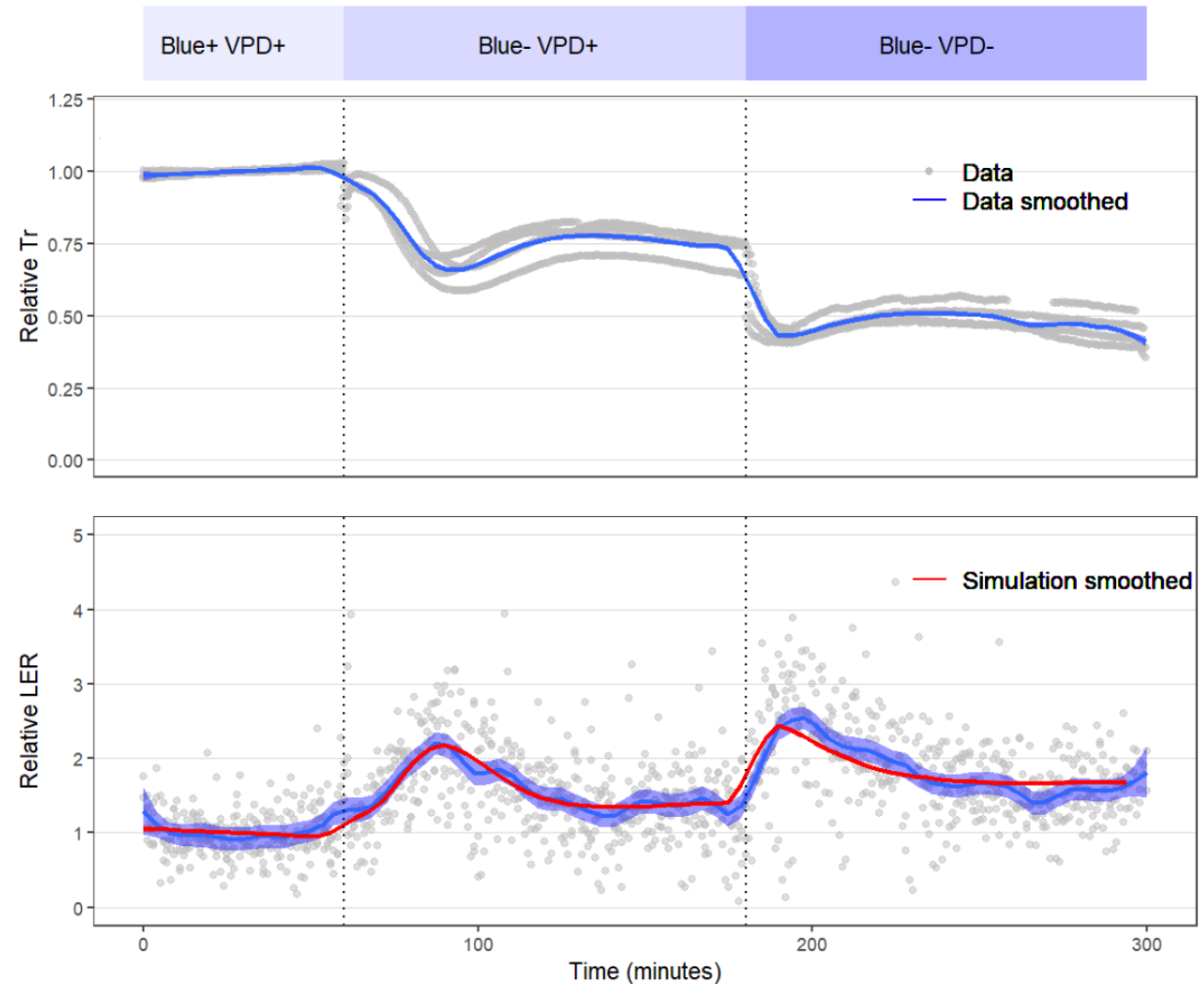
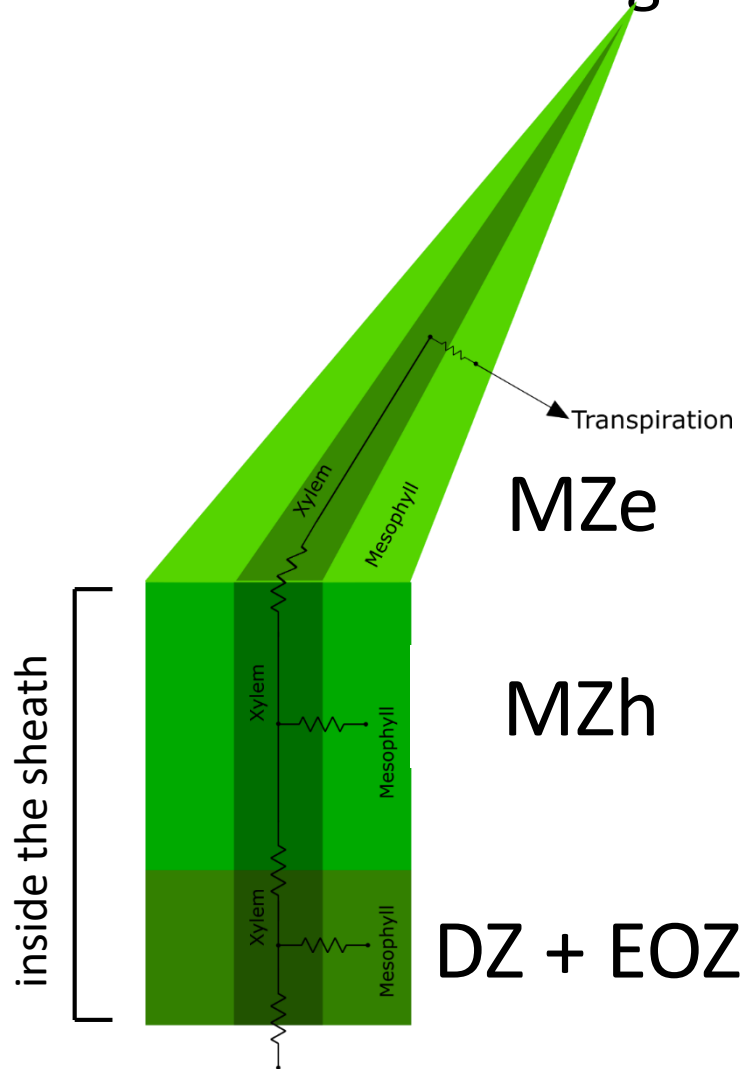
elastic

$$\frac{dP}{dt} = \frac{\varepsilon}{W} \cdot \frac{dW}{dt} - \varepsilon \cdot \phi \cdot (P - \Gamma)$$

visco-elastic

Model to the test (1)

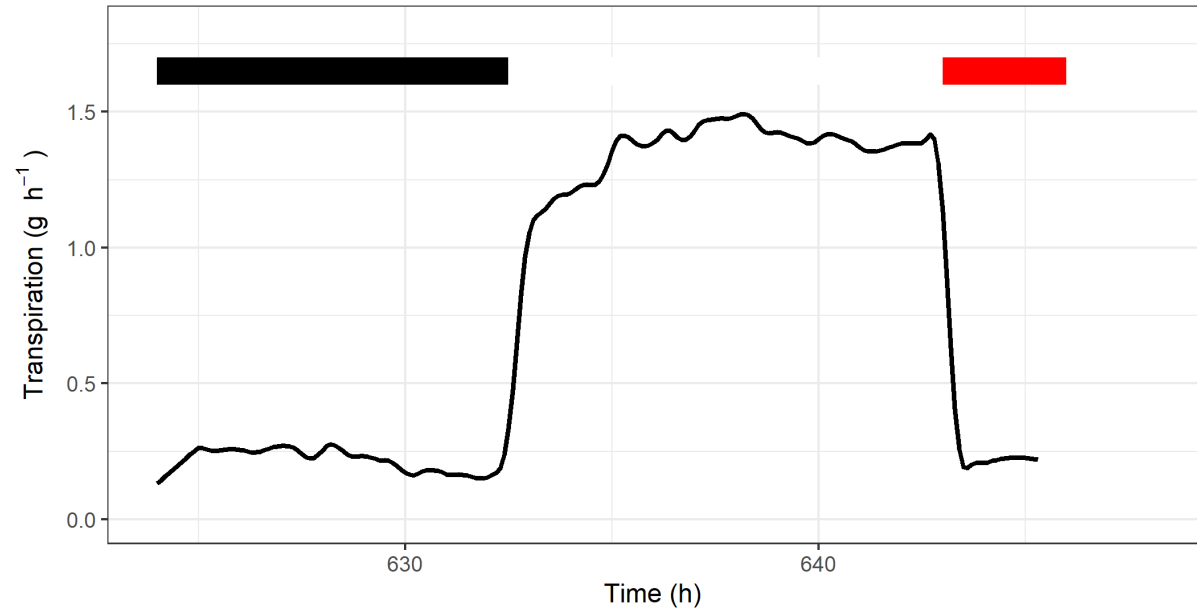
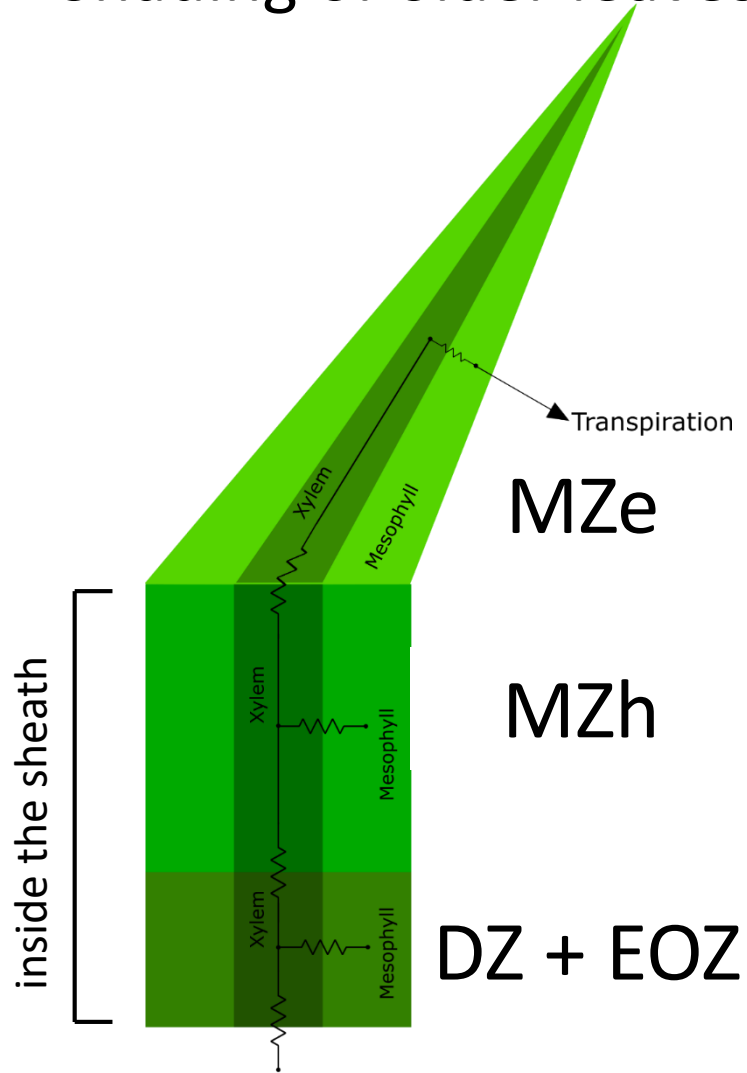
Absence of blue light increases LER



Barillot et al. (2021)

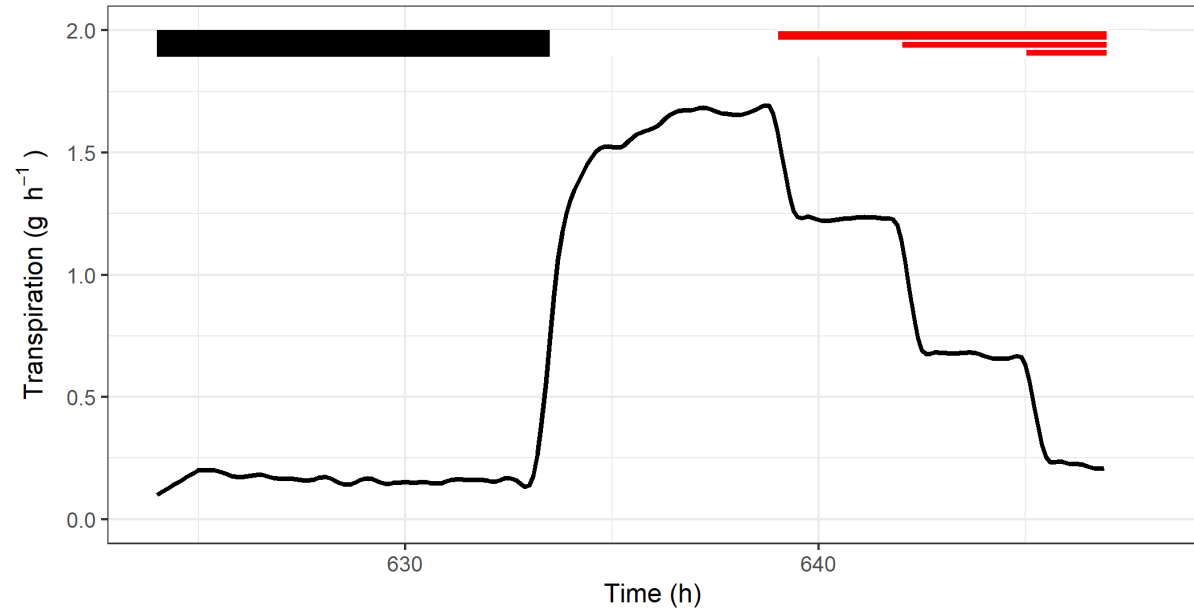
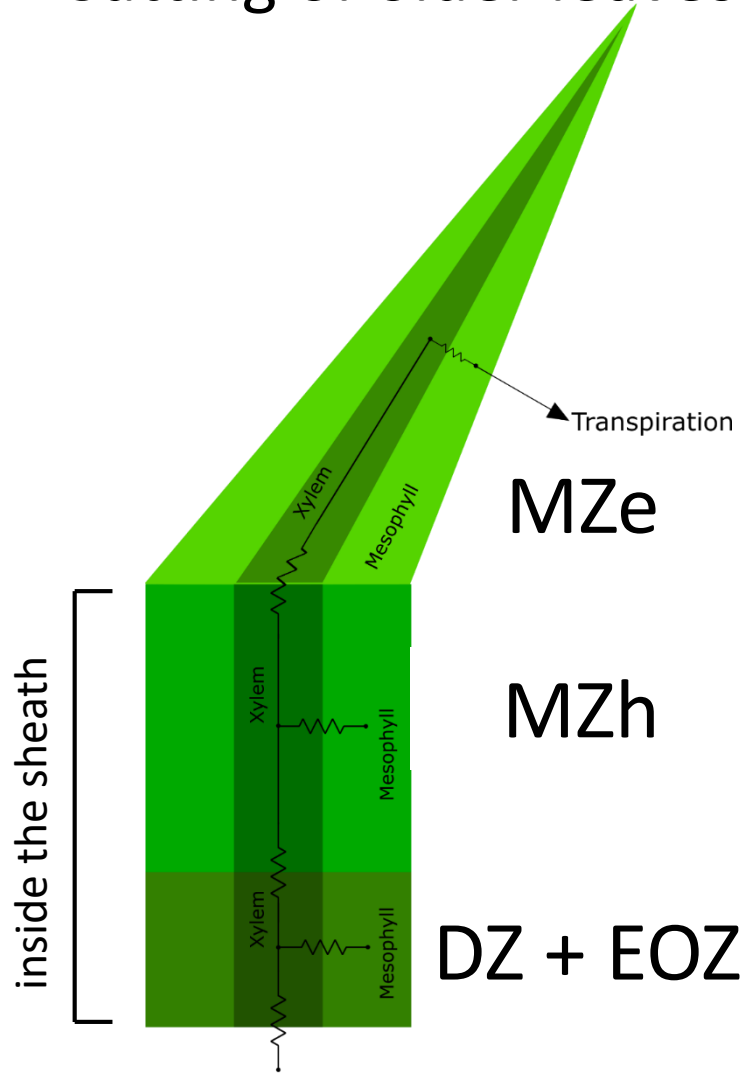
Model to the test (2)

Shading of older leaves

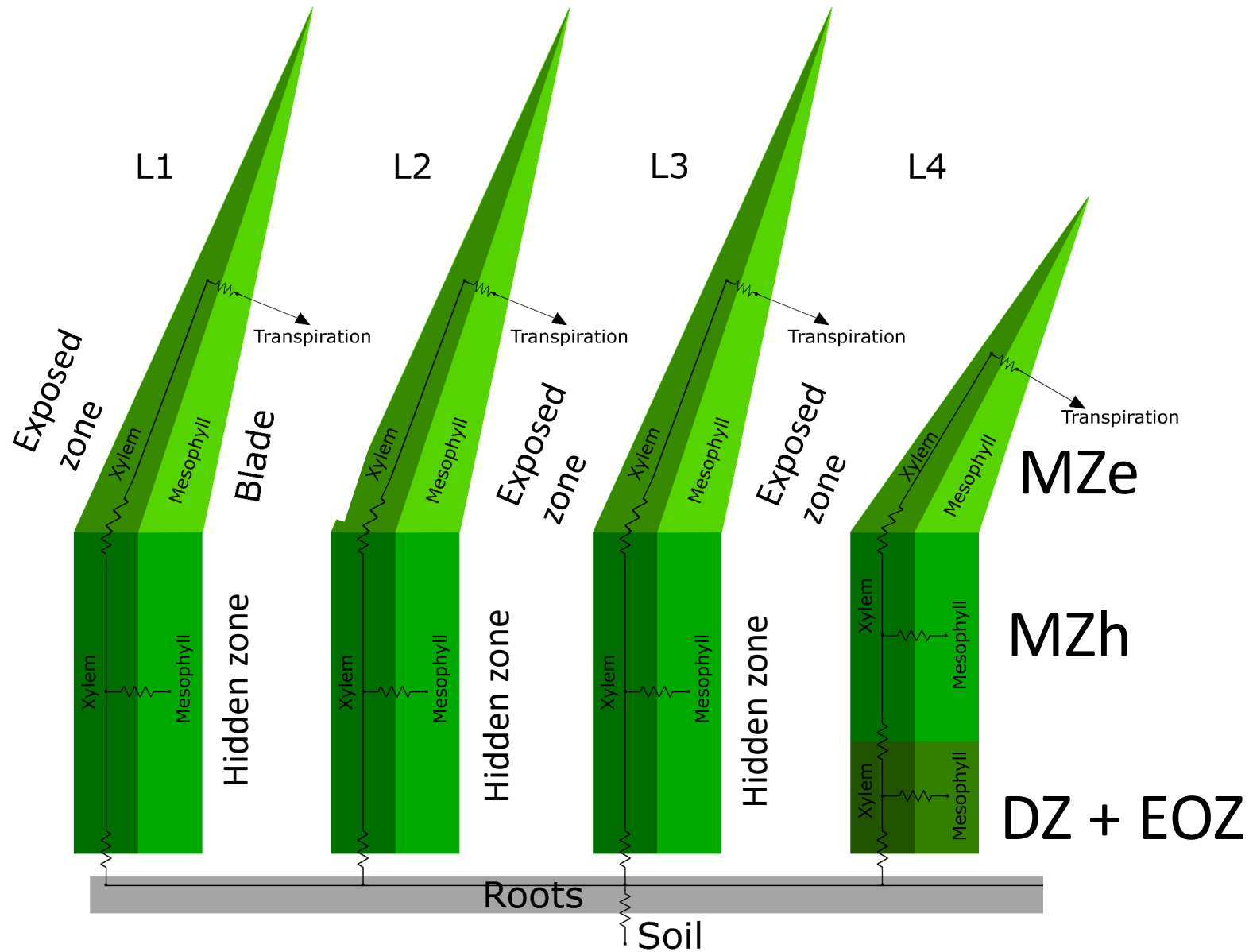


Model to the test (3)

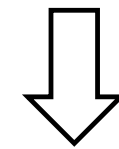
Cutting of older leaves



The hydraulic model: *Festuca arundinacea*

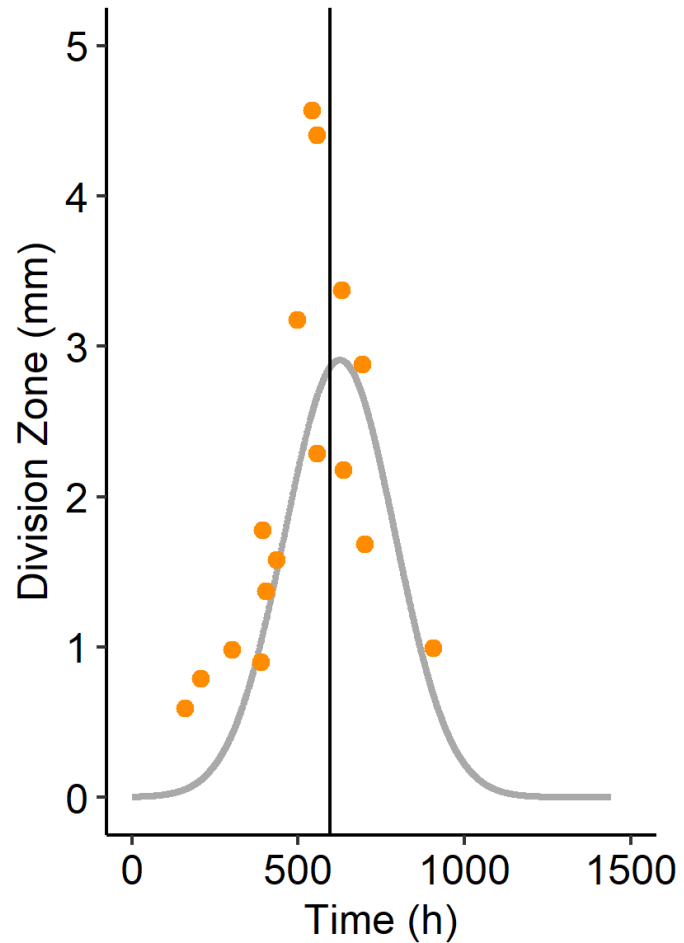


Hydraulics x Ontogeny

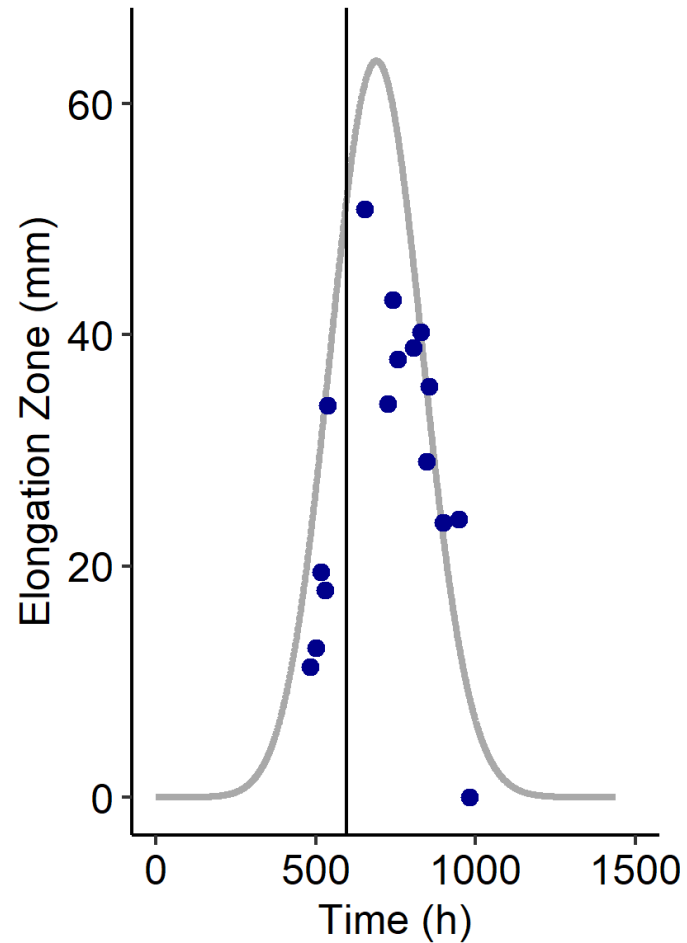


Growth

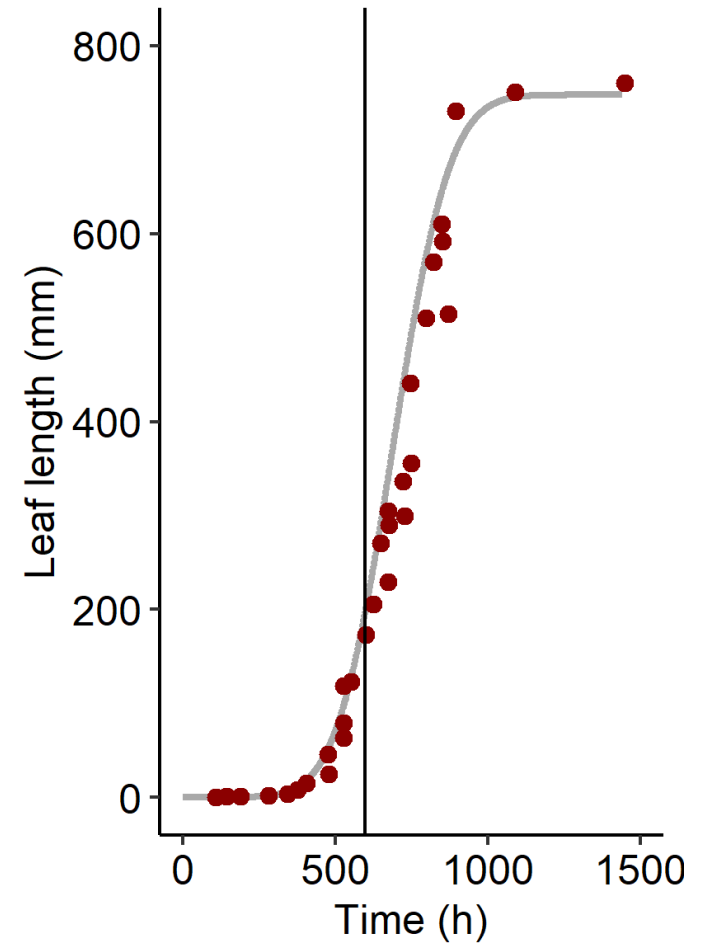
$$\frac{dDZ}{dt} = k_1(1 - a)DZ$$



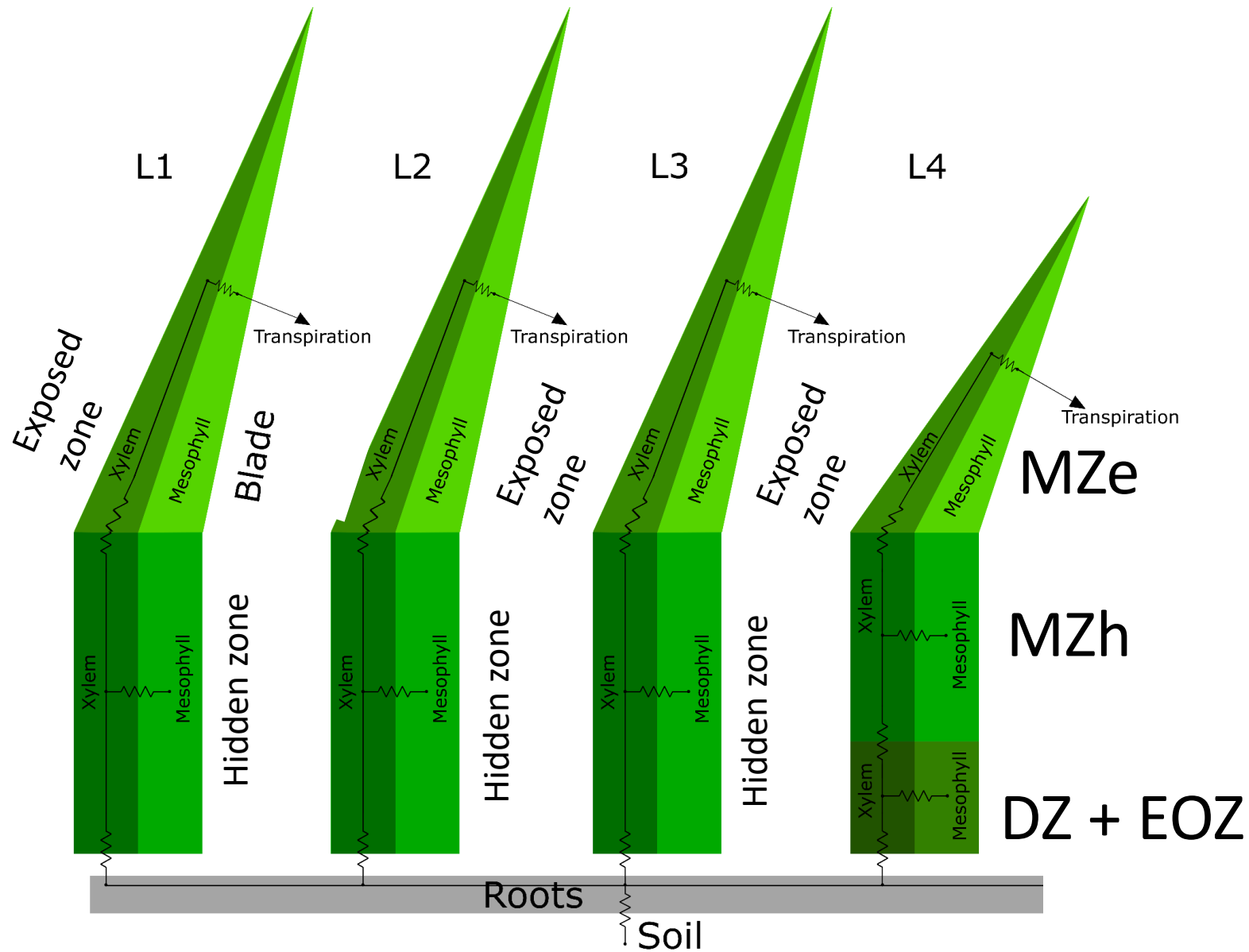
$$\frac{dEOZ}{dt} = k_1 a DZ + k_2(1 - b)EOZ$$



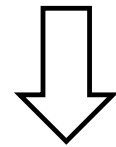
$$LER = k_1 DZ + k_2 EOZ$$



The hydraulic model: *Festuca arundinacea*



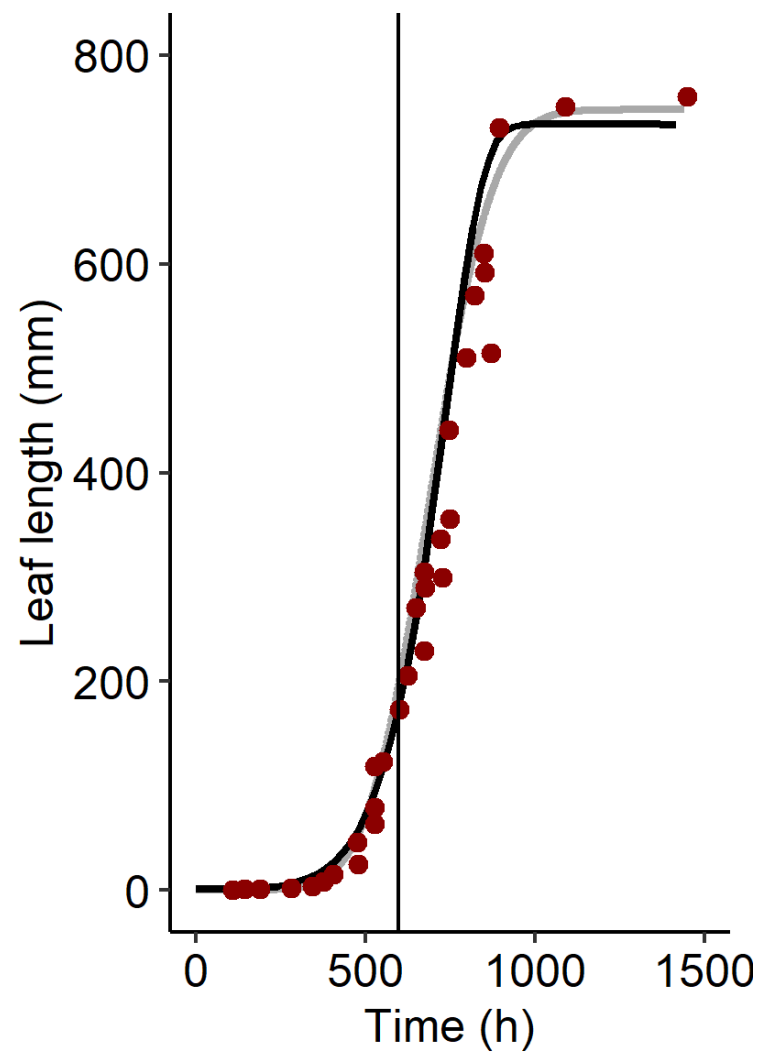
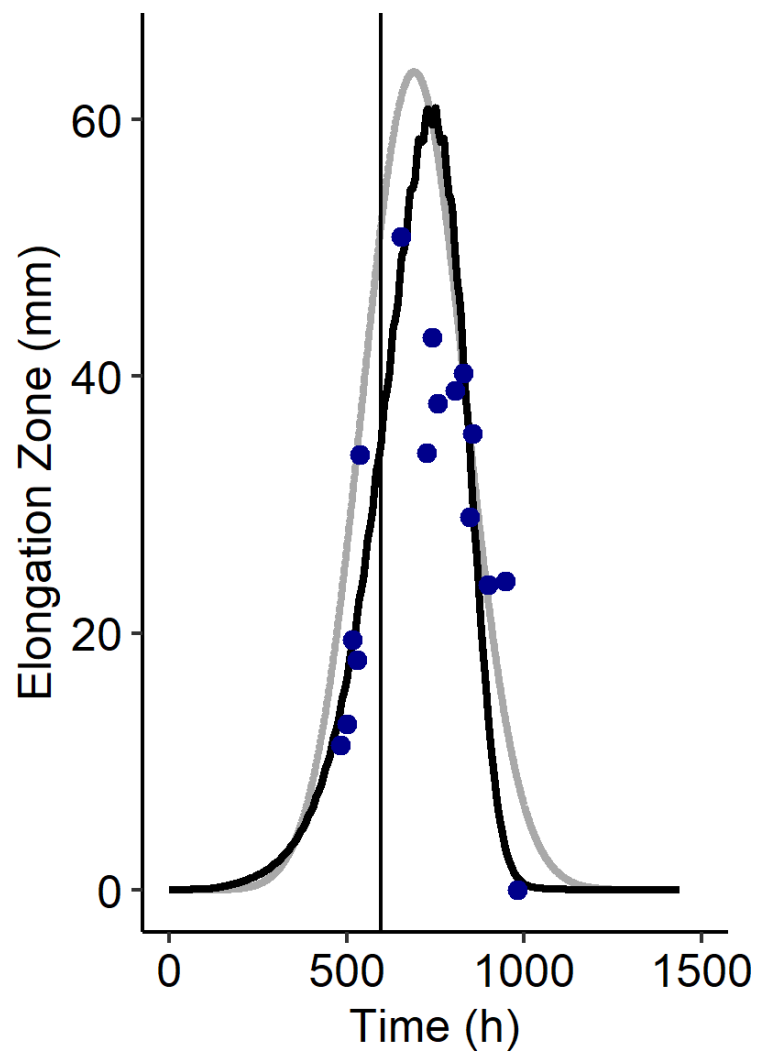
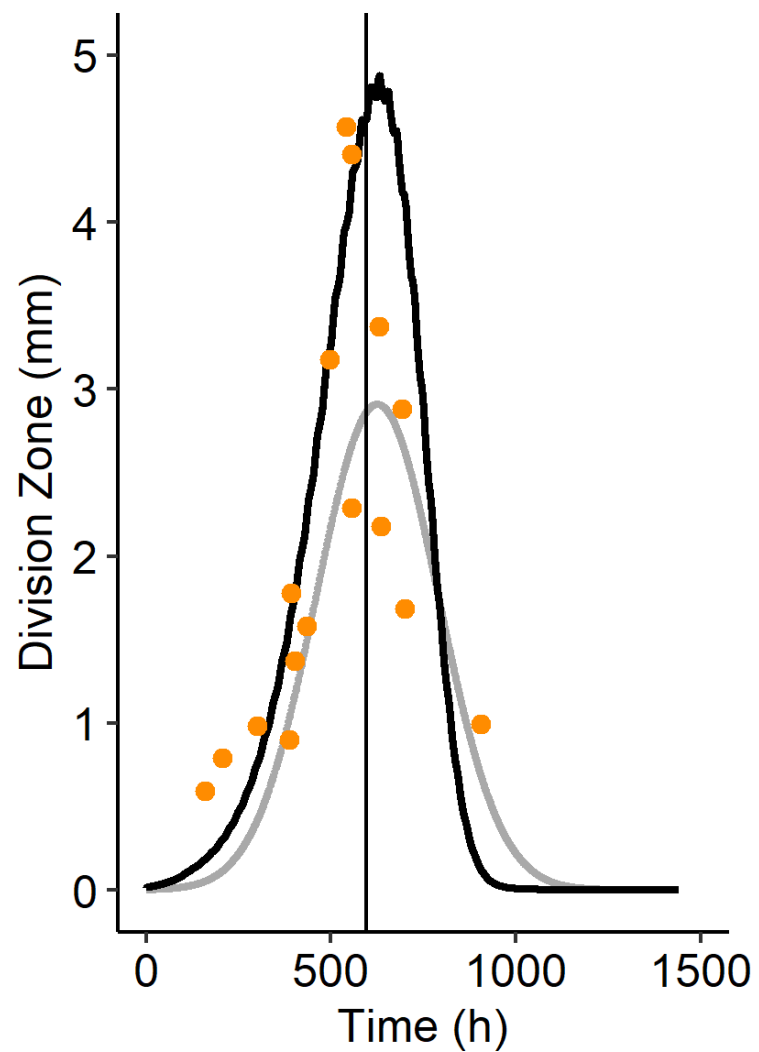
Hydraulics x Ontogeny



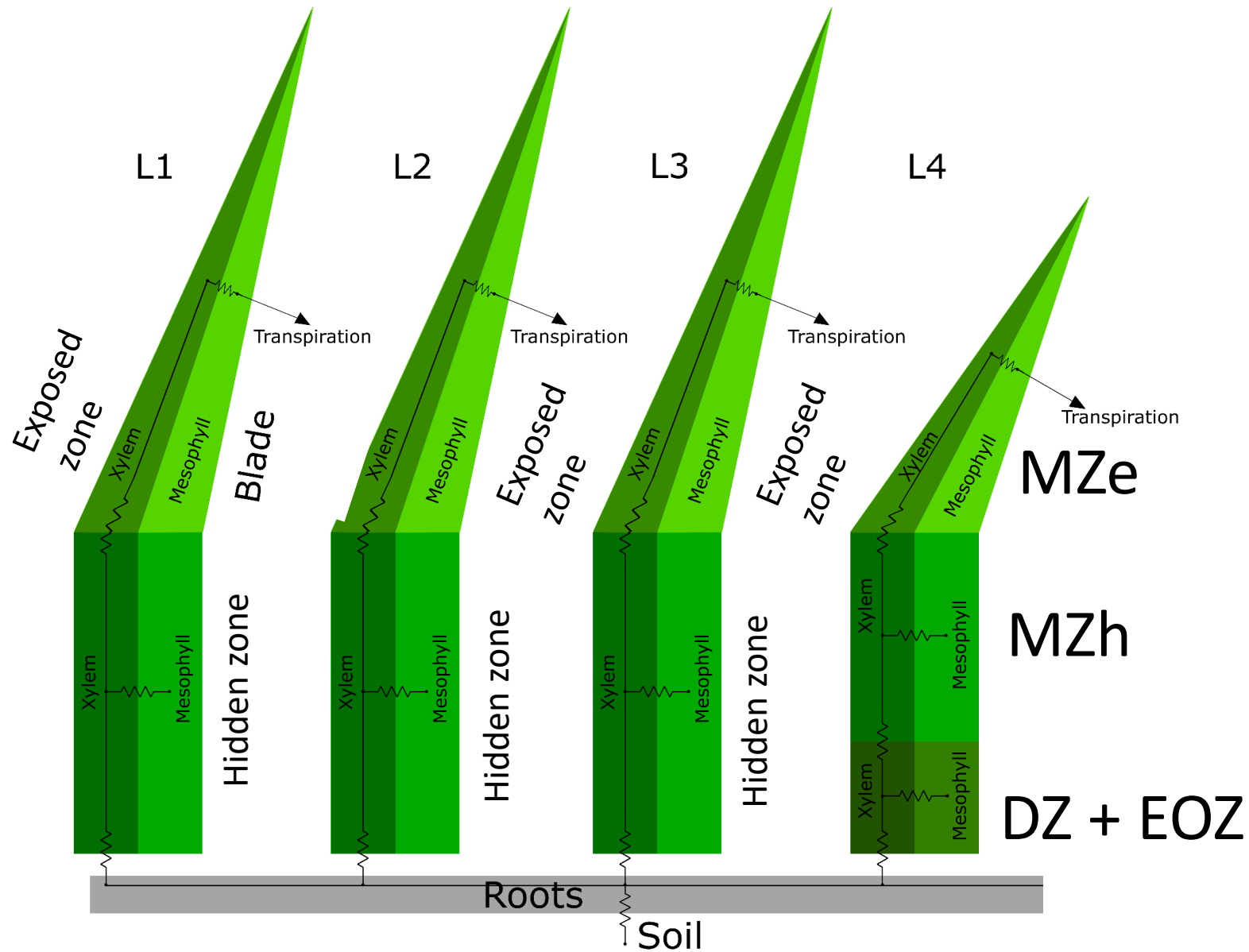
Growth

Model ontogenic “meta-mechanism”

- Cells can only divide X times ?
- Cells grow until maximum cell length?
- At leaf emergence production of proliferative cells gradually stops

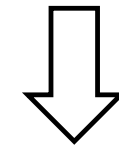


The hydraulic model: *Festuca arundinacea*



?

Hydraulics x Ontogeny



Growth

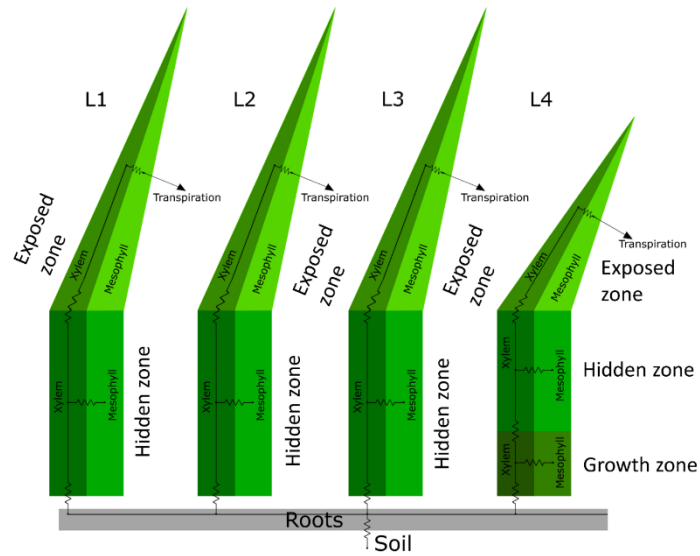
MZe
MZh
DZ + EOZ

My questions to you:

- Is turgor stable in growing cells?
- Is turgor still required for growth?

- Is there a “stem cell”-like line at the base of growing leaves
- Cells can only divide X times ?
- Cells grow until maximum cell length?
- Is leaf emergence the cue to stop cell proliferation

Thank you!



tom.deswaef@ilvo.vlaanderen.be

Tom De Swaef
Mathias Cougnon
Romain Barillot
Jean-Louis Durand

ILVO
Flanders research institute for
agriculture, fisheries and food

INRAE